LOW VOLTAGE DETECTOR

R3111xxx1A/C Series

APPLICATION MANUAL

NO. EA-058-0006

R3111xxx1A/C SERIES

OUTLINE

The R3111 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, resistors for detector threshold setting, an output driver and a hysteresis 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.

The R3111 Series are operable at a lower voltage than that for the RX5VL Series, and can be driven by a single battery.

Four types of packages, TO-92, SOT-89, SOT-23-5 and SC-82AB are available.

FEATURES

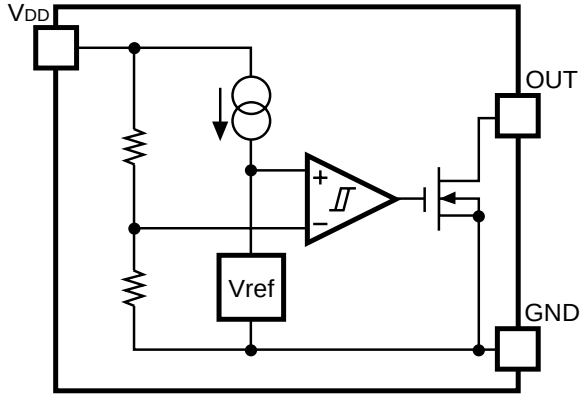
- Ultra-low Supply Current.....TYP. 0.8μA (V_{DD}=1.5V)
- Wide Range of Operating Voltage.....0.7 to 10.0V (Topt=25°C)
- Detector Threshold.....Stepwise setting with a step of 0.1V in the range of 0.9V to 6.0V is possible.
- High Accuracy Detector Threshold.....±2.0%
- Low Temperature-Drift Coefficient of Detector Threshold TYP. ±100ppm/°C
- Two Output Types .....Nch Open Drain and CMOS
- Four Types of Packages.....TO-92, SOT-89(Mini-power Mold), SOT-23-5 (Mini-mold), SC-82AB

APPLICATIONS

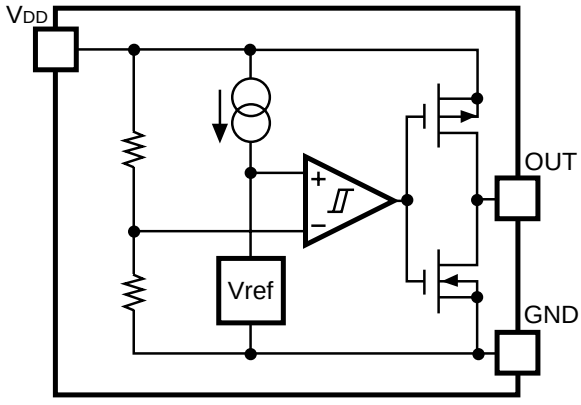
- CPU and Logic Circuit Reset
- Battery Checker
- Window Comparator
- Wave Shaping Circuit
- Battery Back-up Circuit
- Power Failure Detector

BLOCK DIAGRAMS

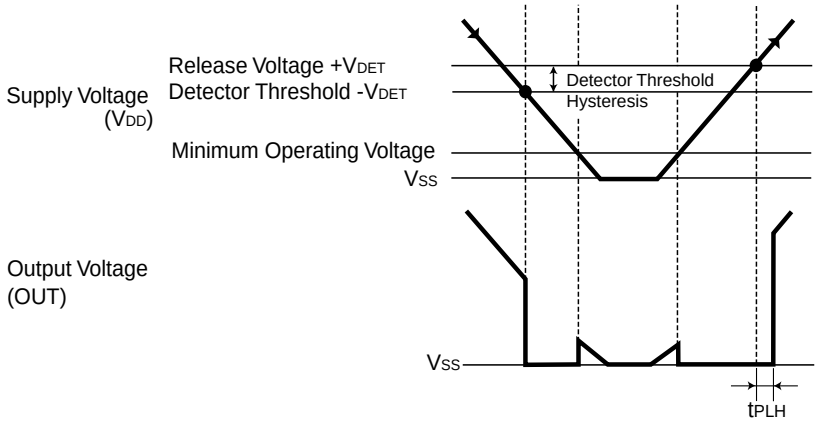
R3111XXX1A



R3111XXX1C



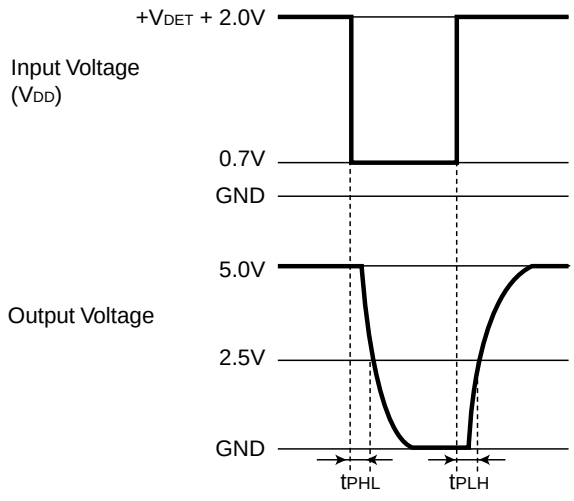
TIMING CHART



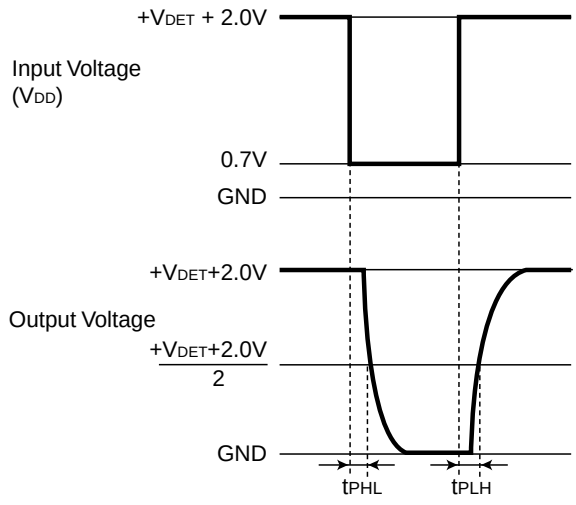
DEFINITION OF OUTPUT DELAY TIME

Output Delay Time t_{PLH} is defined as follows:

1. In the case of Nch Open Drain Output:
   Under the condition of the output pin (OUT) is pulled up through a resistor of 470kΩ to 5V, the time interval between the rising edge of V_{DD} pulse from 0.7V to $(+V_{DET})+$ 2.0V and becoming of the output voltage to 2.5V.
2. In the case of CMOS Output:
   The time interval between the rising edge of V_{DD} pulse from 0.7V to $(+V_{DET})+$ 2.0V and becoming of the output voltage to $(V_{DD}/2)$ V.



Nch Open Drain Output



CMOS Output

SELECTION GUIDE

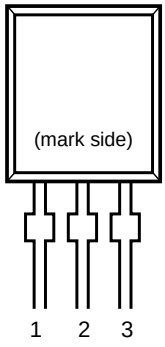
The package type, the detector threshold, the output type and the taping type of R3111 Series can be designated at the users' request by specifying the part number as follows;

R3111×<u>××</u>1×-<u>××</u> ←Part Number
↑↑ ↑↑
a b c d

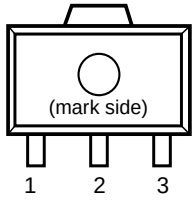
Code	Contents
a	Designation of Package Type; E: TO-92 Q: SC-82AB H: SOT-89 N: SOT-23-5
b	Setting Detector Threshold (-V_{DET}); Stepwise setting with a step of 0.1V in the range of 0.9V to 6.0V is possible.
c	Designation of Output Type; A: Nch Open Drain C: CMOS
d	Designation of Packing or Taping Type ; Ex.TO-92: TZ, SOT-89: T1, SOT-23-5, SC-82AB: TR prescribed as standard directions. (Refer to Taping Specifications.) Antistatic bag for samples: C

PIN CONFIGURATION

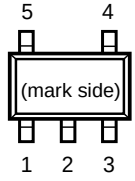
- **TO-92**



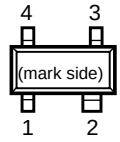
- **SOT-89**



- **SOT-23-5**



- **SC-82AB**



PIN DESCRIPTION

- **TO-92**

Pin No.	Symbol
1	V_{DD}
2	GND
3	OUT

- **SOT-89**

Pin No.	Symbol
1	OUT
2	V_{DD}
3	GND

- **SOT-23-5**

Pin No.	Symbol
1	OUT
2	V_{DD}
3	GND
4	NC
5	NC

- **SC-2AB**

Pin No.	Symbol
1	OUT
2	V_{DD}
3	NC
4	GND

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{DD}	Supply Voltage	12	V
V_{OUT1}	Output Voltage (CMOS)	V_{SS}-0.3 to V_{DD}+0.3	V
V_{OUT2}	Output Voltage (Nch)	V_{SS}-0.3 to 12	V
I_{OUT}	Output Current	70	mA
P_D	Power Dissipation 1*Note1	300	mW
P_D	Power Dissipation 2*Note2	150	mW
Topt	Operating Temperature Range	-40 to 85	°C
Tstg	Storage Temperature Range	-55 to 125	°C
Tsolder	Lead temperature (Soldering)	260°C, 10s	

*Note 1: applied to SOT-89 and TO-92

*Note 2: applied to SOT-23-5 and SC-82AB

ELECTRICAL CHARACTERISTICS

- **R3111x091A/C**

Topt=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 2.90V		0.8 0.9	2.4 2.7	μA
V_{DDH}	Maximum Operating Voltage				10	V
V_{DDL}	Minimum Operating Voltage*Note1	Topt=25°C		0.55	0.70	V
		-40°C≤Topt≤85°C		0.65	0.80	
I_{OUT}	Output Current (Driver Output Pin)	Nch V_{DS}=0.05V,V_{DD}=0.70V V_{DS}=0.50V,V_{DD}=0.85V	 0.01 0.05	 0.05 0.50		mA
		Pch V_{DS}=-2.1V,V_{DD}=4.5V	 1.0	 2.0		mA
t_{PLH}	Output Delay Time*Note2				100	μs
$\Delta-V_{DET}/\Delta T$	Detector Threshold Temperature Coefficient	-40°C≤Topt≤85°C		±100		ppm/°C

• **R3111x181A/C**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold		1.764	1.800	1.836	V
V_{HYS}	Detector Threshold Hysteresis		0.054	0.090	0.126	V
I_{SS}	Supply Current	V_{DD}=1.70V 3.80V		0.8 1.0	2.4 3.0	μA
V_{DDH}	Maximum Operating Voltage				10	V
V_{DDL}	Minimum Operating Voltage*Note1	Topt=25°C		0.55	0.70	V
		-40°C≤Topt≤85°C		0.65	0.80	
I_{OUT}	Output Current (Driver Output Pin)	Nch V_{DS}=0.05V, V_{DD}=0.70V V_{DS}=0.50V, V_{DD}=0.85V	0.01 1.00	0.05 2.00		mA
		Pch V_{DS}=-2.1V,V_{DD}=4.5V	1.0	2.0		mA
t_{PLH}	Output Delay Time*Note2				100	μs
$\Delta-V_{DET}/\Delta T$	Detector Threshold Temperature Coefficient	-40°C≤Topt≤85°C		±100		ppm/°C

• **R3111x271A/C**

Topt=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	0.135	0.189	V
I_{SS}	Supply Current	V_{DD}=2.60V 4.70V		0.9 1.1	2.7 3.3	μA
V_{DDH}	Maximum Operating Voltage				10	V
V_{DDL}	Minimum Operating Voltage*Note1	Topt=25°C		0.55	0.70	V
		-40°C≤Topt≤85°C		0.65	0.80	
I_{OUT}	Output Current (Driver Output Pin)	Nch V_{DS}=0.05V,V_{DD}=0.70V V_{DS}=0.50V,V_{DD}=1.50V	0.01 1.00	0.05 2.00		mA
		Pch V_{DS}=-2.1V,V_{DD}=4.5V	1.0	2.0		mA
t_{PLH}	Output Delay Time*Note2				100	μs
$\Delta-V_{DET}/\Delta T$	Detector Threshold Temperature Coefficient	-40°C≤Topt≤85°C		±100		ppm/°C

- **R3111x361A/C**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold		3.528	3.600	3.672	V
V_{HYS}	Detector Threshold Hysteresis		0.108	0.180	0.252	V
I_{SS}	Supply Current	V_{DD}=3.47V 5.60V		1.0 1.2	3.0 3.6	μA
V_{DDH}	Maximum Operating Voltage				10	V
V_{DDL}	Minimum Operating Voltage*Note1	Topt=25°C		0.55	0.70	V
		-40°C≤Topt≤85°C		0.65	0.80	
I_{OUT}	Output Current (Driver Output Pin)	Nch V_{DS}=0.05V,V_{DD}=0.70V V_{DS}=0.50V,V_{DD}=1.50V	 0.01 1.00	 0.05 2.00		mA
		Pch V_{DS}=-2.1V,V_{DD}=4.5V	 1.0	 2.0		mA
t_{PLH}	Output Delay Time*Note2				100	μs
$\Delta-V_{DET}/\Delta T$	Detector Threshold Temperature Coefficient	-40°C≤Topt≤85°C		±100		ppm/°C

- **R3111x451A/C**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold		4.410	4.500	4.590	V
V_{HYS}	Detector Threshold Hysteresis		0.135	0.225	0.315	V
I_{SS}	Supply Current	V_{DD}=4.34V 6.50V		1.1 1.3	3.3 3.9	μA
V_{DDH}	Maximum Operating Voltage				10	V
V_{DDL}	Minimum Operating Voltage*Note1	Topt=25°C		0.55	0.70	V
		-40°C≤Topt≤85°C		0.65	0.80	
I_{OUT}	Output Current (Driver Output Pin)	Nch V_{DS}=0.05V, V_{DD}=0.70V V_{DS}=0.50V, V_{DD}=1.50V	 0.01 1.00	 0.05 2.00		mA
		Pch V_{DS}=-2.1V,V_{DD}=8.0V	 1.5	 3.0		mA
t_{PLH}	Output Delay Time*Note2				100	μs
$\Delta-V_{DET}/\Delta T$	Detector Threshold Temperature Coefficient	-40°C≤Topt≤85°C		±100		ppm/°C

- **R3111x541A/C**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold		5.292	5.400	5.508	V
V_{HYS}	Detector Threshold Hysteresis		0.162	0.270	0.378	V
I_{SS}	Supply Current	V_{DD}=5.20V 7.40V		1.2 1.4	3.6 4.2	μA
V_{DDH}	Maximum Operating Voltage				10	V
V_{DDL}	Minimum Operating Voltage*Note1	Topt=25°C		0.55	0.70	V
		-40°C≤Topt≤85°C		0.65	0.80	
I_{OUT}	Output Current (Driver Output Pin)	Nch V_{DS}=0.05V, V_{DD}=0.70V V_{DS}=0.50V, V_{DD}=1.50V	0.01 1.00	0.05 2.00		mA
		Pch V_{DS}=-2.1V,V_{DD}=8.0V	1.5	3.0		mA
t_{PLH}	Output Delay Time*Note2				100	μs
$\Delta-V_{DET}/\Delta T$	Detector Threshold Temperature Coefficient	-40°C≤Topt≤85°C		±100		ppm/°C

*Note1: Minimum Operating Voltage means the value of input voltage when output voltage maintains 0.1V or less. (In the case of Nch Open Drain Type, Output pin is pulled up with a resistance of 470kΩ to 5.0V.)

*Note2: In the case of CMOS Output Type: The time interval between the rising edge of V_{DD} input pulse from 0.7V to ($+V_{DET}$)+2.0V and output voltage level becoming to $V_{DD}/2$.
In the case of Nch Open Drain Output Type: Output pin is pulled up with a resistance of 470kΩ to 5.0V, The time interval between the rising edge of V_{DD} input pulse from 0.7V to ($+V_{DET}$)+2.0V and output voltage level becoming to 2.5V.

ELECTRICAL CHARACTERISRICS BY DETECTOR THRESHOLD

- **R3111x09x to R3111x60x**

Part Number	Detector Threshold			Detector Threshold Hysteresis			Supply Current 1			Supply Current 2		
	$-V_{DET}$[V]			V_{HYS}[V]			I_{SS1}[µA]			I_{SS2}[µA]		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	Condition	TYP.	MAX.	Condition	TYP.	MAX.
R3111x091x	0.882	0.900	0.918	0.027	0.045	0.063	V_{DD}= ($-V_{DET}$) -0.10V	0.8	2.4	V_{DD}= ($-V_{DET}$) +2.0V	0.9	2.7
R3111x101x	0.980	1.000	1.020	0.030	0.050	0.070					1.0	3.0
R3111x111x	1.078	1.100	1.122	0.033	0.055	0.077						
R3111x121x	1.176	1.200	1.224	0.036	0.060	0.084						
R3111x131x	1.274	1.300	1.326	0.039	0.065	0.091						
R3111x141x	1.372	1.400	1.428	0.042	0.070	0.098						
R3111x151x	1.470	1.500	1.530	0.045	0.075	0.105						
R3111x161x	1.568	1.600	1.632	0.048	0.080	0.112						
R3111x171x	1.666	1.700	1.734	0.051	0.085	0.119						
R3111x181x	1.764	1.800	1.836	0.054	0.090	0.126						
R3111x191x	1.862	1.900	1.938	0.057	0.095	0.133						
R3111x201x	1.960	2.000	2.040	0.060	0.100	0.140		0.9	2.7		1.1	3.3
R3111x211x	2.058	2.100	2.142	0.063	0.105	0.147						
R3111x221x	2.156	2.200	2.244	0.066	0.110	0.154						
R3111x231x	2.254	2.300	2.346	0.069	0.115	0.161						
R3111x241x	2.352	2.400	2.448	0.072	0.120	0.168						
R3111x251x	2.450	2.500	2.550	0.075	0.125	0.175						
R3111x261x	2.548	2.600	2.652	0.078	0.130	0.182						
R3111x271x	2.646	2.700	2.754	0.081	0.135	0.189						
R3111x281x	2.744	2.800	2.856	0.084	0.140	0.196						
R3111x291x	2.842	2.900	2.958	0.087	0.145	0.203						
R3111x301x	2.940	3.000	3.060	0.090	0.150	0.210	V_{DD}= ($-V_{DET}$) -0.13V	1.0	3.0		1.2	3.6
R3111x311x	3.038	3.100	3.162	0.093	0.155	0.217						
R3111x321x	3.136	3.200	3.264	0.096	0.160	0.224						
R3111x331x	3.234	3.300	3.366	0.099	0.165	0.231						
R3111x341x	3.332	3.400	3.468	0.102	0.170	0.238						
R3111x351x	3.430	3.500	3.570	0.105	0.175	0.245						
R3111x361x	3.528	3.600	3.672	0.108	0.180	0.252						
R3111x371x	3.626	3.700	3.774	0.111	0.185	0.259						
R3111x381x	3.724	3.800	3.876	0.114	0.190	0.266						
R3111x391x	3.822	3.900	3.978	0.117	0.195	0.273						
R3111x401x	3.920	4.000	4.080	0.120	0.200	0.280	V_{DD}= ($-V_{DET}$) -0.16V	1.1	3.3		1.3	3.9
R3111x411x	4.018	4.100	4.182	0.123	0.205	0.287						
R3111x421x	4.116	4.200	4.284	0.126	0.210	0.294						
R3111x431x	4.214	4.300	4.386	0.129	0.215	0.301						
R3111x441x	4.312	4.400	4.488	0.132	0.220	0.308						
R3111x451x	4.410	4.500	4.590	0.135	0.225	0.315						
R3111x461x	4.508	4.600	4.692	0.138	0.230	0.322						
R3111x471x	4.606	4.700	4.794	0.141	0.235	0.329						
R3111x481x	4.704	4.800	4.896	0.144	0.240	0.336						
R3111x491x	4.802	4.900	4.998	0.147	0.245	0.343						
R3111x501x	4.900	5.000	5.100	0.150	0.250	0.350	V_{DD}= ($-V_{DET}$) -0.20V	1.2	3.6		1.4	4.2
R3111x511x	4.998	5.100	5.202	0.153	0.255	0.357						
R3111x521x	5.096	5.200	5.304	0.156	0.260	0.364						
R3111x531x	5.194	5.300	5.406	0.159	0.265	0.371						
R3111x541x	5.292	5.400	5.508	0.162	0.270	0.378						
R3111x551x	5.390	5.500	5.610	0.165	0.275	0.385						
R3111x561x	5.488	5.600	5.712	0.168	0.280	0.392						
R3111x571x	5.586	5.700	5.814	0.171	0.285	0.399						
R3111x581x	5.684	5.800	5.916	0.174	0.290	0.406						
R3111x591x	5.782	5.900	6.018	0.177	0.295	0.413						
R3111x601x	5.880	6.000	6.120	0.180	0.300	0.420						

Note 1: In the case of CMOS Output parts; when the voltage is forced to V_{DD} from 0.7V to ($+V_{DET}$)+2.0V, time interval between the rising edge of V_{DD} and the reaching point at 50% of Output Voltage. In the case of Nch open Drain Output parts : Output pin is pulled up to 5V through 470kΩ,and when the voltage is forced to V_{DD} from 0.7V to ($+V_{DET}$)+2.0V, time interval between the rising edge of V_{DD} and the reaching point ar 50% of Output Voltage.

Note 2: V_{DD} value when Output Voltage is equal or less than 0.1V. In the case of Nch Open Drain Output parts, Output pin is pulled up to 5V through 470kΩ resistor.
Condition 1: Topt=25°C
Condition 2: -40°C≤Topt≤85°C

Output Current 1			Output Current 2				Output Delay Time	Minimum Operating Voltage		Detector Threshold Temperature Coefficient	
I_{OUT1}[mA]			I_{OUT2}[mA]				t_{PLH}[µs]	V_{DDL}[V]		Δ-V_{DET}/ΔT[ppm/°C]	
Condition	MIN.	TYP.	Condition		MIN.	TYP.	MAX.	TYP.	MAX.	Condition	TYP.
				V_{DD}= 0.85V	0.05	0.5					
				V_{DD}= 1.0V	0.2	1.0					
Nch V_{DS}=0.05V V_{DD}=0.7V	0.01	0.05	Nch V_{DS}= 0.5V	V_{DD}= 1.5V	1.0	2.0	Note 1 100	Note 2 Condition 1 0.55 Condition 2 0.65	Note 2 Condition 1 0.70 Condition 2 0.80	-40°C≤ Topt ≤85°C	±100

OPERATION

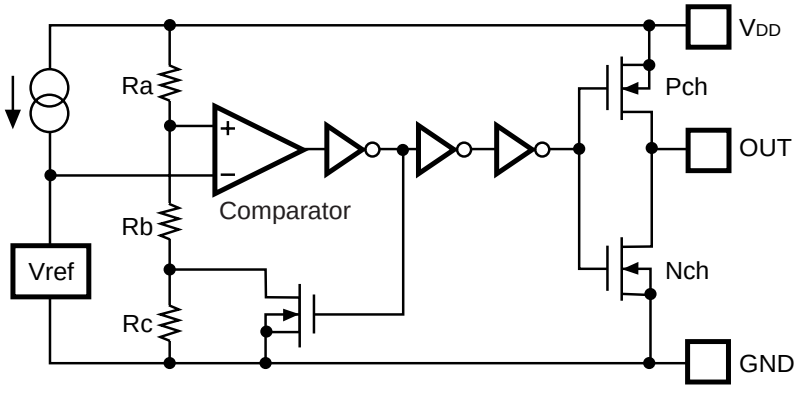
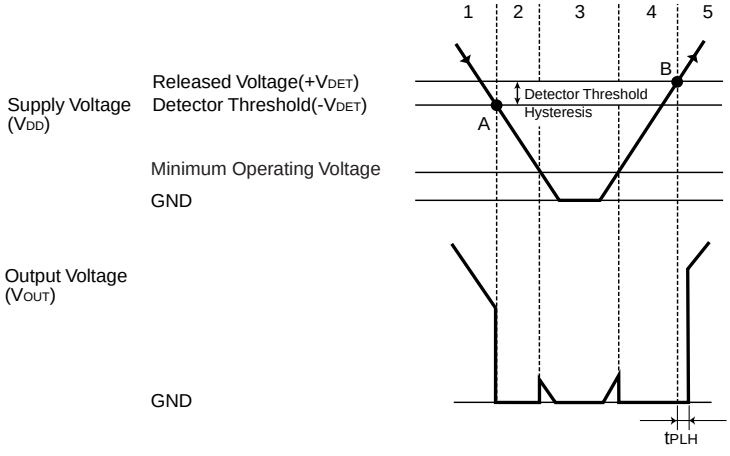


Figure 1. Block Diagram



Step		1	2	3	4	5
Comparator Pin Input Voltage		I	II	III	IV	V
Comparator Output		H	L	Indefinite	L	H
Tr.1		OFF	ON	Indefinite	ON	OFF
Output Tr.	Pch	ON	OFF	Indefinite	OFF	ON
	Nch	OFF	ON	Indefinite	ON	OFF

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

II. $\frac{Rb}{Ra + Rb} \cdot V_{DD}$

Figure 2. Operation Diagram

Step 1. Output Voltage is equal to Supply Voltage (V_{DD}).

Step 2. At Point "A", $Vref \geq V_{DD} \times (Rb+Rc)/(Ra+Rb+Rc)$ is true, as a result, the output of comparator is reverse, and output voltage becomes to GND level. The voltage level of Point A means detector threshold voltage, or ($-V_{DET}$).

Step 3. When the supply voltage is less than minimum operating voltage, the operation of output transistor becomes indefinite, and in the case that output is pulled up to V_{DD}, Output voltage equals to V_{DD} voltage.

Step 4. Output Voltage equals to GND level.

Step 5. At Point "B", $Vref \leq V_{DD} \times Rb/(Ra+Rb)$ is true, Output of the comparator is reverse, and output voltage is equal to the supply voltage, or (V_{DD}). The voltage level of Point B means released voltage, or ($+V_{DET}$).

* The difference between Released Voltage and Detector Threshold Voltage is Detector Threshold Hysteresis.

TEST CIRCUITS

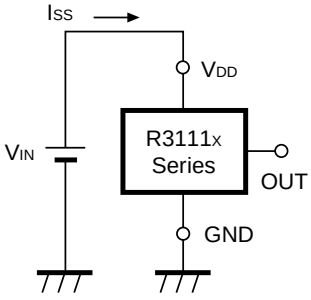
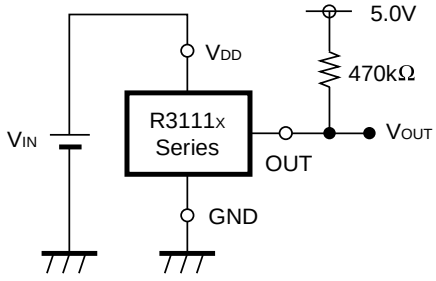


Figure 3. Supply Current Test Circuit



*Pull-up circuit is not necessary for CMOS Output type, or R3111XXXXC.

Figure 4. Detector Threshold Test Circuit

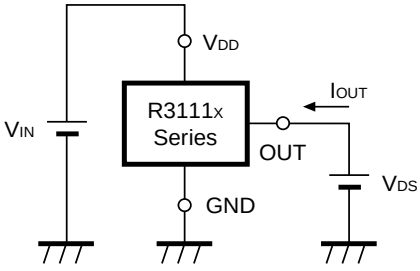
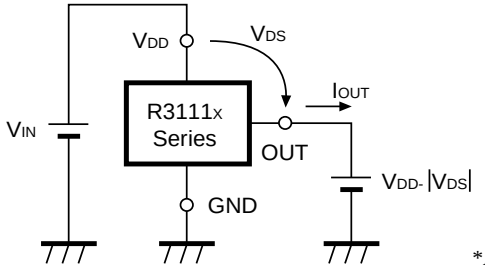


Figure 5. Nch Driver Output Current Test Circuit



*Apply to CMOS Output type only

Figure 6. Pch Driver Output Current Test Circuit

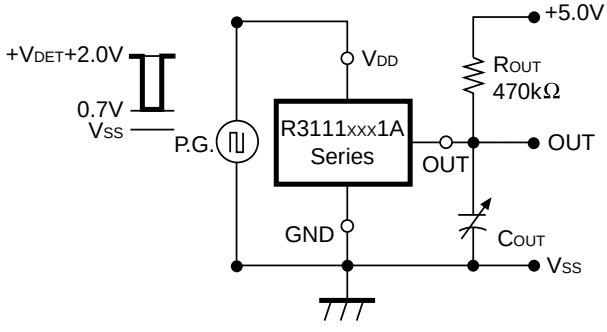


Figure 7. Output Delay Time Test Circuit (1)

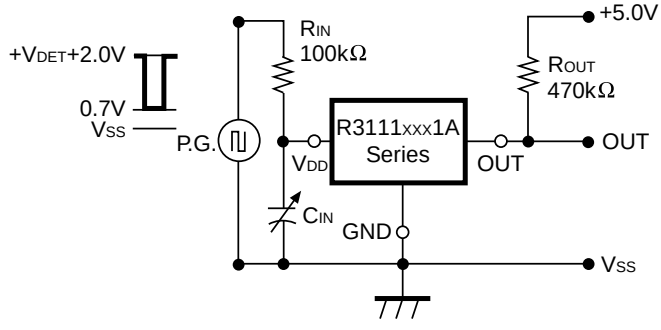
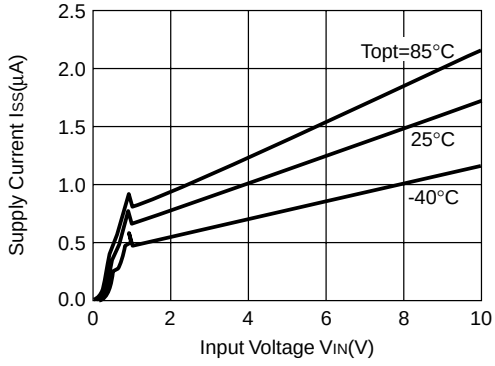


Figure 8. Output Delay Time Test Circuit (2)

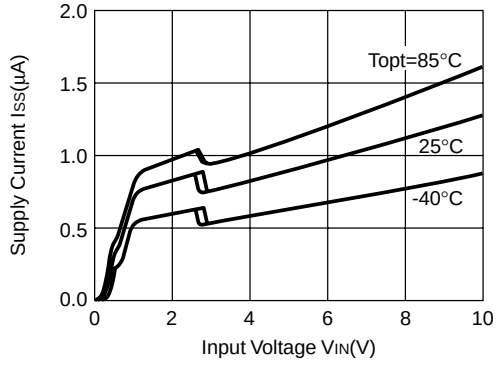
TYPICAL CHARACTERISTICS

1) Supply Current vs. Input Voltage

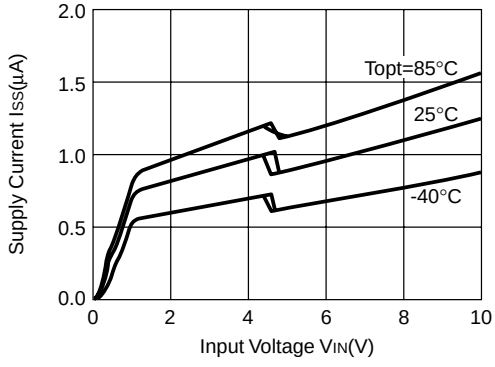
R3111x091C



R3111x271C

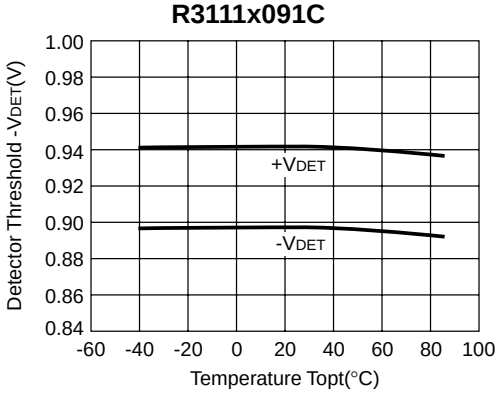


R3111x451C

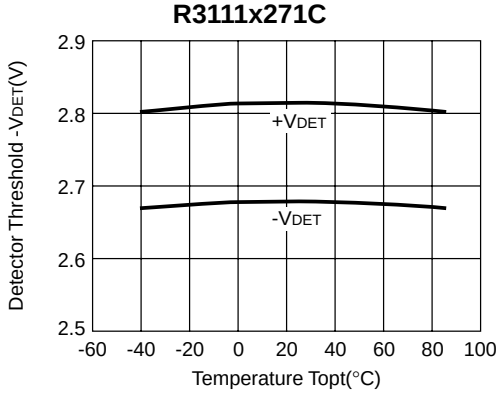


2) Detector Threshold Hysteresis vs. Temperature

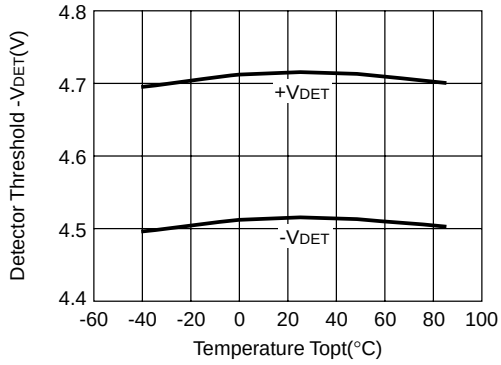
R3111x091C



R3111x271C

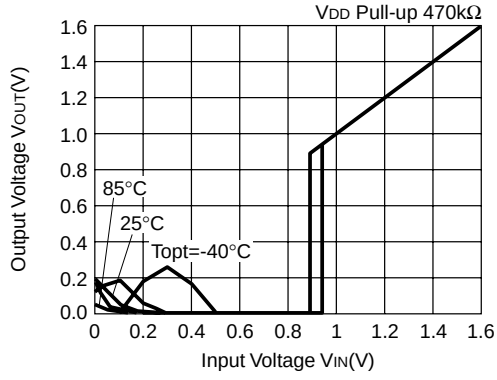


R3111x451C

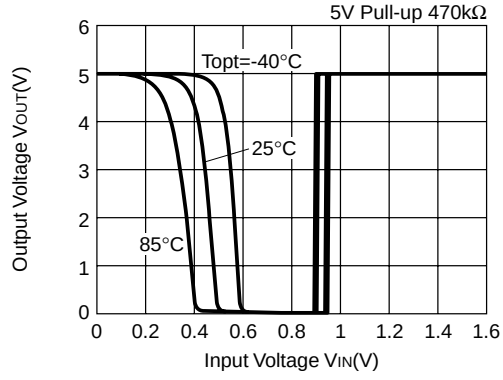


3) Output Voltage vs. Input Voltage

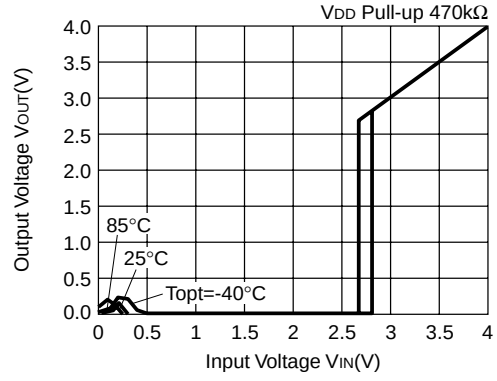
R3111x091C



R3111x091A



R3111x271C



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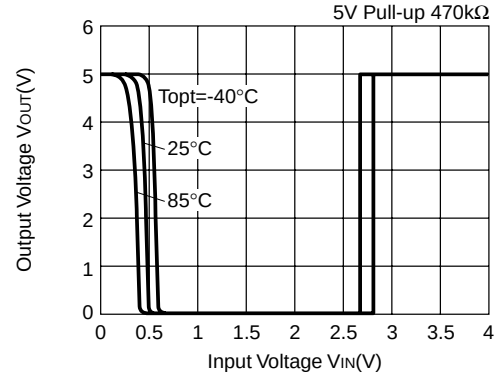
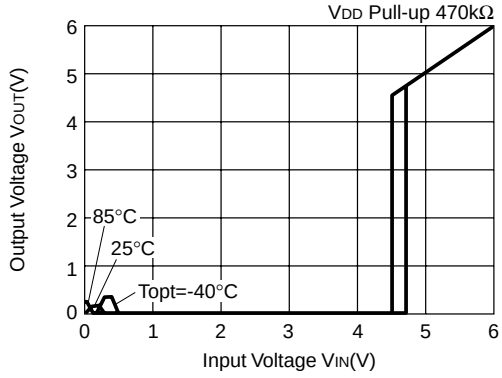


R3111x451C



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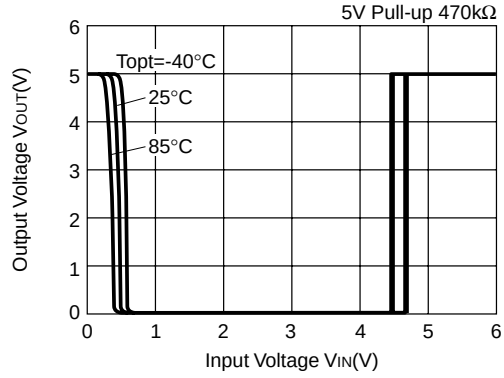
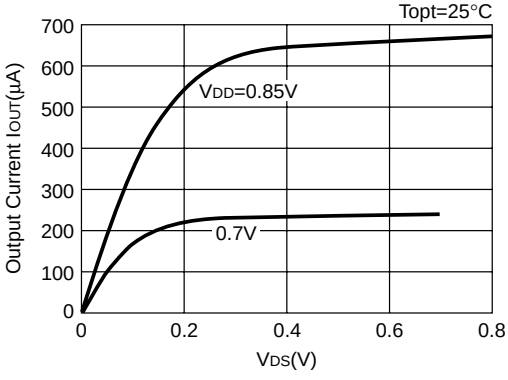
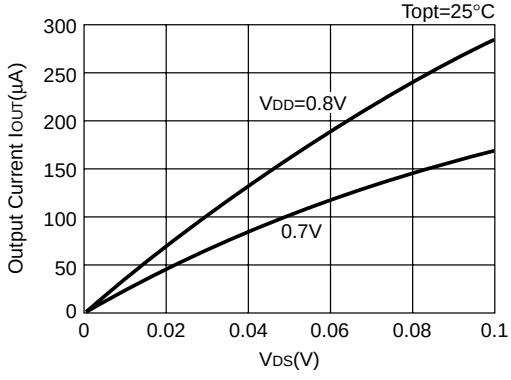


4) Nch Driver Output Current vs. V_{DS}

R3111x091C



R3111x091C



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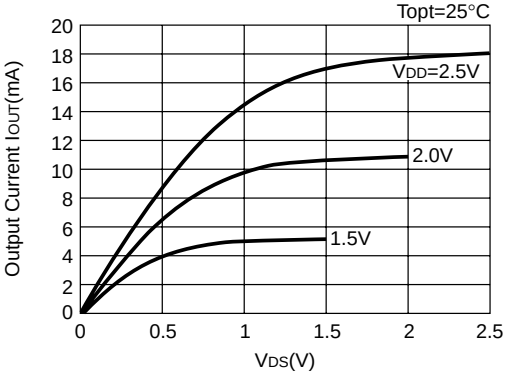

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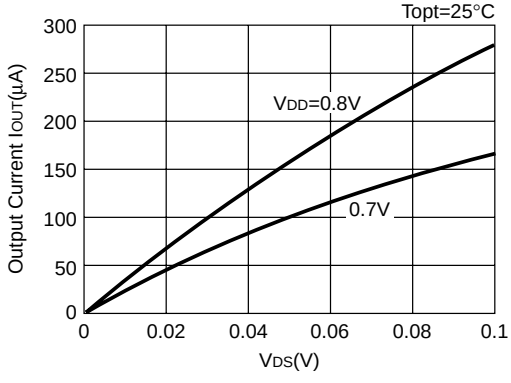

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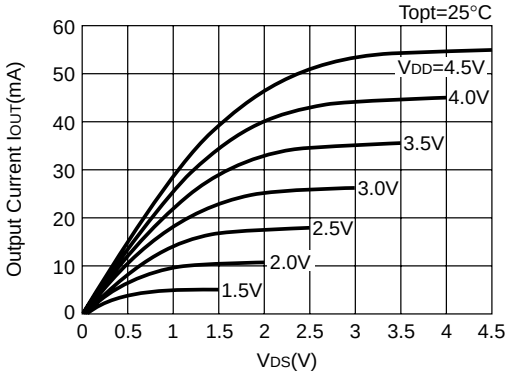

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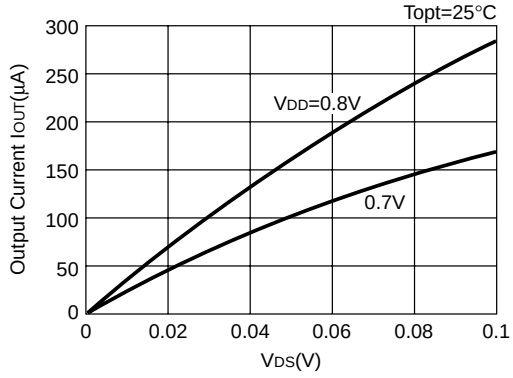
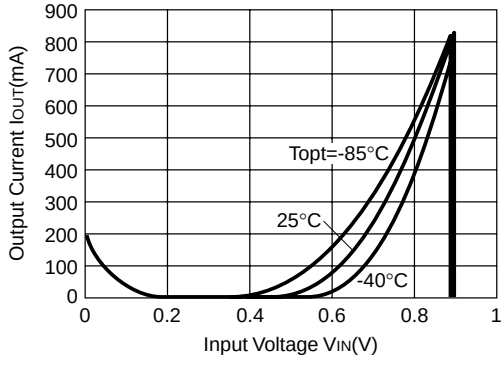
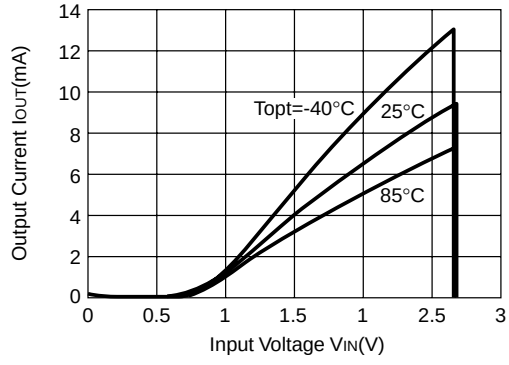


5) Nch Driver Output Current vs. Input Voltage

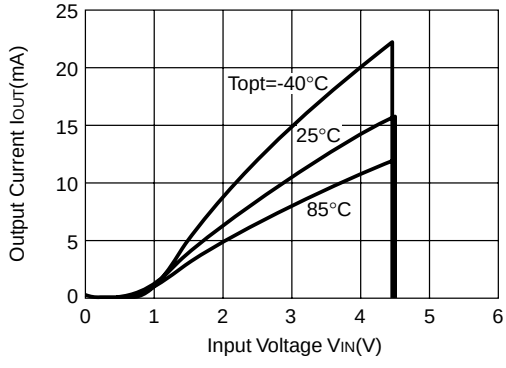
R3111x091C



R3111x271C

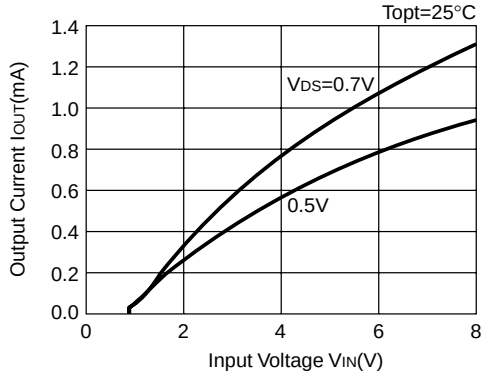


R3111x451C

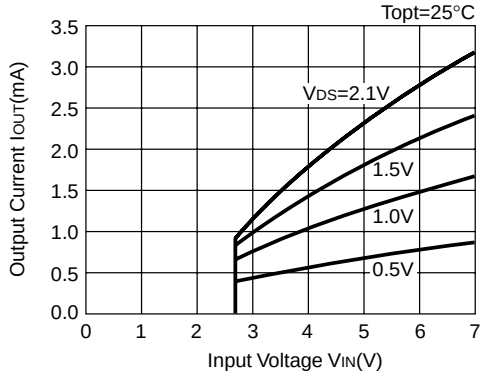


6) Pch Driver Output Current vs. Input Voltage

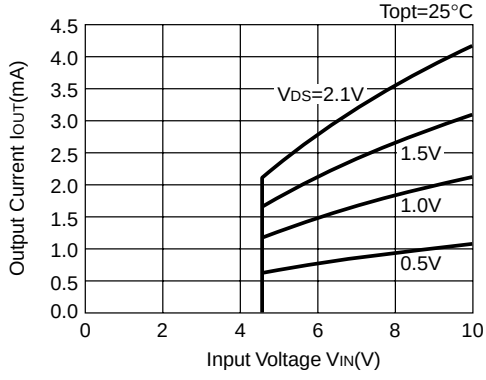
R3111x091C



R3111x271C

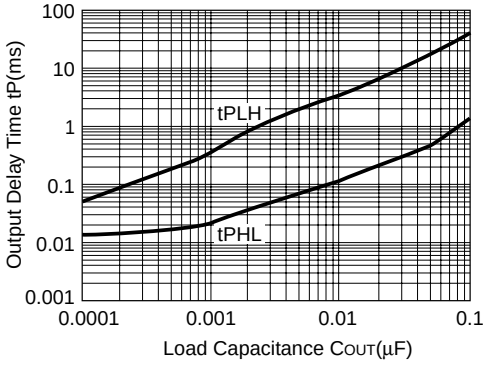


R3111x451C

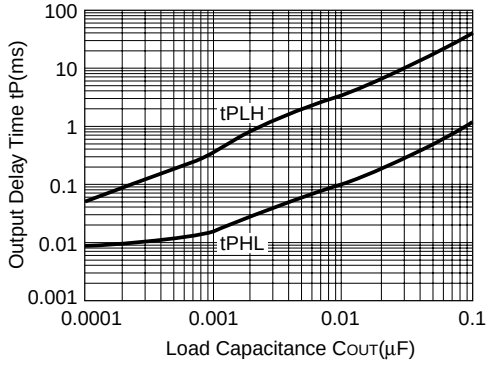


7) Output Delay Time vs. Load Capacitance

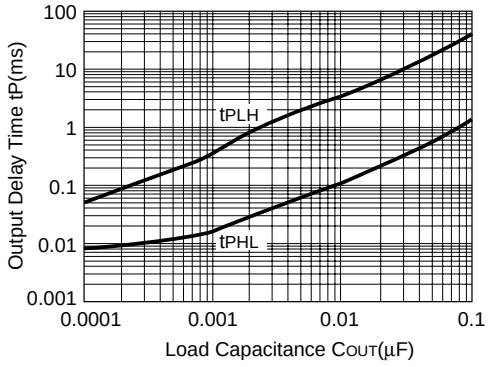
R3111x091A



R3111x271A

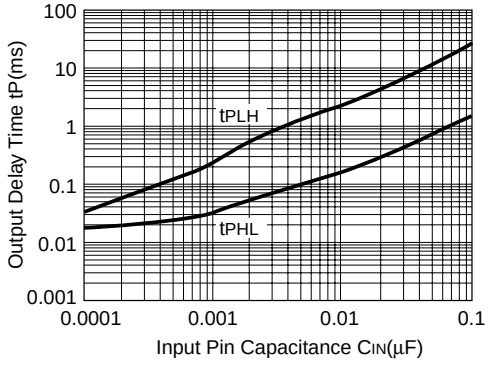


R3111x451A

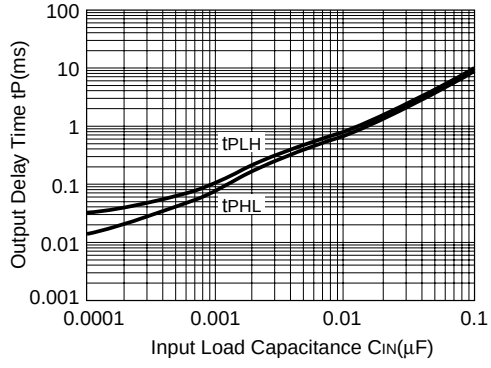


8) Output Delay Time vs. Input Pin Capacitance

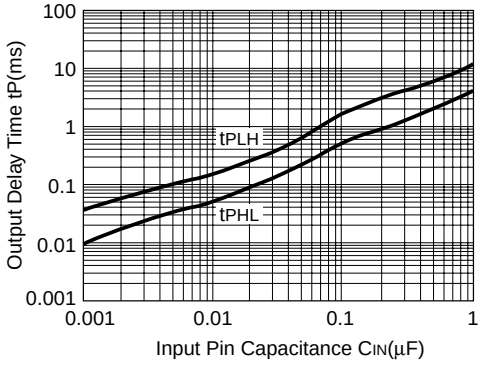
R3111x091A



R3111x271A



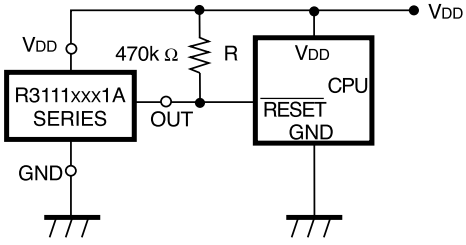
R3111x451A



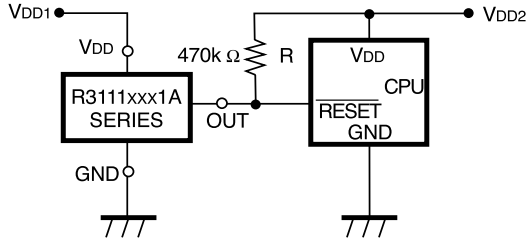
TYPICAL APPLICATION

- **R3111xxx1A CPU Reset Circuit (Nch Open Drain Output)**

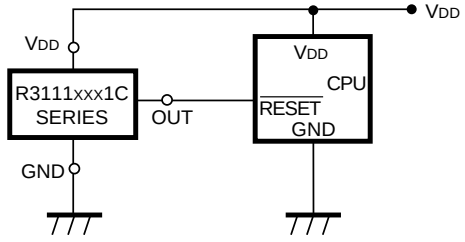
Case 1. Input Voltage to R3111xxx1A is equal to Input Voltage to CPU



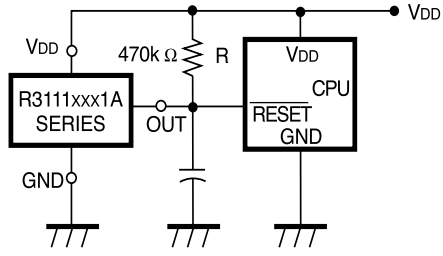
Case 2. Input Voltage to R3111xxx1A is unequal to Input Voltage to CPU



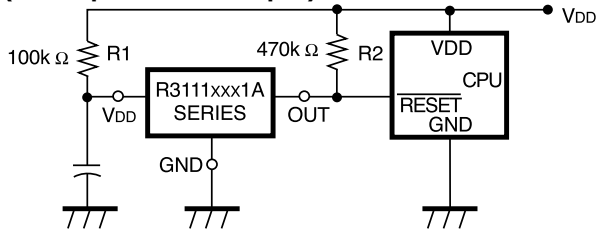
- **R3111xxx1A CPU Reset Circuit CMOS Output**



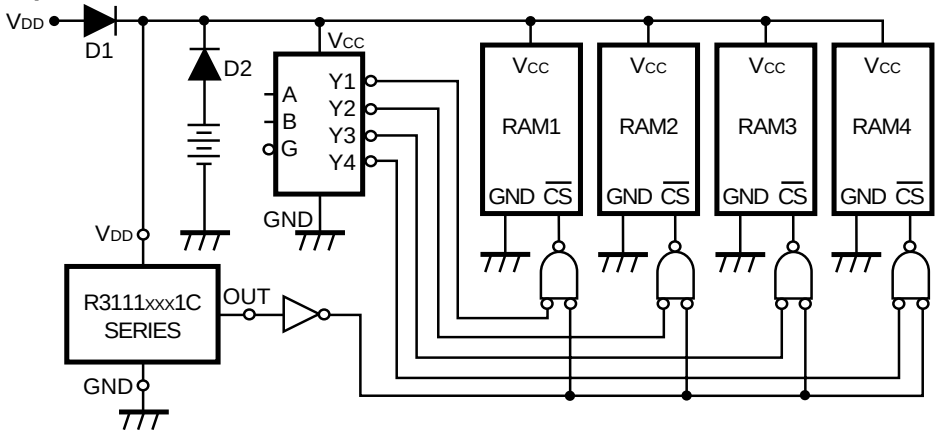
- **R3111xxx1A Output Delay Time Circuit 1 (Nch Open Drain Output)**



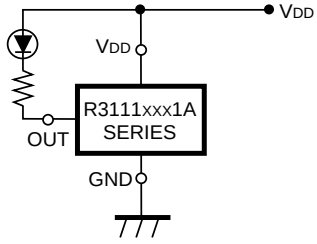
- **R3111xxx1A Output Delay Time Circuit 2 (Nch Open Drain Output)**



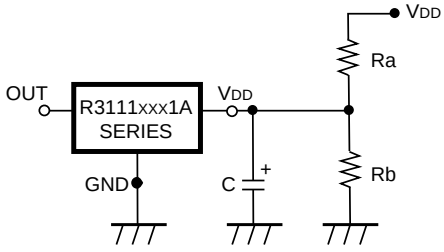
- **Memory Back-up Circuit**



- **Voltage level Indicator Circuit (lighted when the power runs out)**
  (Nch Open Drain Output)



- **Detector Threshold Adjustable Circuit**
  (Nch Open Drain Type Output)



Adjusted Detector Threshold

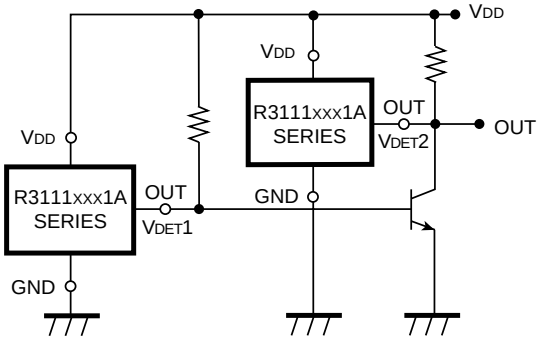
$=(-V_{DET})*(Ra+Rb)/Rb$

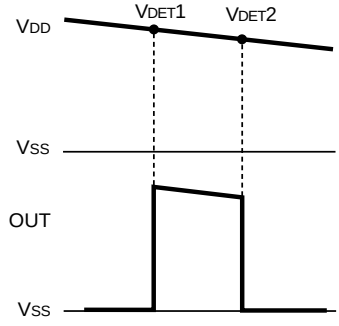
Hysteresis Voltage

$=(V_{HYS})*(Ra+Rb)/Rb$

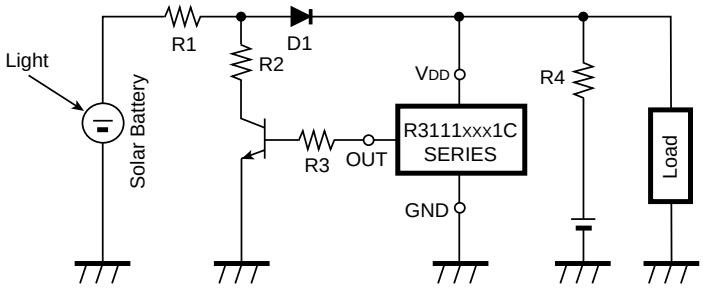
*) If the value of Ra is set excessively large, voltage drop may occur caused by the supply current of IC itself, and detector threshold may vary.

- **Window Comparator Circuit**
  (Nch Open Drain Output)





- **Over-charge Preventing Circuit**



TECHNICAL NOTES

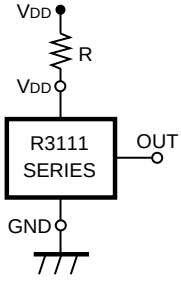


Figure 9

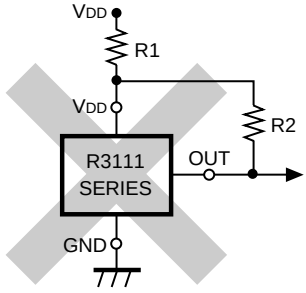


Figure 10

1. In Figure 9, When R3111xxx1C is used, and if an impedance is connected in between Voltage Supplier and the V_{DD} Pin of R3111xxx1C Series, the operation might be unstable by through-type current at detection.
   When R3111xxx1A is used in Figure 9, if the value of R is set excessively large, voltage drop may occur caused by supply crrent of IC itself and Detector threshold may vary.
2. Wiring as shown in Figure 10 may cause the oscillation in both output types of R3111 Series.