



**THE DATASHEET OF
TPL810ADJ-5TR**



24-V Input, 180-mA Output High Voltage and Low Quiescent Current LDO

Features

- Wide Input Voltage Range: 3.6 V to 24 V
- $\pm 1\%$ Output Accuracy under Room Temperature
 - Fixed Output: 2.8 V, 3 V, 3.3 V, and 5 V
 - Adjustable Output: 1.2 V to 15 V
- Ultra-Low Quiescent Current: 2 μA
- Maximum Output Current: 180 mA
- Low Dropout Voltage: 200 mV at 50 mA
- High PSRR: 73 dB at 100 Hz
- Current Limit and Thermal Protection
- Stable with 2.2- μF to 22- μF Low ESR Ceramic Capacitor
- Soft Start Limits Input Current Surge during Enable
- Thermal Shutdown Protection
- Junction Temperature Range: -40°C to $+125^{\circ}\text{C}$
- Packages: SOT89-3, SOT23-5, SOT23-3

Applications

- Handheld Devices with Battery Power Supply
- POS and Power Tools
- Meters and Smoke Detector
- Industrial Control
- Wireless and IoT Modules

Description

The TPL810 is a series of high-performance and low-dropout linear regulators. The TPL810 series supports a maximum 24-V input voltage and 180-mA output current with a low quiescent current and high PSRR. The TPL810 series is stable with a 2.2- μF to 22- μF output capacitor, and a 4.7- μF ceramic capacitor is recommended.

The TPL810 series has a high PSRR of 73 dB at 100 Hz. This feature makes the TPL810 series very suitable for power-sensitive applications with high noise from the previous-stage power supply. The 2- μA ultra-low quiescent current makes the TPL810 series an ideal choice for portable devices with battery power supplies. Current-limit and thermal overload protection circuits improve reliability under heavy load conditions.

The TPL810 series provides fixed output voltage options from 2.8 V to 5 V and adjustable output voltage from 1.2 V to 15 V with $\pm 2\%$ voltage accuracy over the operating conditions. The TPL810 series is guaranteed over the junction temperature range from -40°C to $+125^{\circ}\text{C}$.

Typical Application Circuit

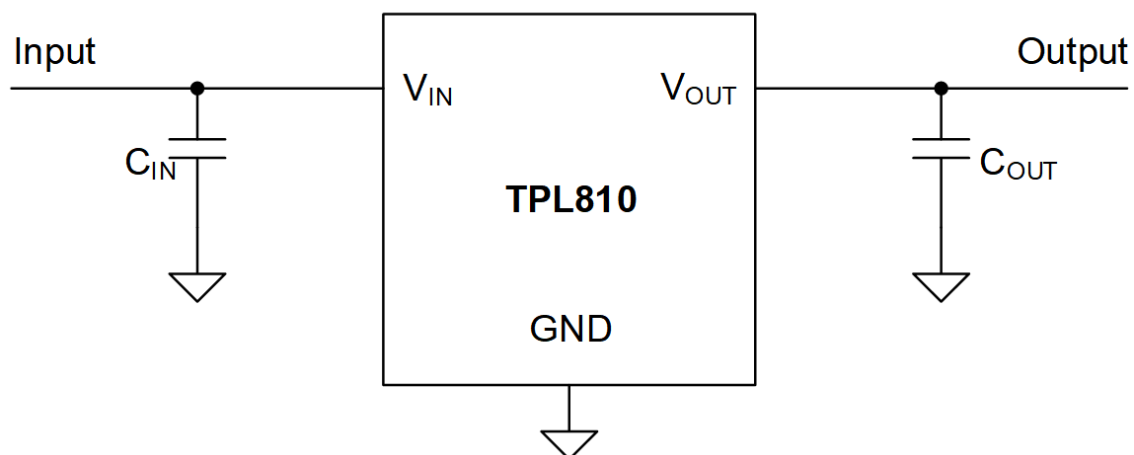


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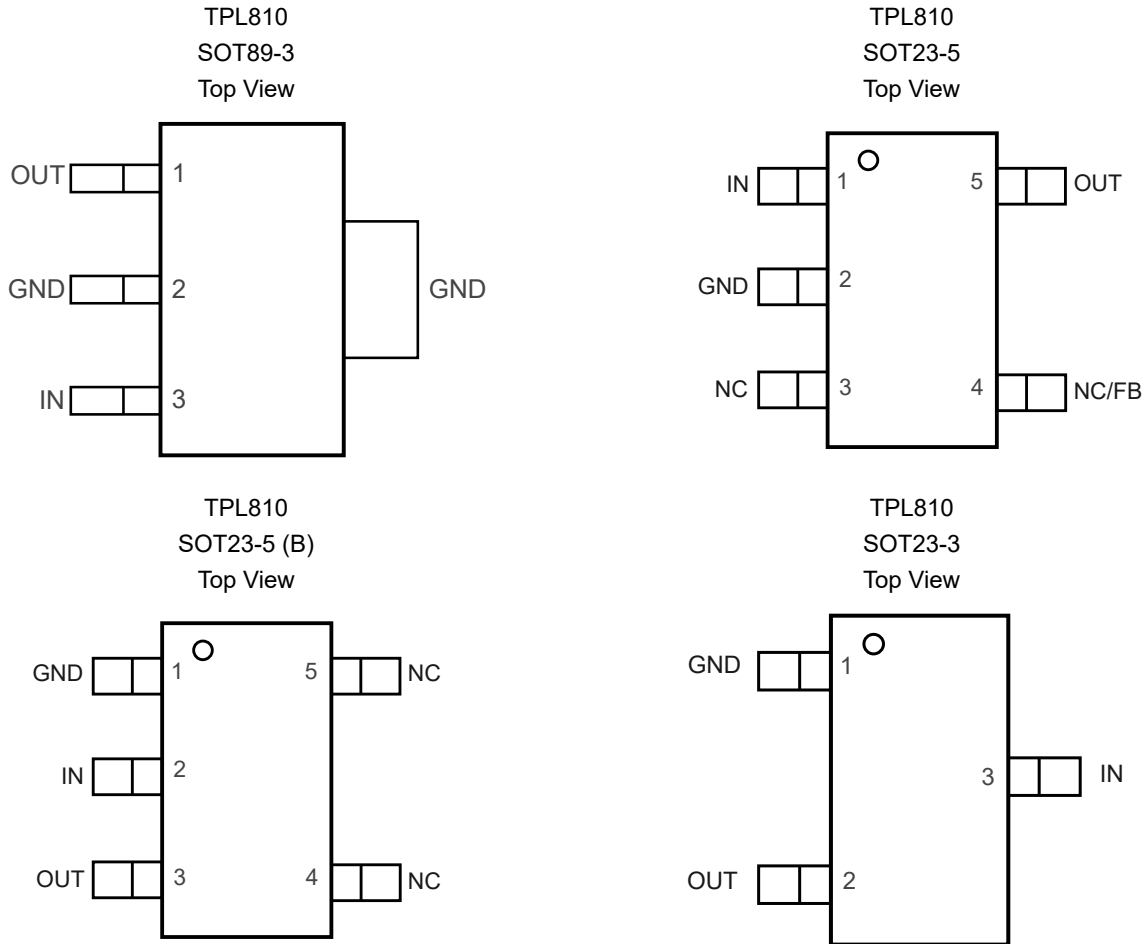
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24-V Input, 180-mA Output High Voltage and Low Quiescent Current LDO**Product Family Table**

Order Number	Output Voltage (V)	Package
TPL810ADJ-5TR	Adjustable (1.2 V to 18 V)	SOT23-5
TPL810F28-89TR	Fixed 2.8 V	SOT89-3
TPL810F30-89TR	Fixed 3.0 V	SOT89-3
TPL810F33-89TR	Fixed 3.3 V	SOT89-3
TPL810F50-89TR	Fixed 5.0 V	SOT89-3
TPL810F33-5TR	Fixed 3.3 V	SOT23-5
TPL810F50-5TR	Fixed 5.0 V	SOT23-5
TPL810U33-5TR	Fixed 3.3 V	SOT23-5 (B)
TPL810U50-5TR	Fixed 5.0 V	SOT23-5 (B)
TPL810F30-3TR	Fixed 3.0 V	SOT23-3
TPL810F33-3TR	Fixed 3.3 V	SOT23-3
TPL810F50-3TR	Fixed 5.0 V	SOT23-3

Revision History

Date	Revision	Notes
2018-09-28	Rev.Pre.0	Preliminary version.
2018-11-27	Rev.A.0	Initial release.
2019-05-31	Rev.A.1	Added an adjustable output version and fixed the 3.7-V output version.
2020-04-30	Rev.A.2	Updated the thermal information of the SOT89-3 package.
2021-03-29	Rev.A.3	1. Changed the pin 1 orientation of the SOT23-3 package. 2. Added Tape and Reel Information.
2021-06-04	Rev.A.4	Corrected the pin name mistake of the SOT23-5 package.
2021-08-31	Rev.A.5	Changed the output current from 200 mA to 180 mA.
2022-03-21	Rev.A.6	1. Added the output capacitor upper limit. 2. Removed the ambient temperature range. 3. Removed the 1.2-V, 1.8-V, 2.5-V, 3.7-V, and 4.5-V output version. 4. Removed the SOT89-3 (B) package.
2024-11-15	Rev.A.7	1. Updated to a new datasheet format. 2. Removed TPL810F28-5TR, TPL810F30-5TR, TPL810U28-5TR, TPL810U30-5TR and TPL810F28-3TR. 3. Updated the thermal information of SOT23-5 package.

Pin Configuration and Functions

Table 1. Pin Functions

Pin No.				Name	I/O	Description
SOT89 -3	SOT23 -5	SOT23 -5 (B)	SOT23 -3			
3	1	2	3	IN	I	Input voltage pin.
-	3,4	4,5	-	NC	-	No connection.
-	4	-	-	FB	I	Output feedback pin (adjustable version only).
1	5	3	2	OUT	O	Regulated output voltage pin.
2	2	1	1	GND	-	Ground reference pin. Connect the GND pin to the PCB ground plane directly.

(1) The thermal pad must be connected to the PCB ground plane to maximize the thermal performance.

24-V Input, 180-mA Output High Voltage and Low Quiescent Current LDO

Specifications

Absolute Maximum Ratings

Parameter		Min	Max	Unit
V _{IN}	Input Voltage	-0.3	45	V
V _{OUT}	Output Voltage (Fixed Version)	-0.3	6	V
V _{OUT}	Output Voltage (Adjustable Version)	-0.3	20	V
V _{FB}	Feedback Voltage (Adjustable Version)	-0.3	6	V
T _J	Junction Temperature Range	-40	150	°C
T _{STG}	Storage Temperature Range	-65	150	°C
T _L	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 GND.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2.5	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 ⁽²⁾	±2	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}	Input Voltage	3.6	24	V
V _{OUT}	Output Voltage (Fixed Version)	1.2	5	V
V _{OUT}	Output Voltage (Adjustable Version)	1.2	15	V
I _{OUT}	Output Current	0	180	mA
T _J	Operating Junction Temperature Range	-40	125	°C
P _D	Power Dissipation (SOT89-3 Package)	0	1000	mW
	Power Dissipation (SOT23-5 Package)	0	300	mW
	Power Dissipation (SOT23-3 Package)	0	300	mW

**24-V Input, 180-mA Output High Voltage and Low Quiescent
Current LDO****Thermal Information**

Package Type	θ_{JA}	θ_{JC}	Unit
SOT89-3	63	9.41	°C/W
SOT23-5	176	62	°C/W
SOT23-3	280	62	°C/W

24-V Input, 180-mA Output High Voltage and Low Quiescent Current LDO

Electrical Characteristics

All test conditions: $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$ or 3.6 V , whichever is greater; $C_{OUT} = 2.2\text{ }\mu\text{F}$, $T_A = +25^\circ\text{C}$, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply Input Voltage and Current						
V_{IN}	Input Voltage Range		3.6		24	V
I_Q	Quiescent Current	$I_{OUT} = 0\text{ mA}$		2	5	μA
		$I_{OUT} = 180\text{ mA}$		400		μA
UVLO	V_{IN} under-Voltage Lock-out	V_{IN} rising		2.9	3.6	V
Regulated Output Voltage and Current						
V_{OUT}	Output Voltage Accuracy	$T_J = +25^\circ\text{C}$		1%		
		$-40^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$	-2		2	%
V_{FB}	Feedback Voltage Accuracy	Adjustable output version		1.2		V
ΔV_{OUT}	Line Regulation	$V_{IN} = V_{OUT(NOM)} + 1\text{ V}$ to 24 V , or $V_{IN} \geq 3.6\text{ V}$, $I_{OUT} = 1\text{ mA}$		3		mV
	Load Regulation	$I_{OUT} = 1\text{ mA}$ to 180 mA		20		mV
$V_{DO}^{(1)}$	Dropout Voltage	$V_{IN} = 0.98 \times V_{OUT(NOM)}$, $I_{OUT} = 50\text{ mA}$		200	600	mV
		$V_{IN} = 0.98 \times V_{OUT(NOM)}$, $I_{OUT} = 180\text{ mA}$		800		mV
I_{OUT}	Output Current	V_{OUT} in regulation	0		180	mA
$I_{CL}^{(2)}$	Output Current Limit	$V_{OUT} = 0.9 \times V_{OUT(NOM)}$	180		800	mA
PSRR	Power Supply Rejection Ratio	$I_{OUT} = 10\text{ mA}$, $f = 100\text{ Hz}$, $C_{OUT} = 4.7\text{ }\mu\text{F}$		75		dB
		$I_{OUT} = 10\text{ mA}$, $f = 1\text{ kHz}$, $C_{OUT} = 4.7\text{ }\mu\text{F}$		65		dB
		$I_{OUT} = 10\text{ mA}$, $f = 10\text{ kHz}$, $C_{OUT} = 4.7\text{ }\mu\text{F}$		65		dB
V_N	Output Noise Voltage	$I_{OUT} = 10\text{ mA}$, BW = 10 Hz to 100 kHz		110		μV_{RMS}
		$I_{OUT} = 10\text{ mA}$, BW = 100 Hz to 100 kHz		70		μV_{RMS}
Temperature Range						
T_{SD}	Thermal Shutdown Threshold			160		$^\circ\text{C}$
	Hysteresis			40		$^\circ\text{C}$

(1) The dropout voltage is the minimum input-to-output voltage differential needed to maintain regulation at a specified output current. In dropout, the output voltage will be equal to $V_{IN} - V_{DD}$.

(2) Measured with $V_{IN} = V_{OUT} + 3\text{ V}$ for $V_{OUT(NOM)} \leq 2.5\text{ V}$. Measured with $V_{IN} = V_{OUT} + 2.5\text{ V}$ for $V_{OUT(NOM)} > 2.5\text{ V}$.

24-V Input, 180-mA Output High Voltage and Low Quiescent Current LDO

Typical Performance Characteristics

All test conditions: $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$ or 3.6 V , whichever is greater; $C_{OUT} = 2.2\ \mu\text{F}$, $T_A = +25^\circ\text{C}$, unless otherwise noted.

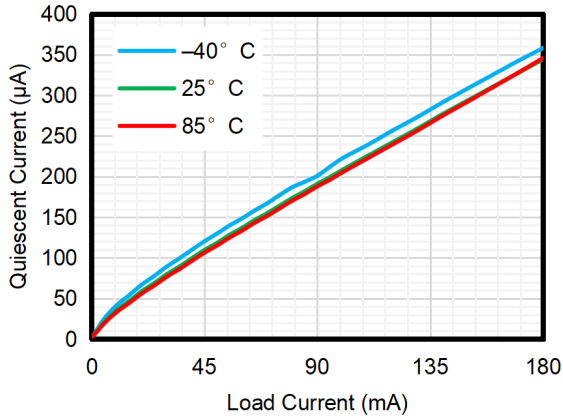


Figure 1. Quiescent Current vs. Output Current

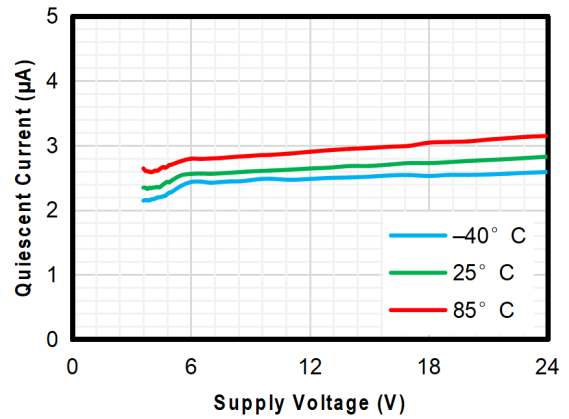


Figure 2. Quiescent Current vs. Input Voltage

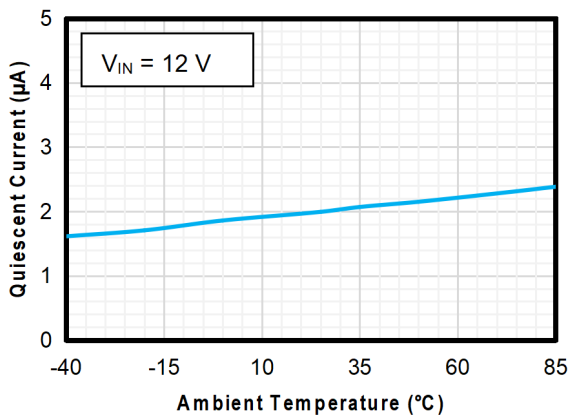


Figure 3. Quiescent Current vs. Ambient Temperature

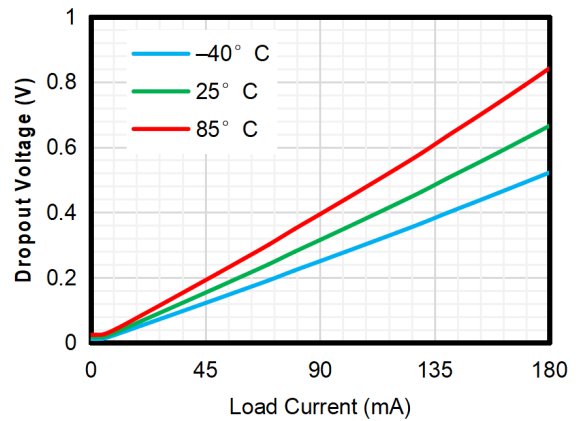


Figure 4. Dropout Voltage vs. Output Current

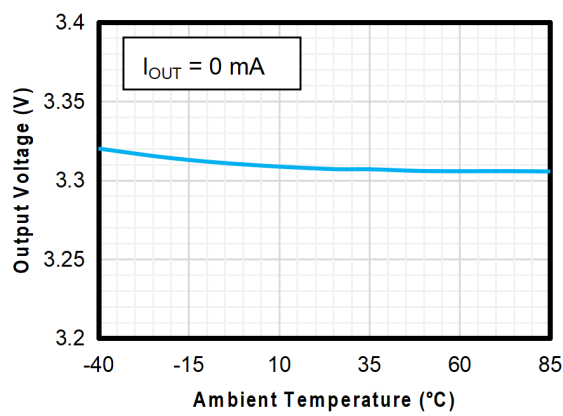


Figure 5. Output Accuracy vs. Ambient Temperature

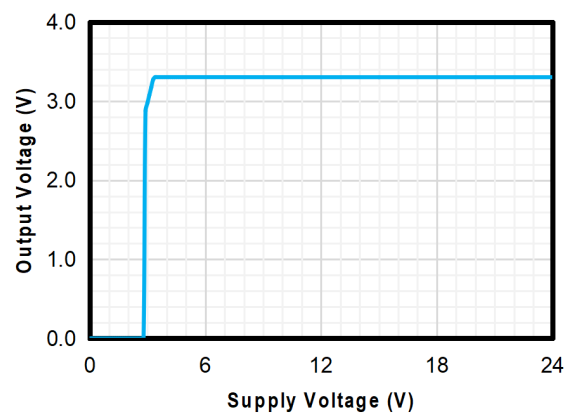


Figure 6. Output Voltage vs. Input Voltage

24-V Input, 180-mA Output High Voltage and Low Quiescent Current LDO

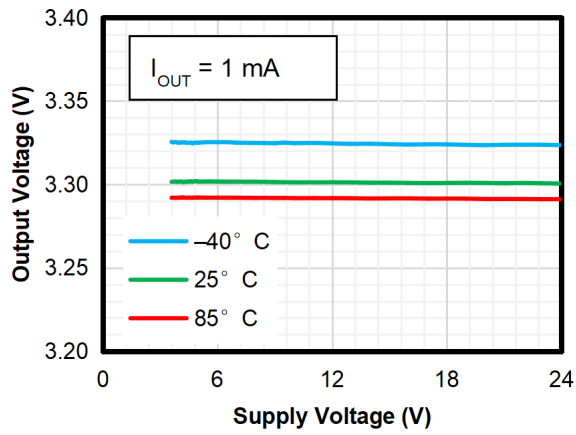


Figure 7. Line Regulation

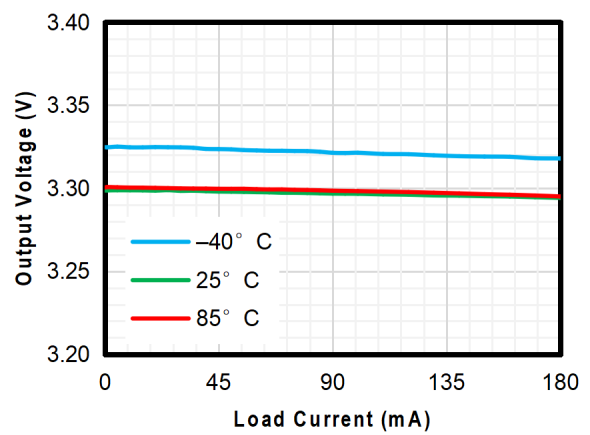


Figure 8. Load Regulation

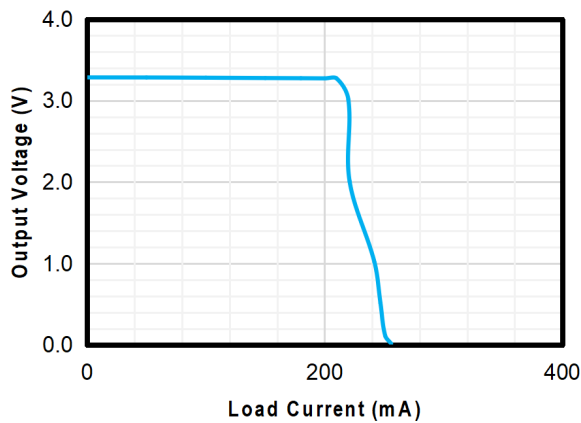


Figure 9. Current Limit

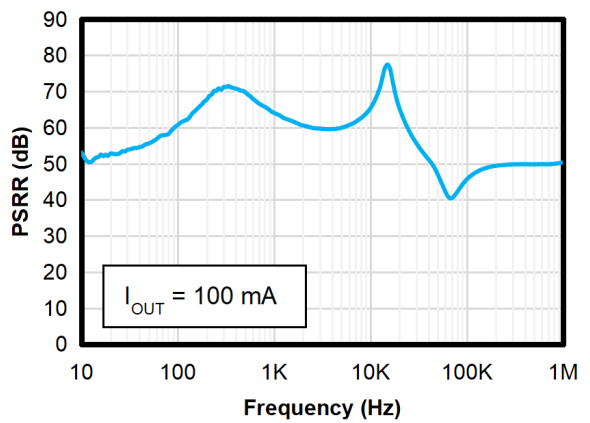


Figure 10. PSRR

Detailed Description

Overview

The TPL810 is a series of 24-V 180-mA wide input range linear regulators with a very low quiescent current. The voltage regulators operate from 3.6 V to 24 V and consume a 2- μ A quiescent current at no load.

The TPL810 series is available in fixed output voltage versions of 2.8 V, 3 V, 3.3 V, and 5 V, and adjustable output voltage from 1.2 V to 15 V with $\pm 2\%$ output voltage accuracy over the operating conditions.

Functional Block Diagram

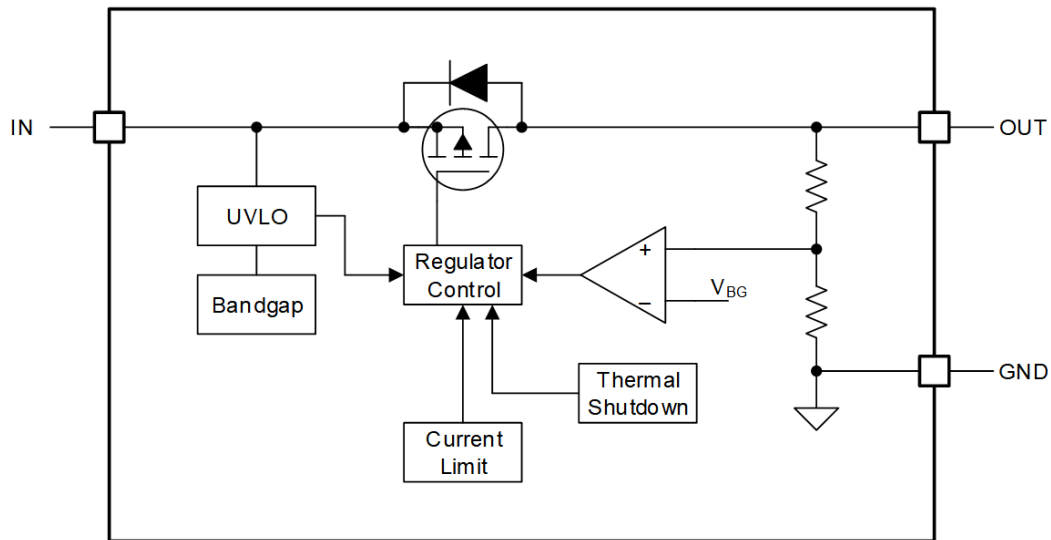


Figure 11. TPL810 Series (Fixed Version)

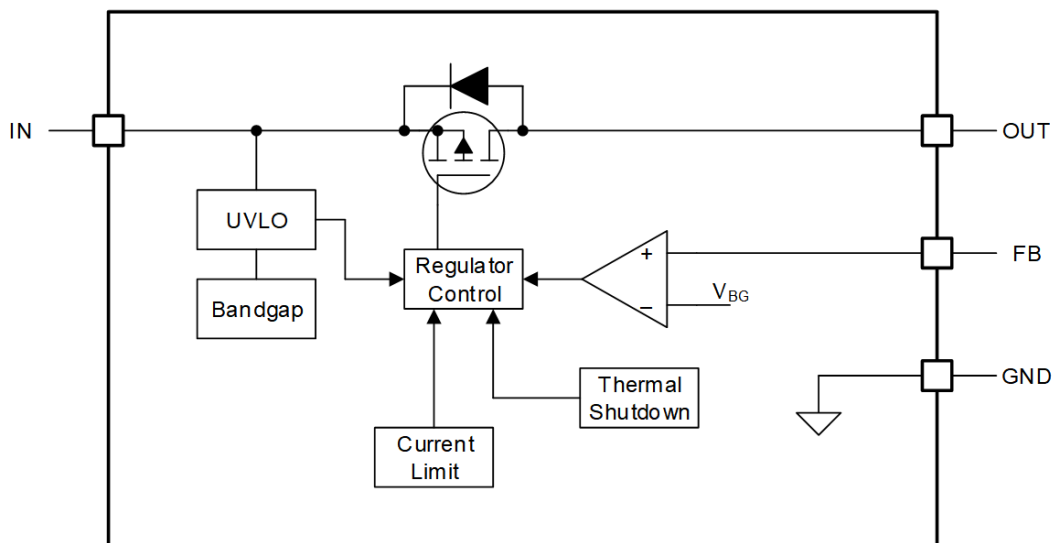


Figure 12. TPL810 Series (Adjustable Version)

Feature Description

Under-Voltage Lockout (UVLO)

The TPL810 series uses an under-voltage lock-out circuit (UVLO = 2.9 V) to shut the output down until the internal circuitry operates properly.

Regulated Output Voltage

The TPL810 series is available in fixed voltage versions of 2.8 V, 3 V, 3.3 V, and 5 V. When the input voltage is higher than $V_{OUT(NOM)} + V_{DO}$ or 3.6 V, the output pin is the regulated output based on the selected voltage version. When the input voltage falls below $V_{OUT(NOM)} + V_{DO}$ or 3.6 V, the output pin tracks the input voltage minus the dropout voltage based on the load current. When the input voltage drops below the UVLO threshold, the output keeps shutting off.

Adjustable Output Voltage

The TPL810 series is also available in adjustable output voltage from 1.2 V to 15 V by selecting suitable external resistor dividers.

Use [Equation 1](#) to calculate the output voltage ($V_{FB} = 1.2\text{ V}$). It is suggested to select the resistor value of $(R1 + R2)$ between 10 k Ω and 100 k Ω .

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

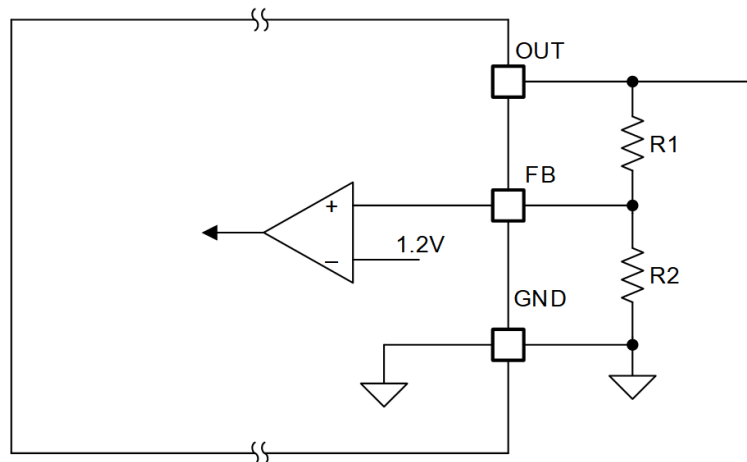


Figure 13. Adjustable Version

Current Limit

The TPL810 series integrates an internal current limit that helps protect the regulator during fault conditions. The output voltage is not regulated when the device is in the current limit mode and is $V_{OUT} = I_{CL} \times R_{LOAD}$.

Thermal Shutdown

During normal operation, the LDO junction temperature should not exceed 125°C. When the junction temperature exceeds the thermal shutdown threshold, the LDO shuts down the output immediately. When the junction temperature falls below the thermal shutdown threshold minus thermal shutdown hysteresis, the output turns on again.

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 TPL810 is a series of 24-V 180-mA wide input range linear regulators with a very low quiescent current. The following application schematic shows a typical usage of the TPL810 series.

Typical Application

Figure 14 shows the typical application schematic of the TPL810 series.

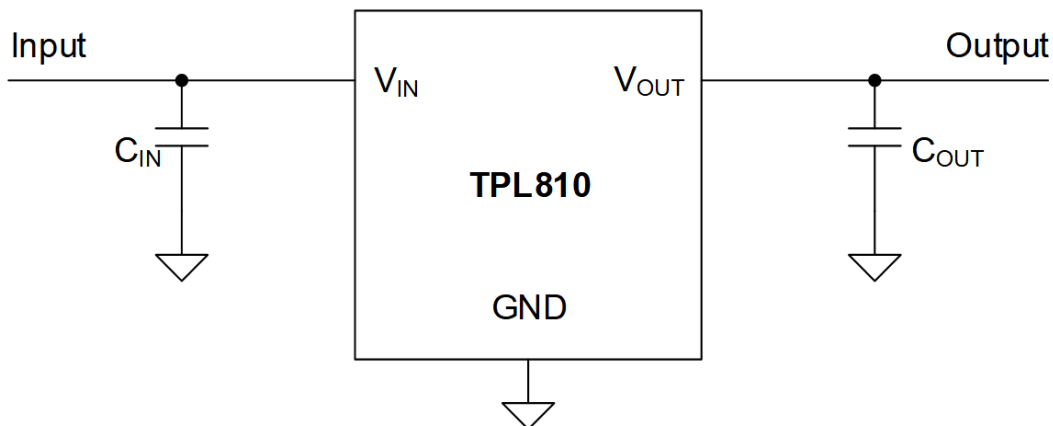


Figure 14. TPL810 Typical Application

Input Capacitor and Output Capacitor

3PEAK recommends adding a 2.2- μF or greater capacitor with a 0.1- μF bypass capacitor in parallel at the IN pin to keep the input voltage stable. An aluminum electrolytic capacitor or other capacitors with high capacitance is suggested for the system power with a large voltage spike. The voltage rating of the capacitors must be greater than the maximum input voltage.

To ensure loop stability, the TPL810 series requires an output capacitor with an effective capacitance value of 2.2 μF to 22 μF . 3PEAK recommends an X5R- or X7R-type 4.7- μF ceramic capacitor with low ESR over the temperature range.

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

Power Dissipation

During normal operation, the LDO junction temperature should not exceed 125°C. Use the equations below to calculate the power dissipation and estimate the junction temperature.

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

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

**24-V Input, 180-mA Output High Voltage and Low Quiescent
Current LDO**

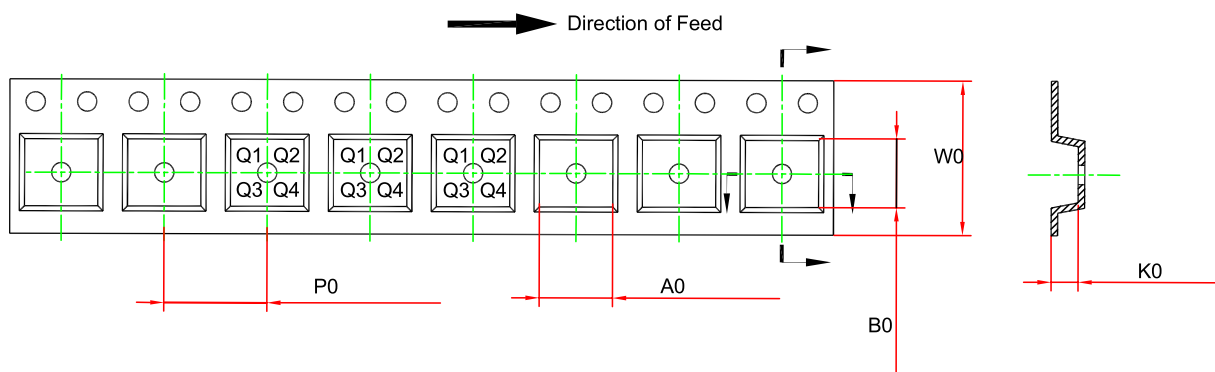
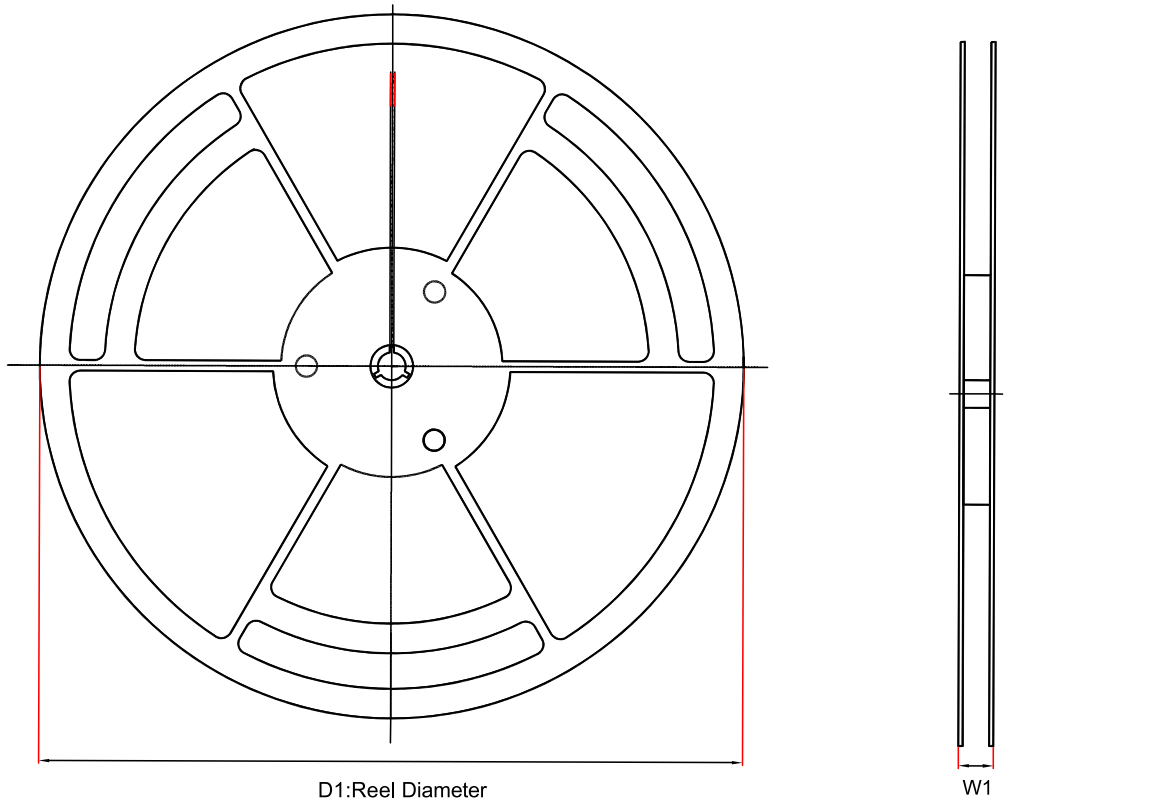
The junction temperature can be estimated using [Equation 3](#). θ_{JA} is the junction-to-ambient thermal resistance (See [Thermal Information](#)).

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

Layout

Layout Guideline

- Both input and output capacitors must be placed as close to the device pins as possible.
- 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 trace to minimize $I \times R$ drop and heat dissipation.

Tape and Reel Information


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPL810ADJ-5TR	SOT23-5	180	13.1	3.2	3.2	1.4	4	8	Q3
TPL810Fxx-89TR	SOT89-3	330	17.6	4.8	4.4	1.8	8	12	Q3
TPL810Fxx-5TR	SOT23-5	180	13.1	3.2	3.2	1.4	4	8	Q3
TPL810Uxx-5TR	SOT23-5	180	13.1	3.2	3.2	1.4	4	8	Q3
TPL810Fxx-3TR	SOT23-3	180	13.1	3.18	3.28	1.32	4	8	Q3

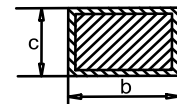
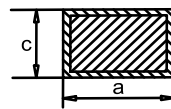
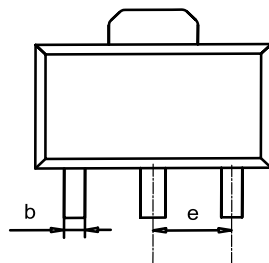
(1) Output voltage value, xx = 28 to 50, e.g., 33 means 3.3-V output voltage.

Package Outline Dimensions

SOT89-3

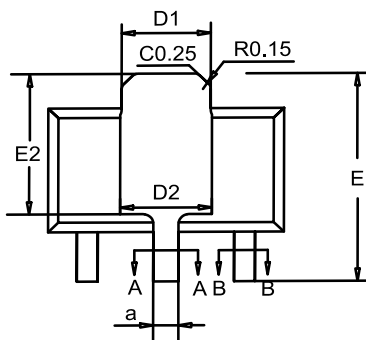
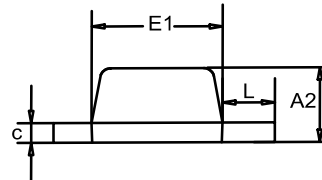
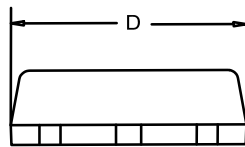
Package Outline Dimensions

89T(SOT89-3-A)



SECTION A-A

SECTION B-B



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A2	1.400	1.600	0.055	0.063
a	0.460	0.560	0.018	0.022
b	0.380	0.470	0.015	0.019
c	0.380	0.440	0.015	0.017
D	4.400	4.600	0.173	0.181
D1	1.600	1.830	0.063	0.072
E	3.950	4.250	0.156	0.167
E1	2.400	2.600	0.094	0.102
e	1.500 BSC		0.059 BSC	
D2	1.600	1.900	0.063	0.075
E2	2.700	3.100	0.106	0.122
L	0.890	1.200	0.035	0.047

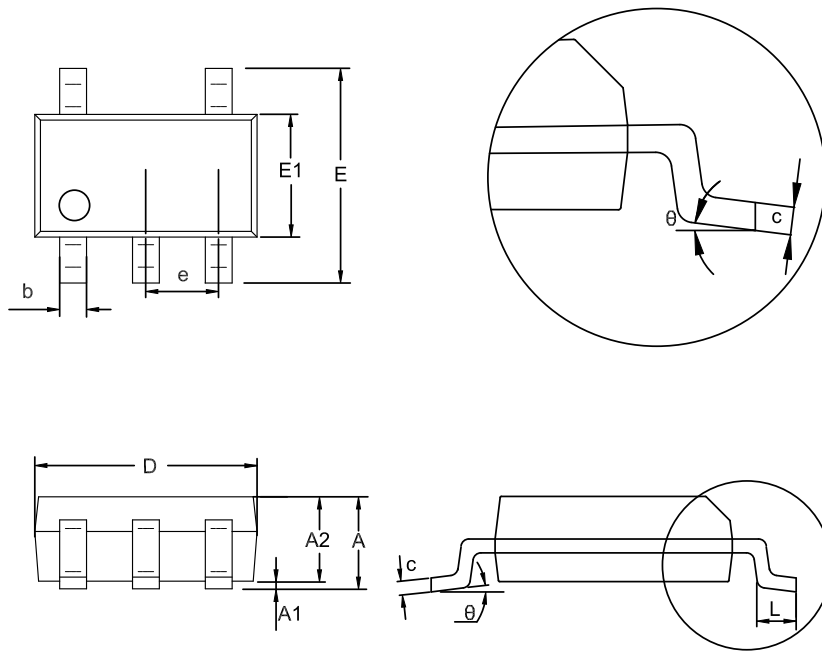
NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

SOT23-5

Package Outline Dimensions

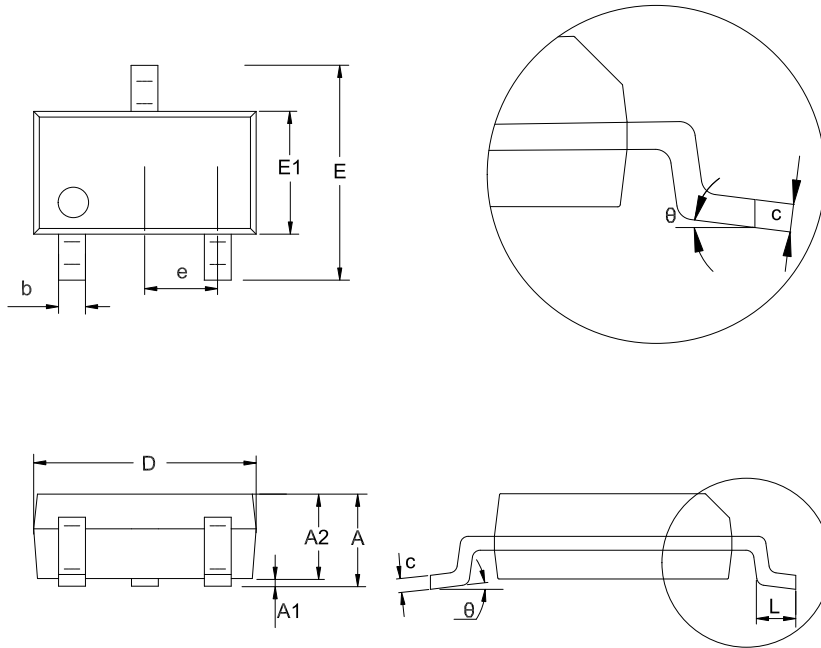
S5T(SOT23-5-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

SOT23-3
Package Outline Dimensions
S3T(SOT23-3-A)


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

24-V Input, 180-mA Output High Voltage and Low Quiescent Current LDO
Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPL810ADJ-5TR	-40 to 125°C	SOT23-5	L4A	MSL3	Tape and Reel, 3,000	Green
TPL810F28-89TR	-40 to 125°C	SOT89-3	L4H	MSL3	Tape and Reel, 4,000	Green
TPL810F30-89TR	-40 to 125°C	SOT89-3	L4I	MSL3	Tape and Reel, 4,000	Green
TPL810F33-89TR	-40 to 125°C	SOT89-3	L4J	MSL3	Tape and Reel, 4,000	Green
TPL810F50-89TR	-40 to 125°C	SOT89-3	L4K	MSL3	Tape and Reel, 4,000	Green
TPL810F33-5TR	-40 to 125°C	SOT23-5	L4J	MSL3	Tape and Reel, 3,000	Green
TPL810F50-5TR	-40 to 125°C	SOT23-5	L4K	MSL3	Tape and Reel, 3,000	Green
TPL810U33-5TR	-40 to 125°C	SOT23-5 (B)	L4Q	MSL3	Tape and Reel, 3,000	Green
TPL810U50-5TR	-40 to 125°C	SOT23-5 (B)	L4R	MSL3	Tape and Reel, 3,000	Green
TPL810F30-3TR	-40 to 125°C	SOT23-3	L4I	MSL3	Tape and Reel, 3,000	Green
TPL810F33-3TR	-40 to 125°C	SOT23-3	L4J	MSL3	Tape and Reel, 3,000	Green
TPL810F50-3TR	-40 to 125°C	SOT23-3	L4K	MSL3	Tape and Reel, 3,000	Green

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

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