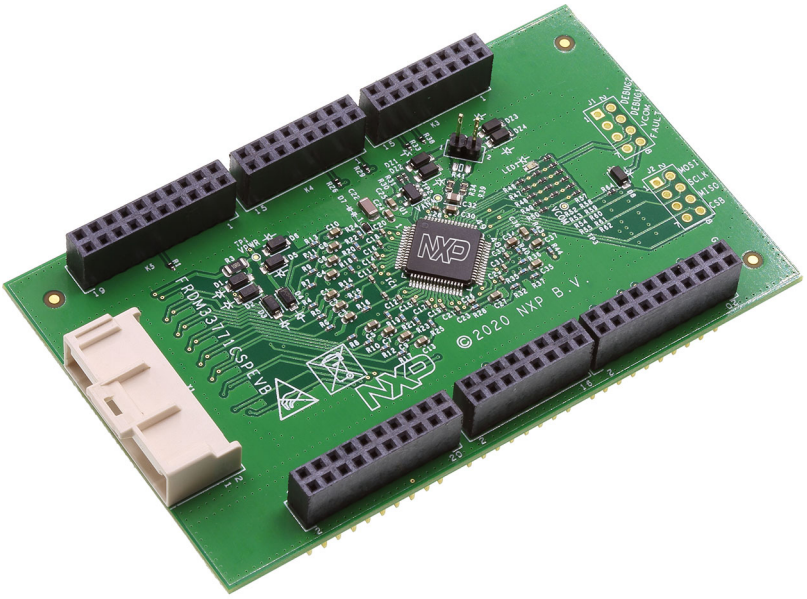
UM11402

FRDM33771CSPEVB evaluation board

Rev. 1 — 29 June 2020 **User manual**



aaa-037954

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The tool summary page for the FRDM33771CSPEVB evaluation board is at http://www.nxp.com/FRDM33771CSPEVB. The tool summary page provides information related to using the evaluation board. The page contains the following sections:

- Overview – A brief summary of the evaluation board and its capabilities
- Supported Devices – A list of devices that the evaluation board supports
- Specifications – An overview of the technical and functional specifications for the board
- Documents and Software/Design Resources – All of the information and resources required by users who have already purchased the FRDM33771CSPEVB. This section includes:
  - Design Tools & FIles – Click on the Download button to download the board Bill of Materials and the Gerber files for the PCB assemblies.
  - Printed Circuit Boards and Schematics – Click on the Download to download a .pdf version of the FRDM33771CSPEVB board schematics.

The Get Started link in the upper left of the menu bar provides information applicable to using the FRDM33771CSPEVB.

1.1 Kit contents/packing list

The kit contents include:

- Assembled and tested evaluation board/module in anti-static bag
- 20 cm 26-pin cell terminal cable
- Quick-start guide

1.2 Required equipment

To use this evaluation board, you need:

- A 7- to 14-cell battery pack or a battery pack emulator, such as BATT-14CEMULATOR

2 Getting to know the hardware

2.1 Board overview

The FRDM33771CSPEVB serves as a hardware evaluation tool in support of NXP's MC33771C device. The MC33771C is a battery cell controller that monitors up to 14 lithium-ion battery cells. It is designed for use in both automotive and industrial applications. The device performs ADC conversions on differential cell voltages and currents. It is also capable of battery charge coulomb counting and battery temperature measurements. The FRDM33771CSPEVB is an ideal platform for rapid prototyping of MC33771C-based applications that involve current, voltage, and temperature sensing.

The FRDM33771CSPEVB supports a standard SPI interface. The information is digitally transmitted to a microcontroller for processing.

2.2 Board features

The FRDM33771CSPEVB's main features are:

- 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

2.3 Block diagram

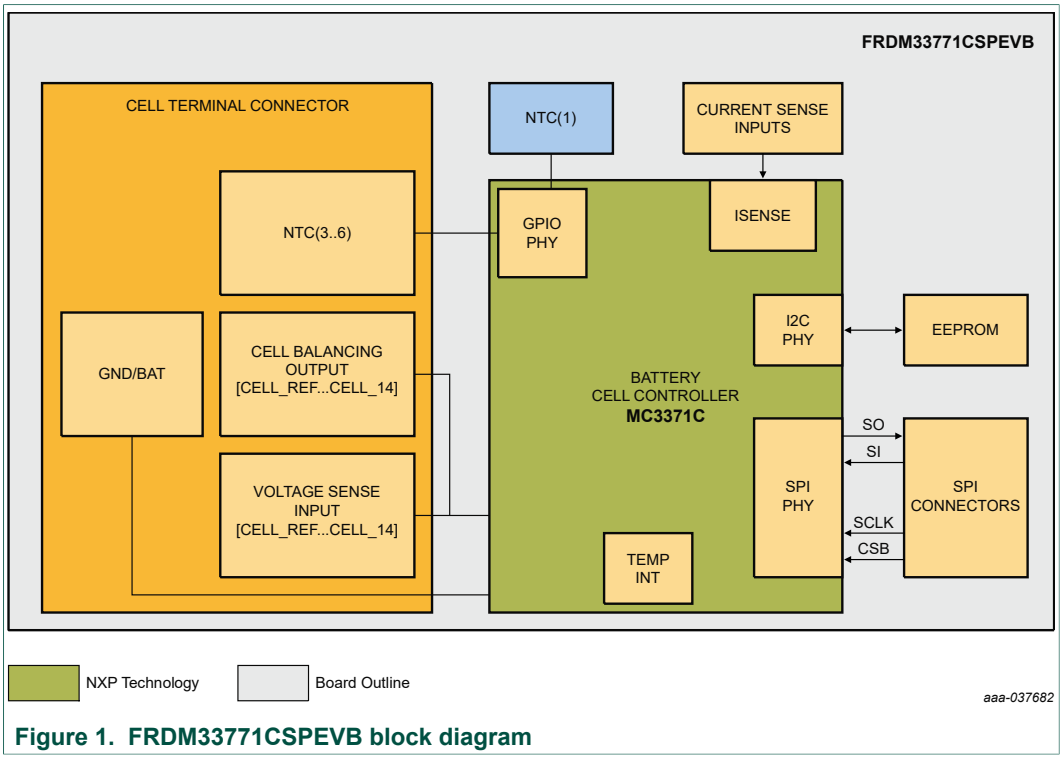

Figure 1. FRDM33771CSPEVB block diagram

2.4 Device features

The MC33771C is a battery cell controller IC designed to monitor battery characteristics, such as voltage, current and temperature. The MC33771C 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. MC33771C device features

Device	Description	Features
MC33771C	Battery cell controller	• 9.6 V ≤ V_{PWR} ≤ 61.6 V operation, 75 V transient • 7 to 14 cells management • Isolated 2.0 Mbps differential communication or 4.0 Mbps SPI • Addressable on initialization • Bidirectional transceiver to support up to 63 nodes in daisy chain • 0.8 mV maximum total voltage measurement error • Synchronized cell voltage/current measurement with coulomb count • Averaging of cell voltage measurements • Total stack voltage measurement • Seven GPIO/temperature sensor inputs • 5.0 V at 5.0 mA reference supply output • 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 • Qualified in compliance with AECQ-100

2.5 Board description

The FRDM33771CSPEVB allows the user to exercise all the functions of the MC33771C battery controller cell.

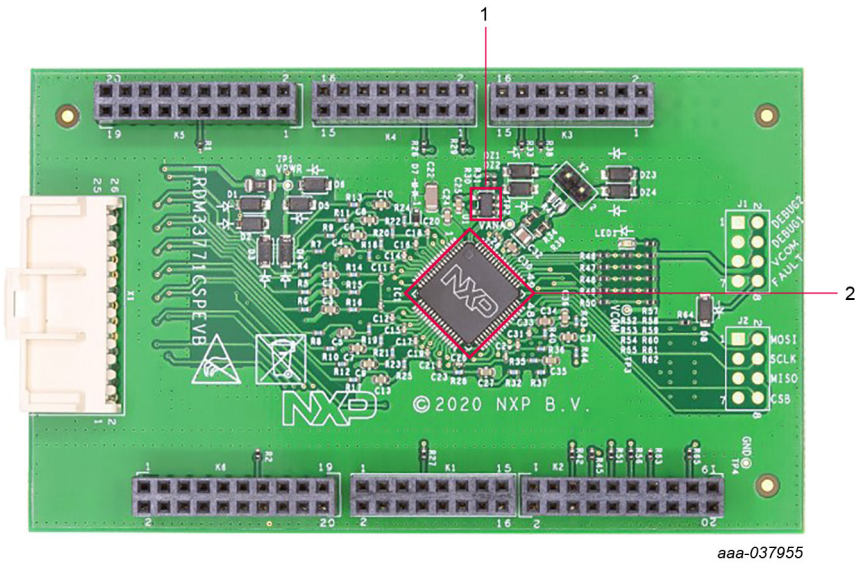

Figure 2. Board description

Table 2. Board components

Number	Label	Name	Description
1	U1	24LC01BT-I/OT	IC memory EEPROM

Number	Label	Name	Description
2	IC1	MC33771C	Battery-cell controller IC

2.6 VCOM LED

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

The VCOM LED indicates when the device is in normal mode. Upon reset, the MC33771C 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 TPL bus after one second, the device resets and the LED turns off (VCOM off).

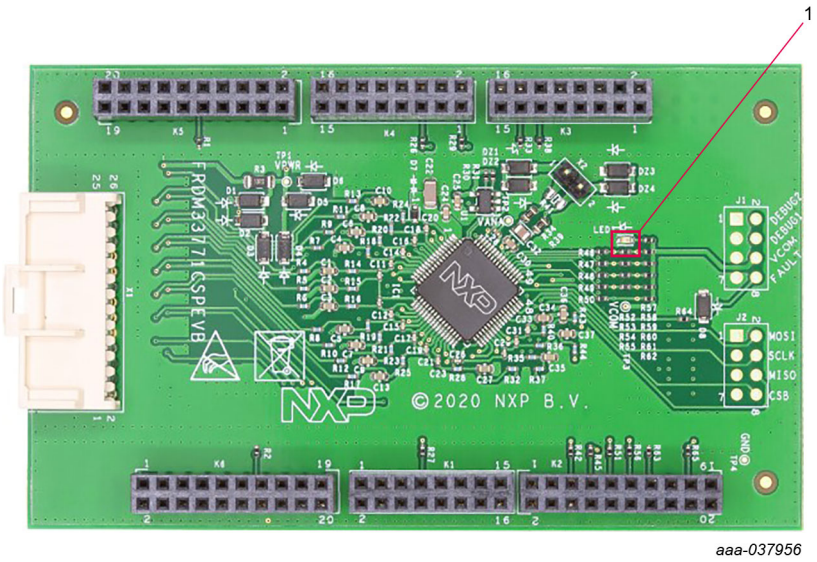

Figure 3. VCOM LED

Table 3. Board Description

Number	Label	Name	Description
1	LED1	VCOM LED	Indicates whether the device is in normal mode or in low power mode

2.7 Test-point definitions

The following test points provide access to various signals to and from the board. Figure 4 and Figure 5 show the location of the test points on the board.

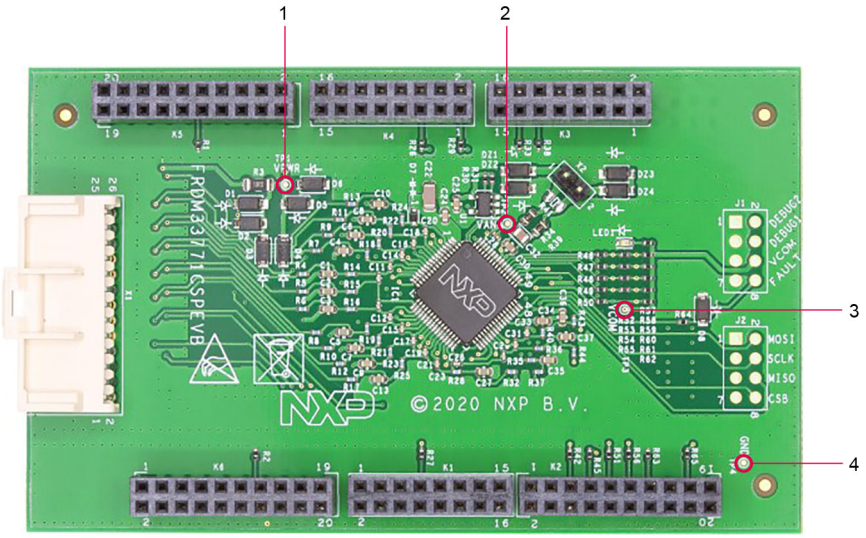

Figure 4. Test points (board top)

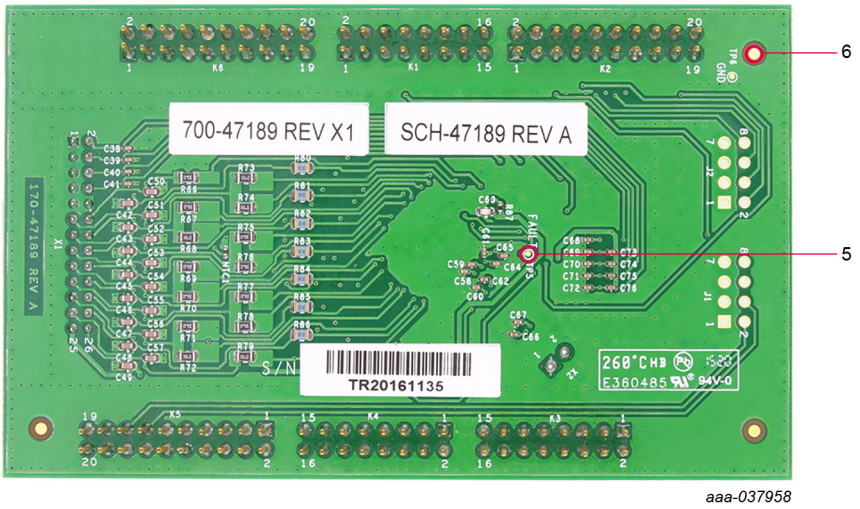

Figure 5. Test points (board bottom)

Table 4. Test points

Number	Label	Signal name	Description
1	TP1	VPWR	Power input to the device
2	TP2	VANA	Precision ADC analog supply output
3	TP3	VCOM	Communication regulator output
4	TP4	GND	Ground reference of the device
5	TP5	FAULT	Device FAULT pin for user defined internal and external faults
6	TP6	GND	Ground reference of the device

2.8 Connectors

Figure 6 shows the location of connectors on the board. The accompanying tables list the pinouts for each connector.

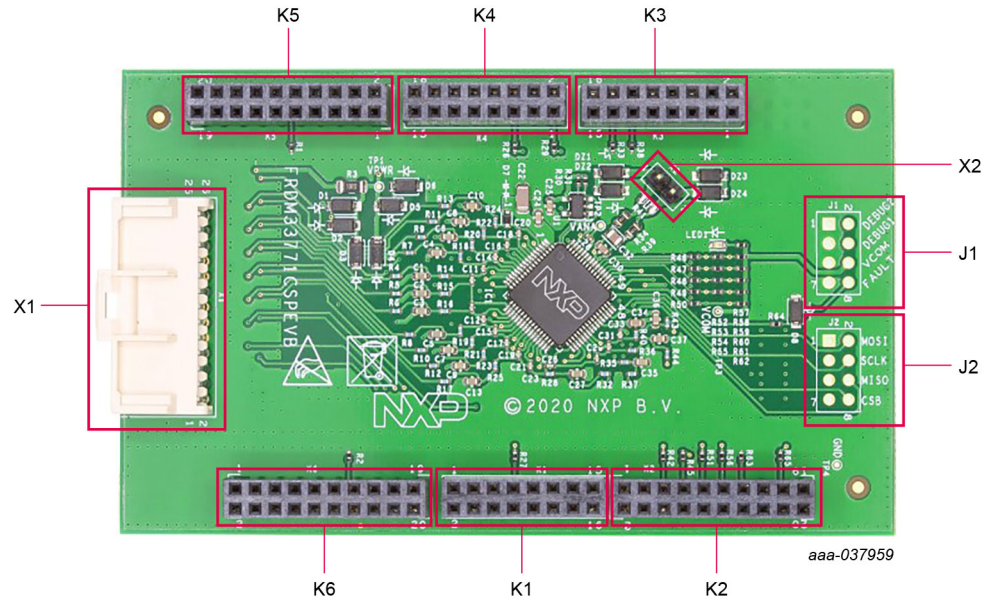

Figure 6. Connectors

Table 5. SPI Connector (K1)

Pin Number	Connection	Description
7	FAULT	Connects via FAULT_MCU to the device FAULT pin
Other	—	No connection

Table 6. SPI Connector (K2)

Pin Number	Connection	Description
5	CSB, J2-8	Connects via CSB to: • the device CSB pin • debug connector J2 pin 8
7	SI/RDTX_IN+, J2-2	Connects via MOSI to: • the device SI/RDTX_IN+ pin • debug connector J2 pin 2
9	SO, J2-6	Connects via MISO to: • the device SO pin • debug connector J2 pin 6
11	SCLK/RDTX_IN-, J2-4	Connects via SCLK to: • the device SCLK/RDTX_IN- pin • debug connector J2 pin 4
13	GND	Connects to the device ground reference

Pin Number	Connection	Description
17	GPIO0	Connects via GPIO_WAKEUP to the device GPIO0 pin
Other	—	No connection

Table 7. SPI Connector (K3)

Pin Number	Connection	Description
11	GND	Connects to the device ground reference
13	GND	Connects to the device ground reference
Other	—	No connection

Table 8. SPI Connector (K4)

Pin Number	Connection	Description
1	RESET	Connects via RESET to the device RESET pin
5	GPIO2	Connects via GPIO2_SOC to the device GPIO2 pin
Other	—	No connection

Table 9. SPI Connector (K5)

Pin Number	Connection	Description
12	GND	Connects to the device ground reference
13	DEBUG1	Connects via DEBUG1 to DEBUG1 (pin 4) on SPI Analyzer Interface connector J1
15	DEBUG2	Connects via DEBUG2 to DEBUG2 (pin 2) on SPI Analyzer Interface connector J1
Other	—	No connection

Table 10. SPI Connector (K6)

Pin Number	Connection	Description
12	GND	Connects to the device ground reference
Other	—	No connection

Table 11. Debug connector (J1)

Pin Number	Connection	Description
2	DEBUG2	Connects via DEBUG2 to pin 15 on connector K5

Pin Number	Connection	Description
4	DEBUG1	Connects via DEBUG1 to pin 13 on connector K5
6	VCOM	Connects to the device VCOM pin
8	FAULT, K1-7	Connects via FAULT_MCU to: • the device FAULT pin • pin 7 on connector K1
Other	GND	Connects to the device ground reference

Table 12. Debug connector (J2)

Pin Number	Connection	Description
2	SI/RDTX_IN+, K2-7	Connects via MOSI to: • the device SI/RDTX_IN+ pin • pin 7 on connector K2
4	SCLK/RDTX_IN-, K2-11	Connects via SCLK to: • the device SCLK/RDTX_IN- pin • pin 11 on connector K2
6	SO, K2-9	Connects via MISO to: • the device SO pin • pin 9 on connector K2
8	CSB, K2-5	Connects via CSB to: • the device CSB pin • in 5 on connector K2
Other	GND	Connects to thep q device ground reference

Table 13. Cell terminal connector (X1)

Pin	Connection	Description
1	GND	NTC connection (-)
2	NTC6	NTC connection (+)
3	GND	NTC connection (-)
4	NTC5	NTC connection (+)
5	GND	NTC connection (-)
6	NTC4	NTC connection (+)
7	GND	NTC connection (-)
8	NTC3	NTC connection (+)
9	GND	negative battery
10	GND	negative battery
11	CELL_1	Battery cell1P connection
12	CELL_REF	Battery cell1M connection

Pin	Connection	Description
13	CELL_3	Battery cell3P connection
14	CELL_2	Battery cell2P connection
15	CELL_5	Battery cell5P connection
16	CELL_4	Battery cell4P connection
17	CELL_7	Battery cell7P connection
18	CELL_6	Battery cell6P connection
19	CELL_9	Battery cell9P connection
20	CELL_8	Battery cell8P connection
21	CELL_11	Battery cell11P connection
22	CELL_10	Battery cell10P connection
23	CELL_13	Battery cell13P connection
24	CELL_12	Battery cell12P connection
25	VBAT	positive battery
26	CELL_14	Battery cell14P connection

Table 14. ISENSE filter connector (X2)

Pin number	Connection	Description
1	ISENSE-	Connects via ISENSE_- to the device ISENSE- pin
2	ISENSE+	Connects via ISENSE_+ to the device ISENSE+ pin

2.9 External EEPROM

The FRDM33771CSPEVB has an integrated gateway communication link to an external local EEPROM. The MC33771C'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 MC33771C registers.

For more information on using an external EEPROM with the MC33771C device, see the MC33771C data sheet.

2.10 GPIO configuration

The MC33771C has seven GPIOs pins available for external connections. On the FRDM33771CSPEVB, those pins are allocated as follows:

- GPIO0 is connected to the S32K connector K2 for the wakeup function
- GPIO1 is connected to an onboard NTC for EVB temperature measurement
- GPIO2 is connected to the S32K connector K4 for Start Of Conversion (SOC) requests
- GPIO3 through GPIO6 are available for temperature measurement through connector X1 to an external NTC

2.11 Cell terminal voltage measurement

The differential measurement of each cell terminal input is designed to function in conjunction with an external anti-aliasing filter with a corner frequency.

2.12 Current sensing

The FRDM33771CSPEVB supports a current sense function with an off-board shunt resistor. The off-board shunt resistor must be connected between X2-2 (ISENSE+) and X2-1 (ISENSE–). Please refer to the MC33771C datasheet regarding the maximum voltage that can be applied on these pins. The on-board current sensing filter and protection circuits are found in the FRDM33771CSPEVB Tool Summary Page: nxp.com/FRDM33771CSPEVB.

2.13 SPI communication interface

The MC33771C 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 MC33771C is controlled by the microcontroller. One 48-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 48 bits.

3 Configuring the hardware

The FRDM33771CSPEVB can be configured as a shield board connected to an S32K144EVB board.

3.1 Board configuration

See Figure 7. When both boards are connected together, the SPI connector is directly connected with the MCU SPI pins. In this configuration, power is supplied to the S32K144EVB through a USB cable connected between the S32K144EVB board and a PC. No external power supply is required.

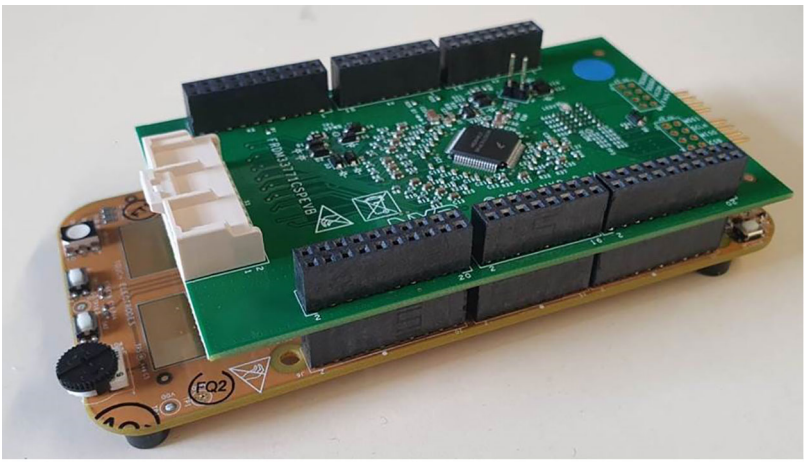

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Figure 7. FRDM33771CSPEVB mounted to a S32K144EVB board

3.2 Battery emulator connection

The FRDM33771CSPEVB supports the use of a battery cell emulator such as NXP's BATT-14CEMULATOR board.

The BATT-14CEMULATOR is a 14-cell battery emulator board that provides an intuitive way to change the voltage across any of the 14 cells and four voltage outputs in order to emulate four external NTC. A minimum of 7 cells and a maximum of 14 cells can be monitored.

The emulator board can be connected to the FRDM33771CSPEVB connector X1 using the provided supply cable. See Figure 8

To exercise the FRDM33771CSPEVB in combination with the BAT-14CEMULATOR, a graphical user interface is available at https://www.nxp.com/webapp/Download?colCode=KIT33771C_V5_APPSP

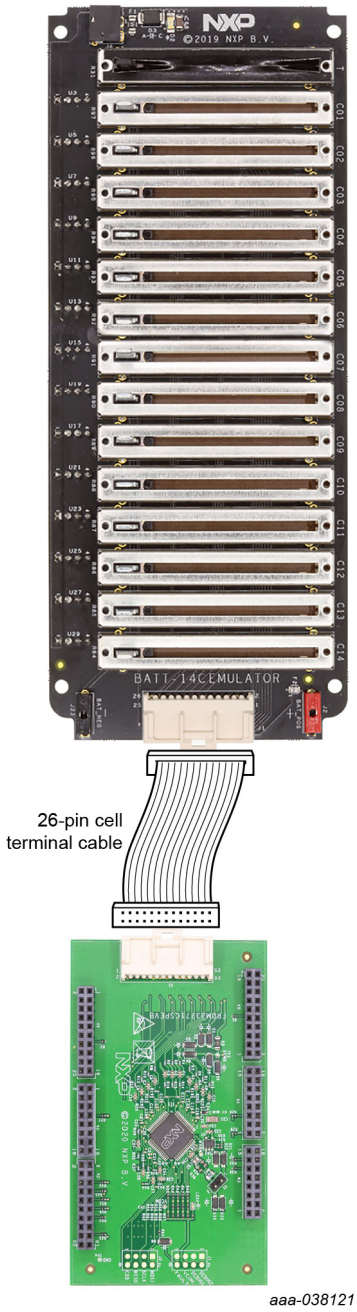

Figure 8. Battery emulator connection

4 References

[1] **FRDM3771CSPEVB tool summary page** — detailed information on the board, including documentation, downloads, software and tools
nxp.com/FRDM33771CSPEVB

[2] **Product summary page** — product information on the MC33771C 14-Channel Li-ion Battery Cell Controller
https://www.nxp.com/products/power-management/battery-management/battery-cell-controllers/14-channel-li-ion-battery-cell-controller-ic:MC33771C

[3] **Tool summary page for battery emulators** — detailed information on the cell battery pack emulator, including documentation, downloads, software and tools
https://www.nxp.com/design/development-boards/analog-toolbox/14-cell-battery-pack-emulator-to-supply-mc33771c-bcc-evbs:BATT-14CEMULATOR

[4] **NXP DocStore** — released NXP documents available to users
docstore.nxp.com

5 Revision history

Table 15. Revision history

Rev	Date	Description
v.1	20200629	Initial release

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