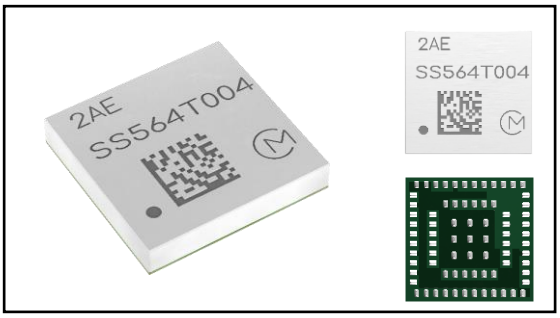
# Murata Type 2AE (LBEE5PK2AE)

## 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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# Table of Contents



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# 1 Scope

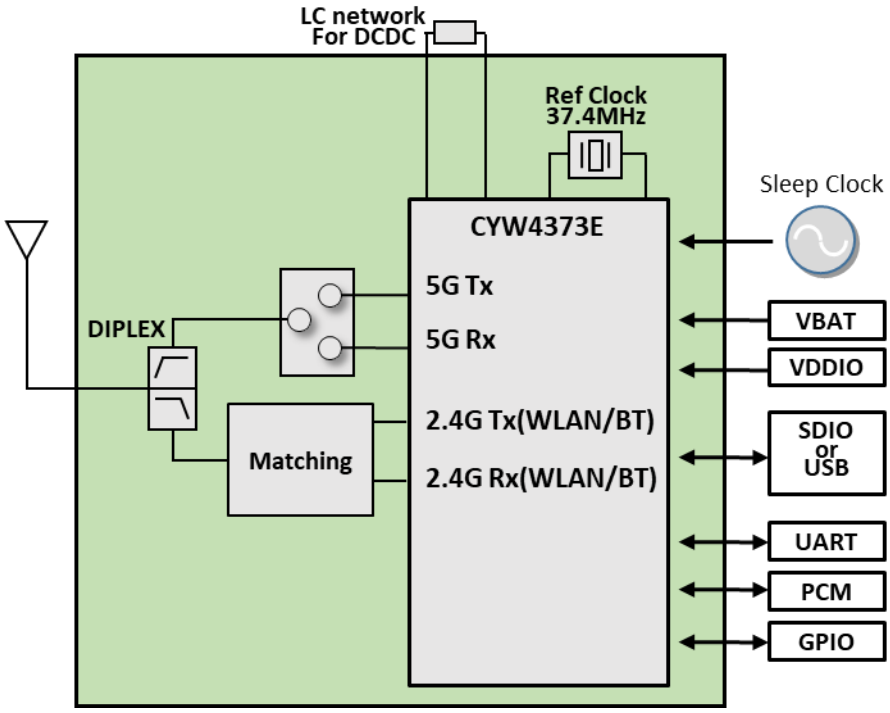
This Application Note covers HW development and provides how to design the Schematic and Layout, and reference RF performance. Refer to “type2AE_datasheet” for Module specification.

# 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

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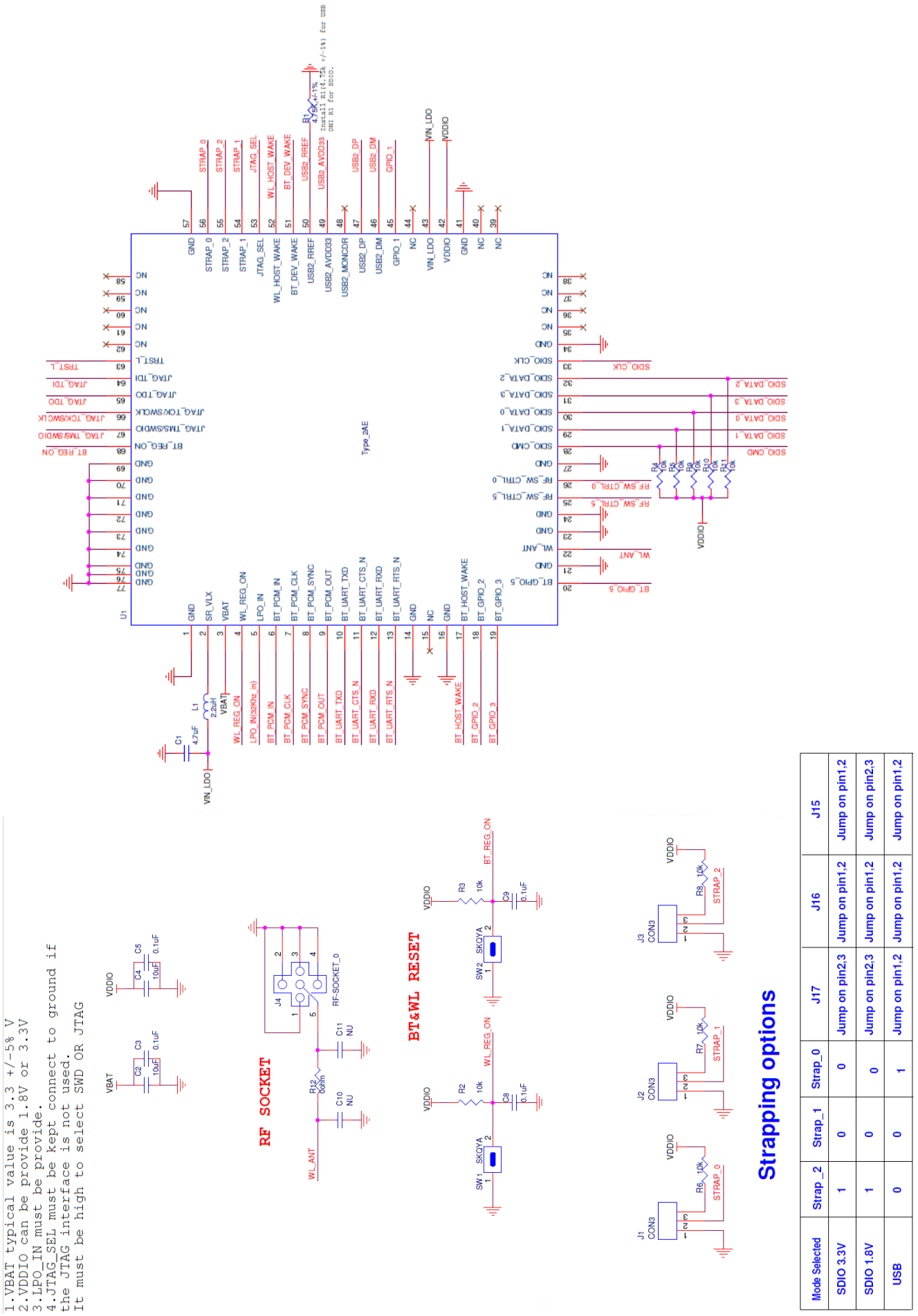
# 3 Reference design

## 3.1 Reference circuitry




| Mode Selected | Strap_2 | Strap_1 | Strap_0 | J17 | J16 | J15 |
|---|---|---|---|---|---|---|
| SDIO 3.3V | 1 | 0 | 0 | Jump on pin2,3 | Jump on pin1,2 | Jump on pin1,2 |
| SDIO 1.8V | 1 | 0 | 0 | Jump on pin2,3 | Jump on pin1,2 | Jump on pin2,3 |
| USB | 0 | 0 | 1 | Jump on pin1,2 | Jump on pin1,2 | Jump on pin1,2 |

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## 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<br>< 5 | ohm<br>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.

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## 3.6 Recommended antenna

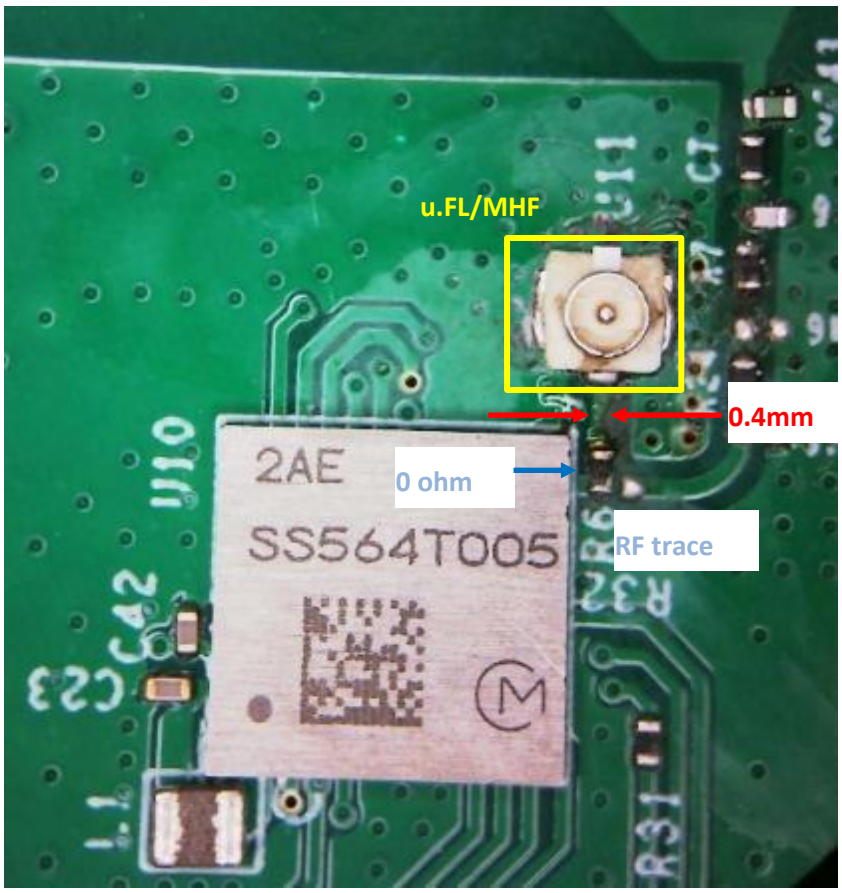
This module is certified with two types of antenna solution by regulatory certification body. To use Murata's regulatory certification, any user must follow below instructions. The DXF file "JS-0967_2AE_Certification Board.dxf" and "type2AE_rf_trace_and_antenna_design_guidelines.pdf" are provided via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

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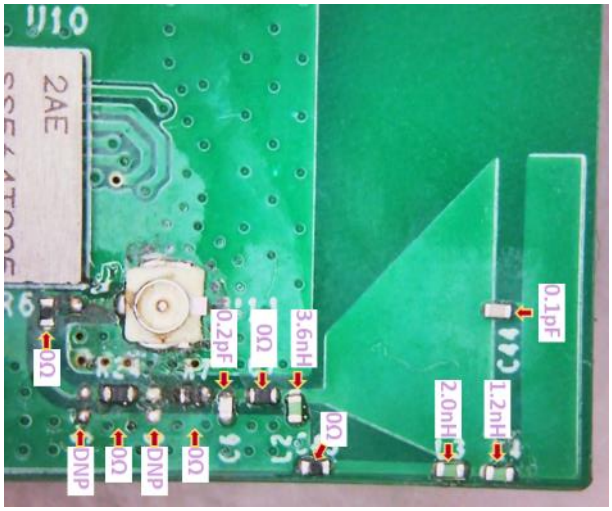
### 3.6.2 Trace Antenna

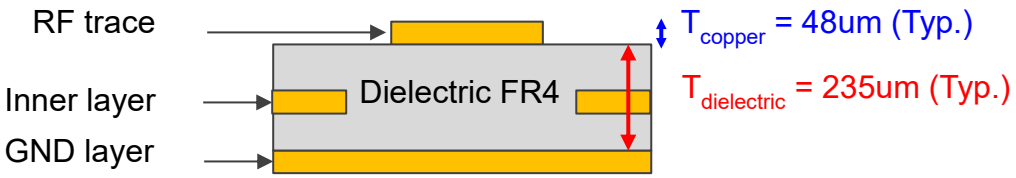
- Any users must copy antenna design from the antenna layout file provided by Murata.

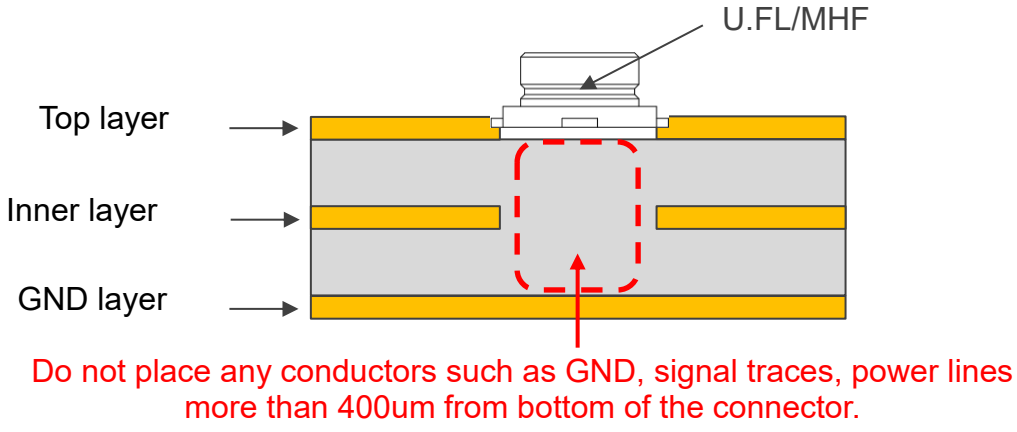
- Any users must copy RF trace to PCB trace antenna from the trace layout file provided by Murata; adhering to below guidelines on:

    - 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 um; keeping inaccuracy within +/-25 um.
    - Passive component location matching Murata design.




### 3.6.3 PCB Stack-up

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### 3.6.4 Trace Antenna Performance

(Gain and Efficiency)

<Efficiency>

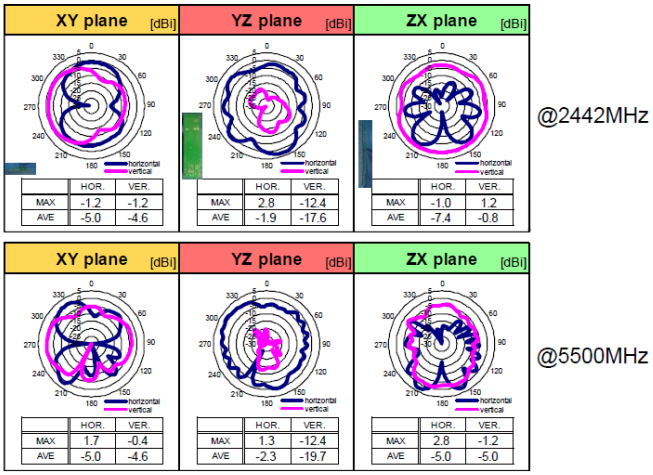
*Red color shows peak gain

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

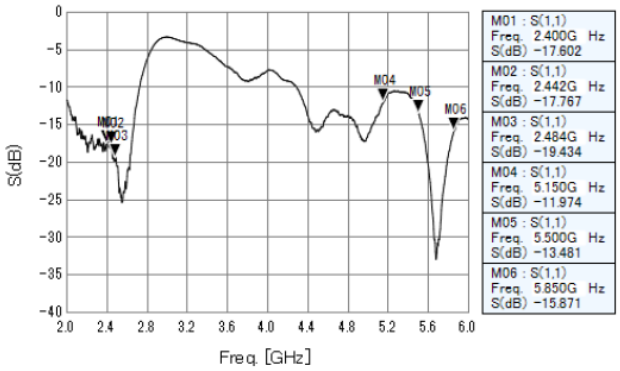
| LINEAR POLAMIZATION | | XY-plane [dBi] hor. | XY-plane [dBi] ver. | YZ-plane [dBi] hor. | YZ-plane [dBi] ver. | ZX-plane [dBi] hor. | ZX-plane [dBi] ver. | Total [dB] Efficiency |
|---|---|---|---|---|---|---|---|---|
| 5150 MHz | MAX. | 1.8 | -0.8 | 1.9 | -12.2 | 2.7 | -0.7 | |
| | AVE. | -4.4 | -4.7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

(Directivity)

<Directivity>

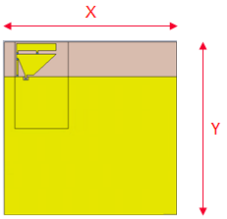
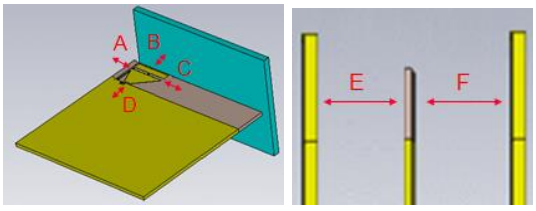
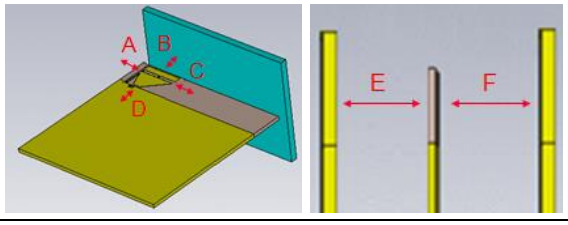



<Return Loss>




### 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<br>Y ≥ 40 mm |
| Clearance to Metal/GND |   | A ≥ 20 mm<br>B ≥ 20 mm<br>C ≥ 20 mm<br>D ≥ 20 mm<br>E/F ≥ 20 mm |
| Clearance to Dielectric |   | A ≥ 4 mm<br>B ≥ 4 mm<br>C ≥ 4 mm<br>D ≥ 4 mm<br>E/F ≥ 4 mm |

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# 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)

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# 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

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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 |

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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 |

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