UM12023

RD33774PDSTEVB featuring the MC33774ATP battery cell controller IC

Rev. 1.1 — 9 April 2024 User manual

Document information

Information	Content
Keywords	RD33774PDSTEVB, MC33774ATP, battery-cell controller, battery emulator, battery management systems
Abstract	This user manual describes how to use the RD33774PDSTEVB evaluation board.

1 Introduction

This user manual describes the RD33774PDSTEVB. The RD33774PDSTEVB features one MC33774ATP battery-cell controller integrated circuit (IC).

The NXP analog product development board provides a platform for evaluating NXP products.

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2 Getting ready

2.1 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 RD33774PDSTEVB evaluation board is at http://www.nxp.com/RD33774PDSTEVB. 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 RD33774PDSTEVB evaluation board, including the downloadable assets referenced in this document.

2.2 Kit contents

- Assembled and tested evaluation board/module in antistatic bag
- One 32-pin battery cell cable
- One two-pin TPL cable

2.3 Required equipment

To use this kit, the following equipment is required:

- A 4-cell to 18-cell battery pack or a battery pack emulator, such as BATT-18EMULATOR
- FRDMDUALK3664EVB (EVB for MC33664A) with the S32K3X4EVB-T172 (S32K3X4 EVB) to interface with a PC
- For the evaluation setup, a graphical user interface, EvalGUI 7, is available in Secure Files at this link: MC33775A Evaluation GUI V7

3 Getting to know the hardware

3.1 Kit overview

The RD33774PDSTEVB serves as a hardware evaluation tool in support of NXP's MC33774ATP device. The MC33774ATP is a battery-cell controller that monitors up to 18 lithium-ion battery cells. RD33774PDSTEVB is designed for use in automotive and industrial applications. The device performs analog-to-digital conversion on the differential cell voltages and currents. It is also capable of battery-charge coulomb counting and battery temperature measurements. The RD33774PDSTEVB can be used for rapid prototyping of MC33774ATP-based applications that involve voltage and temperature sensing.

The information is digitally transmitted to a microcontroller for processing. The evaluation board can be used with a physical layer transformer transceiver driver (MC33664) to convert MCU SPI data bits to pulse bit information for the MC33774ATP and vice versa.

3.2 Board features

The main features of the RD33774PDSTEVB are:

- Daisy-chain device connection
- LED indicator for operation mode
- Cell-balancing resistors (22 Ω per individual cell)
- 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

3.3 Block diagram

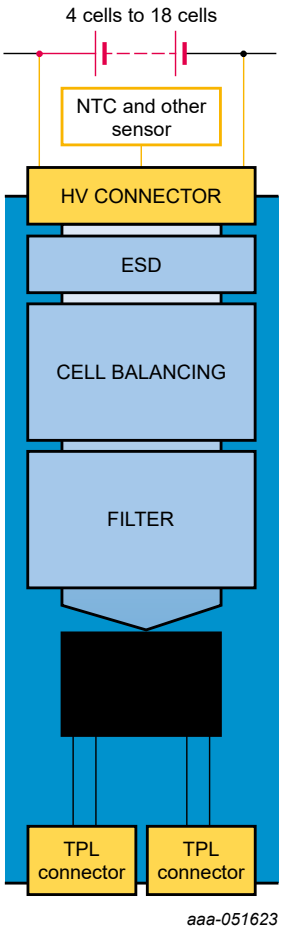

Figure 1. Block diagram

3.4 MC33774ATP features and benefits

The MC33774ATP is a battery-cell controller IC designed to monitor battery characteristics, such as voltage, current, and temperature. The MC33774ATP contains the circuit blocks necessary to perform battery-cell voltage measurement, cell temperature measurement, and integrated cell balancing. The MC33774ATP 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 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
- 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 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 hours 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 because of 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 monitor the pack and the balancing function during sleep
- Capability to wake up the host MCU via daisy chain in case of a fault event
- Host interface supporting SPI or isolated daisy-chain communication (TPL3)
  - 2 Mbit/s data rate for TPL interface
  - 4 Mbit/s data rate for SPI interface
- TPL3 daisy-chain communication supports
  - Two-wire daisy chain with capacitive or inductive isolation
  - Protocol supporting up to six daisy chains and 62 nodes per chain
- Unique device ID with dynamic adressing
- Operation modes
  - Active mode (12 mA typ)
  - Sleep mode (60 µA typ)
  - Deep Sleep mode (15 µA typ)

3.5 Board description

The RD33774PDSTEVB allows the user to exercise all the functions of the MC33774ATP battery controller cell.

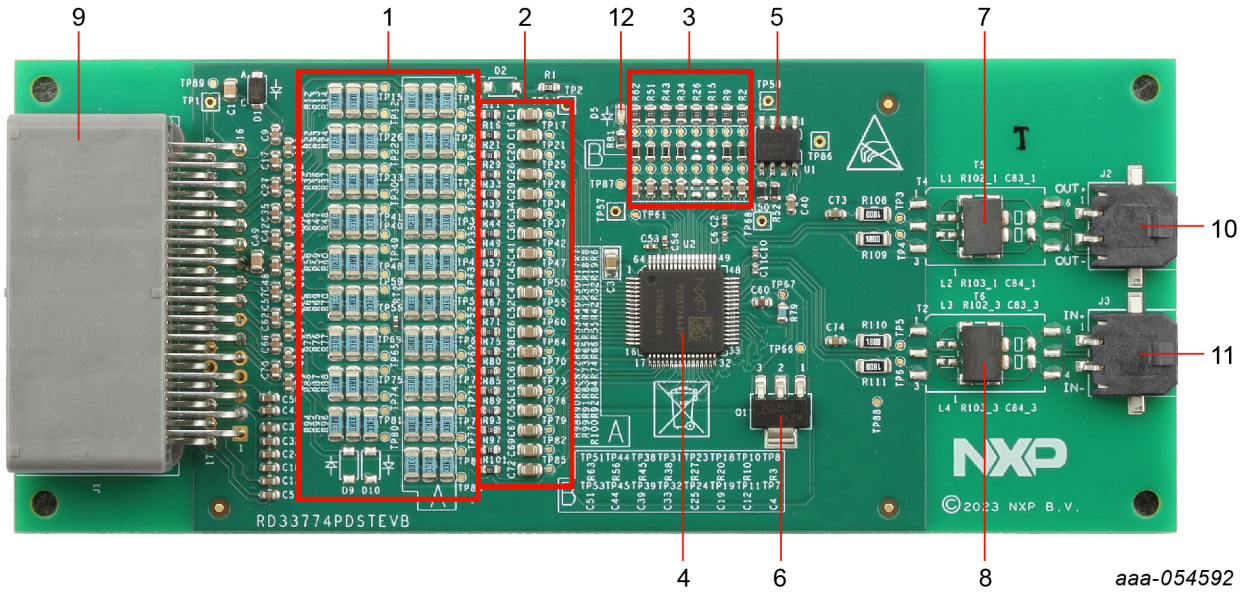

Figure 2. Board description

Table 1. Board description

Number	Name	Description
1	Cell balancing resistors	3 x 33 ohms in parallel on each Cx pin: 200 mA of cell-balancing current @4.5 V
2	Cell terminal low-pass filters	LPF: 10 kΩ resistor/0.047 µF capacitor to GND
3	GPIO low-pass filters	For NTC connections and temperature measurement
4	MC33774ATP (U2)	18-cell battery-cell controller IC
5	NV24C64DWVLT3G (U1)	High-speed 64 Kb I^2C EEPROM
6	NSS1C201MZ4T1G (Q1)	NPN supply bipolar transistor
7, 8	TC102M or capacitive coupling	Default BOM: High-voltage single-channel transformers
9	JAE-MX34032NF2 (J1)	32-pin connector for cell connections and NTC connections
10	MOLEX-43650-0213 (J2)	TPL connector to higher node
11	MOLEX-43650-0213 (J3)	TPL connector to lower node
12	LED	VAUX status

3.5.1 Connectors

3.5.1.1 Battery pack connector J1

The cells and NTC connections are available on J1. 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 RD33774PDSTEVB 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.

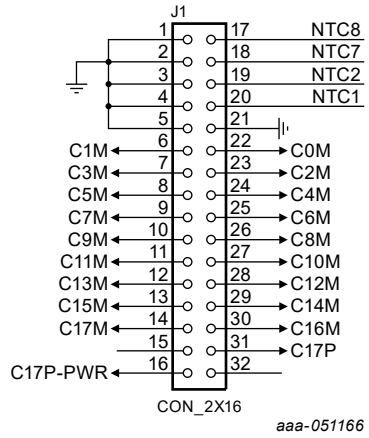

Figure 3. Cell-connector schematic

Board connector reference: MX34032NF2 (32 pins/right-angle version) - Manufacturer : JAE

Corresponding mate connector reference: MX34032SF1

Crimp reference for the mate connector: M34S75C4F1 (applicable cable 0.22 mm^2 to 0.35 mm^2)

3.5.1.2 TPL connectors

Isolated connections to upper and lower nodes can be done through J2 and J3, respectively. As the TPL communications are bidirectional, the connections can be reversed.

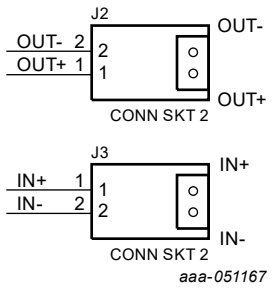

Figure 4. TPL connectors

Board connector reference: Micro-fit 3.0 43650-0213 (two pins/right angle version) - Manufacturer: Molex

Corresponding mate connector reference: 0436450200

Crimp reference for the mate connector: 0436450201

Twisted cable: 64920108 - Manufacturer: Kromberg & Schubert

3.5.1.2.1 TPL configuration

The RD33774PDSTEVB can be configured for capacitive TPL communications instead of the default BOM with inductive TPL communication (transformer). See Table 2 for configuration instructions.

Table 2. Configuration

Name	Value	Inductive isolation	Capacitive isolation
T2	1:1 transformer	Place	Remove
C83_1, C84_1, C83_3, C84_3	22 nF	Remove	Place
R102_1, R103_1, R102_3, R103_3, L1, L2, L3, L4	0 ohms	Remove	Place

3.6 Test points

Test points are provided to access various signals on the board. Main test points are detailed in Table 3.

Table 3. Test points

Label	Signal name	Description
TP1	C17P-VPWR	Battery stack HV+
TP2	VBAT	MC33774ATP VBAT supply
TP3 – TP6	RXTX...	MC33774ATP TPL lines
TP51, 44, 38, 31, 23, 18, 10, 8	NTCx	NTC1 to 8
TP53, 45, 39, 32, 24, 19, 11, 7	GPIO	MC33774 GPIO0 to GPIO7 pins
TP61	ALARM_OUT	MC33774 AINA_ALARM_OUT pin
TP57	VDDA	MC33774 VDDA pin
TP58	VAUX	MC33774 VAUX pin
TP66	DRIVE_VDDC	MC33774 DRIVE_VDDC pin
TP67	IMON_VDDC	MC33774 IMON_VDCC pin
TP68	VDDC, VDDIO	MC33774 VDDC pin
TP86, 87, 88, 89	GND	Battery stack HV-

3.7 GPIO configurations

The MC33774ATP has nine GPIO pins (GPIO0 to GPIO7 and AINA) available for temperature measurements (excepted AINA), absolute analog measurements, and other functions.

The RD33774PDSTEVB makes available the GPIO measurements and functions as described in Table 4.

Table 4. GPIO connections

Connection	Board label	Description - BCC connection
J1-20	NTC1	GPIO0/AIN0 pin through low-pass filter for NTC acquisition - to be connected to an external 10 kΩ NTC (that is, NCP15XV103J03RC)
J1-19	NTC2	GPIO1/AIN1 pin through low-pass filter for NTC acquisition - to be connected to an external 10 kΩ NTC (that is, NCP15XV103J03RC)
J1-18	NTC7	GPIO6/AIN6 pin through low-pass filter for NTC acquisition - to be connected to an external 10 kΩ NTC (that is, NCP15XV103J03RC)
J1-17	NTC8	GPIO7/AIN7 pin through low-pass filter for NTC acquisition - to be connected to an external 10 kΩ NTC (that is, NCP15XV103J03RC)
Onboard NTC NCP15XV103J03RC - TP38	NTC3	GPIO2/AIN2 pin through low-pass filter for NTC acquisition
Not connected - TP31	NTC4	GPIO3/AIN3 pin through low-pass filter for NTC acquisition
Onboard I2Ceeprom - SCL	GPIO4	GPIO4 pin
Onboard I2Ceeprom - SDA	GPIO5	GPIO5 pin
Not connected - TP61	AINA	AINA pin

4 Configuring the hardware

The RD33774PDSTEVB kit is designed for use with the FRDMDUALK3664EVB in high-voltage isolated applications that provide an SPI-to-high-speed isolated communication interface. The FRDMDUALK3664EVB includes two MC33664 isolated-network high-speed transceivers allowing loopback connection. MCU SPI data bits are directly converted to pulse bit information.

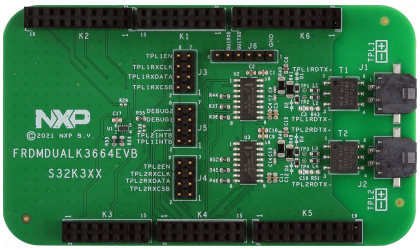

Figure 5. FRDMDUALK3664EVB transceiver board

4.1 Battery emulator connection

The RD33774PDSTEVB supports the use of a battery-cell emulator, such as the BATT-18EMULATOR board.

The BATT-18EMULATOR is an 18-cell battery-emulator board that provides a way to change the voltage across any of the 18 cells and four voltage outputs to emulate four external NTCs. The emulator board can be connected to the RD33774PDSTEVB J1 connector using the provided cell connection cable.

Up to three RD33774PDSTEVB can be connected to one BATT-18EMULATOR. See Figure 6

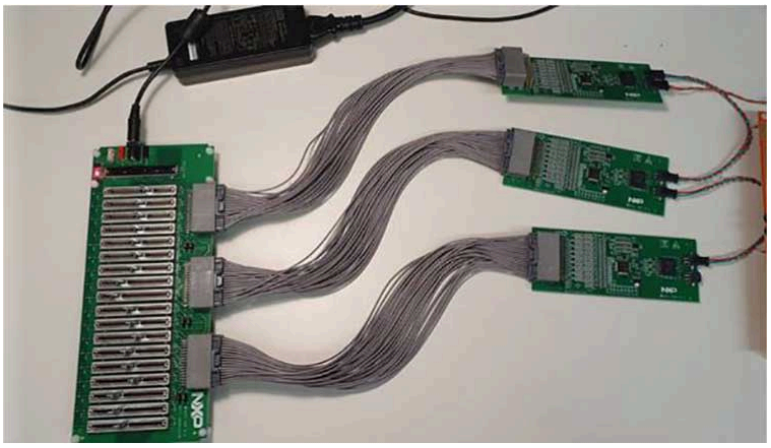

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Figure 6. RD33774PDSTEVBs connection to a BATT-18EMULATOR

4.2 TPL communication connection

In a high-voltage isolated application with a daisy-chain configuration, up to 62 RD33774PDSTEVB boards may be connected.

The TPL connections use the connectors J2 and J3.

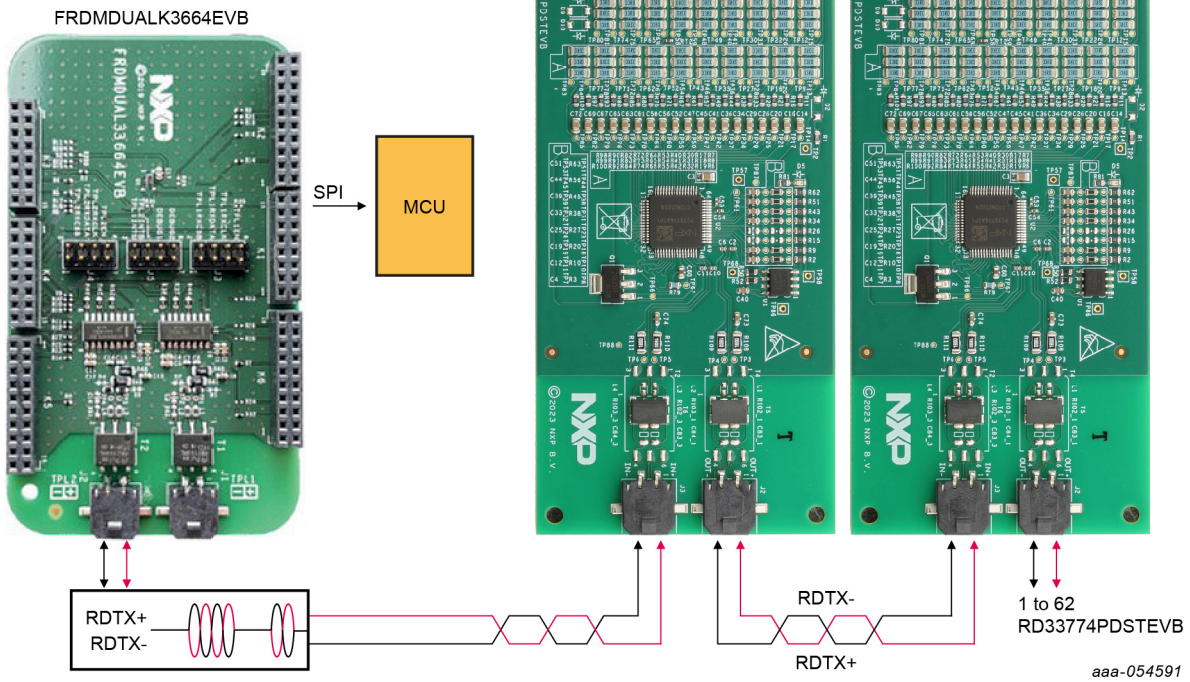

Figure 7. TPL communication connection

5 Revision history

Revision history

Document ID	Date	Description
UM12023 v.1.1	09 April 2024	• Section 2.3: Updated text and link to the EvalGUI 7. • Section 3.5.1.1: Updated text from "Cell1 is connected between C1M(cell1M) and C2M(cell1P), and so on ..." to "Cell1 is connected between C1M and C2M, and so on ..."
UM12023 v.1	07 February 2024	Initial version

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