# 3-TERMINAL ADJUSTABLE REGULATORS

SLVS004C – APRIL 1979 – REVISED JULY 1999

- **Output Voltage Range Adjustable From 1.2 V to 32 V When Used With an External Resistor Divider**
- **Output Current Capability of 100 mA**
- **Input Regulation Typically 0.01% Per Input-Voltage Change**
- **Output Regulation Typically 0.5%**
- **Ripple Rejection Typically 80 dB**

**D PACKAGE
(TOP VIEW)**

| | | |
|---|---|---|
| INPUT | 1 | 8 NC |
| OUTPUT | 2 | 7 OUTPUT |
| OUTPUT | 3 | 6 OUTPUT |
| ADJUSTMENT | 4 | 5 NC |

NC – No internal connection
OUTPUT terminals are all internally connected.

**LP PACKAGE
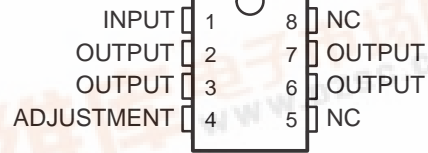(TOP VIEW)**

INPUT
OUTPUT
ADJUSTMENT

## description

The TL317 is an adjustable three-terminal positive-voltage regulator capable of supplying 100 mA over an output-voltage range of 1.2 V to 32 V. It is exceptionally easy to use and requires only two external resistors to set the output voltage.

In addition to higher performance than fixed regulators, this regulator offers full overload protection available only in integrated circuits. Included on the chip are current-limiting and thermal-overload protection. All overload-protection circuitry remains fully functional, even when ADJUSTMENT is disconnected. Normally, no capacitors are needed unless the device is situated far from the input filter capacitors, in which case an input bypass is needed. An optional output capacitor can be added to improve transient response. ADJUSTMENT can be bypassed to achieve very high ripple rejection, which is difficult to achieve with standard three-terminal regulators.

In addition to replacing fixed regulators, the TL317 regulator is useful in a wide variety of other applications. Since the regulator is floating and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input-to-output differential is not exceeded. Its primary application is that of a programmable output regulator, but by connecting a fixed resistor between ADJUSTMENT and OUTPUT, this device can be used as a precision current regulator. Supplies with electronic shutdown can be achieved by clamping ADJUSTMENT to ground, programming the output to 1.2 V, where most loads draw little current.
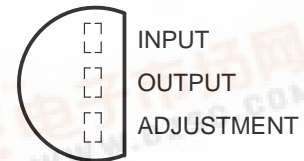
The TL317C is characterized for operation over the virtual junction temperature range of 0°C to 125°C.

**AVAILABLE OPTIONS**

| | PACKAGED DEVICES | | CHIP FORM (Y) |
|---|---|---|---|
| T_J | SMALL OUTLINE (D) | PLASTIC (LP) | |
| 0°C to 125°C | TL317CD | TL317CLP | TL317Y |

The D and LP packages are available taped and reeled. Add the suffix R to device type (e.g., TL317CDR). Chip forms are tested at 25°C.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.
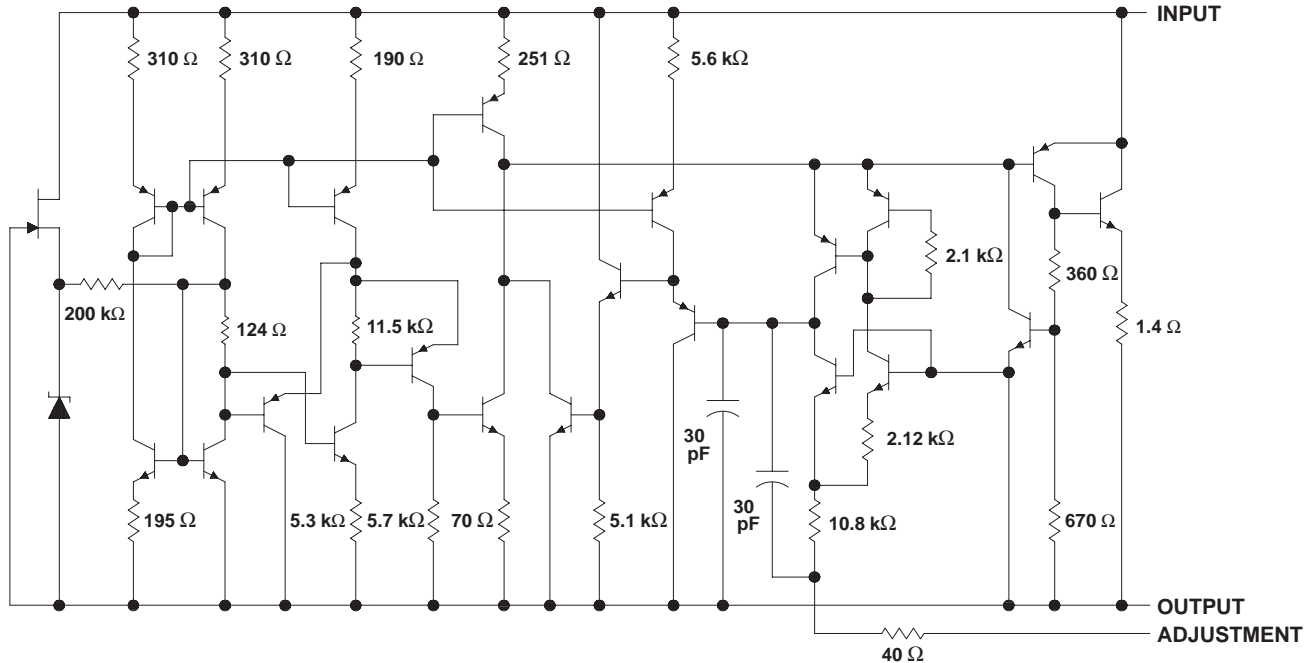
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TEXAS INSTRUMENTS

## schematic



NOTE A:  All component values shown are nominal.

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

Input-to-output differential voltage, $V_I - V_O$ ................................................... 35 V
Operating free-air, $T_A$, case, or virtual-junction temperature range, $T_J$: TL317C ............ 0°C to 150°C
Package thermal impedance, $\theta_{JA}$ (see Notes 1 and 2): D package ........................... 97°C/W
                                          LP package .......................... 156°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ............................. 260°C
Storage temperature range, $T_{stg}$ ............................................... –65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and
  functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not
  implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES:   1.  Maximum power dissipation is a function of $T_J$(max), $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable
               ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can impact reliability.
         2.  The package thermal impedance is calculated in accordance with JESD 51, except for through-hole packages, which use a trace
             length of zero.

## recommended operating conditions

|  |  | MIN | MAX | UNIT |
|---|---|---|---|---|
| Input-to-output voltage differential, $V_I - V_O$ |  |  | 35 | V |
| Output current, $I_O$ |  | 2.5 | 100 | mA |
| Operating virtual-junction temperature, $T_J$ | TL317C | 0 | 125 | °C |

## electrical characteristics over recommended operating virtual-junction temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | | TL317C | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| Input voltage regulation (see Note 3) | $V_I - V_O$ = 5 V to 35 V | $T_J$ = 25°C | | 0.01 | 0.02 | %V |
| | | $I_O$ = 2.5 mA to 100 mA | | 0.02 | 0.05 | |
| Ripple regulation | $V_O$ = 10 V, f = 120 Hz | | | 65 | | dB |
| | $V_O$ = 10 V, 10-μF capacitor between ADJUSTMENT and ground | | 66 | 80 | | |
| Output voltage regulation | $V_I$ = 5 V to 35 V, $I_O$ = 2.5 mA to 100 mA, $T_J$ = 25°C | $V_O \leq$ 5 V | | 25 | | mV |
| | | $V_O \geq$ 5 V | | 5 | | mV/V |
| | $V_I$ = 5 V to 35 V, $I_O$ = 2.5 mA to 100 mA | $V_O \leq$ 5 V | | 50 | | mV |
| | | $V_O \geq$ 5 V | | 10 | | mV/V |
| Output voltage change with temperature | $T_J$ = 0°C to 125°C | | | 10 | | mV/V |
| Output voltage long-term drift | After 1000 hours at $T_J$ = 125°C and $V_I - V_O$ = 35 V | | | 3 | 10 | mV/V |
| Output noise voltage | f = 10 Hz to 10 kHz, $T_J$ = 25°C | | | 30 | | μV/V |
| Minimum output current to maintain regulation | $V_I - V_O$ = 35 V | | | 1.5 | 2.5 | mA |
| Peak output current | $V_I - V_O \leq$ 35 V | | 100 | 200 | | mA |
| ADJUSTMENT current | | | | 50 | 100 | μA |
| Change in ADJUSTMENT current | $V_I - V_O$ = 2.5 V to 35 V, $I_O$ = 2.5 mA to 100 mA | | | 0.2 | 5 | μA |
| Reference voltage (output to ADJUSTMENT) | $V_I - V_O$ = 5 V to 35 V, $I_O$ = 2.5 mA to 100 mA, P ≤ rated dissipation | | 1.2 | 1.25 | 1.3 | V |

† Unless otherwise noted, these specifications apply for the following test conditions: $V_I - V_O$ = 5 V and $I_O$ = 40 mA. Pulse-testing techniques must be used that maintain the junction temperature as close to the ambient temperature as possible. All characteristics are measured with a 0.1-μF capacitor across the input and a 1-μF capacitor across the output.

NOTE 3:  Input voltage regulation is expressed here as the percentage change in output voltage per 1-V change at the input.

## electrical characteristics over recommended operating conditions, $T_J$ = 25°C (unless otherwise noted)

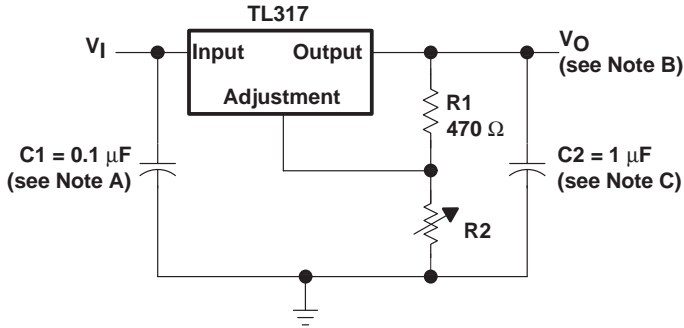| PARAMETER | TEST CONDITIONS† | | TL317Y | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| Input voltage regulation (see Note 3) | $V_I - V_O$ = 5 V to 35 V | | | 0.01 | | %V |
| Ripple regulation | $V_O$ = 10 V, f = 120 Hz | | | 65 | | dB |
| | $V_O$ = 10 V, 10-μF capacitor between ADJUSTMENT and ground | | | 80 | | |
| Output voltage regulation | $I_O$ = 2.5 mA to 100 mA | $V_O \leq$ 5 V | | 25 | | mV |
| | | $V_O \geq$ 5 V | | 5 | | mV/V |
| Output noise voltage | f = 10 Hz to 10 kHz | | | 30 | | μV/V |
| Minimum output current to maintain regulation | $V_I - V_O$ = 35 V | | | 1.5 | | mA |
| Peak output current | $V_I - V_O \leq$ 35 V | | | 200 | | mA |
| ADJUSTMENT current | | | | 50 | | μA |
| Change in ADJUSTMENT current | $V_I - V_O$ = 2.5 V to 35 V, $I_O$ = 2.5 mA to 100 mA | | | 0.2 | | μA |
| Reference voltage (output to ADJUSTMENT) | $V_I - V_O$ = 5 V to 35 V, $I_O$ = 2.5 mA to 100 mA, P ≤ rated dissipation | | | 1.25 | | V |

† Unless otherwise noted, these specifications apply for the following test conditions: $V_I - V_O$ = 5 V and $I_O$ = 40 mA. Pulse-testing techniques must be used that maintain the junction temperature as close to the ambient temperature as possible. All characteristics are measured with a 0.1-μF capacitor across the input and a 1-μF capacitor across the output.

NOTE 3:  Input voltage regulation is expressed here as the percentage change in output voltage per 1-V change at the input.

## TEXAS INSTRUMENTS

## APPLICATION INFORMATION

**TL317**

V$_I$ — Input   Output — V$_O$ (see Note B)

Adjustment

R1
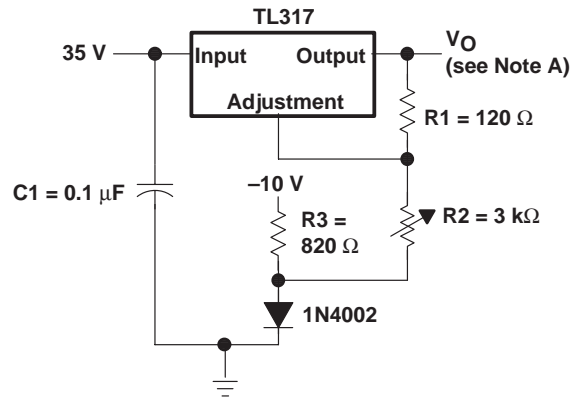470 Ω

C1 = 0.1 μF
(see Note A)

C2 = 1 μF
(see Note C)

R2

NOTES: A. Use of an input bypass capacitor is recommended if
regulator is far from the filter capacitors.
B. Output voltage is calculated from the equation:

$$V_O = V_{ref}\left(1 + \frac{R2}{R1}\right)$$

where: V$_{ref}$ equals the difference between OUTPUT and
ADJUSTMENT voltages (≈1.25 V).
C. Use of an output capacitor improves transient response
but is optional.

**Figure 1. Adjustable Voltage Regulator**

**TL317**
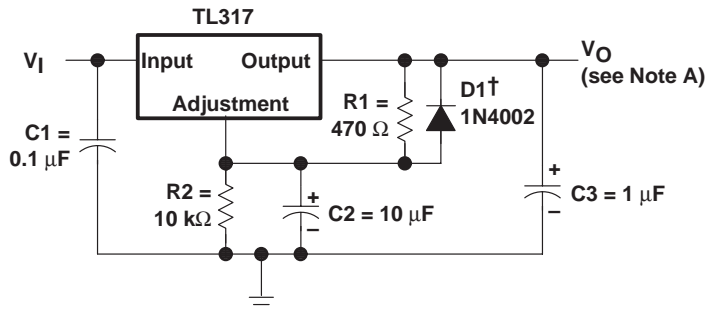
35 V — Input   Output — V$_O$ (see Note A)

Adjustment

R1 = 120 Ω

C1 = 0.1 μF

−10 V

R3 =
820 Ω

R2 = 3 kΩ

**1N4002**

NOTE A: Output voltage is calculated from the equation:

$$V_O = V_{ref}\left(1 + \frac{R2 + R3}{R1}\right) - 10\ V$$

where: V$_{ref}$ equals the difference between OUTPUT
and ADJUSTMENT voltages (≈1.25 V).

**Figure 2. 0-V to 30-V Regulator Circuit**

**TL317**

V$_I$ — Input   Output — V$_O$ (see Note A)

Adjustment

R1 =
470 Ω

D1†
1N4002

R2 =
10 kΩ

C2 = 10 μF

C3 = 1 μF

† D1 discharges C2 if output is shorted to ground.
NOTE A: Use of an output capacitor improves transient response but is
optional.

**Figure 3. Regulator Circuit
With Improved Ripple Rejection**

**TL317**

V$_I$ — Input   Output

Adjustment

R1

$$I_{limit} = \frac{1.25}{R1}$$
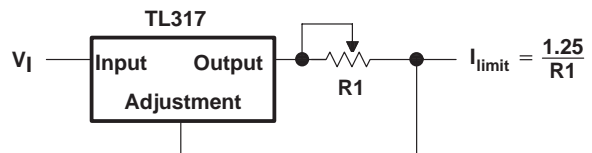
**Figure 4. Precision Current-Limiter Circuit**
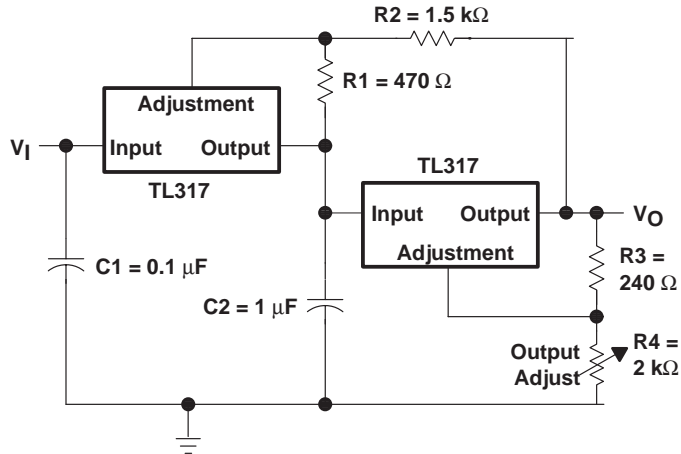
## APPLICATION INFORMATION
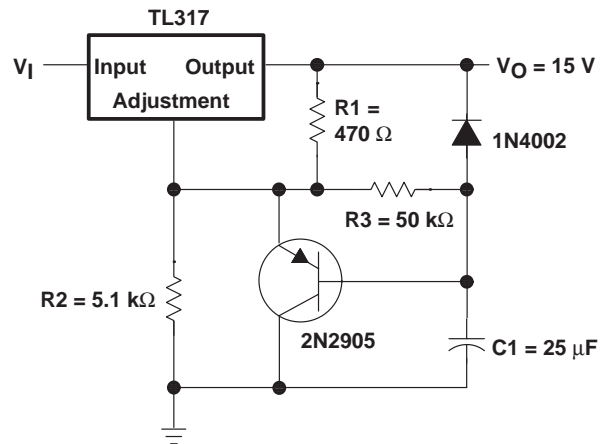
**Figure 5. Tracking Preregulator Circuit**
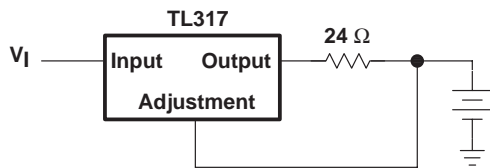
**Figure 6. Slow Turnon 15-V Regulator Circuit**

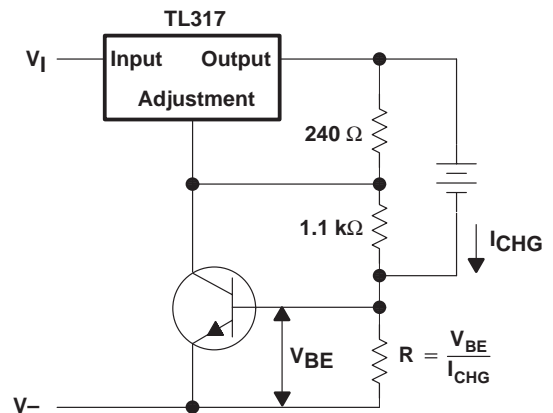**Figure 7. 50-mA Constant-Current Battery Charger Circuit**

**Figure 8. Current-Limited 6-V Charger**

## APPLICATION INFORMATION



† Minimum load current is 30 mA.
‡ Optional capacitor improves ripple rejection

**Figure 9. High-Current Adjustable Regulator**

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