

# Using the TPS56100 to Power DSPs

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## ABSTRACT

The synchronous buck converter controllers (TPS56100, TPS56300, TPS56xx, and TPS5602) made by Texas Instruments are specifically designed to provide excellent transient response and high efficiency to the microprocessor power applications such as the TMS320C6000 and TMS320C5000 DSP families from TI, as well as similar high-speed digital loads. In addition, hysteresis control method is used such that power supply designers do not have to worry about the stability and compensation issues. Table 1 summarizes the controller characteristics.

## 1 Introduction

The TPS56100, a synchronous buck switch-mode power supply controller, provides an accurate programmable supply voltage suitable for microprocessor power applications. The reference voltage, ranging from 1.3 V to 2.6 V, is determined by the voltage programming (VP) pins. The output voltage can be set equal to the reference voltage using VP, or it can be extended to some multiple of the reference voltage using the sampling resistors (R2, R3). The TPS56100 also includes an inhibit input to control power sequencing and undervoltage lockout, thereby insuring the 5-V supply is within limits before the controller starts.

### 1.1 TPS56100 Operating Conditions

**Table 1. Summary of the TI Synchronous Buck Converter Controller and EVM Characteristics**

	V <sub>I</sub> RANGE (POWER STAGE)	V <sub>CC</sub> RANGE (CONTROLLER)	V <sub>O</sub> RANGE (POWER STAGE)	I <sub>O</sub> , MAX <sup>†</sup> (POWER STAGE)	DRIVER CURRENT (CONTROLLER)	OTHERS
TPS56100	4.5 ~ 6 V	4.5 ~ 6 V	1.3 to 2.6 V	7 A	2 A	1 channel
TPS56300	2.8 ~ 5.5 V	2.8 ~ 5.5 V	1.3 to 3.3 V	4 A for RR 6 A for LDO	2 A	2 channels
TPS56xx	4.5 ~ 6 V	12 V	1.5V, 1.8 V, 2.5 V, or 3.3 V	8 A	2 A	1 channel
TPS5602	4.5 ~25 V	4.5 ~25 V	Adjustable	4 A/channel	1.2 A at V <sub>O</sub> =3 V	2 channels

<sup>†</sup> The current capability can be extended if the switching devices are added in parallel; see Table 2 in TI TPS56100/56300 datasheets.

## 1.2 Features

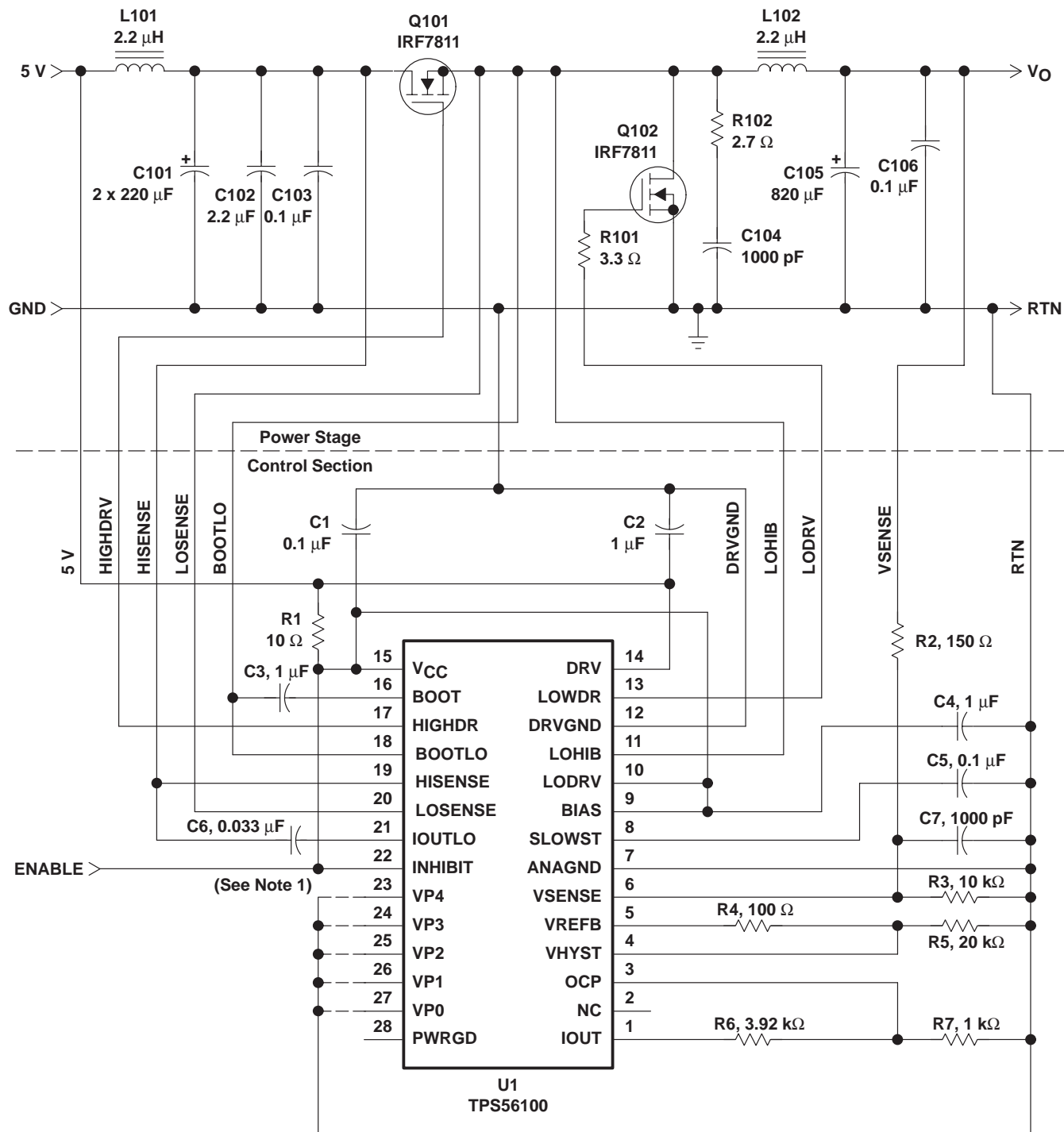
- Single-Channel, 5-V Controller
- Useable for All Common DSP Supply Voltages – Popular Output Voltage Options Set With Program Pins
- Near 85% Efficiency
- Driver Current (2 A)
- EVM Available (SLVP128 and SLVP133)
- Hysteretic Control Technique Enables Fast Transient Response
- Low Supply Current. . . 3 mA Typ
- Low Standby Current (1  $\mu$ A maximum)
- Power Good Output
- 28-Pin TSSOP PowerPAD™ Package

## 2 Application Circuit

Figure 1 shows the typical application circuit using the TPS56100, which features an accurate programmable step-down dc-dc converter. The voltage programming (VP) pins and the two external resistors (R2, R3) determine a programmable output voltage from 1.3 V to approximately 5 V. The output voltage,  $V_O$ , is set with the following equation:

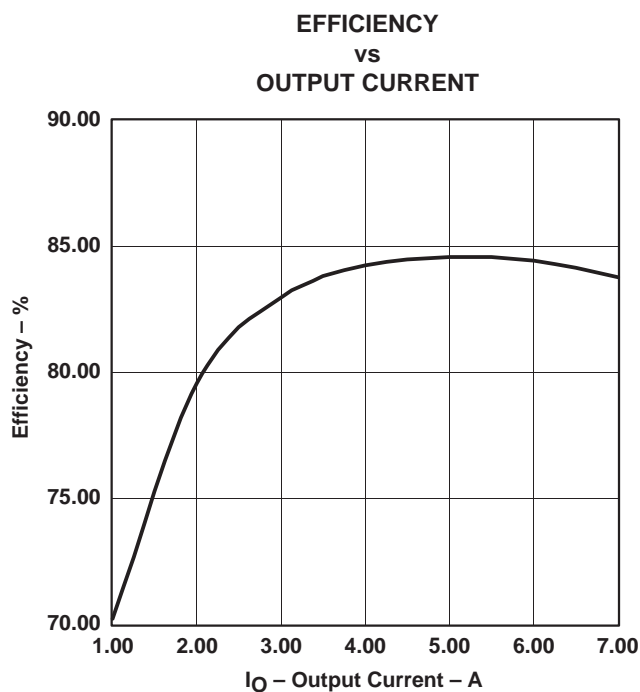
$$V_O = \left(1 + \frac{R2}{R3}\right)V_{ref} \quad (1)$$

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NOTE 1: VP0 – VP4 is user selected to set output voltage.

**Figure 1. Application Circuit Using TPS56100**



**Figure 2. Efficiency of the TPS56100 Evaluation Board**

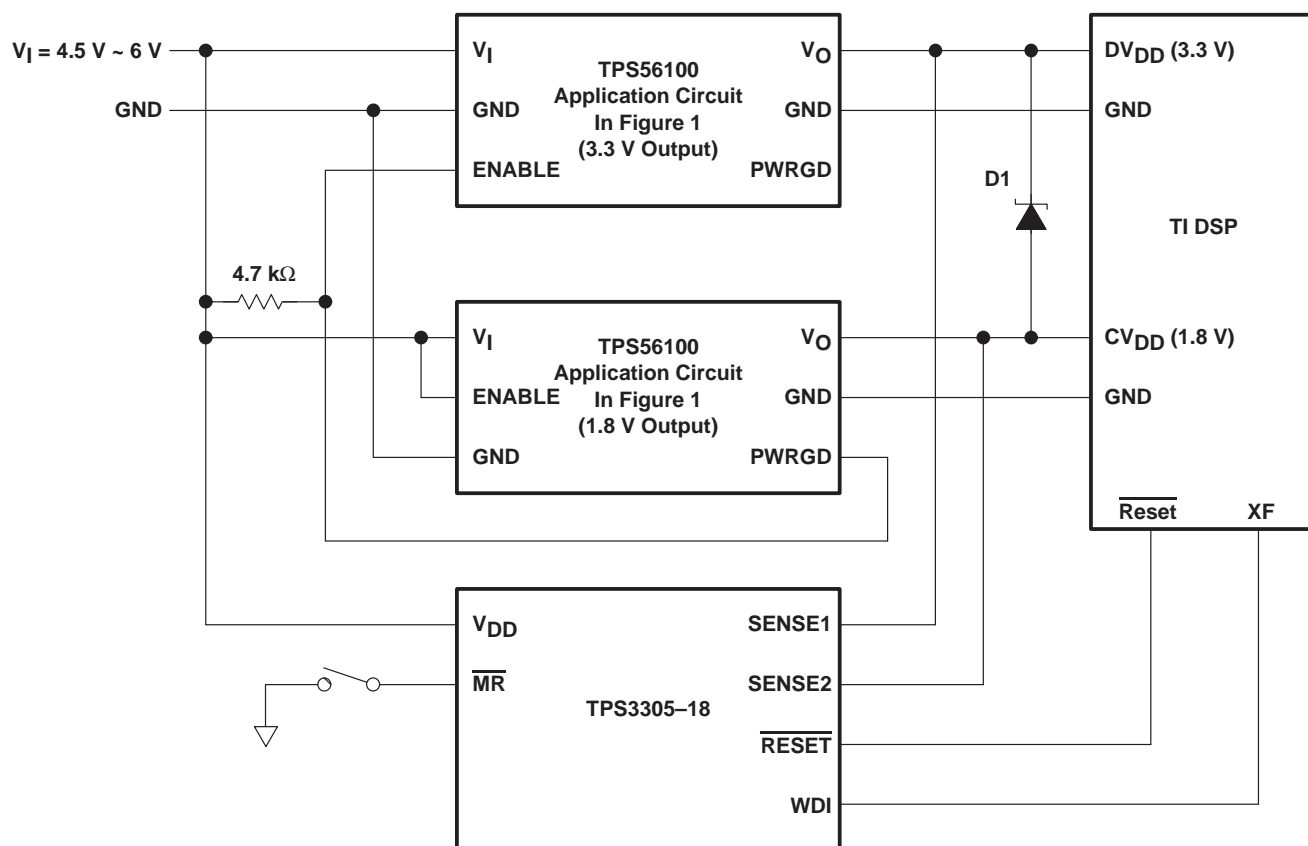
Table 2 shows the setting values of TPS56100 to generate the output voltages 1.5 V, 1.8 V, 2.5 V, or 3.3 V. To obtain the 3.3-V output voltage, set the reference voltage to 1.65 V and replace R2 and R3 with 1-k $\Omega$  resistors. For the 1.5 V, 1.8-V and 2.5-V output voltages, the reference voltage represents the output voltage.

**Table 2. Summary of Setting Values for TPS56100 1.8/2.5/3.3 V Outputs**

OUTPUT VOLTAGE (V)	R2 ( $\Omega$ )	R3 ( $\Omega$ )	C7 (pF)	VP TERMINALS (0 = GND, 1 = FLOATING OR PULLUP TO 5 V)					V <sub>REF</sub> (V <sub>dc</sub> )
				VP4	VP3	VP2	VP1	VP0	
3.3	1k	1k	100	0	1	0	0	0	1.65
2.5	100	20k	1000	1	1	0	1	0	2.50
1.8	100	20k	1000	0	0	1	0	1	1.80
1.5	100	20k	1000	0	1	0	1	1	1.50

## 2.1 Power Supply Solutions

The power solutions for TMS320C6000 and TMS320VC54xx using the TPS56100 are shown in Figure 3.



**Figure 3. TI DSP Power Supply Solutions Using the TPS56100**

**NOTE:** TI DSPs do not require specific power sequencing between the core supply and the I/O supply. However, systems should be designed to insure that neither supply is powered up for extended periods of time if the other supply is below the proper operating voltage. Excessive exposure to these conditions can adversely affect the long term reliability of the device. System level concerns such as bus contention may require supply sequencing to be implemented. In this case, the core supply should be powered up at the same time as, or prior to (and powered down after), the I/O buffers.

Figure 3 shows a simple solution to meet the power sequencing recommendation. The PWRGD (power good) connected to the Enable pin of the other power supply provides the start-up sequencing (core voltage first, then peripheral voltage). After approximately 10 ms set by C5, R4 and R5 (Figure 1), PWRGD pin goes high, and the TPS56100 supplying DV<sub>DD</sub> is enabled.

The Schottky diode D1 provides a measure of protection during the power down sequence and during other periods when the DV<sub>DD</sub> supply is below the CV<sub>DD</sub> supply by limiting the CV<sub>DD</sub> – DV<sub>DD</sub> voltage to the forward drop of D1. If CV<sub>DD</sub> fails, the PWRGD pin of TPS56100 supplying CV<sub>DD</sub> shuts down the other supply.

The core and I/O supply circuits should be placed close to the DSP to minimize the trace resistance and inductance, and to minimize the ground loop current between the two output grounds. This ground loop current can generate radiated EMI noise that can adversely affect any circuitry within the loop. The ground connection must be made directly on the DSP to minimize radiated EMI.

### 3 Evaluation Modules

Two EVMs (evaluation modules), SLVP128 (6-A output) and SLVP133 (3-A output), are available to provide a convenient method for evaluating the performance of the TPS56100. A completed and tested power supply is included in each EVM.

### 4 References

For detailed information;

Data sheet; <http://www-s.ti.com/sc/psheets/slvs201a/slvs201a.pdf>

EVM Board and User's Manual; <http://www-s.ti.com/sc/psheets/slvu018/slvu018.pdf>

Application note; [http://www.ti.com/sc/docs/apps/analog/power\\_management.html](http://www.ti.com/sc/docs/apps/analog/power_management.html)

SVS application note; [http://www.ti.com/sc/docs/apps/analog/supervisory\\_circuits.html](http://www.ti.com/sc/docs/apps/analog/supervisory_circuits.html)

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