

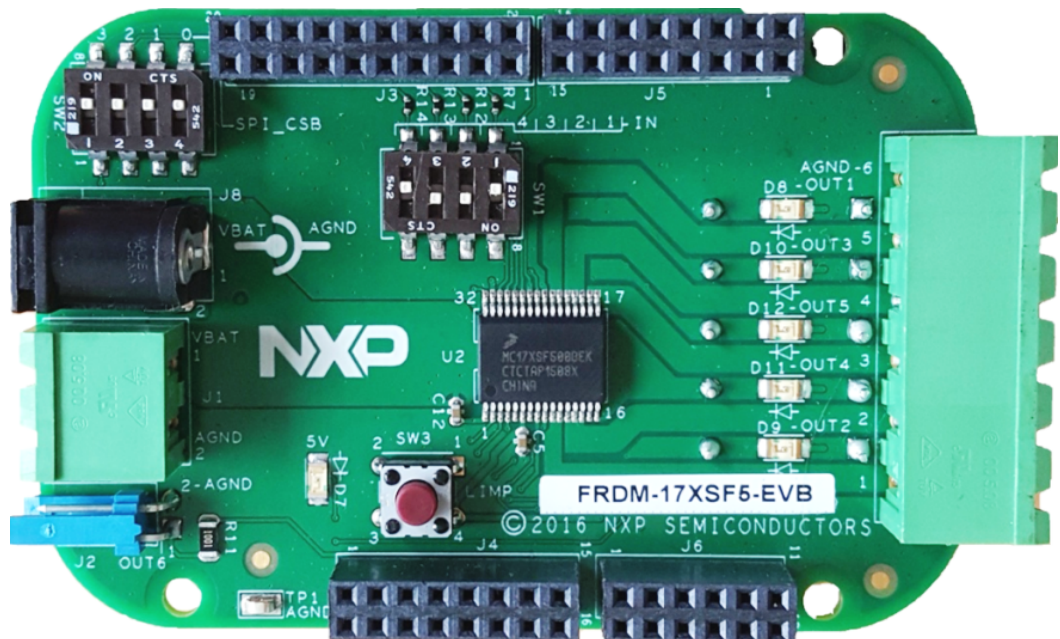
KTFRDM-MC12XSFUG

FRDM-17XSF5-EVB, FRDM-17XSF4-EVB, FRDM-08XSF4-EVB
and FRDM-40XSF5-EVB evaluation boards

Rev. 2.0 — 18 July 2018

User guide

1 FRDM-17XSF5-EVB



2 Important notice

NXP 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 evaluation board 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 evaluation board 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.

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3 Getting started

The NXP analog product development boards provide an easy-to-use platform for evaluating NXP products. These development boards support a range of analog, mixed-signal, and power solutions. These boards incorporate monolithic integrated circuits and system-in-package devices that use proven high-volume technology. NXP products offer longer battery life, a smaller form factor, reduced component counts, lower cost, and improved performance in powering state-of-the-art systems.

The tool summary page is at <http://www.nxp.com/FRDM-MC12XSF>. The overview tab on this page provides an overview of the device, a list of device features, a description of the kit contents, links to supported devices and a **Get Started** section.

The **Get Started** section provides information applicable to using the kit.

1. Go to <http://www.nxp.com/FRDM-MC12XSF>.
2. On the **Overview** tab, locate the **Jump To** navigation feature on the left side of the window.
3. Select the **Get Started** link.
4. Review each entry in the **Get Started** section.
5. Download an entry by clicking on the linked title.

After reviewing the **Overview** tab, visit the other related tabs for additional information:

- **Documentation:** Download current documentation.
- **Software & Tools:** Download current hardware and software tools.
- **Buy/Parametrics:** Purchase the product and view the product parametrics.

After downloading files, review each file, including the user guide, which includes setup instructions. If applicable, the bill of materials (BOM) and supporting schematics are also available for download in the **Get Started** section of the **Overview** tab.

3.1 Kit contents/packing list

The FRDM-17XSF5-EVB, FRDM-17XSF4-EVB, FRDM-08XSF4-EVB and FRDM-40XSF5-EVB contents include:

- Assembled and tested evaluation board/module in anti-static bag
- Connector 1x2 for power supply
- Connector 1x6 for loads
- Quick start guide
- Warranty card

3.2 Required equipment

This kit requires the following items:

- Power supply 7.0 to 18 V
- Typical loads (DC motor, LED, bulb)
- One of the following MCU boards:
 - FRDM-KL25Z
 - FRDM-K64F
 - FRDM-KV10Z
- SPIGen

- CodeWarrior 10.6 or higher, Kinetis Design Studio 3.0.0 or higher, Driver Suite 10.4 or higher, Processor Expert version RT6 or higher

3.3 System requirements

The kit requires the following to function properly with the software:

- USB-enabled PC with Windows® XP or higher

4 Understanding the Freedom platform

The NXP Freedom development platform is a small, low-power, cost-effective evaluation and development system for quick application prototyping and demonstration of Kinetis MCU families.

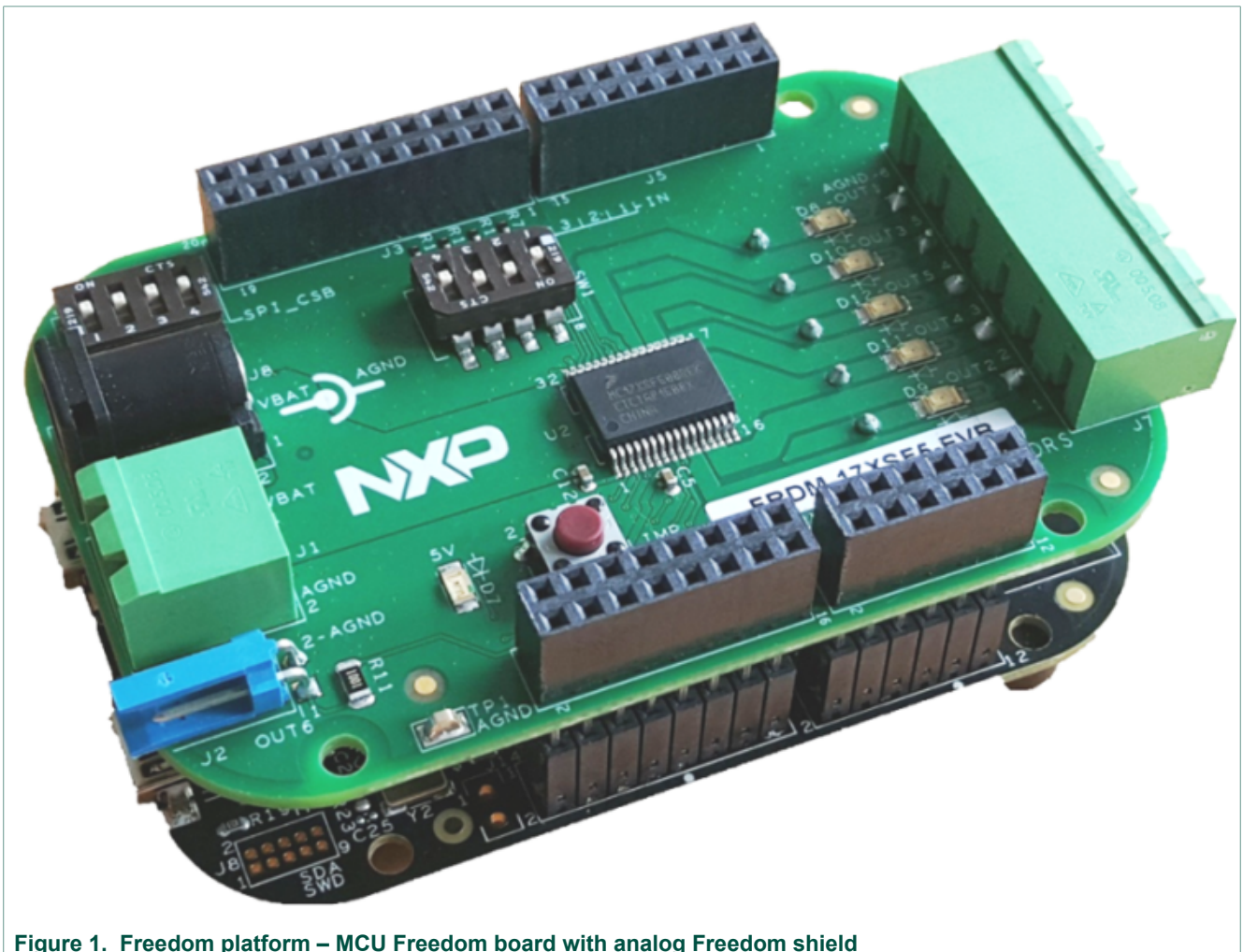


Figure 1. Freedom platform – MCU Freedom board with analog Freedom shield

5 Getting to know the hardware

5.1 Board overview

The FRDM-17XSF5-EVB, FRDM-17XSF4-EVB, FRDM-08XSF4-EVB and FRDM-40XSF5-EVB evaluation boards feature one of the ICs belonging to NXP’s 12XSF and 12XS6 high-side switch family.

The board incorporates up to 5 outputs with freewheeling diode protection and LED indication, external smart power switch control output, on-board voltage regulator and level shifter (from 3.3 V to 5.0 V logic) and switch to enable operation of up to four boards in parallel with separate chip-select pins (parallel SPI operation).

5.2 Device features

12XSF and 12XS6 families of eXtreme switch products are the latest achievement in DC motors and automotive (12XS6) / industrial (12XSF) lighting drivers. The products belong to an expanding family to control and diagnose various types of loads, such as incandescent bulbs or light emitting diodes (LEDs), with enhanced precision.

The products combine flexibility through daisy-chainable SPI at 5.0 MHz, extended digital and analog feedbacks, which supports safety and robustness.

This fourth generation of NXP’s high-side switch family facilitates electronic control unit designs supported by the use of compatible MCU software and PCB footprints, for each device variant.

Common features of 12XSF/12XS6 family:

- Operating voltage range of 7.0 V to 18 V, with sleep current < 5.0 μ A
- 5.0 MHz 16-bit SPI control of overcurrent profiles, channel control including 8-bit PWM duty-cycles, output ON and OFF open load detections, thermal shutdown and pre-warning and fault reporting
- Output current monitoring with programmable synchronization signal and supply voltage feedback
- Programmable overcurrent trip levels
- Watchdog and limp home mode
- External smart power switch control (output 6)
- –16 V reverse polarity and ground disconnect protections
- Compatible PCB foot print and SPI software driver among the family

The 12XSF/12XS6 family products differ in number of available outputs and its $R_{DS(on)}$ resistance. The ICs present on one of the Freedom evaluation boards are in [Table 1](#).

Table 1. Device features

Product number	No. of outputs	OUT1	OUT2	OUT3	OUT4	OUT5	OUT6
MC08XSF421 and MC08XS6421	4 + 1	21 m Ω	21 m Ω	8 m Ω	8 m Ω	N.C	Yes
MC17XSF400 and MC17XS6400	4 + 1	17 m Ω	17 m Ω	17 m Ω	17 m Ω	N.C	Yes
MC17XSF500 and MC17XS6500	5 + 1	17 m Ω	17 m Ω	17 m Ω	17 m Ω	17 m Ω	Yes
MC40XSF500 and MC40XS6500	5 + 1	40 m Ω	40 m Ω	40 m Ω	40 m Ω	40 m Ω	Yes

5.3 Board description

Figure 2 describes the main blocks of the evaluation board.

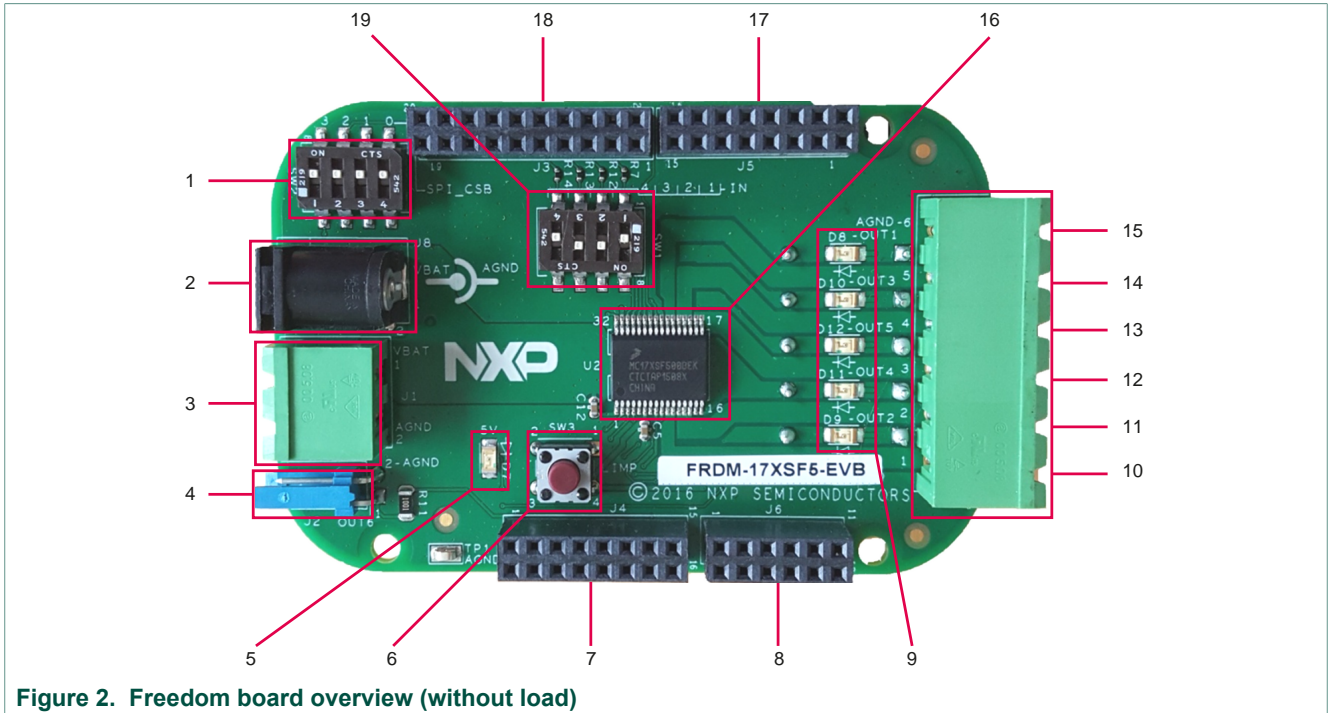


Figure 2. Freedom board overview (without load)

Table 2. Freedom board overview

Number	Description
1	SW2 CS pin selection
2	Connector J8 (Power supply)
3	Connector J1 (Power supply)
4	Connector J2 (OUT6)
5	5.0 V power supply LED
6	LIMP button
7	Connector J4
8	Connector J6
9	Output LEDs
10	Connector J7 (OUT2)
11	Connector J7 (OUT4)
12	Connector J7 (OUT5)
13	Connector J7 (OUT3)
14	Connector J7 (OUT1)
15	Connector J7 (GND)
16	MC17XSF500 IC
17	Connector J5

Number	Description
18	Connector J3
19	SW1 Direct control inputs

5.3.1 LEDs

The following LEDs are provided as visual output devices for the board:

Table 3. LED description

LED identifier	Description
D7	5 V power supply present (voltage regulator output)
D8	Output 1
D9	Output 2
D10	Output 3
D11	Output 4
D12	Output 5

5.3.2 Connectors

Input/output connectors provide the following signals:

Table 4. Connectors description

Connector identifier	Description
J1	VBAT Power (and AGND) connector
J2	External smart power switch control output (and AGND) connector
J3	2x10 Freedom board header
J4	2x8 Freedom board header
J5	2x8 Freedom board header
J6	2x6 Freedom board header
J7	Output 1 to 5 (and AGND) connector
J8	VBAT Power (and AGND) 5.5/2.1 mm socket

5.3.3 Switches definition

The following table defines the evaluation board switches and explains their functions:

Table 5. Switches definition

Switch	Description	Setting	Connection
SW1	Direct control inputs for outputs 1 to 4	ON	Corresponding channel is on when direct inputs are used and no level on MCU pin is set
		OFF	Corresponding channel is off when direct inputs are used and no level on MCU pin is set
SW2	Chip-select pin selection	1 ON, other OFF	CSB3 used as chip-select pin
		2 ON, other OFF	CSB2 used as chip-select pin
		3 ON, other OFF	CSB1 used as chip-select pin
		4 ON, other OFF	CSB0 used as chip-select pin

5.3.4 Test point definition

The following test point provides access to various signals to and from the board:

Table 6. Test point definition

Test point	Signal name	Description
TP1	AGND	Common ground for both MCU and analog Freedom board

5.3.5 Freedom board headers

[Table 7](#) contains information about compatibility with selected MCU Freedom boards:

Table 7. Compatibility with selected MCU Freedom boards

FRDM-12XSF-EVB		Pin description	FRDM-KL25Z		FRDM-K64F		FRDM-KV10Z	
J3 1	RSTB_FRDM	eXtreme Switch reset	J2 1	PTC12	J2 1	PTE26	J2 1	PTE18
J3 3	IN1	Direct control input 1	J2 3	PTC13	J2 3	X	J2 3	PTB1
J3 5	IN2	Direct control input 2	J2 5	PTC16	J2 5	X	J2 5	PTE19
J3 6	CSB0	Chip-select 0	J2 6	PTD0	J2 6	PTD0	J2 6	PTD6
J3 7	IN3	Direct control input 3	J2 7	PTC17	J2 7	X	J2 7	PTE17
J3 8	MOSI	SPI MOSI data	J2 8	PTD2	J2 8	PTD2	J2 8	PTC6
J3 9	IN4	Direct control input 4	J2 9	PTA16	J2 9	X	J2 9	PTE30
J3 10	MISO	SPI MISO data	J2 10	PTD3	J2 10	PTD3	J2 10	PTD3
J3 12	CLK	SPI clock	J2 12	PTD1	J2 12	PTD1	J2 12	PTC5
J3 13	CSB1	Chip-select 1	J2 13	PTE31	J2 13	X	J2 13	X
J3 18	CSB3	Chip-select 3	J2 18	PTE0	J2 18	X	J2 18	X
J3 19	CSB2	Chip-select 2	J2 19	PTD7	J2 19	X	J2 19	X
J5 5	CLK_FRDM	External clock for PWM	J1 5	PTC3	J1 5	PTC1	J1 5	PTE25
J5 6	CSNS_SYNC	Monitoring synchronization	J1 6	PTD4	J1 6	PTB9	J1 6	X
J6 6	CSNS	Monitoring output	J10 6	PTB2	J4 6	PTB10	J4 6	X

6 Installing the software and setting up the hardware

6.1 Using SPIGen software

6.1.1 Installing SPIGen freeware on your computer

The latest version of SPIGen is designed to run on Windows 8, Windows 7, Vista or XP-based operating systems.

To install the software, go to <http://www.nxp.com/FRDM-MC12XSF>. Locate and click **Jump Start Your Design**.

1. Download the SPIGen software as well as the associated configuration file.
2. Run the install program from the desktop. The Installation Wizard conducts the rest of the process.
3. To use SPIGen, go to the **Windows Start menu, Programs, SPIGen**, and then click on the **SPIGen icon**. The SPIGen Graphic User Interface (GUI) appears.
4. Go to the file menu in the upper left hand corner of the GUI, and select **Open**. Browse for the configuration file that was saved on the desktop earlier with the Jump start and select it ("12XSF_SPIGEN_eval.spi"), then click **Open**.
5. The GUI shown in [Figure 3](#) presents some basic SPI commands for quick evaluation of 12XSF devices in addition with access to I/Os with Extra pins. The commands are sent once (single command) or continuously in a loop (batch command).

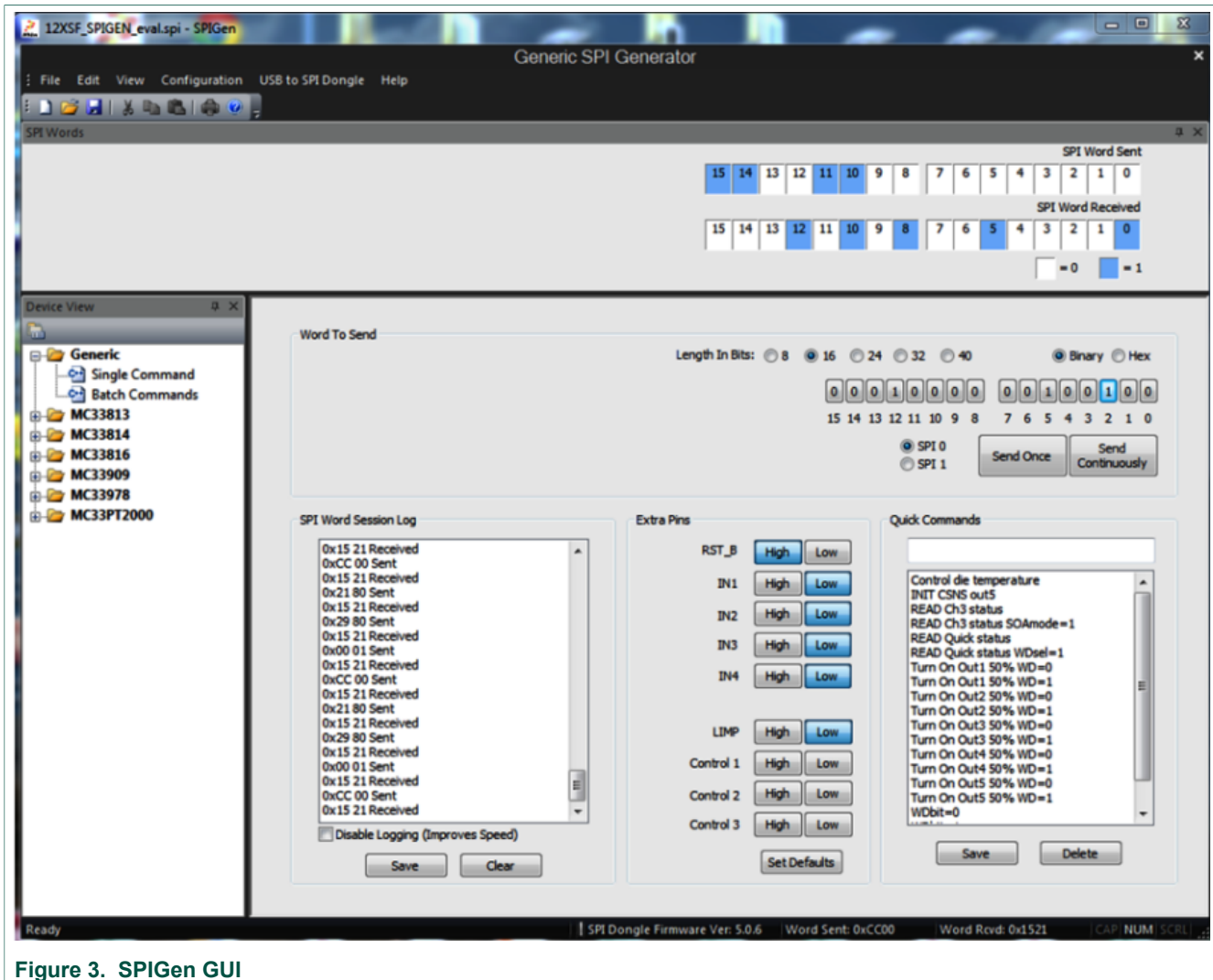


Figure 3. SPIGen GUI

6.1.2 Connecting FRDM-KL25Z Freedom Development Platform

FRDM-17XSF5-EVB can be used with KL25Z Freedom board using SPIGEN software. An USB cable from a USB host connected to KL25Z mini-B USB connector, SPIGEN (7.x and above) and a power supply are needed to use the kit.

Installing the drivers

To flash the Freedom board using drag and drop from Windows Explorer, USB Drivers and OpenSDA Firmware (MSD & Debug) from P&E Micro <http://www.pemicro.com/opensda> must be loaded on the board.

1. Enter OpenSDA Bootloader Mode
Unplug the USB cable if attached. Press and hold the Reset button (SW1). Plug in a USB cable between a USB host and the OpenSDA USB connector. Release the Reset button. A removable drive is visible in the host file system with a volume label of BOOTLOADER. You are now in OpenSDA Bootloader mode.
2. Load an OpenSDA Application
Locate the OpenSDA Applications folder from the downloaded zip file. Copy and paste or drag and drop the MSD Flash Programmer Application (MSD-FRDM-

KL25Z_vXYZ_Pemicro.SDA) to the BOOTLOADER drive (Make sure to unzip the file before doing the paste or drop). Unplug the USB cable and plug it again into the SDA USB Connector. The new OpenSDA Application is now running and a FRDM-KL25Z drive visible in the host file system.

3. Enter OpenSDA Bootloader Mode
 Locate SPIGEN UsbSpiDongleKL25Z_XXX.srec image folder in SPIGEN folder (C:\Program Files (x86)\SPIGen\SPI Dongle Firmware). Copy and paste or drag and drop the .srec files to the FRDM-KL25Z drive. Unplug the USB cable for the open SDA USB Connector and plug it to the USB_KL25Z.

6.1.3 Setting up the hardware using SPIGen

To perform the examples included in the software bundle, the following connections and setup must be performed:

1. Attach the +12 VDC supply to the VBAT input connector on the FRDM-17XSF5-EVB on J8 or J1 (making sure to observe the GND and +12 V terminals). The current capability of the +12 V supply should exceed the maximum total current that the number of simultaneously ON loads require.
2. Attach loads to the output terminals (OUT1..5).
3. Turn on the +12 V supply. Verify all is working correctly by observing the +5.0 V LED D7, which should be illuminated. .
4. Connect the KL25Z to the PC using the USB KL25Z port (left side of SW1). The hardware connection is shown in [Figure 4](#). A window pops up on the SPIGEN GUI as shown in [Figure 5](#).

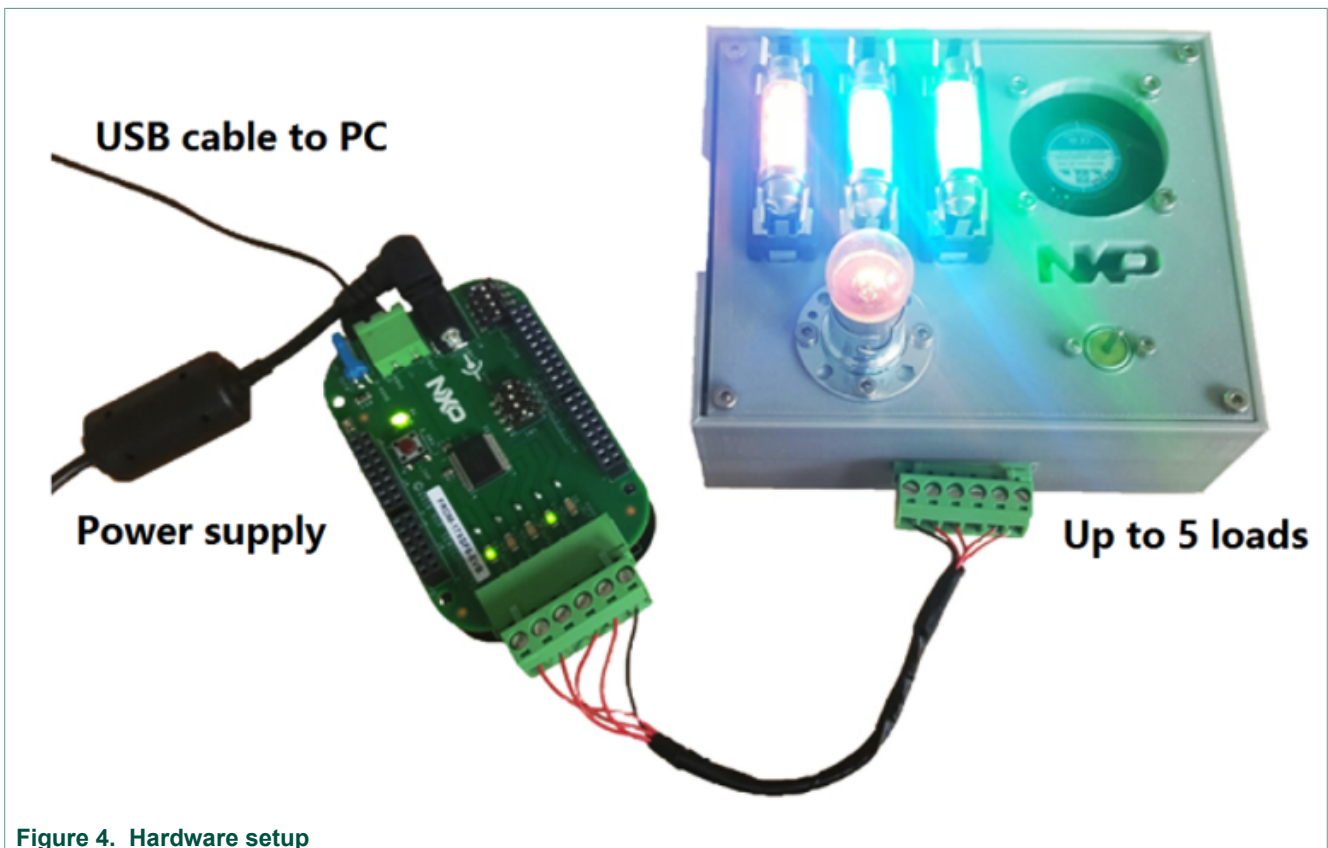


Figure 4. Hardware setup



Figure 5. FRDM-KL25Z connected

6.1.4 Running the example batch files

1. Make sure that bundle **12XSF_SPIGEN_eval.spi** is loaded on your SPIGEN interface.
2. Go to the **Batch commands** page and select the batch file you want to run. There are some choices that allows to Turn ON some outputs, simply refresh the Watchdog and read register, or root the IC's temperature to the analog pin CSNS. Click on the **Send Continuously** button.
3. Observe the desire effect on the outputs or on analog feedback pin CSNS. Note that we can force Fail-safe mode during the SPI communication by pushing LIMP button on board (SW3).

6.2 Using Kinetis Design Studio and Processor Expert

The **Gen4eXtremeSwitch** component for 12XSF and 12XS6 handles initialization, run-time configuration and diagnosis of the device via SPI, feedback measurement and direct input control.

The component package contains various examples showing features of both the component and the device. The component and some examples in the component package are intended for Kinetis Design Studio 3.2.0. For more information about **Gen4eXtremeSwitch** component, Processor Expert and installation of Kinetis Design Studio, see **Gen4eXtremeSwitch** component user guide available at <http://www.nxp.com/GEN4-EXTREMESWITCH-PEXPERT>.

7 Schematics

7.1 FRDM-17XSF5-EVB

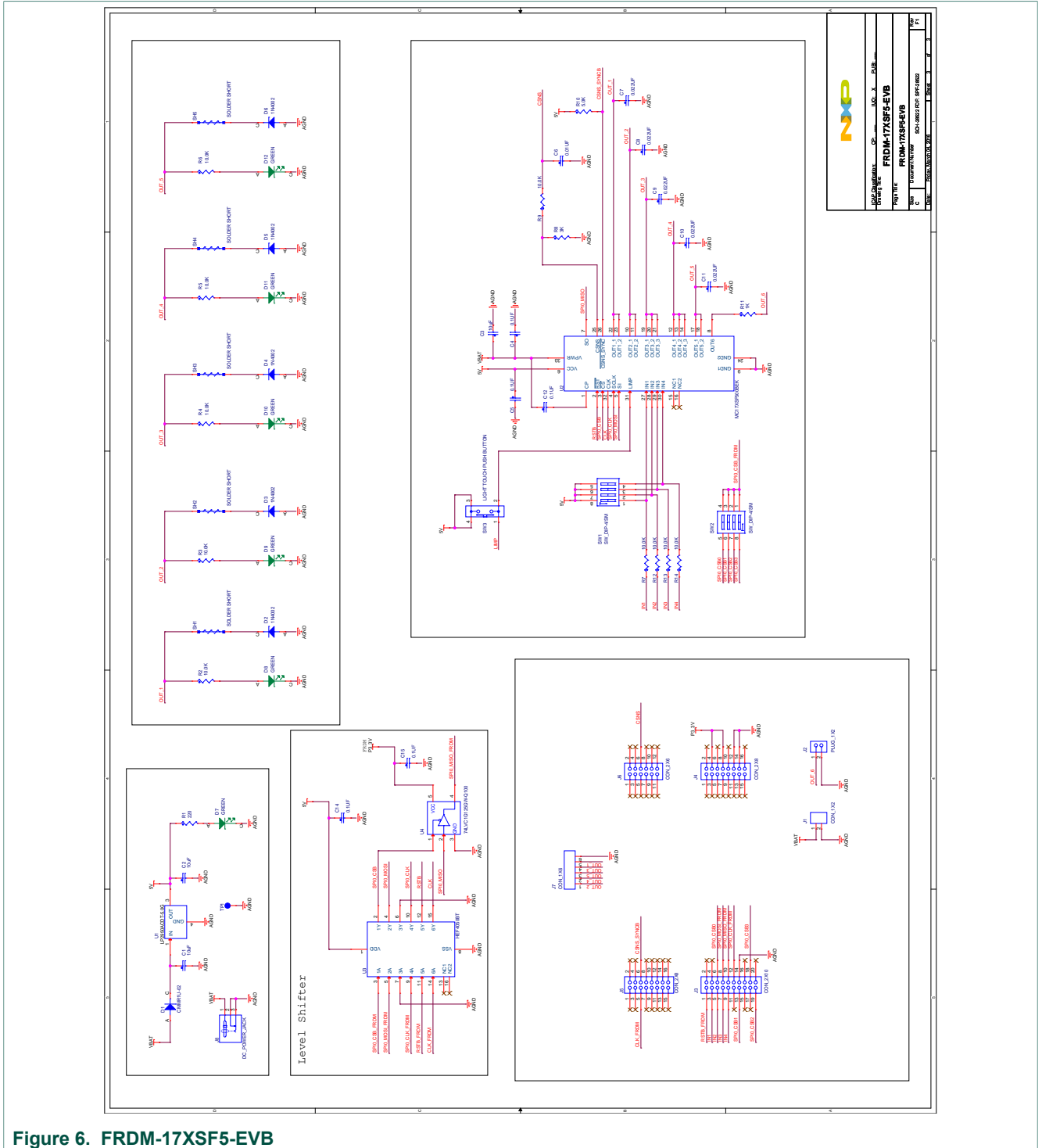


Figure 6. FRDM-17XSF5-EVB

7.2 FRDM-17XSF4-EVB

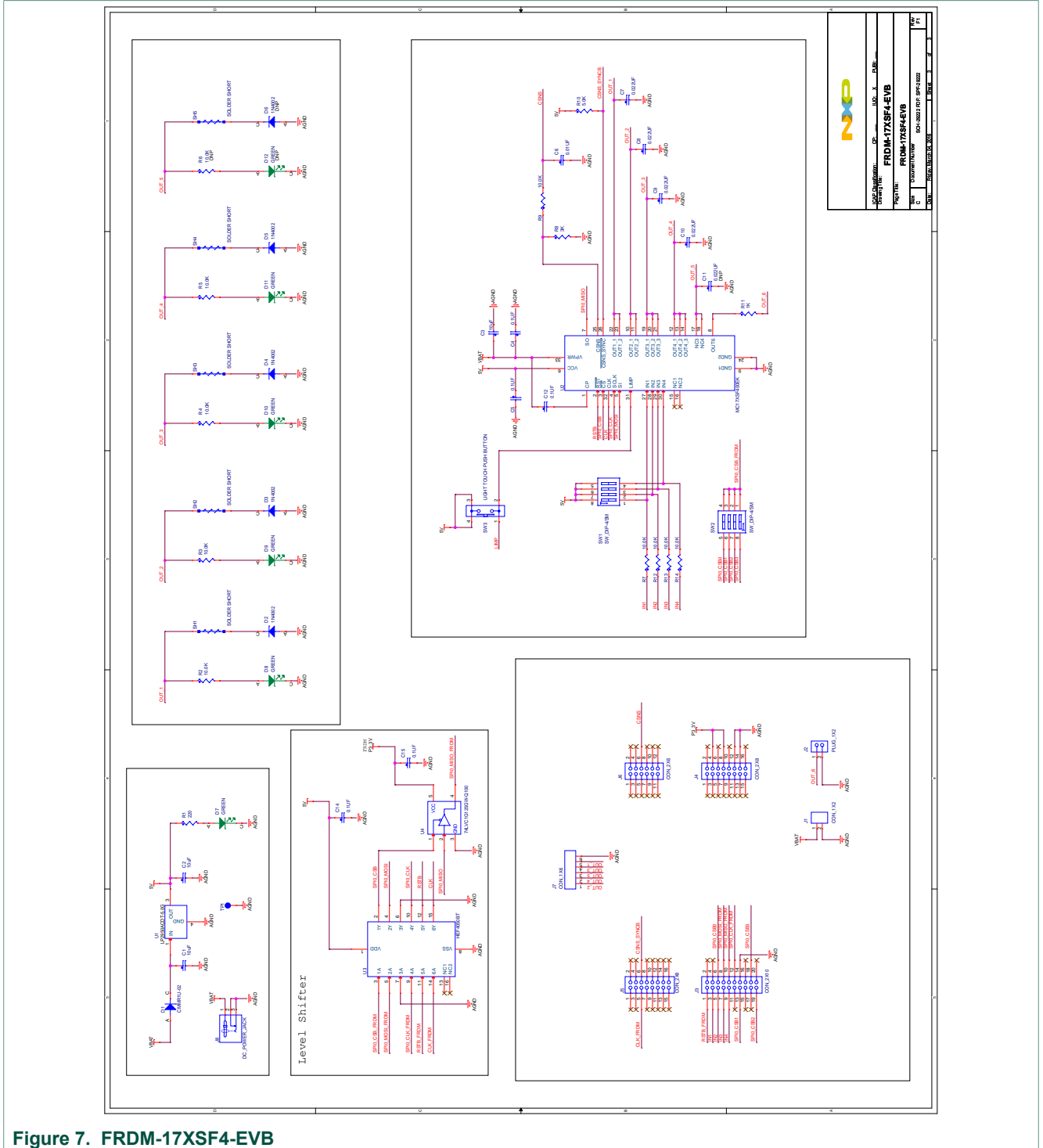


Figure 7. FRDM-17XSF4-EVB

7.3 FRDM-08XSF4-EVB

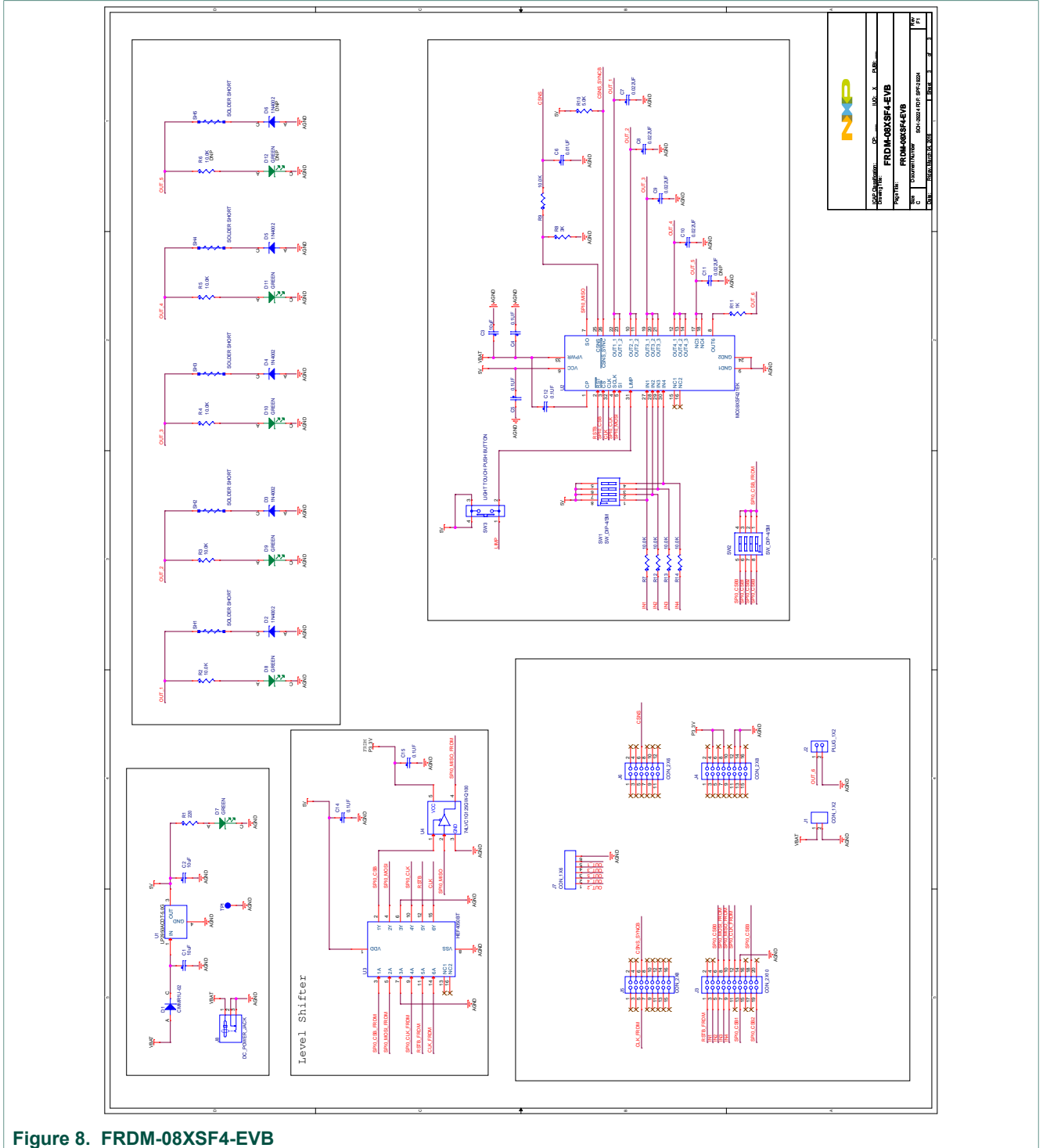


Figure 8. FRDM-08XSF4-EVB

7.4 FRDM-40XSF5-EVB

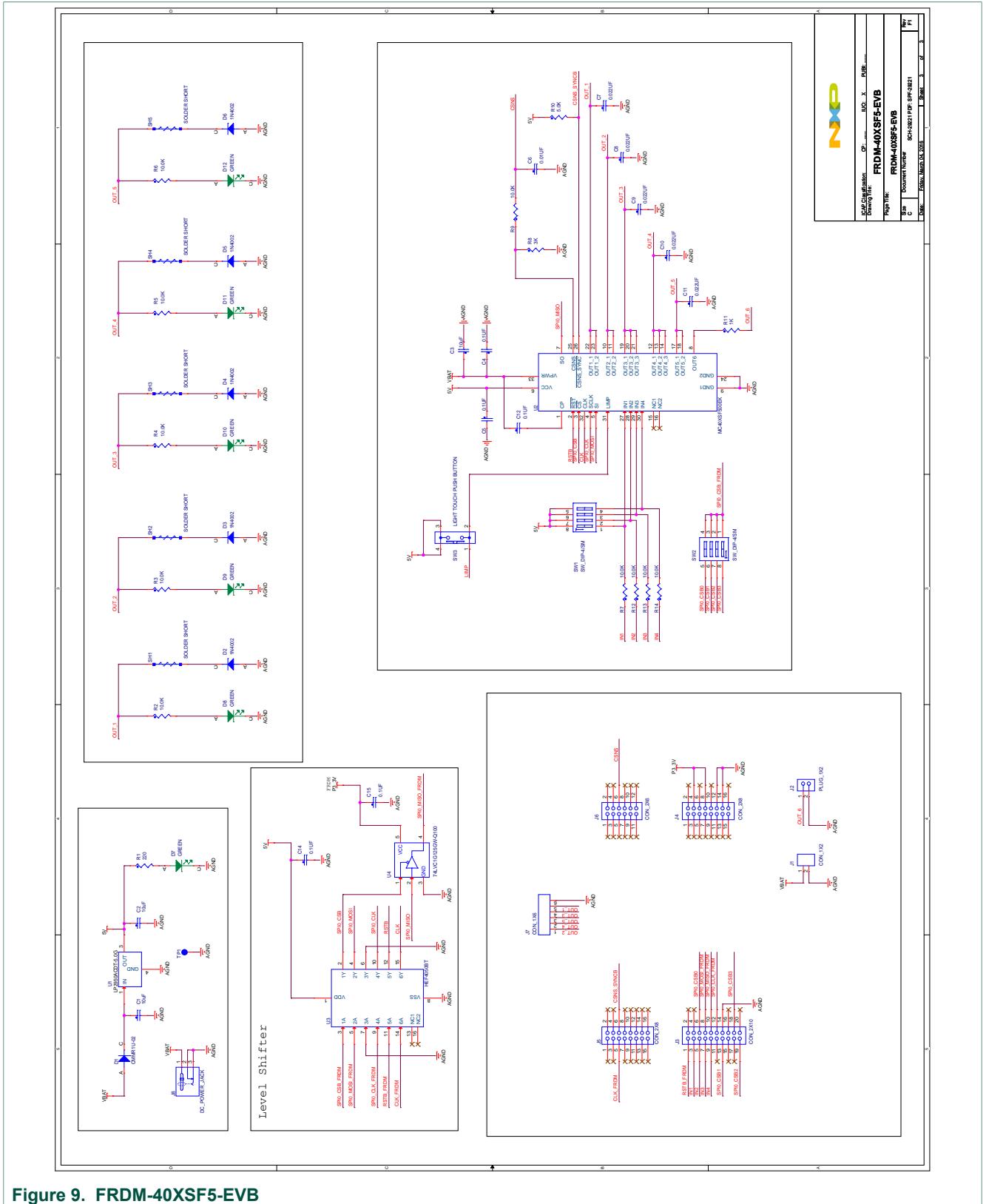
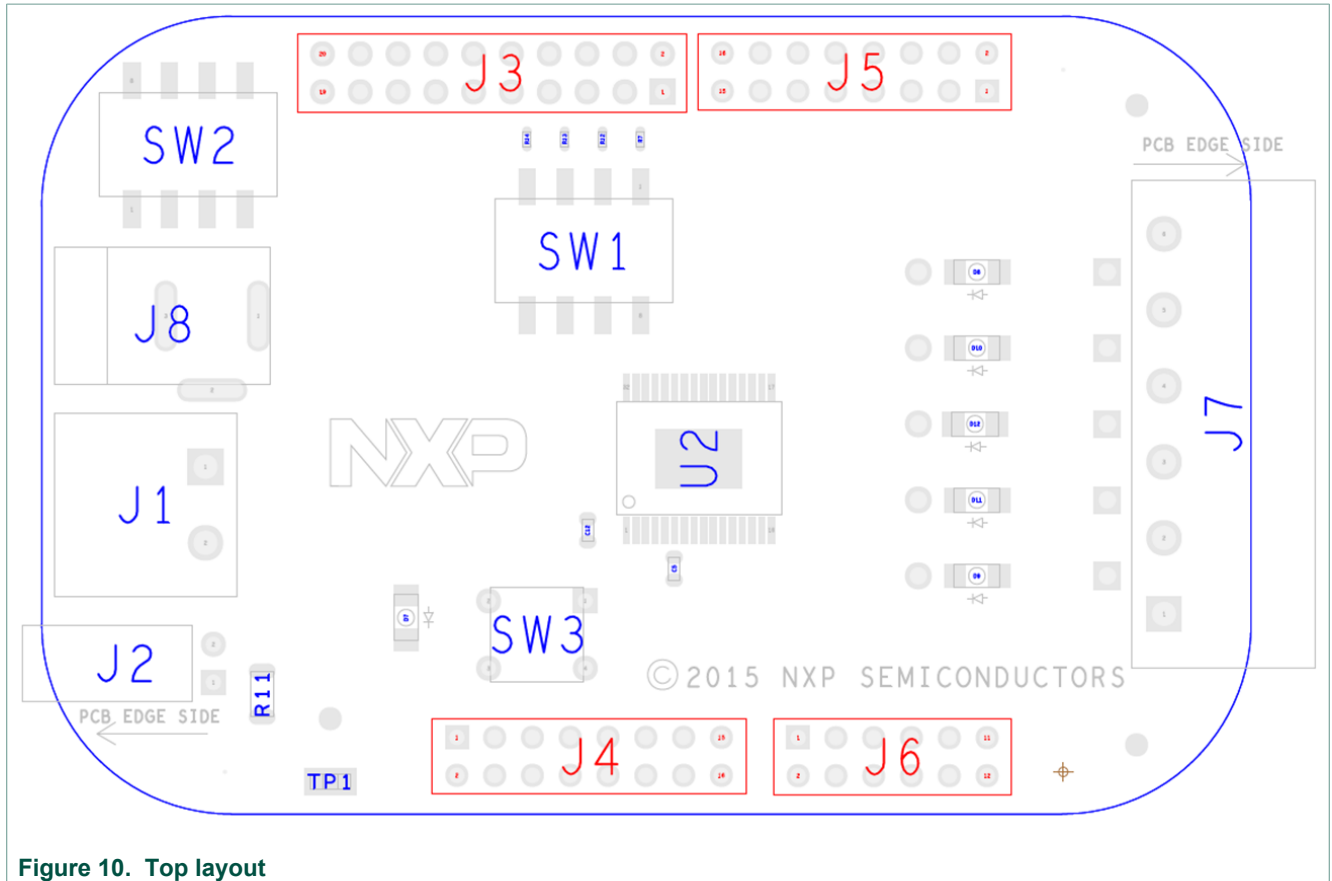


Figure 9. FRDM-40XSF5-EVB

8 Board layout



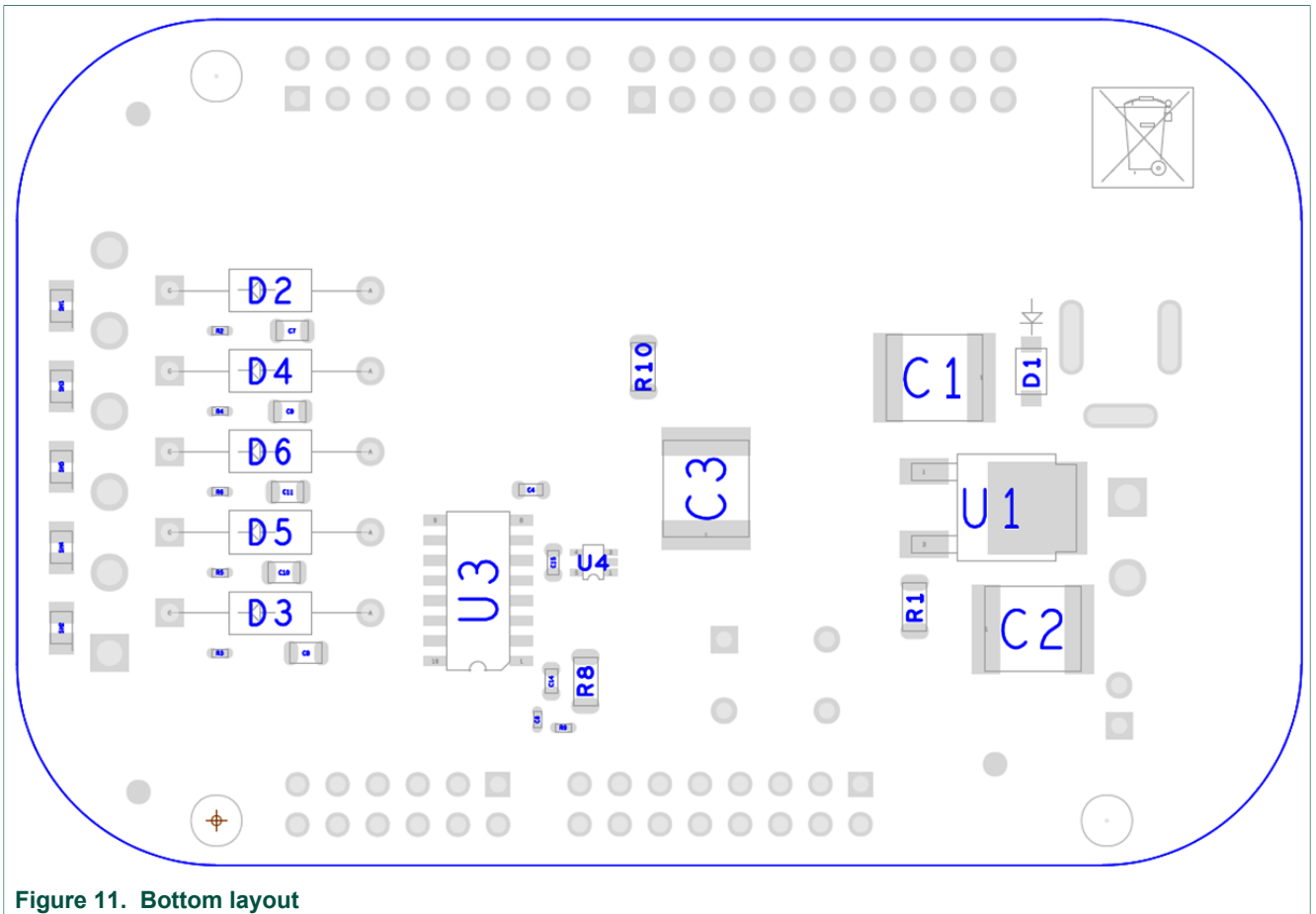


Figure 11. Bottom layout

9 Bill of materials

Bill of materials for FRDM-17XSF5-EVB, FRDM-17XSF4-EVB, FRDM-08XSF4-EVB and FRDM-40XSF5-EVB are available at <http://www.nxp.com/FRDM-MC12XSF> on the Overview tab under Get Started.

10 References

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

NXP.com support pages	Description	URL
Freedom development boards	Freedom development platform	http://www.nxp.com/freedom
Freedom evaluation board	Freedom evaluation board for eXtreme switch 12XSF and 12XS6	http://www.nxp.com/FRDM-MC12XSF
MC12XSF product summary page	External industrial lighting 5 MHz SPI-controlled switch	http://www.nxp.com/MC12XSF
MC12XS6 product summary page	External automotive lighting multichannel eXtreme switch	http://www.nxp.com/MC12XS6
FRDM-KL25Z	Freedom development platform for Kinetis KL14, KL15, KL24, KL25 MCUs	http://www.nxp.com/FRDM-KL25Z
SPIGen	SPI generator software	http://www.nxp.com/SPIGEN
Kinetis Design Studio	Integrated development environment with Processor Expert	http://www.nxp.com/KDS

11 Revision history

Revision history

Rev	Date	Description
v.1	20160516	<ul style="list-style-type: none"> Initial version
v.2	20180718	<ul style="list-style-type: none"> Added automotive reference (MC12XS6) in Section 5.1, Section 5.2 and Section 10 Updated Section 3

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Date of release: 18 July 2018