

ZL2105EV2
Evaluation Board (Rev 1)

AN1467
REV.0.00
May 07, 2009

Description

The ZL2105 is an innovative mixed-signal power management and conversion IC that combines an integrated step-down DC-DC converter with key power and thermal management functions in a single package. The ZL2105EV2 platform allows evaluation of the features in the highly configurable ZL2105 in either stand-alone mode or via an I²C/SMBus interface.

A USB-to-SMBus adapter board can be used to connect the ZL2105EV2 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

- Small, compact design
- PMBus control
- Pin-strap selection for stand-alone operation
- V_{OUT} settable from +0.6 V to +5 V
- Convenient power connection
- Onboard enable switch
- Power good indicator

Target Specifications

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

- V_{IN} = 12 V (Board range 4.5 V to 14 V)
- V_{OUT} = 3.3 V (Board range 0 to 5 V)
- I_{MAX} = 3 A (Board range 0 to 3 A)
- f_{sw} = 400 kHz
- Efficiency: 83% peak
- Output ripple: 0.5%
- Dynamic response: 3% (1–2A step, di/dt=2.5A/μs)
- Temperature: 25°C

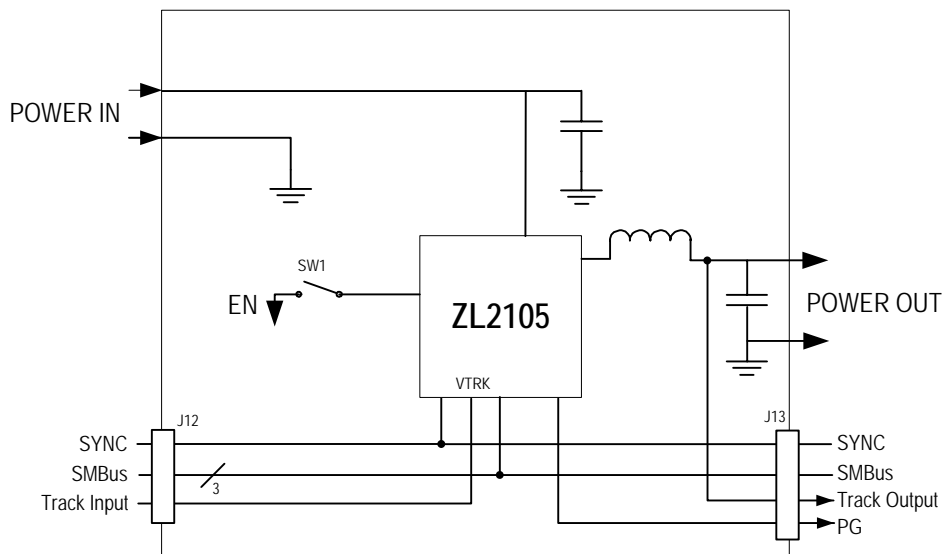


Figure 1. ZL2105EV2 Block Diagram

Functional Description

The ZL2105EV2 provides all circuitry required to demonstrate the features of the ZL2105. The ZL2105EV2 has a functionally-optimized ZL2105 circuit layout that allows efficient operation up to the maximum output current. Power and load connections are provided through plug-in sockets.

Stand alone operation is achieved using the pin-strap settings for the device. The pin-strap settings are described in the ZL2105 data sheet [1].

The ZL2105 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 (VIN and I²C bus) must be removed before changing the jumpers. The back side of the board has 0402 resistor footprints for setting the application pins using resistors.

The hardware enable function is controlled by a toggle switch on the ZL2105EV2 board. The power good (PG) LED is powered from the SMBus/I²C source; it indicates the correct state of PG when external power is applied to the ZL2105EV2 board. The right angle headers at opposite ends of the board are for connecting a USB to I²C control board or for daisy chaining of multiple evaluation boards.

Figure 3 shows the ZL2105 operational circuit. The circuit consists of the ZL2105 power conversion and management IC with its minimal component count to realize a buck converter. The board layout has been optimized for thermal performance. For thermal design considerations relating to the ZL2105, refer to Zilker Labs application note AN10[2].

Figure 5 on Page 8 illustrates the input and output power connections for the ZL2105. The optional input capacitors and output capacitors are also shown on this page.

Operation

Stand Alone Operation

The ZL2105 is easy to setup and operate. It is configured, out of the box, to provide 3.3 V at 3 A from a 12 V source. All input and output connections should be made before turning the input supply on.

When the input power supply is turned on, the ZL2105 will output the configured voltage and the load applied to VOUT+/VOUT- can be varied.

To modify the pin-strap setting of the ZL2105, input power must be turned off. The user pin-strap resistor pads are on the bottom side of the ZL2105EV2 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 ZL2105 data sheet [1] for pin-strap and resistor setting information. Refer to Figure 2 for resistor pad locations.

PMBus Operation

The ZL2105 utilizes the PMBus protocol. The PMBus functionality can be controlled via USB from a PC running the Zilker Labs evaluation software in a Windows XP or Windows 2000/NT operating system.

Install the PowerNavigator software using the CD included in the ZL2105EV2 kit or download it from the web at www.zilkerlabs.com.

For PMBus operation, connect another Zilker Labs evaluation board such as the ZL2005EV1 or the USB-to-SMBus adapter board to J12 of the ZL2105EV2 board. When using multiple evaluation boards together, verify that each device is assigned a different SMBus address. Connect the desired load and an appropriate power supply to the input. Place the ENABLE switch in “DISABLE” and turn on the power.

The evaluation software allows modification of all ZL2105 PMBus parameters. Manually configure the ZL2105 through the various

screens or load a predefined scenario from a configuration file.

Use the mouse-over pop-ups for help with PowerNavigator. Refer to Zilker Labs application note AN13 [3] for PMBus details.

The ENABLE switch can then be moved to “ENABLE” and the ZL2105 can be tested. Alternately, the PMBus ON-OFF CONFIG and OPERATION commands may be used.

Loop Compensation Settings

By default, the ZL2105 EVB is configured for 12 V to 3.3 V conversion at 3 A. The output voltage can be changed by using the V1 and V0 resistor pads or through the use of PMBus commands. If the output voltage is set to 1V or below, the loop compensation needs to be modified. Table 1 summarizes the PID settings. This is achieved by using PMBus commands or by modifying the PowerPlan configuration file.

Table 1. PID Settings versus Output Voltage

| V _{OUT} Range | PID Setting |
|------------------------------|---------------------------|
| 1V < V _{OUT} ≤ 5.0V | A=5000, B=-9016, C=4170 |
| V _{OUT} ≤ 1V | A=10000, B=-18101, C=8324 |

These settings are included in the configuration file that is stored on the ZL2105 EVB and is shown here and at the end of this data sheet for reference.

For output voltages greater than 1V, the loop compensation is set as:

```
#Loop compensation for 12v:3.3v,
PID_TAPS      A=5000, B=-9016, C=4170
#NLR_CONFIG Enable,1.5%,No Outer,1.5%,3,3,0
NLR_CONFIG    0xA250
```

When the output voltage is set to 1V or less, the loop compensation should be:

```
#Loop compensation for 12V:0.8V
PID_TAPS      A=10000, B=-18101, C=8324
#NLR_CONFIG Enable,1.5%,No Outer,2%,3,3,0
NLR_CONFIG    0xA350
```

Quick Start Guide

Stand Alone 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. Set ENABLE switch to “ENABLE”
6. Test ZL2105 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 step 1 - 4 above
2. Insert the Zilker Labs Eval Kit CD
3. Connect USB-to-SMBus adapter board to J12 of ZL2105EV2
4. Connect supplied USB cable from computer to USB-to-SMBus adapter 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 the ZL2105 operation using the evaluation software.

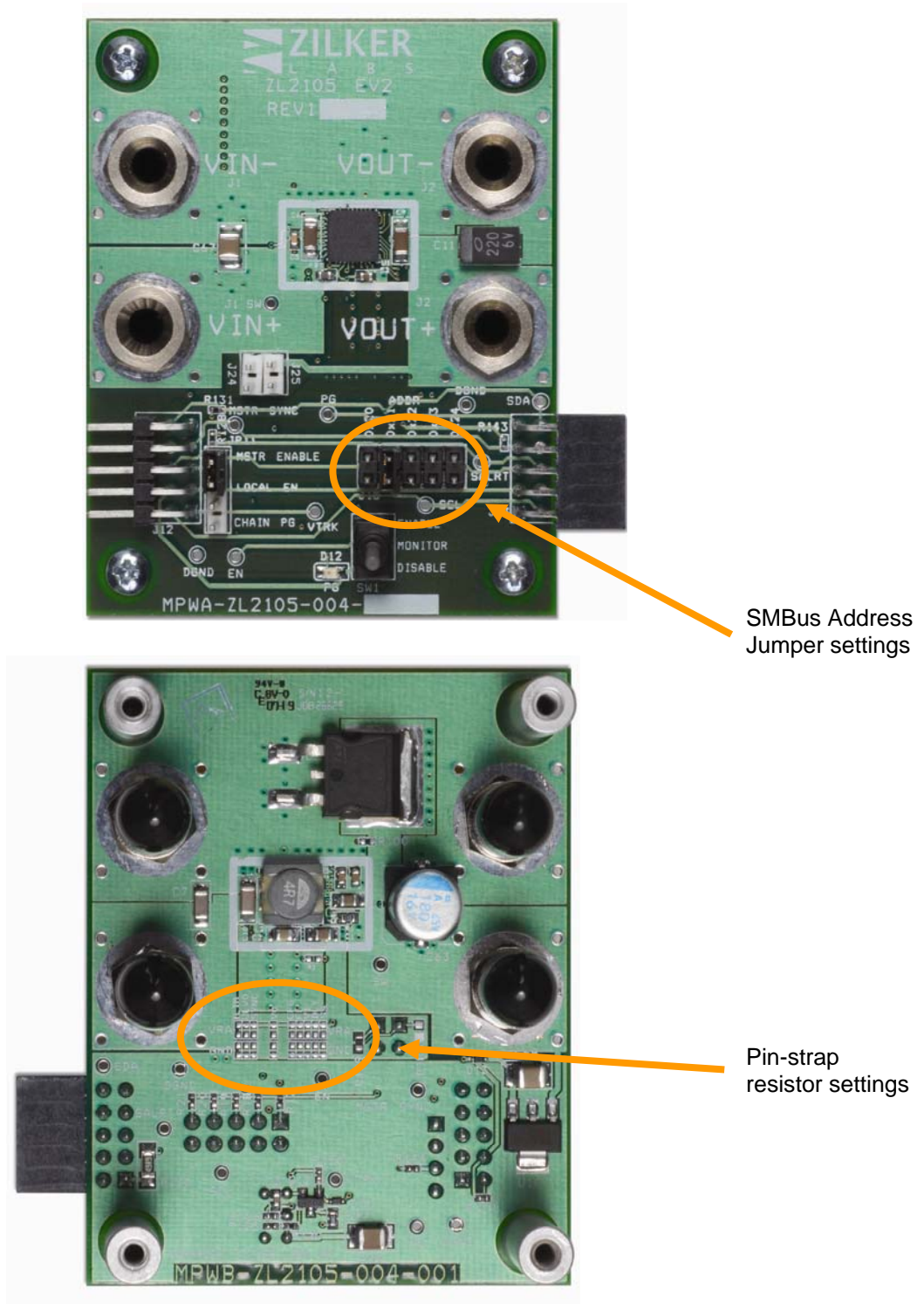


Figure 2. ZL2105EV2 Evaluation Board (Top Side and Bottom Side)

Schematics

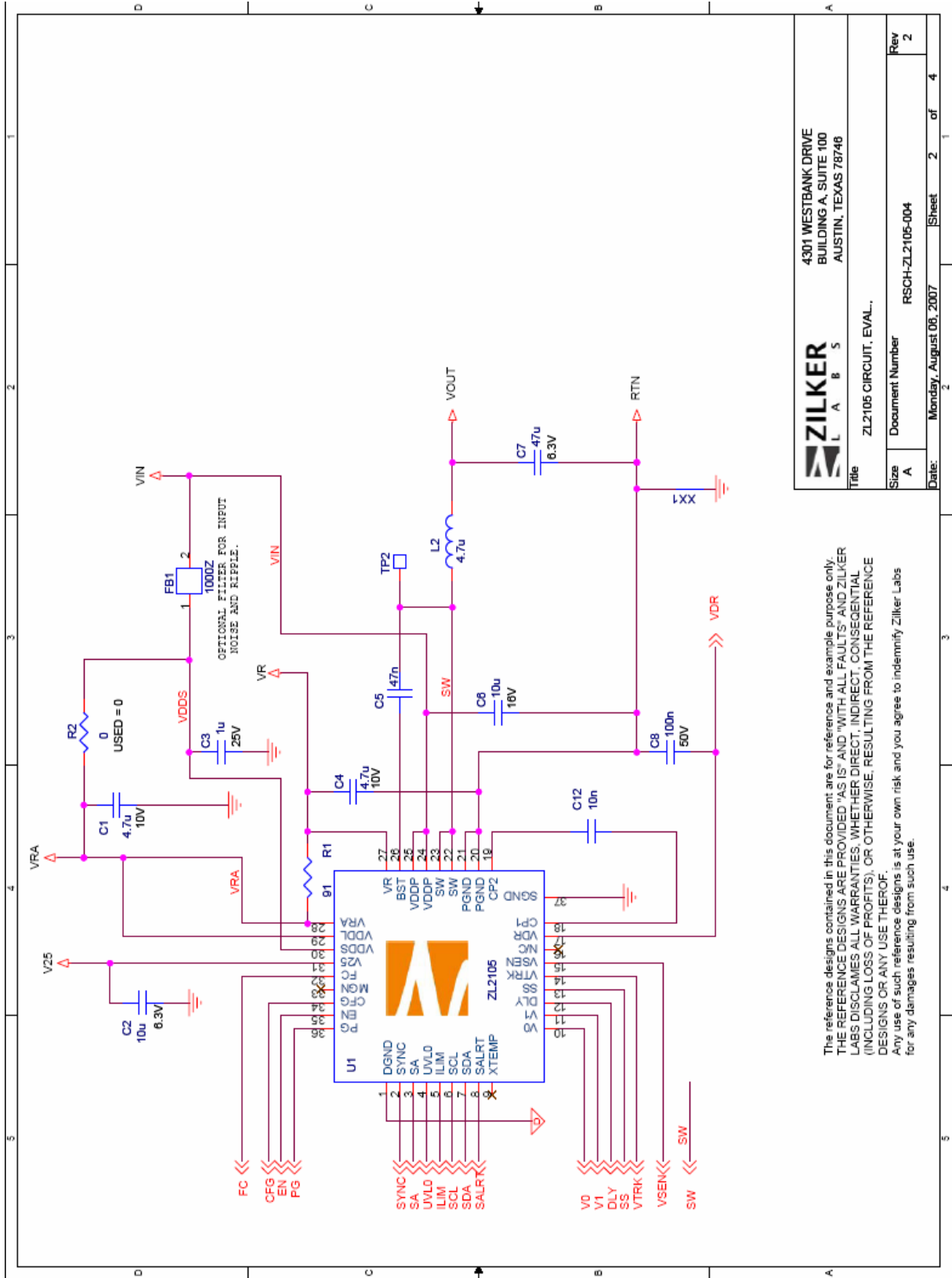

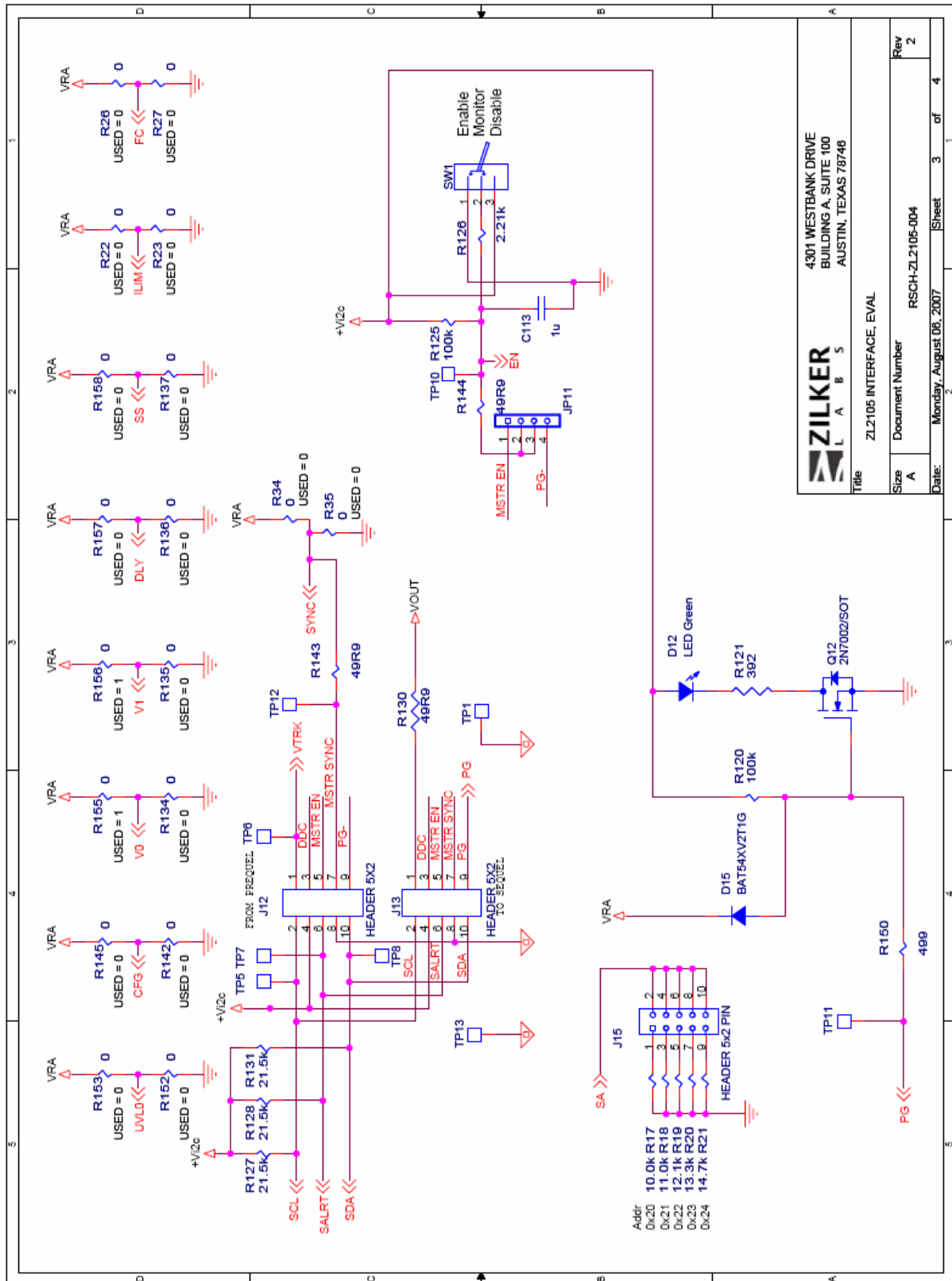


Figure 3. ZL2105EV2 Circuit

| | | | |
|---|------------------------------------|---|-----------------|
|  | | 4301 WESTBANK DRIVE BUILDING A, SUITE 100 AUSTIN, TEXAS 78748 | |
| Title ZL2105 CIRCUIT, EVAL. | | | |
| Size A | Document Number RSCH-ZL2105-004 | Rev 2 | Sheet 2 of 4 |
| Date: Monday, August 06, 2007 | | | |

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| | | | |
|-------------------------------|----------------------------------|---|-------|
| ZILKER | | 4301 WESTBANK DRIVE BUILDING A, SUITE 100 AUSTIN, TEXAS 78746 | |
| Title: ZL2105 INTERFACE, EVAL | | | |
| Size: A | Document Number: RSCH-ZL2105-004 | Sheet: 3 | of: 4 |
| Date: Monday, August 06, 2007 | Rev: 2 | | |

Figure 4. ZL2105EV2 Interface

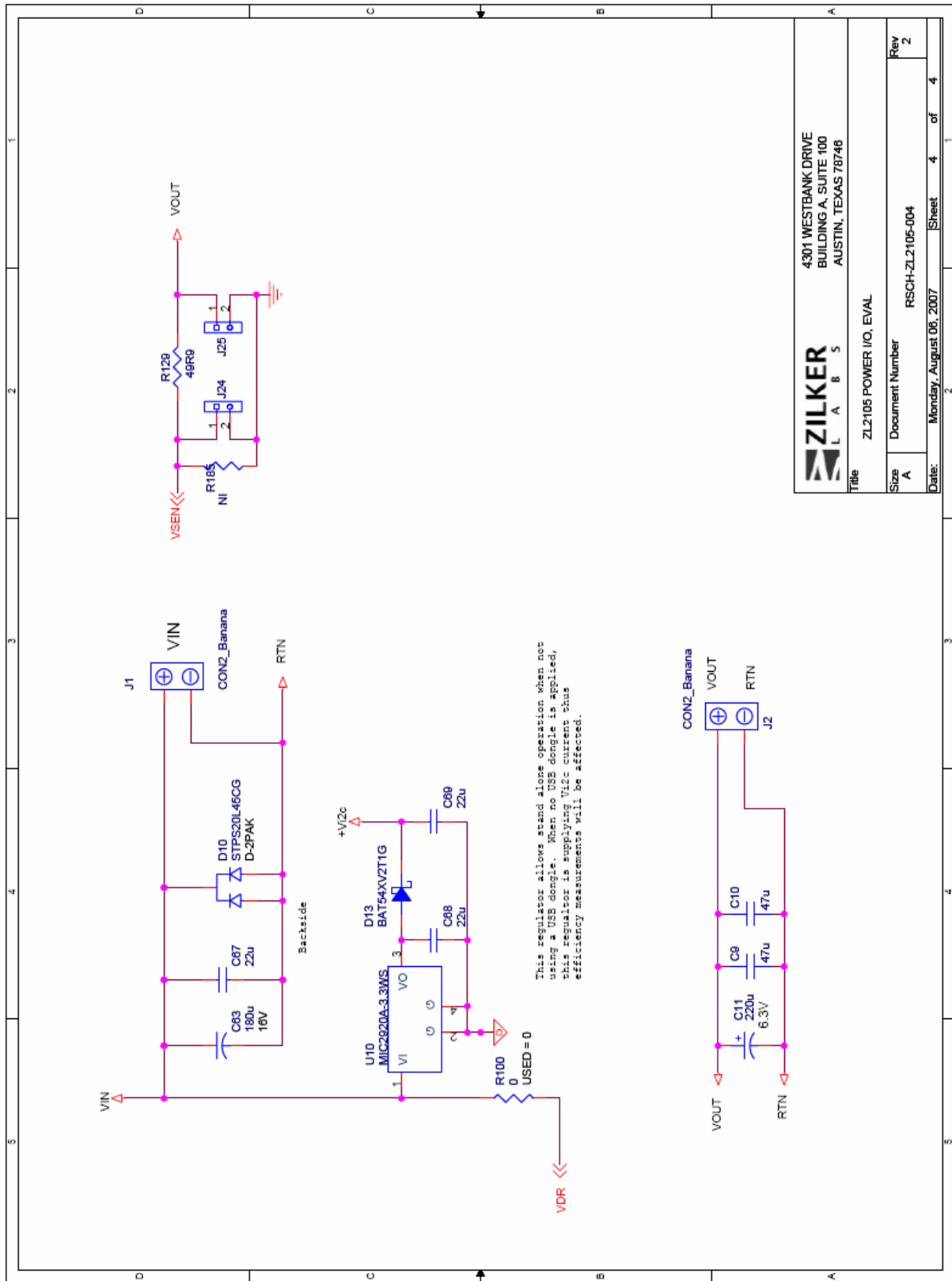


Figure 5. ZL2105EV2 Power I/O

| | | | |
|-------|-------------------------|---|-----------------|
| | | 4301 WESTBANK DRIVE BUILDING A, SUITE 100 AUSTIN, TEXAS 78746 | |
| | | Title: ZL2105 POWER I/O, EVAL | |
| Size | A | Document Number | RSCH-ZL2105-004 |
| Date: | Monday, August 06, 2007 | Sheet | 4 of 4 |
| Rev | 2 | | |

Board Layout – 4 Layers

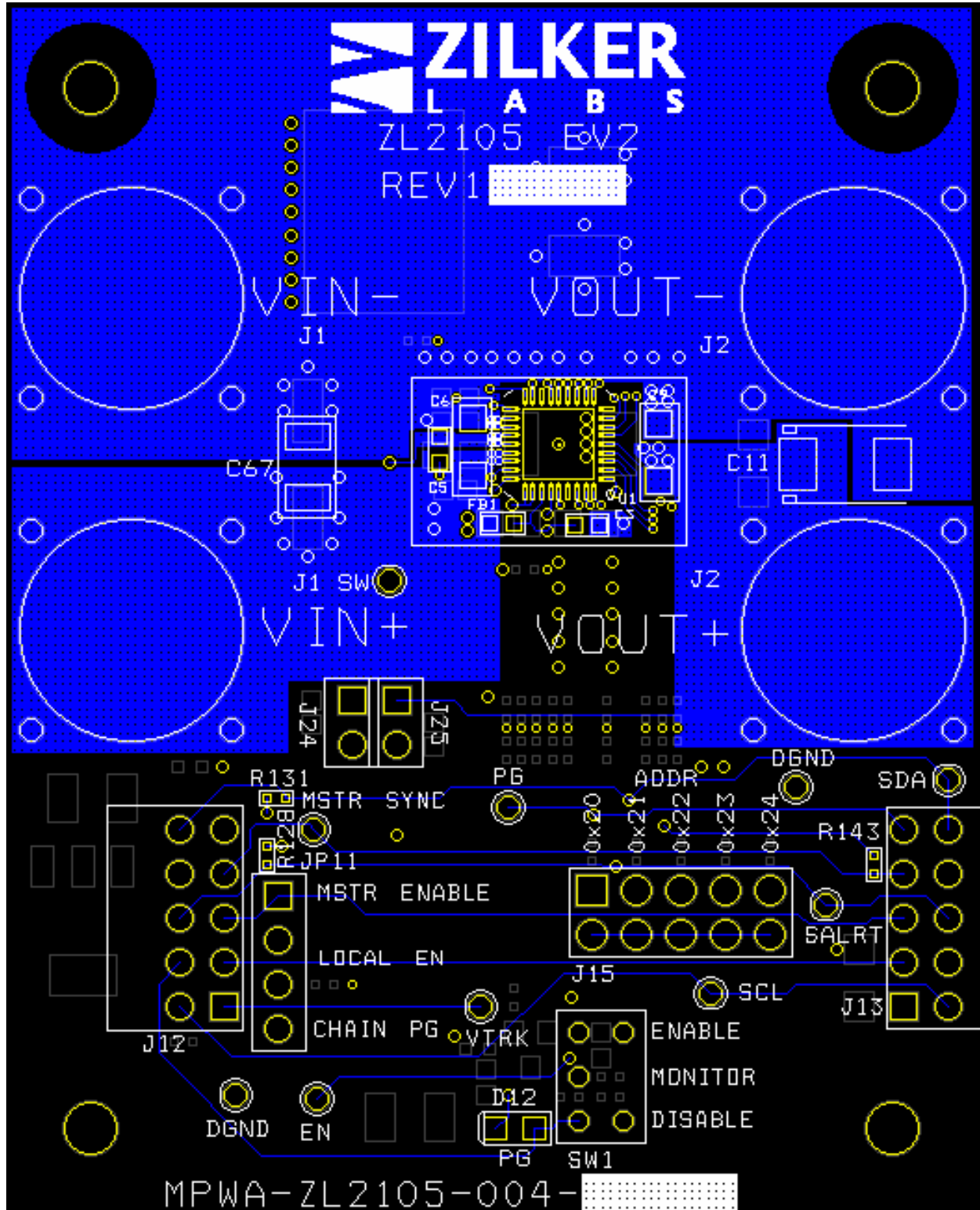


Figure 6. PCB – Top Layer

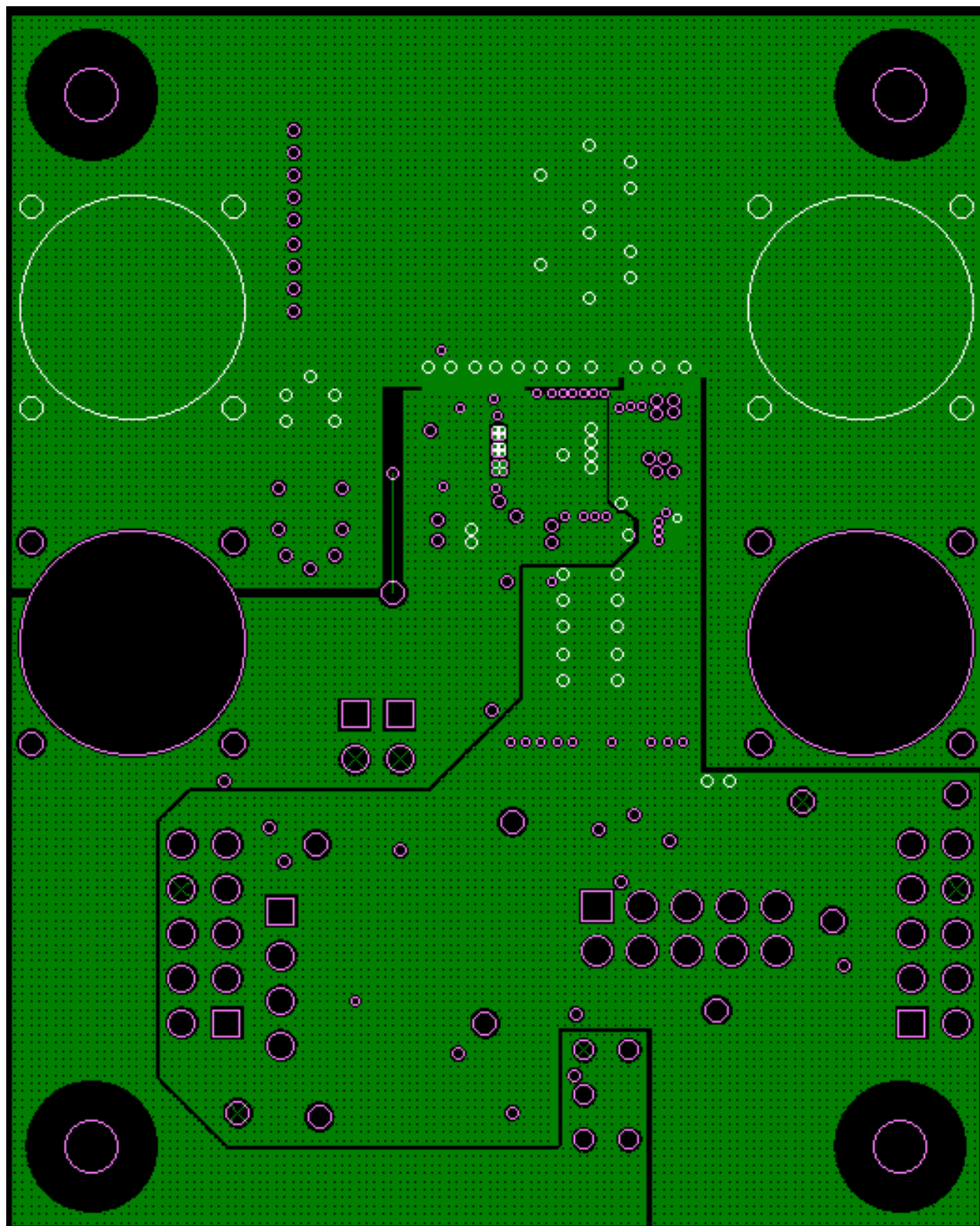


Figure 7. PCB – Inner Layer 1 (Viewed from Top)

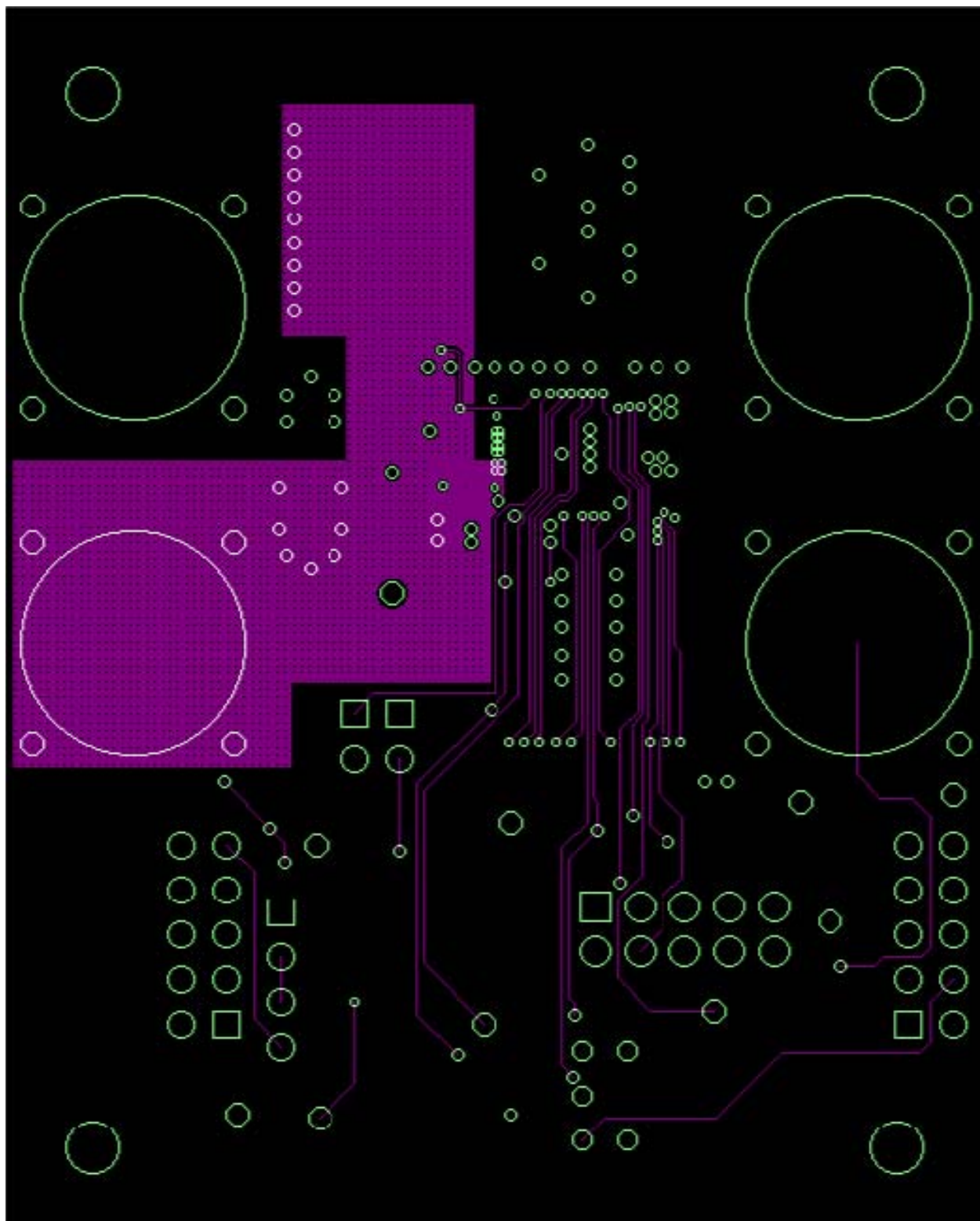


Figure 8. PCB – Inner Layer 2 (Viewed from Top)

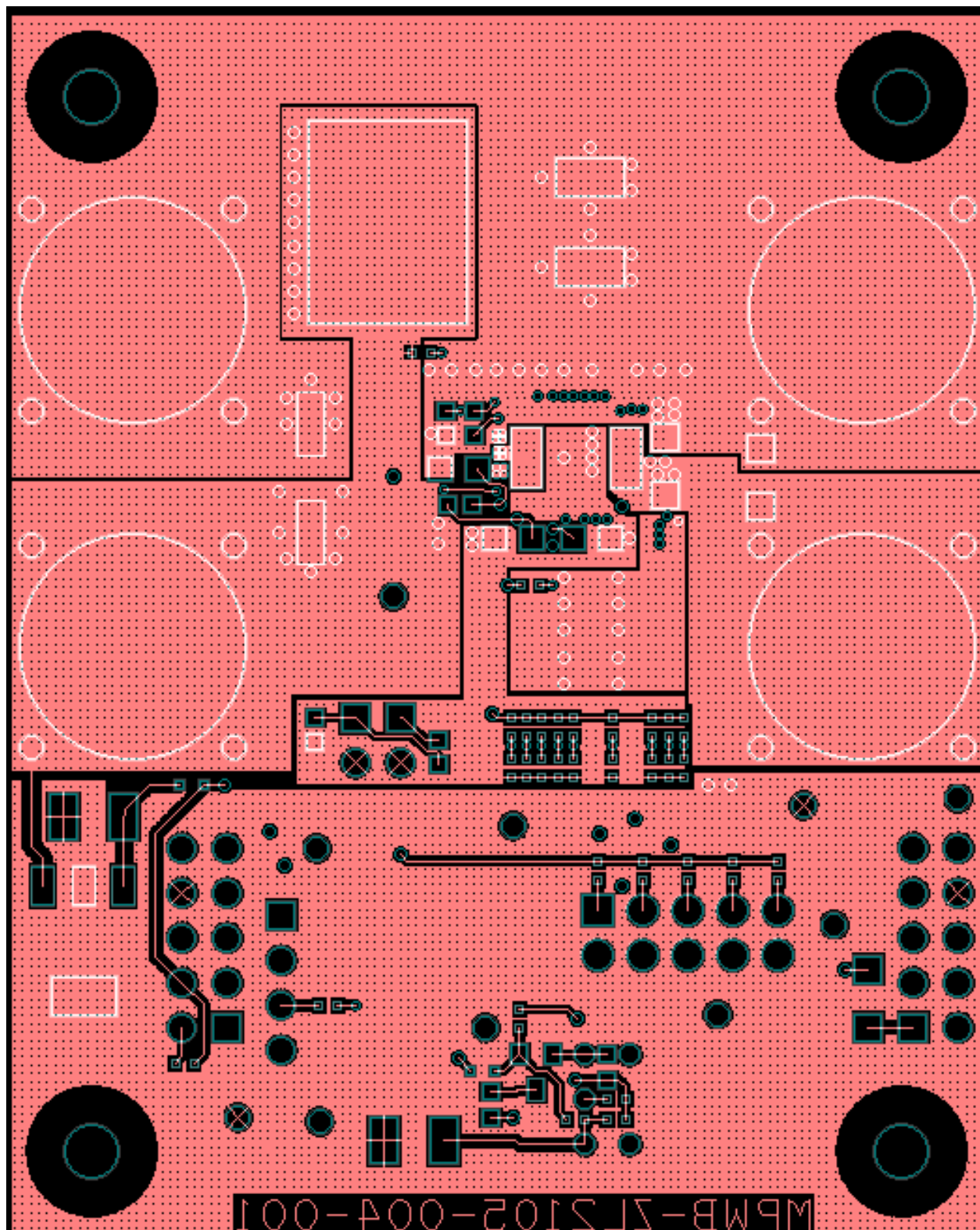


Figure 9. PCB – Bottom Layer (Viewed from Top)

Typical Performance Data for Buck Regulator

Unless noted: $V_{in} = 12V$, $V_{out} = 3.3V$, $f_{sw} = 400kHz$, $T_A = +25^\circ C$

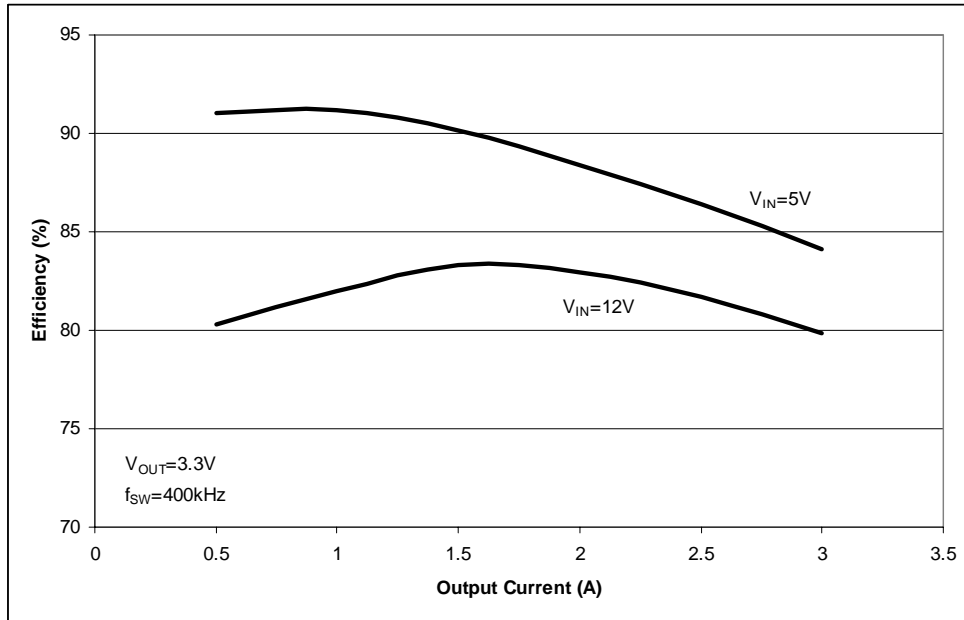


Figure 10. Measured Efficiency

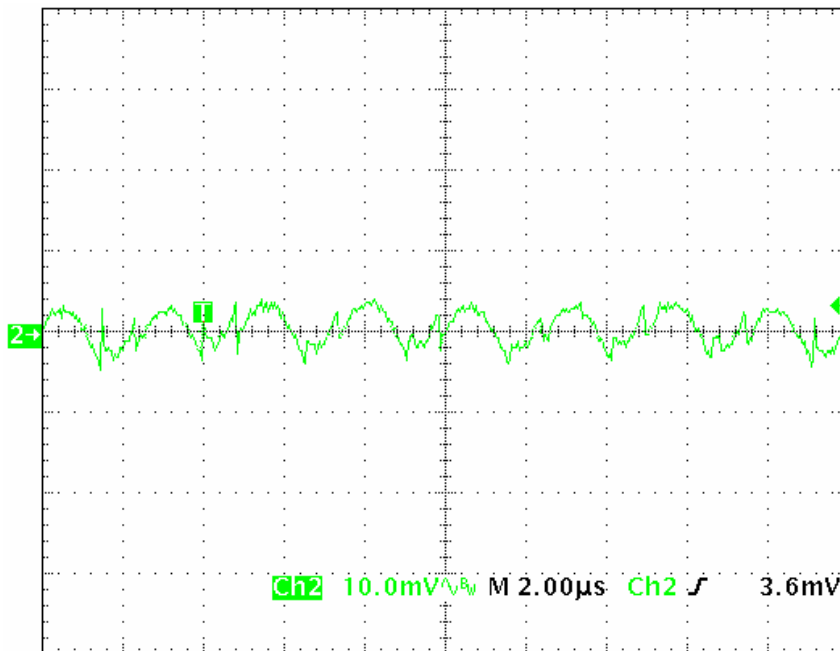


Figure 11. Ripple

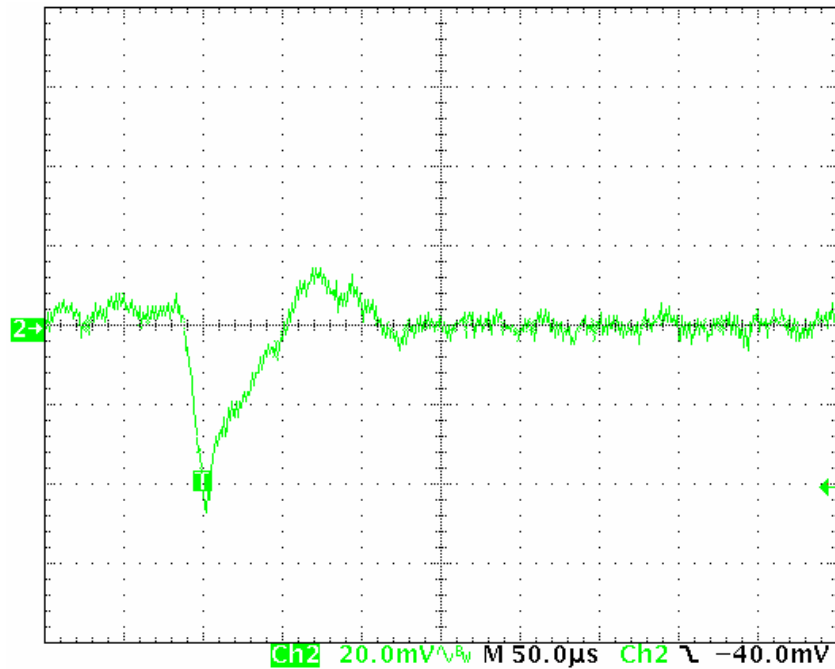


Figure 12. Dynamic Response (1 - 2A load step, di/dt=1A/µs)

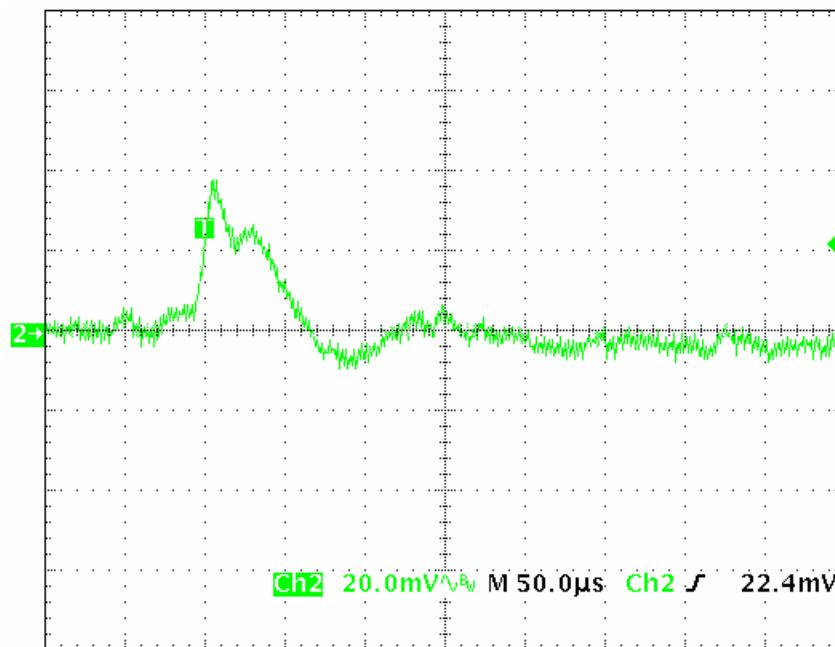


Figure 13. Dynamic Response (2 - 1A load step, di/dt=1A/µs)

Bill of Materials

| ITEM | QTY | REFDES | VALUE | TOL | RATING | TYPE | PCB FOOTPRINT | MFR | MFR PN |
|----------------|-----|---|----------------|-----|--------|------------|--------------------|--------------------|--------------------|
| 1 | 2 | C1,C4 | 4.7u | 20% | 10V | X5R | SM0805 | PANASONIC-ECG | ECJ-GVB1A475M |
| 2 | 1 | C2 | 10u | 20% | 6.3V | X5R | SM0805 | MURATA | GRM21BR60J106ME19L |
| 3 | 1 | C3 | 1u | 10% | 25V | X5R | SM0603 | TAIYO YUDEN | TMK107BJ105KA-T |
| 4 | 1 | C5 | 47n | 10% | 25V | X7R | SM0603 | AVX | 06033C473KAT2A |
| 5 | 1 | C6 | 10u | 20% | 16V | X5R | SM1206 | TDK | C3216X5R1C106M |
| 6 | 3 | C7,C9,C10 | 47u | 20% | 6.3V | X5R | SM1206 | TDK | C3216X5R0J476M |
| 7 | 1 | C8 | 100n | 10% | 50V | X7R | SM0603 | MURATA | GRM188R71H104KA93D |
| 8 | 1 | C11 | 220u | 20% | 6.3V | TANT | SM7343 | NICHICON | F910J227MNC |
| 9 | 1 | C12 | 10n | 10% | 25V | X7R | SM0603 | PANASONIC-ECG | ECJ-1VB1E103K |
| 10 | 1 | C63 | 180u | 20% | 16V | ELECT POLY | 8.3X8.3_PXA_FLD | UCC | APXA160ARA181MHC0G |
| 11 | 3 | C67,C68,C69 | 22u | 10% | 16V | X5R | SM1210 | MURATA | GRM32ER61C226KE20L |
| 12 | 1 | C113 | 1u | 10% | 10V | X7R | SM0603 | TAIYO YUDEN | LMK107BJ105KA-T |
| 13 | 1 | D10 | STPS20L45CG | | 45V | | D-2PAK | ST MICROELECT | STPS20L45CG |
| 14 | 1 | D12 | LED Green | | 20mA | CLR | SM0805_DIO_1C2A | CHICAGO MINIATURE | CMD17-21VGC |
| 15 | 2 | D13,D15 | BAT54XV2T1G | | 30V | SCHOTTKY | SOD-523 | ON SEMI | BAT54XV2T1G |
| 16 | 1 | FB1 | 1000Z | 25% | 50mA | MLC | SM0603 | MURATA | BLM18HD102SN1D |
| 17 | 1 | JP11 | 4 PIN | | | SN | SIP4/100 | TYCO | 644456-4 |
| 18 | 2 | J1,J2 | CON2_Banana | | 15A | | JACK_F | EMERSON | 108-0740-001 |
| 19 | 1 | J12 | HEADER 5X2 | | | SN | HDR5DUALRA100X100 | SAMTEC | TSW-105-08-T-D-RA |
| 20 | 1 | J13 | HEADER 5X2 | | | | HDRF5DUALRA100X100 | SAMTEC | SSQ-105-02-T-D-RA |
| 21 | 1 | J15 | HEADER 5x2 PIN | | | SN | HDR10DUAL100X100 | SAMTEC | TSW-105-07-T-D |
| 22 | 2 | J24,J25 | 2 PIN | | | SN | SIP2/100 | TYCO | 644456-2 |
| 23 | 1 | L2 | 4.7u | 20% | 3.4A | SH DRUM | IHLP_2525BD | TDK | RLF7030T-4R7M3R4 |
| 24 | 1 | Q12 | 2N7002/SOT | | 60V | N-CH | SOT-23 | ON SEMI | 2N7002LT1 |
| 25 | 1 | R1 | 91 | 1% | 100mW | THK FILM | SM0603 | ROHM | MCR03EZPFX91R0 |
| 27 | 1 | R17 | 10.0k | 1% | 63mW | THK FILM | SM0402 | | |
| 28 | 1 | R18 | 11.0k | 1% | 63mW | THK FILM | SM0402 | | |
| 29 | 1 | R19 | 12.1k | 1% | 63mW | THK FILM | SM0402 | | |
| 30 | 1 | R20 | 13.3k | 1% | 63mW | THK FILM | SM0402 | | |
| 31 | 1 | R21 | 14.7k | 1% | 63mW | THK FILM | SM0402 | | |
| 32 | 2 | R120,R125 | 100k | 1% | 63mW | THK FILM | SM0402 | YAGEO | RC0402FR-07100KL |
| 33 | 1 | R121 | 392 | 1% | 100mW | THK FILM | SM0603 | YAGEO | RC0603FR-07392RL |
| 34 | 1 | R126 | 2.21k | 1% | 63mW | THK FILM | SM0402 | YAGEO | RC0402FR-072K21L |
| 35 | 3 | R127,R128,R131 | 21.5k | 1% | 63mW | THK FILM | SM0402 | | |
| 36 | 1 | R129 | 49R9 | 1% | 100mW | THK FILM | SM0603 | ROHM | MCR03EZPFX49R9 |
| 37 | 1 | R130 | 49R9 | 1% | 250mW | THK FILM | SM1206 | YAGEO | RC1206FR-0749R9L |
| 38 | 2 | R143,R144 | 49R9 | 1% | 63mW | THK FILM | SM0402 | YAGEO | RC0402FR-0749R9L |
| 39 | 1 | R150 | 499 | 1% | 63mW | THK FILM | SM0402 | YAGEO | RC0402FR-07499L |
| 40 | 2 | R155,R156 | 0 | 5% | 63mW | THK FILM | SM0402 | YAGEO | RC0402JR-070RL |
| 42 | 1 | SW1 | SW_SPDT | | | | SW_TOG_SPDT | NKK | G13AP |
| 44 | 1 | U1 | ZL2105 | | 3A | | MLF36_6X6BX | ZILKER LABS INC | ZL2105ALNFT |
| 45 | 1 | U10 | MIC2920A-3.3WS | | 400mA | | SOT223_1234_FLD | MICREL | MIC2920A-3.3WS |
| 47 | 2 | XX8,XX9 | | | | | SHUNT_HDR_WITH_TAB | TYCO | 881545-2 |
| 48 | 4 | XX20,XX21,XX22,XX23 | | | | | STANDOFF_4-40 | | |
| 49 | 4 | XX24,XX25,XX26,XX27 | | | | PHL | SCREW_4-40 | BUILDING FASTENERS | PMS 440 0025 PH |
| 50 | 4 | XX30,XX31,XX32,XX33 | | | | | CAP_MOLDED.25ID | CAPLUGS | VC-234-8 |
| 51 | 1 | XX34 | PCB | | | | BDOTLN3.0HX4.0L | ZILKER LABS INC | MPWB-ZL2105-004 |
| NOT INSTALLED: | | | | | | | | | |
| 26 | 18 | R2,R22,R23,R26,R27,R34,R35,R100,R134,R135,R136,R137,R142,R145,R152,R153,R157,R158 | 0 | 5% | 63mW | THK FILM | SM0402 | YAGEO | RC0402JR-070RL |
| 41 | 1 | R185 | NI | 1% | 100mW | THK FILM | SM0603 | | |
| 43 | 10 | TP1,TP2,TP5,TP6,TP7,TP8,TP10,TP11,TP12,TP13 | T POINT S | | | | TP_036H_REV1 | | |
| 46 | 1 | XX1 | TIEPT/10WIDE | | | | TIEPT/10WIDE | | |

Default Configuration Text

The following text is loaded into the ZL2105EV2 as default settings. Each PMBus command is loaded via the ZL2105EV2 interface software. The # symbol is used for a comment line.

```
#ZL2105-002-DB08
#NOTE: This file is intended for the Rev. 1 ZL2105-EV2 with L=4.7uH,
Co=3x(47uF/2.5mohm)+(220uF/250mohm)

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

#Erase user store & default store
RESTORE_FACTORY
STORE_USER_ALL
STORE_DEFAULT_ALL

#RESPONSES
#low FET not enabled for output OV and UV count to 2
OVUV_CONFIG 0x01

#LIMITS
VIN_UV_FAULT_LIMIT 4.5

#Set output peak/valley current protection to 4.0 to -4.0A
IOUT_OC_FAULT_LIMIT 4
IOUT_UC_FAULT_LIMIT -4

#Set output average current protection to 3.3 to -3.3A
IOUT_AVG_OC_FAULT_LIMIT 3.3
IOUT_AVG_UC_FAULT_LIMIT -3.3

#SETTINGS
#Set Vout to 3.3V
VOUT_COMMAND 3.30000

#Set IOUT_SCALE to 151mOhms
IOUT_SCALE 151

#Set IOUT_OFFSET to -0.4A
IOUT_CAL_OFFSET -0.4A

#Use Rdson internal current sense method with internal tempco sensor, delay 512nS, 3 counts
MFR_CONFIG 0x8100

#Set temperature compensation at 400ppm/ C internal temp sensor
TEMPCO_CONFIG 0x04

#Set deadtime to 0ns H-L min dynamic and 16ns L-H fixed
DEADTIME_CONFIG 0x0086
DEADTIME 0x0010

#Loop compensation for 12v:3.3v, ~100mv peak under 1-2A transient @ 2.5A/us, with NLR.
PID_TAPS A=5000, B=-9016, C=4170
#NLR_CONFIG Enable,1.5%,No Outer,1.5%,3,3,0
NLR_CONFIG 0xA250

#Loop compensation for 12V:0.8V, ~20kHz BW, ~60deg PM, ~30mv peak under 0.5A step
#PID_TAPS A=10000, B=-18101, C=8324
#NLR_CONFIG Enable,1.5%,No Outer,2%,3,3,0
NLR_CONFIG 0xA350

STORE_DEFAULT_ALL
RESTORE_DEFAULT_ALL
```

References

- [1] *ZL2105 Data Sheet*, Zilker Labs, Inc., 2008.
- [2] AN10 – *ZL2005 and ZL2105 Thermal and Layout Guideline*, Zilker Labs, Inc., 2006.
- [3] AN13 – *PMBus™ Command Set*, Zilker Labs, Inc., 2007.

Ordering Information

| Orderable Part Number | Description |
|-----------------------|------------------------------------|
| ZL2105EVK2 | ZL2105 Evaluation Kit, one channel |
| ZL2105EV2 | ZL2105 Evaluation board only |

Revision History

| Date | Rev. # | |
|---------|--------|---|
| 1-22-08 | 1.0 | Initial Release based on ZL2105EV1 data sheet |
| | | |
| | | |
| | | |
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