Power Reference Design for the TMS320C6472, 12-Vin DC/DC Controllers, and LDOs (1x C6472)

This reference design is intended for designers who wish to design a TMS320C6472 Digital Signal Processor into a system using a nominal input voltage of 12 V, external FETs for design flexibility, and low-dropout (LDO) regulators for the low-power rails.

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1 Introduction

This reference design is for powering one TMS320C6472 Digital Signal Processor and accounts for voltage and current requirements 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 may also 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

Power Supply Specifications:	
Vin	12 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 200 mA
DDR Termination	0.9 V at 3 A

3   Device Features

TPS40192 DC/DC Buck Controller

- Input Operating Voltage Range: 4.5 V to 18 V
- Up to 20-A Output Currents
- Supports Prebiased 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

TPS72012 Single-Channel, Low-Dropout Regulator

- 350-mA, High-Performance LDO
- Low Quiescent Current: 38 μA
- Excellent Load Transient Response:
    - ±15 mV for ILOAD = 0 mA to 350 mA in 1 μs
- Excellent Line Transient Response:
    - VOUT = ±2 mV for VBIAS = ±600 mV in 1 μs
    - VOUT = ±200 μV for VIN = ±400 mV in 1 μs
- Low Noise: 48 μVRMS (10 Hz to 100 kHz)
- 80-dB VIN PSRR (10 Hz to 10 kHz), 70-dB VBIAS PSRR (10 Hz to 10 kHz)
- Fast Start-Up Time: 140 μs
- Built-In Soft-Start With Monotonic VOUT Rise and Start-Up Current Limited to 100 mA + ILOAD
- Overcurrent and Thermal Protection
- Low Dropout: 110 mV at ILOAD = 350 mA
- Stable With 2.2-μF Output Capacitor

TPS51200 Single-Channel, Low-Dropout Regulator

- 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
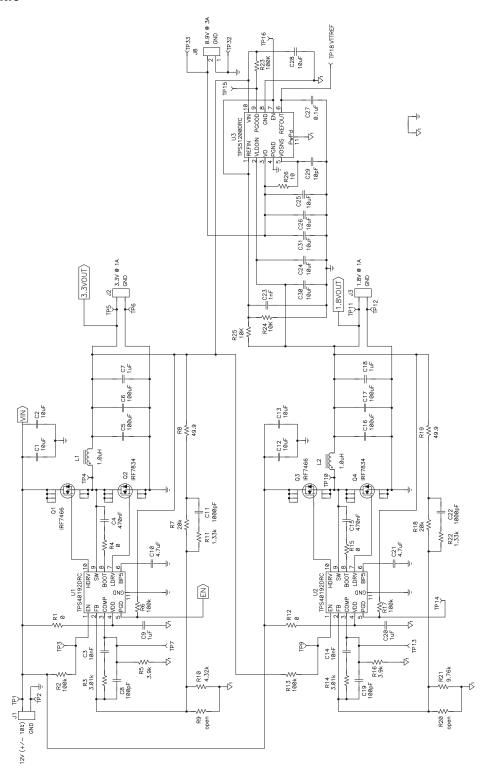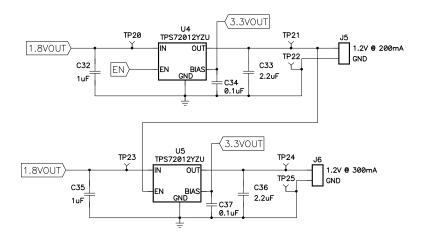
4 Schematic

Figure 1. Schematic, 1 of 2

Power Reference Design for the TMS320C6472, 12-Vin DC/DC Controllers, and LDOs (1x C6472)

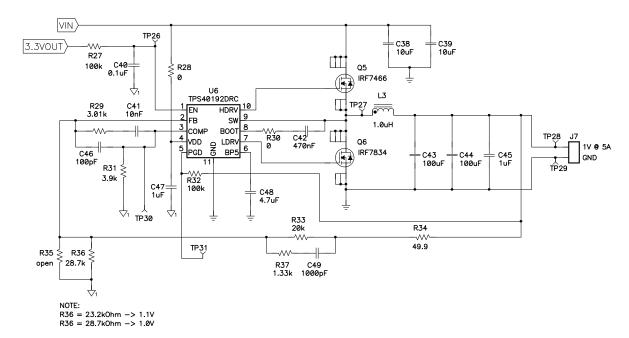Copyright © 2010, Texas Instruments Incorporated

Figure 2. Schematic, 2 of 2

5   Bill of Materials

Table 3. PMP5176.1 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
6	C1	10 µF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C2	10 µF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
3	C3	10 nF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C4	470 nF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
6	C5	100 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C6	100 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
5	C7	1 µF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
3	C8	100 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C9	1 µF	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
2	C10	4.7 µF	Capacitor, Ceramic, 16V, X5R, 20%	0805	Std	Std

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Table 3. PMP5176.1 Bill of Materials (continued)

Count	RefDes	Value	Description	Size	Part Number	MFR
3	C11	1000 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C12	10 µF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C13	10 µF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C14	10 nF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C15	470 nF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C16	100 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C17	100 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C18	1 µF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C19	100 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C20	1.0 µF	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
	C21	4.7 µF	Capacitor, Ceramic, 16V, X5R, 20%	0805	Std	Std
	C22	1000 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C23	1 nF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
6	C24	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C25	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C26	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
3	C27	0.1 µF	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
	C28	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
1	C29	10 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C30	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C31	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C32	1 µF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
2	C33	2.2 µF	Capacitor, Ceramic, 10V, X5R, 20%	0603	Std	Std
	C34	0.1 µF	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
	C35	1 µF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C36	2.2 µF	Capacitor, Ceramic, 10V, X5R, 20%	0603	Std	Std
	C37	0.1 µF	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
	C38	10 µF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C39	10 µF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
1	C40	0.1 µF	Capacitor, Ceramic, 25V, X7R, 10%	0805	Std	Std
	C41	10 nF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
1	C42	470 nF	Capacitor, Ceramic, 10V, X5R, 20%	0603	Std	Std
	C43	100 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C44	100 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C45	1 µF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C46	100 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C47	1 µF	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
1	C48	4.7 µF	Capacitor, Ceramic, 10V, X5R, 20%	0805	Std	Std
	C49	1000 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
6	J1	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OST
	J2	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OST
	J3	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OST
	J5	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OST
	J6	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OST
	J7	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 × 0.35 inch	ED1609	OST
1	J8	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 × 0.25 inch	ED555/2DS	OST
3	L1	1.0 µH	Inductor, SMT, 7.2 mΩ, 17A sat, 12A rms	0.268 × 0.268 inch	PG0083.102	Pulse
	L2	1.0 µH	Inductor, SMT, 7.2 mΩ, 17A sat, 12A rms	0.268 × 0.268 inch	PG0083.102	Pulse
	L3	1.0 µH	Inductor, SMT, 7.2 mΩ, 17A sat, 12A rms	0.268 × 0.268 inch	PG0083.102	Pulse
3	Q1	IRF7466	FET, N-Chan, 30V, 17 mΩ at 4.5V, 23nC at 4.5V	SO8	IRF7466	IR
3	Q2	IRF7834	FET, N-Chan, 30V, 5.5 mΩ at 4.5V, 44nC at 4.5V	SO8	IRF7834	IR

Power Reference Design for the TMS320C6472, 12-Vin DC/DC Controllers, and LDOs (1x C6472)

Table 3. PMP5176.1 Bill of Materials (continued)

Count	RefDes	Value	Description	Size	Part Number	MFR
	Q3	IRF7466	FET, N-Chan, 30V, 17 mΩ at 4.5V, 23nC at 4.5V	SO8	IRF7466	IR
	Q4	IRF7834	FET, N-Chan, 30V, 5.5 mΩ at 4.5V, 44nC at 4.5V	SO8	IRF7834	IR
	Q5	IRF7466	FET, N-Chan, 30V, 17 mΩ at 4.5V, 23nC at 4.5V	SO8	IRF7466	IR
	Q6	IRF7834	FET, N-Chan, 30V, 5.5 mΩ at 4.5V, 44nC at 4.5V	SO8	IRF7834	IR
5	R1	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
7	R2	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	R3	3.01k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R4	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	R5	3.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R6	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	R7	20k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	R8	49.9	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	R9	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R10	4.32k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	R11	1.33k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R12	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R13	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R14	3.01k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R15	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R16	3.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R17	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R18	20k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R19	49.9	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R20	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R21	9.76k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R22	1.33k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R23	100K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R24	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R25	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R26	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R27	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R28	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R29	3.01k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R30	0	Resistor, Chip, 1/16W, 5%	0603	Std	Std
	R31	3.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R32	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R33	20k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R34	49.9	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R35	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R36	28.7k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R37	1.33k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	SH1		Short jumper			
	SH2		Short jumper			
18	TP1	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
7	TP2	5011	Test Point, Black, Thru Hole	0.125 x 0.125 inch	5011	Keystone
	TP3	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP4	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP5	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP6	5011	Test Point, Black, Thru Hole	0.125 x 0.125 inch	5011	Keystone
5	TP7	5012	Test Point, White, Thru Hole	0.125 x 0.125 inch	5012	Keystone
	TP9	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone

Table 3. PMP5176.1 Bill of Materials (continued)

Count	RefDes	Value	Description	Size	Part Number	MFR
	TP10	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP11	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP12	5011	Test Point, Black, Thru Hole	0.125 × 0.125 inch	5011	Keystone
	TP13	5012	Test Point, White, Thru Hole	0.125 × 0.125 inch	5012	Keystone
	TP14	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP15	5012	Test Point, White, Thru Hole	0.125 × 0.125 inch	5012	Keystone
	TP16	5012	Test Point, White, Thru Hole	0.125 × 0.125 inch	5012	Keystone
	TP18	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP20	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP21	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP22	5011	Test Point, Black, Thru Hole	0.125 × 0.125 inch	5011	Keystone
	TP23	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP24	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP25	5011	Test Point, Black, Thru Hole	0.125 × 0.125 inch	5011	Keystone
	TP26	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP27	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP28	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP29	5011	Test Point, Black, Thru Hole	0.125 × 0.125 inch	5011	Keystone
	TP30	5012	Test Point, White, Thru Hole	0.125 × 0.125 inch	5012	Keystone
	TP31	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
	TP32	5011	Test Point, Black, Thru Hole	0.125 × 0.125 inch	5011	Keystone
	TP33	5010	Test Point, Red, Thru Hole	0.125 × 0.125 inch	5010	Keystone
3	U1	TPS40192DRC	IC, Cost Optimized Mid Vin High Freq. Sync. Buck controller	DRC10	TPS40192DRC	TI
	U2	TPS40192DRC	IC, Cost Optimized Mid Vin High Freq. Sync. Buck controller	DRC10	TPS40192DRC	TI
1	U3	TPS51200DRC	IC, Sink/Source DDR Termination Regulator	DRC	TPS51200DRC	TI
2	U4	TPS72012YZU	IC, LDO Linear Regulator With Bias Pin, 350mA	WCSP-5	TPS72012YZU	TI
	U5	TPS72012YZU	IC, LDO Linear Regulator With Bias Pin, 350mA	WCSP-5	TPS72012YZU	TI
	U6	TPS40192DRC	IC, Cost Optimized Mid Vin High Freq. Sync. Buck controller	DRC10	TPS40192DRC	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.
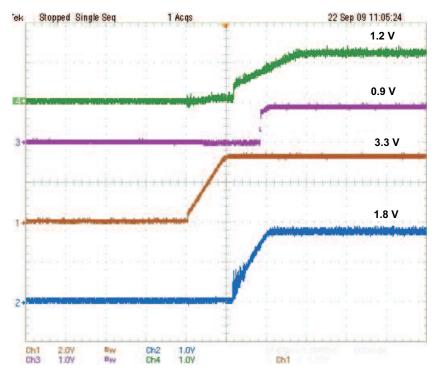Clean flux must be used.

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   12-Vin, DC/DC Controllers and LDOs (1x C6472)

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

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

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		Wireless	www.ti.com/wireless-apps