

High-Speed Rail-to-Rail Input, Push-Pull Output CMOS Comparators

■ FEATURES ($V^+/V^- = 5V/0V$, $T_a = 25^\circ C$)

- Propagation Delay 42ns typ. (t_{PLH})
 35ns typ. (t_{PHL})
 - Rail-to-Rail Input
 - Push Pull Output
 - Supply Current 140 μA /ch typ.
 - Operating Voltage 2.7V to 5.5V
 - Operating Temperature -40°C to 125°C
 - Input Offset Voltage 7mV max.
 - Package
 - NJU77250 SOT-23-5, SC-88A
 - NJU77251 SOT-23-5, SC-88A, DFN6-G1 (ESON6-G1)
 - NJU77252 MSOP8 (VSP8)*, DFN8-U1(ESON8-U1)
- *meet JEDEC MO-187-DA

■ APPLICATION

- Protection circuit for overvoltage detection, overcurrent detection, overheat detection, etc.
- Window comparators
- LED drivers
- Relay drivers
- Electronic and electrical equipment in general

■ GENERAL DESCRIPTION

The NJU77250/NJU77251/NJU77252 are Rail-to-Rail Input CMOS comparators featuring High-Speed and Push-Pull output. These comparators operate from 2.7V to 5.5V and low supply current of 140 μA /ch. typ. This feature is suitable for battery powered application.

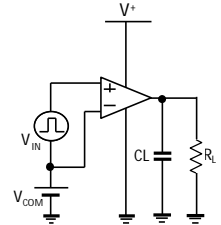
Newly developed circuit technology * Dynamic Transient Stabilizer™ realizes full swing input with suppressed fluctuation of propagation delay time.

In addition, the common mode input voltage range that exceeds the power supply voltage range is specified, and voltage detection near the power supply voltage is supported.

The NJU77251/NJU77252 are available in small size Package, DFN6-G1(1616), DFN8-U1(2020), significantly reducing the required portable application's board area.

* Dynamic Transient Stabilizer™

It is a circuit technology that suppresses fluctuations in propagation delay time even if the reference voltage for voltage detection fluctuates.



■ RELATED PRODUCTS

Features	Single	Dual
High-Speed Rail-to-Rail Input Open-Drain Output CMOS Comparators	NJU77260 NJU77261	NJU77262

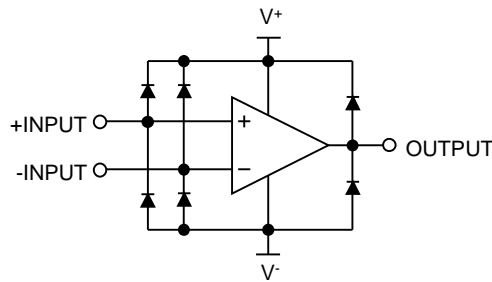
■ PIN CONFIGURATIONS

PRODUCT NAME	NJU77250F	NJU77250F3	NJU77251F	NJU77251F3
Package	SOT-23-5	SC-88A	SOT-23-5	SC-88A
Pin Functions				

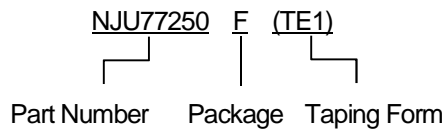
PRODUCT NAME	NJU77251KG1	NJU77252R	NJU77232KU1
Package	DFN6-G1(ESON6-G1)(*)	MSOP8 (VSP8)	DFN8-U1(ESON8-U1) (*)
Pin Functions			

(*)Connect to exposed pad to V-

■ BLOCK DIAGRAM



■ PRODUCT NAME INFORMATION



■ ORDERING INFORMATION

PART NUMBER	PACKAGE OUTLINE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJU77250F (TE1)	SOT-23-5	Yes	Yes	Sn2Bi	1S	15	3000
NJU77250F3 (TE1)	SC-88A	Yes	Yes	Sn2Bi	F5	7.5	3000
NJU77251F (TE1)	SOT-23-5	Yes	Yes	Sn2Bi	1U	15	3000
NJU77251F3 (TE1)	SC-88A	Yes	Yes	Sn2Bi	F6	7.5	3000
NJU77251KG1 (TE3)	DFN6-G1	Yes	Yes	Sn2Bi	77251	3.5	3000
NJU77252R (TE1)	MSOP8(VSP8)	Yes	Yes	Sn2Bi	77252	21	2000
NJU77252KU1 (TE3)	DFN8-U1	Yes	Yes	Sn2Bi	77252	5.3	3000

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	7	V
Input Voltage ^(1,2)	V_{IN}	$V^- - 0.3$ to $V^+ + 0.3$	V
Input Current ⁽²⁾	I_{IN}	10	mA
Output Terminal Input Voltage ⁽¹⁾	V_o	$V^- - 0.3$ to $V^+ + 0.3$	V
Differential Input Voltage ⁽³⁾	V_{ID}	± 7	V
Power Dissipation ($T_a = 25^\circ\text{C}$)	P_D	(2-layer / 4-layer)	mW
SOT-23-5 ⁽⁴⁾		480 / 650	
SC-88A ⁽⁴⁾		360 / 490	
DFN6-G1 ⁽⁵⁾		330 / 1200	
MSOP8(VSP8) ⁽⁴⁾		500 / 660	
DFN8-U1 ⁽⁵⁾	450 / 1200		
Storage Temperature	T_{stg}	- 55 to 150	$^\circ\text{C}$
Junction Temperature	T_j	150	$^\circ\text{C}$

(1) Voltage values are limited at 7V.

(2) Input voltages outside the supply voltage will be clamped by ESD protection diodes. If the input voltage exceeds the supply voltage, the input current must be limited 10mA or less by using a restriction resistance.

(3) Differential voltage is the voltage difference between +INPUT and - INPUT.

For supply voltage less than 7V, the absolute maximum rating is equal to the supply voltage.

(4) Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JDEC standard, 2Layers FR4)

Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JDEC standard, 4Layers FR4), internal Cu area: 74.2x74.2mm

(5) Mounted on glass epoxy board. (101.5x114.5x1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)

Mounted on glass epoxy board. (101.5x114.5x1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)

*For 4Layers: Applying 99.5x99.5mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5

■ THERMAL CHARACTERISTICS

PARAMETER	SYMBOL	VALUE	UNIT
Junction-to-ambient thermal resistance SOT-23-5 ⁽⁶⁾ SC-88A ⁽⁶⁾ DFN6-G1 ⁽⁷⁾ MSOP8(VSP8) ⁽⁶⁾ DFN8-U1 ⁽⁷⁾	θ_{ja}	(2-layer / 4-layer) 259 / 193 352 / 256 381 / 106 252 / 189 278 / 107	$^{\circ}\text{C}/\text{W}$
Junction-to-Top of package characterization parameter SOT-23-5 ⁽⁶⁾ SC-88A ⁽⁶⁾ DFN6-G1 ⁽⁷⁾ MSOP8(VSP8) ⁽⁶⁾ DFN8-U1 ⁽⁷⁾	ψ_{jt}	(2-layer/ 4-layer) 67 / 58 91 / 73 64 / 26 62 / 53 42 / 25	$^{\circ}\text{C}/\text{W}$

(6) Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JDEC standard, 2Layers FR4)

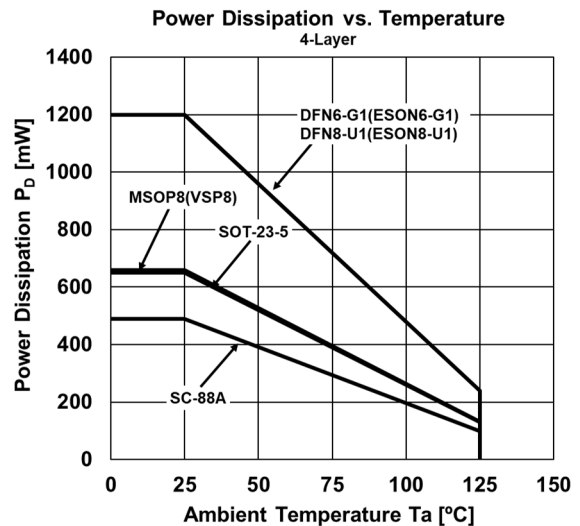
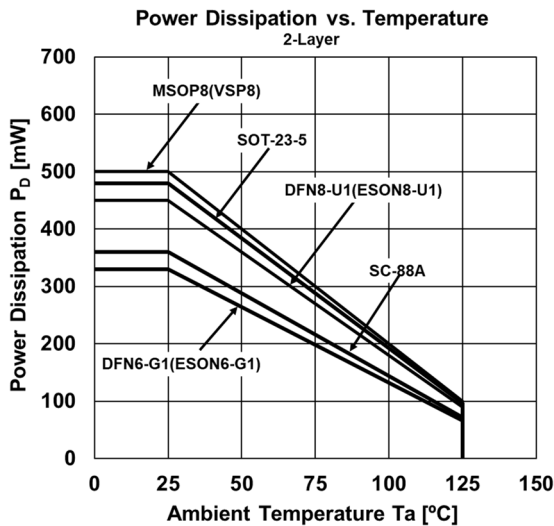
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(7) Mounted on glass epoxy board. (101.5x114.5x1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)

Mounted on glass epoxy board. (101.5x114.5x1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)

*For 4Layers: Applying 99.5x99.5mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5)

■ POWER DISSIPATION vs. AMBIENT TEMPERATURE



■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	$V^+ - V^-$	2.7 to 5.5	V
Input Voltage	V_{IN}	$V^- - 0.2$ to $V^+ + 0.2$ (MAX. 5.5V)	V
Operating Temperature	T_{opr}	- 40 to 125	$^{\circ}\text{C}$

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS

($V^+=5V$, $V^-=0V$, $R_L=OPEN$, $T_a=25^\circ C$, unless otherwise noted.)

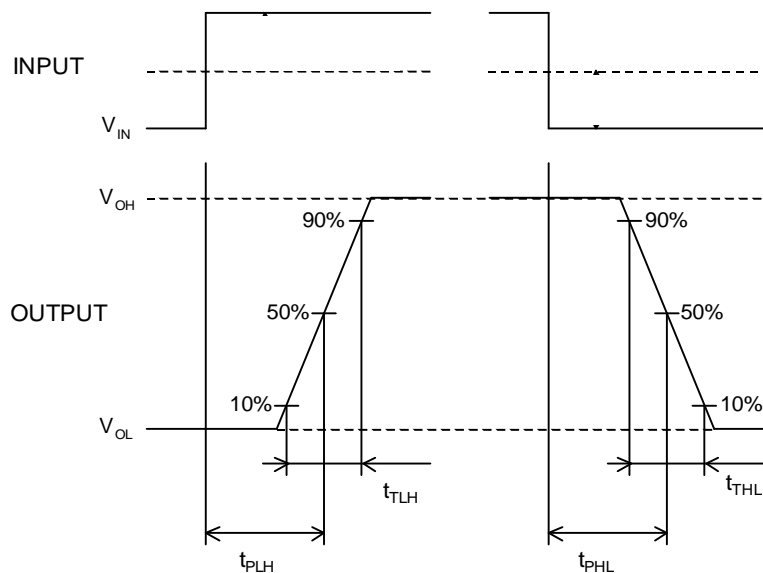
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Supply Current (per comparator)	I_{SUPPLY}	$V_{COM}=-0.2V$, $V_{ID}=100mV$	-	140	210	μA
		$V_{COM}=5.2V$, $V_{ID}=100mV$	-	200	300	
Input Offset Voltage	V_{IO}	$V_{COM}=-0.2V$	-	1	7	mV
		$V_{COM}=5.2V$	-	1	9	
Input Offset Current	I_{IO}		-	1	-	pA
Input Bias Current	I_B		-	1	-	pA
Common Mode Input Voltage Range	V_{ICM}	$CMR \geq 55dB$	-0.2	-	5.2	V
Common Mode Rejection Ratio	CMR	$V_{ICM}=-0.2V$ to $5.2V$	55	70	-	dB
Supply Voltage Rejection Ratio	SVR	$V^+=2.7V$ to $5.5V$	60	85	-	dB
Short-circuit Output Current	I_{SC}	I_{SOURCE} , $V_O=0V$	-	85	-	mA
		I_{SINK} , $V_O=5V$	-	65	-	
High-level Output Voltage	V_{OH}	$I_{SOURCE}=4mA$	4.8	4.9	-	V
Low-level Output Voltage	V_{OL}	$I_{SINK}=4mA$	-	0.1	0.2	V

● SWITCHING CHARACTERISTICS

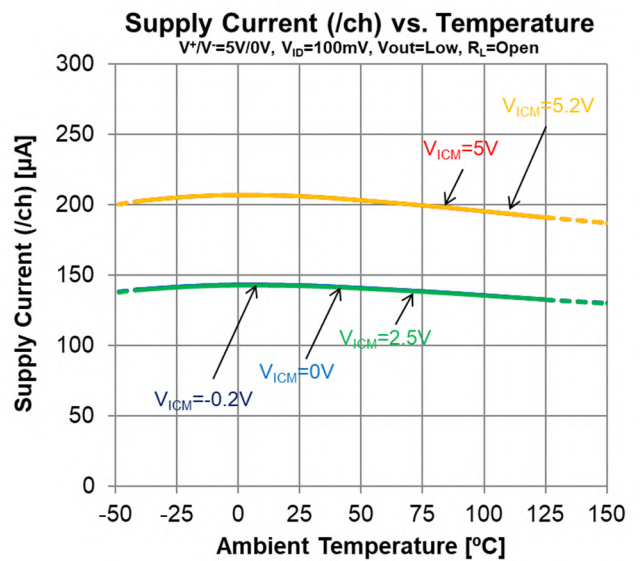
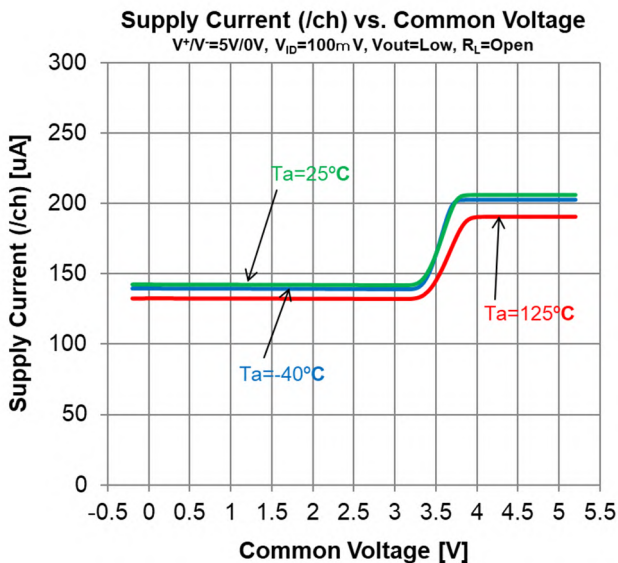
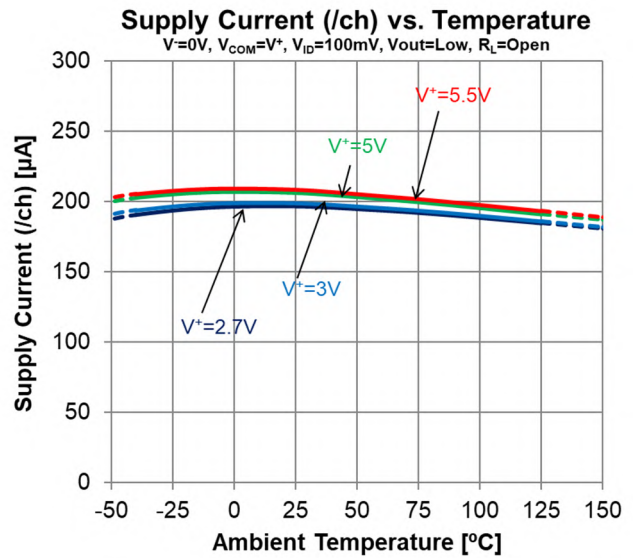
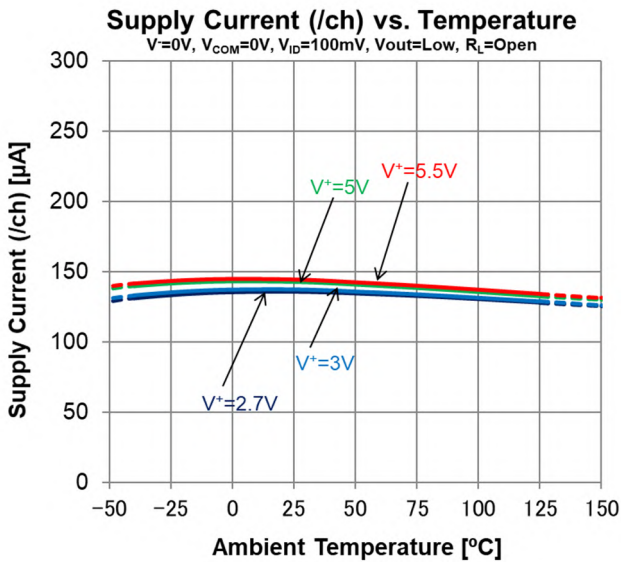
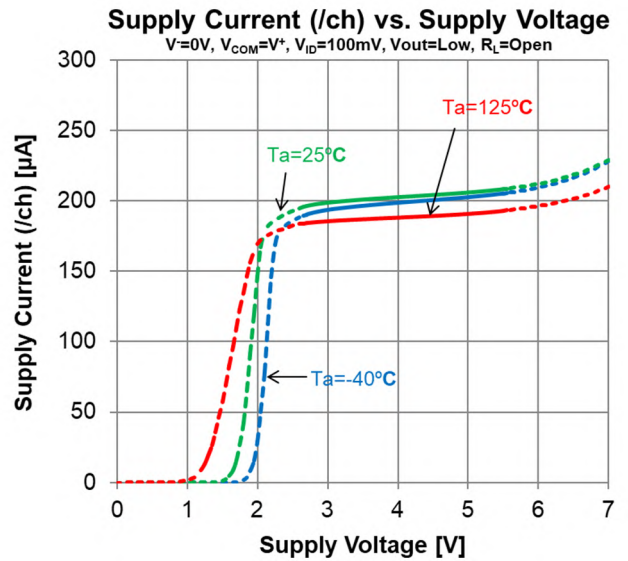
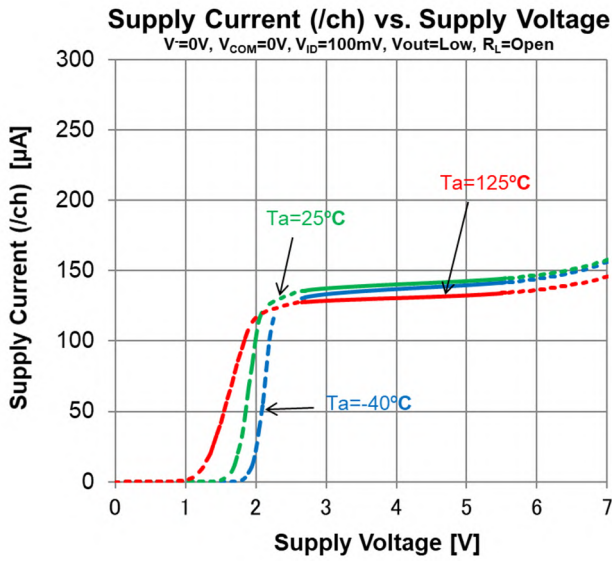
($V^+=5V$, $V^-=0V$, $T_a=25^\circ C$, $C_L=15pF$, $R_L=5.1k\Omega$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Propagation Delay Low to High	t_{PLH}	Overdrive=100mV	-	42	-	ns
Propagation Delay High to Low	t_{PHL}	Overdrive=100mV	-	35	-	ns
Output Signal Rising Time	t_{TLH}	Overdrive=100mV	-	4.0	-	ns
Output Signal Falling Time	t_{THL}	Overdrive=100mV	-	3.5	-	ns

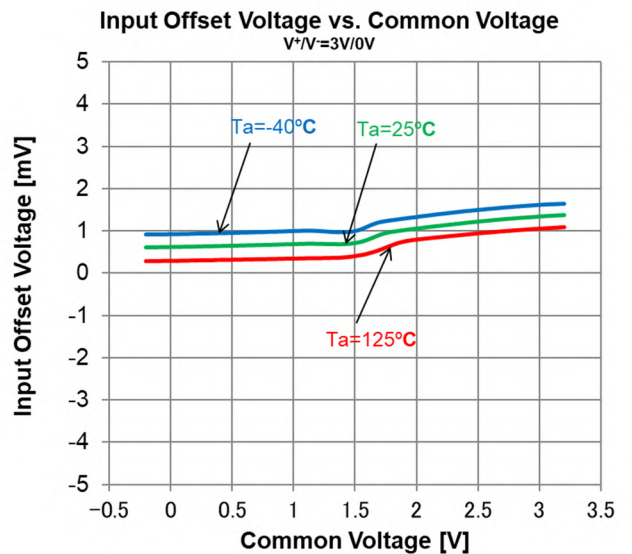
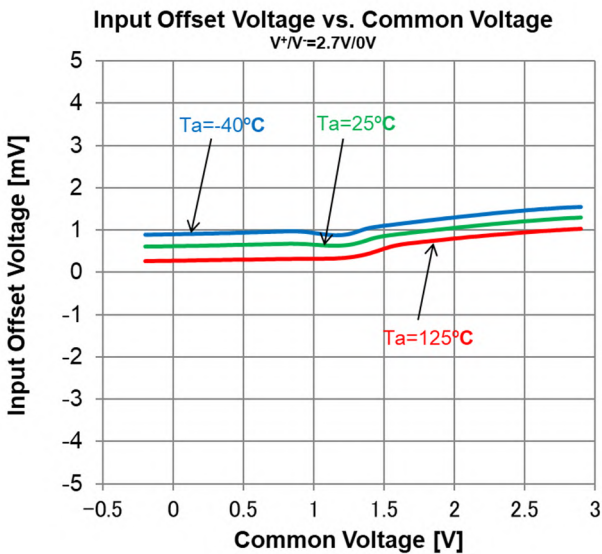
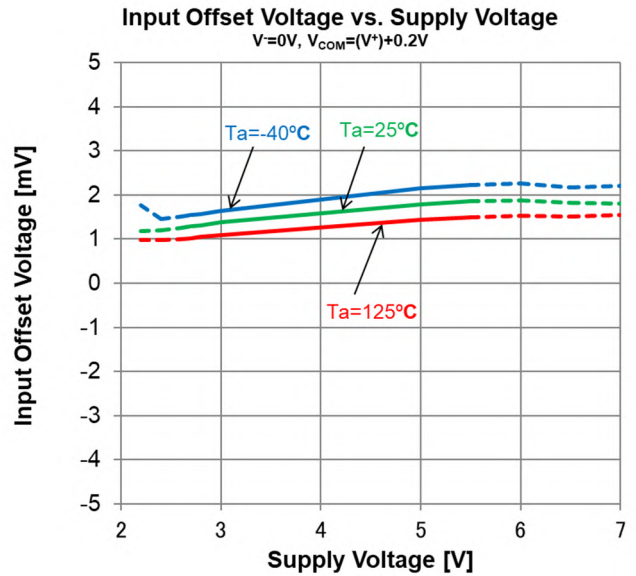
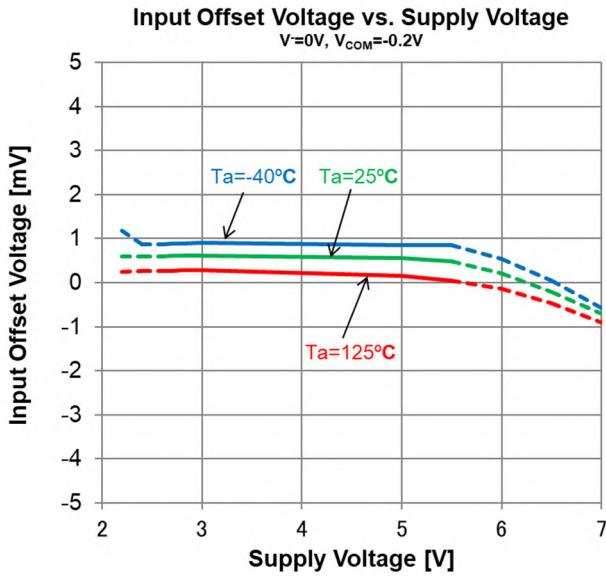
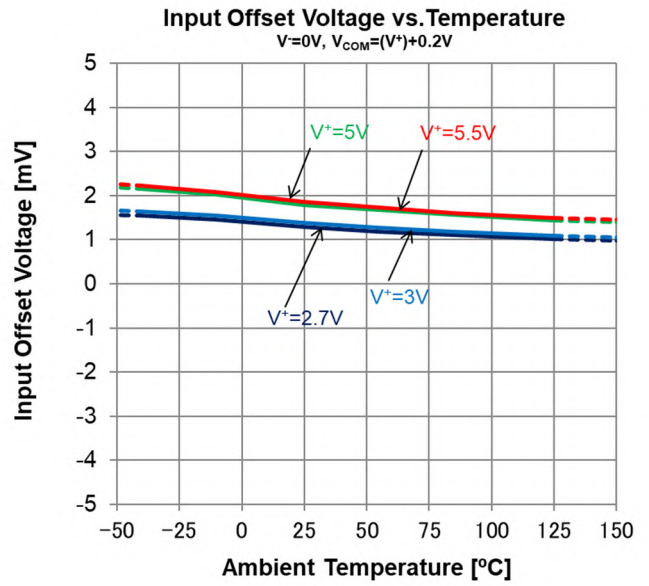
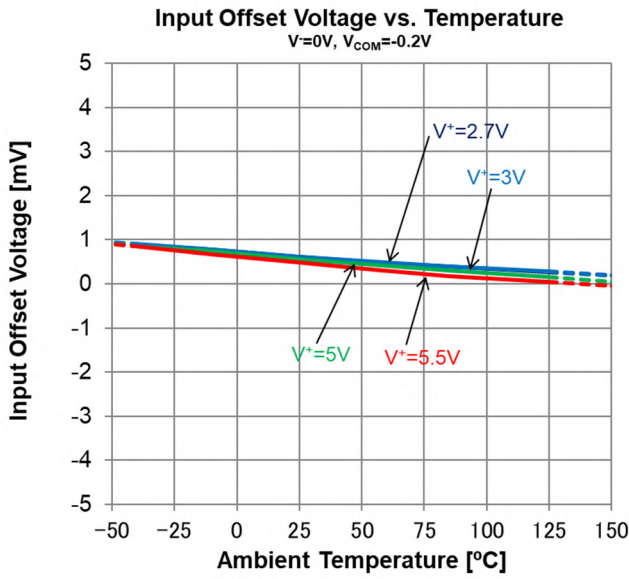
■ TIMING WAVEFORM



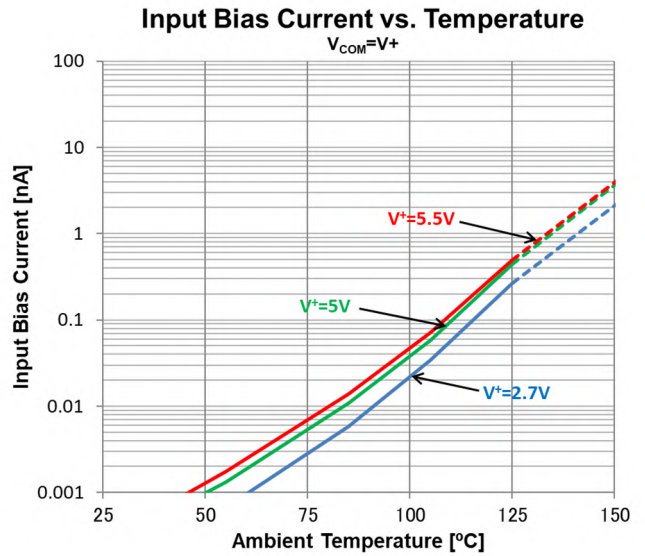
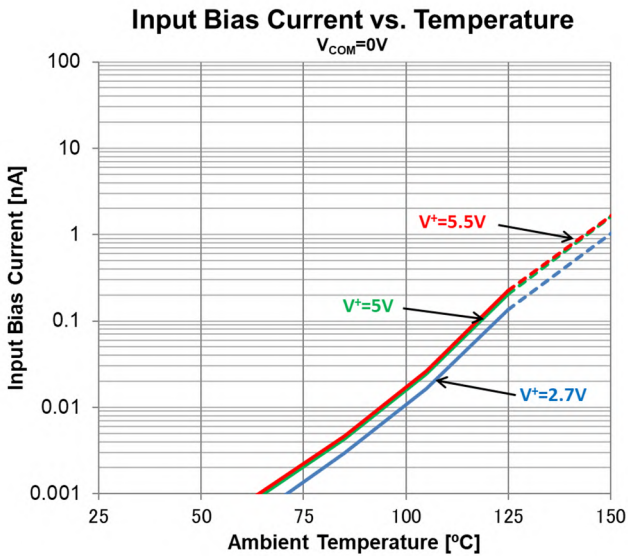
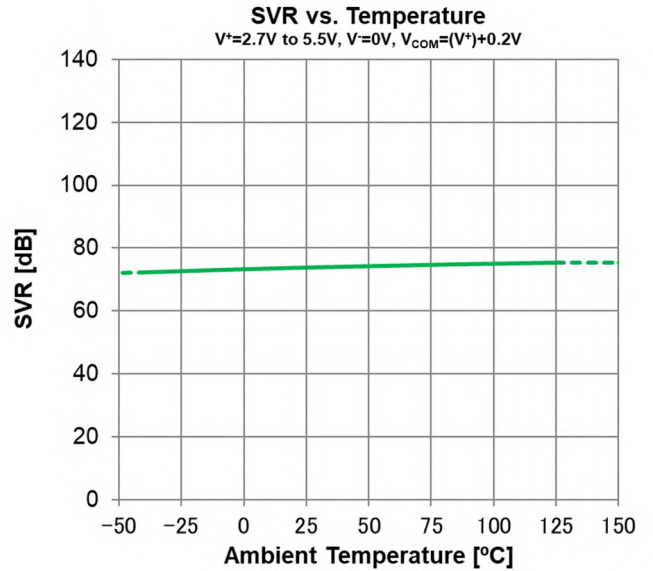
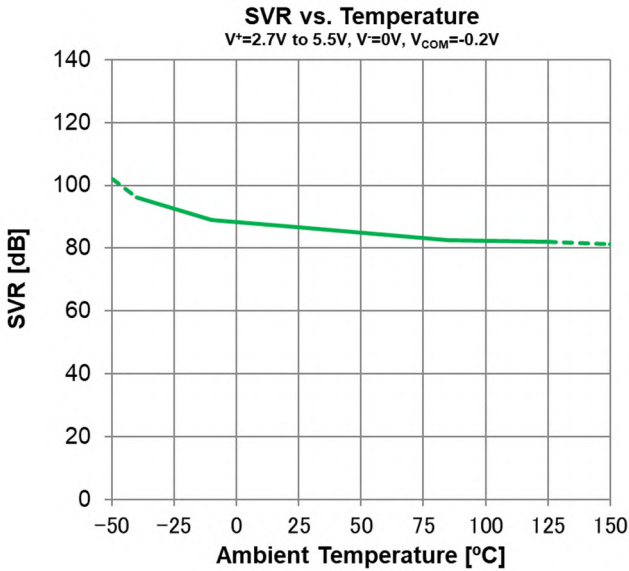
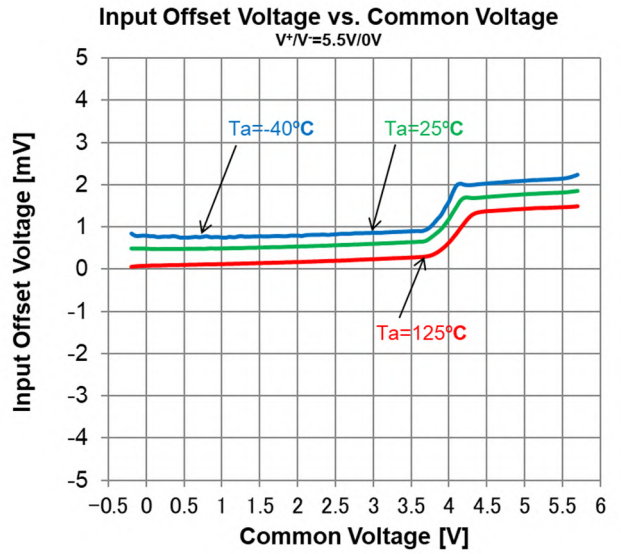
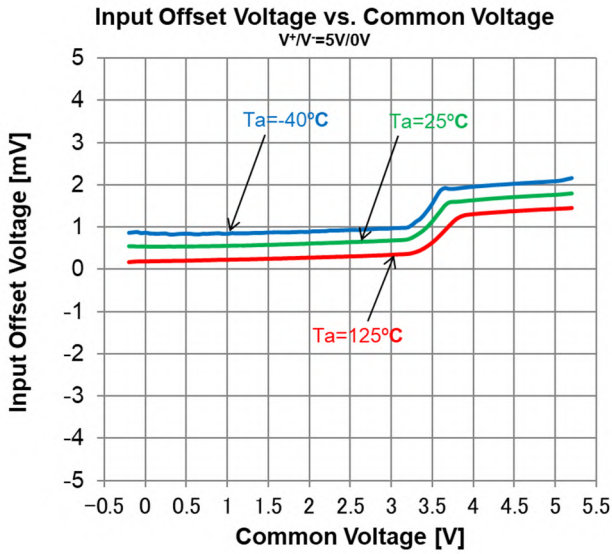
■ TYPICAL CHARACTERISTICS



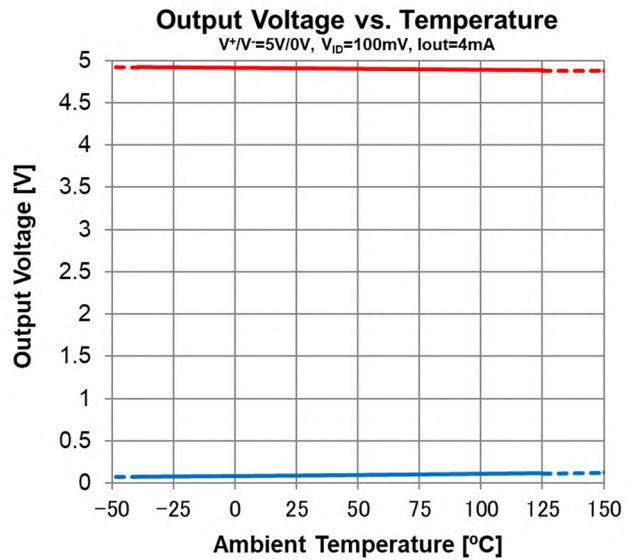
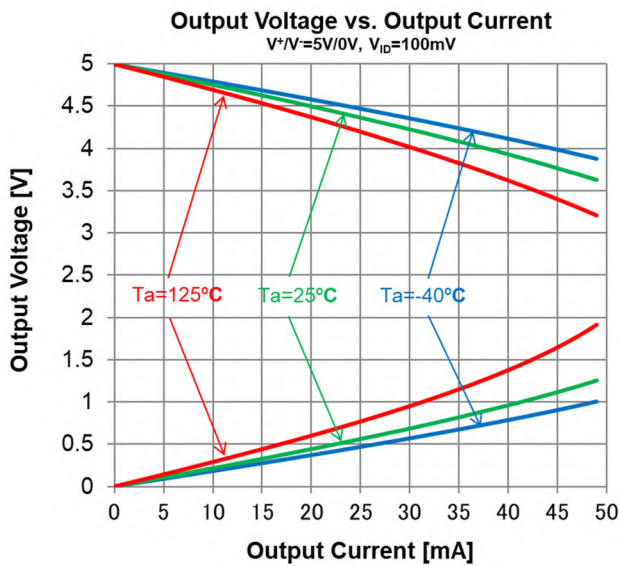
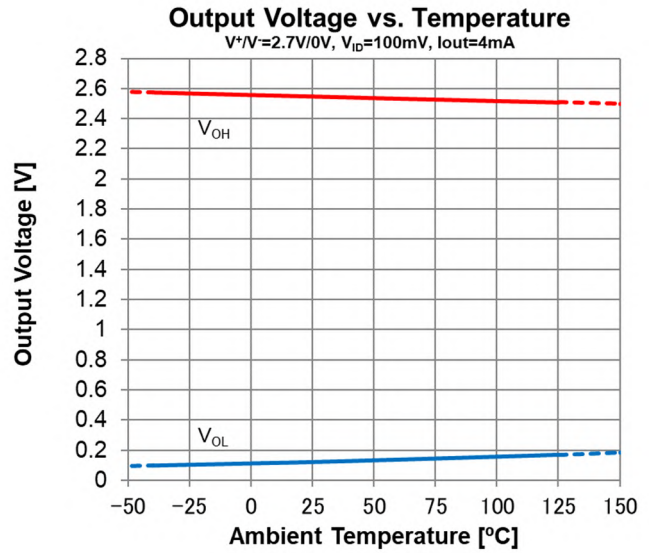
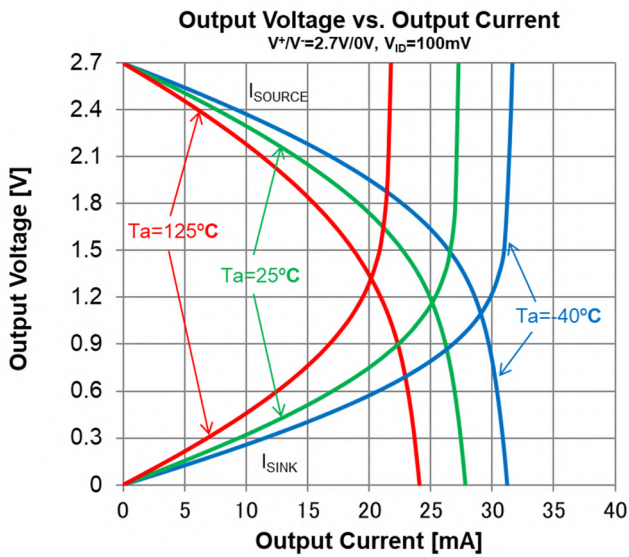
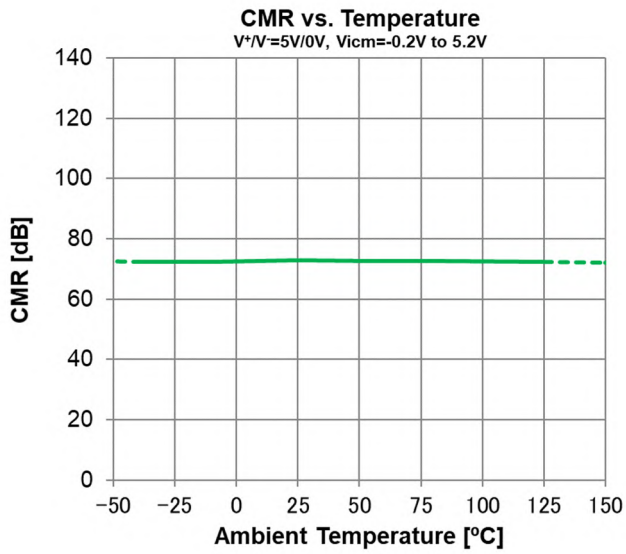
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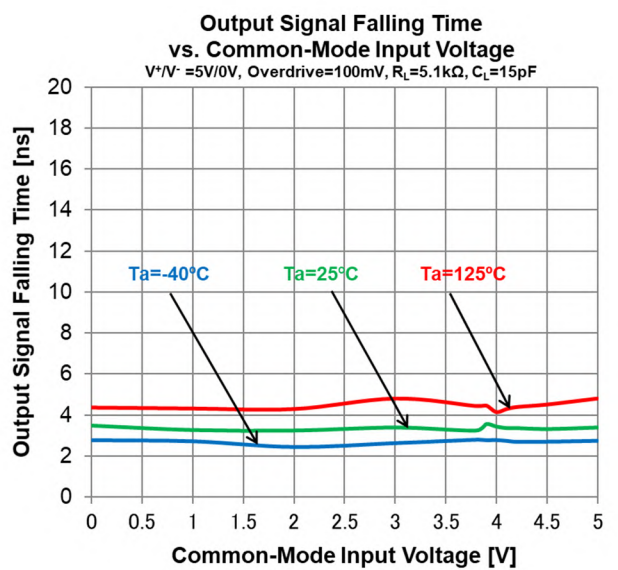
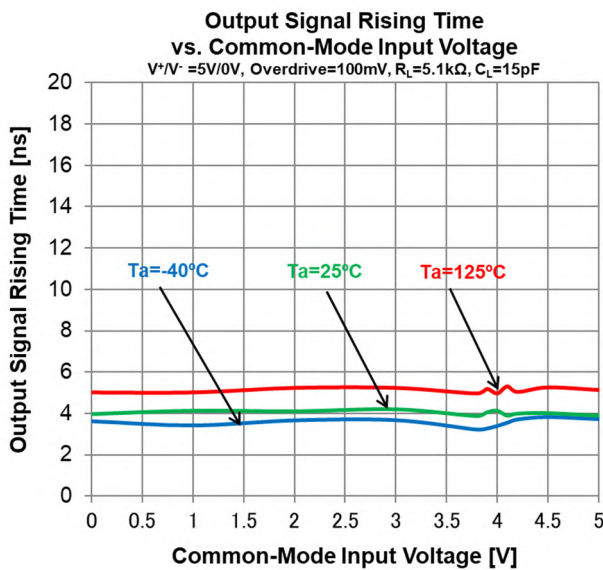
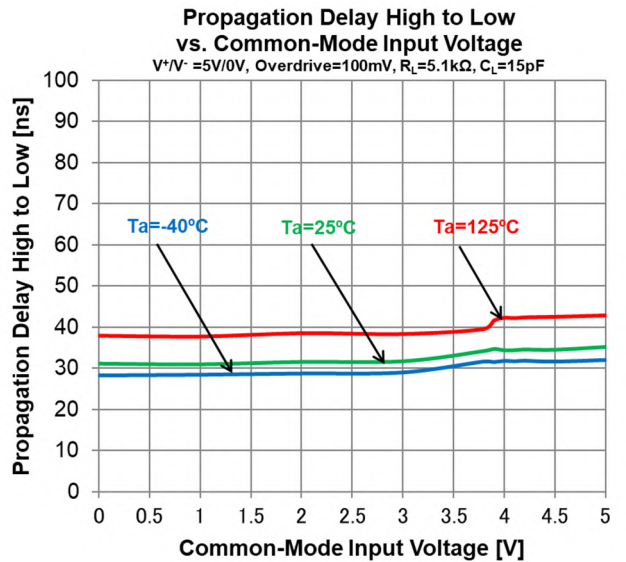
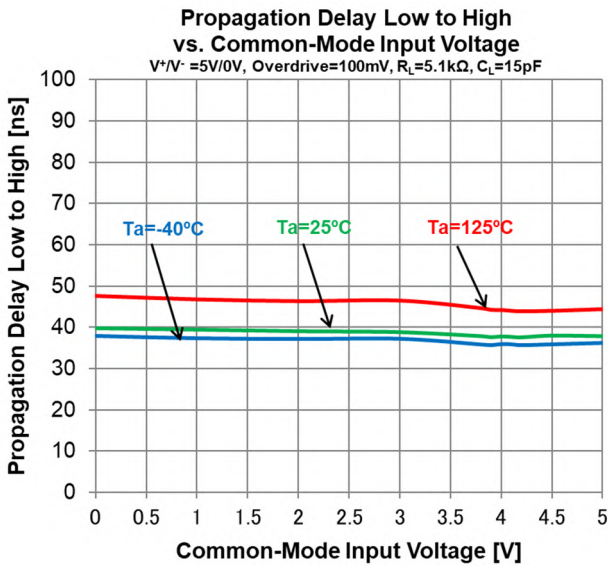
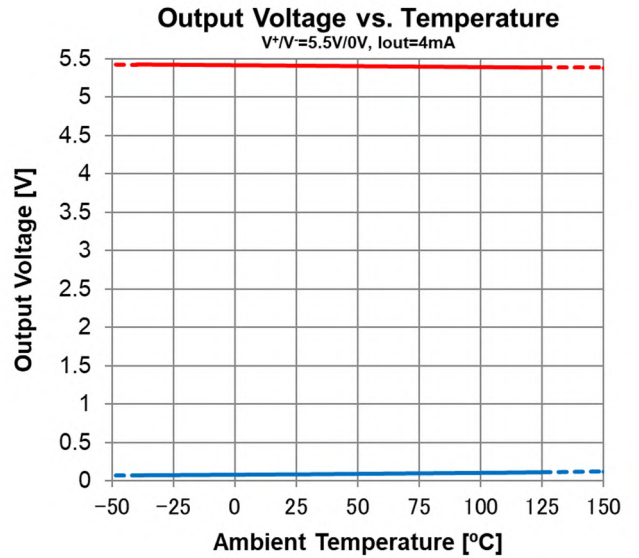
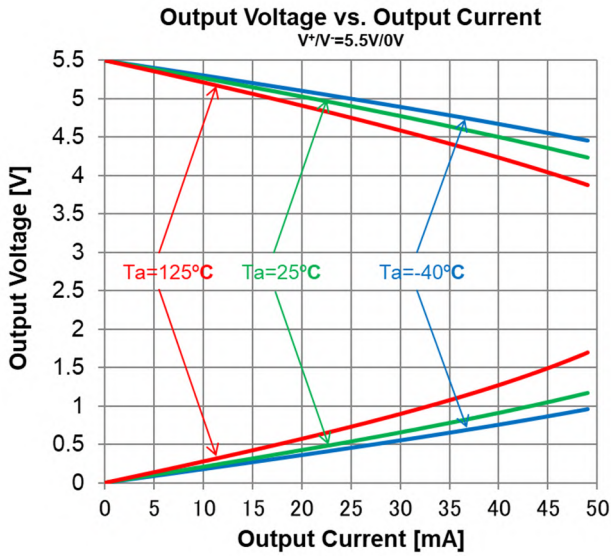
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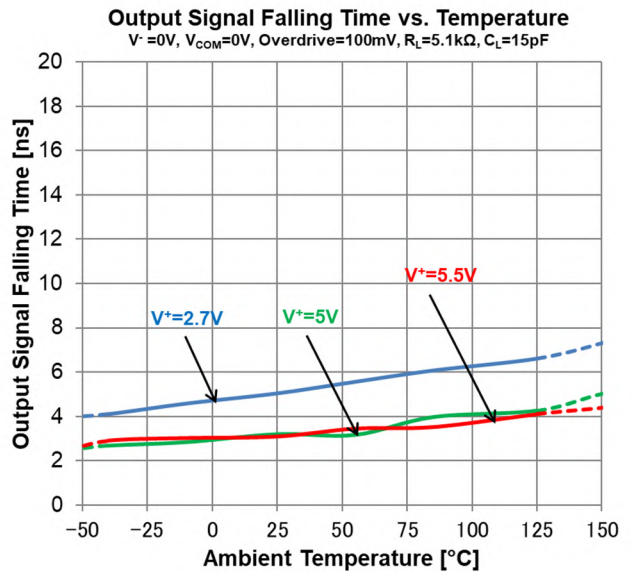
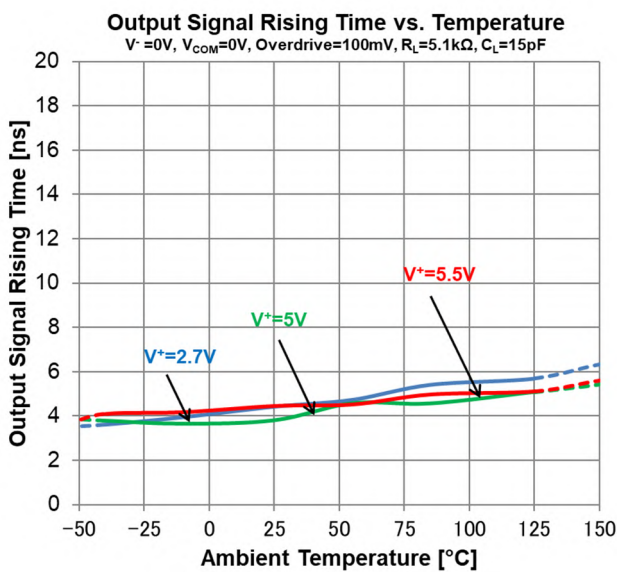
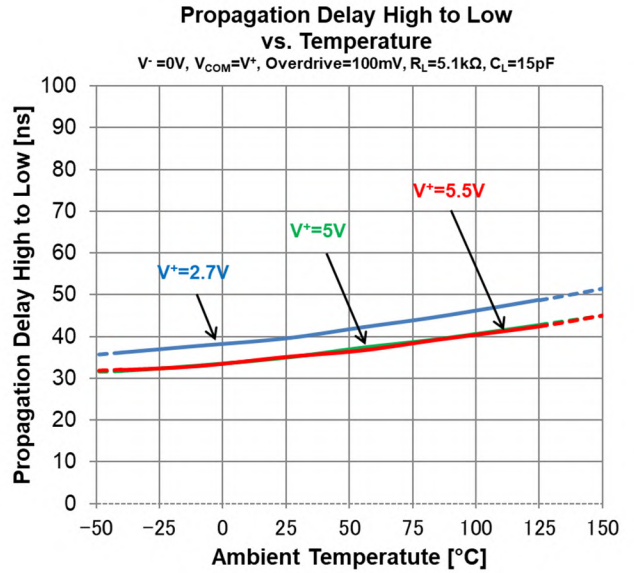
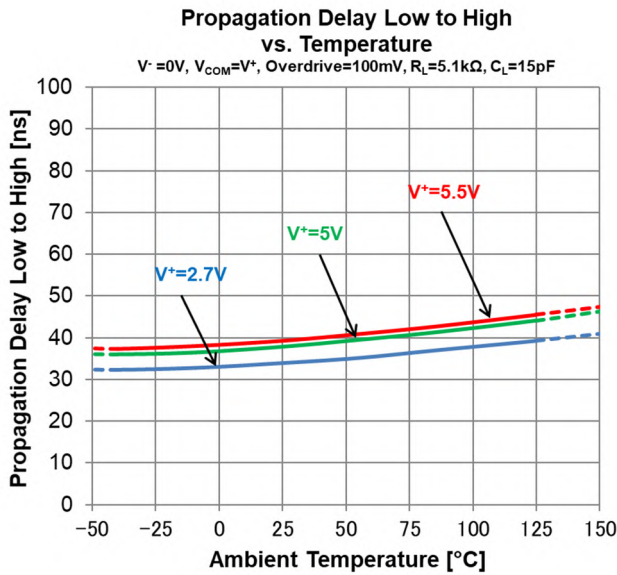
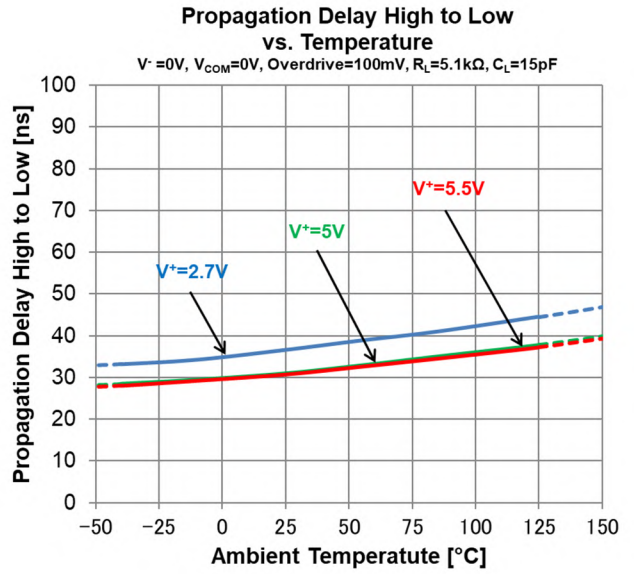
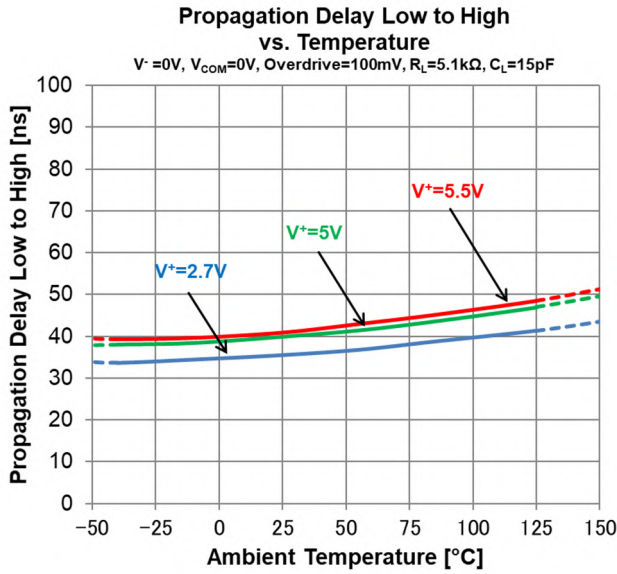
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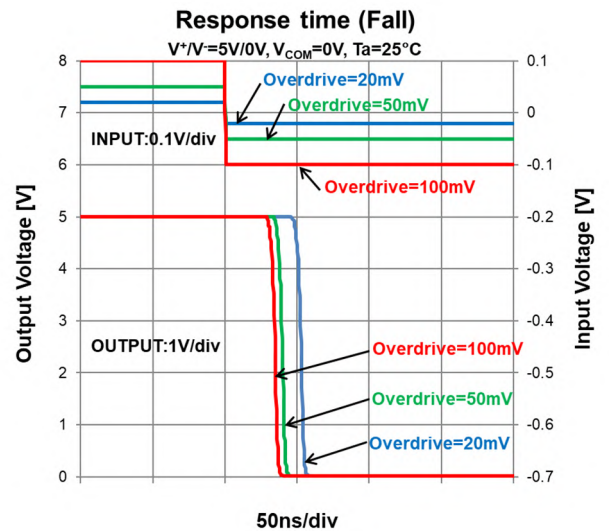
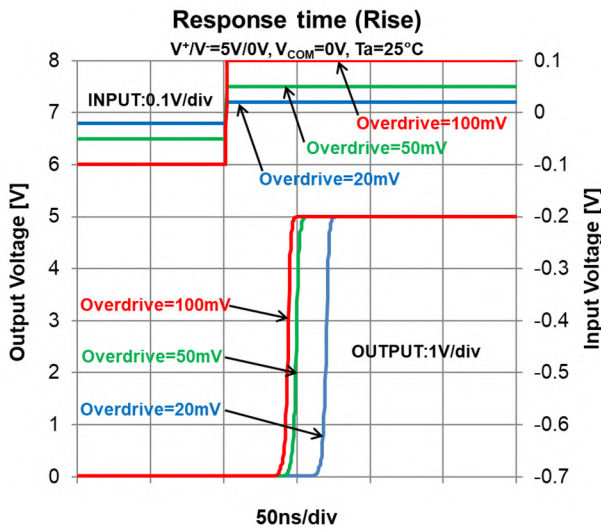
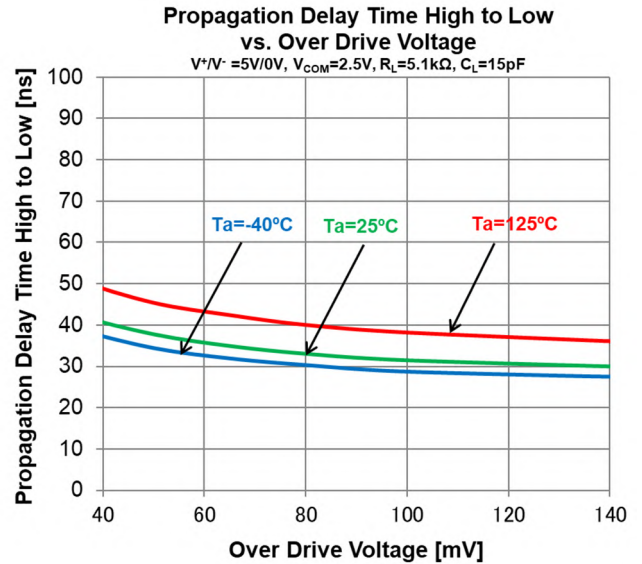
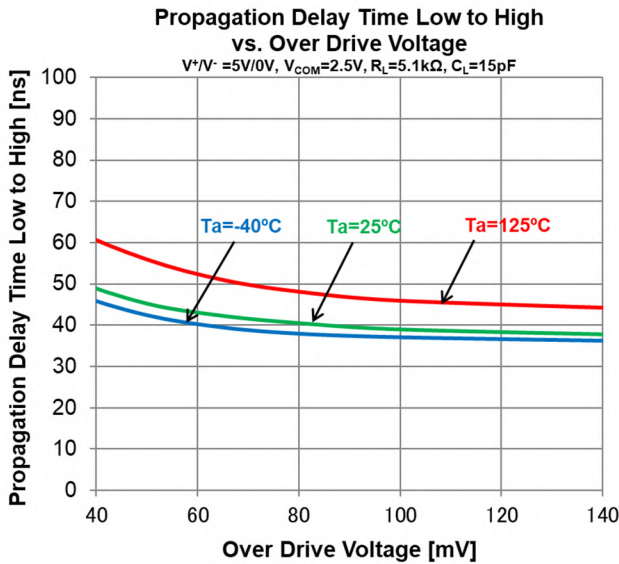
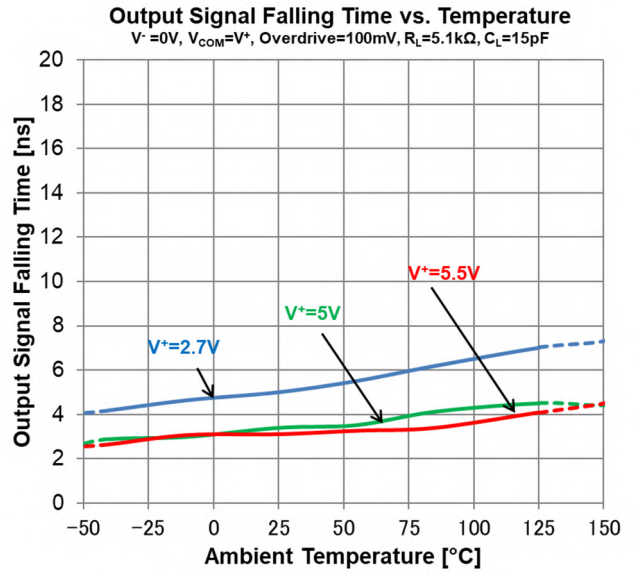
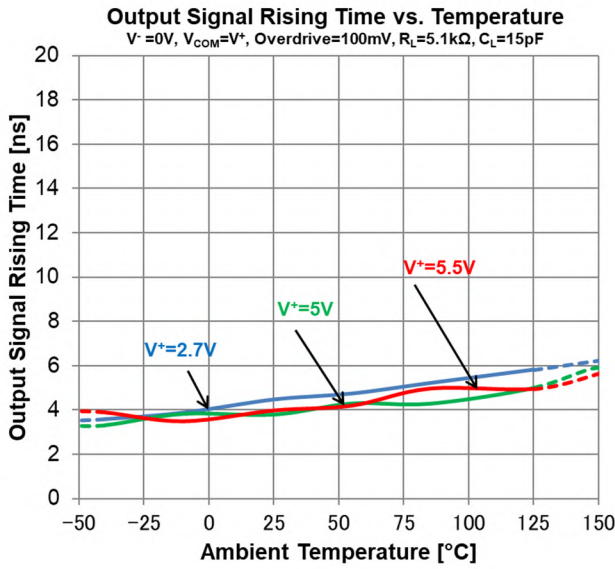
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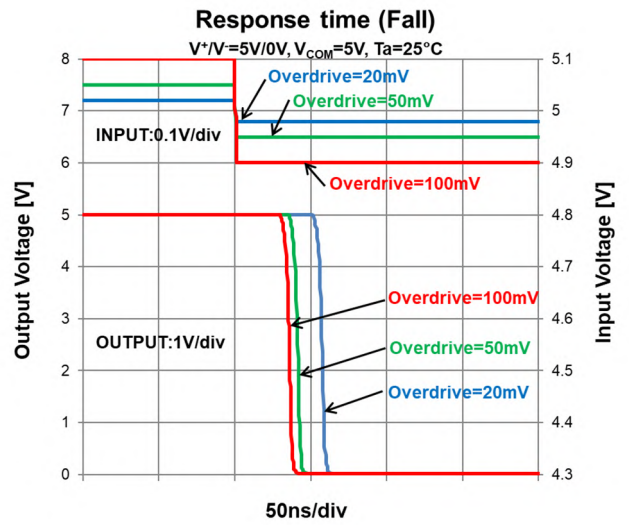
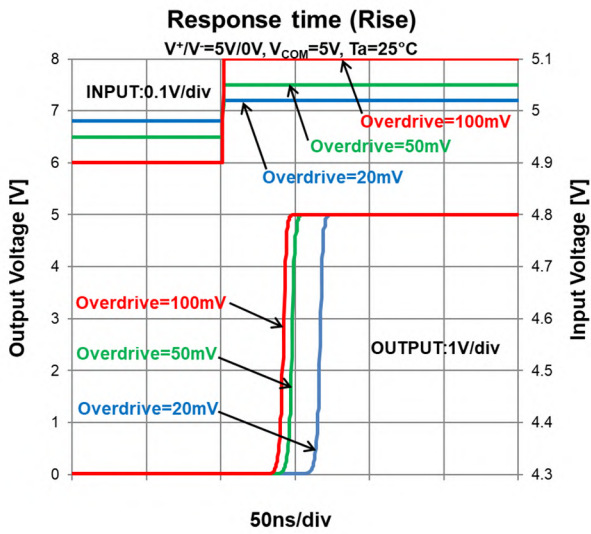
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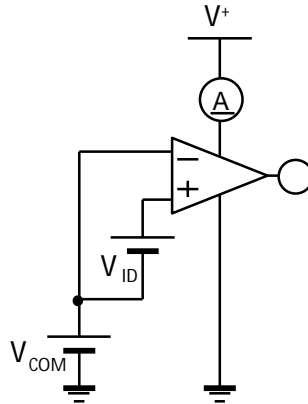
■ TYPICAL CHARACTERISTICS



■ TYPICAL TEST CIRCUIT

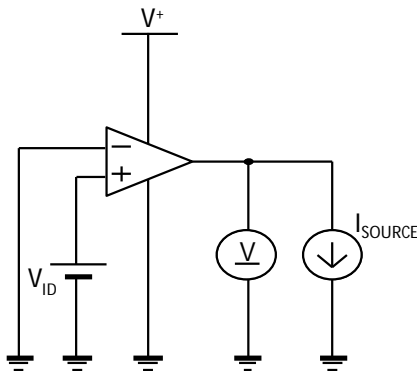
● Supply Current (I_{SUPPLY})

- $V^+=5V, V^-=0V, V_{COM}=-0.2V, V_{ID}=100mV$
- $V^+=5V, V^-=0V, V_{COM}=5.2V, V_{ID}=100mV$



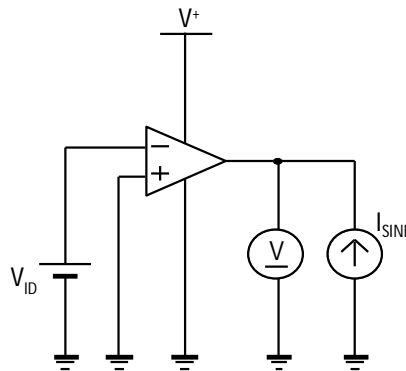
● High-level Output Voltage (V_{OH})

- $V^+=5V, V^-=0V, I_{SOURCE}=4mA, V_{ID}=100mV$



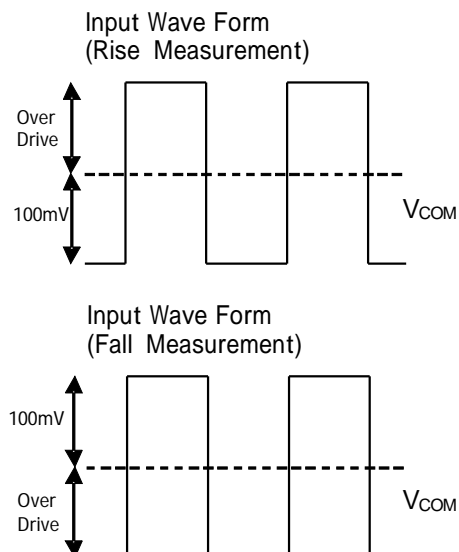
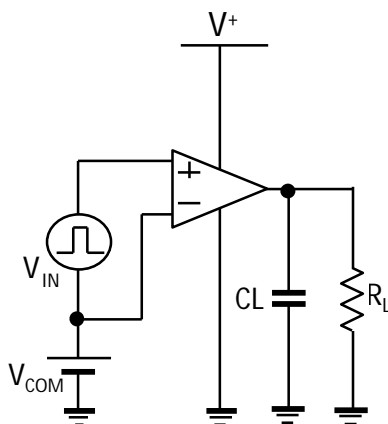
● Low-level Output Voltage (V_{OL})

- $V^+=5V, V^-=0V, I_{SINK}=4mA, V_{ID}=100mV$



● Propagation Delay (t_{PLH}, t_{PHL}), Output Signal Rising Time (t_{rLH}), Output Signal Falling Time (t_{rHL})

- $V^+=5V, V^-=0V, V_{COM}=0V, R_L=5.1k\Omega, C_L=15pF, \text{Over drive}=100mV$



■ APPLICATION NOTE

· Input Voltage Exceeding the Supply Voltage

Inputs of the NJU77250/ NJU77251/ NJU77252 are protected by ESD diodes (shown in Figure1) that will conduct if the input voltages exceed the power supplies by more than approximately 300mV. Momentary voltages greater than 300mV beyond the power supply, inputs can be tolerated if the current is limited to 10mA. Figure2 is easily accomplished with an input resistor. If the input voltage exceeds the supply voltage, the input current must be limited 10mA or less by using a restriction resistance (R_{LIMIT}) as shown in figure2.

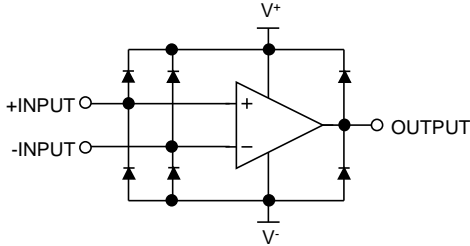


Figure1. Simplified Schematic

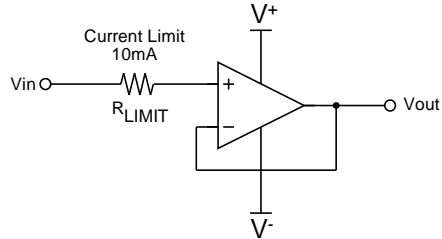


Figure2. Input Current Protection for Voltages exceeding the Supply Voltage.

· Bypass Capacitor

It is advised to add a bypass capacitor between the supply voltage and ground as close as possible to device.

· (Example) Voltage level detection circuit with a window comparator

In a conventional general Rail-to-Rail Input comparator, the propagation delay time may fluctuate by as much as 44% when the level of the input signal changes. Therefore, there is a possibility that signal processing cannot be performed at a desired speed. The NJU77250 series has little variation in propagation delay time with respect to changes in V_{ref} , it can be used for window comparators that are severely affected by the timing difference between lower limit detection and upper limit detection.

Circuit technology **Dynamic Transient Stabilizer™** provides a stable response for signals in all input ranges.

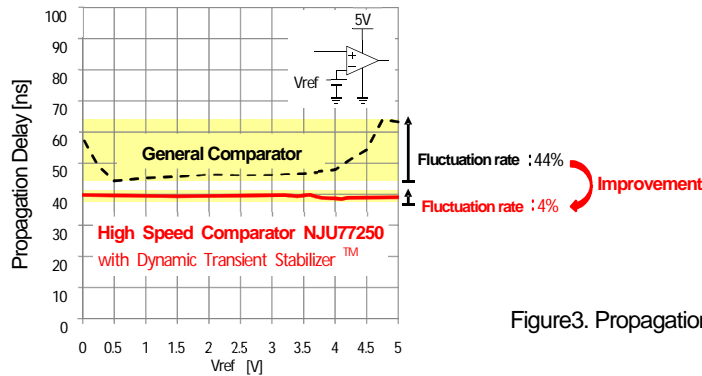
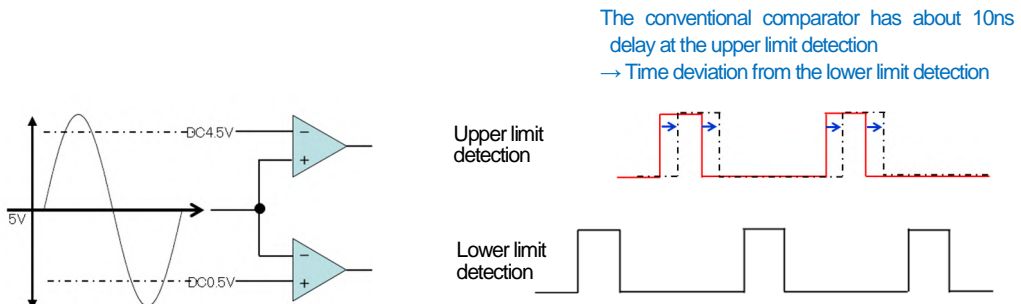


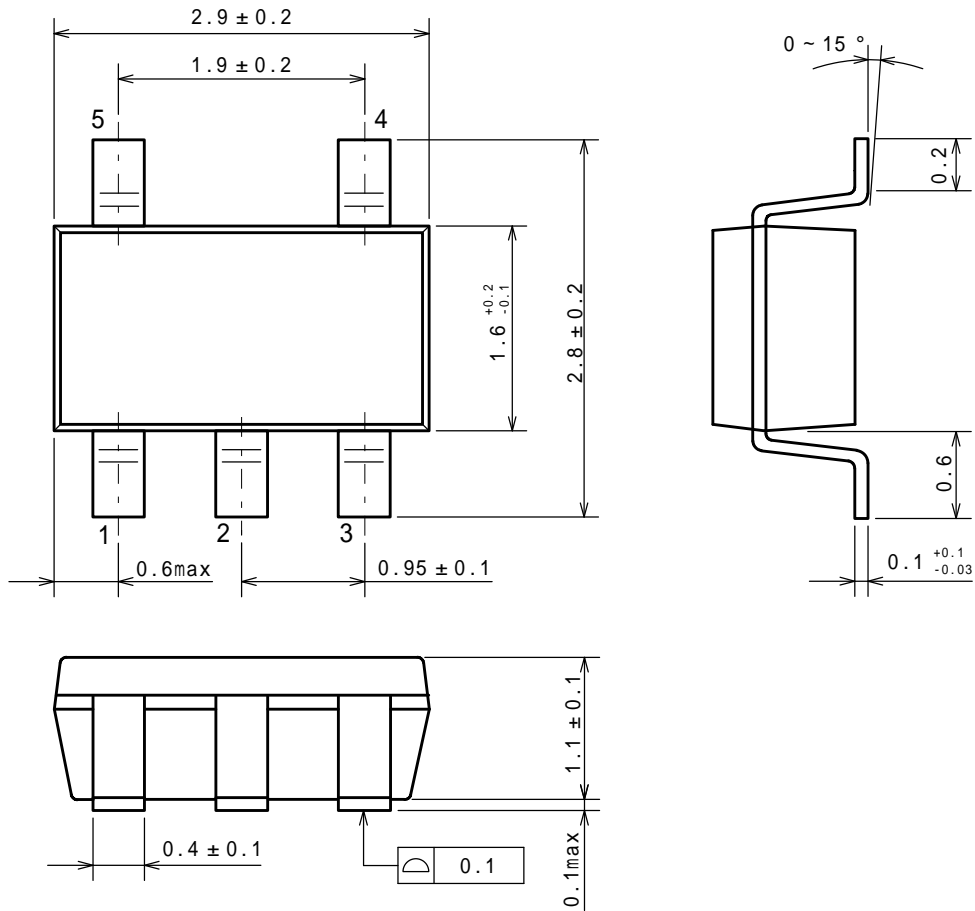
Figure3. Propagation Delay vs. V_{ref}

(Example) Voltage level detector circuit with a window comparator

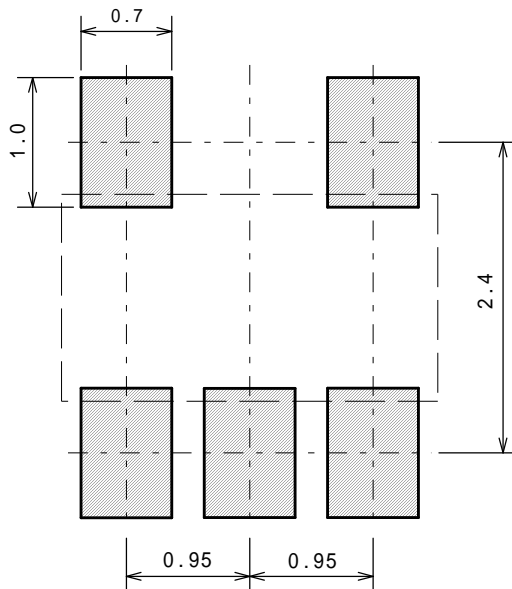


The conventional comparator has about 10ns delay at the upper limit detection
 → Time deviation from the lower limit detection

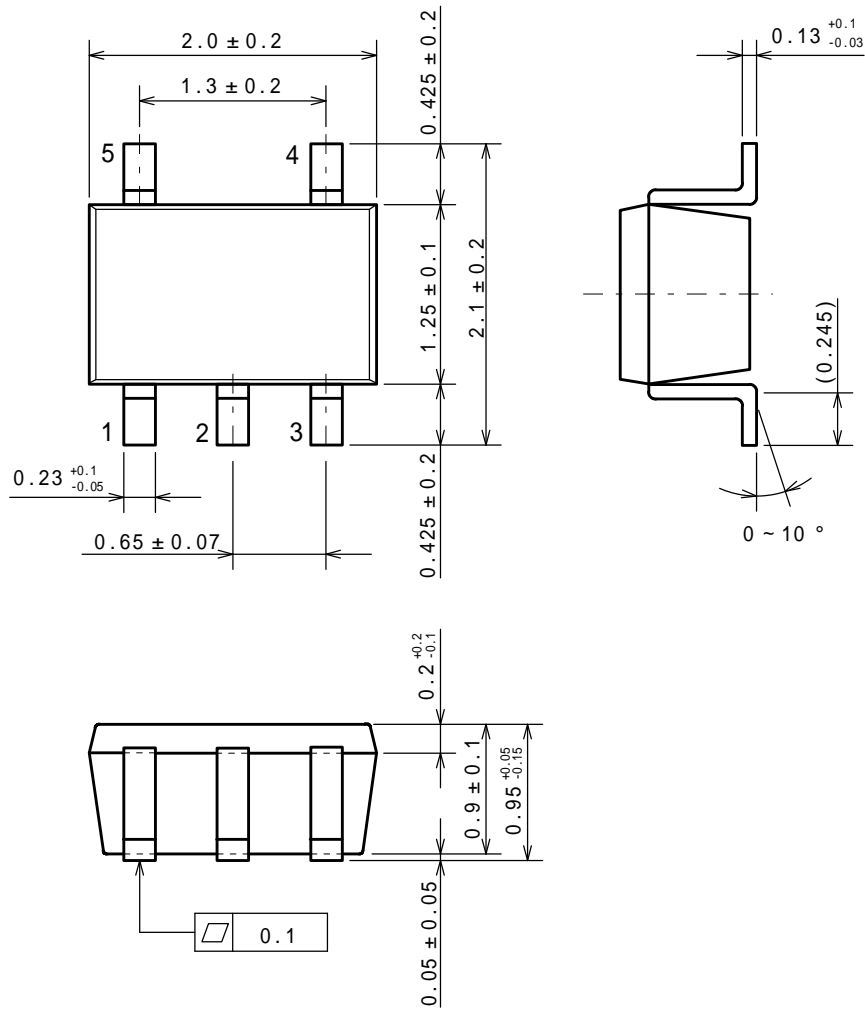
■ PACKAGE DIMENSIONS



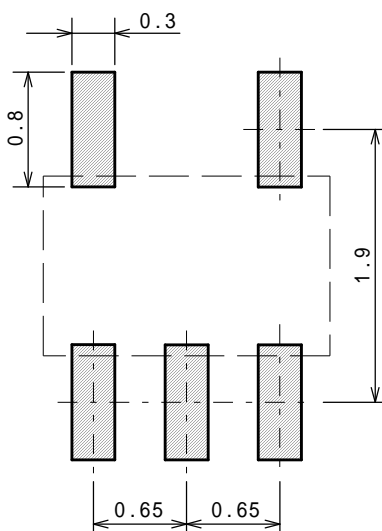
■ EXAMPLE OF SOLDER PADS DIMENSIONS



■ PACKAGE DIMENSIONS

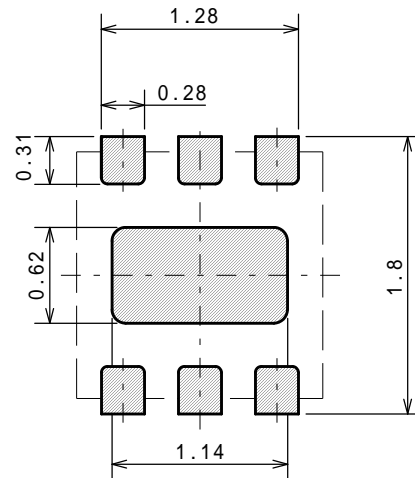
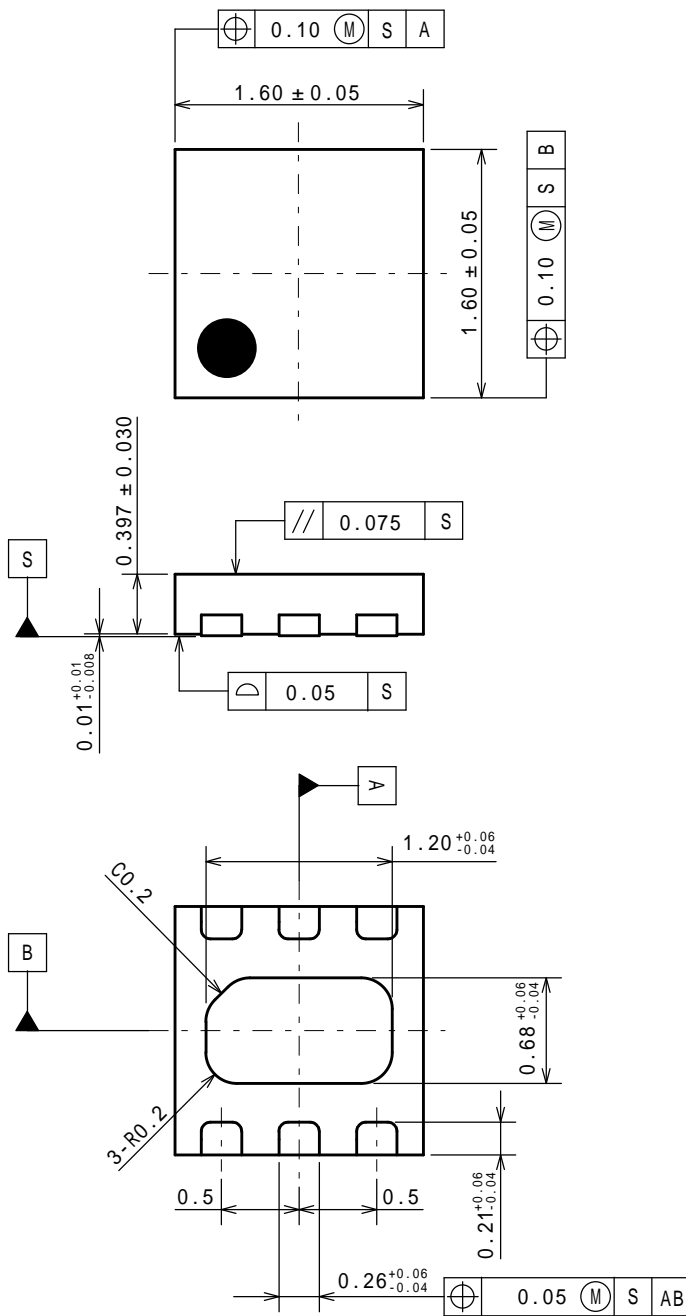


■ EXAMPLE OF SOLDER PADS DIMENSIONS

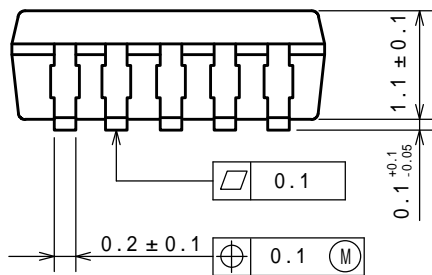
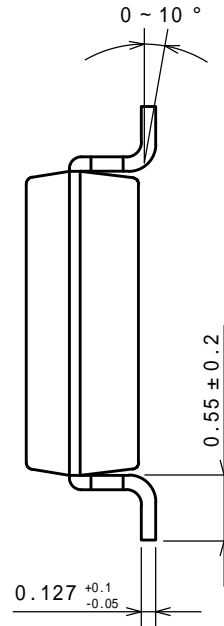
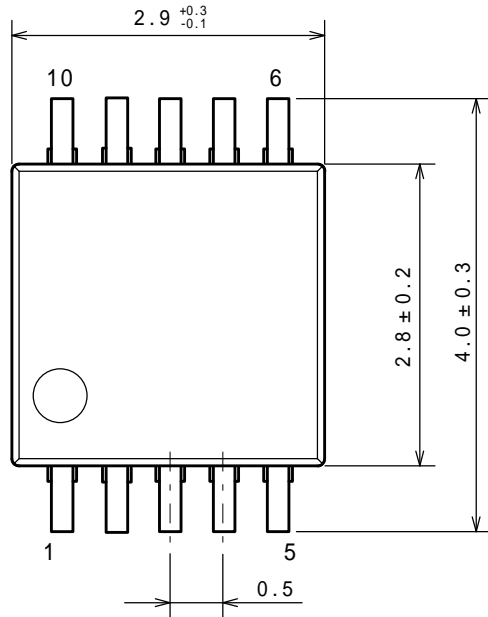


■ PACKAGE DIMENSIONS

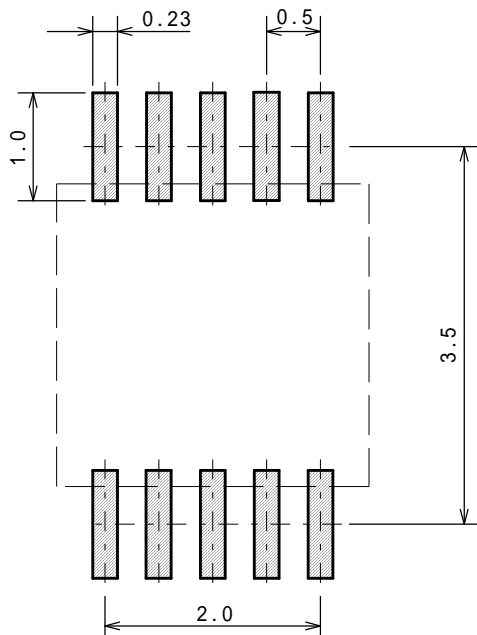
■ EXAMPLE OF SOLDER PADS DIMENSIONS



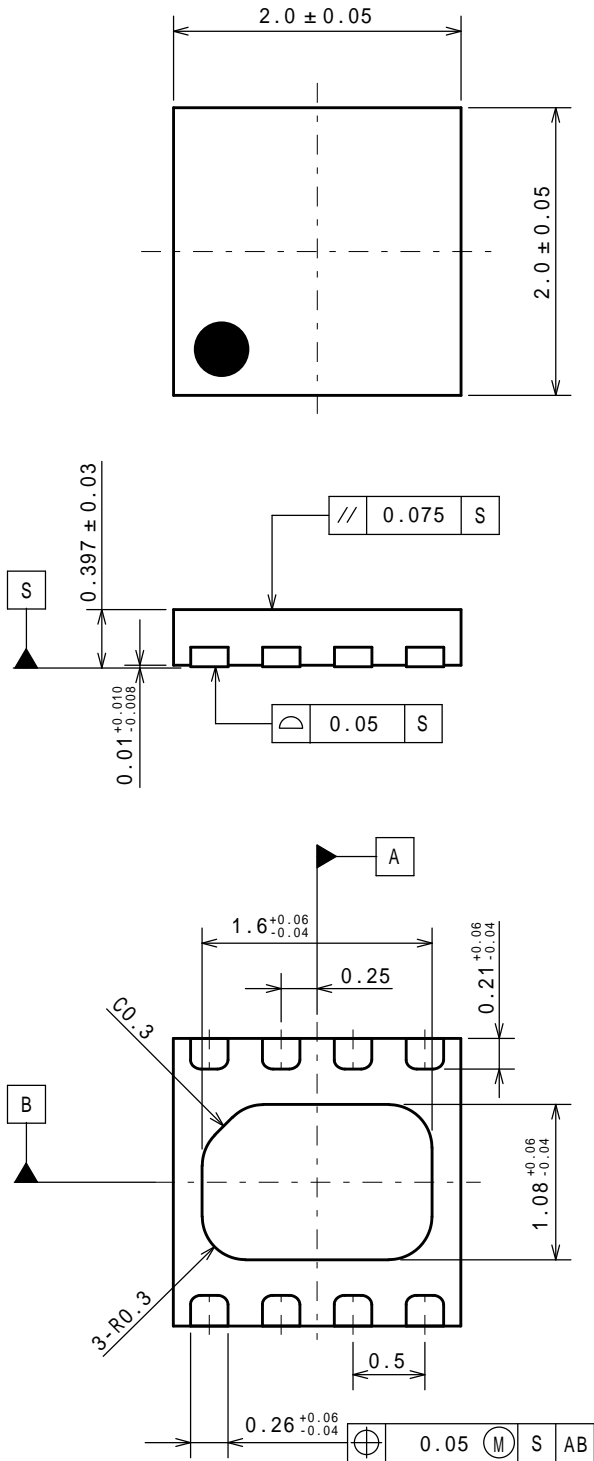
■ PACKAGE DIMENSIONS



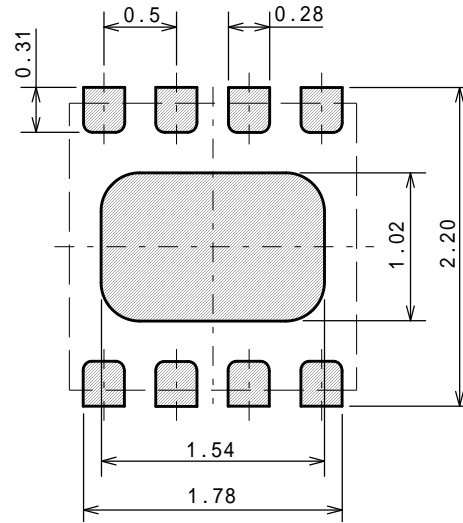
■ EXAMPLE OF SOLDER PADS DIMENSIONS



■ PACKAGE DIMENSIONS

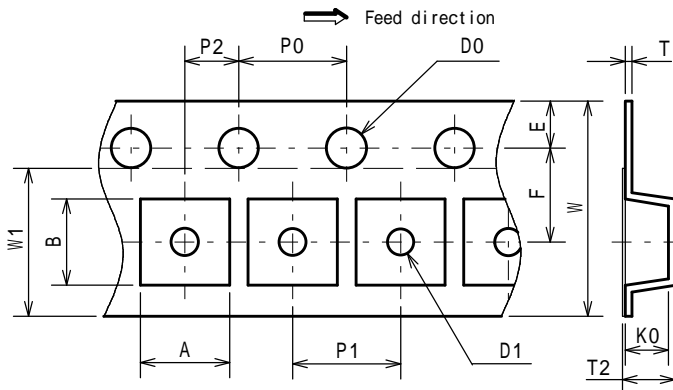


■ EXAMPLE OF SOLDER PADS DIMENSIONS



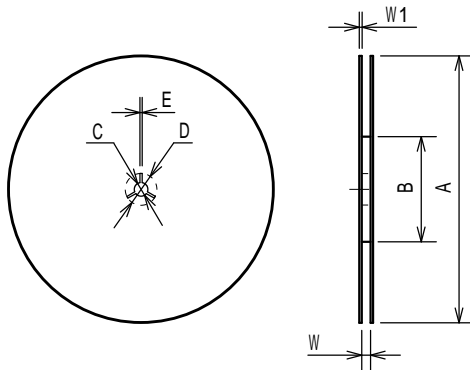
PACKING SPEC

TAPING DIMENSIONS



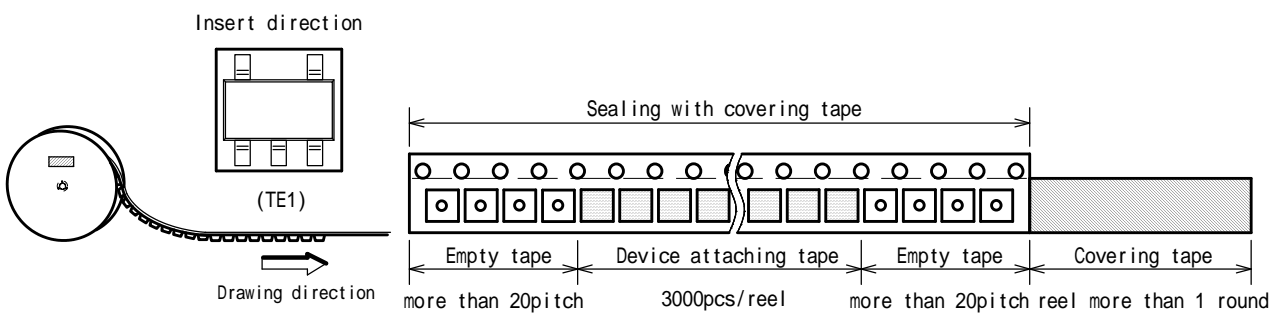
SYMBOL	DIMENSION	REMARKS
A	3.3 ± 0.1	BOTTOM DIMENSION
B	3.2 ± 0.1	BOTTOM DIMENSION
D0	1.55	
D1	1.05	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.82	
K0	1.5 ± 0.1	
W	8.0 ± 0.3	
W1	5.5	THICKNESS 0.1MAX

REEL DIMENSIONS

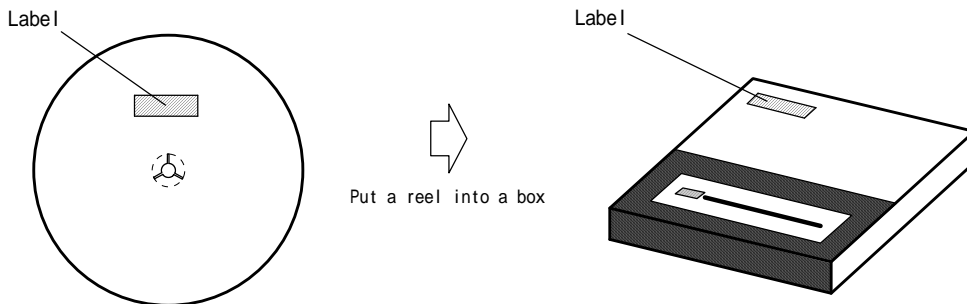


SYMBOL	DIMENSION
A	180 ± 1
B	60 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ± 0.5
W1	1.2 ± 0.2

TAPING STATE

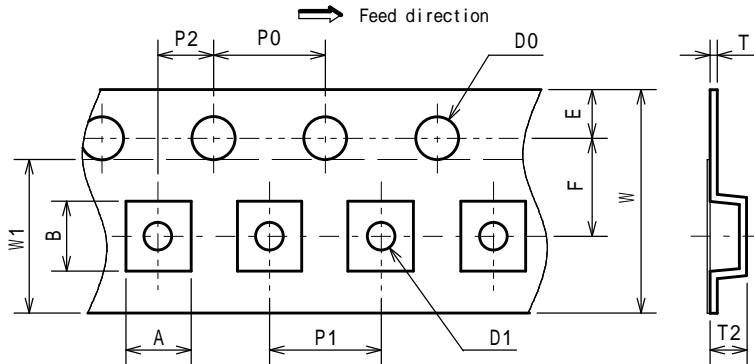


PACKING STATE



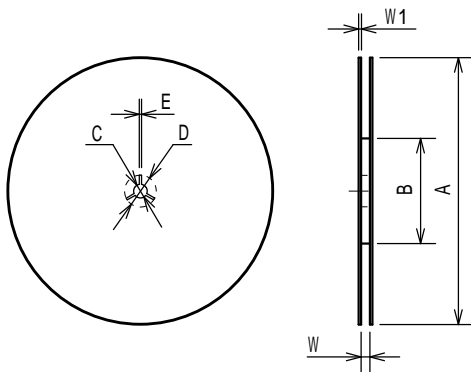
PACKING SPEC

TAPING DIMENSIONS



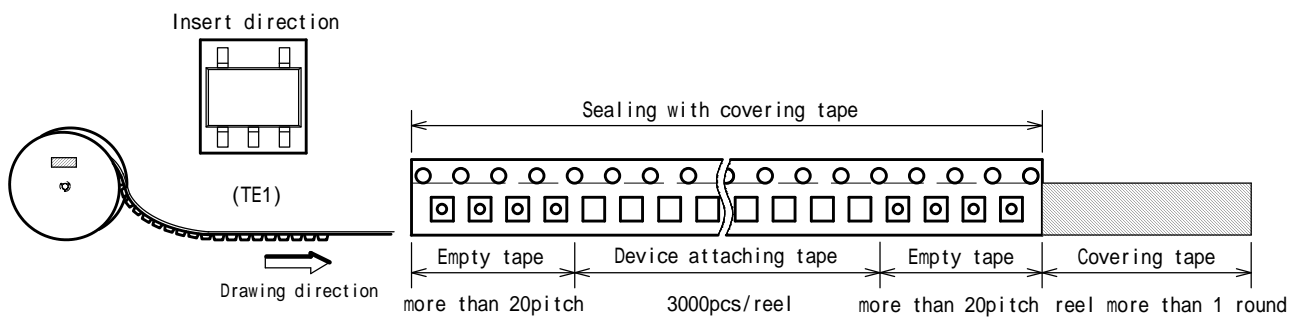
SYMBOL	DIMENSION	REMARKS
A	2.3 ± 0.1	BOTTOM DIMENSION
B	2.5 ± 0.1	BOTTOM DIMENSION
D0	1.55 ± 0.05	
D1	1.05 ± 0.05	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.3 ± 0.1	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

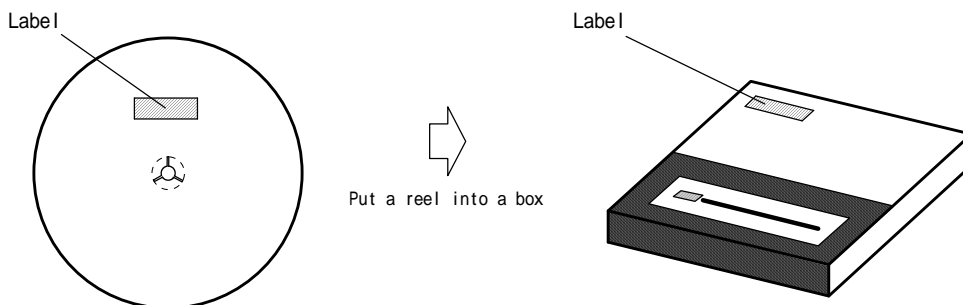


SYMBOL	DIMENSION
A	180 ± 1
B	60 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ± 0.5
W1	1.2 ± 0.2

TAPING STATE

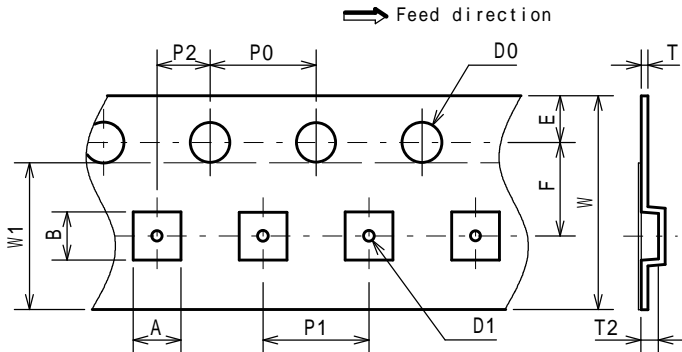


PACKING STATE



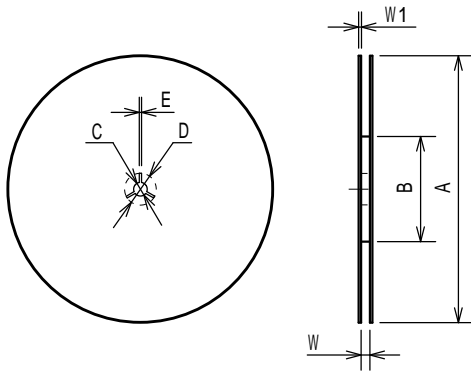
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TAPING DIMENSIONS



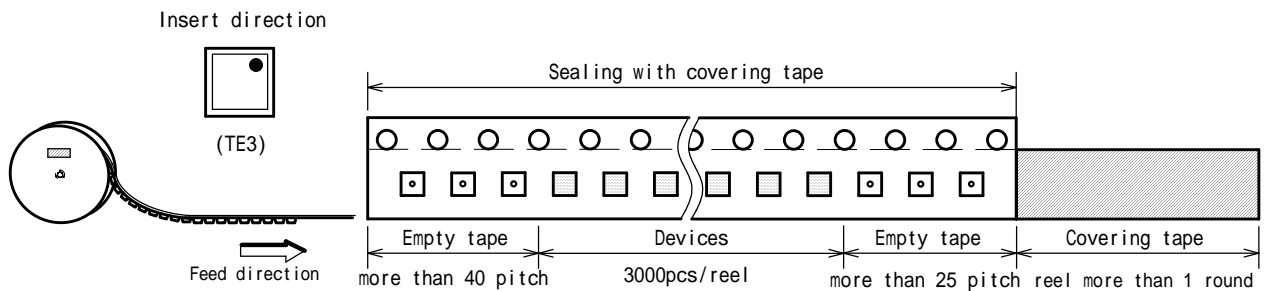
SYMBOL	DIMENSION	REMARKS
A	1.85 ± 0.05	BOTTOM DIMENSION
B	1.85 ± 0.05	BOTTOM DIMENSION
D0	1.5 ^{+0.1} ₀	
D1	0.5 ± 0.1	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	0.65 ± 0.05	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

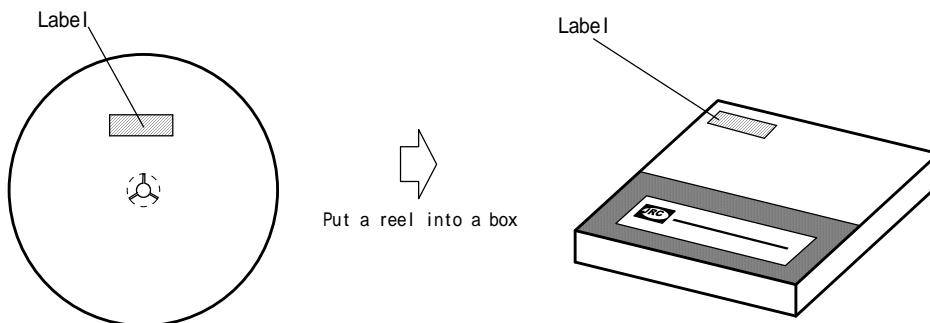


SYMBOL	DIMENSION
A	180 ⁰ _{-1.5}
B	60 ⁺¹ ₀
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ^{+0.3} ₀
W1	1.2

TAPING STATE

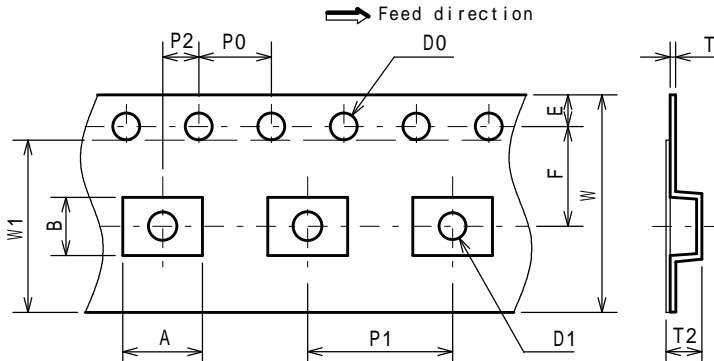


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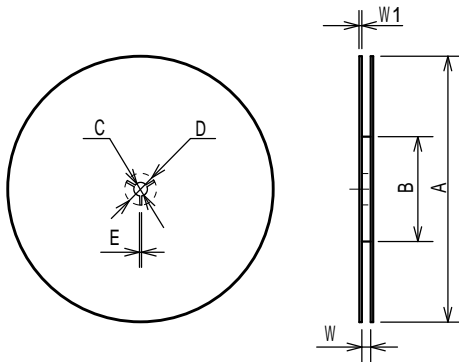
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TAPING DIMENSIONS



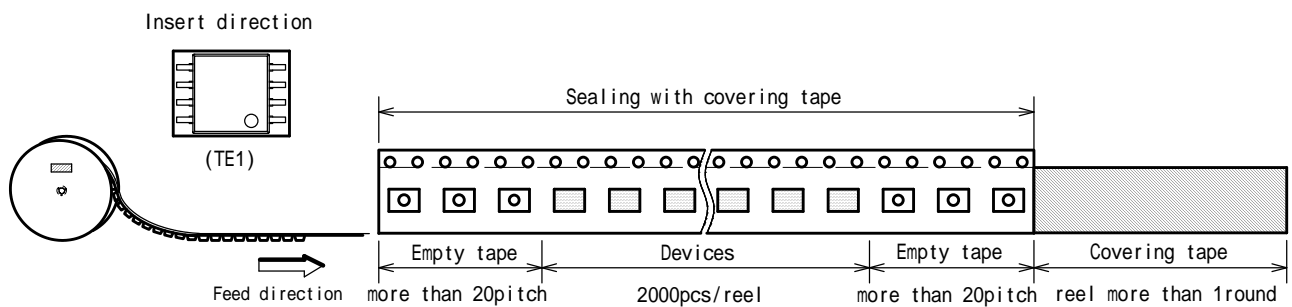
SYMBOL	DIMENSION	REMARKS
A	4.4	BOTTOM DIMENSION
B	3.2	BOTTOM DIMENSION
D0	1.5 ^{+0.1} ₀	
D1	1.5 ^{+0.1} ₀	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.30 ± 0.05	
T2	1.75 (MAX.)	
W	12.0 ± 0.3	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

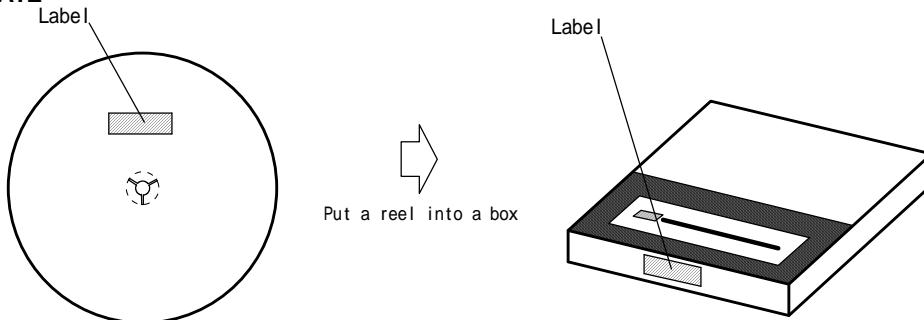


SYMBOL	DIMENSION
A	254 ± 2
B	100 ± 1
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	13.5 ± 0.5
W1	2.0 ± 0.2

TAPING STATE

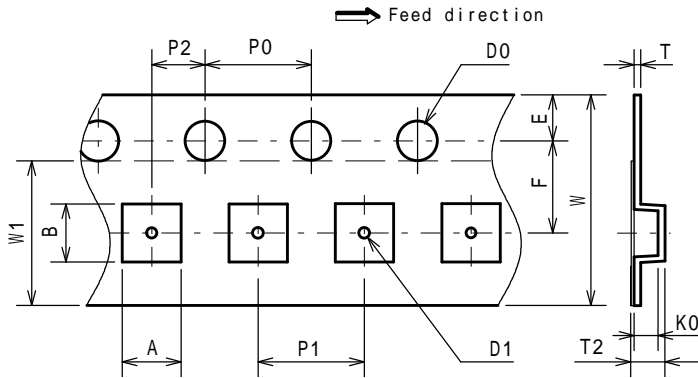


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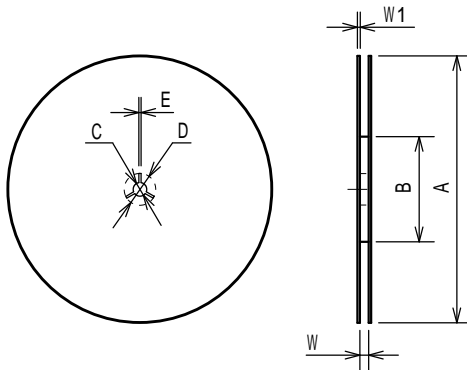
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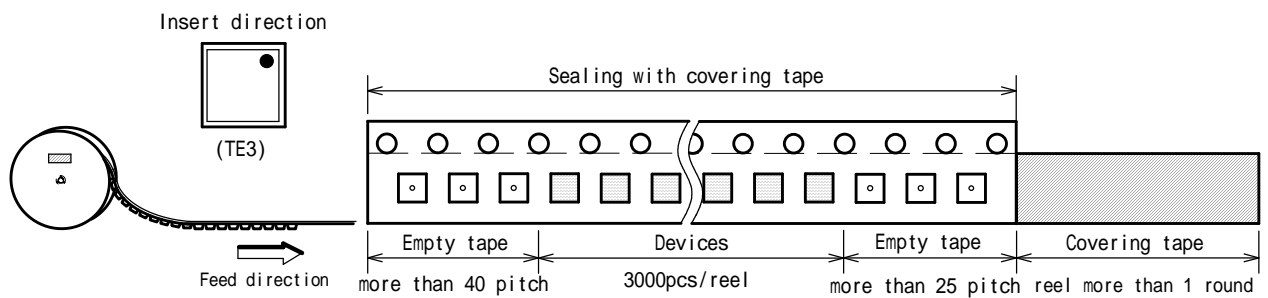
SYMBOL	DIMENSION	REMARKS
A	2.25 ± 0.05	BOTTOM DIMENSION
B	2.25 ± 0.05	BOTTOM DIMENSION
D0	1.5 ^{+0.1} ₀	
D1	0.5 ± 0.1	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
T2	1.00 ± 0.07	
K0	0.65 ± 0.05	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

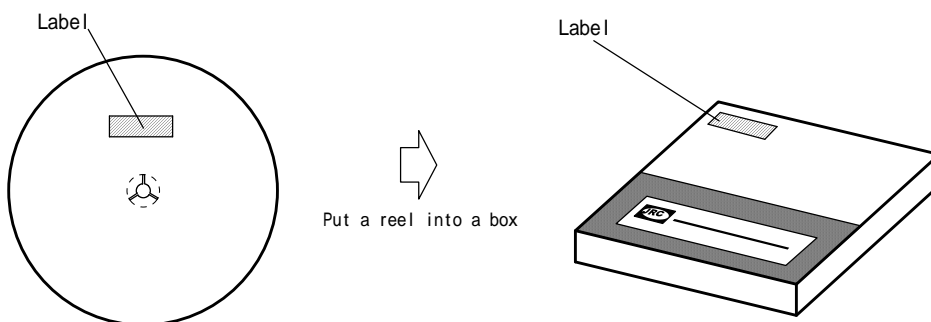


SYMBOL	DIMENSION
A	180 ⁰ _{-1.5}
B	60 ⁺¹ ₀
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ^{+0.3} ₀
W1	1.2

TAPING STATE

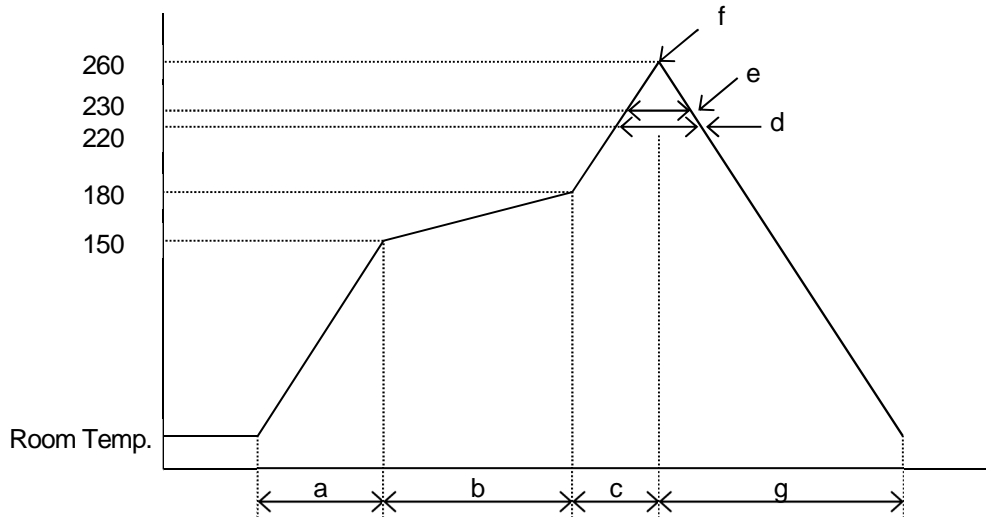


PACKING STATE



RECOMMENDED MOUNTING METHOD

*Recommended reflow soldering procedure



- a: Temperature ramping rate : 1 to 4 /s
- b: Pre-heating temperature : 150 to 180
time : 60 to 120s
- c: Temperature ramp rate : 1 to 4 /s
- d: 220 or higher time : Shorter than 60s
- e: 230 or higher time : Shorter than 40s
- f: Peak temperature : Lower than 260
- g: Temperature ramping rate : 1 to 6 /s

*The temperature indicates at the surface of mold package.

REVISION HISTORY

DATE	REVISION	CHANGES
August 31, 2020	Ver.0.0	Press release.

[CAUTION]

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2. The specifications on this datasheet are only given for information without any guarantee as regards either mistakes or omissions. The application circuits in this datasheet are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.
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The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.
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Equipment Used in the Deep sea
Power Generator Control Equipment (Nuclear, Steam, Hydraulic)
Life Maintenance Medical Equipment
Fire Alarm/Intruder Detector
Vehicle Control Equipment (airplane, railroad, ship, etc.)
Various Safety devices

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