

# ZL8800-2PH-DEMO1Z Demonstration Board

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

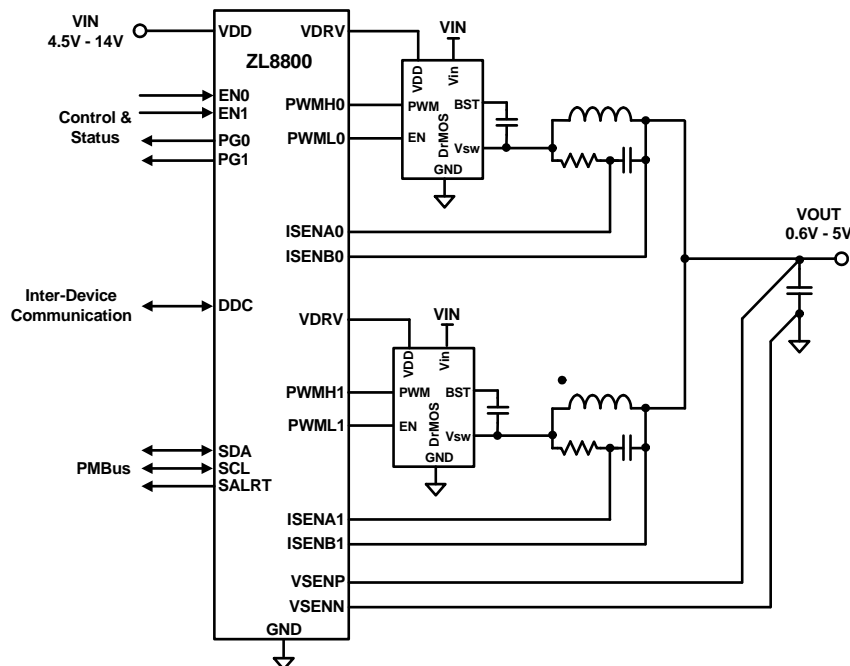
- $V_{IN} = 12V$
- $V_{OUT} = 1.2V/60A$  max
- $f_{SW} = 400kHz$
- Efficiency: 91% at 40A
- Output Ripple:  $\pm 1\%$
- Dynamic response:  $\pm 1\%$  (50% to 100% to 50% load step,  $di/dt = 10A/\mu s$ )
- Board temperature:  $+25^{\circ}C$

## 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

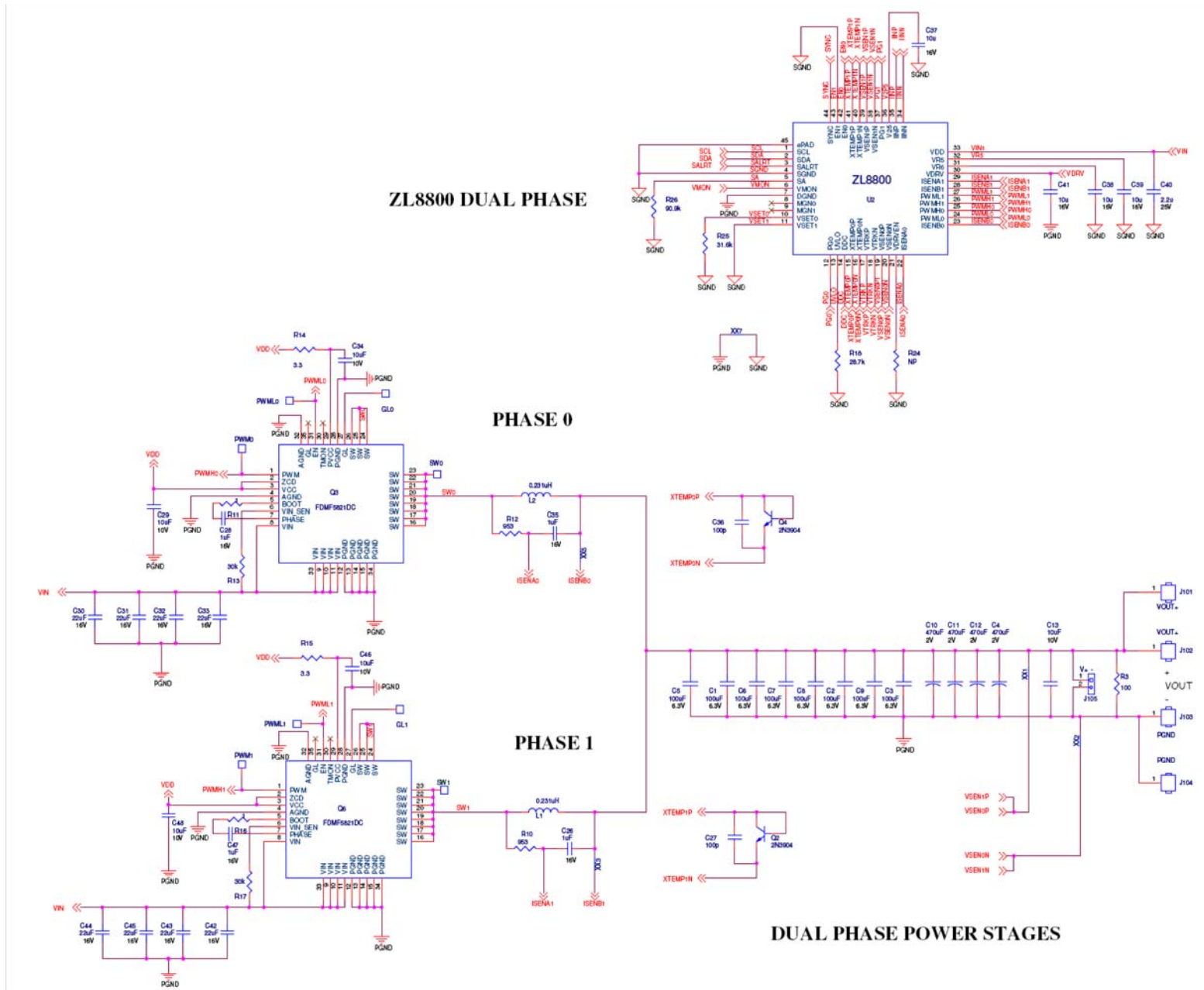
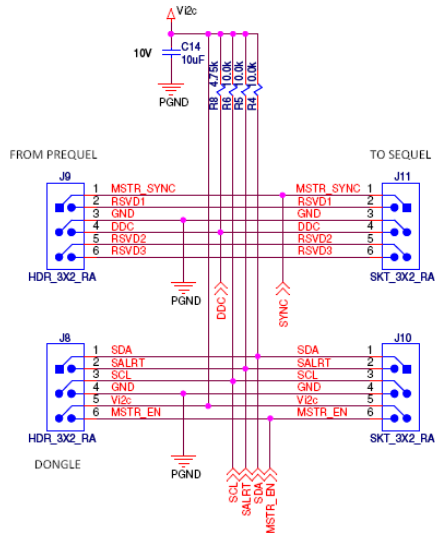


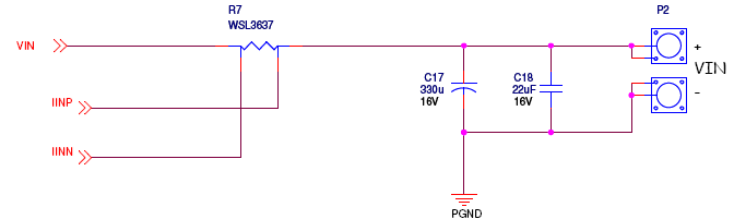
FIGURE 2. APPLICATION CIRCUIT

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

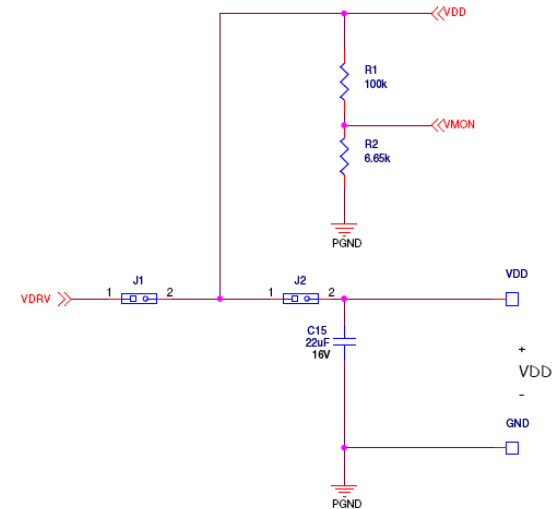
## BOARD TO BOARD INTERFACE



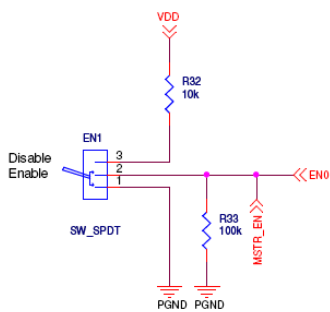
## INPUT CONNECTORS



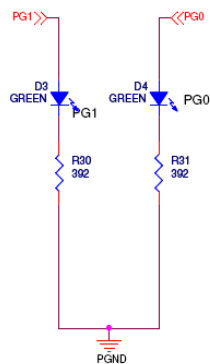
## DRIVER SUPPLY CONNECTORS



## ENABLE



## POWER GOOD



## TRACKING

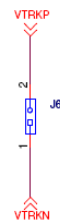


FIGURE 3. ZL8800-2PH-DEMO1Z AUXILIARY CIRCUITRY

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## 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	ZL8800ALAFTK
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

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## 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

# Application Note 1901

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

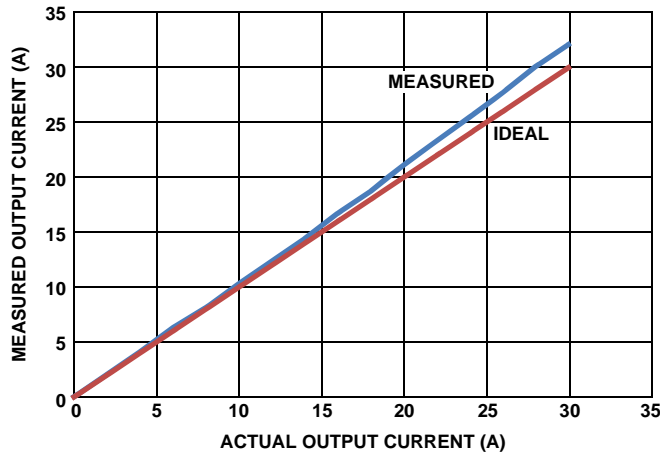


FIGURE 4. OUTPUT CURRENT MEASUREMENT ACCURACY (Single Phase)

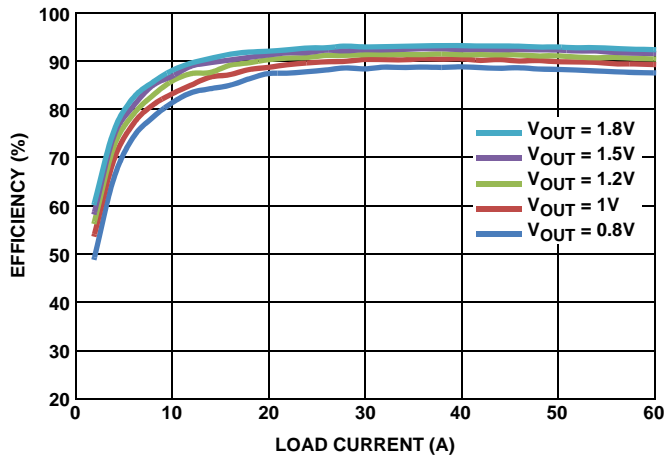


FIGURE 5. EFFICIENCY,  $V_{IN} = 12V$ ,  $f_{SW} = 300kHz$

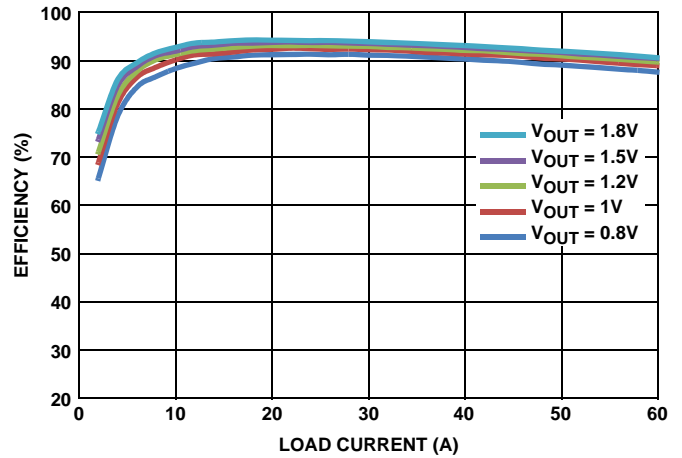


FIGURE 6. EFFICIENCY,  $V_{IN} = 5V$ ,  $f_{SW} = 300kHz$

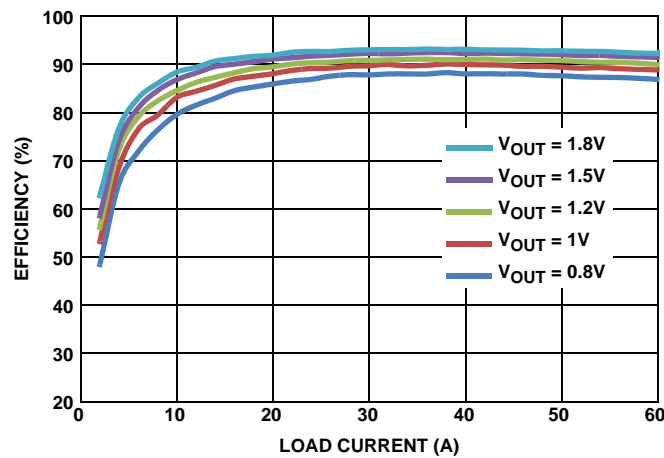


FIGURE 7. EFFICIENCY,  $V_{IN} = 12V$ ,  $f_{SW} = 400kHz$

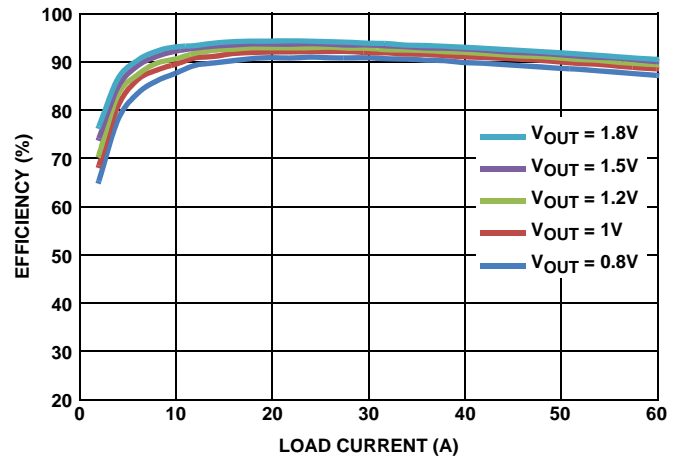


FIGURE 8. EFFICIENCY,  $V_{IN} = 5V$ ,  $f_{SW} = 400kHz$

# Application Note 1901

## Measured Data The following data was acquired using a ZL8800-2PH-DEM01Z Rev B demonstration board. (Continued)

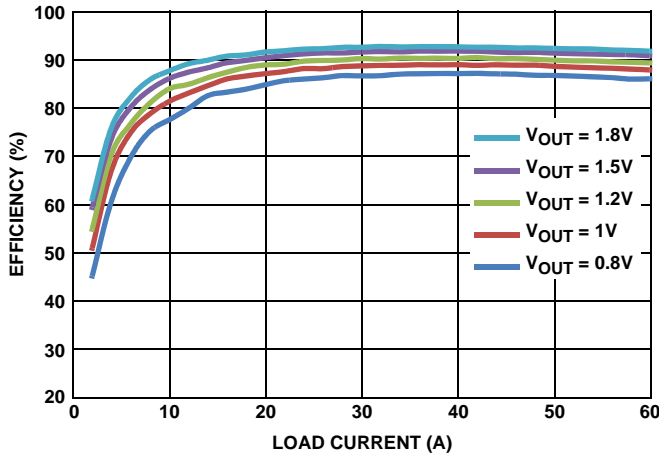


FIGURE 9. EFFICIENCY,  $V_{IN} = 12V$ ,  $f_{SW} = 516kHz$

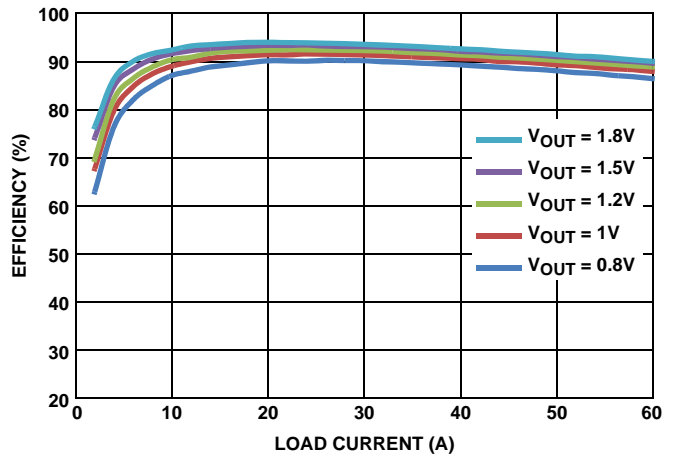


FIGURE 10. EFFICIENCY,  $V_{IN} = 5V$ ,  $f_{SW} = 516kHz$



FIGURE 11. RAMP UP

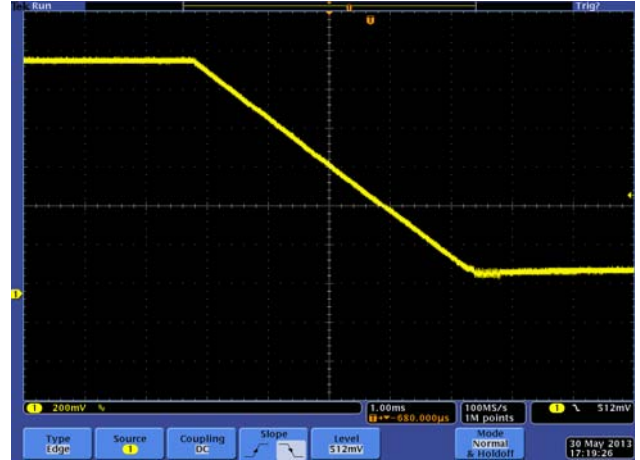


FIGURE 12. RAMP DOWN

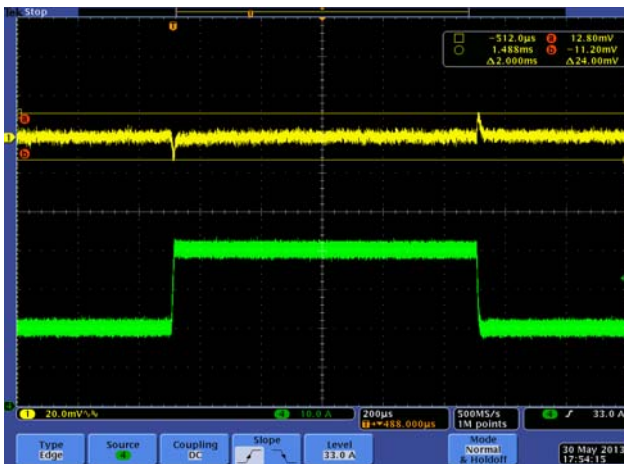


FIGURE 13. STEP RESPONSE, 20A TO 40A @ 5A/ $\mu$ s, ASCR = 1200  
TOTAL DEVIATION WINDOW 25mV = 2.5%



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



ZL8800-2PH-DEMO1Z Board Layout

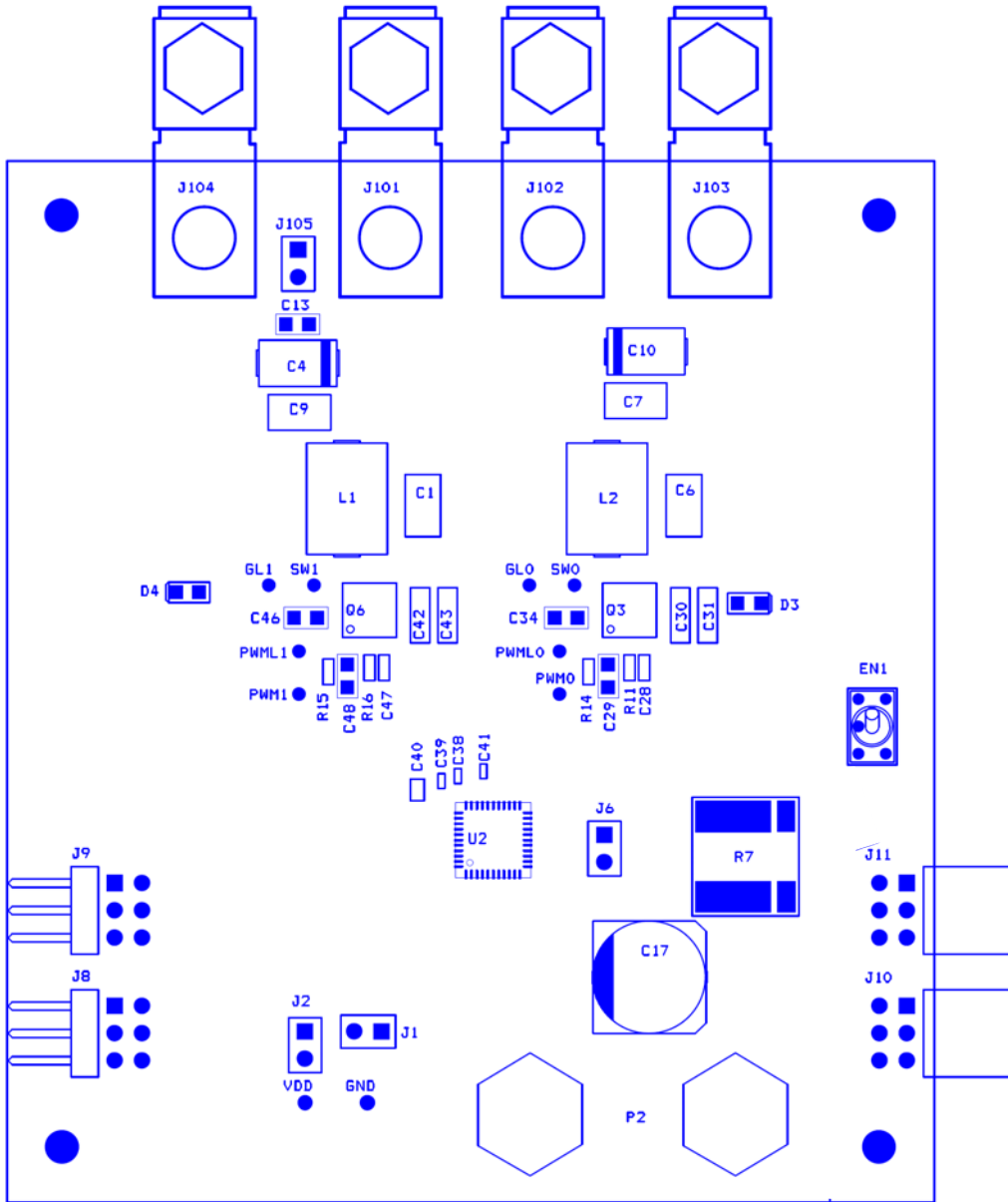


FIGURE 15. PCB - TOP ASSEMBLY

ZL8800-2PH-DEMO1Z Board Layout (Continued)

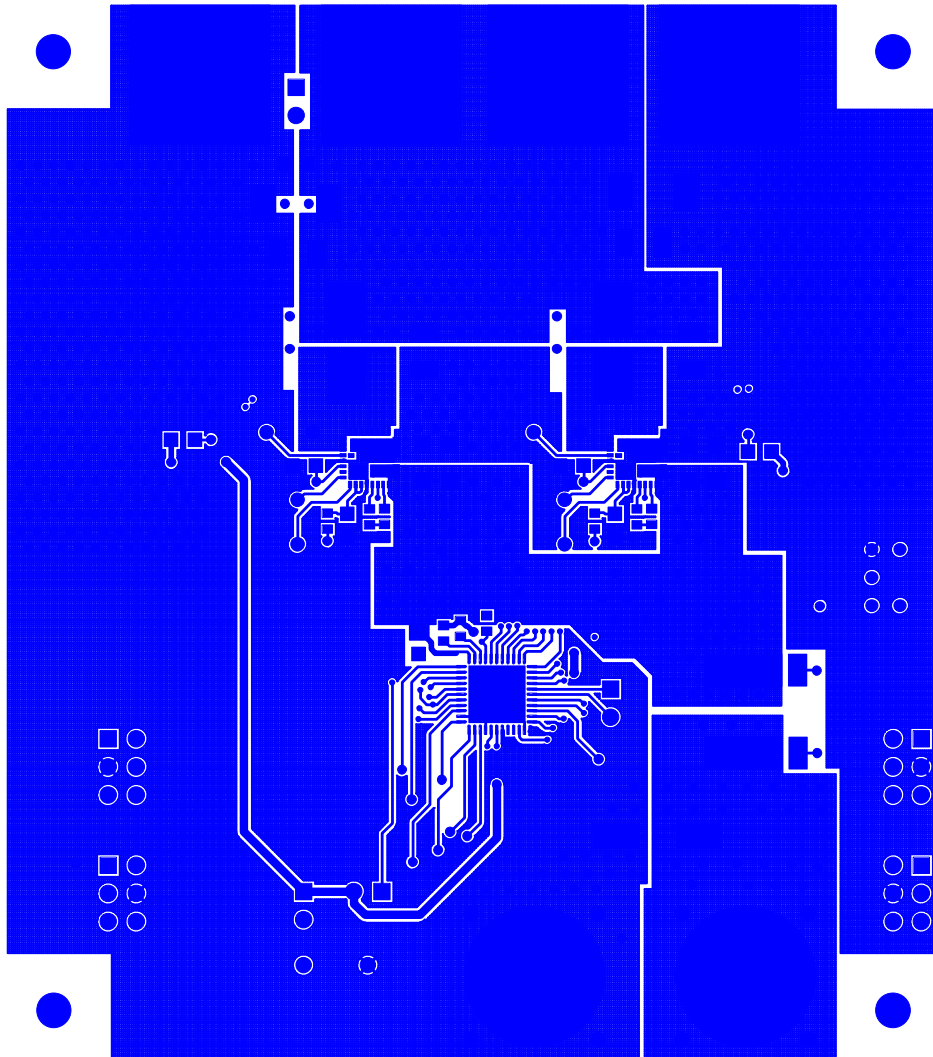


FIGURE 16. PCB - TOP LAYER

ZL8800-2PH-DEMO1Z Board Layout (Continued)

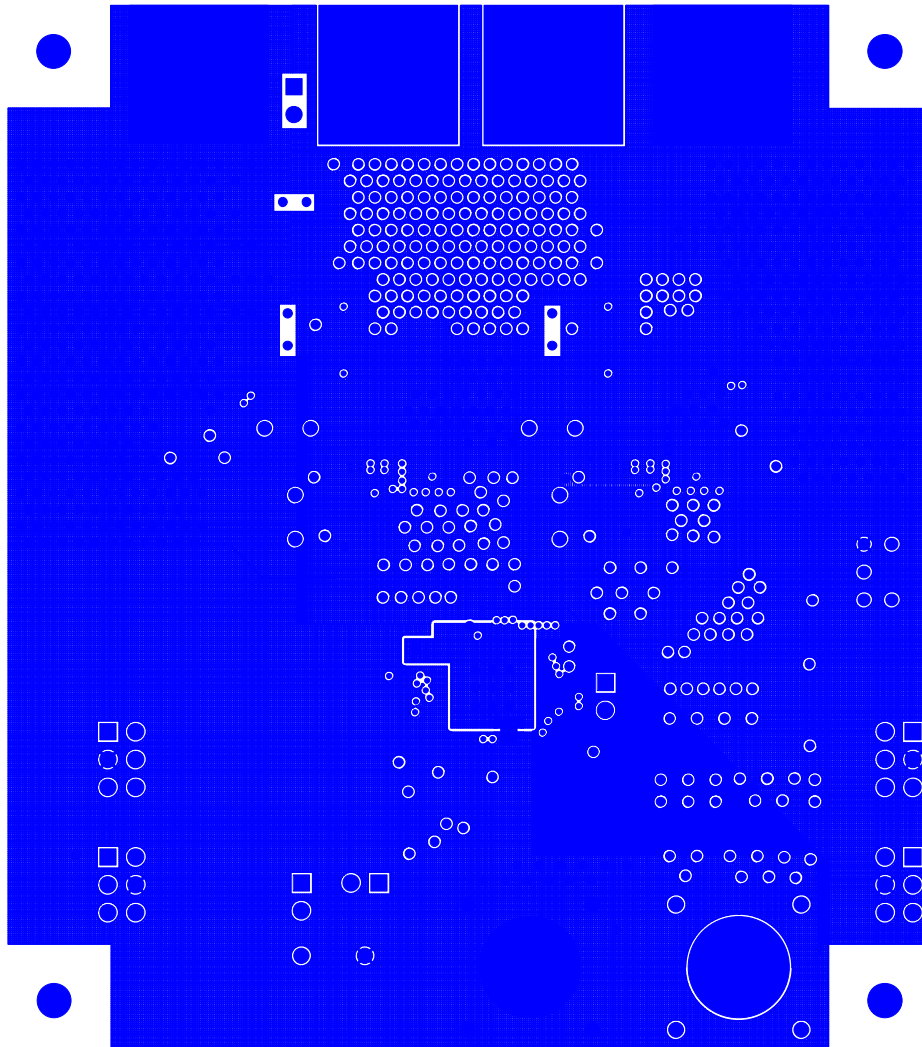


FIGURE 17. PCB - INNER LAYER 1 (TOP VIEW)

ZL8800-2PH-DEMO1Z Board Layout (Continued)

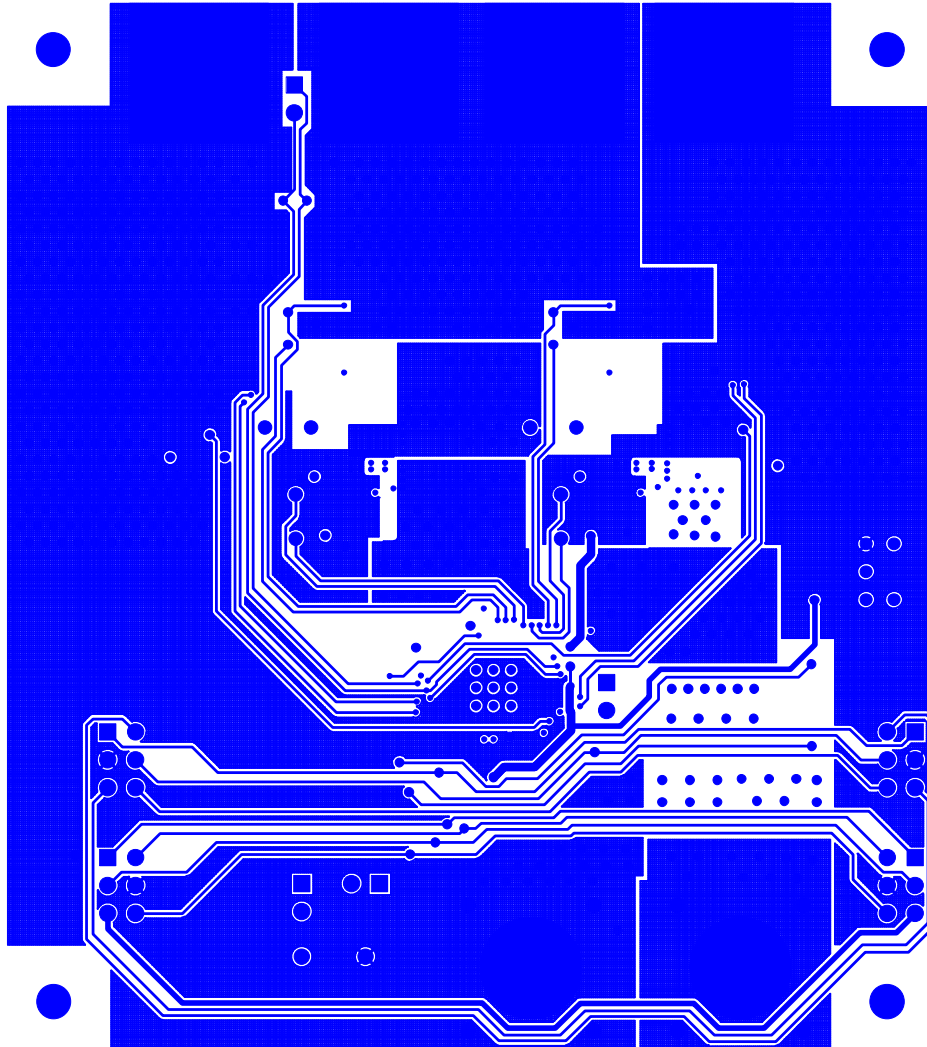


FIGURE 18. PCB - INNER LAYER 2 (TOP VIEW)

ZL8800-2PH-DEMO1Z Board Layout (Continued)

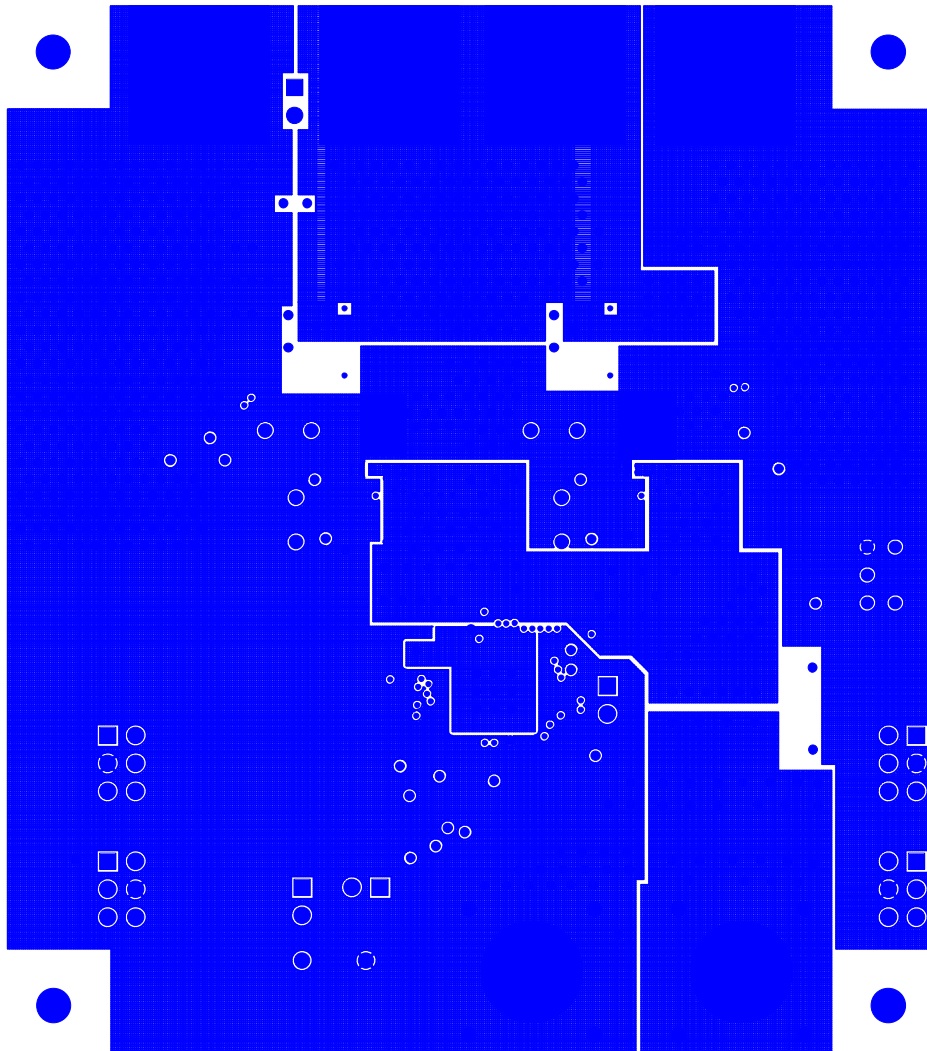


FIGURE 19. PCB - INNER LAYER 3 (TOP VIEW)

ZL8800-2PH-DEMO1Z Board Layout (Continued)

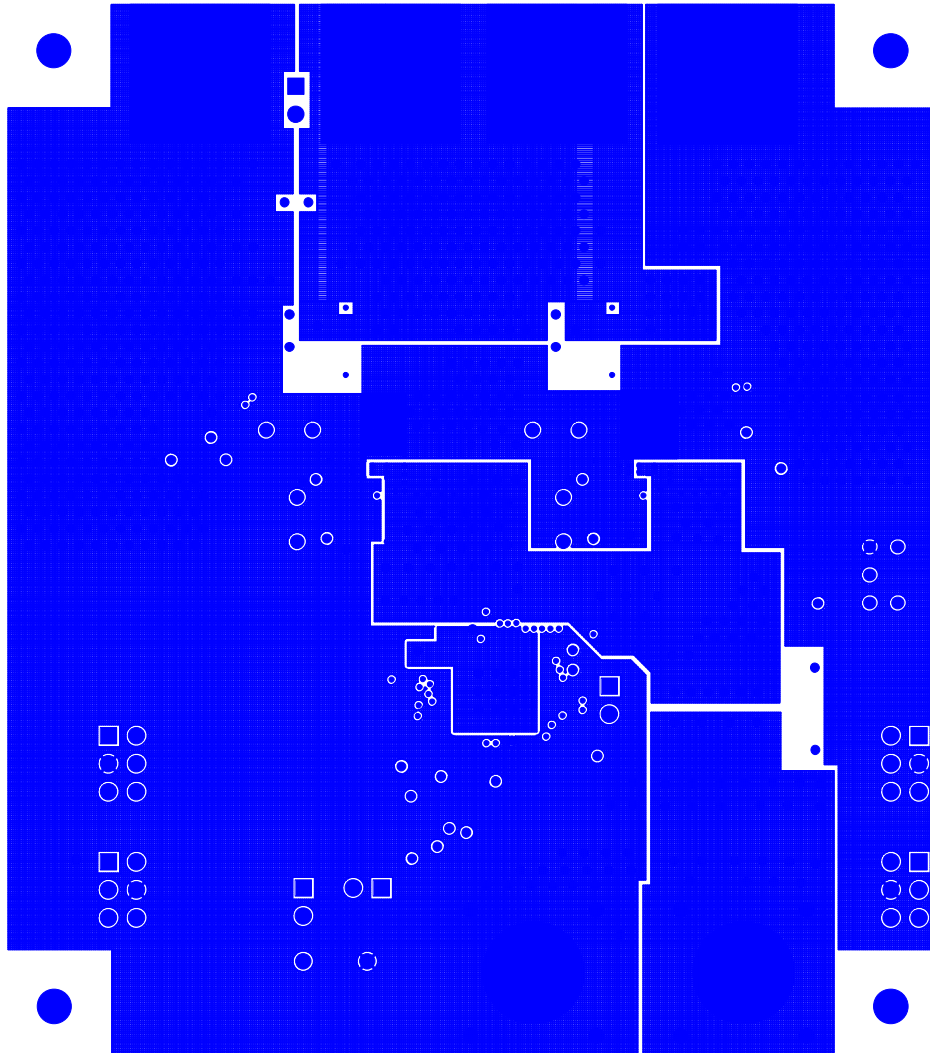


FIGURE 20. PCB - INNER LAYER 4 (TOP VIEW)

ZL8800-2PH-DEMO1Z Board Layout (Continued)

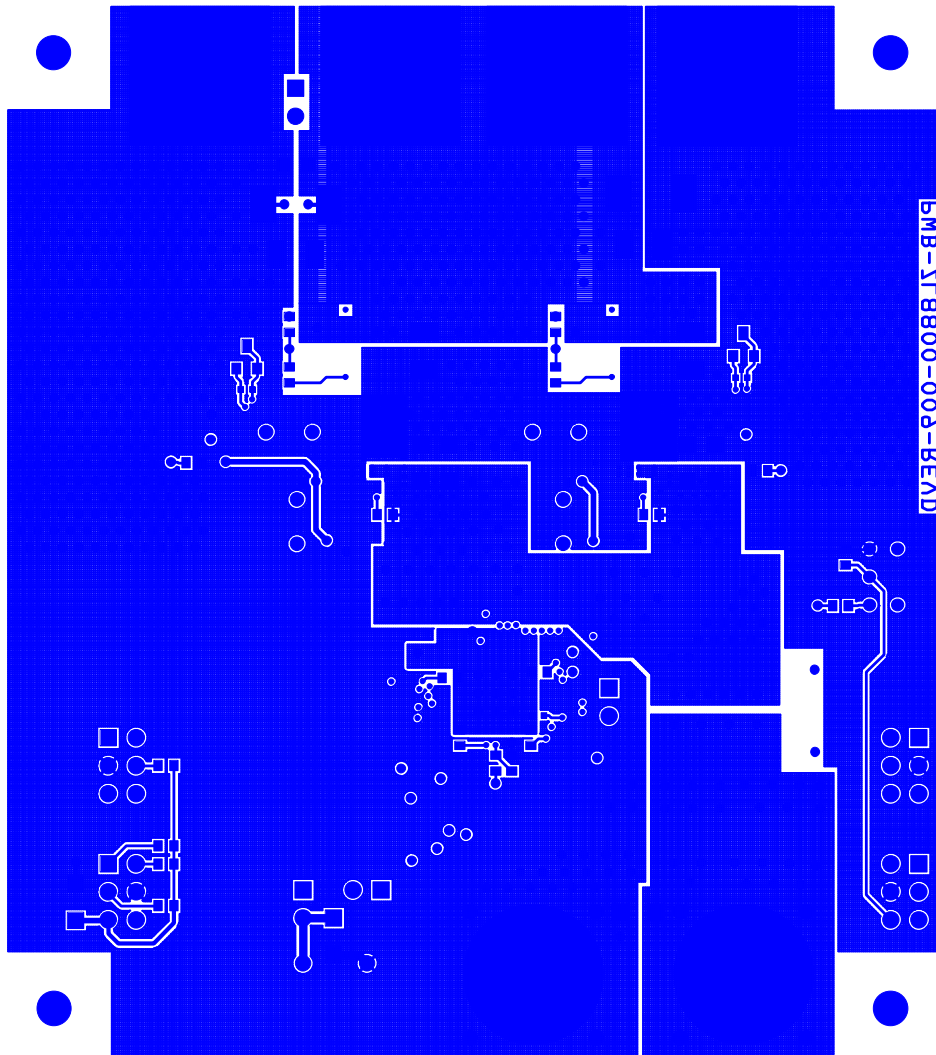


FIGURE 21. PCB - BOTTOM LAYER (TOP VIEW)

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

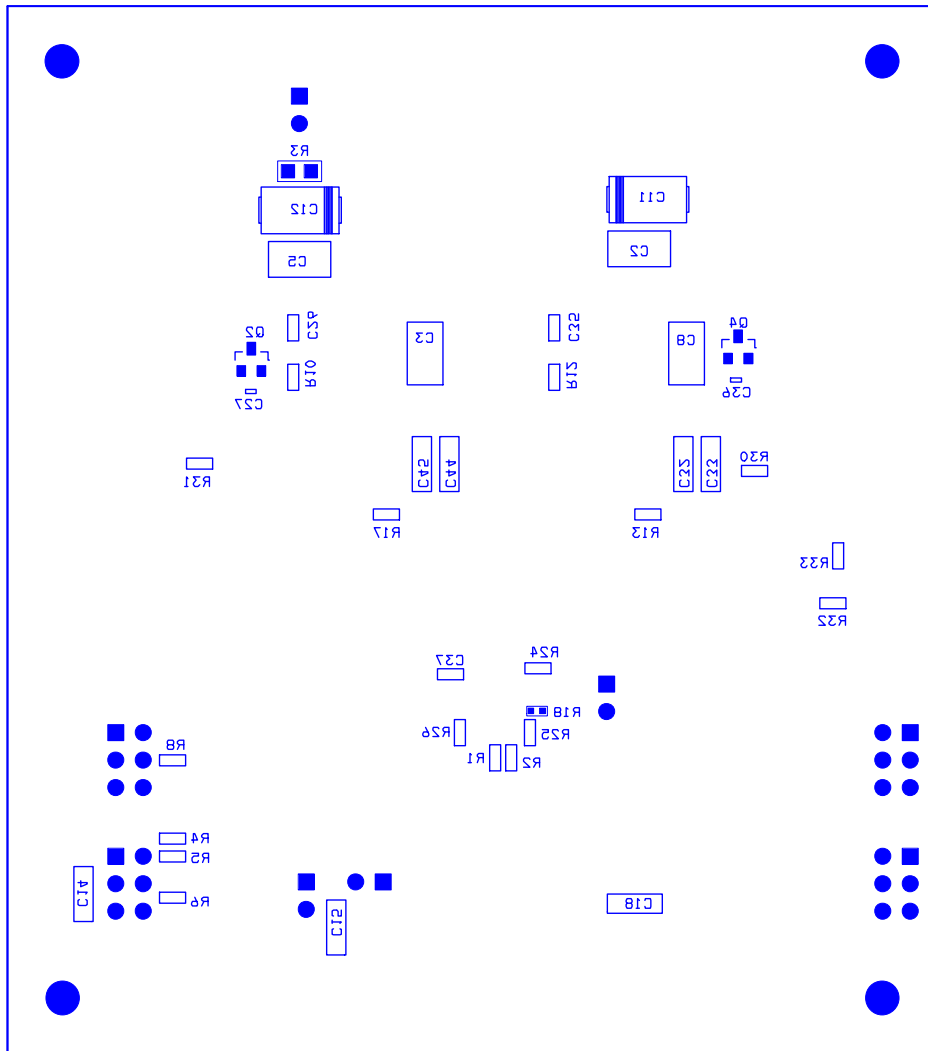


FIGURE 22. PCB - BOTTOM ASSEMBLY (TOP VIEW)

## Related Tools and Documentation

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

Intersil Corporation reserves the right to make changes in circuit design, software and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that the Application Note or Technical Brief is current before proceeding.

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