2AE / 2BC M.2 Module Datasheet (EAR00388 / EAR00436 / EAR00445)

- Wi-Fi 5, 802.11 a/b/g/n/ac
- Bluetooth 5.2 BR/EDR/LE
- SDIO 3.0 interface, SDR50@100MHz
- Chipset: Infineon/Cypress CYW4373E

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

Embedded Artists

Embedded Artists AB
Rundelsgatan 14
211 36 Malmö
Sweden

https://www.EmbeddedArtists.com

Disclaimer

Embedded Artists AB makes no representation or warranties with respect to the contents hereof and specifically disclaim any implied warranties or merchantability or fitness for any particular purpose. The information has been carefully checked and is believed to be accurate, however, no responsibility is assumed for inaccuracies.
Information in this publication is subject to change without notice and does not represent a commitment on the part of Embedded Artists AB.

Feedback

We appreciate any feedback you may have for improvements on this document.

Trademarks

All brand and product names mentioned herein are trademarks, services marks, registered trademarks, or registered service marks of their respective owners and should be treated as such.

Table of Contents

1 Document Information

This document applies to the following products.

Product Name	*Type Number*	*Murata Module*	*Chipset*	*Product Status*
2AE M.2 Module, rev A/A1	EAR00388 / EAR00445	LBEE5PK2AE-564	CYW4373E	Production
2BC M.2 Module, rev A/A1	EAR00436	LBEE5PK2BC-771	CYW4373	Production

1.1 Revision History

Revision	*Date*	*Description*
PA1	2021-10-05	First version.
PA2	2022-02-08	Corrected strap resistor value for alternative interface selection.
PA3	2022-12-23	Added reference to the 2BC module.

2 Introduction

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

The main component in the design is Murata's 2AE module (full part number: LBEE5PK2AE-564) or 2BC module (full part number: LBEE5PK2BC-771), which in turn is based on the Infineon/Cypress CYW4373(E) chipset. The 2AE / 2BC module enables Wi-Fi, Bluetooth and Bluetooth Low Energy (LE) communication.

The 2AE / 2BC M.2 modules are identical except for the operating temperature range.

- The 2AE M.2 is designed for industrial applications, having a temperature range of -40 to +85 degrees Celsius.
- The 2BC M.2 has a temperature range of -20 to +40 degrees Celsius.

There are multiple application areas for the 2AE / 2BC M.2 Module:

- 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 RT/6/7/8 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, 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 2AE / 2BC module (full part number: LBEE5PK2AE / LBEE5PK2BC), which in turn is based around Infineon's CYW4373(E) chipset.

For a full specification, see Murata's 2AE Module (LBEE5PK2AE) product page: https://www.murata.com/products/connectivitymodule/wi-fi-bluetooth/overview/lineup/type2ae and the LBEE5PK2AE datasheet: https://www.murata.com/products/productdata/8816428220446/type2ae.pdf

For a full specification, see Murata's 2BC Module (LBEE5PK2BC) product page: https://www.murata.com/products/connectivitymodule/wi-fi-bluetooth/overview/lineup/type2bc and the LBEE5PK2BC datasheet: https://www.murata.com/products/productdata/8816701374494/type2bc.pdf

Module / Chipset	
Murata module	LBEE5PK2AE-564 / LBEE5PK2BC-771
Chipset	Infineon CYW4373E / CYW4373

Wi-Fi	
Standards	802.11a/b/g/n/ac, Wi-Fi 5
Network	uAP and STA dual mode
Frequency	2.4GHz and 5 GHz band
Data rates	11, 54 Mbps
Host interface	SDIO 3.0, SDR12@24MHz, SDR25@50MHz, SDR50@100MHz, SDR104@208MHz, DDR50@50MHz

Bluetooth	
Standards	5.2 BR/EDR/LE, 3Mbps 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 3.13V operating and RF specification	**Typ** 3.3V	**Max** 3.5V **Note** that LBEE5PK2AE / LBEE5PK2BC module specification has higher maximum voltage (5.5V), but other components on the M.2 module limit the maximum voltage.
Peak current	TBD max		The power supply must be designed for this peak current,

		which typically happen during the startup calibration process.
Receive mode current (WLAN)	TBD mA typical max	Note that current consumption varies widely between different operational modes.
Transmit mode current (WLAN)	TBD mA typical max	Note that current consumption varies widely between different operational modes.

Environmental Specification		
Operational Temperature	-40 to +85 degrees Celsius -20 to +70 degrees Celsius	for 2AE for 2BC
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.

Chipset signals WL_REG_ON (M.2 signal W_DISABLE1#) and BT_REG_ON (M.2 signal W_DISABLE2#) 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	±200 ppm including initial 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 (without trace antenna), 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, 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	0	mm
Ground hole diameter	3.5	mm
Plating around ground hole, diameter	5.5	mm
Module weight	1.5 ±0.5 gram	gram

Embedded Artists has added a non-standard feature to the 2230 M.2 modules designed together with Murata, NXP and Infineon (former Cypress). The pictures below illustrate the how the standard module size has been extended by 14 mm in the length direction in order to include a pcb trace antenna.

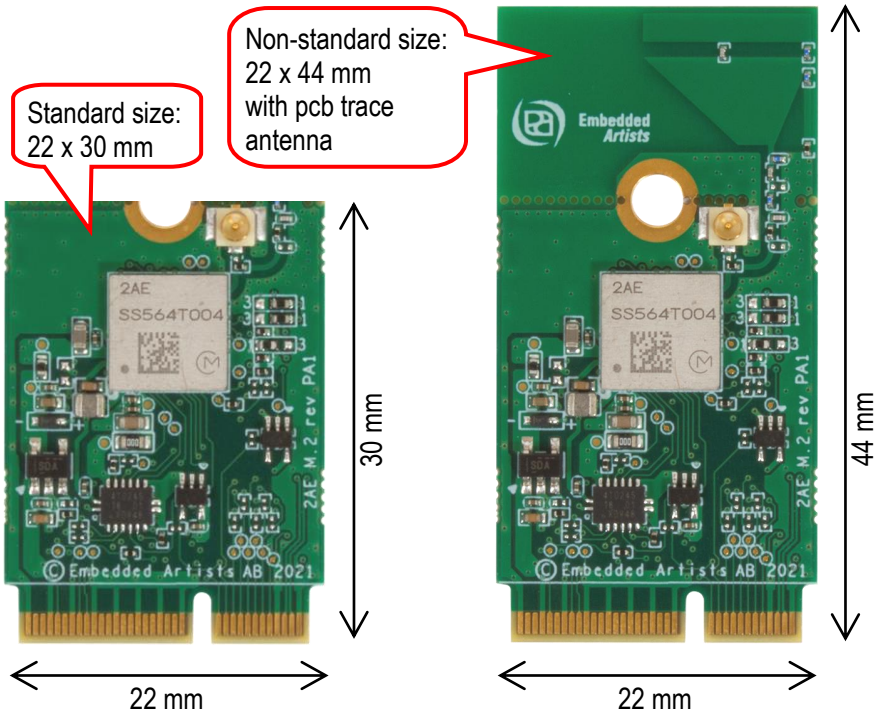


Figure 1 – M.2 Module with, and without, PCB Trace Antenna

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

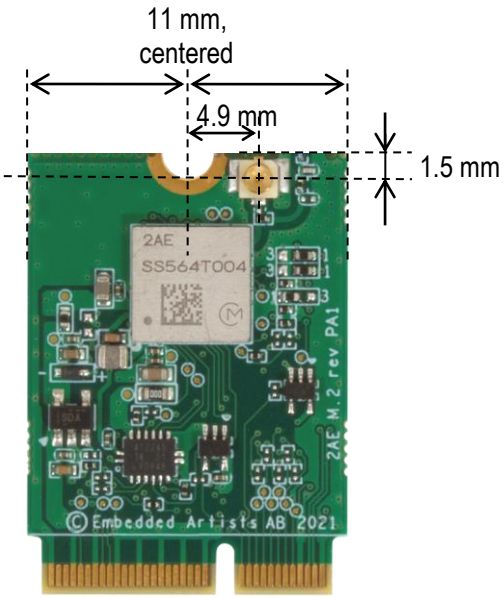


Figure 2 – M.2 Module Without Trace Antenna

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 top and bottom side. The removed pads in the keying notch count (but are obviously non-existing).

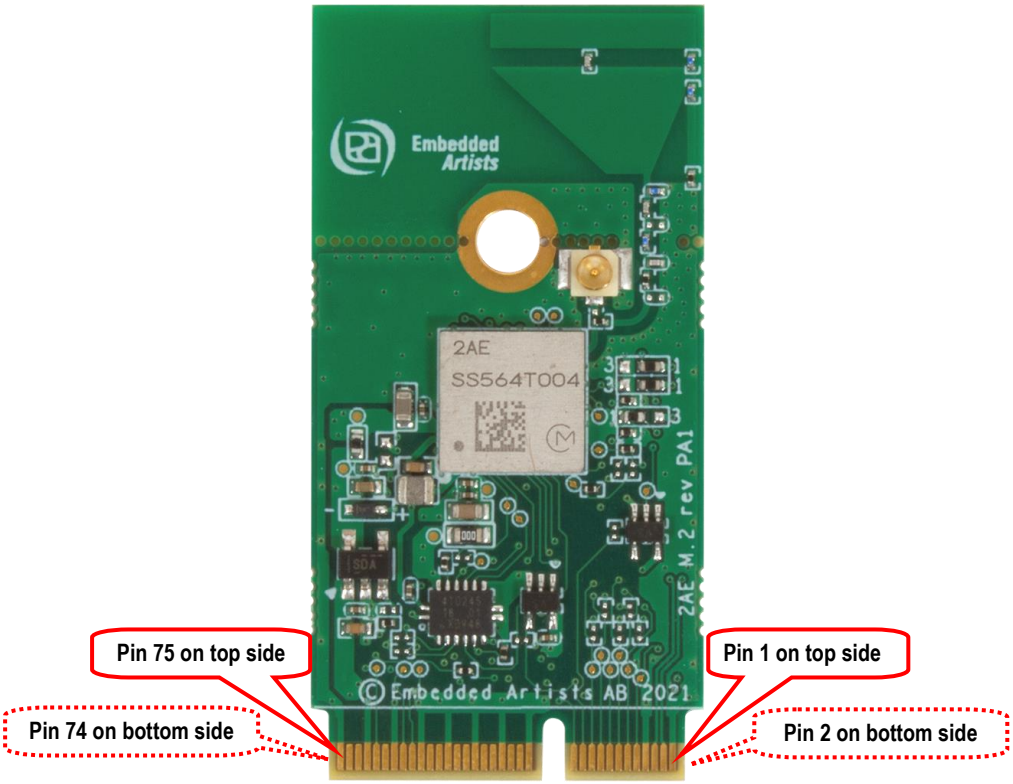


Figure 3 – M.2 Module Pin Numbering

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

- Always: These signals shall always be connected.
- Wi-Fi SDIO: These signals shall always be connected then the Wi-Fi interface is used via SDIO of the M.2 module.
- Wi-Fi USB: These signals shall always be connected then the Wi-Fi interface is used via USB of the M.2 module.
- 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+		Wi-Fi USB	Connected to USB interface of the 2AE / 2BC module.
4	Bottom	3.3 V		Always	Power supply input. Connect to stable, low-noise 3.3V supply.
5	Top	USB_D-		Wi-Fi USB	Connected to USB interface of the 2AE / 2BC module.
6	Bottom	LED_1#			Not connected.
7	Top	GND	GND	Always	Connect to ground.
8	Bottom	PCM_CLK	1.8V I/O	Bluetooth audio	For Bluetooth audio interface: BT_PCM_CLK Connected to 2AE / 2BC module, signal BT_PCM_CLK, pin 7
9	Top	SDIO CLK	1.8V Input to M.2	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_CLK Connected to 2AE / 2BC module, signal SDIO_CLK, pin 33
10	Bottom	PCM_SYNC	1.8V I/O	Bluetooth audio	For Bluetooth audio interface: BT_PCM_SYNC Connected to 2AE / 2BC module, signal BT_PCM_SYNC, pin 8
11	Top	SDIO CMD	1.8V I/O	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_CMD Connected to 2AE / 2BC module, signal SDIO_CMD, pin 28 Note: Require an external 10-100K ohm pullup
12	Bottom	PCM_OUT	1.8V output from M.2	Bluetooth audio	For Bluetooth audio interface: BT_PCM_OUT Connected to 2AE / 2BC module, signal BT_PCM_OUT, pin 9
13	Top	SDIO DATA0	1.8V I/O	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D0 Connected to 2AE / 2BC module, signal SDIO_DAT0, pin 30 Note: Require an external 10-100K ohm pullup
14	Bottom	PCM_IN	1.8V input to M.2	Bluetooth audio	For Bluetooth audio interface: BT_PCM_IN Connected to 2AE / 2BC module, signal BT_PCM_IN, pin 6
15	Top	SDIO DATA1	1.8V I/O	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D1 Connected to 2AE / 2BC module, signal SDIO_DAT1, pin 29 Note: Require an external 10-100K ohm pullup
16	Bottom	LED_2#			Not connected.
17	Top	SDIO DATA2	1.8V I/O	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D2 Connected to 2AE / 2BC module, signal SDIO_DAT2, pin 32 Note: Require an external 10-100K ohm pullup
18	Bottom	GND		Always	Connect to ground.
19	Top	SDIO DATA3	1.8V I/O	Wi-Fi SDIO	For Wi-Fi SDIO interface: SDIO_D3 Connected to 2AE / 2BC module, signal SDIO_DAT3, pin 31 Note: Require an external 10-100K ohm pullup
20	Bottom	UART WAKE#	3.3V OD output from M.2	Bluetooth	For Bluetooth UART interface: BT_HOST_WAKE_L Connected to 2AE / 2BC module, via open drain buffer, pin 17 Require an external 10K pullup resistor to 3.3V.
21	Top	SDIO WAKE#	1.8V OD output from M.2	Wi-Fi SDIO	For Wi-Fi SDIO interface WL_HOST_WAKE_L Connected to 2AE / 2BC module, via open drain buffer, pin 52 Note: Require an external 10K pullup resistor to 1.8V
22	Bottom	UART TXD	1.8V output from M.2	Bluetooth	For Bluetooth UART interface: BT_UART_TXD Connected to 2AE / 2BC module, signal GPIO10, pin 10
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	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	Bluetooth	For Bluetooth UART interface: BT_UART_RXD Connected to 2AE / 2BC module, pin 12
33	Top	GND		Always	Connect to ground.
34	Bottom	UART_RTS	1.8V output from M.2	Bluetooth	For Bluetooth UART interface: BT_UART_RTS Connected to 2AE / 2BC module, pin 13
35	Top	PERp0			Not connected.
36	Bottom	UART_CTS	1.8V input to M.2	Bluetooth	For Bluetooth UART interface: BT_UART_CTS Connected to 2AE / 2BC module, pin 11
37	Top	PERn0			Not connected.
38	Bottom	VENDOR DEFINED	1.8V I/O	Optional	Connected to 2AE / 2BC module, signal GPIO5, pin 45 Note: Signal can be JTAG_TDO
39	Top	GND		Always	Connect to ground.
40	Bottom	VENDOR DEFINED	1.8V I/O	Optional	For Wi-Fi SDIO interface WL_DEV_WAKE_L Connected to 2AE / 2BC module, signal GPIO1, pin 45
41	Top	PETp0			Not connected.
42	Bottom	VENDOR DEFINED	1.8V input to M.2	Bluetooth	For Bluetooth UART interface: BT_DEV_WAKE_L Connected to 2AE / 2BC module, pin 51
43	Top	PETn0			Not connected.
44	Bottom	COEX3	1.8V I/O	Optional	Connected to 2AE / 2BC module, signal GPIO4, pin 64 Note: Signal can be JTAG_TDI
45	Top	GND		Always	Connect to ground.
46	Bottom	COEX_TXD	1.8V I/O	Optional	Connected to 2AE / 2BC module, signal GPIO2, pin 66 Note: Signal can be JTAG_TCK
47	Top	REFCLKp0			Not connected.
48	Bottom	COEX_RXD	1.8V I/O	Optional	Connected to 2AE / 2BC module, signal GPIO3, pin 67 Note: Signal can be JTAG_TMS
49	Top	REFCLKn0			Not connected.
50	Bottom	SUSCLK	3.3V input to M.2	Always	External sleep clock input (32.768kHz) Connected to 2AE / 2BC module, via buffer, signal LPO_IN, pin 5
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	Connected to 2AE / 2BC module, via buffer, signal BT_REG_ON, pin 68 BT_REG_ON, High = BT part of module enabled/internally

					powered, Low = BT disabled/powered down
55	Top	PEWAKE0#			Not connected.
56	Bottom	W_DISABLE1#	3.3V input to M.2	Always	Connected to 2AE / 2BC module, via buffer, signal WL_REG_ON, pin 4 WL_REG_ON, High = Wi-Fi part of module enabled/internally powered, Low = Wi-Fi disabled/powered down
57	Top	GND		Always	Connect to ground.
58	Bottom	I2C_SDA			Not connected.
59	Top	Reserved			Connected to 2AE / 2BC module, signal BT_GPIO2, pin 18
60	Bottom	I2C_CLK			Not connected.
61	Top	Reserved			Connected to 2AE / 2BC module, signal BT_GPIO3, pin 19
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 signals.
65	Top	Reserved			Not connected.
66	Bottom	UIM_SWP			Not connected.
67	Top	Reserved			Connected to 2AE / 2BC module, signal BT_GPIO5, pin 20
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.

3.5 VDDIO Override Feature

The M.2 standard specify 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 in order to get 3.3V voltage level on all data and control signals.

Note: If 3.3V signaling level is used, the SDIO clock frequency is limited to 50 MHz. This can limit the data throughput of the Wi-Fi interface.

Note that it is not enough to connect a 3.3V supply to pin 64. The "Wi-Fi interface control" resistors must also be adjusted, see Figure 4 for location of these resistors.

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 and JTAG Interface Control

It is possible to configure which interface, SDIO or USB, the Wi-Fi interface shall have. The picture below illustrates the location of the controlling resistors. Note that there is no publicly available driver that supports the USB interface. It is currently only available for specific customers.

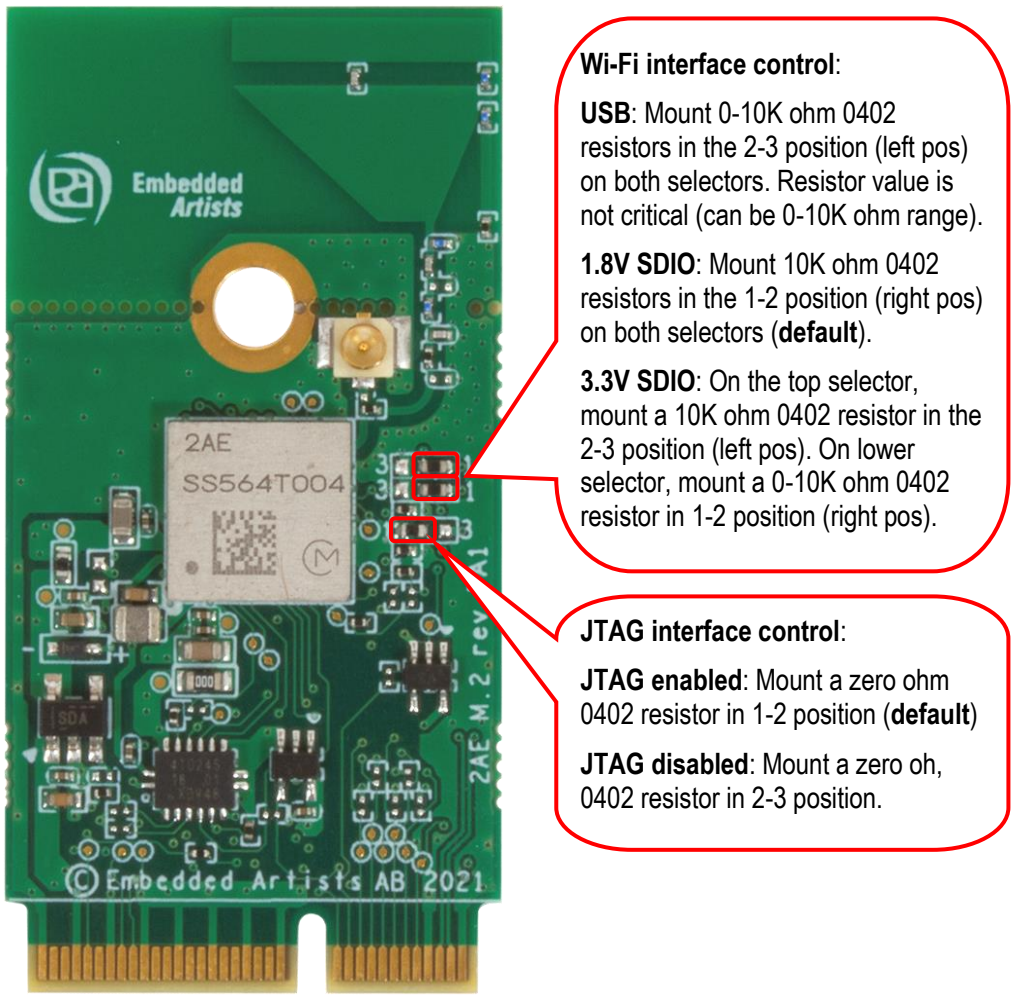


Figure 4 – 2AE / 2BC M.2 Module Wi-Fi and JTAG Interface Control

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.

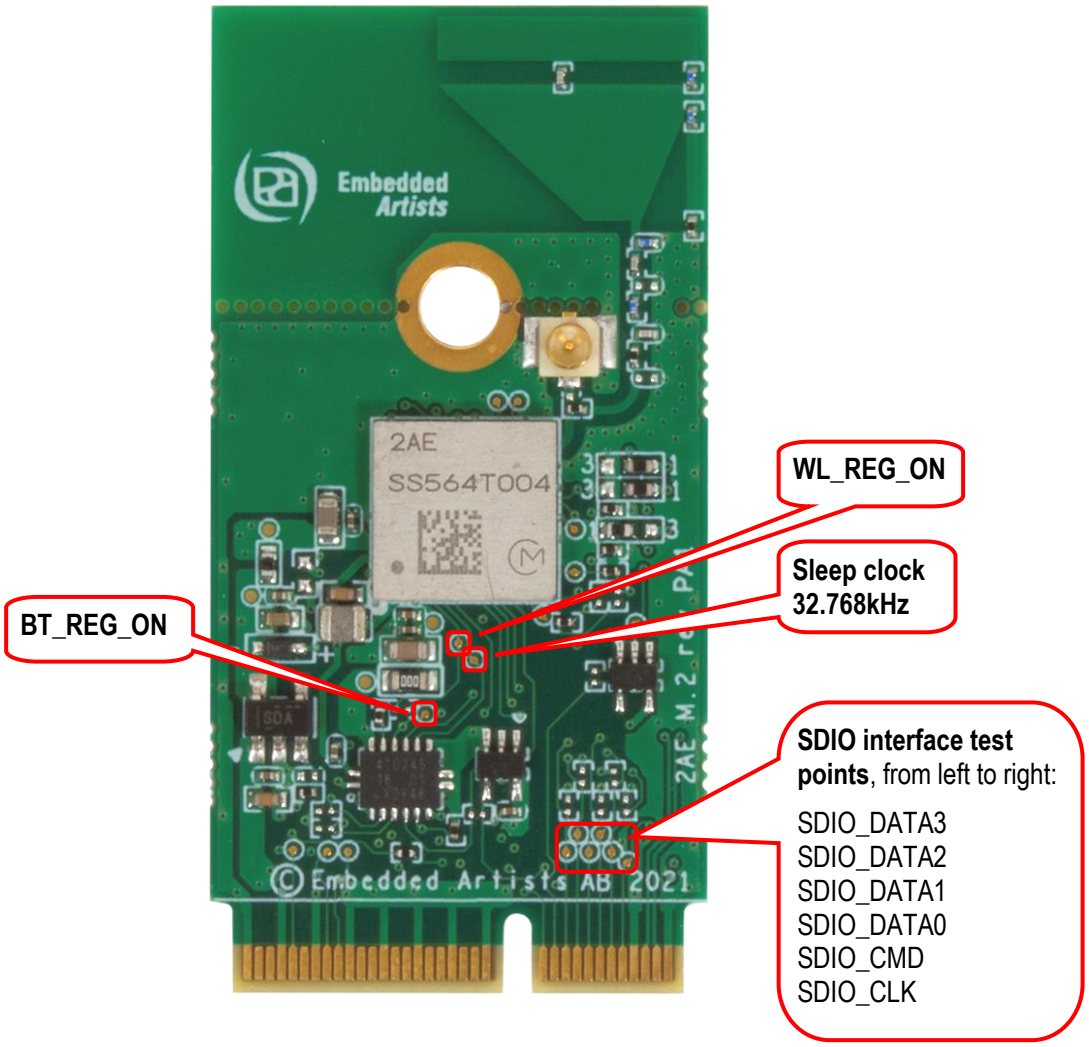


Figure 5 – 2AE / 2BC M.2 Module Test Points

3.9 Current Consumption Measurements

It is possible to measure the currents of the power supplies to the 2AE / 2BC module, VBAT and VDDIO. VBAT is the 3.3V the is supplied to the M.2 interface and VDDIO is an on-board generated 1.8V. VDDIO is generated from the supplied 3.3V. If the supply voltage (3.3V) to the M.2 module is measured it will be both the VBAT and VDDIO currents that is measured. By measuring currents at the illustrated points below it is possible to measure VBAT and VDDIO independently.

Note that zero ohm resistors are mounted by default. Select a series resistor with as low resistance as possible to keep the voltage drop to a minimum. Keep the drop below 100mV. VBAT can be slightly above 1 Amp in peak which means that maximum series resistance is 100 milliOhm for the VBAT resistor. For VDDIO the current is lower so a 1 ohm resistor can be a suitable value.

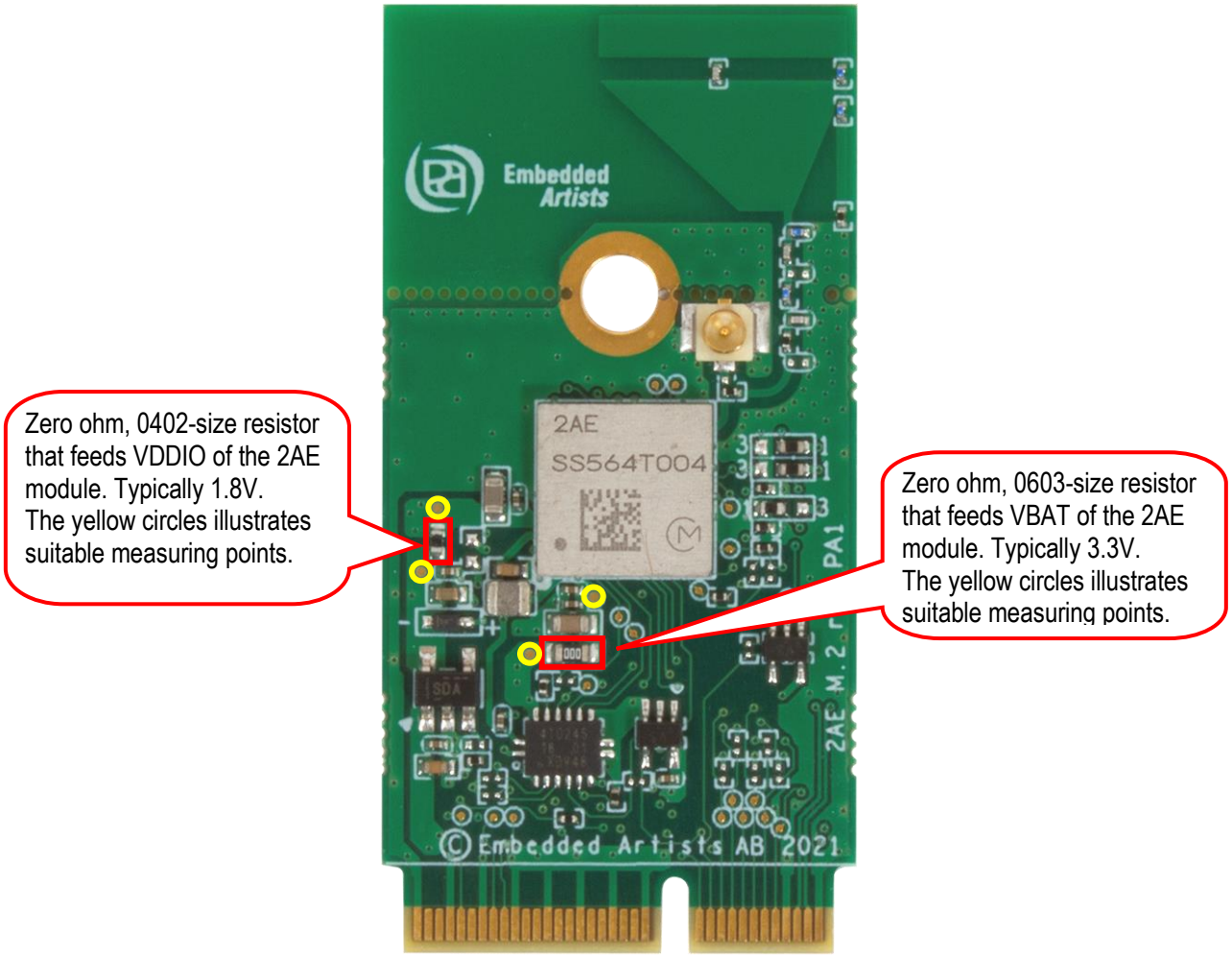


Figure 6 – Current Measurement

4 Antenna

This chapter addresses the antenna side of the module. There is an on-board, reference certified pcb trace antenna. This can be used for testing/evaluation purposes, but also for the final product. Also, for testing and evaluation purposes, it is possible to disconnect the on-board antenna and instead use an u.fl. connector to connect an external antenna.

4.1 Mounting and Clearance

Ideally, arrange the M.2 module so that the antenna is located at a corner of the product. Keep plastic case (i.e., non-metallic) away from the antenna area with at least 5 mm clearance (in all directions). Also keep any metal elements (e.g., connectors, battery, etc.) away from the antenna area with at least 5 mm clearance (in all directions). Keep a clearance area under and above the antenna area of at least 7.5mm , both under and over the PCB.

Human hands or body parts should be kept away (in the normal use case) from the antenna area.

The ground hole in the middle shall be grounded. Use a metal stand-off according to M.2 standard (height suitable for selected M.2 connector) and use metal screw to create a proper ground connection.

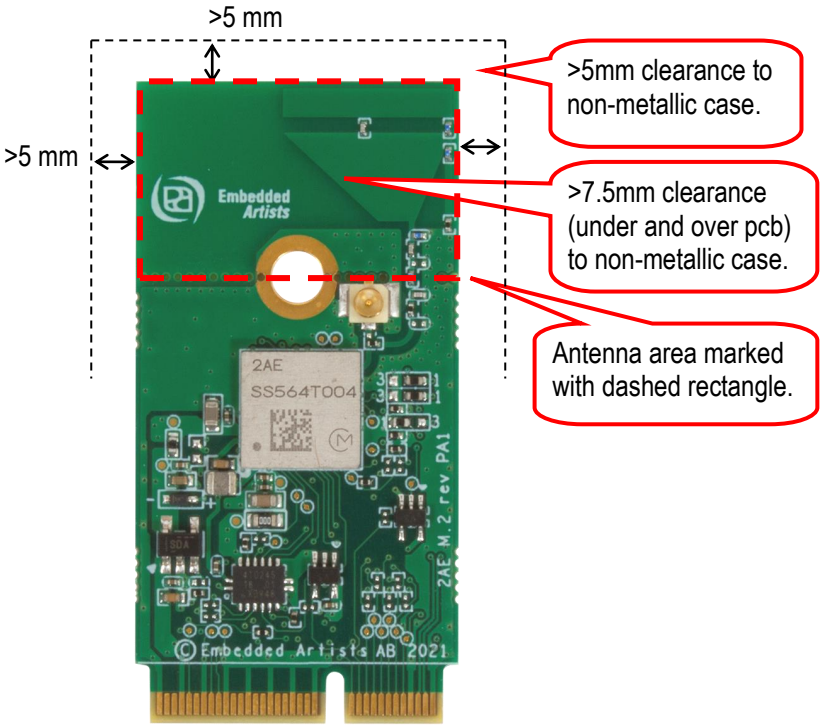


Figure 7 – M.2 Module Clearance Area

4.2 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.

4.3 Overriding on-board PCB Trace Antenna

Per default, the on-board PCB trace antenna is used for the Wi-Fi and Bluetooth interface. The antenna connection from the 2AE / 2BC module can be redirected to the U.FL. connector by just moving one zero ohm 0201 series resistor, see illustration below. The on-board trace antenna can be left as-is, or the antenna part can be snapped-off.

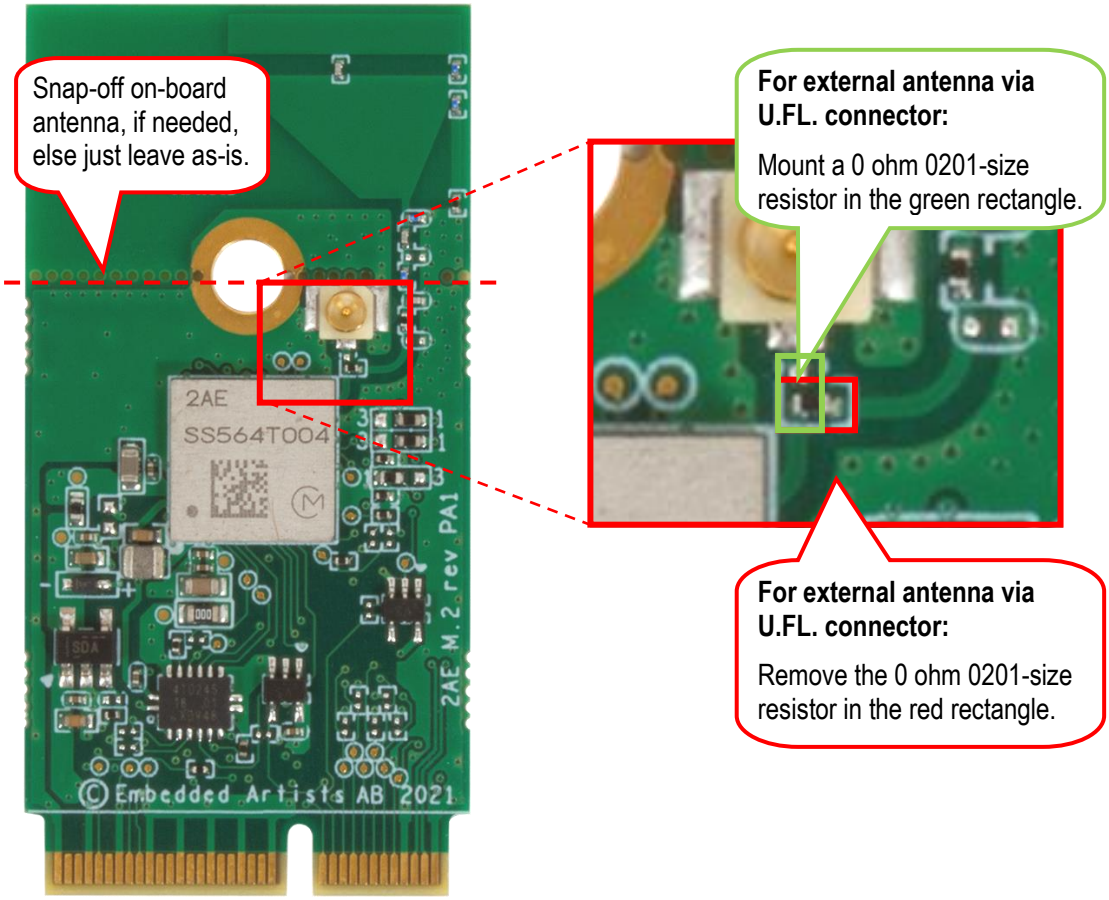


Figure 8 – Rework to Connect U.FL. Connector

4.4 On-board PCB Trace Antenna Performance

The on-board pcb trace antenna type is monopole, certified by Murata.

The table below lists total efficiency:

Measurement condition	Frequency MHz						Total Efficiency in dB		Total Efficiency in %	
	2400	2442	2484	5150	5500	5850	Average 2 GHz band	Average 5 GHz band	Average 2 GHz band	Average 5 GHz band
Certified trace antenna	**-1.0**	**-1.0**	**-0.9**	**-1.3**	**-1.6**	**-1.5**	**-1.0**	**-1.5**	**80.1**	**71.5**

The table below lists peak gain:

Measurement condition	Frequency MHz						Max dBi	
	2400	2442	2484	5150	5500	5850	Max 2 GHz band	Max 5 GHz band
Certified trace antenna	**2.6**	**2.4**	**2.5**	**3.5**	**3.6**	**3.5**	**2.6**	**3.64**

The pictures below illustrate the return loss and efficiency.

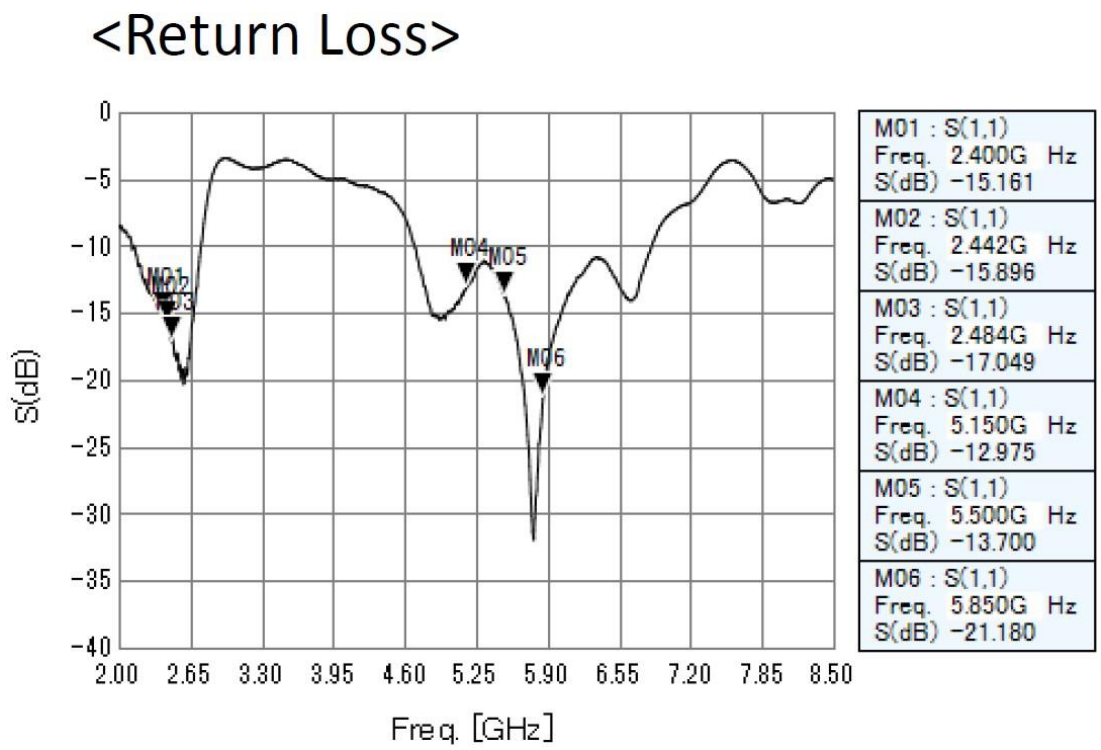


Figure 9 – Return Loss for Certified Trace Antenna

<Efficiency>

[dBi] [dB]

LINEAR POLARIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency
		hor.	ver.	hor.	ver.	hor.	ver.	
2400 MHz	MAX.	-1.6	-0.9	2.6	-16.3	-2.2	1.0	
	AVE.	-4.9	-4.6	-2.0	-20.4	-8.3	-0.9	-1.0
2442 MHz	**MAX.**	**-1.6**	**-0.8**	**2.4**	**-15.0**	**-2.0**	**1.1**	
	AVE.	**-5.1**	**-4.6**	**-1.9**	**-19.5**	**-8.3**	**-0.7**	**-1.0**
2484 MHz	MAX.	-1.7	-0.7	2.5	-13.6	-1.7	1.6	
	AVE.	-5.2	-4.5	-1.6	-18.7	-8.2	-0.5	-0.9

[dBi] [dB]

LINEAR POLARIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency
		hor.	ver.	hor.	ver.	hor.	ver.	
5150 MHz	MAX.	2.3	0.1	2.2	-11.4	3.5	-0.2	
	AVE.	-4.1	-4.5	-2.0	-19.2	-3.9	-3.9	-1.3
5500 MHz	**MAX.**	**2.3**	**-0.6**	**1.0**	**-12.7**	**3.6**	**-1.8**	
	AVE.	**-4.3**	**-5.0**	**-2.4**	**-20.0**	**-4.3**	**-5.1**	**-1.6**
5850 MHz	MAX.	2.3	-0.7	1.0	-12.9	3.5	-1.6	
	AVE.	-4.1	-5.4	-2.4	-19.8	-4.2	-5.5	-1.5

Figure 10 – Efficiency for Certified Trace Antenna

The directivity measurements are presented below for the 2 GHz and 5GHz bands with the orientation as illustrated below.

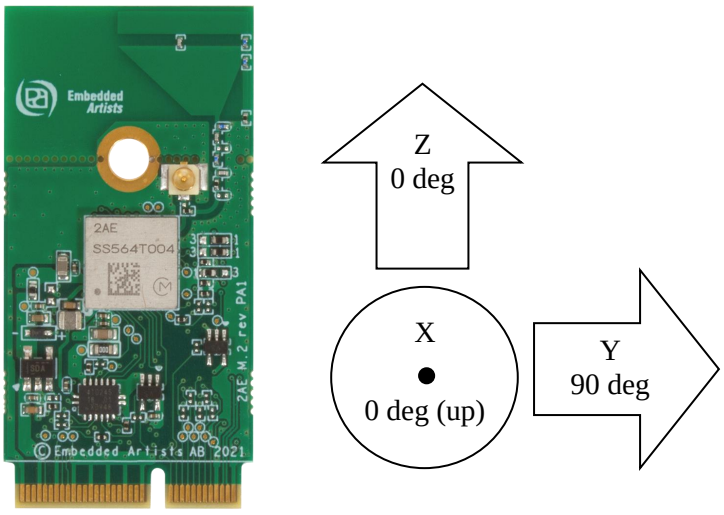
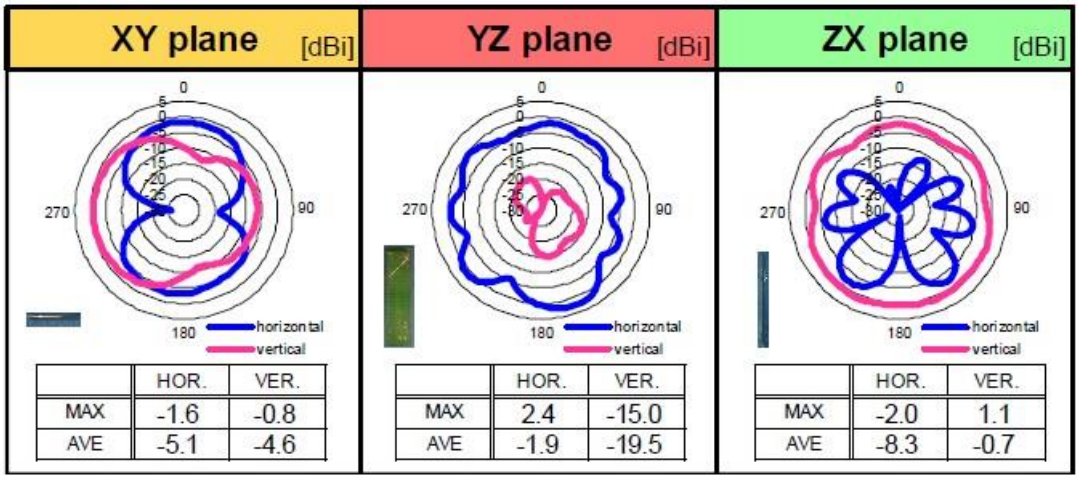


Figure 11 –Plane Orientations

<Directivity>

@2442MHz

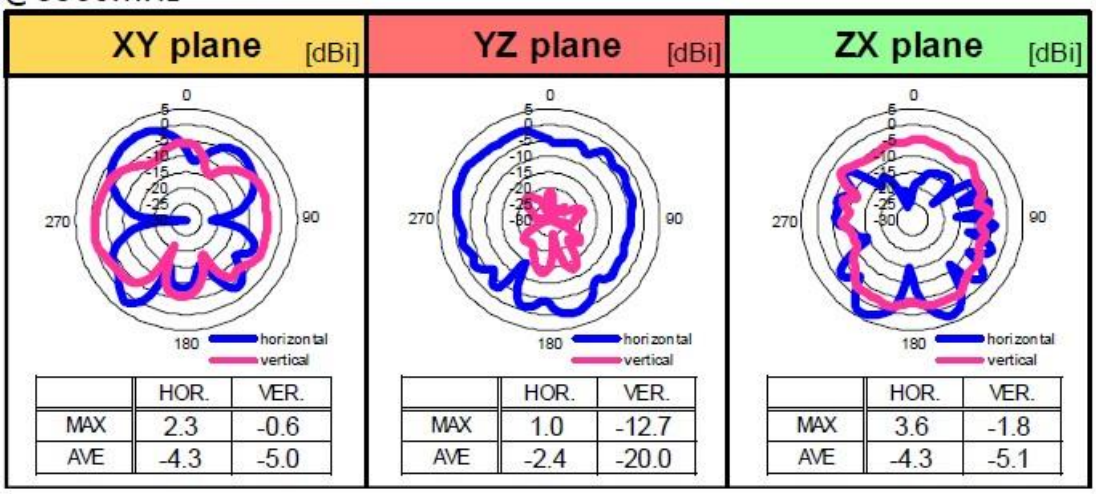


	HOR.	VER.
MAX	-1.6	-0.8
AVE	-5.1	-4.6

	HOR.	VER.
MAX	2.4	-15.0
AVE	-1.9	-19.5

	HOR.	VER.
MAX	-2.0	1.1
AVE	-8.3	-0.7

@5500MHz



	HOR.	VER.
MAX	2.3	-0.6
AVE	-4.3	-5.0

	HOR.	VER.
MAX	1.0	-12.7
AVE	-2.4	-20.0

	HOR.	VER.
MAX	3.6	-1.8
AVE	-4.3	-5.1

Figure 12 – Directivity for Certified Trace Antenna

5 Software and Support

This chapter contains information about software and support.

5.1 Software Driver

The CYW4373(E) chipset do 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	2AE / 2BC M.2 (SDIO) 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 2AE / 2BC module is reference certified. See the LBEE5PK2AE / LBEE5PK2BC datasheet 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 2AE M.2 module (pn EAR00388 / EAR00445) and 2BC (pn EAR00436) 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/2ae-m-2-module/, see document *2AE / 2BC 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
EAR00388/ EAR00436/ EAR00445	Bluetooth BR/EDR/LE	2400 MHz – 2484 MHz	14 dBm
EAR00388/ EAR00436/ EAR00445	Wi-Fi IEEE 802.11b/g/n	2400 MHz – 2484 MHz	20.5 dBm
EAR00388/ EAR00436/ EAR00445	Wi-Fi IEEE 802.11a/n/ac	5150 MHz – 5850 MHz	18 dBm

The 2AE / 2BC 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

Embedded Artists 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.

Customer is responsible for the design and operation of their applications and products using Embedded Artists' products, and Embedded Artists accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the Embedded Artists' 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. Customer is required to have expertise in electrical engineering and computer engineering for the installation and use of Embedded Artists' products.

Embedded Artists 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 Embedded Artists' 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). Embedded Artists does not accept any liability in this respect.

Embedded Artists does not accept any liability for errata on individual components. Customer is responsible to make sure all errata published by the manufacturer of each component are taken note of. The manufacturer's advice should be followed.

Embedded Artists does not accept any liability and no warranty is given for any unexpected software behavior due to deficient components.

Customer is required to take note of manufacturer's specification of used components. Such specifications, if applicable, contain additional information that must be taken note of for the safe and reliable operation.

All Embedded Artists' products are sold pursuant to Embedded Artists' terms and conditions of sale: http://www.embeddedartists.com/sites/default/files/docs/General_Terms_and_Conditions.pdf

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by Embedded Artists for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN EMBEDDED ARTISTS' TERMS AND CONDITIONS OF SALE EMBEDDED ARTISTS DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF EMBEDDED ARTISTS PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY THE CEO OF EMBEDDED ARTISTS, PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, NUCLEAR, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE.

Resale of Embedded Artists' products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by Embedded Artists

for the Embedded Artists' product or service described herein and shall not create or extend in any manner whatsoever, any liability of Embedded Artists.

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

7.1 Definition of Document Status

Preliminary – The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. Embedded Artists does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information. The document is in this state until the product has passed Embedded Artists product qualification tests.

Approved – The information and data provided define the specification of the product as agreed between Embedded Artists and its customer, unless Embedded Artists and customer have explicitly agreed otherwise in writing.