ISL9440BEVAL1Z

Evaluation Board: Triple PWM Step-Down Synchronous Buck Controller and One LDO

AN1454
Rev 0.00
Sep 25, 2009

The ISL9440BEVAL1Z evaluation board features the ISL9440B. The ISL9440B is quad-output controller that integrates three PWM synchronous buck controllers and one low-dropout linear regulator controller. Then ISL9440B offers programmable soft-start, independent enable functions and integrates OV/OC/OT protection. The current mode control architecture and internal compensation network keep peripheral components to a minimum. The strong gate drivers of the ISL9440B are capable of driving 20A current for PWM1 and PWM2 and 15A for PWM3.

Table 1 shows the difference in terms of ISL944xx family features.

TABLE 1. FEATURES OF ISL944X FAMILY

PART NUMBER	EARLY WARNING	SWITCHING FREQUENCY (kHz)	SOFT-STARTING TIME (ms)
ISL9440	YES	300	1.7
ISL9440A	YES	600	1.7
ISL9441	NO	300	1.7
ISL9440B	YES	300	PROGRAMMABLE
ISL9440C	YES	600	PROGRAMMABLE

The ISL9440BEVAL1Z is easy to set up to evaluate the performance of the ISL9440B. Please refer to the "Electrical Specifications" for typical performance summary.

Electrical Specifications Recommended operation conditions, unless otherwise noted. Refer to schematic and typical performance curves.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	All outputs are in regulation	15	19	23	V
$V_{OUT}1$		4.85	5.0	5.15	V
$V_{OUT}2$		3.25	3.32	3.4	V
$V_{OUT}3$		11.64	12.0	12.36	V
$V_{OUT}4$		2.47	2.50	2.58	V
PWM1 Rated Current	V_{IN} = 19V, T_A = +25°C, No forced airflow, All three PWM outputs are fully loaded		15	18	A
PWM2 Rated Current			15	18	A
PWM3 Rated Current			12	14	A
LDO Rated Current	R7 = 0Ω, R4 is not populated		0.8	1.0	A
$V_{OUT}1$ Peak-to-Peak Ripple	V_{IN} = 23V, All three PWM outputs are fully loaded, Oscilloscope is with full bandwidth.		83		mV_{P-P}
$V_{OUT}2$ Peak-to-Peak Ripple			61		mV_{P-P}
$V_{OUT}3$ Peak-to-Peak Ripple			109		mV_{P-P}

What's Insides

The Evaluation Board Kit contains the following materials:

- The ISL9440BEVAL1Z
- The ISL9440B, ISL9440C datasheet
- This EVAL KIT document

Recommended Equipment

The following materials are recommended to perform testing:

- 0V to 24V power supply with at least 20A source current capability
- Three electronics loads capable of sinking current up to 20A
- Digital multimeters (DMMs)
- 100MHz quad-trace Oscilloscope
- Signal generator (for load transient tests)

Quick Set-up Guide

1. Ensure that the circuit is correctly connected to the supply and electronics loads prior to applying any power. Please refer to Figure 1 for proper set-up.
2. Connect Jumpers J3, J4 and J5 in the ENx positions.
3. Turn on the power supply
4. Adjust input voltage V_{IN} within the specified range and observe output voltage. The output voltage variation should be within 3%.
5. Adjust load current within the specified range and observe output voltage. The output voltage variation should be within 3%.
6. Use oscilloscope to observe output voltage ripple and Phase node ringing. For accurate measurement, refer to Figure 2 for proper test set-up.

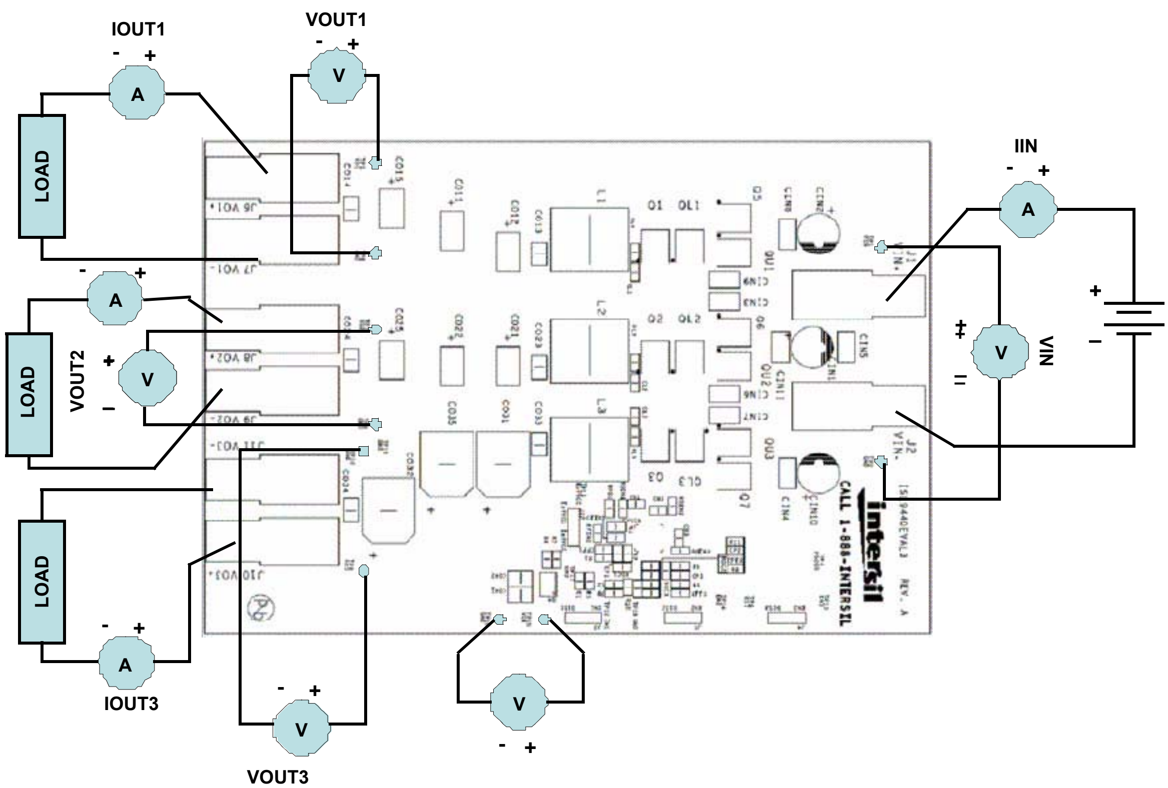

FIGURE 1. PROPER TEST SET-UP

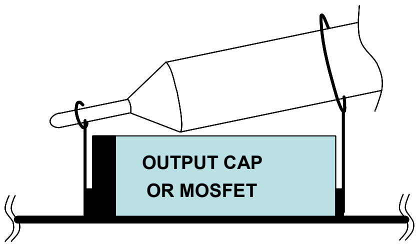

FIGURE 2. PROPER PROBE SET-UP TO MEASURE OUTPUT RIPPLE AND PHASE NODE RINGING.

Load Transient Circuit Set-up

1. Select a DPAK N channel MOSFET with VDSS breakdown > 20V.
2. Install the load transient circuit as indicated on the schematic. Refer to Figure 3 for details.
3. R12, R14, R16 are 10kΩ resistors for discharging the MOSFET gates.
4. R13, R15 and R17 are current sensing resistors to monitor the load step. For accurate measurement, please use 5% tolerance sensing resistor or better. To alleviate thermal stress, use 0.1Ω or smaller resistance. The resistance of the sensing resistors sets the current scale on the oscilloscope.
5. Apply pulse square waveform to the ISTEP_CLK1, ISTEP_CLK2 and ISTEP_CLK3. The duty cycle of the pulse waveform should be small (<5%) to limit thermal stress on current sensing resistor and the MOSFETs (Q8, Q9 and Q10
6. The amplitude of the clock sets the current step amplitude. Adjust the clock amplitude and slew rate to set the current step and slew rate.
7. Monitor overshoot and undershoot at corresponding output.

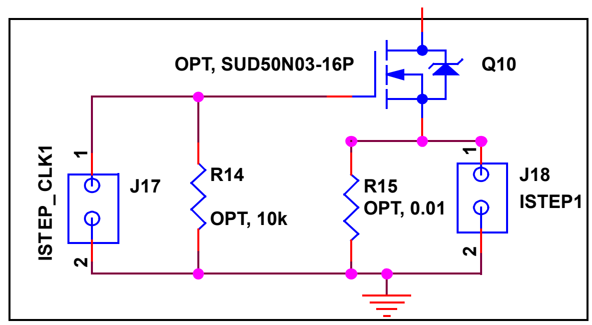

FIGURE 3. LOAD TRANSIENT CIRCUIT FOR PWM1

Typical Evaluation Board Performance Curves

V_{IN} = 9V, unless otherwise specified.

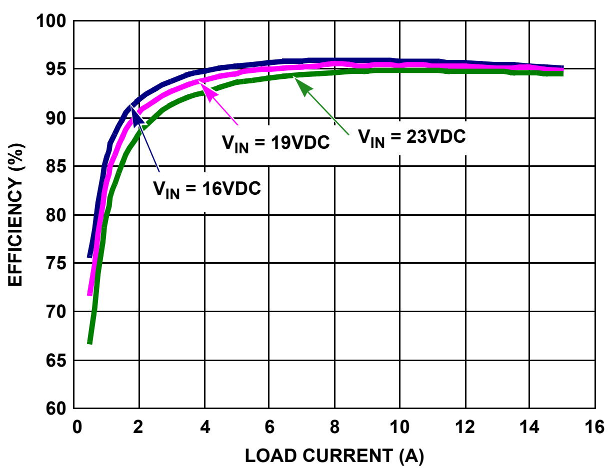

FIGURE 4. PWM1 EFFICIENCY vs LOAD (V_O = 5.0V)

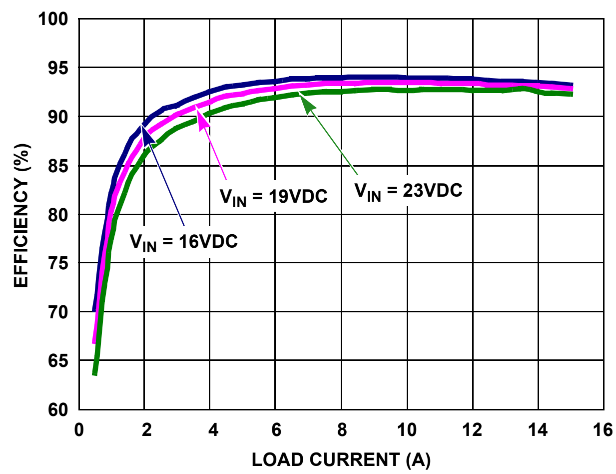

FIGURE 5. PWM2 EFFICIENCY vs LOAD (V_O = 3.3V)

Typical Evaluation Board Performance Curves

V_{IN} = 9V, unless otherwise specified. **(Continued)**

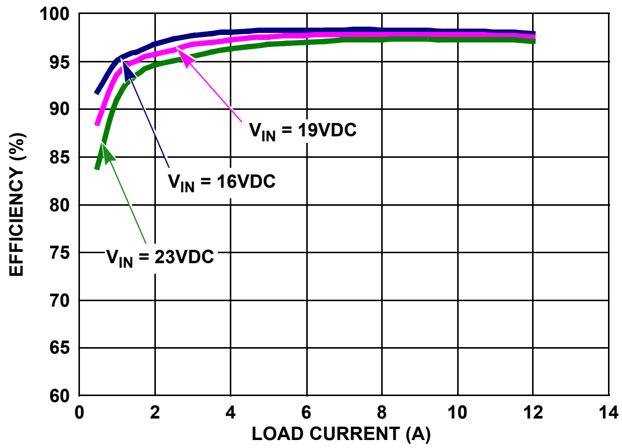

FIGURE 6. PWM3 EFFICIENCY vs LOAD (V_O = 12V)

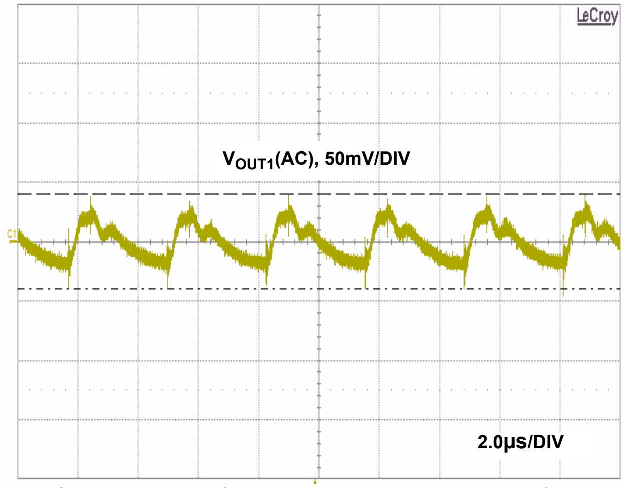

FIGURE 7. PWM1 OUTPUT RIPPLE UNDER MAX LOAD (V_{IN} = 23V, I_{O1} = I_{O2} = 15A, I_{O3} = 12A, FULL BANDWIDTH

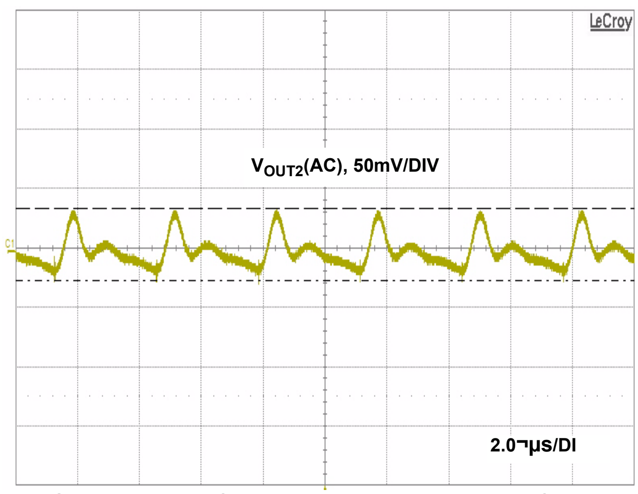

FIGURE 8. PWM2 OUTPUT RIPPLE UNDER MAX LOAD (V_{IN} = 23V, I_{O1} = I_{O2} = 15A, I_{O3} = 12A, FULL BANDWIDTH

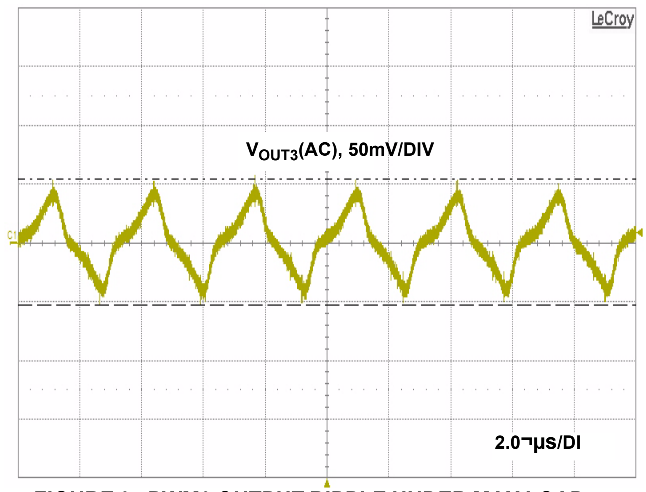

FIGURE 9. PWM3 OUTPUT RIPPLE UNDER MAX LOAD (V_{IN} = 23V, I_{O1} = I_{O2} = 15A, I_{O3} = 12A, FULL BANDWIDTH

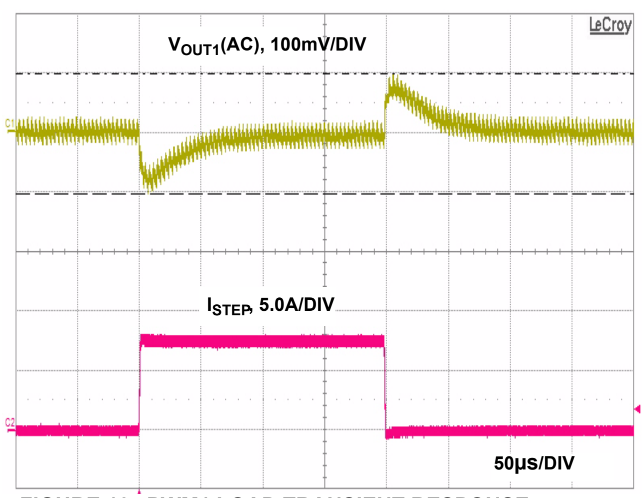

FIGURE 10. PWM1 LOAD TRANSIENT RESPONSE (LOAD STEP FROM 3.75A TO 11.25A

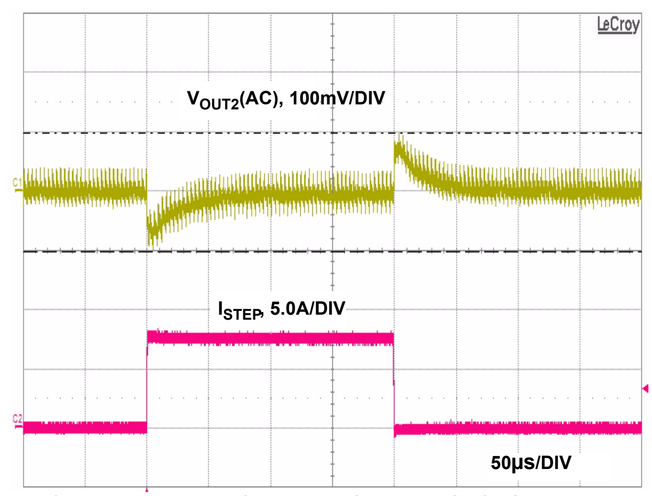

FIGURE 11. PWM2 LOAD TRANSIENT RESPONSE (LOAD STEP FROM 3.75A TO 11.25A

Typical Evaluation Board Performance Curves V_{IN} = 9V, unless otherwise specified. **(Continued)**

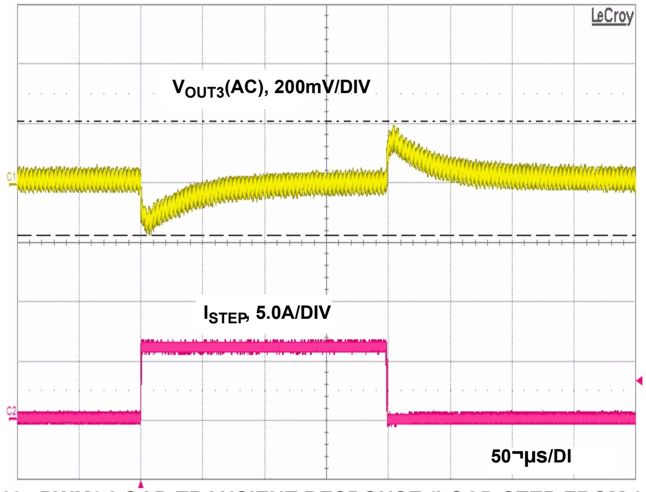

FIGURE 12. PWM3 LOAD TRANSIENT RESPONSE (LOAD STEP FROM 3A TO 9A)

Schematic

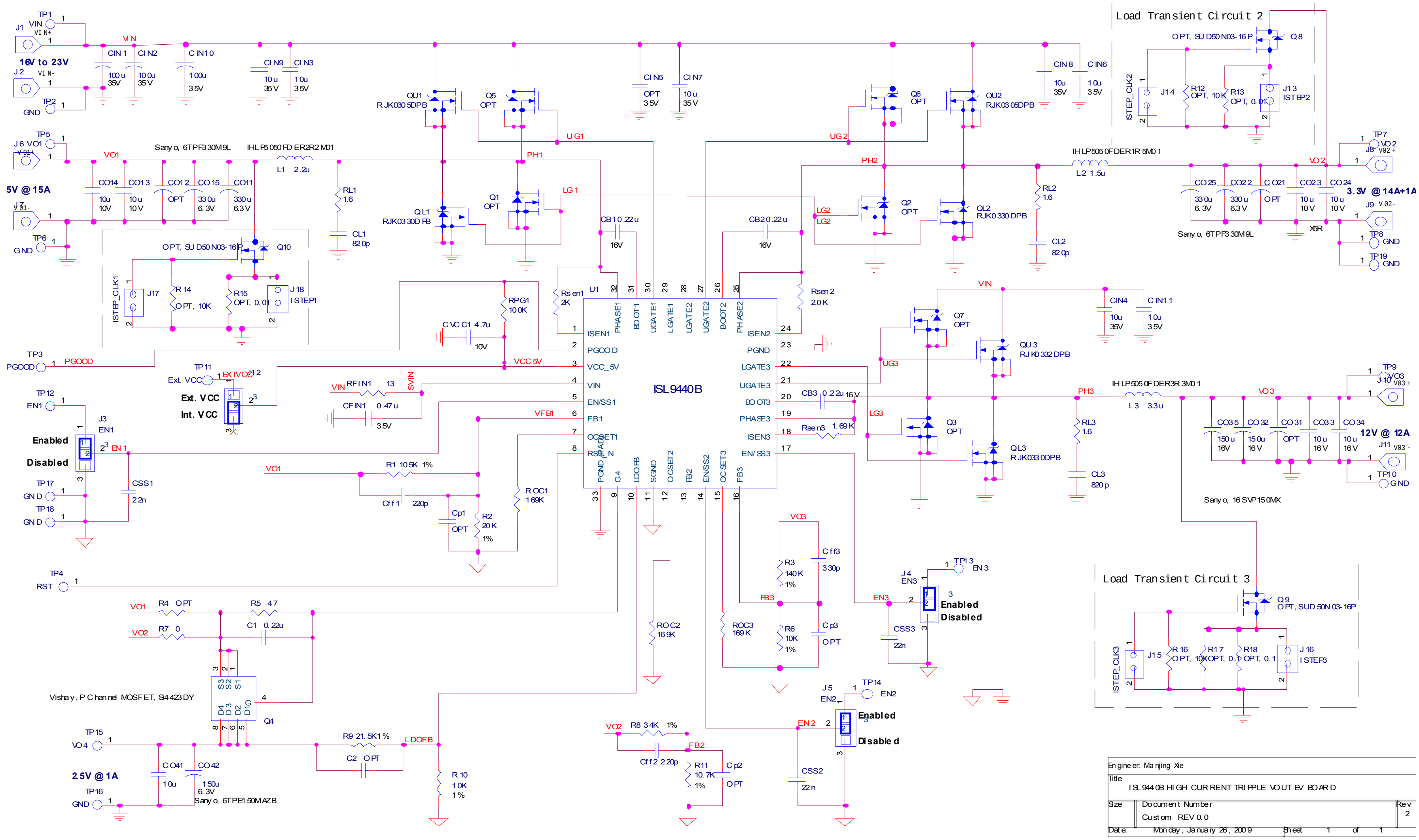
ISL9440B
16V to 23V
5V @ 15A
3.3V @ 14A+1A
12V @ 12A
2.5V @ 1A
Load Transient Circuit 2
Load Transient Circuit 3
Ext. VCC
Int. VCC
Enabled
Disabled
Vishay, P Channel MOSFET, SI4423DY
Engineer: Manjing Xie
Title
ISL9440B HIGH CURRENT TRIPPLE VOUT EV BOARD
Size Custom
Document Number REV 0.0
Rev 2
Date: Monday, January 26, 2009
Sheet 1 of 1

TABLE 2. BILL OF MATERIALS

ITEM	QTY	PART REFERENCE	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
1	1	C1	0.22µF			
2	3	CB1, CB2, CB3	0.22µFF	CERAMIC CAPS, X5R, 16V		AVX, TDK, Murata
3	1	CFIN1	0.47µF	CERAMIC CAPS, X5R, 35V		AVX, TDK, Murata
4	3	CIN1, CIN2, CIN11	150µF	ALUM. ELEC. CAPS, 35V		Panasonic
5	6	CIN3, CIN4, CIN6, CIN7, CIN8, CIN9	10µF	CERAMIC CAPS, X5R, 35V		AVX, TDK, Murata
6	2	CO11, CO12, CO21, CO22	330µF	POSCAP, 6.3V, ESR 9m	6TPF330M9L	Sanyo
7	5	CO13, CO14, CO23, CO24, CO41	10µF	CERAMIC CAPS, 0805, X5R, 6.3V		AVX, TDK, Murata
8	2	CO31, CO32	150µF	SANYO, OSCON, 16V		Sanyo
9	2	CO33, CO34	10µF	CERAMIC CAPS, X5R, 25V		AVX, TDK, Murata
10	1	CO42	150µF	POSCAP, 6.3V	4TPE100MZB	Sanyo
11	1	CVCC1	4.7µF	CERAMIC CAPS, X5R, 16V		AVX, TDK, Murata
12	2	CFF1, CFF2	220pF	CERAMIC CAPS, NP0, 50V		Generic
13	1	CFF3	330pF	CERAMIC CAPS, NP0, 50V		Generic
14	3	CSS1, CSS2, CSS3	22nF	CERAMIC CAPS, NP0, 50V		Generic
15	1	L1	2.2µH	POWER INDUCTOR	IHLP5050FDER2R2M01	Vishay
16	1	L2	1.5µH	POWER INDUCTOR	IHLP5050FDER1R5M01	Vishay
17	1	L3	3.3µH	POWER INDUCTOR	IHLP5050FDER3R3M01	Vishay
18	3	QL1, QL2, QL3		N MOSFET, 30V	RJK0330DPB	Renesas
19	2	QU1, QU2		N MOSFET, 30V	RJK0305DPB	Renesas
20	1	QU3		N MOSFET, 30V	RJK0332DPB	Renesas
21	1	Q4		P MOSFET, 20V	Si4423DY	Vishay
22	1	R1	105kΩ	RESISTOR, 0603, 1/16W		Generic
23	1	R2	20kΩ	RESISTOR, 0603, 1/16W		Generic
24	2	R6, R10	10kΩ	RESISTOR, 0603, 1/16W		Generic
25	1	R3	140kΩ	RESISTOR, 0603, 1/16W		Generic
26	1	R5	47Ω	RESISTOR, 0603, 1/16W		Generic
27	1	R8	34kΩ	RESISTOR, 0603, 1/16W		Generic
28	1	R9	21.5kΩ	RESISTOR, 0603, 1/16W		Generic
29	1	R11	10.7kΩ	RESISTOR, 0603, 1/16W		Generic
30	1	RFIN1	4.7Ω	RESISTOR, 0603, 1/16W		Generic
31	3	ROC1, ROC2, ROC3	169kΩ	RESISTOR, 0603, 1/16W		Generic
32	1	RPG1	100kΩ	RESISTOR, 0603, 1/16W		Generic
33	2	RSEN1, RSEN2	2.0kΩ	RESISTOR, 0603, 1/16W		Generic
34	1	RSEN3	1.69kΩ	RESISTOR, 0603, 1/16W		Generic
35	1	U1		QUAD OUTPUT CONTROLLER	ISL9440B	Intersil
OPTIONAL COMPONENTS OR RESISTOR JUMPERS						
1	1	C2	OPT			Generic
2	3	CL1, CL2, CL3	820pF	CERAMIC CAPS, 0805		Generic
3	0	CIN11,CIN5	OPT			Generic
4	0	CO15, CO25, CO35	OPT			Generic

TABLE 2. BILL OF MATERIALS (Continued)

ITEM	QTY	PART REFERENCE	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
5	0	CP1, CP2, CP3	OPT			Generic
6	0	Q1, Q2, Q3, Q5, Q6, Q7	OPT	N MOSFET, 30V		
7	3	RL1, RL2, RL3	1.6Ω	RESISTOR, 0805, 1/8W		Generic
8	0	R4	OPT			Generic
9	1	R7	0	Resistor jumper		Generic
EVALUATION BOARD HARDWARE						
1	8	J1, J2, J6, J7, J8, J9, J10, J11		Big Lug		
2	1	J3, J4,J5, J12		3 HEAD JUMPER		
3	15	TP1 ~ TP15		TEST POINT		
4	4			STAND OFF		

ISL9440BEVAL1Z PCB Layout

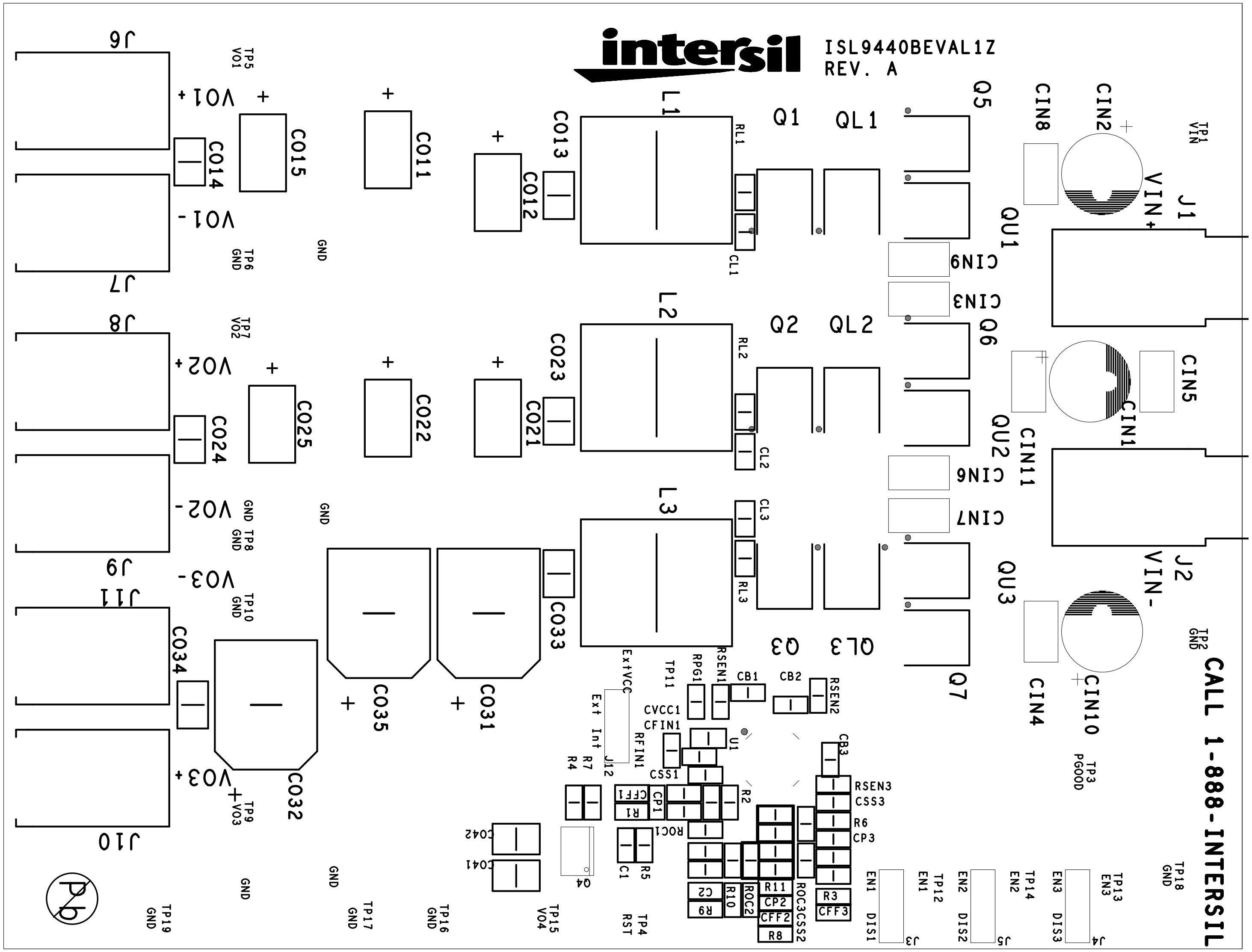

FIGURE 13. TOP COMPONENTS

ISL9440BEVAL1Z PCB Layout (Continued)

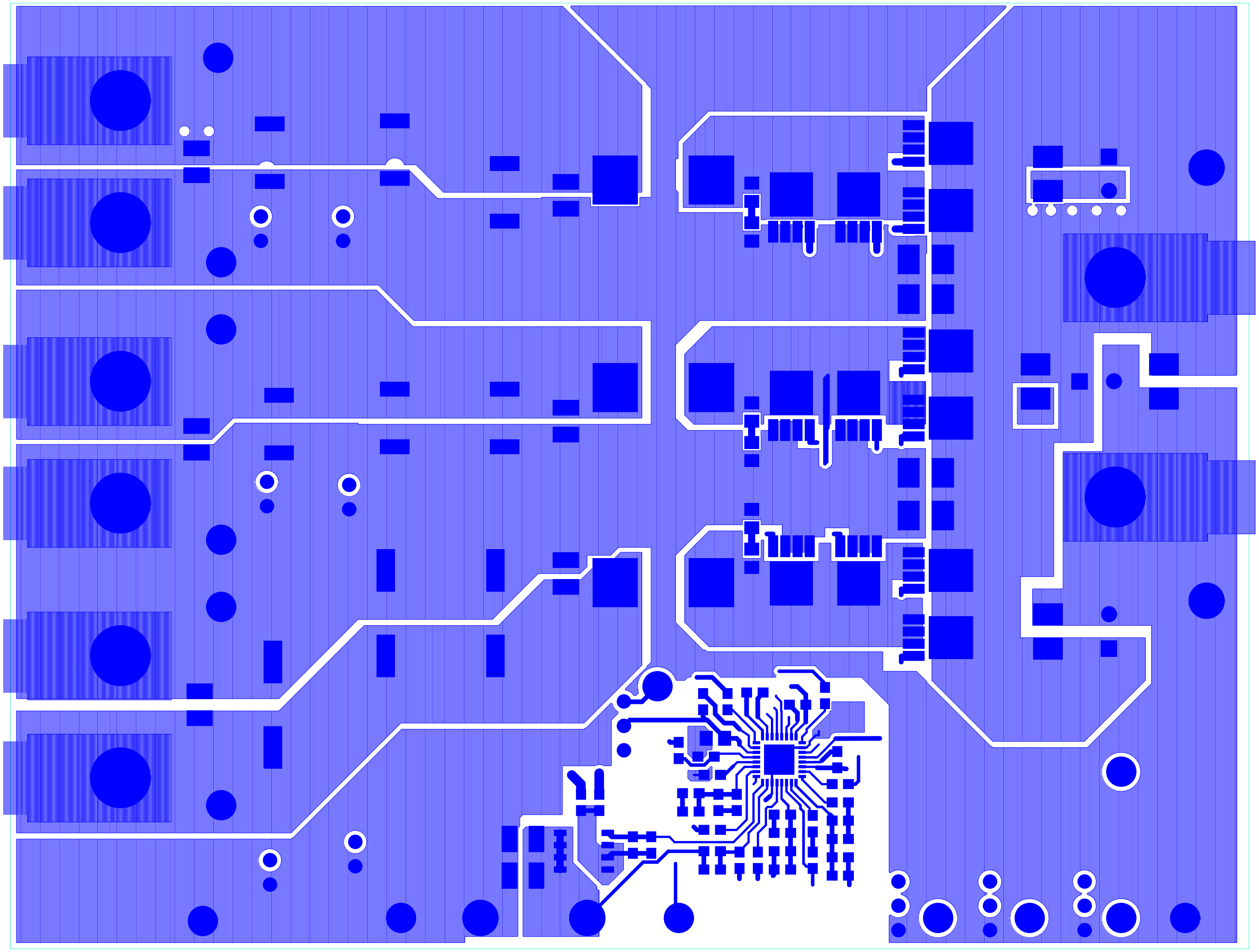

FIGURE 14. TOP LAYER ETCH

ISL9440BEVAL1Z PCB Layout (Continued)

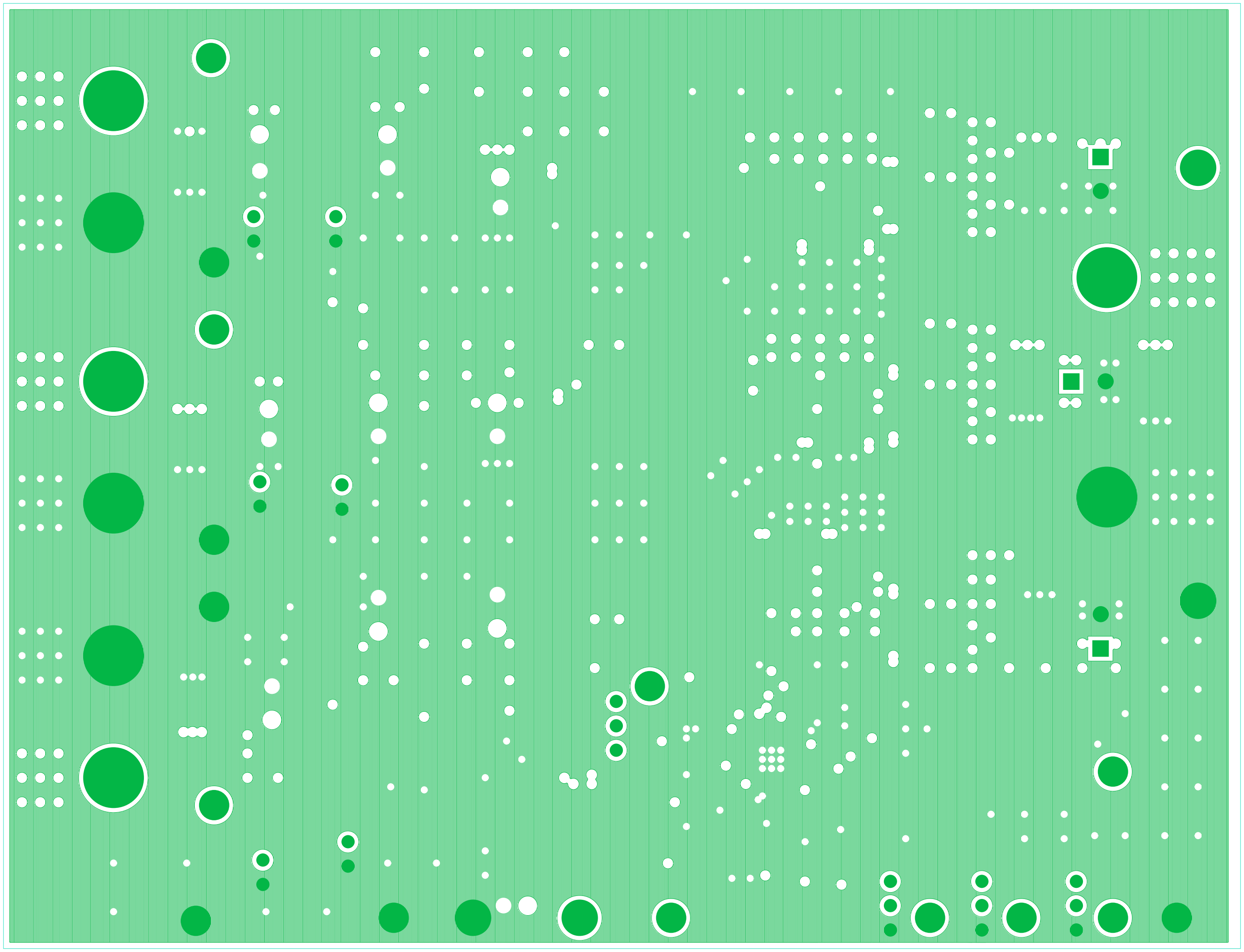

FIGURE 15. SECOND LAYER ETCH

ISL9440BEVAL1Z PCB Layout (Continued)

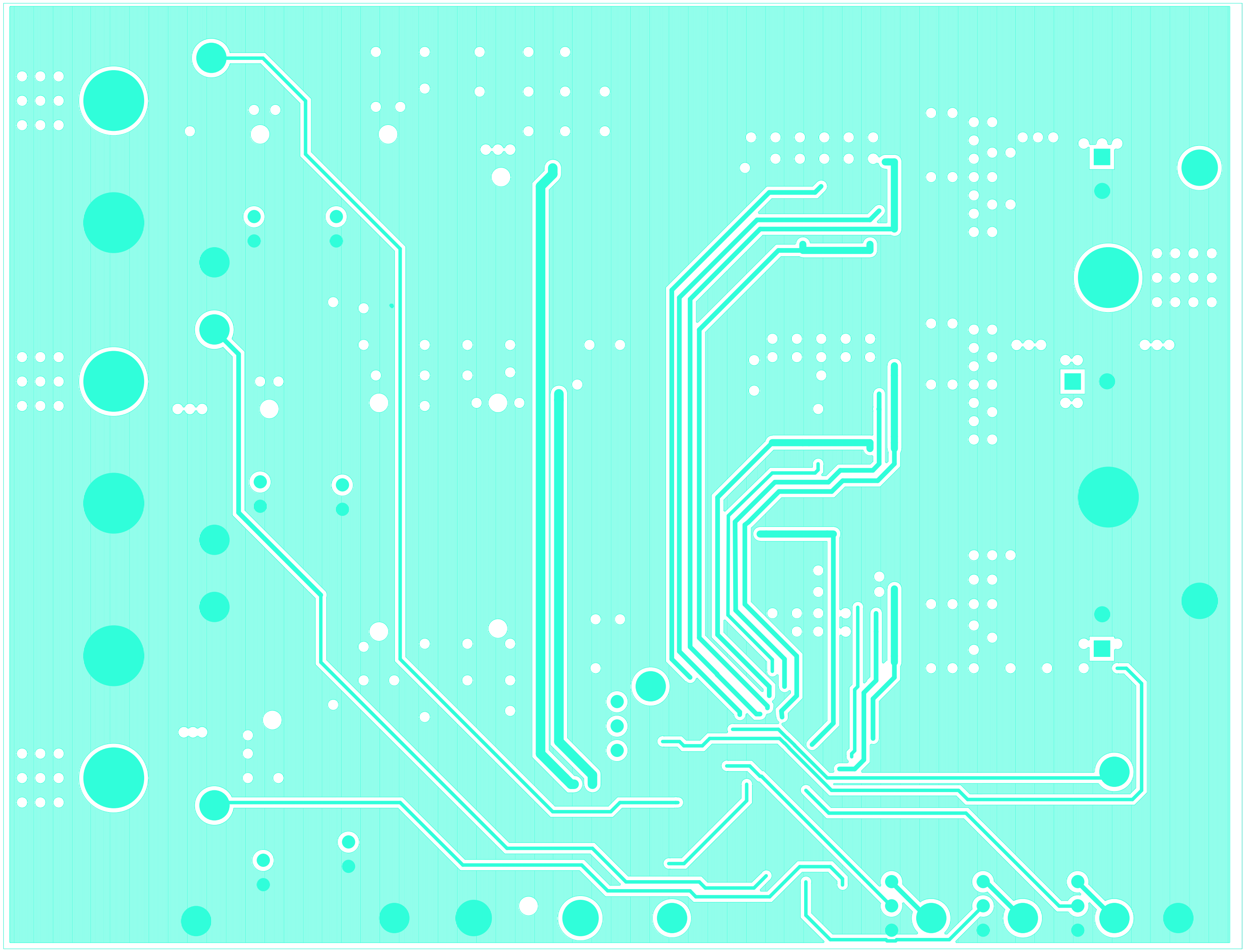

FIGURE 16. THIRD LAYER ETCH

ISL9440BEVAL1Z PCB Layout (Continued)

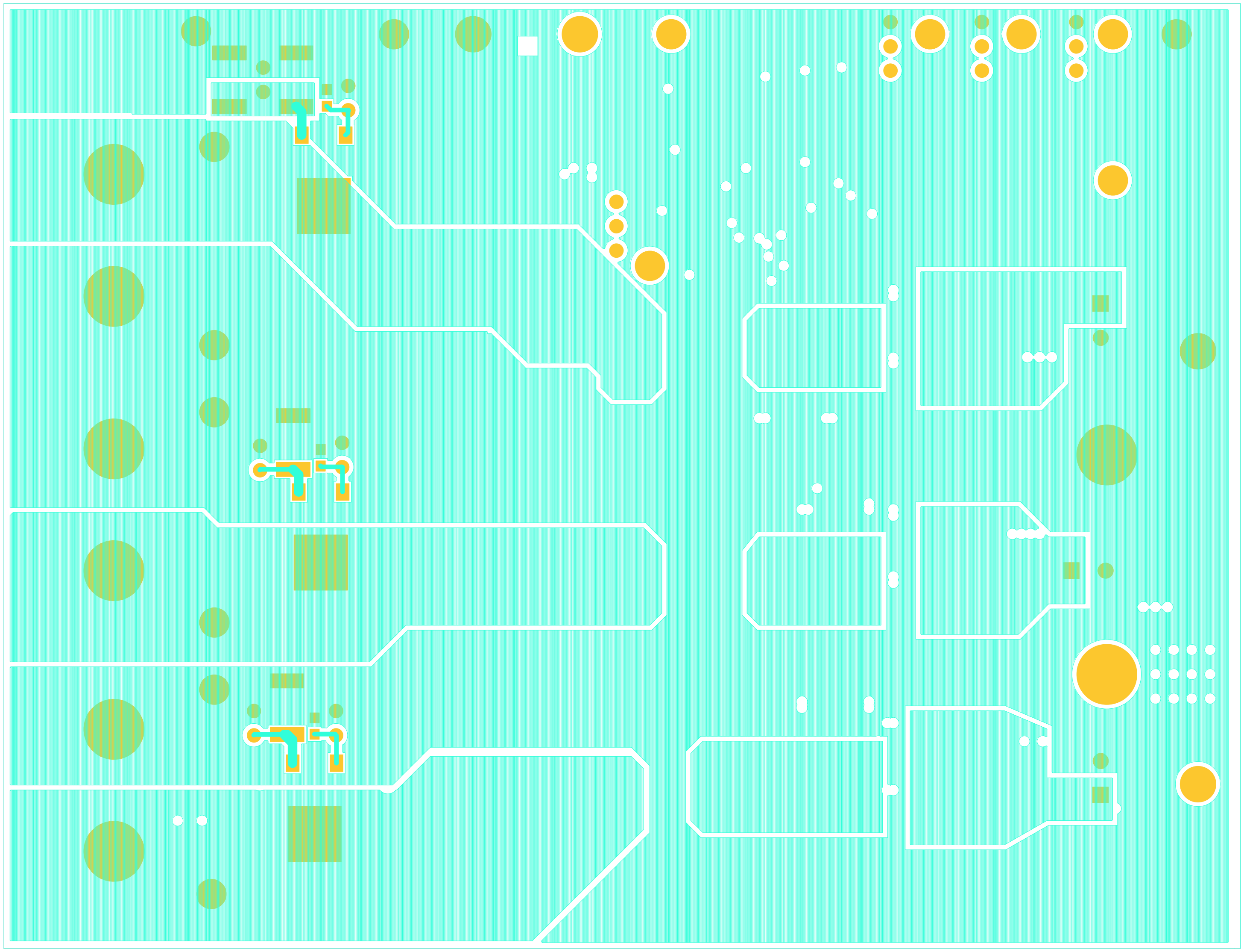

FIGURE 17. BOTTOM LAYER ETCH (MIRRORED)

ISL9440BEVAL1Z PCB Layout (Continued)

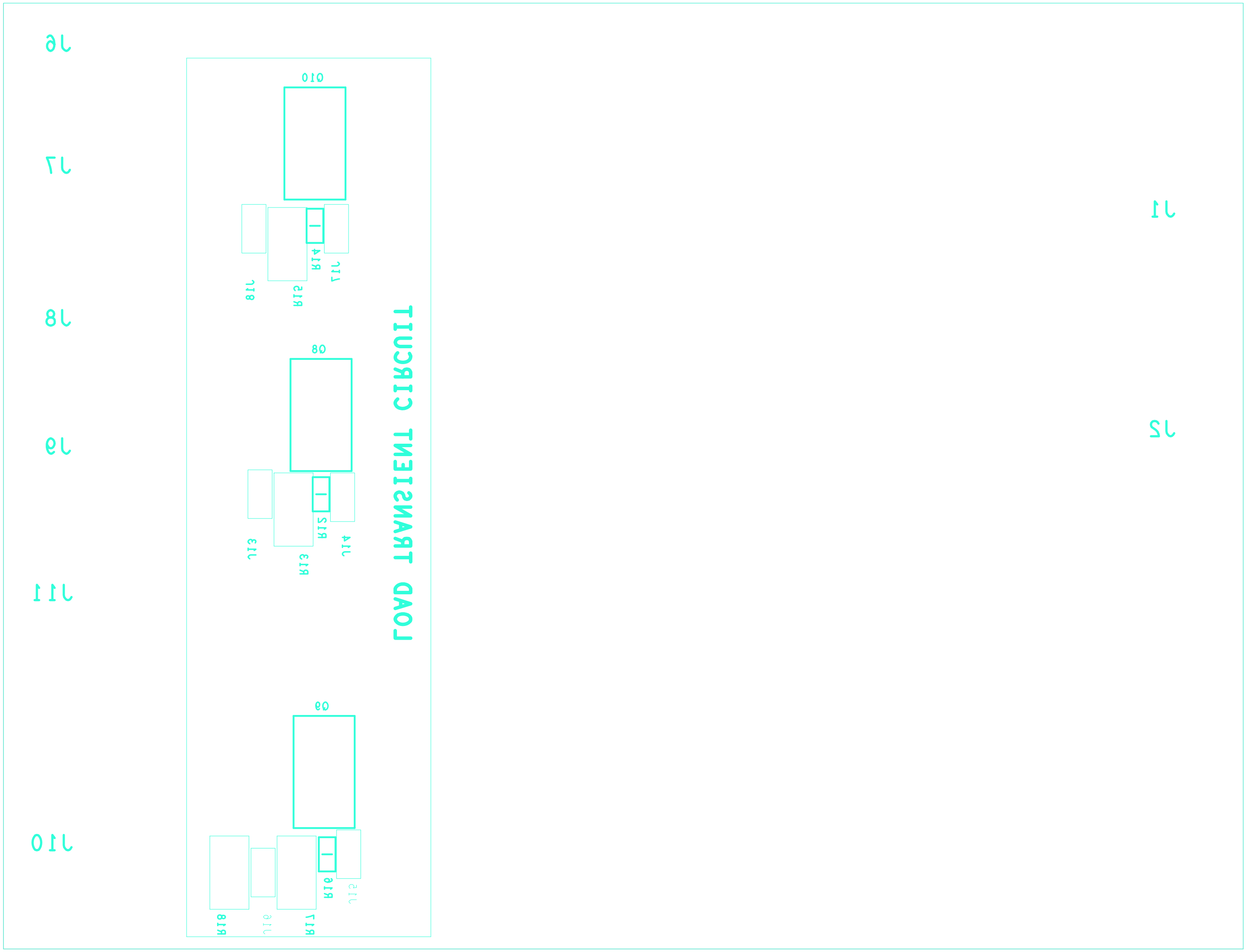

FIGURE 18. BOTTOM COMPONENTS (MIRRORED)

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338

Colophon 7.0