UM11817

Introduction to 18-cell slider battery pack emulator

Rev. 1 — 17 February 2023 User manual

Document information

Information	Content
Keywords	MC33774, battery cell controller, battery emulator, battery management systems
Abstract	This user manual provides the user with an overview of the BATT-18EMULATOR battery pack emulator.

Revision history

Rev	Date	Description
1	20230217	initial version

1 Introduction

The BATT-18EMULATOR board can emulate a multi-cell battery pack that can be easily hooked-up to the evaluation boards for MC33774 18-cell battery cell controllers (BCCs):

- RD33774ADSTEVB - distributed board with single MC33774
- RD33774CNT3EVB - centralized board with three MC33774

The user can connect the BATT-18EMULATOR board for a quick evaluation of NXP BCC ICs, or to help the users in their software development. These boards basically provide a very intuitive way:

- To change the voltage across any of the 18 cells of an emulated battery pack
- To change the voltage across some analog inputs of the BCC IC that are typically used as temperature sensors

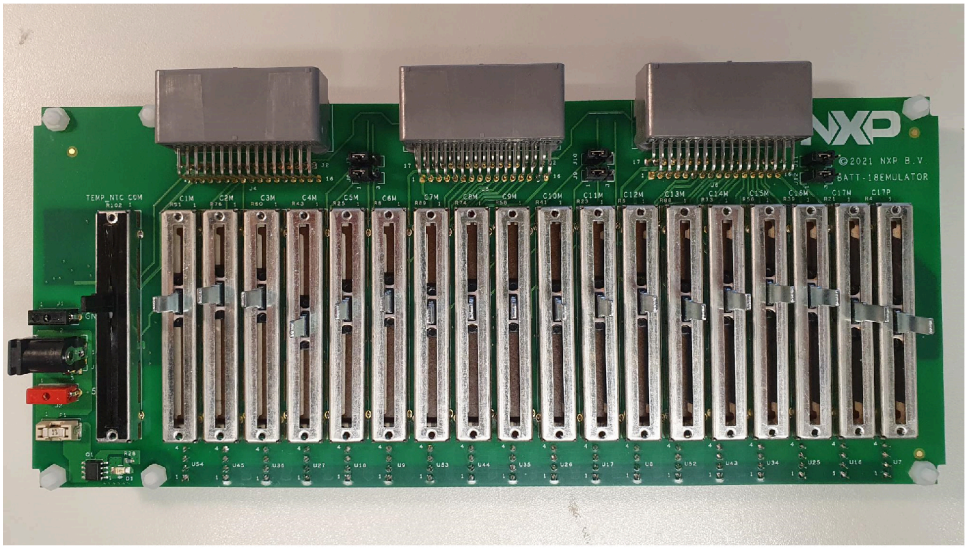

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Figure 1. BATT-18EMULATOR

2 Getting started

2.1 Kit contents/packing list

The kit contents include:

- BATT-18EMULATOR, 18-cell slider battery pack emulator
- 25 W AC-DC adapter with +5 VDC/5 A single output - DC plug type P1J (2.1 × 5.5 × 11 mm), tuning fork type, center positive
- Adapter cable DC plug 2.1 × 5.5 × 11 mm to 2.5 × 5.5 × 9.5 mm

3 Getting to know the hardware

3.1 Board features

- 18 slider potentiometers to adjust the cells voltage between 1.2 V and 3.3 V. The maximum total voltage has been limited to 60 V.
- Three cells voltage can be inverted to apply voltages from −1.2 V to −3.3 V
- Maximum current capability per channel: 200 mA
- Three connectors for MC33774 evaluation boards connections
- Temperature sensor output voltage can vary from 0 V to +4.95 V to simulate negative temperature coefficient (NTC) sensor

3.2 Board functions

The board has been designed and optimized for the operating conditions described in Table 1 and Table 2. Usage of the board beyond these conditions can lead to malfunction and damage.

Table 1. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DDI(p)}$	power input supply voltage		4.5	5.5	V
$I_{DDI(p)}$	power input supply current	[1]	0.5	4	A
$I_{O(cell)}$	cell output current		-	200	mA
T_{amb}	ambient temperature		−10	+40	°C

[1] The maximum input supply current depends on the setup: number of boards connected, cells voltage, activated cell balancing channels; see Section 3.3.3.

Table 2. Electrical characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{O(cell)(min)}$	minimum cell output voltage	slider down	-	1.2	-	V
$V_{O(cell)(max)}$	maximum cell output voltage	slider up [1]	-	3.3	-	V
$V_{O(sen)t(min)}$	minimum temperature sensor output voltage	slider down	-	0	-	V
$V_{O(sen)t(max)}$	maximum temperature sensor output voltage	slider up	-	4.95	-	V
V_{isol}	isolation voltage	between input power supply and battery emulator outputs	-	1.5	-	kV

[1] With jumpers setting, it is possible to get negative voltages from −3.3 V to −1.2 V for cells 13, 8 and 4; see Section 3.3.4.

3.3 Board functional description

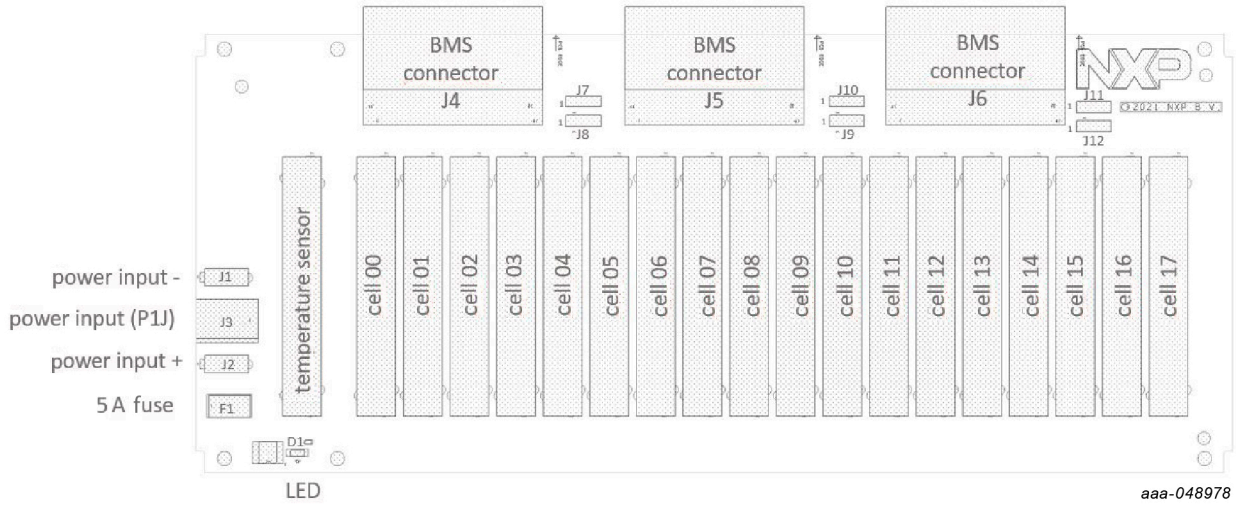

Figure 2. BATT-18EMULATOR board elements

3.3.1 Description

Each cell emulation is made of a 5 V to 5 V unregulated isolated DC-DC converter and an adjustable regulator. The regulator output voltage is set thanks to a voltage slider. Minimum voltage is 1.2 V and maximum is set to 3.3 V.

3.3.2 Connection and configuration

The emulator board requires a 5 V DC power supply with 5 A current capability. The power supply is connected to the board via J3 a Ø2.5 mm jack connector or using the 2 mm bananas J2(+) and J1(−). The center pin is connected to the positive voltage and the ring terminal to the ground. The input of the board is 5 A fuse protected. An LED allows the user to check that the board is powered up. If the voltage is present on the jack connector but the LED is off, then check the fuse F1.

Up to three evaluation boards RD33774ADSTEVB or one RD33774CNT3EVB can be connected using connectors J4, J5, and J6 with no specific order.

3.3.3 Current consumption

The slider pack should be supplied with a +5 V AC-DC adapter or with a lab supply. The required supply current depends on several parameters described below.

With no board connected, the default supply current on the 5 V primary is around 500 mA [19 × 28 mA (DC-DC typ supply current)].

One RD33774ADSTEVB board, communicating, no balancing activated, consumes around 10.5 mA. Then the total supply current required on the 5 V primary is around 700 mA [500 mA + (19 × 10.5 mA)].

If three boards are connected, then the supply current is 500 mA + (3 × 19 × 10.5 mA) = 1 A.

If cell balancing is activated, the primary current depends on the cell voltage, the balancing resistance, and the number of balancing metal-oxide-semiconductor field-effect transistor (MOSFET) activated.

On RD33774ADSTEVB, the balancing resistance is 22 Ω per cell balancing channel. With V_{cell} = 3.3 V, the peak balancing current is 150 mA peak, 75 mA average assuming a 50 % duty cycle. If N cell balancing MOSFETs are activated, then N × 75 mA are added to the primary current needed. If one board is connected and all 18 cell balancing MOSFETs are activated, then the total current is 700 mA + 18 × 75 mA = 2 A. Each individual channel (200 mA of current capability) has to provide 10.5 mA + 75 mA averaged or 10.5 mA + 150 mA peak.

Note: *The current is limited to 180 mA per channel. If several boards are connected, it is recommended to avoid to activate same cell balancing channels at the same time on all the boards.*

3.3.4 Cell polarity selection

Three pairs of jumpers allow the polarity to be reversed for cell polarities for cell4 (C5M − C4M), cell8 (C9M − C8M) and cell13 (C14M − C13M) therefore providing voltages between −1.2 V and −3.3 V; see Table 3.

Table 3. Cell voltage polarity selection

Cell polarity	Jumper positions
Cell4 positive polarity (default)	J7 1-2 (C4M) and J8 1-2 (C5M)
Cell4 negative polarity	J7 2-3 (C4M) and J8 2-3 (C5M)
Cell8 positive polarity (default)	J10 1-2 (C8M) and J9 1-2 (C9M)
Cell8 negative polarity	J10 2-3 (C8M) and J9 2-3 (C9M)
Cell13 positive voltage (default)	J11 1-2 (C14M) and J12 1-2 (C13M)
Cell13 negative voltage	J11 2-3 (C14M) and J12 2-3 (C13M)

Note: *Jumper selections should be done prior to supplying the BATT-18EMULATOR. Adjacent cell voltages are impacted when changing the polarities.*

3.3.5 External voltage injection

The three jumpers can also be used as injection points to inject voltages above slider ranges: −1.2 V < V_{inj} < +1.2 V or 3.3 V < V_{inj}, typically to evaluate MC33774 cell terminal measurements at very low voltage (busbars) or a high-voltage cell.

As example, to inject a voltage between C5M and C4M, remove jumper J8, keep jumper J7 1-2, and connect a floating supply between J8-2 and J7-1 or 2. Do not exceed maximum ratings and keep cell voltage in the range −5 V to +5 V.

3.3.6 Temperature sensor simulation

A separate slider allows the variation of the voltage across the temperature sensors.

The temperature sensor output voltage can vary from 0 V to +4.95 V. It can mimic the temperature variation from −48 °C to +200 °C of a 10 kΩ NTC sensor. This output voltage is connected to four different general-purpose input/output (GPIO) on the MC33774 (GPIO 1, 2, 7, 8) configured as ratiometric inputs with 10 kΩ pull-up resistors to VAUX (3.3 V typ.).

3.4 MC33774 board connections

Three 32 pins connectors (JAE Electronics MX34032NF2) J4, J5, J6 are connected in parallel as per the following schematic Figure 3. Up to three boards (for example, RD33774ADSTEVB) or one board RD33774CNT3EVB can be connected on any of these connectors.

Slider cell 0 is setting the voltage between C0M (cell0M) and C1M (cell0P), slider cell 1 is setting the voltage between C1M (cell1M) and C2M (cell1P), and so on, slider cell 17 is setting the voltage between C17M (cell17M) and C17P (cell17P).

C17P-PWR and GND (pin 21) are used to supply the RD33774ADSTEVB and are separated from C17P and C0M respectively to avoid any voltage drop due to the current consumption of the evaluation boards.

The slide temperature sensor is connected on pin 17 to pin 20 (NTC1, 2, 7 and 8 for RD33774DSTEVB).

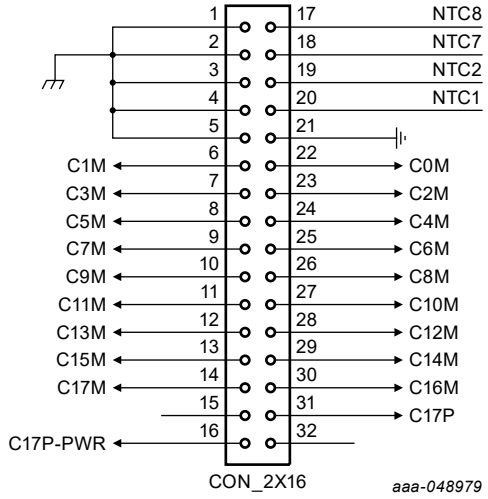

Figure 3. Cell connector schematic

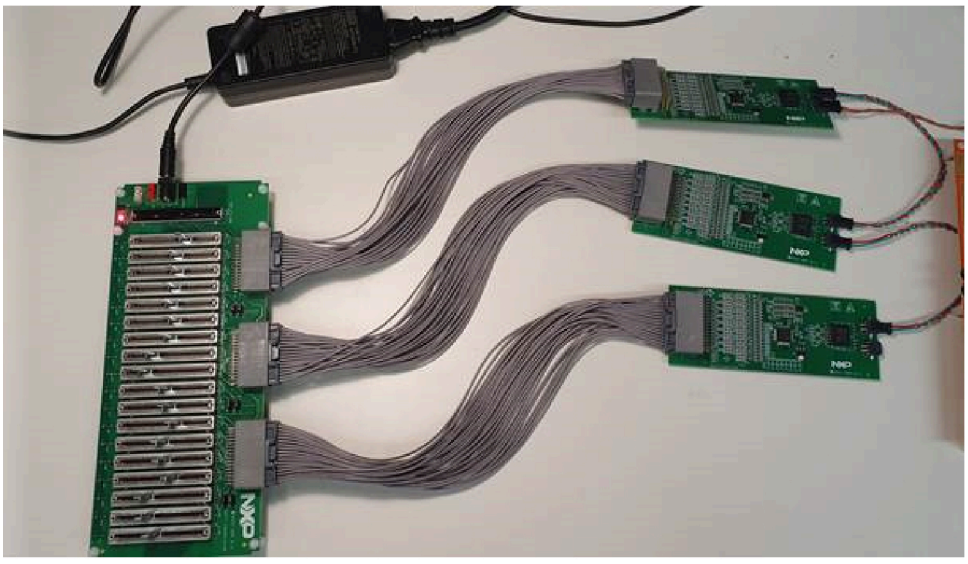

Figure 4. BATT-18EMULATOR connected to three RD33774DSTEVB

4 Schematic

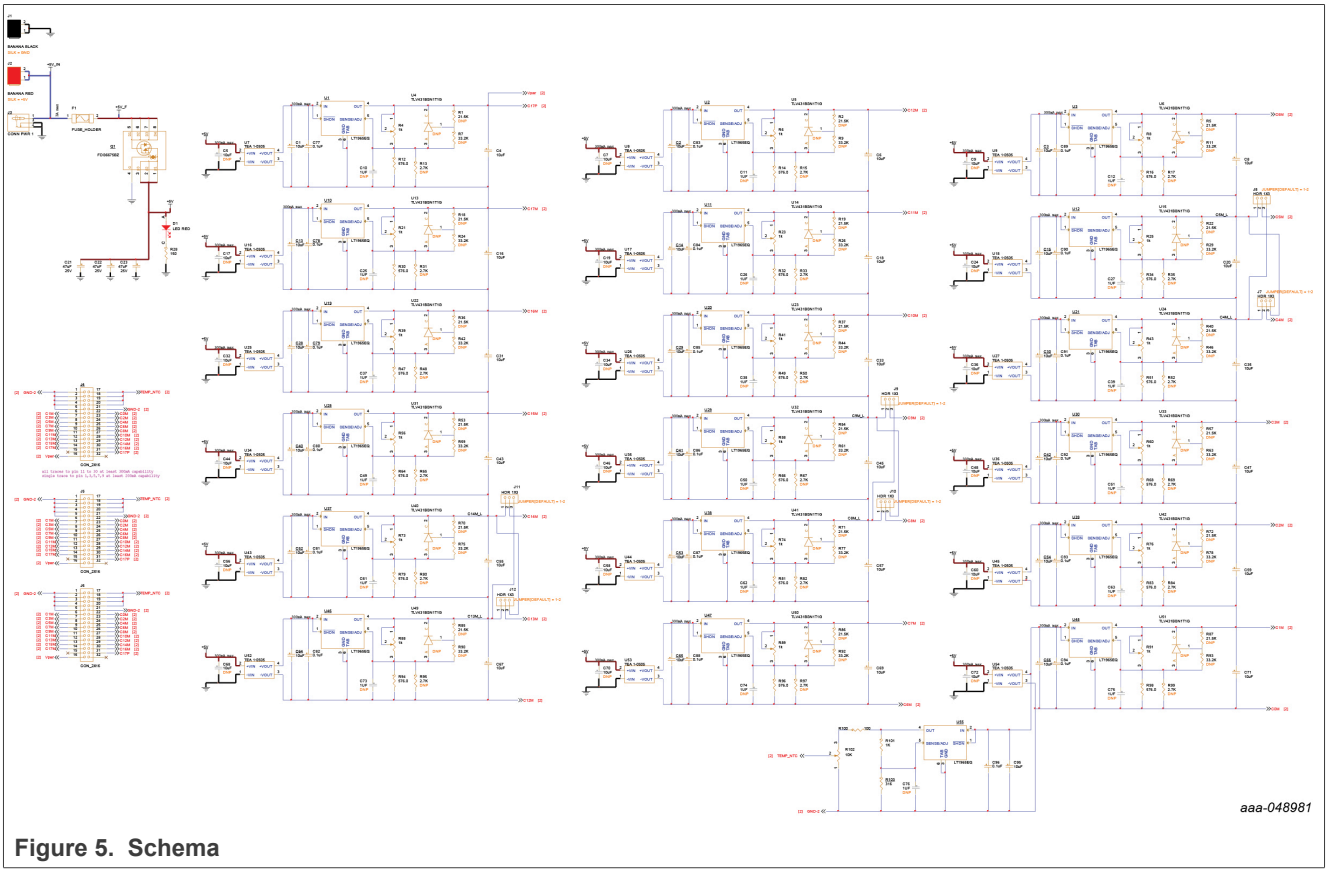

Figure 5. Schema

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