

ZL2106EVAL1Z

Evaluation Board

AN1468  
Rev 2.00  
Sep 15, 2011

**Description**

The ZL2106 is an innovative power conversion and management IC that combines an integrated synchronous step-down DC-DC converter with key power and fault management functions in a small package, resulting in a flexible and integrated solution. The ZL2106EVAL1Z platform allows evaluation of the features in the highly configurable ZL2106 in either stand-alone mode or via an I<sup>2</sup>C/SMBus™ interface.

A USB-to-SMBus reference board can be used to connect the ZL2106EVAL1Z board to a PC. The PMBus command set is accessed by using the PowerNavigator™ evaluation software from a PC running Microsoft Windows.

**Key Features**

- Small, compact design
- PMBus™ control
- Pin-strap selection for stand-alone operation
- V<sub>OUT</sub> settable from 0.6V to 5V
- Convenient power connection
- On-board enable switch
- Power-good indicator

**Specifications**

This board has been optimized as a buck regulator for the following operating conditions:

- V<sub>IN</sub> = 12V
- V<sub>OUT</sub> = 3.3V
- I<sub>MAX</sub> = 6A (with airflow)
- f<sub>SW</sub> = 400kHz
- Peak Efficiency: >85% at 50% Load
- Output Ripple: <0.5% at 6A
- Dynamic Response: 3.5% (3A to 5A and 5A to 3A Steps, di/dt = 2.5A/μs)
- Board Temperature: +25 °C

**Ordering Information**

PART NUMBER	DESCRIPTION
ZL2106EVAL1Z	ZL2106 Evaluation board only, one channel

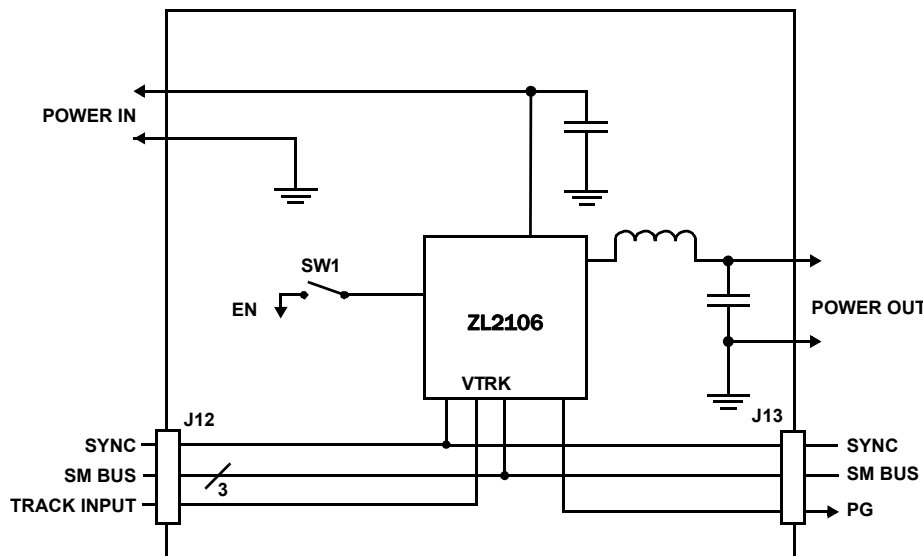


FIGURE 1. ZL2106EVAL1Z BLOCK DIAGRAM

## Functional Description

The ZL2106EVAL1Z provides all circuitry required to demonstrate the features of the ZL2106. The ZL2106EVAL1Z has a functionality-optimized ZL2106 circuit layout that allows efficient operation up to the maximum output current. Power and load connections are provided through plug-in sockets.

Standalone operation is achieved using the pin-strap settings. The pin-strap setting details are described in the ZL2106 data sheet [FN6852](#).

The ZL2106 Evaluation Board is shown in Figure 2. The SMBus address is selectable through jumpers on the top side of the board. All power to the board ( $V_{IN}$  and I<sup>2</sup>C/SMBus bus) must be removed before changing the jumpers. The back side of the board has 0402 resistor footprints for setting the configuration pins using resistors.

The hardware enable function is controlled by a toggle switch on the ZL2106EVAL1Z board. The Power-Good (PG) LED is powered from the I<sup>2</sup>C/SMBus source; it indicates the correct state of PG when external power is applied to the ZL2106EVAL1Z board. The right angle headers at opposite ends of the board are for connecting a USB to I<sup>2</sup>C/SMBus control board or for daisy chaining of multiple evaluation boards. Figure 3 shows the ZL2106 application circuit. The circuit consists of the ZL2106 power conversion and management IC with its minimal component count to realize a buck converter. The board layout has been optimized for thermal performance.

Figure 4 shows the interface connections. Figure 5 illustrates the input and output power connections. The optional input capacitors and output capacitors are also shown in Table 1, which lists the complete bill of materials and is a recommended component list for the ZL2106.

The PCB has four layers and the layout for each layer is shown in Figure 6 to Figure 11. This is a recommended example layout for the ZL2106.

## Operating Range

By default, the ZL2106EVAL1Z is configured for the operating conditions shown on page 1 using the bill of materials listed in Table 1 on page 8. The board can also support a wider operating range, and modifying the operating conditions will change the performance results.

The default board  $V_{OUT}$  range is 0.54V to 5.5V including margin. The output voltage can be changed by using the VSET resistor pad or by using a PMBus command. The board  $I_{OUT}$  range is 0A to 6A.

The board schematic in Figure 3 includes resistor population options for these connections.

The default switching frequency ( $f_{SW}$ ) is 400kHz. The  $f_{SW}$  range is 200kHz to 1MHz. The PWM loop must maintain stability at the selected switching frequency, so the loop compensation PID settings may need to be modified when  $f_{SW}$  is changed. CompZL™ can be used to generate PID settings for different switching frequencies.

## Board Operation

### Stand-Alone Operation

The ZL2106 is easy to setup and operate. It is configured, out of the box, to provide 3.3V at 6A from a 12V source. All input and output connections should be made before turning on the input power supply.

When the input power supply is turned on, the ZL2106 will output the configured voltage and the load applied to  $V_{OUT+}/V_{OUT-}$  can be varied.

To modify the pin-strap setting of the ZL2106, input power must be turned off. The user adjustable pin-strap resistor pads are on the bottom side of the ZL2106EVAL1Z PCB. Once the desired pin-strap settings and component changes have been applied, power can be turned on and the output can be evaluated for the newly configured mode. Refer to the ZL2106 data sheet [FN6852](#) for pin-strap and resistor setting information. Refer to Figure 2 for resistor pad locations.

### PMBus Operation

The ZL2106 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 ZL2106EVAL1Z software using the CD included in the ZL2106EVAL1Z kit.

For PMBus operation, connect another Zilker Labs evaluation board, such as the ZL2006EV2 or the USB-to-SMBus reference board, to J12 of the ZL2106EVAL1Z board. Connect the desired load and an appropriate power supply to the input. Place the ENABLE switch in “DISABLE” and turn on the power.

The PowerNavigator evaluation software allows modification of all ZL2106 PMBus parameters. Refer to Zilker Labs application note [AN2033](#) for PMBus command details. Use the mouse-over pop-ups for PowerNavigator help. Manually configure the ZL2106 through PowerNavigator or load a predefined scenario from a configuration file.

The ENABLE switch can then be moved to “ENABLE” and the ZL2106 can be tested. Alternately, the PMBus ON-OFF CONFIG and OPERATION commands may be used.

### Loop Compensation Settings

These PID settings are included in the configuration file that is stored on the ZL2106 Evaluation Board, and is shown in “Default Configuration Text” on page 18 for reference. CompZL can be used to generate appropriate PID settings for other circuit configurations.

## References

1. ZL2106 Data Sheet, 6A Digital-DC Synchronous Step-Down DC-DC Converter, File No. [FN6852](#).
2. Zilker Labs PMBus Command Set - DDC Products, [AN2033](#)

## Quick Start Guide

### Stand Alone Operation

1. Set ENABLE switch to "DISABLE"
2. Apply load to  $V_{OUT+}/V_{OUT-}$
3. Connect input power supply to  $V_{IN+}/V_{IN-}$  (supply turned OFF)
4. Turn input power supply ON
5. Set ENABLE switch to "ENABLE"
6. Test ZL2106 operation
7. To change hardware settings, turn input power supply OFF, modify resistor settings and then turn the input power supply ON

### USB (PMBus) Operation

1. Follow Steps 1 - 4 for stand alone operation
2. Insert the Zilker Labs Eval Kit CD
3. Connect USB-to-SMBus reference board to J12 of ZL2106EVAL1Z
4. Connect supplied USB cable from computer to USB-to-SMBus reference board
  - a. Upon first-time connection, the Found New Hardware Wizard will appear.
  - b. Windows XP users: Select 'No' at prompt to search the Internet for drivers.
  - c. Follow the steps on the screen to install the drivers from the CD.
5. Install the PowerNavigator evaluation software by running setup.exe from the PowerNavigator\_installer folder on the CD.
6. Set voltage to desired value in GUI.
7. Set ENABLE switch on EVB to "ENABLE"
8. Monitor and configure EVB using PMBus commands in the evaluation software
9. Test ZL2106 operation using the evaluation software.

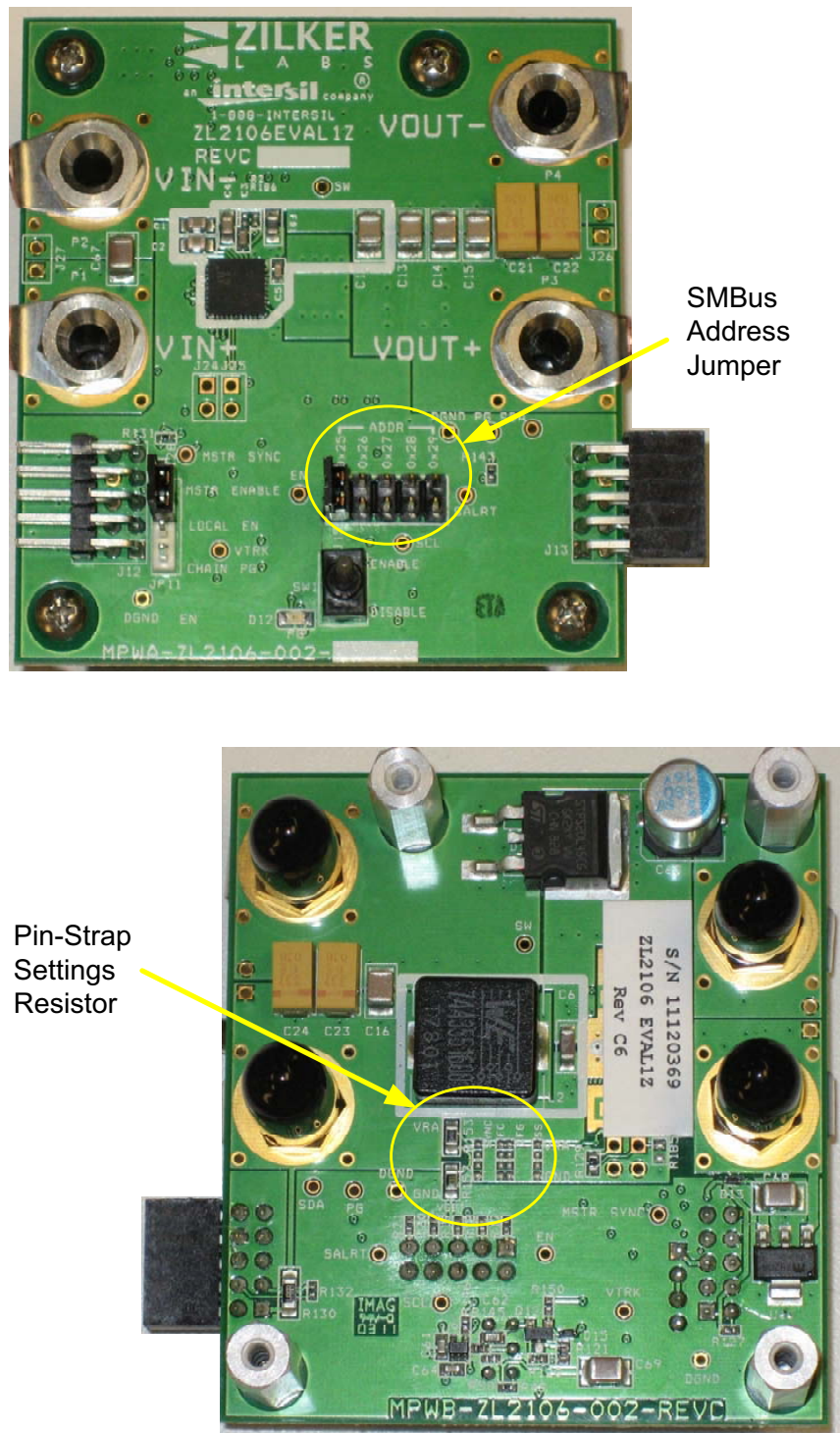


FIGURE 2. ZL2106EVAL1Z EVALUATION BOARD (TOP SIDE AND BOTTOM SIDE)

# ZL2106EVAL1Z Schematics

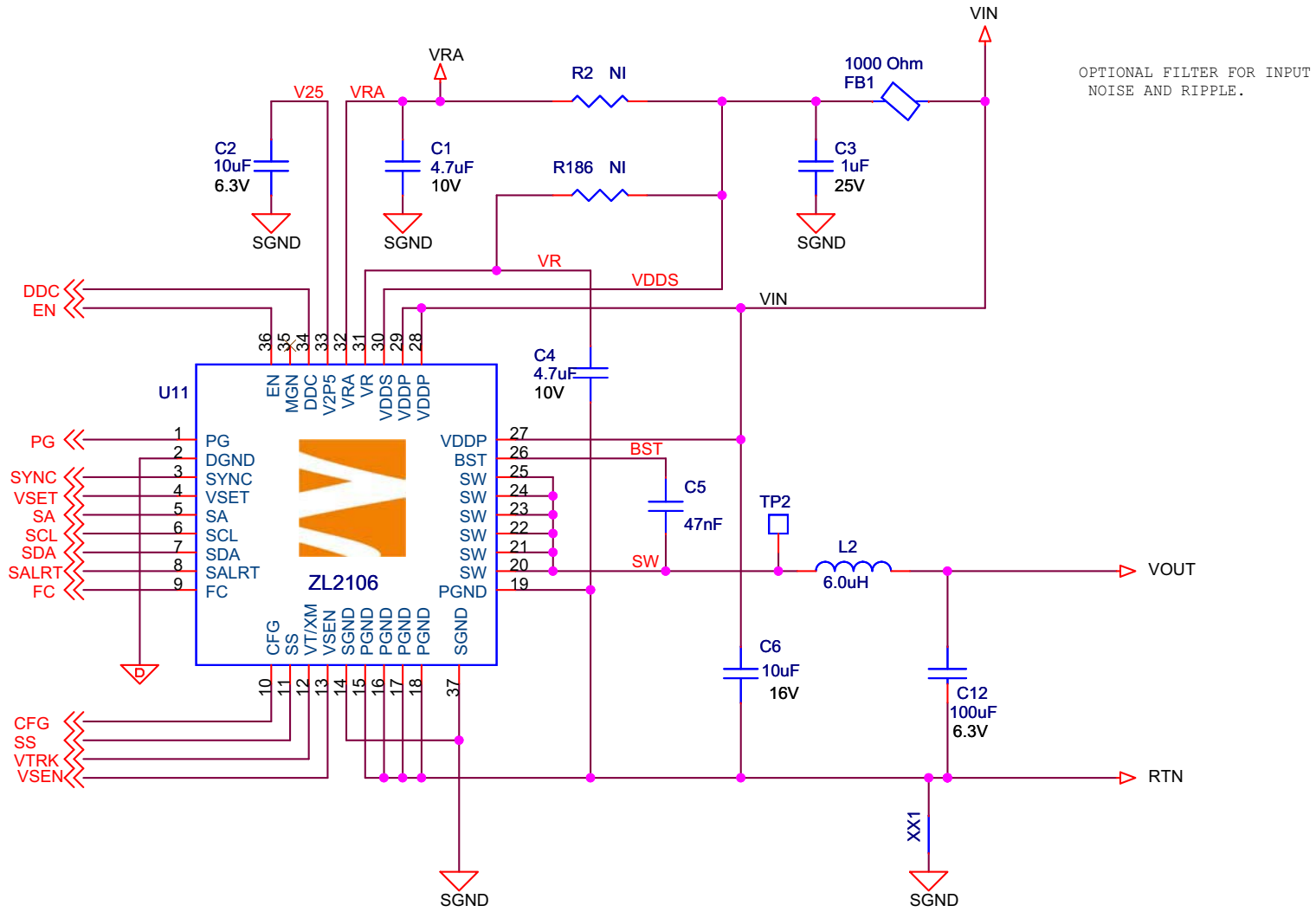


FIGURE 3. ZL2106EVAL1Z CIRCUIT

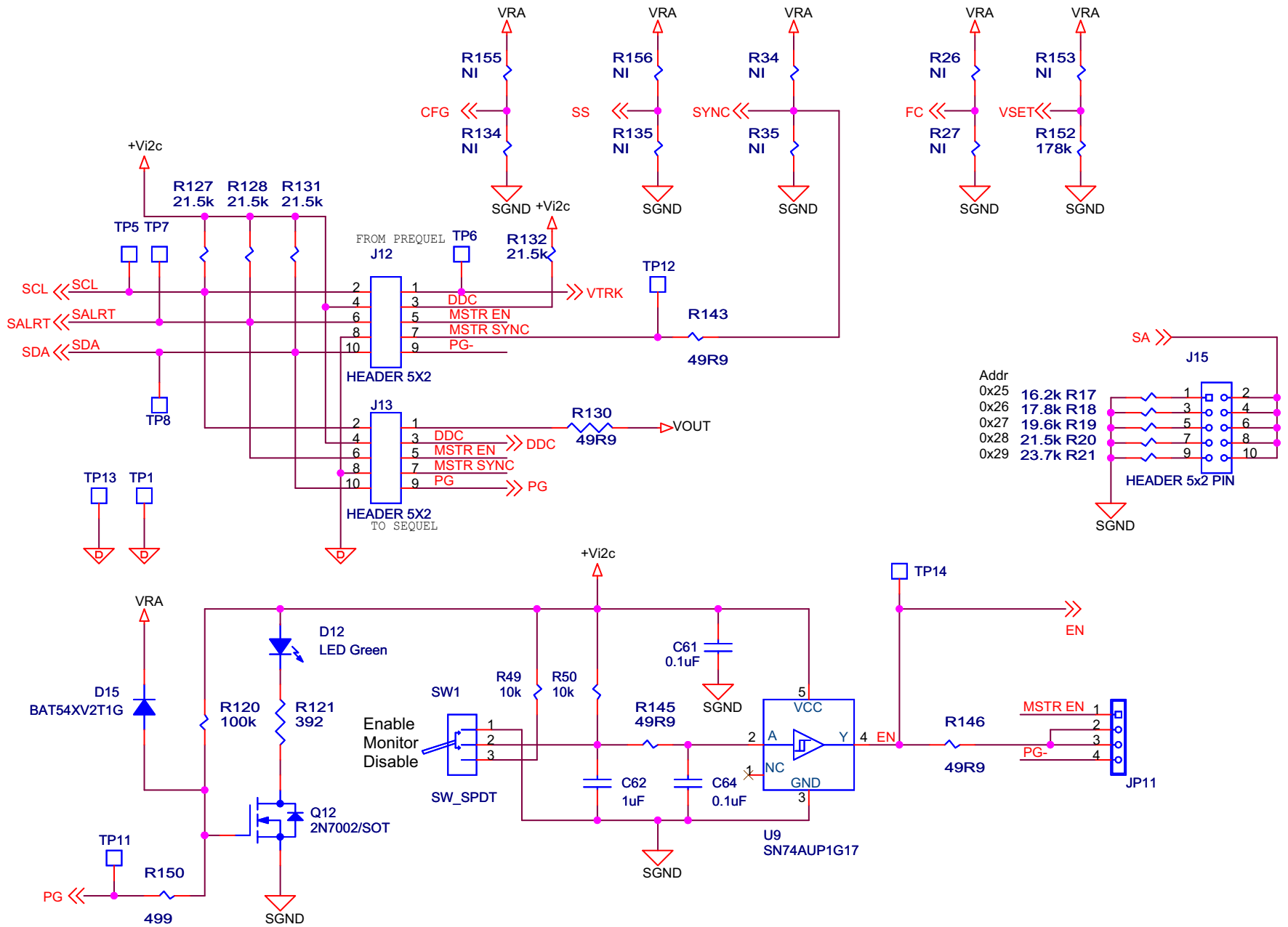
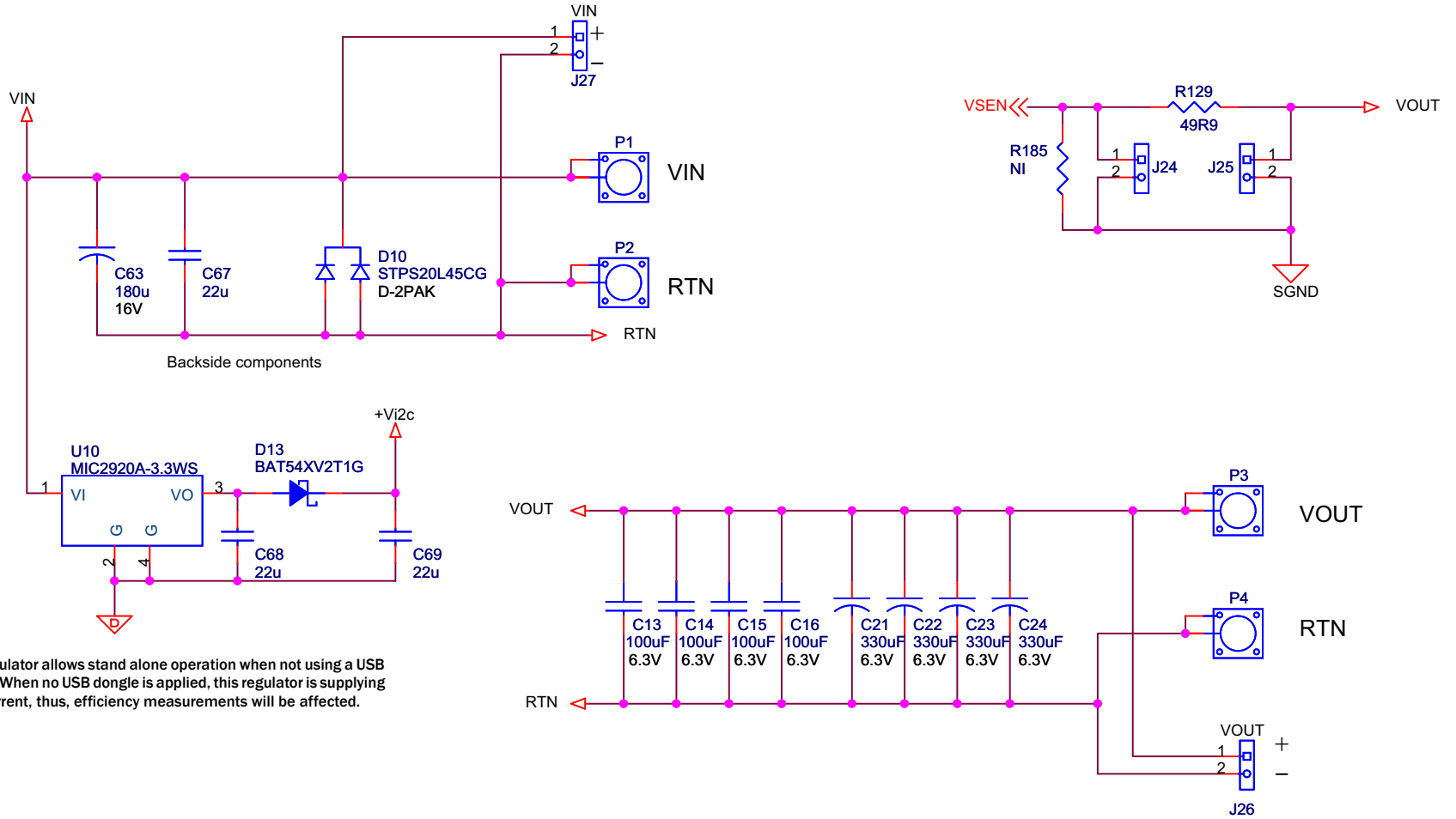


FIGURE 4. ZL2106EVAL1Z INTERFACE



This regulator allows stand alone operation when not using a USB dongle. When no USB dongle is applied, this regulator is supplying Vi2c current, thus, efficiency measurements will be affected.

FIGURE 5. ZL2106EVAL1Z POWER I/O



TABLE 1. BILL OF MATERIALS

PART NUMBER	QTY	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART
ZL2106EVAL1ZREVCPCB	1		PWB-PCB, ZL2106EVAL1Z, REVC, ROHS	IMAGINEERING INC	ZL2106EVAL1ZREVCPCB
H1045-00104-16V10-T	2	C61, C64	CAP, SMD, 0603, 0.1 $\mu$ F, 16V, 10%, X7R, ROHS	MURATA	GRM39X7R104K016AD
H1045-00105-25V10-T	2	C3, C62	CAP, SMD, 0603, 1 $\mu$ F, 25V, 10%, X5R, ROHS	MURATA	GRM188R61E105KA12D
H1045-00473-25V10-T	1	C5	CAP, SMD, 0603, .047 $\mu$ F, 25V, 10%, X7R, ROHS	MURATA	GRM188R71E473KA01D
H1046-00106-10V10-T	1	C2	CAP, SMD, 0805, 10 $\mu$ F, 10V, 10%, X5R, ROHS	MURATA	GRM21BR61A106KE19L (Pb-Free)
H1046-00475-10V10-T	2	C1, C4	CAP, SMD, 0805, 4.7 $\mu$ F, 10V, 10%, X5R, ROHS	AVX	0805ZD475KAT2A
H1065-00106-16V10-T	1	C6	CAP, SMD, 1206, 10 $\mu$ F, 16V, 10%, X5R, ROHS	VENKEL	C1206X5R160-106KNE (Pb-Free)
H1082-00107-6R3V20-T	5	C12, C13, C14, C15, C16	CAP, SMD, 1210, 100 $\mu$ F, 6.3V, 20%, X5R, ROHS	TDK	C3225X5R0J107M
H1082-00226-16V10-T	3	C67, C68, C69	CAP, SMD, 1210, 22 $\mu$ F, 16V, 10%, X7R, ROHS	MURATA	GRM32ER71C226KE18L
T530Y337M006ATE006-T	4	C21, C22, C23, C24	CAP-TANT, LOW ESR, SMD, 7.3X4.3X4, 330 $\mu$ F, 6.3V, 20%, ROHS	KEMET	T530Y337M006ATE006
7443551600	1	L2	COIL-PWR INDUCTOR, SMD, 13.2X12.8, 6.0 $\mu$ H, 20%, 12A, ROHS	Wurth Electronics	7443551600
APXA160ARA181MHC0G-T	1	C63	CAP, SMD, 8X12, 180 $\mu$ F, 16V, 20%, 16M $\Omega$ , ALUM. ELEC., ROHS	NIPPON CHEMI-CON	APXA160ARA181MHC0G
108-0740-001	4	a) P1-P4 (4 each - attach solder lugs)	CONN-JACK, BANANA-SS-SDRLESS, VERTICAL, ROHS	JOHNSON COMPONENTS	108-0740-001
108-0740-001	0	b) Under jack head on top of PCB	CONN-JACK, BANANA-SS-SDRLESS, VERTICAL, ROHS	JOHNSON COMPONENTS	108-0740-001
108-0740-001	0	c) See "DOCUMENT #1"	CONN-JACK, BANANA-SS-SDRLESS, VERTICAL, ROHS	JOHNSON COMPONENTS	108-0740-001
3-644456-2	0	DNP-HS1, J24, J25, J26, J27	CONN-HEADER, 1X2, VERTICAL, 2.54mm, TIN, ROHS	TYCO ELECTRONICS	3-644456-2
3-644456-4	1	JP11	CONN-HEADER, 1X4, VERTICAL, TIN, WHT NYLON, ROHS	AMP/TYCO	3-644456-4
67996-272HLF-2X5	1	J15	CONN-HEADER, 2X5, BRKAWY-2X36, 2.54mm, ROHS	BERG/FCI	67996-272HLF
881545-2	2	J15 = Pin 1 and 2, JP11 = Pin 1 and 2	CONN-JUMPER, SHUNT LP W/HANDLE, 2P, 2.54mm, BLK, ROHS	TYCO ELECTRONICS	881545-2
SSQ-105-02-T-D-RA	1	J13	CONN-SOCKET STRIP, TH, 2X5, 2.54mm, TIN, R/A, ROHS	SAMTEC	SSQ-105-02-T-D-RA
TSW-105-08-T-D-RA	1	J12	CONN-HEADER, 2X5, BRKAWY, 2.54mm, TIN, R/A, ROHS	SAMTEC	TSW-105-08-T-D-RA
BAT54XV2T1G-T	2	D13, D15	DIODE-SCHOTTKY, SMD, 2P, SOD523, 30V, 200mA, ROHS	ON SEMICONDUCTOR	BAT54XV2T1G
STPS20L45CG	1	D10	DIODE-RECTIFIER, SCHOTTKY, SMD, D2PAK, 45V, 10A, ROHS	STMICROELECTRONICS	STPS20L45CG



TABLE 1. BILL OF MATERIALS (Continued)

PART NUMBER	QTY	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART
CMD17-21VGC/TR8-T	1	D12	LED, SMD, 0805, GREEN, CLEAR, 10mcd, 2.1V, 20mA, 570nm, ROHS	CHICAGO MINIATURE	CMD17-21VGC/TR8
BLM21AG102SN1D-T	1	FB1	FERRITE CHIP, SMD, 0805, 1000Ω, 200mA, 100MHz, ROHS	MURATA	BLM21AG102SN1D
MIC2920A-3.3WS	1	U10	IC-LDO REGULATOR, 4P, SOT-223, 3.3V, 400mA, ROHS	MICREL	MIC2920A-3.3WS
SN74AUP1G17DCKR-T	1	U9	IC-BUFFER, SCHMITT TRIGGER, 5P, SC-70-5, 3.6V, 4mA, ROHS	TEXAS INSTRUMENTS	SN74AUP1G17DCKR
ZL2106ALCNT	1	U11	IC-6A DIGITAL-DC CONVERTER, 36P, QFN, 6X6, ROHS	INTERSIL	ZL2106ALCNT
2N7002-7-F-T	1	Q12	TRANSISTOR, N-CHANNEL, 3LD, SOT-23, 60V, 115mA, ROHS	DIODES, INC.	2N7002-7-F
H2510-00R00-1/16W-T	0	a) DNP - R2, R26, R27, R34, R35, R134, R135,	RES, SMD, 0402, 0Ω, 1/16W, 5%, TF, ROHS	VENKEL	CR0402-16W-00T
H2510-00R00-1/16W-T	0	b) DNP - R155, R156, R186	RES, SMD, 0402, 0Ω, 1/16W, 5%, TF, ROHS	VENKEL	CR0402-16W-00T
H2510-01002-1/16W1-T	2	R49, R50	RES, SMD, 0402, 10Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF1002X
H2510-01003-1/16W1-T	1	R120	RES, SMD, 0402, 100Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ2RKF1003
H2510-01622-1/16W1-T	1	R17	RES, SMD, 0402, 16.2Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF1622
H2510-01782-1/16W1-T	1	R18	RES, SMD, 0402, 17.8Ω, 1/16W, 1%, TF, ROHS	KOA	RK73H1ETTP1782F
H2510-01962-1/16W1-T	1	R19	RES, SMD, 0402, 19.6Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF1962
H2510-02152-1/16W1-T	5	R20, R127, R128, R131, R132	RES, SMD, 0402, 21.5Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF2152X
H2510-02372-1/16W1-T	1	R21	RES, SMD, 0402, 23.7Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF2372X
H2510-04990-1/16W1-T	1	R150	RES, SMD, 0402, 499Ω, 1/16W, 1%, TF, ROHS	VENKEL	CR0402-16W-4990FT
H2510-049R9-1/16W1-T	3	R143, R145, R146	RES, SMD, 0402, 49.9Ω, 1/16W, 1%, TF, ROHS	PANASONIC	ERJ-2RKF49R9X
H2511-03920-1/10W1-T	1	R121	RES, SMD, 0603, 392Ω, 1/10W, 1%, TF, ROHS	PANASONIC	ERJ-3EKF3920V
H2511-049R9-1/10W1-T	1	R129	RES, SMD, 0603, 49.9Ω, 1/10W, 1%, TF, ROHS	VENKEL	CR0603-10W-49R9FT
H2511-DNP	0	R185	RES, SMD, 0603, DNP-PLACE HOLDER, ROHS		
H2512-00R00-1/8W-T	1	R153	RES, SMD, 0805, 0Ω, 1/8W, TF, ROHS	YAGEO	RC0805JR-070RL
H2512-01783-1/8W1-T	1	R152	RES, SMD, 0805, 178Ω, 1/8W, 1%, TF, ROHS	VENKEL	CR0805-8W-1783FT
H2513-049R9-1/4W1-T	1	R130	RES, SMD, 1206, 49.9Ω, 1/4W, 1%, TF, ROHS	VISHAY/DALE	CRCW120649R9FKEA
G13AP-RO	1	SW1	SWITCH-TOGGLE, THRU-HOLE, 5P, SPDT, 3POS, ON-OFF-ON, ROHS	NKK	G13AP-RO
172-1024-E	1	Bag & ship w/board.	CABLE-USB 2.0, TYPE A MALE TO TYPE B MALE, 2M, ROHS	KOBICONN	172-1024-E
ZLUSBEVAL1ZFG	1	Bag & ship w/board.	PWB-FG, ZLUSBEVAL1Z, ROHS	INTERSIL	ZLUSBEVAL1ZFG
4-40X1/4-SCREW-SS	4	Four corners	SCREW, 4-40X1/4in, PHILLIPS, PAN, STAINLESS STEEL, ROHS	KEYSTONE	9900

TABLE 1. BILL OF MATERIALS (Continued)

PART NUMBER	QTY	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER	MANUFACTURER PART
4-40X3/4-STANDOFF-SS	4	Four corners	STANDOFF, 4-40X3/4in, F/F, HEX, STAINLESS STEEL, ROHS	KEystone	1921C
5X8-STATIC-BAG	1	Place assy in bag	BAG, STATIC, 5X8, ZIPLOC, ROHS	INTERSIL	212403-013
DOCUMENT #1	1	Banana jack instructions	See attached document for manual or visual instruction	INTERSIL	DOCUMENT #1
INTERSIL-ZILKER_CD1	1	Bag & ship w/board	CD-SOFTWARE, INTERSIL-ZILKER_CD1	INTERSIL	INTERSIL-ZILKER_CD1
Label-serial number	1		Label, for serial number and BOM rev #		
VC-234-8	4	P1, P2, P3, P4	CAPLUG-ROUND VINYL CLOSURE, FLEXIBLE, 0.5X0.234, ROHS	CAPLUGS	VC-234-8

## ZL2106EVAL1Z Board Layout - 6 Layers

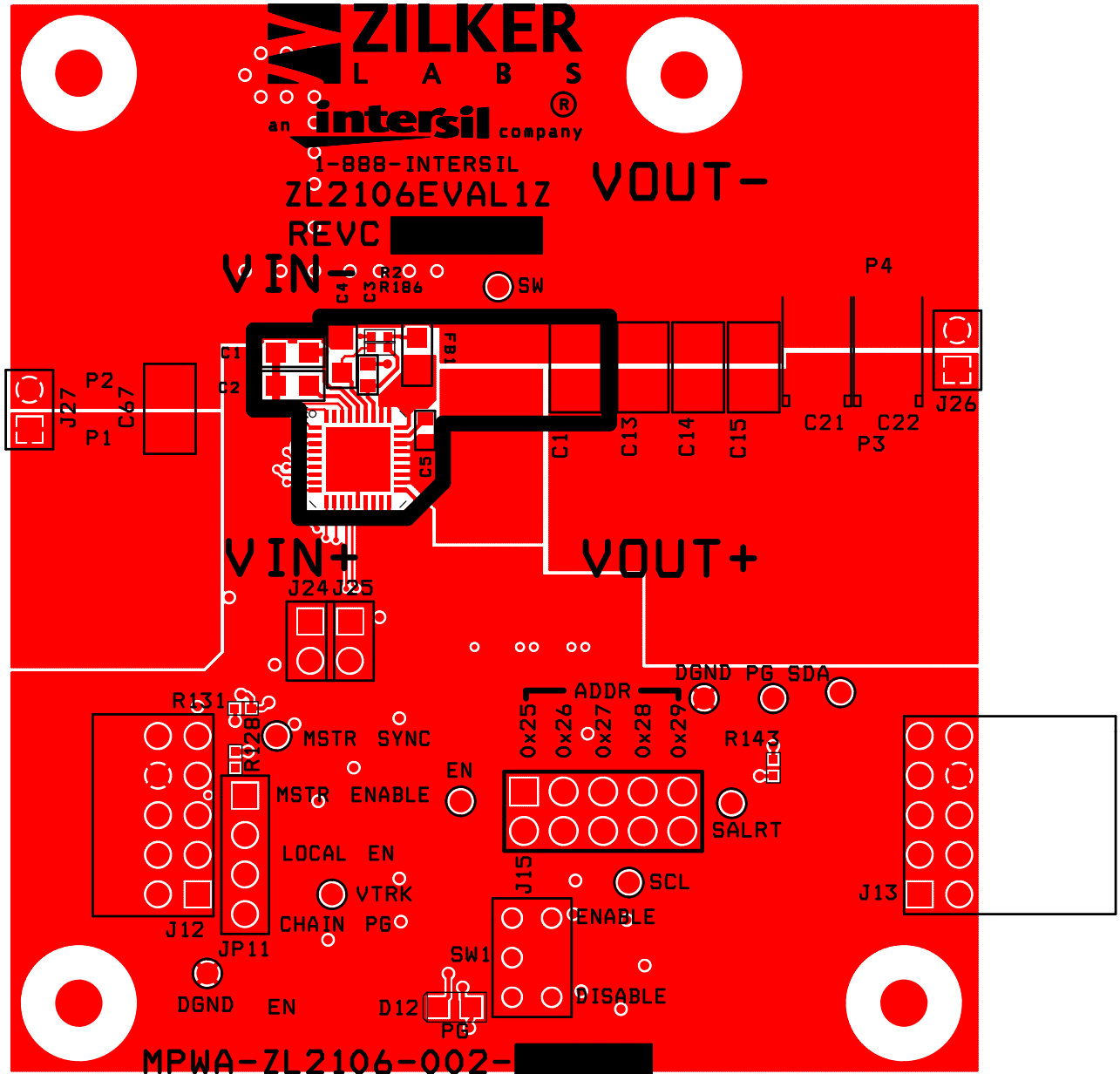


FIGURE 6. TOP LAYER

NOTE: TP2 is labeled SW but is connected to BST (see Figure 3 schematic).

## ZL2106EVAL1Z Board Layout - 6 Layers (Continued)

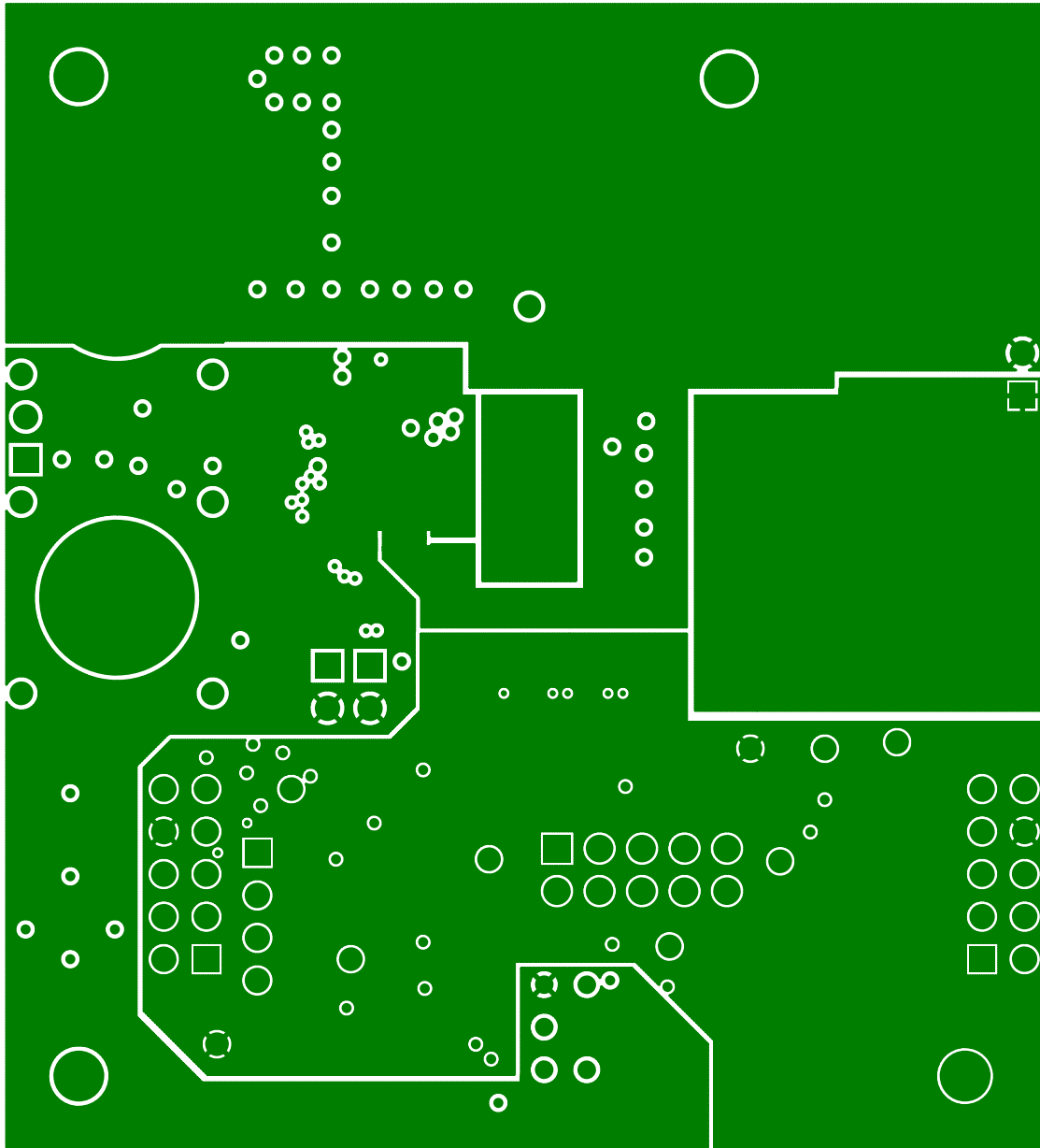


FIGURE 7. PCB - INNER LAYER 1 (VIEWED FROM TOP)

## ZL2106EVAL1Z Board Layout - 6 Layers (Continued)

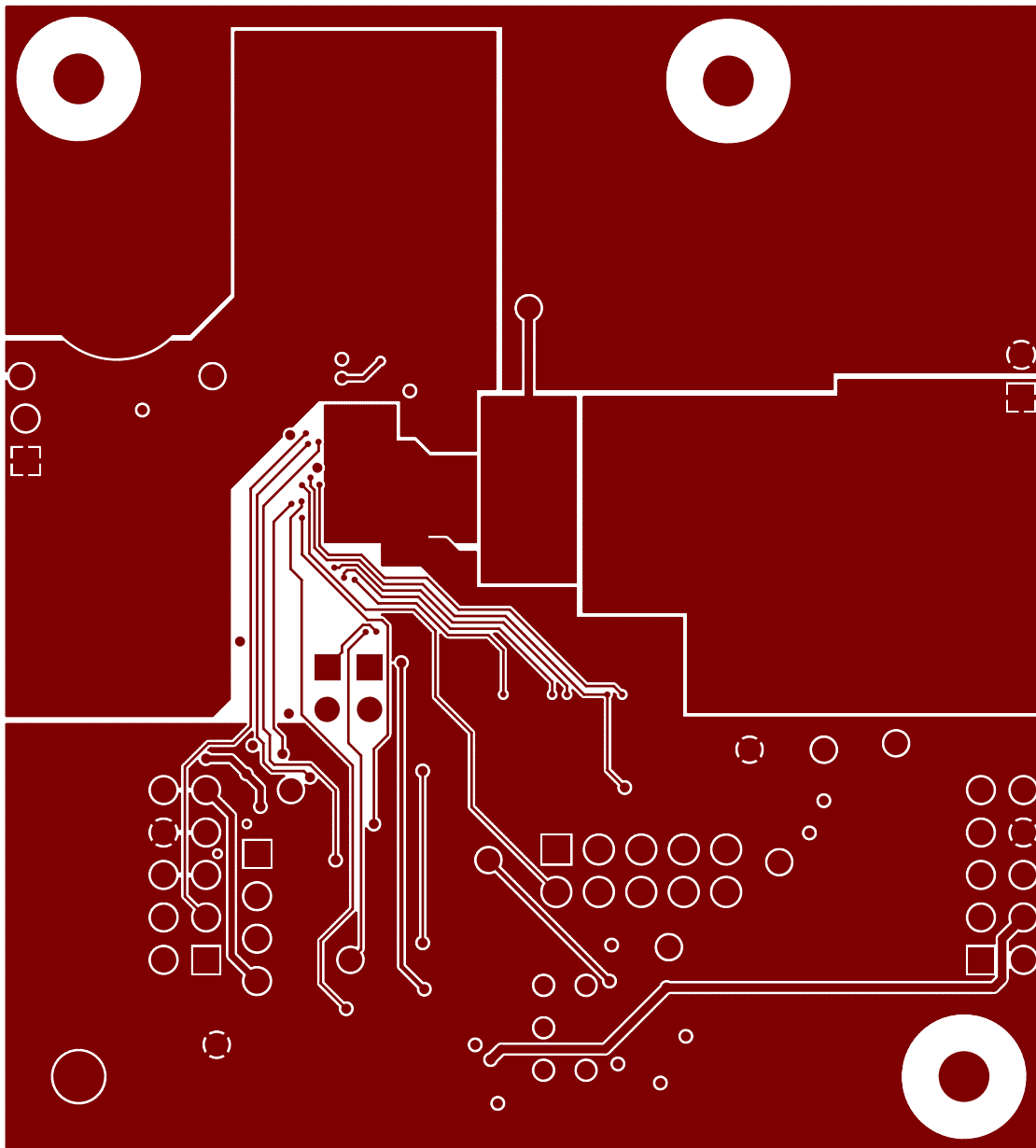


FIGURE 8. PCB - INNER LAYER 2 (VIEWED FROM TOP)

## ZL2106EVAL1Z Board Layout - 6 Layers (Continued)

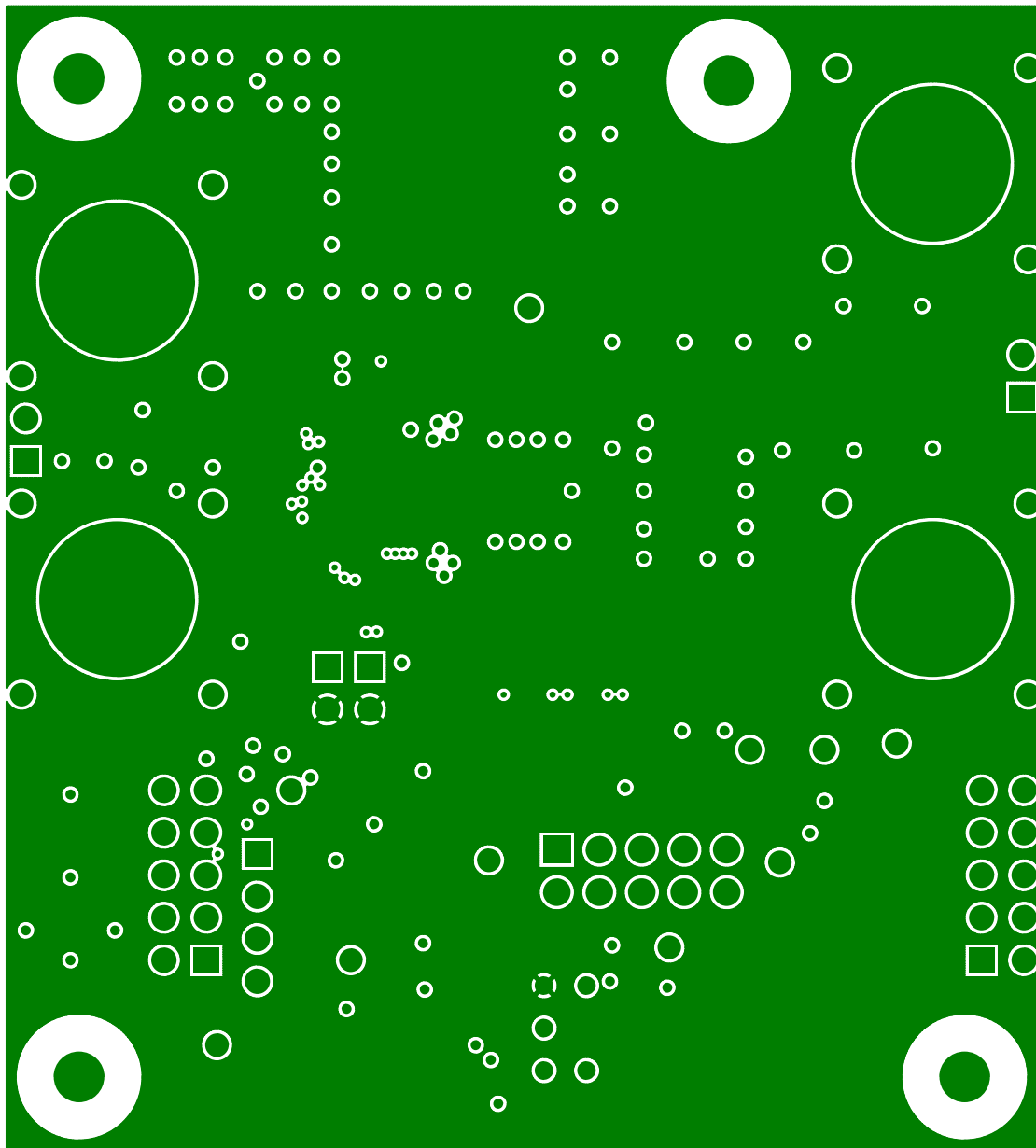


FIGURE 9. PCB - INNER LAYER 3 (VIEWED FROM TOP)

## ZL2106EVAL1Z Board Layout - 6 Layers (Continued)

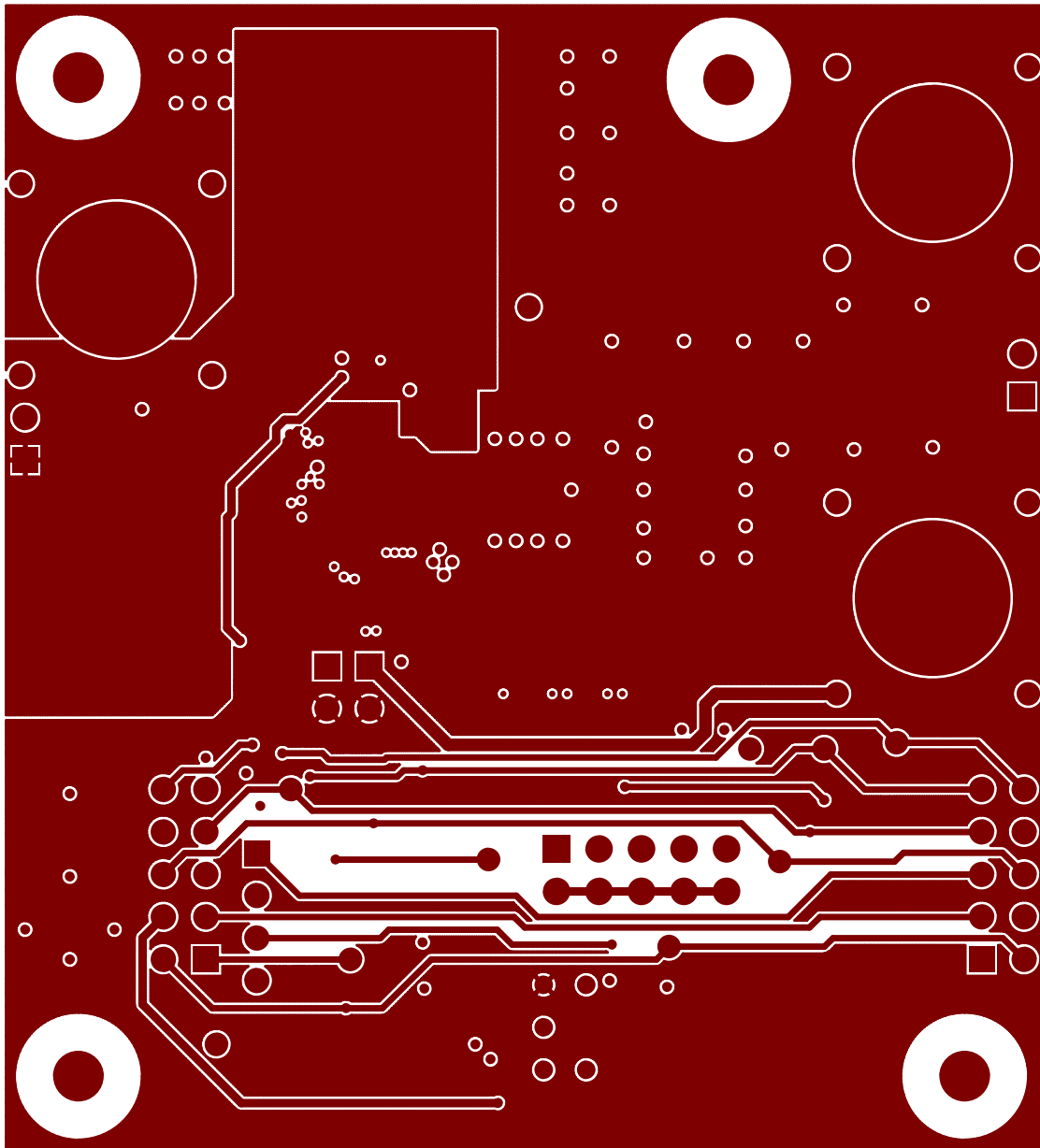


FIGURE 10. PCB - INNER LAYER 4 (VIEWED FROM TOP)



# ZL2106EVAL1Z Board Layout - 6 Layers (Continued)

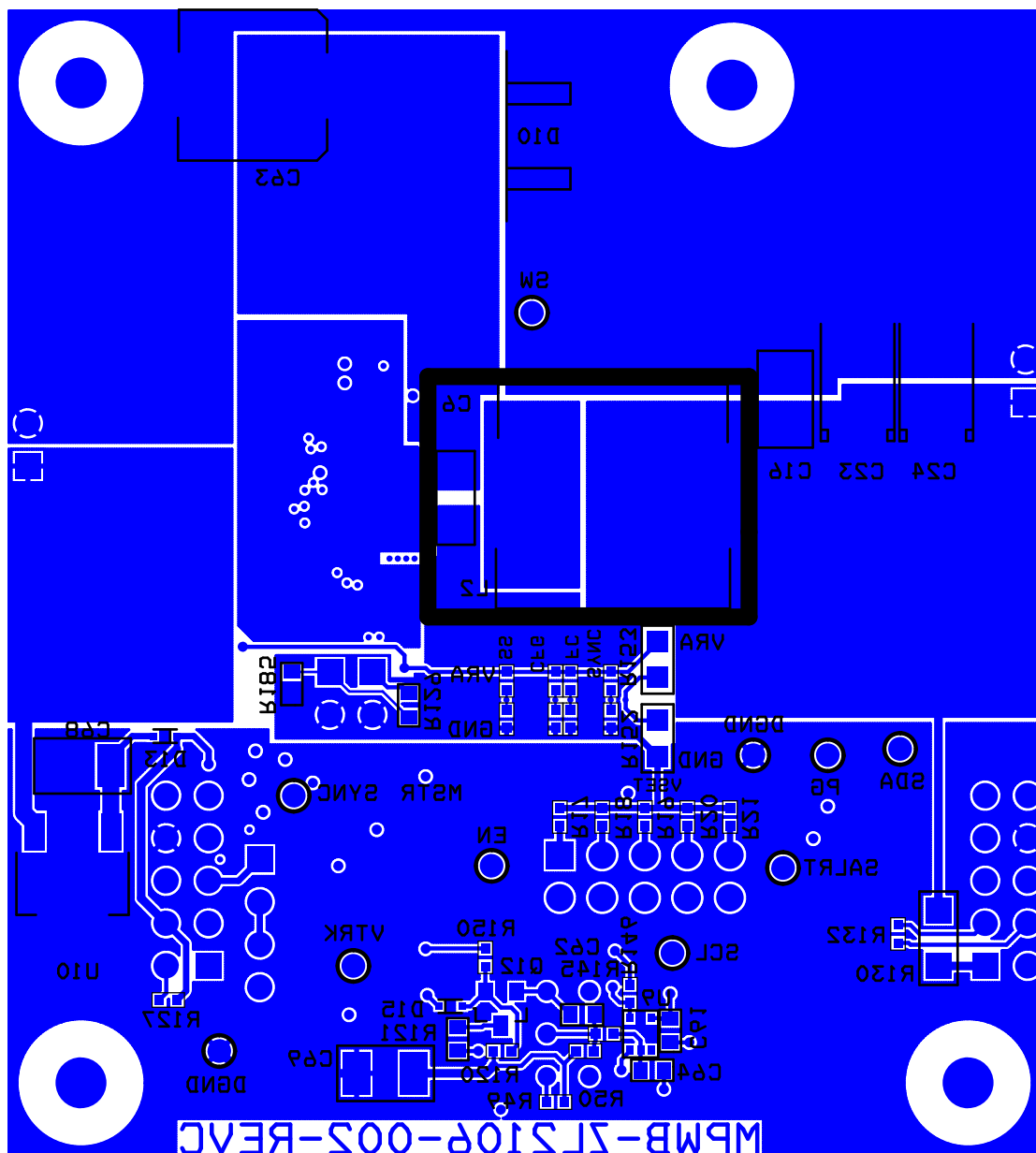


FIGURE 11. PCB - BOTTOM LAYER (VIEWED FROM TOP)

# Typical Performance Curves for ZL2106 Buck Regulator

Unless noted:  $V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $f_{SW} = 400kHz$ ,  $T_A = +25^\circ C$

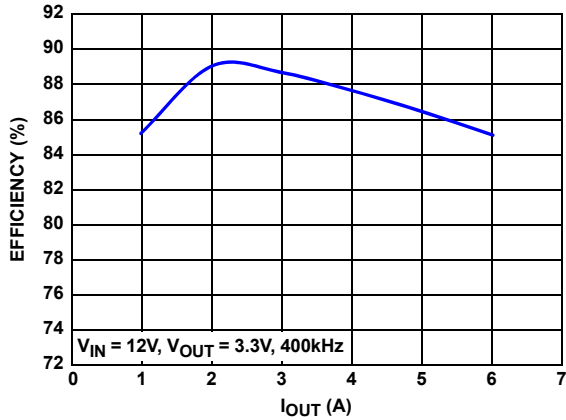


FIGURE 12. MEASURED EFFICIENCY

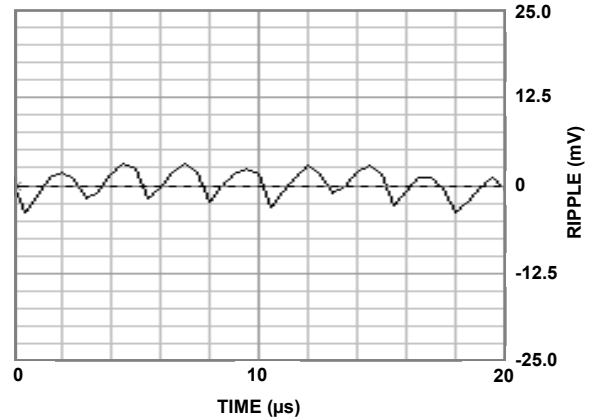


FIGURE 13. OUTPUT RIPPLE

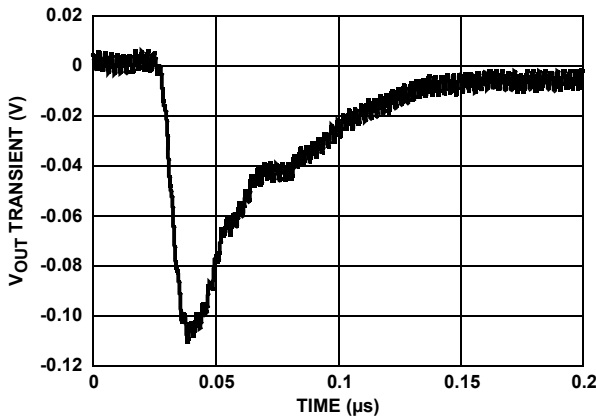


FIGURE 14. DYNAMIC RESPONSE (3A TO 5A LOAD STEP,  $di/dt = 2.5A/\mu s$ )

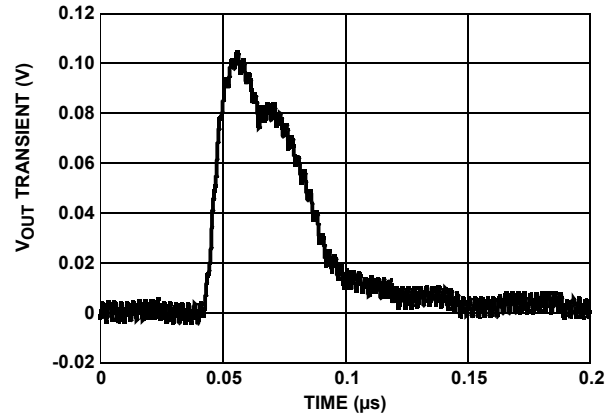


FIGURE 15. DYNAMIC RESPONSE (5A TO 3A LOAD STEP,  $di/dt = 2.5A/\mu s$ )

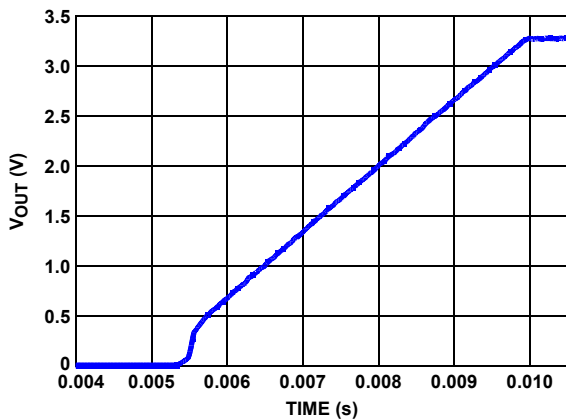


FIGURE 16. RAMP-UP TIME

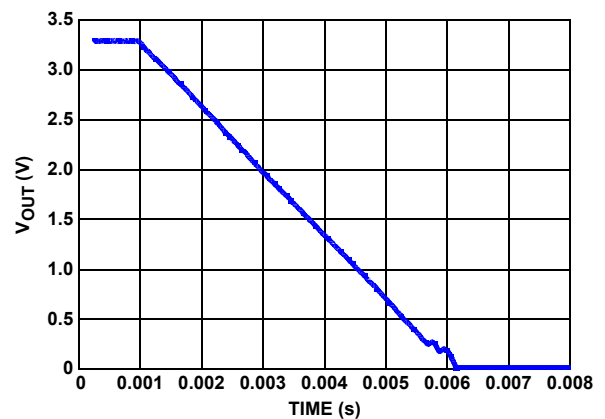


FIGURE 17. RAMP-DOWN TIME

## Default Configuration Text

The following configuration text is loaded into the ZL2106EVAL1Z as default settings. Each PMBus command is loaded via the PowerNavigator software. The # symbol is used for a comment line.

```
#Configuration file for ZL2106
RESTORE_FACTORY
STORE_DEFAULT_ALL
STORE_USER_ALL
RESTORE_DEFAULT_ALL

MFR_ID Zilker_Labs
MFR_MODEL ZL2106_EVAL1Z
MFR_REVISION 1.7
MFR_LOCATION Austin_TX

FREQUENCY_SWITCH 400 # kHz

VOUT_COMMAND 3.3

POWER_GOOD_DELAY 1

VOUT_OV_FAULT_RESPONSE 0x80
VOUT_UV_FAULT_RESPONSE 0x80
OVUV_CONFIG 0x80
VIN_OV_FAULT_RESPONSE 0x80
VIN_UV_FAULT_RESPONSE 0x80

TON_DELAY 5
TON_RISE 10
TOFF_DELAY 5
TOFF_FALL 10

IOUT_OC_FAULT_LIMIT 10
IOUT_AVG_OC_FAULT_LIMIT 10
IOUT_UC_FAULT_LIMIT -4.0
IOUT_AVG_UC_FAULT_LIMIT -3.5

MFR_IOUT_OC_FAULT_RESPONSE 0x80
MFR_IOUT_UC_FAULT_RESPONSE 0x80

OT_FAULT_RESPONSE 0xBF
UT_FAULT_RESPONSE 0xBF

#MFR_CONFIG 0x4200
USER_CONFIG 0x2000
MISC_CONFIG 0x0080
#DDC_CONFIG 0x0000

INDUCTOR 6.0

PID_TAPS A=21237.00, B=-37086.00, C=15871.00
#PID_TAPS A=23303.50, B=-44911.00, C=21628.00

STORE_DEFAULT_ALL
RESTORE_DEFAULT_ALL
```

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**Renesas Electronics Europe Limited**  
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Tel: +44-1628-651-700, Fax: +44-1628-651-804

**Renesas Electronics Europe GmbH**  
Arcadiastrasse 10, 40472 Düsseldorf, Germany  
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

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Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China  
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

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Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

**Renesas Electronics Hong Kong Limited**  
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong  
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**Renesas Electronics India Pvt. Ltd.**  
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Tel: +91-80-67208700, Fax: +91-80-67208777

**Renesas Electronics Korea Co., Ltd.**  
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5338