

## 1.5-A Wide-Input High-Current Low-Dropout Linear Regulator

### Features

- Qualified for Automotive Applications
  - AEC-Q100 Grade 1,  $T_A$ :  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
  - Junction Temperature,  $T_J$ :  $-40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$
- Input Voltage Range: 2.75 V to 29 V
- Adjustable Output Voltage from 1.25 V
- 1.5 A Maximum Output Current
- $\pm 2\%$  Output Accuracy Over Line Regulation, Load Regulation, and Operating Temperature Range
- Low Dropout Voltage: 1.2 V Typically at 1.5 A
- High PSRR:
  - 77 dB at 120 Hz
  - 72 dB at 1 kHz
- Excellent Transient Response
- Stable with a 10  $\mu\text{F}$  to 100  $\mu\text{F}$  Tantalum Output Capacitor
- Integrated Protection:
  - Over-Current Protection
  - Over-Temperature Protection
- Package Options:
  - ESOP8

### Applications

- Automotive High Power Linear Power Supplies
- Automotive Low Noise Power Supplies
- Automotive Microcontroller, ASIC Power Supply

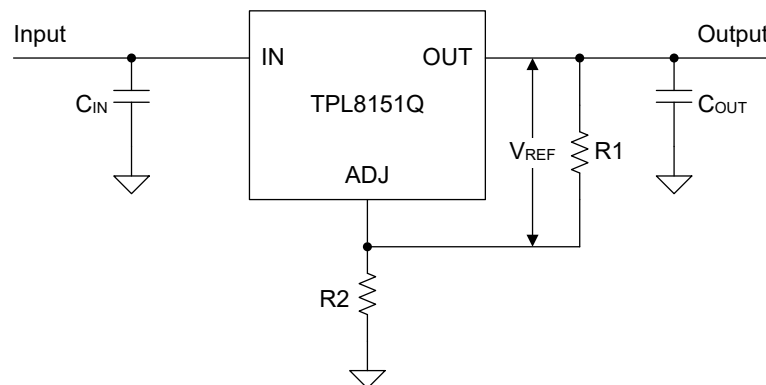
### Description

The TPL8151Q is a 1.5-A high-current, low-dropout linear regulator with up to 29-V wide input voltage range. The TPL8151Q supports adjustable output voltage ranging from 1.25 V with an external resistor divider and is stable with a 10- $\mu\text{F}$  to 100- $\mu\text{F}$  tantalum output capacitor.

The TPL8151Q is compatible with older three-terminal adjustable linear regulators but has lower dropout voltage, tighter output tolerance, and better transient performance.

The TPL8151Q provides a thermal-enhanced ESOP8 package with guaranteed ambient operating temperature ( $T_A$ ) range from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

### Typical Application Circuit



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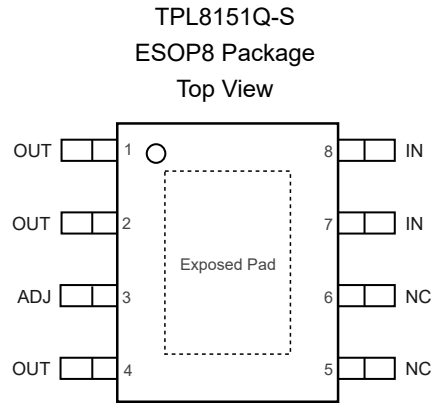
**1.5-A Wide-Input High-Current Low-Dropout Linear Regulator****Product Family Table**

| Order Number      | Output Voltage | Output Current | Package |
|-------------------|----------------|----------------|---------|
| TPL8151ADQ-ES1R-S | Adjustable     | 1.5 A          | ESOP8   |

**Revision History**

| Date       | Revision  | Notes  |
|------------|-----------|--|
| 2021-07-31 | Rev.Pre.0 | Preliminary  |
| 2022-04-15 | Rev.Pre.1 | 1. Updated Thermal Information<br>2. Added Typical Performance Characteristics<br>3. Added Tape and Reel Information |
| 2022-08-15 | Rev.A.0   | Initial released   |
| 2024-04-06 | Rev.A.1   | Updated Thermal Information  |

### Pin Configuration and Functions



**Table 1. Pin Functions: TPL8151Q-S**

| Pin No.                | Pin Name    | I/O | Description  |
|------------------------|-------------|-----|--|
| 3                      | ADJ         | I   | Output voltage adjust pin. Connect to a resistor divider to adjust the output voltage. |
| 7, 8                   | IN          | I   | Input voltage pin.   |
| 5, 6                   | NC          | –   | No connection.   |
| 1, 2, 4 <sup>(1)</sup> | OUT         | O   | Regulated output voltage pin.  |
| –                      | Exposed Pad | –   | The exposed Pad MUST be connected to OUT directly to improve thermal performance.      |

(1) Pin 4 MUST be directly tied to the other OUT pins.

**1.5-A Wide-Input High-Current Low-Dropout Linear Regulator**
**Specifications**
**Absolute Maximum Ratings <sup>(1)</sup>**

| Parameter                          |                                     | Min  | Max | Unit |
|------------------------------------|-------------------------------------|------|-----|------|
| V <sub>IN</sub> <sup>(1)(2)</sup>  |                                     | -0.3 | 32  | V    |
| V <sub>OUT</sub> <sup>(1)(2)</sup> |                                     | -0.3 | 32  | V    |
| T <sub>J</sub> <sup>(1)</sup>      | Maximum Junction Temperature Range  | -40  | 150 | °C   |
| T <sub>STG</sub> <sup>(1)</sup>    | Storage Temperature Range           | -65  | 150 | °C   |
| T <sub>L</sub> <sup>(1)</sup>      | Lead Temperature (Soldering 10 sec) |      | 260 | °C   |

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

(2) All voltage values are with respect to ground.

**ESD, Electrostatic Discharge Protection**

| Parameter |                          | Condition                             | Minimum Level | Unit |
|-----------|--------------------------|---------------------------------------|---------------|------|
| HBM       | Human Body Model ESD     | ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup> | ±3.5          | kV   |
| CDM       | Charged Device Model ESD | ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup> | ±1.5          | kV   |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

**Recommended Operating Conditions**

| Parameter        |                            | Min  | Max | Unit |
|------------------|----------------------------|------|-----|------|
| V <sub>IN</sub>  |                            | 2.75 | 29  | V    |
| V <sub>OUT</sub> |                            | 0    | 25  | V    |
| C <sub>OUT</sub> |                            | 10   | 100 | μF   |
| ESR              |                            | 0.5  | 6   | Ω    |
| T <sub>A</sub>   | Ambient Temperature Range  | -40  | 125 | °C   |
| T <sub>J</sub>   | Junction Temperature Range | -40  | 125 | °C   |

**Thermal Information**

| Package Type | θ <sub>JA</sub> | θ <sub>JB</sub> | θ <sub>JC, TOP</sub> | Unit |
|--------------|-----------------|-----------------|----------------------|------|
| ESOP-8       | 36.1            | 14.63           | 47.53                | °C/W |

**1.5-A Wide-Input High-Current Low-Dropout Linear Regulator**
**Electrical Characteristics**

All test conditions:  $V_{IN} = V_{OUT(NOM)} + 1.5\text{ V}$  or  $4.25\text{ V}$ , whichever is greater;  $C_{IN} = C_{OUT} = 10\text{ }\mu\text{F}$ ,  $-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$ , unless otherwise noted.

| Parameter                            | Conditions                   | Min  | Typ   | Max   | Unit  |                     |
|--------------------------------------|------------------------------|--|-------|-------|-------|---------------------|
| <b>Supply Voltage and Current</b>    |                              |  |       |       |       |                     |
| $V_{IN}^{(1)}$                       | Input Supply Voltage         | $V_{IN, MIN}$  |       | 29    | V     |                     |
| <b>Regulated Voltage and Current</b> |                              |  |       |       |       |                     |
| $V_{OUT}^{(2)}$                      | Output Voltage Accuracy      | $I_{OUT} = 10\text{ mA}$ , $T_A = 25^{\circ}\text{C}$  |       | 1%    |       |                     |
|                                      |                              | $I_{OUT} = 10\text{ mA}$ to $1.5\text{ A}$ , $V_{IN} = 2.75\text{ V}$ to $29\text{ V}$   | -2%   |       | 2%    |                     |
| $V_{REF}^{(3)}$                      | Reference Voltage            | $I_{OUT} = 10\text{ mA}$ , $T_A = 25^{\circ}\text{C}$  | 1.238 | 1.25  | 1.263 | V                   |
|                                      |                              | $I_{OUT} = 10\text{ mA}$ to $1.5\text{ A}$ , $V_{IN} = 2.75\text{ V}$ to $29\text{ V}$   | 1.225 | 1.25  | 1.275 | V                   |
| $\Delta V_{OUT}$                     | Line Regulation              | $I_{OUT} = 10\text{ mA}$ , $V_{IN} = 2.75\text{ V}$ to $16.5\text{ V}$ ,<br>$T_A = 25^{\circ}\text{C}$   |       | 0.04% |       |                     |
|                                      |                              | $I_{OUT} = 10\text{ mA}$ , $V_{IN} = 2.75\text{ V}$ to $16.5\text{ V}$   |       | 0.04% | 0.2%  |                     |
|                                      | Load Regulation              | $I_{OUT} = 10\text{ mA}$ to $1.5\text{ A}$ , $T_A = 25^{\circ}\text{C}$  |       | 0.2%  |       |                     |
|                                      |                              | $I_{OUT} = 10\text{ mA}$ to $1.5\text{ A}$   |       | 0.2%  | 0.4%  |                     |
| $V_{DO}^{(4)}$                       | Dropout Voltage              | $I_{OUT} = 1.5\text{ A}$   |       | 1.3   | 1.5   | V                   |
| $I_{OUT}$                            | Minimum Load                 | $V_{IN} = 29\text{ V}$   |       | 5     | 10    | mA                  |
|                                      | Output Current               | $V_{OUT}$ in regulation  | 0     |       | 1.5   | A                   |
| $I_{ADJ}$                            | ADJ Pin Current              | $V_{IN} = 4.25\text{ V}$ , $I_{OUT} = 10\text{ mA}$  |       | 75    | 120   | $\mu\text{A}$       |
| $I_{SC}$                             | Short-circuit Current Limit  | $V_{IN} - V_{OUT} = 5\text{ V}$  | 1.6   | 2.3   |       | A                   |
|                                      |                              | $V_{IN} - V_{OUT} = 25\text{ V}$   | 50    | 200   |       | mA                  |
| PSRR                                 | Power Supply Rejection Ratio | $I_{OUT} = 0.1\text{ A}$ , $f = 120\text{ Hz}$ , $C_{OUT} = 22\text{ }\mu\text{F}$ , $C_{ADJ} = 22\text{ }\mu\text{F}$ , $V_{OUT} = 1.8\text{ V}$ ,<br>$V_{IN} = V_{OUT} + 2\text{ V}$ |       | 77    |       | dB                  |
|                                      |                              | $I_{OUT} = 0.1\text{ A}$ , $f = 1\text{ kHz}$ , $C_{OUT} = 22\text{ }\mu\text{F}$ , $C_{ADJ} = 22\text{ }\mu\text{F}$ , $V_{OUT} = 1.8\text{ V}$ ,<br>$V_{IN} = V_{OUT} + 2\text{ V}$  |       | 72    |       | dB                  |
|                                      |                              | $I_{OUT} = 0.1\text{ A}$ , $f = 100\text{ kHz}$ , $C_{OUT} = 22\text{ }\mu\text{F}$ , $C_{ADJ} = 22\text{ }\mu\text{F}$ , $V_{OUT} = 1.8\text{ V}$ , $V_{IN} = V_{OUT} + 2\text{ V}$   |       | 35    |       | dB                  |
| $V_N$                                | Output Noise Voltage         | $I_{OUT} = 10\text{ mA}$ , $BW = 10\text{ Hz}$ to $100\text{ kHz}$   |       | 17.5  |       | $\mu\text{V}_{RMS}$ |
| <b>Temperature Range</b>             |                              |  |       |       |       |                     |
| $T_{SD}$                             | Thermal Shutdown Threshold   |  |       | 180   |       | $^{\circ}\text{C}$  |
|                                      | Thermal Shutdown Hysteresis  |  |       | 15    |       | $^{\circ}\text{C}$  |

(1)  $V_{IN, MIN} = V_{OUT(NOM)} + 1.5\text{ V}$  or  $2.75\text{ V}$ , whichever is greater.

(2) Tolerance of external resistor divider is not included.

(3)  $V_{REF}$  is the voltage value between OUT and ADJ.

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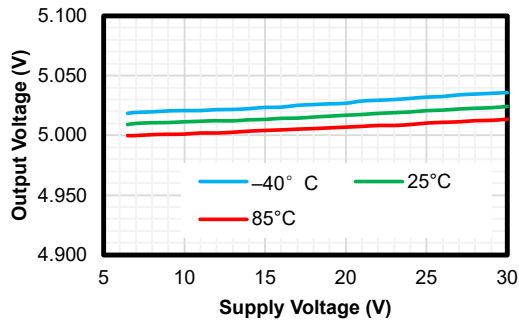
**1.5-A Wide-Input High-Current Low-Dropout Linear Regulator**

- (4) Dropout voltage is the minimum input to output voltage differential needed to maintain regulation at a specified output current and measure for  $V_{OUT} \geq 2.75$  V. In dropout mode, the output voltage will be equal to  $V_{IN} - V_{DO}$ .

# 1.5-A Wide-Input High-Current Low-Dropout Linear Regulator

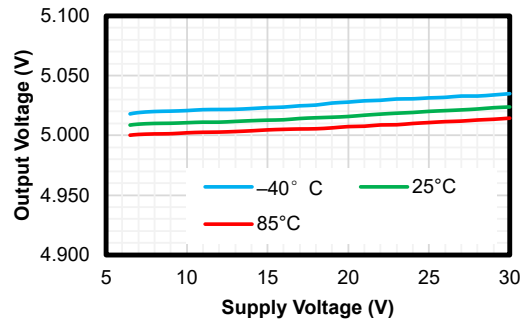
## Typical Performance Characteristics

All test conditions:  $V_{IN} = V_{OUT(NOM)} + 1.5\text{ V}$  or  $4.25\text{ V}$ , whichever is greater;  $C_{IN} = C_{OUT} = 10\ \mu\text{F}$ ,  $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ , unless otherwise noted.



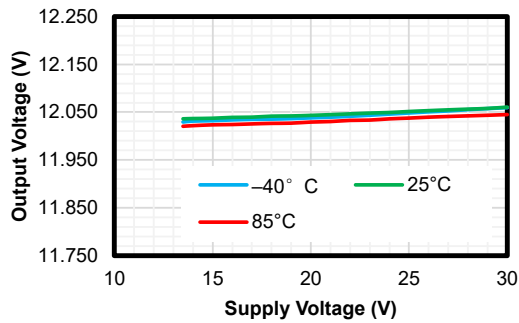
$V_{OUT} = 5\text{ V}$ ,  $I_{OUT} = 1\text{ mA}$

Figure 1. Line Regulation



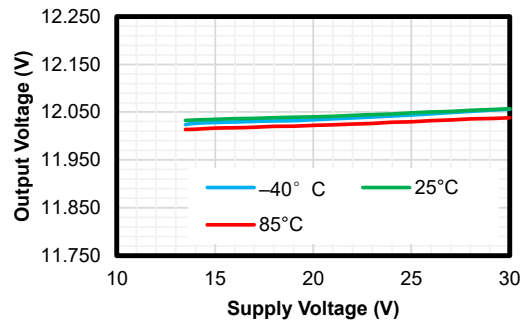
$V_{OUT} = 5\text{ V}$ ,  $I_{OUT} = 100\text{ mA}$

Figure 2. Line Regulation



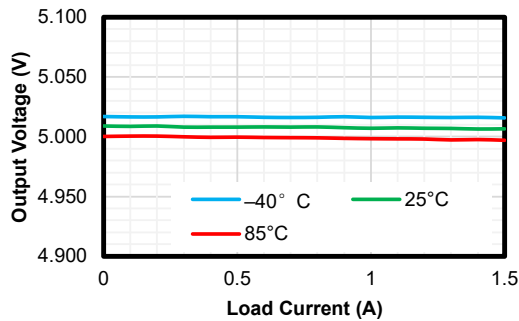
$V_{OUT} = 12\text{ V}$ ,  $I_{OUT} = 1\text{ mA}$

Figure 3. Line Regulation



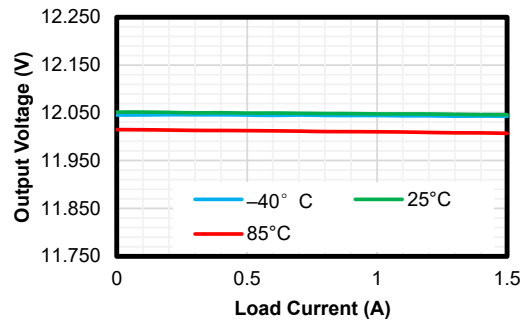
$V_{OUT} = 12\text{ V}$ ,  $I_{OUT} = 100\text{ mA}$

Figure 4. Line Regulation



$V_{OUT} = 5\text{ V}$ ,  $V_{IN} = V_{OUT} + 1\text{ V}$

Figure 5. Load Regulation



$V_{OUT} = 12\text{ V}$ ,  $V_{IN} = V_{OUT} + 1\text{ V}$

Figure 6. Load Regulation



1.5-A Wide-Input High-Current Low-Dropout Linear Regulator

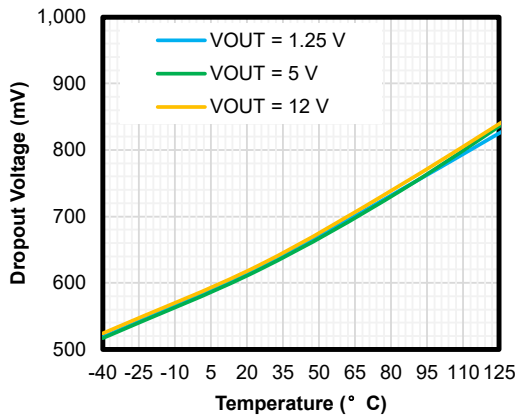


Figure 7. Dropout Voltage vs Temperature

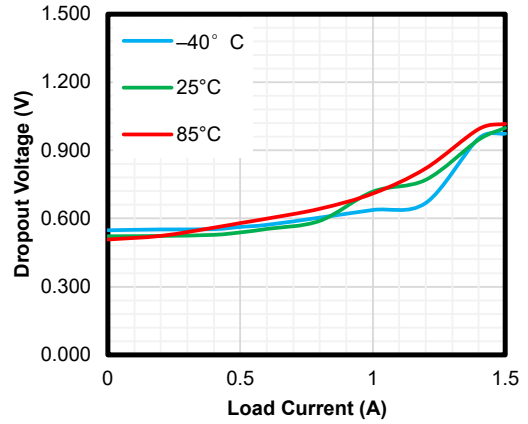
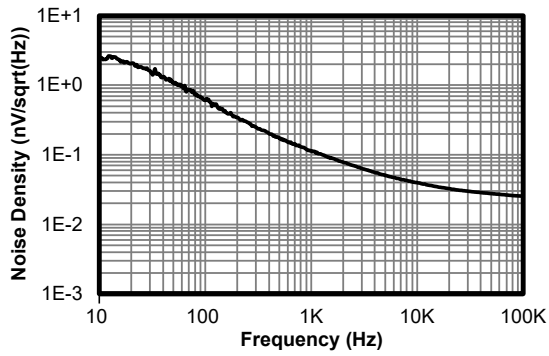
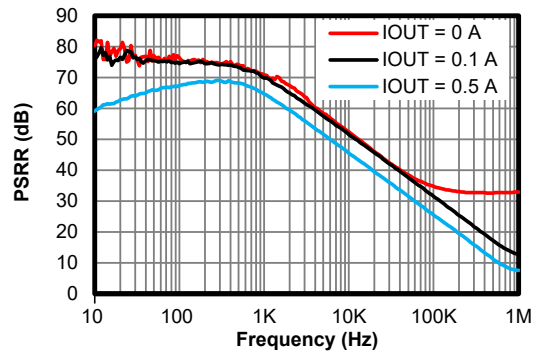


Figure 8. Dropout Voltage vs Load Current



$V_{OUT} = 1.25\text{ V}$ ,  $I_{OUT} = 10\text{ mA}$

Figure 9. Noise



$V_{OUT} = 1.25\text{ V}$ ,  $V_{IN} = V_{OUT} + 2\text{ V}$

Figure 10. PSRR

## Detailed Description

### Overview

The TPL8151Q is a 1.5-A high-current, low-dropout linear regulator with up to 29-V wide input voltage range. The TPL8151Q supports adjustable output voltage ranging from 1.25 V with an external resistor divider and is stable with a 10-μF to 100-μF tantalum output capacitor.

The TPL8151Q is compatible with older three-terminal adjustable linear regulators but has lower dropout voltage, tight output tolerance, and better transient performance.

### Functional Block Diagram

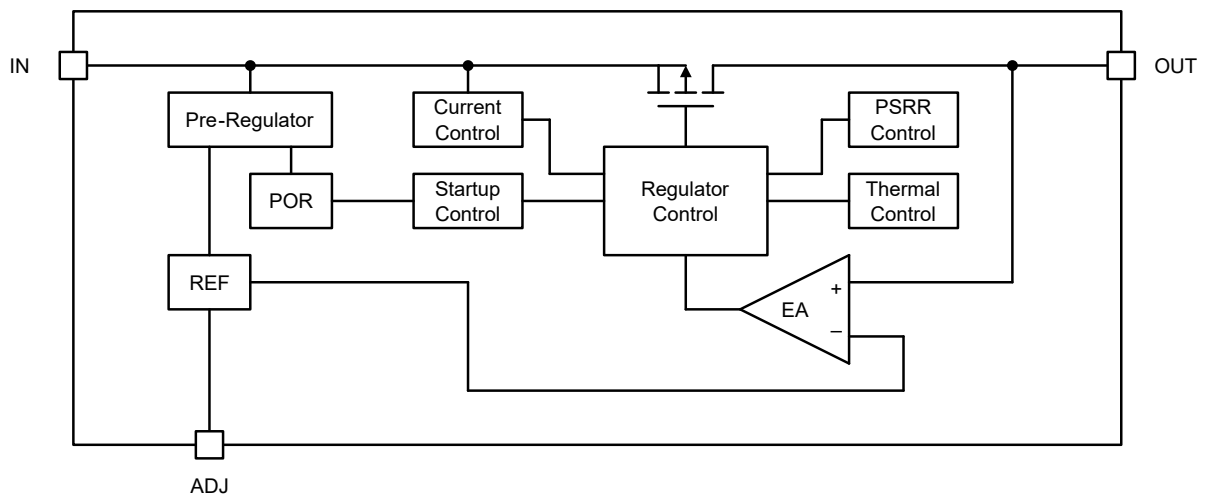


Figure 11. Functional Block Diagram

### Feature Description

#### Adjustable Output Voltage (ADJ and OUT)

The TPL8151Q supports adjustable output voltage ranging from 1.25 V with an external resistor divider. As shown in [Figure 12](#), the voltage ( $V_{REF}$ ) across R1 generates a constant current, and this constant current flows through R2. The voltage across R1 and R2 sets the output voltage. Use [Equation 1](#) to calculate the output voltage.

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

Where the feedback voltage  $V_{REF}$  is 1.25 V.

The current  $I_{ADJ}$  sourcing from the ADJ pin introduces an output error. Suggest selecting the R1 around 100 Ω to minimize the output error. The resistor R1 should be put closely to both the OUT pin and the ADJ pin.

#### Over-Current Protection

The TPL8151Q integrates an internal current limit that helps protect the regulator during fault conditions. When the output is pulled down below the regulated voltage, the over-current protection starts to work and limits the output current.

Under the over-current condition, the internal junction temperature ramps up quickly. When the junction temperature is high enough, it will cause over-temperature protection.

---

**1.5-A Wide-Input High-Current Low-Dropout Linear Regulator****Over-Temperature Protection**

The over-temperature protection starts to work when the junction temperature exceeds the thermal shutdown threshold ( $T_{SD}$ ), which turns off the regulator immediately. Until when the device cools down, the junction temperature falls below a value, which equals to the thermal shutdown threshold minus thermal shutdown hysteresis, the regulator turns on again.

The junction temperature range should be limited according to the [Recommended Operating Conditions](#) table. Continuously operating above the junction temperature range will shorten the lifetime of the device.

## Application and Implementation

### Note

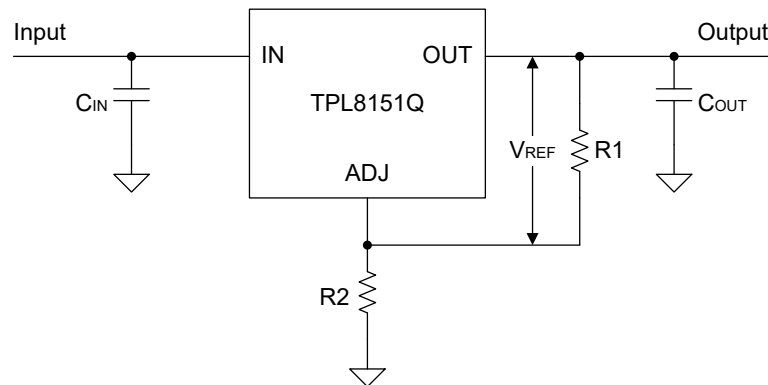
Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## Application Information

The TPL8151Q is a 1.5-A wide-input, high-PSRR, low-noise, low-dropout linear regulator. The following application shows a typical usage of the TPL8151Q.

## Typical Application

Figure 12 shows the typical application schematic.



**Figure 12. Typical Application Circuit**

### Input Capacitor and Output Capacitor

3PEAK recommends adding a 10- $\mu$ F or greater capacitor at the IN pin to keep the input voltage stable. The voltage rating of the capacitors must be higher than the maximum input voltage.

To ensure the loop stability, the TPL8151 requires an output tantalum capacitor of 10  $\mu$ F or greater. 3PEAK recommends selecting a 10- $\mu$ F or greater capacitor with an ESR range from 0.5  $\Omega$  to 6  $\Omega$  at the OUT pin.

Both input capacitors and output capacitors must be placed as close to the device pins as possible.

### Power Dissipation and Thermal Consideration

During the normal operation, the LDO junction temperature should meet the requirement in the [Recommended Operating Conditions](#) table. Use the equations below to calculate the power dissipation and estimate the junction temperature.

The power dissipation can be calculated using [Equation 2](#).

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND} \quad (2)$$

The junction temperature can be estimated using [Equation 3](#).  $\theta_{JA}$  is the junction-to-ambient thermal resistance.

$$T_J = T_A + P_D \times \theta_{JA} \quad (3)$$

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**1.5-A Wide-Input High-Current Low-Dropout Linear Regulator**

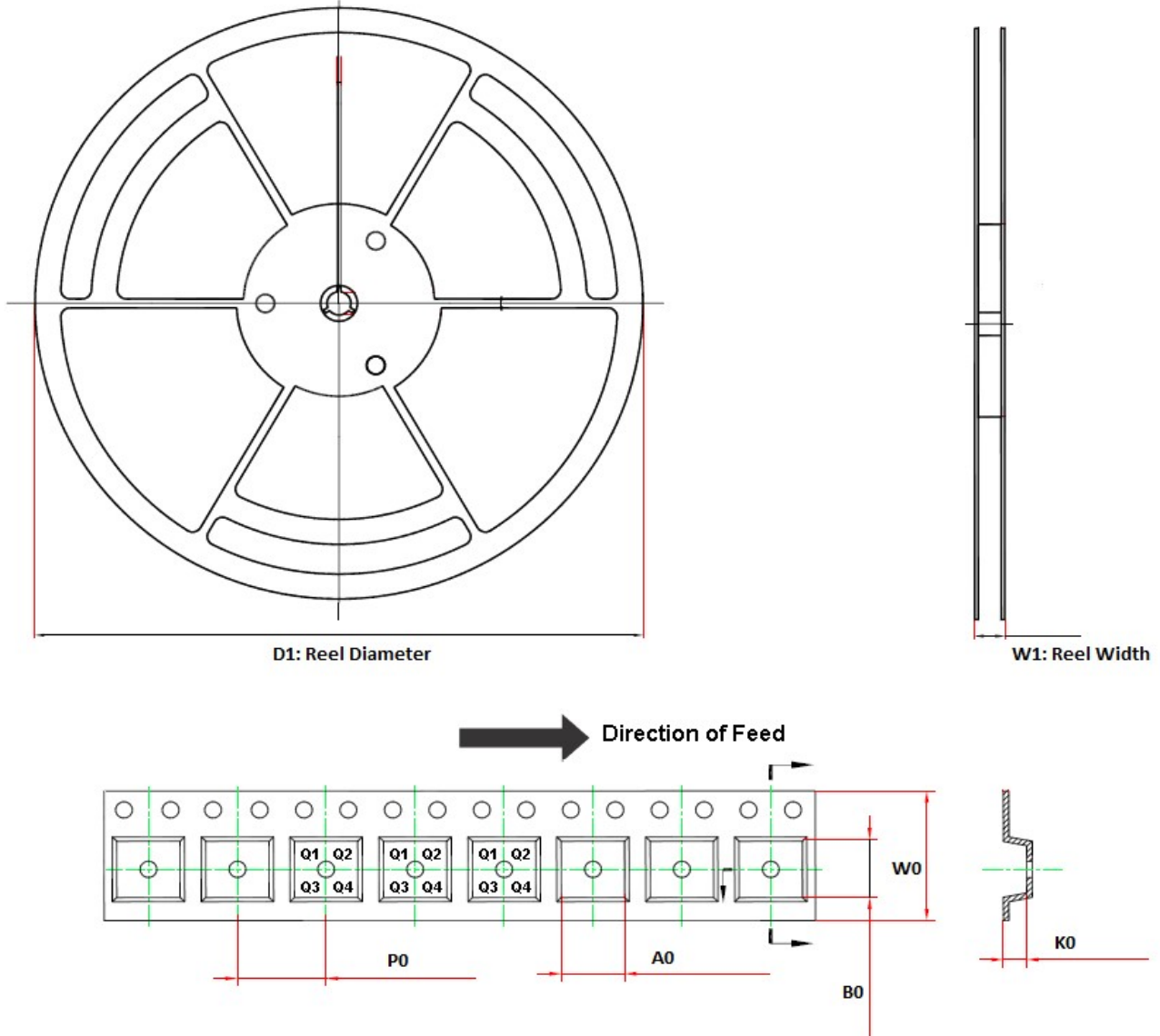
## Layout

### Layout Guideline

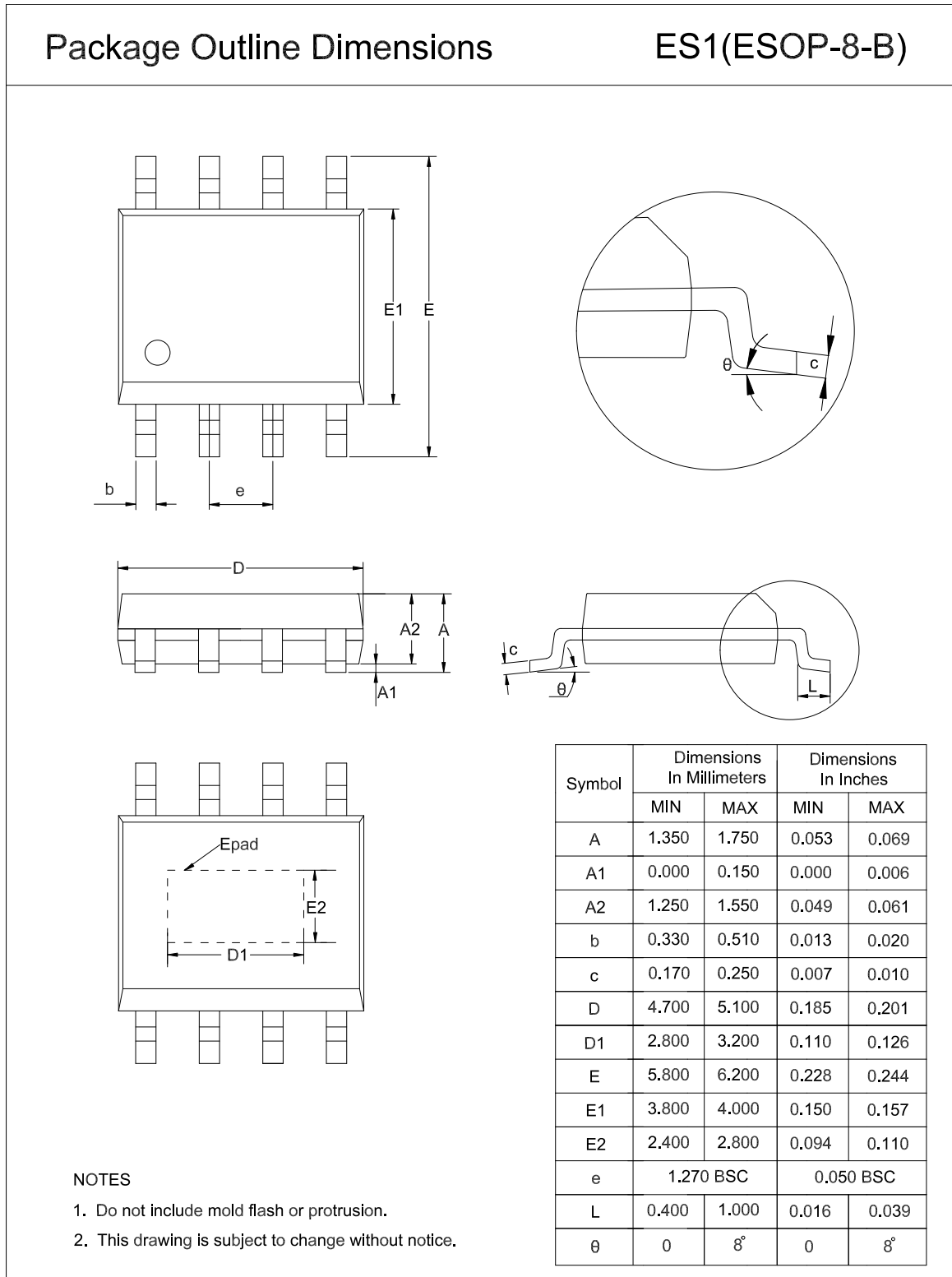
- Both input capacitors and output capacitors must be placed as close to the device pins as possible, and vias between capacitors and device power pins must be avoided.
- It is recommended to bypass the input pin to ground with a 0.1- $\mu$ F bypass capacitor. The loop area formed by the bypass capacitor connection, the IN pin, and the GND pin of the system must be as small as possible.
- It is recommended to use wide and thick copper to minimize I $\times$ R drop and heat dissipation.

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Tape and Reel Information



| Order Number      | Package | D1 (mm) | W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | W0 (mm) | Pin1 Quadrant |
|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------|
| TPL8151ADQ-ES1R-S | ESOP-8  | 330     | 17.6    | 6.4     | 5.4     | 2.1     | 8       | 12      | Q1            |

**1.5-A Wide-Input High-Current Low-Dropout Linear Regulator**
**Package Outline Dimensions**
**ESOP8-B**


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**1.5-A Wide-Input High-Current Low-Dropout Linear Regulator****Order Information**

| Order Number      | Operating Temperature Range | Package | Marking Information | MSL  | Transport Media, Quantity | Eco Plan |
|-------------------|-----------------------------|---------|---------------------|------|---------------------------|----------|
| TPL8151ADQ-ES1R-S | -40 to 125°C                | ESOP8   | L15A                | MSL3 | 4,000                     | Green    |

**Green:** 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.



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## 1.5-A Wide-Input High-Current Low-Dropout Linear Regulator

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