

ZL8101_30AEV2Z

30A Demonstration Board

AN1781
Rev 0.00
Sep 6, 2012

Description

The ZL8101 is an integrated mixed-signal power conversion and management IC that combines an efficient step-down DC/DC converter with key power and thermal management functions in a single package. The ZL8101 incorporates current sharing and adaptive efficiency-optimization algorithms to provide a flexible, efficient power IC building block.

The ZL8101_30AEV2Z Demo Board is a 6-layer board demonstrating a 30A synchronous buck converter. Sequencing, tracking, margining, plus other features can be evaluated using this board.

A USB to SMBus adapter board can be used to connect the demo board to a PC. The PMBus command set is accessed by using the Zilker Labs PowerNavigator™ evaluation software from a PC running Microsoft Windows.

Ordering Information

| PART NUMBER | DESCRIPTION |
|----------------|-----------------------------|
| ZL8101_30AEV2Z | 30A Single Phase Demo Board |

Key Features

- 30A Synchronous Buck Converter
- Optimized for High Current and High Efficiency
- Configurable through SMBus
- Onboard Enable Switch
- Power-Good Indicator

Target Specifications

- $V_{IN} = 12V$
- $V_{OUT} = 1V/30A$
- $F_{SW} = 533kHz$
- Efficiency: >88% at 20A
- Output Ripple: $\pm 1\%$
- Dynamic Response: $\pm 3\%$ (33%-83%-33% LOAD STEP, $di/dt = 5A/\mu s$)
- Operating Temperature: +25°C

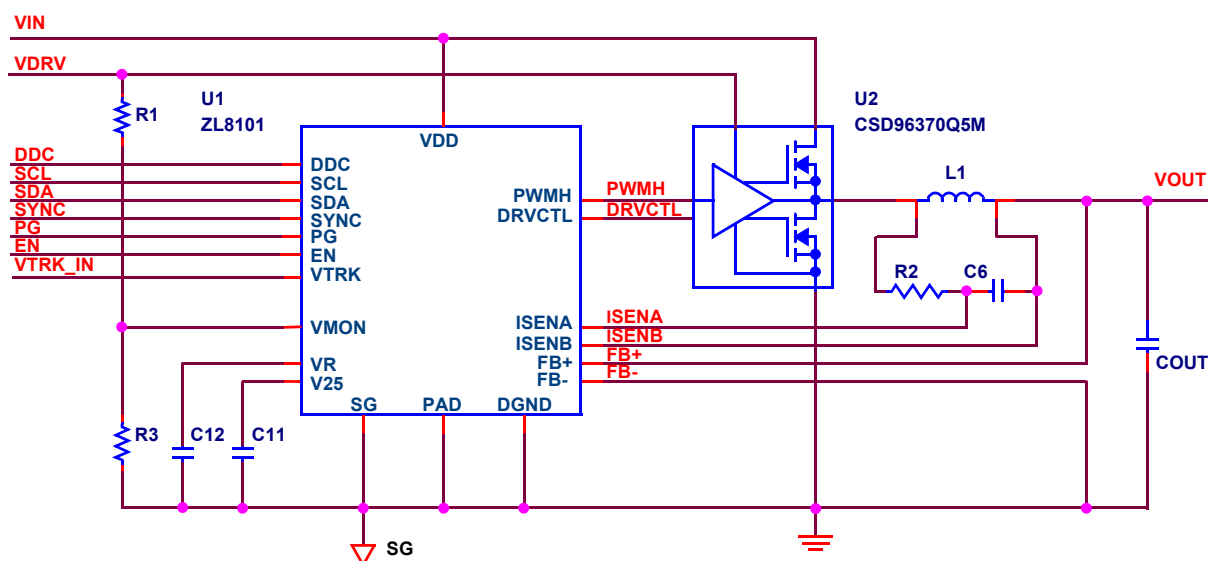


FIGURE 1. ZL8101_30AEV2Z 30A DEMO BOARD SIMPLIFIED SCHEMATIC

Functional Description

The ZL8101_30AEV2Z 30A Demo Board provides all circuitry required to demonstrate the features of the ZL8101. The ZL8101 30A has a functionally optimized ZL8101 circuit layout that allows efficient operation up to the maximum output current. Power and load connections are provided through plug-in sockets.

A majority of the features of the ZL8101 such as soft-start delay and ramp times, supply sequencing, voltage tracking, and voltage margining are available on this board. For voltage tracking and sequencing evaluation, the board can be connected to any other Zilker Labs evaluation boards that supports the Digital DC (DDC) bus.

Figure1 shows a simplified schematic of the ZL8101_30AEV2Z 30A Demo Board. All power to the board (VIN and I²C bus) must be removed before changing the jumpers.

The hardware enable function is controlled by a toggle switch on the ZL8101_30AEV2Z 30A board. The power-good (PG) LED indicates the state of PG when external power is applied to the ZL8101_30AEV2Z 30A board. The right angle headers at opposite ends of the board are for connecting a USB to SMBus adapter board or for easy chaining of multiple evaluation boards.

Figure 2 shows the ZL8101_30AEV2Z 30A Demo Board complete circuit. The circuit consists of the ZL8101 IC with its minimal component count to realize a 30A buck converter. The board layout has been optimized for thermal performance. Figure 3 is the board interface circuitry. Figures 5 through 10 show the PCB layout for the board, including the board fabrication notes.

The bill of materials (BOM) and configuration file are also included for reference.

Operation

PMBus Operation

The ZL8101 utilizes the PMBus protocol. The PMBus functionality can be controlled via USB from a PC running the PowerNavigator evaluation software in a Windows XP, Windows 2000/NT, or Windows 7 operating system.

Install the evaluation software using the CD included in the ZL8101_30AEV2Z 30A Demo Board kit.

For board operation, connect the included USB-to-SMBus adapter board to J2 of the ZL8101_30AEV2Z 30A Demo board. Connect the desired load and an appropriate power supply to the input and connect the included USB cable to the PC running the PowerNavigator evaluation software. Place the ENABLE switch in "DISABLE" and turn on the power.

The evaluation software allows modification of all ZL8101 PMBus parameters. The ZL8101 device on the board has been pre-configured as described in the Target Specifications on the front page, but the user may modify the operating parameters through the PowerNavigator software or by loading a predefined scenario from a configuration file.

Use the mouse-over pop-ups for PowerNavigator help. Refer to Zilker Labs application note [AN2033](#) for PMBus details.

The ENABLE switch can then be moved to "ENABLE" and the ZL8101_30AEV2Z 30A Demo board can be tested. Alternately, the PMBus ON-OFF CONFIG and OPERATION commands may be used.

Quick Start Guide

Stand Alone Operation

1. Set ENABLE switch to "DISABLE".
2. Apply load to VOUT+/VOUT-.
3. Connect the USB to SMBus adapter board to J2 of the board.
4. Ensure that jumper shorting headers J1, J6, and J7 are installed.
5. Connect supplied USB cable from computer to USB to SMBus adapter board.
6. Connect power supply to VIN+/VIN- (supply turned off).
7. Turn power supply on.
8. Set ENABLE switch to "ENABLE".
9. Monitor the ZL8101_30AEV2Z 30A demo board operation using an oscilloscope.

USB (PMBus) Operation

1. Set ENABLE switch to "DISABLE".
2. Apply load to VOUT+/VOUT-.
3. Connect power supply to VIN+/VIN- (supply turned off).
4. Turn power supply on.
5. Insert the Zilker Labs Eval Kit CD.
6. Connect USB to SMBus adapter board to J2 of ZL8101_30AEV2Z 30A Demo Board.
7. Connect supplied USB cable from computer to USB to SMBus adapter board.
8. Upon first-time connection, the Found New Hardware Wizard will appear.
9. Select 'No' at prompt to search the Internet for drivers.
10. Follow the steps on the screen to install the drivers from the CD.
11. Install the PowerNavigator evaluation software by running setup.exe from the PowerNavigator_installer folder on the CD.
12. Using PowerNavigator, set the enable mode to PMBus Enable, press the PMBus Enable button on the PowerNavigator opening screen.
13. Monitor and configure the ZL8101_30AEV2Z 30A Demo Board using PMBus commands in the evaluation software.
14. Test the ZL8101_30AEV2Z 30A Demo Board operation using an oscilloscope and the evaluation software.

Typical room temp efficiency curves are shown in Figure 11. Typical transient and operational waveforms are shown in Figures 12 through 15.

Board Schematics

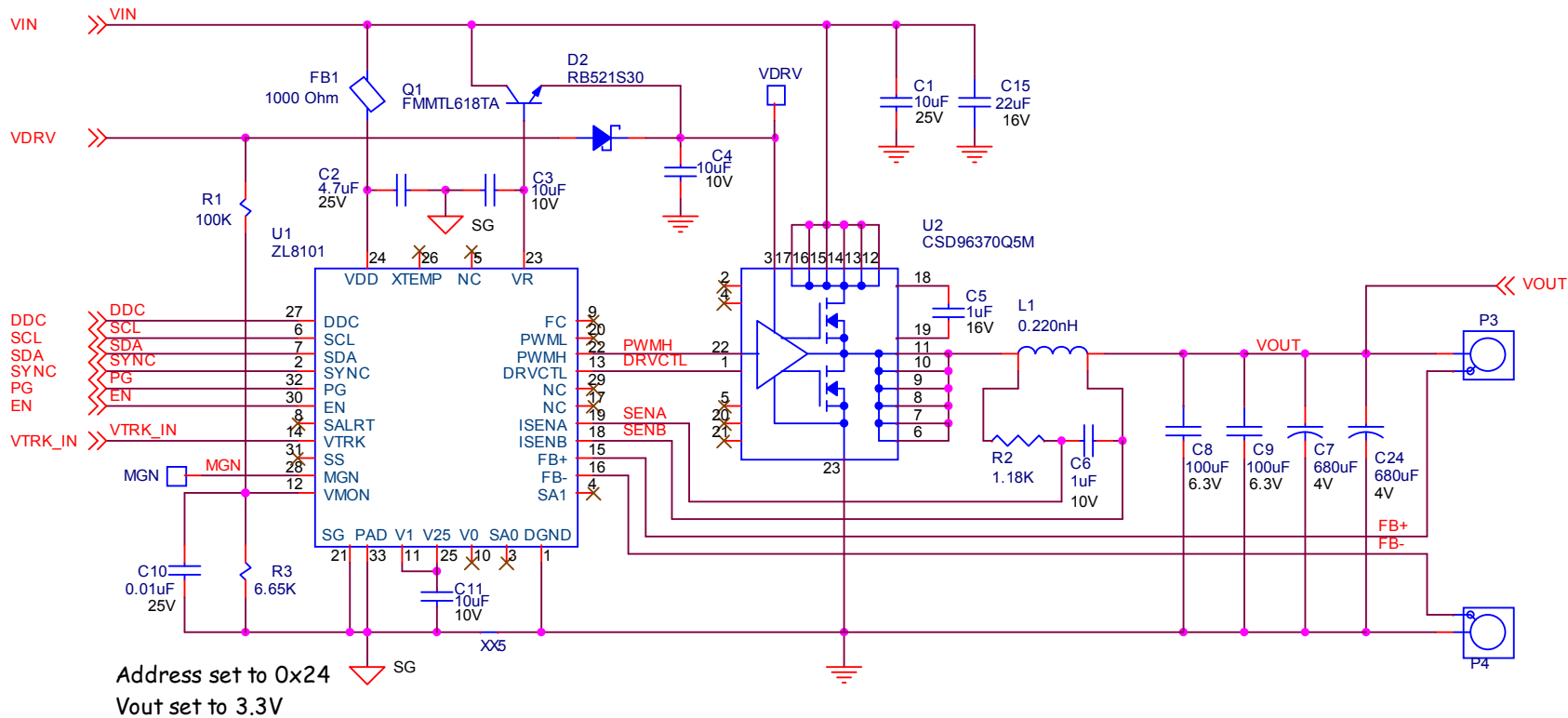


FIGURE 2. ZL8101_30AEV2Z 30A DEMO BOARD COMPLETE CIRCUIT

Board Schematics (Continued)

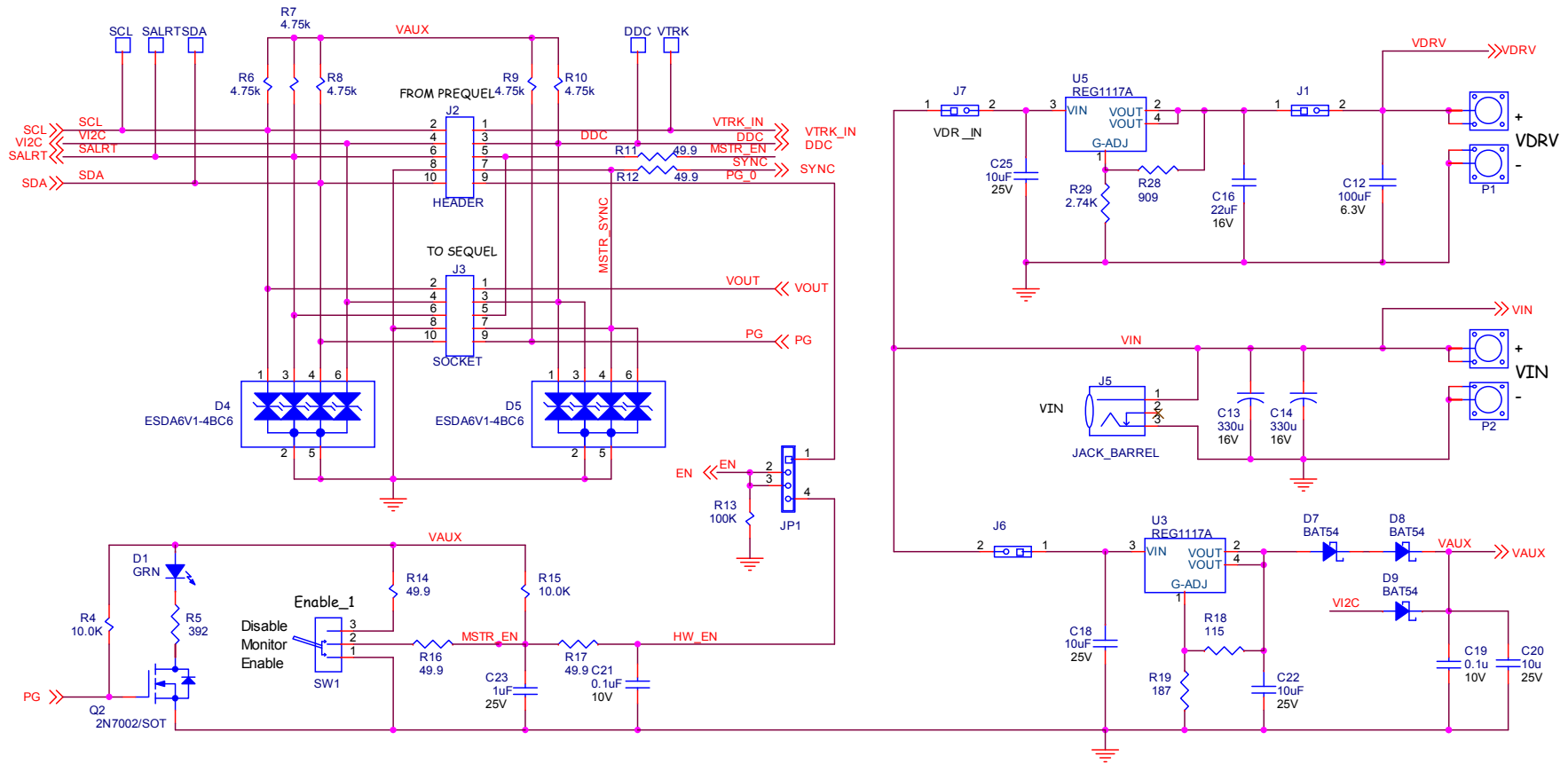


FIGURE 3. ZL8101_30AEV2Z 30A DEMO BOARD - INTERFACE CIRCUITRY

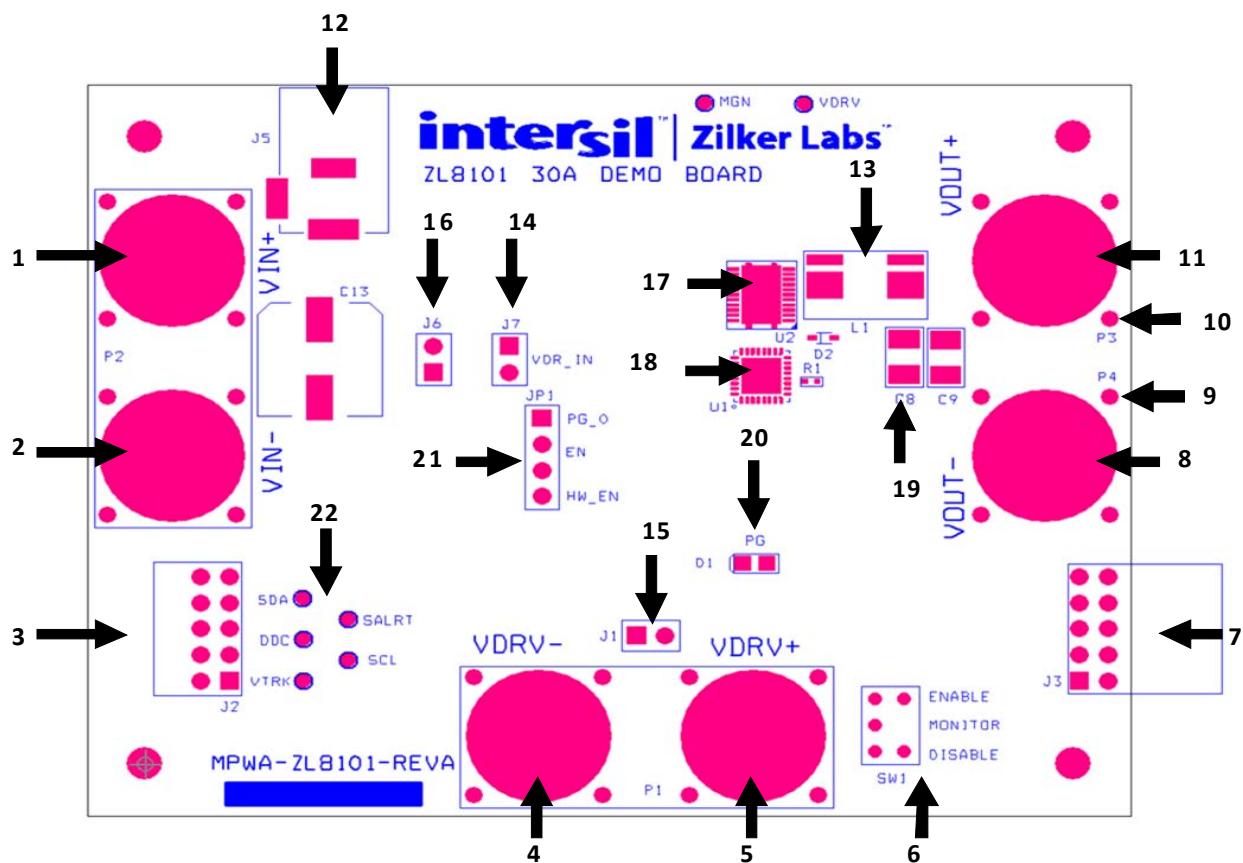


FIGURE 4. ZL8101_30AEV2Z 30A DEMO BOARD GUIDE

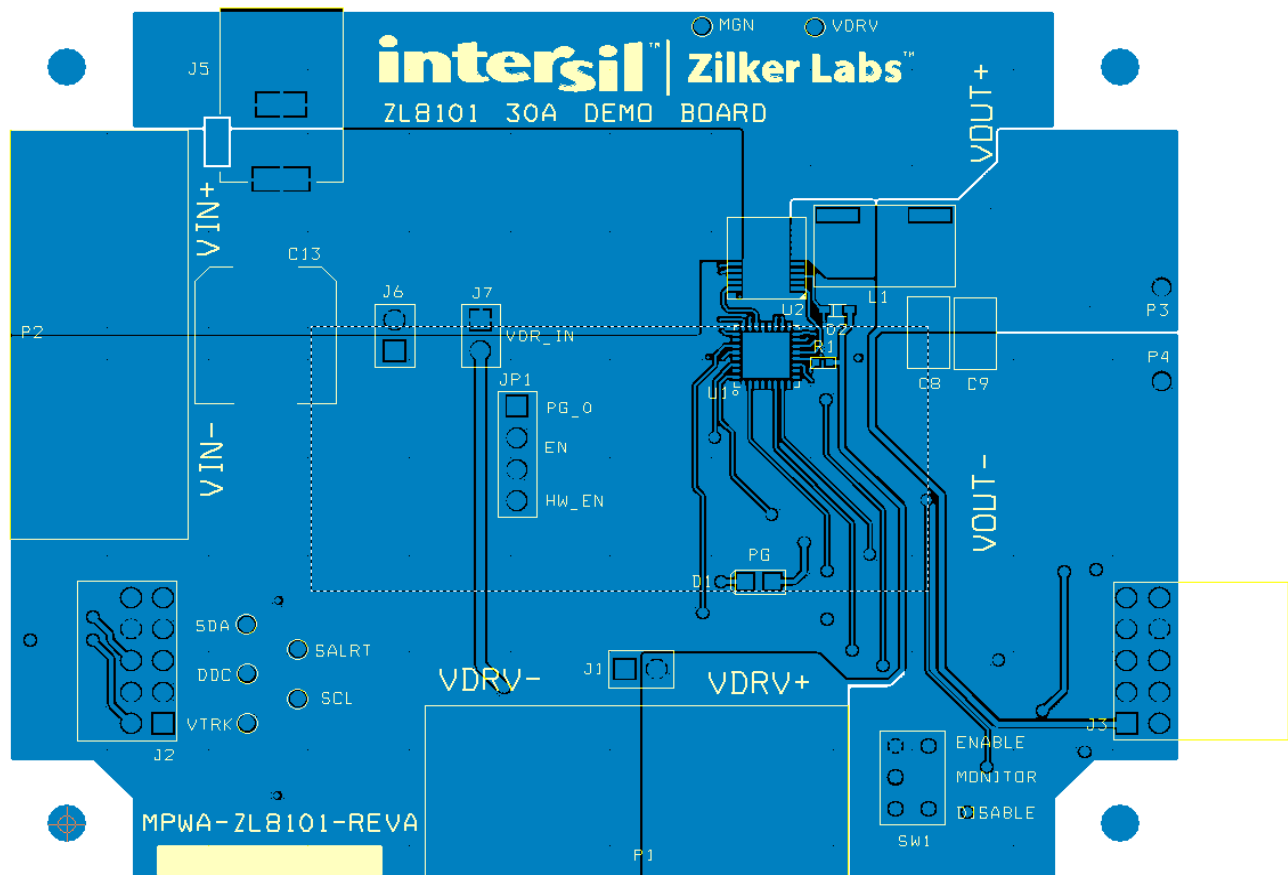
The top view of the ZL8101_30AEV2Z 30A Demo Board is shown in Figure 4, and the most important parts of the board are covered in Table 1

TABLE 1. COMMENTS ABOUT DIFFERENT PARTS IN THE ZL8101_30AEV2Z 30A DEMO BOARD

| ITEM | QUANTITY | REFERENCE | VALUE | TOLERANCE | RATING | TYPE | MANUFACTURER | PART NUMBER | DISTRIBUTOR | DIST. PN |
|------|----------|---------------------|------------------|-----------|--------------|----------|-------------------|--------------------|-------------|---------------------|
| 1 | 1 | C1 | 10μF | ±10% | 25V | X7R | Taiyo Yuden | TMK316B7106KL-TD | Digikey | 587-2399-2-ND |
| 2 | 1 | C2 | 4.7μF | ±10% | 25V | X7R | AVX | 0805YC475KAT2A | Digikey | 478-5722-1-ND |
| 3 | 3 | C3, C4, C11 | 10μF | ±10% | 10V | X7R | Murata | GRM21BR71A106KE51L | Digikey | 490-3905-2-ND |
| 4 | 1 | C5 | 1μF | ±10% | 16V | X7R | Kemet | C0603C105K4RACTU | Digikey | C0603C105K4RACTU-ND |
| 5 | 1 | C6 | 1μF | 10% | 10V | X7R | Taiyo Yuden | LMK107B7105KA-T | Digikey | 587-1242-2-ND |
| 6 | 2 | C7, C24 | 680μF | 20% | 4V | AL POLY | Kemet | T530Y687M004ATE005 | Digikey | 399-4750-1-ND |
| 7 | 3 | C8, C9, C12 | 100μF | | 6.3V | X5R | Taiyo Yuden | JMK325BJ107MY-T | Digikey | 587-1388-2-ND |
| 8 | 1 | C10 | 0.01μF | ±10% | 25V | X7R | Kemet | C0402C103K3RACTU | Digikey | 399-1278-2-ND |
| 9 | 2 | C13, C14 | 330μ | 20% | 16V | AL POLY | United Chemi-Con | APXA160ARA331MJC0G | Digikey | 565-3081-2-ND |
| 10 | 2 | C15, C16 | 22μF | 20% | 16V | X5R | Murata | GRM31CR61C226ME15L | Digikey | 490-4739-2-ND |
| 11 | 3 | C18, C22, C25 | 10μF | 10% | 25V | X5R | Panasonic - ECG | ECJ-3YB1E106K | Digikey | PCC2414TR-ND |
| 12 | 1 | C19 | 0.1μ | 10% | 10V | X7R | Kemet | C0603C104K8RACTU | Digikey | 399-1095-2-ND |
| 13 | 1 | C20 | 10μ | 10% | 25V | X5R | Panasonic - ECG | ECJ-3YB1E106K | Digikey | PCC2414TR-ND |
| 14 | 1 | C21 | 0.1μF | 10% | 10V | X7R | Kemet | C0603C104K8RACTU | Digikey | 399-1095-2-ND |
| 15 | 1 | C23 | 1μF | 10% | 25V | X5R | Taiyo Yuden | TMK107BJ105KA-T | Digikey | 587-1248-2-ND |
| 16 | 1 | D1 | GRN | | 2V | | Chicago Miniature | CMD17-21VGC | Mouser | 606-CMD17-21VGC |
| 17 | 1 | D2 | RB521S30 | | 30V | Schottky | ON SEMI | RB521S30 | Digikey | RB521S30CT-ND |
| 18 | 2 | D4, D5 | ESDA6V1-4BC6 | | 6.1V, 80W | | ST Micro | ESDA6V1-4BC6 | Digikey | 497-4643-2-ND |
| 19 | 3 | D7, D8, D9 | BAT54 | | 30V | Schottky | On Semi | BAT54XV2T10S | Digikey | BAT54XV2T10STR-ND |
| 20 | 1 | FB1 | 1000 Ω | | 150mA | Ferrite | Taiyo Yuden | BK1005HM102-T | Digikey | 587-1835-2-ND |
| 21 | 1 | JP1 | 4 PIN | | | | Tyco | 3-644456-4 | Digikey | A31114-ND |
| 22 | 3 | J1, J6, J7 | 2 POS | | | VERT | Samtec | TSW-102-07-L-S | Digikey | SAM1031-02-ND |
| 23 | 1 | J2 | HEADER | | | RA | Samtec | TSW-105-08-T-D-RA | Digikey | SAM1049-05-ND |
| 24 | 1 | J3 | SOCKET | | | RA | Samtec | SSQ-105-02-T-D-RA | Digikey | SAM1224-05-ND |
| 25 | 1 | J5 | JACK_BARREL | | 1.5A @ 18VDC | RA | Kobiconn | 163-5004-E | Mouser | 163-5004-E |
| 26 | 1 | L1 | 0.220nH | | 70 | Inductor | ITG | SL3732_R22KHF | ITG | SL3732_R22KHF |
| 27 | 2 | P1, P2 | JACK_DUAL_BANANA | | 15A | | Emerson | 108-0740-001 | Digikey | J147-ND |
| 28 | 2 | P3, P4 | JACK_BANANA_1 | | | | | | Digikey | J147-ND |
| 29 | 1 | Q1 | FMMTL618TA | | 20V | NPN | Diodes Inc | FMMTL618TA | Digikey | FMMTL618CT-ND |
| 30 | 1 | Q2 | 2N7002/SOT | | 60V 115mA | N-CH | ON SEMI | 2N7002LT1 | Digikey | 2N7002LT10STR-ND |
| 31 | 1 | R1 | 100k | 1% | | 1/16W | Vishay/Dale | CRCW0402100KFKED | Digikey | 541-100KLTR-ND |
| 32 | 1 | R2 | 1.18k | 1% | | Resistor | Panasonic - ECG | ERJ-3EKF1181V | Digikey | P1.18KHTR-ND |
| 33 | 1 | R3 | 6.65k | 1% | | 1/16W | Panasonic - ECG | ERJ-2RKF6651X | Digikey | P6.65KLTR-ND |
| 34 | 1 | R4 | 10.0k | 1% | | 1/16W | Yageo | RC0402FR-0710KL | Digikey | 311-10.0KLTR-ND |
| 35 | 1 | R5 | 392 | 1% | | THK FILM | Panasonic - ECG | ERJ-3EKF3920V | Digikey | P392HTR-ND |
| 36 | 5 | R6, R7, R8, R9, R10 | 4.75k | 1% | | 1/16W | Panasonic - ECG | ERJ-2RKF4751X | Digikey | P4.75KLTR-ND |
| 37 | 4 | R11, R12, R16, R17 | 49.9 | 1% | 100mW | THK FILM | Panasonic - ECG | ERJ-3EKF49R9V | Digikey | P49.9HTR-ND |
| 38 | 1 | R13 | 100k | 1% | 63mW | THK FILM | Panasonic - ECG | ERJ-2RKF1003X | Digikey | P100KLTR-ND |
| 39 | 1 | R14 | 49.9 | 1% | 63mW | THK FILM | Vishay/Dale | CRCW040249R9FKED | Digikey | 541-49.9LTR-ND |
| 40 | 1 | R15 | 10.0k | 1% | 63mW | THK FILM | Panasonic - ECG | ERJ-2RKF1002X | Digikey | P10.0KLTR-ND |
| 41 | 1 | R18 | 115 | 1% | 100mW | THK FILM | Panasonic - ECG | ERJ-3EKF1150V | Digikey | P115HTR-ND |

TABLE 1. COMMENTS ABOUT DIFFERENT PARTS IN THE ZL8101_30AEV2Z 30A DEMO BOARD (Continued)

| ITEM | QUANTITY | REFERENCE | VALUE | TOLERANCE | RATING | TYPE | MANUFACTURER | PART NUMBER | DISTRIBUTOR | DIST. PN |
|------|----------|-----------|-------------|-----------|--------|----------|-------------------|---------------|-------------|----------------|
| 42 | 1 | R19 | 187 | 1% | 100mW | THK FILM | Panasonic - ECG | ERJ-3EKF1870V | Digikey | P187HTR-ND |
| 43 | 1 | R28 | 909 | 1% | 100mW | THK FILM | Panasonic - ECG | ERJ-3EKF9090V | Digikey | P909HTR-ND |
| 44 | 1 | R29 | 2.74k | 1% | 100mW | THK FILM | Panasonic - ECG | ERJ-3EKF2741V | Digikey | P3.32KHTR-ND |
| 45 | 1 | SW1 | SW_SPDT | | | PCB VERT | NKK | G13AP-R0 | Mouser | 633-G13AP-R0 |
| 53 | 1 | U1 | ZL8101 | | | | Intersil | ZL8101 | Intersil | ZL8101 |
| 54 | 1 | U2 | CSD96370Q5M | | 25V | | Texas Instruments | CSD96370Q5M | Digikey | 296-28235-2-ND |
| 55 | 2 | U3, U5 | REG1117A | | | | Texas Instruments | REG1117A | Digikey | REG1117A-ND |

Board Layout – 6 Layers**FIGURE 5. PCB - TOP LAYER**

Board Layout – 6 Layers (Continued)

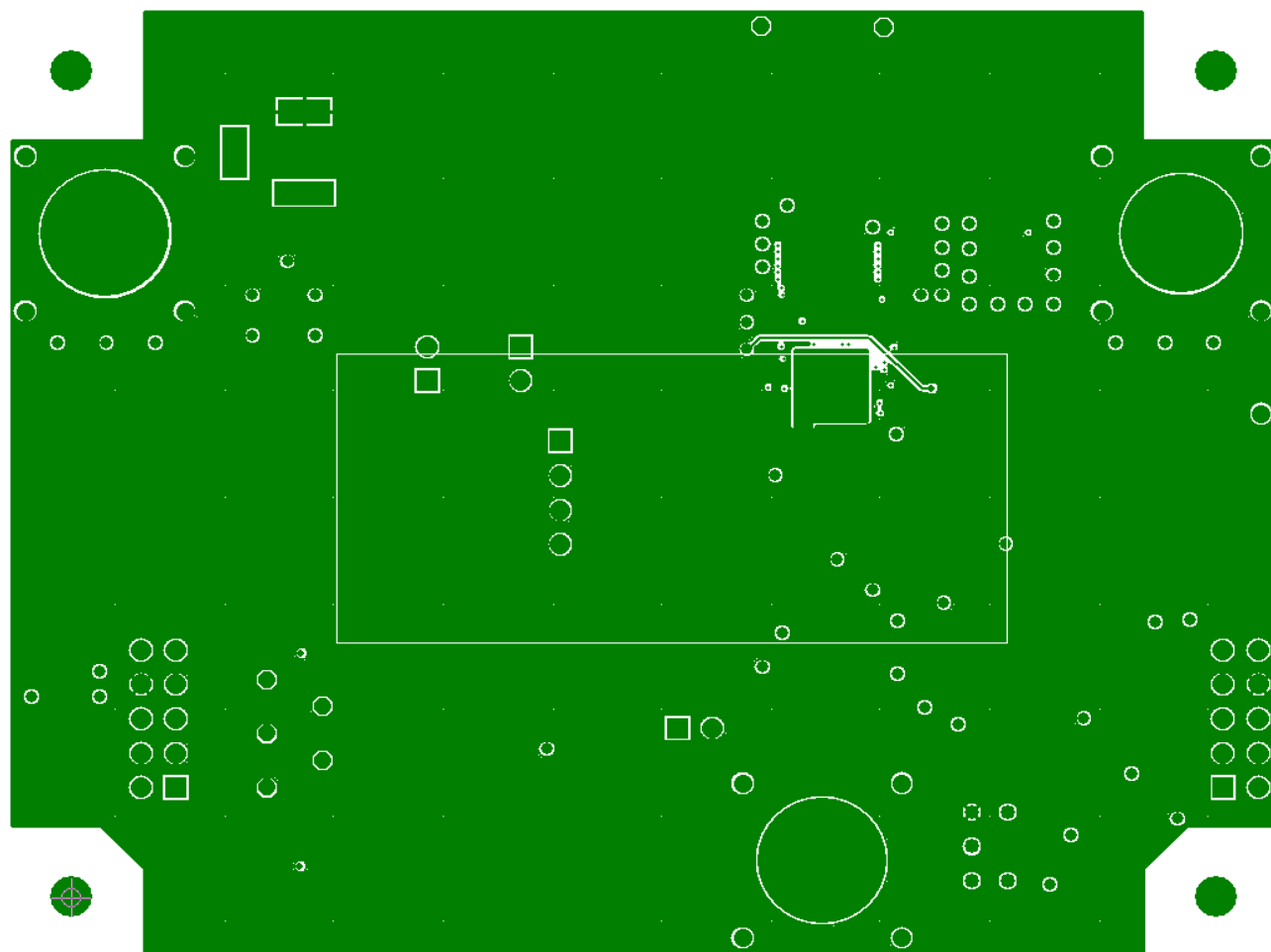


FIGURE 6. PCB - INNER LAYER 1 (VIEWED FROM TOP)

Board Layout – 6 Layers (Continued)

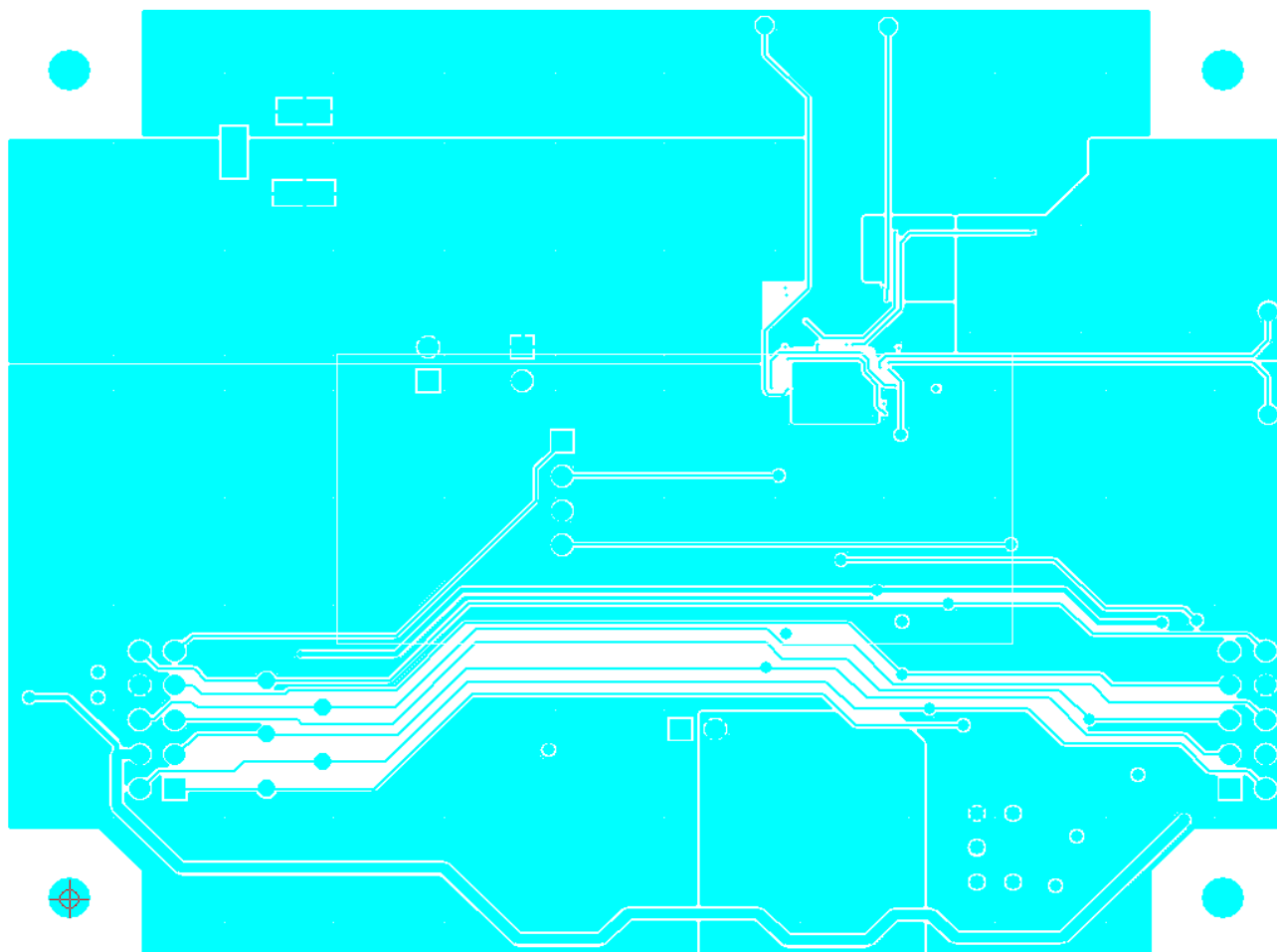


FIGURE 7. PCB - INNER LAYER 2 (VIEWED FROM TOP)

Board Layout – 6 Layers (Continued)

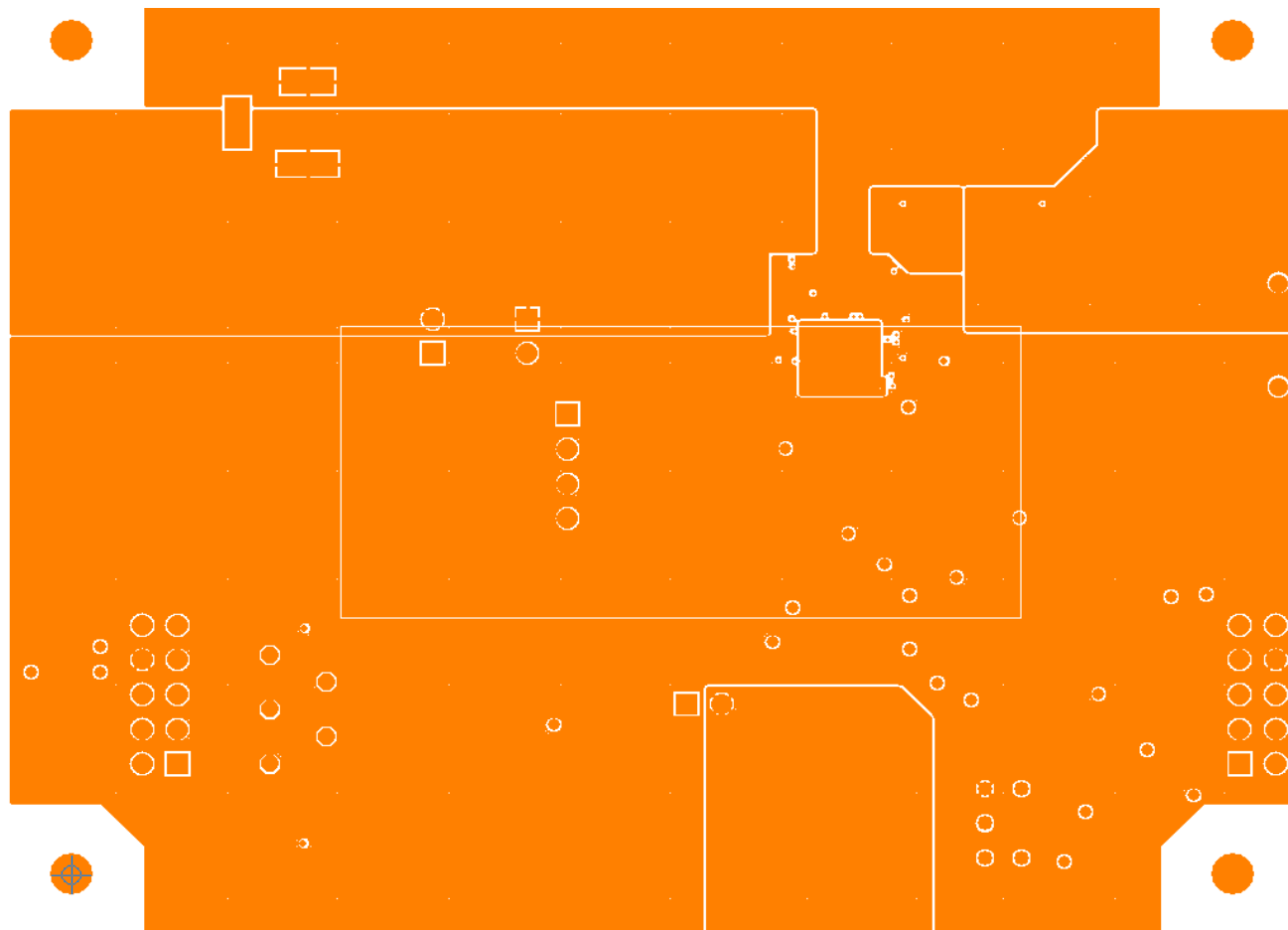


FIGURE 8. PCB - INNER LAYER 3 (VIEWED FROM TOP)

Board Layout – 6 Layers (Continued)

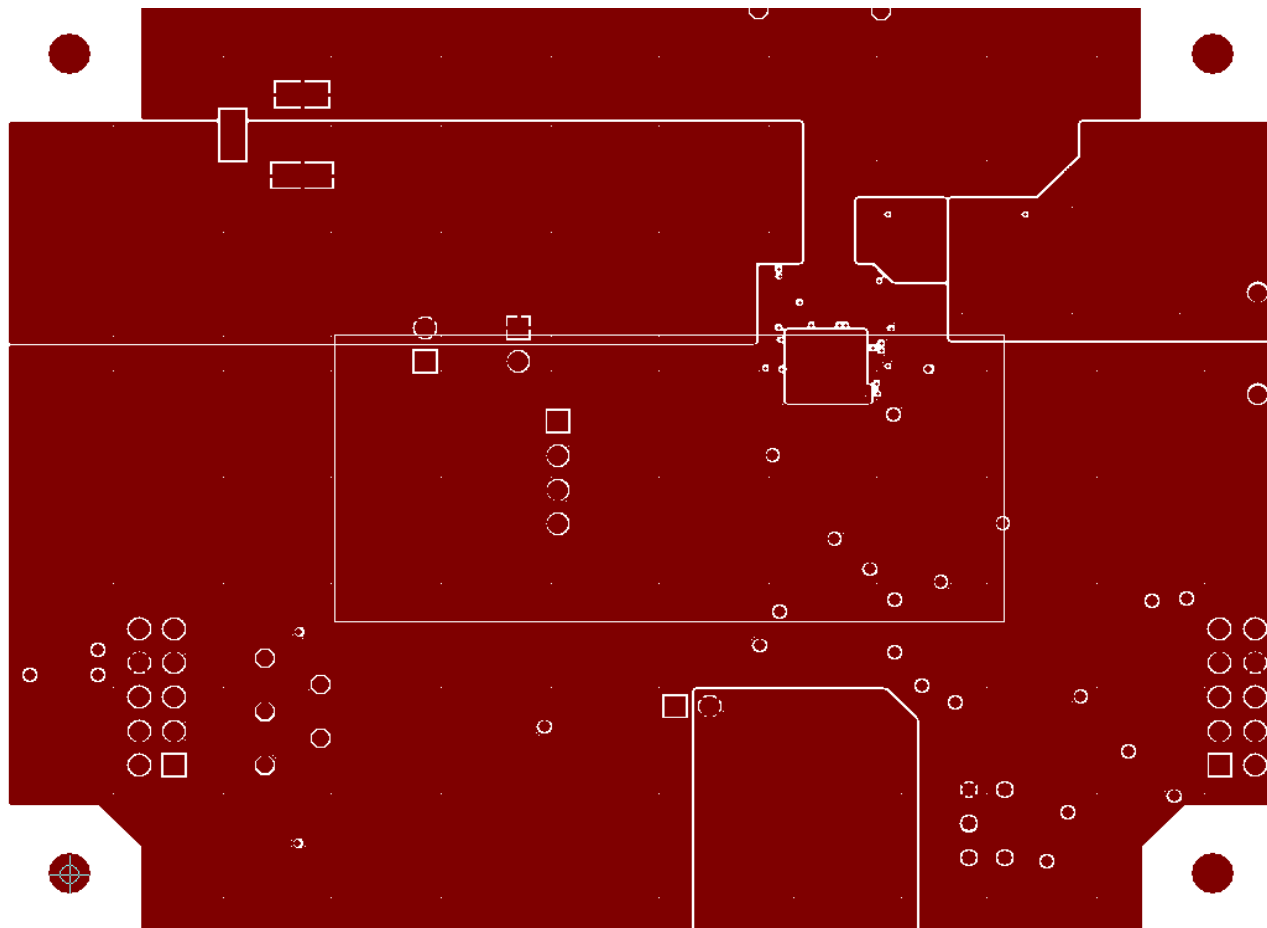
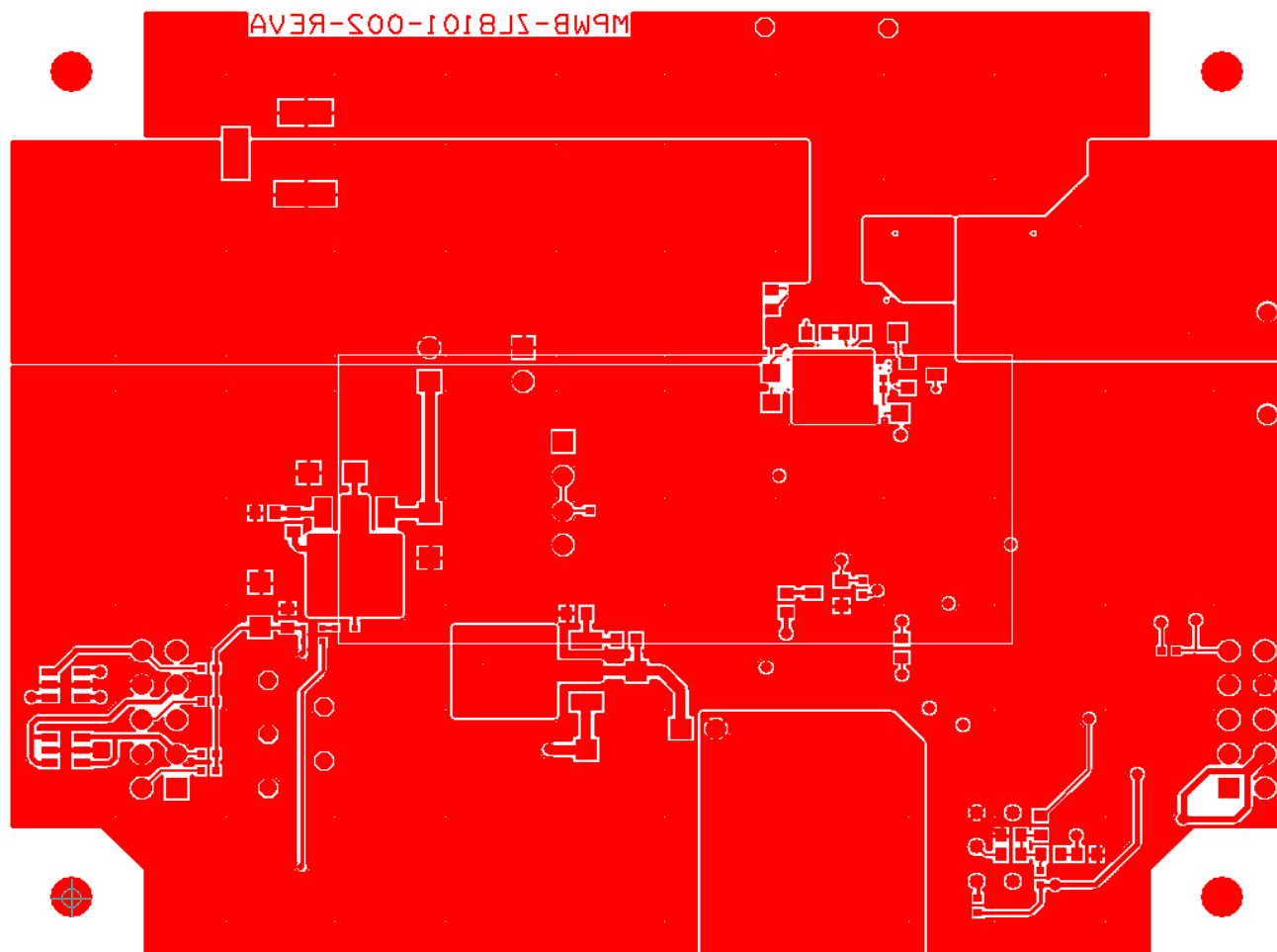


FIGURE 9. PCB - INNER LAYER 4 (VIEWED FROM TOP)

Board Layout – 6 Layers (Continued)**FIGURE 10. PCB - BOTTOM LAYER (VIEWED FROM TOP)**

Default Configuration Text

The following text is loaded into the ZL8101 device on the board as default settings. Each PMBus command is loaded via the PowerNavigator software. The # symbol is used for a comment line.

```
# Zilker Labs 8101 6/7/2012
# ZL Configuration File Revision A
# Schematic revision level
# BOM revision level
# Change log:
RESTORE_FACTORY
STORE_USER_ALL
STORE_DEFAULT_ALL
MFR_ID                Zilker_Labs
MFR_MODEL              30A
MFR_REVISION           REV_A
MFR_LOCATION           Austin
MFR_DATE               8/2012
MFR_SERIAL             1p0V_35A
VOUT_COMMAND           1.0
FREQUENCY_SWITCH        533
POWER_GOOD_DELAY        5
IOUT_SCALE              0.30
IOUT_CAL_OFFSET         -2.0
TON_DELAY               5
TON_RISE                 5
TOFF_DELAY              5
TOFF_FALL               5
VOUT_OV_FAULT_RESPONSE 0x80
VOUT_UV_FAULT_RESPONSE 0x80
OVUV_CONFIG             0x80
IOUT_OC_FAULT_LIMIT     50
IOUT_AVG_OC_FAULT_LIMIT 45
IOUT_UC_FAULT_LIMIT     -40
IOUT_AVG_UC_FAULT_LIMIT -40
MFR_IOUT_OC_FAULT_RESPONSE 0x80
MFR_IOUT_UC_FAULT_RESPONSE 0x80
MFR_VMON_OV_FAULT_LIMIT 7.0
VMON_OV_FAULT_RESPONSE 0x80
MFR_VMON_UV_FAULT_LIMIT 4.5
VMON_UV_FAULT_RESPONSE 0x80
VIN_OV_WARN_LIMIT       14.3
VIN_OV_FAULT_LIMIT      14.5
VIN_OV_FAULT_RESPONSE   0x80
VIN_UV_WARN_LIMIT        4.2
VIN_UV_FAULT_LIMIT       4.0
VIN_UV_FAULT_RESPONSE   0x80
OT_WARN_LIMIT            110.0
OT_FAULT_LIMIT           125
OT_FAULT_RESPONSE        0x80
UT_WARN_LIMIT            -20
UT_FAULT_LIMIT           -40
```

| | |
|---------------------|-----------------------------------|
| UT_FAULT_RESPONSE | 0x00 |
| DEADTIME | 0x0C0C |
| DEADTIME_CONFIG | 0x8686 |
| DEADTIME_MAX | 0x0C0C |
| MAX_DUTY | 94 |
| TRACK_CONFIG | 0x00 |
| INTERLEAVE | 0x0000 |
| #SEQUENCE | 0x0000 |
| MFR_CONFIG | 0x6A10 |
| NLR_CONFIG | 0x00000000 |
| TEMPCO_CONFIG | 0x28 |
| MISC_CONFIG | 0x2000 |
| ISHARE_CONFIG | 0x0000 |
| AUTO_COMP_CONFIG | 0x79 |
| PID_TAPS | A=6504.62, B=-11568.50, C=5078.00 |
| USER_CONFIG | 0x0011 |
| DDC_GROUP | 0x00000000 |
| #DDC_CONFIG | 0x0000 |
| INDUCTOR | 0.22 |
| ON_OFF_CONFIG | 0x1A |
| STORE_DEFAULT_ALL | |
| RESTORE_DEFAULT_ALL | |

Measured Data The following data was acquired using a ZL8101_30AEV2Z 30A Demo Board.

EFFICIENCY

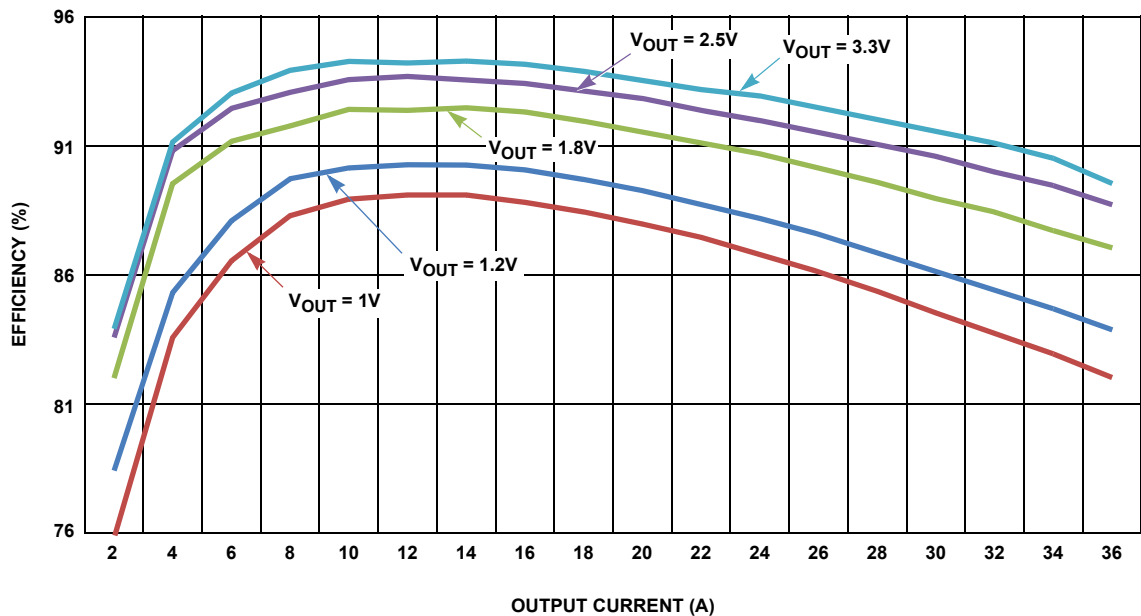


FIGURE 11. EFFICIENCY FOR DIFFERENT OUTPUT VOLTAGES, $V_{IN} = 12V$, $F_{SW} = 533kHz$

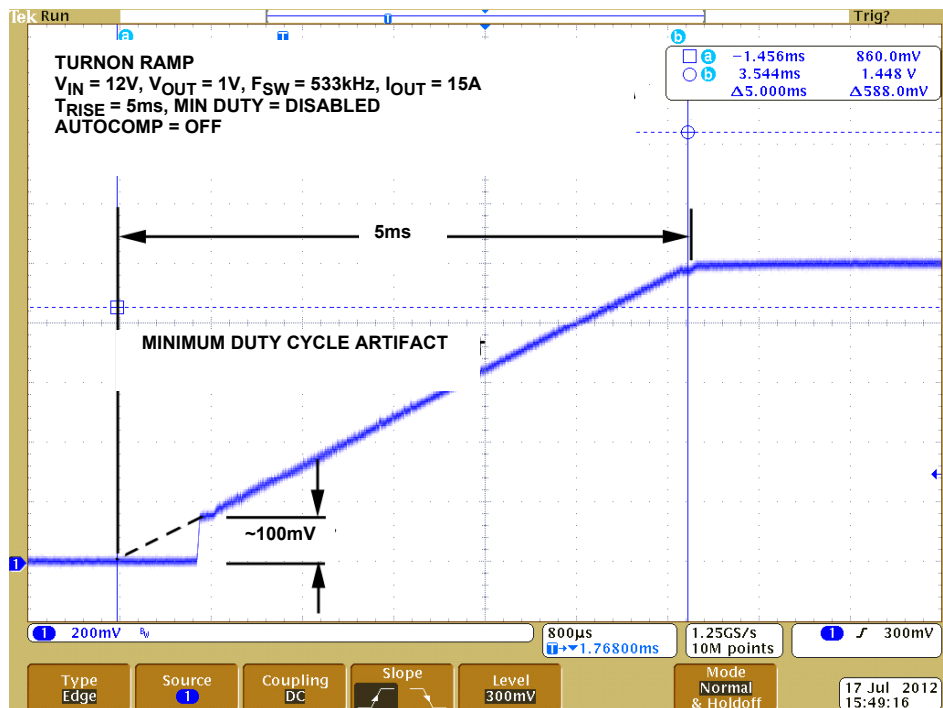


FIGURE 12. RAMP UP

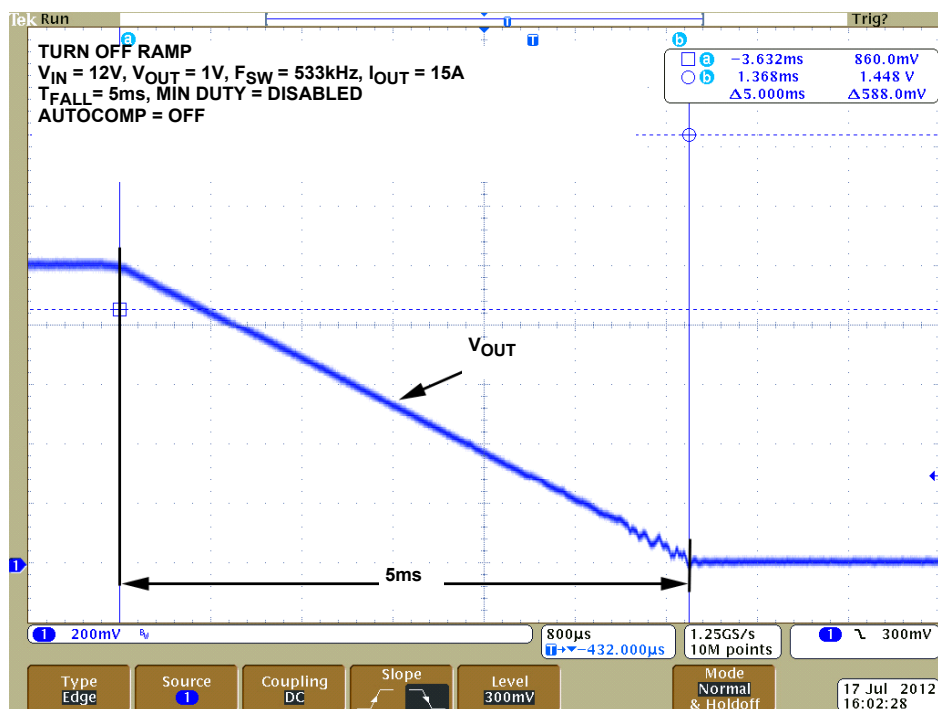


FIGURE 13. RAMP DOWN

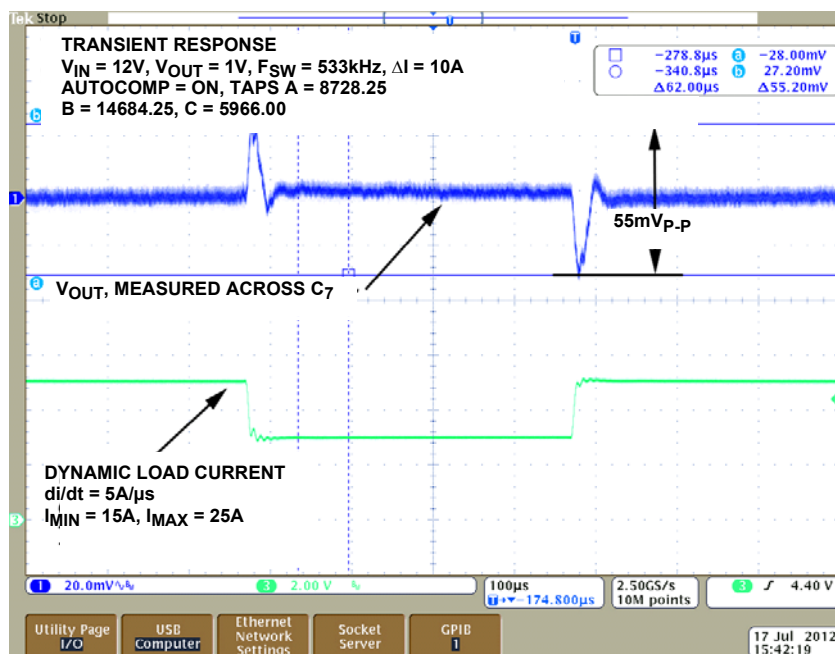


FIGURE 14. DYNAMIC RESPONSE, 10A TO 25A (AND VICE VERSA) LOAD STEP

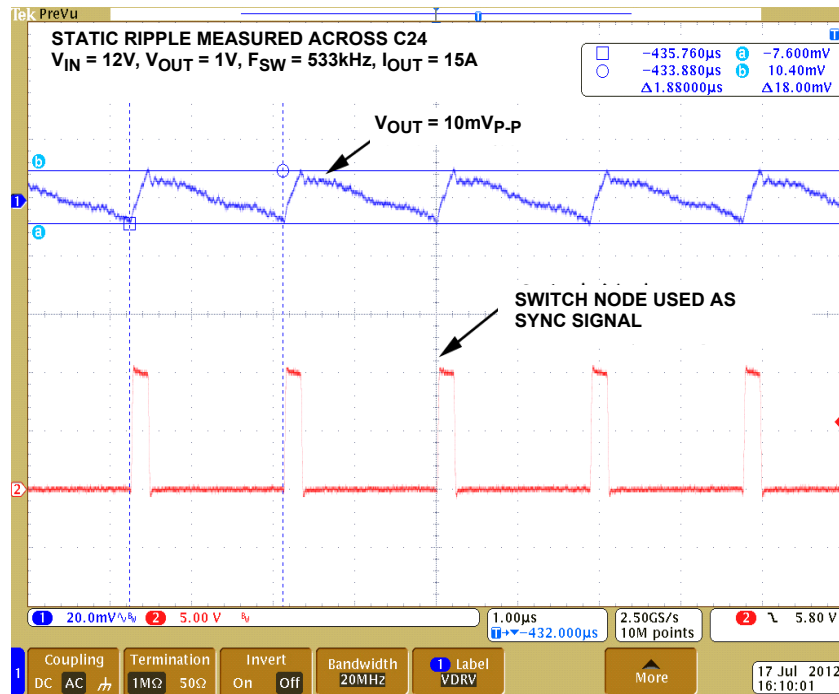


FIGURE 15. OUTPUT VOLTAGE RIPPLE WHEN $V_O = 1V$, $I_O = 25A$, $V_{IN} = 12V$, $F_{SW} = 800kHz$

References

- [1] [ZL8101](#) Data Sheet, Zilker Labs, Inc., 2012.
- [2] [AN2033](#) – PMBus™ Command Set, Zilker Labs, Inc., 2009.

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