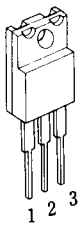
# 3-TERMINAL POSITIVE VOLTAGE REGULATOR

## ■ GENERAL DESCRIPTION

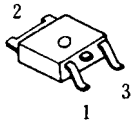
The NJM78M00 series of 3-Terminal Positive Voltage Regulators is constructed using the New JRC Planar epitaxial process. These regulators employ internal current-limiting, thermal-shutdown and safe-area compensation making them essentially indestructible. If adequate heat sinking is provided, they can 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.

## ■ PACAGE OUTLINE

(TO-220F)




(TO-252)



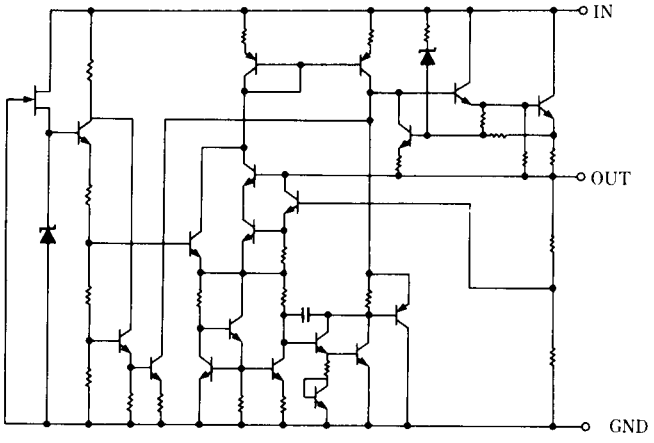

| NJM78M00FA | NJM78M00DL1A |
|---|---|
| 1. IN | 1. IN |
| 2. GND | 2. GND |
| 3. OUT | 3. OUT |

(note) The radiation fin is connected pin2.

## ■ 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

## ■ EQUIVALENT CIRCUIT



## ■ABSOLUTE MAXIMUM RATINGS (Ta=25ºC)

| PARAMETER | SYMBOL | MAXIMUM RATINGS | | UNIT |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | 78M05 to 78M09<br>78M12 to 78M15<br>78M18 to 78M24 | 35<br>35<br>40 | V |
| Storage Temperature Range | $T_{stg}$ | -40 to +150 | | ºC |
| Operating Temperature Range | Operating Junction Temperature | $T_j$ | -40 to +150 | ºC |
| | Operating Junction Temperature | $T_{opr}$ | -40 to +85 | |
| Power Dissipation | $P_D$ | TO-220F 7.5($T_C$≤85ºC)<br>TO-252 7.5($T_C$≤56ºC)<br>1.0(Ta=25ºC) | | W |

## ■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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=7 to 25V, $I_O$=200mA | - | 3 | 50 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, 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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=8 to 25V, $I_O$=200mA | - | 5 | 60 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, 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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=10.5 to 25V, $I_O$=200mA | - | 6 | 60 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, 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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=11.5 to 25V, $I_O$=200mA | - | 6 | 60 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, 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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=14.5 to 30 V, $I_O$=200mA | - | 8 | 60 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, f=120Hz | 55 | 70 | - | dB |
| Output Noise Voltage | $V_{NO}$ | $V_{IN}$=19V, BW=10Hz to 100kHz, $I_O$=350mA | - | 100 | - | µV |

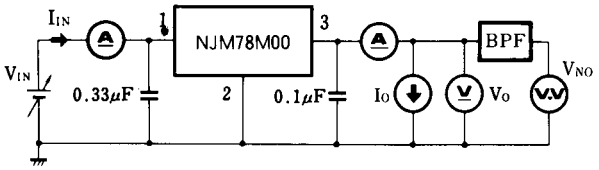
■**ELECTRICAL CHARACTERISTICS** ($C_{IN}$=0.33μF, $C_O$=0.1μF, Tj=25°C)

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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=17.5 to 30V, $I_O$=200mA | - | 10 | 60 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, 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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=21 to 33V, $I_O$=200mA | - | 10 | 60 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, 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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=23 to 35V, $I_O$=200mA | - | 10 | 60 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, 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 | $\Delta V_O$ - $V_{IN}$ | $V_{IN}$=27 to 38V, $I_O$=200mA | - | 10 | 60 | mV |
| Load Regulation | $\Delta V_O$ - $I_O$ | $V_{IN}$=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, $e_{in}$=1$V_{P-P}$, f=120Hz | 50 | 60 | - | dB |
| Output Noise Voltage | $V_{NO}$ | $V_{IN}$=33V, BW=10Hz to 100kHz, $I_O$=350mA | - | 160 | - | μV |

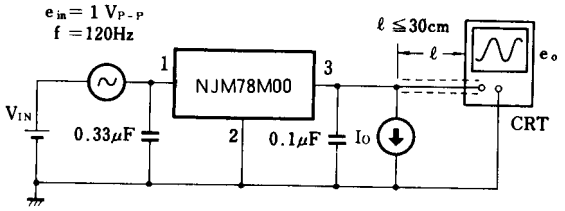
## ■ TEST CIRCUIT

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

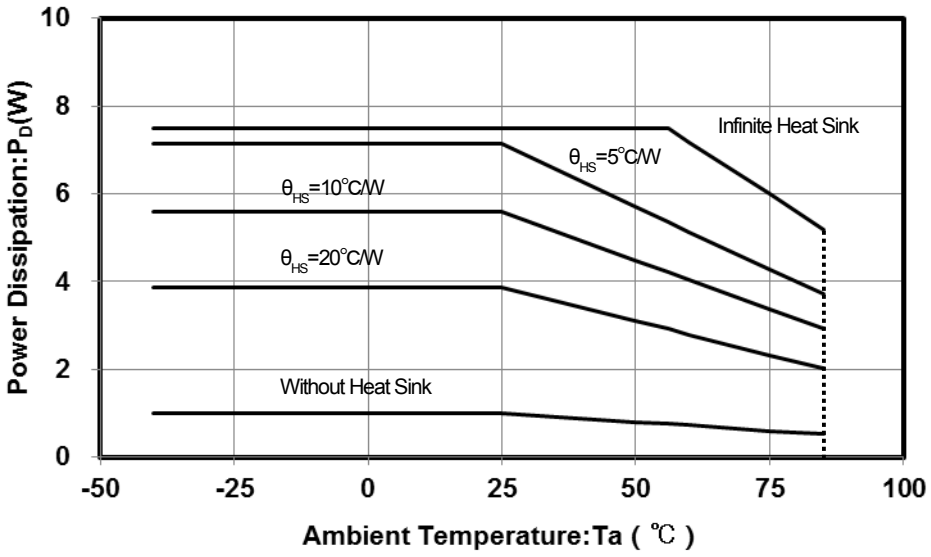



$$RR=20\log_{10}\left(\frac{e_{in}}{e_o}\right)\ [dB]$$

## ■ POWER DISSIPATION VS. AMBIENT TEMPERATURE

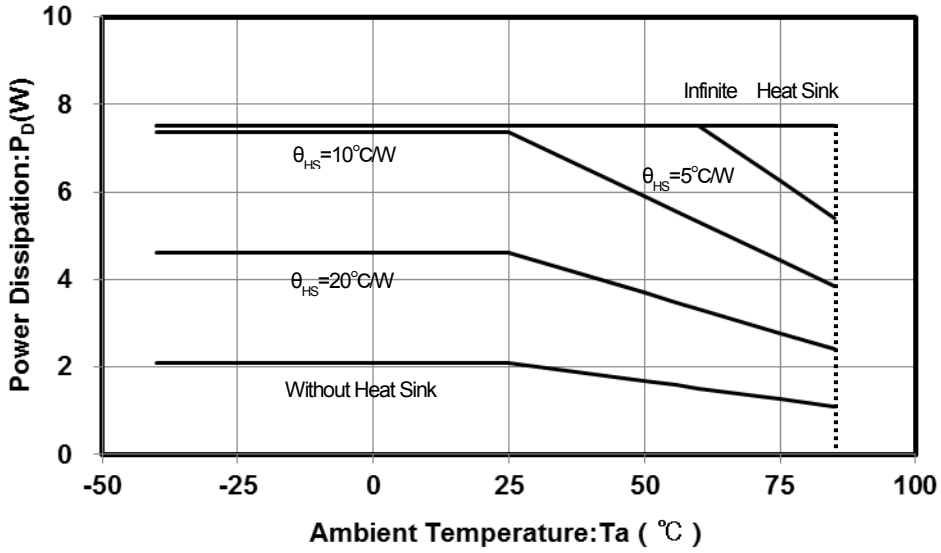
**NJM78M00DL1A Power Dissipation**

**(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.

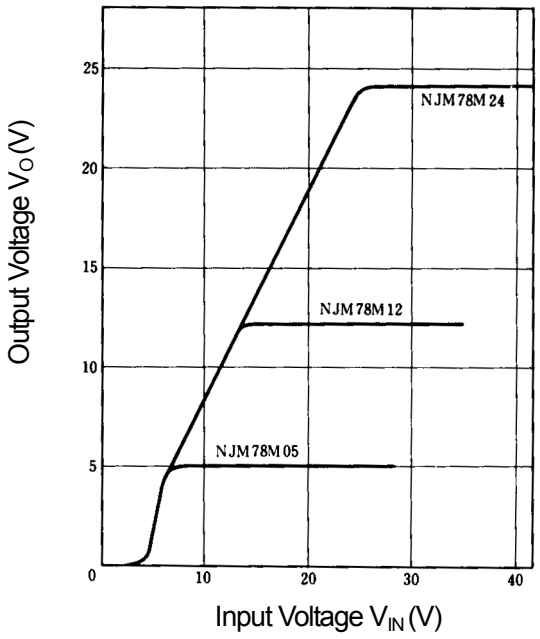
Therefore, use the recommended $C_O$ value (refer to conditions of ELECTRIC CHARACTERISTIC) or larger and should connect between GND and $V_{OUT}$ as shortest path as possible for stable operation

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.

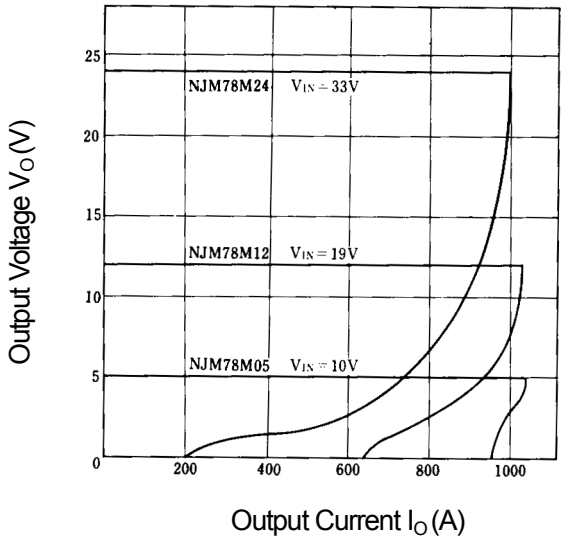
When selecting $C_O$, recommend that have withstand voltage margin against output voltage and superior temperature characteristic though

## ■ TYPICAL CHARACTERISTICS

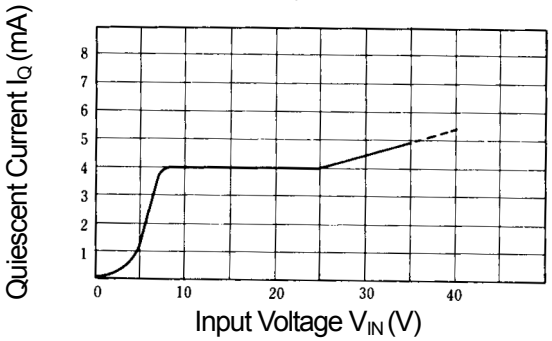
**NJM78M05/M15/M24 Output Characteristics**
(Io=0.35A, Tj=25°C)



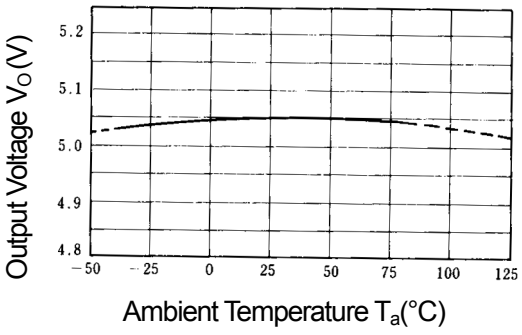

**NJM78M05/M15/M24 Output Characteristics**
(Io=0.35A, Tj=25°C)



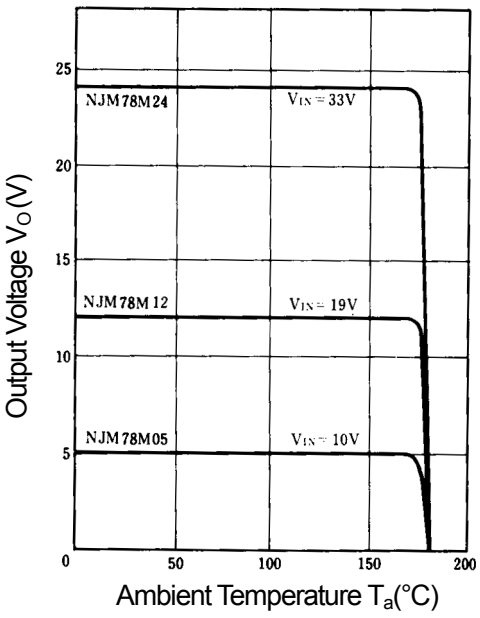

**NJM78M05 Quiescent Current vs. Input Voltage**
(Io=0mA, Tj=25°C,)




**NJM78M05 Output Voltage vs. Temperature**



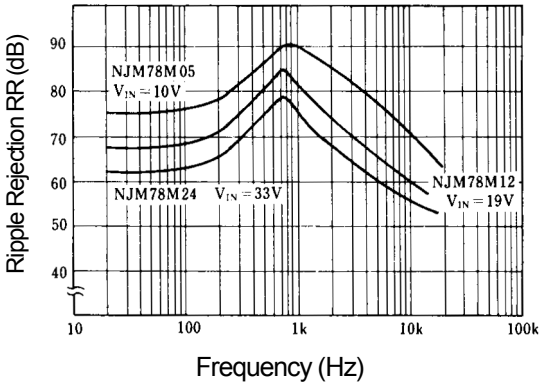

**NJM78M05/M15/M24**
**Thermal Shutdown Characteristics**
(Io=0mA)



## ■ TYPICAL CHARACTERISTICS

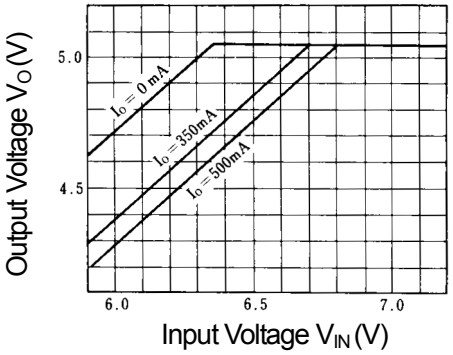
**NJM78M05/15/24 Ripple Rejection**

(Tj=25°C, Io=0.35A, ein=1$V_{P-P}$)



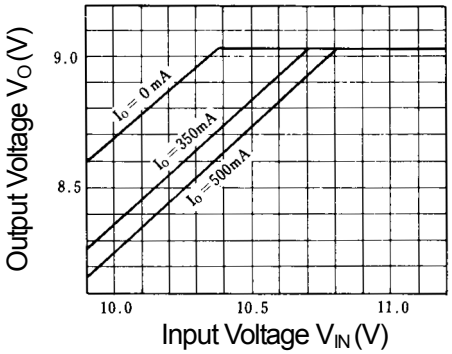

**NJM78M05 Dropout Characteristics**

(Tj=25°C)



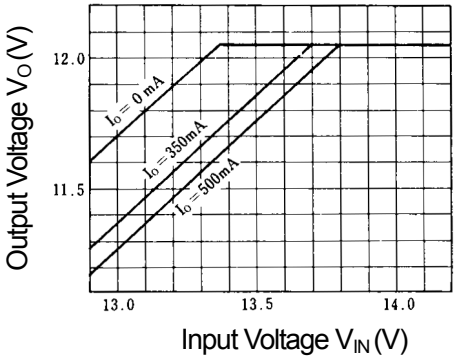

**NJM78M09 Dropout Characteristics**

(Tj=25°C)



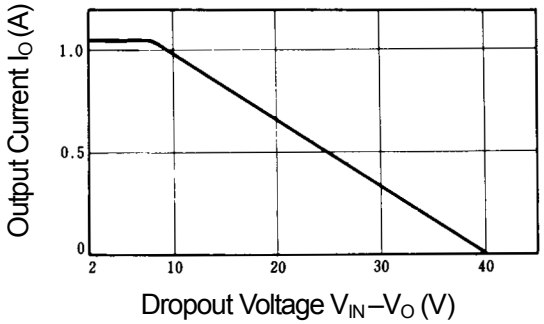

**NJM78M12 Dropout Characteristics**

(Tj=25°C)

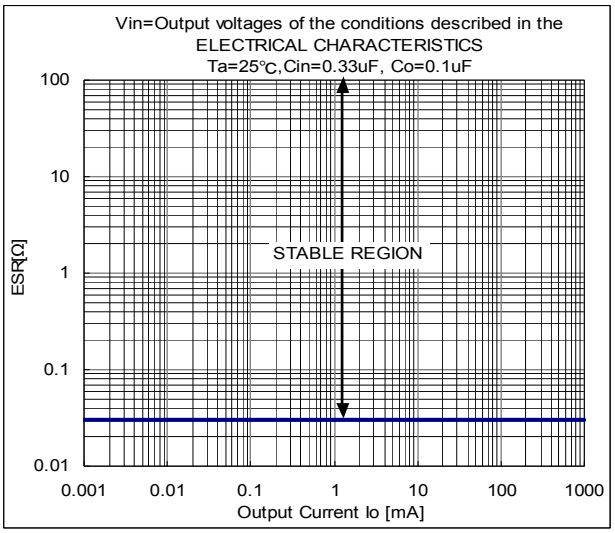



**NJM78M00 Series Short Circuit Output Current**

(Tj=25°C, ∞ Heat Sink)




**NJM78M00 Series Equivalent Series Resistance vs. Output Current**



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