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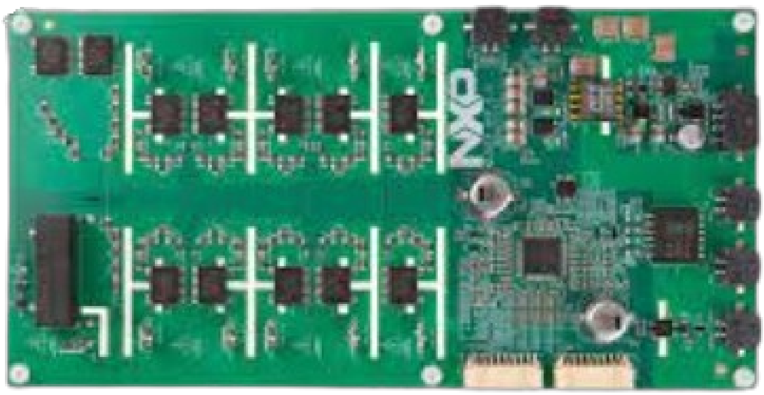
NXP RDA777T2 Battery Junction Box Reference Design



Document information

Information	Content

Keywords	battery junction box, high voltage, 800 V, measurement, isolation, current, contactor, shunt, accuracy, temperature

Abstract	This user manual targets the RDA777T2 board. It is a typical battery junction box (BJB) solution used in high-voltage battery management system (BMS).

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Introduction

NXP provides a BJB reference design (RD) to showcase the MC33777A. The reference design is used to quickly prototype the hardware and software of a high-voltage battery management system. The reference design showcases the latest generation of BJB controller IC. This document describes the reference design features.

Getting to know the hardware

Board features

The reference design offers the following features:

- Four current measurement channels with external shunt (from –300 mV to +300 mV)
- Eight positive high-voltage measurement inputs (from 0 V to +1000 V)
- Two bipolar high-voltage measurement inputs (from –1000 V to +1000 V)
- Isolation monitoring between high-voltage domains and low-voltage domains
- Two temperature measurement channels with an external negative temperature coefficient (NTC) resistor
- One isolated crash signal monitoring input
- Two pyrotechnic switch control outputs with independent energy reservoir capacitor
- One EEPROM for calibration data storage
- Galvanically isolated electrical transport protocol link (ETPL) for communication
- Galvanically isolated DC-DC converter to supply the board from the low-voltage section
- Printed-circuit board (PCB) designed according to IEC 60664 (pollution degree 2,

material group IIIa)

Connectors

Figure 1 shows the location of the connectors interfacing the reference design with a power supply, an emulator, or external instruments.

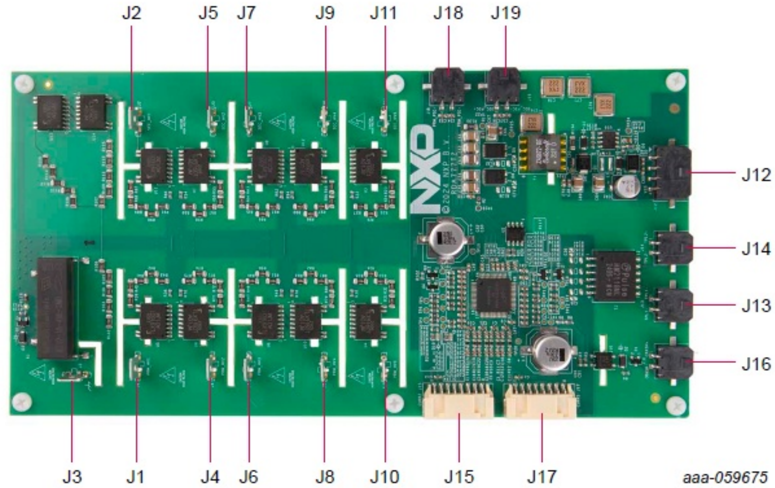

Figure 1. Connector location

Table 1. Connector description

Pin	Connection	Description
Power supply connector (J12)		
J12.1	+12 V	positive power supply terminal
J12.2	NC	not connected
J12.3	NC	not connected
J12.4	LV_GND	negative power supply terminal
ETPL communication (J13)		
J13.1	TPL1_P	ETPL positive input
J13.2	TPL1_N	ETPL negative input
ETPL communication (J14)		

J14.1	TPL2_P	ETPL positive input
J14.2	TPL2_N	ETPL negative input
Crash signal input (J16)		
J16.1	CRASH_P	crash signal positive input
J16.2	CRASH_N	crash signal reference ground
Primary pyrotechnic switch controller output (J18)		
J18.1	PRM_PSC_P	primary pyrotechnic switch controller high-side output
J18.2	PRM_PSC_N	primary pyrotechnic switch controller low-side output
Secondary pyrotechnic switch controller output (J19)		
J19.1	SEC_PSC_P	secondary pyrotechnic switch controller high-side output
J19.2	SEC_PSC_N	secondary pyrotechnic switch controller low-side output
High-voltage connections		
J1	PRM_HV_1	primary positive high-voltage input 1
J2	SEC_HV_1	secondary positive high-voltage input 1
J4	PRM_HV_2	primary positive high-voltage input 2
J5	SEC_HV_2	secondary positive high-voltage input 2
J6	PRM_HV_3	primary positive high-voltage input 3
J7	SEC_HV_3	secondary positive high-voltage input 3

J8	PRM_HV_4	primary positive high-voltage input 4
J9	SEC_HV_4	secondary positive high-voltage input 4
J10	PRM_HV_5	primary bipolar high-voltage input 5
J11	SEC_HV_5	secondary bipolar high-voltage input 5
J3	chassis	chassis input for isolation measurement
First current and temperature measurement connection (J15)		
J15.1	NTC_P	external NTC resistor positive input
J15.2	HV_GND	external NTC resistor negative input
J15.3	HV_GND	ground

Pin	**Connection**	**Description**
J15.4	PRM_ISENSE_P	primary ISENSE positive input
J15.5	PRM_ISENSE_N	primary ISENSE negative input
J15.6	HV_GND	ground
J15.7	SEC_ISENSE_P	secondary ISENSE positive input
J15.8	SEC_ISENSE_N	secondary ISENSE negative input
Second current and temperature measurement connection (J17)		
J17.1	NTC_P	external NTC resistor positive input
J17.2	HV_GND	external NTC resistor negative input
J17.3	HV_GND	ground
J17.4	PRM_VISENSE_P	primary VISENSE positive input

J17.5	PRM_VISENSE_N	primary VISENSE negative input
J17.6	HV_GND	ground
J17.7	SEC_VISENSE_P	secondary VISENSE positive input
J17.8	SEC_VISENSE_N	secondary VISENSE negative input

Table 2 lists the reference of the connectors and their mating part number.

Table 2. Connector part number

Connector	Manufacturer	Part number	Mating connector
J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11	TE Connectivity	63824-1	2-520405-2
J13, J14, J16, J18, J19	Molex	436500213	436450200
J12	Molex	0436500413	436450400
J15, J17	Molex	5023520800	5023510800

LEDs

The battery junction box embeds two LEDs: D10 and D11. They are switched on when the MC33777A is in active mode.

Kit contents

Table 3 lists the components included in the kit.

Table 3. Kit contents

Description	Quantity
ETPL communication cable	1

Power supply cable	1
High-voltage measurement cable (orange)	10
Chassis connection cable (black)	1
Two-point general-purpose cable (pyrotechnic switch connection, crash signal connection)	4
Current measurement and temperature measurement cable	2

Extra hardware

The RDA777T2 requires an external +12 V power supply (see Section 3.1). The following equipment can also ease the evaluation:

- ETPL communication board (KIT-PC2TPLEVB)
- Battery junction box emulator to emulate the high voltages, the battery current, and the pyrotechnic switch controllers (PACK-BJBEMUL)
- High-voltage source
- High-current source coupled with a shunt resistor

Configure the hardware

This section describes the typical setup to configure the RDA777T2 and to evaluate the MC33777A key features. It uses a PACK-BJBEMUL to emulate the voltages, the battery current, and the pyrotechnic switches. Any other external equipment can replace the optional board. The setup shows a KIT-PC2TPLEVB board to interface the MC33777A with the computer via NXP software tools (for example, BMS Script GUI).

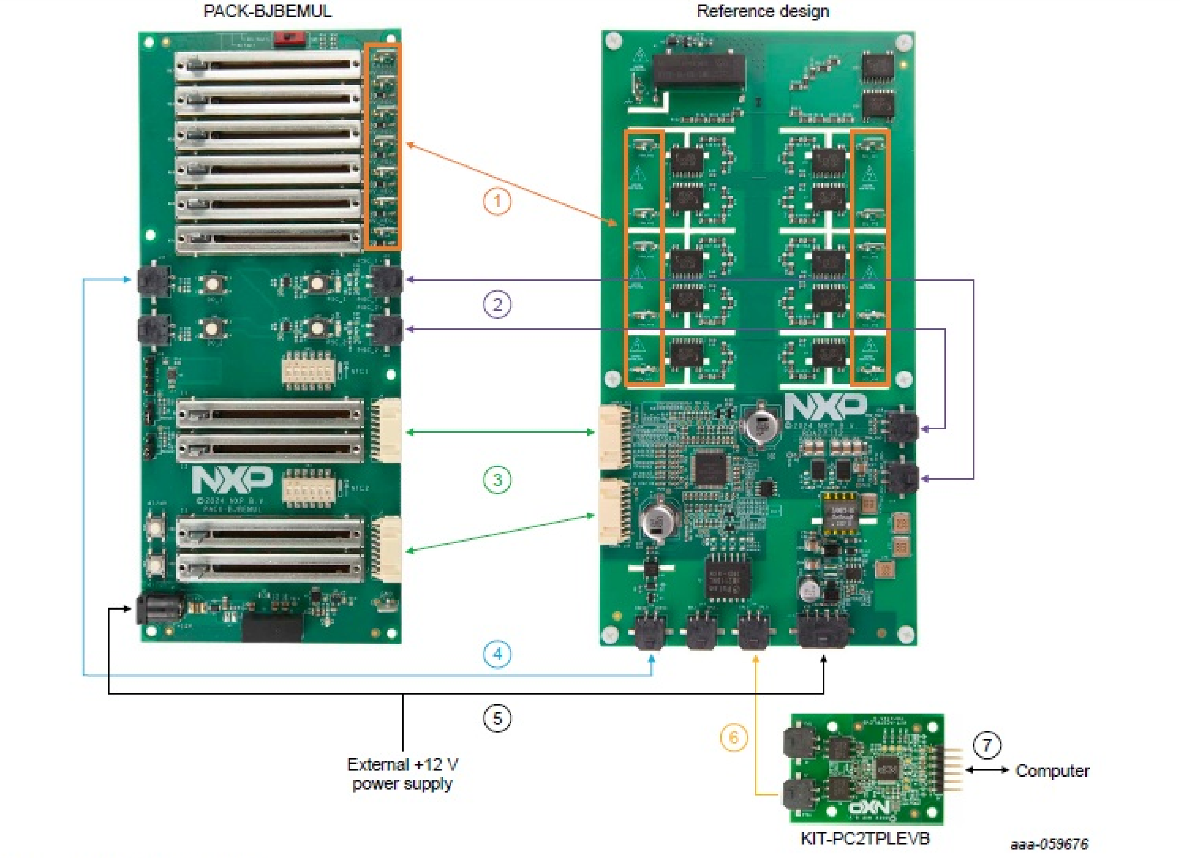

Figure 2. Hardware setup

Table 4 lists the material required to set up the test.

Table 4. Bill of materials

Identifier	Description	Comment
RDA777T2	battery junction box reference design	
PACK-BJBEMUL	battery junction box emulator	
KIT-PC2TPLEVB	communication board	
1	voltage measurement cable	included in the kit
2	pyrotechnic switch cable	included in the kit
3	current and temperature measurement cable	included in the kit

4	crash signal cable	included in the kit
5	power supply cable	included in the kit
6	ETPL communication cable	included in the kit
7	USB to universal asynchronous receiver/transmitter (UART) cable	included in the KIT-PC2TPLEVB kit

Feature description

Power supply

The reference design usually receives power from the battery management unit (BMU) on the connector J12. The power supply must follow the characteristics described in Table 5.

Table 5. Power supply characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VCC	supply voltage		6	12	35	V
ICC	supply current	12 V output voltage, RDA777T2 in active mode	500	–	–	mA

The BMU is in the low-voltage domain, whereas the BJB is in the high-voltage domain. Therefore, the RDA777T2 embeds an isolated DC-DC converter to power the MC33777A and the external circuitry. The converter provides a 1.5 kV isolation.

Current measurement

- The RDA777T2 measures up to four currents.
- For typical use cases, two channels are sufficient to measure redundantly the battery current to meet ASIL D safety goals.

- For more complex systems (for example, switched battery packs with two separate current measurements), the reference design offers two extra current measurement channels.

Current measurement characteristics

The user can connect to current measurement inputs to:

- A shunt resistor to measure the current flowing in it
- An external voltage source emulating the shunt resistor voltage drop

Table 6 lists the current measurement input characteristics.

Table 6. Current measurement characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Vpin	pin voltage	voltage from P pin or N pin relatively to GND	–300	–	+300	mV
Vdif	differential voltage	voltage from P pin relatively to N pin	–300	–	+300	mV

The board follows the MC33777A data sheet regarding the required external components.

Current measurement connection

The RDA777T2 measures the current on the following MC33777A inputs:

Table 7. Current measurement channel allocation

Current measurement	MC33777A measurement lines
Primary ISENSE inputs	PRM_ISENSEP and PRM_ISENSEN

Primary VISENSE inputs	PRM_VISENSEP and PRM_VISENSEN
Secondary ISENSE inputs	SEC_ISENSEP and SEC_ISENSEN
Secondary VISENSE inputs	SEC_VISENSEP and SEC_VISENSEN

The current measurement connector also offers MC33777A ground connections. The ground lines are separated from the measurement lines. It removes the current in the positive/negative lines and improves the accuracy.

The user can evaluate the current measurement with two methods:

- Applying a current in a shunt resistor
- Using an external voltage source

Figure 3 shows an example of a connection on a shunt resistor.

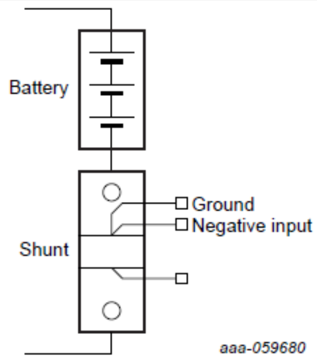

Figure 3. Current measurement with a shunt resistor

- The positive and negative lines are connected on both sides of the shunt sensing element. Inverting the orientation of the lines simply inverts the polarity of the current measurement.
- In the given example, a battery discharge current gives a positive measurement. A battery charge current gives a negative measurement.
- The user must connect the ground line to any side of the shunt resistors. It ensures that the shunt common mode voltage meets the MC33777A input range.

Figure 4 shows an example of a connection with a voltage source.

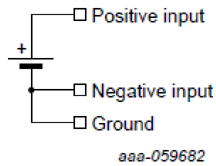

Figure 4. Current measurement with a voltage source

- To evaluate the current measurement, the user can also connect a voltage source to the inputs. Then, there is no need for a high-voltage battery or a high-current source.
- The positive and negative lines are connected on both sides of the voltage source. Inverting the orientation of the lines simply inverts the polarity of the current measurement.
- The user must connect the ground line to any side of the voltage source. It ensures that the common mode voltage meets the MC33777A input range.

Current measurement conversion

- The MC33777A automatically converts the input voltage measurement to a current value (more information is available in the device reference manual).
- The user must configure the sensor current to voltage ratio in a register (for example, the external shunt conductance).

Temperature measurement

- The RDA777T2 measures two temperatures with external NTC resistors. The user has the possibility to place the NTC resistor close to the shunt resistor to measure its temperature.

Temperature measurement characteristics

Table 8 describes the characteristics of the temperature measurement feature.

Table 8. Temperature measurement characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VREF5V0	biasing voltage		–	5	–	V

Rpu	pull-up resistance		–	10	–	kΩ
RNTC (ext)	external NTC resistance	T_{amb} = 25 °C	–	10	–	kΩ

Temperature measurement circuit description

- The user can directly connect the external NTC resistor between the two dedicated pins on the current measurement connector.
- The temperature measurement circuitry follows the MC33777A data sheet recommendations.

The RDA777T2 measures the temperature on the following inputs:

Table 9. Temperature measurement channel allocation

Temperature measurement	MC33777A input
Primary temperature measurement	PRM_IO6
Secondary temperature measurement	SEC_IO6

The MC33777A outputs a 5 V source to bias the NTC resistor. To improve the accuracy of the measurement, the user must configure the analog input for ratiometric measurements.

Temperature measurement conversion

With the analog input configured for ratiometric measurements, the MC33777A returns a ratio of the biasing voltage.

The system controller can calculate the NTC value using the following equation:

$$R_{NTC} = R_{TC} \times \frac{RESULT \times \Delta_{res(ratio\text{-}io)}}{1\text{-}RESULT \times \Delta_{res(ratio\text{-}io)}}$$

Where:

- RNTC is the result of the NTC calculation in Ω
- RTC is the pullup resistor in Ω
- RESULT is the result of the analog-to-digital converter (ADC) measurement (16-bit value)
- Δres(ratio-io) is the ratiometric measurement resolution (see MC33777A data sheet)

Then, the controller can compute the temperature by using the NTC resistor data sheet (for example: calculation with β coefficient, or with look-up table).

High-voltage measurement

The RDA777T2 measures several high voltages in the system. The BMU can compute the result and proceed, for instance, to contactor monitoring.

High-voltage measurement characteristic

Table 10 describes the high-voltage measurement characteristics.

Table 10. High-voltage measurement characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_D	off-state voltage	high-voltage switch disabled	–1500	–	+1500	V
Vh v+	positive voltage measurement range	high-voltage switch enabled	0	–	1000	V
Vhv-	bipolar voltage measurement range	high-voltage switch enabled	–1000	–	+1000	V
f-3dB	cut-off frequency		–	340	–	Hz

t_s	settling time		–	3	–	ms

High-voltage measurement circuit description

The RDA777T2 measures up to ten high voltages in the system.

The eight positive inputs typically monitor the voltage across the high-side contactors and high-side fuses (for example, a contactor between the battery positive terminal and the inverter positive terminal). These inputs accept high voltages meeting Vhv+. Two inputs (one primary and another secondary) can monitor the same point to provide redundancy and increase the overall safety integrity level. The two bipolar inputs typically monitor the voltage across the low-side contactors (for example, a contactor between the battery negative terminal and the charger negative terminal). These inputs accept high voltages meeting Vhv-.

Figure 5 describes the circuitry of positive and bipolar high-voltage measurement paths.

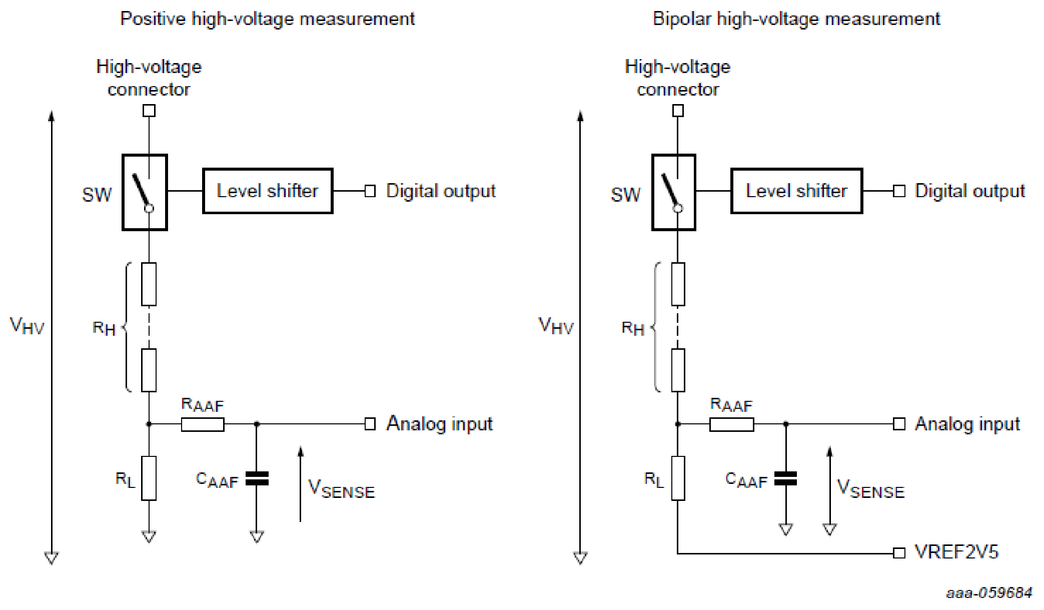

Figure 5. High-voltage measurement circuitry

- To reduce the leakage current in the resistors when there is no measurement, a high-voltage switch can disconnect the bridge. An MC33777A digital output controls this switch.
- A voltage divider divides the high voltage down to the device input voltage range. The resistors forming RH must withstand the high voltage.

- To avoid leakages due to the high voltage, the board has to ensure a big enough creepage distance between the different nodes. The cuttings in the PCB increase the creepage distance. The cuttings are optional when using coating or with lower voltages.
- For bipolar voltage measurement, the MC33777A outputs a 2.5 V reference. It shifts the output of the resistor bridge to half of the MC33777A input voltage range. The device can do a differential measurement between the output of the divider and the reference.
- An analog anti-aliasing filter improves the noise performance. Due to the filter and the switch circuitry response time, the controller must wait ts before starting a voltage measurement.

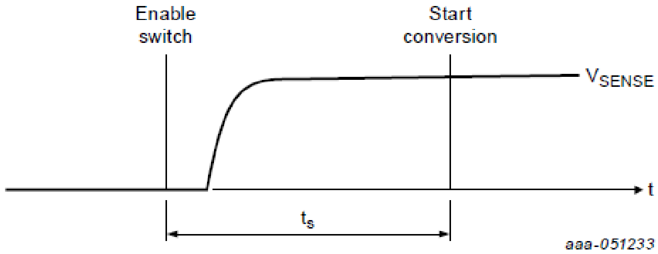

Figure 6. High-voltage measurement settling time

The MC33777A measures the divided voltage. To improve the accuracy, the user must configure the analog input as:

- Absolute mode (for positive measurements)
- Differential mode versus 2.5 V reference (for bipolar measurements)

High-voltage measurement channel allocation

Table 11 describes the RDA777T2 high-voltage measurement channel allocation.

Table 11. Channel allocation

High-voltage measurement	MC33777A measurement input	High-voltage switch control signal
Primary positive high-voltage input 1	PRM_IO1	

Primary positive high-voltage input 2	PRM_IO2	PRM_IO0
Primary positive high-voltage input 3	PRM_IO3	
Primary positive high-voltage input 4	PRM_IO4	
Primary bipolar high-voltage input 5	PRM_IO5	
Secondary positive high-voltage input 1	SEC_IO1	SEC_IO0
Secondary positive high-voltage input 2	SEC_IO2	
Secondary positive high-voltage input 3	SEC_IO3	
Secondary positive high-voltage input 4	SEC_IO4	
Secondary bipolar high-voltage input 5	SEC_IO5	

Positive-voltage measurement conversion

For positive-voltage measurements, the voltage divider is referenced to the MC33777A ground. The device directly measures the output voltage of the divider as:

$$V_{SENSE} = V_{ADC} = V_{HV} \times \frac{R_L}{R_L + R_H}$$

Then, the controller can compute the high-voltage measurement as:

$$V_{HV} = V_{ADC} \times \frac{R_L}{R_L + R_H} = RESULT \times V_{res(abs\text{-}io)} \times \frac{R_L}{R_L + R_H}$$

With:

- VHV is the high voltage to measure in V
- VSENSE is the output of the voltage divider in V
- VADC is the device measurement in V
- RL is the low-side divider resistor equal to 10 kΩ
- RH is the high-side divider resistor equal to 2.1 MΩ
- RESULT is the device measurement result (16-bit number)
- Vres(abs-io) is the device measurement resolution equal to 154 µV/LSB

Bipolar-voltage measurement conversion

For bipolar-voltage measurements, the voltage divider is referenced to the MC33777A 2.5 V reference. The output voltage of the divider is:

$$V_{SENSE} = V_{HV} \times \frac{R_L}{R_L + R_H} + V_{REF} \times \frac{R_H}{R_L + R_H}$$

The device runs a differential measurement between the output of the divider and the 2.5 V reference:

$$V_{ADC} = V_{SENSE} - V_{REF} = \left(V_{HV} - V_{REF}\right) \times \frac{R_L}{R_L + R_H}$$

Then, the controller can calculate the high-voltage measurement as:

$$V_{HV} = V_{ADC} \times \frac{R_L + R_H}{R_L} + V_{REF} = RESULT \times V_{res(v2v5\text{-}io)} \times \frac{R_L + R_H}{R_L} + V_{REF}$$

With:

- VHV is the high voltage to measure in V
- VSENSE is the output of the voltage divider in V

- VADC is the device measurement in V
- RL is the low-side divider resistor equal to 4.7 kΩ
- RH is the high-side divider resistor equal to 2.1 MΩ
- RESULT is the device measurement result (16-bit number)
- Vres(v2v5-io) is the device measurement resolution equal to 154 µV/LSB

Adapting circuitry for low-voltage measurements

- Using a low-voltage source can ease the RDA777T2 evaluation. However, as the board typically measures high voltages, the user can adapt the circuitry.
- The simplest solution is to change the low-side divider resistor (RL). By choosing a higher value resistor, the divider ratio increases.
- The time constant of the anti-aliasing filter depends on the divider impedance. To keep the same cut-off frequency, the user can adapt the capacitor of the filter (CAAF) along with RL.
- Table 12 presents typical values for RL and CAAF to measure low voltage. Following these values ensures meeting the MC33777A measurement range.

Table 12. Component value to measure low voltage

Low voltage to measure	Positive measurement channel		Bipolar measurement channel	
	R_L	CAAF	R_L	CAAF
12 V	1.3 MΩ	680 pF	470 kΩ	1.5 nF
24 V	470 kΩ	1.5 nF	220 kΩ	2.2 nF
48 V	220 kΩ	2.2 nF	100 kΩ	4.7 nF

The user must clearly identify the modified boards. Applying high voltage to a modified board can lead to injuries and permanent damage to the board.

Isolation monitoring

The RDA777T2 is in between the low-voltage section (car chassis, +12 V battery) and the high-voltage section (high-voltage battery, inverter) of the car. The board embeds the circuitry to monitor the isolation between the two sections. It helps to detect any isolation failure that could put the car user in danger.

Note: The RDA777T2 provides the isolation monitoring circuitry as an example to demonstrate the usage. The example has not undergone extensive testing in production. NXP advises the user to evaluate its suitability for their specific use cases.

Isolation monitoring characteristics

Table 13 describes the characteristics of the isolation monitoring feature.

Table 13. Isolation monitoring characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VD(chassis)(max)	maximum chassis off-state voltage	high-voltage switch disabled	–3000	–	+3000	V
t_s	settling time	excluding external capacitors	–	10	–	ms

Isolation monitoring circuit description

Figure 7 describes the isolation monitoring circuitry.

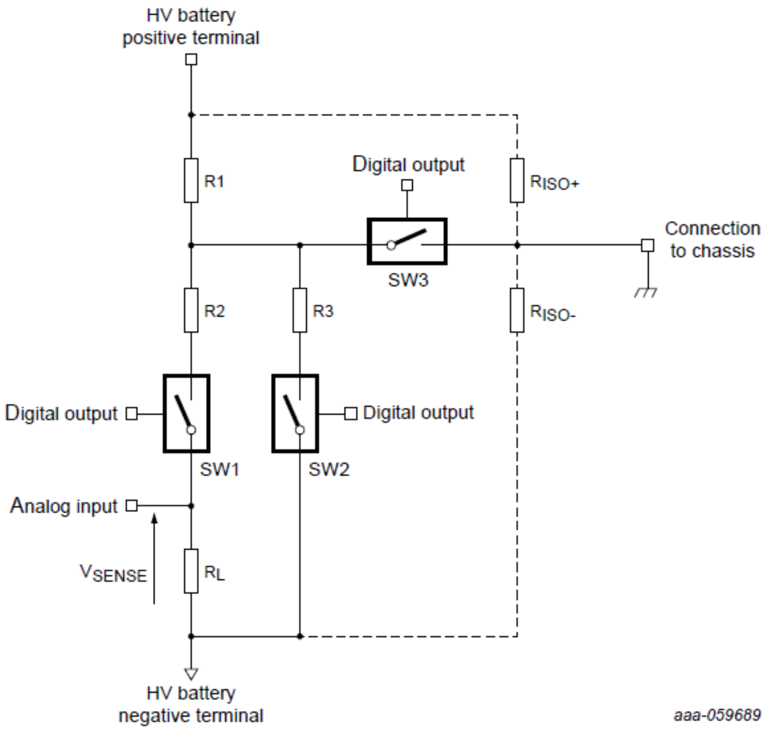

Figure 7. Isolation monitoring circuitry

This feature aims to evaluate the value of the equivalent resistance between:

- The battery positive terminal and the chassis (RISO+)
- The battery negative terminal and the chassis (RISO-)

A high-voltage switch (SW3) connects the chassis to the circuit before measuring. As the measurement resistors are high enough, closing SW3 does not lead to an isolation failure and does not put the car user in danger. Another high-voltage switch (SW1) disconnects the resistor bridge to reduce the leakage current on the high-voltage battery when there is no measurement.

The circuit has to measure two resistors (RISO+ and RISO-). Two voltage measurements are necessary to solve this two-unknown equation. The first measurement involves R1, R2, and RL. Enabling R3 (with SW2) allows getting a second voltage measurement. Section 3.5.3 describes the measurement sequence.

The output voltage (VSENSE) depends on the measurement circuitry (R1, R2, RL, and R3 if enabled), the battery voltage, and the isolation resistors. The MC33777A measures this voltage. To improve the accuracy, the user must configure the analog input for absolute measurements.

Table 14 describes the allocation of the MC33777A inputs and outputs for isolation monitoring.

Table 14. Isolation monitoring channel allocation

Function	Channel
SW1 control	PRM_IO0
SW2 control	GPIO1
SW3 control	GPIO0
V_{SENSE} measurement	PRM_IO7

Due to the switch circuitry response time, the BMU must wait ts before starting each voltage measurement. After running the sequence, the BMU computes the voltage measurements to determine the isolation resistors as explained in Section 3.5.4.

Isolation monitoring sequence

Table 15 describes the steps of the isolation monitoring sequence.

Table 15. Isolation monitoring sequence

Step	Description
1	measure the battery voltage as explained in Section 3.4
2	convert the high-voltage measurement (as explained in Section 3.4.4); name the result V_{BAT}
3	close SW3
4	close SW1
5	wait t_s
6	measure V_{SENSE}

7	convert the voltage measurement (as explained in Section 3.5.4); name the r esult V_1
8	close SW2
9	wait t_s
10	measure V_{SENSE}
11	convert the voltage measurement (as explained in Section 3.5.4); name the r esult V_2
12	open SW1, SW2, and SW3
13	to calculate the isolation resistors, compute the V_{BAT}, V_1, and V_2 (as explaine d in Section 3.5.4)

Isolation monitoring conversion

During the isolation monitoring sequence, the MC33777A proceeds to voltage measurements. The IC returns a 16-bit. The controller computes the result in V following below equation:

$$V_{\text{meas}} = RESULT \times V_{res(abs\text{-}io)}$$

Where:

- Vmeas is the MC33777A input voltage, measured by the ADC, in V
- RESULT is the result of the ADC conversion
- Vres(abs-io) is the device measurement resolution equal to 154 µV/LSB

Once the sequence is over, the controller computes the measurements to calculate the isolation resistors. To ease the calculation, the formula uses the conductance instead of the resistance.

The below equation describes the relationship between resistance and conductance.

$$Y_X = \frac{1}{R_X}$$

Where:

- YX is the conductance in S
- RX is the resistance in Ω

The formula expressing the isolation resistances in function of the measurements is as follows:

$$\begin{cases} Y_{ISO+} = \frac{-V_1 \times V_2}{V_{BAT} \times (V_2 - V_1)} \times \frac{Y_3 \times (Y_L + Y_2)}{Y_2} - Y_1 \\ Y_{ISO-} = -Y_{ISO+} - Y_1 - \frac{Y_L \times Y_2}{Y_L + Y_2} - Y_3 \times \frac{V_2}{V_2 - V_1} \end{cases}$$

Where:

- YISO+ is the conductance of the positive isolation resistance in S
- YISO- is the conductance of the negative isolation resistance in S
- VBAT is the converted high-voltage measurement of the battery in V
- V1 is the first converted voltage measurement of the sequence in V
- V2 is the second converted voltage measurement of the sequence in V
- YL, Y1, Y2, and Y3 are the conductances of the measurement resistors in S Table 16 describes the conversion parameters of the RDA777T2.

Table 16. Isolation measurement conversion parameters

Parameter	Value

R_L	24 kΩ
R_1	4.03 MΩ
R_2	4.03 MΩ
R_3	685 kΩ

Crash signal monitoring

The RDA777T2 monitors an isolated digital signal. It can be a crash signal coming from the low-voltage section. Then, the MC33777A can trigger a reaction (for example, pyrotechnic switch controller) based on the signal state.

Crash signal monitoring characteristics

Table 17 describes the crash signal monitoring characteristics.

Table 17. Crash signal monitoring characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Vi(range)	input voltage range		0	–	12	V
Vth	threshold voltage	input signal low/high or high/low	–	2.5	–	V
VHV	high voltage	RMS value; primary to secondary isolation; ensured by VOMA617A-4X001T	–	3750	–	V

Crash signal monitoring circuitry

Figure 8 describes the crash signal monitoring circuitry.

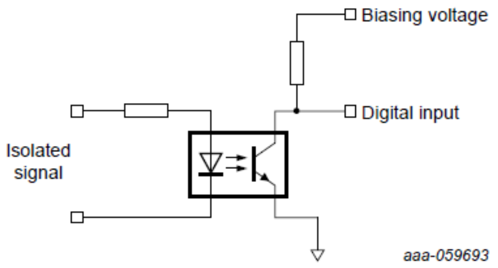

Figure 8. Crash signal monitoring circuitry

The circuitry accepts any voltage meeting Vin. An optocoupler isolates the signal and forwards the information to the MC33777A. The device outputs a 5 V biasing voltage and monitors the signal on a digital input.

The circuitry inverts the signal:

- An input signal lower than Vth results in a high-level reading
- An input signal higher than Vth results in a low-level reading Table 18 describes the channel allocation.

Table 18. Crash signal monitoring channel allocation

Function	Channel
Biasing voltage	SEC_VREF5V0
Digital input	SEC_IO7

Pyrotechnic switch control

The RDA777T2 supports the driving of two pyrotechnic switches, with the MC33777A independent pyrotechnic switch controllers.

Pyrotechnic switch control characteristics

Table 19 describes the pyrotechnic switch control characteristics.

Table 19. Pyrotechnic switch control characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
CER	energy reservoir capacitance	primary capacitor and secondary capacitor	–	1000	–	µF
VCER	energy reservoir capacitor voltage	see MC33777A data sheet	–	18	–	V
Ich	charge current	RPSC_CFG = 200 kΩ	–	86	–	mA
tch	charge time	RPSC_CFG = 200 kΩ	–	210	–	ms

Pyrotechnic switch control circuitry

The two MC33777A pyrotechnic switch controllers are available on two connectors. The user can connect:

- Both controllers to a single pyrotechnic switch (redundant driving)
- Each controller to a different pyrotechnic switch (independent driving)

Both pyrotechnic switch controllers have an independent energy reservoir capacitor (CER). If there is a power supply loss, the capacitors store the energy for the firing and keep the device active. By default, the resistors connected on the pin PSC_CFG configures the capacitor charge current to charge.

Communication

The RDA777T2 communicates with the BMU with ETPL. A transformer galvanically isolates both boards. The MC33777A data sheet describes the required circuitry for the communication.

References

NXP Semiconductors provides online resources for this evaluation board and its supported devices on http://www.nxp.com. The information page for the MC33777A is http://nxp.com/mc33777. The page provides overview information, documentation, software and tools, parametrics, ordering information and a getting started tab.

Revision history

Document ID	Release date	Description
UM12056 v.1.0	21 March 2025	initial version

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Document feedback

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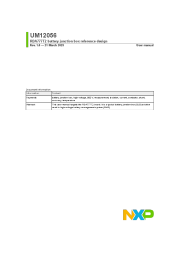
- Document identifier: UM12056

Frequently Asked Questions

1. **Is the RDA777T2 board suitable for high-voltage applications?**
   Yes, the RDA777T2 board is designed for high-voltage battery management systems and can handle up to 800 V.
2. **Can the reference design be used as a standalone product?**
   No, the reference design is intended for evaluation and prototyping purposes only, not as a finished product.
3. **What precautions should be taken when operating the product?**
   Ensure that qualified personnel operate the product in designated test areas due to the risk of electric shock and fire hazards associated with high voltages.

Documents / Resources

	NXP RDA777T2 Battery Junction Box Reference Design [pdf] User Guide RDA777T2 Battery Junction Box Reference Design, RDA777T2, Battery Junction Box Reference Design, Junction Box Reference Design, Box Reference Design, Reference Design

References

- User Manual

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