

UM12024

RD33774PC3EVB featuring the MC33774ATP battery-cell controller IC

Rev. 1 — 7 February 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.

Important notice

IMPORTANT NOTICE

For engineering development or evaluation purposes only



NXP provides the product under the following conditions:

This evaluation kit is 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 connecting it to the host MCU 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 heavily depends 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 product 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 device incorporating the product. Due to the open construction of the product, it is the responsibility of the user to take all appropriate precautions for electric 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.

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/RD33774CNT3EVB>.
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.

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, EvalGUI 7 is available.

4 Getting to know the hardware

4.1 Board overview

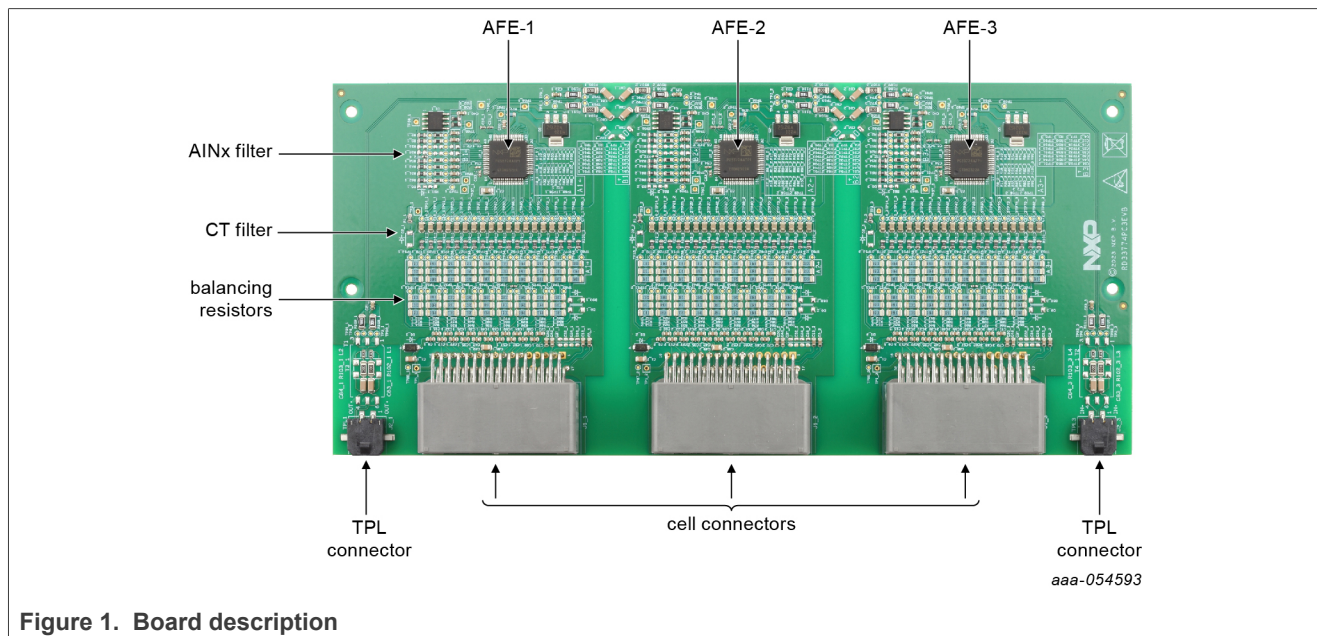
The RD33774PC3EVB is a hardware evaluation tool supporting the NXP MC33774ATP device. The RD33774PC3EVB implements three MC33774ATP battery-cell controller ICs. The MC33774ATP is a battery-cell controller that monitors up to 18 lithium-ion battery cells. It is designed for use in both automotive and 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 I²C-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 capacitive 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).

4.1.1 Board description

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



4.2 Board features

The main features of the RD33774PC3EVB are:

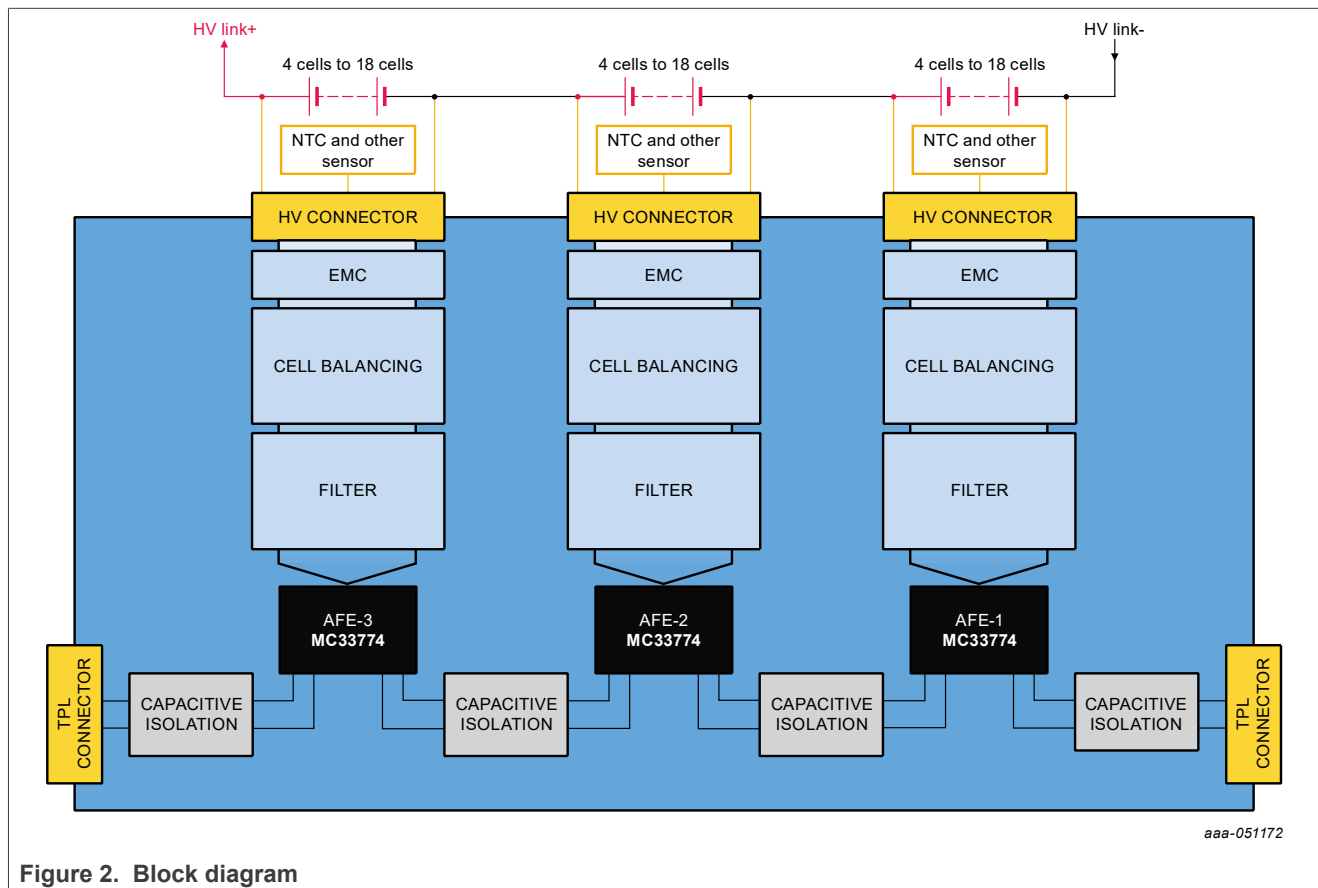
- Reference design with three MC33774ATP, showing optimized BOM as outlined in data sheet
- Capacitive isolation for onboard communication
- Based on NXP core layout for MC33774ATP; core layout is used for NXP internal electromagnetic compatibility (EMC) and hotplug tests
- Four-layer board, all components 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 I²C-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

- 16-bit resolution and ± 0.8 mV typical measurement accuracy with ultra low long-term drift
- 136 μ s 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
- I²C-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 μ A typ)
 - Deep Sleep mode (15 μ A typ)

4.3 Block diagram



4.4 Kit featured components

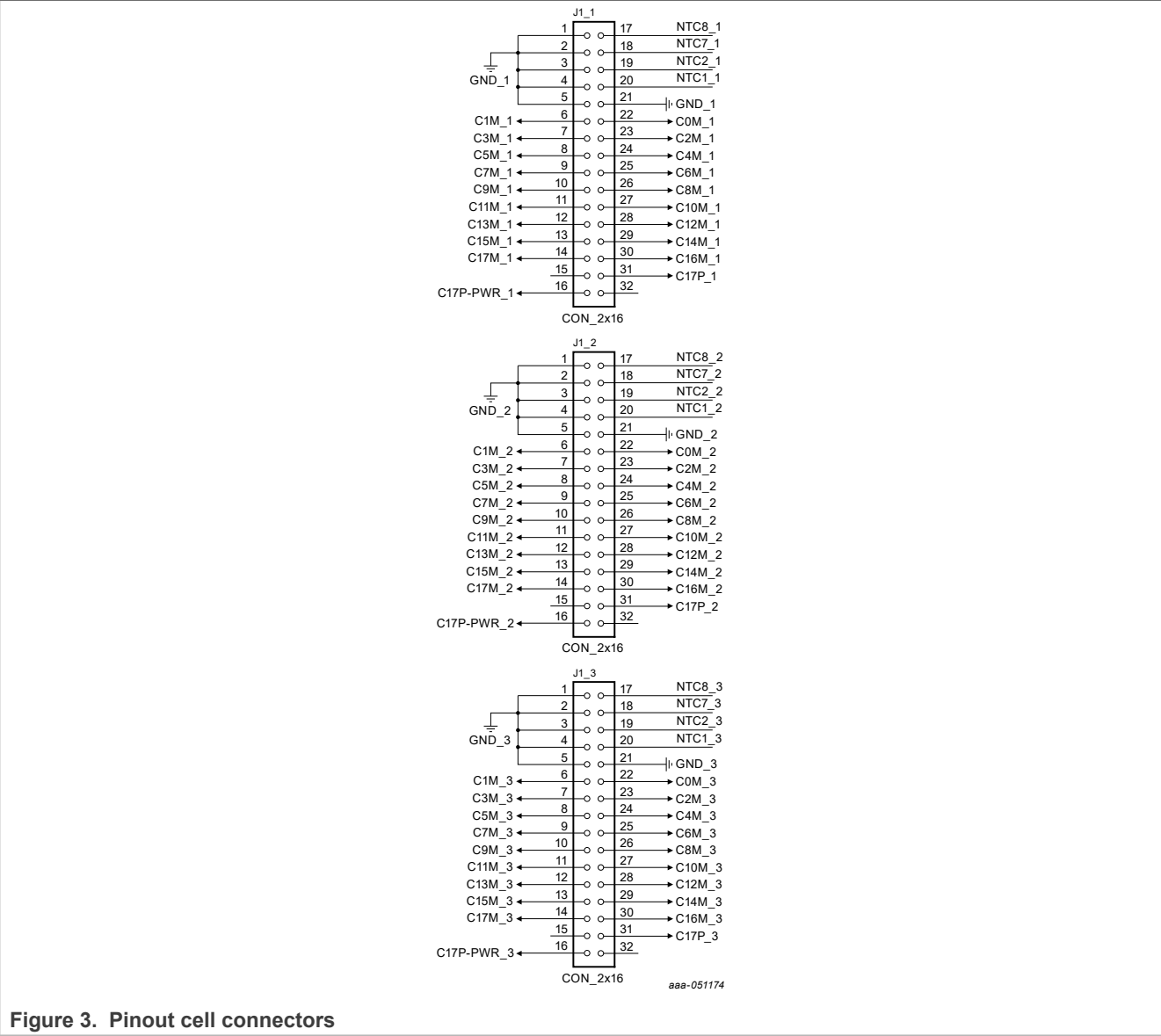
4.4.1 Connectors

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(cell1M) and C2M(cell1P), 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



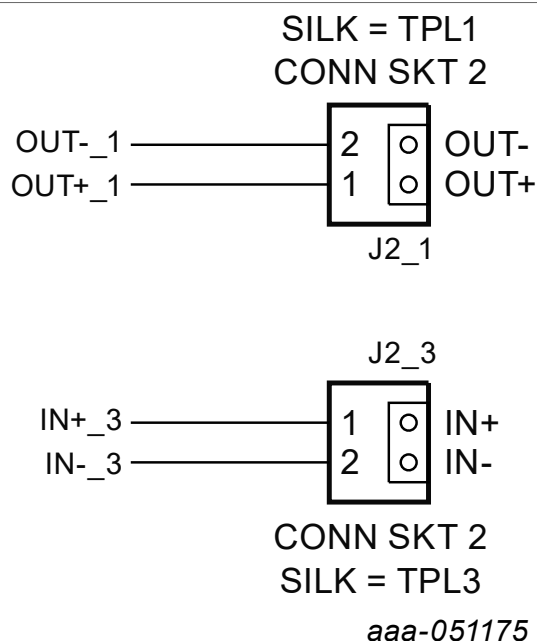


Figure 4. TPL connectors

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>.

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.

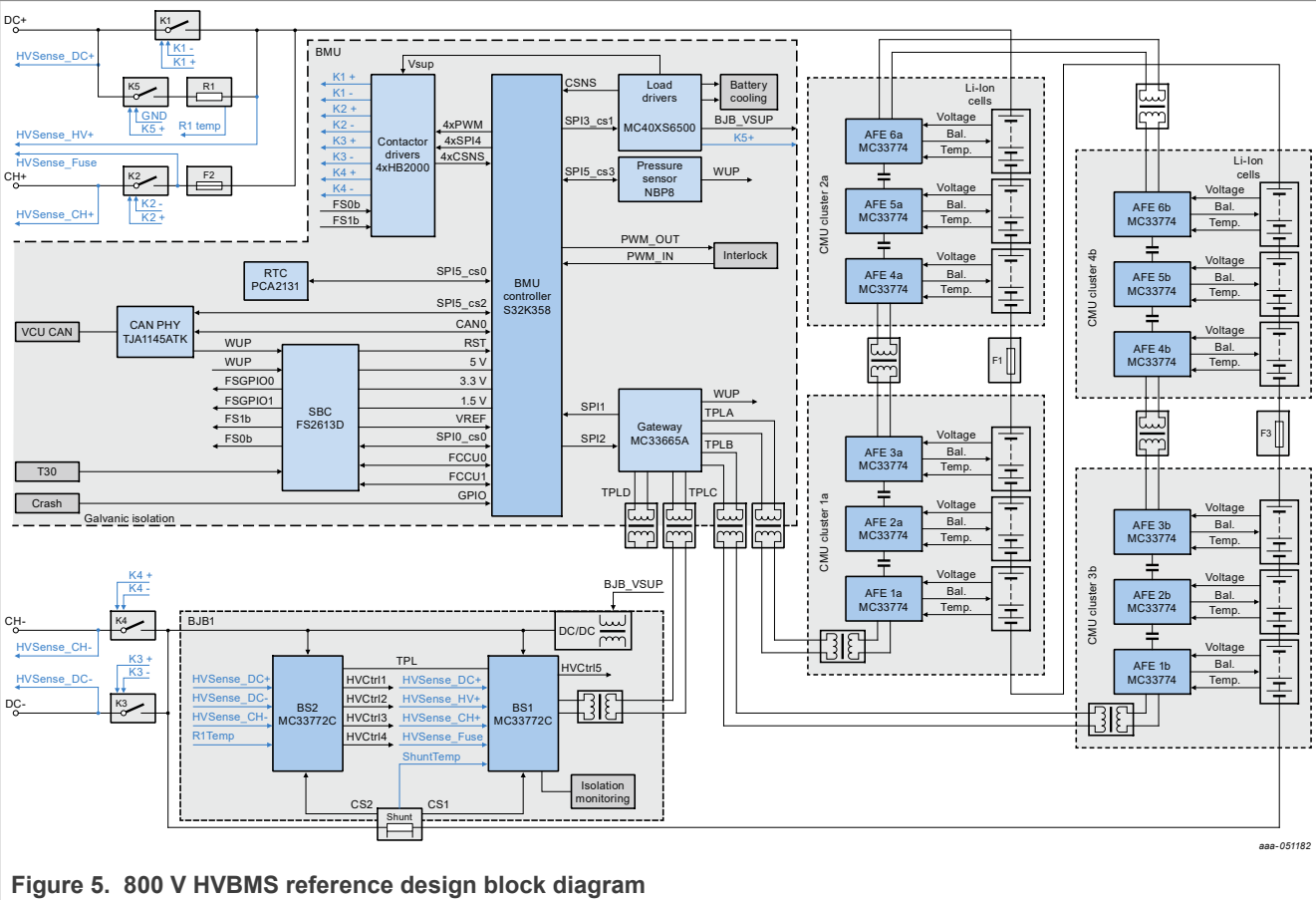
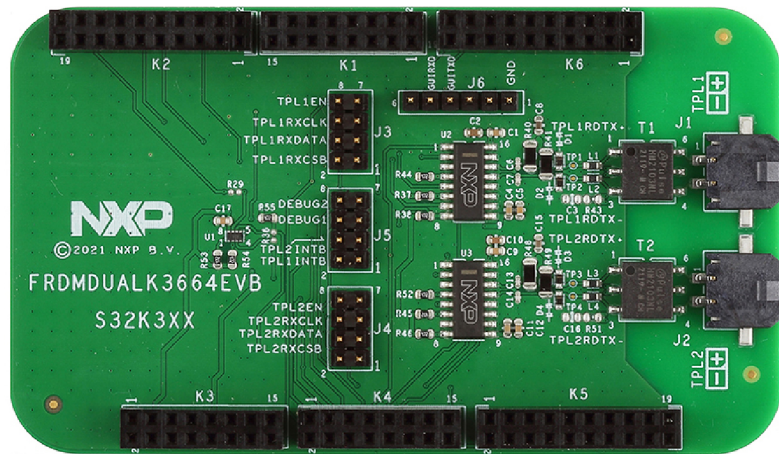


Figure 5. 800 V HVBMS reference design block diagram

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.



aaa-046016

Figure 6. FRDMDUALK3664EVB

5.3 S32K3X4EVB-T172

The S32K3X4EVB provides the control signals for the FRDMDUALK3664EVB.

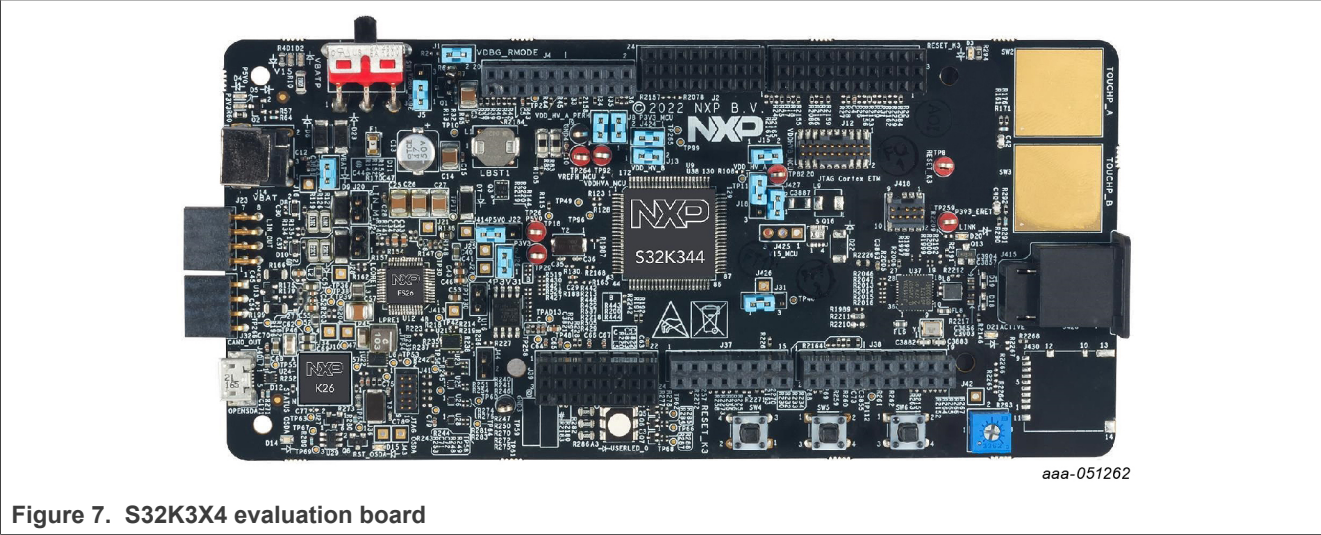


Figure 7. S32K3X4 evaluation board

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](#).

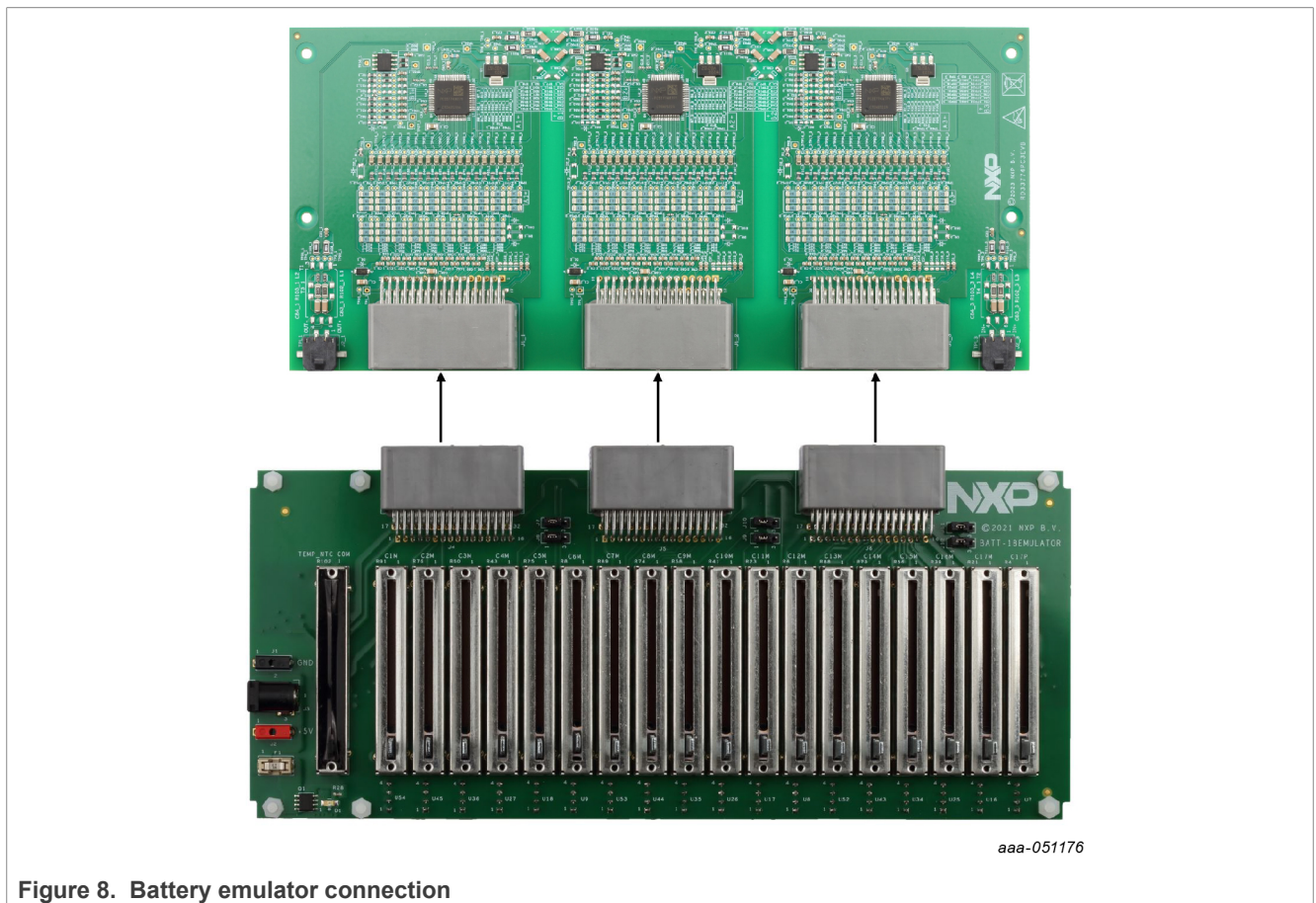
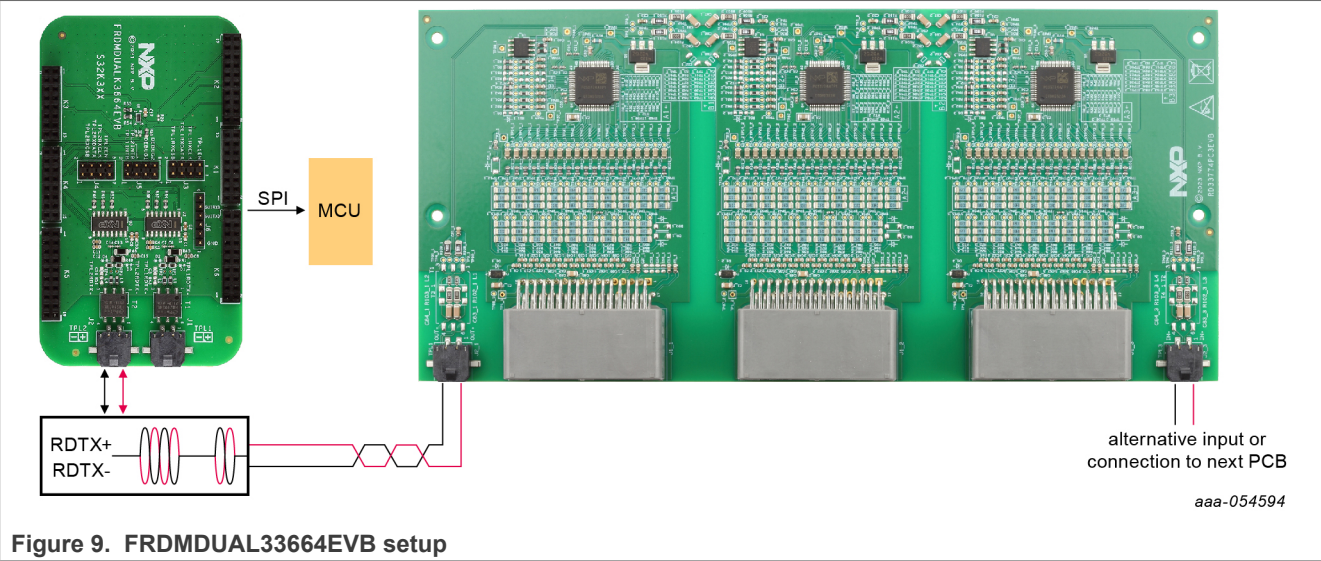


Figure 8. Battery emulator connection

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.



7 Revision history

Revision history

Document ID	Date	Description
UM12024 v.1	07 February 2024	initial version

Legal information

Definitions

Draft — A draft status on a document indicates that the content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included in a draft version of a document and shall have no liability for the consequences of use of such information.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Terms and conditions of commercial sale — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at <https://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Translations — A non-English (translated) version of a document, including the legal information in that document, is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Security — Customer understands that all NXP products may be subject to unidentified vulnerabilities or may support established security standards or specifications with known limitations. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately.

Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP.

NXP has a Product Security Incident Response Team (PSIRT) (reachable at PSIRT@nxp.com) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

Suitability for use in automotive applications (functional safety) — This NXP product has been qualified for use in automotive applications. It has been developed in accordance with ISO 26262, and has been ASIL classified accordingly. If this product is used by customer in the development of, or for incorporation into, products or services (a) used in safety critical applications or (b) in which failure could lead to death, personal injury, or severe physical or environmental damage (such products and services hereinafter referred to as "Critical Applications"), then customer makes the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, safety, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP. As such, customer assumes all risk related to use of any products in Critical Applications and NXP and its suppliers shall not be liable for any such use by customer. Accordingly, customer will indemnify and hold NXP harmless from any claims, liabilities, damages and associated costs and expenses (including attorneys' fees) that NXP may incur related to customer's incorporation of any product in a Critical Application.

NXP B.V. — NXP B.V. is not an operating company and it does not distribute or sell products.

Trademarks

Notice: All referenced brands, product names, service names, and trademarks are the property of their respective owners.

NXP — wordmark and logo are trademarks of NXP B.V.

Figures

Fig. 1.	Board description	7	Fig. 6.	FRDMDUALK3664EVB	13
Fig. 2.	Block diagram	9	Fig. 7.	S32K3X4 evaluation board	14
Fig. 3.	Pinout cell connectors	10	Fig. 8.	Battery emulator connection	15
Fig. 4.	TPL connectors	11	Fig. 9.	FRDMDUAL33664EVB setup	16
Fig. 5.	800 V HVBMS reference design block diagram	12			

Contents

1 Introduction 2

2 Finding kit resources and information on the NXP website 4

3 Getting ready 5

3.1 Kit contents/packing list 5

3.2 Additional hardware 5

4 Getting to know the hardware 6

4.1 Board overview 6

4.1.1 Board description 7

4.2 Board features 7

4.2.1 MC33774ATP features and benefits 7

4.3 Block diagram 9

4.4 Kit featured components 9

4.4.1 Connectors 9

4.5 Schematic, board layout and bill of materials 11

5 Accessory boards 12

5.1 NXP 800 V HVBMS reference design 12

5.2 FRDMDUALK3664EVB 13

5.3 S32K3X4EVB-T172 14

6 Configuring the hardware 15

6.1 Battery emulator connection 15

6.2 TPL communication connection 15

7 Revision history 17

Legal information 18

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.