TEXAS INSTRUMENTS

TPS6020x

Evaluation Module (EVM) for Regulated 3.3-V, 100-mA, Low-Ripple Charge Pump

User's Guide

June 2000

POWER MANAGEMENT PRODUCTS

SLVU027

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Preface

Read This First

About This Manual

This user's guide describes the TPS60200EVM-145 evaluation module (EVM). This EVM helps to evaluate the performance of the regulated low-ripple charge pump dc/dc converter TPS60200. The EVM has the dimension of a 14-pin dual inline package, and the board is a single layer board. The board design is optimized for performance and space.

The user's guide also documents the necessary changes to use the board for the other devices of the TPS6020x family.

How to Use This Manual

This document contains the following chapters:

- ❏ Chapter 1 – Description of the Device and EVM
- ❏ Chapter 2 – Physical Data of the EVM

Information About Cautions and Warnings

This book may contain cautions and warnings.

This is an example of a caution statement.

A caution statement describes a situation that could potentially damage your software or equipment.

This is an example of a warning statement.

A warning statement describes a situation that could potentially cause harm to you.

Related Documentation

1) Data sheet of TPS60200/TPS60201/TPS60202/TPS60203 literature number SLVS274

2) Erich Bayer, Alexander Müller, Hans Schmeller and Günter Sporer: Charge Pump Technology Optimized for Battery-Operated Systems, EE-Times Special Seminar Series, Analog & Mixed Signal Technology, October 1999

3) Brigitte Kormann: TPS6014x Charge Pump Evaluation Module Design Guide, literature number SLVU023

4) Brigitte Kormann: TPS6010x/TPS6011x Charge Pump Application Report, literature number SLVA070

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Chapter 1

Description of the Device and EVM

The Texas Instruments (TI) charge pump, TPS60200, is a regulated voltage doubler. The TPS60200 delivers an output voltage of 3.3 V from 1.6 V to 3.6 V input voltage. The maximum output current is 25 mA for an input voltage of 1.6 V to 1.8 V, 50 mA for 1.8 V to 2 V, and 100 mA for 2 V to 3.6 V.

Additionally, the TPS60200 has a low battery detector (LBI input and LBO output). The trip voltage of the LBI input is typically 1.18 V. Therefore, it can be programmed with an external resistive divider to the specific trip voltage for the application. On the EVM, the resistive divider on the LBI input is connected to the input voltage, V_I, and the trip voltage is set to 2 V typically. The LBO output is an open drain output and is in high impedance state as long as the voltage at LBI is above the trip voltage.

A pullup resistor of 1 MΩ to the output voltage, V_O, is added on the EVM to get a defined high signal as long as the voltage at LBI is above the trip voltage.

For a simple evaluation, a 1-MΩ resistor is added between the input voltage, V_I, and the EN pin to enable the device as long as there is no signal at the EN pin on the EVM.

The minimum number of external capacitors for a push-pull voltage doubler charge pump is four. The EVM is built up with these capacitors. For evaluation it is possible to use other capacitor values like those given in the datasheet (SLVS274).

The capacitors on the EVM are ceramic capacitors. The ESR of all other capacitor types is too high.

The TPS60200 EVMs can also be used to evaluate the other devices of this family (TPS60201, TPS60202 and TPS60203) by replacing the integrated circuit. For TPS60201 and TPS60203, the LBI resistors can be removed, but it is not necessary. The LBO pullup resistor works as PG pullup, and the LBO pad gives the PG signal.

For ordering samples of these parts of the TPS6020x family, refer to the internet at http://www.ti.com. Use the parts search engine to go to the product folder of the specific device. There free samples can be order.

Chapter 2

Physical Data of the EVM

This chapter shows the schematic and the layout of the EVM. The layout of a charge pump circuit is critical; therefore, the given layout can be used as a reference that helps the designer to reduce design and evaluation time.

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2.1 Schematic of the EVM

Figure 2–1 shows the schematic of the EVM. For this EVM, only ceramic capacitors with X7R or X5R material are used.

Figure 2–1. Schematic of the EVM

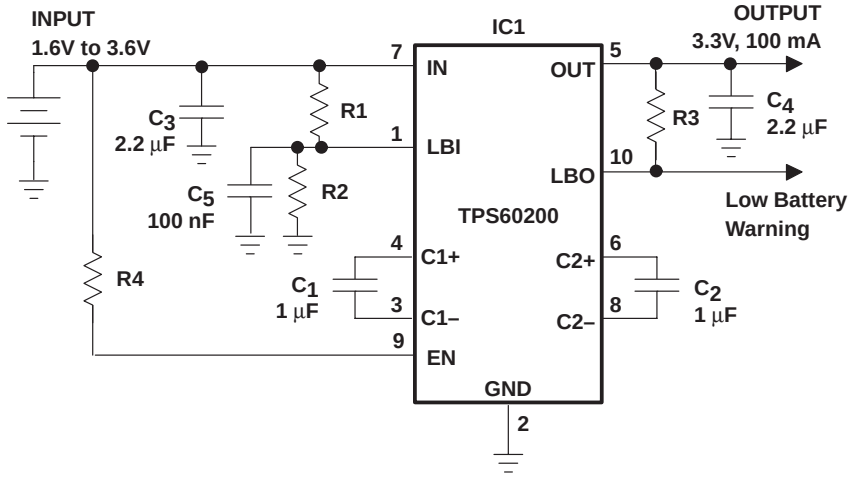


Table 2–1. Bill of Material for the TPS60200 EVM

Component	Value	Part Number	Manufacturer	Description
C1, C2	1 µF, 10 V, 0805	LMK212BJ105KG-T	Taiyo Yuden	Flying capacitors
C3, C4	2.2 µF, 16 V, 1206	EMK316BJ225KL-T	Taiyo Yuden	Input and output capacitor
C5	100 nF			Filter capacitor for the LBI input signal
IC1		TPS60200	Texas Instruments	Charge pump, IC
R1	402 kΩ	E96-Series		LBI input voltage adjustment
R2	576 kΩ	E96-Series		LBI input voltage adjustment
R3	1 MΩ			Pullup for the open drain output LBO
R4	1 MΩ			Pullup for the enable (EN) input

Table 1 contains the bill of material of the TPS60200EVM-145. The following paragraph describes the use of some of the parts.

R1 and R2 adjust the input voltage of the LBI input for low battery detection. The resistive divider on the EVM is connected to the input voltage V_I. For the given resistor values, the LBO signal will go active (low) if the input voltage is below 2 V. The divided input voltage is compared to the internal reference voltage of 1.18 V. C5 works as a filter capacitor for the LBI input voltage. This capacitor is recommended if line or load transients occur, because at the switching point of the LBI comparator, noise at the input can trigger the LBO. This can

lead to oscillations at the LBO pin. Since the LBO output, which signalizes a low battery state, is an open drain output, it requires an external pullup resistor (R3). For R3, a value between 100 kΩ and 1 MΩ is recommended. In case your application does not require low battery detection, these four parts can be omitted, but the LBI pin should be connected to ground in this case.

Applying a logic low level to the EN input turns off the device and disconnects the output from the input. The output capacitor is discharged via the device. In this state, the supply current of the IC decreases to 0.05 μA.

When the device is disabled, be aware that the LBI and EN resistors draw more current than the device itself. For operating the device in this low current mode, the three resistors (R1, R2, R4) must be removed.

For operation with the internal oscillator, connect the EN signal to the input voltage (like on the EVM) or a logic high level respectively. The device can also be synchronized with an external oscillator signal. For synchronization to an external oscillator signal, the EN pin has to be connected to this signal. When the internal logic detects an external clock signal, the device is synchronized to this clock and the internal clock is turned off. For the appropriate frequency and levels, refer to the datasheet (SLVS274).

2.2 Layout of the EVM

Figures 2–2 and 2–3 show the placement of the components and the layout of the EVM. The components and all signals are placed exclusively on the top layer of the PC board.

Figure 2–2. Placement of the Components

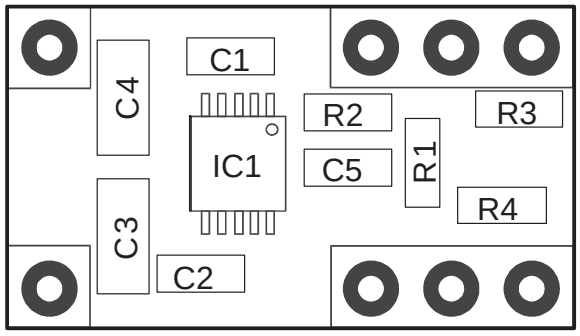


Figure 2–3. Single Layer of the EVM

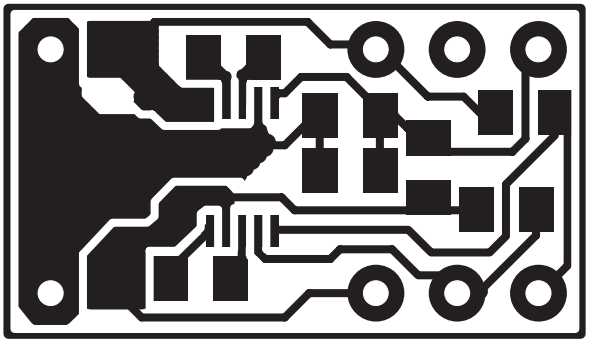
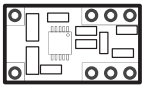


Figure 2–4. Actual Size of the EVM, 17.9 mm x 10.2 mm



The EVM is built so that it can be connected through a 14-pin dual in-line socket. Not all 14 pins are used. Only pins 1 to 3, 7, 8 and 12 to 14 of a dual in-line socket are used. Table 2–2 shows the correlation between the dual in-line pin number and the connected signal of the device on the board.

Table 2–2. Pin Assignment of the Board to a 14-Pin Dual-in-Line Socket

Socket Pin Number	Connected Signal
1	LBI
2	Not connected
3	OUT
7, 8	GND
12	IN
13	EN
14	LBO

As described above, a 14-pin dual-in-line socket can be used to connect the EVM. Therefore, the size of the EVM is:

$$17.9 \text{ mm} \times 10.2 \text{ mm} = 182.6 \text{ mm}^2.$$

2.3 Setup of the EVM

For proper operation of the EVM, follow these few steps:

1) Connect a load to the output (between GND and Out).
   > 33 Ω or 0 mA to 100 mA for 2 V ≤ V_I ≤ 3.6 V
   > 66 Ω or 0 mA to 50 mA for 1.8 V ≤ V_I < 2 V
   > 132 Ω or 0 mA to 25 mA for 1.6 V ≤ V_I ≤ 1.8 V

CAUTION

Start up only with resistive load, not current sink.

2) Connect a dc power supply (or a battery pack) with an appropriate voltage between input (In), and ground (GND).
   1.6 V ≤ V_I ≤ 3.6 V

2.4 Evaluation Information

Due to the pullup resistor (R4) on EN of the EVM, the device is enabled. To disable the device, drive the EN pin of the EVM to GND. By connecting a clock signal between 400 kHz and 800 kHz to the EN pin of the board, the device can be synchronized to an external clock. Refer to the data sheet (SLVS274) for the proper duty cycle and levels.

For testing the functionality of the low battery detector (transition on LBO), reduce the input voltage below 2 V; at this input voltage a transition from high to low can be observed.

Trip voltages other than 2 V can be adjusted by replacing the LBI resistive divider with the appropriate resistors. For different trip voltages, refer to the data sheet (SLVS274).

It is also possible to evaluate several different capacitors on the EVM. In the data sheet (SLVS274) a capacitor selection list with the corresponding output voltage ripple can be found.

CAUTION

Do not use this device for long periods of time with the maxium input voltage, maxium output current, and maxium ambient temperature. The dissipated power will heat up the device and possibly destroy it.

This is normally not a problem in battery driven systems. For more details please refer to the data sheet (SLVS274).