UM12140

RDI7014DT1 featuring the BMI7014TA1 battery cell controller IC

Rev. 1 — 12 August 2024 User manual

Document information

Information	Content
Keywords	RDI7014DT1, hardware, evaluation, BMI7014TA1, battery-cell controller
Abstract	The RDI7014DT1 serves as a hardware evaluation tool in support of NXP's BMI7014TA1 device.

1 Introduction

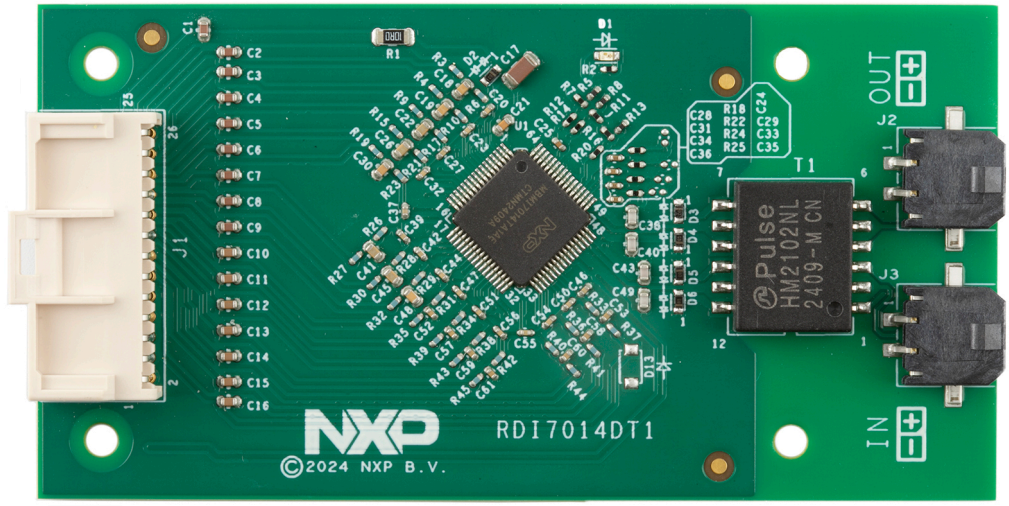


Figure 1. RDI7014DTI

NXP analog product development boards provide an easy-to-use platform for evaluating NXP products. These development boards support a range of analog, mixed-signal, and power solutions. These boards incorporate monolithic integrated circuits (IC) and system-in-package devices that use proven high-volume technology. NXP products offer long battery life, a small form factor, reduced component counts, low cost, and excellent performance in powering state-of-the-art systems.

Important notice

IMPORTANT NOTICE

For engineering development or evaluation purposes only

NXP provides the product under the following conditions:

This evaluation kit is for use of ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY. It is provided as a sample IC pre-soldered to a printed-circuit board to make it easier to access inputs, outputs and supply terminals. This evaluation board may be used with any development system or other source of I/O signals by connecting it to the host MCU computer board via off-the-shelf cables. This evaluation board is not a Reference Design and is not intended to represent a final design recommendation for any particular application. Final device in an application heavily depends on proper printed-circuit board layout and heat sinking design as well as attention to supply filtering, transient suppression, and I/O signal quality.

The product provided may not be complete in terms of required design, marketing, and or manufacturing related protective considerations, including product safety measures typically found in the end device incorporating the product. Due to the open construction of the product, it is the responsibility of the user to take all appropriate precautions for electric discharge. In order to minimize risks associated with the customers' applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards. For any safety concerns, contact NXP sales and technical support services.

2 Finding the 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 RDI7014DT1 evaluation board is at http://www.nxp.com/RDI7014DT1. 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 RDI7014DT1 evaluation board, including the downloadable assets referenced in this document.

3 Getting ready

The tool summary page for RDI7014DT1 is nxp.com/RDI7014DT1. The Overview tab on this page provides an overview of the device, a list of device features, a description of the kit contents, links to supported devices, and a Get Started section.

The Get Started section provides information applicable to using the RDI7014DT1.

1. Go to nxp.com/RDI7014DT1.
2. On the Overview tab, locate the Jump To navigation feature on the left side of the window.
3. Select the Get Started link.
4. Review each entry in the Get Started section.
5. Download an entry by clicking the linked title.

After reviewing the Overview tab, visit the other related tabs for additional information:

- **Documentation**: Download current documentation.
- **Software and Tools**: Download current hardware and software tools.
- **Buy/Parametrics**: Purchase the product and view the product parametrics.

After downloading the files, review each file, including the user guide, which includes setup instructions. If applicable, the bill of materials (BOM), supporting schematics, and layout are available via Secure Files in NXP[5].

3.1 Kit contents

- Assembled and tested evaluation board/module in an antistatic bag
- Cell-terminal cable
- TPL cable
- Quick Start guide

3.2 Additional hardware

- A 7-cell to 14-cell battery pack or a battery pack emulator, such as BATT-14CEMULATOR

4 Getting to know the hardware

4.1 Board overview

The RDI7014DT1 serves as a hardware evaluation tool that supports NXP's BMI7014TA1 device. The BMI7014TA1 is a battery-cell controller that monitors up to 14 Li-ion battery cells. It is designed for use in industrial applications. The device performs analog-to-digital conversion (ADC) on the differential cell voltages. It is also capable of battery temperature measurements. The RDI7014DT1 is an ideal platform for rapid prototyping of BMI7014TA1-based applications that involve voltage and temperature sensing.

The RDI7014DT1 includes a transformer enabling communication in a high-speed isolated communication network. The information is digitally transmitted to a microcontroller for processing. The evaluation board can be used with a transceiver physical layer (TPL) transformer driver (MC33664) to convert microcontroller unit serial peripheral interface (MCU SPI) data bits to pulse-bit information for the BMI7014TA1 and vice versa.

4.2 Board features

The main features of the RDI7014DT1 are as follows:

- Daisy-chain device connection
- LED indicator for operation mode
- Cell-balancing resistors
- Transformer isolation
- Cell-sense input with RC filter
- GPIO: digital I/O, wake-up inputs, convert trigger inputs, ratiometric analog inputs, analog inputs with absolute measurements

4.3 Block diagram

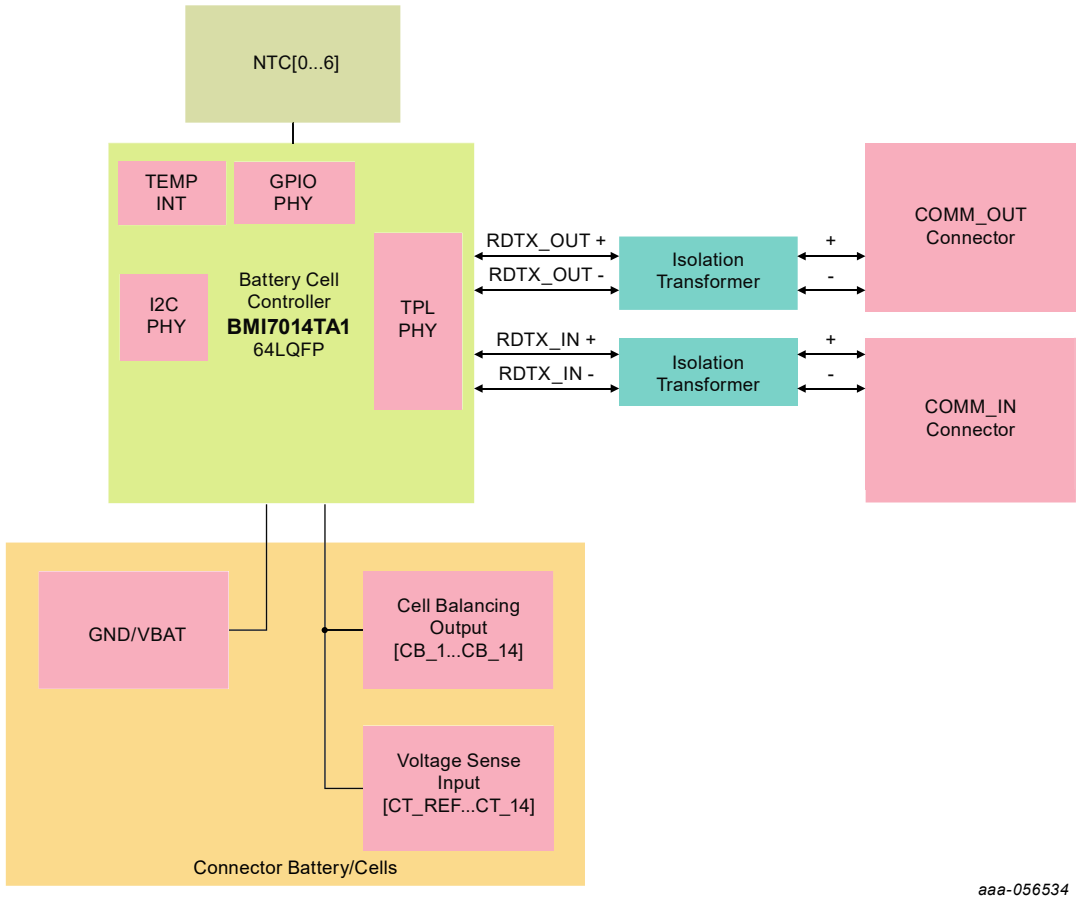


Figure 2. Block diagram

4.4 Device features

The BMI7014TA1 is a SMARTMOS Li-ion battery-cell controller IC family designed for industrial applications, such as energy storage systems (ESS) and uninterruptible power supply (UPS) systems.

The device performs ADC conversions of the differential cell voltages and battery temperature measurements.

The information is transmitted to the MCU using one of the microcontroller interfaces (SPI or transformer physical layer (TPL)) of the IC.

The BMI7014TA1 supports the following functions:

Table 1. BMI7014TA1 device features

Device	Description	Features
BMI7014TA1	Battery-cell controller	• 9.6 V ≤ V_{PWR} ≤ 61.6 V operation, 75 V transient • Seven cells to 14 cells management • Isolated 2.0 Mbps differential communication or 4.0 Mbps SPI • Addressable on initialization • Bidirectional transceiver to support up to 63 nodes in a daisy chain • 0.8 mV maximum total voltage measurement error • Averaging of cell-voltage measurements • Total stack voltage measurement • Seven GPIO/temperature sensor inputs • 5.0 V at 5.0 mA reference supply output • Automatic over/undervoltage and temperature detection routable to fault pin • Integrated Sleep mode over/undervoltage and temperature monitoring • Onboard 300 mA passive cell balancing with diagnostics • Hot-plug capable • Detection of internal and external faults, as open lines, shorts, and leakages • Qualified in compliance with AECQ-100

4.5 Board description

The RDI7014DT1 allows the user to exercise all the functions of the BMI7014TA1 battery controller cell.

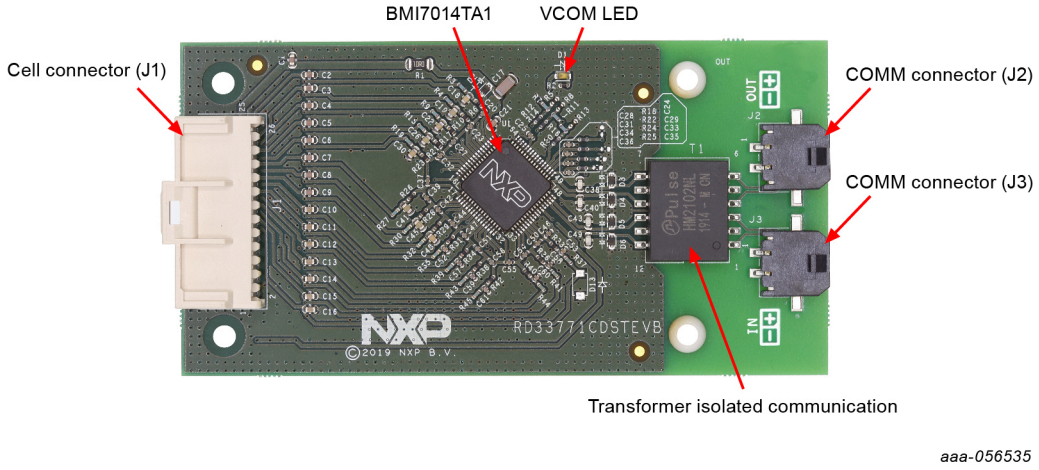


Figure 3. BMI7014TA1 functions

4.6 VCOM LED

The VCOM LED is on the board as shown in Figure 3.

The VCOM LED indicates when the device is in Normal mode. Upon reset, the BMI7014TA1 enters Normal mode (VCOM turns on). If there is no activity on the bus after a timeout period of 60 seconds, the device enters Low-power idle mode (VCOM turns off). Once the device is initialized, if no communication occurs on the TPL bus after one second, the device resets and the LED turns off (VCOM off). Depending on the device settings, the VCOM LED may flash 0.1...8 seconds during cyclic acquisition.

4.7 Connectors

Figure 3 shows the location of the connectors on the board. Table 2, Table 3, and Table 4 list the pinouts for each connector.

Table 2. Cell connector (J1)

Pin	Connection	Description
1	GND	NTC connection (-)
2	NTC3	NTC connection (+)
3	GND	NTC connection (-)
4	NTC2	NTC connection (+)
5	GND	NTC connection (-)
6	NTC1	NTC connection (+)
7	GND	NTC connection (-)
8	NTC0	NTC connection (+)
9	GND	negative battery
10	GND	negative battery
11	CELL_1	Battery cell1P connection
12	CELL_REF	Battery cell1M connection
13	CELL_3	Battery cell3P connection
14	CELL_2	Battery cell2P connection
15	CELL_5	Battery cell5P connection
16	CELL_4	Battery cell4P connection
17	CELL_7	Battery cell7P connection
18	CELL_6	Battery cell6P connection
19	CELL_9	Battery cell9P connection
20	CELL_8	Battery cell8P connection
21	CELL_11	Battery cell11P connection
22	CELL_10	Battery cell10P connection
23	CELL_13	Battery cell13P connection
24	CELL_12	Battery cell12P connection
25	VBAT	positive battery
26	CELL_14	Battery cell14P connection

Table 3. COMM connector (J2)

Pin #	Name	Description
1	OUT+	Receive/transmit output positive
2	OUT–	Receive/transmit output negative

Table 4. Table 4. COMM connector (J3)

Pin #	Name	Description
1	IN+	Receive/transmit input positive
2	IN–	Receive/transmit input negative

4.8 Temperature measurement

The RDI7014DT1 offers seven GPIOs [GPIO_0...GPIO_6] for measuring external temperature with onboard or offboard NTCs. Four offboard negative temperature coefficient (NTC) connections are available on the J1 connector.

4.9 Cell-terminal voltage measurement

The differential measurement of each cell-terminal input is designed to function with an external antialiasing filter.

4.10 Bus-terminal communication

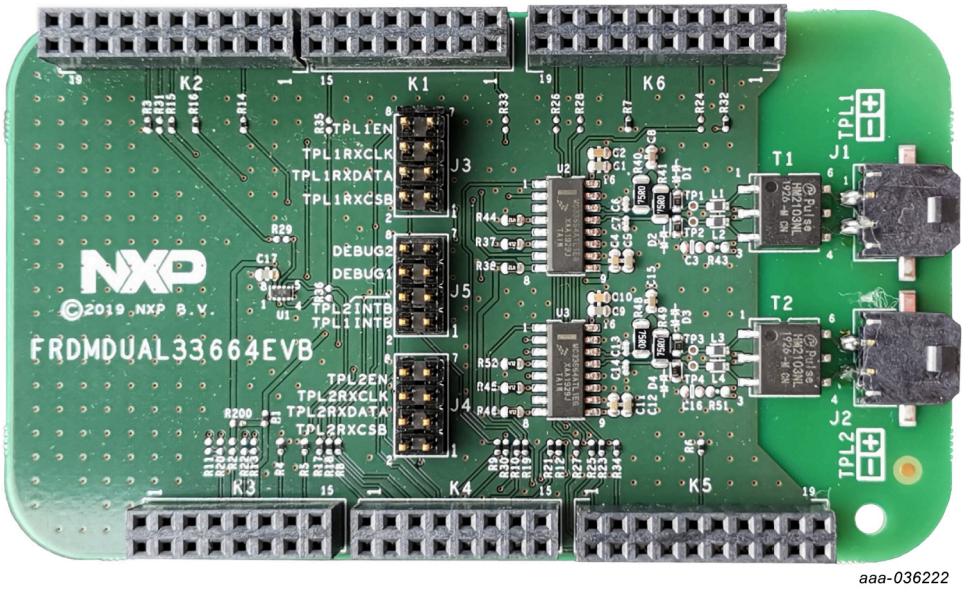
The transformers isolate communication between the BMI7014TA1 and the pack controller and between each BMI7014TA1. They are protected against ESD. There are significant advantages to using transformers for isolation and communication:

- High degree of voltage isolation
- Communication rates of 2.0 MHz with low-radiated emissions
- Ability to force the secondary signals to be true differential-reducing radiated emissions
- Ability to loop the network back to the pack controller

Detailed schematic, component selection, and layout recommendations can be obtained from the NXP DocStore (NDA required) [5].

5 Accessory transceiver board

The RDI7014DT1 kit is designed for use with the FRDMDUAL33664EVB in high-voltage, isolated applications that provide a SPI-to-high-speed isolated communication interface. The FRDMDUAL33664EVB includes two MC33664 isolated network, high-speed transceivers allowing loopback connection. MCU SPI data bits are directly converted to pulse-bit information.



aaa-036222

Figure 4. FRDMDUAL33664EVB

6 Configuring the hardware

6.1 Battery-emulator connection

A minimum of seven cells and a maximum of 14 cells can be monitored. NXP provides a 14-cell battery emulator board, BATT-14CEMULATOR. This board provides an intuitive way to change the voltage across any of the 14 cells of an emulated battery pack and four voltage outputs to emulate four external NTCs. The emulator board can be connected to the RDI7014DT1 connector J1 using the provided supply cable. See Figure 5.

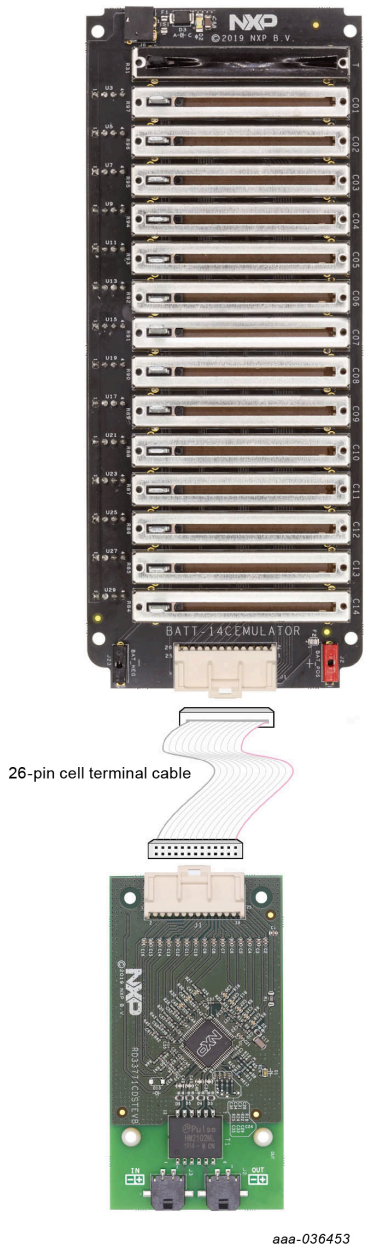


Figure 5. Battery-emulator connection

6.2 TPL communication connection

In a high-voltage, isolated application with a daisy-chain configuration, up to 63 RDI7014DT1 boards may be connected.

The TPL connections use the COMM connectors (J2, J3).

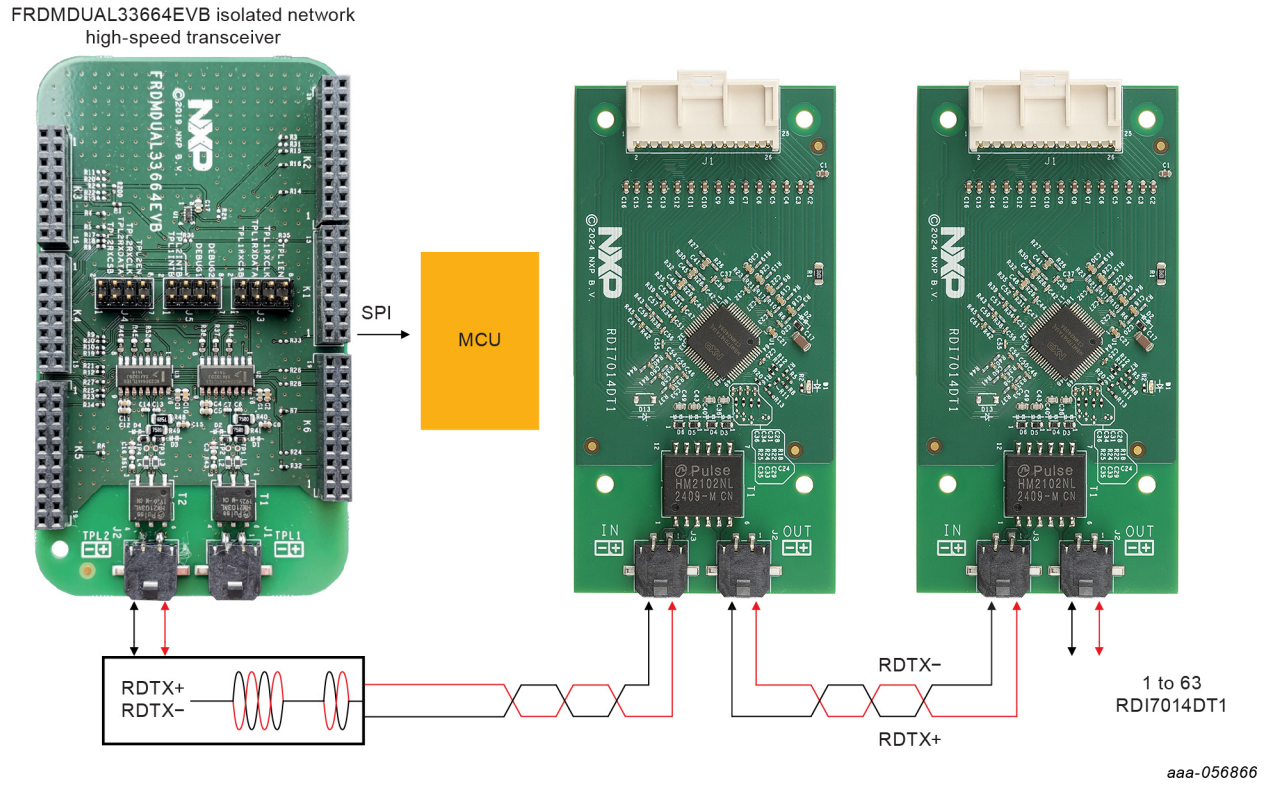


Figure 6. FRDMDUAL33664EVB board setup

7 Available accessories

Note: *NXP does not assume liability, endorse, or warrant components from external manufacturers referenced in circuit drawings or tables. While NXP offers component recommendations in this configuration, it is the customer's responsibility to validate the application.*

Table 5. Bill of materials

Part number	Description
BATT-14CEMULATOR	14-cell slider battery pack emulator kit with shunt for current sense
FRDMDUAL33664EVB	EVB for MC33664ATL isolated network high-speed transceiver

8 References

1. **Board summary page** — nxp.com/RDI7014DT1
2. **Product summary page** — nxp.com/BATTERY-CELL-CONTROLLERS
3. **Tool summary page** — nxp.com/FRDMDUAL33664EVB
4. **Tool summary page for battery emulators** — nxp.com/BATT-14CEMULATOR
5. **Secure files on NXP.com** — docstore.nxp.com

9 Revision history

Table 6. Revision history

Document ID	Release date	Description
UM12140 v.1.0	12 August 2024	Initial version

Legal information

Definitions

Draft — A draft status on a document indicates that the content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included in a draft version of a document and shall have no liability for the consequences of use of such information.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Terms and conditions of commercial sale — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at https://www.nxp.com/profile/terms, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

HTML publications — An HTML version, if available, of this document is provided as a courtesy. Definitive information is contained in the applicable document in PDF format. If there is a discrepancy between the HTML document and the PDF document, the PDF document has priority.

Translations — A non-English (translated) version of a document, including the legal information in that document, is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Security — Customer understands that all NXP products may be subject to unidentified vulnerabilities or may support established security standards or specifications with known limitations. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately.

Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP.

NXP has a Product Security Incident Response Team (PSIRT) (reachable at PSIRT@nxp.com) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

Suitability for use in industrial applications (functional safety) — This NXP product has been qualified for use in industrial applications. It has been developed in accordance with IEC 61508, and has been SIL-classified accordingly. If this product is used by customer in the development of, or for incorporation into, products or services (a) used in safety critical applications or (b) in which failure could lead to death, personal injury, or severe physical or environmental damage (such products and services hereinafter referred to as "Critical Applications"), then customer makes the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, safety, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP. As such, customer assumes all risk related to use of any products in Critical Applications and NXP and its suppliers shall not be liable for any such use by customer. Accordingly, customer will indemnify and hold NXP harmless from any claims, liabilities, damages and associated costs and expenses (including attorneys' fees) that NXP may incur related to customer's incorporation of any product in a Critical Application.

NXP B.V. — NXP B.V. is not an operating company and it does not distribute or sell products.

Trademarks

Notice: All referenced brands, product names, service names, and trademarks are the property of their respective owners.

NXP — wordmark and logo are trademarks of NXP B.V.

Tables

Figures

Contents