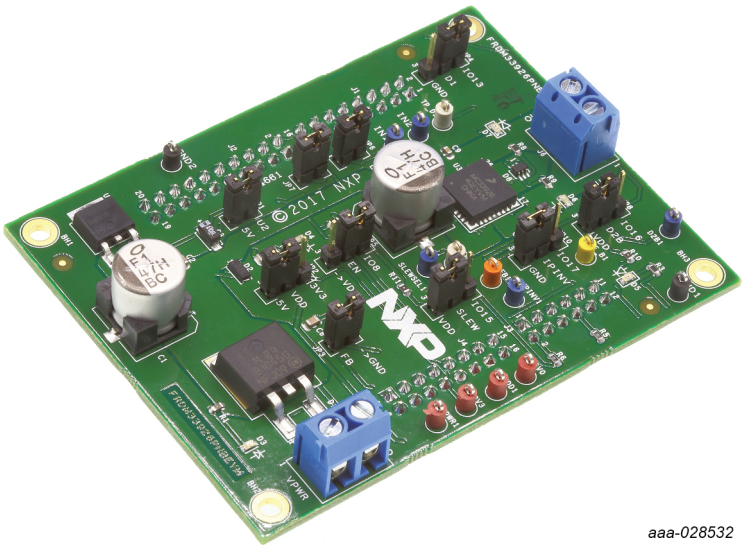
KTFRDM33926PNBEVMUG

FRDM-33926PNBEVM evaluation board

Rev. 2 — 8 December 2017 User guide

1 FRDM-33926PNBEVM



aaa-028532

2 Important notice

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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.

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 NXP sales and technical support services.

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3 Getting started

3.1 Kit contents/packing list

The FRDM-33926PNBEVM contents include:

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

3.2 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/FRDM-33926PNBEVM
2. Review your tool 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.

3.3 Required equipment

To use this kit, you need:

- DC Power supply: 5.0 V to 40 V with up to 10 A current handling capability, depending on motor requirements
- USB standard A (male) to mini-B (male) cable
- Typical loads (brushed DC motor, power resistors or inductive load with up to 5.0 A and 28 V operation)
- Function generator (optional)
- FRDM-KL25Z Freedom Development Platform (optional)
- ARM®mbed™ firmware loaded on FRDM-KL25Z board (to compile the code, you need to have an account in http://www.mbed.org)
- MC33926 microcode loaded on FRDM-KL25Z
- Graphical user interface required for use with FRDM-KL25Z

3.4 System requirements

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

- A USB enabled computer with Windows® XP or later (required only if FRDM-KL25Z MCU board is used)

4 Getting to know the hardware

4.1 Board overview

The FRDM-33926PNBEVM evaluation board (EVB) provides a development platform that exercises all the functions of the MC33926 H-bridge IC. The EVB is designed for use in conjunction with the FRDM-KL25Z board (not included with the evaluation board). See Section 6 "Installing the software and setting up the hardware" for the FRDM-KL25Z and the hardware configuration.

To control the MCU outputs, use the graphical user interface “GUI Brushed DC FRDM-33926PNBEVM” available on NXP website. Alternatively, the EVB can be used without the FRDM-KL25Z. In this case, the parallel inputs in the device must be controlled through 3.3/5.0 V compatible GPIO of the MCU or by connecting the board to a function generator.

4.2 Board features

The board allows evaluation of NXP part MC33926PNB and all its functions. The board features the following:

- Compatibility with NXP's Freedom Development Platform
- Built-in reverse battery protection
- Test points to allow signal probing
- Built-in voltage regulator to supply logic level circuitry
- LEDs to indicate the supply status and direction of motor
- Transient voltage suppressor to handle system level transients

4.3 Block diagram

The hardware block diagram is shown in Figure 1.

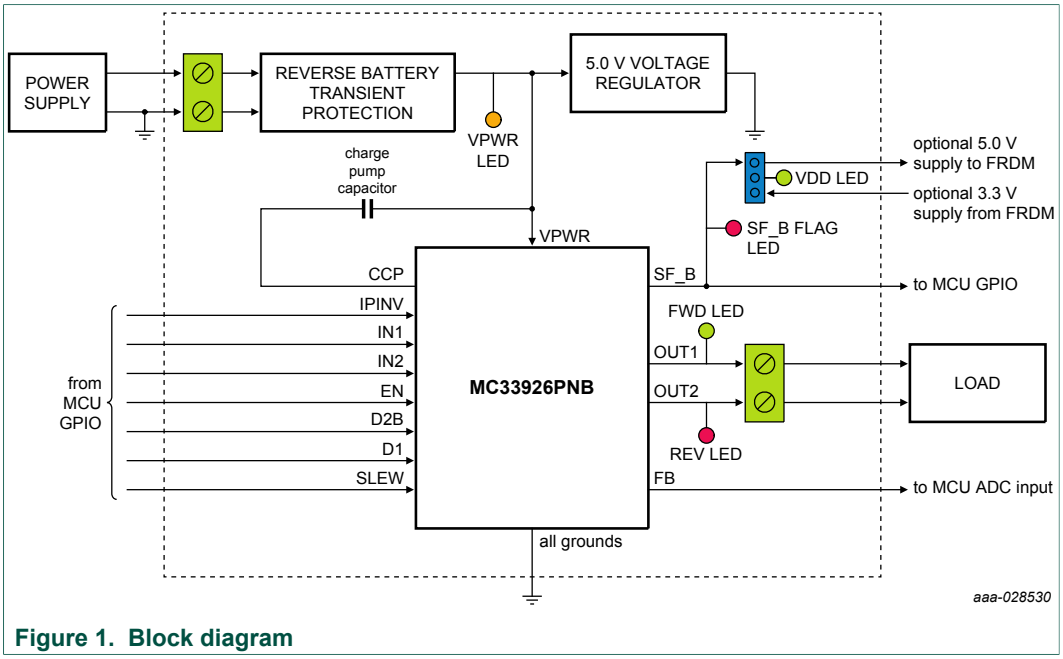


Figure 1. Block diagram

4.3.1 Device features

This evaluation board features the following NXP product:

Table 1. Device features

Device	Description	Features
MC33926PNB	Monolithic H-bridge power IC in a robust thermally enhanced 32-pin PQFN-EP package	• 5.0 V to 28 V continuous operation (transient operation from 5.0 V to 40 V) • 3.0 V and 5.0 V TTL/CMOS logic compatible inputs • 225 mΩ maximum $R_{DS(on)}$ at T_J = 150 °C (each H-bridge MOSFET) • Overcurrent limiting (regulation) via internal constant-off-time PWM • Output short-circuit protection (short to VPWR or GND) • Temperature dependent current limit threshold reduction • Sleep mode with current draw < 50 µA

4.3.2 Operation modes

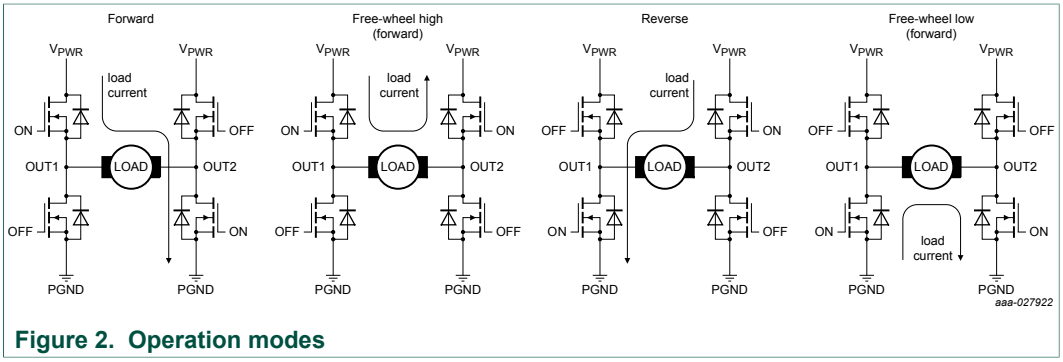


Figure 2. Operation modes

4.3.3 Architecture

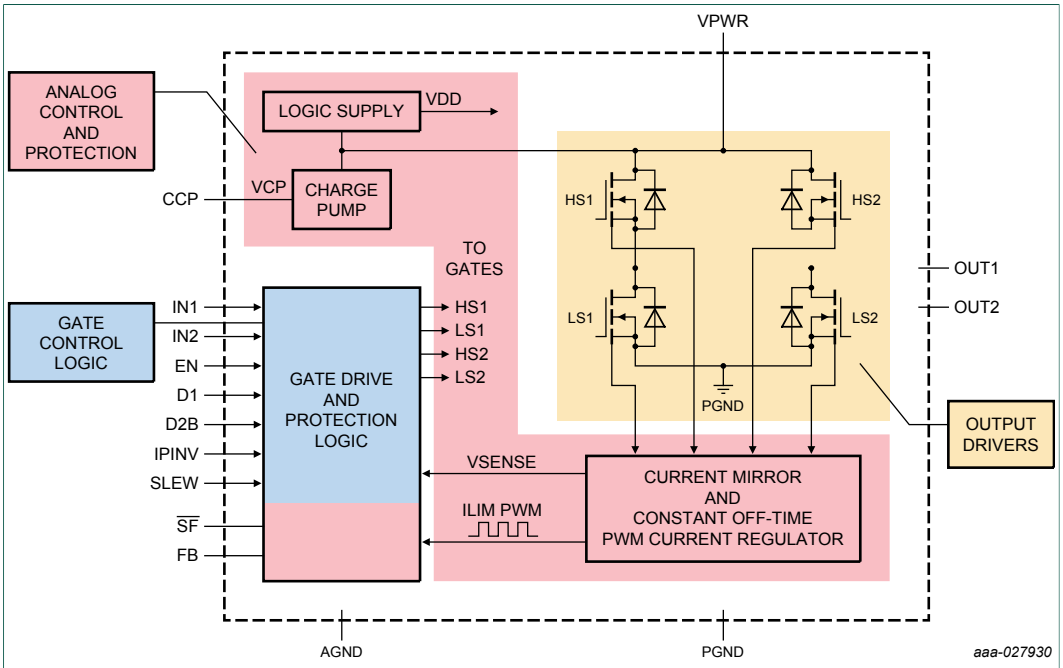


Figure 3. General architecture diagram

4.3.4 Thermal management

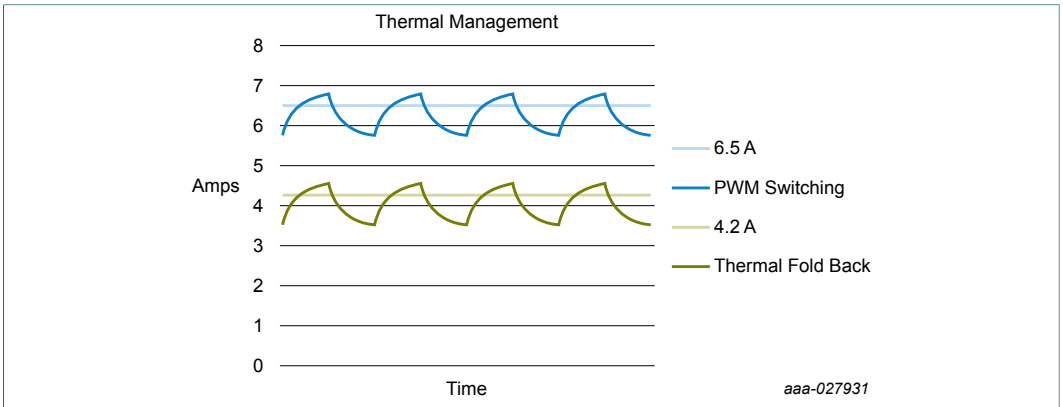


Figure 4. Thermal management (thermal foldback)

Thermal management

PWM switching to 6.5 A at < 165 °C

- Below 165 °C, the device PWMs the outputs, averaging under 6.5 A to reduce thermals while continuing the operation

Thermal foldback to 4.2 A at 165 °C < T < 185 °C

- Above 165 °C, the device goes into thermal foldback, averaging under 4.2 A to reduce thermals while continuing the operation

Thermal shutdown at 175 °C < T < 200 °C

- The device shuts down

4.4 Board description

Figure 5 and Table 2 describe the main blocks of the evaluation board.

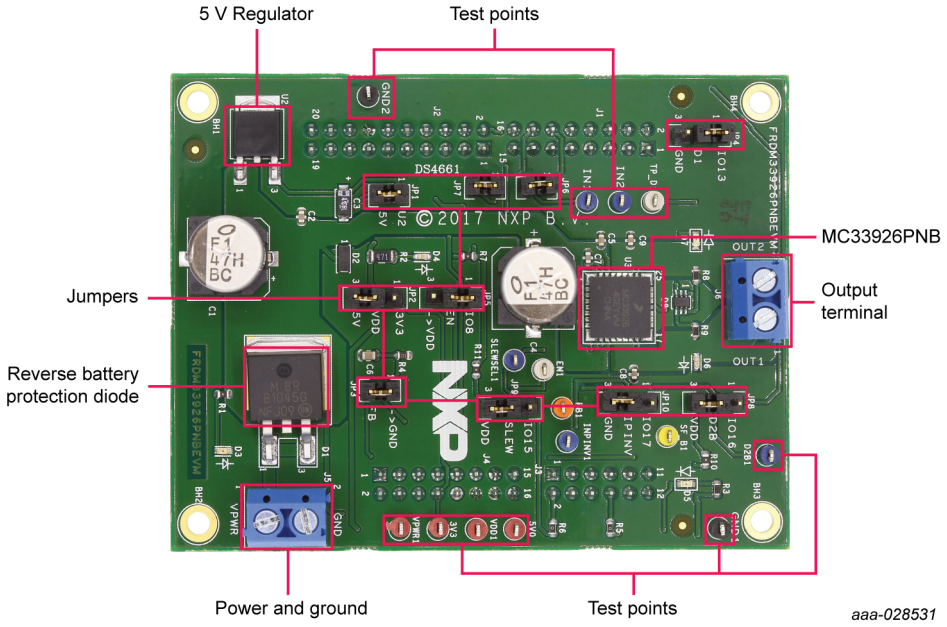


Figure 5. Board description

Table 2. Board description

Name	Description
MC33926PNB	Monolithic H-bridge power IC in a robust thermally enhanced 32-pin PQFN-EP package
5.0 V regulator	5.0 V regulator for VDD and supply
Jumpers	Jumpers for configuring the board for different modes of operation
Reverse battery protection diode	Diode for protecting MC33926PNB in reverse battery condition
Power and ground inputs	Power supply terminal to connect the battery/power supply with the board
Test points	Test points to probe different signals
Output terminal	Output connector to connect a load to the MC33926PNB outputs

4.5 LED display

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

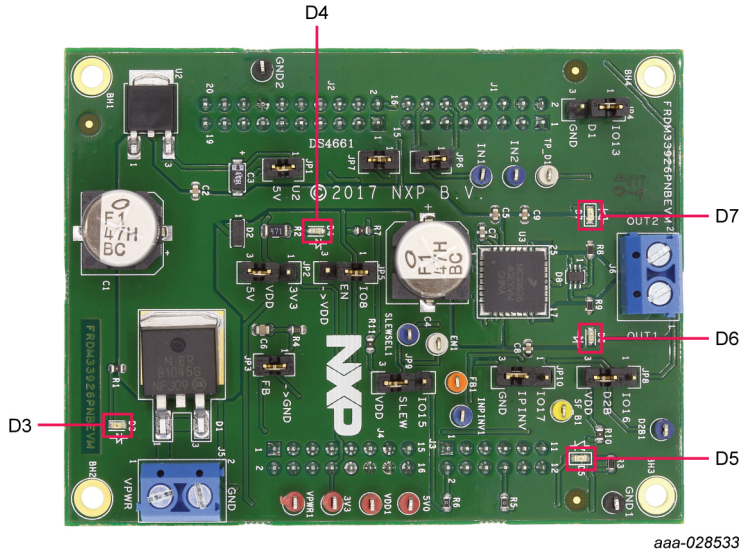


Figure 6. LED display

Table 3. LED display

LED ID	Description
D3	Yellow LED indicates when main/battery supply is connected
D4	Green LED indicates when +5.0 V supply is connected
D5	Red LED illuminates when the H-bridge detects a fault
D6	Green LED indicates current flowing in forward direction
D7	Red LED indicates current flowing in reverse direction

4.6 Jumper definitions

Figure 7 shows the jumper locations on the board.

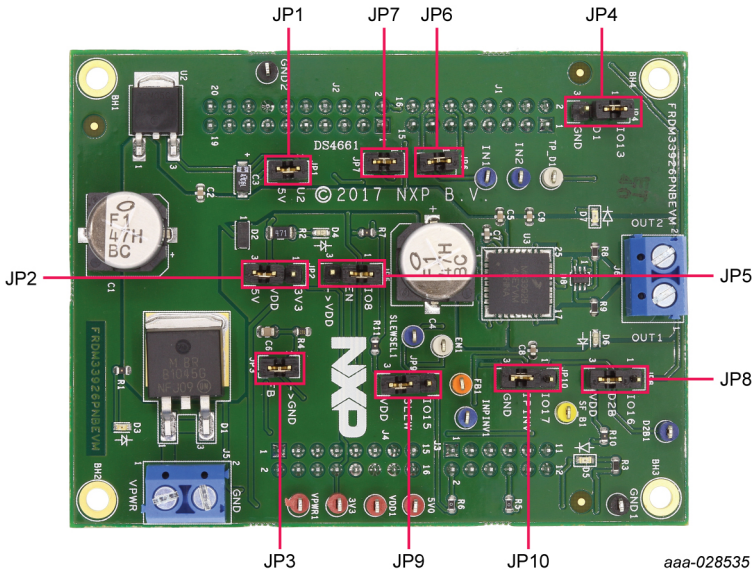


Figure 7. Jumpers

Table 4 defines the evaluation board jumper positions and explains their functions. The default settings are shown in bold.

Table 4. Jumper definitions

Jumper	Description	Setting	Connection
JP1	5.0 V regulator output	**1-2**	5.0 V regulator connected/external or USB 5.0 V
JP2	VDD select	1-2	3.3 V as VDD
		2-3	5.0 V as VDD
JP3	FB	**1-2**	Feedback to MCU ADC/NC
JP4	D1	**1-2**	MCU GPIO/EXT signal to disable/tri-state outputs OUT1 and OUT2 (active high)
		2-3	GND
JP5	EN	**1-2**	MCU GPIO/EXT signal to EN Enable outputs (active high). Sleep mode (active low).
		2-3	VDD
JP6	IN1	**1-2**	MCU GPIO/EXT signal to IN1
JP7	IN2	**1-2**	MCU GPIO/EXT signal to IN2
JP8	D2B	**1-2**	MCU GPIO/EXT signal to D2B tri-state outputs OUT1 and OUT2 (active low)
		2-3	VDD
JP10	IPINV	**1-2**	MCU GPIO/EXT signal to IPINV
		2-3	GND
JP9	SLEW	**1-2**	MCU GPIO/EXT signal to SLEW
		2-3	VDD

4.7 Input signal definitions

The board has following input signals which are used to control the outputs or functions inside the circuit.

Table 5. Input signals

Input name	Description
D1	Disable signal to tri-state the outputs (active high)
EN	Disable signal to tri-state the output and put the part in Sleep mode (active low)
IN1	Logic input to control OUT1
IN2	Logic input to control OUT2
SLEW	Fast or slow slew rate selection for PWM frequencies
IPINV	Input invert reverse direction of current through load attached to OUT1 and OUT2 (active high)
D2B	Active low tri-states outputs OUT1 and OUT2

4.8 Output signal definitions

The board has the following output signals which are used to drive a load such as a brushed DC motor. It provides an analog output for real time load current monitoring. This signal allows closed loop control of the load.

Table 6. Output signals

Output name	Description
OUT1	Output 1 of H-bridge controlled by the logic input IN1
OUT2	Output 2 of H-bridge controlled by the logic input IN2
SF_B	Open drain active low status flag output to indicate a fault
FB	Current mirror output for real time load current monitoring

4.9 Test points

Figure 8 shows the location of the test points on the board.

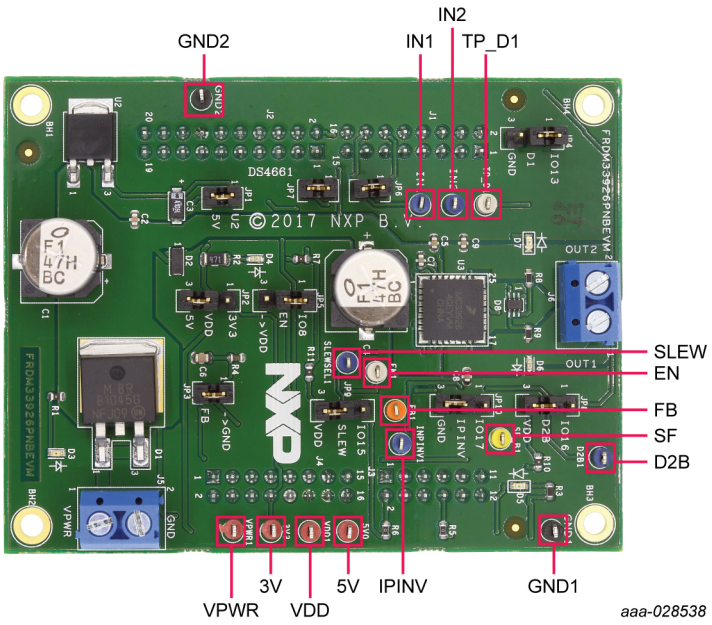


Figure 8. Test points

The following test points provide access to various signals to and from the board.

Table 7. Test point definitions

Test point name	Signal name	Description
TP_D1	D1	Disable signal to tri-state the outputs (active high)
EN	EN	Put the part in sleep mode (active high)
D2B	D2B	Disable signal to tri-state the outputs (active low)
FB	FB	Current mirror output for real time load current monitoring
IN1	IN1	Logic input to control OUT1
IN2	IN2	Logic input to control OUT2
SF_B	SF_B	Open drain active low status flag output to indicate a fault
GND1	GND	Common ground
GND2	GND	Common ground
VPWR	VBAT	Battery or power supply input voltage
3V	3V3	3.3 V supply from the FRDM board
VDD	VDD	VDD supply for the FS_B pull-up resistor
IPINV	IPINV	Input inverted (active high), input non-inverted (active low)
SLEW	SLEW	Logic 1 = fast slew rate, Logic 0 = slow slew rate

4.10 Screw terminal connections

The board has following screw terminal connections to connect the power supply and the load. Figure 9 shows the location of the screw terminal connectors.

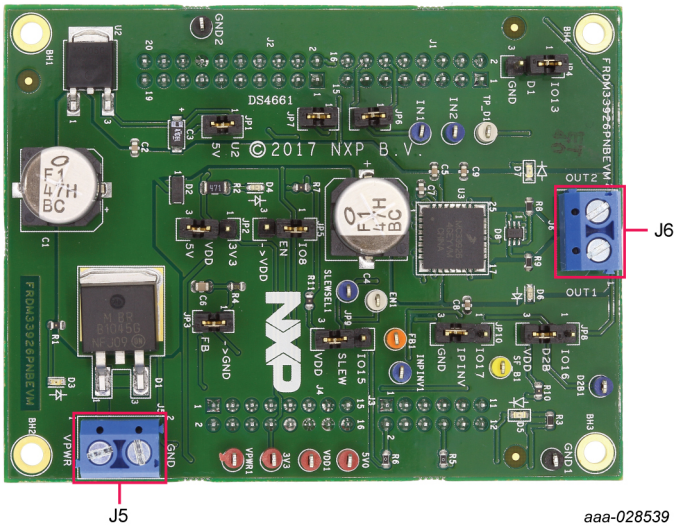


Figure 9. Screw terminal connectors

Table 8. Screw terminal connections

Screw terminal name	Description
J5	Power supply connector for the MC33926PNB
J6	Output connector for connecting to a load

5 FRDM-KL25Z Freedom Development Platform

The NXP Freedom development platform is a set of software and hardware tools facilitating rapid prototyping of designs based on the Kinetis family of microcontrollers. The NXP FRDM-KL25Z board serves as the basic hardware component of the development platform. The FRDM-KL25Z implements a Kinetis L Series microcontroller and makes use of the device's built-in USB, LED, and I/O port features. The board can be loaded with application specific firmware and can be configured with Graphical User Interface software that supports development and testing.

The NXP FRDM-33926PNBEVM may be mounted to the FRDM-KL25Z as a shield board. When used in conjunction with the FRDM-33926PNBEVM,the FRDM-KL25Z provides basic functions, such as PC communication, that support the application-specific features of the evaluation board.

For use with the FRDM-33926PNBEVM, the FRDM-KL25Z must have ARM®mbed™ firmware installed (see Section 6.2.2 "Downloading mbed® firmware to the FRDM-KL25Z board"), MC33926 microcode installed (see Section 6.2.3 "Downloading the MC33926 microcode to the FRDM-KL25Z board"), and must use the NXP "GUI Brushed DC FRDM-33926PNBEVM" as the software interface (see Section 6.2.4 "Installing the graphical user interface").

For complete information on the FRDM-KL25Z, see documentation available on the http://www.nxp.com/FRDM-KL25Z page.

5.1 Connecting the FRDM-KL25Z to the board

The FRDM-KL25Z development board provides an ideal support platform for the FRDM-33926PNBEVM kit. In this configuration, the FRDM-KL25Z connects to a PC and allows the user via the GUI to set parameters that control the operation of the motor. The FRDM-33926PNBEVM connects to the FRDM-KL25Z using the four dual row Arduino™ R3 connectors on the bottom of the board.

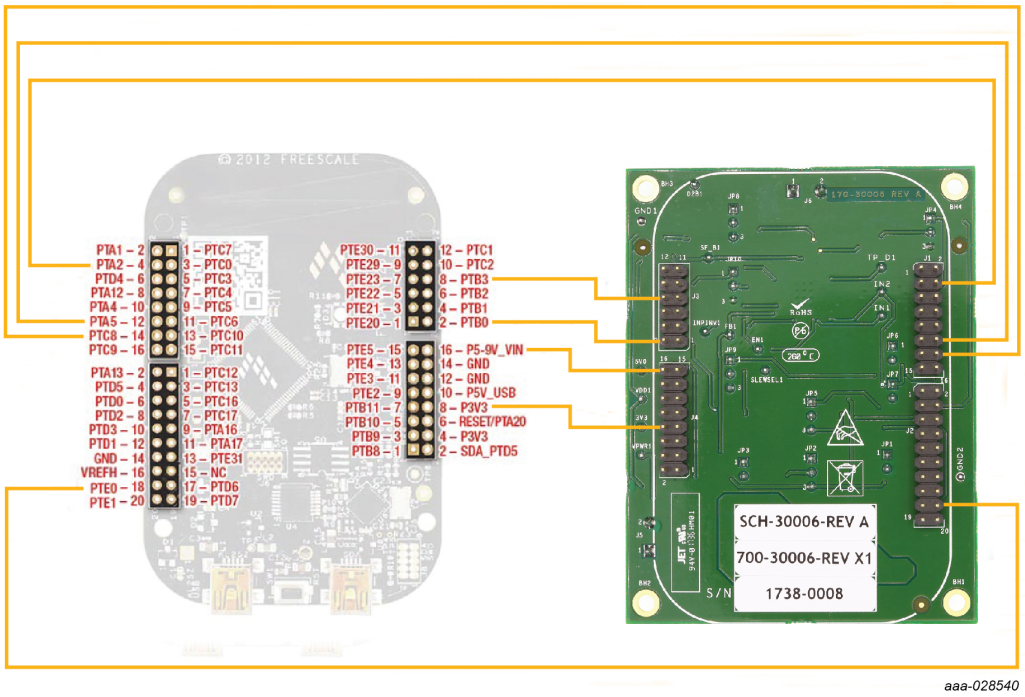


Figure 10. FRDM-KL25Z to FRDM-33926PNBEVM connections

Table 9. FRDM-33926PNBEVM to FRDM-KL25Z connections

FRDM-33926PNBEVM		FRDM-KL25Z		Pin hardware name		Description
Header	Pin	Header	Pin	FRDM-33926PNBEVM	FRDM-KL25Z	
J1	1	J1	1	N/C	PTC7	Not connected
J1	2	J1	2	N/C	PTA1	Not connected
J1	3	J1	3	N/C	PTC0	Not connected
J1	4	J1	4	IO13 (D1)	PTA2	Disable signal to tri-state the outputs (active high)
J1	5	J1	5	N/C	PTC3	Not connected
J1	6	J1	6	N/C	PTD4	Not connected
J1	7	J1	7	N/C	PTC4	Not connected
J1	8	J1	8	N/C	PTA12	Not connected
J1	9	J1	9	N/C	PTC5	Not connected
J1	10	J1	10	N/C	PTA4	Not connected
J1	11	J1	11	N/C	PTC6	Not connected
J1	12	J1	12	PWM1 (IN1)	PTA5	Not connected
J1	13	J1	13	N/C	PTC10	Not connected
J1	14	J1	14	PWM1 (IN2)	PTC8	Not connected
J1	15	J1	15	N/C	PTC11	Not connected
J1	16	J1	16	N/C	PTC9	Not connected
J2	1	J2	1	N/C	PTC12	Not connected
J2	2	J2	2	IO15 (SLEW)	PTA13	Slew rate control
J2	3	J2	3	N/C	PTC13	Not connected
J2	4	J2	4	IO16 (D2B)	PTD5	Disable signal to tri-state the outputs (active high)
J2	5	J2	5	N/C	PTC16	Not connected

FRDM-33926PNBEVM		FRDM-KL25Z		Pin hardware name		Description
Header	Pin	Header	Pin	FRDM-33926PNBEVM	FRDM-KL25Z	
J2	6	J2	6	IO17 (IPINV)	PTD0	Input invert control
J2	7	J2	7	N/C	PTC17	Not connected
J2	8	J2	8	N/C	PTD2	Not connected
J2	9	J2	9	N/C	PTA16	Not connected
J2	10	J2	10	N/C	PTD3	Not connected
J2	11	J2	11	N/C	PTA17	Not connected
J2	12	J2	12	N/C	PTD1	Not connected
J2	13	J2	13	N/C	PTE31	Not connected
J2	14	J2	14	N/C	GND	Not connected
J2	15	J2	15	N/C	N/C	Not connected
J2	16	J2	16	N/C	VREFH	Not connected
J2	17	J2	17	N/C	PTD6	Not connected
J2	18	J2	18	IO8 (EN)	PTE0	Disable signal to tri-state the output and put the part in Sleep mode (active low)
J2	19	J2	19	N/C	PTD7	Not connected
J2	20	J2	20	N/C	PTE1	Not connected
J3	1	J10	1	N/C	PTE20	Not connected
J3	2	J10	2	FB	PTB0	Current mirror output for real time load current monitoring
J3	3	J10	3	N/C	PTE21	Not connected
J3	4	J10	4	N/C	PTB1	Not connected
J3	5	J10	5	N/C	PTE22	Not connected
J3	6	J10	6	N/C	PTB2	Not connected
J3	7	J10	7	N/C	PTE23	Not connected
J3	8	J10	8	SF_B	PTB3	Open drain active low status flag output to indicate a fault
J3	9	J10	9	N/C	PTE29	Not connected
J3	10	J10	10	N/C	PTC2	Not connected
J3	11	J10	11	N/C	PTE30	Not connected
J3	12	J10	12	N/C	PTC1	Not connected
J4	1	J9	1	N/C	PTB8	Not connected
J4	2	J9	2	N/C	SDA_PTD5	Not connected
J4	3	J9	3	N/C	PTB9	Not connected
J4	4	J9	4	N/C	P3V3	Not connected
J4	5	J9	5	N/C	PTB10	Not connected
J4	6	J9	6	N/C	RESET/PTA20	Not connected
J4	7	J9	7	N/C	PTB11	Not connected
J4	8	J9	8	FSD 3V3 OUT	P3V3	3.3 V logic output from FRDM-KL25Z board to FRDM-33926PNBEVM
J4	9	J9	9	N/C	PTE2	Not connected
J4	10	J9	10	N/C	P5V_USB	Not connected
J4	11	J9	11	N/C	PTE3	Not connected
J4	12	J9	12	GND	GND	GND
J4	13	J9	13	N/C	PTE4	Not connected
J4	14	J9	14	GND	GND	GND
J4	15	J9	15	N/C	PTE5	Not connected

FRDM-33926PNBEVM		FRDM-KL25Z		Pin hardware name		Description
Header	Pin	Header	Pin	FRDM-33926PNBEVM	FRDM-KL25Z	
J4	16	J9	16	FSD 5V IN	P5-9V_VIN	5.0 V logic input to FRDM-KL25Z board from FRDM-33926PNBEVM

6 Installing the software and setting up the hardware

The evaluation board is designed to work in conjunction with NXP's FRDM-KL25Z board with the PC-based GUI providing direct access to the MC33926PNB MCU for testing and analysis. Alternatively, the board may be used as a stand-alone component. The lab hardware, such as a function generator, must be used to support testing and analysis.

The evaluation board consists of an H-bridge, a parallel interface, power conditioning circuitry, and a set of two input select jumpers. All +5.0 V VDD power required by the board is obtained via the parallel interface.

Caution:

To avoid damaging the board, the following restrictions must be observed:

- *The motor supply voltage (V_{PWR}) must be at least 5.0 V, but must not exceed 28 V.*
- *The peak operating current of the load must not exceed 5.0 A.*

6.1 Setting up the FRDM-33926PNBEVM as a stand-alone component

This section describes how to configure the FRDM-33926PNBEVM for use as a stand-alone component. The procedure assumes that you are using a four-channel function generator to perform testing and analysis. The same connections apply if the board is connected to a microcontroller instead of a function generator. See Section 4.4 "Board description", and the MC33926 data sheet to determine the best way to configure the board.

1. Connect the function generator to the board. There are two options:
   - Use the function generator to control the enabling and disabling of the MC33926PNB H-bridge outputs.
   - Set the H-bridge outputs to be continuously enabled while the board is connected to the function generator.
     Figure 11 illustrates how to set the jumpers and connect to a function generator (or an MCU) for each of these options.
2. With the power switched off, attach the DC power supply to the VPWR and GND screw connector terminals on the evaluation board (J5 in Figure 9).
3. Attach one set of coils of the brushed motor to the OUT1 and OUT2 screw connector terminals on the evaluation board (J6 in Figure 9).

Figure 11 illustrates the hardware configuration.

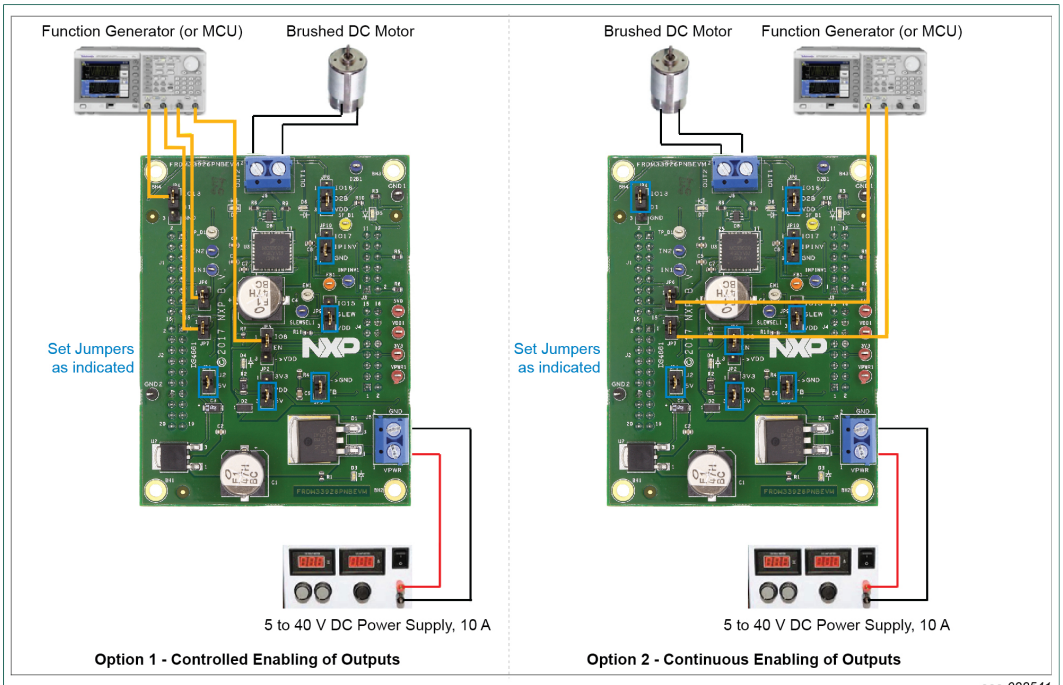


Figure 11. Hardware configuration - stand-alone

6.2 Setting up the FRDM-33926PNBEVM for use with the FRDM-KL25Z

To configure the evaluation board for use with the FRDM-KL25Z and the graphical user interface (GUI), consider the following steps:

1. Connect the hardware.
2. Download the mbed firmware to the FRDM-KL25Z board.
3. Download the MC33931 microcode to the FRDM-KL25Z board.
4. Install the graphical user Interface “GUI Brushed DC FRDM-3x931-EVB”.

6.2.1 Connecting the hardware

The FRDM-33926PNBEVM consists of an H-bridge, a parallel interface, power conditioning circuitry, and a set of two input select jumpers. All +5.0 V VDD power required by the board is obtained via the parallel interface.

Warning:

To avoid damaging the board, the following restrictions must be observed:

- *The motor supply voltage (V_{PWR}) must be at least 5.0 V, but must not exceed 28 V.*
- *The peak operating current of the load must not exceed 5.0 A.*

1. Connect the FRDM-33926PNBEVM to the FRDM-KL25Z.
2. With the power is switched off, attach the DC power supply to the VPWR and GND screw connector terminals on the evaluation board (J5 in Figure 9).
3. Attach one set of coils of the brushed motor to the OUT1 and OUT2 screw connector terminals on the evaluation board (J6 in Figure 9).

Figure 12 illustrates the hardware configuration.

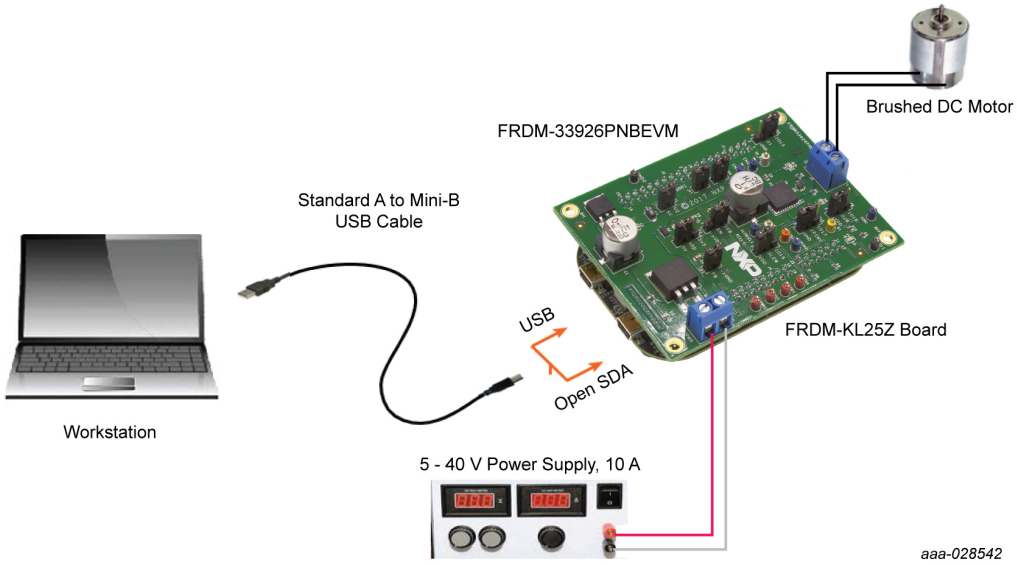


Figure 12. FRDM-33926PNBEVM with FRDM-KL25Z hardware configuration

6.2.2 Downloading mbed® firmware to the FRDM-KL25Z board

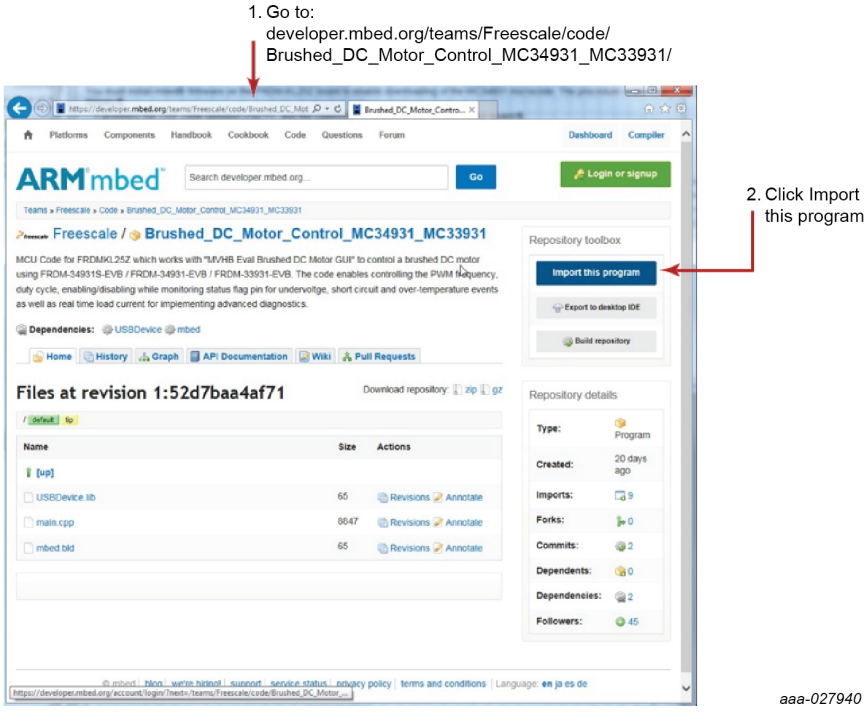
Firmware for FRDM-KL25Z is pre-installed from factory. In the event firmware reinstall is required, follow this procedure. To enable downloading of the MC33926 microcode install mbed® firmware on the FRDM-KL25Z board. The procedure is as follows:

1. Connect the USB cable between your PC and the OpenSDA port on the FRDM-KL25Z board.
2. Download the mbed firmware onto the FRDM-KL25Z board. The instructions are on the ARM®mbed™ website at the following url: https://developer.mbed.org/handbook/Firmware-FRDM-KL25Z.
3. After downloading the mbed firmware, power cycle the board (by disconnecting and then reconnecting the USB cable to the OpenSDA port) to initiate the firmware update. When this process completes, a USB drive named “mbed” appears on the PC.

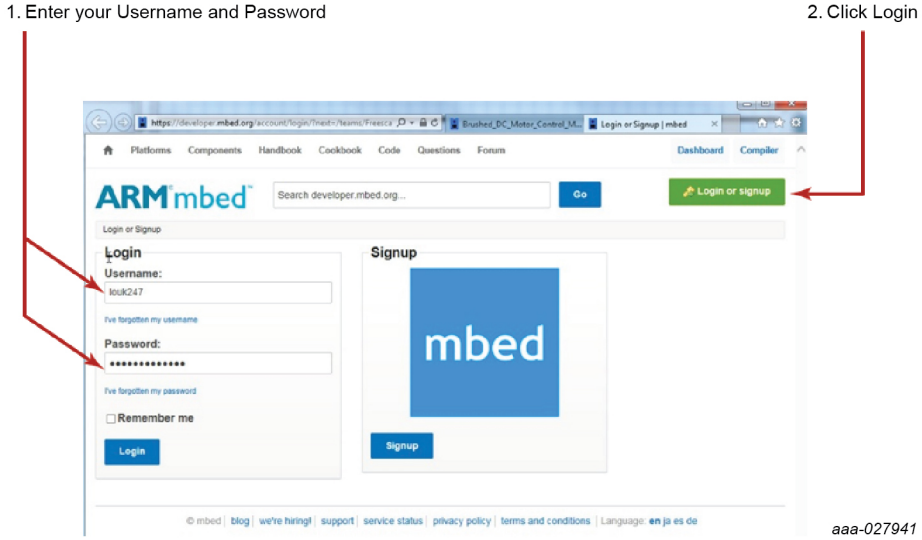
6.2.3 Downloading the MC33926 microcode to the FRDM-KL25Z board

The microcode provides the firmware interface between the MC33926 device, the Freedom platform, and the GUI. Firmware for the KTFRDM33926PNBEVM is pre-installed from the factory. If modifications are needed, the code can be imported, modified (if desired) and compiled from the developer.mbed.org site below. The procedure is as follows:

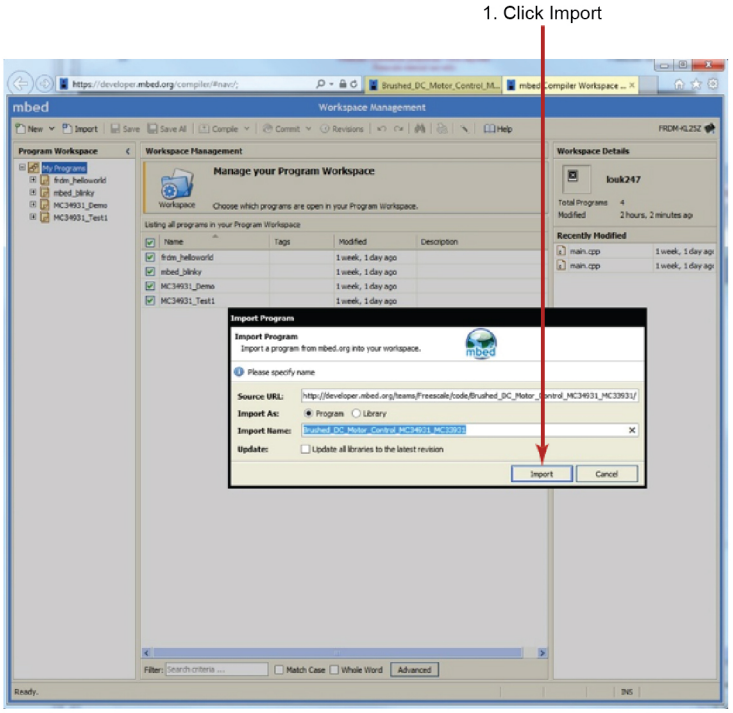
1. Connect the USB cable between the PC and the OpenSDA port on the FRDM-KL25Z board.
2. Go to https://developer.mbed.org/teams/NXP/code/Brushed_DC_Motor_Control_MC34931_MC33931, and then click **Import this Program**.



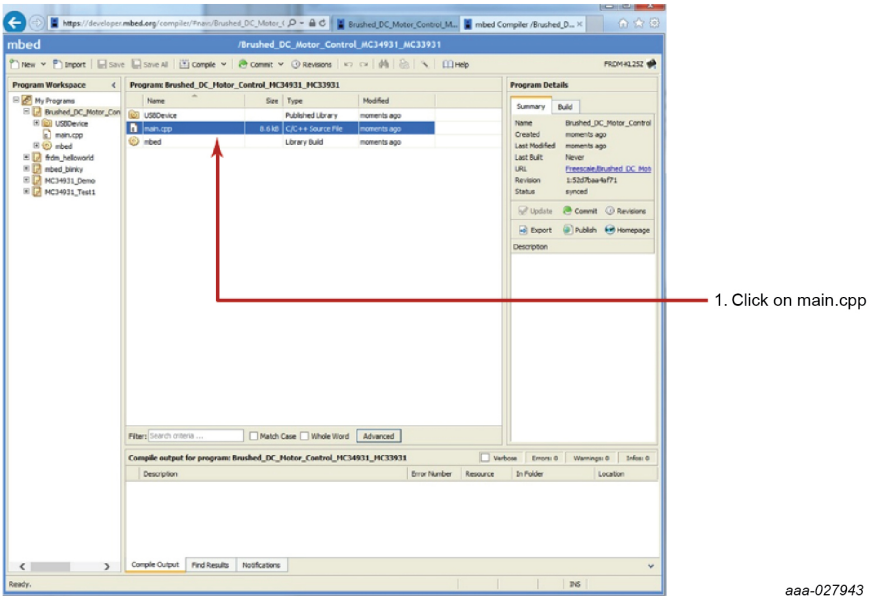
3. Log into your mbed account (if you do not have an mbed account, you must create one).



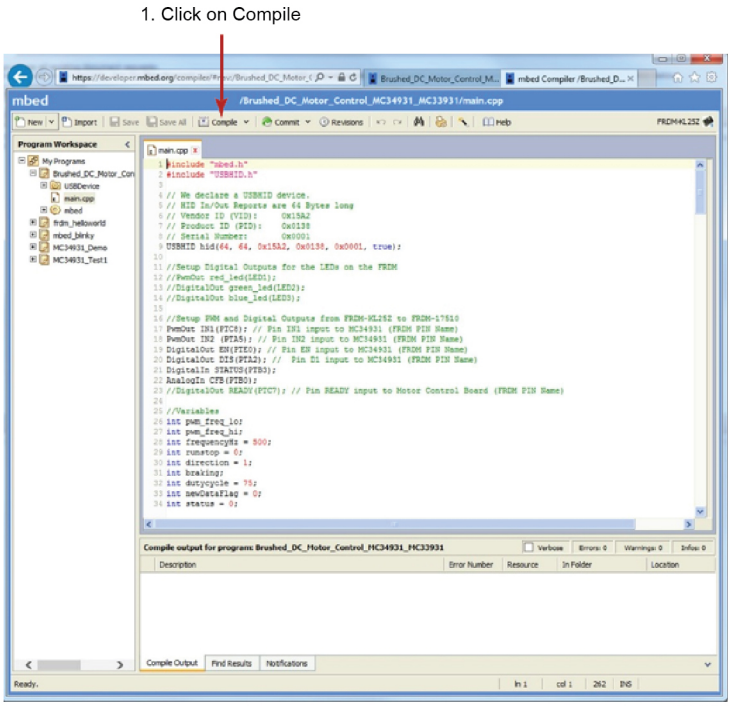
4. The mbed compiler opens with the Import Program window displayed. Click **Import** .



5. When the import completes, the mbed compiler screen should look like the following screen. Click **main.cpp** item.

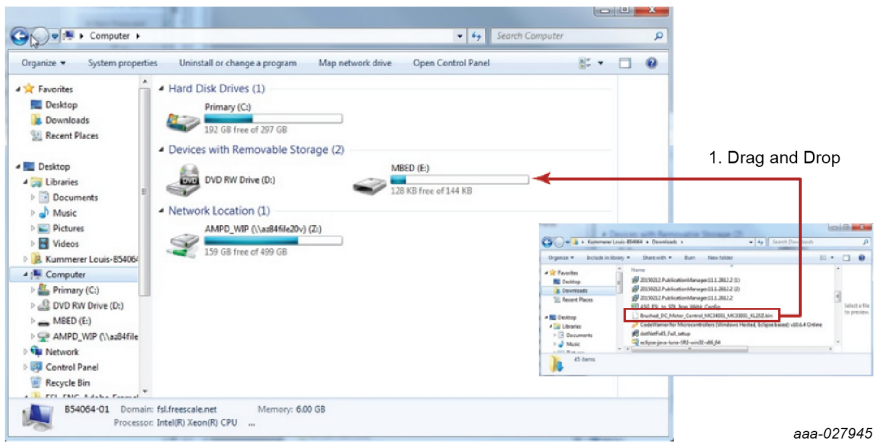


6. The source code for main.cpp appears in the code editor. Click **Compile** to compile the main.cpp source code.



aaa-027944

7. When the compiler completes, an executable file named “Brushed_DC_Motor_Control_MC33931_MC33931_KL25Z.bin” downloads to your system download folder. Drag and drop this file to the mbed device which appears as a USB drive on your system.



aaa-027945

8. Remove the USB connector from the FRDM-KL25Z OpenSDA USB port and insert it in the FRDM-KL25Z USB port.

The FRDM-KL25Z board is now ready for use with the FRDM-33926PNBEVM and the GUI.

6.2.4 Installing the graphical user interface

The graphical user interface provides a PC-based interface allowing you to easily exercise FRDM-33926PNBEVM functions to control a DC Brushed Motor. The GUI runs on any Windows 8, Windows 7, Vista, or XP-based operating system at a maximum PWM frequency of 10 kHz.

To install the software:

1. Go to the evaluation board tool summary page http://www.nxp.com/FRDM-33926PNBEVM.
2. Under **Jump Start Your Design**, click **Get Started with the FRDM-33926PNBEVM**.
3. From the list of files that appear, click the link for the “GUI Brushed DC FRDM-33926PNBEVM” software.

The software automatically downloads to your PC and initiates the installation process. An installation wizard guides you through the rest of the process.

6.2.5 Using the graphical user interface

To start the GUI, do the following:

1. Connect the hardware (Section 6.2.1 "Connecting the hardware") and plug the USB cable into the USB port on the FRDM-KL25Z.
2. Click the NXP GUI Brushed DC FRDM-33926PNBEVM icon to launch the GUI.
3. Make sure the GUI recognizes the FRDM-KL25Z. Check the USB connection in the upper left corner of the GUI.
   - The hex vendor ID value should display as 0x15A2 and the part ID value should display as 0x138.
   - If these values do not appear, the GUI has failed to establish a connection with the FRDM-KL25Z. You may need to disconnect and reconnect the USB cable to the board’s FRDM-KL25Z USB port. If the connection still fails, press the reset button on the FRDM-KL25Z board.
4. Select **Enable Target** checkbox on the GUI screen. The target parameter on the GUI screen should change from “DISABLED” to “ENABLED.”
5. Set the DI, EN/D2_B, Direction and Braking as desired (see Section 6.2.5.1 "Forward with high-side recirculation", Section 6.2.5.2 "Forward with low-side recirculation", Section 6.2.5.3 "Reverse with high-side recirculation", and Section 6.2.5.4 "Reverse with low-side recirculation"). Adjust the PWM Frequency and Duty Cycle to meet your requirements.
6. Click **Run** to run the motor. Notice that some options of the GUI are disabled while the motor is running. To make changes, click **Stop** on the GUI, make the desired changes, and then click **Run** on the GUI to continue.
7. When finished, clear **Enable Target** checkbox on the GUI screen, and then click **Quit**. Turn off DC power supply and remove the USB cable.

The GUI is shown in Figure 13. The hex address numbers at the top are loaded with the vendor ID for NXP (0x15A2), and the part ID (0x138). The left side panel displays these numbers only if the PC is communicating with the FRDM-KL25Z via the USB interface.

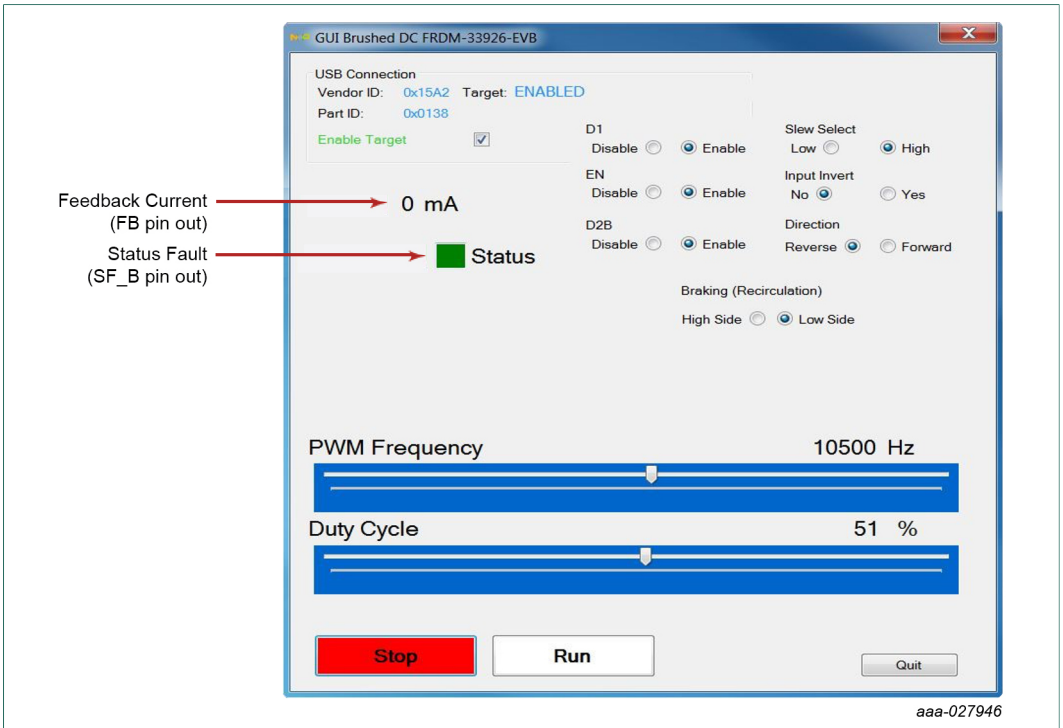


Figure 13. GUI screen

6.2.5.1 Forward with high-side recirculation

To test the FRDM-33926PNBEVM in the forward with high-side recirculation mode, configure the GUI as follows:

- D1: Enable
- EN/D2_B: Enable
- Direction: Forward
- Braking: High-side

Figure 14 shows this configuration with the motor running.

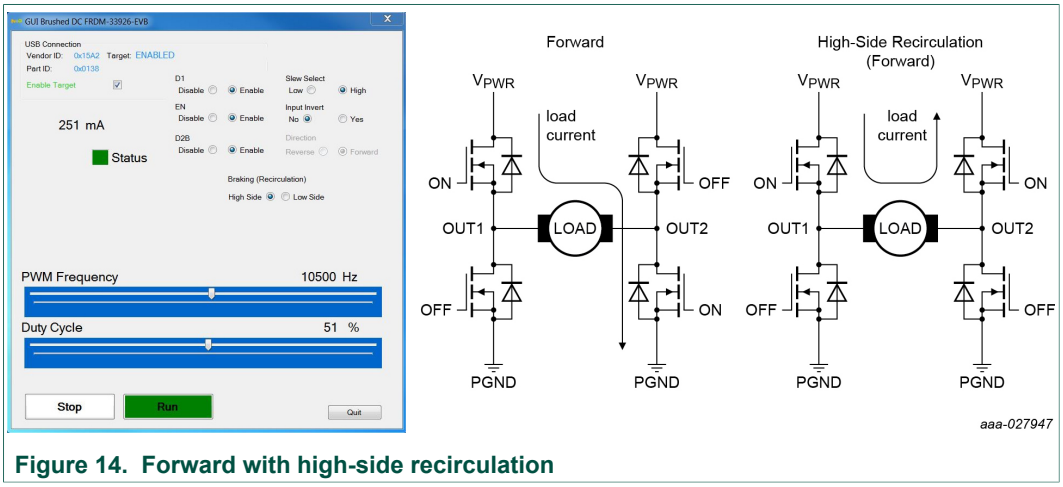


Figure 14. Forward with high-side recirculation

6.2.5.2 Forward with low-side recirculation

To test the FRDM-33926PNBEVM in the forward with low-side recirculation mode, configure the GUI as follows:

- D1: Enable
- EN/D2_B: Enable
- Direction: Forward
- Braking: Low-side

Figure 15 shows this configuration with the motor running.

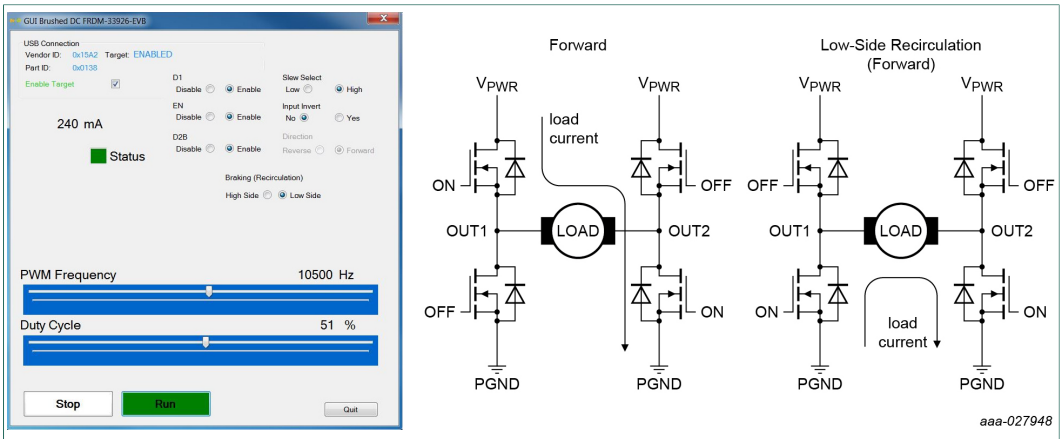


Figure 15. Forward with low-side recirculation

6.2.5.3 Reverse with high-side recirculation

To test the FRDM-33926PNBEVM in the reverse with high-side recirculation mode, configure the GUI as follows:

- D1: Enable
- EN/D2_B: Enable
- Direction: Reverse
- Braking: High-side

Figure 16 shows this configuration with the motor running.

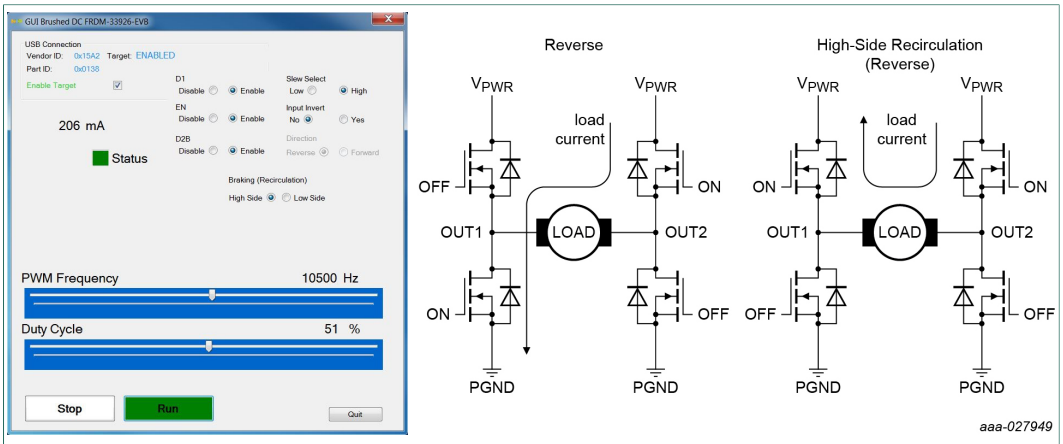


Figure 16. Reverse with high-side recirculation

6.2.5.4 Reverse with low-side recirculation

To test the FRDM-33926PNBEVM in the reverse with low-side recirculation mode, configure the GUI as follows:

- D1: Enable
- EN/D2_B: Enable
- Direction: Reverse
- Braking: Low-side

Figure 17 shows this configuration with the motor running.

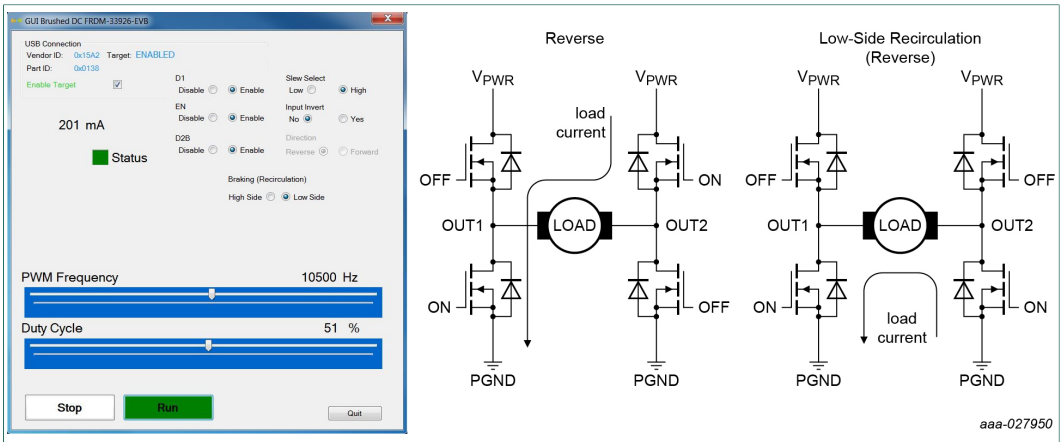


Figure 17. Reverse with low-side recirculation

6.2.5.5 Direction control with high-side versus low-side recirculation

Table 10 illustrates the login behind direction control with high-side versus low-side recirculation.

Table 10. H-bridge operation logic

1	Forward - high-side recirculation
	IN1 = 1 IN2 = PWM signal with selected duty cycle and frequency
2	Reverse - high-side recirculation
	IN1 = 0 IN2 = PWM signal with selected duty cycle and frequency
3	Forward - low-side recirculation
	IN1 = PWM signal with selected duty cycle frequency IN2 = 0
4	Reverse - low-side recirculation
	IN1 = 0 IN2 = PWM signal with selected duty cycle

7 Schematics, board layout and bill of materials

Board schematics, board layout and bill of materials are available in the download tab of the tool summary page: http://www.nxp.com/FRDM-33926PNBEVM.

8 References

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

NXP.com support pages	Description	URL
FRDM-33926PNBEVM	Tool summary page	http://www.nxp.com/FRDM-33926PNBEVM
MC33926	Product summary page	http://www.nxp.com/MC33926
FRDM-KL25Z	Tool summary page	http://www.nxp.com/FRDM-KL25Z

9 Revision history

Revision	Date	Description of changes
2	20171208	• update Figure 13 to Figure 17 • text changed in Section 6.2.2 and Section 6.2.3
1	10/2017	initial release

10 Contact information

Visit http://www.nxp.com/support for a list of phone numbers within your region.
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