

36V Input Voltage Detector for Automotive Applications

NO.EC-367-141202

OUTLINE

The R3151N is a CMOS-based voltage detector IC that provides high-voltage resistance, high voltage accuracy and low supply current. This device is suitable for battery voltage supervisor. The R3151NxxxA/ B provide V_{DD} pin detection and the R3151NxxxE/ F provide SENSE pin detection. Detector threshold and Release voltage can be specified separately. Both the detector threshold accuracy and the release voltage accuracy are $\pm 1.5\%$ (25°C) (Detector Threshold Hysteresis is 5% to 30%).

The detect output delay time and the release output delay time (Power-on Reset Time) are adjustable by using external capacitors. The output types are Nch open drain "L" output and Nch open drain "H" output.

The R3151N is available in SOT-23-6 package that is possible to achieve high-density mounting on boards.

FEATURES

- Operating Voltage Range (Maximum Rating) R3151NxxxA/ B: 1.4V to 36.0V (50.0V)
R3151NxxxE/ F: 3.6V to 6.0V (7.0V)
- Operating Temperature Range -40°C to 105°C
- Supply Current R3151NxxxA/ B: Typ. $3.8\mu\text{A}$
R3151NxxxE/ F: Typ. $3.5\mu\text{A}$
- Detector Threshold Range 5.0V to 10.0V (0.1V steps)
- Detector Threshold Accuracy $\pm 1.5\%$ ($+25^{\circ}\text{C}$)
 $\pm 2.0\%$ (-40°C to 105°C)
- Release Voltage Range*¹ 5.3V to 11.0V (0.1V steps)
- Release Voltage Accuracy $\pm 1.5\%$ ($+25^{\circ}\text{C}$)
 $\pm 2.0\%$ (-40°C to 105°C)
- Detect Output Delay Time Accuracy -35% to 40% (-40°C to 105°C)
- Release Output Delay Time Accuracy -35% to 40% (-40°C to 105°C)
- Output Type Nch Open Drain
- Package SOT-23-6

Detect Output Delay Time and Release Output Delay Time are adjustable by external capacitor.

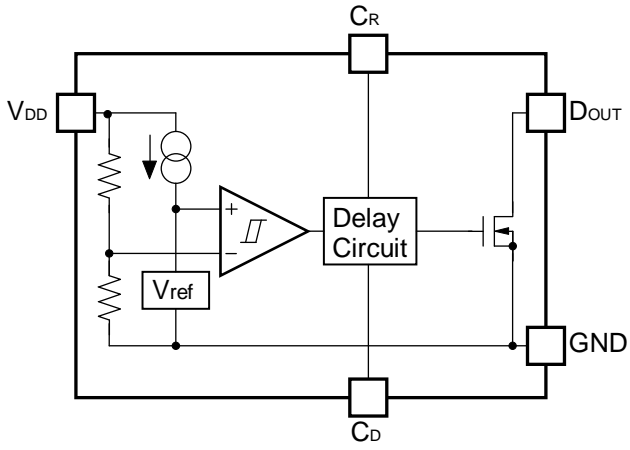
*¹ The release voltage can be adjusted by having the hysteresis set to 5% to 30% of the detector threshold.

APPLICATIONS

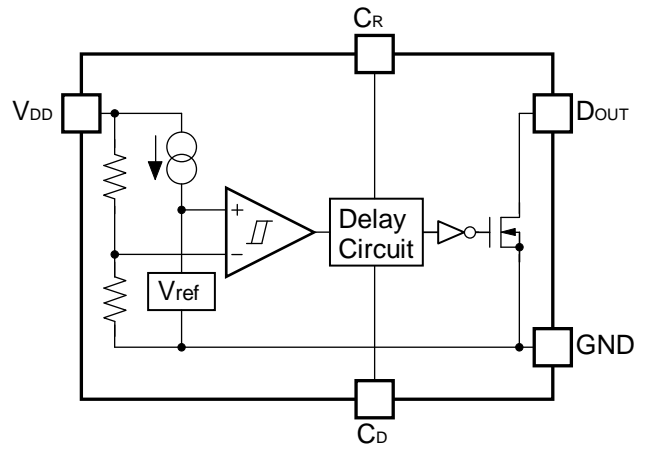
- Voltage monitoring for car accessories including car audios, car navigation systems, and ETC systems.

BLOCK DIAGRAMS

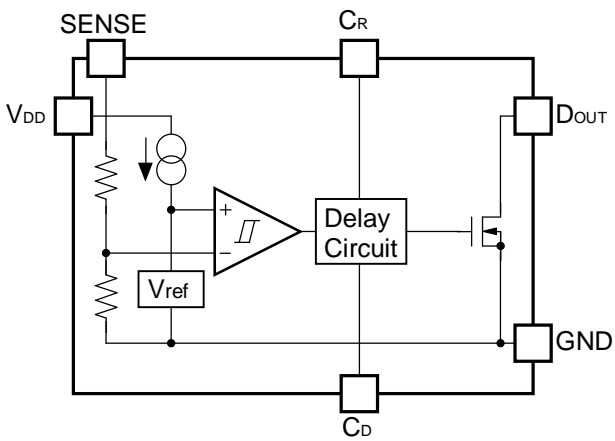
R3151NxxxA



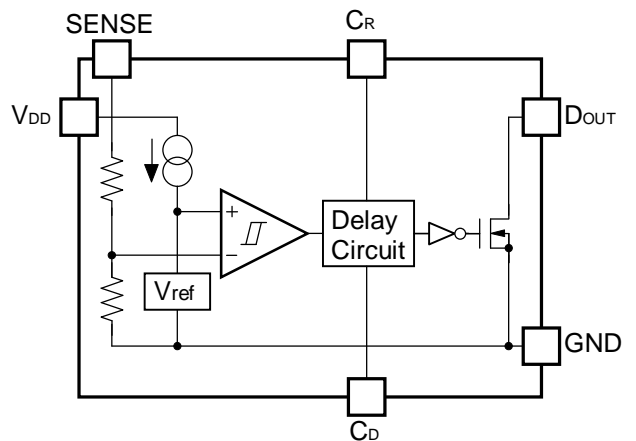
R3151NxxxB



R3151NxxxE



R3151NxxxF

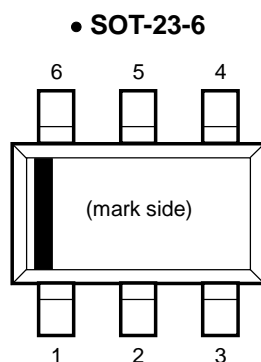


SELECTION GUIDE

VD Detector Threshold and Release Voltage for the ICs are user-selectable options.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free								
R3151Nxxx*-TR-#E	SOT-23-6	3,000 pcs	Yes	Yes								
<p>xxx: Specify a combination of Set Detector Threshold ($-V_{SET}$) and Set Release Voltage ($+V_{SET}$) by using serial numbers starting from 001. $-V_{SET}$ can be designated between 5.0V and 10.0V in 0.1V steps. $+V_{SET}$ can be designated between 5.3V and 11.0V in 0.1V steps.</p> <p>*: Select an output type from below. A: V_{DD} Voltage Detection Type "L" Output B: V_{DD} Voltage Detection Type "H" Output E: SENSE Voltage Detection Type "L" Output F: SENSE Voltage Detection Type "H" Output</p> <p>#: Specify Automotive Class Code</p> <table border="1"> <thead> <tr> <th></th> <th>Operating Temperature Range</th> <th>Guaranteed Specs Temperature Range</th> <th>Screening</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>-40°C to 105°C</td> <td>25°C</td> <td>High temperature</td> </tr> </tbody> </table>						Operating Temperature Range	Guaranteed Specs Temperature Range	Screening	A	-40°C to 105°C	25°C	High temperature
	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening									
A	-40°C to 105°C	25°C	High temperature									

PIN DESCRIPTIONS



Pin No.	Symbol	Description
1	C_D	Release Output Delay Time (t_{delay}) Setting Pin
2	C_R	Detect Output Delay Time (t_{reset}) Setting Pin
3	NC	No Connection (R3151NxxxA/ B)
	SENSE	VD Voltage SENSE Pin (R3151NxxxE/ F)
4	V_{DD}	Input Pin
5	GND	Ground Pin
6	D_{OUT}	V_D Output Pin (Nch Open Drain)

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit	
V _{DD}	Supply Voltage (R3151NxxxA/B)	-0.3 to 50.0	V	
	Supply Voltage (R3151NxxxE/F)	-0.3 to 7.0	V	
V _{SENSE}	SENSE Pin Voltage (R3151NxxxE/F)	-0.3 to 50.0	V	
V _{DOUT}	D _{OUT} Pin Output Voltage	-0.3 to 7.0	V	
V _{CD}	C _D Pin Output Voltage	-0.3 to 7.0	V	
V _{CR}	C _R Pin Output Voltage	-0.3 to 7.0	V	
I _{OUT}	D _{OUT} Pin Output Current	20	mA	
P _D	Power Dissipation (SOT-23-6)*1	Standard Land Pattern	525	mW
T _j	Junction Temperature	-40 to 150	°C	
T _{stg}	Storage Temperature Range	-55 to 150	°C	

*1 Please refer to *PACKAGE INFORMATION* for detailed information.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime 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

Symbol	Item	Rating	Unit
V _{DD}	Operating Voltage (R3151NxxxA/B)	1.4 to 36.0	V
	Operating Voltage (R3151NxxxE/F)	3.6 to 6.0	V
V _{SENSE}	SENSE Input Voltage (R3151NxxxE/F)	0 to 36	V
T _a	Operating Temperature Range	-40 to 105	°C

RECOMMENDED OPERATING CONDITIONS

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

$C_D=1000\text{pF}$, $C_R=1000\text{pF}$, Pull-up resistance=100k Ω , Pull-up voltage=5V, unless otherwise noted.

The specifications surrounded by are guaranteed by design engineering at $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$.

R3151NxxxA/ B

($T_a=25^\circ\text{C}$)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{DDL}	Minimum Operating Voltage ^{*1}				1.4	V
I_{SS}	Supply Current	$V_{DD} = -V_{SET} - 0.1\text{V}$		3.8	6.1	μA
		$V_{DD} = +V_{SET} + 1.0\text{V}$		3.8	6.4	
$-V_{DET}$	Detector Threshold	$T_a=25^\circ\text{C}$	x0.985		x1.015	V
		$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	x0.980		x1.020	
$+V_{DET}$	Release Voltage	$T_a=25^\circ\text{C}$	x0.985		x1.015	V
		$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	x0.980		x1.020	
treset	Detect Output Delay Time ^{*2}	$C_R=1000\text{pF}$, $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	6.5	10	14.0	ms
tdelay	Release Output Delay Time ^{*3}	$C_D=1000\text{pF}$, $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	6.5	10	14.0	ms
I_{OUT}	Output Current (Nch Driver Output Pin)	R3151NxxxA $V_{DD}=4.5\text{V}$, $V_{DS}=0.05\text{V}$	0.5		2.0	mA
		R3151NxxxB $V_{DD}=13.0\text{V}$, $V_{DS}=0.05\text{V}$				
R_{CD}	C_D Pin Discharge Tr. On Resistance	$V_{DD}=13\text{V}$, $V_{CD}=0.5\text{V}$	0.50		2.60	k Ω
R_{CR}	C_R Pin Discharge Tr. On Resistance	$V_{DD}=4.5\text{V}$, $V_{CR}=0.5\text{V}$	0.50		2.60	k Ω

All test items listed under Electrical Characteristics are done under the pulse load condition ($T_j \approx T_a = 25^\circ\text{C}$).

^{*1} The minimum operating voltage is the voltage required for the stable operation of the devices.

^{*2} A time that V_{DOUT} requires to reach 2.5 V when changed V_{DD} from “ $-V_{SET} + 1.0\text{V}$ ” to “ $-V_{SET} - 1.0\text{V}$ ”.

^{*3} A time that V_{DOUT} requires to reach 2.5 V when changed V_{DD} from “ $+V_{SET} - 1.0\text{V}$ ” to “ $+V_{SET} + 1.0\text{V}$ ”.

R3151N

NO.EC-367-141202

$C_D=1000\text{pF}$, $C_R=1000\text{pF}$, Pull-up resistance= $100\text{k}\Omega$, Pull-up voltage= 5V , unless otherwise noted.

The specifications surrounded by are guaranteed by design engineering at $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$.

R3151NxxxE/ F

(Ta=25°C)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V _{DDL}	Minimum Operating Voltage ^{*1}				3.6	V
I _{SS}	Supply Current ^{*2}	V _{DD} =5.0V, V _{SENSE} = -V _{SET} -0.1V		3.5	5.5	μA
		V _{DD} =5.0V, V _{SENSE} = +V _{SET} +1.0V		3.5	5.6	
R _{SENSE}	SENSE Resistance		4.5		51.5	MΩ
-V _{DET}	Detector Threshold	Ta=25°C	x0.985		x1.015	V
		-40°C≤Ta≤105°C	x0.980		x1.020	
+V _{DET}	Release Voltage	Ta=25°C	x0.985		x1.015	V
		-40°C≤Ta≤105°C	x0.980		x1.020	
treset	Detect Output Delay Time ^{*3}	C _R =1000pF, -40°C≤Ta≤105°C	6.5	10	14.0	ms
tdelay	Release Output Delay Time ^{*4}	C _D =1000pF, -40°C≤Ta≤105°C	6.5	10	14.0	ms
I _{OUT}	Output Current (Nch Driver Output Pin)	R3151NxxxE V _{DD} =5.0V, V _{DS} =0.05V, V _{SENSE} = -V _{SET} -0.1V	0.5		2.0	mA
		R3151NxxxF V _{DD} =5.0V, V _{DS} =0.05V, V _{SENSE} = +V _{SET} +1.0V				
R _{CD}	C _D Pin Discharge Tr. On Resistance	V _{DD} =4.5V, V _{SENSE} =13V, V _{CD} =0.5V	0.50		2.60	kΩ
R _{CR}	C _R Pin Discharge Tr. On Resistance	V _{DD} =4.5V, V _{SENSE} =4.5V, V _{CR} =0.5V	0.50		2.60	kΩ

All test items listed under Electrical Characteristics are done under the pulse load condition (T_j≈T_a=25°C).

*1 The minimum operating voltage is the voltage required for the stable operation of the devices.

*2 Not including the current for SENSE resistance.

*3 A time that V_{DOUT} requires to reach 2.5 V when changed V_{SENSE} from “-V_{SET}+1.0 V” to “-V_{SET}-1.0 V”.

*4 A time that V_{DOUT} requires to reach 2.5 V when changed V_{SENSE} from “+V_{SET}-1.0 V” to “+V_{SET}+1.0 V”.

Product-specific Electrical Characteristics

The specifications surrounded by are guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$.

R3151NxxxA

(Ta=25°C)

Product Name	-V _{DET} [V] (Ta = 25°C)			-V _{DET} [V] (-40°C≤Ta≤105°C)			+V _{DET} [V] (Ta = 25°C)			+V _{DET} [V] (-40°C≤Ta≤105°C)		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
R3151N001A	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3151N002A	8.373	8.500	8.627	8.330	8.500	8.670	8.865	9.000	9.135	8.820	9.000	9.180
R3151N003A	8.865	9.000	9.135	8.820	9.000	9.180	9.358	9.500	9.642	9.310	9.500	9.690
R3151N004A	5.812	5.900	5.988	5.782	5.900	6.018	6.698	6.800	6.902	6.664	6.800	6.936
R3151N005A	6.403	6.500	6.597	6.370	6.500	6.630	6.994	7.100	7.206	6.958	7.100	7.242
R3151N006A	6.206	6.300	6.394	6.174	6.300	6.426	6.797	6.900	7.003	6.762	6.900	7.038
R3151N007A	5.713	5.800	5.887	5.684	5.800	5.916	6.206	6.300	6.394	6.174	6.300	6.426
R3151N018A	5.910	6.000	6.090	5.880	6.000	6.120	7.092	7.200	7.308	7.056	7.200	7.344

R3151NxxxB

(Ta=25°C)

Product Name	-V _{DET} [V] (Ta = 25°C)			-V _{DET} [V] (-40°C≤Ta≤105°C)			+V _{DET} [V] (Ta = 25°C)			+V _{DET} [V] (-40°C≤Ta≤105°C)		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
R3151N001B	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3151N002B	8.373	8.500	8.627	8.330	8.500	8.670	8.865	9.000	9.135	8.820	9.000	9.180
R3151N003B	8.865	9.000	9.135	8.820	9.000	9.180	9.358	9.500	9.642	9.310	9.500	9.690
R3151N004B	5.812	5.900	5.988	5.782	5.900	6.018	6.698	6.800	6.902	6.664	6.800	6.936
R3151N005B	6.403	6.500	6.597	6.370	6.500	6.630	6.994	7.100	7.206	6.958	7.100	7.242
R3151N006B	6.206	6.300	6.394	6.174	6.300	6.426	6.797	6.900	7.003	6.762	6.900	7.038
R3151N007B	5.713	5.800	5.887	5.684	5.800	5.916	6.206	6.300	6.394	6.174	6.300	6.426
R3151N008B	7.388	7.500	7.612	7.350	7.500	7.650	8.865	9.000	9.135	8.820	9.000	9.180
R3151N011B	7.683	7.800	7.917	7.644	7.800	7.956	8.865	9.000	9.135	8.820	9.000	9.180
R3151N012B	7.191	7.300	7.409	7.154	7.300	7.446	8.570	8.700	8.830	8.526	8.700	8.874
R3151N014B	7.979	8.100	8.221	7.938	8.100	8.262	8.373	8.500	8.627	8.330	8.500	8.670
R3151N015B	5.910	6.000	6.090	5.880	6.000	6.120	6.403	6.500	6.597	6.370	6.500	6.630
R3151N016B	5.418	5.500	5.582	5.390	5.500	5.610	5.910	6.000	6.090	5.880	6.000	6.120
R3151N017B	5.221	5.300	5.379	5.194	5.300	5.406	6.206	6.300	6.394	6.174	6.300	6.426
R3151N019B	5.910	6.000	6.090	5.880	6.000	6.120	7.388	7.500	7.612	7.350	7.500	7.650

R3151N

NO.EC-367-141202

The specifications surrounded by are guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$.**R3151NxxxE**

(Ta=25°C)

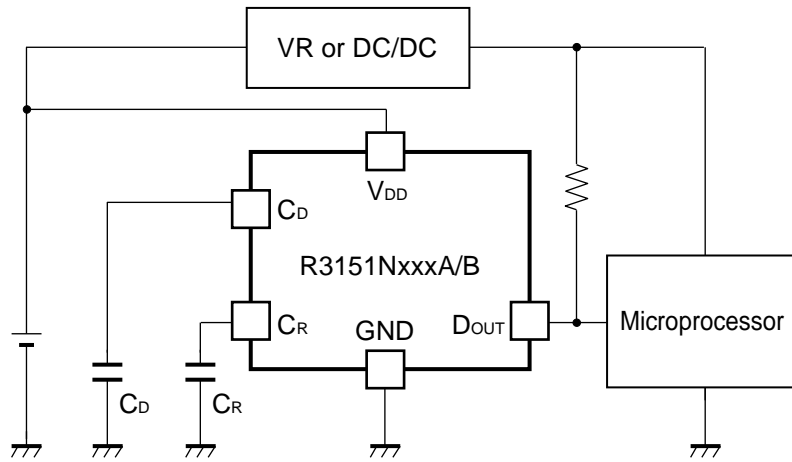
Product Name	-V _{DET} [V] (Ta = 25°C)			-V _{DET} [V] (-40°C ≤ Ta ≤ 105°C)			+V _{DET} [V] (Ta = 25°C)			+V _{DET} [V] (-40°C ≤ Ta ≤ 105°C)		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
R3151N001E	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3151N002E	8.373	8.500	8.627	8.330	8.500	8.670	8.865	9.000	9.135	8.820	9.000	9.180
R3151N003E	8.865	9.000	9.135	8.820	9.000	9.180	9.358	9.500	9.642	9.310	9.500	9.690
R3151N004E	5.812	5.900	5.988	5.782	5.900	6.018	6.698	6.800	6.902	6.664	6.800	6.936
R3151N005E	6.403	6.500	6.597	6.370	6.500	6.630	6.994	7.100	7.206	6.958	7.100	7.242
R3151N006E	6.206	6.300	6.394	6.174	6.300	6.426	6.797	6.900	7.003	6.762	6.900	7.038
R3151N007E	5.713	5.800	5.887	5.684	5.800	5.916	6.206	6.300	6.394	6.174	6.300	6.426
R3151N013E	6.895	7.000	7.105	6.860	7.000	7.140	7.388	7.500	7.612	7.350	7.500	7.650

R3151NxxxF

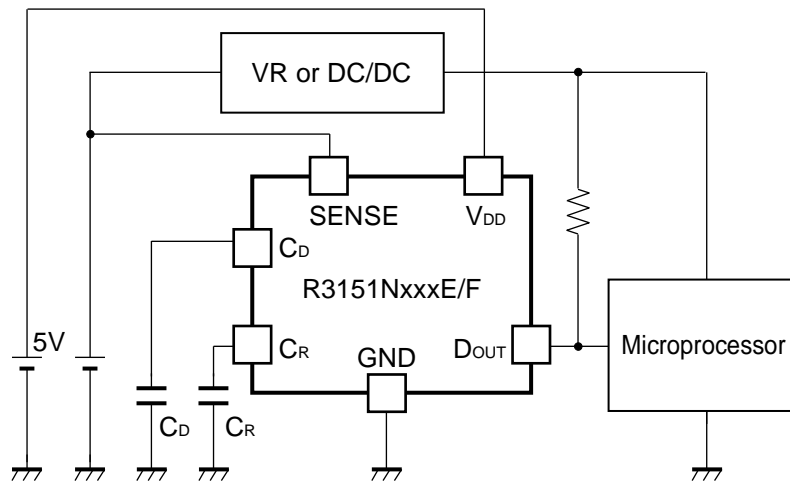
(Ta=25°C)

Product Name	-V _{DET} [V] (Ta = 25°C)			-V _{DET} [V] (-40°C ≤ Ta ≤ 105°C)			+V _{DET} [V] (Ta = 25°C)			+V _{DET} [V] (-40°C ≤ Ta ≤ 105°C)		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
R3151N001F	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3151N002F	8.373	8.500	8.627	8.330	8.500	8.670	8.865	9.000	9.135	8.820	9.000	9.180
R3151N003F	8.865	9.000	9.135	8.820	9.000	9.180	9.358	9.500	9.642	9.310	9.500	9.690
R3151N004F	5.812	5.900	5.988	5.782	5.900	6.018	6.698	6.800	6.902	6.664	6.800	6.936
R3151N005F	6.403	6.500	6.597	6.370	6.500	6.630	6.994	7.100	7.206	6.958	7.100	7.242
R3151N006F	6.206	6.300	6.394	6.174	6.300	6.426	6.797	6.900	7.003	6.762	6.900	7.038
R3151N007F	5.713	5.800	5.887	5.684	5.800	5.916	6.206	6.300	6.394	6.174	6.300	6.426
R3151N008F	7.388	7.500	7.612	7.350	7.500	7.650	8.865	9.000	9.135	8.820	9.000	9.180
R3151N011F	7.683	7.800	7.917	7.644	7.800	7.956	8.865	9.000	9.135	8.820	9.000	9.180
R3151N012F	7.191	7.300	7.409	7.154	7.300	7.446	8.570	8.700	8.830	8.526	8.700	8.874
R3151N015F	5.910	6.000	6.090	5.880	6.000	6.120	6.403	6.500	6.597	6.370	6.500	6.630
R3151N016F	5.418	5.500	5.582	5.390	5.500	5.610	5.910	6.000	6.090	5.880	6.000	6.120
R3151N017F	5.221	5.300	5.379	5.194	5.300	5.406	6.206	6.300	6.394	6.174	6.300	6.426

TYPICAL APPLICATION



R3151NxxxA/ B Typical Application



R3151NxxxE/ F Typical Application

TECHNICAL NOTES

When connecting resistors to the device's input pin

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

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

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

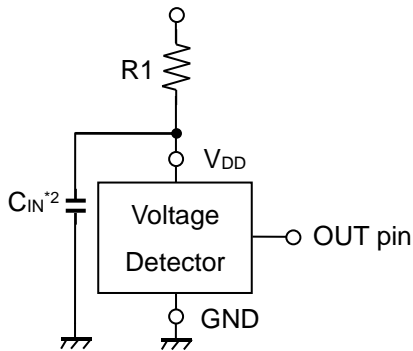


Figure A

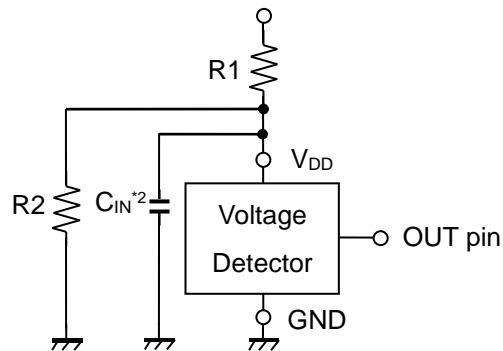


Figure B

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

*² Note the bias dependence of capacitors.

Prohibited Area of Supply Voltage Fluctuations (V_{DD} Voltage Detection Type)

As for the steep change of the supply voltages in the prohibited area as shown in Figure C, the detector may cause a false detection if the supply voltage is over the detector threshold, as shown in Figure D. In addition, the detector may take an incorrect detect output delay time if the supply voltage is less than $-V_{DET}$, as shown in Figure E.

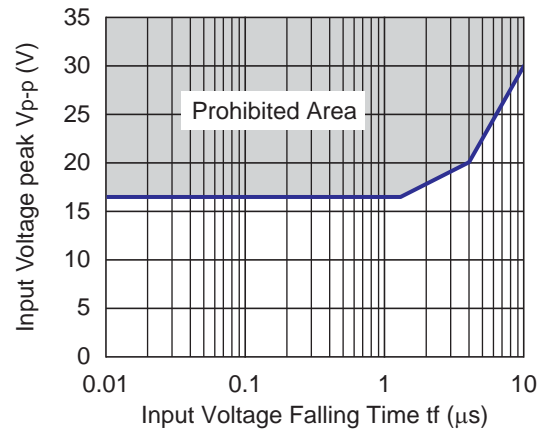


Figure C. Prohibited Area

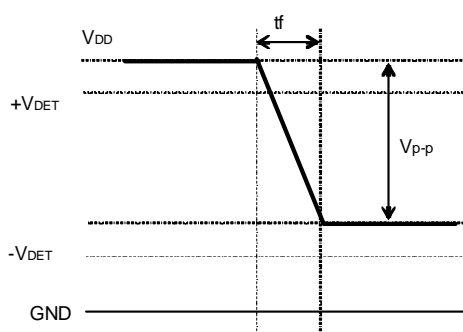


Figure D

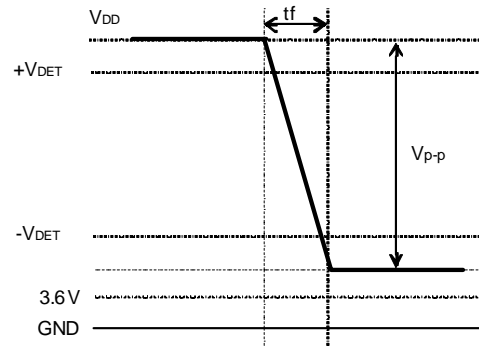
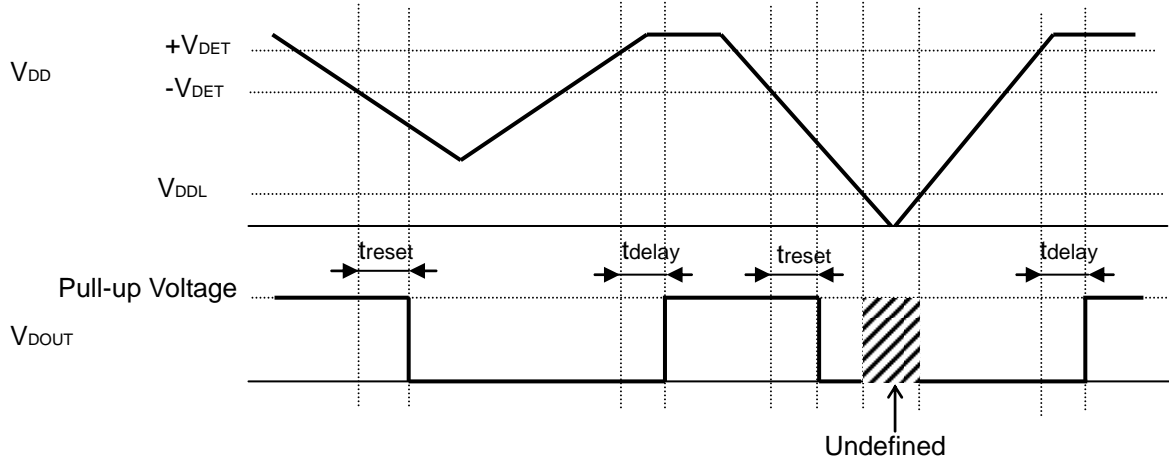


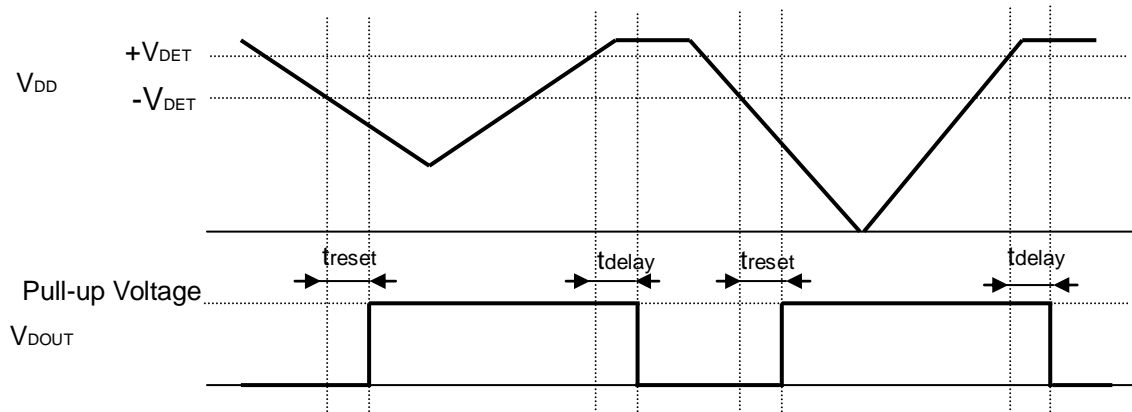
Figure E

TIMING CHART

R3151NxxxA/B (V_{DD} Voltage Detection Type)

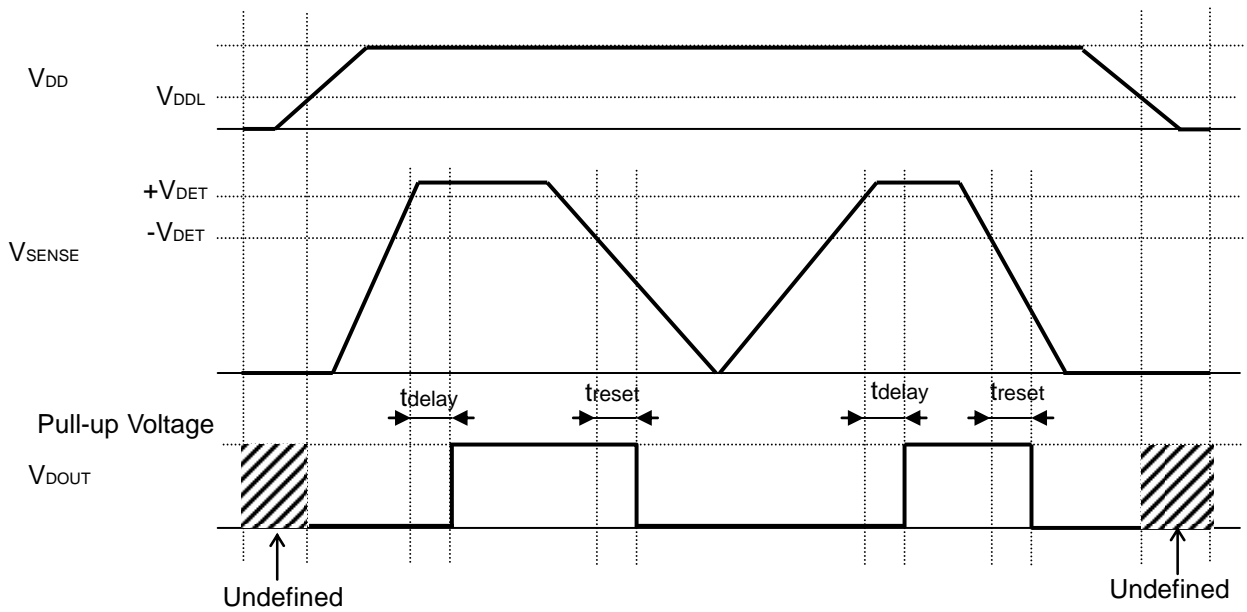


R3151NxxxA

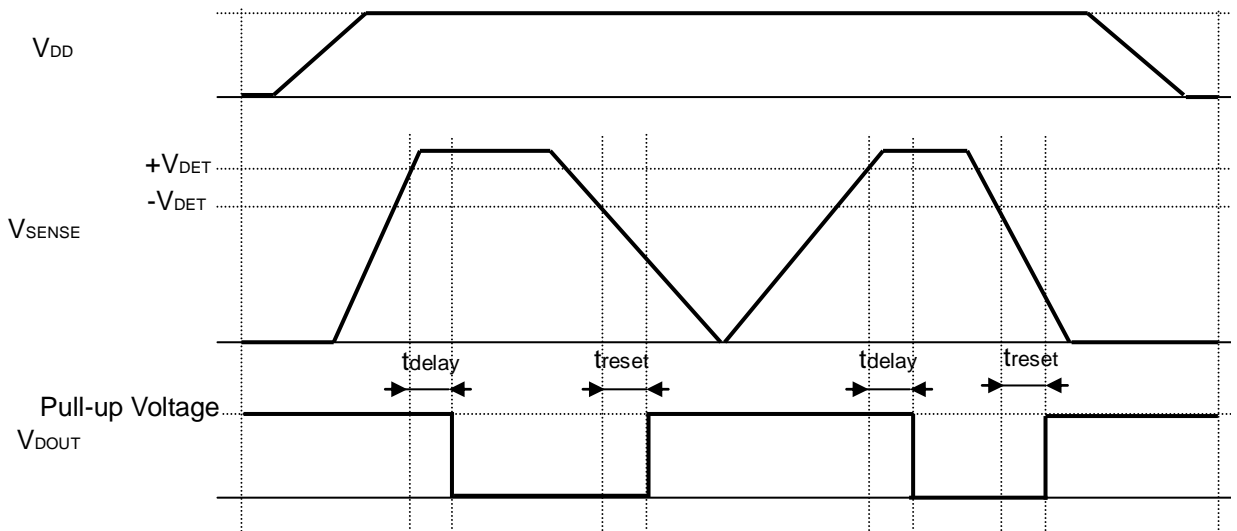


R3151NxxxB

R3151NxxxE/F (SENSE Voltage Detection Type)



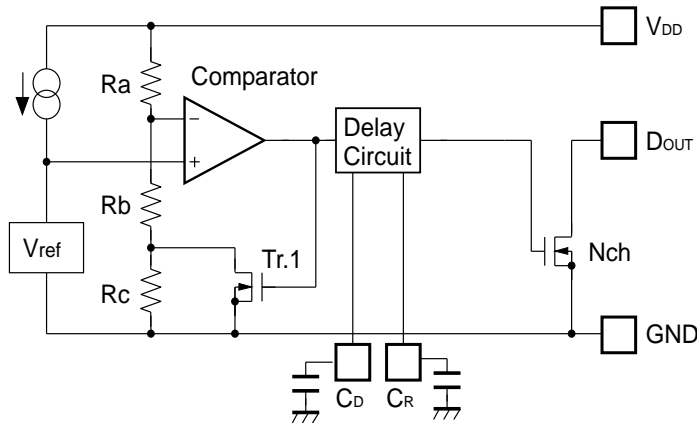
R3151NxxxE



R3151NxxxF

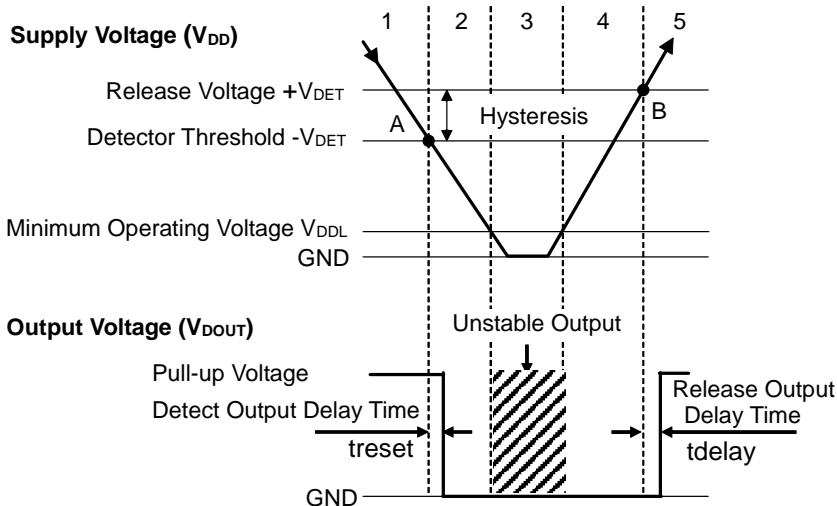
OPERATING DESCRIPTION

• **R3151NxxxA (V_{DD} Voltage Detection Type)**



*) D_{OUT} pin should be pulled-up to an external voltage level.

Block Diagram with External Capacitors



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

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

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

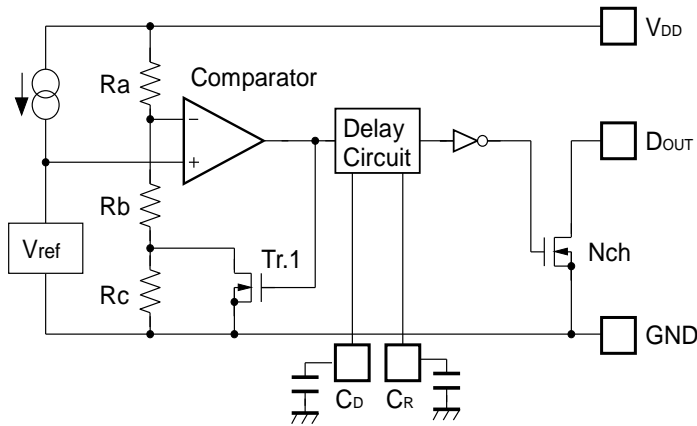
Operation Diagram

OPERATING CONDITIONS

1. The output voltage is equalized to the pull-up voltage.
2. The V_{DD} voltage drops to the detector threshold (A point) which means $V_{ref} \geq V_{DD} \times (R_b + R_c) / (R_a + R_b + R_c)$, and the comparator output shifts from “L” to “H” voltage, and the output pin voltage shifts from the pull-up voltage to “L” voltage.
3. If the V_{DD} voltage is lower than the minimum operating voltage, the output voltage becomes unstable.
4. The output pin voltage becomes “L” voltage.
5. The V_{DD} voltage becomes higher than the release voltage (B point) which means $V_{ref} \leq V_{DD} \times R_b / (R_a + R_b)$, and the comparator output shifts from “H” to “L” voltage, and the output pin voltage is equalized to the pull-up voltage.

* The gap between the release voltage and the detector threshold is hysteresis.

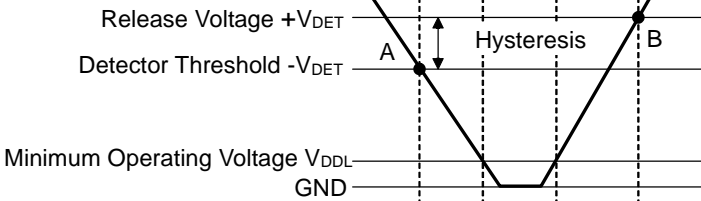
● R3151NxxxB (V_{DD} Voltage Detection Type)



*) D_{OUT} pin should be pulled-up to an external voltage level.

Block Diagram with External Capacitors

Supply Voltage (V_{DD})

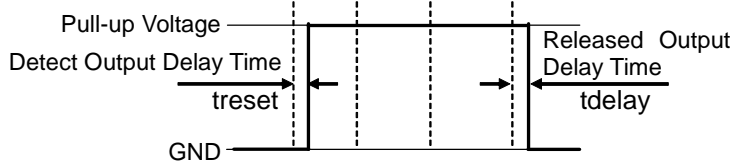


Step	1	2	3	4	5
Comparator (-) Pin Input Voltage	I	II	II	II	I
Comparator Output	L	H	H	H	L
Tr.1	OFF	ON	ON	ON	OFF
Output Tr. (Nch)	ON	OFF	OFF	OFF	ON

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

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

Output Voltage (V_{bout})



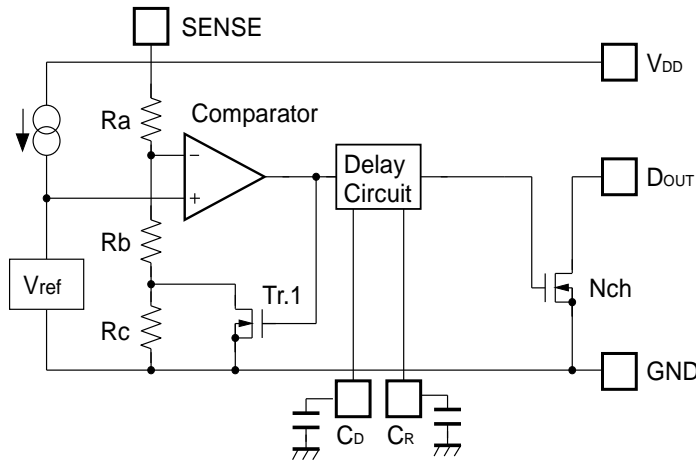
Operation Diagram

OPERATING CONDITIONS

1. The output pin voltage becomes "L" voltage.
2. The V_{DD} voltage drops to the detector threshold (A point) which means $V_{ref} \geq V_{DD} \times (R_b + R_c) / (R_a + R_b + R_c)$, and the comparator output shifts from "L" to "H" voltage and the output voltage is equalized to the pull-up voltage.
3. If the V_{DD} voltage is lower than the minimum operating voltage, the output is the pull-up voltage.
4. The output voltage is equalized to the pull-up voltage.
5. The V_{DD} voltage becomes higher than the release voltage (B point) which means $V_{ref} \leq V_{DD} \times R_b / (R_a + R_b)$, and the comparator output shift from "H" to "L" voltage and the output voltage becomes "L" voltage.

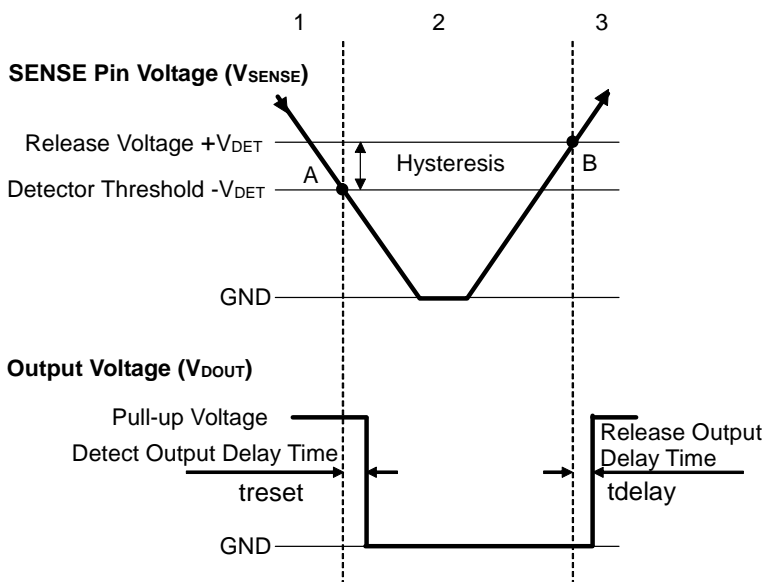
* The gap between the release voltage and the detector threshold is hysteresis.

• **R3151NxxxE (SENSE Voltage Detection Type)**



*) D_{OUT} pin should be pulled-up to an external voltage level.

Block Diagram with External Capacitors



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

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

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

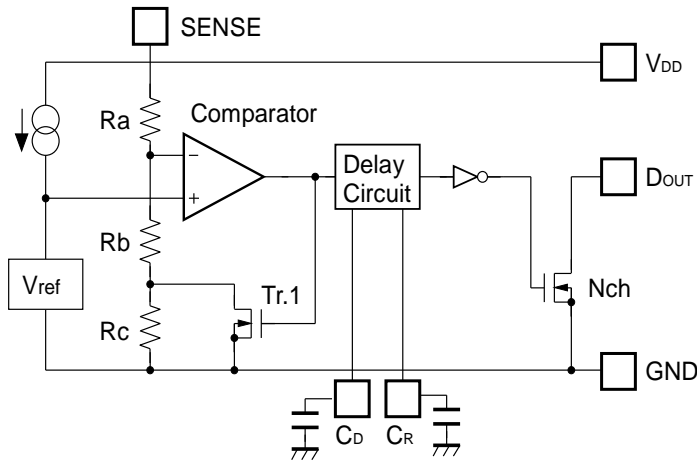
Operation Diagram

OPERATING CONDITIONS

1. The output voltage is equalized to the pull-up voltage.
2. The SENSE pin voltage drops to the detector threshold (A point) which means $V_{ref} \geq V_{DD} \times (Rb+Rc) / (Ra+Rb+Rc)$, and the comparator output shifts from “L” to “H” voltage, and the output pin voltage shifts from the pull-up voltage to “L” voltage. (If the V_{DD} voltage is higher than the minimum operating voltage, the output remains as “L” voltage)
3. The SENSE pin voltage becomes higher than the release voltage (B point) which means $V_{ref} \leq V_{SENSE} \times Rb / (Ra+Rb)$, and the comparator output shifts from “H” to “L” voltage, and the output pin voltage is equalized to the pull-up voltage.

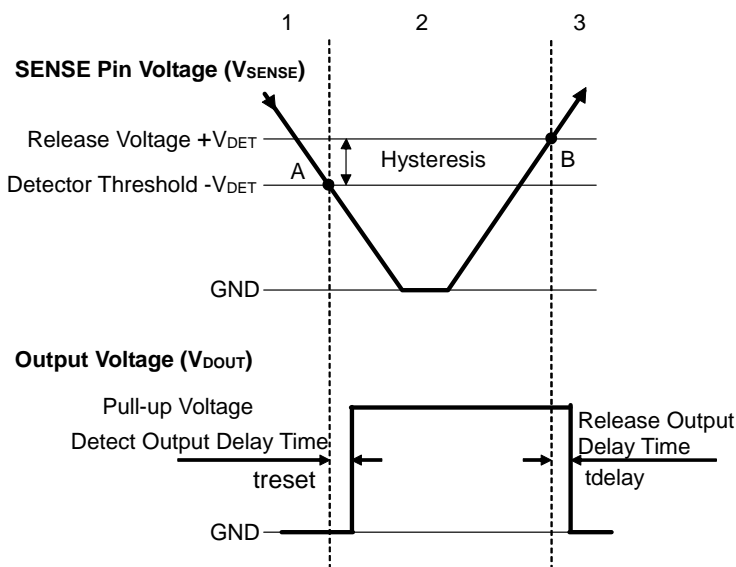
* The gap between the release voltage and the detector threshold is hysteresis.

● R3151NxxxF (SENSE Voltage Detection Type)



*) DOUT pin should be pulled-up to an external voltage level.

Block Diagram with External Capacitors



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

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

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

Operation Diagram

OPERATING CONDITIONS

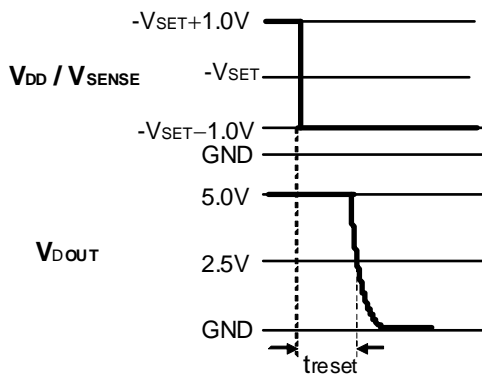
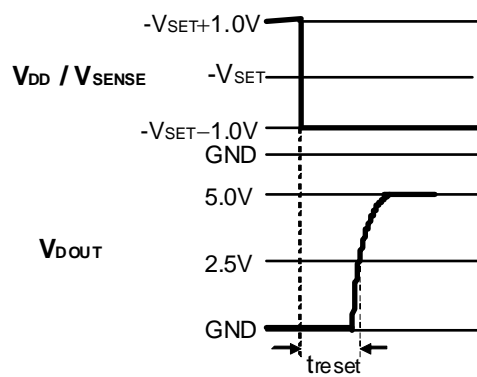
1. The output becomes "L" voltage if the SENSE pin voltage is higher than the detector threshold.
2. The SENSE pin voltage drops to the detector threshold (A point) which means $V_{ref} \geq V_{SENSE} \times (Rb+Rc) / (Ra+Rb+Rc)$, and the comparator output shifts from "L" to "H" voltage and the output voltage is equalized to the pull-up voltage. (If the VDD voltage is higher than the minimum operating voltage, the output remains as the pull-up voltage.)
3. The SENSE pin voltage becomes higher than the release voltage (B point) which means $V_{ref} \leq V_{SENSE} \times Rb / (Ra+Rb)$, and the comparator output shift from "H" to "L" voltage and the output voltage becomes "L" voltage.

* The gap between the release voltage and the detector threshold is hysteresis.

DETECT OUTPUT DELAY TIME (t_{reset})

Detect Output Delay Time (t_{reset}) is defined as follows:

t_{reset} starts after the output pin (D_{OUT}) is pulled up to 5V with a 100k Ω resistor and the V_{DD}/V_{SENSE} is shifted from “ $-V_{SET} + 1.0V$ ” to “ $-V_{SET} - 1.0V$ ”. t_{reset} ends when the output voltage reaches to 2.5V.

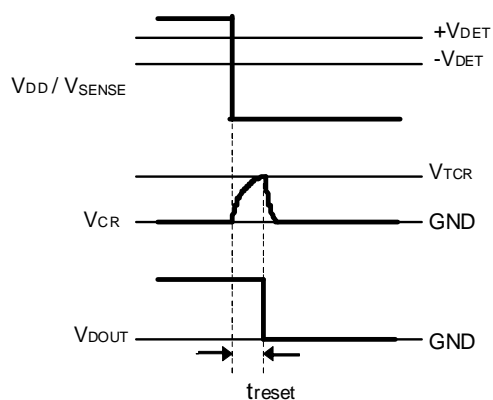
**R3151NxxxA/E****R3151NxxxB/F**

t_{reset} is calculated by the following equation:

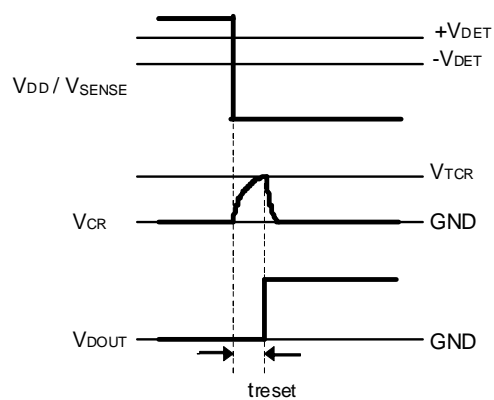
$$t_{reset} (s) = C_R \times 10^7$$

With the R3151NxxxA/ B, if the V_{DD} voltage after detection is 3.6V or less, the normal detect output delay time cannot be expected due to insufficient voltage (The detect output delay time decreases along with the decrease of V_{DD} voltage).

DETECT OUTPUT DELAY



R3151NxxxA/E



R3151NxxxB/F

If the voltage lower than the detector threshold is applied to $V_{DD}/SENSE$ pin while the voltage higher than the release voltage is applied to the $V_{DD}/SENSE$ pin, the external capacitor starts to charge electricity and the C_R pin voltage starts to increase.

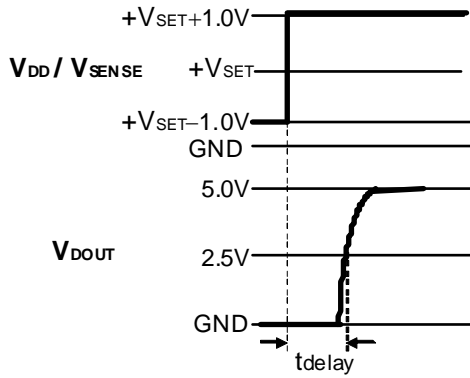
Until the C_R pin voltage reaches to the detector threshold of the detect output delay pin (V_{TCR}), the output voltage maintains the release output. If the C_R pin voltage becomes higher than V_{TCR} , the output voltage shifts from the release output to the detection output.

In addition, if the output voltage shift from the release output to the detection output, the external capacitor starts to discharge electricity and the C_R pin voltage starts decrease.

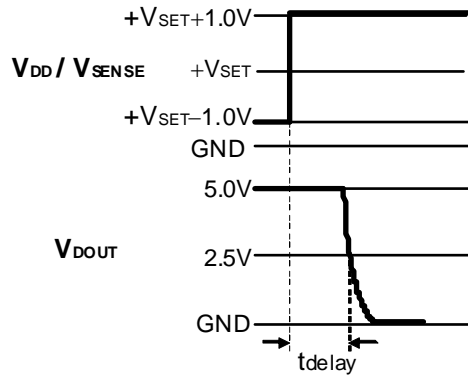
RELEASE OUTPUT DELAY TIME (tdelay)

Release Output Delay Time (tdelay) is defined as follows:

tdelay starts after the output pin (DOUT) is pulled up to 5V with a 100kΩ resistor, and the VDD/ VSENSE is shifted from “+VSET -1.0V” to “+VSET +1.0V”. It ends when the output voltage reaches to 2.5V.



R3151NxxxA/E

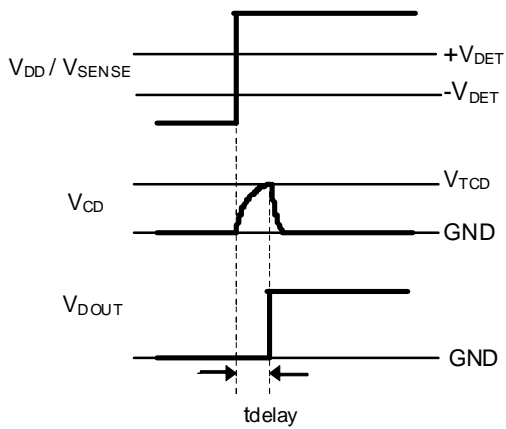


R3151NxxxB/F

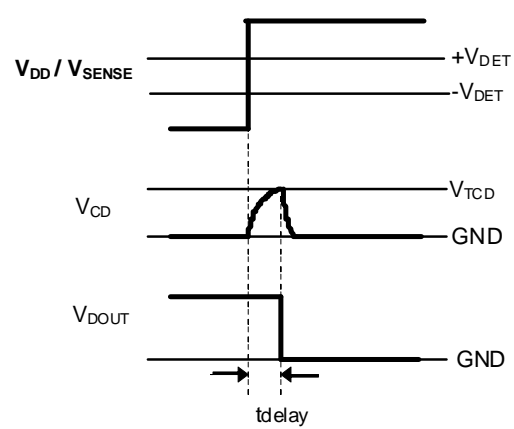
tdelay is calculated by the following equation:

$$tdelay (s) = C_D \times 10^7$$

RELEASE OUTPUT DELAY



R3151NxxxA/E



R3151NxxxB/F

If the voltage higher than the release voltage is applied to the $V_{DD}/SENSE$ pin while the voltage lower than the detector threshold is applied to $V_{DD}/SENSE$ pin, the external capacitor starts to charge electricity and the C_D pin voltage starts to increase.

Until the C_D pin voltage reaches to the release voltage of the release output delay pin (V_{TCD}), the output voltage maintains the release output. If the C_D pin voltage becomes higher than the release voltage of the release output delay pin, the output voltage shifts from the detection output to the release output.

In addition, if the output voltage shifts from the detection output to the release output, the external capacitor starts to discharge electricity and the C_D pin voltage starts to decrease.

START-UP AND SHUTDOWN SEQUENCES

The R3151NxxxE/ F (SENSE Voltage Detection Type) supervise the SENSE pin voltage while the voltage higher than the minimum operating voltage is applied to V_{DD} pin.

At start-up, either the V_{DD} pin or SENSE pin can be started up first, however, if the V_{DD} pin is started up with a voltage lower than the minimum operating voltage while the SENESE pin has already been started up, the start-up slope angle of the V_{DD} pin should be 10V/ ms or less.

At shutdown, the SNESE pin should be shut down first, then after treset, the V_{DD} pin should be shut down.

DETECTOR OPERATION VS. GLITCH INPUT VOLTAGE

The R3151N has built-in rejection of fast transients on the V_{DD} (R3151NxxxA/B) or SNESE (R3151NxxxE/F) pins. The rejection of transients depends on both the pulse width and the overdrive voltage, as shown in Figure 1.

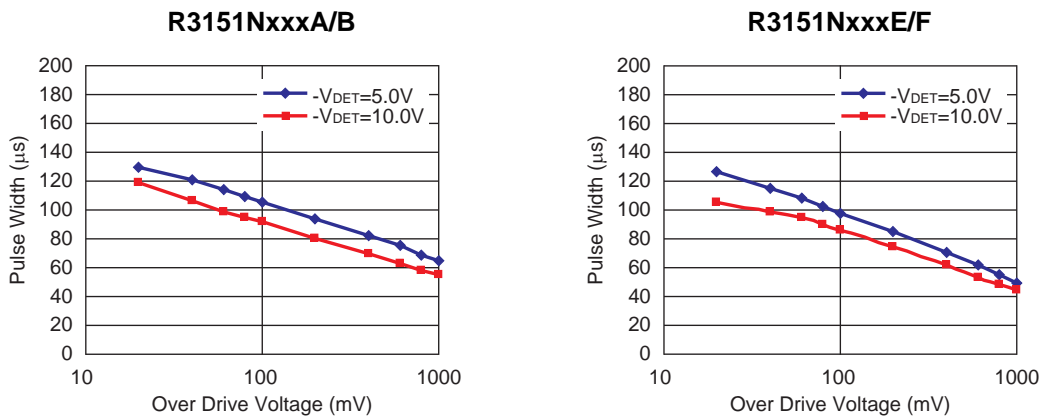


Figure 1. Minimum Pulse Width at V_{DD} / SENSE vs. Overdrive Voltage

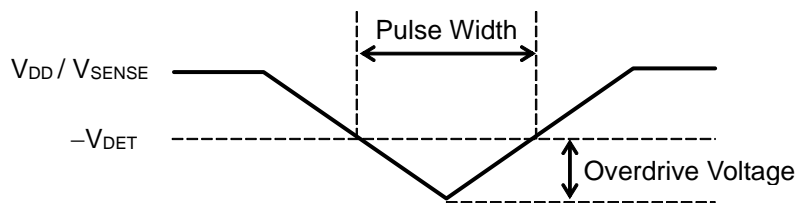


Figure 2. V_{DD} / V_{SENSE} Input Waveform

The R3151N does not respond to transients that are short pulse width / large overdrive voltage or long pulse width / small overdrive voltage. Any combination of pulse width and overdrive voltage above the curve generates a reset signal.

The overdrive voltage indicates between the minimum value of input voltage (V_{DD} or V_{SENSE}) and $-V_{DET}$, as shown in Figure 2.

RELEASE OPERATION VS. GLITCH INPUT VOLTAGE

The R3151N has built-in rejection of fast transients on the V_{DD} (R3151NxxxA/B) or S_{ENSE} (R3151NxxxE/F) pins. The rejection of transients depends on both the pulse width and the overdrive voltage, as shown in Figure 1.

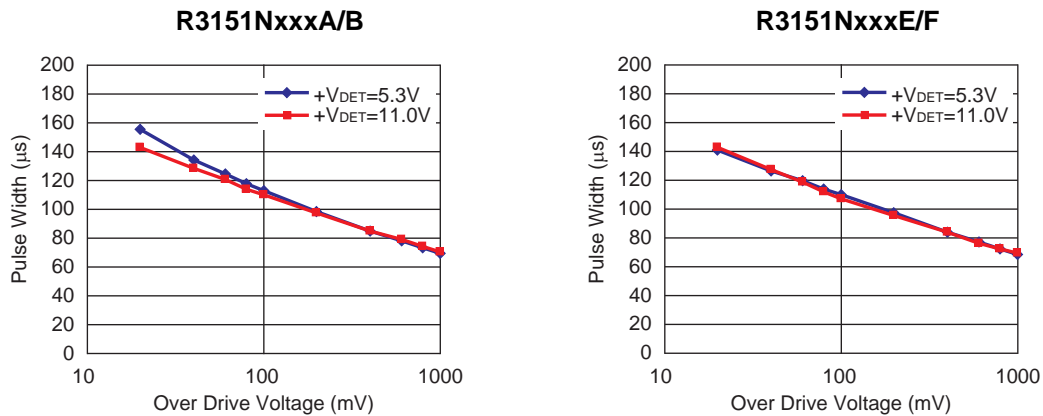


Figure 1. Minimum Pulse Width at V_{DD} / S_{ENSE} vs. Overdrive Voltage

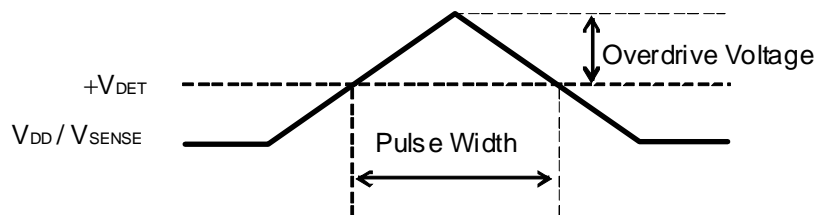


Figure 2. V_{DD} / V_{SENSE} Input Waveform

The R3151N does not respond to transients that are short pulse width / large overdrive voltage or long pulse width / small overdrive voltage. Any combination of pulse width and overdrive voltage above the curve generates a reset signal.

The overdrive voltage indicates between the maximum value of input voltage (V_{DD} or V_{SENSE}) and $+V_{DET}$, as shown in Figure 2.

PACKAGE INFORMATION

POWER DISSIPATION (SOT-23-6)

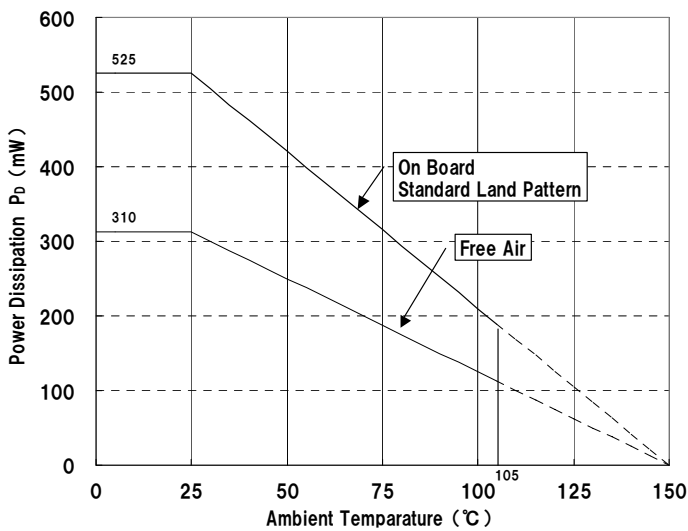
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

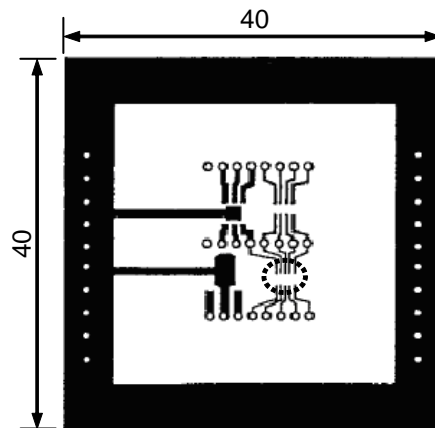
	Standard Test Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm x 40mm x 1.6mm
Copper Ratio	Top side: Approx. 50%, Back side: Approx. 50%
Through-holes	ϕ 0.5mm * 44pcs


Measurement Result: (Ta=25°C, Tjmax=150°C)

	Standard Test Land Pattern	Free Air
Power Dissipation	525mW	310mW
Thermal Resistance	$\theta_{ja} = (150-25^\circ\text{C})/0.525\text{W} = 238^\circ\text{C/W}$	400°C/W



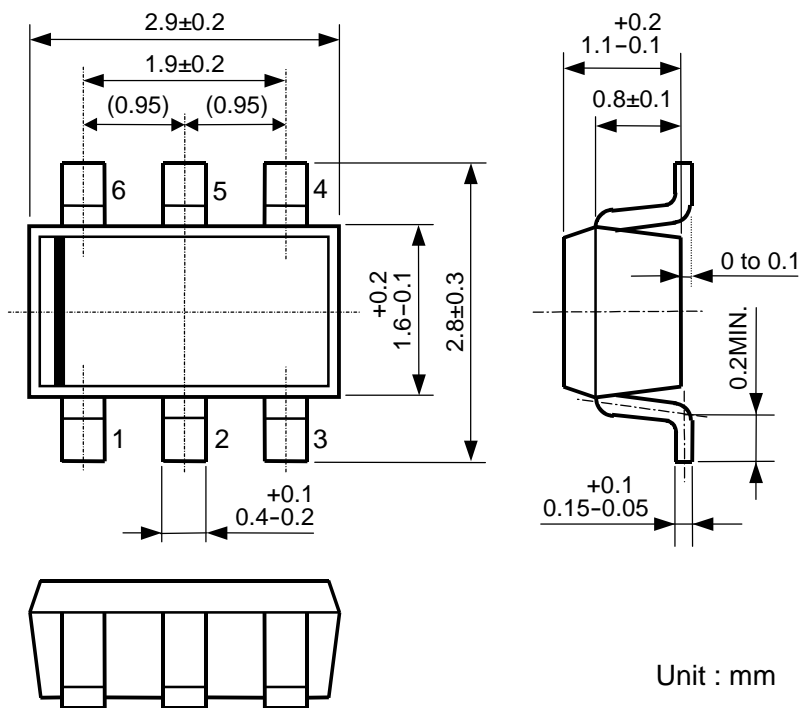
Power Dissipation



 IC Mount Area (Unit: mm)

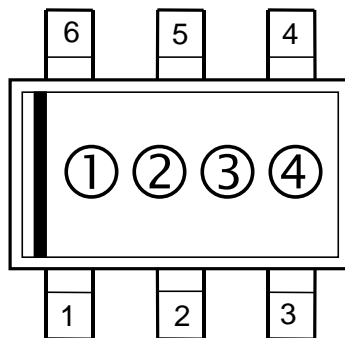
Measurement Board Pattern

PACKAGE DIMENSIONS (SOT-23-6)



MARK SPECIFICATION (SOT-23-6)

- ①②: Product Code ... Refer to *MARK SPECIFICATION TABLE*.
- ③④: Lot Number ... Alphanumeric Serial Number



R3151N

NO.EC-367-141202

MARK SPECIFICATION TABLE (SOT-23-6)**R3151NxxxA**

Product Name	① ②	Set Voltage	
		Detection	Release
R3151N001A	D F	6.4	7.3
R3151N002A	D G	8.5	9.0
R3151N003A	D H	9.0	9.5
R3151N004A	D J	5.9	6.8
R3151N005A	D K	6.5	7.1
R3151N006A	D L	6.3	6.9
R3151N007A	D M	5.8	6.3
R3151N018A	E U	6.0	7.2

R3151NxxxB

Product Name	① ②	Set Voltage	
		Detection	Release
R3151N001B	D A	6.4	7.3
R3151N002B	D N	8.5	9.0
R3151N003B	D P	9.0	9.5
R3151N004B	D Q	5.9	6.8
R3151N005B	D R	6.5	7.1
R3151N006B	D S	6.3	6.9
R3151N007B	D T	5.8	6.3
R3151N008B	E E	7.5	9.0
R3151N011B	E G	7.8	9.0
R3151N012B	E J	7.3	8.7
R3151N014B	E M	8.1	8.5
R3151N015B	E N	6.0	6.5
R3151N016B	E Q	5.5	6.0
R3151N017B	E S	5.3	6.3
R3151N019B	E V	6.0	7.5

R3151NxxxE

Product Name	① ②	Set Voltage	
		Detection	Release
R3151N001E	D U	6.4	7.3
R3151N002E	D V	8.5	9.0
R3151N003E	D W	9.0	9.5
R3151N004E	D X	5.9	6.8
R3151N005E	D Y	6.5	7.1
R3151N006E	D Z	6.3	6.9
R3151N007E	E A	5.8	6.3
R3151N013E	E L	7.0	7.5

R3151NxxxF

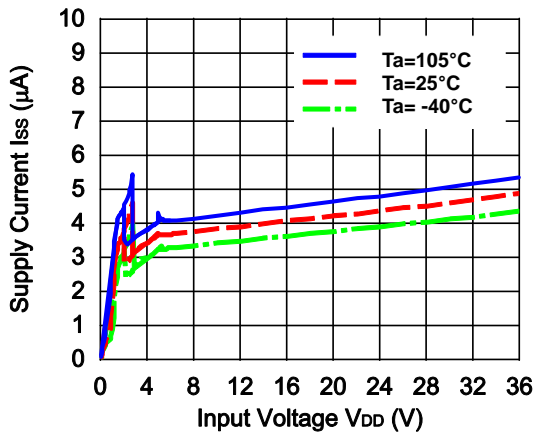
Product Name	① ②	Set Voltage	
		Detection	Release
R3151N001F	D B	6.4	7.3
R3151N002F	E B	8.5	9.0
R3151N003F	E C	9.0	9.5
R3151N004F	E D	5.9	6.8
R3151N005F	D C	6.5	7.1
R3151N006F	D D	6.3	6.9
R3151N007F	D E	5.8	6.3
R3151N008F	E F	7.5	9.0
R3151N011F	E H	7.8	9.0
R3151N012F	E K	7.3	8.7
R3151N015F	E P	6.0	6.5
R3151N016F	E R	5.5	6.0
R3151N017F	E T	5.3	6.3

TYPICAL CHARACTERISTICS

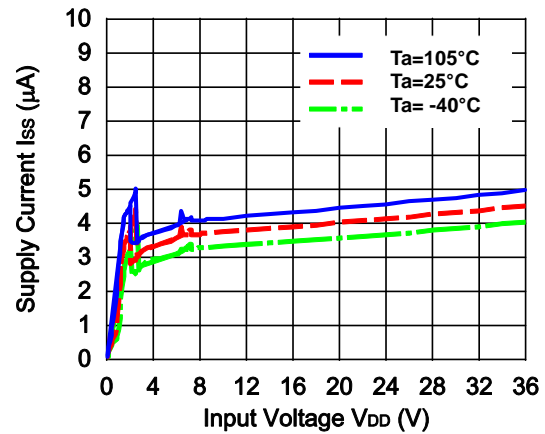
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Supply Current vs. Input Voltage

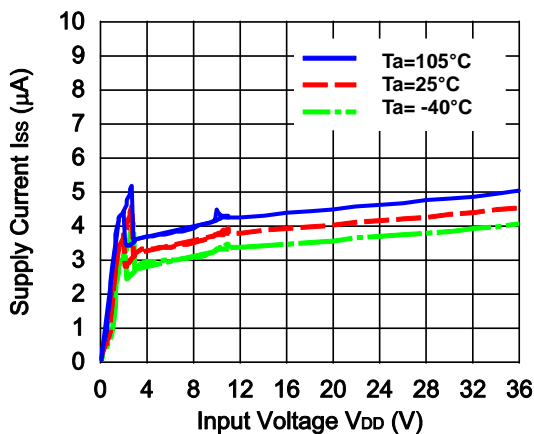
R3151NxxxA/ B ($-V_{DET} = 5.0V$, $+V_{DET} = 5.3V$)



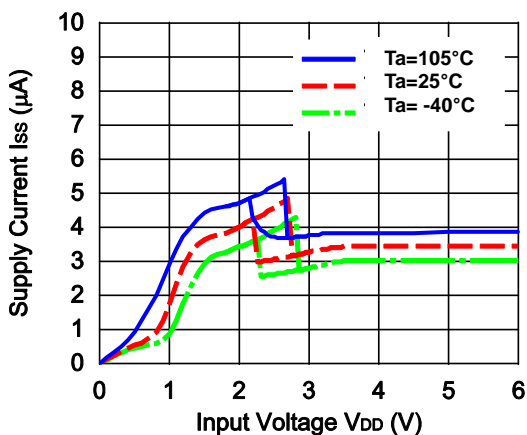
R3151NxxxA/ B ($-V_{DET} = 6.4V$, $+V_{DET} = 7.3V$)



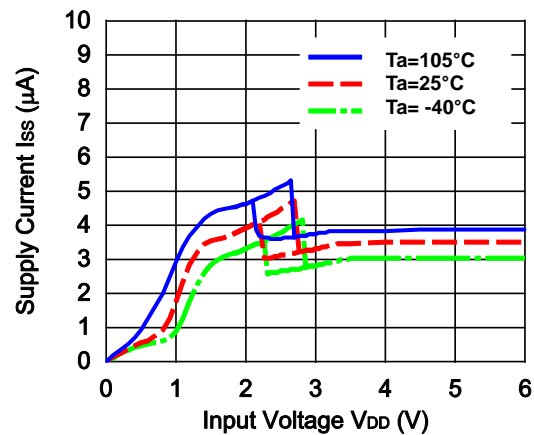
R3151NxxxA/ B ($-V_{DET} = 10.0V$, $+V_{DET} = 11.0V$)



R3151NxxxE/ F ($V_{SENSE} = -V_{DET} - 0.1V$)

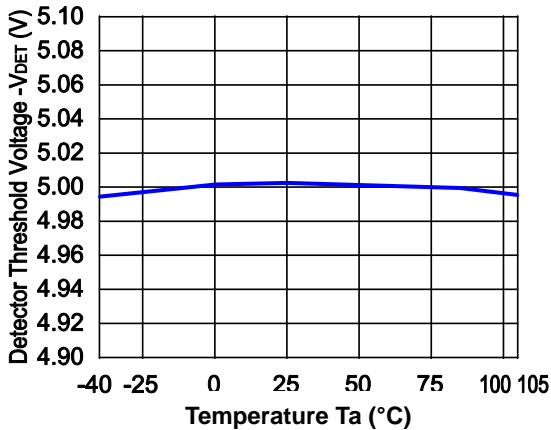


R3151NxxxE/ F ($V_{SENSE} = +V_{DET} + 0.1V$)

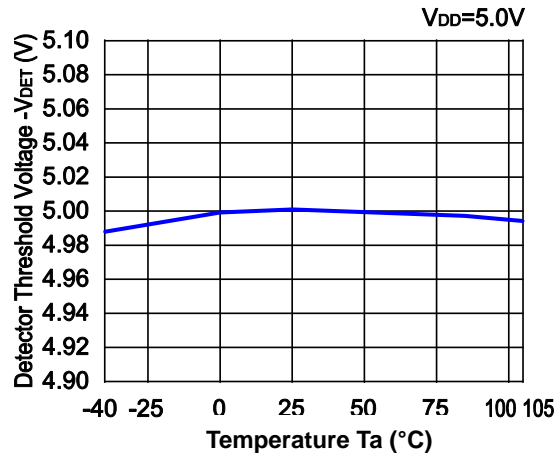


2) Detector Threshold vs. Temperature

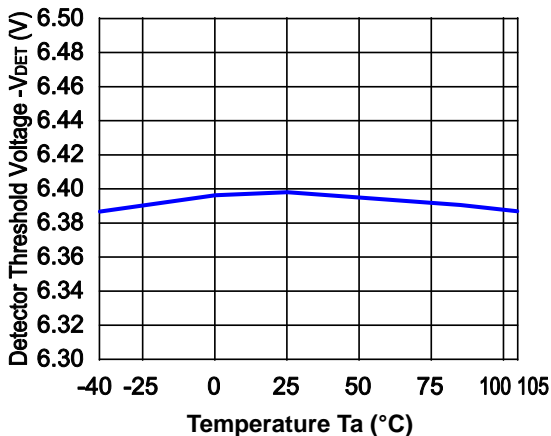
R3151NxxxA/ B (-V_{DET}=5.0V)



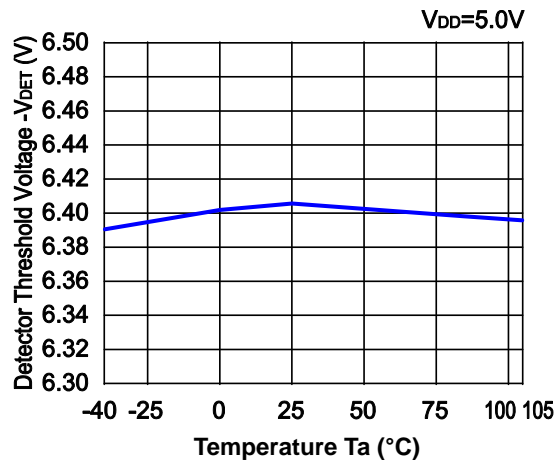
R3151NxxxE/ F (-V_{DET}=5.0V)



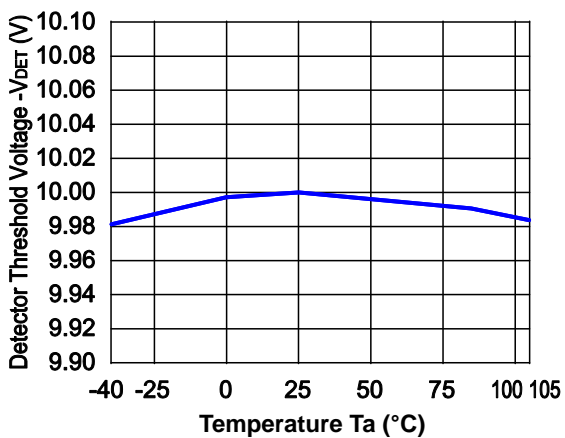
R3151NxxxA/ B (-V_{DET}=6.4V)



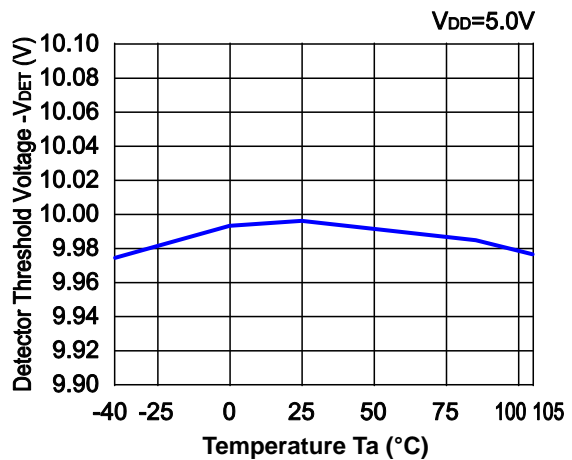
R3151NxxxE/ F (-V_{DET}=6.4V)



R3151NxxxA/ B (-V_{DET}=10.0V)

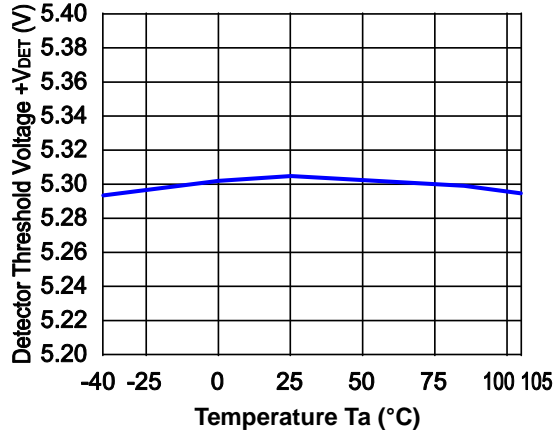


R3151NxxxE/ F (-V_{DET}=10.0V)



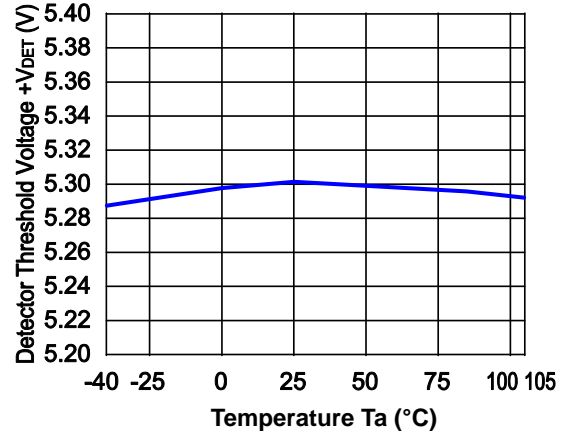
3) Release Voltage vs. Temperature

R3151NxxxA/ B (+V_{DET}=5.3V)

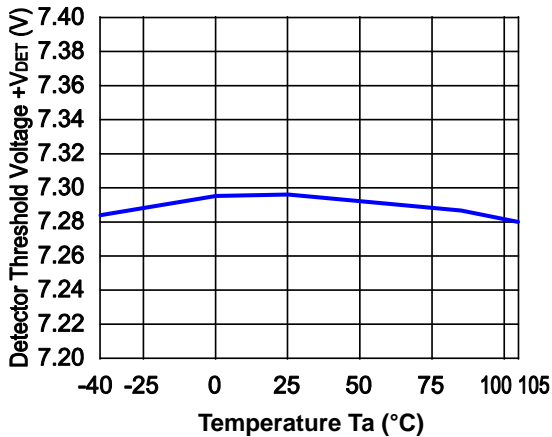


R3151NxxxE/ F (+V_{DET}=5.3V)

V_{DD}=5.0V

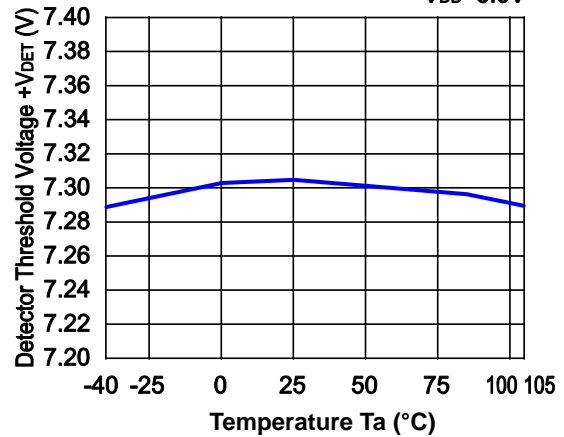


R3151NxxxA/ B (+V_{DET}=7.3V)

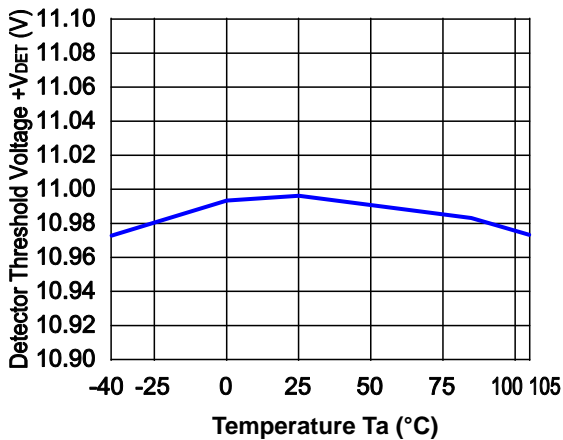


R3151NxxxE/ F (+V_{DET}=7.3V)

V_{DD}=5.0V

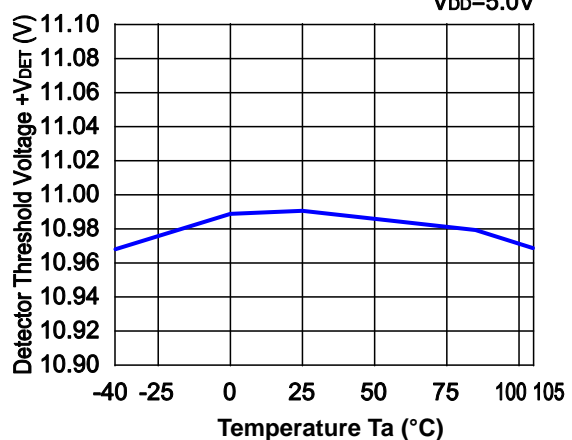


R3151NxxxA/ B (+V_{DET}=11.0V)



R3151NxxxE/ F (+V_{DET}=11.0V)

V_{DD}=5.0V

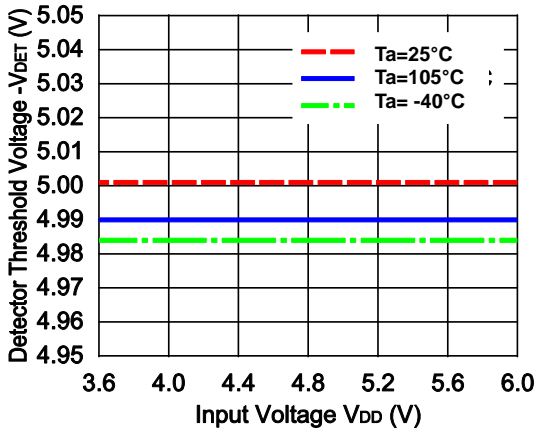


R3151N

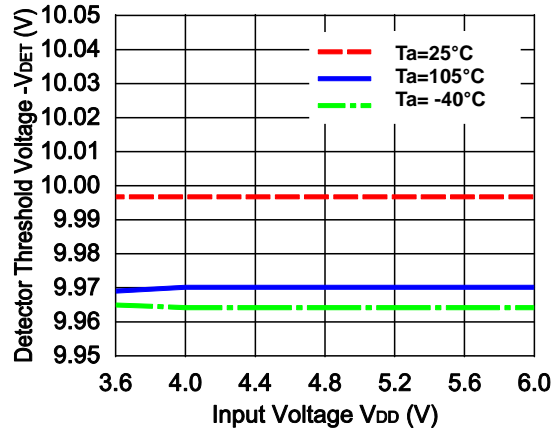
NO.EC-367-141202

4) Detector Threshold vs. Input Voltage

R3151NxxxE/ F (-V_{DET}=5.0V)

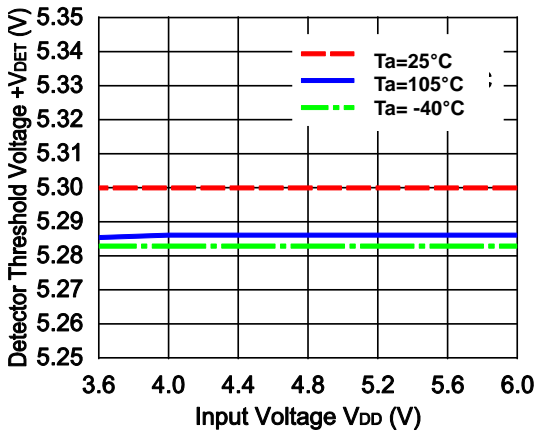


R3151NxxxE/ F (-V_{DET}=10.0V)

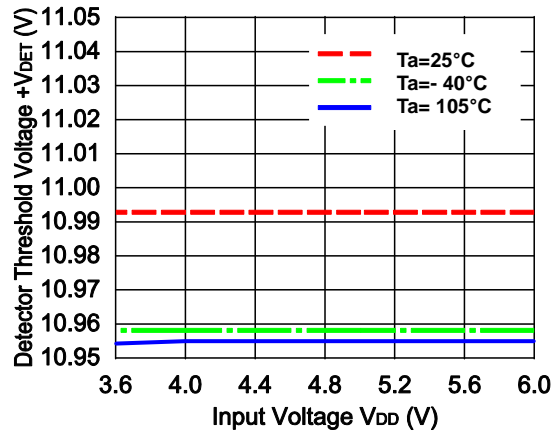


5) Release Voltage vs. Input Voltage

R3151NxxxE/ F (+V_{DET}=5.3V)

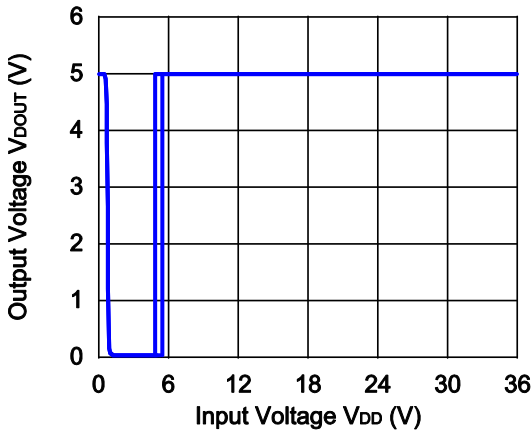


R3151NxxxE/ F (+V_{DET}=11.0V)

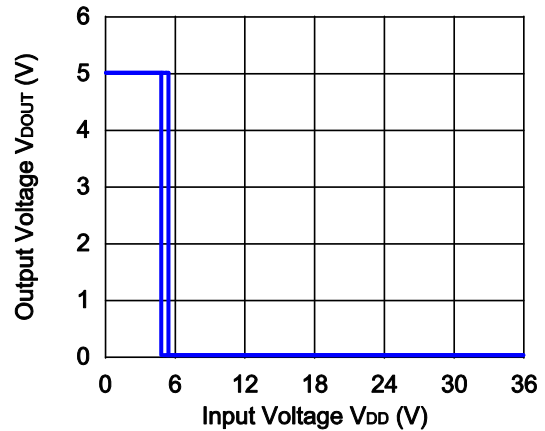


6) Output Voltage vs. Input Voltage (Ta=25°C, D_{OUT} pin is pulled-up to 5V and 100Ω)

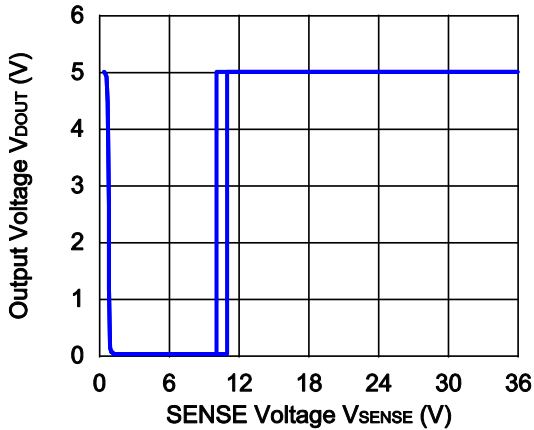
R3151NxxxA (-V_{DET}=5.0V, +V_{DET}=5.3V)



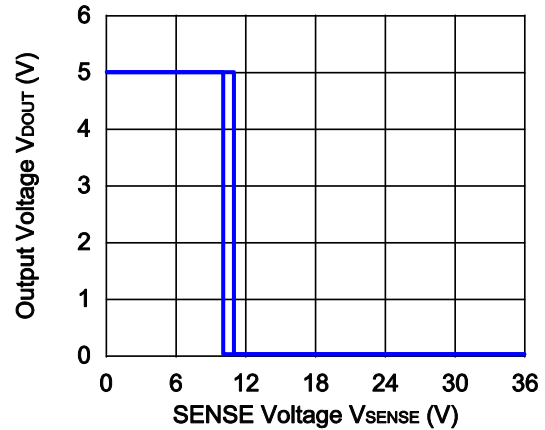
R3151NxxxB (-V_{DET}=5.0V, +V_{DET}=5.3V)



R3151NxxxA (-V_{DET}=10.0V, +V_{DET}=11.0V)

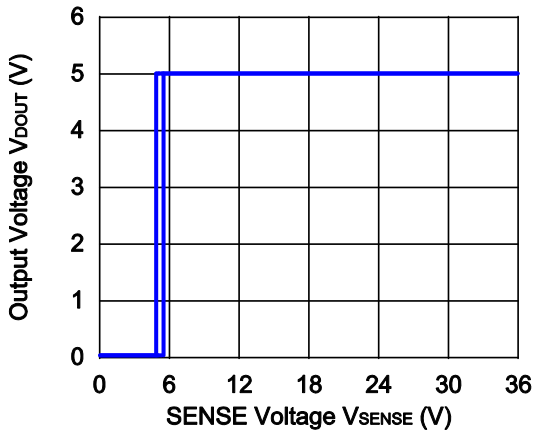


R3151NxxxB (-V_{DET}=10.0V, +V_{DET}=11.0V)

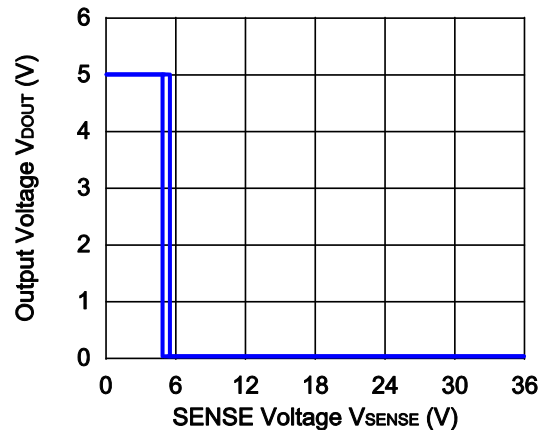


7) Output Voltage vs. SENSE pin Input Voltage (Ta=25°C, D_{OUT} pin is pulled-up to 5V and 100Ω)

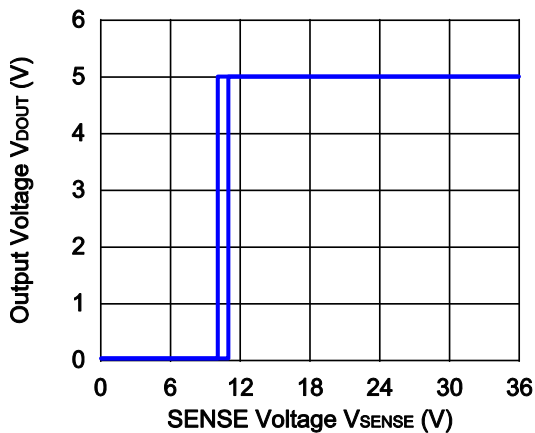
R3151NxxxE (-V_{DET}=5.0V, +V_{DET}=5.3V)



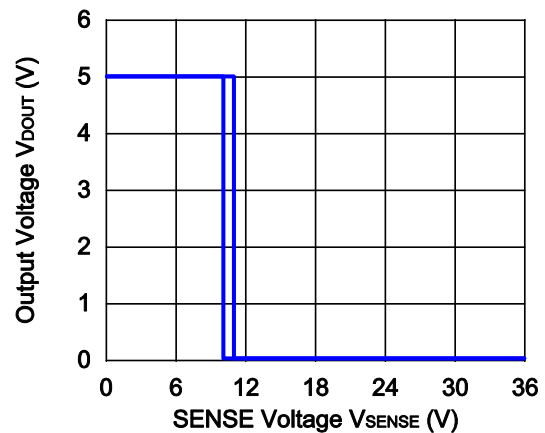
R3151NxxxF (-V_{DET}=5.0V, +V_{DET}=5.3V)



R3151NxxxE (-V_{DET}=10.0V, +V_{DET}=11.0V)



R3151NxxxF (-V_{DET}=10.0V, +V_{DET}=11.0V)

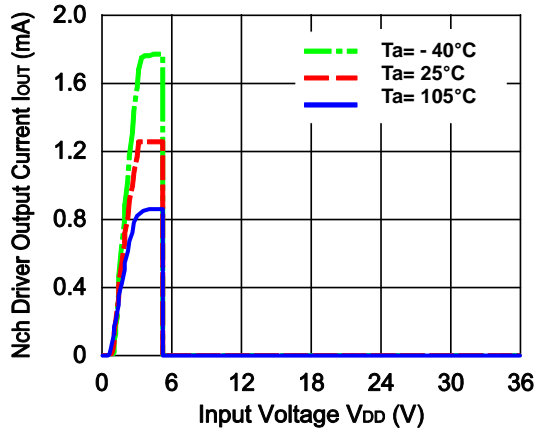


R3151N

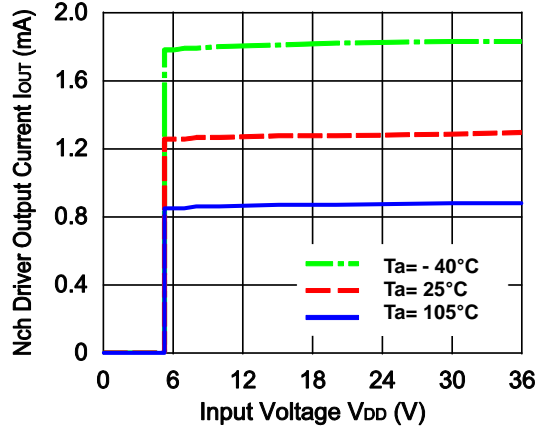
NO.EC-367-141202

8) Nch Driver Output Current vs. Input Voltage

R3151NxxxA (+V_{DET}=5.3V, V_{DOUT}=0.05V)

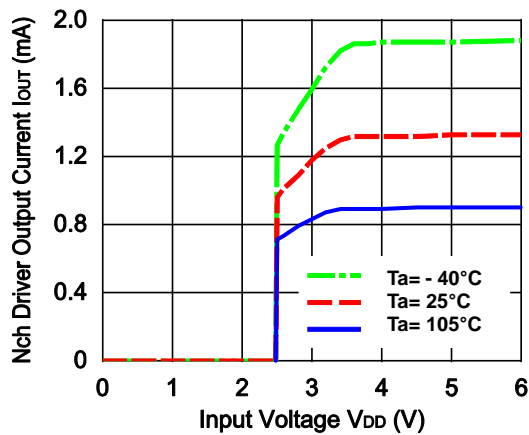


R3151NxxxB (+V_{DET}=5.3V, V_{DOUT}=0.05V)

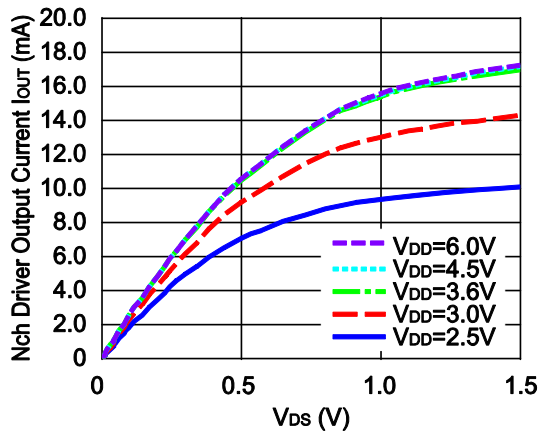


R3151NxxxE (V_{SENSE}=-V_{DET}-1.0V, V_{DOUT}=0.05V)

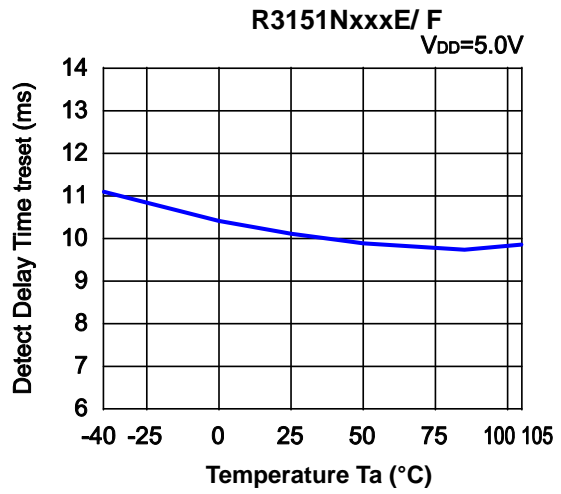
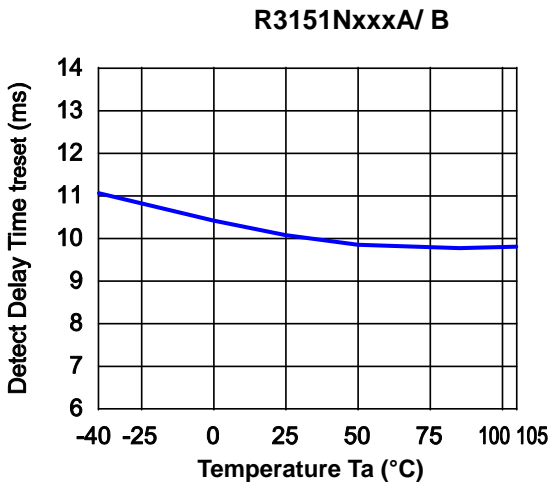
R3151NxxxF (V_{SENSE}=+V_{DET}+1.0V, V_{DOUT}=0.05V)



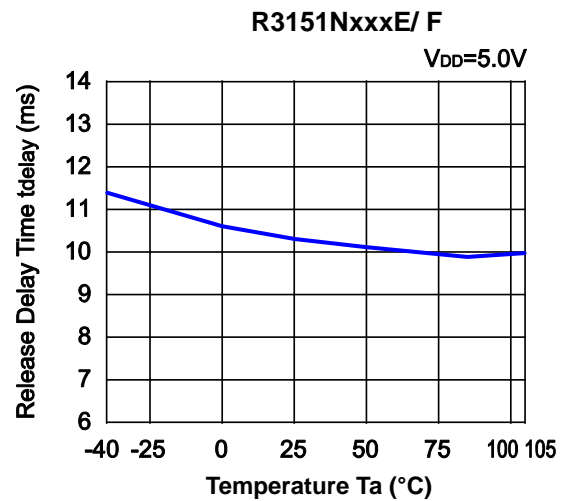
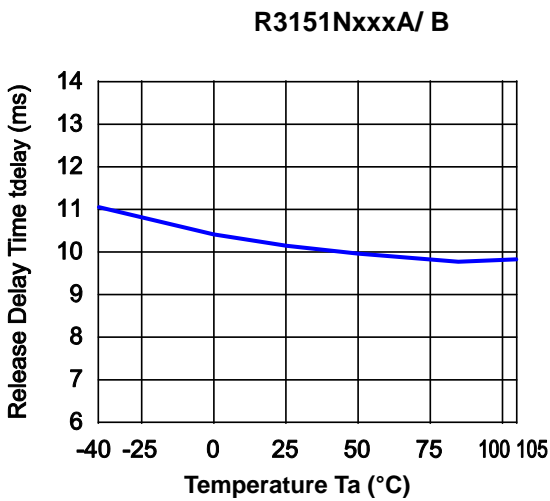
9) Nch Driver Output Current vs. V_{DS}



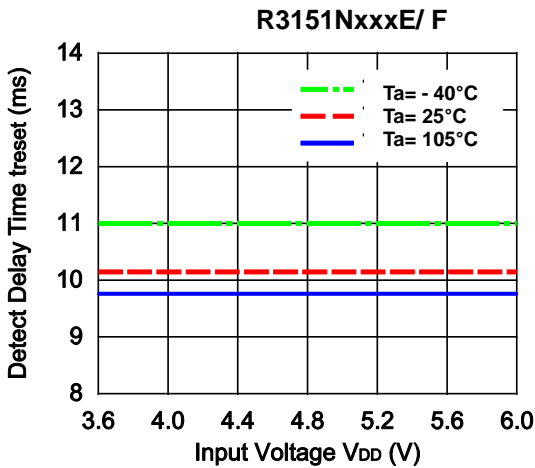
10) Output Reset Time vs. Temperature ($C_R=1.0\mu F$)



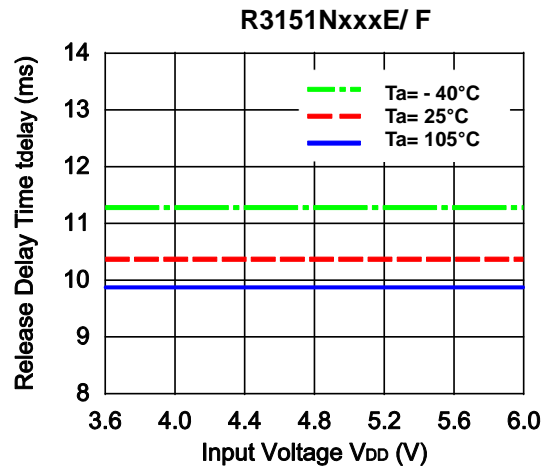
11) Output Delay Time vs. Temperature ($C_D=1.0\mu F$)



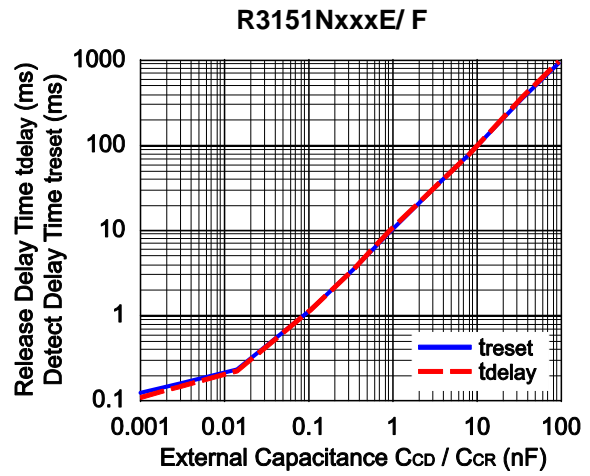
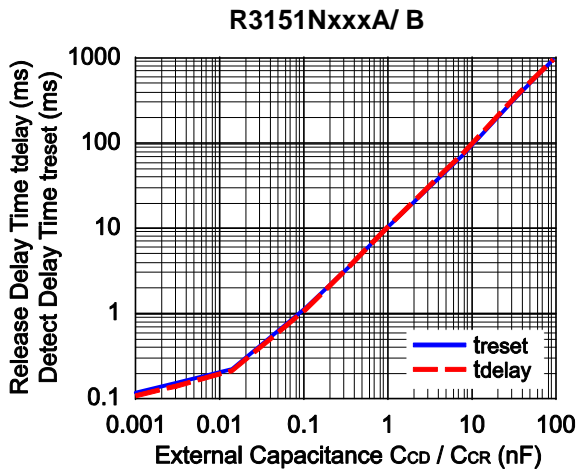
12) Detector Threshold vs. Input Voltage



13) Release Voltage vs. Input Voltage



14) Detector or Release Delay Time vs. C_D pin C_R pin External Capacity (Ta=25°C)





1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.
3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh's or any third party's intellectual property rights or any other rights.
5. The products in this document are designed for automotive applications. However, when using the products for automotive applications, please make sure to contact Ricoh sales representative in advance due to confirming the quality level.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. Anti-radiation design is not implemented in the products described in this document.
8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
9. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact Ricoh sales or our distributor before attempting to use AOI.
11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.



Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment.

Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

RICOH RICOH ELECTRONIC DEVICES CO., LTD.

<http://www.e-devices.ricoh.co.jp/en/>

Sales & Support Offices

RICOH ELECTRONIC DEVICES CO., LTD.

Higashi-Shinagawa Office (International Sales)
3-32-3, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140-8655, Japan
Phone: +81-3-5479-2857 Fax: +81-3-5479-0502

RICOH EUROPE (NETHERLANDS) B.V.

Semiconductor Support Centre
Prof. W.H. Keesomlaan 1, 1183 DJ Amstelveen, The Netherlands
Phone: +31-20-5474-309

RICOH INTERNATIONAL B.V. - German Branch

Semiconductor Sales and Support Centre
Oberrather Strasse 6, 40472 Düsseldorf, Germany
Phone: +49-211-6546-0

RICOH ELECTRONIC DEVICES KOREA CO., LTD.

3F, Haesung Bldg, 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2051-5713

RICOH ELECTRONIC DEVICES SHANGHAI CO., LTD.

Room 403, No.2 Building, No.690 Bilbo Road, Pu Dong New District, Shanghai 201203, People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

RICOH ELECTRONIC DEVICES CO., LTD.

Taipei office
Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623