

## High Voltage $I_o=1000\text{mA}$ Adjustable Low Dropout Regulator

### ■ GENERAL DESCRIPTION

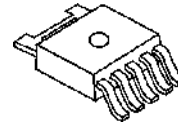
The NJW4188 is a high voltage and low current consumption low dropout regulator.

NJW4188 is an adjustable output voltage type, so it can provide the optimum selection for various applications.

NJW4188 is mounted to TO-252-5 package and corresponded to Low ESR capacitor (MLCC).

The wide input range and wide operate temperature make NJW4188 suitable for a, Car accessory, Industrial supplies demanded high reliability.

### ■ PACKAGE OUTLINE

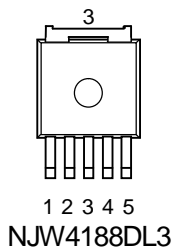


NJW4188DL3

### ■ FEATURES

- |  |   |
|--|---|
| ● Operating Voltage Range                | 4.0V to 40V   |
| ● Low Current Consumption                | 55 $\mu\text{A}$ typ. ( $T_a=25^\circ\text{C}$ )<br>110 $\mu\text{A}$ (max.) ( $T_a=-40^\circ\text{C}$ to $+125^\circ\text{C}$ )        |
| ● Correspond to Low ESR capacitor (MLCC) |   |
| ● Output Current                         | $I_o$ (min.)=1000mA   |
| ● High Precision Reference Voltage       | $V_{\text{ref}} \pm 1.0\%$ ( $T_a=25^\circ\text{C}$ )<br>$V_{\text{ref}} \pm 2.0\%$ ( $T_a=-40^\circ\text{C}$ to $+125^\circ\text{C}$ ) |
| ● Available Output Voltage Range         | 2.0V to 15.0V   |
| ● ON/OFF Control                         |   |
| ● Internal Thermal Overload Protection   |   |
| ● Internal Over Current Protection       |   |
| ● Package Outline                        | TO-252-5  |

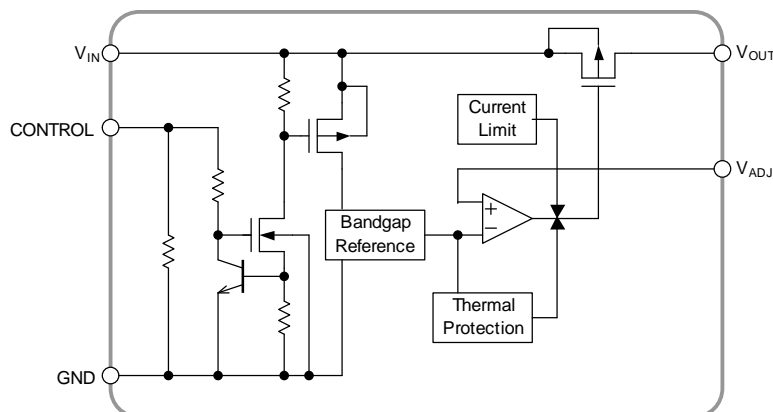
### ■ PIN CONFIGURATION



#### Pin Function

1.  $V_{\text{IN}}$
2. CONTROL
3. GND
4.  $V_{\text{ADJ}}$
5.  $V_{\text{OUT}}$

### ■ BLOCK DIAGRAM



# Automotive NJW4188-T1

## ■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Input Voltage	V <sub>IN</sub>	-0.3 to +45	V
Control Voltage	V <sub>CONT</sub>	-0.3 to +45	V
Output Adjustable Voltage	V <sub>ADJ</sub>	-0.3 to +6	V
Output Voltage	V <sub>O</sub>	-0.3 to V <sub>IN</sub> ≤ 17	V
Power Dissipation	P <sub>D</sub>	1190 (*1) 3125 (*2)	mW
Junction Temperature	T <sub>J</sub>	-40 to +150	°C
Operating Temperature	T <sub>opr</sub>	-40 to +125	°C
Storage Temperature	T <sub>stg</sub>	-40 to +150	°C

(\*1): Mounted on glass epoxy board. (76.2×114.3×1.6mm:EIA/JDEC standard size, 2Layers, copper area 100mm<sup>2</sup>)

(\*2): Mounted on glass epoxy board. (76.2×114.3×1.6mm:EIA/JDEC standard size, 4Layers)

(4Layers inner foil: 74.2 x 74.2mm applying a thermal via hole to a board based on JEDEC standard JESD51-5)

## ■ INPUT VOLTAGE RANGE

V<sub>IN</sub>=4.0V to 40V

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## ■ ELECTRICAL CHARACTERISTICS

(Unless otherwise noted,  $V_O \geq 3V$  :  $V_{IN} = V_O + 1V, C_{IN} = 1.0\mu F, C_O = 4.7\mu F (3V \leq V_O < 3.4V: 10\mu F), R1 = 500k\Omega, T_a = 25^\circ C$   
 $V_O < 3V$ :  $V_{IN} = 4.0V, C_{IN} = 1.0\mu F, C_O = 10\mu F, R1 = 500k\Omega, T_a = 25^\circ C$ )

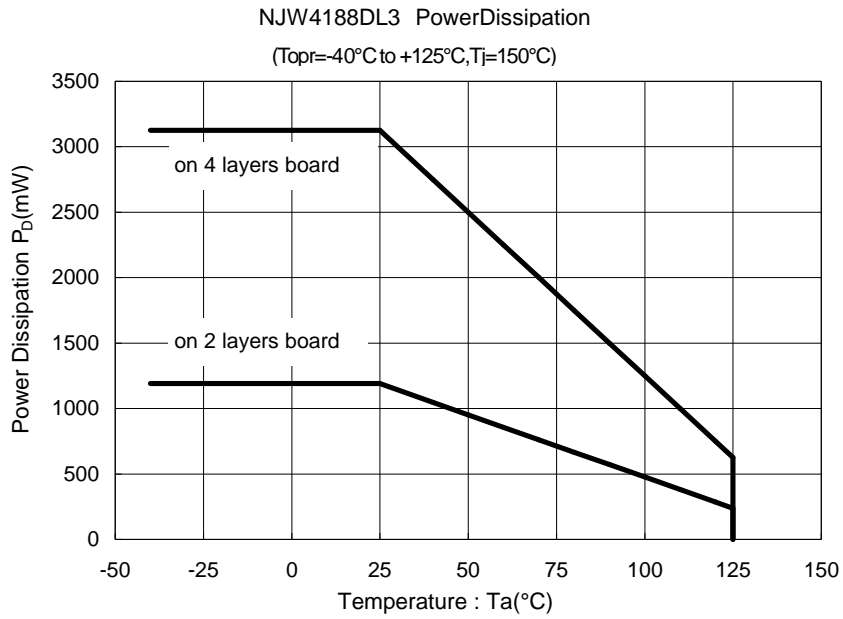
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference Voltage	$V_{ref}$		-1.0%	1.29	+1.0%	V
		$T_a = -40^\circ C$ to $+125^\circ C$	-2.0%	1.29	+2.0%	
Quiescent Current	$I_Q$	$I_O = 0mA$ , except $I_{CONT}$	-	55	90	$\mu A$
		$I_O = 0mA$ , except $I_{CONT}, T_a = -40^\circ C$ to $+125^\circ C$	-	-	110	
Quiescent Current at Control OFF	$I_{Q(OFF)}$	$V_{CONT} = 0V$	-	-	1	$\mu A$
		$V_{CONT} = 0V, T_a = -40^\circ C$ to $+125^\circ C$	-	-	1	
Output Current	$I_O$	$V_O \times 0.9$	1000	-	-	mA
		$V_O \times 0.9, T_a = -40^\circ C$ to $+125^\circ C$	1000	-	-	
Line Regulation	$\Delta V_O / \Delta V_{IN}$	$V_{IN} = V_O + 1V$ to $40V, I_O = 200mA (V_O \geq 3V)$ $V_{IN} = 4V$ to $40V, I_O = 200mA (V_O < 3V)$	-	-	0.03	% / V
		$V_{IN} = V_O + 1V$ to $40V, I_O = 200mA (V_O \geq 3V)$ $V_{IN} = 4V$ to $40V, I_O = 200mA (V_O < 3V)$ $T_a = -40^\circ C$ to $+125^\circ C (*3)$	-	-	0.03	
Load Regulation	$\Delta V_O / \Delta I_O$	$I_O = 0$ to $1000mA$	-	-	0.004	% / mA
		$I_O = 0$ to $1000mA, T_a = -40^\circ C$ to $+125^\circ C (*3)$	-	-	0.006	
Ripple Rejection	RR	$e_{in} = 200mV_{rms}, f = 1kHz, I_O = 10mA,$ $V_O = 3.3V$	-	58	-	dB
Dropout Voltage	$\Delta V_{IO}$	$I_O = 600mA$	-	0.27	0.42	V
		$I_O = 600mA, T_a = -40^\circ C$ to $+125^\circ C$	-	-	0.65	
Average Temperature Coefficient of Output Voltage	$\Delta V_O / \Delta T_a$	$T_a = 0^\circ C$ to $85^\circ C, I_O = 200mA$	-	$\pm 50$	-	ppm/ $^\circ C$
Control Current	$I_{CONT}$	$V_{CONT} = 1.6V$	-	1	3	$\mu A$
		$V_{CONT} = 1.6V, T_a = -40^\circ C$ to $+125^\circ C$	-	-	3	
Control Voltage for ON-state	$V_{CONT(ON)}$		1.6	-	-	V
		$T_a = -40^\circ C$ to $+125^\circ C$	1.6	-	-	
Control Voltage for OFF-state	$V_{CONT(OFF)}$		-	-	0.6	V
		$T_a = -40^\circ C$ to $+125^\circ C$	-	-	0.6	
Available Output Voltage Range	$V_O$		2.0	-	15	V
		$T_a = -40^\circ C$ to $+125^\circ C$	2.0	-	15	

(\*3): These parameter are guaranteed with only  $-40^\circ C$  and  $+125^\circ C$ .

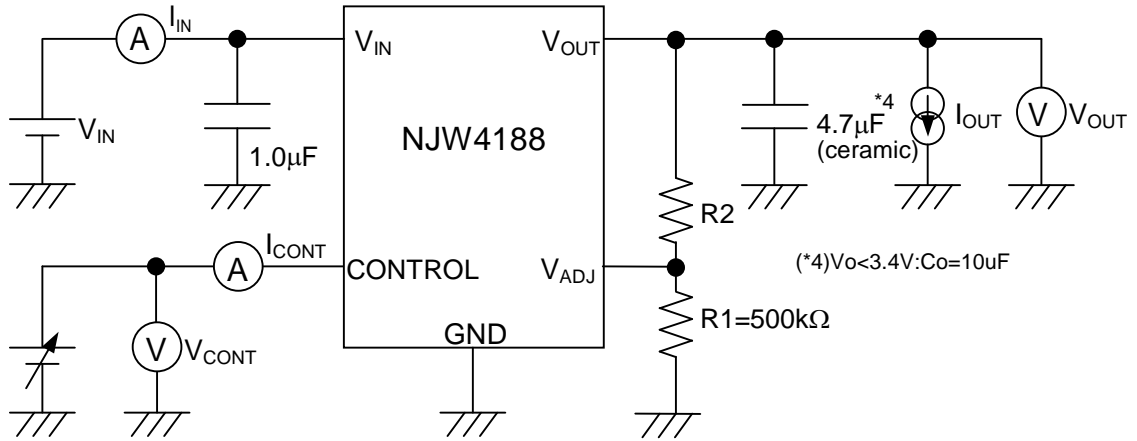
\* These parameters are tested by Pulse Measurement.

# Automotive NJW4188-T1

## POWER DISSIPATION vs. AMBIENT TEMPERATURE

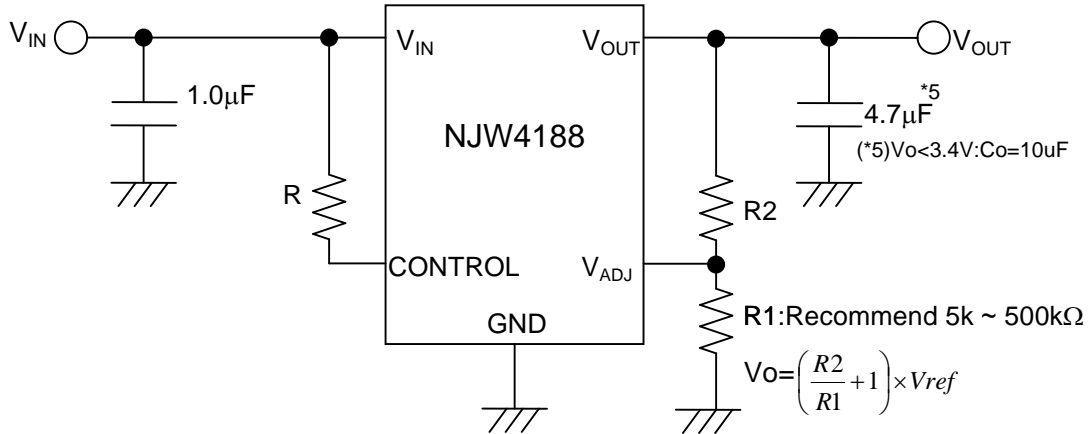


## TEST CIRCUIT



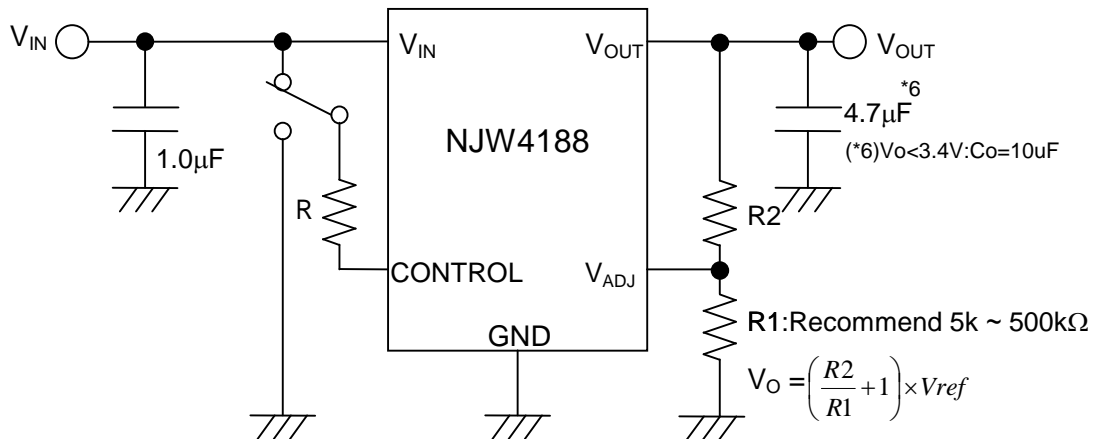
## ■ TYPICAL APPLICATION

① In the case where ON/OFF Control is not required



Connect control pin to  $V_{IN}$  pin

② In use of ON/OFF CONTROL



State of control pin:

- “H”→ output is enabled.
- “L” or “open” → output is disabled.

\*In the case of using a resistance "R" between  $V_{IN}$  and control.

If this resistor is inserted, it can reduce the control current when the control voltage is high.

The applied voltage to control pin should set to consider voltage drop through the resistor “R” and the minimum control voltage for ON-state.

The  $V_{CONT(ON)}$  and  $I_{CONT}$  have temperature dependence as shown in the "Control Current vs. Temperature" and "Control Voltage vs. Temperature" characteristics. Therefore, the resistance "R" should be selected to consider the temperature characteristics.

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## \*Feed back Resistance R1

The output voltage may rise against the set point by the leak current from the  $V_{OUT}$  pin at high temperature when this resistance is set too big.

Conversely, the current flowing to R1 grows big when R1 is set too small, and make the consumption current increase.

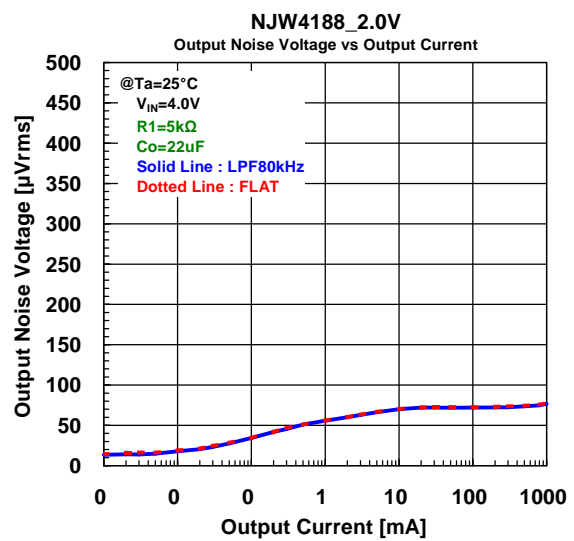
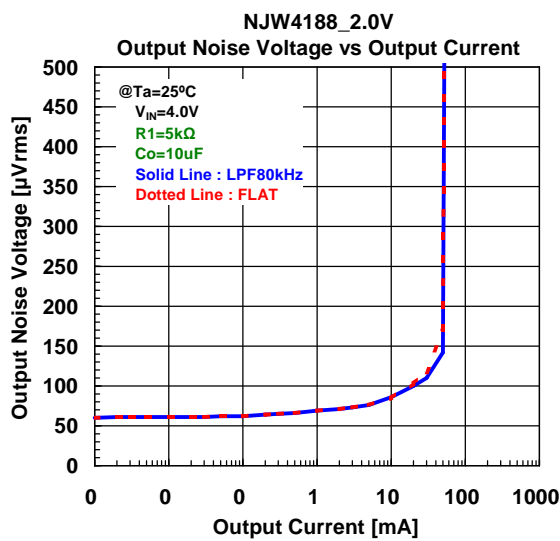
From the above, recommend  $5k\Omega$  to  $500k\Omega$  as a set range of R1.

But, the output noise voltage tends to increase with the resistance value of R1 become small.

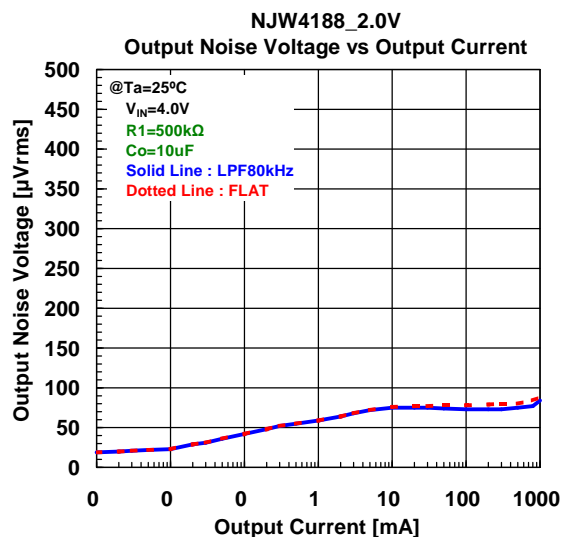
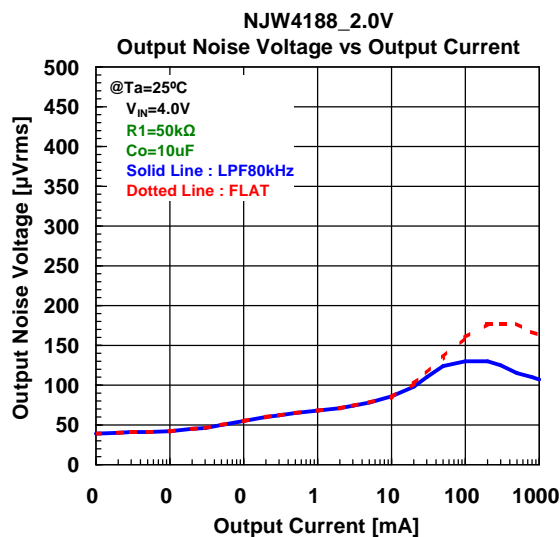
Especially, In the case of low output voltage setting such as  $V_{OUT}=2.0V$ , there is the possibility that the output voltage becomes unstable in the condition of recommended output capacitor ( $C_o=4.7\mu F$ ) and too small feedback resistor (R1).

In that case, It can improve by making  $C_o$  or R1 bigger.

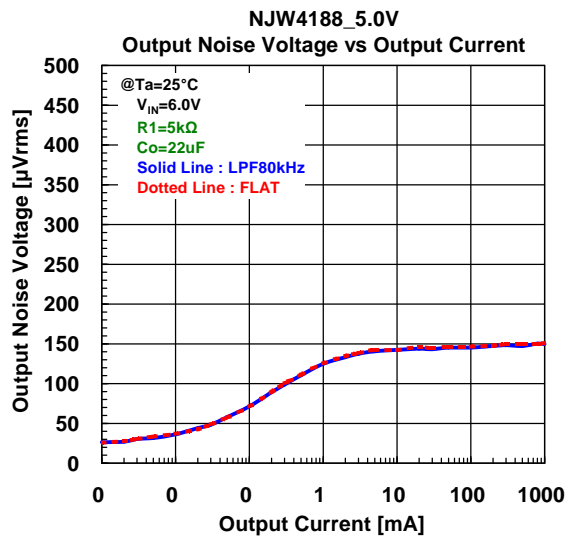
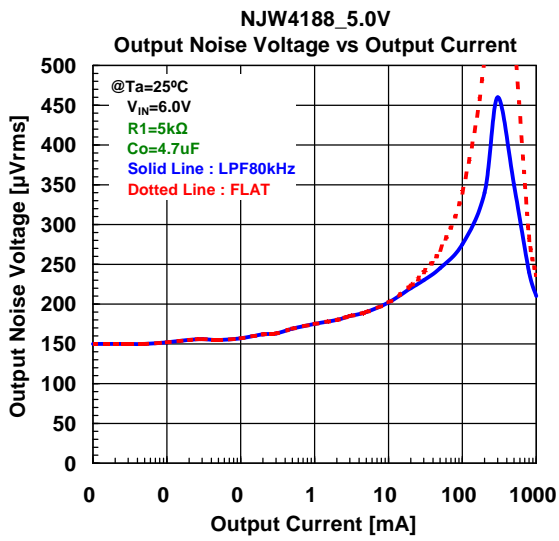
Show a characteristic example when changed a condition at the time of the  $V_o=2.0V / 5.0V$  setting for reference.



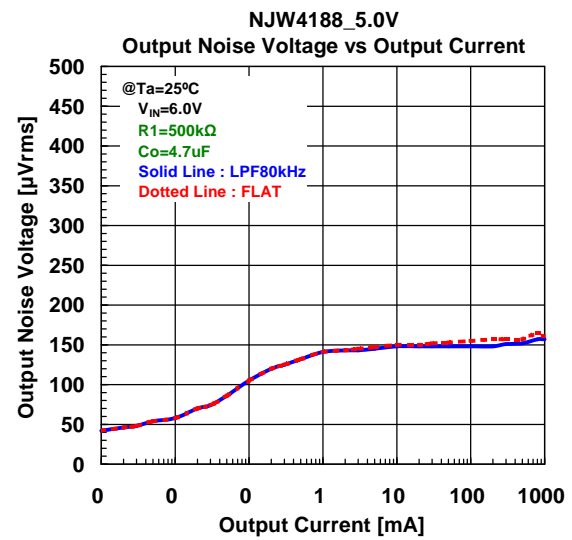
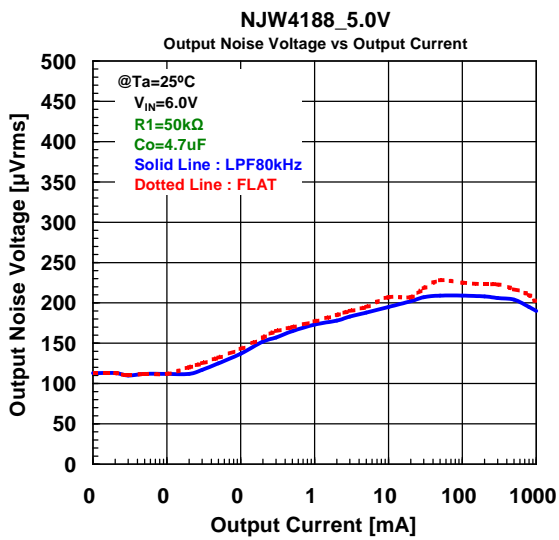
$V_{OUT}=2.0V$ Setting (R1=5k,  $C_o=10\mu F / C_o=22\mu F$ )



$V_{OUT}=2.0V$ Setting (R1=50k / 500k,  $C_o=10\mu F$ )



V<sub>OUT</sub>=5.0V Setting (R1=5k, Co=4.7μF / Co=22μF)



V<sub>OUT</sub>=5.0V Setting (R1=50k / 500k, Co=4.7μF)

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## \*Input Capacitor $C_{IN}$

Input Capacitor  $C_{IN}$  is required to prevent oscillation and reduce power supply ripple for applications when high power supply impedance or a long power supply line.

Therefore, use the recommended  $C_{IN}$  value (refer to conditions of ELECTRIC CHARACTERISTIC) or larger and should connect between GND and  $V_{IN}$  as shortest path as possible to avoid the problem.

## \*Output Capacitor $C_O$

Output capacitor ( $C_O$ ) will be required for a phase compensation of the internal error amplifier.

The capacitance and the equivalent series resistance (ESR) influence to stable operation of the regulator.

Use of a smaller  $C_O$  may cause excess output noise or oscillation of the regulator due to lack of the phase compensation.

On the other hand, Use of a larger  $C_O$  reduces output noise and ripple output, and also improves output transient response when rapid load change.

Therefore, use the recommended  $C_O$  value (refer to conditions of ELECTRIC CHARACTERISTIC) or larger and should connect between GND and  $V_{OUT}$  as shortest path as possible for stable operation

The recommended capacitance depends on the output voltage rank. Especially, low voltage regulator requires larger  $C_O$  value.

In addition, you should consider varied characteristics of capacitor (a frequency characteristic, a temperature characteristic, a DC bias characteristic and so on) and unevenness peculiar to a capacitor supplier enough.

When selecting  $C_O$ , recommend that have withstand voltage margin against output voltage and superior temperature characteristic.



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\*The notes of the evaluation when  $V_{OUT}$  pin is shorted to GND

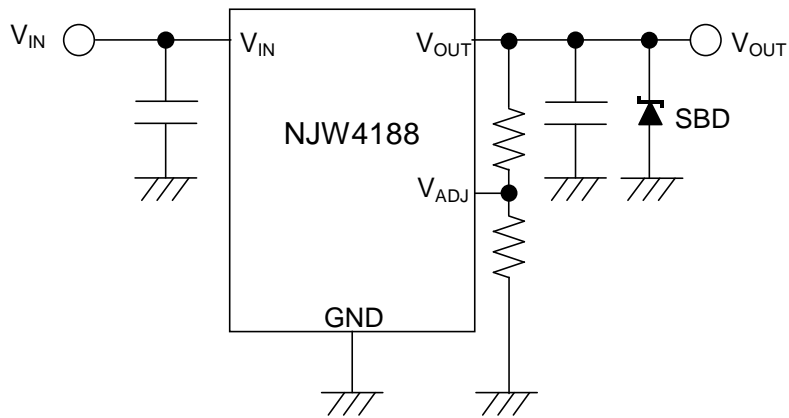
When evaluated short circuit test, the IC may break down because of regenerated energy by the parasitic inductance included in wiring pattern.

It phenomenon appears conspicuously when output voltage is high( $V_{OUT}=8.0V$  or more)or connected to inductive load.

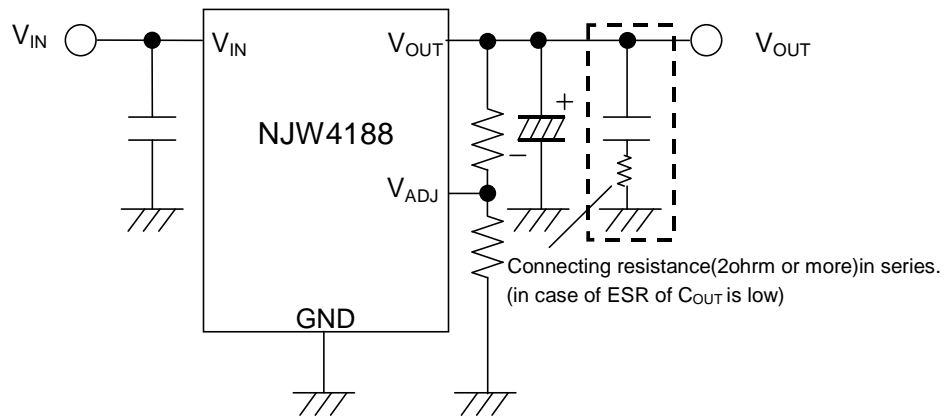
In case of short circuit in actual application, not likely to destruction of IC because of some of Resistance exist between load.

If happened above phenomenon by the short circuit test with the actual application, recommend connecting schottky barrier diode(SBD) between  $V_{OUT}$  pin and the GND or using output capacitor that have ESR more than 2ohm like a tantalum or aluminum electrolytic capacitor.(see below figure)

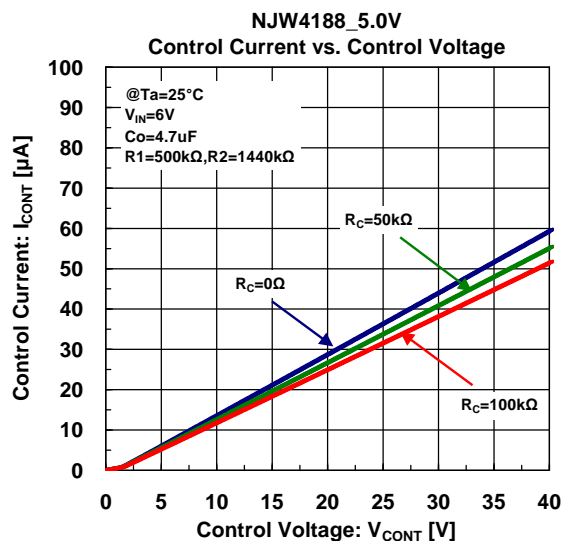
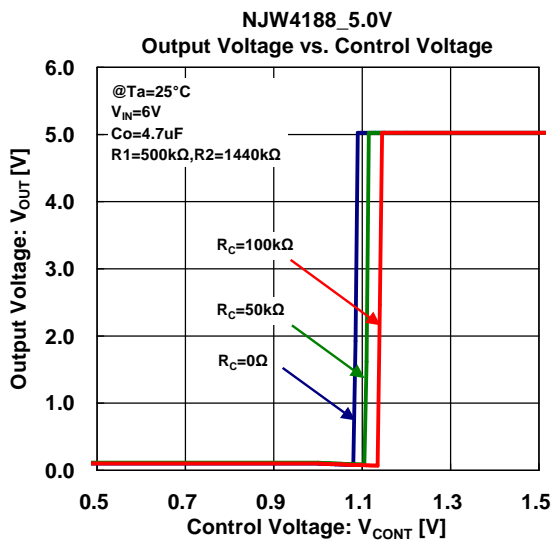
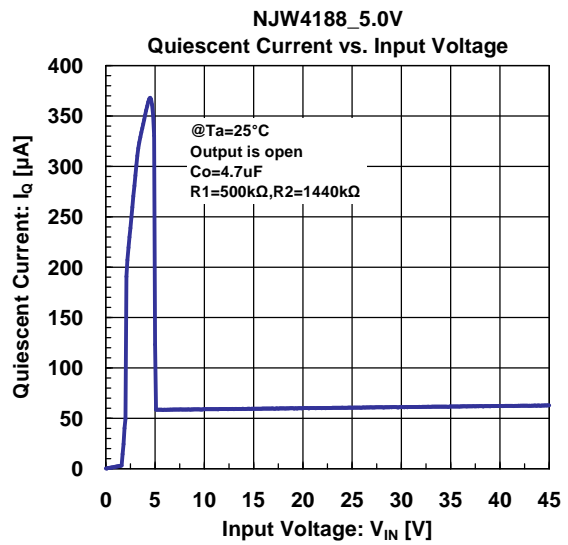
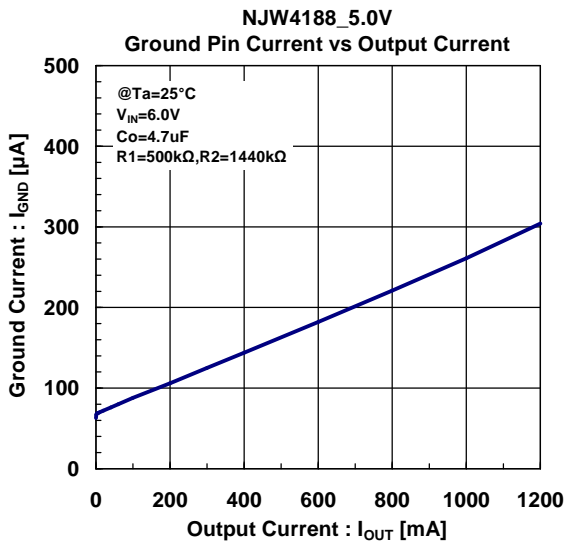
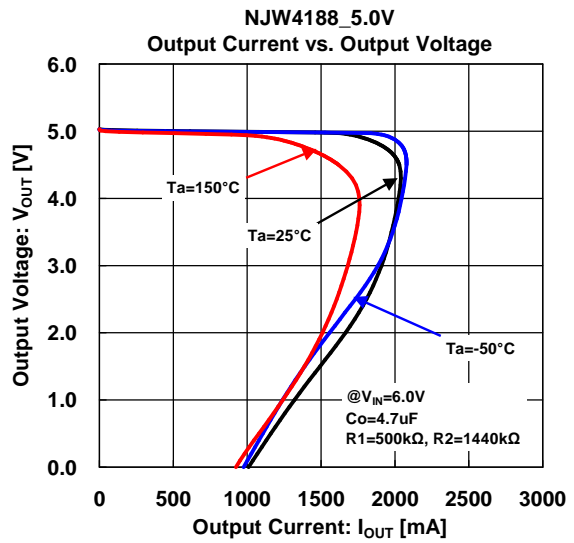
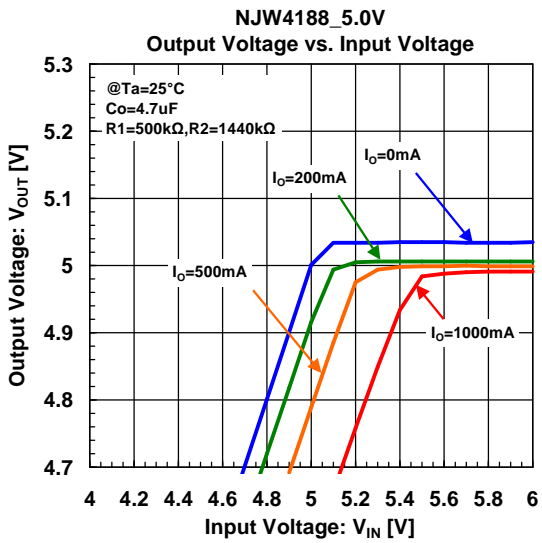
(a)In case of insert Schottky barrier diode between  $V_{OUT}$  pin- GND

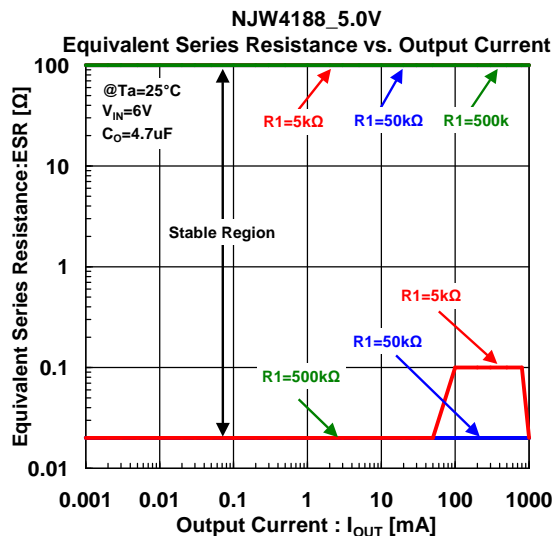
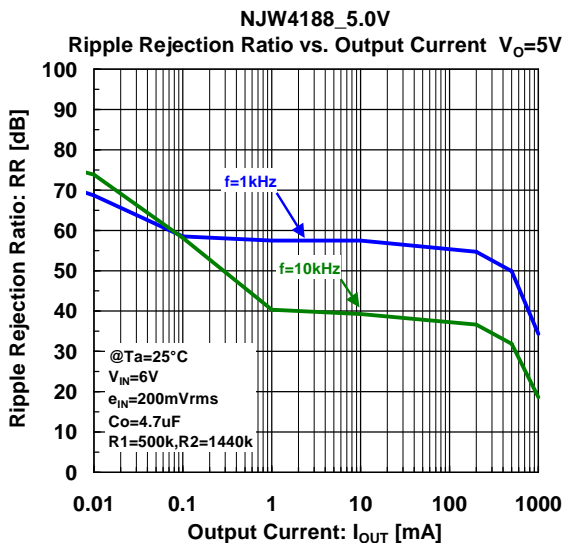
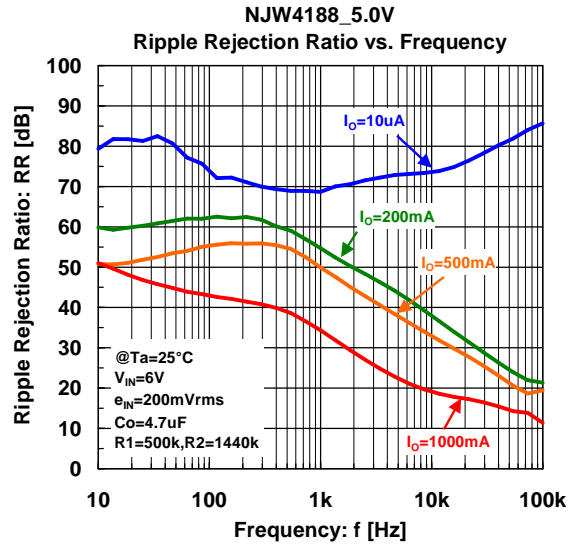
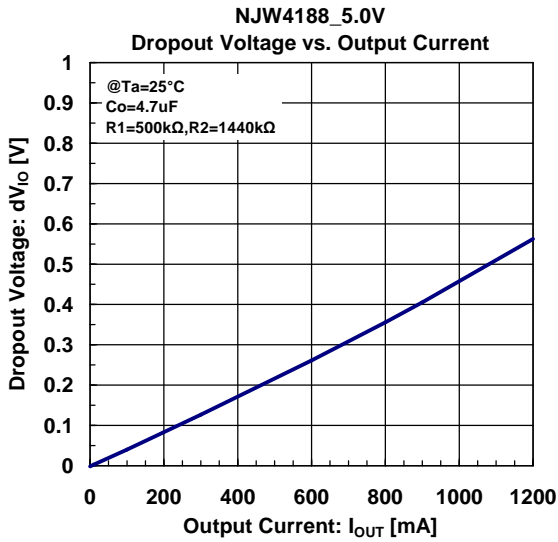
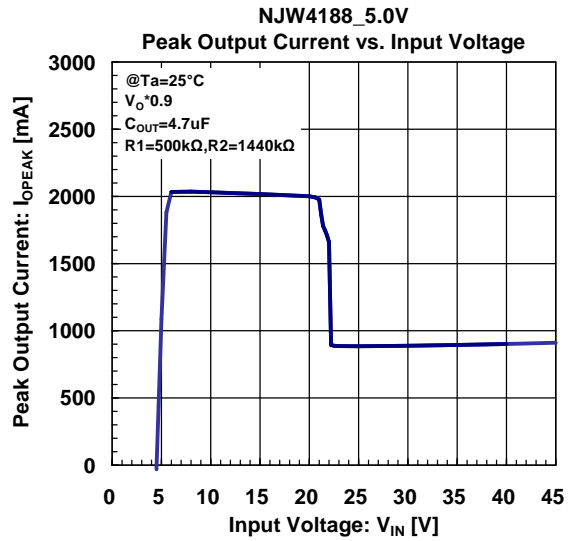
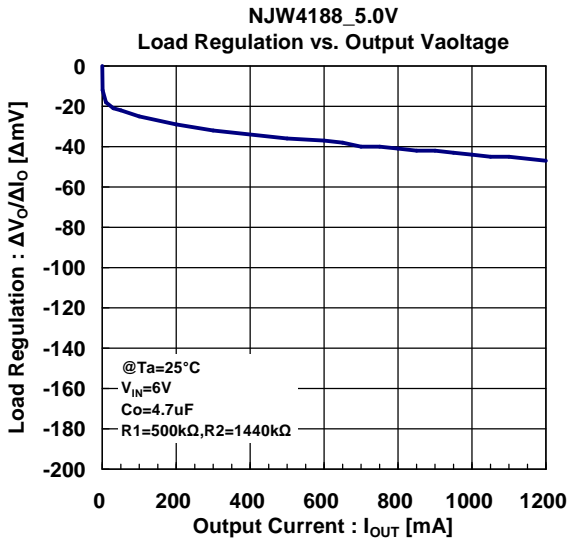


(b) In case of using the electrolysis capacitor or insert series resistance

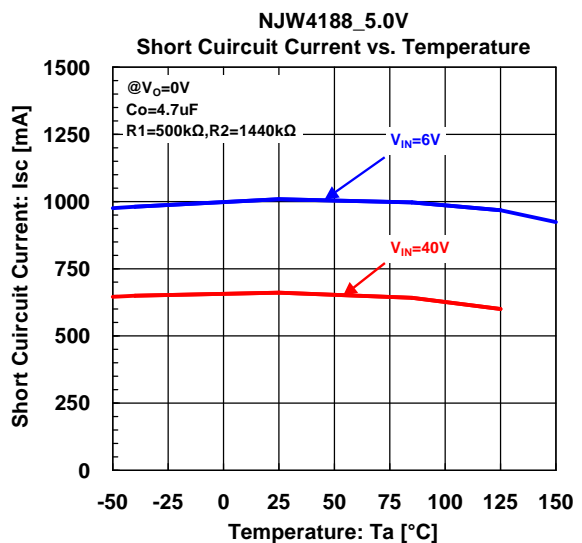
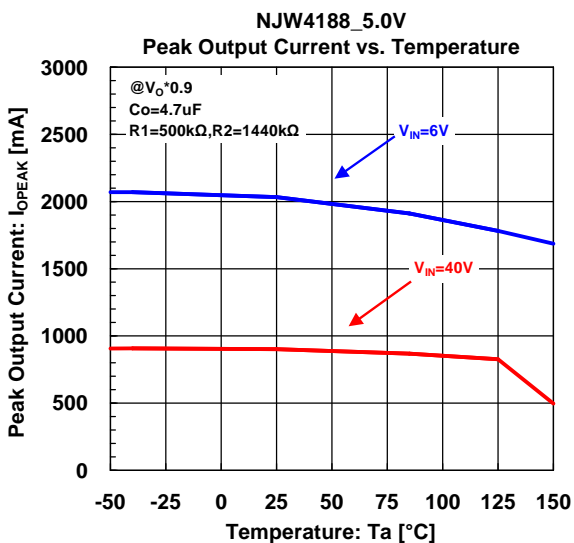
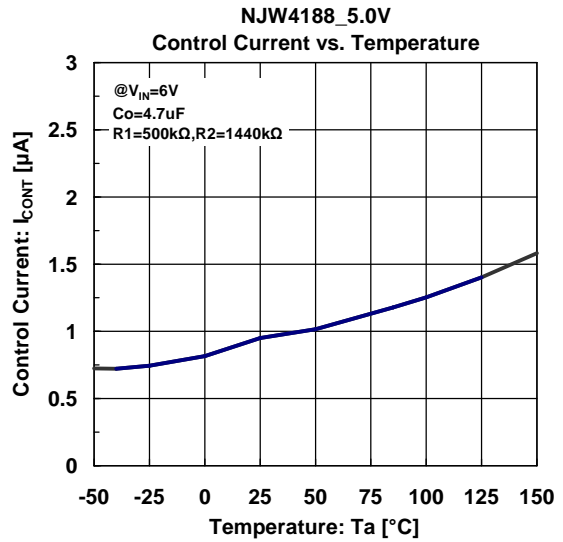
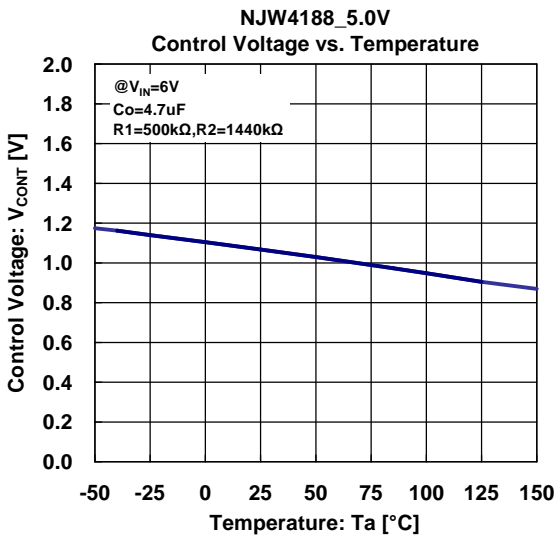
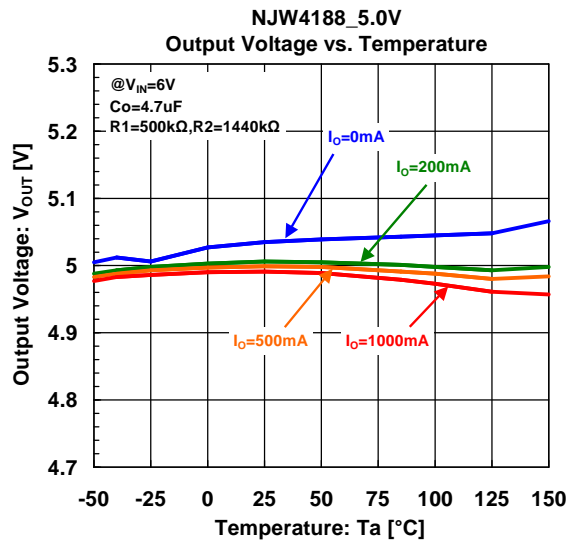
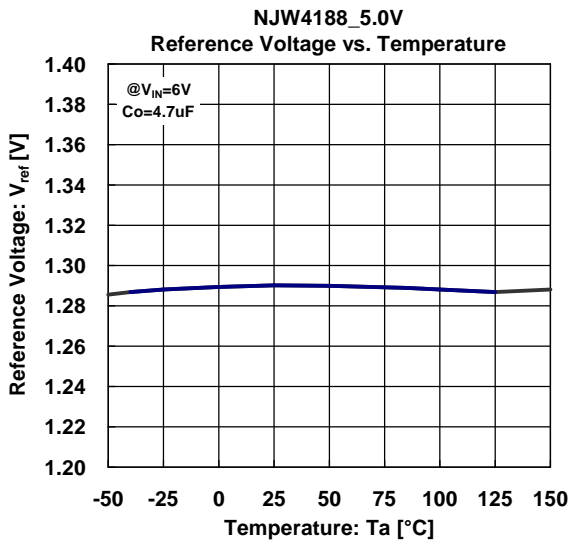


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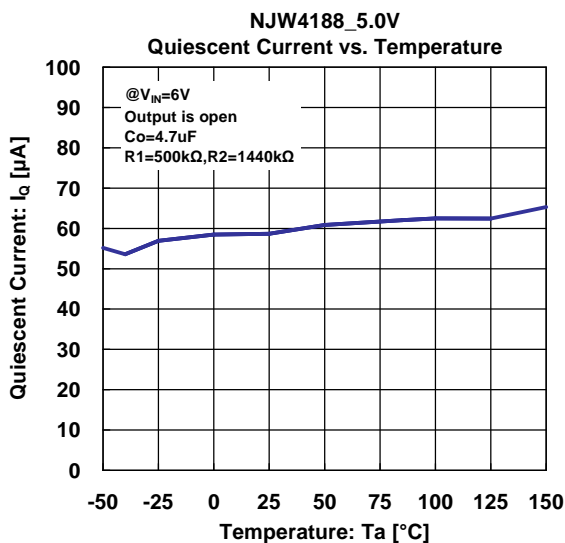
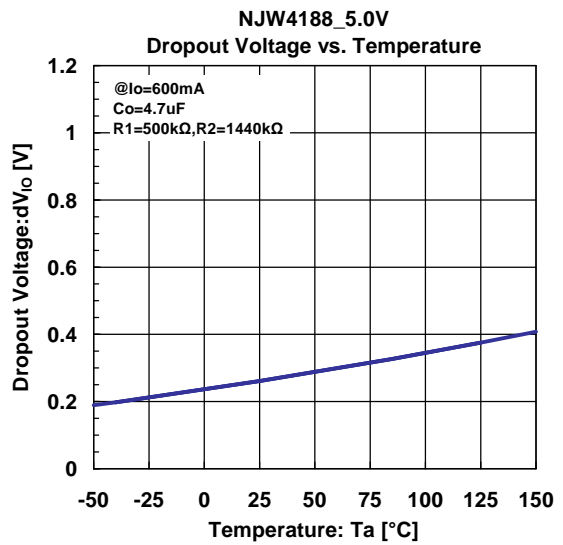
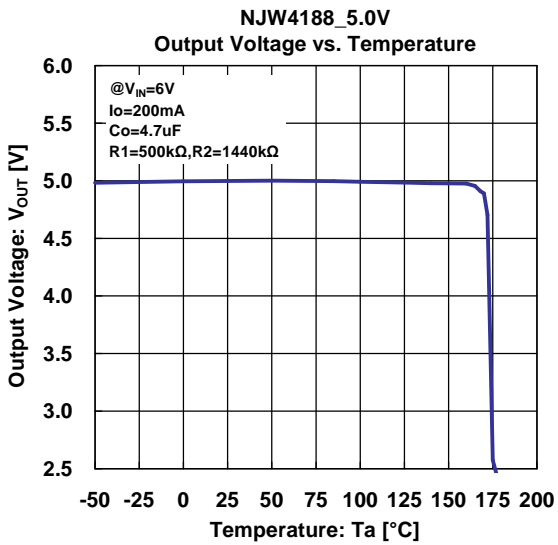
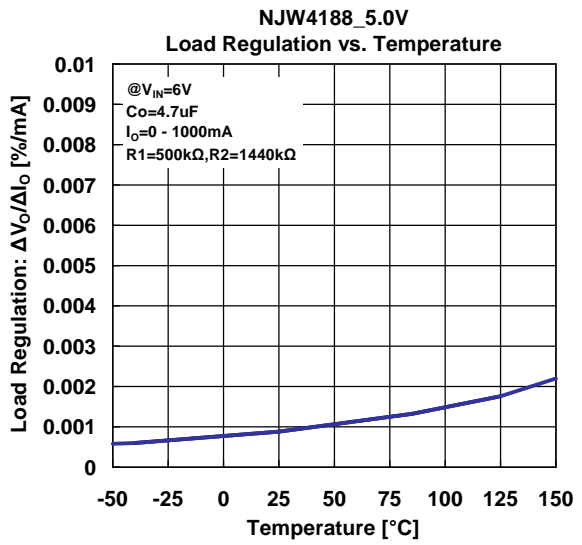
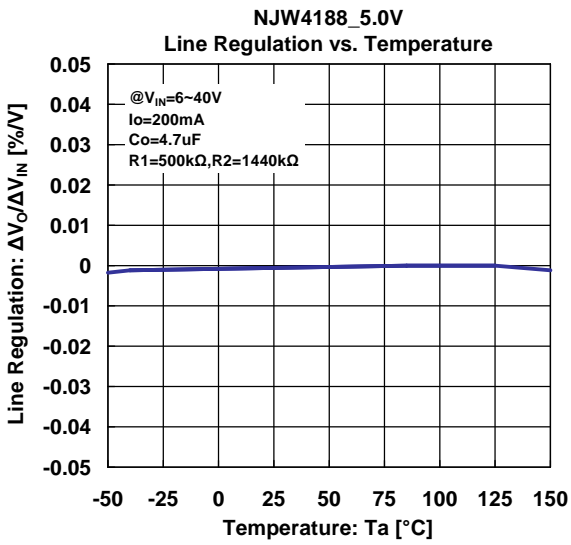




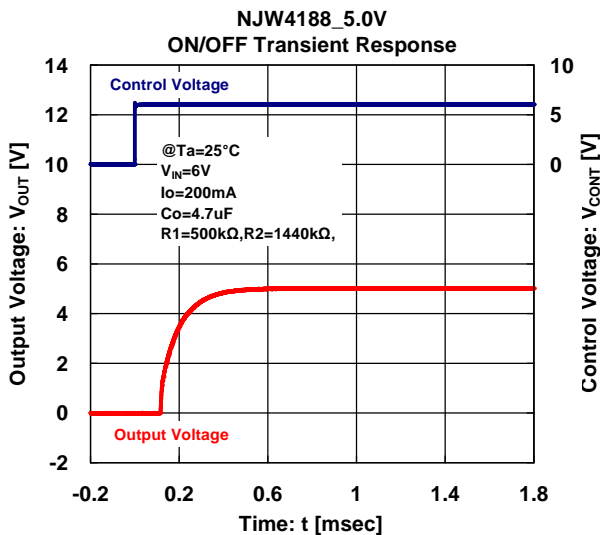
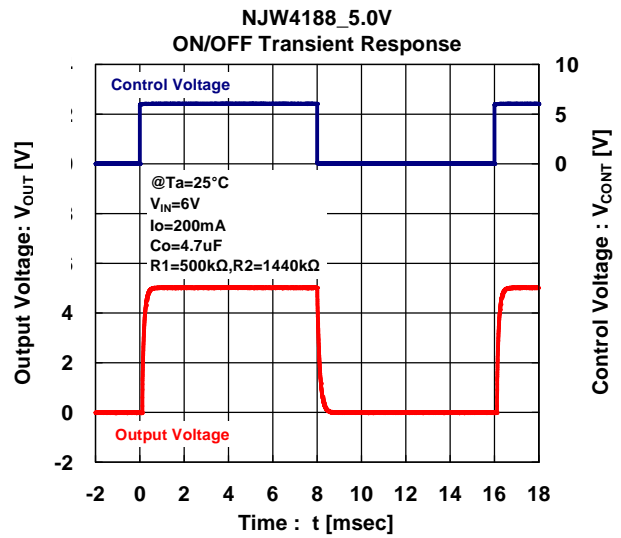
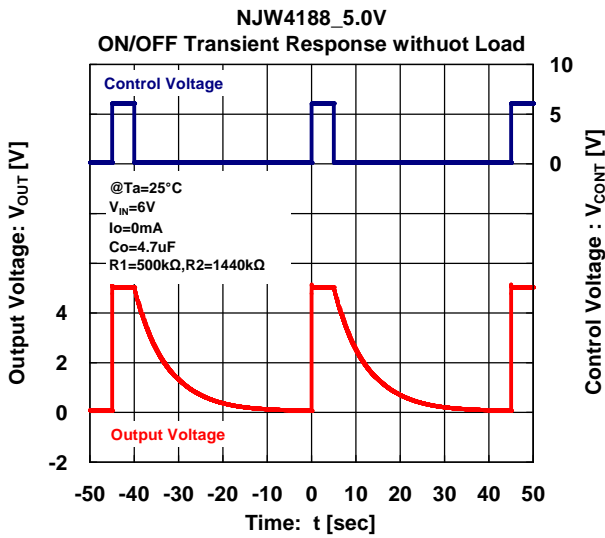
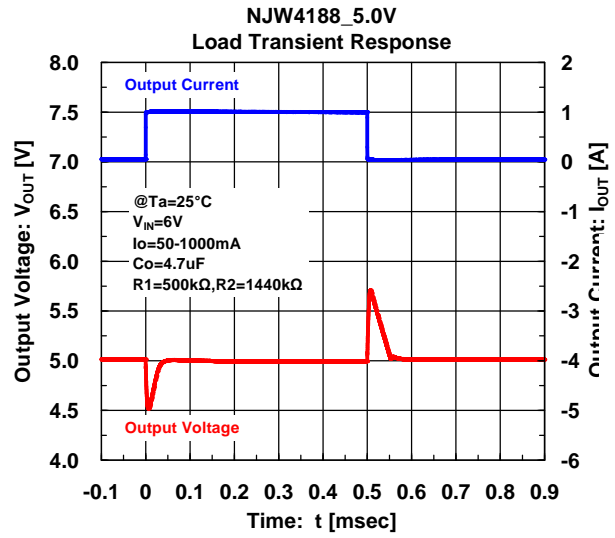
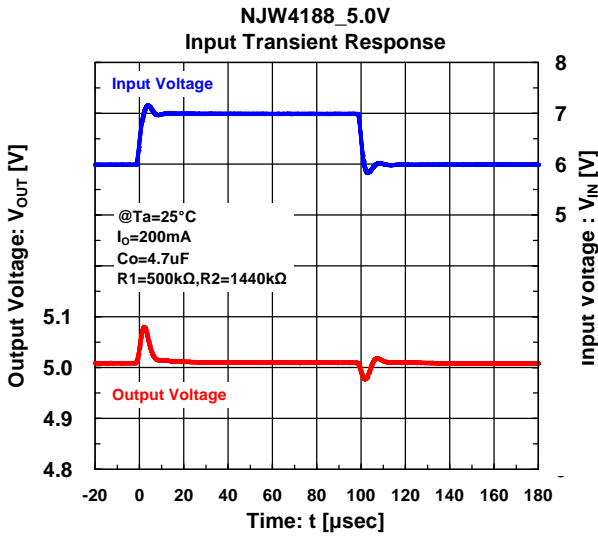
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- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

**Телефон:** 8 (812) 309 58 32 (многоканальный)

**Факс:** 8 (812) 320-02-42

**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.