Freescale Semiconductor
User's Guide

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KIT10XS3425EVBE Evaluation Board

Featuring the MC10XS3425 Quad High Side Switch

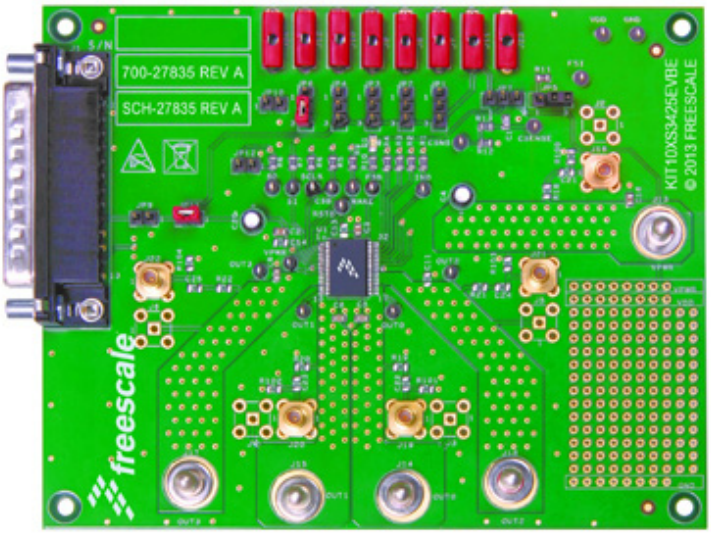

Figure 1. KIT10XS3425EVBE Evaluation Board

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1 Kit Contents/Packing List

- Assembled and tested evaluation board/module in anti-static bag.
- Warranty Card

2 Jump Start

- Go to www.freescale.com/analogtools
- Locate your kit
- Review your Tool Summary Page
- Look for


Jump Start Your Design

Download documents, software and other information

3 Important Notice

Freescale provides the enclosed product(s) under the following conditions:

This evaluation kit is intended for use of ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY. It is provided as a sample IC pre-soldered to a printed circuit board to make it easier to access inputs, outputs, and supply terminals. This EVB may be used with any development system or other source of I/O signals by simply connecting it to the host MCU or computer board via off-the-shelf cables. This EVB is not a Reference Design and is not intended to represent a final design recommendation for any particular application. Final device in an application will be heavily dependent on proper printed circuit board layout and heat sinking design as well as attention to supply filtering, transient suppression, and I/O signal quality.

The goods provided may not be complete in terms of required design, marketing, and or manufacturing related protective considerations, including product safety measures typically found in the end product incorporating the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. In order to minimize risks associated with the customers applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards. For any safety concerns, contact Freescale sales and technical support services.

Should this evaluation kit not meet the specifications indicated in the kit, it may be returned within 30 days from the date of delivery and will be replaced by a new kit.

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4 Introduction

This evaluation board demonstrates the capability of the MC10XS3425 as a 12 V quad high side switch product family, with integrated control and a high number of protective and diagnostic functions.

The MC10XS3425 is one in a family of devices designed for low-voltage automotive lighting applications. Its four low $R_{DS(ON)}$ MOSFETs (dual 10 mΩ and dual 25 mΩ) can control four separate 55 W / 28 W bulbs, and/or Xenon modules, and/or LEDs.

Programming, control and diagnostics are accomplished using a 16-bit SPI interface. Output slew rates are selectable to control electromagnetic emissions. Additionally, each output has its own parallel input or SPI control for pulse-width modulation (PWM) control if desired. The MC10XS3425 allows the user to program via the SPI the fault current trip levels and duration of acceptable lamp inrush. The device has Fail-safe mode to provide fail-safe functionality of the outputs in case of MCU damage.

The four channels can be controlled individually by external/internal clock-signals or by direct inputs. Using the internal clock allows fully autonomous device operation. Programmable output voltage slew rates (individually programmable) helps improve EMC performance. To avoid shutting off the device upon inrush current, while still being able to closely track the load current, a dynamic overcurrent threshold profile is featured. Switching current of each channel can be sensed with a programmable sensing ratio. Whenever communication with the external microcontroller is lost, the device enters a fail-safe operation mode, but remains operational, controllable, and protected.

5 Evaluation Board Features

This family of devices is designed for low-voltage automotive lighting applications. Its four low $R_{DS(ON)}$ MOSFETs can control:

- Four separate 55 W/28 W bulbs
- Two separate Xenon modules
- Four separate LEDs
- Four separate Other type of loads

In addition, this family of devices has the following features:

- Programming, control, and diagnostics are accomplished using a 16-bit SPI interface
- Its output with selectable slew-rate allows to satisfy electromagnetic compatibility (EMC) requirements
- Each output can be controlled with an internal PWM modulated clock signal, instead of an external clock

6 MC10XS3425 Device Features

- Four protected 10 mΩ and 25 mΩ high side switches
- Operating voltage range of 6.0 to 20 V with sleep current < 5.0 μA, extended mode from 4.0 to 28 V
- 8.0 MHz 16-bit 3.3 V and 5.0 V SPI control and status reporting with daisy chain capability
- PWM module using external clock or calibratable internal oscillator with programmable outputs delay management
- Smart overcurrent shutdown, severe short-circuit, over-temperature protections with time limited auto-retry, and fail-safe mode in case of MCU damage
- Output OFF or ON open-load detection compliant to bulbs or LEDs and short-to-battery detection. Analog current feedback with selectable ratio and board temperature feedback

Freescale analog ICs are manufactured using the SMARTMOS process, a combinational BiCMOS manufacturing flow that integrates precision analog, power functions and dense CMOS logic together on a single cost-effective die.

7 KITUSBSPIEVME USB-to-Parallel Interface Board

The KITUSBSPIEVME board converts from USB to SPI and from USB to parallel data transmission. The main function provided by this board is to allow a PC that may not have a parallel port to communicate with other Freescale evaluation boards via a USB port.

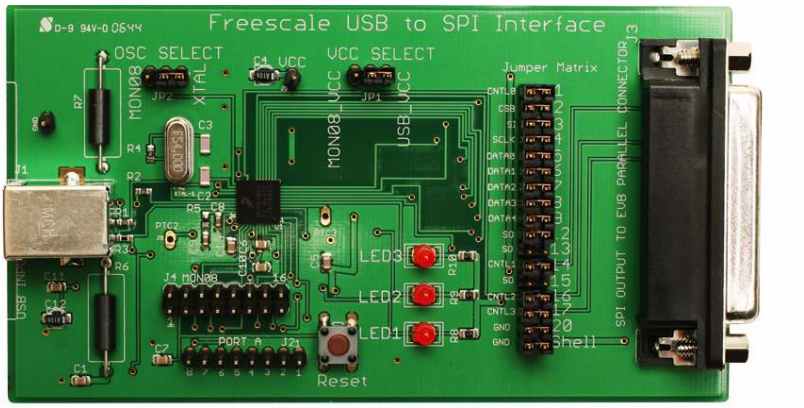


Figure 2. KITUSBSPIEVME Converter Board

8 Required Equipment

Minimum required equipment:

- DC power supply that can produce voltage levels in the range of 4.0V and 28V with current capability of about 40 A
- 5 V DC power supply, 1 A current capability. (This may be supplied through the USB-to-SPI interface that is connected to the PC.)
- Computer with an available USB port, running Windows XP or higher
- KITUSBSPIEVME interface board
- Latest version of SPIGen software (available through Jump Start)
- Typical load (lamps,...)

9 Installing SPIGen Freeware on your Computer

The latest version of SPIGen is designed to run on any Windows 8, Windows 7, Vista or XP-based operating system. To install the software, go to www.freescale.com/analogtools and select your kit. Click on that link to open the corresponding Tool Summary Page. Look for “Jump Start Your Design”. Download to your computer desktop the SPIGen software as well as the associated configuration file.

Run the install program from the desktop. The Installation Wizard will guide you through the rest of the process.

To use SPIGen, go to the Windows Start menu, then Programs, then SPIGen, and click on the SPIGen icon. The SPIGen Graphic User Interface (GUI) will appear. Go to the file menu in the upper left hand corner of the GUI, and select “Open”. In the file selection window that appears, set the “Files of type:” drop-down menu to “SPIGen Files (*.spi)”. (As an exceptional case, the file name may have a .txt extension, in which case you should set the menu to “All Files (*.*)”.) Next, browse for the configuration file you saved on your desktop earlier and select it. Click “Open”, and SPIGen will create a specially configured SPI command generator for your evaluation board.

The GUI is shown in **Figure 3**. The text at the top is the name of the configuration file loaded. The left side panel displays folders that group user interfaces. The process of loading the configuration file has assigned a list of “Extra Pins” as well as a list “Quick Commands”, all of which are board-specific.

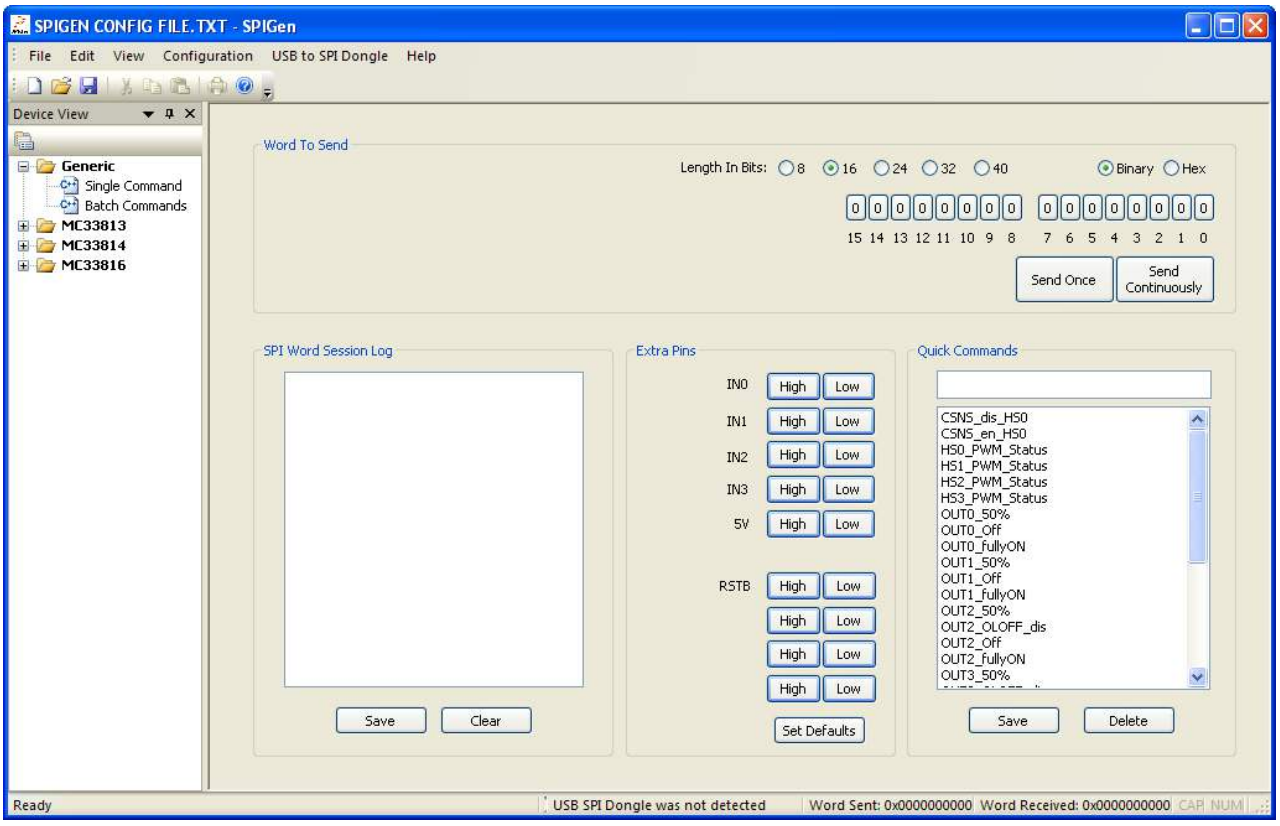


Figure 3. SPIGen GUI

10 EVB Setup Configuration

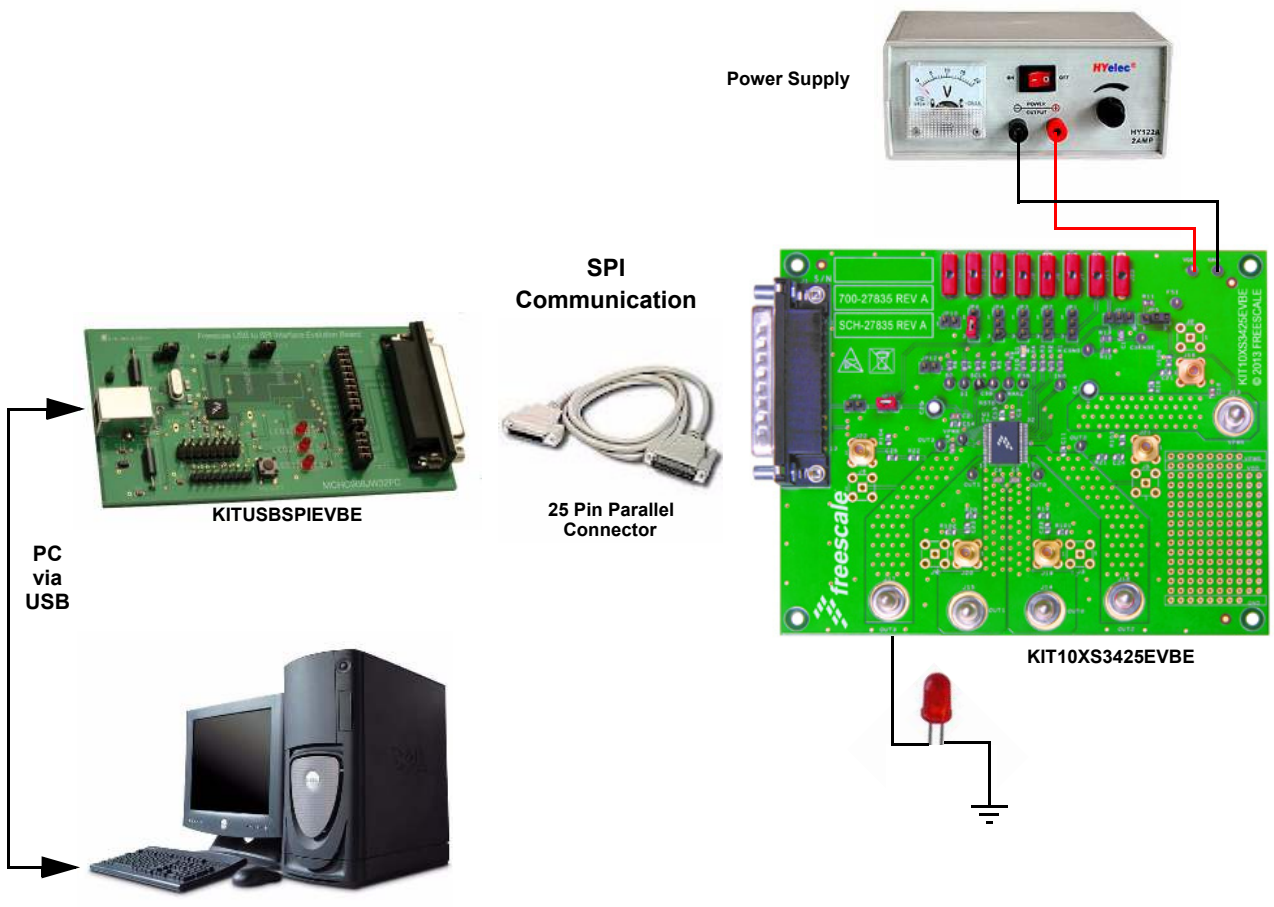


Figure 4. KIT10XS3425EVBE Setup Configuration Diagram

11 Setup and Using the Hardware

1. The KIT10XS3425EVBE evaluation board operates with one VPWR power supply from 4.0 V to 28 V. A separate 5.0 V VDD power supply can optionally be sourced to the evaluation board through the auxiliary KITUSBSPIEVME USB-to-parallel interface board, which gets its power from a controlling PC. (See subsection “KITUSBSPIEVME USB-to-Parallel Interface Board”).
2. On the KIT10XS3425EVBE board, use the 4.0 V-to-28 V supply to apply a 12V high-side input power voltage from the VPWR terminal (positive) to the GND terminal (negative).
3. A load is connected between the board output OUT0 and the GND associated with the VPWR line. If additional loads are desired, they can be connected between OUT1, OUT2 or OUT3 (corresponding to HS1, HS2 or HS3) and the same GND.
4. For setting up the USB-to-SPI (implemented as a parallel port) communication link between a PC and the evaluation board, it is necessary to first download and install the SPIGen software. Instructions are provided in the section “Installing SPIGen Freeware on your Computer”.
5. Connect the PC to the USB port of the KITUSBSPIEVME board using a standard USB cable. Connect the parallel port of the same board to the KIT10XS3425EVBE board using a standard 25-pin D-sub (DB25) cable. (See the KIT10XS3425EVBE Setup Configuration Diagram.)
6. The PC serves as a 5.0 V source for the USB-to-SPI interface, and through that, to the VDD rail of the KIT10XS3425EVBE board (jumper JP9 must be closed). Alternatively, an external power supply can be connected directly to the on-board VDD terminal (which is JP11 with JP9 open). In this last case, without +5.0 V externally applied, the MC10XS3425 device will be in Fail-Safe mode.
7. For direct control of the outputs, apply +5.0 V to any of the IN0 - IN3 connectors (J7 through J10, respectively). Then the corresponding high-side output (OUT0, OUT1, OUT2 or OUT3) will turn on. Voltage applied to any of these inputs will wake up the MC10XS3425 device.
8. To prepare the evaluation board for SPIGen, close jumpers JP9 and JP10.
9. To use SPIGen, go to the Windows Start menu, then Programs, then SPIGen, and click on the SPIGen icon. The SPIGen GUI will appear. Loading of the configuration file specific to the KIT10XS3425EVBE board is described in section “Installing SPIGen Freeware on your Computer”. Once having loaded the configuration file, SPIGen will open a specifically configured SPI command generator for the evaluation board. The configuration file will set all parameters for SPI signals from the PC and provide a list of commands that may be sent to the EVB.
10. To initialize the MC10XS3425 device to read switch inputs, the user may use batch commands. To do this, select the “Batch Commands” option inside the “Generic” folder on the left-hand panel. In the window that appears, select “Full Initialize” from the “Batch Name” drop-down menu. To send this batch of commands to the evaluation board, click the “Send Once” tab.
11. To quickly evaluate the board as well as the MC10XS3425 device, simply select the “Single Command” option inside the “Generic” folder on the left-hand panel. In the window that appears, select the “Switch Status” command from the “Quick Commands” list, then click the “Send Continuously” button. The opening and closing of switches may now be seen in the “Word Rcvd” field located at the bottom of the SPIGen GUI. Refer to the MC10XS3425 data sheet for detailed information on I/O communication and device operation.

12 Jumper Connections

Name	Description
JP1 JP2 JP3 JP4	Allows independent control of each high side switch output 1-2 selection: outputs are controlled via SPIGen or connectors J7 - J10 2-3 selection: direct control of the output, appropriate output is ON
JP5	FSI selection 1-2: FSI terminal connected through 6.8 kOhm resistor to ground 2-3: FSI terminal connected to ground
JP6	Allows wake-up function of IC. 1-2 selection will give external control through connector J12. 2-3 selection is to wake-up from battery voltage, i.e. in the case of ignition.
JP7	Selection of supplying of FSB LED 1-2: FSB LED D1 connected to VDD (5.0 V) 2-3: FSB LED D1 connected to V_{PWR} (12 V)
JP9	Source of VDD (+5.0 V) Closed: +5.0 V is provided by PC via parallel cable Open: +5.0 V must be connected to J11, otherwise the device is in fail-safe mode (the output states depend on R11 value)
JP10	Connection of RSTB input Closed: control through SPIGen Open: RSTB is ground. This means that the IC is in Sleep mode
JP11	Connection of VDD to the device Closed: VDD connected to the device Open: Device without VDD
JP12	R8 bypassing Closed: R8 is bypassed with 0 Ohm. For higher speed of SPI (MCU control of the device only) Open: Low speed SPI operation with SPIGen software
TEST POINTS	Several test points are presented on the evaluation board to check some signals using an oscilloscope if necessary.

13 Schematic

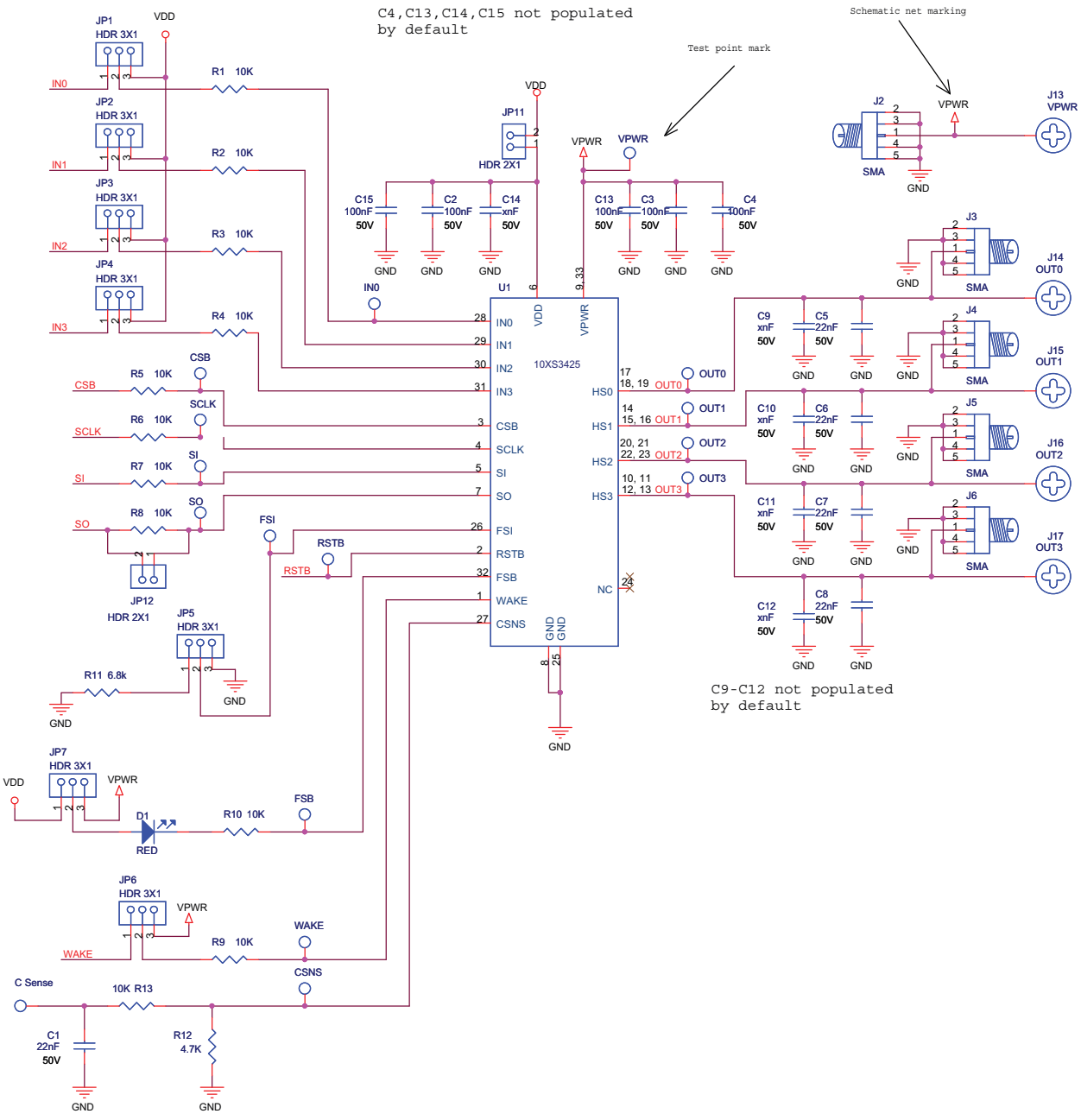


Figure 5. Schematic Part One

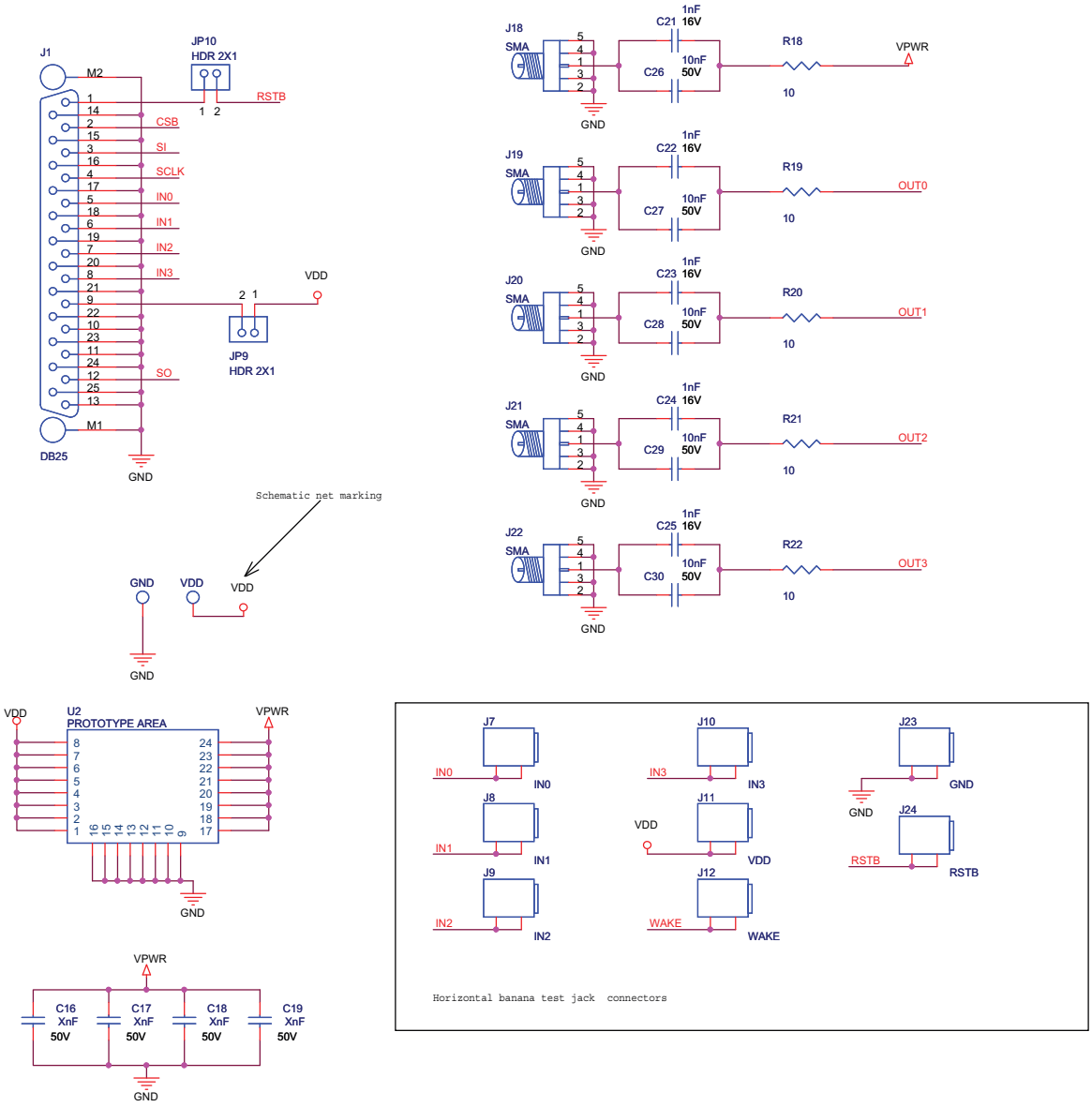
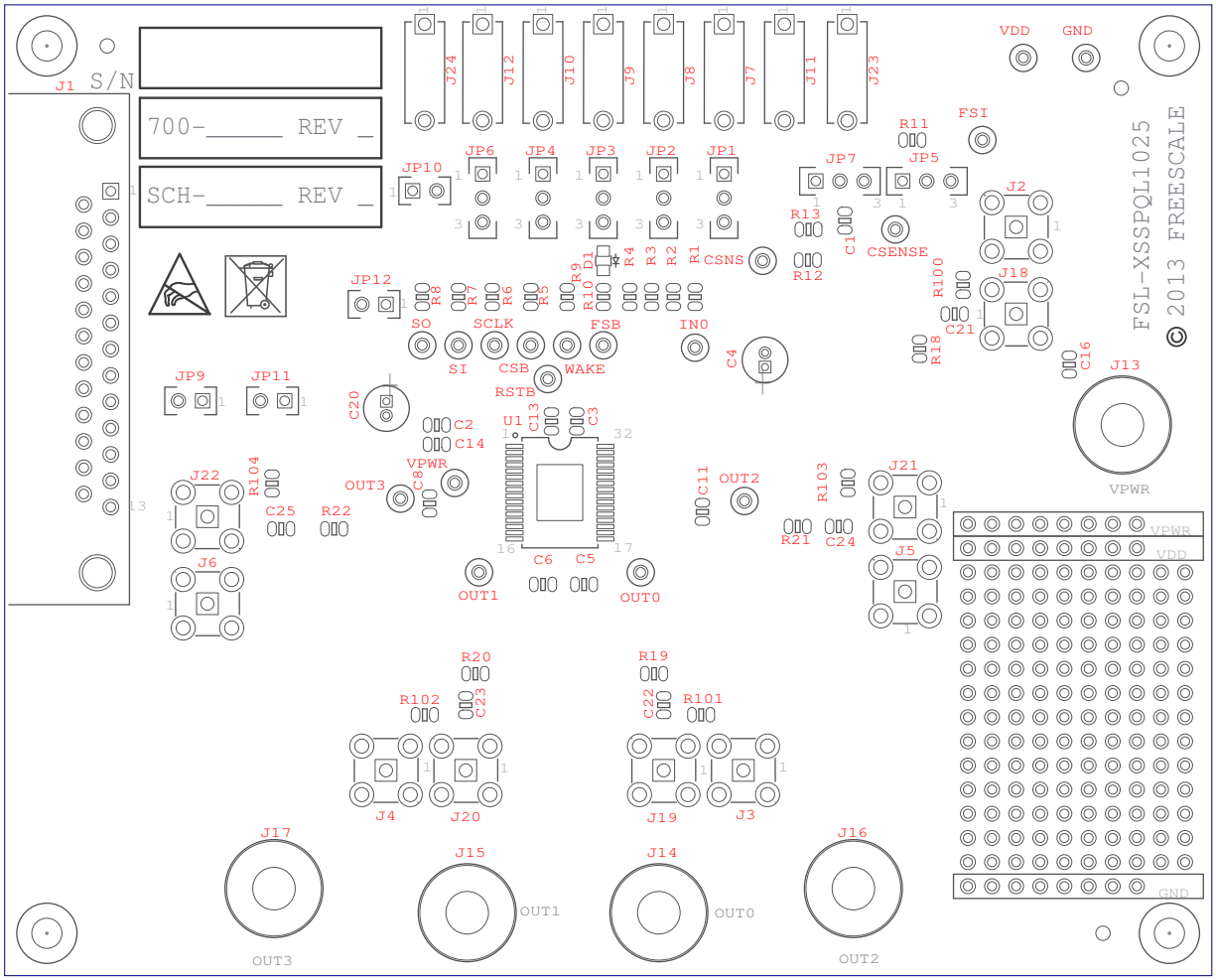


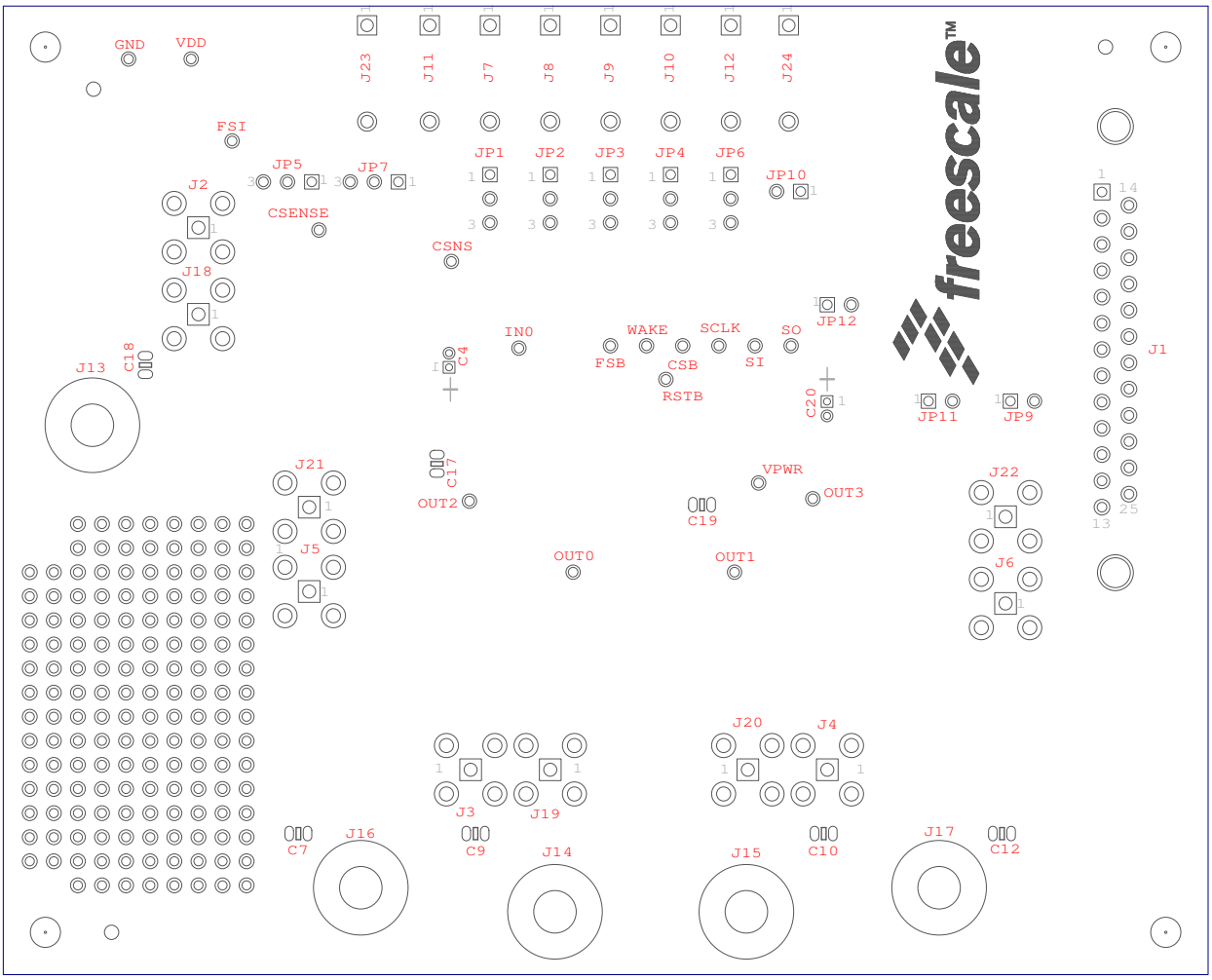
Figure 6. Schematic Part Two

14 Board Layout

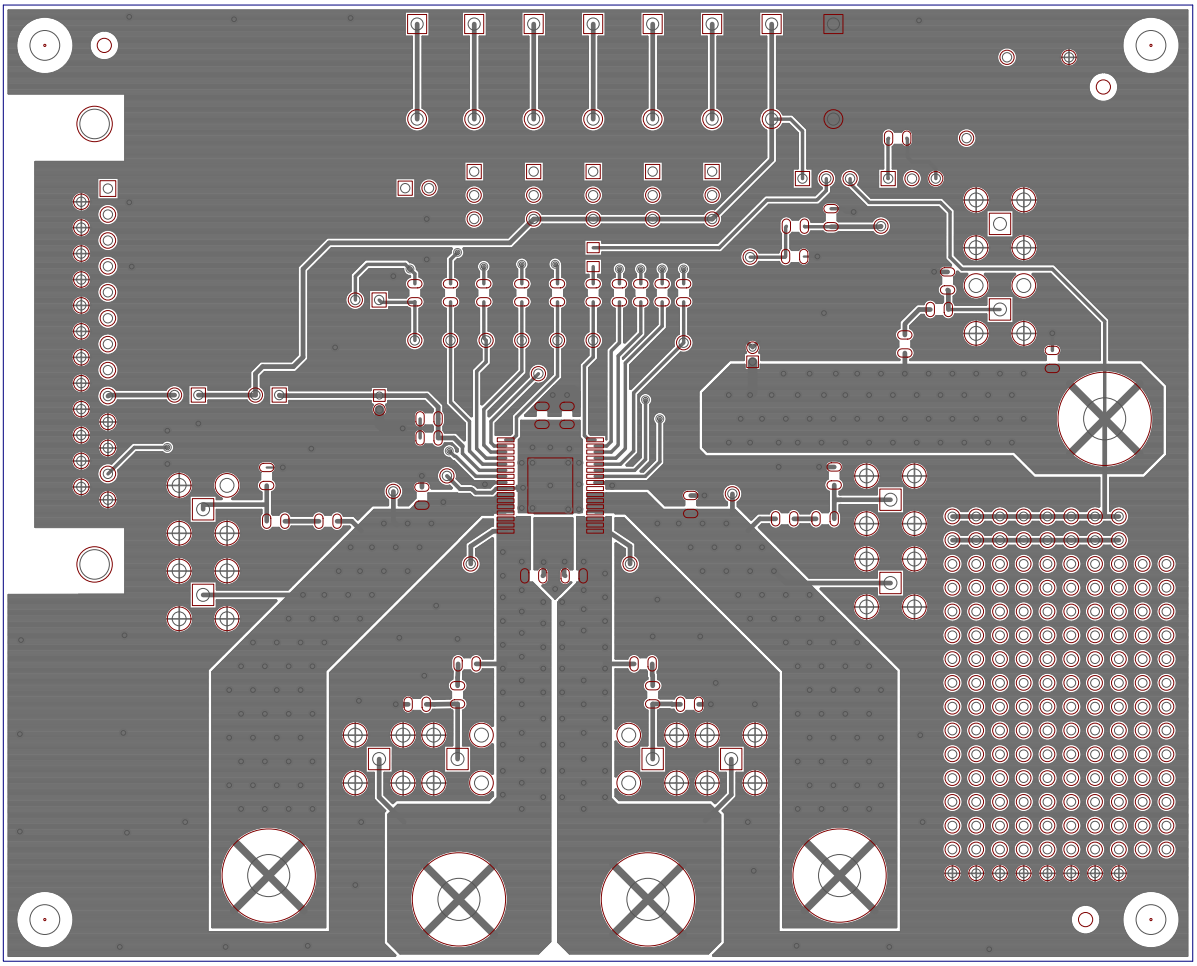
14.1 Assembly Top Layer



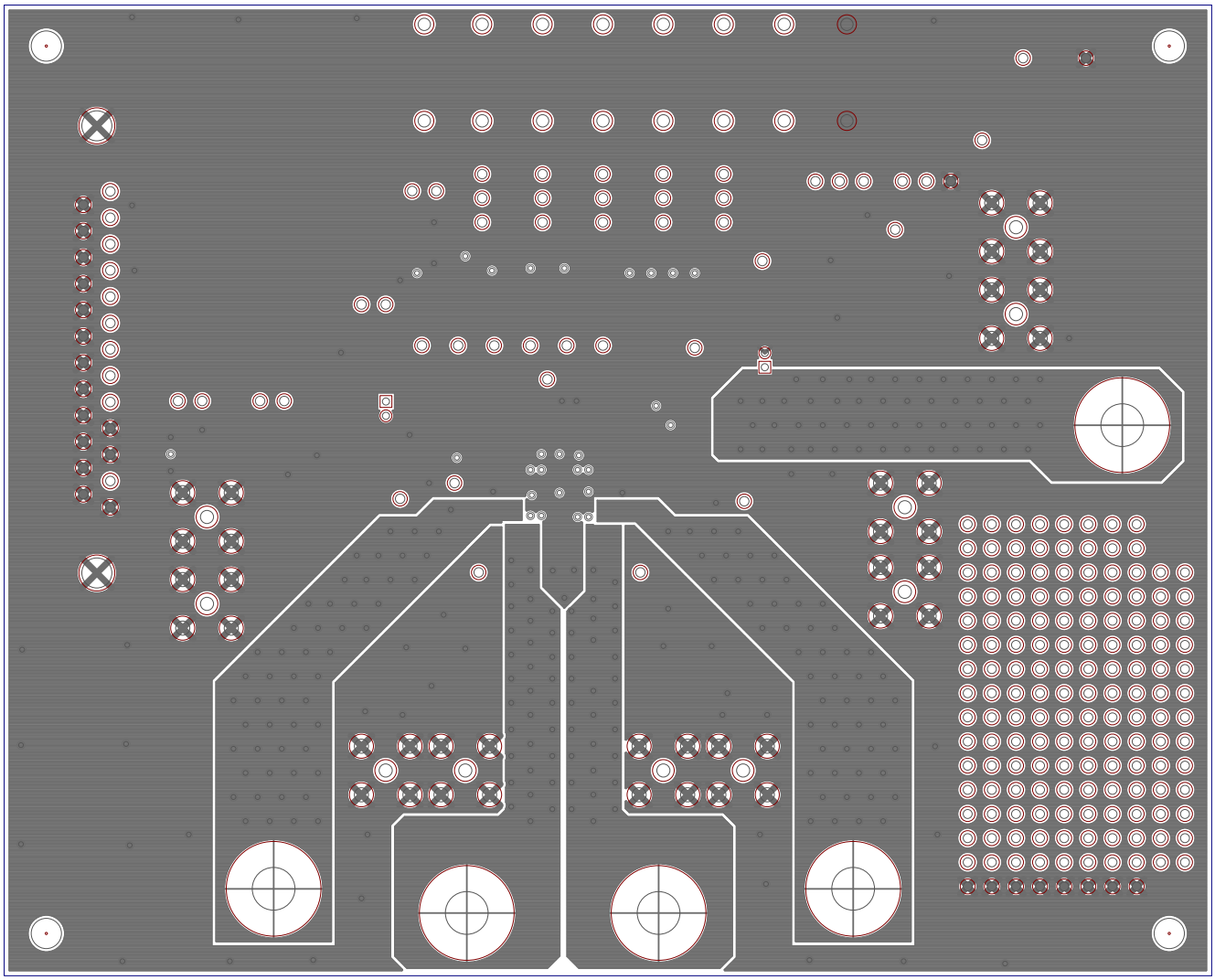
14.2 Assembly Layer Bottom



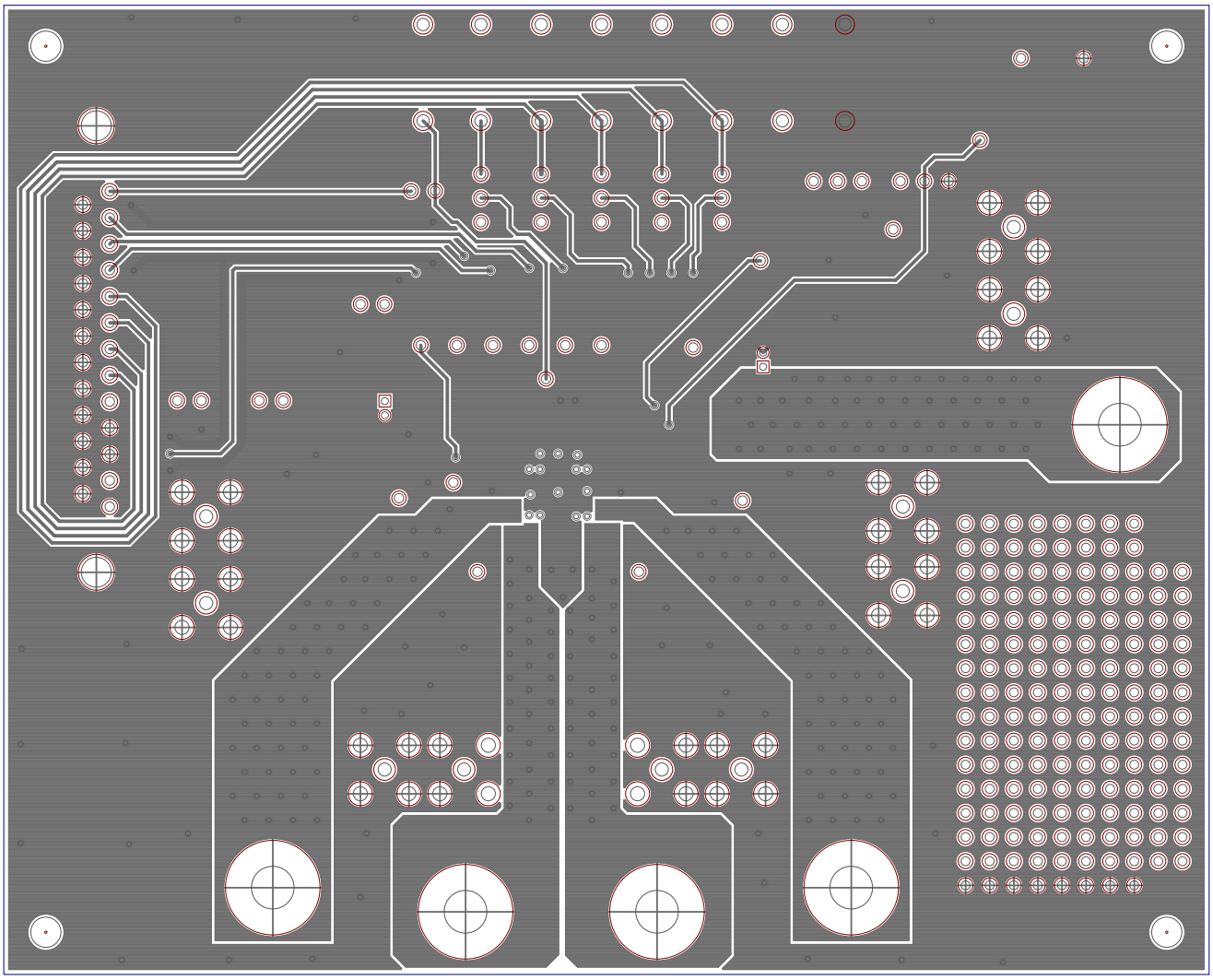
14.3 Top Layer Routing



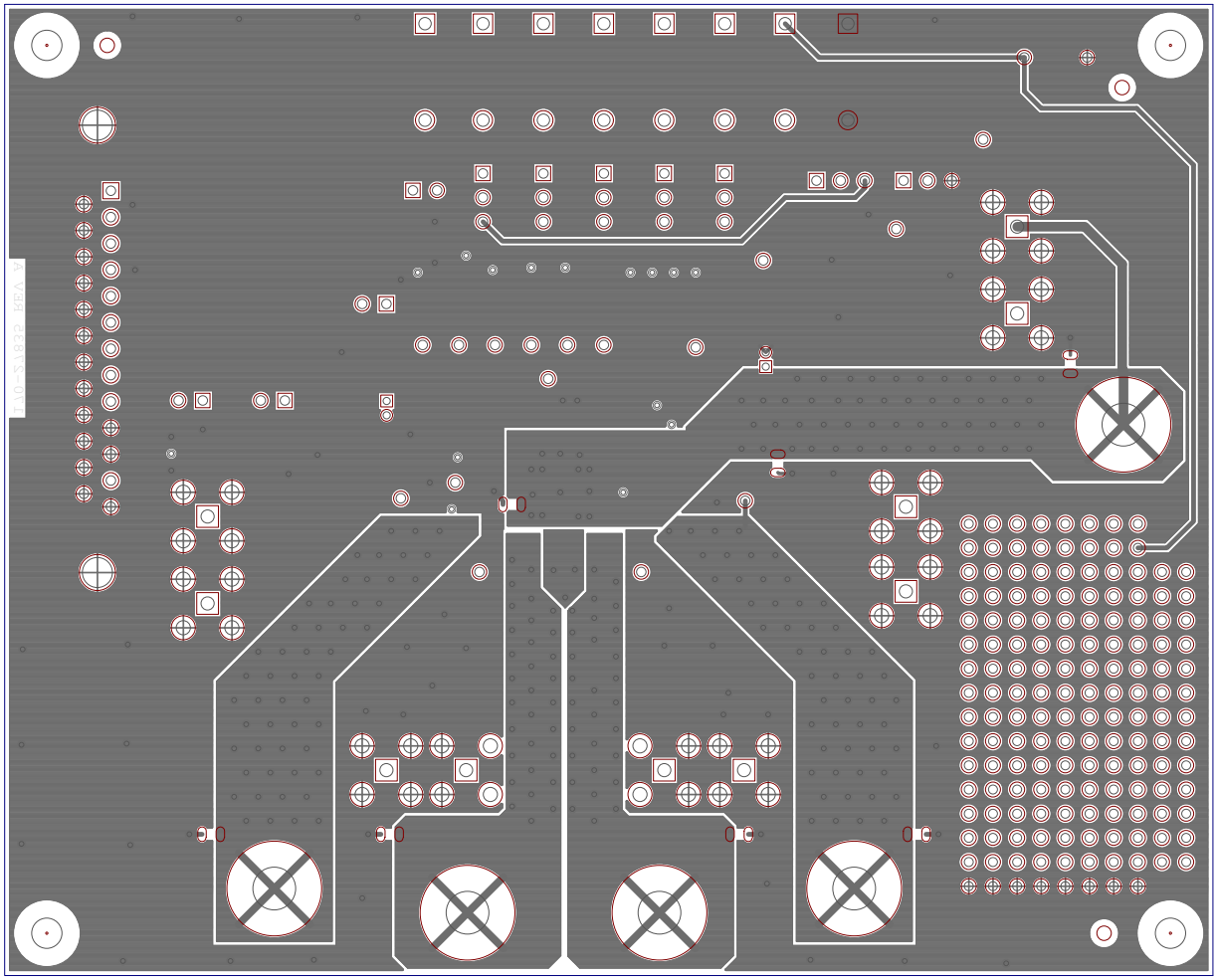
14.4 Inner Layer 1 Routing



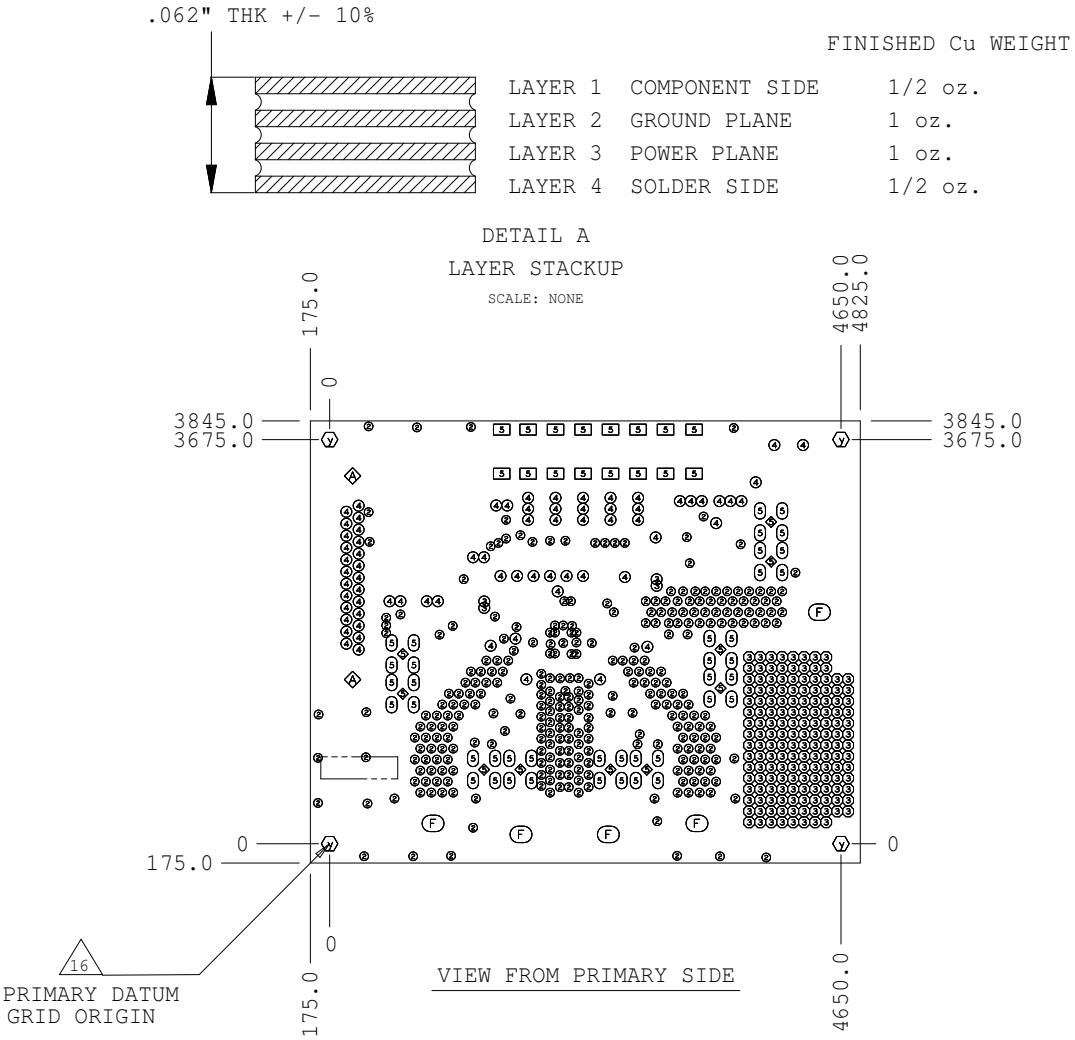
14.5 Inner Layer 2 Routing



14.6 Bottom Layer Routing



14.7 Drill Location



DRILL CHART: TOP to BOTTOM				
ALL UNITS ARE IN MILS				
FIGURE	SIZE	TOLERANCE	PLATED	QTY
②	20.0	+2.0/-2.0	PLATED	303
③	30.0	+2.0/-2.0	PLATED	4
③	38.0	+3.0/-3.0	PLATED	154
④	40.0	+3.0/-3.0	PLATED	72
5	52.0	+3.0/-3.0	PLATED	16
◈	55.0	+3.0/-3.0	PLATED	10
⑤	59.0	+3.0/-3.0	PLATED	40
Ⓐ	125.0	+3.0/-3.0	PLATED	2
Ⓕ	177.0	+3.0/-3.0	PLATED	5
Ⓨ	126.0	+4.0/-0.0	NON-PLATED	4

15 Bill of Material

Table 1. KIT10XS3425EVBE Bill of Material

Qty	Schematic Label	Value	Description	Package
Capacitors				
1	C1	10 nF	Ceramic Capacitor 50 V	SMD 0805
5	C26, C27, C28, C29, C30	10 nF	Ceramic Capacitor 50 V	SMD 1206
4	C2, C3, C13, C15	100 nF	Ceramic Capacitor 50 V	SMD 0805
2	C4, C20	10 μF	Electrolytic Capacitor 63 V Thru - hole 5.0 mm	
4	C5, C6, C7, C8	22 nF	Ceramic Capacitor 50 V	SMD 0805
9	C9, C10, C11, C12, C14, C16, C17, C18, C19	For EMC tuning	Ceramic Capacitor	SMD 0805
5	C21, C22, C23, C24, C25	1.0 nF	Ceramic Capacitor 50 V	SMD 1206
Resistors				
11	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R13	10 k	Resistor 5%	SMD 0805
1	R11	6.8 k	Resistor 1%	SMD 0805
1	R12	2.7 k	Resistor 1% Thru-hole 10 mm	
5	R18, R19, R20, R21, R22	10 R	Resistor 5% 1.0 W Thru-hole 10 mm	
Diodes				
1	D1		Red LED	SMD 0805
Integrated Circuits				
1	U1	MC10XS3425EK	Freescale Quad High Side Switch	32-pin SOICW-EP
Connectors, Jumpers and Push Buttons				
7	JP1, JP2, JP3, JP4, JP5, JP6, JP7		Header 3x1	
4	JP9, JP10, JP11, JP12		Header 2x1	
1	J1		25-pin PCB connector 90°	
10	J2, J3, J4, J5, J6, J18, J19, J20, J21, J22		SMA Jack 19-46-1-TGG	
8	J7, J8, J9, J10, J11, J12, J23, J24		Horizontal Test jack 105-0752-001	
5	J13, J14, J15, J16, J17		4.0 mm screw diameter + 2 nuts + 2 washers each for power connector	
18	OUT1,OUT2, OUT3, WAKE, VPWR, VDD, SO, SI, SCLK, RSTB, OUT0, IN0, GND, FSI, FSB, CSNS, CSB, CSENSE		PCB Test Terminal 200-203	

Note: Freescale does not assume liability, endorse, or warrant components from external manufacturers that are referenced in circuit drawings or tables. While Freescale offers component recommendations in this configuration, it is the customer's responsibility to validate their application.

16 References

Following are URLs where you can obtain information on related Freescale products and application solutions:

Freescale.com Support Pages	URL
MC10XS3425 Product Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MC10XS3425
KITUSBSPIEVME Tool Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=KITUSBSPIEVME
SPIGen Tool Summary Page	http://www.freescale.com/files/soft_dev_tools/software/device_drivers/SPIGen.html
Analog Home Page	http://www.freescale.com/analog
Automotive Home Page	http://www.freescale.com/automotive

16.1 Support

Visit Freescale.com/support for a list of phone numbers within your region.

16.2 Warranty

Visit Freescale.com/warranty for a list of phone numbers within your region.

17 Revision History

Revision	Date	Description of Changes
1.0	6/2013	• Initial Release

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