# ZL9117EVAL1Z Digital DC/DC 17A Module Evaluation Board

## Description

The ZL9117M is a 17A variable output, step-down power supply module. Included in the module is a high-performance digital PWM controller, power MOSFETs, an inductor, and all the passive components required for a highly integrated DC/DC power solution. This power module has built-in auto-compensation algorithms, which optimizes transient response over varying load conditions. The ZL9117M operates over a wide input voltage range and supports an output voltage range of 0.6V to 3.6V, which can be set by external resistors or via the PMBus. This high-efficiency power module is capable of delivering 17A. Only bulk input and output capacitors are needed to finish the design. The output voltage can be precisely regulated to as low as 0.6V with ±1% output voltage regulation.

The ZL9117EVAL1Z is a 6-layer board that provides a single-phase power rail up to 17A loads. The board is designed to efficiently transfer heat away from the module with passive cooling.

A USB to SMBus adapter is used to connect the ZL9117EVAL1Z board to a PC. The PMBus command set is accessed by using the PowerNavigator™ evaluation software.

## Key Features

- Complete Switch Mode Power Supply
- 17A DC Output Current
- Auto Compensating PID Filter
- Adjustable +0.6V to +3.6V Output Range
- Up to 90% Efficiency
- Digital Control PWM
- Fixed 571kHz Switching Frequency
- Fast Transient Response
- Enable Function Option
- Power-Good Indicator
- Convenient Power Connection
- Multiple Power Options
- Single Supply Operation
- Configurable Through SMBus

## Key Specifications

The ZL9117EVAL1Z has been designed and optimized for the following parameters:

- $V_{IN}$ = 12V
- $V_{OUT}$ = 1.0V
- $I_{OUT(MAX)}$ = 17A
- $F_{SW}$ = 571kHz
- $V_{OUT(RIPPLE)}$ < 1%
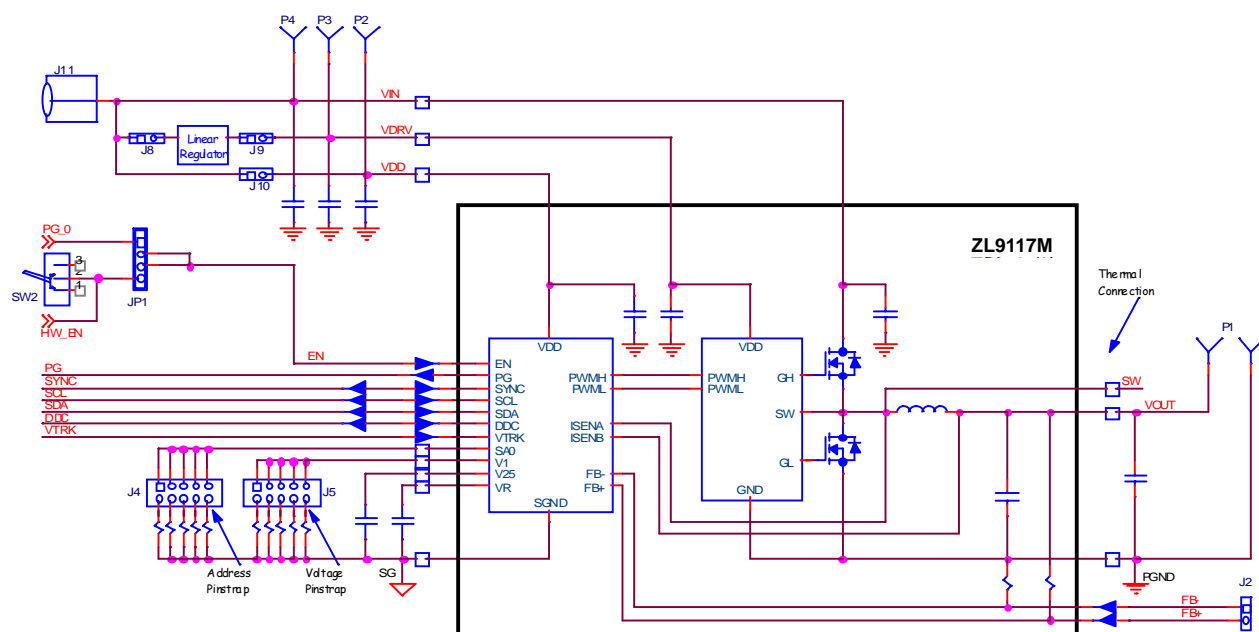- Transient Response = 3% (3A to 9A step at 2.5A/µs)



**FIGURE 1.  ZL9117EVAL1Z EVALUATION BOARD BLOCK DIAGRAM**

# Functional Description

The ZL9117EVAL1Z evaluation board provides all the circuitry required to evaluate the features of the ZL9117M module. The ZL9117EVAL1Z has a performance-optimized, single-phase ZL9117M circuit layout that allows operation up to the maximum rated output current. Power options and load connections are provided through plug-in sockets and shorting jumpers.

Figure 1 shows a functional block diagram of the ZL9117EVAL1Z board. The SMBus address is selectable through J4 located on the top side of the board. All power to the board ($V_{IN}$ and $I^2C$ bus) must be removed before changing the jumpers.

The hardware enable function is controlled by a toggle switch on the ZL9117EVAL1Z board. The power-good (PG) LED indicates the state of PG when external power is applied to the ZL9117EVAL1Z board. The right-angle headers at opposite ends of the board are for connecting a USB to an SMBus adapter board or for daisy-chaining of multiple evaluation boards.

Figure 2 shows the ZL9117EVAL1Z operational circuit. The circuit consists of the ZL9117M module and supporting components.

Figure 3 shows the ZL9117EVAL1Z interface schematic.

Figures 4 through 9 show the layers of the ZL9117EVAL1Z evaluation board.

## Basic Operation

The ZL9117EVAL1Z evaluation board is easy to set up and operate. It is optimally configured, out of the box, to provide 1.0V at 17A from a 12V source. All input and output connections should be made before applying power.

The ZL9117M module requires a configuration file in order to operate. The ZL9117M supports pinstrap configuration for output voltage and SMBus address. All other parameters must be configured with a text-based configuration file. See application note AN2031 for more information on writing configuration files. An example configuration file is listed at the end of this document.

## Pinstraps

The ZL9117M requires a configuration file for normal operation; however, there are two pinstrap functions to be configured: Voltage and SMBus address. Ensure that input power is removed, and then set the address and voltage pinstraps using J4 and J5. Apply $V_{DD}$ power, and the new settings will be in effect.

## PMBus Operation

The ZL9117M 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 PowerNavigator™ software using the CD included in the ZL9117EVAL1Z kit. For PMBus operation, connect the USB-to-SMBus dongle board to J7 of the ZL9117EVAL1Z 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 ZL9117M PMBus parameters. See Application Note AN2033 for PMBus command details. Use the mouse-over pop-ups for PowerNavigator™ help. Manually configure the ZL9117M through

PowerNavigator™ or load a predefined scenario from a configuration file.

The ENABLE switch can then be moved to "ENABLE" and the ZL9117M can be tested. Alternately, the PMBus ONOFF, CONFIG, and OPERATION commands can be used.

## Single-Supply Operation

The ZL9117EVAL1Z board was designed to facilitate operation from a single power supply input. The single input power mode reduces the number of connections but results in a minor reduction of efficiency.

The driver bias is supplied by an onboard linear regulator. Figure 3 shows the onboard regulator circuit for powering the ZL9117M driver. Jumpers J8 and J9 connect the supply power to the linear regulator that is used to power the driver, and J6 connects input power to the ZL9117M digital module. If single-supply operation is desired, J6, J8, and J9 must be installed.

## Multi-Supply Operation (External Driver Supply)

To operate the ZL9117EVAL1Z driver from an external power supply, remove J8 and J9, and connect an external power supply to the driver connector, P3, between 4.5V to 6.5V.

To operate the ZL9117EVAL1Z board using different power supplies for the controller and FETs, remove J6 and apply an external power supply to power the FETs to P4 to between 4.5V and 14V.

Apply a power supply voltage to the ZL9117M module through the P2 connector.

If the $V_{DD}$ voltage is $4.5V \leq V_{DD} \leq 5.5V$, then apply 4.5V to 5.5V to P2, and connect $V_R$ to $V_{DD}$. Do not exceed 5.5V while $V_R$ is connected to $V_{DD}$ or permanent damage will result.

If the $V_{DD}$ voltage is $5.5V \leq V_{DD} \leq 14V$, then apply 5.5V to 14V to P2, and do not connect to $V_R$.

The ZL9117EVAL1Z comes configured to use hardware Enable. Toggle the power switch to the Enable position to power on. Use the GUI to change the configuration, if desired.

## Power Good

The ZL9117M provides a Power-Good (PG) signal, which indicates that the output voltage is within a specified tolerance of its target level and that no fault condition exists. By default, the PG pin asserts if the output is within 10% of the target voltage. These limits and the polarity of the pin may be changed via the $I^2C$/SMBus interface. See Application Note AN2033 for details.

A PG delay period is defined as the time from when all conditions within the ZL9117M for asserting PG are met to when the PG pin is actually asserted. This feature is commonly used instead of using an external reset controller to control external digital logic. By default, the ZL9117M PG delay is set equal to the soft-start ramp time setting of 5ms. The PG delay may be set independently of the soft-start ramp by using the $I^2C$/SMBus as described in Application Note AN2033.

# Application Note 1670

## Switching Frequency and PLL

The ZL9117M incorporates an internal phase-locked loop (PLL) to clock the internal circuitry. The PLL can be driven by an external clock source connected to the SYNC pin via J7 or J14. When using the internal oscillator, the SYNC pin can be configured as a clock source.

The internal switching frequency of the ZL9117M is 571kHz. Operation below 571kHz will increase the inductor ripple current and cause permanent damage.

## Loop Compensation

The ZL9117M operates as a voltage-mode synchronous buck controller with a fixed frequency PWM scheme. The module is internally compensated via the I$^2$C/SMBus interface. The ZL9117M has an auto compensation feature that measures the characteristics of the power train and calculates the proper tap coefficients. On the evaluation board, auto compensation is configured to execute one time after ramp, without storing results, with 70% Auto Comp Gain, and Power-Good asserted immediately after the first Auto Comp cycle completes. The compensation tool, CompZL™ can be used to generate appropriate PID settings for other circuit configurations. Please refer to Application Note AN2033 for further details.

## Adaptive Diode Emulation

Adaptive diode emulation mode turns off the low-side FET gate drive at low load currents to prevent the inductor current from going negative, thus reducing energy losses and increasing overall efficiency. Diode emulation is available to single-phase devices only.

NOTE: The overall bandwidth of the device may be reduced when in diode emulation mode. It is recommended that diode emulation be disabled prior to applying significant load steps.

## Input Undervoltage Lockout

The input undervoltage lockout (UVLO) prevents the ZL9117M from operating when the input falls below a preset threshold, indicating the input supply is out of its specified range. The UVLO threshold ($V_{UVLO}$) can be set between 2.85V and 16V using the I$^2$C/SMBus interface.

Once an input undervoltage fault condition occurs, the device can respond in a number of ways as follows:

1. Continue operating without interruption.
2. Continue operating for a given delay period, followed by shutdown if the fault still exists. The device remains in shutdown until instructed to restart.

## Connectors and Jumpers

Connector and jumpers are shown in Figure 10.

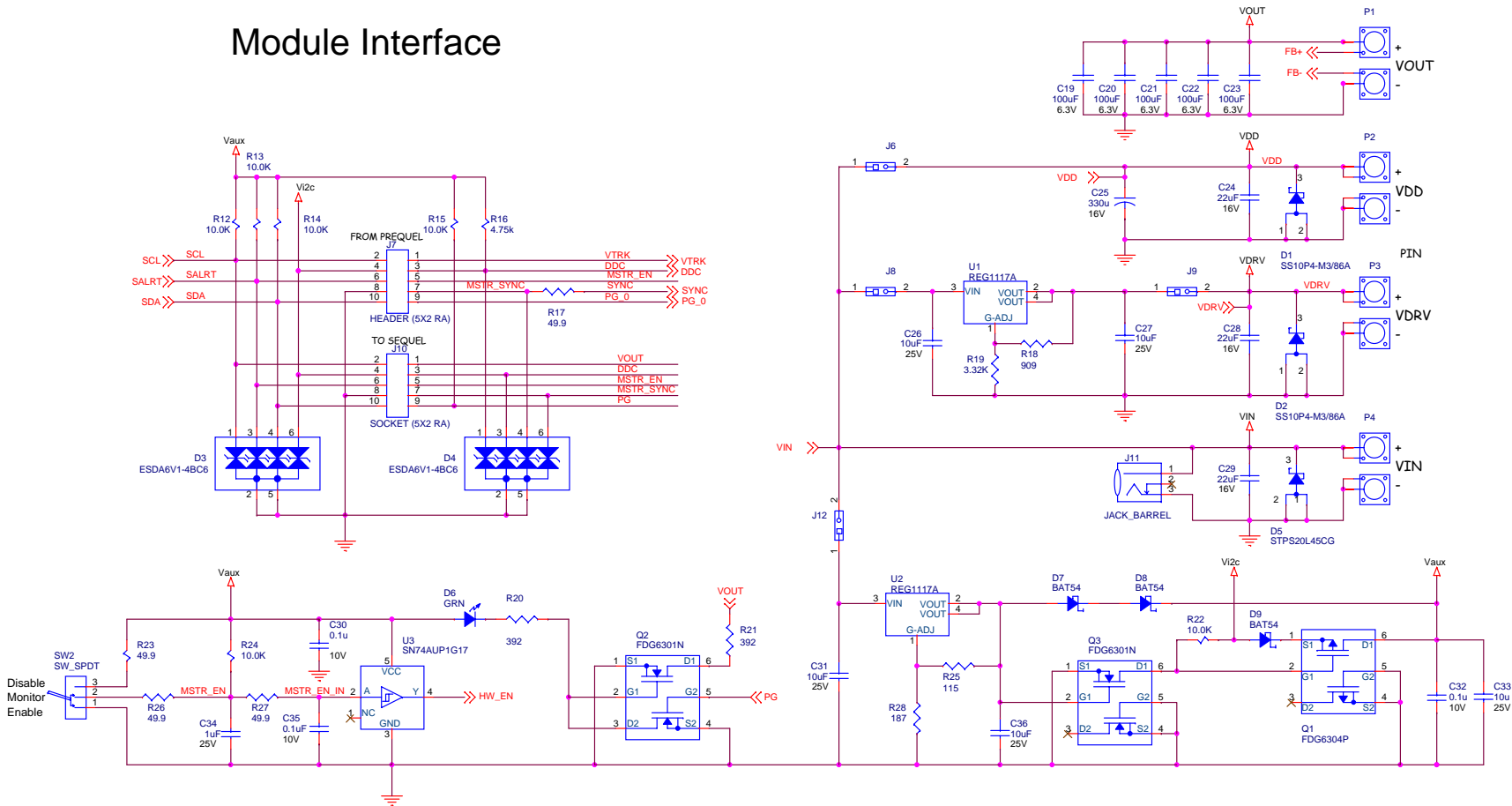FIGURE 2. ZL9117EVAL1Z CIRCUIT SCHEMATIC

# Module Interface



**FIGURE 3. ZL9117EVAL1Z INTERFACE SCHEMATIC**

# Default Configuration File

The following text is loaded into the ZL9117M devices on the ZL9117EVAL1Z evaluation board as the default settings. This configuration file can be loaded using the PowerNavigator™ software, ConfigCheck™ software, or a user-created application. The # symbol denotes a comment line.

```
# Intersil ZL9117M 08/30/2011
# ZL Configuration File Revision 1
# Schematic revision level
# BOM revision level
# ZL Author
# Change log:

RESTORE_FACTORY
STORE_DEFAULT_ALL
STORE_USER_ALL

MFR_ID                        Intersil
MFR_MODEL                     ZL9117
MFR_REVISION                  REV_3p1
MFR_LOCATION
MFR_DATE
MFR_SERIAL

VOUT_MAX                      3.60

IOUT_SCALE                    1.083
IOUT_CAL_OFFSET               -1

TON_DELAY                     5
TON_RISE                      5
TOFF_DELAY                    5
TOFF_FALL                     5

FREQUENCY_SWITCH              571

VOUT_OV_FAULT_RESPONSE        0x80
VOUT_UV_FAULT_RESPONSE        0x80
OVUV_CONFIG                   0x80

IOUT_OC_FAULT_LIMIT           30.00
IOUT_AVG_OC_FAULT_LIMIT       24.00
IOUT_UC_FAULT_LIMIT           -30.0
IOUT_AVG_UC_FAULT_LIMIT       -24.0

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       4.0
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        4.4
VIN_UV_FAULT_LIMIT       4.0
VIN_UV_FAULT_RESPONSE    0x80

OT_WARN_LIMIT            140.0
OT_FAULT_LIMIT           150
OT_FAULT_RESPONSE        0x80

UT_WARN_LIMIT            -40
UT_FAULT_LIMIT           -55
UT_FAULT_RESPONSE        0x80

AUTO_COMP_CONFIG         0x69

POWER_GOOD_DELAY         5

DEADTIME                 0x1010
DEADTIME_CONFIG          0x0808
DEADTIME_MAX             0x2828

MAX_DUTY                 94

MFR_CONFIG               0x8311

NLR_CONFIG               0x00000000

USER_CONFIG              0x2011

TEMPCO_CONFIG            0x28

MISC_CONFIG              0x0880

INTERLEAVE               0x0000
SEQUENCE                 0x0000

DDC_GROUP                0x00000000

DDC_CONFIG               0x0101
ISHARE_CONFIG            0x0100

INDUCTOR                 0.20

ON_OFF_CONFIG            0x16

STORE_DEFAULT_ALL
RESTORE_DEFAULT_ALL
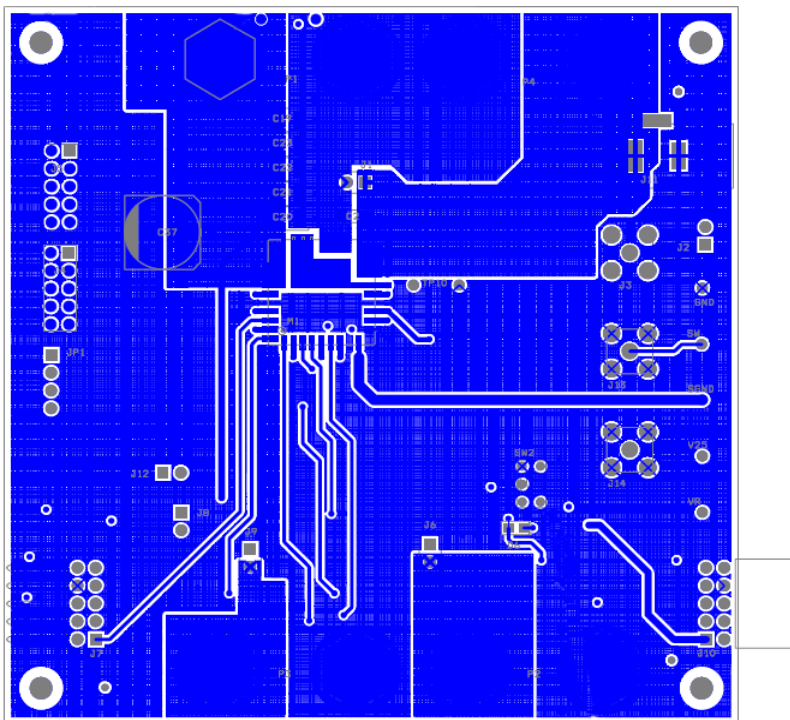
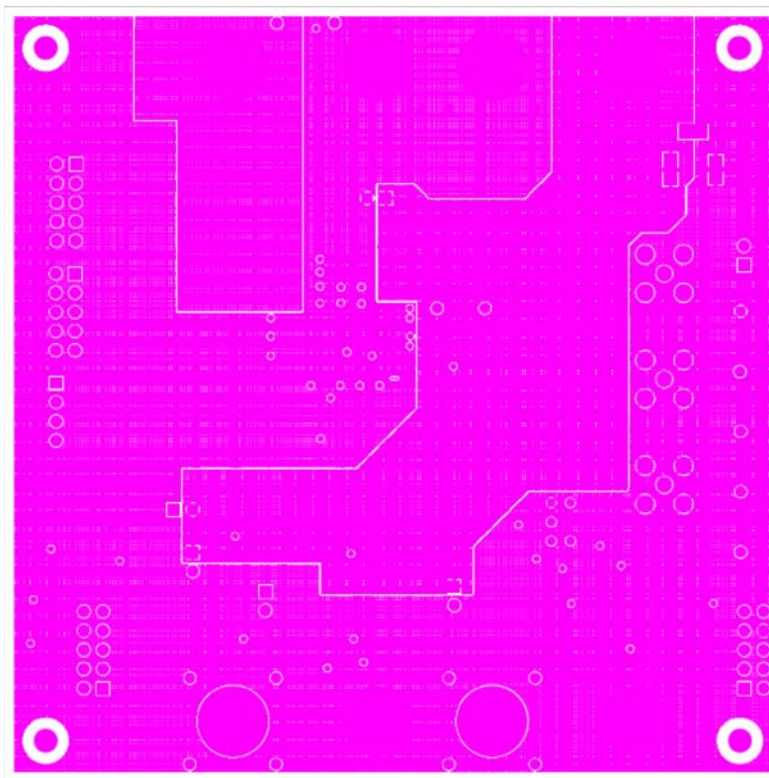**FIGURE 4. TOP LAYER**
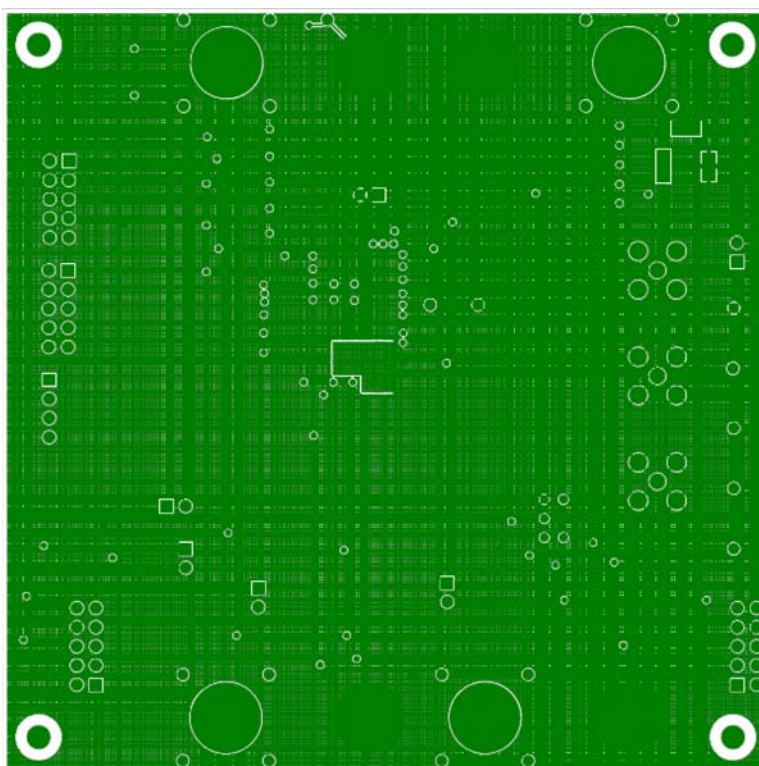


**FIGURE 5. INNER_1**
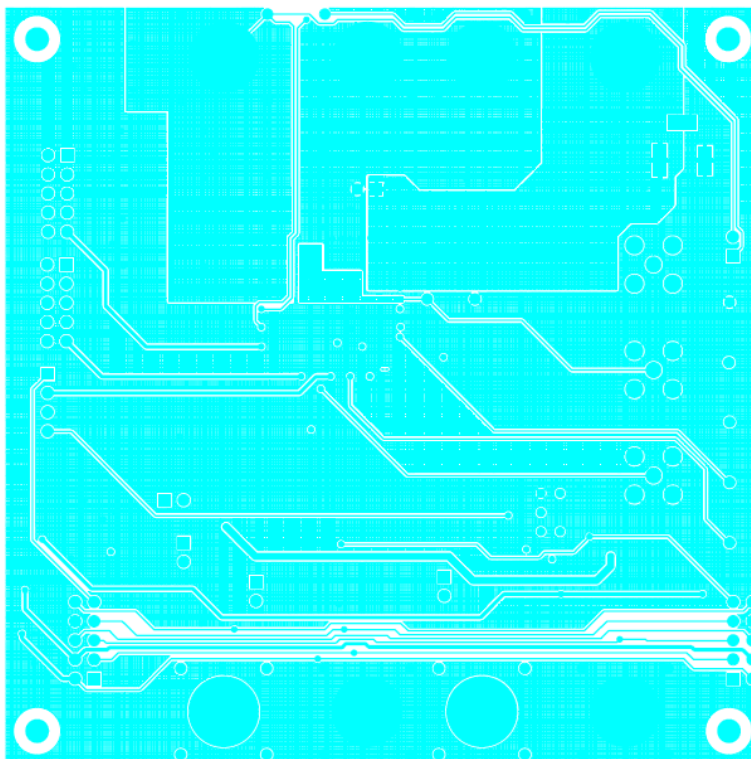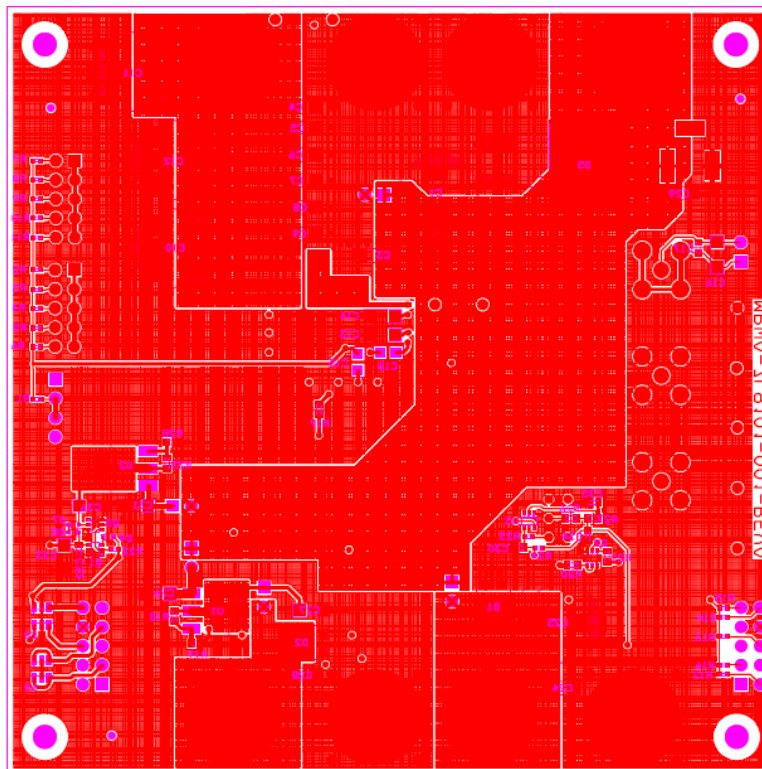
**FIGURE 6. INNER_2**



**FIGURE 7. INNER_3**
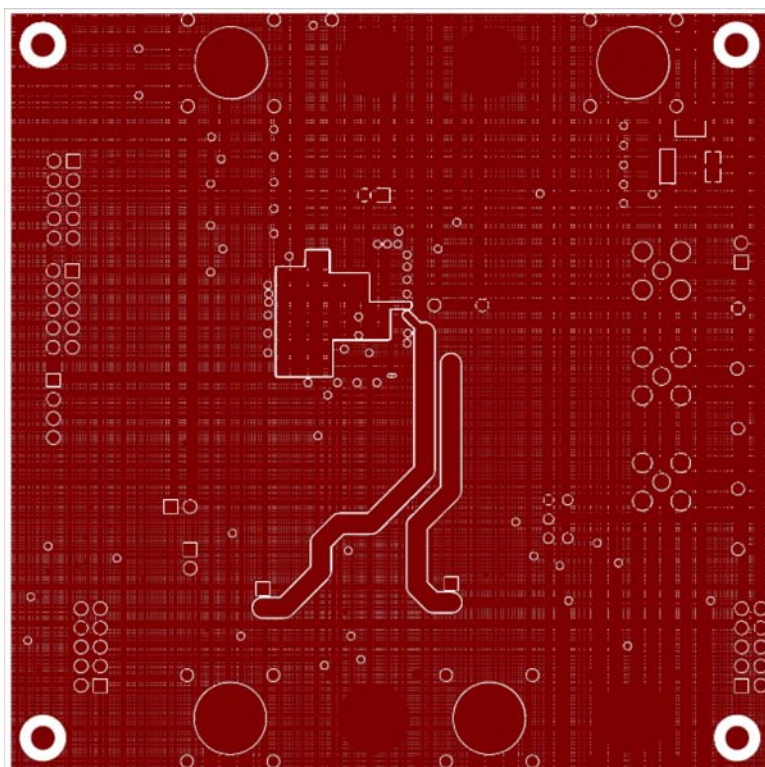
FIGURE 8. INNER_4



FIGURE 9. BOTTOM
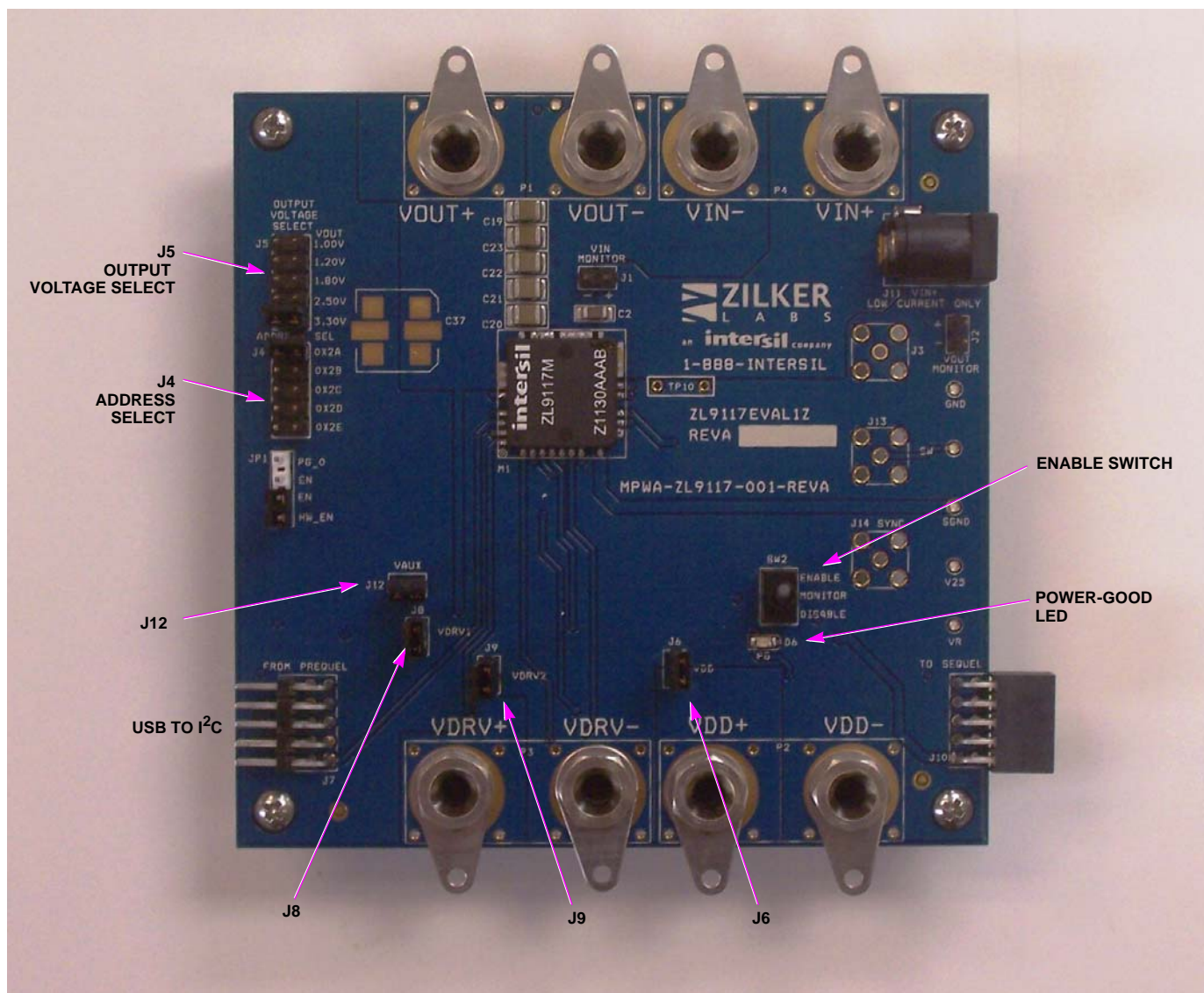
**FIGURE 10. PHOTO SHOWING JUMPERS AND CONNECTORS**

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