UG10341

EIS enablement package quick start guide

Rev. 1.0 — 24 October 2025 User guide

Document information

Information	Content
Keywords	Battery management system, BMS, electrochemical impedance spectroscopy, EIS
Abstract	This document aims to help getting started with the electrochemical impedance spectroscopy (EIS) software packages.

1 Intro

The battery in an electric vehicle typically accounts for **30 % to 40 % of the total vehicle cost**, making its longevity and reliability a critical factor. To ensure a long battery lifetime, **accurate monitoring of key parameters** such as voltage, current, and temperature is essential.

Traditionally, battery management systems (BMS) rely on **time-domain measurements**, where values are sampled at intervals from 1 Hz to 10 Hz. These measurements are processed using algorithms, often Kalman filters, to estimate the internal states of the battery cells. From these estimates, the system derives safe operating conditions for the next 30 seconds. However, these estimations often lack precision when it comes to **long-term performance and degradation**.

A promising enhancement is the integration of **electrochemical impedance spectroscopy (EIS)** into BMS. EIS enables analysis in the **frequency domain**. This approach allows for the evaluation of the **complex impedance** of the battery, offering deeper insights into the state of the battery.

The **NXP BMS solution** implements this approach with a modular architecture consisting of three specialized chips:

- **BMA6x02**: Provides accurate time synchronization across the system.
- **BMA7x18**: Measures the voltage of each individual cell.
- **BMA8420**: Measures the current of the entire battery pack.

These BMA7x18 and BMA8420 perform **on-chip transformation of high-speed measurements into the frequency domain**. This feature significantly reduces the computational load and memory usage of the main MCU. Also, this architecture lowers the data traffic on the isolated communication bus, which reduces the MCU loading even further.

EIS-based analysis enables:

- **State-of-health (SoH)**: More accurate tracking of degradation and failure conditions.
- **Temperature and gradients**: Estimation of internal cell temperatures.
- **Cell anomalies**: Early detection of internal failures, helping to prevent **thermal runaway incidents**.

These insights allow:

- **Faster charging**, by safely pushing thermal limits.
- **Extended driving range**, through improved state-of-charge (SoC) estimation.
- **Longer battery lifetime**, by optimizing usage based on more reliable health data.

2 Hardware setup

The NXP hardware setup for EIS consists of **three evaluation boards (EVBs)**, each integrating a dedicated BMS chip:

- **EVBMA6x02BMU**
  Hosts the **BMA6x02** chip, which is responsible for **time synchronization** across the system.
  An **S32K358 MCU**, powered by an **FS26 safety system basis chip (SBC)**, controls the BMA6x02 chip.
- **EVBMA8420DT**
  Contains the **BMA8420**, which measures the **battery pack current**.
- **EVBMA7x18DT1**
  Integrates the **BMA7x18**, which measures the **voltage of individual battery cells**.
  For systems with more than 18 cells, **multiple EVBMA7x18DT1 boards** can be daisy-chained.

In addition to these boards, an **excitation source** is required to perform EIS. NXP supports various excitation methods. For details on the supported excitation methods, refer to the detailed user guide.

The EIS measurement system is controlled via a **standard PC** using **NXP-provided software**. See Section 3 for details on the software (SW) setup. The PC connects to the **EVBMA6x02BMU** via an **FTDI USB-to-universal asynchronous receiver/transmitter (UART) cable**. This cable is included in the EVBMA6x02BMU package. The complete setup is shown in Figure 1.

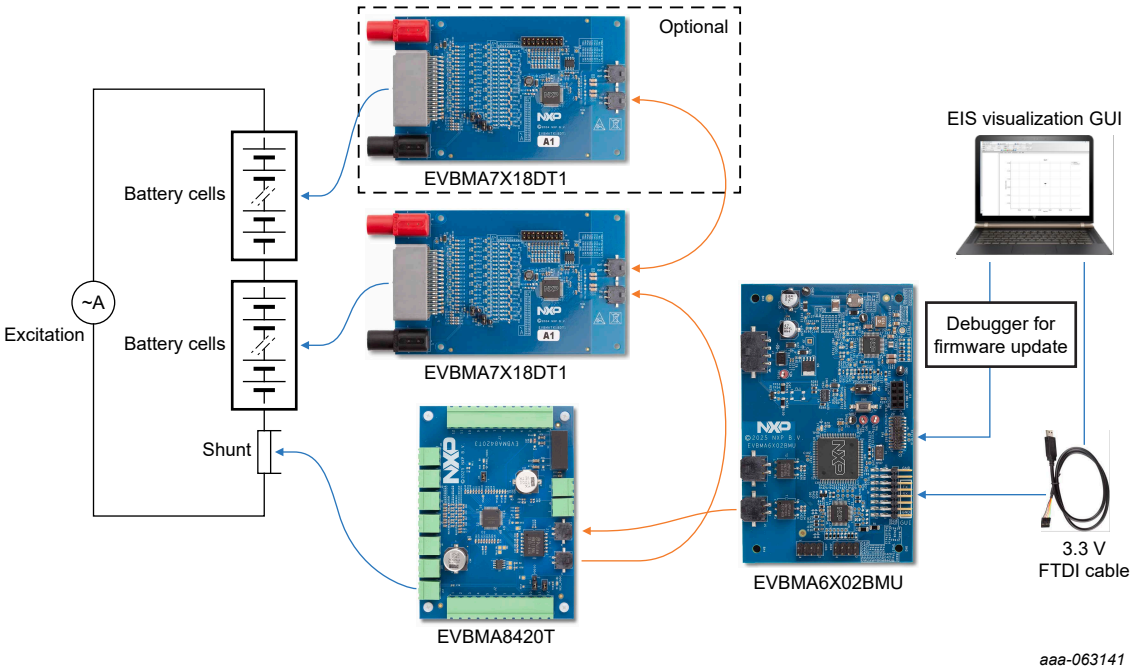


Figure 1. EIS enablement package system view

2.1 Connection of EVBMA7x18DT1

The EVBMA7x18DT1 evaluation board can be powered either via a laboratory power supply (connectors J7 and J8) or through a stack of battery cells (connector J1). Next to the supply, the boards must also be connected to the daisy chain.

- **Supply connection:**

1. **Laboratory power supply:**
   If the battery stack voltage of the devices under test is below 15 V (such as when testing a single cell) an external power source is required. It is recommended to use a laboratory power supply set to 20 V. Connect this supply to terminals J7 and J8.
2. **Battery stack connection:**
   Alternatively, the board can be connected directly to a real battery stack using connector J1. The pin configuration for this connector is detailed in the EVBMA7x18DT1 documentation.

Depending on the selected power supply method, additional printed-circuit board (PCB) modifications may be required. Refer to the detailed user guide.

- **Communication connection:**

Connectors J2 and J3 are used for daisy chain communication between multiple boards:

1. **J3** connects to the next lower EVBMA7x18DT1 board or to **J7** of the EVBMA8420T3 board.
2. **J2** connects to the next higher EVBMA7x18DT1 board.

Figure 2 shows position of the connectors of the EVBMA7x18DT1.

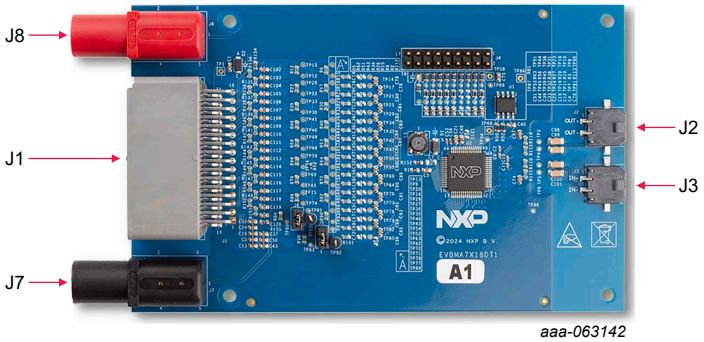


Figure 2. Connection of EVBMA7x18DT1

2.2 Connection of EVBMA8420T3

The EVBMA8420T3 evaluation board must be powered from J13. A 24 V power supply is recommended. Next to the supply, the boards must also be connected to the daisy chain. The connection to the shunt sensing the pack current is done via J3.

- **Supply connection:**

Connect a 24 V supply to **J13**.

- **Communication connection:**

Connectors J7 and J8 are used for daisy chain communication between multiple boards:

1. **J7** connects to the first EVBMA7x18DT1 board.
2. **J8** connects to the EVBMA6X02BMU board.

- **Shunt connection:**

To measure the battery pack current, the board interfaces with a shunt resistor. The connection to the shunt resistor is done with **J3**. Refer to the detailed user guide.

- **Excitation signal**

The BMA8420 can generate a pulse width modulation (PWM) signal for the excitation. This signal is routed to **J1-1**. Refer to the detailed user guide.

Figure 3 shows position of the connectors of the EVBMA8420T3 board.

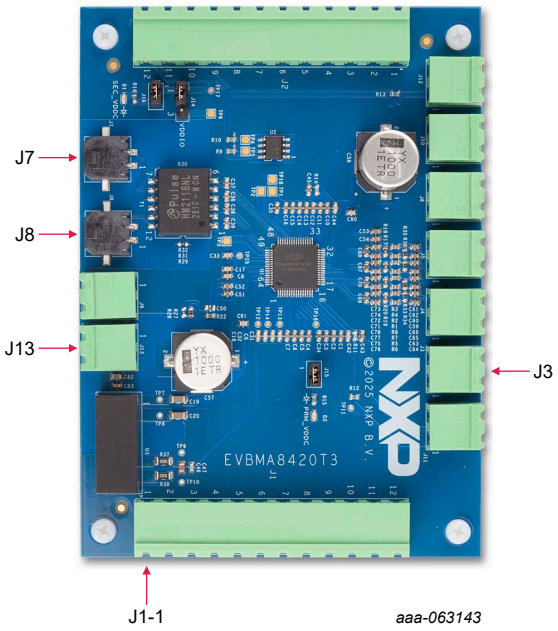


Figure 3. Connection of EVBMA8420T3

2.3 Connection of EVBMA6x02BMU

The EVBMA6x02BMU evaluation board must be powered from J1. A 12 V power supply is included as part of the EVBMA6x02BMU package. Next to the supply, the boards must also be connected to the daisy chain. The connection to the PC is established via J8 and the FTDI cable.

- **Supply connection:**

Connect a 12 V supply to **J1**.

- **Daisy chain communication connection:**

Connector **J5** is used to connect to the EVBMA8420T3.

- **Connection to the PC**

Connector **J8** is used to connect via the FTDI cable to the PC. Ensure that the connection is done as shown in Figure 5 using the lower connectors.

- **Programming interface**

J6 is a standard debug connector that allows flashing of the latest firmware into the MCU. Before first measurements are done, ensure that the latest firmware is downloaded to the MCU. Refer to the detailed user guide.

Figure 4 shows position of the connectors of the EVBMA6x02BMU board.

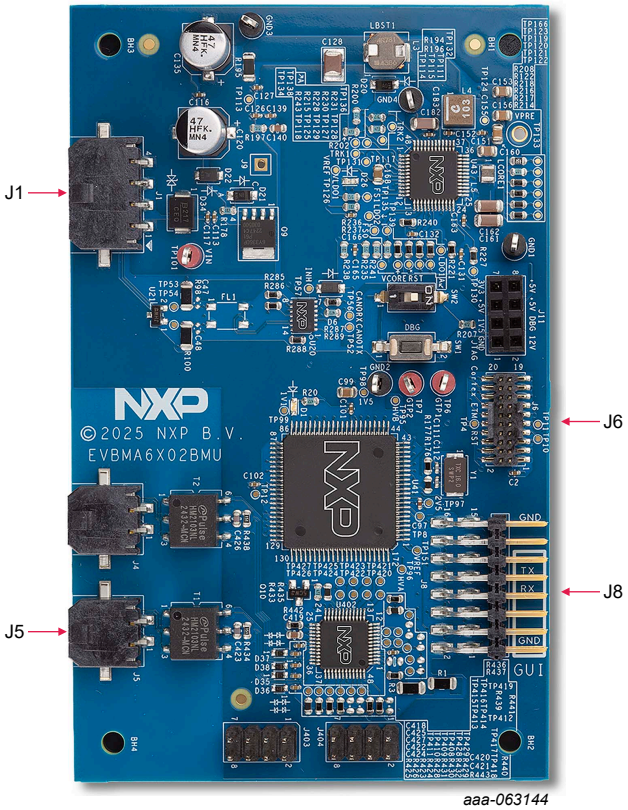


Figure 4. Connection of EVBMA6x02BMU

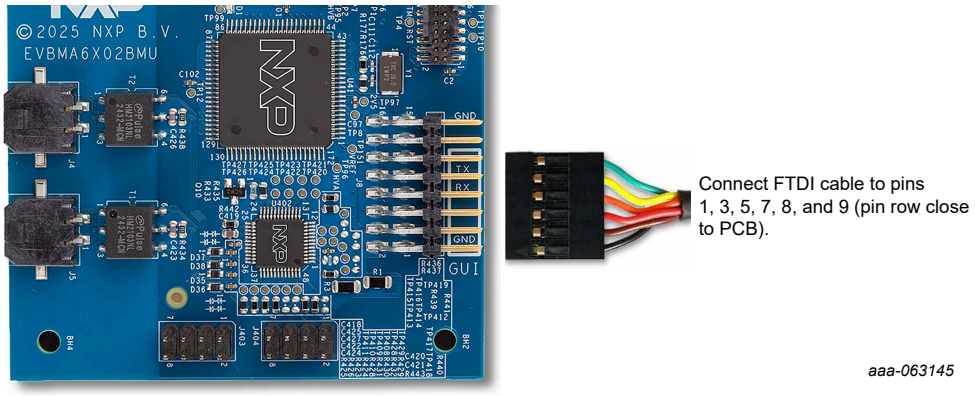


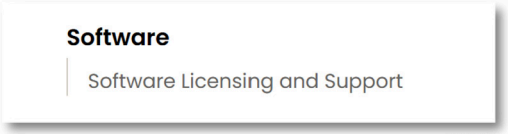
Figure 5. Connection of FTDI cable

3 Software setup

3.1 Getting the SW

To start with the EIS enablement package, the following steps must be performed:

1. Create an account at nxp.com (https://www.nxp.com)
2. Register for secure files at nxp.com (https://www.nxp.com/webapp-signup/register)
3. Log in to your registered account at nxp.com.
4. Locate software and licensing support and click on it.



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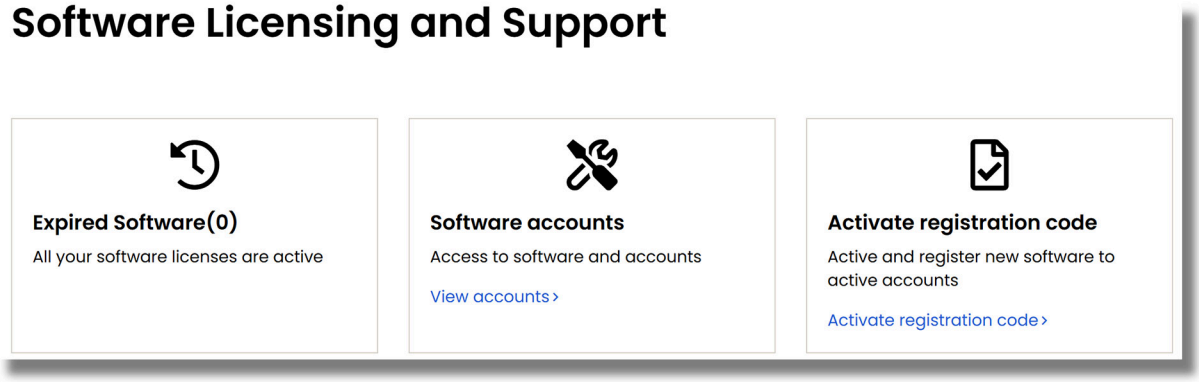
5. Click on activate registration code



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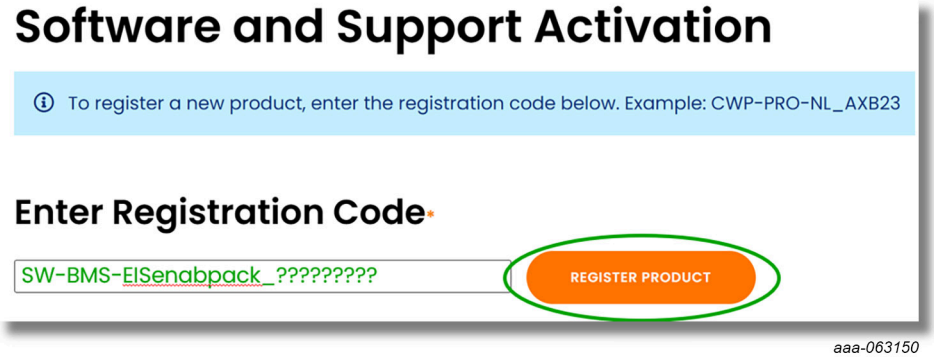
6. Enter your registration code and register it, to get this code contact your NXP representative.



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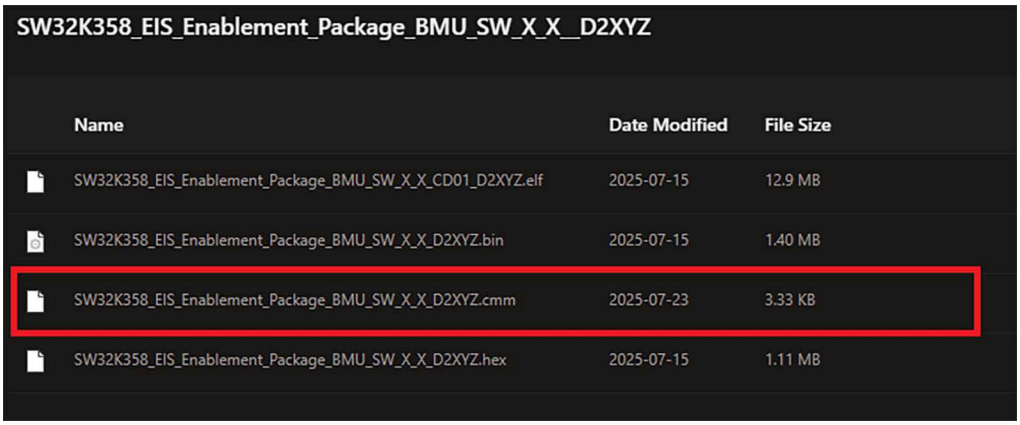
3.2 Prerequisites for starting the SW

1. Before running the GUI, it is recommended to flash the battery management unit (BMU) with the latest SW, using the highlighted cmm script with a Lauterbach debugger and T32 tools.



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2. Download and install FTDI cable drivers https://ftdichip.com/drivers/vcp-drivers/
3. Once the driver is installed and the cable is connected, the PC assigns it as a COM port. The GUI automatically detects the COM port.

3.3 SW start and first checklist

The GUI is started with the GUI.exe file located in the folder: SW32K358_EIS_Enablement_Package_GUI*

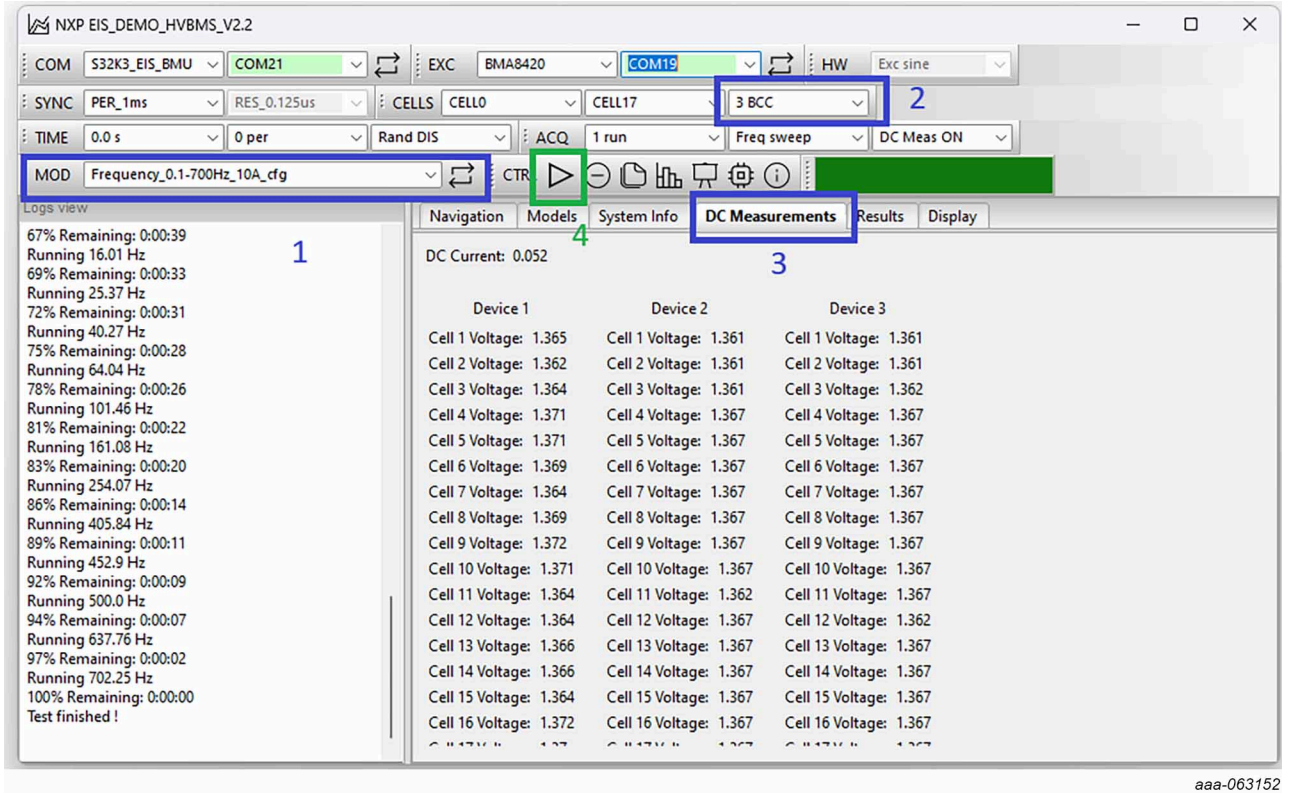

Figure 6. NXP EIS SW GUI screenshot with command elements explained

1. Select the default, or a user-defined model
2. Select the number of battery cell controller (BCC) that are connected in daisy chain
3. Check the DC measurements for each device for the configured cells
4. Run the model

As an extra validation step, measure with an oscilloscope the pin J1-1 from the EVBMA8420T3 board for excitation frequencies.

3.4 Connecting to the excitation HW

The EIS enablement package GUI provides two methods for controlling the excitation hardware:

Option 1 = BMA8420: In this mode, the BMA8420 IC generates an excitation control signal on general-purpose input/output (GPIO) PRM_IO6 with a 50 % duty cycle at the EIS frequency selected in the GUI. This signal can be used in two ways:

- Passive excitation: Connect the excitation control signal directly to a metal-oxide-semiconductor field-effect transistor (MOSFET) that switches a load connected to the battery. See the diagram below for an example.
- Active excitation: To deliver a controlled excitation current to the battery pack, route the excitation control signal to a current amplifier (for example, the 4-quadrant amplifier TOE7621).

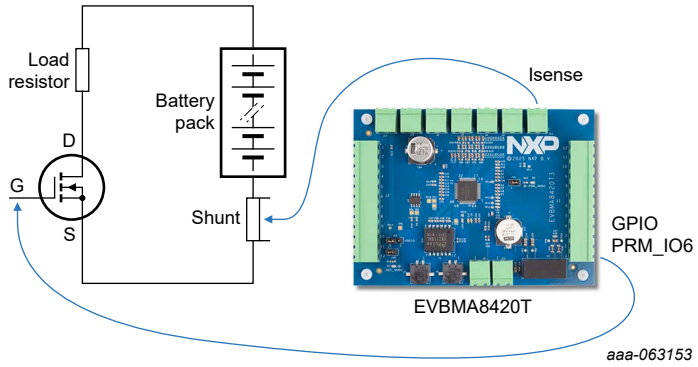

Figure 7. Example for passive excitation with BMA8420

Option 2 = Server: This mode allows the GUI to interface with external lab equipment via general-purpose interface bus (GPIB), Ethernet, controller area network (CAN) bus, or other communication protocols to control the excitation applied to the battery pack. Further details are available in the software documentation package.

Option 3 = BMA8420 + TAA3033: This mode assumes that the RDA8420TEIS0 is used as excitation source. The RDA8420TEIS0 replaces the EVBMA8420T3. On the RDA8402TEIS0, there is next to the BMA8420, an SPI connected TAA3033. The combination of both ICs may generate the excitation current signal for the whole battery system on pack level.

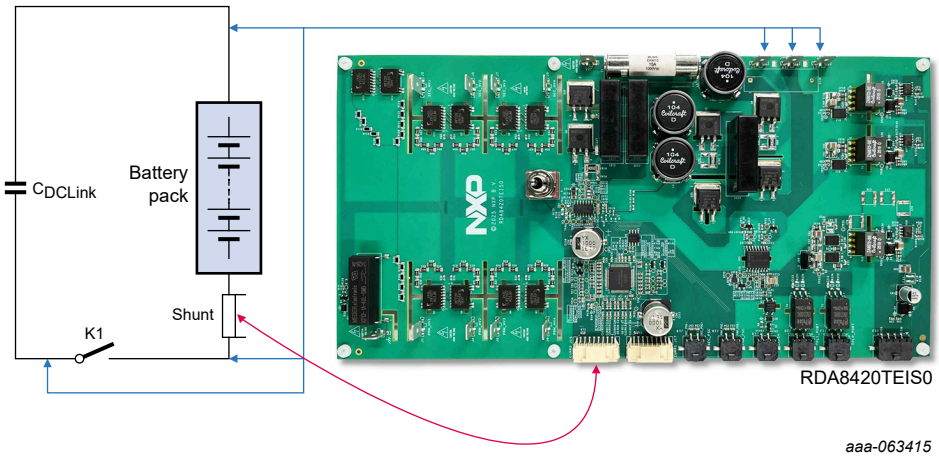

Figure 8. Connection of RDA8420TEIS0

4 References

The following references provide additional information:

1. EIS system webpage https://www.nxp.com/EIS
2. White paper on EIS
3. Detailed user guide for the enablement package https://www.nxp.com/design/design-center/software/battery-management-software-for-electrochemical-impedance-spectroscopy-eis:BMS-EIS-SW
4. Board page for the EVBMA7x18DT1 https://www.nxp.com/EVBMA7x18DT1
5. Board page for the EVBMA8420DT https://www.nxp.com/EVBMA8420DT
6. Board page for the EVBMA6x02BMU https://www.nxp.com/EVBMA6x02BMU
7. Product page for the BMA7418 https://www.nxp.com/BMA7418
8. Product page for the BMA8420 https://www.nxp.com/BMA8420
9. Product page for the BMA6x02 https://www.nxp.com/bma6x02
10. Board page for the RDA8420TEIS0 https://www.nxp.com/RDA8420TEIS0
11. Product page for the TAA3033 https://www.nxp.com/TAA3033

5 Revision history

Table 1. Revision history

Document ID	Release date	Description
UG10341 v.1.0	24 October 2025	initial version

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