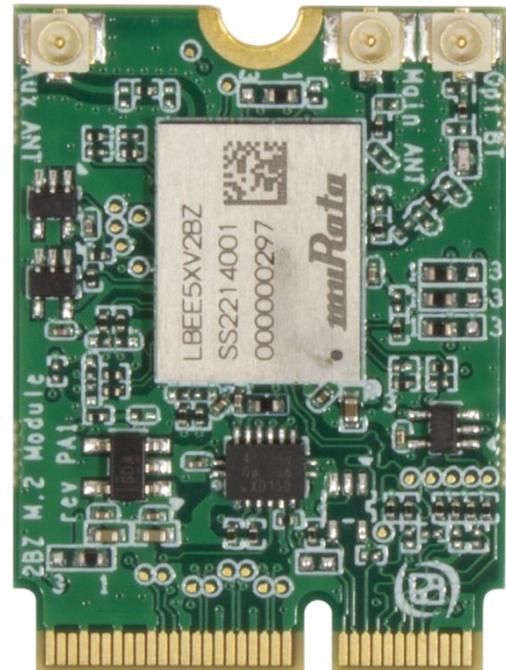# 2BZ M.2 Module (EAR00414) Datasheet

- Wi-Fi 5, 802.11 a/b/g/n/ac 2x2 MIMO
- Bluetooth 5.2 BR/EDR/LE
- SDIO 3.0 interface, SDR104@208MHz
- Chipset: Infineon/Cypress CYW54590

Get Up-and-Running Quickly and
Start Developing Your Application On Day 1!

Embedded Artists

Embedded Artists AB

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Table of Contents

1   Document Revision History

This document applies to the following products.

Product Name	Type Number	Murata Module	Chipset	Product Status
2BZ M.2 Module, rev A	EAR00414	LBEE5XV2BZ-883	CYW54590	Mass Market

1.1   Revision History

Revision	Date	Description
PA1	2023-01-12	Initial release.

2   Introduction

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

The main component in the design is Murata's 2BZ module (full part number: LBEE5XV2BZ-883), which in turn is based on the Infineon CYW54590 chipset. The 2BZ module enables Wi-Fi, Bluetooth and Bluetooth Low Energy (LE) communication.

There are multiple application areas for the 2BZ M.2 Module:

- Industrial and Buildings 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) with responsive support from Murata.
- Supported by Embedded Artists' Developer's Kits for i.MX RT/6/7/8/9 development, including advanced debugging support on carrier boards
- One component to buy, instead of 30+
- No RF expertise is required
- Developed in close collaboration with Murata and Infineon

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, RoHS3, 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 2BZ module (full part number: LBEE5XV2BZ), which in turn is based around Infineon (former Cypress) CYW54590 chipset.

For a full specification, see on Murata's 2BZ module (LBEE5XV2BZ-883) see Murata's 2BZ product page (https://www.murata.com/products/connectivitymodule/wi-fi-bluetooth/overview/lineup/type2bz) and the 2BZ datasheet (https://www.murata.com/products/productdata/8817342119966/TYPE2BZ.pdf).

Module / Chipset	
Murata module	LBEE5XV2BZ-883
Chipset	Infineon (former Cypress) CYW54590

Wi-Fi	
Standards	802.11a/b/g/n/ac 5G 2x2 MIMO, Wi-Fi 5
Network	uAP and STA dual mode
Frequency	2.4GHz and 5 GHz band
Data rates	11, 54, 144, 300, 866 Mbps
Host interface	SDIO 3.0, SDR12@25MHz, SDR25@50MHz, SDR50@100MHz, SDR104@208MHz

Bluetooth	
Standards	5.2 BR/EDR/LE, 3MPHY
Power Class	Class 2
Host interface	4-wire UART@3MBaud
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**	**Typ**	**Max**
	0.0V minimum 3.0V operating and RF specification	3.3V	3.6V **Note** that LBEE5XV2BZ module specification has higher maximum voltage (4.8V), but other components on the M.2 module limits the maximum voltage.
Receive mode current (WLAN)	250 mA typical max		
Transmit mode current (WLAN)	540 mA typical max		

Environmental Specification	

Operational Temperature	-40 to +85 degrees Celsius	Functionally ok, but specification is derated at temperature extremes
Specification Temperature	-10 to +70 degrees Celsius	Fully specified
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.

Signals WL_REG_ON or BT_REG_ON must be held low for at least 700 microseconds after supply voltage has reached specification level before pulled high. 2 clock cycles of the 32.678kHz clock must also have passed before any of the signals is pulled high. These clock cycles will typically occur during the 700 microseconds but if the clock signal has a long delay during power-up, the 700 microsecond period can be extended.

3.2 External Sleep Clock

The sleep clock signals can be applied to a powered and unpowered M.2 module.

Clock Specification	
Frequency	32.768 kHz
Frequency accuracy	±250 ppm (including tolerance, aging, temperature, etc)
Duty cycle	30 - 70%
Clock jitter	10 000 ppm max (during initial start-up)
Voltage level	3.3V logic, according to M.2 standard

3.3 Mechanical Dimensions

The M.2 module is of type: 2230-S3-E according to the M.2 nomenclature. This means width 22 mm, length 30mm, top 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	30	mm
PCB thickness	0.8	mm
Maximum component height on top side	1.5	mm
Maximum component height on bottom side	0	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.
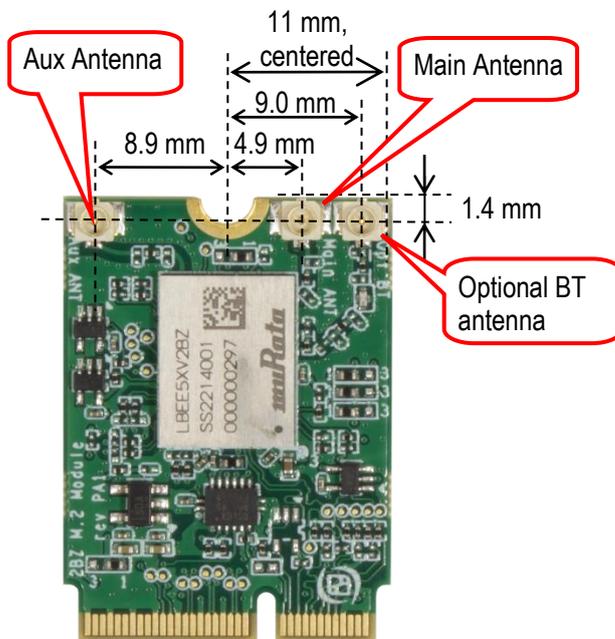
Figure 1 – M.2 Module Antenna Connector Measurements

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/Cypress.

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

Figure 2 – M.2 Module Pin Numbering

The Wi-Fi interface uses the SDIO interface. The Bluetooth interface uses the UART interface for control and PCM interface for audio. The table below lists the pin usage for the 2BZ M.2 modules. The column "When is signal needed" signals four different categories:

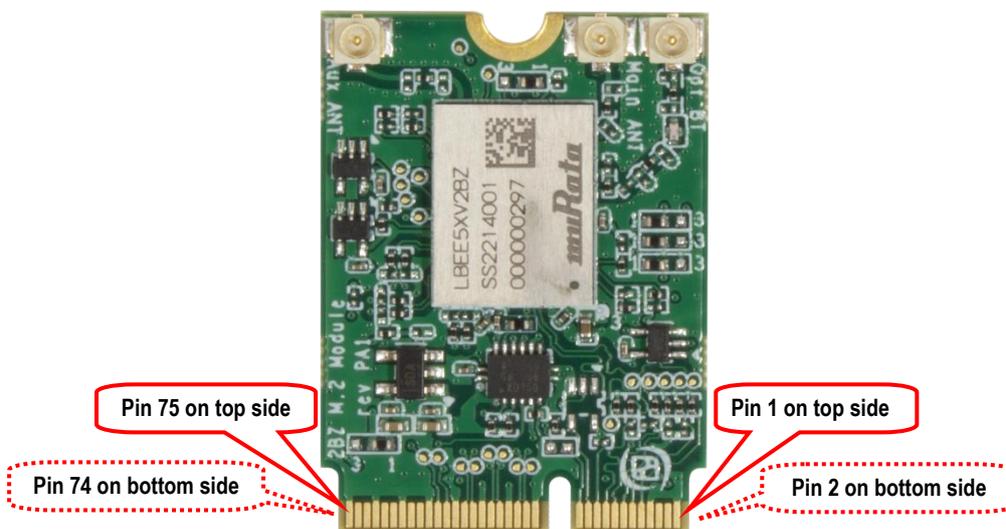- Always: These signals shall always be connected.
- Wi-Fi: These signals shall always be connected then the Wi-Fi interface is used.
- Bluetooth: These signals shall always be connected then the Bluetooth interface is used.
- Optional: These signals are optional to connect.

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#			Not connected.
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 2BZ module, signal BT_PCM_CLK, pin 76
9	Top	SDIO CLK	1.8V Input to M.2[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_CLK Connected to 2BZ module, signal SDIO_CLK, pin 59
10	Bottom	PCM_SYNC	1.8V I/O[1]	Bluetooth audio	For Bluetooth audio interface: BT_PCM_SYNC Connected to 2BZ module, signal BT_PCM_SYNC, pin 77
11	Top	SDIO CMD	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_CMD Connected to 2BZ module, signal SDIO_CMD, pin 58 Note: 10-100K ohm pullup required
12	Bottom	PCM_OUT	1.8V output from M.2[1]	Bluetooth audio	For Bluetooth audio interface: BT_PCM_OUT Connected to 2BZ module, signal BT_PCM_OUT, pin 75
13	Top	SDIO DATA0	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D0 Connected to 2BZ module, signal SDIO_DATA0, pin 60 Note: 10-100K ohm pullup required
14	Bottom	PCM_IN	1.8V input to M.2[1]	Bluetooth audio	For Bluetooth audio interface: BT_PCM_IN Connected to 2BZ module, signal BT_PCM_IN, pin 74
15	Top	SDIO DATA1	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D1 Connected to 2BZ module, signal SDIO_DATA1, pin 63 Note: 10-100K ohm pullup required
16	Bottom	LED_2#			Not connected.
17	Top	SDIO DATA2	1.8V I/O[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D2 Connected to 2BZ module, signal SDIO_DATA2, pin 62 Note: 10-100K ohm pullup required
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 2BZ module, signal SDIO_DATA3, pin 61
					Note: 10-100K ohm pullup required
20	Bottom	UART WAKE#	3.3V OD output from M.2	Bluetooth	For Bluetooth UART interface: BT_HOST_WAKE_L, also called DEV_BT_WAKE
					Connected to 2BZ module, signal BT_HOST_WAKE, pin 22
					Require an external 10K pull-up resistor to 3.3V.
21	Top	SDIO WAKE#	1.8V OD output from M.2[1]	Wi-Fi SDIO	For Wi-Fi SDIO interface: WL_HOST_WAKE_L, also called DEV_WL_WAKE
					Connected to 2BZ module, signal GPIO_0, pin 90
					Require an external 10K pull-up resistor to 3.3V.
22	Bottom	UART TXD	1.8V output from M.2[1]	Bluetooth	For Bluetooth UART interface: BT_UART_TXD
					Connected to 2BZ module, signal BT_UART_TXD, pin 39
23	Top	SDIO RESET#			Not connected.
24	Key, non existing				
25	Key, non existing				
26	Key, non existing				
27	Key, non existing				
28	Key, non existing				
29	Key, non existing				
30	Key, non existing				
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 2BZ module, signal BT_UART_RXD, pin 38
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 2BZ module, signal BT_UART_RTS, pin 36
35	Top	PERp0			Not connected.
36	Bottom	UART_CTS	1.8V input to M.2[1]	Bluetooth	For Bluetooth UART interface: BT_UART_CTS
					Connected to 2BZ module, signal BT_UART_CTS, pin 37
37	Top	PERn0			Not connected.
38	Bottom	VENDOR DEFINED			Not connected.
39	Top	GND		Always	Connect to ground.
40	Bottom	VENDOR DEFINED	1.8V I/O[1]	Optional	For Wi-Fi SDIO interface WL_DEV_WAKE_L, also called HOST_WL_WAKE
					Connected to 2BZ module, signal GPIO_1, pin 89
41	Top	PETp0			Not connected.
42	Bottom	VENDOR DEFINED	1.8V input to M.2[1]	Bluetooth	For Bluetooth UART interface: BT_DEV_WAKE_L
					Connected to 2BZ module, signal BT_DEV_WAKE, pin 23
43	Top	PETn0			Not connected.
44	Bottom	COEX3			Not connected.
45	Top	GND		Always	Connect to ground.
46	Bottom	COEX_TXD			Not connected.
47	Top	REFCLKp0			Not connected.

48	Bottom	COEX_RXD			Not connected.
49	Top	REFCLKn0			Not connected.
50	Bottom	SUSCLK	3.3V input to M.2	Always	External sleep clock input (32.768kHz)
51	Top	GND		Always	Connect to ground.
52	Bottom	PERST0#			Not connected.
53	Top	CLKREQ0#			Not connected.
54	Bottom	W_DISABLE2#	3.3V input to M.2	Always	BT_REG_ON, High = BT part of module enabled/internally powered, Low = BT disabled/powered down Connected to 2BZ module, signal BT_REG_ON, pin 6
55	Top	PEWAKE0#			Not connected.
56	Bottom	W_DISABLE1#	3.3V input to M.2	Always	WL_REG_ON, High = Wi-Fi part of module enabled/internally powered, Low = Wi-Fi disabled/powered down Connected to 2BZ module, signal WL_REG_ON, pin 5
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			Not connected.
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: Signaling voltage can be changed to 3.3V, see section 0

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 a smaller rework of the 2BZ M.2 board. Note that the rework is needed at two locations on the board (both must be done), see picture below.

VDDIO select:

VDDIO=1.8V (default):
no resistor in upper position. 10K ohm 0201-size resistor in lower position.

VDDIO=3.3V (requires rework):
Zero ohm 0201-size resistor in upper position. No resistor in lower position.

VDDIO select:

Right pos (1-2), default, 1.8V

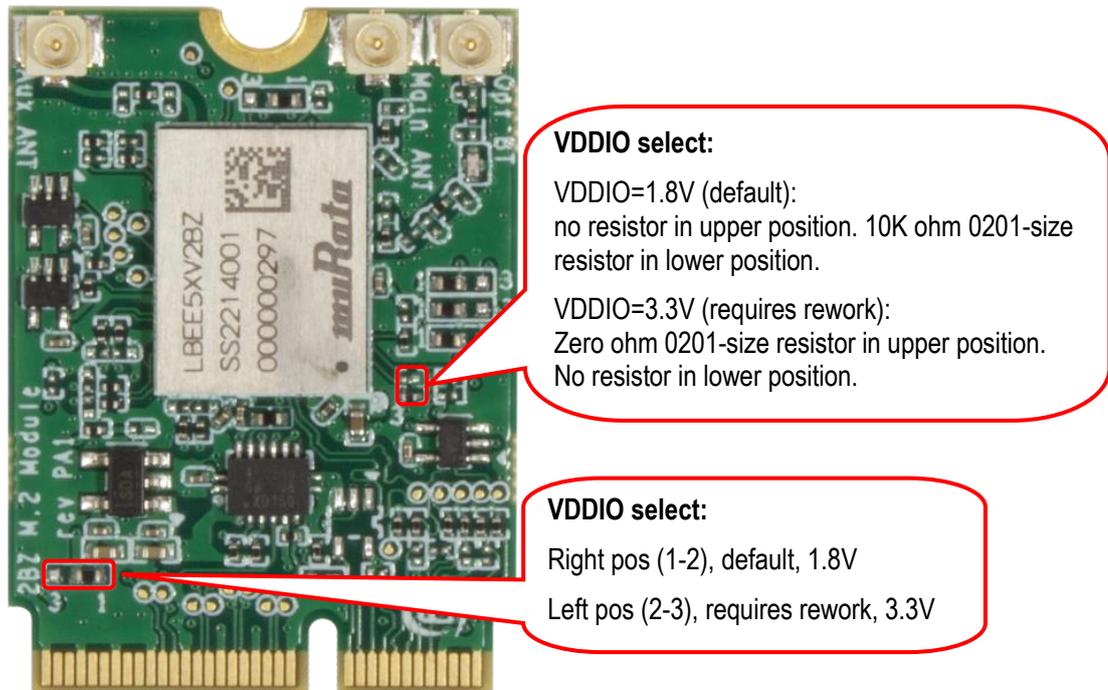Left pos (2-3), requires rework, 3.3V

Figure 3 – 2BZ M.2 Module Rework for 3.3V IO

Note that using the 3.3V VIO option will limit the SDIO clock to 50 MHz, thereby limiting throughput. Running at 1.8V VIO will support up to 200 MHz SDIO clock which is ultimately needed for maximum 802.11ac throughput, see next section for details.

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

3.7 Test Points

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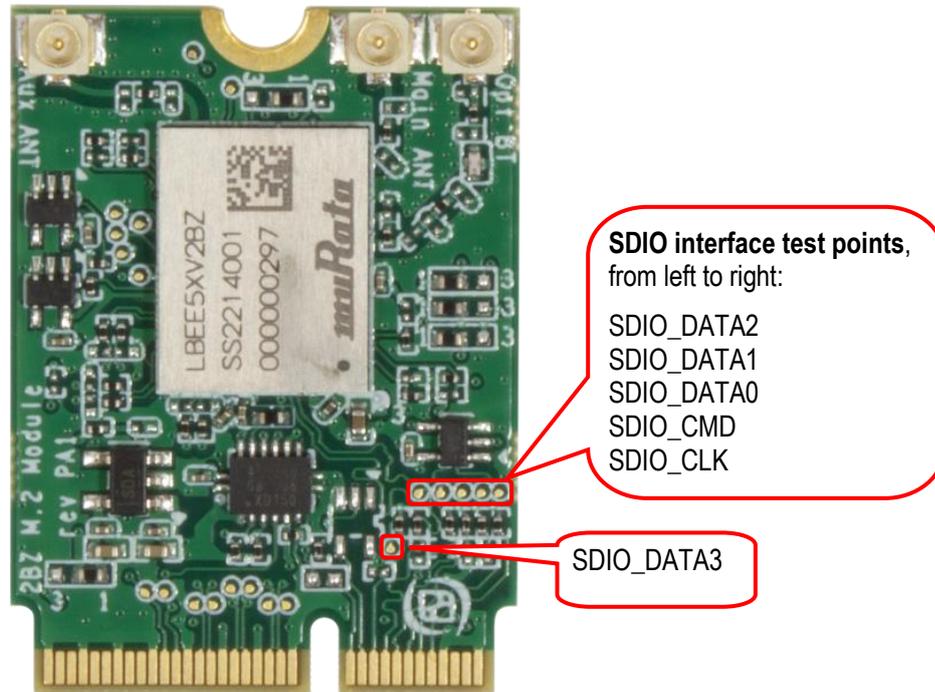

Figure 4 – 2BZ M.2 Module Test Points

4   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).

Two different antenna types have been used for the reference certification of the 1YM module.

- Molex 1461870050 is a balanced, dipole-type, high efficiency antenna. It is ground plane independent, dual band antenna that supports the 2400-2500MHz and 5150-5850MHz 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.

- Molex 1461530050 is also a balanced, dipole-type, high efficiency antenna. It is ground plane independent, dual band antenna that supports the 2400-2500MHz and 5150-5850MHz frequency bands. The physical size is 35 x 9 x 0.1mm. 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 5 – Reference Certified Antenna

Note that it is **not** the Molex 1461870050 antenna that is included when ordering the evaluation bundle of the 2BZ M.2 board (bulk/tray orders of 2BZ M.2 do not include antennas). Instead, it is the Molex 1461870100 antenna that is included. This antenna has 100 mm cable. Murata permits using this antenna (Molex 1461870100) with a *Class I Permissive Change*.

Also note that it is not allowed to mix the two reference certified antennas. Both antennas must be of the same time in any given installation

4.1   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 targets industrial users, where the Hirose U.FL. connector standard is more commonly used. U.FL. is compatible with the IPEX MHF1 connector specification.

5 Software and Support

This chapter contains information about software and support.

5.1 Software Driver

The CYW54590 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 the different iMX Developer's Kits.

iMX Developer's Kit	2BZ M.2 support
iMX8M Mini uCOM	Linux v5.15.32
iMX8M Nano uCOM	Linux v5.15.32
iMX8M COM	No
iMX7 Dual COM	Linux v5.15.32
iMX7 Dual uCOM	Linux v5.15.32
iMX7ULP uCOM	No
iMX 6 Quad COM	Linux v5.15.32
iMX 6 DualLite COM	Linux v5.15.32
iMX 6 SoloX COM	Linux v5.15.32
iMX 6 UltraLite/ULL COM	Linux v5.15.32
iMX RT1176 uCOM	No
iMX RT1166 uCOM	No
iMX RT1064 uCOM	No
iMX RT1062 OEM	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.

5.2 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

6   Regulatory

The Murata 2BZ module is reference certified. See the LBEE5XV2BZ datasheets from Murata for details.

6.1   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 2BZ M.2 module (pn EAR00414) 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/2bz-m-2-module/, see documents *2BZ 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
EAR00414	Bluetooth BR/EDR/LE	2400 MHz – 2484 MHz	14.5 dBm
EAR00414	Wi-Fi IEEE 802.11b/g/n	2400 MHz – 2484 MHz	19.5 dBm
EAR00414	Wi-Fi IEEE 802.11a/n/ac	5150 MHz – 5850 MHz	16.5 dBm

The 2BZ M.2 module complies with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

7   Disclaimers

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