

TI TPS5602 for powering TI's DSP

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The TI TPS5602 (a dual-channel synchronous buck switch-mode power-supply controller) features very fast feedback control and dual channels, and is designed specifically for DSP applications that require fast transient response and high efficiency. By using the hysteretic control method, it is ideal for high-transient current applications such as the 'C6000 and multiple 'C54x DSPs. The up and down power sequencing can be achieved by setting the standby pins, since both channels are independent. The wide input voltage and adjustable output voltage make the TPS5602 suitable for many applications.

TPS5602 operating conditions

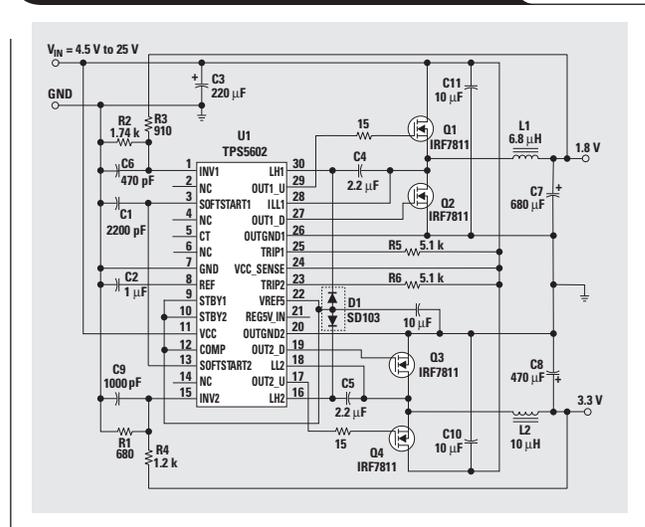
- V_{IN} range — 4.5 V to 25 V
- V_{OUT} range — 1.2 V to given input voltage
- I_{OUT} range — 14 A per output (the current capability can be extended in multi-phase configuration or if the switching devices are added in parallel)

Key features

- Independent dual channels
- Hysteretic control for fast transient response
- Adjustable output voltage down to 1.2 V
- Minimized external component count
- Synchronous rectifier enables efficiencies of >95%
- Separate standby control and over-current protection
- Low supply current (0.8 mA typ)
- 30-pin TSSOP
- Low standby current (1 μ A maximum)
- EVM available (TPS5602EVM-121)
- Driver current 1.2 A at $V_o = 3$ V

Figure 1 shows a typical circuit design using the TPS5602 which features a dual-channel synchronous buck converter (1.8-V and 3.3-V outputs). The two output

Figure 1. Typical circuit design using the TPS5602



voltages are independent and can be adjustable (1.2 V to approximately input voltage) by using the sampling resistors R1, R2, R3, and R4. The output voltages, V_{OUT1} and V_{OUT2} , are set with the following equations, where the reference voltage is 1.185 volts.

$$V_{OUT1} = \left(1 + \frac{R3}{R2}\right) V_{REF} \tag{1}$$

$$V_{OUT2} = \left(1 + \frac{R4}{R1}\right) V_{REF} \tag{2}$$

Figure 2 shows the TPS5602's transient response. The response is less than 2 microseconds after a load is applied. Conventional PWM buck converters exhibit approximately 100 microseconds of response.

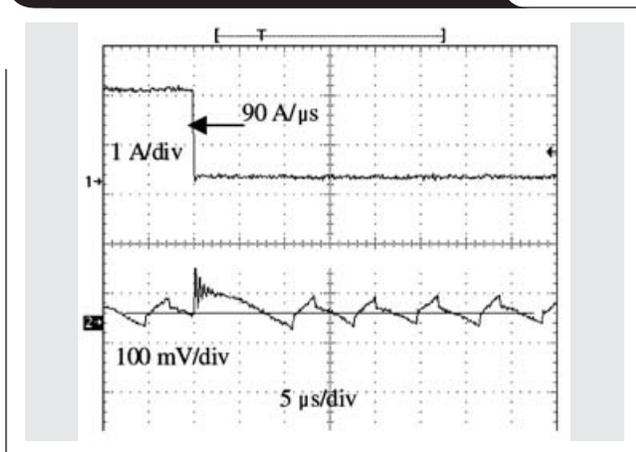
Figures 3 and 4 show the efficiency of the two controllers over load up to 5 A. Efficiency can be improved by choosing lower on-resistance MOSFET.

Table 1 shows the setting values of TPS5602 to generate the output voltages 1.8 V, 2.5 V, or 3.3 V.

Table 1. Summary of setting values for TPS5602 1.8/2.5/3.3-V outputs

OUTPUT VOLTAGE (V)	R2 (or R1) (Ω)	R3 (or R4) (Ω)
3.3	680	1.2K
2.5	1K	1.1K
1.8	1.74K	910

Figure 2. Fast load transient response



The power solutions for TMS320C6xxx and TMS320VC54xx using TPS5602 are shown in Figures 5 and 6.

To avoid bus contention issues within a DSP system, start-up sequencing is recommended. The TMS320C6xxx specifications state that the core and I/O supplies should come up simultaneously, or the core first, followed by the I/O supply. The TMS320VC54xx specifications recommend that the I/O voltage should come up first, or simultaneously. There is a simple solution to meet the power sequencing recommendation. By using the SOFTSTART1 and SOFTSTART2 pins in Figure 1, the start-up sequencing (core voltage first, then peripheral voltage or vice versa) can be easily achieved. The softstart timing can be adjusted by selecting the softstart capacitor value, such as C1 and C12 shown in Figure 1. The equation is

$$C_{\text{soft}} (\mu\text{F}) = 2 \times T_{\text{soft}} (\text{ms}), \tag{3}$$

where C_{soft} is the softstart capacitance and T_{soft} is the start-up time. For example, to set the start-up time $T_{\text{soft}} = 5 \text{ ms}$, the capacitance value of $C_{\text{soft}} = 0.01 \mu\text{F}$ is needed.

In addition, The TPS5602 has two external pins (STBY1, STBY2) that can be alternatively used for power-sequencing.

Figure 4. Efficiency of 1.8-V output

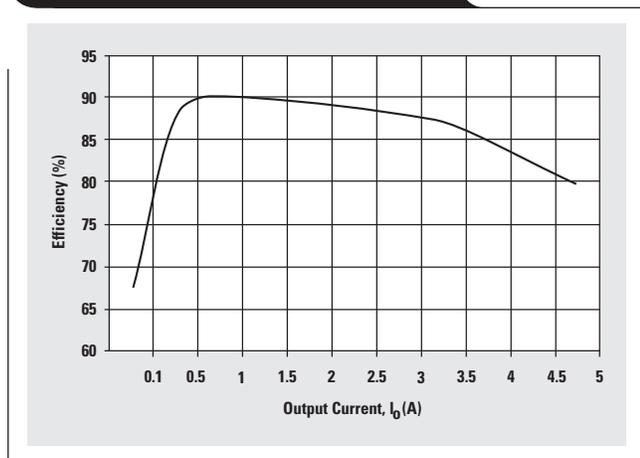


Figure 5. TMS320C6201B/'C6202/'C6211/'C6701/'C6711 power-supply solution using TPS5602

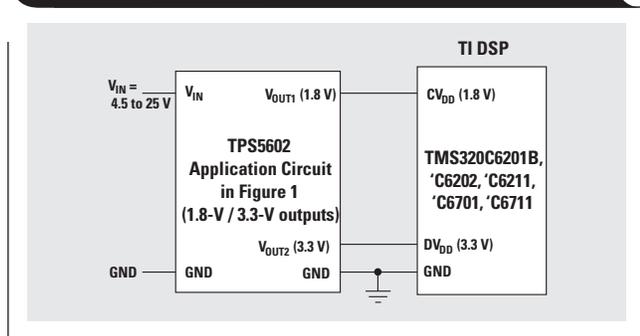
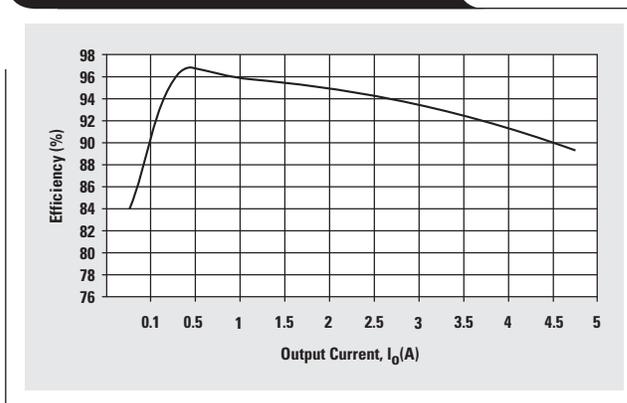


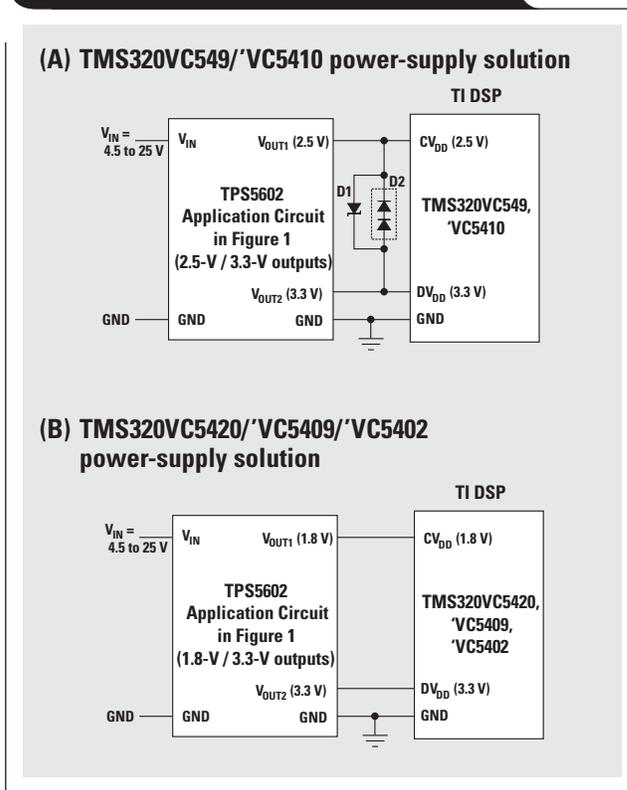
Figure 3. Efficiency of 3.3-V output



Protection diodes D1 and D2 shown in Figure 6 prevent excessive voltage differences (>2 V) between two outputs under any conditions, which is recommended by TMS320VC549/'VC5410.

The two power 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 6. TMS320VC54xx power-supply solutions using TPS5602



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