

36 V Input Voltage Detector

No. EA-230-230828

OUTLINE

The R3150N 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 R3150NxxxA/B provide V_{DD} pin detection and the R3150NxxxE/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 20%).

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 R3150N is available in SOT-23-6 package that is possible to achieve high-density mounting on boards.

FEATURES

- Operating Voltage Range (Maximum Rating) R3150NxxxA/B: 1.4 V to 36.0 V (50.0 V)
R3150NxxxE/F: 3.6 V to 6.0 V (7.0 V)
- Operating Temperature Range -40°C to 105°C
- Supply Current R3150NxxxA/B: Typ. 3.8 μA
R3150NxxxE/F: Typ. 3.5 μA
- Detector Threshold Range 5.0 V to 10.0 V (0.1 V step)
- Detector Threshold Accuracy $\pm 1.5\%$ (25°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°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.

APPLICATIONS

- Voltage monitoring for laptops, digital TVs, cordless phones, and private LAN systems for home.

⁽¹⁾ The release voltage can be adjusted by having the hysteresis set to 5% to 20% of the detector threshold.

SELECTION GUIDE

The detector threshold, release voltage, and output type for the ICs are user-selectable options.

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R3150Nxxx*-TR-FE	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

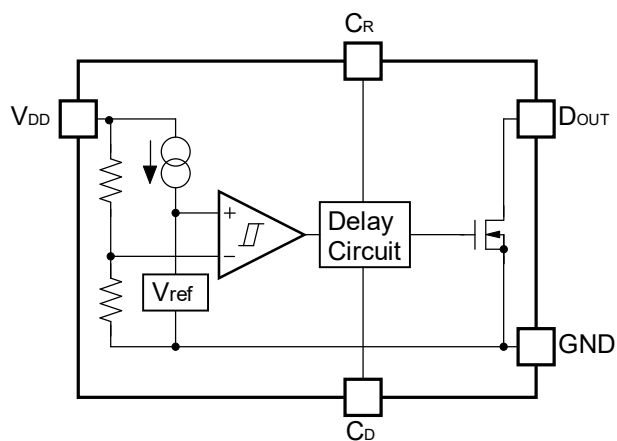
B: V_{DD} Voltage Detection Type "H" Output

E: SENSE Voltage Detection Type "L" Output

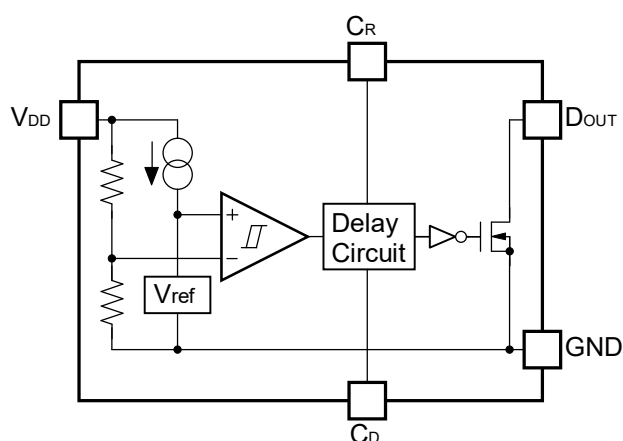
F: SENSE Voltage Detection Type "H" Output

BLOCK DIAGRAMS

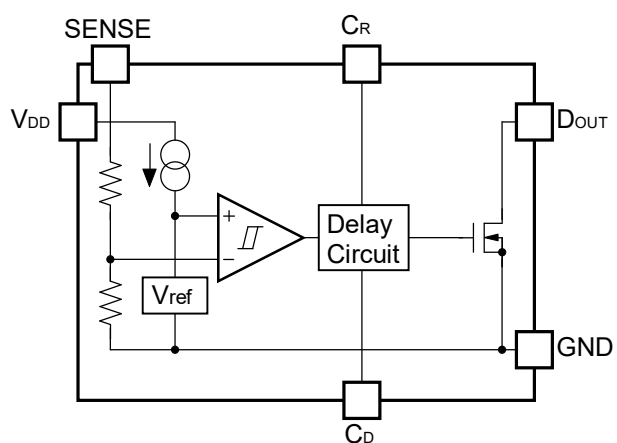
R3150NxxxA



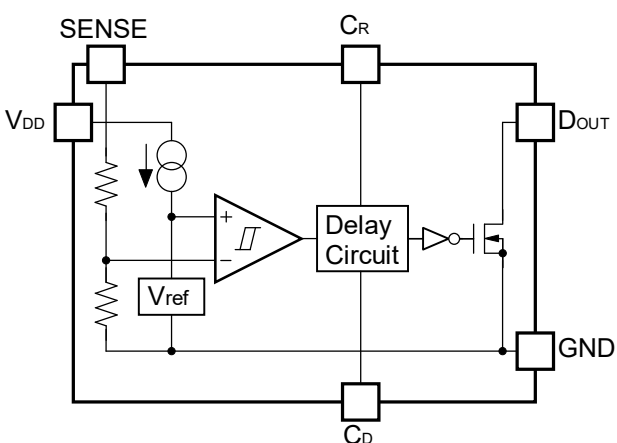
R3150NxxxB



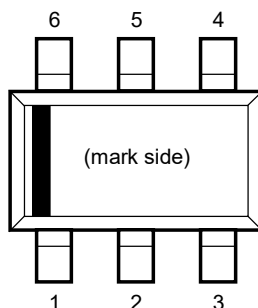
R3150NxxxE



R3150NxxxF



PIN DESCRIPTIONS



SOT-23-6 Pin Configuration

SOT-23-6 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 (R3150NxxxA/B)
	SENSE	VD Voltage SENSE Pin (R3150NxxxE/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 (R3150NxxxA/B)			-0.3 to 50.0	V
	Supply Voltage (R3150NxxxE/F)			-0.3 to 7.0	V
V_{SENSE}	SENSE Pin Voltage (R3150NxxxE/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 Curren			20	mA
P_D	Power Dissipation ⁽¹⁾	SOT-23-6	JEDEC STD. 51-7 Test Land Pattern	660	mW
T_j	Junction Temperature Range			-40 to 125	°C
T_{stg}	Storage Temperature Range			-55 to 125	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage 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	R3150NxxxA/B	1.4 to 36.0	V
		R3150NxxxE/F	3.6 to 6.0	V
V_{SENSE}	SENSE Input Voltage	R3150NxxxE/F	0 to 36.0	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 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

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

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

Electrical Characteristics R3150NxxxA/B

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

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{DD}	Operating Voltage ⁽¹⁾	R3150NxxxA	1.4		36.0	V
		R3150NxxxB				
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	$T_a = 25^\circ\text{C}$	$\times 0.985$		$\times 1.015$	V
		$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	$\times 0.980$		$\times 1.020$	
$+V_{DET}$	Release Voltage	$T_a = 25^\circ\text{C}$	$\times 0.985$		$\times 1.015$	V
		$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	$\times 0.980$		$\times 1.020$	
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)	R3150NxxxA: $V_{DD} = 4.5 \text{ V}$, $V_{DS} = 0.05 \text{ V}$	0.5		2.0	mA
		R3150NxxxB: $V_{DD} = 13.0 \text{ V}$, $V_{DS} = 0.05 \text{ V}$				
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 “ $+V_{SET} + 1.0 \text{ V}$ ”.

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

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

Electrical Characteristics R3150NxxxE/F

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

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{DD}	Operating Voltage ⁽¹⁾		3.6		6.0	V
V_{SENSE}	SENSE Input Voltage				36.0	V
I_{SS}	Supply Current ⁽²⁾	$V_{DD} = 5.0 \text{ V}$, $V_{SENSE} = -V_{SET} - 0.1 \text{ V}$		3.5	5.5	μA
		$V_{DD} = 5.0 \text{ V}$, $V_{SENSE} = +V_{SET} + 1.0 \text{ V}$		3.5	5.6	
R_{SENSE}	SENSE Resistance		4.5		51.5	$\text{M}\Omega$
$-V_{DET}$	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	
t_{reset}	Detect Output Delay Time ⁽³⁾	$C_R = 1000 \text{ pF}$, $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	6.5	10	14.0	ms
t_{delay}	Release Output Delay Time ⁽⁴⁾	$C_D = 1000 \text{ pF}$, $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	6.5	10	14.0	ms
I_{OUT}	Output Current (Nch Driver Output Pin)	R3150NxxxE $V_{DD} = 5.0 \text{ V}$, $V_{DS} = 0.05 \text{ V}$, $V_{SENSE} = -V_{SET} - 0.1 \text{ V}$	0.5		2.0	mA
		R3150NxxxF $V_{DD} = 5.0 \text{ V}$, $V_{DS} = 0.05 \text{ V}$, $V_{SENSE} = +V_{SET} + 1.0 \text{ V}$				
R_{CD}	C_D Pin Discharge Tr. On Resistance	$V_{DD} = 4.5 \text{ V}$, $V_{SENSE} = 13 \text{ V}$, $V_{CD} = 0.5 \text{ V}$	0.50		2.60	$\text{k}\Omega$
R_{CR}	C_R Pin Discharge Tr. On Resistance	$V_{DD} = 4.5 \text{ V}$, $V_{SENSE} = 4.5 \text{ V}$, $V_{CR} = 0.5 \text{ V}$	0.50		2.60	$\text{k}\Omega$

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⁾ Not including the current for SENSE resistance.

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

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

Product-specific Electrical Characteristics

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

R3150NxxxA

(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.
R3150N001A	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3150N002A	8.373	8.500	8.627	8.330	8.500	8.670	8.865	9.000	9.135	8.820	9.000	9.180
R3150N003A	8.865	9.000	9.135	8.820	9.000	9.180	9.358	9.500	9.642	9.310	9.500	9.690
R3150N004A	5.812	5.900	5.988	5.782	5.900	6.018	6.698	6.800	6.902	6.664	6.800	6.936
R3150N005A	6.403	6.500	6.597	6.370	6.500	6.630	6.994	7.100	7.206	6.958	7.100	7.242
R3150N006A	6.206	6.300	6.394	6.174	6.300	6.426	6.797	6.900	7.003	6.762	6.900	7.038
R3150N007A	5.713	5.800	5.887	5.684	5.800	5.916	6.206	6.300	6.394	6.174	6.300	6.426
R3150N013A	6.895	7.000	7.105	6.860	7.000	7.140	7.388	7.500	7.612	7.350	7.500	7.650
R3150N018A	5.910	6.000	6.090	5.880	6.000	6.120	7.092	7.200	7.308	7.056	7.200	7.344
R3150N020A	6.895	7.000	7.105	6.860	7.000	7.140	8.274	8.400	8.526	8.232	8.400	8.568
R3150N021A	5.910	6.000	6.090	5.880	6.000	6.120	6.206	6.300	6.394	6.174	6.300	6.426
R3150N025A	8.865	9.000	9.135	8.820	9.000	9.180	9.752	9.900	10.048	9.702	9.900	10.098
R3150N026A	9.850	10.000	10.150	9.800	10.000	10.200	10.835	11.000	11.165	10.780	11.000	11.220
R3150N027A	4.925	5.000	5.075	4.900	5.000	5.100	5.418	5.500	5.582	5.390	5.500	5.610

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

R3150NxxxB

(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.
R3150N001B	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3150N002B	8.373	8.500	8.627	8.330	8.500	8.670	8.865	9.000	9.135	8.820	9.000	9.180
R3150N003B	8.865	9.000	9.135	8.820	9.000	9.180	9.358	9.500	9.642	9.310	9.500	9.690
R3150N004B	5.812	5.900	5.988	5.782	5.900	6.018	6.698	6.800	6.902	6.664	6.800	6.936
R3150N005B	6.403	6.500	6.597	6.370	6.500	6.630	6.994	7.100	7.206	6.958	7.100	7.242
R3150N006B	6.206	6.300	6.394	6.174	6.300	6.426	6.797	6.900	7.003	6.762	6.900	7.038
R3150N007B	5.713	5.800	5.887	5.684	5.800	5.916	6.206	6.300	6.394	6.174	6.300	6.426
R3150N008B	7.388	7.500	7.612	7.350	7.500	7.650	8.865	9.000	9.135	8.820	9.000	9.180
R3150N011B	7.683	7.800	7.917	7.644	7.800	7.956	8.865	9.000	9.135	8.820	9.000	9.180
R3150N012B	7.191	7.300	7.409	7.154	7.300	7.446	8.570	8.700	8.830	8.526	8.700	8.874
R3150N013B	6.895	7.000	7.105	6.860	7.000	7.140	7.388	7.500	7.612	7.350	7.500	7.650
R3150N014B	7.979	8.100	8.221	7.938	8.100	8.262	8.373	8.500	8.627	8.330	8.500	8.670
R3150N015B	5.910	6.000	6.090	5.880	6.000	6.120	6.403	6.500	6.597	6.370	6.500	6.630
R3150N016B	5.418	5.500	5.582	5.390	5.500	5.610	5.910	6.000	6.090	5.880	6.000	6.120
R3150N017B	5.221	5.300	5.379	5.194	5.300	5.406	6.206	6.300	6.394	6.174	6.300	6.426
R3150N019B	5.910	6.000	6.090	5.880	6.000	6.120	7.388	7.500	7.612	7.350	7.500	7.650
R3150N020B	6.895	7.000	7.105	6.860	7.000	7.140	8.274	8.400	8.526	8.232	8.400	8.568
R3150N021B	5.910	6.000	6.090	5.880	6.000	6.120	6.206	6.300	6.394	6.174	6.300	6.426
R3150N025B	8.865	9.000	9.135	8.820	9.000	9.180	9.752	9.900	10.048	9.702	9.900	10.098
R3150N026B	9.850	10.000	10.150	9.800	10.000	10.200	10.835	11.000	11.165	10.780	11.000	11.220
R3150N027B	4.925	5.000	5.075	4.900	5.000	5.100	5.418	5.500	5.582	5.390	5.500	5.610

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

R3150NxxxE

(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.
R3150N001E	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3150N002E	8.373	8.500	8.627	8.330	8.500	8.670	8.865	9.000	9.135	8.820	9.000	9.180
R3150N003E	8.865	9.000	9.135	8.820	9.000	9.180	9.358	9.500	9.642	9.310	9.500	9.690
R3150N004E	5.812	5.900	5.988	5.782	5.900	6.018	6.698	6.800	6.902	6.664	6.800	6.936
R3150N005E	6.403	6.500	6.597	6.370	6.500	6.630	6.994	7.100	7.206	6.958	7.100	7.242
R3150N006E	6.206	6.300	6.394	6.174	6.300	6.426	6.797	6.900	7.003	6.762	6.900	7.038
R3150N007E	5.713	5.800	5.887	5.684	5.800	5.916	6.206	6.300	6.394	6.174	6.300	6.426
R3150N013E	6.895	7.000	7.105	6.860	7.000	7.140	7.388	7.500	7.612	7.350	7.500	7.650
R3150N027E	4.925	5.000	5.075	4.900	5.000	5.100	5.418	5.500	5.582	5.390	5.500	5.610

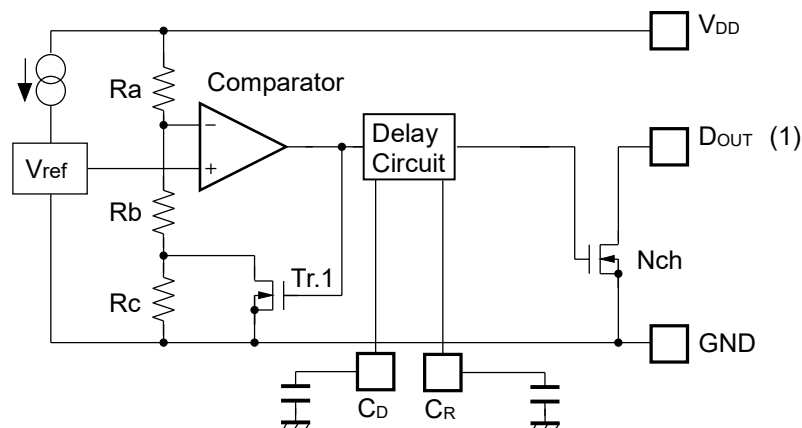
R3150NxxxF

(Ta = 25°C)

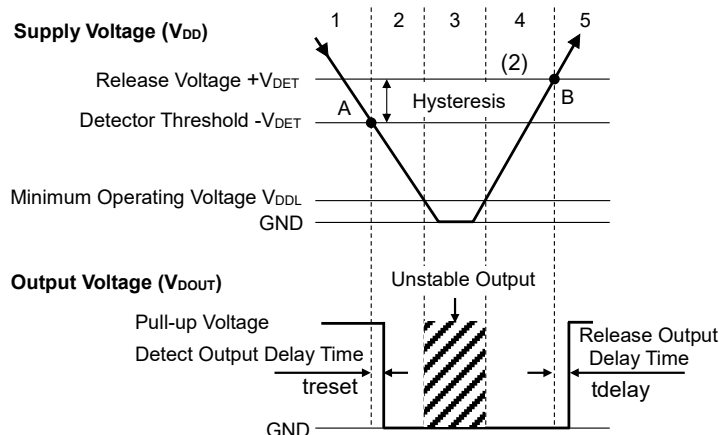
Product Name	-V _{DET} [V] (Ta = 25°C)			-V _{DET} [V] (-40°C ≤ Ta ≤ 105°C)			+V _{DET} [V] (Ta = 25°C)			+V _{DET} [V] (-40°C ≤ Ta ≤ 105°C)		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
R3150N001F	6.304	6.400	6.496	6.272	6.400	6.528	7.191	7.300	7.409	7.154	7.300	7.446
R3150N002F	8.373	8.500	8.627	8.330	8.500	8.670	8.865	9.000	9.135	8.820	9.000	9.180
R3150N003F	8.865	9.000	9.135	8.820	9.000	9.180	9.358	9.500	9.642	9.310	9.500	9.690
R3150N004F	5.812	5.900	5.988	5.782	5.900	6.018	6.698	6.800	6.902	6.664	6.800	6.936
R3150N005F	6.403	6.500	6.597	6.370	6.500	6.630	6.994	7.100	7.206	6.958	7.100	7.242
R3150N006F	6.206	6.300	6.394	6.174	6.300	6.426	6.797	6.900	7.003	6.762	6.900	7.038
R3150N007F	5.713	5.800	5.887	5.684	5.800	5.916	6.206	6.300	6.394	6.174	6.300	6.426
R3150N008F	7.388	7.500	7.612	7.350	7.500	7.650	8.865	9.000	9.135	8.820	9.000	9.180
R3150N011F	7.683	7.800	7.917	7.644	7.800	7.956	8.865	9.000	9.135	8.820	9.000	9.180
R3150N012F	7.191	7.300	7.409	7.154	7.300	7.446	8.570	8.700	8.830	8.526	8.700	8.874
R3150N013F	6.895	7.000	7.105	6.860	7.000	7.140	7.388	7.500	7.612	7.350	7.500	7.650
R3150N015F	5.910	6.000	6.090	5.880	6.000	6.120	6.403	6.500	6.597	6.370	6.500	6.630
R3150N016F	5.418	5.500	5.582	5.390	5.500	5.610	5.910	6.000	6.090	5.880	6.000	6.120
R3150N017F	5.221	5.300	5.379	5.194	5.300	5.406	6.206	6.300	6.394	6.174	6.300	6.426
R3150N027F	4.925	5.000	5.075	4.900	5.000	5.100	5.418	5.500	5.582	5.390	5.500	5.610

THEORY OF OPERATION

R3150NxxxA (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

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

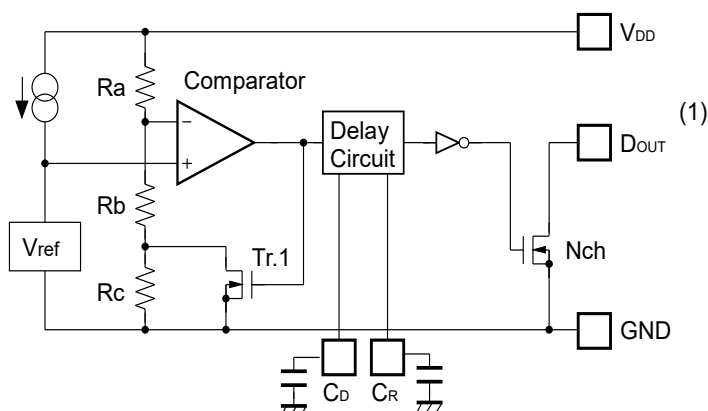
$$\text{II} \quad \frac{R_b}{R_a + R_b} \times V_{DD}$$

Operation Diagram

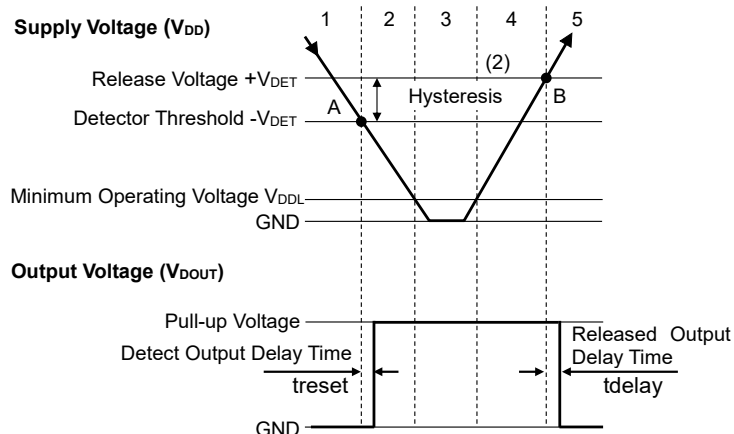
1. The output voltage is equalized to the pull-up voltage.
2. The V_{DD} voltage drops to the detector threshold (A point) which means $V_{ref} \geq V_{DD} \times (R_b + R_c) / (R_a + R_b + R_c)$, and the comparator output shifts from "L" to "H" voltage, and the output pin voltage shifts from the pull-up 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.

(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.

R3150NxxxB (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

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

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

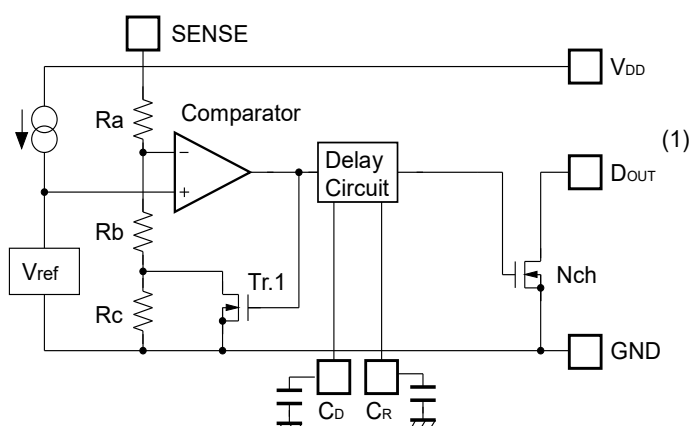
Operation Diagram

1. The output pin voltage becomes "L" voltage.
2. The V_{DD} voltage drops to the detector threshold (A point) which means $V_{ref} \geq V_{DD} \times (R_b + R_c) / (R_a + R_b + R_c)$, 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.

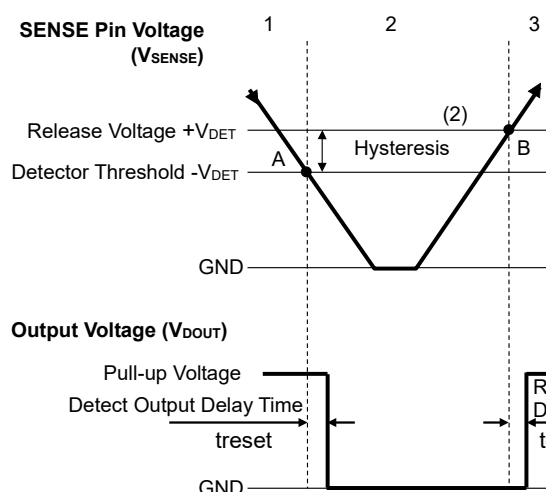
(1) D_{OUT} pin should be pulled-up to an external voltage level.

(2) The gap between the release voltage and the detector threshold is hysteresis.

R3150NxxxE (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

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

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

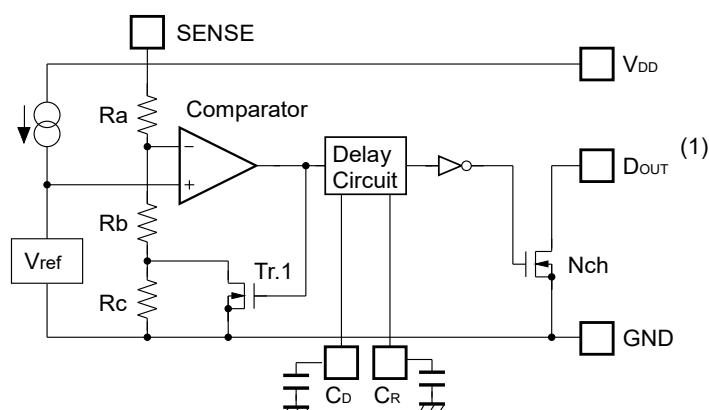
Operation Diagram

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 $V_{\text{ref}} \geq V_{\text{DD}} \times (R_b + R_c) / (R_a + R_b + R_c)$, and the comparator output shifts from "L" to "H" voltage, and the output pin voltage shifts from the pull-up voltage to "L" voltage. (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 $V_{\text{ref}} \leq V_{\text{SENSE}} \times R_b / (R_a + R_b)$, and the comparator output shifts from "H" to "L" voltage, and the output pin voltage is equalized to the pull-up voltage.

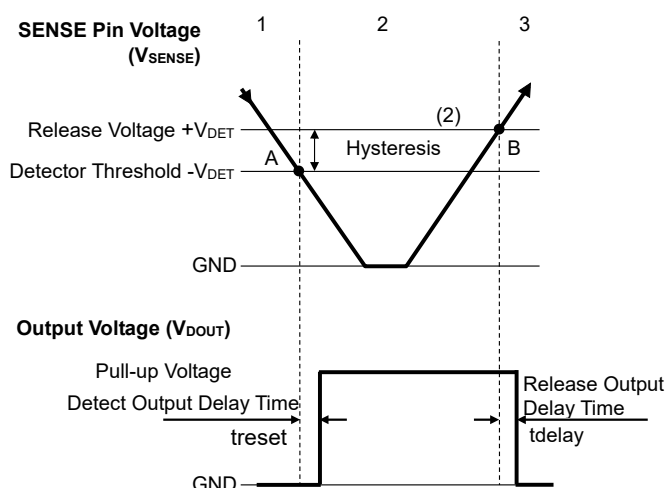
(1) DOUT pin should be pulled-up to an external voltage level.

(2) The gap between the release voltage and the detector threshold is hysteresis.

R3150NxxxF (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

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

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

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 $V_{\text{ref}} \geq V_{\text{SENSE}} \times (R_b + R_c) / (R_a + R_b + R_c)$, and the comparator output shifts from "L" to "H" voltage and the output voltage is equalized to the pull-up voltage. (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 $V_{\text{ref}} \leq V_{\text{SENSE}} \times R_b / (R_a + R_b)$, and the comparator output shift from "H" to "L" voltage and the output voltage becomes "L" voltage.

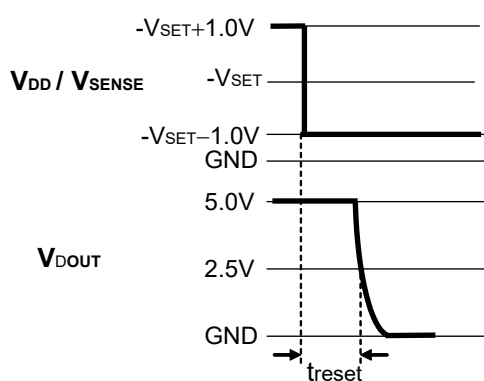
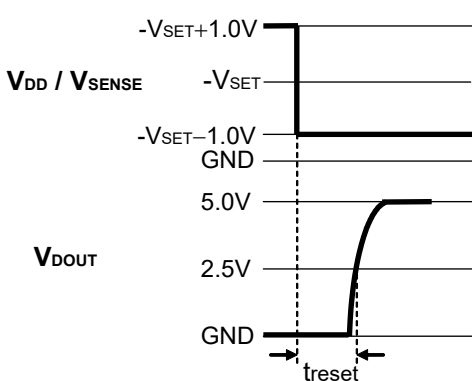
(1) DOUT pin should be pulled-up to an external voltage level.

(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.

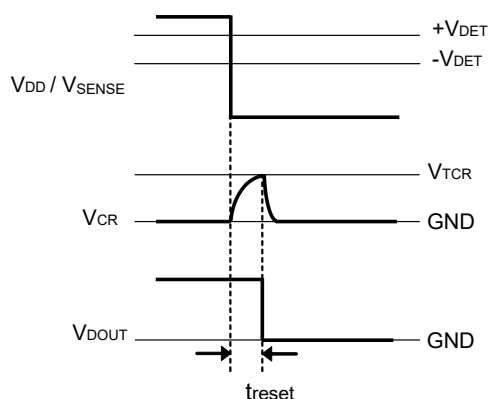
**R3150NxxxA/E****R3150NxxxB/F**

treset is calculated by the following equation:

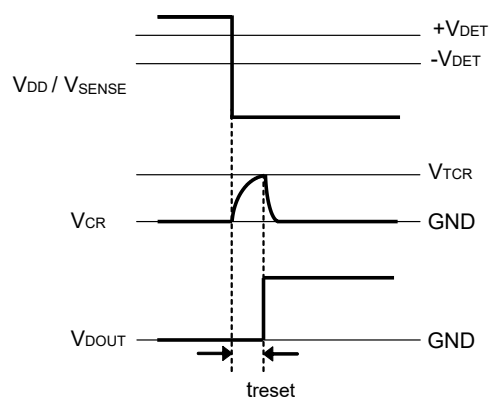
$$t_{\text{reset}} (\text{s}) = C_R \times 10^7$$

With the R3150NxxxA/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



R3150NxxxA/E



R3150NxxxB/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.

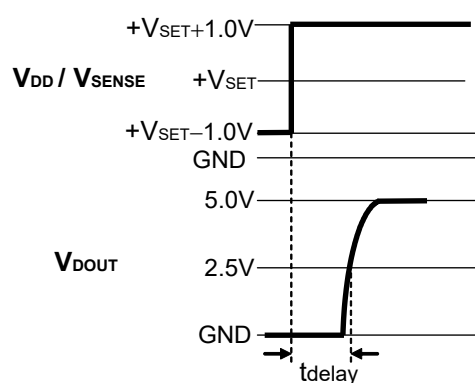
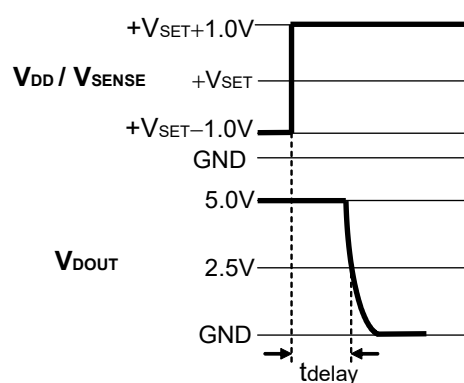
Until the C_R pin voltage reaches to the detector threshold of the detect output delay pin (V_{TCR}), the output voltage maintains the release output. If the C_R pin voltage becomes higher than V_{TCR} , the output voltage shifts from the release output to the detection output.

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 (t_{delay})

Release Output Delay Time (t_{delay}) is defined as follows:

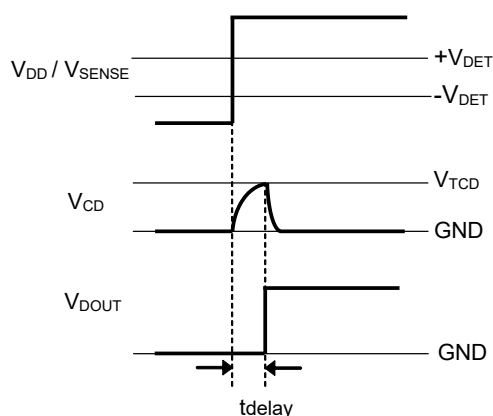
t_{delay} starts after the output pin (D_{OUT}) is pulled up to 5 V with a 100 k Ω resistor, and the $V_{\text{DD}}/V_{\text{SENSE}}$ is shifted from “+ $V_{\text{SET}} - 1.0$ V” to “+ $V_{\text{SET}} + 1.0$ V”. It ends when the output voltage reaches to 2.5 V.

**R3150NxxxA/E****R3150NxxxB/F**

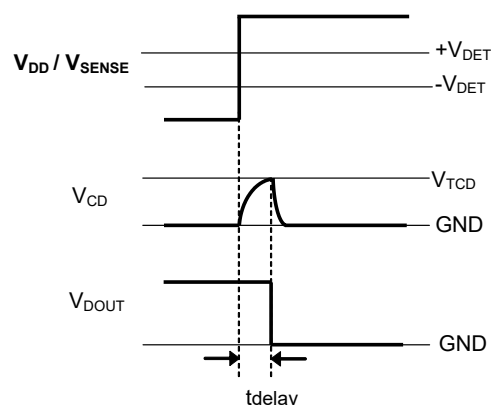
t_{delay} is calculated by the following equation:

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

RELEASE OUTPUT DELAY



R3150NxxxA/E



R3150NxxxB/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 R3150NxxxE/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 SENSE 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 R3150N has built-in rejection of fast transients on the V_{DD} (R3150NxxxA/B) or SENSE (R3150NxxxE/F) pins. The rejection of transients depends on both the pulse width and the overdrive voltage, as shown in Figure 1. The R3150N 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.

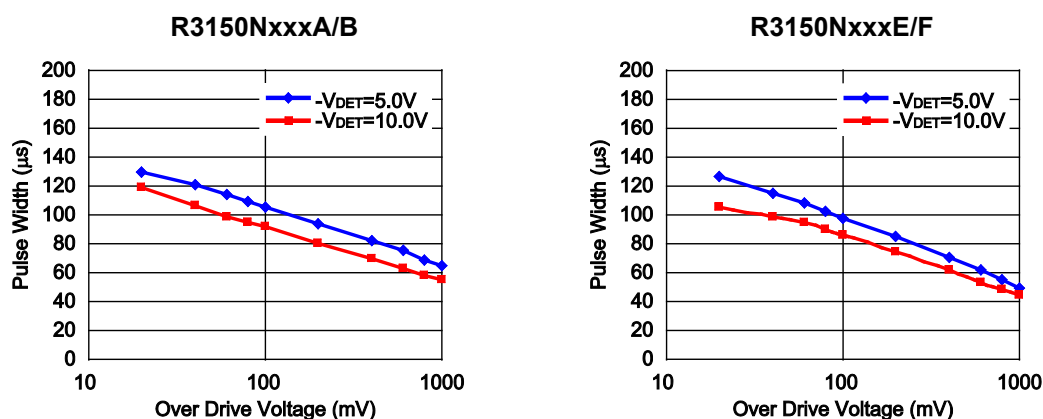


Figure 1. Minimum Pulse Width at V_{DD} /SENSE vs. Overdrive Voltage

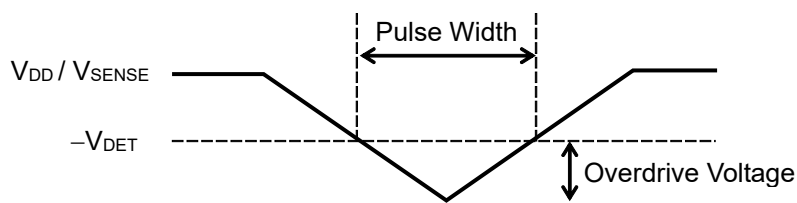


Figure 2. V_{DD} / V_{SENSE} Input Waveform

RELEASE OPERATION VS. GLITCH INPUT VOLTAGE

The R3150N has built-in rejection of fast transients on the V_{DD} (R3150NxxxA/B) or SENSE (R3150NxxxE/F) pins. The rejection of transients depends on both the pulse width and the overdrive voltage, as shown in Figure 3. The R3150N 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.

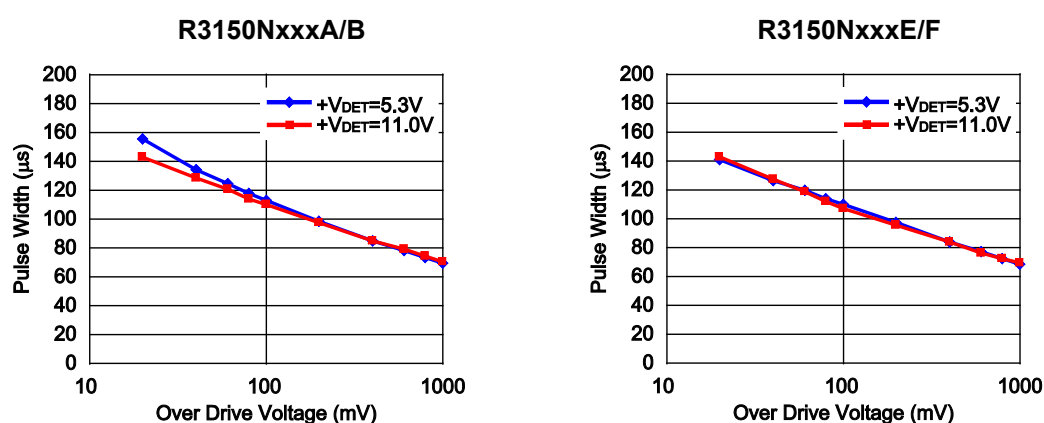


Figure 3. Minimum Pulse Width at $V_{DD}/SENSE$ vs. Overdrive Voltage

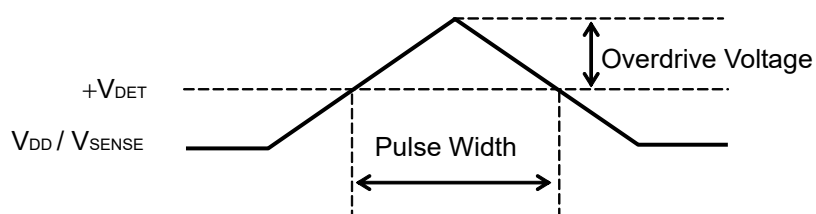
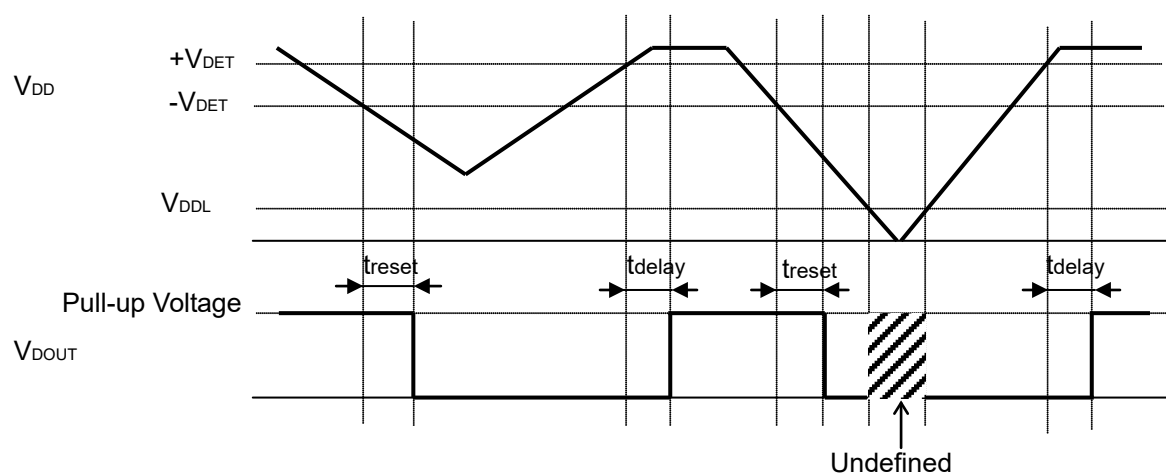
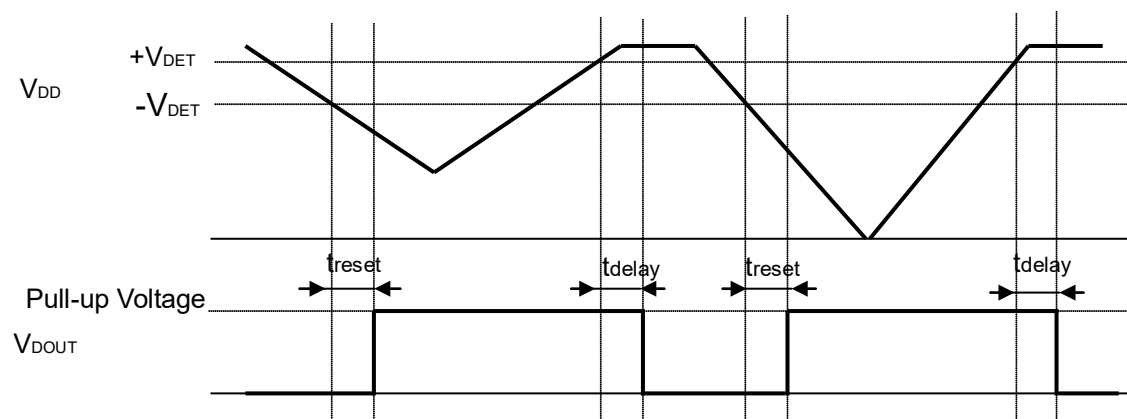


Figure 4. V_{DD}/V_{SENSE} Input Waveform

TIMING CHART

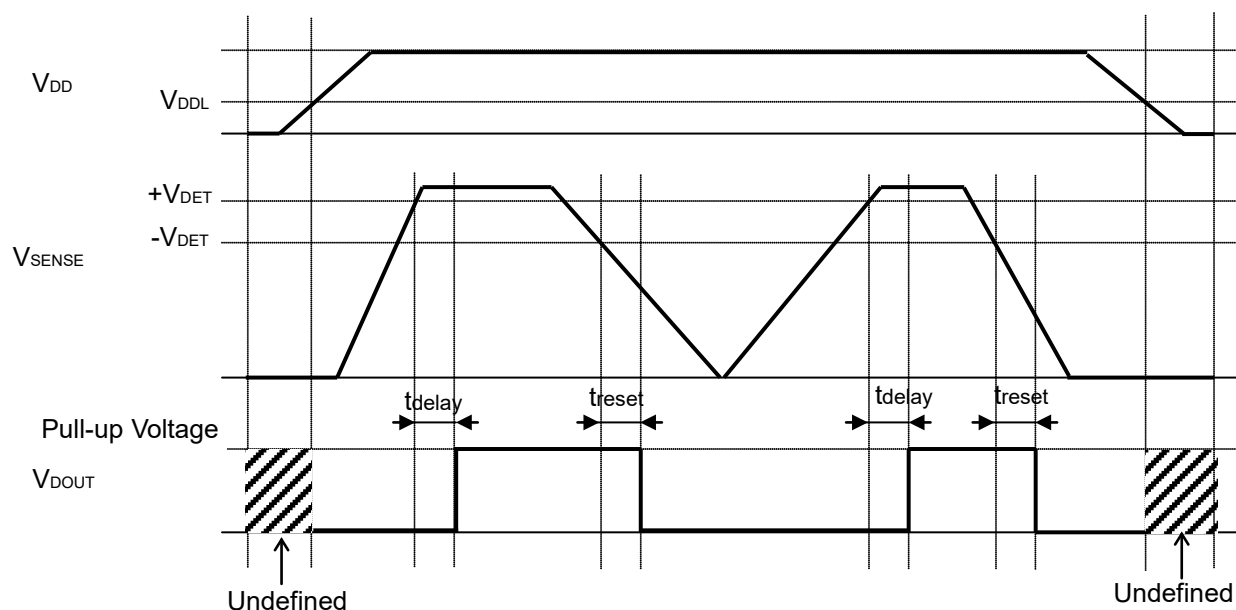
R3150NxxxA/B (V_{DD} Voltage Detection Type)

R3150NxxxA

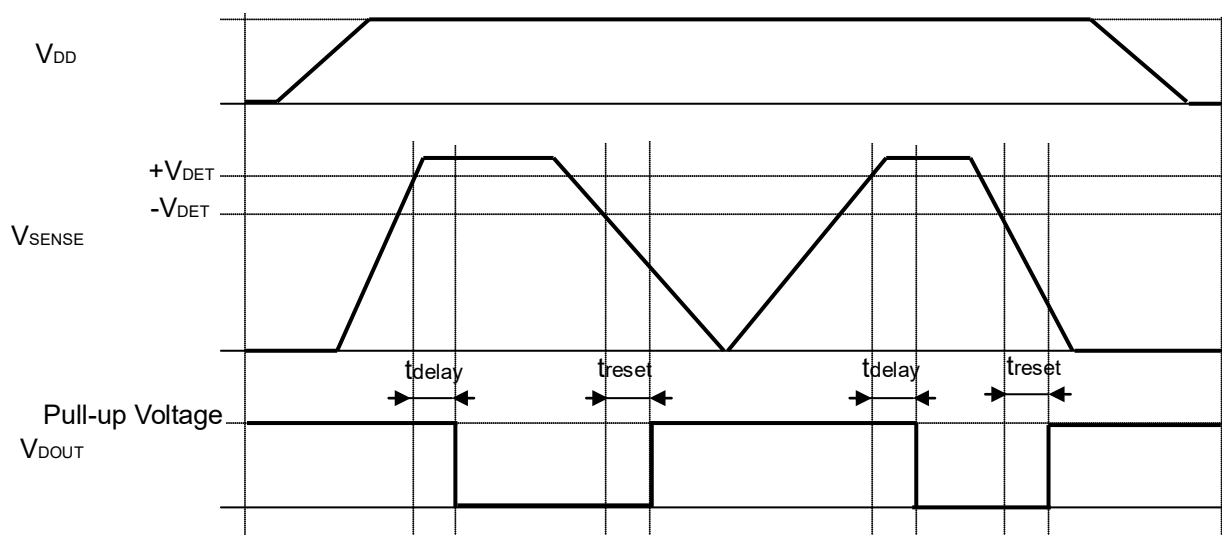


R3150NxxxB

R3150NxxxE/F (SENSE Voltage Detection Type)



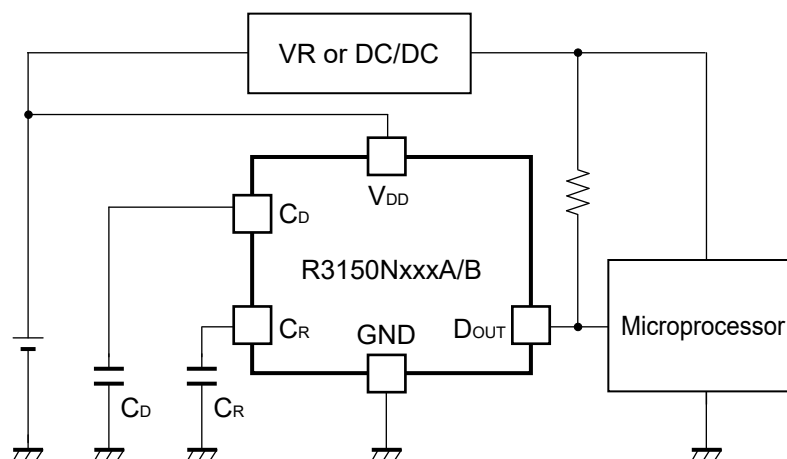
R3150NxxxE



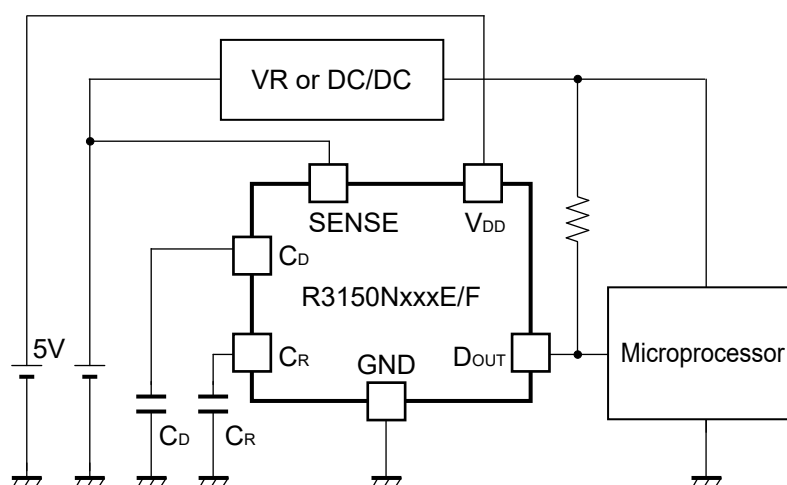
R3150NxxxF

APPLICATION INFORMATION

TYPICAL APPLICATION



R3150NxxxA/B Typical Application



R3150NxxxE/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 k Ω or less as a guide, and connect C_{IN} of 0.1 μ F 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.

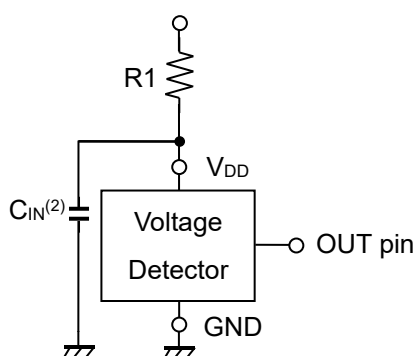


Figure A

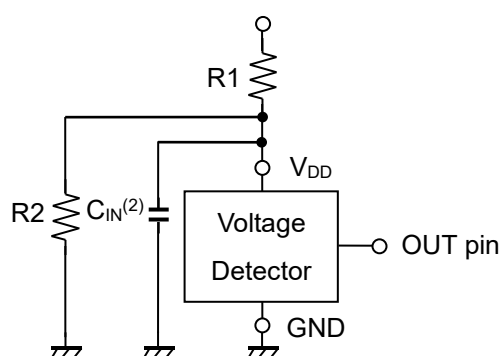


Figure B

⁽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.

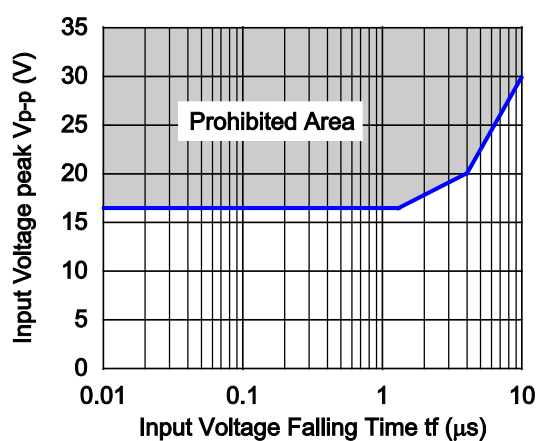


Figure C. Prohibited Area

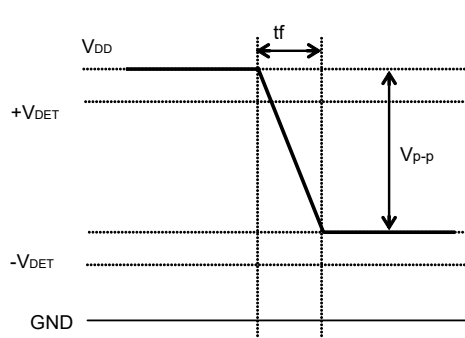


Figure D

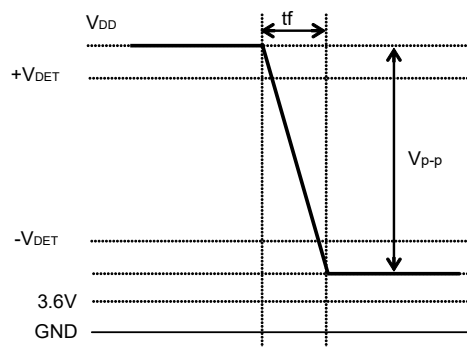


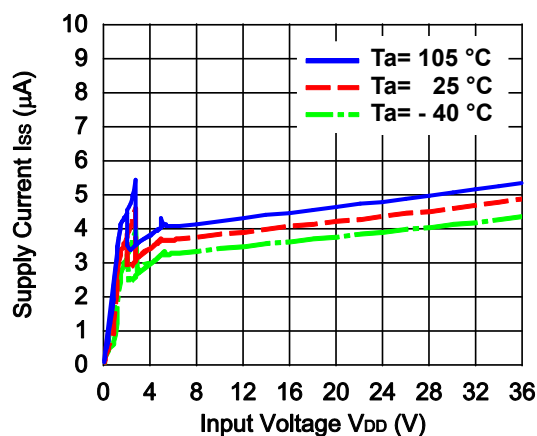
Figure E

TYPICAL CHARACTERISTICS

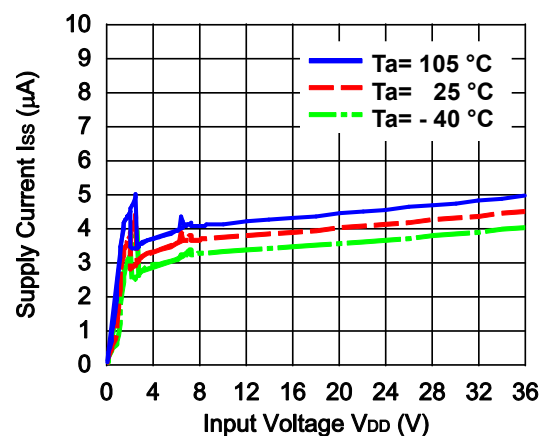
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Supply Current vs. Input Voltage

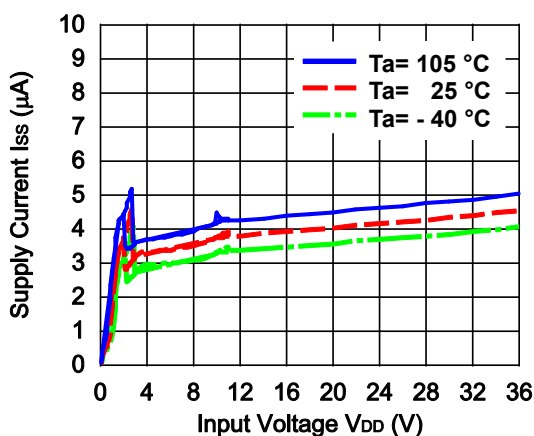
R3150NxxxA/B ($-V_{DET} = 5.0\text{ V}$, $+V_{DET} = 5.3\text{ V}$)



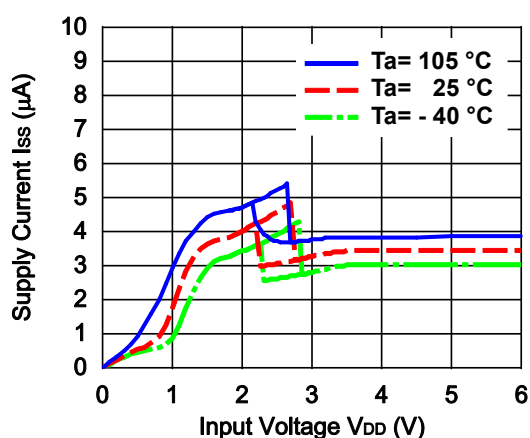
R3150NxxxA/B ($-V_{DET} = 6.4\text{ V}$, $+V_{DET} = 7.3\text{ V}$)



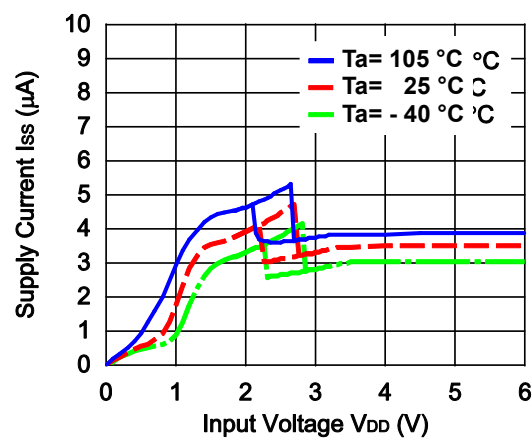
R3150NxxxA/B ($-V_{DET} = 10.0\text{ V}$, $+V_{DET} = 11.0\text{ V}$)



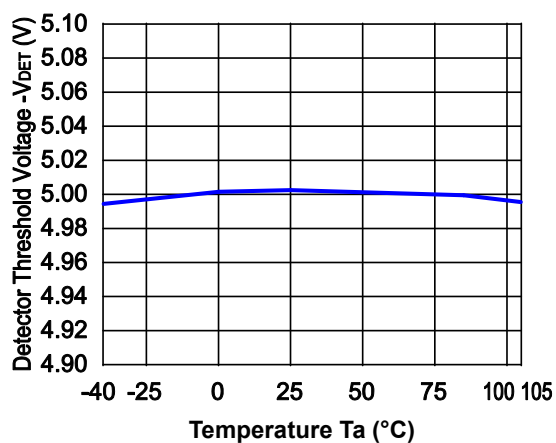
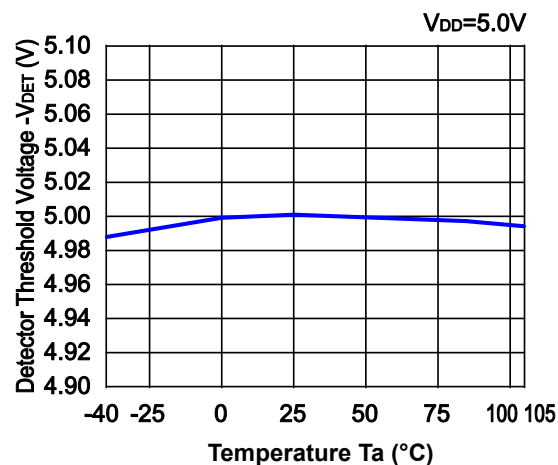
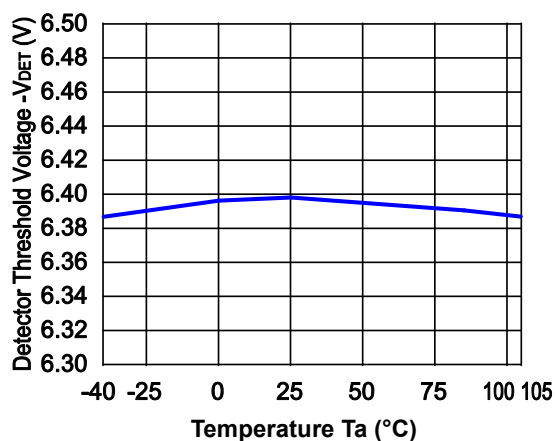
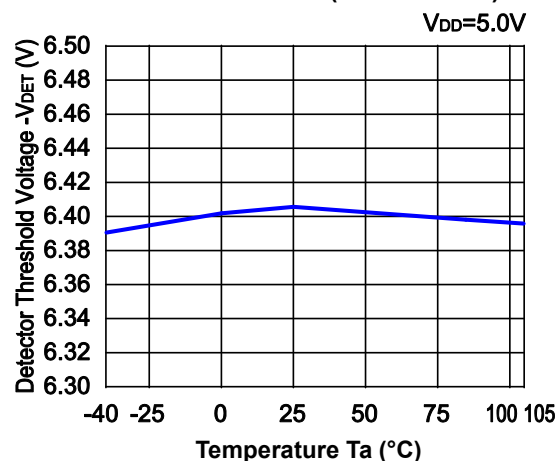
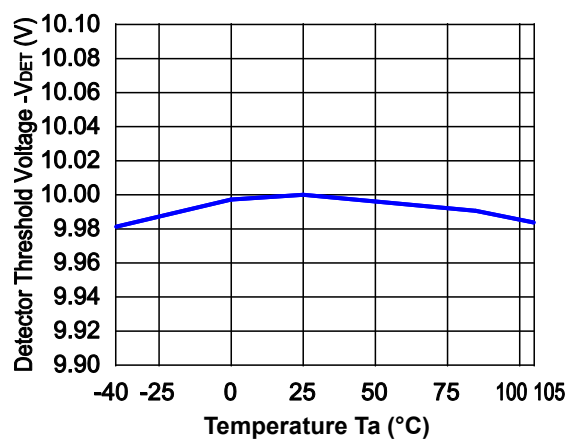
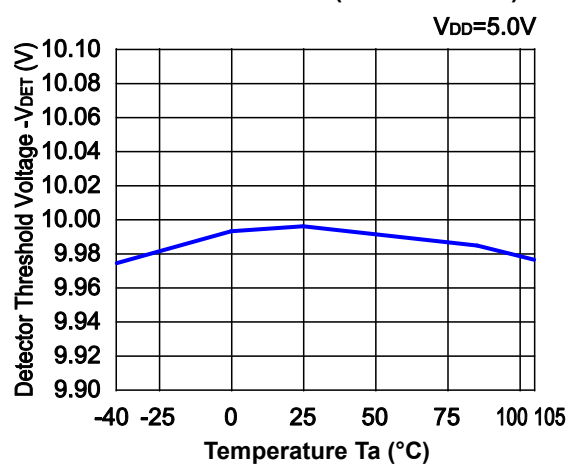
R3150NxxxE/F ($V_{SENSE} = -V_{DET} - 0.1\text{ V}$)



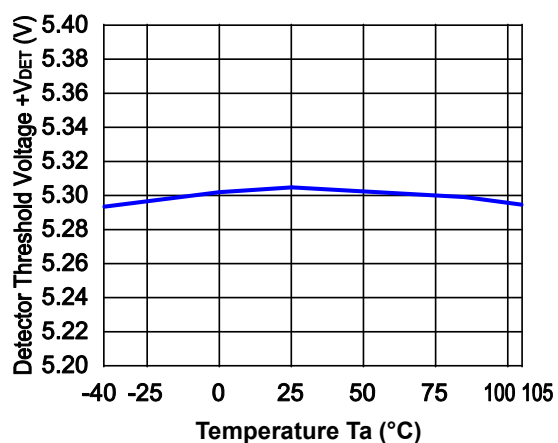
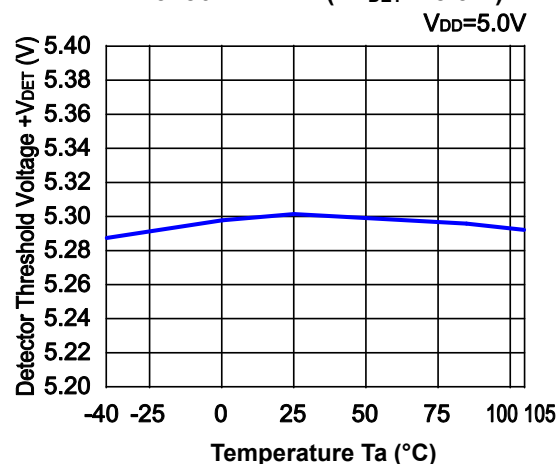
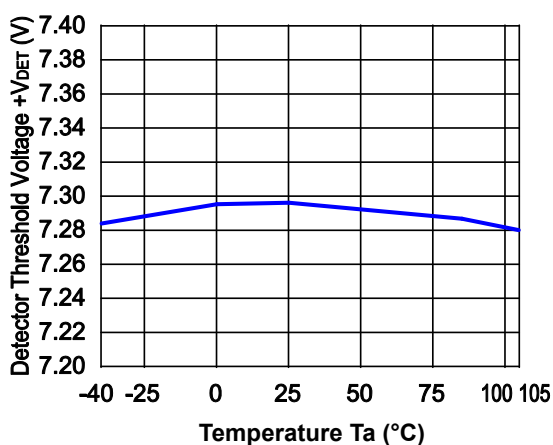
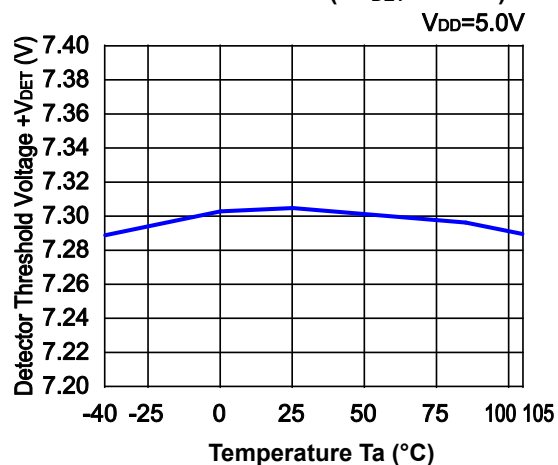
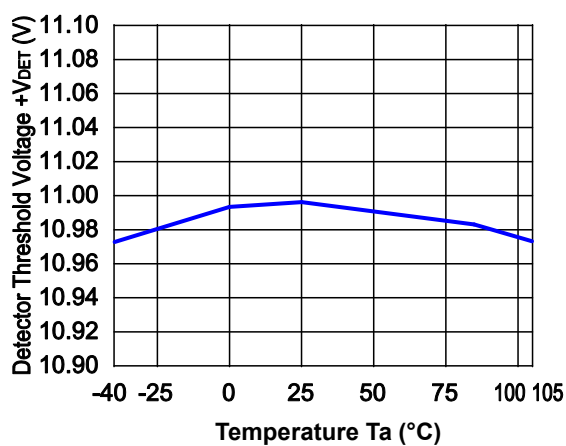
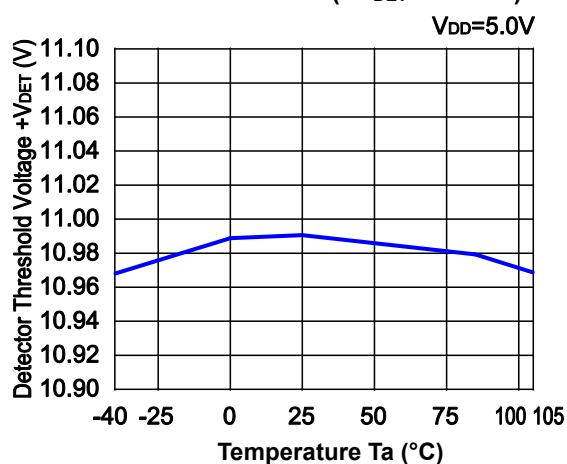
R3150NxxxE/F ($V_{SENSE} = +V_{DET} + 0.1\text{ V}$)



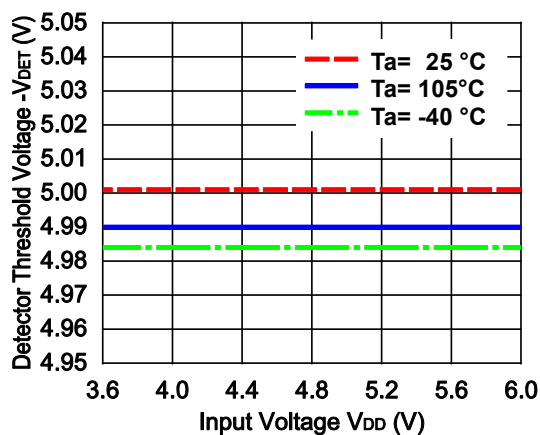
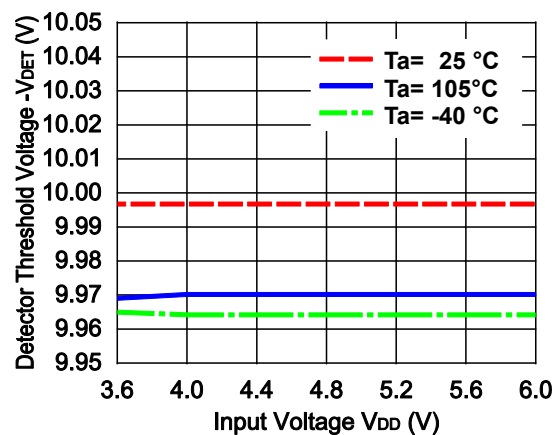
2) Detector Threshold vs. Temperature

R3150NxxxA/B ($-V_{DET} = 5.0\text{ V}$)R3150NxxxE/F ($-V_{DET} = 5.0\text{ V}$)R3150NxxxA/B ($-V_{DET} = 6.4\text{ V}$)R3150NxxxE/F ($-V_{DET} = 6.4\text{ V}$)R3150NxxxA/B ($-V_{DET} = 10.0\text{ V}$)R3150NxxxE/F ($-V_{DET} = 10.0\text{ V}$)

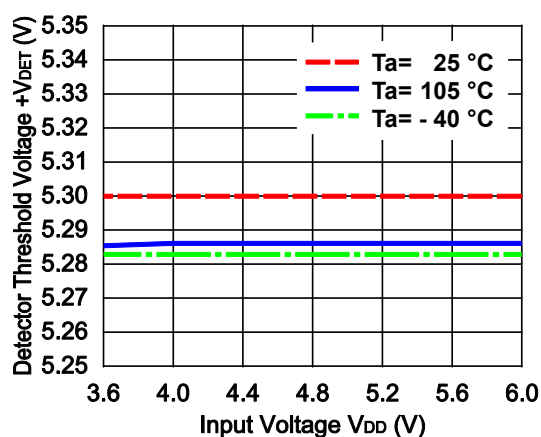
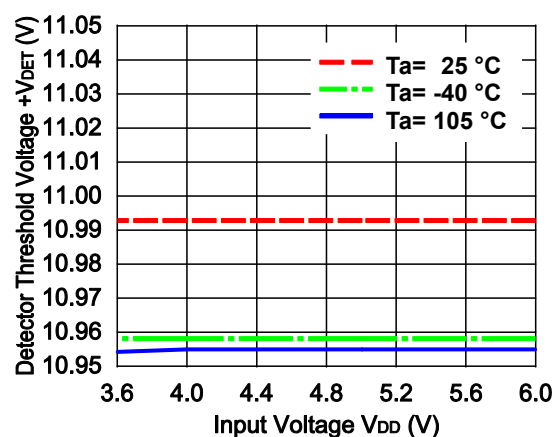
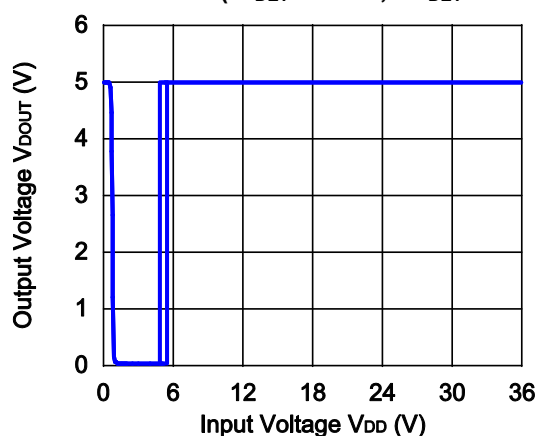
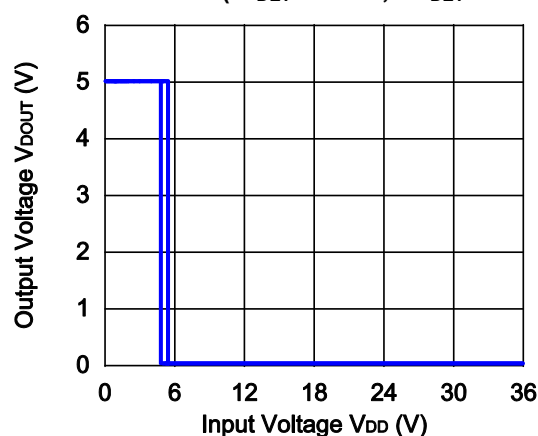
3) Release Voltage vs. Temperature

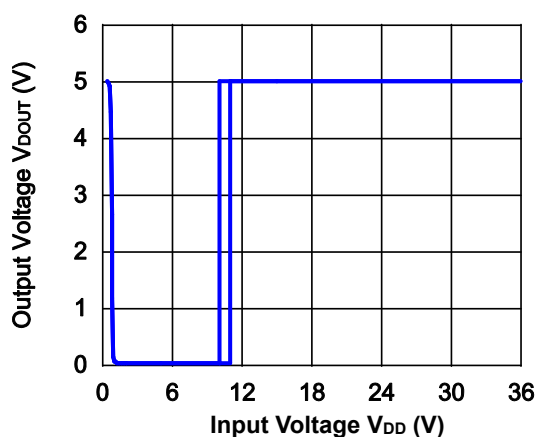
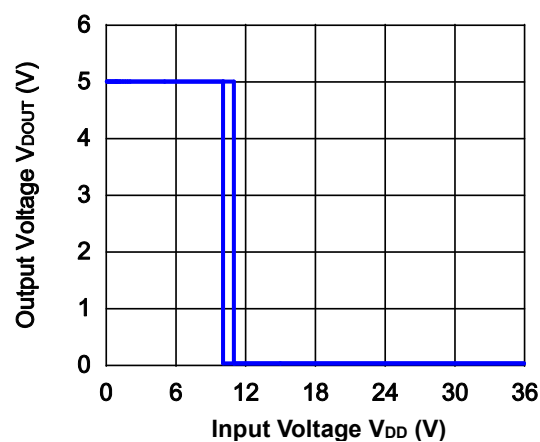
R3150NxxxA/B (+V_{DET} = 5.3 V)R3150NxxxE/F (+V_{DET} = 5.3 V)R3150NxxxA/B (+V_{DET} = 7.3 V)R3150NxxxE/F (+V_{DET} = 7.3 V)R3150NxxxA/B (+V_{DET} = 11.0 V)R3150NxxxE/F (+V_{DET} = 11.0 V)

4) Detector Threshold vs. Input Voltage

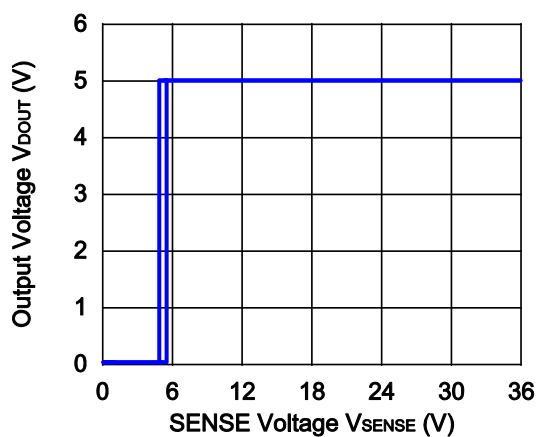
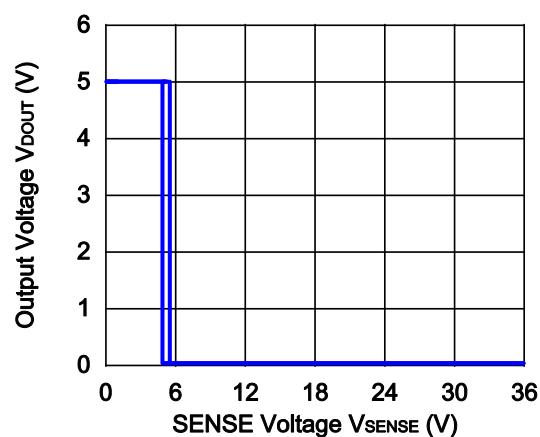
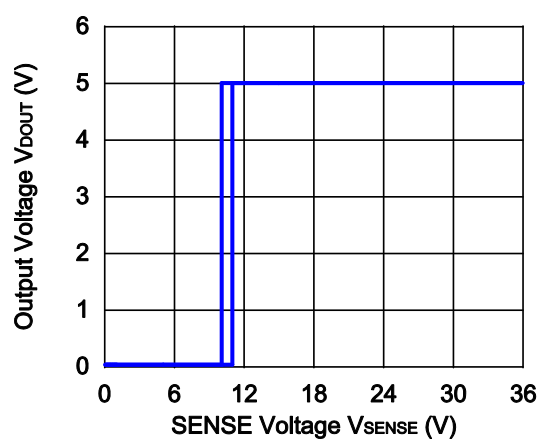
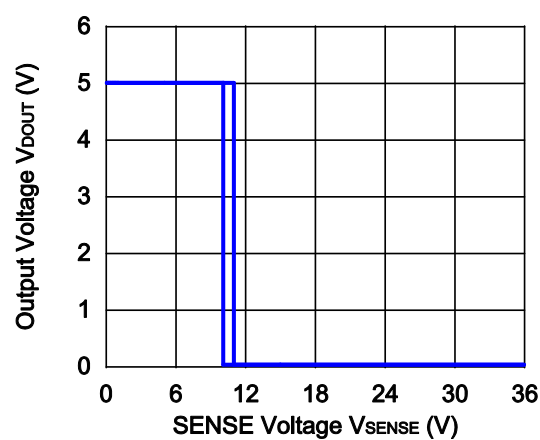
R3150NxxxE/F ($-V_{DET} = 5.0\text{ V}$)R3150NxxxE/F ($-V_{DET} = 10.0\text{ V}$)

5) Release Voltage vs. Input Voltage

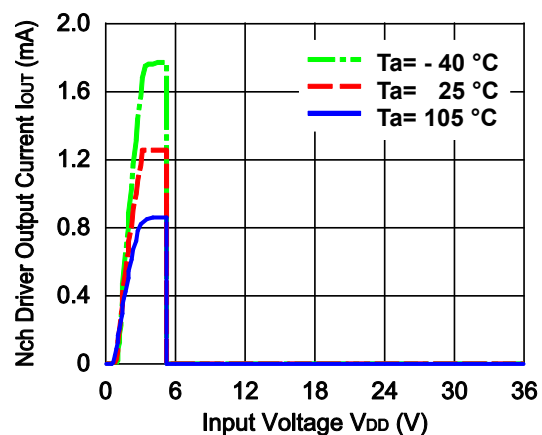
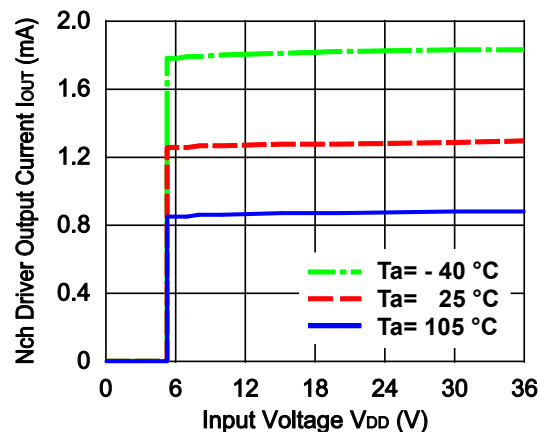
R3150NxxxE/F ($+V_{DET} = 5.3\text{ V}$)R3150NxxxE/F ($+V_{DET} = 11.0\text{ V}$)6) Output Voltage vs. Input Voltage ($T_a = 25^\circ\text{C}$, D_{OUT} pin is pulled-up to 5 V and 100 k Ω)R3150NxxxA ($-V_{DET} = 5.0\text{ V}$, $+V_{DET} = 5.3\text{ V}$)R3150NxxxB ($-V_{DET} = 5.0\text{ V}$, $+V_{DET} = 5.3\text{ V}$)

R3150NxxxA ($-V_{DET} = 10.0\text{ V}$, $+V_{DET} = 11.0\text{ V}$)R3150NxxxB ($-V_{DET} = 10.0\text{ V}$, $+V_{DET} = 11.0\text{ V}$)

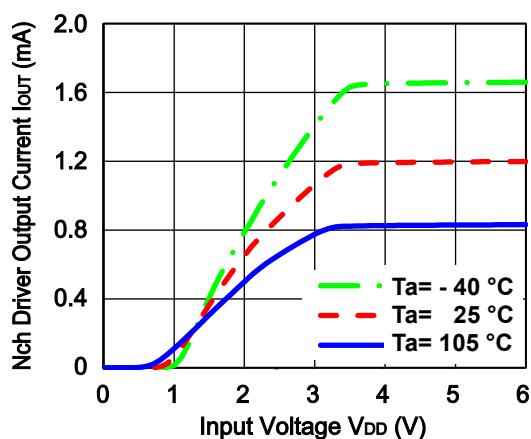
7) Output Voltage vs. SENSE pin Input Voltage ($T_a = 25^\circ\text{C}$, DOUT pin is pulled-up to 5 V and 100 k Ω)

R3150NxxxE ($-V_{DET} = 5.0\text{ V}$, $+V_{DET} = 5.3\text{ V}$)R3150NxxxF ($-V_{DET} = 5.0\text{ V}$, $+V_{DET} = 5.3\text{ V}$)R3150NxxxE ($-V_{DET} = 10.0\text{ V}$, $+V_{DET} = 11.0\text{ V}$)R3150NxxxF ($-V_{DET} = 10.0\text{ V}$, $+V_{DET} = 11.0\text{ V}$)

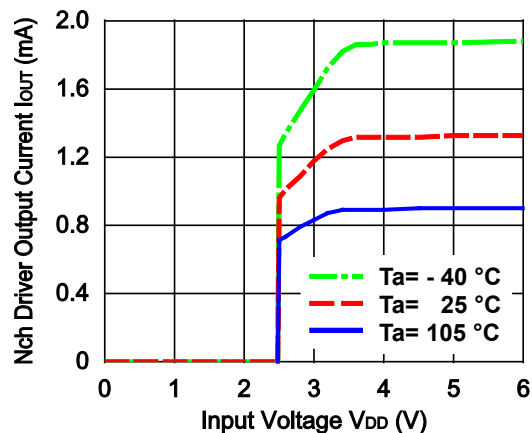
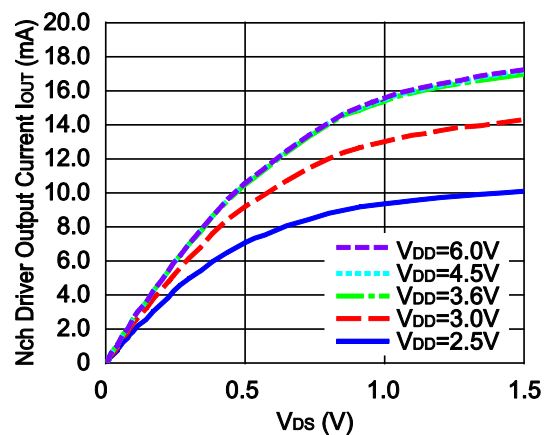
8) Nch Driver Output Current vs. Input Voltage

R3150NxxxA (+V_{DET} = 5.3 V, V_{DOUT} = 0.05 V)R3150NxxxB (+V_{DET} = 5.3 V, V_{DOUT} = 0.05 V)

R3150NxxxE

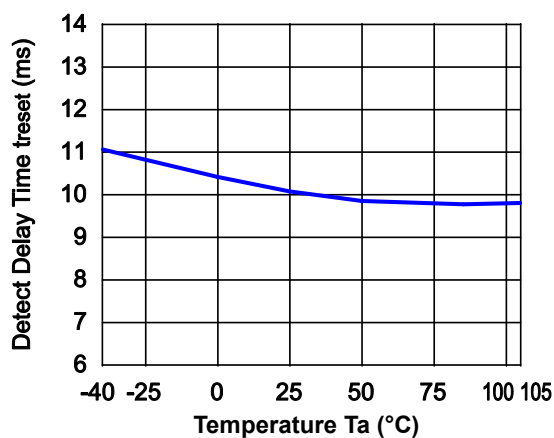
(V_{SENSE} = -V_{DET} - 1.0 V, V_{DOUT} = 0.05 V)

R3150NxxxF

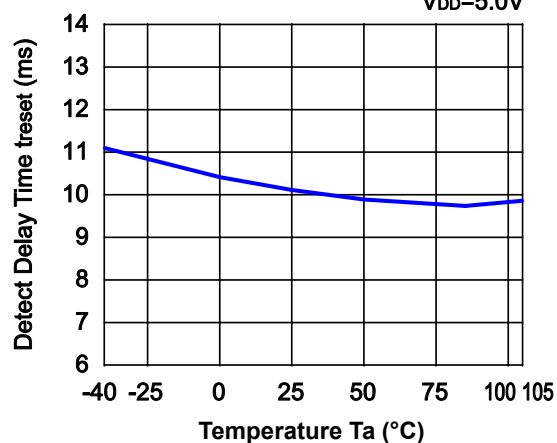
(V_{SENSE} = +V_{DET} + 1.0 V, V_{DOUT} = 0.05 V)9) Nch Driver Output Current vs. V_{DS}

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

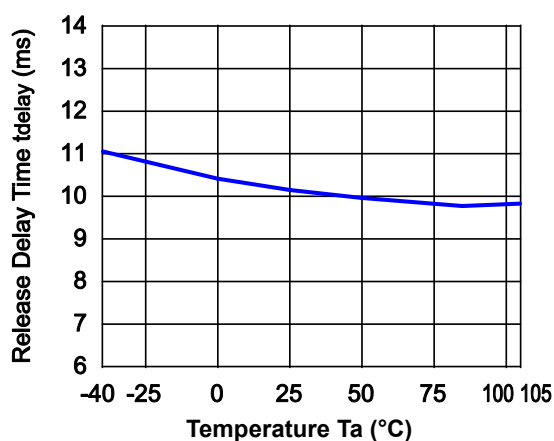
R3150NxxxA/ B



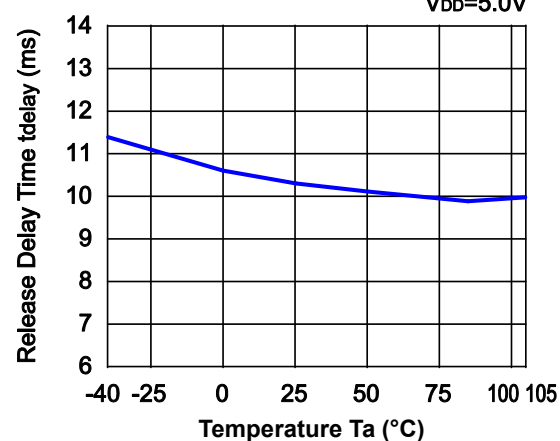
R3150NxxxE/ F

 $V_{DD}=5.0V$ 11) Output Delay Time vs. Temperature ($C_D = 1.0 \mu F$)

R3150NxxxA/ B

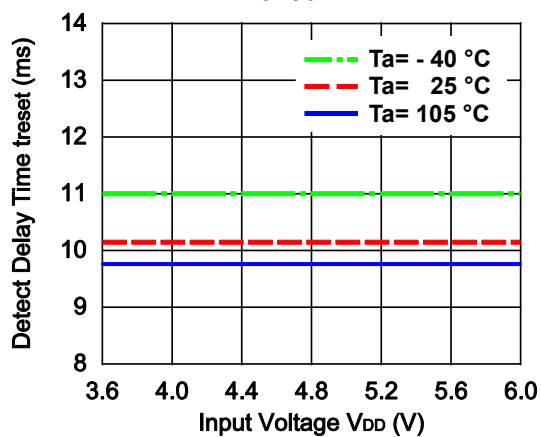


R3150NxxxE/ F

 $V_{DD}=5.0V$ 

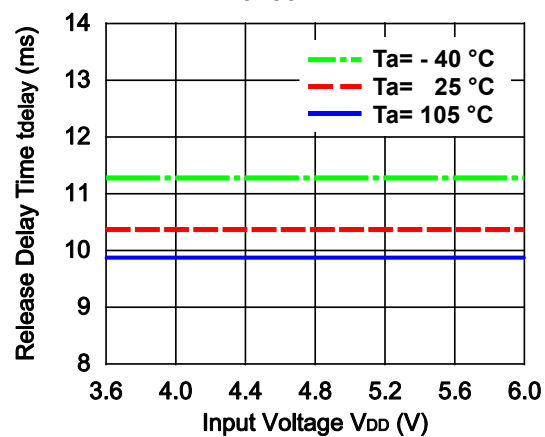
12) Output Reset Time vs. Input Voltage

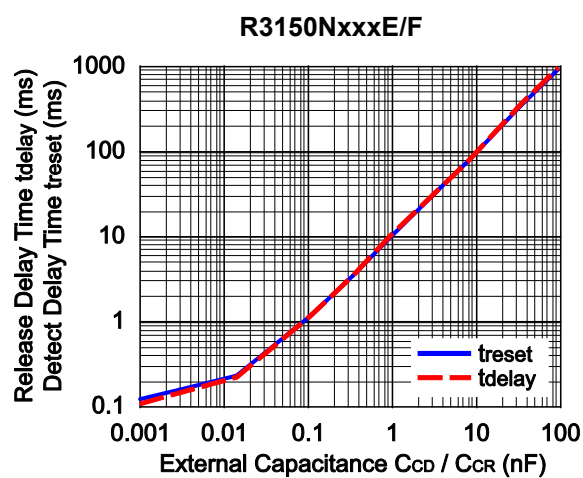
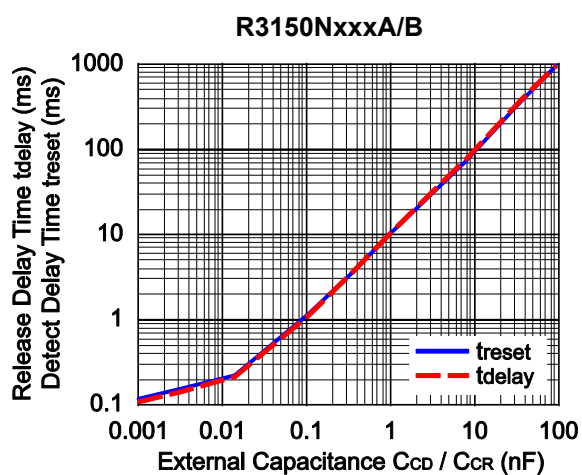
R3150NxxxE/F



13) Output Delay Time vs. Input Voltage

R3150NxxxE/F



14) Detector or Release Delay Time vs. C_D pin C_R pin External Capacity ($T_a = 25^\circ\text{C}$)

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

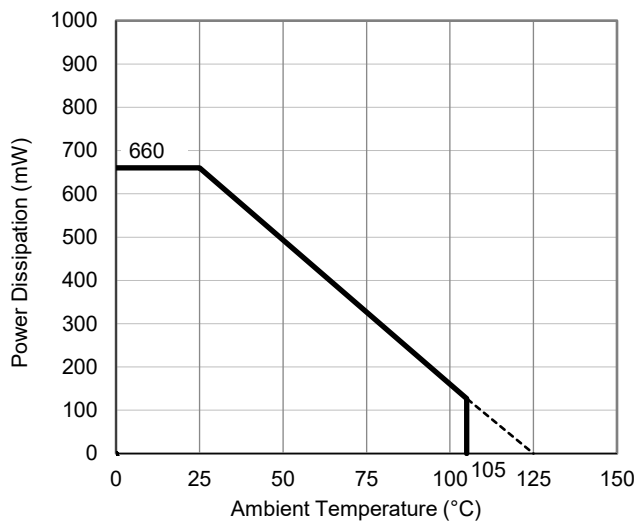
Measurement Result

(Ta = 25°C, Tjmax = 125°C)

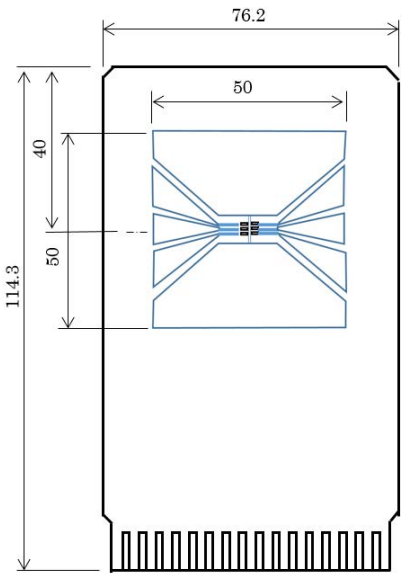
Item	Measurement Result
Power Dissipation	660 mW
Thermal Resistance (θja)	θja = 150°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 51°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature

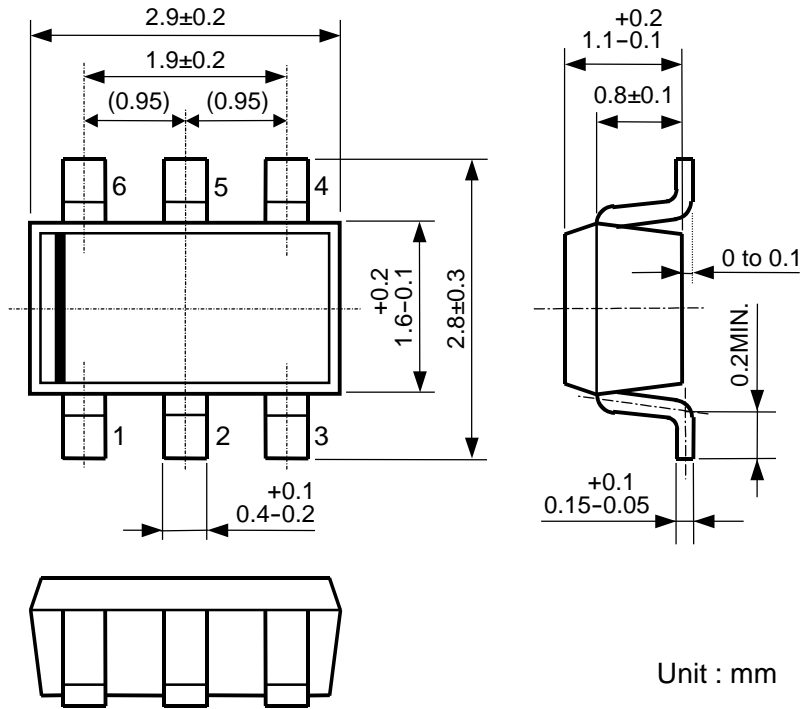


Measurement Board Pattern

PACKAGE DIMENSIONS SOT-23-6

PACKAGE DIMENSIONS SOT-23-6

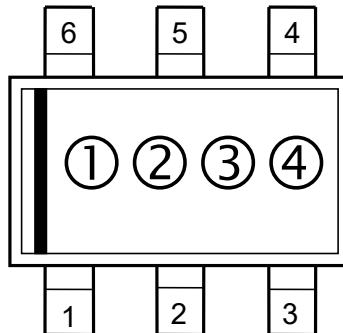
DM-SOT-23-6-JE-B



SOT-23-6 Package Dimensions (Unit: mm)

①②: Product Code … Refer to *Part Marking List*

③④: Lot Number … Alphanumeric Serial Number



R3150N (SOT-23-6) Part Markings

NOTICE

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 our sales or our distributor before attempting to use AOI.

PART MARKINGS

R3150N

MK-R3150N-JE-E

R3150N Part Marking List

Product Name	①	②
R3150N001B	P	A
R3150N001F	P	B
R3150N005F	P	C
R3150N006F	P	D
R3150N007F	P	E
R3150N001A	P	F
R3150N002A	P	G
R3150N003A	P	H
R3150N004A	P	J
R3150N005A	P	K
R3150N006A	P	L
R3150N007A	P	M
R3150N002B	P	N
R3150N003B	P	P
R3150N004B	P	Q
R3150N005B	P	R
R3150N006B	P	S
R3150N007B	P	T
R3150N001E	P	U
R3150N002E	P	V
R3150N003E	P	W
R3150N004E	P	X
R3150N005E	P	Y
R3150N006E	P	Z
R3150N007E	Z	A
R3150N002F	Z	B
R3150N003F	Z	C
R3150N004F	Z	D
R3150N008B	Z	E
R3150N008F	Z	F

Product Name	①	②
R3150N011B	Z	G
R3150N011F	Z	H
R3150N012B	Z	J
R3150N012F	Z	K
R3150N013A	0	A
R3150N013B	0	B
R3150N013E	Z	L
R3150N013F	0	C
R3150N014B	Z	M
R3150N015B	Z	N
R3150N015F	Z	P
R3150N016B	Z	Q
R3150N016F	Z	R
R3150N017B	Z	S
R3150N017F	Z	T
R3150N018A	Z	U
R3150N019B	Z	V
R3150N020A	Z	W
R3150N020B	Z	X
R3150N021A	Z	Y
R3150N021B	Z	Z
R3150N025A	0	D
R3150N025B	0	E
R3150N026A	0	F
R3150N026B	0	G
R3150N027A	0	H
R3150N027B	0	J
R3150N027E	0	K
R3150N027F	0	L

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 our 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 the prior written consent of us.
3. This product and any technical information relating thereto are subject to complementary export controls (so-called KNOW controls) under the Foreign Exchange and Foreign Trade Law, and related politics ministerial ordinance of the law. (Note that the complementary export controls are inapplicable to any application-specific products, except rockets and pilotless aircraft, that are insusceptible to design or program changes.) Accordingly, when exporting or carrying abroad this product, follow the Foreign Exchange and Foreign Trade Control Law and its related regulations with respect to the complementary export controls.
4. The technical information described in this document shows typical characteristics 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 our or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death should first contact us.
 - Aerospace Equipment
 - Equipment Used in the Deep Sea
 - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
 - Life Maintenance Medical Equipment
 - Fire Alarms / Intruder Detectors
 - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
 - Various Safety Devices
 - Traffic control system
 - Combustion equipment

In case your company desires to use this product for any applications other than general electronic equipment mentioned above, make sure to contact our company in advance. Note that the important requirements mentioned in this section are not applicable to cases where operation requirements such as application conditions are confirmed by our company in writing after consultation with your company.

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. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. **Quality Warranty**
 - 8-1. **Quality Warranty Period**
In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
 - 8-2. **Quality Warranty Remedies**
When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
 - 8-3. **Remedies after Quality Warranty Period**
With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.



Nisshinbo Micro Devices Inc.

Official website

<https://www.nisshinbo-microdevices.co.jp/en/>

Purchase information

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