

42-V 300-mA Wide-input Ultra-low Quiescent 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: 3 V to 42 V
- Output Voltage:
 - Fixed 5 V and 3.3 V
- $\pm 2.5\%$ Output Accuracy Over Line Regulation, Load Regulation, and Operating Temperature Range
- Low Current Consumption:
 - 400-nA Shutdown Current
 - 3- μA Typical Quiescent Current
- 300-mA Maximum Output Current
- Low Dropout Voltage: 720 mV Maximum at 200 mA Load Current
- Stable with 1- μF to 200- μF Output Capacitor with ESR Range from 0.001 Ω to 10 Ω
- Integrated Protection:
 - Over-Current Protection
 - Over-Temperature Protection
- Package Options:
 - DFN3X3-8
 - EMSOP8
 - SOT223-3

Applications

- Automotive Clusters and Infotainment
- Automotive Headlights and Interior Lighting
- Automotive Domain Control
- Automotive BCM and Door Handler

Description

The TPL8031Q series supports operating with 3 V to 42 V (45-V maximum transient voltage). Operating with as low as 3 V allows the TPL8031Q to continue to work well during cold-crank and start-stop conditions.

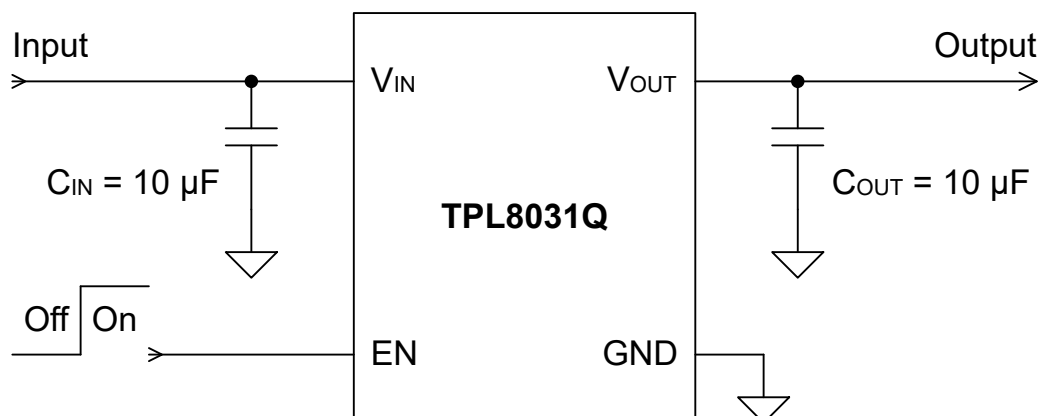
The TPL8031Q products are 3- μA ultra-low quiescent low dropout voltage linear regulators with 300-mA maximum output current capability.

With the above features, the TPL8031Q products are the optimal solutions for powering the MCU, CAN/LIN transceivers in the always-on applications, and the battery-connected applications in the automotive systems.

The TPL8031Q series provides fixed 5-V and 3.3-V output voltage options, and the TPL8031Q series supports a wide range of output capacitors from 1 μF to 200 μF with an ESR range from 0.001 Ω to 10 Ω . Also, the TPL8031Q series integrates over-current protection and over-temperature protection.

The TPL8031Q series operates in the ambient temperature range from -40°C to $+125^{\circ}\text{C}$. Additionally, the TPL8031Q series provides thermal-enhanced packages of DFN3X3-8, EMSOP8, and SOT223-3 to enable sustained operation despite significant dissipation across the device.

Typical Application Circuit



**42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout
Linear Regulator****Table of Contents**

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**42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout
Linear Regulator****Product Family Table**

Order Number	Output Voltage (V)	Package
TPL803133Q-DF6R-S	3.3 V	DFN3X3-8
TPL803150Q-DF6R-S	5.0 V	DFN3X3-8
TPL803133Q-EV1R-S	3.3 V	EMSOP8
TPL803150Q-EV1R-S	5.0 V	EMSOP8
TPL803133Q-ST4R-S	3.3 V	SOT223-3
TPL803150Q-ST4R-S	5.0 V	SOT223-3

Revision History

Date	Revision	Notes
2022-03-21	Rev.Pre.0	Preliminary Datasheet.
2023-04-28	Rev.Pre.1	Updated Pin Map of EMSOP8 Package.
2023-05-31	Rev.Pre.2	1. Updated Thermal Information 2. Updated Electrical Characteristics Table.
2023-06-15	Rev.A.0	Initial Released.
2025-08-26	Rev.A.1	The following updates are all about new formats or typo corrections. The actual product remains unchanged. <ul style="list-style-type: none">Added description to POD information required by packaging reference standards.Updated the Tape and Reel Information.

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

Pin Configuration and Functions

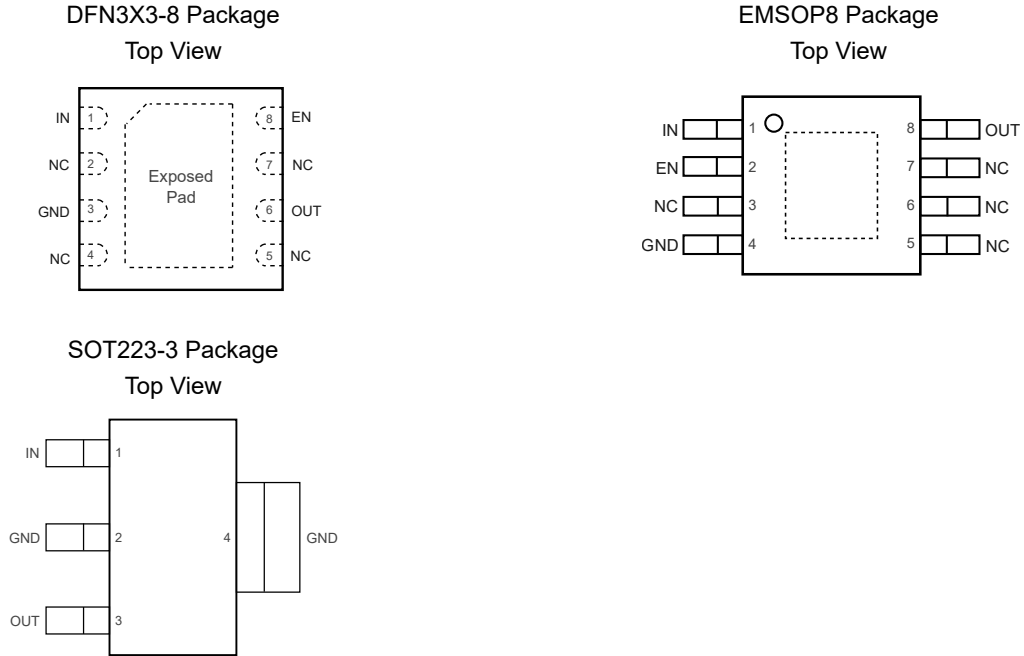


Table 1. Pin Functions: TPL8031Q-S

Pin Number			Pin Name	I/O	Description
DFN3X3-8	EMSOP8	SOT223-3			
8	2	—	EN	I	Regulator enable pin. Drive EN high to turn on the regulator; drive EN low to turn off the regulator.
3	4	2, 4	GND	I	Ground reference pin. Connect GND pin to PCB ground plane directly.
1	1	1	IN	I	Input voltage pin. Bypass IN to GND with a 1 μ F or greater capacitor.
4, 5, 7	3, 5, 6, 7	—	NC	-	No connection.
6	8	3	OUT	O	Regulated output voltage pin. Bypass OUT to GND with a 1 μ F or greater capacitor.

(1) Thermal Pad **MUST** be connected to PCB ground plane directly.

**42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout
Linear Regulator****Specifications****Absolute Maximum Ratings**

Parameter		Min	Max	Unit
EN, IN		-0.3	45	V
OUT		-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	AEC Q100-002	±2	kV
CDM	Charged Device Model ESD	AEC Q100-011	±1	kV

Recommended Operating Conditions

Parameter		Min	Max	Unit
IN		3	42	V
EN		0	V _{IN}	V
C _{OUT}	Output Capacitor Requirements	1	200	μF
ESR	Output Capacitor ESR Requirements	0.001	10	Ω
T _A	Ambient Temperature Range	-40	125	°C
T _J	Junction Temperature Range	-40	150	°C

Thermal Information

Package Type	θ _{JA}	θ _{JB}	θ _{JC,top}	θ _{JC,bottom}	Unit
DFN3X3-8	45.0	42.0	88.8	10.7	°C/W
EMSOP8	45.6	43.3	95.2	12.8	°C/W
SOT223-3	65.0	40.0	60.0	15.0	°C/W

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

Electrical Characteristics

All test conditions: $V_{IN} = 13.5\text{ V}$, $V_{EN} = 2\text{ V}$, $C_{IN} = C_{OUT} = 10\text{ }\mu\text{F}$, $I_{OUT} = 0.1\text{ mA}$. $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$, $T_J = -40^\circ\text{C}$ to 150°C , unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply Input Voltage and Current						
V _{IN}	Input Supply Voltage Range ⁽¹⁾		V _{IN,MIN}		42	V
UVLO	V _{IN} Under-Voltage Lockout Threshold	V _{IN} rising, V _{EN} = 2 V, I _{OUT} = 200 mA		2.6	2.8	V
	Hysteresis			260		mV
I _{SD}	Shutdown Current	V _{EN} = 0 V		0.4	2	μA
I _Q	Quiescent Current	I _{OUT} = 0 mA		3	5.5	μA
		I _{OUT} = 0.1 mA		4	6.5	μA
Enable Input Voltage and Current						
V _{IH,EN}	EN Logic Input High (Enable)		1.4		V _{IN}	V
V _{IL,EN}	EN Logic Input Low (Disable)		0		0.7	V
I _{EN}	EN Pin Leakage Current	V _{EN} = 2 V to 42 V	-200		200	nA
Regulated Output Voltage and Current						
V _{OUT}	Output Accuracy	V _{IN} = 6 V to 42 V, I _{OUT} = 1 mA to 300 mA	-2.5%		2.5%	
ΔV _{OUT}	Line Regulation	V _{IN} = 6 V to 42 V, I _{OUT} = 10 mA		0.1		mV
	Load Regulation	I _{OUT} = 1 mA to 300 mA		5		mV
V _{DO}	Dropout Voltage ⁽²⁾	I _{OUT} = 100 mA, V _{OUT} = 3.3 V		280	450	mV
		I _{OUT} = 200 mA, V _{OUT} = 3.3 V		580	900	mV
		I _{OUT} = 100 mA, V _{OUT} = 5 V		220	360	mV
		I _{OUT} = 200 mA, V _{OUT} = 5 V		440	720	mV
I _{OUT}	Output Current Range	V _{OUT} in regulation	0		300	mA
I _{CL}	Output Current Limit	V _{OUT} is forced to 0.9*V _{OUT(NOM)}	320	500	900	mA
t _{SU}	Start-Up Time ⁽³⁾			2		ms
PSRR	Power Supply Rejection Ratio ⁽³⁾	I _{OUT} = 10 mA, f = 1 kHz		65		dB
		I _{OUT} = 10 mA, f = 100 kHz		50		dB
		I _{OUT} = 10 mA, f = 1 MHz		40		dB
Temperature Range						
T _{SD}	Thermal Shutdown Threshold			175		°C
	Thermal Shutdown Hysteresis			20		°C

(1) $V_{IN,MIN} = 3\text{ V}$ or $V_{OUT(NOM)} + 1\text{ V}$, whichever is greater.

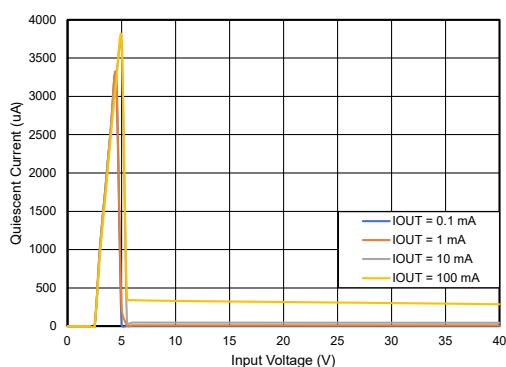
(2) Dropout voltage is the minimum input to output voltage differential needed to maintain regulation at a specified output current. Dropout voltage is measured when the output voltage has dropped 100 mV from the nominal value. In dropout, the output voltage will be equal to $(V_{IN} - V_{DO})$.

(3) Not test during production.

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

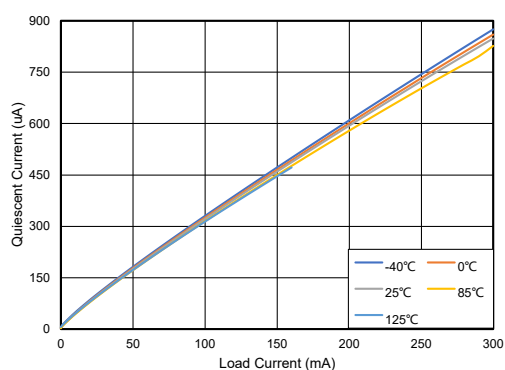
Typical Performance Characteristics

All test conditions: $V_{IN} = 13.5\text{ V}$, $V_{EN} = 2\text{ V}$, $C_{IN} = C_{OUT} = 10\text{ }\mu\text{F}$, $I_{OUT} = 0.1\text{ mA}$. $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$, $T_J = -40^\circ\text{C}$ to 150°C , unless otherwise noted.



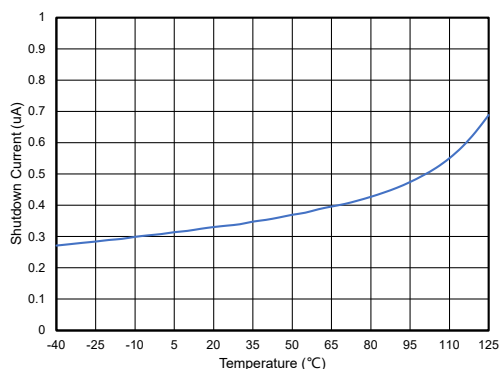
$V_{OUT} = 5\text{ V}$

Figure 1. Quiescent Current vs. Input Voltage



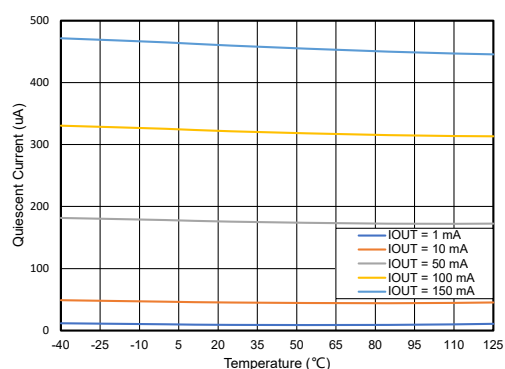
$V_{OUT} = 5\text{ V}$

Figure 2. Quiescent Current vs. Load Current



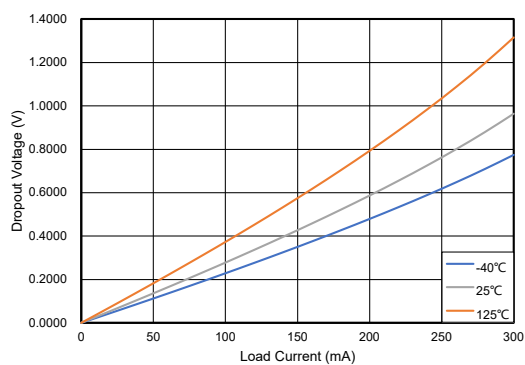
$V_{EN} = 0\text{ V}$

Figure 3. Shutdown Current vs. Ambient Temperature



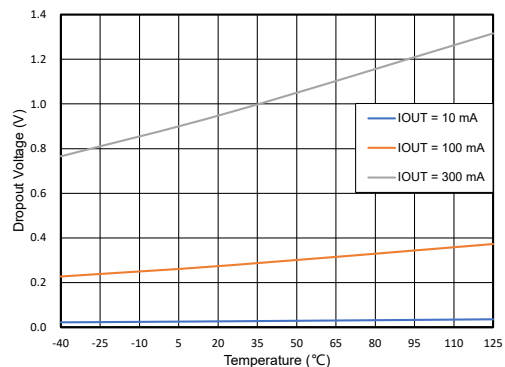
$V_{OUT} = 5\text{ V}$

Figure 4. Quiescent Current vs. Ambient Temperature



$V_{OUT} = 3.3\text{ V}$

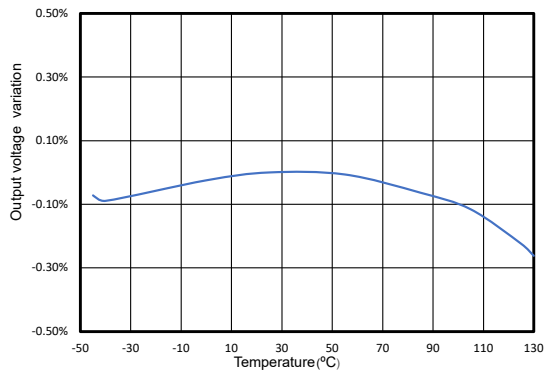
Figure 5. Dropout Voltage vs. Load Current



$V_{OUT} = 5\text{ V}$

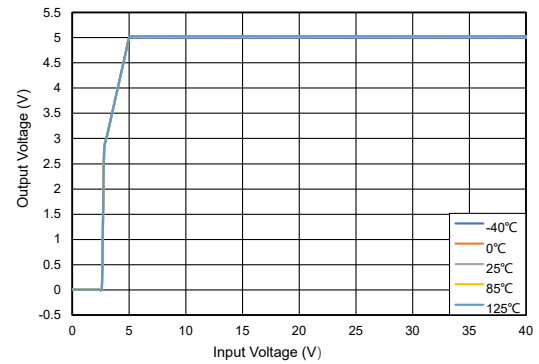
Figure 6. Dropout Voltage vs. Ambient Temperature

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator



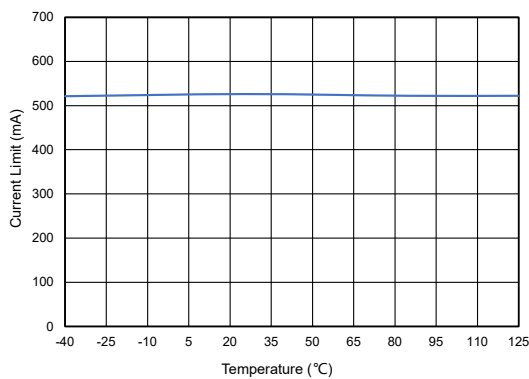
$V_{OUT} = 5\text{ V}$

Figure 7. Output Voltage Variation vs. Ambient Temperature



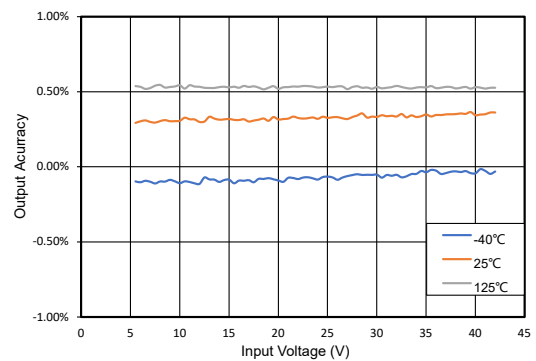
$V_{OUT} = 5\text{ V}$, $I_{OUT} = 1\text{ mA}$

Figure 8. Output Voltage vs. Input Voltage



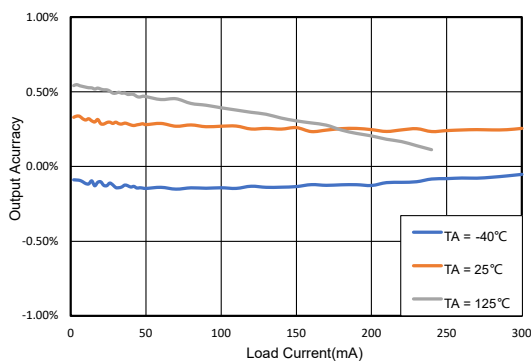
$V_{OUT} = 5\text{ V}$, force $V_{OUT} = 0.9 \times V_{OUT}$

Figure 9. Output Current Limit vs. Ambient Temperature



$V_{OUT} = 5\text{ V}$

Figure 10. Line Regulation



$V_{OUT} = 5\text{ V}$

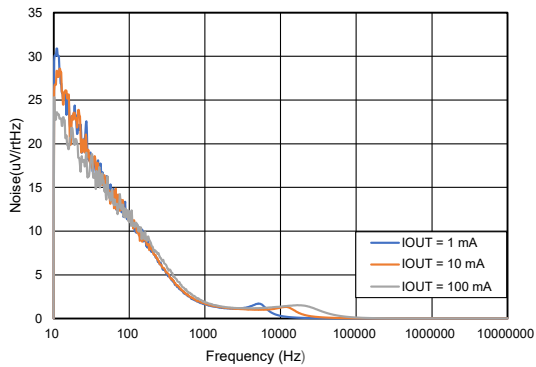
Figure 11. Load Regulation



$V_{OUT} = 5\text{ V}$

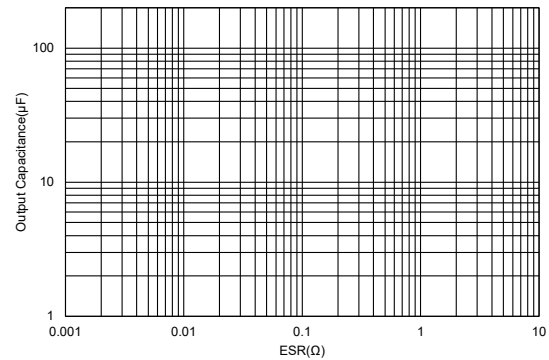
Figure 12. PSRR

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator



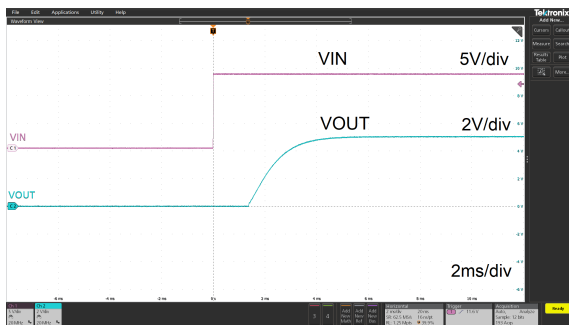
$V_{OUT} = 5\text{ V}$

Figure 13. Noise



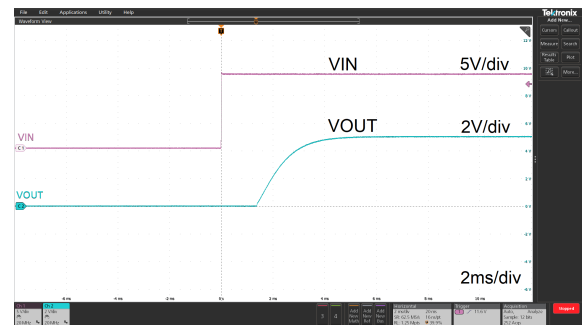
Output Capacitance and ESR stability range

Figure 14. Output Capacitance vs. ESR stability



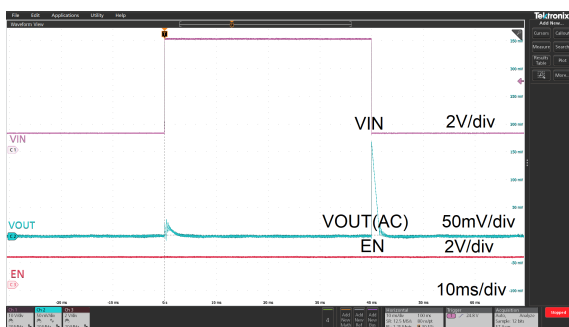
$C_{OUT} = 1\text{ }\mu\text{F}$, $V_{IN} = 0\text{ V to }13.5\text{ V}$, $V_{OUT} = 0\text{ V to }5\text{ V}$

Figure 15. Startup Waveform



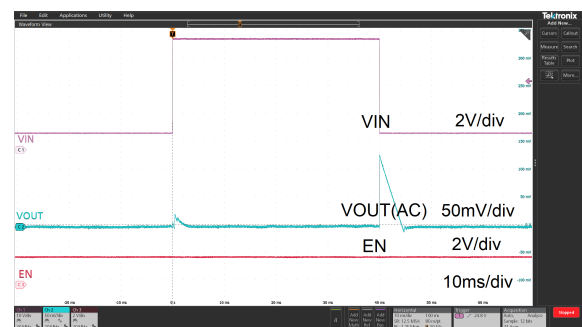
$C_{OUT} = 10\text{ }\mu\text{F}$, $V_{IN} = 0\text{ V to }13.5\text{ V}$, $V_{OUT} = 0\text{ V to }5\text{ V}$

Figure 16. Startup Waveform



$C_{OUT} = 1\text{ }\mu\text{F}$, $V_{IN} = 6\text{ V to }40\text{ V in }30\text{ }\mu\text{s}$

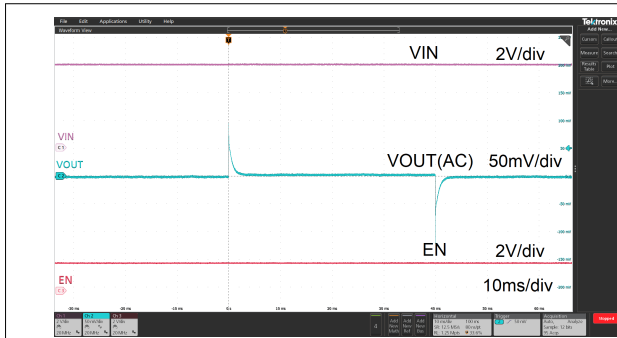
Figure 17. Line Transient



$C_{OUT} = 10\text{ }\mu\text{F}$, $V_{IN} = 6\text{ V to }40\text{ V in }30\text{ }\mu\text{s}$

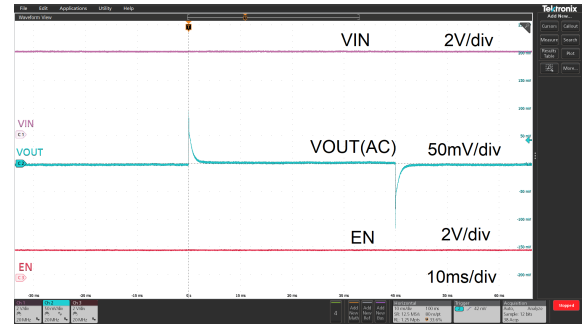
Figure 18. Line Transient

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator



$C_{OUT} = 1 \mu F$, $I_{OUT} = 10 \text{ mA to } 100 \text{ mA in } 5 \mu s$

Figure 19. Load Transient



$C_{OUT} = 10 \mu F$, $I_{OUT} = 10 \text{ mA to } 100 \text{ mA in } 5 \mu s$

Figure 20. Load Transient

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

Detailed Description

Overview

The TPL8031Q series supports the operating range from 3 V to 42 V (45-V maximum transient voltage). Operating with as low as 3 V allows the TPL8031Q to continue to work well during cold-crank and start-stop conditions.

The TPL8031Q products are 3- μ A ultra-low quiescent low dropout voltage linear regulators with 300-mA maximum output current capability.

With the above features, the TPL8031Q products are the optimal solutions for powering the MCU, CAN/LIN transceivers in the always-on applications, and the battery-connected applications in the automotive systems.

The TPL8031Q series provides fixed 5-V and 3.3-V output voltage options. The TPL8031Q supports a wide range of output capacitors from 1 μ F to 200 μ F with an ESR range from 0.001 Ω to 10 Ω . Also, the TPL8031Q series integrates over-current protection and over-temperature protection.

Functional Block Diagram

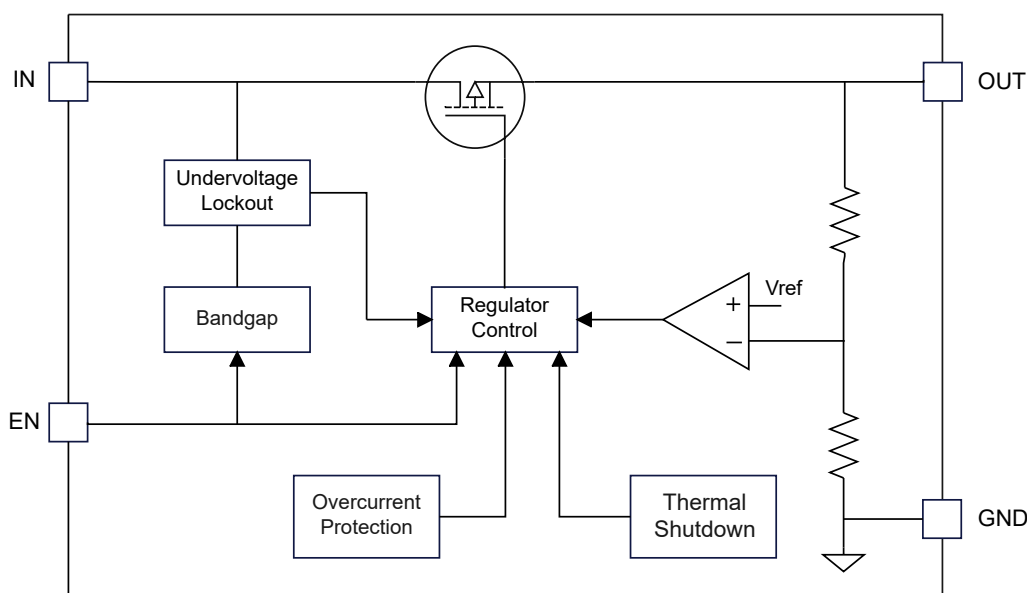


Figure 21. Functional Block Diagram

Feature Description

Enable (EN)

The enable pin (EN) is active high. Connect this pin to the GPIO of an external processor or digital logic control circuit to enable and disable the device. Or connect this pin to the IN pin for self-bias applications.

**42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout
Linear Regulator****Under-Voltage Lockout (UVLO)**

The TPL8031Q series uses an under-voltage lockout circuit to keep the output shut off until the internal circuitry operates properly. Refer to the Electrical Characteristics table for UVLO threshold and hysteresis.

Regulated Output Voltage (OUT)

The TPL8031Q series is available in fixed voltage versions of 5 V and 3.3 V. When the input voltage is higher than $V_{OUT(NOM)} + V_{DO}$, the output pin is the regulated output based on the selected voltage version. When the input voltage falls below $V_{OUT(NOM)} + V_{DO}$, the output pin tracks the input voltage minus the dropout voltage based on the load current.

Over-Current Protection

The TPL8031Q series integrates an internal current limit that helps to protect the regulator during fault conditions, e.g., the output is shorted to ground, or the output is forced below $V_{OUT(NOM)}$. The output voltage is not regulated when the device is in current limit, and $V_{OUT} = I_{CL} \times R_{LOAD}$.

Over-Temperature Protection

The over-temperature protection starts to work when the junction temperature exceeds the thermal shutdown (TSD) threshold, which turns off the regulator immediately. Until the device cools down and the junction temperature falls below 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 reduce the device lifetime.

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

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 TPL8031Q products are 42-V 3-μA ultra-low quiescent low dropout voltage linear regulators with 300-mA maximum output current capability. The following application schematic shows a typical usage of the TPL8031Q series.

Typical Application

Figure 22 shows the typical application schematic of the TPL8031Q series.

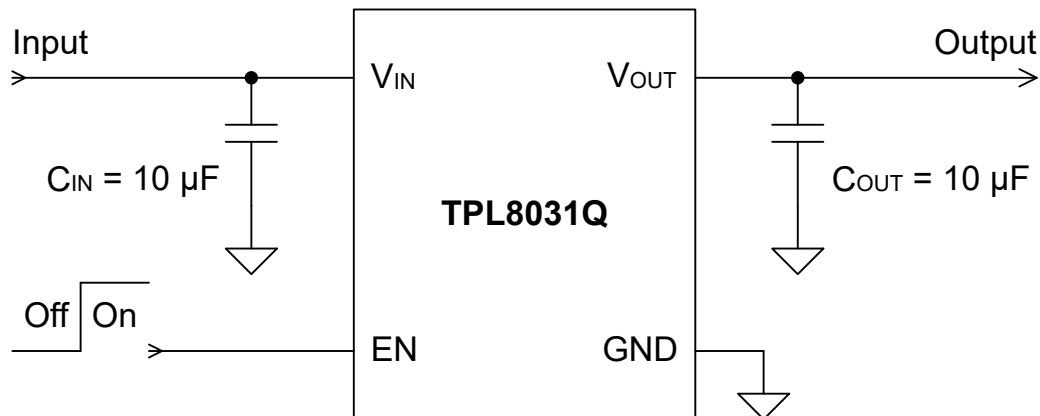


Figure 22. Typical Application Circuit

Input Capacitor and Output Capacitor

3PEAK recommends adding a 10-μF or greater capacitor with a 0.1-μF bypass capacitor in parallel at the IN pin to keep the input voltage stable. The voltage rating of the capacitors must be greater than the maximum input voltage.

To ensure loop stability, the TPL8031Q series requires an output capacitor of 1 μF to 200 μF with an ESR range from 0.001 Ω to 10 Ω. 3PEAK recommends selecting an X7R type 10-μF ceramic capacitor with low ESR over temperature.

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

Power Dissipation and Thermal Consideration

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

The power dissipation can be calculated using the [Equation 1](#).

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND} \quad (1)$$

The junction temperature can be estimated using the [Equation 2](#). θ_{JA} is the junction-to-ambient thermal resistance.

$$T_J = T_A + P_D \times \theta_{JA} \quad (2)$$

**42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout
Linear Regulator**

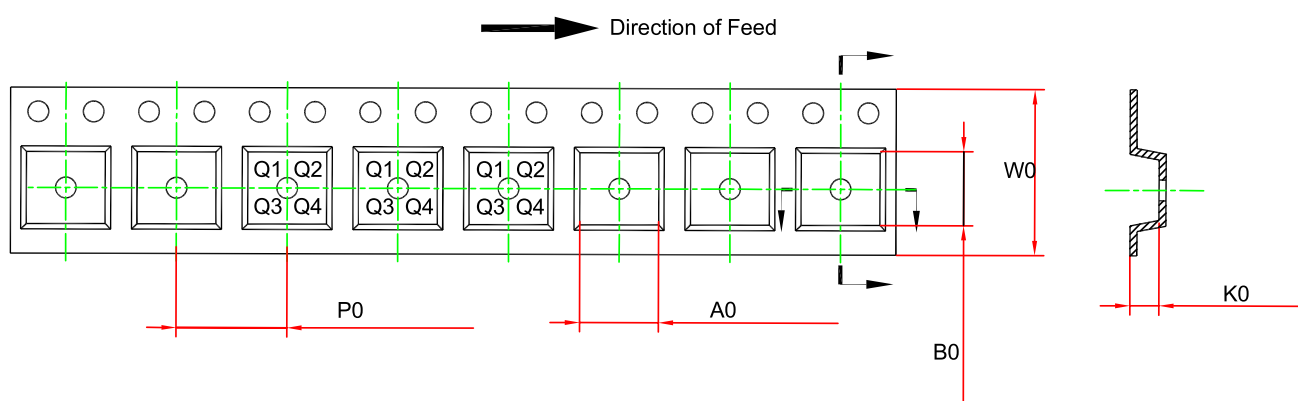
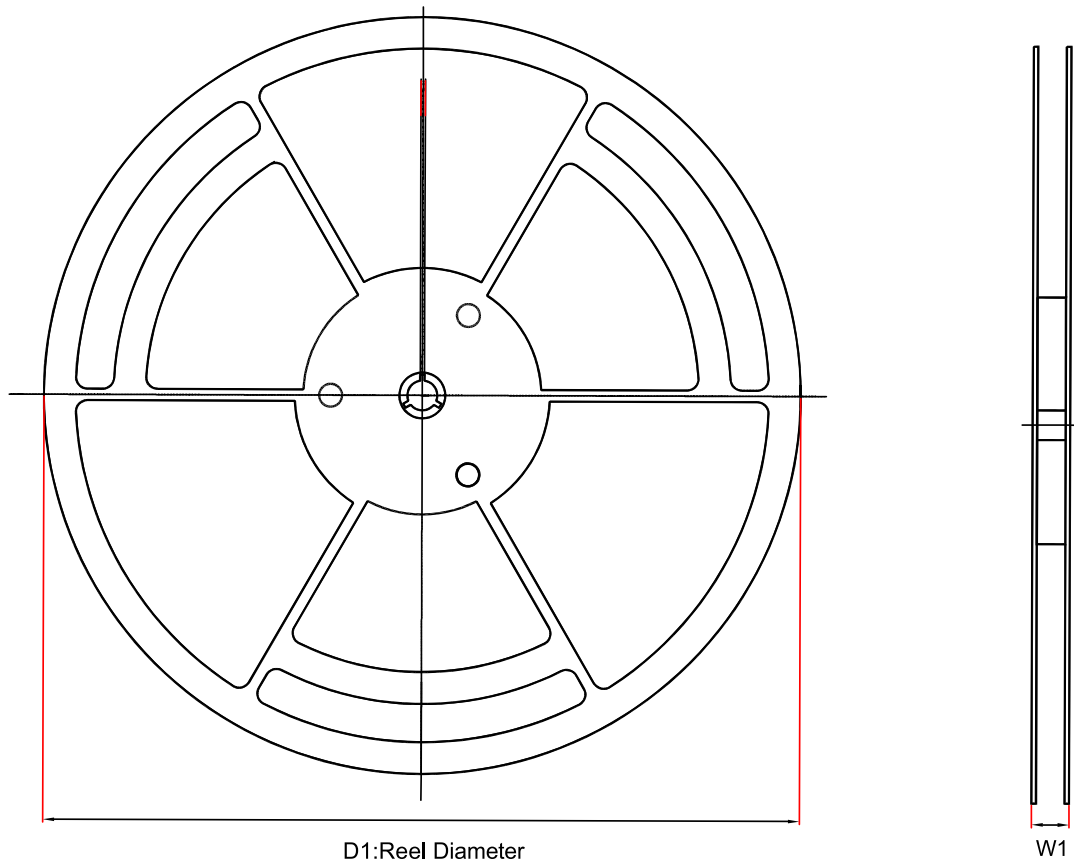
Layout

Layout Guideline

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

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

Tape and Reel Information



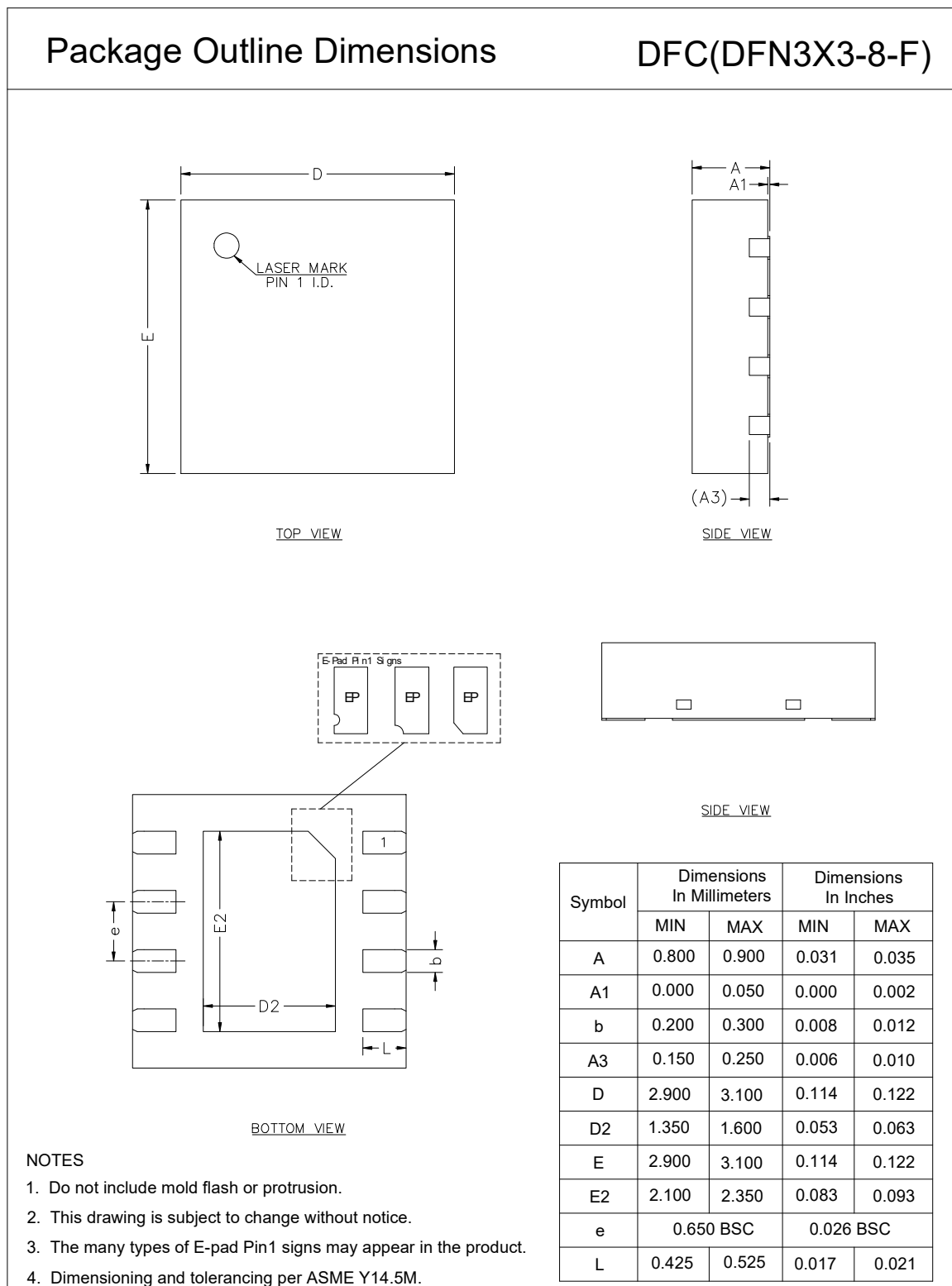
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPL803133Q- DF6R-S	DFN3X3-8	330	17.6	3.3	3.3	1.1	8	12	Q1

**42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout
Linear Regulator**

Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPL803150Q- DF6R-S	DFN3X3-8	330	17.6	3.3	3.3	1.1	8	12	Q1
TPL803133Q- EV1R-S	EMSOP8	330	17.6	5.3	3.4	1.4	8	12	Q1
TPL803150Q- EV1R-S	EMSOP8	330	17.6	5.3	3.4	1.4	8	12	Q1
TPL803133Q- ST4R-S	SOT223-3	330	17.6	7.05	7.3	1.9	8	12	Q3
TPL803150Q- ST4R-S	SOT223-3	330	17.6	7.05	7.3	1.9	8	12	Q3

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

Package Outline Dimensions

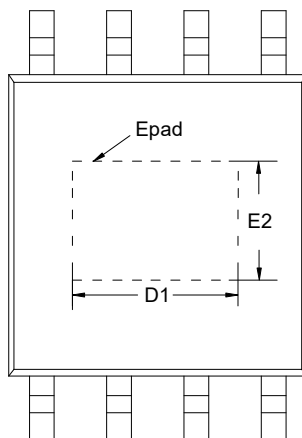
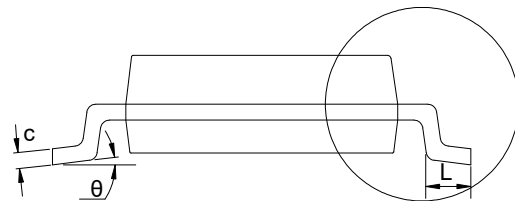
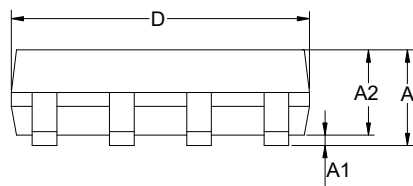
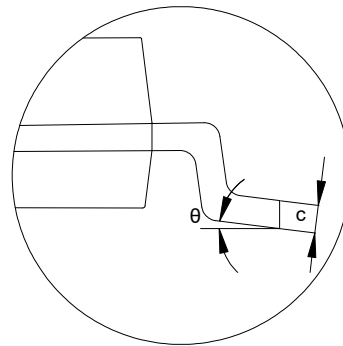
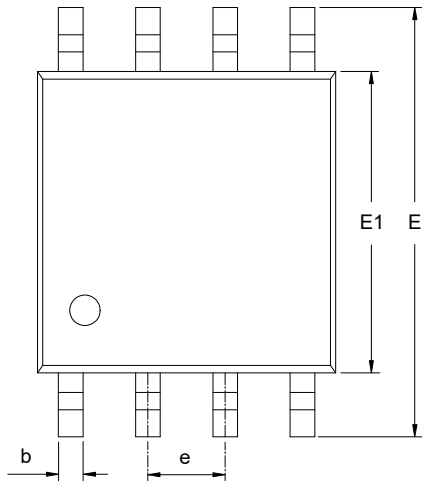
DFN3X3-8


42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

EMSOP8

Package Outline Dimensions

EV1(EMSOP-8-B)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
D1	1.920	2.220	0.076	0.087
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
E2	1.450	1.750	0.057	0.069
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0	8°	0	8°

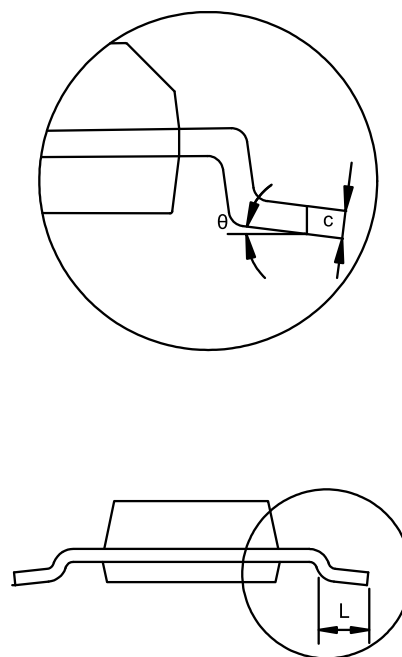
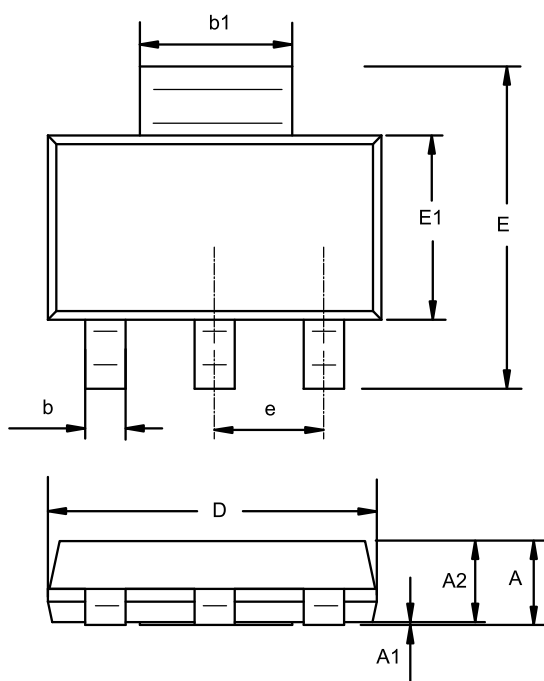
NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.
3. Dimensioning and tolerancing per ASME Y14.5M.

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator

SOT223-3

Package Outline Dimensions

ST4(SOT223-3-A)


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.500	1.800	0.059	0.071
A1	0.020	0.100	0.001	0.004
A2	1.500	1.700	0.059	0.067
b	0.660	0.840	0.026	0.033
b1	2.900	3.100	0.114	0.122
c	0.230	0.350	0.009	0.014
D	6.300	6.700	0.248	0.264
E	6.700	7.300	0.264	0.287
E1	3.300	3.700	0.130	0.146
e	2.300 BSC		0.091 BSC	
L	0.750	1.150	0.030	0.045
θ	0	10°	0	10°

NOTES

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

42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout Linear Regulator**Order Information**

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPL803133Q-DF6R-S	-40 to 150°C	DFN3X3-8	L3133	MSL3	4,000	Green
TPL803150Q-DF6R-S	-40 to 150°C	DFN3X3-8	L3150	MSL3	4,000	Green
TPL803133Q-EV1R-S	-40 to 150°C	EMSOP8	L3133	MSL2	3,000	Green
TPL803150Q-EV1R-S	-40 to 150°C	EMSOP8	L3150	MSL2	3,000	Green
TPL803133Q-ST4R-S	-40 to 150°C	SOT223-3	LDC	MSL3	4,000	Green
TPL803150Q-ST4R-S	-40 to 150°C	SOT223-3	LDD	MSL3	4,000	Green

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

**42-V 300-mA Wide-input Ultra-low Quiescent Current Low-Dropout
Linear Regulator****IMPORTANT NOTICE AND DISCLAIMER**

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