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NXP RD33774CNT3EVB Featuring The MC33774A Battery Cell Controller IC User Manual

Contents

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Document Information

Information	Content
Keywords	MC33774A, HVBMS cell monitoring unit, centralized evaluation board
Abstract	This user manual describes the RD33774CNT3EVB. The RD33774CNT3EVB features three MC33774A battery cell controller ICs. With the evaluation board (EVB), the key functions of the MC33774A can be explored.

Revision history

Rev	Date	Description
1	20230501	initial version

IMPORTANT NOTICE	
For engineering development or evaluation purposes only	
	NXP provides the product under the following conditions:
	This reference design is intended 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 reference design may be used with
	any development system or other source of I/O signals by simply connecting it to the host MCU or computer board via off-the-shelf cables. Final device in an application will be heavily dependent 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
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Introduction

This user manual describes the RD33774CNT3EVB. The RD33774CNT3EVB features three MC33774A battery cell controller ICs.

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.

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 RD33774CNT3EVB evaluation board is at http://www.nxp.com/RD33774CNT3EVB. The information page provides overview information, documentation, software and tools, parametrics, ordering information and a Getting Started tab. The Getting Started tab provides quick-referenceinformation applicable to using the RD33774CNT3EVB evaluation board, including the downloadable assets referenced in this document.

The tool summary page for RD33774CNT3EVB is at HVBMS Cell Monitoring Unit (CMU). The overview tab onthis 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 RD33774CNT3EVB.

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 files, review

    each file, including the user guide, which includes setup instructions.

Getting ready

Working with the RD33774CNT3EVB requires the kit contents, additional hardware, and a Windows PC workstation with installed software.

Kit contents/packing list

The kit contents include:

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

Additional hardware

To use this kit, you need:

- A 4-cell to 18-cell battery pack or a battery pack emulator, such as BATT-18CEMULATOR [1].
- A TPL communication 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 consist of the HVBMS battery management unit (RD-K358BMU [2]) and the 800 V HVBMS battery junction box (RD772BJBTPL8EVB[3]). For the 800 V HVBMS reference design, a graphical user interface based on FreeMASTER[4] is
- The evaluation setup consists of the FRDMDUALK3364EVB (EVB for MC33664A) [5] in combination with the S32K3X4EVB-T172 (S32K3X4 EVB)[6]
- For the evaluation setup, a graphical user interface EvalGUI 7[7] is

Getting to know the hardware

Board overview

The RD33774CNT3EVB is a hardware evaluation tool supporting the NXP MC33774A device. The RD33774CNT3EVB implements three MC33774A battery cell controller ICs. The MC33774A 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 RD33774CNT3EVB is an ideal platform for rapid prototyping of MC33774A-based applications that involve voltage and temperature sensing.

The RD33774CNT3EVB uses no capacative isolation for offboard communication. The galvanic isolation for onboard communication is established via capacitors.

The RD33774CNT3EVB 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)[2] and the 800 V HVBMS battery junction box (BJB)[3].

Board description

With the RD33774CNT3EVB, the user can explore all functions of the MC33774A battery cell controller.

Figure 1. Board description
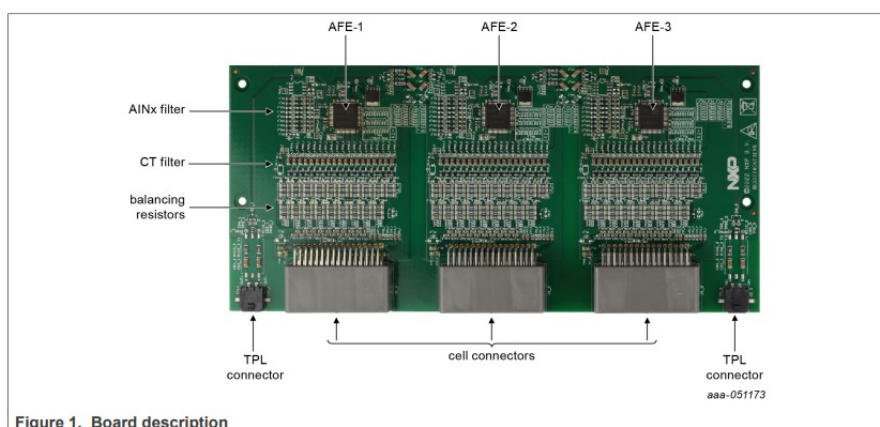
Board features

The main features of RD33774CNT3EVB are:

- Reference design with three MC33774A, showing optimized BOM as outlined in data sheet
- Capacitive isolation for onboard communication

- Based on NXP core layout for MC33774A; 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^{2}C-bus EEPROM
- Can be used together with the 800 V HVBMS reference design or the evaluation setup

MC33774A features and benefits

- The MC33774A is a battery cell controller IC designed to monitor battery characteristics such as voltage and The MC33774A 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 to 18 cells per device
  - Supports bus bars voltage measurement with +5/-3 V input voltage

- 16 bit resolution and ±1 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
  - 6 V to 81 V input range
  - 16-bit resolution and 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 150 mA average with 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 an fault
- 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)
  - Sleep mode (60 µA)

Deep sleep mode (15 µA typ.)

Block diagram

Figure 2. Block diagram
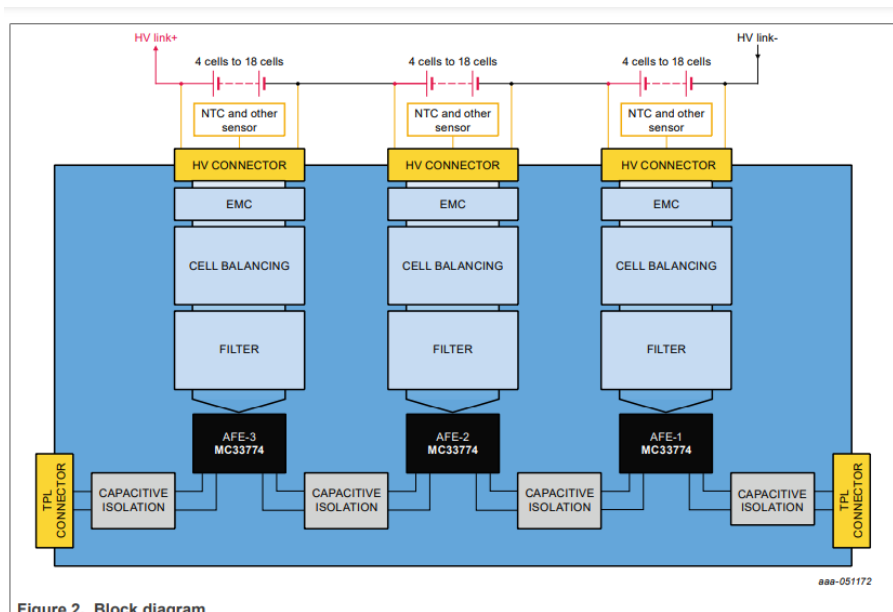
- **Kit featured components**

Connectors

The cells and NTCs 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), etc… 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 due to the EVB current consumption.
Optional external 10KΩ 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 3. Pinout cell connectors
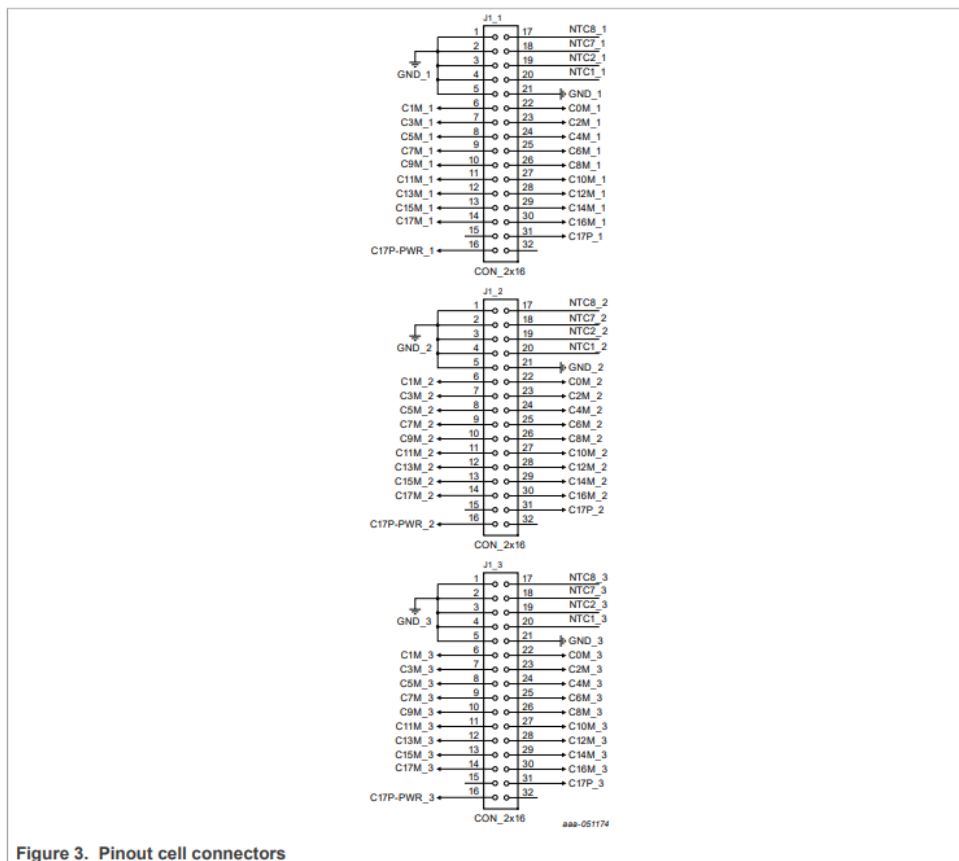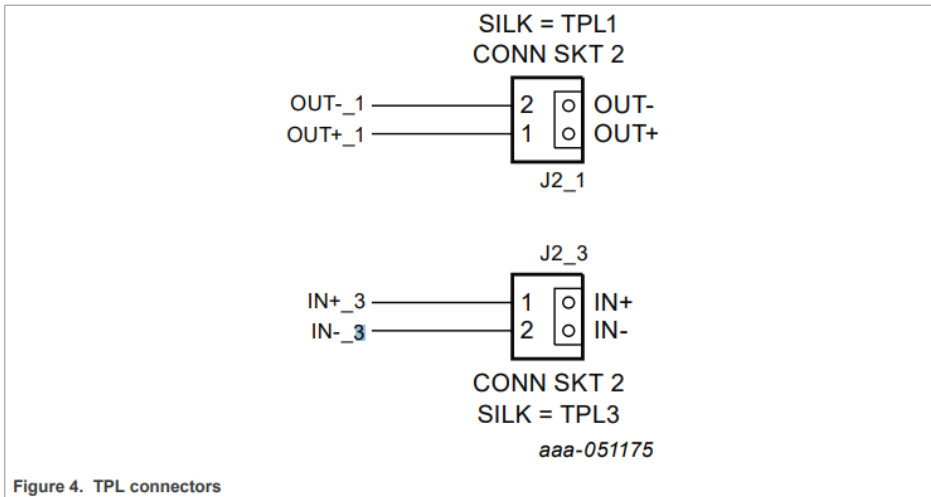
NXP Semiconductors

Figure 4. TPL connectors

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

- onnector 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.
- Schematic, board layout and bill of materials

The schematic, board layout and bill of materials for the RD33774CNT3EVB evaluation board are available at http://www.nxp.com/RD33774ACNT3EVB.

Accessory boards

NXP 800 V HVBMS reference desig

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
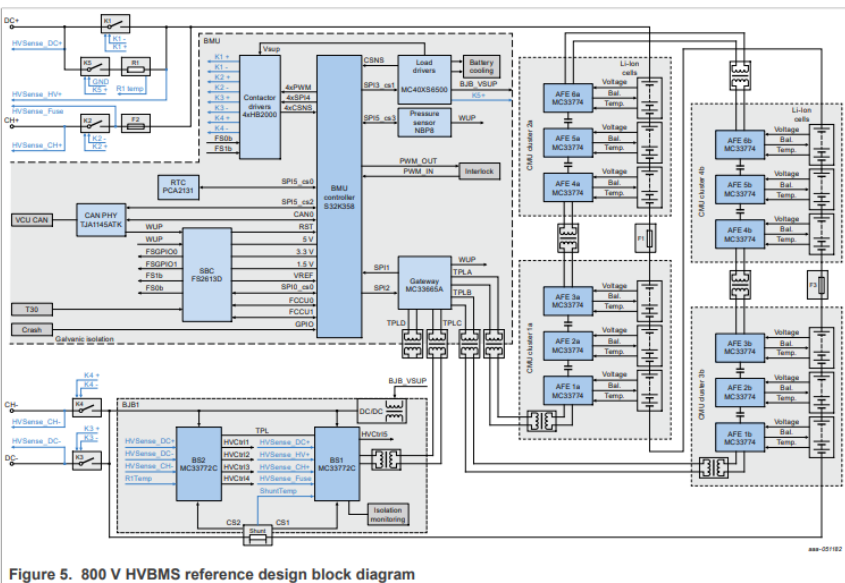
FRDMDUALK3664EVB

The RD33774CNT3EVB kit is designed for use with the FRDMDUALK3664EVB[5]. 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 which allow loopback connection. MCU SPI data bits are directly converted to pulse bit information.

Figure 6. FRDMDUALK3664EVB

S32K3X4EVB-T172

The S32K3X4EVB[6] provides the control signals for the FRDMDUALK3664EVB.

Figure 7. S32K3X4 evaluation board
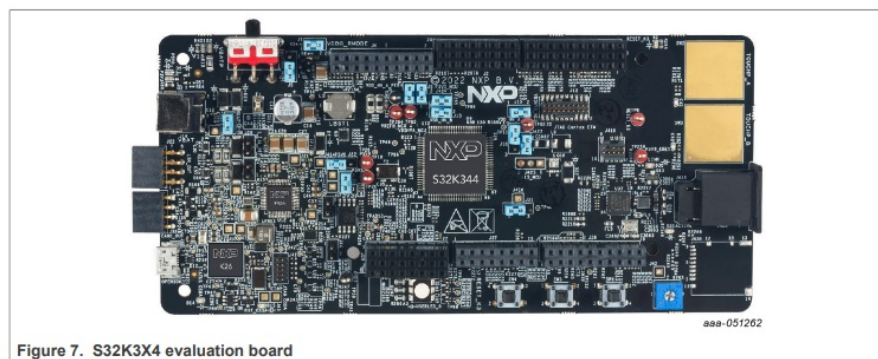
Configuring the hardware

Battery emulator connection

A minimum of four cells and a maximum of 18 cells can be monitored by one MC33774A. NXP provides an 18-cell battery emulator board, BATT-18EMULATOR [1]. This board provides an intuitive way to change the voltage across any of the 18 cells of an emulated battery pack. The board RD33774CNT3EVB 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.
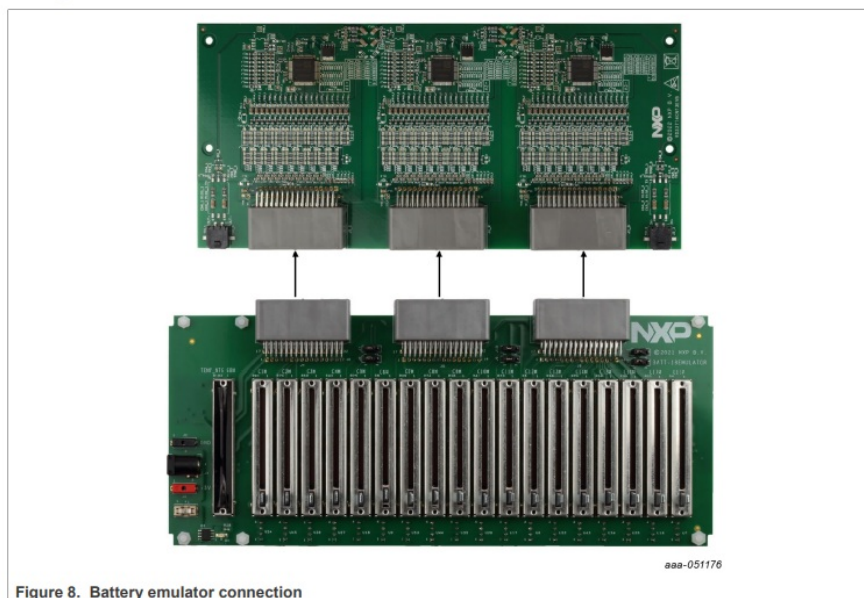
Figure 8. Battery emulator connection

2 TPL communication connection

In a high-voltage isolated application with a daisy chain configuration, up to 63 RD33774CNT3EVB boards may be connected.

The TPL connections use the COMM connectors J1 and J2 of the FRDMDUALK3664EVB[5] and J2_1 and J2_3 of the RD33774CNT3EVB.
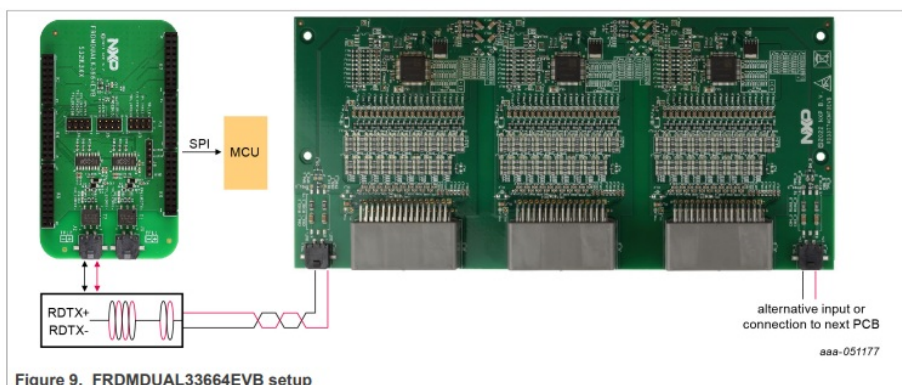

Figure 9. FRDMDUAL33664EVB setup

References

[1] Tool summary page for battery emulators — BATT-18EMULATOR
[2] RD-K358BMU HVBMS Battery Management Unit (BMU) https://https://www.nxp.com/part/RD-K358BMU
[3] RD772BJBTPL8EVB HVBMS Battery Junction Box (BJB) https://www.nxp.com/design/designs/hvbms-batteryjunction-box-bjb:RD772BJBTPL8EVB
[4] https://www.nxp.com/design/software/development-software/freemaster-run-time-debugging-tool:FREEMASTER
[5] Tool summary page for evaluation board for MC33664ATL isolated network high-speed transceiver — FRDMDUALK3664EVB
[6] Tool summary page for S32K3X4 evaluation board — https://www.nxp.com/design/development-boards/automotive-development-platforms/s32k-mcu-platforms/s32k3x4evb-t172-evaluation-board-for-automotivegeneral-purpose:S32K3X4EVB-T172
[7] Tool summary page for RD33774CNT3EVB evaluation board — https://www.nxp.com/RD33774CNT3EVB

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References

- [**HVBMS | Centralized Cell Monitoring Unit (CMU) | NXP Semiconductors**](#)
- [**NXP® Semiconductors Official Site | NXP Semiconductors**](#)
- [**NXP® Semiconductors Official Site | NXP Semiconductors**](#)
- [**BATT-18EMULATOR | 18-Cell Battery Pack Emulator to Supply MC33774 BCC EVBs | NXP Semiconductors**](#)
- [**Evaluation Board for MC33664ATL Isolated Network High-Speed Transceiver | NXP Semiconductors**](#)
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- [**HVBMS | Centralized Cell Monitoring Unit (CMU) | NXP Semiconductors**](#)

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