

***TPS6030x EVM-170***  
***Single-Cell Charge Pump***  
***Evaluation Module***

*User's Guide*

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# Read This First

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### ***About This Manual***

This user's guide describes the TPS6030x single-cell charge pump EVM.

### ***How to Use This Manual***

This document contains the following chapters:

- Chapter 1—Introduction
- Chapter 2—EVM Description
- Chapter 3—Capacitor Selection and Measurements

### ***Related Documentation From Texas Instruments***

The evaluation module (EVM) for the new Texas Instruments (TI) TPS60300 to TPS60303 charge pump devices helps designers evaluate these devices.

With these EVMs it is possible to evaluate all different modes of the devices as well as their performance. Only a dc voltage source is needed to operate the EVM.

The layout of the charge pump circuit is critical and is similar to the layout of the inductive dc/dc converters. The suggested layout of the EVM board can be used as a reference design to reduce design time.



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# Introduction

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The Texas Instruments TPS6030x charge pumps are regulated voltage converters intended for use with a single NiCd, NiMH, or alkaline cell. The TPS60300 and TPS60302 have an output voltage of 3.3 V from an input signal between 0.9 V and 1.8 V. The TPS60301 and TPS60303 have an output voltage of 3 V from an input voltage between 0.9 V and 1.8 V.

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## 1.1 Basic Operation of the Device

The TPS6030x series are charge pumps working either in a tripler or in a quadrupler mode.

They consist of an unregulated doubler stage with its capacitors  $C_{FLY1}$  and  $C_{OUT1}$ . Its output voltage can be found at OUT1. The voltage at OUT1 is internally connected to the input of a regulated charge pump that works in a  $\times 1.5$  or  $\times 2$  mode, respectively. It provides 3.3-V (3-V) output voltage at its output OUT2.

The maximum output current of the TPS6030x devices is 20 mA at the regulated output (OUT2). The unregulated output (OUT1) can deliver up to 40 mA when OUT2 is not loaded.

The TPS6030x charge pumps are available with an open drain or push-pull power good output. On the EVM, the TPS60302 with a 3.3-V output voltage and push-pull power good output is used.

For a description of the different operation modes and a functional description, refer to the TPS6030x data sheet (literature number SLVS302).

# **EVM Description**

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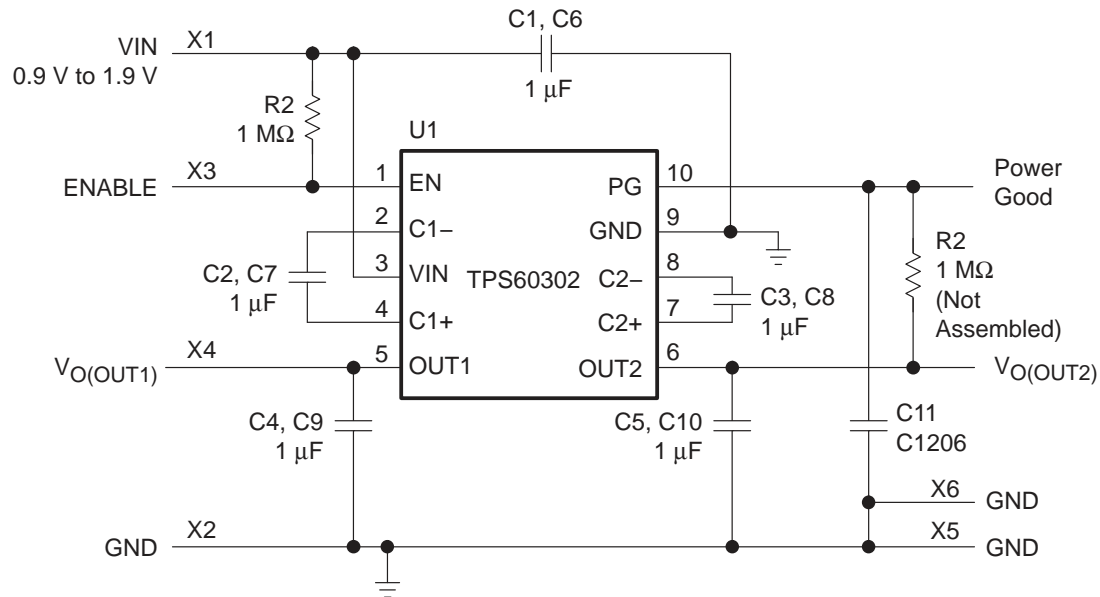
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This chapter contains a description and layout of the EVM.

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## 2.1 EVM Schematic

Figure 2–1. EVM Schematic



For all necessary signals there are single-pin connectors on the board.

To operate the board, connect a power source with the appropriate voltage level between VIN and GND.

A pullup resistor at EN was added to ensure that the device can start without a signal applied to the EN pin. Connect EN to GND to disable the device. In this state, the supply current of the IC decreases to 0.05  $\mu\text{A}$ . When the EVM is used in this mode, be aware that the pullup resistors R1 and R2 draw more current than the device itself. When operating the device in this low-current mode, these resistors must be removed.

Some additional GND pins have been added for convenience.

Capacitors C6 to C11 are 1206-size SMD footprints. These parts are not necessary for operation and have only been added for test purposes. They can be used as test points or to easily increase the value of a capacitor by adding another one in parallel.

## 2.2 EVM Layout

Figure 2–2. EVM Board Layout

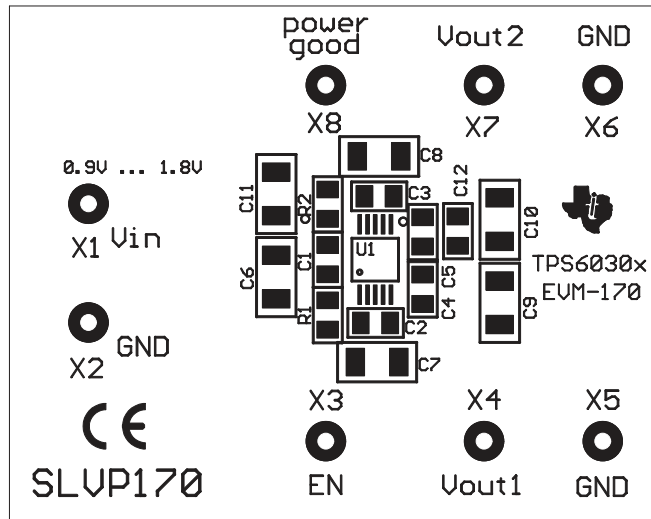
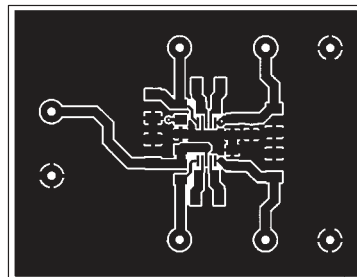


Figure 2–2 shows the placement of the components of the EVM. Components are only placed on the top layer of the board. The size of the EVM is  $42,0 \times 33,0 \text{ mm}^2$  ( $1386 \text{ mm}^2$ ), which is much larger than required for the IC and its capacitors.

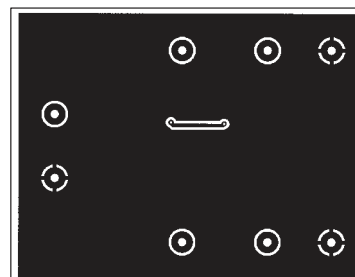
The total space required for the IC and the capacitors on the EVM is only about  $8 \text{ mm} \times 10 \text{ mm} = 80 \text{ mm}^2$ . The capacitors are not optimized for space, but are optimized for performance. It is possible to use smaller capacitors to optimize the layout for minimum board space. On the EVM, it is also possible to solder other capacitors because the 1206-size pads have been added in parallel to  $C_{IN}$ ,  $C_{OUT}$ , and  $C_{FLY}$ .

The signal on the bottom is the ground signal (GND). For good performance, the entire bottom layer is one GND plane, only interrupted by some vias. Figure 2–3 shows the board layers.

Figure 2–3. EVM Board Layers



a) Top Layer (Size 1:1)



b) Bottom Layer (Mirrored, Size 1:1)

## 2.3 Setup of the EVM

For proper operation of the EVM, use the following steps:

- 1) Connect a load to the output (between GND and OUT2).
  - TPS60300, TPS60302:  $>165\ \Omega$  or 0 mA to 20 mA at  $V_{IN} \geq 1.1\ \text{V}$   
 $>330\ \Omega$  or 0 mA to 10 mA at  $V_{IN} \geq 1\ \text{V}$  (during start-up)
  - TPS60301, TPS60303:  $>150\ \Omega$  or 0 mA to 20 mA at  $V_{IN} \geq 1.1\ \text{V}$   
 $>300\ \Omega$  or 0 mA to 10 mA at  $V_{IN} \geq 1\ \text{V}$  (during start-up)
- 2) Connect a signal source (or a battery pack) with the appropriate voltage between the input (VIN) and ground (GND): 0.9 V to 1.8 V. A pullup resistor at EN ensures that the device starts immediately. Connect EN to GND to disable the device.

**NOTE:** Do not load OUT1 during start-up more than 1 mA.

## 2.4 Bill of Materials

Table 2–4 lists materials required for the EVM.

Table 2–1. Bill of Materials

Ref Des	Part Number	Description	MFG
X1 to X8	MC S1–B	Connector	Multicontact
U1	TPS60302DGS	Charge pump IC with push-pull power-good output	TI
C1, C4, C5	1 $\mu\text{F}/10\ \text{V}$ ; 0805 X7R	Input and output capacitors	Taiyo Yuden
C2, C3	1 $\mu\text{F}/10\ \text{V}$ ; 0805 X7R	Flying capacitors	Taiyo Yuden
R1	1 $\text{M}\Omega$ 0805	Pullup resistor for ENABLE	Several
R2	Not assembled	Pullup resistor for open-drain power-good	---
C12	10 nF/50 V; 0805 X7R	Ceramic capacitor	Several
C6 to C11	Footprint; 1206	For test purposes	---

# Capacitor Selection and Measurements

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This chapter gives the selection and measurements for the capacitors.

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