

UM12204

RDI7018C3T1 featuring the BMI7018 battery cell controller integrated circuit

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User manual

Document information

Information	Content
Keywords	BMI7018, HVBESS cell monitoring unit, centralized evaluation board
Abstract	This user manual describes the RDI7018C3T1. The board features three BMI7018 battery cell controller ICs. With the evaluation board (EVB), the key functions of the BMI7018 can be explored.



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1 Introduction

This user manual describes the RDI7018C3T1. The board features three BMI7018 battery cell controller integrated circuits (IC).

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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 devices on <http://www.nxp.com>.

The information page for the RDI7018C3T1 evaluation board is at <http://www.nxp.com/RDI7018C3T1>. 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 [RDI7018C3T1](http://www.nxp.com/RDI7018C3T1) evaluation board, including the downloadable assets referenced in this document.

The Getting Started section provides information applicable to using the RDI7018C3T1.

1. Go to <http://www.nxp.com/RDI7018C3T1>
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:

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- **Buy/Parametrics:** Purchase the product and view the product parametrics

After downloading files, review each file, including the user guide, which includes setup instructions.

3 Getting ready

Working with the RDI7018C3T1 requires the kit contents, additional hardware, and a Windows PC workstation with installed software.

3.1 Kit contents

The kit contents include:

- Assembled and tested evaluation board/module in antistatic bag
- Three cell terminal cables
- One transport protocol link (TPL) communication cable

3.2 Additional hardware

To use this kit, the following hardware is required:

RDI7018C3T1 featuring the BMI7018 battery cell controller integrated circuit

- A 4-cell to 18-cell battery pack or a battery pack emulator, such as BATT-18EMULATOR^[1]
- A TPL communication system
 - The evaluation setup consists of the FRDM665SPIEB (EVB for MC33665A)^[2] with the S32K3X4EVB-T172 (S32K3 MCU)^[3]
 - For the evaluation setup, EvalGUI 7^[4] is available

4 Getting to know the hardware

4.1 Kit overview

The RDI7018C3T1 is a hardware evaluation tool supporting the NXP BMI7018 device. The RDI7018C3T1 implements three BMI7018 battery cell controller ICs. The BMI7018 is a battery cell controller that monitors up to 18 Li-ion battery cells. It is designed for use in 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 an I²C-bus to other devices. The RDI7018C3T1 is an ideal platform for rapid prototyping of BMI7018 based applications that involve voltage and temperature sensing.

The RDI7018C3T1 measures the pressure of the battery module using the onboard FXPS7250A4ST1 pressure sensor. The RDI7018C3T1 converts the battery module voltage to 12 V using the TEA1721AT/N1,118 flyback controller, then converts the 12 V to 5 V to supply the pressure sensor.

The RDI7018C3T1 uses inductive isolation for offboard communication. The galvanic isolation for onboard communication is established via capacitors.

4.1.1 Board description

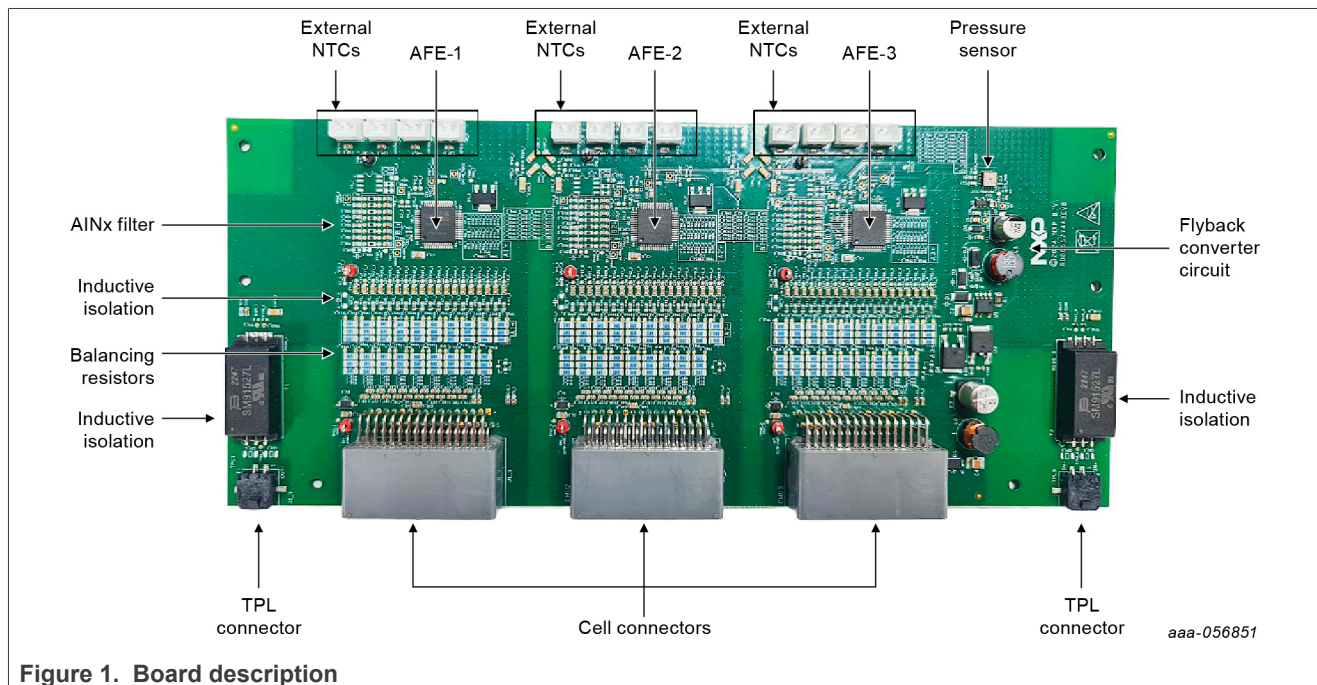


Figure 1. Board description

With the RDI7018C3T1, the user can explore all functions of the BMI7018 battery cell controller.

4.2 Board features

The main features of RDI7018C3T1 are:

RDI7018C3T1 featuring the BMI7018 battery cell controller integrated circuit

- Reference design with three BMI7018, showing an optimized bill of materials (BOM); see data sheet [BMI7018](#)
- Capacitive isolation for onboard communication
- Based on NXP core layout for BMI7018; 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
- Onboard high-performance, high-precision absolute pressure sensor
- Placeholder for I²C-bus EEPROM

4.2.1 Pressure sensor power circuit

The RDI7018C3T1 measures the pressure of the battery module using the onboard FXPS7250A4ST1 pressure sensor. The RDI7018C3T1 converts the battery module voltage to 12 V using the TEA1721AT/N1,118 flyback controller then converts the 12 V to 5 V to supply the pressure sensor.

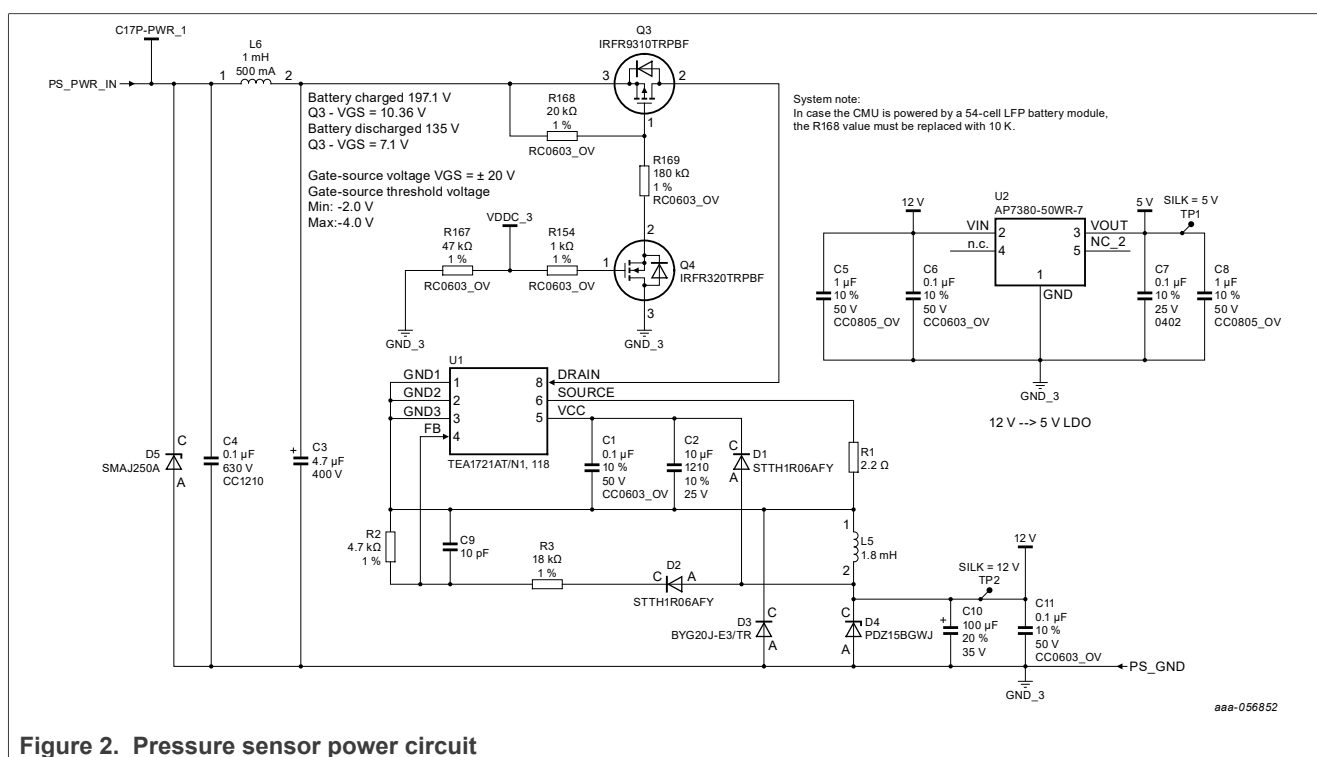
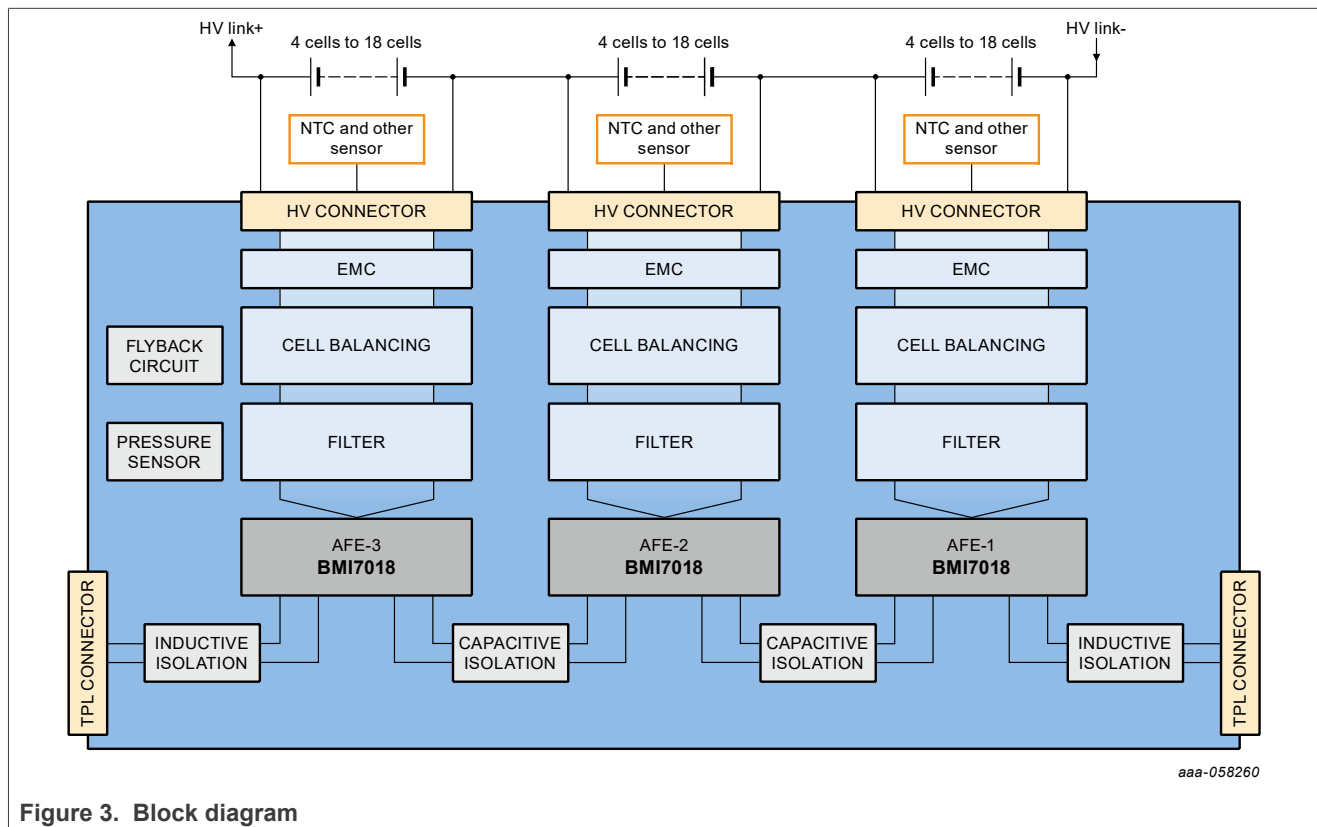


Figure 2. Pressure sensor power circuit

The RDI7018C3T1 can be used with the 18-cell battery emulator board, BATT-18EMULATOR^[1]. The battery emulator board powers the RDI7018C3T1 board through a 5 V power supply.

In the case of replacing the battery emulator board with a battery module that consists of 54 LFP cells in series, the nominal battery module voltage changes to around 173 V on the RDI7018C3T1 board. Therefore, replace the R168 (20 kΩ) with 10 kΩ 0603 resistor for the proper operation of the metal-oxide-semiconductor field-effect transistor (MOSFET).

4.3 Block diagram



4.4 Kit featured components

4.4.1 BMI7018: 18-channel Li-ion battery cell controller IC

The BMI7018 is a battery cell controller IC designed to monitor battery characteristics, such as voltage and temperature. The BMI7018 contains all necessary circuit blocks, such as battery cell voltage, cell temperature measurement, and integrated cell balancing from $-20\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$ ambient temperature range. The device supports the following functions:

- Cell voltage measurement
 - 4 cells to 18 cells per device
 - Supports busbars voltage measurement with +5 V or -3 V input voltage
 - 16-bit resolution and $\pm 1\text{ mV}$ typical measurement accuracy with ultralow, 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 $\pm 5\text{ mV}$ typical measurement accuracy
 - Integrated configurable digital filter
- Module voltage measurement
 - 9.6 V to 90 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 150 mA average with 0.5 Ω R_{DSon} 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 pause 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 a fault event
- Host interface supporting serial peripheral interface (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.)

4.4.2 FXPS7250A4ST1: analog absolute pressure sensor

Battery module pressure monitoring

- Absolute pressure range: 20 kPa to 250 kPa
- Operating temperature range: –40 °C to +130 °C
- Analog output for monitoring of the absolute pressure signal
- Pressure transducer and digital signal processor (DSP)
- Internal self-test
- Capacitance to voltage converter with antialiasing filter
- Sigma-delta analog-to-digital converter (ADC) plus sinc filter
- 800 Hz or 1000 Hz low-pass filter for absolute pressure
- Lead-free, 16-pin HQFN, 4 mm x 4 mm x 1.98 mm package

4.4.3 Connectors

The cells and negative temperature coefficient (NTC) connections are available on J1_1, J1_2 and J1_3; see [Figure 4](#). Other NTC connections are available on J3_X, J4_X, J5_X, J6_X.

Cell 0 is connected between C0M(cell0M) and C1M(cell0P); cell 1 is connected between C1M(cell1M) and C2M(cell1P), and so on. Cell17 is connected between C17M (cell17M) and C17P (cell17P). C17P-PWR and GND (pin 21) are used to supply the analog front-end (AFE) and are separated from C17P and C0M respectively, to avoid any voltage drop due to the EVB current consumption.

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

JAE MX34032NF2 connector

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

JST B2B-XH connector

- NTC connector type: JST B2B-XH-A(LF)(SN) (two pins/top mount version)
- Corresponding mate connector reference: XHP-2
- Crimp reference for the mate connector: SXH-001T-P0.6N

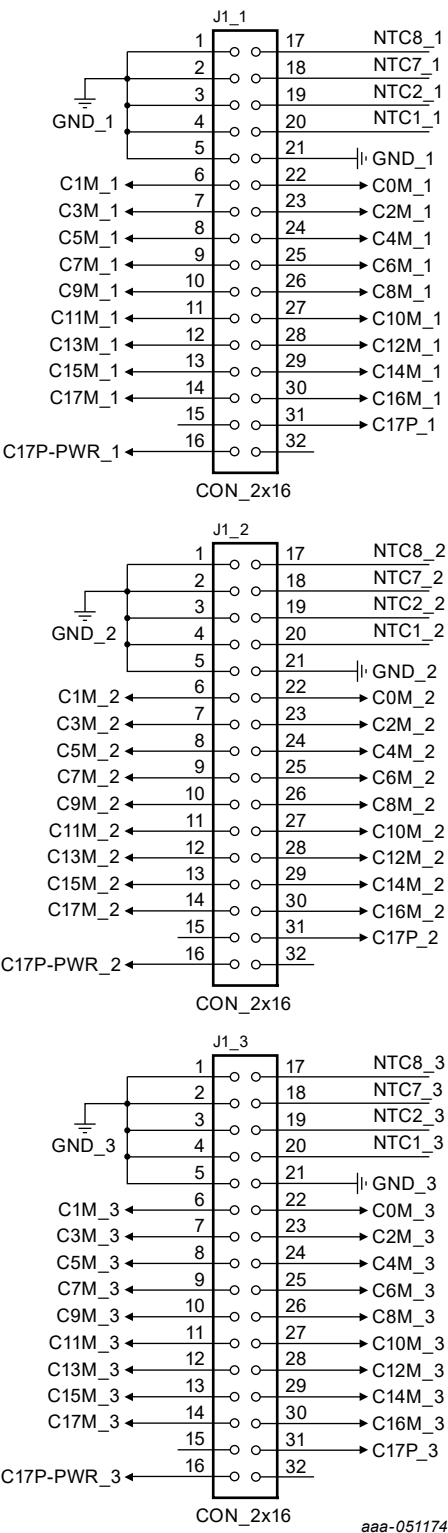


Figure 4. Pinout cell connectors

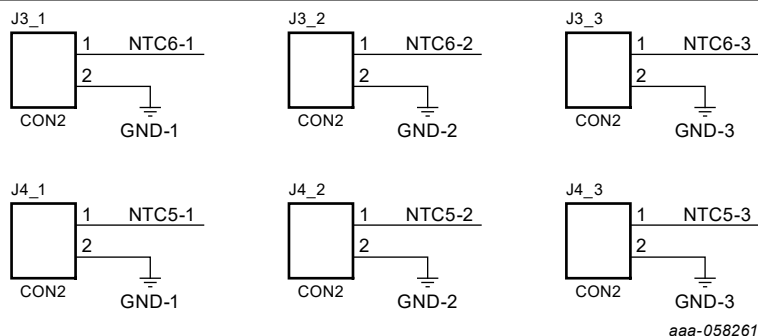


Figure 5. NTC connectors

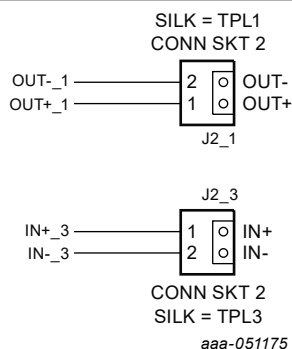


Figure 6. TPL connectors

The TPL connections are available on J2_1 and J2_3; see [Figure 6](#).

- 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.

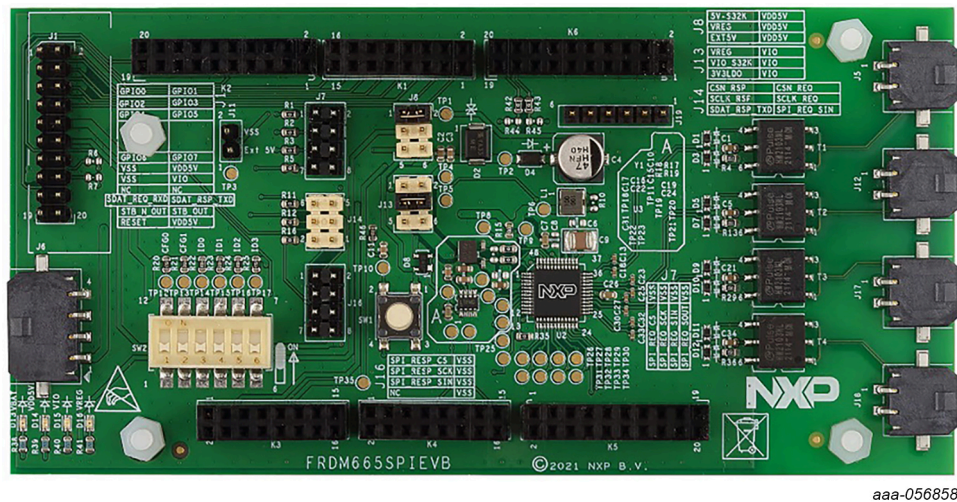
4.5 Schematic, board layout, and bill of materials

The schematic, board layout, and bill of materials for the RDI7018C3T1 evaluation board are available at <http://www.nxp.com/RDI7018C3T1>.

4.6 Accessory boards

4.6.1 FRDM665SPIEBV

The RDI7018C3T1 kit is designed for use with the FRDM665SPIEBV^[2]. The FRDM665SPIEBV is an evaluation board for MC33665A, a gateway router that can route TPL messages from the MCU to four different TPL ports. It is designed for use in both automotive and industrial applications. The device can route both transformer physical layer 2 (TPL2) and TPL3 messages. The FRDM665SPIEBV is an ideal board for rapid prototyping of the MC33665A for SPI interface to an MCU. The onboard TPL interface for four TPL ports has transformer isolation.

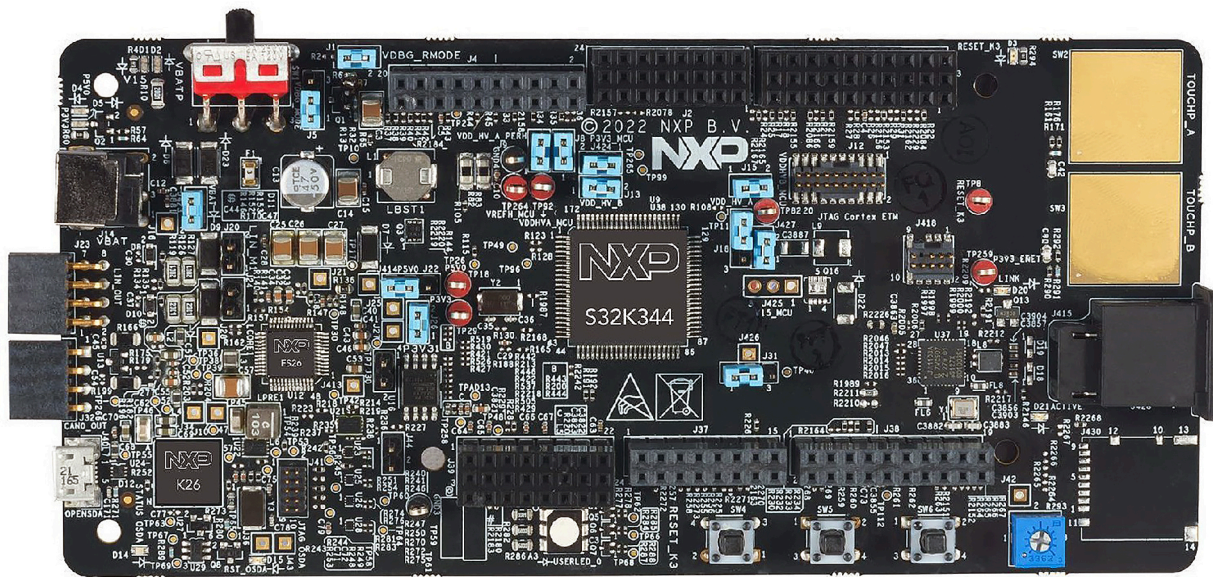


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Figure 7. FRDM665SPIEBV

4.6.2 S32K3X4EV-B-T172

The S32K3X4EV-B^[3] provides the control signals for the FRDM665SPIEBV.



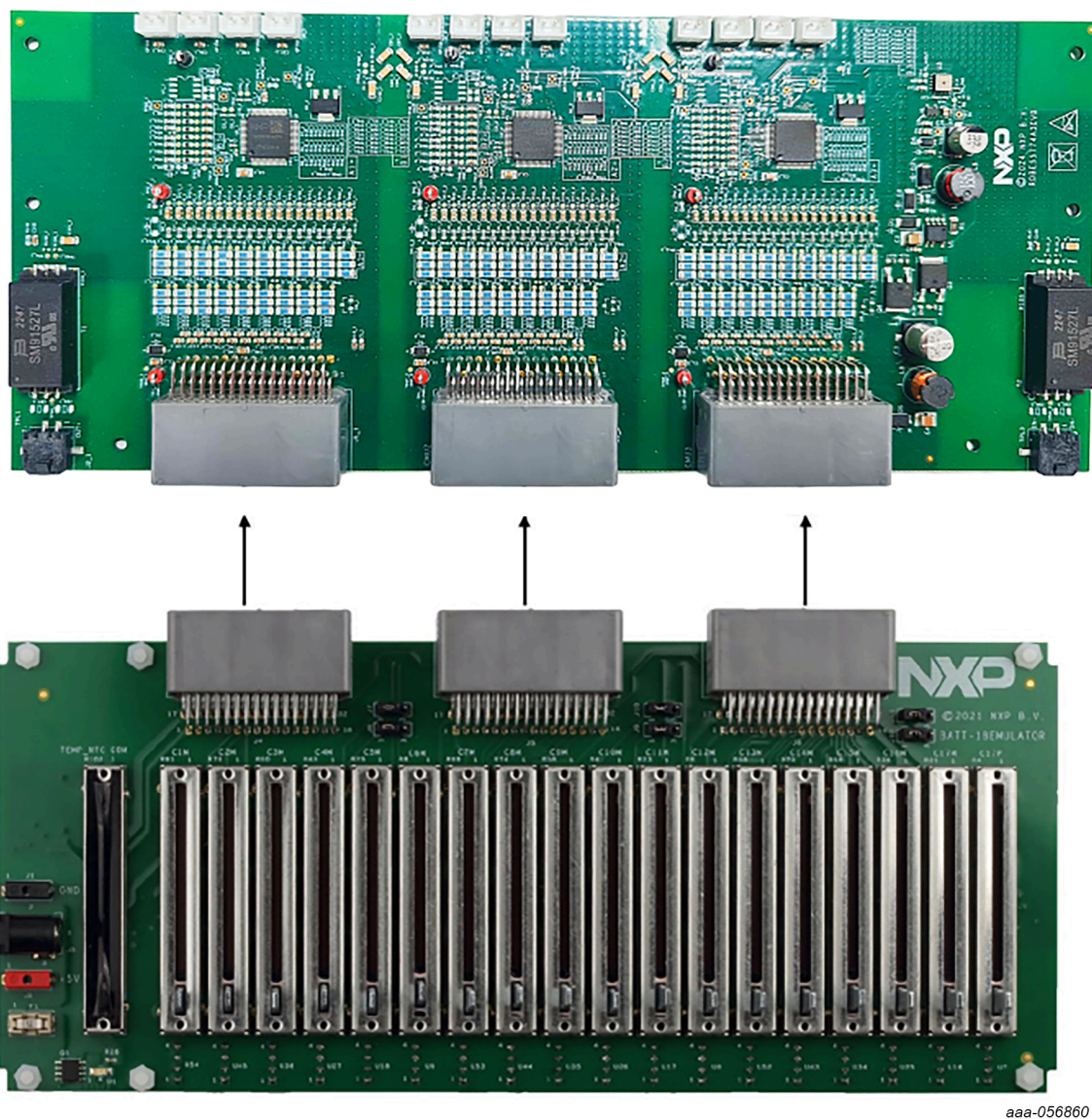
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Figure 8. S32K3X4 evaluation board

5 Configuring the hardware

5.1 Battery emulator connection

One BMI7018 can monitor a minimum of four cells and a maximum of 18 cells. NXP provides an 18-cell battery emulator board, BATT-18EMULATOR^[4]. This board provides an intuitive way to change the voltage across any of the 18 cells of an emulated battery pack. The board RDI7018C3T1 can be connected to an 18-cell battery emulator board using the connectors J1_1, J1_2 and J1_3, with the provided supply cables; see [Figure 9](#).



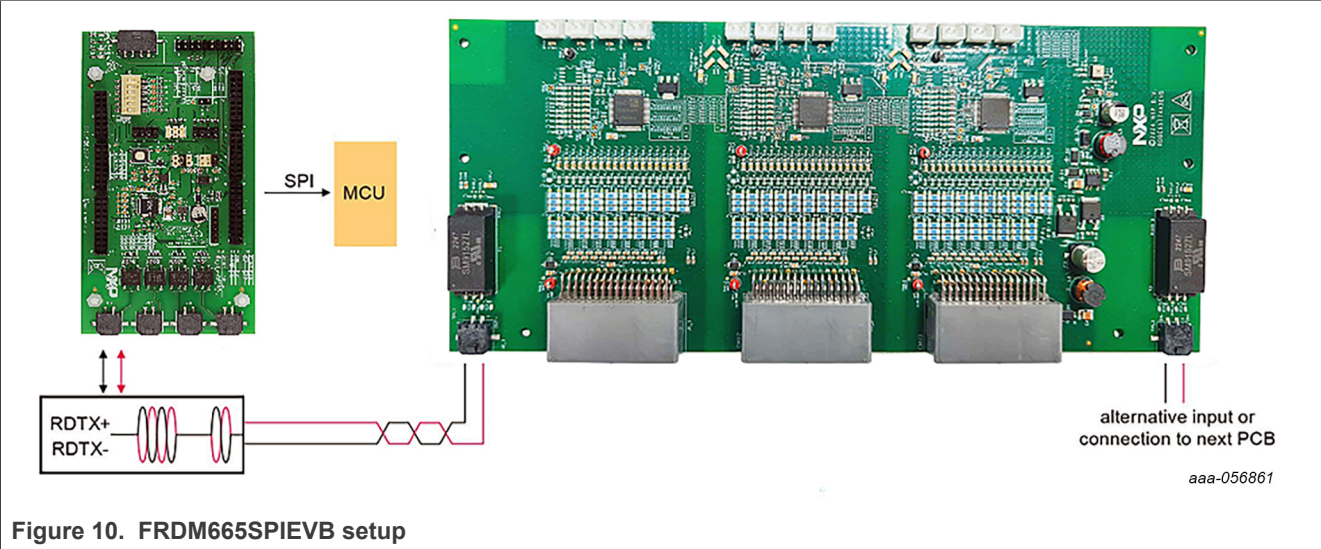
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Figure 9. Battery emulator connection

5.2 TPL communication connection

In a high-voltage isolated application with a daisy chain configuration, up to 21 RDI7018C3T1 boards can be connected.

The TPL connections use the COMM connectors J1 and J2 of the FRDM665SPIEBV^[2] and J2_1 and J2_3 of the RDI7018C3T1.



6 References

1. Tool summary page for battery emulators — [BATT-18EMULATOR](#)
2. Tool summary page for evaluation board for MC33665A with SPI and TPL Communication — [FRDM665SPIEB](#)
3. 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-automotive-general-purpose:S32K3X4EVB-T172>
4. Tool summary page for RDI7018C3T1 evaluation board — <http://www.nxp.com/RDI7018C3T1>

7 Revision history

Table 1. Revision history

Document ID	Release date	Description
UM12204 v.1.0	22 November 2024	initial version

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