FCC Regulatory Certification (CYW)

Test Guide - Rev. 2.0

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About This Document

This document provides some lab test procedures for Federal Communications Commission (FCC) Part 15C regulatory certification for Murata Wi-Fi/Bluetooth modules based on Infineon wireless chipsets.

This document does not cover other regulatory certification tests required for FCC such as unintentional radiation or RF exposure test. Details for complete regulatory certification tests are available from regulatory test lab

Audience & Purpose

The Audience and Purpose of this document is to provide information necessary for the regulatory evaluation of Murata's Wi-Fi/BT modules with Infineon chipsets.

Document Conventions

Table 1 describes the document conventions.

Table 1: Document Conventions

Conventions	Description
🛑	**Warning Note** Indicates very important note. Users are strongly recommended to review.
ⓘ	**Info Note** Intended for informational purposes. Users should review.
🖿	**Menu Reference** Indicates menu navigation instructions. **Example**: Insert➜Tables➜Quick Tables➜Save Selection to Gallery 🖿
⬈	**External Hyperlink** This symbol indicates a hyperlink to an external document or website. **Example**: Embedded Artists AB ⬈ Click on the text to open the external link.
⬃	**Internal Hyperlink** This symbol indicates a hyperlink within the document. **Example**: References ⬃ Click on the text to open the link.
`Console input/output or code snippet`	**Console I/O or Code Snippet** This text *Style* denotes console input/output or a code snippet.
`# Console I/O comment` `// Code snippet comment`	**Console I/O or Code Snippet Comment** This text *Style* denotes a console input/output or code snippet comment. 1. Console I/O comment (preceded by "#") is for informational purposes only and does not denote actual console input/output. 2. Code Snippet comment (preceded by "//") may exist in the original code.

1 Murata Certified Wi-Fi® and Bluetooth® modules

Murata designs and manufactures IEEE802.11 WLAN and Bluetooth radio modules that can be FCC certified or non-certified. A customer device that installs a non-certified radio module shall go through full FCC certification process to obtain the certified FCC ID.

Most of the Murata modules are reference certified that can significantly reduce the customer FCC certification effort. **Table 2** lists the different Infineon chipset-based Murata modules and the offered FCC certification types.

Table 2: Murata Modules' Certification Types

Module	Certification Status	Antenna Options
1DX ↗	Reference certified	PCB trace, u.FL connector
1MW ↗	Reference certified	PCB trace, u.FL connector
1LV ↗	Reference certified	PCB trace, u.FL connectors
1CX ↗	Not certified	u.FL connectors
1XA ↗	Reference certified	u.FL connectors

2 Wi-Fi RF Test

The first step to start the Wi-Fi regulatory testing is to perform rework on the Embedded Artists' M.2 Evaluation Board (EVB) you are using. The manufacturing firmware must be installed in the platform to conduct the regulatory testing. All the supported Murata modules (i.e., 1DX, 1LV, 1MW and 1XA) included in this document are based on Infineon chipsets. The manufacturing test utility used for Infineon chipset-based modules is known as wl tool. Murata maintains 32 bit ↗ and 64 bit ↗ wl tool binaries in the GitHub.

Table 3 lists the resources provided by Murata for easier certification tests. These resources are referred to at various places in this document.

Table 3: Murata RF Test Resources

Item	Description
Murata_IFX_RF_Test_Tool.py ↗	Murata IFX RF Test Script (written in python)

2.1 Hardware Setup

The Embedded Artists' M.2 EVBs have built in reference antenna (except for Type 1XA). To direct the antenna connection to the u.FL connector, rework must be done (except for Type 1XA). The same rework is needed for both Wi-Fi and BT testing. This document includes the rework for Murata's three M.2 modules i.e., 1DX (CYW4343W), 1LV (CYW43012) and 1MW (CYW43455). All the M.2 EVBs are co-developed by Murata and Embedded Artists.

2.1.1 Type 1DX

Type 1DX is a small and high-performance module based on Infineon chipset CYW4343W combo chipset which supports Wi-Fi 802.11b/g/n + Bluetooth 5.1 BR/EDR/LE up to 65 Mbps PHY data rate on Wi-Fi and 3 Mbps PHY data rate on Bluetooth.

The antenna connection can be redirected to u.FL connector by just moving one zero-ohm 0402 resistor. It is illustrated in **Figure 1** below.

Figure 1: Rework to Connect u.FL Connector for 1DX

Snap-off on-board antenna, if needed, else just leave as-is.

Remove this series resistor and mount a 0-ohm 0402 resistor as shown in red rectangle (towards u.FL connector)
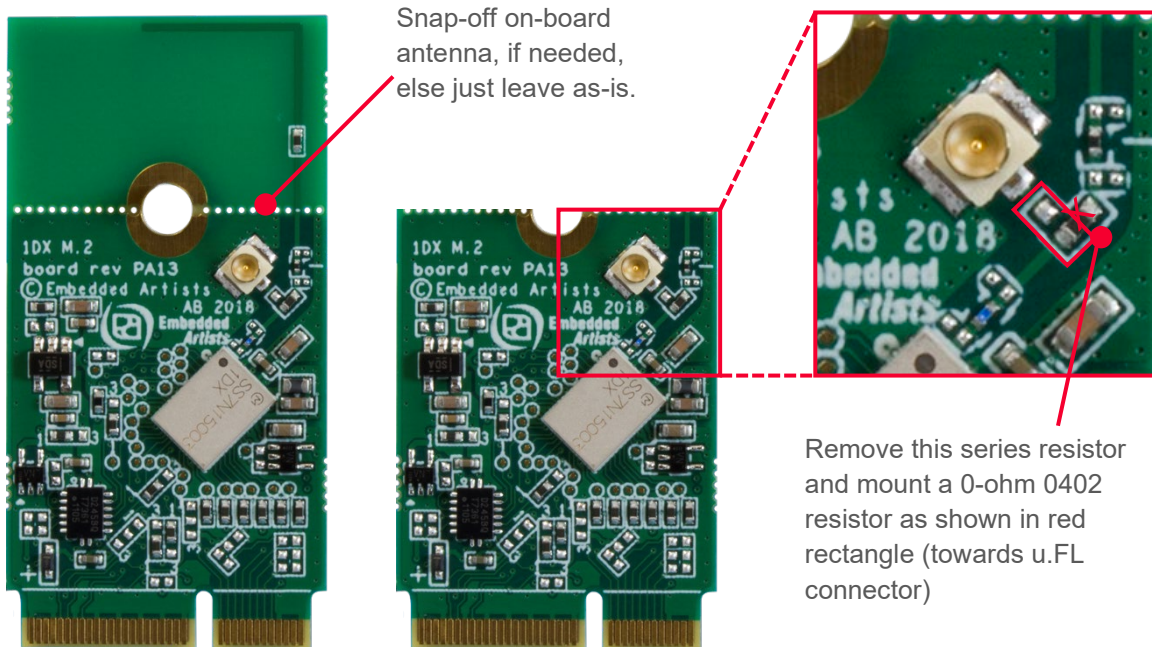
> ⓘ You do not need to snap-off the PCB trace antenna. It is completely optional.

Refer to Section 2.1.5 ⬀ for a recommended external antenna.

2.1.2 Type 1LV

Type 1LV is a small and high-performance module based on Infineon CYW43012 combo chipset which supports Wi-Fi 802.11a/b/g/n + Bluetooth 5.0 BR/EDR/LE up to 72.2 Mbps PHY data rate on Wi-Fi and 3 Mbps PHY data rate on Bluetooth. 2 Mbps LE PHY is also supported.

There are two u.FL connectors on 1LV EVB. The left one can be used as combined Wi-Fi/BT antenna or Wi-Fi only and the right one can be used as BT antenna only.

- The first rework (i.e., moving one zero-ohm 0201 series resistor) directs the antenna connection to the left u.FL connector. The left antenna becomes combined Wi-Fi/BT antenna per default. It is shown in upper right corner in **Figure 2** below.

- It is possible to separate Wi-Fi and BT antenna. By doing the second rework (see lower right corner in the picture below), the right u.FL connector becomes the separate BT antenna and the left u.FL connector becomes the Wi-Fi antenna connector. Both first and second rework must be done for separate Wi-Fi and BT antenna.

- Refer to Section 2.1.5 ⬀ for a recommended external antenna.

Figure 2: Rework to Connect u.FL Connector for 1LV

For external Wi-Fi and/or BT antenna:
Remove 0201 series resistor. Mount a 0-ohm 0201 resistor in position to u.FL connector (shown by red rectangle)

Snap-off on-board antenna, if needed, else just leave as-is.

Combined Wi-Fi/BT antenna or separate Wi-Fi antenna

Optional separate BT antenna

For separate BT antenna:
Remove 0201 resistor in the middle. Mount a 50-ohm 0201 resistor in left position and a 0-ohm 0201 resistor in right position (shown by red rectangles)

> *i* You do not need to snap-off the PCB trace antenna. It is completely optional.

2.1.3 Type 1MW

Type 1MW is a small and very high-performance module based on Infineon CYW43455 combo chipset which supports Wi-Fi 802.11a/b/g/n/ac + Bluetooth 5.0 BR/EDR/LE up to 433 Mbps PHY data rate on Wi-Fi and 3 Mbps PHY data rate on Bluetooth.

The antenna connection can be redirected to the u.FL connector by just moving one zero-ohm 0402 resistor. It is illustrated in **Figure 3** below.

Refer to Section 2.1.5 ⌐ for a recommended external antenna.

Figure 3: Rework to Connect u.FL Connector for 1MW

Snap-off on-board antenna, if needed, else just leave as-is.

Remove this series resistor and mount a 0-ohm 0402 resistor as shown in red rectangle (towards u.FL connector)
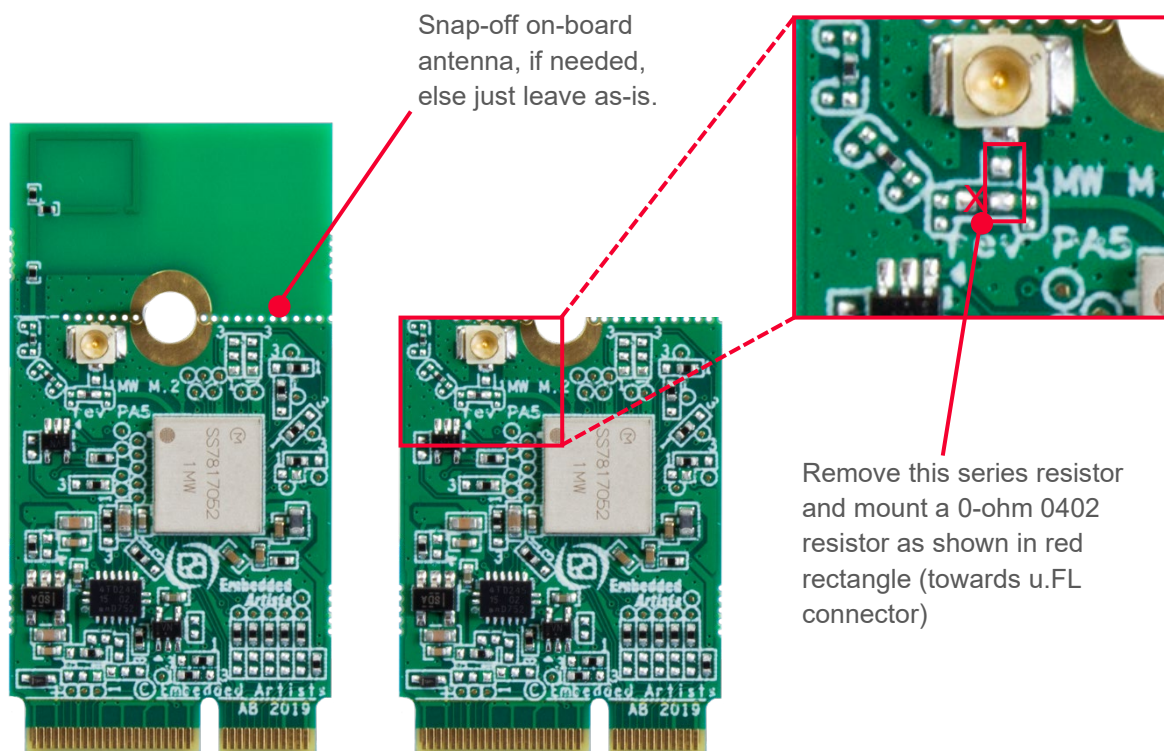
> ⓘ You do not need to snap-off the PCB trace antenna. It is completely optional.

2.1.4 Type 1XA

Type 1XA is a small and very high-performance module based on Infineon CYW54591 combo chipset which supports Wi-Fi 802.11a/b/g/n/ac 2x2 MIMO RSDB + Bluetooth 5.2 BR/EDR/LE up to 866 Mbps PHY data rate on Wi-Fi and 3 Mbps PHY data rate on Bluetooth. The WLAN section supports PCIe v3.0 Gen 1 interface and the Bluetooth section supports high-speed 4-wire UART interface and PCM for audio data.

The module does not have any on-board antenna because the module is too small to get spatial separation of the two antennas. The antenna configurations for Type 1XA module is shown in **Figure 4**. Two external antennas must be connected (to support MIMO). Murata uses Molex 1461870100 external antenna for reference certification of the Type 1XA M.2 EVB. Refer to Section 2.1.5 ⬀ for details of the antenna.

Figure 4: No Rework Needed to Connect u.FL Connector for 1XA

Aux antenna   Main antenna

Optional BT antenna
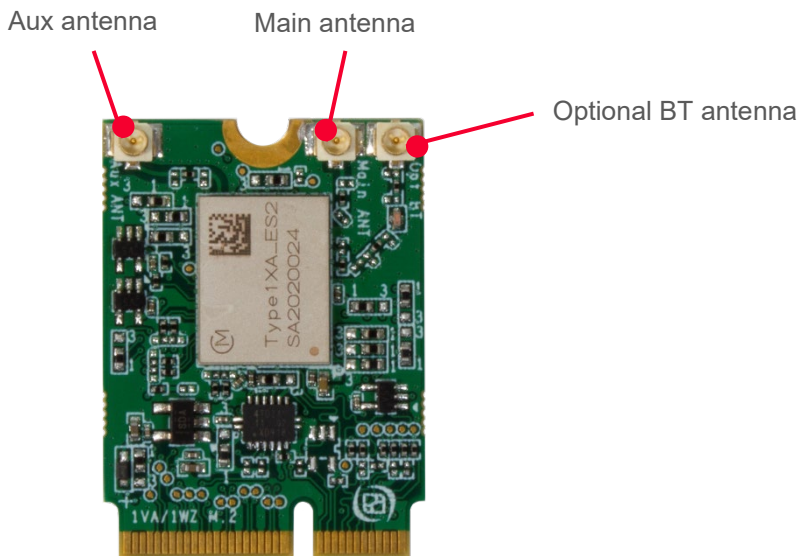
2.1.5 External Antenna

Murata recommends Molex 146153 (Digi-Key part number WM12218-ND ⤢) or Molex 146187 (WM16990-ND ⤢) module for use as external antenna with its EVBs. The same antenna is used for reference certification of the Type 1XA EVB.

The Molex 146153/146187 is a balanced, dipole-type, high efficiency antenna. It is ground plane independent, dual band antenna that supports the 2400-2500 MHz, 5150-5850 MHz frequency bands. The physical size is 40.95 x 9 x 0.7 mm. The antenna cable come in 6 standard length options: 50/100/150/200/250/300 mm (100 mm is used for the reference certification) and the connector is MHF-I, which is a u.FL compatible connector.

Figure 5: Molex 146153 and 146187 Antennas
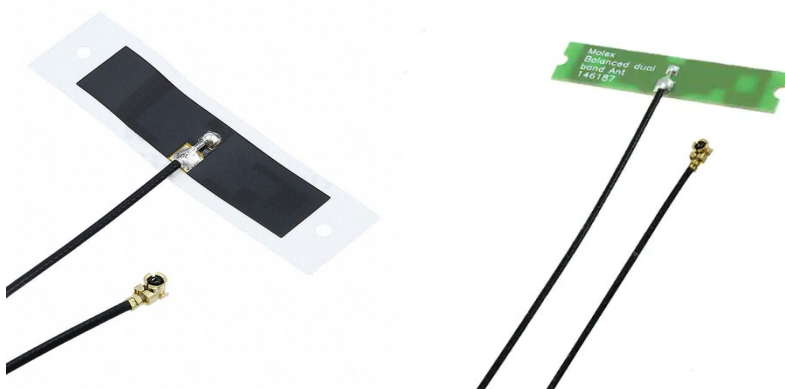
2.2 Software Setup

The first step to get started with the software set up is to download the latest image from the manufacturer's website. The second step is to flash the reference platform with the default image. There are two types of WLAN firmware i.e., production firmware and manufacturing firmware.

Production version of the WLAN firmware is used as a default image. Manufacturing firmware is needed to run the RF or regulatory testing. Murata supports Linux Operating System (OS).

2.2.1 Linux

The most important step to run Wi-Fi regulatory testing with FMAC driver is to switch over the manufacturing firmware and reboot the platform. The user can request the manufacturing firmware files from Murata. First, we need to flash the developer's kit with Embedded Artist image. Download the UUU zip file for the board you are using from Embedded Artists ⤴.

To flash the i.MX board using UUU tool, please follow the steps mentioned in the Section 6 of Embedded Artist "Getting Started with M.2 modules and i.MX 6/7/8 on Linux v5.10" document. You can download the document from the Getting Started with M.2 modules Guide ⤴.

After flashing the board, you need to switch to manufacturing firmware to run the wl test on the module. Please follow the steps below to switch over to manufacturing firmware:

- Obtain manufacturing test firmware tar ball. If you need assistance, please contact Murata via the Forum ⤴

- Mount flashed (micro) SD card on Linux host PC.

- "*cd*" to "*lib/firmware/cypress*" folder.

- Switch user to "*root*".

- Create "*mfgtest*" and "*production*" sub-folders in "*/lib/firmware/cypress*" folder.

- Backup existing "**.bin*" and "**.clm_blob*" files to "*production*" sub-folder.

- Copy manufacturing test firmware files (from "mfgtest" sub-folder) into "*lib/firmware/cypress*" folder.

- Insert (micro) SD card on i.MX platform and boot.

- Verify that "*WLTEST*" is logged when "*FMAC*" driver loads.

On host, insert (micro) SD card and configure sub-folder for production and manufacturing test firmware:

```
$ cd <path to mounted rootfs>/lib/firmware/cypress
$ sudo mkdir mfgtest
$ sudo mkdir production
$ sudo cp *.bin production/
$ sudo cp *.clm_blob production/
$ sudo cp <path to mfgtest binaries>/*.bin mfgtest/
$ sudo cp <path to mfgtest binaries>/*.clm_blob mfgtest/
```

On i.MX Target, insert modified (micro) SD card, boot platform and note firmware log message:

```
brcmfmac: brcmf_c_preinit_dcmds: Firmware version = wl0: Sep 21 2018 04:08:34
version 7.45.173 (r707987 CY) FWID 01-d2799ea2
```

Now copy over "mfgtest" sub-folder contents to "/lib/firmware/cypress":

```
$ cd /lib/firmware/cypress
$ cp mfgtest/* .
```

Reboot platform and note different log message (with "WLTEST" string) for manufacturing test firmware:

```
brcmfmac: brcmf_c_preinit_dcmds: Firmware version = wl0: Sep 21 2018 04:02:19
version 7.45.173 (r707987 CY WLTEST) FWID 01-3c82dde4
```

> **ⓘ** The version number of firmware for production and manufacturing test **should not differ**. In this example, both firmware versions are "7.45.173".

Now you can run RF testing using the wl tool. Note that manufacturing test firmware does not support some interoperability modes that production firmware does. The manufacturing test firmware is a specific release and is intended only to be used for RF testing.

Once RF testing is done, you can easily revert to the normal production firmware:

```
$ cd /lib/firmware/cypress
$ cp production/* .
```

3 Murata IFX RF Test Script

Murata has simplified the RF testing steps by providing an easy-to-use python script that can be run on the test platform. Steps for downloading and invoking the script are detailed here.

3.1 Dependency

The Murata IFX RF test script requires python to be present in the test machine. Both python 2 and 3 are supported.

3.2 Download Murata IFX RF Test Script File

Download the latest Murata IFX RF test script ⤴

3.3 Run the script

Murata IFX RF test script performs the following tasks:

- Prompts the user to select the host type being used (additionally, port number in case of Windows host)
- Verifies the firmware. To run RF test commands, the manufacturing firmware is needed. The script checks to see if the manufacturing firmware is loaded. It cannot continue otherwise.
- Prompts the user to select the Murata Wi-Fi/Bluetooth module being tested.
- Prompts the user to select the RF test to conduct.
- Depending on the selected test, prompts the user to select/enter the relevant parameters:
  - Band
  - Bandwidth
  - Option to include DFS channels

- Channel
- Antenna
- Data rate
- Transmission power
- For Continuous Transmission test, allows the user to further customize the following:
  - Packet interval
  - Packet length
  - Number of frames
- Provides the selected configuration for the user to review and accept.
- Starts the test and continues until the user presses 'Enter'.
- Stops the test once the user presses 'Enter'
- For Receive test, shows relevant statistics.

Running the script file is straightforward. Simply invoke the following command from the folder on the test platform where the script is located:

```
python Murata_IFX_RF_Test_Tool.py
```

The script flow logic is shown in below. For an example input/output sequence, please refer to Appendix A: Sample output of Murata IFX RF Test Script ⬚

3.3.1 Script Flow

The following **Figure 6**, **Figure 7**, **Figure 8**, and **Figure 9** describes the user interaction flow of the script for modules 1DX, 1LV, 1MW and 1XA respectively.

Figure 6: Murata IFX RF Test Script Flow for 1DX
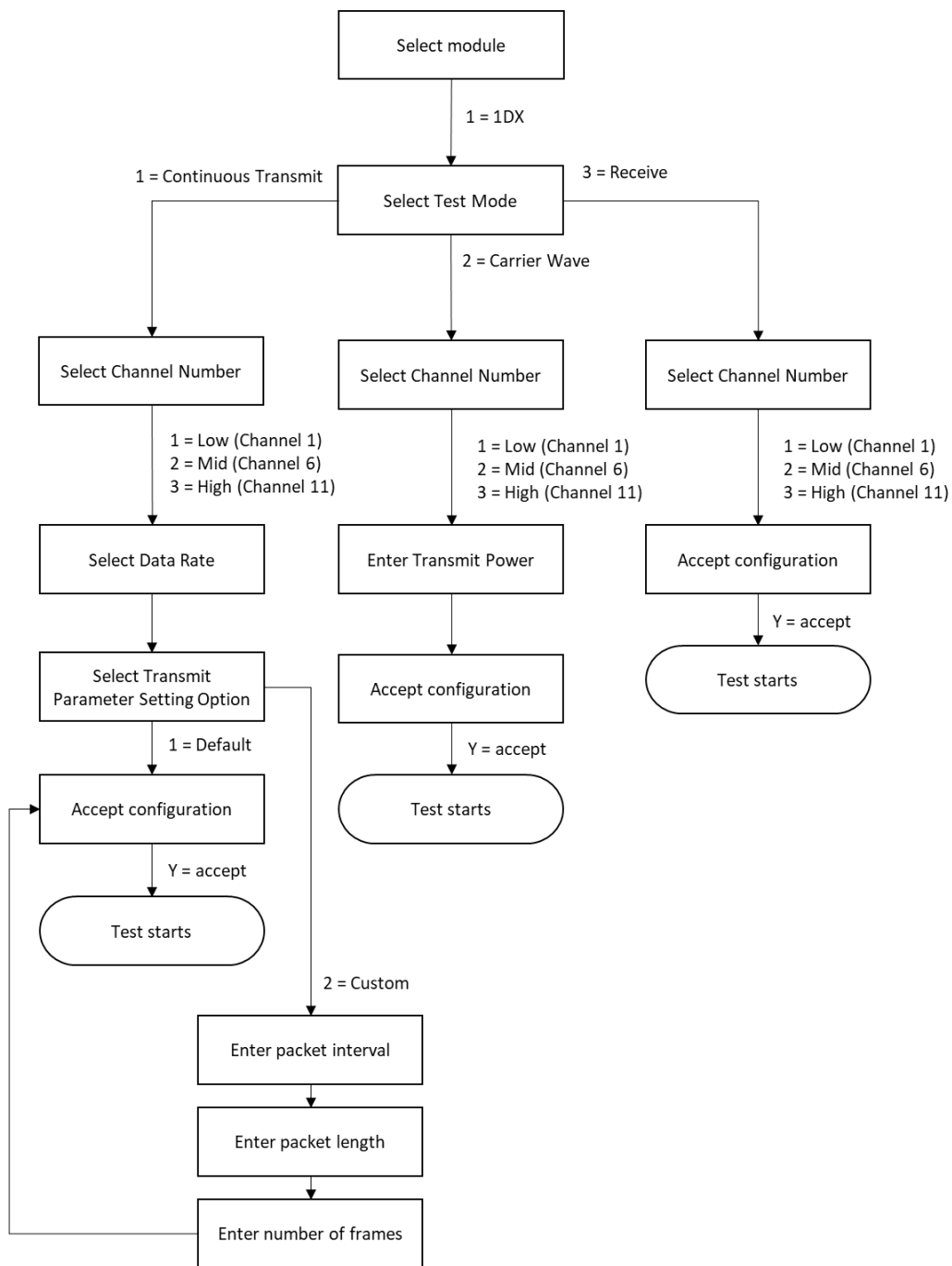
Figure 7: Murata IFX RF Test Script Flow for 1LV
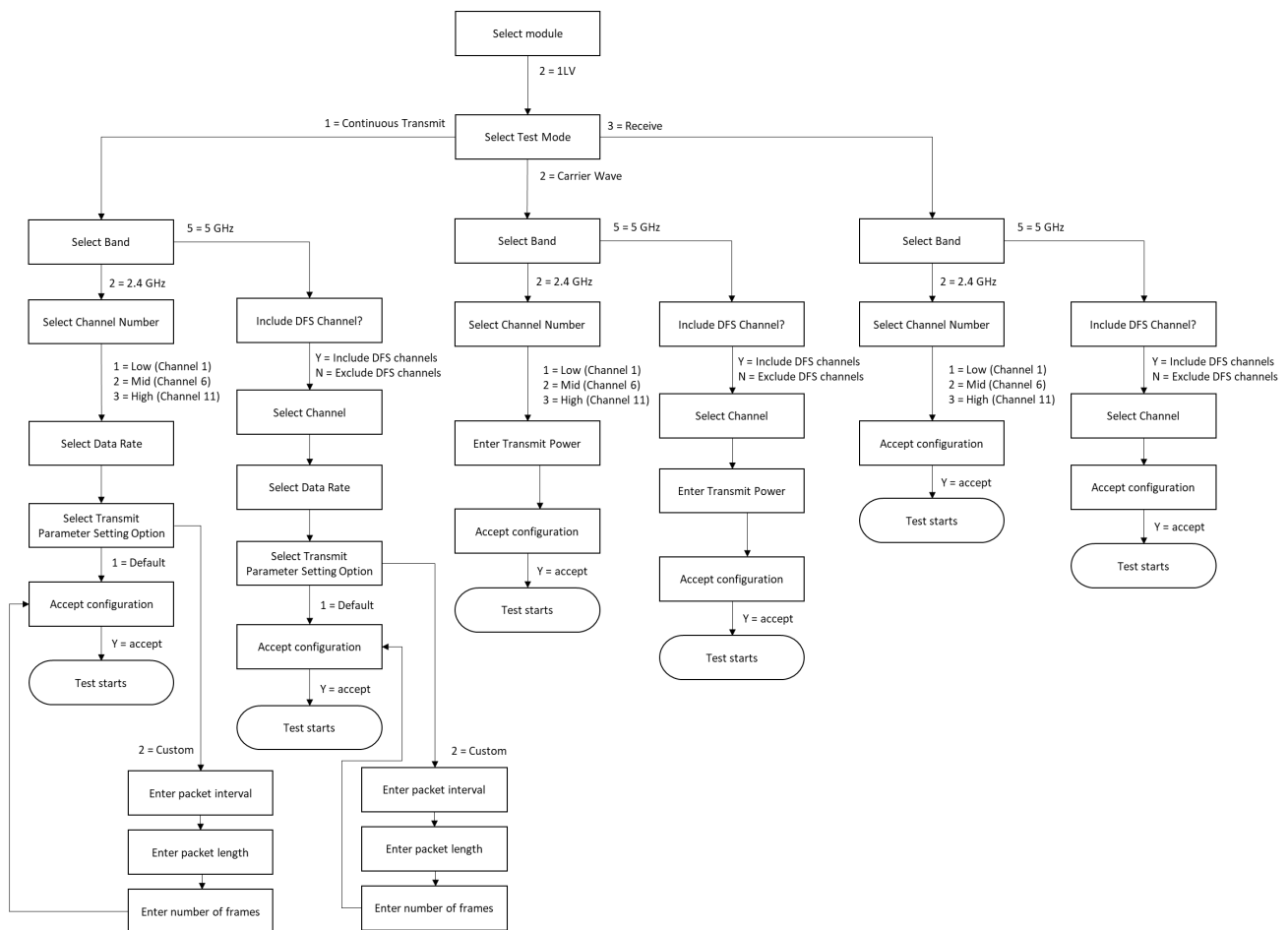
Figure 8: Murata IFX RF Test Script Flow for 1MW
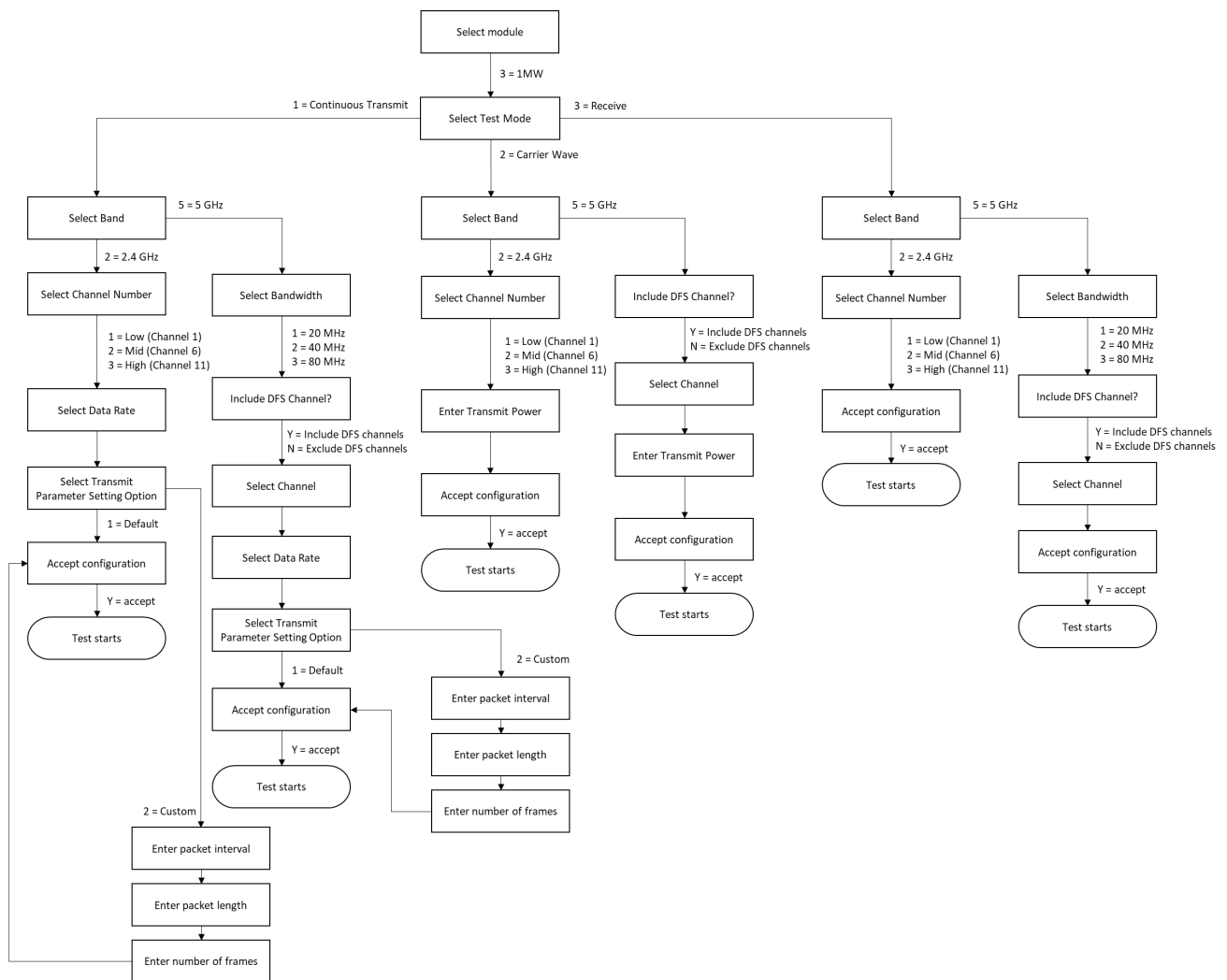
Figure 9: Murata IFX RF Test Script Flow for 1XA
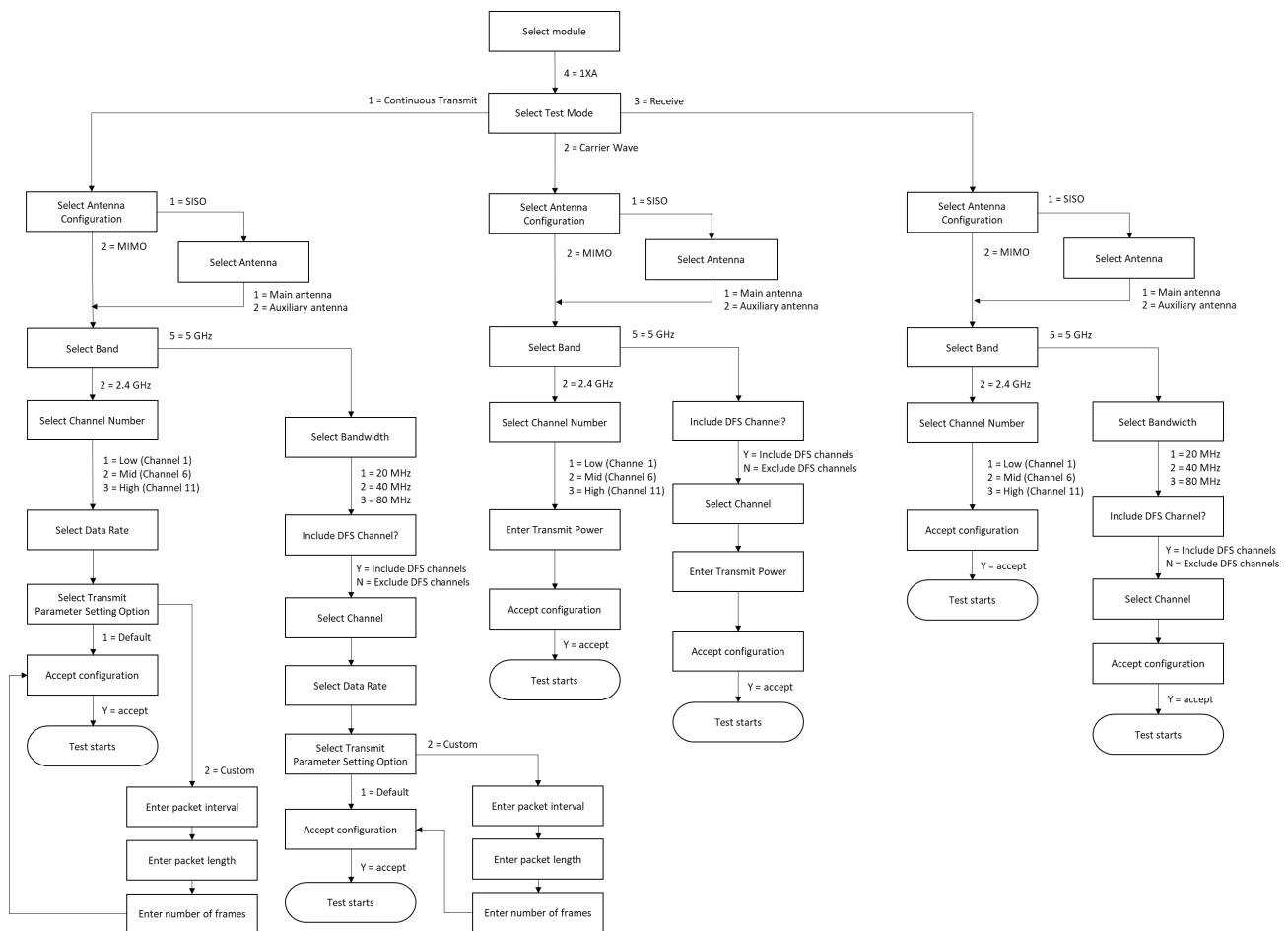
3.3.2 Automation Option in the script

User can provide a configuration file to the script to automate a test partly or fully. Invoke the script with '-c' switch and provide the config file name.

```
python Murata_IFX_RF_Test_Tool.py -c config.txt
```

A demo config file is given below – the parameters are self-explanatory. Supported values are same as that of the script inputs. In case a required parameter is not provided, or the value provided is not supported, the script will request the user to select/enter the parameter as per normal script operation. This allows the user to automate a test fully (by providing all required parameters), or partly (by providing parameters that will not change between tests). One additional parameter used by the config file is 'TIME' which indicates the time (in seconds) the test should run.

```
# This config file will execute a Continuous Transmission test on Murata 1MW
# Module for 5 GHz band (40 MHz bandwidth) on channel 62 and data rate 180
# Mbps. Transmission parameters are kept at default (packet interval = 20,
# packet length = 1024, number of frames = unlimited).
```

```
# Module selection option
# 1 = 1DX, 2 = 1LV, 3 = 1MW, 4 = 1XA
```

```
MODULE = 3
```

```
# Test selection option
# 1 = Continuous Transmit, 2 = Carrier Wave, 3 = Receive
```

```
TEST = 1
```

```
# Band selection option
# 2 = 2.4 GHz, 5 = 5 GHz
```

```
BAND = 5
```

```
# Bandwidth selection option
# 1 = 2 MHz, 2 = 40 MHz, 3 = 80 MHz
```

```
BANDWIDTH = 2
```

```
# DFS selection option
# Y = Include DFS channels, N = Do not include DFS channels
```

```
DFS = Y
```

```
# Channel selection option
```

```
CHANNEL = 62
```

```
# Data rate selection option
```

```
RATE = 180
```

```
# Continuous TX test transmit setting selection option
# 1 = Use default parameters, 2 = Use custom parameters
```

```
DEFAULT_PARAM = 1
```

```
# Time to run Continuous Transmit test (in seconds)
```

```
TIME = 10
```

3.3.3 Test parameters

Please check Appendix B: Test Parameters ⤴ for supported test parameters for 1DX, 1LV, 1MW and 1XA.

4 Technical Support Contact

Table 4 lists all the support resources available for the Murata Wi-Fi/Bluetooth solution.

Table 4: List of Support Resources

Support Site	Notes
Murata Community Forum ↗	Primary support point for technical queries. Registration only needed to ask questions; viewing available to anyone.
Murata i.MX Landing Page ↗	No login credentials required. Murata documentation covering hardware, software, testing, etc. is provided here
Murata uSD-M.2 Adapter Landing Page ↗	Landing page for uSD-M.2 Adapter. In conjunction with Murata i.MX Landing Page, this should provide the user with comprehensive getting started documentation.
Murata Module Landing Page ↗	No login credentials required. Murata documentation covering all Infineon -based Wi-Fi/BT modules is provided here.

5 Appendix A: Sample output of Murata IFX RF Test Script

Test scenario: Running Continuous Transmission test on Murata 1MW module (on Linux) for 5 GHz band (40 MHz bandwidth) on channel 62 and data rate 180 Mbps. Transmission parameters are kept at default (packet interval = 20, packet length = 1024, number of frames = unlimited).

```
Murata Regulatory Script Version 1.22
Select MODULE
-------------


---------------------------------------------------------
| Entry |    MODULE Name       |     Description        |
|-------|----------------------|------------------------|
|   1   |    1DX               | 802.11 b/g/n           |
|   2   |    1LV               | 802.11 a/b/g/n         |
|   3   |    1MW               | 802.11 a/b/g/n/ac      |
|   4   |    1XA               | 802.11 a/b/g/n/ac      |
---------------------------------------------------------

Select your entry for MODULE: 3

Select Test Mode
----------------


---------------------------------------------
| Entry |    Test Mode                      |
|-------|-----------------------------------|
|   1   |    Continuous Transmit            |
|   2   |    Carrier Wave                   |
|   3   |    Receive                        |
---------------------------------------------

Select your entry for Test Mode: 1

Running Continuous Transmit test for 1MW

Select Band
-----------


----------------------------------
| Entry |   Band                 |
|-------|------------------------|
|   2   |   2.4 GHz              |
|   5   |   5 GHz                |
----------------------------------

Select your entry for band: 5

Select Bandwidth
----------------


----------------------------------
| Entry |   Bandwidth            |
|-------|------------------------|
|   1   |   20 MHz               |
|   2   |   40 MHz               |
|   3   |   80 MHz               |
----------------------------------
```

```
Select your entry for Bandwidth: 2

Do you want to include DFS channels (Y/N): Y

Select channel
[38, 46, 54, 62, 102, 110, 118, 134, 142, 151, 159]
Enter a Channel Number: 62

Select data rate
[13.5, 27, 40.5, 54, 81, 108, 121.5, 135, 162, 180]

Enter data rate: 180
Select Transmit Parameter Setting Option
-----------------------------------------


-----------------------------------------
| Entry |   Band                          |
|-------|---------------------------------|
|   1   |    Use default parameters       |
|       |      - Packet interval = 20     |
|       |      - Packet length = 1024     |
|       |      - Number of frames = 0     |
|   2   |    Input custom parameters      |
-----------------------------------------

Select your entry: 1

Please verify your selection
----------------------------


--------------------------------------------------------------
| Module                        | 1MW                        |
| Test                          | Continuous Transmit test   |
| Bandwidth                     | 40 MHz                     |
| Band                          | 5 GHz                      |
| Channel Number                | 62                         |
| Data Rate                     | 180 Mbps                   |
| Transmit Power                | 10 dBm                     |
--------------------------------------------------------------

Do you accept selected configurations ? (Y/N): Y
Transmission starts

Press Enter to stop transmission
 .  .  .

Transmission stopped
```

6 Appendix B: Test Parameters

6.1 1DX

Table 5: FCC Regulatory Test Parameters for 1DX

Band	BW	Operating Mode	Data Rates	Channels	TX Power	Frequency (MHz)
2.4 GHz	20	802.11b	1, 2, 5.5, 11	1	17	2412
				6	17	2437
				11	17	2462
		802.11g	6, 9, 12, 18, 24, 36, 48, 54	1	13	2412
				6	13	2437
				11	13	2462
		802.11n	6.5, 13, 19.5, 26, 39, 52, 58.5, 65	1	12	2412
				6	12	2437
				11	12	2462

6.2 1LV

Table 6: FCC Regulatory Test Parameters for 1LV

Band	BW	U-NII Band	Operating Mode	Data Rate	Channels (With DFS)	Channels (Without DFS)	TX Power
2.4 GHz	20	NA	802.11b	ALL (1, 2, 5.5, 11)	1, 6, 11	1, 6, 11	17
			802.11g	6/9 Mbps	1, 6, 11	1, 6, 11	17
				12/18/24 Mbps	1, 6, 11	1, 6, 11	16
				36/48 Mbps	1, 6, 11	1, 6, 11	15
				54 Mbps	1, 6, 11	1, 6, 11	14
			802.11n-HT20	MCS0-2 (6.5, 13, 19.5)	1, 6, 11	1, 6, 11	17
				MCS3 (26)	1, 6, 11	1, 6, 11	16
				MCS4-5 (39, 52)	1, 6, 11	1, 6, 11	15
				MCS6 (58.5)	1, 6, 11	1, 6, 11	14
				MCS7 (65)	1, 6, 11	1, 6, 11	13
5 GHz	20	U-NII-1, U-NII-2A, U-NII-2C,U-NII-3	802.11a	6/9/12/18 Mbps	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	16
				24/36 Mbps	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	15
				48 Mbps	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	14
				54 Mbps	36, 44, 48, 52, 60, 64, 100,	36, 44, 48, 149, 157, 165	13

							116, 120, 140, 144, 149, 157, 165		
				802.11n-HT20		MCS0-2 (6.5, 13, 19.5)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	16
						MCS3-4 (26, 39)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	15
						MCS5 (52)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	14
						MCS6 (58.5)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	13
						MCS7 (65)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	12
				802.11ac-VHT20		MCS0-2 (6.5, 13, 19.5)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	16
						MCS3-4 (26, 39)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	15
						MCS5 (52)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	14
						MCS6 (58.5)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	13
						MCS7 (65)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	12
						MCS8 (78)	36, 44, 48, 52, 60, 64, 100, 116, 120, 140, 144, 149, 157, 165	36, 44, 48, 149, 157, 165	10

6.3 1MW

Table 7: FCC Regulatory Test Parameters for 1MW

Band	BW	U-NII Band	Operating Mode	Data Rate	Channels (with DFS)	Channels (without DFS)	TX Power
2.4 GHz	20	NA	802.11b	ALL (1, 2, 5.5, 11)	1,6,11	1,6,11	17
			802.11g	6/9/12/18/24 Mbps	1	1	12
					6	6	16
					11	11	12
				36/48/54 Mbps	1	1	12
					6	6	13
					11	11	12
			802.11n-HT20	MCS0-4 (6.5, 13, 19.5, 26, 39)	1	1	12
					6	6	14
					11	11	12
				MCS5-7 (52, 58.5, 65)	1,6,11	1,6,11	12
5 GHz	20	U-NII-1, U-NII-2A, U-NII-2C,U-NII-3	802.11a	6/9/12/18/24 Mbps	36	36	12
					44, 48, 52	44, 48	15
					60, 64, 100		12
					116, 120		15
					140, 144, 149	149	12
					157	157	15
					165	165	12
				36/48/54 Mbps	36	36	12
					44, 48, 52	44, 48	13
					60, 64, 100		12
					116, 120		13
					140, 144, 149	149	12
					157	157	13
					165	165	12
			802.11n (HT20)	MCS0-3 (6.5, 13, 19.5, 26)	36	36	12
					44, 48, 52	44, 48	15
					60, 64, 100		12
					116, 120		15
					140, 144, 149	149	12
					157	157	15
					165	165	12
				MCS4-7 (39, 52, 58.5, 65)	36	36	12
					44, 48, 52	44, 48	13
					60, 64, 100		12
					116, 120		13
					140, 144, 149	149	12
					157	157	13
					165	165	12
			802.11ac (VHT20)	MCS0-3 (6.5, 13, 19.5, 26)	36	36	12
					44, 48, 52	44, 48	15
					60, 64, 100		12
					116, 120		15
					140, 144, 149	149	12
					157	157	15

BW	U-NII Band	Operating Mode	Data Rate	Channels (with DFS)	Channels (without DFS)	TX Power
				165	165	12
			MCS4-8 (39, 52, 58.5, 65, 78)	36	36	12
				44, 48, 52	44, 48	13
				60, 64, 100		12
				116, 120		13
				140, 144, 149	149	12
				157	157	13
				165	165	12
40	U-NII-1, U-NII-2A, U-NII-2C, U-NII-3	802.11n (HT40)	MCS0-3 (13.5, 27, 40.5, 54)	38	38	10
				46, 54	46	15
				62, 102		10
				110, 118		15
				134, 142, 151, 159	151, 159	10
			MCS4-7 (81, 108, 121.5, 135)	38	38	10
				46, 54	46	13
				62, 102		10
				110, 118		13
				134, 142, 151, 159	151, 159	10
		802.11ac (VHT40)	MCS0-3 (13.5, 27, 40.5, 54)	38	38	10
				46, 54	46	15
				62, 102		10
				110, 118		15
				134, 142, 151, 159	151, 159	10
			MCS4-9 (81, 108, 121.5, 135, 162, 180)	38	38	10
				46, 54	46	13
				62, 102		10
				110, 118		13
				134, 142, 151, 159	151, 159	10
80	U-NII-1, U-NII-2A, U-NII-2C, U-NII-3	802.11ac (VHT80)	MCS0-9 (29.3, 58.5, 87.8, 117, 175.5, 234, 263.3, 292.5, 351, 390)	42, 58, 106, 122, 138, 155	42, 155	10

6.4 1XA

Table 8: FCC Regulatory Test Parameters for 1XA

Band	BW	U-NII Band	Operating Mode	Spatial Stream	Data Rate	Channels (with DFS)	Channels (without DFS)	TX Power
2.4 GHz	20	NA	802.11b	1	ALL (1/2/5.5/11 Mbps)	1	1	14.5
						6	6	17
						11	11	15.5
			802.11g	1	6/9/12/18 Mbps	1, 11	1, 11	12.5
						6	6	15.5
					24/36 Mbps	1, 11	1, 11	12.5
						6	6	15
					48/54 Mbps	1, 11	1,11	12.5
						6	6	15

Protocol	Streams	MCS/Rate			
802.11n/ac (HT20)	1	MCS0-3 (6.5, 13, 19.5, 26)	1	1	11
			6	6	15.5
			11	11	11.5
		MCS4-7 (39, 52, 58.5, 65)	1	1	11
			6	6	15
			11	11	11.5
802.11ac (HT20)	1	MCS8 (78)	1	1	11
			6	6	14
			11	11	11.5
802.11n/ac (HT20)	2	MCS0-8 (6.5, 13, 19.5, 26, 39, 52, 58.5, 65, 78)	1	1	8
			6	6	14
			11	11	10
802.11a	1	6/9/12/18/24 Mbps	36, 100, 140	36	10
			44, 48	44, 48	13.5
			52, 60, 116, 120, 144, 149, 157, 165	149, 157, 165	15
			64		10.5
		36/48/54 Mbps	36, 100, 140	36	10
			44, 48	44, 48	13.5
			52, 60, 116, 120, 144, 149, 157, 165	149, 157, 165	14
			64		10.5
802.11n/ac (HT20)	1	MCS0-3 (6.5, 13, 19.5, 26)	36, 100, 140	36	9
			44, 48	44, 48	13.5
			52, 60, 116, 120, 144, 149, 157, 165	149, 157, 165	15
			64		10.5
		MCS4-6 (39, 52, 58.5)	36, 100, 140	36	9
			44, 48	44, 48	13.5
			52, 60, 116, 120, 144, 149, 157, 165	149, 157, 165	14
			64		10
		MCS7 (65)	36, 100, 140	36	9
			44, 48, 52, 60, 116, 120, 144, 149, 157, 165	44, 48, 149, 157, 165	13
			64		10
802.11ac (HT20)	1	MCS8 (78)	36, 100, 140	36	9
			44, 48, 52, 60, 116, 120, 144, 149, 157, 165	44, 48, 149, 157, 165	12
			64		10
802.11n/ac (HT20)	2	MCS0-3 (6.5, 13, 19.5, 26)	36	36	7.5
			44, 48	44, 48	10.5
			52, 60		14
			64, 100		7
			116, 120, 144		14.5
			140		6
			149, 157, 165	149, 157, 165	15
		MCS4-6 (39, 52, 58.5)	36	36	7.5
			44, 48	44, 48	10.5

					52, 60		14
					64, 100		7
					116, 120, 144, 149, 157, 165	149, 157, 165	14
					140		6
				MCS7 (65)	36	36	7.5
					44, 48	44, 48	10.5
					52, 60, 116, 120, 144, 149, 157, 165	149, 157, 165	13
					64, 100		7
					140		6
		802.11ac (HT20)	2	MCS8 (78)	36	36	7.5
					44, 48	44, 48	10.5
					52, 60, 116, 120, 144, 149, 157, 165	149, 157, 165	12
					64, 100		7
					140		6
40	U-NII-1, U-NII-2A, U-NII-2C, U-NII-3	802.11n/ac (HT40)	1	MCS0-5 (13.5, 27, 40.5, 54, 81, 108)	38	38	10.5
					46	46	13
					54, 110, 118, 142, 151, 159	151, 159	14
					62		9.5
					102		8.5
					134		12
				MCS6 (121.5)	38	38	10.5
					46, 54, 110, 118, 142, 151, 159	46, 151, 159	13
					62		9.5
					102		8.5
					134		12
				MCS7 (135)	38	38	10.5
					46, 54, 110, 118, 134, 142, 151, 159	46, 151, 159	12
					62		9.5
					102		8.5
		802.11ac (HT40)	1	MCS8 (162)	38	38	10.5
					46, 54, 110, 118, 134, 142, 151, 159	46, 151, 159	11
					62		9.5
					102		8.5
				MCS9 (180)	38, 46, 54, 110, 118, 134, 142, 151, 159	38, 46, 151, 159	10
					62		9.5
					102		8.5
		802.11n/ac (HT40)	2	MCS0-5 (13.5, 27, 40.5, 54, 81, 108)	38	38	7.5
					46	46	10
					54, 110, 118, 142, 151, 159	151, 159	14
					62		7
					102		8

					134		9
				MCS6 (121.5)	38	38	7.5
					46	46	10
					54, 110, 118, 142, 151, 159	151, 159	13
					62		7
					102		8
					134		9
				MCS7 (135)	38	38	7.5
					46	46	10
					54, 110, 118, 142, 151, 159	151, 159	12
					62		7
					102		8
					134		9
		802.11ac (HT40)	2	MCS8 (162)	38	38	7.5
					46	46	10
					54, 110, 118, 142, 151, 159	151, 159	11
					62		7
					102		8
					134		9
				MCS9 (180)	38	38	7.5
					46, 54, 110, 118, 142, 151, 159	46, 151, 159	10
					62		7
					102		8
					134		9
80	U-NII-1, U-NII-2A, U-NII-2C, U-NII-3	802.11ac (HT80)	1	MCS0-5 (29.3, 58.5, 87.8, 117, 175.5, 234)	42	42	8
					58		5.5
					106		7.5
					122, 138		14
					155	155	13
				MCS6 (263.3)	42	42	8
					58		5.5
					106		7.5
					122, 138, 155	155	13
				MCS7 (292.5)	42	42	8
					58		5.5
					106		7.5
					122, 138, 155	155	12
				MCS8 (351)	42	42	8
					58		5.5
					106		7.5
					122, 138, 155	155	11
				MCS9 (390)	42	42	8
					58		5.5
					106		7.5
					122, 138, 155	155	10
		802.11ac (HT80)	2	MCS0-5 (29.3, 58.5, 87.8, 117, 175.5, 234)	42	42	6
					58		4
					106		5.5
					122, 138		14
					155	155	10.5

						MCS6 (263.3)	42	42	6
							58		4
							106		5.5
							122, 138		13
							155	155	10.5
						MCS7 (292.5)	42	42	6
							58		4
							106		5.5
							122, 138		12
							155	155	10.5
						MCS8 (351)	42	42	6
							58		4
							106		5.5
							122, 138		11
							155	155	10.5
						MCS9 (390)	42	42	6
							58		4
							106		5.5
							122, 138		10
							155	155	10.5

7 Acronyms

Table 9: Acronyms used in Test Guide

Acronym	Meaning
AP	Access Point
BLE	Bluetooth Low Energy
BT	Bluetooth
CLM	Country Locale Matrix
EA	Embedded Artists designs, manufactures and distributes current Wi-Fi/BT M.2 EVBs (link here ↗). EA also have enhanced i.MX developer kits which provide comprehensive support for Murata modules (link here ↗).
EVB	Evaluation Board (Embedded Artists' Wi-Fi/BT module)
EVK	Evaluation Kit (includes EVB + Adapter)
FCC	Federal Communications Commission
FW	Firmware
OS	Operating System
PC	Personal Computer
PCIe	PCI Express
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTS	Request to Send
SDIO	Secure Digital Input Output
STA	Station
UART	Universal Asynchronous Receiver/Transmitter
uSD	Micro SD
uSD-M.2	Micro SD to M.2 Adapter
Wi-Fi	Wireless LAN: "Wi-Fi" is a registered trademark of the Wi-Fi Alliance
WLAN	Wireless Local Area Network

8 References

This section reviews all the key reference documents that the user may like to refer to.

8.1 FCC Regulatory Certification Guide

This document ⤢ provides general information on FCC Regulatory Certification with respect to Murata Wi-Fi/Bluetooth modules.

8.2 Infineon Wi-Fi CLM Regulatory Manual

This document ⤢ from Infineon introduces the CLM regulatory compliance process.

8.3 Murata's Community Forum Support

Murata's Community provides online support for the Murata Wi-Fi/Bluetooth modules on various i.MX platforms. Refer to this link ⤢ for existing support threads.

8.4 Murata Wi-Fi/BT Solution Landing Page for i.MX

This landing page ⤢ provides documentation to get customers up and running quickly on NXP and Embedded Artists' i.MX reference platforms. The focus is on enabling Wi-Fi/Bluetooth interfaces.

8.5 Murata Wi-Fi/BT (CYW) Solution for i.MX Linux User Guide

This User Guide ⤢ details configuring/enabling/testing Murata Wi-Fi/BT modules (based on CYW chipsets) on both NXP and Embedded Artists i.MX 6/7/8 Developer Kits.

Revision History

Revision	Date	Author	Change Description
1.0	Oct 29, 2021	TF	Initial Release
2.0	Oct 19, 2022	TF	Updated to new format