



## TPS63700 DC-DC Inverter

### 1 Features

- Adjustable Output Voltage Down to  $-15\text{ V}$
- 2.7-V to 5.5-V Input Voltage Range
- Up to 360-mA Output Current
- 1000-mA Typical Switch Current Limit
- Up to 84% Efficiency
- Typical 1.4-MHz Fixed-Frequency PWM Operation
- Thermal Shutdown
- Typical  $-19\text{-V}$  Output Overvoltage Protection
- 1.5- $\mu\text{A}$  Shutdown Current
- Small 3-mm  $\times$  3-mm SON-10 Package (DRC)

### 2 Applications

- Generic Negative Voltage Supply
- Small-to-Medium Size OLED Displays
- Bias Supply

### 3 Description

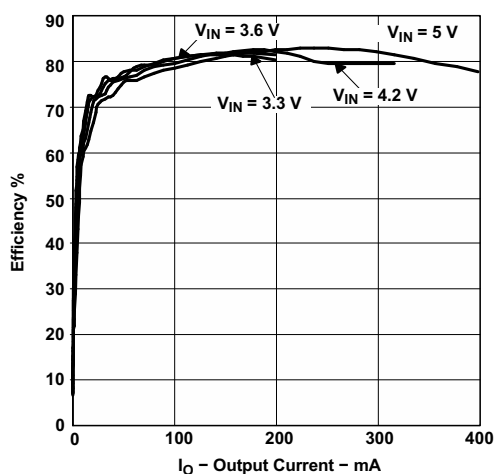
The TPS63700 is an inverting DC/DC converter generating a negative output voltage down to  $-15\text{ V}$  with output currents up to 360 mA, depending on input-voltage to output-voltage ratio. With a peak efficiency of 84%, the device is ideal for portable battery-powered equipment. The input voltage range of 2.7 V to 5.5 V allows the TPS63700 to be directly powered from a Li-ion battery, from 3-cell NiMH/NiCd, from a 3.3-V or 5-V supply rail.

The inverter operates with a fixed-frequency pulse width modulation (PWM) control topology. The device has an internal current limit, overvoltage protection, and a thermal shutdown for highest reliability under fault conditions.

A switching frequency of typically 1.4 MHz allows the use of small external components enabling a small solution size.

The TPS63700 comes in a small 3-mm  $\times$  3-mm SON-10 package.

Efficiency vs Output Current

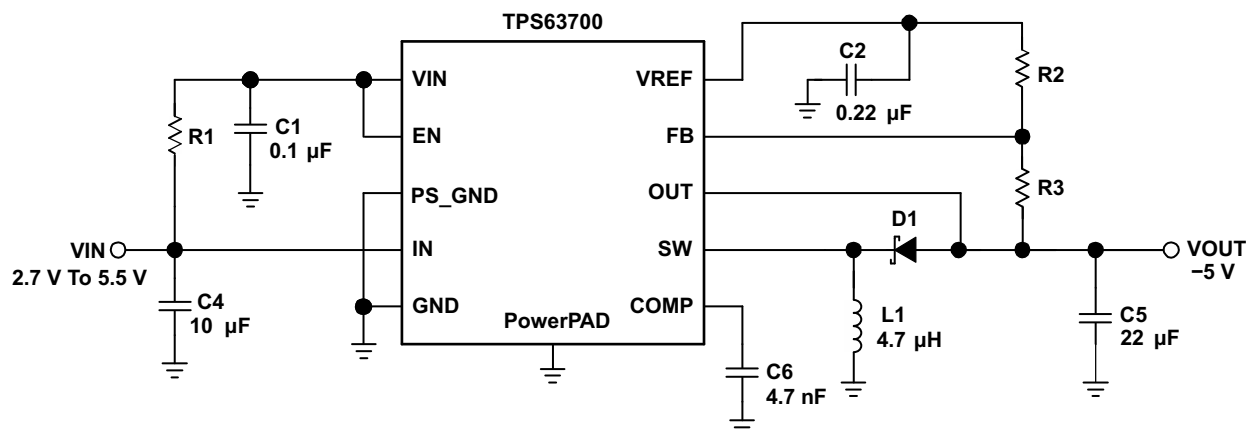


Device Information<sup>(1)</sup>

| PART NUMBER | PACKAGE   | BODY SIZE (NOM)          |
|-------------|-----------|--------------------------|
| TPS63700    | VSON (10) | 3.00 mm $\times$ 3.00 mm |

(1) For all available packages, see the orderable addendum at the end of the datasheet.

Typical Application Schematic



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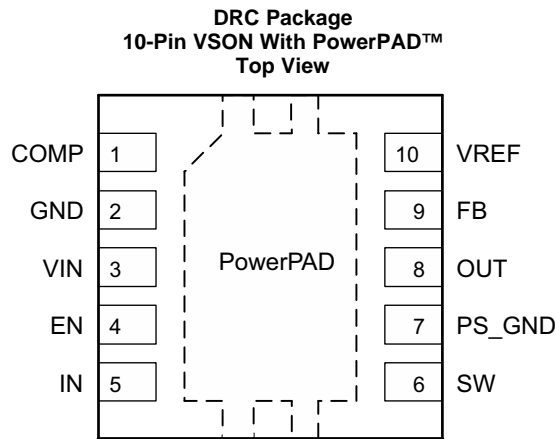
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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision C (June 2013) to Revision D   | Page     |
|---|----------|
| <ul style="list-style-type: none"> <li>Added <i>Pin Configuration and Functions</i> section, <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i>, <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section .....</li> </ul> | <b>1</b> |
| Changes from Revision B (November 2007) to Revision C   | Page     |
| <ul style="list-style-type: none"> <li>Deleted Dissipation Ratings table and added Thermal Information table. ....</li> </ul>   | <b>4</b> |

## 5 Pin Configuration and Functions



### Pin Functions

| PIN    |     | I/O | DESCRIPTION  |
|--------|-----|-----|--|
| NAME   | NO. |     |  |
| COMP   | 1   | I/O | Compensation pin for control, connect a 4.7 nF capacitor between this pin and GND  |
| GND    | 2   | —   | Ground pin   |
| VIN    | 3   | I   | Supply voltage input for control logic, connect a RC circuit of 10R and 100 nF to filter this supply voltage                                   |
| EN     | 4   | I   | Enable pin (EN = GND: disabled; EN = VIN: enabled)   |
| IN     | 5   | I   | Supply voltage for the power switch  |
| SW     | 6   | O   | Inverter switch output   |
| PS_GND | 7   | I   | Connect to GND for control logic   |
| OUT    | 8   | I   | Output voltage sense input   |
| FB     | 9   | I   | Feedback pin for the voltage divider   |
| VREF   | 10  | O   | Reference voltage output. Connect a 220-nF capacitor to ground. Connect the lower resistor of the negative output voltage divider to this pin. |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range unless otherwise noted<sup>(1)</sup>

|  | MIN  | MAX       | UNIT |
|--|------|-----------|------|
| Input voltage at VIN <sup>(2)</sup>                    | −0.3 | 6         | V    |
| Input voltage at IN <sup>(2)</sup>                     |      | VIN       | V    |
| Minimum voltage at OUT <sup>(2)</sup>                  |      | −18       | V    |
| Voltage at EN, FB, COMP, PS_GND <sup>(2)</sup>         | −0.3 | VIN + 0.3 | V    |
| Differential voltage between OUT to VIN <sup>(2)</sup> |      | 24        | V    |
| Operating virtual junction temperature, TJ             | −40  | 150       | °C   |
| Storage temperature, Tstg                              | −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) All voltage values are with respect to network ground terminal, unless otherwise noted.

### 6.2 ESD Ratings

|                                |  | VALUE | UNIT |
|--------------------------------|--|-------|------|
| V(ESD) Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(1)</sup>              | ±2000 | V    |
|                                | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup> | ±1000 |      |

- (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.

### 6.3 Recommended Operating Conditions

|  | MIN | MAX | UNIT |
|--|-----|-----|------|
| Input voltage range, VIN                   | 2.7 | 5.5 | V    |
| Operating free-air temperature, TA         | −40 | 85  | °C   |
| Operating virtual junction temperature, TJ | −40 | 125 | °C   |

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | TPS63700   | UNIT |
|-------------------------------|--|------------|------|
|                               |  | DRC (VSON) |      |
|                               |  | 10 PINS    |      |
| RθJA                          | Junction-to-ambient thermal resistance       | 41.2       | °C/W |
| RθJC(top)                     | Junction-to-case(top) thermal resistance     | 62.8       | °C/W |
| RθJB                          | Junction-to-board thermal resistance         | 16.6       | °C/W |
| ΨJT                           | Junction-to-top characterization parameter   | 1.2        | °C/W |
| ΨJB                           | Junction-to-board characterization parameter | 16.8       | °C/W |
| RθJC(bot)                     | Junction-to-case(bottom) thermal resistance  | 4.1        | °C/W |

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

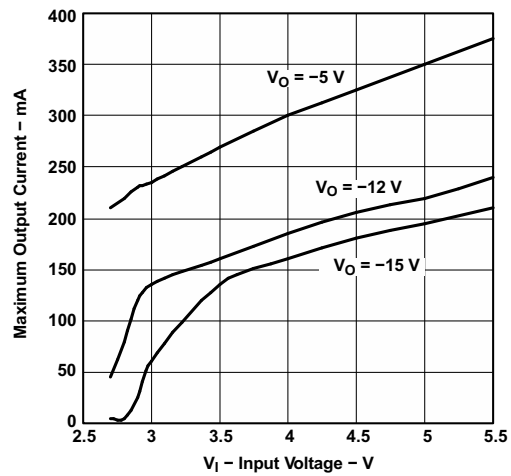
## 6.5 Electrical Characteristics

–40°C to 85°C, over recommended input voltage range, typical at an ambient temperature of 25°C (unless otherwise noted)

| PARAMETER <sup>(1)</sup> |  |     | TEST CONDITIONS   | MIN    | TYP   | MAX   | UNIT |
|--------------------------|--|-----|---|--------|-------|-------|------|
| <b>SUPPLY</b>            |  |     |   |        |       |       |      |
| V <sub>IN</sub>          | Input voltage range                    |     | Pin VIN, IN   | 2.7    |       | 5.5   | V    |
| I <sub>(Q)</sub>         | Quiescent current                      | VIN | V <sub>IN</sub> = 3.6 V, I <sub>OUT</sub> = 0, EN = V <sub>IN</sub> , no switching<br>V <sub>OUT</sub> = –5 V |        | 330   | 400   | μA   |
|                          |  | IN  |   |        | 640   | 750   | μA   |
| I <sub>SD</sub>          | Shutdown supply current                |     | EN = GND  |        | 0.2   | 1.5   | μA   |
| UVLO                     | Undervoltage lockout threshold         |     |   | 2.1    | 2.35  | 2.7   | V    |
| T <sub>SD</sub>          | Thermal shutdown temperature           |     |   |        | 150   |       | °C   |
|                          | Thermal Shutdown hysteresis            |     | Junction temperature decreasing   |        | 5     |       | °C   |
| <b>CONTROL STAGE</b>     |  |     |   |        |       |       |      |
| V <sub>EN</sub>          | High level input voltage               |     |   | 1.4    |       |       | V    |
| V <sub>EN</sub>          | Low level input voltage                |     |   |        |       | 0.4   | V    |
| I <sub>EN</sub>          | Input current                          |     | EN = V <sub>IN</sub> or GND   |        | 0.01  | 0.1   | μA   |
| <b>POWER SWITCH</b>      |  |     |   |        |       |       |      |
| I <sub>LIM</sub>         | Inverter switch current limit          |     | 2.7 V < V <sub>IN</sub> < 5.5 V   | 860    | 1000  | 1140  | mA   |
| R <sub>DS(ON)</sub>      | Inverter switch on-resistance          |     | V <sub>IN</sub> = 3.6 V   |        | 440   | 600   | mΩ   |
|                          |  |     | V <sub>IN</sub> = 5 V   |        | 370   | 500   |      |
| D <sub>MAX</sub>         | Maximum duty cycle inverting converter |     |   |        | 87.5% |       |      |
| D <sub>MIN</sub>         | Minimum duty cycle inverting converter |     |   |        | 12.5% |       |      |
| f <sub>S</sub>           | Oscillator frequency                   |     |   | 1250   | 1380  | 1500  | kHz  |
| <b>OUTPUT</b>            |  |     |   |        |       |       |      |
| V <sub>OUT</sub>         | Adjustable output voltage range        |     |   | –15    |       | –2    | V    |
| V <sub>OUT</sub>         | DC output accuracy                     |     | PWM mode, device switching  |        | ±3%   |       |      |
| V <sub>REF</sub>         | Reference voltage                      |     | I <sub>REF</sub> = 10 μA  | 1.2    | 1.213 | 1.225 | V    |
| V <sub>OVP</sub>         | Output overvoltage protection          |     |   |        | –19   |       | V    |
| V <sub>FB</sub>          | Negative feedback regulation voltage   |     | V <sub>IN</sub> = 2.7 V to 5.5 V  | –0.024 | 0     | 0.024 | V    |
| I <sub>FB</sub>          | Negative feedback input bias current   |     | V <sub>FBN</sub> = 0.1 V <sub>REF</sub>   |        | 2     |       | nA   |

(1) Parameter does not include tolerance of external resistors.

## 6.6 Typical Characteristics



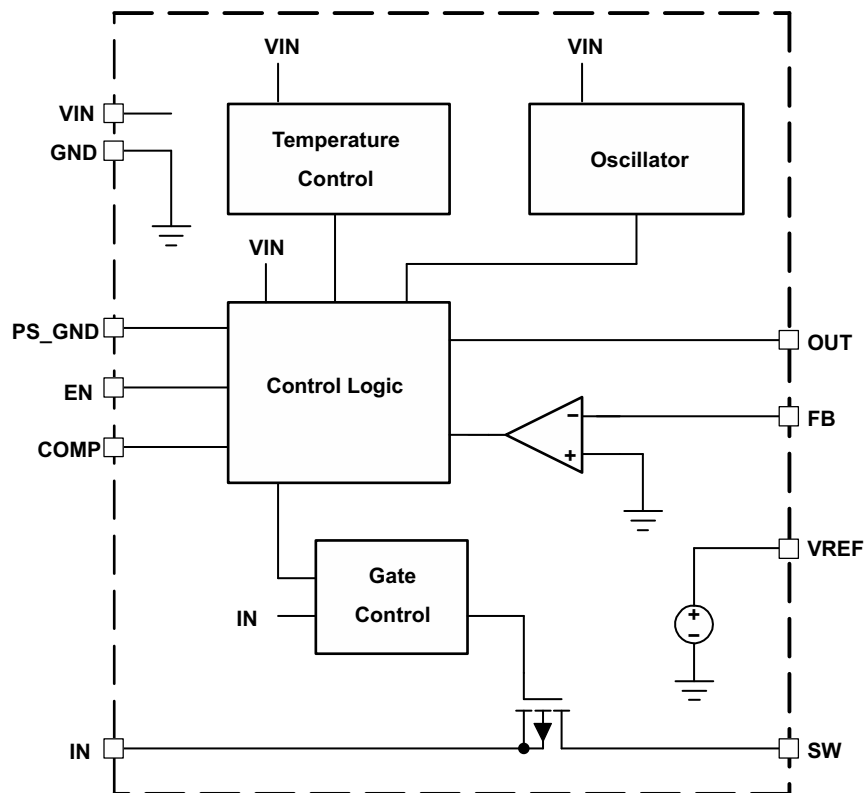
**Figure 1. Maximum Output Current vs Input Voltage**

## 7 Detailed Description

### 7.1 Overview

The TPS63700 is a DC/DC converter for negative output voltages using buck-boost topology. It operates with an input voltage range of 2.7 V to 5.5 V and generates a negative output voltage down to  $-15$  V. The output is controlled by a fixed-frequency, pulse-width-modulated (PWM) regulator. In normal operation mode, the converter operates at continuous conduction mode (CCM). At light loads it can enter discontinuous conduction mode (DCM).

### 7.2 Functional Block Diagram



### 7.3 Feature Description

#### 7.3.1 Enable

Applying GND signal at the EN pin disables the converter, where all internal circuitry is turned off. The device now just consumes low shutdown current flowing into the VIN pin. The output load of the converter is also disconnected from the battery as described in [Load Disconnect](#). Pulling the EN pin to  $V_{IN}$  enables the converter. Internal circuitry, necessary to operate the converter, is then turned on.

#### 7.3.2 Load Disconnect

The device supports complete load disconnection when the converter is disabled. The converter turns off the internal PMOS switch, thus no DC current path remains between load and input voltage source.

#### 7.3.3 Output Overvoltage Protection

The converter has an output overvoltage protection implemented. The output voltage is limited to  $-19$  V in case the feedback connection from the output to the FB pin is open.

## Feature Description (continued)

### 7.3.4 Undervoltage Lockout

An undervoltage lockout prevents the device from starting up and operating if the supply voltage at VIN is lower than the programmed threshold shown in the [Electrical Characteristics](#) table. The device automatically shuts down the converter when the supply voltage at VIN falls below this threshold. Nevertheless, parts of the control circuits remain active, which is different than device shutdown using EN inputs. The undervoltage lockout function is implemented to prevent device malfunction.

### 7.3.5 Overtemperature Shutdown

The device automatically shuts down if the implemented internal temperature detector detects a chip temperature above the programmed threshold shown in the electrical characteristics table. It starts operating again when the chip temperature decreases. A built-in temperature hysteresis avoids undefined operation caused by ringing from over-temperature shutdown.

## 7.4 Device Functional Modes

### 7.4.1 Soft-Start

The converter has a soft-start function. When the converter is enabled, the implemented switch current limit ramps up slowly to its nominal value. Soft-start is implemented to limit the input current during start-up to avoid high peak currents at the battery which could interfere with other systems connected to the same battery.

Without soft-start, uncontrolled input peak currents flow to charge up the output capacitors and to supply the load during start-up. This would cause significant voltage drops across the series resistance of the battery and its connections.

### 7.4.2 PWM Operation

The converter operates in a fixed-frequency, pulse-width-modulated control scheme. The on-time of the switches varies depending on input-to-output voltage ratio and the load. During this on-time, the inductor connected to the converter is charged with current. In the remaining time, the time period set by the fixed operating frequency, the inductor discharges into the output capacitor via the rectifier diode. At medium to heavy loads the inductor current is continuous and the device operates in continuous conduction mode (CCM).

### 7.4.3 Power Save Mode Operation

As the load current decreases, the converter enters Power Save Mode. Entering Power Save Mode happens at the boundary to discontinuous conduction mode (DCM). During light load, the inductor current of this converter can become discontinuous. In this case, the control circuit of the controller output automatically takes care of these changing conditions to always operate with an optimum control setup.

### 7.4.4 Control

The controller circuit of the converter is based on a fixed-frequency, multiple-feed-forward controller topology. Input voltage, output voltage, and voltage drop across the switch are monitored and forwarded to the regulator. Changes in the operating conditions of the converter directly affect the duty cycle.

The error amplifier compares the voltage at FB pin with GND to generate an accurate and stable output voltage. The error amplifier is internally compensated. At light loads, the converter operates in discontinuous conduction mode (DCM).

If the load will be further decreased, the energy transmitted to the output capacitor cannot be absorbed by the load and would lead to an increase of the output voltage. In this case, the converter limits the output voltage increase by skipping switch pulses.



## 8 Application and Implementation

### NOTE

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

### 8.1 Application Information

The TPS63700 DC/DC converter is intended for systems typically powered by a single-cell Li-ion or Li-polymer battery with a terminal voltage between 2.7 V up to 4.2 V. Due to the recommended input voltage going up to 5.5 V, the device is also suitable for 3-cell alkaline, NiCd, or NiMH batteries, as well as regulated supply voltages of 3.3 V or 5 V.

### 8.2 Typical Application

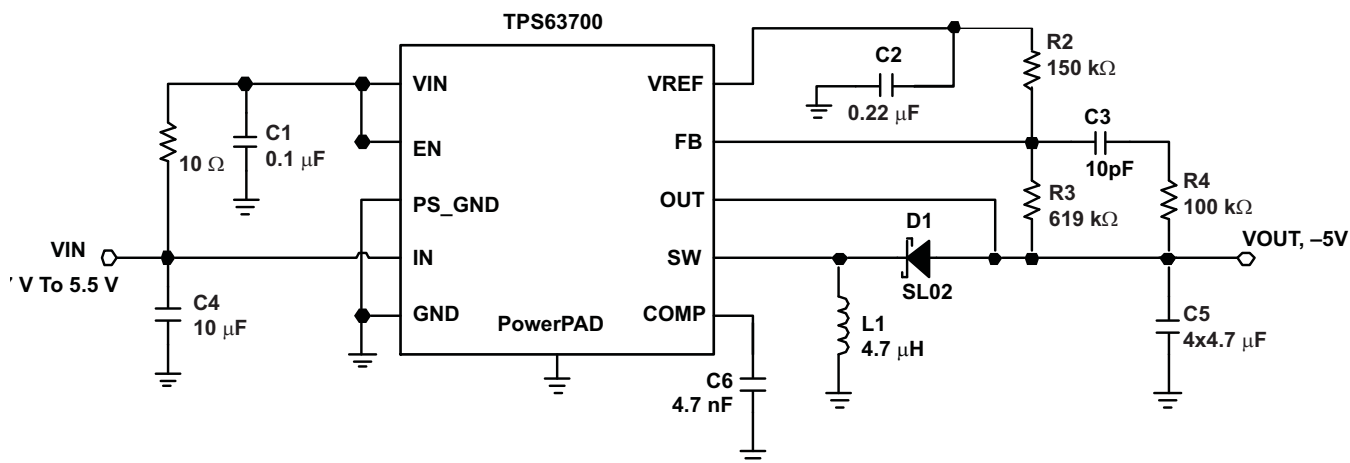


Figure 2. Circuit for –5-V Output

#### 8.2.1 Design Requirements

The design of the inverter can be adapted to different output voltage and load current needs by choosing external components appropriately. The following design procedure is adequate for the whole  $V_{IN}$ ,  $V_{OUT}$  and load current range of TPS63700.

Table 1 shows the list of components for the [Application Curves](#).

Table 1. List of Components

| REFERENCE       | DESCRIPTION  |
|-----------------|--|
| C1, C2, C3, C4, | X7R/X5R ceramic  |
| C5              | 4 × 4.7 μF X7R/X5R ceramic   |
| D1              | SL03/SL02 Vishay   |
| L1              | –5V: TDK VLF4012 4R7, TDK SLF6025-4R7, Coilcraft LPS4018-472,<br>–12V: Sumida CDRH5D18 10 μH |

## 8.2.2 Detailed Design Procedure

### 8.2.2.1 Programming the Output Voltage: Converter

The output voltage of the TPS63700 converter can be adjusted with an external resistor divider connected to the FB pin. The reference point of the feedback divider is the reference voltage  $V_{REF}$  with 1.213 V. The typical value of the voltage at the FB pin is 0 V. The minimum recommended output voltage at the converter is –15 V. The feedback divider current should be 10  $\mu$ A. The voltage across R2 is 1.213 V. Based on those values, the recommended value for R2 should be 120 k $\Omega$  to 200 k $\Omega$  in order to set the divider current at the required value. The value of the resistor R3 can then be calculated using Equation 1, depending on the needed output voltage ( $V_{OUT}$ ).

$$R3 = R2 \times \left( \frac{V_{REF} - V_{OUT}}{V_{REF}} - 1 \right) \quad (1)$$

For example, if an output voltage of –5 V is needed and a resistor of 150 k $\Omega$  has been chosen for R2, a 619-k $\Omega$  resistor is needed to program the desired output voltage.

#### 8.2.2.1.1 Inductor Selection

An inductive converter normally requires two main passive components for storing energy during the conversion. An inductor and a storage capacitor at the output are required.

The average inductor current depends on the output load, the input voltage  $V_{IN}$ , and the output voltage  $V_{OUT}$ . It can be estimated with Equation 2, which shows the formula for the inverting converter.

$$I_{Lavg} = \frac{V_{IN} - V_{OUT}}{V_{IN} \times 0.8} \times I_{OUT}$$

where

- $I_{Lavg}$  = Average inductor current

An important parameter for choosing the inductor is the desired current ripple in the inductor.

A ripple current value between 20% and 80% of the average inductor current can be considered as reasonable, depending on the application requirements. A smaller ripple reduces the losses in the inductor, as well as output voltage ripple and EMI. But in the same way, the inductor becomes larger and more expensive.

Keeping those parameters in mind, the possible inductor value can be calculated using Equation 3.

$$L = \frac{V_{IN} \times V_{OUT}}{\Delta I_L \times (V_{OUT} - V_{IN}) \times f}$$

where

- $\Delta I_L$  = Peak-to-peak ripple current
- $f$  = Switching frequency
- $L$  = Inductor value

With the known inductor current ripple, the peak inductor value can be approximated with Equation 4. The peak current through the switch and the inductor depends also on the output load, the input voltage  $V_{IN}$ , and the output voltage  $V_{OUT}$ . To select the right inductor, it is recommended to keep the possible peak inductor current below the current-limit threshold of the power switch. For example, the current-limit threshold of the TPS63700 switch for the inverting converter is nominally 1000 mA.

$$I_{Lmax} = \frac{V_{IN} - V_{OUT}}{V_{IN} \times 0.8} \times I_{OUT} + \frac{\Delta I_L}{2}$$

where

- $I_{LMAX}$  = Peak inductor current
- $\Delta I_L$  = Peak-to-peak ripple current

With Equation 5, the inductor current ripple at a given inductor can be approximated.

$$\Delta I_L = \frac{V_{IN} \times V_{OUT}}{L \times (V_{OUT} - V_{IN}) \times f}$$

where

- $\Delta I_L$  = Peak-to-peak ripple current
- L = Inductor value
- f = Switching frequency

(5)

Care has to be taken for the possibility that load transients and losses in the circuit can lead to higher currents as estimated in [Equation 4](#). Also, the losses caused by magnetic hysteresis losses and copper losses are a major parameter for total circuit efficiency.

The following inductor series from different suppliers have been tested with the TPS63700 converter, see [Table 2](#).

**Table 2. List of Inductors**

| Output Voltage | Vendor    | SUGGESTED INDUCTOR  |
|----------------|-----------|---------------------|
| –5 V           | TDK       | VLF4012 4.7 $\mu$ H |
|                |           | SLF6025-4.7 $\mu$ H |
| –5 V           | Coilcraft | LPS4018 4.7 $\mu$ H |
|                |           | LPS3015 4.7 $\mu$ H |
| –12 V          | Sumida    | CDRH5D18 10 $\mu$ H |
| –12 V          | Coilcraft | MOS6020 10 $\mu$ H  |

### 8.2.2.2 Capacitor Selection

#### 8.2.2.2.1 Input Capacitor

At least a 10- $\mu$ F ceramic input capacitor is recommended for a good transient behavior of the regulator, and EMI behavior of the total power supply circuit.

#### 8.2.2.2.2 Output Capacitors

One of the major parameters necessary to define the capacitance value of the output capacitor is the maximum allowed output voltage ripple of the converter. This ripple is determined by two parameters of the capacitor, the capacitance and the ESR. It is possible to calculate the minimum capacitance needed for the defined ripple, supposing that the ESR is zero, by using [Equation 6](#) for the inverting converter output capacitor.

$$C_{min} = \frac{I_{OUT} \times V_{OUT}}{f_S \times \Delta V \times (V_{OUT} - V_{IN})}$$

where

- f = Switching frequency
- $\Delta V$  = Maximum allowed ripple
- $C_{min}$  = Minimum capacitance

(6)

With a chosen ripple voltage in the range of 10 mV, a minimum capacitance of 12  $\mu$ F is needed. The total ripple is larger due to the ESR of the output capacitor. This additional component of the ripple can be calculated using [Equation 7](#).

$$\Delta V_{ESR} = I_{OUT} \times R_{ESR}$$

where

- $\Delta V_{ESR}$  = Voltage ripple caused by  $R_{ESR}$  of capacitor
- $R_{ESR}$  = Equivalent series resistance of capacitor

(7)

An additional ripple of 2 mV is the result of using a typical ceramic capacitor with an ESR in a 10-mΩ range. The total ripple is the sum of the ripple caused by the capacitance, and the ripple caused by the ESR of the capacitor. In this example, the total ripple is 12 mV. Additional ripple is caused by load transients. When the load current increases rapidly, the output capacitor must provide the additional current until the inductor current has been increased by the control loop by setting a higher on-time at the main switch (duty cycle). The higher duty cycle results in longer inductor charging periods, but the rate of increase of the inductor current is also limited by the inductance itself. When the load current decreases rapidly, the output capacitor needs to store the excessive energy (stored in the inductor) until the regulator has decreased the inductor current by reducing the duty cycle. The recommendation is to use higher capacitance values, as the previous calculations show.

### **8.2.2.3 Stabilizing the Control Loop**

#### **8.2.2.3.1 Feedback Divider**

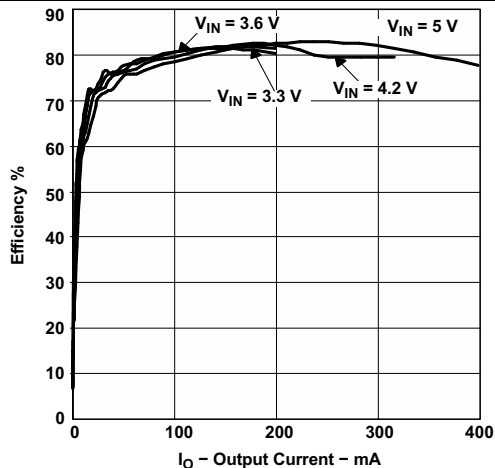
To speed up the control loop, a feed-forward capacitor of 10 pF is recommended in the feedback divider, parallel to R3.

To avoid coupling noise into the control loop from the feed-forward capacitor, the feed-forward effect can be bandwidth-limited by adding series resistor R4. A value in the range of 100 kΩ is suitable. The higher the resistance, the lower the noise coupled into the control loop system.

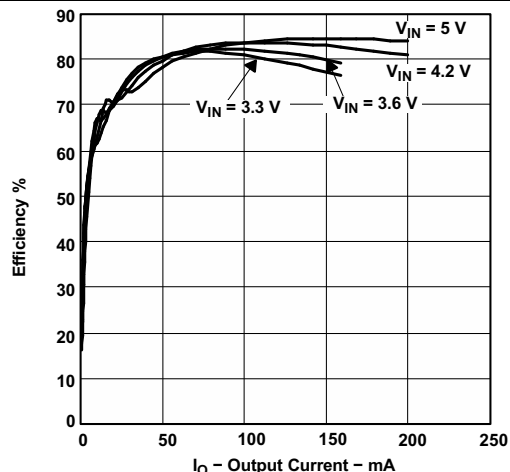
#### **8.2.2.3.2 Compensation Capacitor**

The control loop of the converter is completely compensated internally. However the internal feed-forward system requires an external capacitor. A 4.7-nF capacitor at the COMP pin of the converter is recommended.

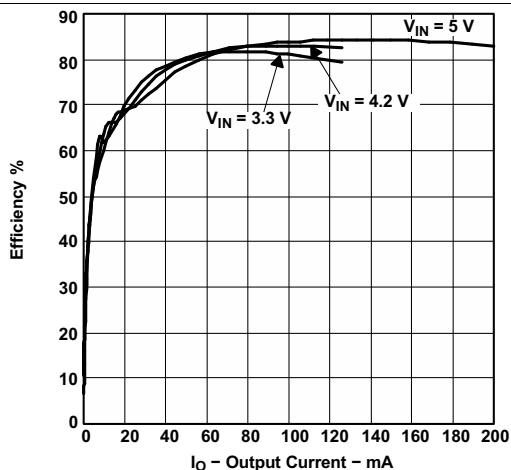
## 8.2.3 Application Curves



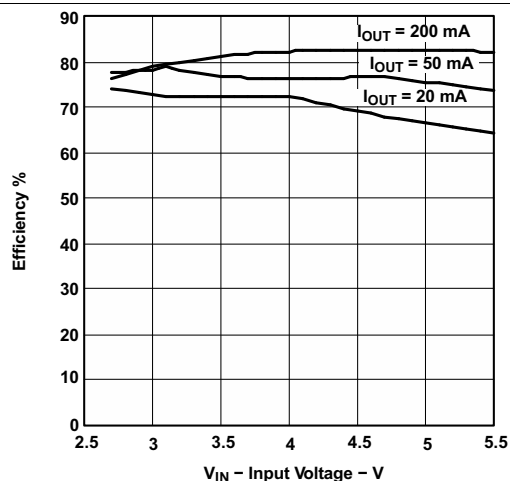
**Figure 3. Efficiency vs Output Current,  
VOUT = -5 V**



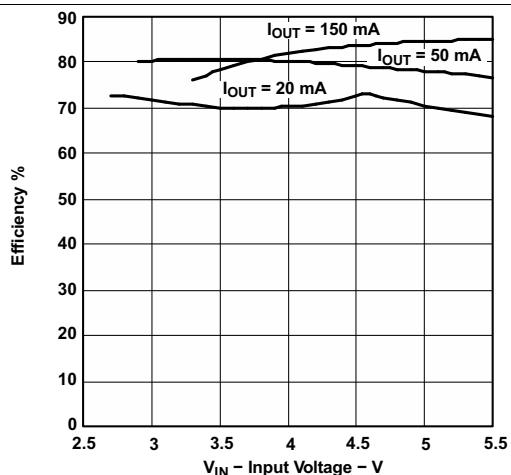
**Figure 4. Efficiency vs Output Current,  
VOUT = -12 V**



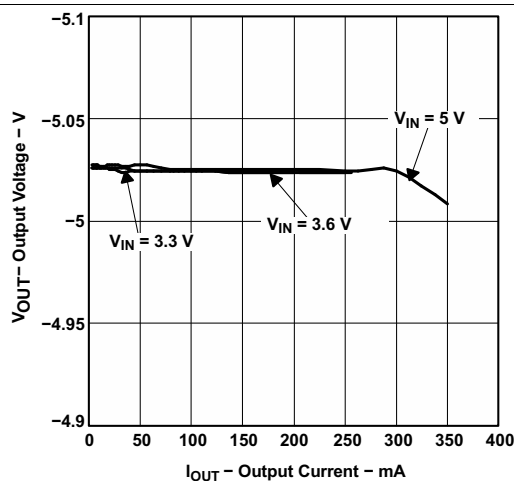
**Figure 5. Efficiency vs Output Current,  
VOUT = -15 V**



**Figure 6. Efficiency vs Input Voltage,  
VOUT = -5 V**



**Figure 7. Efficiency vs Input Voltage,  
VOUT = -12 V**



**Figure 8. Output Voltage vs Output Current**

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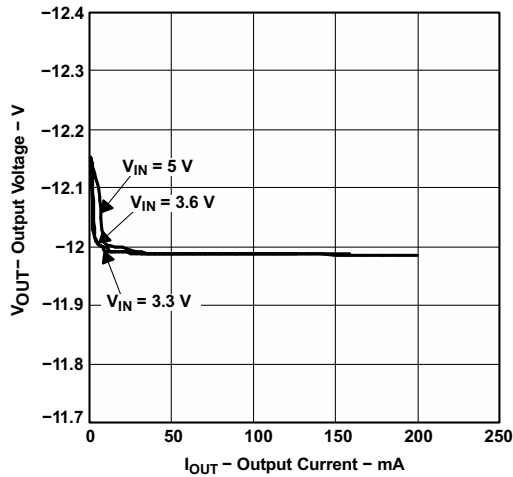


Figure 9. Output Voltage vs Output Current

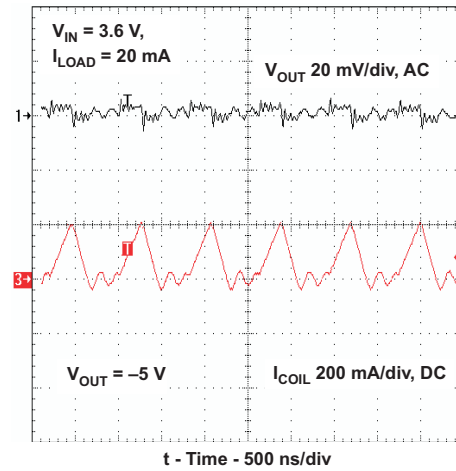


Figure 10. Output Voltage in Discontinuous Conduction Mode

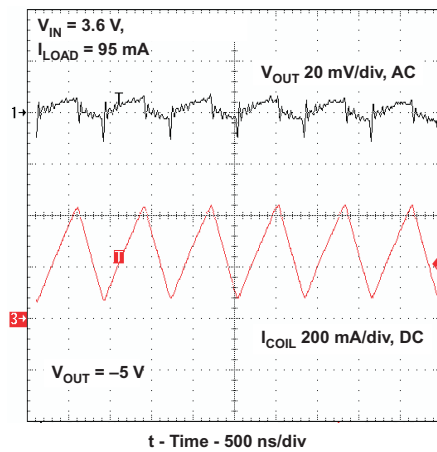


Figure 11. Output Voltage in Continuous Conduction Mode

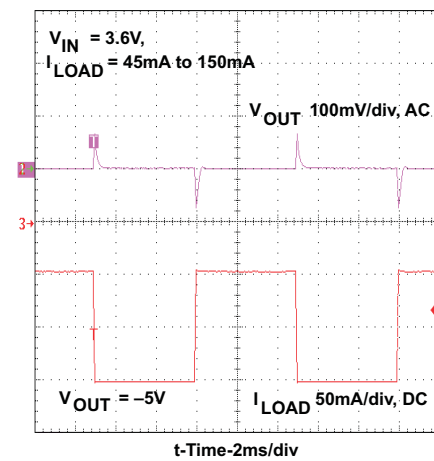


Figure 12. Load Transient Response, -5 V, 45 to 150 mA

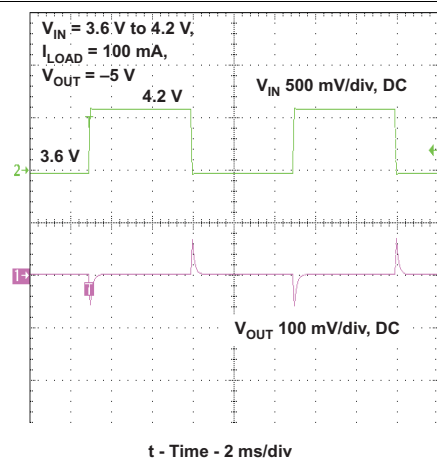


Figure 13. Line Transient Response, -5 V

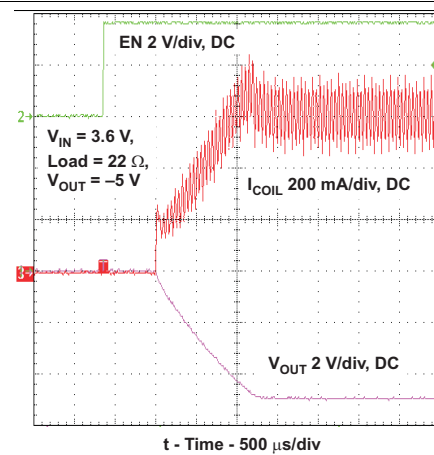


Figure 14. Start-Up After Enable, -5 V

### 8.3 System Example

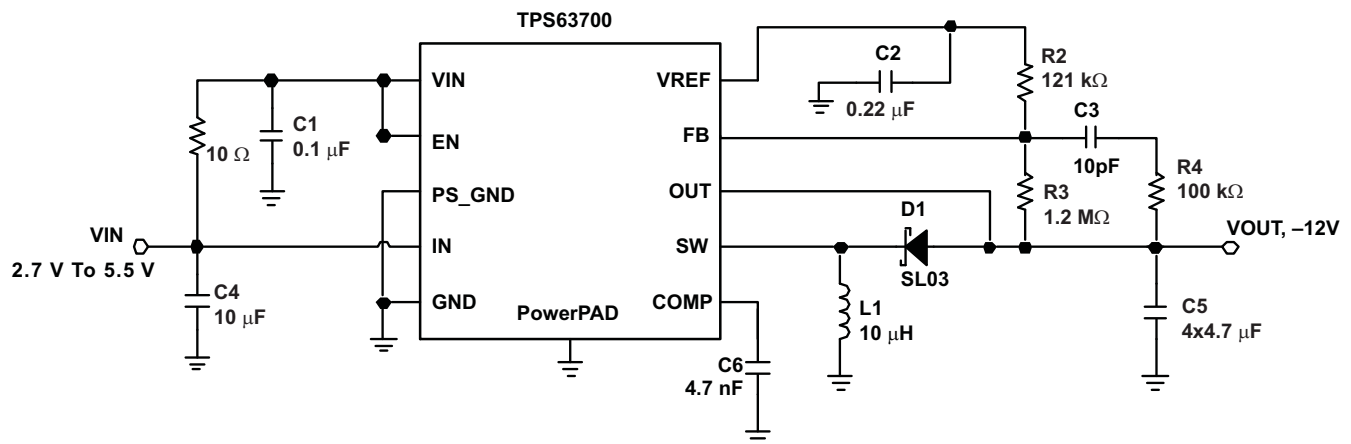


Figure 15. Circuit for -12-V Output

## 9 Power Supply Recommendations

The power supply to the TPS63700 needs to have a current rating according to the input supply voltage, output voltage and output current of the TPS63700.

## 10 Layout

### 10.1 Layout Guidelines

For all switching power supplies the layout is an important step in the design, especially at high peak currents and high switching frequencies. If the layout is not carefully done, the regulator could show stability problems as well as EMI problems. Therefore, use wide and short traces for the main current paths, and for the power-ground tracks. The input and output capacitors should be placed as close as possible to the IC. The diode need to be connected closest to the SW pin to minimize parasitic inductance. For low noise operation small bypass capacitors  $C_{IN\_BP}$  and  $C_{OUT\_BP}$  in the nF range can be added close to the IC.

The feedback divider should be placed as close as possible to the  $V_{REF}$  pin of the IC. Use short traces when laying out the control ground. [Figure 18](#) shows the layout of the EVM board.

### 10.2 Layout Example

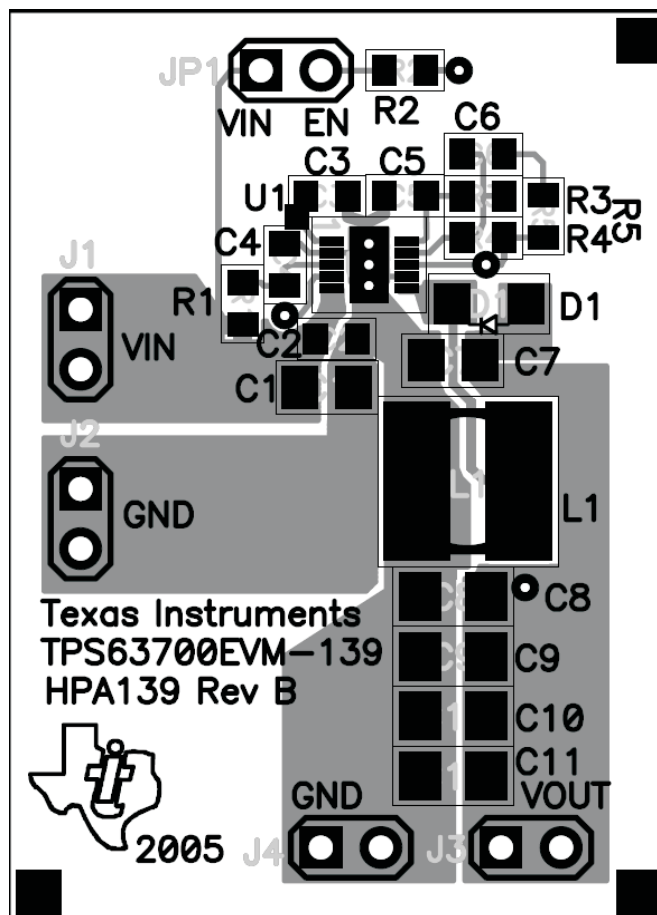


Figure 16. Layout Considerations, Top View



## Layout Example (continued)

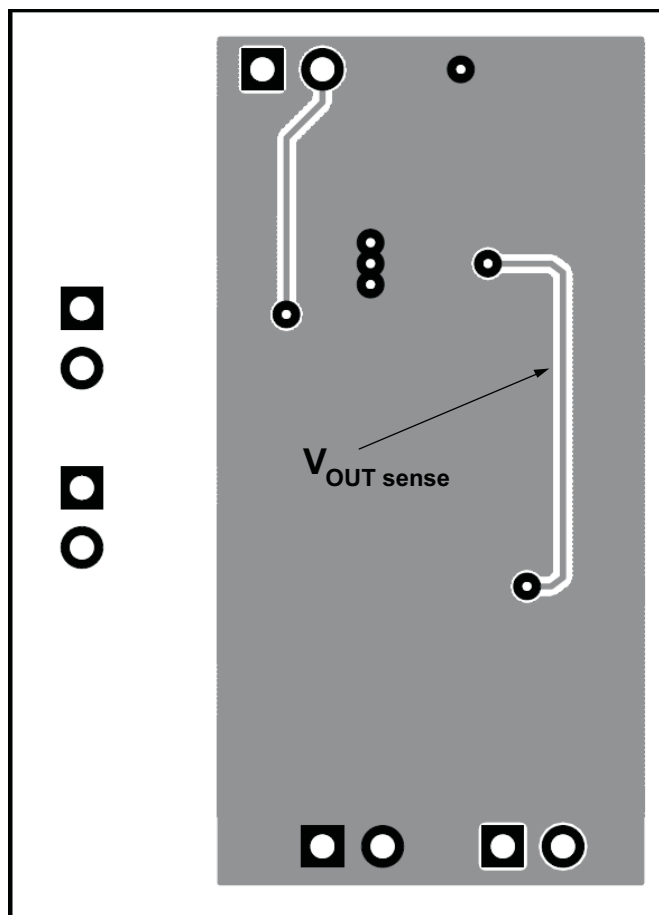


Figure 17. Layout Considerations, Bottom View

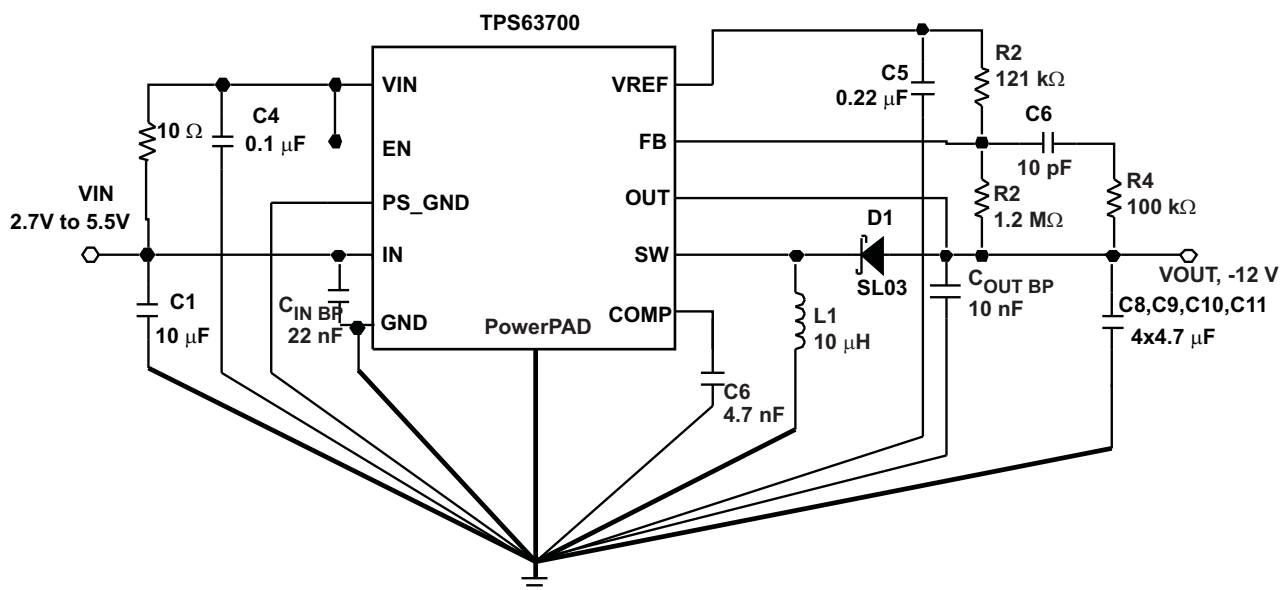


Figure 18. Layout Circuit

## 11 Device and Documentation Support

### 11.1 Device Support

#### 11.1.1 Third-Party Products Disclaimer

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### 11.2 Community Resources

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**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 11.3 Trademarks

PowerPAD, E2E are trademarks of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 11.4 Electrostatic Discharge Caution



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.

### 11.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## PACKAGING INFORMATION

| Orderable part number        | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">TPS63700DRCR</a> | Active        | Production           | VSON (DRC)   10 | 3000   LARGE T&R      | Yes         | NIPDAU   NIPDAU                      | Level-2-260C-1 YEAR               | -40 to 125   | NUB                 |
| TPS63700DRCR.B               | Active        | Production           | VSON (DRC)   10 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | NUB                 |
| TPS63700DRCRG4.B             | Active        | Production           | VSON (DRC)   10 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | NUB                 |
| <a href="#">TPS63700DRCT</a> | Active        | Production           | VSON (DRC)   10 | 250   SMALL T&R       | Yes         | NIPDAU   NIPDAU                      | Level-2-260C-1 YEAR               | -40 to 125   | NUB                 |
| TPS63700DRCT.B               | Active        | Production           | VSON (DRC)   10 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | NUB                 |
| TPS63700DRCTG4               | Active        | Production           | VSON (DRC)   10 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | NUB                 |

(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.

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## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS63700DRCR | VSON         | DRC             | 10   | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS63700DRCR | VSON         | DRC             | 10   | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| TPS63700DRCT | VSON         | DRC             | 10   | 250  | 180.0              | 12.5               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS63700DRCR | VSON         | DRC             | 10   | 3000 | 338.0       | 355.0      | 50.0        |
| TPS63700DRCR | VSON         | DRC             | 10   | 3000 | 356.0       | 356.0      | 35.0        |
| TPS63700DRCT | VSON         | DRC             | 10   | 250  | 338.0       | 355.0      | 50.0        |

## GENERIC PACKAGE VIEW

**DRC 10**

**VSON - 1 mm max height**

3 x 3, 0.5 mm pitch

PLASTIC SMALL OUTLINE - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.





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## NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.



# EXAMPLE BOARD LAYOUT

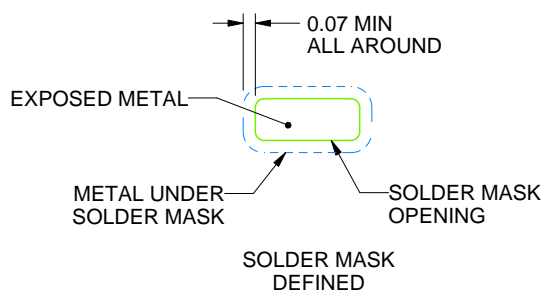
DRC0010J

VSON - 1 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:20X



SOLDER MASK DETAILS

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NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).

5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

**DRC0010J**

**VSON - 1 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 11:  
80% PRINTED SOLDER COVERAGE BY AREA  
SCALE:25X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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