

## LOW VOLTAGE DETECTOR WITH OUTPUT DELAY R3112xxx1A/C Series

### ■ OUTLINE

The R3112 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 system reset as an example.

Each of these ICs consists of a voltage reference unit, a comparator, resistor net for detector threshold setting, an output driver, a hysteresis circuit, and an output delay 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.

Two types of packages, SOT-23-5 and ultra small SC-82AB can be selected so that high density mounting on boards is possible.

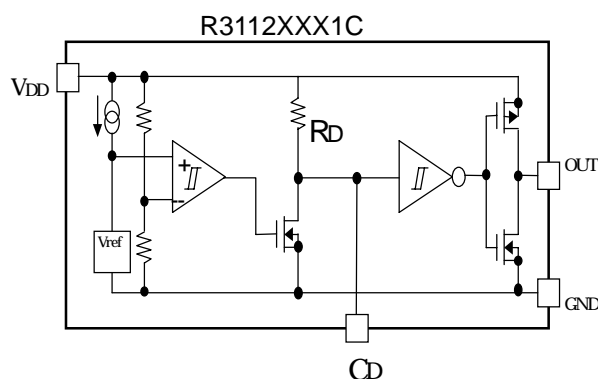
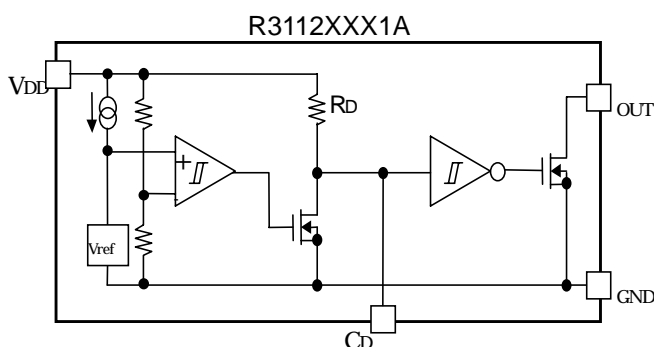
### ■ FEATURES

- Built-in Output Delay Circuit.....TYP. 100ms with an external capacitor: 0.022 $\mu$ F
- Ultra-low Supply Current.....TYP. 1.0 $\mu$ A (VDD=3.5V)
- Wide Range of Operating Voltage.....0.7~6.0V (T<sub>opt</sub>=25°C)
- Detector Threshold.....Stepwise setting with a step of 0.1V in the range of 0.9V to 5.0V is possible.
- High Accuracy Detector Threshold..... $\pm$ 2.0%
- Low Temperature-Drift Coefficient of Detector Threshold.....TYP.  $\pm$ 100ppm/°C
- Two Output Types.....Nch Open Drain and CMOS
- Two Types of Packages.....SOT-23-5 (Mini-mold), SC-82AB

### ■ APPLICATIONS

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

### ■ BLOCK DIAGRAMS



## ■ OPERATION

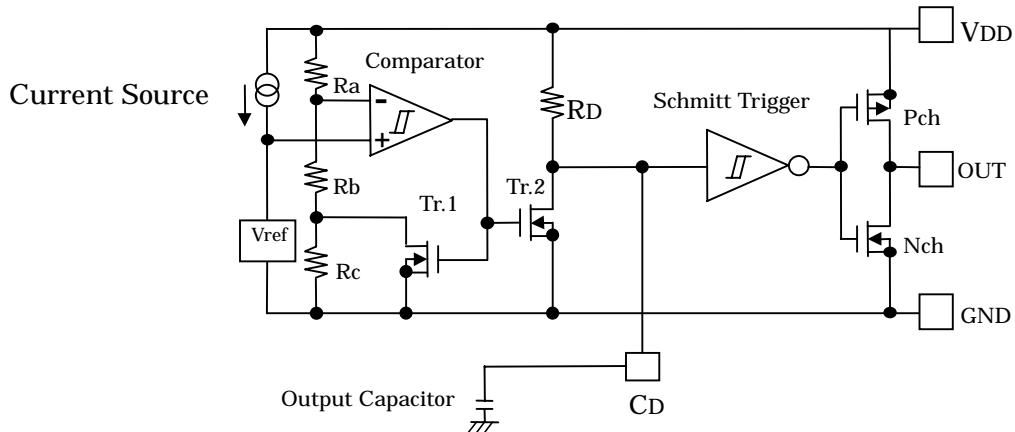


Fig. 1 Block Diagram with an external capacitor

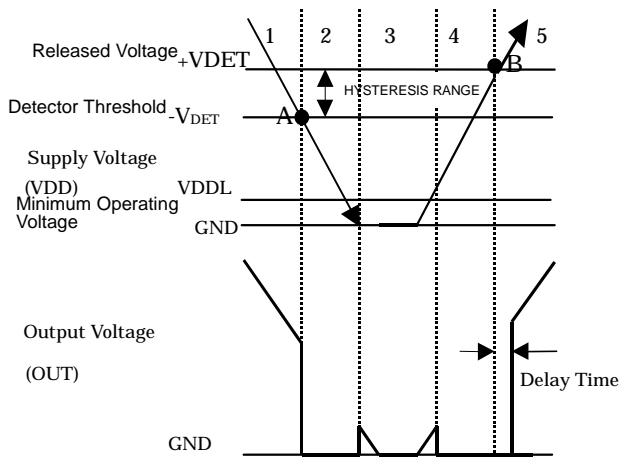


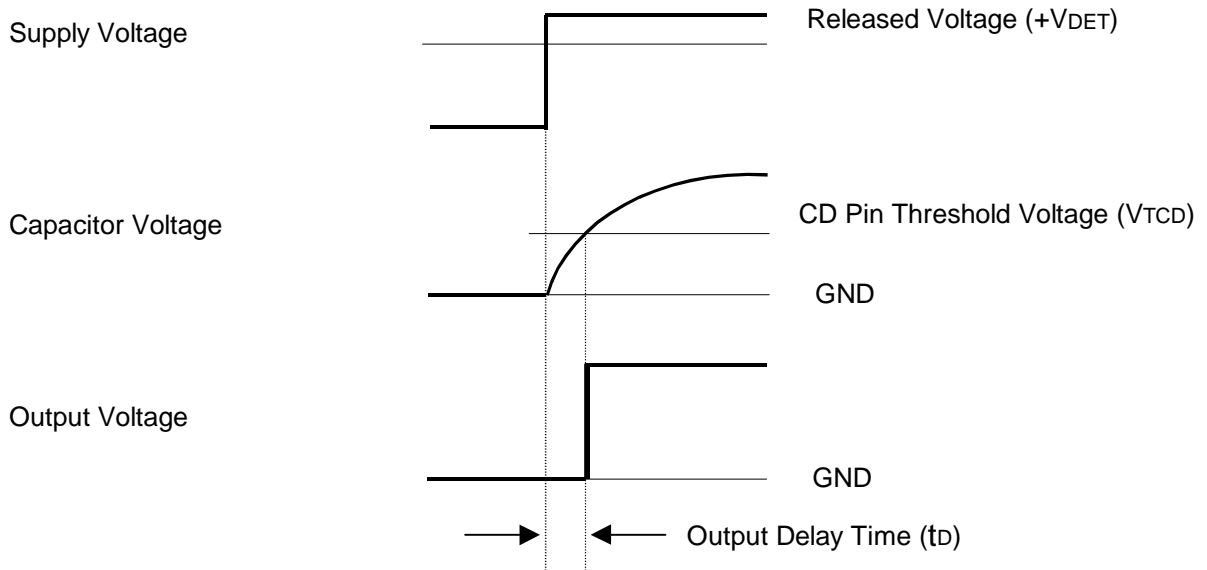
Fig. 2 Operation Diagram

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

$$\begin{aligned} \text{I} & \quad \frac{R_b + R_c}{R_a + R_b + R_c} \times V_{DD} \\ \text{II} & \quad \frac{R_b}{R_a + R_b} \times V_{DD} \end{aligned}$$

1. Output Voltage is equal to Supply Voltage. (As for Nch Open Drain Type, equal to pull-up voltage.)
  2. When the Supply Voltage is down to the detector threshold voltage level(Point A),  $V_{ref} \geq V_{DD} \times (R_b + R_c) / (R_a + R_b + R_c)$  is true, then output of the comparator is reversed from "L" to "H", therefore Output Voltage becomes GND level.
  3. When the Supply Voltage is lower than Minimum Operating Voltage, the operation of Output Transistor is indefinite. In the case of Nch Open Drain Type, Output Voltage is equal to pull-up Voltage.
  4. Output Voltage becomes GND level.
  5. When the Supply Voltage is higher than released voltage (Point B),  $V_{ref} \leq V_{DD} \times R_b / (R_a + R_b)$  is true, then Output of the comparator reaches the threshold level, and Output of Schmitt Trigger is reversed from "H" to "L", then Output Voltage is equal to Supply Voltage. (As for Nch Open Drain Type, equal to pull-up voltage.)
- \*) The difference between Released Voltage and Detector Threshold Voltage means Hysteresis Range Voltage.

● Operation of Output Delay



When the Supply Voltage which is higher than Released Voltage is forced to V<sub>DD</sub> pin, charge to an external capacitor starts, then capacitor voltage increases. Until the capacitor voltage reaches to CD Pin Threshold Voltage, Output Voltage maintains “L”. When the capacitor voltage becomes higher than CD pin threshold voltage, Output Voltage is reversed from “L” to “H”. Where, the time interval between the rising edge of Supply Voltage and Output Voltage Reverse point means Output Delay Time.

● Output Delay Time

Output Delay Time (t<sub>D</sub>) can be calculated with the next formula.

$$t_D = 0.69 \times R_D \times C_D (\text{s})$$

R<sub>D</sub> is internal resistor and set at 6.5MΩ(TYP.) typically. C<sub>D</sub>(F) describes the capacitance value of an external capacitor. Therefore,

$$t_D = 0.69 \times 6.5 \times 10^6 \times C_D (\text{s})$$

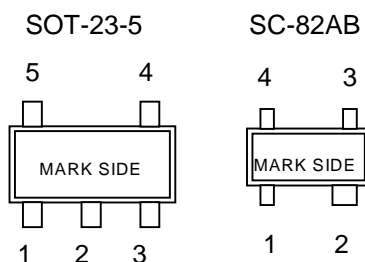
## SELECTION GUIDE

The package type, the detector threshold, the output type, and the taping type of R3112 Series can be designated at the users' request by specifying the part number as follows;

R3112XXX1X-XX ← Part Number  
 ↑↑ ↑↑  
 a b c d

| Code | Contents   |
|------|--|
| a    | Designation of Package Type;<br>Q:SC-82AB                      N:SOT-23-5  |
| b    | Setting Detector Threshold (-VDET);<br>Stepwise setting with a step of 0.1V in the range of 0.9V to 5.0V is possible.                          |
| c    | Designation of Output Type;<br>A: Nch Open Drain<br>C: CMOS  |
| d    | Designation of Packing or Taping Type ;<br>Ex. SOT-23-5, SC-82AB: TR is prescribed as standard directions.<br>(Refer to Taping Specifications) |

## PIN CONFIGURATION



## PIN DESCRIPTION

| SOT-23-5 |        |  |
|----------|--------|--|
| Pin No.  | Symbol | Description  |
| 1        | OUT    | Output Pin(Output "L" at detector threshold, Output "H" at released voltage) |
| 2        | VDD    | Voltage Supply Pin   |
| 3        | GND    | Ground Pin   |
| 4        | NC     | No Connection  |
| 5        | CD     | Pin for External Capacitor (for setting output delay)                        |

| SC-82AB |        |  |
|---------|--------|--|
| Pin No. | Symbol | Description  |
| 1       | VDD    | Voltage Supply Pin   |
| 2       | GND    | Ground Pin   |
| 3       | CD     | Pin for External Capacitor (for setting output delay)                        |
| 4       | OUT    | Output Pin(Output "L" at detector threshold, Output "H" at released voltage) |

## ■ABSOLUTE MAXIMUM RATINGS

| Symbol  | Item                         | Rating          | Unit |
|---------|------------------------------|-----------------|------|
| VDD     | Supply Voltage               | 6.5             | V    |
| VOUT1   | Output Voltage(CMOS)         | VSS-0.3~VDD+0.3 | V    |
| VOUT2   | Output Voltage(Nch)          | VSS-0.3~6.5     | V    |
| IOUT    | Output Current               | 20              | mA   |
| Pd      | Power Dissipation(SOT23-5)   | 250             | mW   |
|         | Power Dissipation(SC82-AB)   | 150             |      |
| Topt    | Operating Temperature Range  | -40~85          | °C   |
| Tstg    | Storage Temperature Range    | -55~125         | °C   |
| Tsolder | Lead temperature (Soldering) | 260°C, 10s      |      |

### ABSOLUTE MAXIMUM RATINGS

Absolute Maximum ratings are threshold limit values that must not be exceeded ever 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.

### ●R3112x091A/C

Topt=25°C

| Symbol    | Item                                       | Conditions                  | MIN.  | TYP.  | MAX.  | Unit   |
|-----------|--|-----------------------------|-------|-------|-------|--------|
| -VDET     | Detector Threshold                         |                             | 0.882 | 0.900 | 0.918 | V      |
| VHYS      | Detector Threshold Hysteresis              |                             | 0.027 | 0.045 | 0.063 | V      |
| ISS       | Supply Current                             | VDD=0.80V                   |       | 0.6   | 2.0   | μA     |
|           |  | 1.90V                       |       | 0.5   | 2.0   |        |
| VDDH      | Maximum Operating Voltage                  |                             |       |       | 6.0   | V      |
| VDDL      | Minimum Operating Voltage*Note1            | Topt=25°C                   |       |       | 0.70  | V      |
|           |  | -40°C ≤ Topt ≤ 85°C         |       |       | 0.80  |        |
| IOUT      | Output Current (Driver Output Pin)         | Nch<br>VDS=0.05V, VDD=0.70V | 10    | 120   |       | μA     |
|           |  | VDS=0.50V, VDD=0.85V        | 0.05  | 0.9   |       | mA     |
|           |  | Pch<br>VDS=-2.1V, VDD=4.5V  | 1.0   | 3.5   |       | mA     |
| VTCD      | CD pin Threshold Voltage                   | VDD=0.99V                   | 0.297 | 0.495 | 0.693 | V      |
| ICD       | CD pin Output Current                      | VDS=0.10V, VDD=0.70V        | 2     | 70    |       | μA     |
|           |  | VDS=0.50V, VDD=0.85V        | 10    | 400   |       |        |
| RD        | Output Delay Resistance                    |                             | 3.25  | 6.50  | 13.00 | MΩ     |
| Δ-VDET/ΔT | Detector Threshold Temperature Coefficient | -40°C ≤ Topt ≤ 85°C         |       | ±100  |       | ppm/°C |

●R3112x271A/C

T<sub>opt</sub>=25°C

| Symbol    | Item  | Conditions                      | MIN.  | TYP.  | MAX.  | Unit   |
|-----------|---|---------------------------------|-------|-------|-------|--------|
| -VDET     | Detector Threshold                          |                                 | 2.646 | 2.700 | 2.754 | V      |
| VHYS      | Detector Threshold Hysteresis               |                                 | 0.081 |       | 0.189 | V      |
| ISS       | Supply Current                              | VDD=2.60V                       |       | 1.0   | 2.5   | μA     |
|           |   | 3.70V                           |       | 0.5   | 3.0   |        |
| VDDH      | Maximum Operating Voltage                   |                                 |       |       | 6.0   | V      |
| VDDL      | Minimum Operating Voltage* <sup>Note1</sup> | T <sub>opt</sub> =25°C          |       |       | 0.7   | V      |
|           |   | -40°C ≤ T <sub>opt</sub> ≤ 85°C |       |       | 0.8   |        |
| IOUT      | Output Current<br>(Driver Output Pin)       | Nch<br>VDS=0.05V, VDD=0.70V     | 10    | 120   |       | μA     |
|           |   | VDS=0.50V, VDD=1.50V            | 1.0   | 3.0   |       | mA     |
|           |   | Pch<br>VDS=-2.1V, VDD=4.5V      | 1.0   | 3.5   |       | mA     |
| VTCD      | CD pin Threshold Voltage                    | VDD=2.97V                       | 0.891 | 1.485 | 2.079 | V      |
| ICD       | CD pin Output Current                       | VDS=0.1V, VDD=0.7V              | 2.0   | 70    |       | μA     |
|           |   | VDS=0.5V, VDD=1.5V              | 200   | 500   |       |        |
| RD        | Output Delay Resistance                     |                                 | 3.25  | 6.50  | 13.00 | MΩ     |
| Δ-VDET/ΔT | Detector Threshold Temperature Coefficient  | -40°C ≤ T <sub>opt</sub> ≤ 85°C |       | ±100  |       | ppm/°C |

●R3112x501A/C

T<sub>opt</sub>=25°C

| Symbol    | Item  | Conditions                      | MIN.  | TYP.  | MAX.  | Unit   |
|-----------|---|---------------------------------|-------|-------|-------|--------|
| -VDET     | Detector Threshold                          |                                 | 4.900 | 5.000 | 5.100 | V      |
| VHYS      | Detector Threshold Hysteresis               |                                 | 0.150 | 0.250 | 0.350 | V      |
| ISS       | Supply Current                              | VDD=4.9V                        |       | 1.5   | 2.5   | μA     |
|           |   | 6.0V                            |       | 0.6   | 3.0   |        |
| VDDH      | Maximum Operating Voltage                   |                                 |       |       | 6.0   | V      |
| VDDL      | Minimum Operating Voltage* <sup>Note1</sup> | T <sub>opt</sub> =25°C          |       |       | 0.7   | V      |
|           |   | -40°C ≤ T <sub>opt</sub> ≤ 85°C |       |       | 0.8   |        |
| IOUT      | Output Current<br>(Driver Output Pin)       | Nch<br>VDS=0.05V, VDD=0.70V     | 10    | 120   |       | μA     |
|           |   | VDS=0.50V, VDD=1.50V            | 1.0   | 3.0   |       | mA     |
|           |   | Pch<br>VDS=-2.1V, VDD=6.0V      | 1.5   | 4.5   |       | mA     |
| VTCD      | CD pin Threshold Voltage                    | VDD=2.97V                       | 1.650 | 2.750 | 3.850 | V      |
| ICD       | CD pin Output Current                       | VDS=0.1V, VDD=0.7V              | 2.0   | 70    |       | μA     |
|           |   | VDS=0.5V, VDD=1.5V              | 200   | 500   |       |        |
| RD        | Output Delay Resistance                     |                                 | 3.25  | 6.50  | 13.00 | MΩ     |
| Δ-VDET/ΔT | Detector Threshold Temperature Coefficient  | -40°C ≤ T <sub>opt</sub> ≤ 85°C |       | ±100  |       | ppm/°C |

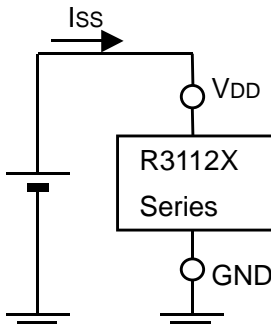
\*Note1: Minimum Operating Voltage means the value of input voltage when output voltage maintains 0.1V or less.

(In the case of Nch Open Drain Type, Output pin is pulled up with a resistance of 470kΩ to 5.0V.)

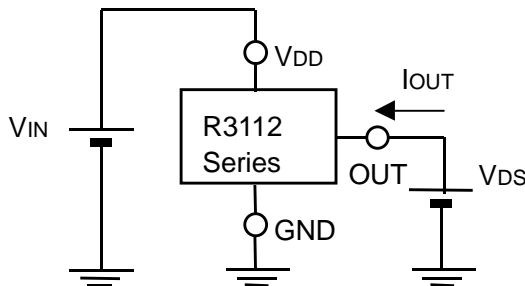
## TEST CIRCUITS

\*Pull-up circuit is not necessary for CMOS Output type, or R3112XXXXC.

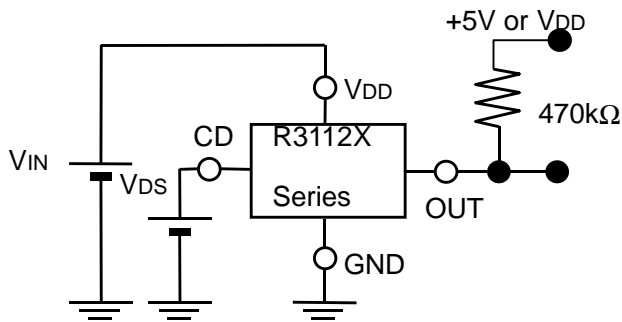
Supply Current Test Circuit



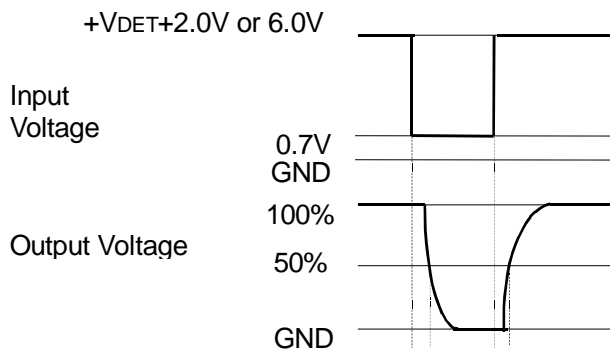
Nch Driver Output Current Test Circuit



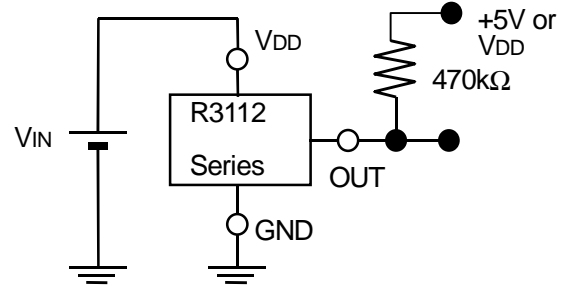
CD Pin Threshold Test Circuit



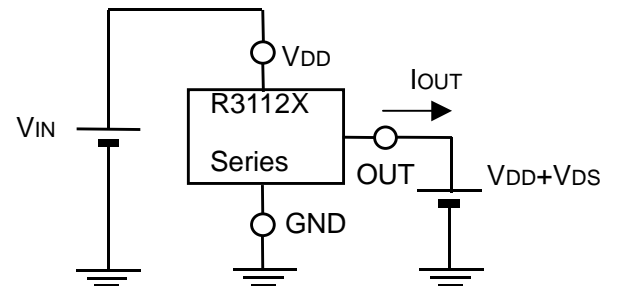
Output Delay Time Test Circuit



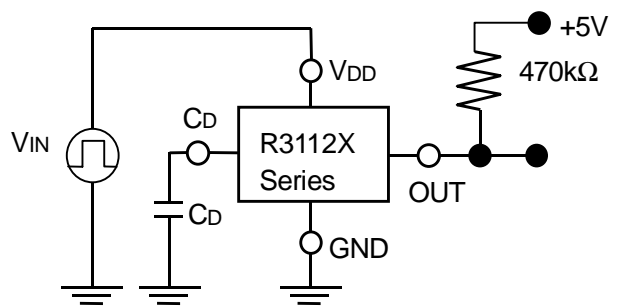
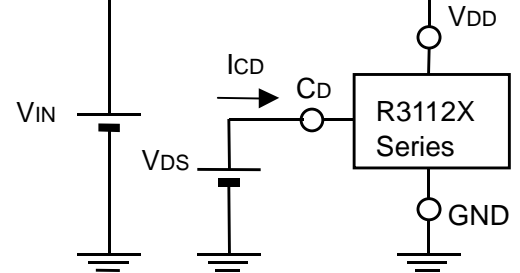
Detector Threshold Test Circuit



Pch Driver Output Current Test Circuit \*Apply only to CMOS



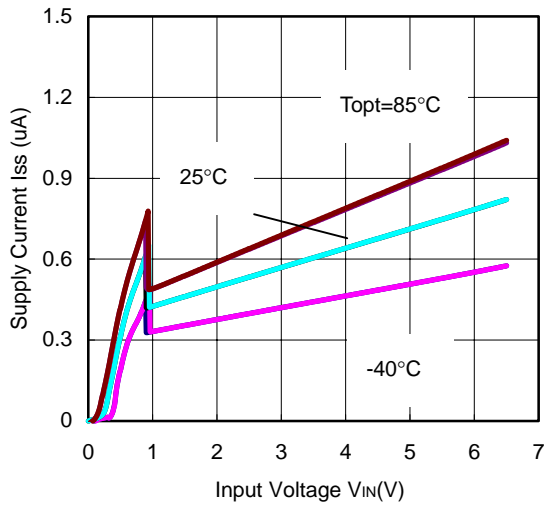
CD Pin Output Current Test Circuit



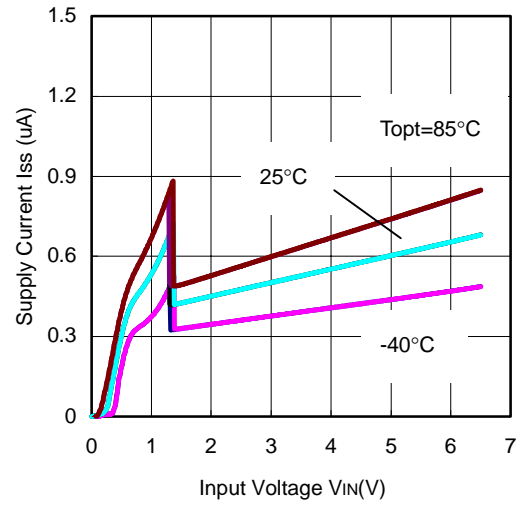
## TYPICAL CHARACTERISTICS

### 1) Supply Current vs. Input Voltage

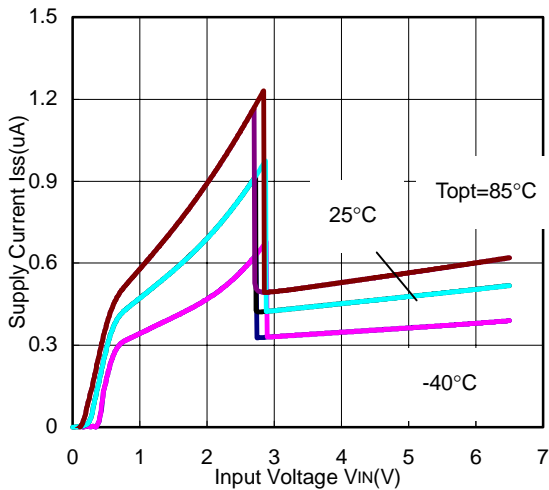
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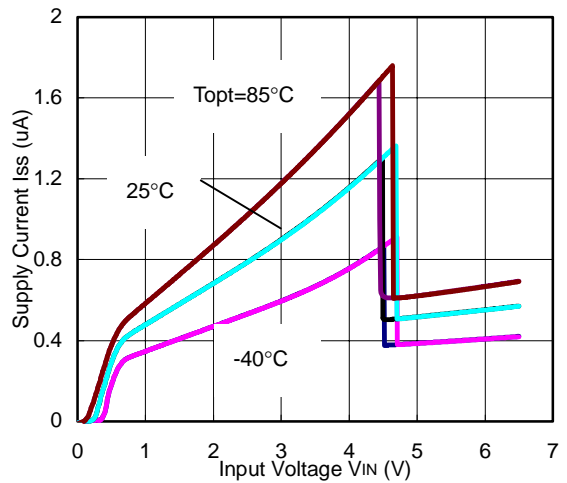
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R3112X271X

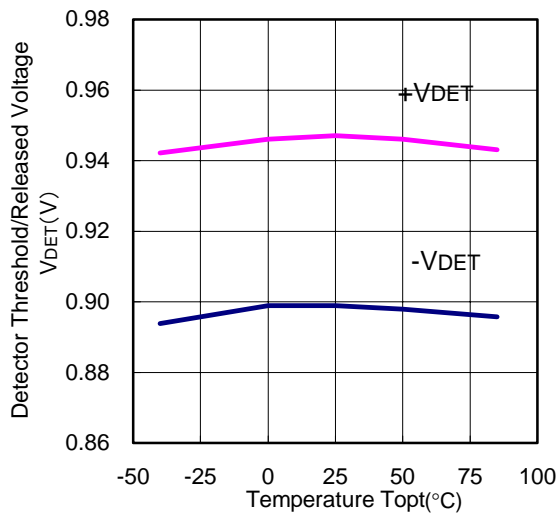


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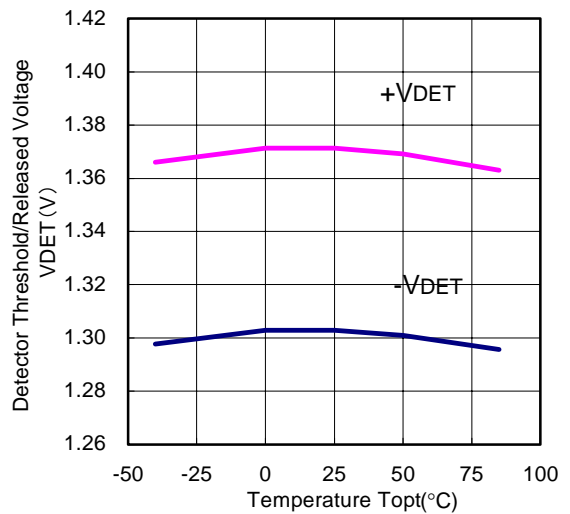


### 2) Detector Threshold vs. Temperature

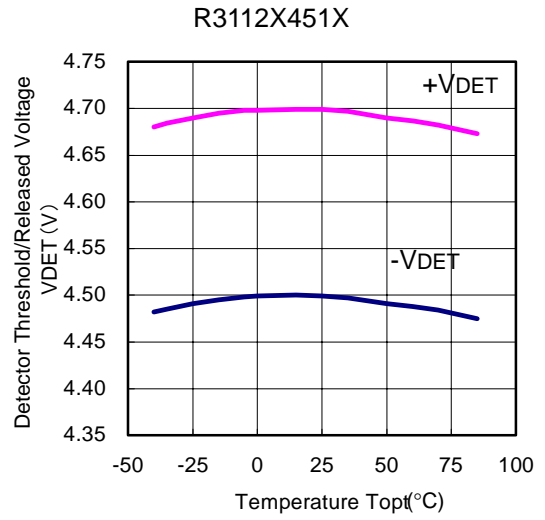
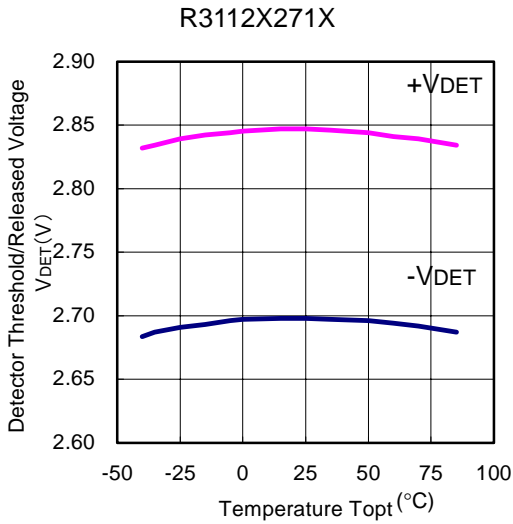
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R3112X131X



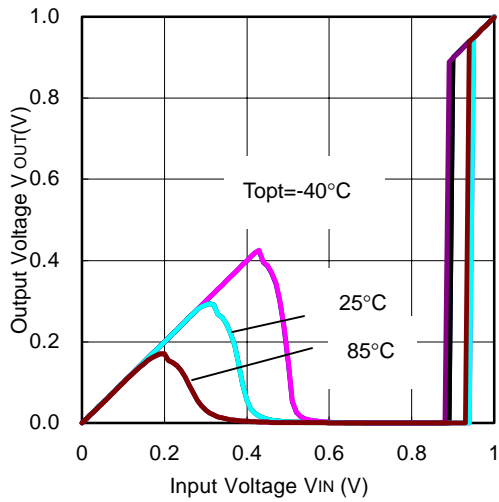




3) Output Voltage vs. Input Voltage

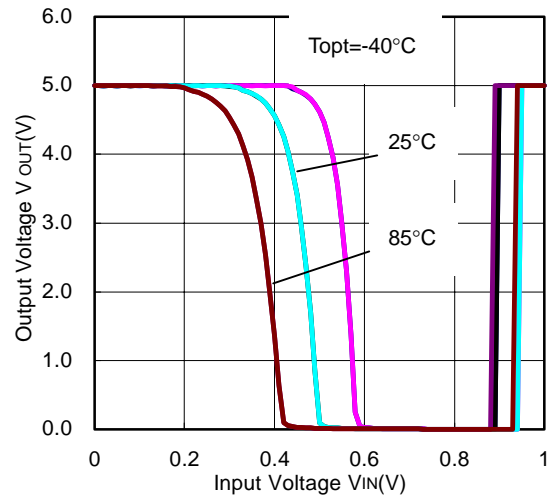
**R3112X091X**

Nch Output Type: VDD pull up



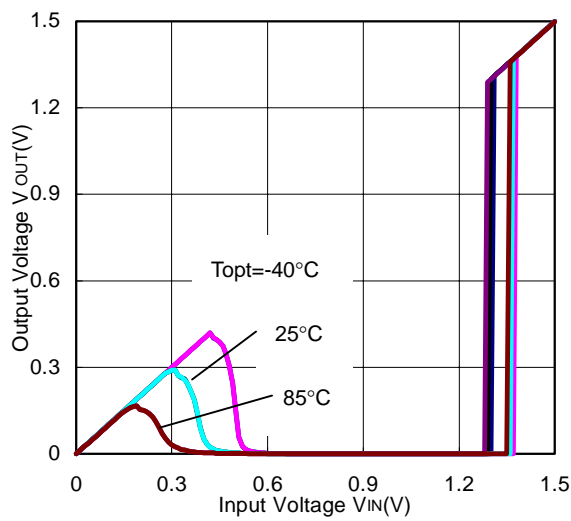
**R3112X091A**

5V pull up via 470kΩ



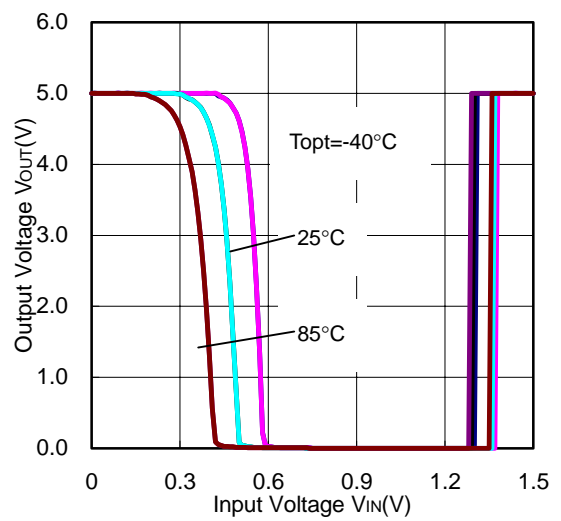
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Nch Output Type: VDD pull up

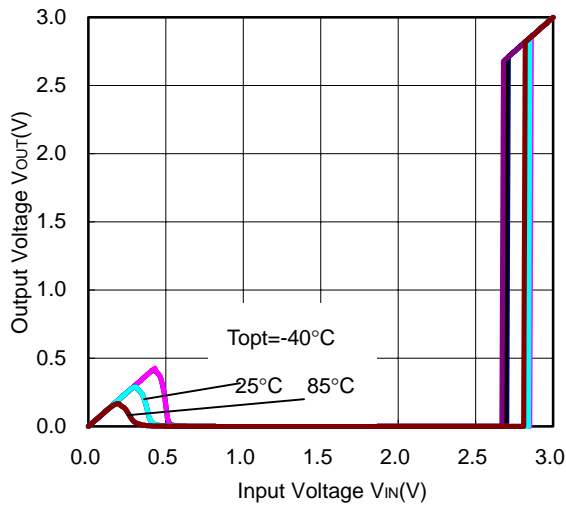


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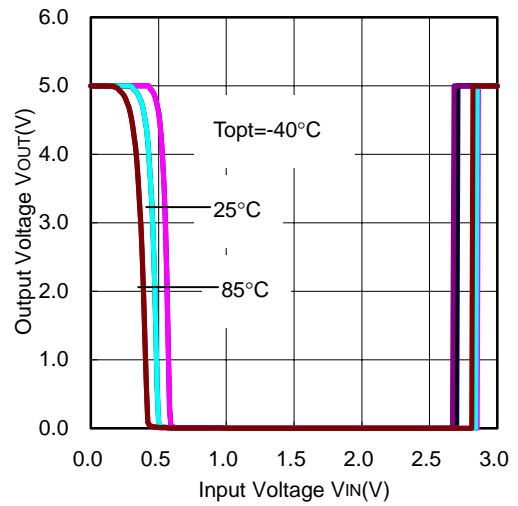
5V pull up via 470kΩ



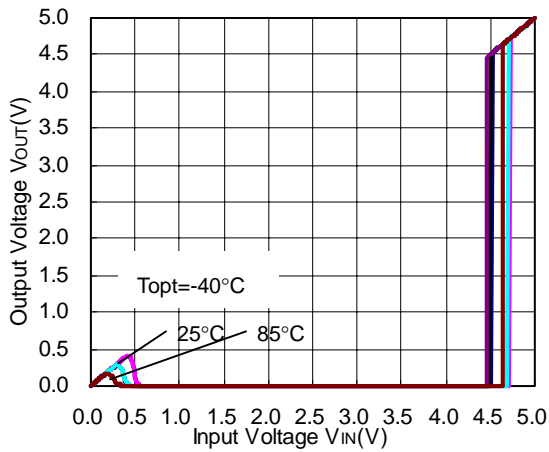
R3112X271X  
Nch Output Type: VDD pull up



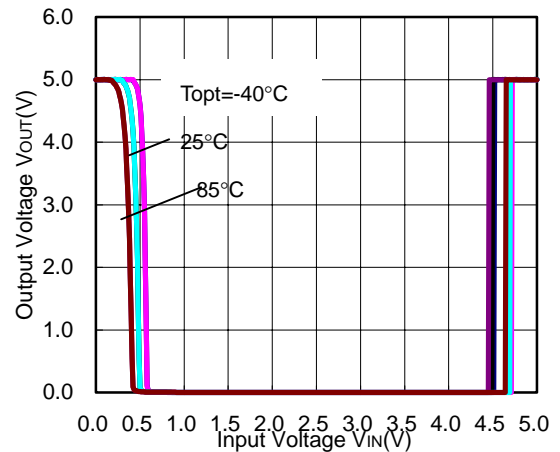
R3112X271A  
5V pull up via 470kΩ



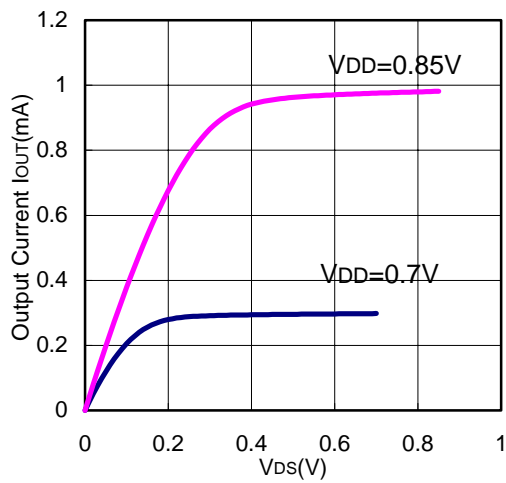
R3112X451X  
Nch Output Type: VDD pull up



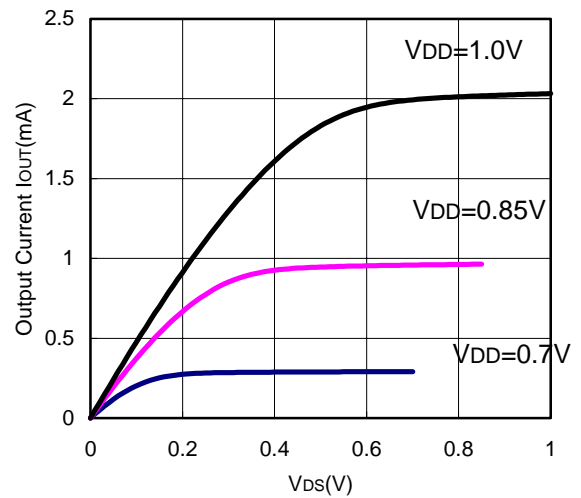
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5V pull up via 470kΩ

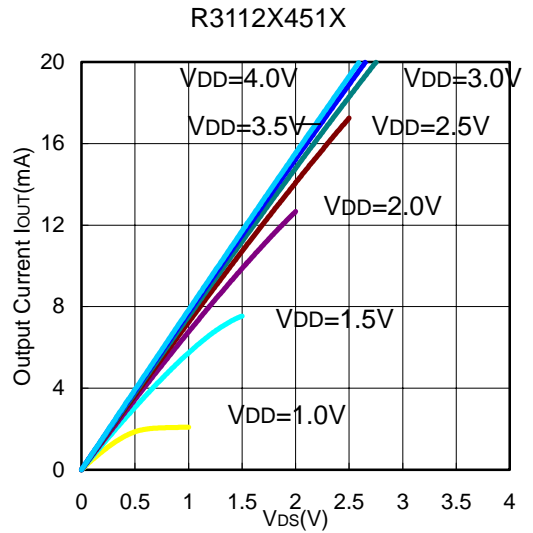
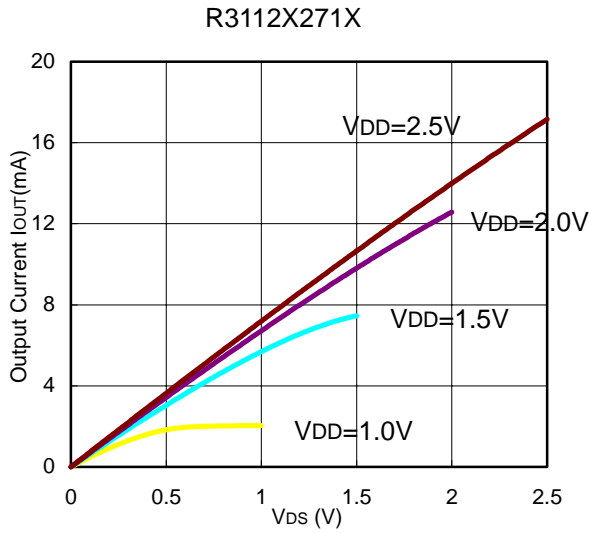


4) Nch Driver Output Current vs. Vds  
R3112X091X

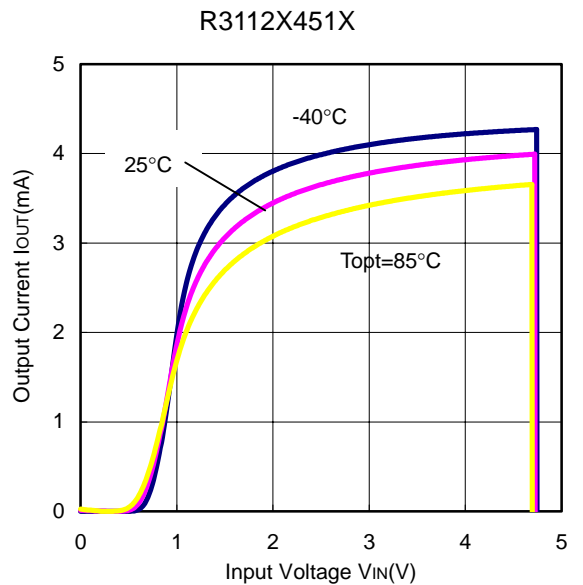
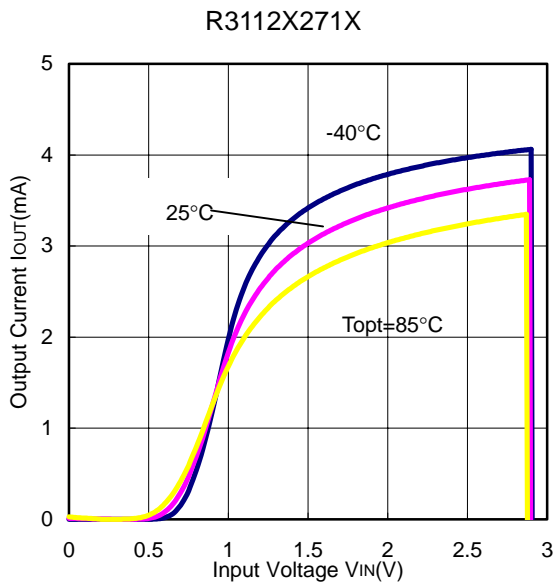
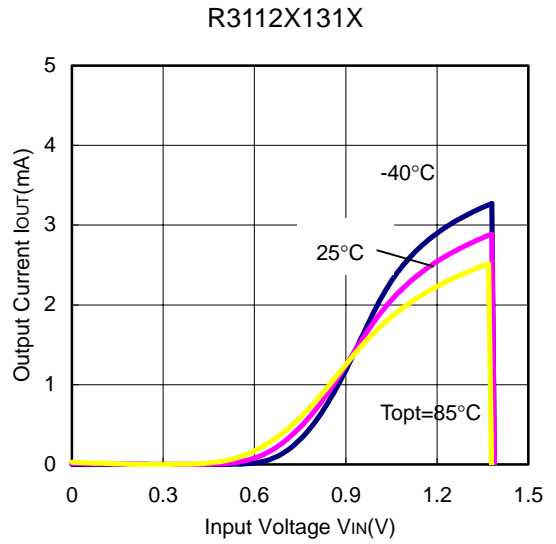
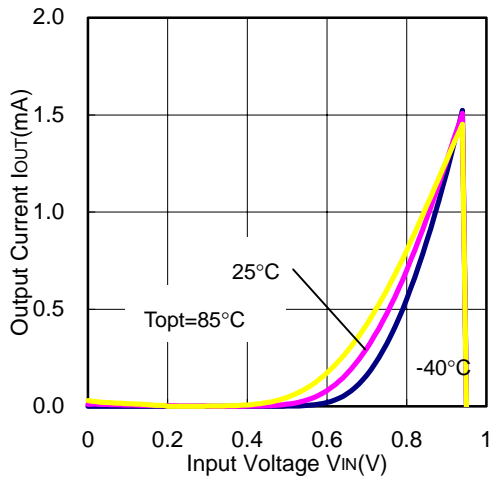


R3112X131X

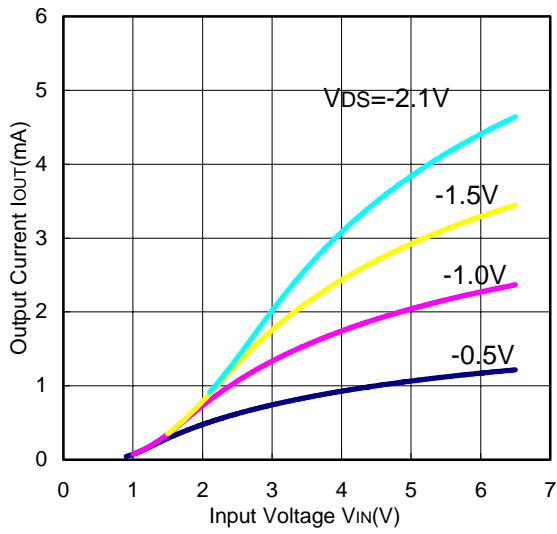




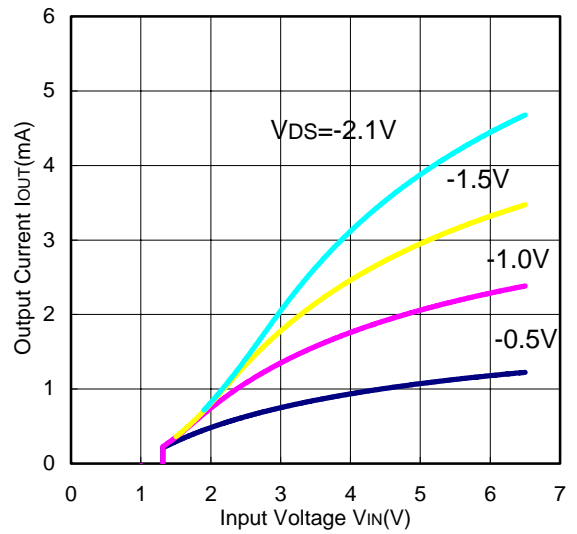
5) Nch Driver Output Current vs. Input Voltage  
**R3112X091X**



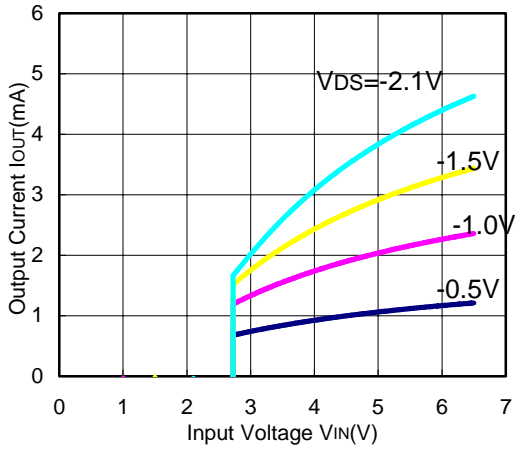
6) Pch Driver Output Current vs. Input Voltage  
R3112X091C



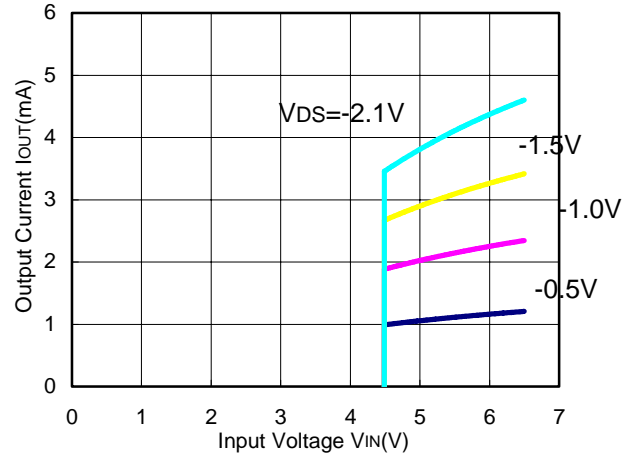
R3112X131C



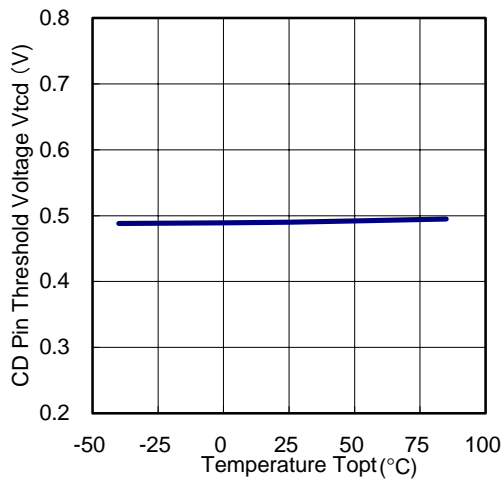
R3112X271C



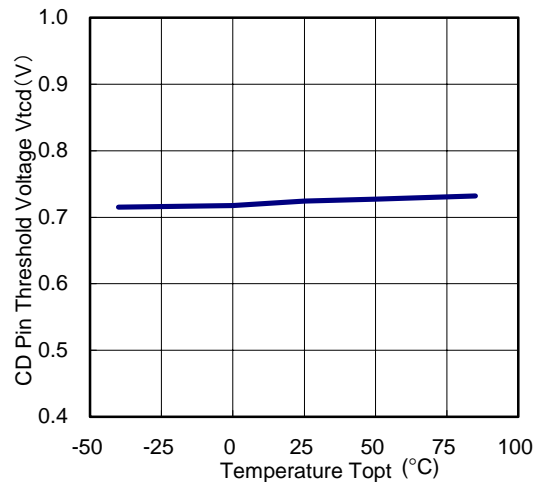
R3112X451C

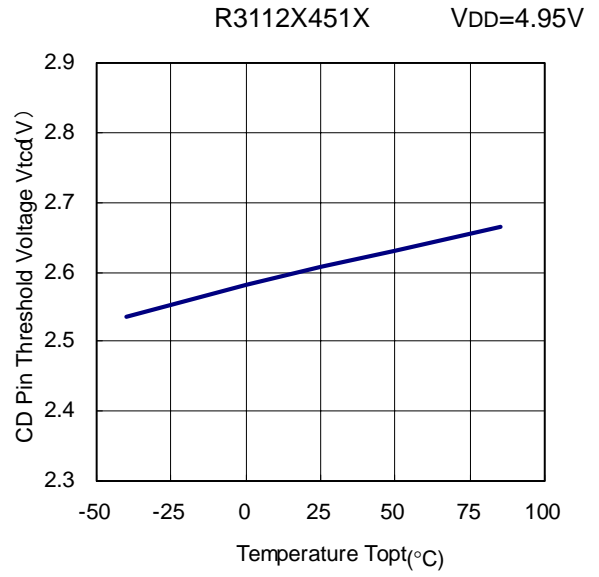
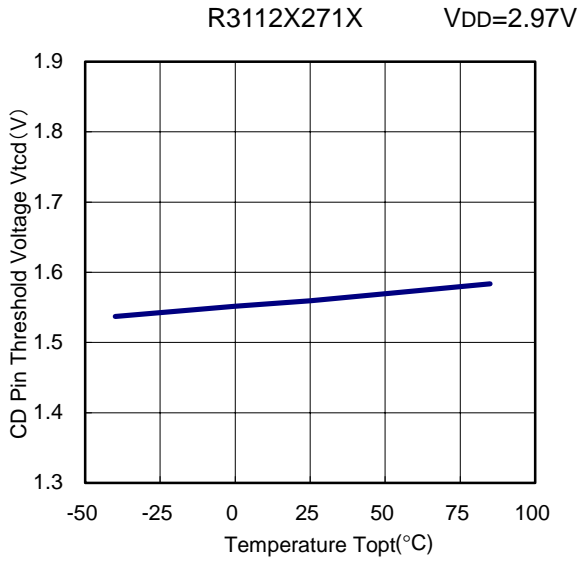


7) CD Pin Threshold Voltage vs. Temperature  
R3112X091X VDD=0.99V

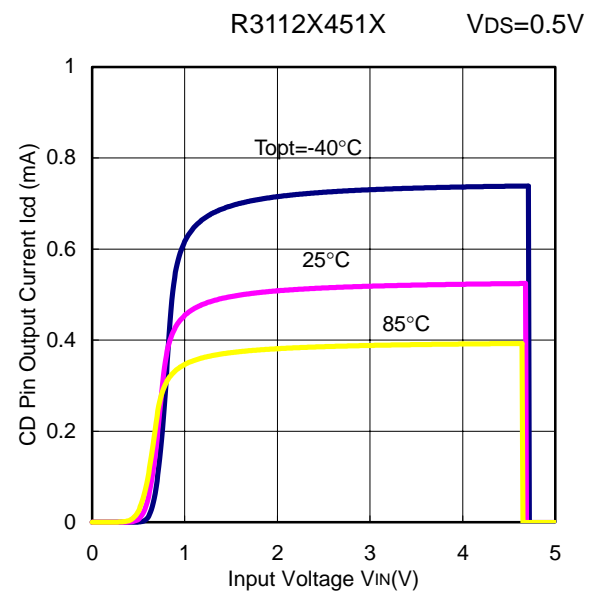
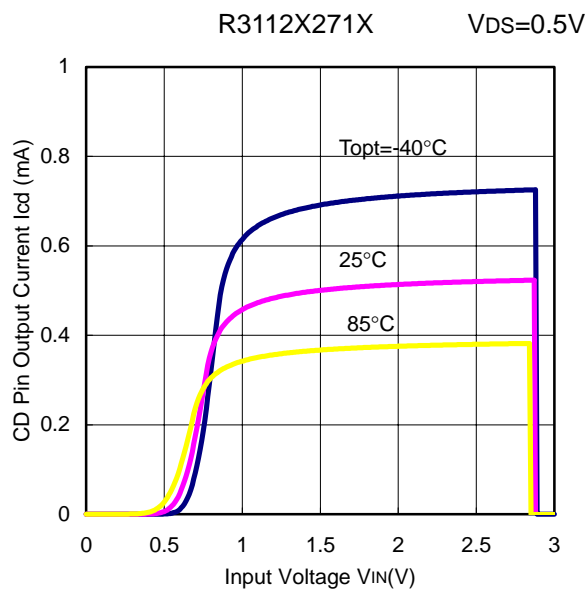
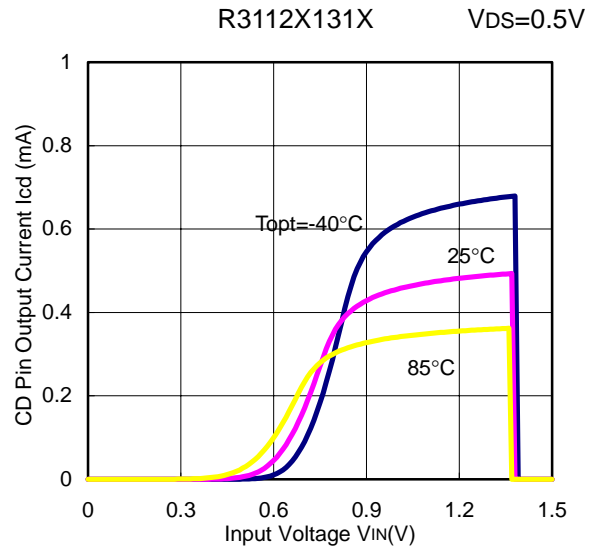
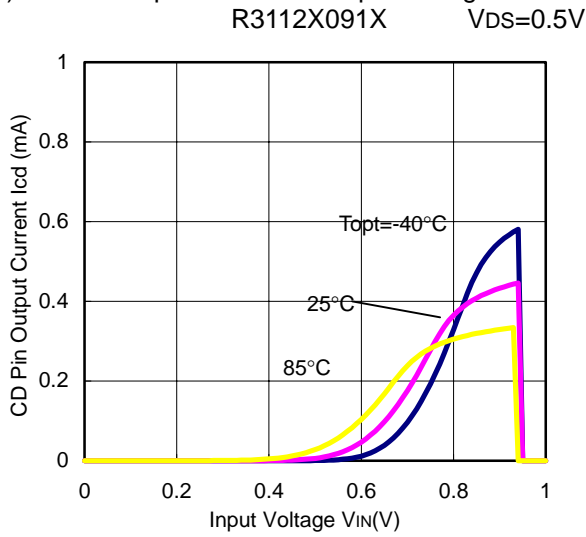


R3112X131X VDD=1.43V

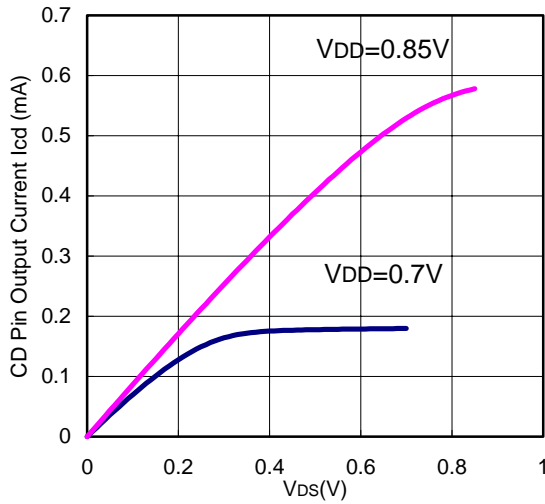




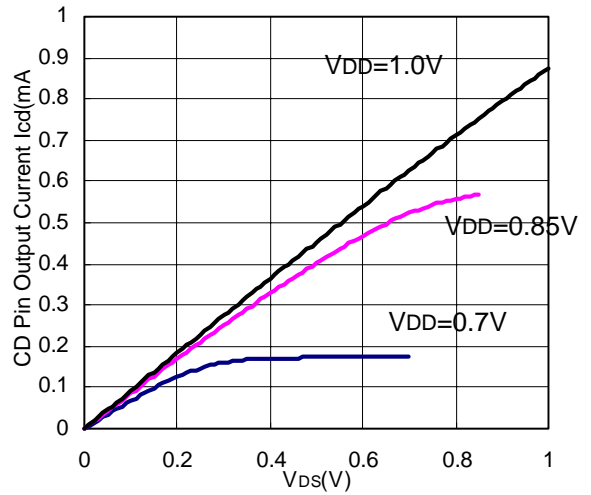
8) CD Pin Output Current vs. Input Voltage



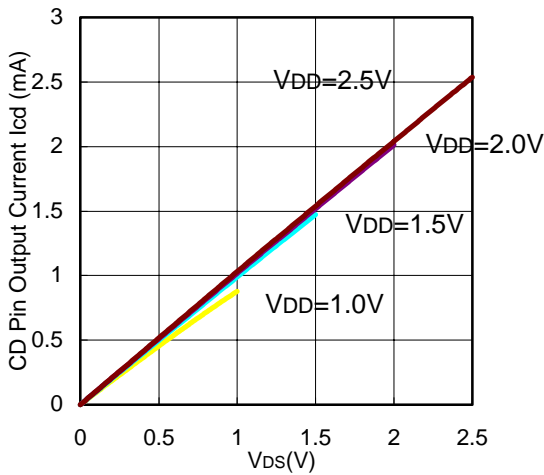
9) CD Pin Output Current vs. VDS (T<sub>opt</sub>=25°C)  
R3112X091X



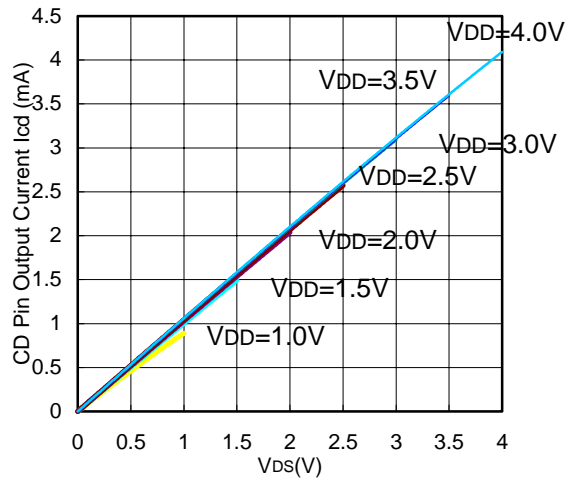
R3112X131X



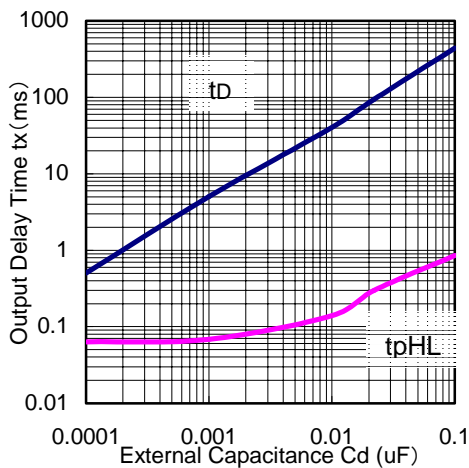
R3112X271X



R3112X451X

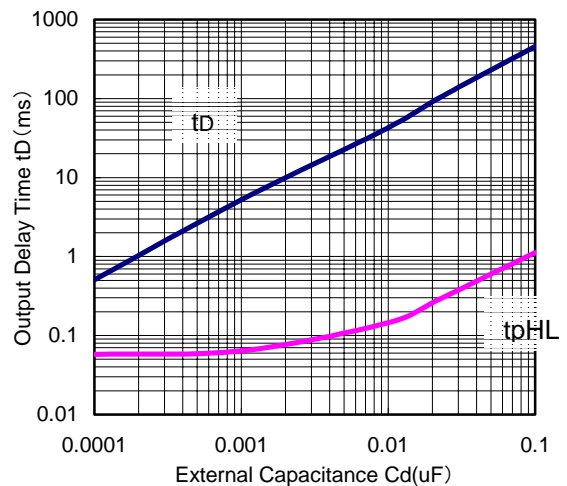


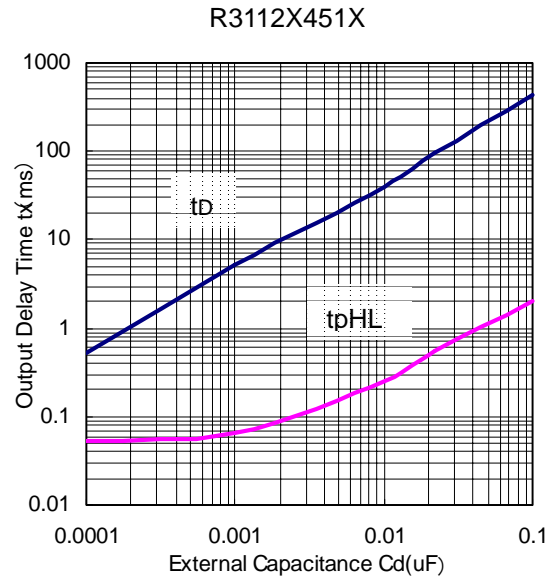
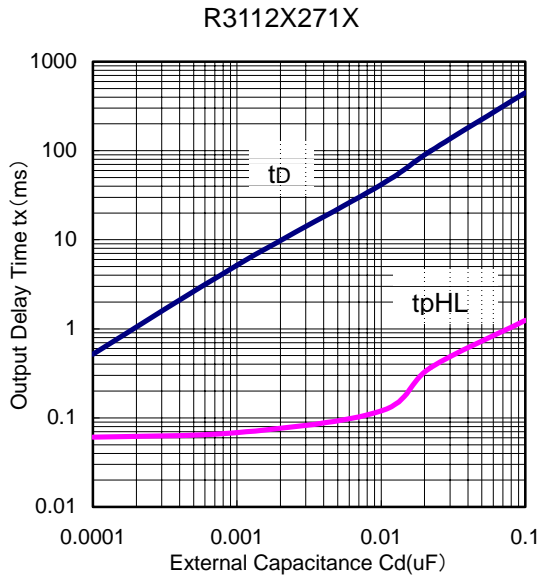
10) Output Delay Time vs. External Capacitance  
R3112X091X



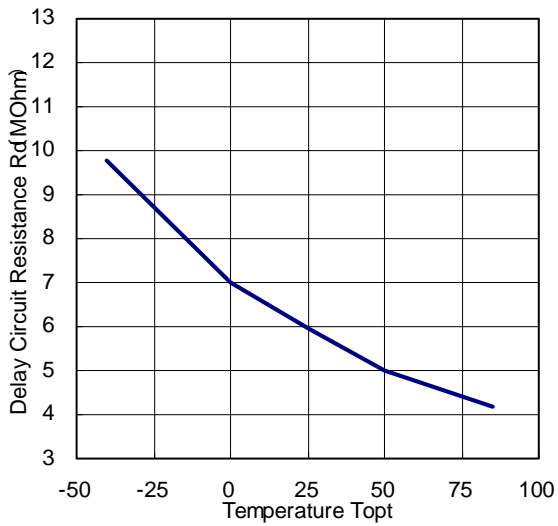
(T<sub>opt</sub>=25°C)

R3112X131X



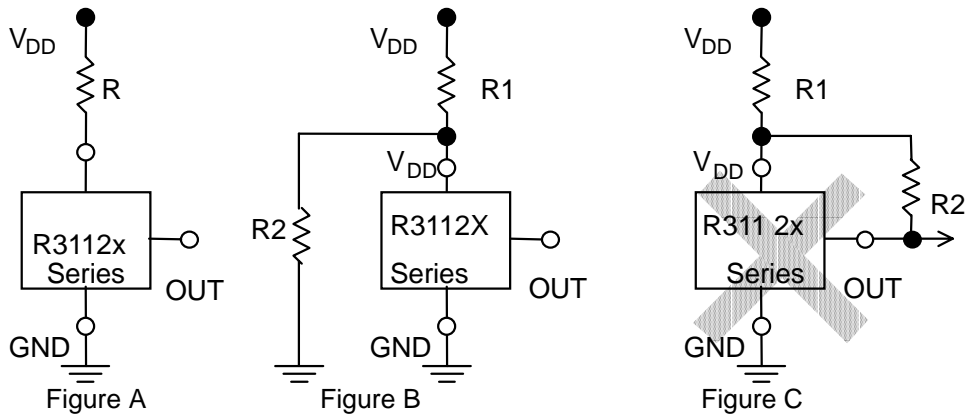


11) Delay Circuit Resistance vs. Temperature  
R3112XXX1X



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## ■ TECHNICAL NOTES



When R3112XXX1A (Nch Open Drain Output Type) is used in Figure A or Figure B, if Impedance of Voltage Supply pin, V<sub>DD</sub> and V<sub>DD</sub> of this IC is large, detector threshold level would shift by voltage dropdown caused by the consumption current of the IC itself. Released voltage may also shift and delay time for start-up might be generated by this usage.

When R3112XXX1C (CMOS Output Type) is used in Figure A or Figure B, Output level could be unstable by throughout current which is generated at detector threshold level or at released voltage level, therefore, do not use R3112XXX1C with the connection in Figure A or Figure B.

The connection in Figure C may cause the oscillation in both R3112XXX1C (CMOS Output) and R3112XXX1A (Nch Open Drain Output), therefore do not use R3112XXX1X Series with the connection in Figure C.



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