HIGH VOLTAGE I_O = 500 mA ADJUSTABLE LDO REGULATOR

■ FEATURES*

- AEC-Q100 grade 1 qualified
- Fast transient response
- Wide operating voltage 4.0 V to 40 V
- Wide operating temperature T_a = −40°C to 125°C
- High-accuracy ADJ voltage
  V_{ADJ} = 1.24 V ±1.0% (T_a = 25°C)
  V_{ADJ} = 1.24 V ±2.0% (T_a = −40°C to 125°C)
- Adjustable output voltage range 2.5 V to 16 V
- Output current 500 mA (min)
- ON/OFF control
- Ceramic capacitor compatible
- Undervoltage lockout
- Thermal shutdown
- Overcurrent protection
- Package TO-252-5-L5

■ APPLICATIONS*

- Car infotainment
- Automotive ECUs
- Industrial equipment

**T1 grade is not recommended for powertrain, vehicle electrification and autonomous driving related applications.*

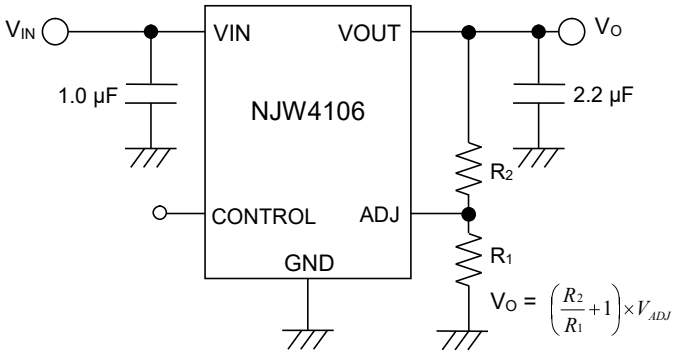
■ DESCRIPTION

The NJW4106-T1 is a 45 V, I_O = 500 mA fast transient response low dropout regulator. This device achieves fast transient response and offers stable output voltage at line or load fluctuations.

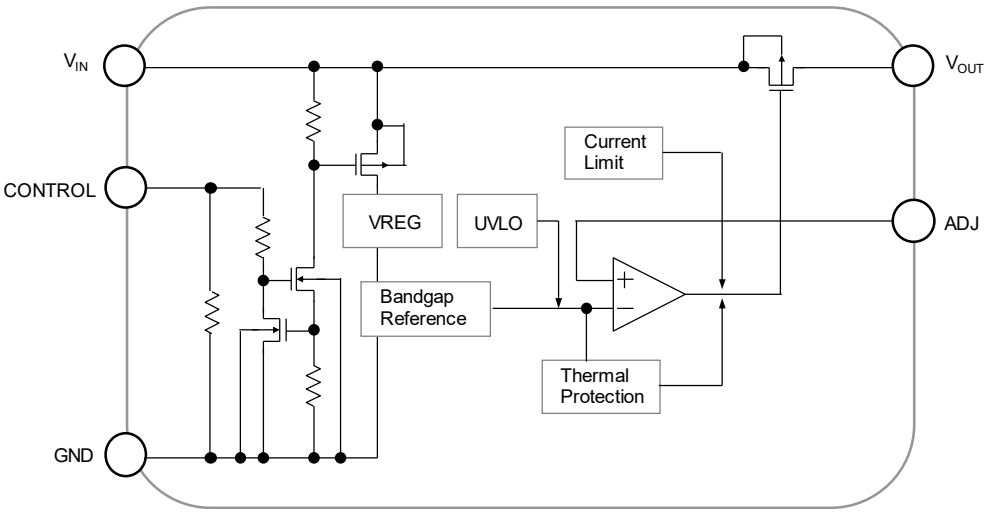
The NJW4106-T1 provides outstanding high ADJ voltage accuracy that guaranteed 1.24 V ±2.0% under the conditions of V_{IN} = V_O + 1 V to 40 V, I_O = 0 mA to 500 mA, and T_a = −40°C to 125°C.

Moreover, wide operating voltage and wide operating temperature makes the NJW4106-T1 ideal for automotive equipment or applications that require high reliability.

■ TYPICAL APPLICATION

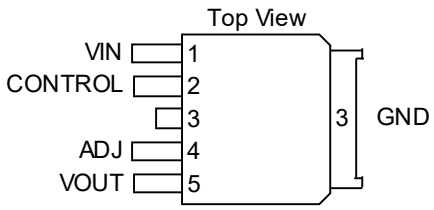


■ BLOCK DIAGRAM



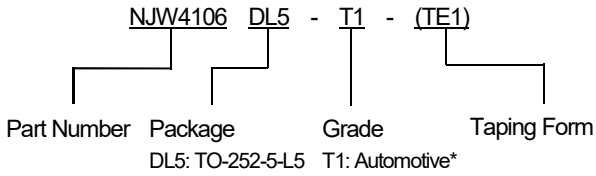
■ PIN CONFIGURATION

TO-252-5-L5



PIN NO.	NAME	FUNCTION
1	VIN	Input pin
2	CONTROL	ON/OFF control pin
3	GND	Ground pin
4	ADJ	Output voltage adjustment pin
5	VOUT	Output pin

■ PRODUCT NAME INFORMATION



** The detail information of automotive grades and recommended applications are described in NJR website. (https://www.njr.com/electronic_device/semiconductor/application/automotive.html.)*

■ ORDERING INFORMATION

PRODUCT NAME	PACKAGE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJW4106DL5-T1 (TE1)	TO-252-5-L5	Yes	Yes	Sn-2Bi	4106T1	301	3000

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Input Voltage	V_{IN}	−0.3 to 45	V
Control Pin Voltage	V_{CONT}	−0.3 to 45	V
ADJ Pin Voltage	V_{ADJ}	−0.3 to 6	V
Output Voltage	V_O	−0.3 to V_{IN} ≤ +17 (1)	V
Power Dissipation (T_a = 25°C) TO-252-5-L5	P_D	2-Layer / 4-Layer / High Power 4-Layer 870 (2) / 3000 (3) / 4700 (4)	mW
Junction Temperature	T_j	−40 to 150	°C
Storage Temperature	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 the input voltage is below 17 V, the maximum output voltage is 17 V.
(2) 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).
(3) 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.)
(4) High Power 4-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm, 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.)
*For the specifications of each board, see the Board Specifications of THERMAL CHARACTERISTICS.

■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	VALUE	UNIT
Operating Voltage	V_{IN}	4.0 to 40	V
Control Voltage	V_{CONT}	0 to 40	V
Output Voltage Setting	V_O	2.5 to 16	V
Output Voltage Setting Resistor	R_1	5 to 500	kΩ
Output Current	I_O	0 to 500	mA
Operating Temperature	T_{opr}	−40 to 125	°C

■ **ELECTRICAL CHARACTERISTICS** $V_O \geq 3$ V: $V_{IN} = V_O + 1$ V, $C_{IN} = 1.0$ µF, $C_O = 2.2$ µF, R1 = 250 kΩ, $T_a = 25°C$
$V_O < 3$ V: $V_{IN} = 4.0$ V, $C_{IN} = 1.0$ µF, $C_O = 4.7$ µF, R1 = 250 kΩ, $T_a = 25°C$, unless otherwise noted.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
ADJ Voltage	V_{ADJ}	V_{IN} = 4 V to 40 V (V_O < 3 V), V_{IN} = V_O + 1 V to 40 V ($V_O \geq 3$ V), I_O = 0 mA to 500 mA	−1.0%	1.24	+1.0%	V
		V_{IN} = 4 V to 40 V (V_O < 3 V), V_{IN} = V_O + 1 V to 40 V ($V_O \geq 3$ V), I_O = 0 mA to 500 mA, T_a = −40°C to 125°C	−2.0%	-	+2.0%	
Quiescent Current	I_Q	I_O = 0 mA, except I_{CONT}	-	65	105	µA
		I_O = 0 mA, except I_{CONT}, T_a = −40°C to 125°C	-	-	115	
Quiescent Current at Control OFF	$I_{Q\,(OFF)}$	V_{CONT} = 0 V	-	-	1	µA
		V_{CONT} = 0 V, T_a = −40°C to 125°C	-	-	1	
Output Current	I_O	V_O × 0.9	500	-	-	mA
		V_O × 0.9, T_a = −40°C to 125°C	500	-	-	
Line Regulation	$\Delta V_O/\Delta V_{IN}$	V_{IN} = V_O + 1 V to 40 V, I_O = 30 mA, V_O = 5.0 V	-	-	34.0	mV
		V_{IN} = V_O + 1 V to 40 V, I_O = 30 mA, V_O = 5.0 V, T_a = −40°C to 125°C	-	-	51.0	
Load Regulation	$\Delta V_O/\Delta I_O$	I_O = 0 mA to 500 mA, V_O = 5.0 V	-	-	22.5	mV
		I_O = 0 mA to 500 mA, V_O = 5.0 V, T_a = −40°C to 125°C	-	-	45.0	
Ripple Rejection	RR	V_{IN} = V_O + 1 V, ein = 200 mVrms, f = 1 kHz, I_O = 30 mA, V_O = 5.0 V	-	53	-	dB
Dropout Voltage 1	ΔV_{IO1}	I_O = 300 mA	-	0.24	0.42	V
		I_O = 300 mA, T_a = −40°C to 125°C	-	-	0.60	
Dropout Voltage 2	ΔV_{IO2}	I_O = 500 mA	-	0.40	0.70	V
		I_O = 500 mA, T_a = −40°C to 125°C	-	-	1.00	
Control Current	I_{CONT}	V_{CONT} = 1.6 V	-	0.5	2.0	µA
		V_{CONT} = 1.8 V, T_a = −40°C to 125°C	-	-	3.0	
Control Voltage for ON-State	$V_{CONT\,(ON)}$		1.6	-	-	V
		T_a = −40°C to 125°C	1.8	-	-	
Control Voltage for OFF-State	$V_{CONT\,(OFF)}$		-	-	0.6	V
		T_a = −40°C to 125°C	-	-	0.6	
UVLO Release Voltage	V_{UVLO}	V_{IN} = low to high	2.3	2.7	3.1	V
		V_{IN} = low to high, T_a = −40°C to 125°C	2.2	-	3.2	
UVLO Hysteresis Voltage	V_{HYS}	V_{IN} = high to low	200	500	-	mV
		V_{IN} = high to low, T_a = −40°C to 125°C	200	-	-	
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T_a$	T_a = −40°C to 125°C, I_O = 30 mA	-	±50	-	ppm/°C

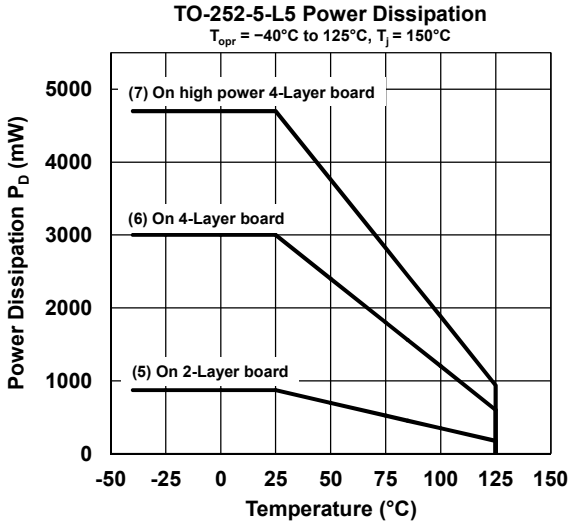
■ THERMAL CHARACTERISTICS

PARAMETER	SYMBOL	VALUE	UNIT
Junction-To-Ambient Thermal Resistance TO-252-5-L5	θ_{ja}	2-Layer / 4-Layer / High Power 4-Layer 143 (5) / 41 (6) / 26 (7)	°C/W
Junction-To-Top of Package Characterization Parameter TO-252-5-L5	Ψ_{jt}	2-Layer / 4-Layer / High Power 4-Layer 30 (5) / 15 (6) / 11 (7)	°C/W

■ BOARD SPECIFICATIONS

BOARD		JEDEC 2-LAYER BOARD	JEDEC 4-LAYER BOARD	HIGH POWER 4-LAYER BOARD
Dimension		76.2 mm × 114.3 mm, t = 1.6 mm		
Material		FR-4		
Cu Area	Surface Layer (Thickness: 70 µm)	NJR recommended land pattern + Measurement wiring	NJR recommended land pattern + Measurement wiring	NJR recommended land pattern + Heat dissipation pattern (50 mm × 50 mm) + Measurement wiring
	2nd Layer (Thickness: 35 µm)	-	74.2 mm × 74.2 mm	74.2 mm × 74.2 mm
	3rd Layer (Thickness: 35 µm)	-	74.2 mm × 74.2 mm	74.2 mm × 74.2 mm
	Back Layer (Thickness: 70 µm)	-	-	74.2 mm × 74.2 mm
Thermal Vias		-	Connected from surface layer to 2nd layer	All layers are connected

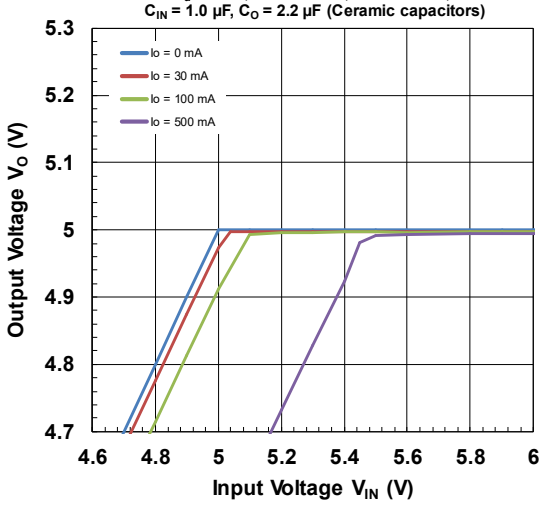
■ POWER DISSIPATION vs. AMBIENT TEMPERATURE



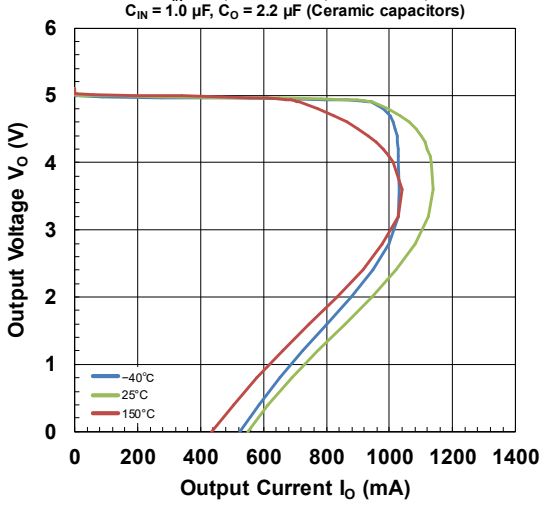
(5) 2-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 2-layer FR-4).
(6) 4-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 4-layer FR-4).
(For 4-layer: Applying 74.2 mm × 74.2 mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5.)
(7) High Power 4-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm, 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.)

■ TYPICAL CHARACTERISTICS

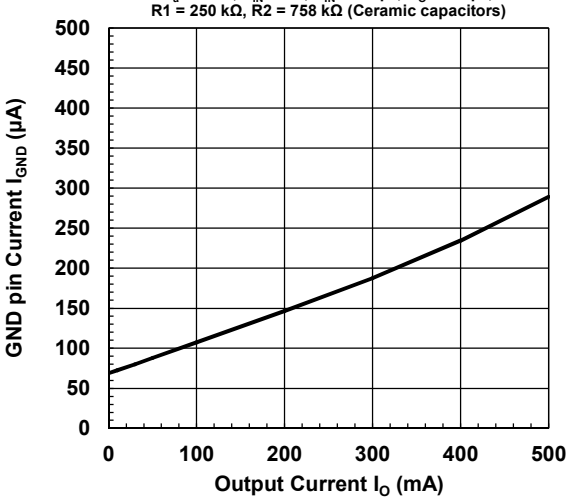
NJW4106_5.0V
Output Voltge vs. Input voltage
T_a = 25°C, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



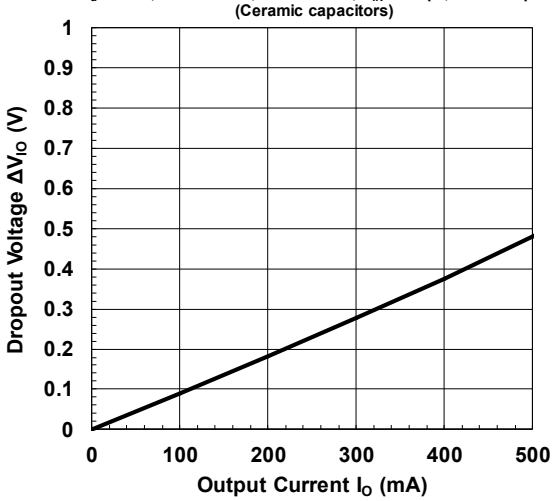
NJW4106_5.0V
Output Voltage vs. Output Current
V_{IN} = 6 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



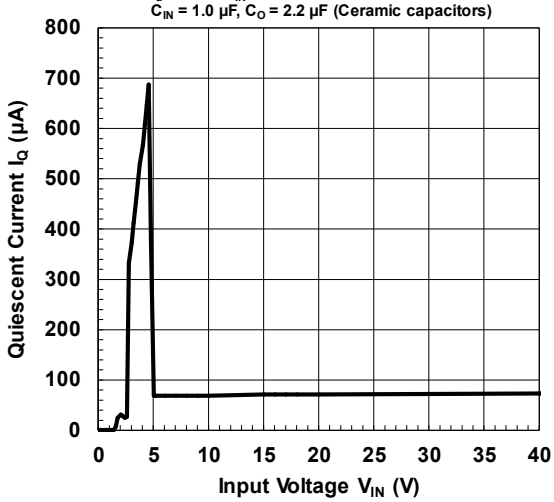
NJW4106_5.0V
GND pin Current vs. Output Current
T_a = 25°C, V_{IN} = 6 V, C_{IN} = 1.0 µF, C_O = 2.2 µF,
R1 = 250 kΩ, R2 = 758 kΩ (Ceramic capacitors)



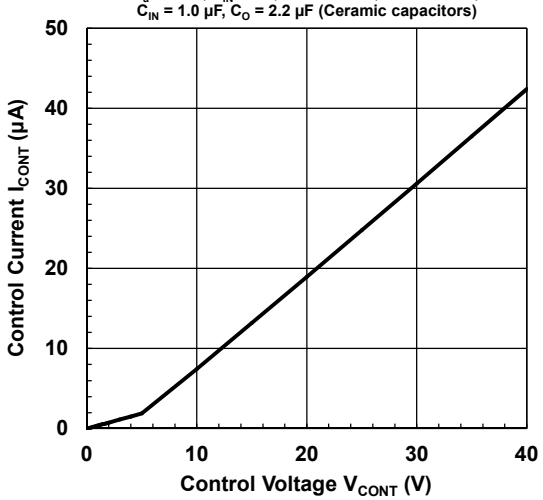
NJW4106_5.0V
Dropout Voltage vs. Output Current
T_a = 25°C, R1 = 250 kΩ, R2 = 758 kΩ, C_{IN} = 1.0 µF, CO = 2.2 µF
(Ceramic capacitors)



NJW4106_5.0V
Quiescent Current vs. Input Voltage
T_a = 25°C, V_{IN} = 6 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)

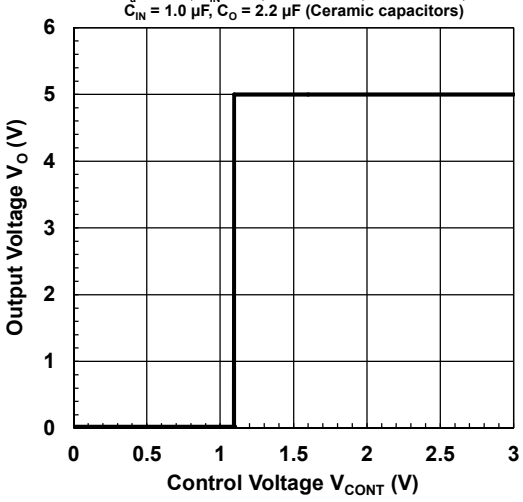


NJW4106_5.0V
Control Current vs. Control Voltage
T_a = 25°C, V_{IN} = 6 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)

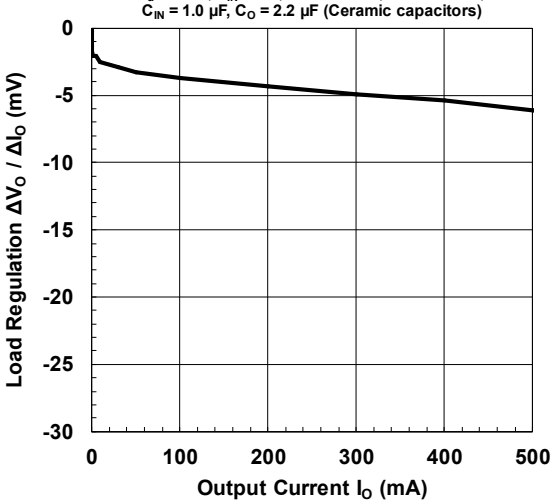


■ TYPICAL CHARACTERISTICS

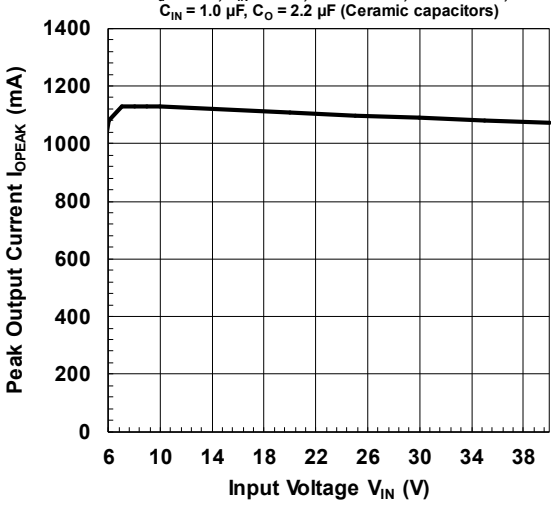
NJW4106_5.0V
Output Voltage vs. Control Voltage
T_a = 25°C, V_{IN} = 6 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



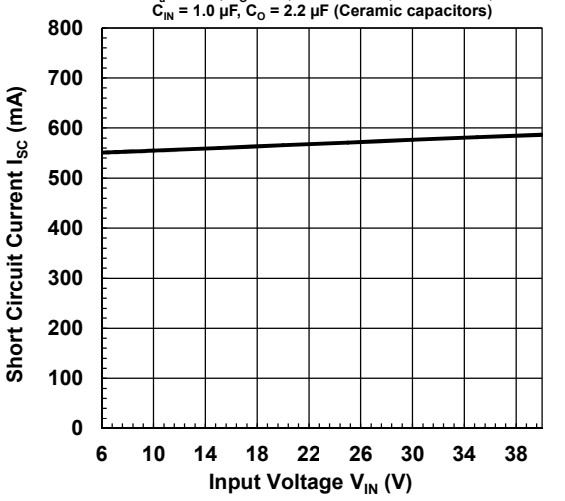
NJW4106_5.0V
Load Regulation vs. Output Current
T_a = 25°C, V_{IN} = 6 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



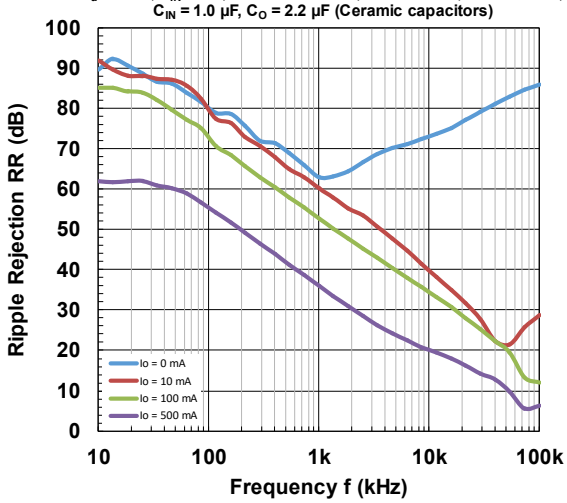
NJW4106_5.0V
Peak Output Current vs. Input Voltage
T_a = 25°C, V_{IN} = 4.5 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



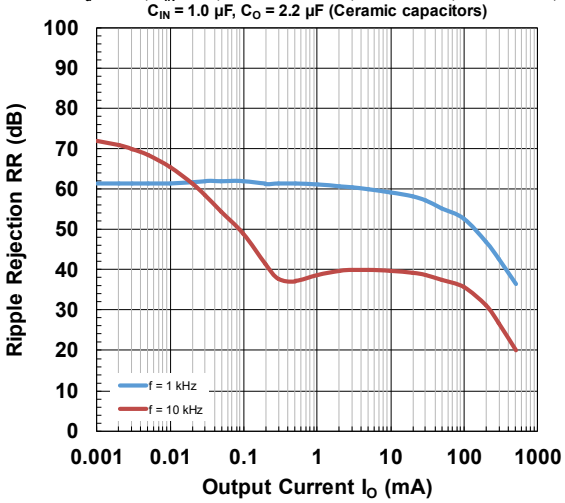
NJW4106_5.0V
Short Circuit Current vs. Input Voltage
T_a = 25°C, V_O = 0 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



NJW4106_5.0V
Ripple Rejection vs. Frequency
T_a = 25°C, V_{IN} = 6 V, ein = 200 mVrms, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)

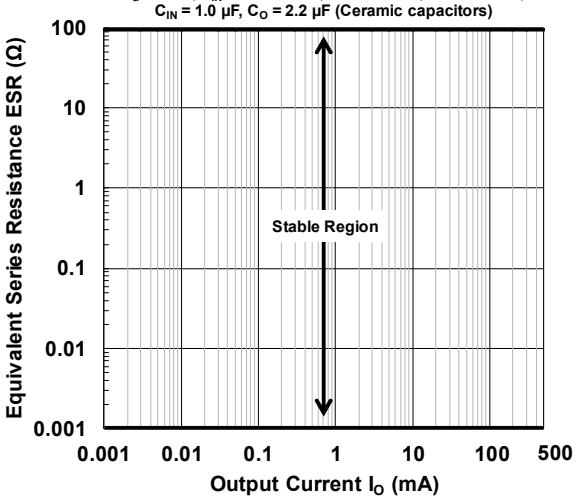


NJW4106_5.0V
Ripple Rejection vs. Output Current
T_a = 25°C, V_{IN} = 6 V, ein = 200 mVrms, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)

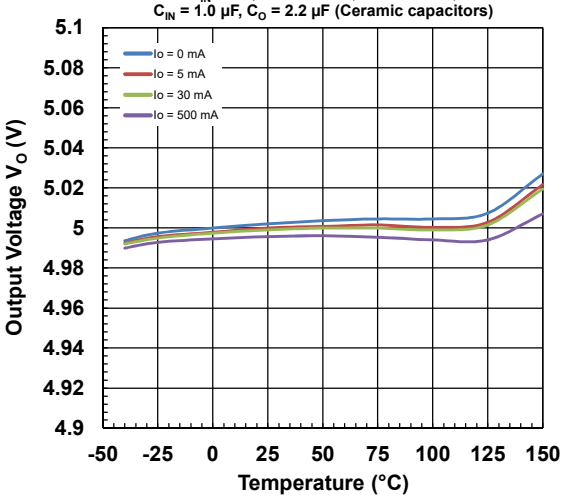


■ TYPICAL CHARACTERISTICS

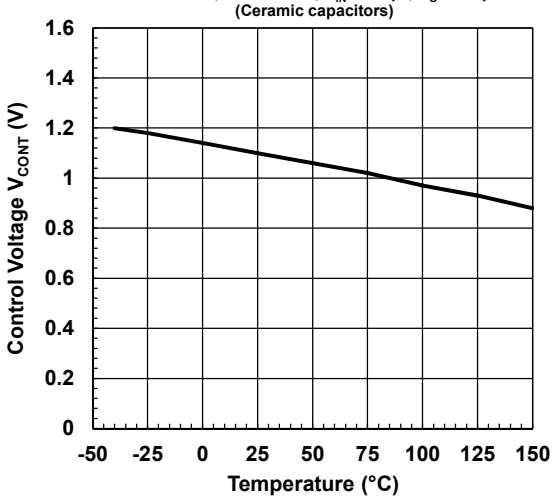
NJW4106_5.0V
Equivalent Series Resistance vs. Output Current
T_a = 25°C, V_{IN} = 6 V to 40 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



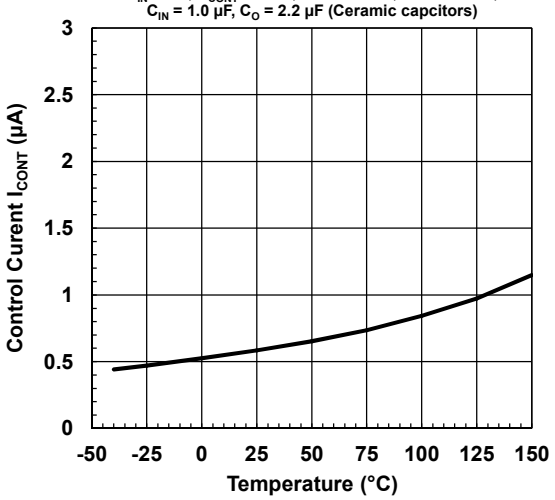
NJW4106_5.0V
Output Voltage vs. Temperature
V_{IN} = 6 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



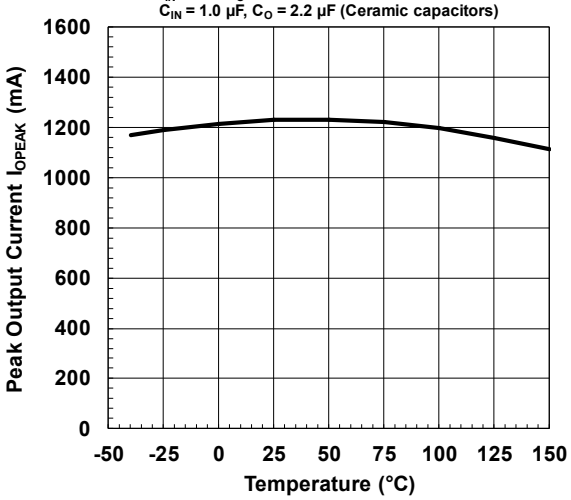
NJW4106_5.0V
Control Voltage vs. Temperature
R1 = 250 kΩ, R2 = 758 kΩ, C_{IN} = 1.0 µF, C_O = 2.2 µF
(Ceramic capacitors)



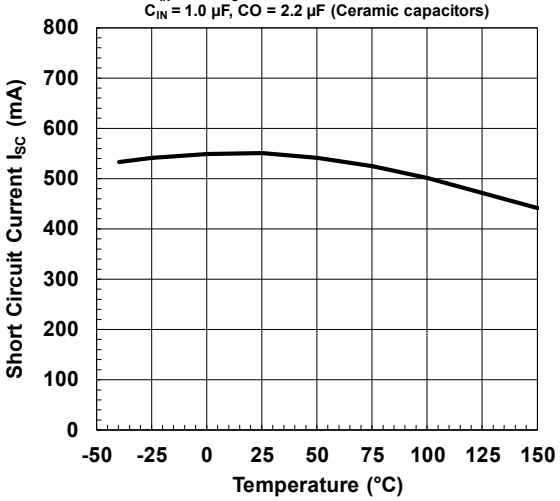
NJW4106_5.0V
Control Current vs. Temperature
V_{IN} = 6 V, V_{CONT} = 1.6 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capcitors)



NJW4106_5.0V
Peak Output Current vs. Temperature
V_{IN} = 6 V, V_O = 4.5 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)

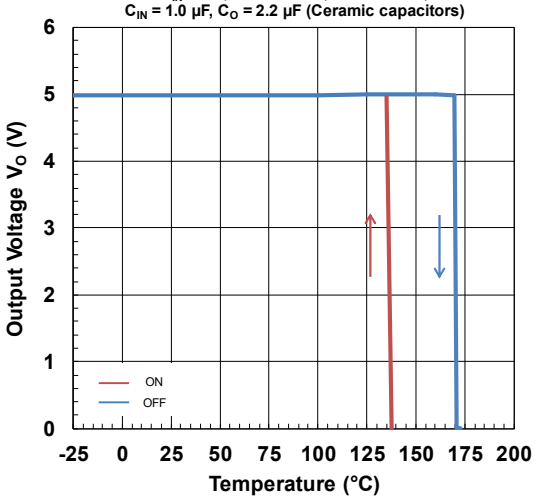


NJW4106_5.0V
Short Circuit Current vs. Temperature
V_{IN} = 6 V, V_O = 0 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, CO = 2.2 µF (Ceramic capacitors)

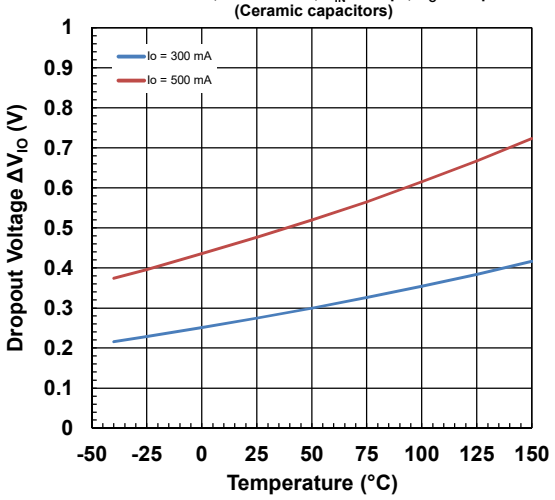


■ TYPICAL CHARACTERISTICS

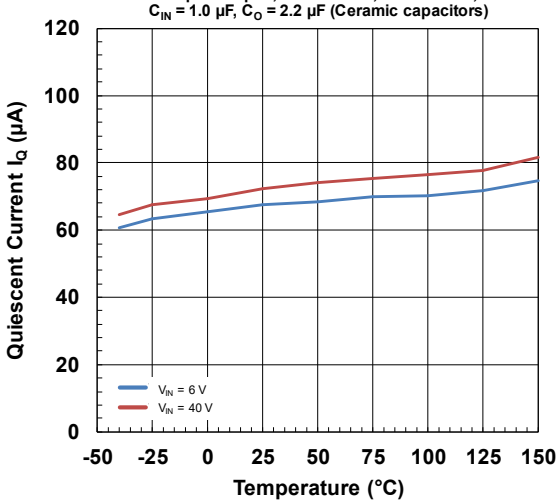
NJW4106_5.0V
Output Voltage vs. Temperature
V_{IN} = 6 V, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



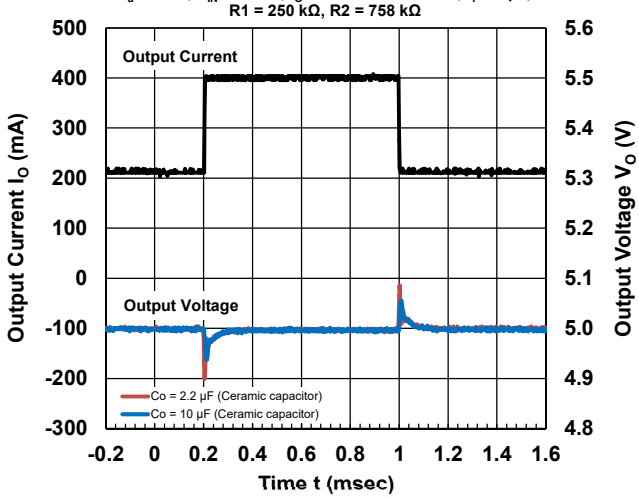
NJW4106_5.0V
Dropout Voltage vs. Temperature
R1 = 250 kΩ, R2 = 758 kΩ, C_{IN} = 1.0 µF, C_O = 2.2 µF
(Ceramic capacitors)



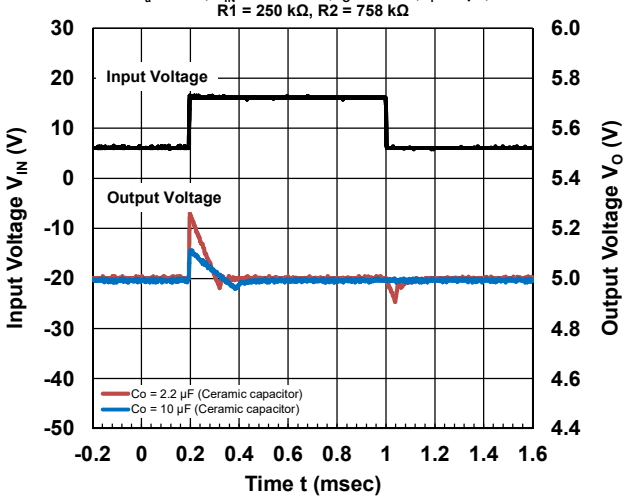
NJW4106_5.0V
Quiescent Current vs. Temperature
Output is open, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



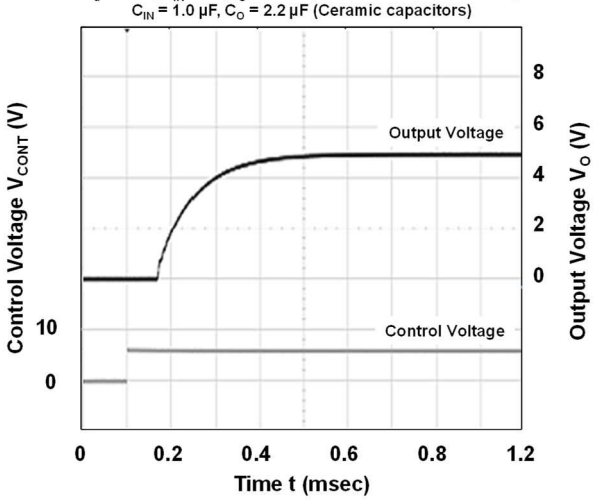
NJW4106_5.0V
Load Transient Response
T_a = 25°C, V_{IN} = 13.5 V, I_O = 200 mA to 400 mA, t_r = 1 µs,
R1 = 250 kΩ, R2 = 758 kΩ



NJW4106_5.0V
Input Transient Response
T_a = 25°C, V_{IN} = 6 V to16 V, I_O = 10 mA, t_r = 1 µs,
R1 = 250 kΩ, R2 = 758 kΩ

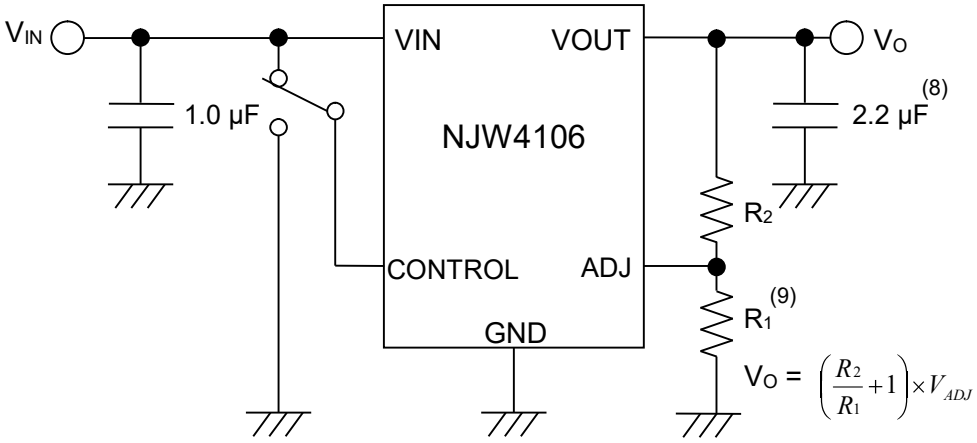


NJW4106_5.0V
ON/OFF Transient Response
T_a = 25°C, V_{IN} = 6 V, I_O = 30 mA, R1 = 250 kΩ, R2 = 758 kΩ,
C_{IN} = 1.0 µF, C_O = 2.2 µF (Ceramic capacitors)



■TYPICAL APPLICATION

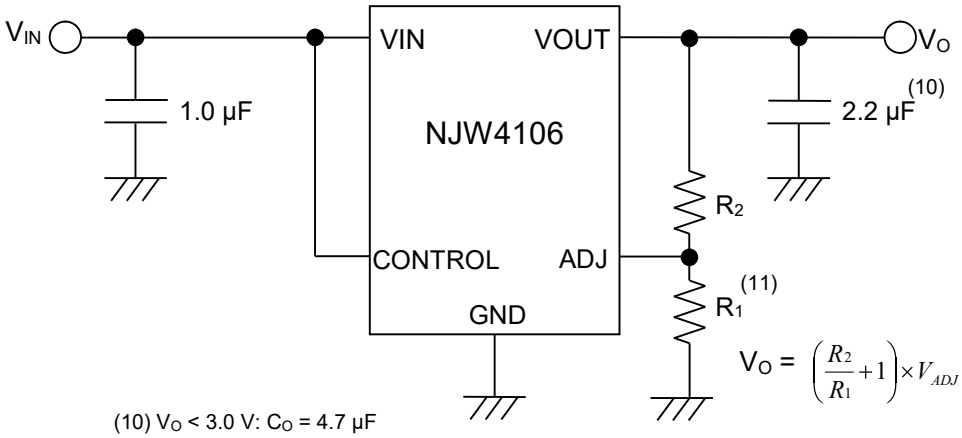
1. When ON/OFF control is used.



(8) V_O < 3.0 V: C_O = 4.7 µF
(9) R_1: Recommend 5 kΩ to 500 kΩ

The CONTROL pin is turned on at high level and turned off at open or low level.

2. When ON/OFF control is not used.



(10) V_O < 3.0 V: C_O = 4.7 µF
(11) R_1: Recommend 5 kΩ to 500 kΩ

Connect the CONTROL pin to the V_{IN}.

■ APPLICATION NOTE

Input Capacitor (C_{IN})

The C_{IN} prevents oscillations and reduce power supply ripple of applications when the power supply impedance is high or power supply line is long. Connecting a 1.0 µF or larger C_{IN} between V_{IN} and GND pins as short path as possible.

Output Capacitor (C_O)

C_O is necessary for phase compensation of the internal error amplifier in the regulator, and the capacitance value and ESR affect the stability of the circuit. If a capacitor less than 2.2 µF (at $V_O \geq 3$ V) is used, output noise and/or regulator oscillation may occur due to lack of the phase compensation. For stable operation, connect a 2.2 µF or larger C_O within the stable operation region (0.001 Ω ≤ ESR ≤ 100 Ω) between the V_{OUT} and GND pins as short path as possible. The recommended capacitance value varies depending on the output voltage, and a low output voltage may require a large capacitance value; therefore, confirm the recommended capacitance of the required output voltage. As the capacitance value of C_O increases, output noise and ripple decrease, and the response to output load fluctuations also improves.

Select the output capacitor considering various characteristics such as frequency characteristics, temperature characteristics, and DC bias characteristics. For the C_O, a capacitor with excellent temperature characteristics and sufficient margin for output voltage is recommended.

Undervoltage Lockout (UVLO)

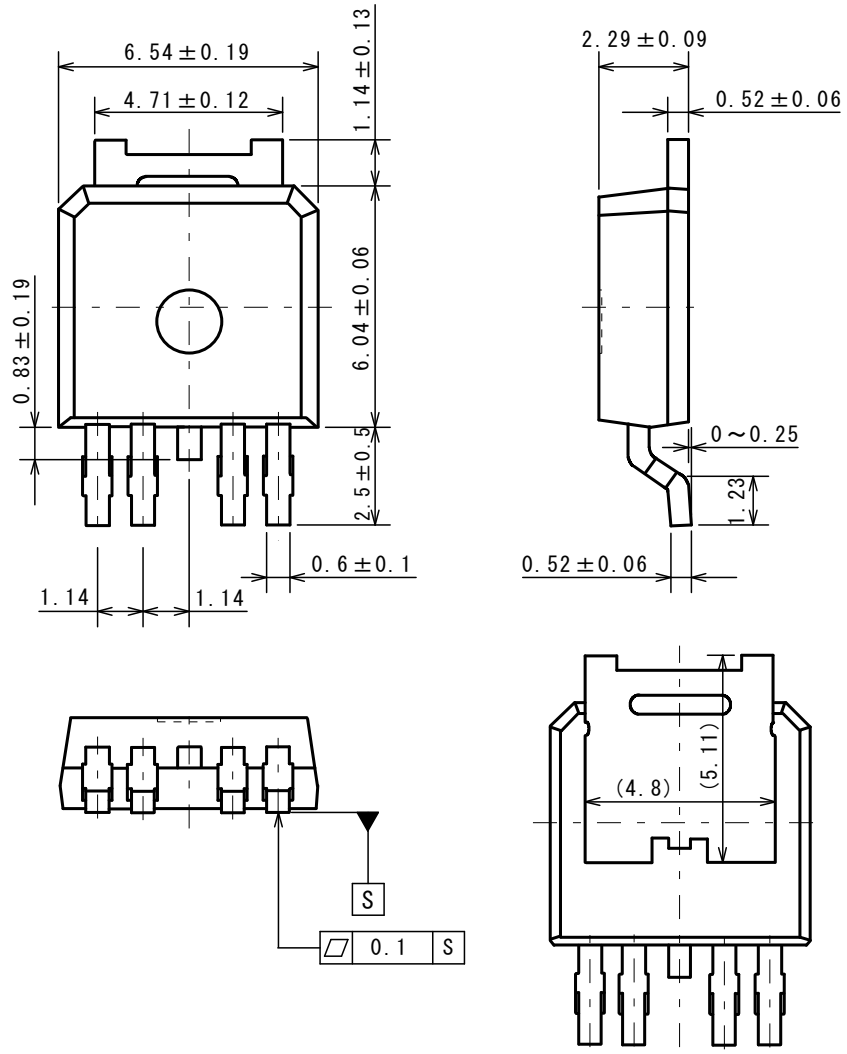
This circuit prevents malfunction by locking out the output when V_{IN} is below the UVLO detection voltage. The output voltage rises when the input voltage rises and exceeds the UVLO release voltage (2.7 V, typ). When the input voltage drops below the UVLO detection voltage (2.2 V, typ)*, the output voltage falls.

*UVLO detection voltage (2.2 V, typ) = UVLO release voltage (2.7 V, typ) − UVLO hysteresis voltage (500 mV, typ)

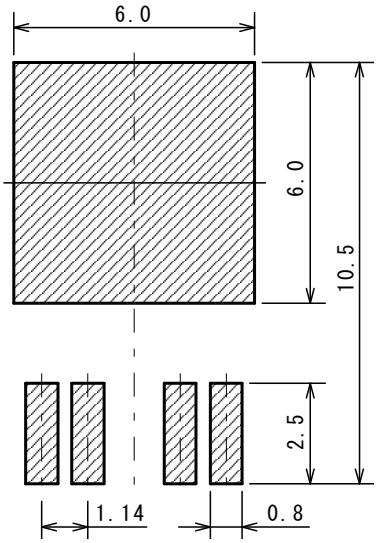
TO-252-5-L5

Unit: mm

■ PACKAGE DIMENSIONS



■ EXAMPLE OF SOLDER PADS DIMENSIONS

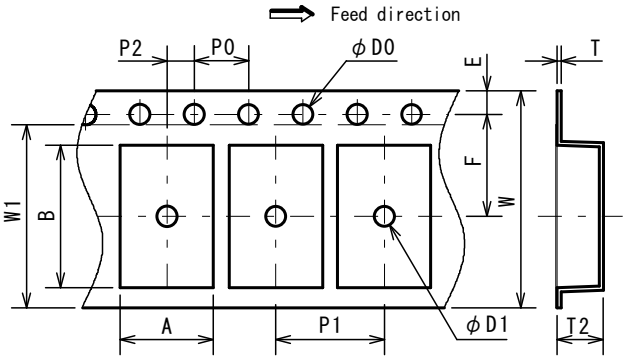


TO-252-5-L5

■ PACKING SPEC

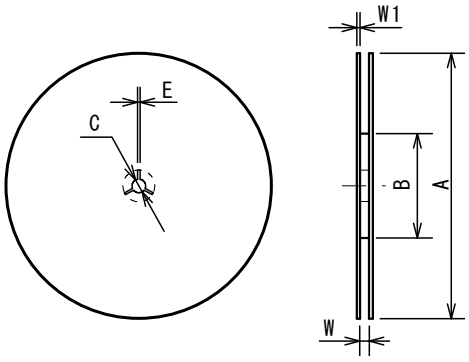
Unit: mm

TAPING DIMENSIONS



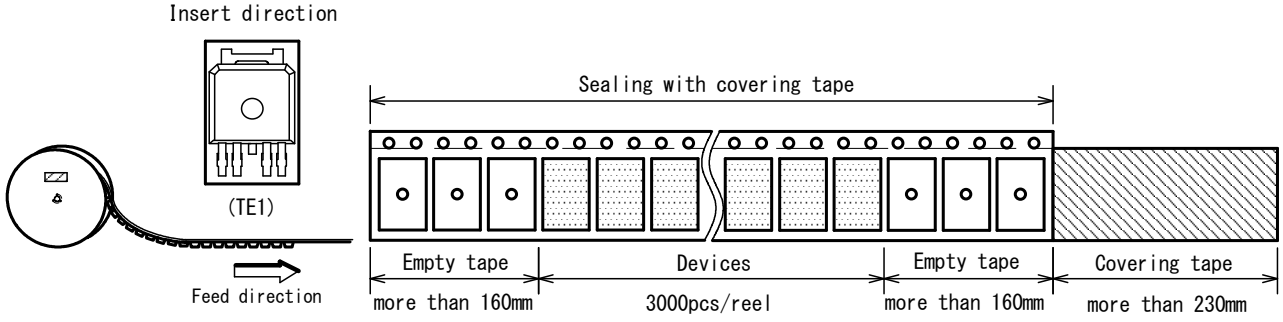
SYMBOL	DIMENSION	REMARKS
A	6.9±0.1	BOTTOM DIMENSION
B	10.5±0.1	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	$1.5^{+0.1}_{0}$	
E	1.75±0.1	
F	7.5±0.1	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.1	
T	0.3±0.1	
T2	3.4 max	
W	16.0±0.3	
W1	13.5	THICKNESS 0.1max

REEL DIMENSIONS

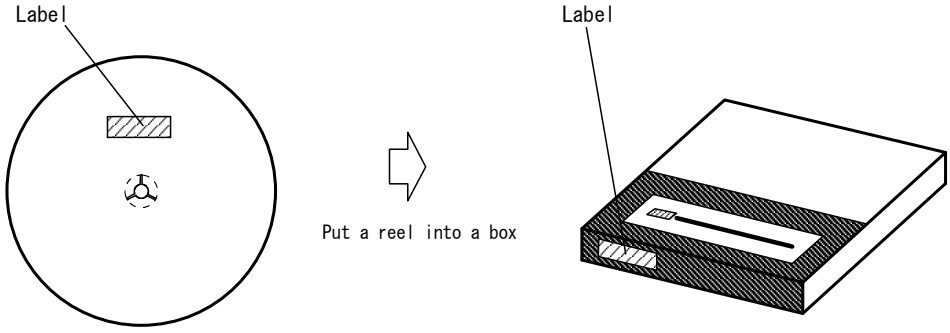


SYMBOL	DIMENSION
A	φ330±2
B	φ 80±1
C	φ 13±0.5
E	2
W	17.5±0.5
W1	2±0.5

TAPING STATE

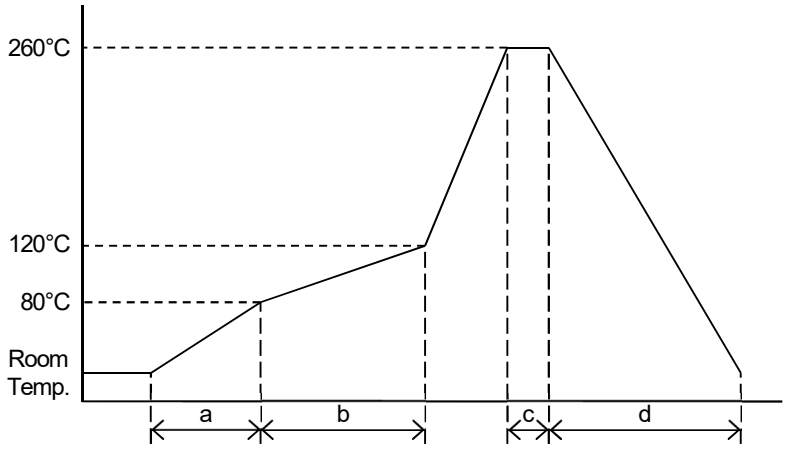


PACKING STATE



■ RECOMMENDED MOUNTING METHOD

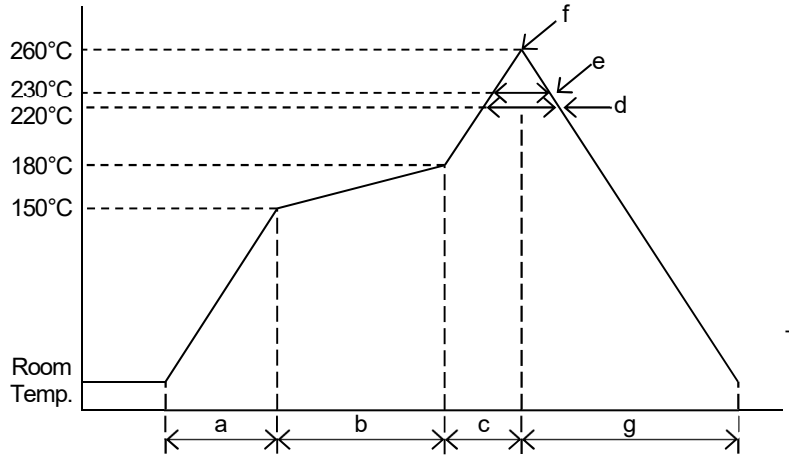
FLOW SOLDERING PROFILE



a	Temperature ramping rate	1 to 7°C/s
b	Pre-heating temperature Pre-heating time	80 to 120°C 60 to 120s
c	Peak temperature Peak time	lower than 260°C shorter than 10s
d	Temperature ramping rate	1 to 7°C/s

The temperature indicates at the surface of mold package.

INFRARED REFLOW SOLDERING PROFILE



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

The temperature indicates at the surface of mold package.

■ REVISION HISTORY

DATE	REVISION	CHANGES
June 9, 2021	Ver.1.0	New Release

[CAUTION]

1. NJR strives to produce reliable and high quality semiconductors. NJR's semiconductors are intended for specific applications and require proper maintenance and handling. To enhance the performance and service of NJR's semiconductors, the devices, machinery or equipment into which they are integrated should undergo preventative maintenance and inspection at regularly scheduled intervals. Failure to properly maintain equipment and machinery incorporating these products can result in catastrophic system failures

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 property rights.
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3. To ensure the highest levels of reliability, NJR products must always be properly handled.
   The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.

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6. The products listed in this datasheet may not be appropriate for use in certain equipment where reliability is critical or where the products may be subjected to extreme conditions. You should consult our sales office before using the products in any of the following types of equipment.

   - 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 (Airplane, railroad, ship, etc.)
   - Various Safety Devices

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8. 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.

9. The product specifications and descriptions listed in this datasheet are subject to change at any time, without notice.