KTFRDMPKPT2000EVM

FRDMPKPT2000EVM evaluation board

Rev. 1.0 — 7 December 2016 User guide

1 FRDMPKPT2000EVM

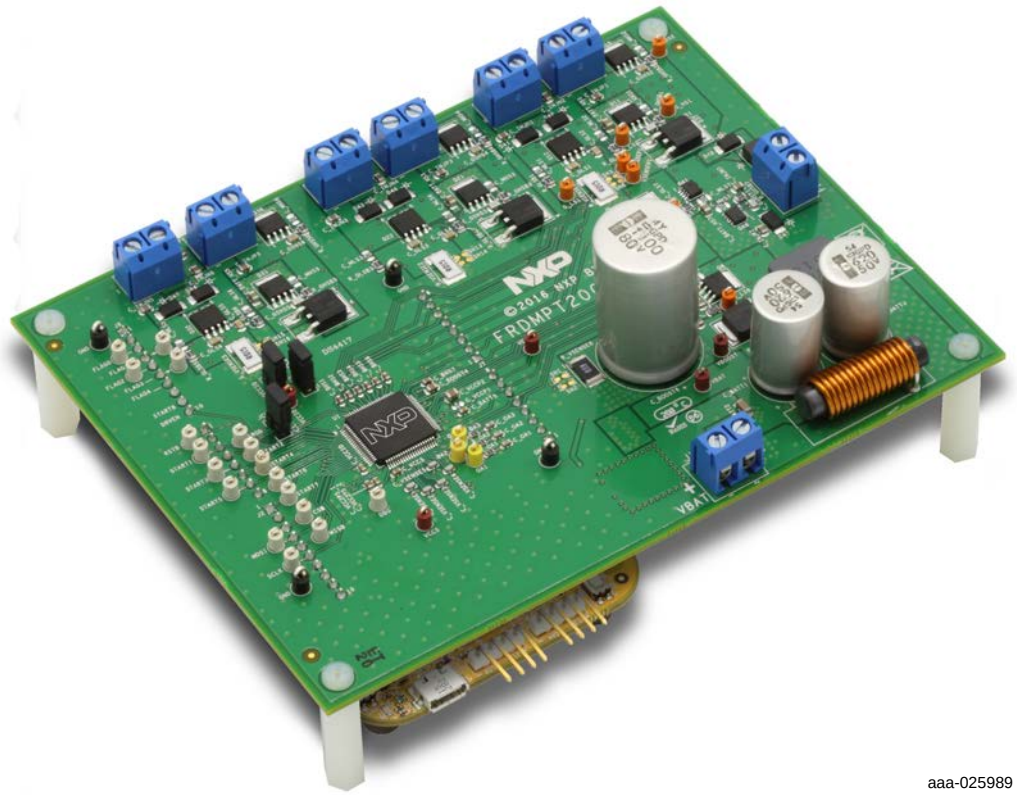

Figure 1. FRDMPKPT2000EVM

2 Important notice

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3 Overview

The FRDMPKPT2000EVM evaluation module provides a platform for developing and testing automotive fuel-injection control systems based on NXP's MC33PT2000 direct injection pre-driver IC. The evaluation module consists of the FRDMPT2000EVM board and a companion FRDMPK144-Q100 board.

The FRDMPT2000EVM contains an MC33PT2000 Programmable Solenoid Controller (PSC) and provides connections for up to six fuel injectors, a fuel pump and a DC/DC converter. The MCU used on the FRDMPK144-Q100 board is the S32K144, an automotive Kinetis processor which offers the high-speed performance required to evaluate PT2000 automotive fuel system designs. While the FRDMPK144-Q100 features a range of capabilities, its primary purpose when used with the FRDMPKPT2000EVM is to control SPI and digital I/O communications with the MC33PT2000.

The boards are attached by means of two parallel rows of single Arduino™ connectors on the top (FRDMPK144-Q100) or bottom (FRDMPT2000EVM) of each board. In this configuration the developer interacts with the MC33PT2000 by connecting a USB cable between a USB port on a host PC and an OpenSDA USB port on the FRDMPK144-Q100. NXP's S32 Design Studio software serves as the platform for developing application-specific microcode and downloading it to the FRDMPK144-Q100 through the OpenSDA port. Alternatively, NXP's PT2000 Design Studio provides a software platform for developing microcode for the FRDMPT2000EVM.

With the FRDMPKPT2000EVM in this configuration, the developer can run application code but cannot directly access the registers and memory locations on the MC33PT2000 device. For developers who wish to read and write to device registers and memory during the development process, an alternative configuration is available. By replacing the FRDMPK144-Q100 with a FRDM-KL25Z board (sold separately), the developer can use NXP's SPIGen software to directly access the MC33PT2000 on the FRDMPT2000EVM board. However, this configuration has limitations. The FRDM-KL25Z MCU is designed for commercial use and may not be able to meet the performance demands of automotive applications being evaluated in real time.

4 Getting started

4.1 Kit contents/packing list

The FRDMPKPT2000EVM development kit contents includes:

- Assembled and tested FRDMPT2000EVM board mounted to a FRDMPK144-Q100 board in anti-static bag
- Quick start guide

4.2 Jump start

NXP's analog product development boards 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 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/FRDMPKPT2000EVM.
2. Review your Tools Summary Page.
3. Locate and click:

4. Download the documents, software and other information.

Once the files are downloaded, review the user guide in the bundle. The user guide includes setup instructions, BOM and schematics. Jump start bundles are available on each tool summary page with the most relevant and current information. The information includes everything needed for design.

4.3 Required equipment

This kit requires the following items:

- 1/8" blade screwdriver for connecting the loads
- DC Power supply: 12 V with minimum 5.0 A current handling capability, depending on load requirements
- USB Standard A (male) to micro-B (male) cable (for included K144 Freedom board)
- USB Standard A (male) to mini-B (male) cable (for optional KL25Z Freedom board)
- Typical loads (direct injection fuel injectors)
- FRDM-KL25Z Freedom Development Platform for SPI communication (optional)
- NXP SPIGen software (for use with optional FRDM-KL25Z based SPI Dongle)
- NXP's S32 Design Studio software (for use with the FRDM-PK144-Q100)
- NXP's PT2000 Developer Studio (for use with the FRDM-PT2000-EVM)

4.4 System requirements

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

- USB enabled computer running Windows 7 or newer

5 Getting to know the hardware

The FRDMPKPT2000EVM consists of two boards: The FRDMPT2000EVM board and an attached FRDMPK144-Q100 board. An optional FRDM-KL25Z (sold separately) may also be used with the FRDMPT2000EVM. This section describes all three boards.

5.1 The FRDMPT2000EVM board

5.1.1 Board overview

The FRDMPKPT2000EVM serves as the interface between the MC33PT2000 and the components it controls. The board contains a commercial version of the MC33PT2000 and connectors for up to six fuel injectors, a fuel pump and a DC/DC converter.

5.1.2 Board features

The board features are as follows:

- an MC33PT2000 direct injection pre-driver integrated circuit
- external MOSFETs
- power-conditioning circuitry
- +12 V to +36 V VSUPP power to the MC33PT2000

5.1.3 Block diagram

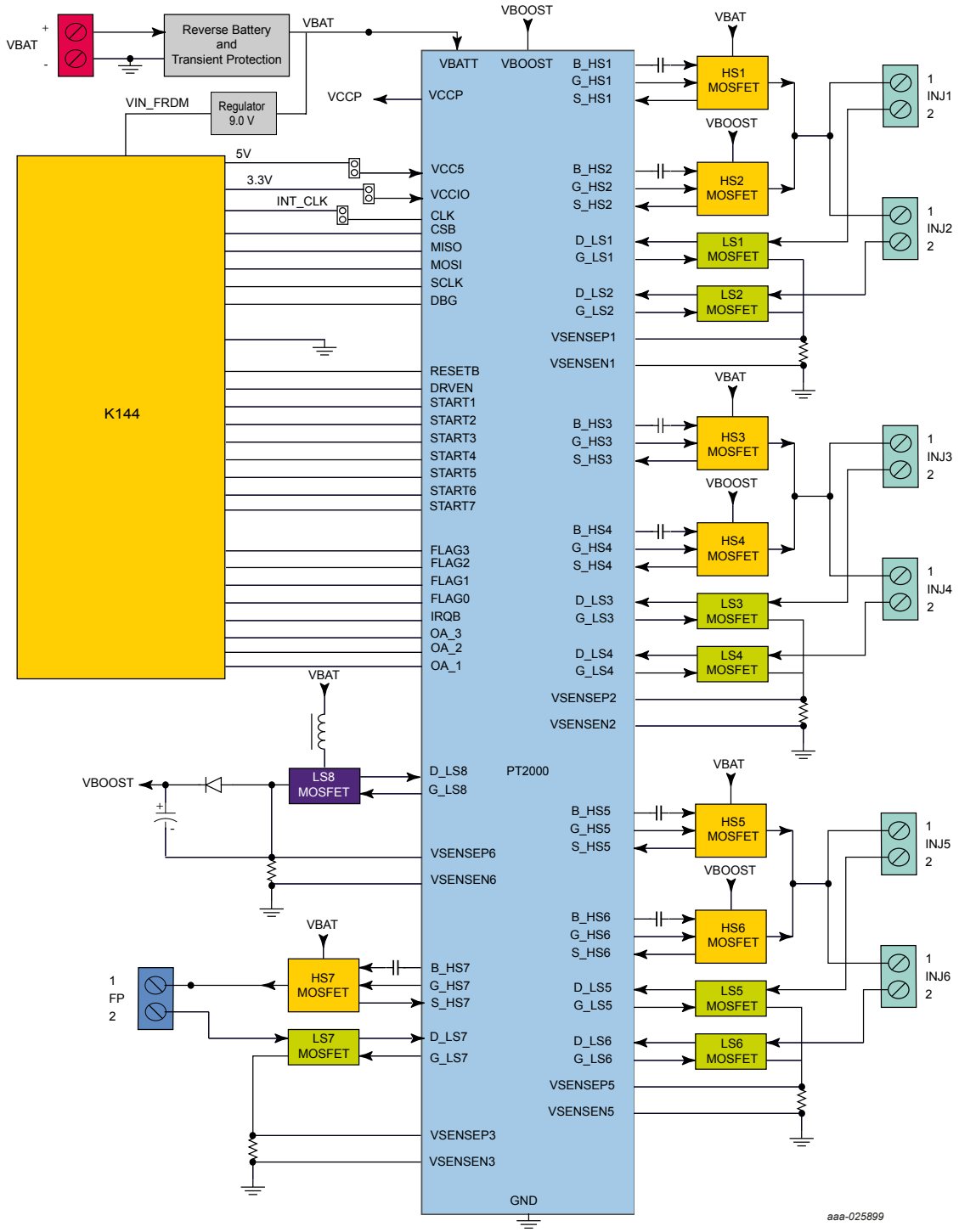

Figure 2. Block diagram

Note: *The 9.0 V is regulator is optional and is used only to allow high voltage on the battery without damaging the MCU. The PT2000 supports up to 72 V on the battery line, but the reverse battery FETs are only rated to 40 V. Therefore, the board supply should be limited to 36 V.*

5.1.4 Device features

Table 1. Device features

Device	Description	Features
MC33PT2000	Programmable Solenoid Controller, 5 high-sides and 7 low-sides	• Battery voltage range, 5.5 V < VBATT < 32 V • Pre-drive operating voltage up to 72 V • High-side/low-side pre-drive PWM capability up to 100 kHz • Four selectable slew rates with all pre-drivers • Eight selectable, pre-defined VDS monitoring thresholds • Encryption for microcode protection • Integrated 1.0 MHz back-up clock
MCU S32K144	Microcontroller	• 112 MHz ARM Cortex-M4 core with SFPU • Modified Harvard architecture to support tightly coupled RAM and 4 KB I/D cache • Hardware security engine supporting SHE specification • 128-bit unique identification (UID) number per chip • Internal 48 MHz RC (IRC) oscillator • Up to six FlexCAN, a maximum of two with FD support • FlexIO emulating communication protocols, e.g. SPI, UART, etc. • Supports ISO 26262 ASIL-B

5.1.5 Board description

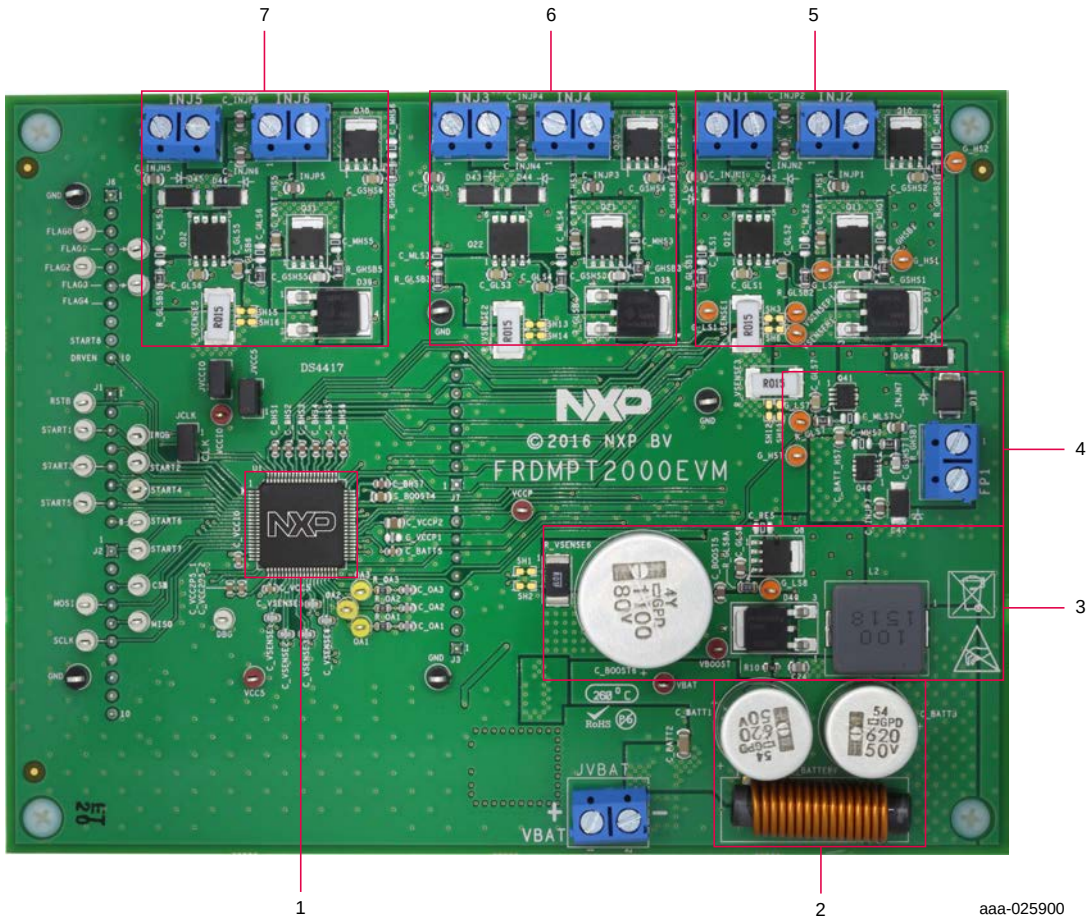

Figure 3. Board description

Table 2. Board description

Number	Name	Description
1	MC33PT2000	Programmable solenoid controller
2	Pi filter	Circuitry to remove undesired frequencies
3	DC/DC	DC/DC converter to generate BOOST voltage
4	Fuel pump	One high-side and one low-side control for high pressure fuel pump
5	Injector Bank 1	Two high-side and two low-side controls for fuel injectors 1 and 2
6	Injector Bank 2	Two high-side and two low-side controls for fuel injectors 3 and 4
7	Injector Bank 3	Two high-side and two low-side controls for fuel injectors 5 and 6

5.1.6 Jumper definitions

Figure 4 shows the location of jumpers on the FRDM-PT2000-EVM board.

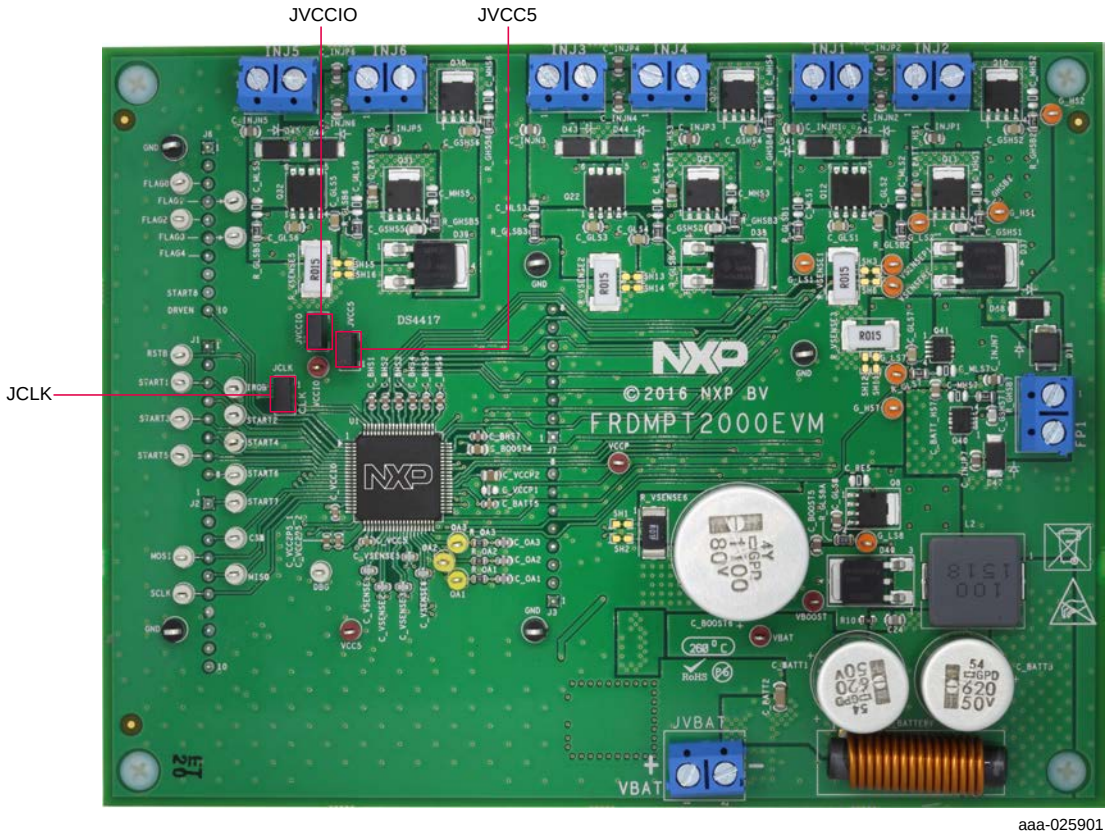

Figure 4. Jumper locations

Table 3 describes the function of the board jumpers. The bold font in the Setting column indicates the default setting.

Table 3. Jumper definitions

Jumper	Description	Setting	Connection/Result
JVCC5	VCC5_SEL	**Connected**	Supplies VCC5 from the +5.0 V regulator on the FRDMPK144-Q100
		Not connected	VCC5 must be supplied with +5.0 V from an external supply
JVCCIO	VCCIO_SEL	**Connected**	Supplies VCCIO from the +3.3 V regulator on the FRDMPK144-Q100 (5.0 V logic)
		Not connected	No voltage goes through the I/Os
JCLK	CLK_SEL	**Connected**	Sets the FRDMPK144-Q100 oscillator to 1.0 MHz
		Not connected	Uses internal 1.0 MHz backup CLK

5.1.7 Test point definitions

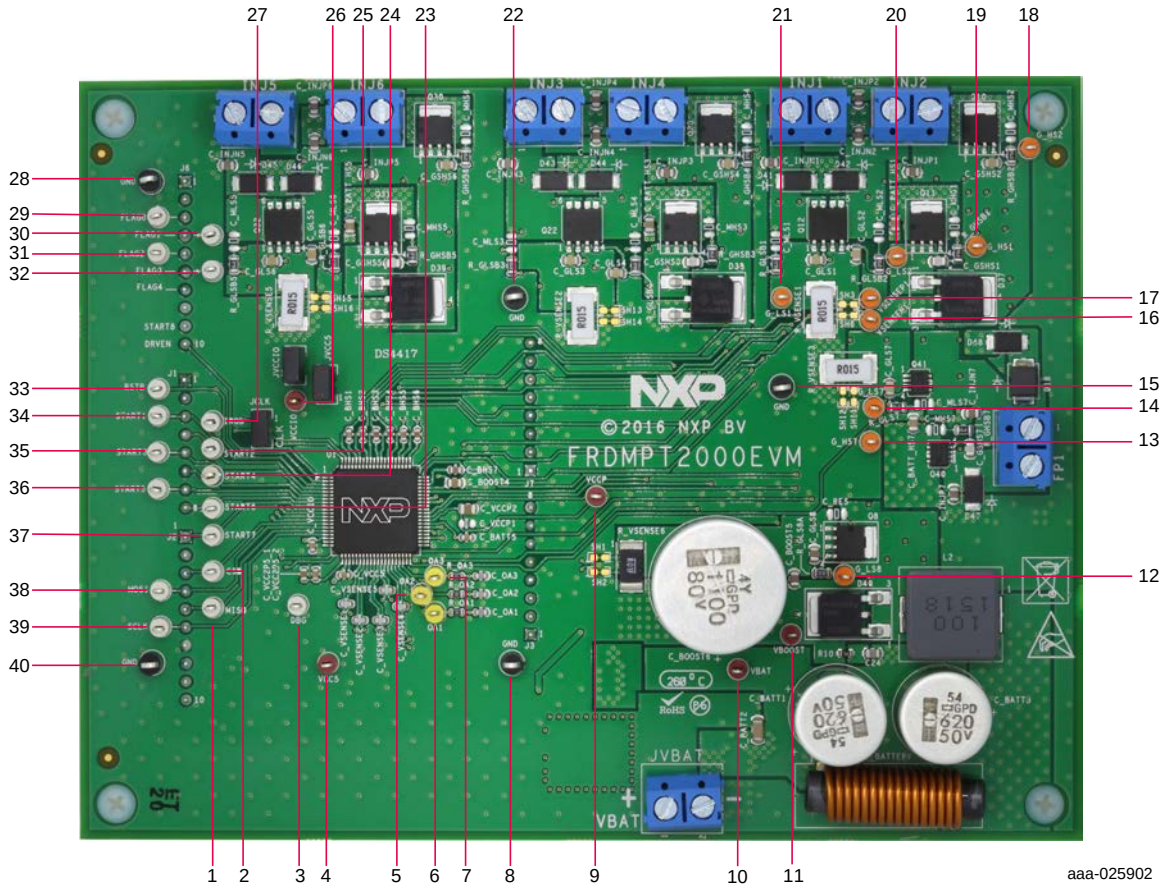

Figure 5. Test point locations

Table 4. Test points

Number	Name	Description
1	MISO	SPI master in slave out
2	CSB	SPI chip select
3	DBG	I/O that can be configured to disable internal VCCP. Also used by the KITPSCDEBUGEVM Tracer tool during power-up.
4	VCC5	5.0 V VCC5 voltage
5	OA2	OA2 test point for current recopy or I/Os
6	OA1	OA1 test point for current recopy or I/Os
7	OA3	OA3 test point for current recopy or I/Os
8	GND	Ground test point
9	VCCP	VCCP voltage
10	VBAT	Battery voltage
11	VBOOST	Vboost voltage
12	G_LS8	Gate 8 low-side

Number	Name	Description
13	G_HS7	Gate 7 high-side
14	G_LS7	Gate 7 low-side
15	GND	Ground test point
16	VSENSSEN1	Negative current sense
17	VSENSEP1	Positive current sense used to monitor injector current
18	G_HS2	Gate 2 high-side
19	G_HS1	Gate 1 high-side
20	G_LS2	Gate 2 low-side
21	G_LS1	Gate 1 low-side
22	GND	Ground test point
23	START6	Provides start signal for Injector 6
24	START4	Provides start signal for Injector 4
25	START2	Provides start signal for Injector 2
26	VCCIO	I/O voltage set to 3.3V by default (JVCCIO)
27	IRQB	Interrupt pin used to report fault to MCU
28	GND	Ground test point
29	FLAG0	Flag pin used as input or output
30	FLAG1	Flag pin used as input or output
31	FLAG2	Flag pin used as input or output
32	FLAG3	Flag pin used as input or output
33	RSTB	When the RESETB line is held low, the MC33PT2000 resets
34	START1	Provides start signal for Injector 1
35	START3	Provides start signal for Injector 3
36	START5	Provides start signal for Injector 5
37	START7	Provides start signal for fuel pump
38	MOSI	SPI Master Out Slave In
39	SCLK	SPI CLK up to 10MHz
40	GND	Ground test point

5.1.8 Connectors

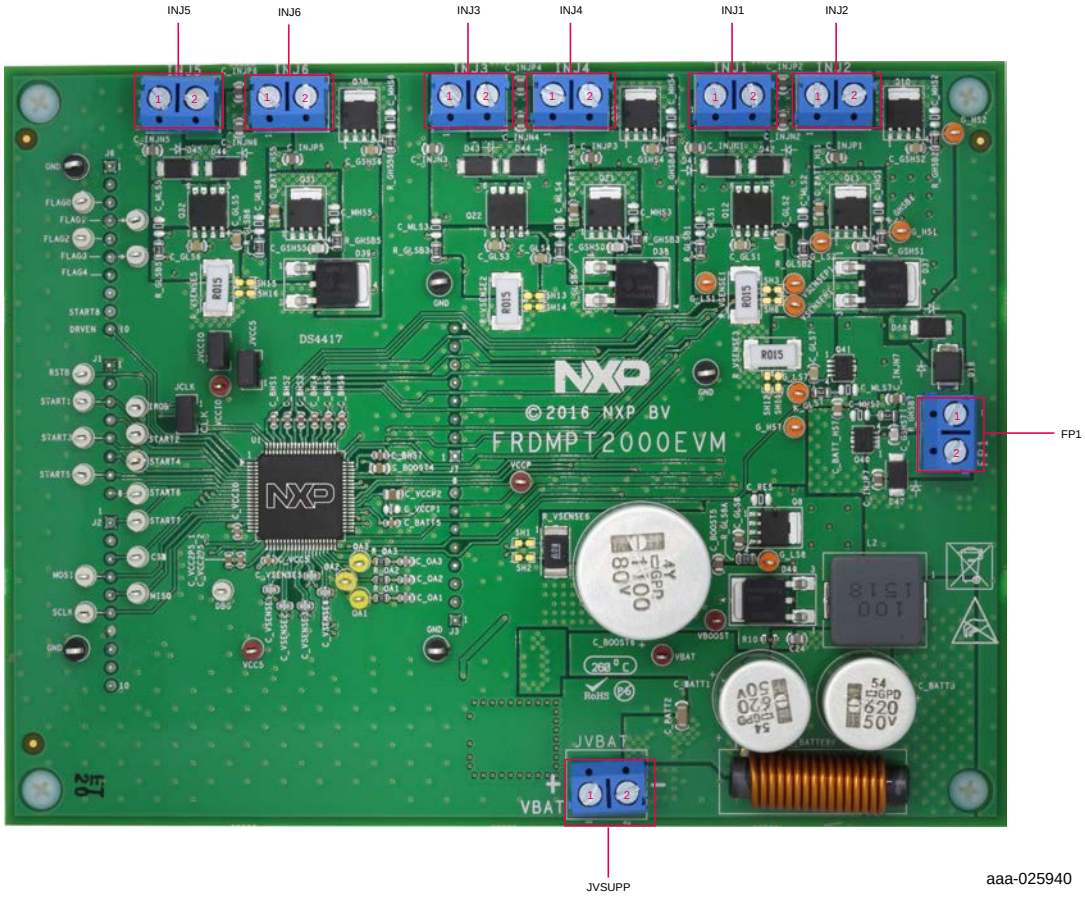

Figure 6. Connectors

Table 5. Input connectors

Name	Description	Connection
JVSUPP	Power supply input	Screw terminal 1: 12 V to 36 V
		Screw terminal 2: Ground

Table 6. Output connectors

Name	Description	Connection
INJ1	Injector output 1	Screw terminal 1: High-side drive
		Screw terminal 2: Low-side drive
INJ2	Injector output 2	Screw terminal 1: High-side drive
		Screw terminal 2: Low-side drive
INJ3	Injector output 3	Screw terminal 1: High-side drive
		Screw terminal 2: Low-side drive
INJ4	Injector output 4	Screw terminal 1: High-side drive

Name	Description	Connection
		Screw terminal 2: Low-side drive
INJ5	Injector output 5	Screw terminal 1: High-side drive
		Screw terminal 2: Low-side drive
INJ6	Injector output 6	Screw terminal 1: High-side drive
		Screw terminal 2: Low-side drive
FP1	Fuel pump output	Screw terminal 1: High-side drive
		Screw terminal 2: Low-side drive

5.2 The FRDMPK144-Q100 board

The FRDMPK144-Q100 features the MCU S32K144, an automotive Kinetis processor which provides the high-speed performance required to evaluate MC33PT2000 automotive fuel system designs. While the FRDMPK144-Q100 offers a range of capabilities, its primary purpose when used with the FRDMPKPT2000EVM is to control SPI and digital I/O communications with the MC33PT2000.

In that context, two on-board switches (SW2 and SW3) allow developers to control the MC33PT2000 when using the example projects provided on the FRDMPKPT2000EVM Tool Summary Page. The board also includes a potentiometer for RPM control and three LEDs that light to indicate when a MC33PT2000 fault occurs.

For additional information on this board, contact local support for the FRDMPK144-Q100 board.

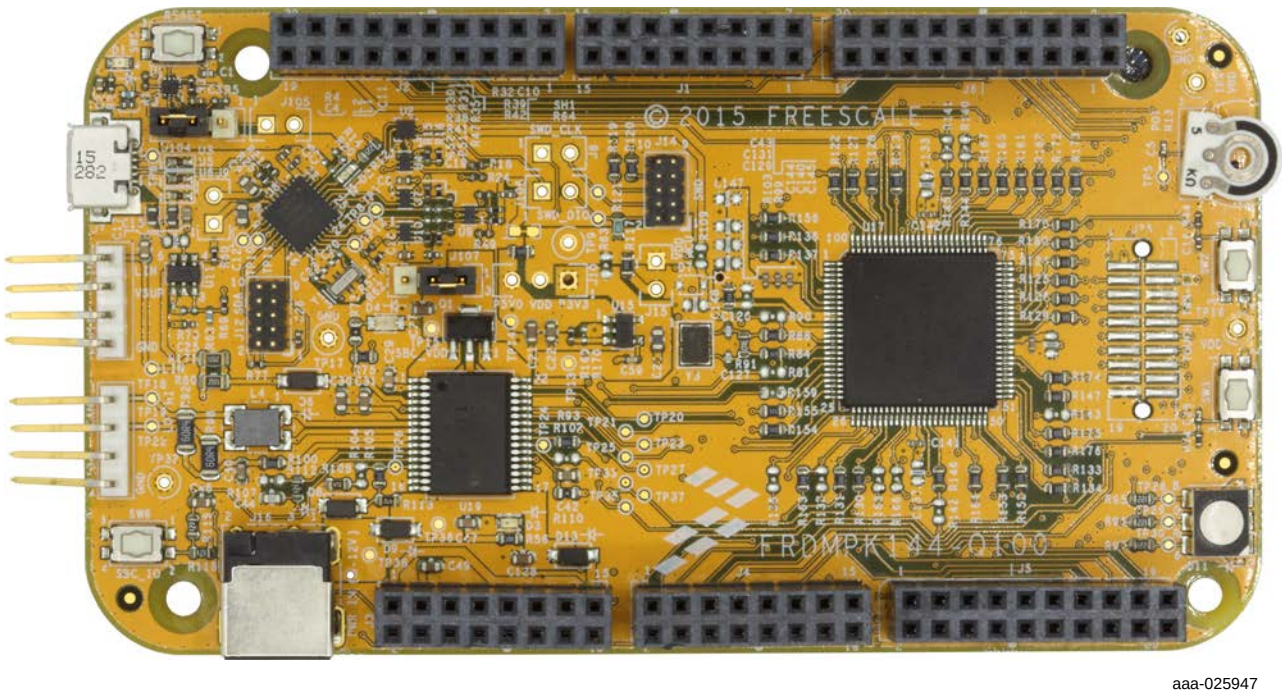

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Figure 7. FRDMPK144-Q100

5.3 The FRDM-KL25Z board

NXP's Freedom development platform is a set of software and hardware tools that provide an ideal platform for the rapid prototyping of microcontroller- based applications. The FRDM-KL25Z board is a key component of the development platform.

The board features a Kinetis L Series microcontroller, the industry's first microcontroller built on the ARM® Cortex™ –M0+ core. It makes use of the USB, the built in LEDs and the I/O ports available with NXP's Kinetis KL2x family of microcontrollers. When used in conjunction with other Freedom evaluation boards, the FRDM-KL25Z controls SPI communication between the evaluation board and a PC. It permits the user to regulate the power outputs and implement the features of the device on the evaluation board.

The FRDM-KL25Z also monitors the SPI registers, thereby facilitating the use of safety and advanced diagnostic functions.

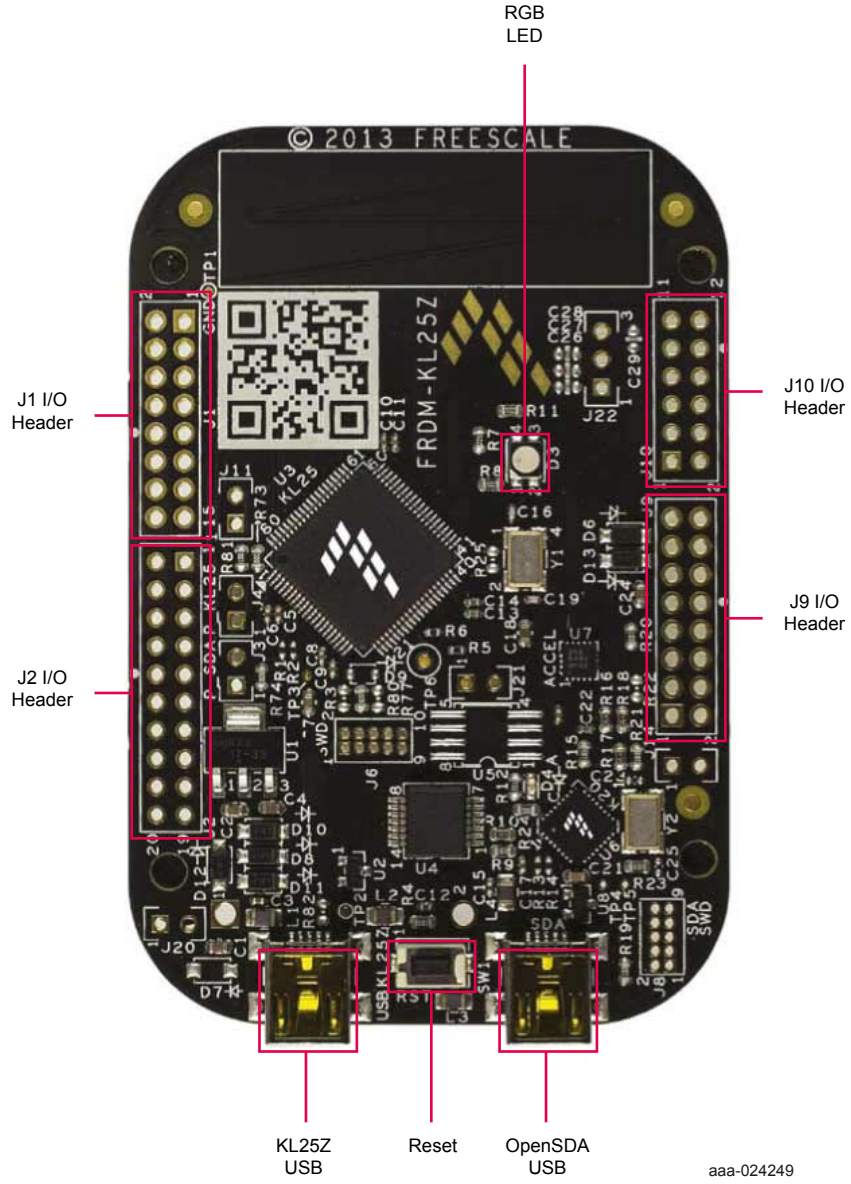


Figure 8. FRDM-KL25Z

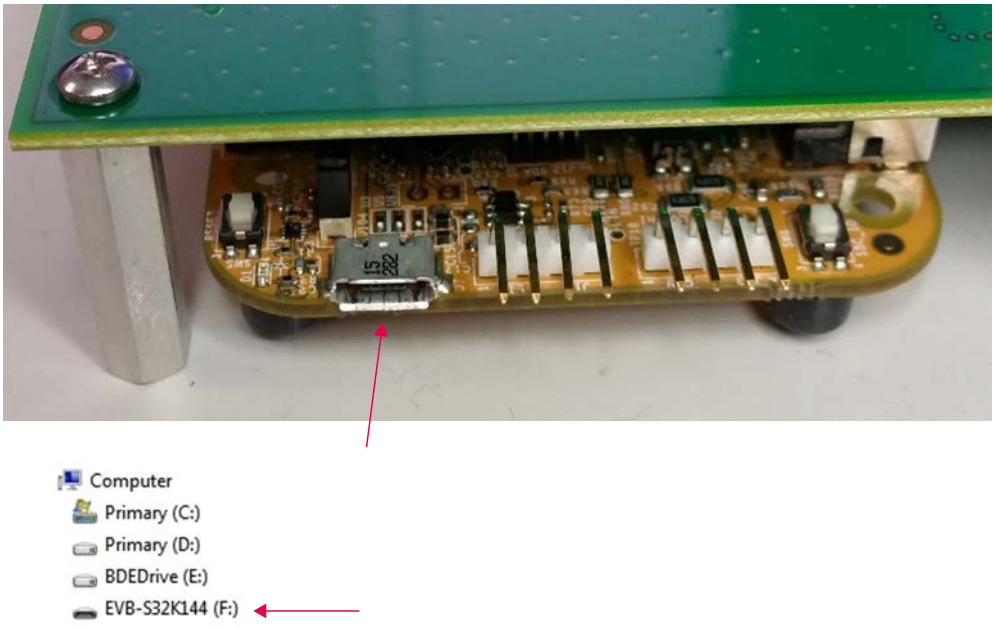
For additional information on the FRDM-KL25Z board, see the *FRDM-KL25Z User's Manual* available here: http://www.nxp.com/products/software-and-tools/hardware-development-tools/freedom-development-boards/freedom-development-platform-for-kinetis-kl14-kl15-kl24-kl25-mcus:FRDM-KL25Z?fpsp=1&tab=Documentation_Tab&lang_cd=en

6 Operating the FRDMPKPT2000EVM with the FRDMPK144-Q100

The FRDMPKPT2000EVM ships with a FRDMPK144-Q100 board attached via Arduino™ connectors to the bottom side of the FRDMPT2000EVM board. In this configuration, the MC33PT2000 functionality can only be exercised by downloading the appropriate microcode to the device.

6.1 Configuring the hardware for use with the FRDMPKPT2000EVM

1. Connect the micro-B plug on the USB cable to the USB port on the FRDMPK144-Q100 board. Connect the USB cable's Standard A plug to the host PC. An icon named EVB-S32K144 appears as a removable drive on the host PC.



2. With the power supply switched off, attach the +12 VDC supply to the VSUPP input connector on the FRDMPT2000EVM board. Make sure that the power supply is connected to the correct GND and +12 V terminals on the board. The current capability of the +12 V supply must exceed the maximum total current required by the number of loads that can be simultaneously ON.
3. Attach loads (Injectors) to the INJ1, INJ2, INJ3, INJ4, INJ5 and INJ6 output terminals as desired.
4. Turn on the +12 V supply. The +5.0 V LED illuminates, indicating that the board is properly connected.

6.2 Downloading microcode

To use the FRDMPKPT2000EVM in a development environment, the developer must install an NXP Integrated Design Environment (IDE) to download and run microcode. The procedure for downloading microcode differs depending on whether the microcode is being downloaded to the FRDMPK144-Q100 or to the FRDMPT2000EVM.

6.2.1 Downloading microcode to the FRDMPK144-Q100

The procedure for downloading microcode to the S32K144 device on the FRDMPK144-Q100 consist of the following steps

1. Installing NXP's S32 Design Studio
2. Downloading the FRDMPK144-Q100 example project file
3. Importing the example project file into S32 Design Studio
4. Customizing (optional) and building the example project file firmware image
5. Downloading the firmware image to the FRDMPK144-Q100

The following sections describe each of these steps in detail

6.2.1.1 Installing S32 Design Studio

NXP’s S32 Design Studio allows developers to customize the FRDMPK144-Q100's MCU code to meet application-specific requirements. The S32 Design Studio IDE is a complimentary integrated development environment that enables editing, compiling and debugging of automotive and ultra-reliable designs. Based on free, open-source software including Eclipse IDE, GNU Compiler Collection (GCC) and GNU Debugger (GDB), the S32 Design Studio IDE is a straightforward development tool with no code-size limitations.

This procedure explains how to obtain and install the latest version of S32 Design Studio. If S32 Design Studio is already installed on the host PC, skip this section.

1. Obtain the latest S32 Design Studio installer file from the NXP website http://www.nxp.com/S32DS.
2. Run the executable file and follow the instructions.

The S32 Design Studio SDK library is distributed with the IDE already integrated, so no explicit action is required to add or link it manually.

6.2.1.2 Downloading the FRDMPK144-Q100 example file

The Jump Start package on the FRDMPKPT2000EVM Tool Summary Page contains an example microcode project file. This project demonstrates a typical application that exercises the functionality of the fuel injectors and the fuel pump controllers. Developers can download this file and edit the source code to accommodate their application.

To download the example file, do the following:

1. Go to the Tool Summary Page at http://www.nxp.com/FRDMPKPT2000EVM and click on the Jump Start icon.
2. Locate and download the zip file named S32K144_PT2000_EXAMPLE.zip.
3. Unzip this file into a folder on the computer that has the S32 Design Studio installed

6.2.1.3 Importing the example file

Once the demo file has been downloaded, the developer must import it into S32 Design Studio. The procedure is as follows:

1. Open S32 Design Studio
2. From the S32 Design Studio menu bar, click **File**->**Import**. A **Select** window opens.
3. In the **Select** window, expand the folder named **General**. Then select **Existing Projects into Workspace** and click **Next**. An **Import Projects** window opens.

4. In the **Import Project** window, browse for and select the root directory containing the example file. In the **Projects** panel, select the example file. Then click **Finish**. See Figure 9.

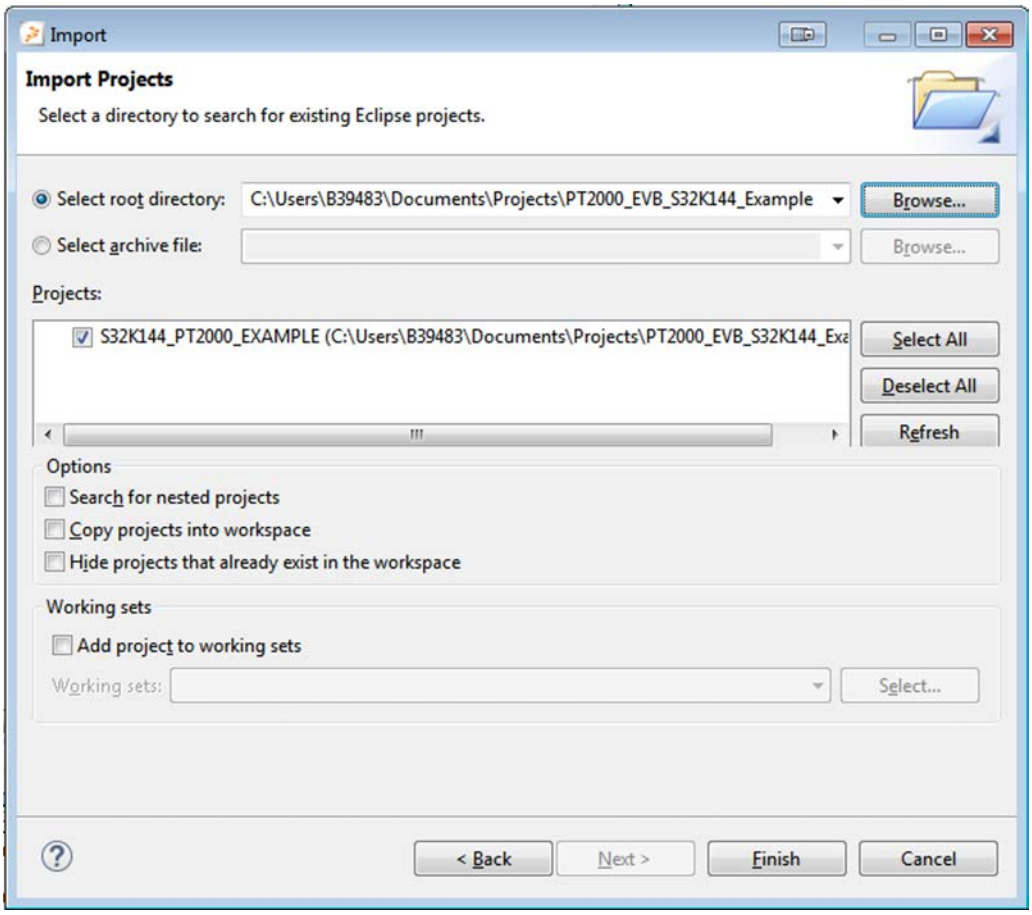


Figure 9. Import Projects dialog

The example file appears in the Project Explorer panel on the left side of the IDE.

6.2.1.4 Customizing and building the example file

Developers can flash the MCU on the FRDMK144-Q100 with the unmodified example file microcode if they so desire. They may also choose to modify the source code to meet the specific requirements of their application. In either case, the project must be built in S32 Design Studio before downloading the microcode.

1. To customize the example file, expand the example project tree in the Project Explorer window to view the file folders. The source code is located in the **src** folder and the include files are located in the **include** folder. Double-clicking the file name in the Project Explorer will open the file for editing where changes can be made.
2. To build the project, select the project in the Project Explorer window, then click on the hammer icon on the S32 Design Studio toolbar. If there are no errors during the build, the output file will be located in the **Debug** folder under the main project folder. The file will have a .srec extension (example: S32K144_PT2000_EXAMPLE.srec).

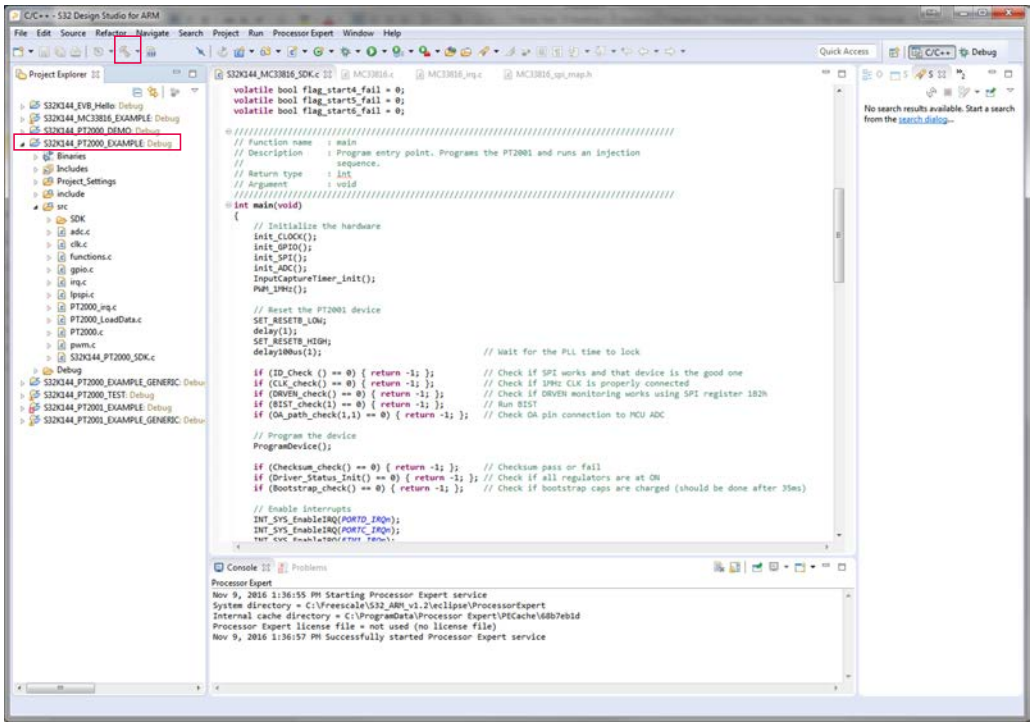


Figure 10. S32 Design Studio build project

6.2.1.5 Downloading the firmware to the FRDMPK144-Q100

1. Connect the micro-B plug on the USB cable to the USB port on the FRDMPK144-Q100 board. Connect the USB cable's Standard A plug to the host PC. An icon named EVB-S32K144 appears as a removable drive on the host PC.
2. To download the firmware, locate the firmware file (S32K144_PT2000_EXAMPLE.srec) on your computer and drag and drop the file onto the EVB-S32K144 icon.

The firmware program begins running immediately after the download has completed.

6.2.2 Updating microcode on the FRDMPT2000EVM

This section provides an overview of the process for updating the microcode on the FRDMPT2000EVM. For in depth information on the process, refer to the *MC33PT2000 Developer Studio User's Guide* (PT2000_IDEUG). In general, the procedure consist of the following steps:

1. Installing NXP's PT2000 Developer Studio
2. Loading, building and regenerating the example projects
3. Updating the FRDMPK144-Q100 with the new project data

6.2.2.1 Installing PT2000 Developer Studio

1. Obtain the latest version of the PT2000 Developer Studio installer file from the NXP website: http://www.nxp.com/products/power-management/engine-and-dc-

motor-control/powertrain-engine-control/developer-studio-for-pt2000-programmable-solenoid-controller:PT2000IDE?tab=Design_Tools_Tab.

2. Run the executable file and follow the Wizard instructions.

6.2.2.2 Loading, building and regenerating the example projects

Two relevant example projects—**FRDMPKPT2000EVM Software Files for Peak and Hold with Diagnostics and DCDC** and **FRDMPKPT2000EVM Software Files for Peak and Hold and DCDC**—are available on the FRDMPKPT2000EVM Tool Summary Page. These examples can be used as starting points for developing application specific microcode. For information on how to load and build projects using the IDE, refer to the *MC33PT2000 Developer Studio User's Guide* which can be accessed using the Help menu on the IDE.

After successfully building a project, the PT2000 load data files must be regenerated. To do this,

- In the MC33PT2000 Developer Studio toolbar, select **Tools**->**Generate MC33PT2000 Load Data Code**. When the regeneration process completes, the Code Generation Results window will appear as shown in Figure 11.

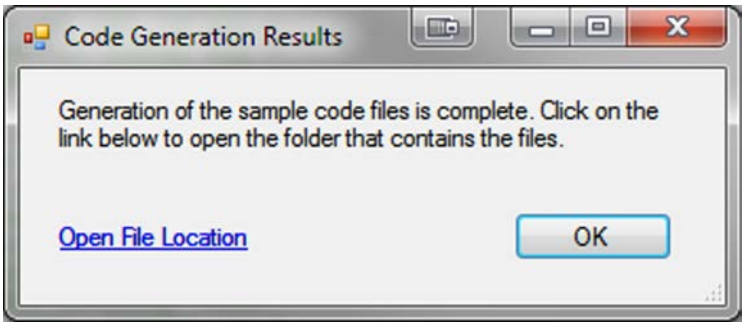


Figure 11. Code Generation Results

6.2.2.3 Updating the FRDMPK144-Q100

1. In Windows Explorer, open the folder that the generated code files were saved to. Locate the files **PT2000_LoadData.h** and **PT2000_LoadData.c** (usually found in the folder named **sample_code**). These files contain the code RAM, data RAM, and register settings that get loaded into the PT2000. The MC33PT2000 Developer Studio also creates other files that may be useful when creating a new MCU project from scratch. See the *MC33PT2000 Developer Studio User's Guide*, available here http://www.nxp.com/assets/documents/data/en/user-guides/PT2000-IDEUG.pdf?fsrch=1&sr=1&pageNum=1, for a description of these files and how they are used.
2. To update the S32 design studio project, copy **PT2000_LoadData.c** over the existing file in the src folder of the S32 Design Studio project, and copy the **PT2000_LoadData.h** file over the existing file in the include folder.
3. To run the updated microcode on the EVB, rebuild the project and reload the FRDMPK144-Q100 board as described in Section 6.2.2.2 "Loading, building and regenerating the example projects".

7 Operating the FRDMPKPT2000EVM with SPIGen and the FRDM-KL25Z

In its out-of-the-box configuration, the FRDMPKPT2000EVM's MC33PT2000 device can only be exercised by downloading the appropriate microcode. To access the device's registers and internal memory, the developer must replace the FRDMPK144-Q100 with a FRDM-KL25Z board. With the FRDM-KL25Z serving as an SPI dongle, the developer can then use NXP's SPIGen software to communicate with the device.

7.1 Preparing to use the FRDM-KL25Z

Before the FRDM-KL25Z can be used in conjunction with FRDMPT2000EVM board, the following steps must be taken:

1. Install SPIGen on the host PC
2. Download microcode to the FRDM-KL25Z
3. Connect the FRDM-KL25Z to the FRDMPT2000EVM board

The following sections describe each step in detail.

7.1.1 Installing SPIGen on the host PC

SPIGen currently runs on Windows 7, Windows 8 and Windows 10 operating systems. The procedure for installing the software is as follows:

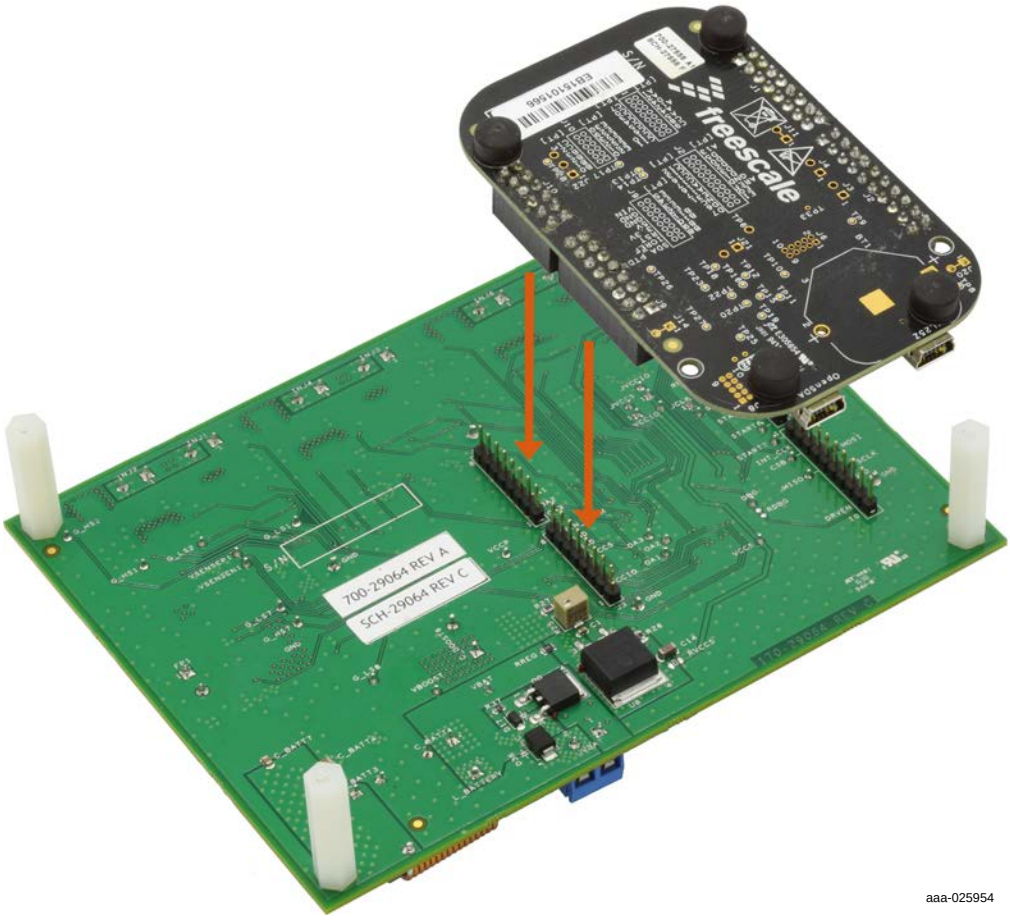
1. Go to the FRDMPKPT2000EVM Tool Summary Page at www.nxp.com/FRDMPKPT2000EVM and locate the **Jump Start Your Design** section.
2. From the list of files, download the SPIGen software as well as the associated configuration files.
3. Run the install program from the desktop. Follow the guidance of the installation wizard through the rest of the process.

7.1.2 Connecting the FRDM-KL25Z to the FRDMPT2000EVM

When connected to the FRDMPT2000EVM board, the FRDM-KL25Z allows developers to drive the evaluation board inputs to operate injectors or other solenoid loads via the GPIOs and SPI pins. The FRDM-KL25Z can also read and write the SPI registers, thereby allowing the user to modify parameters on the PT2000 and us the advanced diagnostic functions.

The procedure for configuring the FRDMPT2000EVM for use with the FRDM-KL25Z is as follows:

1. Detach the FRDMPK144-Q100 from the FRDMPT2000-EVM board.
2. Place connectors blocks on the outer rows of all four Arduino connectors on the FRDM-KL25Z.
3. Attach the FRDM-KL25Z to the underside of the FRDMPT2000EVM board such that connector J3 on the FRDMPT2000EVM aligns with connector J9 on the FRDM-KL25Z and connector J2 on the FRDMPT2000EVM aligns with connector J2 on the FRDM-KL25Z.



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4. Connect the Standard-A plug of the USB cable to the host PC. Connect the mini-B plug on the cable to the port labeled **USBKL25Z** on the FRDM-KL25Z.

7.1.3 Downloading microcode to the FRDM-KL25Z

Note that this procedure requires a Standard-A (male) to mini-B (male) USB cable.

1. Go to the P & E Microcomputer Systems OpenSDA page at http://www.pemicro.com/opensda and in the **OpenSDA Firmware (MSD & Debug)** box, click to download the **Firmware Apps** zip file.

2. When the download completes, unzip the file contents to a folder on the host PC.
3. Connect the Standard A plug of the USB cable to the host PC.
4. On the FRDM-KL25Z, press and hold down the Reset button. With the button held down, attach the mini-B plug of the USB cable to the FRDM-KL25Z USB port labeled **SDA**. Then release the Reset button. A blinking LED indicates the board is in Bootloader mode.
5. Open Windows Explorer on the host PC. An icon labeled **BOOTLOADER** appears as a removable drive on the PC.
6. From the files extracted from the PEMicro zip file, locate the driver file named **MSDDEBUG- FRDM-KL25Z_Pemicro_v118.SDA**. Drag and drop this file onto the BOOTLOADER icon.
7. Unplug the USB mini-B plug then re-insert the plug back into the SDA port. A blinking LED on the board indicates that the FRDM-KL43Z is in bootload mode.
8. Locate the SPIGEN **UsbSpiDongleKL25Zv507.srec** image folder in the SPIGEN folder (C:\Program Files (x86)\SPIGen\SPI Dongle Firmware).
9. Copy and paste or drag and drop the .srec file to the FRDM-KL25Z removable drive icon on the host PC.
10. Unplug the USB cable from the FRDM-KL25Z SDA port.

7.2 Configuring the hardware for use with the FRDM-KL25Z

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

1. Make sure SPIGen 7.0 (or higher) is installed on the PC and it can communicate with the Freedom board KL25Z. A blue LED lights on the FRDM-KL25Z when SPIGen is running and the board is properly connected.
2. Connect the KL25Z to the PC using the USB KL25Z port (left side of SW1). The USB_PWR LED on the FRDMPT2000EVM should be illuminated.
3. With the power supply switched off, attach the +12 VDC supply to the VSUPP input connector on the FRDMPT2000EVM. Make sure that the power supply is connected to the correct GND and +12 V terminals on the board. The current capability of the +12 V supply must exceed the maximum total current required by the number of loads that can be simultaneously ON.

4. Attach loads (Injectors) to the INJ1, INJ2, INJ3, INJ4, INJ5 and INJ6 output terminals as desired.
5. Turn on the +12 V supply. The +5.0 V LED illuminates, indicating that the board is properly connected.

7.3 Using SPIGen

7.3.1 Configuring the SPIGen software

1. In the Windows Start menu, go to **Programs**->**SPIGen** and click on the SPIGen icon. This icon will appear on the Windows desktop if the appropriate option ws selected during installation.
2. When the SPIGen Graphical User Interface (GUI) appears, go to the the file menu in the upper left corner and select Open. A file selection window opens. In the bottom right corner of the window, the dropdown box value should be set to **SPIGen Files (*.spi)**. If the configuration file name has a .txt extension, set this value to **All Files (*.*)**.
3. Browse for the SPIGen configuration file downloaded from the Tool Summary Page (see Section 7.1.1 "Installing SPIGen on the host PC").
   Select the configuration file and click **Open**. SPIGen creates an SPI command generator configured specifically for the FRDMPT2000EVM board.

The GUI is shown in Figure 16. The text at the top is the name of the configuration file that is loaded. The left side panel displays folders that group user interfaces. The interfaces in the pre-installed MC33PT2000 folder pertain specifically to the board FRDMPT2000EVM. When the configuration file loads, SPIGen is assigned a FRDMPT2000EVM-specific list of **Extra Pins** and **Quick Commands**.

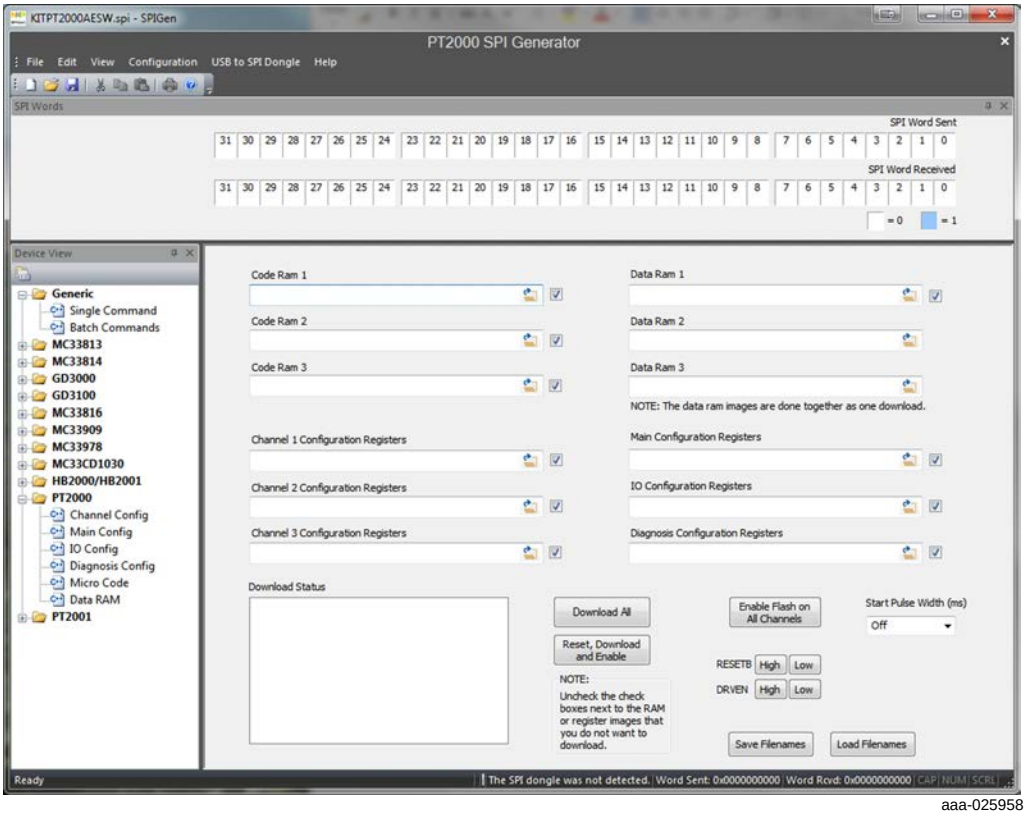

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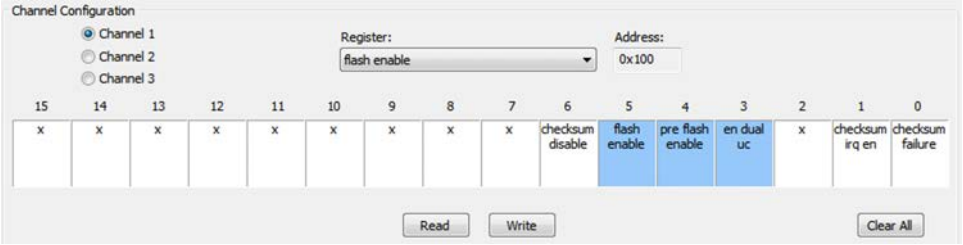
Figure 12. SPIGen PT2000 Microcode User Interface

7.3.2 Running an example file

1. With the FRDMPT2000EVM and FRDM-KL25Z configures as described in Section 7.2 "Configuring the hardware for use with the FRDM-KL25Z ", launch the SPIGen program.
2. Load the configuration file, by clicking **File->Open** and browsing to the **KITPT2000SW.spi** file located inside the **Injector Demo Files** directory.
3. In the **Device View** panel, expand the **PT2000** folder and click on **Micro Code**.
4. In the SPIGen menu bar, click on **Files->Open** and select the **SPIGenMC33PT2000Files.txt** included in the project example. All cells in the Micro Code page (Code Ramx, Data Ramx, Channelx, Main, IO, and Diagnostics Configuration Registers) should populate with the appropriate path.
5. Click the **Reset, Download and Enable** button to load and enable the PT2000.
6. In the **Start Pulse Width (ms)** cell, select the appropriate duration.
7. In the **Device View** panel, in the **PT2000** folder and click on **Channel Config**. Select **Channel 1**.
   a. Check to assure that **flash enable** is selected in the **Register:** cell.
   b. Click on the **Read** button and assure that the **checksum failure** bit is not set.
   c. Assure that Bits 3, 4 and 5 are set as shown below.



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8. Repeat the **Channel Config** process for **Channel 2** and **Channel 3**.

7.3.3 Running the example batch files

1. In the **Device View** panel, expand the **Generic** folder and click on **Batch Commands**. There are five choices. The **Start1** through **Start3** options pulse a single injector only (Injector 1, 2 or 3, respectively). The **Start1-3** batch command pulses all three injectors in sequence.
2. Click on the **Send Continuously** button.
3. Notice that the three loads attached to the FRDMPT2000EVM board are turning on and off in succession.

7.3.4 Reading and writing registers

SPIGen can also be used to read and write the registers on the PT2000. There a four different register configuration pages under the PT2000 **Device View**:

- Channel Configuration
- Main Configuration
- IO Configuration
- Diagnosis Configuration

The Channel Configuration register page covers all three channels and is shown in Figure 13.

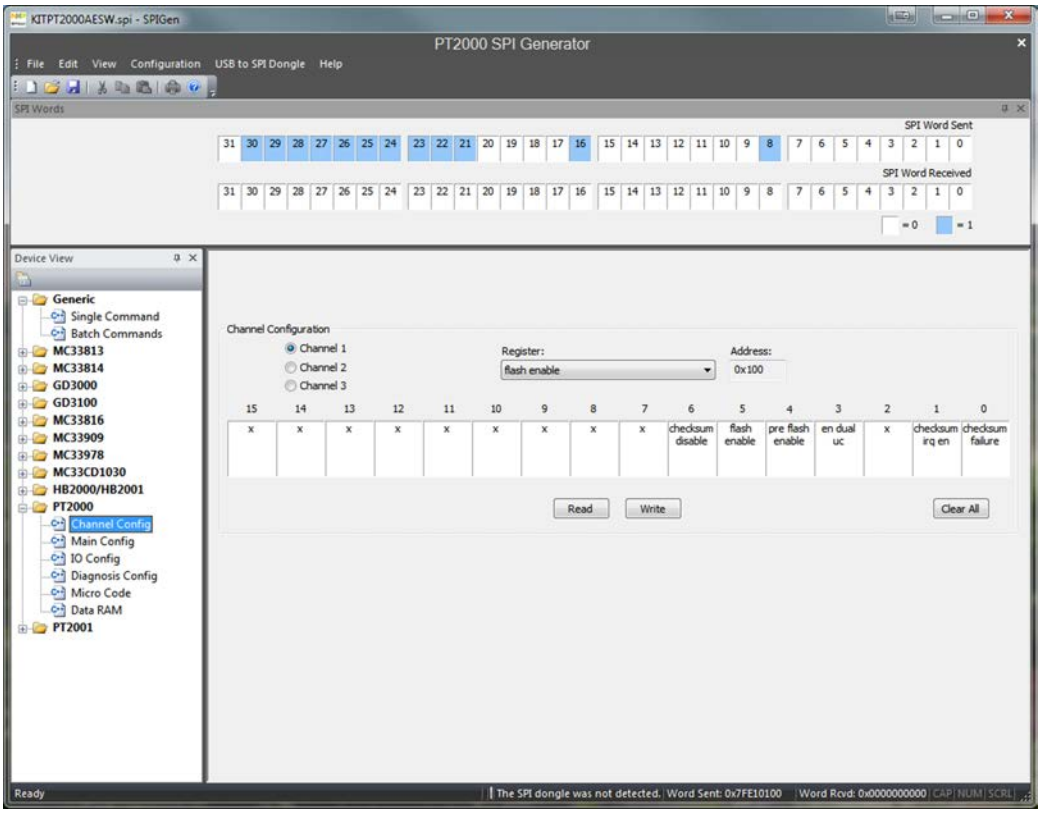

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Figure 13. PT2000 channel configuration register page

To read or write a specific register on the PT2000, select the register name from the **Register** drop down on the top center of the page. The register address will be shown to the right of the name. To read the contents of the register, click on the **Read** button. The bits that are set (1) are colored blue; the bits that are cleared (0) are colored white.

To write to a specific register, click on the bits to be changed to set them to the proper state Then click the **Write** button. The read and write process is the same for the other register groups which can be accessed by clicking on the register group name under PT2000 in the **Device View** window.

8 Schematics, board layout and bill of materials

FRDMPKPT2000EVM board schematics, board layout and bill of materials are available in the Jump Start section of the Tool summary page at the following URL: http://www.nxp.com/%0AFRDMPKPT2000EVM

9 Revision history

Revision	Date	Description of changes
1.0	12/2016	Initial release

10 References

The following URLs reference related NXP products and application solutions:

NXP.com support pages	Description	URL
FRDMPKPT2000EVM	Tool summary page	http://www.nxp.com/FRDMPKPT2000EVM
FRDMPK144-Q100	NA	Contact local support
FRDM-KL25Z	Tool summary page	http://www.nxp.com/FRDM-KL25Z
S32 Design Studio	Software	http://%0Awww.nxp.com/S32DS
PT2000Design Studio	Software	http://www.nxp.com/products/power-management/engine-and-dcmotor-%0Acontrol/powertrain-engine-control/developer-studio-for-pt2000-programmablesolenoid-%0Acontroller:PT2000IDE?tab=Design_Tools_Tab
MC33PT2000 Developer Studio User's Guide	User guide	http://www.nxp.com/assets/documents/data/en/user-guides/PT2000-IDEUG.pdf

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