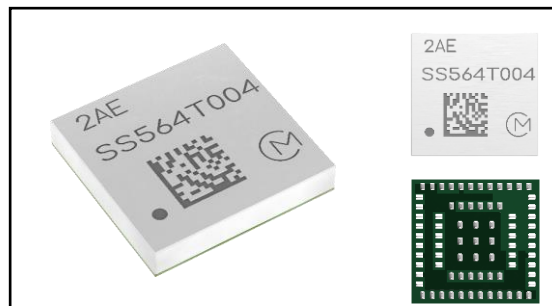


Murata Type 2AE (LBEE5PK2AE)

Hardware Application Note



Revision History

Revision	Date	Section	Change Description
1	May. 9, 2022	-	First issue
2	Jun.14,2022	Features	Cypress ->Infineon

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1 Scope

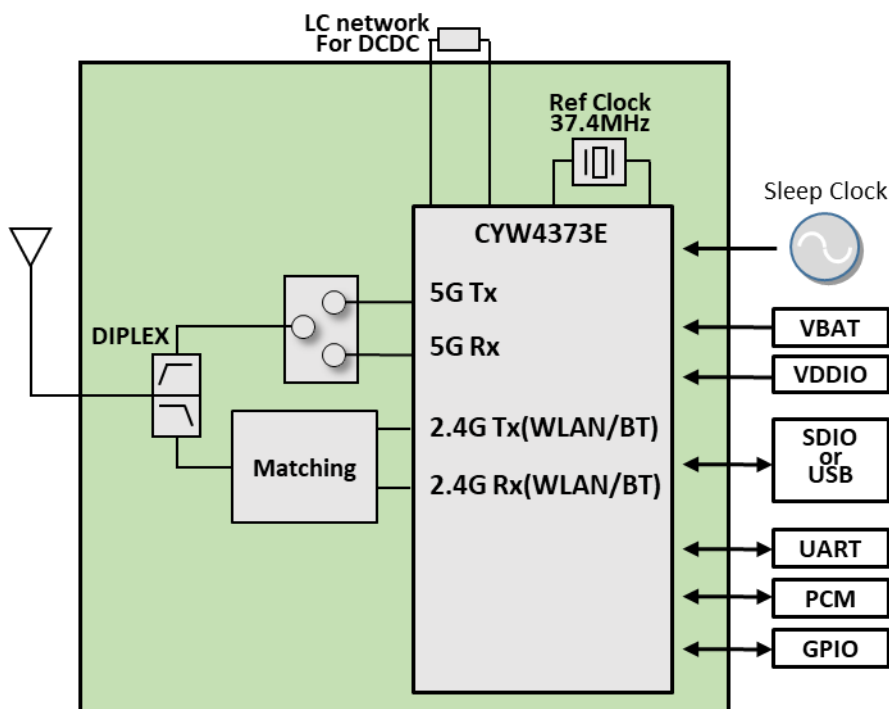
This Application Note covers HW development and provides how to design the Schematic and Layout, and reference RF performance. Refer to “type2AE_datasheet” for Module specification.

2 Module Introduction

2.1 Features

- WLAN(11a/b/g/n/ac) 1x1 SISO + Bluetooth and low energy (v5.2) combo SMD module with Infineon CYW4373E
- Small size LGA package with resin molding and metal shielding.
- SDIO3.0/USB(shared) for WLAN and UART/USB(shared) for Bluetooth as the host interface.
- MAC address and BD address are stored in OTP

2.2 Hardware block diagram



3.2 Requirements for SDIO signals

SDIO traces should be isometric zero delay routing with 50-ohm impedance.

3.3 External sleep clock requirements

External sleep clock (LPO) is necessary if internal sleep clock is not used. The following table shows requirements for external sleep clock.

Parameter	External LPO Clock	Unit
Nominal input frequency	32.768	kHz
Frequency accuracy	+/-200	ppm
Duty cycle	30-70	%
Input signal amplitude	200 - 3300	mV, p-p
Signal type	Square-wave or sine-wave	-
Input impedance ^a	> 100k	ohm
	< 5	pF
Clock jitter (during initial start-up)	<10,000	ppm

a) When power is applied or switch off.

3.4 Requirements for unused signals

Any pull-up/down is not necessary (floating) for GPIO if these signals are not used.

3.5 Module footprint design

Refer to dimensions in the datasheet "type2AE.pdf". The DXF file of module footprint "2AE_Module_terminal pin.dxf" is provided via website.

3.6 Recommended antenna

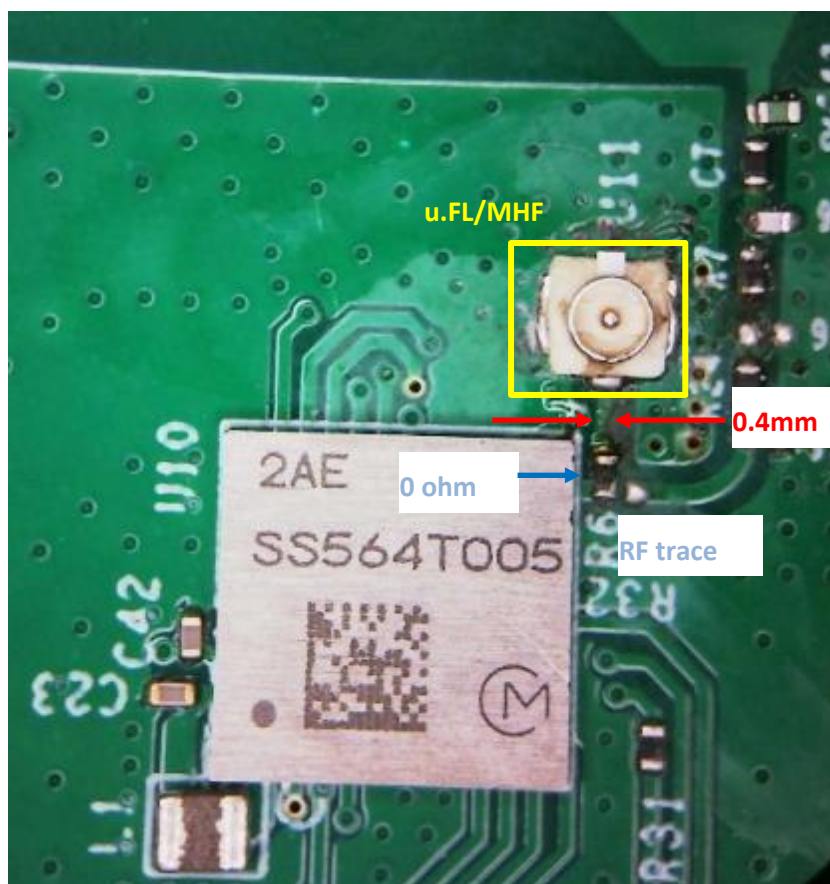
This module is certified with two types of antenna solution by regulatory certification body. To use Murata's regulatory certification, any user must follow below instructions. The DXF file "JS-0967_2AE_Certification Board.dxf" and "type2AE_rf_trace_and_antenna_design_guidelines.pdf" are provided via web site.

3.6.1 PCB Type Di-pole Antenna with the co-axial connector

- Any users must use recommended antennas. However, user can use any equivalent type antenna with less antenna gain than antenna gain of recommended antennas for US and EU under approval of Class I Permissive Change by Murata.

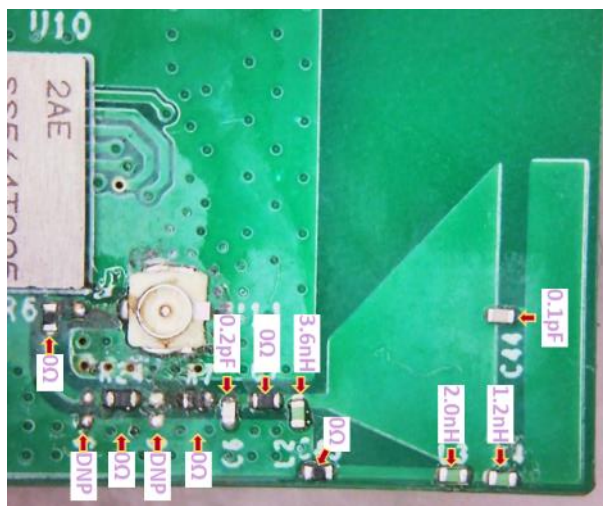
P/N	Vendor	Form factor	Type	2.4GHz Gain	5GHz Gain	Cable options
146187	Molex	U.FL/PCB	Di-pole	3.4dBi	4.75dBi	050,100,150,200,250 and 300

- Any users must copy RF trace to U.FL/MHF connector from the trace layout file provided by Murata; adhering to below guidelines on:
 - Trace width accuracy within +/- 0.025 mm.
 - Stack height between GND layer and RF trace of 210 ~ 260 um (include inaccuracy of PCB).
 - Passive component location matching Murata design.
 - Necessary "Keep out" area around U.FL/MHF connector.

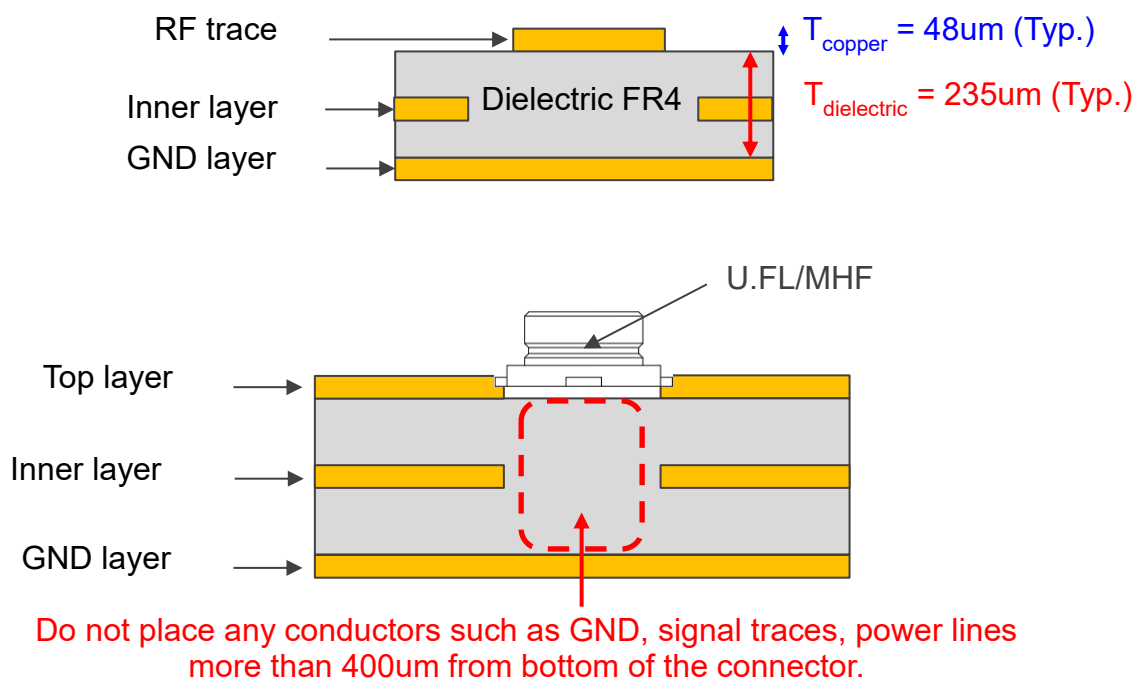


3.6.2 Trace Antenna

- Any users must copy antenna design from the antenna layout file provided by Murata.
- Any users must copy RF trace to PCB trace antenna from the trace layout file provided by Murata; adhering to below guidelines on:
 - Trace width accuracy within +/- 0.025 mm.
 - PCB thickness within 0.6 ~ 1.6 mm range (0.8 mm typ.).
 - Stack height between GND layer and RF trace of 235 μm ; keeping inaccuracy within +/-25 μm .
 - Passive component location matching Murata design.



3.6.3 PCB Stack-up



3.6.4 Trace Antenna Performance

(Gain and Efficiency)

<Efficiency>

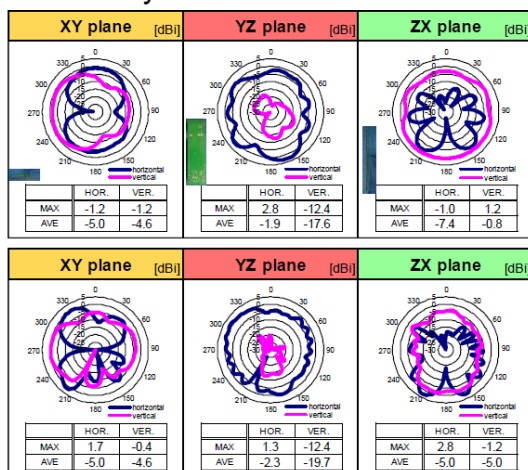
*Red color shows peak gain
[dBi]

LINEAR POLAMIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency
		hor.	ver.	hor.	ver.	hor.	ver.	
2400 MHz	MAX.	-1.1	-1.0	3.0	-13.4	-1.1	0.9	-0.9
	AVE.	-4.8	-4.5	-2.0	-18.7	-7.5	-1.0	
2442 MHz	MAX.	-1.2	-1.2	2.8	-12.4	-1.0	1.2	-0.9
	AVE.	-5.0	-4.6	-1.9	-17.6	-7.4	-0.8	
2484 MHz	MAX.	-1.5	-0.5	3.0	-11.8	-0.5	1.7	-0.8
	AVE.	-5.2	-4.1	-1.7	-16.8	-7.3	-0.6	

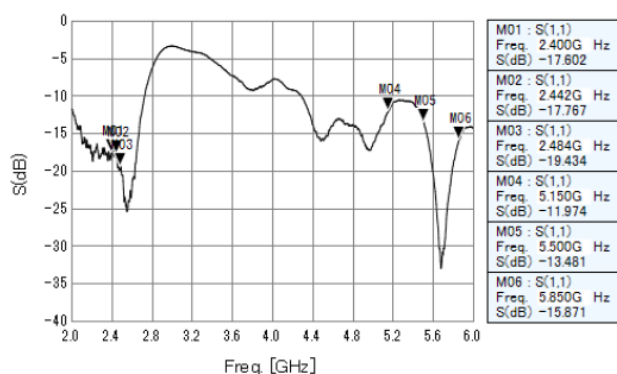
LINEAR POLAMIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency
		hor.	ver.	hor.	ver.	hor.	ver.	
5150 MHz	MAX.	1.8	-0.8	1.9	-12.2	2.7	-0.7	-1.4
	AVE.	-4.4	-4.7	-2.1	-19.6	-4.6	-4.4	
5500 MHz	MAX.	1.7	-0.4	1.3	-12.4	2.8	-1.2	-1.6
	AVE.	-5.0	-4.6	-2.3	-19.7	-5.0	-5.0	
5850 MHz	MAX.	2.1	-1.4	0.9	-12.7	3.3	-3.0	-1.6
	AVE.	-4.7	-5.6	-2.5	-19.8	-4.4	-6.0	

(Directivity)

<Directivity>



<Return Loss>



3.6.5 Trace Antenna Installation

Keep board size and clearance to Metal/GND and Dielectric around the trace antenna for good antenna performance.

Board Size		X ≥ 40 mm Y ≥ 40 mm
Clearance to Metal/GND		A ≥ 20 mm B ≥ 20 mm C ≥ 20 mm D ≥ 20 mm E/F ≥ 20 mm
Clearance to Dielectric		A ≥ 4 mm B ≥ 4 mm C ≥ 4 mm D ≥ 4 mm E/F ≥ 4 mm

4 Setup configuration files

To enable Murata's regulatory certification, below configuration file shall be loaded initially. Murata will provide configuration files via Murata's GitHub. (<https://github.com/murata-wireless>)

4.1 WLAN configuration files for Linux

The following files shall be used to satisfy regulatory requirements if user wants to use Murata regulatory certification.

WLAN Tx power configuration files

cyfmac4373-sdio.2AE.txt (<https://github.com/murata-wireless/cyw-fmac-nvram>)

WLAN regulatory limitation configuration file

cyfmac4373-sdio.2AE.clm.blob (<https://github.com/murata-wireless/cyw-fmac-fw>)

4.2 Bluetooth configuration files for Linux

Bluetooth Tx power configuration script file shall be loaded after Bluetooth device initialization.

Bluetooth Tx power configuration files

BCM4373A0.2AE.hcd (<https://github.com/murata-wireless/cyw-bt-patch>)

5 Reference performance data

5.1 Typical Tx output power level (at module antenna port)

5.1.1 WLAN

<Condition>

- VBAT=3.3V, VIO=1.8V
- Tx output power setting is defined by “cyfmac4373-sdio.2AE.clm.blob” which is provided at Murata GitHub. <https://github.com/murata-wireless>

US/Canada

2.4GHz

Mode	Data Rate	Output Power in dBm (typ.)				
		Ch.1	Ch.2-3	Ch.4-8	Ch.9-10	Ch.11
11b	1-11M	16	17	17	17	16
11g	6-54M	9	9	16	9	9
11n-20	MCS0-7	8	8	18	8	8

5GHz

Mode	Data Rate	Output Power in dBm (typ.)						
		Ch.36	Ch.40-60	Ch.64	Ch.100	Ch.104-136	Ch.140	Ch.144-165
11a	6,9M	14	16	14	13	16	13	16
	12-54M	14	14	14	13	14	13	14
11n-20	MCS0-1	14	16	14	12	16	12	16
	MCS3-7	14	14	14	12	14	12	14
11ac-20	MCS0-2	14	16	14	12	16	12	16
	MCS3-8	13	13	13	12	13	12	13
Mode	Data Rate	Ch.38	Ch.46-54	Ch.62	Ch.102	Ch.110-126	Ch.134	Ch.142-159
11n-40	MCS0	10	14	10	10	14	10	14
	MCS1-7	10	13	10	10	13	10	13
11ac-40	MCS0	10	14	10	10	14	10	14
	MCS1-9	10	11	10	10	11	10	11
Mode	Data Rate	Ch.42	-	Ch.58	Ch.106	-	Ch.(122)-138	Ch.155
11ac-80	MCS0,1,2	11	-	11	11	-	11	11
	MCS3,4	11	-	11	11	-	11	11
	MCS5,6,7	11	-	11	11	-	11	11
	MCS8,9	11	-	11	11	-	11	11

() : Only US/FCC

EU

2.4GHz

Mode	Data Rate	Output Power in dBm (typ.)
		Ch.1-13
11b	1-11M	14
11g	6-54M	16
11n-20	MCS0-4	16
	MCS4-7	14

5GHz

Mode	Data Rate	Output Power in dBm (typ.)			
		Ch.36-48	Ch.52-64	Ch.100-140	Ch.149-165
11a	6-9M	16	13	13	8
	12-54M	14	13	13	8
11n-20	MCS0-1	16	13	13	8
	MCS2-7	14	13	13	8
11ac-20	MCS0-2	16	13	13	8
	MCS3-8	13	13	13	8
Mode	Data Rate	Ch.38-46	Ch.54-62	Ch.102-134	Ch.151-159
11n-40	MCS0	14	13	13	8
	MCS1-7	13	13	13	8
11ac-40	MCS0	14	13	13	8
	MCS1-9	11	11	11	8
Mode	Data Rate	Ch.42-58	-	Ch.106-138	Ch.155
11ac-80	MCS0-7	13	-	13	8
	MCS8-9	11	-	11	8

Japan
2.4GHz

Mode	Data Rate	Output Power in dBm (typ.)
		Ch.1-13
11b	1-11M	16
11g	6-36M	18
	48-54M	16
11n-20	MCS0-4	16
	MCS5-7	14

5GHz

Mode	Data Rate	Output Power in dBm (typ.)		
		Ch.36-48	Ch.52-64	Ch.100-144
11a	6-9M	15	12	16
	12-54M	14	12	14
11n-20	MCS0-1	15	12	16
	MCS2-7	14	12	14
11ac-20	MCS0-2	15	12	16
	MCS3-8	13	12	13
Mode	Data Rate	Ch.38-46	Ch.54-62	Ch.102-142
11n-40	MCS0	14	13	14
	MCS1-7	13	13	13
11ac-40	MCS0	14	13	14
	MCS1-9	11	11	11
Mode	Data Rate	Ch.42-58	-	Ch.106-138
11ac-80	MCS0-7	13	-	13
	MCS8-9	11	-	11