RENESAS

ISL68301EVAL3Z

User's Manual: Evaluation Board

Core Power Solutions

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RENESAS

ISL68301EVAL3Z

Evaluation Board

1. Overview

The ISL68301 is a PMBus compliant, single-phase digital DC/DC controller with integrated gate drivers for use with N-channel MOSFETs. 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 ISL68301EVAL3Z 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, 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 highlights the current-sharing feature of the ISL68301 in the 2-phase configuration. It is configured for the following operating conditions by default:

- V_{IN} = 7V to 16V
- V_{OUT} = 1.0V
- I_{MAX} = 60A
- f_{SW} = 400kHz
- Peak efficiency: >89% at 50% load
- On/off delay = 5ms, on/off ramp time = 5ms

1.3 Ordering Information

Part Number	Description
ISL68301EVAL3Z	ISL68301 evaluation 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 80A

- Digital Multimeters (DMMs)
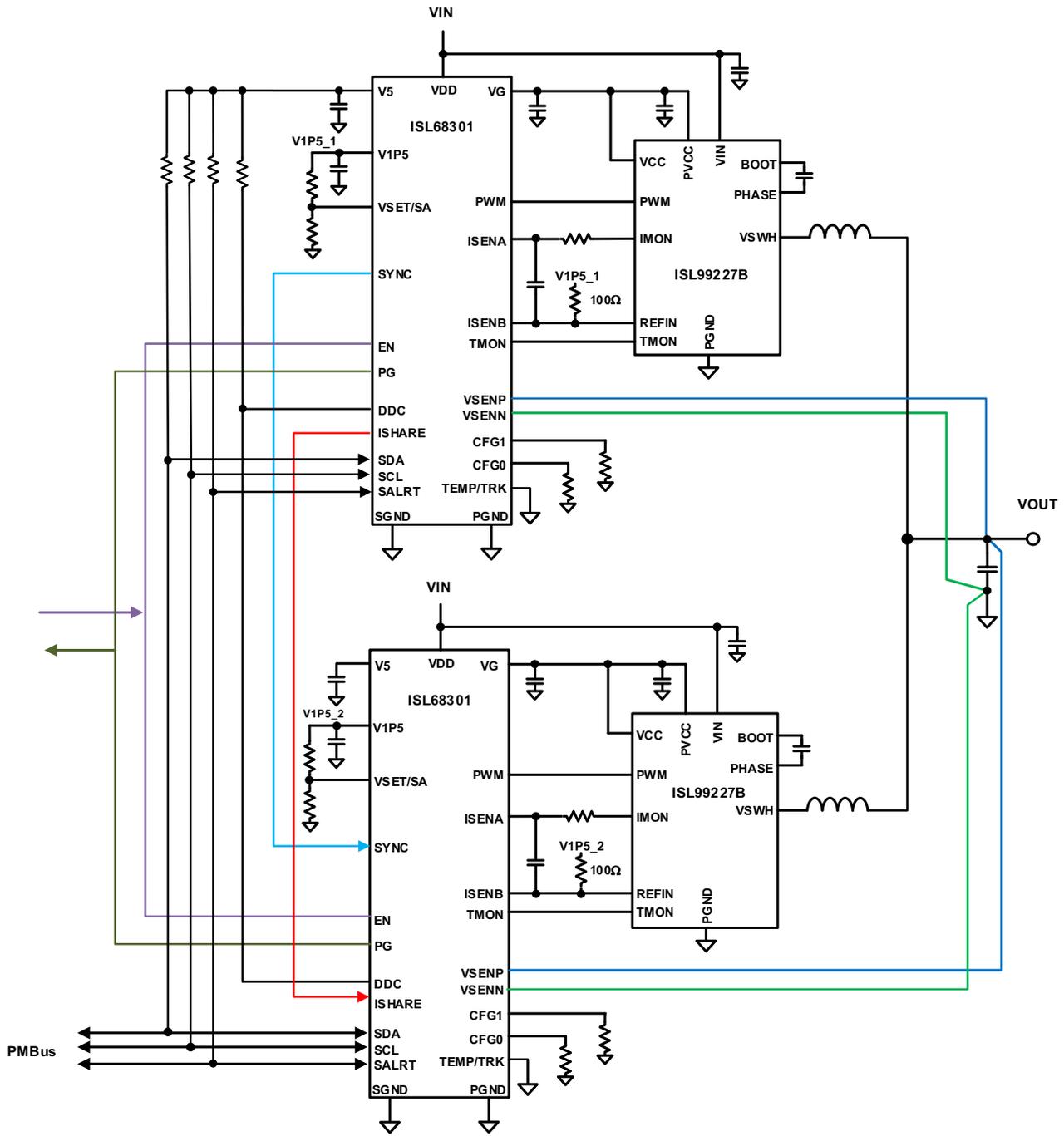
- Oscilloscope with higher than 100MHz bandwidth

Figure 1. ISL68301EVAL3Z Block Diagram

2. Functional Description

The ISL68301EVAL3Z 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 ISL68301EVAL3Z evaluation board.

2.1 Operating Range

By default, the ISL68301EVAL3Z is configured to operate at V_{OUT} = 1.0V, f_{SW} = 400kHz. 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, load current range is from 0A to 60A, and the switching frequency can 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 provided 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 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 ISL68301EVAL1Z 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   PMBus Option

The ISL68301EVAL3Z can be evaluated for all features using the provided ZLUSBEVAL3Z dongle and PowerNavigator. Follow these 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 ISL68301EVAL3Z board to 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 ISL68301EVAL3Z 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 ISL68301 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
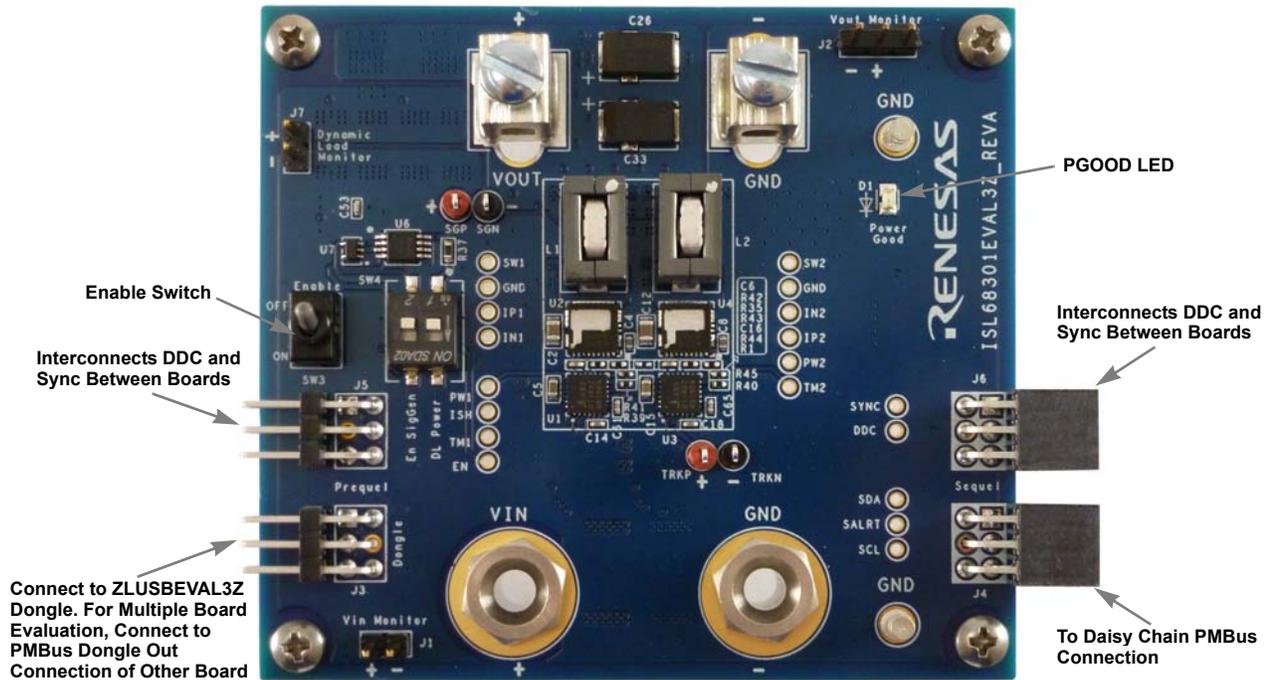
Figure 2. ISL68301EVAL3Z Evaluation Board (Top Side)
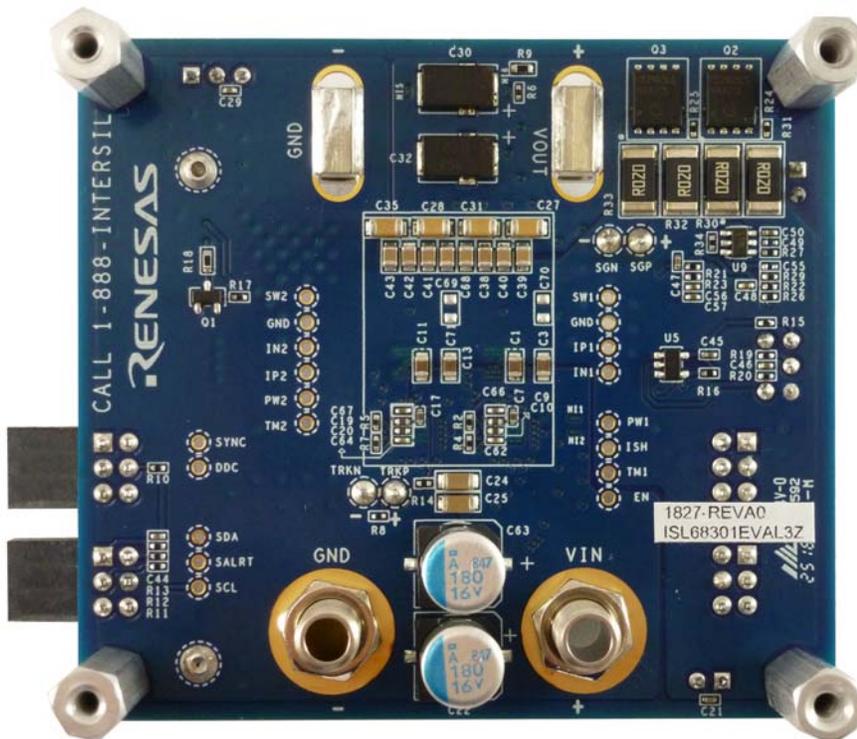
Figure 3. ISL68301EVAL3Z Evaluation Board (Bottom Side)
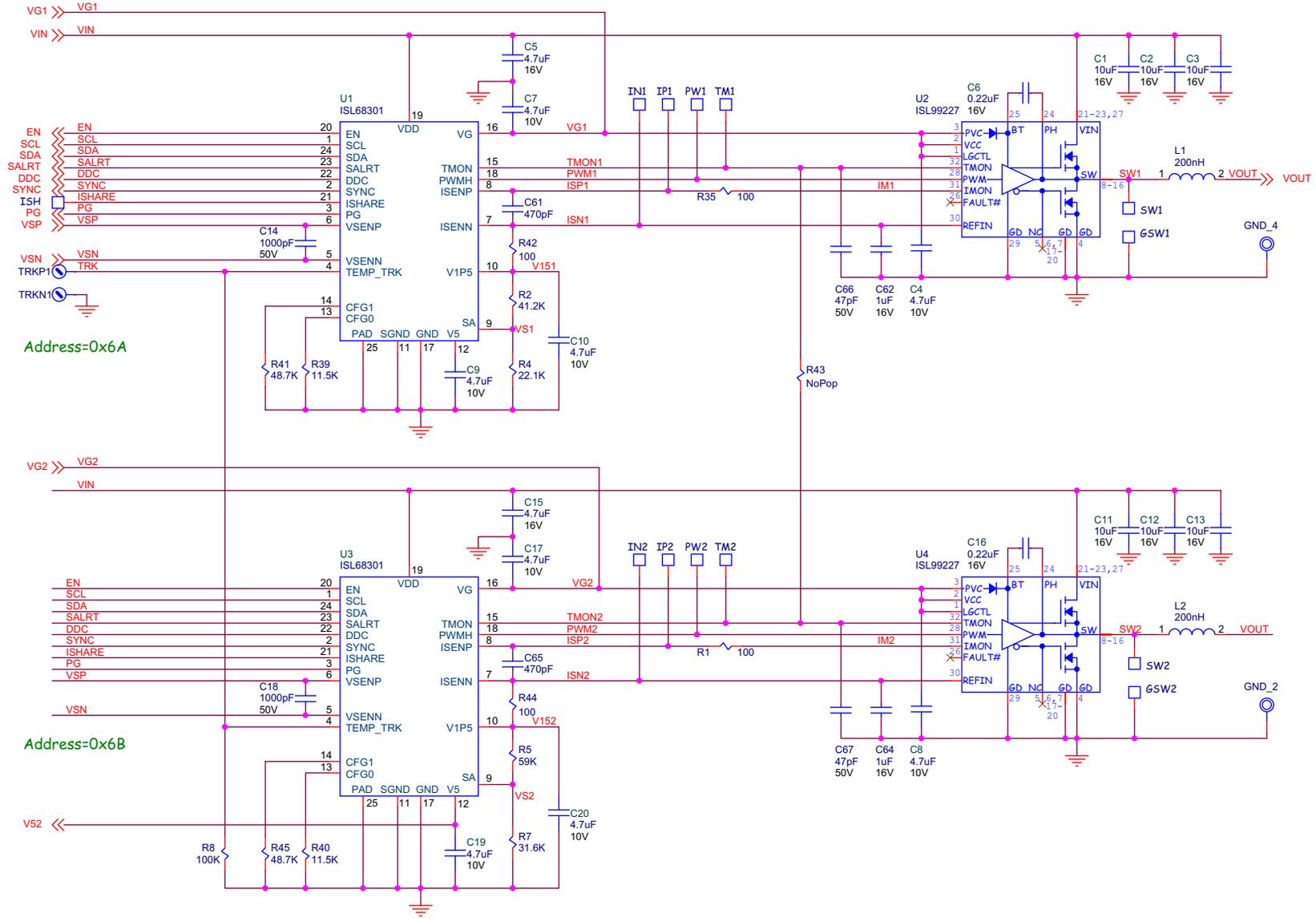
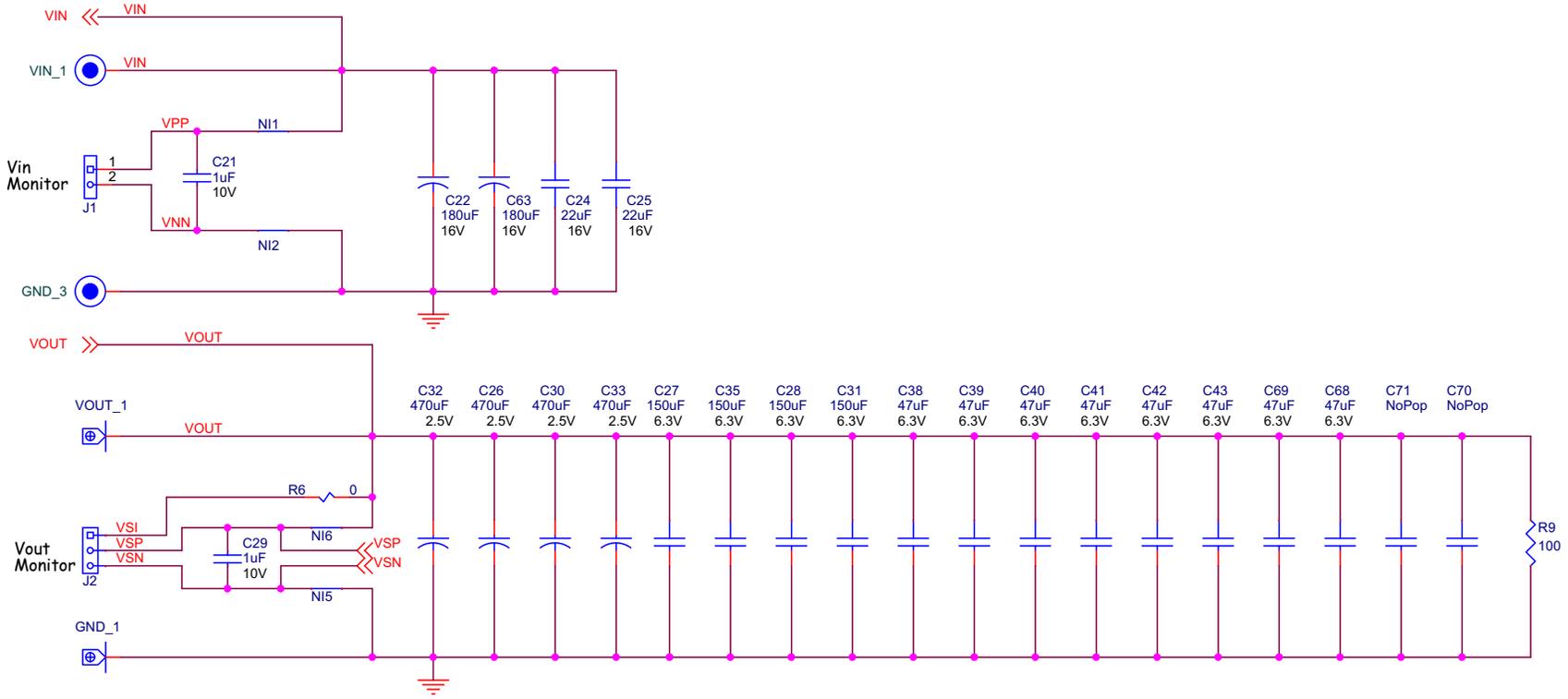## 3.1 ISL68301EVAL3Z Board Schematic

Figure 4. Schematic

Address=0x6A

Address=0x6B

Figure 5. Schematic - Input and Output Filters
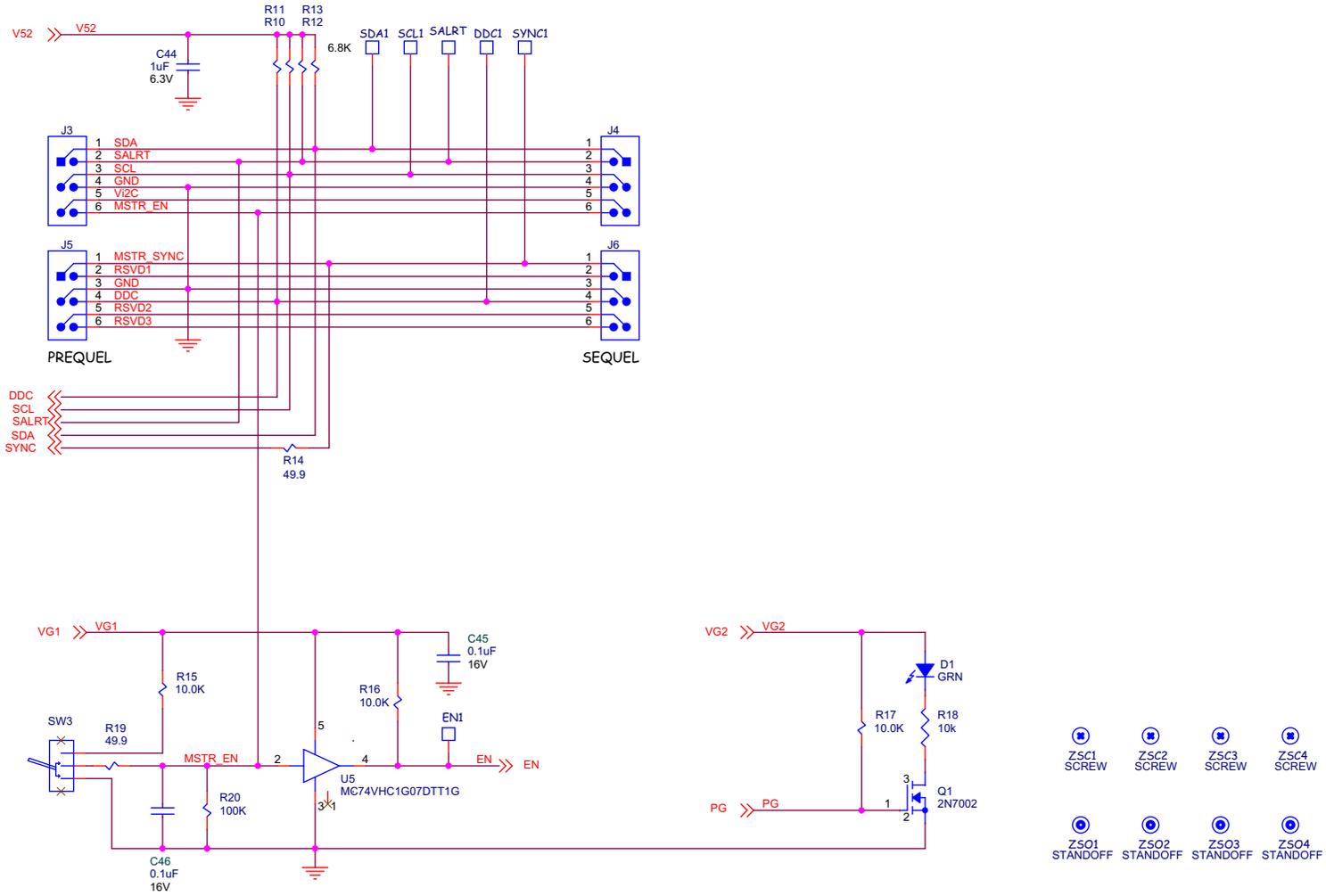
Figure 6. Schematic - I²C, Enable, PG, SALRT

Figure 7. Schematic - Dynamic Load

3.2   Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
6	C1, C2, C3, C11, C12, C13	CAP, SMD, 0805, 10µF, 16V, 10%, X6S, ROHS	TDK	C2012X6S1C106K085AC
4	C27, C28, C31, C35	CAP, SMD, 1206, 150µF, 6.3V, 20%, X5R, ROHS	Murata	GRM31CR60J157ME11L
2	C14, C18	CAP, SMD, 0402, 1000pF, 50V, 5%, C0G, ROHS	Venkel	C0402C0G500-102JNE
7	C45, C46, C47, C48, C50, C56, C57	CAP, SMD, 0402, 0.1µF, 16V, 10%, X7R, ROHS	Murata	GRM155R71C104JA88D
5	C21, C29, C44, C62, C64	CAP, SMD, 0402, 1.0µF, 16V, 10%, X5R, ROHS	TDK	C1005X5R1C105K050BC
2	C6, C16	CAP, SMD, 0402, 0.22µF, 10V, 10%, X5R, ROHS	Venkel	C0402X5R100-224KNE
1	C53	CAP, SMD, 0402, 27pF, 50V, 5%, NP0, ROHS	Murata	GRM36COG270J050AQ
2	C66, C67	CAP, SMD, 0402, 47pF, 50V, 5%, NP0, ROHS	Murata	GRM36COG470J050AQ
2	C61, C65	CAP, SMD, 0402, 470pF, 50V, 5%, NP0, ROHS	AVX	04025A471JAT2A
8	C4, C7, C8, C9, C10, C17, C19, C20	CAP, SMD, 0402, 4.7µF, 10V, 10%, X5R, ROHS	TDK	C1005X5R1A475K050BC
8	C38, C39, C40, C41, C42, C43, C68, C69	CAP, SMD, 0805, 47µF, 6.3V, 20%, X5R, ROHS	Kemet	C0805C476M9PACTU
2	C24, C25	CAP, SMD, 1206, 22µF, 25V, 10%, X5R, ROHS	Murata	GRM31CR61E226KE15L
2	C5, C15	CAP, SMD, 0603, 4.7µF, 16V, 10%, X5R, ROHS	Venkel	C0603X5R160-475KNE
2	C22, C63	CAP, SMD, 8x12, 180µF, 16V, 20%, 16mΩ, ALUM.ELEC., ROHS	Nippon Chemi-Con	APXA160ARA181MJC0G
4	C26, C30, C32, C33	CAP, SMD, D, 470µF, 2.5V, 20%, 3mΩ, POLY.AL.EL., ROHS	Panasonic	EEF-GX0E471L
2	L1, L2	COIL-PWR INDUCTOR, SMD, 10.7x7, 200nH, 10%, 61A, 18mΩ, ROHS	Eaton/Bussmann	FP1110V2-R200-R
1	D1	LED, SMD, 0805, GREEN/CLEAR, 2.2V, 20mA, 574nm, 45mcd, ROHS	Lumex	SML-LX0805SUGC-TR
2	U1, U3	IC-DIGITAL DC/DC CONTROLLER, 24P, QFN, ROHS	Renesas	ISL68301IRAZ
2	U2, U4	IC-5V PWM SPS MODULE, 32P, QFN 5x5, ROHS	Renesas	ISL99227BFRZ
1	U9	IC-OP AMP, R/R, SMD, 6P, TSOT23, 325MHz, 85mA, ROHS	Linear Technology	LT1806IS6#TRMPBF
1	U5	IC-NON-INVERTING BUFFER, SMD, 5P, TSOT23-5, ROHS	On Semiconductor	MC74VHC1G07DTT1G
1	U7	IC-INVERTER, SCHMITT TRIGGER, SMD, 5P, SC-70-5, ROHS	On Semiconductor	MC74VHC1G14DFT1G
1	U6	IC-TIMER/OSCILLATOR, 2.1MHz, SMD, 8P, SOIC, ROHS	Texas Instruments	TLC555CDR
1	Q1	TRANSISTOR, N-CHANNEL, 3LD, SOT-23, 60V, 115mA, ROHS	Diodes, Inc.	2N7002-7-F
2	Q2, Q3	TRANSIST-MOS, N-CHANNEL, 30V, 57A, SMD, 8P, PG-TDSON-8, ROHS	Infineon Technology	BSC052N03LS
4	R30, R31, R32, R33	RES-AEC-Q200, CURR.SENSE, SMD, 2512, 0.02Ω, 3W, 1%, TF, ROHS	Bourns	CRA2512-FZ-R020ELF

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
2	R24, R25	RES, SMD, 0402, 4.3Ω, 1/16W, 5%, TF, ROHS	Vishay/Dale	CRCW04024R30FKED
1	R6	RES, SMD, 0402, 0Ω, 1/16W, 5%, TF,ROHS	Venkel	CR0402-16W-00T
5	R1, R29, R35, R42, R44	RES, SMD, 0402, 100Ω, 1/16W, 1%, TF, ROHS	Venkel	CR0402-16W-1000FT
3	R15, R16, R17	RES, SMD, 0402, 10k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1002X
4	R8, R20, R22, R34	RES, SMD, 0402, 100k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ2RKF1003
2	R39, R40	RES, SMD, 0402, 11.5k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ2RKF1152
1	R23	RES, SMD, 0402, 2k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF2001
1	R27	RES, SMD, 0402, 249Ω, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF2490
1	R7	RES, SMD, 0402, 31.6kΩ, 1/16W, 5%, TF, ROHS	Venkel	CR0402-16W-3162FT
1	R26	RES, SMD, 0402, 3.32k, 1/16W, 1%, TF, ROHS	Yageo	RC0402FR-073K32L
1	R21	RES, SMD, 0402, 36k, 1/16W, 1%, TF, ROHS	Yageo	RC0402FR-0736KL
1	R2	RES, SMD, 0402, 41.2k, 1/16W, 5%, TF, ROHS	Vishay/Dale	CRCW040241K2FKED
1	R4	RES, SMD, 0402, 22.1k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF2212V
2	R14, R19	RES, SMD, 0402, 49.9Ω, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF49R9X
1	R5	RES, SMD, 0402, 59k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF5902
4	R10, R11, R12, R13	RES, SMD, 0402, 6.8k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF6801X
1	R37	RES, SMD, 0603, 10Ω, 1/10W, 1%, TF, ROHS	KOA	RK73H1JT10R0F
1	R9	RES, SMD, 0603, 100Ω, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1000FT
1	R18	RES, SMD, 0603, 10kΩ, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1002FT
2	R41, R45	RES, SMD, 0402, 48.7k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF4872X
1	SW3	SWITCH-TOGGLE, SPDT, TH, 5P, 28V, 0.4VA, ON-ON, ROHS	NKK	G12AP
1	SW4	SWITCH-SLIDE, SMD, 7.06mm, 2POS, SPST, 25mA, 24V, ROHS	C&K Components	SDA02H1SBD
2	GND3_1, VOUT_1	HARDWARE, 65A PCB WIRE LUG, TH/SMD, 8.5x3.5, 6-14AWG, ROHS	International Hydraulics Inc	B6A-PCB-SS
2	VIN_1, GND_3	CONN-JACK, BANANA-SS-SDRLESS, VERTICAL, 0.53Length, ROHS	Johnson Components	108-0740-001
2	GND_2, GND_4	CONN-DBL TURRET, TH, 0.218x0.078 PCB MNT, TIN/BRASS, ROHS	Keystone	1502-1
2	TRKP1, SGP1	CONN-MINI TEST PT, VERTICAL, RED, ROHS	Keystone	5000
2	TRKN1, SGN1	CONN-MINI TEST PT, VERTICAL, BLK, ROHS	Keystone	5001
2	J1, J7	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

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
0	C70, C71, C49, C55	DO NOT POPULATE		
0	R43	DO NOT POPULATE		

3.3   ISL68301EVAL3Z Board Layout
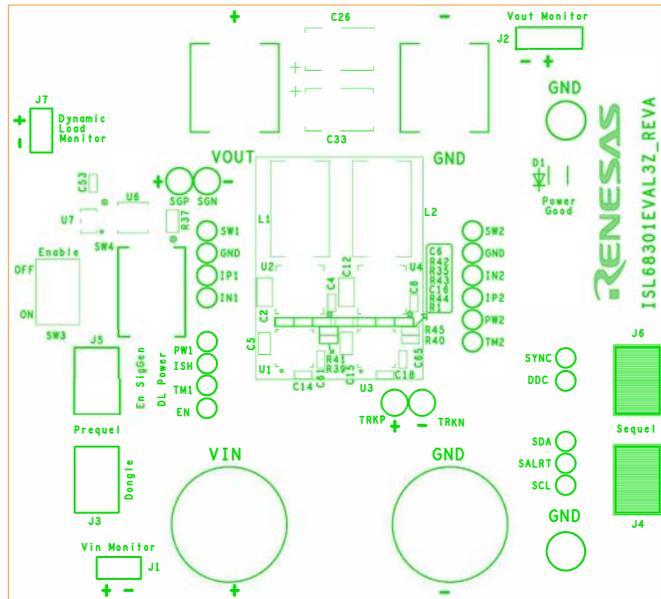
Figure 8. PCB - Top Silk Screen
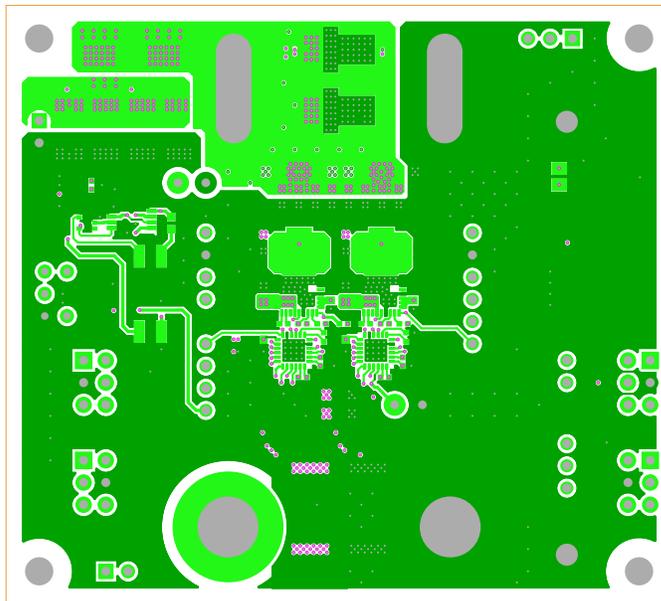
Figure 9. PCB - Top Layer
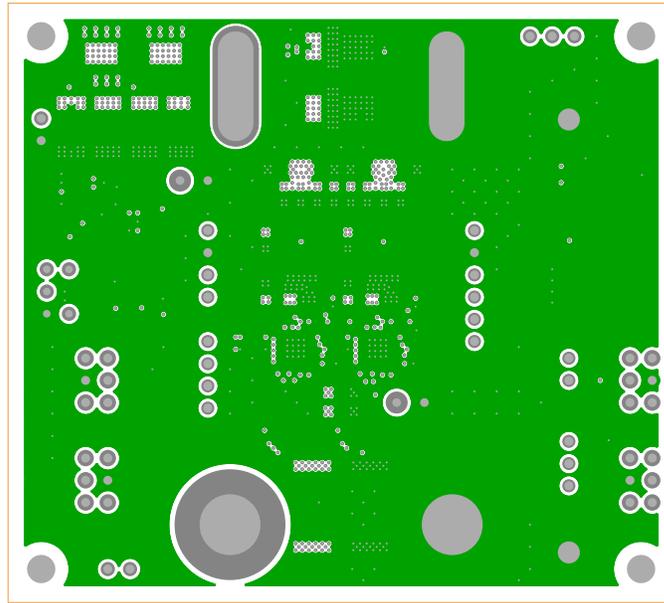
Figure 10. PCB - Inner Layer - Layer 2 (Top View)
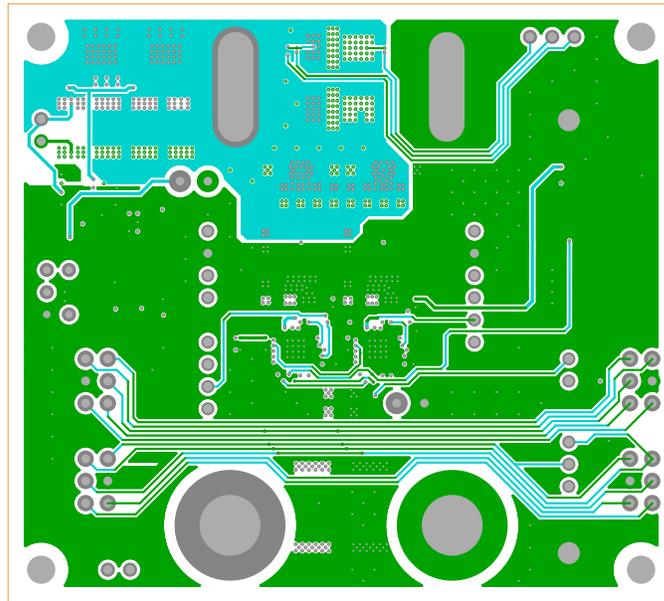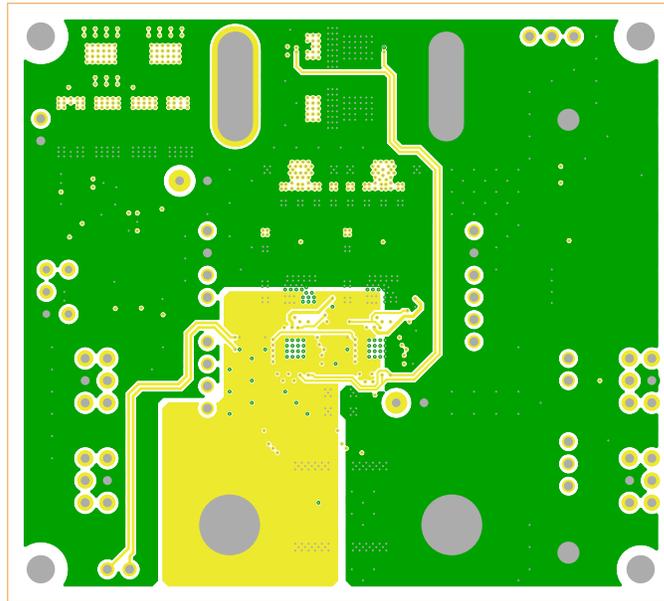

Figure 11. PCB - Inner Layer - Layer 3 (Top View)

Figure 12. PCB - Inner Layer - Layer 4 (Top View)
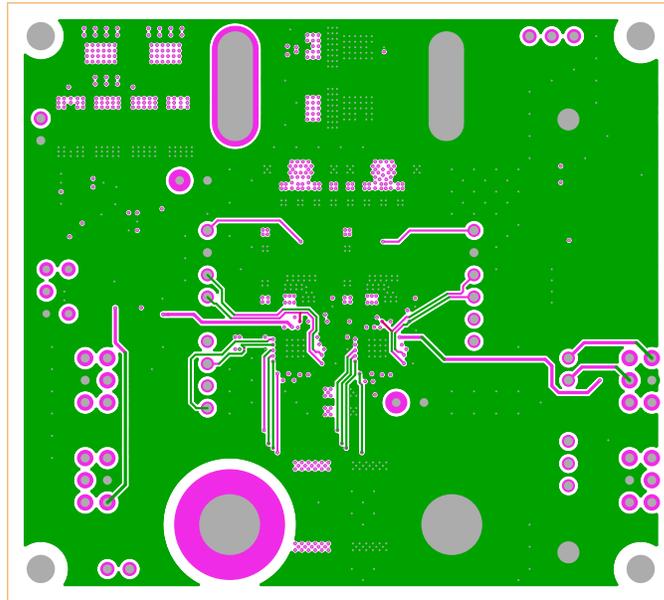
Figure 13. PCB - Inner Layer - Layer 5 (Top View)
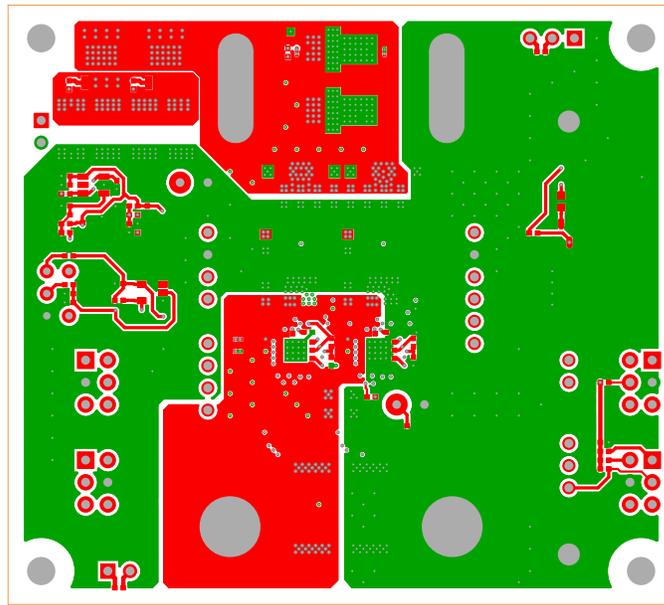
Figure 14. PCB - Bottom Layer (Top View)
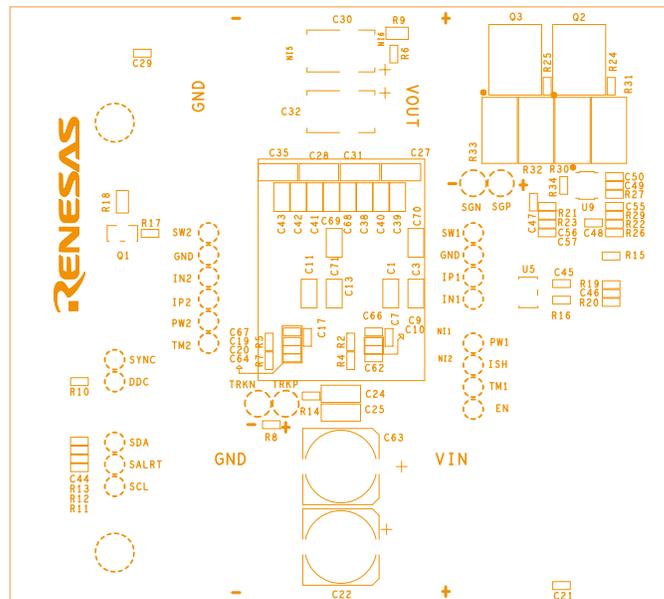
Figure 15. PCB - Bottom Silk Screen

4.   Typical Performance Curves

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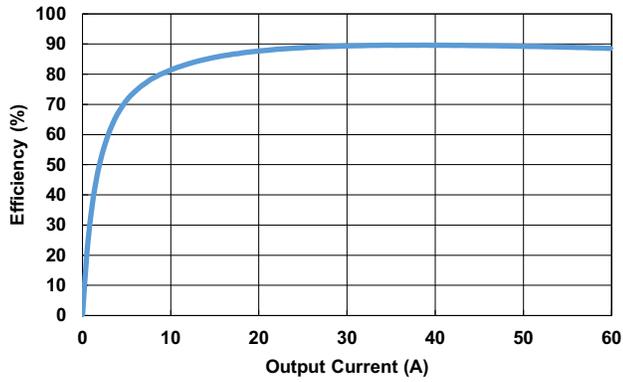
Figure 16. Efficiency
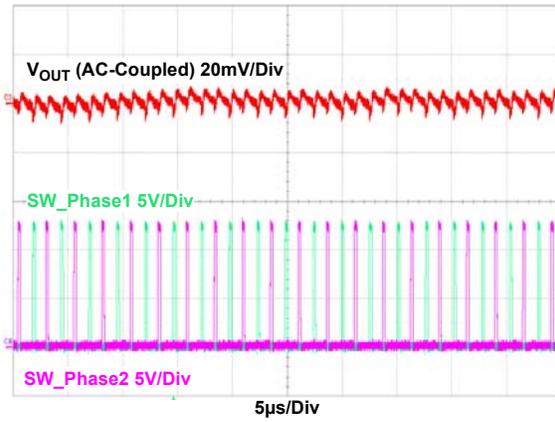
Figure 17. Output Ripple at Full Load
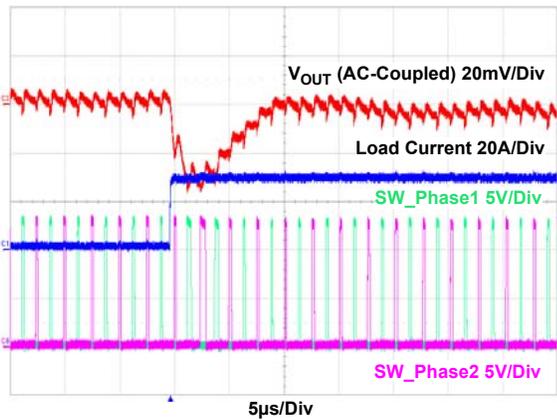
Figure 18. Load Transient Waveforms
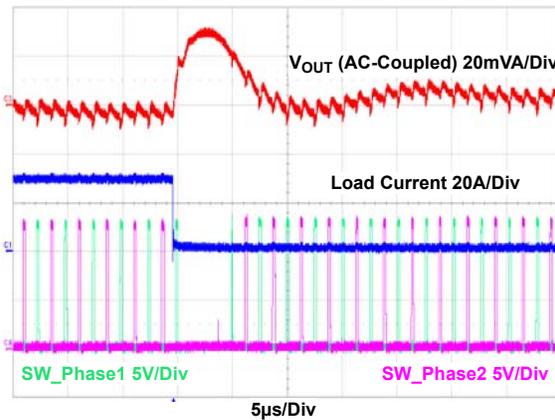
Figure 19. Load Transient Waveforms

5. Configuration Files

Sample configuration files for the ISL68301 in the ISL68301EVAL3Z. 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.

• Configuration file for the master device (Address = 0x6A)

STORE_CONTROL   0x21

STORE_CONTROL   0x11

STORE_CONTROL   0x12

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

ON_OFF_CONFIG   0x17

FREQUENCY_SWITCH   0xFB20   # 400 kHz

POWER_MODE   0x00

VOUT_OV_FAULT_RESPONSE   0x80

VOUT_UV_WARN_LIMIT   0x1B33   # 0.85 V

VOUT_UV_FAULT_LIMIT   0x199A   # 0.8 V

VOUT_UV_FAULT_RESPONSE   0x80

IOUT_OC_FAULT_LIMIT   0xE320   # 50 A

IOUT_OC_WARN_LIMIT   0xE2D0   # 45 A

OT_FAULT_RESPONSE   0x80

UT_FAULT_RESPONSE   0x80

VIN_OV_FAULT_RESPONSE   0x80

VIN_UV_FAULT_RESPONSE   0x80

ISENSE_CONFIG   0x6103

USER_CONFIG   0x1405

DDC_CONFIG   0x0B01

ASCR_ADVANCED   0x220D

INDUCTOR   0xA333   # 0.2 µH

ASCR_CONFIG   0x3B450226

DDC_GROUP   0x00202020

MFR_IOUT_OC_FAULT_RESPONSE   0x80

MFR_IOUT_UC_FAULT_RESPONSE   0x80

IOUT_AVG_OC_FAULT_LIMIT   0xE280   # 40 A

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

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

STORE_CONTROL   0x13

End User Store

RENESAS

• Configuration file for the slave device (Address = 0x6B)

STORE_CONTROL	0x21		
STORE_CONTROL	0x11		
STORE_CONTROL	0x12		

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

ON_OFF_CONFIG	0x17		
VOUT_COMMAND	0x2000	# 1 V	
VOUT_CAL_OFFSET	0x0000	# 0 V	
VOUT_MAX	0x24CD	# 1.15 V	
VOUT_MARGIN_HIGH	0x2199	# 1.05 V	
VOUT_MARGIN_LOW	0x1E66	# 0.95 V	
MAX_DUTY	0xEAD0	# 90 %	
FREQUENCY_SWITCH	0xFB20	# 400 kHz	
POWER_MODE	0x00		
INTERLEAVE	0x0008		
IOUT_CAL_OFFSET	0x0000	# 0 A	
VOUT_OV_FAULT_LIMIT	0x2333	# 1.1 V	
VOUT_OV_FAULT_RESPONSE	0x80		
VOUT_UV_FAULT_LIMIT	0x1B33	# 0.85 V	
VOUT_UV_FAULT_RESPONSE	0x80		
IOUT_OC_FAULT_LIMIT	0xE320	# 50 A	
IOUT_OC_WARN_LIMIT	0xE2D0	# 45 A	
IOUT_UC_FAULT_LIMIT	0xE57F	# -40.062 A	
OT_FAULT_LIMIT	0xEBE8	# 125 °C	
OT_FAULT_RESPONSE	0x80		
OT_WARN_LIMIT	0xEB70	# 110 °C	
UT_WARN_LIMIT	0xDC40	# -30 °C	
UT_FAULT_LIMIT	0xE530	# -45 °C	
UT_FAULT_RESPONSE	0x80		
VIN_OV_FAULT_LIMIT	0xDA00	# 16 V	
VIN_OV_FAULT_RESPONSE	0x80		
VIN_OV_WARN_LIMIT	0xD3E0	# 15.5 V	
VIN_UV_WARN_LIMIT	0xCB80	# 7 V	
VIN_UV_FAULT_LIMIT	0xCB40	# 6.5 V	
VIN_UV_FAULT_RESPONSE	0x80		
POWER_GOOD_ON	0x1CCD	# 0.9 V	
TON_RISE	0xCA80	# 5 ms	
TOFF_FALL	0xCA80	# 5 ms	

ISENSE_CONFIG   0x6103

USER_CONFIG   0x1406

DDC_CONFIG   0x2B01

POWER_GOOD_DELAY   0xBA00   # 1 ms

ASCR_ADVANCED   0x220D

INDUCTOR   0xA333   # 0.2 µH

OVUV_CONFIG   0x00   # 0 null

TEMPCO_CONFIG   0x80

ASCR_CONFIG   0x3B450226

SEQUENCE   0x0000

TRACK_CONFIG   0x00

DDC_GROUP   0x00202020

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   0xE5FF   # -32.062 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 Figure 5. Updated sample configuration files.
0.00	Jun 29, 2018	Initial release

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