

ZL2008EVAL1Z

Evaluation Board

AN1517  
Rev 1.00  
March 15, 2010

Description

The ZL2008 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 ZL2008 incorporates current sharing and adaptive efficiency-optimization algorithms to provide a flexible, efficient power IC building block.

The ZL2008EVAL1Z platform is a 4-layer board demonstrating a 15A 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 eval board to a PC. The PMBus command set is accessed by using the Zilker Labs PowerNavigator™ evaluation software from a PC running Microsoft Windows.

Features

- 15A synchronous buck converter
- Optimized for small circuit footprint and dynamic response
- Configurable through SMBus
- Onboard enable switch
- Power good indicator

Target Specifications

- $V_{IN} = 12V$
- $V_{OUT} = 1.2V/15A$  (20A max)
- $f_{sw} = 615kHz$
- Efficiency: 86% at 10A
- Output ripple:  $\pm 1\%$
- Dynamic response:  $\pm 3\%$   
(50%-100%-50% load step,  $di/dt = 2.5A/\mu s$ )
- Board temperature:  $+25^{\circ}C$

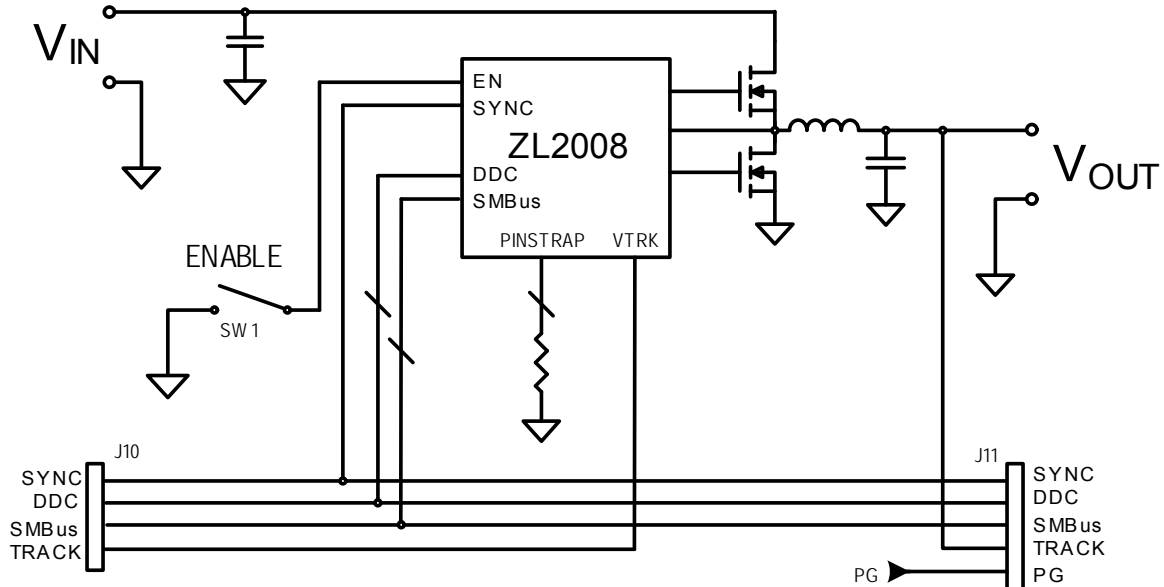


FIGURE 1. ZL2008EVAL1Z BLOCK DIAGRAM

## Functional Description

The ZL2008EVAL1Z provides all circuitry required to demonstrate the features of the ZL2008. The ZL2008EVAL1Z has a functionally-optimized ZL2008 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 ZL2008 such as soft-start delay and ramp times, supply sequencing, voltage tracking, and voltage margining are available on this evaluation board. For voltage tracking and sequencing evaluation, the board can be connected to any other Zilker Labs evaluation board that supports the Digital DC (DDC) bus.

Figure 1 shows a functional block diagram of the ZL2008EVAL1Z board. The SMBus address is selectable through a jumper on the top side of the board. All power to the board (VIN and I<sup>2</sup>C bus) must be removed before changing the jumpers.

The hardware enable function is controlled by a toggle switch on the ZL2008EVAL1Z board. The power good (PG) LEDs indicate the correct state of PG when external power is applied to the ZL2008EVAL1Z board. The right angle headers at opposite ends of the board are for connecting a USB to SMBus adapter board or for daisy chaining of multiple evaluation boards.

Figure 2 shows the operational circuit. The circuit consists of the ZL2008 IC with its minimal component count to realize a 15A buck converter. The board layout has been optimized for thermal performance. Figure 3 is the board interface circuitry. Figure 4 through Figure 8 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 ZL2008 utilizes the PMBus protocol. The PMBus functionality can be controlled via USB from a PC running the PowerNavigator evaluation software in a Windows XP or Windows 2000/NT operating system.

Install the evaluation software using the CD included in the ZL2008EVAL1Z kit.

For board operation, connect the included USB-to-SMBus adapter board to J10 of the ZL2008EVAL1Z 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 ZL2008 PMBus parameters. The ZL2008 device on the board has been pre-configured as described in this document, but the user may modify the operating parameters through

the eval 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 ZL2008EVAL1Z board can be tested. Alternately, the PMBus ON-OFF CONFIG and OPERATION commands may be used.

## Quick Start Guide

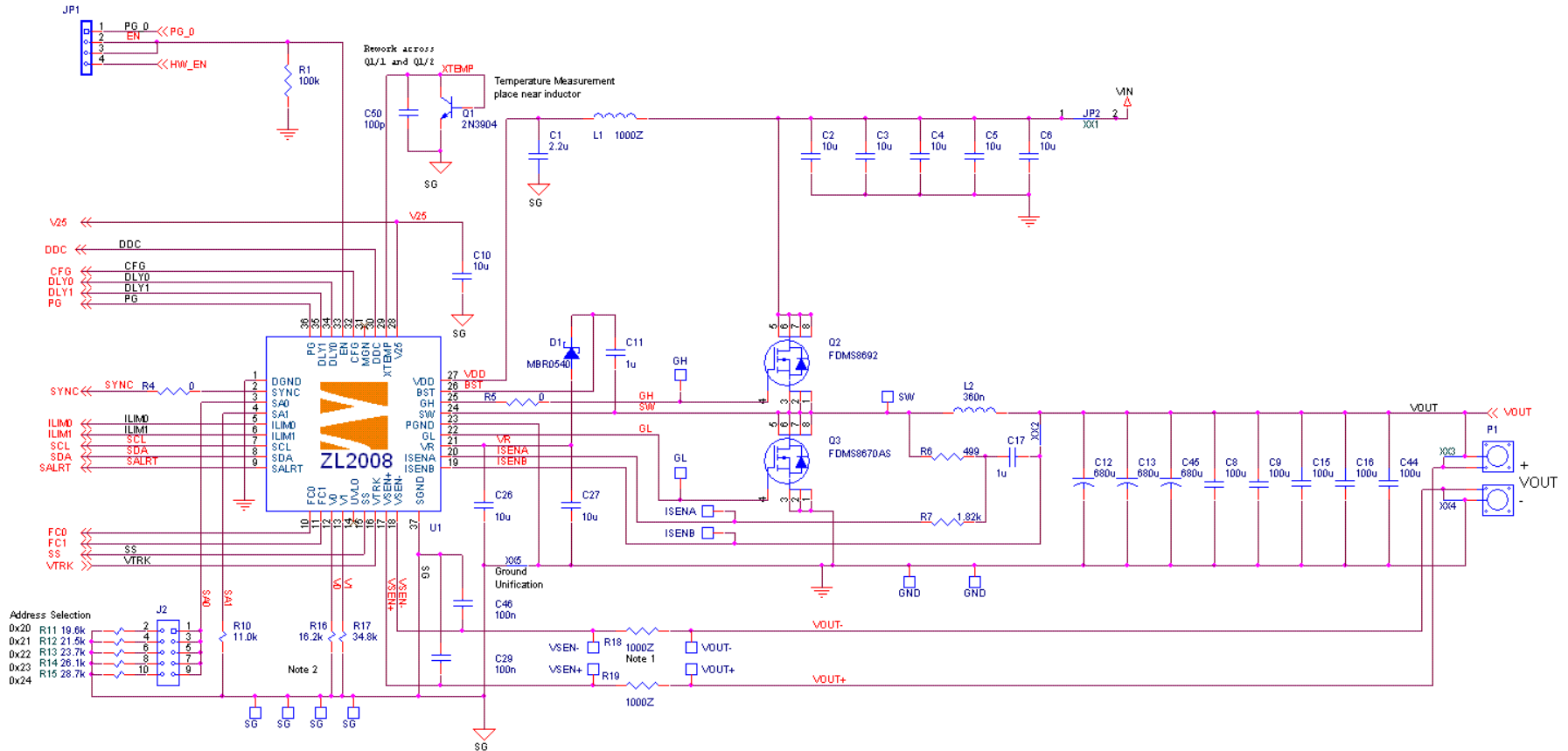
### Stand Alone Operation

1. Set ENABLE switch to "DISABLE"
2. Apply load to VOUT+/VOUT-
3. Connect the USB to SMBus adapter board to J10 of ZL2008EVAL1Z
4. Connect supplied USB cable from computer to USB to SMBus adapter board
5. Connect power supply to VIN+/VIN- (supply turned off)
6. Turn power supply on
7. Set ENABLE switch to "ENABLE"
8. Monitor ZL2008EVAL1Z 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 J10 of ZL2008EVAL1Z
7. Connect supplied USB cable from computer to USB to SMBus adapter board
  - Upon first-time connection, the Found New Hardware Wizard will appear.
  - Windows XP users: Select 'No' at prompt to search the Internet for drivers.
  - Follow the steps on the screen to install the drivers from the CD.
8. Install the PowerNavigator evaluation software by running setup.exe from the PowerNavigator\_installer folder on the CD.
9. Set ENABLE switch on EVB to "ENABLE"
10. Monitor and configure the ZL2008EVAL1Z board using PMBus commands in the evaluation software
11. Test the ZL2008EVAL1Z operation using an oscilloscope and the evaluation software.

# Board Schematics



**Notes:**

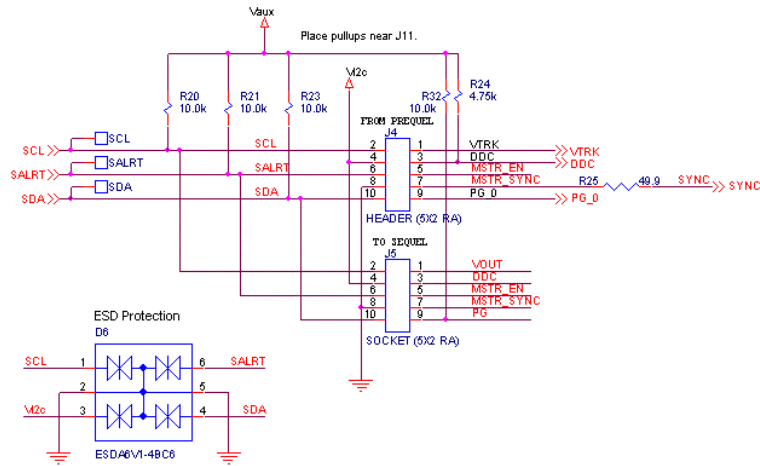
- 1) Frequency response measurement components. (backside)  
Substitute with 49.9 Ohm resistors for loop injection.
- 2) Vout is pinstrapped to 3.3V. Override with PMBus.  
Pinstrap output voltage can be modified to reduce the max output voltage.

NI = Not Installed

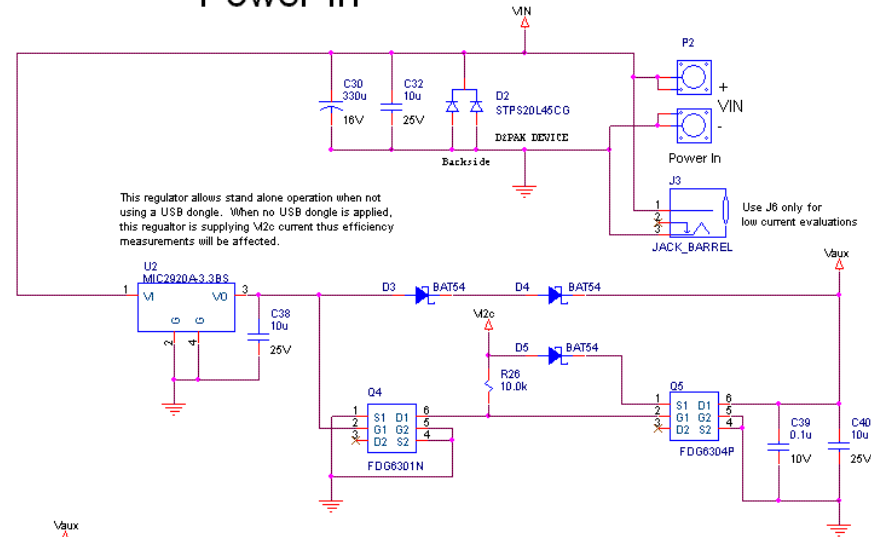
**FIGURE 2. ZL2008EVAL1Z OPERATIONAL CIRCUIT**

# Board Schematics (Continued)

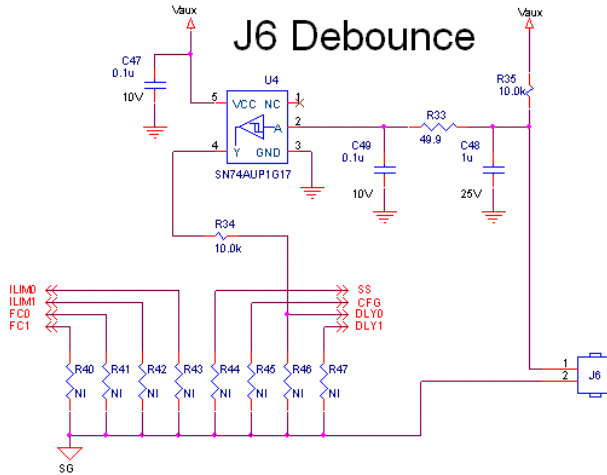
## Board to Board Interface



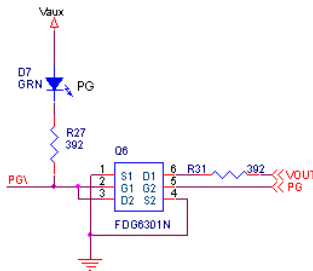
## Power In



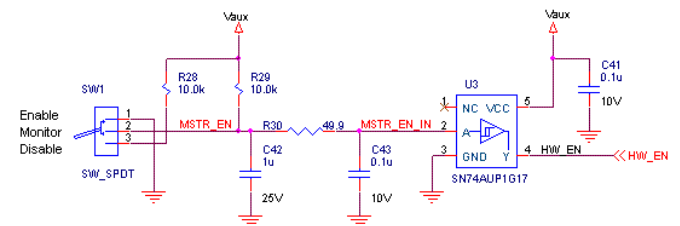
## J6 Debounce



## Power Good LED



## Enable Switch Debounce



## Auxiliary Pinstrap

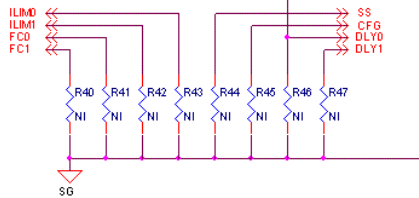


FIGURE 3. ZL2008EVAL1Z INTERFACE CIRCUITRY

# Board Layout – 4 Layers

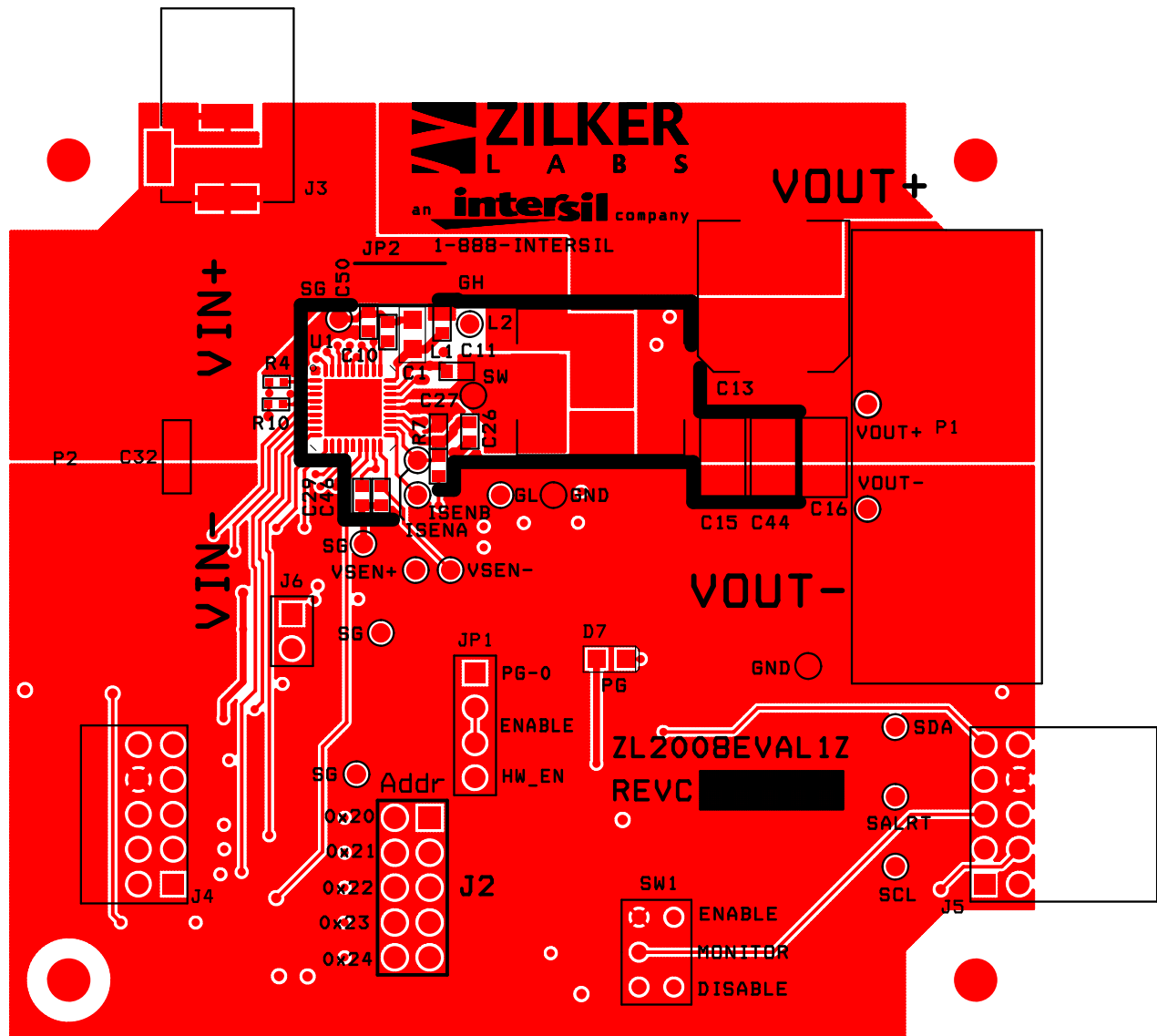


FIGURE 4. PCB – TOP LAYER

## Board Layout – 4 Layers (Continued)

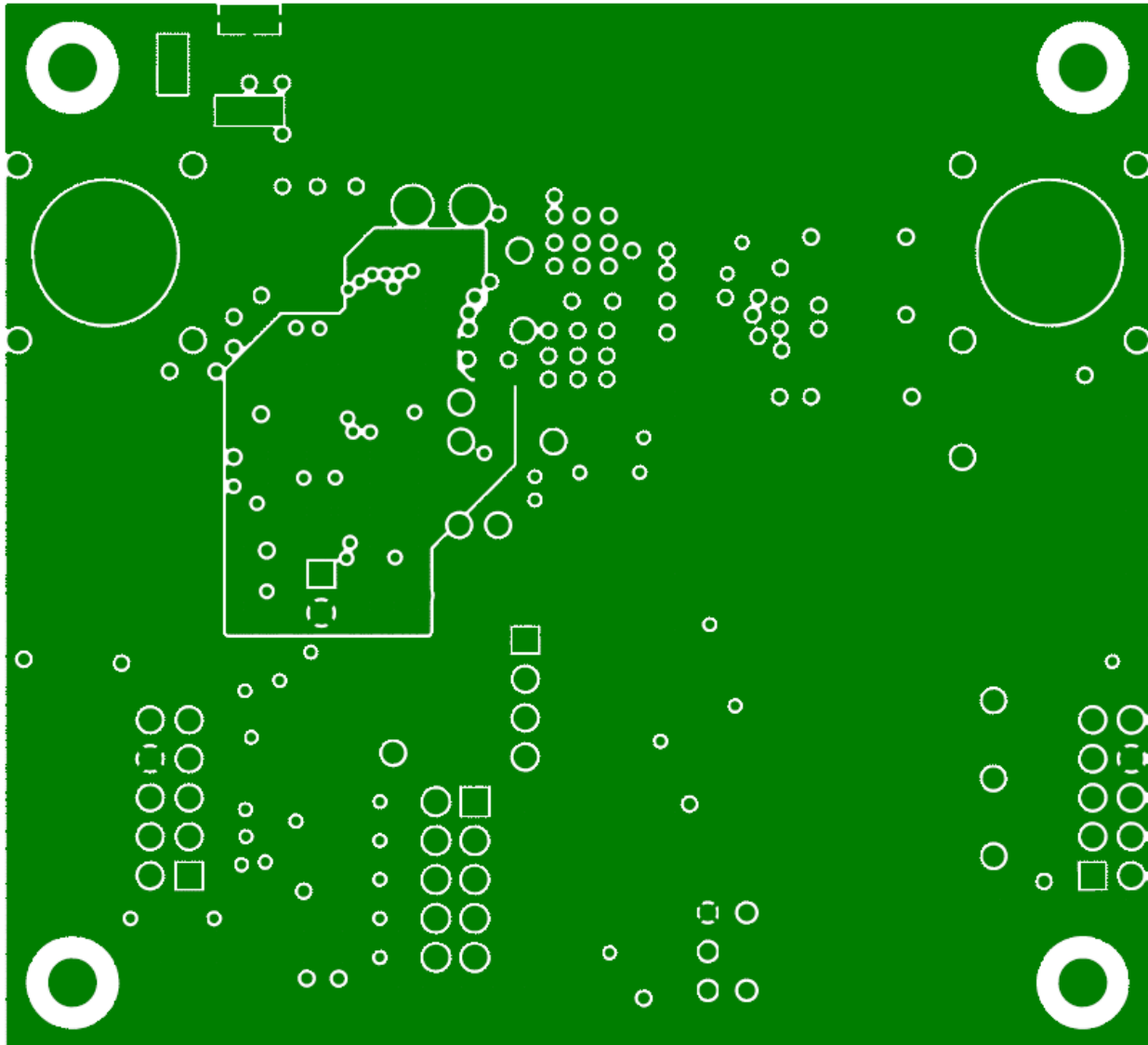


FIGURE 5. PCB – INNER LAYER 1 (VIEWED FROM TOP)

## Board Layout – 4 Layers (Continued)

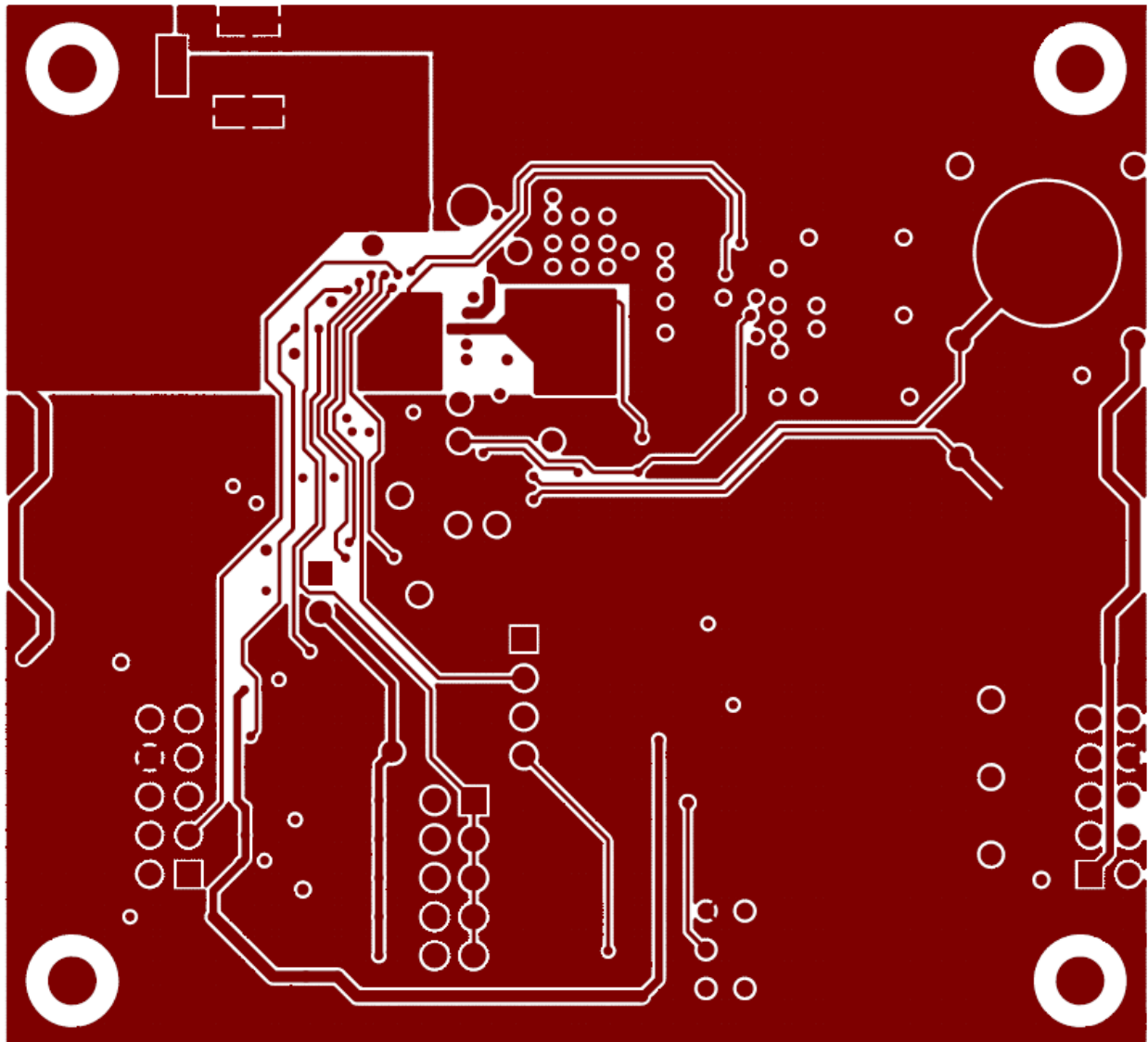


FIGURE 6. PCB – INNER LAYER 2 (VIEWED FROM TOP)

## Board Layout – 4 Layers (Continued)

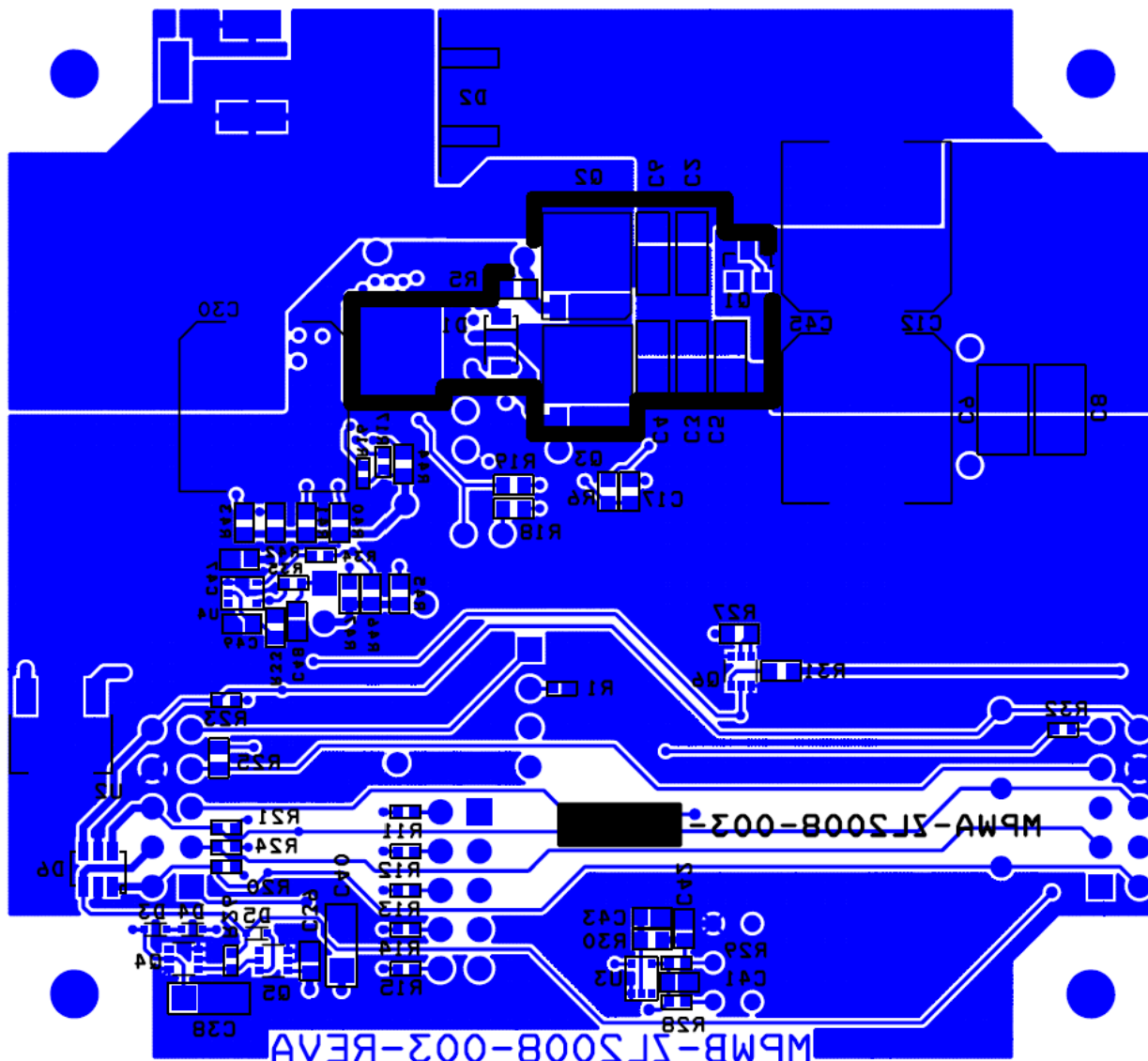


FIGURE 7. PCB – BOTTOM LAYER (VIEWED FROM TOP)



## NOTES UNLESS OTHERWISE SPECIFIED:

1. FABRICATE USING ARTWORK AND DRILL FILES PER TABLE BELOW.
2. FINISHED BOARDS MUST CONFORM TO ZILKER LABS QUALITY PROCEDURE SQAS-002-PCBREQ.
3. MATERIAL: NEMA GRADE FR-4; MINIMUM UL FLAMMABILITY RATING 94 V-0  
BOARD LAYER SPACING  
SPACING BETWEEN 1-2 = .013 TO .017  
SPACING BETWEEN 3-4 = .013 TO .017  
TOTAL BOARD THICKNESS = .062
4. COPPER THICKNESS SHALL BE 1 OZ. INNER LAYERS, 1 OZ. PLATED TO 2 OZ. OUTER LAYERS.
5. REFERENCE POINT 0,0 FOR DRILL FILE LISTING.
6. ALL HOLES PLATED THROUGH (UNLESS OTHERWISE NOTED). PLATING IN HOLES PER ZILKER LABS QUALITY PROCEDURE SQAS-002-PCBREQ.
7. BOARD COATING SHALL BE SOLDERMASK OVER BARE COPPER, HOT AIR SOLDER LEVELING.
8. SOLDERMASK PER ZILKER LABS QUALITY PROCEDURE SQAS-002-PCBREQ.
9. VENDOR IDENTIFICATION, UL COMPLIANCE AND DATE CODE TO BE PERMANENTLY AFFIXED AND LOCATED AS SHOWN, ON BOTTOM TRACE LAYER.
10. ELECTRICAL TEST MARK, ON BOTTOM TRACE LAYER, PER ZILKER LABS QUALITY PROCEDURE SQAS-002-PCBREQ.
11. FIDUCIALS TOP AND BOTTOM THESE LOCATIONS.
12. WARNING: THE MANUFACTURING PROCESSES AND THE MATERIALS ASSOCIATED WITH THIS PART MAY REQUIRE SPECIAL SAFETY PRECAUTIONS.

FIGURE 8. BOARD FABRICATION NOTES

# Bill of Materials

SCHEMATIC, ZL2008EVAL1Z			Bill Of Materials							Page1	
ITEM	QTY	REFDES	VALUE	TOL	RATING	TYPE	PCB FOOTPRINT	MFR	MFR PN	DIST	DIST PN
1	1	C1	2.2u	10%	16V	X5R	SM0605	MURATA	GRM21BR61C225KA88L	DIGIKEY	490-3331-2-ND
2	3	C2,C3,C4	10u	10%	25V	X5R	SM1206	PANASONIC-ECG	ECJ-3YB1E106K	DIGIKEY	PCC2414TR-ND
3	2	C8,C9	100u	20%	6.3V	X5R	SM1210	TAIYO YUDEN	JMK325BJ107MY-T	DIGIKEY	587-1388-2-ND
4	3	C10,C26,C27	10u	20%	6.3V	X5R	SM0603	PANASONIC-ECG	ECJ-1VBOJ106M	DIGIKEY	PCC2395CT-ND
5	3	C11,C17,C42	1u	10%	25V	X5R	SM0603	TAIYO YUDEN	TMK107BJ105KA-T	DIGIKEY	587-1248-2-ND
6	2	C12,C13	680u	20%	6.3V	AL POLY	SM10P5X10P5/SM7343	UNITED CHEM-CON	APXA6R3ARA681MJC0G	DIGIKEY	565-3119-1-ND
7	2	C29,C46	270n	10%	10V	X7R	SM0603	ROHM	C0603C274KBRACU	DIGIKEY	399-4914-1-ND
8	1	C30	330u	20%	16V	AL POLY	SM_CAP_10.3X10.3_PXA	UNITED CHEM-CON	APXA160ARA331MJC0G	DIGIKEY	565-3081-2-ND
9	3	C32,C38,C40	10u	10%	25V	X7R	SM1206	PANASONIC-ECG	ECJ-13YB1E106K	DIGIKEY	PCC2414TR-ND
10	3	C39,C41,C43	0.1u	10%	10V	X7R	SM0603	KEMET	C0603C104KBRACU	DIGIKEY	399-1095-2-ND
11	2	C47,C49	0.1u	10%	10V	X7R	SM0603	KEMET	C0603C104KBRACU	DIGIKEY	399-1095-2-ND
12	1	C48	1u	10%	25V	X5R	SM0603	TAIYO YUDEN	TMK107BJ105KA-T	DIGIKEY	587-1248-2-ND
13	1	D1	MBR0540		40V	SCHOTTKY	SOD123	ON SEMI	MBR0540T1	DIGIKEY	MBR0540T1OSTR-ND
14	1	D2	STPS20L45CG		45V-20A	SCHOTTKY-2CC	D-2PAK	ST MICRO	STPS20L45CG	DIGIKEY	497-2752-5-ND
15	3	D3,D4,D5	BAT54		30V	SCHOTTKY	SOD523	ON SEMI	BAT54XV2T1OS	DIGIKEY	BAT54XV2T1OSTR-ND
16	1	D6	ESDA6V1-4BC6		6.1V, 80W		SOT23_6L	ST MICRO	ESDA6V1-4BC6	DIGIKEY	497-4643-2-ND
17	1	D7	GRN		2V	VERT	SM0605	CHICAGO MINIATURE	CMD17-21VGC	MOUSER	606-CMD17-21VGC
18	1	JP1	4 PIN				SIP4/100	TYCO/AMP	3-644456-4	DIGIKEY	A31114-ND
19	1	J2	HEADER 5x2 PIN			VERT	HDR10DUAL100X100	SAMTEC	TSW-105-07-T-D		
20	1	J3	JACK_BARREL		1.5A @ 18V	RA	JACK_RA.079PIN	KOBICONN	163-5004-E	MOUSER	163-5004-E
21	1	J4	HEADER (5X2 RA)			RA	HDR10DUAL100X100	SAMTEC	TSW-105-08-T-D-RA		
22	1	J5	SOCKET (5X2 RA)			RA	HDRF5DUALRA100X100	SAMTEC	SSQ-105-02-T-D-RA		
23	1	J6	2 POS			VERT	SIP2/100	SAMTEC	TSW-102-07-L-S		
24	3	L1,R18,R19	1000Z		50mA	FERRITE	SM0603	MURATA	BLM18HD102SN1D	DIGIKEY	490-1031-1-ND
25	1	L2	360n	20%	35A	POWDER	IHLP_4040DZ_05	VISHAY	IHLP4040DZERR36M61	MOUSER	70-IHLP4040DZERR36M61
26	2	P1,P2	JACK_DUAL_BANANA		15A		JACK_F_NI_2P.750SP_175PL	EMERSON	108-0740-001	DIGIKEY	J147-ND
27	1	Q1	2N3904		40V	NPN	SOT-23	ON SEMI	MMBT3904LT3G	DIGIKEY	MMBT3904LT3GOSTR-ND
28	1	Q2	FDMS8692		30V	N-CH	FLMP/S08FL_ALLP	FAIRCHILD	FDMS8692	DIGIKEY	FDMS8692TR-ND
29	1	Q3	FDMS8670AS		30V	N-CH	FLMP/S08FL_ALLP	FAIRCHILD	FDMS8670AS	DIGIKEY	FDMS8670ASTR-ND
30	2	Q4,Q6	FDG6301N		25V	DUAL N-CH	SC70_6	FAIRCHILD	FDG6301N	DIGIKEY	FDG6301NCT-ND
31	1	Q5	FDG6304P		25V	DUAL P-CH	SC70_6	FAIRCHILD	FDG6304P	DIGIKEY	FDG6304PTR-ND
32	1	R1	100k	1%	63mW	THK FILM	SM0402	VISHAY	CRCW0402100KFED	DIGIKEY	541-100KLTR-ND
33	1	R4	0	5%	63mW	THK FILM	SM0402	ROHM	MCR01MZPJ000	DIGIKEY	RHM0.0JTR-ND
34	1	R5	0	5%	100mW	THK FILM	SM0603	YAGEO	RC0603JR-070RL	DIGIKEY	311-0.0GRTR-ND
35	1	R6	499	1%	100mW	THK FILM	SM0603	PANASONIC-ECG	ERJ-3EKF4990V	DIGIKEY	P499HTR-ND
36	1	R7	1.82k	1%	100mW	THK FILM	SM0603	PANASONIC-ECG	ERJ-3EKF1821V	DIGIKEY	P1.82KHTR-ND
37	1	R10	11.0k	1%	63mW	THK FILM	SM0402	VISHAY	CRCW040211K0FKED	DIGIKEY	541-11.0KLTR-ND
38	1	R11	19.6k	1%	63mW	THK FILM	SM0402	VISHAY	CRCW040219K6FKED	DIGIKEY	541-19.6KLTR-ND
39	1	R12	21.5k	1%	63mW	THK FILM	SM0402	VISHAY	CRCW040221K5FKED	DIGIKEY	541-21.5KLTR-ND
40	1	R13	23.7k	1%	63mW	THK FILM	SM0402	VISHAY	CRCW040223K7FKED	DIGIKEY	541-23.7KLTR-ND
41	1	R14	26.1k	1%	63mW	THK FILM	SM0402	VISHAY	CRCW040226K1FKED	DIGIKEY	541-26.1KLTR-ND
42	1	R15	28.7k	1%	63mW	THK FILM	SM0402	VISHAY	CRCW040228K7FKED	DIGIKEY	541-28.7KLTR-ND
43	1	R16	16.2k	1%	63mW	THK FILM	SM0402	PANASONIC-ECG	ERJ-2RKF1622X	DIGIKEY	P16.2KLCT-ND
44	1	R17	34.8k	1%	63mW	THK FILM	SM0402	PANASONIC-ECG	ERJ-2RKF3482X	DIGIKEY	P34.8KLCT-ND
45	7	R20,R21,R23,R26,R28,R29,R32	10.0k	1%	63mW	THK FILM	SM0402	YAGEO	RC0402FR-0710KL	DIGIKEY	311-10.0KLRTR-ND
46	1	R24	4.75k	1%	63mW	THK FILM	SM0402	PANASONIC-ECG	ERJ-2RKF4751X	DIGIKEY	P4.75KLTR-ND
47	2	R25,R30	49.9	1%	100mW	THK FILM	SM0603	ROHM	MCR03EZPFX49R9	DIGIKEY	RHM49.9HTR-ND
48	2	R27,R31	392	1%	100mW	THK FILM	SM0603	PANASONIC-ECG	ERJ-3EKF3920V	DIGIKEY	P392HTR-ND
49	1	R33	49.9	1%	100mW	THK FILM	SM0603	ROHM	MCR03EZPFX49R9	DIGIKEY	RHM49.9HTR-ND
50	2	R34,R35	10.0k	1%	63mW	THK FILM	SM0402	YAGEO	RC0402FR-0710KL	DIGIKEY	311-10.0KLRTR-ND
51	1	SW1	SW_SPDT			PCB VERT	SW_TOG_ULTRAMIN_SPDT	NKK	G13AP-RO	MOUSER	633-G13AP-RO
52	1	U1	ZL2008				MLF36_6X6BX	INTERSIL	ZL2008ALNFT		
53	1	U2	MIC2920A-3.3BS				SOT223_1234_FLD	MICREL	MIC2920A-3.3WVS	DIGIKEY	576-1116-1-ND
54	1	U3	SN74AUP1G17			TTL	SC70_5	TI	SN74AUP1G17DCKR	DIGIKEY	296-18209-1-ND
55	1	U4	SN74AUP1G17			TTL	SC70_5	TI	SN74AUP1G17DCKR	DIGIKEY	296-18209-1-ND
56	2	J2:1-2, JP1:3-4	SHUNT_HDR_WITH_TAB				SHUNT_HDR_WITH_TAB	TYCO	881545-2	DIGIKEY	A26242-ND
57	4	Corners	STANDOFF_#4-40.75LG				STANDOFF_4-40			DIGIKEY	3481K-ND
58	4	Corners	SCREW_#4-40.25LG_ZP_PH_PLHP			PHL	SCREW_4-40	BUILDING FASTENERS	PMS 440 0025 PH	DIGIKEY	H342-ND
59	4	(P1, P2)	CAP_MOLDED.25ID_BLK				CAP_MOLDED.25ID	CAPPLUGS	VC-234-8		
60	1		PCB			FR-4		ZILKER LABS INC	MPWB-ZL2008-003		

## Configuration Text

The following configuration text is loaded into the ZL2008 device on the ZL2008EVAL1Z. The configuration is stored in the DEFAULT store. Each PMBus command can be viewed via the PowerNavigator software. The text following the # symbol is used for a comment.

```
#ZL2008
#PowerPlan file
#11/30/2009
#NOTE: This file is intended for the ZL2008EVAL1Z
#with L=400nH, Co=5x(100uF/2.0mohm)+(2X680uF/10mohm)

#Configuration File Format:
#PMBus Command <tab> Hex Value

#Erase user store & default store
RESTORE_FACTORY
STORE_USER_ALL
STORE_DEFAULT_ALL

MFR_ID                Zilker_Labs
MFR_MODEL              ZL2008EVAL1Z
MFR_REVISION           Rev7
MFR_LOCATION           Austin_TX
#MFR_DATE

VOUT_COMMAND           1.20#V

IOUT_SCALE              0.7  #mOhm
IOUT_CAL_OFFSET        2    #A

IOUT_OC_FAULT_LIMIT    45.0    #A
IOUT_AVG_OC_FAULT_LIMIT 38.0    #A
IOUT_UC_FAULT_LIMIT    -15.0    #A
IOUT_AVG_UC_FAULT_LIMIT -12.0    #A
MFR_IOUT_OC_FAULT_RESPONSE 0x80
MFR_IOUT_UC_FAULT_RESPONSE 0x80

VIN_OV_FAULT_LIMIT     14.0    #V
VIN_OV_WARN_LIMIT      13.5    #V
VIN_OV_FAULT_RESPONSE  0x80
VIN_UV_WARN_LIMIT      4.641    #V
VIN_UV_FAULT_LIMIT     4.50    #V
VIN_UV_FAULT_RESPONSE  0x80

POWER_GOOD_DELAY       1    #ms
TON_DELAY               5    #ms
TON_RISE                5    #ms
TOFF_DELAY              5    #ms
TOFF_FALL               5    #ms

DEADTIME                0x2424
DEADTIME_CONFIG         0x0404

MAX_DUTY                95
INDUCTOR                0.4  #uH

FREQUENCY_SWITCH        400  #kHz

PID_TAPS                A=13682.50, B=-23641.00, C=9993.75
```

## Configuration Text (Continued)

# Advanced

USER_CONFIG	0x6010
MFR_CONFIG	0x6AD5
#NLR_CONFIG	0xE1060C00
TEMPCO_CONFIG	0xA8

# Advanced 2

MISC_CONFIG	0x0080
DDC_CONFIG	0x0101
DDC_GROUP	0x00000000

STORE\_DEFAULT\_ALL  
RESTORE\_DEFAULT\_ALL

## Measured Data

The following data was acquired using a ZL2008EVAL1Z rev 2 evaluation board.

### Efficiency

Adaptive diode emulation and adaptive frequency modes are disabled for these efficiency measurements.

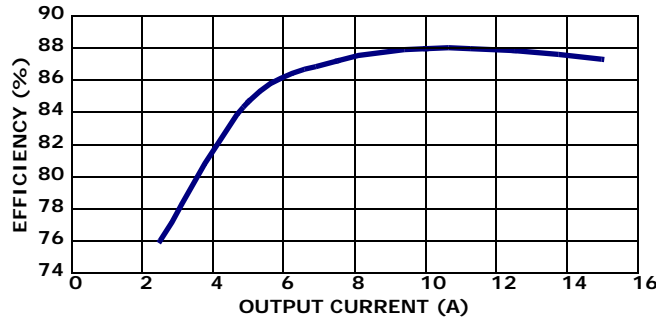


FIGURE 9. EFFICIENCY,  $V_{IN} = 12V$ ,  $V_{OUT} = 1.2V$

### Ramp-up/Ramp-down Characteristics

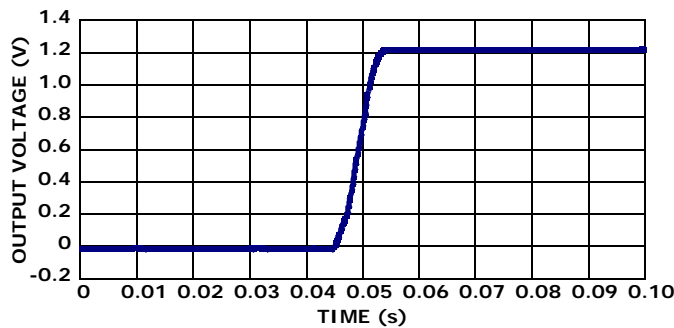


FIGURE 10. RAMP UP

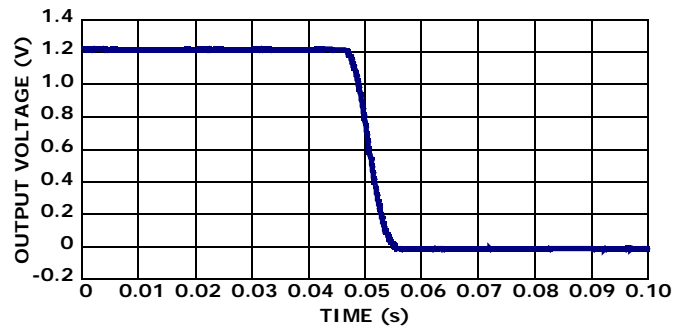


FIGURE 11. RAMP DOWN

### Dynamic Load Response

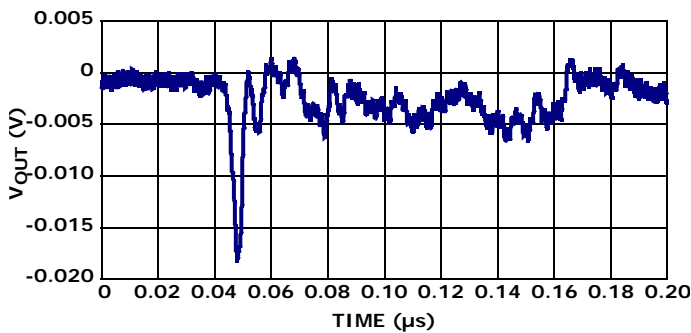


FIGURE 12. DYNAMIC RESPONSE, 7A TO 15A LOAD STEP

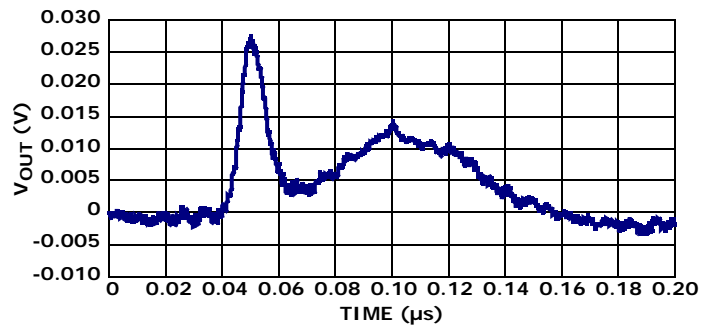


FIGURE 13. DYNAMIC RESPONSE, 15A TO 7A LOAD STEP

## References

ZL2008 Data Sheet, Zilker Labs, Inc., 2008.

AN2033 – PMBus™ Command Set, Zilker Labs, Inc., 2008.

## Ordering Information

ORDERABLE PART NUMBER	DESCRIPTION
ZL2008EVAL1Z	ZL2008 Evaluation Kit (EVB, USB Adapter, Cable, Software)

## Revision History

DATE	REV. #	DESCRIPTION
March 2010	AN1517.1	In "Target Specifications" on page 1, changed "Dynamic response: $\pm 2.5\%$ " to "Dynamic response: $\pm 3\%$ "
December 2009	AN1517.0	Initial release

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