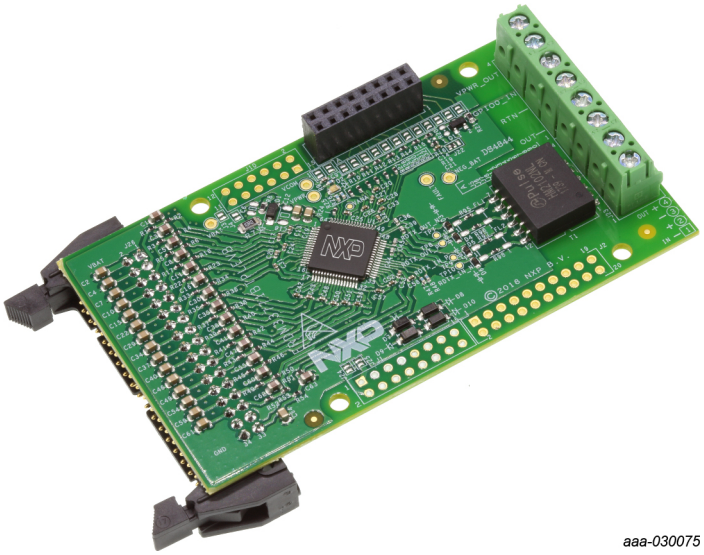
FRDM33771BTPLEVB

Featuring the MC33771B battery cell controller IC

Rev. 1.0 — 28 June 2018 User guide

1 FRDM33771BTPLEVB



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The tool summary page for FRDM33771BTPLEVB is at nxp.com/FRDM33771BTPLEVB. 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 FRDM33771BTPLEVB.

1. Go to nxp.com/FRDM33771BTPLEVB.
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 7- to 14-cell battery pack, such as BATT-14AAAPACK, or a battery pack emulator, such as BATT-14EMULATOR

4 Getting to know the hardware

4.1 Board overview

The FRDM33771BTPLEVB serves as a hardware evaluation tool in support of NXP's MC33771B device. The MC33771B 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 conversion on the differential cell voltages and currents. It is also capable of battery charge coulomb counting and battery temperature measurements. The FRDM33771BTPLEVB is an ideal platform for rapid prototyping of MC33771B-based applications that involve current, voltage, and temperature sensing.

The FRDM33771BTPLEVB includes a transformer enabling communication in a high-speed isolated communication network. The information is digitally transmitted to a microcontroller for processing. The evaluation board can be used in conjunction with a transceiver physical layer transformer driver (MC33664) to convert MCU SPI data bits to pulse bit information for the MC33771B and vice versa.

4.2 Board features

This FRDM33771BTPLEVB's main features are as follows:

- Daisy chain device connection
- LED indicator for operation mode
- Cell-balancing resistors
- Transformer isolation
- 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

4.3 Block diagram

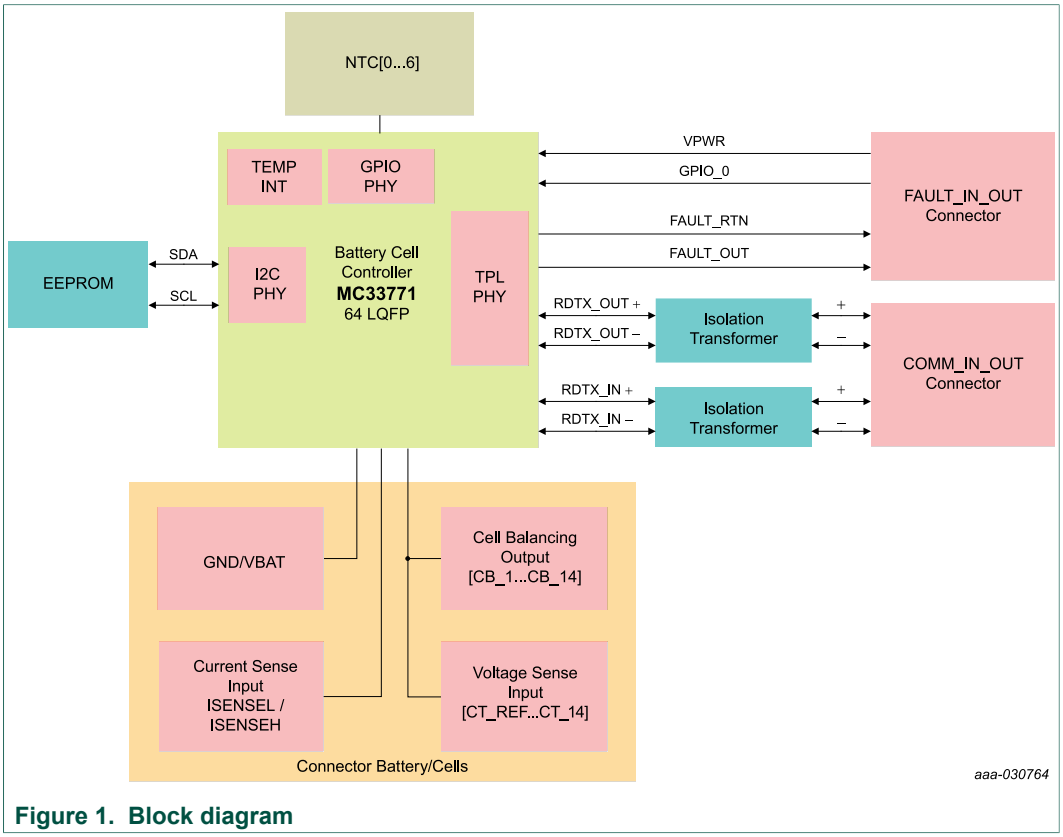

Figure 1. Block diagram

4.4 Device features

The MC33771B is a battery cell controller IC designed to monitor battery characteristics, such as voltage, current and temperature. The MC33771B 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. MC33771B device features

Device	Description	Features
MC33771B	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 • 0.8 mV maximum total voltage measurement error • Synchronized cell voltage/current measurement with coulomb count • 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 capability • Fully compatible with the MC33772 for a maximum of six cells • Qualified in compliance with AECQ-100

4.5 Board description

The FRDM33771BTPLEVB allows the user to exercise all the functions of the MC33771B battery controller cell.

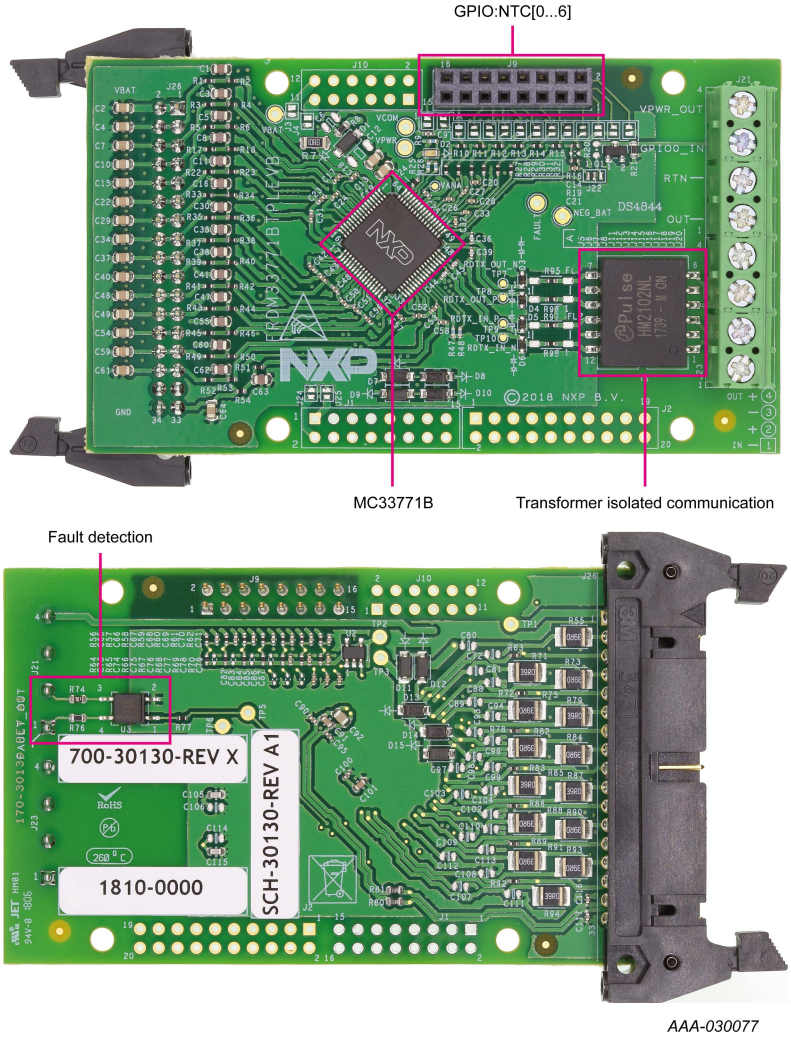

Figure 2. Board description

Table 2. Board description

Name	Description
MC33771B	Battery-cell controller IC
GPIO:NTC[0…6]	Support off-board NTC
Fault detection	Fault lines

4.6 VCOM LED

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

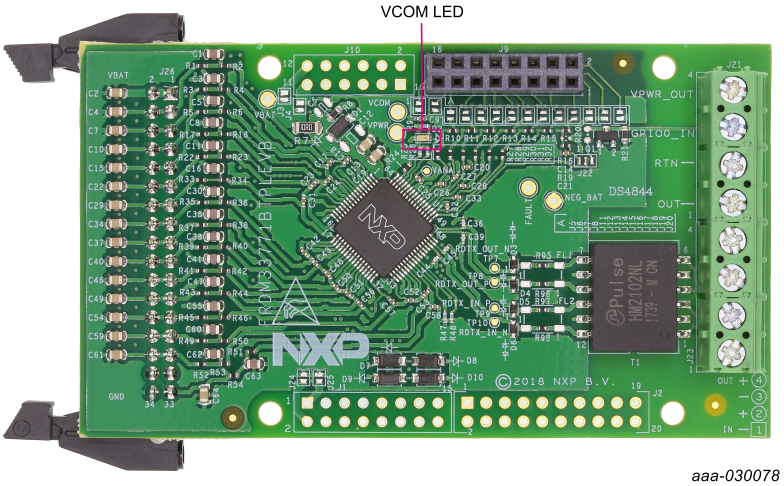

Figure 3. VCOM LED

The VCOM LED indicates when the device is in normal mode. Upon reset, the MC33771B 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). 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.

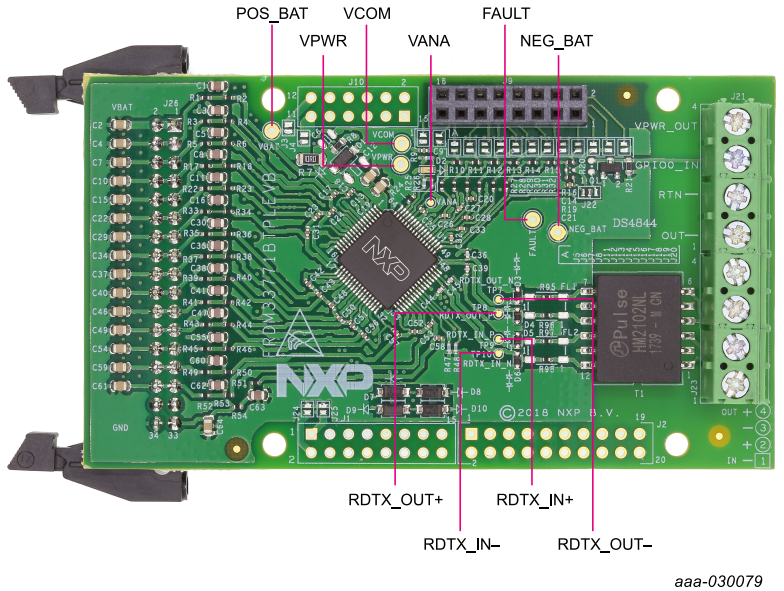

Figure 4. Test points

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

Table 3. Test points

Test-point name	Signal name	Description
RTDX_IN_N	SI/RDTX_IN–	Measures the isolated pulse communication
RTDX_IN_P	SCLK/RTDX_IN+	
RTDX_OUT_N	RTDX_OUT–	
RTDX_OUT_P	RTDX_OUT+	
FAULT	FAULT	Measures the fault detection sent by the device
NEG_BAT	GNDREF	Ground reference of the device
POS_BAT	V_{BAT}	Positive V_{BAT}
VCOM	VCOM	Communication regulator output
VPWR	VPWR	Power input to the device
VANA	VANA	Precision ADC analog supply output

4.8 Connectors

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

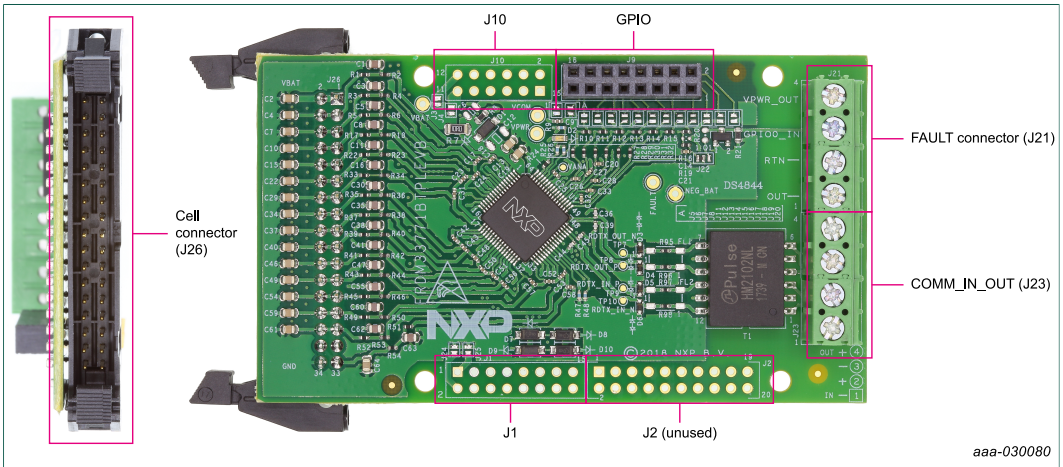

Figure 5. Connectors

Table 4. Connector (J1)

Pin #	Name	Description
1	GND	Connected via J24 to GND
2	GND	Connected via J25 to GND
Other	—	No connection

Table 5. Connector (J10)

Pin #	Name	Description
11	VBAT	Connected via J4 to VBAT
12	VBAT	Connected via J3 to VBAT

Pin #	Name	Description
Other	—	No connection

Table 6. GPIO connector (J9)

Pin #	Connected to	Description
1	J17	NTC0_P, to GPIO0
2	J20	To GND
3	J16	NTC1_P, to GPIO1
4	J19	To GND
5	J15	NTC2_P, to GPIO2
6	J18	To GND
7	J14	NTC3_P, to GPIO3
8	J13	To GND
9	J12	NTC4_P, to GPIO4
10	J11	To GND
11	J8	NTC5_P, to GPIO5
12	J6	To GND
13	J7	NTC6_P, to GPIO6
14	J5	To GND
15	-	No Connection
16	-	No Connection

Table 7. Fault connector (J21)

Pin #	Name	Description
1	FAULT_OUT	Fault output
2	FAULT_RTN	Fault return
3	GPIO0_IN	Wakeup / Fault daisy chain
4	VPWR_OUT	External supply for fault daisy chain

Table 8. COMM connector (J23)

Pin #	Name	Description
1	IN–	Receive/transmit input negative
2	IN+	Receive/transmit input positive
3	OUT–	Receive/transmit output negative
4	OUT+	Receive/transmit output positive

Table 9. Cell connector (J26)

Pin #	Connection	Description
J26-1 J26-2	VBAT	MC33771B Power supply
J26-3 J26-4	CT_14 CB_14	Cell pin 14 input with external LPF resistor. Cell balance driver. Terminate to cell 14 cell balance load resistor
J26-5 J26-6	CT_13 CB_14:13_C	Cell pin 13 input with external LPF resistor. Cell balance 14:13 common. Terminate to cell 14 and 13 common pin
J26-7 J26-8	CT_12 CB_13/CB_12	Cell pin 12 input with external LPF resistor. Cell balance driver. Terminate to cell 13 and 12 cell balance load resistor
J26-9 J26-10	CT_11 CB_12:11_C	Cell pin 11 input with external LPF resistor. Cell balance 12:11 common. Terminate to cell 12 and 11 common pin
J26-11 J26-12	CT_10 CB_11/CB_10	Cell pin 10 input with external LPF resistor. Cell balance driver. Terminate to cell 11 and 10 cell balance load resistor
J26-13 J26-14	CT_9 CB_10:9_C	Cell pin 9 input with external LPF resistor. Cell balance 10:9 common. Terminate to cell 10 and 9 common pin
J26-15 J26-16	CT_8 CB_9/CB_8	Cell pin 8 input with external LPF resistor. Cell balance driver. Terminate to cell 9 and 8 cell balance load resistor
J26-17 J26-18	CT_7 CB_8:7_C	Cell pin 7 input with external LPF resistor. Cell balance 8:7 common. Terminate to cell 8 and 7 common pin
J26-19 J26-20	CT_6 CB_7/CB_6	Cell pin 6 input with external LPF resistor. Cell balance driver. Terminate to cell 7 and 6 cell balance load resistor
J26-21 J26-22	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
J26-23 J26-24	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
J26-25 J26-26	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
J26-27 J26-28	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
J26-29 J26-30	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
J26-31	ISENSE_+	Current measurement input+ with external filter RC
J26-32	ISENSE_–	Current measurement input– with external filter RC
J26-33	CT_REF CB_1	Cell pin REF input with external LPF resistor. Cell balance driver. Terminate to cell 1 cell balance load resistor.
J26-34	GND	Negative_Battery

4.9 External EEPROM

The FRDM33771BTPLEVB has an integrated gateway communication link to an external local EEPROM. The MC33771B'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 MC33771B registers.

4.10 GPIO configuration

The FRDM33771BTPLEVB offers seven customizable GPIOs [GPIO_0...GPIO_6] for measuring external temperature with on-board or off-board NTCs. The off-board NTC connection is described in Section 6.5 "Off-board NTC configuration ".

4.11 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.

4.12 Fault detection

The FRDM33771BTPLEVB uses an optocoupler to detect a fault that is dependent on user defined internal or external faults.

The fault signal can be chained between EVBs and can be made available on the controller inputs. With two FRDM33771BTPLEVB boards, the fault is chained as shown in Section 6.4 "Fault chain connection".

4.13 Current sensing

The FRDM33771BTPLEVB supports current sense function with off-board shunt resistor. The off-board shunt resistor shall be connected between J26-31 (ISENSE+) and J26-32 (ISENSE–). On-board current sensing filter and protection circuits can be found in EVB schematic shared via NXP DocStore (NDA required).

4.14 Bus terminal communication

The transformers isolate communication between the MC33771B and the pack controller and between each MC33771B. They are protected against ESD. There are significant advantages to using transformers for isolation and communication:

- High degree of voltage isolation
- Communication rates of 2.0 MHz with very low radiated emissions
- Ability to force the secondary signals to be true differential reducing radiated emissions
- Ability to loop the network back to the pack controller

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

5 Accessory transceiver board

The FRDM33771BTPLEVB kit is designed for use with the FRDM33664BEVB in high-voltage isolated applications that provide a SPI-to-high-speed isolated communication interface. The FRDM33664BEVB includes an MC33664 isolated network high-speed transceiver. MCU SPI data bits are directly converted to pulse bit information.

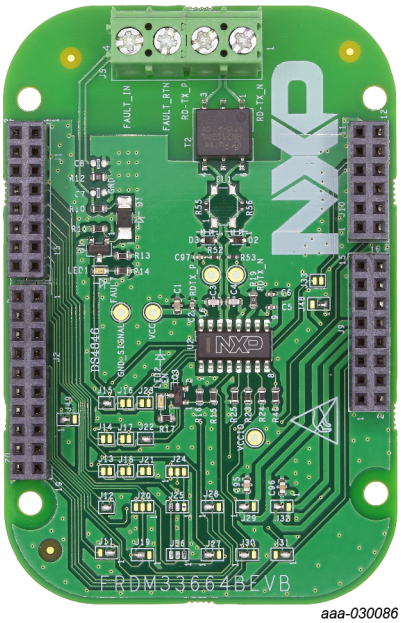

Figure 6. FRDM33664BEVB

6 Configuring the hardware

6.1 Battery stack connection

A minimum of 7 cells and a maximum of 14 cells can be monitored. NXP provides a 14-cell battery emulator board, BATT-14EMULATOR. This board provides an intuitive way to change the voltage across any of the 14 cells of an emulated battery pack as well as the voltage across an emulated current sense shunt resistor. In addition, a battery pack (BATT-14AAAPACK, in Figure 7) using AAA batteries is available to support FRDM33771BTPLEVB.

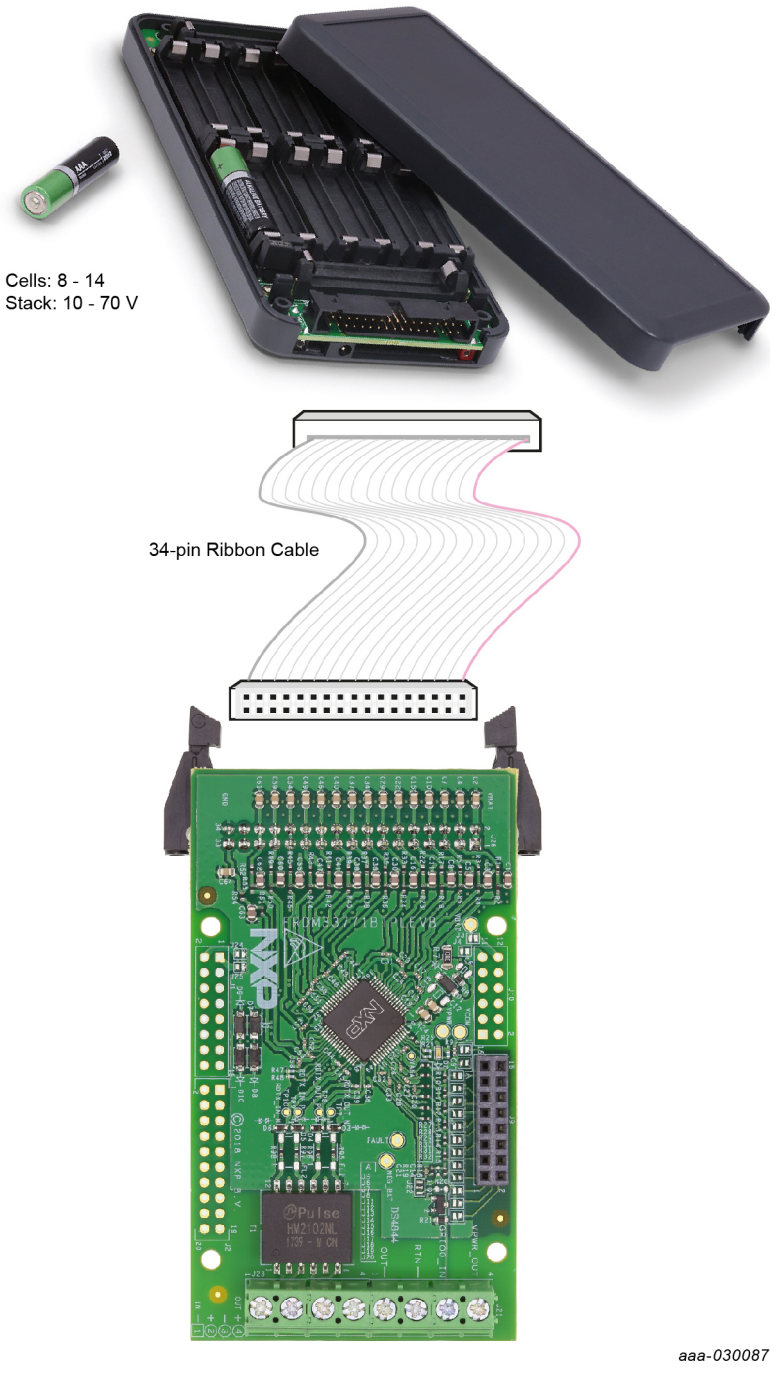

Figure 7. Battery stack connection

6.2 Jumper connection

One hand-soldered jumper (J22) on the EVB is used to set the GPIO0 pin input. In position 1-2 (default), the NTC (NTC1) is connected to GPIO0 pin of the MC33771B. This input can be used as analog input. If the jumper is placed in position 2-3, the GPIO0 can be used as fault input for fault daisy chain function.

6.3 TPL communication connection

In a high-voltage Isolated application with a daisy chain configuration, up to 15 FRDM33771BTPLEVB boards may be connected.

The TPL connections use the COMM (J23) connector.

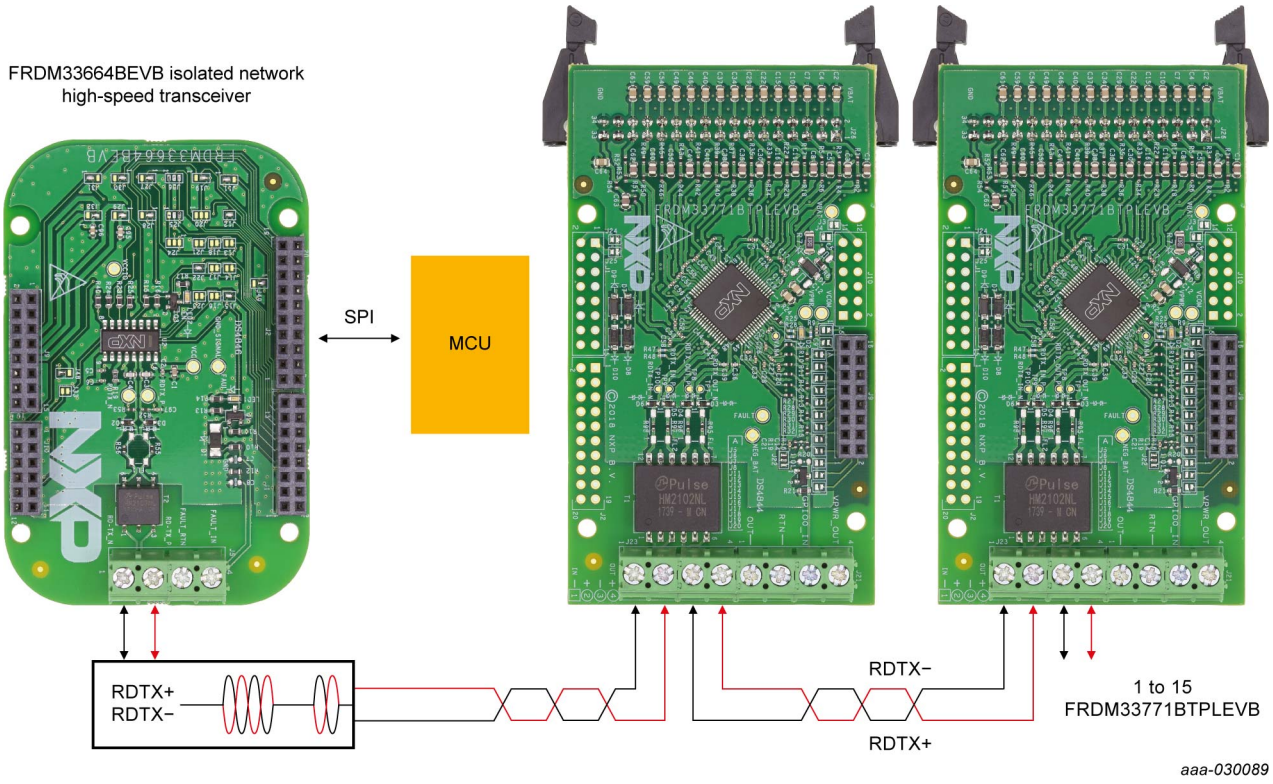

Figure 8. FRDM33771BTPLEVB board setup

6.4 Fault chain connection

The FAULT chain connection is optional. When used, it connects through the FAULT (J21) connector.

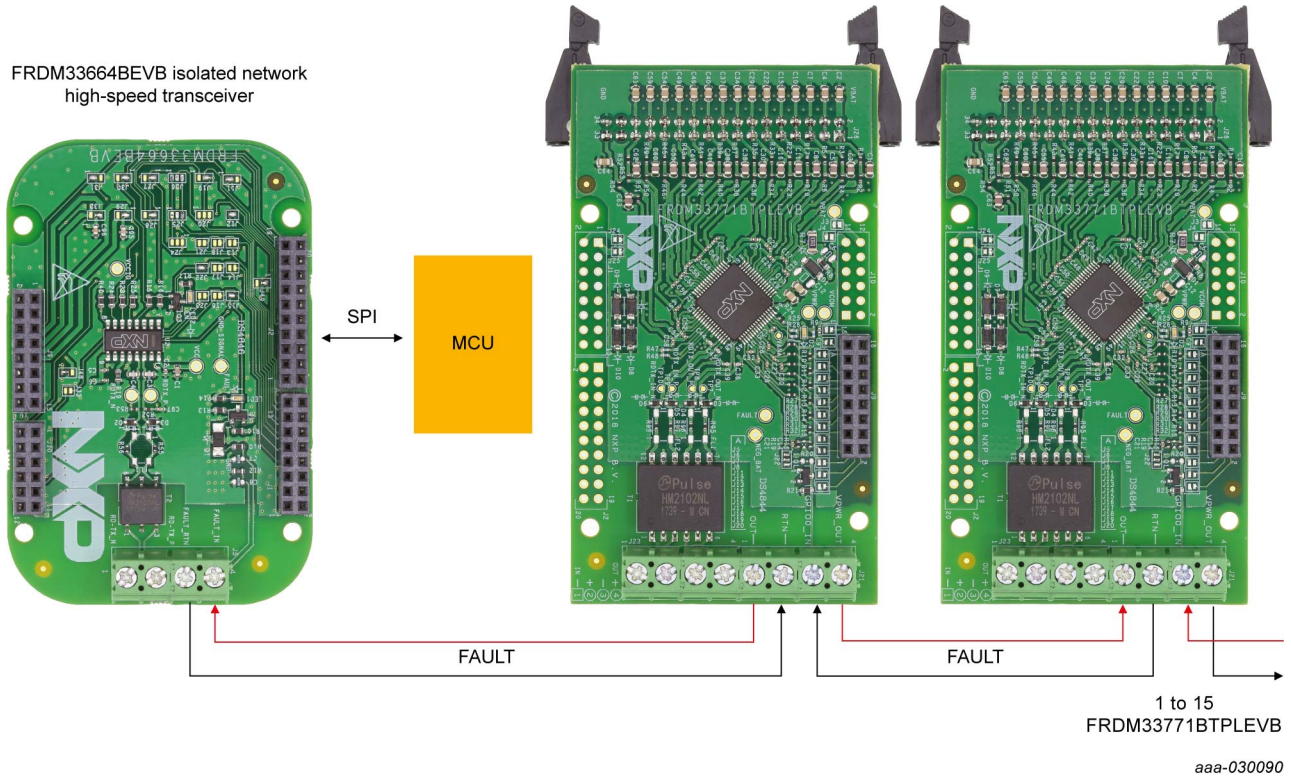

Figure 9. Fault chain connection

6.5 Off-board NTC configuration

FRDM33771BTPLEVB supports off-board NTC, please follow the instruction in the following table.

Table 10. Off-board NTC configuration

	Remove	Short	Short	Connect off-board NTC between
NTC0	R56	J17	J20	J9 1–2
NTC1	R57	J16	J19	J9 3–4
NTC2	R58	J15	J18	J9 5–6
NTC3	R59	J14	J13	J9 7–8
NTC4	R60	J12	J11	J9 9–10
NTC5	R61	J8	J6	J9 11–12
NTC6	R62	J7	J5	J9 13–14

7 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 11. Bill of materials

Part number	Description
M50-9101742	34-pin ribbon cable
BATT-14AAAPACK	3- to 14-cell configurable AAA battery pack
BATT-14EMULATOR	14-cell slider battery pack emulator kit with shunt for current sense
FRDM33664BEVB	EVB for MC33664ATL Isolated Network High-Speed Transceiver

8 References

[1] **Board summary page** — nxp.com/FRDM33771BTPLEVB

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

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

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

[5] **Tool summary page for battery emulators** — nxp.com/BATT-14EMULATOR

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

9 Revision history

Table 12. Revision history

Rev	Date	Description
v.1.0	20180628	Initial release

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