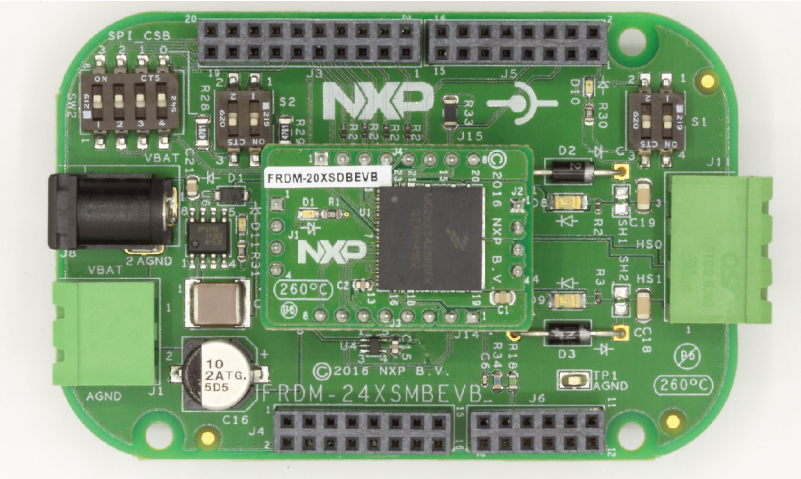
KTFRDM24XS4EVBUG

24 V multipurpose low $R_{DS(on)}$ eXtreme switch evaluation board user guide

Rev. 1 — 22 May 2017 User guide

1 FRDM-24XSMBEVB with its shield board and FRDM-KL25Z



aaa-026842

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

3.1 General information

This kit concerns the MC24XS4 extreme switch device family. Using this evaluation board is achieved by the superposition of the mother board FRDM-24XSMBEVB and one of the following shield boards integrating one device of the MC24XS4 family:

- FRDM-06XSDBEVB: dual 6 mΩ in 23-pin PQFN package
- FRDM-10XSDBEVB: dual 10 mΩ in 23-pin PQFN package
- FRDM-20XSDBEVB: dual 20 mΩ in 23-pin PQFN package
- FRDM-22XSDBEVB: dual 22 mΩ in 32-pin SOICEP package
- FRDM-50XSDBEVB: dual 50 mΩ in 32-pin SOICEP package

FRDM-24XSMBEVB and its shield board can be used with the FRDM-KL25Z Freedom board using SPIGen software. It can also be associated with KL25Z, KV10Z or K64F Freedom development platform using Kinetis design studio and Processor Expert component.

3.2 Kits contents/packing list

The FRDM-24XSMBEVB content includes:

- Assembled and tested evaluation board/module in antistatic bag
- Quick start guide
- Power connectors for supply and outputs

The FRDM-xxXSDBEVB content includes:

- Assembled and tested evaluation board/module in anti-static bag
- Quick start guide

3.3 Jump start

The analog product development boards of NXP provide an easy-to-use platform for evaluating NXP products. The boards support a range of analog, mixed-signal and power solutions. They incorporate monolithic ICs and system-in-package devices that use proven high-volume SMARTMOS 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.

1. Go to http://www.nxp.com/FRDM-24XSMBEVB
2. Review your tools summary page
3. Locate and click:



4. Download the documents, software and other information

Once the files are downloaded for your hardware, review the corresponding chapter in this user guide. The user guide includes setup instructions, BOM and schematics.

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Jump start bundles are available on each tool summary page with the most relevant and current information. The information includes everything needed for design.

3.4 Required equipment

This kit requires the following items:

- 3/16-inch blade screwdriver for connecting the cables
- DC power supply: 5.0 V to 36 V with up to 20 A current handling capability, depending on load requirements
- Typical loads (DC motor, bulbs, power resistors or inductive load with 20 A and 36 V maximum operation)
- One of the following Freedom boards for SPI communication, configuration and control:
  - KL25Z
  - KV10Z
  - K64F
- SPIGen software v7; see http://www.nxp.com/SPIGEN

3.5 System requirements

The kit requires the following to function properly with the different hardware:

- USB-enabled PC with Windows XP or higher

4 Getting to know the hardware

4.1 Board overview

The FRDM-24XSMBEVB associated with an expansion board, is an evaluation kit that exercises all the functions of the different devices from MC24XS4 family. It can be associated to each of the devices from this family. These devices are differentiated by their power channel $R_{DS(on)}$. Each device has two power outputs that can be parallelized. Its usage and control is only feasible through the hardware interface.

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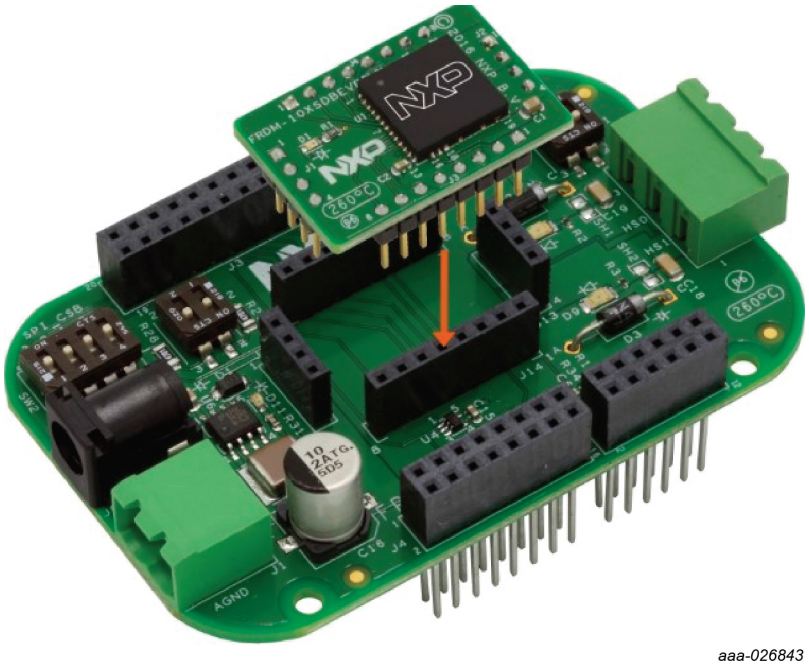


Figure 1. FRDM-24XSMBEVB and its shield board

The board can be used with different Kinetis MCU. This user guide is more dedicated on FRDM-KL25Z board connected to a USB port of a PC and SPIGen software.

Configuration, control and statis monitoring the status of the power is accomplished by using the SPI communication capabilities of the board. Control can be achieved through the GPIO, configuring the direct input pins. Embedded LEDs witnesses the faults, mode and output state.

4.2 Board features

The FRDM-24XSMBEVB is a tool to evaluate one of the NXP parts MC06XS4200, MC10XS4200, MC20XS4200, MC22XS4200 or MC50XS4200. The board set (mother board + expansion board) features:

- One fully protected dual smart high side switch
- 5 V voltage regulator
- One solder shunt per channel for freewheeling diode in case of high inductive loads
- 10 µF tank capacitor on supply terminal to help to maintain voltage during inrush current

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4.3 Device features

This evaluation board features the following NXP product:

Table 1. Device features

Device	Description	Features
MCxxXS4200[1]	The MCxxXS4200 is a dual smart high switch power IC, enhanced with SPI configurability, protection and diagnostic capabilities.	• Up to 12 A steady-state current per channel for 6 mΩ version • Separate bulb and DC motor latched overcurrent handling • Sleep mode with minimal supply current (< 10 µA @ 24 V) • Individually programmable internal/external PWM clock signals • Overcurrent, short-circuit, and overtemperature protection with programmable auto-retry functions • Accurate temperature and current sensing • Open-load detection (channel in OFF and ON state), also for LED applications (7.0 mA typ.) • Normal operating range: 8.0 V to 36 V; extended range: 6.0 V to 58 V • 3.3 V and 5.0 V compatible 16-bit SPI port for device control, configuration, and diagnostics at rates up to 8.0 MHz

[1] xx refers to the channel $R_{DS(on)}$. It can be either 06, 10, 20, 22 or 50 depending on the chosen expansion board.

For more details on this device, open the family webpage: http://www.nxp.com/MC24XS4

4.4 Application diagram

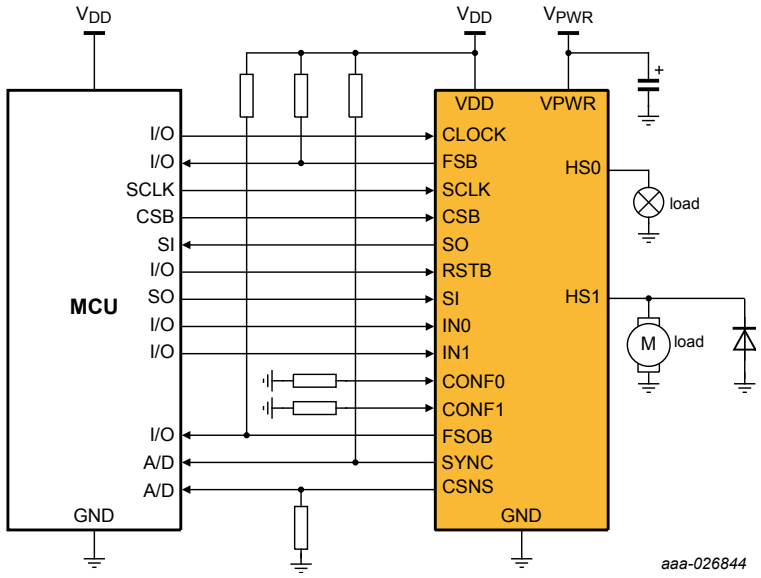


Figure 2. Application diagram

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4.5 Internal block diagram

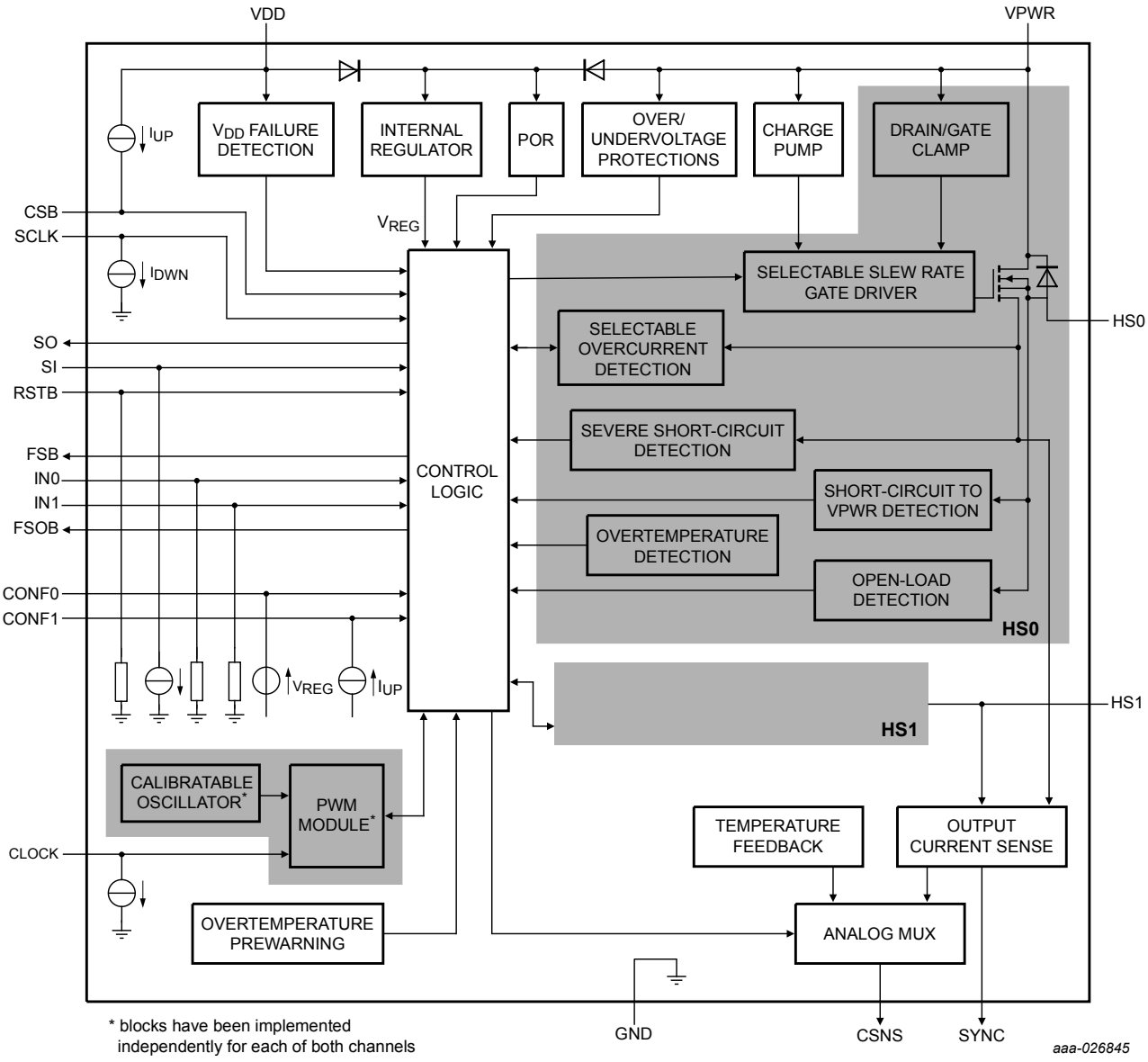


Figure 3. Internal block diagram

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4.6 Transient overcurrent protection management

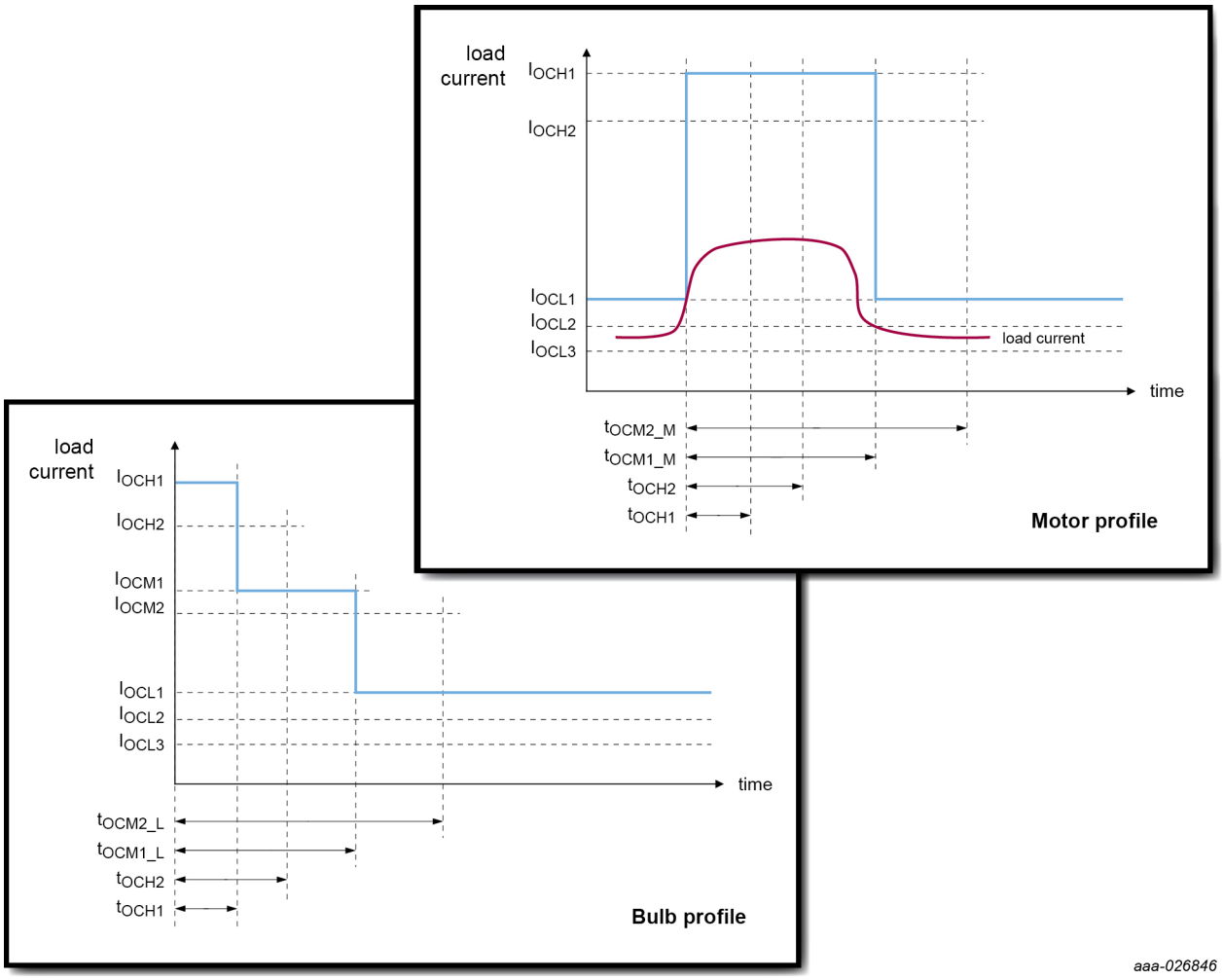


Figure 4. Overcurrent protection management

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4.7 Board description

Figure 5 describes the main elements on the FRDM-24XSMBEVB.

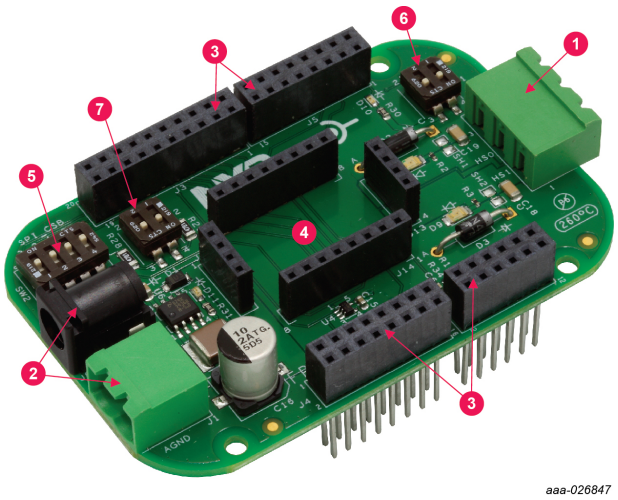


Figure 5. Board description

Table 2. Board description

Number	Name	Description
1	power output connectors	power connections for HS0, HS1 and GND
2	supply connectors	power connection for VPWR and GND (wire or laptop power supply)
3	Freedom connectors	female connectors for FRDM-KL25Z
4	connectors for shield board	foot print for FRDM-xxXSDBEVB dual high side smart power switches
5	CSB address selector	4 position switch for chip select rooting
6	direct input switches	IN0 and IN1 for direct input command
7	conf input switch	CONF0 and CONF1 switches for motor/lighting configuration

4.7.1 LEDs

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

Table 3. LED description

LED identifier	Location	Description
D10	FRDM-24XSMBEVB	fault status bar (FSB); witness that a fault occurs on the device
D11	FRDM-24XSMBEVB	5 V power supply present (voltage regulator output)
D8	FRDM-24XSMBEVB	output HS0
D9	FRDM-24XSMBEVB	output HS1
D1	FRDM-xxXSDBEVB	fail safe output bar (FSOB); witness that device is in fail safe mode

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4.7.2 Connectors

Table 4. Connectors description

Output name	Description
J1	VBAT power (and AGND) connector
J3	2x10 Freedom board header
J4	2x8 Freedom board header
J5	2x8 Freedom board header
J6	2x6 Freedom board header
J8	VBAT power (and AGND) 5.5/2.1 mm socket
J11	output HS0 and HS1 (and AGND) connector
J12	1x4 power connection to shield board (supply)
J13	1x4 power connection to shield board (outputs)
J14	1x8 signal connection to shield board
J15	1x8 signal connection to shield board

4.7.3 Switches definition

The mother board has two switches for the fail safe configuration:

Table 5. Switches definition

Switch	Description	Setting	Connection
S1	direct control inputs for HS0 and HS1	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
S2	configuration inputs for HS0 and HS1	ON	corresponding channel is set to motor profile current protection
		OFF	corresponding channel is set to lighting profile current protection
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

4.7.4 Test point definition

Table 6. Test point definition

Test point	Location	Name	Description
TP1	FRDM-24XSMBEVB	AGND	common ground for MCU and analog Freedom board
TP1	FRDM-xxXSDBEVB	AGND	common ground for MCU and analog Freedom board

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4.7.5 Freedom board headers

Table 7 contains information about compatibility with FRDM-KL25Z and its SPIGen software:

Table 7. Pin connection with FRDM-KL25Z and SPIGen software

FRDM-24XSMBEVB			Pin description	FRDM-KL25Z			SPIGen software
J2	1	RSTB	eXtreme switch reset	J2	1	PTC12	data 0
J2	3	IN0	direct input control HS0	J2	3	PTC13	data 1
J2	5	IN1	direct input control HS1	J2	5	PTC16	data 2
J2	6	SPI0_CSB0	chip select 0	J2	6	PTD0	SPI0_CS
J2	7	CONF0	configuration pin HS0	J2	7	PTC17	data 3
J2	8	MOSI	SPI MOSI data	J2	8	PTD2	SPI0_MOSI
J2	9	CONF1	configuration pin HS1	J2	9	PTA16	data 4
J2	10	MISO	SPI MISO data	J2	10	PTD3	SPI0_MISO
J2	12	CLK	SPI clock	J2	12	PTD1	SPI0_CLK
J2	13	CSB1	chip select 1	J2	13	PTE31	Ctrl1
J2	18	CSB3	chip select 3	J2	18	PTE0	Ctrl3
J2	19	CSB2	chip select 2	J2	19	PTD7	Ctrl2
J5	5	CLK	clock pin for PWM	J1	5	PTC3	CLKOUT
J5	6	CSNS_SYNCB	synchronization signal	J1	6	PTD4	n/a
J5	8	FSB	fault status signal	J1	8	PTA12	n/a
J6	6	CSNS	monitoring output	J10	6	PTB2	n/a

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5 Operation with FRDM-KL25Z Freedom and SPIGen

The NXP Freedom development platform is a set of software and hardware tools supporting evaluation and development. It is ideal for rapid prototyping of microcontroller-based applications. The NXP Freedom KL25Z hardware, FRDM-KL25Z, is a simple, yet sophisticated design featuring a Kinetis L series microcontroller, the first microcontroller of the industry built on the ARM Cortex-M0+ core.

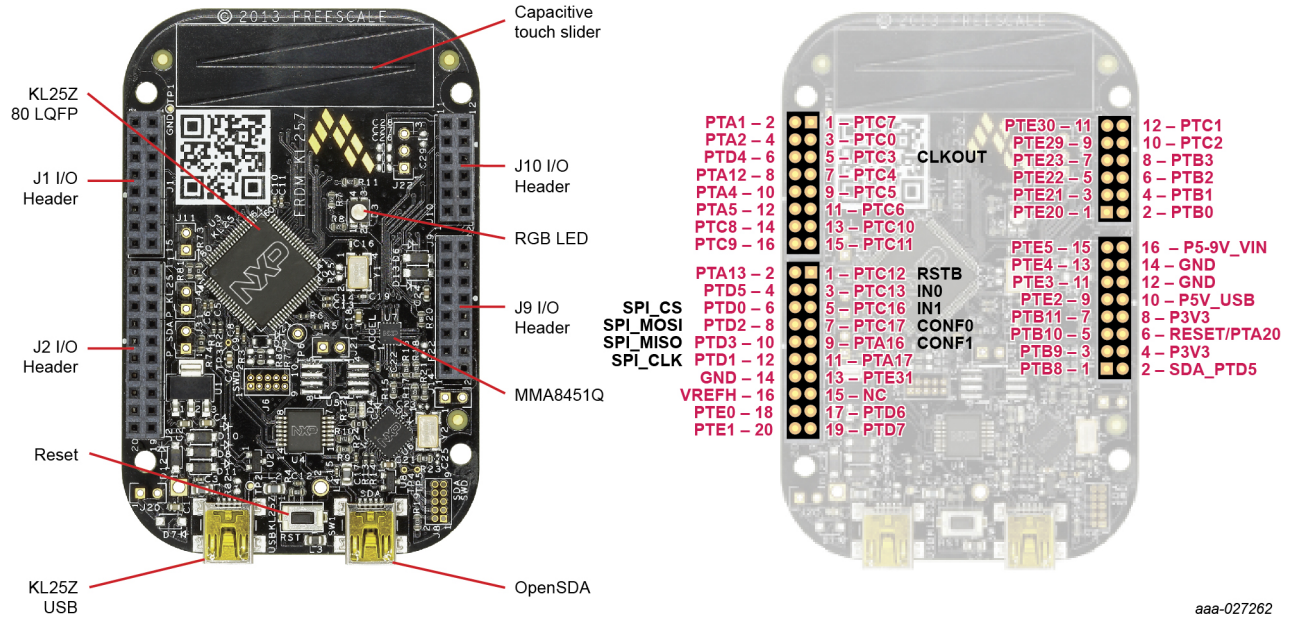


Figure 6. FRDM-KL25Z

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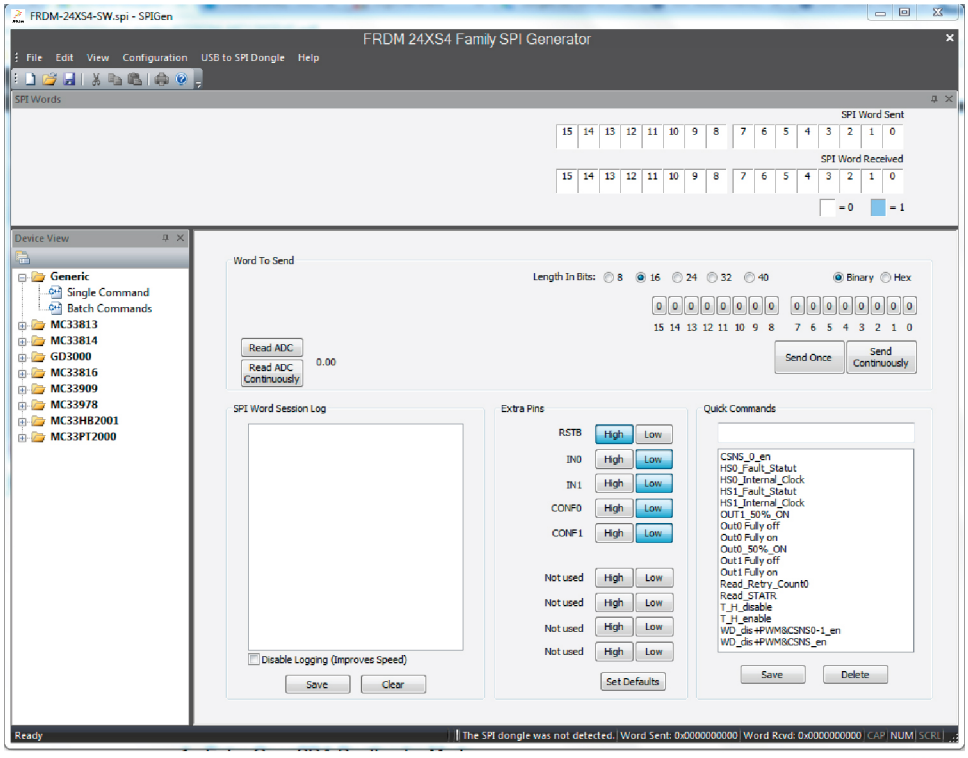
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5.1 Installing SPIGen freeware on your computer

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

To install the software, go to http://www.nxp.com/FRDM-24XSMBEVB-Downloads. Locate and click jump start your design.

1. Download the SPIGen software as well as the associated configuration file.
2. Run the installed 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 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 option and select it (FRDM-24XS4-SW.spi), then click open.
5. The GUI shown in Figure 7 presents some basic SPI commands for quick evaluation of devices from MC24XS4 family, in addition with access to I/Os with extra pins. The commands are sent once (single command) or continuously in a loop (batch command).



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Figure 7. SPIGen GUI

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5.2 Installing the drivers

To flash the Freedom board using drag and drop from Windows-Explorer, USB drivers and OpenSDA firmware (MSD and debug) from P&E http://www.pemicro.com/opensda must be loaded on the board.

5.2.1 Enter OpenSDA boot loader mode

1. Unplug the USB cable if attached from the FRDM-KL25Z
2. Press and hold the reset button (SW1)
3. Plug in a USB cable between a USB host and the OpenSDA USB connector
4. 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 boot loader mode.

5.2.2 Load an OpenSDA application

1. Locate the OpenSDA applications folder from the downloaded zip file
2. 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.
3. 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.

5.2.3 Using the MSD flash programmer

1. Locate SPIGen UsbSpiDongleKL25Z_XXX.srec image folder in SPIGen folder C:\Program Files (x86)\SPIGen\SPI Dongle Firmware
2. Copy and paste or drag and drop the .srec files to the FRDM-KL25Z drive. Unplug the USB cable for the OpenSDA USB connector and plug it to the USB_KL25Z.

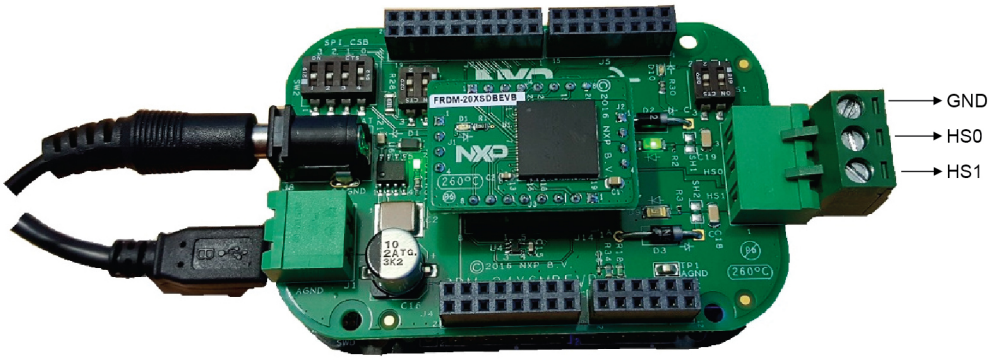
5.3 Setting up the hardware using SPIGen

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

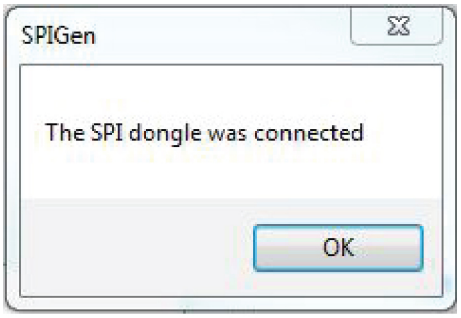
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1. Attach the +24 V DC supply to the V_{BAT} input connector on the FRDM-24XSMBEVB on J8 or J1 (making sure to observe the GND and +24 V terminals). The current capability of the +24 V supply should exceed the maximum total current that the number of simultaneously ON loads requires.
2. Attach the FRDM-24XSMBEVB to FRDM-KL25Z and loads to the output terminals (HS0 and HS1)
3. Turn on the +24 V supply. Verify all is working correctly by observing the +5.0 V LED D11, which should be illuminated.
4. Connect the KL25Z to the PC using the USB KL25Z port (left side of SW1). A window pops up on the SPIGen GUI.

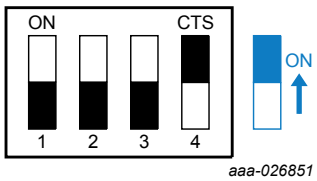


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5. The switch SW2 must be set according to the default CSB0 connection from FRDM-KL25Z to the device:



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6. Connect loads to the screw terminal J11

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5.3.1 Running over the GUI and the different commands

1. Make sure that bundle FRDM-24XS4-SW.spi is loaded on your SPIGen interface
2. The software presents some basic SPI commands for quick evaluation of MC24XS4 devices in addition with access to I/Os with extra pins. Use single command or batch command to send commands continuously in a configurable loop.
3. Set RSTB to HIGH inside the extra pins box and go to the batch commands page. In order to initialize the device with internal clock for PWM and disable the watchdog, select the batch file 'init'.
4. Now you can either try the batch sequence 'flasher' that toggle the output ON/OFF at 1 Hz or try various presaved commands on 'single command' pane.

6 Using Kinetis design studio and Processor Expert

The 36 V eXtreme switch component for MC24XS4 devices family handles initialization, runtime configuration and diagnosis of the device via SPI, feedback measurement and direct input control.

Under the jump start section, there is a basic software sample that can be used for easy start of using this hardware with Kinetis design studio. This software example in the component package is intended for Kinetis design studio 3.2.0.

This section describes how to import the component and software example into Kinetis design studio. For more information about 36 V eXtreme switch component, installation and usage of Kinetis design studio, see user guides dedicated for Freedom usage with KDS at http://www.nxp.com/FRDM-MC36XSD-EVB.

6.1 Setting up the software

Before any evaluation on FRDM-24XSMBEVB board, you need the following:

1. Kinetis design studio 3.2.0 or higher installed: http://www.nxp.com/KDS
2. Download example project and 36 V eXtreme switch component SW-KDS-MC24XS4.zip file and unzip it into your computer: http://www.nxp.com/FRDM-24XSMBEVB-Downloads

36 V eXtreme switch is an analog software component that contains low-level drivers used to make device operational in an easy and quick way.

6.2 Import the project example with CodeWarrior

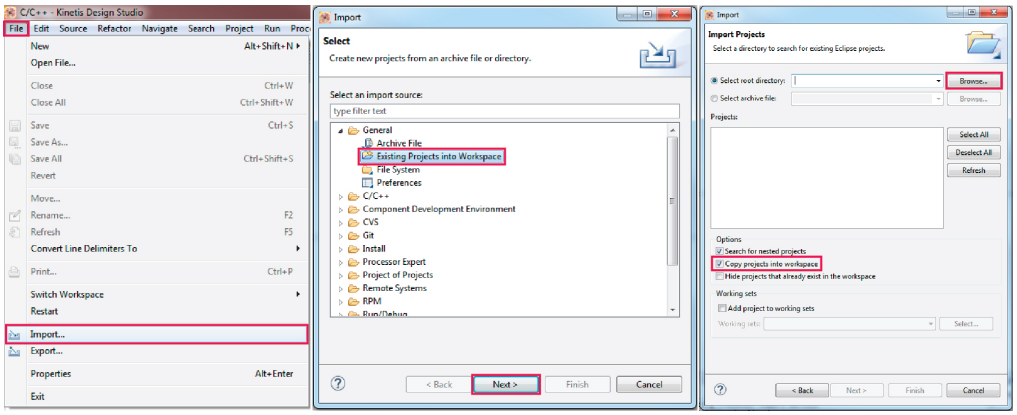
This portion of the user guide depicts how to import a software example dedicated for this hardware and connections.

To get more information on how to create a project with Kinetis design studio and Processor Expert, see detailed steps in http://www.nxp.com/PEXMC36XSDSWUG.

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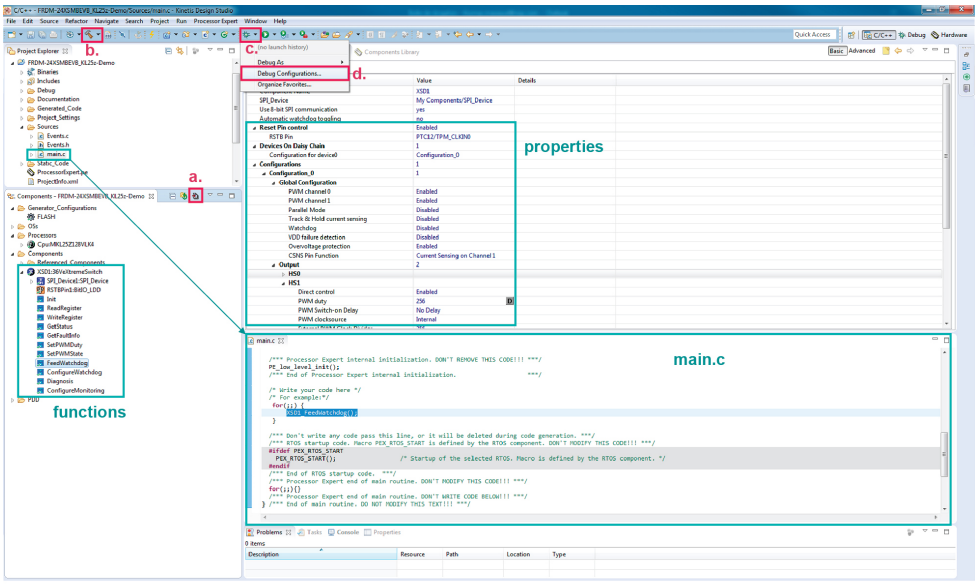
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1. Open Kinetis design studio on your computer and set a default workspace
2. In the menu bar, click File → Import.
   In the pop-up window, select General → Existing Projects into Workspace, then click Next.
   In the Import Projects window, click Browse and locate the folder where the downloaded files were unzipped. Select FRDM-24XSMBEVB_KL25Z-Demo and click Finish.



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3. Now the demo project is open, do the following steps:
   a. Generate code
   b. Build
   c. Debug Configurations\FRDM-24XSMBEVB_KL25Z-Demo_FLASH_OpenSDA
   d. Click Debug button



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This example project configures the outputs through the Processor Expert component properties to: HS0 = 100 % ON and HS1 = 50 % ON with internal clock.

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You can go through the main.c to draw your own code, use some of the functions listed under the XSD1:36VeXtremeSwitch component or configure the different properties set during initialization.

7 Schematics, board layout and bill of materials

Schematics, board layout and bill of materials are available on the tool summary page http://www.nxp.com/FRDM-24XSMBEVB.

8 References

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

Support page	Description	URL
FRDM-24XSMBEVB	tool summary page	http://www.nxp.com/FRDM-24XSMBEVB
MC24XS4	product summary page	http://www.nxp.com/MC24XS4
FRDM-KL25Z	tool summary page	http://www.nxp.com/FRDM-KL25Z
KDS v3.2	Kinetis design studio	http://www.nxp.com/KDS
TWR-MC36XSDEVB	tool summary page	http://www.nxp.com/TWR-MC36XSDEVB
FRDM-MC36XSDEVB	tool summary page	http://www.nxp.com/FRDM-MC36XSD-EVB

9 Revision history

Revision	Date	Description
1	20170522	initial release

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