

Voltage Detector with Separated Sense Pin & Delay Capacitor Pin

■ GENERAL DESCRIPTION

The XC6108 series is highly precise, low power consumption voltage detector, manufactured using CMOS and laser trimming technologies.

Since the sense pin is separated from power supply, it allows the IC to monitor added power supply.

Using the IC with the sense pin separated from power supply enables output to maintain the state of detection even when voltage of the monitored power supply drops to 0V.

Moreover, with the built-in delay circuit, connecting the delay capacitance pin to the capacitor enables the IC to provide an arbitrary release delay time.

Both CMOS and N-channel open drain output configurations are available.

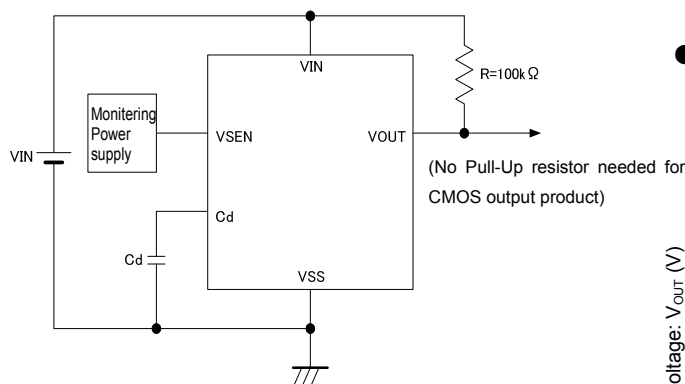
■ APPLICATIONS

- Microprocessor reset circuitry
- Charge voltage monitors
- Memory battery back-up switch circuits
- Power failure detection circuits

■ FEATURES

- Highly Accurate** : $\pm 2\%$ (Detect Voltage $\geq 1.5V$)
 $\pm 30mV$ (Detect Voltage $< 1.5V$)
- Low Power Consumption** : $0.6 \mu A$ TYP. (detect, $V_{IN} = 1.0V$)
 $0.8 \mu A$ TYP. (release, $V_{IN} = 1.0V$)
- Detect Voltage Range** : $0.8V \sim 5.0V$ in $0.1V$ increments
- Operating Voltage Range** : $1.0V \sim 6.0V$
- Temperature Stability** : $\pm 100ppm/^\circ C$ TYP.
- Output Configuration** : CMOS or N-channel open drain
- Operating Temperature** : $-40^\circ C \sim +85^\circ C$
- Separated Sense Pin** : V_{SEN} Pin Available
- Built-In Delay Circuit** : Delay Time Adjustable
- Packages** : USP-4, SOT-25
- Environmentally Friendly** : EU RoHS Compliant, Pb Free

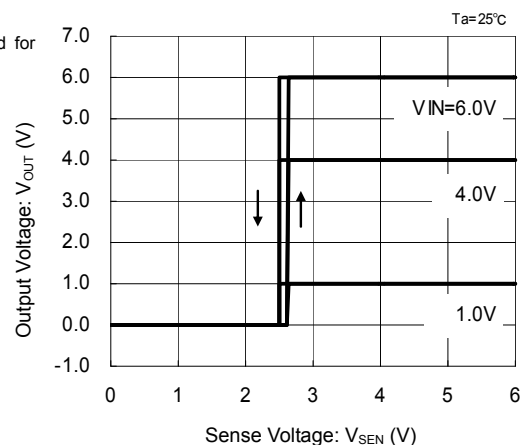
■ TYPICAL APPLICATION CIRCUIT



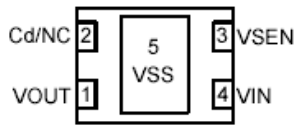
■ TYPICAL PERFORMANCE CHARACTERISTICS

● Output Voltage vs. Sense Voltage

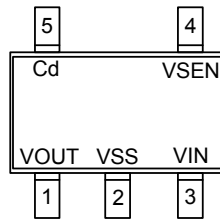
XC6108C25AGR



PIN CONFIGURATION



USP-4
(BOTTOM VIEW)



SOT-25
(TOP VIEW)

* In the XC6108xxxA/B series, the dissipation pad should not be short-circuited with other pins.

* In the XC6108xxxC/D series, when the dissipation pad is short-circuited with other pins, connect it to the NC pin (No.2) pin before use.

PIN ASSIGNMENT

| PIN NUMBER | | PIN NAME | FUNCTION |
|------------|--------|----------|----------------------------------|
| USP-4 | SOT-25 | | |
| 1 | 1 | VOUT | Output (Detect "L") |
| 2 | 5 | Cd | Delay Capacitance ⁽¹⁾ |
| 2 | - | NC | No Connection |
| 3 | 4 | VSEN | Sense |
| 4 | 3 | VIN | Input |
| 5 | 2 | VSS | Ground ⁽²⁾ |

NOTE:

*1: With the VSS pin of the USP-4 package, a tab on the backside is used as the pin No.5.

*2: In the case of selecting no built-in delay capacitance pin type, the delay capacitance (Cd) pin will be used as the N.C.

PRODUCT CLASSIFICATION

Ordering Information

XC6108 ①②③④⑤⑥-⑦⁽¹⁾

| DESIGNATOR | DESCRIPTION | SYMBOL | DESCRIPTION |
|------------|-------------------------------------|---------|--|
| ① | Output Configuration | C | CMOS output |
| | | N | N-ch open drain output |
| ②③ | Detect Voltage | 08 ~ 50 | e.g. 18→1.8V |
| ④ | Output Delay & Hysteresis (Options) | A | Built-in delay capacitance pin, hysteresis 5% (TYP.)(Standard*) |
| | | B | Built-in delay capacitance pin, hysteresis less than 1%(Standard*) |
| | | C | No built-in delay capacitance pin, hysteresis 5% (TYP.) (Semi-custom) |
| | | D | No built-in delay capacitance pin, hysteresis less than 1% (Semi-custom) |
| ⑤⑥-⑦ | Packages Taping Type ⁽²⁾ | GR | USP-4 |
| | | GR-G | USP-4 |
| | | MR | SOT-25 |
| | | MR-G | SOT-25 |

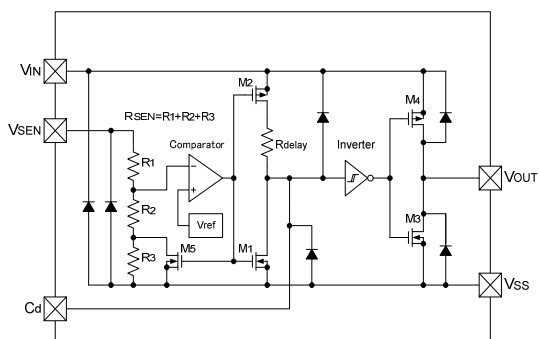
*When delay function isn't used, open the delay capacitance pin before use.

⁽¹⁾ The "-G" suffix indicates that the products are Halogen and Antimony free as well as being fully RoHS compliant.

⁽²⁾ The device orientation is fixed in its embossed tape pocket. For reverse orientation, please contact your local Torex sales office or representative. (Standard orientation: ⑤R-⑦, Reverse orientation: ⑤L-⑦)

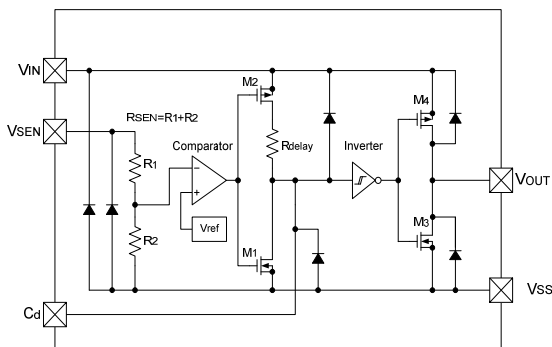
■ BLOCK DIAGRAMS

(1) XC6108CxxA



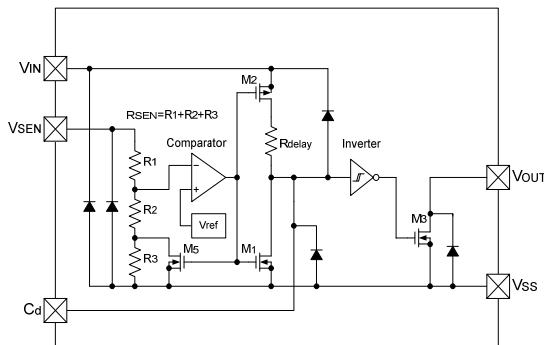
*The delay capacitance pin (Cd) is not connected to the circuit in the block diagram of XC6108CxxC (semi-custom).

(2) XC6108CxxB



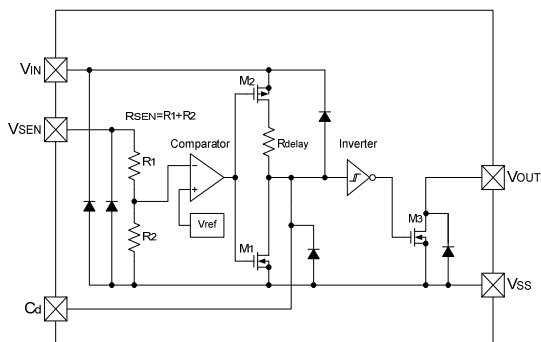
*The delay capacitance pin (Cd) is not connected to the circuit in the block diagram of XC6108CxxD (semi-custom).

(3) XC6108NxxA



*The delay capacitance pin (Cd) is not connected to the circuit in the block diagram of XC6108NxxC (semi-custom).

(4) XC6108NxxB



*The delay capacitance pin (Cd) is not connected to the circuit in the block diagram of XC6108NxxD (semi-custom).

ABSOLUTE MAXIMUM RATINGS

●XC6108xxxA/B

Ta = 25°C

| PARAMETER | | SYMBOL | RATINGS | UNITS |
|-------------------------------|------------------------|------------------|---|-------|
| Input Voltage | | V _{IN} | V _{SS} -0.3 ~ 7.0 | V |
| Output Current | | I _{OUT} | 10 | mA |
| Output Voltage | XC6108C ⁽¹⁾ | V _{OUT} | V _{SS} -0.3 ~ V _{IN} +0.3 | V |
| | XC6108N ⁽²⁾ | | V _{SS} -0.3 ~ 7.0 | |
| Sense Pin Voltage | | V _{SEN} | V _{SS} -0.3 ~ 7.0 | V |
| Delay Capacitance Pin Voltage | | V _{CD} | V _{SS} -0.3 ~ V _{IN} +0.3 | V |
| Delay Capacitance Pin Current | | I _{CD} | 5.0 | mA |
| Power Dissipation | USP-4 | P _d | 120 | mW |
| | SOT-25 | | 250 | |
| Operating Temperature Range | | T _a | -40 ~ +85 | °C |
| Storage Temperature Range | | T _{stg} | -55 ~ +125 | °C |

●XC6108xxxC/D

Ta = 25°C

| PARAMETER | | SYMBOL | RATINGS | UNITS |
|-----------------------------|------------------------|------------------|---|-------|
| Input Voltage | | V _{IN} | V _{SS} -0.3 ~ 7.0 | V |
| Output Current | | I _{OUT} | 10 | mA |
| Output Voltage | XC6108C ⁽¹⁾ | V _{OUT} | V _{SS} -0.3 ~ V _{IN} +0.3 | V |
| | XC6108N ⁽²⁾ | | V _{SS} -0.3 ~ 7.0 | |
| Sense Pin Voltage | | V _{SEN} | V _{SS} -0.3 ~ 7.0 | V |
| Power Dissipation | USP-4 | P _d | 120 | mW |
| | SOT-25 | | 250 | |
| Operating Temperature Range | | T _a | -40 ~ +85 | °C |
| Storage Temperature Range | | T _{stg} | -55 ~ +125 | °C |

NOTE:

*1: CMOS output

*2: N-ch open drain output

■ ELECTRICAL CHARACTERISTICS

● XC6108xxxA

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUITS | |
|---|---|--|--|-------|-------|--------|----------|---|
| Operating Voltage | V _{IN} | V _{DF(T)} = 0.8 ~ 5.0V ^(*1) | 1.0 | - | 6.0 | V | - | |
| Detect Voltage | V _{DF} | V _{IN} = 1.0 ~ 6.0V | E-1 | | | V | ① | |
| Hysteresis Width | V _{HYS} | V _{IN} = 1.0 ~ 6.0V | E-2 | | | V | ① | |
| Detect Voltage Line Regulation | $\frac{\Delta V_{DF}}{(\Delta V_{IN} \cdot V_{DF})}$ | V _{IN} = 1.0 ~ 6.0V | - | ±0.1 | - | %/V | ① | |
| Supply Current 1 ^(*2) | ISS1 | V _{SEN} = V _{DF} x 0.9 | V _{IN} = 1.0V | - | 0.6 | 1.5 | μA | ② |
| | | | V _{IN} = 6.0V | - | 0.7 | 1.6 | | |
| Supply Current 2 ^(*2) | ISS2 | V _{SEN} = V _{DF} x 1.1 | V _{IN} = 1.0V | - | 0.8 | 1.7 | μA | ② |
| | | | V _{IN} = 6.0V | - | 0.9 | 1.8 | | |
| Output Current ^(*3) | I _{OUT1} | V _{SEN} = 0V V _{DS} = 0.5V (N-ch) | V _{IN} = 1.0V | 0.1 | 0.7 | - | mA | ③ |
| | | | V _{IN} = 2.0V | 0.8 | 1.6 | | | |
| | | | V _{IN} = 3.0V | 1.2 | 2.0 | | | |
| | | | V _{IN} = 4.0V | 1.6 | 2.3 | | | |
| | | | V _{IN} = 5.0V | 1.8 | 2.4 | | | |
| | V _{IN} = 6.0V | | 1.9 | 2.5 | | | | |
| I _{OUT2} | V _{SEN} = 6.0V V _{DS} = 0.5V (P-ch) | V _{IN} = 1.0V | - | -0.30 | -0.08 | mA | ④ | |
| | | V _{IN} = 6.0V | - | -2.00 | -0.70 | | | |
| Leakage Current | CMOS Output | I _{LEAK} | V _{IN} =6.0V, V _{SEN} =6.0V, V _{OUT} =6.0V, Cd: Open | - | 0.20 | - | μA | ③ |
| | Nch Open Drain Output | | | - | 0.20 | 0.40 | | |
| Temperature Characteristics | $\frac{\Delta V_{DF}}{(\Delta T_{OP} \cdot V_{DF})}$ | -40 °C ≤ Ta ≤ 85°C | - | ±100 | - | ppm/°C | ① | |
| Sense Resistance ^(*4) | R _{SEN} | V _{SEN} = 5.0V, V _{IN} = 0V | E-4 | | | MΩ | ⑤ | |
| Delay Resistance ^(*5) | R _{delay} | V _{SEN} = 6.0V, V _{IN} = 5.0V, Cd = 0V | 1.6 | 2.0 | 2.4 | MΩ | ⑥ | |
| Delay capacitance pin Sink Current | I _{CD} | V _{DS} = 0.5V, V _{IN} = 1.0V | - | 200 | - | μA | ⑥ | |
| Delay Capacitance Pin Threshold Voltage | V _{TCD} | V _{SEN} = 6.0V, V _{IN} = 1.0V | 0.4 | 0.5 | 0.6 | V | ⑦ | |
| | | V _{SEN} = 6.0V, V _{IN} = 6.0V | 2.9 | 3.0 | 3.1 | | | |
| Unspecified Operating Voltage ^(*6) | V _{UNS} | V _{IN} = V _{SEN} = 0V ~ 1.0V | - | 0.3 | 0.4 | V | ⑧ | |
| Detect Delay Time ^(*7) | t _{DF0} | V _{IN} = 6.0V, V _{SEN} = 6.0V → 0.0V Cd: Open | | 30 | 230 | μs | ⑨ | |
| Release Delay Time ^(*8) | t _{DR0} | V _{IN} = 6.0V, V _{SEN} = 0.0V → 6.0V Cd: Open | | 30 | 200 | μs | ⑨ | |

NOTE:

- *1: V_{DF(T)}: Nominal detect voltage
- *2: Current flows the sense resistor is not included.
- *3: The Pch values are applied only to the XC6108C series (CMOS output).
- *4: Calculated from the voltage value and the current value of the V_{SEN}.
- *5: Calculated from the voltage value of the V_{IN} and the current value of the Cd.
- *6: The maximum voltage of the V_{OUT} in the range of the V_{IN} 0V to 1.0V when the V_{IN} and the V_{SEN} are short-circuited
This value is applied only to the XC6108C series (CMOS output).
- *7: Time which ranges from the state of V_{SEN}=V_{DF} to the V_{OUT} reaching 0.6V when the V_{SEN} falls without connecting to the Cd pin.
- *8: Time which ranges from the state of V_{IN}= V_{DF} +V_{HYS} to the V_{OUT} reaching 5.4V when the V_{SEN} rises without connecting to the Cd pin.

ELECTRICAL CHARACTERISTICS (Continued)

●XC6108xxxB

Ta=25°C

| PARAMETER | | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUITS | |
|--|-----------------------|---|--|------------------------|------|-------|--------|----------|---|
| Operating Voltage | | V _{IN} | V _{DF(T)} = 0.8 ~ 5.0V ⁽¹⁾ | 1.0 | - | 6.0 | V | - | |
| Detect Voltage | | V _{DF} | V _{IN} = 1.0 ~ 6.0V | E-1 | | | V | ① | |
| Hysteresis Width | | V _{HYS} | V _{IN} = 1.0 ~ 6.0V | E-3 | | | V | ① | |
| Detect Voltage Line Regulation | | $\frac{\Delta V_{DF}}{(\Delta V_{IN} \cdot V_{DF})}$ | V _{IN} = 1.0 ~ 6.0V | - | ±0.1 | - | %/V | ① | |
| Supply Current 1 ⁽²⁾ | | ISS1 | V _{SEN} = V _{DF} x 0.9 | V _{IN} = 1.0V | - | 0.6 | 1.5 | μA | ② |
| | | | | V _{IN} = 6.0V | - | 0.7 | 1.6 | | |
| Supply Current 2 ⁽²⁾ | | ISS2 | V _{SEN} = V _{DF} x 1.1 | V _{IN} = 1.0V | - | 0.8 | 1.7 | μA | ② |
| | | | | V _{IN} = 6.0V | - | 0.9 | 1.8 | | |
| Output Current ⁽³⁾ | | I _{OUT1} | V _{SEN} = 0V V _{DS} = 0.5V (N-ch) | V _{IN} = 1.0V | 0.1 | 0.7 | - | mA | ③ |
| | | | | V _{IN} = 2.0V | 0.8 | 1.6 | - | | |
| | | | | V _{IN} = 3.0V | 1.2 | 2.0 | - | | |
| | | | | V _{IN} = 4.0V | 1.6 | 2.3 | - | | |
| | | | | V _{IN} = 5.0V | 1.8 | 2.4 | - | | |
| | | | | V _{IN} = 6.0V | 1.9 | 2.5 | - | | |
| | | I _{OUT2} | V _{SEN} = 6.0V V _{DS} = 0.5V (P-ch) | V _{IN} = 1.0V | - | -0.30 | -0.08 | mA | ④ |
| | | | | V _{IN} = 6.0V | - | -2.00 | -0.70 | | |
| Leakage Current | CMOS Output | I _{LEAK} | V _{IN} =6.0V, V _{SEN} =6.0V, V _{OUT} =6.0V, Cd: Open | - | 0.20 | - | μA | ③ | |
| | Nch Open Drain Output | | | | 0.20 | 0.40 | | | |
| Temperature Characteristics | | $\frac{\Delta V_{DF}}{(\Delta T_{opr} \cdot V_{DF})}$ | -40 °C ≤ Ta ≤ 85°C | - | ±100 | - | ppm/°C | ① | |
| Sense Resistance ⁽⁴⁾ | | R _{SEN} | V _{SEN} = 5.0V, V _{IN} = 0V | E-4 | | | MΩ | ⑤ | |
| Delay Resistance ⁽⁵⁾ | | R _{delay} | V _{SEN} = 6.0V, V _{IN} = 5.0V, Cd = 0V | 1.6 | 2.0 | 2.4 | MΩ | ⑥ | |
| Delay capacitance pin Sink Current | | I _{CD} | V _{DS} = 0.5V, V _{IN} = 1.0V | - | 200 | - | μA | ⑥ | |
| Delay Capacitance Pin Threshold Voltage | | V _{TCD} | V _{SEN} = 6.0V, V _{IN} = 1.0V | 0.4 | 0.5 | 0.6 | V | ⑦ | |
| | | | V _{SEN} = 6.0V, V _{IN} = 6.0V | 2.9 | 3.0 | 3.1 | | | |
| Unspecified Operating Voltage ⁽⁶⁾ | | V _{UNS} | V _{IN} = V _{SEN} = 0V ~ 1.0V | - | 0.3 | 0.4 | V | ⑧ | |
| Detect Delay Time ⁽⁷⁾ | | t _{DF0} | V _{IN} = 6.0V, V _{SEN} = 6.0V → 0.0V Cd: Open | | 30 | 230 | μs | ⑨ | |
| Release Delay Time ⁽⁸⁾ | | t _{DR0} | V _{IN} = 6.0V, V _{SEN} = 0.0V → 6.0V Cd: Open | | 30 | 200 | μs | ⑨ | |

NOTE:

*1: V_{DF(T)}: Nominal detect voltage

*2: Current flows the sense resistor is not included.

*3: The Pch values are applied only to the XC6108C series (CMOS output).

*4: Calculated from the voltage value and the current value of the V_{SEN}.

*5: Calculated from the voltage value of the V_{IN} and the current value of the Cd.

*6: The maximum voltage of the V_{OUT} in the range of the V_{IN} 0V to 1.0V when the V_{IN} and the V_{SEN} are short-circuited

This value is applied only to the XC6108C series (CMOS output).

*7: Time which ranges from the state of V_{SEN}=V_{DF} to the V_{OUT} reaching 0.6V when the V_{SEN} falls without connecting to the Cd pin.

*8: Time which ranges from the state of V_{IN}= V_{DF} +V_{HYS} to the V_{OUT} reaching 5.4V when the V_{SEN} rises without connecting to the Cd pin.

■ ELECTRICAL CHARACTERISTICS (Continued)

● XC6108xxxC

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUITS | |
|--|---|---|---|------|-------|--------|----------|---|
| Operating Voltage | V _{IN} | V _{DF(T)} = 0.8 ~ 5.0V ⁽¹⁾ | 1.0 | - | 6.0 | V | - | |
| Detect Voltage | V _{DF} | V _{IN} = 1.0 ~ 6.0V | E-1 | | | V | ① | |
| Hysteresis Width | V _{HYS} | V _{IN} = 1.0 ~ 6.0V | E-2 | | | V | ① | |
| Detect Voltage Line Regulation | $\frac{\Delta V_{DF}}{(\Delta V_{IN} \cdot V_{DF})}$ | V _{IN} = 1.0 ~ 6.0V | - | ±0.1 | - | %/V | ① | |
| Supply Current 1 ⁽²⁾ | ISS1 | V _{SEN} = | V _{IN} = 1.0V | - | 0.6 | 1.5 | μA | ② |
| | | V _{DF} x 0.9 | V _{IN} = 6.0V | - | 0.7 | 1.6 | | |
| Supply Current 2 ⁽²⁾ | ISS2 | V _{SEN} = | V _{IN} = 1.0V | - | 0.8 | 1.7 | μA | ② |
| | | V _{DF} x 1.1 | V _{IN} = 6.0V | - | 0.9 | 1.8 | | |
| Output Current ⁽³⁾ | I _{OUT1} | V _{SEN} = 0V V _{DS} = 0.5V (N-ch) | V _{IN} = 1.0V | 0.1 | 0.7 | - | mA | ③ |
| | | | V _{IN} = 2.0V | 0.8 | 1.6 | | | |
| | | | V _{IN} = 3.0V | 1.2 | 2.0 | | | |
| | | | V _{IN} = 4.0V | 1.6 | 2.3 | | | |
| | | | V _{IN} = 5.0V | 1.8 | 2.4 | | | |
| | | | V _{IN} = 6.0V | 1.9 | 2.5 | | | |
| | I _{OUT2} | V _{SEN} = 6.0V V _{DS} = 0.5V (P-ch) | V _{IN} = 1.0V | - | -0.30 | -0.08 | mA | ④ |
| V _{IN} = 6.0V | - | -2.00 | -0.70 | | | | | |
| Leakage Current | CMOS Output | I _{LEAK} | V _{IN} =6.0V, V _{SEN} =6.0V, V _{OUT} =6.0V, C _d : Open | - | 0.20 | - | μA | ③ |
| | Nch Open Drain Output | | | | 0.20 | 0.40 | | |
| Temperature Characteristics | $\frac{\Delta V_{DF}}{(\Delta T_{opr} \cdot V_{DF})}$ | -40 °C ≤ Ta ≤ 85°C | - | ±100 | - | ppm/°C | ① | |
| Sense Resistance ⁽⁴⁾ | R _{SEN} | V _{SEN} = 5.0V, V _{IN} = 0V | E-4 | | | MΩ | ⑤ | |
| Unspecified Operating Voltage ⁽⁵⁾ | V _{UNS} | V _{IN} = V _{SEN} = 0V ~ 1.0V | - | 0.3 | 0.4 | V | ⑦ | |
| Detect Delay Time ⁽⁶⁾ | t _{DF0} | V _{IN} = 6.0V, V _{SEN} = 6.0V → 0.0V | | 30 | 230 | μs | ⑨ | |
| Release Delay Time ⁽⁷⁾ | t _{DR0} | V _{IN} = 6.0V, V _{SEN} = 0.0V → 6.0V | | 30 | 200 | μs | ⑨ | |

NOTE:

- *1: V_{DF(T)}: Nominal detect voltage
- *2: Current flows the sense resistor is not included.
- *3: The Pch values are applied only to the XC6108C series (CMOS output).
- *4: Calculated from the voltage value and the current value of the V_{SEN}.
- *5: The maximum voltage of the V_{OUT} in the range of the V_{IN} 0V to 1.0V when the V_{IN} and the V_{SEN} are short-circuited
This value is applied only to the XC6108C series (CMOS output).
- *6: Time which ranges from the state of V_{SEN}=V_{DF} to the V_{OUT} reaching 0.6V when the V_{SEN} falls.
- *7: Time which ranges from the state of V_{IN}= V_{DF} +V_{HYS} to the V_{OUT} reaching 5.4V when the V_{SEN} rises.

ELECTRICAL CHARACTERISTICS (Continued)

●XC6108xxxD

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUITS | |
|---|---|---|--|-------|-------|--------|----------|---|
| Operating Voltage | V _{IN} | V _{DF(T)} = 0.8 ~ 5.0V ^{(*)1} | 1.0 | - | 6.0 | V | - | |
| Detect Voltage | V _{DF} | V _{IN} = 1.0 ~ 6.0V | E-1 | | | V | 1 | |
| Hysteresis Width | V _{HYS1} | V _{IN} = 1.0 ~ 6.0V | E-3 | | | V | 1 | |
| Detect Voltage Line Regulation | $\frac{\Delta V_{DF}}{(\Delta V_{IN} \cdot V_{DF})}$ | V _{IN} = 1.0 ~ 6.0V | - | ±0.1 | - | %/V | 1 | |
| Supply Current 1 ^{(*)2} | ISS1 | V _{SEN} = | V _{IN} = 1.0V | - | 0.6 | 1.5 | μA | 2 |
| | | V _{DF} x 0.9 | V _{IN} = 6.0V | - | 0.7 | 1.6 | | |
| Supply Current 2 ^{(*)2} | ISS2 | V _{SEN} = | V _{IN} = 1.0V | - | 0.8 | 1.7 | μA | 2 |
| | | V _{DF} x 1.1 | V _{IN} = 6.0V | - | 0.9 | 1.8 | | |
| Output Current ^{(*)3} | I _{OUT1} | V _{SEN} =0V V _{DS} =0.5V (N-ch) | V _{IN} = 1.0V | 0.1 | 0.7 | - | mA | 3 |
| | | | V _{IN} = 2.0V | 0.8 | 1.6 | | | |
| | | | V _{IN} = 3.0V | 1.2 | 2.0 | | | |
| | | | V _{IN} = 4.0V | 1.6 | 2.3 | | | |
| | | | V _{IN} = 5.0V | 1.8 | 2.4 | | | |
| | V _{IN} = 6.0V | 1.9 | 2.5 | | | | | |
| I _{OUT2} | V _{SEN} = 6.0V V _{DS} = 0.5V (P-ch) | V _{IN} = 1.0V | - | -0.30 | -0.08 | mA | 4 | |
| | | V _{IN} = 6.0V | - | -2.00 | -0.70 | | | |
| Leakage Current | CMOS Output | I _{LEAK} | V _{IN} =6.0V, V _{SEN} =6.0V, V _{OUT} =6.0V, Cd: Open | - | 0.20 | - | μA | 3 |
| | Nch Open Drain Output | | | 0.20 | 0.40 | | | |
| Temperature Characteristics | $\frac{\Delta V_{DF}}{(\Delta T_{OP} \cdot V_{DF})}$ | -40 °C ≤ Ta ≤ 85°C | - | ±100 | - | ppm/°C | 1 | |
| Sense Resistance ^{(*)4} | R _{SEN} | V _{SEN} = 5.0V, V _{IN} = 0V | E-4 | | | MΩ | 5 | |
| Unspecified Operating Voltage ^{(*)5} | V _{UNS} | V _{IN} = V _{SEN} = 0V ~ 1.0V | - | 0.3 | 0.4 | V | 7 | |
| Detect Delay Time ^{(*)6} | t _{DF0} | V _{IN} = 6.0V, V _{SEN} = 6.0V → 0.0V | | 30 | 230 | μs | 9 | |
| Release Delay Time ^{(*)7} | t _{DR0} | V _{IN} = 6.0V, V _{SEN} = 0.0V → 6.0V | | 30 | 200 | μs | 9 | |

NOTE:

*1: V_{DF(T)}: Nominal detect voltage

*2: Current flows the sense resistor is not included.

*3: The Pch values are applied only to the XC6108C series (CMOS output).

*4: Calculated from the voltage value and the current value of the V_{SEN}.

*5: The maximum voltage of the V_{OUT} in the range of the V_{IN} 0V to 1.0V when the V_{IN} and the V_{SEN} are short-circuited

This value is applied only to the XC6108C series (CMOS output).

*6: Time which ranges from the state of V_{SEN}=V_{DF} to the V_{OUT} reaching 0.6V when the V_{SEN} falls.

*7: Time which ranges from the state of V_{IN}= V_{DF} +V_{HYS} to the V_{OUT} reaching 5.4V when the V_{SEN} rises.

VOLTAGE CHART

| SYMBOL | E-1 | | E-2 | | E-3 | | E-4 | |
|------------------------|--------------------------------------|-------|-------------------------|-------|-------------------------|-------|--------------------------|------|
| NOMINAL DETECT VOLTAGE | DETECT VOLTAGE ^(*) (V) | | HYSTERESIS RANGE (V) | | HYSTERESIS RANGE (V) | | SENSE RESISTANCE (MΩ) | |
| VDF(T) (V) | VDF | | V _{HYS} | | V _{HYS} | | R _{SEN} | |
| | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | TYP. |
| 0.8 | 0.770 | 0.830 | 0.015 | 0.066 | 0 | 0.008 | 10 | 20 |
| 0.9 | 0.870 | 0.930 | 0.017 | 0.074 | | 0.009 | | |
| 1.0 | 0.970 | 1.030 | 0.019 | 0.082 | | 0.010 | | |
| 1.1 | 1.070 | 1.130 | 0.021 | 0.090 | | 0.011 | | |
| 1.2 | 1.170 | 1.230 | 0.023 | 0.098 | | 0.012 | | |
| 1.3 | 1.270 | 1.330 | 0.025 | 0.106 | | 0.013 | | |
| 1.4 | 1.370 | 1.430 | 0.027 | 0.114 | | 0.014 | | |
| 1.5 | 1.470 | 1.530 | 0.029 | 0.122 | | 0.015 | | |
| 1.6 | 1.568 | 1.632 | 0.031 | 0.131 | | 0.016 | | |
| 1.7 | 1.666 | 1.734 | 0.033 | 0.085 | | 0.017 | | |
| 1.8 | 1.764 | 1.836 | 0.035 | 0.147 | | 0.018 | | |
| 1.9 | 1.862 | 1.938 | 0.037 | 0.155 | | 0.019 | | |
| 2.0 | 1.960 | 2.040 | 0.039 | 0.163 | | 0.020 | | |
| 2.1 | 2.058 | 2.142 | 0.041 | 0.171 | | 0.021 | | |
| 2.2 | 2.156 | 2.244 | 0.043 | 0.180 | | 0.022 | | |
| 2.3 | 2.254 | 2.346 | 0.045 | 0.188 | | 0.023 | | |
| 2.4 | 2.352 | 2.448 | 0.047 | 0.196 | | 0.024 | | |
| 2.5 | 2.450 | 2.550 | 0.049 | 0.204 | | 0.026 | | |
| 2.6 | 2.548 | 2.652 | 0.051 | 0.212 | 0.027 | | | |
| 2.7 | 2.646 | 2.754 | 0.053 | 0.220 | 0.028 | | | |
| 2.8 | 2.744 | 2.856 | 0.055 | 0.228 | 0.029 | | | |
| 2.9 | 2.842 | 2.958 | 0.057 | 0.237 | 0.030 | | | |
| 3.0 | 2.940 | 3.060 | 0.059 | 0.245 | 0.031 | | | |
| 3.1 | 3.038 | 3.162 | 0.061 | 0.253 | 0.032 | | | |
| 3.2 | 3.136 | 3.264 | 0.063 | 0.261 | 0.033 | | | |
| 3.3 | 3.234 | 3.366 | 0.065 | 0.269 | 0.034 | | | |
| 3.4 | 3.332 | 3.468 | 0.067 | 0.277 | 0.035 | | | |
| 3.5 | 3.430 | 3.570 | 0.069 | 0.286 | 0.036 | | | |
| 3.6 | 3.528 | 3.672 | 0.071 | 0.294 | 0.037 | | | |
| 3.7 | 3.626 | 3.774 | 0.073 | 0.302 | 0.038 | | | |
| 3.8 | 3.724 | 3.876 | 0.074 | 0.310 | 0.039 | | | |
| 3.9 | 3.822 | 3.978 | 0.076 | 0.318 | 0.040 | | | |
| 4.0 | 3.920 | 4.080 | 0.078 | 0.326 | 0.041 | | | |
| 4.1 | 4.018 | 4.182 | 0.080 | 0.335 | 0.042 | | | |
| 4.2 | 4.116 | 4.284 | 0.082 | 0.343 | 0.043 | | | |
| 4.3 | 4.214 | 4.386 | 0.084 | 0.351 | 0.044 | | | |
| 4.4 | 4.312 | 4.488 | 0.086 | 0.359 | 0.045 | | | |
| 4.5 | 4.410 | 4.590 | 0.088 | 0.367 | 0.046 | | | |
| 4.6 | 4.508 | 4.692 | 0.090 | 0.375 | 0.047 | | | |
| 4.7 | 4.606 | 4.794 | 0.092 | 0.384 | 0.048 | | | |
| 4.8 | 4.704 | 4.896 | 0.094 | 0.392 | 0.049 | | | |
| 4.9 | 4.802 | 4.998 | 0.096 | 0.400 | 0.050 | | | |
| 5.0 | 4.900 | 5.100 | 0.098 | 0.408 | 0.051 | | | |
| | | | | | | | 13 | 24 |
| | | | | | | | 15 | 28 |

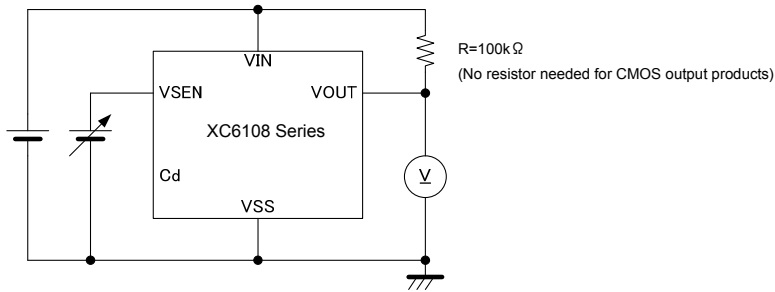
NOTE:

*1: When $VDF(T) \leq 1.4V$, the detection accuracy is $\pm 30mV$.

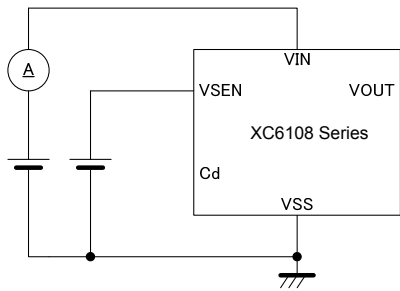
When $VDF(T) \geq 1.5V$, the detection accuracy is $\pm 2\%$.

TEST CIRCUITS

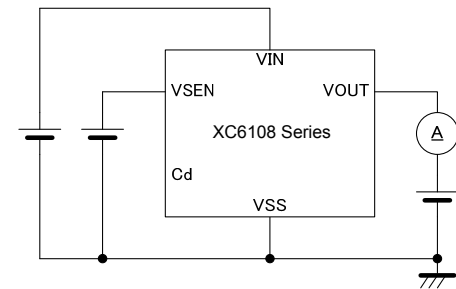
Circuit 1



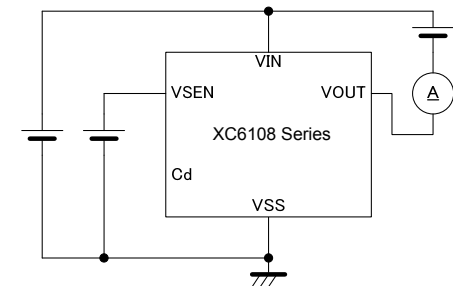
Circuit 2



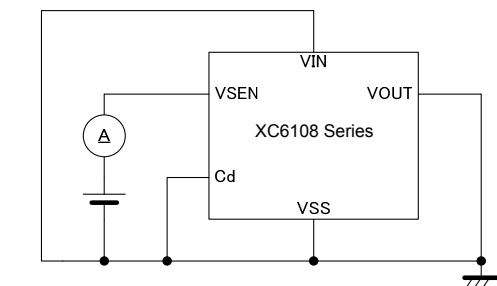
Circuit 3



Circuit 4

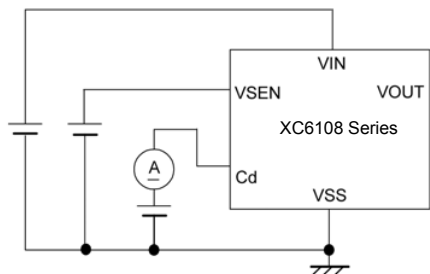


Circuit 5

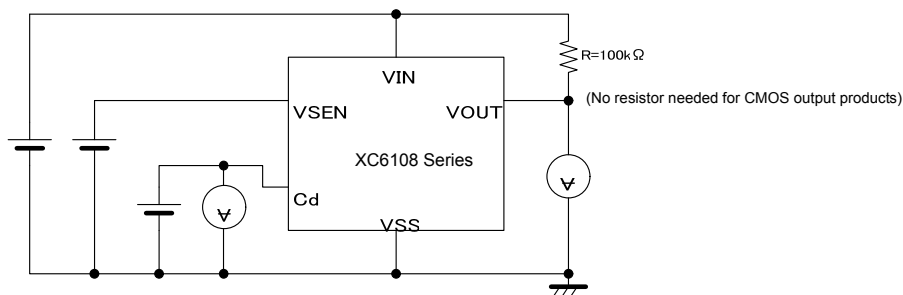


■ TEST CIRCUITS (Continued)

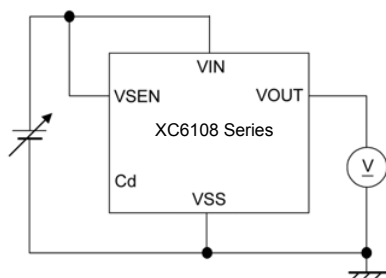
Circuit 6



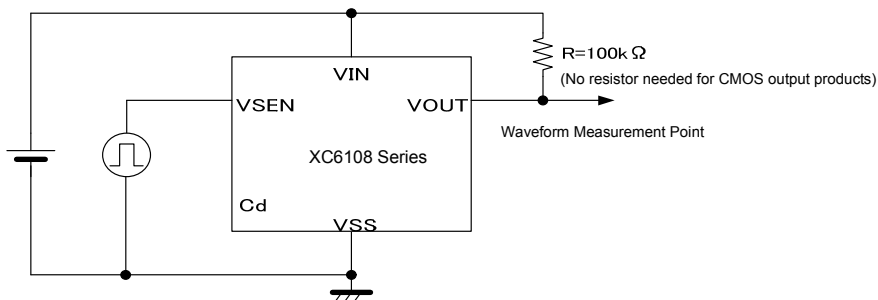
Circuit 7



Circuit 8



Circuit 9



*No delay capacitance pin available in the XC6108xxxC/D series.

OPERATIONAL EXPLANATION

A typical circuit example is shown in Figure 1, and the timing chart of Figure 1 is shown in Figure 2 on page 14.

- ① As an early state, the sense pin is applied sufficiently high voltage (6.0V MAX.) and the delay capacitance (Cd) is charged to the power supply input voltage, (VIN: 1.0V MIN., 6.0V MAX.). While the sense pin voltage (VSEN) starts dropping to reach the detect voltage (VDF) (VSEN>VDF), the output voltage (VOUT) keeps the "High" level (=VIN).
* If a pull-up resistor of the XC6108N series (N-ch open drain) is connected to added power supply different from the input voltage pin, the "High" level will be a voltage value where the pull-up resistor is connected.
- ② When the sense pin voltage keeps dropping and becomes equal to the detect voltage (VSEN =VDF), an N-ch transistor (M1) for the delay capacitance (Cd) discharge is turned ON, and starts to discharge the delay capacitance (Cd). An inverter (Inv.1) operates as a comparator of the reference voltage VIN, and the output voltage changes into the "Low" level (=VSS). The detect delay time [tDF] is defined as time which ranges from VSEN=VDF to the VOUT of "Low" level (especially, when the Cd pin is not connected: tDF0).
- ③ While the sense pin voltage keeps below the detect voltage, the delay capacitance (Cd) is discharged to the ground voltage (=VSS) level. Then, the output voltage maintains the "Low" level while the sense pin voltage increases again to reach the release voltage (VSEN< VDF +VHYS).
- ④ When the sense pin voltage continues to increase up to the release voltage level (VDF+VHYS), the N-ch transistor (M1) for the delay capacitance (Cd) discharge will be turned OFF, and the delay capacitance (Cd) will start discharging via a delay resistor (Rdelay). The inverter (Inv.1) will operate as a comparator (Rise Logic Threshold: VTLH=VTCD, Fall Logic Threshold: VTHL=VSS) while the sense pin voltage keeps higher than the detect voltage (VSEN > VDF).
- ⑤ While the delay capacitance pin voltage (VCD) rises to reach the delay capacitance pin threshold voltage (VTCD) with the sense pin voltage equal to the release voltage or higher, the sense pin will be charged by the time constant of the RC series circuit. Assuming the time to the release delay time (tDR), it can be given by the formula (1).

$$t_{DR} = -R_{delay} \times C_d \times \ln(1 - V_{TCD} / V_{IN}) \dots(1)$$

* ln = a natural logarithm

The release delay time can also be briefly calculated with the formula (2) because the delay resistance is 2.0MΩ (TYP.) and the delay capacitance pin voltage is VIN /2 (TYP.)

$$t_{DR} = R_{delay} \times C_d \times 0.69 \dots(2)$$

* : Rdelay is 2.0MΩ (TYP.)

As an example, presuming that the delay capacitance is 0.68 μF, tDR is :

$$2.0 \times 10^6 \times 0.68 \times 10^{-6} \times 0.69 = 938(ms)$$

* Note that the release delay time may remarkably be short when the delay capacitance (Cd) is not discharged to the ground (=VSS) level because time described in ③ is short.

- ⑥ When the delay capacitance pin voltage reaches to the delay capacitance pin threshold voltage (VCD=VTCD), the inverter (Inv.1) will be inverted. As a result, the output voltage changes into the "High" (=VIN) level. tDR0 is defined as time which ranges from VSEN=VDF+VHYS to the VOUT of "High" level without connecting to the Cd.
- ⑦ While the sense voltage is higher than the detect voltage (VSEN > VDF), the delay capacitance pin is charged until the delay capacitance pin voltage becomes the input voltage level. Therefore, the output voltage maintains the "High"(=VIN) level.

■ OPERATIONAL EXPLANATION (Continued)

● Function Chart

| V _{SEN} | Cd | TRANSITION OF V _{OUT} CONDITION *1 | | |
|------------------|----|---|---|---|
| | | ① | | ② |
| L | L | L | ⇒ | L |
| | H | | | |
| | L | H | | |
| | H | | | |
| H | L | L | ⇒ | L |
| | H | | ⇒ | |
| | L | H | ⇒ | H |
| | H | | | |

*1: V_{OUT} transits from condition ① to ② because of the combination of V_{SEN} and Cd.

● Example

ex. 1) V_{OUT} ranges from 'L' to 'H' in case of V_{SEN} = 'H' (V_{DR} ≥ V_{SEN}), Cd='H' (V_{TC} ≥ Cd) while V_{OUT} is 'L'.

ex. 2) V_{OUT} maintains 'H' when Cd ranges from 'H' to 'L', V_{SEN}='H' and Cd='L' when V_{OUT} becomes 'H' in ex.1.

● Release Delay Time Chart

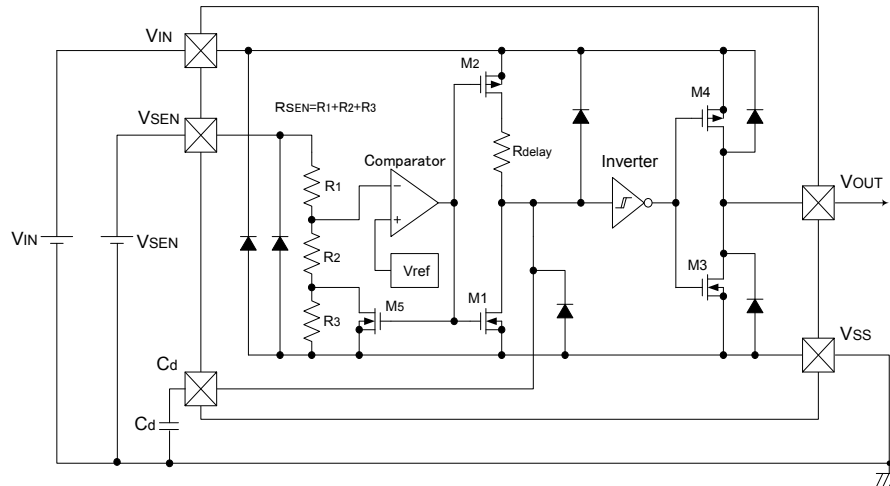
| DELAY CAPACITANCE [Cd] (μF) | RELEASE DELAY TIME [t _{DR}] (TYP.) (ms) | RELEASE DELAY TIME [t _{DR}] *2 (MIN. ~ MAX.) (ms) |
|--------------------------------|---|---|
| 0.010 | 13.8 | 11.0 ~ 16.6 |
| 0.022 | 30.4 | 24.3 ~ 36.4 |
| 0.047 | 64.9 | 51.9 ~ 77.8 |
| 0.100 | 138 | 110 ~ 166 |
| 0.220 | 304 | 243 ~ 364 |
| 0.470 | 649 | 519 ~ 778 |
| 1.000 | 1380 | 1100 ~ 1660 |

* The release delay time values above are calculated by using the formula (2).

*2: The release delay time (t_{DR}) is influenced by the delay capacitance Cd.

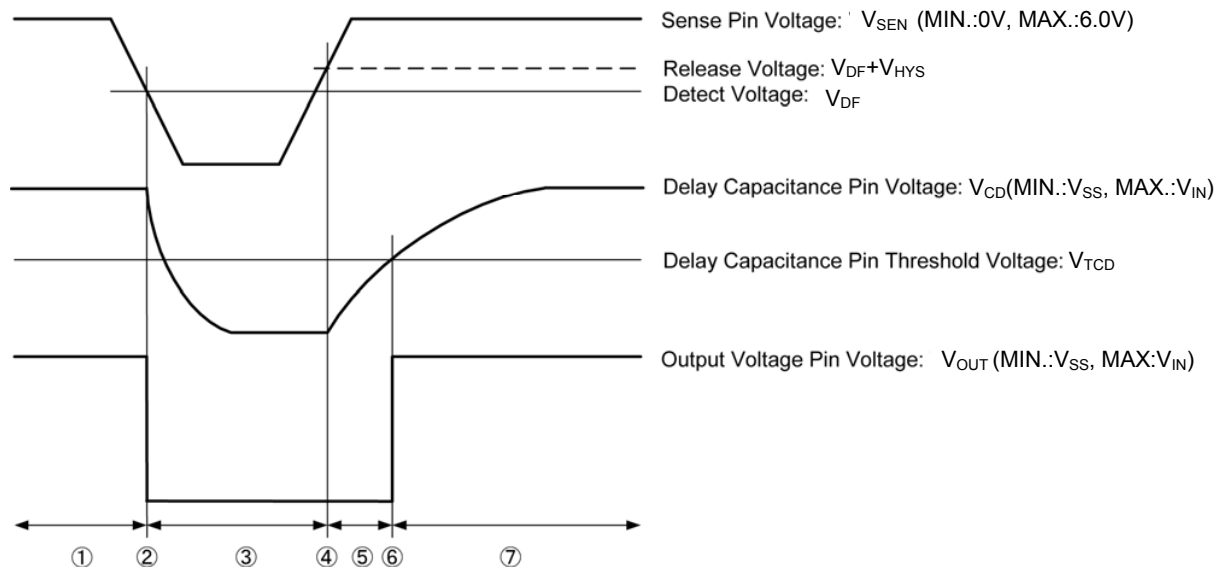
OPERATIONAL EXPLANATION (Continued)

Figure 1: Typical application circuit example



*The XC6108N series (N-ch open drain output) requires a pull-up resistor for pulling up output.

Figure 2: The timing chart of Figure 1



NOTES ON USE

1. Use this IC within the stated maximum ratings. Operation beyond these limits may cause degrading or permanent damage to the device.
2. The power supply input pin voltage drops by the resistance between power supply and the V_{IN} pin, and by through current at operation of the IC. At this time, the operation may be wrong if the power supply input pin voltage falls below the minimum operating voltage range. In CMOS output, for output current, drops in the power supply input pin voltage similarly occur. Moreover, in CMOS output, when the V_{IN} pin and the sense pin are short-circuited and used, oscillation of the circuit may occur if the drops in voltage, which caused by through current at operation of the IC, exceed the hysteresis voltage. Note it especially when you use the IC with the V_{IN} pin connected to a resistor.
3. When the setting voltage is less than 1.0V, be sure to separate the V_{IN} pin and the sense pin, and to apply the voltage over 1.0V to the V_{IN} pin.
4. Note that a rapid and high fluctuation of the power supply input pin voltage may cause a wrong operation.
5. Power supply noise may cause operational function errors, Care must be taken to put the capacitor between V_{IN} -GND and test on the board carefully.
6. When there is a possibility of which the power supply input pin voltage falls rapidly (e.g.: 6.0V to 0V) at release operation with the delay capacitance pin (C_d) connected to a capacitor, use a schottky barrier diode connected between the V_{IN} pin and the C_d pin as the Figure 3 shown below.
6. In N channel open drain output, V_{OUT} voltage at detect and release is determined by resistance of a pull up resistor connected at the V_{OUT} pin. Please choose proper resistance values with referring to Figure 4;

During detection : $V_{OUT} = V_{pull} / (1 + R_{pull} / R_{ON})$

V_{pull} : Pull up voltage

$R_{ON}(\times 1)$: On resistance of N channel driver M3 can be calculated as V_{DS} / I_{OUT1} from electrical characteristics,

For example, when $(\times 2)$ $R_{ON} = 0.5 / 0.8 \times 10^{-3} = 625 \Omega$ (MIN.) at $V_{IN}=2.0V$, $V_{pull} = 3.0V$ and $V_{OUT} \leq 0.1V$ at detect,

$$R_{pull} = (V_{pull} / V_{OUT} - 1) \times R_{ON} = (3 / 0.1 - 1) \times 625 \approx 18 k \Omega$$

In this case, R_{pull} should be selected higher or equal to 18k Ω in order to keep the output voltage less than 0.1V during detection.

$(\times 1)$ R_{ON} is bigger when V_{IN} is smaller, be noted.

$(\times 2)$ For calculation, Minimum V_{IN} should be chosen among the input voltage range.

During releasing : $V_{OUT} = V_{pull} / (1 + R_{pull} / R_{off})$

V_{pull} : Pull up voltage

R_{off} : On resistance of N channel driver M3 is 15M Ω (MIN.) when the driver is off (as to V_{OUT} / I_{LEAK})

For example : when $V_{pull} = 6.0V$ and $V_{OUT} \geq 5.99V$,

$$R_{pull} = (V_{pull} / V_{OUT} - 1) \times R_{off} = (6 / 5.99 - 1) \times 15 \times 10^6 \approx 25k \Omega$$

In this case, R_{pull} should be selected smaller or equal to 25k Ω in order to obtain output voltage higher than 5.99V during releasing.

Figure 3: Circuit example with the delay capacitance pin (C_d) connected to a schottky barrier diode

Figure 4: Circuit example of XC6108N Series

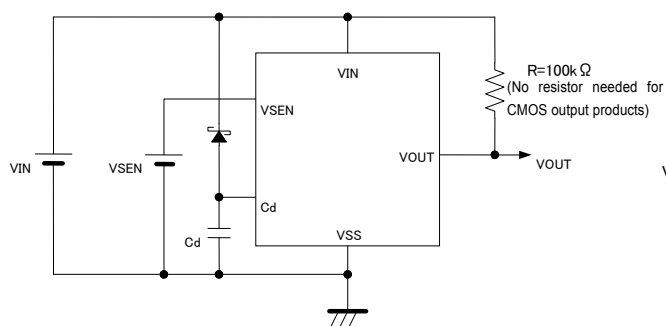
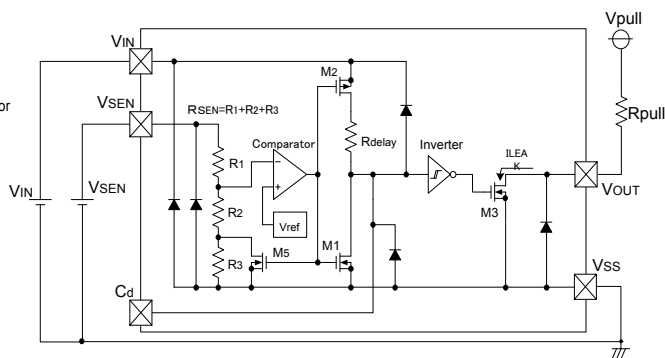


Figure 3

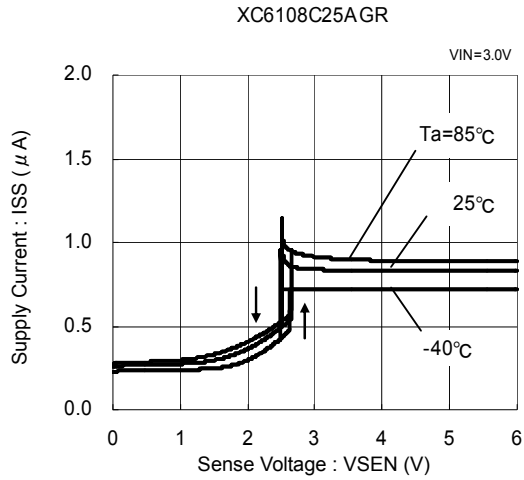


NOTE : $R_{off} = V_{OUT} / I_{LEAK}$

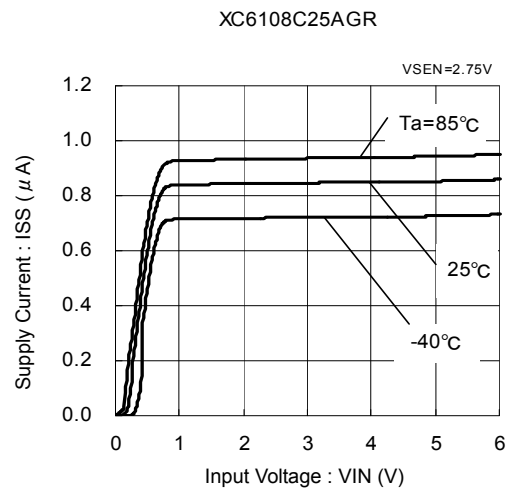
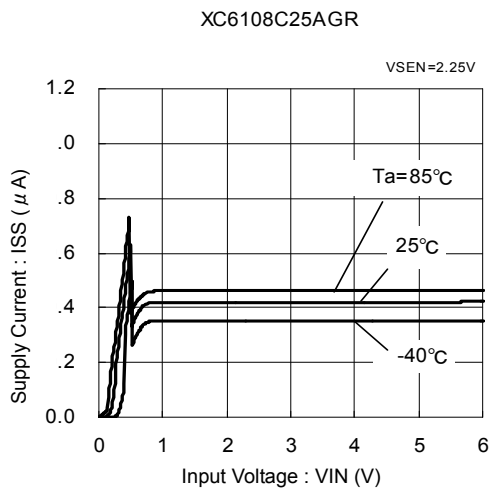
Figure 4

TYPICAL PERFORMANCE CHARACTERISTICS

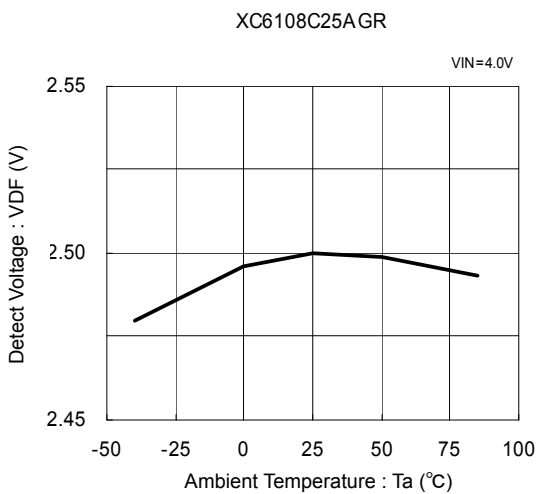
(1) Supply Current vs. Sense Voltage



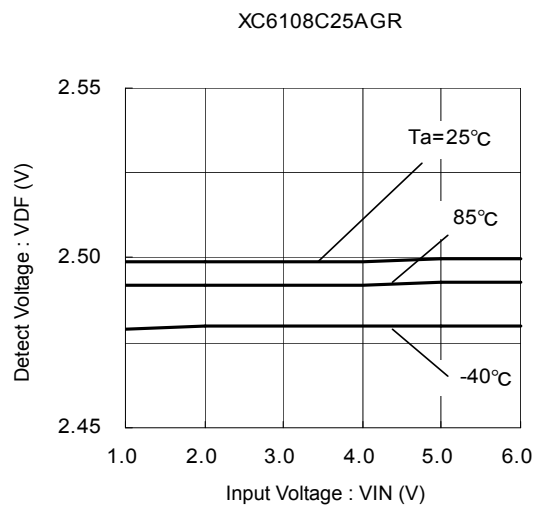
(2) Supply Current vs. Input Voltage



(3) Detect Voltage vs. Ambient Temperature

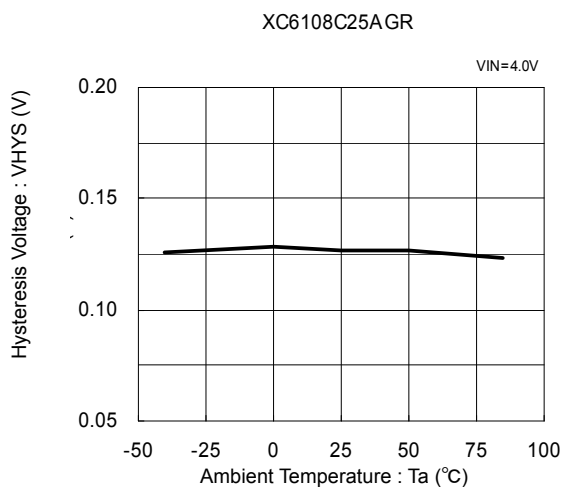


(4) Detect Voltage vs. Input Voltage

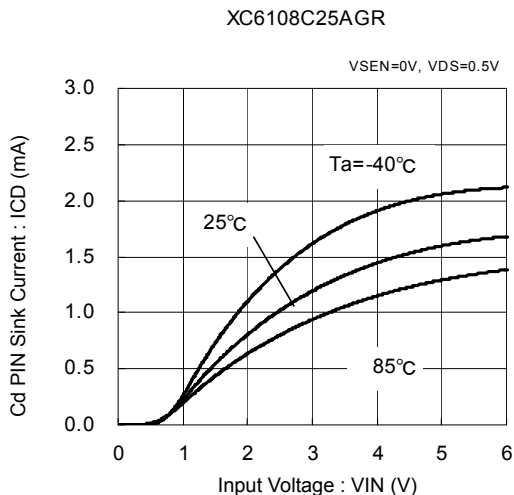


■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

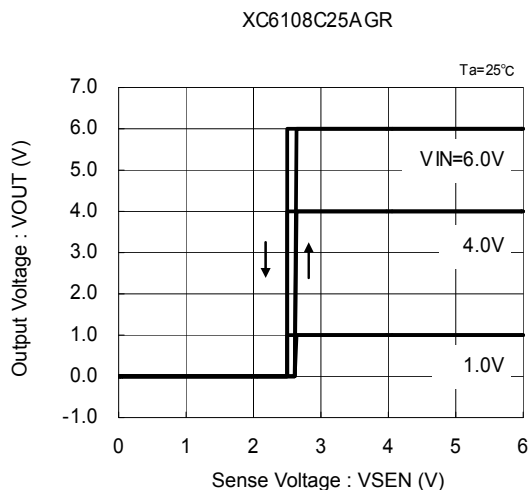
(5) Hysteresis Voltage vs. Ambient Temperature



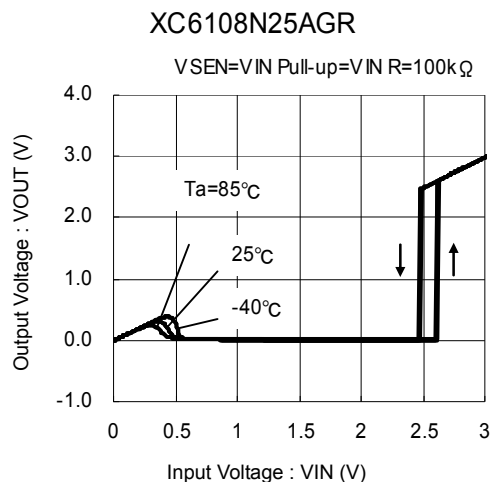
(6) CD Pin Sink Current vs. Input Voltage



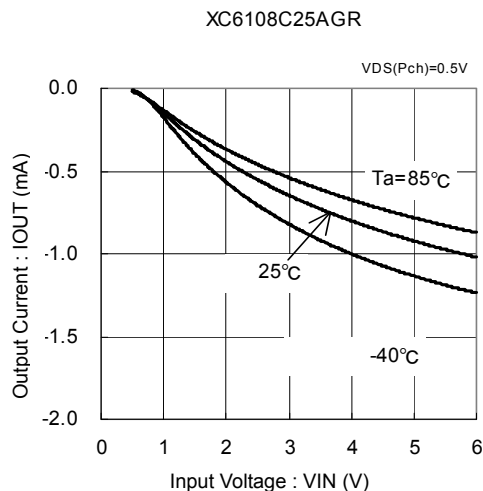
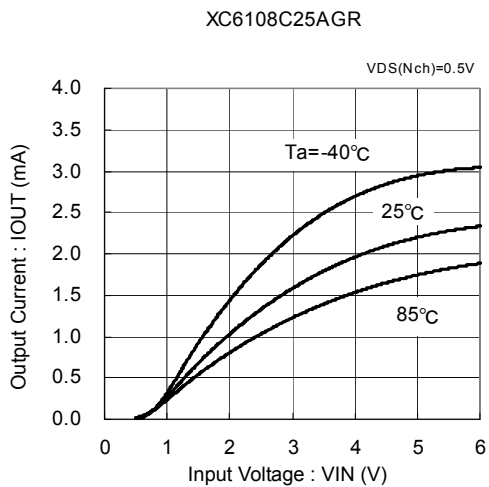
(7) Output Voltage vs. Sense Voltage



(8) Output Voltage vs. Input Voltage

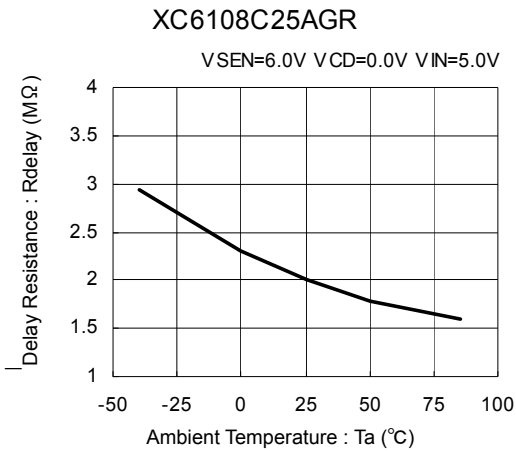


(9) Output Current vs. Input Voltage

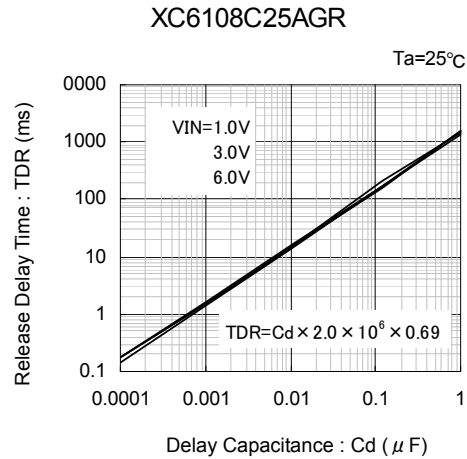


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

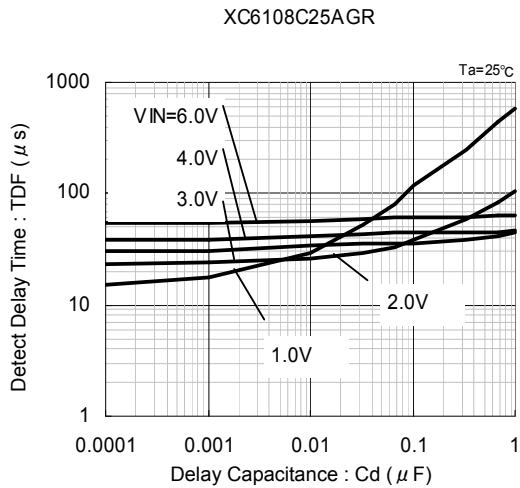
(10) Delay Resistance vs. Ambient Temperature



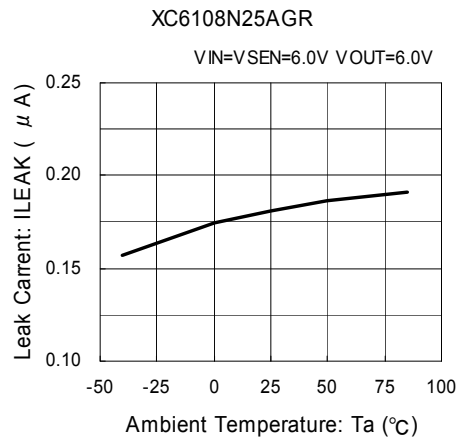
(11) Release Delay Time vs. Delay Capacitance



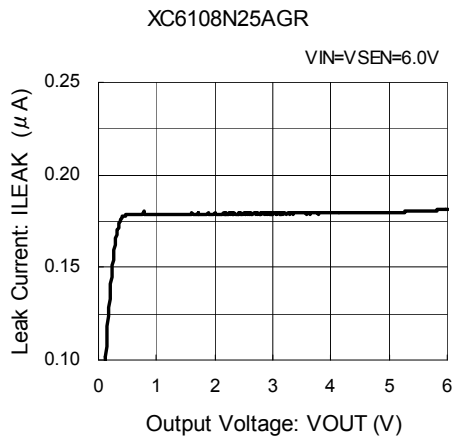
(12) Detect Delay Time vs. Delay Capacitance



(13) Leakage Current vs. Ambient Temperature

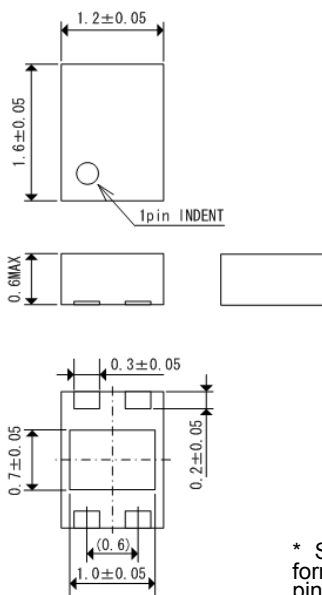


(14) Leakage Current vs. Supply Voltage



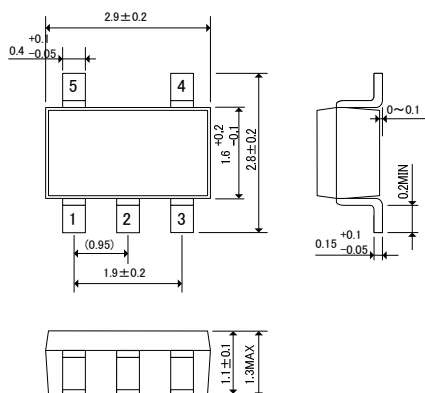
■ PACKAGING INFORMATION

● USP-4



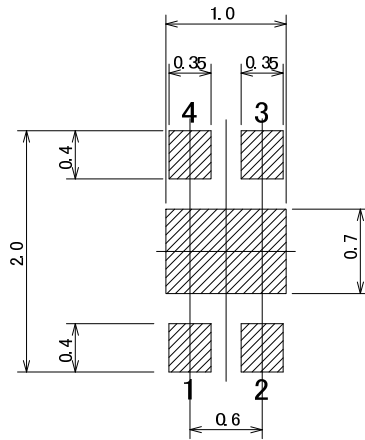
* Soldering fillet surface is not formed because the sides of the pins are plated.

● SOT-25

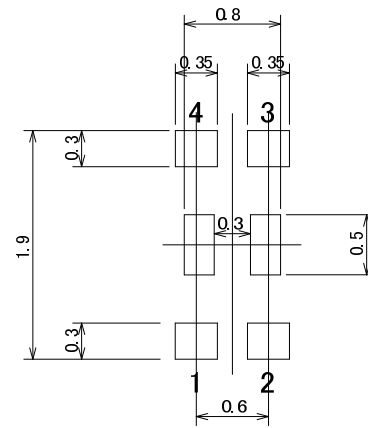


PACKAGING INFORMATION (Continued)

● USP-4 Reference Pattern Layout

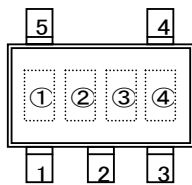


● USP-4 Reference Metal Mask Design



MARKING RULE

●SOT-25



SOT-25
(TOP VIEW)

① represents output configuration and integer number of detect voltage

CMOS Output (XC6108C Series)

| MARK | VOLTAGE (V) |
|------|-------------|
| A | 0.x |
| B | 1.x |
| C | 2.x |
| D | 3.x |
| E | 4.x |
| F | 5.x |

N-ch Open Drain Output (XC6108N Series)

| MARK | VOLTAGE (V) |
|------|-------------|
| K | 0.x |
| L | 1.x |
| M | 2.x |
| N | 3.x |
| P | 4.x |
| R | 5.x |

② represents decimal number of detect voltage
(ex.)

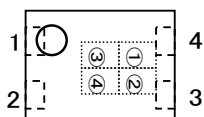
| MARK | VOLTAGE (V) | PRODUCT SERIES |
|------|-------------|----------------|
| 3 | x.3 | XC6108xx3xxx |
| 0 | x.0 | XC6108xx0xxx |

③ represents options

| MARK | OPTIONS | PRODUCT SERIES |
|------|---|----------------|
| A | Built-in delay capacitance pin with hysteresis 5% (TYP.) (Standard) | XC6108xxxAxx |
| B | Built-in delay capacitance pin with hysteresis less than 1% (Standard) | XC6108xxxBxx |
| C | No built-in delay capacitance pin with hysteresis 5% (TYP.) (Semi-custom) | XC6108xxxCxx |
| D | No built-in delay capacitance pin with hysteresis less than 1% (Semi-custom) | XC6108xxxDxx |

④ represents production lot number
0 to 9, A to Z or inverted characters of 0 to 9, A to Z repeated.
(G, I, J, O, Q, W excluded)

●USP-4



USP-4
(TOP VIEW)

① represents output configuration and integer number of detect voltage

CMOS Output (XC6108C Series)

| MARK | VOLTAGE (V) |
|------|-------------|
| A | 0.x |
| B | 1.x |
| C | 2.x |
| D | 3.x |
| E | 4.x |
| F | 5.x |

N-ch Open Drain Output (XC6108N Series)

| MARK | VOLTAGE (V) |
|------|-------------|
| K | 0.x |
| L | 1.x |
| M | 2.x |
| N | 3.x |
| P | 4.x |
| R | 5.x |

② represents decimal number of detect voltage
(ex.)

| MARK | VOLTAGE (V) | PRODUCT SERIES |
|------|-------------|----------------|
| 3 | x.3 | XC6108xx3xxx |
| 0 | x.0 | XC6108xx0xxx |

③ represents options

| MARK | OPTIONS | PRODUCT SERIES |
|------|---|----------------|
| A | Built-in delay capacitance pin with hysteresis 5% (TYP.) (Standard) | XC6108xxxAxx |
| B | Built-in delay capacitance pin with hysteresis less than 1% (Standard) | XC6108xxxBxx |
| C | No built-in delay capacitance pin with hysteresis 5% (TYP.) (Semi-custom) | XC6108xxxCxx |
| D | No built-in delay capacitance pin with hysteresis less than 1% (Semi-custom) | XC6108xxxDxx |

④ represents production lot number
0 to 9, A to Z repeated. (G, I, J, O, Q, W excluded)
*No character inversion used.

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