1XL / 2XS M.2 Module Datasheet (EAR00387 / EAR00411 / EAR00418 / EAR00419 / EAR00444 / EAR00447 / EAR00449 / EAR00450)

- Wi-Fi 6, 802.11 a/b/g/n/ac/ax 2x2 MU-MIMO
- Bluetooth 5.3 BR/EDR/LE
- PCIe interface, in M.2 form factor (22 x 30 mm)
- Chipset: NXP 88W9098

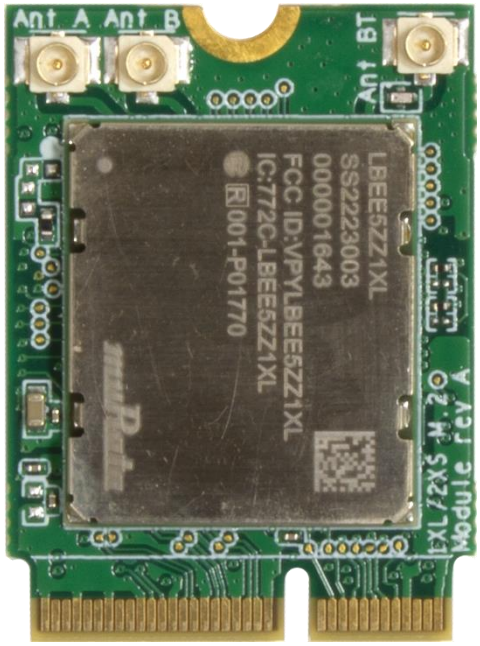

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Table of Contents

1 Document Information

This document applies to the following products.

Product Name	*Type Number*	*Murata Module*	*Chipset*	*Product Status*
1XL M.2 Module, rev A/PB2/B	EAR00387 / EAR00418 / EAR00419 / EAR00444	LBEE5ZZ1XL-774	88W9098	Initial Production
2XS M.2 Module, rev A/PB2/B	EAR00411 / EAR00447 / EAR00449 / EAR00450	LBEE5ZZ2XS-846	88W9098	Initial Production

This table below lists the product differences. All products are not stocked. Consult Embedded Artists for availability and lead time.

Type Number	*Product Name*	*Host Interface for Wi-Fi functionality*	*Packaging*
EAR00387	1XL-PCIe M.2 Module	PCIe	Individual packing for evaluation, including 3 trace antennas.
EAR00418	1XL-PCIe M.2 Module	PCIe	Tray, no antenna included.
EAR00419	1XL-SDIO M.2 Module	SDIO	Individual packing for evaluation, including 3 trace antennas.
EAR00444	1XL-SDIO M.2 Module	SDIO	Tray, no antenna included.
EAR00411	2XS-PCIe M.2 Module	PCIe	Individual packing for evaluation, including 2 trace antennas.
EAR00447	2XS-PCIe M.2 Module	PCIe	Tray, no antenna included.
EAR00449	2XS-SDIO M.2 Module	SDIO	Individual packing for evaluation, including 2 trace antennas.
EAR00450	2XS-SDIO M.2 Module	SDIO	Tray, no antenna included.

1.1 Revision History

Revision	*Date*	*Description*
PA1	2021-10-15	First version.
PA2	2021-10-15	Added information about power consumption.
PA3	2022-05-04	Updated information about used antenna for reference certification.
PA4	2022-07-08	Updated for rev A boards and added information about 2XS.
A	2022-11-11	Corrected antenna gain information and pinning information.
PB1	2023-01-04	Added information about pinning change for rev PB2. Added information about orderable products.
PB2	2023-08-30	Corrected information about PCIe/SDIO interface selection. Added information about board rev B.
PB3	2025-01-29	Added information about different baud rates.

2 Introduction

This document is a datasheet that specifies and describes the *1XL M.2 module* and the *2XS M.2 module* mainly from a hardware point of view.

The main component in the design is Murata's 1XL module (full part number: LBEE5ZZ1XL-774) or the 2XS module (full part number: LBEE5ZZ2XS-846), respectively. The 1XL and 2XS modules differ in antenna configuration but are both based on the NXP 88W9098 chipset. The 1XL / 2XS M.2 module enables Wi-Fi, Bluetooth and Bluetooth Low Energy (LE) communication.

There are multiple application areas for the 1XL / 2XS M.2 Modules:

- Industrial and building automation
- Asset management
- IoT applications
- Smart home: Voice assist device, smart printer, smart speaker, home automation gateway, and IP camera
- Retail/POS
- Healthcare and medical devices
- Smart city

2.1 Benefits of Using an M.2 Module to get Wi-Fi/BT Connectivity

There are several benefits to use an *M.2 module* to add connectivity to an embedded design:

- Drop-in, certified solution!
- Modular and flexible approach to evaluate different Wi-Fi/BT solutions - with different trade-offs around performance, cost, power consumption, longevity, etc.
- Access to maintained software drivers (Linux and SDK) with responsive support from Murata.
- Supported by Embedded Artists' Developer's Kits for i.MX 6/7/8/9 development, including advanced debugging support on carrier boards
- One component to buy, instead of 40+
- No RF expertise is required
- Developed in close collaboration with Murata

2.2 More M.2 Related Information

For more information about the M.2 standard and Embedded Artists' adaptation, see: M.2 Primer

For more general information about the M.2 standard, see: https://en.wikipedia.org/wiki/M.2

The official M.2 specification (PCI Express M.2 Specification) is available from: www.pcisig.com

2.3 ESD Precaution and Handling

Please note that the M.2 module come without any case/box and all components are exposed for finger touches – and therefore extra attention must be paid to ESD (electrostatic discharge) precaution, for example use of static-free workstation and grounding strap. Only qualified personnel shall handle the product.

Make it a habit always to first touch the mounting hole (which is grounded) for a few seconds with both hands before touching any other parts of the boards. That way, you will have the same potential as the board and therefore minimize the risk for ESD.

In general, touch as little as possible on the boards to minimize the risk of ESD damage. The only reasons to touch the board are when mounting/unmounting it on a carrier board.

Note that Embedded Artists does not replace modules that have been damaged by ESD.

2.4 Product Compliance

Visit Embedded Artists' website at http://www.embeddedartists.com/product_compliance for up-to-date information about product compliances such as CE, RoHS2/3, Conflict Minerals, REACH, etc.

3 Specification

This chapter lists some of the more important characteristics of the M.2 module, but it is not a full specification of performance and timing. The main component in the design is Murata's 1XL / 2XS module (full part number: LBEE5ZZ1XL-774 / LBEE5ZZ2XS-846), which in turn is based around NXP's 88W9098 chipset.

For a full specification, see Murata's 1XL Module (LBEE5ZZ1XL) product page:
https://www.murata.com/en-us/products/connectivitymodule/wi-fi-bluetooth/overview/lineup/type1xl
and the LBEE5ZZ1XL datasheet:
https://www.murata.com/products/productdata/8813653524510/type1xl.pdf
For a full specification, see Murata's 2XS Module (LBEE5ZZ2XS) product page:
https://www.murata.com/en-us/products/connectivitymodule/wi-fi-bluetooth/overview/lineup/type2xs
and the LBEE5ZZ2XS datasheet:
https://www.murata.com/products/productdata/8818219548702/TYPE2XS.pdf

Module / Chipset	
Murata module	LBEE5ZZ1XL-774 or LBEE5ZZ2XS-846
Chipset	NXP 88W9098

Wi-Fi	
Standards	802.11a/b/g/n/ac/ax 2x2 MU-MIMO, Wi-Fi 6
Network	uAP and STA dual mode
Frequency	2.4GHz and 5 GHz band
Data rates	11, 54, 144, 300, 866 Mbps
Host interface	PCIe up to 5 GT/s (default) or SDIO 3.0, SDR104@208MHz / DDR50@50MHz with rework (or on special order)

Bluetooth	
Standards	5.3 BR/EDR/LE, 2Mbps PHY
Power Class	Class 1
Host interface	4-wire UART@4MBaud
Audio interface	PCM for audio

Powering			
Supply voltage to M.2 module **Note: Do not exceed minimum or maximum voltage. Module will be permanently damaged above this limit!**	**Min** 0.0V minimum 3.14V operating and RF specification	**Typ** 3.3V	**Max** 3.5V **Note** that LBEE5ZZ1XL / LBEE5ZZ2XS module specification has higher maximum voltage (5.5V), but other components on the M.2 module limit the maximum voltage.
Peak current	2500 mA max		**Note: The power supply must be designed for this peak**

		current, which typically happen during the startup calibration process.
Receive mode current (WLAN, Concurrent dual-band receive)	450 mA max	Note that current consumption varies widely between different operational modes.
Transmit mode current (WLAN, Concurrent dual-band transmit)	1650 mA max	Note that current consumption varies widely between different operational modes.

Environmental Specification	
Operational Temperature	-40 to +85 degrees Celsius
Storage Temperature	-40 to +85 degrees Celsius
Relative Humidity (RH), operating and storage	10 - 90% non-condensing

3.1 Power Up Sequence

The supply voltage shall not rise (10 - 90%) faster than 40 microseconds and not slower than 100 milliseconds.

M.2 signal W_DISABLE1# (chipset signal PMIC_EN) must be held low for at least 100 milliseconds after supply voltage has reached specification level before pulled high.

3.2 External Sleep Clock

No external sleep clock is needed.

3.3 Mechanical Dimensions

The M.2 module is of type: 2230-D5-E according to the M.2 nomenclature. This means width 22 mm, length 30mm, top and bottom side component height 1.5 mm and key-E connector. The table below lists the different dimensions and weight.

M.2 Module Dimension	Value (±0.15 mm)	Unit
Width	22	mm
Height, with pcb trace antenna Height, without pcb trace antenna	44 30	mm mm
PCB thickness	0.8	mm
Maximum component height on top side	1.5	mm
Maximum component height on bottom side	1.5	mm
Ground hole diameter	3.5	mm
Plating around ground hole, diameter	5.5	mm
Module weight	1.5 ±0.5 gram	gram

The picture below gives dimensions for the grounded center (half) hole and the u.fl. antenna connectors.

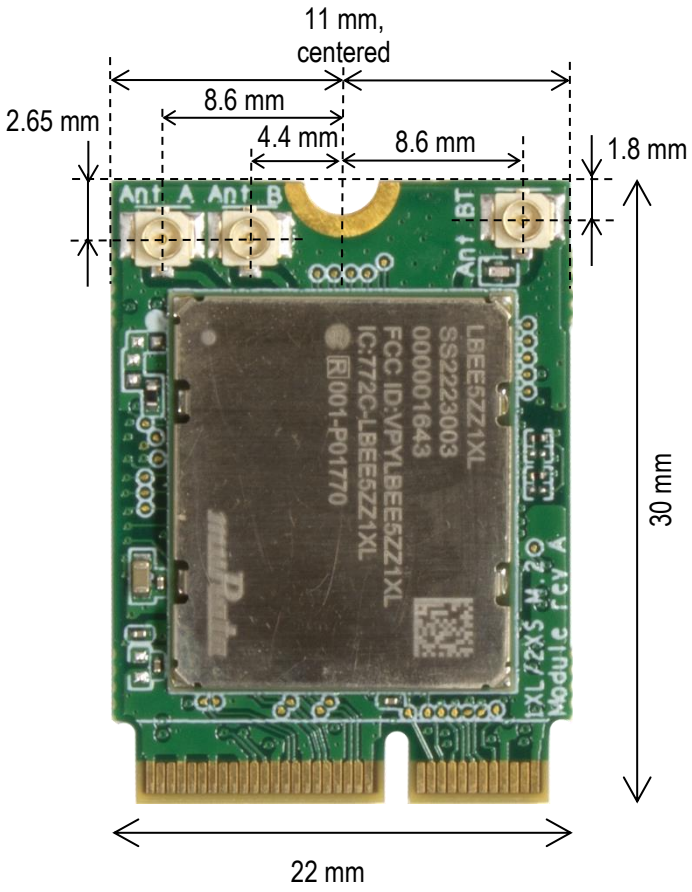

Figure 1 – M.2 Module Dimensions

3.4 M.2 Pinning

This section presents the pinning used for the M.2 module. It is essentially M.2 Key-E compliant with enhancements to support additional debug signals and 3.3V VDDIO override. The pin assignment for specific control and debug signals has been jointly defined by Embedded Artists, Murata, NXP and Infineon (former Cypress).

The picture below illustrates the edge pin numbering. It starts on the right edge and alternates between the top and bottom side. The removed pads in the keying notch count (but are obviously non-existing).

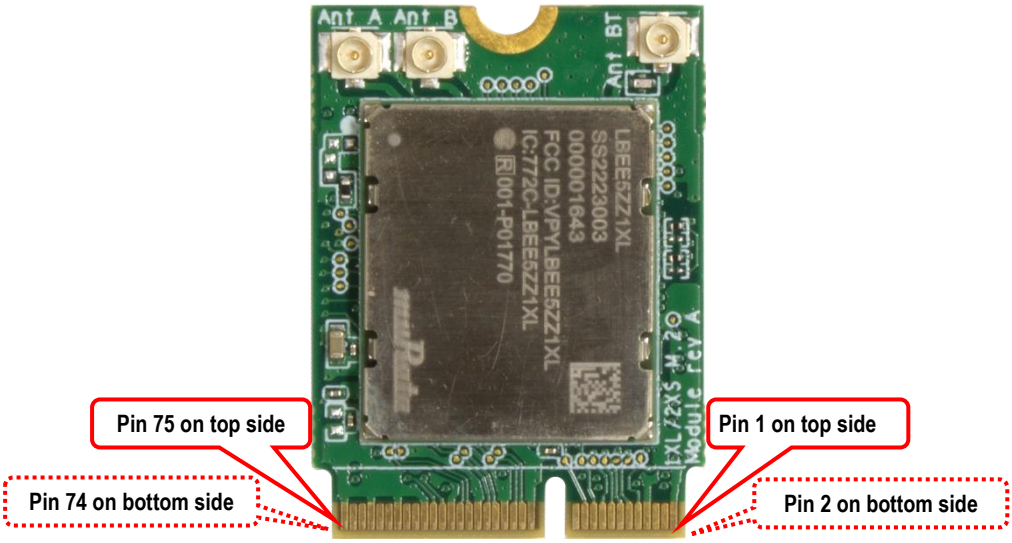

Figure 2 – M.2 Module Pin Numbering

The Wi-Fi interface uses either the PCIe interface or SDIO interface, depending on configuration, see section 3.6 for details how to change interface. The Bluetooth interface uses the UART interface for control and PCM interface for audio. The table below lists the pin usage for the 1XL / 2XS M.2 module. The column "When is signal needed" signals four different categories:

- Always: These signals shall always be connected.
- Wi-Fi PCIe: These signals shall always be connected then the PCIe interface is used for Wi-Fi
- Wi-Fi SDIO: These signals shall always be connected then the SDIO interface is used for Wi-Fi
- Bluetooth: These signals shall always be connected when the Bluetooth interface is used.
- Optional: These signals are optional to connect.

Pin #	Side of pcb	M.2 Name	Voltage Level and Signal Direction	When is signal needed	Note
1	Top	GND	GND	Always	Connect to ground
2	Bottom	3.3 V		Always	Power supply input. Connect to stable, low-noise 3.3V supply.
3	Top	USB_D+			Not connected.
4	Bottom	3.3 V		Always	Power supply input. Connect to stable, low-noise 3.3V supply.
5	Top	USB_D-			Not connected.
6	Bottom	LED_1#	1.8V output from M.2[1]		Connected to 1XL / 2XS module, signal GPIO2, pin 52
7	Top	GND	GND	Always	Connect to ground.

8	Bottom	PCM_CLK	1.8V I/O[1]	Bluetooth audio	For Bluetooth audio interface: BT_PCM_CLK Connected to 1XL / 2XS module, signal BT_PCM_CLK, pin 10
9	Top	SDIO CLK	1.8V Input to M.2[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_CLK Connected to 1XL / 2XS module, signal SDIO_CLK, pin 36
10	Bottom	PCM_SYNC	1.8V I/O[1]	Bluetooth audio	For Bluetooth audio interface: BT_PCM_SYNC Connected to 1XL / 2XS module, signal BT_PCM_SYNC, pin 12
11	Top	SDIO CMD	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_CMD Connected to 1XL / 2XS module, signal SDIO_CMD, pin 37 Note: Signa require an external 10-100K ohm pullup
12	Bottom	PCM_OUT	1.8V output from M.2[1]	Bluetooth audio	For Bluetooth audio interface: BT_PCM_OUT Connected to 1XL / 2XS module, signal BT_PCM_OUT, pin 11
13	Top	SDIO DATA0	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D0 Connected to 1XL / 2XS module, signal SDIO_DAT0, pin 38 Note: Signal require an external 10-100K ohm pullup
14	Bottom	PCM_IN	1.8V input to M.2[1]	Bluetooth audio	For Bluetooth audio interface: BT_PCM_IN Connected to 1XL / 2XS module, signal BT_PCM_IN, pin 9
15	Top	SDIO DATA1	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D1 Connected to 1XL / 2XS module, signal SDIO_DAT1, pin 39 Note: Signal require an external 10-100K ohm pullup
16	Bottom	LED_2#	1.8V output from M.2[1]		Connected to 1XL module, signal GPIO3, pin 51
17	Top	SDIO DATA2	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D2 Connected to 1XL / 2XS module, signal SDIO_DAT2, pin 40 Note: Signal require an external 10-100K ohm pullup
18	Bottom	GND		Always	Connect to ground.
19	Top	SDIO DATA3	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D3 Connected to 1XL / 2XS module, signal SDIO_DAT3, pin 42 Note: Signal require an external 10-100K ohm pullup
20	Bottom	UART WAKE#	3.3V output from M.2	Bluetooth	For Bluetooth UART interface: BT_HOST_WAKE_L This is a wake signal for the Bluetooth interface from the device (Wi-Fi/BT chipset) to the host (CPU). Connected to 1XL / 2XS module, via buffer, signal GPIO16, pin 13
21	Top	SDIO WAKE#	1.8V output from M.2[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface WL_HOST_WAKE_L This is a wake signal for the Wi-Fi interface from the device (Wi-Fi/BT chipset) to the host (CPU). Connected to 1XL / 2XS module, via buffer, signal GPIO15, pin 14
22	Bottom	UART TXD	1.8V output from M.2[1]	Bluetooth	For Bluetooth UART interface: BT_UART_TXD Connected to 1XL / 2XS module, signal GPIO8, pin 56
23	Top	SDIO RESET#			Not connected. The Wi-Fi SDIO interface is controlled by pin 56, W_DISABLE1#, which is a 3.3V logic level signal.
24-31	Key, non-existing				
32	Bottom	UART_RXD	1.8V input to M.2[1]	Bluetooth	For Bluetooth UART interface: BT_UART_RXD Connected to 1XL / 2XS module, signal GPIO9, pin 55

33	Top	GND		Always	Connect to ground.
34	Bottom	UART_RTS	1.8V output from M.2[1]	Bluetooth	For Bluetooth UART interface: BT_UART_RTS Connected to 1XL / 2XS module, signal GPIO11, pin 53
35	Top	PERp0	PCIe input to M.2	Wi-Fi PCIe	PCIe data input (receive, positive signal) Connected to 1XL / 2XS module, signal PCIE_RXP, pin 30
36	Bottom	UART_CTS	1.8V input to M.2[1]	Bluetooth	For Bluetooth UART interface: BT_UART_CTS Connected to 1XL / 2XS module, signal GOIO10, pin 54
37	Top	PERn0	PCIe input to M.2	Wi-Fi PCIe	PCIe data input (receive, negative signal) Connected to 1XL / 2XS module, signal PCIE_RXN, pin 29
38	Bottom	VENDOR DEFINED	1.8V I/O[1]	Optional	Board rev PA2/A: Connected to 1XL / 2XS module, signal GPIO31, pin 47. Note: Signal can be JTAG_TDO Board rev PB2: Connected to 1XL / 2XS module, signal GPIO29, pin 48. Note: Signal can be JTAG_TMS
39	Top	GND		Always	Connect to ground.
40	Bottom	VENDOR DEFINED	1.8V input to M.2[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface WL_DEV_WAKE_L This is a wake signal for the Wi-Fi interface from the host (CPU) to the device (Wi-Fi/BT chipset). Connected to 1XL / 2XS module, signal GPIO12, pin 57
41	Top	PETp0	PCIe output from M.2	Wi-Fi PCIe	PCIe data output (transmit, positive signal) Connected to 1XL / 2XS module, signal PCIE_TXN, pin 27 **Note** that the transmit data pair is lane reversed. This is allowed according to the PCIe standard.
42	Bottom	VENDOR DEFINED	1.8V input to M.2[1]	Bluetooth	For Bluetooth UART interface: BT_DEV_WAKE_L This is a wake signal for the Bluetooth interface from the host (CPU) to the device (Wi-Fi/BT chipset). Connected to 1XL / 2XS module, signal GPIO1, pin 6
43	Top	PETn0	PCIe output from M.2	Wi-Fi PCIe	PCIe data output (transmit, negative signal) Connected to 1XL / 2XS module, signal PCIE_TXP, pin 26 **Note** that the transmit data pair is lane reversed. This is allowed according to the PCIe standard.
44	Bottom	COEX3	1.8V I/O[1]	Optional	Board rev PA2/A: Connected to 1XL / 2XS module, signal GPIO30, pin 49. Note: Signal can be JTAG_TDI Board rev PB2: Connected to 1XL / 2XS module, signal GPIO28, pin 50. Note: Signal can be JTAG_TCK
45	Top	GND		Always	Connect to ground.
46	Bottom	COEX_TXD	1.8V I/O[1]	Optional	Board rev PA2/A: Connected to 1XL / 2XS module, signal GPIO28, pin 50. Note: Signal can be JTAG_TCK Board rev PB2: Connected to 1XL / 2XS module, signal GPIO31, pin 47. Note: Signal can be JTAG_TDO
47	Top	REFCLKp0	PCIe clock input to M.2	Wi-Fi PCIe	PCIe clock input (receive, positive signal) Connected to 1XL / 2XS module, signal PCIE_CLKP, pin 24
48	Bottom	COEX_RXD	1.8V I/O[1]	Optional	Board rev PA2/A: Connected to 1XL / 2XS module, signal GPIO29, pin 48. Note: Signal can be JTAG_TMS Board rev PB2: Connected to 1XL / 2XS module, signal GPIO30, pin 49. Note: Signal can be JTAG_TDI
49	Top	REFCLKn0	PCIe clock input to M.2	Wi-Fi PCIe	PCIe clock input (receive, negative signal) Connected to 1XL / 2XS module, signal PCIE_CLKN, pin 23
50	Bottom	SUSCLK			Not connected.

51	Top	GND		Always	Connect to ground.
52	Bottom	PERST0#	3.3V input to M.2	Wi-Fi PCIe	PCIe PERST# signal, used to initialize the M.2 functions once power sources stabilize. Connected to 1XL / 2XS module, via voltage translator, signal GPIO20, pin 43
53	Top	CLKREQ0#	3.3V OD output from M.2	Wi-Fi PCIe	PCIe clock request (low level request reference clock) Connected to 1XL / 2XS module, via open drain buffer, signal PCIE_CLKREQ_N, pin 44 **Note**: Requires external 10Kohm pull-up
54	Bottom	W_DISABLE2#			Not connected.
55	Top	PEWAKE0#	3.3V OD output from M.2	Wi-Fi PCIe	PCIe wake request (low level request host wakeup) Connected to 1XL / 2XS module, via open drain buffer, signal PCIE_WAKEUP_N, pin 45 **Note**: Requires external 10Kohm pull-up
56	Bottom	W_DISABLE1#	3.3V input to M.2	Always	Connected to 1XL / 2XS module, via buffer, signal PD_N, pin 15 PD_N High = Module enabled/internally powered, PD_N Low = Module disabled/powered down This input has an on-board 10K ohm pull-up resistor.
57	Top	GND		Always	Connect to ground.
58	Bottom	I2C_SDA			Not connected.
59	Top	Reserved			Not connected.
60	Bottom	I2C_CLK			Not connected.
61	Top	Reserved			Not connected.
62	Bottom	ALERT#			Not connected.
63	Top	GND		Always	Connect to ground.
64	Bottom	RESERVED		Optional	Optional supply voltage input for control and data signal voltage level. Apply a stable, low-noise, 3.3V 100mA supply to set 3.3V voltage level on all control signals (that normally are 1.8V).
65	Top	Reserved			Not connected.
66	Bottom	UIM_SWP			Not connected.
67	Top	Reserved			Not connected.
68	Bottom	UIM_POWER_SNK			Not connected.
69	Top	GND		Always	Connect to ground.
70	Bottom	UIM_POWER_SRC/GPIO_1			Not connected.
71	Top	Reserved			Not connected.
72	Bottom	3.3 V		Always	Power supply input. Connect to stable, low-noise 3.3V supply.
73	Top	Reserved			Not connected.
74	Bottom	3.3 V		Always	Power supply input. Connect to stable, low-noise 3.3V supply.
75	Top	GND		Always	Connect to ground.

[1] Note: It is possible to change the interface voltage on all control and SDIO signals to 3.3V (which is non-standard), see section 3.5

3.5 VDDIO Override Feature

The M.2 standard specifies 1.8V logic level on several of the data and control signals. It is possible to override the voltage level for the 1.8V signals via pin 64. Apply a 3.3V / 100 mA supply to pin 64 and a small rework (mount R41 and remove R44) to get 3.3V voltage level on all data and control signals.

Note that it is not enough to connect a 3.3V supply to pin 64. Resistor R41 must be mounted and resistor R44 must be removed. See Figure 4 for location of these resistors.

Note: Changing VDDIO does not make sense when the Wi-Fi PCIe interface is used since the voltage levels of the PCIe interface are fixed and the PCIe related control signals are already defined for 3.3V operation (by the M.2 specification). The Bluetooth interface signals will however change from 1.8V to 3.3V logic levels.

Note: If SDIO is used for the Wi-Fi interface, the SDIO control signals will have 3.3V signaling level (if VDDIO is overridden to 3.3V). Also note that this limits the SDIO clock to 50 MHz, thereby limiting throughput. Running at 1.8V VIO will support the highest SDIO clock frequency, which is needed for 802.11ac/ax throughput.

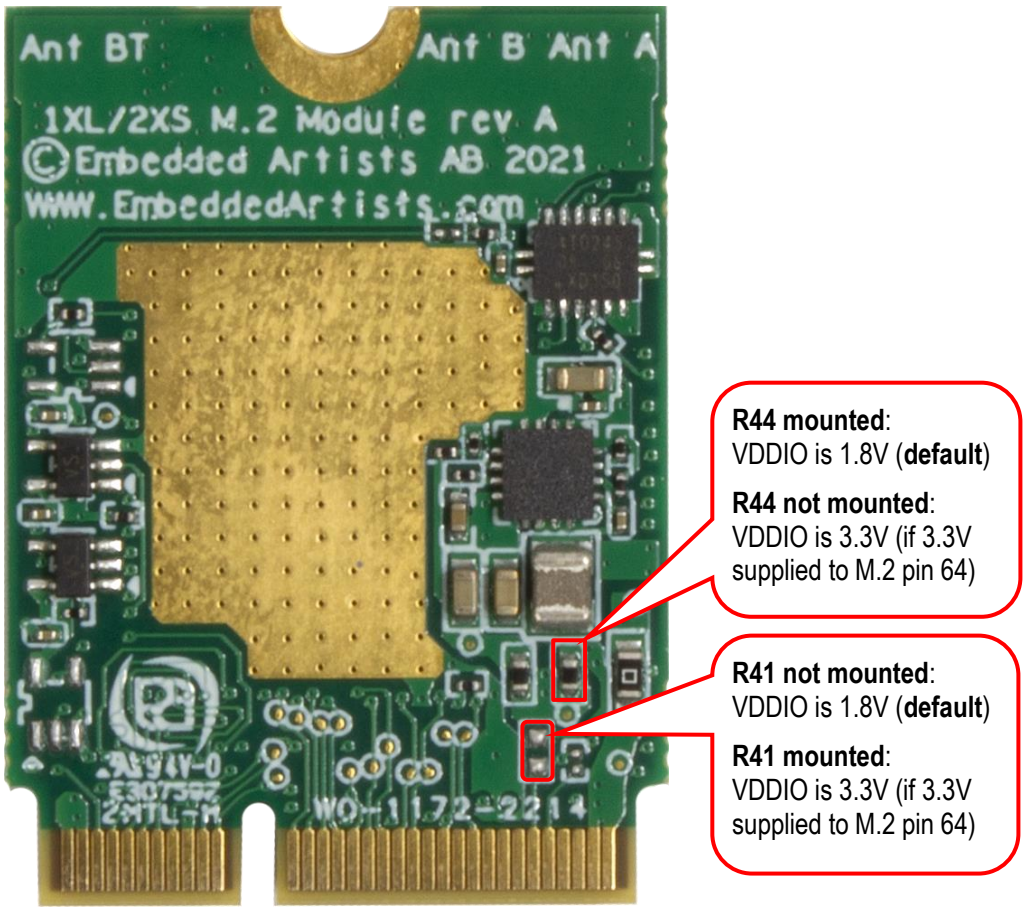

Figure 3 – 1XL / 2XS M.2 Module VDDIO Override Rework

3.6 SDIO Interface

The SDIO interface conforms to the SDIO v3.0 specification, including the UHS-I modes, and is backward compatible with SDIO v2.0.

SDIO bus speed modes	Max SDIO clock frequency	Max bus speed	Signaling voltage according to M.2 specification	Supported in 3.3V VDDIO Override Mode
DS (Default speed)	25 MHz	12.5 MByte/s	1.8 V	Yes
HS (High speed)	50 MHz	25 MByte/s	1.8 V	Yes
SDR12	25 MHz	12.5 MByte/s	1.8 V	No
SDR25	50 MHz	25 MByte/s	1.8 V	No
SDR50	100 MHz	50 MByte/s	1.8 V	No
SDR104	208 MHz	104 MByte/s	1.8 V	No
DDR50	50 MHz	50 MByte/s	1.8 V	No

3.7 Wi-Fi Interface Control

Depending on the ordered board version, either the PCIe or SDIO interface to Wi-Fi is enabled. It is possible to change the interface with a small rework, as described in the picture below.

Depending on the board version, the rework process is slightly different, see the two pictures below for rev A/PB2 and rev B, respectively.

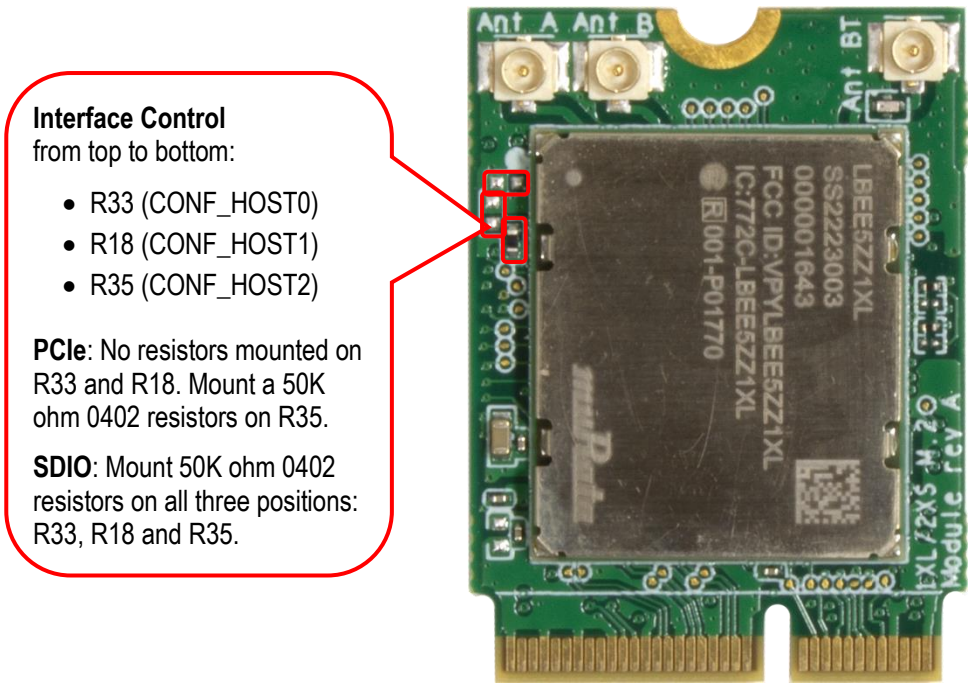

Figure 4 – 1XL / 2XS M.2 Module Wi-Fi Interface Control, rev A and rev PB2

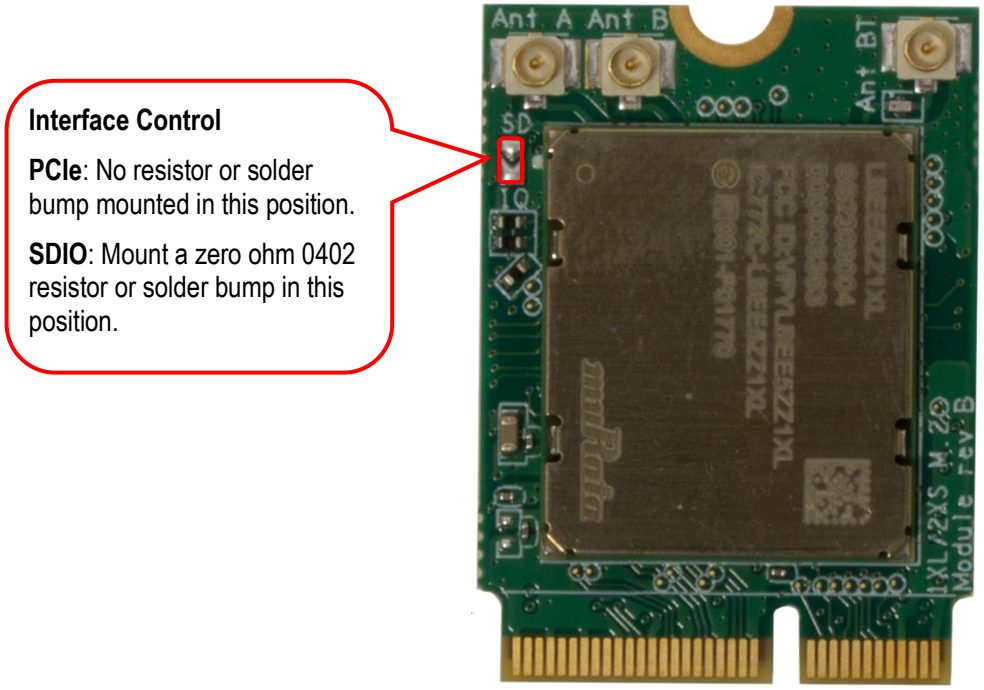

Figure 5 – 1XL / 2XS M.2 Module Wi-Fi Interface Control, rev B

3.8 Test Points

There are some test points that can be of interest to probe for debugging purposes, as illustrated in the picture below.

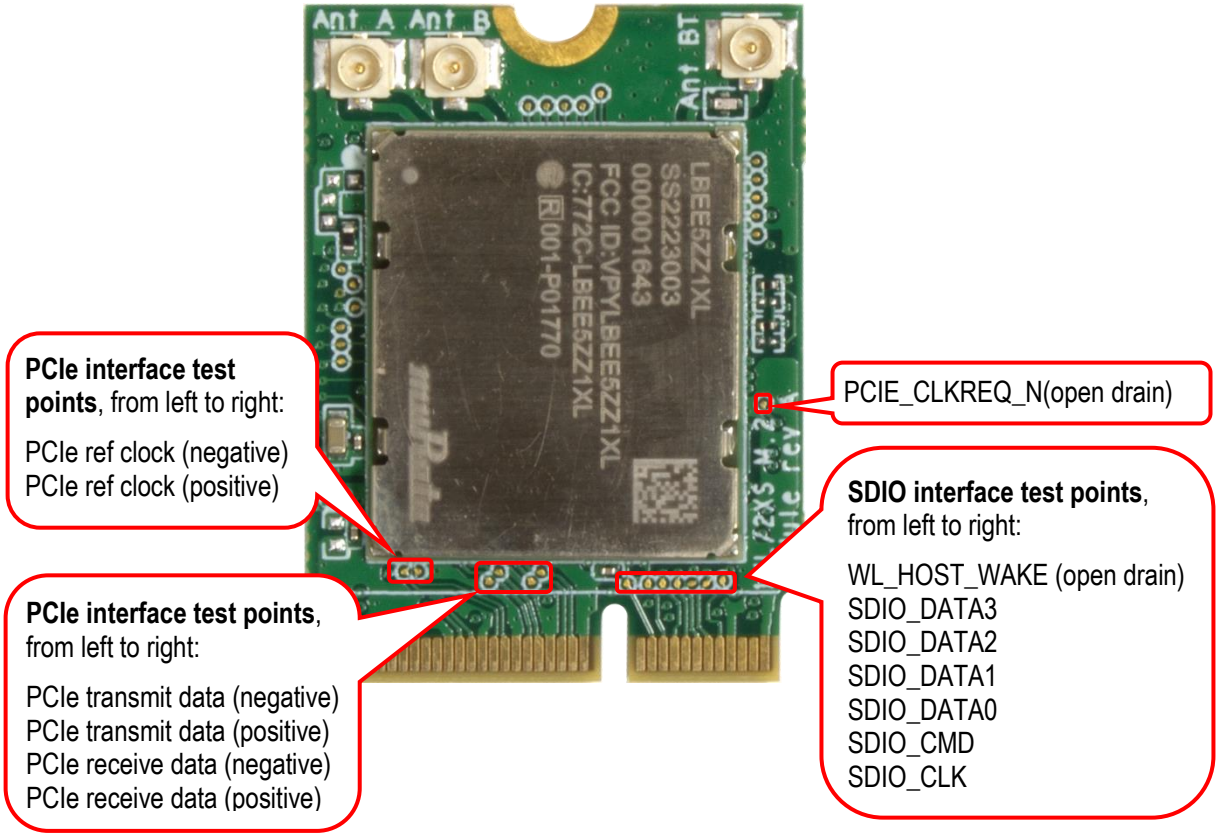

Figure 6 – 1XL / 2XS M.2 Module Test Points

3.9 Baud rate Differences between module Revisions

There are two kinds of 1XL/2XS modules. The older/original versions set the initial baud rate of Bluetooth UART interface to 3 Mbps, while the new versions set it to 115200 bps.

The different versions are identified by the number printed on the 1XL/2XS modules, as illustrated below.

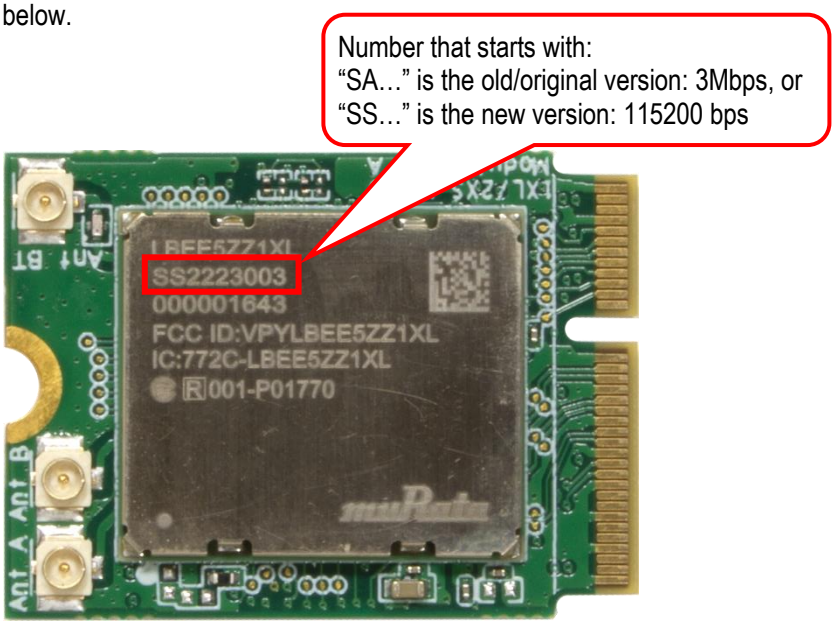

Figure 7 –Identifying 1XL/2XS Versions

The Linux BSP release supports the new version of the 1XL/2XS modules (115200 bps) by default. To use the older/original 1XL/2XS modules (3 Mbps), add the

```
fw-init-baudrate = <3000000>
```

property in Bluetooth device node of the dts file to make it work.

3.10 Differences between Revisions

To align the M.2 pinning with the coexistence interface, the M.2 pinning of four signals has been adjusted on rev PB2 (and above), as listed in the table below. If the coexistence interface has not been used/enabled, the pinning update does not affect any operation.

M.2 pin	M.2 pin definition	Board rev PA2/A	Board rev PB2/B
38	VENDORDEFINED	GPIO31, pin 47 Signal can be JTAG_TDO	GPIO29, pin 48 Signal can be JTAG_TMS
44	COEX3	GPIO30, pin 49 Signal can be JTAG_TDI	GPIO28, pin 50 Signal can be JTAG_TCK
46	COEX_TXD	GPIO28, pin 50 Signal can be JTAG_TCK	GPIO31, pin 47 Signal can be JTAG_TDO
48	COEX_RXD	GPIO29, pin 48 Signal can be JTAG_TMS	GPIO30, pin 49 Signal can be JTAG_TDI

4 Thermal Management

The module has a high current consumption and will hence generate up to 5.5 Watt of heat. A thermal management system is absolutely needed to operate the module without damaging it.

One solution is to dissipate the heat from the bottom side of the 1XL / 2XS M.2 board via a thermal pad to the carrier board, as illustrated in the picture below.

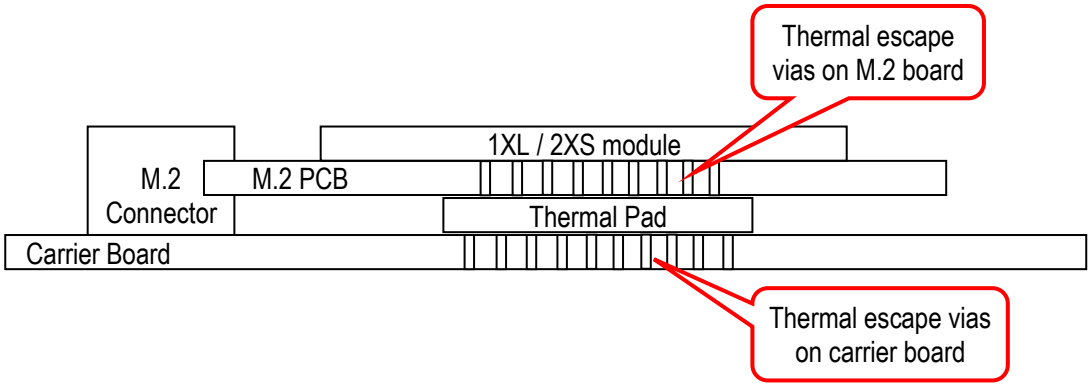

Figure 8 – Thermal Management

5 Antenna

The module does not have any on-board antenna because the module is too small to get spatial separation of the two antennas. Two external antennas must be connected (to support MIMO).

Molex 1461530050 is a balanced, dipole-type, high efficiency antenna used for the reference certification of the 1XL / 2XS module. It is ground plane independent, dual band antenna that supports the 2400-2500MHz, 5150-5850MHz, 5925-7125MHz frequency bands. The physical size is 40.95 x 9 x 0.7mm. The antenna cable comes in 6 standard length options: 50/100/150/200/250/300mm (50mm is used for the reference certification) and the connector is MHF-I, which is a U.FL compatible connector.

Figure 9 – Reference Certified Antenna

Note that it is **not** the Molex 1461530050 antenna that is included when ordering the evaluation bundle of the 1XL / 2XS M.2 board (bulk/tray orders of 1XL / 2XS M.2 do not include antennas). Instead, it is the Molex 1461870100 antenna that is included. This antenna has 100mm cable. Murata permits using this antenna (Molex 1461870100) with a *Class I Permissive Change*.

5.1 Antenna Connector

The M.2 standard specifies a 1.5 mm outer ring diameter male connector, which is compatible with the Murata MSC and IPEX MHF4 connector specifications. This connector is not used since our M.2 modules also target industrial users, where the Hirose U.FL. connector standard is more commonly used. U.FL. is compatible with the IPEX MHF1 connector specification.

5.2 1XL / 2XS Difference - Shared Bluetooth Antenna

For 1XL, the Bluetooth interface has a separate antenna connector so there are three antenna connectors in total for this board. This allows MIMO operation on both the 2.4GHz and 5GHz bands while Bluetooth is active.

For 2XS, Wi-Fi main antenna B and Bluetooth share the same antenna. There are two antenna connectors in total for this board. This limits MIMO operation to only the 5GHz bands while Bluetooth is active. This is typically not a severe limitation and the benefits of saving one antenna outweigh the lack of MIMO operation on the 2.4GHz band. The 2XS will be best suited for most applications.

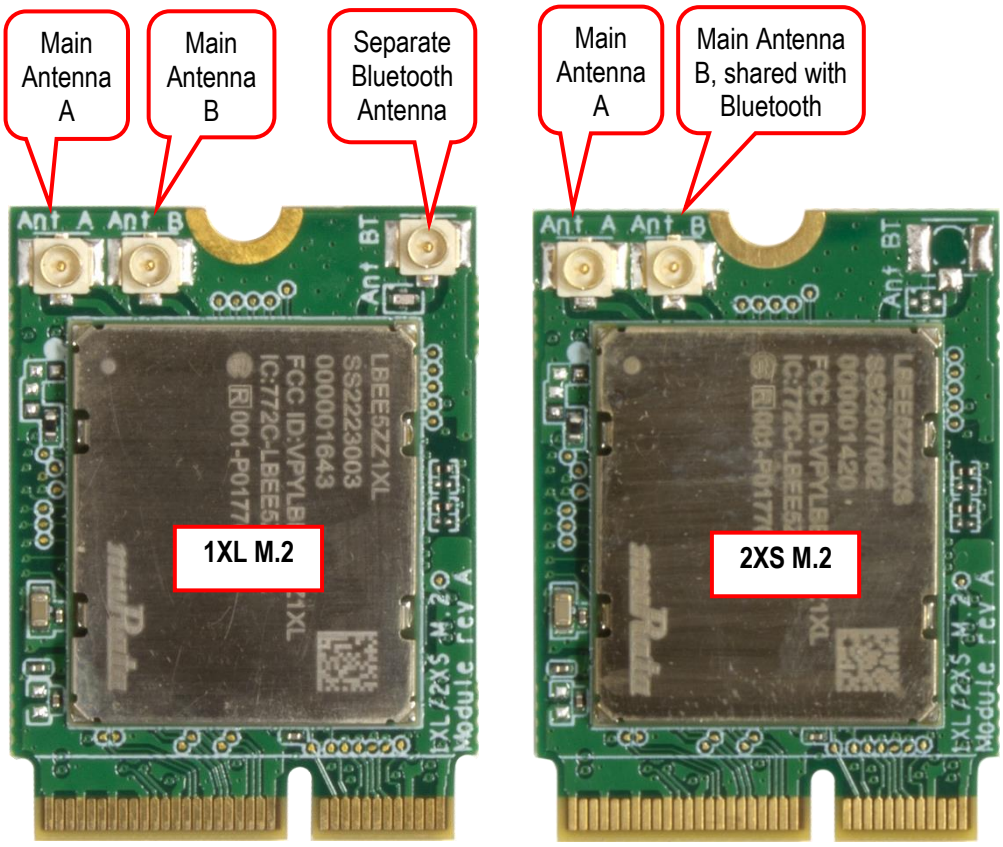

Figure 10 – Bluetooth Antenna Difference between 1XL and 2XS

6 Software and Support

This chapter contains information about software and support.

6.1 Software Driver

The 88W9098 chipset does not contain any persistent software. A firmware image must be downloaded by the host at start-up. This is the responsibility of the operating system driver.

There are three different cases, depending on which host processor is used:

1. **Embedded Artists' Computer-on-Modules, (u)COM, as host processor**
   Embedded Artists' Linux BSPs and SDKs for the different (u)COM board contains all drivers available and pre-configured. Everything has been tested and works out-of-the-box on our many iMX Developer's Kits.

iMX Developer's Kit	1XL / 2XS M.2 PCIe support	1XL / 2XS M.2 SDIO support
iMX93 uCOM	No	Linux v6.1.1
iMX8M Mini uCOM	Linux v5.10.35	Linux v5.15.32
iMX8M Nano uCOM	No	Linux v5.15.32
iMX7 Dual COM	Linux v5.10.35	Linux v5.15.32
iMX7 Dual uCOM	Linux v5.10.35	Linux v5.15.32
iMX7ULP uCOM	No	No
iMX6 Quad COM	Linux v5.10.35	Linux v5.15.32
iMX6 DualLite COM	Linux v5.10.35	Linux v5.15.32
iMX6 SoloX COM	Linux v5.10.35	Linux v5.15.32
iMX6 UltraLite/ULL COM	No	Linux v5.15.32
iMX RT1176 uCOM	No	No
iMX RT1166 uCOM	No	No
iMX RT1064 uCOM	No	No
iMX RT1062 OEM	No	No

2. **Other i.MX based, for example NXP's EVKs**
   Murata has created documentation how to compile the Linux kernel for the NXP EVKs https://wireless.murata.com/products/rf-modules-1/wi-fi-bluetooth-for-nxp-i-mx.html#Linux

3. **Non-i.MX host processor**
   There is no ready-to-go driver exist. Contact Murata to check driver availability on the hardware platform used.

6.2 Support

Embedded Artists supports customers that use our M.2 module in combination with Embedded Artists' Computer-on-Modules, (u)COM, based on NXP's i.MX RT/6/7/8/9 families.

For other platforms, support is provided by Murata via their Community Support Forum:
https://community.murata.com/s/topic/0TO5F0000002TLWWA2/connectivity-modules

7 Regulatory

The Murata 1XL / 2XS modules are reference certified. See the LBEE5ZZ1XL / LBEE5ZZ2XS datasheets from Murata for details.

7.1 European Union Regulatory Compliance

EUROPEAN DECLARATION OF CONFORMITY (Simplified DoC per Article 10.9 of the Radio Equipment Directive 2014/53/EU)

This apparatus, namely 1XL / 2XS M.2 module (pn EAR00387 / EAR00418 / EAR00419 / EAR00444 / EAR00411 / EAR00447 / EAR00449 / EAR00450) conforms to the Radio Equipment Directive (RED) 2014/53/EU. The full EU Declaration of Conformity for this apparatus can be found at this location: https://www.embeddedartists.com/products/1xl-m-2-module/, see documents *1XL M.2 module Declaration of Conformity* and *2XS M.2 module Declaration of Conformity*

The following information is provided per Article 10.8 of the Radio Equipment Directive 2014/53/EU:

(a) Frequency bands in which the equipment operates.

(b) The maximum RF power transmitted.

PN	RF Technology	(a) Frequency Ranges (EU)	(b) Max Transmitted Power
EAR00387 / EAR00418 / EAR00419 / EAR00444 / EAR00411 / EAR00447 / EAR00449 / EAR00450	Bluetooth BR/EDR/LE	2400 MHz – 2484 MHz	6 dBm
EAR00387 / EAR00418 / EAR00419 / EAR00444 / EAR00411 / EAR00447 / EAR00449 / EAR00450	Wi-Fi IEEE 802.11b/g/n	2400 MHz – 2484 MHz	20 dBm
EAR00387 / EAR00418 / EAR00419 / EAR00444 / EAR00411 / EAR00447 / EAR00449 / EAR00450	Wi-Fi IEEE 802.11a/n/ac/ax	5150 MHz – 5850 MHz	19 dBm

The 1XL / 2XS M.2 modules complies with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

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