

# AN13049

## Wi-Fi/Bluetooth/802.15.4 M.2 Key E Pinout Definition

Rev. 4 — 30 May 2023

Application note

### Document Information

Information	Content
Keywords	AN13049, Wi-Fi, Bluetooth, 802.15.4, M.2, Pinout, Tri-Radio
Abstract	This document defines M.2 usage for both NXP Wi-Fi/Bluetooth and Tri-Radio M.2 module design.



# 1 Introduction

M.2 is a form factor for mobile adapters defined by the PCI-SIG (<http://www.pcisig.com>). The pinouts for M.2 sockets are defined in the PCI Express M.2 Specification.

M.2 sockets with mechanical Key E are used on platforms based on NXP MPUs and MCUs to support wireless connectivity modules based on NXP Wi-Fi/Bluetooth/802.15.4 radios.

Some of the signals defined in the pinout are used to connect optional sideband and debug signals used by NXP Wi-Fi/Bluetooth/802.15.4 radios.

To ensure proper connection for the sideband and debug signals, this document defines the pin assignments for M.2 sockets (mechanical Key E) on platforms based on NXP MPUs and MCUs.

This document defines M.2 usage for both NXP Wi-Fi/Bluetooth and Tri-Radio M.2 module design.

Figure 1 shows NXP Single/Dual Radio M.2 interface block diagram.

Figure 2 shows NXP Tri-Radio M.2 interface block diagram. It must add SPI interface for 802.15.4 device, and add an I/O expander to support sideband control signals.

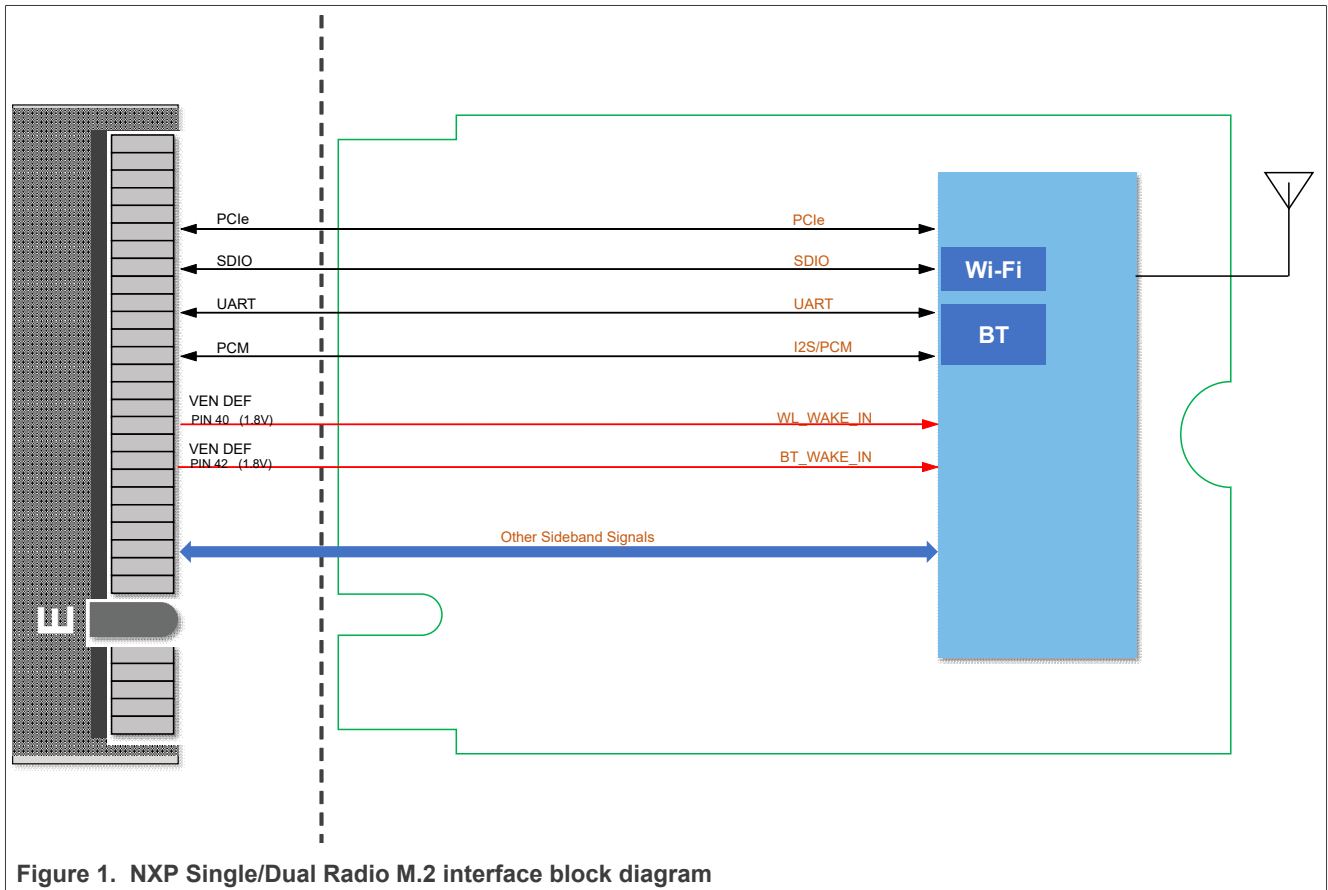
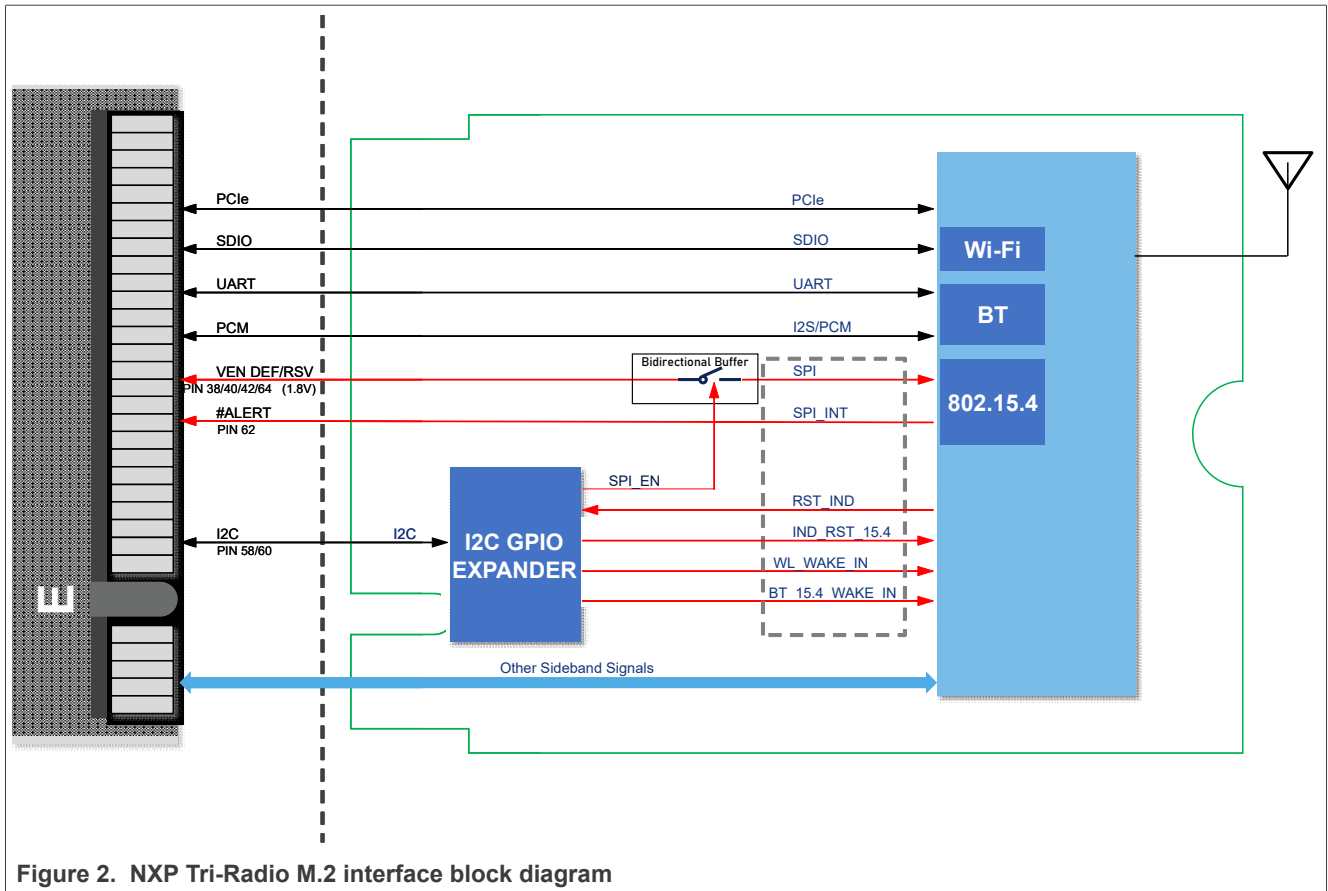


Figure 1. NXP Single/Dual Radio M.2 interface block diagram



Before building your board, check the interface connector specification from the wireless module vendor to confirm the pinout used by the module.

For the full definition of the socket pinout, see the *PCI Express M.2 Specification*, available from PCI-SIG website (<http://www.pcisig.com>).

**Note:** All the pins that are not listed in this document are recommended to follow the *PCI Express M.2 Type E specification* or should not be connected.

## 2 Usage signals for Wi-Fi/Bluetooth and Tri-Radio

This section describes the NXP defined sideband control and SPI signals between the NXP Radio module and MPU/MCU.

[Table 1](#) shows the pin assignments utilized for sideband and SPI signals.

**Note:** For details on the mandatory and optional lines, see the module data sheet.

Table 1. Sideband and SPI signals

Pin	PCIe M.2 Signal	Type <sup>[1]</sup>	Voltage	Usage for NXP Single/Dual Radio	Usage for NXP Tri-Radi
20	UART_WAKE#	I	3.3 V	BT_WAKE_OUT: Bluetooth radio to wake up the MPU/MCU. Active Low by default.	BT_15.4_WAKE_OUT: Bluetooth radio to wake up the MPU/MCU. Active Low by default.

Table 1. Sideband and SPI signals...continued

Pin	PCIe M.2 Signal	Type <sup>[1]</sup>	Voltage	Usage for NXP Single/Dual Radio	Usage for NXP Tri-Radi
				Connect to MPU/MCU GPIO open-drain. Pullup required on platform.	Connect to MPU/MCU GPIO open-drain. Pullup required on platform.
21	SDIO_WAKE#	I	1.8 V	WL_WAKE_OUT: Wi-Fi radio to wake up the MPU/MCU. Active Low by default. Connect to MPU/MCU Open-drain. Pullup required on platform.	Same as single/dual radio.
23	SDIO_RESET#	O	1.8 V	IND_RST_WL: Independent software reset for Wi-Fi. Active Low by default. Connect to MPU/MCU GPIO.	Same as single/dual radio.
38	VENDOR DEFINED	O	1.8 V	NC	SPI_TXD: SPI transmit signal.
40	VENDOR DEFINED	I/O	1.8 V	WL_WAKE_IN: MPU/MCU to wake up the Wi-Fi radio. Active Low by default. Connect to MPU/MCU GPIO.	SPI_RXD: SPI receive signal.
42	VENDOR DEFINED	O	1.8 V	BT_WAKE_IN: MPU/MCU to wake up the Bluetooth radio. Active Low by default. Connect to MPU/MCU GPIO.	SPI_CLK: SPI clock signal.
44 <sup>[2]</sup>	COEX3	I/O	1.8 V	Talk to NXP support team.	Same as single/dual radio.
46 <sup>[2]</sup>	COEX2	I	1.8 V	Talk to NXP support team.	Same as single/dual radio.
48 <sup>[2]</sup>	COEX1	O	1.8 V	Talk to NXP support team.	Same as single/dual radio.
54	W_DISABLE2#	O	3.3 V	IND_RST_BT: Independent software reset for Bluetooth. Active Low by default Connect to MPU/MCU GPIO.	Same as single/dual radio.
56	W_DISABLE1#	O	3.3 V	PDn: Full power down for the Wi-Fi/Bluetooth radio or controls the PMIC ENABLE signal. High = Normal Low = Full Power-down mode Connect to MPU/MCU GPIO.	PDn: Full power down for the Tri-radio or controls the PMIC ENABLE signal. High = Normal Low = Full Power-down mode Connect to MPU/MCU GPIO.
58	I2C_DATA	I/O	1.8 V	NC	I2C SDA: I2C data for I/O expander. Open-drain. Pullup required on platform. See <a href="#">Table 2</a> .
60	I2C_CLK	O	1.8 V	NC	I2C SCL:

Table 1. Sideband and SPI signals...continued

Pin	PCIe M.2 Signal	Type <sup>[1]</sup>	Voltage	Usage for NXP Single/Dual Radio	Usage for NXP Tri-Radi
					I2C clock from MPU/MCU for I/O expander. See <a href="#">Table 2</a> .
62	ALERT#	I	1.8 V	NC	SPI_INT: SPI interrupt signal. Open-drain. Pullup required on platform.
64 <sup>[3]</sup>	RESERVED	O	1.8 V	NC	SPI_FRM: SPI frame signal.

[1] Type refers to the signal direction:

- Type O means signal is an output from the MPU/MCU to the adapter.
- Type I means that the signal is an input to the MPU/MCU from the adapter.

[2] For future use, reserve the sideband signals of coexistence and audio trigger on the M.2 board.

- [3]
- To avoid the potential risk on which 1.8 V is designed on other platform, optionally add a serial 100-1K ohm resistor on the path from SPI\_FRM to M.2 PIN64.
  - On the Tri-radio M.2 adapter side for the SPI signals, follow the SPI signal definitions based on M.2 Spec Rev 3.0 in the application note document. Do not follow the M.2 Spec Rev 4.0 signal definitions.
  - On the host side, the SPI signal definitions on M.2 connector should be consistent as mention in the application note document. Otherwise, the 802.15.4 transceiver of Tri-radio M.2 adapter cannot work normally. However, this does not impact the Wi-Fi and Bluetooth of the Tri-radio adapter.

### 2.1 I2C I/O expander for sideband signals

For a Tri-Radio M.2 module, it uses an I2C expander to support sideband control signals. It is important to use an NXP [PCAL6408A](#) part. It is an 8-bit general-purpose I/O expander that provides GPIO expansion via the I2C bus interface. See the I/O expander port assignment or the sideband signals in [Table 2](#).

Table 2. I/O expander function

Symbol	Type	Voltage	NXP Usage	Description
P0	O	VIO	SPI Buffer enable	Enable SPI Buffer when Tri-radio is designed. Active high by default. Pull down required on M.2 board.
P1	O	VIO	IND_RST_15.4	Independent software reset for 802.15.4 radio. Active low by default.
P2	O	VIO	WL_WAKE_IN	MPU/MCU to wake up the Wi-Fi radio. Active low by default.
P3	O	VIO	BT_15.4_W AKE_IN	MPU/MCU to wake up the Bluetooth and 802.15.4 radio. Active low by default.
P4	I	VIO	RST_IND	Independent software reset indicator output signal to host.
P5-P7	Reserved			Not used. Recommend to add test pads on P5-P7.

## 3 Host and audio interfaces

The wireless connectivity module may support an audio interface.

The modules may also support various host interfaces including SDIO, UART<sup>1</sup>, or PCI Express.

<sup>1</sup> CTS and RTS flow control lines are requested for Bluetooth control.

For the pin assignments on these interfaces, see the PCI\_Express\_M.2\_Spec document on <http://www.pcisig.com>.

## 4 JTAG debug signals

The JTAG debug signals JTAG\_TDI, JTAG\_TDO, JTAG\_TCK, and JTAG\_TMS are used to support Software development. Keeping a JTAG connector ([Hirose FH12-10S-0.5SH\(55\)](#)) or test pads on the M.2 module is recommended.

## 5 Revision history

[Table 3](#) summarizes the changes to this document.

**Table 3. Revision history**

Revision number	Date	Substantive changes
1	12 November 2020	Initial release.
2	16 September 2021	Updated <a href="#">Section 1</a> and <a href="#">Section 2</a> .
3	17 January 2022	Added the usage for Tri-Radio design. Removed the JTAG signals from the M.2 pins.
4	30 May 2023	Updated <a href="#">Section 2</a> and added <a href="#">Section 3</a> .

## 6 Legal information

### 6.1 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.

### 6.2 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.

**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 <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.

**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.

**Suitability for use in non-automotive qualified products** — Unless this data sheet expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

**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](mailto: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.

### 6.3 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.

**Bluetooth** — the Bluetooth wordmark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by NXP Semiconductors is under license.

---

## Contents

---

<b>1</b>	<b>Introduction .....</b>	<b>2</b>
<b>2</b>	<b>Usage signals for Wi-Fi/Bluetooth and Tri- Radio .....</b>	<b>3</b>
2.1	I2C I/O expander for sideband signals .....	5
<b>3</b>	<b>Host and audio interfaces .....</b>	<b>5</b>
<b>4</b>	<b>JTAG debug signals .....</b>	<b>6</b>
<b>5</b>	<b>Revision history .....</b>	<b>6</b>
<b>6</b>	<b>Legal information .....</b>	<b>7</b>

---

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

---

© 2023 NXP B.V.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

Date of release: 30 May 2023  
Document identifier: AN13049