

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

Features

- Qualified for Automotive Applications
 - AEC-Q100 Grade 1, T_A : -40°C to $+125^{\circ}\text{C}$
 - Junction Temperature, T_J : -40°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 μF to 100 μF 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- μF to 100- μF 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°C to $+125^{\circ}\text{C}$.

Typical Application Circuit

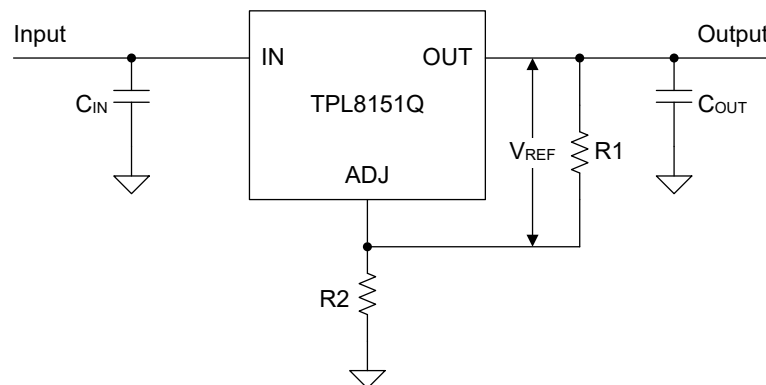


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1.5-A Wide-Input High-Current Low-Dropout Linear Regulator**Product Family Table**

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 2. Added Typical Performance Characteristics 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

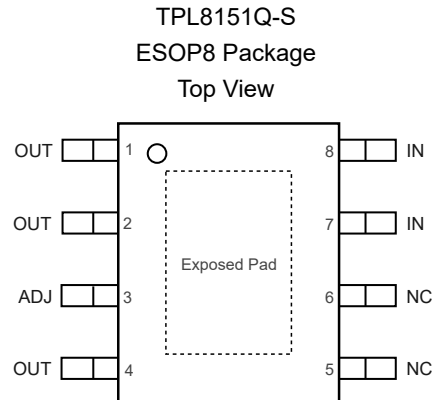


Table 1. Pin Functions: TPL8151Q-S

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 ⁽¹⁾	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.

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Specifications
Absolute Maximum Ratings ⁽¹⁾

Parameter		Min	Max	Unit
V _{IN} ⁽¹⁾⁽²⁾		-0.3	32	V
V _{OUT} ⁽¹⁾⁽²⁾		-0.3	32	V
T _J ⁽¹⁾	Maximum Junction Temperature Range	-40	150	°C
T _{STG} ⁽¹⁾	Storage Temperature Range	-65	150	°C
T _L ⁽¹⁾	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 ⁽¹⁾	±3.5	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 ⁽²⁾	±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 _{IN}		2.75	29	V
V _{OUT}		0	25	V
C _{OUT}		10	100	μF
ESR		0.5	6	Ω
T _A	Ambient Temperature Range	-40	125	°C
T _J	Junction Temperature Range	-40	125	°C

Thermal Information

Package Type	θ _{JA}	θ _{JB}	θ _{JC, TOP}	Unit
ESOP-8	36.1	14.63	47.53	°C/W

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Electrical Characteristics

All test conditions: $V_{IN} = V_{OUT(NOM)} + 1.5\text{ V}$ or 4.25 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	
Supply Voltage and Current						
$V_{IN}^{(1)}$	Input Supply Voltage	$V_{IN, MIN}$		29	V	
Regulated Voltage and Current						
$V_{OUT}^{(2)}$	Output Voltage Accuracy	$I_{OUT} = 10\text{ mA}$, $T_A = 25^{\circ}\text{C}$		1%		
		$I_{OUT} = 10\text{ mA}$ to 1.5 A , $V_{IN} = 2.75\text{ V}$ to 29 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 A , $V_{IN} = 2.75\text{ V}$ to 29 V	1.225	1.25	1.275	V
ΔV_{OUT}	Line Regulation	$I_{OUT} = 10\text{ mA}$, $V_{IN} = 2.75\text{ V}$ to 16.5 V , $T_A = 25^{\circ}\text{C}$		0.04%		
		$I_{OUT} = 10\text{ mA}$, $V_{IN} = 2.75\text{ V}$ to 16.5 V		0.04%	0.2%	
	Load Regulation	$I_{OUT} = 10\text{ mA}$ to 1.5 A , $T_A = 25^{\circ}\text{C}$		0.2%		
		$I_{OUT} = 10\text{ mA}$ to 1.5 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	μA
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	$I_{OUT} = 0.1\text{ A}$, $f = 120\text{ Hz}$, $C_{OUT} = 22\text{ }\mu\text{F}$, $C_{ADJ} = 22\text{ }\mu\text{F}$, $V_{OUT} = 1.8\text{ V}$, $V_{IN} = V_{OUT} + 2\text{ V}$		77		dB
		$I_{OUT} = 0.1\text{ A}$, $f = 1\text{ kHz}$, $C_{OUT} = 22\text{ }\mu\text{F}$, $C_{ADJ} = 22\text{ }\mu\text{F}$, $V_{OUT} = 1.8\text{ V}$, $V_{IN} = V_{OUT} + 2\text{ V}$		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 kHz		17.5		μV_{RMS}
Temperature Range						
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 V , whichever is greater.

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

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

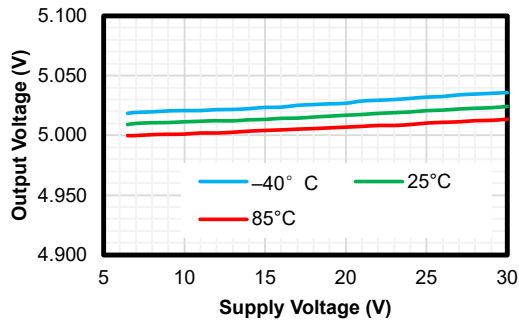
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- (4) Dropout voltage is the minimum input to output voltage differential needed to maintain regulation at a specified output current and measure for $V_{OUT} \geq 2.75$ V. In dropout mode, the output voltage will be equal to $V_{IN} - V_{DO}$.

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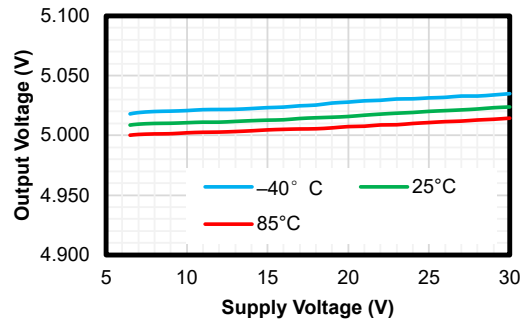
Typical Performance Characteristics

All test conditions: $V_{IN} = V_{OUT(NOM)} + 1.5\text{ V}$ or 4.25 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.



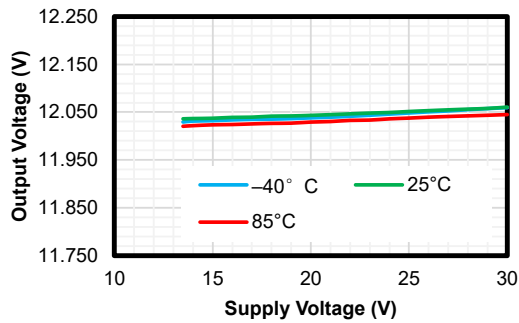
$V_{OUT} = 5\text{ V}$, $I_{OUT} = 1\text{ mA}$

Figure 1. Line Regulation



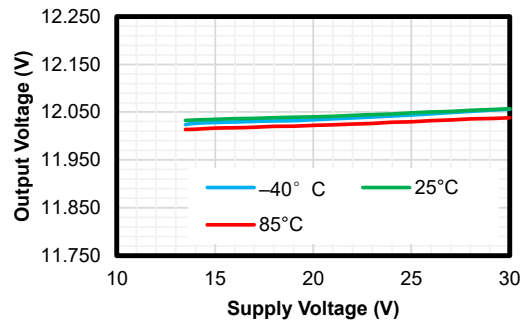
$V_{OUT} = 5\text{ V}$, $I_{OUT} = 100\text{ mA}$

Figure 2. Line Regulation



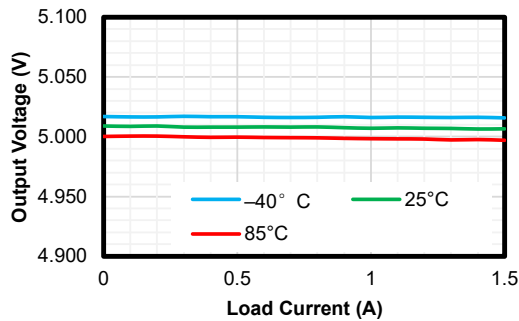
$V_{OUT} = 12\text{ V}$, $I_{OUT} = 1\text{ mA}$

Figure 3. Line Regulation



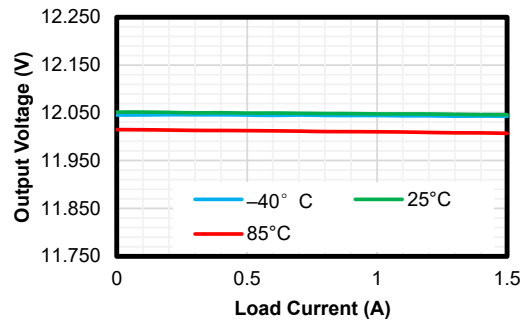
$V_{OUT} = 12\text{ V}$, $I_{OUT} = 100\text{ mA}$

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

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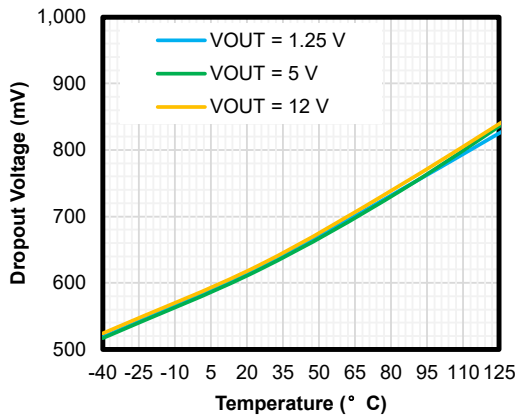


Figure 7. Dropout Voltage vs Temperature

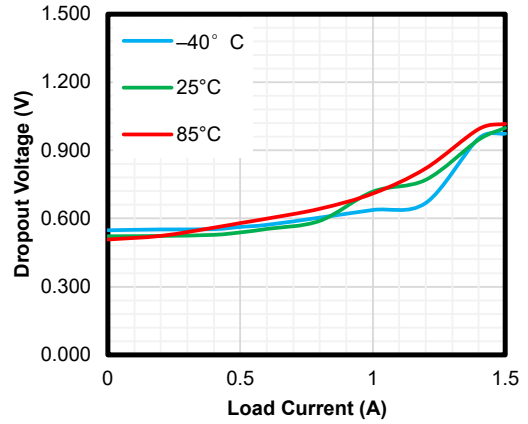
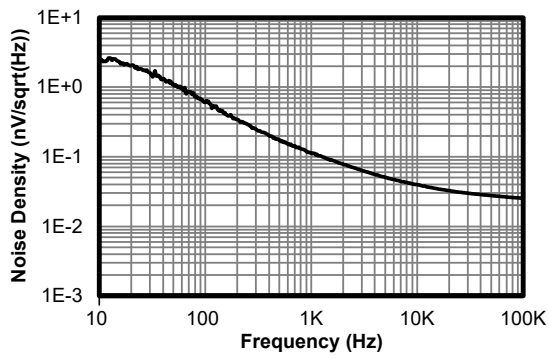
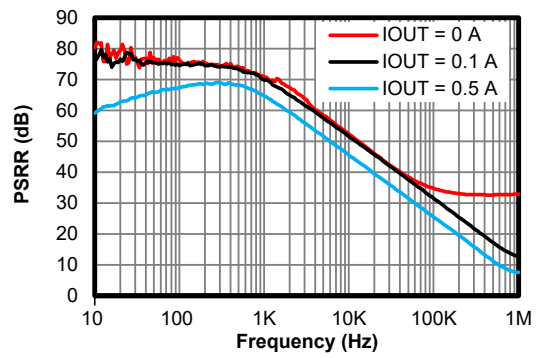


Figure 8. Dropout Voltage vs Load Current



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

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- μ F to 100- μ F 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

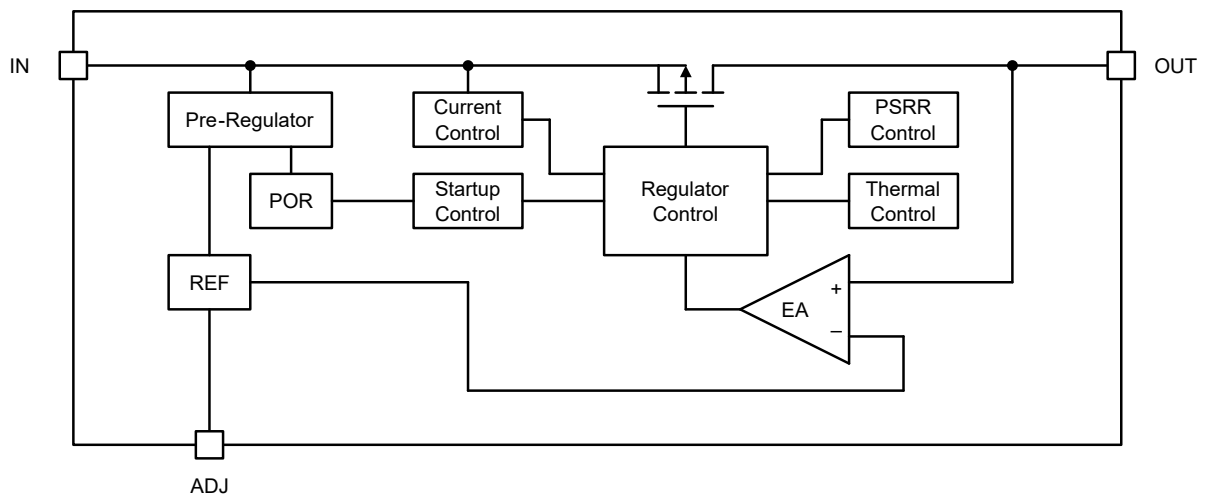


Figure 11. Functional Block Diagram

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.

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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.

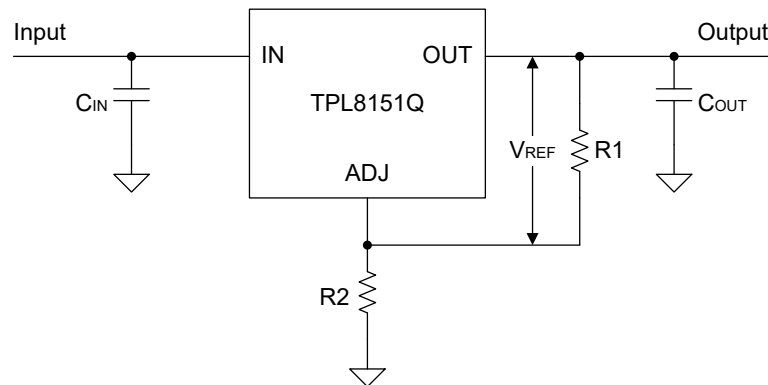


Figure 12. Typical Application Circuit

Input Capacitor and Output Capacitor

3PEAK recommends adding a 10- μ 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 μ F or greater. 3PEAK recommends selecting a 10- μ F or greater capacitor with an ESR range from 0.5 Ω to 6 Ω 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](#). θ_{JA} is the junction-to-ambient thermal resistance.

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

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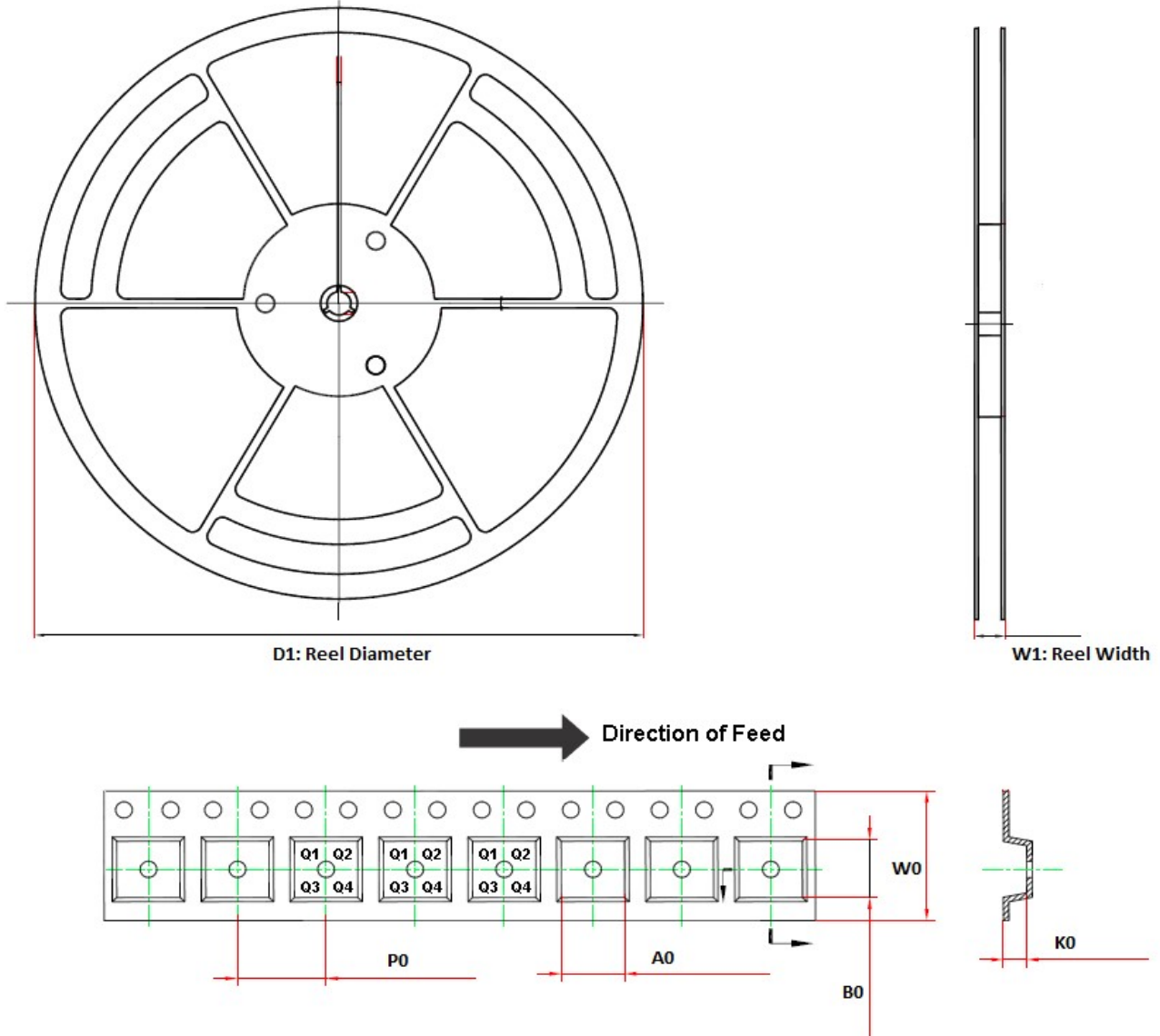
Layout

Layout Guideline

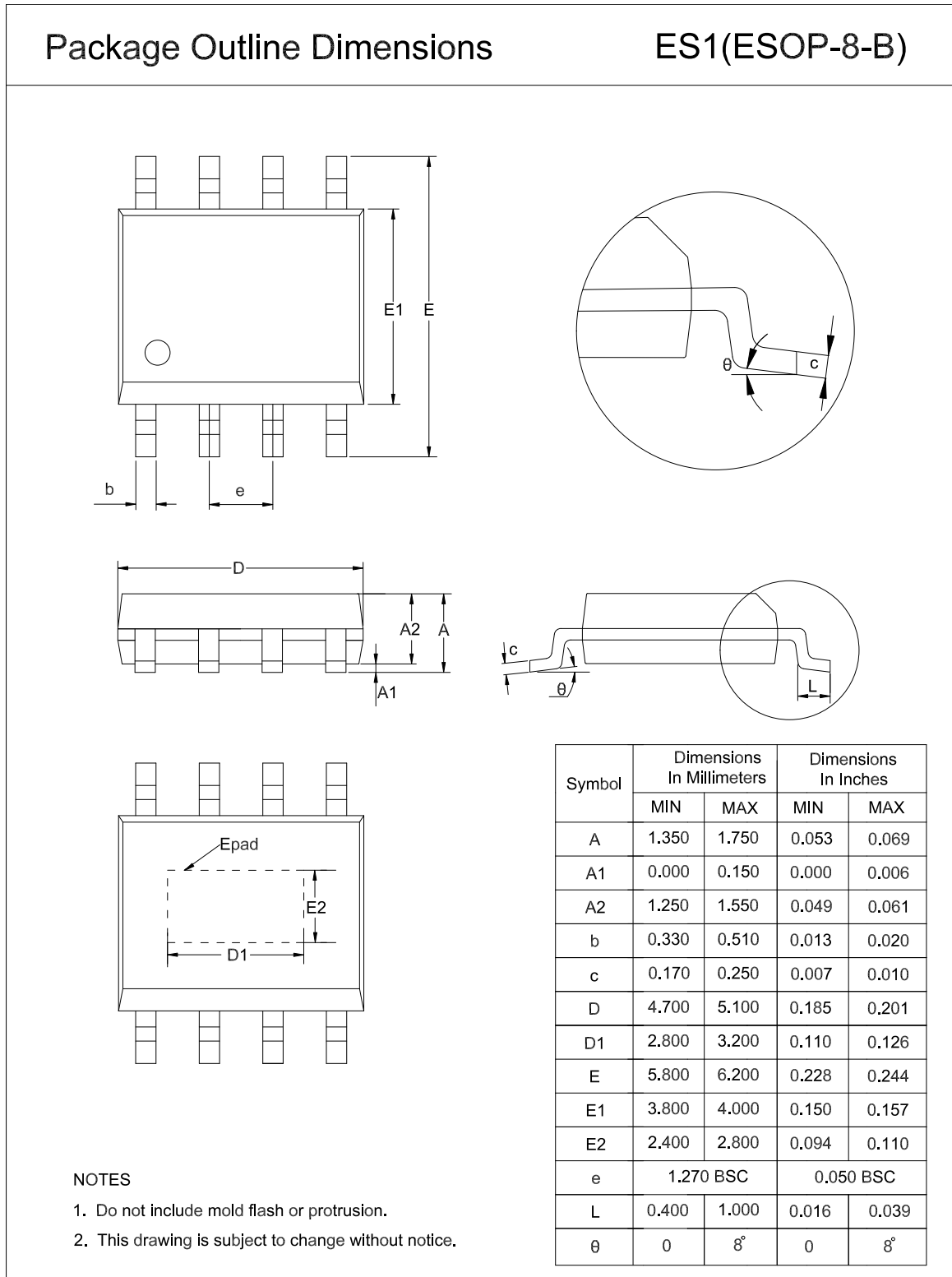
- Both input capacitors and output capacitors must be placed as close to the device pins as possible, and vias between capacitors and device power pins must be avoided.
- It is recommended to bypass the input pin to ground with a 0.1- μ F bypass capacitor. The loop area formed by the bypass capacitor 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


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.

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

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