3-TERMINAL POSITIVE VOLTAGE REGULATOR

■ GENERAL DESCRIPTION

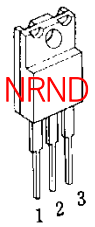
The NJM78M00 series of 3-Terminal Positive Voltage Regulators is constructed using the New JRC Planar epitaxial process. These regulators employ internal current-limiting, thermal-shutdown and safe-area compensation making them essentially indestructible. If adequate heat sinking is provided, they can deliver in excess of 500mA output current. They are intended as fixed voltage regulation 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 to use as fixed voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents.

■ FEATURES

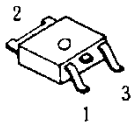
- Internal Short Circuit Current Limit
- Internal Thermal Overload Protection
- Excellent Ripple Rejection
- Guaranteed 500mA Output Current
- Package Outline TO-220F, TO-252
- Bipolar Technology

■ PACAGE OUTLINE

(TO-220F)



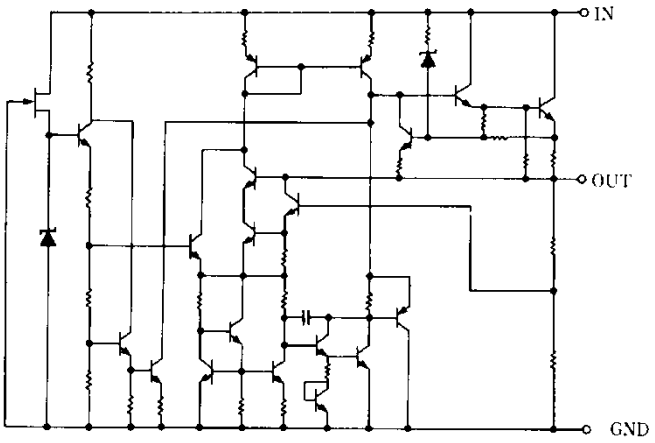
(TO 252)



NJM78M00FA	NJM78M00DL1A
1. IN	1. IN
2. GND	2. GND
3. OUT	3. OUT

(note) The radiation fin is connected pin2.

■ EQUIVALENT CIRCUIT



■ABSOLUTE MAXIMUM RATINGS (Ta=25ºC)

PARAMETER	SYMBOL	MAXIMUM RATINGS		UNIT
Input Voltage	V_{IN}	78M05 to 78M09 78M12 to 78M15 78M18 to 78M24	35 35 40	V
Storage Temperature Range	T_{stg}	-40 to +150		ºC
Operating Temperature Range	Operating Junction Temperature Operating Junction Temperature	T_j T_{opr}	-40 to +150 -40 to +85	ºC
Power Dissipation	P_D	TO-220F 7.5(T_C≤85ºC) (*1) TO-252 7.5(T_C≤56ºC) (*1)		W

(*1) Infinite Heat Sink

THERMAL CHARACTERISTICS

Package	Measurement Result		Unit
	Thermal Resistance (θja)	Thermal Characterization Parameter (ψjt)	
TO-252	141 *1 / 35 *2	32 *1 / 10 *2	°C/W

θja: Junction-to-Ambient Thermal Resistance, ψjt: Junction-to-Top Thermal Characterization Parameter

*1 2-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 2-layer FR-4), Cu area: 100 mm^2

*2 4-Layer: Mounted on glass epoxy board (76.2 mm × 114.3 mm × 1.6 mm: based on EIA/JEDEC standard, 4-layer FR-4).
(For 4-layer: Applying 74.2 mm × 74.2 mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5.)

■ELECTRICAL CHARACTERISTICS (C_{IN}=0.33μF, C_O=0.1μF, Tj=25°C)

Measurement is to be conducted in pulse testing.

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NJM78M05FA/DL1A						
Output Voltage	V_O	V_{IN}=10V, I_O=350mA	4.8	5.0	5.2	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=7 to 25V, I_O=200mA	-	3	50	mV
Load Regulation	ΔV_O - I_O	V_{IN}=10V, I_O=5 to 500mA	-	5	50	mV
Quiescent Current	I_Q	V_{IN}=10V, I_O=0mA	-	4	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=10V, I_O=5mA	-	-1	-	mV/ºC
Ripple Rejection	RR	V_{IN}=10V, I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	60	80	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=10V, BW=10Hz to 100kHz, I_O=350mA	-	60	-	μV

■ ELECTRICAL CHARACTERISTICS (C_{IN}=0.33µF, C_O=0.1µF, Tj=25°C)

Measurement is to be conducted in pulse testing.

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NJM78M06FA/DL1						
Output Voltage	V_O	V_{IN}=11V, I_O =350mA	5.75	6.0	6.25	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=8 to 25V, I_O=200mA	-	5	60	mV
Load Regulation	ΔV_O - I_O	V_{IN}=11V, I_O=5 to 500mA	-	5	60	mV
Quiescent Current	I_Q	V_{IN}=11V, I_O=0mA	-	4	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=11V, I_O=5mA	-	-1	-	mV/ºC
Ripple Rejection	RR	V_{IN}=11V,I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	59	75	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=11V, BW=10Hz to100kHz, I_O=350mA	-	70	-	µV
NJM78M08FA/DL1						
Output Voltage	V_O	V_{IN}=14V, I_O=350mA	7.7	8.0	8.3	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=10.5 to 25V, I_O=200mA	-	6	60	mV
Load Regulation	ΔV_O - I_O	V_{IN}=14V, I_O=5 to 500mA	-	8	80	mV
Quiescent Current	I_Q	V_{IN}=14V, I_O=0mA	-	4	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=14V, I_O=5mA	-	-1	-	mV/ºC
Ripple Rejection	RR	V_{IN}=14V,I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	56	75	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=14V, BW=10Hz to 100kHz, I_O=350mA	-	80	-	µV
NJM78M09FA/DL1						
Output Voltage	V_O	V_{IN}=15V, I_O=350mA	8.65	9.0	9.35	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=11.5 to 25V, I_O=200mA	-	6	60	mV
Load Regulation	ΔV_O - I_O	V_{IN}=15V, I_O=5 to 500mA	-	8	90	mV
Quiescent Current	I_Q	V_{IN}=15V, I_O=0mA	-	4.1	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=15V, I_O=5mA	-	-1	-	mV/ºC
Ripple Rejection	RR	V_{IN}=15V,I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	56	70	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=15V, BW=10Hz to 100kHz, I_O=350mA	-	90	-	µV
NJM78M12FA/DL1						
Output Voltage	V_O	V_{IN}=19V, I_O=350mA	11.5	12.0	12.5	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=14.5 to 30 V, I_O=200mA	-	8	60	mV
Load Regulation	ΔV_O - I_O	V_{IN}=19V, I_O=5 to 500mA	-	8	120	mV
Quiescent Current	I_Q	V_{IN}=19V, I_O=0mA	-	4.1	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=19V, I_O=5mA	-	-1	-	mV/ºC
Ripple Rejection	RR	V_{IN}=19V,I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	55	70	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=19V, BW=10Hz to 100kHz, I_O=350mA	-	100	-	µV

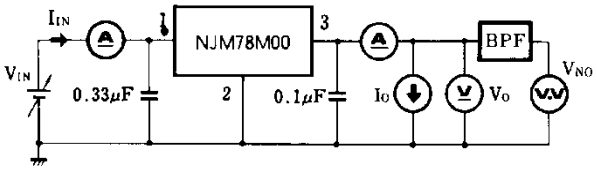
■ELECTRICAL CHARACTERISTICS (C_{IN}=0.33µF, C_O=0.1µF, Tj=25°C)

Measurement is to be conducted in pulse testing.

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NJM78M15FA/DL1						
Output Voltage	V_O	V_{IN}=23V, I_O=350mA	14.4	15.0	15.6	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=17.5 to 30V, I_O=200mA	-	10	60	mV
Load Regulation	ΔV_O - I_O	V_{IN}=23V, I_O=5 to 500mA	-	10	150	mV
Quiescent Current	I_Q	V_{IN}=23V, I_O=0mA	-	4.1	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=23V, I_O=5mA	-	-1	-	mV/ºC
Ripple Rejection	RR	V_{IN}=23V,I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	54	70	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=23V, BW=10Hz to 100kHz, I_O=350mA	-	120	-	µV
NJM78M18FA/DL1						
Output Voltage	V_O	V_{IN}=27V, I_O=350mA	17.3	18.0	18.7	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=21 to 33V, I_O=200mA	-	10	60	mV
Load Regulation	ΔV_O - I_O	V_{IN}=27V, I_O=5 to 500mA	-	15	180	mV
Quiescent Current	I_Q	V_{IN}=27 V, I_O=0mA	-	4.2	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=27V, I_O=5mA	-	-1.1	-	mV/ºC
Ripple Rejection	RR	V_{IN}=27V,I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	53	65	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=27V, BW=10Hz to 100kHz, I_O=350mA	-	140	-	µV
NJM78M20FA/DL1						
Output Voltage	V_O	V_{IN}=29V, I_O=350mA	19.2	20.0	20.8	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=23 to 35V, I_O=200mA	-	10	60	mV
Load Regulation	ΔV_O - I_O	V_{IN}=29V, I_O=5 to 500mA	-	20	200	mV
Quiescent Current	I_Q	V_{IN}=29V, I_O=0mA	-	4	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=29V, I_O=5mA	-	-1.1	-	mV/ºC
Ripple Rejection	RR	V_{IN}=29V,I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	53	65	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=29V, BW=10Hz to 100kHz, I_O=350mA	-	150	-	µV
NJM78M24FA/DL1						
Output Voltage	V_O	V_{IN}=33V, I_O=350mA	23.0	24	25.0	V
Line Regulation	ΔV_O - V_{IN}	V_{IN}=27 to 38V, I_O=200mA	-	10	60	mV
Load Regulation	ΔV_O - I_O	V_{IN}=33V, I_O=5 to 500mA	-	20	240	mV
Quiescent Current	I_Q	V_{IN}=33V, I_O=0mA	-	4.2	6	mA
Average Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$	V_{IN}=33V, I_O=5mA	-	-1.2	-	mV/ºC
Ripple Rejection	RR	V_{IN}=33V,I_O=350mA, e_{in}=1V_{P-P}, f=120Hz	50	60	-	dB
Output Noise Voltage	V_{NO}	V_{IN}=33V, BW=10Hz to 100kHz, I_O=350mA	-	160	-	µV

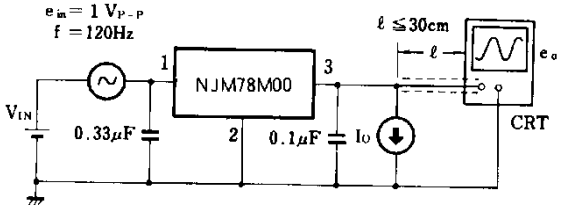
■ TEST CIRCUIT

1. Output Voltage, Line Regulation, Load Regulation, Quiescent Current, Average Temperature Coefficient of Output Voltage, Output Noise Voltage



- Measurement is to be conducted
- $I_Q = I_{IN} - I_O$ in pulse testing

2. Ripple Rejection

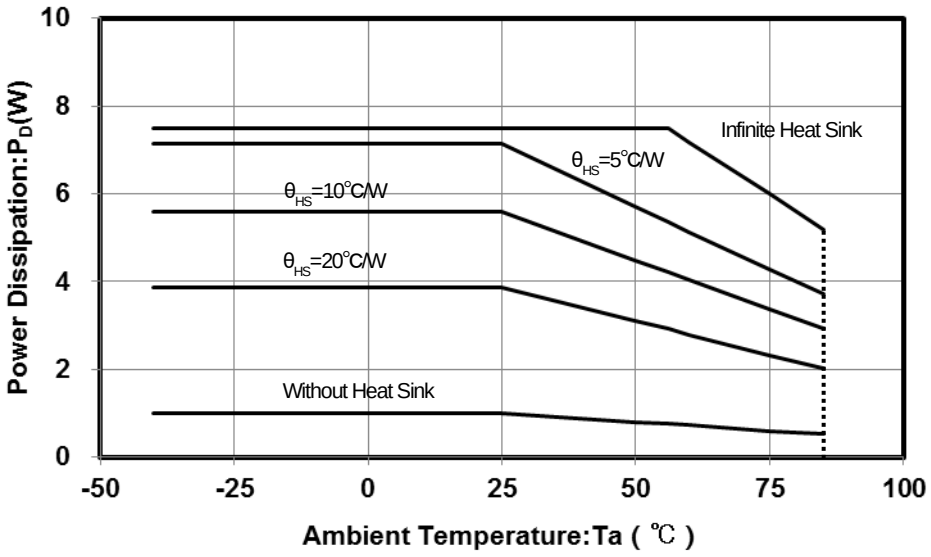


$$RR = 20\log_{10}\left(\frac{e_{in}}{e_o}\right) \quad [dB]$$

■ POWER DISSIPATION VS. AMBIENT TEMPERATURE

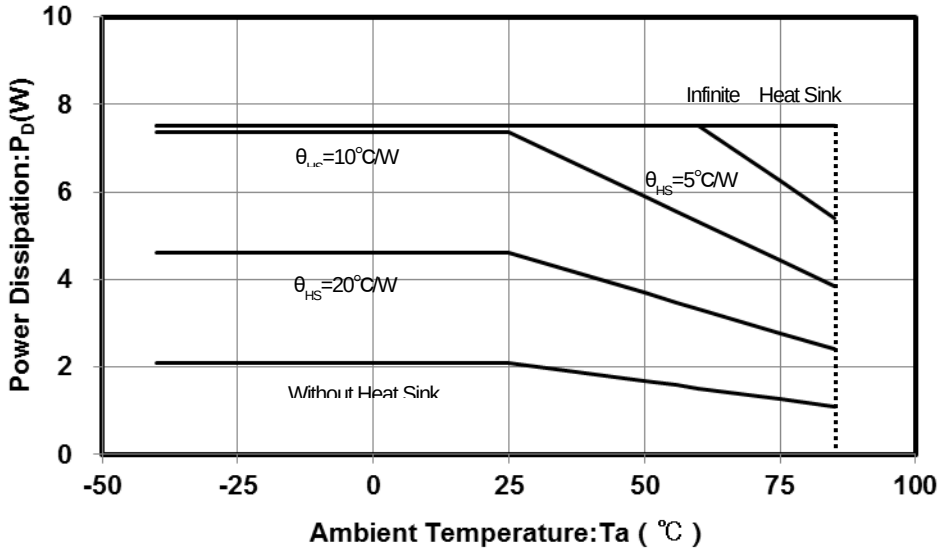
NJM78M00DL1A Power Dissipation

(Topr=-40~+85℃,Tj=~+150℃,P_D=7.5W(Tc≦56℃),P_D=1W(Ta≦25℃))



NJM78M00FA Power Dissipation

(Topr=-40~+85℃,Tj=~+150℃,P_D=7.5W(Tc≦85℃))



■ 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.

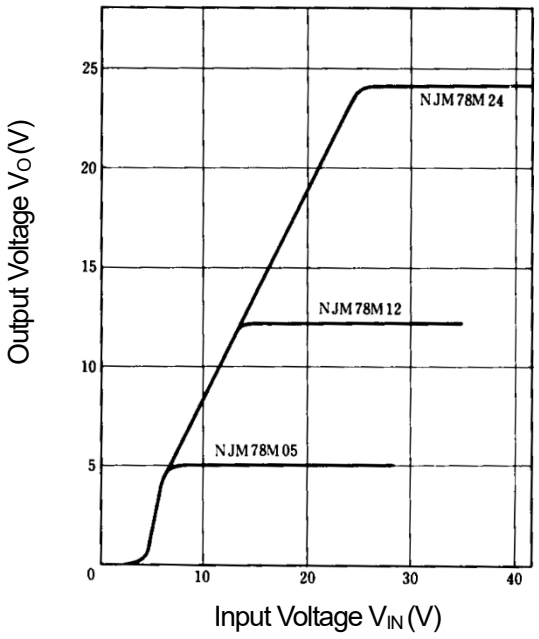
Therefore, use the recommended C_O value (refer to conditions of ELECTRIC CHARACTERISTIC) or larger and should connect between GND and V_{OUT} as shortest path as possible for stable operation

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.

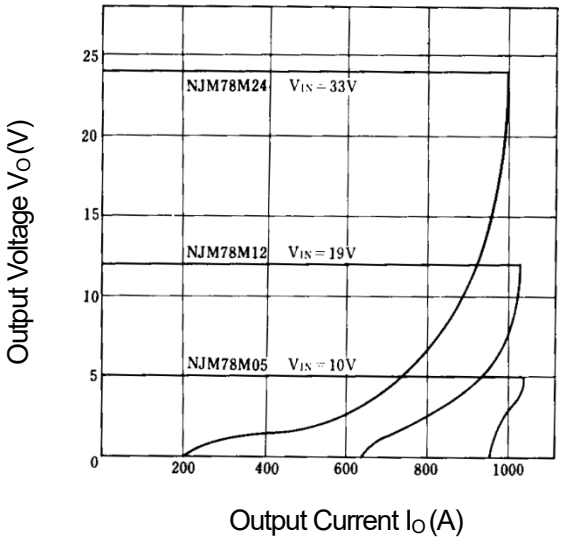
When selecting C_O, recommend that have withstand voltage margin against output voltage and superior temperature characteristic though

■ TYPICAL CHARACTERISTICS

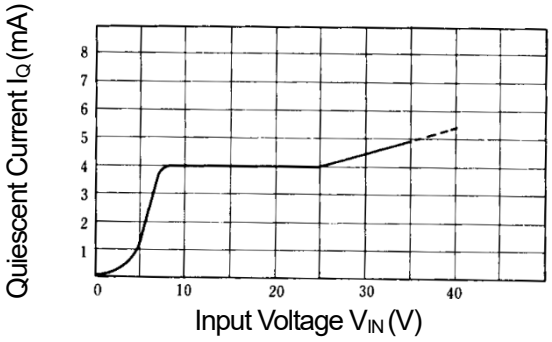
NJM78M05/M15/M24 Output Characteristics
(Io=0.35A, Tj=25°C)



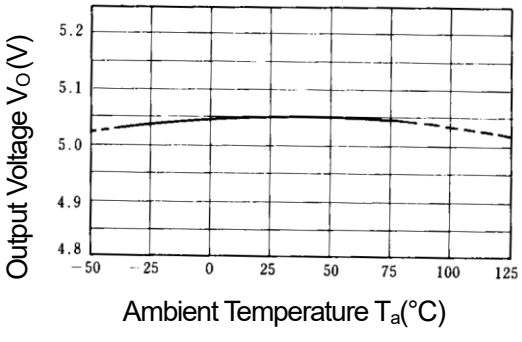
NJM78M05/M15/M24 Output Characteristics
(Io=0.35A, Tj=25°C)



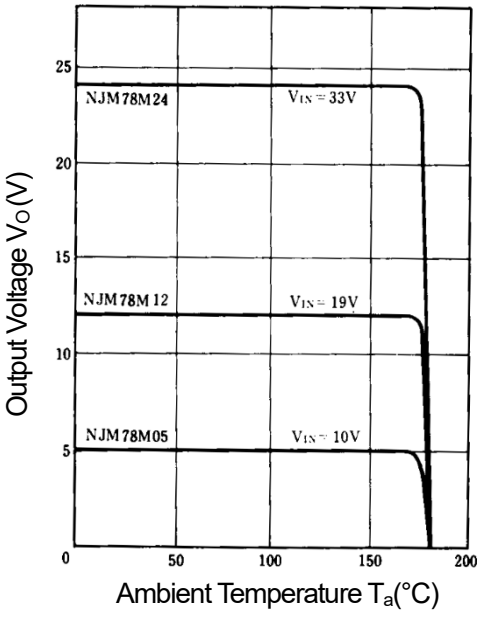
NJM78M05 Quiescent Current vs. Input Voltage
(Io=0mA, Tj=25°C,)



NJM78M05 Output Voltage vs. Temperature



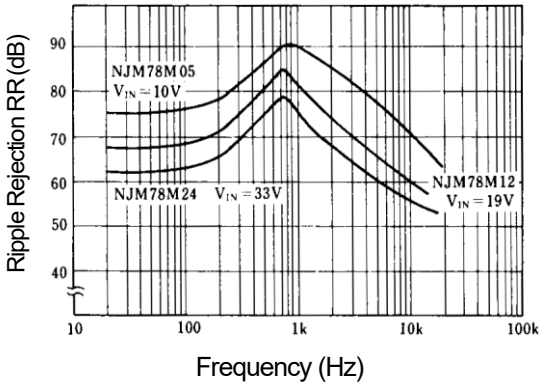
NJM78M05/M15/M24
Thermal Shutdown Characteristics
(Io=0mA)



■ TYPICAL CHARACTERISTICS

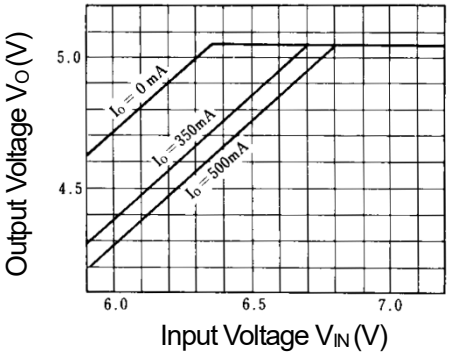
NJM78M05/15/24 Ripple Rejection

(Tj=25°C, Io=0.35A, ein=1V_{P-P})



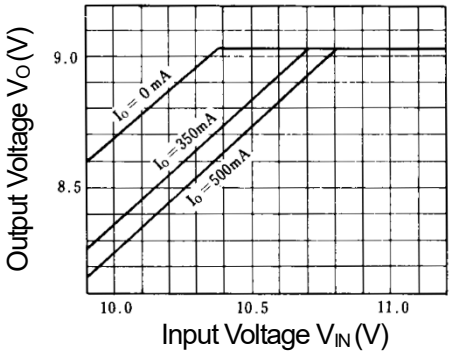
NJM78M05 Dropout Characteristics

(Tj=25°C)



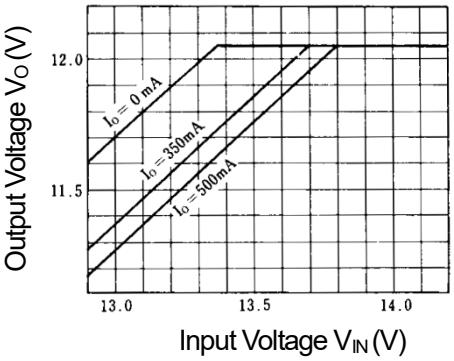
NJM78M09 Dropout Characteristics

(Tj=25°C)



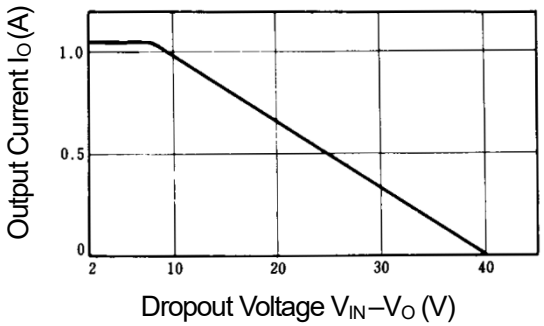
NJM78M12 Dropout Characteristics

(Tj=25°C)



NJM78M00 Series Short Circuit Output Current

(Tj=25°C, ∞ Heat Sink)



NJM78M00 Series Equivalent Series Resistance vs. Output Current