XC6119 Series

TOREX

Voltage Detector with Delay Time Adjustable

■GENERAL DESCRIPTION

The XC6119 series is a highly precise, low power consumption voltage detector, manufactured using CMOS and laser trimming technologies.

The device includes the built-in delay circuit. A release delay time can be set freely by connecting an external delay capacitor to the Cd pin.

The device using an ultra small package (USPN-4) is suited for high density mounting applications.

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

|	
High Accuracy	: $\pm 2\%$
	(Detection Voltage $\geq 1.5V$)
	$\pm 30mV$
	(Detection Voltage $<1.5V$)
Low Power Consumption	: $0.5\mu A$ TYP. in detect state
	($V_{DF}=1.0V$, $V_{IN}=0.9V$)
	$0.9\mu A$ TYP. in release state
	($V_{DF}=1.0V$, $V_{IN}=1.1V$)
Detect Voltage Options	: 0.8V ~ 5.0V (0.1V increments)
Operating Voltage Range	: 0.7V ~ 6.0V
Detect Voltage Temperature Characteristics	
	: $\pm 100ppm/^{\circ}C$ TYP.
Output Configuration	: CMOS or
	N-channel open drain
Built-In Delay Circuit	: Delay Time Adjustable
Operating Ambient Temperature	: $-40^{\circ}C$ ~ $+85^{\circ}C$
Packages	: SSOT-24, USPN-4
Environmentally Friendly	: EU RoHS Compliant, Pb Free

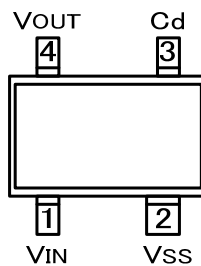## ■TYPICAL APPLICATION CIRCUIT

■TYPICAL PERFORMANCE CHARACTERISTICS
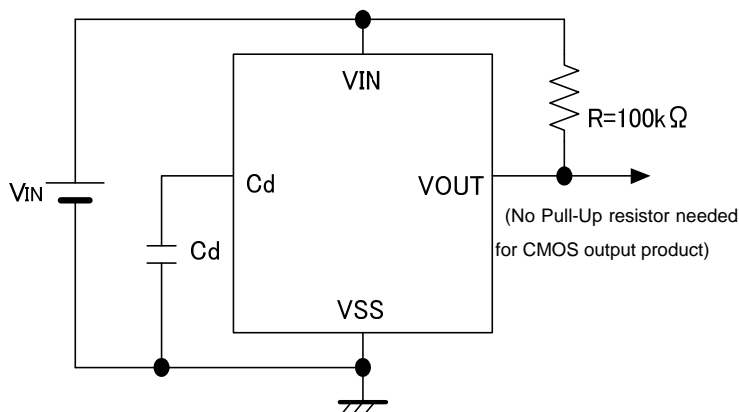
● Release Delay Time vs. Delay Capacitance
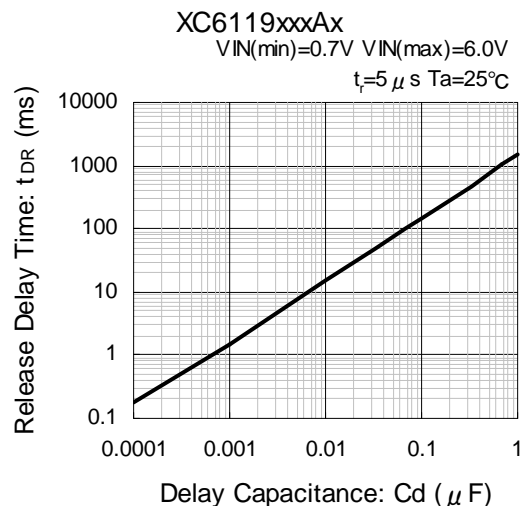
■PIN CONFIGURATION
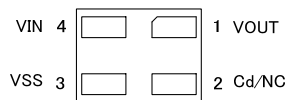
USPN-4
(BOTTOM VIEW)

SSOT-24
（TOP VIEW）

■PIN ASSIGNMENT

PIN NUMBER		PIN NAME	FUNCTION
USPN-4	SSOT-24		
1	4	V_{OUT}	Output (Detect "L")
2	3	Cd	Delay Capacitance
3	2	V_{SS}	Ground
4	1	V_{IN}	Input

■PRODUCT CLASSIFICATION

●Ordering Information

XC6119①②③④⑤⑥−⑦[*1]

| DESIGNATOR	ITEM	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	A	Built-in delay pin & hysteresis 5% (TYP.)
⑤⑥-⑦	Packages (Order Unit)	7R-G	USPN-4 (5,000/Reel)
		NR-G	SSOT-24 (3,000/Reel)

[*1] The "-G" suffix denotes Halogen and Antimony free as well as being fully RoHS compliant.

■BLOCK DIAGRAMS

(1) XC6119C (CMOS Output)
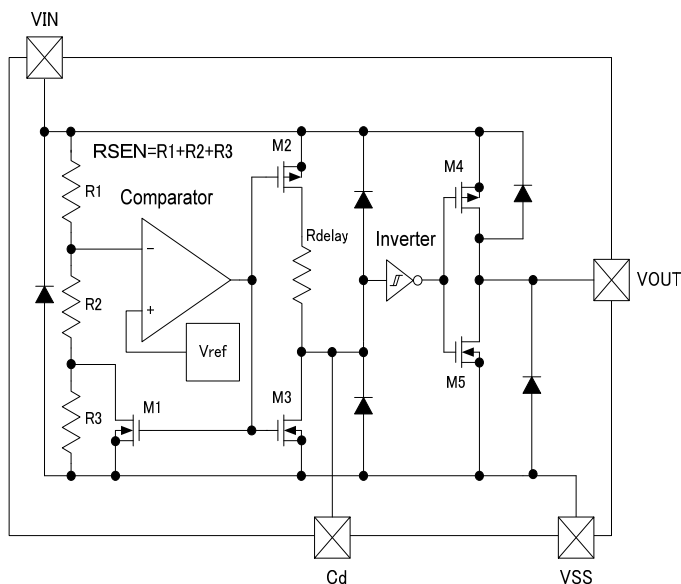
(2) XC6119N (N-ch Open Drain Output)
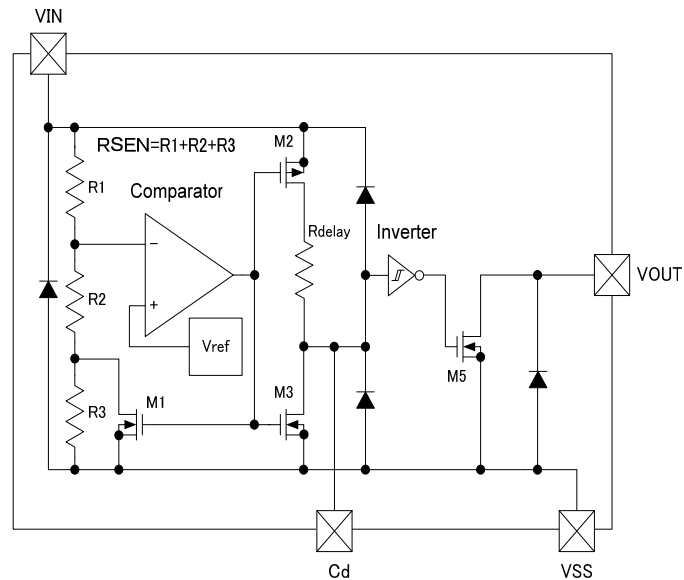
* Diodes inside the circuits are ESD protection diodes and parasitic diodes.

■ABSOLUTE MAXIMUM RATINGS

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	XC6119C (*1)	V_{OUT}	V_{SS}-0.3～V_{IN}+0.3	V
	XC6119N (*2)		V_{SS}-0.3～+7.0	
Delay Pin Voltage		V_{CD}	V_{SS}-0.3～V_{IN}+0.3	V
Delay Pin Current		I_{CD}	5.0	mA
Power Dissipation	USPN-4 *	Pd	100	mW
	SSOT-24		150	
Operating Ambient Temperature		Ta	-40～+85	°C
Storage Temperature		Tstg	-55～+125	°C

NOTE:
*1: CMOS output
*2: N-ch open drain output

■ELECTRICAL CHARACTERISTICS

Ta=25℃

PARAMETER		SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Operating Voltage		V_{IN}	$V_{DF(T)}$=0.8～5.0V [*1]	0.7		6.0	V	-
Detect Voltage		V_{DF}	$V_{DF(T)}$=0.8～5.0V		E-1		V	①
Hysteresis Width		V_{HYS}	V_{IN}=1.0～6.0V	V_{DF} ×0.02	V_{DF} ×0.05	V_{DF} ×0.08	V	①
Supply Current 1		I_{SS1}	V_{IN}=V_{DF}×0.9 $V_{DF(T)}$=0.8～1.9V $V_{DF(T)}$=2.0～3.9V $V_{DF(T)}$=4.0～5.0V		0.5 0.6 0.7	1.2 1.3 1.4	μA	②
Supply Current 2		I_{SS2}	V_{IN}=V_{DF}×1.1 $V_{DF(T)}$=0.8～1.9V $V_{DF(T)}$=2.0～3.9V $V_{DF(T)}$=4.0～5.0V		0.9 1.1 1.2	1.8 2.0 2.2	μA	②
Output Current		I_{OUT1}	V_{IN}=0.7V V_{DS}=0.5V(Nch)	0.01	0.36		mA	③
			V_{IN}=1.0V(※2) V_{DS}=0.5V(Nch)	0.1	0.7			
			V_{IN}=2.0V(※3) V_{DS}=0.5V(Nch)	0.8	1.6			
			V_{IN}=3.0V(※4) V_{DS}=0.5V(Nch)	1.2	2.0			
			V_{IN}=4.0V(※5) V_{DS}=0.5V(Nch)	1.6	2.3			
		I_{OUT2} [*6]	V_{IN}=VDF×1.1 V_{DS}=0.5V(Pch)		E-2		mA	④
Leakage Current	CMOS output (P-ch)	I_{LEAK}	V_{IN} = V_{DF}×0.9, V_{OUT} = 0V, Cd: Open		-0.20		μA	③
	N-ch Open Drain Output		V_{IN} = 6.0V, V_{OUT} = 6.0V, Cd: Open		0.20	0.40		
Temperature Characteristics		$\Delta V_{DF}/ (\Delta Ta \cdot V_{DF})$	-40℃≦T_a≦85℃		±100		ppm/℃	①
Delay Resistance [*7]		R_{DELAY}	V_{IN}=6.0V, Cd=0V	1.6	2.0	2.4	MΩ	⑤
Delay Pin Sink Current		I_{CD}	Cd=0.5V, V_{IN}=0.7V	8	60		μA	⑤
Delay Capacitance Pin Threshold Voltage		V_{TCD}	V_{IN}=1.0V	0.4	0.5	0.6	V	⑥
			V_{IN}=6.0V	2.9	3.0	3.1		
Unspecified Operating Voltage [*8]		V_{UNS}	V_{IN}=0～0.7V		0.3	0.4	V	⑦
Detect Delay Time [*9]		t_{DF0}	V_{IN}=6.0→0.7V Cd: Open		30	230	μs	⑧
Detect Delay Time [*9]		t_{DR0}	V_{IN}=0.7V→6.0V Cd: Open		30	200	μs	⑧

NOTE:
*1: VDF(T): Setting Detect Voltage
*2: VDF(T)＞1.0V
*3: VDF(T)＞2.0V
*4: VDF(T)＞3.0V
*5: VDF(T)＞4.0V
*6: This numerical value is applied only to the XC6119C series (CMOS output).
*7: Calculated from the voltage value and the current value of both ends of the resistor.
*8: The maximum voltage of the VOUT in the range of the VIN 0 to 0.7V. This numerical value is applied only to the XC6119C series (CMOS output).
*9: Time which ranges from the state of VIN =VDF to the VOUT reaching 0.6V when the VIN falls without connecting to the Cd pin.
*10: Time which ranges from the state of VIN= VDF +VHYS to the VOUT reaching 5.4V when the VIN rises without connecting to the Cd pin.

■VOLTAGE CHART

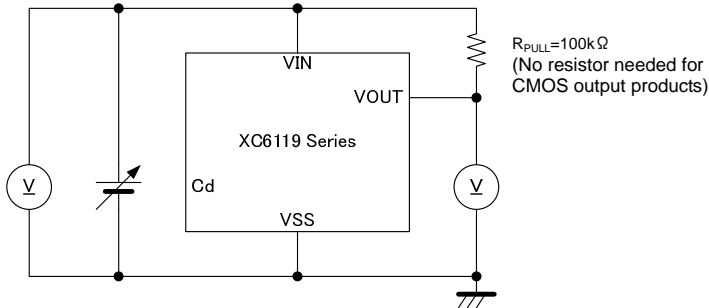| SYMBOL	E-1			E-2	
PARAMETER SETTING DETECT VOLTAGE	DETECT VOLTAGE [*1] (V)			OUTPUT CURRENT [*2] (mA)	
$V_{DF(T)}$	V_{DF}			I_{OUT2}	
	MIN.	TYP.	MAX.	MIN.	TYP.
0.8	0.770	0.8	0.830	-0.40	-0.20
0.9	0.870	0.9	0.930		
1.0	0.970	1.0	1.030		
1.1	1.070	1.1	1.130	-0.60	-0.30
1.2	1.170	1.2	1.230		
1.3	1.270	1.3	1.330		
1.4	1.370	1.4	1.430		
1.5	1.470	1.5	1.530	-0.80	-0.40
1.6	1.568	1.6	1.632		
1.7	1.666	1.7	1.734		
1.8	1.764	1.8	1.836		
1.9	1.862	1.9	1.938		
2.0	1.960	2.0	2.040	-1.00	-0.50
2.1	2.058	2.1	2.142		
2.2	2.156	2.2	2.244		
2.3	2.254	2.3	2.346		
2.4	2.352	2.4	2.448		
2.5	2.450	2.5	2.550		
2.6	2.548	2.6	2.652		
2.7	2.646	2.7	2.754		
2.8	2.744	2.8	2.856		
2.9	2.842	2.9	2.958		
3.0	2.940	3.0	3.060	-1.20	-0.60
3.1	3.038	3.1	3.162		
3.2	3.136	3.2	3.264		
3.3	3.234	3.3	3.366		
3.4	3.332	3.4	3.468		
3.5	3.430	3.5	3.570		
3.6	3.528	3.6	3.672		
3.7	3.626	3.7	3.774		
3.8	3.724	3.8	3.876		
3.9	3.822	3.9	3.978		
4.0	3.920	4.0	4.080	-1.30	-0.65
4.1	4.018	4.1	4.182		
4.2	4.116	4.2	4.284		
4.3	4.214	4.3	4.386		
4.4	4.321	4.4	4.488		
4.5	4.410	4.5	4.590		
4.6	4.508	4.6	4.692		
4.7	4.606	4.7	4.794		
4.8	4.704	4.8	4.896		
4.9	4.802	4.9	4.998		
5.0	4.900	5.0	5.100		

NOTE:

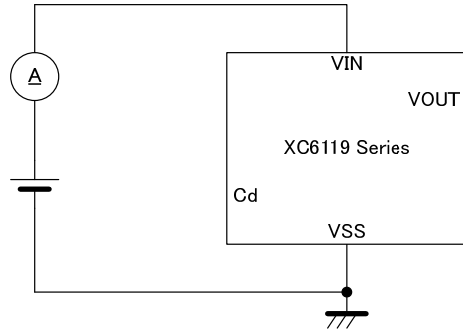*1: When VDF(T)≦1.4V, the detection accuracy is ±30mV.   When VDF(T)≧1.5V, the detection accuracy is ±2%.

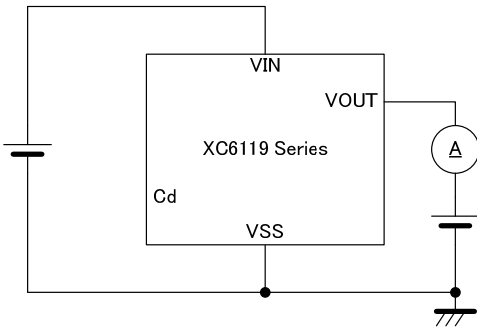*2: This numerical value is applied only to the XC6119C series (CMOS output).

■TEST CIRCUITS

Circuit 1
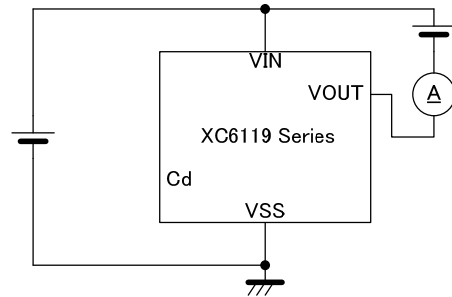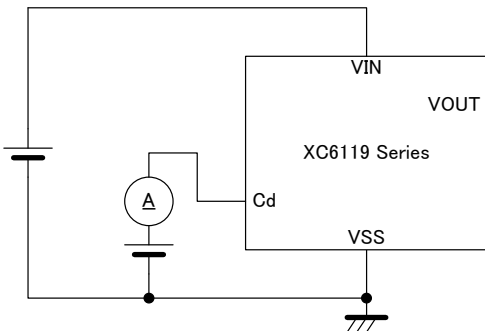

R$_{PULL}$=100kΩ
(No resistor needed for CMOS output products)

Circuit 2

Circuit 3

Circuit 4

Circuit 5

Circuit 6

R$_{PULL}$=100kΩ
(No resistor needed for CMOS output

Circuit 7

Circuit 8
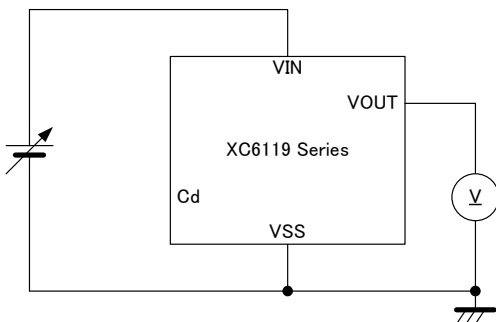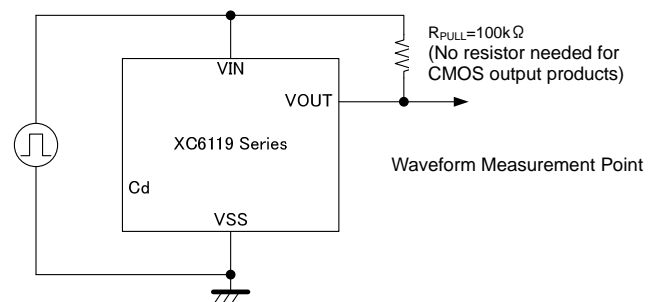

R$_{PULL}$=100kΩ
(No resistor needed for CMOS output products)

Waveform Measurement Point
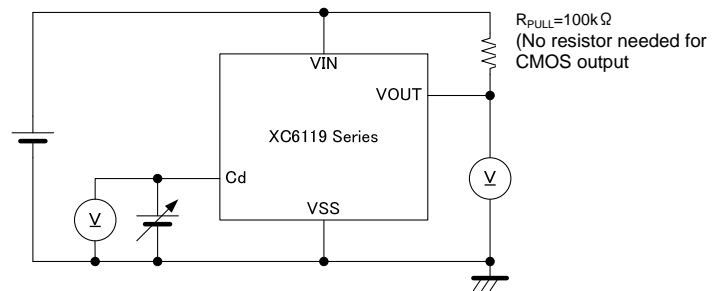
■OPERATIONAL EXPLANATION

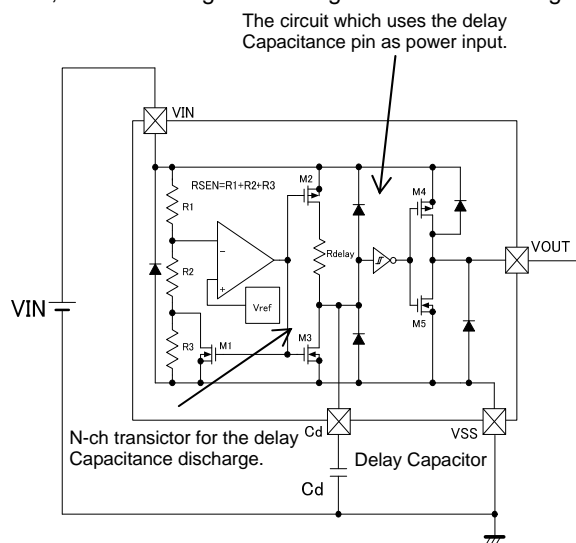A typical circuit example is shown in Figure 1, and the timing chart of Figure 1 is shown in Figure 2 on the next page.

Figure 1: Typical application circuit example
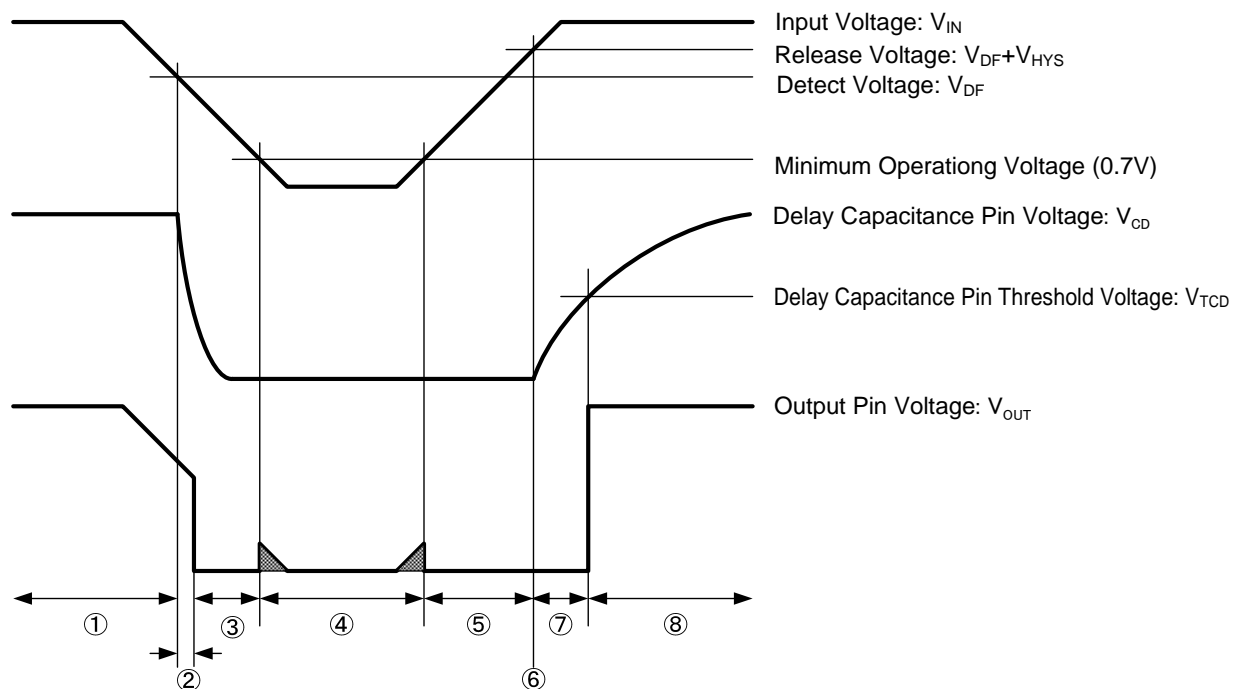
Figure 2: The timing chart of Figure 1

① As an early state, the input voltage pin is applied sufficiently high voltage to the release voltage and the delay capacitance (Cd) is charged to the input pin voltage. While the input pin voltage (V_{IN}) starts dropping to reach the detect voltage (V_{DF}) ($V_{IN} > V_{DF}$), the output voltage (V_{OUT}) keeps the "High" level (=V_{IN}).

② When the input pin voltage keeps dropping and becomes equal to the detect voltage ($V_{IN} = V_{DF}$), an N-ch transistor for the delay capacitance discharge is turned ON, and starts to discharge the delay capacitance. For the internal circuit, which uses the delay capacitance pin as power input, the reference voltage operates as a comparator of VIN, and the output voltage changes into the "Low" level ($\leqq V_{IN} \times 0.1$). The detect delay time (t_{DF}) is defined as time which ranges from $V_{IN} = V_{DF}$ to the V_{OUT} of "Low" level (especially, when the Cd pin is not connected: t_{DF0}).

③ While the input pin voltage keeps below the detect voltage, and 0.7V or more, the delay capacitance is discharged to the ground voltage (=V_{SS}) level. Then, the output voltage (V_{OUT}) maintains the "Low" level.

④ While the input pin voltage drops to less than 0.7V and it increases again to 0.7V or more, the output voltage may not be able to maintain the "Low" level. Such an operation is called "Unspecified Operation", and voltage which occurs at the output pin voltage is defined as unstable operating voltage (V_{UNS}).

TOREX

■OPERATIONAL EXPLANATION (Continued)

⑤ While the input pin voltage increases more than 0.7V and it reaches to the release voltage level ($V_{IN} < V_{DF} + V_{HYS}$), the output voltage ($V_{OUT}$) maintains the "Low" level.

⑥ When the input pin voltage continues to increase more than 0.7V up to the release voltage level (= V_{DF} + V_{HYS}), the N-ch transistor for the delay capacitance discharge will be turned OFF, and the delay capacitance will be started discharging via a delay resistor (R_{DELAY}). The internal circuit, which uses the delay capacitance pin as power input, will operate as a hysteresis comparator (Rise Logic Threshold: $V_{TLH} = V_{TCD}$, Fall Logic Threshold: $V_{THL} = V_{SS}$) while the input pin voltage keeps higher than the detect voltage ($V_{IN} > V_{DF}$).

⑦ While the input pin voltage becomes equal to the release voltage or higher and keeps the detect voltage or higher, the delay capacitance (Cd) will be charged up to the input pin voltage. When the delay capacitance pin voltage (V_{CD}) reaches to the delay capacitance pin threshold voltage (V_{TCD}), the output voltage changes into the "High" (=V_{IN}) level. t_{DR} is defined as time which ranges from $V_{IN} = V_{DF} + V_{HYS}$ to the V_{OUT} of "High" level (especially when the Cd pin is not connected: t_{DR0}). t_{DR} can be given by the formula (1).

$$t_{DR} = -R_{DELAY} \times Cd \times ln\ (1 - VTCD\ /\ VIN) + t_{DR0} \cdots (1)$$
$$* \ ln = a\ natural\ logarithm$$

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 threshold voltage is VIN /2 (TYP.)

$$t_{DR} = R_{DELAY} \times Cd \times 0.69 \cdots (2)$$

* R_{DELAY} is 2.0MΩ (TYP.)

As an example, presuming that the delay capacitance is 0.68 μF, t_{DR} 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 is not discharged to the ground (=V_{SS}) level because time described in ③ is short.

⑧ While the input pin voltage is higher than the detect voltage ($V_{IN} > V_{DF}$), therefore, the output voltage maintains the "High"(=V_{IN}) level.

●Release Delay Time Chart

Delay Capacitance [Cd] (μF)	Release Delay Time [tDR] (TYP.) (ms)	Release Delay Time [tDR] (MIN. ~ MAX.) *1 (ms)
0.01	13.8	11.0 ~ 16.6
0.022	30.4	24.3 ~ 36.4
0.047	64.9	51.9 ~ 77.8
0.1	138	110 ~ 166
0.22	304	243 ~ 364
0.47	649	519 ~ 778
1	1380	1100 ~ 1660

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

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

■NOTES ON USE

1. Please use this IC within the stated maximum ratings. For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.

2. The input pin voltage drops by the resistance between power supply and the VIN pin, and by through current at operation of the IC.　At this time, the operation may be wrong if the input pin voltage falls below the minimum operating voltage range. In CMOS output, for output current, drops in the input pin voltage similarly occur.　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 VIN pin connected to a resistor.

3. Note that a rapid and high fluctuation of the input pin voltage may cause a wrong operation.

4. Power supply noise may cause an operational function error. Care must be taken to put an external capacitor between V_{IN}-GND and test on the board carefully.

5. When there is a possibility of which the input pin voltage falls rapidly (e.g.: 6.0V to 0V) at release operation with the delay capacitance pin (Cd) connected to a capacitor, use a schottky barrier diode connected between the VIN pin and the Cd pin as the Figure 3 shown below.

6. When N-channel open drain output is used, output voltages V_{OUT} at voltage detection and release are determined by a pull-up resistor tied to the output pin.　A resistance value of the pull-up resistor can be selected with referring to the followings. (Refer to Figure 4)

    During detection, the formula is given as
    $$V_{OUT}=V_{PULL}/(1+R_{PULL}/R_{ON})$$
    where V_{PULL} is pull-up voltage and R_{ON} (*1) is ON resistance of N-channel driver M5 ($R_{ON}=V_{DS}/I_{OUT1}$ from the electrical characteristics table).

    For example, when V_{IN}=2.0V (*2), $R_{ON} = 0.5/0.8\times10^{-3}$=625Ω(MIN.) and if you want to get V_{OUT} less than 0.1V when V_{PULL}=3.0V, R_{PULL} can be calculated as follows;
    $$R_{PULL}=(V_{PULL}/V_{OUT}-1)\times R_{ON}=(3/0.1-1)\times625\fallingdotseq18 k Ω$$
    Therefore, pull-up resistance should be selected 18kΩ or higher.
    (*1) V_{IN} is smaller, R_{ON} is bigger
    (*2) For the calculation, the lowest V_{IN} should be used among of the V_{IN} range

    During release, the formula is given as
    $$V_{OUT}=V_{PULL}/(1+R_{PULL}/R_{OFF})$$
    where V_{PULL} is pull-up voltage R_{OFF} is OFF resistance of N-channel driver M5 ($R_{OFF}=V_{OUT}/I_{LEAK}$=15MΩ from the electrical characteristics table)

    For examples, if you want to get V_{OUT} larger than 5.99V when V_{PULL} is 6.0V, R_{PULL} can be calculated as follows;
    $$R_{PULL}=(V_{PULL}/V_{OUT}-1)\times R_{OFF}=(6/5.99-1)\times15\times10^6\fallingdotseq25k Ω$$
    Therefore, pull-up resistance should be selected 25kΩ or below.

7. Torex places an importance on improving our products and their reliability. We request that users incorporate fail-safe designs and post-aging protection treatment when using Torex products in their systems.
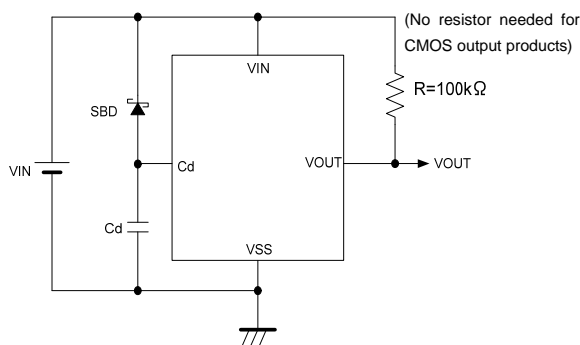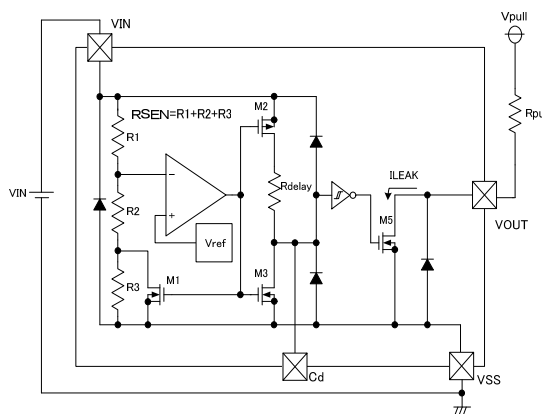

Figure 3: Circuit example with the delay capacitance pin (Cd) connected to a schottky barrier diode
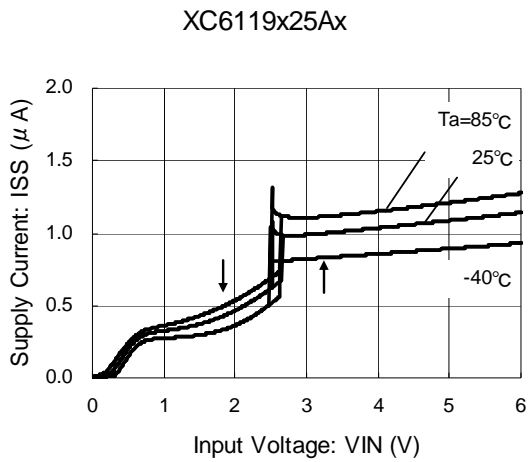

Note: $R_{OFF}=V_{OUT}/I_{LEAK}$
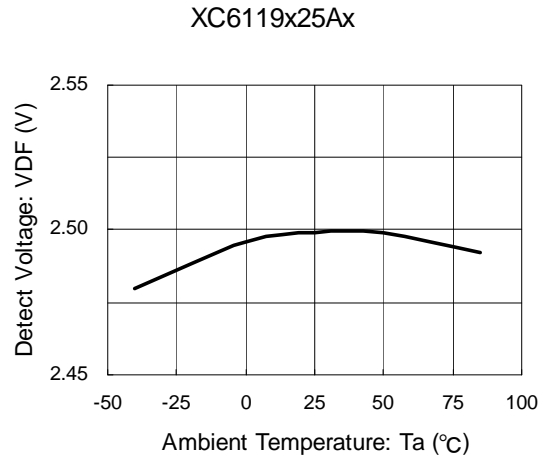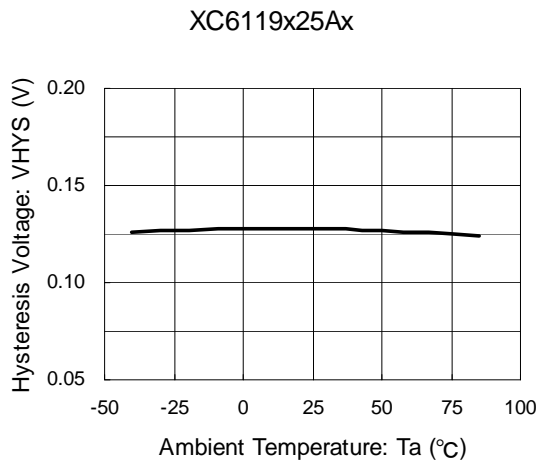Figure 4: Circuit example of XC6109N Series

TOREX

■TYPICAL PERFORMANCE CHARACTERISTICS
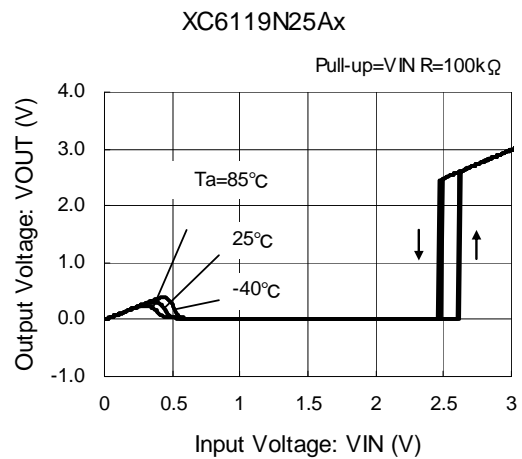
(1) Supply Current vs. Input Voltage

(2) Detect Voltage vs. Ambient Temperature

XC6119x25Ax

XC6119x25Ax

(3) Hysteresis Voltage vs. Ambient Temperature

XC6119x25Ax

(4) Output Voltage vs. Input Voltage

XC6119C25Ax

XC6119N25Ax
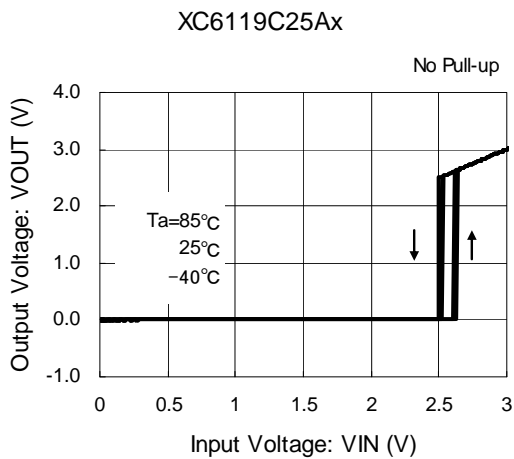
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(5) Output Current vs. Input Voltage

XC6119x50Ax

VDS(nch)=0.5V

Ta=-40℃
25℃
85℃

Output Current: IOUT (mA)
Input Voltage: VIN (V)

XC6119C08Ax

VDS(pch)=0.5V

Ta=85℃
25℃
-40℃

Output Current: IOUT (mA)
Input Voltage: VIN (V)
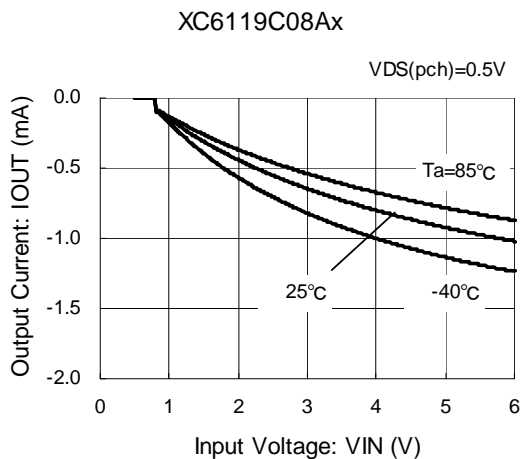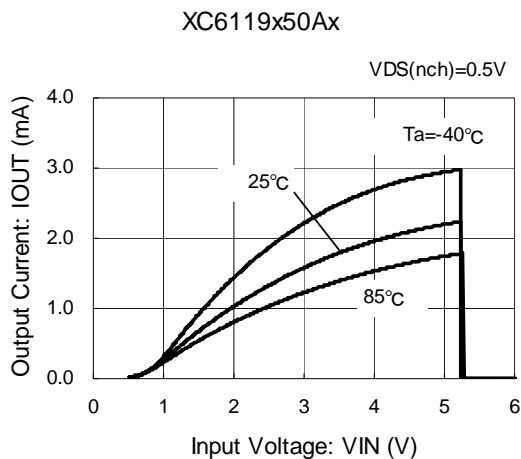
(6) Cd Pin Sink Current vs. Input Voltage

XC6119x50Ax

VDS=0.5V

Ta=-40℃
25℃
85℃

Cd PIN Current: ICD (mA)
Input Voltage: VIN (V)
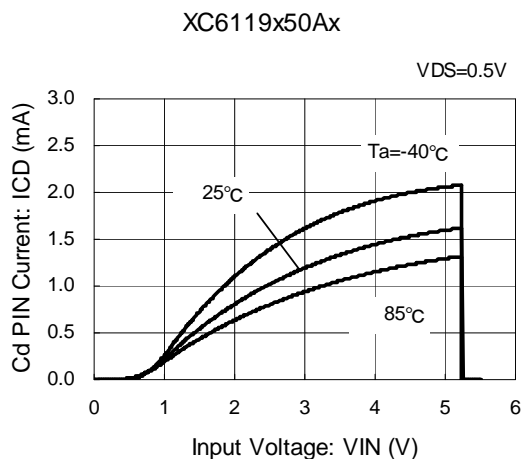
(7) Delay Resistance vs. Ambient Temperature

XC6119xxxAx

VCD=0.0V VIN=6.0V

Delay Resistance: Rdelay (MΩ)
Ambient Temperature: Ta (℃)

(8) Release Delay Time vs. Delay Capacitance

XC6119xxxAx
VIN(min)=0.7V VIN(max)=6.0V
t_r=5μs Ta=25℃

t_{DR}=Cd×2.0×10^6×0.69
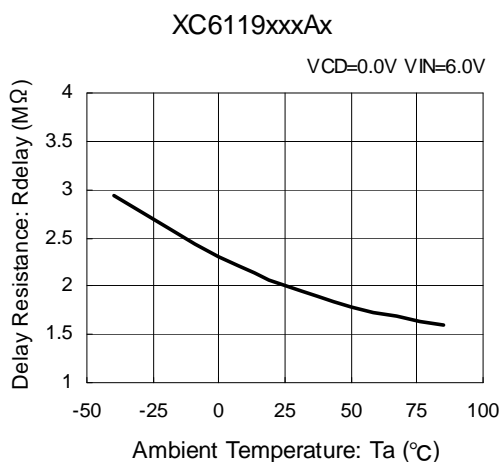
Release Delay Time: t_{DR} (ms)
Delay Capacitance: Cd (μF)
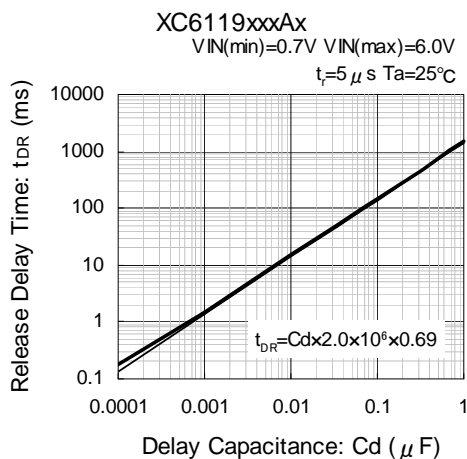
(9) Detect Delay Time vs. Delay Capacitance

XC6119xxxAx
VIN(min)=0.7V VIN(max)=6.0V
t_f=5μs Ta=25℃

Detect Delay Time: t_{DF} (μs)
Delay Capacitance: Cd (μF)
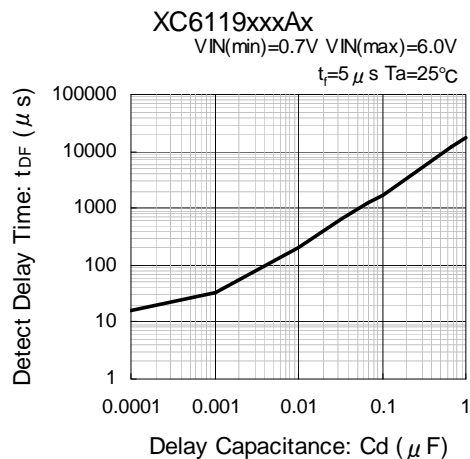
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) Leak Current vs. Ambient Temperature
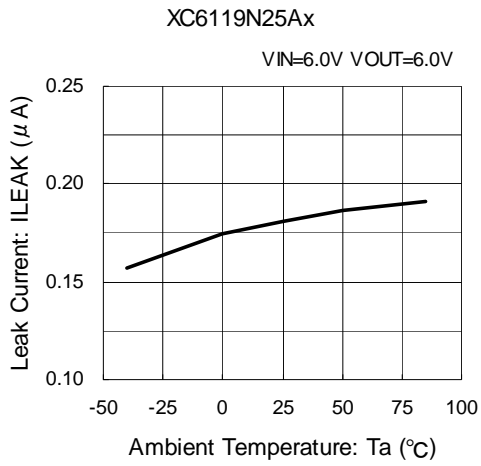
(11) Leak Current vs. Supply Voltage

XC6119N25Ax

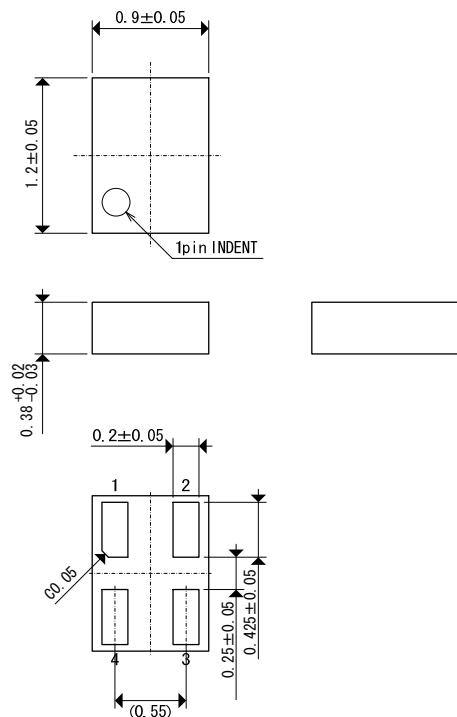VIN=6.0V VOUT=6.0V

XC6119N25Ax

VIN=6.0V
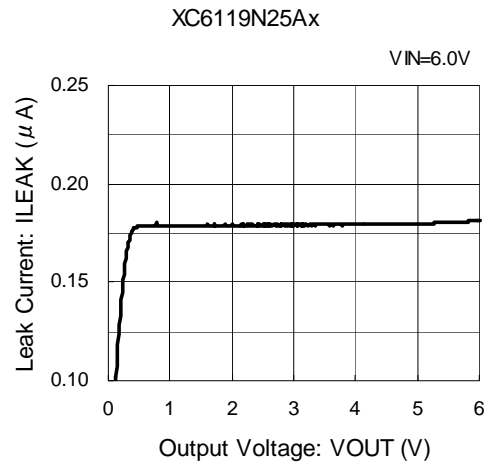
■PACKAGING INFORMATION

●SSOT-24
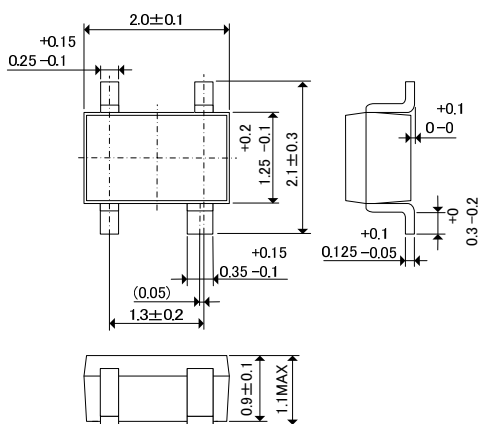
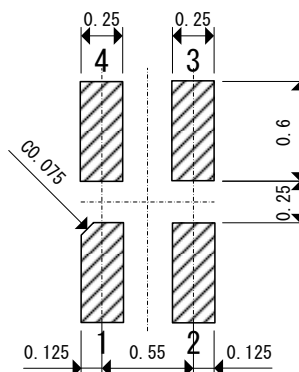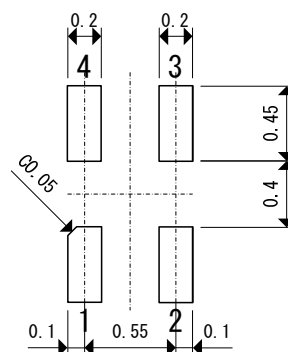## ●USPN-4

（unit : mm）

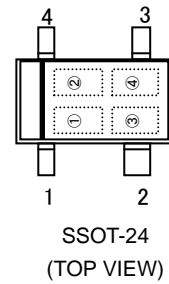●USPN-4　　Reference Pattern Layout

●USPN-4　　Reference Metal Mask Design

■MARKING RULE

● SSOT-24

① represents output configuration and integer number of detect voltage

CMOS Output (XC6119C Series)

MARK	VOLTAGE (V)	PRODUCT SERIES
A	0.X	XC6119C0**N*
B	1.X	XC6119C1**N*
C	2.X	XC6119C2**N*
D	3.X	XC6119C3**N*
E	4.X	XC6119C4**N*
F	5.X	XC6119C5**N*

N-channel Open Drain Output (XC6119N Series)

MARK	VOLTAGE (V)	PRODUCT SERIES
H	0.X	XC6119N0**N*
K	1.X	XC6119N1**N*
L	2.X	XC6119N2**N*
M	3.X	XC6119N3**N*
N	4.X	XC6119N4**N*
P	5.X	XC6119N5**N*

② represents decimal number of detect voltage

MARK	VOLTAGE (V)	PRODUCT SERIES
N	X.0	XC6119**0*N*
P	X.1	XC6119**1*N*
R	X.2	XC6119**2*N*
S	X.3	XC6119**3*N*
T	X.4	XC6119**4*N*
U	X.5	XC6119**5*N*
V	X.6	XC6119**6*N*
X	X.7	XC6119**7*N*
Y	X.8	XC6119**8*N*
Z	X.9	XC6119**9*N*

③④ represents production lot number
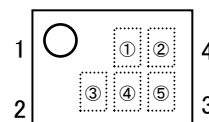01 to 09, 0A to 0Z,11 to 9Z, A1 to A9,AA to Z9,ZA to ZZ repeated (G, I, J, O, Q, W excluded).
Note: No character inversion used.

SSOT-24
(TOP VIEW)

■ MARKING RULE (Continued)

●USPN-4

① represents product series.

MARK	PRODUCT SERIES
B	XC6119******-G

② represents output configuration and integer number of detect voltage

USPN-4
(TOP VIEW)

CMOS Output (XC6119C Series)

MARK	VOLTAGE (V)	PRODUCT SERIES
A	0.X	XC6119C0**7*-G
B	1.X	XC6119C1**7*-G
C	2.X	XC6119C2**7*-G
D	3.X	XC6119C3**7*-G
E	4.X	XC6119C4**7*-G
F	5.X	XC6119C5**7*-G

N-channel Open Drain Output (XC6119N Series)

MARK	VOLTAGE (V)	PRODUCT SERIES
H	0.X	XC6119N0**7*-G
K	1.X	XC6119N1**7*-G
L	2.X	XC6119N2**7*-G
M	3.X	XC6119N3**7*-G
N	4.X	XC6119N4**7*-G
P	5.X	XC6119N5**7*-G

③ represents decimal number of detect voltage

MARK	VOLTAGE (V)	PRODUCT SERIES
N	X.0	XC6119**0*7*-G
P	X.1	XC6119**1*7*-G
R	X.2	XC6119**2*7*-G
S	X.3	XC6119**3*7*-G
T	X.4	XC6119**4*7*-G
U	X.5	XC6119**5*7*-G
V	X.6	XC6119**6*7*-G
X	X.7	XC6119**7*7*-G
Y	X.8	XC6119**8*7*-G
Z	X.9	XC6119**9*7*-G

④⑤ represents production lot number
   01 to 09, 0A to 0Z,11 to 9Z, A1 to A9,AA to Z9,ZA to ZZ repeated (G, I, J, O, Q, W excluded).
   Note: No character inversion used.