RENESAS

ISL68301EVAL1Z

User's Manual: Evaluation Board

Core Power Solutions

RENESAS

Rev.1.00   Jul 2018

ISL68301EVAL1Z

Evaluation Board

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 ISL68301EVAL1Z 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 0.5V to 2.5V
- 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} = 1.0V
- I_{MAX} = 30A
- f_{SW} = 500kHz
- Peak efficiency: >88% at 50% load
- On/off delay = 5ms, on/off ramp time = 5ms

1.3 Ordering Information

Part Number	Description
ISL68301EVAL1Z	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)

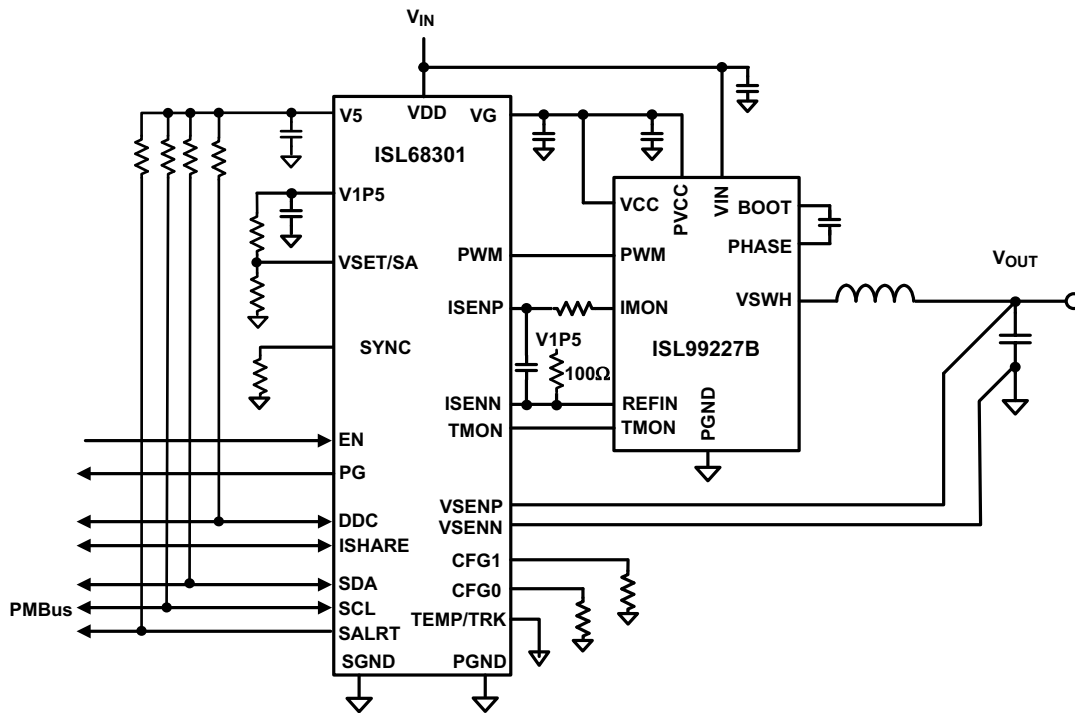- Oscilloscope with higher than 100MHz bandwidth

Figure 1. ISL68301EVAL1Z Block Diagram

2. Functional Description

The ISL68301EVAL1Z 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 show the ISL68301EVAL1Z evaluation board.

2.1 Operating Range

By default, the ISL68301EVAL1Z is configured to operate at V_{OUT} = 1.0V, 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 0.5V to 2.5V, the load current range is from 0A to 35A, and the switching frequency can also be tuned.

For 4.5V to 5.5V input voltage range, tie the V5 and VG directly to VIN by populating resistors R_4 and R_6.

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 ISL68300 PMBus parameters. The ISL68300 device on the board has been preconfigured as described in this document, but the user can modify the operating parameters through the evaluation software or by loading a predefined set-up from a configuration file. A sample "Configuration File" on page 18 is provided and can be copied to a text editor to make desired changes.

The ENABLE switch, SW3, can then be moved to "ON" and the ISL68301EVAL1Z board can be tested. Alternately, the PMBus ON_OFF_CONFIG and OPERATION commands can be used from the PowerNavigator GUI.

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2.3   Quick Start Guide

2.3.1   Pin-Strap Option

The ISL68301EVAL1Z 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} = 1.0V, f_{SW} = 500kHz, and PMBus address = 68h. Complete the following steps to evaluate the ISL68301 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 1% standard 0402 resistors 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 ISL68301EVAL1Z can be evaluated for all features using the provided ZLUSBEVAL3Z dongle and PowerNavigator evaluation software. 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 ISL68301EVAL1Z 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 ISL68301EVAL1Z board using the PMBus commands in PowerNavigator.

PowerNavigator tutorial videos are available at 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 ISL68301EVAL1Z 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.
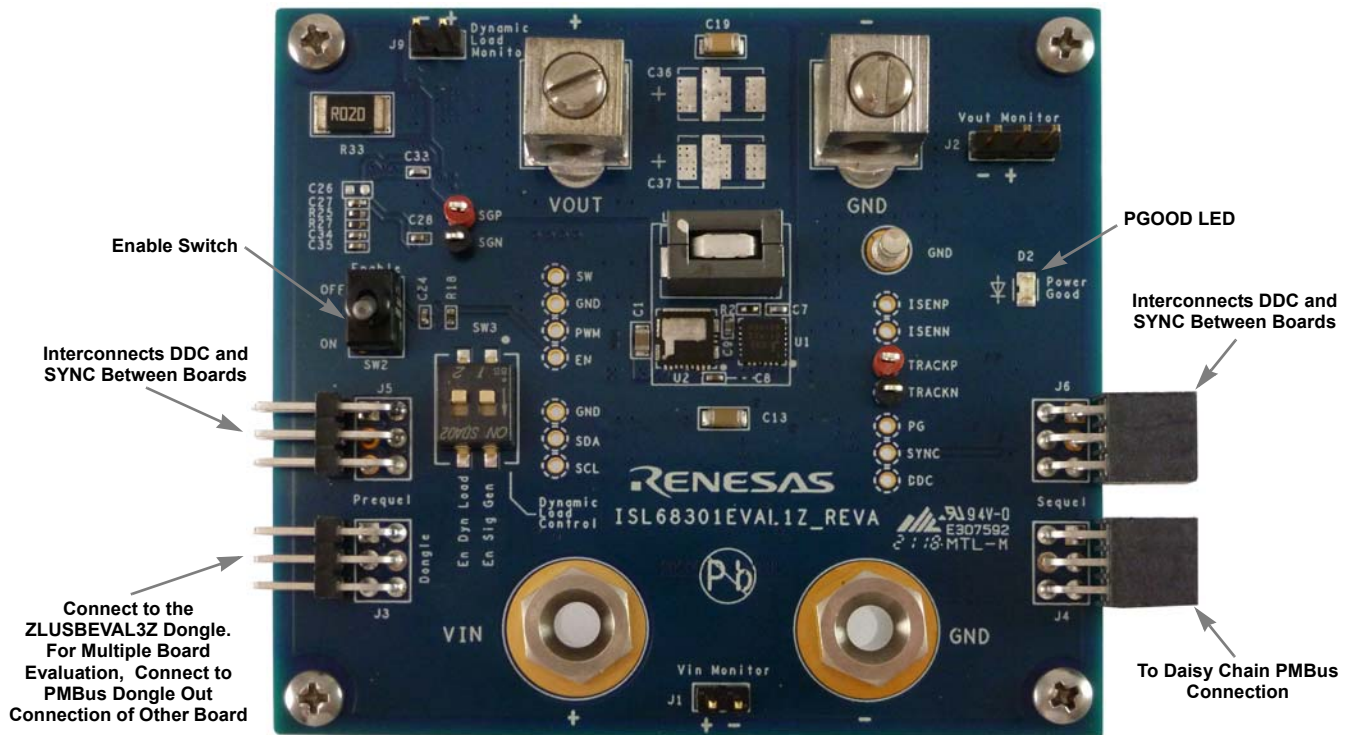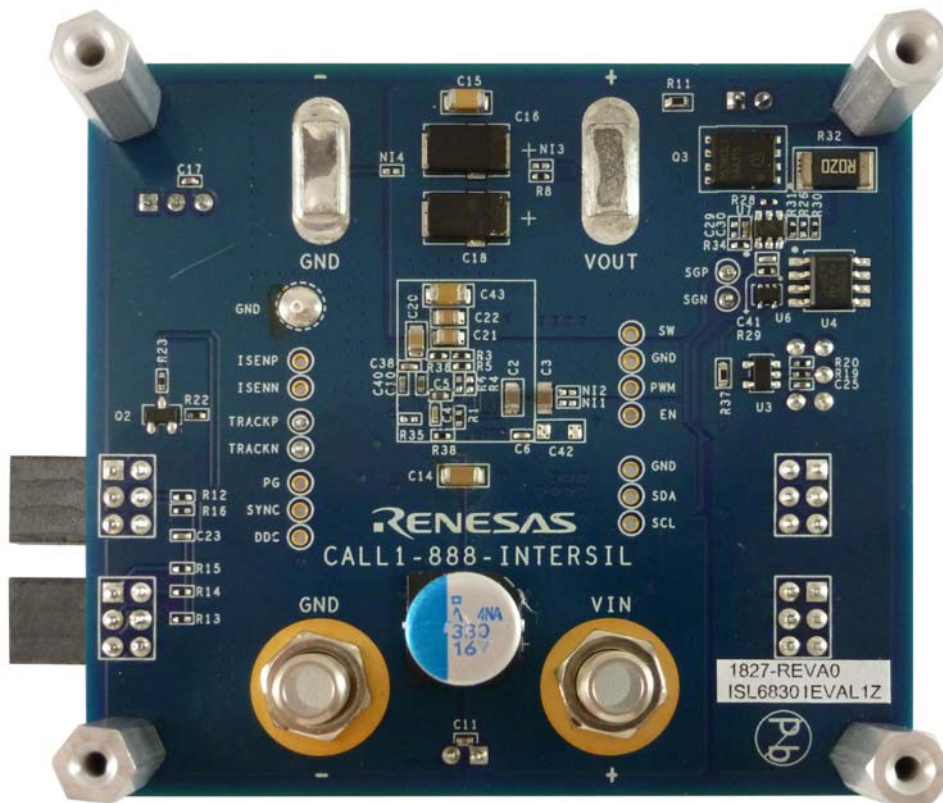
Figure 2. ISL68301EVAL1Z Evaluation Board (Top Side)

Figure 3. ISL68301EVAL1Z Evaluation Board (Bottom Side)
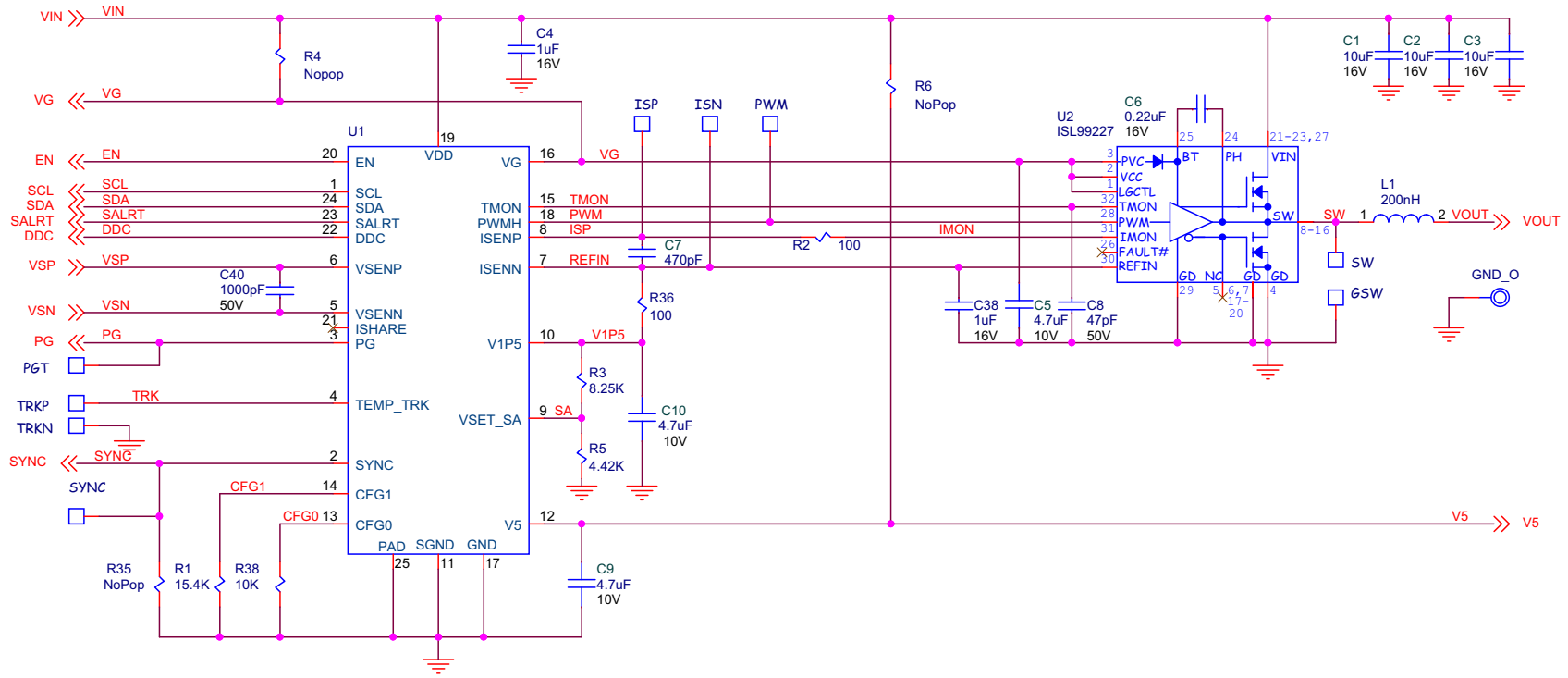
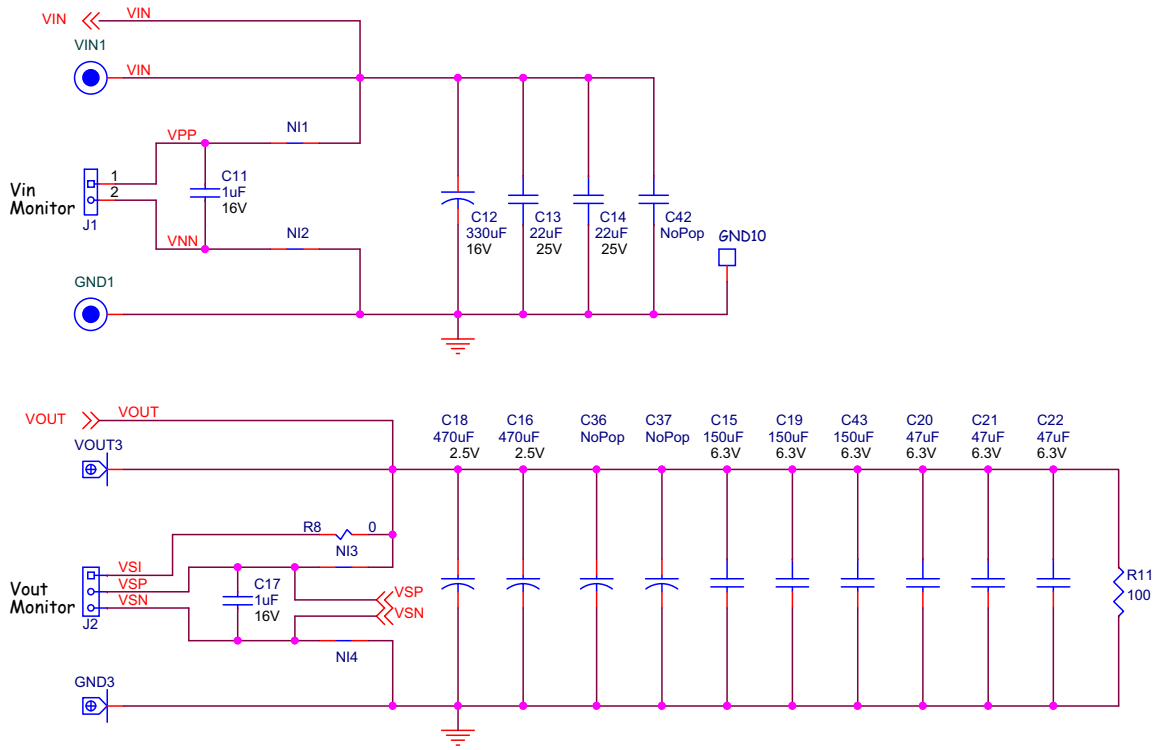## 2.4   ISL68301EVAL1Z Board Schematic

Figure 4. Schematic

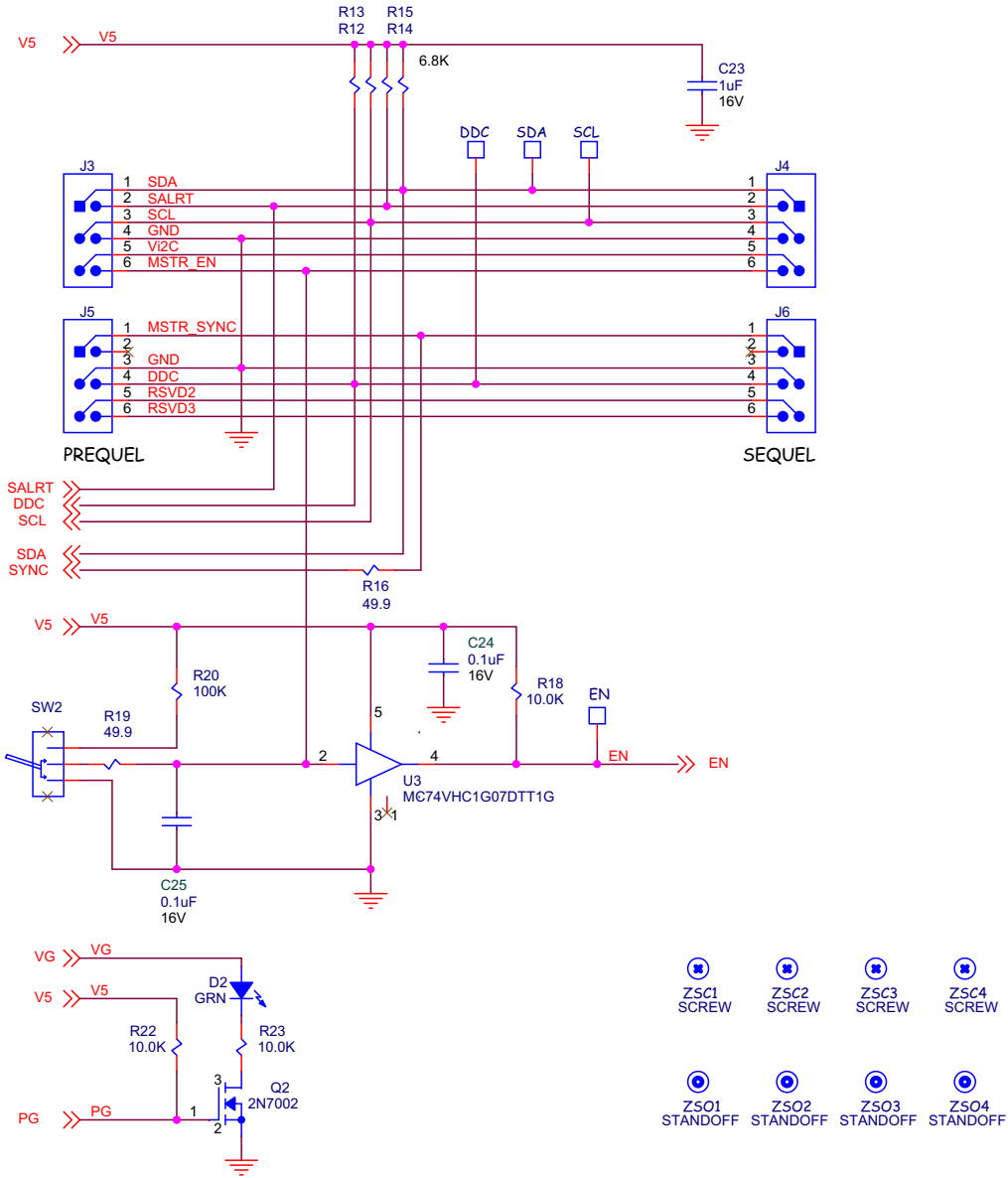**Figure 5. Schematic - Input and Output Filters**

V5

R13 R15
R12 R14
6.8K

DDC SDA SCL

C23
1uF
16V

J3
1 SDA
2 SALRT
3 SCL
4 GND
5 Vi2C
6 MSTR_EN

J4
1
2
3
4
5
6

J5
1 MSTR_SYNC
2
3 GND
4 DDC
5 RSVD2
6 RSVD3

J6
1
2
3
4
5
6

PREQUEL

SEQUEL

SALRT
DDC
SCL

SDA
SYNC

R16
49.9

V5

R20
100K

C24
0.1uF
16V

R18
10.0K

EN

EN

EN

SW2

R19
49.9

5

2

4

U3
MC74VHC1G07DTT1G

3 1

C25
0.1uF
16V

VG

V5

D2
GRN

R22
10.0K

R23
10.0K

3

Q2
2N7002

PG

1

2

ZSC1
SCREW

ZSC2
SCREW

ZSC3
SCREW

ZSC4
SCREW

ZSO1
STANDOFF

ZSO2
STANDOFF

ZSO3
STANDOFF

ZSO4
STANDOFF

Figure 6. Schematic - Page 3
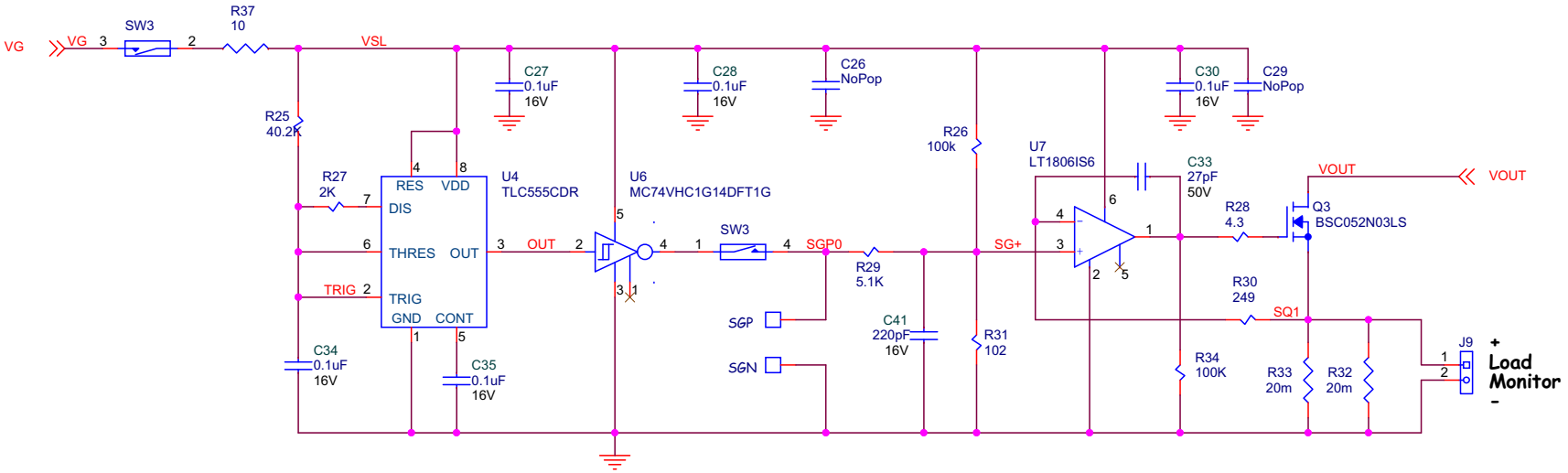
Figure 7. Schematic - Dynamic Load

2.5   Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
3	C1, C2, C3	CAP, SMD, 0805, 10µF, 16V, 10%, X6S, ROHS	TDK	C2012X6S1C106K085AC
3	C15, C19, C43	CAP, SMD, 1206, 150µF, 6.3V, 20%, X5R, ROHS	Murata	GRM31CR60J157ME11L
1	C40	CAP, SMD, 0402, 1000pF, 50V, 5%, C0G, ROHS	Venkel	C0402C0G500-102JNE
7	C24, C25, C27, C28, C30, C34, 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	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
2	C13, C14	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, 470µF, 2.5V, 20%, 4.5mΩ, POLY.AL.EL., ROHS	Panasonic	EEF-LX0E471R4
1	L1	COIL-PWR INDUCTOR, SMD, 10.7x7, 200nH, 10%, 61A, 18mΩ, ROHS	Eaton/Vussmann	FP1110V2-R200-R
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, 0.02Ω, 3W, 1%, TF, ROHS	Bourns	CRA2512-FZ-R020ELF
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
4	R18, R22, R23, R38	RES, SMD, 0402, 10k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1002X
2	R20, R34	RES, SMD, 0402, 100k, 1/16W, 1%, TF,ROHS	Panasonic	ERJ2RKF1003

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	R31	RES, SMD, 0402, 102Ω, 1/16W, 1%, TF, ROHS	Vishay/dale	CRCW0402102RFKED
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	Panasonic	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, 4.42k, 1/16W, 1%,TF, ROHS	Panasonic	ERJ-2RKF4421X
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, 8.25k, 1/16W, 1%,TF, ROHS	Panasonic	ERJ-2RKF8251
1	R37	RES, SMD, 0603, 10Ω, 1/10W, 1%, TF, ROHS	KOA	RK73H1JT10R0F
1	R11	RES, SMD, 0603, 100Ω, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1000FT
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, 0.53 Length, 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, 0.230x 0.120, 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	R4, R6, R26, R35	DO NOT POPULATE		

2.6   ISL68301EVAL1Z Board Layout
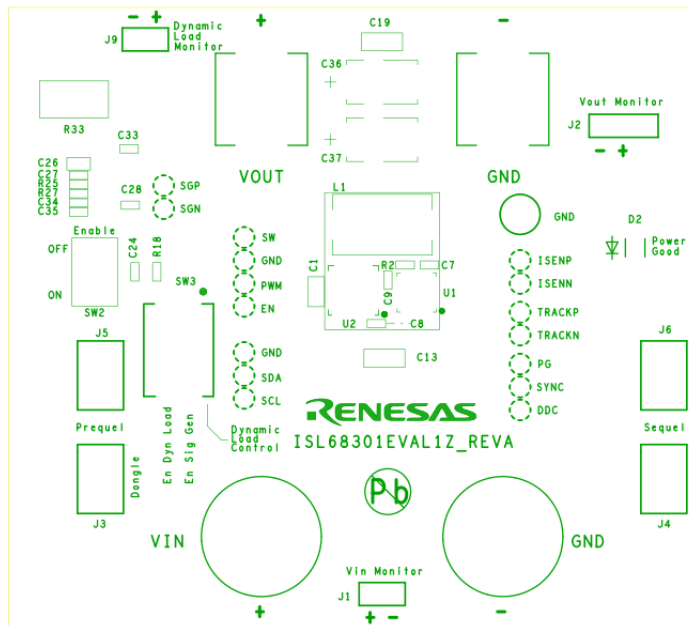
Figure 8. PCB - Top Silk Screen
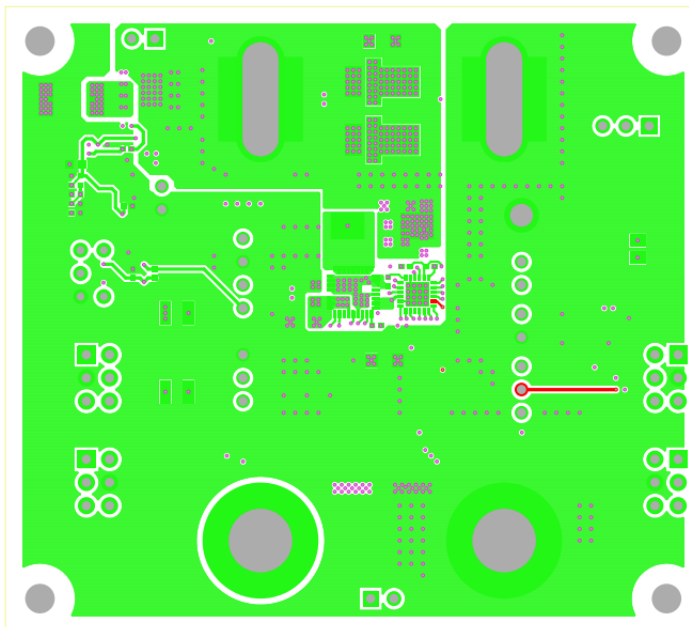
Figure 9. PCB - Top Layer
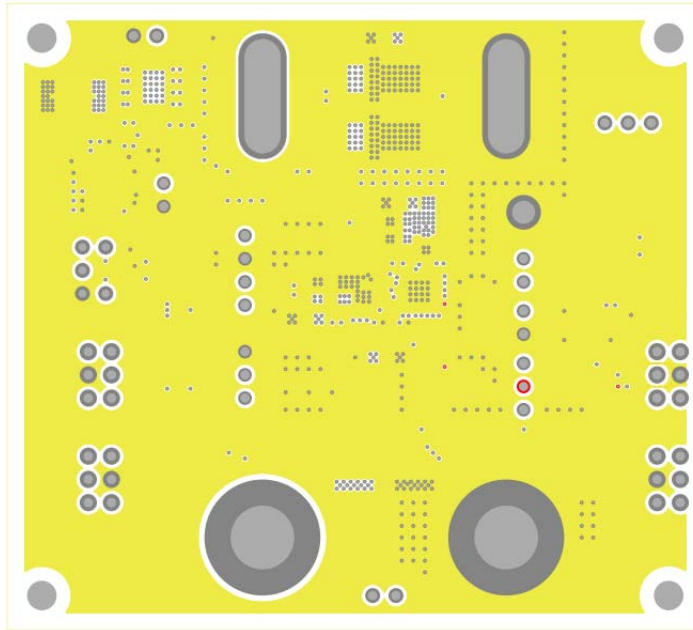
Figure 10. PCB - Inner Layer - Layer 2 (Top View)
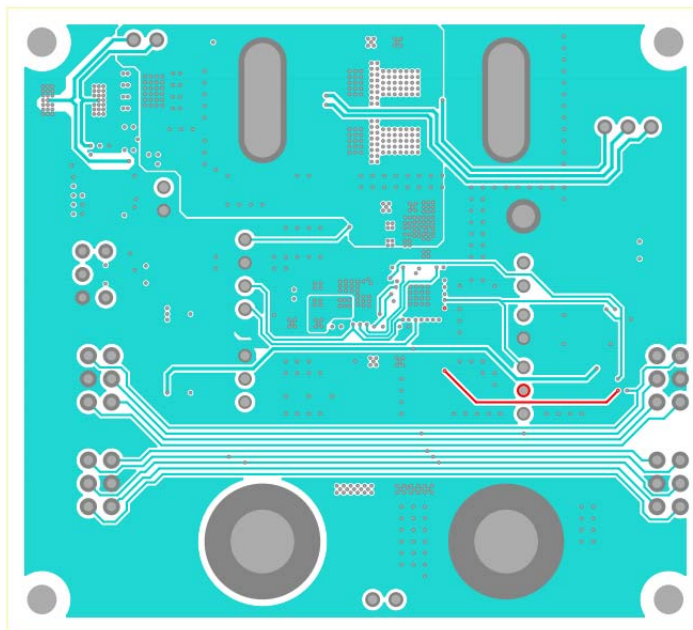
Figure 11. PCB - Inner Layer - Layer 3 (Top View)
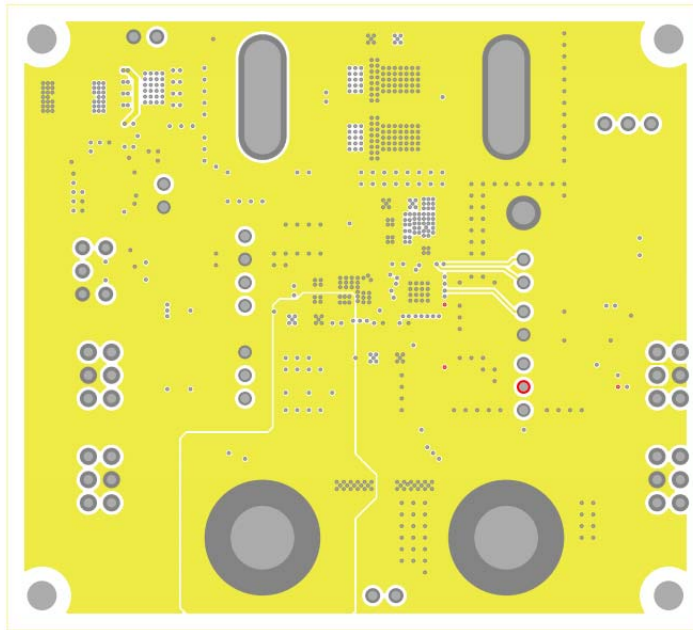
Figure 12. PCB - Inner Layer - Layer 4 (Top View)
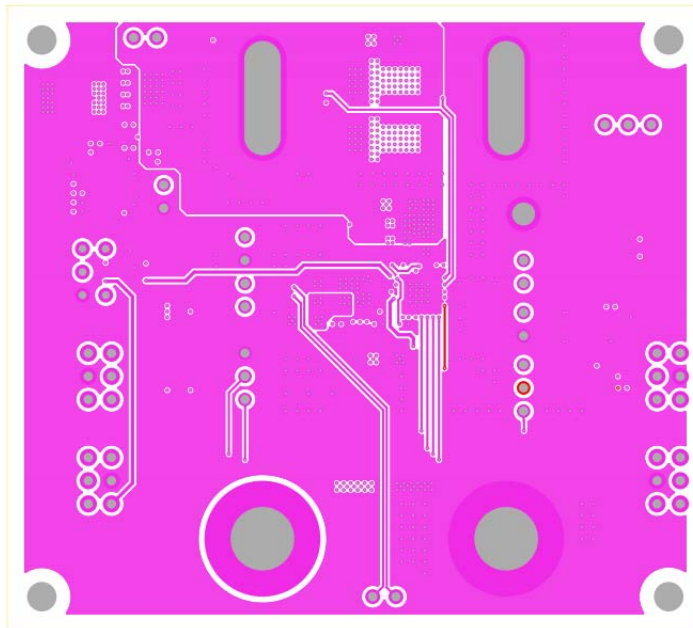
Figure 13. PCB - Inner Layer - Layer 5 (Top View)

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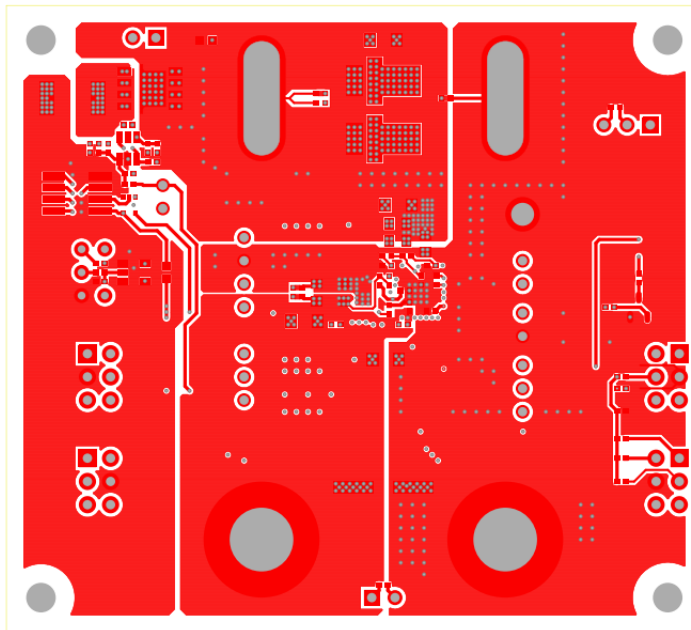
Figure 14. PCB - Bottom Layer (Top View)
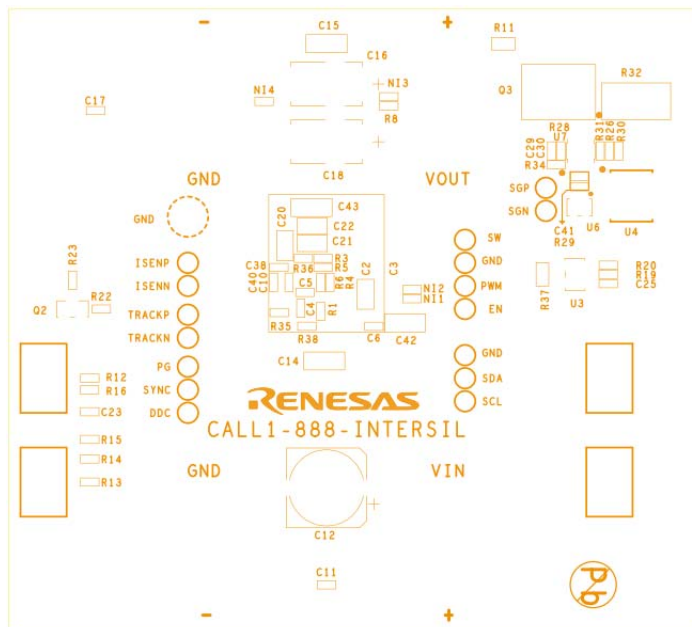
Figure 15. PCB - Bottom Silk Screen

3. Typical Performance Curves

Unless noted: V_{IN} = 12V, T_A = +25°C
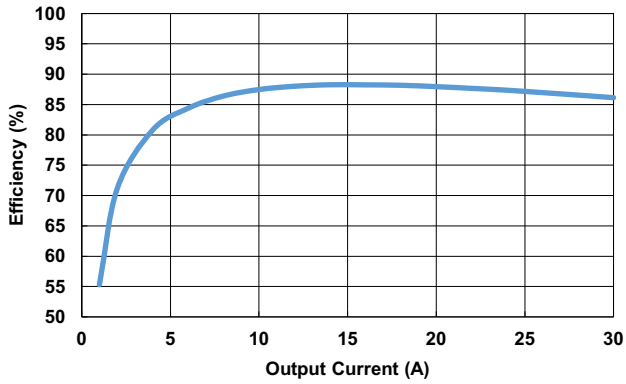
Figure 16. Efficiency
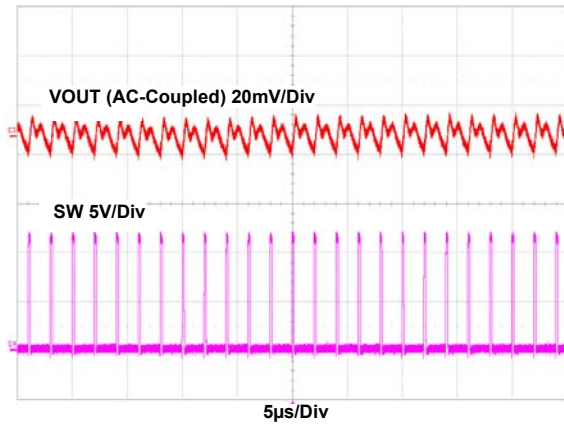
Figure 17. Load Transient Waveforms
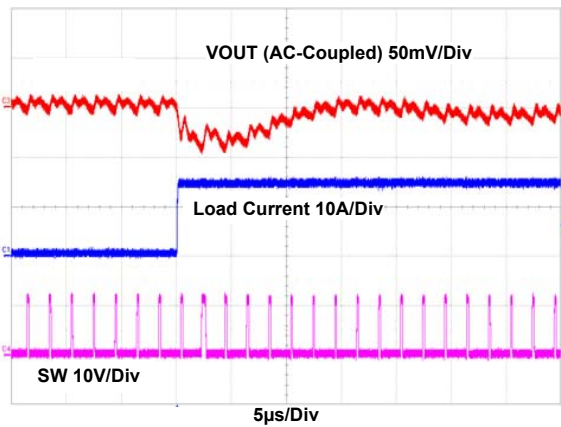
Figure 18. Load Transient Waveforms
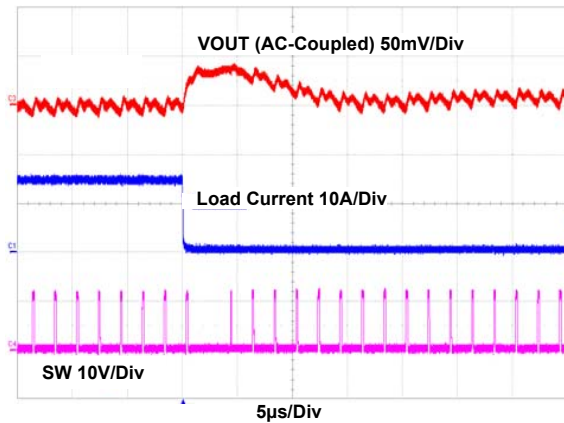
Figure 19. Load Transient Waveforms

4.   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.

STORE_CONTROL   0x21

STORE_CONTROL   0x11

STORE_CONTROL   0x12

-------------Start of User Settings------------

VOUT_COMMAND   0x2000   # 1 V

VOUT_MAX   0x24CD   # 1.15 V

VOUT_MARGIN_HIGH   0x219A   # 1.05 V

VOUT_MARGIN_LOW   0x1E66   # 0.95 V

FREQUENCY_SWITCH   0xFBE8   # 500 kHz

VOUT_OV_FAULT_LIMIT   0x2333   # 1.1 V

VOUT_OV_FAULT_RESPONSE   0x80

VOUT_OV_WARN_LIMIT   0x228F   # 1.08 V

VOUT_UV_WARN_LIMIT   0x1CCD   # 0.9 V

VOUT_UV_FAULT_LIMIT   0x1B33   # 0.85 V

VOUT_UV_FAULT_RESPONSE   0x80

IOUT_OC_FAULT_LIMIT   0xE320   # 50 A

IOUT_OC_WARN_LIMIT   0xE230   # 35 A

IOUT_UC_FAULT_LIMIT   0xE4E0   # -50 A

OT_FAULT_RESPONSE   0x80

UT_FAULT_RESPONSE   0x80

VIN_OV_FAULT_RESPONSE   0x80

VIN_UV_FAULT_RESPONSE   0x80

POWER_GOOD_ON   0x1CCD   # 0.9 V

ISENSE_CONFIG   0x6103

ASCR_ADVANCED   0x20FF

INDUCTOR   0xA333   # 0.2 ?H

ASCR_CONFIG   0x644F02BC

MFR_IOUT_OC_FAULT_RESPONSE   0x80

MFR_IOUT_UC_FAULT_RESPONSE   0x80

IOUT_AVG_OC_FAULT_LIMIT   0xE280   # 40 A

IOUT_AVG_UC_FAULT_LIMIT   0xE580   # -40 A

--------------End of User Settings-------------

----------Store Setup - Do Not Modify----------

STORE_CONTROL   0x13

End User Store

5.   Revision History

Rev.	Date	Description
1.00	Jul 13, 2018	Updated board photos on page 6. Updated Fgure 5 schematic on page 8.
0.00	Jul 3, 2018	Initial release

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