# UM11965

## MR CANHUBK344 Software User Manual

Rev. 0 — 22 August 2023 User manual

**Document Information**

| Information | Content |
|---|---|
| Keywords | MR_CANHUBK3, MR_CANHUBK344, Ethernet to CAN, CAN to Ethernet, IEEE 1722, ACF-CAN, S32K344, FS26, SE050, TJA1103, TJA1443, TJA1463, TJA1153. |
| Abstract | Software User Manual for IEEE1722 CAN over Ethernet example. Package contents, instructions, open issues, fixes and limitations. |

# 1 Introduction

This document is the release notes for the **MR-CANHUBK344** demonstration software, which converts Ethernet to CAN and CAN to Ethernet using the IEEE 1722 ACF-CAN protocol.

The user manual also describe the kit's contents, open issues, changes, fixes, and limitations of the released version.

This release of the switch code supports all six CAN ports and 100BASE-T1 Ethernet port. The 100BASE-T1 port has automatic mode detection enabled, so no further adjustments are needed.

***Note:*** *Other code examples specific to Mobile Robotics team, vehicle software stacks, and associated RTOSs may be found elsewhere on nxp.com/mr-canhubk344.*

## 1.1 Abbreviations

**Table 1. Abbreviations**

| Term | Description |
|---|---|
| IEEE 1722 | Layer 2 transport protocol working group for time-sensitive streams. |
| 100BASE-T1 | Full-duplex single twisted pair ethernet |
| CAN | Controller Area Network 1 Mbps “classical CAN”, although may sometimes be inclusive of CAN-FD. |
| CAN FD | CAN Flexible Data rate (up to 8 Mbps) |
| CAN SIC | CAN FD using Signal Improvement CAN PHY |
| CAN SCT | CAN FD using Secure CAN Transceiver |
| JTAG | Joint Test Action Group, interface commonly used for software debugging |
| KB | 1024 bytes |
| MAC | Media Access Control, a MAC address is a so called physical address |
| Mbit/s | Million bits per second ($10^6$ bits/s) |
| NFC | Near Field Communication |
| PCB | Printed Circuit Board |
| SDK | Software Development Kit |

## 2 MR-CANHUBK344 kit content

The released package consists of:

- Hardware:
  - MR-CANHUBK344 board
  - DCD-LZ Programming Adapter board (giving access to a console UART)
  - USB-UART adapter cable (attaches to DCD-LZ)
  - Power adapter cables, including JST-JH to common red SY connector, barrel connector, XT-60 Lipo battery connector
  - 6x CAN cables
  - 6x CAN Termination boards
  - 1x T1 Ethernet cable (using JST-GH connectors)
  - Generic JST-GH cables for UART/SPI/I2C/customizing to your specific needs.
  - Small OLED display
  - NFC antenna connected to secure element.
- Documentation and software:
  - MR-CANHUBK344 HW User Manual
  - MR-CANHUBK344 HW design package
  - MR-CANHUBK344 SW User Manual
  - S32 Design Studio project file

# 3 Changes

Table 2. Changes

| Item | Description |
|---|---|
| Release package | MR-CANHUBK344 IEEE1772 ACF-CAN over ethernet demo |
| Documentation | |

# 4 Limitations

Table 3. Limitations

| Item | Description |
|---|---|
| Software stack | **Limitation:** (none currently reported)<br>**Impact:** |

# 5 Known issues

Table 4. Known issues

| Item | Description |
| --- | --- |
| Hardware bugs PCB version1 | **Limitation:** (None currently reported).<br>**Impact:** |

# 6 Board connections

The MR-CANHUBK344 board includes several interfaces. The board is designed for testing within the application space of small mobile robotics. This has defined the use of Linux foundation DroneCode connectors. These cables are easily assembled and customized using housings and pre-crimped cables. There is the added benefit of many off-the-shelf modules being able to plug in directly. Cables are typically provided in the kit and may need to be cut or modified for your specific needs.

## 6.1 Power input

The power input connection and PMIC support a wide input voltage range from 5 V to 40 V and are suitable for direct connection to a battery. For example, a 12 V car battery or a 2 S, 3 S, 4 S LiPo battery.

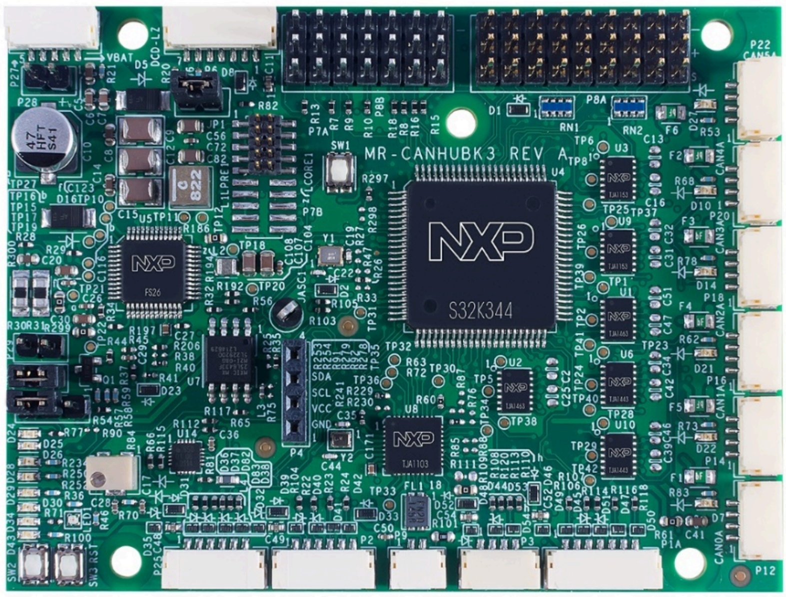


Figure 1. Power input

The power is to be supplied at the five-pin P27 (Pin 1-2 power, Pin 3 NC, Pin 4-5 ground) connector at the top left corner of the board (see Figure 1) or at the two-pin P28 connector (Pin 1 power, Pin 2 ground). The board draws roughly 100 mA @ 12 V.

## 6.2 CAN bus connections

P12-P23 are CAN connectors with following pinout.

Table 5. CAN connectors pinout

| Pin # | Signal | Specification |
|---|---|---|
| 1 | 5V4 | 5.4 V |
| 2 | CANx_H | 5.0 V |
| 3 | CANx_L | 5.0 V |
| 4 | GND | 0 V |

A CAN bus generally requires termination at both ends; assuming this CANHUBK344 is at one end of the bus, connecting one of the included CAN-TERM termination boards on the corresponding CAN connector accomplishes termination for this end.

The CAN ports on MR-CANHUBK344 sources 5 V power on pin 1 to connected devices. You may gently remove the Pin1 wire on the connector if this is not required.

Note that while these CAN-TERM boards may be able to *inject* 5 V through the USB connector interface, you should take extra care and consideration to validate that this is what you intend for your system.

## 6.3 100Base-T1 Ethernet connection

The T1 connector (P9) is a 2-pin JST-GH connector for two wire 100 Mbps ethernet. The signals are capacitively coupled and are polarized P and N. On this board, the TJA1103 T1 interface chip auto-negotiates the polarity if it is reversed. This cable connects directly to other Mobile Robotics boards such as UCANS32K1SIC, UCANS32K1SCT, RDDRONET1ETH8, and NavQPlus.

RDDRONE-T1ADAPT may translate to an RJ45 connection type. Alternatively, you can adapt this cable to other connector types as required, by cutting the cable and soldering to the wires.

On the back of the PCB, there is a yellow LED (D88) that shows the link status. If it is flashing, it means there is a link.

## 6.4 Main semiconductor components

This compact board holds some key components, which are briefly described in this section. More detailed documentation on these components can be found online.

### 6.4.1 S32K344 MCU

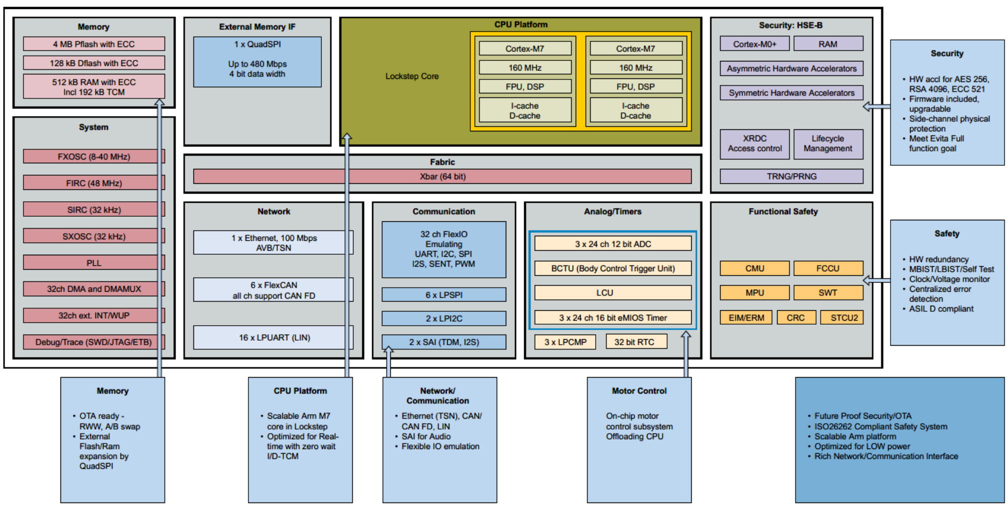


**Figure 2. S32K344 block diagram**

S32K344 is an automotive general purpose MCU of NXP Semiconductors. Figure 2 shows the block diagram of this chip. The software discussed in this document runs on the Lockstep Arm Cortex M7 embedded in this chip.

***Note:*** *There are equivalent versions of this chip where the two cores can run independently (S32K324).*

### 6.4.2 FS26 Functional safety SBC

F26 is the '*Safety System Basis Chip with Low Power Fit for ASIL D'* of NXP Semiconductors. Figure 3 shows the block diagram of this power supply chip. Although capable of much more, in this design it allows for a compact power supply design and high input voltage.

The FS26 is connected through SPI to the S32K344 and implements a challenger window watchdog. Sending challenges to the through SPI S32K344 as the window watchdog when the response is invalid or not during the timing window the FS26 will reset the S32K344 MCU. In this included sample code, the ***challenge watchdog*** functionality has ***not*** been implemented. Instead during startup of the S32K344 the sample application sends a request to the FS26 to ***disable the watchdog functionality*** thus avoiding the S32K344 will go into reset.

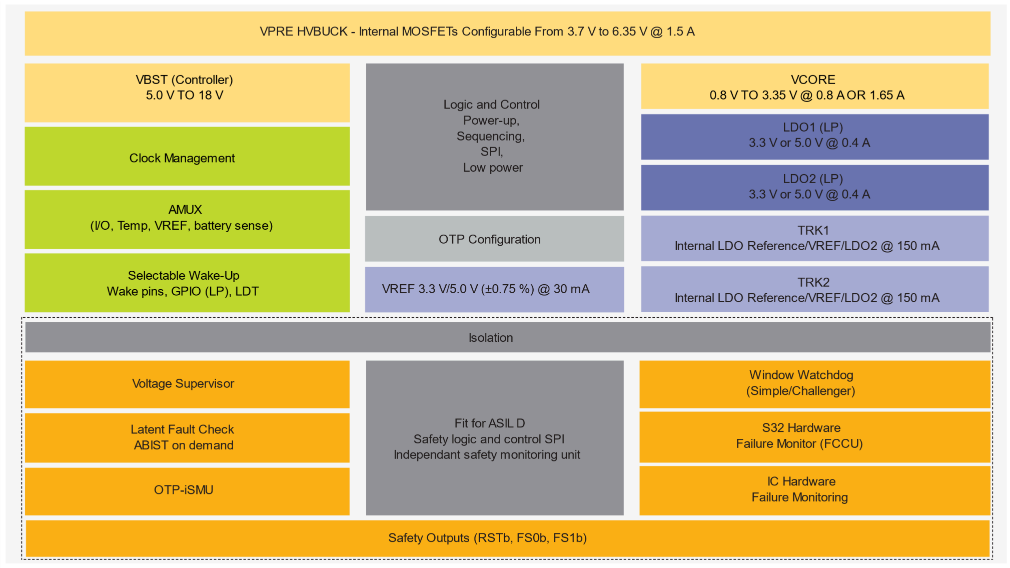


**Figure 3. FS26 block diagram**

# 7 Board power up sequence

As described in Section 6.4.2, the FS26, by default, implements a challenger window watchdog that resets the S32K344 MCU continuously if the challenge is not managed.

To circumvent this, the FS26 must enter into debug mode. This is done by removing JP1, supplying 12.0 V on P27 or P28, and inserting the JP1 jumper.

Once completed, the reset LED D24 stops blinking, indicating that the S32K344 does not reset continuously by the FS26.

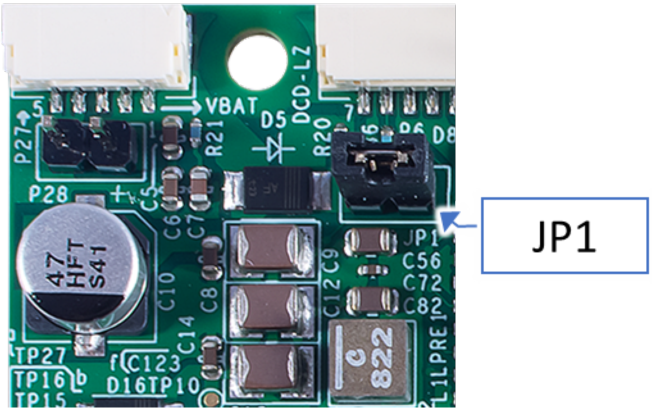


**Figure 4. Power connectors and debug mode jumper**

## 8 S32 design example project

The included `MR_CANHUBK3_IEEE1722.zip` project file is compatible with S32 Design Studio for S32 Platform version 3.4.

***Note:*** *The S32DS version 3.4 is located under previous tab.*

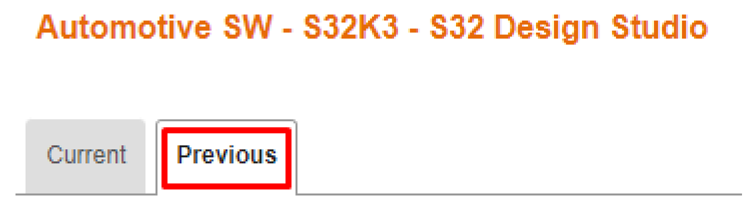


**Figure 5. Automotive SW - S32K3 - S32 Design Studio (previous tab)**

The following extensions are required to build the project:

- FreeRTOS for S32K3 2.0.0
- S32K3 RTD AUTOSAR 4.4 Version 2.0.0
- S32K3xx development package Version 3.4.3

Figure 6 gives an overview what the S32 Design Studio extension manager should show. Click on Add Update Sites link to add manually downloaded update site files.

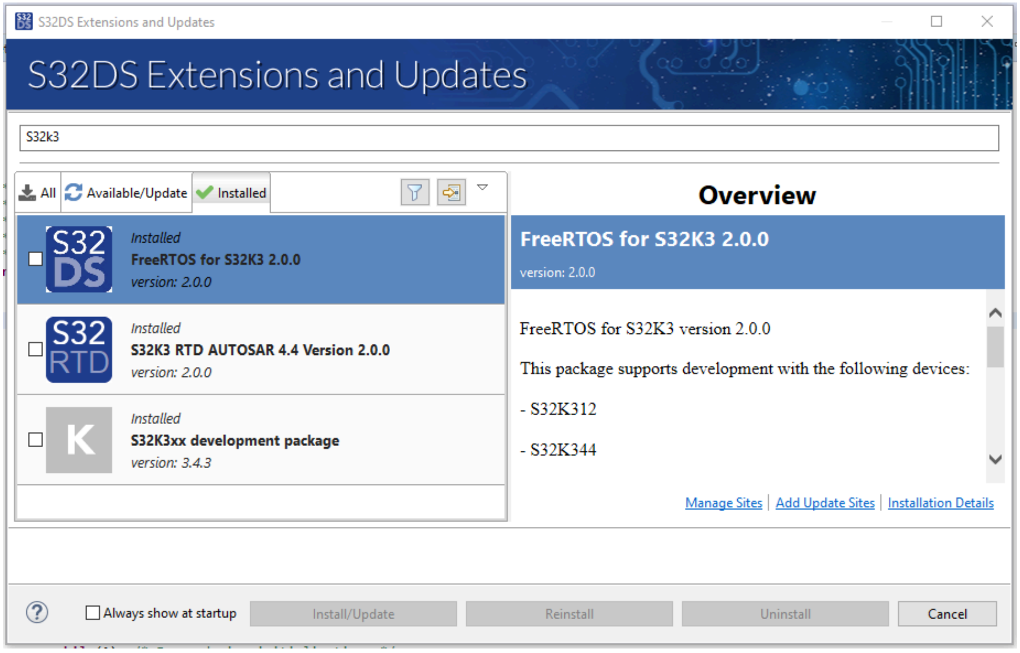


**Figure 6. S32DS extensions and updates**

To import the included `MR_CANHUBK3_IEEE1722.zip` , open *File -> Import -> General -> Project* from folder or archive and then select the `Project.zip` archive.

After the project has imported, right click on “MR_CANHUBK3_IEEE1722” in the projects explorer and select *S32 Configuration Tools -> Open Pins*.

The S32 Pin tool perspective view appears and in the menu there is a button “Update Code” and select “OK” now the driver configuration files are generated.

Go back to the Project Explorer right click on “MR_CANHUBK3_IEEE1722” and select “Build Project”. Now you can flash the “MR_CANHUBK3_IEEE1722.elf” using your programmer.

See Getting started with S32K3 & S32DS guide, for more information regarding S32 Design Studio, S32 configuration tools, and debugging.

## 8.1 Application

After MR_CANHUBK3_IEEE1722 is successfully flashed on the MR-CANHUBK344 board, it acts as an ETH <-> CAN IEEE1722 protocol converter.

CAN messages received on CAN0 through CAN5 are converted to an IEEE1722 ACF-CAN fame and are broadcasted to the ethernet. To view incoming CAN frames, you can install WireShark on a Windows/Linux machine (https://www.wireshark.org/).

***Note:*** *The 100BaseTx to 100BASE-T1 media converter tool (not included with the board) is necessary for debugging Ethernet frames. You may use for example NXP RDDRONE-T1ADAPT.*

You can also **simulate** CAN messages by pressing SW1 or SW2.

SW1 sends a CAN message to CAN0 and SW2 sends a CAN message to CAN1.

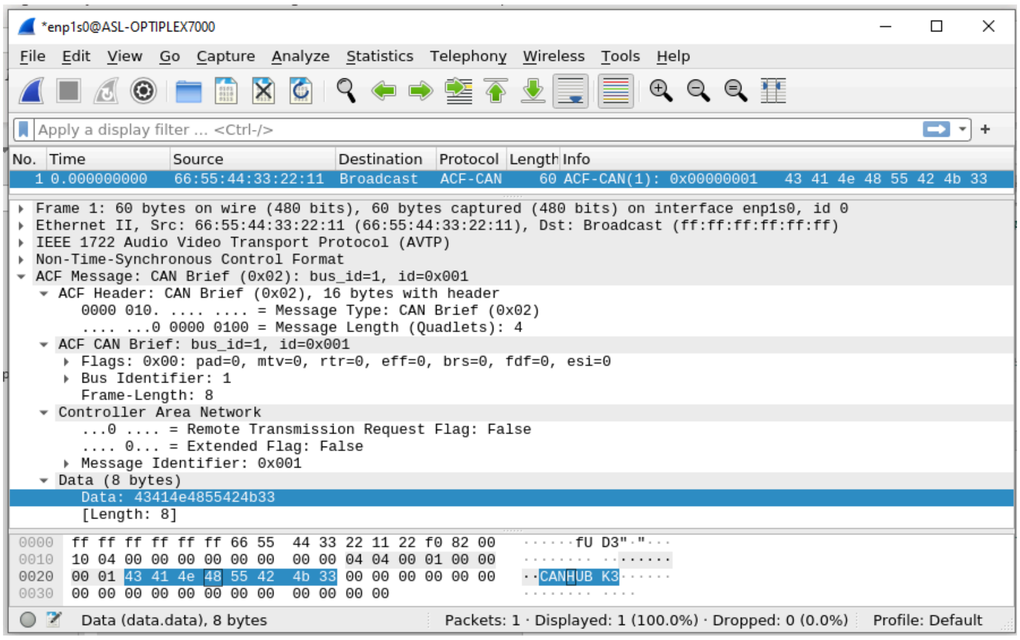


**Figure 7. WireShark tool**

You can connect CAN0 (P12) back to CAN1 (P14) to create a bus using included cable for a setup without CAN peripherals. Also, connect the CAN-Term board to P13 to terminate the bus. When pressing either SW1 or SW2, both LEDs D7 and D22 turn on indicating there’s CAN packet. When connected to a PC running WireShark, it shows there’s a CAN packet send using IEEE1722 as shown in Figure 6.

## 8.2 Board Status LEDs

The MR-CANHUBK344 has various LEDs to indicate status as shown in Table 6. Under normal circumstances, the state of the LEDs is shown in the following table:

Table 6. Board Status LEDs

| Dxx | LED name | Normal state | Description |
|---|---|---|---|
| D24 | RESET_K3 | Off | Indicates if the S32K344 is in reset |
| D25 | P1V8_TRK2 | On | Indicates FS26 SBC 1V8_TRK2 status |
| D26 | P3V3_TRK1 | On | Indicates FS26 SBC 3V3_TRK1 status |
| D28 | P3V3_LDO2 | On | Indicates FS26 SBC 3V3_LDO2 status |
| D29 | P3V3_LDO1 | On | Indicates FS26 SBC 3V3_LDO1 status |
| D30 | VBATP_SW | On | Indicates VBAT status |
| D34 | V15_MCU | On | Indicates FS26 SBC V15 status |
| D43 | P5V4 | On | Indicates FS26 SBC P5V4 status |
| LED1 | RGB Status LED | Green | Controlled by the software, green indicates normal operation, blue indicates initialization, red indicates that an error has occurred. |

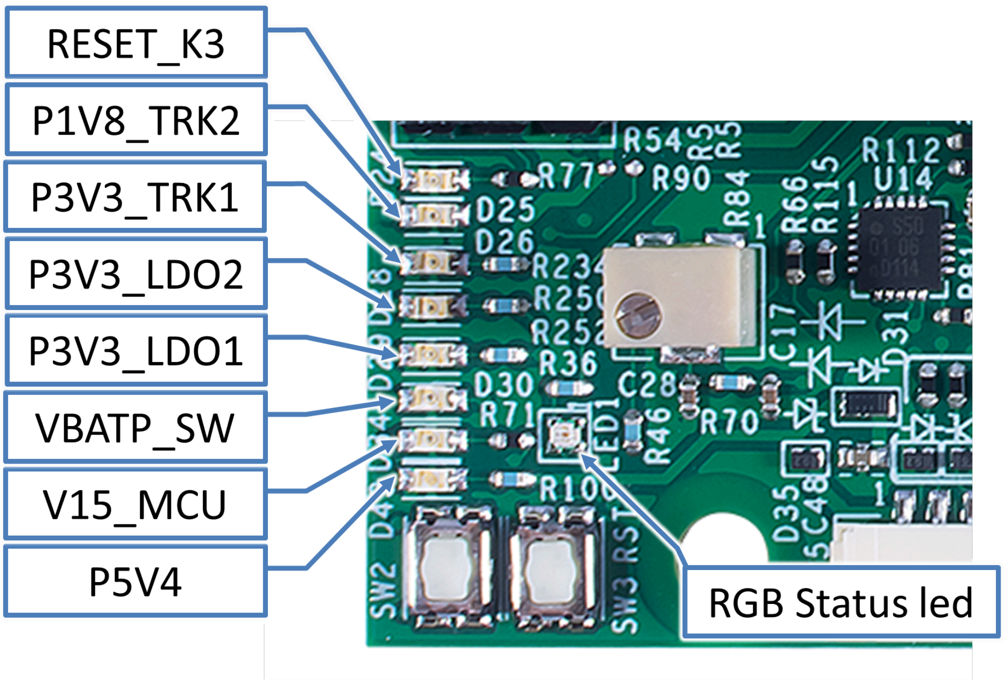


Figure 8. Board Status LEDs

# 9 Revision history

Table 7. Revision history

| Rev. No. | Date | Substancial changes |
|---|---|---|
| 0 | August 2023 | Initial version |

# 10 Legal information

## 10.1 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.

## 10.2 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.

**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 http://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.

**Suitability for use in automotive applications** — This NXP product has been qualified for use in automotive applications. 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.

**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.

**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.

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

## 10.3 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.

**AMBA, Arm, Arm7, Arm7TDMI, Arm9, Arm11, Artisan, big.LITTLE, Cordio, CoreLink, CoreSight, Cortex, DesignStart, DynamIQ, Jazelle, Keil, Mali, Mbed, Mbed Enabled, NEON, POP, RealView, SecurCore, Socrates, Thumb, TrustZone, ULINK, ULINK2, ULINK-ME, ULINK-PLUS, ULINKpro, μVision, Versatile** — are trademarks and/or registered trademarks of Arm Limited (or its subsidiaries or affiliates) in the US and/or elsewhere. The related technology may be protected by any or all of patents, copyrights, designs and trade secrets. All rights reserved.

# Tables



 

# Figures

# Contents





**Date of release: 22 August 2023**
**Document identifier: UM11965**