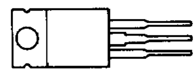
# SERIES LM340
# POSITIVE-VOLTAGE REGULATORS

D2332, SEPTEMBER 1977—REVISED MARCH 1983

- 3-Terminal Regulators
- Output Current up to 1.5 A
- No External Components
- Internal Thermal Overload
- High Power Dissipation Capability
- Internal Short-Circuit Current Limiting
- Output Transistor Safe-Area Compensation
- Output Load Regulation . . . 0.3% Typ
- Direct Replacements for National LM340 Series

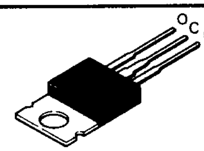
| NOMINAL OUTPUT VOLTAGE | REGULATOR |
|---|---|
| 5 V | LM340-5 |
| 12 V | LM340-12 |
| 15 V | LM340-15 |

KC PACKAGE
(TOP VIEW)




THE COMMON TERMINAL IS IN ELECTRICAL CONTACT WITH THE MOUNTING BASE

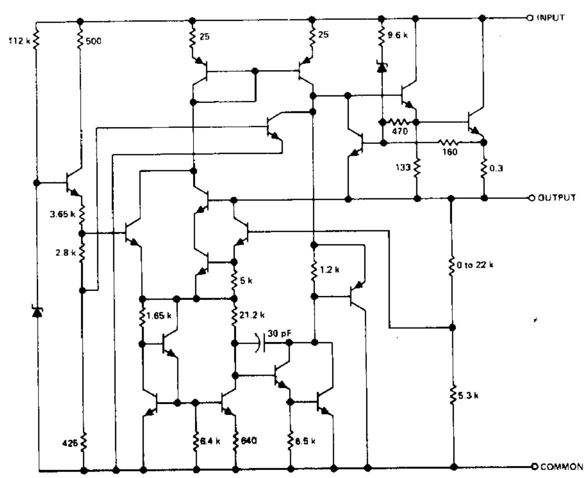
TO-220AB




## description

This series of fixed-voltage monolithic integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Any of these regulators can deliver up to 1.5 amperes of output current. The internal current limiting and thermal shutdown features of these regulators make them essentially immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents and also as the power-pass element in precision regulators.

## schematic




Resistor values shown are nominal and in ohms.

**absolute maximum ratings over operating temperature range (unless otherwise noted)**

Input voltage ........................................................ 35 V
Continuous total dissipation at 25°C free-air temperature (see Note 1) ........................ 2 W
Continuous total dissipation at (or below) 25°C case temperature (see Note 1) .................. 15 W
Operating free-air, case, or virtual junction temperature range .................... −55°C to 150°C
Storage temperature range ............................................... −65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ........................... 260°C

NOTE 1: For operation above 25°C free-air or case temperature, refer to Figures 1 and 2. To avoid exceeding the design maximum virtual junction temperature, these ratings should not be exceeded. Due to variations in individual device electrical characteristics and thermal resistance, the built-in thermal overload protection may be activated at power levels slightly above or below the rated dissipation.

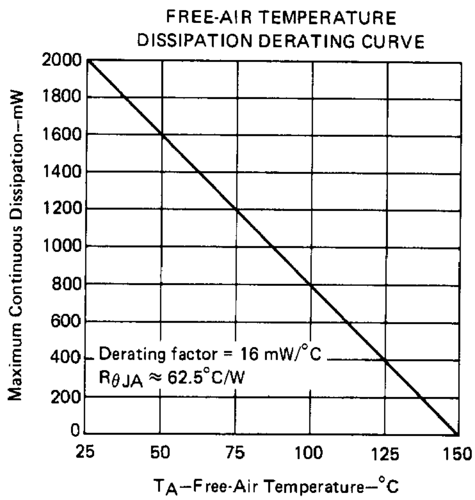



**FIGURE 1**

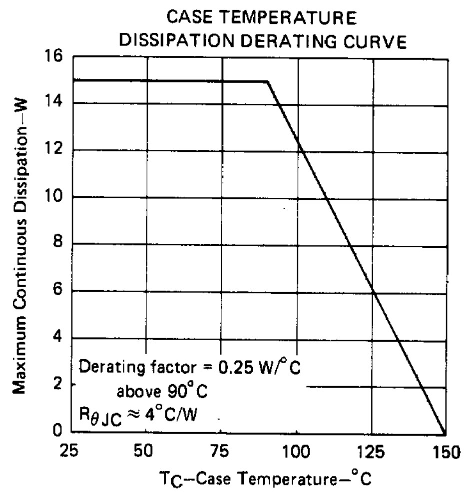



**FIGURE 2**



**recommended operating conditions**

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Input voltage, $V_I$ | LM340-5 | 7 | 25 | V |
| | LM340-12 | 14.5 | 30 | |
| | LM340-15 | 17.5 | 30 | |
| Output current, $I_O$ | | | 1.5 | A |
| Operating virtual junction temperature, $T_J$ | | 0 | 125 | °C |



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**LM340-5 electrical characteristics at specified virtual junction temperature, $V_I$ = 10 V, $I_O$ = 1 A (unless otherwise noted)**

| PARAMETER | TEST CONDITIONS† | | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Output voltage | $I_O$ = 5 mA to 1 A | | 25°C | 4.8 | 5 | 5.2 | V |
| | $V_I$ = 7 V to 20 V, P ≤ 15 W | $I_O$ = 5 mA to 1 A, | 0°C to 125°C | 4.75 | | 5.25 | |
| Input regulation | $I_O$ = 500 mA | $V_I$ = 7 V to 25 V | 25°C | | 3 | 50 | mV |
| | | $V_I$ = 8 V to 20 V | 0°C to 125°C | | | 50 | |
| | $I_O$ = 1 A | $V_I$ = 7.3 V to 20 V | 25°C | | | 50 | |
| | | $V_I$ = 8 V to 12 V | 0°C to 125°C | | | 25 | |
| Ripple rejection | $V_I$ = 8 V to 18 V, f = 120 Hz | $I_O$ ≤ 1 A | 25°C | 62 | 80 | | dB |
| | | $I_O$ ≤ 500 mA | 0°C to 125°C | 62 | | | |
| Output regulation | $I_O$ = 250 mA to 750 mA | | 25°C | | | 25 | mV |
| | $I_O$ = 5 mA to 1.5 A | | | | 10 | 50 | |
| | $I_O$ = 5 mA to 1 A | | 0°C to 125°C | | | 50 | |
| Output noise voltage | f = 10 Hz to 100 kHz | | 25°C | | 40 | | μV |
| Dropout voltage | $I_O$ = 1 A | | 25°C | | 2 | | V |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | | 0°C to 125°C | | −0.6 | | mV/°C |
| Output impedance | f = 1 kHz | | 25°C | | 8 | | mΩ |
| Bias current | $I_O$ ≤ 1 A | | 25°C | | | 8 | mA |
| | | | 0°C to 125°C | | | 8.5 | |
| Bias current change | $V_I$ = 7.5 V to 20 V, | $I_O$ ≤ 1 A | 25°C | | | 1 | mA |
| | $V_I$ = 7 V to 25 V, | $I_O$ ≤ 500 mA | 0°C to 125°C | | | 1 | |
| | $I_O$ = 5 mA to 1 A | | | | | 0.5 | |
| Peak output current | | | 25°C | | 2.4 | | A |
| Short-circuit current | | | 25°C | | 2.1 | | A |

† All characteristics are measured with a capacitor across the input of 0.22 μF and a capacitor across the output of 0.1 μF. All characteristics except noise voltage rejection ratio are measured using pulse techniques ($t_w$ ≤ 10 ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

**LM340-12 electrical characteristics at specified virtual junction temperature, $V_I$ = 19 V, $I_O$ = 1 A (unless otherwise noted)**

| PARAMETER | TEST CONDITIONS† | | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Output voltage | $I_O$ = 5 mA to 1 A | | 25°C | 11.5 | 12 | 12.5 | V |
| | $V_I$ = 14.5 V to 27 V, $I_O$ = 5 mA to 1 A, P ≤ 15 W | | 0°C to 125°C | 11.4 | | 12.6 | |
| Input regulation | $I_O$ = 500 mA | $V_I$ = 14.5 V to 30 V | 25°C | | 4 | 120 | mV |
| | | $V_I$ = 15 V to 27 V | 0°C to 125°C | | | 120 | |
| | $I_O$ = 1 A | $V_I$ = 14.6 V to 27 V | 25°C | | | 120 | |
| | | $V_I$ = 16 V to 22 V | 0°C to 125°C | | | 120 | |
| Ripple rejection | $V_I$ = 15 V to 25 V, f = 120 Hz | $I_O$ ≤ 1 A | 25°C | 55 | 72 | | dB |
| | | $I_O$ ≤ 500 mA | 0°C to 125°C | 55 | | | |
| Output regulation | $I_O$ = 250 mA to 750 mA | | 25°C | | | 60 | mV |
| | $I_O$ = 5 mA to 1.5 A | | | | 12 | 120 | |
| | $I_O$ = 5 mA to 1 A | | 0°C to 125°C | | | 120 | |
| Output noise voltage | f = 10 Hz to 100 kHz | | 25°C | | 75 | | μV |
| Dropout voltage | $I_O$ = 1 A | | 25°C | | 2 | | V |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | | 0°C to 125°C | | −1.5 | | mV/°C |
| Output impedance | f = 1 kHz | | 25°C | | 18 | | mΩ |
| Bias current | $I_O$ ≤ 1 A | | 25°C | | | 8 | mA |
| | | | 0°C to 125°C | | | 8.5 | |
| Bias current change | $V_I$ = 14.8 V to 27 V, $I_O$ ≤ 1 A | | 25°C | | | 1 | mA |
| | $V_I$ = 14.5 V to 30 V, $I_O$ ≤ 500 mA | | 0°C to 125°C | | | 1 | |
| | $I_O$ = 5 mA to 1 A | | | | | 0.5 | |
| Peak output current | | | 25°C | | 2.4 | | A |
| Short-circuit current | | | 25°C | | 1.5 | | A |

† All characteristics are measured with a capacitor across the input of 0.22 μF and a capacitor across the output of 0.1 μF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_w$ ≤ 10 ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.





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**LM340-15 electrical characteristics at specified virtual junction temperature, $V_I$ = 23 V, $I_O$ = 1 A (unless otherwise noted)**

| PARAMETER | TEST CONDITIONS† | | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Output voltage | $I_O$ = 5 mA to 1 A | | 25°C | 14.4 | 15 | 15.6 | V |
| | $V_I$ = 17.5 V to 30 V, $I_O$ = 5 mA to 1 A, P ≤ 15 W | | 0°C to 125°C | 14.25 | | 15.75 | |
| Input regulation | $I_O$ = 500 mA | $V_I$ = 17.5 V to 30 V | 25°C | | 4 | 150 | mV |
| | | $V_I$ = 18.5 V to 30 V | 0°C to 125°C | | | 150 | |
| | $I_O$ = 1 A | $V_I$ = 17.7 V to 30 V | 25°C | | | 150 | |
| | | $V_I$ = 20 V to 26 V | 0°C to 125°C | | | 75 | |
| Ripple rejection | $V_I$ = 18.5 V to 28.5 V, f = 120 Hz | $I_O$ ≤ 1 A | 25°C | 54 | 70 | | dB |
| | | $I_O$ ≤ 500 mA | 0°C to 125°C | 54 | | | |
| Output regulation | $I_O$ = 250 mA to 750 mA | | 25°C | | | 75 | mV |
| | $I_O$ = 5 mA to 1.5 A | | | | 12 | 150 | |
| | $I_O$ = 5 mA to 1 A | | 0°C to 125°C | | | 150 | |
| Output noise voltage | f = 10 Hz to 100 kHz | | 25°C | | 90 | | μV |
| Dropout voltage | $I_O$ = 1 A | | 25°C | | 2 | | V |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | | 0°C to 125°C | | −1.8 | | mV/°C |
| Output impedance | f = 1 kHz | | 25°C | | 19 | | mΩ |
| Bias current | $I_O$ ≤ 1 A | | 25°C | | | 8 | mA |
| | | | 0°C to 125°C | | | 8.5 | |
| Bias current change | $V_I$ = 17.9 V to 30 V, $I_O$ ≤ 1 A | | 25°C | | | 1 | mA |
| | $V_I$ = 17.5 V to 30 V, $I_O$ ≤ 500 mA | | 0°C to 125°C | | | 1 | |
| | $I_O$ = 5 mA to 1 A | | | | | 0.5 | |
| Peak output current | | | 25°C | | 2.4 | | A |
| Short-circuit current | | | 25°C | | 1.2 | | A |

† All characteristics are measured with a capacitor across the input of 0.22 μF and a capacitor across the output of 0.1 μF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_w$ ≤ 10 ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

## TYPICAL CHARACTERISTICS

NORMALIZED OUTPUT VOLTAGE
vs
VIRTUAL JUNCTION TEMPERATURE

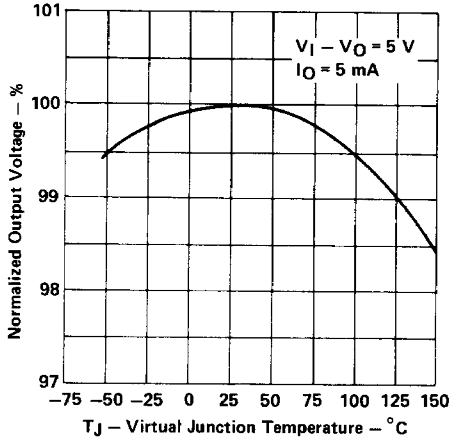


FIGURE 3

RIPPLE REJECTION
vs
FREQUENCY

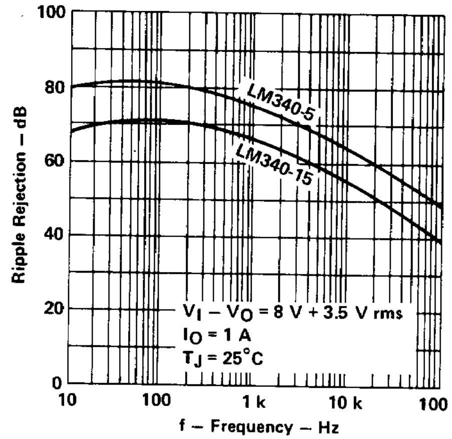


FIGURE 4

DROPOUT VOLTAGE
vs
VIRTUAL JUNCTION TEMPERATURE

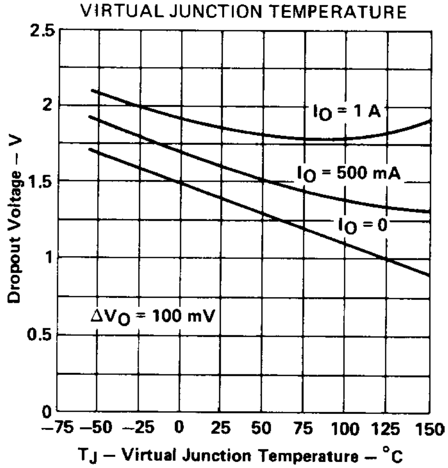


FIGURE 5

LM340-5
DROPOUT VOLTAGE
vs
INPUT VOLTAGE

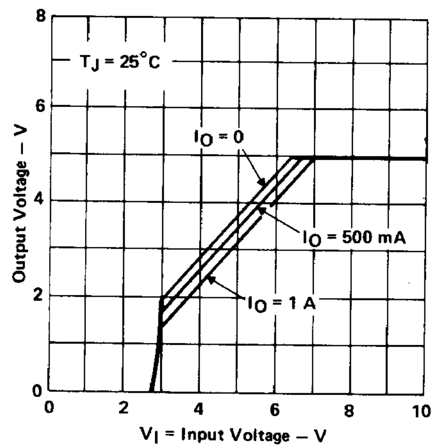


FIGURE 6



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## TYPICAL CHARACTERISTICS

LM340-5
BIAS CURRENT
vs
VIRTUAL JUNCTION TEMPERATURE

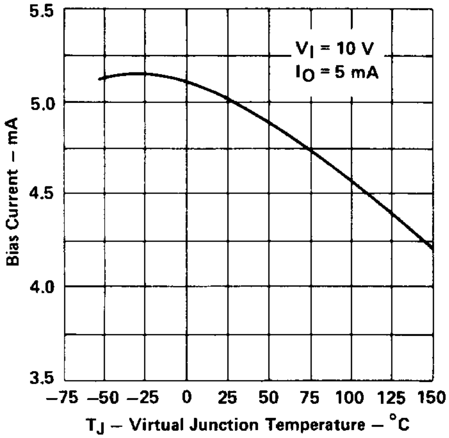


FIGURE 7

LM340-5
BIAS CURRENT
vs
INPUT VOLTAGE

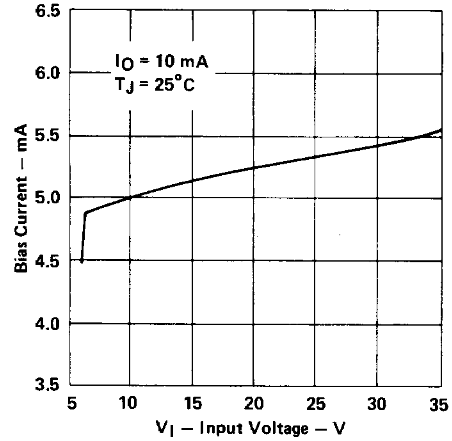


FIGURE 8

LM340-5
OUTPUT IMPEDANCE
vs
FREQUENCY

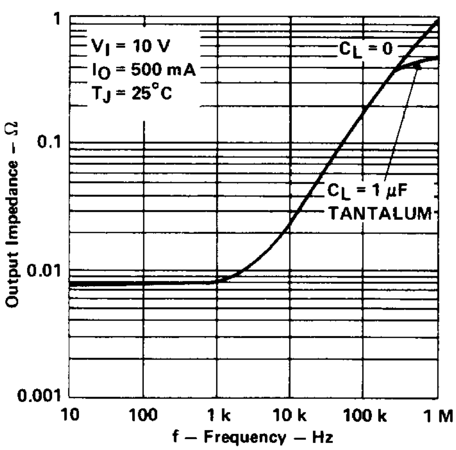


FIGURE 9

PEAK OUTPUT CURRENT
vs
INPUT-TO-OUTPUT VOLTAGE DIFFERENTIAL

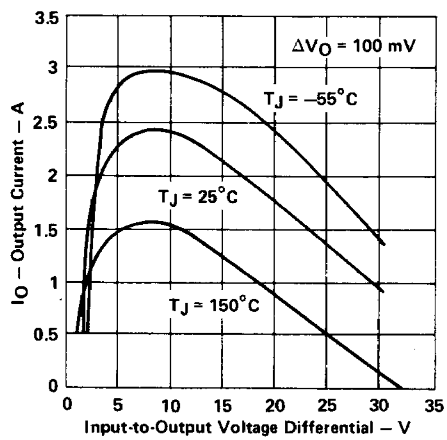


FIGURE 10

Voltage Regulators

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## TYPICAL APPLICATION DATA

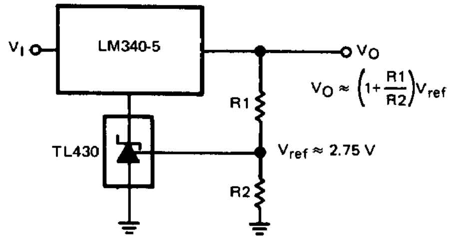
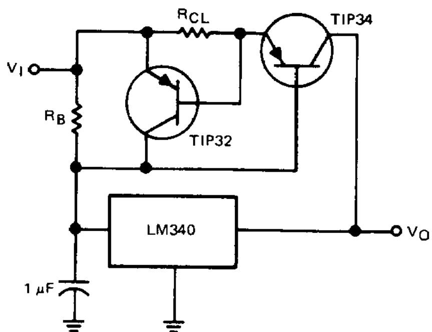



**FIGURE 11—ADJUSTABLE SUPPLY WITH STABLE OUTPUT FROM 8 VOLTS TO 35 VOLTS**




The boost circuit takes over at a level determined by $R_B$.

$$R_B \approx \frac{0.6\ \text{V}}{I_B}$$

where $I_B$ is the LM340 operating level.

Maximum current limit $I_{CL}$ is determined by $R_{CL}$.

$$R_{CL} \approx \frac{0.6\ \text{V}}{I_{CL}}$$

Example: If $I_B$ is selected to be 0.5 A, then $R_B = 1.2\ \Omega$. If $I_{CL}$ is 3 A, then $R_{CL} = 0.2\ \Omega$.

**FIGURE 12—OUTPUT CURRENT BOOST CIRCUIT**





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