

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 1118A-A POLYPHASE HIGH DENSITY POWER MODULE

LTM4601EV

DESCRIPTION

Demonstration circuit 1118A-A features the LTM[®]4601EV, the high efficiency, high density switch mode step-down power modules. The input voltage range is from 5V to 20V. The output voltages are 3.3V and 2.5V; refer to step down ratio curve in the LTM4601 datasheet. The rated load currents are 10 A for 3.3V output and 12A for 2.5V output, while derating is necessary for certain V_{IN} and thermal conditions. The output of U2 is set to coincidentally track with the 3.3V output. Margining function is provided for the user who wants to stress their system by

varying supply voltages during testing; refer to data-sheet for functional diagram. The DC1118A-A has onboard 180 degree interleaving clock generator at 750 KHz. Integrated input and output filters enable a simple PCB layout. Only bulk input and output capacitors are needed.

Design files for this circuit board are available. Call the LTC Factory.


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Table 1. Performance Summary ($T_A = 25^\circ\text{C}$)

| PARAMETER | CONDITION | VALUE |
|-----------------------------|-------------------------------------------|--------------------------------------|
| Minimum Input Voltage | | 5V |
| Maximum Input Voltage | | 20V |
| Output Voltage V_{OUT1} | $V_{IN} = 5$ to 20V, $I_{OUT} = 0$ to 10A | $3.3V \pm 2\%$ |
| Output Voltage V_{OUT2} | $V_{IN} = 5$ to 20V, $I_{OUT} = 0$ to 12A | $2.5V \pm 2\%$ |
| Default Operating Frequency | | 750kHz |
| Load Transient | $V_{IN} = 12V$, $V_{OUT} = 3.3V$ | See Figure 3 and Table 1 for details |
| | $V_{IN} = 12V$, $V_{OUT} = 2.5V$ | See Figure 4 and Table 1 for details |

QUICK START PROCEDURE

Demonstration circuit 1118A-A is easy to set up to evaluate the performance of the LTM4601EV. Please refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

1. Place jumpers in the following positions for a typical application:

| | | |
|-----|------------------|------------------|
| RUN | U1 & U2 MARG0 | U1 & U2 MARG1 |
| ON | LO | LO |

2. With power off, connect the input power supply, load, and meters as shown in Figure 1. Preset

the load to 0A and V_{IN} supply to be less than 20V.

3. Turn on the power at the input. The output voltage of U1 should be $3.3V \pm 2\%$, while the output voltage of U2 should $2.5V \pm 2\%$.
4. Once the proper output voltage is established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters. When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the V_{IN} or V_{OUT} capacitors. See Figure 2 for proper scope probe technique.

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- For tracking function test, shut down the power supply, discharge the output capacitors until outputs read 0V. Use single trigger of the oscilloscope to capture the input waveform and output waveforms of U1 and U2.
- For Margining function test, place jumper MARG0 and MARG1 in the configurations shown

in the following table, measure the output voltage at Vo+ and Vo-.

| MARG1 | MARG0 | Vout |
|-------|-------|------|
| LO | LO | 0 |
| LO | HI | +5% |
| HI | LO | -5% |
| HI | HI | 0 |

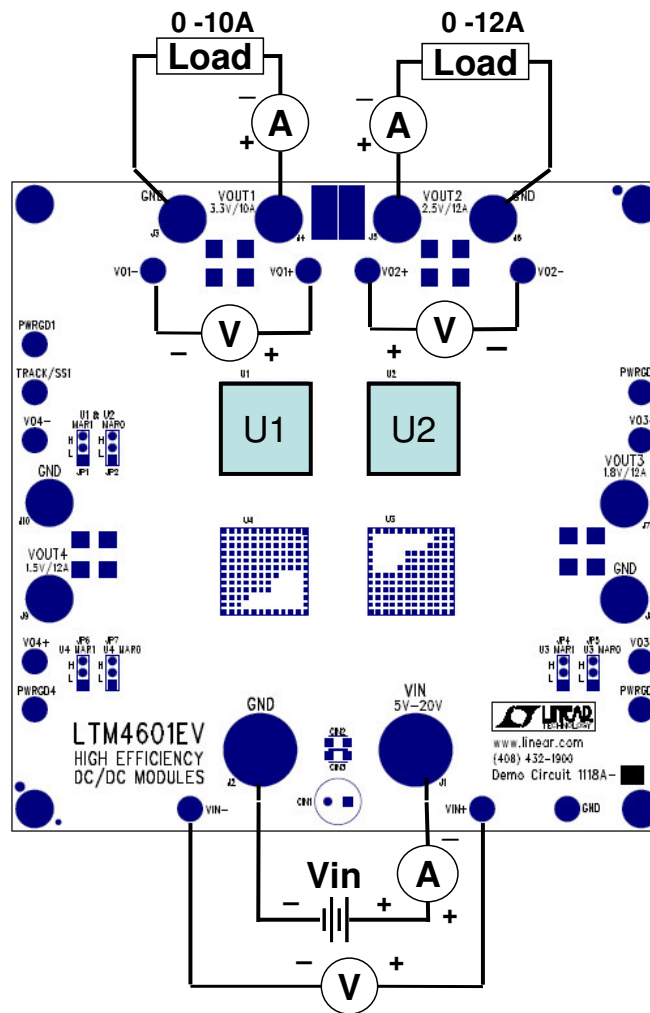
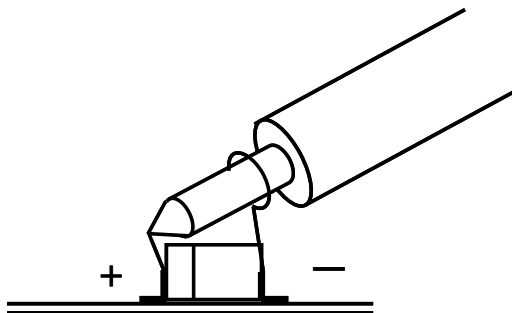


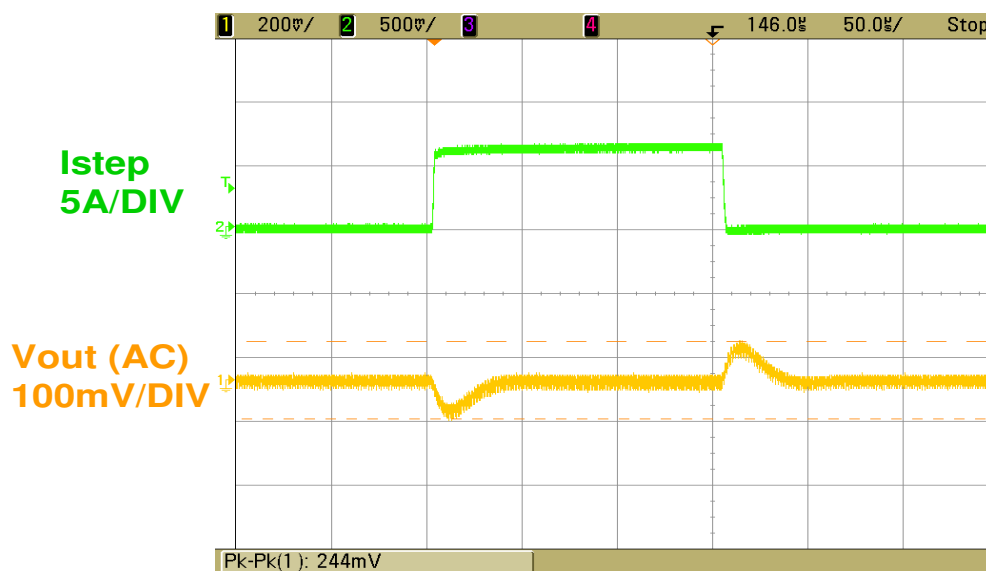
Figure 1. Proper Measurement Equipment Setup

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Input or Output Capacitor

Figure 2. Scope Probe Placements for Measuring Input or Output Ripple on capacitors.



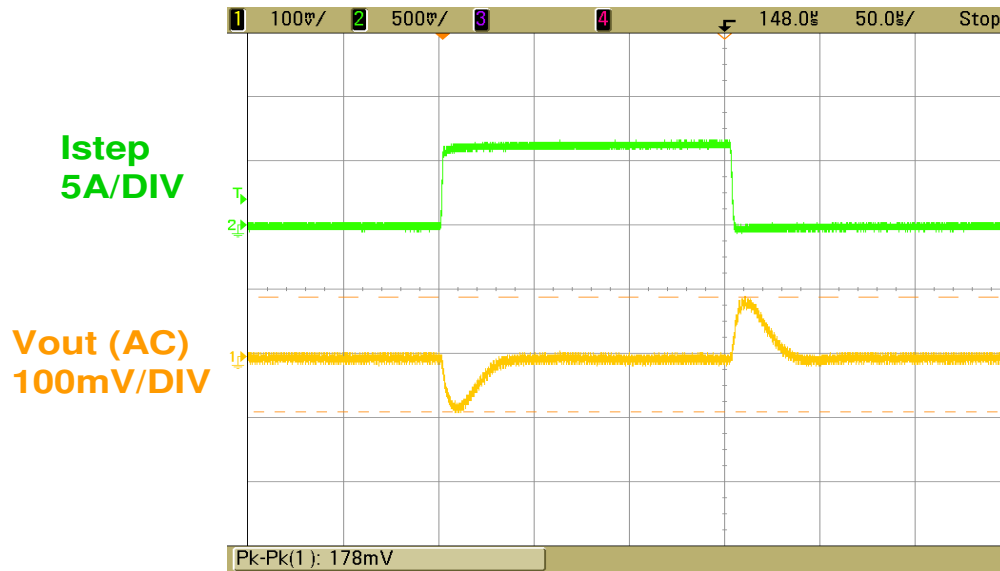
$V_{in} = 12V$

$V_{out} = 3.3V$

$C_{out} = 2 \times 22\mu F$ ceramic (1206), $2 \times 100\mu F$ ceramic (1812), $C_{12} = 47pF$

Figure 3. Measured Load Transient Response (3-9A Step) of 3.3V output.

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$V_{in} = 12V$

$V_{out} = 2.5V$

$C_{out} = 2 \times 22\mu F$ ceramic (1206), $2 \times 100\mu F$ ceramic (1812), $C52 = 47pF$

Figure 4. Measured Load Transient Response (3-9A Step) of 2.5V output.

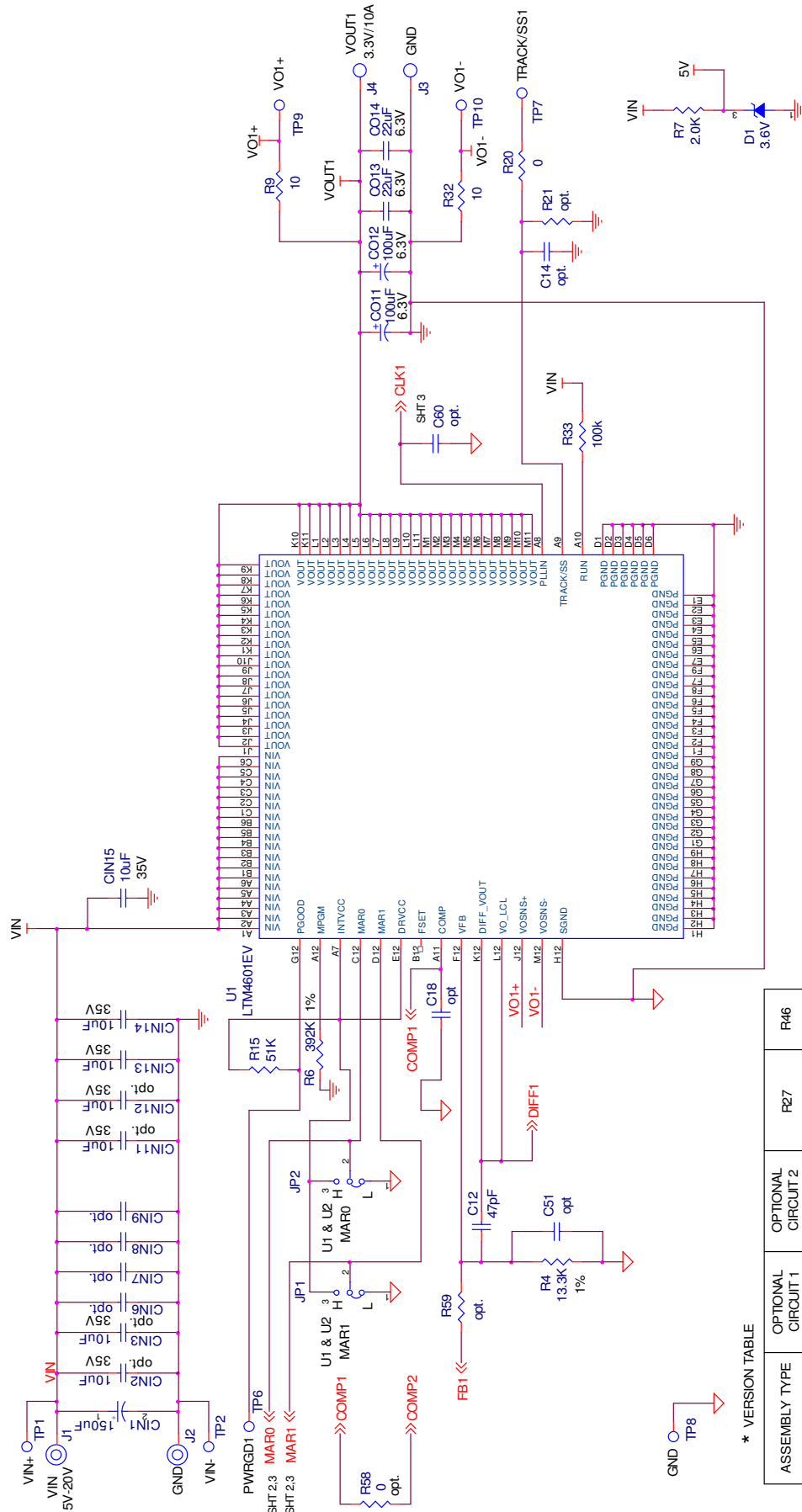
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Table1. Output Capacitor vs, Load Transient (3-9A Step)

| TYPICAL MEASURED VALUES | | | | | | | | | | | | |
|-------------------------|---------------|---------------------------------|-----------------|--------------|-------|---------------|---------|---------------------------|---------------|--------------------|------------------|-------------|
| Cout1 VENDORS | | PART NUMBER | | | | Cout2 VENDORS | | PART NUMBER | | | | |
| TDK | | C4532X5R0J107MZ (100UF, 6.3V) | | | | SANYO POS CAP | | 6TPE330ML (330UF, 6.3V) | | | | |
| TAIYO YUDEN | | JMK432BJ107MU-T (100UF, 6.3V) | | | | SANYO POS CAP | | 2R5TPE470M9 (470UF, 2.5V) | | | | |
| TAIYO YUDEN | | JMK316BJ226ML-T501 (22UF, 6.3V) | | | | SANYO POS CAP | | 4TPE470MCL (470UF, 4V) | | | | |
| Vout (V) | Cin (ceramic) | Cin (bulk) | Cout1 (Ceramic) | Cout2 (Bulk) | Ccomp | CFF | Vin (V) | Droop (mV) | Pk to Pk (mV) | Recovery time (uS) | Load Step (A/uS) | Rset (kOhm) |
| 1.2 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 5 | 50 | 109 | 18 | 6 | 60.4 |
| 1.2 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 2.5V | NONE | 100pF | 5 | 50 | 97 | 20 | 6 | 60.4 |
| 1.2 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 5 | 65 | 113 | 10 | 6 | 60.4 |
| 1.2 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 5 | 50 | 95 | 10 | 6 | 60.4 |
| 1.2 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 12 | 50 | 109 | 18 | 6 | 60.4 |
| 1.2 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 2.5V | NONE | 100pF | 12 | 50 | 97 | 20 | 6 | 60.4 |
| 1.2 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 12 | 65 | 113 | 13 | 6 | 60.4 |
| 1.2 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 12 | 55 | 97 | 15 | 6 | 60.4 |
| 1.5 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 5 | 55 | 116 | 20 | 6 | 40.2 |
| 1.5 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 2.5V | NONE | 100pF | 5 | 55 | 97 | 23 | 6 | 40.2 |
| 1.5 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 5 | 65 | 122 | 13 | 6 | 40.2 |
| 1.5 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 5 | 57 | 100 | 18 | 6 | 40.2 |
| 1.5 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 12 | 55 | 116 | 20 | 6 | 40.2 |
| 1.5 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 2.5V | NONE | 100pF | 12 | 58 | 100 | 23 | 6 | 40.2 |
| 1.5 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 12 | 70 | 122 | 15 | 6 | 40.2 |
| 1.5 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 12 | 61 | 105 | 18 | 6 | 40.2 |
| 1.8 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 5 | 60 | 120 | 20 | 6 | 30.1 |
| 1.8 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 2.5V | NONE | 100pF | 5 | 65 | 106 | 24 | 6 | 30.1 |
| 1.8 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 5 | 80 | 134 | 20 | 6 | 30.1 |
| 1.8 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 5 | 63 | 109 | 18 | 6 | 30.1 |
| 1.8 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 12 | 60 | 122 | 20 | 6 | 30.1 |
| 1.8 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 2.5V | NONE | 100pF | 12 | 70 | 106 | 28 | 6 | 30.1 |
| 1.8 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 12 | 85 | 134 | 20 | 6 | 30.1 |
| 1.8 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 12 | 68 | 114 | 21 | 6 | 30.1 |
| 2.5 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 4V | NONE | 100pF | 5 | 80 | 131 | 30 | 6 | 19.1 |
| 2.5 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 5 | 95 | 159 | 20 | 6 | 19.1 |
| 2.5 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 5 | 75 | 134 | 25 | 6 | 19.1 |
| 2.5 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 5 | 75 | 134 | 23 | 6 | 19.1 |
| 2.5 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 4V | NONE | 100pF | 12 | 85 | 131 | 30 | 6 | 19.1 |
| 2.5 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 12 | 75 | 138 | 25 | 6 | 19.1 |
| 2.5 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 12 | 100 | 159 | 22 | 6 | 19.1 |
| 2.5 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 12 | 80 | 134 | 23 | 6 | 19.1 |
| 3.3 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 7 | 115 | 188 | 35 | 6 | 13.3 |
| 3.3 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 4V | NONE | 100pF | 7 | 88 | 147 | 30 | 6 | 13.3 |
| 3.3 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 7 | 85 | 159 | 30 | 6 | 13.3 |
| 3.3 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 7 | 89 | 161 | 24 | 6 | 13.3 |
| 3.3 | 2 x 10uF 25V | 150uF 35V | 1 x 100uF | 470uF 4V | NONE | 100pF | 12 | 100 | 156 | 30 | 6 | 13.3 |
| 3.3 | 2 x 10uF 25V | 150uF 35V | 3 x 22uF | 470uF 4V | NONE | 100pF | 12 | 90 | 159 | 30 | 6 | 13.3 |
| 3.3 | 2 x 10uF 25V | 150uF 35V | 2 x 100uF | 330uF 6.3V | NONE | 100pF | 12 | 120 | 188 | 39 | 6 | 13.3 |
| 3.3 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 12 | 89 | 169 | 24 | 6 | 13.3 |
| 5 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 15 | 140 | 253 | 25 | 6 | 8.25 |
| 5 | 2 x 10uF 25V | 150uF 35V | 4 x 100uF | NONE | NONE | 100pF | 20 | 145 | 159 | 25 | 6 | 8.25 |

LTM4601 module has similar load transient response at 12V_{in} and 20V_{in}

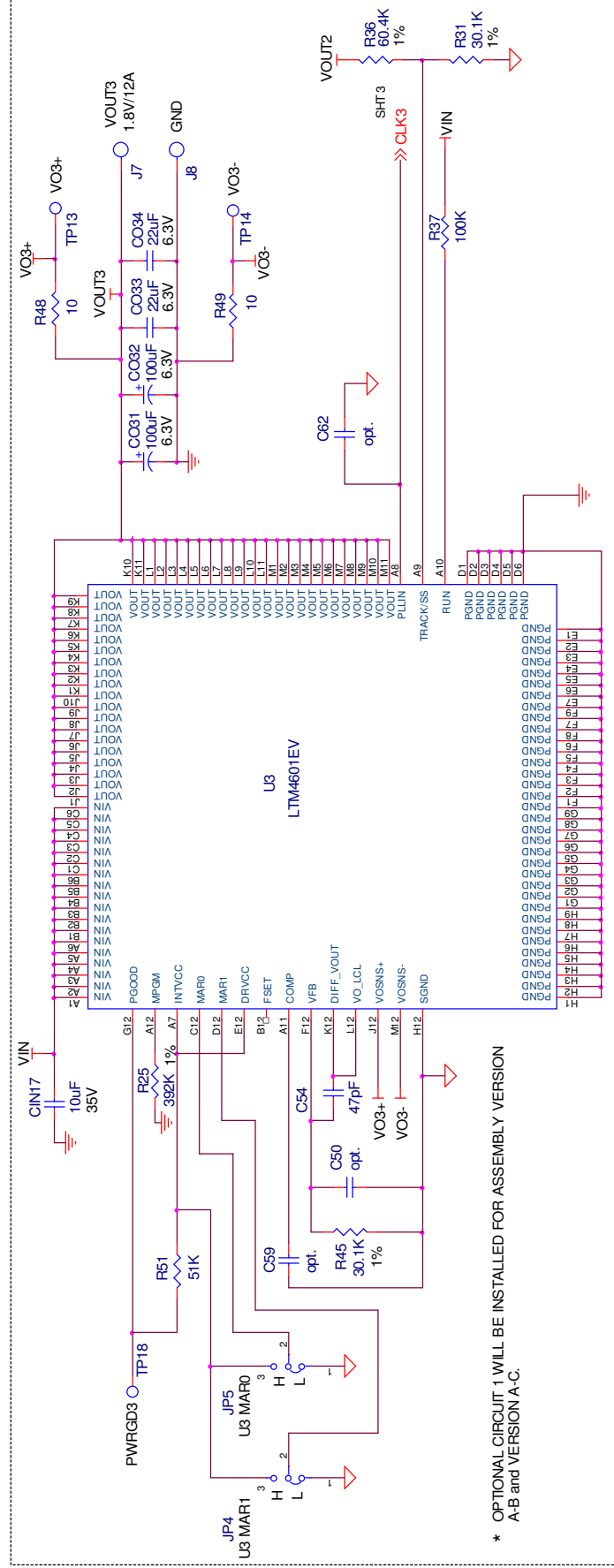
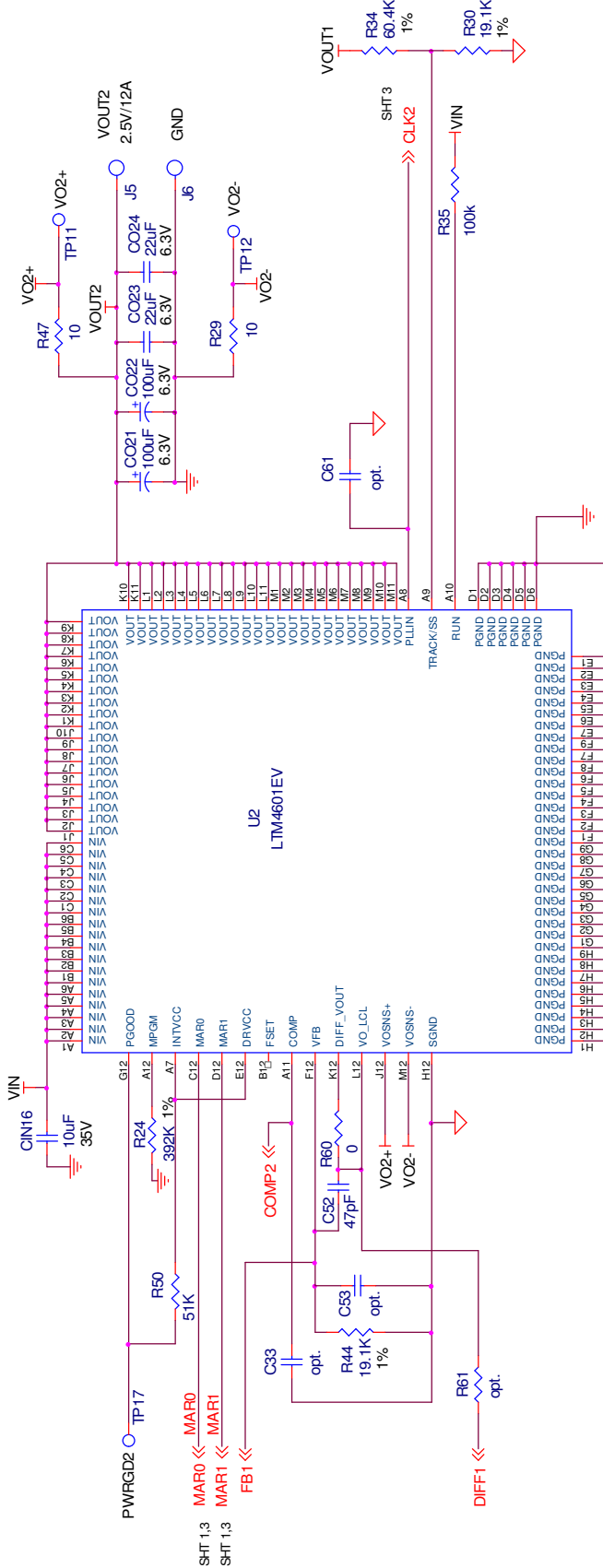
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* VERSION TABLE

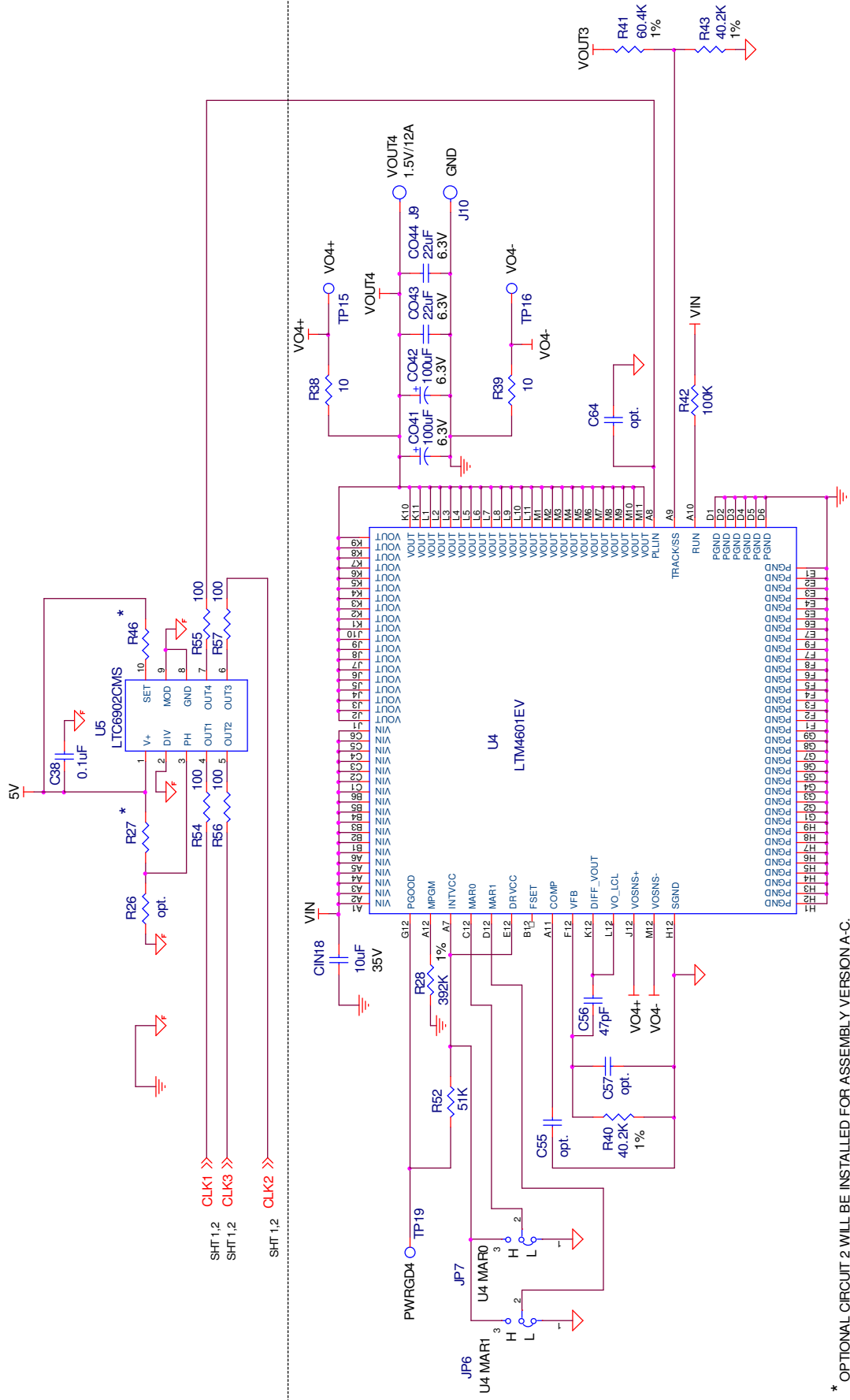
| ASSEMBLY TYPE | OPTIONAL CIRCUIT 1 | OPTIONAL CIRCUIT 2 | R46 |
|---------------|--------------------|--------------------|-------|
| DC1118A-A | NOT INSTALLED | NOT INSTALLED | 66.5K |
| DC1118A-B | INSTALLED | NOT INSTALLED | 88.7K |
| DC1118A-C | INSTALLED | INSTALLED | 66.5K |

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* OPTIONAL CIRCUIT 1 WILL BE INSTALLED FOR ASSEMBLY VERSION A-B and VERSION A-C.

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* OPTIONAL CIRCUIT 2 WILL BE INSTALLED FOR ASSEMBLY VERSION A-C.

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 1118A-A POLYPHASE HIGH DENSITY POWER MODULE

DC1118A-A BOM

| Item | Qty | Reference | Part Description | Manufacturer / Part # |
|--------------------------------------------------------------------|-----|------------------------------------------------------|-----------------------------------|-----------------------------------|
| REQUIRED CIRCUIT COMPONENTS: | | | | |
| 1 | 1 | CIN1 | CAP., ALUM, 150uF 20% 35V (PBF) | SANYO 35ME150WXV+TS |
| 2 | 4 | CIN13,CIN14,CIN15,CIN16 | CAP., X5R, 10uF, 35V, 20%, 1206 | TAIYO YUDEN, GMK316BJ106ML-T |
| 3 | 4 | CO11,CO12,CO21,CO22 | CAP., X5R, 100uF, 6.3V, 20% 1812 | TDK C4532X5R0J107MZ |
| 4 | 4 | CO13,CO14,CO23,CO24 | CAP., X5R, 22uF, 6.3V, 20% 1206 | TAIYO YUDEN JMK316BJ226ML-T |
| 5 | 1 | C38 | CAP., X7R, 0.1uF, 10V, 10%, 0603 | AVX, 0603ZC104KAT2A |
| 6 | 2 | C12,C52 | CAP., C0G, 47pF, 50V, 5%, 0603 | AVX, 06035A470JAT2A |
| 7 | 1 | R4 | RES., CHIP, 13.3K, 1/16W, 1% 0603 | VISHAY, CRCW060313K3FKEA |
| 8 | 2 | R6,R24 | RES., CHIP, 392K, 1/16W, 1% 0603 | VISHAY, CRCW0603392KFKEA |
| 9 | 4 | R9,R29,R32,R47 | RES., CHIP, 10, 1/16W, 0603 | VISHAY, CRCW060310R0JNEA |
| 10 | 1 | R44 | RES., CHIP, 19.1K, 1/16W, 1% 0603 | VISHAY, CRCW060319K1FKEA |
| 11 | 2 | R33,R35 | RES., CHIP, 100K, 1/16W, 5% 0603 | VISHAY, CRCW0603100KJNEA |
| 12 | 1 | R46 | RES., CHIP, 66.5K, 1/16W, 1% 0603 | VISHAY, CRCW060366K5FKEA |
| 13 | 4 | R54,R55,R56,R57 | RES., CHIP, 100, 1/16W, 5% 0603 | VISHAY, CRCW0603100RJNEA |
| 14 | 2 | U1,U2 | IC, LTM4601EV 15mm x15mm LGA | LINEAR TECH. LTM4601EV#PBF |
| 15 | 1 | U5 | I.C, LTC6902CMS MSOP10 | LINEAR TECH., LTC6902CMS |
| ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS: | | | | |
| 1 | 0 | CIN2,CIN3,CIN6,CIN7,CIN8, CIN9,CIN11,CIN12 (opt.) | CAP., 1206 | |
| 2 | 0 | C14,C18,C33,C51,C53,C60,C61 (opt.) | CAP., 0603 | |
| 3 | 1 | D1 | DIODE, 3.6V SOT23 | DIODES INC., MMBZ5227B |
| 4 | 1 | R7 | RES., CHIP, 2.0K, 1/8W, 5% 0805 | VISHAY, CRCW08052K00JNEA |
| 5 | 2 | R15,R50 | RES., CHIP, 51K, 1/16W, 5% 0603 | VISHAY, CRCW060351K0JNEA |
| 6 | 0 | R21,R26,R58,R59,R61 (opt.) | RES., 0603 | |
| 7 | 2 | R20,R60 | RES., CHIP, 0, 1/16W, 5% 0603 | VISHAY, CRCW06030000Z0EA |
| 8 | 1 | R27 | RES., CHIP, 0, 1/16W, 0603 | VISHAY, CRCW06030000Z0EA |
| 9 | 1 | R30 | RES., CHIP, 19.1K, 1/16W, 1% 0603 | VISHAY, CRCW060319K1FKEA |
| 10 | 1 | R34 | RES., CHIP, 60.4K, 1/16W, 1% 0603 | VISHAY, CRCW060360K4FKEA |
| HARDWARE-FOR DEMO BOARD ONLY: | | | | |
| 1 | 6 | JP1,JP2,JP4-JP7 | HEADER 3 PIN 0.079 SINGLE ROW | SAMTEC, TMM103-02-L-S |
| 2 | 6 | XJP1,XJP2,XJP4-XJP7 | SHUNT, .079" CENTER | SAMTEC, 2SN-BK-G |
| 3 | 2 | J1,J2 | STUD | PEM, KFH-032-10 |
| 4 | 4 | J1,J2(2 EACH) | NUT, BRASS, #10-32 | ANY |
| 5 | 2 | J1,J2 | Ring, Lug Ring # 10 | KEYSTONE 8205 |
| 6 | 2 | J1,J2 | WASHER, STAR #10 BRASS NICHEL | ANY |
| 7 | 8 | J3-J10 | JACK BANANA | KEYSTONE, 575-4 |
| 8 | 16 | TP1,TP2,TP6-TP19 | TESTPOINT, TURRET, .094" pbf | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 9 | 4 | (STAND-OFF) | STAND-OFF, NYLON 0.50" | KEYSTONE, 8833(SNAP ON) |
| OPTIONAL CIRCUIT 1 & 2 COMPONENTS (NOT INSTALL FOR A-A) | | | | |
| 1 | 2 | CIN17,CIN18 | CAP., X5R, 10uF, 35V, 20%, 1206 | TAIYO YUDEN, GMK316BJ106ML-T |
| 2 | 4 | CO31,CO32,CO41,CO42 | CAP., X5R, 100uF, 6.3V, 20% 1812 | TDK C4532X5R0J107MZ |
| 3 | 4 | CO33,CO34,CO43,CO44 | CAP., X5R, 22uF, 6.3V, 20% 1206 | TAIYO YUDEN JMK316BJ226ML-T |
| 4 | 0 | C50,C55,C57,C59,C62,C64(opt.) | CAP., 0603 | |
| 5 | 2 | C54,C56, | CAP., C0G, 47pF, 50V, 5%, 0603 | AVX, 06035A470JAT2A |
| 6 | 2 | R25,R28 | RES., CHIP, 392K, 1/16W, 1% 0603 | VISHAY, CRCW0603392KFKEA |
| 7 | 2 | R38,R39 | RES., CHIP, 0, 1/16W, 0603 | VISHAY, CRCW06030000Z0EA |
| 8 | 2 | R48,R49 | RES., CHIP, 10, 1/16W, 0603 | VISHAY, CRCW060310R0JNEA |
| 9 | 2 | R51,R52 | RES., CHIP, 51K, 1/16W, 5% 0603 | VISHAY, CRCW060351K0JNEA |
| 10 | 2 | R31,R45 | RES., CHIP, 30.1K, 1/16W, 1% 0603 | VISHAY, CRCW060330K1FKEA |
| 11 | 2 | R40,R43 | RES., CHIP, 40.2K, 1/16W, 1% 0603 | VISHAY, CRCW060340K2FKEA |
| 12 | 2 | R36,R41 | RES., CHIP, 60.4K, 1/16W, 1% 0603 | VISHAY, CRCW060360K4FKEA |
| 13 | 2 | R37,R42 | RES., CHIP, 100K, 1/16W, 5% 0603 | VISHAY, CRCW0603100KJNEA |
| 14 | 2 | U3,U4 | IC, LTM4601EV 15mm x15mm LGA | LINEAR TECH. LTM4601EV#PBF |