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 ±2.0%
- Output Current I_O (min.) = 500mA
- 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 DFN8-WA (ESON8-WA)

■ GENERAL DESCRIPTION

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

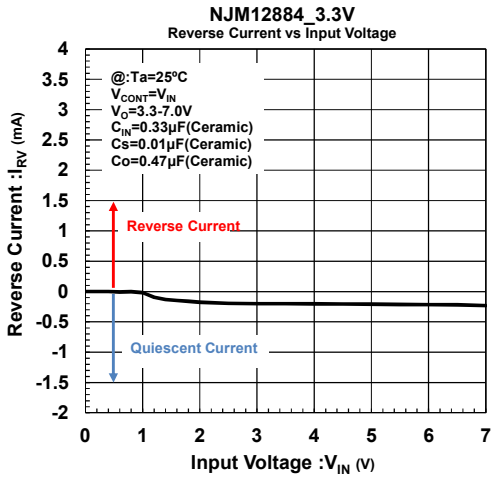
Adjustable soft-start function is useful for reducing inrush current and controlling power-on sequence. Moreover the discharge function makes effective sequence control with the soft-start function.

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

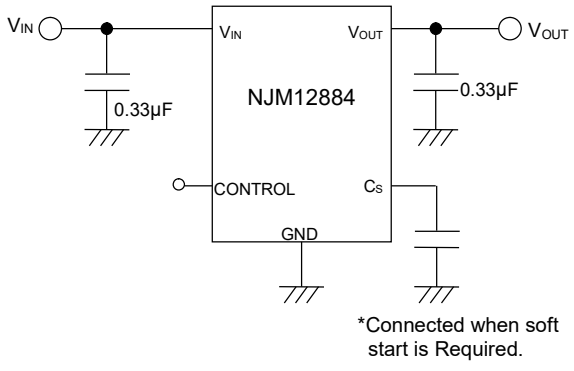
■ APPLICATION

- Automotive infotainment
- Automotive ECU unit
- Industrial equipment

■ REVERSE CURRENT PROTECTION CHARACTERISTICS

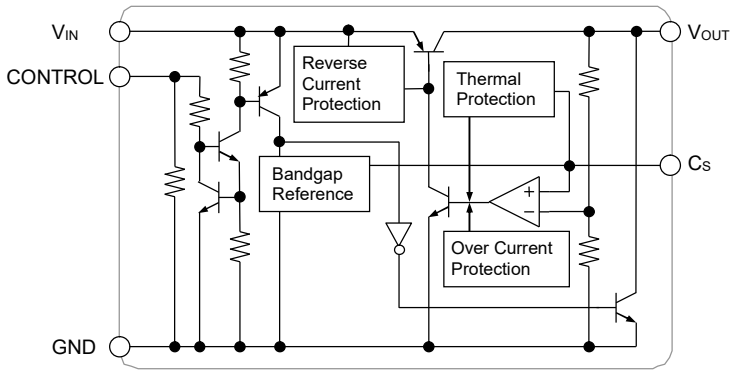


■ TYPICAL APPLICATION



*Connected when soft start is Required.

■ BLOCK DIAGRAM



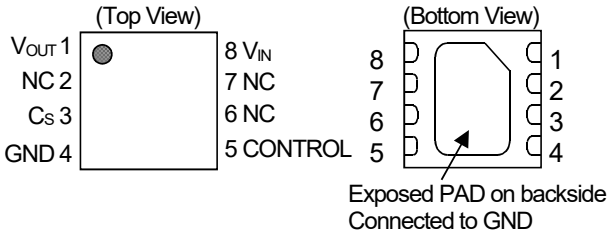
■ OUTPUT VOLTAGE RANK

DFN8-WA (ESON8-WA)

STATUS	PART NUMBER	OUTPUT VOLTAGE	STATUS	PART NUMBER	OUTPUT VOLTAGE
PLAN	NJM12884KWA-15-H	1.5V	M.P.	NJM12884KWA-33-H	3.3V
PLAN	NJM12884KWA-18-H	1.8V	PLAN	NJM12884KWA-05-H	5.0V
PLAN	NJM12884KWA-25-H	2.5V			

■ PIN CONFIGURATION

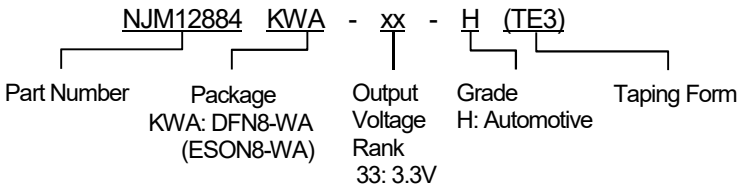
DFN8-WA (ESON8-WA)



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



* 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

PART NUMBER	OUTPUT VOLTAGE	PACKAGE OUTLINE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJM12884KWA-33-H (TE3)	3.3V	DFN8-WA (ESON8-WA)	Yes	Yes	Sn2Bi	88433	18	3000

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

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING		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≤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 (Ta=25°C) DFN8-WA (ESON8-WA)	P_D	2-Layer / 4-Layer 610(1)/ 1800(2)		mW
Junction Temperature	Tj	−40 to 150		°C
Operating Temperature	T_{opr}	−40 to 125		°C
Storage Temperature	T_{stg}	−50 to 150		°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	VALUE	UNIT
Operating Voltage Range	V_{IN}	2.3 to 6.5	V
Control Voltage	V_{CONT}	0 to 6.5	V

■ **ELECTRICAL CHARACTERISTICS** $V_{IN}=V_O+1V$, $C_{IN}=0.33\mu F$, $C_O=0.33\mu F$ ($C_O=0.47\mu F$: $2.9V<V_O\leq 3.4V$, $C_O=2.2\mu F$: $1.7V<V_O\leq 2.9V$, $C_O=4.7\mu F$: $V_O\leq 1.7V$), $C_S=0.01\mu F$, Ta=25°C, unless other noted.

PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Output Voltage	V_O	I_O=100mA		−1.0%	-	+1.0%	V
		I_O=100mA, Ta=−40°C to 125°C		−2.0%	-	+2.0%	
Quiescent Current	I_Q	I_O=0mA, except I_{CONT}		-	200	280	μA
		I_O=0mA, except I_{CONT}, Ta=−40°C to 125°C		-	-	300	
Quiescent Current at OFF-state	$I_{Q(OFF)}$	V_{CONT}=0V		-	-	10	μA
		V_{CONT}=0V, Ta=−40°C to 125°C		-	-	20	
Output Current	I_O	V_O × 0.9 V		500	-	-	mA
		V_O × 0.9 V, Ta=−40°C to 125°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, Ta=−40°C to 125°C	V_O=3.3V	-	-	15	
Load Regulation	$\Delta V_O/\Delta I_O$	I_O=0mA to 500mA	V_O=3.3V	-	-	83	mV
		I_O=0mA to 500mA, Ta=−40°C to 125°C	V_O=3.3V	-	-	165	
Dropout Voltage (3)	ΔV_{IO}	I_O=300mA		-	0.18	0.25	V
		I_O=300mA, Ta=−40°C to 125°C		-	-	0.35	
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta Ta$	I_O=100mA, Ta=−40°C to 125°C		-	±50	-	ppm/°C
Ripple Rejection	RR	ein=200mVrms, 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	-	μVrms
Control Current	I_{CONT}	V_{CONT}=1.6V		-	3	12	μA
		V_{CONT}=1.8V, Ta=−40°C to 125°C		-	-	20	
Control Voltage at ON-state	$V_{CONT(ON)}$			1.6	-	-	V
		Ta=−40°C to 125°C		1.8	-	-	
Control Voltage at OFF-state	$V_{CONT(OFF)}$			-	-	0.6	V
		Ta=−40°C to 125°C		-	-	0.5	
Soft Start Time	$t_{S(ON)}$	V_{CONT}=L→H, I_O=100mA, C_S=0.022μF		-	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

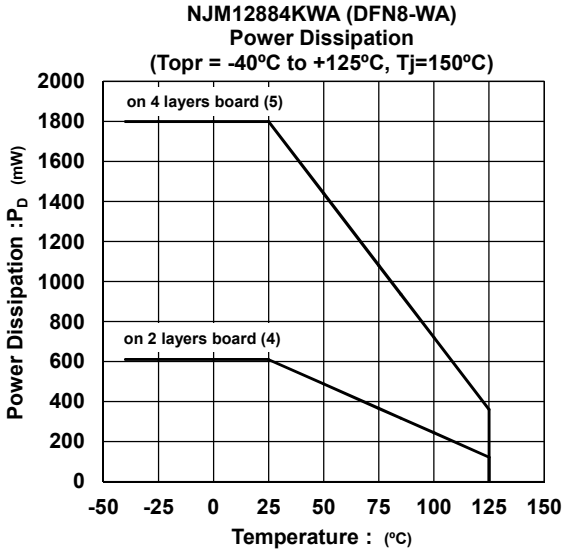
The above specifications are common specifications for all output voltages. Therefore, it may be different from the individual specification for a specific output voltage.

■ THERMAL CHARACTERISTICS

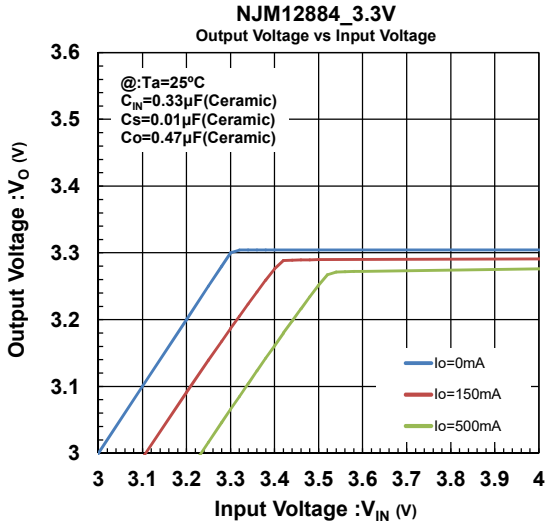
PARAMETER	SYMBOL	VALUE	UNIT
Junction-To-Ambient Thermal Resistance DFN8-WA (ESON8-WA)	θ_{ja}	2-Layer / 4-Layer 205(4) / 70(5)	°C /W
Junction-To-Top of Package Characterization Parameter DFN8-WA (ESON8-WA)	Ψ_{jt}	2-Layer / 4-Layer 29(4) / 18(5)	°C /W

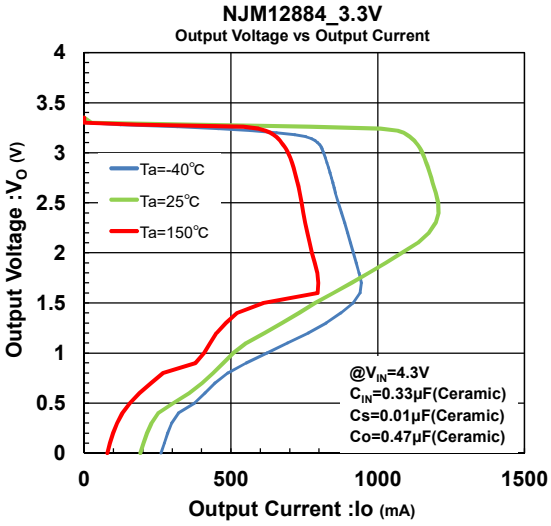
(4) Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)
(5) Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)
(For 4Layers: Applying 99.5×99.5mm inner Cu area and thermal via holes to a board based on JEDEC standard JESD51-5)

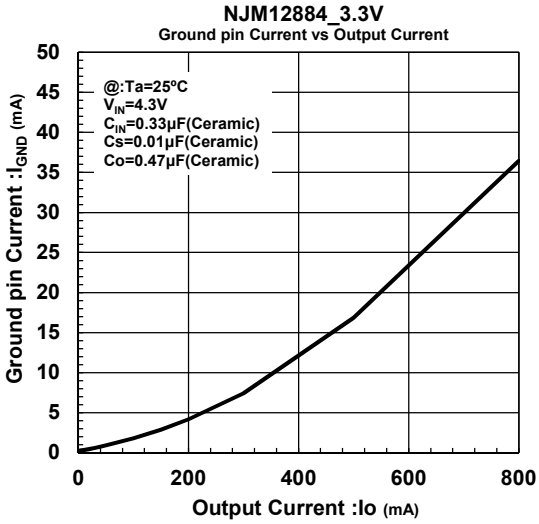
■ POWER DISSIPATION vs. AMBIENT TEMPERATURE

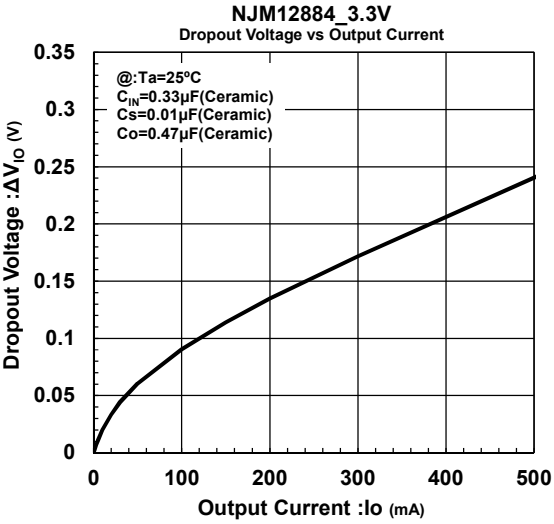


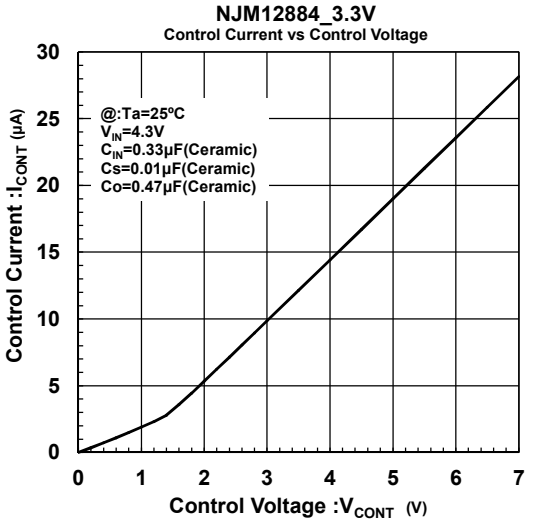
■ TYPICAL CHARACTERISTICS

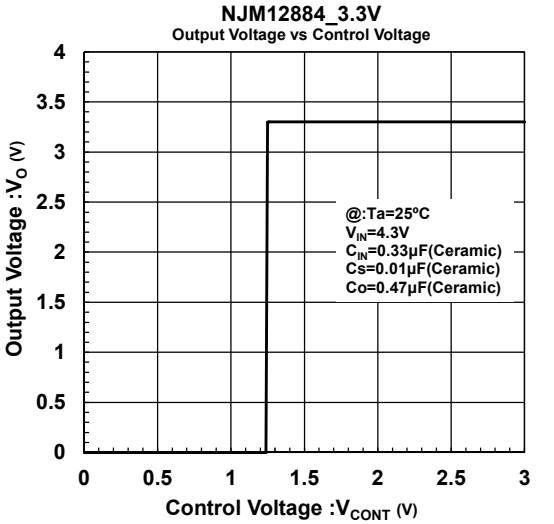




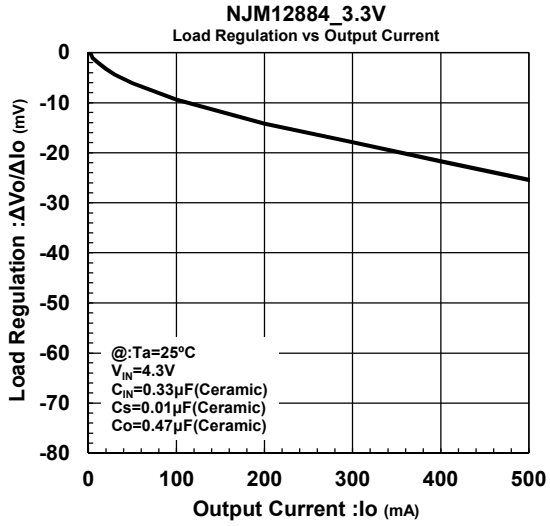


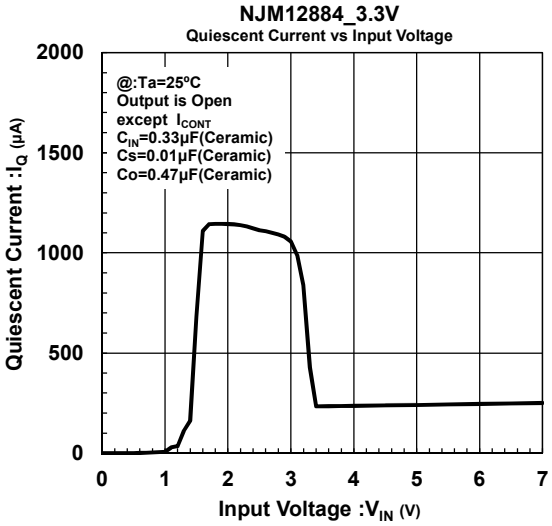


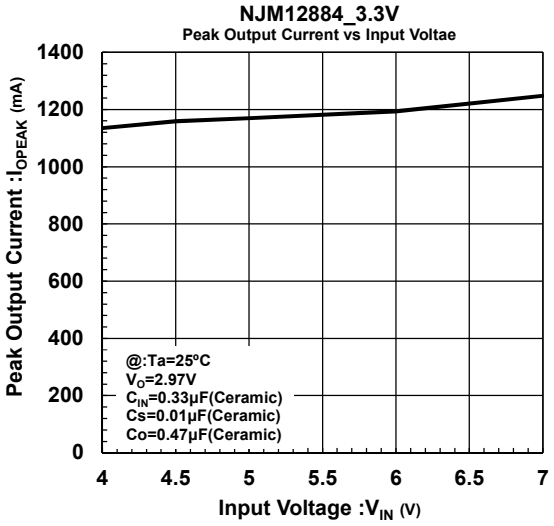


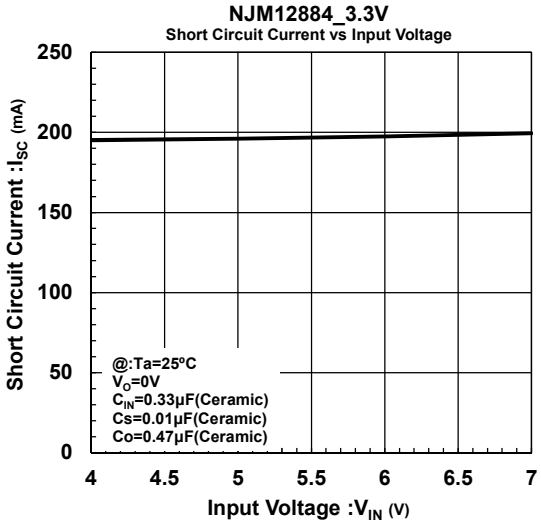


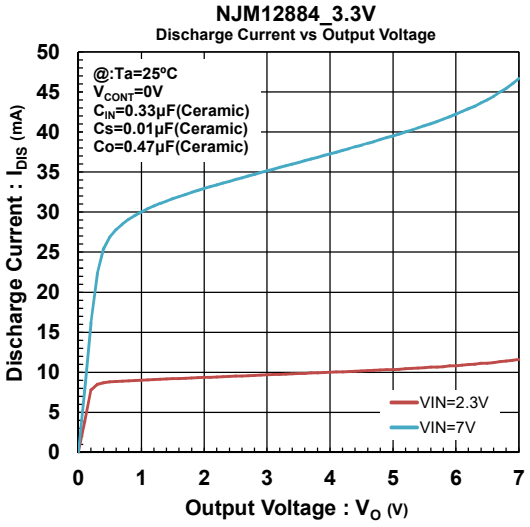
■ TYPICAL CHARACTERISTICS

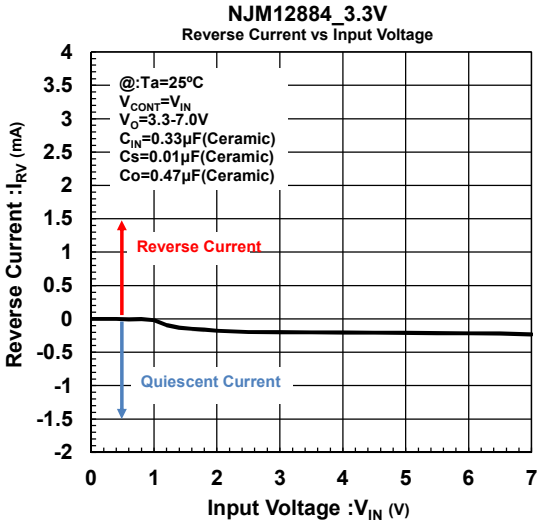






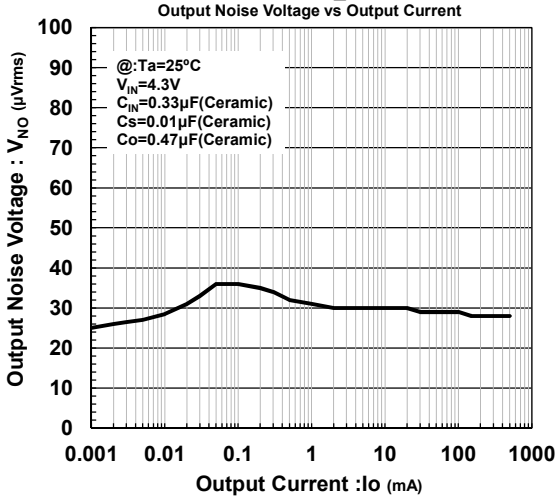




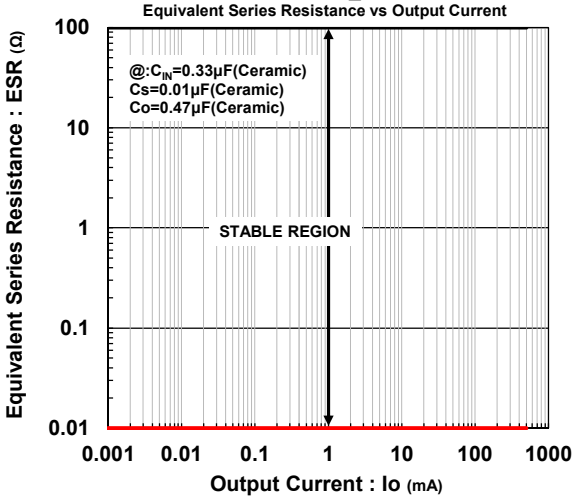


■ TYPICAL CHARACTERISTICS

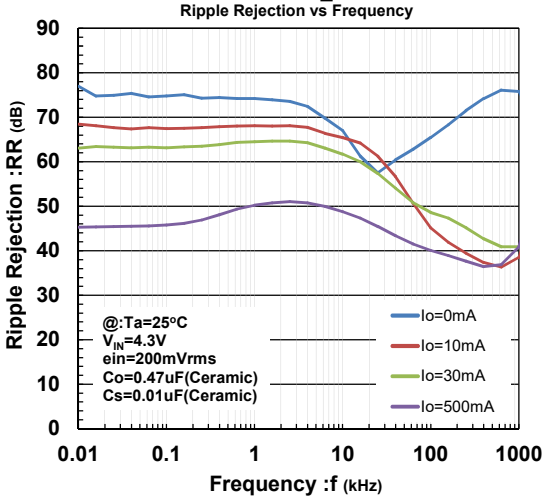
NJM12884_3.3V
Output Noise Voltage vs Output Current



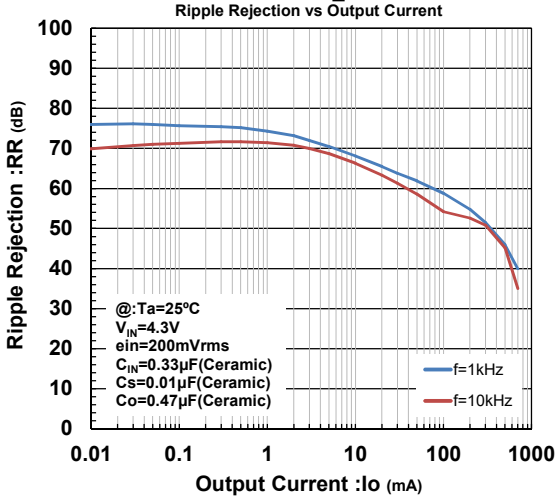
NJM12884_3.3V
Equivalent Series Resistance vs Output Current



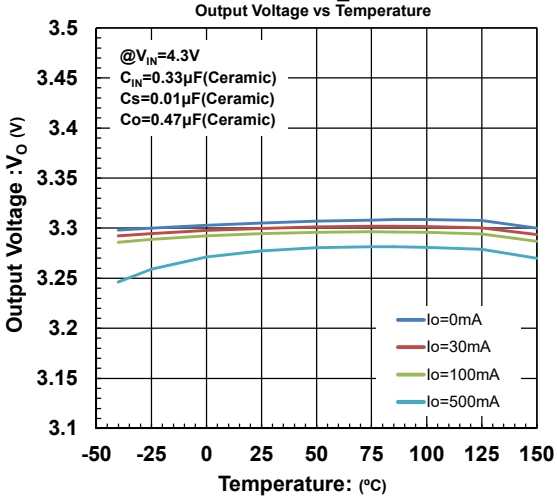
NJM12884_3.3V
Ripple Rejection vs Frequency



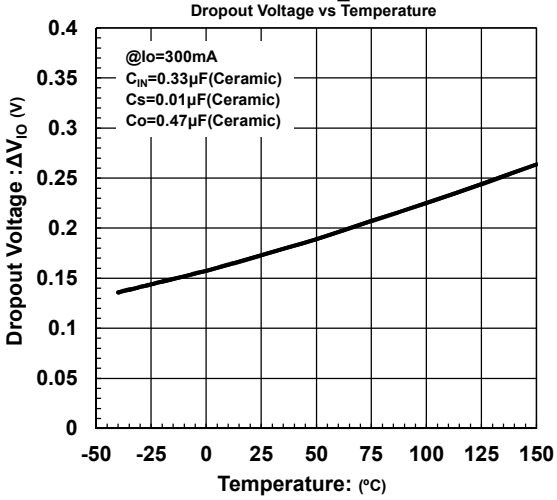
NJM12884_3.3V
Ripple Rejection vs Output Current



NJM12884_3.3V
Output Voltage vs Temperature

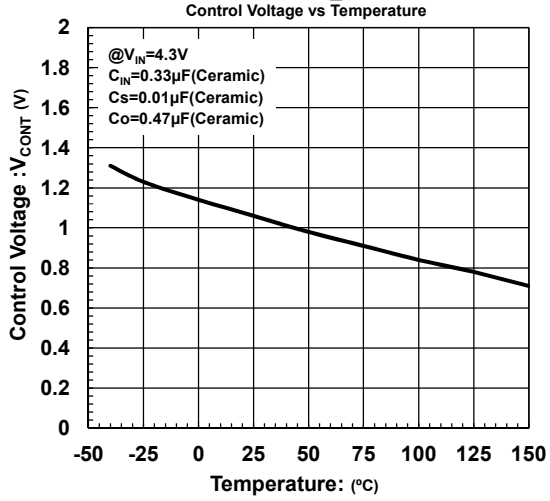


NJM12884_3.3V
Dropout Voltage vs Temperature

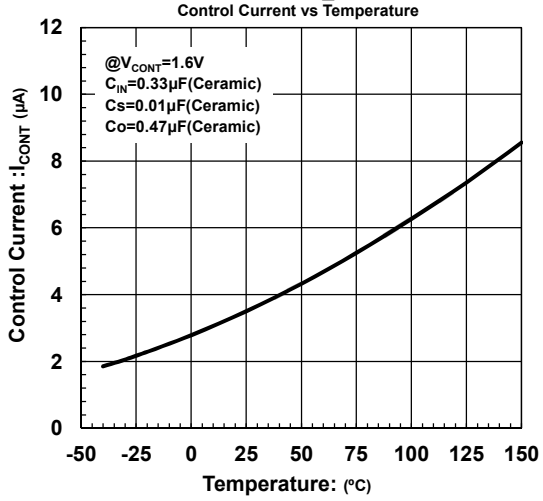


■ TYPICAL CHARACTERISTICS

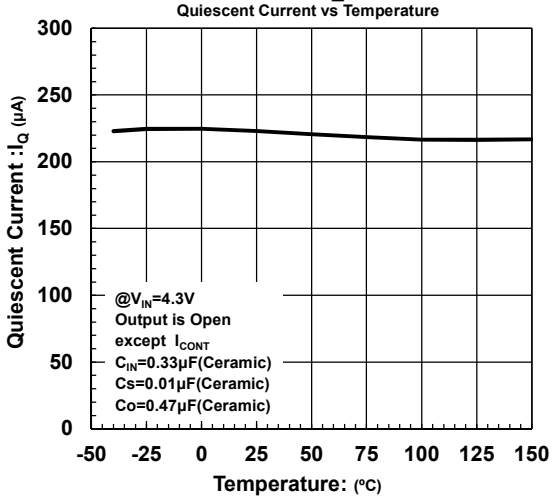
NJM12884_3.3V
Control Voltage vs Temperature



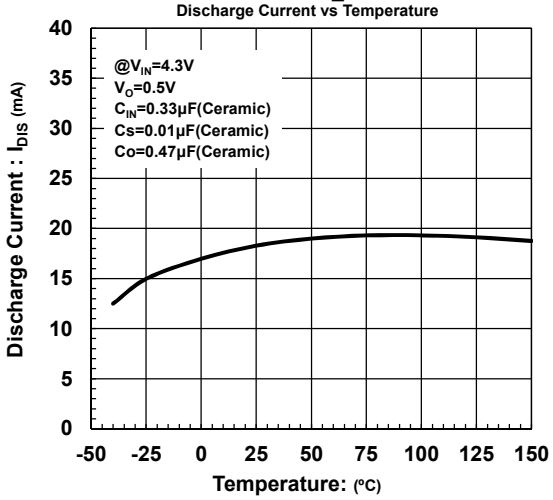
NJM12884_3.3V
Control Current vs Temperature



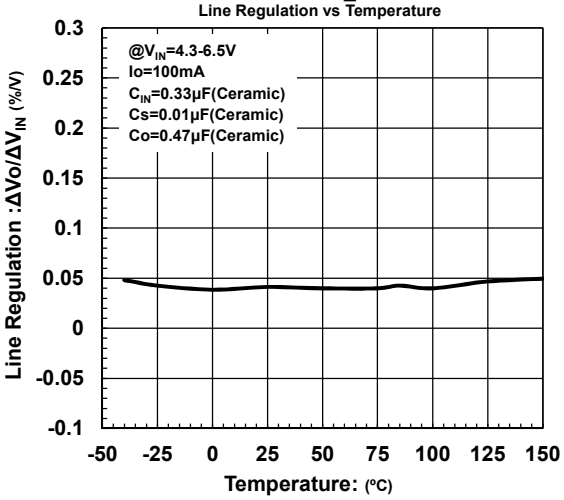
NJM12884_3.3V
Quiescent Current vs Temperature



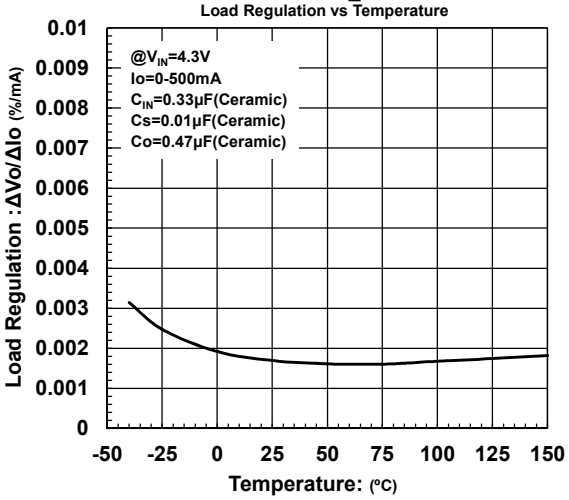
NJM12884_3.3V
Discharge Current vs Temperature



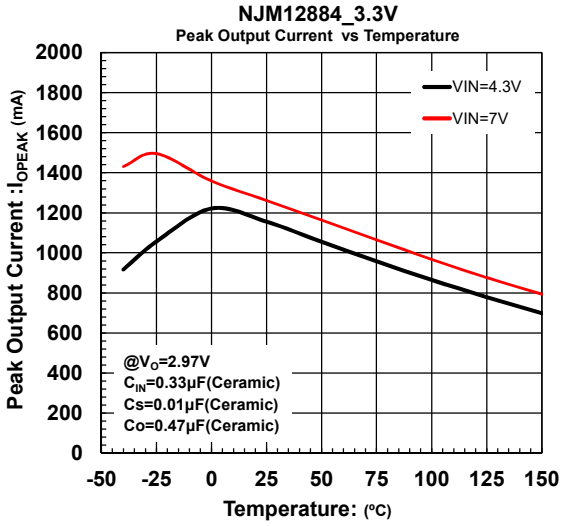
NJM12884_3.3V
Line Regulation vs Temperature

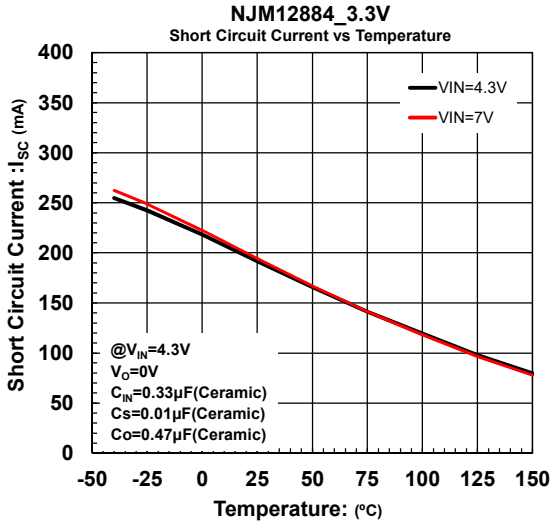


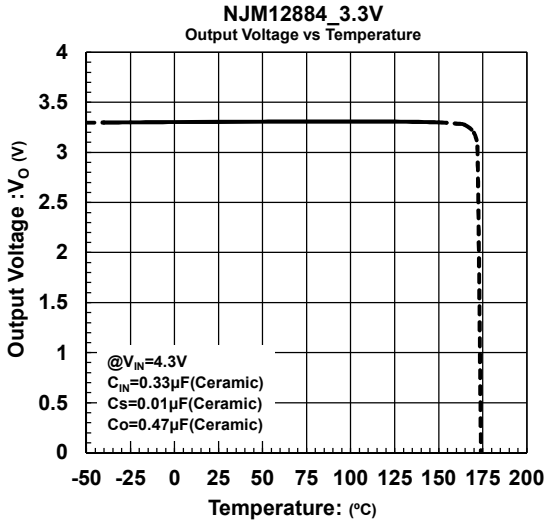
NJM12884_3.3V
Load Regulation vs Temperature



■ TYPICAL CHARACTERISTICS

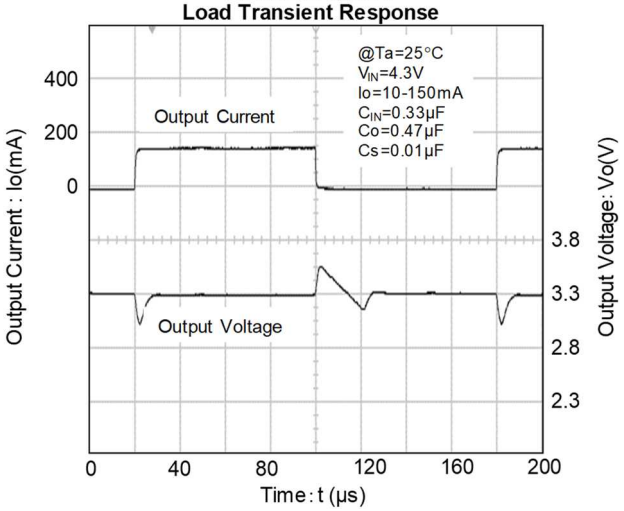




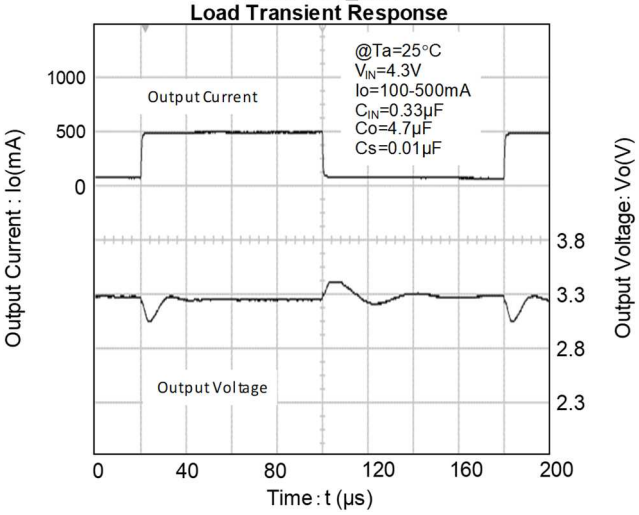


■ TYPICAL CHARACTERISTICS

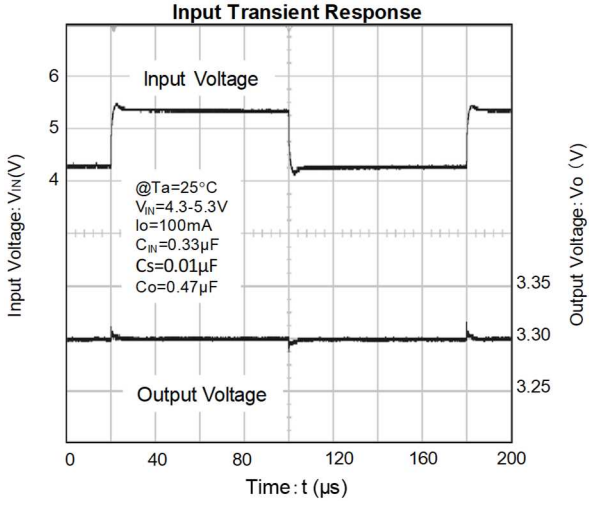
NJM12884_3.3V
Load Transient Response



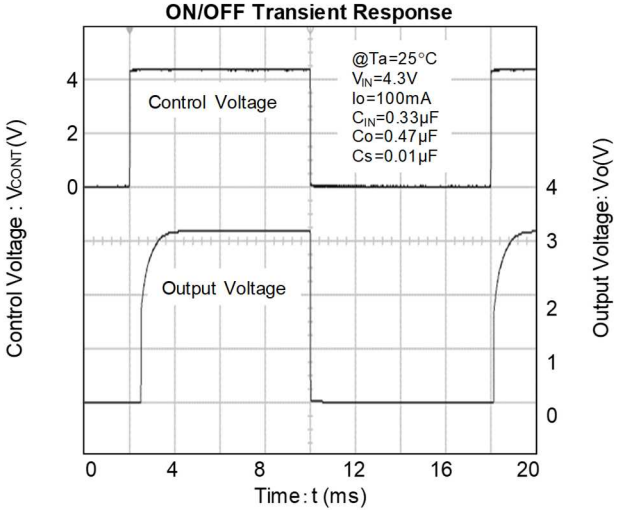
NJM12884_3.3V
Load Transient Response



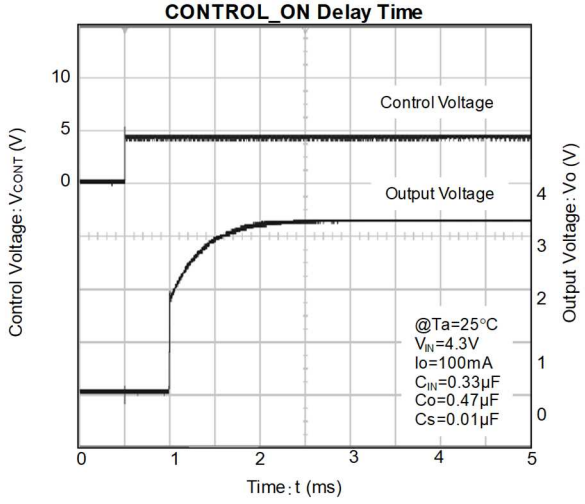
NJM12884_3.3V
Input Transient Response



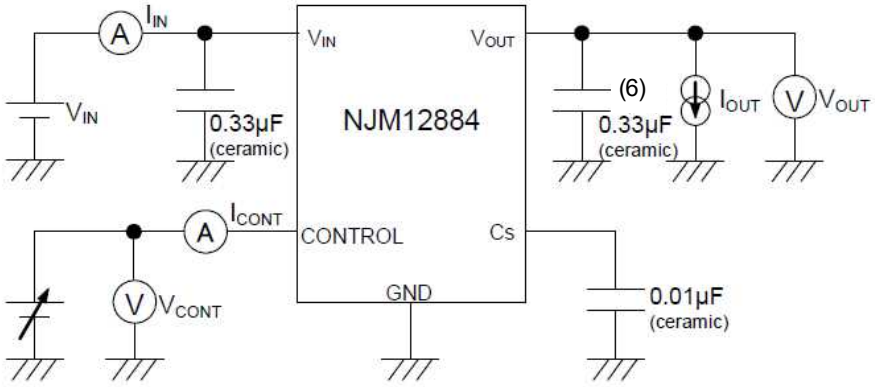
NJM12884_3.3V
ON/OFF Transient Response



NJM12884_3.3V
CONTROL_ON Delay Time



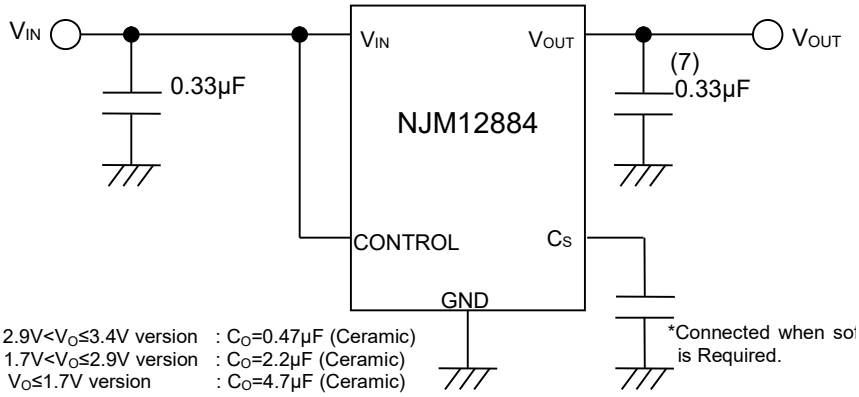
■ TEST CIRCUIT



(6) 2.9V<Vo≤3.4V version :Co=0.47μF(Ceramic)
1.7V<Vo≤2.9V version :Co=2.2μF(Ceramic)
Vo≤1.7V version :Co=4.7μF(Ceramic)

■ TYPICAL APPLICATION

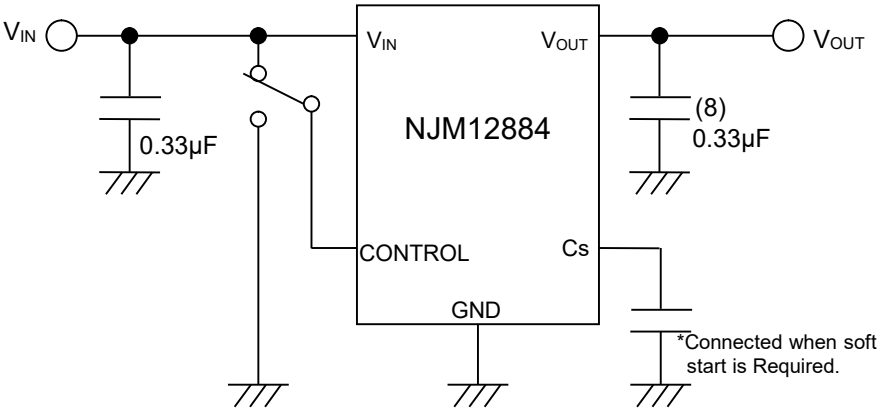
1. In the case where ON/OFF Control is not required



(7) 2.9V<V_O≤3.4V version : C_O=0.47μF (Ceramic)
1.7V<V_O≤2.9V version : C_O=2.2μF (Ceramic)
V_O≤1.7V version : C_O=4.7μF (Ceramic)

Connect CONTROL Pin to V_{IN} Pin

2. In use of ON/OFF CONTROL



(8) 2.9V<V_O≤3.4V version : C_O=0.47μF (Ceramic)
1.7V<V_O≤2.9V version : C_O=2.2μF (Ceramic)
V_O≤1.7V version : C_O=4.7μF (Ceramic)

State of CONTROL Pin:
"H" → output is enabled.
"L" or "open" → output is disabled

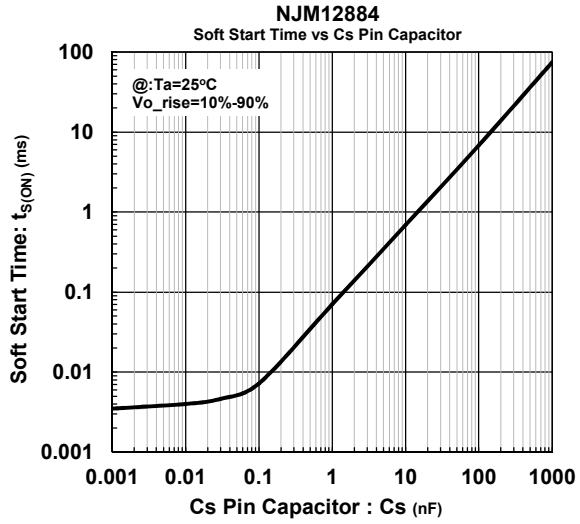
■ APPLICATION NOTE / GLOSSARY

Reverse Current Protection

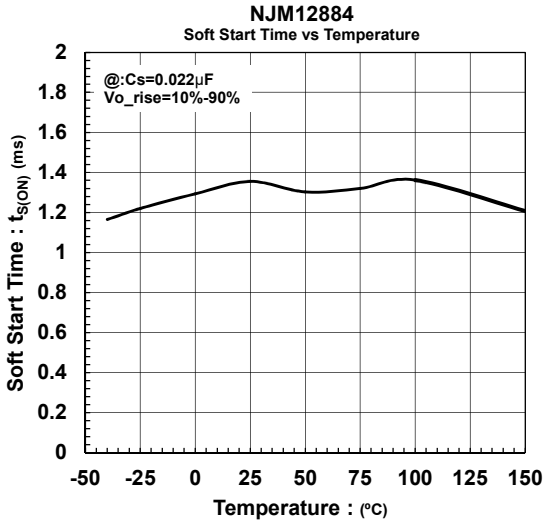
The NJM12884 has built-in Reverse Current Protection circuit.
This circuit prevents the large reverse current when output voltage is higher than input voltage.
Therefore external schottky-barrier diode (SBD) is not required

Soft Start capacitor C_S

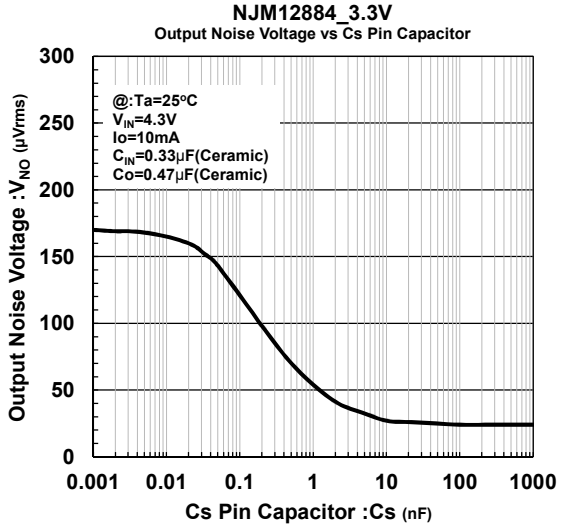
The Soft Start function can control the rise time of Output Voltage and reduce the inrush current by connecting the C_S capacitor.
The Soft Start time is defined as 10% to 90% of the Output Voltage.
The C_S capacitor is not essential, but it used for noise bypass of bandgap reference either. Therefore Output Noise Voltage increases when the capacitor isn't connected.
If the C_S capacitor is not used, the C_S Pin should be OPEN.



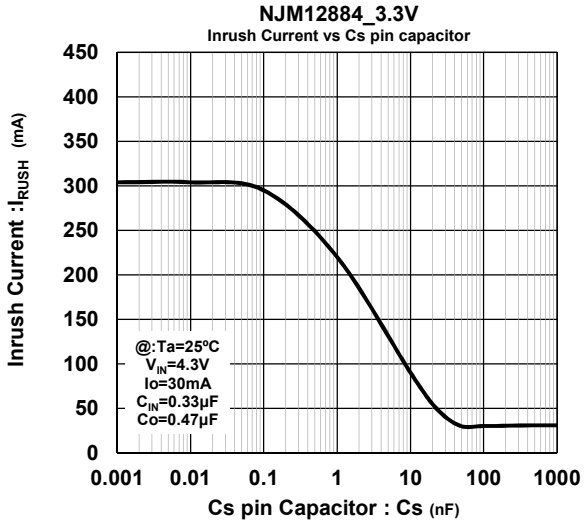
Soft-Start Time vs. C_S Pin Capacitor



Soft-Start Time (0.022µF) vs. Temperature



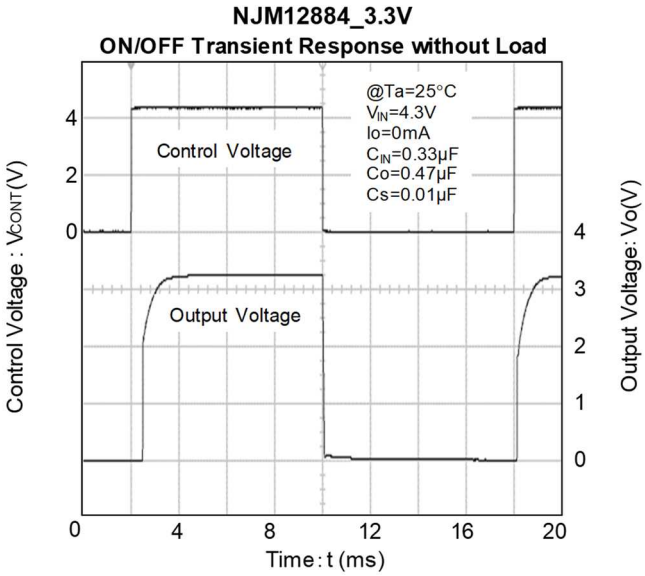
Output Noise Voltage vs. C_S Pin Capacitor



Inrush Current vs. C_S 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.



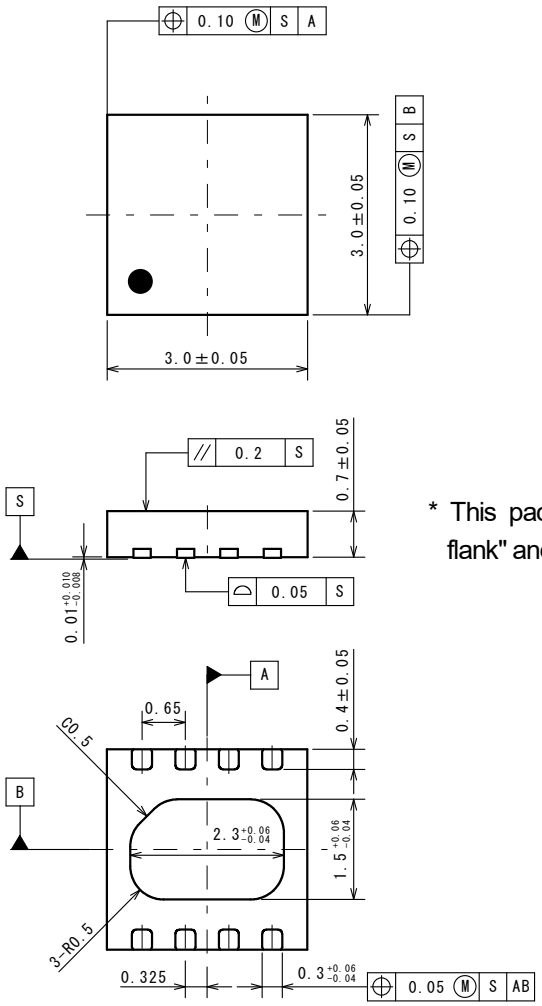
Input Capacitor C_{IN}

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

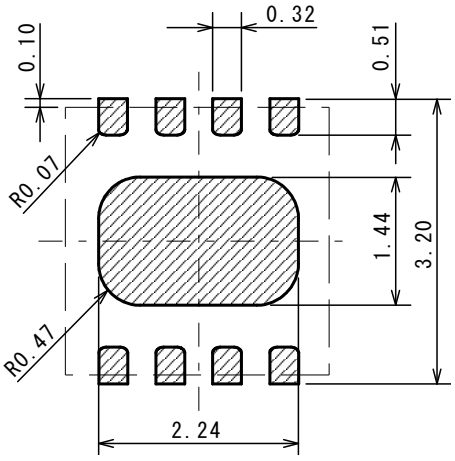
The output capacitor C_O is required for a phase compensation of the internal error amplifier, and the capacitance and the equivalent series resistance (ESR) influence stable operation of the regulator.
If use a smaller output capacitor than the recommended capacitance (refer to conditions of ELECTRIC 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.

■ PACKAGE OUTLINE
DFN8-WA (ESON8-WA)



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

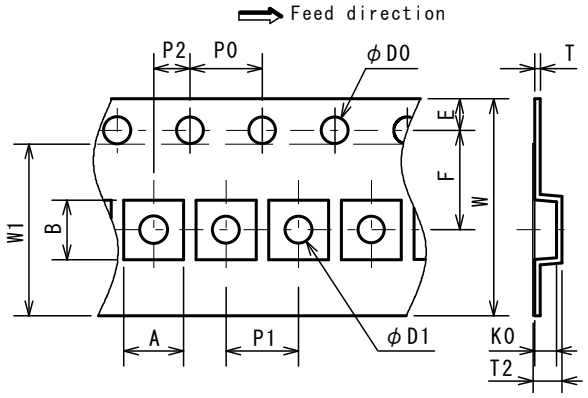
■ SOLDER FOOT PRINT
DFN8-WA (ESON8-WA)



■ PACKING SPEC

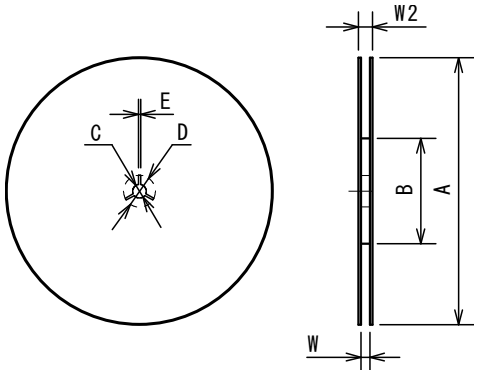
TAPING DIMENSIONS

Unit: mm



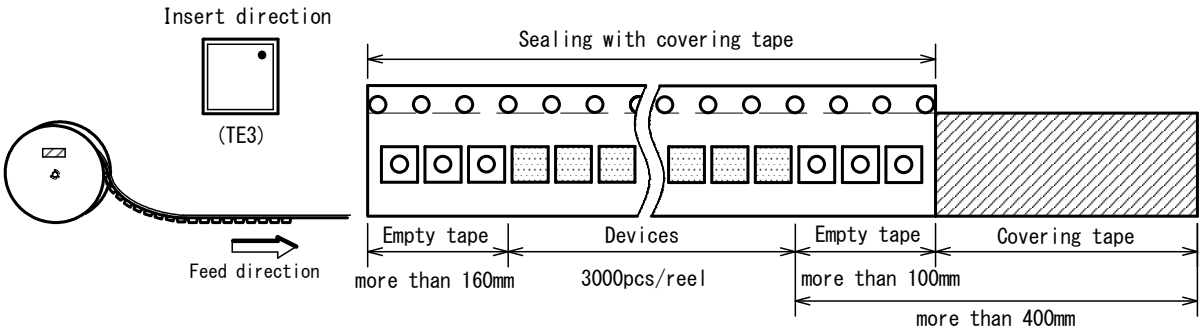
SYMBOL	DIMENSION	REMARKS
A	3.3±0.1	BOTTOM DIMENSION
B	3.3±0.1	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	$1.5^{+0.1}_{0}$	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.30±0.05	
T2	1.26±0.11	
K0	0.9±0.05	
W	$12.0^{+0.3}_{-0.1}$	
W1	9.5	THICKNESS 0.1max

REEL DIMENSIONS

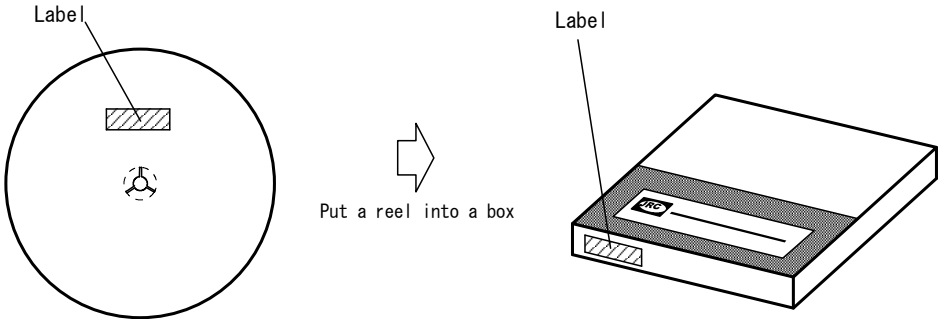


SYMBOL	DIMENSION
A	φ254±2
B	φ100±1
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	13.5±1
W2	17.5±1

TAPING STATE

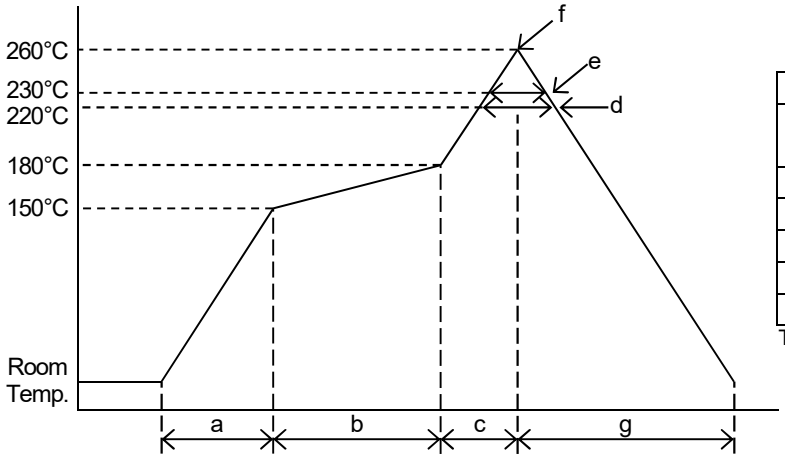


PACKING STATE



■ RECOMMENDED MOUNTING METHOD

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
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 ψjt 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
2.Sep.2021	Ver.2.4	Added (ESON8-WA) to the DFN8-WA package name, STATUS in OUTPUT VOLTAGE RANK, and figure of TEST CIRCUIT. Correction of value of T2 in TAPING DIMENTIONS

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

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