National Semiconductor

# LM320L 3-Terminal Negative Regulators

## General Description

The LM320L series of 3-terminal negative voltage regulators features fixed output voltages of −5V, −12V, and −15V, with output current capabilities in excess of 100 mA. These devices were designed using the latest computer techniques for optimizing the packaged IC thermal/electrical performance. The LM320L series, even when combined with a minimum output compensation capacitor of 0.1 μF, exhibits an excellent transient response, a maximum line regulation of 0.07% $V_O$/V, and a maximum load regulation of 0.01% $V_O$/mA.

The LM320L series also includes, as self-protection circuitry: safe operating area circuitry for output transistor power dissipation limiting, a temperature independent short circuit current limit for peak output current limiting, and a thermal shutdown circuit to prevent excessive junction temperature. Although designed primarily as fixed voltage regulators, these devices may be combined with simple external circuitry for boosted and/or adjustable voltages and currents. The LM320L series is available in the 3-lead TO-92 package.

For output voltages other than −5V, −12V and −15V, the LM137 and LM137HV series provide an output voltage range from −1.2V to −47V.

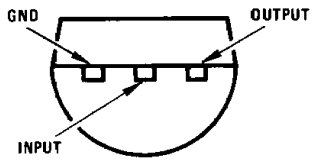
## Features

- Preset output voltage error is less than ±5% over load, line and temperature
- LM320L is specified at an output current of 100 mA
- Internal short-circuit, thermal and safe operating area protection
- Easily adjustable to higher output voltages
- Maximum line regulation less than 0.07% $V_{OUT}$/V
- Maximum load regulation less than 0.01% $V_{OUT}$/mA
- Easily compensated with a small 0.1 μF output capacitor

| Device | Package | Rated Power Dissipation | Design Output Current |
|---|---|---|---|
| LM320L | TO-92 (Z) | 0.6W | 0.1A |

## Connection Diagram

**TO-92 Plastic Package (Z)**

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**Order Number LM320LZ-5.0, LM320LZ-12 or LM320LZ-15**
**See NS Package Number Z03A**

## Absolute Maximum Ratings

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.**

| | |
|---|---|
| Input Voltage | |
| $V_{OUT}$ = −5V 12V and 15V | −35V |
| Internal Power Dissipation (Notes 1 and 3) | Internally Limited |
| Operating Temperature Range | 0°C to +70°C |
| Maximum Junction Temperature | +125°C |
| Storage Temperature Range Molded TO-92 | −55°C to +150°C |
| Lead Temperature (Soldering, 10 sec.) | 260°C |

## Electrical Characteristics (Note 2) $T_A$ = 0°C to +70°C unless otherwise noted.

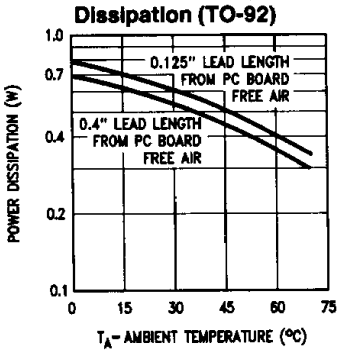
| **Output Voltage** | | | **−5V** | | | **−12V** | | | **−15V** | | | **Units** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input Voltage (unless otherwise noted)** | | | **−10V** | | | **−17V** | | | **−20V** | | | |
| **Symbol** | **Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| $V_O$ | Output Voltage | $T_j$ = 25°C, $I_O$ = 100 mA | −5.2 | −5 | −4.8 | −12.5 | −12 | −11.5 | −15.6 | −15 | −14.4 | |
| | | 1 mA ≤ $I_O$ ≤ 100 mA<br>$V_{MIN} \le V_{IN} \le V_{MAX}$ | −5.25 | | −4.75<br>(−20 ≤ $V_{IN}$ ≤ −7.5) | −12.6 | | −11.4<br>(−27 ≤ $V_{IN}$ ≤ −14.8) | −15.75 | | −14.25<br>(−30 ≤ $V_{IN}$ ≤ −18) | V |
| | | 1 mA ≤ $I_O$ ≤ 40 mA<br>$V_{MIN} \le V_{IN} \le V_{MAX}$ | −5.25 | | −4.75<br>(−20 ≤ $V_{IN}$ ≤ −7) | −12.6 | | −11.4<br>(−27 ≤ $V_{IN}$ ≤ −14.5) | −15.75 | | −14.25<br>(−30 ≤ $V_{IN}$ ≤ −17.5) | |
| $\Delta V_O$ | Line Regulation | $T_j$ = 25°C, $I_O$ = 100 mA | | | 60 | | | 45 | | | 45 | mV |
| | | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | | (−20 ≤ $V_{IN}$ ≤ −7.3) | | | (−27 ≤ $V_{IN}$ ≤ −14.6) | | | (−30 ≤ $V_{IN}$ ≤ −17.7) | V |
| | | $T_j$ = 25°C, $I_O$ = 40 mA | | | 60 | | | 45 | | | 45 | mV |
| | | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | | (−20 ≤ $V_{IN}$ ≤ −7) | | | (−27 ≤ $V_{IN}$ ≤ −14.5) | | | (−30 ≤ $V_{IN}$ ≤ −17.5) | V |
| $\Delta V_O$ | Load Regulation | $T_j$ = 25°C<br>1 mA ≤ $I_O$ ≤ 100 mA | | | 50 | | | 100 | | | 125 | mV |
| $\Delta V_O$ | Long Term Stability | $I_O$ = 100 mA | | 20 | | | 48 | | | 60 | | mV/khr |
| $I_Q$ | Quiescent Current | $I_O$ = 100 mA | | 2 | 6 | | 2 | 6 | | 2 | 6 | mA |
| $\Delta I_Q$ | Quiescent Current Change | 1 mA ≤ $I_O$ ≤ 100 mA | | | 0.3 | | | 0.3 | | | 0.3 | mA |
| | | 1 mA ≤ $I_O$ ≤ 40 mA | | | 0.1 | | | 0.1 | | | 0.1 | |
| | | $I_O$ = 100 mA<br>$V_{MIN} \le V_{IN} \le V_{MAX}$ | | | 0.25<br>(−20 ≤ $V_{IN}$ ≤ −7.5) | | | 0.25<br>(−27 ≤ $V_{IN}$ ≤ −14.8) | | | 0.25<br>(−30 ≤ $V_{IN}$ ≤ −18) | mA<br>V |
| $V_n$ | Output Noise Voltage | $T_j$ = 25°C, $I_O$ = 100 mA<br>f = 10 Hz–10 kHz | | 40 | | | 96 | | | 120 | | μV |
| $\frac{\Delta V_{IN}}{\Delta V_O}$ | Ripple Rejection | $T_j$ = 25°C, $I_O$ = 100 mA<br>f = 120 Hz | 50 | | | 52 | | | 50 | | | dB |
| | Input Voltage Required to Maintain Line Regulation | $T_j$ = 25°C<br>$I_O$ = 100 mA | | | −7.3 | | | −14.6 | | | −17.7 | V |
| | | $I_O$ = 40 mA | | | −7.0 | | | −14.5 | | | −17.5 | |

**Note 1:** Thermal resistance of Z package is typically 60°C/W $\theta_{JC}$, 232°C/W $\theta_{jA}$ at still air, and 88°C/W at 400 ft/min of air. The maximum junction temperature shall not exceed 125°C on electrical parameters.

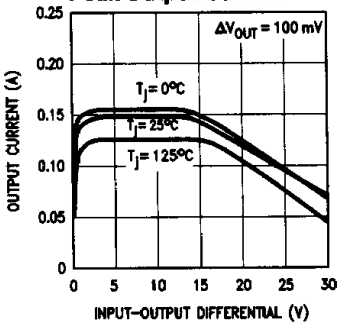
**Note 2:** To ensure constant junction temperature pulse testing is used.

# Typical Performance Characteristics

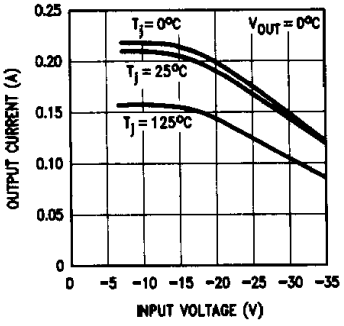
**Maximum Average Power Dissipation (TO-92)**



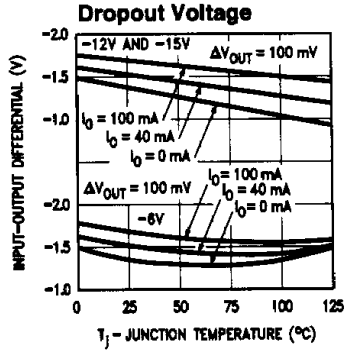

**Peak Output Current**



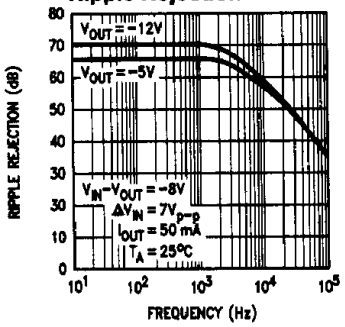

**Short Circuit Output Current**



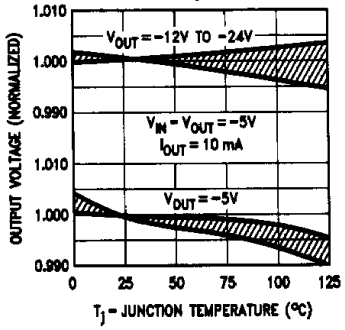

**Dropout Voltage**



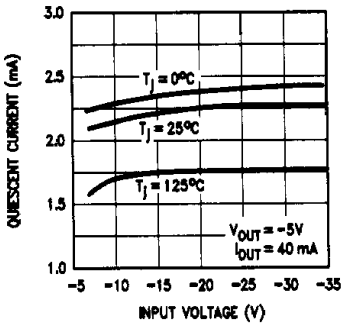

**Ripple Rejection**



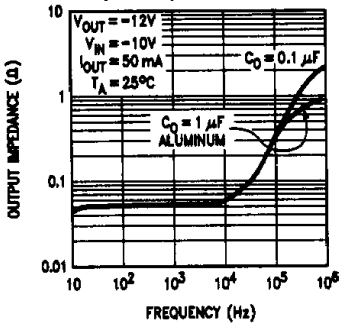

**Output Voltage vs Temperature (Normalized to 1V @ 25°C)**




**Quiescent Current**




**Output Impedance**

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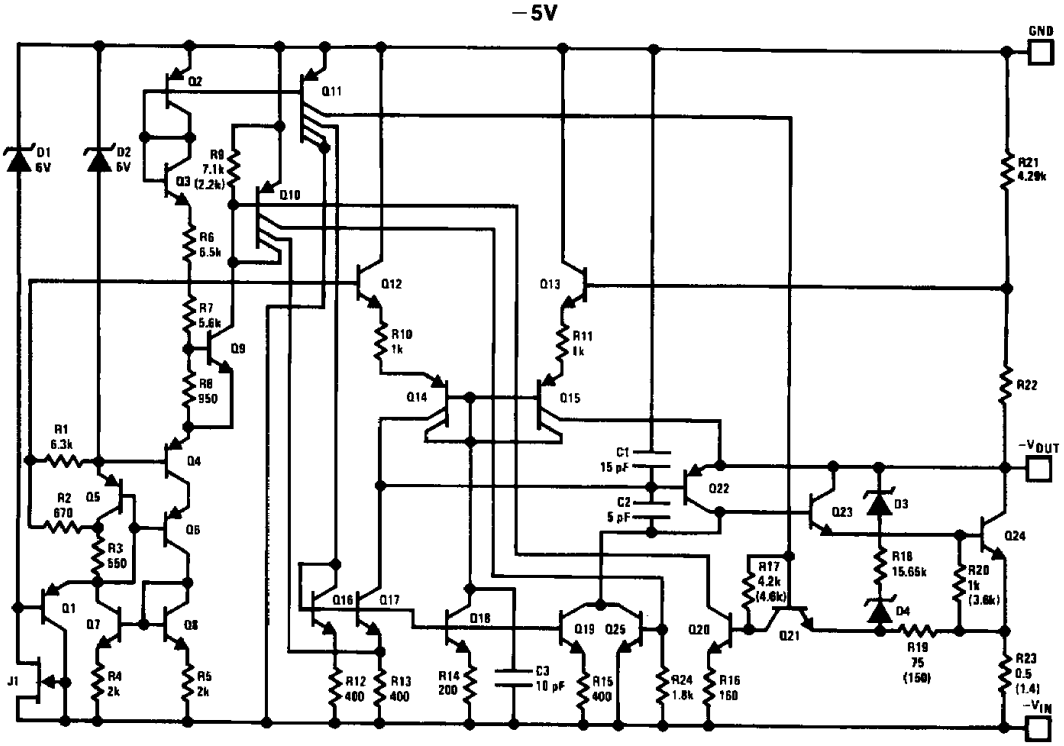
## Schematic Diagrams

−5V

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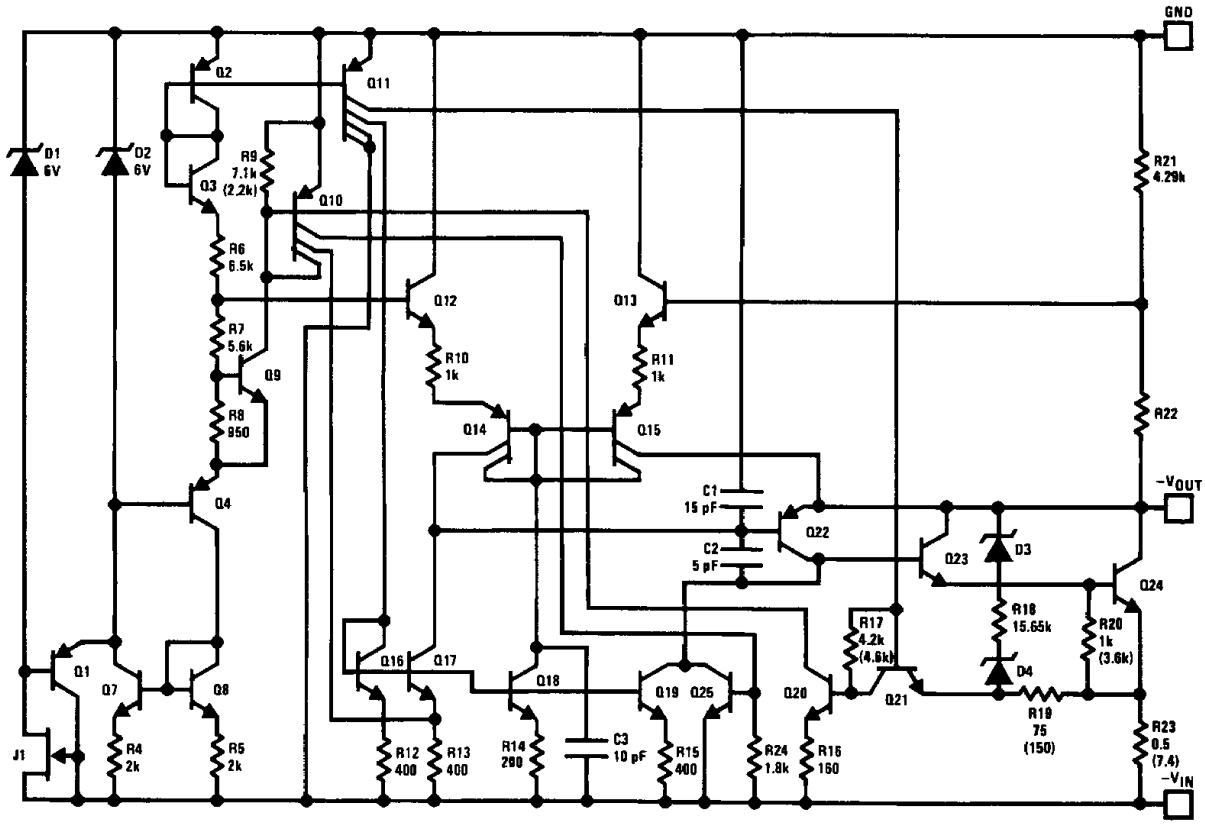
−12V and −15V

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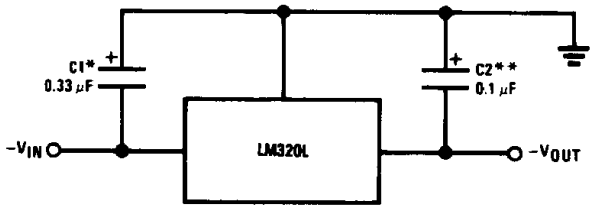
# Typical Applications

### Fixed Output Regulator

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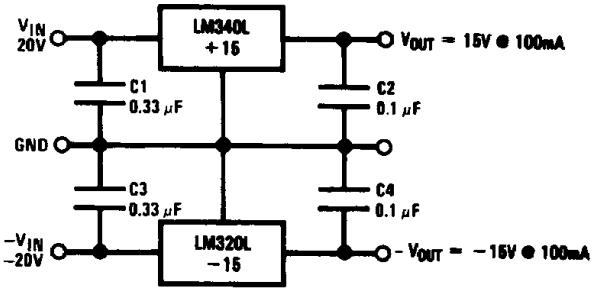
*Required if the regulator is located far from the power supply filter. A 1 μF aluminum electrolytic may be substituted.

**Required for stability. A 1 μF aluminum electrolytic may be substituted.

### ±15V, 100 mA Dual Power Supply

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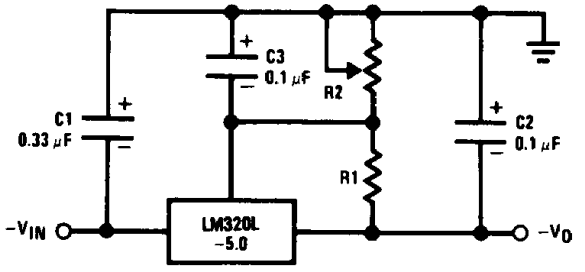
### Adjustable Output Regulator

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$$-V_O = -5V - (5V/R1 + I_Q) \bullet R2,$$
$$5V/R1 > 3\,I_Q$$