±5V，250mA 双输出电源

特性

- 输入电压范围 **2.9V** 至 **5.0V**
- 固定 **5.0V** $V_{正向}$输出电压
  - **1%** 输出电压精度
- 固定 **5.0V** $V_{负向}$输出电压
  - **1%** 输出电压精度
- $V_{正向}$至 $V_{负向}$区间内高达 **250mA** 的输出电流
- 出色的线路和负载瞬态响应
- 运行在连续传导模式 **(CCM)** 以实现无噪声输出电压
- 升压转换器能够运行在“下行模式”下（**VIN** 接近或高于 $V_{正向}$）
- 高转换器效率
- 短路保护
- 热关断
- **3mm × 3mm 12** 引脚四方扁平无引线 **(QFN)** 封装

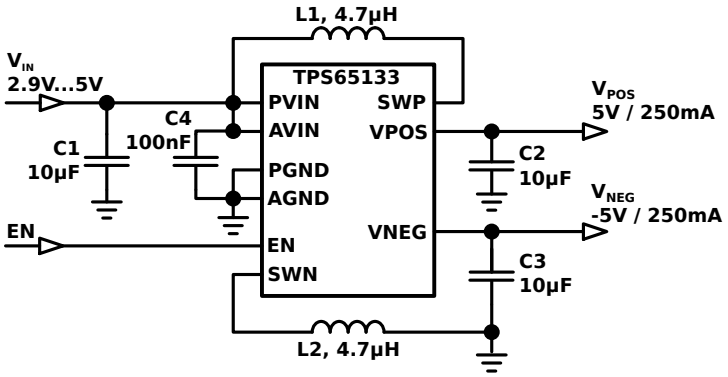
应用范围

- **LCD** 偏置
- 有源矩阵 **OLED**
- 运算放大器电源
- 普通 **±5V** 电源

说明

TPS65133 被设计成驱动需要一个正向和负向电源轨的 LCD 显示屏。 它还可被用作一个为运算放大器，或者为其它要求相似正向和负向电源的器件供电的普通 ±5V 电源。 此器件集成了一个升压转换器和一个适合于电池供电类产品的反相降压-升压转换器。

典型应用



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ORDERING INFORMATION(1) (2)

T_A	PACKAGE	ORDERING P/N	TOP-SIDE MARKING
–40°C to 85°C	12-Pin 3x3 QFN	TPS65133DPDR	SHY

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)(1)

		VALUE		UNIT
		MIN	MAX	
Input voltage range(2)	SWP, VPOS, PVIN, AVIN, EN	-0.3	6.0	V
	VNEG	-6.5	0.3	
	SWN	-6.5	5.5	
ESD rating	HBM		2	kV
	MM		200	V
	CDM		500	V
Operating junction temperature range	T_J	-40	150	°C
Operating ambient temperature range	T_A	-40	85	°C
Storage temperature range	T_{stg}	-65	150	°C

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute–maximum–rated conditions for extended periods may affect device reliability.
(2) With respect to GND pin.

THERMAL INFORMATION

THERMAL METRIC(1)		QFN (12 PINS)	UNIT
θ_{JA}	Junction-to-ambient thermal resistance	51.5	°C/W
θ_{JB}	Junction-to-board thermal resistance	25.0	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	0.5	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	25.2	°C/W

(1) For more information about traditional and new thermal metrics, see the IC Package Thermal Metrics application report, SPRA953.

RECOMMENDED OPERATING CONDITIONS(1)

		MIN	NOM	MAX	UNIT
V_{IN}	Input voltage range	2.9	3.7	5	V
T_A	Operating ambient temperature	-40		85	°C
T_J	Operating junction temperature	-40		125	°C

(1) Refer to application section for further information.

ELECTRICAL CHARACTERISTICS

V_{IN} = 3.7V, EN = V_{IN}, V_{POS} = 5V, V_{NEG} = -5V, T_A = -40°C to 85°C, typical values are at T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY CURRENT AND THERMAL PROTECTION						
V_{IN}	Input voltage range		2.9		5	V
I_{SD}	Shutdown current into V_{IN}	EN = GND		0.1	15	µA
UVLO	Under-voltage lockout threshold	V_{IN} falling			2.1	V
		V_{IN} rising			2.5	
T_{SD}	Thermal shutdown temperature			135		°C
LOGIC SIGNALS						
V_H	Logic high-level voltage		1.2			V
V_L	Logic low-level voltage				0.4	V
BOOST CONVERTER (V_{POS})						
V_{POS}	Positive output voltage		4.95	5	5.05	V
$R_{DS(ON)}$	SWP MOSFET on-resistance	I_{SWP} = 200mA		250		mΩ
	SWP MOSFET rectifier on-resistance			350		
f_{SWP}	SWP switching frequency	I_{POS} = 200mA	1.2	1.7	2.2	MHz
I_{SWP}	SWP switch current limit	Inductor valley current	0.8	1.1		A
$V_{P(SCP)}$	Short circuit threshold in operation	V_{POS} falling		4.1		V
$t_{P(SCP)}$	Short circuit detection time in operation		1	3	5	ms
$R_{P(DCG)}$	V_{POS} Discharge resistance	EN = GND, I_{POS} = 1mA	15	30	60	Ω
	Line regulation	I_{POS} = 100 mA		.02		%/V
	Load regulation	VIN = 3.7 V		.24		%/A
BUCK-BOOST CONVERTER (V_{NEG})						
V_{NEG}	Negative output voltage default		-5.05	-5	-4.95	V
$R_{DS(ON)}$	SWN MOSFET on-resistance	I_{SWN} = 200mA		250		mΩ
	SWN MOSFET rectifier on-resistance			350		
f_{SWN}	SWN switching frequency	I_{NEG} = 200mA	1	1.7	2.4	MHz
I_{SWN}	SWN switch current limit	Inductor valley current	1.5	2.2		A
$V_{N(SCP)}$	Short circuit threshold in operation			-4.5		V
$t_{N(SCP)}$	Short circuit detection time in operation		1	3	5	ms
$R_{N(DCG)}$	V_{NEG} Discharge resistance	EN = GND, I_{NEG} = 1mA	100	150	200	Ω
$t_{N(DLY)}$	Start-up delay time after V_{POS} reaches target output to when V_{NEG} will begin startup			2		ms
	Line regulation	I_{NEG} = 100 mA		.01		%/V
	Load regulation	VIN = 3.7 V		.16		%/A

DEVICE INFORMATION

10 PIN TQFN PACKAGE
(TOP VIEW)

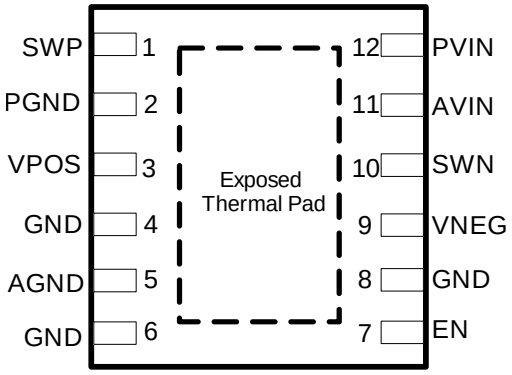
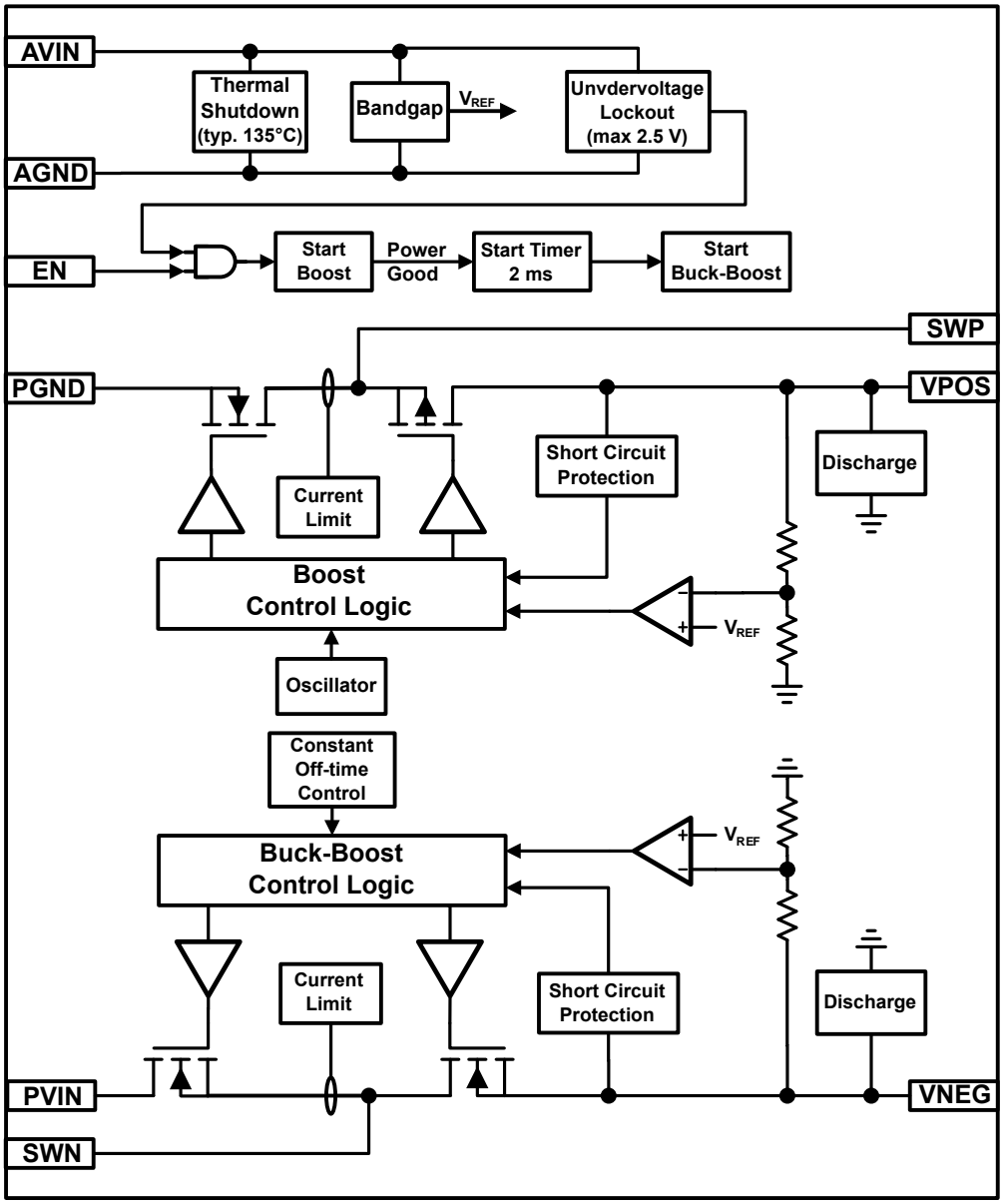


Table 1. Pin Functions

NO.	NAME	TYPE(1)	DESCRIPTION
1	SWP	I	Switch pin of the boost converter
2	PGND	G	Power ground of the boost converter
3	VPOS	O	Output of the boost converter (V_{POS}), place a capacitor close to this pin.
4	GND	G	Ground
5	AGND	G	Analog ground
6	GND	G	Ground
7	EN	I	Enable of boost and buck boost converter
8	GND	G	Ground
9	VNEG	O	Output of the negative buck boost converter (V_{NEG}), place a capacitor close to this pin
10	SWN	I	Switch pin of the negative buck boost converter
11	AVIN	I	Internal logic supply pin
12	PVIN	I	Supply pin for the negative buck boost converter. Place a capacitor close to this pin
—	Exposed thermal pad	G	Connect this pad to all GND pins

(1) G = Ground, I = Input, O = Output

FUNCTIONAL BLOCK DIAGRAM



TYPICAL CHARACTERISTICS

Table 2. Table of Graphs

		FIGURE
Efficiency vs. Output current	V_{POS} = 5 V, V_{NEG} = -5 V $I_{OUT} = I_{POS} + I_{NEG}$, $I_{POS} = I_{NEG}$	Figure 1
Line Regulation	V_{POS} = 5 V, VIN = 2.9 V to 5.0 V	Figure 2
	V_{NEG} = -5 V, VIN = 2.9 V to 5.0 V	Figure 3
Startup	V_{POS} Boost and V_{NEG} Buck-Boost	Figure 4
Switch pin, inductor current and output waveform	V_{POS} Boost, V_{POS} = 5 V, I_{OUT} = 100 mA	Figure 5
	V_{POS} Boost, V_{POS} = 5 V, I_{OUT} = 250 mA	Figure 6
	V_{NEG} Buck-Boost, V_{NEG} = -5 V, I_{OUT} = 100 mA	Figure 7
	V_{NEG} Buck-Boost, V_{NEG} = -5 V, I_{OUT} = 250 mA	Figure 8
Load Transient	VIN = 3.7 V, I_{POS} = 50 mA to 200 mA	Figure 9
	VIN = 3.7 V, I_{NEG} = 50 mA to 200 mA	Figure 10

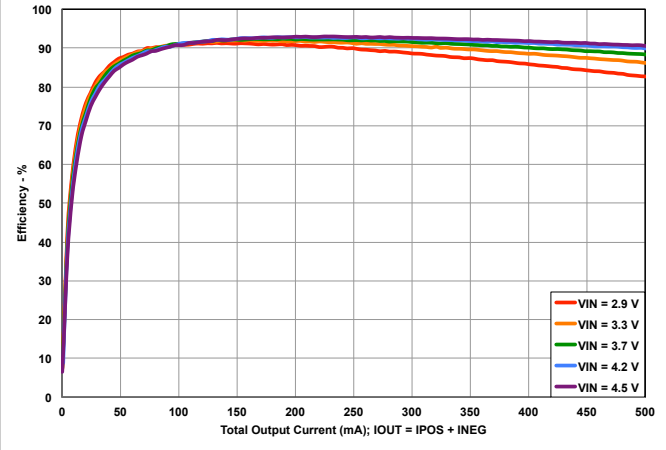


Figure 1. EFFICIENCY vs. OUTPUT CURRENT
V_{POS} = 5 V, V_{NEG} = -5 V
$I_{OUT} = I_{POS} + I_{NEG}$, $I_{POS} = I_{NEG}$

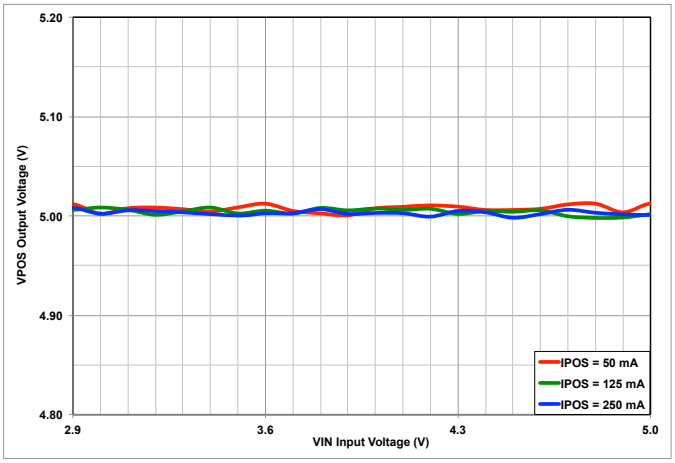


Figure 2. V_{POS} OUTPUT VOLTAGE vs. INPUT VOLTAGE
V_{POS} = 5 V, VIN = 2.9 V to 5.0 V

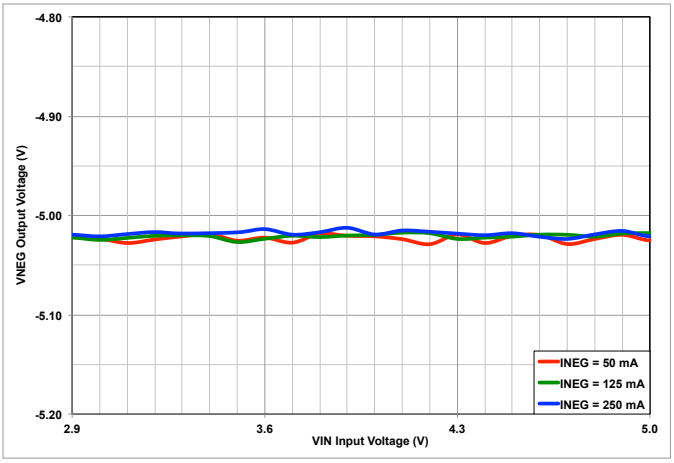


Figure 3. V_{NEG} OUTPUT VOLTAGE vs. INPUT VOLTAGE
V_{NEG} = -5 V, VIN = 2.9 V to 5.0 V

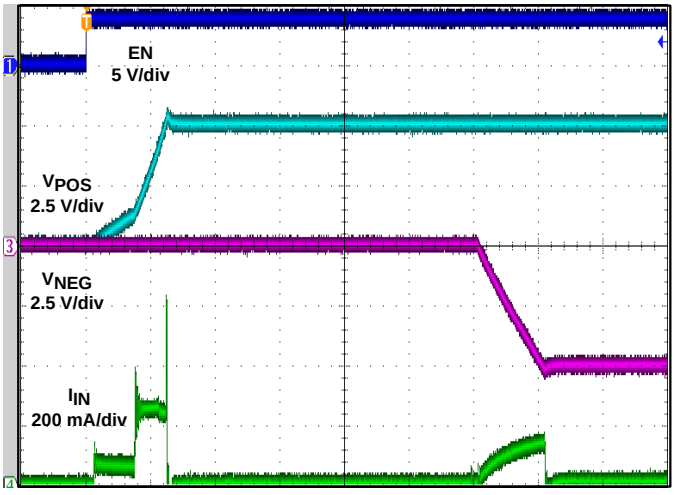


Figure 4. START UP
V_{POS} BOOST and V_{NEG} BUCK-BOOST

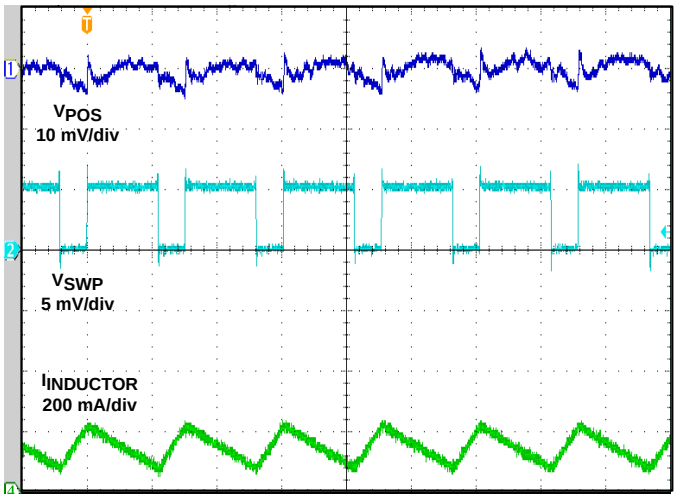


Figure 5. SWITCH PIN, INDUCTOR CURRENT and OUTPUT V_{POS} BOOST, V_{POS} = 5 V, I_{OUT} = 100 mA

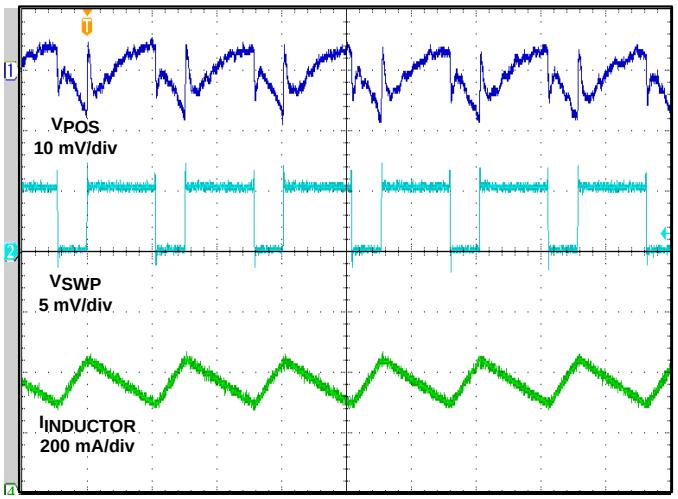


Figure 6. SWITCH PIN, INDUCTOR CURRENT and OUTPUT V_{POS} BOOST, V_{POS} = 5 V, I_{OUT} = 250 mA

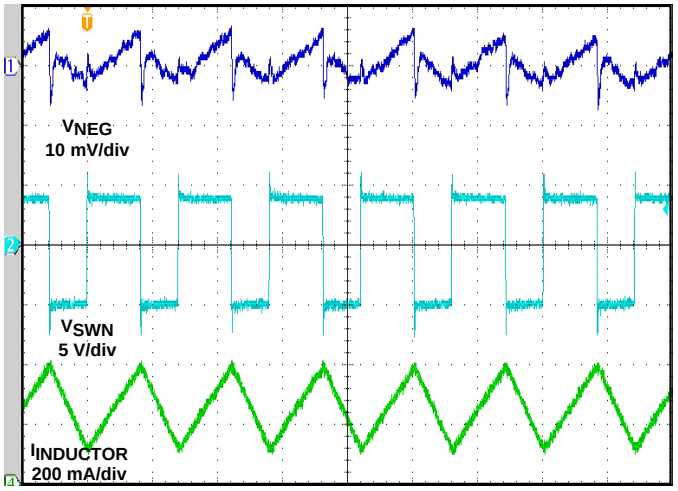


Figure 7. SWITCH PIN, INDUCTOR CURRENT and OUTPUT V_{NEG} BOOST, V_{NEG} = –5 V, I_{OUT} = 100 mA

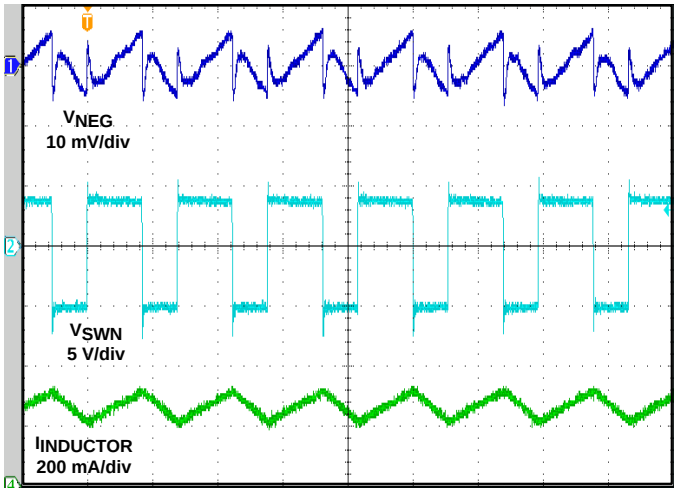


Figure 8. SWITCH PIN, INDUCTOR CURRENT and OUTPUT V_{NEG} BOOST, V_{NEG} = –5 V, I_{OUT} = 250 mA

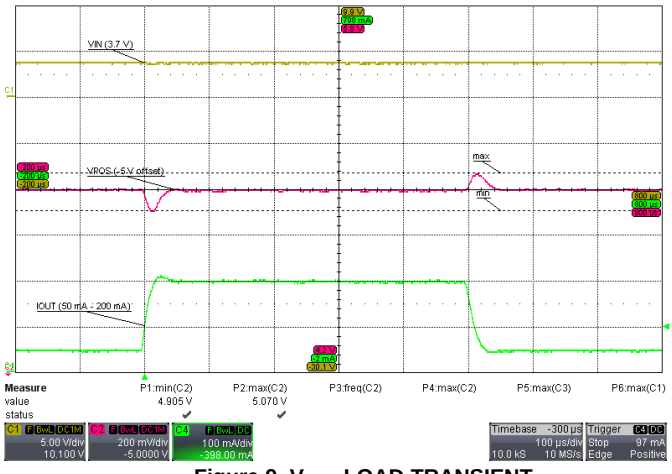


Figure 9. V_{POS} LOAD TRANSIENT VIN = 3.7 V, I_{POS} = 50 mA to 200 mA

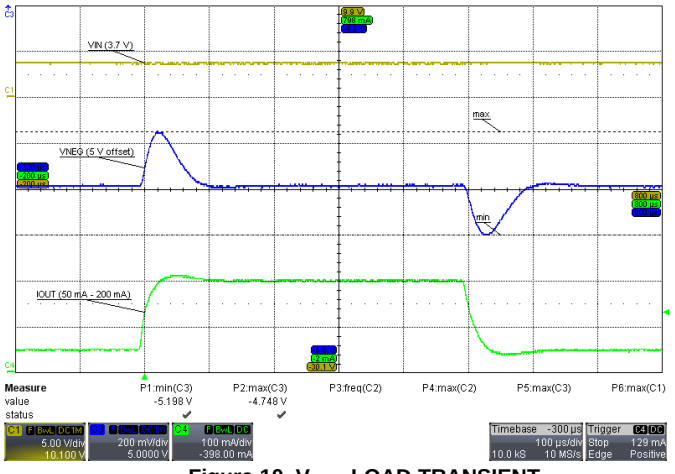


Figure 10. V_{NEG} LOAD TRANSIENT VIN = 3.7 V, I_{NEG} = 50 mA to 200 mA

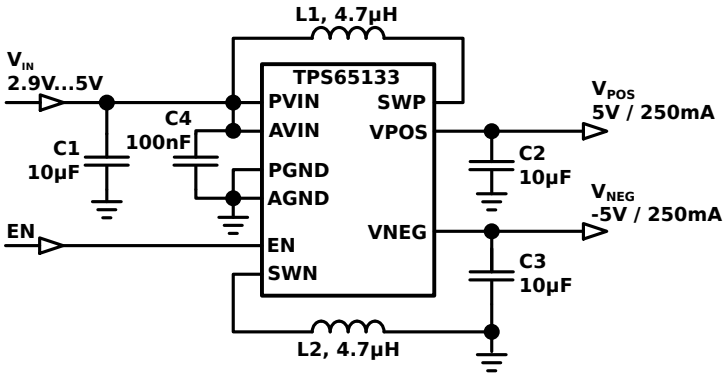


Figure 11. Application for Typical Characteristics

Table 3. Bill of Materials for Typical Characteristics

COMPONENT	VALUE	PART NUMBER	MANUFACTURER
C1, C2, C3	10µF	GRM219R61A106KE44	Murata
L1, L2	4.7µH	1239AS-H-4R7M (DFE 252012C)	TOKO

DETAILED DESCRIPTION

The TPS65133 integrates a boost converter and an inverting buck-boost converter. The positive output is fixed at 5 V and negative output is fixed at –5 V.

ENABLE (EN PIN)

The EN pin enables the boost and buck-boost converters. When EN is pulled high the device is enabled and both rails will startup according to the start-up sequence. When EN is pulled low the device is disabled and both outputs are discharged to ground.

START-UP AND SHUT-DOWN SEQUENCE

The device is enabled by EN pin going high, the boost converter (V_{POS}) will first start. Typically 2 ms after V_{POS} is in regulation, the buck-boost converter (V_{NEG}) starts. To reduce the inrush current, the switch current limit during start-up is reduced (soft-start). The start-up times depend on the output capacitances and the load currents.

During shut-down (EN = low) the outputs are actively discharged to GND, as long as V_{IN} > 1.5 V (typ). The discharge time depends on the output capacitance and the load current. The V_{POS} discharge circuit is stronger than the V_{NEG} discharge circuit, that means for the same output capacitance and load V_{POS} is discharged faster. The start-up and shut-down sequence for the typical application with 10 µF output capacitance is shown in Figure 12.

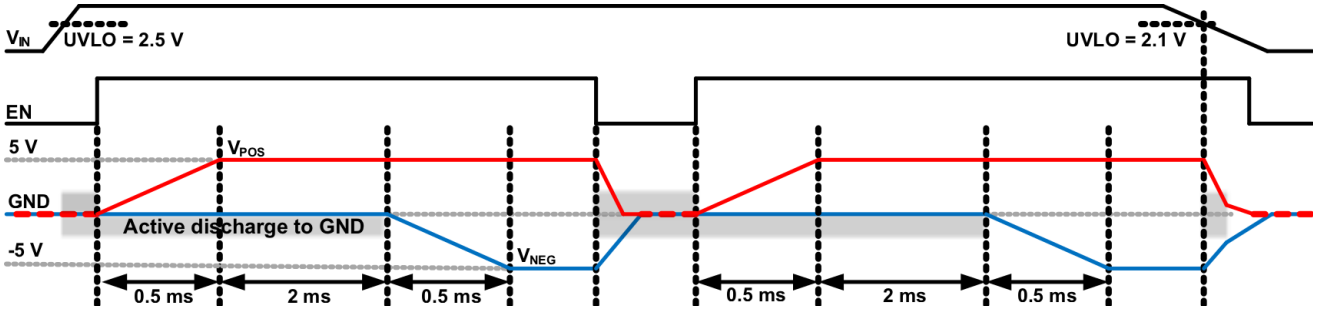


Figure 12. Start-up Sequence

INPUT VOLTAGE OPERATING RANGE

The TPS65133 is designed to work optimally over an input voltage range of 2.9V to 5V. However, as the input voltage drops below 2.9V and approaches the UVLO falling threshold (typically 2.1V), the device will continue to operate. The device is also able to function as the input voltage approaches the target output voltage of the switching converters; that is to say, as VIN approaches and reaches 5V, the VPOS and VNEG rails will continue to output +5V and -5V. The device is able to operate in a 'down' mode similar to an LDO in this condition as VIN approaches and reaches 5V.

OUTPUT DISCHARGE

The device actively discharges V_{POS} and V_{NEG} to GND when the device is disabled (see Figure 12 shaded area).

SHORT CIRCUIT PROTECTION

The device is protected against short circuits of V_{POS} and V_{NEG} to GND.

Short Before Power-up:

When a short-circuit is present before power-up, the output current is limited until the short is removed.

Short During Operation:

A short-circuit is detected if V_{POS} falls below 4.1 V for longer than 3 ms or V_{NEG} is pulled above –4.5V longer than 3 ms. In either case, the device goes into shutdown and this state is latched. Input and outputs are disconnected. To resume normal operation, V_{IN} must cycle below UVLO or EN has to toggle from low to high.

THERMAL SHUTDOWN

A thermal shutdown is implemented to prevent damage because of excessive heat and power dissipation. Once a temperature of typically 135°C is exceeded the device goes into shutdown. To resume normal operation, V_{IN} must cycle below UVLO or EN has to toggle from low to high.

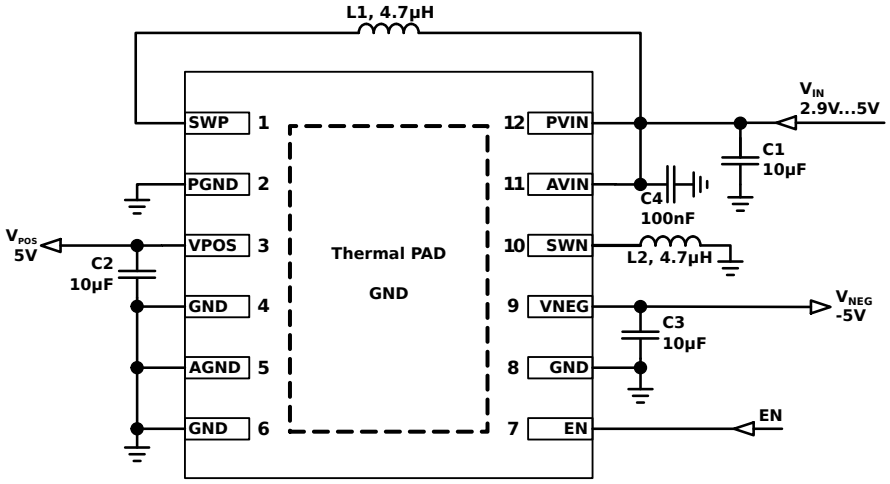


Figure 13. Typical Application Circuit

PCB LAYOUT

1. Place the input capacitor on PVIN and the output capacitor on VNEG as close as possible to device. Use short and wide traces to connect the input capacitor on PVIN and the output capacitor on VNEG.
2. Place the output capacitor on VPOS as close as possible to the device. Use short and wide traces to connect the output capacitor on VPOS.
3. Connect the ground of AVIN capacitor with AGND.
4. Connect input ground and output ground on the same board layer, not through via hole.
5. Connect AGND, PGND and GND with exposed thermal pad.

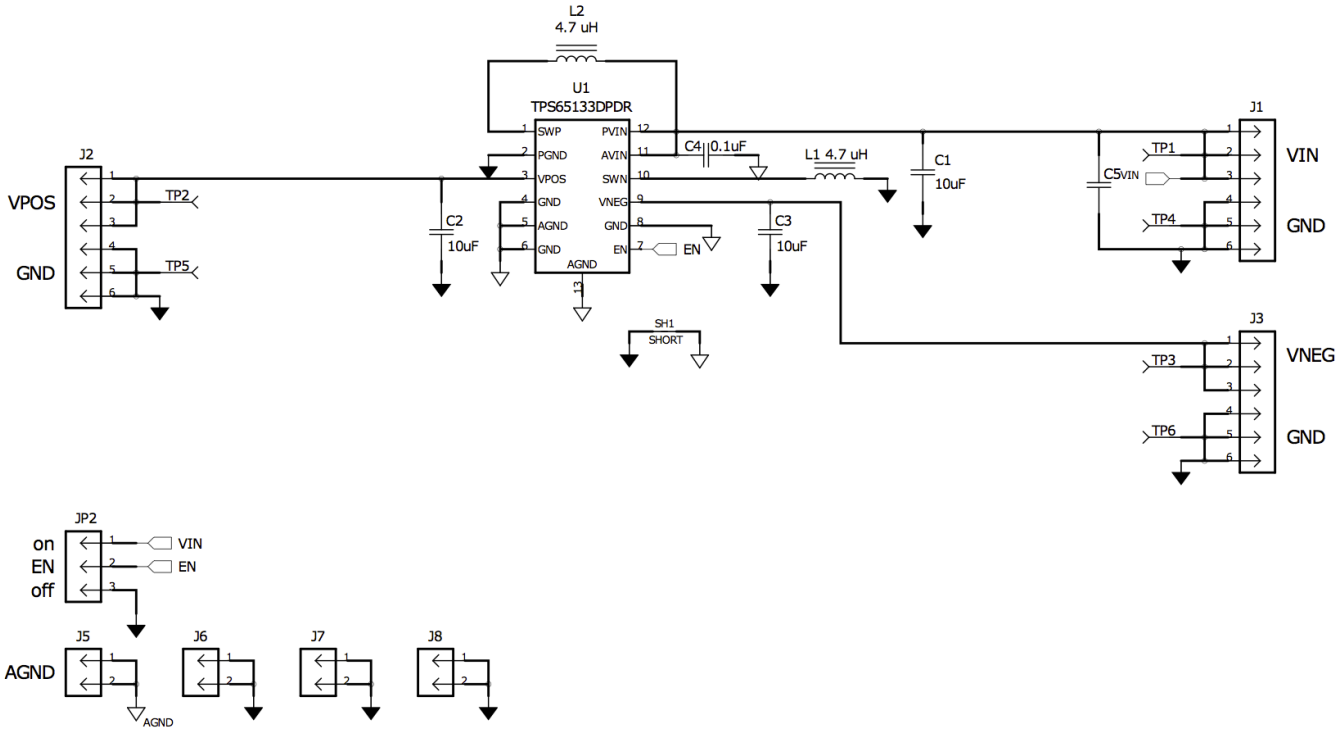


Figure 14. TPS65133 EVM Schematic

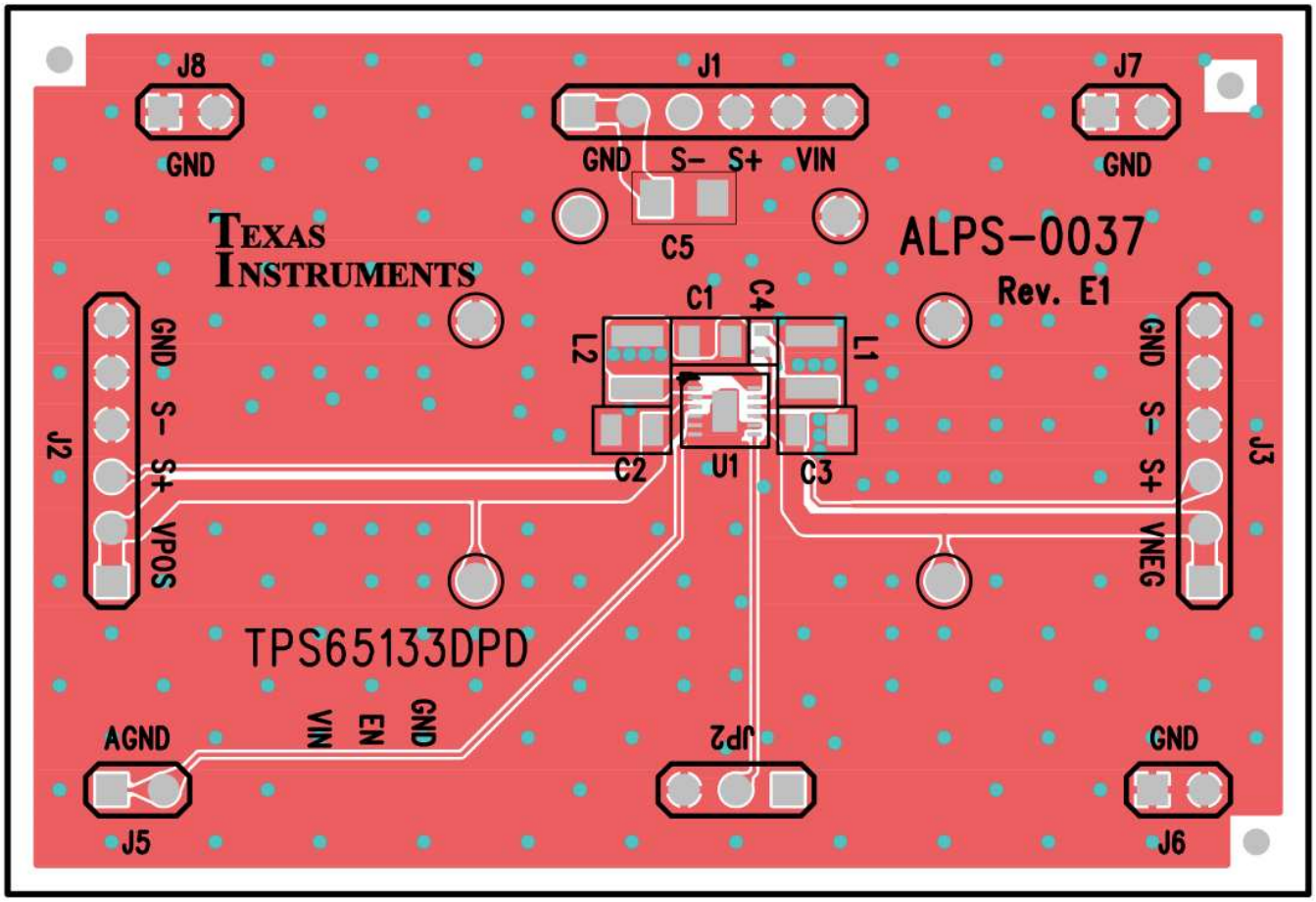


Figure 15. TPS65133 EVM Layout, Top Layer

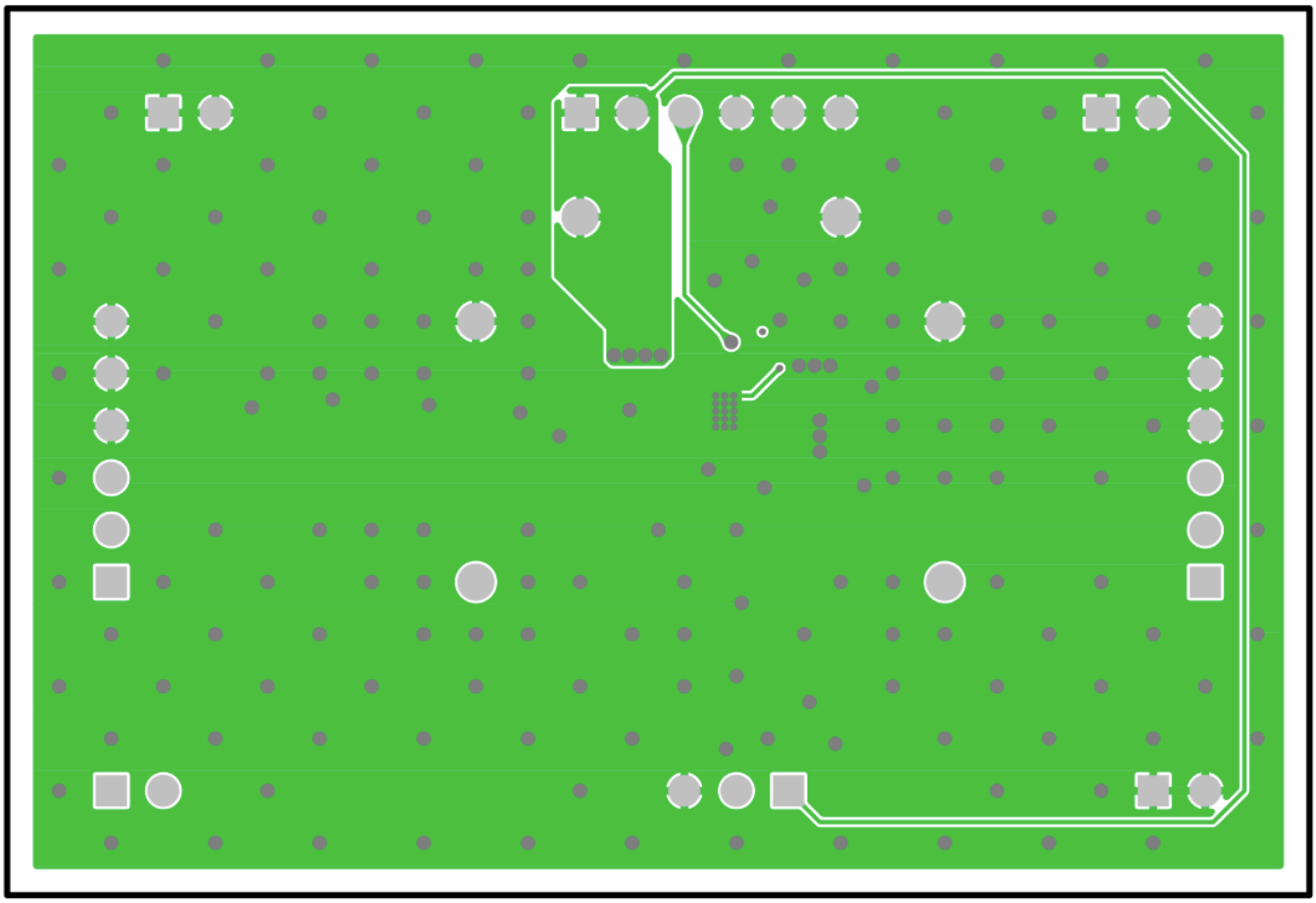


Figure 16. TPS65133 EVM Layout, Bottom Layer

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TPS65133DPDR	Active	Production	WSON (DPD) | 12	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SHY
TPS65133DPDR.A	Active	Production	WSON (DPD) | 12	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SHY
TPS65133DPDRG4	Active	Production	WSON (DPD) | 12	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SHY
TPS65133DPDRG4.A	Active	Production	WSON (DPD) | 12	3000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	SHY

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

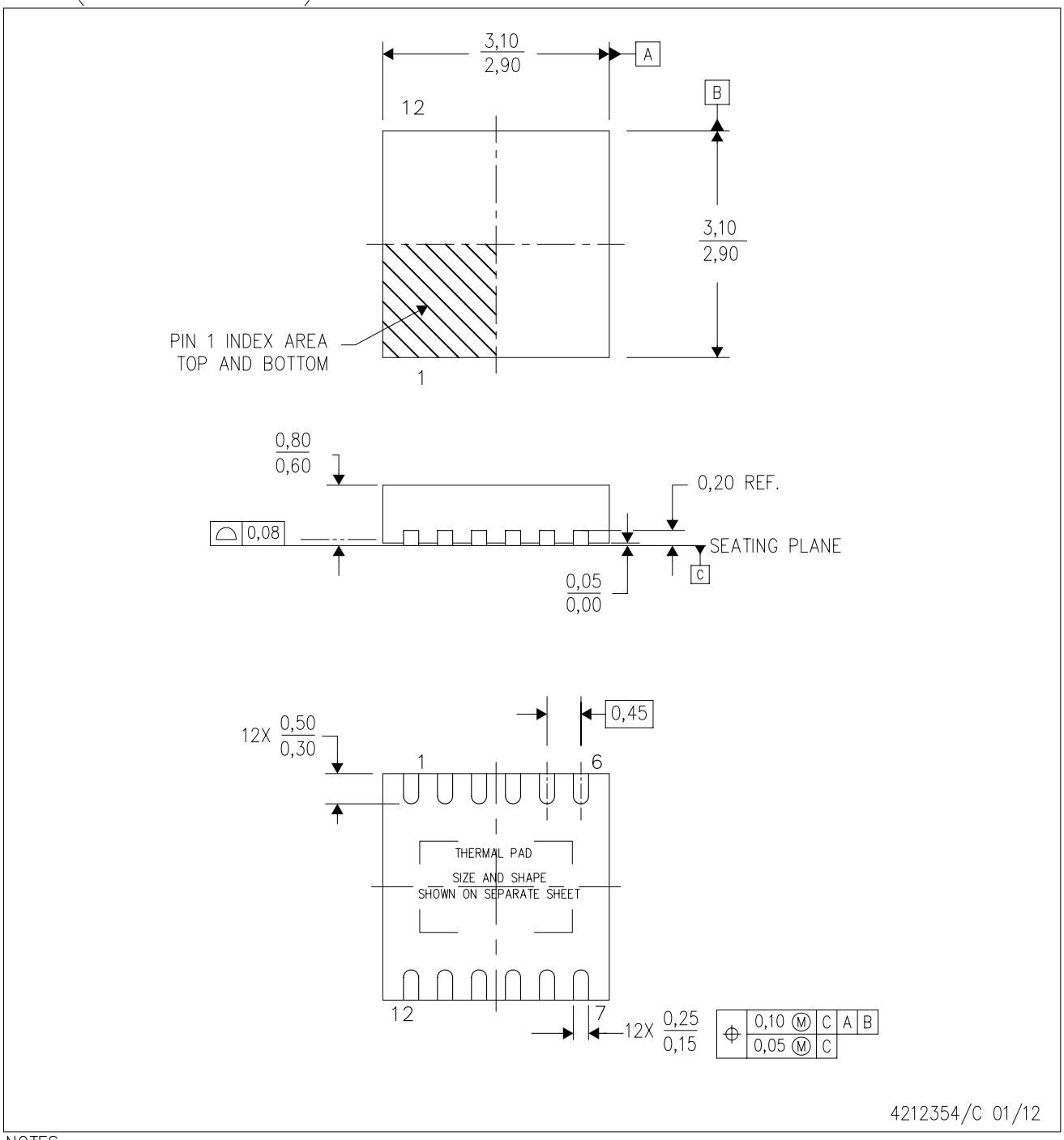
(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

DPD (S–PWSON–N12) PLASTIC SMALL OUTLINE NO–LEAD



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Small Outline No–Lead (SON) package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance, if present.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions, if present

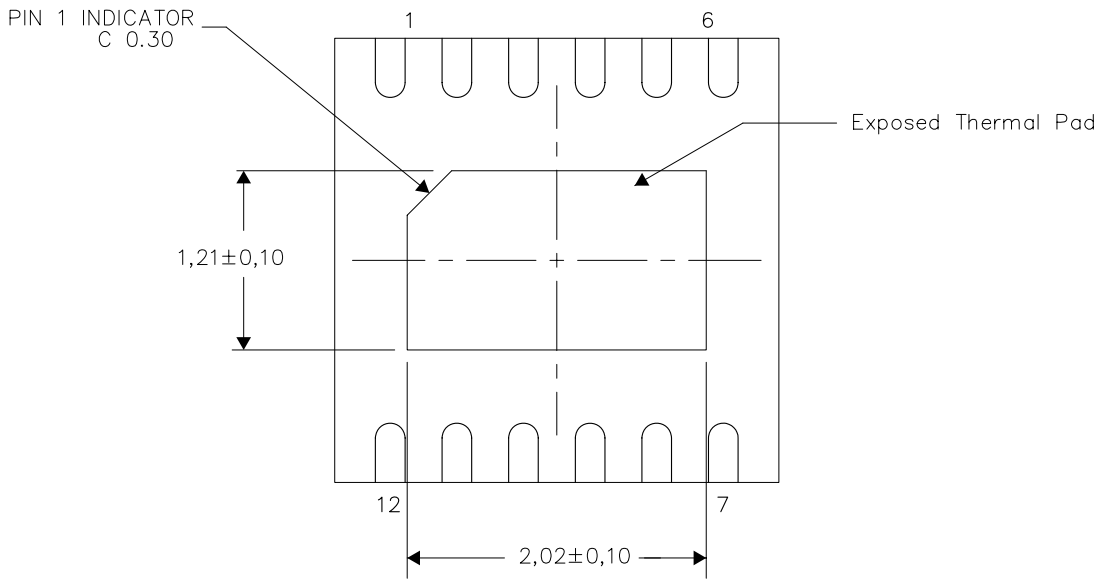
DPD (S–PUSON–N12) PLASTIC SMALL OUTLINE NO–LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No–Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

Exposed Thermal Pad Dimensions

4212468/A 02/12

NOTE: All linear dimensions are in millimeters

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最后更新日期：2025 年 10 月