**ABSTRACT**

This document shows a solution to enhance the start-up performance of the TPS603xx charge pumps. With the circuitry shown, the device can drive at start-up into full load (40 mA).

The TPS603xx charge pumps consist of two charge pump stages that operate in series. The first one is an unregulated doubler charge pump with its output OUT1. It supplies a second regulated charge pump which provides 3.3 V or 3 V respectively at OUT2. Therefore, the first charge pump must be able to provide twice or 1.5 times the output current of the second one, which works in either a x2 or x1.5 conversion mode. This means that the input voltage of the second charge pump stage is either doubled or increased by a factor of 1.5.

However, at start-up, the output current of the first charge pump is limited to typically 2 mA until the output voltage at OUT2 reaches its nominal value. This is because the internal circuits use the output voltage of OUT2 as supply voltage. At start-up the lower voltage from the input is used, which limits the start-up performance.

The document shows a solution to enhance the start-up performance. With this circuitry the device can drive at start-up into full load (40 mA) at OUT1.

**NOTE:** When OUT1 is loaded with 40 mA, OUT2 must not be loaded.

---

**Figure 1. Schematic for Improved Start-Up at OUT1**

Figure 1 shows the circuit consisting of the TPS6030x charge pump and two external transistors. The schematic is shown for the open drain power-good version. If the push-pull power good version is used, R1 must be connected between the power good output and the base of T1. The value of T1 should then be in the 100 kΩ range.
Figure 2 shows the timing diagram for start-up. With the device enabled, the voltage at OUT1 and thereby the voltage at the source pin of $T_2$ rises to about $2 \times V_I$. When the output voltage at OUT2 reaches its nominal value, the power good output (PG) becomes high and $T_1$ begins to conduct. $T_1$ pulls the gate of the PMOS transistor $T_2$ to GND, switching on $T_2$ and providing the output voltage at pin $V_O$. Channel 2 in Figure 2 shows the output current rising immediately to 40 mA. In order to minimize losses, a low VT, low-voltage PMOS transistor (IRLML 6302) has been used for $T_2$.

![Figure 2. Start-Up Timing](image)

Free samples can be ordered from [http://www.ti.com](http://www.ti.com). Type in the complete device name in the quick search box and select check stock or order under Availability/Samples. To get more detailed information about the device, see the TPS6030x data sheet (literature number SLVS302).
IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer’s applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such products or services might be or are used. TI’s publication of information regarding any third party’s products or services does not constitute TI’s approval, license, warranty or endorsement thereof.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations and notices. Representation or reproduction of this information with alteration voids all warranties provided for an associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Resale of TI’s products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Also see: Standard Terms and Conditions of Sale for Semiconductor Products, www.ti.com/sc/docs/stdterms.htm

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

Copyright © 2001, Texas Instruments Incorporated