

Simple Power Solution Using LDOs

Ambreesh Tripathi

PMP - DC/DC Low-Power Converters

ABSTRACT

This reference design helps those desiring to design-in the TMS320C6742, TMS320C6746, TMS320C6748, and OMAP-L138. This design, employing sequenced power supplies, describes a system with an input voltage of 3.3 V, and uses LDOs for a small, simple system.

Sequenced power supply architectures are becoming commonplace in high-performance microprocessor and digital signal processor (DSP) systems. To save power and increase processing speeds, processor cores have smaller geometry cells and require lower supply voltages than the system bus voltages. Power management in these systems requires special attention. This application report addresses these topics and suggests solutions for output voltage sequencing.

Contents

1	Introduction	2
2	Power Requirements	2
3	Features	3
4	List of Material	6

List of Figures

1	PMP4980 Reference Design Schematic.....	4
2	Optional Circuit for DVDD_A, DVDD_B, and DVDD_C.....	5
3	Sequencing in Start-Up Waveform	7

List of Tables

1	Power Requirements	2
2	PMP4980 List of Material	6

1 Introduction

In dual voltage architectures, coordinated management of power supplies is necessary to avoid potential problems and ensure reliable performance. Power supply designers must consider the timing and voltage differences between core and I/O voltage supplies during power-up and power-down operations.

Sequencing refers to the order, timing and differential in which the two voltage rails are powered up and down. A system designed without proper sequencing may be at risk for two types of failures. The first of these represents a threat to the long term reliability of the dual voltage device, while the second is more immediate, with the possibility of damaging interface circuits in the processor or system devices such as memory, logic or data converter ICs.

Another potential problem with improper supply sequencing is bus contention. Bus contention is a condition when the processor and another device both attempt to control a bidirectional bus during power up. Bus contention also may affect I/O reliability. Power supply designers must check the requirements regarding bus contention for individual devices.

The power-on sequencing for the OMAP-L138, TMS320C6742, TMS320C6746, and TMS320C6748 are shown in [Table 1](#). No specific voltage ramp rate is required for any of the supplies as long as the 3.3-V rail never exceeds the 1.8-V rail by more than 2 volts.

2 Power Requirements

The power requirements are as specified in the following table.

Table 1. Power Requirements

	PIN NAME	VOLTAGE ^{(1) (2)} (V)	I _{MAX} (mA)	TOLERANCE	SEQUENCING ORDER	TIMING DELAY
I/O	RTC_CVDD	1.2	1	-25%, +10%	1 ⁽³⁾	
Core	CVDD ⁽⁴⁾	1.0 / 1.1 / 1.2	600	-9.75%, +10%	2	
I/O	RVDD, PLL0_VDDA, PLL1_VDDA, SATA_VDD, USB_CVDD, USB0_VDDA12	1.2	200	-5%, +10%	3	
I/O	USB0_VDDA18, USB1_VDDA18, DDR_DVDD18, SATA_VDDR, DVDD18	1.8	180	$\pm 5\%$	4	
I/O	USB0_VDDA33, USB1_VDDA33	3.3	24	$\pm 5\%$	5	
I/O	DVDD3318_A, DVDD3318_B, DVDD3318_C	1.8 / 3.3	50 / 90 ⁽⁵⁾	$\pm 5\%$	4 / 5	

⁽¹⁾ If 1.8-V LVCMOS is used, power rails up with the 1.8-V rails. If 3.3-V LVCMOS is used, power it up with the ANALOG33 rails (VDDA33_USB0/1)

⁽²⁾ No specific voltage ramp rate is required for any of the supplies as long as a LVCMOS33 (USB0_VDDA33, USB1_VDDA33) never exceeds STATIC18 (USB0_VDDA18, USB1_VDDA18, DDR_DVDD18, SATA_VDDR, DVDD18) by more than 2 volts.

⁽³⁾ If RTC is not used/maintained on a separate supply, it can be included in the STATIC12 (fixed 1.2 V) group.

⁽⁴⁾ If using CVDD at fixed 1.2 V, all 1.2-V rails may be combined.

⁽⁵⁾ If DVDD3318_A, B, and C are powered independently, maximum power for each rail is 1/3 the above maximum power.

3 Features

The design uses the LDOs.

INPUT VOLTAGE	~3.3 V
	Simple (no DVFS)
COMBINE RTC AND STATIC 1.2	
Core 1.2 V at 600 mA	TPS74801
Static 1.2 V + VRTC at 251 mA	TPS74701
Static 1.8 V at 230 mA	TPS71718
Static 3.3 V at 115 mA	TPS74801

Here VRTC is included in the STATIC12 (fixed 1.2V) group.

TPS74801 and TPS74701

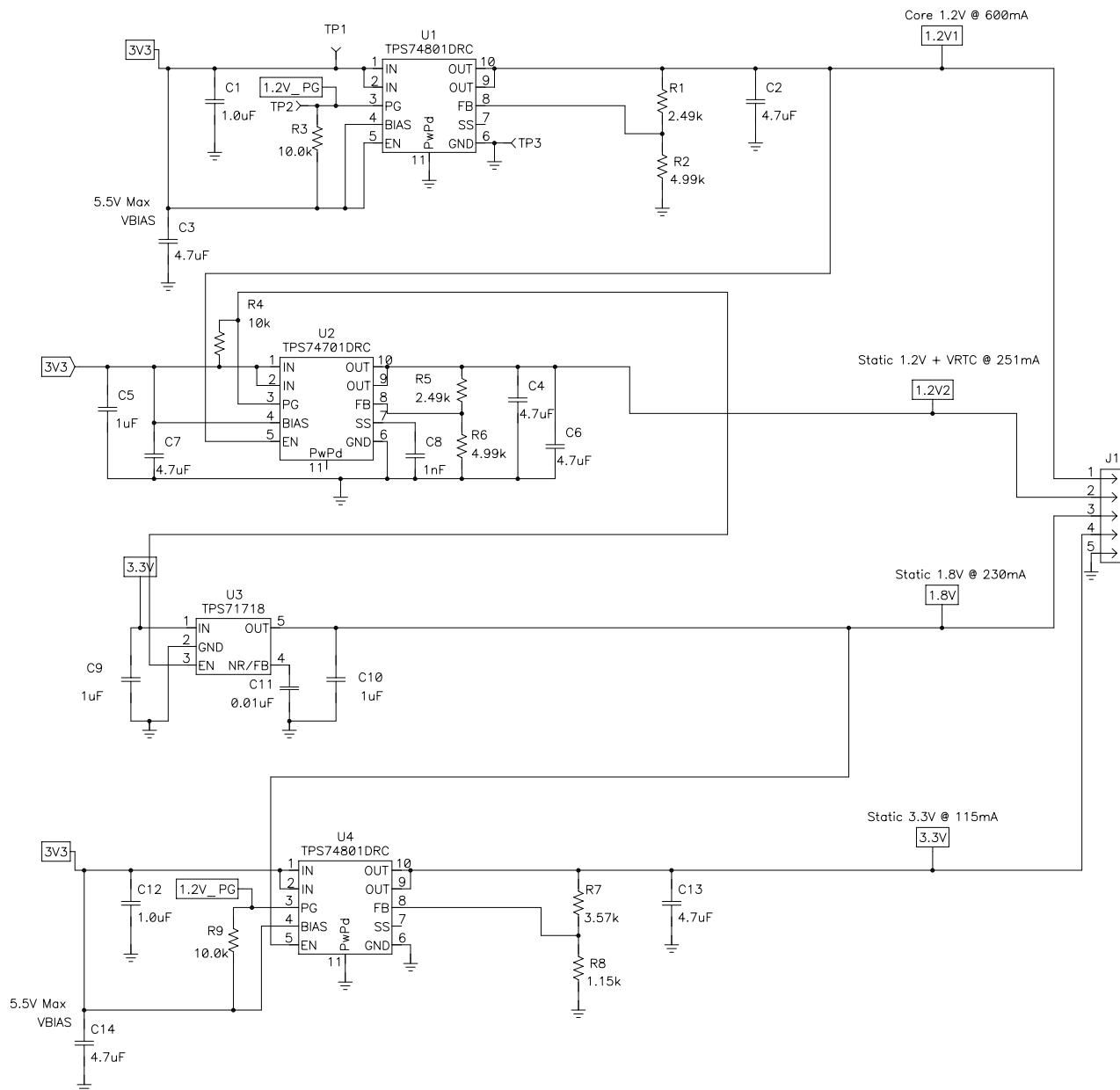
- VOUT Range: 0.8 V to 3.6 V
- 2% Accuracy Over Line/Load/Temperature
- Programmable Soft-Start Provides Linear Voltage Startup
- Stable with Any Output Capacitor $\geq 2.2 \mu\text{F}$
- Available in a Small 3-mm \times 3-mm \times 1-mm SON-10 and 5 \times 5 QFN-20 Packages

TPS71718

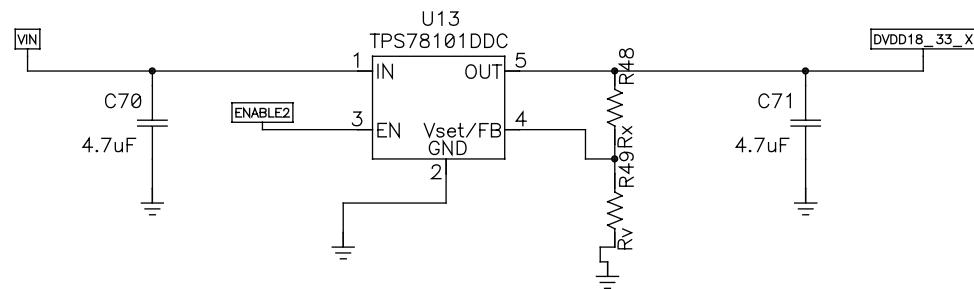
- 150-mA Low-Dropout Regulator with Enable
- Low Noise: 30 μV typical (100 Hz to 100 kHz)
- Excellent Load/Line Transient Response
- Small SC70-5, 2-mm \times 2-mm SON-6, and 1.5-mm \times 1.5-mm SON-6 Packages

More information on the devices can be found from the data sheets.

- TPS74801, <http://focus.ti.com/lit/ds/symlink/tps74801.pdf>
- TPS74701, <http://focus.ti.com/lit/ds/symlink/tps74701.pdf>
- TPS71718, <http://focus.ti.com/lit/ds/symlink/tps71718.pdf>


Figure 1. PMP4980 Reference Design Schematic

Proper sequencing is ensured in the design with the use of enable pins. As required, Core 1.2 V at 600 mA comes first, followed by Static 1.2 V + VRTC at 251 mA, Static 1.8 V at 230 mA which in turn enable the LDO and hence at last Static 3.3 V at 115 mA comes up.



- (1) Use three such LDOs to power up DVDDA, DVDDB, DVDDC (It can either be 1.8 V or 3.3 V)
- (2) $R_x = 0.499 \text{ M}\Omega$, $R_y = 1 \text{ M}\Omega$ for $V_{out} = 1.8 \text{ V}$
- (3) $R_x = 1.8 \text{ M}\Omega$, $R_y = 1 \text{ M}\Omega$ for $V_{out} = 3.3 \text{ V}$
- (4) For proper sequencing of output, enable of the LDOs are fed either from 1.2-V output from TPS74701 if DVDDX is 1.8 V or from 1.8-V output from TPS71718 if DVDDX is 3.3 V.

Figure 2. Optional Circuit for DVDD_A, DVDD_B, and DVDD_C

4 List of Material

Table 2. PMP4980 List of Material

Count	RefDes	Value	Description	Size	Part Number	MFR	Area
1	C1	1.0uF	Capacitor, Ceramic, 25V, X5R, 10%	0603	C1608X5R1E105K	TDK	5650
2	C2	4.7uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0603	C1608X5R0J106M	TDK	5650
2	C3	4.7uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0603	C1608X5R0J475K	TDK	5650
3	C4	4.7uF	Capacitor, Ceramic, 4.7uF, 6.3V, X5R	0603	C1608X5R0J475M	TDK	5650
1	C5	1uF	Capacitor, Ceramic, 1uF, 16V, X5R	0603	C1608X5R1C105K	TDK	5650
	C6	4.7uF	Capacitor, Ceramic, 4.7uF, 6.3V, X5R	0603	C1608X5R0J475M	TDK	5650
	C7	4.7uF	Capacitor, Ceramic, 4.7uF, 6.3V, X5R	0603	C1608X5R0J475M	TDK	5650
1	C8	1nF	Capacitor, Ceramic, 1000pF, 50V, X7R, 10%	0603	C1608X7R1H102K	TDK	5650
2	C9	1uF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	C1608X5R1E105M	TDK	5650
	C10	1uF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	C1608X5R1E105M	TDK	5650
1	C11	0.01uF	Capacitor, Ceramic, 50V, COG, 10%	0402	Std	Std	2800
1	C12	1.0uF	Capacitor, Ceramic, 25V, X5R, 10%	0603	C1608X5R1E105K	TDK	5650
	C13	4.7uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0603	C1608X5R0J106M	TDK	5650
	C14	4.7uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0603	C1608X5R0J475K	TDK	5650
1	J1	PEC36SAAN	Header, Male 5-pin, 100mil spacing, (36-pin strip)	0.100 inch × 5	PEC36SAAN	Sullins	60000
1	R1	2.49k	Resistor, Chip, 1/16W, 1%	0603	Std	Std	5650
1	R2	4.99k	Resistor, Chip, 1/16W, 1%	0603	Std	Std	5650
2	R3	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std	5650
1	R4	10k	Resistor, Chip, 10k-Ohms 1/16W, 5%	0603	Std	Std	5,650
1	R5	2.49k	Resistor, Chip, 2k49-Ohms, 1/16W, 5%	0603	Std	Std	5,650
1	R6	4.99k	Resistor, Chip, 4k99-Ohms, 1/16W, 5%	0603	Std	Std	5,650
1	R7	3.57k	Resistor, Chip, 1/16W, 1%	0603	Std	Std	5650
1	R8	1.15k	Resistor, Chip, 1/16W, 1%	0603	Std	Std	5650
	R9	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std	5650
2	TP1	5000	Test Point, Red, Thru Hole Color Keyed	0.100 × 0.100	5000	Keyston e	10
	TP2	5000	Test Point, Red, Thru Hole Color Keyed	0.100 × 0.100	5000	Keyston e	10
1	TP3	5001	Test Point, Black, Thru Hole Color Keyed	0.100 × 0.100 inch	5001	Keyston e	10
2	U1	TPS74801DRC	IC, 1.5A LDO Regulator with Soft-Start	SON-10	TPS74801DRC	TI	30400
1	U2	TPS74701DRC	IC, 1.5A LDO Regulator with Soft-Start	SON-10	TPS74701DRC	TI	30400
1	U3	TPS71718	IC, 150mA, Low Iq, Wide Bandwidth, LDO Linear Regulators	SC70	TPS71718	TI	18600
	U4	TPS74801DRC	IC, 1.5A LDO Regulator with Soft-Start	SON-10	TPS74801DRC	TI	30400

Notes: 1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants.
 Use of unclean flux is unacceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk ('**') cannot be substituted.
 All other components can be substituted with equivalent MFG's components.

4.1 Test Results

The start-up waveform is shown in [Figure 3](#), which specifies the sequencing order that is required.

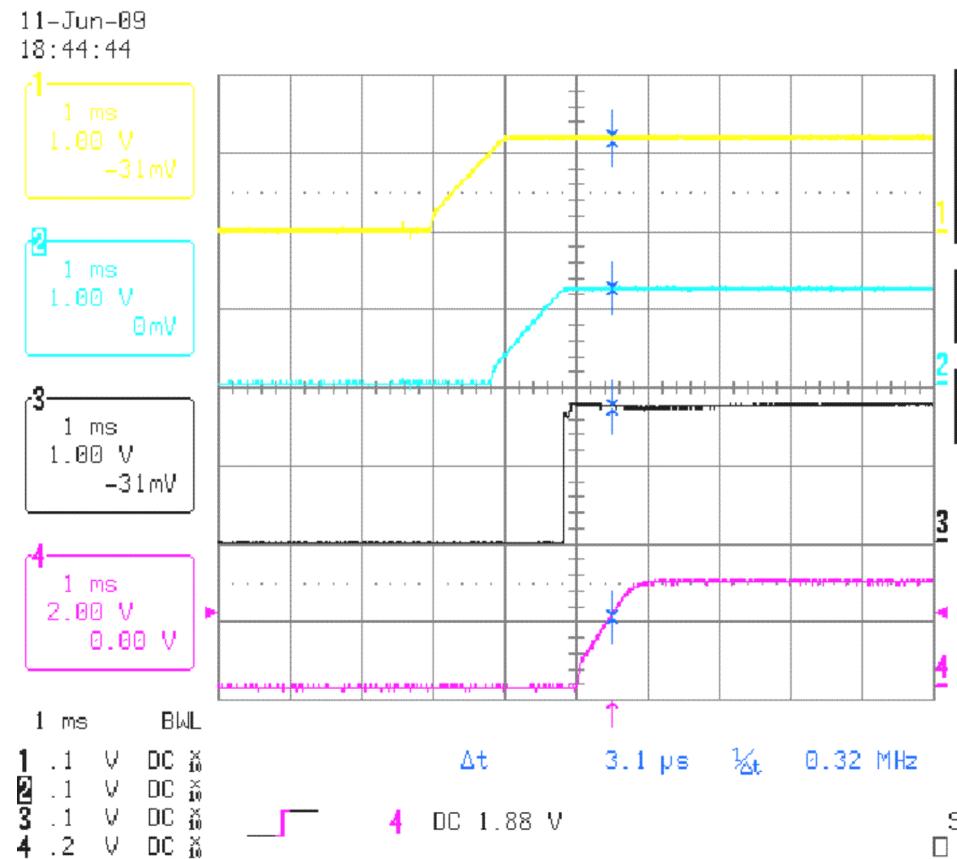


Figure 3. Sequencing in Start-Up Waveform

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI 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 and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps