*R3112Qxx2 (SC-88A) is the limited product. As of March in 2018.

RICOH

R3112x SERIES

LOW VOLTAGE DETECTOR WITH OUTPUT DELAY

NO. EA-087-160310

OUTLINE

The R3112x Series are CMOS-based voltage detector ICs with high detector threshold accuracy and ultra-low supply current, which can be operated at an extremely low voltage and is used for system reset as an example.

Each of these ICs consists of a voltage reference unit, a comparator, 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.

Three types of packages, SOT-23-5, small SC-82AB, SC-88A and ultra-small SON1612-6 can be selected so that high density mounting on boards is possible.

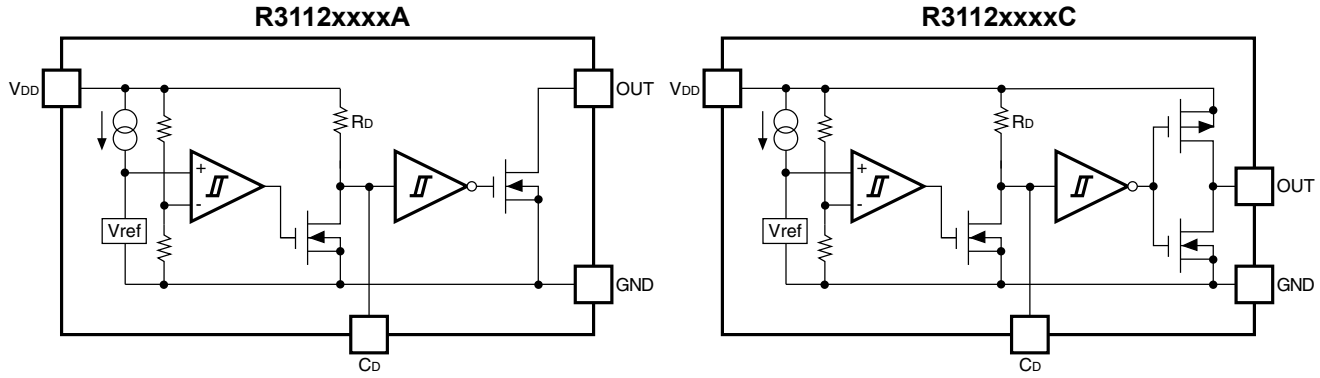
FEATURES

- Built-in Output Delay Circuit ..... Typ. 100ms with an external capacitor: 0.022μF
- Supply Current ..... Typ. 0.5μA (R3112x27xA/C, V_{DD}=2.6V)
- Operating Voltage ..... 0.7 to 6.0V (Topt=25°C)
- Detector Threshold ..... 0.9V to 5.0V (0.1V steps)
- Detector Threshold Accuracy ..... ±2.0%
- Temperature-Drift Coefficient of Detector Threshold ..... Typ. ±100ppm/°C
- Output Types ..... Nch Open Drain and CMOS
- Packages SON1612-6, SC-82AB, SC-88A, SOT-23-5

APPLICATIONS

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

BLOCK DIAGRAMS



SELECTION GUIDE

The package type, the detector threshold, and the output type for the ICs can be selected at the users' request.

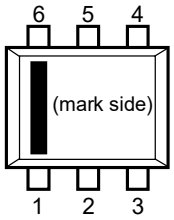
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R3112Dxx1∗-TR-FE	SON1612-6	4,000 pcs	Yes	Yes
R3112Qxx1∗-TR-FE	SC-82AB	3,000 pcs	Yes	Yes
R3112Qxx2∗-TR-FE	SC-88A	3,000 pcs	Yes	Yes
R3112Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx: The detector threshold can be designated in the range from 0.9V(09) to 5.0V(50) in 0.1V steps.

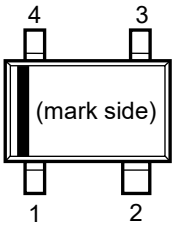
∗ : Designation of Output Type
(A) Nch Open Drain
(C) CMOS

PIN CONFIGURATION

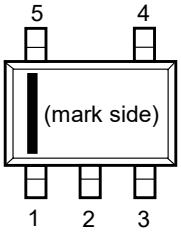
● SON1612-6



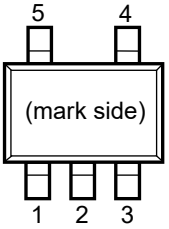
● SC-82AB



● SC-88A



● SOT-23-5



PIN DESCRIPTION

● SON1612-6

Pin No	Symbol	Pin Description
1	OUT	Output Pin (Output "L" at detection)
2	GND	Ground Pin
3	C_D	Pin for External Capacitor (for setting output delay)
4	NC	No Connection
5	GND	Ground Pin
6	V_{DD}	Voltage Supply Pin

● SC-82AB

Pin No	Symbol	Pin Description
1	V_{DD}	Voltage Supply Pin
2	GND	Ground Pin
3	C_D	Pin for External Capacitor (for setting output delay)
4	OUT	Output Pin (Output "L" at detection)

● SC-88A

Pin No	Symbol	Pin Description
1	V_{DD}	Voltage Supply Pin
2	NC	No Connection
3	GND	Ground Pin
4	C_D	Pin for External Capacitor (for setting output delay)
5	OUT	Output Pin (Output "L" at detection)

● SOT-23-5

Pin No	Symbol	Pin Description
1	OUT	Output Pin (Output "L" at detection)
2	V_{DD}	Voltage Supply Pin
3	GND	Ground Pin
4	NC	No Connection
5	C_D	Pin for External Capacitor (for setting output delay)

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{DD}	Supply Voltage	6.5	V
V_{OUT}	Output Voltage (CMOS)	V_{SS}–0.3 to V_{DD}+0.3	V
	Output Voltage (Nch)	V_{SS}–0.3 to 6.5	V
I_{OUT}	Output Current	20	mA
P_D	Power Dissipation (SON1612-6)*	500	mW
	Power Dissipation (SC-82AB)*	380	
	Power Dissipation (SC-88A)*	380	
	Power Dissipation (SOT-23-5)*	420	
Topt	Operating Temperature Range	–40 to 85	°C
Tstg	Storage Temperature Range	–55 to 125	°C

∗) For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field.
The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

- **R3112xxxxA/C**

Topt=25°C

Symbol	Item	Conditions			Min.	Typ.	Max.	Unit
$-V_{DET}$	Detector Threshold				$-V_{DET}$ ×0.98		$-V_{DET}$ ×1.02	V
V_{HYS}	Detector Threshold Hysteresis				$-V_{DET}$ ×0.03	$-V_{DET}$ ×0.05	$-V_{DET}$ ×0.07	V
I_{SS}	Supply Current	$-V_{DET}$<1.1V	$V_{DD}=-V_{DET}-0.1V$			0.6	2.0	µA
			$V_{DD}=-V_{DET}+1.0V$			0.5	2.0	
		1.1V ≤$-V_{DET}$<1.6V	$V_{DD}=-V_{DET}-0.1V$			0.7	2.5	
			$V_{DD}=-V_{DET}+1.0V$			0.5	2.0	
		1.6V ≤$-V_{DET}$<3.1V	$V_{DD}=-V_{DET}-0.1V$			1.0	3.0	
			$V_{DD}=-V_{DET}+1.0V$			0.5	2.5	
		3.1V ≤$-V_{DET}$<4.1V	$V_{DD}=-V_{DET}-0.1V$			1.2	3.0	
			$V_{DD}=-V_{DET}+1.0V$			0.6	2.5	
		4.1V ≤$-V_{DET}$	$V_{DD}=-V_{DET}-0.1V$			1.5	3.0	
			$V_{DD}=-V_{DET}+1.0V$			0.6	2.5	
V_{DDH}	Maximum Operating Voltage						6.0	V
V_{DDL}	Minimum Operating Voltage*	Topt=25°C					0.7	V
		−40°C≤Topt≤85°C					0.8	
I_{OUT}	Output Current (Driver Output Pin)	Nch	$V_{DS}=0.05V$ $V_{DD}=0.7V$		0.01	0.12		mA
			$-V_{DET}$<1.1V	$V_{DS}=0.50V$ $V_{DD}=0.85V$	0.05	0.9		
			1.1V ≤$-V_{DET}$<1.6V	$V_{DS}=0.50V$ $V_{DD}=1.00V$	0.2	1.8		
			1.6V ≤$-V_{DET}$	$V_{DS}=0.50V$ $V_{DD}=1.50V$	1.0	3.0		
		Pch	$-V_{DET}$<4.0V	$V_{DS}=-2.1V$ $V_{DD}=4.50V$	1.5	3.5		mA
			4.0V ≤$-V_{DET}$	$V_{DS}=-2.1V$ $V_{DD}=6.00V$	2.0	4.5		
V_{TCD}	C_D pin Threshold Voltage	$V_{DD}=-V_{DET}\times1.1V$			V_{DD} ×0.3	V_{DD} ×0.5	V_{DD} ×0.7	V
I_{CD}	C_D pin Output Current	$V_{DS}=0.1V$, $V_{DD}=0.7V$			20	70		µA
		$-V_{DET}$<1.1V	$V_{DS}=0.50V$, $V_{DD}=0.85V$		10	400		
		1.1V ≤$-V_{DET}$<1.6V	$V_{DS}=0.50V$, $V_{DD}=1.00V$		50	450		
		1.6V ≤$-V_{DET}$	$V_{DS}=0.50V$, $V_{DD}=1.50V$		200	500		
R_D	Output Delay Resistance				3.25	6.5	13	MΩ
$\Delta-V_{DET}/\Delta Topt$	Detector Threshold Temperature Coefficient	−40°C≤Topt≤85°C				±100		ppm/°C

*) 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.)

ELECTRICAL CHARACTERISTICS BY DETECTOR THRESHOLD

Product Code	Detector Threshold			Hysteresis Range			Supply Current 1			Supply Current 2			Output Current 1			Output Current 2			
	-V_{DET}[V]			V_{HYS}[V]			I_{SS1}[µA]			I_{SS2}[µA]			I_{OUT1}[mA]			I_{OUT2}[mA]			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Condi-tions	Typ.	Max.	Condi-tions	Typ.	Max.	Condi-tions	Min.	Typ.	Conditions		Min.	Typ.
R3112x09xA/C	0.882	0.900	0.918	0.027	0.045	0.063	V_{DD}= -V_{DET} −0.1V	0.6	2.0	V_{DD}= -V_{DET} +1.0V	0.5	2.0	V_{DS}= 0.05V V_{DD}= 0.7V	0.01	0.12	Nch	V_{DS}= 0.5V V_{DD}= 0.85V	0.05	0.9
R3112x10xA/C	0.980	1.000	1.020	0.030	0.050	0.070													
R3112x11xA/C	1.078	1.100	1.122	0.033	0.055	0.077		0.7	2.5								V_{DS}= 0.5V V_{DD}= 1.0V	0.2	1.8
R3112x12xA/C	1.176	1.200	1.224	0.036	0.060	0.084													
R3112x13xA/C	1.274	1.300	1.326	0.039	0.065	0.091													
R3112x14xA/C	1.372	1.400	1.428	0.042	0.070	0.098													
R3112x15xA/C	1.470	1.500	1.530	0.045	0.075	0.105													
R3112x16xA/C	1.568	1.600	1.632	0.048	0.080	0.112		1.0	3.0		0.5	2.5					V_{DS}= 0.5V V_{DD}= 1.5V	1.0	3.0
R3112x17xA/C	1.666	1.700	1.734	0.051	0.085	0.119													
R3112x18xA/C	1.764	1.800	1.836	0.054	0.090	0.126													
R3112x19xA/C	1.862	1.900	1.938	0.057	0.095	0.133													
R3112x20xA/C	1.960	2.000	2.040	0.060	0.100	0.140													
R3112x21xA/C	2.058	2.100	2.142	0.063	0.105	0.147													
R3112x22xA/C	2.156	2.200	2.244	0.066	0.110	0.154													
R3112x23xA/C	2.254	2.300	2.346	0.069	0.115	0.161													
R3112x24xA/C	2.352	2.400	2.448	0.072	0.120	0.168													
R3112x25xA/C	2.450	2.500	2.550	0.075	0.125	0.175													
R3112x26xA/C	2.548	2.600	2.652	0.078	0.130	0.182													
R3112x27xA/C	2.646	2.700	2.754	0.081	0.135	0.189													
R3112x28xA/C	2.744	2.800	2.856	0.084	0.140	0.196													
R3112x29xA/C	2.842	2.900	2.958	0.087	0.145	0.203													
R3112x30xA/C	2.940	3.000	3.060	0.090	0.150	0.210													
R3112x31xA/C	3.038	3.100	3.162	0.093	0.155	0.217		1.2	3.0		0.6	2.5							
R3112x32xA/C	3.136	3.200	3.264	0.096	0.160	0.224													
R3112x33xA/C	3.234	3.300	3.366	0.099	0.165	0.231													
R3112x34xA/C	3.332	3.400	3.468	0.102	0.170	0.238													
R3112x35xA/C	3.430	3.500	3.570	0.105	0.175	0.245													
R3112x36xA/C	3.528	3.600	3.672	0.108	0.180	0.252													
R3112x37xA/C	3.626	3.700	3.774	0.111	0.185	0.259													
R3112x38xA/C	3.724	3.800	3.876	0.114	0.190	0.266													
R3112x39xA/C	3.822	3.900	3.978	0.117	0.195	0.273													
R3112x40xA/C	3.920	4.000	4.080	0.120	0.200	0.280													
R3112x41xA/C	4.018	4.100	4.182	0.123	0.205	0.287		1.5	3.0		0.6	2.5							
R3112x42xA/C	4.116	4.200	4.284	0.126	0.210	0.294													
R3112x43xA/C	4.214	4.300	4.386	0.129	0.215	0.301													
R3112x44xA/C	4.312	4.400	4.488	0.132	0.220	0.308													
R3112x45xA/C	4.410	4.500	4.590	0.135	0.225	0.315													
R3112x46xA/C	4.508	4.600	4.692	0.138	0.230	0.322													
R3112x47xA/C	4.606	4.700	4.794	0.141	0.235	0.329													
R3112x48xA/C	4.704	4.800	4.896	0.144	0.240	0.336													
R3112x49xA/C	4.802	4.900	4.998	0.147	0.245	0.343													
R3112x50xA/C	4.900	5.000	5.100	0.150	0.250	0.350													

Output Current 3				Minimum Operating Voltage				CD pin Threshold Voltage				CD pin Output Current 1			CD pin Output Current 2			Resistance for Output Delay			Detector Threshold Temperature	
I_{OUT3}[mA]				V_{DDL}[V]				V_{TCD}[V]				I_{CD1}[μA]			I_{CD2}[μA]			R_D[MΩ]			Δ-V_{DET}/ ΔTopt [ppm/°C]	
Condition		Min.	Typ.	Condition	Max.	Condition	Max.	Condition	Min.	Typ.	Max.	Condition	Min.	Typ.	Condition	Min.	Typ.	Min.	Typ.	Max.	Condition	Typ.
Pch	V_{DS}= −2.1V V_{DD}= 4.5V	1.5	3.5	Topt= 25°C	0.7	−40°C ≦ Topt ≦ 85°C	0.8	V_{DD}= (-V_{DET}) ×1.1V	0.297	0.495	0.693	V_{DS}= 0.1V V_{DD}= 0.7V	20	70	V_{DS}= 0.5V V_{DD}= 0.85V	10	400	3.25	6.5	13.0	−40°C ≦ Topt ≦ 85°C	±100
									0.330	0.550	0.770											
									0.363	0.605	0.847				V_{DS}= 0.5V V_{DD}= 1.0V	50	450					
									0.396	0.660	0.924											
									0.429	0.715	1.001											
									0.462	0.770	1.078											
									0.495	0.825	1.155											
									0.528	0.880	1.232											
									0.561	0.935	1.309											
									0.594	0.990	1.386											
									0.627	1.045	1.463											
									0.660	1.100	1.540											
									0.693	1.155	1.617											
									0.726	1.210	1.694											
									0.759	1.265	1.771											
									0.792	1.320	1.848											
									0.825	1.375	1.925											
									0.858	1.430	2.002											
									0.891	1.485	2.079											
									0.924	1.540	2.156											
									0.957	1.595	2.233											
									0.990	1.650	2.310											
									1.023	1.705	2.387				V_{DS}= 0.5V V_{DD}= 1.5V	200	500					
									1.056	1.760	2.464											
									1.089	1.815	2.541											
									1.122	1.870	2.618											
									1.155	1.925	2.695											
									1.188	1.980	2.772											
									1.221	2.035	2.849											
									1.254	2.090	2.926											
									1.287	2.145	3.003											
	V_{DS}= −2.1V V_{DD}= 6.0V	2.0	4.5						1.320	2.200	3.080											
									1.353	2.255	3.157											
									1.386	2.310	3.234											
									1.419	2.365	3.311											
									1.452	2.420	3.388											
									1.485	2.475	3.465											
									1.518	2.530	3.542											
									1.551	2.585	3.619											
									1.584	2.640	3.696											
									1.617	2.695	3.773											
									1.650	2.750	3.850											

OPERATION

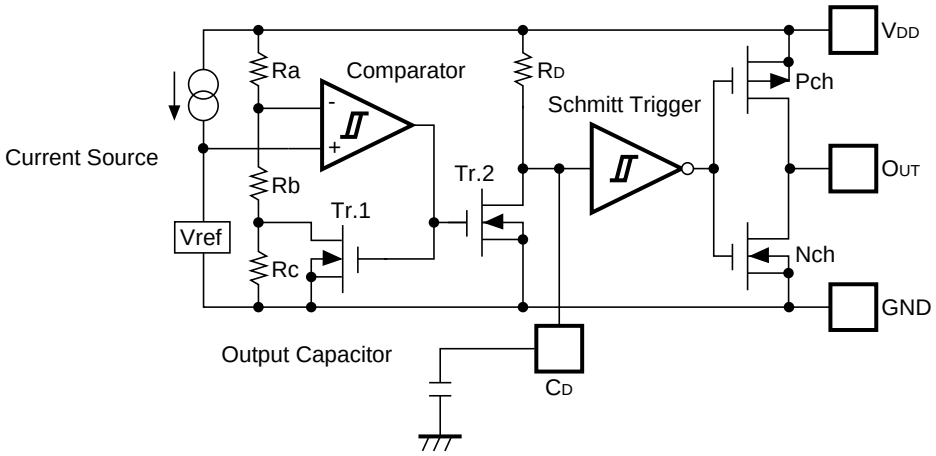
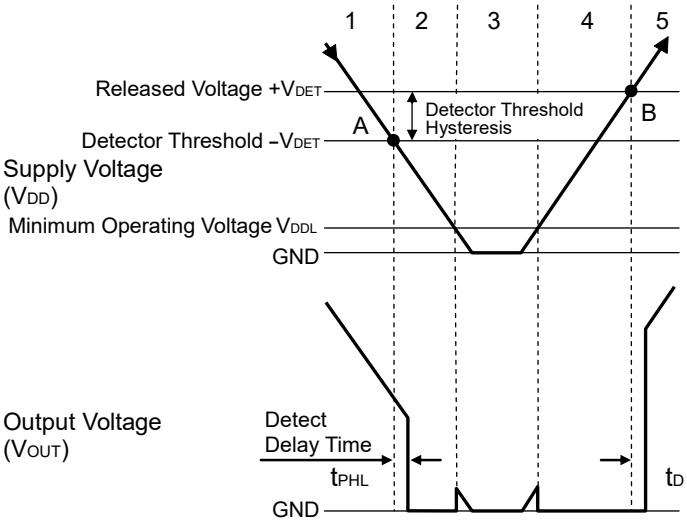


Fig. 1 Block Diagram with an external capacitor



Step		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.	Pch	ON	OFF	Indefinite	OFF	ON
	Nch	OFF	ON	Indefinite	ON	OFF

$$\text{I} \quad \frac{Rb+Rc}{Ra+Rb+Rc} \times V_{DD}$$

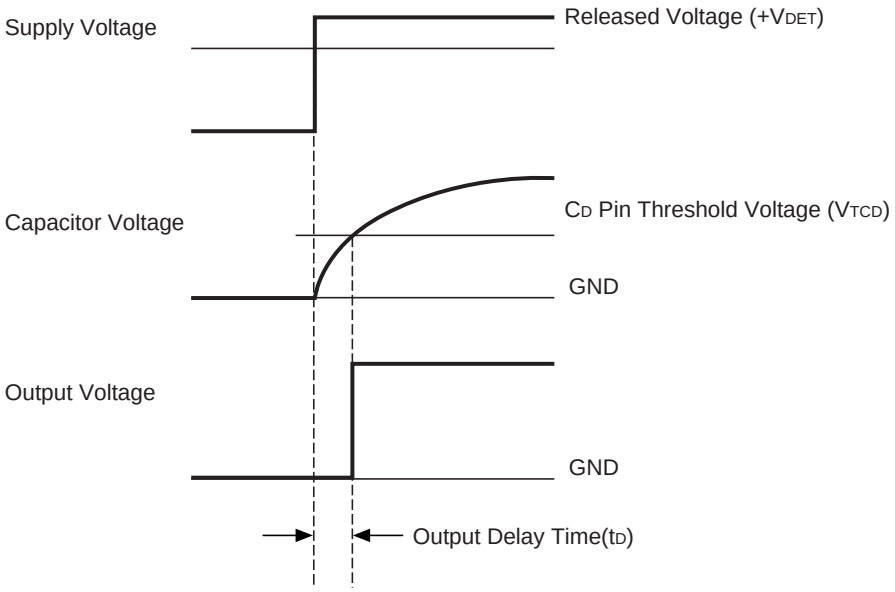
$$\text{II} \quad \frac{Rb}{Ra+Rb} \times V_{DD}$$

Fig. 2 Operation Diagram

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), $V_{ref} \geq V_{DD} \times (Rb+Rc)/(Ra+Rb+Rc)$ 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), $V_{ref} \leq V_{DD} \times Rb/(Ra+Rb)$ is true, then output of the comparator reaches the threshold level, and Output of Shmitt 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_{DD} pin, charge to an external capacitor starts, then capacitor voltage increases. Until the capacitor voltage reaches to C_D Pin threshold voltage, output voltage maintains "L". When the capacitor voltage becomes higher than C_D 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_D) can be calculated with the next formula.

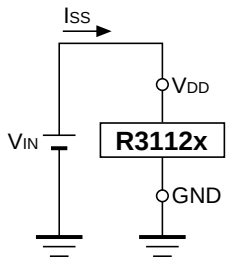
$t_D=0.69\times R_D\times C_D(s)$

R_D is internal resistor and set at 6.5MΩ(Typ.) typically. C_D(F) describes the capacitance value of an external capacitor. Therefore,

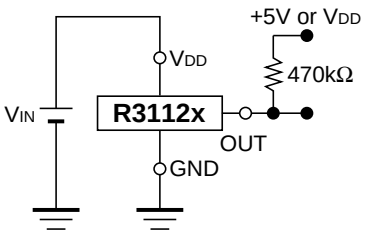
$t_D=0.69\times 6.5\times 10^6\times C_D(s)$

TEST CIRCUITS

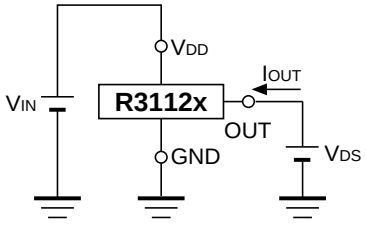
∗Pull-up circuit is not necessary for CMOS Output type, or R3112xxxxC.



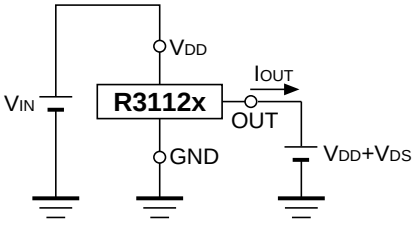
Supply Current Test Circuit



Detector Threshold Test Circuit

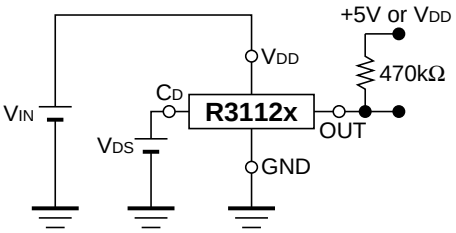


Nch Driver Output Current Test Circuit

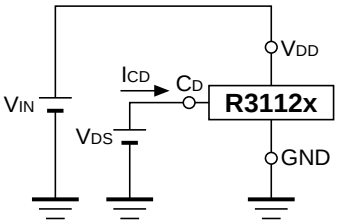


Pch Driver Output Current Test Circuit

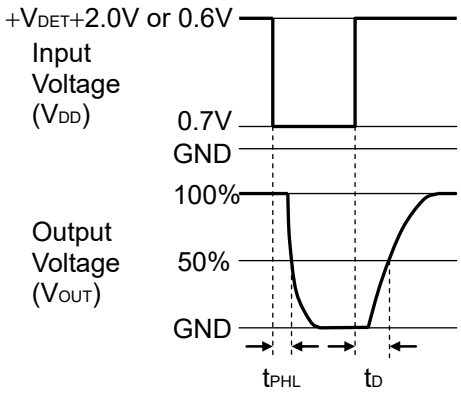
∗Apply only to CMOS

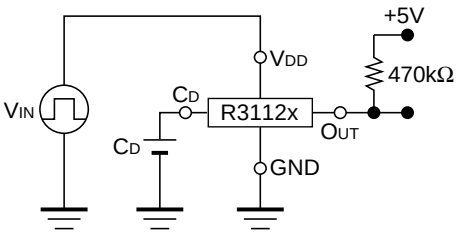


CD Pin Threshold Test Circuit



CD Pin Output Current Test Circuit



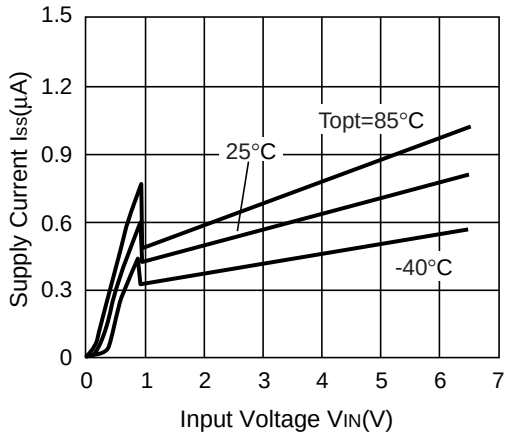


Output Delay Time Test Circuit

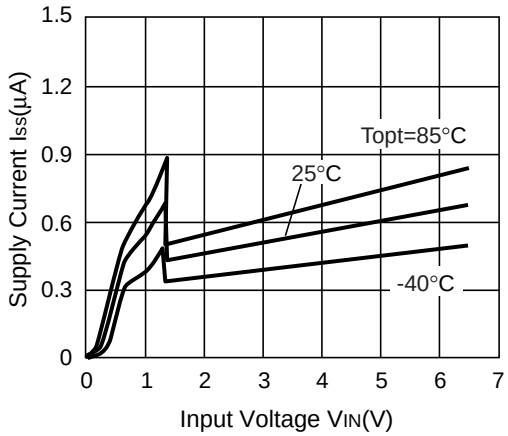
TYPICAL CHARACTERISTICS

1) Supply Current vs. Input Voltage

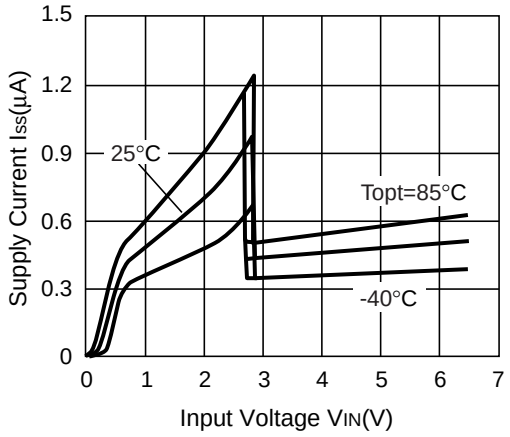
R3112x09xA/C



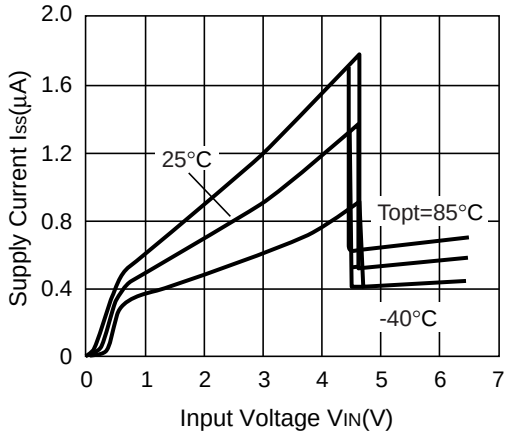
R3112x13xA/C



R3112x27xA/C

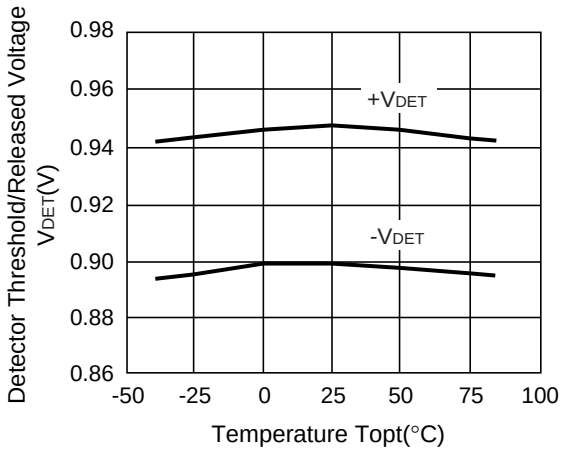


R3112x45xA/C



2) Detector Threshold vs. Temperature

R3112x09xA/C



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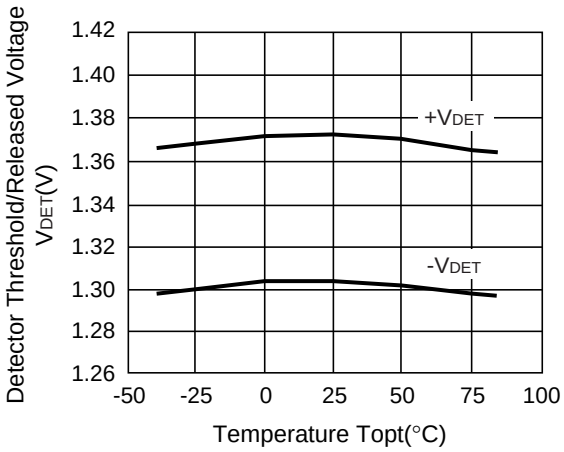

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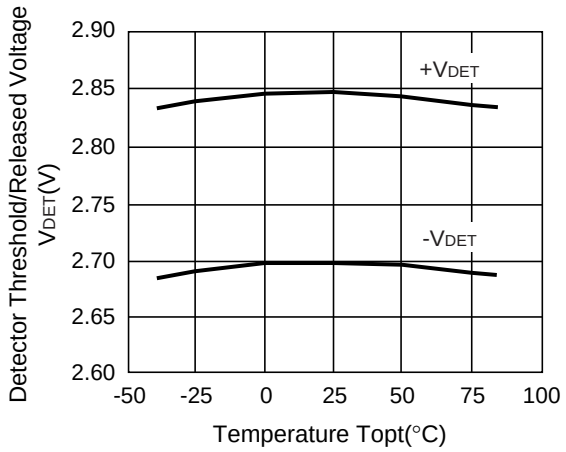

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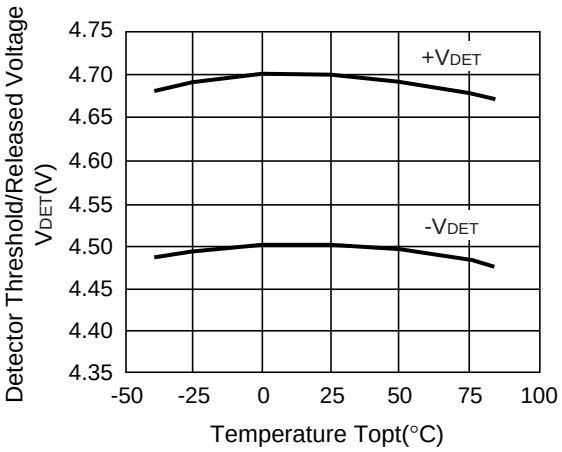
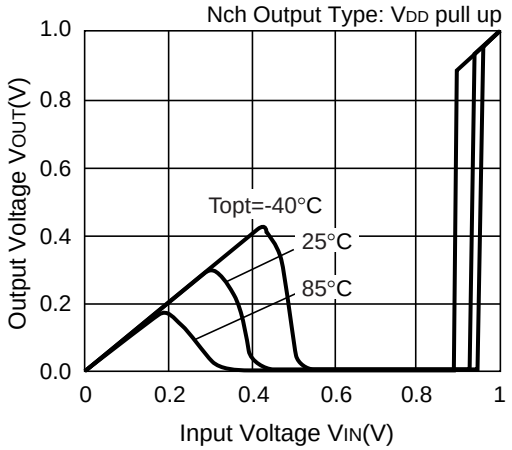


3) Output Voltage vs. Input Voltage

R3112x09xA/C



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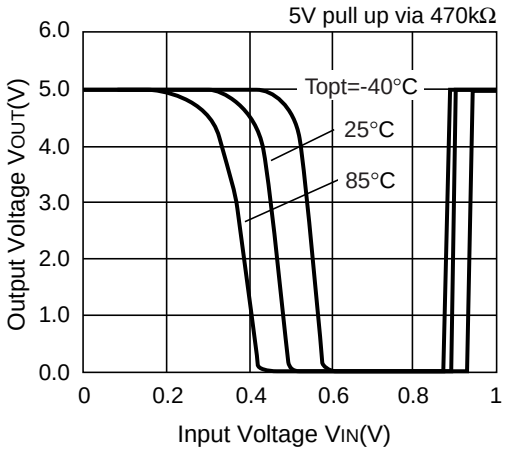
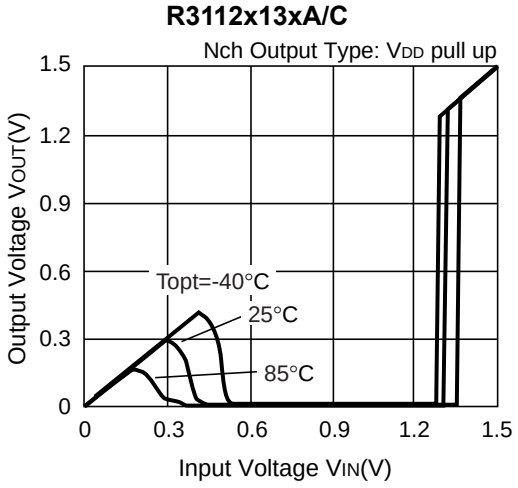
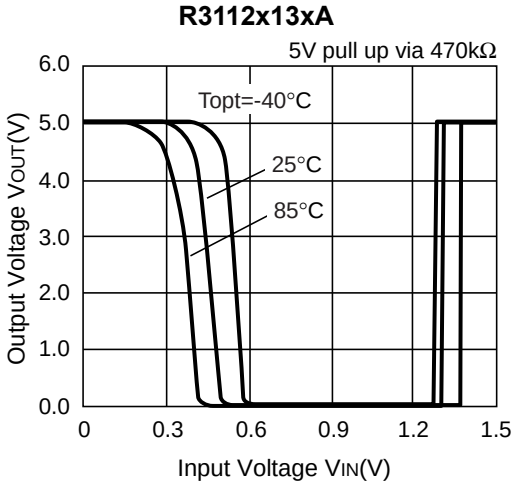


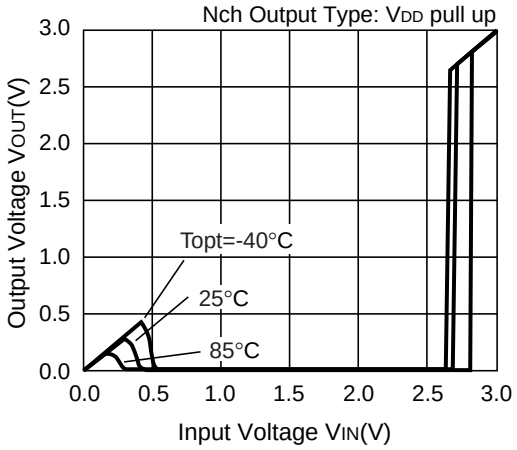
R3112x13xA/C



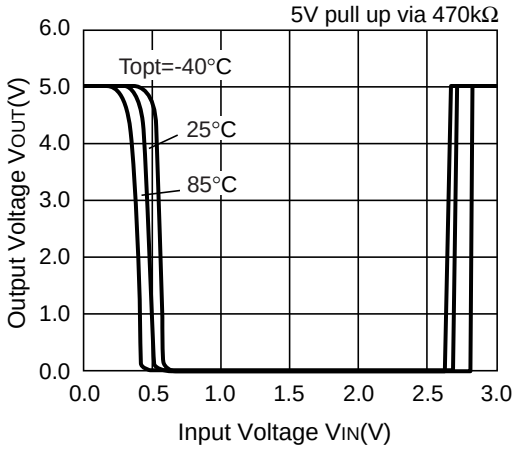
R3112x13xA



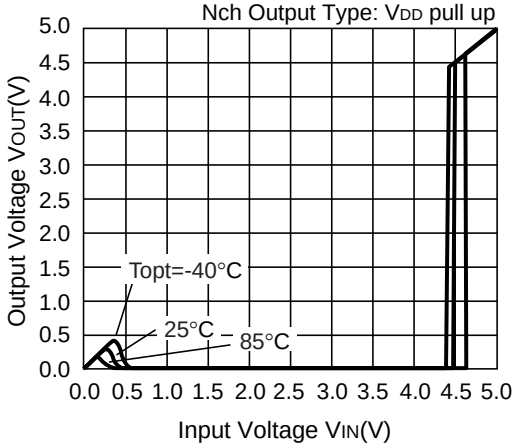
R3112x27xA/C



R3112x27xA



R3112x45xA/C



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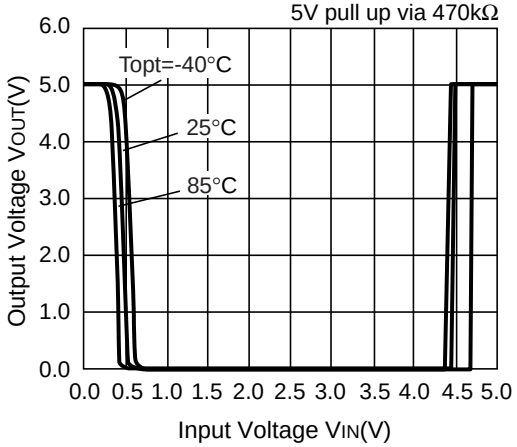
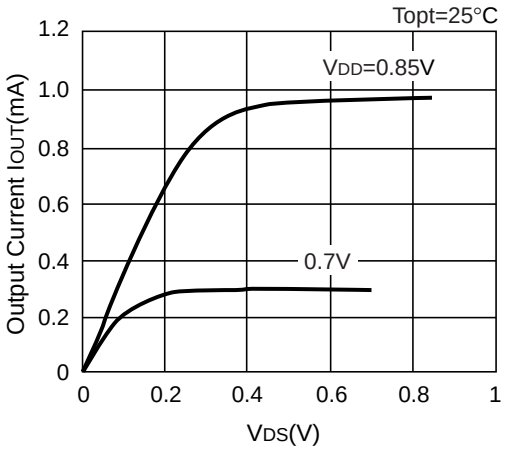


4) Nch Driver Output Current vs. VDS

R3112x09xA/C



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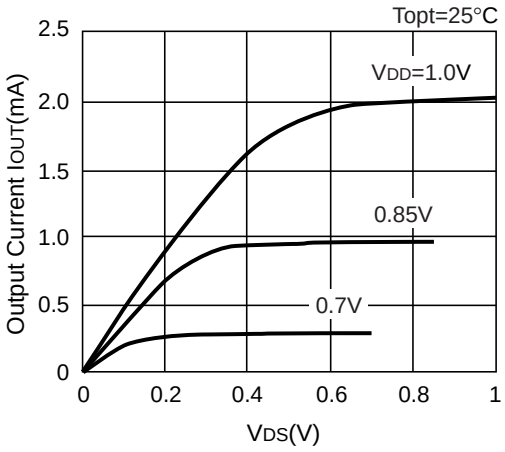

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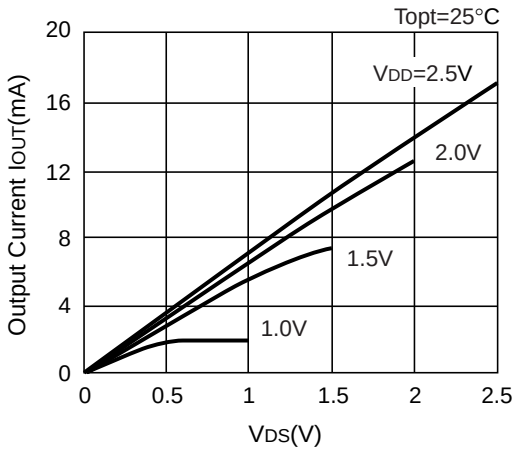
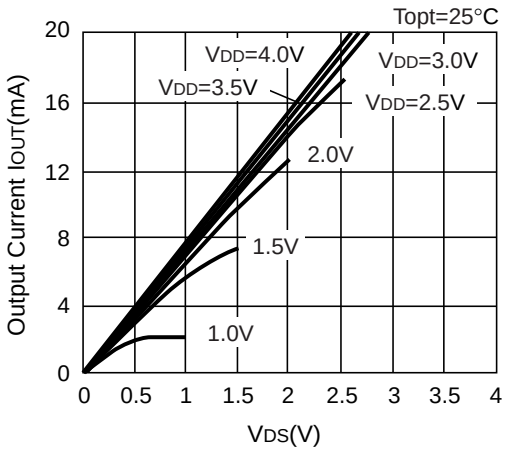
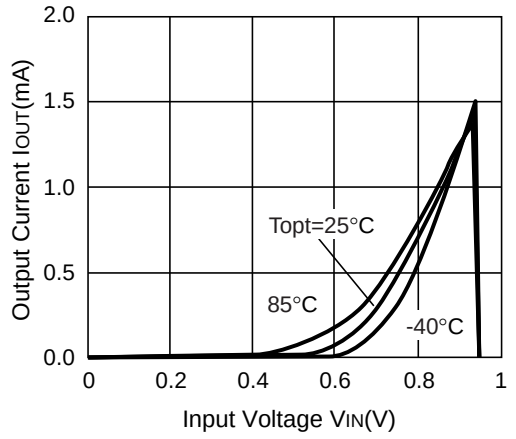


R3112x45xA/C

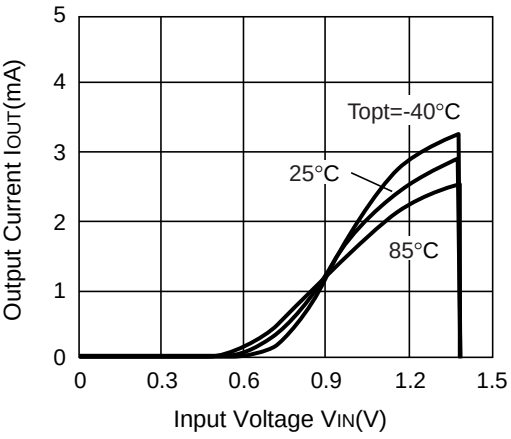


5) Nch Driver Output Current vs. Input Voltage

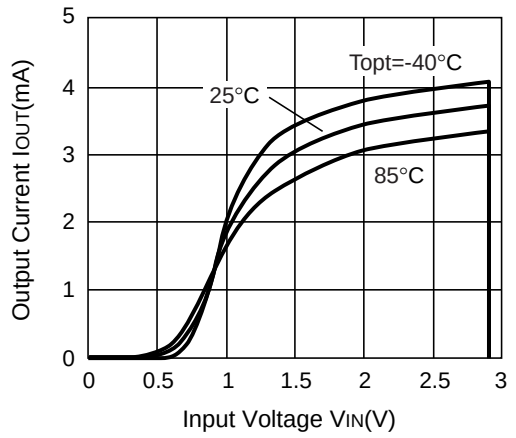
R3112x09xA/C



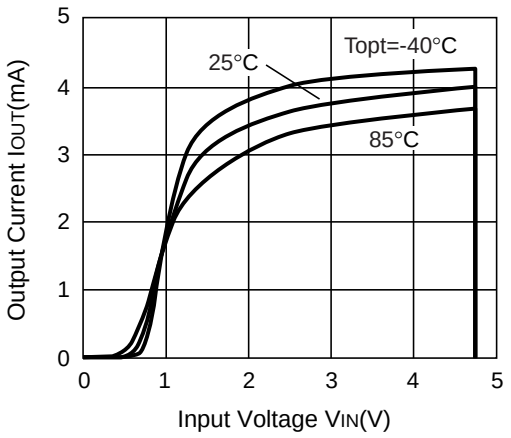
R3112x13xA/C



R3112x27xA/C

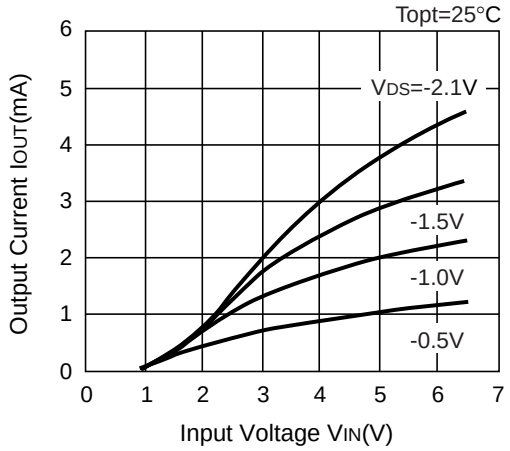


R3112x45xA/C

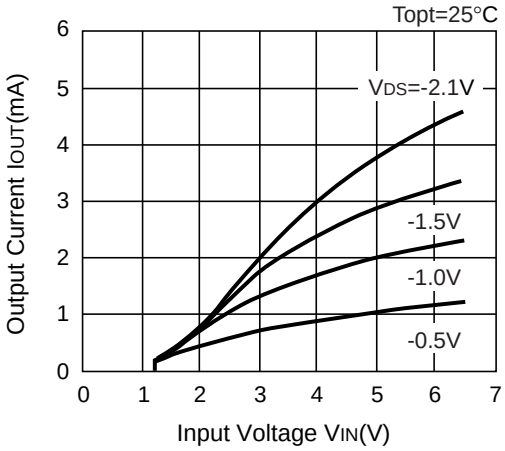


6) Pch Driver Output Current vs. Input Voltage

R3112x09xC



R3112x13xC



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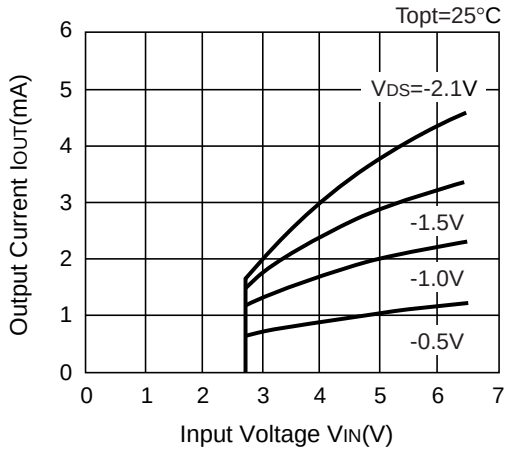
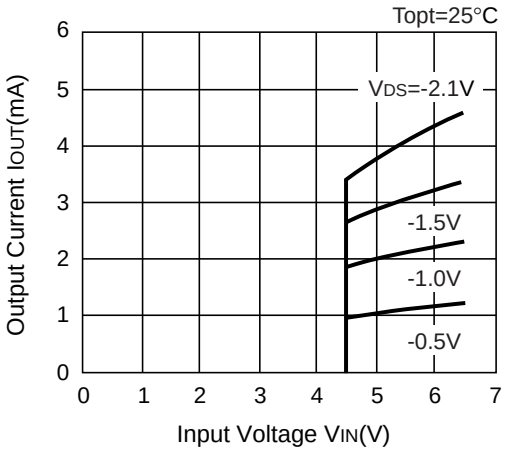
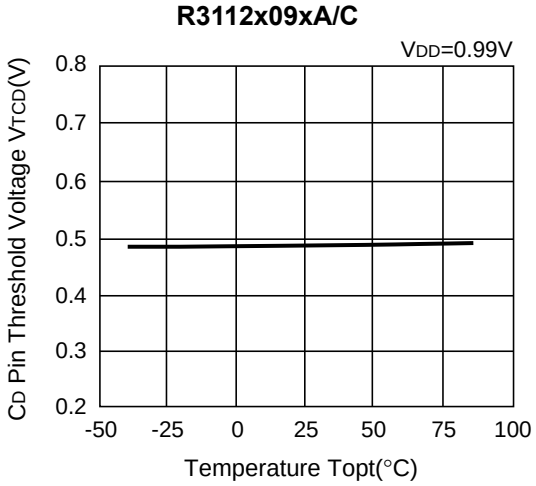


R3112x45xC

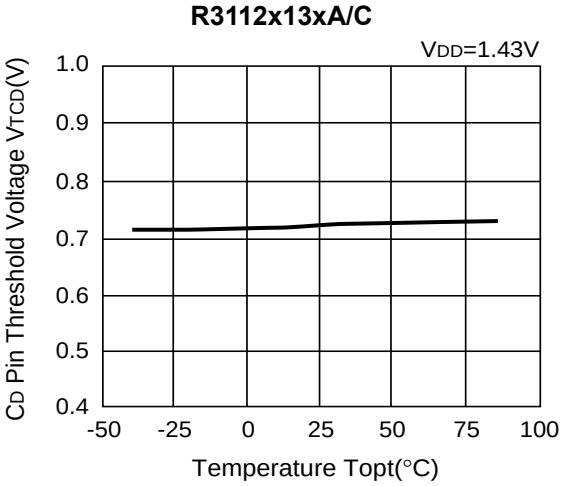


7) CD Pin Threshold Voltage vs. Temperature

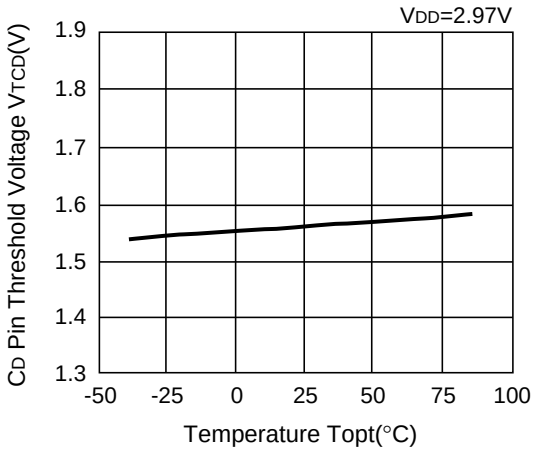
R3112x09xA/C



R3112x13xA/C



R3112x27xA/C



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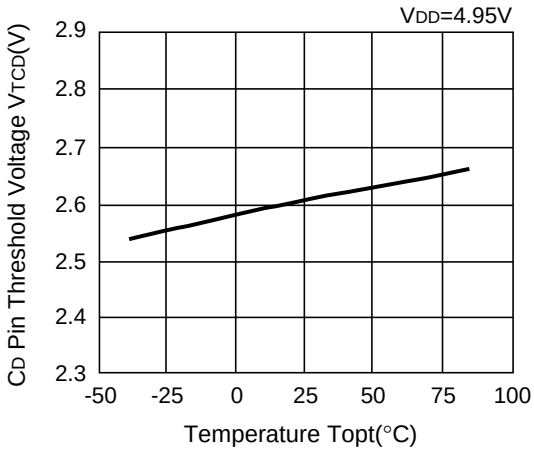
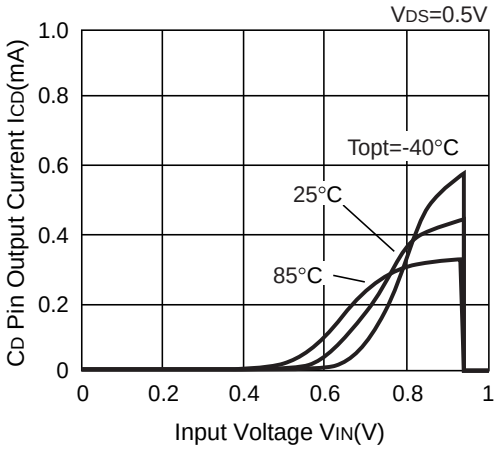
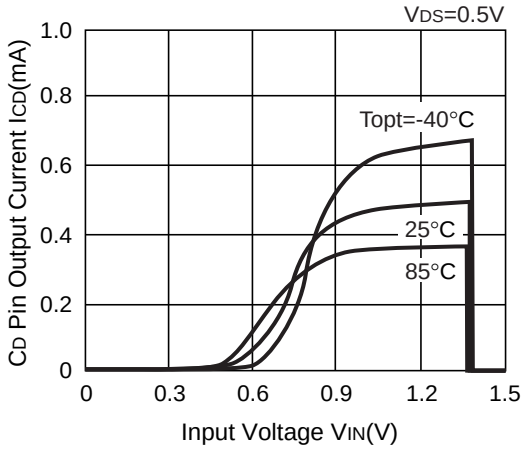


8) CD Pin Output Current vs. Input Voltage

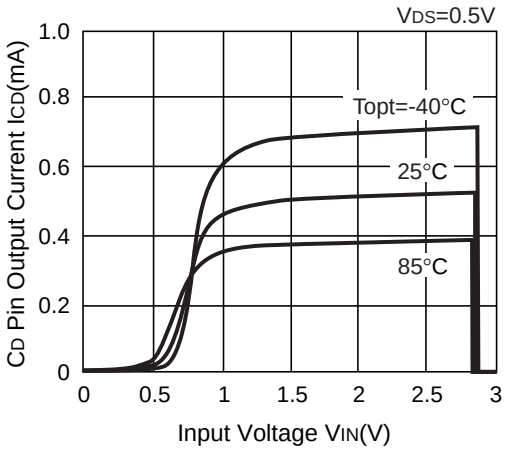
R3112x09xA/C



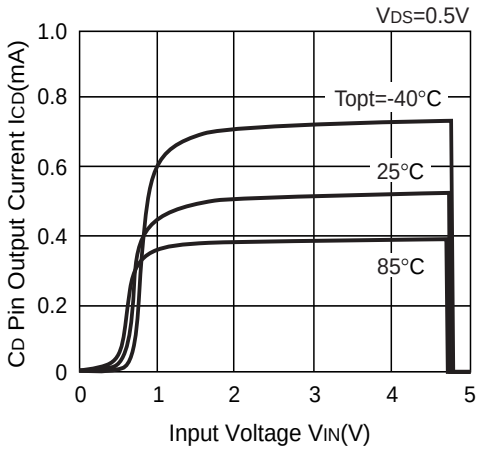
R3112x13xA/C



R3112x27xA/C

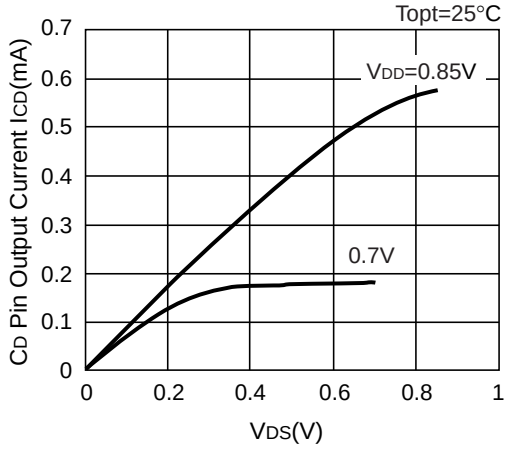


R3112x45xA/C

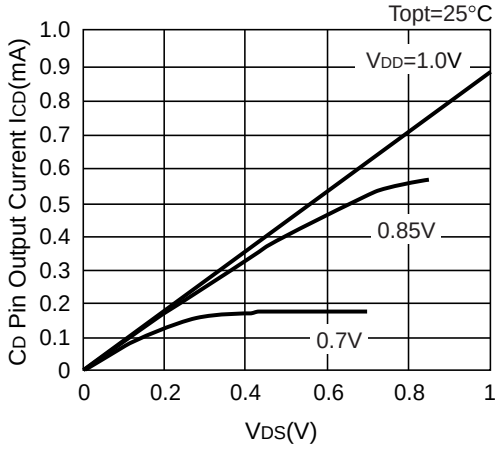


9) C_D Pin Output Current vs. V_{DS} (Topt=25°C)

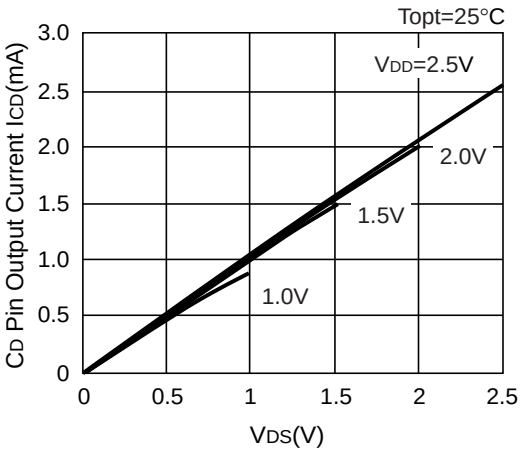
R3112x09xA/C



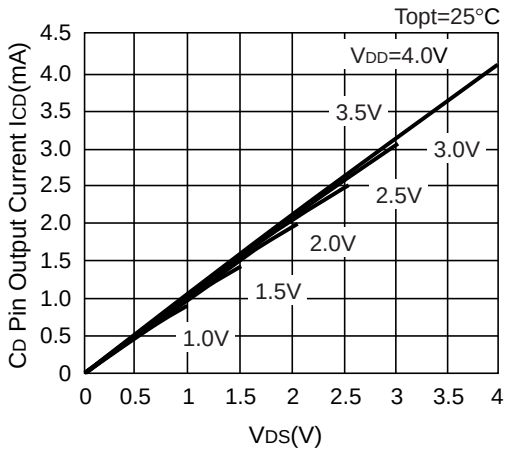
R3112x13xA/C



R3112x27xA/C

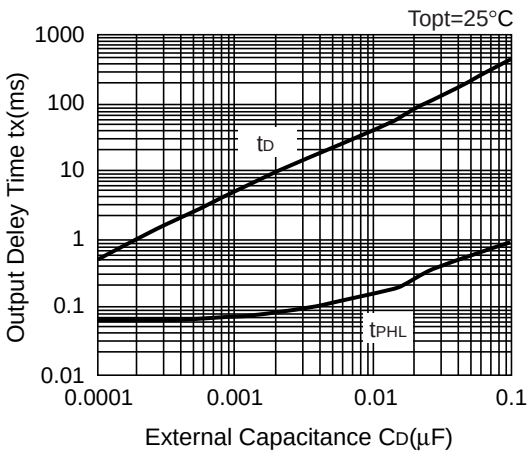


R3112x45xA/C

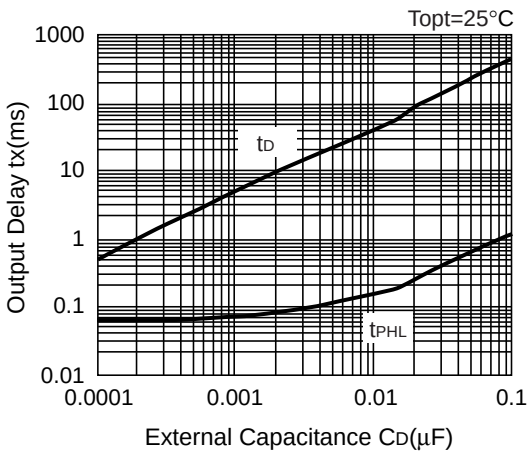


10) Output Delay Time vs. External Capacitance (Topt=25°C)

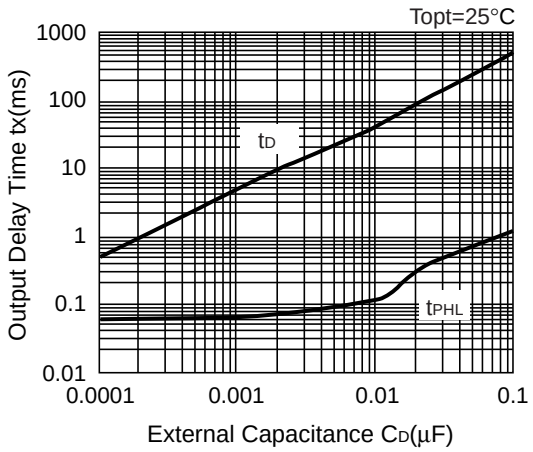
R3112x09xA/C



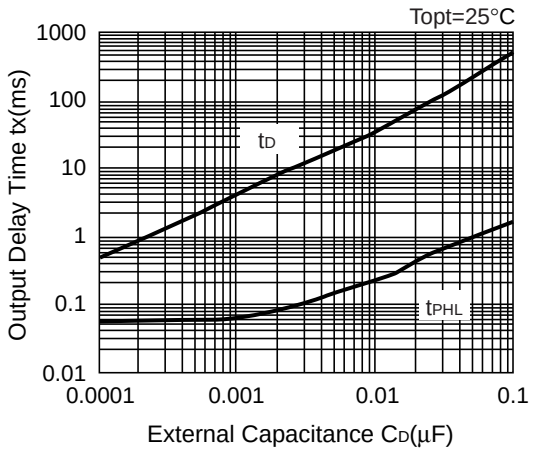
R3112x13xA/C



R3112x27xA/C

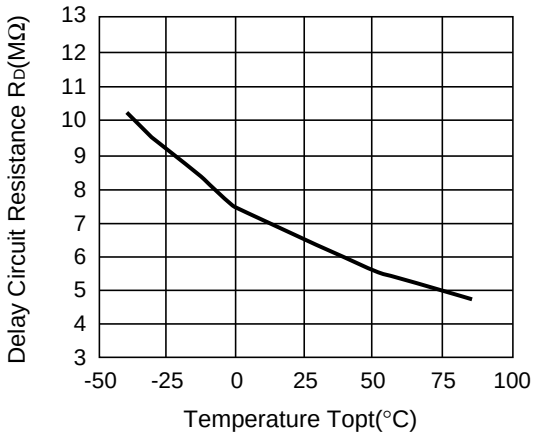


R3112x45xA/C



11) Delay Circuit Resistance vs. Temperature

R3112xxxxA/C



TECHNICAL NOTES

When connecting resistors to the device's input pin

When connecting a resistor (R1) to an input of this device, the input voltage decreases by [Device's Consumption Current] x [Resistance Value] only. And, the cross conduction current*1, which occurs when changing from the detecting state to the release state, is decreased the input voltage by [Cross Conduction Current] x [Resistance Value] only. And then, this device will enter the re-detecting state if the input voltage reduction is larger than the difference between the detector voltage and the released voltage.

When the input resistance value is large and the VDD is gone up at mildly in the vicinity of the released voltage, repeating the above operation may result in the occurrence of output.

As shown in Figure A/B, set R1 to become 100 kΩ or less as a guide, and connect C_{IN} of 0.1 µF and more to between the input pin and GND. Besides, make evaluations including temperature properties under the actual usage condition, with using the evaluation board like this way. As a result, make sure that the cross conduction current has no problem.

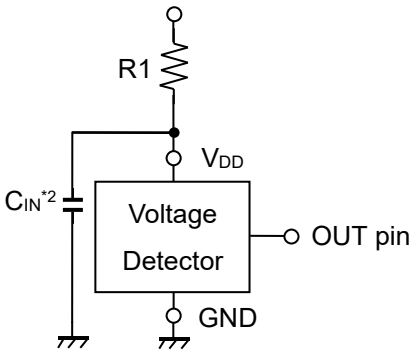


Figure A

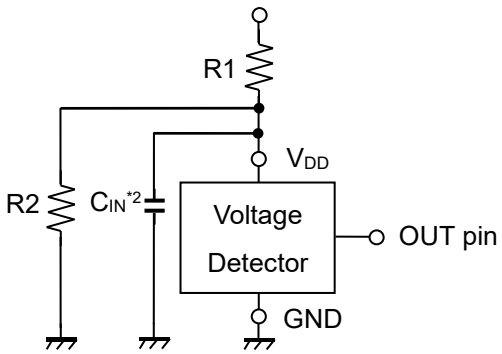


Figure B

*1 In the CMOS output type, a charging current for OUT pin is included.

*2 Note the bias dependence of capacitors.

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.
*R3112Qxx2 (SC-88A) is the limited product. As of March in 2018.
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Halogen Free

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