User's Manual

ISL68301EVAL2Z

User's Manual: Evaluation Board

Core Power Solutions

Rev.1.00 Jul 2018

1. Overview

The ISL68301 is a PMBus compliant, single-phase digital DC/DC controller for use with SPS and DrMOS power stages. The ISL68301 implements the Renesas fully digital ChargeMode™ control modulation scheme, allowing both ease of use and industry leading performance. ChargeMode control provides an inherently stable control loop that can respond to load transients in a single switching cycle, significantly decreasing output capacitor requirements.

A dedicated current share bus allows for paralleling up to eight devices in a current share configuration, allowing support for a wide range of load currents.

The ISL68301EVAL2Z evaluation board is a 2.7in x 3.0in 6-layer FR4 board with 2oz. copper on all layers. This evaluation board comes with a placeholder for pin-strap resistors to adjust output voltage, switching frequency, fault response, current limit threshold and ASCR gain, and the device PMBus address. More configurations, such as soft-start and fault limits, can be easily programmed or changed using a PMBus compliant serial bus interface.

This evaluation board includes the ZLUSBEVAL3Z (USB to PMBus adapter), which connects the evaluation board to a PC to activate the PMBus communication interface. The PMBus command set is accessed by using the PowerNavigator™ evaluation software from a PC running Microsoft Windows.

1.1 Key Features

- V_{IN} range of 4.5V to 16V, V_{OUT} adjustable from 2.5V to 5.5V
- Programmable V_{OUT}, margining, UV/OV, I_{OUT} limit, soft-start/stop, sequencing, and external synchronization
- Monitor: V_{IN}, V_{OUT}, I_{OUT}, temperature, duty cycle, switching frequency, and faults
- ChargeMode control tunable with PMBus
- On-board load step circuit
- Mechanical switch for enable and power-good LED indicator

1.2 Specifications

This board is configured for the following operating conditions by default:

- V_{IN} = 7V to 16V
- V_{OUT} = 3.3V
- I_{MAX} = 20A
- f_{SW} = 500kHz
- Peak efficiency: >94% at 50% load
- On/off delay = 5ms, On/off ramp time = 5ms

1.3 Ordering Information

Part Number	Description
ISL68301EVAL2Z	ISL68301 board (EVB, ZLUSBEVAL3Z Adapter, USB Cable)

1.4 Related Literature

For a full list of related documents, visit our website

- ISL68301 product page

1.5 Recommended Equipment

- DC power supply with minimum 15V/25A sourcing capacity
- Electronic load capable of sinking current up to 33A
- Digital Multimeters (DMMs)
- Oscilloscope with higher than 100MHz bandwidth

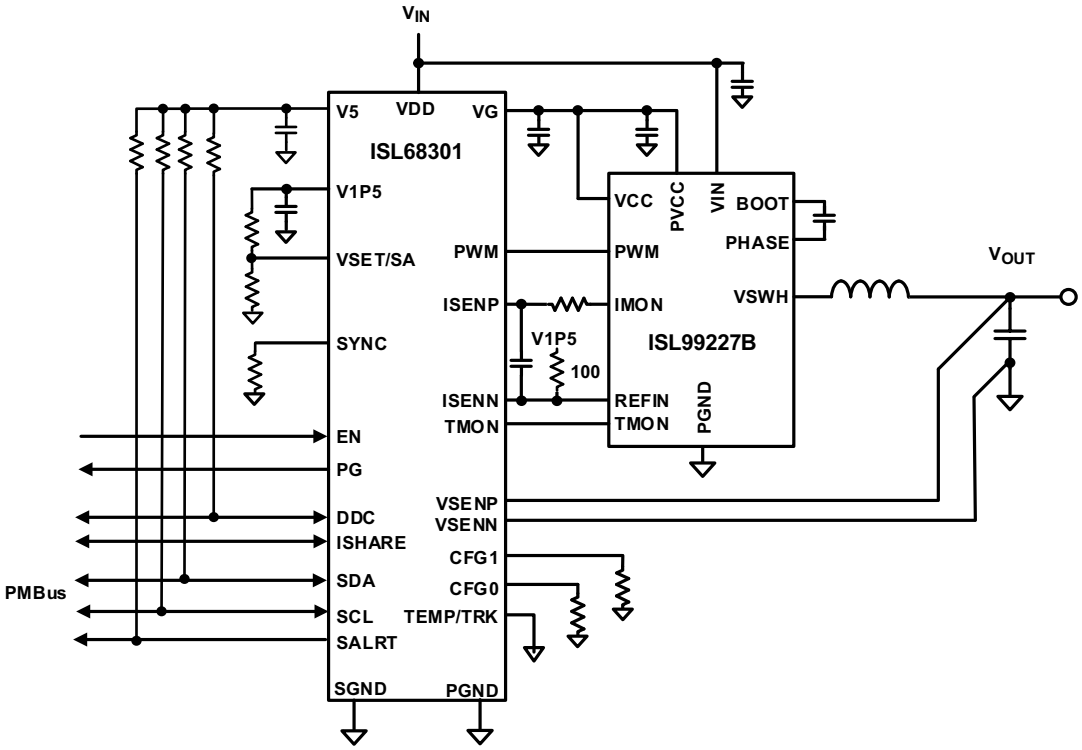

Figure 1. ISL68301EVAL2Z Block Diagram

2. Functional Description

The ISL68301EVAL2Z provides all circuitry required to evaluate the features of the ISL68301. A majority of the features of the ISL68301, such as compensation-free ChargeMode control, soft-start delay and ramp times, supply sequencing, and voltage margining are available on this evaluation board. For sequencing evaluation, the board can be connected to any Renesas digital module evaluation board that supports the Digital-DC™ (DDC) bus.

Figures 2 and 3 on page 6 show the ISL68301EVAL2Z evaluation board.

2.1 Operating Range

By default, the ISL68301EVAL2Z is configured to operate at V_{OUT} = 3.3V, f_{SW} = 500kHz, and V_{IN} ranges from 7V to 16V. The board can also support a wider operating range to meet the requirements of specific applications. The V_{OUT} can be adjusted from 2.5V to 5.5V and the switching frequency can also be tuned.

If using external synchronization, connect the SYNC test point to the external clock. Note that the external clock signal should be valid before the ISL68301 is enabled.

2.2 PMBus Operation

The ISL68301 uses the PMBus protocol. The PMBus functionality can be controlled using the ZLUSBEVAL3Z dongle from a PC running the PowerNavigator evaluation software.

Install PowerNavigator from the Renesas website.

For board operation, connect the included ZLUSBEVAL3Z dongle to the 6-pin male connector, J3, labeled “DONGLE”. Connect the desired load and an appropriate power supply to the input and connect the included USB cable to the PC running PowerNavigator. Set the ENABLE switch, SW3, to “OFF” before turning on the power.

PowerNavigator allows modification of all ISL68301 PMBus parameters. The ISL68301 device on the board is configured by pin-strapping resistors, but the user can modify the operating parameters through the evaluation software or by loading a predefined set-up from a configuration file.

The ENABLE switch, SW3, can then be moved to “ON” and the ISL68301EVAL2Z board can be tested. Alternately, the PMBus ON_OFF_CONFIG and OPERATION commands can be used from PowerNavigator.

2.3 Quick Start Guide

2.3.1 Pin-Strap Option

The ISL68301EVAL2Z can be configured in Pin-Strap mode with standard 1% 0402 resistors. The PMBus interface is not required to evaluate ISL68301 in Pin-Strap mode. Output voltage (V_{OUT}), switching frequency (f_{SW}), fault response, current limit threshold, ASCR gain, and the device PMBus address can be adjusted by changing the pin-strape resistors at the VSET/SA, SYNC, CFG0, and CFG1 pins. By default, the evaluation board is programmed to regulate at V_{OUT} = 3.3V, f_{SW} = 500kHz, and PMBus address = 69h. Complete the following steps to evaluate the ISL68301EVAL2Z in Pin-Strap mode:

(1) Set the ENABLE switch to “OFF”.

(2) Connect a load to the VOUT lug connectors.

(3) Connect a power supply to the VIN connectors. Make sure the power supply is not enabled when making the connection.

(4) Turn the power supply on.

(5) Set the ENABLE switch to “ON”.

(6) To change V_{OUT}, disconnect the board from the setup and populate with 1% standard 0402 resistors at R_3 and R_5. Refer to the “Output Voltage and SMBus Address Selection” table in the ISL68301 datasheet for recommended values. By default, VOUT_MAX is set to 115% of V_{OUT} by the pin-strap resistor.

(7) To change the switching frequency, disconnect the board from the setup and populate with a 1% standard 0402 resistor at R_{35}. Refer to the “Switching Frequency” table in the ISL68301 datasheet for recommended values.

(8) To change fault response, current limit threshold, or ASCR gain, disconnect the board from the setup and populate with 1% standard 0402 resistors at R_{38}, and R_1. Refer to the “Configuration Setting” table in the ISL68301 datasheet for the recommended values.

2.3.2 PMBus Option

The ISL68301EVAL2Z can be evaluated for all features using the provided ZLUSBEVAL3Z dongle and PowerNavigator. Complete the following steps to evaluate the ISL68301 with the PMBus option.

(1) Install PowerNavigator.

(2) Set the ENABLE switch to “OFF”.

(3) Connect the load to the VOUT lug connectors.

(4) Connect the power supply to the VIN connectors. Make sure the power supply is not enabled when making the connection.

(5) Turn the power supply on.

(6) Connect the ZLUSBEVAL3Z dongle (USB to PMBus adapter) to the ISL68301EVAL2Z board using the 6-pin male connector, J3, labeled “DONGLE”.

(7) Connect the supplied USB cable from the computer through the USB to the ZLUSBEVAL3Z dongle.

(8) Launch PowerNavigator.

(9) Set the ENABLE switch to “ON”.

(10) Monitor and configure the ISL68301EVAL2Z board using the PMBus commands in the evaluation software.

PowerNavigator tutorial videos are available on the Renesas website.

To sequence using the Digital-DC Bus (DDC), or to evaluate multiple Renesas digital power products using a single ZLUSBEVAL3Z dongle, the ISL68301EVAL2Z can be daisy chained with other digital power evaluation boards. The PMBus address can be changed by placing 1% standard 0402 resistors at R_3 and R_5. Refer to the “Output Voltage and SMBus Address Selection” table in the ISL68301 datasheet for recommended values.

3. PCB Layout Guidelines

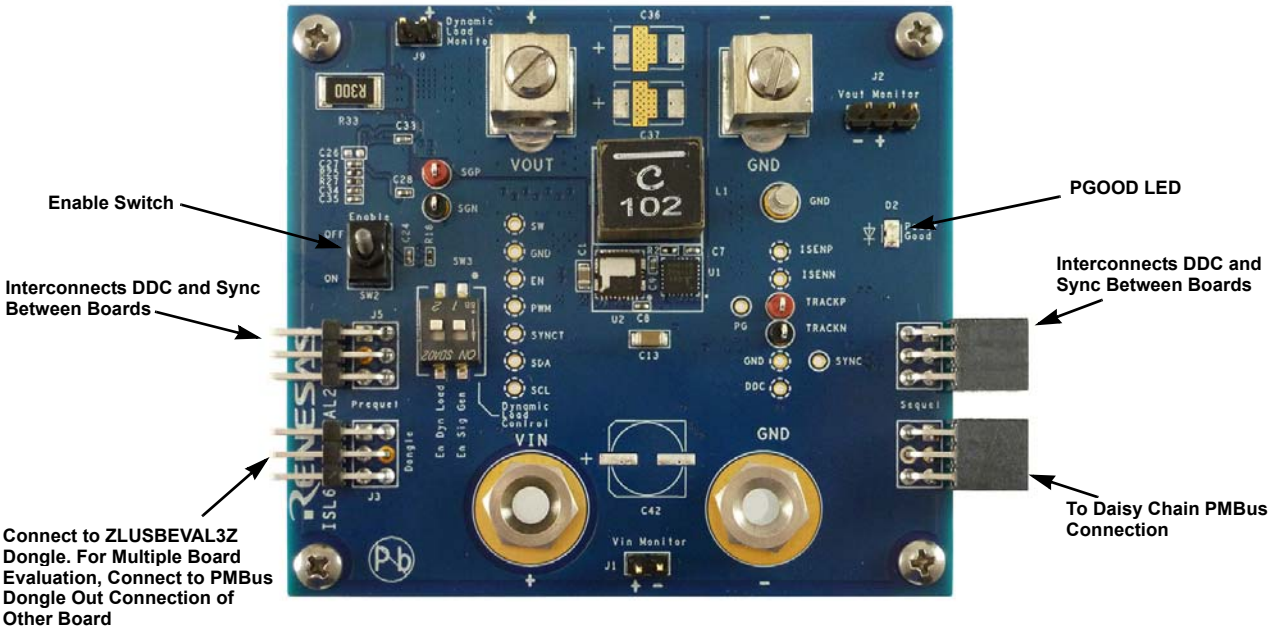

Figure 2. ISL68301EVAL2Z Evaluation Board (Top Side)

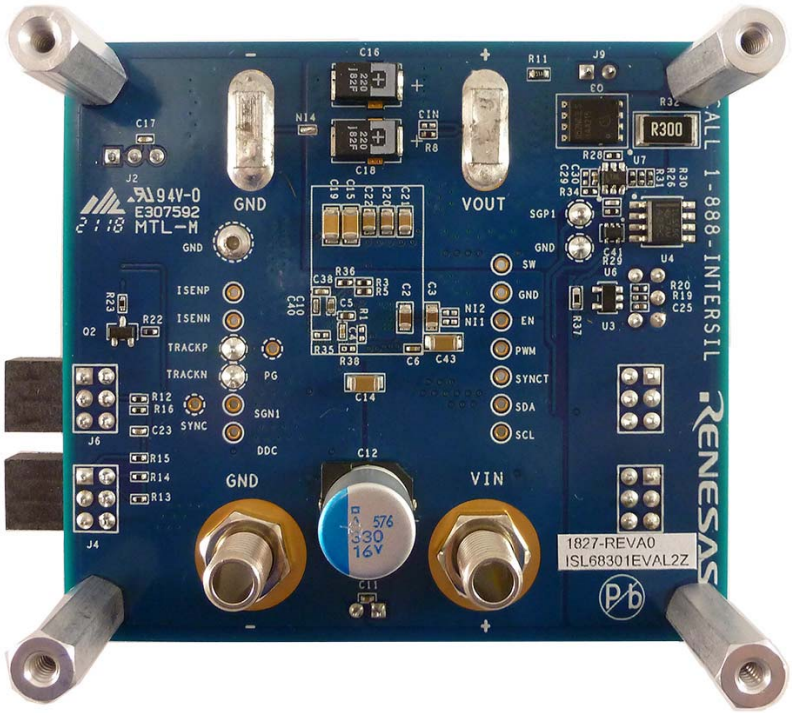

Figure 3. ISL68301EVAL2Z Evaluation Board (Bottom Side)

3.1 ISL68301EVAL2Z Board Schematic

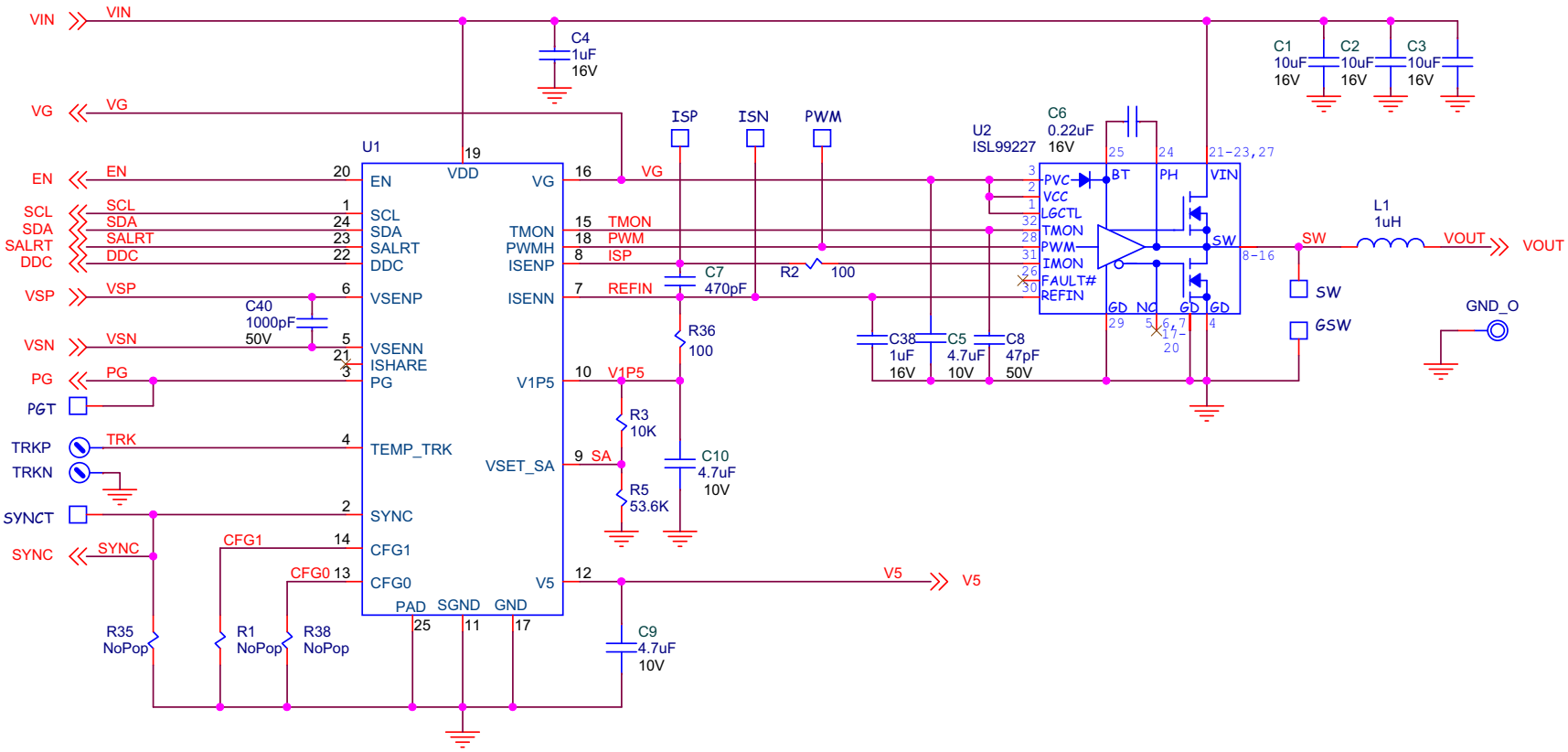

Figure 4. Schematic

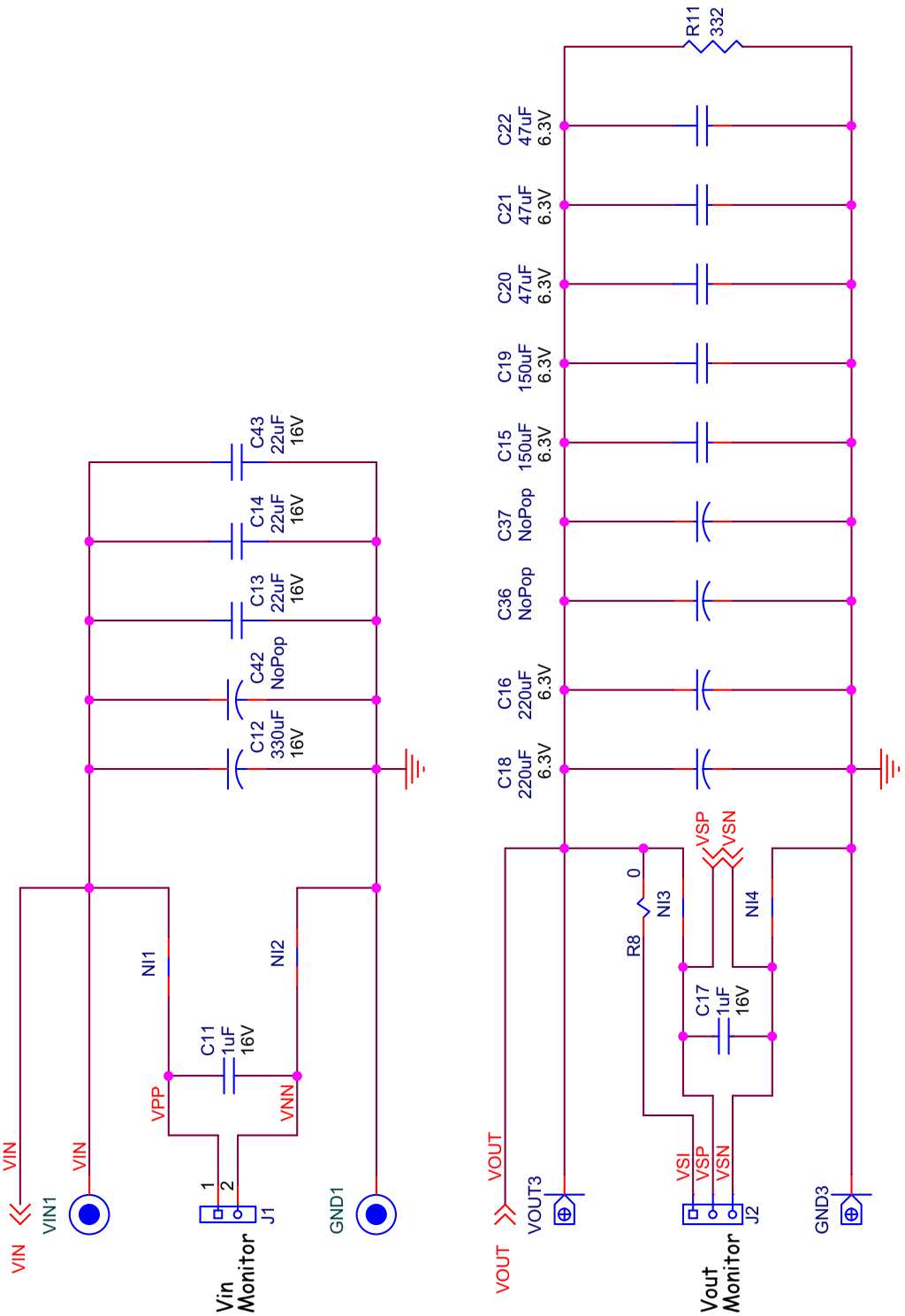

Figure 5. Schematic - Input and Output Filters

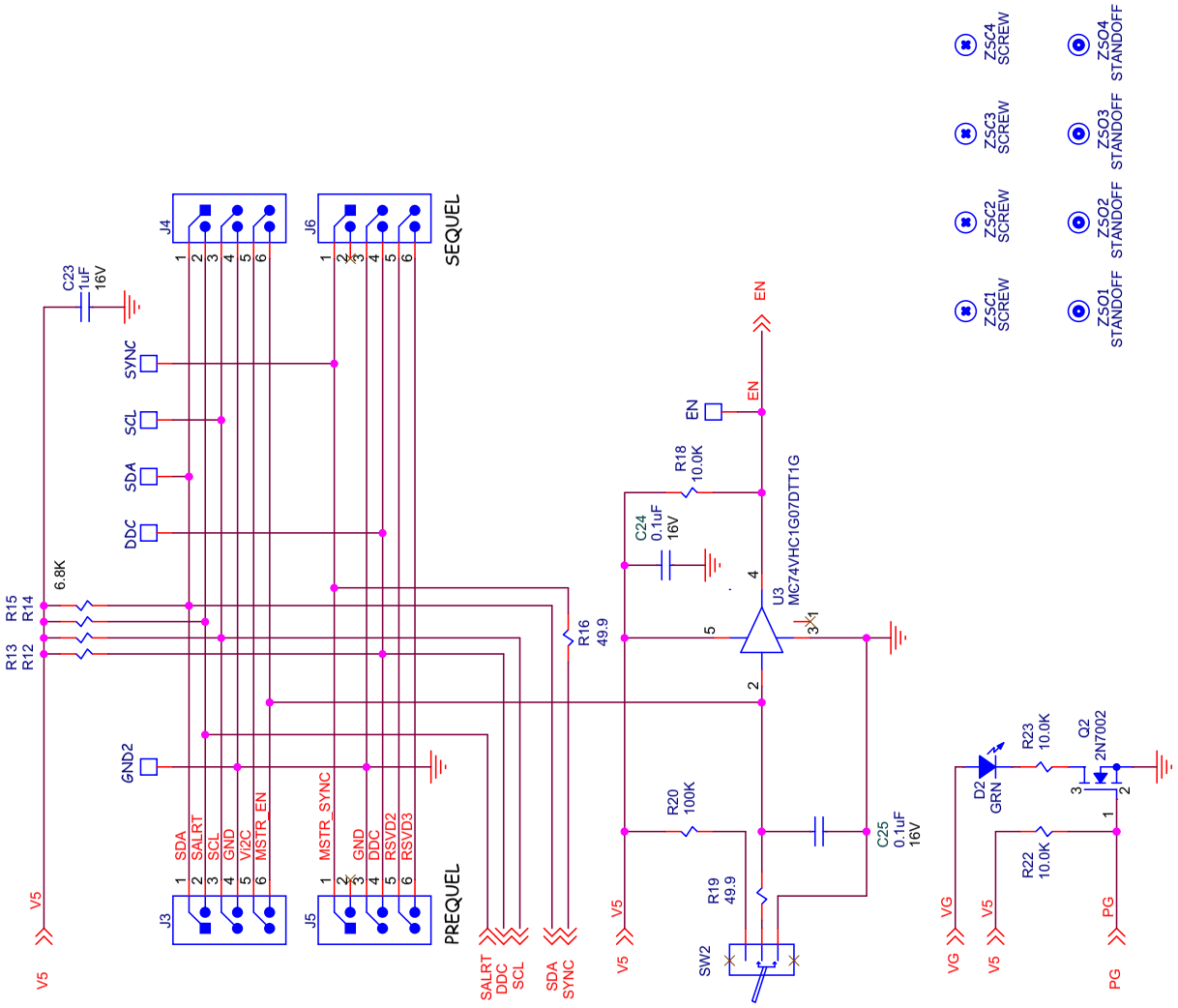

Figure 6. Schematic - I²C, Enable, PG

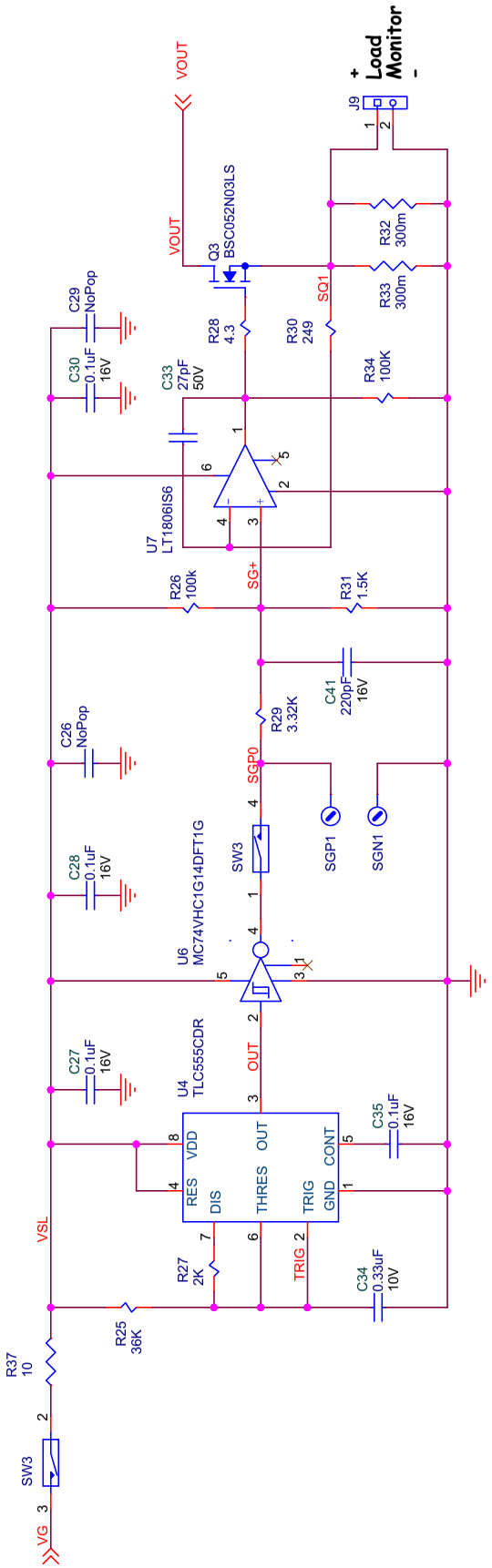

Figure 7. Schematic - Dynamic Load

3.2 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
3	C1, C2, C3	CAP, SMD, 0805, 10µF, 16V, 10%, X6S, ROHS	TDK	C2012X6S1C106K085AC
2	C15, C19	CAP, SMD, 1206, 150µF, 6.3V, 20%, X5R, ROHS	Murata	GRM31CR60J157ME11L
1	C40	CAP, SMD, 0402, 1000pF, 50V, 5%, C0G, ROHS	Venkel	C0402C0G500-102JNE
6	C24, C25, C27, C28, C30, C35	CAP, SMD, 0402, 0.1µF, 16V, 10%, X7R, ROHS	Venkel	C0402X7R160-104KNE
5	C4, C11, C17, C23, C38	CAP, SMD, 0402, 1.0µF, 16V, 10%, X5R, ROHS	TDK	C1005X5R1C105K050BC
1	C41	CAP, SMD, 0402, 220pF, 50V, 5%, C0G, ROHS	Panasonic	ECU-E1H221JCQ
1	C6	CAP, SMD, 0402, 0.22µF, 10V, 10%, X5R, ROHS	Venkel	C0402X5R100-224KNE
1	C33	CAP, SMD, 0402, 27pF, 50V, 5%, NP0, ROHS	Murata	GRM36COG270J050AQ
1	C34	CAP, SMD, 0402, 0.33µF, 6.3V, 10%, X5R, ROHS	Murata	GRM155R60J334KE01J
1	C8	CAP, SMD, 0402, 47pF, 50V, 5%, NP0, ROHS	Murata	GRM36COG470J050AQ
1	C7	CAP, SMD, 0402, 470pF, 50V, 5%, NP0, ROHS	AVX	04025A471JAT2A
3	C5, C9, C10	CAP, SMD, 0402, 4.7µF, 10V, 10%, X5R, ROHS	TDK	C1005X5R1A475K050BC
3	C20, C21, C22	CAP, SMD, 0805, 47µF, 6.3V, 20%, X5R, ROHS	Kemet	C0805C476M9PACTU
3	C13, C14, C43	CAP, SMD, 1206, 22µF, 25V, 10%, X5R, ROHS	Murata	GRM31CR61E226KE15L
1	C12	CAP, SMD, 10x12, 330µF, 16V, 20%, 14mΩ, ALUM.ELEC., ROHS	Nippon Chemi-Con	APXA160ARA331MJC0G
2	C16, C18	CAP, SMD, D, 220µF, 6.3V, 20%, POLY.AL.EL., ROHS	Panasonic	6TPF220M5L
1	L1	COIL-PWR INDUCTOR, SMD, 1µH, ROHS	Coilcraft	XAL1010-102MEB
1	D2	LED, SMD, 0805, GREEN/CLEAR, 2.2V, 20mA, 574nm, 45mcd, ROHS	Lumex	SML-LX0805SUGC-TR
1	U1	IC-DIGITAL DC/DC CONTROLLER, 24P, QFN, ROHS	Renesas	ISL68301IRAZ
1	U2	IC-5V PWM SPS MODULE, 32P, QFN 5X5, ROHS	Renesas	ISL99227BFRZ-T
1	U7	IC-OP AMP, R/R, SMD, 6P, TSOT23, 325MHz, 85mA, ROHS	Linear Technology	LT1806IS6#TRMPBF
1	U3	IC-NON-INVERTING BUFFER, SMD, 5P, TSOT23-5, ROHS	On Semiconductor	MC74VHC1G07DTT1G
1	U6	IC-INVERTER, SCHMITT TRIGGER, SMD, 5P, SC-70-5, ROHS	On Semiconductor	MC74VHC1G14DFT1G
1	U4	IC-TIMER/OSCILLATOR, 2.1MHz, SMD, 8P, SOIC, ROHS	Texas Instruments	TLC555CDR
1	Q2	TRANSISTOR, N-CHANNEL, 3LD, SOT-23, 60V, 115mA, ROHS	Diodes, Inc.	2N7002-7-F
1	Q3	TRANSIST-MOS, N-CHANNEL, 30V, 57A, SMD, 8P, PG-TDSON-8, ROHS	Infineon Technology	BSC052N03LS
2	R32, R33	RES-AEC-Q200, CURR.SENSE, SMD, 2512, 0.3Ω, 2W, 1%, TF, ROHS	Bourns	CRM2512-FX-R300ELF
1	R28	RES, SMD, 0402, 4.3Ω, 1/16W, 5%, TF, ROHS	Vishay/Dale	CRCW04024R30FKED
1	R8	RES, SMD, 0402, 0Ω, 1/16W, 5%, TF, ROHS	Venkel	CR0402-16W-00T
2	R2, R36	RES, SMD, 0402, 100Ω, 1/16W, 1%, TF, ROHS	Venkel	CR0402-16W-1000FT
2	R18, R22	RES, SMD, 0402, 10k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1002X
4	R20, R23, R26, R34	RES, SMD, 0402, 100k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ2RKF1003
1	R31	RES, SMD, 0402, 1.5kΩ, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1501X

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	R1	RES, SMD, 0402, 15.4k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1542X
1	R27	RES, SMD, 0402, 2k, 1/16W, 1%, TF, ROHS	Panasonici	ERJ-2RKF2001
1	R30	RES, SMD, 0402, 249Ω, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF2490
1	R29	RES, SMD, 0402, 3.32k, 1/16W, 1%, TF, ROHS	Yageo	RC0402FR-073K32L
1	R25	RES, SMD, 0402, 36k, 1/16W, 1%, TF, ROHS	Yageo	RC0402FR-0736KL
1	R5	RES, SMD, 0402, 53.6k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF5362X
2	R16, R19	RES, SMD, 0402, 49.9Ω, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF49R9X
4	R12, R13, R14, R15	RES, SMD, 0402, 6.8k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF6801X
1	R3	RES, SMD, 0402, 10k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1002
1	R37	RES, SMD, 0603, 10Ω, 1/10W, 1%, TF, ROHS	KOA	RK73H1JT10R0F
1	R11	RES, SMD, 0603, 332Ω, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF3320V
2	R16, R19	RES, SMD, 0402, 49.9Ω, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF49R9X
1	SW2	SWITCH-TOGGLE, SPDT, TH, 5P, 28V, 0.4VA, ON-ON, ROHS	NKK	G12AP
1	SW3	SWITCH-SLIDE, SMD, 7.06mm, 2POS, SPST, 25mA, 24V, ROHS	C&K Components	SDA02H1SBD
2	GND3, VOUT3	HARDWARE, 65A PCB WIRE LUG, TH/SMD, 8.5x3.5, 6-14AWG, ROHS	International Hydraulics Inc	B6A-PCB-SS
2	VIN1, GND1	CONN-JACK, BANANA-SS-SDRLESS, VERTICAL, 0.53Length, ROHS	Johnson Components	108-0740-001
1	GND_O	CONN-DBL TURRET, TH, 0.218x0.078 PCB MNT, TIN/BRASS, ROHS	Keystone	1502-1
2	TRKP, SGP	CONN-MINI TEST PT, VERTICAL, RED, ROHS	Keystone	5000
2	TRKN, SGN	CONN-MINI TEST PT, VERTICAL, BLK, ROHS	Keystone	5001
2	J1, J9	CONN-HEADER, 1x2, RETENTIVE, 2.54mm, 0.230x0.120, ROHS	BERG/FCI	69190-202HLF
1	J2	CONN-HEADER, 1x3, BRKAWY 1x36,2.54mm, TAIL LENGTH.145"	3M	929647-09-36-I-1X3
2	J4, J6	CONN-SOCKET STRIP, TH, 2x3, 2.54mm, TIN, R/A, ROHS	Samtec	SSQ-103-02-T-D-RA
2	J3, J5	CONN-HEADER, 2x3, BRKAWY, 2.54mm, TIN, R/A, ROHS	Samtec	TSW-103-08-T-D-RA
4	ZSC1, ZSC2, ZSC3, ZSC4	SCREW, 4-40x1/4in, PHILLIPS, PANHEAD, STAINLESS, ROHS	Building Fasteners	PMSSS 440 0025 PH
4	ZSO1, ZSO2, ZSO3, ZSO4	STANDOFF, 4-40x3/4in, F/F, HEX, ALUMINUM, 0.25 OD, ROHS	Keystone	2204
0	C26, C29, C36, C37, C42	DO NOT POPULATE		
0	R1, R35, R38	DO NOT POPULATE		

3.3 ISL68301EVAL2Z Board Layout

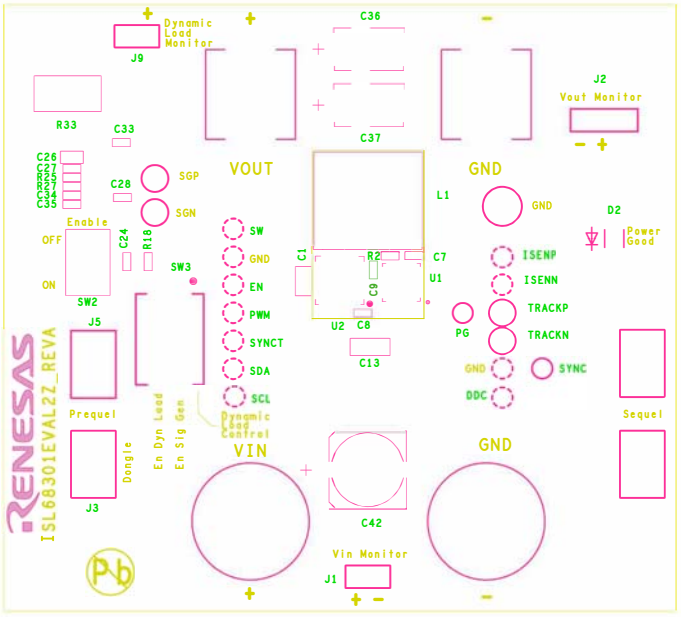

Figure 8. PCB - Top Silk Screen

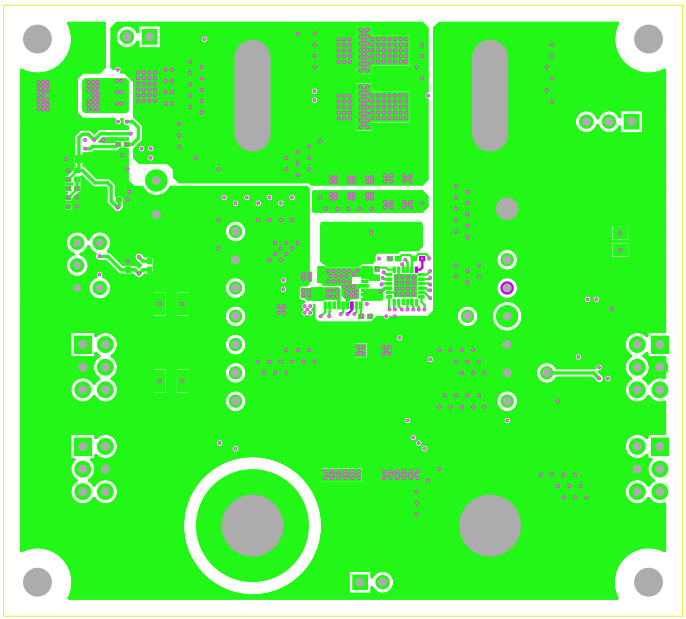

Figure 9. PCB - Top Layer

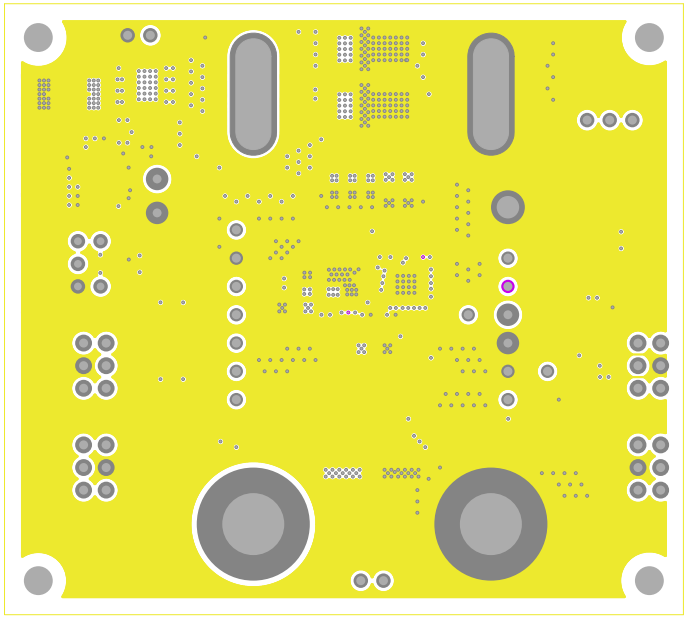

Figure 10. PCB - Inner Layer - Layer 2 (Top View)

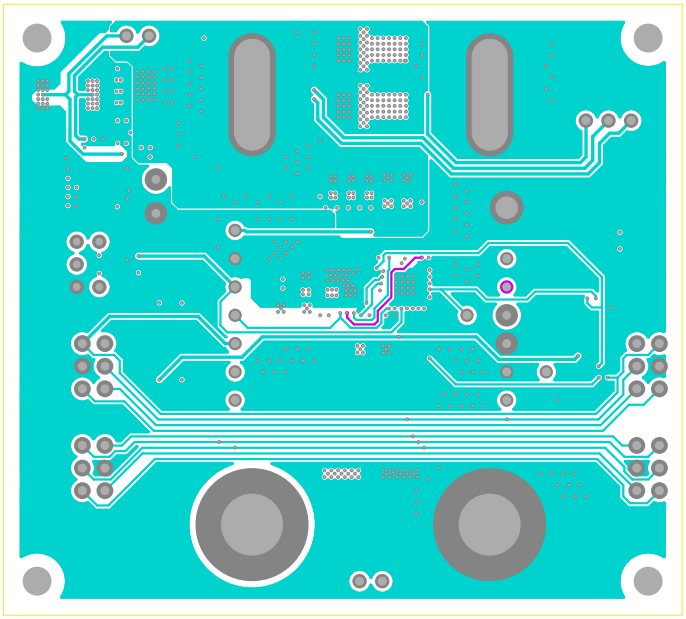

Figure 11. PCB - Inner Layer - Layer 3 (Top View)

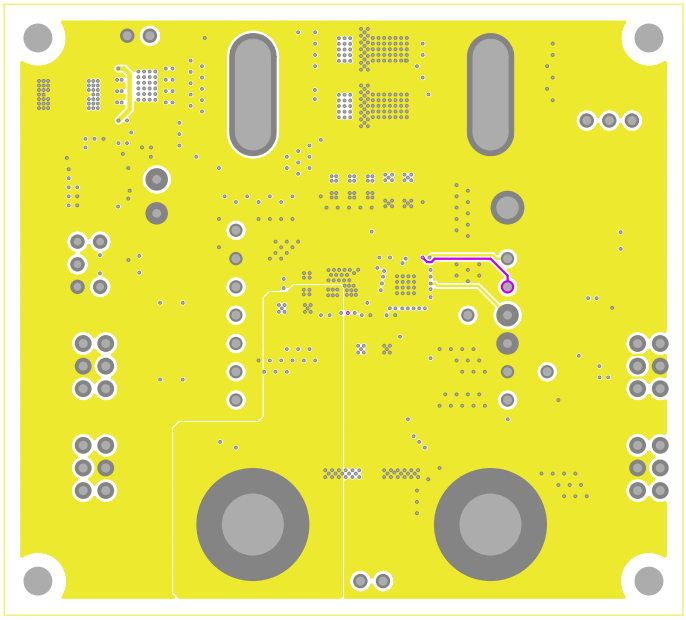

Figure 12. PCB - Inner Layer - Layer 4 (Top View)

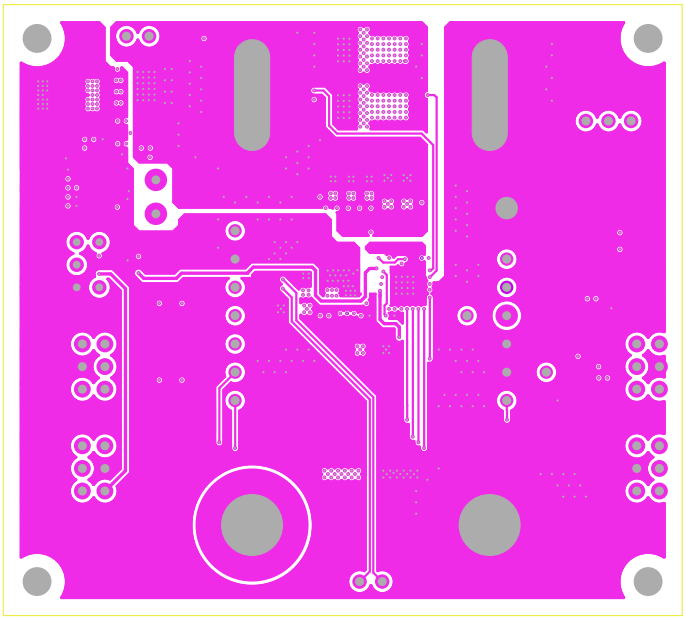

Figure 13. PCB - Inner Layer - Layer 5 (Top View)

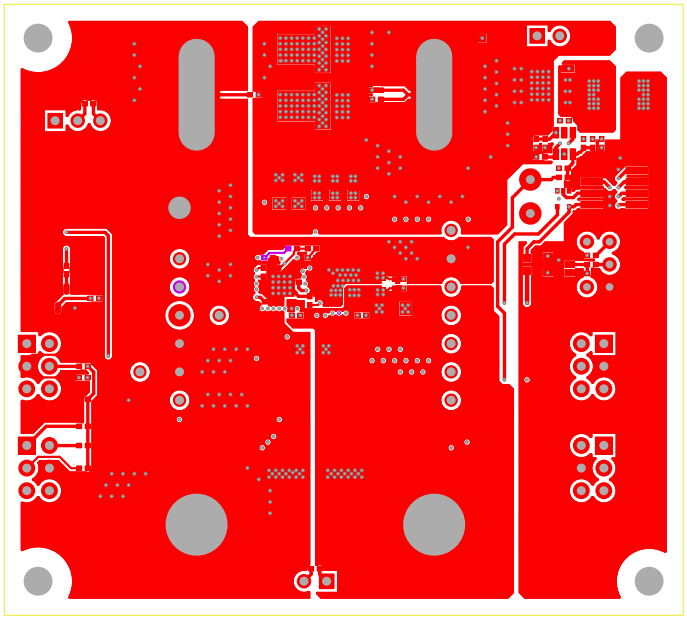

Figure 14. PCB - Bottom Layer (Top View)

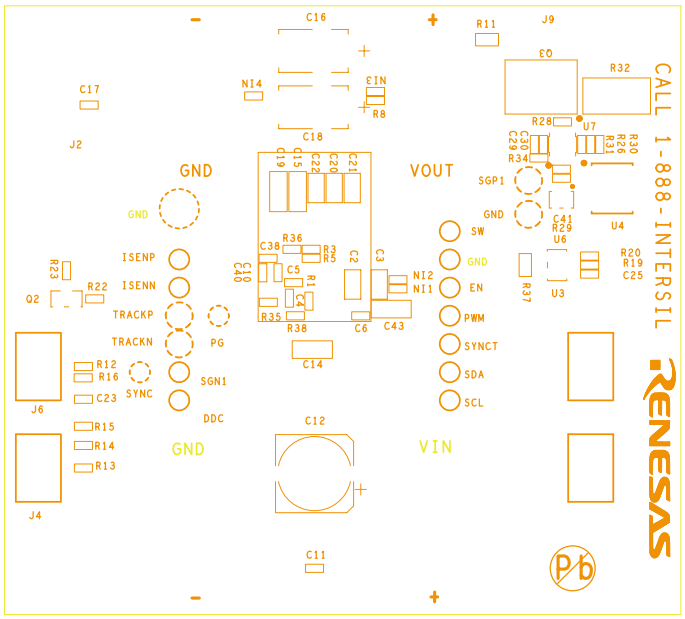

Figure 15. PCB - Bottom Silk Screen

4. Typical Performance Curves

Unless noted: V_{IN} = 12V, T_A = +25°C

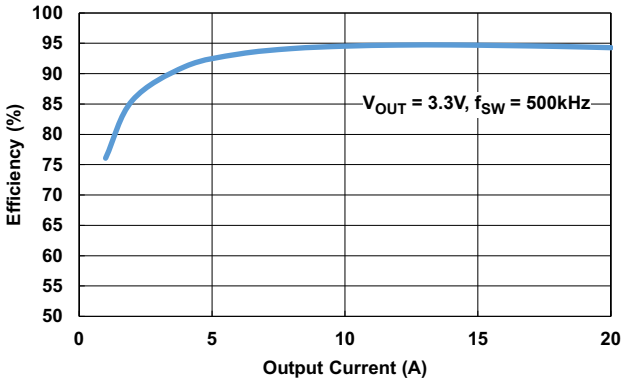

Figure 16. Efficiency

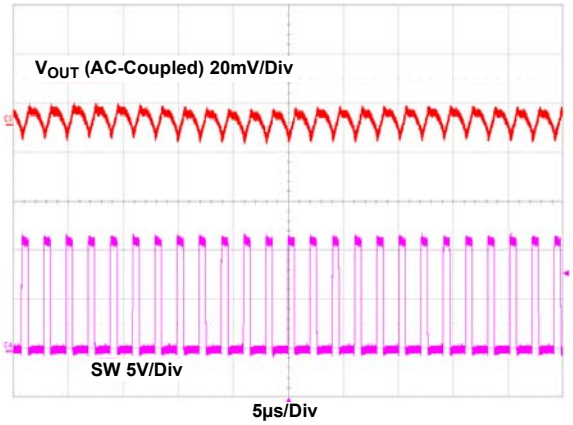

Figure 17. Output Ripple at Full Load

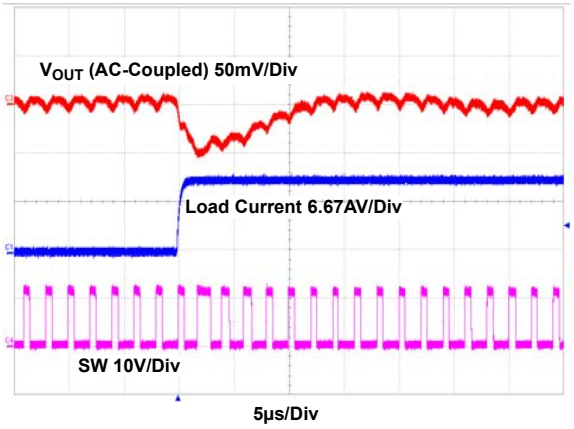

Figure 18. Load Transient Waveforms

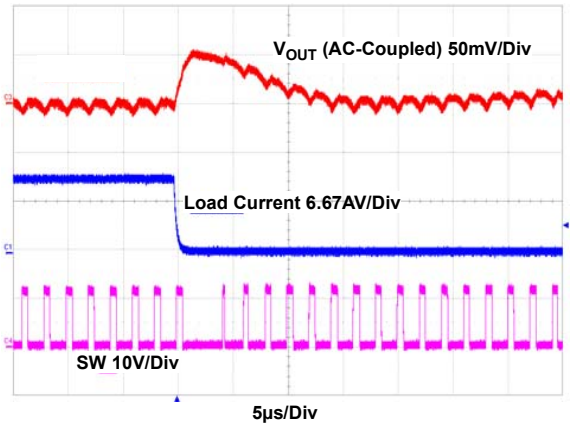

Figure 19. Load Transient Waveforms

5. Configuration File

Sample configuration file for the ISL68301. Copy and paste (from STORE_CONTROL to ### End User Store) to a text editor and save it as Confile_file_name.txt. The # symbol is used for a comment line.

```
# ISL68301-0 0x69


STORE_CONTROL                0x21
STORE_CONTROL                0x11
STORE_CONTROL                0x12
# -------------Start of User Settings------------
ON_OFF_CONFIG                0x17
VOUT_COMMAND                  0x699A       # 3.3 V
VOUT_MARGIN_HIGH              0x6EE1       # 3.465 V
VOUT_MARGIN_LOW               0x6452       # 3.135 V
POWER_MODE                   0x00
VOUT_OV_FAULT_LIMIT           0x7428       # 3.63 V
VOUT_OV_WARN_LIMIT            0x720D       # 3.564 V
VOUT_UV_WARN_LIMIT            0x59C3       # 2.805 V
VOUT_UV_FAULT_LIMIT           0x547B       # 2.64 V
IOUT_OC_FAULT_LIMIT           0xE280       # 40 A
IOUT_OC_WARN_LIMIT            0xE230       # 35 A
IOUT_UC_FAULT_LIMIT           0xE580       # -40 A
POWER_GOOD_ON                 0x5F0B       # 2.97 V
ISENSE_CONFIG                0x6103
ASCR_ADVANCED                 0x20FF
INDUCTOR                    0xBA00       # 1 µH
ASCR_CONFIG                  0x3B5903E8
IOUT_AVG_OC_FAULT_LIMIT       0xDBC0       # 30 A
IOUT_AVG_UC_FAULT_LIMIT       0xDC40       # -30 A
# --------------End of User Settings-------------
# ----------Store Setup - Do Not Modify----------
STORE_CONTROL                0x13
### End User Store
```

6. Revision History

Rev.	Date	Description
1.00	Jul 16, 2018	Updated board pictures. Updated Figures 4 and 5. Updated the sample configuration file on page 18.
0.00	Jul 3, 2018	Initial release

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