

LDO with Reverse Current Protection / Soft Start / Discharge Function

■FEATURES

- AEC-Q100 Grade 1 Qualified
- Operating Voltage Range 2.3V to 6.5V
- Output Voltage Accuracy $V_O \pm 2.0\%$
- Output Current $I_O(\text{min.})=500\text{mA}$
- Reverse Current Protection
- Adjustable soft-start Function
- Discharge Function
- ON/OFF Control
- Correspond to Low ESR capacitor (MLCC)
- Thermal Shutdown Circuit
- Over Current Protection Circuit
- Package Outline DFN8-WA

■APPLICATION

- Automotive infotainment
- Automotive ECU unit
- Industrial equipment

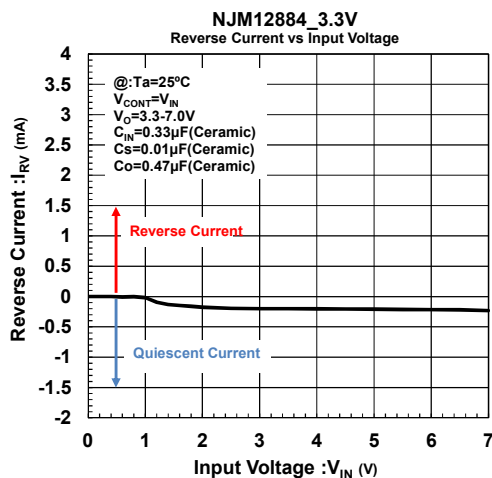
■GENERAL DESCRIPTION

The NJM12884 is a low dropout regulator which achieves high ripple rejection, low noise and high speed response with the bipolar technology.

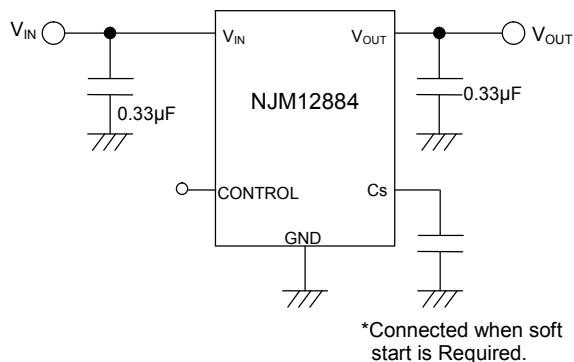
Adjustable soft-start function is useful for reducing inrush current and controlling power-on sequence. Moreover the discharge function makes effective sequence control with the soft-start function.

In addition, the reverse current protection makes external SBD unnecessary.

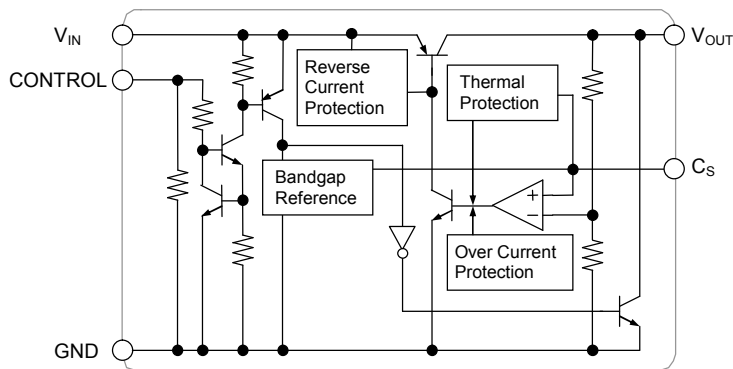
■Reverse Current Protection Characteristics



■TYPICAL APPLICATION



■BLOCK DIAGRAM



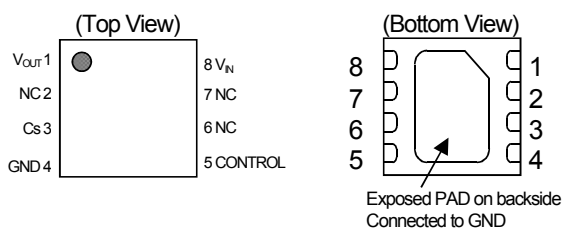
■OUTPUT VOLTAGE RANK

DFN8-WA

PART NUMBER	OUTPUT VOLTAGE	PART NUMBER	OUTPUT VOLTAGE
NJM12884KWA-15-H	1.5V	NJM12884KWA-33-H	3.3V
NJM12884KWA-18-H	1.8V	NJM12884KWA-05-H	5.0V
NJM12884KWA-25-H	2.5V		

■PIN CONFIGURATION

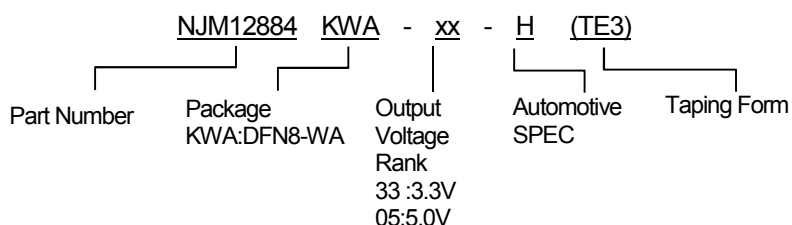
DFN8-WA



PIN NO.	SYMBOL	DESCRIPTION
1	V_{OUT}	Output
2	NC	Not internally connected *
3	Cs	Soft Start
4	GND	Ground
5	CONTROL	ON/OFF Control
6	NC	Not internally connected *
7	NC	Not internally connected *
8	V_{IN}	Input

Note) NC pin is not connect to internally circuit. This pin can be open or connected to ground. Connecting to ground is recommended to improve thermal dissipation.

■PRODUCT NAME INFORMATION



■ORDERING INFORMATION

PART NUMBER	OUTPUT VOLTAGE	PACKAGE OUTLINE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ(pcs)
NJM12884KWA-33-H(TE3)	3.3V	DFN8-WA	yes	yes	Sn2Bi	88433	18	3000

Note) "-" is non-evaluation. Please contact your sales representative for more information.

■ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS		UNIT
Input Voltage	V_{IN}	-0.3 to +7		V
Control Pin Voltage	V_{CONT}	-0.3 to +7		V
Output Voltage	V_{OUT}	$V_O \leq 1.8V$	-0.3 to +5.5	V
		$V_O > 1.8V$	-0.3 to +7	V
Soft start Pin Voltage	V_{CS}	-0.3 to +4		V
Power Dissipation($T_a=25^\circ C$) DFN8-WA	P_D	(2-layer / 4-layer) 610 ⁽¹⁾ / 1800 ⁽²⁾		mW
Junction Temperature Range	T_j	-40 to +150		$^\circ C$
Operating Temperature Range	T_{opr}	-40 to +125		$^\circ C$
Storage Temperature Range	T_{stg}	-50 to +150		$^\circ C$

(1): Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)

(2): Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)

(For 4Layers: Applying 99.5×99.5mm inner Cu area and thermal via holes to a board based on JEDEC standard JESD51-5)

■RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	RATINGS	UNIT
Operating Voltage Range	V_{IN}	2.3 to 6.5	V
Control Voltage	V_{CONT}	0 to 6.5	V

■ELECTRICAL CHARACTERISTICS

(Unless other noted, $V_{IN}=V_O+1V$, $C_{IN}=0.33\mu F$, $C_O=0.33\mu F$ ($C_O=0.47\mu F$: $2.9V < V_O \leq 3.4V$, $C_O=2.2\mu F$: $1.7V < V_O \leq 2.9V$, $C_O=4.7\mu F$: $V_O \leq 1.7V$), $C_S=0.01\mu F$, $T_a=25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Output Voltage	V_O	$I_O=100mA$		-1.0%	-	+1.0%	V
		$I_O=100mA$, $T_a=-40$ to $+125^\circ C$		-2.0%	-	+2.0%	
Quiescent Current	I_Q	$I_O=0mA$, except I_{CONT}		-	200	280	μA
		$I_O=0mA$, except I_{CONT} , $T_a=-40$ to $+125^\circ C$		-	-	300	
Quiescent Current at OFF-state	$I_{Q(OFF)}$	$V_{CONT}=0V$		-	-	10	μA
		$V_{CONT}=0V$, $T_a=-40$ to $+125^\circ C$		-	-	20	
Output Current	I_O	$V_O \times 0.9$		500	-	-	mA
		$V_O \times 0.9$, $T_a=-40$ to $+125^\circ C$		500	-	-	
Line Regulation	$\Delta V_O / \Delta V_{IN}$	$V_{IN}=V_O+1V$ to $6.5V$, $I_O=100mA$	$V_O=3.3V$	-	-	7.3	mV
		$V_{IN}=V_O+1V$ to $6.5V$, $I_O=100mA$, $T_a=-40$ to $+125^\circ C$	$V_O=3.3V$	-	-	15	
Load Regulation	$\Delta V_O / \Delta I_O$	$I_O=0$ to $500mA$	$V_O=3.3V$	-	-	83	mV
		$I_O=0$ to $500mA$, $T_a=-40$ to $+125^\circ C$	$V_O=3.3V$	-	-	165	
Dropout Voltage ⁽³⁾	ΔV_{IO}	$I_O=300mA$		-	0.18	0.25	V
		$I_O=300mA$, $T_a=-40$ to $+125^\circ C$		-	-	0.35	
Average Temperature Coefficient of Output Voltage	$\Delta V_O / \Delta T_a$	$T_a=-40$ to $+125^\circ C$, $I_O=100mA$		-	± 50	-	ppm/ $^\circ C$
Ripple Rejection	RR	$e_{in}=200mV_{rms}$, $f=1kHz$, $I_O=10mA$	$V_O=3.3V$	-	68	-	dB
Output Noise Voltage	V_{NO}	$f=10Hz$ to $80kHz$, $I_O=10mA$	$V_O=3.3V$	-	28	-	μV_{rms}
Control Current	I_{CONT}	$V_{CONT}=1.6V$		-	3	12	μA
		$V_{CONT}=1.8V$, $T_a=-40$ to $+125^\circ C$		-	-	20	
Control Voltage at ON-state	$V_{CONT(ON)}$			1.6	-	-	V
		$T_a=-40$ to $+125^\circ C$		1.8	-	-	
Control Voltage at OFF-state	$V_{CONT(OFF)}$			-	-	0.6	V
		$T_a=-40$ to $+125^\circ C$		-	-	0.5	
Soft Start Time	$t_{S(ON)}$	$V_{CONT}=L \rightarrow H$, $I_O=100mA$, $C_S=0.022\mu F$		-	1.2	-	msec
Discharge Current at OFF-state	I_{DIS}	$V_{IN}=2.3V$, $V_{CONT}=0V$, $V_O=0.5V$		2	9	-	mA
		$V_{IN}=6.5V$, $V_{CONT}=0V$, $V_O=0.5V$		15	25	-	

(3): Except Output Voltage Rank less than 2.1V

The above specifications are common specifications for all output voltages. Therefore, it may be different from the individual specification for a specific output voltage.

■ THERMAL CHARACTERISTICS

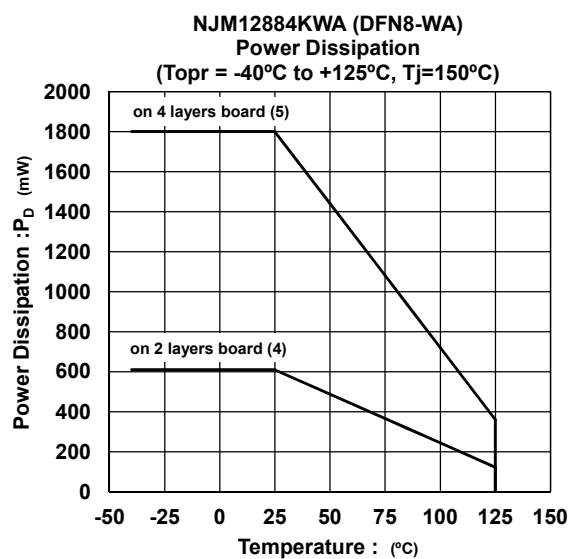
PARAMETER	SYMBOL	VALUE		UNIT
Junction-to-ambient thermal resistance	θ_{ja}	DFN8-WA	205 ⁽⁴⁾ 70 ⁽⁵⁾	°C/W
Junction-to-Top of package characterization parameter	ψ_{jt}	DFN8-WA	29 ⁽⁴⁾ 18 ⁽⁵⁾	°C/W

(4): Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)

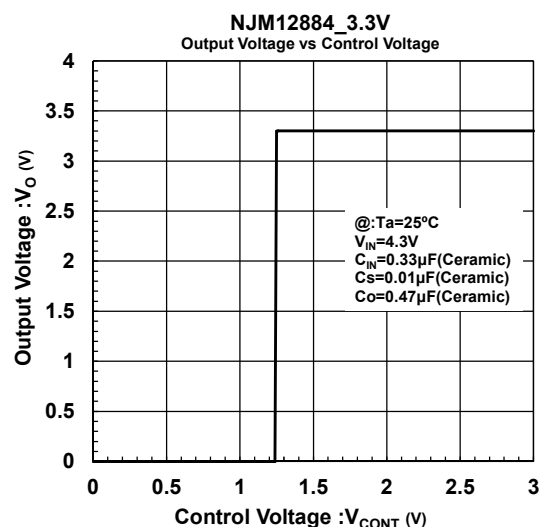
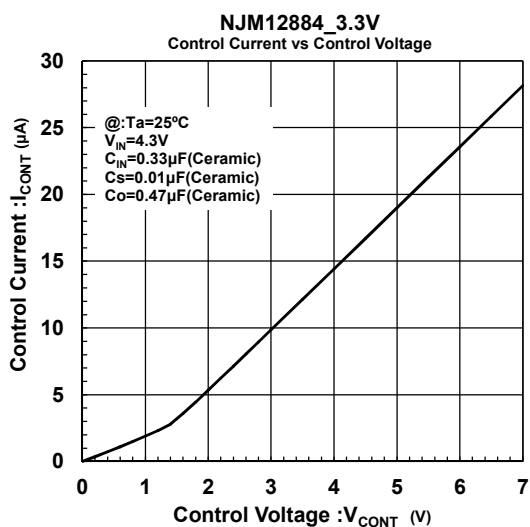
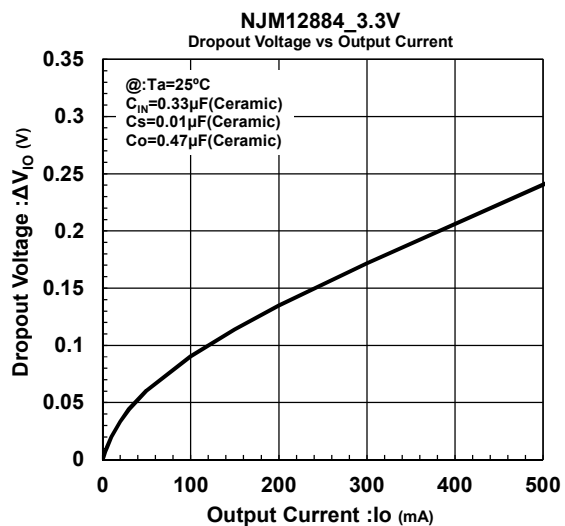
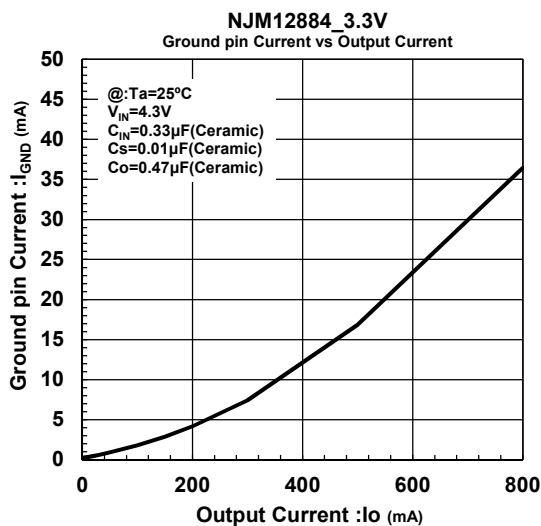
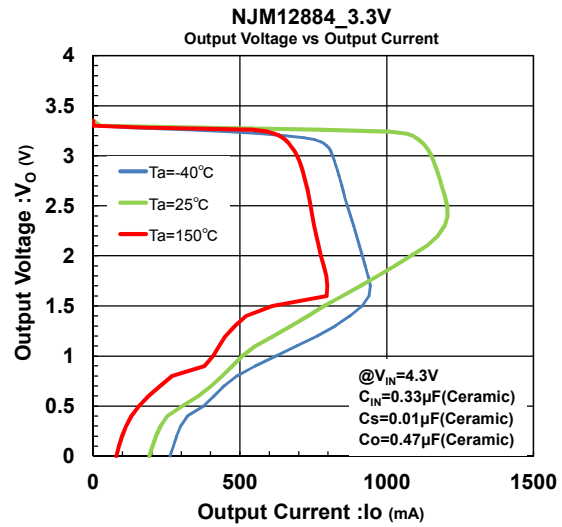
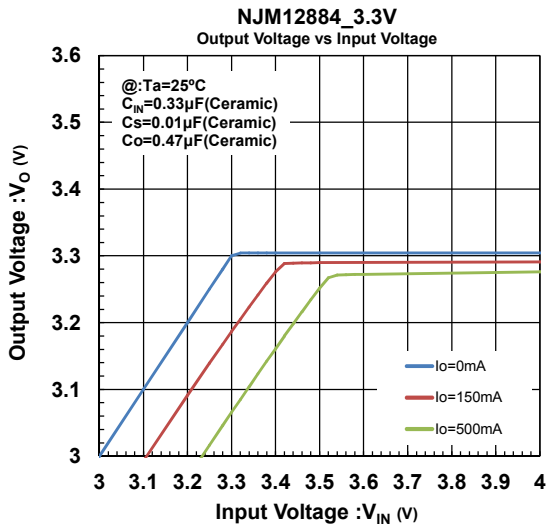
(5): Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)

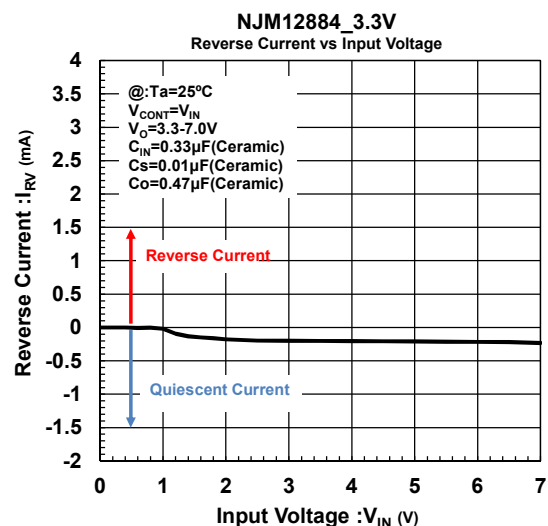
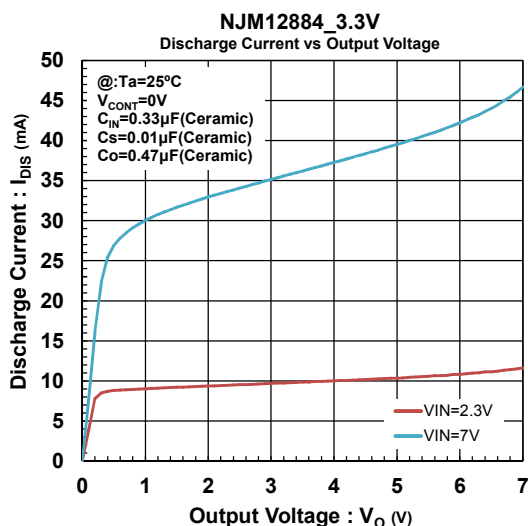
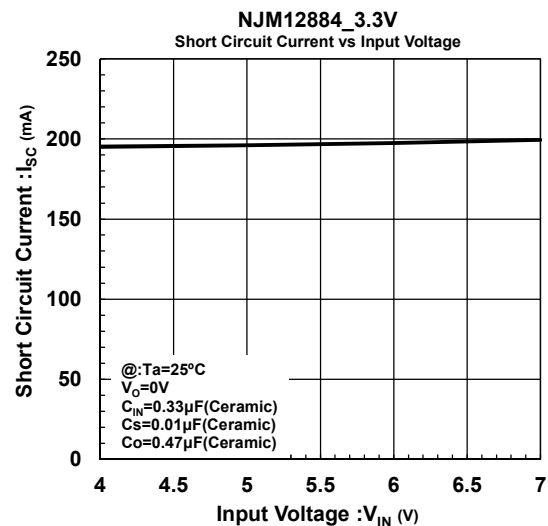
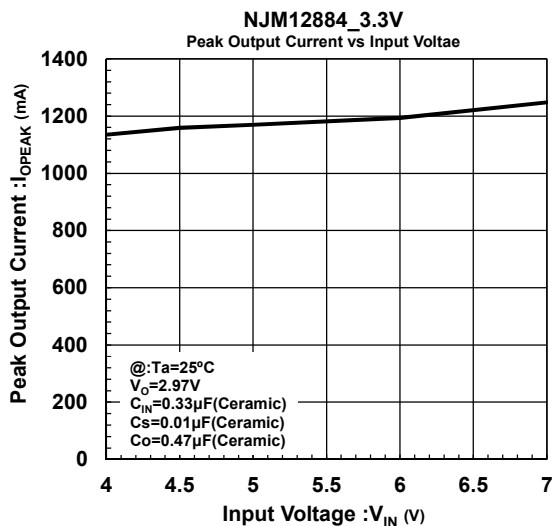
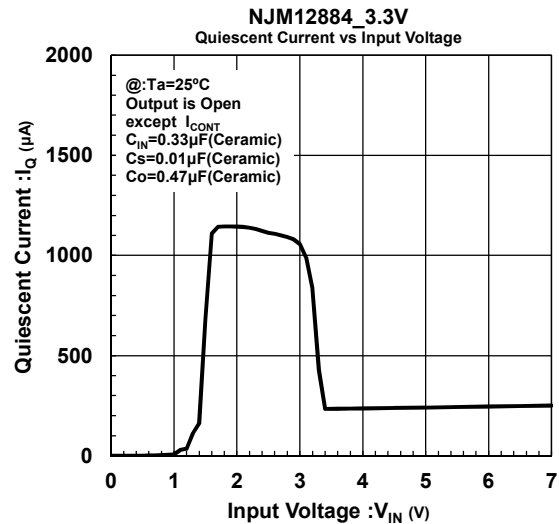
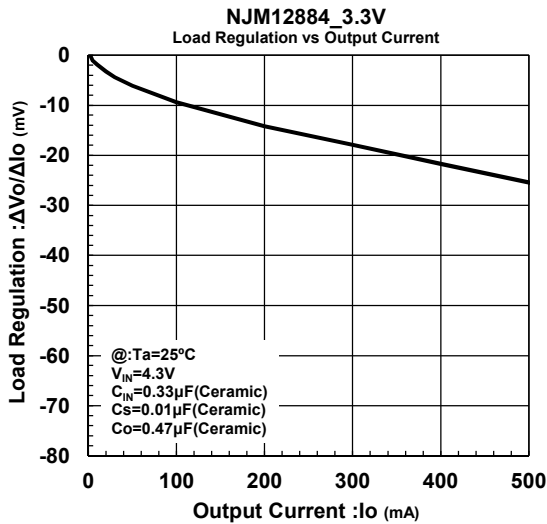
(For 4Layers: Applying 99.5×99.5mm inner Cu area and thermal via holes to a board based on JEDEC standard JESD51-5)

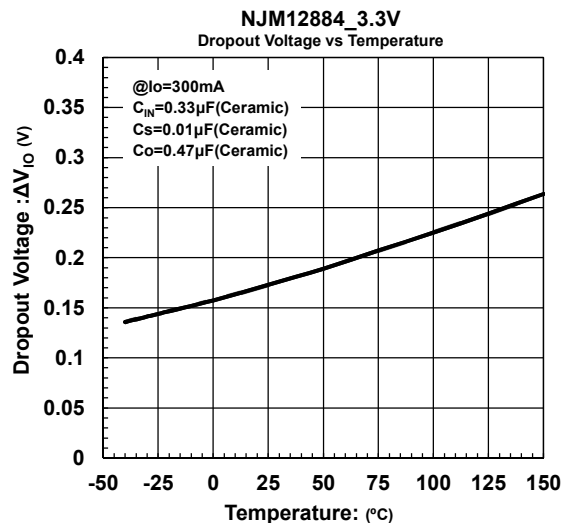
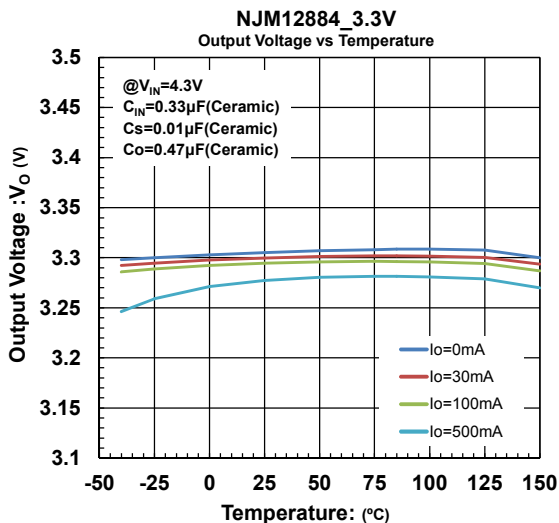
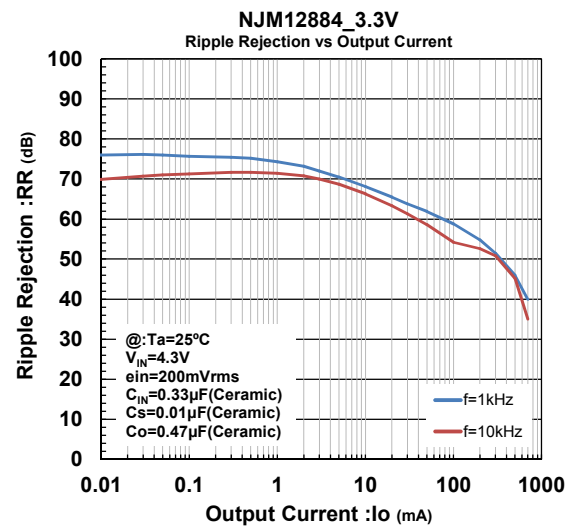
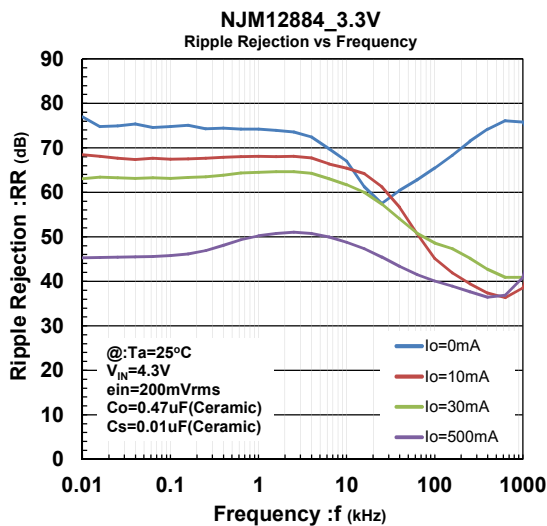
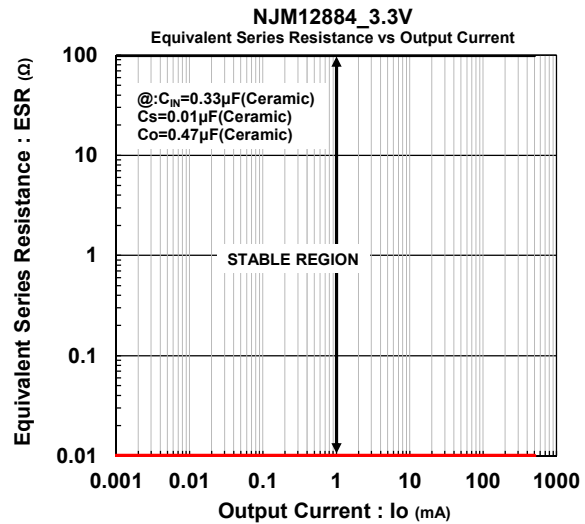
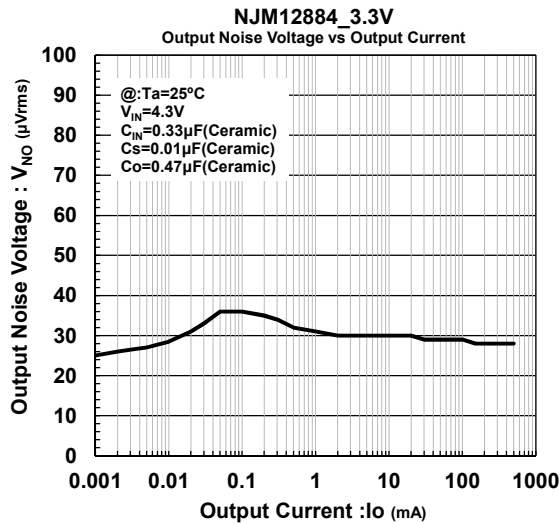
■ POWER DISSIPATION vs. AMBIENT TEMPERATURE

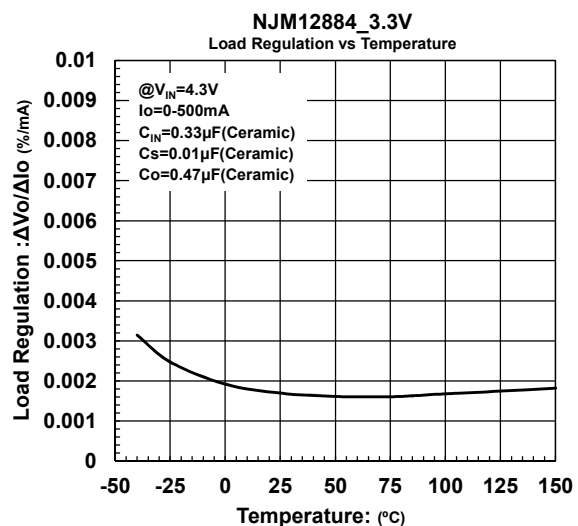
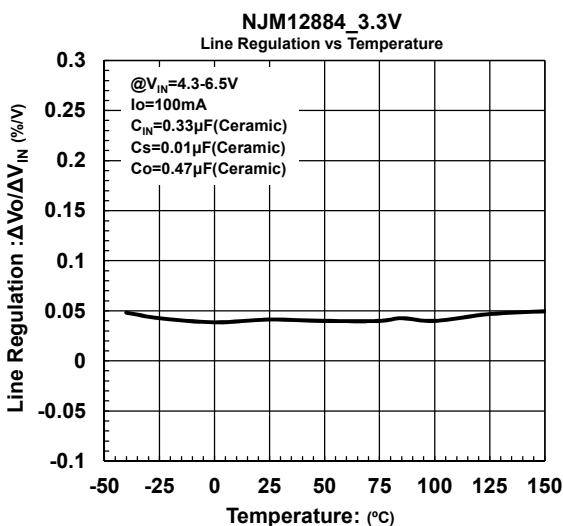
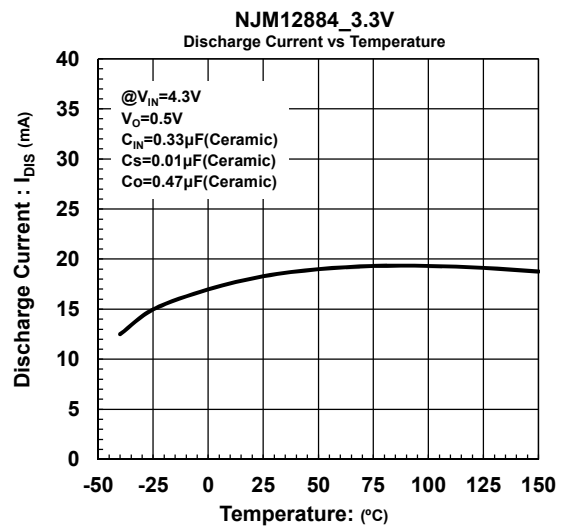
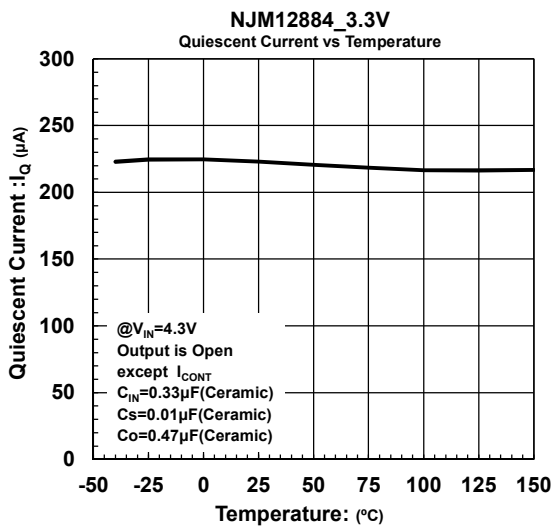
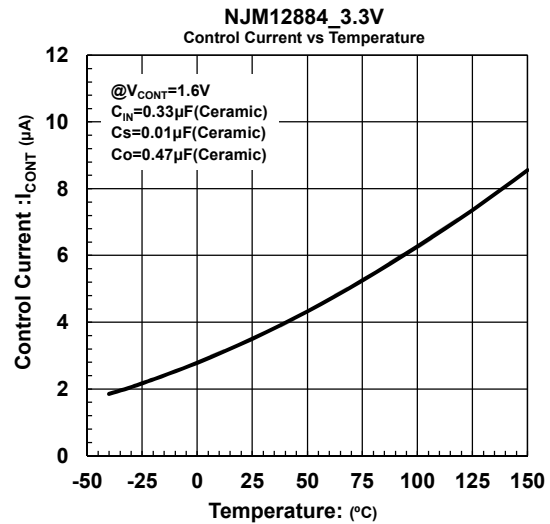
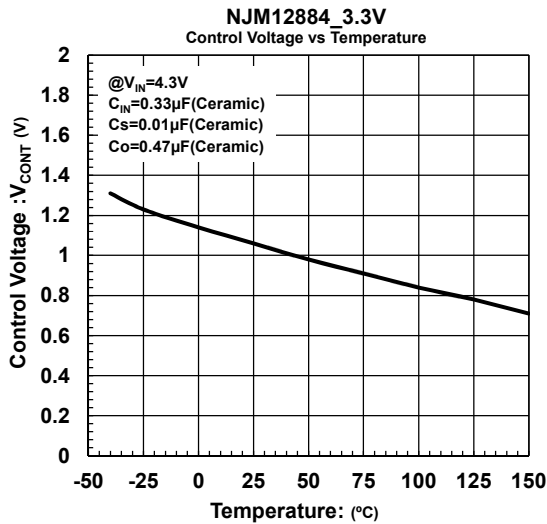


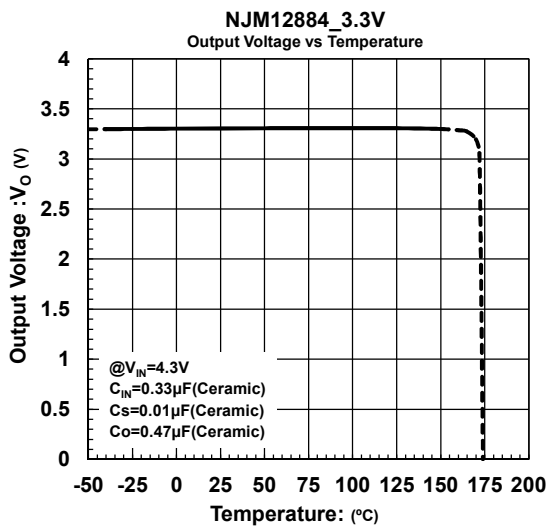
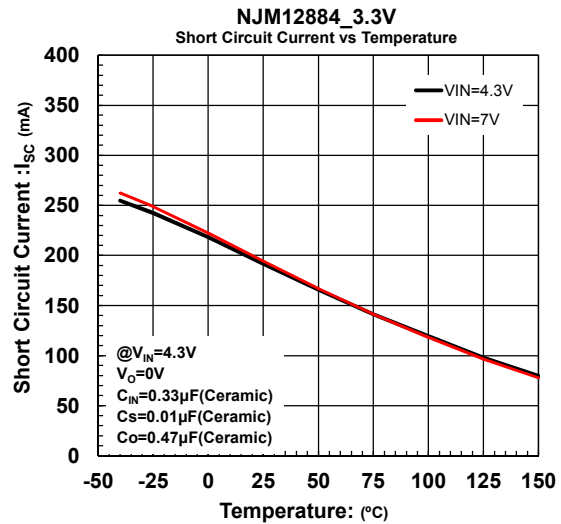
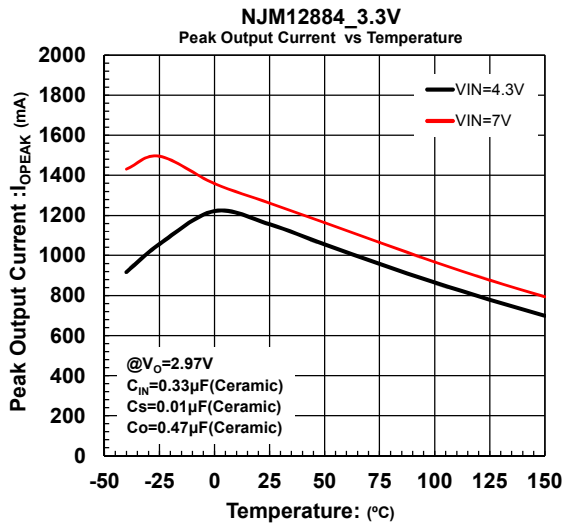
■ TYPICAL CHARACTERISTICS

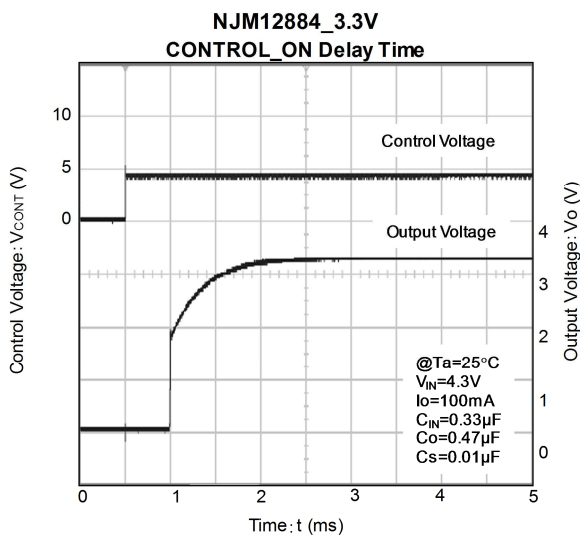
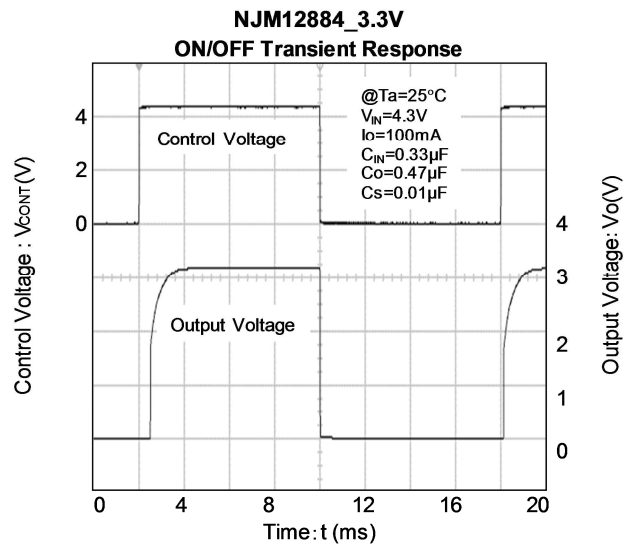
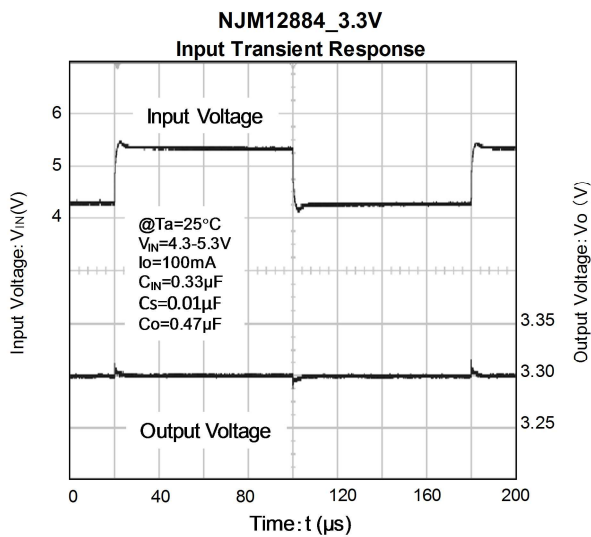
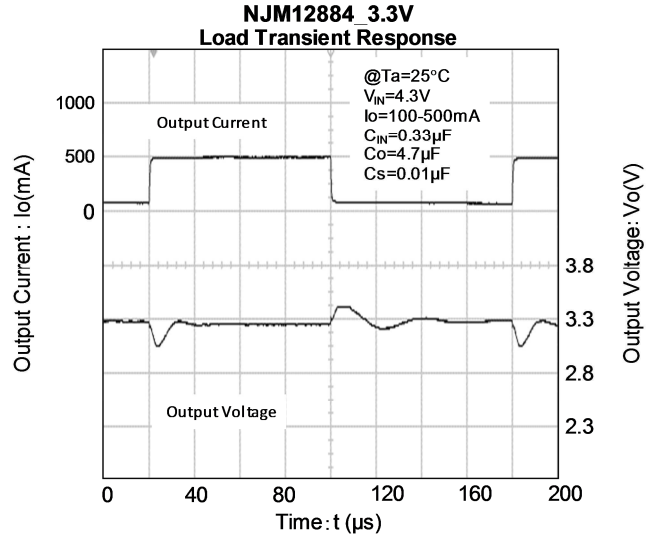
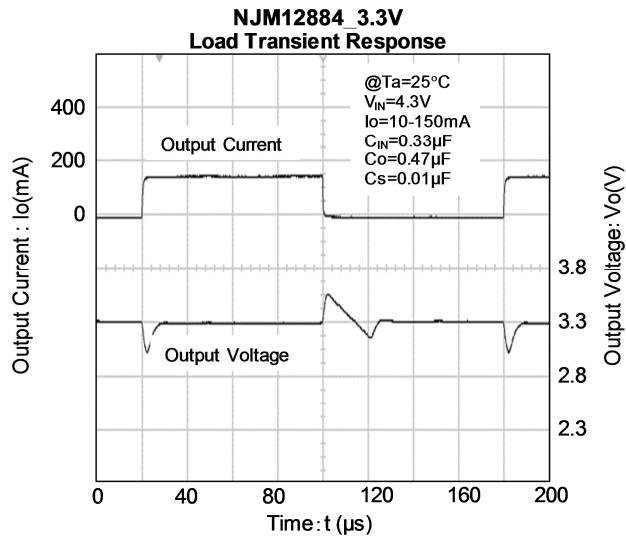






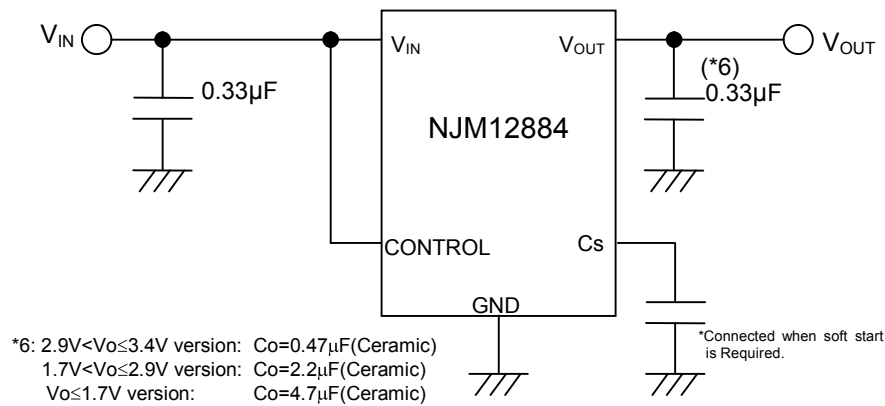






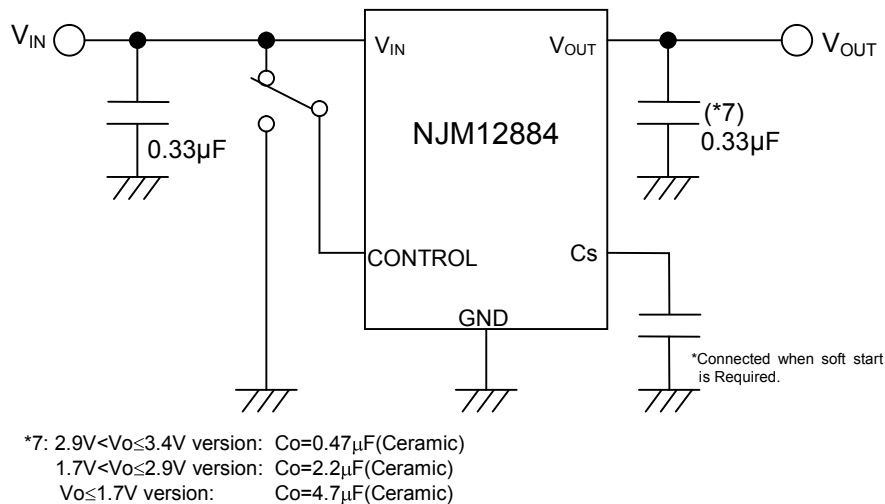
■TYPICAL APPLICATION

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



Connect CONTROL Pin to VIN Pin

2. In use of ON/OFF CONTROL



State of CONTROL Pin:

“H” → output is enabled.

“L” or “open” → output is disabled

■APPLICATION NOTE / GLOSSARY

*Reverse Current Protection

The NJM12884 has built-in Reverse Current Protection circuit.

This circuit prevents the large reverse current when output voltage is higher than input voltage.

Therefore external schottky-barrier diode(SBD) is not required

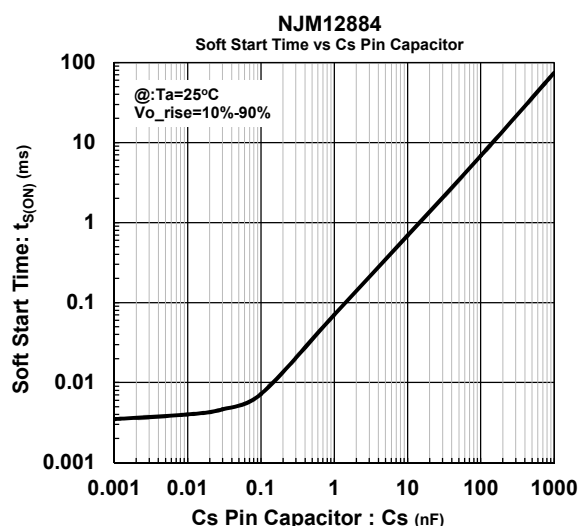
*Soft Start capacitor Cs

The Soft Start function can control the rise time of Output Voltage and reduce the inrush current by connecting the Cs capacitor.

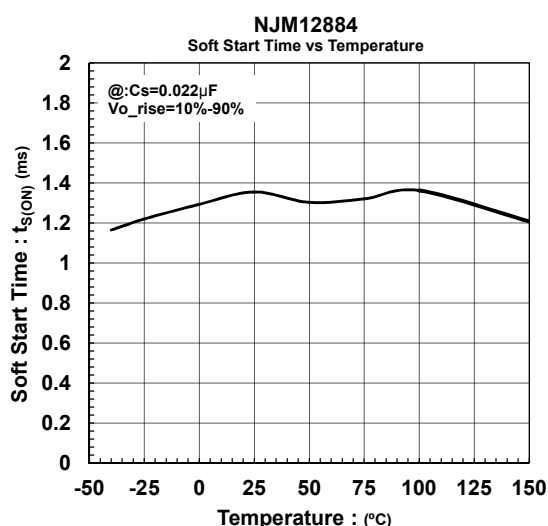
The Soft Start time is defined as 10% to 90% of the Output Voltage.

The Cs capacitor is not essential, but it used for noise bypass of bandgap reference either. Therefore Output Noise Voltage increases when the capacitor isn't connected.

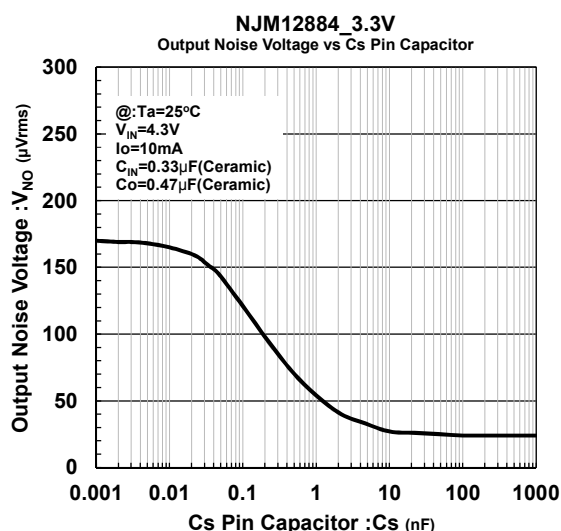
If the Cs capacitor is not used, the Cs Pin should be OPEN.



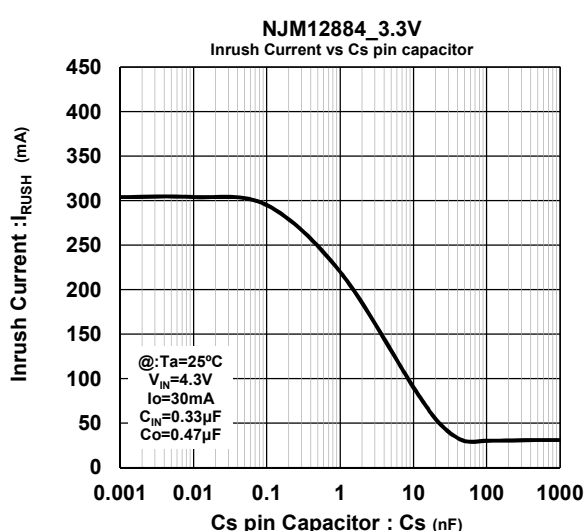
Soft-Start Time vs. Cs Pin Capacitor



Soft-Start Time (0.022μF) vs. Temperature



Output Noise Voltage vs. Cs Pin Capacitor

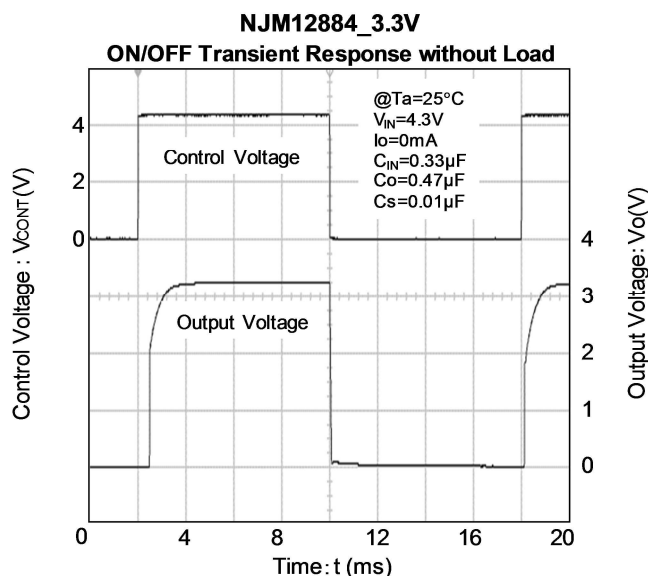


Inrush Current vs. Cs Pin Capacitor

*Discharge Function

The NJM12884 has a built-in discharge circuit to discharge the charged output capacitors.

Discharge circuit operates when the CONTROL Pin is set in LOW level. The circuit discharges the charged output capacitors rapidly.



*Input Capacitor C_{IN}

The input capacitor C_{IN} is required in order to prevent oscillation and reduce power supply ripple of applications when high power supply impedance or a long power supply line.

Therefore, the recommended capacitance (refer to conditions of ELECTRIC CHARACTERISTIC) or larger input capacitor, connected between V_{IN} and GND as short path as possible, is recommended in order to avoid the problem.

*Output Capacitor C_O

The output capacitor C_O is required for a phase compensation of the internal error amplifier, and the capacitance and the equivalent series resistance (ESR) influence stable operation of the regulator.

If use a smaller output capacitor than the recommended capacitance (refer to conditions of ELECTRIC CHARACTERISTIC), it may cause excess output noise or oscillation of the regulator due to lack of the phase compensation. Therefore, the recommended capacitance or larger output capacitor, connected between V_{OUT} and GND as short path as possible, is recommended for stable operation. The recommended capacitance may be different by output voltage, therefore confirm the recommended capacitance of the required output voltage.

Furthermore, a larger output capacitor reduces output noise and ripple output, and also improves Output Transient Response when a load changes rapidly.

Selecting the output capacitor, should consider varied characteristics of a capacitor: frequency characteristics, temperature characteristics, DC bias characteristics and so on. Therefore, the capacitor that has a sufficient margin of the rated voltage against the output voltage and superior temperature characteristics, is recommended for C_O .

The drawing consists of three views of a mechanical part:

- TOP VIEW:** Shows a square part with a side length of 3.0 ± 0.050 . A circular feature is located in the bottom-left corner. Surface A is indicated on the top and left faces with a feature control frame: $\oplus 0.10 \text{ (M) S A}$.
- SIDE VIEW:** Shows the part's profile with a total height of 0.7 ± 0.050 . A surface texture symbol $\text{/// } 0.2 \text{ S}$ is shown on the top surface. A datum S is established at the bottom. A vertical dimension of $0.01^{+0.010}_{-0.008}$ is shown from the datum to the bottom of the part. A circular feature is shown with a feature control frame: $\text{D } 0.05 \text{ S}$.
- BOTTOM VIEW:** Shows the part's base with a width of 0.4 ± 0.050 . A central slot has a width of $1.5^{+0.060}_{-0.040}$ and a depth of 0.325 . The slot is flanked by two $3\text{-}R0.5$ fillets. A datum B is established at the bottom left. A feature control frame at the bottom right indicates a surface texture of $\oplus 0.05 \text{ (M) S A B}$.

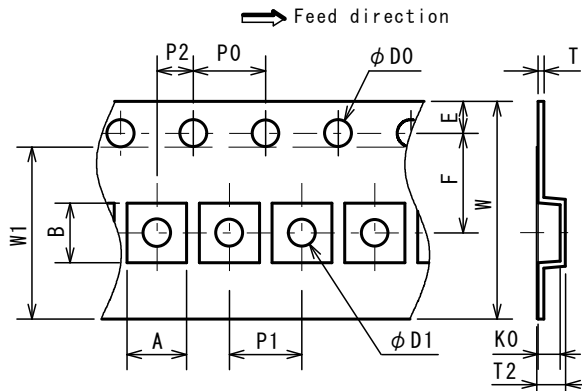
* This package is not correspond "Wettable flank" and side of terminal is not plated.

Technical drawing of a package outline. The drawing shows a rectangular package with a central rounded rectangular cutout. The overall dimensions are 3.20 (height) and 2.24 (width). The central cutout has a width of 1.44 and a height of 0.51. The package has four mounting holes, each with a diameter of 0.65. The distance between the centers of the holes is 0.65. The package has a top radius of R0.47 and a bottom radius of R0.07. The package outline is indicated by a dashed line. The dimensions are given in millimeters.

PACKING SPEC

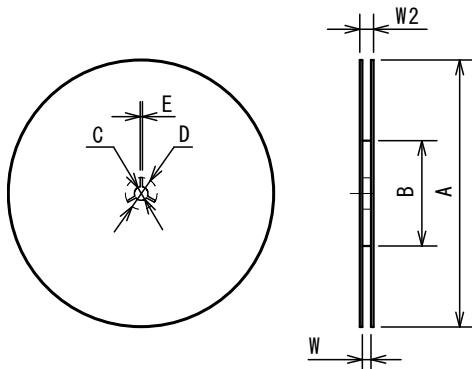
Unit: mm

TAPING DIMENSIONS



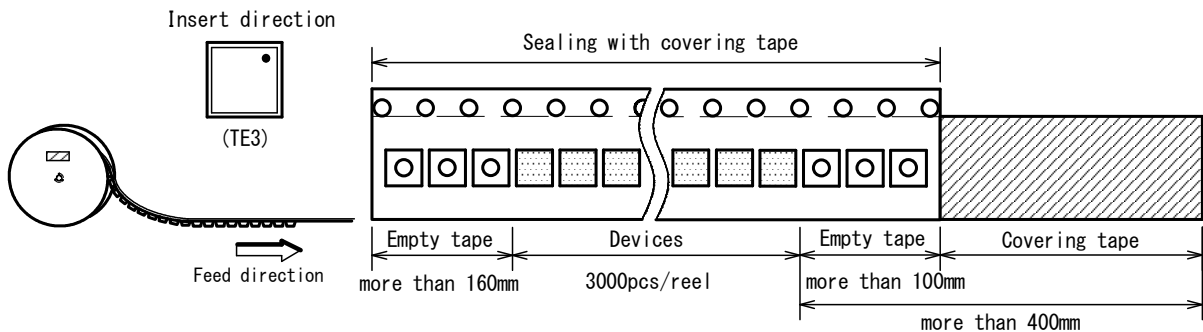
SYMBOL	DIMENSION	REMARKS
A	3.3 ± 0.1	BOTTOM DIMENSION
B	3.3 ± 0.1	BOTTOM DIMENSION
D0	$1.5^{+0.1}_0$	
D1	$1.5^{+0.1}_0$	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.30 ± 0.05	
T2	1.3 ± 0.07	
K0	0.9 ± 0.05	
W	$12.0^{+0.3}_{-0.1}$	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

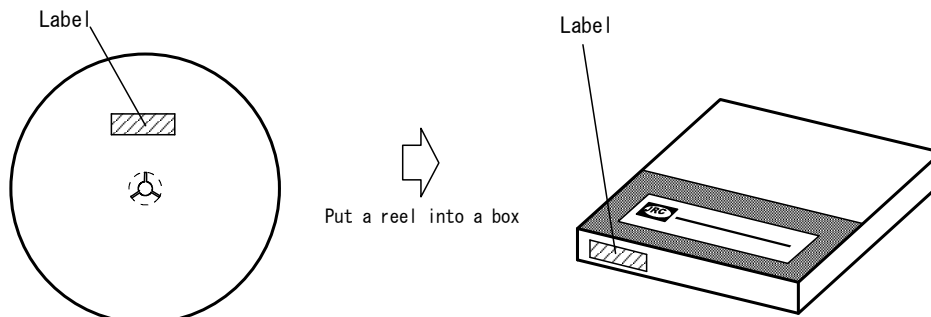


SYMBOL	DIMENSION
A	$\phi 254 \pm 2$
B	$\phi 100 \pm 1$
C	$\phi 13 \pm 0.2$
D	$\phi 21 \pm 0.8$
E	2 ± 0.5
W	13.5 ± 1
W2	17.5 ± 1

TAPING STATE



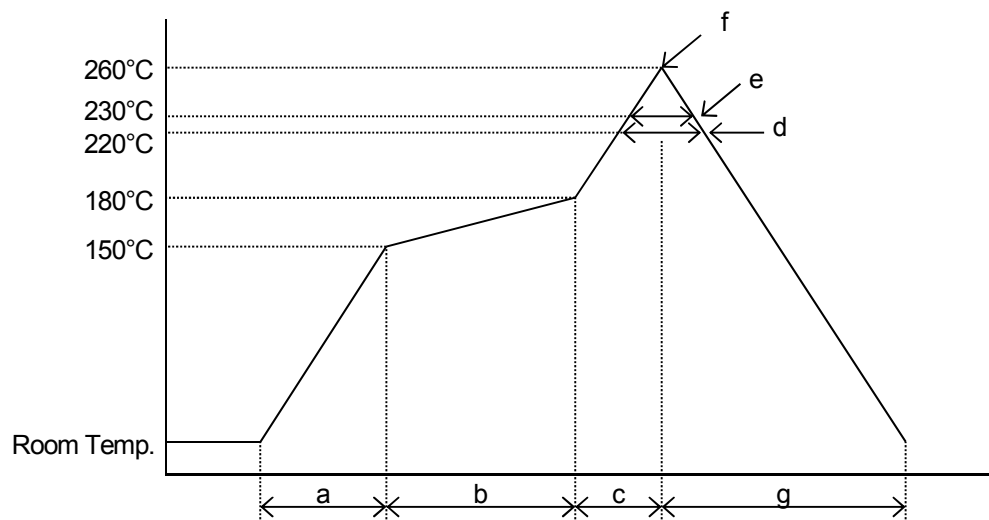
PACKING STATE



■RECOMMENDED MOUNTING METHOD

INFRARED REFLOW SOLDERING METHOD

Recommended reflow soldering procedure



a: Temperature ramping rate	: 1 to 4°C/s
b: Pre-heating temperature 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
22.Jun.2016	Ver.1.0	New Release Automotive "H" spec.
7.Jul.2016	Ver.1.1	Added output voltage lineup. Reconsidered significant figures in Line/Load Regulation
12.Apr.2017	Ver.2.0	Revised the package outline as leads length extended 0.3 to 0.4mm in order to strengthen BLR and changed the package name DFN8-W2 to DFN8-WA. Along with this revise, renamed the part number NJM12884KW2 to NJM12884KWA and renamed package names in related section. Revised the MOQ in ORDERING INFORMATION from 1500 to 3000pcs. Along with this revise, revised the related values of REEL DIMENSIONS, TAPING STATE and PACKING STATE in PACKING SPEC.
7.Aug.2017	Ver.2.1	Added comment of wettable flank on PACKAGE OUTLINE. Changed the description in ORDERING INFORMATION and ELECTRICAL CHARACTERISTICS to only released output voltage rank.
26.Sep.2017	Ver.2.2	Correction of following errors: -Value of ψ_{jt} in THERMAL CHARACTERISTICS -Test condition of Soft Start Time in ELECTRICAL CHARACTERISTICS
20.Dec.2017	Ver.2.3	Added conformity with AEC-Q100 to FEATURES section

[CAUTION]

1. New JRC strives to produce reliable and high quality semiconductors. New JRC's semiconductors are intended for specific applications and require proper maintenance and handling. To enhance the performance and service of New JRC'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 rights.
All other trademarks mentioned herein are property of their respective companies.
3. To ensure the highest levels of reliability, New JRC products must always be properly handled.
The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.
4. New JRC offers a variety of semiconductor products intended for particular applications. It is important that you select the proper component for your intended application. You may contact New JRC's Sale's Office if you are uncertain about the products listed in this catalog.
5. Special care is required in designing devices, machinery or equipment which demand high levels of reliability. This is particularly important when designing critical components or systems whose failure can foreseeably result in situations that could adversely affect health or safety. In designing such critical devices, equipment or machinery, careful consideration should be given to amongst other things, their safety design, fail-safe design, back-up and redundancy systems, and diffusion design.
6. The products listed in the catalog 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)
Life Maintenance Medical Equipment
Fire Alarm/Intruder Detector
Vehicle Control Equipment (airplane, railroad, ship, etc.)
Various Safety devices
7. New JRC's 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 catalog. Failure to employ New JRC products in the proper applications can lead to deterioration, destruction or failure of the products. New JRC shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of its products. Products are sold without warranty of any kind, either express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose.
8. Warning for handling Gallium and Arsenic(GaAs) Products (Applying to GaAs MMIC, Photo Reflector). This Products uses 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, 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 catalog are subject to change at any time, without notice.

