Power Reference Design for the TMS320C6472 5-Vin, DC/DC Converters (1x C6472)

This reference design is intended for designers who wish to design a TMS320C6472 Digital Signal Processor (DSP) into a system using a nominal input voltage of 5 V, DC/DC converters with integrated FETs, and allowing for ease-of-design and a smaller solution size.

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1 Introduction

This reference design is for powering one TMS320C6472 DSP and accounts for voltage and current requirements, which are given in Table 2. The core voltage has been optimized for 1-V operation. This design also includes enough margin on the 1.8-V rail to account for typical amounts of memory (2 × 667MHz DDR SDRAM), which comes to just over 600 mA.

The TMS320C6472 requires a 3.3-V, 1.8-V, 1.2-V, and 1-V/1.1-V/1.2-V input. Power-up sequencing is required and is shown in Table 1. In multivoltage 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 failure represents a threat to the long-term reliability of the dual-voltage device, whereas the second failure is more immediate, with the possibility of damaging interface circuits in the processor or system devices such as memory, logic or data converter integrated circuits (IC).

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.

2 Power Requirements

The power requirements for each TMS320C6472 follow. For more information and other reference designs, visit www.ti.com/processorpower.

Table 1. TMS320C6472[1] Power Requirements

Core, I/O	Pin Name	Voltage (V)	Imax (mA)	Tolerance	Sequencing Order	Timing Delay
Core	CVDD, CVDD2[2]	1 / 1.1 / 1.2	9500	±5	2	<200 ms
	CVDD1	1.2	260	±5		
IO	DVDD33	3.3	100	±5	1	<200 ms
	DVDD18[3], DVDD15	1.8[4]	150	±5	3	
Analog	AVDDA1, AVDDA2, AVDDA3, DVDDD	1.8[4]	190	±5		<200 ms
	AVDDA, DVDDD, AVDDT, AVDDA4, DVDDR	1.2	170	±5		

(1) Consult the TMS320C6472 power spreadsheet for your exact power requirements.
(2) CVDD and CVDD2 are 1 V @ 500 MHz, 1.1 V @ 625 MHz (Imax = 4900 mA), and 1.2 V @ 700 MHz (Imax = 9500 mA).
(3) DVDD18 voltage rail includes power required for external DDR2 memory.
(4) All 1.8-V rails may be combined and all 1.1-V rails may be combined; however, follow the filtering recommendations for each voltage rail in the *TMS320C6472 Hardware Design Guide* (SPRAAQ4).

Table 2. Reference Design Parameters

Vin	5 V ± 10%
Vout1	1 V ± 5% at 5 A
Vout2	1.2 V ± 5% at 300 mA
Vout3	3.3 V ± 5% at 1 A
Vout4	1.8 V ± 5% at 1 A
Vout5	1.2 V ± 5% at 1.6 A
DDR Termination	0.9 V at 3 A

3 Device Features

TPS54880

- Input Operating Voltage Range: 4.5 V to 18 V
- Up to 20-A Output Currents
- Supports Pre-Biased Outputs
- 0.5% 0.591-V Reference
- Three Selectable Thermally Compensated Short-Circuit Protection Levels
- Hiccup Restart From Faults
- Internal 5-V Regulator
- High- and Low-Side FET RDSON Current Sensing

TPS62200

- 350-mA, High-Performance LDO
- Low Quiescent Current: 38 µA
- Excellent Load Transient Response

TPS62040

- 350-mA, High-Performance LDO
- Low Quiescent Current: 38 µA
- Excellent Load Transient Response

TPS51200

- 3-A DDR Termination LDO
- VLDOIN Voltage Range: 1.1 V to 3.5 V
- Sink/Source Termination Regulator Includes Droop Compensation
- Requires Minimum Output Capacitance of 20-µF (Typically 3 × 10-µF MLCCs) for Memory Termination Applications (DDR)
- PGOOD to Monitor Output Regulation and Remote Sensing (VOSNS)
- ±10-mA Buffered Reference (REFOUT)
- Meets DDR, DDR2 JEDEC Specifications; Supports DDR3 and Low-Power DDR3/DDR4 VTT Applications

4 Schematic

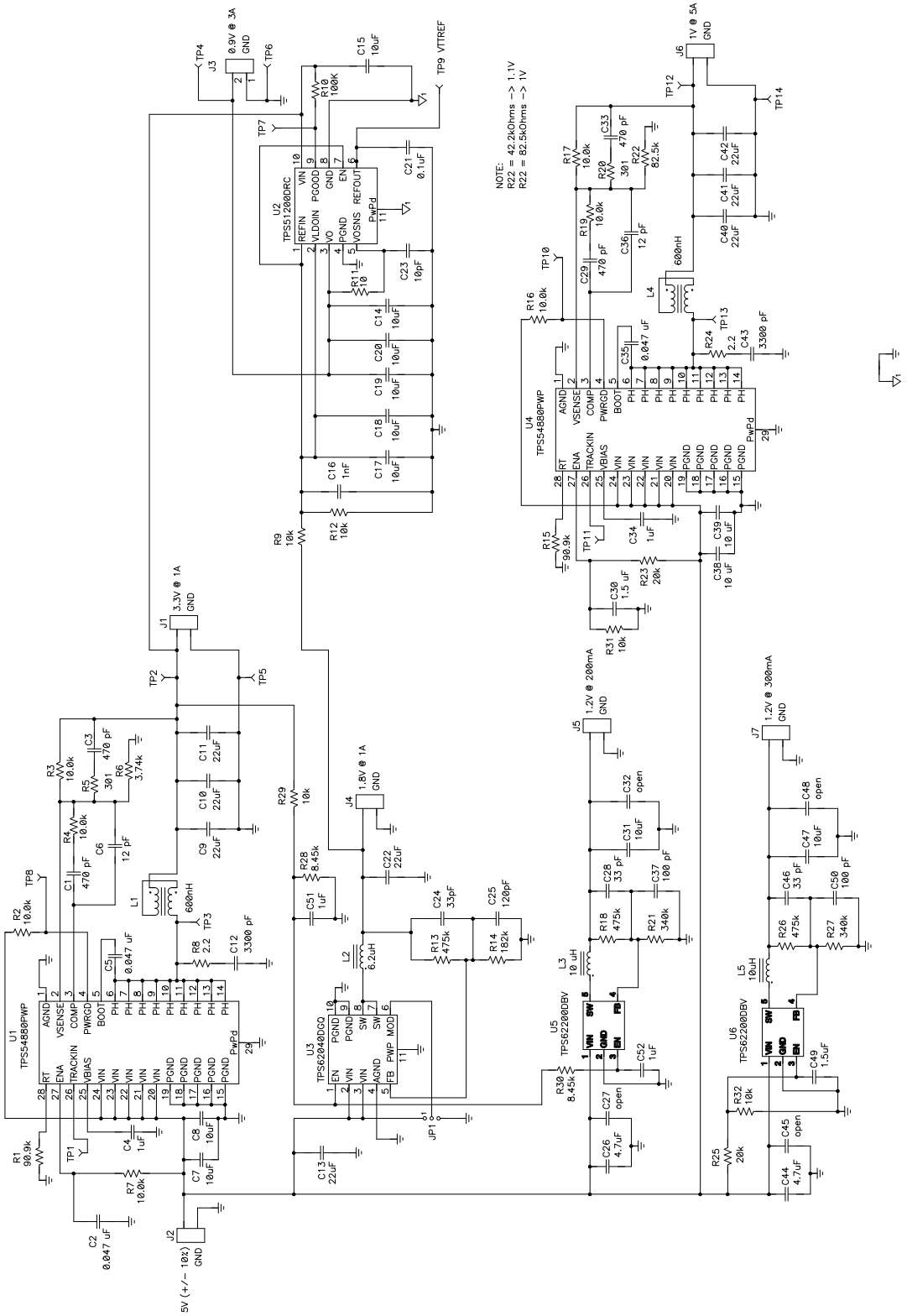

Figure 1. Schematic

5 Bill of Materials

Table 3. PMP5176 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
4	C1	470 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
3	C2	0.047 μF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C3	470 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C4	1.0 μF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C5	0.047 μF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C6	12 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
4	C7	10 μF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C8	10 μF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
6	C9	22 μF	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
	C10	22 F	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
	C11	22 F	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
2	C12	3300 pF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C13	22 F	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
	C14	10 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C15	10 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
1	C16	1 NF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C17	10 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C18	10 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C19	10 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C20	10 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
1	C21	0.1 F	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
	C22	22 F	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
1	C23	10 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C24	33 pF	Capacitor, Ceramic, 50V, C0G, 5%	0805	Std	Std
1	C25	120 pF	Capacitor, Ceramic, 50V, C0G, 5%	0805	Std	Std
2	C26	4.7 F	Capacitor, Ceramic, 10V, X5R, 20%	0805	Std	Std
2	C27	open	Capacitor, Ceramic	0805	Std	Std
2	C28	33 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C29	470 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
2	C30	1.5 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
7	C31	10 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
2	C32	open	Capacitor, Ceramic	1210	Std	Std
	C33	470 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C34	1 F	Capacitor, Ceramic, 25V, X5R, 10%	0603	Std	Std
	C35	0.047 F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C36	12 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
2	C37	100 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C38	10 F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C39	10 F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C40	22 F	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
	C41	22 F	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
	C42	22 F	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
	C43	3300 pF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C44	4.7 F	Capacitor, Ceramic, 10V, X5R, 20%	0805	Std	Std
	C45	open	Capacitor, Ceramic	0805	Std	Std
	C46	33 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C47	10 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C48	open	Capacitor, Ceramic	1210	Std	Std
	C49	1.5 F	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std

Table 3. PMP5176 Bill of Materials (continued)

Count	RefDes	Value	Description	Size	Part Number	MFR
	C50	100 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
2	C51	1 F	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
	C52	1 F	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
6	J1	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OT
	J2	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OT
1	J3	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 × 0.25 inch	ED555/2DS	OT
	J4	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OT
	J5	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OT
	J6	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OT
	J7	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OT
1	JP1		Header, 3-pin, 100mil spacing, (36-pin strip)	0.100 × 3"	PTC36SAAN	Sullies
2	L1	600 NH	Inductor, SMT, 2.53mΩ, 12.6A sat,10.7A rms	0.340 × 0.250	PA0277	Pulse
1	L2	6.2 μH	Inductor, SMT, 45mΩ, 1.8A rms	0.224",CDRH5D28-6R2"	Sumida	
2	L3	10 μH	Inductor, SMD, 128mΩ, 1A rms	0.185 × 0.185	CDRH4D28-100	Sumida
	L4	600 nH	Inductor, SMT, 2.53mΩ, 12.6A sat,10.7A rms	0.340 × 0.250	PA0277	Pulse
	L5	10 μH	Inductor, SMD, 128mΩ, 1A rms	0.185 × 0.185	CDRH4D28-100	Sumida
1	R1	90.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	R2	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R3	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R4	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R5	301	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R6	3.74k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R7	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R8	2.2	Resistor, Chip, 2.2-Ω, 1/4-W, 1%	1206	ERJ-8RQF2R2	Panasonic
1	R9	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R10	100K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R11	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R12	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R13	475k	Resistor, Chip, 1/10W, 1%	0805	Std	Std
1	R14	182k	Resistor, Chip, 1/10W, 1%	0805	Std	Std
1	R15	90.9k	Resistor, Chip, 90.9 kΩ, 1/16-W, 1%	0603	Std	Std
1	R16	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R17	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R18	475k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R19	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R20	301	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R21	340k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R22	82.5k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R23	20k	Resistor, Chip, 10.0 kΩ, 1/16-W, 1%	0603	Std	Std
	R24	2.2	Resistor, Chip, 2.2-Ω, 1/4-W, 1%	1206	ERJ-8RQF2R2	Panasonic
1	R25	20k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R26	475k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
	R27	340k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	R28	8.45k	Resistor, Chip, 1/10W, 1%	0805	Std	Std
1	R29	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R30	8.45k	Resistor, Chip, 1/10W, 1%	0805	Std	Std
1	R31	10k	Resistor, Chip, 10.0 kΩ, 1/16W, 1%	0603	Std	Std
1	R32	10k	Resistor, Chip, 1/10W, 1%	0805	Std	Std
1	SH1		Short jumper			
8	TP1		Test Point, Red, 1mm	0.038", 240–345"	Farnell	
	TP2		Test Point, Red, 1mm	0.038", 240–345"	Farnell	

Table 3. PMP5176 Bill of Materials (continued)

Count	RefDes	Value	Description	Size	Part Number	MFR
	TP3		Test Point, Red, 1mm	0.038", 240–345"	Farnell	
2	TP4	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
2	TP5		Test Point, Black, 1mm	0.038", 240–333"	Farnell	
1	TP6	5011	Test Point, Black, Thru Hole	0.125 × 0.125 inch	5011	Keystone
1	TP7	5012	Test Point, White, Thru Hole	0.125 × 0.125 inch	5012	Keystone
	TP8		Test Point, Red, 1mm	0.038", 240–345"	Farnell	
	TP9	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP10		Test Point, Red, 1mm	0.038", 240–345"	Farnell	
	TP11		Test Point, Red, 1mm	0.038", 240–345"	Farnell	
	TP12		Test Point, Red, 1mm	0.038", 240–345"	Farnell	
	TP13		Test Point, Red, 1mm	0.038", 240–345"	Farnell	
	TP14		Test Point, Black, 1mm	0.038", 240–333"	Farnell	
2	U1	TPS54880PWP	IC, 4-6V Input, 8-A Output Tracking Sync. Buck PWM Switcher w/Integrated FETs	HTSSOP-28	TPS54880PWP	TI
1	U2	TPS51200DRC	IC, Sink/Source DDR Termination Regulator	DRC	TPS51200DRC	TI
1	U3	TPS62040DGQ	IC, High-Efficiency Step-Down Low Power DC-DC Converter, Adj V	DGS10	TPS62040DGQ	TI
	U4	TPS54880PWP	IC, 4-6V Input, 8-A Output Tracking Sync. Buck PWM Switcher w/Integrated FETs	HTSSOP-28	TPS54880PWP	TI
2	U5	TPS62200DBV	IC, Switching Buck Converter, 1.8-V, 300-mA	SOT23-5		TI
	U6	TPS62200DBV	IC, Switching Buck Converter, 1.8-V, 300-mA	SOT23-5		TI

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. Reference designators marked with an asterisk ('**') cannot be substituted. All other components can be substituted with equivalent MFG's components.

6 Power-Up Waveforms

CH1 – Vout 4, CH2 – DDR termination, CH3 – Vout 5, CH4 – Vout 3
(2 V/div, 1 V/div, 1 V/div, 2 V/div, 4 ms/div)

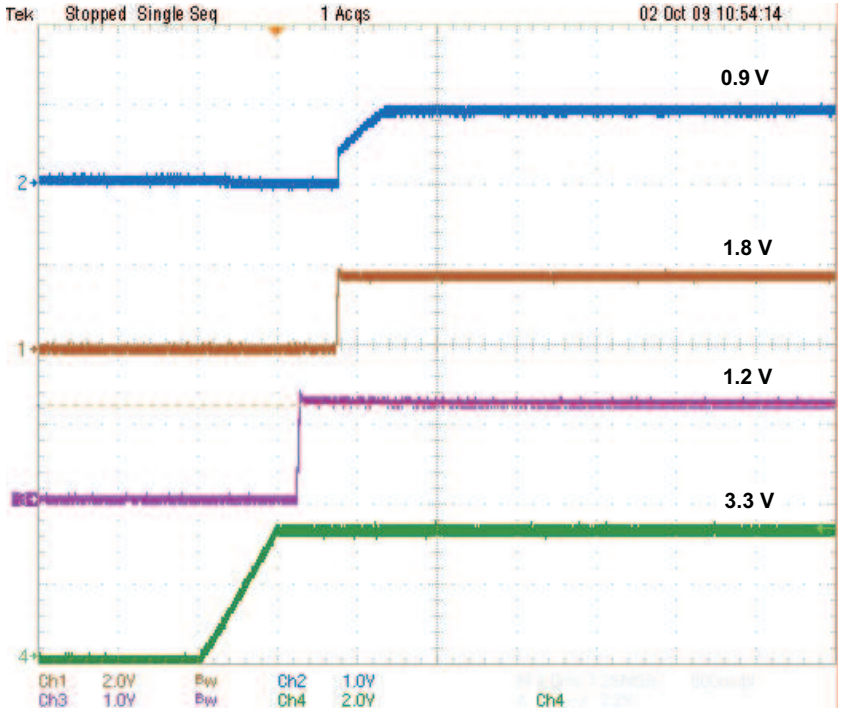

Figure 2. Power-Up Waveform, Part 1

CH1 – Vout 2, CH2 – Vout 1, CH3 – Vout 5, CH4 – Vout 3
(1 V/div, 1 V/div, 1 V/div, 1 V/div 4 ms/div)

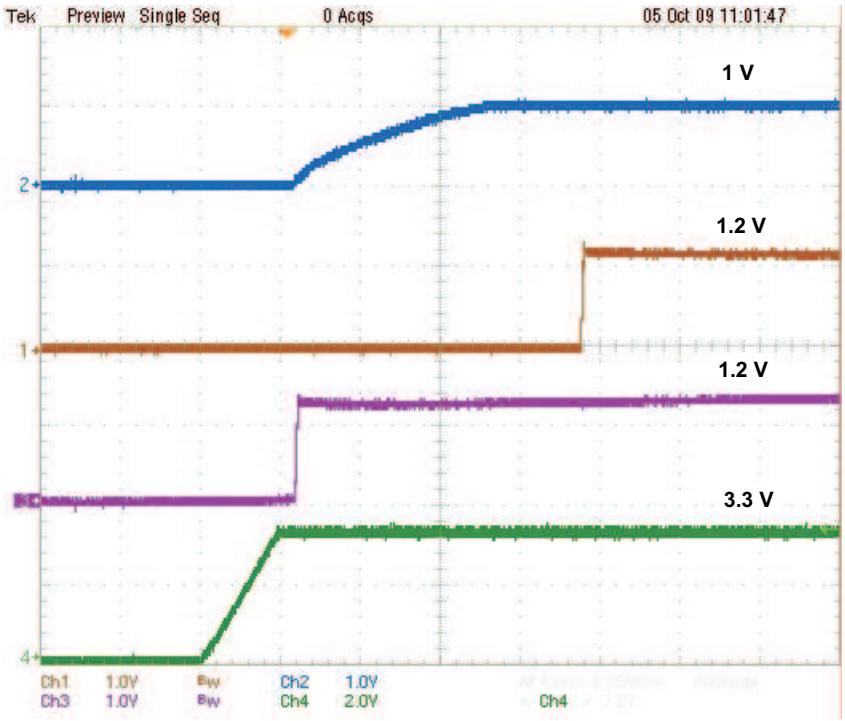

Figure 3. Power-Up Waveform, Part 2

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