## 1. DESCRIPTION

The XL317 is an adjustable positive voltage regulator capable of supplying 100 mA over a 1.2V to 32V output range. The XL317 is easy to use and requires only two external resistors to set the output voltage. Both line and load regulation are better than standard fixed regulators. The XL317 is available SOP8 package.

The XL317 offers full overload protection. Included on the chip are current limit, thermal overload protection, and safe area protection. Normally, no capacitors are required unless the device is situated more than 6 inches from the input filter capacitors, in which case an input bypass is required.

The XL317 uses floating topology and sees only the input-to-output differential voltage, therefore supplies of dozens volts can be regulated, provided the maximum input-to-output differential is not exceeded. The device makes a simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the XL317 can be used as a precision current regulator.

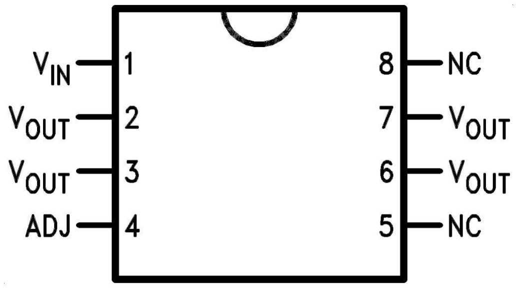
## 2. FEATURES

- Adjustable Output Down to 1.2 V
- 100mA Output Current
- Capable of Handling up to 35V
- Line Regulation Typically 0.02% /V
- Load Regulation Typically 0.3% /A
- Current Limit Constant With Temperature
- Eliminates the Need to Stock Many Voltages
- Standard SOP8 Package
- 80-dB Ripple Rejection
- Output is Short-Circuit Protected

## 3. APPLICATIONS

- Battery Chargers
- Post Regulation for Switching Supplies
- Constant-Current Regulators
- Microprocessor Supplies

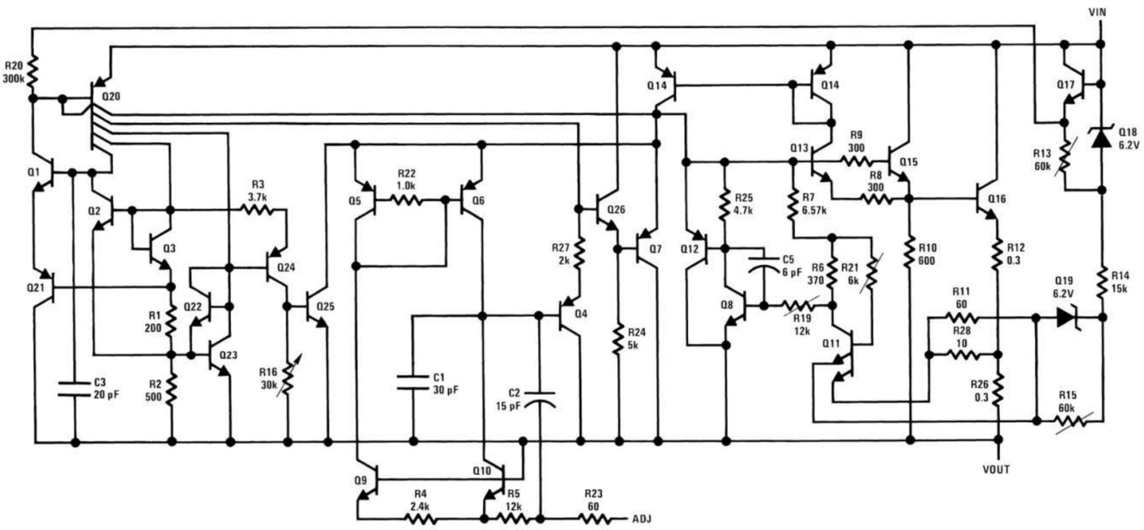
## 4. PIN CONFIGURATIONS AND FUNCTIONS




(Top View)

| Symbol | Pin | IO | Description |
|---|---|---|---|
| $V_{IN}$ | 1 | I | Supply input pin |
| $V_{OUT}$ | 2, 3, 6, 7 | O | Voltage output pin |
| ADJ | 4 | I | Output voltage adjustment pin. Connect to a resistor divider to set $V_{out}$. |
| NC | 5, 8 | — | No connection |

## 5. BLOCK DIAGRAM



# 6. SPECIFICATIONS

## 6.1 Absolute Maximum Ratings

| PARAMETER | MIN | MAX | UNIT |
|---|---|---|---|
| Power dissipation | Internally Limited | | — |
| Input-output voltage differential | | 35 | V |
| Operating virtual-junction temperature (Tj) | | 150 | ℃ |
| Lead temperature (soldering, 4 seconds) | | 260 | ℃ |
| Storage temperature, $T_{stg}$ | −50 | 150 | ℃ |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## 6.2 ESD Ratings

| PARAMETER | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001[1] | ±2000 | V |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Pins listed as ±2000 V may actually have higher performance.

## 6.3 Recommended Operating Conditions

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_O$ | Output voltage | 1.25 | 32 | V |
| $V_I - V_O$ | Input-to-output voltage differential | 2.5 | 32 | V |
| $I_O$ | Output current | 2.5 | 100 | mA |
| TJ | Operating virtual-junction temperature | -40 | 125 | ℃ |
| Top | Operating ambient temperature | -40 | 85 | ℃ |
| Pd | power dissipations | - | 625 | mW |

## 6.4 Thermal Information

| THERMAL METRIC | | SOP8 | UNIT |
|---|---|---|---|
| $R\theta_{JA}$ | Junction-to-ambient thermal resistance | 108 | ℃/W |

## 6.5 Electrical Characteristics

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Line regulation | $T_J$ = 25°C, 3 V ≤ ($V_{IN}$ − $V_{OUT}$) ≤ 32 V, $I_L$ ≤ 20 mA(2) | — | 0.02 | 0.07 | %/V |
| Load regulation | $T_J$ = 25°C, 5 mA ≤ $I_{OUT}$ ≤ $I_{MAX}$ (2) | — | 0.3% | 1.5% | %/A |
| Thermal regulation | $T_J$ = 25°C, 10-ms Pulse | — | 0.04 | 0.2 | %/W |
| Adjustment pin current | — | — | 50 | 200 | μA |
| Adjustment pin current change | 5 mA ≤ $I_L$ ≤ 100 mA<br>3 V ≤ ($V_{IN}$ − $V_{OUT}$) ≤ 32 V, P ≤ 625 mW | | 0.2 | 10 | μA |
| Reference voltage | 3 V ≤ ($V_{IN}$ − $V_{OUT}$) ≤ 32V<br>5 mA ≤ $I_{OUT}$ ≤ 100 mA, P ≤ 625 mW | 1.2 | 1.25 | 1.3 | V |
| Temperature stability | $T_{MIN}$ ≤ $T_J$ ≤ $T_{MAX}$ | | | 0.65% | — |
| Minimum load current to maintain regulation | ($V_{IN}$ − $V_{OUT}$) ≤ 32 V | | 3.5 | 5 | mA |
| | 3 V ≤ ($V_{IN}$ − $V_{OUT}$) ≤ 15 V | — | 1.5 | 2.5 | |
| Current limit | 3 V ≤ ($V_{IN}$ − $V_{OUT}$) ≤ 13 V | 100 | 200 | — | mA |
| | ($V_{IN}$ − $V_{OUT}$) = 32 V | 25 | 30 | 50 | |
| RMS output noise, % of $V_{OUT}$ | $T_J$ = 25°C, 10 Hz ≤ f ≤ 10 kHz | | | 0.1% | — |
| Ripple rejection ratio | $V_{OUT}$ = 10 V, f = 120 Hz, $C_{ADJ}$ = 0 | | | 65 | dB |
| | $C_{ADJ}$ = 10 μF | 66 | 80 | — | |

(1) Unless otherwise noted, these specifications apply: −45°C ≤ $T_j$ ≤ 85°C for the XL317; $V_{IN}$ − $V_{OUT}$ = 5 V and $I_{OUT}$ = 40 mA. Although power dissipation is internally limited, these specifications are applicable for power dissipations up to 625 mW. $I_{MAX}$ is 100 mA.

(2) Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

## 7. Detailed Description

The XL317 device is a 100mA linear regulator with high voltage tolerance up to 32 V. The device has a feedback voltage that is relative to the output instead of ground. This ungrounded design allows the XL317 device to have superior line and load regulation. This design also allows the XL317 device to be used as a current source or current sink using a single resistor. Any output voltage from 1.25 to 32 V can be obtained by using two resistors. The bias current of the device, up to 2.5 mA, flows to the output; this current must be used by the load or the feedback resistors. The power dissipation is the product of pass-element voltage and current, which is calculated as shown following:

$$PD = (VIN – VOUT) \times IOUT$$

The application heat sink must be able to absorb the power calculated in above formula.

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 ADJ 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.

ADJ 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 XL317 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 ADJ and VOUT, this device can be used as a precision current regulator. Supplies with electronic shutdown can be achieved by clamping ADJ to ground, programming the output to 1.25 V, where most loads draw little current.

In operation, the XL317 develops a nominal 1.25V reference voltage, VREF, between the output and adjustment terminal. The reference voltage is impressed across program resistor R1 and, because the voltage is constant, a constant current I1 then flows through the output set resistor R2, giving an output voltage of:

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}(R2)$$

Because the 100μA current from the adjustment terminal represents an error term, the XL317 was designed to minimize IADJ and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

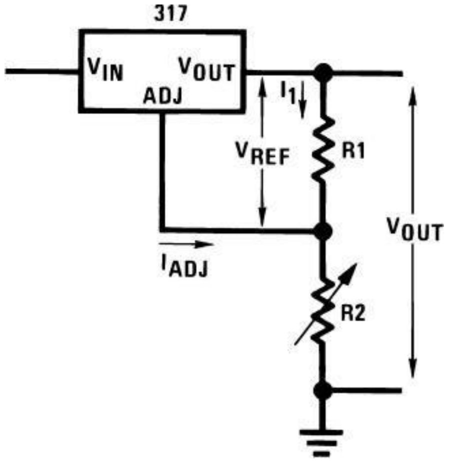



**Figure 1. Typical Application Circuit for Adjustable Regulator**

# 8. Application and Implementation

## 8.1 Application Information

The two output resistors are the only components required to adjust $V_{OUT}$(Vo).

## 8.2 Typical Application

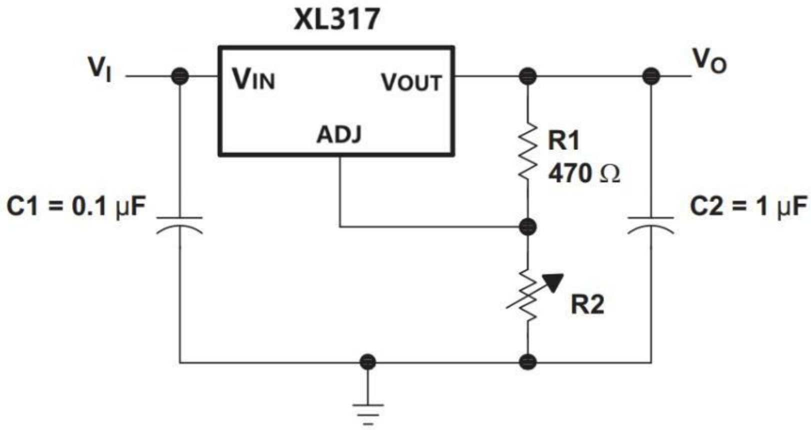



Figure 2. Adjustable Regulator

### 8.2.1 Design Requirements

1. Use of an input bypass capacitor is recommended if regulator is far from the filter capacitors.
2. For this design example, use the parameters listed in Table 1.
3. Use of an output capacitor improves transient response, but is optional.

**Table 1. Design Parameters**

| DESIGN PARAMETER | EXAMPLE VALUE |
|---|---|
| Input voltage range | (Output Voltage + 2.5 V) to 32 V |
| Output voltage | $V_{REF} \times (1 + R_2 / R_1) + I_{ADJ} \times R_2$ |

### 8.2.2 Detailed Design Procedure

#### *8.2.2.1 Input Capacitor*

An input capacitor is not required, but it is recommended, particularly if the regulator is not in close proximity to the power-supply filter capacitors. A 0.1μF ceramic or 1μF tantalum provides sufficient bypassing for most applications, especially when adjustment and output capacitors are used.

#### *8.2.2.2 Output Capacitor*

An output capacitor improves transient response, but it not needed for stability.

#### 8.2.2.3 Feedback Resistors

The feedback resistor set the output voltage using following formula:

$$V_{REF} \times (1 + R_2 / R_1) + I_{ADJ} \times R_2$$

#### 8.2.2.4 Adjustment Terminal Capacitor

The optional adjustment pin capacitor will improve ripple rejection by preventing the amplification of the ripple. When capacitor is used and VOUT > 6 V, a protection diode from adjust to output is recommended.

#### 8.2.2.5 Design Options and Parameters

Common Linear Regulator designs are concerned with the following parameters:

- Input voltage range
- Input capacitor range
- Output voltage
- Output current rating
- Output capacitor range
- Input short protection
- Stability
- Ripple rejection

#### 8.2.2.6 Output Voltage

$V_{OUT}$ is calculated as shown in following formula:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_2}{R_1}\right) + (I_{ADJ} \times R_2)$$

use $I_{ADJ}$ typically is 50 μA, it is negligible in most applications.

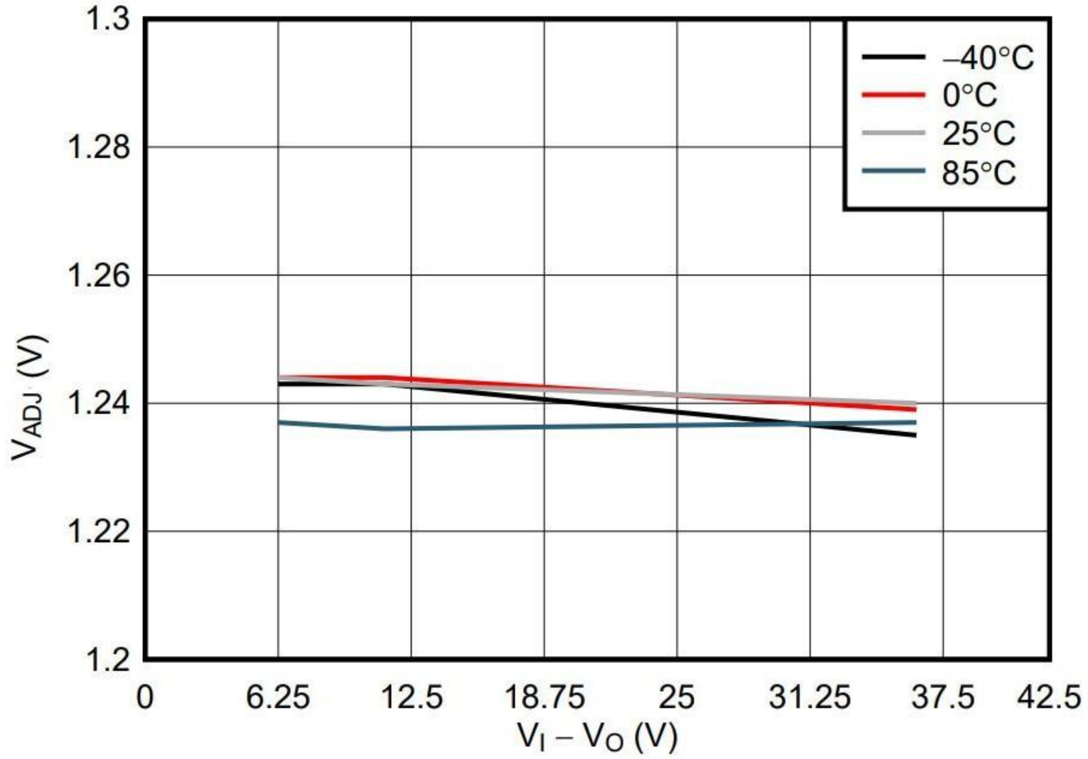
#### 8.2.2.7 Ripple Rejection

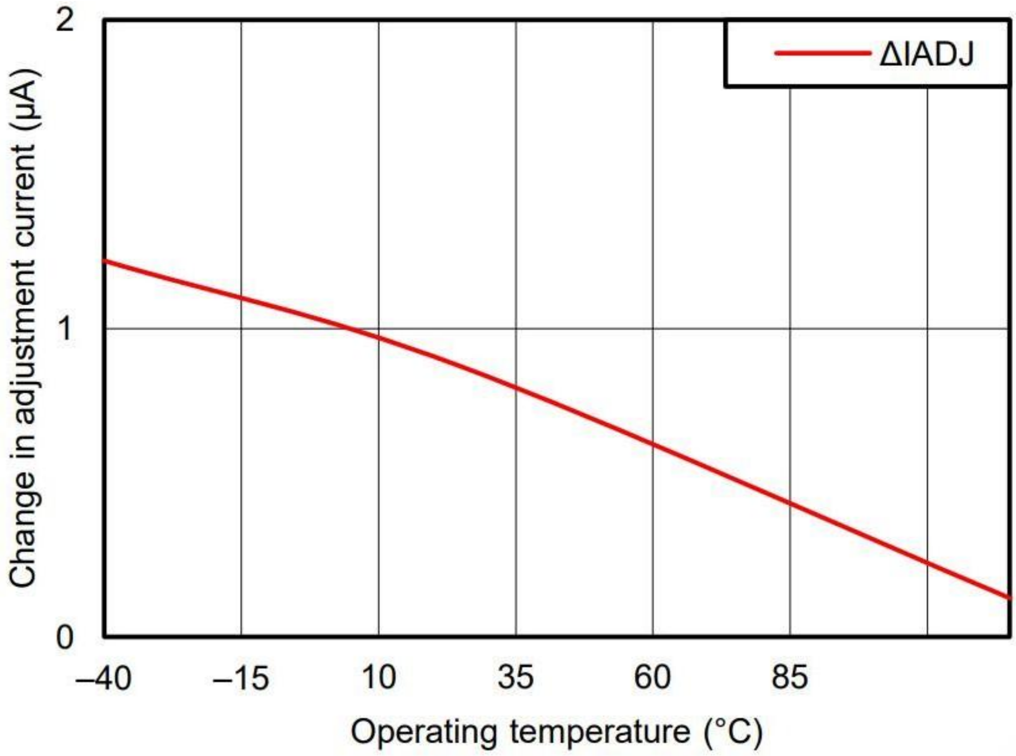
$C_{ADJ}$ is used to improve ripple rejection; it prevents amplification of the ripple as the output voltage is adjusted higher. If $C_{ADJ}$ is used, it is best to include protection diodes.

#### 8.2.2.8 Input Short Protection

If the input is shorted to ground during a fault condition, protection diodes provide measures to prevent the possibility of external capacitors discharging through low-impedance paths in the IC. By providing low-impedance discharge paths for $C_{OUT}$ and $C_{ADJ}$, respectively, D1 and D2 prevent the capacitors from discharging into the output of the regulator.

### 8.3 Application Curves



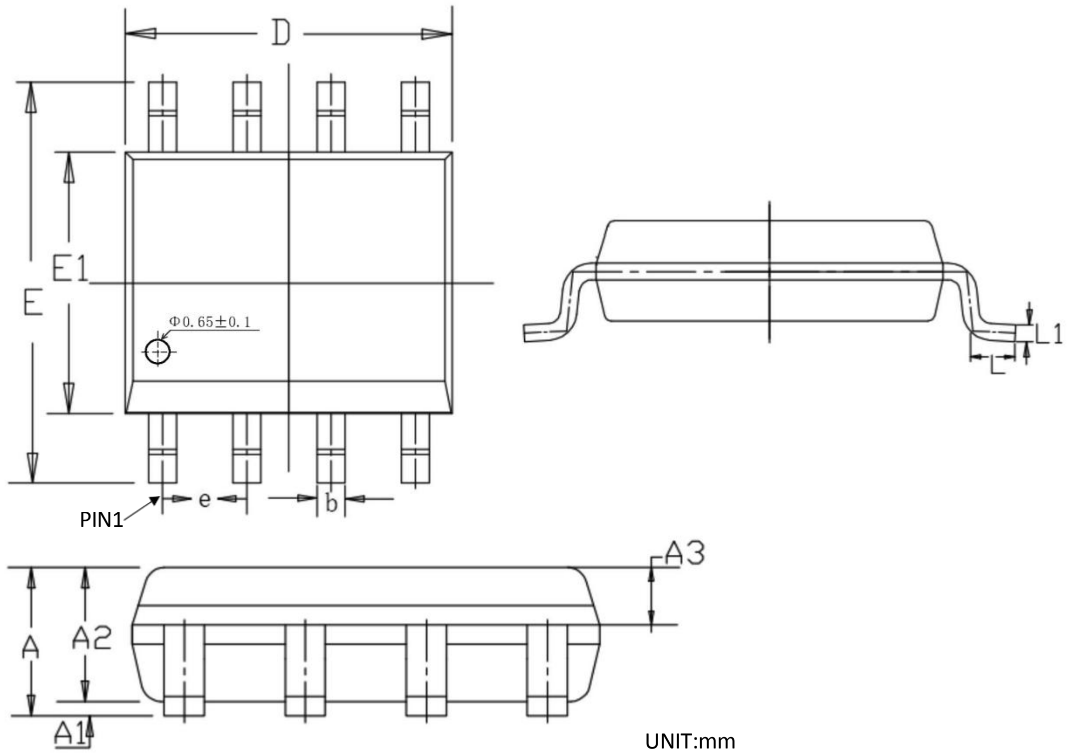
## 9. ORDERING INFORMATION

**Ordering Information**

| Part Number | Device Marking | Package Type | Body size (mm) | Temperature (°C) | MSL | Transport Media | Package Quantity |
|---|---|---|---|---|---|---|---|
| XL317 | XL317 | SOP8 | 4.90 * 3.90 | - 40 to 85 | MSL3 | T&R | 2500 |

## 10. DIMENSIONAL DRAWING

**SOP8**




UNIT:mm

| | MIN | NOM | MAX |
|---|---|---|---|
| A | 1.450 | 1.550 | 1.650 |
| A1 | 0.100 | 0.150 | 0.200 |
| A2 | 1.300 | 1.400 | 1.500 |
| A3 | 0.600 | 0.650 | 0.700 |
| b | 0.380 | – | 0.510 |
| e | 1.240 | 1.270 | 1.300 |
| D | 4.800 | 4.900 | 5.000 |
| E | 5.800 | 6.000 | 6.200 |
| E1 | 3.800 | 3.900 | 4.000 |
| L | 0.450 | 0.600 | 0.750 |
| L1 | — | 0.25BSC | — |