

Restrictions:

IDT shall not be liable for any damages arising out of defects resulting from (i) delivered hardware (ii) non-observance of instructions contained in this manual, or (iii) misuse, abuse, use under abnormal conditions, or alteration by anyone other than IDT. To the extent permitted by law, IDT hereby expressly disclaims and User expressly waives any and all warranties, whether express, implied, or statutory, including, without limitation, implied warranties of merchantability and of fitness for a particular purpose, statutory warranty of non-infringement, and any other warranty that may arise by reason of usage of trade, custom, or course of dealing.

Contents

1	Kit Contents	2
2	Introduction	2
3	ZSPM4023/ZSPM4022 Evaluation Kit Board	3
4	Setup	4
4.1.	Board Connections	4
4.2.	Test Points	5
5	Board Options	5
5.1.	Custom Output Voltage Selection	5
6	Evaluation Board Schematic and Layout	6
6.1.	Evaluation Board Layout	7
6.2.	ZSPM4023/ZSPM4022 Evaluation Board Bill of Materials	9
7	Ordering Information	11
8	Related Documents	11
9	Document Revision History	12

List of Figures

Figure 3.1	Overview of the Evaluation Kit Board – Example using the ZSPM4023-12	3
Figure 6.1	Schematic for the Evaluation Board Revision 3.0	6

List of Tables

Table 2.1	Kit Variations	2
Table 4.1	Evaluation Board Connectors	4
Table 4.2	VOUT J3 Jumper Selection	4
Table 4.3	Evaluation Board Test Points	5
Table 6.1	Evaluation Board Bill of Materials	9

1 Kit Contents

- ZSPM4023/ZSPM4022 Evaluation Board
- Kit User Guide

2 Introduction

The ZSPM4023-KIT/ZSPM4022-KIT Evaluation Kit is a complete, self-contained system for measuring the performance and operating characteristics of the ZSPM4023/ZSPM4022 family of synchronous DC/DC buck regulator ICs; i.e., the device under test (DUT). The board contains various jumpers and test points to facilitate evaluation of all basic functions of the DUT. For each product family, the kit is available in three versions that are adapted for the three output current variations of the product: 6, 9, and 12 amps. The Evaluation Board and the components on it are the same for all versions, except for the DUT. This manual uses the ZSPM4023-12 version for examples, but the content applies to all six products, except as noted.

The kit can be factory-configured with either the ZSPM4023 DC-DC regulator, which operates at a V_{IN} of 4.5V to 28V, or with the ZSPM4022 DC-DC regulator, which operates at a V_{IN} of 4.5V to 19V.

Note: Upon receipt of the kit, verify that the markings on the product identification label on the Evaluation Board (see Figure 3.1) match the product with the correct current and input supply range requirements for the user's application.

Table 2.1 Kit Variations

Kit	Product (DUT)	Input Supply Range to be Regulated	Regulated Output Current	Output Voltage Adjustment Range (Typical Accuracy $\pm 1\%$)
ZSPM4023-12-KIT	ZSPM4023-12	4.5V to 28V	12A	0.8V to 5.5V
ZSPM4023-09-KIT	ZSPM4023-09	4.5V to 28V	9A	0.8V to 5.5V
ZSPM4023-06-KIT	ZSPM4023-06	4.5V to 28V	6A	0.8V to 5.5V
ZSPM4022-12-KIT	ZSPM4022-12	4.5V to 19V	12A	0.8V to 5.5V
ZSPM4022-09-KIT	ZSPM4022-09	4.5V to 19V	9A	0.8V to 5.5V
ZSPM4022-06-KIT	ZSPM4022-06	4.5V to 19V	6A	0.8V to 5.5V

All product variations operate at a switching frequency of 600 KHz. The switching frequency remains fairly constant regardless of changes in input voltage and output load.

The rapid-control architecture of the ZSPM4023 and ZSPM4022 allows a quick transient response while reducing the output capacitance and making a high input/output voltage ratio possible. Both products also utilize an adaptive t_{ON} ripple control architecture. An undervoltage lockout feature is provided to ensure proper operation under power-sag conditions. An internal soft-start feature reduces the inrush current. A foldback current limit and "hiccup" mode short-circuit protection, as well as thermal shutdown, ensure protection of the DUT during fault conditions.

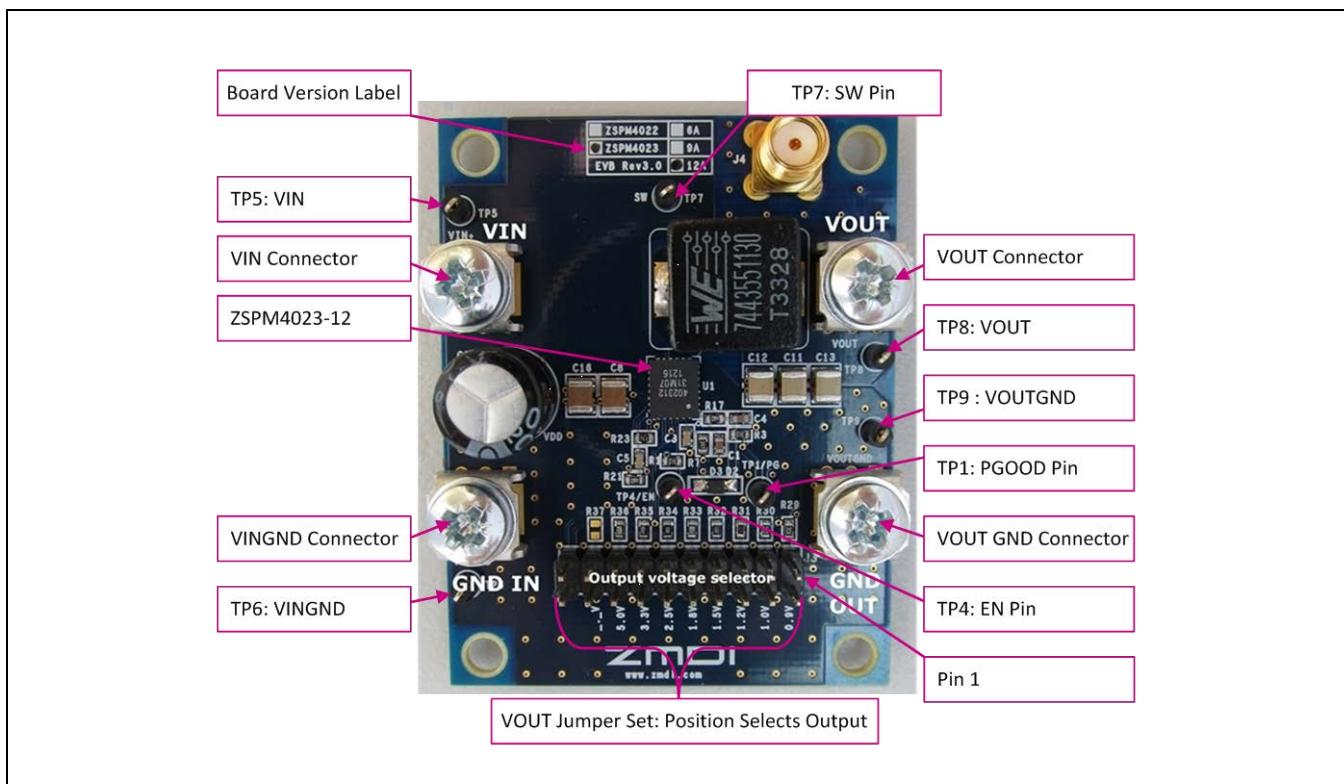
3 ZSPM4023/ZSPM4022 Evaluation Kit Board

The ZSPM4023/ZSPM4022 Evaluation Kit Board is based on a typical application for the DUT. The user's output load connected to the Evaluation Board output can be either active or passive.

The Evaluation Board circuit hardwires the EN pin of the DUT as pulled high via the PVIN pin, which enables the DUT on power-up.

Important: The Evaluation Board does not have reverse polarity protection. Applying a negative voltage to the VIN terminal could damage the device. Ensure that the specifications given in Table 2.1 and Table 4.1 are not exceeded.

Figure 3.1 Overview of the Evaluation Kit Board – Example using the ZSPM4023-12



4 Setup

Setup of the ZSPM4023/ZSPM4022 Evaluation Kit is relatively straightforward. In addition to the Evaluation Board, a power supply with suitable cables for connecting to the Evaluation Board is required.

4.1. Board Connections

Refer to Figure 3.1 for the locations of the Evaluation Board connectors. Table 4.1 gives details for the connections for external signals and supplies.

Table 4.1 Evaluation Board Connectors

Connector Label	Description
VIN	The input supply voltage for the board. Note the polarity of the connection. Positive (+) connects to VIN. Important: the board will be damaged if the input supply voltage exceeds +29V. Ensure that the input supply voltage is within the specifications given in Table 2.1.
VINGND	The input supply voltage ground for the board. Note the polarity of the connection. Negative (-) connects to VINGND.
VOUT	The regulated output supply voltage for the board. Note the polarity of the connection. Positive (+) connects to VOUT.
VOUTGND	The output supply voltage ground for the board. Note the polarity of the connection. Negative (-) connects to VOUTGND.
J3	Jumper header for VOUT selection. Refer to Table 4.2 for voltage selection positions for the jumper shunt.

The output voltage is selected by the J3 jumper header as detailed in Table 4.2.

Table 4.2 VOUT J3 Jumper Selection

Output Voltage Selection	Place J3 Jumper Across Pin Numbers
0.9V	1 – 2
1.0V	3 – 4
1.2V	5 – 6
1.5V	7 – 8
1.8V	9 – 10
2.5V	11 – 12
3.3V	13 – 14
5.0V	15 – 16

The J3 jumper position across pins 17-18 is not populated. See section 5.1 for options related to this position. The J3 jumper position across pins 19-20 is not supported.

4.2. Test Points

The board provides the test points described in Table 4.3.

Table 4.3 Evaluation Board Test Points

Test Point	Description
TP1	PGOOD pin: Power Good indicator from the regulator.
TP4	EN pin of the regulator: connection to the EN (enable) pin on the ZSPM4023/ZSPM4022. The EN pin on the Evaluation Board is pulled high to the PVIN pin (VIN supply voltage) by a 10kΩ resistor so that the ZSPM4023/ZSPM4022 is always enabled on power-on.
TP5	VIN voltage: test point for the input voltage for the ZSPM4023/ZSPM4022.
TP6	VINGND: test point for the ground of the input voltage for the ZSPM4023/ZSPM4022.
TP7	SW pin: test point for the SW pin, which can be used to evaluate the switching node of the regulator. SW is the internal connection for the high-side MOSFET source and low-side MOSFET drain. TP7 is located before the inductor L1.
TP8	VOUT: test point for the output voltage of the ZSPM4023/ZSPM4022. TP8 is located after the inductor L1.
TP9	VOUTGND: test point for the ground of the output voltage for the ZSPM4023/ZSPM4022.

5 Board Options

5.1. Custom Output Voltage Selection

If the user wishes to drive to a custom V_{OUT} voltage, resistor position R37 can be populated with an appropriate value to set the output voltage. If the jumper is positioned across pins 17-18 of J3, resistor R37 is used as shown in the schematic in Figure 6.1. The output voltage V_{OUT} is determined by the following equation:

$$V_{OUT} = V_{FB} * \left(1 + \left(\frac{R28}{R37} \right) \right)$$

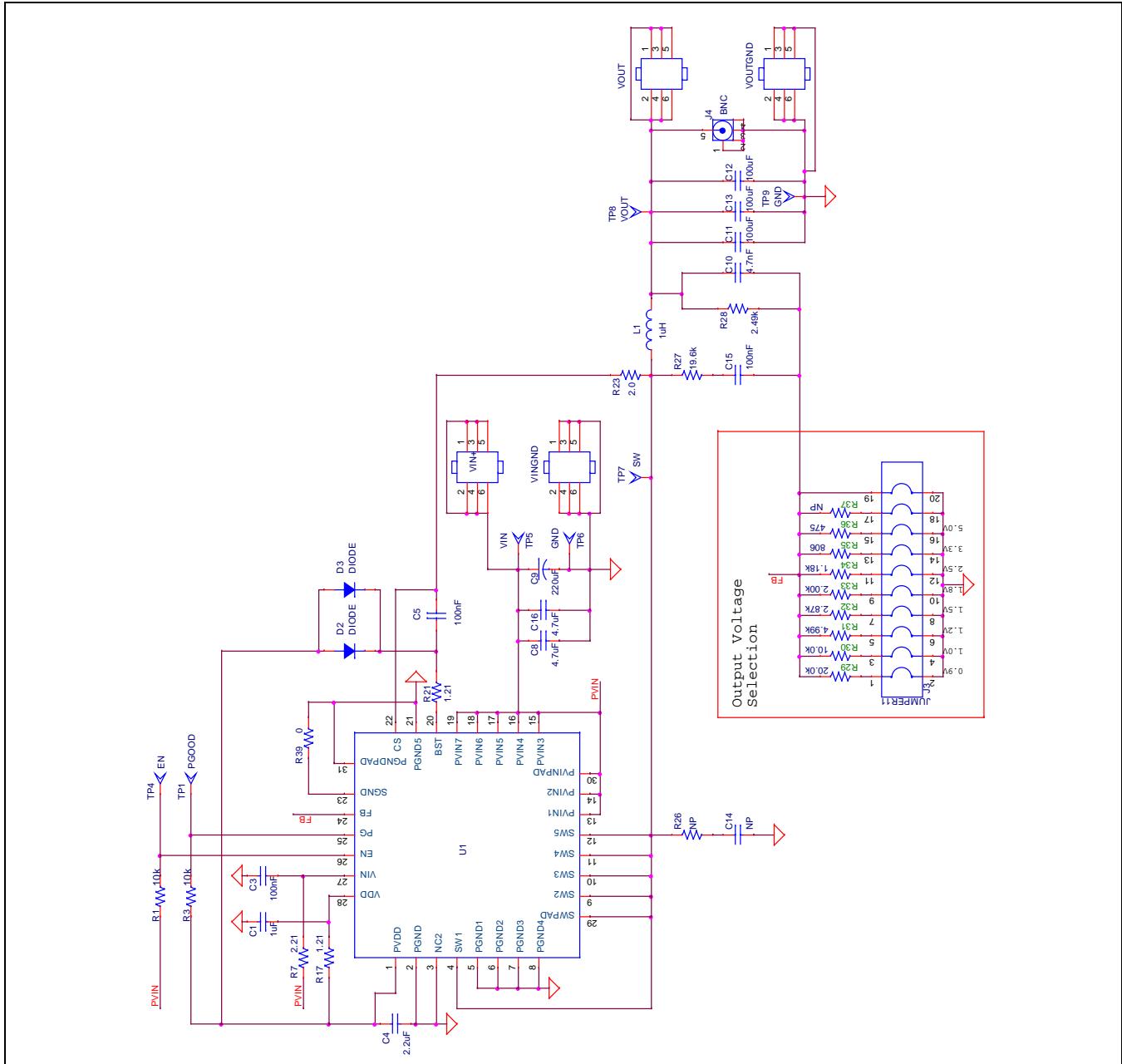
Where $V_{FB} = 0.8V$. For the Evaluation Board, R28 is a 2.49kΩ resistor as shown in the schematic in Figure 6.1. The J3 jumper position across pins 19-20 is not supported in the Evaluation Board.

Note: V_{OUT} should be limited to 5.5V as explained in section 3.1.5 of the *ZSPM4023 Datasheet* and *ZSPM4022 Datasheet*, which provide additional recommendations.

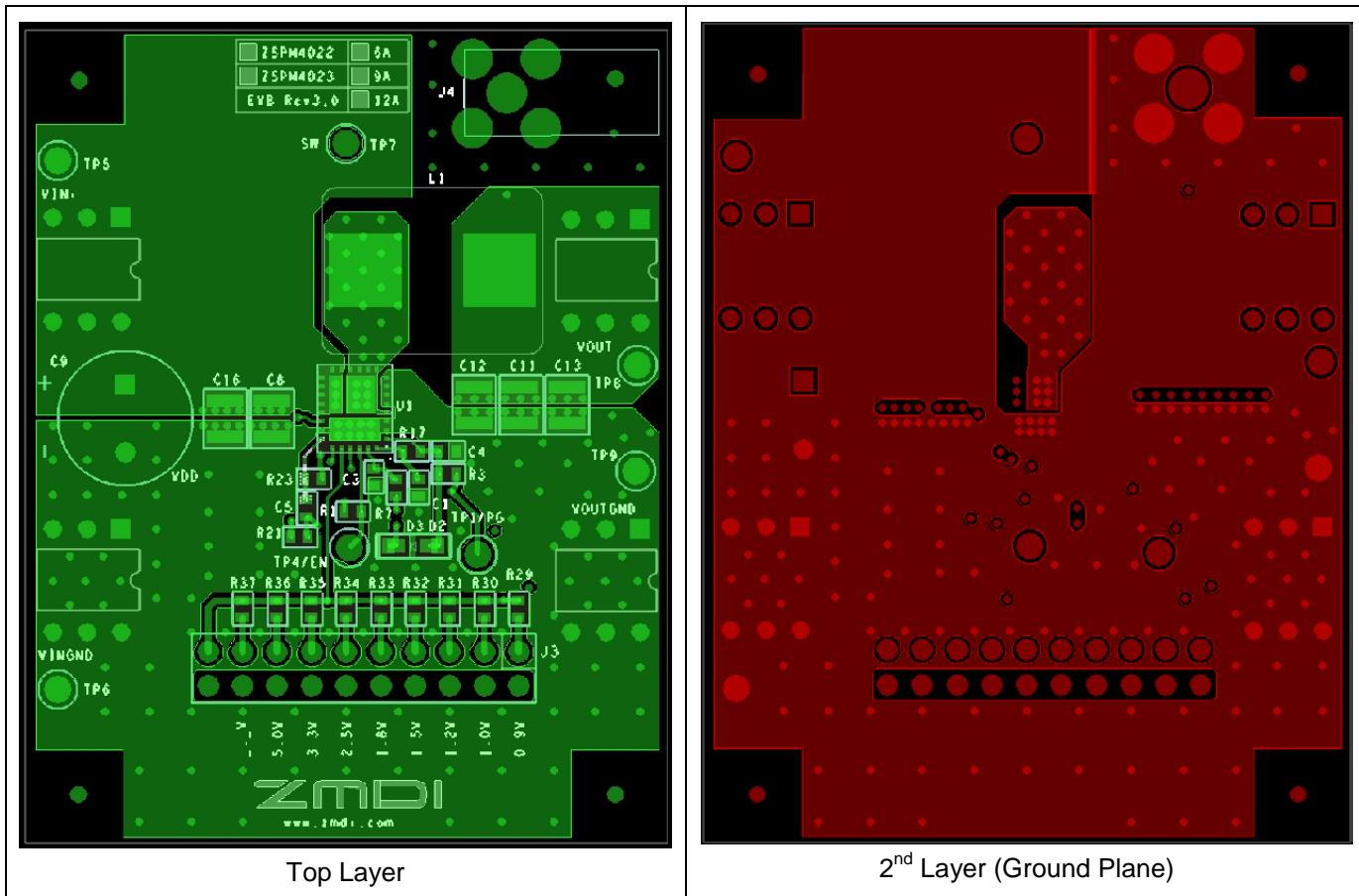
6 Evaluation Board Schematic and Layout

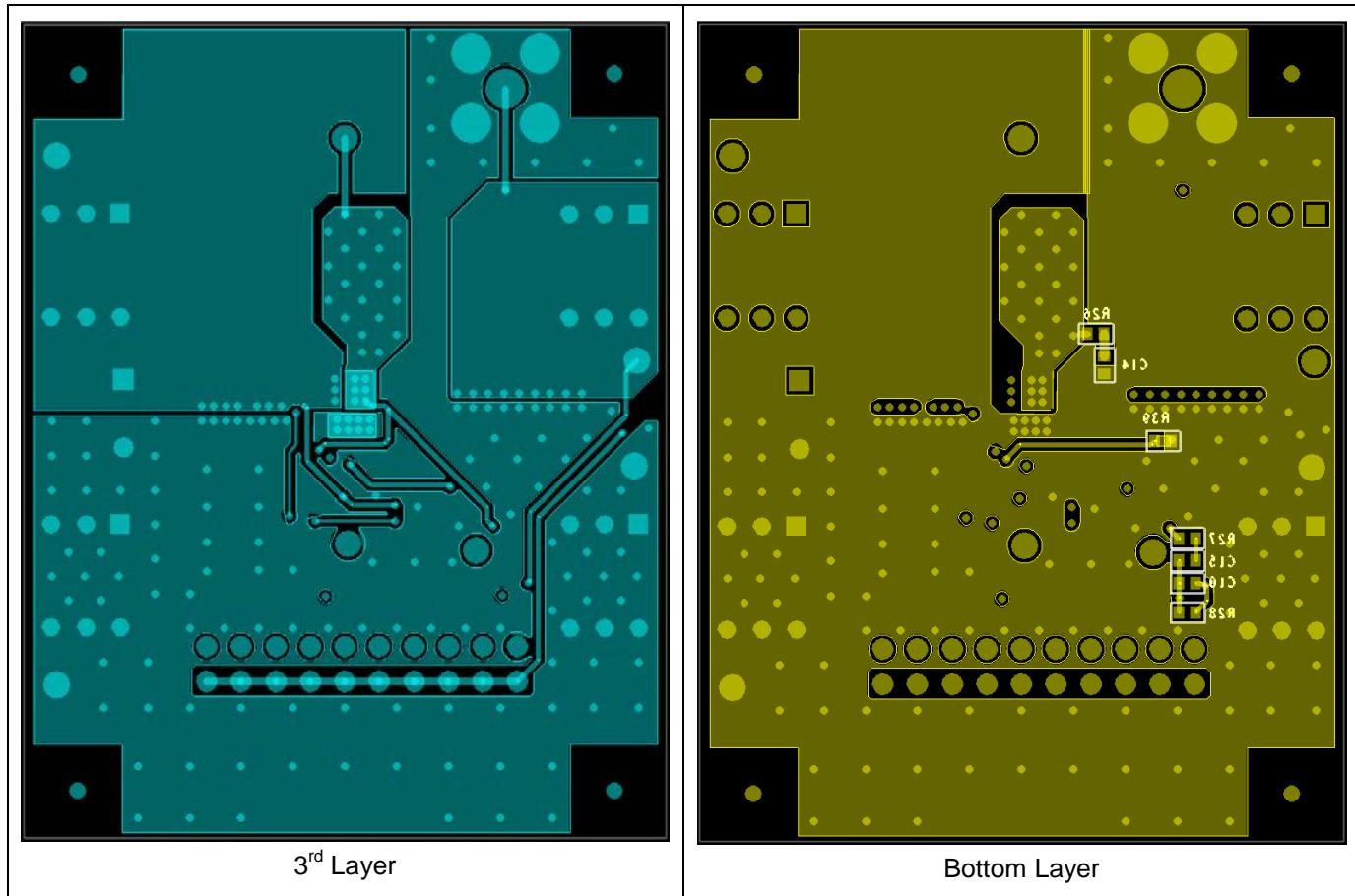
Figure 6.1 Schematic for the Evaluation Board Revision 3.0

Note: U1 is the DUT for the board version as indicated by the product identification label (see Figure 3.1).



6.1. Evaluation Board Layout





6.2. ZSPM4023/ZSPM4022 Evaluation Board Bill of Materials

Table 6.1 Evaluation Board Bill of Materials

Item	Manufacturer Part Number	Manufacturer	Description	Quantity
C16, C8	C1210C475K5RACTU	Kemet	CAP CER 4.7UF 50V 10% X7R 1210	2
C11, C12, C13	C1210C107M9PACTU	Kemet	CAP CER 100UF 6.3V 20% X5R 1210	3
C3, C5, C15	C1608X7R1H104K080AA	TDK	CAP CER 0.1UF 50V 10% X7R 0603	3
C1	LMK107B7105KA-T	Taiyo Yuden	CAP CER 1UF 10V 10% X7R 0603	1
C4	CC0603KRX5R6BB225	Yageo	CAP CER 2.2UF 10V 10% X5R 0603	1
C14	Not populated.		Open	1
C10	GRM188R71H472MA01D	Murata	CAP CER 4700PF 50V 20% X7R 0603	1
C9	ESC227M035AH1AA	Kemet	CAP ALUM 220UF 35V 20% RADIAL	1
D3	SD103AWS-7-F	Diodes Inc	DIODE SCHOTTKY 40V 350MA SOD323	1
J3		Molex	Connector header 20 pos	1
J4	2081233-1	TE Connectivity	CONN JACK SMA PCB VERT	1
L1	7443551130	WURTH	INDUCTOR, HCI 1365, 1.3UH 20% 25A	1
R7	RMCF0603FT2R21	Stackpole	RES TF 2.21 OHM 1% 0.1W 0603	1
R23	CRCW06032R00JNEA	Vishay Dale	RES 2.0 OHM 1/10W 5% 0603 SMD	1
R27	RMCF0603FT19K6	Stackpole	RES 19.6K OHM 1/10W 1% 0603 SMD	1
R28	RMCF0603FT2K49	Stackpole	RES 2.49K OHM 1/10W 1% 0603 SMD	1
R29	RMCF0603JT20K0	Stackpole	RES 20K OHM 1/10W 5% 0603 SMD	1
R1, R3, R30	RNCP0603FTD10K0	Stackpole	RES 10K OHM 1/8W 1% 0603 SMD	3
R31	RMCF0603FT4K99	Stackpole	RES 4.99K OHM 1/10W 1% 0603 SMD	1
R32	RMCF0603FT2K87	Stackpole	RES 2.87K OHM 1/10W 1% 0603 SMD	1
R33	RMCF0603FT2K00	Stackpole	RES 2K OHM 1/10W 1% 0603 SMD	1
R34	CRCW06031K18FKEA	Vishay Dale	RES 1.18K OHM 1/10W 1% 0603 SMD	1
R35	RMCF0603FT806R	Stackpole	RES 806 OHM 1/10W 1% 0603 SMD	1
R36	RMCF0603FT475R	Stackpole	RES 475 OHM 1/10W 1% 0603 SMD	1
R37	Not populated.		Open	
R39			Shorted connection	1
R17, R21	RMCF0603FT1R21	Stackpole	RES TF 1.21 OHM 1% 0.1W 0603	2
R26	Not populated.		Open	1

Item	Manufacturer Part Number	Manufacturer	Description	Quantity
TP1, TP4, TP5, TP6, TP7, TP8 ,TP9	5001	Keystone	TEST POINT PC MINI .040"D BLACK	7
VIN, VINGND, VOUT, VOUTGND	214788	ERNI	PowerTab_ERNI_M4-6pin	4
U1	ZSPM4023 or ZSPM4022	IDT	Synchronous Buck DC-DC Regulator	1

IDT: www.IDT.com

Murata: www.murata.com

Diode Inc.: www.diodes.com

Keystone: www.keyelco.com

Wurth: www.we-online.com

Kemet: www.kemet.com

Yageo: www.yageo.com

Molex: www.molex.com

TDK: www.tdk.com

Vishay: www.vishay.com

Stackpole: www.seiselect.com

ERNI: www.erni.com

TE Connectivity: www.te.com

Taiyo Yuden: www.t-yuden.com

7 Ordering Information

Product Sales Code	Description
ZSPM4023-12-KIT	Evaluation kit for ZSPM4023-12, including ZSPM4023-12 Evaluation Board
ZSPM4023-09-KIT	Evaluation kit for ZSPM4023-09, including ZSPM4023-09 Evaluation Board.
ZSPM4023-06-KIT	Evaluation kit for ZSPM4023-06, including ZSPM4023-06 Evaluation Board
ZSPM4022-12-KIT	Evaluation kit for ZSPM4022-12, including ZSPM4022-12 Evaluation Board
ZSPM4022-09-KIT	Evaluation kit for ZSPM4022-09, including ZSPM4022-09 Evaluation Board
ZSPM4022-06-KIT	Evaluation kit for ZSPM4022-06, including ZSPM4022-06 Evaluation Board

8 Related Documents

Document
ZSPM4023-12 Data Sheet
ZSPM4023-09 Data Sheet
ZSPM4023-06 Data Sheet
ZSPM4022-12 Data Sheet
ZSPM4022-09 Data Sheet
ZSPM4022-06 Data Sheet

Visit IDT's website www.IDT.com or contact your nearest sales office for the latest version of these documents.

9 Document Revision History

Revision	Date	Description
1.00	October 4, 2013	First release
	April 14, 2016	Changed to IDT branding.

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES ("RENESAS") PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.