PR418
TMS320VC550x Design 1

FEATURES:

- Provides sequenced core and I/O voltages from input voltages from 2.4 V to 5.0 V.
- /RESET delay fixed at 65 ms minimum, 130 ms typical.
- Wide input voltage range covering input voltages above and below the I/O voltage.
- The current draw on the input power supply is minimized by sequencing first the core rail and then the I/O rail.

IMPORTANT WEB LINKS:

- Link to the TI power management home page at http://power.ti.com then select the TI DSP Solutions link for more information and other reference designs.
- Link to datasheets at:
  - http://focus.ti.com/lit/ds/symlink/tps61130.pdf
  - http://focus.ti.com/lit/ds/symlink/tps3103k33.pdf
- Link to application note SLVA118 http://focus.ti.com/lit/an/slva118/slva118.pdf to explore the thermal considerations in using linear regulators.

THEORY OF OPERATION:

PR418 is designed around Texas Instrument's TPS61130 combination SEPIC converter and linear regulator (LDO). The circuit uses the SEPIC converter to generate 3.3 V from the input voltage source. The 3.3 V is used for the I/O voltage and to supply the LDO input voltage for the core. The LDO regulates the 3.3 V down to the core voltage of 1.2 or 1.6 V. The reset signal for the DSP is provided by a TPS3103 that monitors both the I/O and core voltages. The TPS3103 will hold /RESET low for about 130 ms once the I/O and core voltages exceed about 90% of their nominal values.

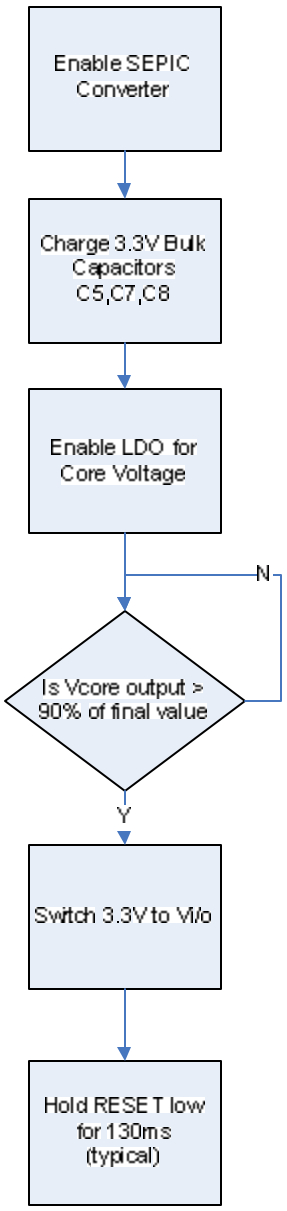
CIRCUIT LIMITATIONS AND CAPABILITIES:

The SEPIC converter of the TPS61130 is capable of supplying about 350 mA of current with an input voltage of 2.4 V. The SEPIC converter also supplies current to the LDO for the core voltage, so the sum of the core and I/O currents can not exceed 350 mA. This limit should be checked against the end application. Additionally, the LDO of the TPS61130 has a 200 mA output current limit. This may not be enough current for some 1.6 V, 200Mhz Core configurations and should be checked against the application.

For the current capability at other input voltages, see Figure 1 of the TPS61130 datasheet. From Figure 1, it is possible to operate this circuit with an input voltage as low as 1.8 V;

however, the SEPIC converter will only supply about 250 mA, which may not be enough total current for all DSP configurations.

POWER UP SEQUENCING:



The circuit will apply the I/O voltage about 7 ms after the Core voltage exceeds 90% of its nominal voltage level. The 7 ms is set by a RC time constant that is created by R6 and C9. This additional delay is used to allow a reduction in peak turn on currents in the core voltage before turning on the I/O voltage. This time can be increased by increasing C9. It is not recommended to decrease this time constant.

The sequencing circuits can be removed if sequencing is not required. Components R6, R7, R8, R9, C9, Q1, and Q2 can all be removed and the I/O voltage supplied directly from the top of C8. The LDO enable can then be tied to the SEPIC's enable pin or simply tied to the input voltage so that it is always enabled. This will not affect the RESET timing. However, the SEPIC converter is only capable of supplying a total of 350 mA of current which includes both the I/O and core currents. If both the I/O and Core voltages are enabled together, there is a risk that the start-up currents may exceed 350 mA and the converter will have difficulties turning on. This condition should be checked in the application if the sequencing is removed.

IMPLEMENTATION NOTES:

- **Component selection:**
  - If different capacitors are used for C4 and C7 than recommended per the BOM, they must meet the ESR requirements per the datasheet.

WAVEFORMS:

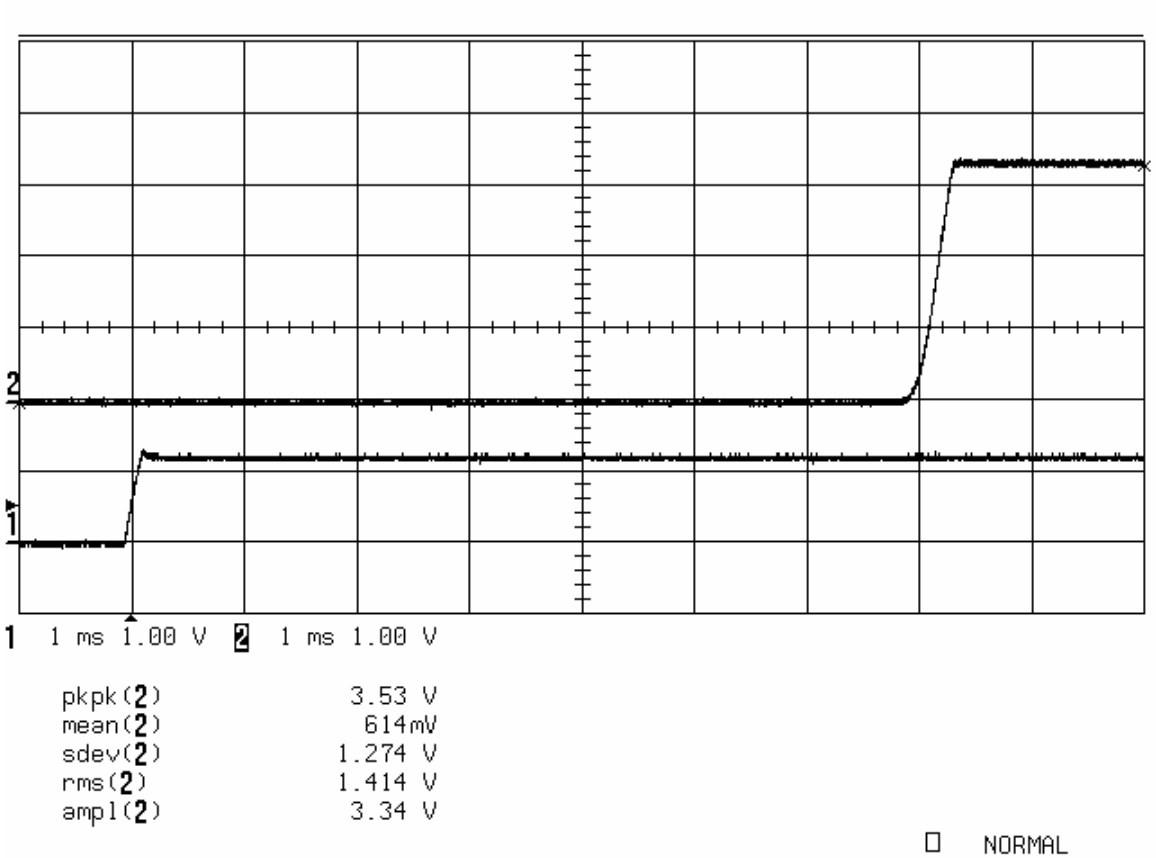


Figure 1 - Power up with V_{IN} = 2.4 V, Vcore=1.2 V @ 110 mA, Vi/o = 3.3 V @ 50 mA

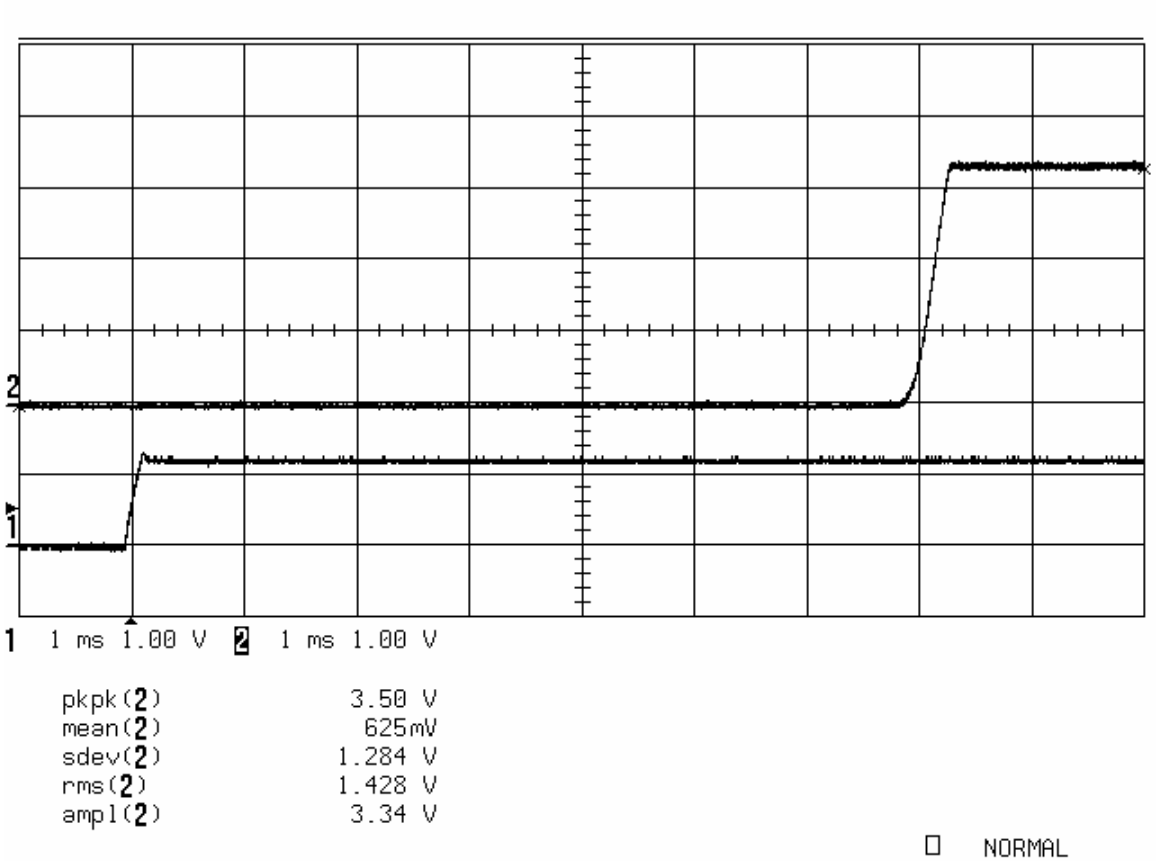


Figure 2 - Power up from Enable when V_{IN} = 2.4 V, Vcore=1.2 V @ 110 mA, Vi/o = 3.3 V @ 50 mA

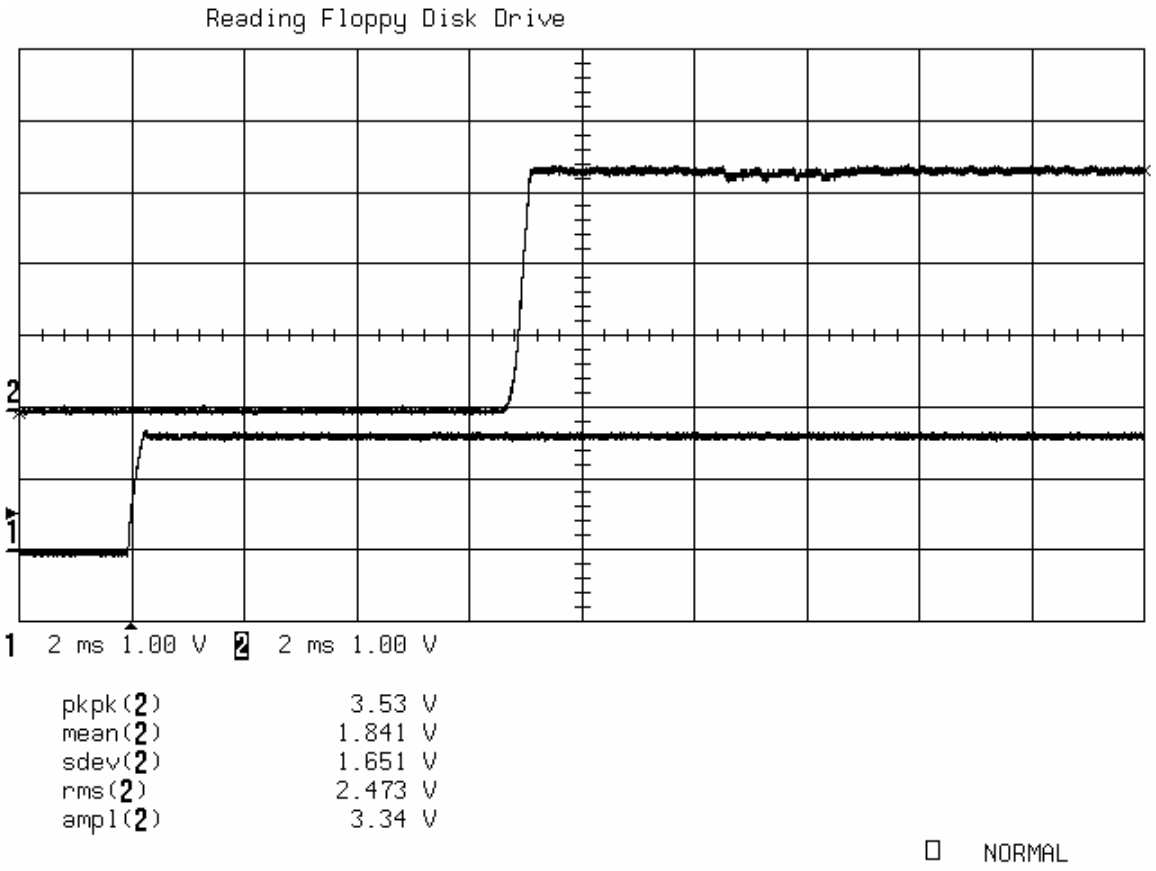


Figure 3 - Power up with V_{IN} = 2.4 V, Vcore=1.6 @ 228ma, Vi/o = 3.3V @ 70ma

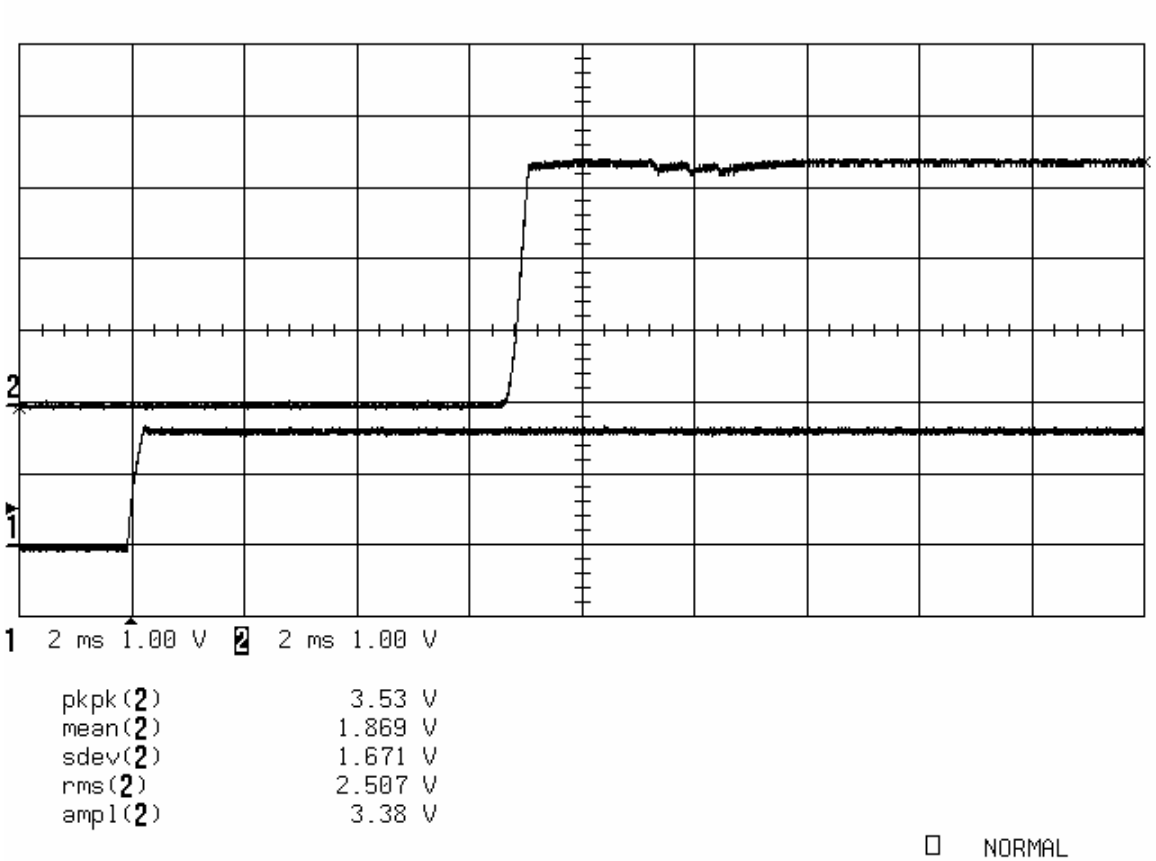


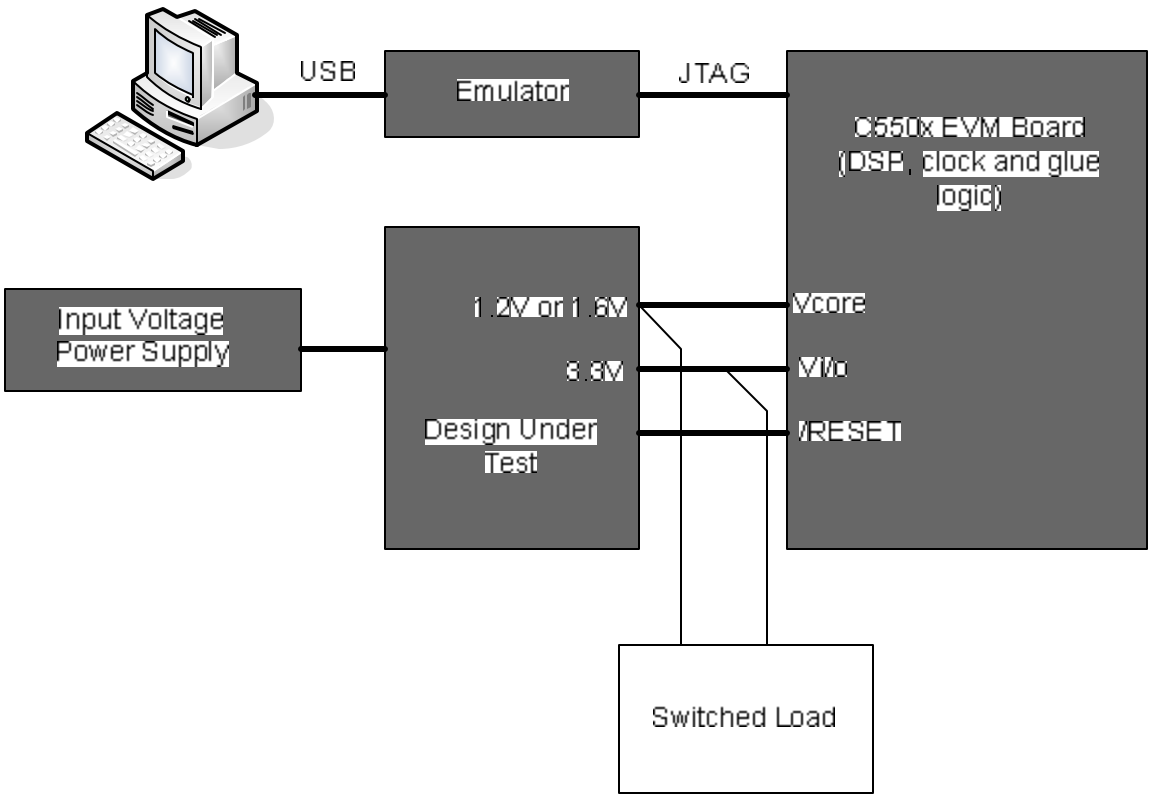
Figure 4 - Power up from Enable when V_{IN} = 2.4 V, Vcore=1.6 V@ 228 mA, Vi/o = 3.3 V @ 70 mA

TESTING METHOD:

The solution was tested on the bench and in an actual DSP circuit. Bench testing included start up into full DSP load, switched load from no load to full DSP load, and power up sequencing. The full DSP load is defined as the current draw a C550x DSP would present to the power supply under worst operating conditions. This full DSP load current is heavily dependent on board layout, firmware configurations, DSP clock speed and core voltage. For testing purposes, the following values were assumed to be the full DSP load current.

Voltage (V)	Function	Full load current (mA)
1.2	Core	110
1.6	Core	256
3.3	I/O	70

The solution was also tested in an active DSP board. The following test set up was used for this testing:



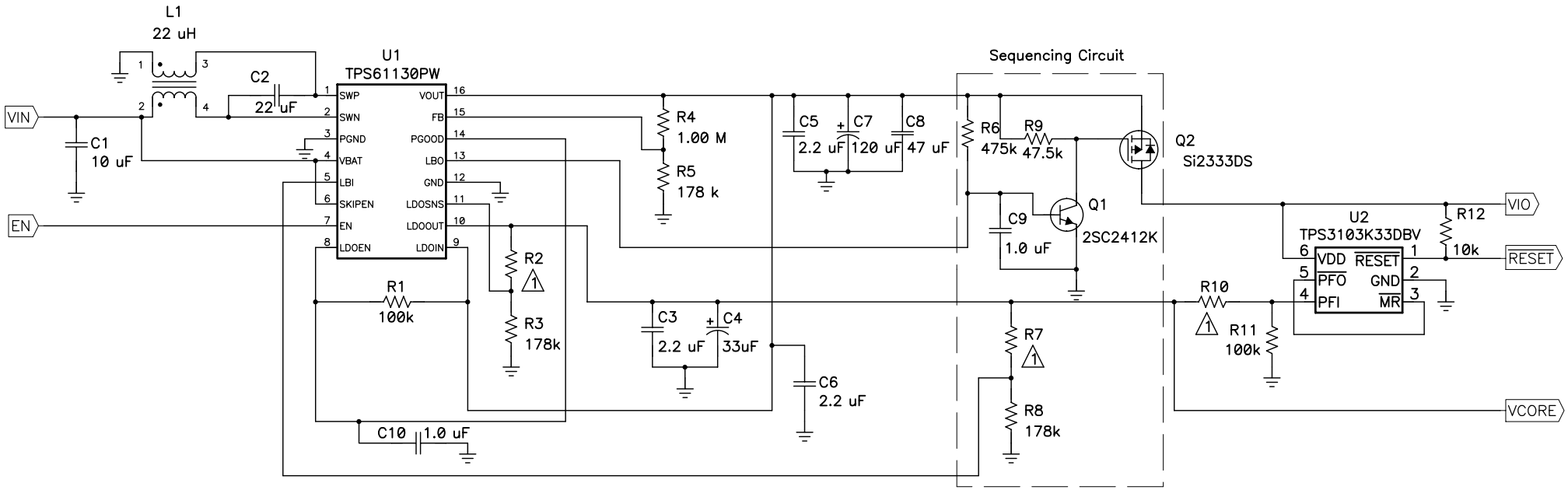
mailto:dsppower@list.ti.com

Filename: PR418_bom.xls

Date: 02/14/2005

PR418 BOM

COUNT						
-001	-002	RefDes	Description	Size	Part Number	MFR
1	1	C1	Capacitor, Ceramic, 10-uF, 6.3-V, X5R, 10%	0805	GRM21BR60J106KE01	muRata
1	1	C2	Capacitor, Ceramic, 22-uF, 10-V, X5R, 10%	1210	GRM32ER61A226KA65	muRata
3	3	C3, C5, C6	Capacitor, Ceramic, 2.2-uF, 6.3-V, X5R, 10%	0805	GRM21BR60J225KC01B	muRata
1	1	C4	Capacitor, POSCAP, 33-uF, 8-V, 70-milliohm, 20%	6032 (C)	8TPC33M	Sanyo
1	1	C7	Capacitor, Tantalum, 120-uF, 10-V, 140-milliohm, 20%	7343 (D)	595D127X0010D2T	Vishay
1	1	C8	Capacitor, Ceramic, 47-uF, 6.3-V, X5R, 10%	1210	GRM32ER60J476ME20	muRata
2	2	C9, C10	Capacitor, Ceramic, 1.0-uF, 10-V, X5R, 10%	0603	GRM188R61A105KA61	muRata
1	1	L1	Inductor, SMT, 22-uH, 811-mA, 429-milliohm	0.300 x 0.300	DRQ74-220	Cooper
1	1	Q1	Transistor, NPN General Purpose, VCE 50V, VCB 60V, VEB 7V, IC 0.15A	SOT-23	2SC2412K	ROHM
1	1	Q2	MOSFET,P-ch, -12 V, 4 A, 51 milliohm	SOT23	Si2333DS	Vishay
2	2	R1, R11	Resistor, Chip, 100k-Ohms, 1/16-W, 1%	0603	Std	Std
1	0	R10	Resistor, Chip, 97.6k-Ohms, 1/16-W, 1%	0603	Std	Std
0	1		Resistor, Chip, 162k-Ohms, 1/16-W, 1%	0603	Std	Std
1	1	R12	Resistor, Chip, 10k-Ohms, 1/16-W, 1%	0603	Std	Std
1	0	R2	Resistor, Chip, 249k-Ohms, 1/16-W, 1%	0603	Std	Std
0	1		Resistor, Chip, 392k-Ohms, 1/16-W, 1%	0603	Std	Std
3	3	R3, R5, R8	Resistor, Chip, 178k-Ohms, 1/16-W, 1%	0603	Std	Std
1	1	R4	Resistor, Chip, 1.00M-Ohms, 1/16-W, 1%	0603	Std	Std
1	1	R6	Resistor, Chip, 475k-Ohms, 1/16-W, 1%	0603	Std	Std
1	0	R7	Resistor, Chip, 205k-Ohms, 1/16-W, 1%	0603	Std	Std
0	1		Resistor, Chip, 332k-Ohms, 1/16-W, 1%	0603	Std	Std
1	1	R9	Resistor, Chip, 47.5k-Ohms, 1/16-W, 1%	0603	Std	Std
1	1	U1	IC, Single Cell or Dual Cell Li-Ion Boost/Sepic Converter	TSSOP-16	TPS61130PW	TI
1	1	U2	IC, Utra Low Current/Supply, Voltage Supervisor	SOT23-6	TPS3103K33DBV	TI



⚠1

Voltage	R2	R7	R10
1.2V	249k	205k	97.6k
1.6V	392k	332k	162k

Title	C5000 DSP Attach Design 1 for 2.4 < Vin < 5.0V	
Size B	Number PR418	Rev
Date 02/14/05		Drawn by
Filename pr418.sch		Sheet of

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 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.

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.

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
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265