3-TERMINAL POSITIVE VOLTAGE REGULATOR

■ GENERAL DESCRIPTION

The **NJM78L00** series of 3-Terminal Positive Voltage egulators are constructed using the New JRC Planar epitaxial process.

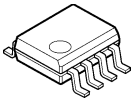
These regulators employ internal current limiting and thermal shut down, making them essentially indestructible. If adequate heat sinking is provided, they can deliver up to 100mA output current. They are intended as fixed voltage regulators in a wide range of applications including local or on-card regulation for elimination of noise and distribution problems associated with single-point regulation. In addition, they can be used with power pass elements to make high-current voltage regulators.

The **NJM78L00** series used as a Zener diode/resistor combination replacement, offers an effective output impedance improvement of typically two orders of magnitude, along with lower quiescent current and lower noise.

■ PACKAGE OUTLINE



NJM78L00UA
(SOT-89)

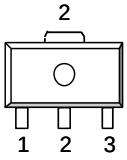


NJM78L00EA
(SOP8)
(5V, ~~9V~~, 12V Version Only)

■ FEATURES

- Internal Short Circuit Current Limit
- Internal Thermal Overload Protection
- Excellent Ripple Rejection
- Guaranteed 100mA Output Current
- Package Outline SOT-89, SOP8 JEDEC 150mil
- Bipolar Technology

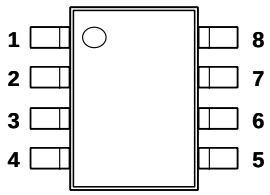
■ PIN CONFIGURATION



PIN CONFIGURATION

1. OUT
2. GND
3. IN

NJM78L00UA

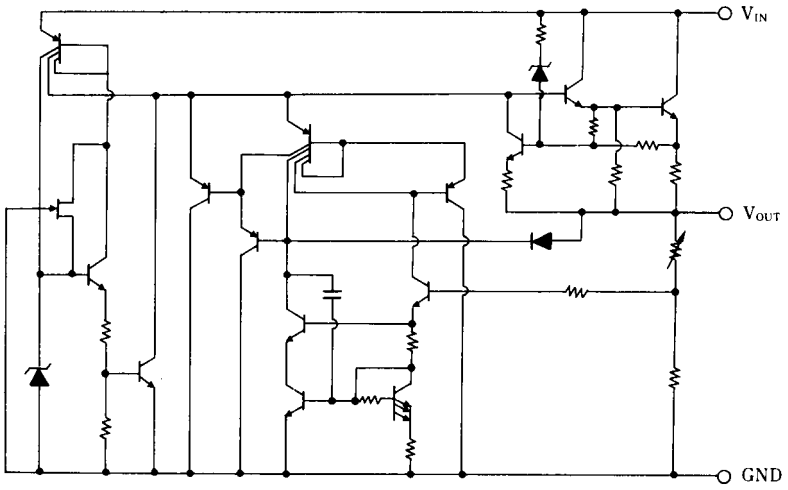


PIN CONFIGURATION

1. OUT
2. GND
3. GND
4. NC
5. NC
6. GND
7. GND
8. IN

NJM78L00EA

■ EQUIVALENT CIRCUIT



■ ABSOLUTE MAXIMUM RATINGS

(T_a=25°C)

PARAMETER	SYMBOL	MAXIMUM RATINGS	UNIT
Input Voltage	V_{IN}	(78L02A to 78L09A) 30 (78L10A to 78L15A) 35 (78L18A to 78L24A) 40	V
Power Dissipation	P_D	(SOT-89) 350 (SOP8) 700(*1)	mW
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-40 to +150	°C

(*1) Mounted on glass epoxy board

■ ELECTRICAL CHARACTERISTICS

(C_{IN}=0.33μF, C_O=0.1μF, T_j=25°C) Measurement is to be conducted is pulse testing.

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NJM78L02UA						
Output Voltage	V_O	V_{IN}=9V, I_O=40mA	2.47	2.6	2.73	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=4.75V to 20V, I_O=40mA	-	-	125	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=5V to 20V, I_O=40mA	-	-	100	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=9V, I_O=1 to 40mA	-	-	25	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=9V, I_O=1 to 100mA	-	-	50	mV
Quiescent Current	I_Q	V_{IN}=9V, I_O=0mA	-	2.0	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=9V, I_O=1mA	-	0.2	-	mV/°C
Ripple Rejection	RR	6V< V_{IN} <16V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	43	73	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=9V, BW=10Hz to 100kHz, I_O=40mA	-	35	-	μV
NJM78L03UA						
Output Voltage	V_O	V_{IN}=9V, I_O=40mA	2.85	3.0	3.15	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=5V to 20V, I_O=40mA	-	-	125	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=6V to 20V, I_O=40mA	-	-	100	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=9V, I_O=1 to 40mA	-	-	25	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=9V, I_O=1 to 100mA	-	-	50	mV
Quiescent Current	I_Q	V_{IN}=9V, I_O=0mA	-	2.0	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=9V, I_O=1mA	-	0.2	-	mV/°C
Ripple Rejection	RR	6V< V_{IN} <16V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	43	72	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=9V, BW=10Hz to 100kHz, I_O=40mA	-	40	-	μV
NJM78L05UA/EA						
Output Voltage	V_O	V_{IN}=10V, I_O=40mA	4.75	5.0	5.25	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=7V to 20V, I_O=40mA	-	-	200	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=8V to 20V, I_O=40mA	-	-	150	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=10V, I_O=1 to 40mA	-	-	30	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=10V, I_O=1 to 100mA	-	-	60	mV
Quiescent Current	I_Q	V_{IN}=10V, I_O=0mA	-	2.0	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=10V, I_O=1mA	-	0.4	-	mV/°C
Ripple Rejection	RR	8V< V_{IN} <18V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	40	69	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=10V, BW=10Hz to 100kHz, I_O=40mA	-	70	-	μV

■ ELECTRICAL CHARACTERISTICS

(C_{IN}=0.33μF, C_O=0.1μF, T_j=25°C) Measurement is to be conducted is pulse testing.

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NJM78L06UA						
Output Voltage	V_O	V_{IN}=12V, I_O=40mA	5.7	6.0	6.3	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=8.5V to 20V, I_O=40mA	-	-	200	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=9V to 20V, I_O=40mA	-	-	150	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=12V, I_O=1 to 40mA	-	-	40	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=12V, I_O=1 to 100mA	-	-	80	mV
Quiescent Current	I_Q	V_{IN}=12V, I_O=0mA	-	2.0	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=12V, I_O=1mA	-	0.5	-	mV/°C
Ripple Rejection	RR	9V< V_{IN} <20V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	40	67	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=12V, BW=10Hz to 100kHz, I_O=40mA	-	80	-	μV
NJM78L07UA						
Output Voltage	V_O	V_{IN}=13V, I_O=40mA	6.65	7.0	7.35	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=9.5V to 22V, I_O=40mA	-	-	210	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=10V to 22V, I_O=40mA	-	-	160	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=13V, I_O=1 to 40mA	-	-	45	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=13V, I_O=1 to 100mA	-	-	90	mV
Quiescent Current	I_Q	V_{IN}=13V, I_O=0mA	-	2.1	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=13V, I_O=1mA	-	0.55	-	mV/°C
Ripple Rejection	RR	10V< V_{IN} <20V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	39	66	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=13V, BW=10Hz to 100kHz, I_O=40mA	-	100	-	μV
NJM78L08UA						
Output Voltage	V_O	V_{IN}=14V, I_O=40mA	7.6	8.0	8.4	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=10.5V to 23V, I_O=40mA	-	-	225	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=11V to 23V, I_O=40mA	-	-	175	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=14V, I_O=1 to 40mA	-	-	50	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=14V, I_O=1 to 100mA	-	-	100	mV
Quiescent Current	I_Q	V_{IN}=14V, I_O=0mA	-	2.1	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=14V, I_O=1mA	-	0.6	-	mV/°C
Ripple Rejection	RR	11V< V_{IN} <20V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	39	66	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=14V, BW=10Hz to 100kHz, I_O=40mA	-	115	-	μV

■ ELECTRICAL CHARACTERISTICS

(C_{IN}=0.33μF, C_O=0.1μF, T_j=25°C) Measurement is to be conducted is pulse testing.

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NJM78L09UA/EA						
Output Voltage	V_O	V_{IN}=15V, I_O=40mA	8.55	9.0	9.45	V
Line Regulation 1	ΔV_O-$V_{IN}1$	V_{IN}=11.5V to 23V, I_O=40mA	-	-	250	mV
Line Regulation 2	ΔV_O-$V_{IN}2$	V_{IN}=12V to 23V, I_O=40mA	-	-	200	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=15V, I_O=1 to 40mA	-	-	50	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=15V, I_O=1 to 100mA	-	-	100	mV
Quiescent Current	I_Q	V_{IN}=15V, I_O=0mA	-	2.1	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=15V, I_O=1mA	-	0.65	-	mV/°C
Ripple Rejection	RR	12V< V_{IN} <21V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	38	65	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=15V, BW=10Hz to 100kHz, I_O=40mA	-	125	-	μV
NJM78L10UA						
Output Voltage	V_O	V_{IN}=16V, I_O=40mA	9.5	10.0	10.5	V
Line Regulation 1	ΔV_O-$V_{IN}1$	V_{IN}=13V to 25V, I_O=40mA	-	-	250	mV
Line Regulation 2	ΔV_O-$V_{IN}2$	V_{IN}=14V to 25V, I_O=40mA	-	-	200	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=16V, I_O=1 to 40mA	-	-	50	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=16V, I_O=1 to 100mA	-	-	100	mV
Quiescent Current	I_Q	V_{IN}=16V, I_O=0mA	-	2.1	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=16V, I_O=1mA	-	0.7	-	mV/°C
Ripple Rejection	RR	13V< V_{IN} <22V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	37	64	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=16V, BW=10Hz to 100kHz, I_O=40mA	-	135	-	μV
NJM78L12UA/EA						
Output Voltage	V_O	V_{IN}=19V, I_O=40mA	11.4	12.0	12.6	V
Line Regulation 1	ΔV_O-$V_{IN}1$	V_{IN}=14.5V to 27V, I_O=40mA	-	-	250	mV
Line Regulation 2	ΔV_O-$V_{IN}2$	V_{IN}=16V to 27V, I_O=40mA	-	-	200	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=19V, I_O=1 to 40mA	-	-	50	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=19V, I_O=1 to 100mA	-	-	100	mV
Quiescent Current	I_Q	V_{IN}=19V, I_O=0mA	-	2.1	6.5	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=19V, I_O=1mA	-	0.9	-	mV/°C
Ripple Rejection	RR	15V< V_{IN} <25V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	37	62	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=19V, BW=10Hz to 100kHz, I_O=40mA	-	160	-	μV
NJM78L15UA						
Output Voltage	V_O	V_{IN}=23V, I_O=40mA	14.3	15.0	15.7	V
Line Regulation 1	ΔV_O-$V_{IN}1$	V_{IN}=17.5V to 30V, I_O=40mA	-	-	300	mV
Line Regulation 2	ΔV_O-$V_{IN}2$	V_{IN}=20V to 30V, I_O=40mA	-	-	250	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=23V, I_O=1 to 40mA	-	-	75	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=23V, I_O=1 to 100mA	-	-	150	mV
Quiescent Current	I_Q	V_{IN}=23V, I_O=0mA	-	2.2	6.5	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=23V, I_O=1mA	-	1.0	-	mV/°C
Ripple Rejection	RR	18.5V< V_{IN} <28.5V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	34	60	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=23V, BW=10Hz to 100kHz, I_O=40mA	-	190	-	μV

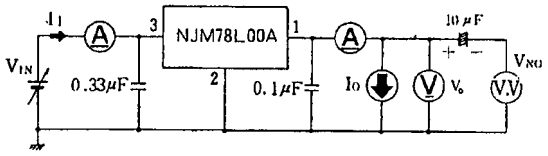
■ ELECTRICAL CHARACTERISTICS

(C_{IN}=0.33μF, C_O=0.1μF, T_j=25°C) Measurement is to be conducted is pulse testing.

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NJM78L18UA						
Output Voltage	V_O	V_{IN}=27V, I_O=40mA	17.1	18.0	18.9	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=22V to 33V, I_O=40mA	-	-	320	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=22V to 33V, I_O=40mA	-	-	270	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=27V, I_O=1 to 40mA	-	-	80	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=27V, I_O=1 to 100mA	-	-	160	mV
Quiescent Current	I_Q	V_{IN}=27V, I_O=0mA	-	2.2	6.5	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=27V, I_O=1mA	-	1.1	-	mV/°C
Ripple Rejection	RR	23V< V_{IN} <33V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	33	59	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=27V, BW=10Hz to 100kHz, I_O=40mA	-	230	-	μV
NJM78L20UA						
Output Voltage	V_O	V_{IN}=29V, I_O=40mA	19.0	20.0	21.0	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=23V to 34V, I_O=40mA	-	-	330	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=24V to 34V, I_O=40mA	-	-	280	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=29V, I_O=1 to 40mA	-	-	90	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=29V, I_O=1 to 100mA	-	-	180	mV
Quiescent Current	I_Q	V_{IN}=29V, I_O=0mA	-	2.3	7	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=29V, I_O=1mA	-	1.2	-	mV/°C
Ripple Rejection	RR	24V< V_{IN} <34V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	32	58	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=29V, BW=10Hz to 100kHz, I_O=40mA	-	250	-	μV
NJM78L24UA						
Output Voltage	V_O	V_{IN}=33V, I_O=40mA	22.8	24	25.2	V
Line Regulation 1	ΔV_O-V_{IN}1	V_{IN}=27V to 38V, I_O=40mA	-	-	350	mV
Line Regulation 2	ΔV_O-V_{IN}2	V_{IN}=28V to 38V, I_O=40mA	-	-	300	mV
Load Regulation 1	ΔV_O-I_O1	V_{IN}=33V, I_O=1 to 40mA	-	-	100	mV
Load Regulation 2	ΔV_O-I_O2	V_{IN}=33V, I_O=1 to 100mA	-	-	200	mV
Quiescent Current	I_Q	V_{IN}=33V, I_O=0mA	-	2.3	7	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=33V, I_O=1mA	-	1.4	-	mV/°C
Ripple Rejection	RR	27.5V< V_{IN} <37.5V, I_O=40mA, e_{in}=1V_{P-P}, f=120Hz	32	57	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=33V, BW=10Hz to 100kHz, I_O=40mA	-	280	-	μV

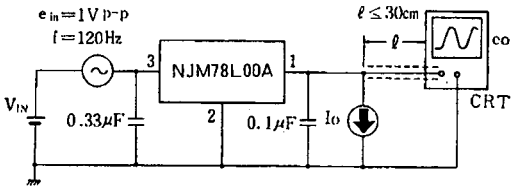
■ TEST CIRCUIT

1. Output Voltage Line Regulation, Load Regulation, Quiescent Current, Average Temperature Coefficient of Output Voltage, Output Noise Voltage, Peak Output/Short-Circuit Current



○ Measurement is to be conducted in pulse testing.
○ $I_Q = I_I - I_O$

2. Ripple Rejection

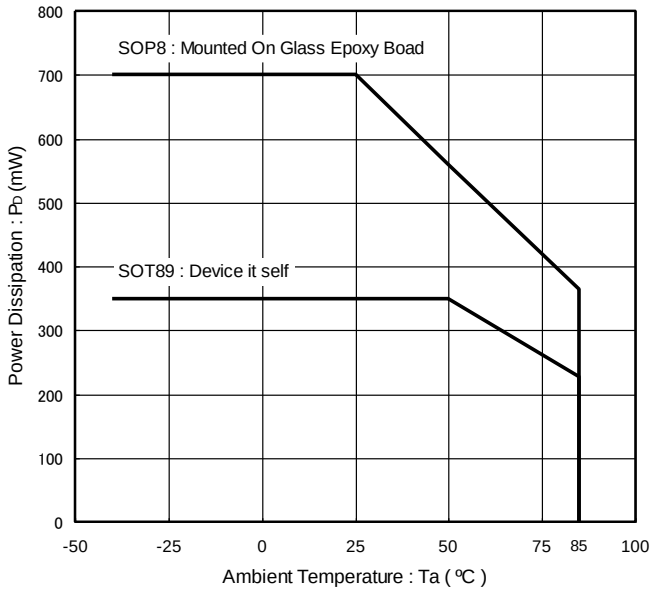


$$RR = 20\log_{10}\left(\frac{e_{in}}{e_O}\right) \quad (dB)$$

■ AMBIENT TEMPERATURE VS.POWER DISSIPATION

Power Dissipation vs. Ambient Temperature

(Topr = - 40ºC ~ + 85ºC, Tj = ~ +150ºC)



■ 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.

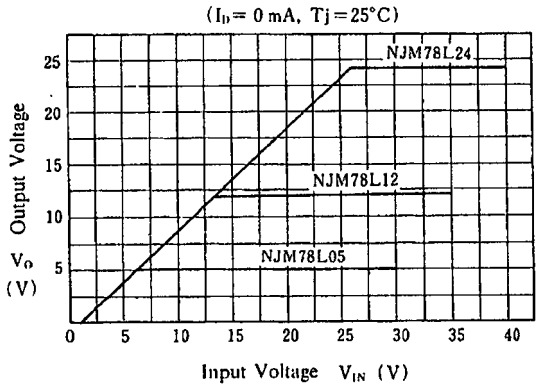
Therefore, use the recommended C_O value (refer to conditions of ELECTRIC CHARACTERISTIC) or larger and should connect between GND and V_{OUT} as shortest path as possible for stable operation

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.

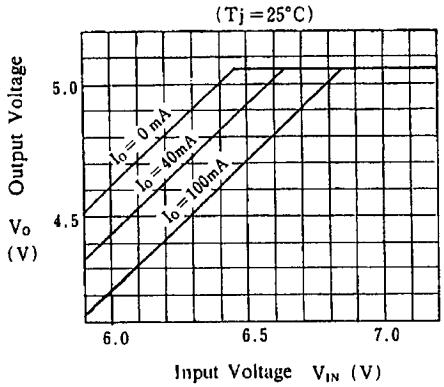
When selecting C_O, recommend that have withstand voltage margin against output voltage and superior temperature characteristic though this product is designed stability works with wide range ESR of capacitor including low ESR products.

■ TYPICAL CHARACTERISTICS

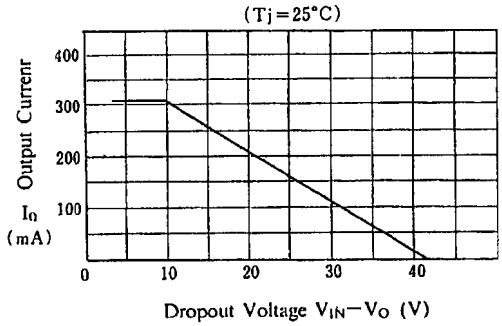
NJM78L05 / L12 / L24 Output Characteristics



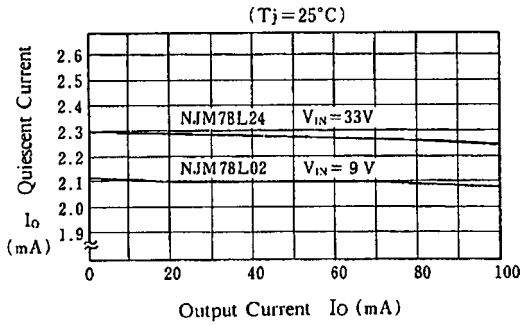
NJM78L05 Dropout Characteristics



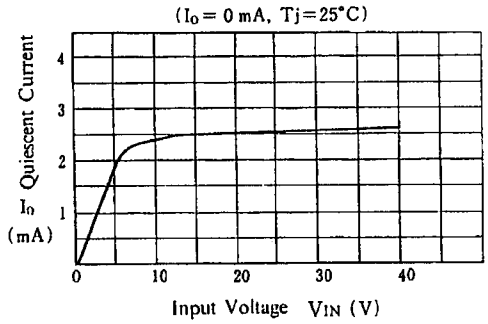
NJM78L00 Series Short Circuit Output Current



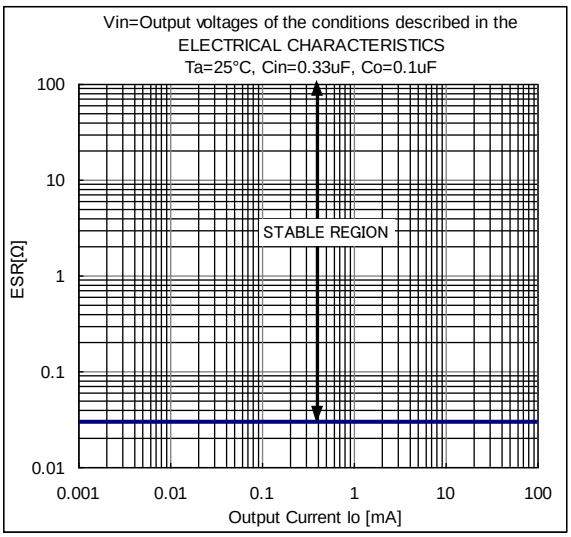
NJM78L02 / L24 Quiescent Current vs. Output Current



NJM78L05 Quiescent Current vs. Input Voltage

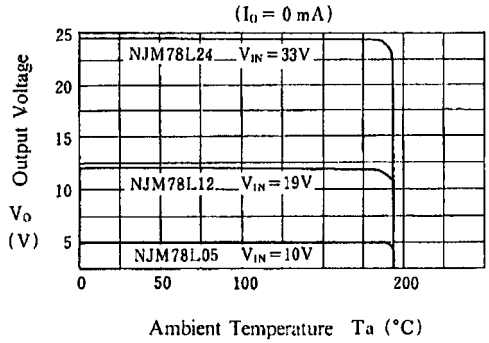


NJM78L00 Equivalent Series Resistance vs. Output Current

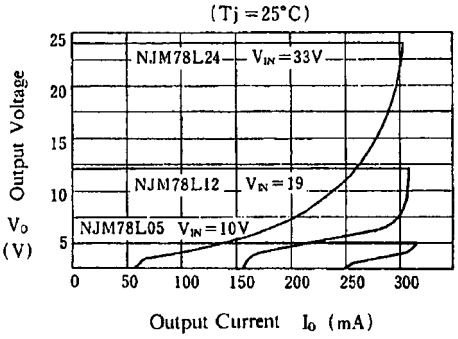


■ TYPICAL CHARACTERISTICS

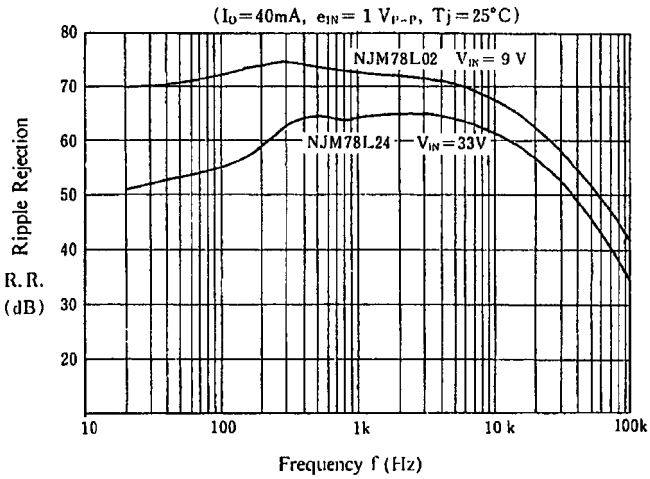
NJM78L05 / L12 / L24 Thermal Shutdown Characteristics



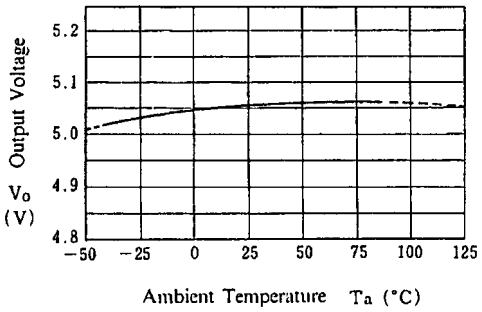
NJM78L05 / L12 / L24 Load Characteristics



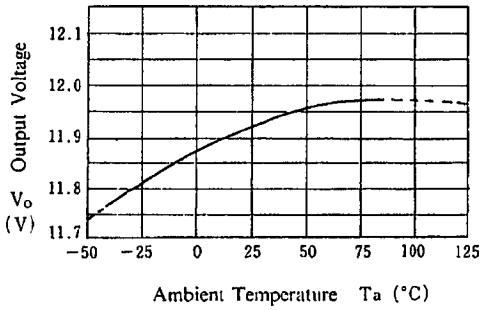
NJM78L02 / L24 Ripple Rejection



NJM78L05 Output Voltage vs. Temperature



NJM78L12 Output Voltage vs. Temperature



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