Automotive NP4271

40 V I_O = 500mA LDO With Watchdog Timer and Reset

FEATURES

- AEC-Q100 Grade 1
- Fast transient response
- Wide operating voltage 4.0 V to 40 V
- Wide operating temperature T_a = −40°C to 125°C
- Output voltage accuracy
  V_O ±2.0% (T_a = −40°C to 125°C)
- Output voltage 3.3V, 5.0V
- Window detection voltage
- Low-side detection voltage V_{DETL} ±2%
- High-side detection voltage V_{DETH} ±5%
- Output current 500 mA
- ON/OFF control
- Watchdog time setting by external capacitor
- Ceramic capacitor compatible
- Undervoltage lockout
- Thermal shutdown
- Overcurrent protection
- Package HSOP-8-AC

APPLICATIONS

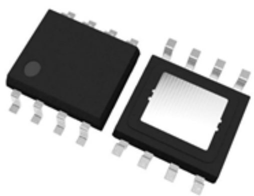
- Automotive ECUs
- Industrial equipment

GENERAL DESCRIPTION

The NP4271 is a using Bi-CMOS process, I_O = 500 mA low dropout regulator with watchdog timer and reset functions.

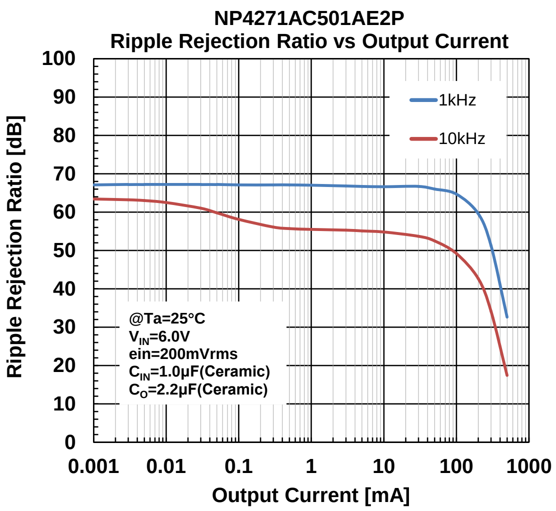
The output voltage is detected by window detection that can detect the high-side voltage and low-side voltage.

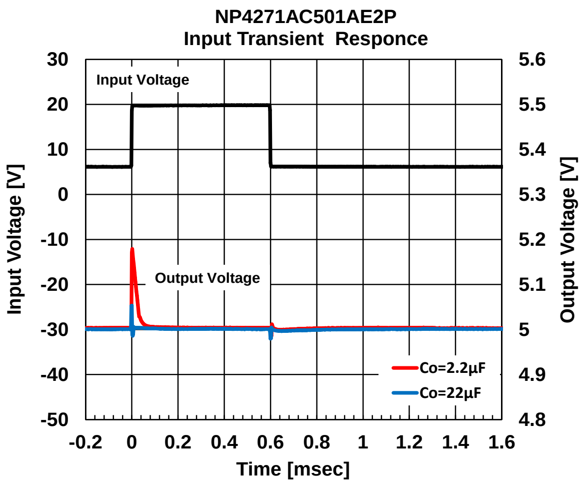
The NP4271 offers outstanding high output voltage accuracy that guaranteed ±2% under the conditions of V_{IN} = V_O+ 1V to 40 V, I_O = 5 mA to 500 mA, and Ta = −40°C to 125°C. This feature makes the device well suited as automotive ECUs and industrial applications.



HSOP-8-AC
5.2 × 6.2 × 1.5(mm)

【Ripple Rejection Ratio vs. Input Transient Response Characteristics Example]





■ PRODUCT NAME INFORMATION

NP4271 aa bbb c dd e

Description of configuration

Composition	Item	Description
aa	Package code	AC: HSOP-8-AC
bbb	Option	Output Voltage / High side Detection Voltage / Low side Detection Voltage Discrimination Codes
c	Version	Indicates whether the High side detection function is enabled or disabled.
dd	Packing	Insert Direction. Refer to the packing specifications.
e	Grade	Indicates the quality grade. P: Automotive

Version

composition c	High side Detection Function
A	✓
B	-

Combination configuration

composition bbbc	Output voltage	Low side detect voltage	High side detect voltage	High side detect function
301B	3.3V	3.0V	-	-
501A	5.0V	4.6V	5.6V	✓
502A	5.0V	4.1V	5.6V	✓

Low side detection voltage: 2.6V to 3.2V 4.0V to 4.7V (0.1V step)
High side detection voltage: 3.4V to 4.0V 5.3V to 6.0V (0.1V step)
Note: Contact our sales representatives for other voltages.

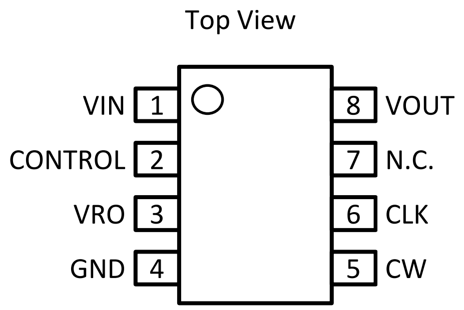
Grade

e	Applications	Operating Temperature Range	Test Temperature
P	Chassis, Body control and In-vehicle	−40°C to 125°C	25°C, 125°C

■ ORDER INFORMATION

PRODUCT NAME	PACKAGE	RoHS	HALOGEN-FREE	PLATING COMPOSITION	WEIGHT (mg)	QUANTITY PER REEL (pcs/reel)
NP4271AC501AE2P	HSOP-8-AC	✓	✓	Sn-Ag	81	1000
NP4271AC502AE2P	HSOP-8-AC	✓	✓	Sn-Ag	81	1000
NP4271AC301BE2P	HSOP-8-AC	✓	✓	Sn-Ag	81	1000

■ PIN DESCRIPTIONS



NP4271 HSOP-8-AC Pin Configuration

Pin No.	Pin Name	I/O	Description
1	VIN	Power	Power supply input pin Connect a capacitor between the VIN pin and GND.
2	CONTROL	I	ON/OFF control pin It can be set to active state with "High" input and shutdown state with "Low" input. It pulls down with a constant current inside the IC.
3	VRO	O	Reset output pin Output pin for the voltage detector and watchdog timer. Pulled up to the V_{OUT} node inside the IC.
4	GND	GND	Ground pin
5	CW	-	Time setting pin by external capacitor Connect a capacitor that sets the output delay time of the voltage detector, monitoring time of the watchdog timer, and reset time.
6	CLK	I	Clock input pin This pin is for inputting the clear pulse of the watchdog timer.
7	N.C.	-	Not internally connected It is electrically open inside the IC. Electrically open or any voltage on the printed circuit board.
8	VOUT	O	Output pin Connect a capacitor between the VOUT pin and GND

The potential of the tab on the back of the IC is GND. It is recommended to solder the tab to the printed circuit board and connect it to GND potential. Otherwise, the mounting strength will be weak and the heat dissipation will be poor.

■ ABSOLUTE MAXIMUM RATINGS

	Symbol	Ratings	Unit
Input Voltage	V_{IN}	−0.3 to 45	V
Control Pin Voltage	V_{CONT}	−0.3 to 45	V
Output Voltage	V_{OUT}	−0.3 to V_{IN} ≤ 17 (1)	V
Reset Output Voltage (2)	V_{RO}	−0.3 to 45	V
Clock Input Voltage	V_{CLK}	−0.3 to 6.0	V
CW Pin Voltage	V_{CW}	−0.3 to 6.0	V
Junction Temperature Range (3)	T_j	−40 to 150	°C
Storage Temperature Range	T_{stg}	−50 to 150	°C

(1) When the input voltage is less than 17 V, the absolute maximum output voltage is equal to the input voltage. If input voltage exceeds 17V, rated output voltage is 17V
(2) The reset output pin is pulled up to the VOUT pin with a resistor inside the IC. If a voltage higher than the V_{OUT} set voltage is applied to the reset output terminal, the VOUT pin voltage may exceed the set voltage. In that case, be careful not to exceed the maximum operating voltage of the circuit downstream of the V_{OUT} line.
(3) Calculate the power consumption of the IC from the operating conditions, and calculate the junction temperature with the thermal resistance.

Please refer to "*Thermal characteristics*" for the thermal resistance under our measurement board conditions.

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.

■ THERMAL CHARACTERISTICS

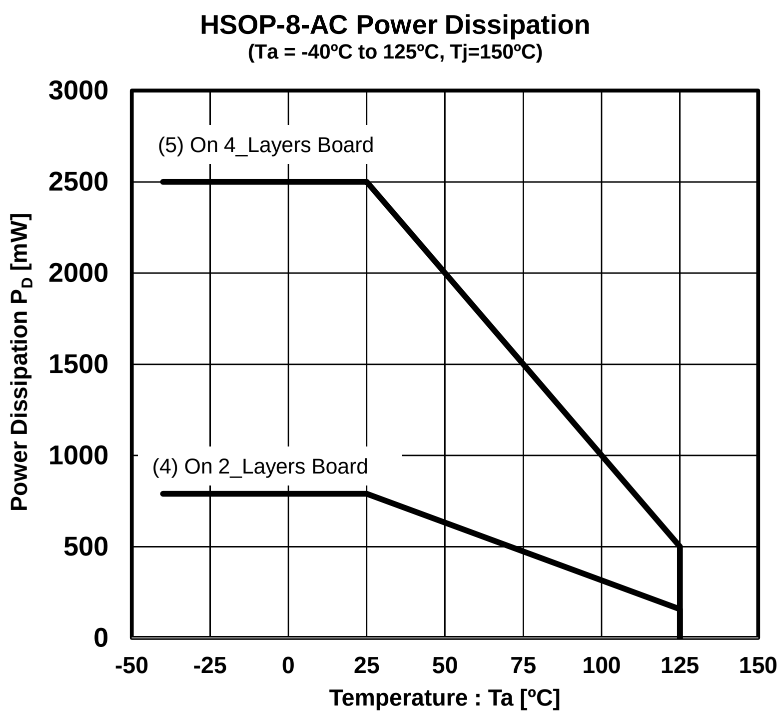
Package	Parameter	Measurement result	Unit
HSOP-8-AC	Thermal Resistance (θja)	2-Layer / 4-Layer 158 (4) / 50 (5)	°C/W
	Thermal Characterization Parameter (ψjt)	2-Layer / 4-Layer 28 (4) / 12 (5)	°C/W

θja : Junction-to-Ambient Thermal Resistance
ψjt : Junction-to-Top Thermal Characterization Parameter

(4) 2-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 2-layer FR-4).

(5) 4-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 4-layer FR-4).
(For 4-layer: Applying 74.2 mm × 74.2 mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5 as reference data).

■ POWER DISSIPATION -AMBIENT TEMPERATURE CHARACTERISTICS



■ ELECTROSTATIC DISCHARGE(ESD) PROTECTION VOLTAGE

	Conditions	Protection Voltage
HBM	C = 100 pF, R = 1.5 kΩ	±2000 V
CDM		±1000 V

ELECTROSTATIC DISCHARGE RATINGS
The electrostatic discharge test is done based on JEDEC JS001 and JS002.

■ RECOMMENDED OPERATING CONDITIONS

	Symbol	Ratings	Unit
Input Voltage	V_{IN}	4.0 to 40	V
Control Pin Voltage	V_{CONT}	0 to 40	V
Output Current Range	I_{OUT}	0 to 500	mA
Operating Temperature Range	T_a	−40 to 125	°C

RECOMMENDED OPERATING CONDITIONS
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

■ ELECTRICAL CHARACTERISTICS

$V_{IN} = V_O + 1$ V, $C_{IN} = 1.0$ µF, $C_O = 2.2$ µF, unless otherwise specified.
For parameter that do not describe the temperature condition, the MIN/MAX value under the condition of −40 °C ≤ T_a ≤ 125 °C is described.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
GENERAL CHARACTERISTICS						
Operating Current	I_{SS}	WDT enabled, T_a = 25°C	-	120	160	µA
		WDT enabled	-	-	180	
Operating Current at OFF-State	$I_{Q(OFF)}$	V_{CONT} = 0 V, T_a = 25°C	-	-	1	µA
		V_{CONT} = 0 V	-	-	1	
Control Current	I_{CONT}	V_{CONT} = 1.6 V, T_a = 25°C	-	0.5	3	µA
		V_{CONT} = 1.6 V	-	-	3	
Control Voltage at ON-State	$V_{CONT(ON)}$	T_a = 25°C	1.6	-	-	V
			1.6	-	-	
Control Voltage at OFF-State	$V_{CONT(OFF)}$	T_a = 25°C	-	-	0.6	V
			-	-	0.6	
UVLO Release Voltage	V_{UVLO}	V_{IN} = L to H, T_a =25°C	2.3	2.7	3.1	V
		V_{IN} = L to H	2.2	-	3.2	
UVLO Hysteresis Voltage	V_{HYS}	V_{IN} = H to L, T_a = 25°C	200	550	-	mV
		V_{IN} = H to L	200	-	-	

■ ELECTRICAL CHARACTERISTICS (LDO REGULATOR)

$V_{IN} = V_O + 1$ V, $C_{IN} = 1.0$ µF, $C_O = 2.2$ µF, unless otherwise specified.
For parameter that do not describe the temperature condition, the MIN/MAX value under the condition of −40 °C ≤ T_a ≤ 125 °C is described.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
LDO REGULATOR						
Output Voltage	V_O	$V_{IN} = V_O$ + 1V to 40V, I_O = 5 mA to 500 mA, T_a = 25°C	x0.99	-	x1.01	V
		$V_{IN} = V_O$ + 1V to 40V, I_O = 5 mA to 500 mA	x0.98	-	x1.02	
Output Current	I_O	V_O × 0.9, T_a = 25°C	500	-	-	mA
		V_O × 0.9	500	-	-	
Line Regulation	$\Delta V_O/\Delta V_{IN}$	V_{OUT} = 5V, $V_{IN} = V_O$ + 1V to 40V, I_O = 30mA, T_a = 25°C	-	-	16	mV
		V_{OUT} = 3.3V, $V_{IN} = V_O$ + 1V to 40V, I_O = 30mA, T_a = 25°C	-	-	11	
		V_{OUT} = 5V, $V_{IN} = V_O$ + 1V to 40V, I_O = 30mA	-	-	30	
		V_{OUT} = 3.3V, $V_{IN} = V_O$ + 1V to 40V, I_O = 30mA	-	-	20	
Load Regulation	$\Delta V_O/\Delta I_O$	V_{OUT} = 5V, I_O = 0mA to 500mA, T_a = 25°C	-	-	50	mV
		V_{OUT} = 3.3V, I_O = 0mA to 500mA, T_a = 25°C	-	-	33	
		V_{OUT} = 5V, I_O = 0mA to 500mA	-	-	60	
		V_{OUT} = 3.3V, I_O = 0mA to 500mA	-	-	40	
Ripple Rejection	RR	V_{OUT} = 5V, $V_{IN} = V_O$ + 1V, T_a = 25°C, ein = 200mVrms, f = 1kHz, I_O = 10mA	-	68	-	dB
		V_{OUT} = 3.3V, $V_{IN} = V_O$ + 1V, T_a = 25°C, ein = 200mVrms, f = 1kHz, I_O = 10mA	-	71	-	
Dropout Voltage	ΔV_{IO}	I_O = 300mA, V_{OUT} = 5.0V, T_a = 25°C	-	0.3	0.5	V
		I_O = 300mA, V_{OUT} = 5.0V	-	-	0.57	
		I_O = 300mA, V_{OUT} = 3.3V, T_a = 25°C	-	-	1.0	
		I_O = 300mA, V_{OUT} = 3.3V	-	-	1.0	
Output Voltage Temperature Coefficient	$\Delta V_O/\Delta T_a$	I_O = 30mA	-	±50	-	ppm/°C

■ ELECTRICAL CHARACTERISTICS (VOLTAGE DETECTOR)

$V_{IN} = V_O + 1$ V, $C_{IN} = 1.0$ µF, $C_O = 2.2$ µF, unless otherwise specified.
For parameter that do not describe the temperature condition, the MIN/MAX value under the condition of −40 °C ≤ T_a ≤ 125 °C is described.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
VOLTAGE DETECTOR						
Low-Side Detection Voltage	V_{DETL}	$T_a = 25°C$	x0.99	-	x1.01	V
			x0.98	-	x1.02	
High-Side Detection Voltage (6)	V_{DETH}	$T_a = 25°C$	x0.97	-	x1.03	V
			x0.95	-	x1.05	
Hysteresis Voltage at Low-Side Release	V_{HYS}	$T_a = 25°C$	65	100	135	mV
			65	-	135	
Average Temperature Coefficient of Detection Voltage	$\Delta V_{DET} / \Delta T_a$		-	±50	-	ppm/°C
C_W Pin Charging Current at Delay Hold	I_{CWD}	$V_{CW} = 0.5V$, $T_a = 25°C$	4.8	6	7.2	µA
		$V_{CW} = 0.5V$	4.8	-	7.2	
C_W Pin Threshold Voltage at Reset Release	V_{TCWD}	$T_a = 25°C$	-	1.0	-	V
Output Delay Hold Time	t_D	$C_W = 0.01µF$, V_{RO} = L to H, $T_a = 25°C$	1.44	1.70	1.96	ms
		$C_W = 0.01µF$, V_{RO} = L to H	1.36	-	2.04	
Reset Reaction Time	t_{RR}	Low-side detected, V_{RO} = H to L, $T_a = 25°C$	-	-	25	µs
		High-side detected, V_{RO} = H to L, $T_a = 25°C$	-	-	25	
Low-Level Reset	V_{ROL}	$V_O = V_{DETL} - 0.5V$, $I_{SINK} = (V_{DETL} - 0.5V) / R_{PU}$, $T_a = 25°C$	-	0.02	0.2	V
		$V_O = V_{DETL} - 0.5$ V, $I_{SINK} = (V_{DETL} - 0.5V) / R_{PU}$,	-	-	0.2	V
Reset output section operating voltage	V_{OPL}	$T_a = 25°C$	0.8	-	-	V
			0.8	-	-	
Reset Output Voltage at Start-Up	V_{ROUV}	V_{IN} start-up, $T_a = 25°C$	-	0.05	-	V
Pull-Up Resistor	R_{PU}	$T_a = 25°C$	-	100	-	kΩ

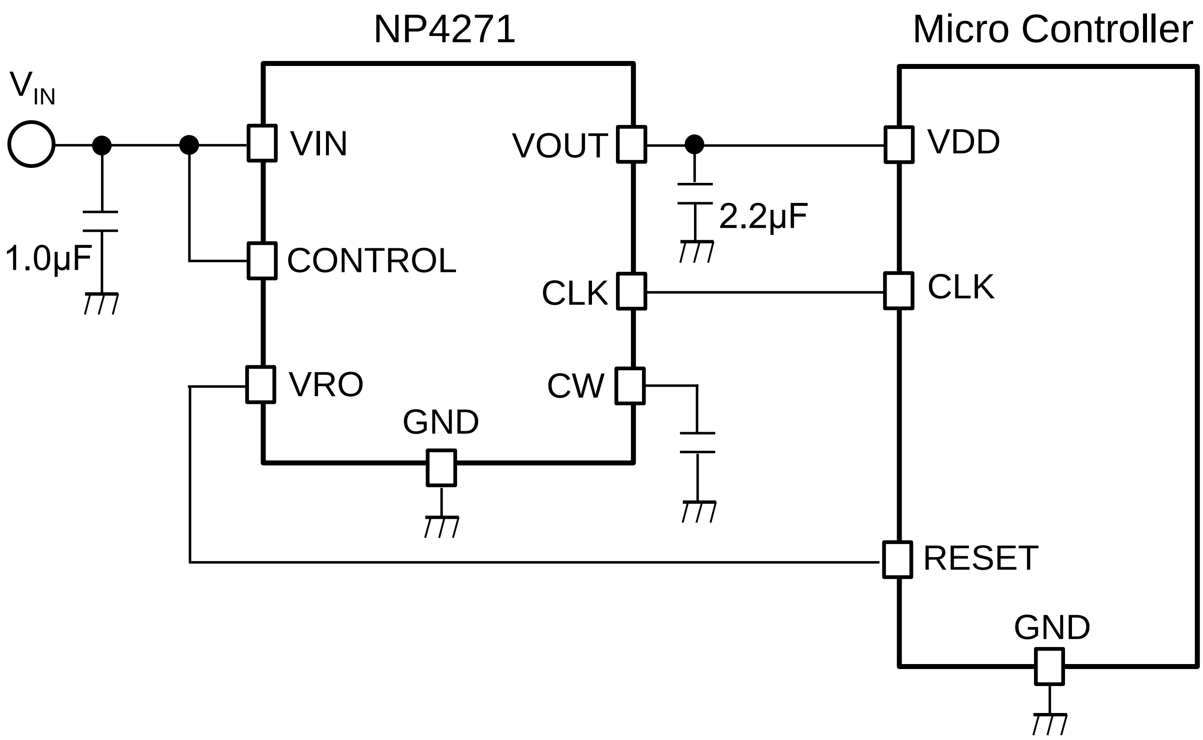
(6) A version

■ ELECTRICAL CHARACTERISTICS (WATCH DOG TIMER)

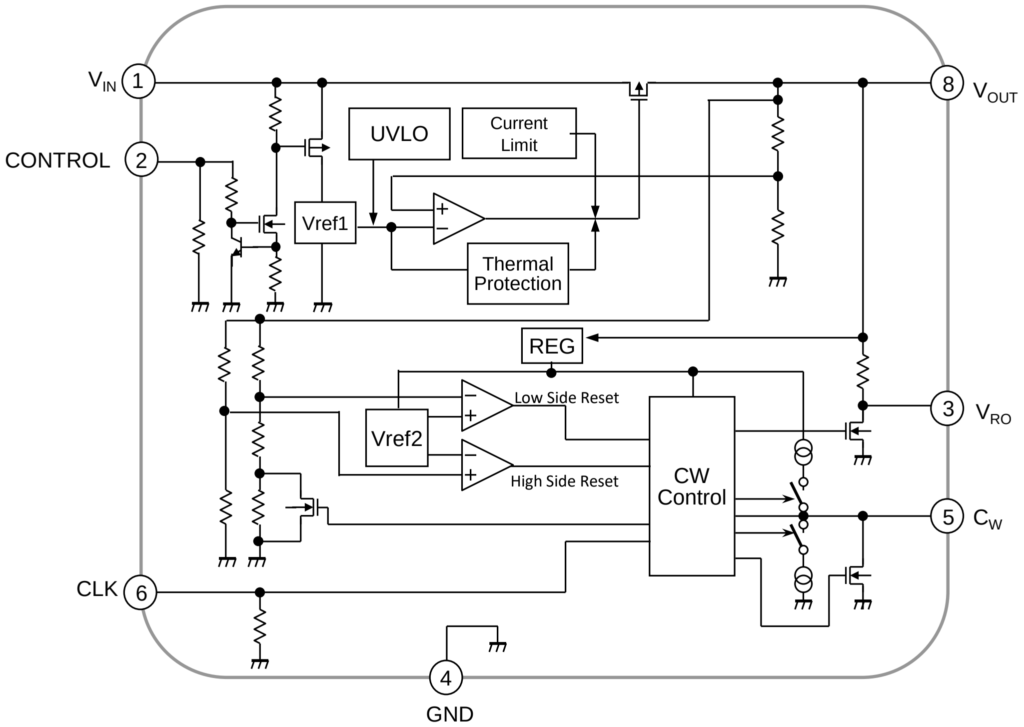
$V_{IN} = V_O + 1$ V, $C_{IN} = 1.0$ µF, $C_O = 2.2$ µF, unless otherwise specified.
For parameter that do not describe the temperature condition, the MIN/MAX value under the condition of −40 °C ≤ T_a ≤ 125 °C is described.

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
WATCHDOG TIMER						
Clock Input High-Level	V_{TCKH}	V_{OUT} = 5V, T_a = 25°C	4.0	-	-	V
		V_{OUT} = 3.3V, T_a = 25°C	2.6	-	-	
		V_{OUT} = 5V	4.0	-	-	
		V_{OUT} = 3.3V	2.6	-	-	
Clock Input Low-Level	V_{TCKL}	V_{OUT} = 5V, T_a = 25°C	-	-	1.0	V
		V_{OUT} = 3.3V, T_a = 25°C	-	-	0.7	
		V_{OUT} = 5V	-	-	1.0	
		V_{OUT} = 3.3V	-	-	0.7	
Clock Input Pulse Width	t_{CKW}	T_a = 25°C	0.5	-	-	µs
			0.5	-	-	
Clock Input Cycle	t_{CK}	T_a = 25°C	1.0	-	-	µs
			1.0	-	-	
CW Pin Discharge Current	I_{CW}	V_{CW} = 0.5 V, T_a = 25°C	1.6	2	2.4	µA
		V_{CW} = 0.5 V	1.6	-	2.4	
CW Pin Charging Current	I_{CWL}	V_{CW} = 0.5V, T_a = 25°C	4.8	6	7.2	µA
		V_{CW} = 0.5V	4.8	-	7.2	
High-Side Threshold Voltage	V_{TCWH}	T_a = 25°C	-	1.0	-	V
Low-Side Threshold Voltage	V_{TCWL}	T_a = 25°C	-	0.2	-	V
WDT Monitoring Time	t_{WD}	C_W = 0.01 µF, T_a = 25°C	3.4	4.0	4.6	ms
		C_W = 0.01 µF,	3.2	-	4.8	
WDT Reset Time	t_{WR}	C_W = 0.01 µF, T_a = 25°C	1.10	1.30	1.50	ms
		C_W = 0.01 µF	1.04	-	1.56	

■ TYPICAL APPLICATION CIRCUIT



■ BLOCK DIAGRAMS

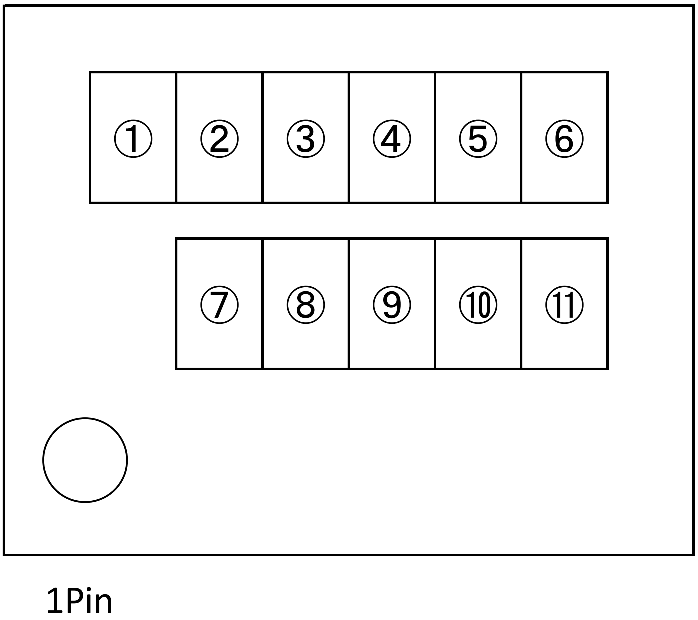


NP4271 Block Diagram

■ MARKING SPECIFICATION

①②③④⑤⑥⑦⑧: Product Code … Refer to Part Marking List

⑨⑩⑪: Lot Number … Alphanumeric Serial Number



HSOP-8-AC Part Markings

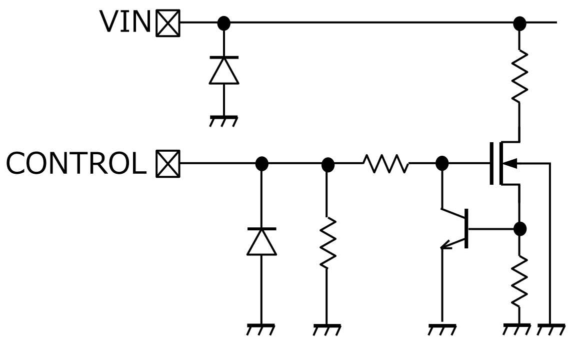
NOTICE
There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

NP4271 Part Marking List

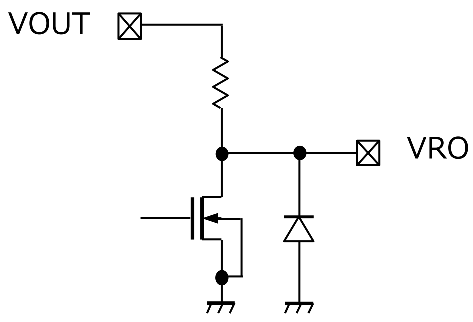
Product Name	① ② ③ ④ ⑤ ⑥ ⑦ ⑧
NP4271AC501AE2P	4 2 7 1 0 1 P A
NP4271AC502AE2P	4 2 7 1 0 2 P A
NP4271AC301BE2P	4 2 7 1 0 0 P B

■ APPLICATION NOTES

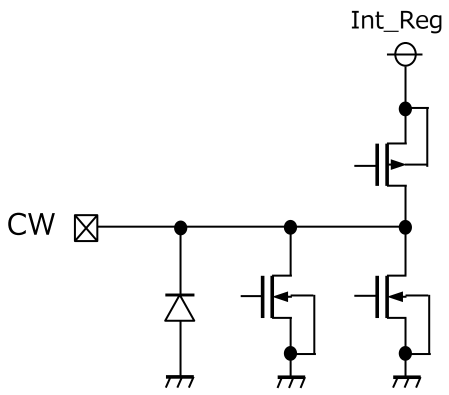
● **Internal Equivalent Circuit Diagram of Pin**



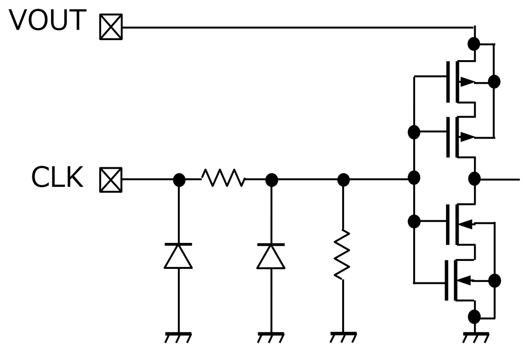
CONTROL pin



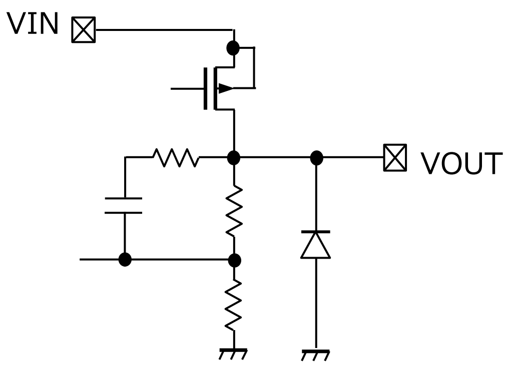
VRO pin



CW pin

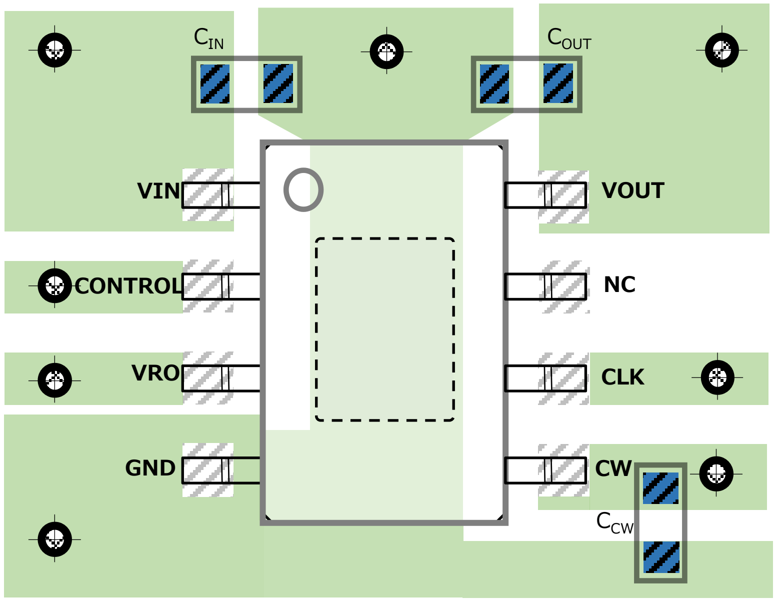


CLK pin



VOUT pin

● **Evaluation Board / PCB Layout**



NP4271

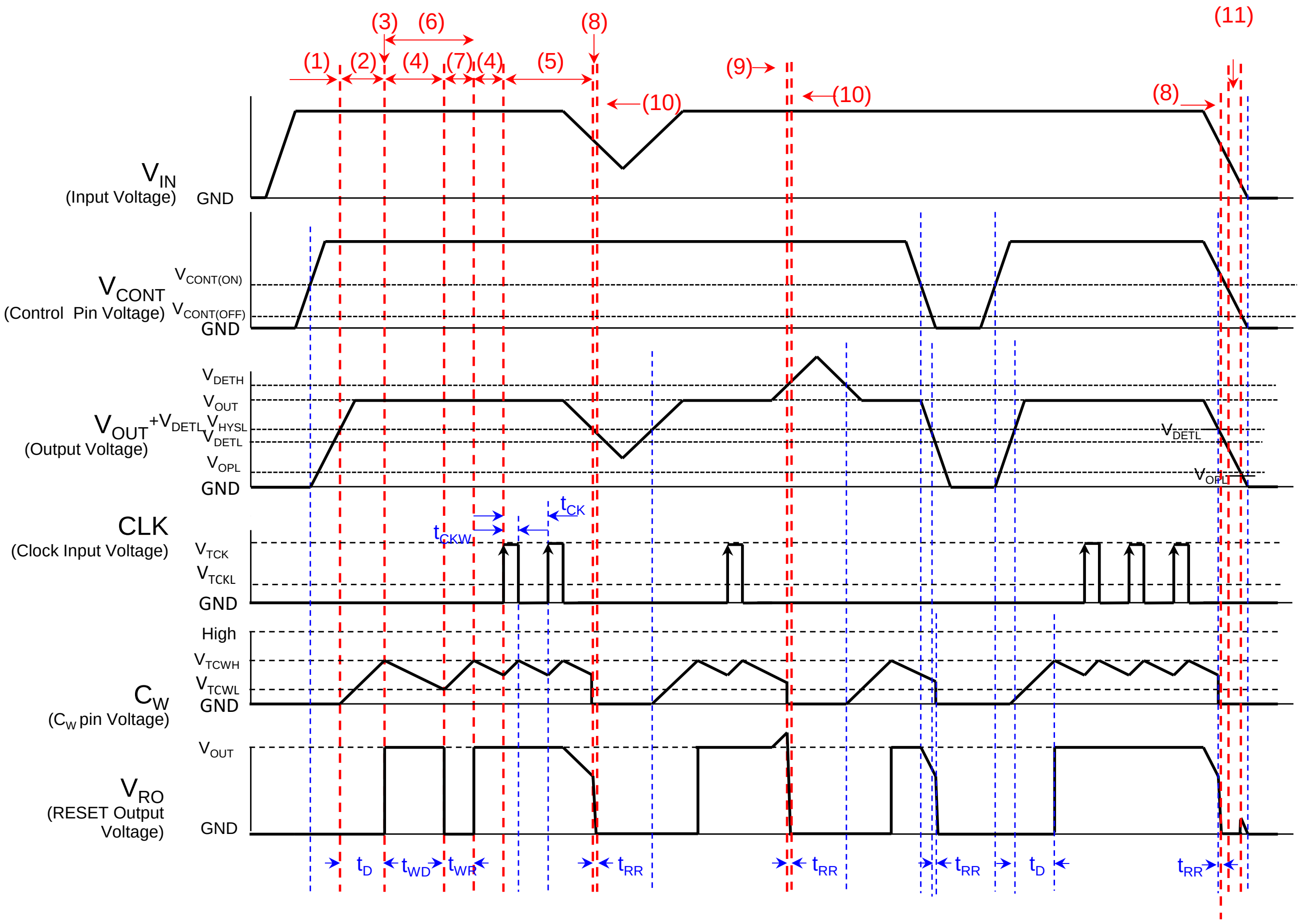
Input Capacitor (C_{IN})

C_{IN} has the effect of preventing oscillation when the power supply impedance is High or when the V_{IN} and GND wires are long. Therefore, connect a C_{IN} of 1.0 μF or more between the V_{IN} and GND terminals and make the wiring as short as possible.

Output Capacitor (C_O)

C_O is required to provide phase compensation for the error amplifier with an integrated regulator, and the capacitance value and the equivalent series resistance (ESR) affect the stability of the circuit. The ESR should be in the range of the Stable Region in the Equivalent Series Resistance vs Output Current characteristic example. Use of a C_O with an ESR below the recommended capacitance value or outside the stable operation region will degrade the stability of the internal circuit, resulting in increased output noise and ringing, and possible oscillation.
For stable operation, a ceramic capacitor with a value of 2.2uF or more, including capacitance value variation, temperature dependence, and DC bias dependence, should be connected between the VOUT pin and the GND pin
The larger the capacitance value, the lower the output noise and ripple components, and the smaller the output voltage fluctuation when the output load changes.

■ Timing Chart



● Output Delay Time (t_D)

In order to prevent malfunction due to chattering after the output voltage (V_O) exceeds the reset release voltage (V_{DETL} + V_{HYS}), a t_D is provided until the reset output pin outputs High.

(1) Initial State
When the V_O is less than the V_{DETL} + V_{HYS}, the CW pin voltage (V_{CW}) is 0 V and V_{RO} (reset output voltage) = Low. The NP4271 has the ability to maintain a Low reset output pin voltage (V_{ROUV} typ. 0.05 V) during start-up, even when V_{IN} is below the minimum operating voltage.

(2) Start of Output Delay Time
If V_O exceeds V_{DETL} + V_{HYS}, the CW pin capacitor (C_W) is charged with the CW pin charging current (I_{CWD}) (6μA, typ) when voltage is detected, and the t_D starts. V_{RO} = Low is maintained during the t_D. When V_O falls below V_{DETL} + V_{HYS} during C_W charging, the state returns to (1) (V_{CW} = 0 V, V_{RO} = Low).

(3) Detectable State of the Output Voltage Drop
When V_{CW} reaches the CW pin threshold voltage (V_{TCWH}) (1.0V, typical), V_{RO} switches from Low to High.
Ic can detect the output voltage drop from the time when $V_O \geq V_{DETL}+V_{HYS}$ to the time when V_{RO}=High is t_D.
After VCW reaches V_{TCWH}, capacitor C_W is discharged at discharge current (I_{CW}) (2μA, typ) and V_{CW} falls.

• Watchdog Timer Monitoring Time and Reset Time

The watchdog timer monitoring time (t_{WD}) can be set as the time to monitor the clock of a microcontroller or other device.When the rising edge of the clock is not detected within the set time, the reset output pin outputs Low for the period set by the watchdog timer reset time (t_{WR}).

(4) Clock Rising Edge Detection Standby State
The capacitor C_W is discharged by the discharge current (I_{CW}) and monitors the clock rising edge input until the CW pin voltage V_{CW} reaches the lower threshold voltage (V_{TCWL}) (0.2V, typ).

The time at which the capacitor C_W is discharged from V_{TCWH} to V_{TCWL} is the watchdog timer monitoring (t_{WD})

(5) Clock Rising Edge If Detected
When a rising edge of the clock is detected during the monitoring time, the capacitor C_W switches from discharging to charging.After that, when the voltage V_{CW} reaches V_{TCWH}, the capacitor C_W changes from charging to discharging and starts waiting for clock rising edge detection (4).

(6) Clock Rising Edge Is Not Detected
If the rising edge of the clock is not detected while the capacitor C_W is being discharged, and V_{CW} reaches the lower threshold voltage (V_{TCWL}) (0.2V, typ), the V_{RO} switches from High to Low and begins charging the capacitor C_W. The time at which the capacitor C_W is charged from V_{TCWL} to V_{TCWH} is the watchdog timer reset time (t_{WR}).

(7) Watchdog Timer Reset Output
Start charging the capacitor $_{CW}$ and then hold V_{RO}=Low until the voltage VCW reaches V_{TCWH}. When V_{CW} reaches V_{TCWH}, it switches from V_{RO} = Low to High.

• Output Voltage Error Detection

(8) When output voltage V_O < Low side detection voltage V_{DETL}
The time of watchdog timer monitoring (t_{WD}) and reset (t_{WR}) become V_{RO} = Low when V_O falls below V_{DETL}, and the CW pin discharges the capacitor (C_W) rapidly and becomes V_{CW} = 0 V. After becoming a V_{RO} = Low it returns to the initial state of (1). Low side detection has hysteresis V_{HYS}.

(9) When output voltage V_O > High side detection voltage V_{DETH}
While the watchdog timer is monitoring the clock, if V_O becomes higher than V_{DETH}, V_{RO} = Low. Also, the capacitor C_W on the CW pin is rapidly discharged and V_{CW} = 0V. After V_{RO} = Low, it returns to the initial state (1). High side detection has no hysteresis.

• Reset Delay time (t_{RR})

(10) The time from detection of the low side detection voltage V_{DETL} and High side detection voltage V_{DETH} until V_{RO} = Low is the reset delay time (t_{RR}) (10μs, typ)

(11) When the output voltage V_O drops, V_{RO} = Low is held until the voltage V_O becomes the reset output operating voltage (V_{OPL}) (about 0.8V).

• When the Watchdog Timer is Not Used

The watchdog timer can be stopped by forcing the CW pin voltage (V_{CW}) to High-level. At that time, the reset functions (V_{DETL}, V_{DETH}) by output voltage monitoring is also stopped and V_{RO} = High is maintained until the V_{CW} falls below the lower threshold voltage (V_{TCWL}) (0.2 V, typ). To set V_{CW} to High-level, connect to V_O or apply a voltage of 1.1 V to 5.5 V. The CW pin voltage (V_{CW}) can be forced to High level at any timing.
If the CW pin voltage (V_{CW}) is stopped being forced to a High level, the capacitor C_{CW} begins to discharge and holds V_{RO} = High until V_{CW} falls below the lower threshold hold voltage (V_{TCWL}) (0.2 V, typ).

• Time setting capacitor (C_W) constant setting method

The time setting capacitor (C_W) sets the output delay time (t_D), watchdog timer monitoring time (t_{WD}), and watchdog timer reset time (t_{WR}). The C_W setting method for each episode is as follows.
To calculate the C_W use Equation 2, Equation 6, or Equation 10.
To calculate time from C_W use Equation 3, Equation 7, or Equation 11.
To calculate time dispersion use Equation 4, Equation 8, or Equation 12.
Capacitor C_W can be set in the range of 0.001μF to 47μF.

• Setting the C_W from the Output Delay Time (t_D)

The t_D is the period from when C_W pin capacitor (C_W) is charged with I_{CW} until V_{CW} reaches 0 V to V_{TCWD} (threshold voltage). Therefore, the C_W value from t_D can be estimated as follows:

$$C_W = \frac{I_{CWD}}{V_{TCWD}} \cdot t_D$$ ······Equation <1>

Where charging current (I_{CWD}) is 6 µA (typ) and threshold voltage (V_{TCWD}) is 1.0 V (typ), the C_W is calculated by the below equation:

$$C_W = \frac{6\times10^{-6}}{1.0} t_D$$

$$= (6 \times 10^{-6}) \cdot t_D \quad [F]$$ ······Equation <2> (The unit of t_D is [s].)

The t_D can be calculated from C_W according to the following equation:

$$t_D = \frac{C_W}{I_{CWD}} \cdot V_{TCWD}$$

$$= \frac{C_W}{6\times10^{-6}} \quad [s]$$ ······Equation <3> (The unit of C_W is [F].)

Calculate the t_D dispersion using the ration of C_W from the minimum and maximum values when C_W = 0.01 µF is connected:

$$t_D = t_D(C_W = 0.01\mu F) \times \frac{C_W}{0.01\times10^{-6}} [ms]$$ ······Equation <4> (The unit of C_W is [F].)

For example, when C_W = 1 µF and T_a = −40°C to 125°C, 136 ms ≤ t_D ≤ 204 ms.

• Setting the C_W from the Watchdog Timer Monitoring Time (t_{WD})

The t_{WD} is the period from when V_{CW} reaches threshold voltage (V_{TCWD}) or High-side threshold voltage (V_{TCWH}) until V_{CW} = V_{TCWL} (low-side threshold voltage) due to discharge by I_{CW}. Therefore, the C_W value from t_{WD} can be estimated as follows:

$$C_W = \frac{I_{CW}}{V_{TCWH} - V_{TCWL}} \cdot t_{WD}$$ ・・・・・・Equation <5>

※V_{TCWH} is used here because V_{TCWD} = V_{TCWH}.

Since the discharge current (I_{CW}) is typically 2μA and the threshold voltages are V_{TCWH} = 1.0 V (typ) and V_{TCWL} = 0.2 V (typ), C_W can be easily calculated using the following equations:

$$C_W = \frac{2\times10^{-6}}{1.0-0.2} \cdot t_{WD}$$

$$= (2.5\times10^{-6}) \cdot t_{WD}\ [\mathrm{F}]$$ ・・・・・・Equation <6> (The unit of t_{WD} is [s].)

The t_{WD} can be calculated from C_W according to the following equation:

$$t_{WD} = \frac{C_W}{I_{CW}} \cdot (V_{TCWH} - V_{TCWL})$$

$$= (0.4 \times 10^{6}) \cdot C_W\ [\mathrm{s}]$$ ・・・・・・Equation <7> (The unit of C_W is [F].)

Calculate the t_{WD} dispersion using the ration of C_W from the minimum and maximum values when C_W = 0.01 μF is connected:

$$t_{WD} = t_{WD}\ (C_W = 0.01\mu F) \times \frac{C_W}{0.01\times10^{-6}}\ [\mathrm{ms}]$$ ・・・・・・Equation <8> (The unit of C_W is [F].)

For example, when C_W = 1 μF and T_a = −40°C to 125°C, 320 ms ≤ t_{WD} ≤ 480 ms.

- **Setting the C_W from the Watchdog Timer Reset Time (t_{WR})**

The t_{WR} starts after the watchdog timer monitoring time (t_{WD}). The t_{WR} is the period from when CW pin voltage (V_{CW}) reaches V_{TCWD} until switching from discharging to charging, charging the capacitor with the charging current (I_{CW}), and V_{CW} reaching V_{TCWH}. Therefore, the C_W value from t_{WR} can be estimated as follows:

$$C_W = \frac{I_{CWL}}{V_{TCWH} - V_{TCWL}} \cdot t_{WR}$$ ······ Equation <9>

The formula for calculating C_W is as follows. The charging current (I_{CWL}) is 6 μA (typ), the threshold voltage, V_{TCWH} = 1.0 V (typ), and V_{TCWL} = 0.2 V (typ).

$$C_W = \frac{6\times10^{-6}}{1.0-0.2} \cdot t_{WR}$$

$$= (7.5\times10^{-6}) \cdot t_{WR} \text{ [F]}$$ ······ Equation <10> (The unit of t_{WR} is [s].)

The t_{WR} can be calculated from C_W according to the following equation:

$$t_{WR} = \frac{C_W}{I_{CWL}} (V_{TCWH} - V_{TCWL})$$

$$= (0.133\times10^{6}) \cdot C_W \text{ [s]}$$ ······ Equation <11> (The unit of C_W is [F].)

Calculate the t_{WR} dispersion using the ration of C_W from the minimum and maximum values when C_W = 0.01 μF is connected:

$$t_{WR} = t_{WR}\ (C_W = 0.01\mu F) \times \frac{C_W}{0.01\times10^{-6}} \text{ [ms]}$$ ······ Equation <12> (The unit of C_W is [F].)

For example, when C_W = 1 μF and T_a = −40°C to 125°C, 104 ms ≤ t_{WR} ≤ 156 ms.

Figure 1 shows the correlation between the C_W value and t_D, t_{WD}, or t_{WD} from Equation <3>, Equation <7>, and Equation <11>.

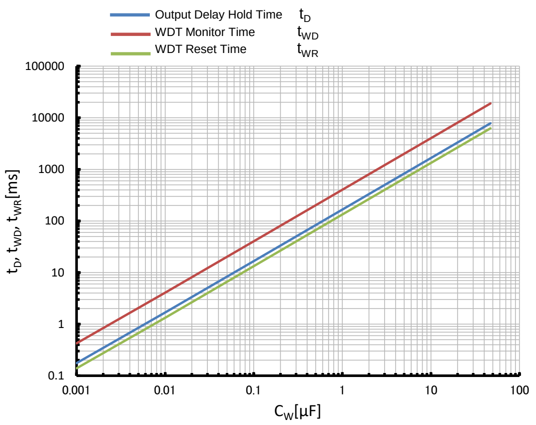
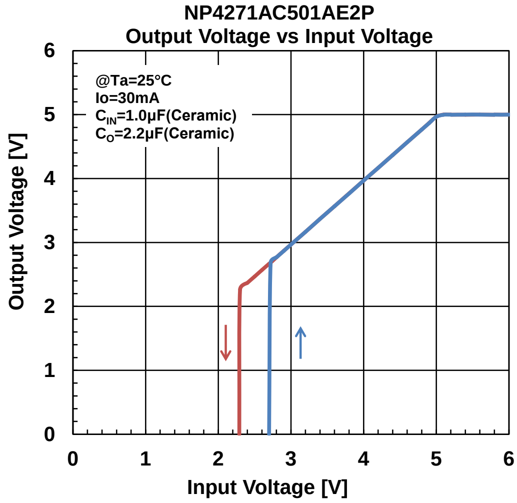


Figure 1. The Correlation between C_W Value and t_D, t_{WD}, or t_{WR}

• Undervoltage Lockout (UVLO)

The NP4271has a UVLO circuit that prevents malfunction by locking out the output when V_{IN} is below the UVLO release voltage (2.7 V, typ). When the input voltage drops below the UVLO detection voltage (2.15 V, typ)*, the output voltage falls.

*UVLO detection voltage (2.15 V, typ) = UVLO release voltage (2.7 V, typ) − UVLO hysteresis voltage (550 mV, typ)



• Control Function

The CONTROL pin can be set to active state by inputting "High" or shutdown state by inputting "Low".The CONTROL pin is pulled down internally with Typ. 3.2MΩ. There is no problem if voltage is applied to the CONROL pin before the VIN pin. At startup, input "High".

• Thermal Shutdown Function

When the IC junction temperature (T_j) exceeds the thermal shutdown detection temperature (Typ.175 °C), the output voltage (V_{OUT}) is cut off to suppress self-heating. After that, when the junction temperature (T_j) falls below the thermal shutdown release temperature (Typ.140 °C), it will restart. When restarting, the operation is the same as starting with the CONTROL pin.
The thermal shutdown function prevents the IC from fuming and ignition but does not ensure the IC’s reliability or keep the IC below the absolute maximum ratings. The thermal shutdown function does not operate on the heat generated by other than the normal IC operation such as latchup and overvoltage application. The thermal shutdown function operates in a state over the absolute maximum ratings, therefore the thermal shutdown function should not be used for a system design.

• Overcurrent protection function

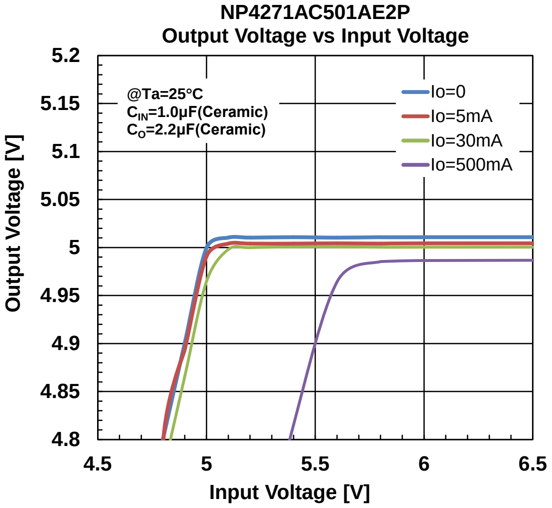
The NP4271 has built-in overcurrent protection with foldback characteristics. The overcurrent protection function works at a minimum of 500 mA, so the load current should be designed to be less than that.

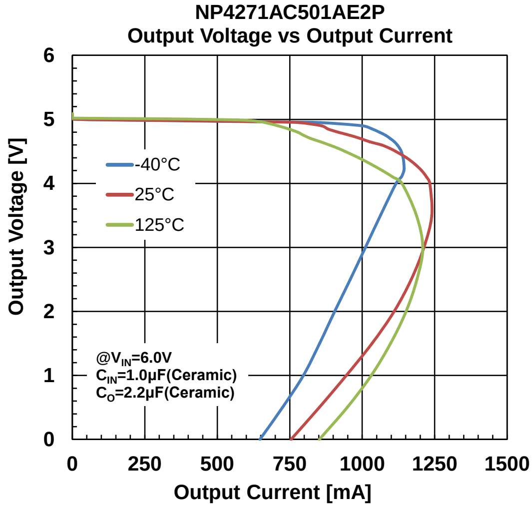
• High/Low monitoring (window detection) function

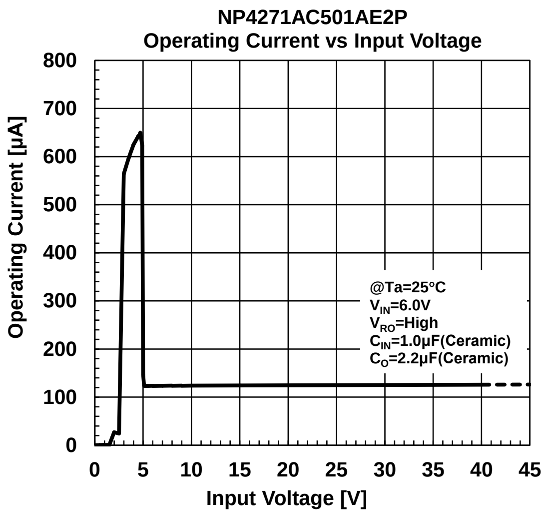
When the output voltage of the voltage regulator exceeds the high or low side (A version) detection voltage, VRO = Low (B version is only for low side detection); there is no hysteresis for high side detection.

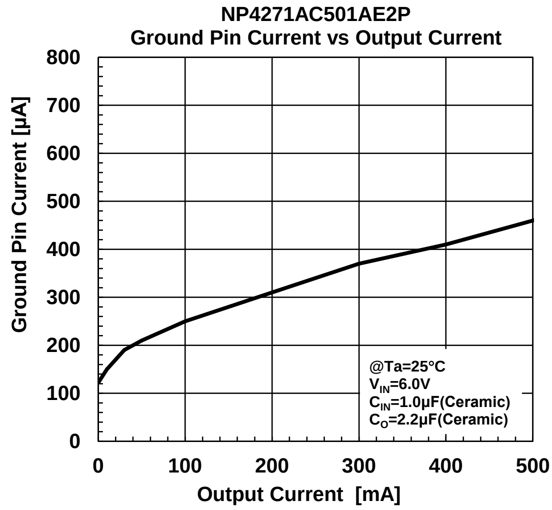
■ TYPICAL CHARACTERISTICS

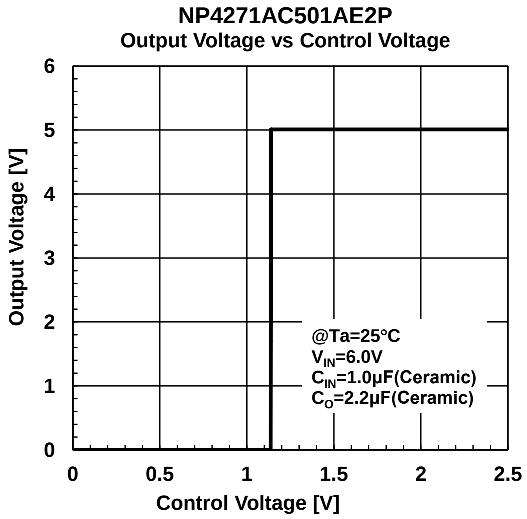
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

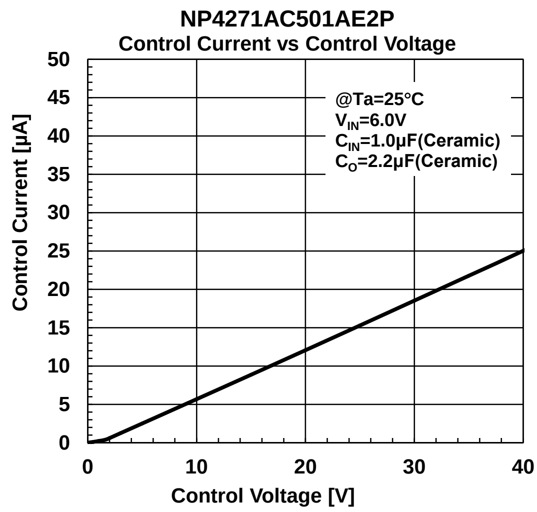












■ TYPICAL CHARACTERISTICS

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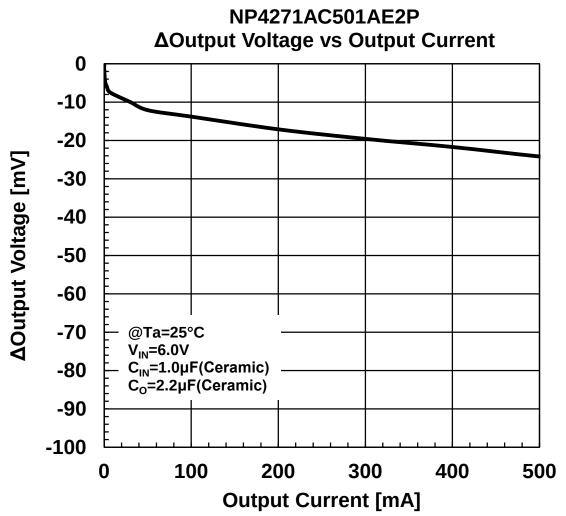

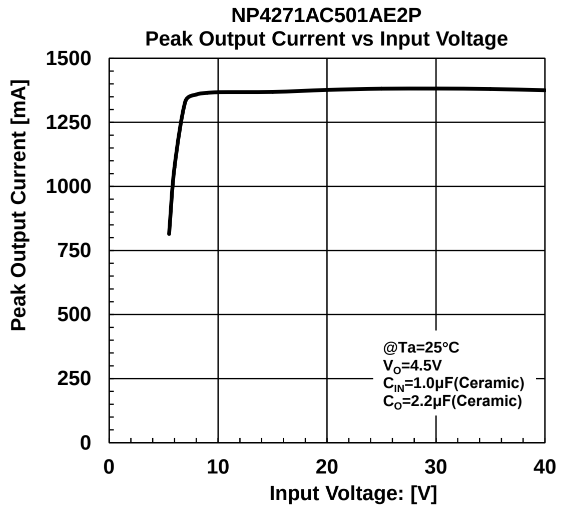

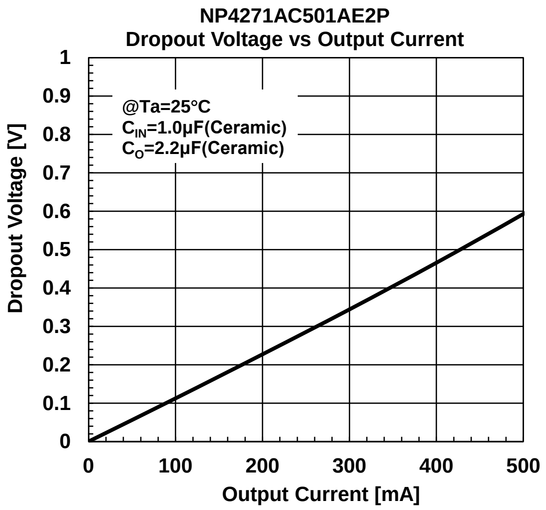

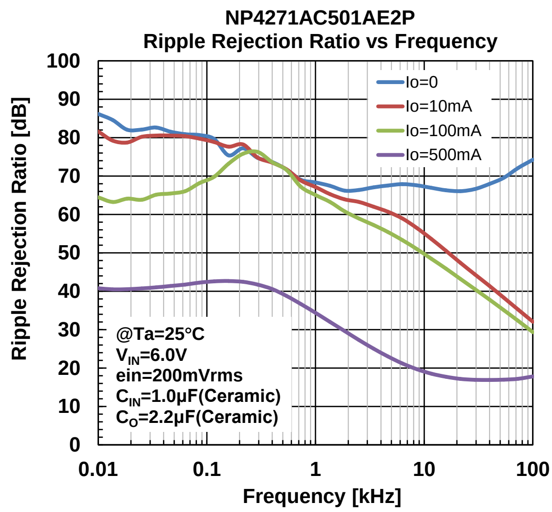

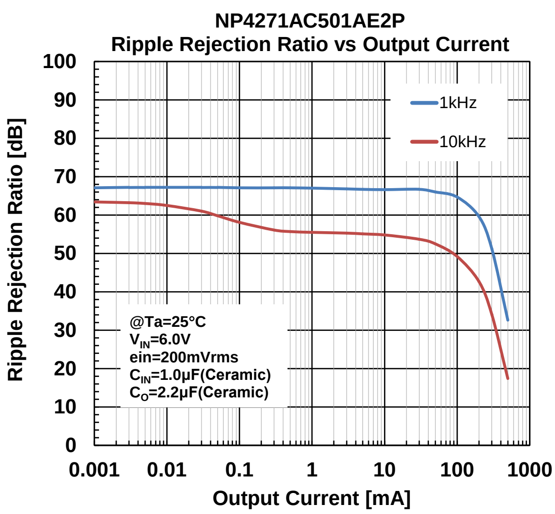

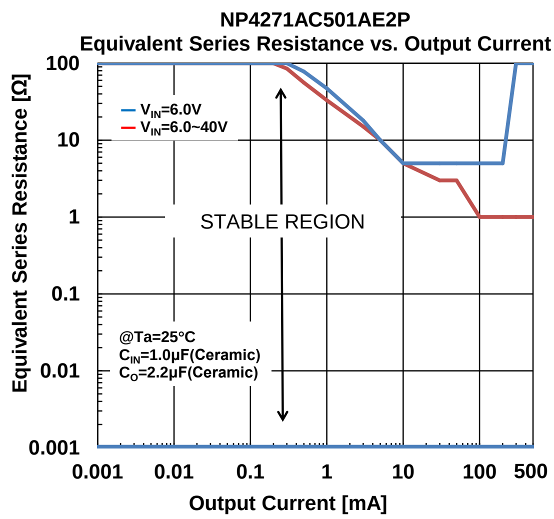

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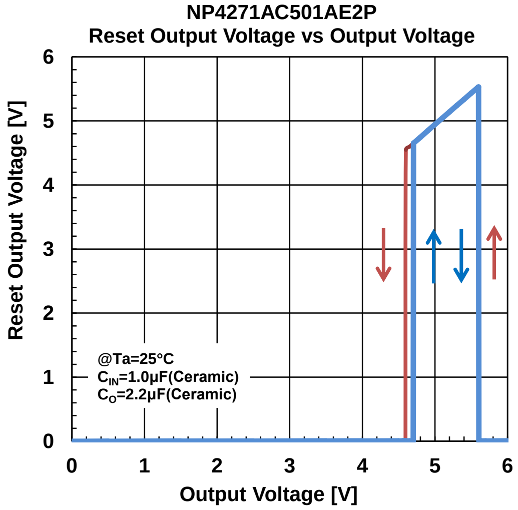
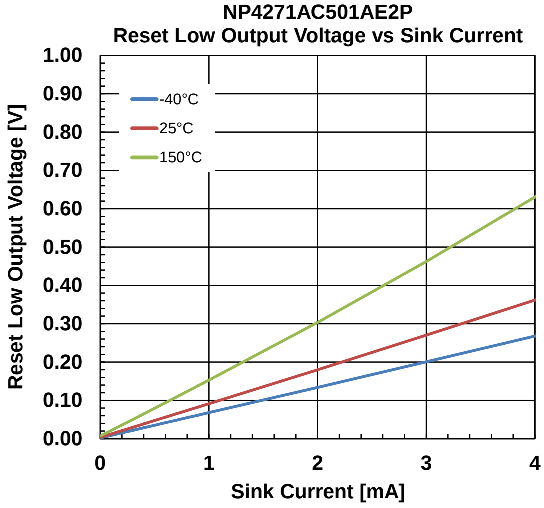
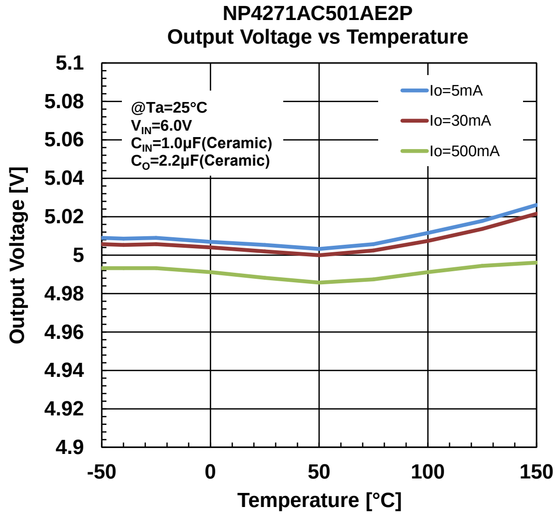
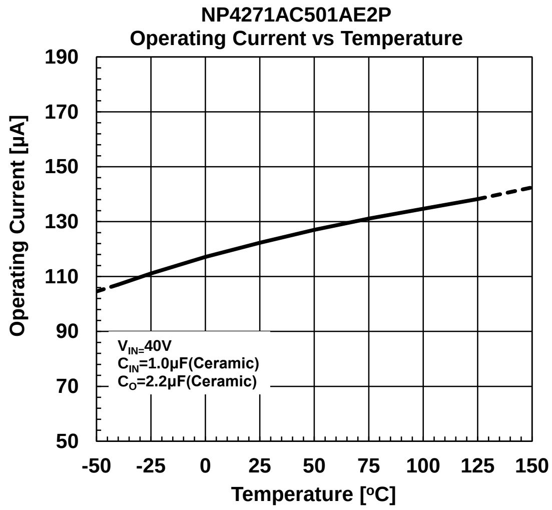
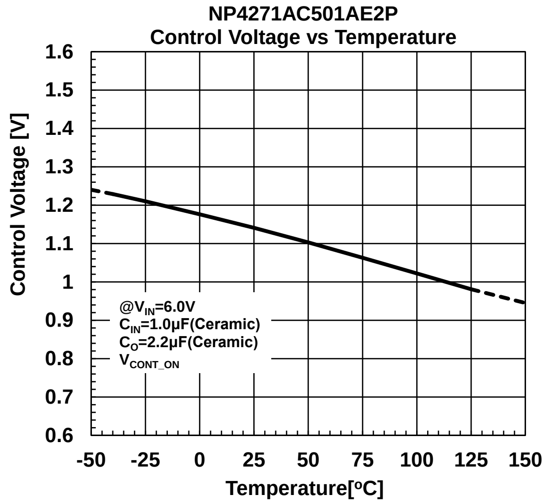
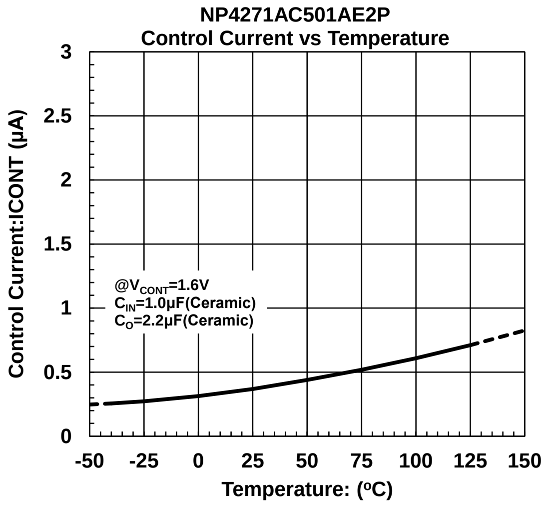








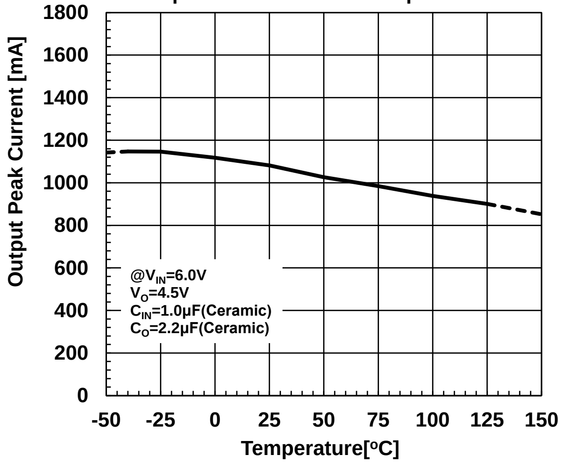




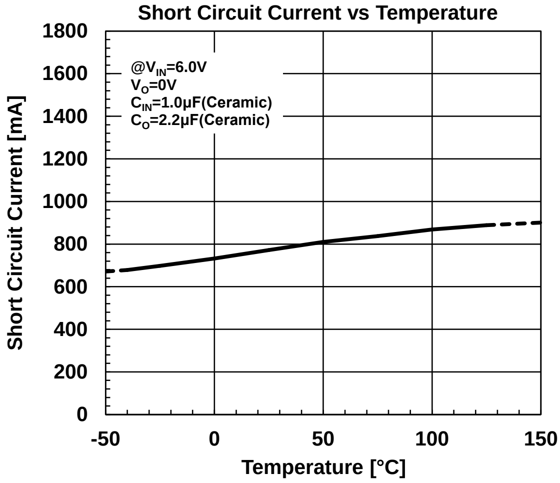
■ TYPICAL CHARACTERISTICS

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

NP4271AC501AE2P
Output Peak Current vsTemperature



NP4271AC501AE2P
Short Circuit Current vs Temperature



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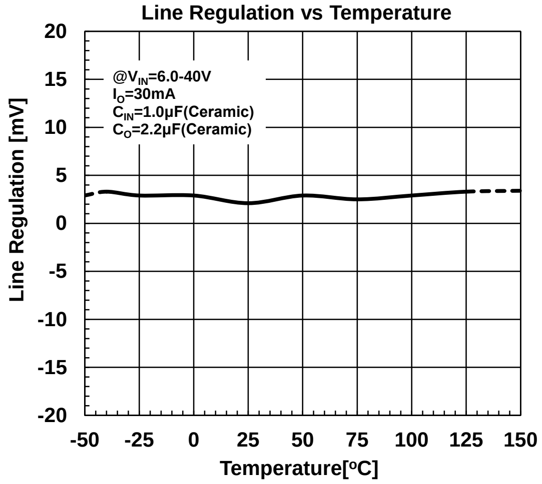
Line Regulation vs Temperature



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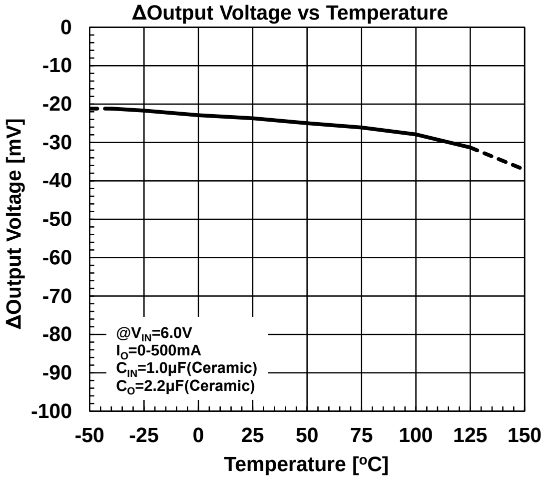
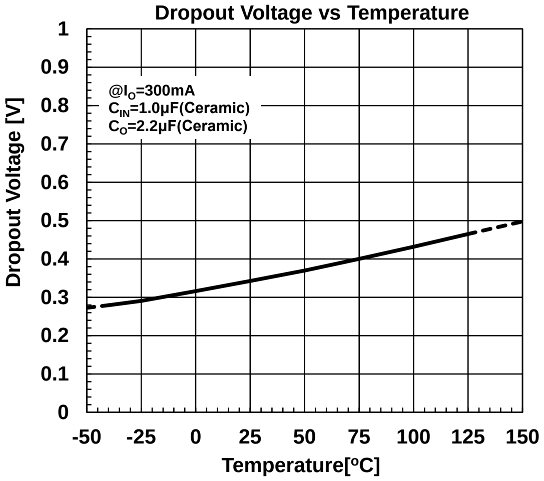
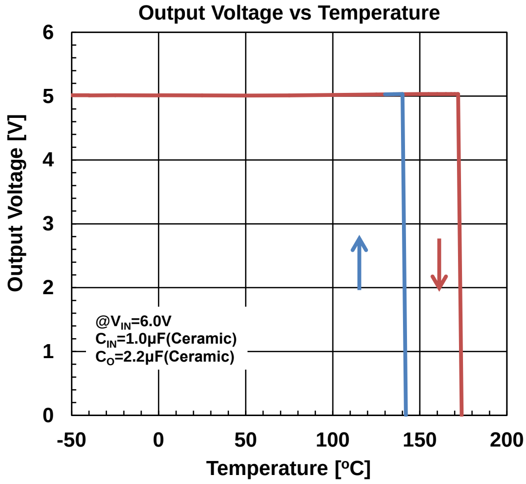
ΔOutput Voltage vs Temperature



NP4271AC501AE2P
Dropout Voltage vs Temperature



NP4271AC501AE2P
Output Voltage vs Temperature



■ TYPICAL CHARACTERISTICS

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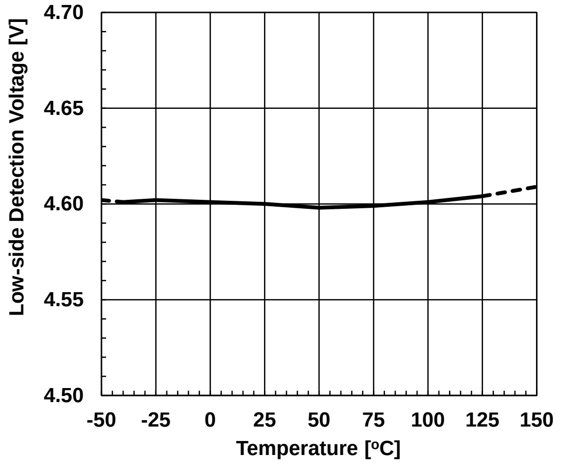
NP4271AC501AE2P
Low-side Detection Voltage vs Temperature



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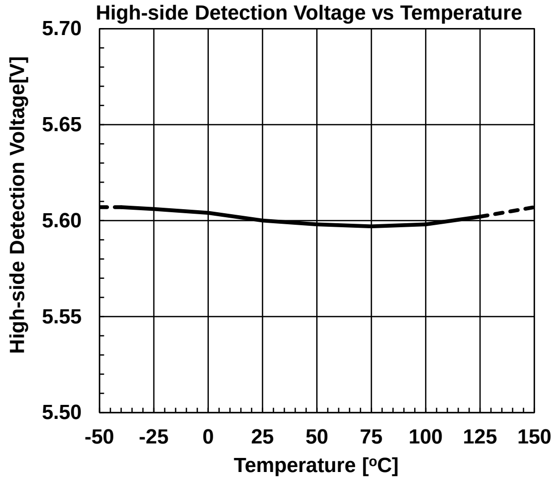
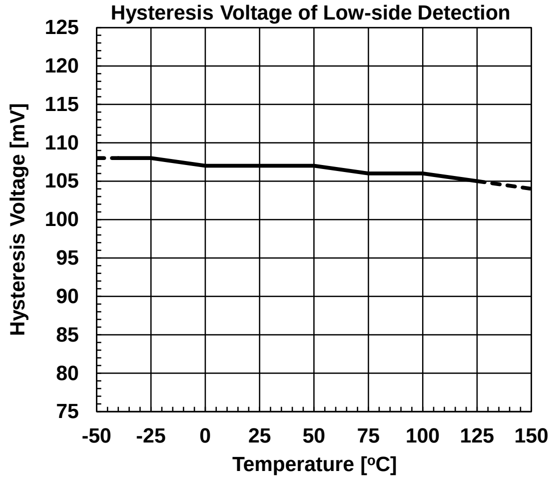
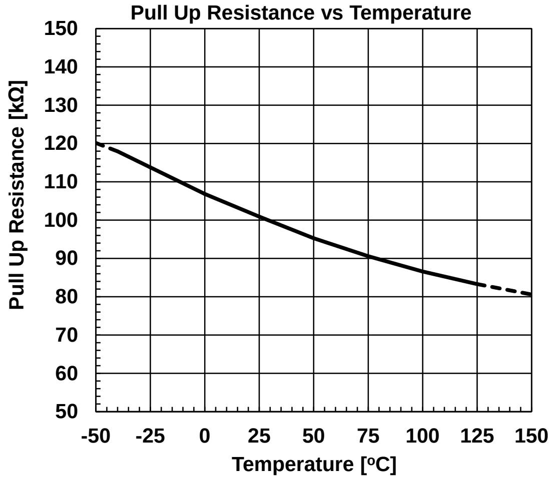
High-side Detection Voltage vs Temperature



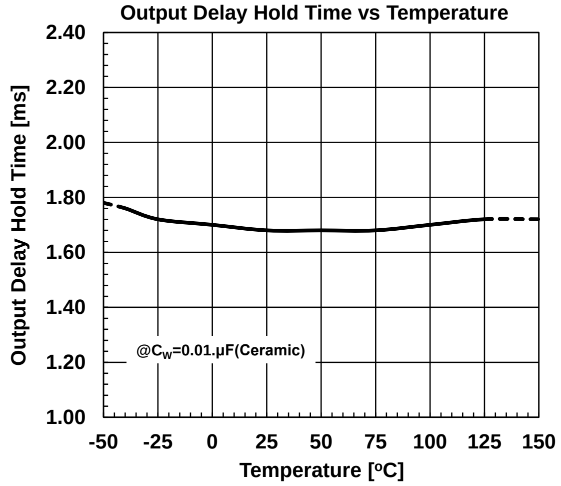
NP4271AC501AE2P
Hysteresis Voltage of Low-side Detection



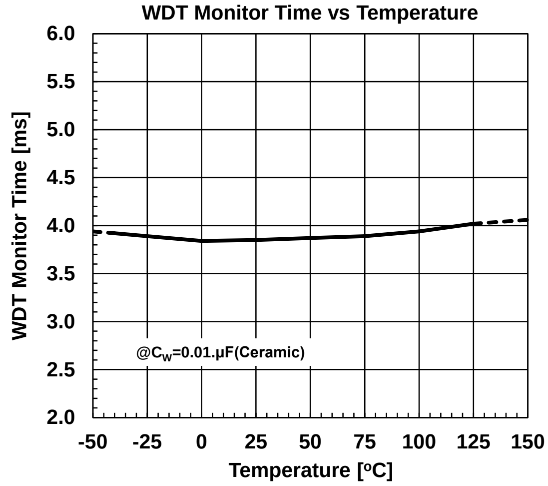
NP4271AC501AE2P
Pull Up Resistance vs Temperature



NP4271AC501AE2P
Output Delay Hold Time vs Temperature



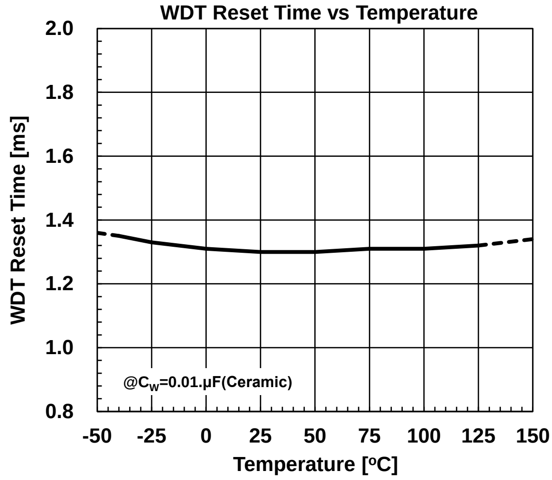
NP4271AC501AE2P
WDT Monitor Time vs Temperature



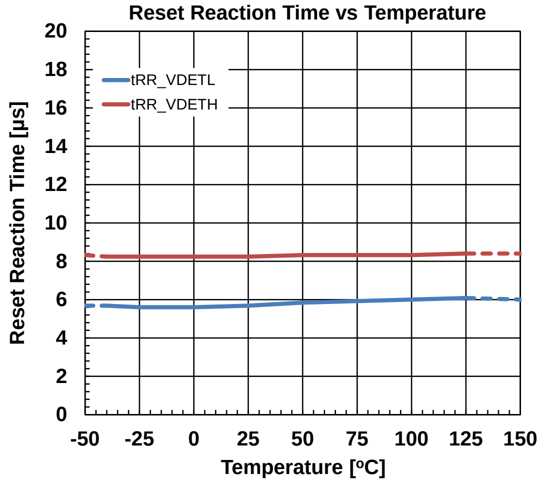
■ TYPICAL CHARACTERISTICS

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

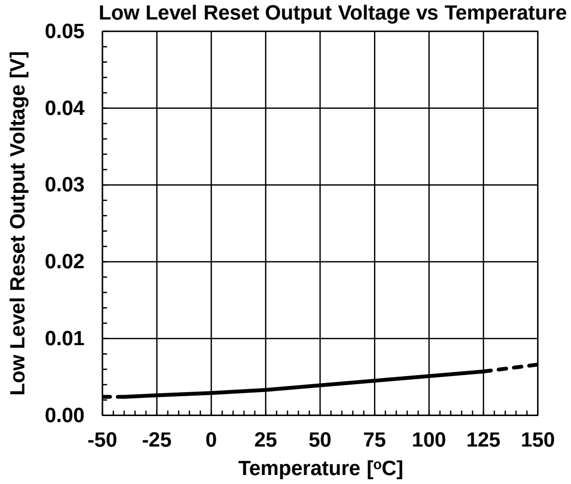
NP4271AC501AE2P
WDT Reset Time vs Temperature



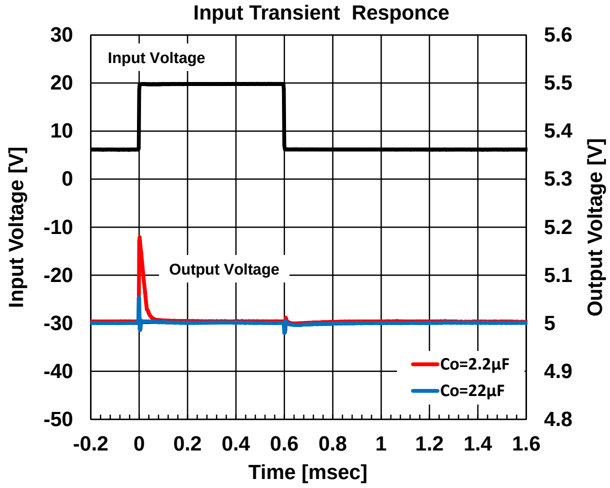
NP4271AC501AE2P
Reset Reaction Time vs Temperature



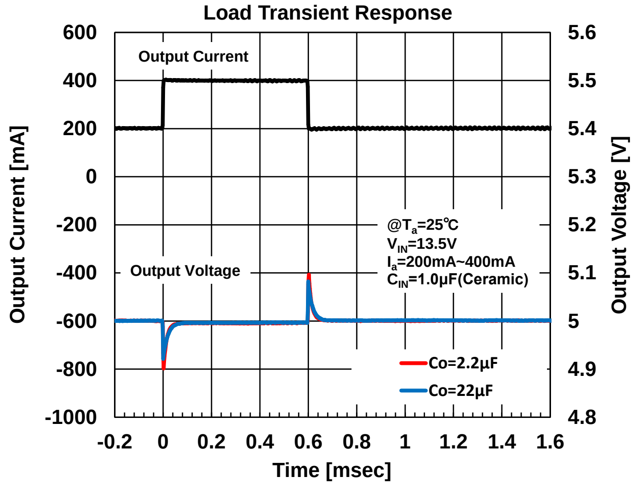
NP4271AC501AE2P
Low Level Reset Output Voltage vs Temperature



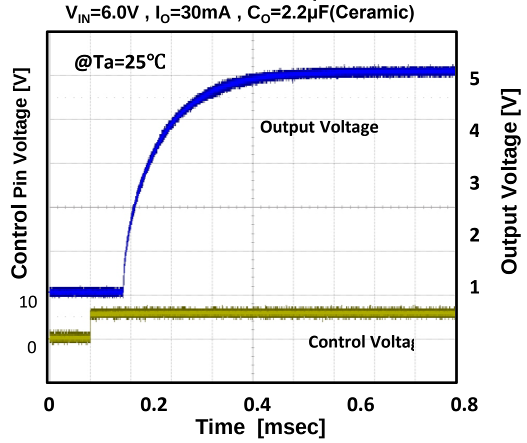
NP4271AC501AE2P
Input Transient Responce



NP4271AC501AE2P
Load Transient Response



NP4271AC501AE2P
ON/OFF Transient Responce
V_{IN}=6.0V , I_O=30mA , C_O=2.2μF(Ceramic)



■ REVISION HISTORY

Date	Revision	Contents of Changes
JUN 1 2024	Ver. 1.0	Initial release

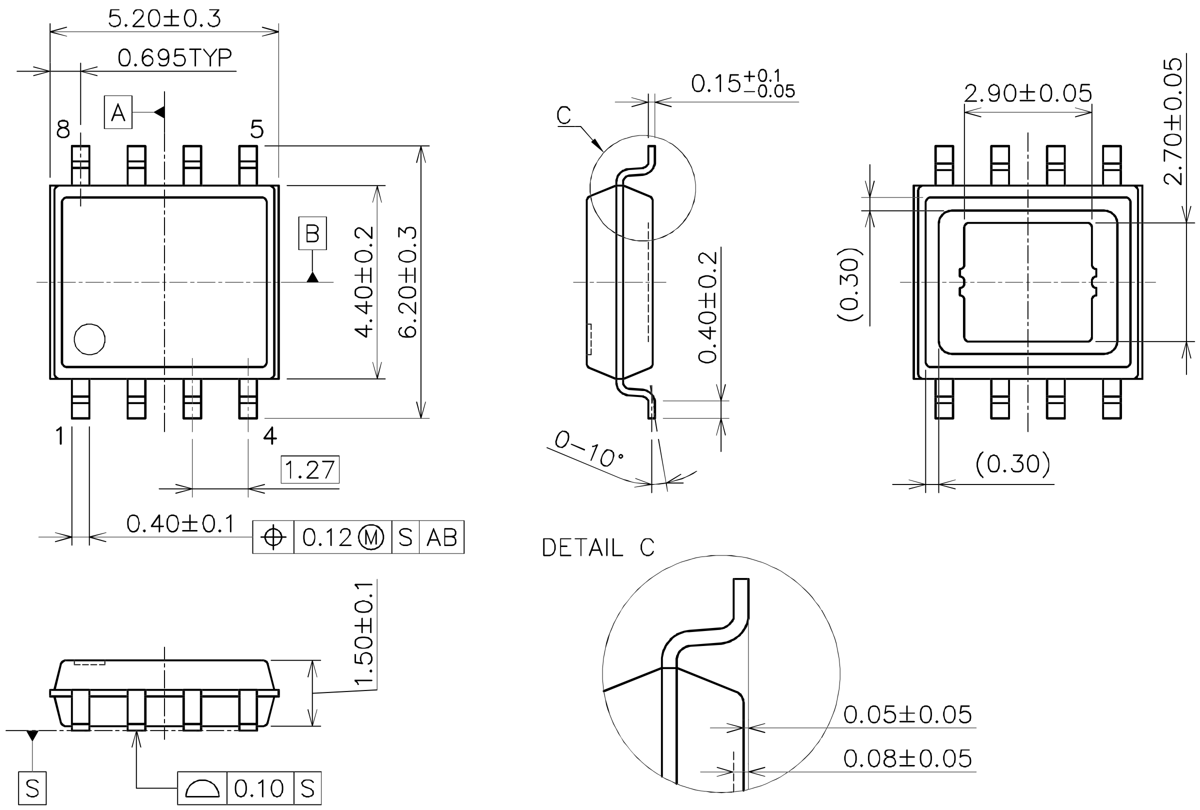
Nisshinbo Micro Devices Inc.

HSOP-8-AC

PI-HSOP-8-AC-01-E-A

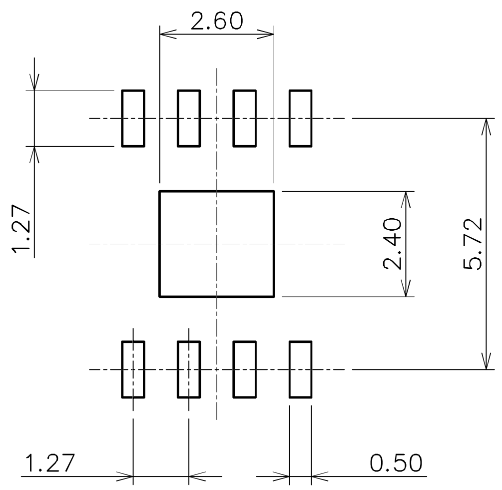
■ PACKAGE DIMENSIONS

UNIT: mm



■ EXAMPLE OF SOLDER PADS DIMENSIONS

UNIT: mm



<Instructions for mounting>

Please be careful when mounting, because there is a standoff on the backside electrode of the package.

Nisshinbo Micro Devices Inc.

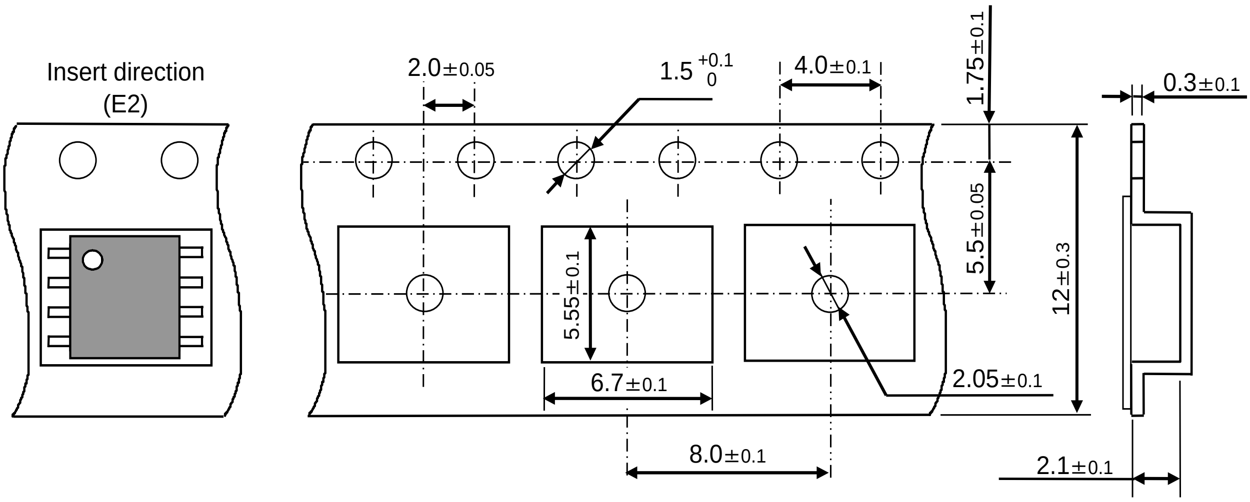
HSOP-8-AC

PI-HSOP-8-AC-01-E-A

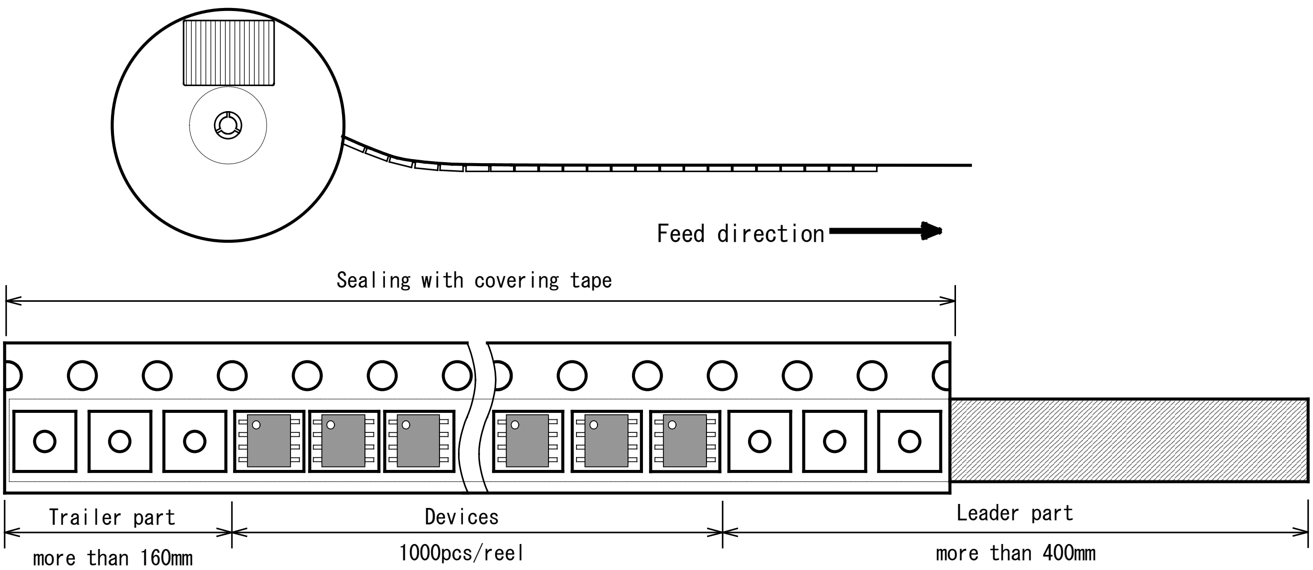
■ **PACKING SPEC**

UNIT: mm

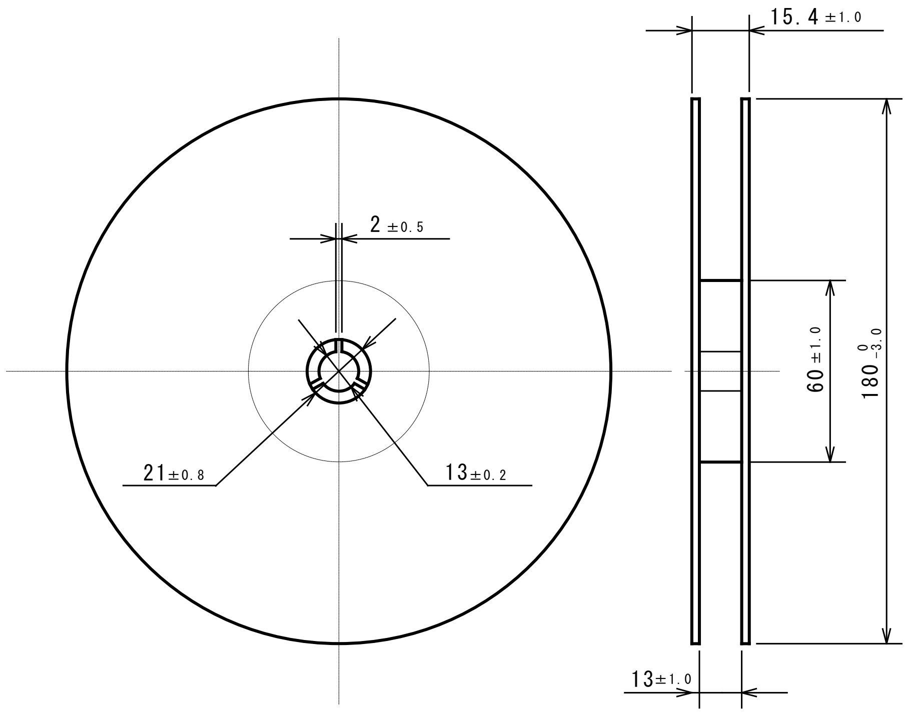
(1) Taping dimensions / Insert direction



(2) Taping state

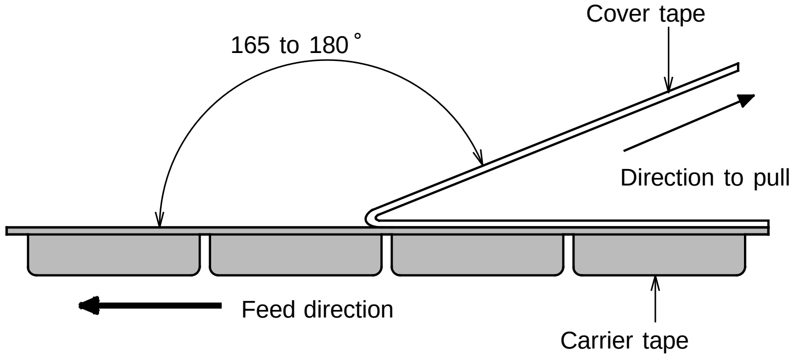


(3) Reel dimensions

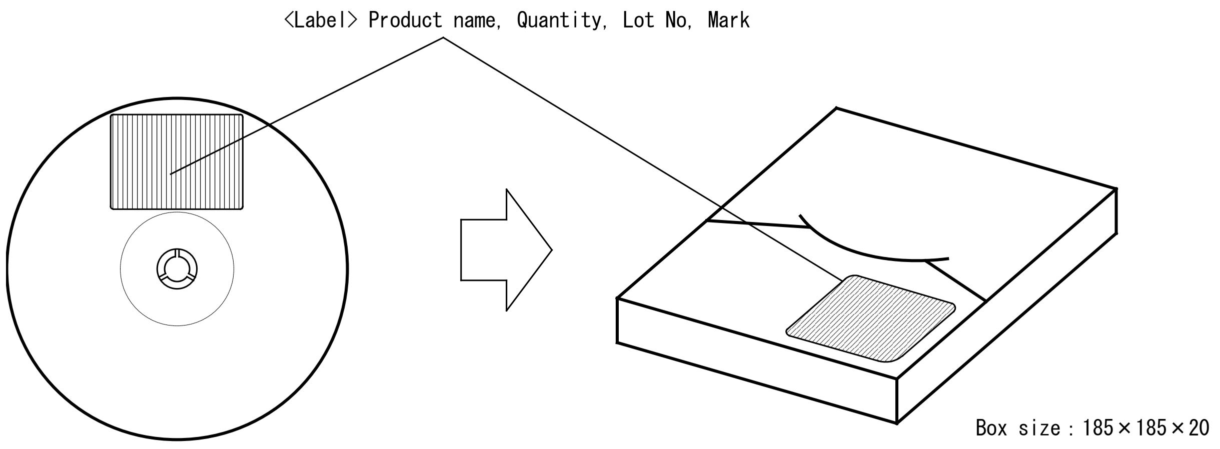


(4) Peeling strength

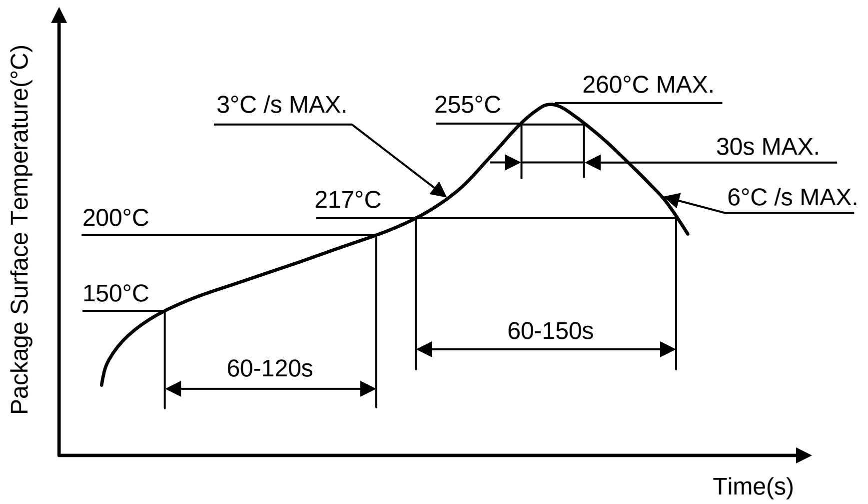
Peeling strength of cover tape
・Peeling angle 165 to 180°degrees to the taped surface.
・Peeling speed 300mm/min
・Peeling strength 0.1 to 1.3N



(5) Packing state



■ **HEAT-RESISTANCE PROFILES**



Reflow profile

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.
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    - Aerospace Equipment
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    - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
    - Life Maintenance Medical Equipment
    - Fire Alarms / Intruder Detectors
    - Vehicle Control Equipment (airplane, railroad, ship, etc.)
    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

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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.