TMS320F28xx and TMS320F28xxx DSP Power Reference Design

This reference design takes into account the voltage, current, and start-up requirements of the TMS320F280x Digital Signal Processor (DSP) families. The operating input voltage ranges from 3.4 V to 6 V. This design is a high-efficiency solution that provides two voltage rails (1.8-V core supply and 3.3-V I/O supply) and an active-low reset signal to the DSP. This design can be easily adapted to fit requirements for the TMS320F28xxx and TMS320F281x, which have a 1.9-V core supply and 3.3-V I/O supply.

Features

- Provides core and I/O voltages from 3.4-V to 6-V input voltages
- High-efficiency solution
- Small solution size using dual converter
- Optional power-save mode, watchdog timer, and power-fail comparator

Related Documentation

For detailed information about operating conditions and component characteristics, click links in Table 1:

Table 1. Related Documentation Links

DEVICE	DATA SHEET
TMS320F28xxx	TMS320F28335, F28334, F28332 F28235, F28234, F28232 DSCs (SPRS439)
TMS320F281x	TMS320F2810, F2811, F2812, C2810, C2811, C2812 DSPs (SPRS174)
TMS320F280x	TMS320F2809, F2808, F2806, F2802, F2801, C2802, C2801, F2801x DSPs (SPRS230)
TPS62400	Adjustable Dual Step-Down Converter (SLVS681)
TPS62402	TPS62402 Dual Step-Down Converter (SLVS681)
TPS3306-18	Dual Processor Supervisor (SLVS290)

Requirements

The TMS320F280x requires two input rails: 1.8 V for the core and 3.3 V for input/output (I/O). To avoid glitches on power up, the 1.8-V rail must be powered prior to or simultaneously with the 3.3-V rail, ensuring that the 1.8-V rail reaches 0.7 V before the 3.3-V rail reaches 0.7 V. See the Power Sequencing section of the relevant DSP data sheet for further details.

Implementation

This design uses the TPS62402 dual-output, step-down converter and the TPS3306-18 dual-supply voltage supervisor (SVS) as shown in Figure 1.

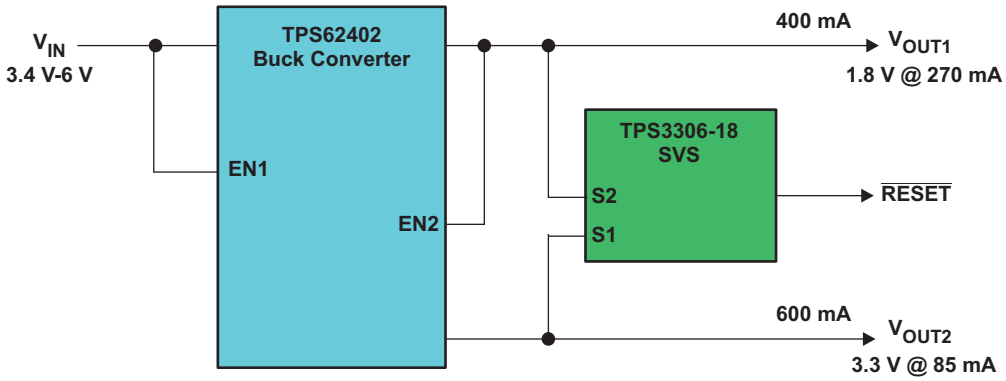


Figure 1. Block Diagram of Power Design

Start-Up

The TPS62402 is a dual step-down converter, with an enable (EN) pin for each output. In this design, the EN1 pin is connected to the input voltage (V_{IN}), so that the 1.8-V rail voltage rises first. The EN2 pin is connected to the 1.8-V rail. Once the voltage reaches the enable threshold of 1.2 V, the 3.3-V rail voltage rises. The 1.8-V rail voltage rises before the 3.3-V rail, so that the start-up requirements are met.

Figure 2 and Figure 3 show the start-up waveforms using a V_{IN} of 5 V and a standard Spectrum Digital EVM board for the F2808 (part number 761132) as the load. The power chip on the board and related circuitry (output capacitors, feedback resistors) are removed, and this design is used to power the board. The TPS62401EVM-167 (HPA167-002) board with the TPS62402DRC instead of the TPS62401DRC is connected to the TPS3305-18D SVS. Then, the voltage rails and reset signal are attached to the F2808 EVM. The TPS62402 is set to forced-PWM mode.

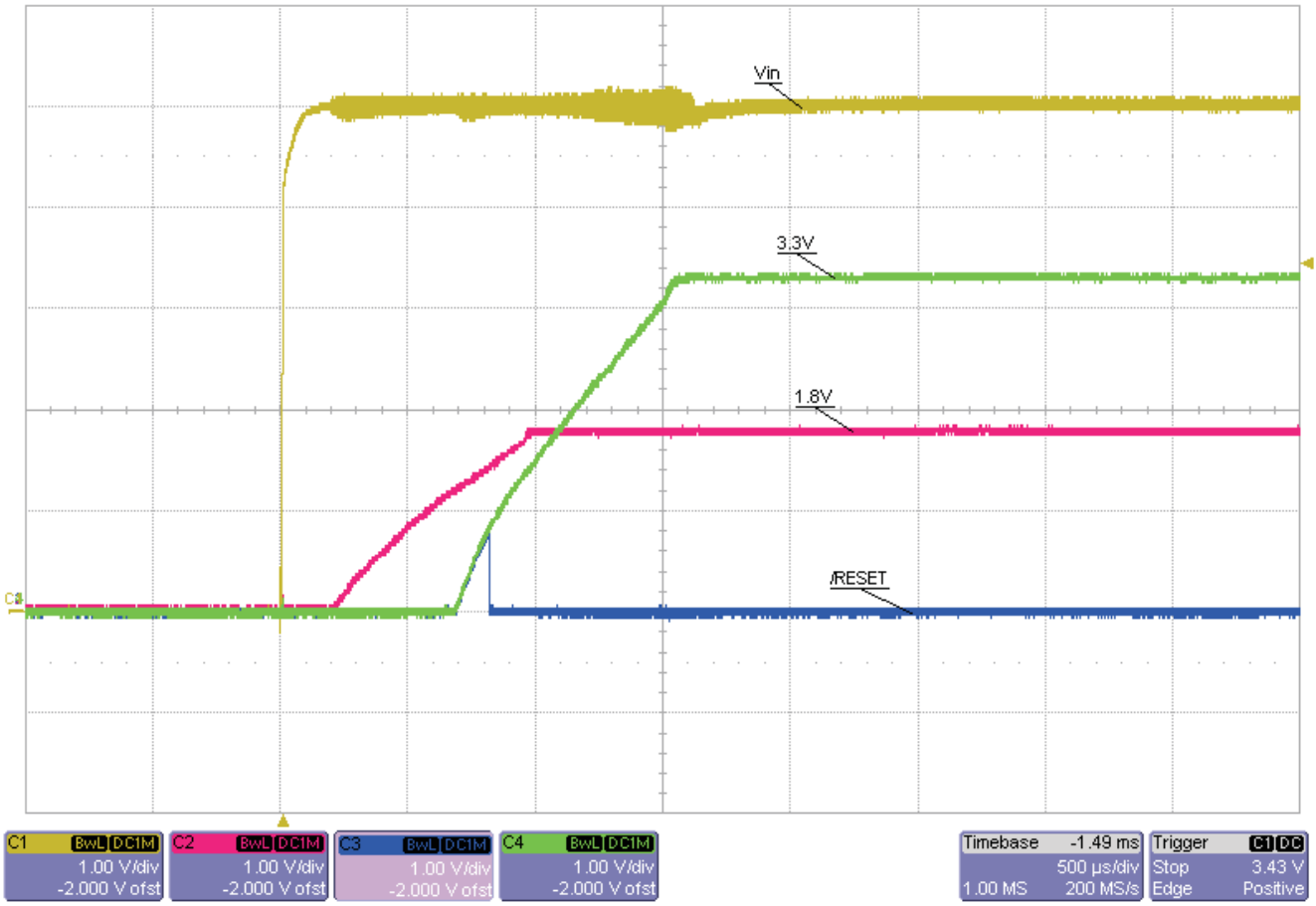


Figure 2. The 1.8-V Rail Voltage Rises Before the 3.3-V Rail

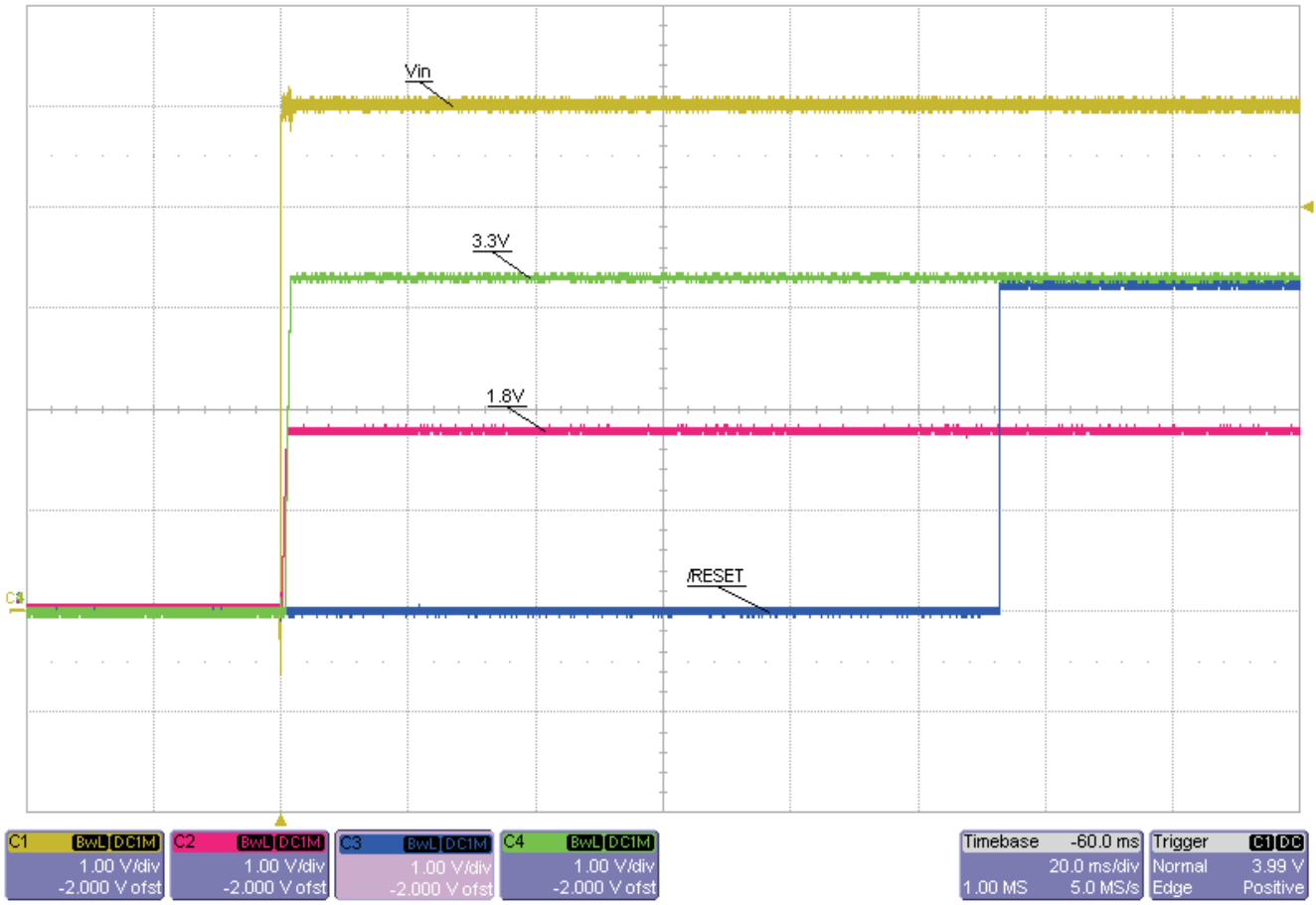


Figure 3. The $\overline{\text{RESET}}$ Signal Held Low for a 100-ms Typical Fixed Delay

Voltage Ripple

For precise measurements on the analog-to-digital converter (ADC) of the DSP, power supply noise and ripple needs to be low. The peak-to-peak voltage ripple values of this design at a Vin of 5 V are shown in Table 2. Switching power supplies inherently have more noise and ripple than linear regulators; so, if low noise and ripple is required, consider using a linear regulator like the TPS767D301. For more information on the TPS767D301, see the TPS767D3xx data sheet (SLVS209) or go to the TPS767D301 TI Product Page. For more detail on the DSP noise and ripple requirements, see the *Total Power Requirement and Selecting Voltage Regulators* section of the *Hardware Design Guidelines for TMS320F28xx and TMS320F28xxx DSCs* application report (SPRAAS1).

Table 2. Voltage Rail Ripple Voltage Values

OUTPUT CURRENT (mA)	1.8-V RAIL VOLTAGE RIPPLE (mV)	3.3-V RAIL VOLTAGE RIPPLE (mV)
1	5	10
5	5	12
10	5	11
50	6	14
100	6	17
200	6	23
300	9	35
400	10	41

Table 2. Voltage Rail Ripple Voltage Values (continued)

OUTPUT CURRENT (mA)	1.8-V RAIL VOLTAGE RIPPLE (mV)	3.3-V RAIL VOLTAGE RIPPLE (mV)
500	-	53

Output Current

Because the overall requirements depend on the specific application, the maximum output current for the power design is higher than the estimated DSP current consumption at full operation (see Table 3). For full details on output currents, see the appropriate DSP data sheet.

Table 3. Maximum Output Current

DSP FAMILY	VOLTAGE RAIL (V)	MAXIMUM CONSTANT CURRENT (mA)	CURRENT USED DURING FLASH ERASE(Er)/Write(Wr)
TMS320F28xxx	1.8	328	See data sheet
	3.3	67	
TMS320F281x	1.8	230	140 mA
	3.3	125	95 mA (Er) / 55 mA (Wr)
TMS320F280x	1.8	268	140 mA
	3.3	69	95 mA (Er) / 55 mA (Wr)
TMS320F28044	1.8	268	140 mA
	3.3	57	95 mA (Er) / 55 mA (Wr)

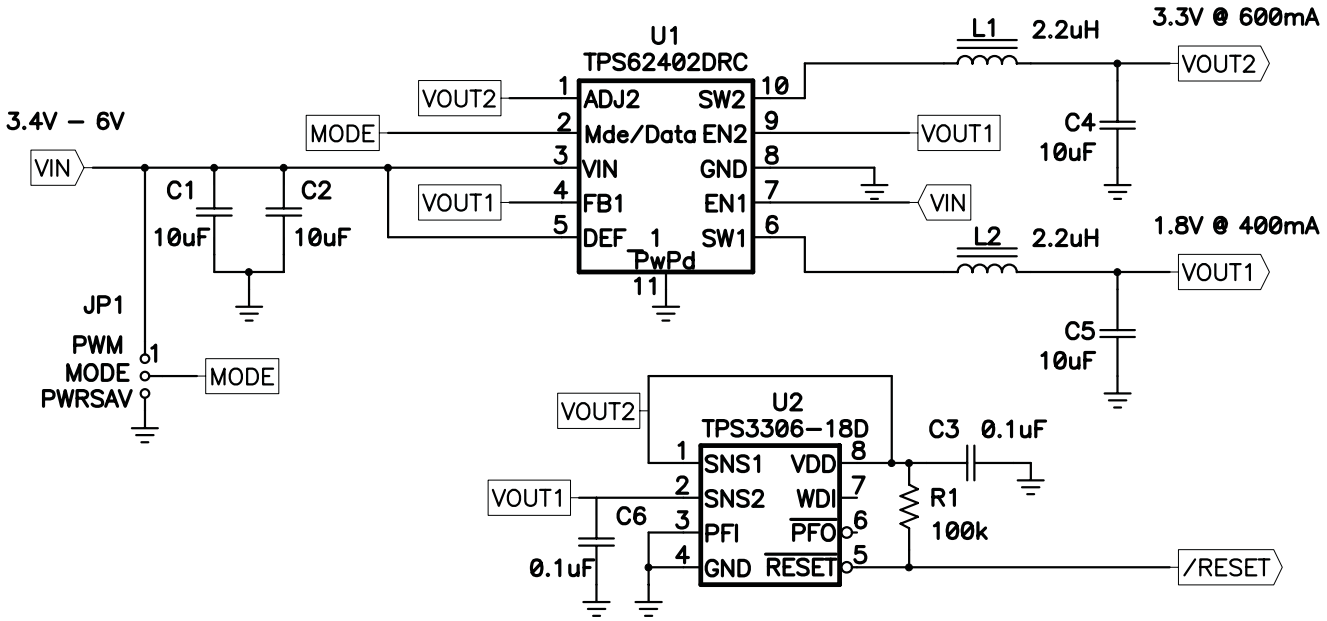
Optional Features

Power-Save Mode—The TPS62402 can be set to constant-PWM mode or Power-Save mode by connecting the MODE/DATA pin to V_{IN} or GND, respectively. See the TPS62402 data sheet (SLVS681) for more details.

Watchdog Timer—The TPS3306-18 has a Watchdog Timer Input (WTI) that can be connected to the DSP. The Watchdog Timer is deactivated if the WTI pin is left open. See the TPS3306-18 data sheet (SLVS290) for additional information.

Power-Fail Comparator — The TPS3306-18 has a Power-Fail Comparator that can be used to monitor voltages other than the nominal supply voltages. The threshold can be set using the power-fail input (PFI), which controls the open-drain, power-fail output ($\overline{PFO}$). See the TPS3306-18 data sheet (SLVS290) for more detail.

Schematic



Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
4	C1, C2, C4, C5	10 µF	Capacitor, Ceramic, 10V, X5R, 10%	0805	C2012X5R1A106K	TDK
2	C3, C6	0.1 µF	Capacitor, Ceramic, 25V, X5R, 10%	0603	C1608X5R1E104K	TDK
2	L1, L2	2.2 µH	Inductor, SMT, 1.2A, 90 mΩ	0.118 × 0.118 in	LPS3010-222ML	Coilcraft
1	R1	100k	Resistor, Chip, 1/16W, 1%	0603	Std	
1	U1	TPS62402DRC	IC, 2.25 MHz Dual Step Down Converter	QFN10	TPS62402DRC	TI
1	U2	TPS3306-18D	IC, Dual Processor Supervisory Circuit with Power-fail	SO8	TPS3306-18D	TI

Modifications for the TMS320F281x and TMS320F28xxx

This design can be modified to fit the requirements for the TMS320F281x and TMS320F28xxx. The TPS62402 can be replaced with the TPS62400, which is the adjustable version of the same dual step-down converter. Sequencing requirements can be changed by connecting the enable pin of each converter to the preceding voltage rail. For example, to bring up the 3.3-V rail first, attach the EN2 pin to VIN and the EN1 pin to the 3.3-V rail. The same TPS3306-18 $\overline{\text{SVS}}$ can be used because its voltage threshold is 1.68 V or another SVS can be used as long as the $\overline{\text{RESET}}$ signal is open drain.

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