

## ZL8800-2PH-DEMO1Z

Demonstration Board

AN1901  
Rev 0.00  
October 31, 2013

The ZL8800 is a digital 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 ZL8800 incorporates compensation-free ChargeMode control to achieve single-cycle transient response.

The ZL8800-2PH-DEMO1Z demonstration board is a 6-layer board demonstrating a 2 phase 60A synchronous buck converter. Sequencing, margining, plus other features can be evaluated using this demonstration board.

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

### Key Features

- 2 phase 60A synchronous buck converter with compensation-free ChargeMode control
- Designed to be easy to use and modify. Optimized for small circuit footprint and dynamic response
- Configurable through PMBus
- $V_{IN}$  range of 4.5V to 14V,  $V_{OUT}$  adjustable from 0.54 to 5.5V
- Enable switches and power-good indicators

### Ordering Information

PART NUMBER	DESCRIPTION
ZL8800-2PH-DEMO1Z	ZL8800 Demonstration Kit (EVB, USB Adapter, Cable)

### Target Specifications

- $V_{IN} = 12V$
- $V_{OUT} = 1.2V/60A$  max
- $f_{SW} = 400kHz$
- Efficiency: 91% at 40A
- Output Ripple:  $\pm 1\%$
- Dynamic response:  $\pm 1\%$  (50% to 100% to 50% load step,  $di/dt = 10A/\mu s$ )
- Board temperature:  $+25^{\circ}C$

### Functional Description

The ZL8800-2PH-DEMO1Z provides all circuitry required to demonstrate the features of the ZL8800. The ZL8800-2PH-DEMO1Z has a functionally-optimized ZL8800 circuit layout that allows efficient operation up to the maximum output current.

A majority of the features of the ZL8800, such as compensation-free ChargeMode control, soft-start delay and ramp times, supply sequencing, voltage tracking, and voltage margining are available on this demonstration board. For voltage tracking and sequencing demonstration, the board can be connected to any other Zilker Labs demonstration board that supports the Digital-DC™ (DDC) bus.

Figure 1 shows a simplified schematic diagram of the ZL8800-2PH-DEMO1Z board.

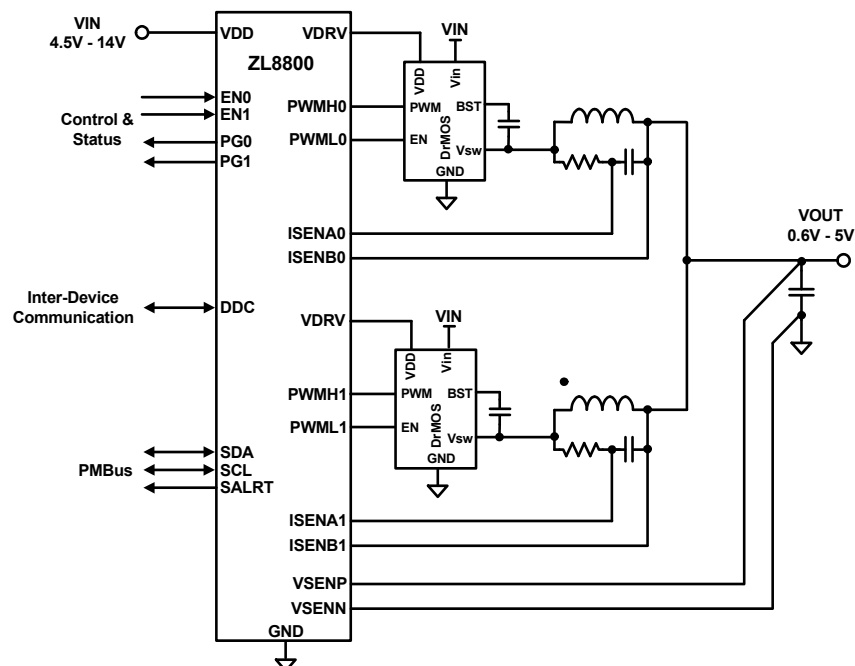


FIGURE 1. ZL8800-2PH-DEMO1Z SIMPLIFIED SCHEMATIC

The hardware enable function is controlled by a toggle switch on the ZL8800-2PH-DEMO1Z board. The power-good (PG) LEDs indicate the correct state of PG for each phase when external power is applied to the ZL8800-2PH-DEMO1Z board and the corresponding phase is functioning properly. The right angle headers at opposite ends of the board are for connecting a USB to PMBus adapter board or for daisy chaining multiple demonstration boards together to build multi-output configurations.

Figures 2 and 3 show the detailed demonstration circuit. Figure 2 shows the ZL8800 IC with its minimal component count to realize a 60A output. Figure 3 has interface circuitry unique to the demonstration board that is not typically contained in a user's application circuit. Figures 4 through 10 show typical performance data, and Figures 15 through 22 demonstrate the PCB board layout. The default configuration file is shown on page 6, and the Bill of Materials (BOM) is included for reference beginning on page 5.

## Operation

### PMBus Operation

The ZL8800 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 7 operating systems.

Install the evaluation software from the following Intersil website:

<http://www.intersil.com/en/products/power-management/zilker-labs-digital-power/powernavigator.html>

For board operation, connect the included USB-to-PMBus adapter board to J8 of the ZL8800-2PH-DEMO1Z board labeled "DONGLE". 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 switches in "DISABLE" and turn on the power.

The evaluation software allows modification of all ZL8800 PMBus parameters. The ZL8800 device on the board has been pre-configured as described in this document, but the user may modify the operating parameters through the evaluation software or by loading a predefined set-up from a configuration file.

The ENABLE switch can then be moved to "ENABLE" and the ZL8800-2PH-DEMO1Z board can be tested. Alternately, the PMBus ON\_OFF\_CONFIG and OPERATION commands may be used from the PowerNavigator GUI.

## Quick Start Guide

### Stand Alone Operation

1. Set ENABLE switch to "DISABLE"
2. Apply load to VOUT0 and/or VOUT1
3. Connect the USB to PMBus adapter board to J8 (labeled "DONGLE") of ZL8800-2PH-DEMO1Z
4. Connect supplied USB cable from computer to USB to PMBus adapter board
5. Connect power supply to VIN (supply turned off)
6. Turn power supply on
7. Set ENABLE switch to "ENABLE"
8. Monitor ZL8800-2PH-DEMO1Z board operation using an oscilloscope

### USB (PMBus) Operation

1. Set ENABLE switch to "DISABLE"
2. Apply load to VOUT and/or VOUT1
3. Connect power supply to VIN (supply turned off)
4. Turn power supply on
5. Connect USB to PMBus adapter board to J8 of ZL8800-2PH-DEMO1Z
6. Connect supplied USB cable from computer to USB to PMBus adapter board.

Install the PowerNavigator evaluation software from the following Intersil website:

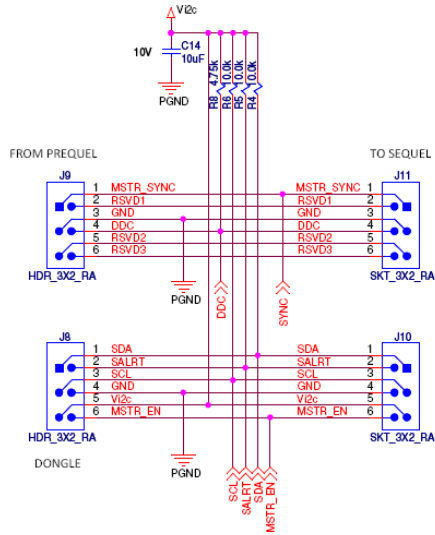
<http://www.intersil.com/en/products/power-management/zilker-labs-digital-power/powernavigator.html>

7. Set ENABLE switch to "ENABLE".
8. Monitor and configure the ZL8800-2PH-DEMO1Z board using PMBus commands in the evaluation software.
9. Test the ZL8800-2PH-DEMO1Z operation using an oscilloscope and the evaluation software.

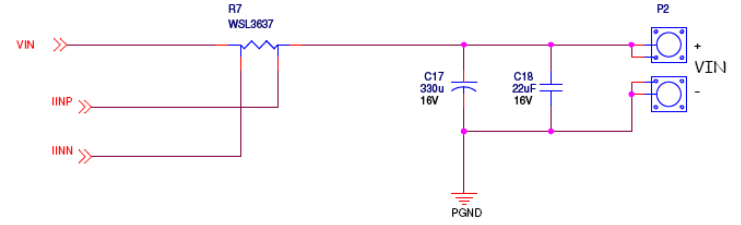


# ZL8800-2PH-DEMO1Z Board Schematics (Continued)

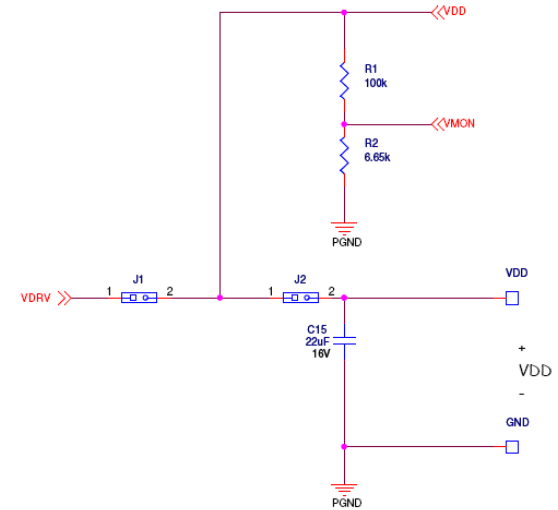
## BOARD TO BOARD INTERFACE



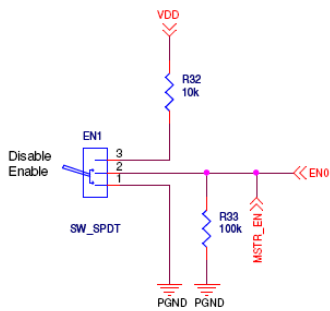
## INPUT CONNECTORS



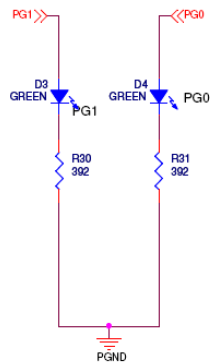
## DRIVER SUPPLY CONNECTORS



## ENABLE



## POWER GOOD



## TRACKING

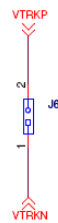


FIGURE 3. ZL8800-2PH-DEMO1Z AUXILIARY CIRCUITRY

## ZL8800-2PH-DEMO1Z Bill of Materials

QTY	REFERENCE	VALUE	TOL	RATING	TYPE	PCB FOOTPRINT	MFR	PART NUMBER
1	U2	ZL8800	-	14V	-	MLF44_7X7_XX	Intersil-Zilker Labs	ZL8800ALAFK
8	C1, C2, C3, C5, C6, C7, C8, C9	100µF	20%	6.3V	X5R	SM1210	Taiyo Yuden	JMK325BJ107MY-T
4	C4, C10, C11, C12	470µF	20%	2V	AL	SM7343P	Panasonic	EEF-SX0D471E4
5	C13, C46, C34, C48, C29	10µF	10%	10V	X5R	SM0805	Taiyo Yuden	LMK212B7106KG-TD
10	C15, C18, C30, C31, C32, C33, C42, C43, C44, C45	22µF	20%	16V	X5R	SM1206	Murata	GRM31CR61C226ME15L
1	C17	330u	20%	16V	AL POLY	SM_CAP_10.5X10.5	UNITED CHEMI	APXA160ARA331MJCOG
4	C47, C26, C28, C35	1µF	20%	16V	X7R	SM0603	TDK	C1608X7R1C105K
2	C27, C36	100p	5%	50V	NPO	SM0402_WSS	MURATA	GRM1555C1H101JZ01D
4	C38, C39, C41, C37	10µ	0.2	16V	X5R	SM0603	Taiyo Yuden	EMK107BBJ106MA-T
1	C40	2.2µ	10%	25V	X5R	SM0805	MURATA	GRM21BR71E225KA73L
2	L1, L2	0.231µH	5%	35A	FERRITE	IND_SLC1175	Coil Craft	SLC1175-231ME_
2	Q6, Q3	FDMF5821DC	-	60A/20V	DR MOS	PQFN40_5X5_P5S	Fairchild	FDMF5821DC
2	Q2, Q4	2N3904	-	40V	NPN	SOT-23	ON SEMI	MMBT3904LT1G
2	R1, R33	100k	1%	63mW	THK FILM	SM0603	Panasonic	ERJ-3EKF1003V
1	R2	6.65k	1%	63mW	THK FILM	SM0603	Panasonic	ERJ-3EKF6651V
1	R3	100	1%	100mW	THK FILM	SM0805	Panasonic	ERJ-6ENF1000V
1	R7	5mΩ	1%	3W	THK FILM	WSL3637	Vishay Dale	WSL36375L000FEA
2	R16, R11	1	5%	63mW	THK FILM	SM0603	Panasonic	ERJ-2RKF1R00X
2	R10, R12	953	1%	63mW	THK FILM	SM0603	Panasonic	ERJ-3EKF9530V
1	R18	28.7k	1%	50mW	THK FILM	SM0402	Panasonic	ERJ-3EKF2872V
1	R25	31.6k	1%	63mW	THK FILM	SM0603	Panasonic	ERJ-3EKF3162V
0	R26	90.9k	1%	63mW	THK FILM	SM0603	Panasonic	ERJ-3EKF9092V
2	R17, R13	30k	5%	63mW	THK FILM	SM0603	Panasonic	ERJ-3GEYJ303V
2	R14, R15	3.3Ω	5%	63mW	THK FILM	SM0603	Panasonic	ERJ-3GEYJ3R3V
<b>DEMONSTRATION BOARD SPECIFIC AUXILIARY PARTS BILL OF MATERIALS</b>								
2	R30, R31	392	1%	63mW	THK FILM	SM0603	Panasonic	ERJ-3EKF3920V
0	R24	NOT USED	-		-	SM0603	-	-
1	R8	4.75k	1%	63mW	THK FILM	SM0603	Panasonic	ERJ-2RKF4751X
4	R4, R5, R6, R32	10.0k	1%	63mW	THK FILM	SM0603	Panasonic	ERJ-2RKF1002X
2	P2	JACK_BANANA	-	15A	-	JACK_F_NI_2P.750SP	EMERSON	108-0740-001
2	D3, D4	GREEN	-	2V, 20mA	LED	SM0805	CHICAGO MINI	CMD17-21VGC/TR8
1	EN1	SW_SPDT	-	-	PCB VERT	SW_TOG_SPDT	NKK	G12AP
3	J1, J2, J105	2 POS	-	-	VERT	SIP2/100	SAMTEC	TSW-102-07-L-S
2	J8, J9	HDR_3X2_RA	-	-	RA	HDRMDUALRA100X100	SAMTEC	TSW-103-08-T-D-RA
2	J10, J11	SKT_3X2_RA	-	-	RA	HDRFDUALRA100X100	SAMTEC	SSQ-103-02-T-D-RA
4	J101, J102, J103, J104	VOUT+, PGND	-	-	-	JACK_F_175PLUG	Burndy	KPA8CTP
1	C14	10µF	10%	10V	X5R	SM1206	Murata	GRM31CR61A106KA01L
0	VDD	TP	-	Red	PC Test Point	TP_036H_SSREF	Keystone Electronics	5000
0	GND	TP	-	Black	PC Test Point	TP_036H_SSREF	Keystone Electronics	5001

## Configuration File

The following text is loaded into the ZL8800 device on the ZL8800-2PH-DEMO1Z as default settings. Each PMBus command is loaded via the PowerNavigator software. The # symbol is used for a comment line.

# Initialize device to factory settings

RESTORE\_FACTORY  
STORE\_DEFAULT\_ALL  
STORE\_USER\_ALL

### Begin Default Store  
RESTORE\_DEFAULT\_ALL

# Global commands

FREQUENCY\_SWITCH      0xfb20      # 400 kHz  
VIN\_OV\_FAULT\_LIMIT     0xd380      # 14 V  
VIN\_OV\_FAULT\_RESPONSE   0xff  
VIN\_OV\_WARN\_LIMIT      0xd360      # 13.5 V  
VIN\_UV\_WARN\_LIMIT      0xca40      # 4.5 V  
VIN\_UV\_FAULT\_LIMIT     0xca00      # 4 V  
VIN\_UV\_FAULT\_RESPONSE   0xff  
IIN\_CAL\_GAIN            0xca80      # 5 mV/A  
DDC\_ENG                0xa5a  
USER\_GLOBAL\_CONFIG     0x100  
VMON\_OV\_FAULT\_RESPONSE   0x80  
VMON\_UV\_FAULT\_RESPONSE   0x80  
PRIVATE\_PASSWORD  
PUBLIC\_PASSWORD  
UNPROTECT  
0x00FF  
FFFFFFFFFFFFFF

# PAGE 0 commands

PAGE                    0x0  
ON\_OFF\_CONFIG          0x17  
VOUT\_COMMAND            0x2666      # 1.2 V  
VOUT\_TRIM               0x0          # 0 V  
VOUT\_CAL\_OFFSET         0x0          # 0 V  
VOUT\_MAX                0x4000      # 2 V  
VOUT\_MARGIN\_HIGH        0x2852      # 1.26 V  
VOUT\_MARGIN\_LOW         0x247b      # 1.14 V  
VOUT\_TRANSITION\_RATE    0xba00      # 1 mV/us  
VOUT\_DROOP              0x0          # 0 mV/A  
INTERLEAVE              0x0  
IOUT\_CAL\_GAIN            0xb127      # 0.288 mV/A  
IOUT\_CAL\_OFFSET         0xbe00      # -1 A  
VOUT\_OV\_FAULT\_LIMIT     0x2a6f      # 1.326 V  
VOUT\_OV\_FAULT\_RESPONSE   0x80  
VOUT\_UV\_FAULT\_LIMIT     0x225e      # 1.074 V  
VOUT\_UV\_FAULT\_RESPONSE   0x80  
IOUT\_OC\_FAULT\_LIMIT     0xe370      # 55 A  
IOUT\_UC\_FAULT\_LIMIT     0xe490      # -55 A  
OT\_FAULT\_LIMIT          0xebe8      # 125 °C  
OT\_FAULT\_RESPONSE       0x80  
OT\_WARN\_LIMIT            0xeb70      # 110 °C  
UT\_WARN\_LIMIT            0xdc40      # -30 °C  
UT\_FAULT\_LIMIT          0xe530      # -45 °C

UT\_FAULT\_RESPONSE        0x80  
POWER\_GOOD\_ON            0x228f      # 1.08 V  
TON\_DELAY                0xca80      # 5 ms  
TON\_RISE                 0xca80      # 5 ms  
TOFF\_DELAY               0xca80      # 5 ms  
TOFF\_FALL                0xca80      # 5 ms  
DEADTIME\_MAX             0x3838  
ISENSE\_CONFIG            0x4204  
USER\_CONFIG              0x786  
DDC\_CONFIG               0x101  
POWER\_GOOD\_DELAY         0xba00      # 1 ms  
PID\_TAPS                 0x64  
INDUCTOR                 0xb114      # 0.27 uH  
VOUT\_MARGIN\_RATIO        0xca80      # 5 %  
OVUV\_CONFIG              0x0  
XTEMP\_SCALE              0xba00      # 1 1/°C  
XTEMP\_OFFSET             0x8000      # 0 °C  
TEMPCO\_CONFIG            0xa7  
DEADTIME                 0x1010  
DEADTIME\_CONFIG         0x8080  
ASCR\_CONFIG              0x15a0100  
SEQUENCE                 0x0  
TRACK\_CONFIG             0x0  
DDC\_GROUP                0x0  
MFR\_IOUT\_OC\_FAULT\_RESPONSE 0x80  
MFR\_IOUT\_UC\_FAULT\_RESPONSE 0x80  
IOUT\_AVG\_OC\_FAULT\_LIMIT   0xe230      # 35 A  
IOUT\_AVG\_UC\_FAULT\_LIMIT   0xe5d0      # -35 A  
SNAPSHOT\_CONTROL         0x0  
MFR\_VMON\_OV\_FAULT\_LIMIT   0xcb00      # 6 V  
MFR\_VMON\_UV\_FAULT\_LIMIT   0xca00      # 4 V

# PAGE 1 commands

PAGE                    0x1  
VOUT\_COMMAND            0x2666      # 1.2 V  
VOUT\_MAX                0x4000      # 2 V  
VOUT\_MARGIN\_HIGH        0x2852      # 1.26 V  
VOUT\_MARGIN\_LOW         0x247b      # 1.14 V  
IOUT\_CAL\_GAIN            0xb127      # 0.288 mV/A  
IOUT\_CAL\_OFFSET         0xbe00      # -1 A  
VOUT\_OV\_FAULT\_LIMIT     0x2a6f      # 1.326 V  
VOUT\_UV\_FAULT\_LIMIT     0x225e      # 1.074 V  
IOUT\_OC\_FAULT\_LIMIT     0xe370      # 55 A  
IOUT\_UC\_FAULT\_LIMIT     0xe490      # -55 A  
POWER\_GOOD\_ON            0x228f      # 1.08 V  
USER\_CONFIG              0x786  
DDC\_CONFIG               0x2101  
INDUCTOR                 0xb114      # 0.27 uH  
TEMPCO\_CONFIG            0xa7  
IOUT\_AVG\_OC\_FAULT\_LIMIT   0xe230      # 35 A  
IOUT\_AVG\_UC\_FAULT\_LIMIT   0xe5d0      # -35 A  
MFR\_VMON\_OV\_FAULT\_LIMIT   0xcb00      # 6 V  
MFR\_VMON\_UV\_FAULT\_LIMIT   0xca00      # 4 V

STORE\_DEFAULT\_ALL  
### End Default Store

# Measured Data

The following data was acquired using a ZL8800-2PH-DEMO1Z Rev B demonstration board.

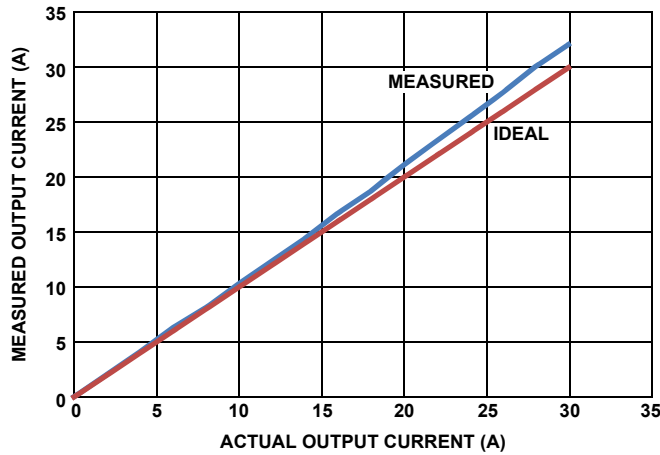


FIGURE 4. OUTPUT CURRENT MEASUREMENT ACCURACY (Single Phase)

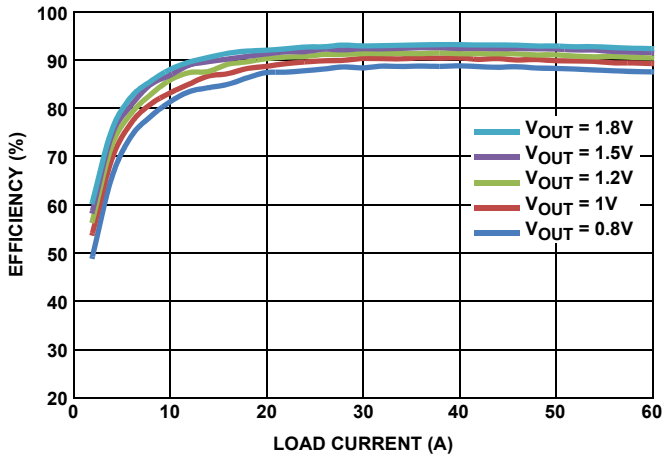


FIGURE 5. EFFICIENCY,  $V_{IN} = 12V$ ,  $f_{SW} = 300kHz$

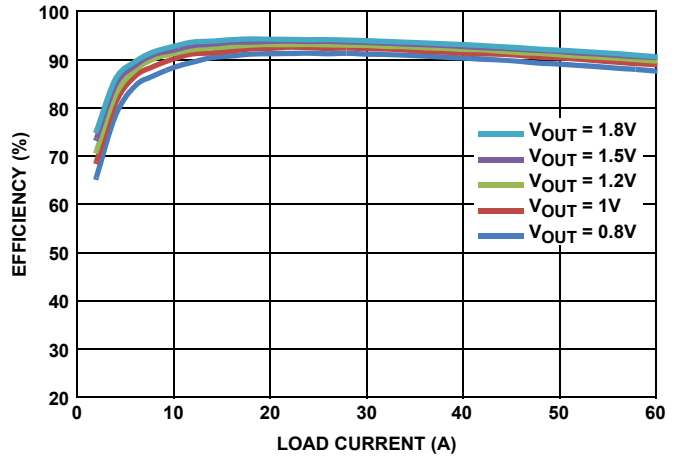


FIGURE 6. EFFICIENCY,  $V_{IN} = 5V$ ,  $f_{SW} = 300kHz$

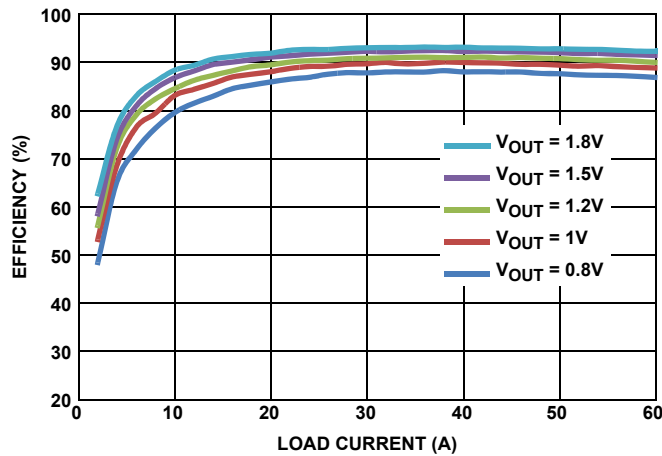


FIGURE 7. EFFICIENCY,  $V_{IN} = 12V$ ,  $f_{SW} = 400kHz$

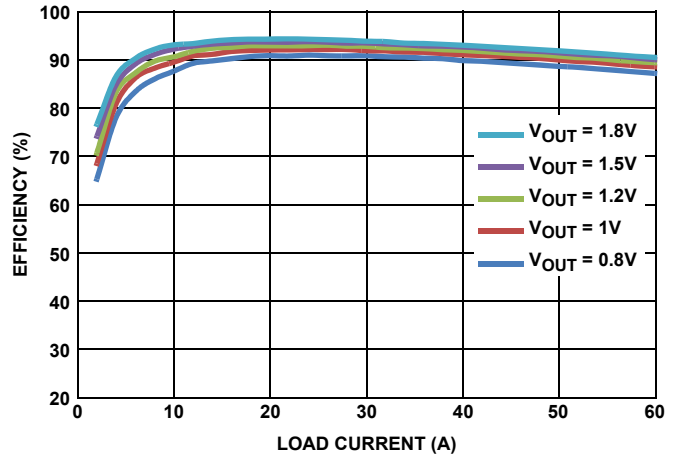


FIGURE 8. EFFICIENCY,  $V_{IN} = 5V$ ,  $f_{SW} = 400kHz$



**Measured Data** The following data was acquired using a ZL8800-2PH-DEMO1Z Rev B demonstration board. (Continued)

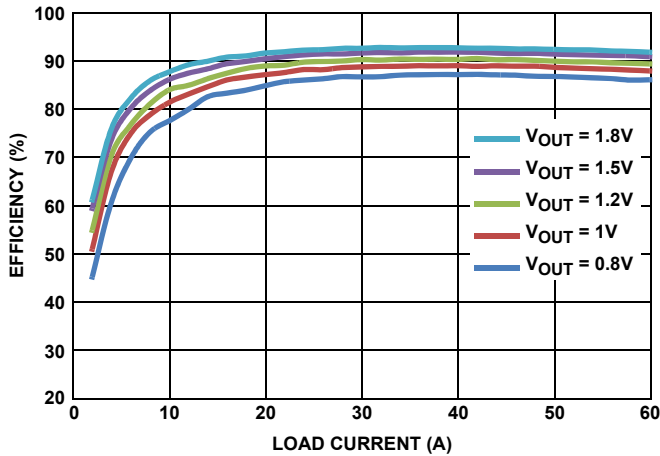


FIGURE 9. EFFICIENCY, V<sub>IN</sub> = 12V, f<sub>SW</sub> = 516kHz

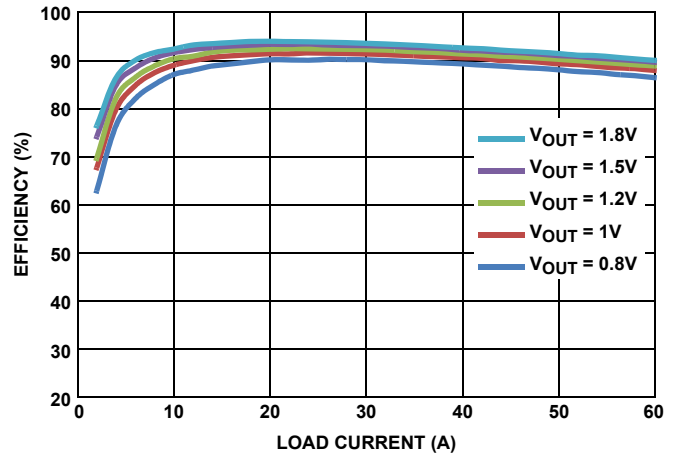


FIGURE 10. EFFICIENCY, V<sub>IN</sub> = 5V, f<sub>SW</sub> = 516kHz



FIGURE 11. RAMP UP



FIGURE 12. RAMP DOWN

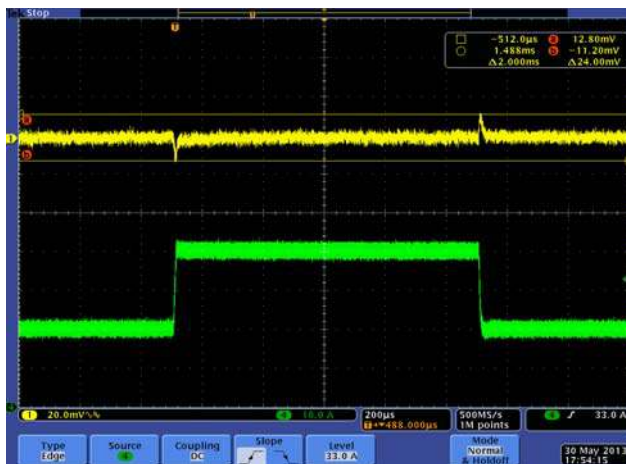


FIGURE 13. STEP RESPONSE, 20A TO 40A @ 5A/µs, ASCR = 1200  
TOTAL DEVIATION WINDOW 25mV = 2.5%

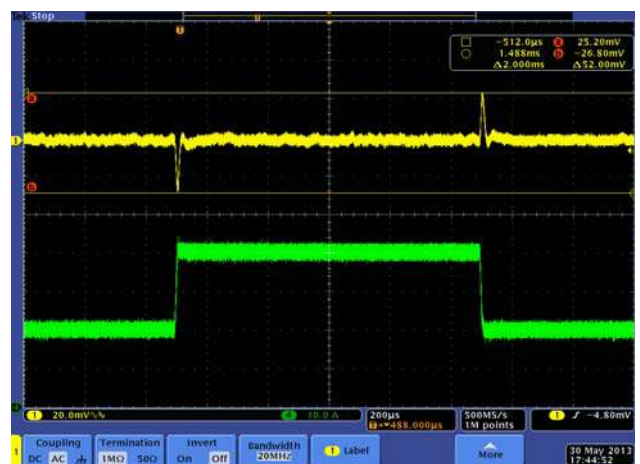


FIGURE 14. STEP RESPONSE, 20A TO 40A @ 5A/µs, ASCR = 400  
TOTAL DEVIATION WINDOW 50mV = 5%





## ZL8800-2PH-DEMO1Z Board Layout (Continued)

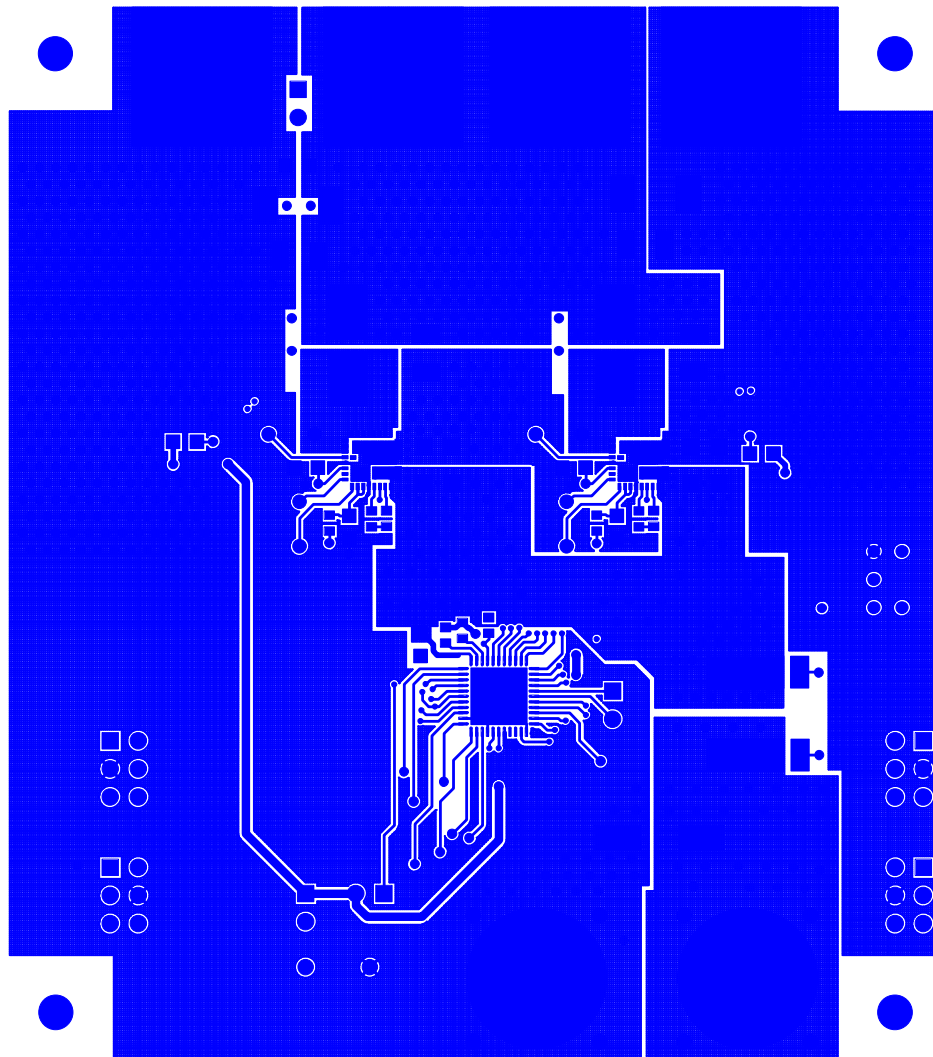


FIGURE 16. PCB - TOP LAYER

# ZL8800-2PH-DEMO1Z Board Layout (Continued)

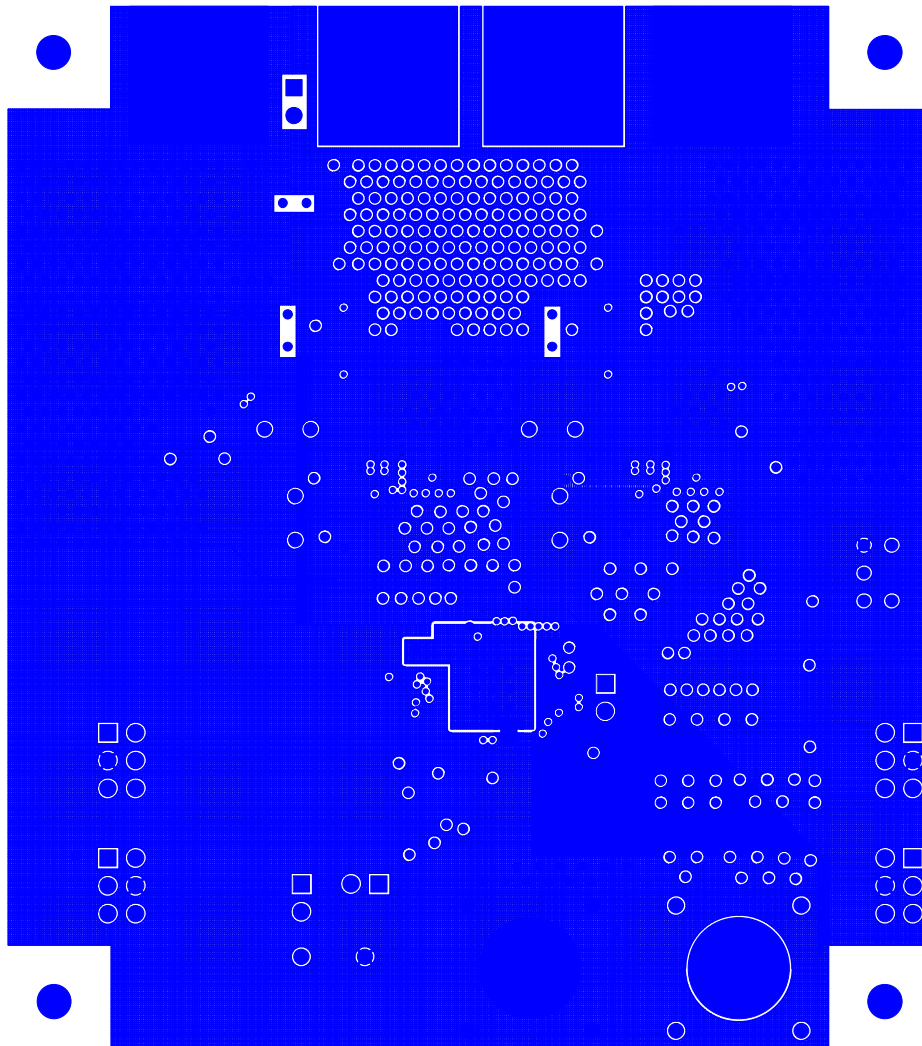


FIGURE 17. PCB - INNER LAYER 1 (TOP VIEW)

## ZL8800-2PH-DEMO1Z Board Layout (Continued)

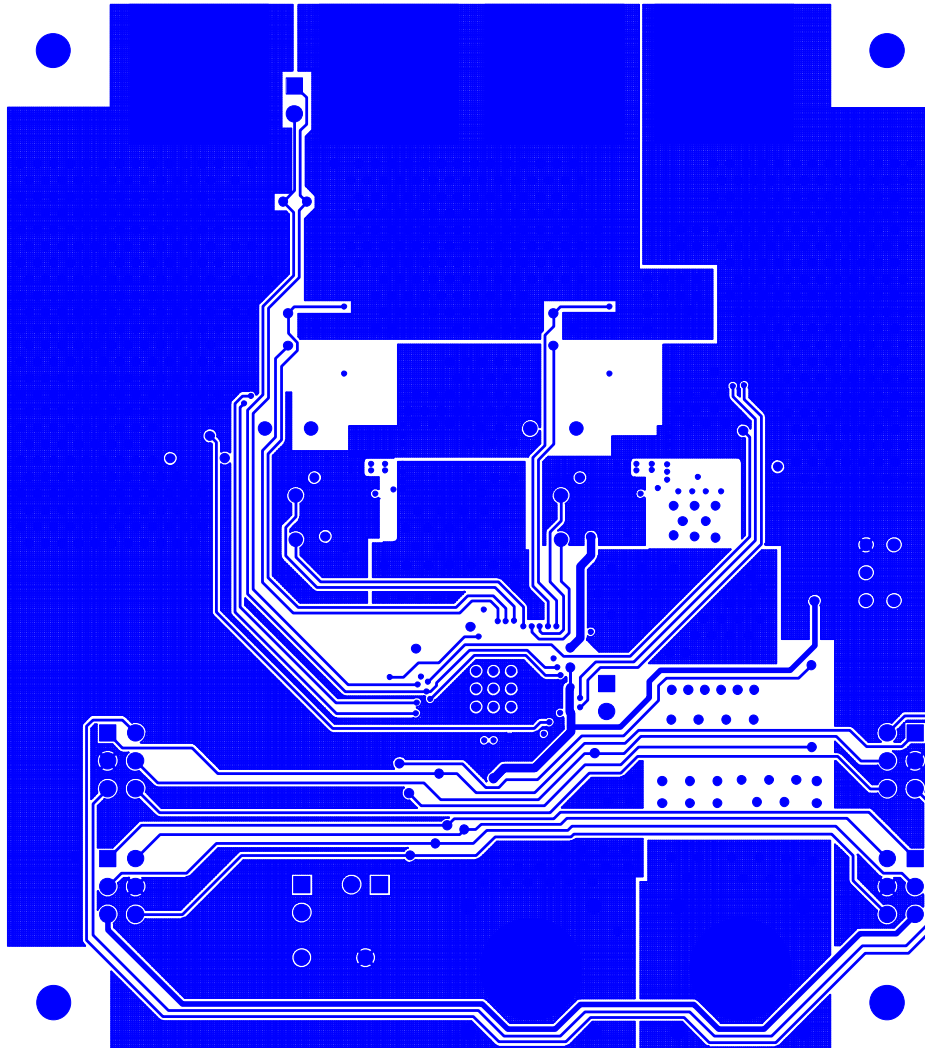


FIGURE 18. PCB - INNER LAYER 2 (TOP VIEW)

# ZL8800-2PH-DEMO1Z Board Layout (Continued)

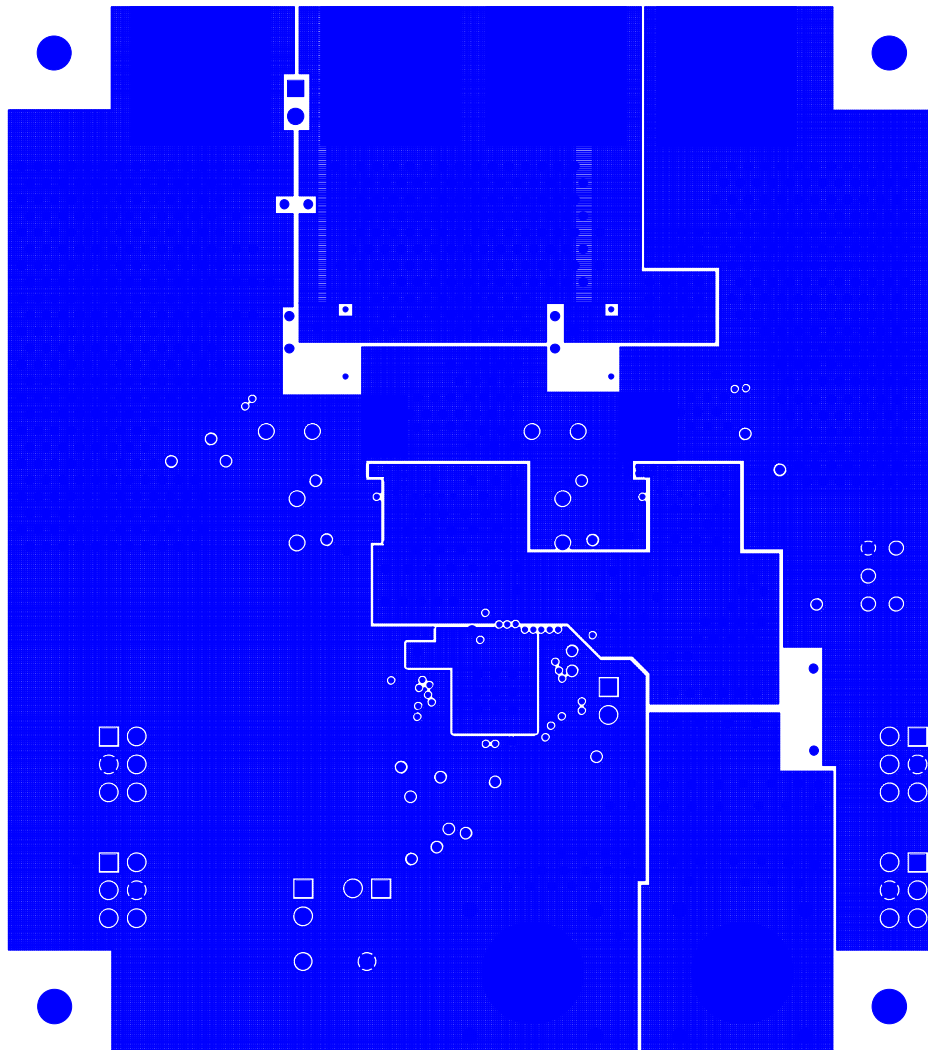


FIGURE 19. PCB - INNER LAYER 3 (TOP VIEW)

## ZL8800-2PH-DEMO1Z Board Layout (Continued)

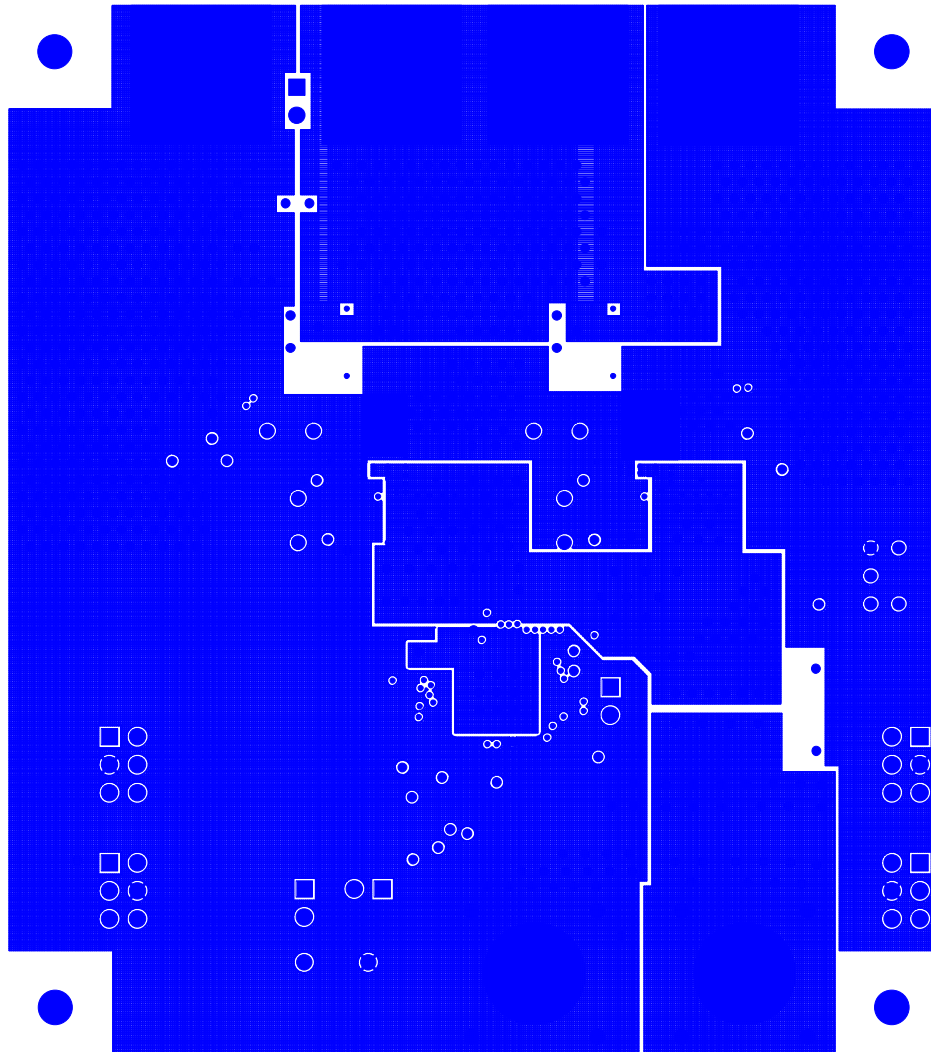


FIGURE 20. PCB - INNER LAYER 4 (TOP VIEW)



## ZL8800-2PH-DEMO1Z Board Layout (Continued)

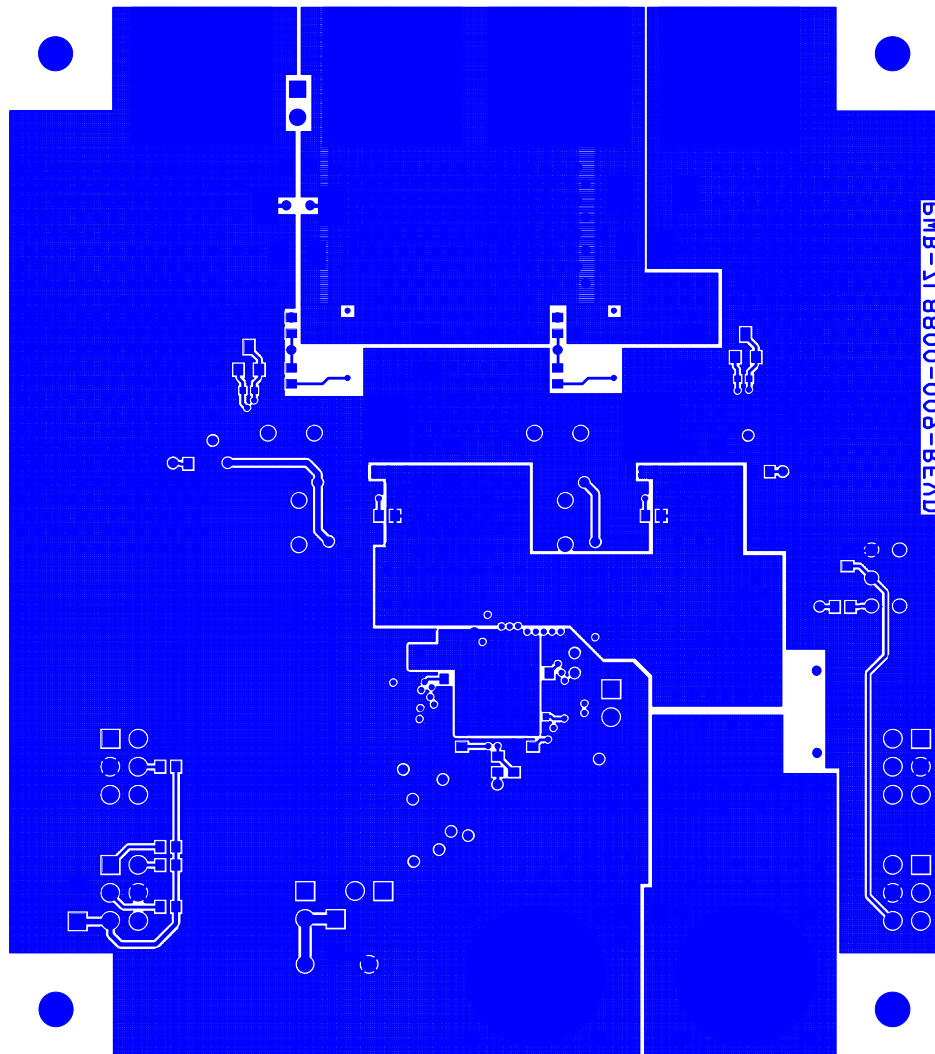


FIGURE 21. PCB - BOTTOM LAYER (TOP VIEW)

## ZL8800-2PH-DEMO1Z Board Layout (Continued)

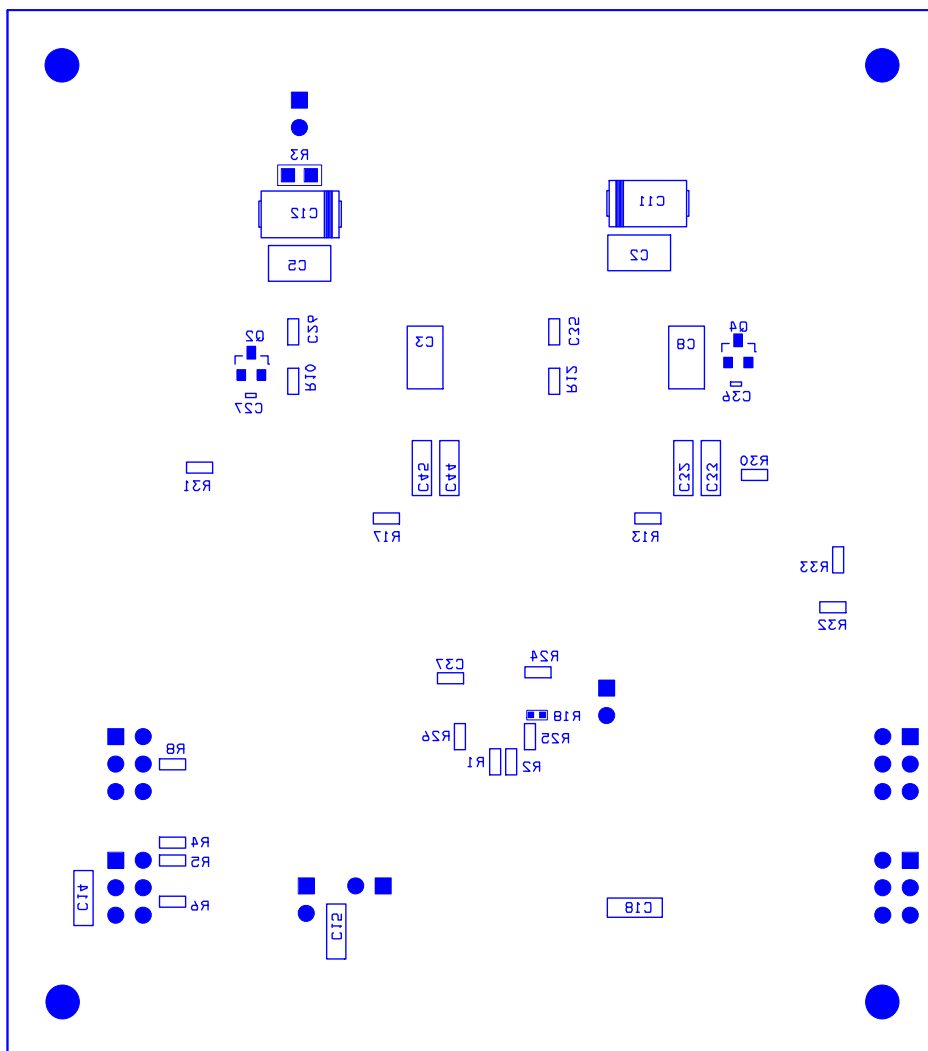


FIGURE 22. PCB - BOTTOM ASSEMBLY (TOP VIEW)

## Related Tools and Documentation

DOCUMENT	DESCRIPTION
<a href="#">FN7558</a>	ZL8800 Datasheet, "Dual Channel/Dual Phase PMBus™ ChargeMode Control DC/DC Digital Controller"

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(Rev.4.0-1 November 2017)



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