
0.8% LOW VOLTAGE DETECTOR WITH OUTPUT DELAY

NO.EA-161-110106

OUTLINE

The R3116x 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, resistors for detector threshold setting, an output driver, a hysteresis circuit and an output delay circuit. The detector threshold is internally fixed with high accuracy and does not require any adjustment.

Two output types, Nch open drain type and CMOS type are available.

The R3116x series are operable at a lower voltage than that of the R3112x series, and can be driven by a single battery.

Three types of packages, SOT-23-5, SC-82AB, and DFN(PLP)1010-4 are available.

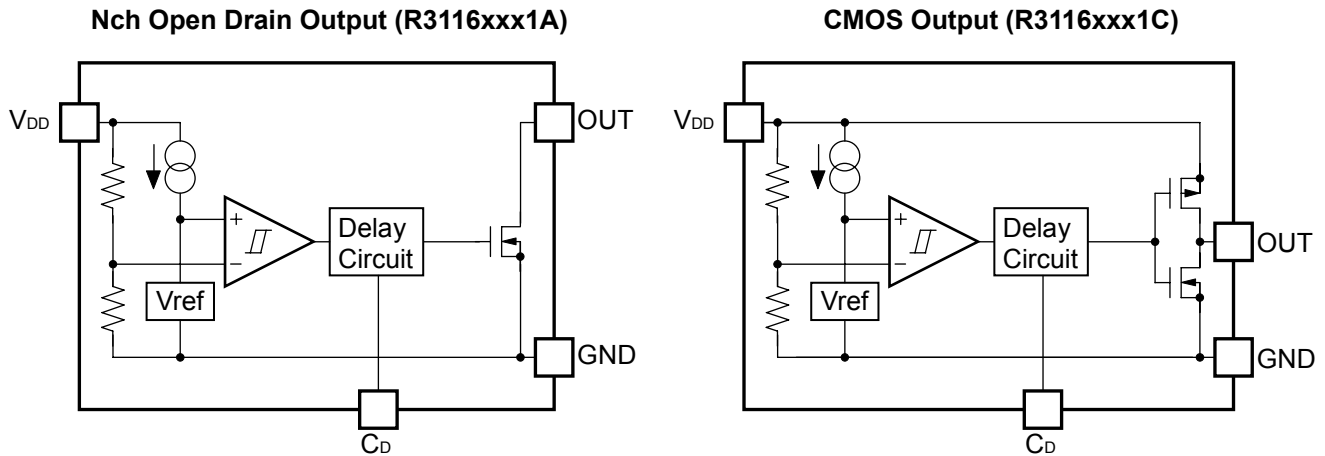
FEATURES

- Supply Current Typ. 0.35 μ A ($-V_{DET}=1.5V$, $V_{DD}=-V_{DET}+1V$)
- Operating Voltage Range..... 0.5V to 6.0V ($T_{opt}=25^{\circ}C$)
- Detector Threshold Range..... 0.7V to 5.0V (0.1V steps)
(For other voltages, please refer to MARK INFORMATION.)
- Detector Threshold Accuracy..... $\pm 0.8\%$ ($-V_{DET} \geq 1.5V$)
- Temperature-Drift Coefficient of Detector Threshold Typ. $\pm 30ppm/^{\circ}C$
- Built-in Output Delay Circuit..... Typ. 100ms with an external capacitor: 0.022 μ F
- Output Delay Time Accuracy..... $\pm 15\%$ ($-V_{DET} \geq 1.5V$)
- Output Types..... Nch Open Drain "L" and CMOS
- Packages DFN(PLP)1010-4, SC-82AB, 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, the output type and the taping type for the ICs can be selected at the users' request.

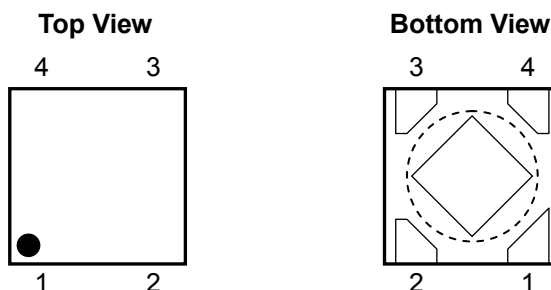
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R3116Kxx1*-TR	DFN(PLP)1010-4	10,000 pcs	Yes	Yes
R3116Qxx1*-TR-FE	SC-82AB	3,000 pcs	Yes	Yes
R3116Nxx1*-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx: The detector threshold can be designated in the range from 0.7V(07) to 5.0V(50) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

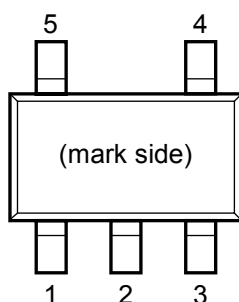
* : Designation of Output Type
(A) Nch Open Drain
(C) CMOS

PIN CONFIGURATIONS

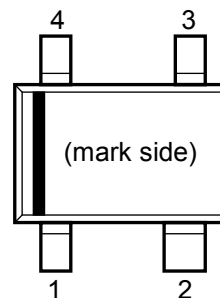
• DFN(PLP)1010-4*



• SOT-23-5



• SC-82AB



PIN DESCRIPTIONS

• DFN(PLP)1010-4*

Pin No.	Symbol	Description
1	OUT	Output Pin ("L" at detection)
2	C _D	Pin for External Capacitor (for setting output delay)
3	GND	Ground Pin
4	V _{DD}	Input Pin

*) Tab is GND level. (They are connected to the reverse side of this IC.)

The tab is better to be connected to the GND, but leaving it open is also acceptable.

• SOT-23-5

Pin No.	Symbol	Description
1	OUT	Output Pin ("L" at detection)
2	V _{DD}	Input Pin
3	GND	Ground Pin
4	NC	No Connection
5	C _D	Pin for External Capacitor (for setting output delay)

• SC-82AB

Pin No.	Symbol	Description
1	V _{DD}	Input Pin
2	GND	Ground Pin
3	C _D	Pin for External Capacitor (for setting output delay)
4	OUT	Output Pin ("L" at detection)

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{DD}	Supply Voltage	7.0	V
V_{OUT}	Output Voltage (Nch Open Drain Output)	$V_{SS}-0.3$ to 7.0	V
	Output Voltage (CMOS Output)	$V_{SS}-0.3$ to $V_{DD}+0.3$	
I_{OUT}	Output Current	20	mA
P_D	Power Dissipation (SOT-23-5)*	420	mW
	Power Dissipation (SC-82AB)*	380	
	Power Dissipation (DFN(PLP)1010-4)*	400	
T_{opt}	Operating Temperature Range	-40 to 85	°C
T_{stg}	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

● R3116x071A/C values indicate $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$, unless otherwise noted. $T_{\text{opt}}=25^{\circ}\text{C}$

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
-V _{DET}	Detector Threshold	T _{opt} =25°C	0.6880	0.7	0.7120	V	
		-40°C ≤ T _{opt} ≤ 85°C	0.6775		0.7225		
V _{HYS}	Detector Threshold Hysteresis		0.028		0.049	V	
I _{SS}	Supply Current	V _{DD} =0.6V			1.4	μA	
		V _{DD} =1.7V			1.2		
V _{DDH}	Maximum Operating Voltage				6	V	
V _{DDL}	Minimum Operating Voltage* ¹	T _{opt} =25°C			0.50	V	
		-40°C ≤ T _{opt} ≤ 85°C			0.55		
I _{OUT}	Output Current (Driver Output Pin)	Nch	V _{DD} =0.55V, V _{DS} =0.05V		7	μA	
			V _{DD} =0.6V, V _{DS} =0.5V		0.02	mA	
		Pch* ²	V _{DD} =4.5V, V _{DS} =-2.1V		0.65	mA	
I _{LEAK}	Nch Driver Leakage Current* ³	V _{DD} =6.0V, V _{DS} =7.0V			80	nA	
Δ-V _{DET} / ΔT _{opt}	Detector Threshold Temperature Coefficient	-40°C ≤ T _{opt} ≤ 85°C		±30		ppm /°C	
t _d	Output Delay Time	C _D =0.022μF V _{DD} =0.6V→0.77V	T _{opt} =25°C	80	100	130	ms
			-40°C ≤ T _{opt} ≤ 85°C	70		150	

● R3116x151A/C values indicate $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$, unless otherwise noted. $T_{\text{opt}}=25^{\circ}\text{C}$

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
-V _{DET}	Detector Threshold	T _{opt} =25°C	1.4880	1.5	1.5120	V	
		-40°C ≤ T _{opt} ≤ 85°C	1.4775		1.5225		
V _{HYS}	Detector Threshold Hysteresis		0.060		0.105	V	
I _{SS}	Supply Current	V _{DD} =1.4V			1.4	μA	
		V _{DD} =2.5V		0.35	1.2		
V _{DDH}	Maximum Operating Voltage				6	V	
V _{DDL}	Minimum Operating Voltage* ¹	T _{opt} =25°C			0.50	V	
		-40°C ≤ T _{opt} ≤ 85°C			0.55		
I _{OUT}	Output Current (Driver Output Pin)	Nch	V _{DD} =0.55V, V _{DS} =0.05V		7	μA	
			V _{DD} =1.0V, V _{DS} =0.5V		0.40	mA	
		Pch* ²	V _{DD} =4.5V, V _{DS} =-2.1V		0.65	mA	
I _{LEAK}	Nch Driver Leakage Current* ³	V _{DD} =6.0V, V _{DS} =7.0V			80	nA	
Δ-V _{DET} / ΔT _{opt}	Detector Threshold Temperature Coefficient	-40°C ≤ T _{opt} ≤ 85°C		±30		ppm /°C	
t _d	Output Delay Time	C _D =0.022μF V _{DD} =1.4V→1.65V	T _{opt} =25°C	85	100	115	ms
			-40°C ≤ T _{opt} ≤ 85°C	75		135	

All of unit are tested and specified under load conditions such that T_{opt}=25°C except for Detector Threshold Temperature Coefficient.

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

*2: In case of CMOS type

*3: In case of Nch Open Drain type

R3116x

• **R3116x271A/C** values indicate $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$, unless otherwise noted. $T_{\text{opt}}=25^{\circ}\text{C}$

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
$-V_{\text{DET}}$	Detector Threshold	$T_{\text{opt}}=25^{\circ}\text{C}$	2.6784	2.7	2.7216	V	
		$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$	2.6595		2.7405		
V_{HYS}	Detector Threshold Hysteresis		0.108		0.189	V	
I_{SS}	Supply Current	$V_{\text{DD}}=2.6\text{V}$			1.5	μA	
		$V_{\text{DD}}=3.7\text{V}$			1.2		
V_{DDH}	Maximum Operating Voltage				6	V	
V_{DDL}	Minimum Operating Voltage*1	$T_{\text{opt}}=25^{\circ}\text{C}$			0.50	V	
		$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$			0.55		
I_{OUT}	Output Current (Driver Output Pin)	Nch	$V_{\text{DD}}=0.55\text{V}, V_{\text{DS}}=0.05\text{V}$		7	μA	
			$V_{\text{DD}}=1.5\text{V}, V_{\text{DS}}=0.5\text{V}$		1.00	mA	
		Pch*2	$V_{\text{DD}}=4.5\text{V}, V_{\text{DS}}=-2.1\text{V}$		0.65	mA	
I_{LEAK}	Nch Driver Leakage Current*3	$V_{\text{DD}}=6.0\text{V}, V_{\text{DS}}=7.0\text{V}$			80	nA	
$\frac{\Delta V_{\text{DET}}}{\Delta T_{\text{opt}}}$	Detector Threshold Temperature Coefficient	$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$		± 30		ppm/ $^{\circ}\text{C}$	
t_{D}	Output Delay Time	$C_{\text{D}}=0.022\mu\text{F}$ $V_{\text{DD}}=2.6\text{V} \rightarrow 2.97\text{V}$	$T_{\text{opt}}=25^{\circ}\text{C}$	85	100	115	ms
			$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$	75		135	

• **R3116x451A/C** values indicate $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$, unless otherwise noted. $T_{\text{opt}}=25^{\circ}\text{C}$

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
$-V_{\text{DET}}$	Detector Threshold	$T_{\text{opt}}=25^{\circ}\text{C}$	4.4640	4.5	4.5360	V	
		$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$	4.4325		4.5675		
V_{HYS}	Detector Threshold Hysteresis		0.180		0.315	V	
I_{SS}	Supply Current	$V_{\text{DD}}=4.4\text{V}$			1.7	μA	
		$V_{\text{DD}}=5.5\text{V}$			1.4		
V_{DDH}	Maximum Operating Voltage				6	V	
V_{DDL}	Minimum Operating Voltage*1	$T_{\text{opt}}=25^{\circ}\text{C}$			0.50	V	
		$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$			0.55		
I_{OUT}	Output Current (Driver Output Pin)	Nch	$V_{\text{DD}}=0.55\text{V}, V_{\text{DS}}=0.05\text{V}$		7	μA	
			$V_{\text{DD}}=3.0\text{V}, V_{\text{DS}}=0.5\text{V}$		2.40	mA	
		Pch*2	$V_{\text{DD}}=6.0\text{V}, V_{\text{DS}}=-2.1\text{V}$		0.90	mA	
I_{LEAK}	Nch Driver Leakage Current*3	$V_{\text{DD}}=6.0\text{V}, V_{\text{DS}}=7.0\text{V}$			80	nA	
$\frac{\Delta V_{\text{DET}}}{\Delta T_{\text{opt}}}$	Detector Threshold Temperature Coefficient	$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$		± 30		ppm/ $^{\circ}\text{C}$	
t_{D}	Output Delay Time	$C_{\text{D}}=0.022\mu\text{F}$ $V_{\text{DD}}=4.4\text{V} \rightarrow 4.95\text{V}$	$T_{\text{opt}}=25^{\circ}\text{C}$	85	100	115	ms
			$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$	75		135	

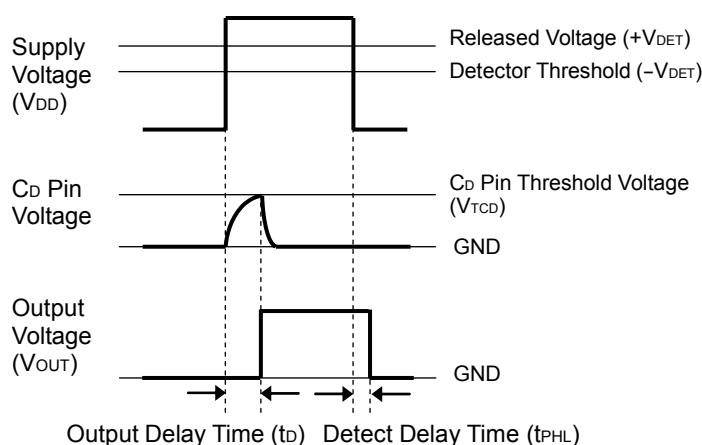
All of unit are tested and specified under load conditions such that $T_{\text{opt}}=25^{\circ}\text{C}$ except for Detector Threshold Temperature Coefficient.

*1: Minimum operating voltage means the value of input voltage when output voltage maintains 0.1V or less.
(In case of Nch Open Drain Output type, the output pin is pulled up with a resistance of 470k Ω to 5.0V)

*2: In case of CMOS type

*3: In case of Nch Open Drain type

TIMING CHART



When the supply voltage, which is higher than released voltage, is forced to V_{DD} pin, charge to an external capacitor starts, then C_D pin voltage increases. Until the C_D pin voltage reaches to C_D pin threshold voltage, output voltage maintains "L". When the C_D pin 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.

When the output voltage reverses from "L" to "H", the external capacitor starts to discharge. Therefore, when lower voltage than the detector threshold voltage is forced to V_{DD} pin, the output voltage reverses from "H" to "L" thus the detect delay time is constant not being affected by the external capacitor.

• Output Delay Time

Output Delay Time (t_D) can be calculated with the next formula using the external capacitor:

$$t_D(s) = 4.5 \times 10^6 \times C_D(F)$$

DEFINITION OF OUTPUT DELAY TIME

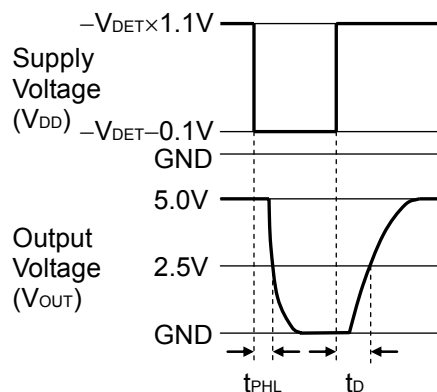
Output Delay Time (t_D) is defined as follows:

1. In the case of Nch Open Drain Output:

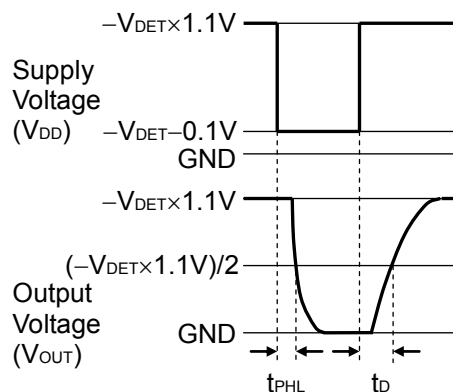
Under the condition of the output pin (OUT) is pulled up through a resistor of 470k Ω to 5V, the time interval between the rising edge of V_{DD} pulse from $(-V_{DET})-0.1V$ to $(-V_{DET})\times 1.1V$ pulse voltage is supplied, the becoming of the output voltage to 2.5V.

2. In the case of CMOS Output:

The time interval between the rising edge of V_{DD} pulse from $(-V_{DET})-0.1V$ to $(-V_{DET})\times 1.1V$ pulse voltage is supplied, the becoming of the output voltage to $((-V_{DET})\times 1.1V)/2$.



Nch Open Drain Output
(R3116xxx1A)



CMOS Output
(R3116xxx1C)

R3116x

ELECTRICAL CHARACTERISTICS BY DETECTOR THRESHOLD

• R3116x071A/C to R3116x501A/C

Bold values are checked and guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 85^{\circ}\text{C}$, unless otherwise noted.

$T_{\text{opt}}=25^{\circ}\text{C}$

Part Number	Detector Threshold1		Detector Threshold2		Detector Threshold Hysteresis		Supply Current1		Supply Current2		Max. Op. Voltage	Min. Op. Voltage
	-VDET1 [V]		-VDET2 [V]		VHYS [V]		Iss1 [μA]		Iss2 [μA]		VDDH [V]	VDDL [V]
	Min.	Max.	Min.	Max.	Min.	Max.	Cond.	Max.	Cond.	Max.	Max.	Max.
R3116x071A/C	0.6880	0.7120	0.6775	0.7225	0.028	0.049	VDD= -VDET -0.1V	1.400				0.50
R3116x081A/C	0.7880	0.8120	0.7775	0.8225	0.032	0.056						
R3116x091A/C	0.8880	0.9120	0.8775	0.9225	0.036	0.063						
R3116x101A/C	0.9880	1.0120	0.9775	1.0225	0.040	0.070						
R3116x111A/C	1.0880	1.1120	1.0775	1.1225	0.044	0.077						
R3116x121A/C	1.1880	1.2120	1.1775	1.2225	0.048	0.084						
R3116x131A/C	1.2880	1.3120	1.2775	1.3225	0.052	0.091						
R3116x141A/C	1.3880	1.4120	1.3775	1.4225	0.056	0.098						
R3116x151A/C	1.4880	1.5120	1.4775	1.5225	0.060	0.105						
R3116x161A/C	1.5872	1.6128	1.5760	1.6240	0.064	0.112						
R3116x171A/C	1.6864	1.7136	1.6745	1.7255	0.068	0.119						
R3116x181A/C	1.7856	1.8144	1.7730	1.8270	0.072	0.126						
R3116x191A/C	1.8848	1.9152	1.8715	1.9285	0.076	0.133						
R3116x201A/C	1.9840	2.0160	1.9700	2.0300	0.080	0.140						
R3116x211A/C	2.0832	2.1168	2.0685	2.1315	0.084	0.147						
R3116x221A/C	2.1824	2.2176	2.1670	2.2330	0.088	0.154						
R3116x231A/C	2.2816	2.3184	2.2655	2.3345	0.092	0.161						
R3116x241A/C	2.3808	2.4192	2.3640	2.4360	0.096	0.168						
R3116x251A/C	2.4800	2.5200	2.4625	2.5375	0.100	0.175						
R3116x261A/C	2.5792	2.6208	2.5610	2.6390	0.104	0.182						
R3116x271A/C	2.6784	2.7216	2.6595	2.7405	0.108	0.189						
R3116x281A/C	2.7776	2.8224	2.7580	2.8420	0.112	0.196						
R3116x291A/C	2.8768	2.9232	2.8565	2.9435	0.116	0.203						
R3116x301A/C	2.9760	3.0240	2.9550	3.0450	0.120	0.210						
R3116x311A/C	3.0752	3.1248	3.0535	3.1465	0.124	0.217						
R3116x321A/C	3.1744	3.2256	3.1520	3.2480	0.128	0.224						
R3116x331A/C	3.2736	3.3264	3.2505	3.3495	0.132	0.231						
R3116x341A/C	3.3728	3.4272	3.3490	3.4510	0.136	0.238						
R3116x351A/C	3.4720	3.5280	3.4475	3.5525	0.140	0.245						
R3116x361A/C	3.5712	3.6288	3.5460	3.6540	0.144	0.252						
R3116x371A/C	3.6704	3.7296	3.6445	3.7555	0.148	0.259						
R3116x381A/C	3.7696	3.8304	3.7430	3.8570	0.152	0.266						
R3116x391A/C	3.8688	3.9312	3.8415	3.9585	0.156	0.273						
R3116x401A/C	3.9680	4.0320	3.9400	4.0600	0.160	0.280						
R3116x411A/C	4.0672	4.1328	4.0385	4.1615	0.164	0.287						
R3116x421A/C	4.1664	4.2336	4.1370	4.2630	0.168	0.294						
R3116x431A/C	4.2656	4.3344	4.2355	4.3645	0.172	0.301						
R3116x441A/C	4.3648	4.4352	4.3340	4.4660	0.176	0.308						
R3116x451A/C	4.4640	4.5360	4.4325	4.5675	0.180	0.315						
R3116x461A/C	4.5632	4.6368	4.5310	4.6690	0.184	0.322						
R3116x471A/C	4.6624	4.7376	4.6295	4.7705	0.188	0.329						
R3116x481A/C	4.7616	4.8384	4.7280	4.8720	0.192	0.336						
R3116x491A/C	4.8608	4.9392	4.8265	4.9735	0.196	0.343						
R3116x501A/C	4.9600	5.0400	4.9250	5.0750	0.200	0.350						

*Note1) VDD value when output voltage is equal or less than 0.1V. In the case of Nch Open Drain output type, the output pin is pulled up to 5.0V through 470kΩ resistor.

Nch Driver Output Current1		Nch Driver Output Current2		Pch Driver Output Current		Nch Driver Leakage Current		Detector Threshold Temperature Coefficient	Output Delay Time		
IOUT1 [μ A]		IOUT2 [mA]		IOUT3 [mA]		ILEAK [nA]		Δ -VDET/ Δ T _{opt} [ppm/ $^{\circ}$ C]	t _d [ms]		
Cond.	Min.	Cond.	Min.	Cond.	Min.	Cond.	Max.	Typ.	Cond.	Min.	Max.
V _{DD} = 0.55V V _{DS} = 0.05V	7	V _{DD} = 0.6V V _{DS} = 0.5V	0.020	V _{DD} = 4.5V V _{DS} = -2.1V	0.650	V _{DD} = 6.0V V _{DS} = 7.0V	80	±30	V _{DD} = -V _{DET} -0.1V ↓ -V _{DET} ×1.1V *Note2	80	130
		V _{DD} = 1.0V V _{DS} = 0.5V	0.400							70	150
		V _{DD} = 1.5V V _{DS} = 0.5V	1.000							85	115
		V _{DD} = 3.0V V _{DS} = 0.5V	2.400							75	135
		V _{DD} = 6.0V V _{DS} = -2.1V	0.900								

*Note2) 1. In the case of CMOS output type:

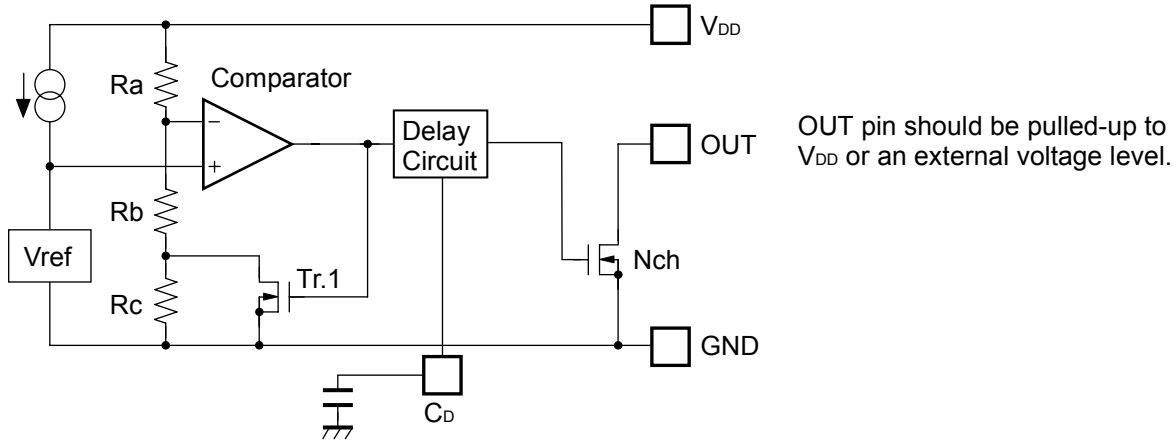
When the voltage is forced from (-V_{DET})-0.1V to (-V_{DET})×1.1V pulse voltage is added to V_{DD}, time interval that the output voltage reaches ((-V_{DET})×1.1V)/2.

2. In the case of Nch Open Drain output type:

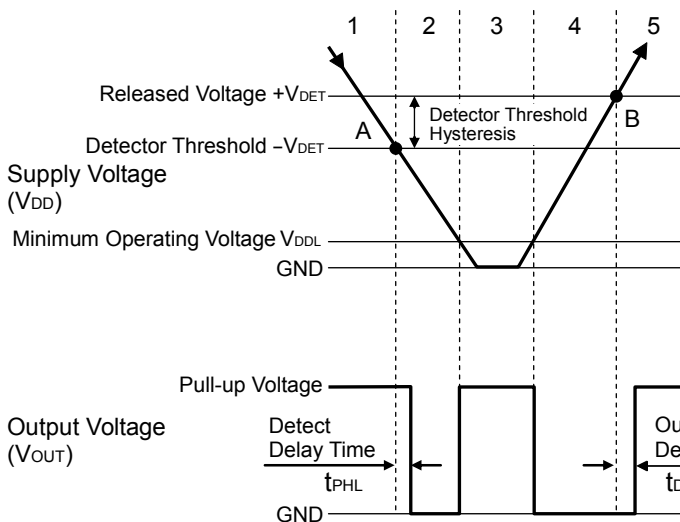
The output pin is pulled up to 5.0V through 470k Ω , and when the voltage is forced from (-V_{DET})-0.1V to (-V_{DET})×1.1V pulse voltage is added to V_{DD}, time interval that the output voltage reaches 2.5V.

OPERATION

• Operation of R3116xxx1A



Block Diagram (R3116xxx1A)



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

$$I \quad \frac{R_b + R_c}{R_a + R_b + R_c} \times V_{DD}$$

$$II \quad \frac{R_b}{R_a + R_b} \times V_{DD}$$

Operation Diagram

• Explanation of operation

Step 1. The output voltage is equal to the pull-up voltage.

Step 2. At Point "A", $V_{ref} \geq V_{DD} \times (R_b + R_c) / (R_a + R_b + R_c)$ is true, as a result, the output of comparator is reversed from "L" to "H", therefore the output voltage becomes the GND level. The voltage level of Point A means a detector threshold voltage ($-V_{DET}$).

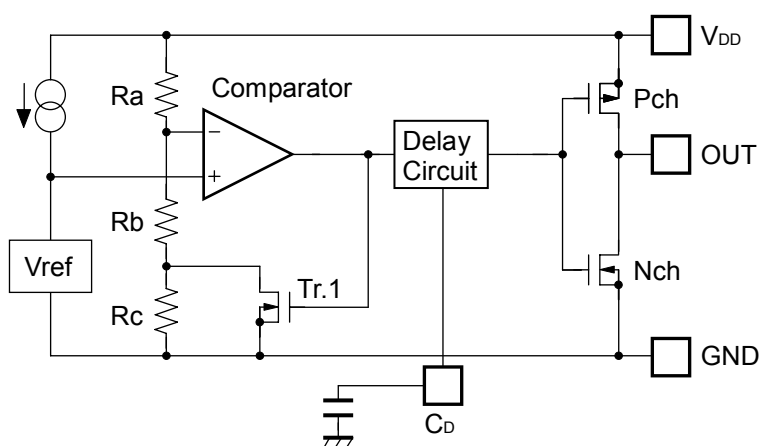
Step 3. When the supply voltage is lower than the minimum operating voltage, the operation of the output transistor becomes indefinite. The output voltage is equal to the pull-up voltage.

Step 4. The output voltage is equal to the GND level.

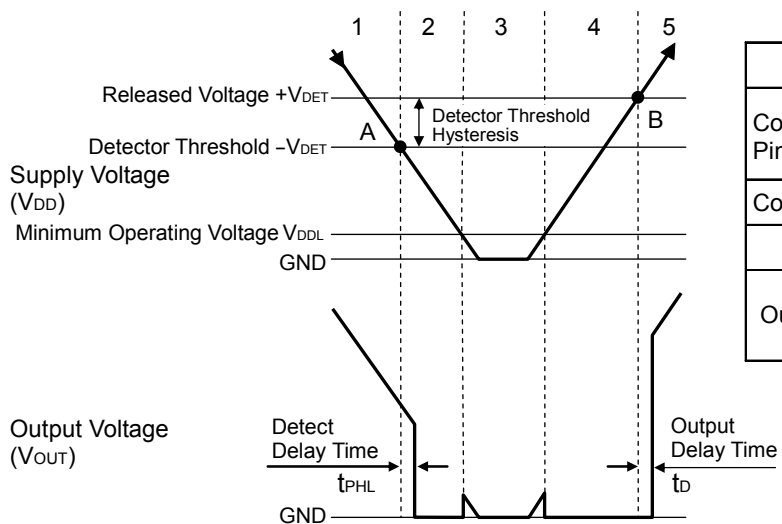
Step 5. At Point "B", $V_{ref} \leq V_{DD} \times R_b / (R_a + R_b)$ is true, as a result, the output of comparator is reversed from "H" to "L", then the output voltage is equal to the pull-up voltage. The voltage level of Point B means a released voltage ($+V_{DET}$).

*) The difference between a released voltage and a detector threshold voltage is a detector threshold hysteresis.

• Operation of R3116xxx1C



Block Diagram (R3116xxx1C)



Operation Diagram

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

$$I \quad \frac{R_b + R_c}{R_a + R_b + R_c} \times V_{DD}$$

$$II \quad \frac{R_b}{R_a + R_b} \times V_{DD}$$

• Explanation of operation

Step 1. The output voltage is equal to the supply voltage (V_{DD}).

Step 2. At Point "A", $V_{ref} \geq V_{DD} \times (R_b + R_c) / (R_a + R_b + R_c)$ is true, as a result, the output of comparator is reversed from "L" to "H", therefore the output voltage becomes the GND level. The voltage level of Point A means a detector threshold voltage ($-V_{DET}$).

Step 3. When the supply voltage is lower than the minimum operating voltage, the operation of the output transistor becomes indefinite.

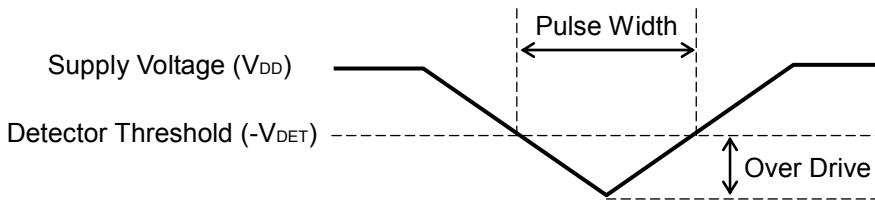
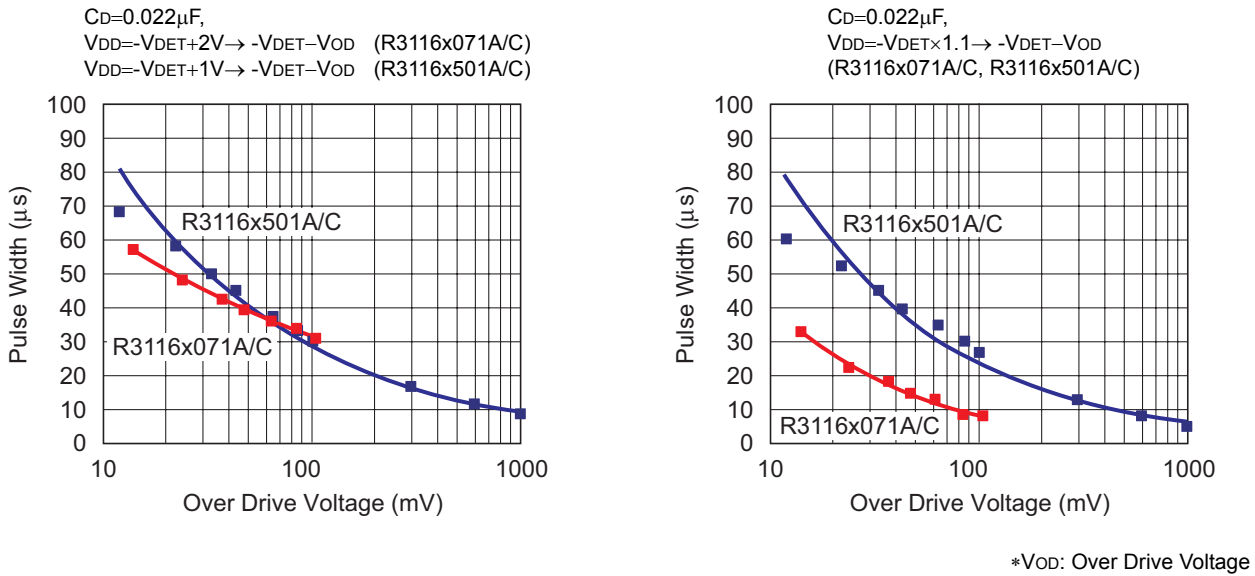
Step 4. The output voltage is equal to the GND level.

Step 5. At Point "B", $V_{ref} \leq V_{DD} \times R_b / (R_a + R_b)$ is true, as a result, the output of comparator is reversed from "H" to "L", then the output voltage is equal to the supply voltage (V_{DD}). The voltage level of Point B means a released voltage ($+V_{DET}$).

*) The difference between a released voltage and a detector threshold voltage is a detector threshold hysteresis.

Detector Operation vs. glitch input voltage to the V_{DD} pin

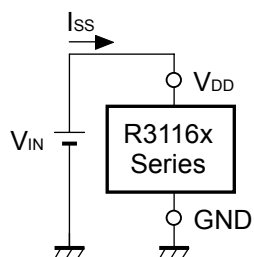
When the R3116x is at released, if the pulse voltage which the detector threshold or lower voltage, the graph below means that the relation between pulse width and the amplitude of the swing to keep the released state for the R3116x.



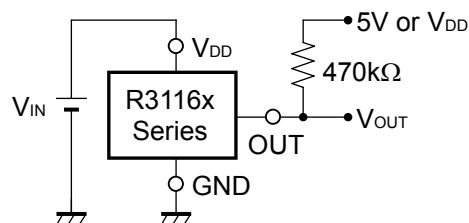
V_{DD} Input Waveform

This graph shows the maximum pulse conditions to keep the released voltage. If the pulse with larger amplitude or wider width than the graph above, is input to V_{DD} pin, the reset signal may be output.

TEST CIRCUITS

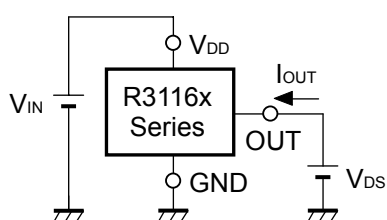


Supply Current Test Circuit

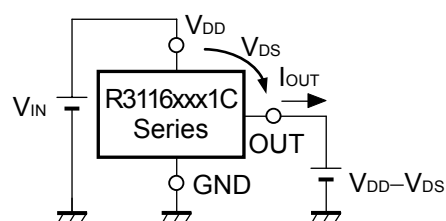


Detector Threshold Test Circuit

(Pull-up circuit is not necessary for CMOS Output type.)

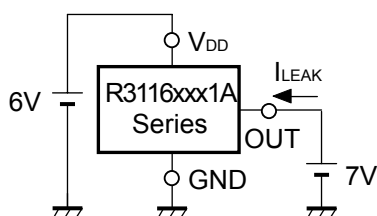


Nch Driver Output Current Test Circuit



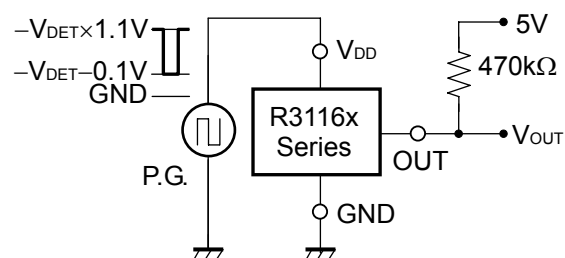
Pch Driver Output Current Test Circuit

*Apply to CMOS Output type only



Nch Driver Leakage Current Test Circuit

*Apply to Nch Driver Output type only

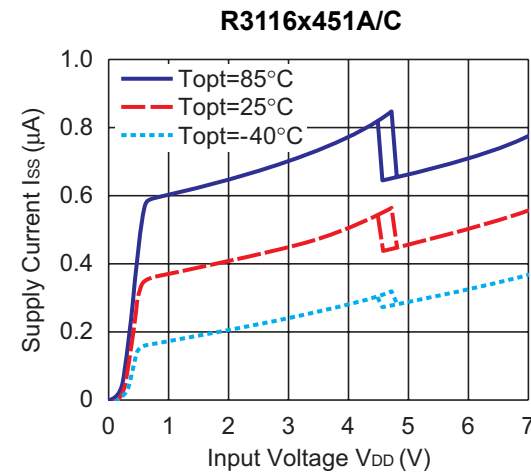
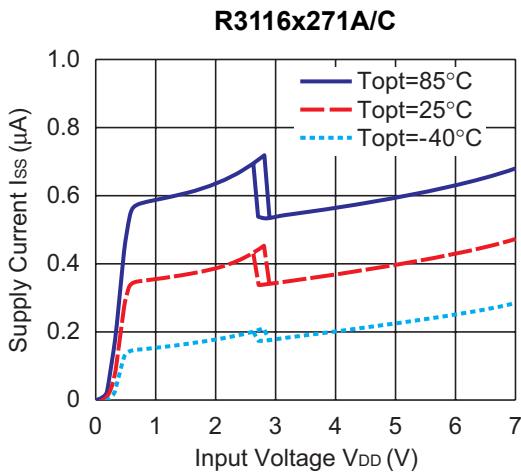
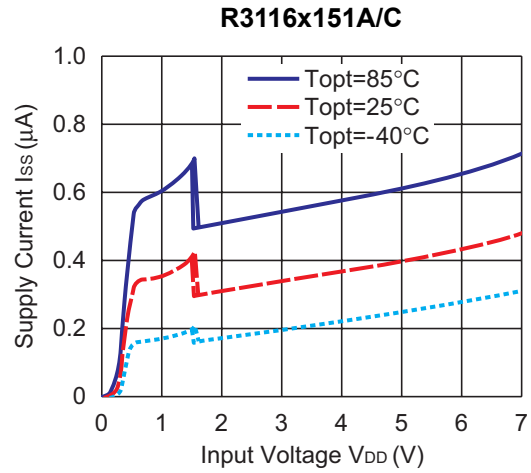
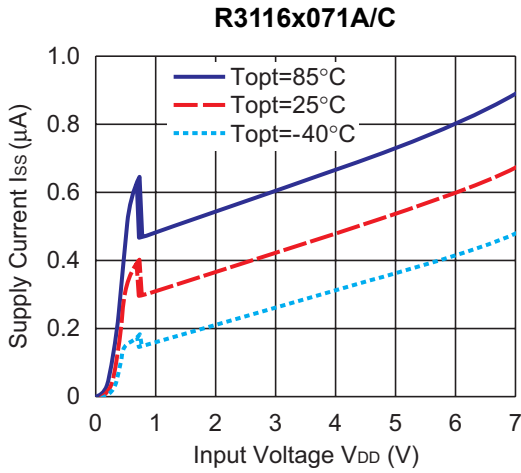


Output Delay Time Test Circuit

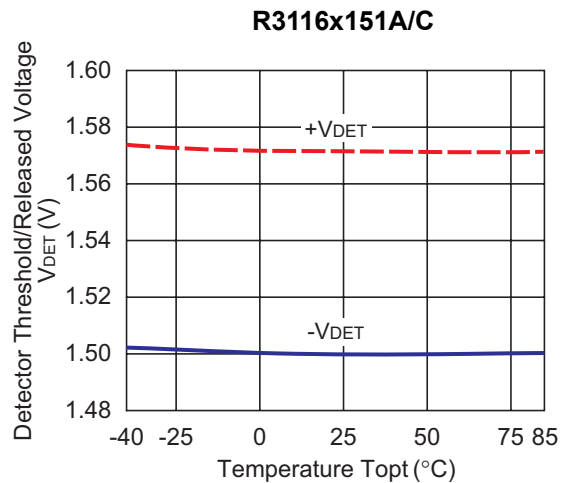
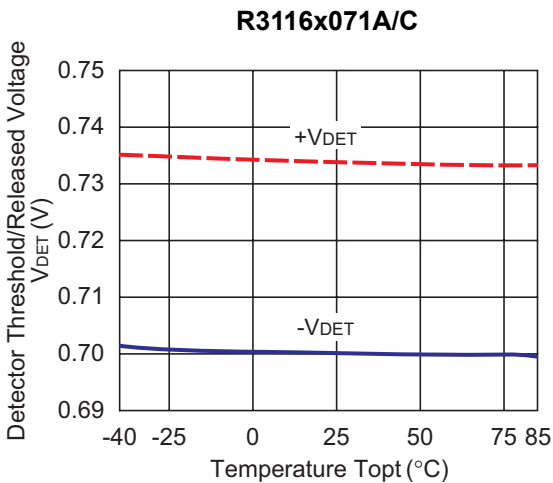
(Pull-up circuit is not necessary for CMOS Output type.)

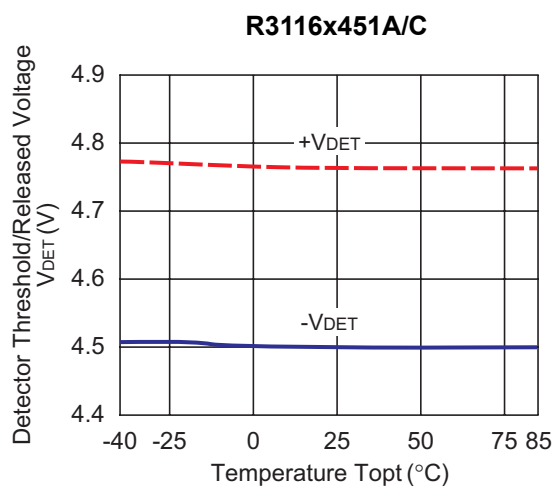
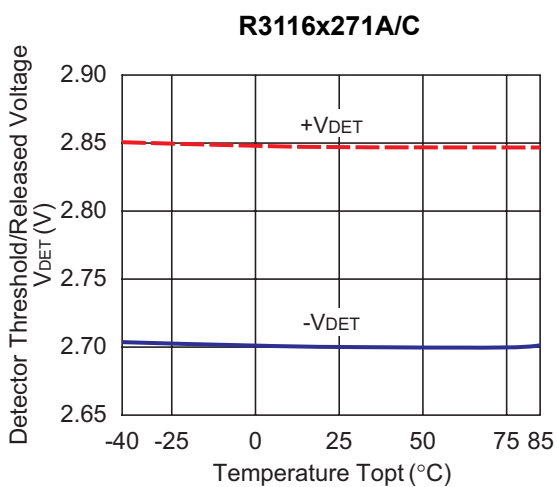
TYPICAL CHARACTERISTICS

1) Supply Current vs. Input Voltage

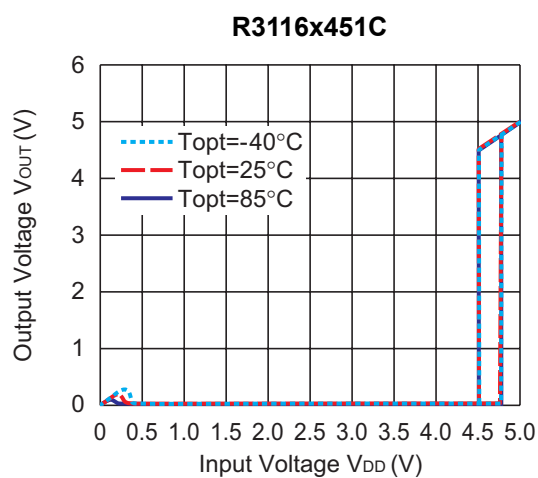
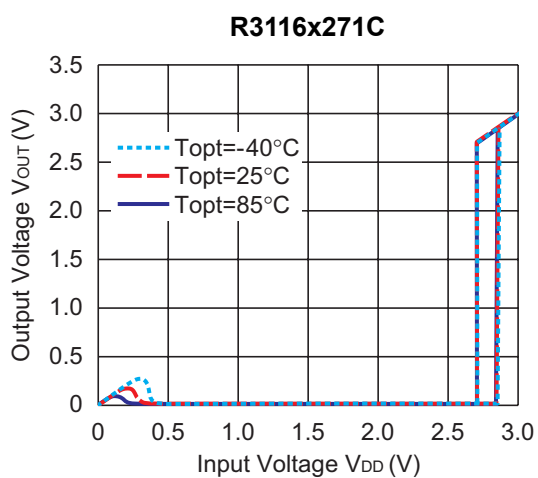
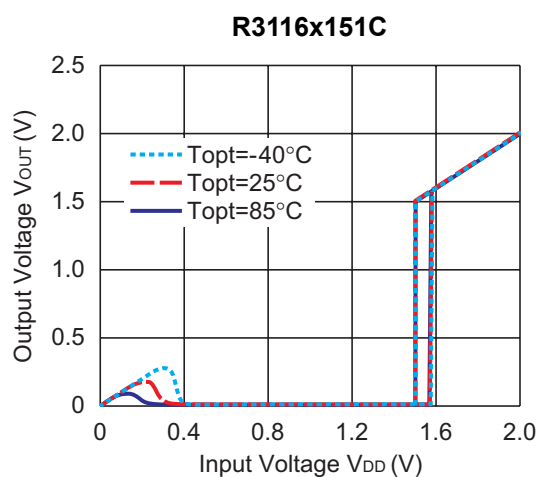
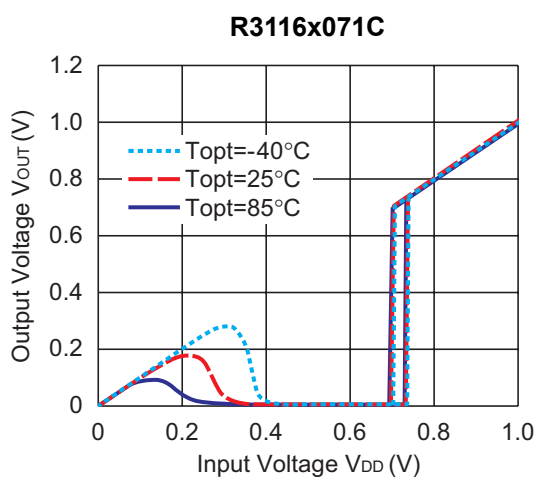


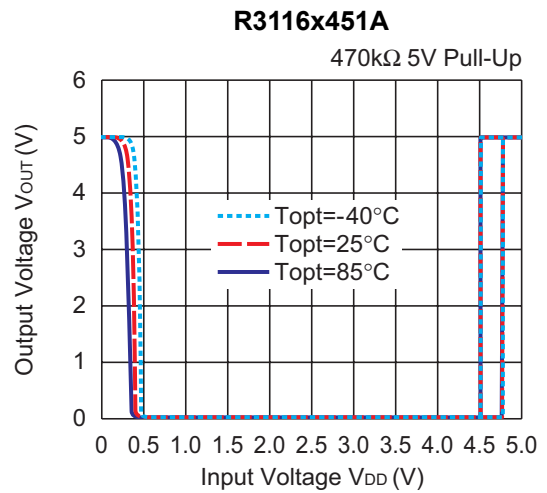
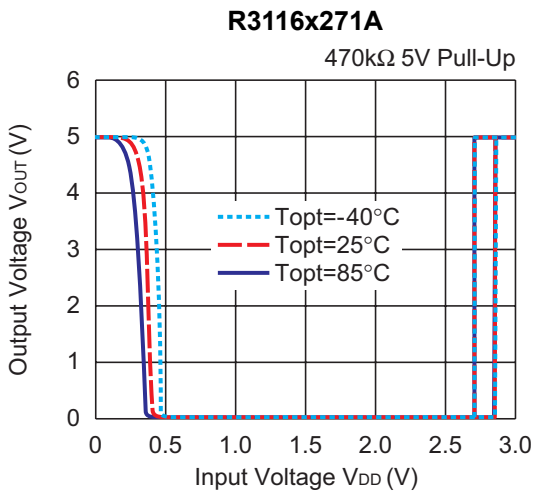
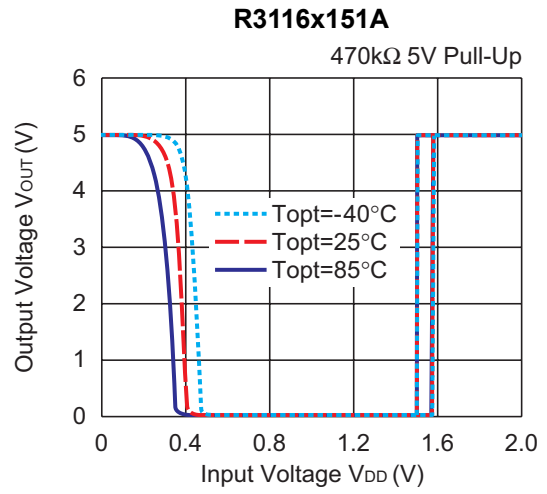
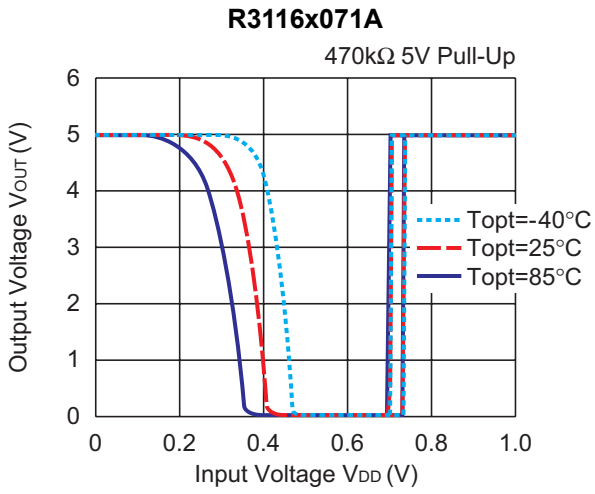
2) Detector Threshold vs. Temperature



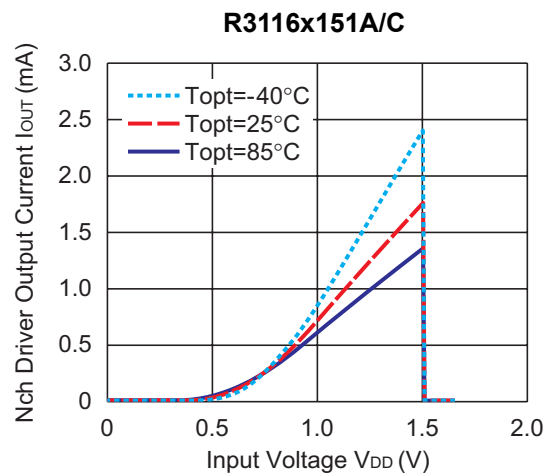
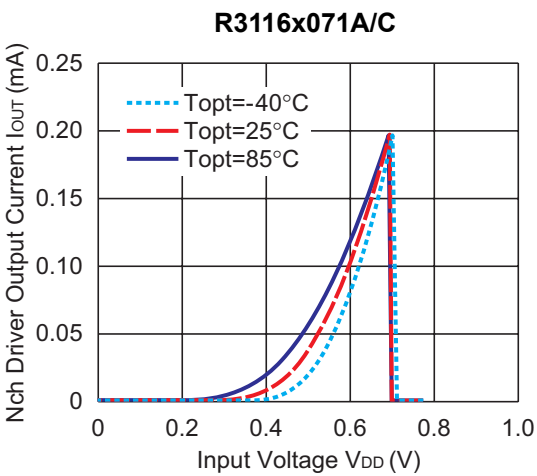


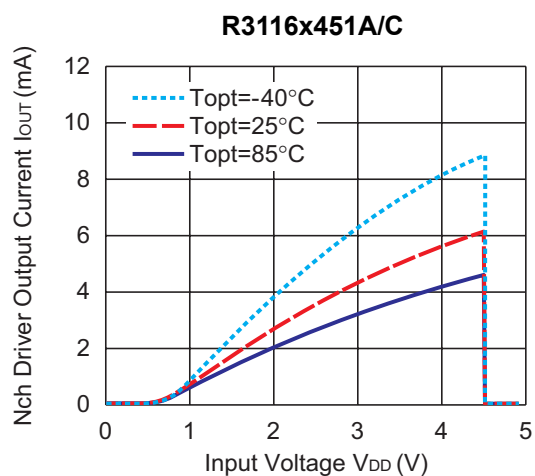
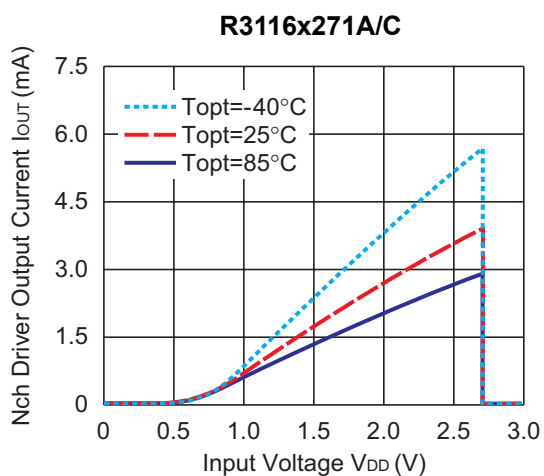
3) Output Voltage vs. Input Voltage



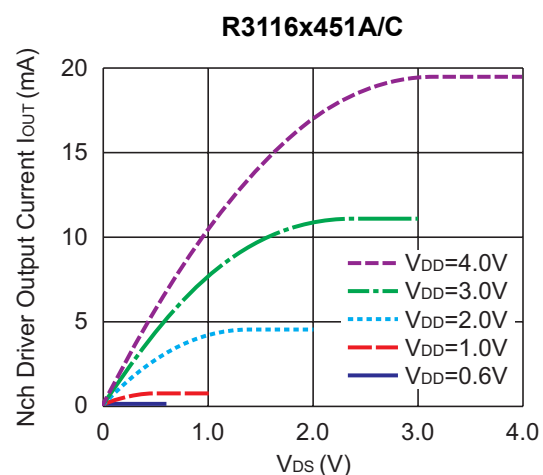
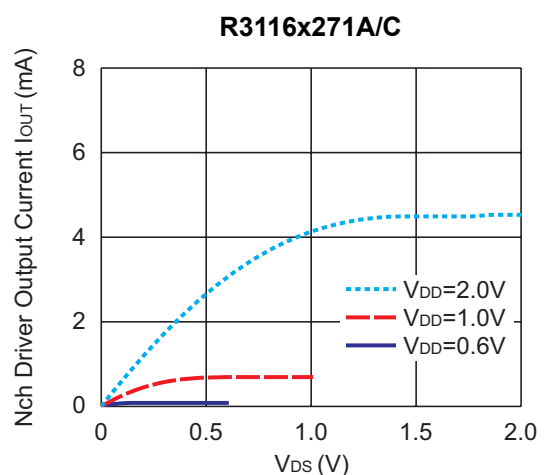
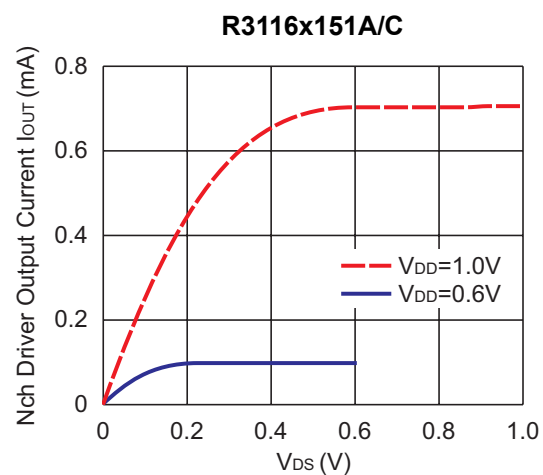
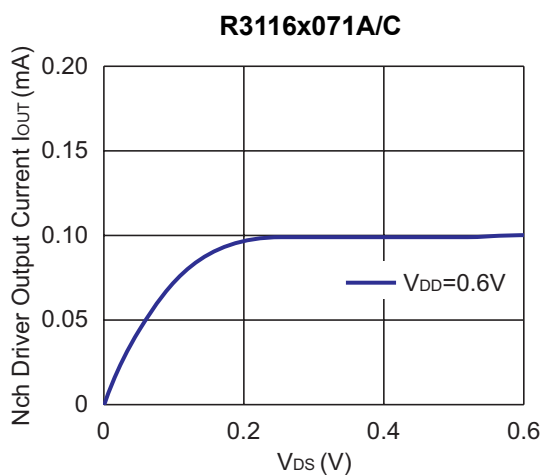


4) Nch Driver Output Current vs. Input Voltage ($V_{DS}=0.5V$)

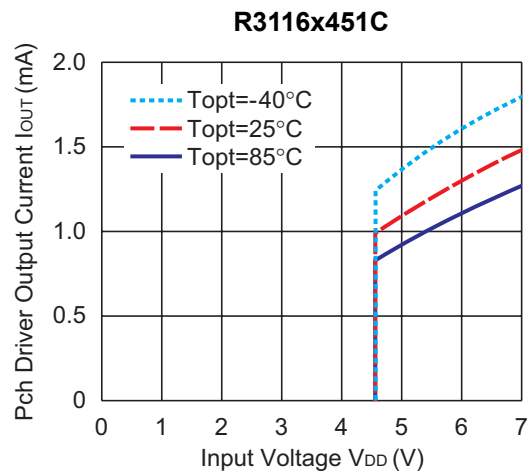
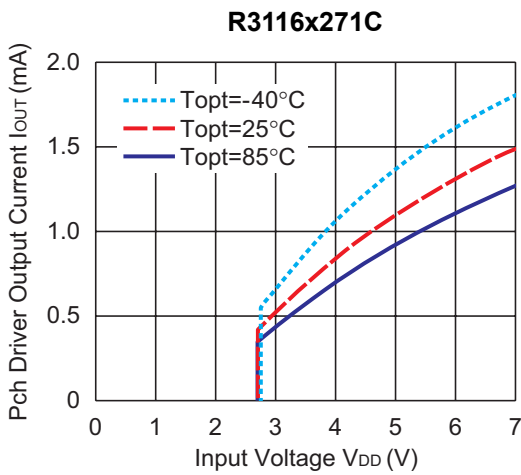
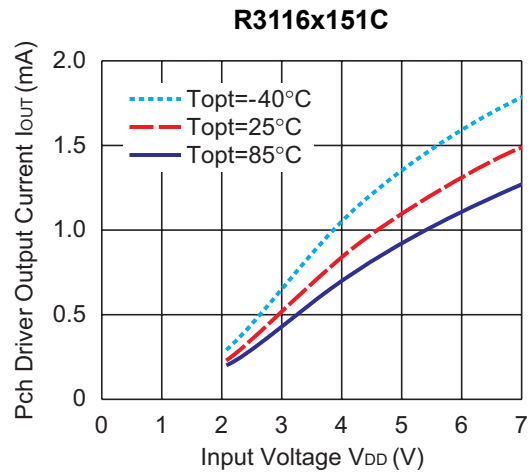
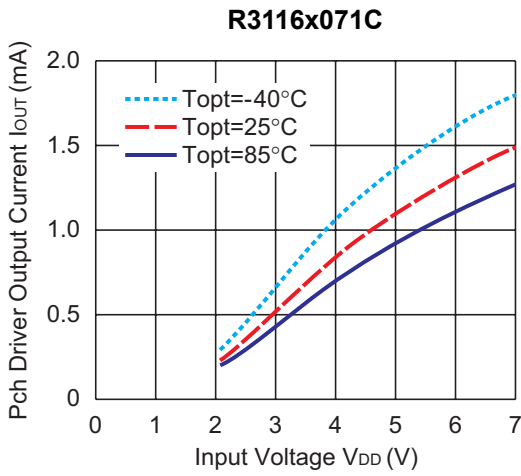




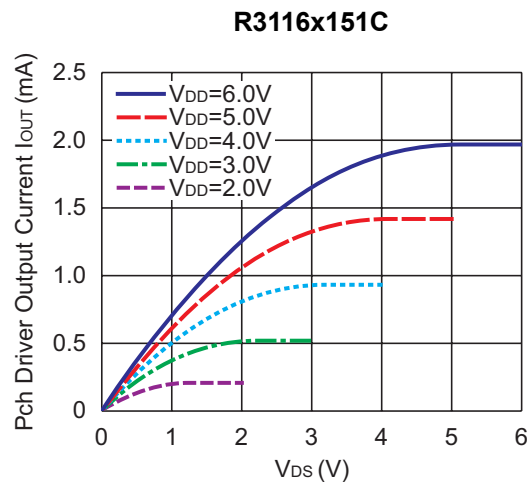
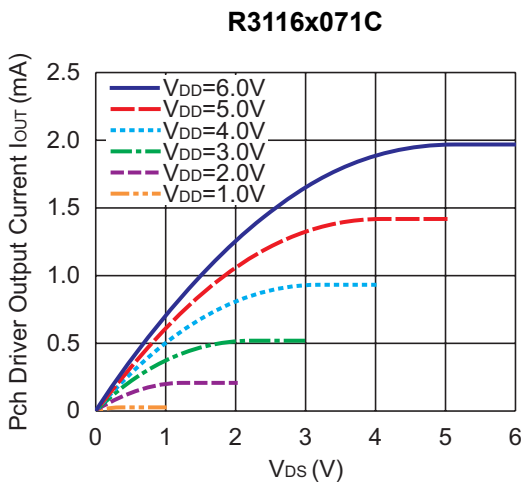
5) Nch Driver Output Current vs. V_{DS}

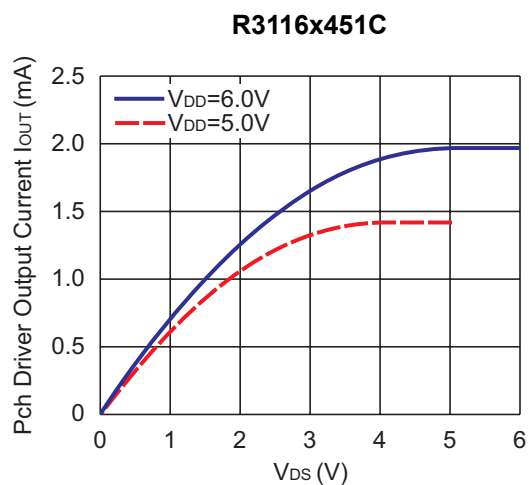
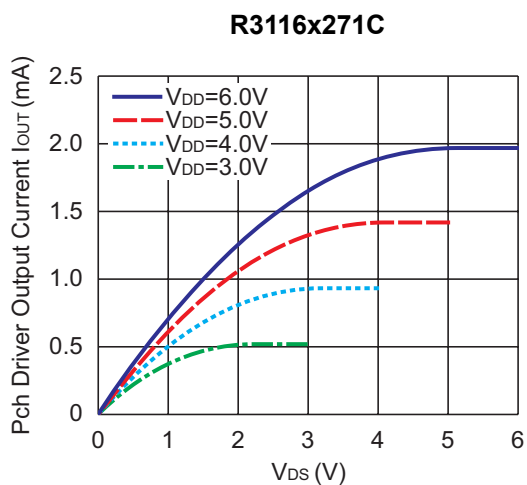


6) Pch Driver Output Current vs. Input Voltage ($V_{ds}=-2.1V$)

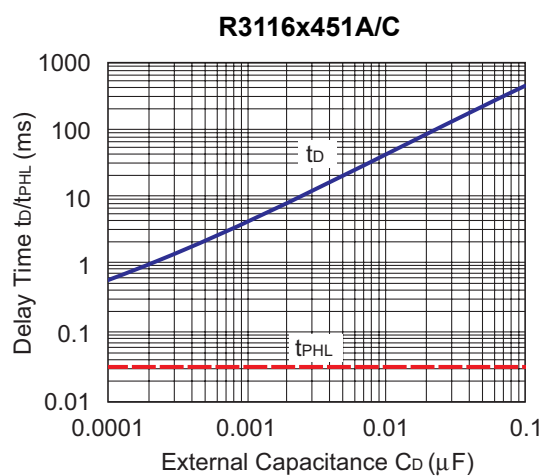
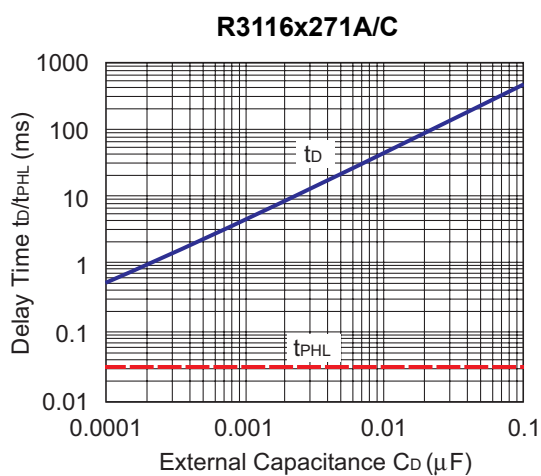
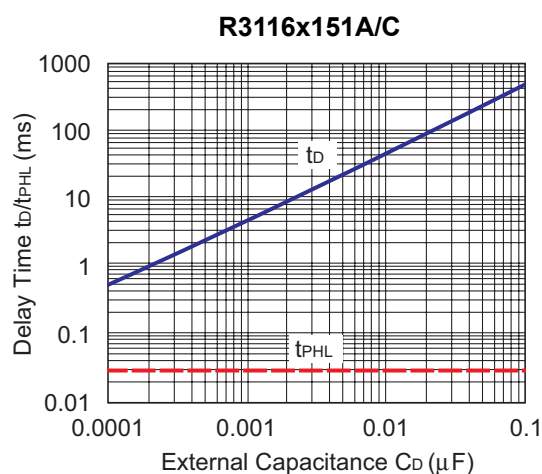
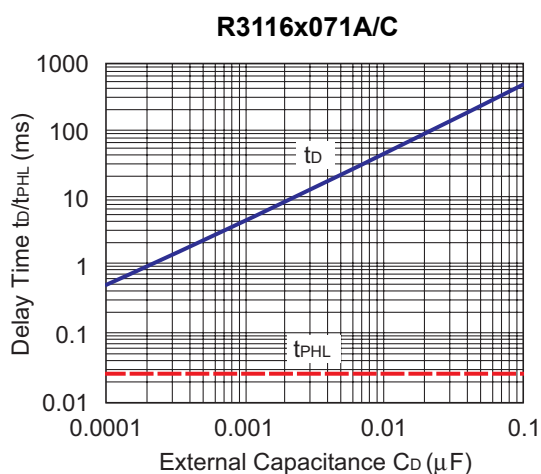


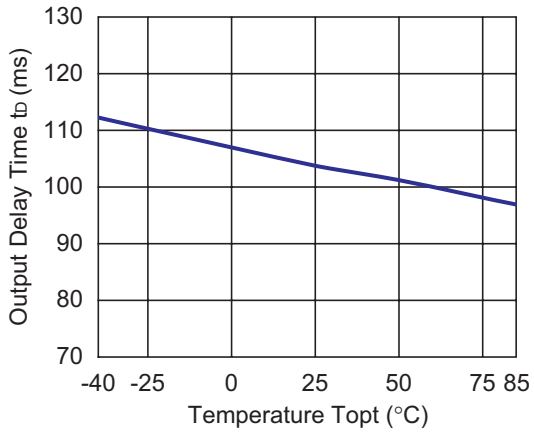
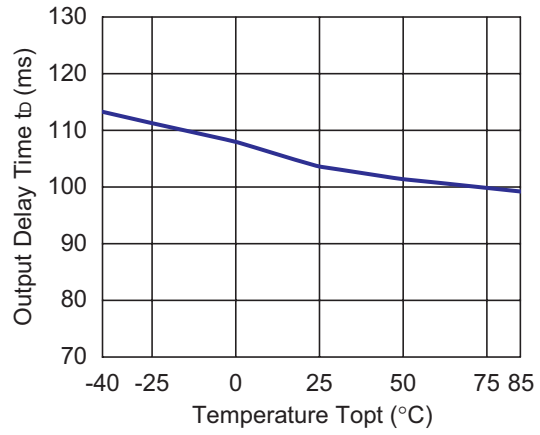
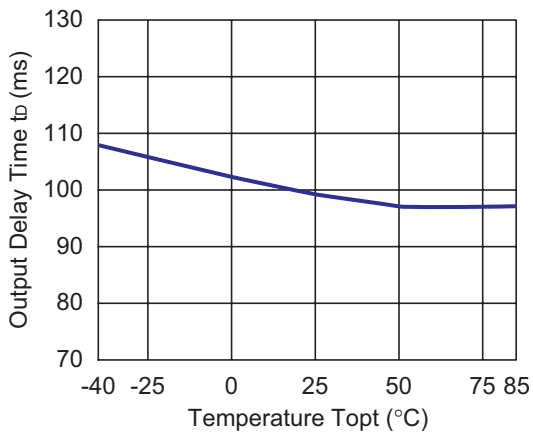
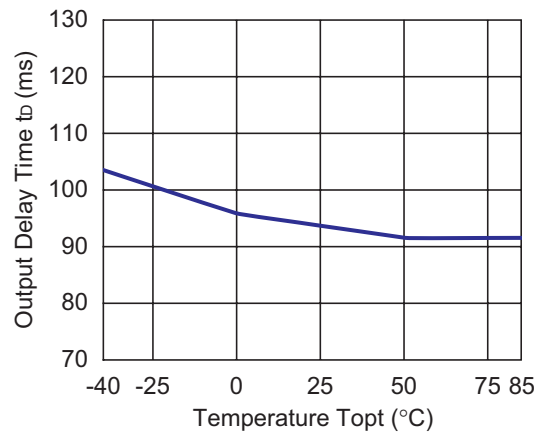
7) Pch Driver Output Current vs. V_{ds}





8) Output Delay Time vs. External Capacitance

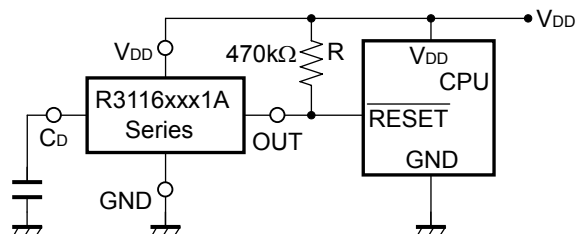


9) Output Delay Time vs. Temperature (C_D=22nF)**R3116x071A/C****R3116x151A/C****R3116x271A/C****R3116x451A/C**

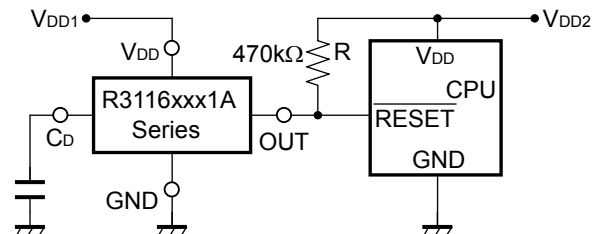
TYPICAL APPLICATION

• R3116xxx1A CPU Reset Circuit 1 (Nch Open Drain Output)

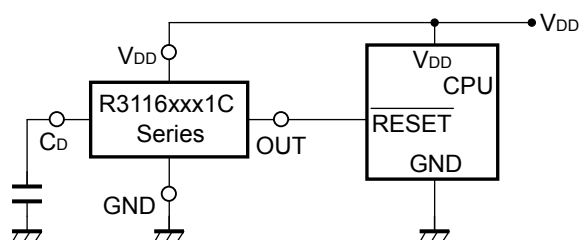
Case1. Input Voltage to R3116xxx1A is equal to Input Voltage to CPU



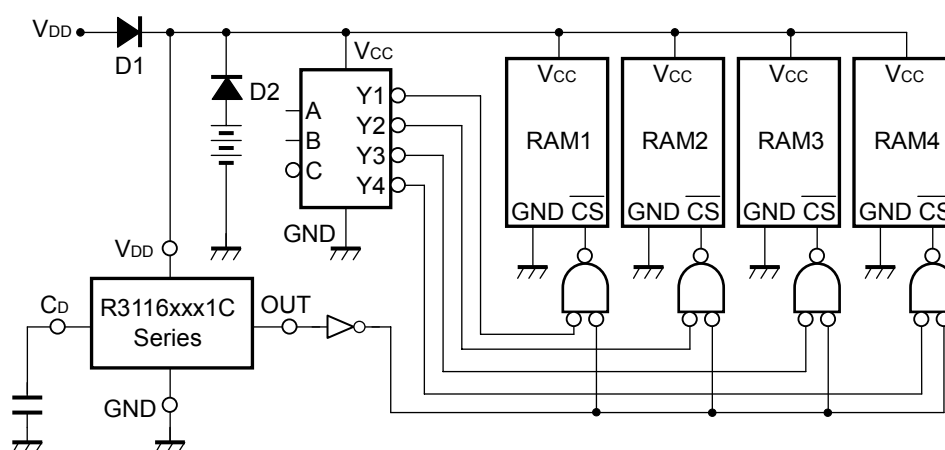
Case2. Input Voltage to R3116xxx1A is unequal to Input Voltage to CPU



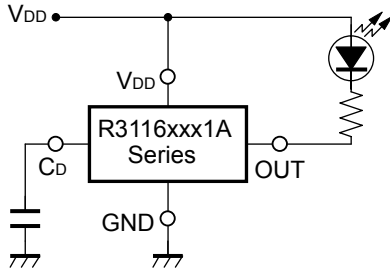
• R3116xxx1C CPU Reset Circuit 2 (CMOS Output)



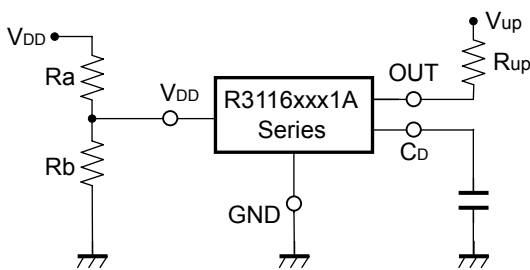
• Memory Back-up Circuit



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



• **Detector Threshold Adjustable Circuit 1
(Nch Open Drain Output)**

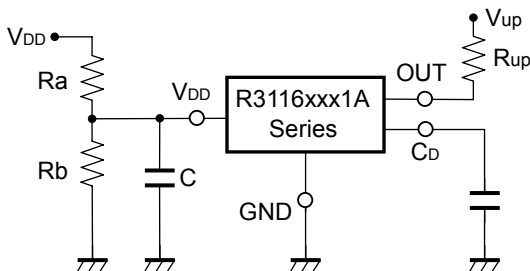


$$\text{Adjustable Detector Threshold} = (-V_{\text{DET}}) \times (R_a + R_b) / R_b$$

$$\text{Hysteresis Voltage} = (V_{\text{HYS}}) \times (R_a + R_b) / R_b$$

- *1) To prevent oscillation, set $R_a \leq 1\text{k}\Omega$, $R_b \leq 100\Omega$.
- *2) If the value of R_a is set excessively large, voltage drop may occur caused by the supply current of IC itself, and detector threshold and hysteresis voltage may vary.
- *3) If V_{up} and V_{DD} are connected, the voltage dropdown caused by R_{up} , may cause difference in the hysteresis voltage.

• **Detector Threshold Adjustable Circuit 2
(Nch Open Drain Output)**

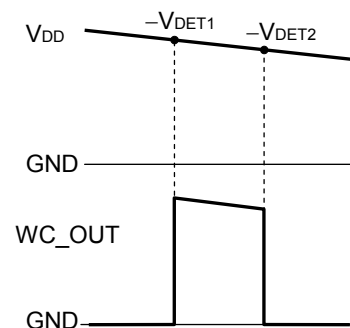
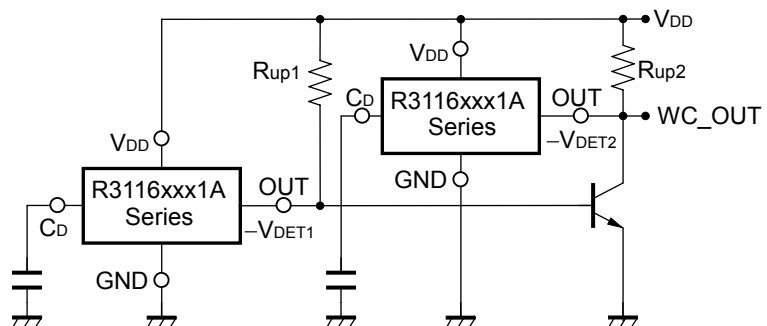


$$\text{Adjustable Detector Threshold} = (-V_{\text{DET}}) \times (R_a + R_b) / R_b$$

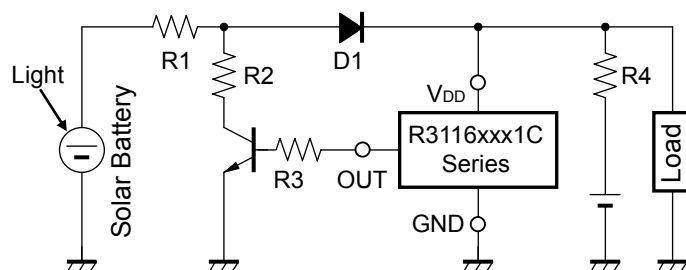
$$\text{Hysteresis Voltage} = (V_{\text{HYS}}) \times (R_a + R_b) / R_b$$

- *1) To prevent oscillation, set $R_a \leq 10\text{k}\Omega$, $R_b \leq 1\text{k}\Omega$, $C \geq 1\mu\text{F}$.
- *2) If the value of R_a is set excessively large, voltage drop may occur caused by the supply current of IC itself, and detector threshold and hysteresis voltage may vary.
- *3) If V_{up} and V_{DD} are connected, the voltage dropdown caused by R_{up} , may cause difference in the hysteresis voltage.
- *4) If the value of R_a , R_b and C are set excessively large, the delay of the start-up may become too long.

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



- **Over-charge Preventing Circuit**



TECHNICAL NOTES

When R3116xxx1A/C is used in Figure X, if the value of R1 is set excessively large, the dropdown voltage caused by the consumption current of IC itself, may vary the detector threshold and the release voltage. Also, if the value of R1 is set excessively large, there may be delay in start-up and may cause oscillation generated by cross conduction current.

When R3116xxx1A/C is used in Figure Y, if the value of R1 is set excessively large, the dropdown voltage caused by the consumption current of IC itself, may vary the detector threshold and the released voltage. Also, if the value of R1 and R2 is set excessively large, there may be delay in start-up and may cause oscillation generated by cross conduction current.

When R3116xxx1A/C is used in Figure Z, if the value of R1 is set excessively large, the dropdown voltage caused by the consumption current of IC itself may vary the detector threshold and the release voltage. Also, if the value of R1 is set excessively large, there may be delay in start-up and may cause oscillation generated by cross conduction current. Furthermore, if the value of R1 is set large and the value of R2 is set small, released voltage level may shift and the minimum operating voltage may differ. If the value of R2 is set excessively small from R1, release may not occur and may cause oscillation.

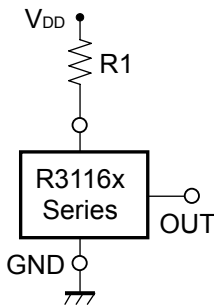


Figure X

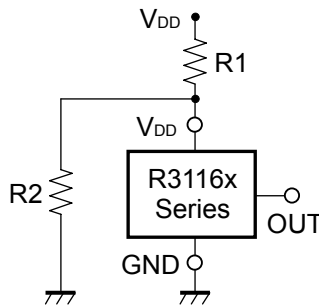


Figure Y

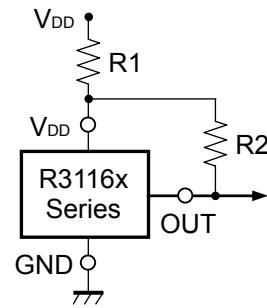


Figure Z



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Ricoh completed the organization of the Lead-free production for all of our products. After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive.