UM12024

RD33774PC3EVB featuring the MC33774ATP battery-cell controller IC

Rev. 1.1 — 9 April 2024 User manual

Document information

Information	Content
Keywords	RD33774PC3EVB, MC33774ATP, HVBMS cell monitoring unit, centralized evaluation board
Abstract	This user manual describes the RD33774PC3EVB. The RD33774PC3EVB features three MC33774ATP battery-cell controller integrated circuits (IC). With the evaluation board (EVB), the key functions of the MC33774ATP can be explored.

1 Introduction

This user manual describes the RD33774PC3EVB. The RD33774PC3EVB features three MC33774ATP battery-cell controller integrated circuits (IC).

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.

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2 Finding kit resources and information on the NXP website

NXP Semiconductors provides online resources for this evaluation board and its supported device(s) on http://www.nxp.com.

The information page for the RD33774PC3EVB evaluation board is at http://www.nxp.com/RD33774PC3EVB. The information page provides overview information, documentation, software and tools, parametrics, ordering information and a Getting Started tab. The Getting Started tab provides quick-reference information applicable to using the RD33774PC3EVB evaluation board, including the downloadable assets referenced in this document.

The tool summary page for RD33774PC3EVB is at HVBMS Cell Monitoring Unit (CMU). 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 **Getting Started** section.

The **Getting Started** section provides information applicable to using the RD33774PC3EVB.

1. Go to http://www.nxp.com/RD33774PC3EVB.
2. On the **Overview** tab, locate the **Jump To** navigation feature on the left side of the window.
3. Select the **Getting Started** link.
4. Review each entry in the **Getting Started** section.
5. Download an entry by clicking 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 the files, review each file, including the user guide, which includes setup instructions.

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3 Getting ready

Working with the RD33774PC3EVB requires the kit contents, additional hardware, and a Windows PC workstation with installed software.

3.1 Kit contents/packing list

The kit contents include:

- Assembled and tested evaluation board/module in antistatic bag
- Three cell terminal cables
- Transformer physical layer (TPL) cable

3.2 Additional hardware

The following equipment is necessary to use this kit:

- A 4-cell to 18-cell battery pack or a battery pack emulator, such as BATT-18EMULATOR.
- A TPL communication system. If a user-specific system is not available, the evaluation setup or the 800 V HVBMS reference design can be used.
  - The 800 V HVBMS reference design consists of the HVBMS battery management unit (RD-K358BMU) and the 800 V HVBMS battery junction box (RD772BJBTPL8EVB). For the 800 V HVBMS reference design, a graphical user interface (GUI) based on FreeMASTER is available.
  - The evaluation setup consists of the FRDMDUALK3364EVB (EVB for MC33664A) in combination with the S32K3X4EVB-T172 (S32K3X4 EVB)
  - For the evaluation setup, a graphical user interface, EvalGUI 7, is available in Secure Files at this link: MC33775A Evaluation GUI V7

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4 Getting to know the hardware

4.1 Board overview

The RD33774PC3EVB is a hardware evaluation tool supporting the NXP MC33774ATP device. The RD33774PC3EVB implements three MC33774ATP battery-cell controller ICs. The MC33774ATP is a battery-cell controller that monitors up to 18 lithium-ion battery cells. It is designed for use in both automotive and industrial applications. The device performs analog-to-digital conversions on the differential cell voltages. It is also capable of temperature measurements and can forward communication via I^2C-bus to other devices. The RD33774PC3EVB is an ideal platform for rapid prototyping of MC33774ATP-based applications that involve voltage and temperature sensing.

The RD33774PC3EVB uses no capacative isolation for offboard communication. The galvanic isolation for onboard communication is established via capacitors.

The RD33774PC3EVB is also used as part of the 800 V high-voltage battery management system (HVBMS) reference design consisting of the HVBMS battery management unit (BMU) and the 800 V HVBMS battery junction box (BJB).

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4.1.1 Board description

With the RD33774PC3EVB, the user can explore all functions of the MC33774ATP battery-cell controller.

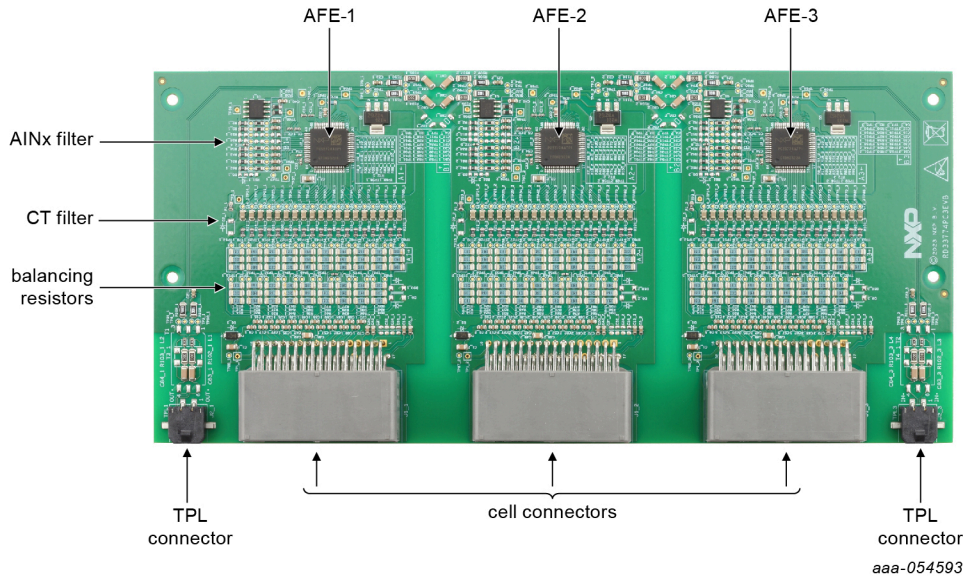

Figure 1. Board description

4.2 Board features

The main features of the RD33774PC3EVB are:

- Reference design with three MC33774ATP, showing optimized BOM as outlined in data sheet
- Capacitive isolation for onboard communication
- Based on NXP core layout for MC33774ATP; core layout is used for NXP internal electromagnetic compatibility (EMC) and hotplug tests
- Four-layer board, all components are assembled only on the top side
- Cell electrostatic discharge (ESD) capacitors package 0805
- 0805 packages used for all signals with a voltage higher than approximately 25 V
- Three 1206 surface-mounted device (SMD) resistors per balancing channel for individual cell-voltage balancing
- All eight external thermistor inputs are available
- Placeholder for I^2C-bus EEPROM
- Can be used together with the 800 V HVBMS reference design or the evaluation setup

4.2.1 MC33774ATP features and benefits

- The MC33774ATP is a battery-cell controller IC designed to monitor battery characteristics. such as voltage and temperature. The MC33774ATP contains all the circuit blocks necessary to perform battery-cell voltage, cell temperature measurement, and integrated cell balancing. The device supports the following functions:
  - AEC-Q100 grade 1 qualified: -40 °C to 125 °C ambient temperature range
  - ISO 26262 ASIL D support for cell-voltage and cell-temperature measurements from the host microcontroller unit (MCU) to the cell
- Cell-voltage measurement
  - 4 cells to 18 cells per device
  - Supports busbar voltage measurement with -3 V to 5 V input voltage

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  - 16-bit resolution and ±0.8 mV typical measurement accuracy with ultra low long-term drift
  - 136 µs synchronicity of cell voltage measurements
  - Integrated configurable digital filter
- External temperature and auxiliary voltage measurements
  - One analog input for absolute measurement, 5 V input range
  - Eight analog inputs configurable as absolute or ratiometric, 5 V input range
  - 16-bit resolution and ±5 mV typical measurement accuracy
  - Integrated, configurable digital filter
- Module voltage measurement
  - 9.6 V to 81 V input range
  - 16-bit resolution and 0.3 % measurement accuracy
  - Integrated, configurable digital filter
- Internal measurement
  - Two redundant internal temperature sensors
  - Supply voltages
  - External transistor current
- Cell voltage balancing
  - 18 internal-balancing field-effect transistors (FET), up to 360 mA peak with 0.5 Ω RDSon per channel (typ)
  - Support for simultaneous passive balancing of all channels with automatic odd/even sequence
  - Global-balancing timeout timer
  - Timer-controlled balancing with individual timers with 10 s resolution and up to 45 h duration
  - Voltage-controlled balancing with global and individual undervoltage thresholds
  - Temperature-controlled balancing; if balancing resistors are in overtemperature, balancing is interrupted
  - Configurable pulse width modulation (PWM) duty cycle balancing
  - Automatic pausing of balancing during measurement with configurable filter settling time
  - Configurable delay of the start of balancing after transition to sleep
  - Automatic discharge of the battery pack (emergency discharge)
  - Constant current cell balancing to compensate the balancing current variation due to cell voltage variation
- I^2C-bus master interface to control external devices, for example, EEPROMs and security ICs
- Configurable alarm output
- Cyclic wake-up to supervise the pack during sleep and balancing
- Capability to wake-up the host MCU via daisy chain in case of a fault event
- Host interface supporting SPI or transformer physical layer 3 (TPL3)
  - 2 Mbit data rate for TPL3 interface
  - 4 Mbit data rate for SPI
- TPL3 communication supports
  - Two-wire daisy chain with capacitive and inductive isolation
  - Protocol supporting up to six daisy chains and 62 nodes per chain
- Unique device ID
- Operation modes
  - Active mode (12 mA typ)
  - Sleep mode (60 µA typ)
  - Deep Sleep mode (15 µA typ)

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4.3 Block diagram

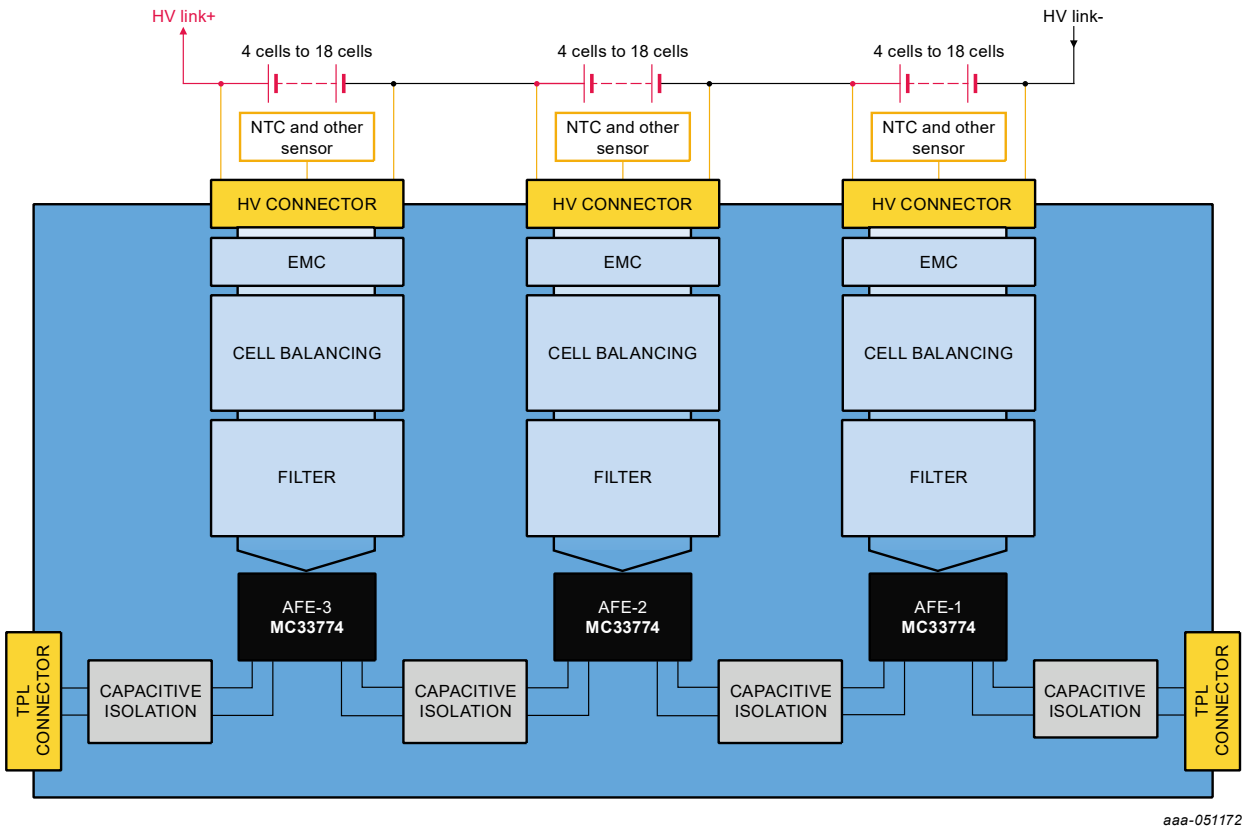

Figure 2. Block diagram

4.4 Kit featured components

4.4.1 Connectors

The cells and NTC connections are available on J1_1, J1_2 and J1_3. See Figure 3.

Cell0 is connected between C0M(cell0M) and C1M(cell0P); Cell1 is connected between C1M and C2M, and so on ... Cell17 is connected between C17M (cell17M) and C17P (cell17P). C17P-PWR and GND (pin21) are used to supply the AFE and are separated from C17P and C0M respectively, to avoid any voltage drop because of the EVB current consumption.

Optional external 10 kΩ NTCs can be connected between each NTCx terminal and one GND terminal.

- Connector type: JAE MX34032NF2 (32 pins/right-angle version)
- Corresponding mate connector reference: MX34032SF1
- Crimp reference for the mate connector: M34S7C4F1c

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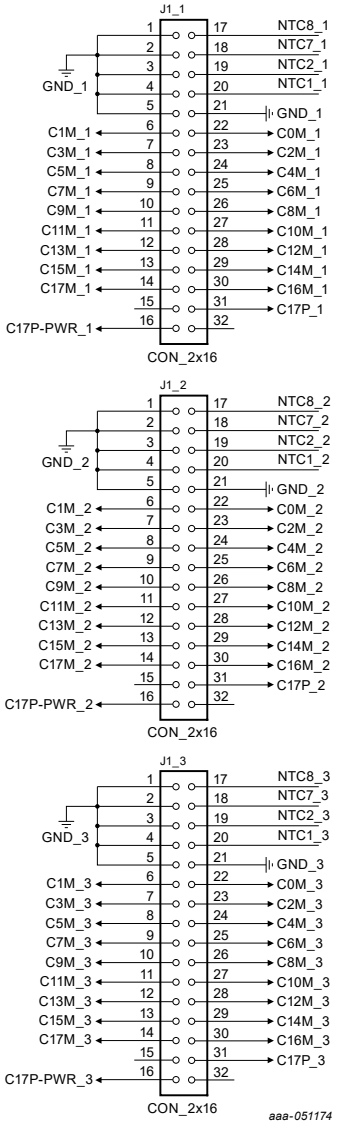

Figure 3. Pinout cell connectors

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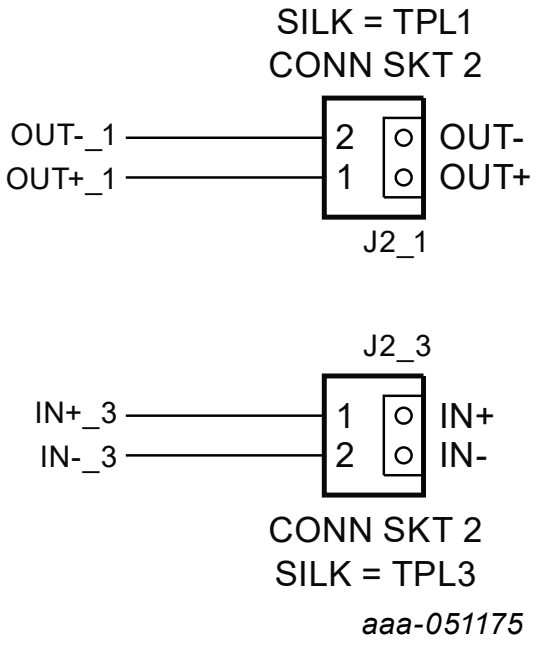

Figure 4. TPL connectors

The TPL connections are available on J2_1 and J2_3. See Figure 4

- Connector type: Molex Micro-fit 3.0, 43650-0213
- Corresponding mate connector reference: 0436450200
- Crimp reference for the mate connector: 0436450201
- Figure 1 shows the location of connectors on the board.

4.5 Schematic, board layout and bill of materials

The schematic, board layout and bill of materials for the RD33774PC3EVB evaluation board are available at http://www.nxp.com/RD33774PC3EVB.

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5 Accessory boards

5.1 NXP 800 V HVBMS reference design

The NXP 800 V HVBMS reference design is a scalable ASIL D architecture for high-voltage applications, composed of three modules: BMU, CMU, and BJB.

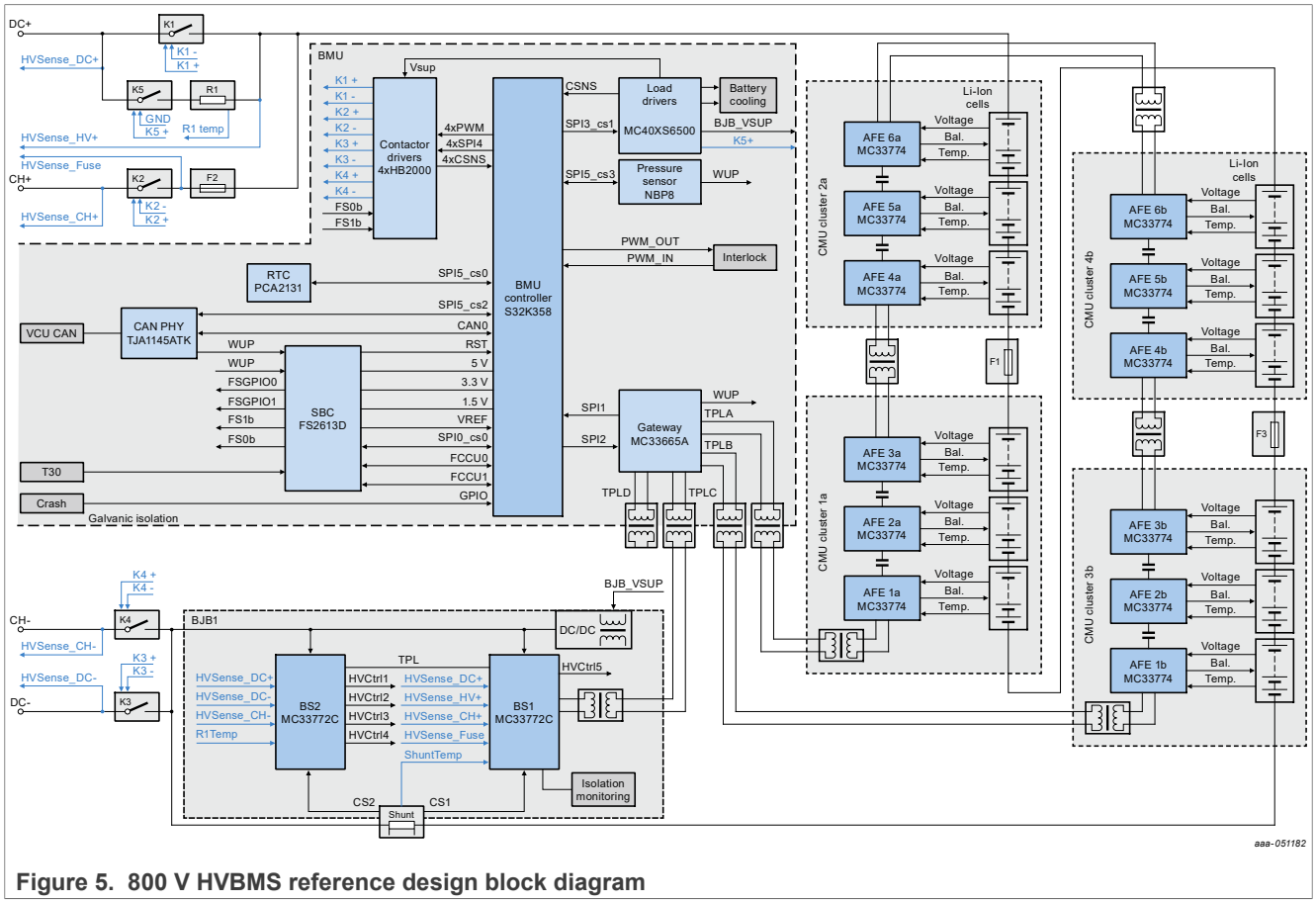

Figure 5. 800 V HVBMS reference design block diagram

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5.2 FRDMDUALK3664EVB

The RD33774PC3EVB kit is designed for use with the FRDMDUALK3664EVB. The FRDMDUALK3664EVB is an evaluation board for MC33664ATL, an isolated network high-speed transceiver. The EVB can be used in high-voltage isolated applications and provides an SPI-to-high-speed isolated communication interface. The FRDMDUALK3664EVB includes two MC33664 isolated network high-speed transceivers that allow loopback connection. MCU SPI data bits are directly converted to pulse bit information.

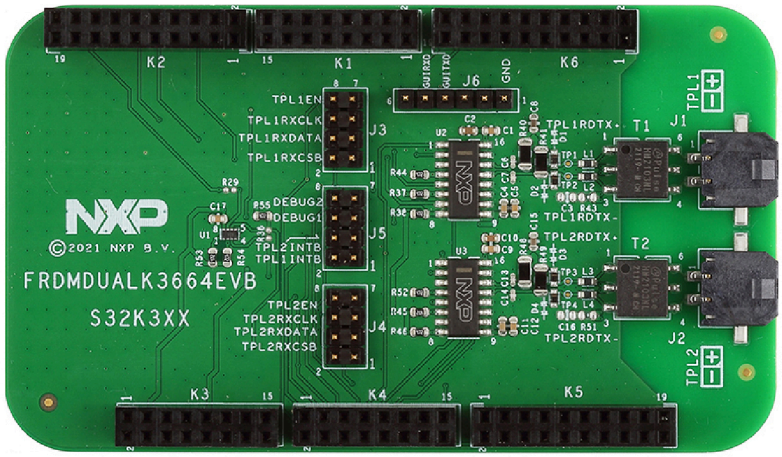

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Figure 6. FRDMDUALK3664EVB

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5.3 S32K3X4EVB-T172

The S32K3X4EVB provides the control signals for the FRDMDUALK3664EVB.

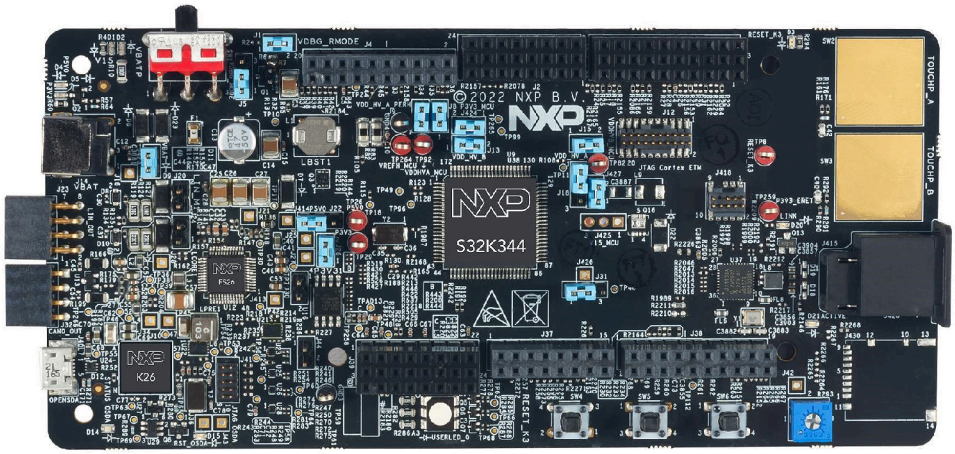

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Figure 7. S32K3X4 evaluation board

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6 Configuring the hardware

6.1 Battery emulator connection

A minimum of four cells and a maximum of 18 cells can be monitored by one MC33774ATP. NXP provides an 18-cell battery emulator board, BATT-18EMULATOR. This board provides an intuitive way to change the voltage across any of the 18 cells of an emulated battery pack. The board RD33774PC3EVB can be connected to an 18-cell battery emulator board using the connectors J1_1, J1_2, and J1_3, with the provided supply cable.

See Figure 8.

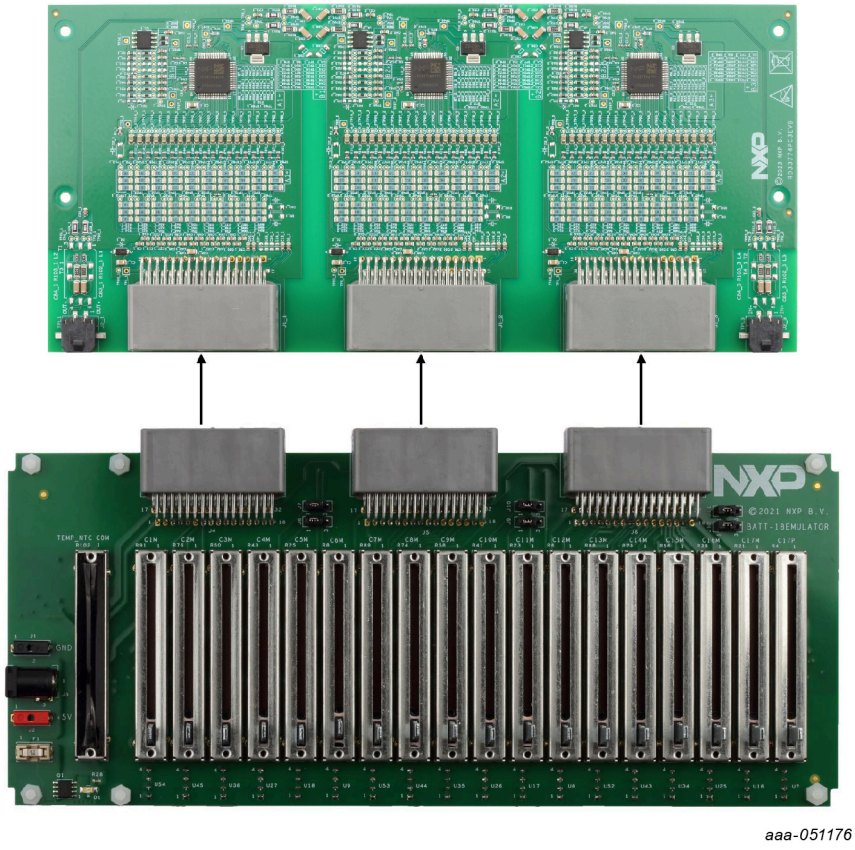

Figure 8. Battery emulator connection

6.2 TPL communication connection

In a high-voltage isolated application with a daisy-chain configuration, up to 63 RD33774PC3EVB boards may be connected.

The TPL connections use the COMM connectors J1 and J2 of the FRDMDUALK3664EVB and J2_1 and J2_3 of the RD33774PC3EVB.

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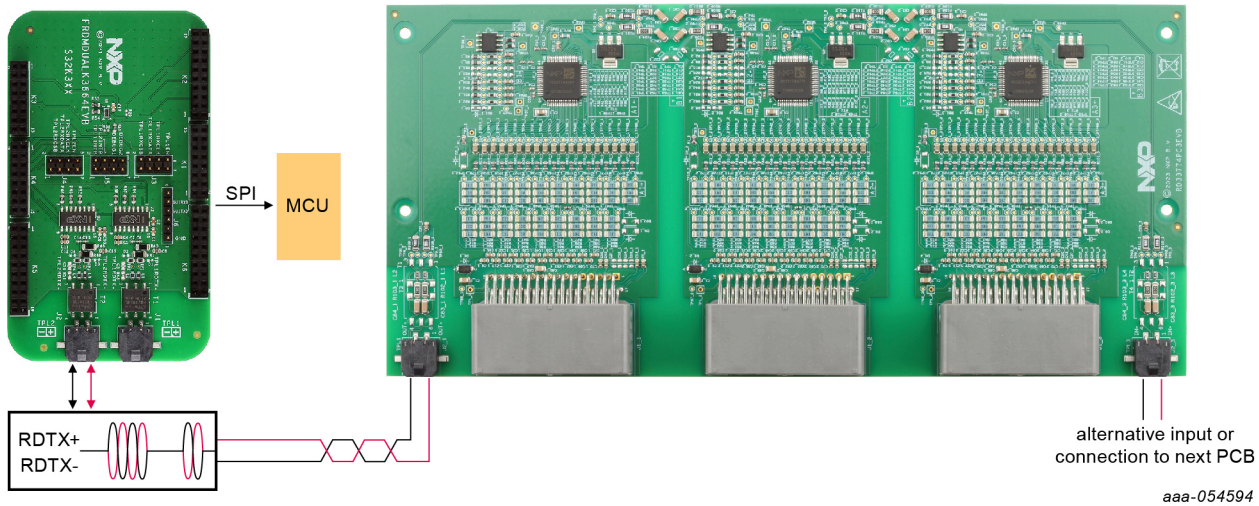

Figure 9. FRDMDUAL33664EVB setup

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7 Revision history

Revision history

Document ID	Date	Description
UM12024 v.1.1	09 April 2024	• Section 2: Corrected link text • Section 3.2: Updated link to EvalGUI 7. • Section 4.4.1: Updated text from "Cell1 is connected between C1 M(cell1M) and C2M(cell1P), and so on ..." to "Cell1 is connected between C1M and C2M, and so on ..."
UM12024 v.1	07 February 2024	initial version

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Date of release: 9 April 2024
Document identifier: UM12024