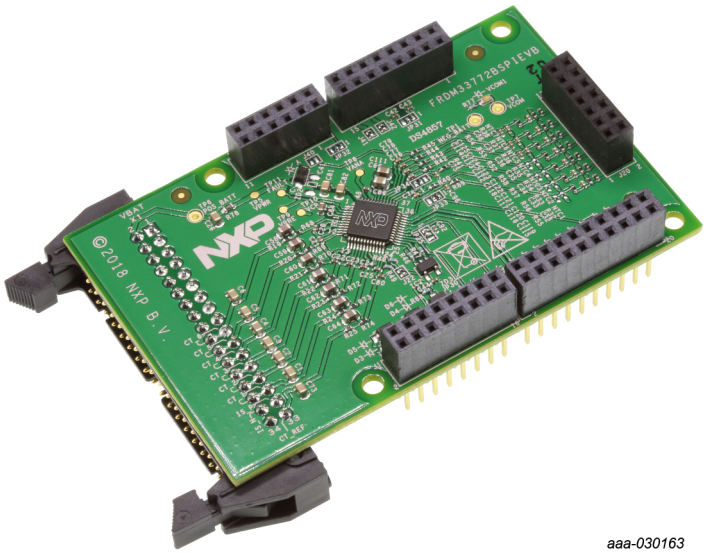
FRDM33772BSPIEVB

Featuring the MC33772B battery cell controller IC

Rev. 1.0 — 22 June 2018 User guide

1 FRDM33772BSPIEVB



aaa-030163

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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 for FRDM33772BSPIEVB is at nxp.com/FRDM33772BSPIEVB. 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 FRDM33772BSPIEVB.

1. Go to nxp.com/FRDM33772BSPIEVB.
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), suporting schematics, and layout are available via NXP DocStore. [6]

3.1 Kit contents/packing list

The kit contents include:

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

3.2 Required equipment

To use this kit, you need:

- A 3- to 6-cell battery pack, such as BATT-14AAAPACK, or a battery pack emulator, such as BATT-6EMULATOR

4 Getting to know the hardware

4.1 Board overview

The FRDM33772BSPIEVB serves as a hardware evaluation tool in support of NXP's MC33772B device. The MC33772B is a battery cell controller that monitors up to 6 lithium-ion battery cells. It is designed for use in both automotive and industrial

applications. The device performs ADC conversion on the differential cell voltages and currents. It is also capable of battery charge coulomb counting and battery temperature measurements. The FRDM33772BSPIEVB is an ideal platform for rapid prototyping of MC33772B-based applications that involve current, voltage, and temperature sensing.

The FRDM33772BSPIEVB supports standard SPI interface. The information is digitally transmitted to a microcontroller for processing.

4.2 Board features

This FRDM33772BSPIEVB's main features are as follows:

- Standard SPI communication
- LED indicator for operation mode
- Cell-balancing resistors
- Cell sense input with RC filter
- GPIO: digital I/O, wake-up inputs, convert trigger inputs, ratiometric analog inputs, analog inputs with absolute measurements
- EEPROM (connected to the IC with I^2C interface) to store user-defined calibration parameters
- Fault detection pin report
- Current Measurement Input via external shunt

4.3 Block diagram

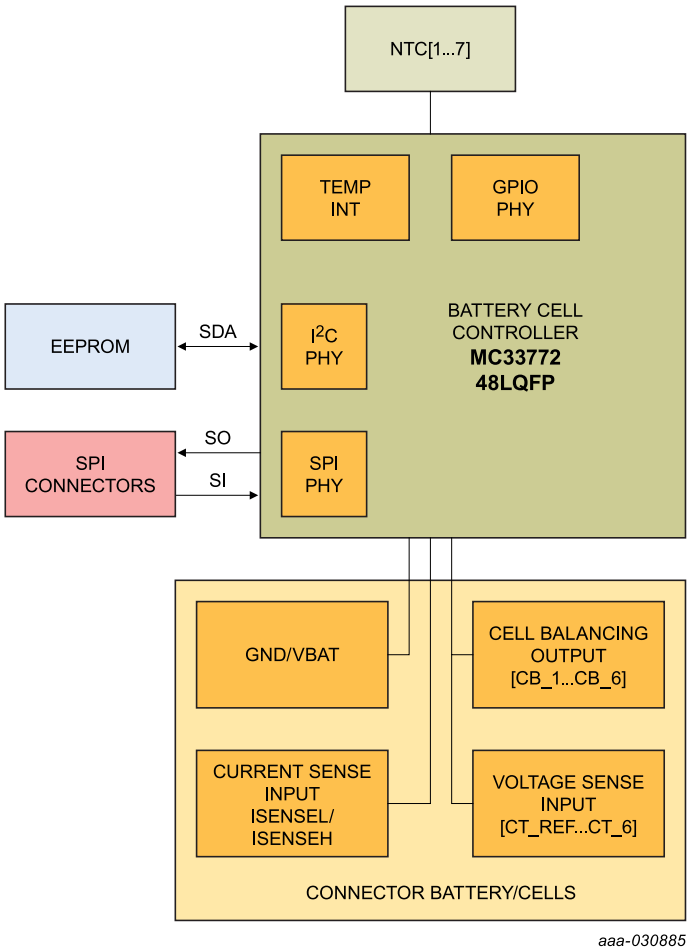

Figure 1. Block diagram

4.4 Device features

The MC33772B is a battery cell controller IC designed to monitor battery characteristics, such as voltage, current and temperature. The MC33772B contains all the circuit blocks necessary to perform synchronous battery cell voltage/current measurement, coulomb counting, cell temperature measurement and integrated cell balancing. The device supports the following functions:

Table 1. MC33772B device features

Device	Description	Features
MC33772B	Battery cell controller	• 5.0 V ≤ VPWR ≤ 30 V operation, 40 V transient • 3 to 6 cells management • 0.8 mV total cell voltage measurement error • Isolated 2.0 Mbps differential communication or 4.0 Mbps SPI • Addressable on initialization • Synchronized cell voltage/current measurement with coulomb count • Total stack voltage measurement • Seven GPIO/temperature sensor inputs • 5.0 V reference supply output with 5 mA capability • Automatic over/undervoltage and temperature detection routable to fault pin • Integrated sleep mode over/undervoltage and temperature monitoring • Onboard 300 mA passive cell balancing with diagnostics • Hot plug capable • Detection of internal and external faults, as open lines, shorts, and leakages • Designed to support ISO 26262 up to ASIL D safety system • Fully compatible with the MC33772 for a maximum of 14 cells • Qualified in compliance with AEC-Q100

4.5 Board description

The FRDM33772BSPIEVB allows the user to exercise all the functions of the MC33772B battery controller cell.

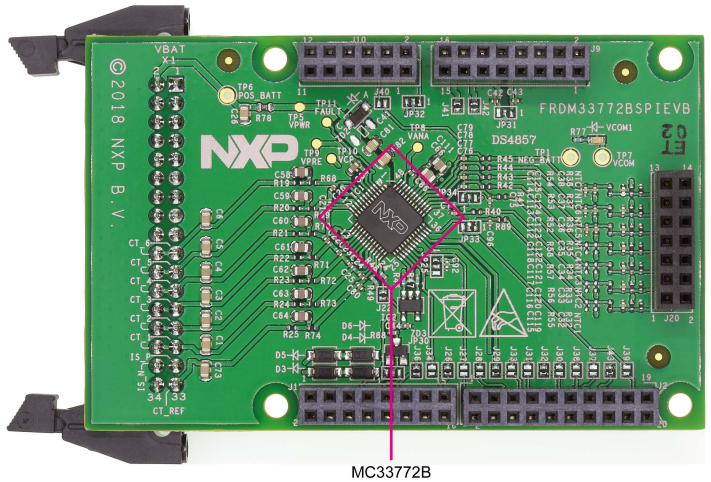

Figure 2. Board description

Table 2. Board description

Name	Description
MC33772B	Battery-cell controller IC

4.6 VCOM LED

The VCOM LED is located on the board as shown in Figure 3.

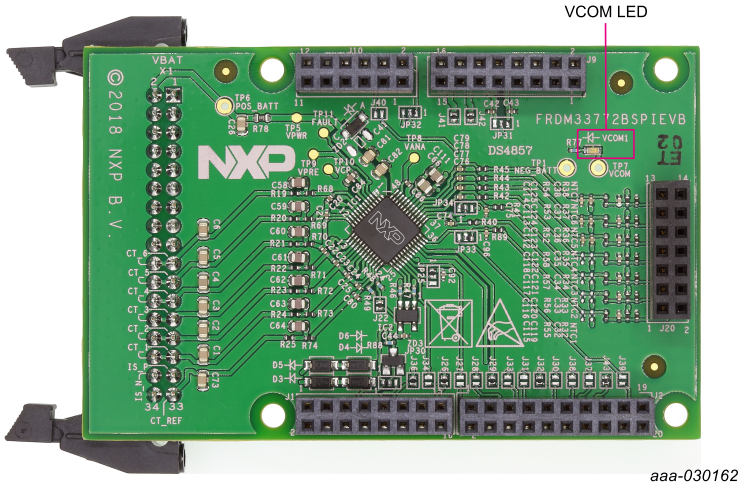

Figure 3. VCOM LED

The VCOM LED indicates when the device is in normal mode. Upon reset, the MC33772B enters into normal mode (VCOM turns on). If there is no activity on the bus after a timeout period of 60 seconds, the device enters low-power idle mode (VCOM turns off). Once the device is initialized, if no communication occurs on the bus after one second, the device resets and the LED turns off (VCOM off). Depending on the device settings, the VCOM LED may flash 0.1...8 seconds during cyclic acquisition.

4.7 Test-point definitions

Figure 4 shows the location of the test points on the board.

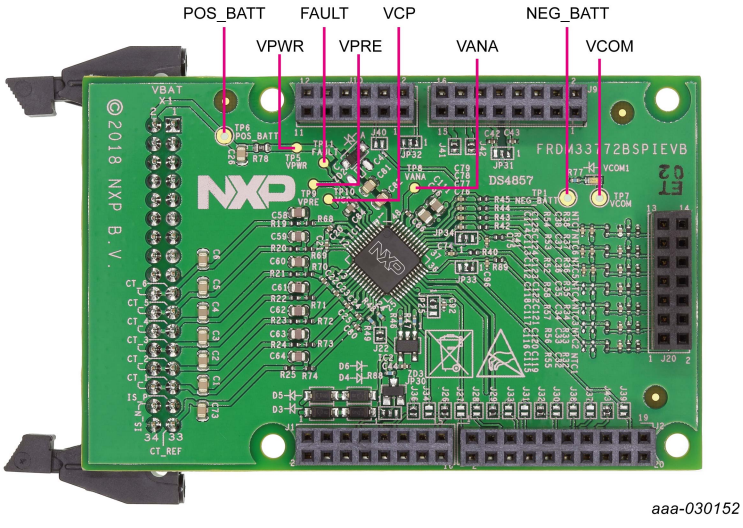

Figure 4. Test points

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

Table 3. Test points

Test-point name	Signal name	Description
FAULT	FAULT	Measures the fault detection sent by the device
NEG_BAT	GNDREF	Ground reference of the device

Test-point name	Signal name	Description
POS_BAT	V_{BAT}	Positive V_{BAT}
VPWR	VPWR	Power input to the device
VANA	VANA	Precision ADC analog supply output
VCOM	VCOM	Communication regulator output
VCP	VCP	VCP regulator output
VPRE	VPRE	VPRE regulator output

4.8 Connectors

Figure 5 shows the location of connectors on the board. The following tables list the pinouts for each connector.

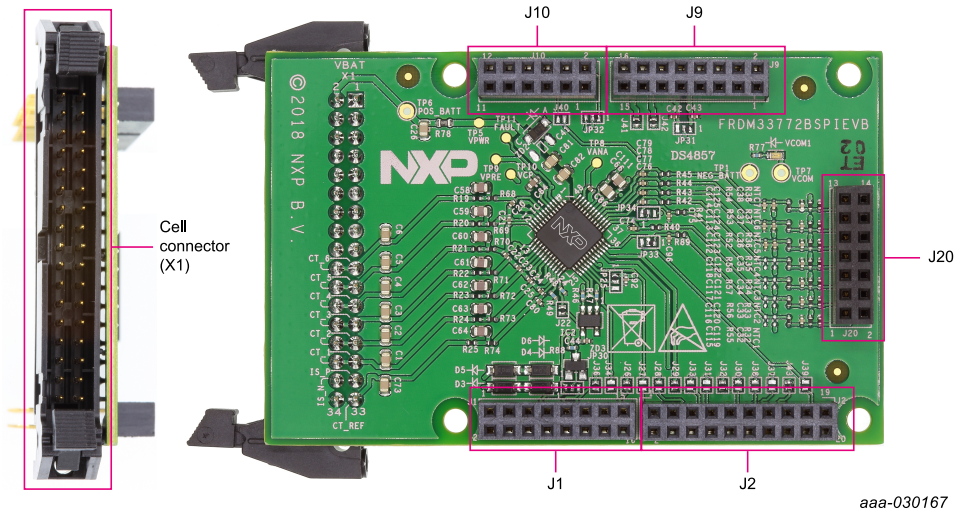

Figure 5. Connectors

Table 4. Cell connector (X1)

Pin #	Connection	Description
X1-2	VBAT	MC33772B Power supply
X1-19 X1-20	CT_6 CB_6	Cell pin 6 input with external LPF resistor. Cell balance driver. Terminate to cell 6 cell balance load resistor
X1-21 X1-22	CT_5 CB_6:5_C	Cell pin 5 input with external LPF resistor. Cell balance 6:5 common. Terminate to cell 6 and 5 common pin
X1-23 X1-24	CT_4 CB_5/CB_4	Cell pin 4 input with external LPF resistor. Cell balance driver. Terminate to cell 5 and 4 cell balance load resistor
X1-25 X1-26	CT_3 CB_4:3_C	Cell pin 3 input with external LPF resistor. Cell balance 4:3 common. Terminate to cell 4 and 3 common pin
X1-27 X1-28	CT_2 CB_3/CB_2	Cell pin 2 input with external LPF resistor. Cell balance driver. Terminate to cell 3 and 2 cell balance load resistor
X1-29 X1-30	CT_1 CB_2:1_C	Cell pin 1 input with external LPF resistor. Cell balance 2:1 common. Terminate to cell 2 and 1 common pin

Pin #	Connection	Description
X1-31	ISENSE_P	Current measurement input+ with external filter RC
X1-32	ISENSE_N	Current measurement input– with external filter RC
X1-33	CT_REF CB_1	Cell pin REF input with external LPF resistor. Cell balance driver. Terminate to cell 1 cell balance load resistor.
X1-34	GND	Negative_Battery

4.9 External EEPROM

The FRDM33772BSPIEVB has an integrated gateway communication link to an external local EEPROM. The MC33772B's I^2C Communication Interface manages communication with the EEPROM.

After a reset, the EEPROM is not enabled. When the EEPROM is enabled, the device can load the EEPROM calibration parameters into the MC33772B registers.

4.10 GPIO configuration

The FRDM33772BSPIEVB offers seven customizable GPIOs [GPIO_0...GPIO_6] for measuring external temperature with a bridge divider. [GPIO_0] can be used as the input for wake-up or fault daisy chain.

4.11 Cell terminal voltage measurement

The differential measurement of each cell terminal input is designed to function in conjunction with an external low path filter.

4.12 Current sensing

The FRDM33772BSPIEVB supports current sense function with off-board shunt resistor. The off-board shunt resistor shall be connected between X1-31 (IS_P) and X1-32 (IS_N). On-board current sensing filter and protection circuits can be found in EVB schematic shared via NXP DocStore (NDA required).

4.13 SPI communication interface

The MC33772B SPI interface is a standard SPI slave interface with a chip select (CSB), clock (SCLK), Slave Out (SO), and Slave In (SI). The SI/SO shifting of the data follows a first-in-first-out protocol, with both input and output words transferring the Most Significant Bit (MSB) first.

All SPI communication to the MC33772B is controlled by the microcontroller. One 40-bit register of previously requested data is retrieved through serial out for each current serial in message sent by the MCU. For message integrity and communication robustness, each SPI transmit message consists of six fields containing 40 bits.

The six transmit fields are defined as the following:

1. Cyclical redundancy check (8 bits)
2. Command field (4 bits)
3. Cluster ID field (4 bits)
4. Memory address field (7 bits)

5. Master/slave field (1 bit)
6. Memory data field (16 bits)

Messages having less or more than 40 bits or incorrect CRC are disregarded. Communication faults set the COM_ERR_FLT fault bit in the FAULT1_STATUS register and increments the COM_STATUS[COM_ERR_COUNT] register.

Detailed schematic, component selection, and layout recommendations can be obtained from the NXP DocStore (NDA required) [6].

5 Configuring the hardware

The FRDM33772BSPIEVB can be configured as a shield board connected to selected Freedom boards.

5.1 Compatible NXP MCU development platforms

FRDM33772BSPIEVB is compatible with multiple NXP MCU development platforms:

- FRDM-KL25Z (default)
- FRDM-KE06Z
- FRDM-KL43Z
- FRDM-KV31F
- FRDM-KW40Z
- FRDM-KEAZ128
- S32K144EVB
- Arduino R3

MCU development platform ordering, instruction, and other information is on nxp.com.

Table 5. Jumper setting to work with FRDM-KL25Z (default)

Jumper	Setting	Description
J22	1-2	RESET
J26	1-2	CSB
J27	open	—
J28	open	—
J29	1-2	MOSI
J30	open	—
J31	open	—
J32	1-2	MISO
J33	open	—
J34	open	—
J36	1-2	SLCK
J37	open	—
J38	open	—
J41	1-2	GND

Jumper	Setting	Description
J42	1-2	GND
JP25	1-2	VDDIO
JP30	1-2	FAULT
JP31	1-2	3.3 V
JP32	1-2	RESET

Table 6. Jumper Setting to Work with FRDM-KE06Z

Jumper	Setting	Description
J22	1-2	RESET
J26	open	—
J27	1-2	CSB
J28	open	—
J29	1-2	MOSI
J30	open	—
J31	open	—
J32	open	—
J33	open	—
J34	1-2	MISO
J36	open	—
J37	1-2	SLCK
J38	open	—
J41	open	—
J42	open	—
JP25	1-2	VDDIO
JP30	2-3	FAULT
JP31	1-2	3.3 V
JP32	2-3	RESET

Table 7. Jumper Setting to Work with FRDM-KL43Z

Jumper	Setting	Description
J22	1-2	RESET
J26	open	—
J27	1-2	CSB
J28	open	—

Jumper	Setting	Description
J29	1-2	MOSI
J30	open	—
J31	open	—
J32	1-2	MISO
J33	open	—
J34	open	—
J36	open	—
J37	1-2	SLCK
J38	open	—
J41	open	—
J42	open	—
JP25	1-2	VDDIO
JP30	2-3	FAULT
JP31	1-2	3.3 V
JP32	2-3	RESET

Table 8. Jumper Setting to Work with FRDM-KV31F

Jumper	Setting	Description
J22	1-2	RESET
J26	open	—
J27	1-2	CSB
J28	open	—
J29	1-2	MOSI
J30	open	—
J31	open	—
J32	1-2	MISO
J33	open	—
J34	open	—
J36	open	—
J37	1-2	SLCK
J38	open	—
J41	open	—
J42	open	—
JP25	1-2	VDDIO

Jumper	Setting	Description
JP30	2-3	FAULT
JP31	1-2	3.3 V
JP32	2-3	RESET

Table 9. Jumper Setting to Work with FRDM-KW40Z

Jumper	Setting	Description
J22	1-2	RESET
J26	1-2	CSB
J27	open	—
J28	open	—
J29	open	—
J30	1-2	MOSI
J31	open	—
J32	open	—
J33	1-2	MISO
J34	open	—
J36	open	—
J37	1-2	SLCK
J38	open	—
J41	open	—
J42	open	—
JP25	1-2	VDDIO
JP30	2-3	FAULT
JP31	1-2	3.3 V
JP32	2-3	RESET

Table 10. Jumper Setting to Work with FRDM-KEAZ128

Jumper	Setting	Description
J22	1-2	RESET
J26	open	—
J27	1-2	CSB
J28	open	—
J29	1-2	MOSI
J30	open	—

Jumper	Setting	Description
J31	open	—
J32	1-2	MISO
J33	open	—
J34	open	—
J36	open	—
J37	1-2	SLCK
J38	open	—
J41	open	—
J42	open	—
JP25	1-2	VDDIO
JP30	1-2	FAULT
JP31	1-2	3.3 V
JP32	2-3	RESET

Table 11. Jumper Setting to Work with S32K144EVB

Jumper	Setting	Description
J22	1-2	RESET
J26	open	—
J27	1-2	CSB
J28	open	—
J29	1-2	MOSI
J30	open	—
J31	open	—
J32	1-2	MISO
J33	open	—
J34	open	—
J36	open	—
J37	1-2	SLCK
J38	open	—
J41	open	—
J42	open	—
JP25	1-2	VDDIO
JP30	2-3	FAULT
JP31	2-3	5 V

Jumper	Setting	Description
JP32	2-3	RESET

Table 12. Jumper Setting to Work with Arduino R3

Arduino R3 has a single-line connector that connects to the outer row of the FRDM33772BSPIEVB connectors.

Jumper	Setting	Description
J22	1-2	RESET
J26	open	—
J27	1-2	CSB
J28	open	—
J29	1-2	MOSI
J30	open	—
J31	open	—
J32	1-2	MISO
J33	open	—
J34	open	—
J36	open	—
J37	1-2	SLCK
J38	open	—
J41	open	—
J42	open	—
JP25	1-2	VDDIO
JP30	2-3	FAULT
JP31	1-2	3.3 V
JP32	2-3	RESET

5.2 Freedom board configuration

The layout of the connectors allow MCU development boards mentioned in Section 5.1 "Compatible NXP MCU development platforms" to be mounted directly to the FRDM33772BSPIEVB. See Figure 6. When both boards are connected together, the SPI connector is directly connected with the MCU SPI pins. The routing of SPI signals through the Arduino connectors depends on the specific Freedom board being used. In this configuration, power is supplied to the FRDM33772BSPIEVB through a USB cable connected between the Freedom board and a PC. No external power supply is required.

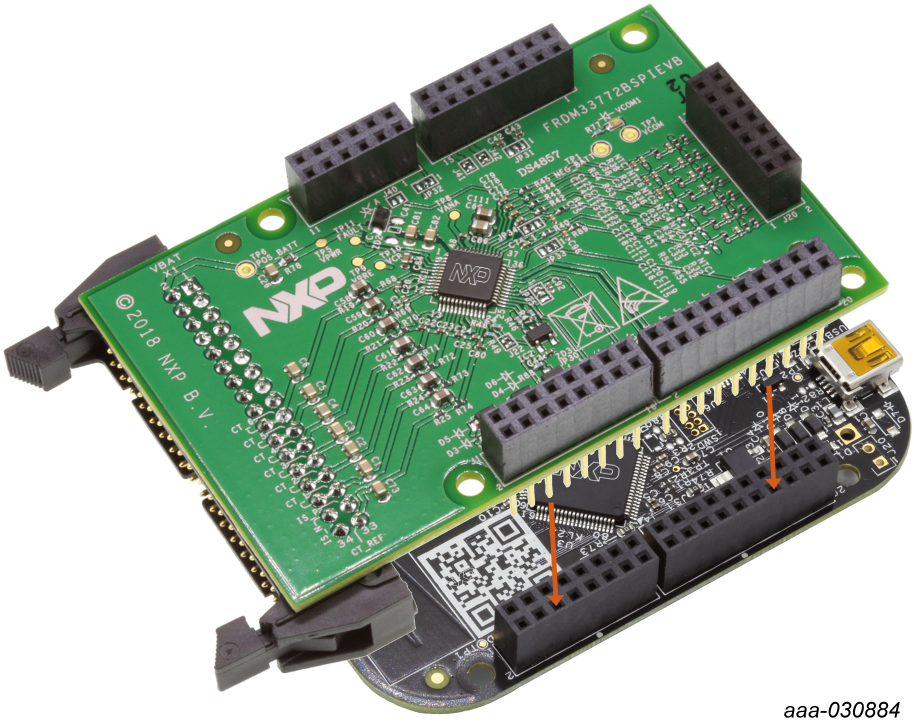

Figure 6. FRDM33772BSPIEVB mounted to a FRDM-KL25Z

The board must be modified to be compatible with each specific Freedom board. This modification is described in Section 5.1 "Compatible NXP MCU development platforms".

5.3 Off-board NTC configuration

FRDM33772BSPIEVB supports off-board NTC, please follow the instruction in the following table.

Table 13. Off-board NTC configuration

Temperature input	Remove	Connect off-board NTC between
GPIO0	NTC1	J20 1-2
GPIO1	NTC2	J20 3-4
GPIO2	NTC3	J20 5-6
GPIO3	NTC4	J20 7-8
GPIO4	NTC5	J20 9-10
GPIO5	NTC6	J20 11-13
GPIO6	NTC7	J20 13-14

6 Available accessories

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

Table 14. Bill of materials

Part number	Description
M50-9101742	34-pin ribbon cable
BATT-14AAAPACK	3- to 14-cell configurable AAA battery pack
BATT-6EMULATOR	6-cell slider battery pack emulator kit with shunt for current sense

7 References

[1] **Board summary page** — nxp.com/FRDM33772BSPIEVB

[2] **Product summary page** — nxp.com/BATTERY-CELL-CONTROLLERS

[3] **Tool summary page** — nxp.com/FRDM33664BEVB

[3] **Tool summary page for BATT-14AAAPACK battery pack** — nxp.com/BATT-14AAAPACK

[5] **Tool summary page for battery emulators** — nxp.com/BATT-6EMULATOR

[6] **NXP DocStore** — docstore.nxp.com

8 Revision history

Table 15. Revision history

Rev	Date	Description
v.1.0	20180622	Initial release

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