

# Using the TPS56xx to Power DSPs

*Bang S. Lee*
*Mixed Signal Products*

## 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

Synchronous buck converters using the TPS56xx synchronous buck switch-mode power supply controller that features fixed output voltages of 3.3 V, 2.5 V, 1.8 V and 1.5 V respectively provide an exceptional power supply solution for rapidly transitioning DSP loads, fast memory, and similar processors. The TPS56xx is useful in applications with very high transient loads and wide dc load ranges, such as multiple DSP applications.

A hysteretic controller with user-selectable hysteresis is used to dramatically reduce overshoot and undershoot caused by load transients. The INHIBIT pin can be used to control power sequencing. INHIBIT and undervoltage lockout assures that the 12-V supply voltage and system supply voltage (5 V) are within proper operating limits before the controller starts. The TPS56xx family is available in a 28-pin TSSOP PowerPad™ package.

### 1.1 TPS56xx 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, MAX</sub> <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	1.5 V, 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 Key Features

- Fixed Output Voltage Options of 1.5 V, 1.8 V, 2.5 V, and 3.3 V
- > 90% Efficiency
- Driver Current (2A)
- EVM Available
- User-Selectable Hysteretic-Type Control
- $\pm 1\%$  Reference Over Full Operating Temperature Range
- Programmable Soft-Start
- Power Good Output
- Overvoltage/Overcurrent Protection
- Active Deadtime Control
- Low Supply Current. . .3 mA Typ

## 2 Application Circuit

Figure 1 shows the typical application circuit using the TPS5633, which features an accurate 3.3-V output. The optional output voltages (1.5 V, 1.8 V, or 2.5 V) are obtained by replacing controller U1 with TPS5615, TPS5618, or TPS5625 devices, since the power stage circuitry is identical.

TI DSP's 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.

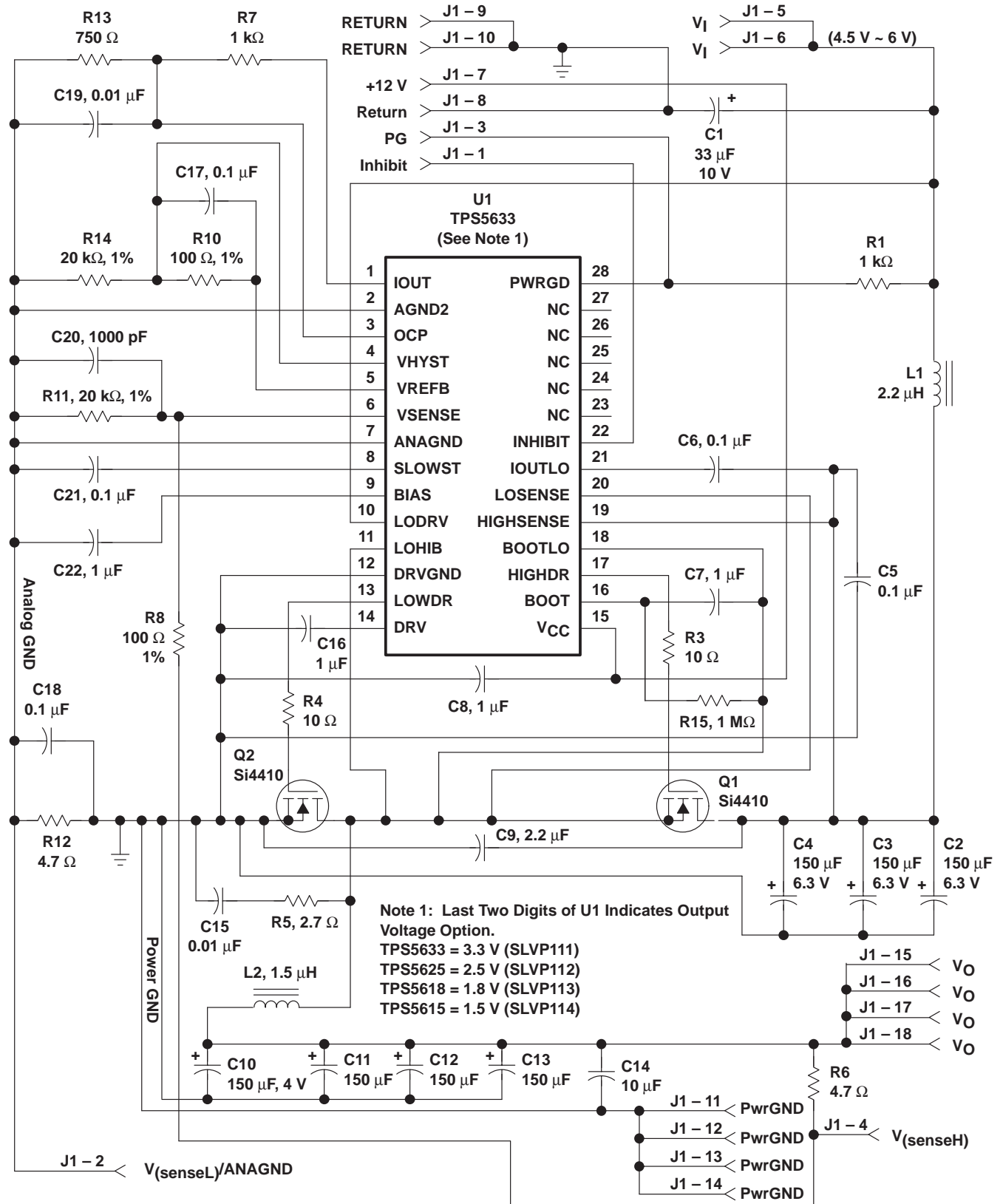
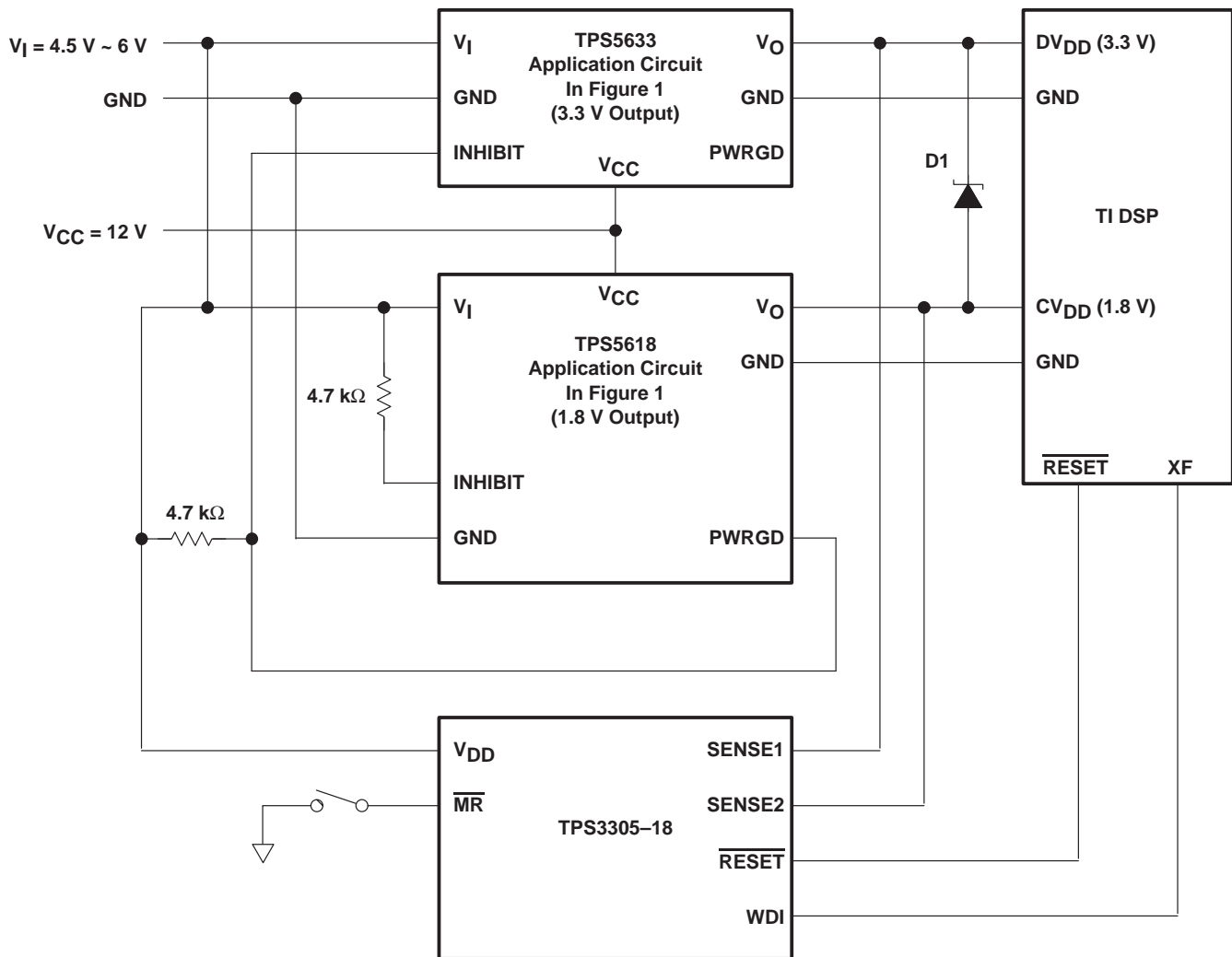


Figure 1. Application Circuit Using TPS56XX

### 3 Power Supply Solutions

Power solutions to meet the power sequencing recommendation using the TPS56xx for TI's DSP are shown in Figure 2. The PWRGD (power good signal) connected to the INHIBIT pin of the other power supply provides the start-up sequencing (core voltage first, then peripheral voltage). After approximately 10 ms, set by C21, R10 and R14 (Figure 1), the voltage on the PWRGD pin goes high, and the TPS56xx supplying DV<sub>DD</sub> is enabled.



**Figure 2. TI DSP Power Supply Solutions Using TPS5618 and TPS5633**

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.

Figure 3 shows the efficiency of the three controllers over load up to 8 A. Efficiency can be improved by choosing lower on-resistance MOSFET and/or by choosing lower switching frequency.

The two supplies 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 help minimize the problem.

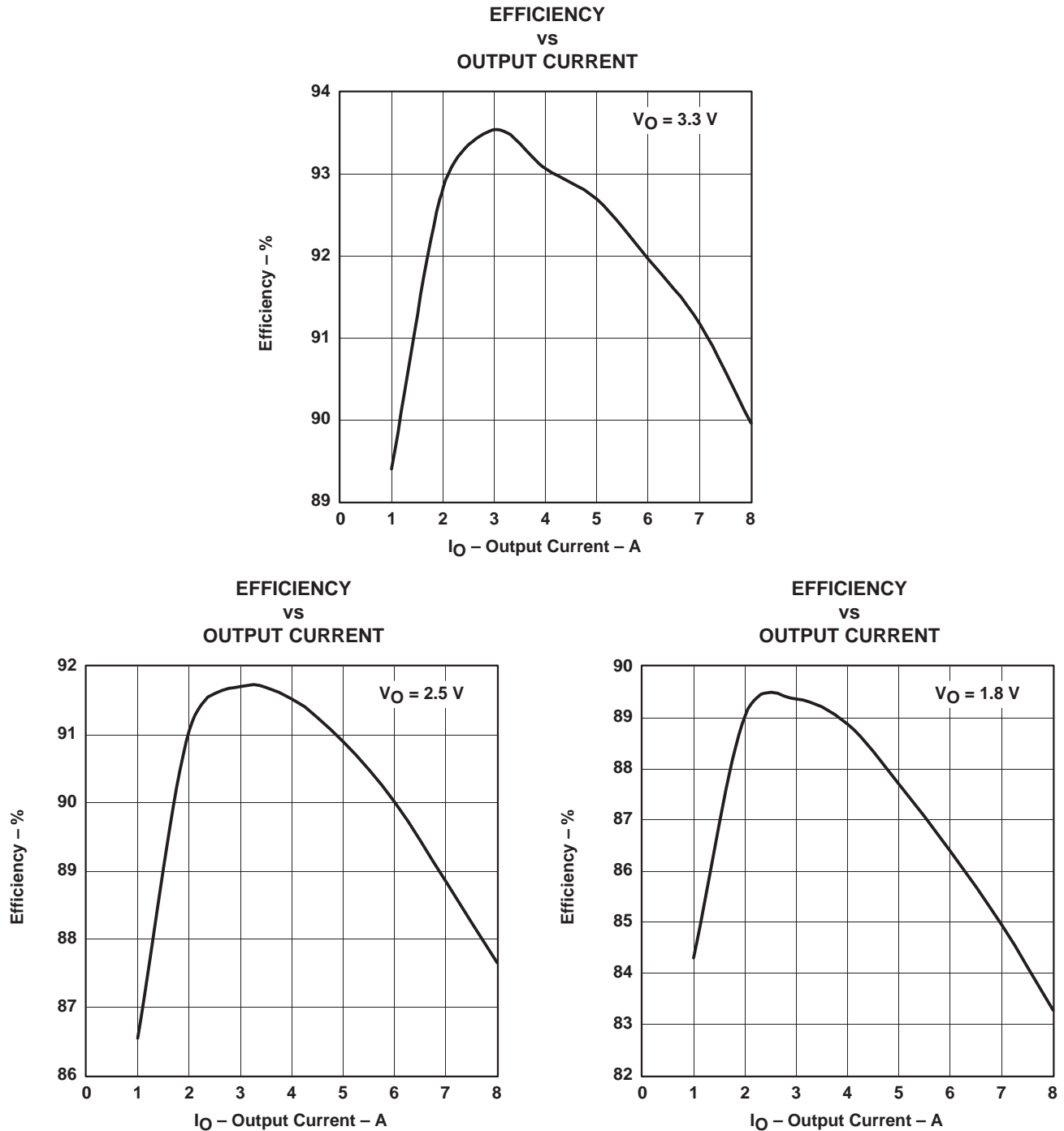


Figure 3. Efficiency of the TPS56xx Evaluation Board

## 4 Evaluation Modules

Four evaluation modules (EVM), the SLVP111 (3.3 V), SLVP112 (2.5 V), SLVP113 (1.8 V), and SLVP114 (1.5 V), are available to provide a convenient method for evaluating the performance of the TPS56xx. A completed and tested power supply is included in the EVM.

## 5 References

For detailed information;

Data sheet; <http://www-s.ti.com/sc/psheets/slvs177a/slvs177a.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)

EVM Board and User's Manual; 1) <http://www-s.ti.com/sc/psheets/slvu007/slvu007.pdf>

2) <http://www-s.ti.com/sc/psheets/slvu013/slvu013.pdf>

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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