36 V Input Voltage Detector for Automotive Applications

No. EC-367-210222

OUTLINE

The R3151N is a voltage detector 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 ±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: 1.4 V to 36.0 V (50.0 V)
  R3151NxxxE/F: 3.6 V to 6.0 V (7.0 V)
- Operating Temperature Range ······································ −40°C to 105°C
- Supply Current ·· R3151NxxxA/B: Typ. 3.8 μA
  R3151NxxxE/F: Typ. 3.5 μA
- Detector Threshold Range ·· 5.0 V to 10.0 V (0.1 V step)
- Detector Threshold Accuracy ······································ ±1.5% (25°C)
  ±2.0% (−40°C to 105°C)
- Release Voltage Range[1] ·· 5.3 V to 11.0 V (0.1 V step)
- Release Voltage Accuracy ··· ±1.5% (25°C)
  ±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.

APPLICATIONS

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

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

SELECTION GUIDE

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

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R3151Nxxx∗-TR-#E	SOT-23-6	3,000 pcs	Yes	Yes

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 5.0 V and 10.0 V in 0.1 V step.
$+V_{SET}$ can be designated between 5.3 V and 11.0 V in 0.1 V step.

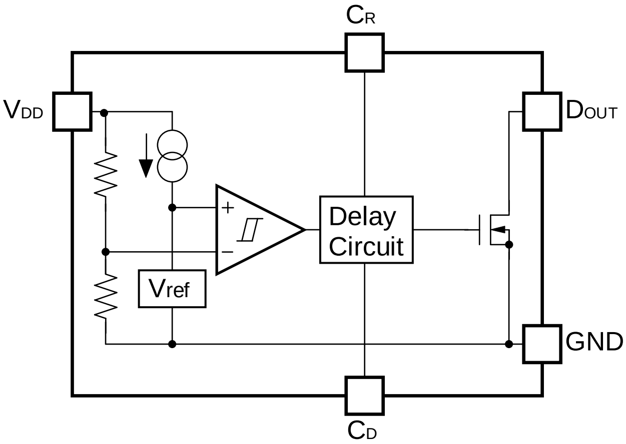
∗: Select an output type from below.
A: V_{DD} Voltage Detection Type “L” Output
B: V_{DD} Voltage Detection Type “H” Output
E: SENSE Voltage Detection Type “L” Output
F: SENSE Voltage Detection Type “H” Output

#: Quality Class

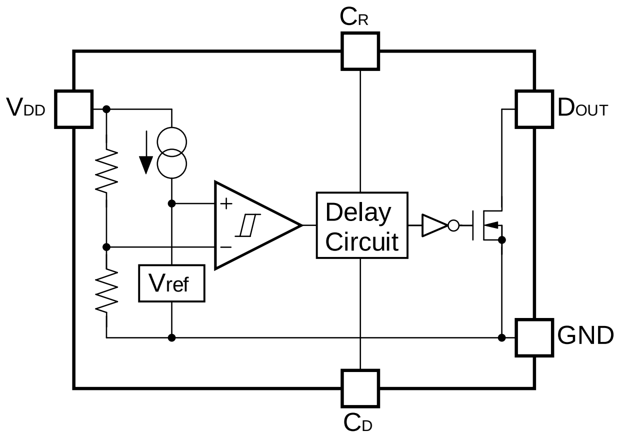
#	Operating Temperature Range	Test Temperature
A	−40°C to 105°C	25°C, High

BLOCK DIAGRAMS

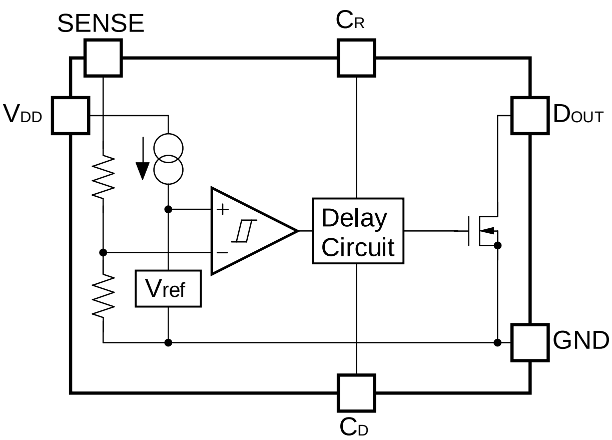
R3151NxxxA



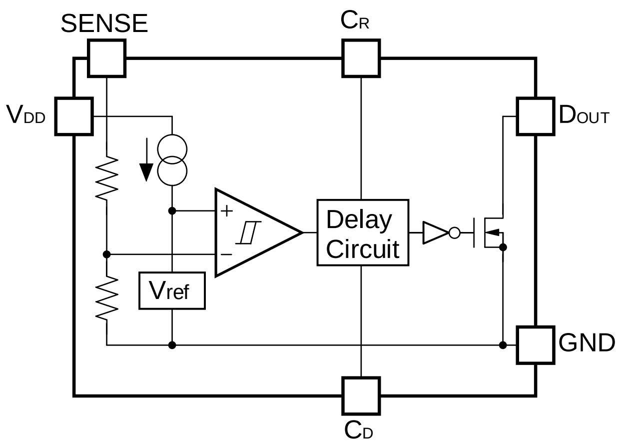
R3151NxxxB



R3151NxxxE

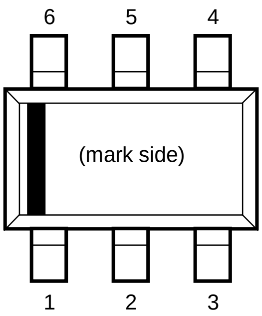


R3151NxxxF



RICOH

PIN DESCRIPTIONS



SOT-23-6 Pin Configuration

SOT-23-6 Pin Descriptions

Pin No.	Symbol	Description
1	C_D	Release Output Delay Time (tdelay) Setting Pin
2	C_R	Detect Output Delay Time (treset) 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

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(1)	SOT-23-6	JEDEC STD. 51-7 Test Land Pattern	830	mW
Tj	Junction Temperature Range			−40 to 150	°C
Tstg	Storage Temperature Range			−55 to 150	°C

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

Recommended Operating Conditions

Symbol	Parameter		Rating	Unit
V_{DD}	Operating Voltage	R3151NxxxA/B	1.4 to 36.0	V
		R3151NxxxE/F	3.6 to 6.0	V
V_{SENSE}	SENSE Input Voltage	R3151NxxxE/F	0 to 36.0	V
Ta	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.

(1) Refer to *POWER DISSIPATION* for detailed information.

ELECTRICAL CHARACTERISTICS

C_D = 1000 pF, C_R =1000 pF, Pull-up resistance = 100 kΩ, Pull-up voltage = 5 V, unless otherwise noted.
The specifications surrounded by ☐ are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

Electrical Characteristics R3151NxxxA/B (Ta = 25°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 V			3.8	6.1	μA
		V_{DD} = +V_{SET} + 1.0 V			3.8	6.4	
-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(2)	C_R = 1000 pF, −40°C ≤ Ta ≤ 105°C		6.5	10	14.0	ms
tdelay	Release Output Delay Time(3)	C_D = 1000 pF, −40°C ≤ Ta ≤ 105°C		6.5	10	14.0	ms
I_{OUT}	Output Current (Nch Driver Output Pin)	R3151NxxxA	V_{DD} = 4.5 V, V_{DS} = 0.05 V	0.5		2.0	mA
		R3151NxxxB	V_{DD} = 13.0 V, V_{DS} = 0.05 V				
R_{CD}	C_D Pin Discharge Tr. On Resistance	V_{DD} = 13 V, V_{CD} = 0.5 V		0.50		2.60	kΩ
R_{CR}	C_R Pin Discharge Tr. On Resistance	V_{DD} = 4.5 V, V_{CR} = 0.5 V		0.50		2.60	kΩ

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj ≈ Ta = 25°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 V" to "-V_{SET} − 1.0 V".
(3) A time that V_{DOUT} requires to reach 2.5 V when changed V_{DD} from "+V_{SET} − 1.0 V" to "+V_{SET} + 1.0 V".

C_D = 1000 pF, C_R =1000 pF, Pull-up resistance = 100 kΩ, Pull-up voltage = 5 V, unless otherwise noted.
The specifications surrounded by [ ] are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

Electrical Characteristics 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} = 5.0 V, V_{SENSE} = $-V_{SET}$ - 0.1 V			3.5	[5.5]	μA
		V_{DD} = 5.0 V, V_{SENSE} = $+V_{SET}$ + 1.0 V			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 = 1000 pF, −40°C ≤ Ta ≤ 105°C		[6.5]	10	[14.0]	ms
tdelay	Release Output Delay Time[4]	C_D = 1000 pF, −40°C ≤ Ta ≤ 105°C		[6.5]	10	[14.0]	ms
I_{OUT}	Output Current (Nch Driver Output Pin)	R3151NxxxE	V_{DD} = 5.0 V, V_{DS} = 0.05 V, V_{SENSE} = $-V_{SET}$ - 0.1 V	[0.5]		[2.0]	mA
		R3151NxxxF	V_{DD} = 5.0 V, V_{DS} = 0.05 V, V_{SENSE} = $+V_{SET}$ + 1.0 V				
R_{CD}	C_D Pin Discharge Tr. On Resistance	V_{DD} = 4.5 V, V_{SENSE} = 13 V, V_{CD} = 0.5 V		[0.50]		[2.60]	kΩ
R_{CR}	C_R Pin Discharge Tr. On Resistance	V_{DD} = 4.5 V, V_{SENSE} = 4.5 V, V_{CR} = 0.5 V		[0.50]		[2.60]	kΩ

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj ≈ Ta = 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 [box] are guaranteed by design engineering at −40°C ≤ Ta ≤105°C.

R3151NxxxA (-AE) (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
R3151N019A	5.910	6.000	6.090	5.880	6.000	6.120	7.388	7.500	7.612	7.350	7.500	7.650
R3151N020A	6.895	7.000	7.105	6.860	7.000	7.140	8.274	8.400	8.526	8.232	8.400	8.568
R3151N021A	5.910	6.000	6.090	5.880	6.000	6.120	6.206	6.300	6.394	6.174	6.300	6.426
R3151N022A	6.600	6.700	6.800	6.566	6.700	6.834	8.373	8.500	8.627	8.330	8.500	8.670
R3151N025A	8.865	9.000	9.135	8.820	9.000	9.180	9.752	9.900	10.048	9.702	9.900	10.098
R3151N026A	9.850	10.000	10.150	9.800	10.000	10.200	10.835	11.000	11.165	10.780	11.000	11.220

The specifications surrounded by ☐ are guaranteed by design engineering at −40°C ≤ Ta ≤105°C.

R3151NxxxB (-AE) (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
R3151N020B	6.895	7.000	7.105	6.860	7.000	7.140	8.274	8.400	8.526	8.232	8.400	8.568
R3151N021B	5.910	6.000	6.090	5.880	6.000	6.120	6.206	6.300	6.394	6.174	6.300	6.426
R3151N025B	8.865	9.000	9.135	8.820	9.000	9.180	9.752	9.900	10.048	9.702	9.900	10.098
R3151N026B	9.850	10.000	10.150	9.800	10.000	10.200	10.835	11.000	11.165	10.780	11.000	11.220

The specifications surrounded by [box] are guaranteed by design engineering at −40°C ≤ Ta ≤105°C.

R3151NxxxE (-AE) (Ta = 25°C)

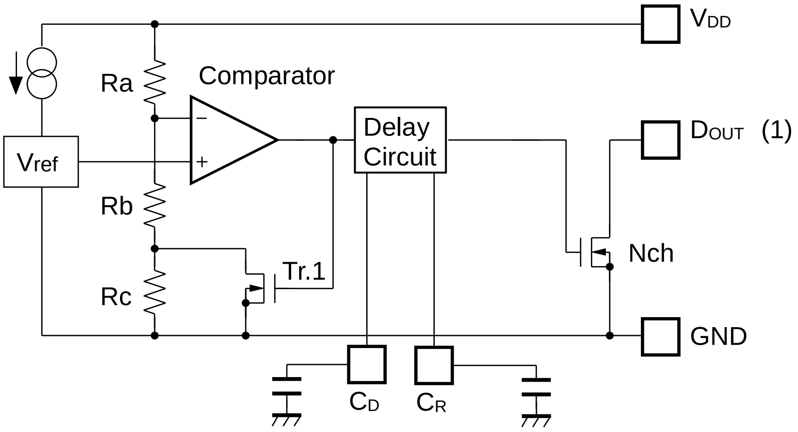
Product Name	$-V_{DET}$ [V] (Ta = 25°C)			$-V_{DET}$ [V] (–40°C ≤ Ta ≤ 105°C)			$+V_{DET}$ [V] (Ta = 25°C)			$+V_{DET}$ [V] (–40°C ≤ Ta ≤ 105°C)		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
R3151N001E	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3151N002E	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
R3151N022E	6.600	6.700	6.800	6.566	6.700	6.834	8.373	8.500	8.627	8.330	8.500	8.670

R3151NxxxF (-AE) (Ta = 25°C)

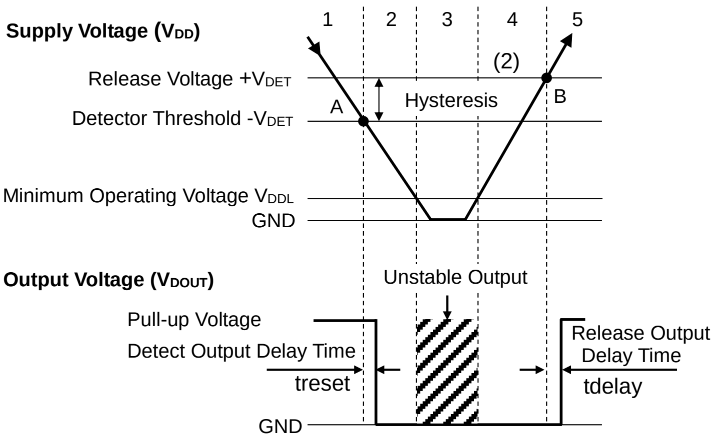
Product Name	$-V_{DET}$ [V] (Ta = 25°C)			$-V_{DET}$ [V] (–40°C ≤ Ta ≤ 105°C)			$+V_{DET}$ [V] (Ta = 25°C)			$+V_{DET}$ [V] (–40°C ≤ Ta ≤ 105°C)		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
R3151N001F	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3151N002F	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

THEORY OF OPERATION

R3151NxxxA (V_{DD} VOLTAGE DETECTION TYPE)



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

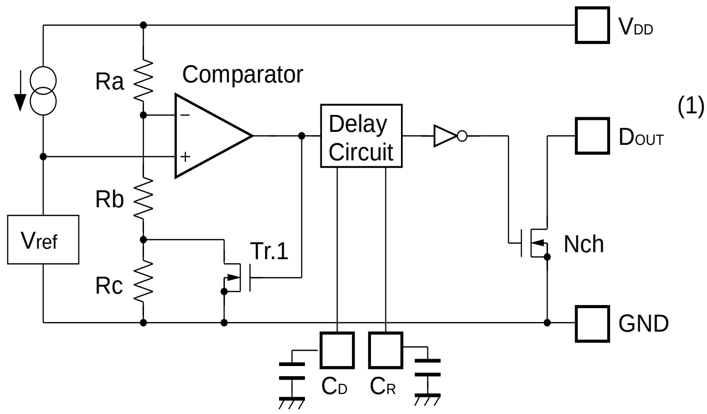
II $\frac{Rb}{Ra+Rb} \times V_{DD}$

Operation Diagram

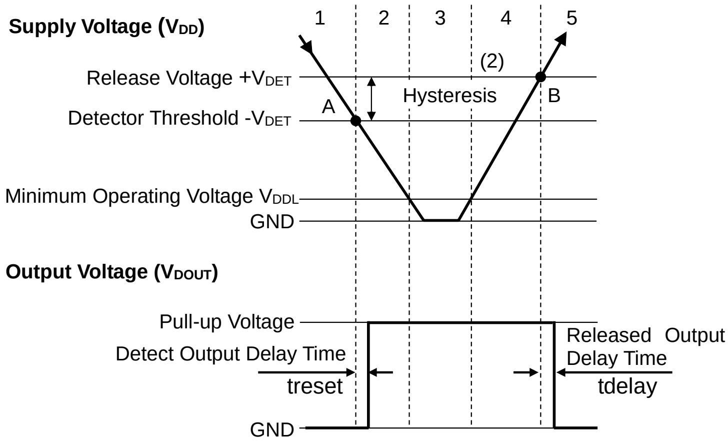
1. The output voltage is equalized to the pull-up voltage.
2. The V_{DD} voltage drops to the detector threshold (A point) which means Vref ≥ V_{DD} x (Rb + Rc) / (Ra + Rb + Rc), and the comparator output shifts from “L” to “H” voltage, and the output pin voltage shifts from the pull-up voltage to “L” voltage.
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 Vref ≤ V_{DD} x 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.

(1) D_{OUT} pin should be pulled-up to an external voltage level.
(2) The gap between the release voltage and the detector threshold is hysteresis.

R3151NxxxB (V_{DD} VOLTAGE DETECTION TYPE)



Block Diagram with External Capacitors



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 $\frac{Rb+Rc}{Ra+Rb+Rc} x V_{DD}$

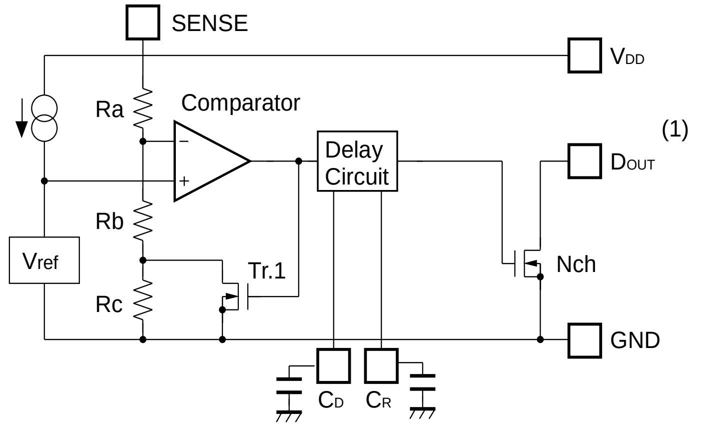
II $\frac{Rb}{Ra+Rb} x V_{DD}$

Operation Diagram

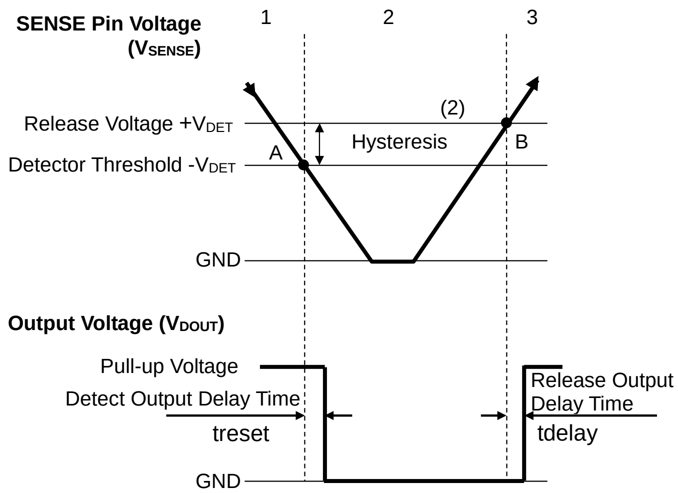
1. The output pin voltage becomes “L” voltage.
2. The V_{DD} voltage drops to the detector threshold (A point) which means $Vref \geq V_{DD} \times (Rb + Rc) / (Ra + Rb + Rc)$, and the comparator output shifts from “L” to “H” voltage and the output voltage is equalized to the pull-up voltage.
3. If the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

(1) D_{OUT} pin should be pulled-up to an external voltage level.
(2) The gap between the release voltage and the detector threshold is hysteresis.

R3151NxxxE (SENSE VOLTAGE DETECTION TYPE)



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 $\frac{Rb+Rc}{Ra+Rb+Rc} x V_{SENSE}$

II $\frac{Rb}{Ra+Rb} x V_{SENSE}$

Operation Diagram

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 $Vref \geq V_{DD}$ x (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 $Vref \leq V_{SENSE}$ x 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.

(1) D_{OUT} pin should be pulled-up to an external voltage level.
(2) The gap between the release voltage and the detector threshold is hysteresis.

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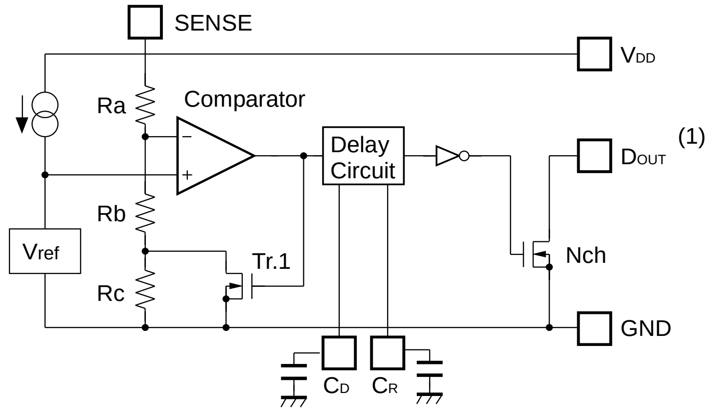
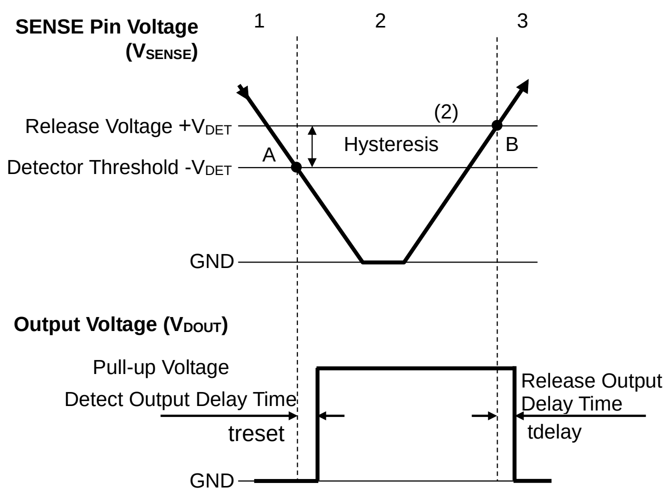
R3151NxxxF (SENSE VOLTAGE DETECTION TYPE)



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

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

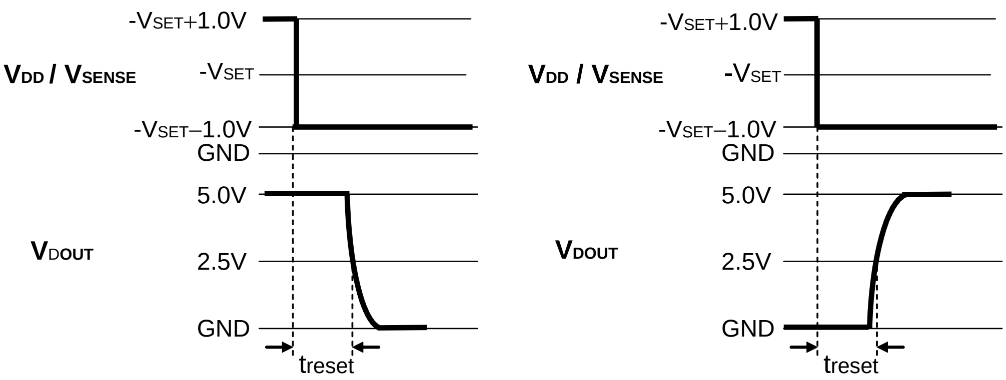
Operation Diagram

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 $Vref \geq V_{SENSE}$ x (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 V_{DD} 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 $Vref \leq V_{SENSE}$ x Rb / (Ra + Rb), and the comparator output shift from "H" to "L" voltage and the output voltage becomes "L" voltage.

(1) D_{OUT} pin should be pulled-up to an external voltage level.
(2) The gap between the release voltage and the detector threshold is hysteresis.

DETECT OUTPUT DELAY TIME (treset)

Detect Output Delay Time (treset) is defined as follows:
treset starts after the output pin (D_{OUT}) is pulled up to 5 V with a 100 kΩ resistor and the V_{DD}/V_{SENSE} is shifted from "$-V_{SET}$ + 1.0 V" to "$-V_{SET}$ - 1.0 V". treset ends when the output voltage reaches to 2.5 V.



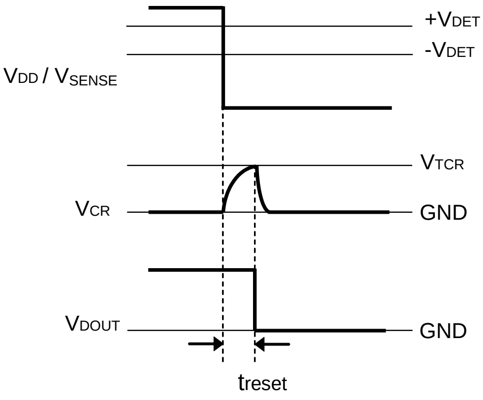
R3151NxxxA/E **R3151NxxxB/F**

treset is calculated by the following equation:

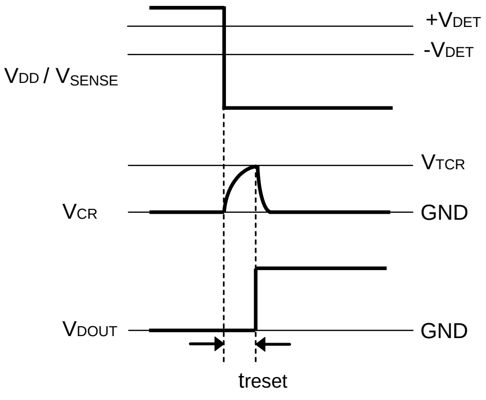
$$\text{treset (s)} = C_R \times 10^7$$

With the R3151NxxxA/B, if the V_{DD} voltage after detection is 3.6 V 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

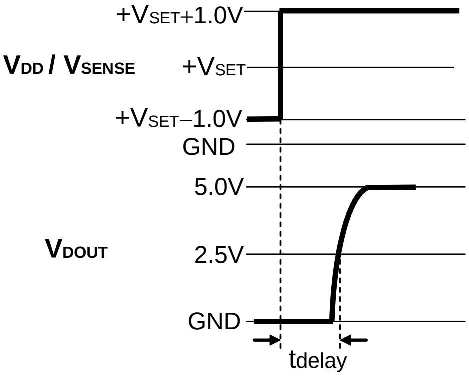
If the voltage lower than the detector threshold is applied to V_{DD}/SENSE pin while the voltage higher than the release voltage is applied to the V_{DD}/SENSE pin, the external capacitor starts to charge electricity and the C_R pin voltage starts to increase.

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.

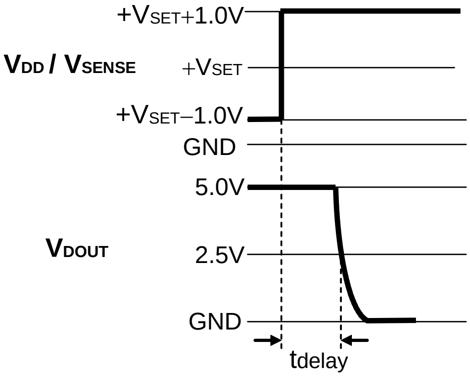
In addition, if the output voltage shift from the release output to the detection output, the external capacitor starts to discharge electricity and the C_R pin voltage starts decrease.

RELEASE OUTPUT DELAY TIME (tdelay)

Release Output Delay Time (tdelay) is defined as follows:
tdelay starts after the output pin (D_{OUT}) is pulled up to 5 V with a 100 kΩ resistor, and the V_{DD}/V_{SENSE} is shifted from "+V_{SET} - 1.0 V" to "+V_{SET} + 1.0 V". It ends when the output voltage reaches to 2.5 V.



R3151NxxxA/E



R3151NxxxB/F

tdelay is calculated by the following equation:

$$t_{delay}\ (s) = C_D \times 10^7$$

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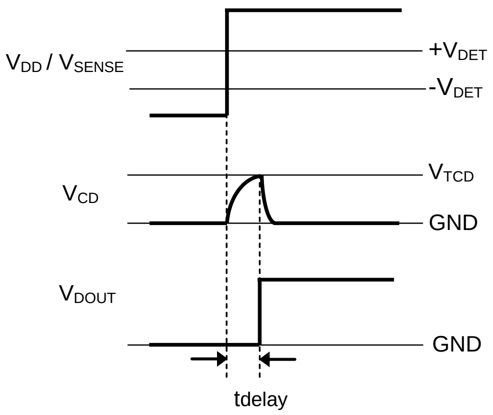
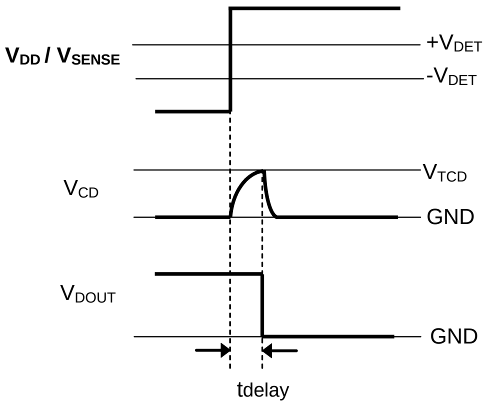
RELEASE OUTPUT DELAY



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 10 V/ms or less.
At shutdown, the SENSE 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 SENSE (R3151NxxxE/F) pins. The rejection of transients depends on both the pulse width and the overdrive voltage, as shown in Figure 1. 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.

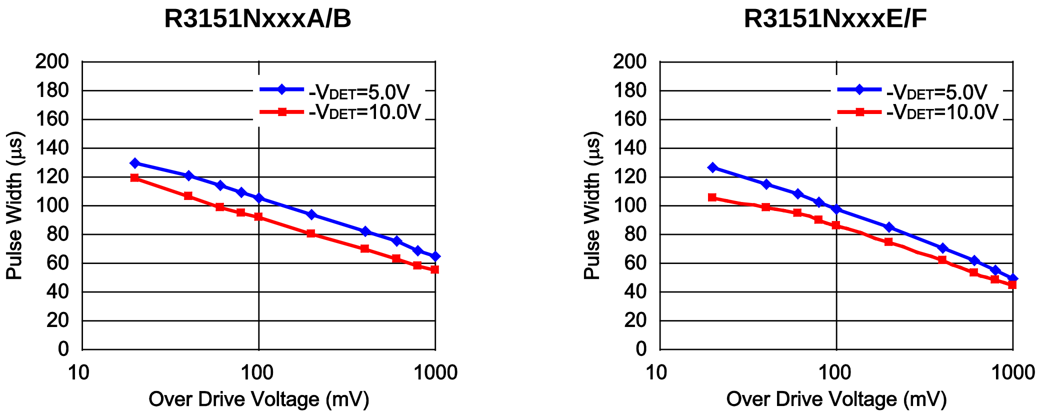


Figure 1. Minimum Pulse Width at V_{DD}/SENSE vs. Overdrive Voltage

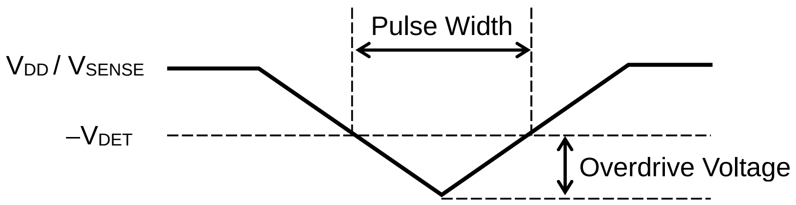


Figure 2. V_{DD}/V_{SENSE} Input Waveform

RELEASE OPERATION VS. GLITCH INPUT VOLTAGE

The R3151N has built-in rejection of fast transients on the V_{DD} (R3151NxxxA/B) or SENSE (R3151NxxxE/F) pins. The rejection of transients depends on both the pulse width and the overdrive voltage, as shown in Figure 3. 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 4.

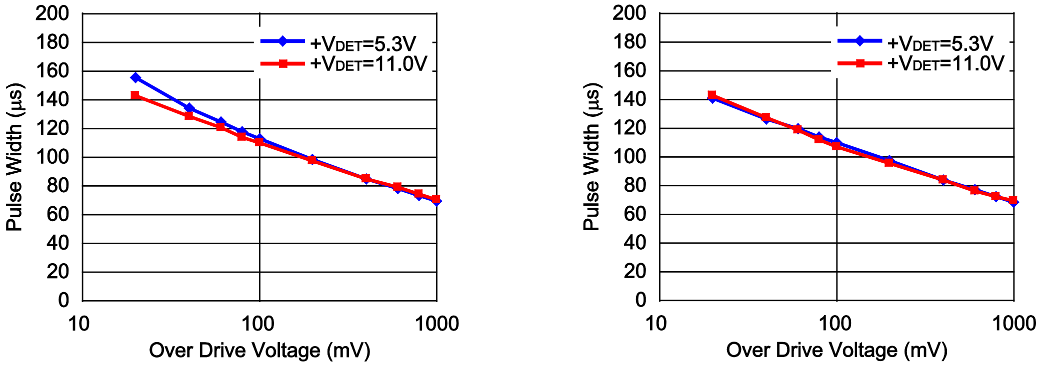


Figure 3. Minimum Pulse Width at V_{DD}/SENSE vs. Overdrive Voltage

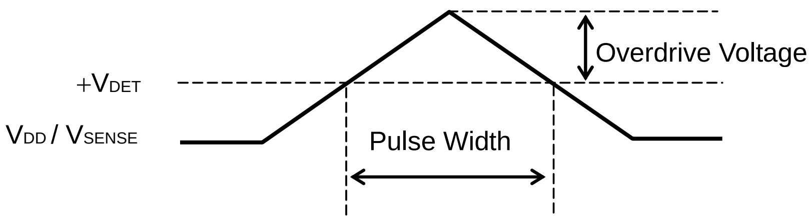
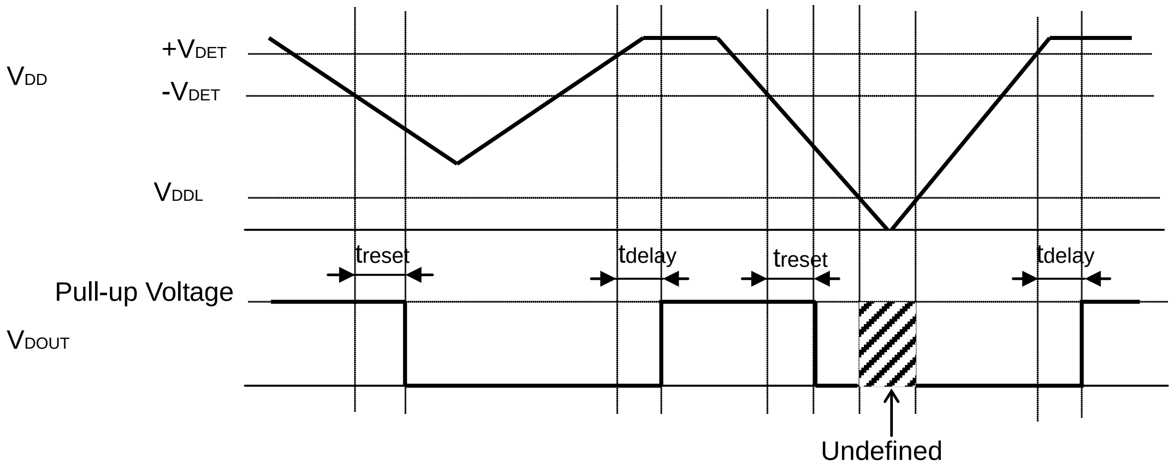


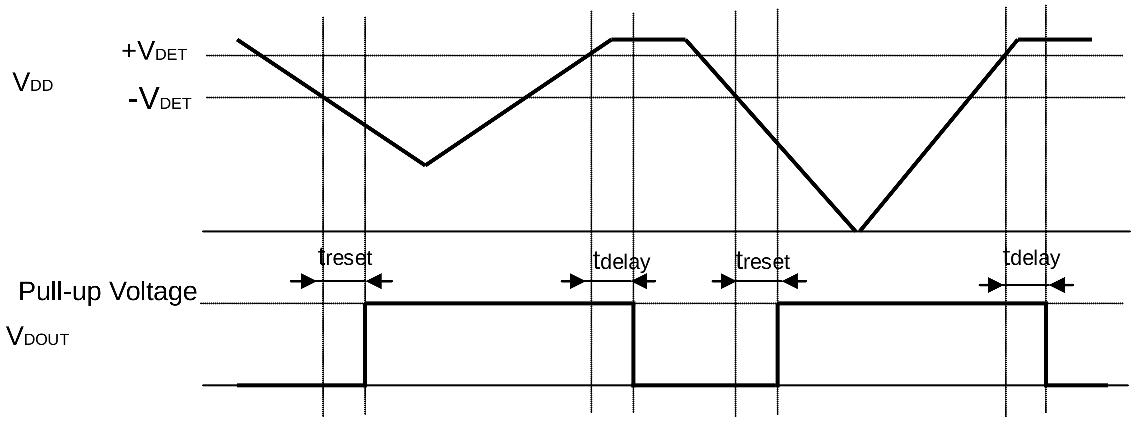
Figure 4. V_{DD}/V_{SENSE} Input Waveform

TIMING CHART

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

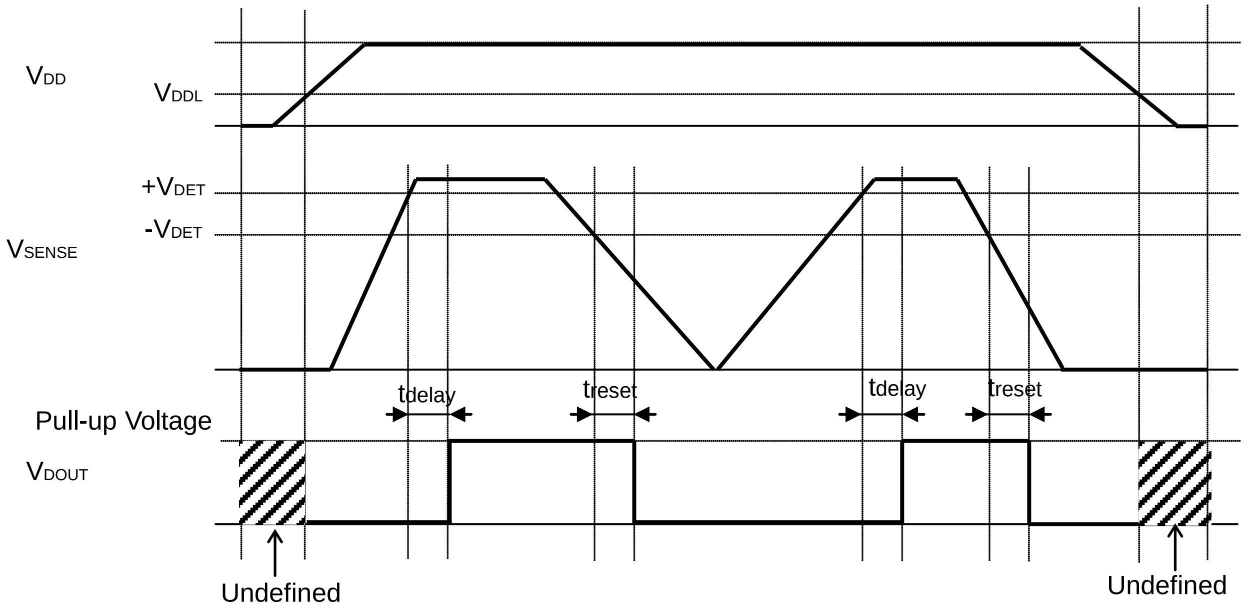


R3151NxxxA

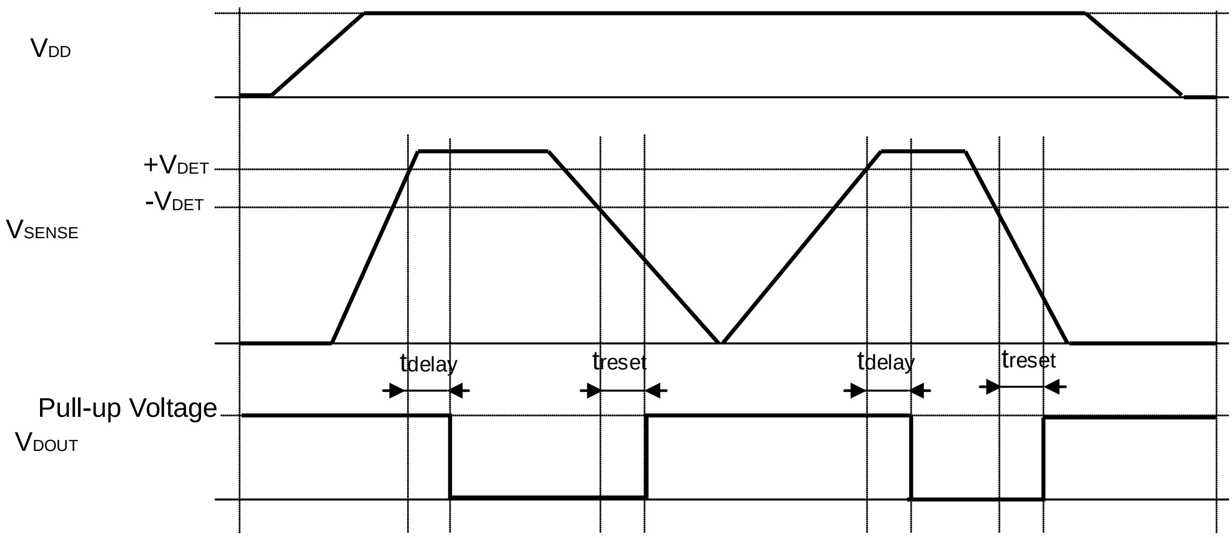


R3151NxxxB

R3151NxxxE/F (SENSE Voltage Detection Type)



R3151NxxxE



R3151NxxxF

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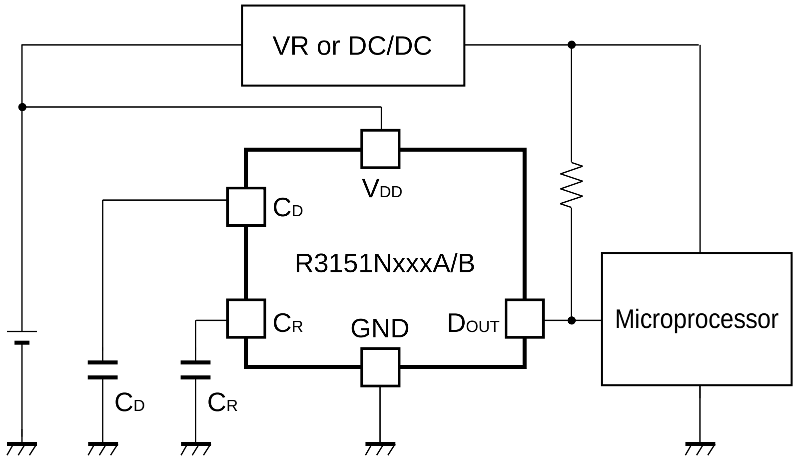
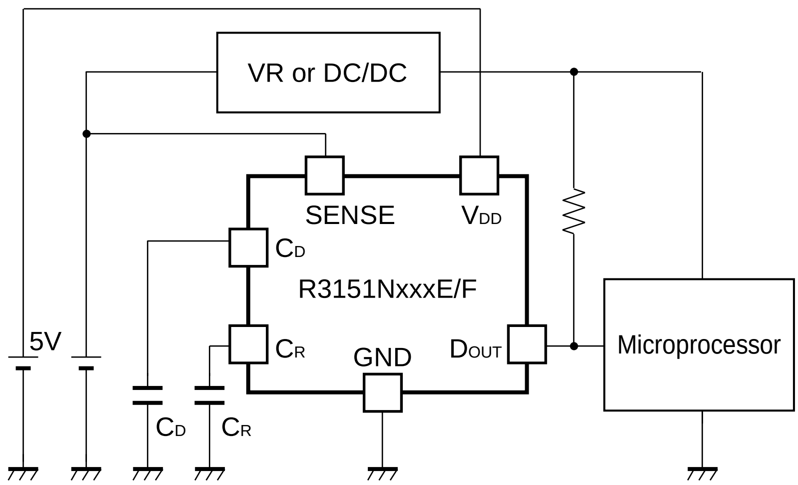
APPLICATION INFORMATION

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 V_{DD} is gone up at mildly in the vicinity of the released voltage, repeating the above operation may result in the occurrence of output.

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

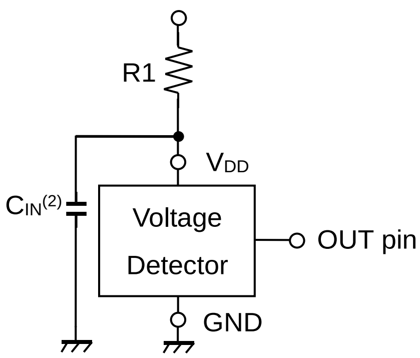


Figure A

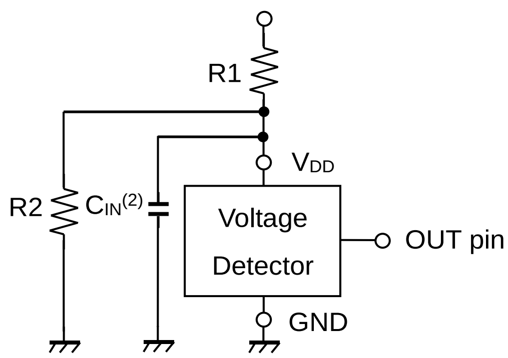


Figure B

[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.

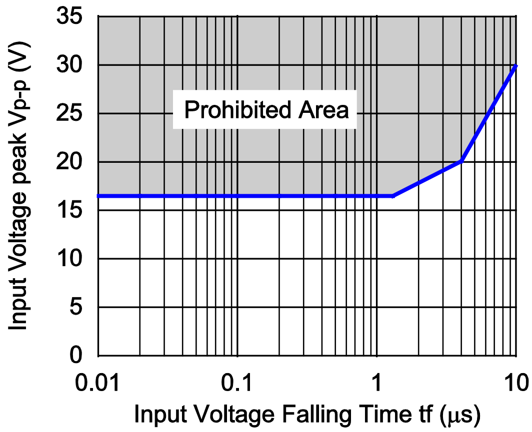


Figure C. Prohibited Area

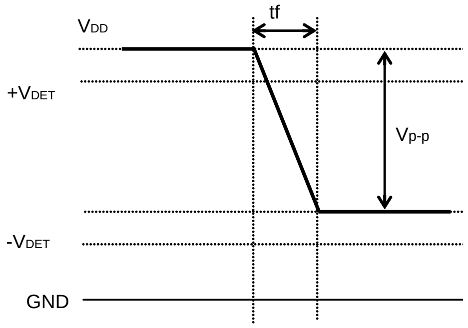


Figure D

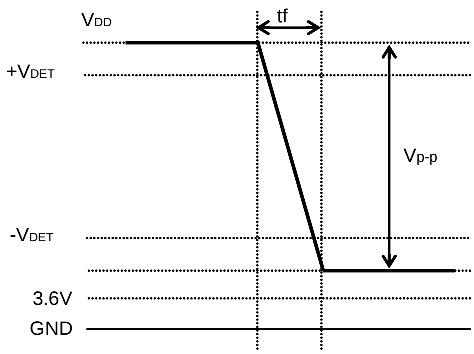


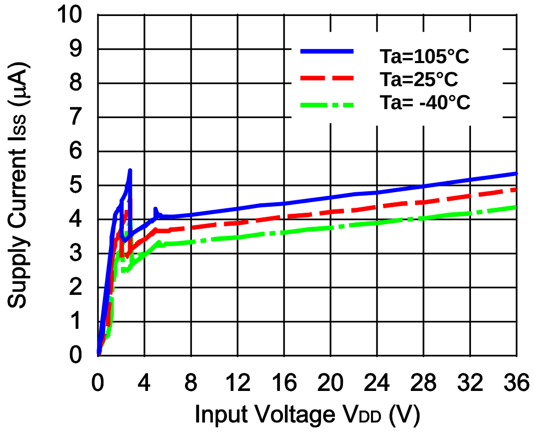
Figure E

TYPICAL CHARACTERISTICS

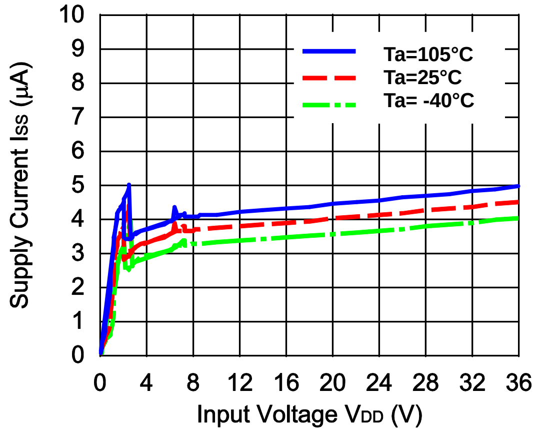
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Supply Current vs. Input Voltage

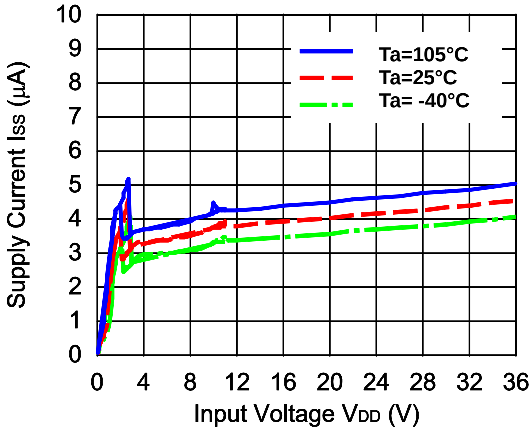
R3151NxxxA/B (-V_{DET} = 5.0 V, +V_{DET} = 5.3 V)



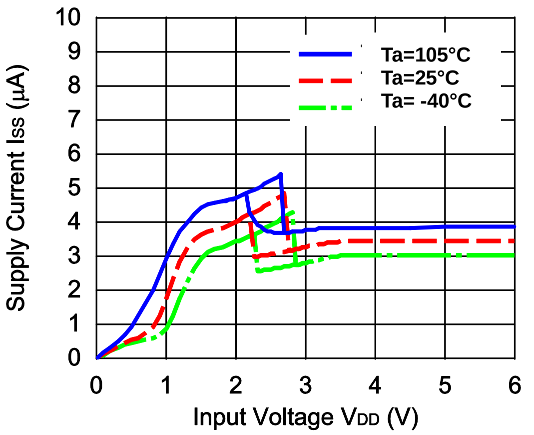
R3151NxxxA/B (-V_{DET} = 6.4 V, +V_{DET} = 7.3 V)



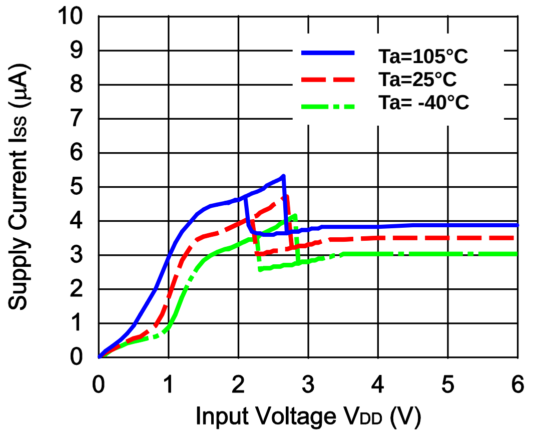
R3151NxxxA/B (-V_{DET} = 10.0 V, +V_{DET} = 11.0 V)



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

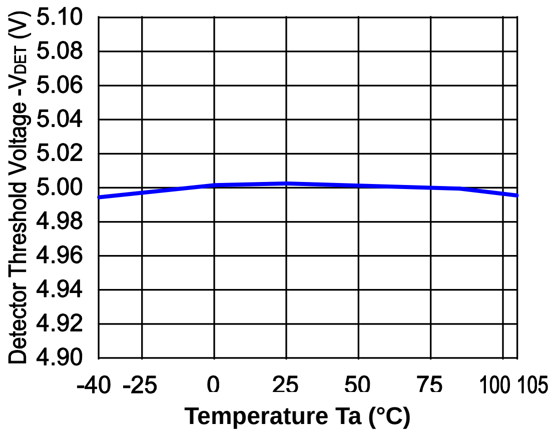


R3151NxxxE/F (V_{SENSE} = +V_{DET} + 0.1 V)

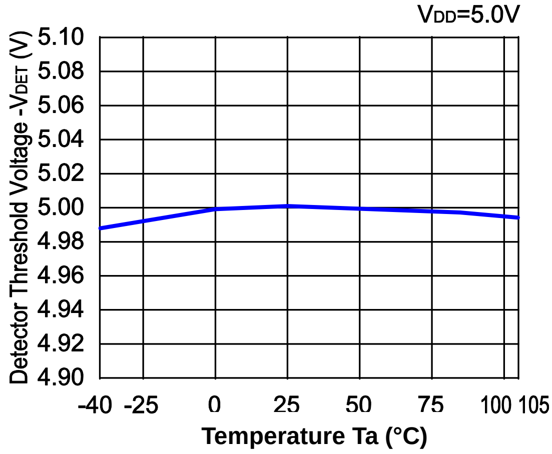


2) Detector Threshold vs. Temperature

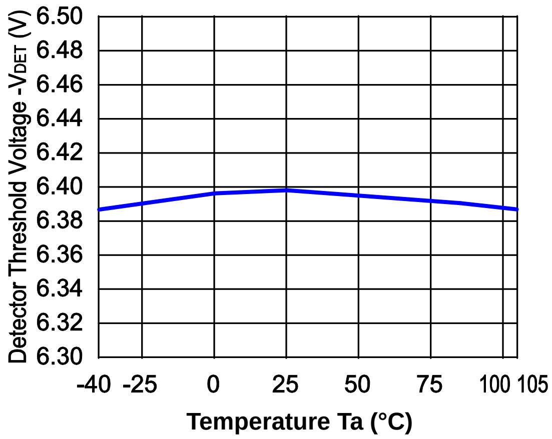
R3151NxxxA/B ($-V_{DET}$ = 5.0 V)



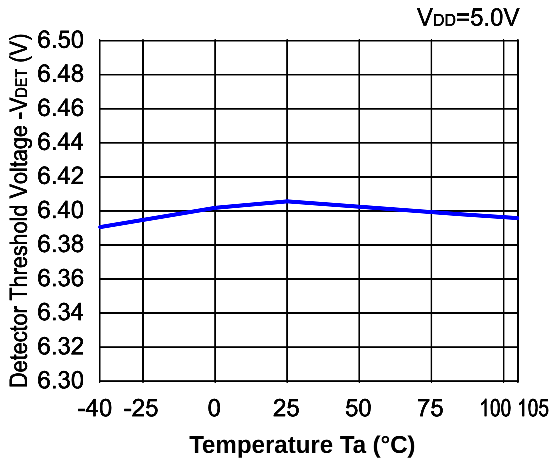
R3151NxxxE/F ($-V_{DET}$ = 5.0 V)



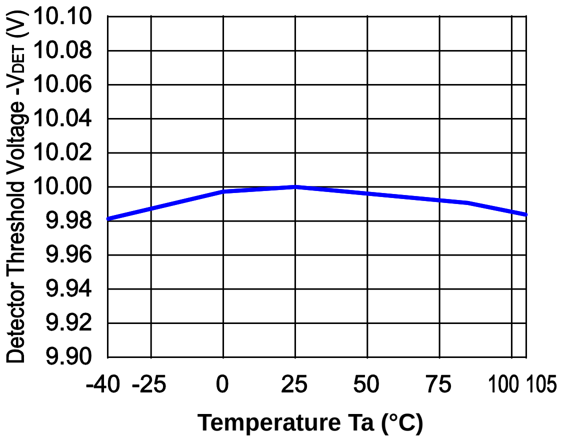
R3151NxxxA/B ($-V_{DET}$ = 6.4 V)



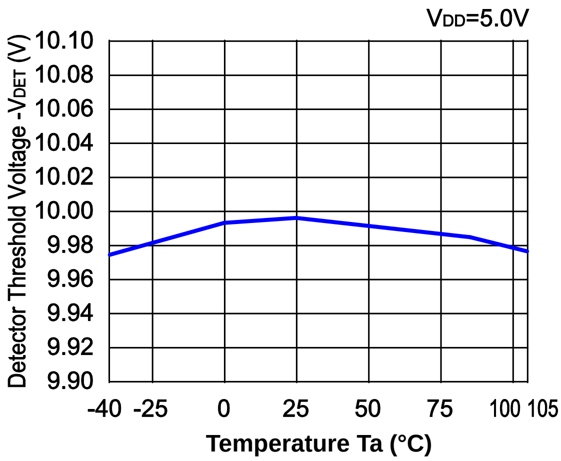
R3151NxxxE/F ($-V_{DET}$ = 6.4 V)



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

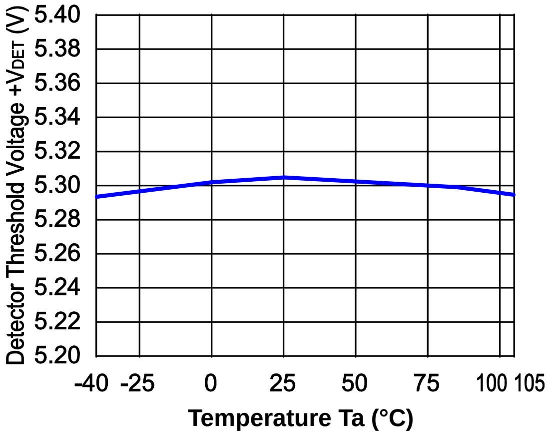


R3151NxxxE/F ($-V_{DET}$ = 10.0 V)

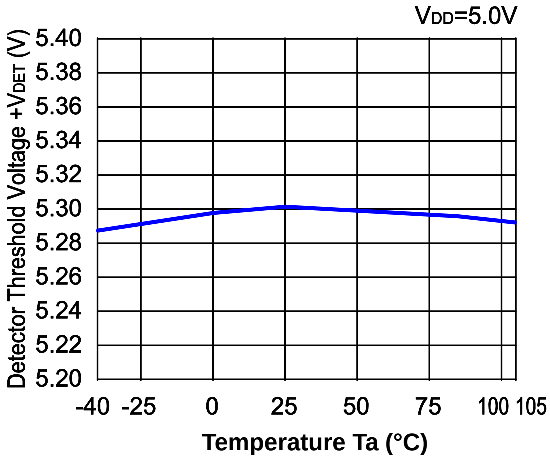


3) Release Voltage vs. Temperature

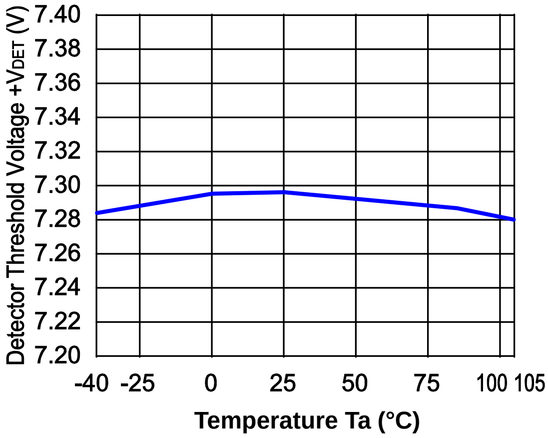
R3151NxxxA/B (+V_{DET} = 5.3 V)



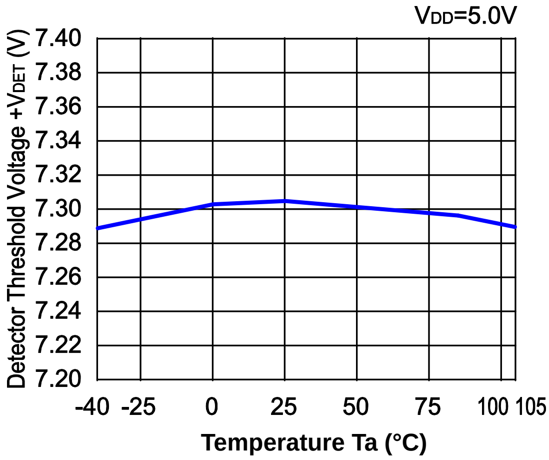
R3151NxxxE/F (+V_{DET} = 5.3 V)



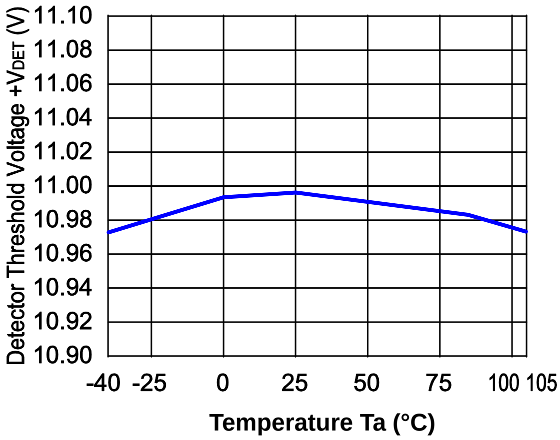
R3151NxxxA/B (+V_{DET} = 7.3 V)



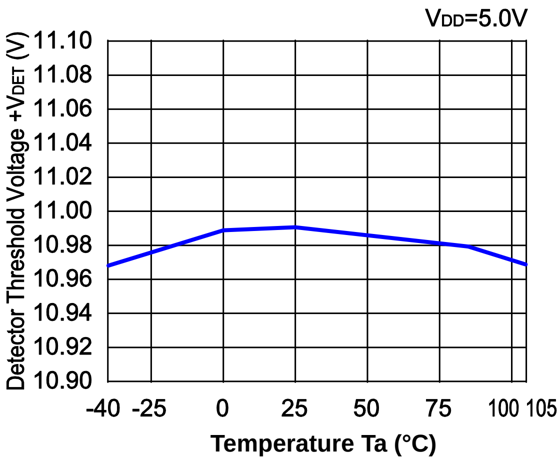
R3151NxxxE/F (+V_{DET} = 7.3 V)



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



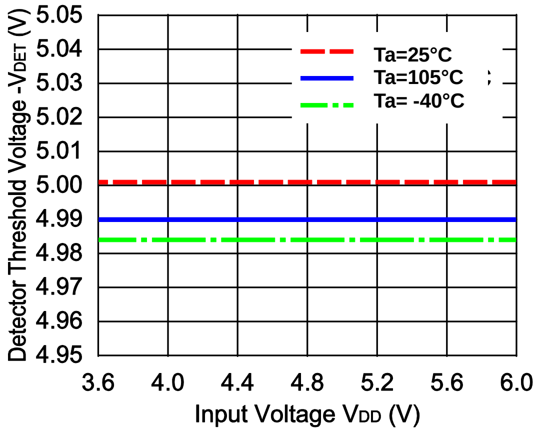
R3151NxxxE/F (+V_{DET} = 11.0 V)



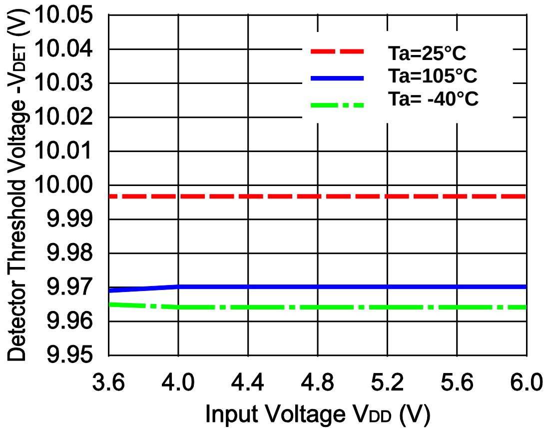
RICOH

4) Detector Threshold vs. Input Voltage

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

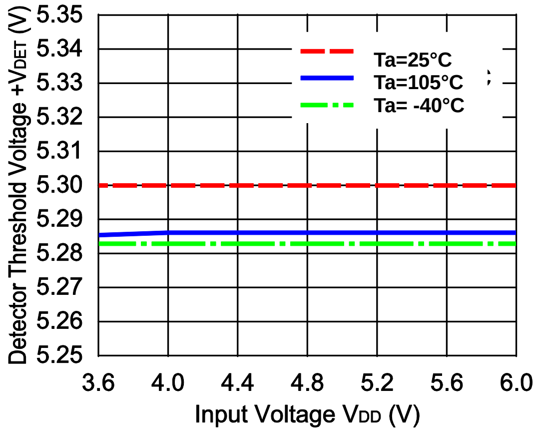


R3151NxxxE/F ($-V_{DET}$ = 10.0 V)

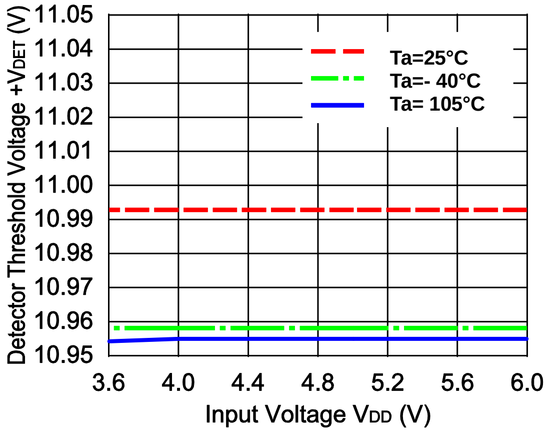


5) Release Voltage vs. Input Voltage

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

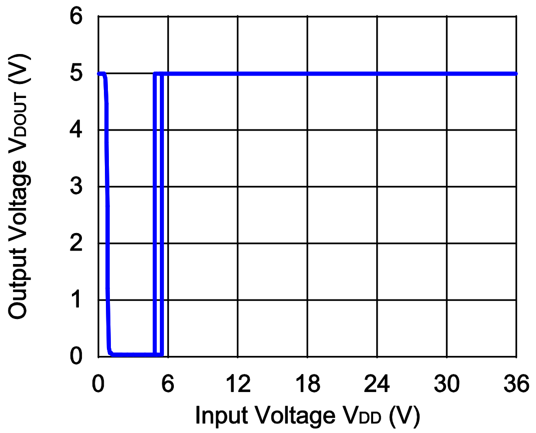


R3151NxxxE/F ($+V_{DET}$ = 11.0 V)

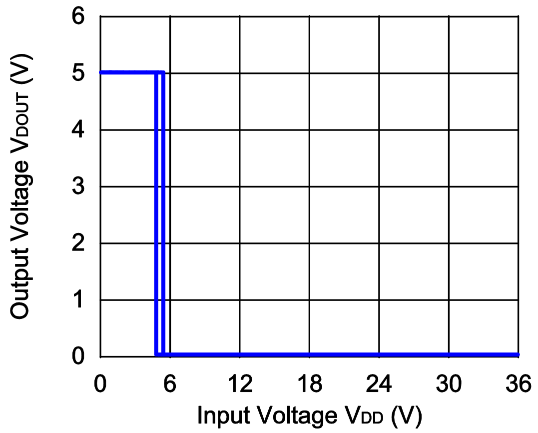


6) Output Voltage vs. Input Voltage (Ta = 25°C, D_{OUT} pin is pulled-up to 5 V and 100 kΩ)

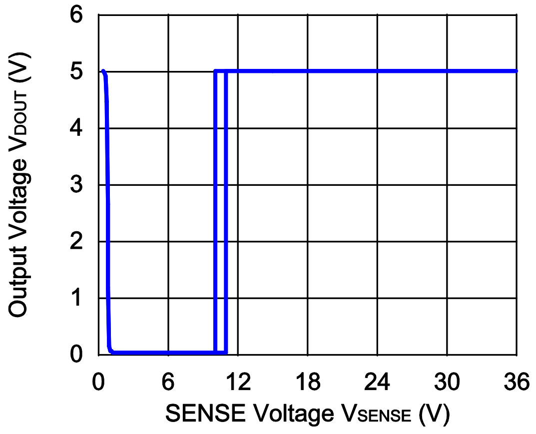
R3151NxxxA ($-V_{DET}$ = 5.0 V, $+V_{DET}$ = 5.3 V)



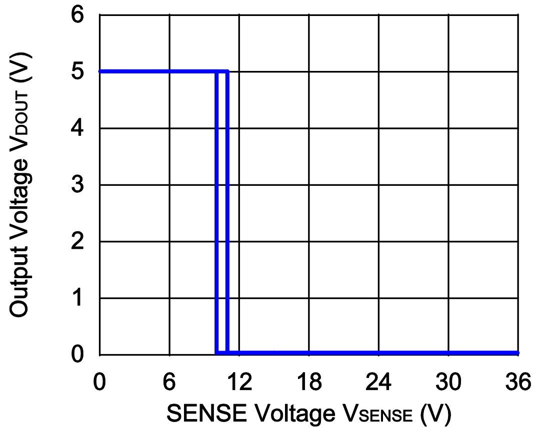
R3151NxxxB ($-V_{DET}$ = 5.0 V, $+V_{DET}$ = 5.3 V)



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

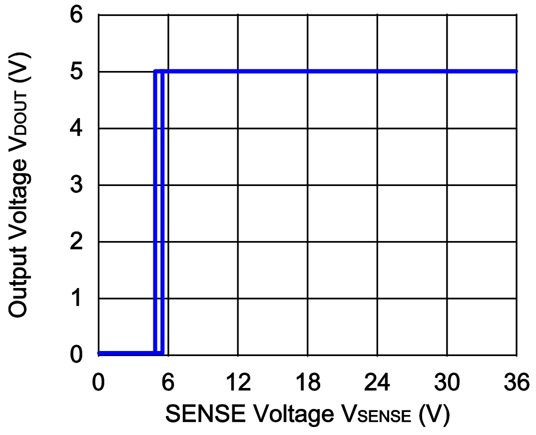


R3151NxxxB ($-V_{DET}$ = 10.0 V, $+V_{DET}$ = 11.0 V)

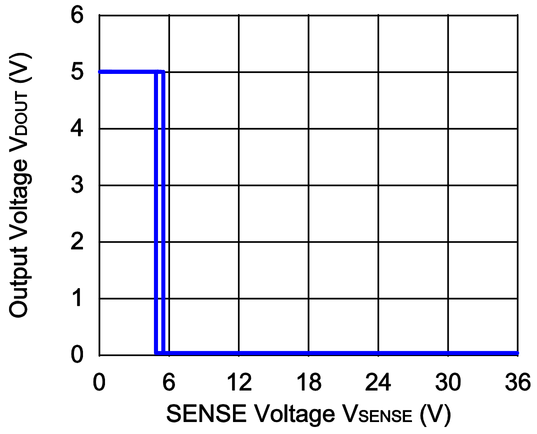


7) Output Voltage vs. SENSE pin Input Voltage (Ta = 25°C, DOUT pin is pulled-up to 5 V and 100 kΩ)

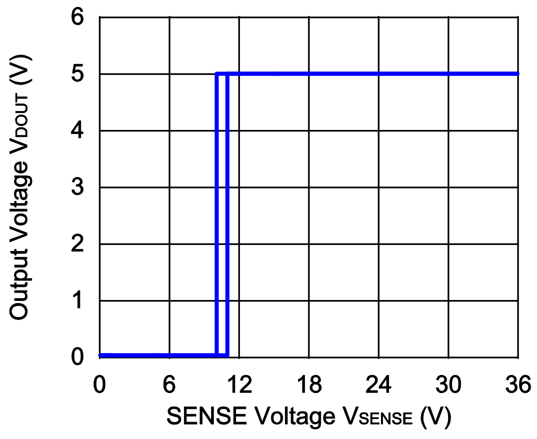
R3151NxxxE ($-V_{DET}$ = 5.0 V, $+V_{DET}$ = 5.3 V)



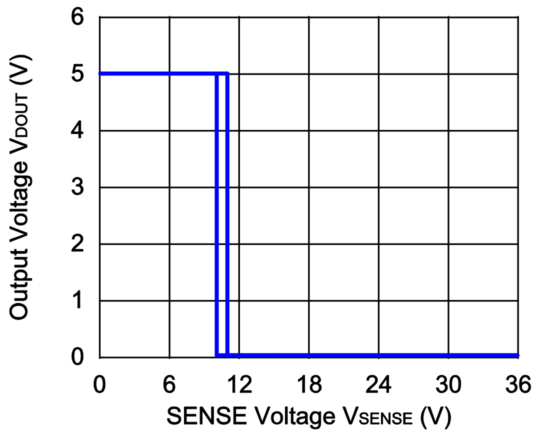
R3151NxxxF ($-V_{DET}$ = 5.0 V, $+V_{DET}$ = 5.3 V)



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

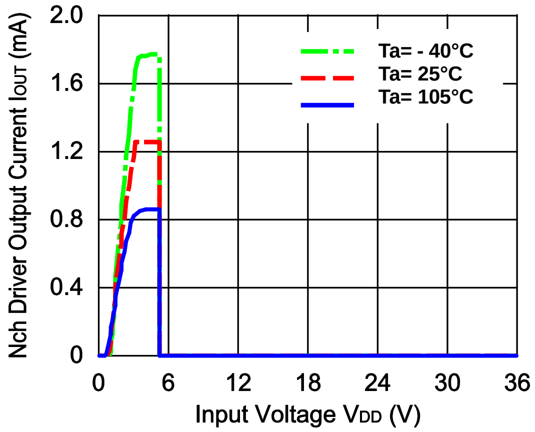


R3151NxxxF ($-V_{DET}$ = 10.0 V, $+V_{DET}$ = 11.0 V)

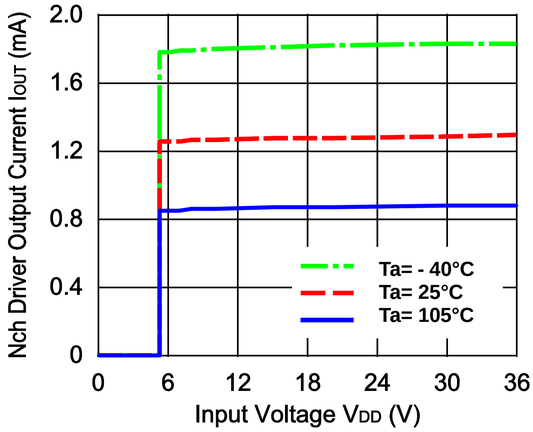


8) Nch Driver Output Current vs. Input Voltage

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

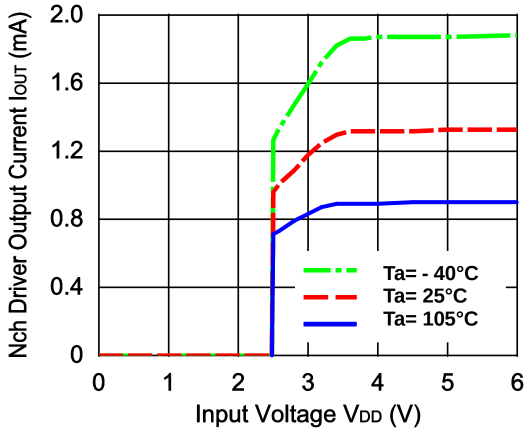


R3151NxxxB (+V_{DET} = 5.3 V, V_{DOUT} = 0.05 V)

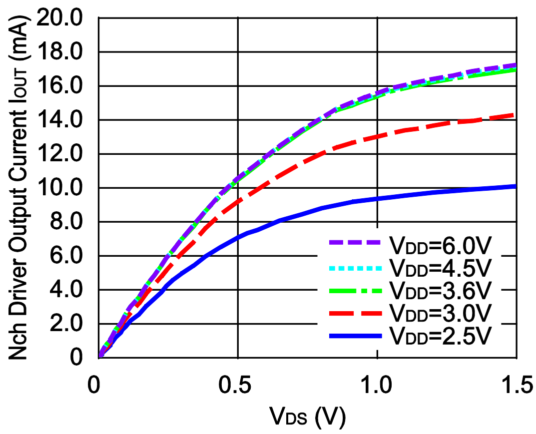


R3151NxxxE (\V_{SENSE} = -V_{DET} - 1.0 V, V_{DOUT} = 0.05 V)

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

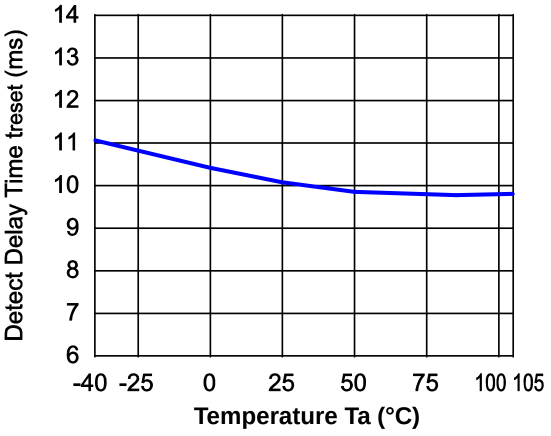


9) Nch Driver Output Current vs. V_{DS}

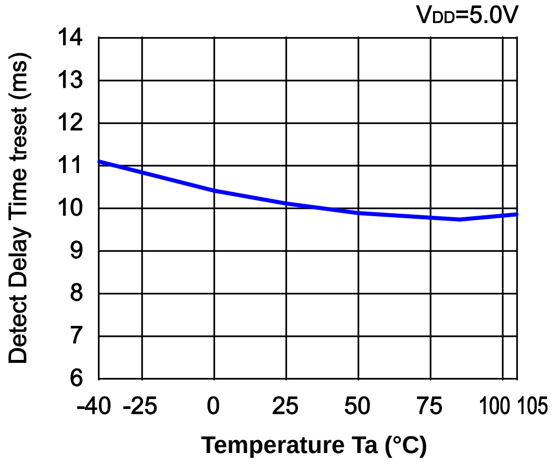


10) Output Reset Time vs. Temperature (C_R = 1.0 μF)

R3151NxxxA/B

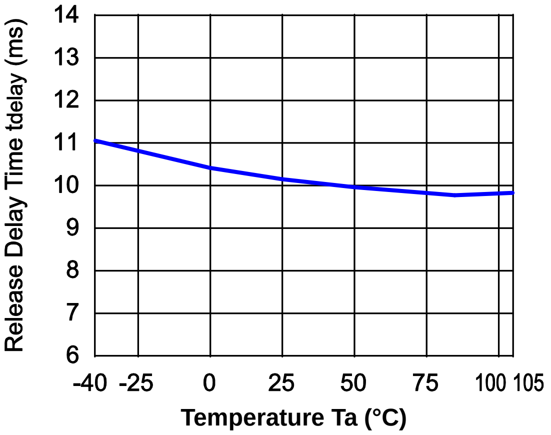


R3151NxxxE/F

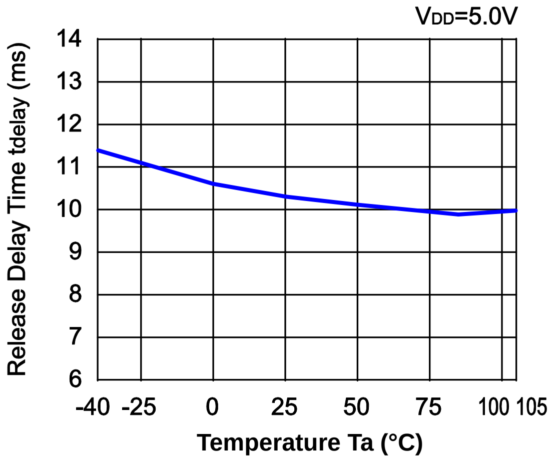


11) Output Delay Time vs. Temperature (C_D = 1.0 μF)

R3151NxxxA/B

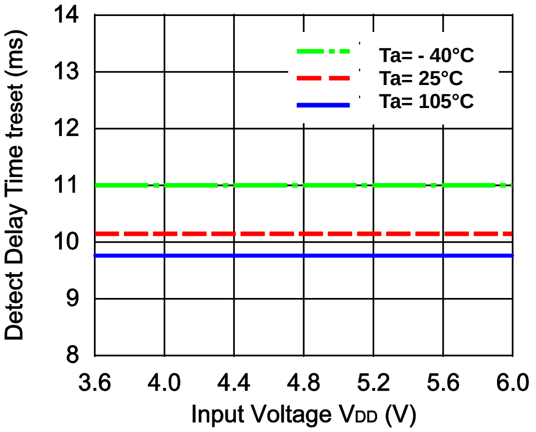


R3151NxxxE/F



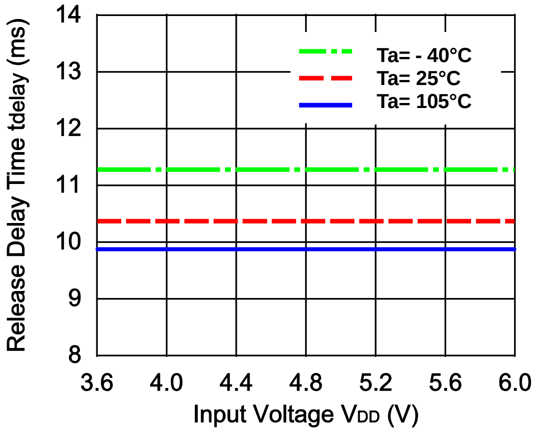
12) Detector Threshold vs. Input Voltage

R3151NxxxE/F



13) Release Voltage vs. Input Voltage

R3151NxxxE/F



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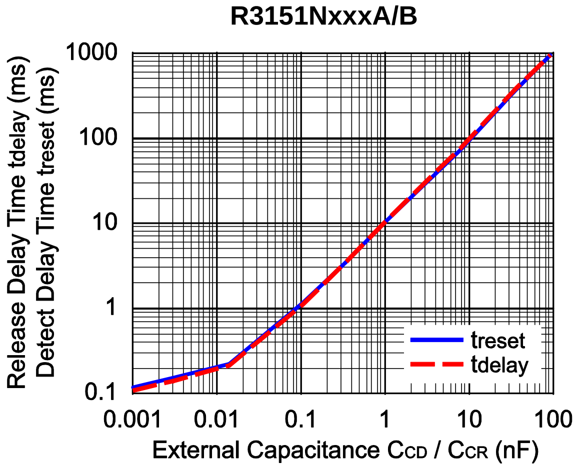
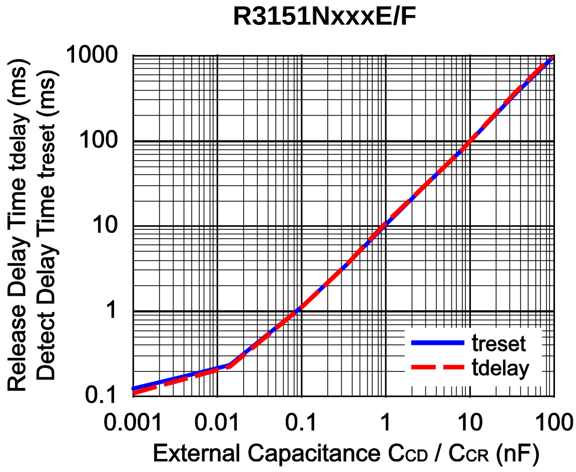
14) Detector or Release Delay Time vs. C_D pin C_R pin External Capacity (Ta = 25°C)





Ver. A

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

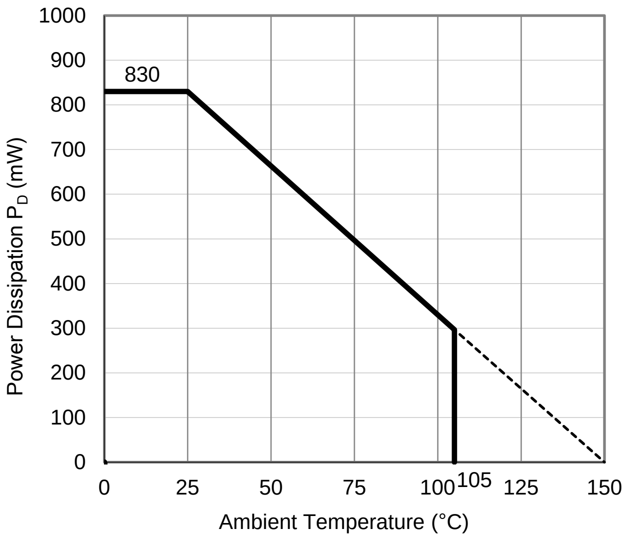
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 7 pcs

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

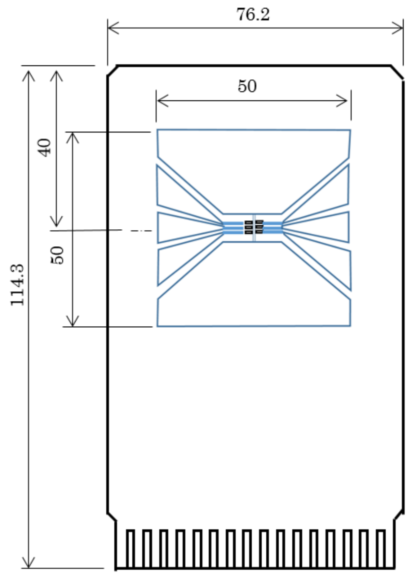
Item	Measurement Result
Power Dissipation	830 mW
Thermal Resistance (θja)	θja = 150°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 51°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter

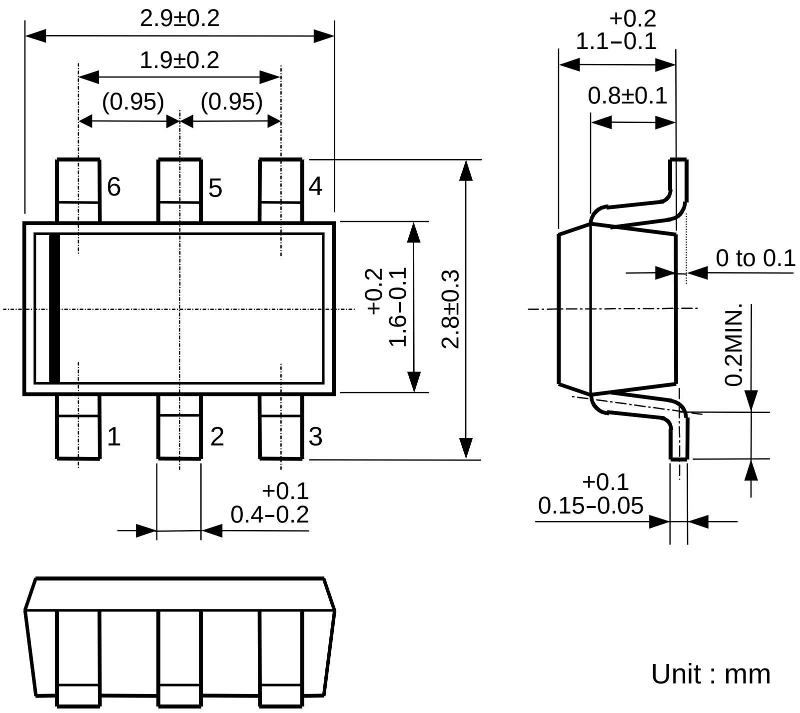


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

Ver. A



SOT-23-6 Package Dimensions

RoHS Compliant
Halogen Free

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.

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