

# **TMS320C6472 5-V Input Power Design, Integrated FET DC/DC Converters and Controllers (8x C6472)**

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This reference design is intended for designers who wish to design up to eight TMS320C6472 Digital Signal Processors (DSP) into a system using a nominal input voltage of 5 V, with a flexible design using external FETs, and low-dropout (LDO) regulators for the low-power rails.

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## 1 Introduction

This reference design is for powering up to eight TMS320C6472 DSPs 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) per TMS320C6472, 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 DSP are listed in [Table 1](#).

For more information and other reference designs, visit [www.ti.com/processorpower](http://www.ti.com/processorpower).

**Table 1. TMS320C6472<sup>(1)</sup> Power Requirements**

Core, I/O	Pin Name	Voltage (V)	I <sub>max</sub> (mA)	Tolerance	Sequencing Order	Timing Delay
Core	CVDD, CVDD2 <sup>(2)</sup>	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 <sup>(3)</sup> , DVDD15	1.8 <sup>(4)</sup>	150	±5		
Analog	AVDDA1, AVDDA2, AVDDA3, DVDDD	1.8 <sup>(4)</sup>	190	±5	3	<200 ms
	AVDDA, DVDDD, AVDDT, AVDDA4, DVDDR	1.2	170	±5		

<sup>(1)</sup> Consult the TMS320C6472 power spreadsheet for your exact power requirements.

<sup>(2)</sup> CVDD and CVDD2 are 1 V @ 500 MHz, 1.1 V @ 625 MHz (I<sub>max</sub> = 4900 mA), and 1.2 V @ 700 MHz (I<sub>max</sub> = 9500 mA).

<sup>(3)</sup> DVDD18 voltage rail includes power is required for external DDR2 memory.

<sup>(4)</sup> 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 specs:	
V <sub>in</sub>	12 V ± 10%
V <sub>out1</sub>	1 V ± 5% at 40 A
V <sub>out2</sub>	1.2 V ± 5% at 2.4 mA
V <sub>out3</sub>	3.3 V ± 5% at 8 A
V <sub>out4</sub>	1.8 V ± 5% at 8 A
V <sub>out5</sub>	1.2 V ± 5% at 1.6 mA
DDR Termination	0.9 V at 3 A (x8)

### 3 Device Features

#### TPS40131

- Two-Phase Interleaved Operation
- Operates With Pre-Biased Outputs
- 1-V to 40-V Power Stage Operation Range
- 10- $\mu$ A Shutdown Current
- Programmable Switching Frequency up to 1 MHz/Phase
- Current Mode Control with Forced Current Sharing
- Better than 1% Internal 0.7-V Reference
- Programmable Input Undervoltage Lockout
- True Remote Sensing Differential Amplifier

#### TPS40192

- 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

#### TPS74401

- Soft-Start (SS) Pin Provides a Linear Start-Up With Ramp Time Set by External Capacitor
- 1% Accuracy Over Line, Load, and Temperature
- Supports Input Voltages as Low as 0.9 V With External Bias Supply
- Adjustable Output (0.8 V to 3.6 V)
- Ultralow Dropout: 115 mV at 3 A (typ)
- Stable With Any or No Output Capacitor
- Available in 5-mm  $\times$  5-mm  $\times$  1-mm QFN and DDPACK-7 Packages

#### 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- $\mu$ F (Typically 3  $\times$  10- $\mu$ F MLCCs) for Memory Termination Applications (DDR)
- PGOOD to Monitor Output Regulation and Remote Sensing (VOSNS)
- $\pm$ 10-mA Buffered Reference (REFOUT)
- Meets DDR, DDR2 JEDEC Specifications; Supports DDR3 and Low-Power DDR3/DDR4 VTT Applications

4 Schematics

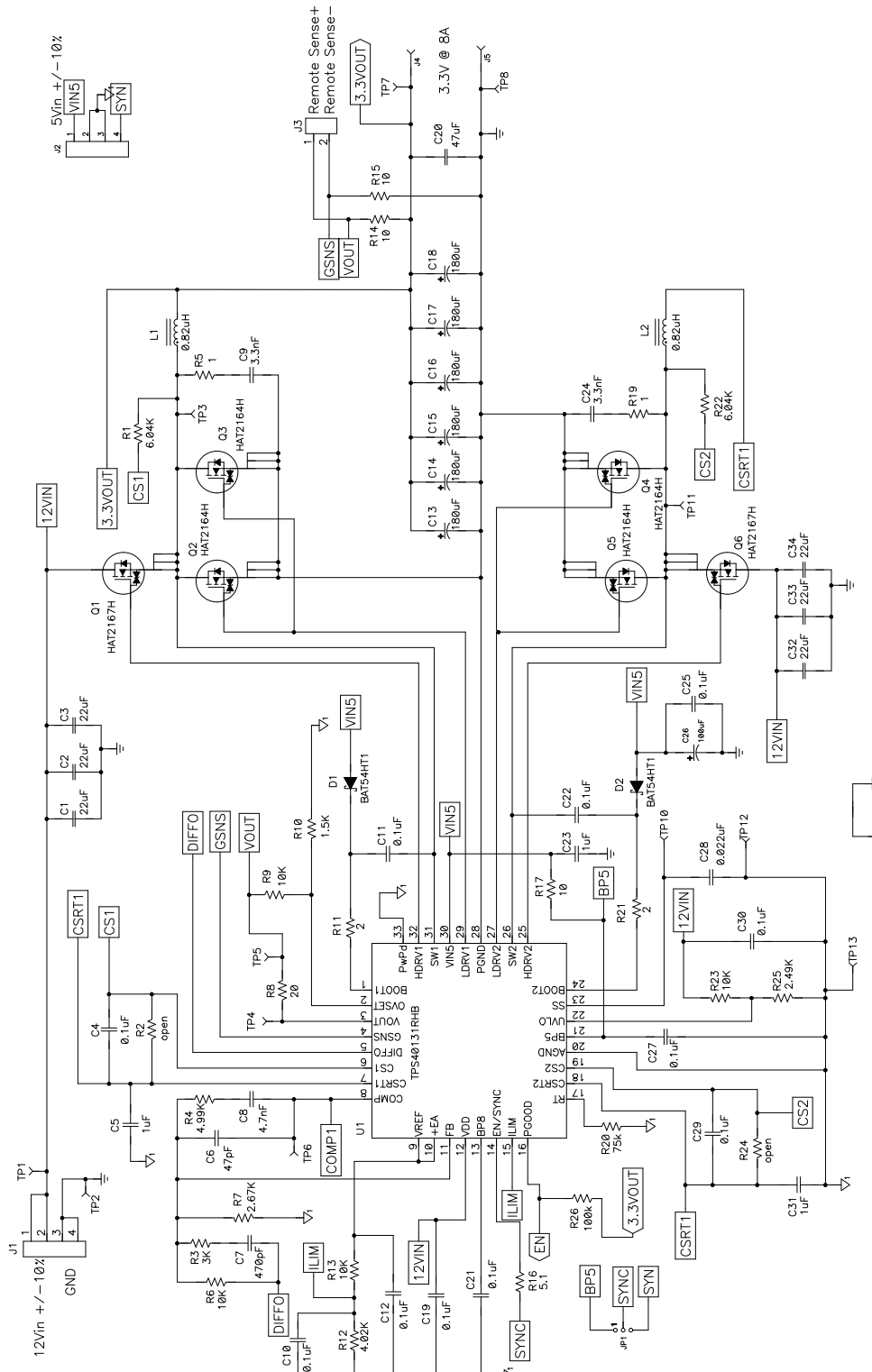


Figure 1. Schematic, 1 of 4

Repeat this block 7 more times for a total of 8 DDR termination blocks.

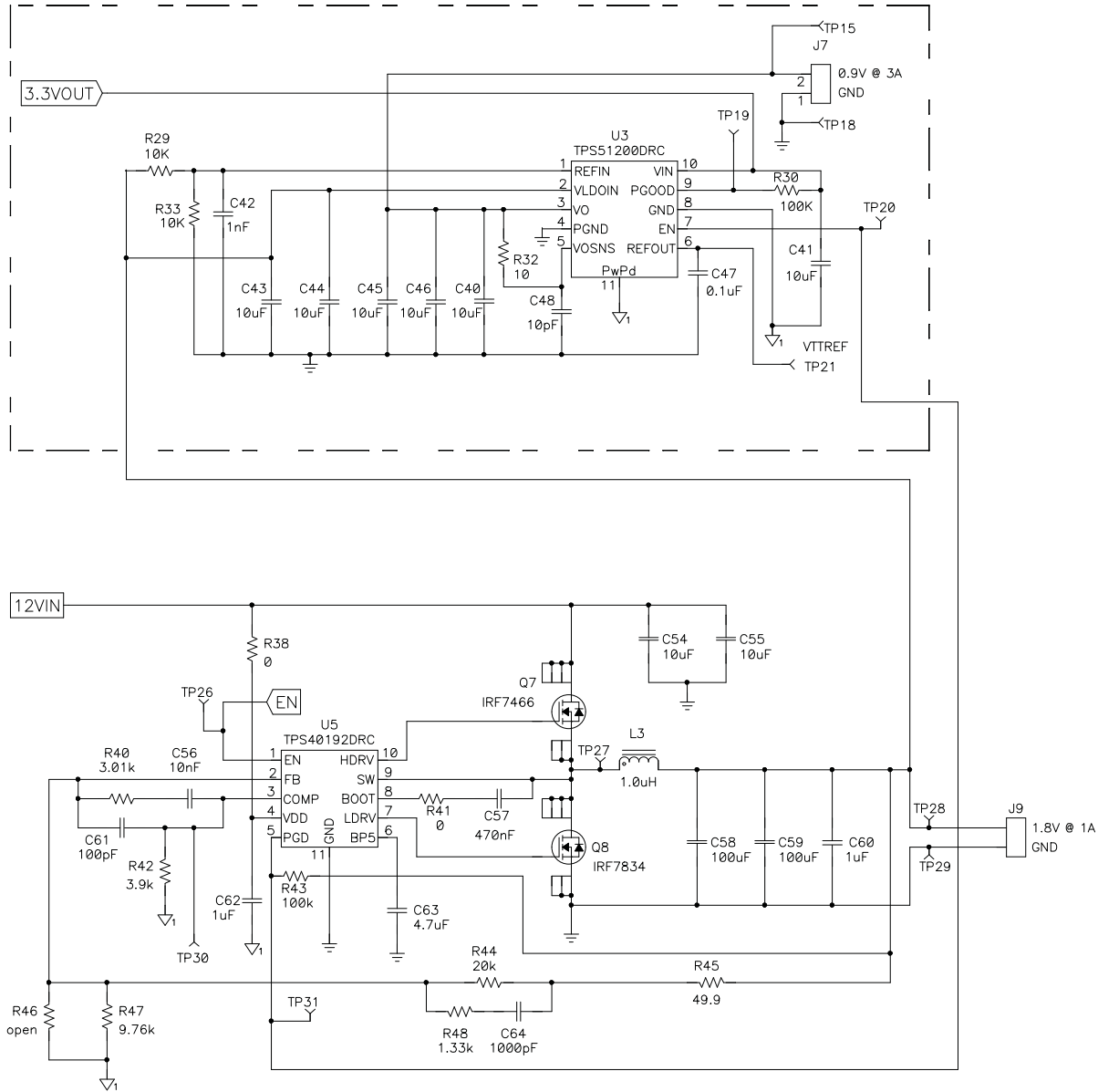


Figure 2. Schematic, 2 of 4

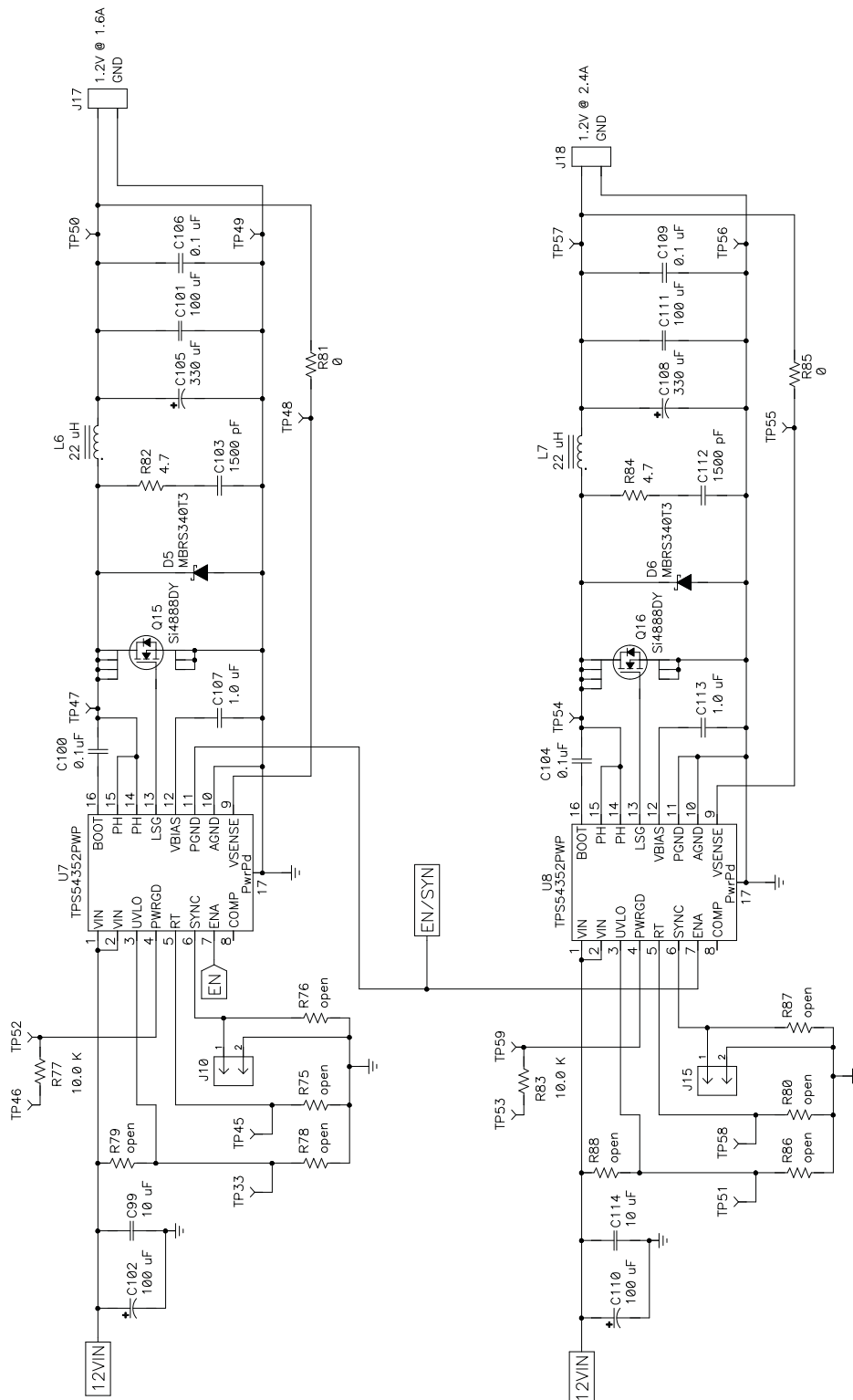


Figure 3. Schematic, 3 of 4

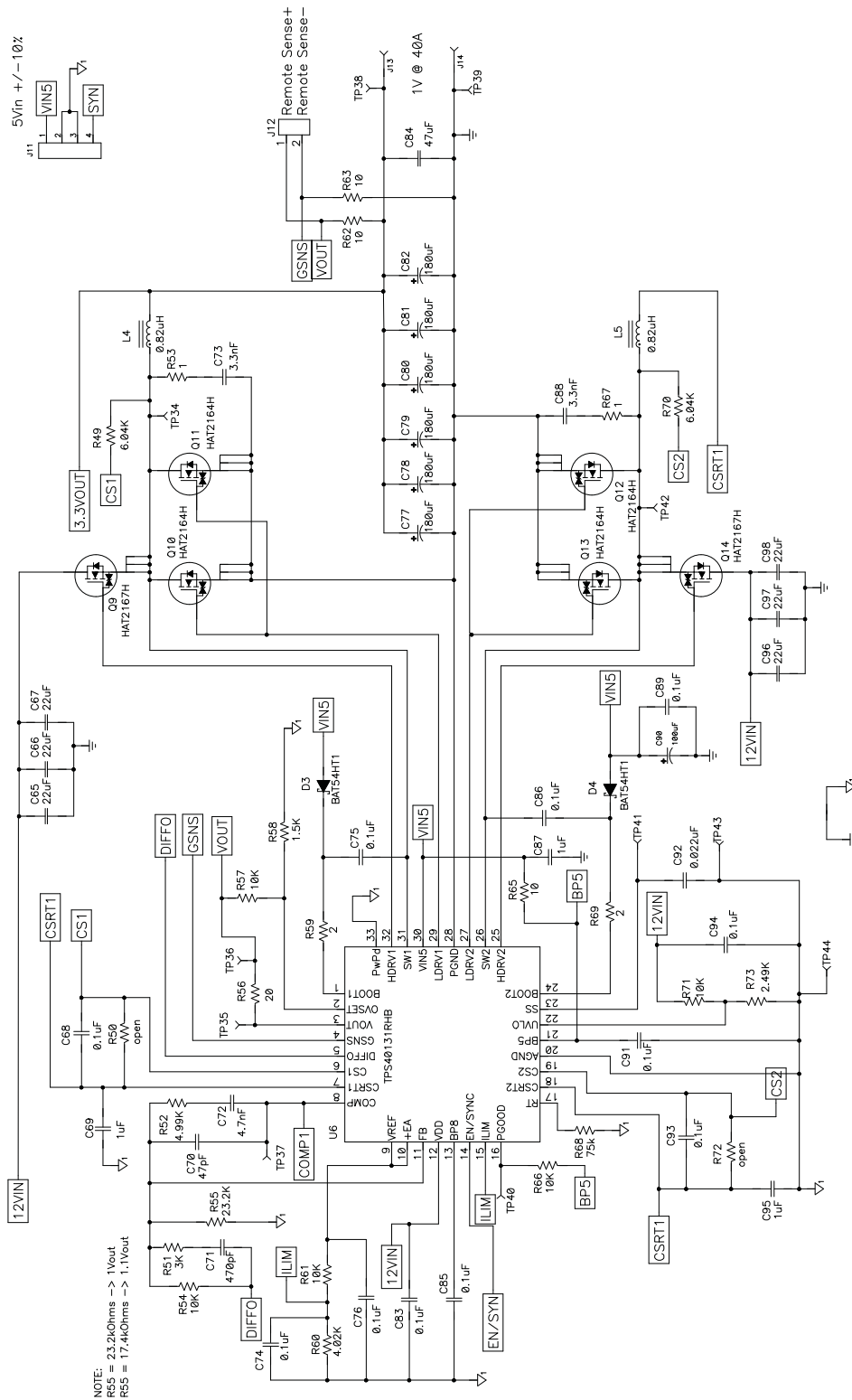


Figure 4. Schematic, 4 of 4

## 5 Bill of Materials

**Table 3. PMP5176 Bill of Materials**

Count	RefDes	Value	Description	Size	Part Number	MFR
12	C1	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C2	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C3	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C4	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C5	1 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
2	C6	47 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
2	C7	470 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
2	C8	4.7 nF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
4	C9	3.3 nF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C10	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C11	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C12	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
12	C13	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C14	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C15	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C16	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C17	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C18	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C19	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C20	47 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C21	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C22	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
7	C23	1 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C24	3.3 nF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
23	C25	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C26	100 $\mu$ F	Capacitor, Aluminum, 16V, 360m $\Omega$ , 240mA ripple	0.260 x 0.276 inch	EEEFK1C101P	Panasonic
	C27	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C28	0.022 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C29	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C30	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C31	1 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C32	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C33	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C34	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
6	C40	10 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C41	10 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
1	C42	1 nF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C43	10 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C44	10 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C45	10 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C46	10 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
	C47	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
1	C48	10 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
2	C54	10 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C55	10 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
1	C56	10 nF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
1	C57	470 nF	Capacitor, Ceramic, 10V, X5R, 20%	0603	Std	Std
2	C58	100 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C59	100 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std



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

Count	RefDes	Value	Description	Size	Part Number	MFR
	C60	1 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
1	C61	100 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	C62	1 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
1	C63	4.7 $\mu$ F	Capacitor, Ceramic, 10V, X5R, 20%	0805	Std	Std
1	C64	1000 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C65	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C66	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C67	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
2	C68	0.1 $\mu$ F	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
	C69	1 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C70	47 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C71	470 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C72	4.7 nF	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C73	3.3 nF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C74	0.1 $\mu$ F	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
	C75	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C76	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C77	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C78	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C79	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C80	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C81	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C82	180 $\mu$ F	Capacitor, SP-Cap, 6.3V, 5m $\Omega$	7343	EEF-SE0J181R	Panasonic
	C83	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C84	47 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C85	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C86	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C87	1 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C88	3.3 nF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C89	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C90	100 $\mu$ F	Capacitor, Aluminum, 16V, 360m $\Omega$ , 240mA ripple	0.260 x 0.276 inch	EEEFK1C101P	Panasonic
	C91	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C92	0.022 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C93	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C94	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C95	1 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
	C96	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C97	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C98	22 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
2	C99	10 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
	C100	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C101	100 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
2	C102	100 $\mu$ F	Capacitor, Aluminum, 16V, 360m $\Omega$ , 240mA ripple	8x10mm	EEEFK1C101P	Panasonic
2	C103	1500 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C104	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C105	330 $\mu$ F	Capacitor, Aluminum, 6.3V, 20%, 340m $\Omega$ , 280mA ripple	0.268 x 0.307	EEEFK0J331XP	Panasonic
2	C106	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
2	C107	1.0 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
	C108	330 $\mu$ F	Capacitor, Aluminum, 6.3V, 20%, 340m $\Omega$ , 280mA ripple	0.268 x 0.307	EEEFK0J331XP	Panasonic
	C109	0.1 $\mu$ F	Capacitor, Ceramic, 50V, X7R, 10%	0603	Std	Std
	C110	100 $\mu$ F	Capacitor, Aluminum, 16V, 360m $\Omega$ , 240mA ripple	8x10mm	EEEFK1C101P	Panasonic

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

Count	RefDes	Value	Description	Size	Part Number	MFR
	C111	100 $\mu$ F	Capacitor, Ceramic, 6.3V, X5R, 20%	1210	Std	Std
	C112	1500 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
	C113	1.0 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	0805	Std	Std
	C114	10 $\mu$ F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
4	D1	BAT54HT1	Diode, Schottky, 30V, 0.35Vf, SOD-323	SOD323	BAT54HT1	On Semi
	D2	BAT54HT1	Diode, Schottky, 30V, 0.35Vf, SOD-323	SOD323	BAT54HT1	On Semi
	D3	BAT54HT1	Diode, Schottky, 30V, 0.35Vf, SOD-323	SOD323	BAT54HT1	On Semi
	D4	BAT54HT1	Diode, Schottky, 30V, 0.35Vf, SOD-323	SOD323	BAT54HT1	On Semi
2	D5	MBRS340T3	Diode, Schottky, 3-A, 40-V	SMC	MBRS340T3	Motorola
	D6	MBRS340T3	Diode, Schottky, 3-A, 40-V	SMC	MBRS340T3	Motorola
1	J1		Terminal Block, 4-pin, 15-A, 5.1mm	0.80 x 0.35	ED2227	OST
2	J2	ED1516	Terminal Block, 4-pin, 6-A, 3.5mm	0.55 x 0.25 inch	ED1516	OST
2	J3	ED1514	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED1514	OST
4	J4	33457	Lug, Solderless, #10 – #10-12 AWG, Copper/Tin, Uninsulated	0.375 x 1.00 inch	33457	AMP
	J5	33457	Lug, Solderless, #10 – #10-12 AWG, Copper/Tin, Uninsulated	0.375 x 1.00 inch	33457	AMP
1	J7	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED555/2DS	OST
1	J9	ED1609-ND	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 x 0.35 inch	ED1609	OST
2	J10	PTC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 x 2	PTC36SAAN	Sullins
	J11	ED1516	Terminal Block, 4-pin, 6-A, 3.5mm	0.55 x 0.25 inch	ED1516	OST
	J12	ED1514	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED1514	OST
	J13	33457	Lug, Solderless, #10 – #10-12 AWG, Copper/Tin, Uninsulated	0.375 x 1.00 inch	33457	AMP
	J14	33457	Lug, Solderless, #10 – #10-12 AWG, Copper/Tin, Uninsulated	0.375 x 1.00 inch	33457	AMP
	J15	PTC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 x 2	PTC36SAAN	Sullins
2	J17	ED1514	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED1514	OST
	J18	ED1514	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED1514	OST
1	JP1		Header, 3-pin, 100mil spacing, (36-pin strip)	0.100 inch x 3	PTC36SAAN	Sullins
2	L1	0.82 $\mu$ H	Inductor, SMT, 0.82 $\mu$ H	0.512 x 0.571 inch	Vishay 0.82 $\mu$ H	Vishay
	L2	0.82 $\mu$ H	Inductor, SMT, 0.82 $\mu$ H	0.512 x 0.571 inch	Vishay 0.82 $\mu$ H	Vishay
1	L3	1.0 $\mu$ H	Inductor, SMT, 7.2m $\Omega$ , 17A sat, 12A rms	0.268 x 0.268 inch	PG0083.102	Pulse
2	L4	0.82 $\mu$ H	Inductor, SMT, 0.82 $\mu$ H, 1.9m $\Omega$ , 50A sat, 33A rms	0.512 x 0.571 inch	IHLP-5050FD-01, 0.82 $\mu$ H	Vishay
	L5	0.82 $\mu$ H	Inductor, SMT, 0.82 $\mu$ H, 1.9m $\Omega$ , 50A sat, 33A rms	0.512 x 0.571 inch	IHLP-5050FD-01, 0.82 $\mu$ H	Vishay
2	L6	22 $\mu$ H	Inductor, SMT, 39m $\Omega$ , 7.5A sat, 4.0A rms	0.492 sq inch	DR127-220	Coiltronics
	L7	22 $\mu$ H	Inductor, SMT, 39m $\Omega$ , 7.5A sat, 4.0A rms	0.492 sq inch	DR127-220	Coiltronics
4	Q1	HAT2167H	MOSFET, N-Ch, 30V, 9.3m $\Omega$ , 17nC	LFPAK	HAT2167H	Hitachi
8	Q2	HAT2164H	MOSFET, N-Ch, 30V, 4.4m $\Omega$ , 50nC	LFPAK	HAT2164H	Hitachi
	Q3	HAT2164H	MOSFET, N-Ch, 30V, 4.4m $\Omega$ , 50nC	LFPAK	HAT2164H	Hitachi
	Q4	HAT2164H	MOSFET, N-Ch, 30V, 4.4m $\Omega$ , 50nC	LFPAK	HAT2164H	Hitachi
	Q5	HAT2164H	MOSFET, N-Ch, 30V, 4.4m $\Omega$ , 50nC	LFPAK	HAT2164H	Hitachi
	Q6	HAT2167H	MOSFET, N-Ch, 30V, 9.3m $\Omega$ , 17nC	LFPAK	HAT2167H	Hitachi
1	Q7	IRF7466	MOSFET, N-Chan, 30V, 17m $\Omega$ , 23nC	SO8	IRF7466	IR
1	Q8	IRF7834	MOSFET, N-Chan, 30V, 5.5m $\Omega$ , 44nC	SO8	IRF7834	IR
	Q9	HAT2167H	MOSFET, N-Ch, 30V, 9.3m $\Omega$ , 17nC	LFPAK	HAT2167H	Hitachi
	Q10	HAT2164H	MOSFET, N-Ch, 30V, 4.4m $\Omega$ , 50nC	LFPAK	HAT2164H	Hitachi
	Q11	HAT2164H	MOSFET, N-Ch, 30V, 4.4m $\Omega$ , 50nC	LFPAK	HAT2164H	Hitachi
	Q12	HAT2164H	MOSFET, N-Ch, 30V, 4.4m $\Omega$ , 50nC	LFPAK	HAT2164H	Hitachi
	Q13	HAT2164H	MOSFET, N-Ch, 30V, 4.4m $\Omega$ , 50nC	LFPAK	HAT2164H	Hitachi
	Q14	HAT2167H	MOSFET, N-Ch, 30V, 9.3m $\Omega$ , 17nC	LFPAK	HAT2167H	Hitachi

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

Count	RefDes	Value	Description	Size	Part Number	MFR
2	Q15	Si4888DY	MOSFET, N-ch, 30V, 10mΩ, 24nC	SO8	Si4888DY	Vishay
	Q16	Si4888DY	MOSFET, N-ch, 30V, 10mΩ, 24nC	SO8	Si4888DY	Vishay
4	R1	6.04K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
13	R2	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R3	3K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R4	4.99K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	R5	1	Resistor, Chip, 1/10W, 1%	0805	Std	Std
11	R6	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R7	2.67K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R8	20	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R9	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R10	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	R11	2	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R12	4.02K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R13	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
7	R14	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R15	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R16	5.1	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R17	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R19	1	Resistor, Chip, 1/10W, 1%	0805	Std	Std
2	R20	75k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R21	2	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R22	6.04K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R23	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R24	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R25	2.49K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	R26	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R29	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R30	100K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R32	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R33	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R38	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R39	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R40	3.01k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R41	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R42	3.9k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R43	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R44	20k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R45	49.9	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R46	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R47	9.76k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R48	1.33k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R49	6.04K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R50	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R51	3K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R52	4.99K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R53	1	Resistor, Chip, 1/10W, 1%	0805	Std	Std
	R54	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R55	23.2K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R56	20	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R57	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std

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

Count	RefDes	Value	Description	Size	Part Number	MFR
	R58	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R59	2	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R60	4.02K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R61	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R62	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R63	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R65	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R66	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R67	1	Resistor, Chip, 1/10W, 1%	0805	Std	Std
	R68	75k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R69	2	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R70	6.04K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R71	10K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R72	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R73	2.49K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R75	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R76	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R77	10.0 K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R78	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R79	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R80	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R81	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R82	4.7	Resistor, Chip, 1/2W, 5%	2010	Std	Std
	R83	10.0 K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R84	4.7	Resistor, Chip, 1/2W, 5%	2010	Std	Std
	R85	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R86	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R87	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	R88	open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	SH1		Short jumper			
	SH2		Short jumper			
	SH3		Short jumper			
16	TP1	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
7	TP2	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
	TP3	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP4	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP5	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP6	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP7	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP8	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
	TP10	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP11	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP12	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
	TP13	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
	TP15	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
2	TP18	5011	Test Point, Black, Thru Hole	0.125 x 0.125 inch	5011	Keystone
	TP19	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP20	5012	Test Point, White, Thru Hole	0.125 x 0.125 inch	5012	Keystone
	TP21	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
15	TP26	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP27	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone

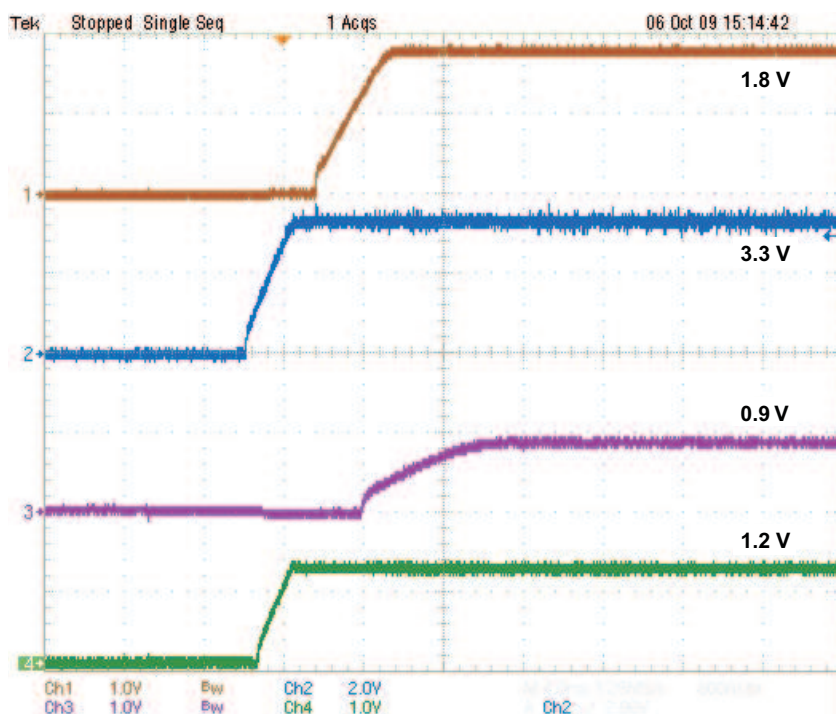
**Table 3. PMP5176 Bill of Materials (continued)**

Count	RefDes	Value	Description	Size	Part Number	MFR
	TP28	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP29	5011	Test Point, Black, Thru Hole	0.125 x 0.125 inch	5011	Keystone
2	TP30	5012	Test Point, White, Thru Hole	0.125 x 0.125 inch	5012	Keystone
	TP31	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
4	TP33		Test Point, Red, 1mm	0.038	240-345	Farnell
	TP34	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP35	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP36	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP37	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP38	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP39	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
	TP40	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP41	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP42	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
	TP43	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
	TP44	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
	TP45		Test Point, Red, 1mm	0.038	240-345	Farnell
	TP46	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP47	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
4	TP48		Test Point, Black, 1mm	0.038	240-333	Farnell
	TP49		Test Point, Black, 1mm	0.038	240-333	Farnell
	TP50	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP51		Test Point, Red, 1mm	0.038	240-345	Farnell
	TP52	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP53	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP54	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP55		Test Point, Black, 1mm	0.038	240-333	Farnell
	TP56		Test Point, Black, 1mm	0.038	240-333	Farnell
	TP57	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
	TP58		Test Point, Red, 1mm	0.038	240-345	Farnell
	TP59	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
2	U1	TPS40131RH B	Two-Phase Synchronous Buck Controller w/Integrated MOSFET Drivers	QFN-32	TPS40131RHB	TI
1	U3	TPS51200DR C	IC, Sink/Source DDR Termination Regulator	DRC	TPS51200DRC	TI
1	U5	TPS40192DR C	IC, Cost Optimized Mid Vin High Freq. Sync. Buck controller	DRC10	TPS40192DRC	TI
	U6	TPS40131RH B	Two-Phase Synchronous Buck Controller w/Integrated MOSFET Drivers	QFN-32	TPS40131RHB	TI
2	U7	TPS54352P WP	3-A Output Synchronous PWM Switcher w/Integrated FET	PWP16	TPS54350PWP	TI
	U8	TPS54352P WP	3-A Output Synchronous PWM Switcher w/Integrated FET	PWP16	TPS54350PWP	TI

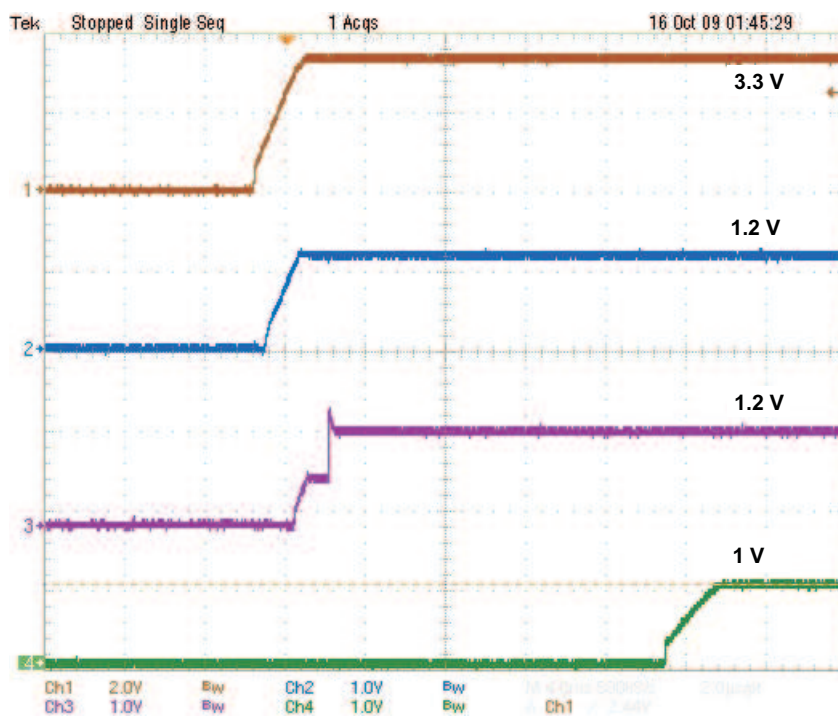
- Notes: 1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants. Use of unclean flux is unacceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with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

## 6 12-Vin, DC/DC Controllers and Converters (8x C6472)

CH1 – Vout 4, CH2 – Vout 3, CH3 – DDR termination, CH4 – Vout 5  
 (1 V/div, 2 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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DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>	Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>	Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Energy	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Space, Avionics & Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>	Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
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