LOW VOLTAGE DETECTOR WITH OUTPUT DELAY

R3112xxx1A/C Series

■ OUTLINE

The R3112 Series are voltage detector ICs with high detector threshold accuracy and ultra-low supply current by CMOS process, which can be operated at an extremely low voltage and is used for system reset as an example.

Each of these ICs consists of a voltage reference unit, a comparator, resistor net for detector threshold setting, an output driver, a hysteresis circuit, and an output delay circuit. The detector threshold is fixed with high accuracy internally and does not require any adjustment. Two output types, Nch open drain type and CMOS type are available.

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

■ FEATURES

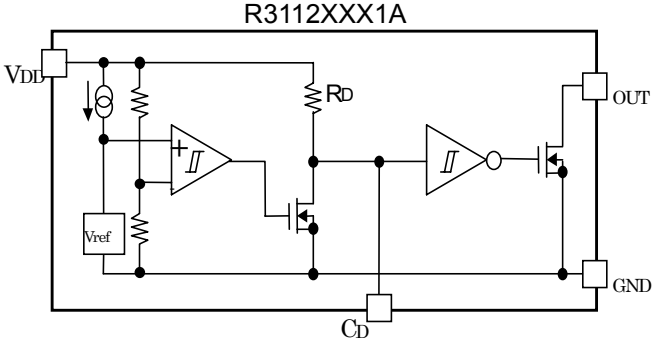
- ●Built-in Output Delay Circuit• • • • • • • • • • • •TYP. 100ms with an external capacitor: 0.022μF
- ●Ultra-low Supply Current• • • • • • • • • • • •TYP. 1.0μA (V_{DD}=3.5V)
- ●Wide Range of Operating Voltage • • • • • •0.7V~6.0V(Topt=25°C)
- ●Detector Threshold • • • • • • • • •Stepwise setting with a step of 0.1V in the range of 0.9V to 5.0V is possible.
- ●High Accuracy Detector Threshold • • • • • • • ±2.0%
- ●Low Temperature-Drift Coefficient of Detector Threshold• • • • • • • • • TYP. ±100ppm/°C
- ●Two Output Types• Nch Open Drain and CMOS
- ●Two Types of Packages • • • • • • • • • • SOT-23-5 (Mini-mold), SC-82AB

■ APPLICATIONS

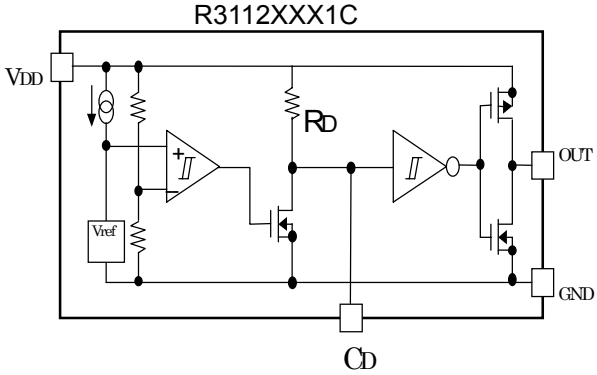
- CPU and Logic Circuit Reset
- Battery Checker
- Window Comparator
- Wave Shaping Circuit
- Battery Back-up Circuit
- Power Failure Detector

■ BLOCK DIAGRAMS

R3112XXX1A



R3112XXX1C



■ OPERATION

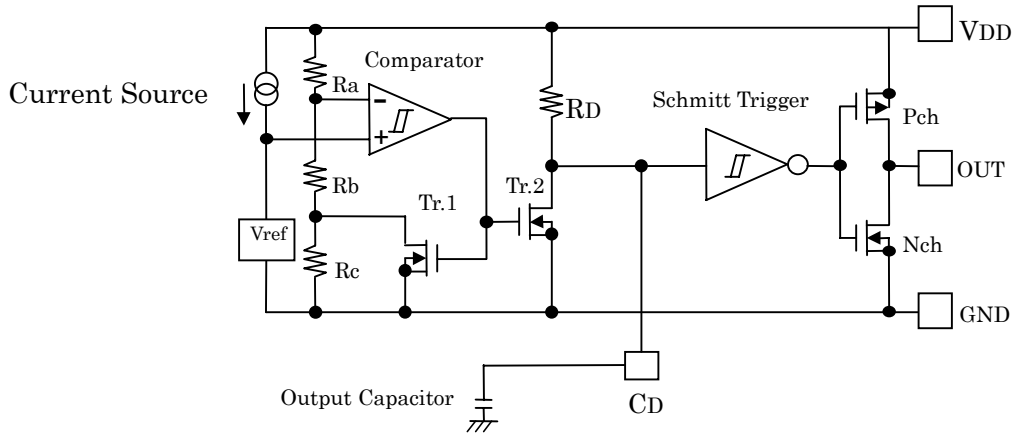
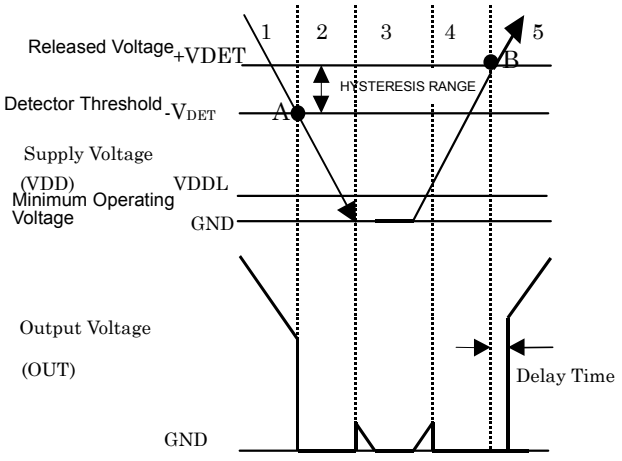


Fig. 1 Block Diagram with an external capacitor



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

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

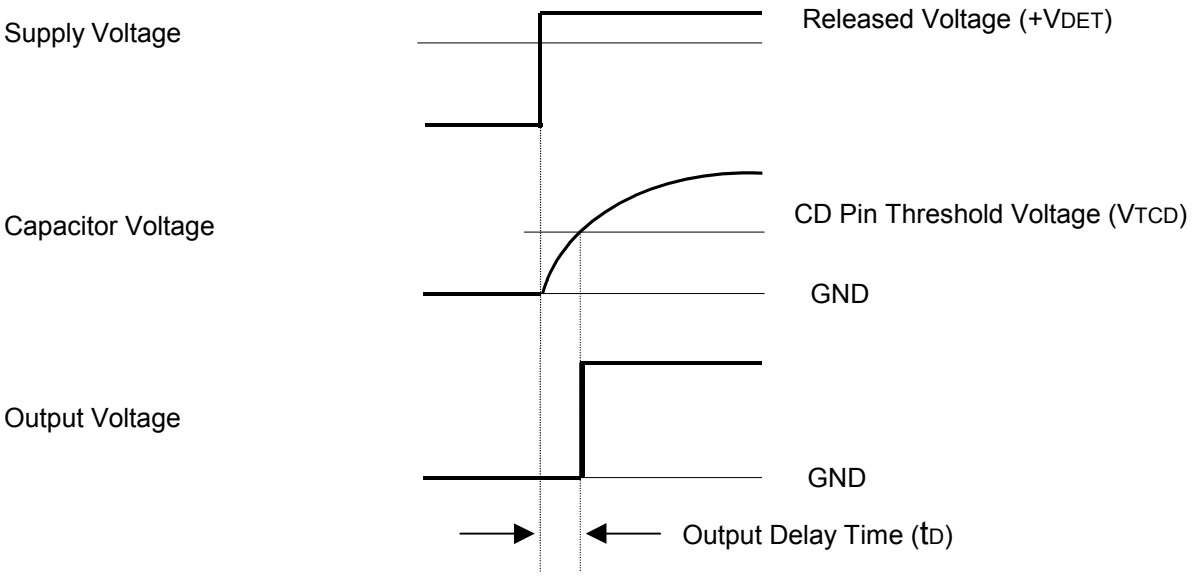
II $\frac{Rb}{Ra+Rb} \times V_{DD}$

Fig. 2 Operation Diagram

1. The 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 the 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, the output voltage is equal to pull-up voltage.
4. The 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 the output of the comparator reaches the threshold level, and the output of Shmitt trigger is reversed from "H" to "L", then the output voltage is equal to the supply voltage. (As for Nch open drain type, equal to pull-up voltage.)

*) The difference between the released voltage and the detector threshold voltage means the hysteresis range voltage.

●Operation of Output Delay



When the supply voltage which is higher than the released voltage is forced to V_{DD} pin, charge to an external capacitor starts, then capacitor voltage increases. Until the capacitor voltage reaches to CD Pin threshold voltage, the output voltage maintains “L”. When the capacitor voltage becomes higher than CD pin threshold voltage, the output voltage is reversed from “L” to “H”. Where, the time interval between the rising edge of the supply voltage and the output voltage reverse point, means the output delay time.

● Output Delay Time

The output delay time (tD) can be calculated with the next formula.

$$t_D = 0.69 \times R_D \times C_{D(s)}$$

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

$$t_D = 0.69 \times 6.5 \times 10^6 \times C_{D(s)}$$

■ SELECTION GUIDE

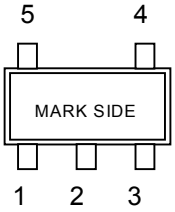
The package type, the detector threshold, the output type, and the taping type of R3112 Series can be designated at the users' request by specifying the part number as follows;

R3112×××1×-××←Part Number
↑↑ ↑↑
a b c d

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

■ PIN CONFIGURATION

SOT-23-5



SC-82AB

■ PIN DESCRIPTION

SOT-23-5

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

SC-82AB

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

■ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{DD}	Supply Voltage	6.5	V
V_{OUT1}	Output Voltage(CMOS)	V_{SS}-0.3~V_{DD}+0.3	V
V_{OUT2}	Output Voltage(Nch)	V_{SS}-0.3~6.5	V
I_{OUT}	Output Current	20	mA
P_D	Power Dissipation(SOT23-5)	250	mW
	Power Dissipation(SC82-AB)	150	
T_{opt}	Operating Temperature Range	-40~85	°C
T_{stg}	Storage Temperature Range	-55~125	°C
T_{solder}	Lead temperature (Soldering)	260°C, 10s	

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum ratings are threshold limit values that must not be exceeded ever for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.

●R3112x091A/C

T_{opt}=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold		0.882	0.900	0.918	V
V_{HYS}	Detector Threshold Hysteresis		0.027	0.045	0.063	V
I_{SS}	Supply Current	V_{DD}=0.80V		0.6	2.0	μA
		1.90V		0.5	2.0	
V_{DDH}	Maximum Operating Voltage				6.0	V
V_{DDL}	Minimum Operating Voltage*Note1	T_{opt}=25°C			0.70	V
		-40°C ≤ Topt ≤ 85°C			0.80	
I_{OUT}	Output Current (Driver Output Pin)	Nch V_{DS}=0.05V,V_{DD}=0.70V	10	120		μA
		V_{DS}=0.50V,V_{DD}=0.85V	0.05	0.90		mA
		Pch V_{DS}=-2.1V,V_{DD}=4.5V	1.0	3.5		mA
V_{TCD}	CD pin Threshold Voltage	V_{DD}=0.99V	0.297	0.495	0.693	V
I_{CD}	CD pin Output Current	V_{DS}=0.10V, V_{DD}=0.70V	2	70		μA
		V_{DS}=0.50V, V_{DD}=0.85V	10	400		
R_D	Output Delay Resistance		3.25	6.50	13.00	MΩ
$\Delta-V_{DET}/\Delta T$	Detector Threshold Temperature Coefficient	-40°C ≤ Topt ≤ 85°C		±100		ppm/°C

●R3112x271A/C

T_{opt}=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold		2.646	2.700	2.754	V
V_{HYS}	Detector Threshold Hysteresis		0.081		0.189	V
I_{SS}	Supply Current	V_{DD}=2.60V		1.0	3.0	μA
		3.70V		0.5	2.5	
V_{DDH}	Maximum Operating Voltage				6.0	V
V_{DDL}	Minimum Operating Voltage*Note1	T_{opt}=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}=0.70V	10	120		μA
		V_{DS}=0.50V,V_{DD}=1.50V	1.0	3.0		mA
		Pch V_{DS}=-2.1V,V_{DD}=4.5V	1.0	3.5		mA
V_{TCD}	CD pin Threshold Voltage	V_{DD}=2.97V	0.891	1.485	2.079	V
I_{CD}	CD pin Output Current	V_{DS}=0.1V, V_{DD}=0.7V	2.0	70		μA
		V_{DS}=0.5V, V_{DD}=1.5V	200	500		
R_D	Output Delay Resistance		3.25	6.50	13.00	MΩ
Δ-V_{DET}/ΔT	Detector Threshold Temperature Coefficient	-40°C ≤Topt≤85°C		±100		ppm/°C

●R3112x501A/C

T_{opt}=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold		4.900	5.000	5.100	V
V_{HYS}	Detector Threshold Hysteresis		0.150	0.250	0.350	V
I_{SS}	Supply Current	V_{DD}=4.9V		1.5	3.0	μA
		6.0V		0.6	2.5	
V_{DDH}	Maximum Operating Voltage				6.0	V
V_{DDL}	Minimum Operating Voltage*Note1	T_{opt}=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}=0.70V	10	120		μA
		V_{DS}=0.50V,V_{DD}=1.50V	1.0	3.0		mA
		Pch V_{DS}=-2.1V,V_{DD}=6.0V	1.5	4.5		mA
V_{TCD}	CD pin Threshold Voltage	V_{DD}=5.50V	1.650	2.750	3.850	V
I_{CD}	CD pin Output Current	V_{DS}=0.1V, V_{DD}=0.7V	2.0	70		μA
		V_{DS}=0.5V, V_{DD}=1.5V	200	500		
R_D	Output Delay Resistance		3.25	6.50	13.00	MΩ
Δ-V_{DET}/ΔT	Detector Threshold Temperature Coefficient	-40°C≤Topt≤85°C		±100		ppm/°C

*Note1: The minimum operating voltage means the value of input voltage when output voltage maintains 0.1V or less.

(In the case of Nch open drain type, the output pin is pulled up with a resistance of 470kΩ to 5.0V.)

■ ELECTRICAL CHARACTERISTICS BY DETECTOR THRESHOLD

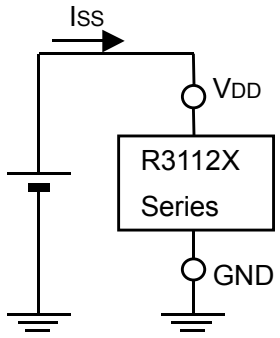
Product Code	Detector Threshold			Hysteresis Range			Supply Current1			Supply Current2			Output Current1			Output Current2			
	-V_{DET}[V]			V_{HYS} [V]			I_{SS1} [uA]			I_{SS2} [uA]			I_{OUT1} [mA]			I_{OUT2} [mA]			
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	Condition	TYP.	MAX.	Condition	TYP.	MAX.	Condition	MIN.	TYP.	Conditions		MIN.	TYP.
R3112x091A/C	0.882	0.900	0.918	0.027	0.045	0.063		0.6	2.0									0.05	0.9
R3112x101A/C	0.980	1.000	1.020	0.030	0.050	0.070													
R3112x111A/C	1.078	1.100	1.122	0.033	0.055	0.077											V_{DS}=0.5V		
R3112x121A/C	1.176	1.200	1.224	0.036	0.060	0.084					0.5	2.0					V_{DD}=0.85V		
R3112x131A/C	1.274	1.300	1.326	0.039	0.065	0.091		0.7	2.5									0.2	1.8
R3112x141A/C	1.372	1.400	1.428	0.042	0.070	0.098													
R3112x151A/C	1.470	1.500	1.530	0.045	0.075	0.105													
R3112x161A/C	1.568	1.600	1.632	0.048	0.080	0.112													
R3112x171A/C	1.666	1.700	1.734	0.051	0.085	0.119													
R3112x181A/C	1.764	1.800	1.836	0.054	0.090	0.126													
R3112x191A/C	1.862	1.900	1.938	0.057	0.095	0.133													
R3112x201A/C	1.960	2.000	2.040	0.060	0.100	0.140													
R3112x211A/C	2.058	2.100	2.142	0.063	0.105	0.147													
R3112x221A/C	2.156	2.200	2.244	0.066	0.110	0.154													
R3112x231A/C	2.254	2.300	2.346	0.069	0.115	0.161		1.0	3.0		0.5	2.5							
R3112x241A/C	2.352	2.400	2.448	0.072	0.120	0.168													
R3112x251A/C	2.450	2.500	2.550	0.075	0.125	0.175													
R3112x261A/C	2.548	2.600	2.652	0.078	0.130	0.182													
R3112x271A/C	2.646	2.700	2.754	0.081	0.135	0.189													
R3112x281A/C	2.744	2.800	2.856	0.084	0.140	0.196													
R3112x291A/C	2.842	2.900	2.958	0.087	0.145	0.203	V_{DD}=			V_{DD}=			V_{DS}=0.05V	0.01	0.12	Nch			
R3112x301A/C	2.940	3.000	3.060	0.090	0.150	0.210	-V_{DET}-0.1V			-V_{DET}+1.0V			V_{DD}=0.7V						
R3112x311A/C	3.038	3.100	3.162	0.093	0.155	0.217													
R3112x321A/C	3.136	3.200	3.264	0.096	0.160	0.224											V_{DS}=0.5V		
R3112x331A/C	3.234	3.300	3.366	0.099	0.165	0.231											V_{DD}=1.5V	1.0	3.0
R3112x341A/C	3.332	3.400	3.468	0.102	0.170	0.238													
R3112x351A/C	3.430	3.500	3.570	0.105	0.175	0.245		1.2	3.0		0.6	2.5							
R3112x361A/C	3.528	3.600	3.672	0.108	0.180	0.252													
R3112x371A/C	3.626	3.700	3.774	0.111	0.185	0.259													
R3112x381A/C	3.724	3.800	3.876	0.114	0.190	0.266													
R3112x391A/C	3.822	3.900	3.978	0.117	0.195	0.273													
R3112x401A/C	3.920	4.000	4.080	0.120	0.200	0.280													
R3112x411A/C	4.018	4.100	4.182	0.123	0.205	0.287													
R3112x421A/C	4.116	4.200	4.284	0.126	0.210	0.294													
R3112x431A/C	4.214	4.300	4.386	0.129	0.215	0.301													
R3112x441A/C	4.312	4.400	4.488	0.132	0.220	0.308													
R3112x451A/C	4.410	4.500	4.590	0.135	0.225	0.315		1.5	3.0		0.6	2.5							
R3112x461A/C	4.508	4.600	4.692	0.138	0.230	0.322													
R3112x471A/C	4.606	4.700	4.794	0.141	0.235	0.329													
R3112x481A/C	4.704	4.800	4.896	0.144	0.240	0.336													
R3112x491A/C	4.802	4.900	4.998	0.147	0.245	0.343													
R3112x501A/C	4.900	5.000	5.100	0.150	0.250	0.350													

Output Current3				Minimum Operating Voltage				CD pin Threshold Voltage				CD pin Output Current			CD pin Output Current2			Resistance for Output Delay			Detector Threshold Temperature	
I_{OUT3} [mA]				V_{DDL} [V]				VT_{CD} [V]				I_{CD1} [uA]			I_{CD2} [uA]			R_D [Mohm]			-V_{DET}/Topt [ppm/	
	Condition	MIN.	TYP.	Condition	MAX.	Condition	MAX.	Condition	MIN.	TYP.	MAX.	Condition	MIN.	TYP.	Conditions	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	#####	0.495	0.693	V_{DS}=0.1V V_{DD}=0.7V	2.0	70	V_{DS}=0.5V V_{DD}=0.85V	0.01	400	3.25	6.5	13.0	-40 Topt 85	±100
									#####	0.550	0.770											
									#####	0.605	0.847				V_{DS}=0.5V V_{DD}=0.85V	0.05	450					
									#####	0.660	0.924											
									#####	0.715	1.001											
									#####	0.770	1.078											
									#####	0.825	1.155											
									#####	0.880	1.232											
									#####	0.935	1.309											
									#####	0.990	1.386											
									#####	1.045	1.463											
									#####	1.100	1.540											
									#####	1.155	1.617											
									#####	1.210	1.694											
									#####	1.265	1.771											
									#####	1.320	1.848											
									#####	1.375	1.925											
									#####	1.430	2.002											
									#####	1.485	2.079											
									#####	1.540	2.156											
									#####	1.595	2.233											
									#####	1.650	2.310											
									#####	1.705	2.387											
									#####	1.760	2.464											
									#####	1.815	2.541					0.20	500					
									#####	1.870	2.618											
									#####	1.925	2.695											
									#####	1.980	2.772											
									#####	2.035	2.849											
									#####	2.090	2.926											
									#####	2.145	3.003											
									#####	2.200	3.080											
									#####	2.255	3.157											
									#####	2.310	3.234											
									#####	2.365	3.311											
									#####	2.420	3.388											
									#####	2.475	3.465											
									#####	2.530	3.542											
									#####	2.585	3.619											
									#####	2.640	3.696											
									#####	2.695	3.773											
	VDS=-2.1V VDD=6.0V	2.0	4.5						#####	2.750	3.850											

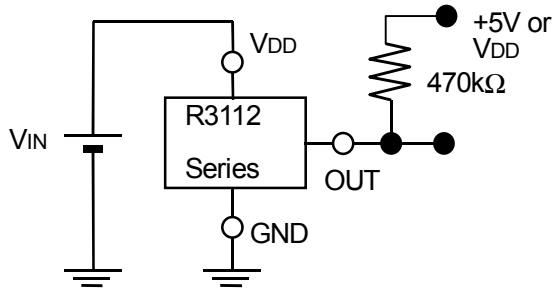
TEST CIRCUITS

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

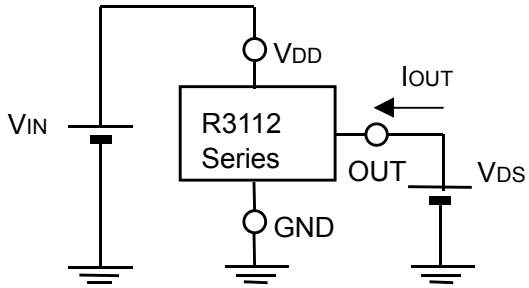
Supply Current Test Circuit



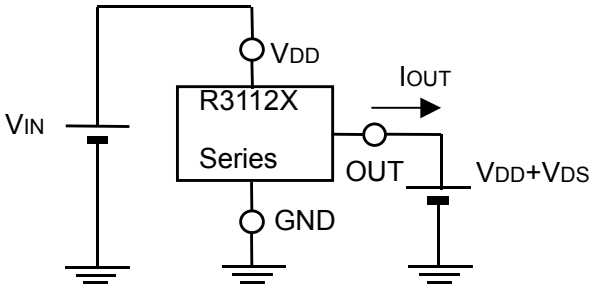
Detector Threshold Test Circuit



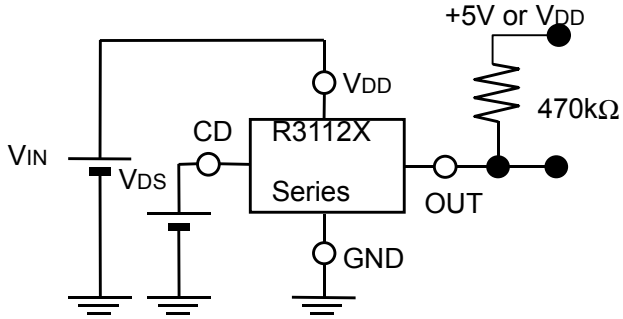
Nch Driver Output Current Test Circuit



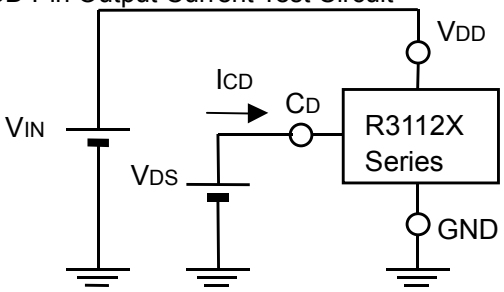
Pch Driver Output Current Test Circuit *Apply only to CMOS



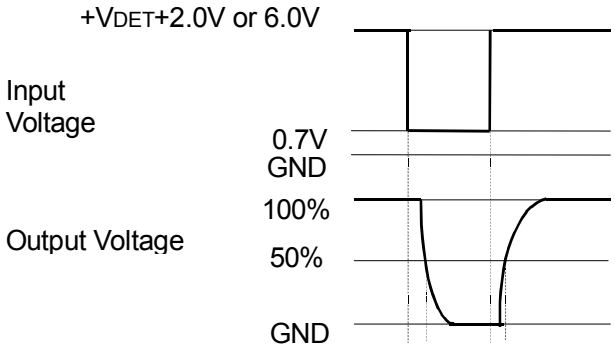
CD Pin Threshold Test Circuit

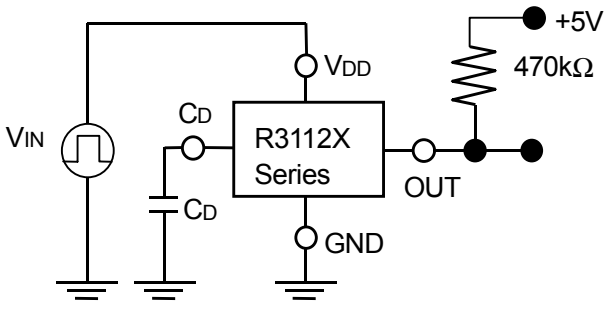


CD Pin Output Current Test Circuit



Output Delay Time Test Circuit

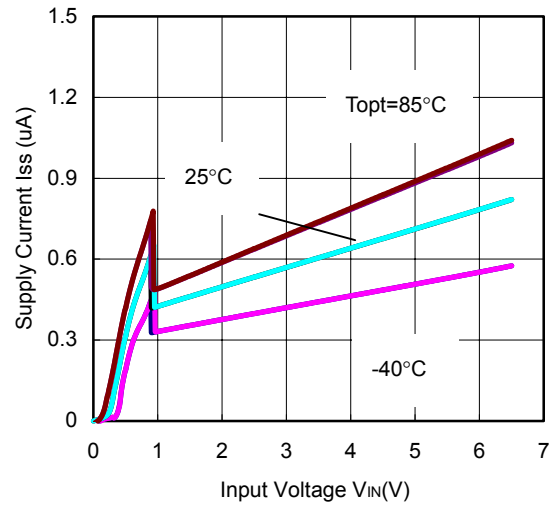




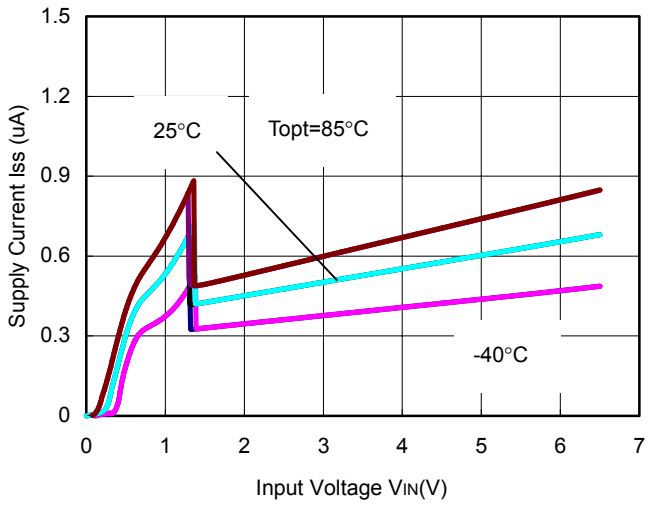
■ TYPICAL CHARACTERISTICS

1) Supply Current vs. Input Voltage

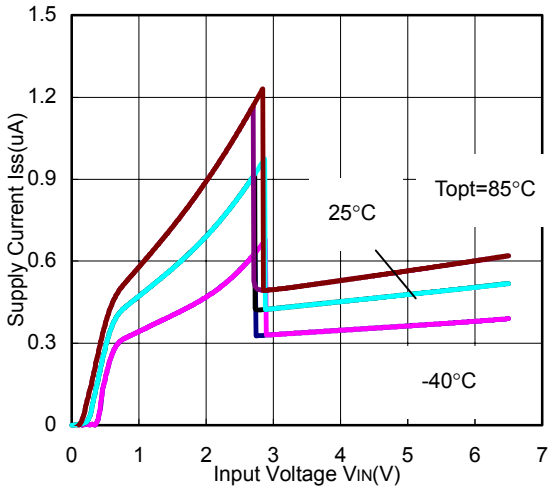
R3112X091X



R3112X131X



R3112X271X



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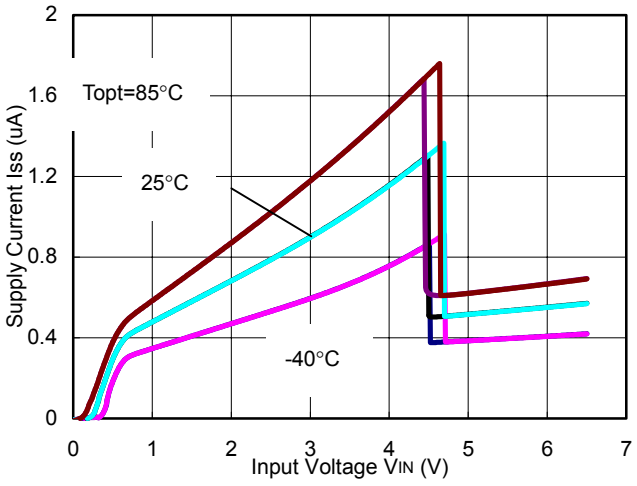
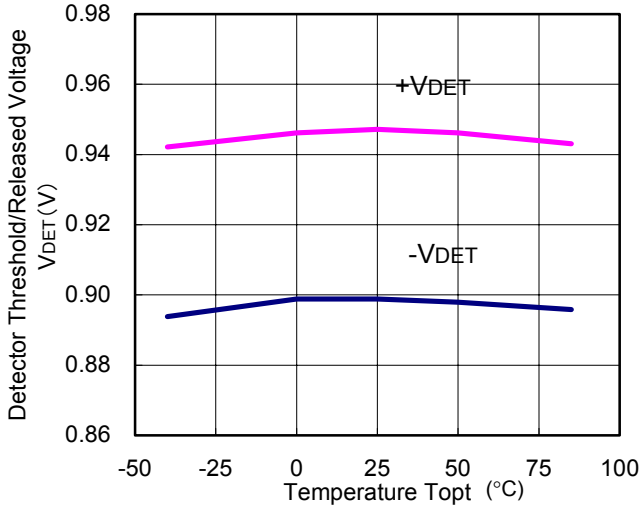


2) Detector Threshold vs. Temperature

R3112X091X



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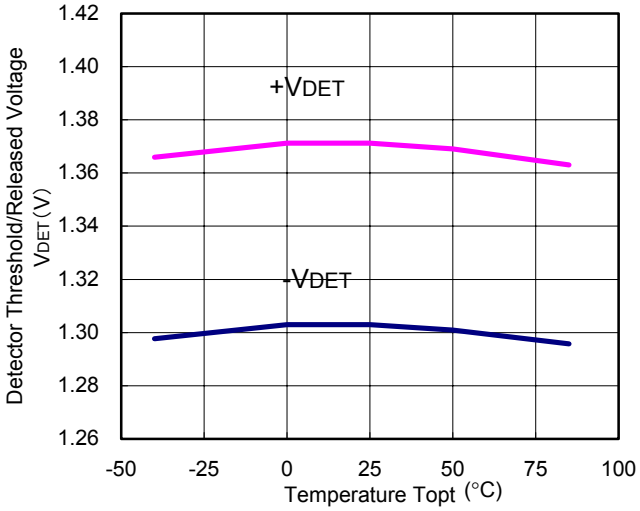

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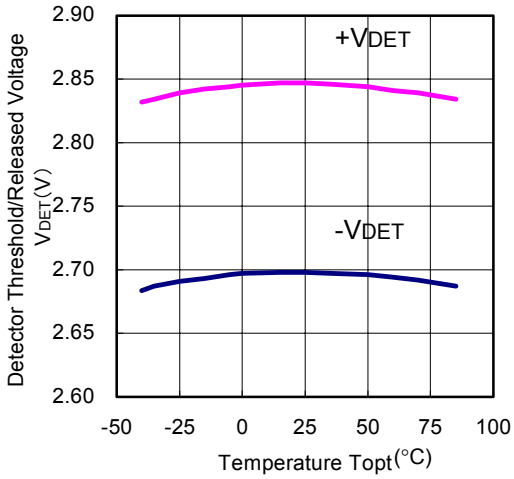

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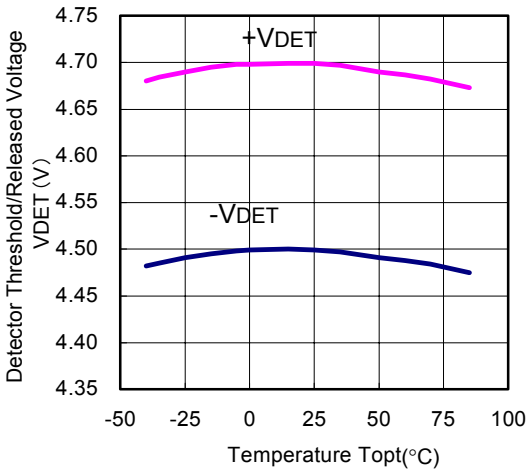
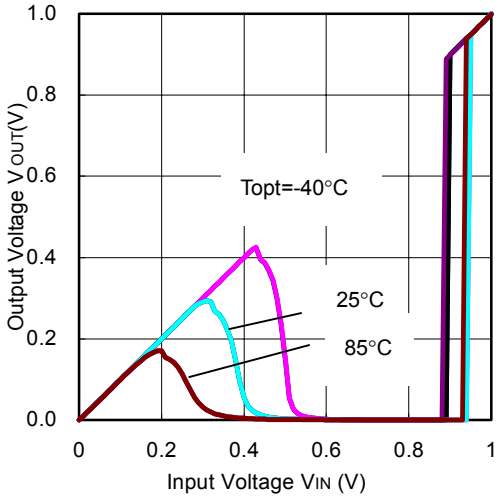


3) Output Voltage vs. Input Voltage

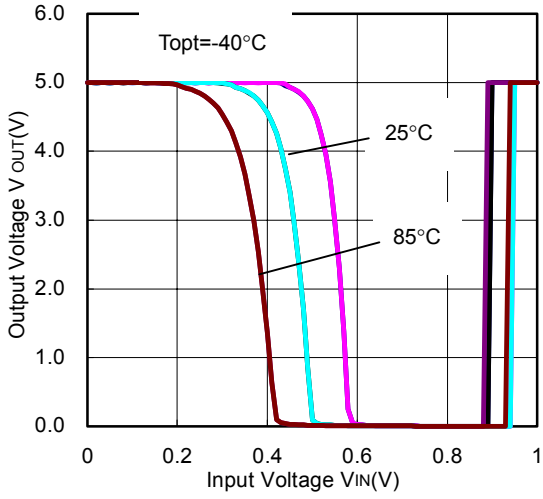
R3112X091X

Nch Output Type: VDD pull up



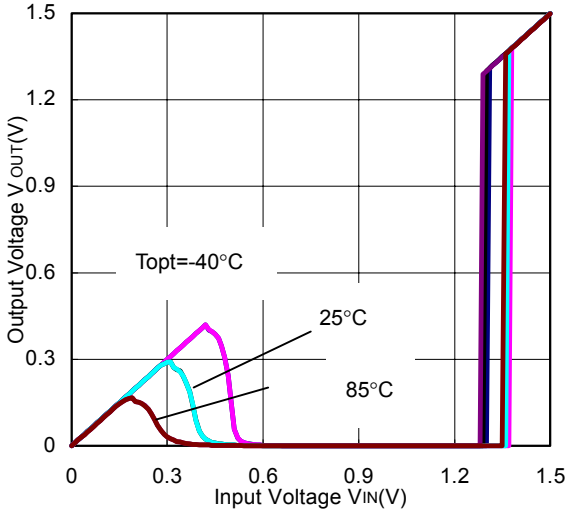
R3112X091A

5V pull up via 470kΩ



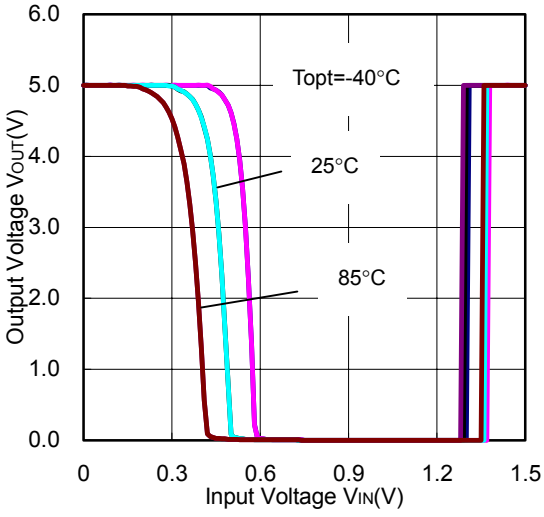
R3112X131X

Nch Output Type: VDD pull up



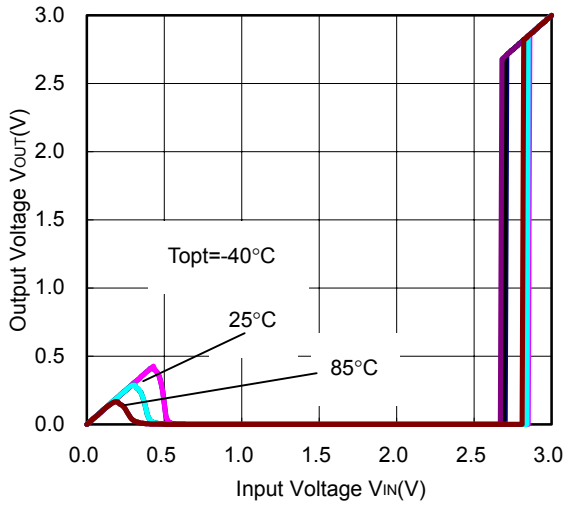
R3112X131A

5V pull up via 470kΩ



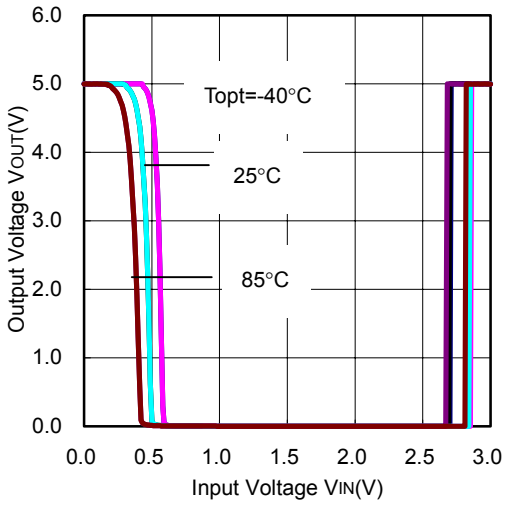
R3112X271X

Nch Output Type: VDD pull up



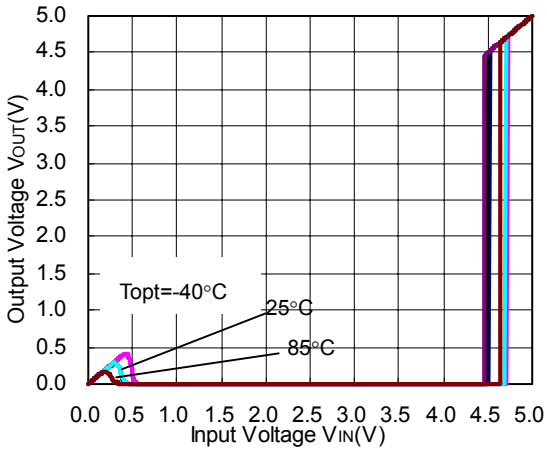
R3112X271A

5V pull up via 470kΩ



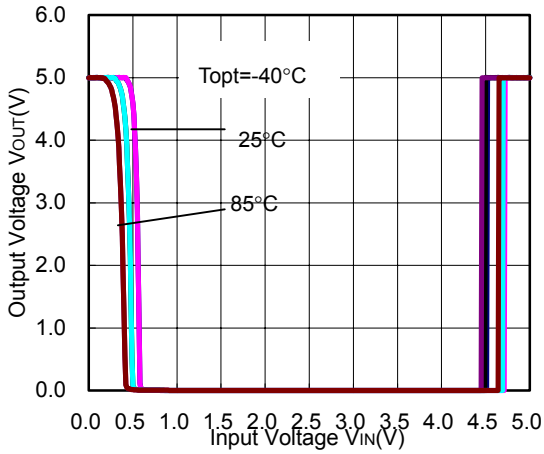
R3112X451X

Nch Output Type: VDD pull up



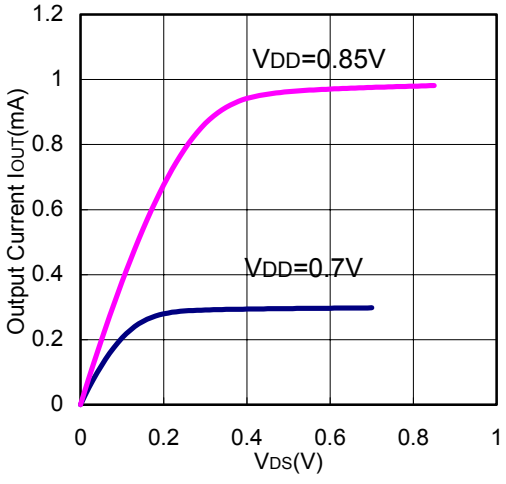
R3112X451A

5V pull up via 470kΩ



4) Nch Driver Output Current vs. VDS

R3112X091X



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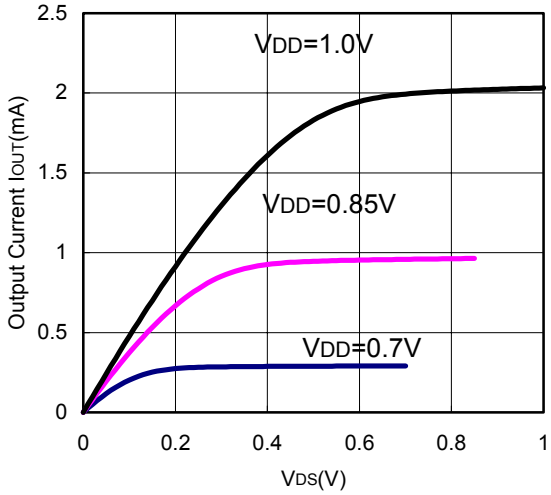

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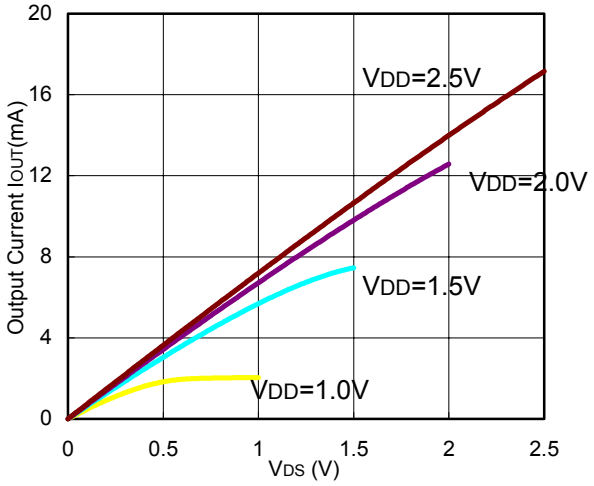

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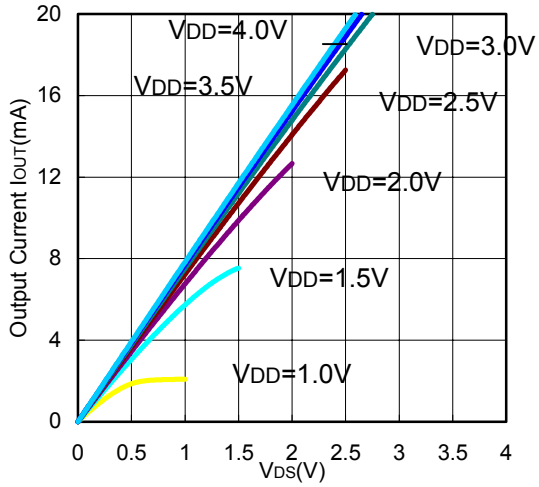
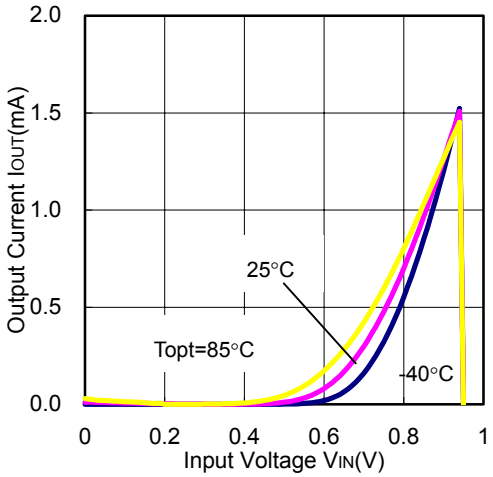
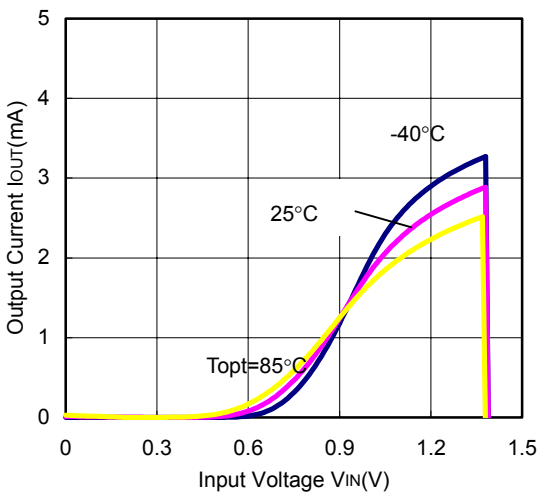


5) Nch Driver Output Current vs. Input Voltage

R3112X091X



R3112X131X



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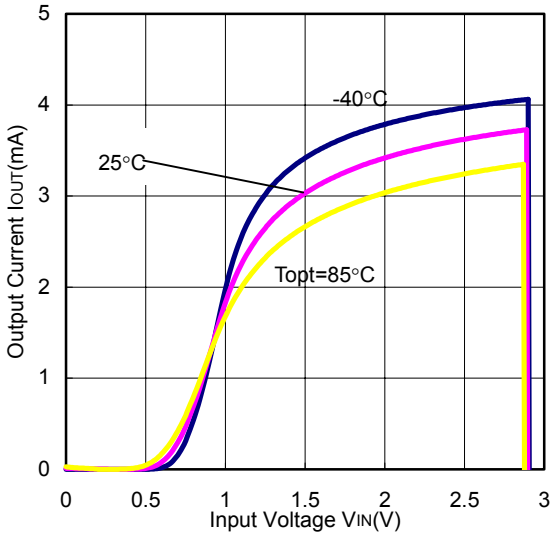

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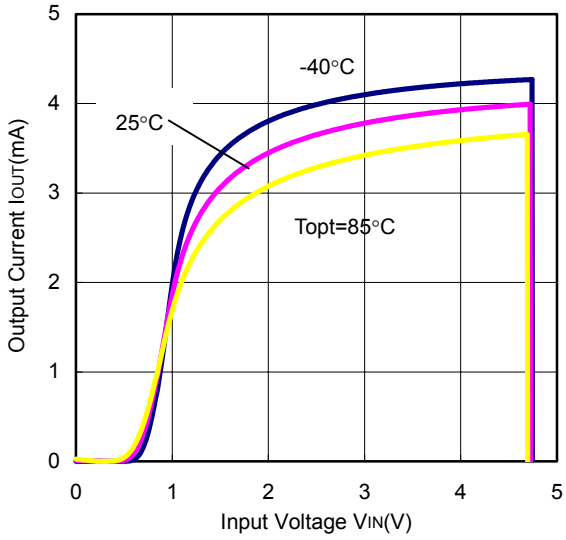
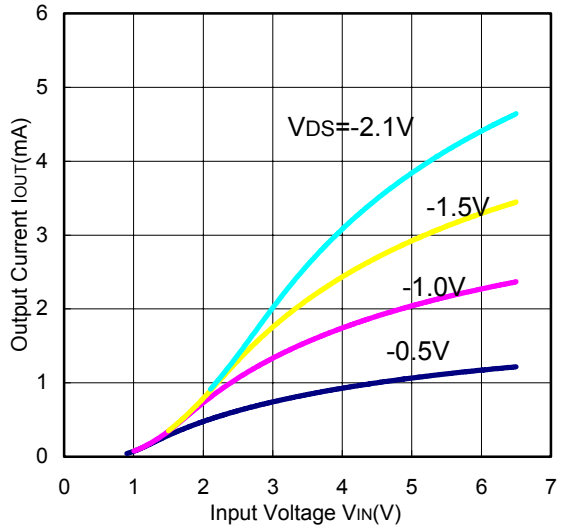
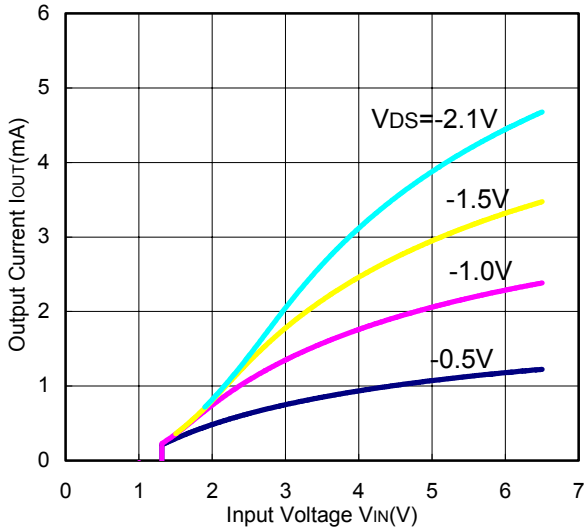


6) Pch Driver Output Current vs. Input Voltage

R3112X091C



R3112X131C



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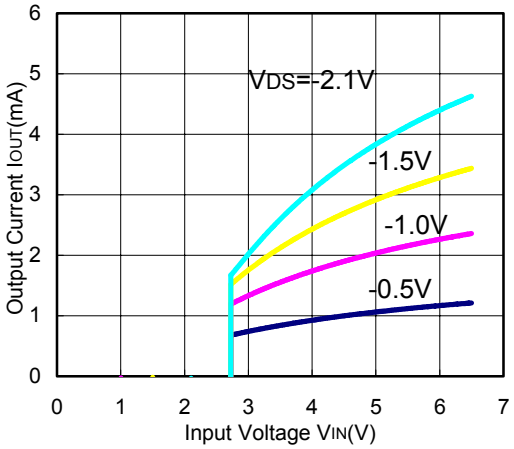
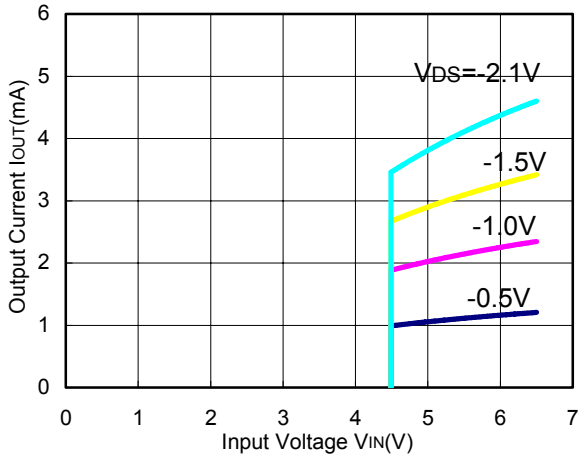
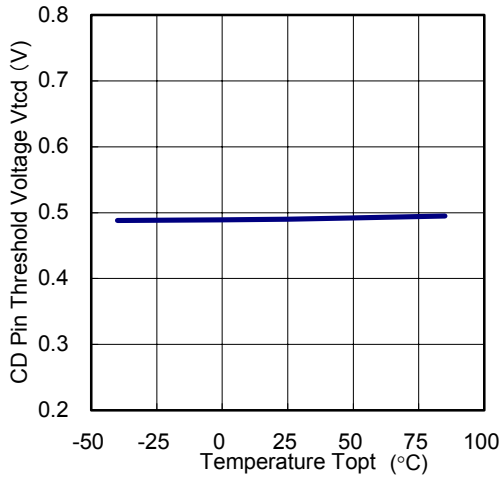


R3112X451C

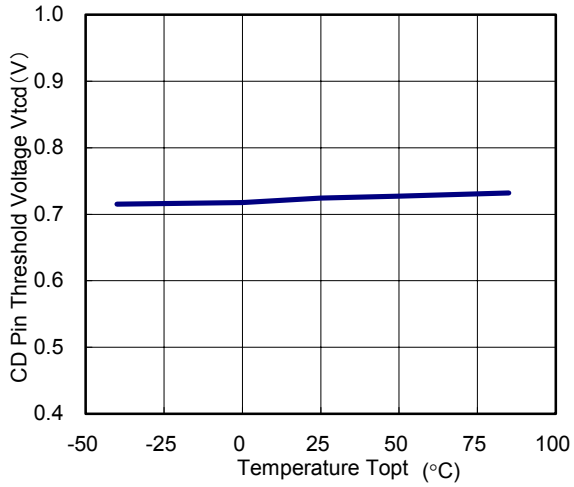


7) CD Pin Threshold Voltage vs. Temperature

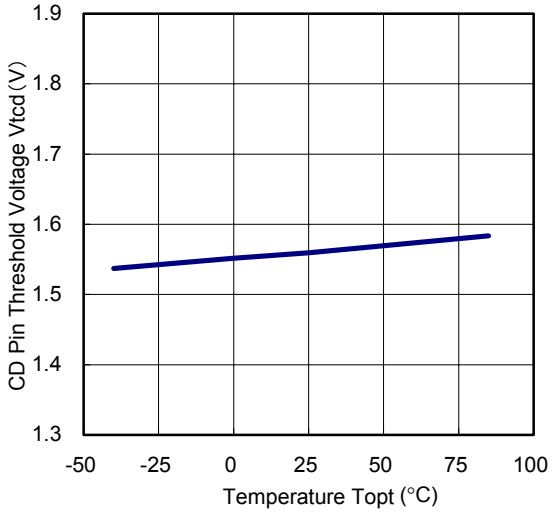
R3112X091X VDD=0.99V



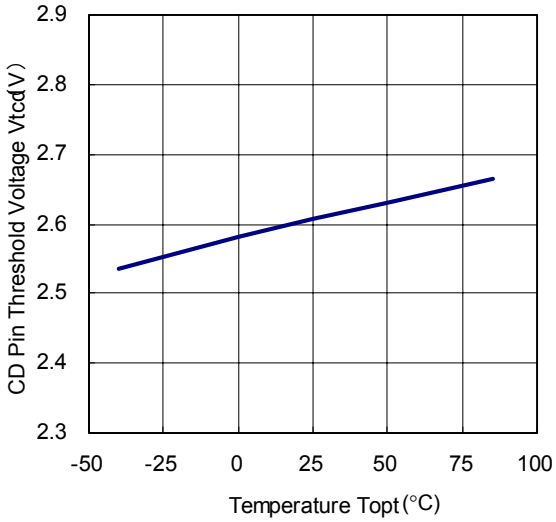
R3112X131X VDD=1.43V



R3112X271X V_{DD}=2.97V

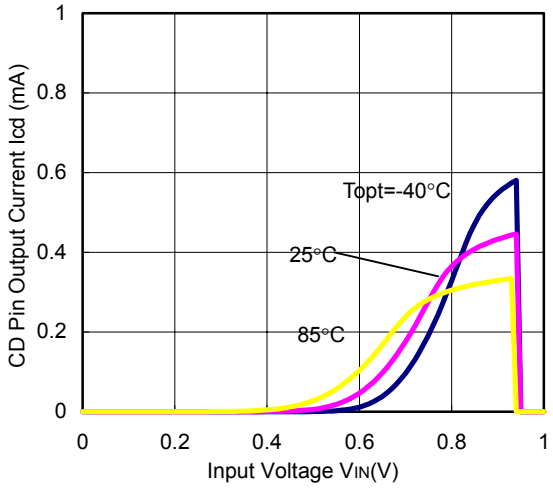


R3112X451X V_{DD}=4.95V

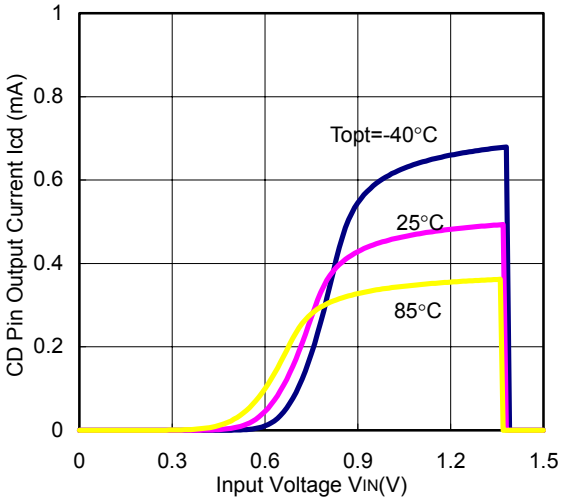


8) CD Pin Output Current vs. Input Voltage

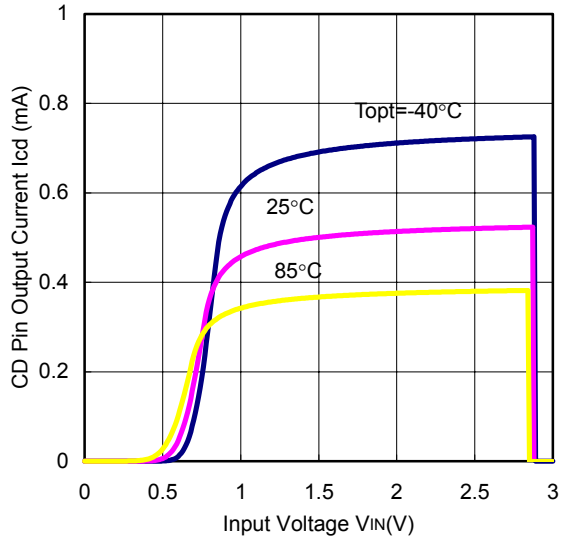
R3112X091X V_{DS}=0.5V



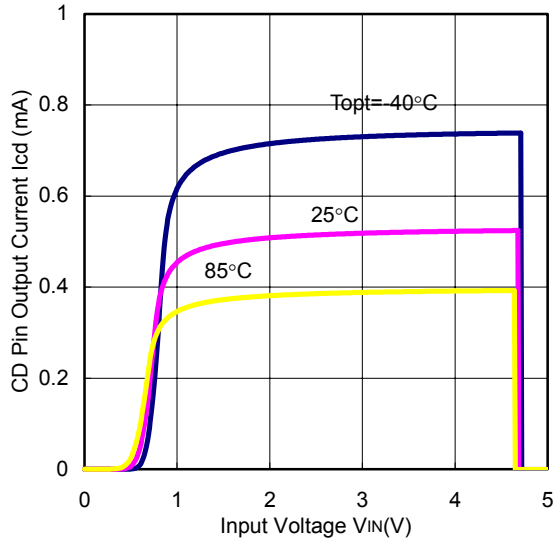
R3112X131X V_{DS}=0.5V



R3112X271X V_{DS}=0.5V

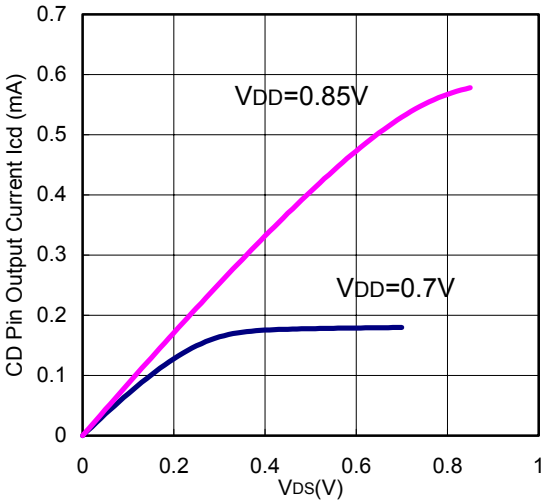


R3112X451X V_{DS}=0.5V

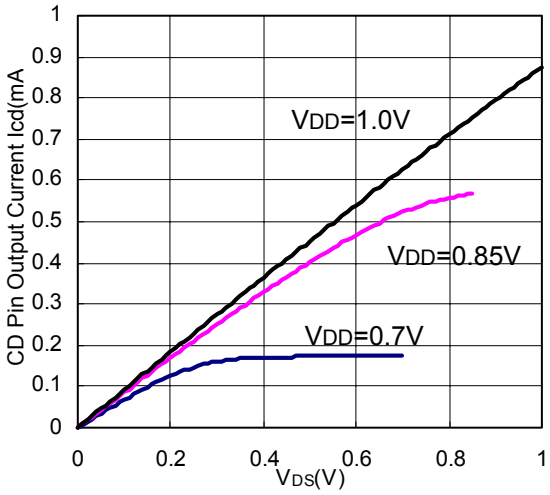


9) CD Pin Output Current vs. VDS (Topt=25°C)

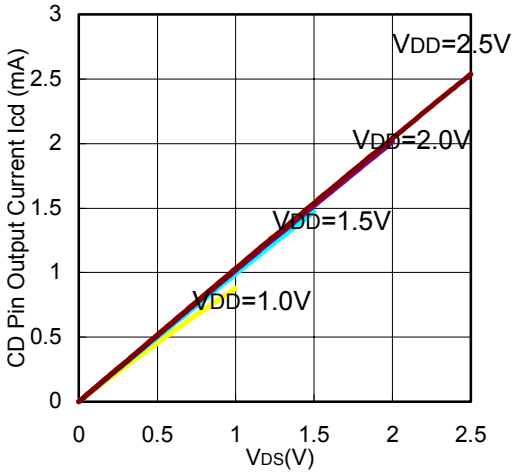
R3112X091X



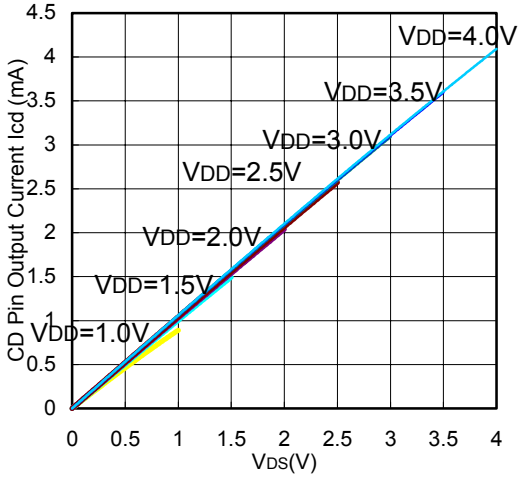
R3112X131X



R3112X271X

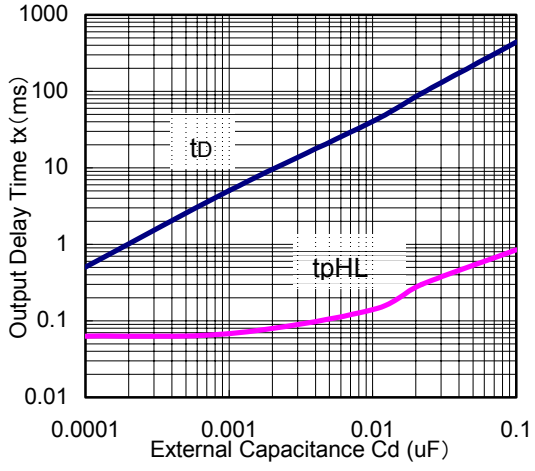


R3112X451X

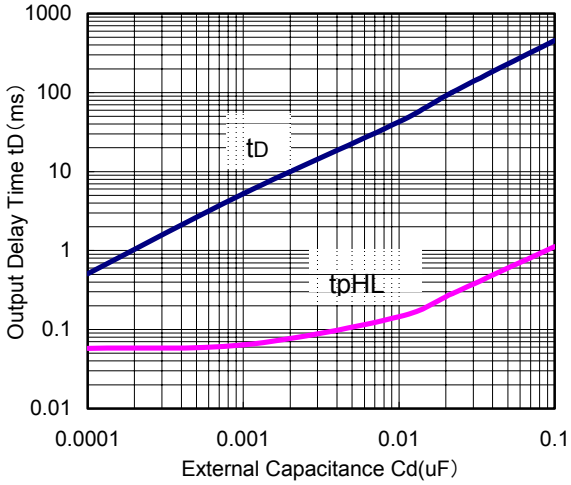


10) Output Delay Time vs. External Capacitance (Topt=25°C)

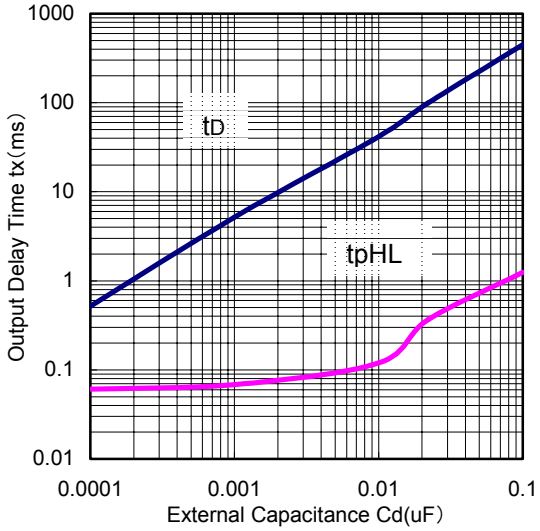
R3112X091X



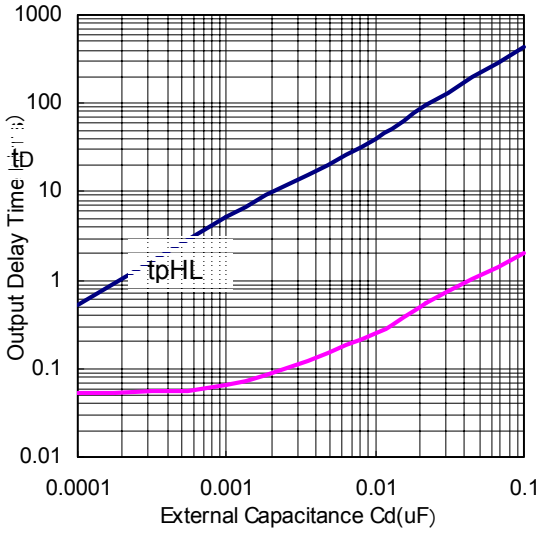
R3112X131X



R3112X271X

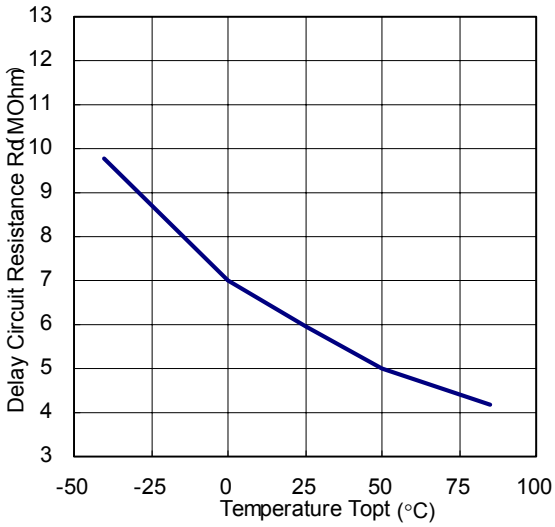


R3112X451X



11) Delay Circuit Resistance vs. Temperature

R3112XXX1X



■ TECHNICAL NOTES

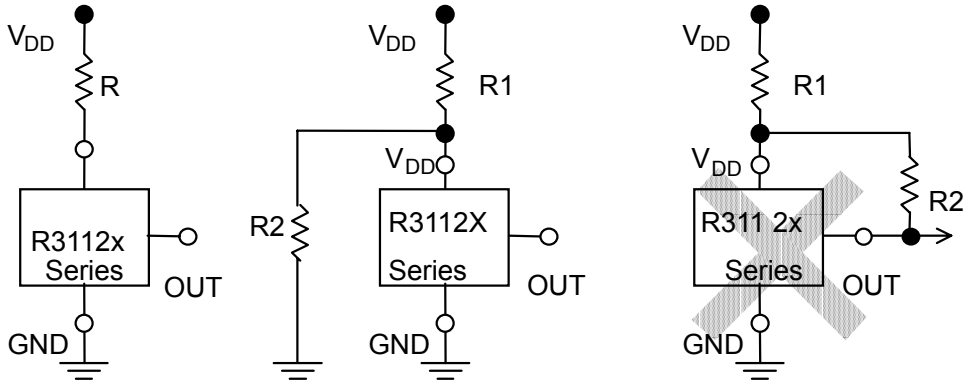


Figure A Figure B Figure C

When R3112XXX1A (Nch open drain output type) is used in Figure A or Figure B, if the impedance between the voltage supply pin, V_{DD} and V_{DD} of this IC is large, detector threshold level would shift by voltage dropdown caused by the consumption current of the IC itself. The released voltage may also shift and delay time for start-up might be generated by this usage.

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

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