Negative Output Low Drop Out voltage regulator

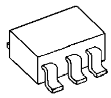
■ GENERAL DESCRIPTION

The NJM2828 is a negative output low dropout regulator. Advanced bipolar technology achieves low noise, high precision voltage and high ripple rejection.

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

1.0µF Output capacitor and small package can make NJM2828 suitable for portable items.

■ PACKAGE OUTLINE

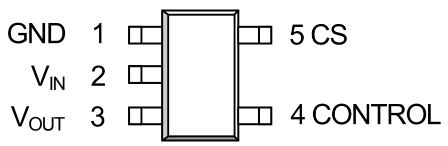


NJM2828F3

■ FEATURES

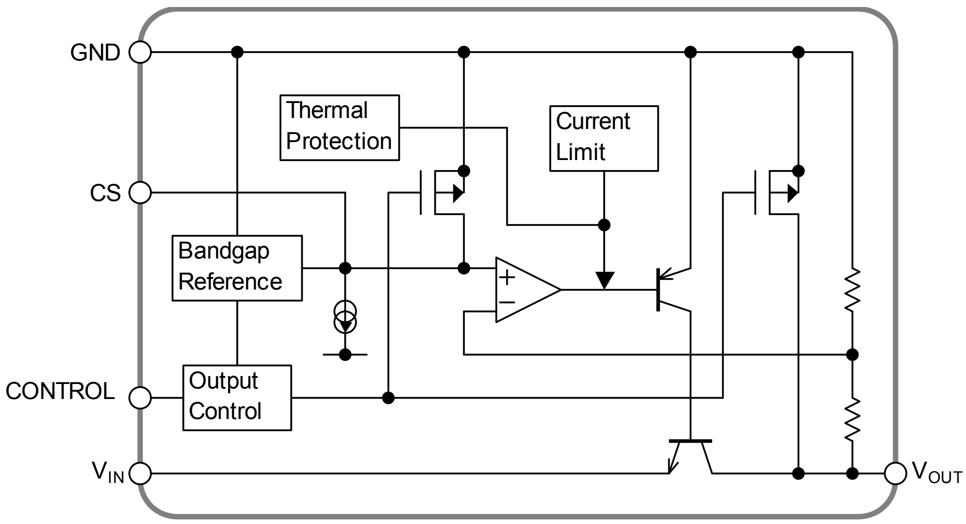
- Low Current Consumption 0.13V (typ.) @Io=60mA
- High Precision Output ±1.5%
- High Ripple Rejection 65dB(typ.) @f=1kHz, Vo=-7V Version
- Correspond to Low ESR capacitor with 1.0F ceramic capacitor.
- Output Current Io(max.)=100mA
- ON/OFF Control(Positive voltage control from 0 to +5V)
- Soft-start Function
- Shunt SW Function
- Thermal Shutdown Circuit
- Over Current Protection
- Bipolar Technology
- Package Outline SC88A

■ PIN CONFIGURATION



NJM2828F3-XX

■ BLOCK DIAGRAM



■ OUTPUT VOLTAGE RANK LIST

Device Name	V_{OUT}	Device Name	V_{OUT}
NJM2828F3-14	-1.4V	NJM2828F3-06	-6.0V
NJM2828F3-15	-1.5V	NJM2828F3-63	-6.3V
NJM2828F3-02	-2.0V	NJM2828F3-65	-6.5V
NJM2828F3-22	-2.2V	NJM2828F3-07	-7.0V
NJM2828F3-03	-3.0V	NJM2828F3-75	-7.5V
NJM2828F3-04	-4.0V	NJM2828F3-08	-8.0V
NJM2828F3-05	-5.0V	NJM2828F3-85	-8.5V
NJM2828F3-51	-5.1V	NJM2828F3-09	-9.0V
NJM2828F3-55	-5.5V	NJM2828F3-10	-10.0V

Output voltage options available : -1.5 ~ -10.0V (0.1V step)

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Input Voltage	V_{IN}	-14	V
Control Voltage	V_{CONT}	+5	V
Power Dissipation	P_D	250(*1)	mW
Operating Temperature	Topr	–40 ~ +85	°C
Storage Temperature	Tstg	–40 ~ +125	°C
Output Sink Current at OFF-state	$I_{SINK(OFF)}$	10	mA

(*1): Mounted on glass epoxy board. (76.2×114.3×1.6mm: based on EIA/JEDEC standard, 2Layers)

■ Operating voltage

V_{IN}=-3.2 ~ -12V (In case of Vo>-3.0V version)

■ ELECTRICAL CHARACTERISTICS

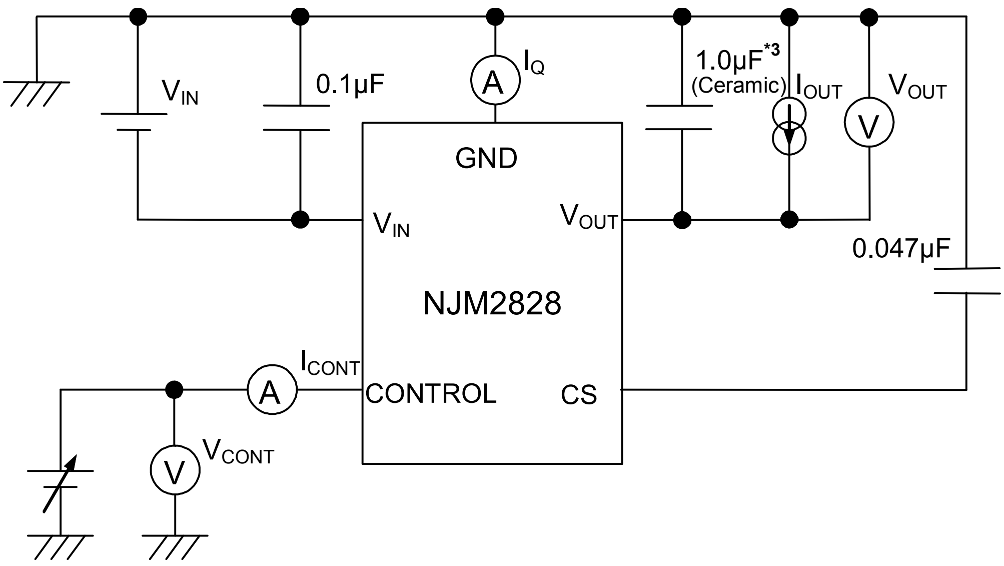
(Vo<-2.2V Version: V_{IN}=Vo-1V, V_{CONT}=3V, C_{IN}=0.1µF, Co=1.0µF, Ta=25°C)
(Vo≥-2.2V Version: V_{IN}=-3.2V, V_{CONT}=3V, C_{IN}=0.1µF, Co=2.2µF(Vo>-2.0V: Co=4.7µF), Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	Vo	Io=30mA	+1.5%	-	-1.5%	V
Quiescent Current	I_Q	Io=0mA, except Icont	-	130	200	µA
Quiescent Current at OFF-state	$I_{Q(OFF)}$	V_{CONT}=0V	-	-	100	nA
Output Current	Io	V_O+0.3V	100	130	-	mA
Line Regulation	$\Delta Vo/\Delta V_{IN}$	V_{IN}=Vo-1V~ -12V, Io=30mA	-	-	0.10	%/V
Load Regulation	ΔVo/ΔIo	Io=0~60mA	-	-	0.03	%/mA
Dropout Voltage(*2)	$\Delta V_{I\ O}$	Io=60mA	-	0.13	0.23	V
Ripple Rejection	RR	ein=200mVrms, f=1kHz, Io=10mA Vo=-7V Version	-	65	-	dB
Average Temperature Coefficient of Output Voltage	ΔVo/ΔTa	Ta=0~85°C, Io=10mA	-	±50	-	ppm/°C
Output Noise Voltage1	V_{NO}	f=10Hz~80kHz, Io=10mA, Vo=-7V Version	-	100	-	µVrms
CS Terminal Charge Current	Ics	V_{CS}=0V	4	5	6	µA
Output Resistance at OFF-state	$R_{O(OFF)}$	V_{CONT}=0V, Vo=-7V Version	-	360	-	Ω
Control Current	I_{CONT}	V_{CONT}=1.6V	-	2	4	µA
Control Voltage for ON-state	$V_{CONT(ON)}$		1.6	-	-	V
Control Voltage for OFF-state	$V_{CONT(OFF)}$		-	-	0.6	V
Input Voltage	V_{IN}		-12	-	-	V

(*2):Excludes Vo>-3.0V version.

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

■ TEST CIRCUIT



*3 -2.2V≤Vo< -2.0V version : Co=2.2µF(Ceramic)
Vo≥-2.0V version : Co=4.7µ F(Ceramic)

■ TYPICAL APPLICATIONS

∗ON/OFF control

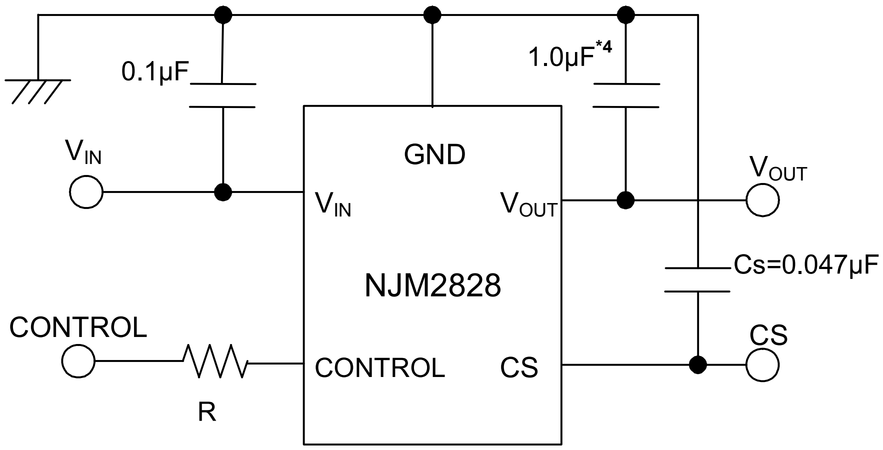
ON/OFF control can be controlled by positive logic voltage.

When V_{CONT} is “H”, the output becomes ON state, If V_{CONT} is "L" or open (High Z), the output becomes OFF state.

The relations between V_{CONT} and the state is as follows:

V_{CONT} +1.6V ≤ V_{CONT} ≤ +5V ("H" level):	ON state
V_{CONT} 0V ≤ V_{CONT} ≤ +0.6V ("L" level):	OFF state
V_{CONT} +0.6V < V_{CONT} < +1.6V ("L" level):	Undefined

If ON/OFF control is not used, keep applying positive V_{CONT} to CONTROL pin to make the output constantly ON.
Negative voltage should not use for V_{CONT} .



*4 -2.2V≤Vo< -2.0V version : Co=2.2µF
Vo≥-2.0V version : Co=4.7µ F

*In the case of using a resistor "R" to control line.

If need to reduce the control current when the control voltage, insert a resistor to control pin.

When insert the resistor “R”, should consider voltage drop by the resistor. Therefore the control voltage should set in order to satisfy minimum $V_{CONT(ON)}$ with considering voltage drop.

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

*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.

*Soft-start function

The capacitor Cs, that is connected between CS pin and GND, controls the following:

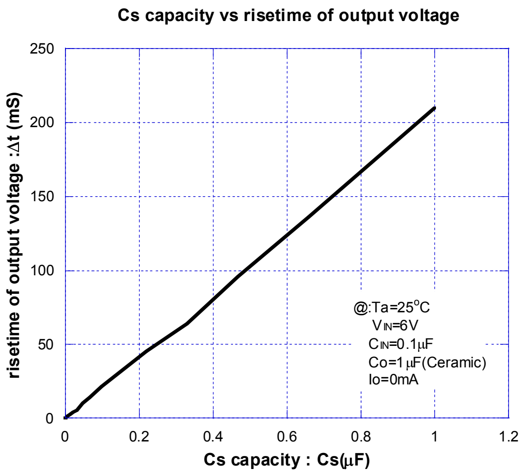
- The rising time of output voltage.
- The inrush current at start-up.

When the soft start function is not used, CS pin should be open.

1. Cs capacitance vs rise time of output voltage

   The rise time of output voltage is calculated as follows:

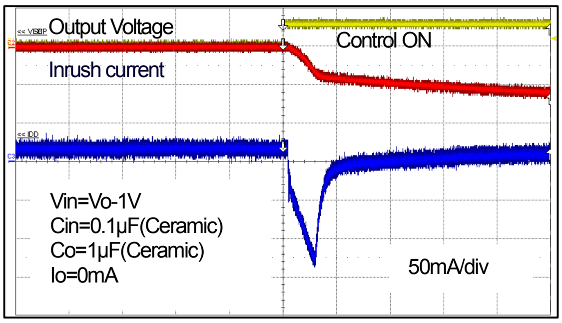
$$\Delta t\,(ms) \cong 213 \times Cs(\mu F)$$



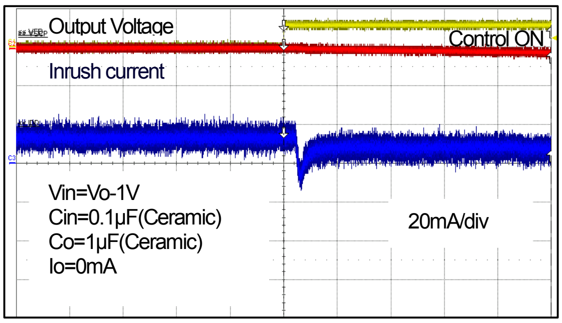
2. Inrush current at start-up

   The peak value of the inrush current can be limited according to the capacitance of the Cs.

Inrush current wave :



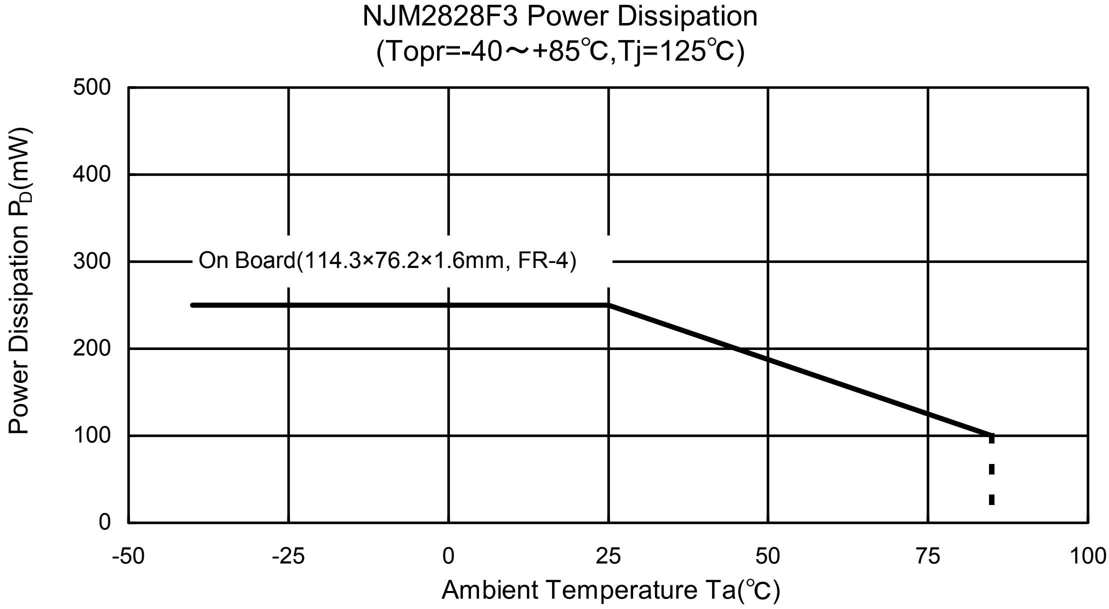
Peak current: 150mA at CS=0μF



Peak current: 20mA at CS=0.0047μF

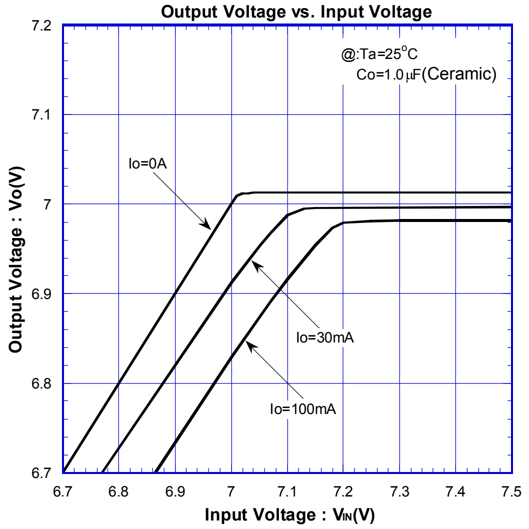
* This characteristic is one example. It is necessary to examine the characteristic with an actual circuit because there is an influence by the characteristic such as output voltage/output capacitor.

■ POWER DISSIPATION vs. AMBIENT TEMPERATURE

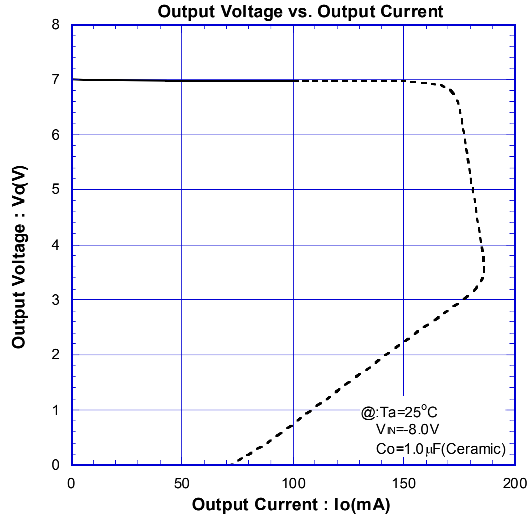


■ ELECTRICAL CHARACTERISTICS

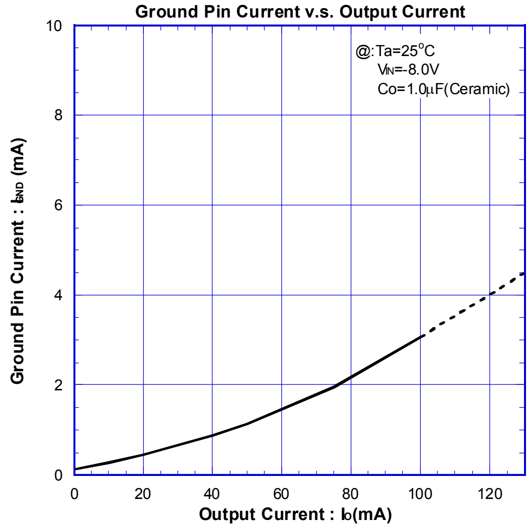
NJM2828/-7.0V
Output Voltage vs. Input Voltage



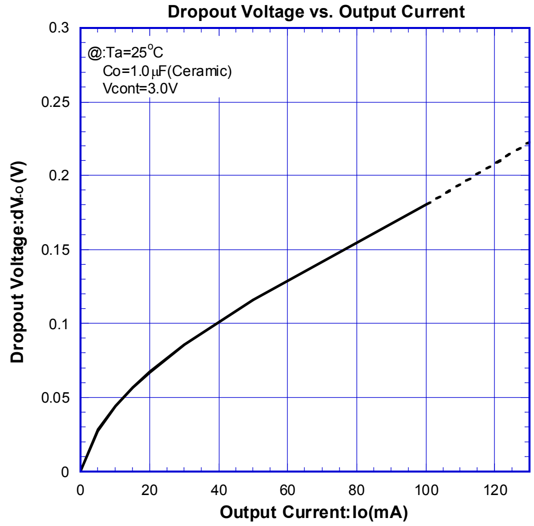
NJM2828/-7.0V
Output Voltage vs. Output Current



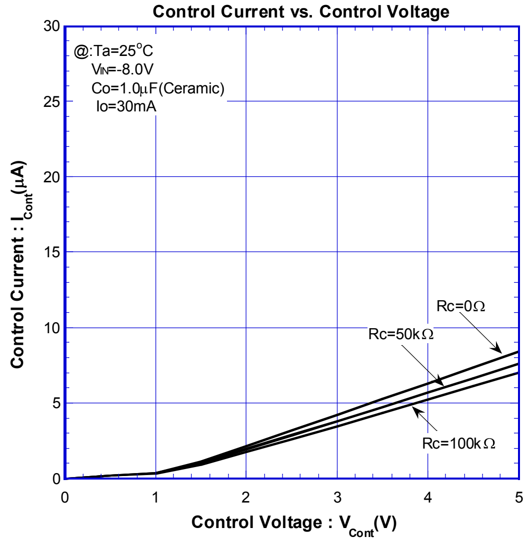
NJM2828/-7.0V
Ground Pin Current v.s. Output Current



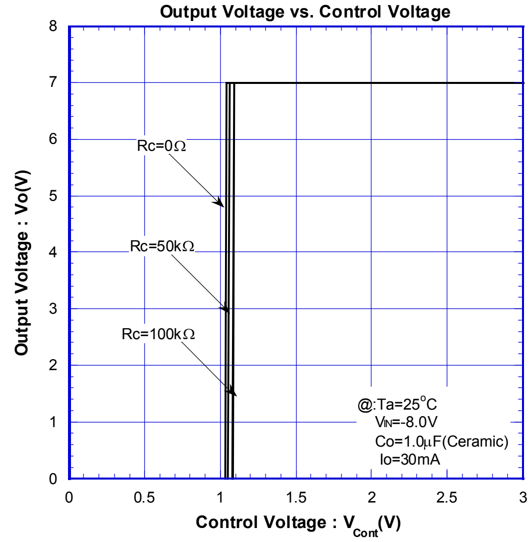
NJM2828/-7.0V
Dropout Voltage vs. Output Current



NJM2828/-7.0V
Control Current vs. Control Voltage



NJM2828/-7.0V
Output Voltage vs. Control Voltage



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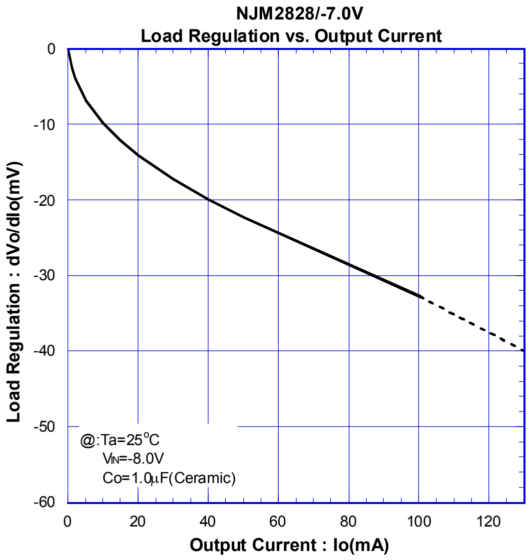

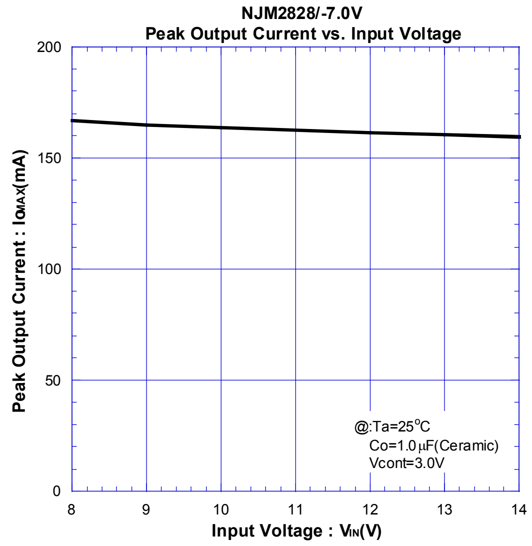

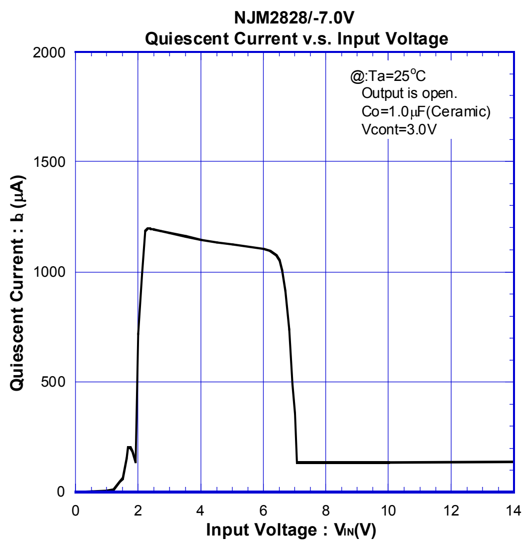

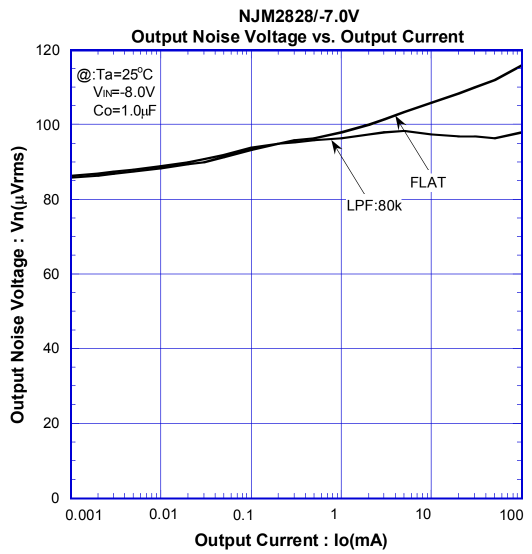

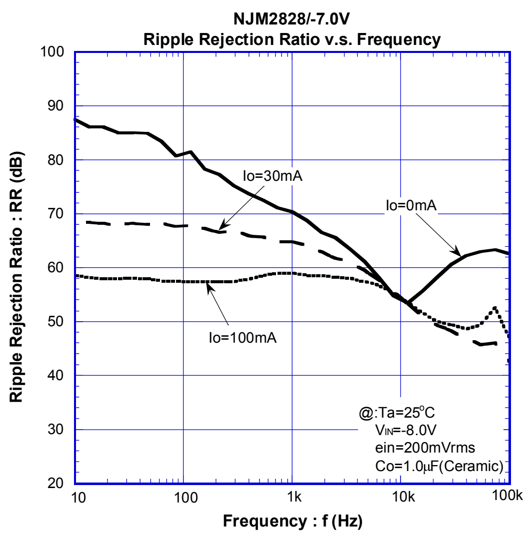

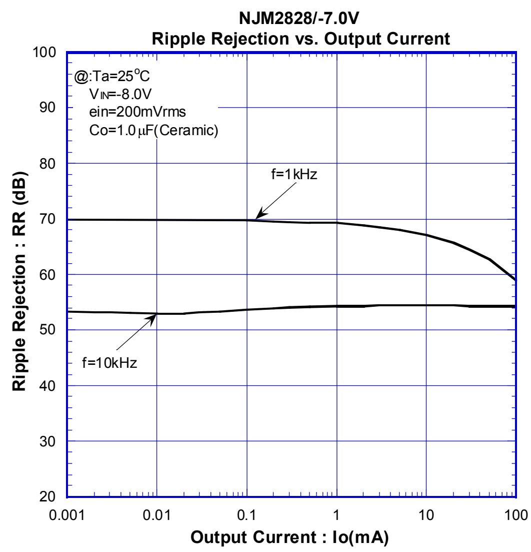

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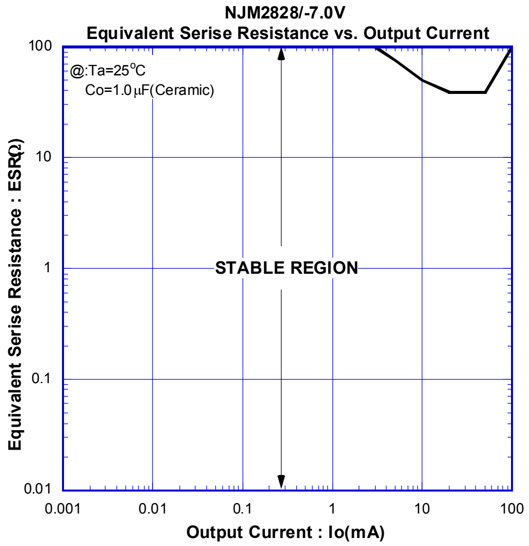

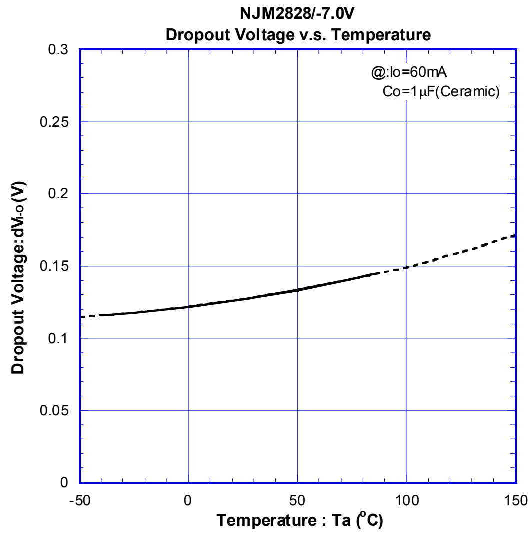

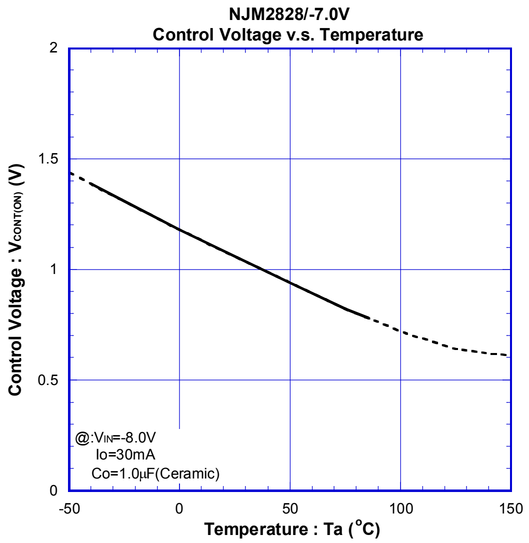

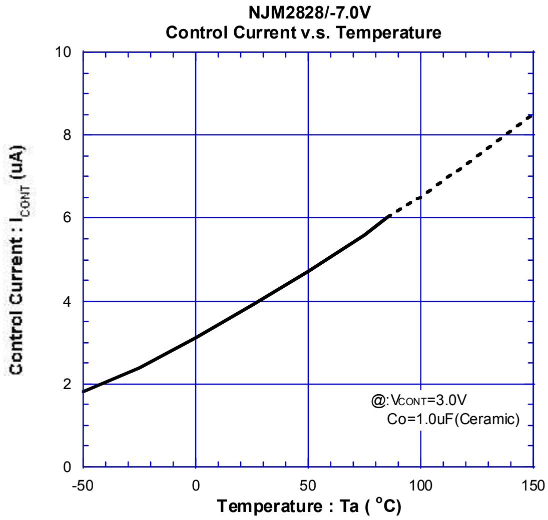

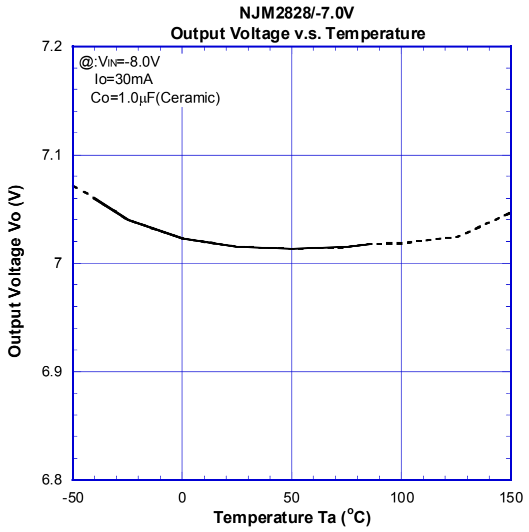

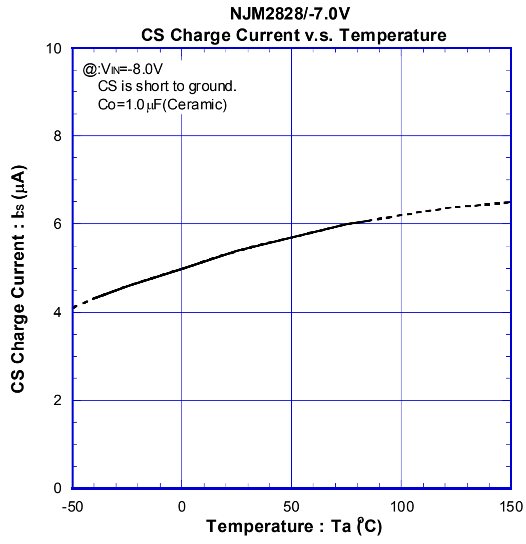

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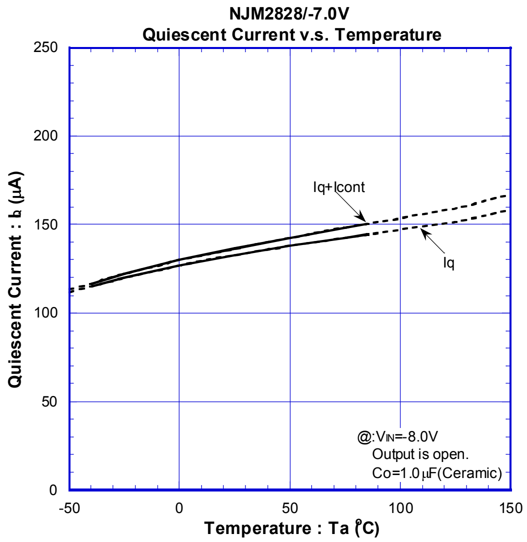

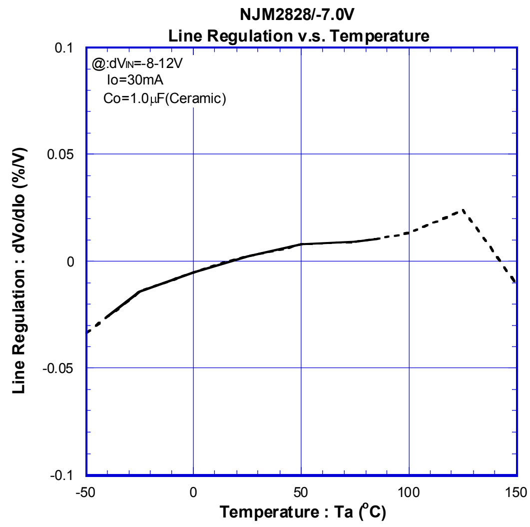

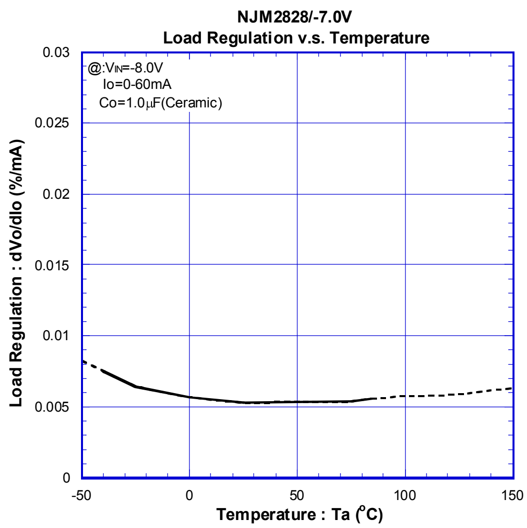

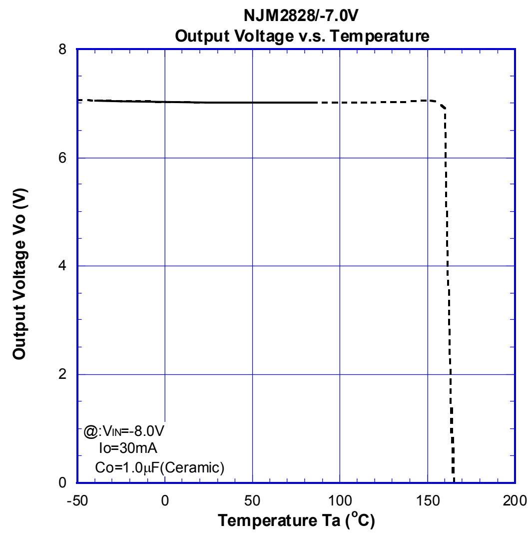

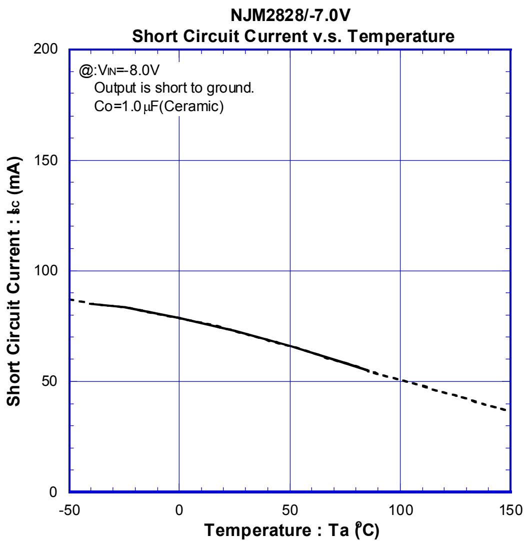

■ ELECTRICAL CHARACTERISTICS