Laon Technology

KUM1000-MA0-03

AUG 23, 2019

LAON Technology Co., Ltd.

Revisions

Date	Version	Prepared by	Descriptions
AUG 23, 2019	1.0		Initial edition

- Contents -

1. Overview

1.1. Features and Functions

LAON Technology('LAON')'s KUM1000-MA0-03("MA0-03") has been designed to meet IEEE 802.11a standard specification requirements adopting 5.0GHz band which provides sufficient number of usable channels for smooth full-duplex audio communications with less frequency interferences.

"MA0-03" is LAON's all-in-one SoC ("KUM1000") based RF module and Media Access Control ('MAC') chip and Baseband Processor ('BBP') are all combined in the SoC.

"MA0-03" provides a designated internal flash memory for various parameters set up and download of the control-related operating software. It is designed to use with the relevant application devices not applying an extra external CPU as it, by its own CPU, supports external interfaces such as UART, SPI, I2C and GPIO.

Also, 'Direct Conversion' is applied which is a method to direct convert the Baseband signals from BBP to RF signals and it supports switching function and etc to implement 'Diversity' capability.

2. Specifications

2.1. "MA0-03" specifications

No	Parameters	Specifications	Remarks
1	Frequency Band	- 5180MHz ~ 5240MHz [1] - 5745MHz ~ 5825MHz [2]	Refer to 'Channel ID'
2	Channel Band Width	20MHz	
3	Wireless Media	OFDM	
4	Modulation	BPSK : 6Mbps	
		QPSK : 12Mbps	
		16-QAM : 36MbPs	
5	Data Rate	6Mbps,12Mbps,36Mbps	
6	Transmitted Power	- +26dBm(Max.)@EIRP	Peak Power
7	Receiving Sensitivity	-80dBm @ 36Mbps	
8	Frequency Tolerance	± 20ppm	
9	Chipset	LAON Technology (KUM1000)	
10	Operation voltage	3.3V ± 5%, 5.0V ± 5%,	
11	Power consumption	Master Mode : 550mA MAX,3.3V@TX 200mA MAX,5.0V@TX	
		Slave Mode : 300mA MAX,3.3V@TX 200mA MAX,5.0V@TX	
12	Dimension (W x H x D)	58mm x 20mm x 6mm	
13	Operation temperature	0℃ ~ +50℃	
14	Storage temperature	-20℃ ~ +70℃	
15	Antenna Interface[4]	2 x CMJ(U.FL compatible) Connector	
16	System Interface	2 x 04-6296-051-931846 Connector	

*1: To see the correct properties of "MA0-03", it is required to measure after approx. 1 minute from the power supply.

[1] Channel ID : 36,40,44,48
[2] Channel ID : 149,153,157,161,165

The channels and frequency bandwidths currently being used by "MA0-02" are as following tables.

1) Frequency band: 5180~5240MHz

No.	LaON Channel	WiFi Channel ID	Center Freq.	Freq. Range	Remarks
1	2	36	5180 MHz	5170~5190 MHz	
2	3	40	5200 MHz	5190~5120 MHz	
3	4	44	5220 MHz	5210~5230 MHz	
4	5	48	5240 MHz	5230~5250 MHz	

2) Frequency band: 5745~5825MHz

No.	LaON Channel	WiFi Channel ID	Center Freq.	Freq. Range	Remarks
1	23	149	5745 MHz	5735~5755 MHz	
2	24	153	5765 MHz	5755~5775 MHz	
3	25	157	5785 MHz	5775~5795 MHz	
4	26	161	5805 MHz	5795~5815 MHz	
5	27	165	5825 MHz	5815~5835 MHz	

2.2. Pin Maps (System Interface)

1) CON1 : Connector : 04-6296-051-931846

1-1. Audio Input, Output			
Pin No	Pin Name	Type[5]	Description
1	SYS Clock	O	Codec Main Clock
3	LRCK	O	Data Bit clock
5	BCK	O	Data Sampling Clock
7	Sdin 1	I	Data Input: Mic In#1
9	Sdout 1	O	Data Output:1
11	Sdout 2	O	Data Output:2
13	Sdin 2	I	Data Input: Mic In#2
1-2. Codec Reset / GPIO			
15	Reset-1	O	Reset_1 /GPIO1
17	Reset-2	O	Reset_2 /GPIO2
19	Reset-3	O	Reset_3 /GPIO3
21	Reset-4	O	Reset-4 /GPIO4
23	Reset-5	O	Reset-5 /GPIO5
25	Reset-6	O	Reset-6 /GPIO6
27	Reset-7	O	Reset-7 /GPIO7
29	Reset-8	O	Reset-8 /GPIO8
31	Sdin 3	I	Data Input: Mic In#3
33	Reset-10	O	Reset-10 /GPIO10
35	Reset-11	O	Reset-11 /GPIO11
37	Reset-tx	O	Tx_reset : 1 /GPIO12
1-3. I2C			
39	I2C_SCL	O	I^2C Clock /GPIO13
41	I2C_SDA	B	I^2C Data /GPIO14
43	I2C_EN	O	I^2C Enable /GPIO15
45	Ni-MH Input	AI	Battery Monitoring
47	GND		

[5] O : Output / I : Input / B : Input, Output / AI : Analog Input

- Pin Maps Continued (CON1)

1-4. UART2, SPI Interface(4-Wire)			
Pin No	Pin Name	Type[6]	Description
49	UART_Tx2	O	UART2_Tx /GPIO16
51	UART_Rx2	I	UART2_Rx /GPIO17
2	SPI_CSB(1)	B	GPIO18
4	SPI_CLK(1)	B	GPIO19
6	SPI_MOSI(1)	B	GPIO20
8	SPI_MISO(1)	B	GPIO21
1-5. UART1			
10	UART_Tx1	O	UART 1 Tx
12	UART_Rx1	I	UART 1 Rx
14	Sdin 4	I	Data Input: Mic In#4
1-6. JTAG, Reset			
16	TMS	I	Test Mode Select
18	TDO	O	Test Data Out
20	TCLK	I	Test Clock
22	TDI	I	Test Data In
24	nTRST	I	Reset / Active Low
1-7. Flash Memory			
26	Flash_ext_SI	O	Flash_Serial Input
28	Flash_ext_SO	I	Flash_Serial Output
30	Sdin 5	I	Data Input: Mic In#5
32	Sdin 6	I	Data Input: Mic In#6
34	Flash_ext_CLK	O	Flash_Serial Clock
36	Flash_ext_CE	O	Flash_Chip Select
1-8. Power			
38	VCC		VCC +3.3V / Max : 0.6A
40	VCC		VCC +3.3V
42	VCC		VCC +3.3V
44	VCC		VCC +3.3V
46	GND		
48	GND		
50	GND		

[6] O : Output / I : Input / B : Input, Output / AI : Analog Input

2) CON2 : Connector : 04-6296-051-931846

2-1. Codec In / Out			
Pin No	Pin Name	Type[7]	Description
1	Sdout 3	O	Data Output:3
3	Reset-9	I	Reset-9 /GPIO9
5	Test Pattern Output	O	
7	Flash_ext_RST	O	Flash Reset
9	Flash_ext_WP	O	Flash_Write Protect
11	Sdout 4	O	Data Output:4
13	Sdout 5	O	Data Output:5
15	Sdout 6	O	Data Output:6
17	Sdout 7	O	Data Output:7
19	Sdout 8	O	Data Output:8
21	Sdout 9	O	Data Output:9
23	Sdout 10	O	Data Output:10
25	Sdout 11	O	Data Output:11
2-2. Frame Bus Control			
27	FRM_bus0	O	Frame Bus [0..5]
29	FRM_bus1	O	
31	FRM_bus2	O	
33	FRM_bus3	O	
35	FRM_bus4	O	
37	FRM_bus5	O	
39	FRM0	O	Frame0
41	EXT_SYNC_IN	I	
43	EXT_SYNC_OUT	O	
45	CLK_20MHz	O	
47	ETH_WE	O	
49	ETH_RD	O	
51	ETH_CE	O	

[7] O : Output / I : Input / B : Input, Output / AI : Analog Input

- Pin Maps Continued (CON2)

2-3. Ethernet Address			
Pin No	Pin Name	Type[8]	Description
2	Address0	I	TCP/IP Address[0..13]
4	Address1	I	
6	Address2	I	
8	Address3	I	
10	Address4	I	
12	Address5	I	
14	Address6	I	
16	Address7	I	
18	Address8	I	
20	Address9	I	
22	Address10	I	
24	Address11	I	
26	Address12	I	
28	Address13	I	
2-4. Ethernet Data			
30	Data0	B	TCP/IP Data [0..7]
32	Data1	B	
34	Data2	B	
36	Data3	B	
38	Data4	B	
40	Data5	B	
42	Data6	B	
44	Data7	B	
2-5. UART2			
46	UART_Tx2	O	UART2_Tx /GPIO16
48	UART_Rx2	I	UART2_Rx /GPIO17
50	GND		

[8] O : Output / I : Input / B : Input, Output / AI : Analog Input

3. Product applications and cases

3.1. Product applications

"MA0-03" has been developed with a focus on miniaturization in view of various applications that require even compact and portable devices. It is an industry wide solution that the main applications include wireless microphones, conferences, interpretations, wireless intercom systems, security at construction sites and etc.

The wireless microphones and intercoms can also be applied for large-sized restaurants, family restaurants, Fast food restaurants, drive-thru, health care and sports gyms, churches and schools for civilian industries.

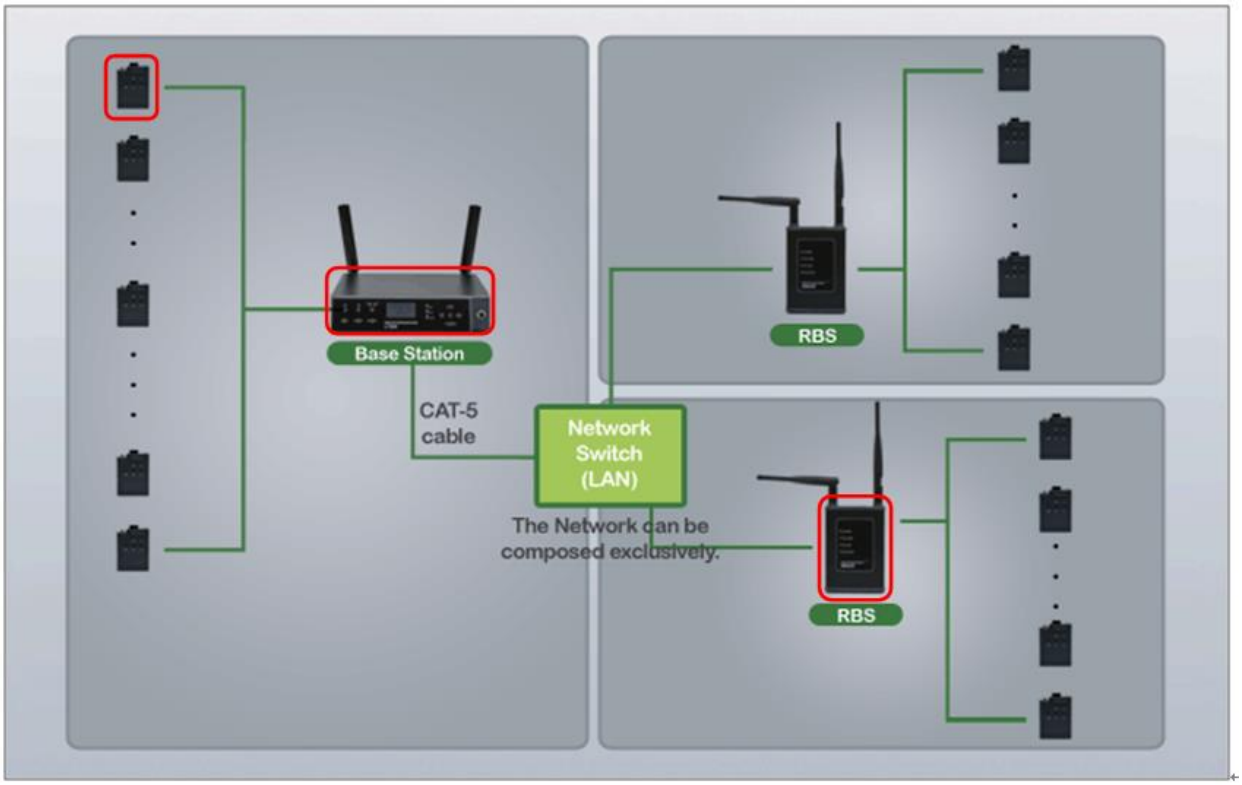
3.2. Application cases

Below image is a LAON's wireless intercom system and "MA0-03" is built in the Base Station product, Remote Base Station(RBS) product and Belt Pack product each for wireless links.

3.2.1. System usages

Below is a system configuration example in indoor to fill the blind spots or halls of wireless coverage using the Base Station(in the middle of the image below) and UTP Cable. Using this system enables audio communications even in blind areas and supports fully flexible scalability to expand wireless coverage regardless of the places within the network.

"MA0-02" is built in each product which is indicated in red in below figure, to enable the devices wireless audio signal transmissions for wireless sections.



4. Operating Description

1) Operating Frequency Range

Operating Frequency Range is that :

- 1st Band : 5180MHz ~ 5240MHz
- 2nd Band : 5745MHz ~ 5825MHz

2) MAX2829 IC

It performs modulation function to send DATA after generating 5GHz TX frequency required by LAON ASIC MCU control. It also performs the ability to amplify the desired RF POWER LEVEL in DRIVE AMP.

It also performs the function of demodulating the RX frequency received from the antenna and LNA as an IQ signal. 40MHz CLOCK is supplied.

3) LAON ASIC IC

It performs the function of converting the RX IQ signal received from MAX2829 to DATA and the function of converting TX DATA to an IQ signal. The built-in MCU function also performs the control function of the KUM1000-MA0-03. It also performs the TX/RX cycle signal supply function and The TX AMP/RX AMP ON/OFF function. 40MHz CLOCK is supplied

4) DC/DC Converter

It receives + 3.3V from Interface Connector and supplies the 3.3V / 1.2V power necessary for the IC.

5) TX Path

The 5GHz TX frequency supplied by the MAX2829 is amplified by the driver AMP into amplifiable LEVEL in the PA. The POWER AMP is amplified by about 26 dBm and the switch radiates into the air through the antenna. The switch is controlled by the TX / RX signal provided on the Laon ASIC. POWER AMP LEVEL using RF attenuator is also attenuated to 3dB, 6dB, 9dB and 12dB.

6) RX Path

The 5GHz frequency received from the antenna is amplified by the LOW NOISE AMP through

a switch that is operated only during the RX cycle. It is amplified from the DRIVER AMP to a demodulator level on the MAX2829. It also uses 5GHz BPF to eliminate unnecessary frequencies.

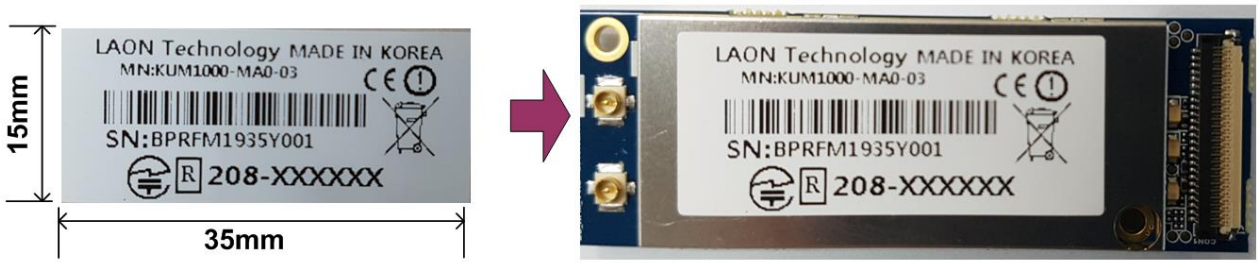
5. RF Shield Method

Use RF shield can as the RF shield method.

- **Shield can Size** : 19 X 43.5 X 2 mm
- The RF module is protected by a shield can. The shield can not be removed by hand without tools. The shield can is tightly sealed. It is designed to be opened only with sharp tools such as tweezers.

6. Label

6.1. Product Label & LABEL LOCATION



- **Size** : 35 X 15 mm
- **Contents**
  - Model : KUM1000-MA0-03
  - Manufacture : LAON Technology
  - SN : BPRFMXXXXY001 or BSRFMXXXXY001
  - MADE IN KOREA

Antenna Requirement

ANTENNA TYPE	Antenna 1 (Basic)	Dipole Antenna [Model name: AE-T2450/5500DP5-RSMA]		
	Antenna 2 (Additional)	PCB Antenna [Model name: AEi-2450/5500P-IPEX35]		
	Antenna 3 (Additional)	PCB Antenna [Model name: AEi-5500DP5-IPEX100[Bottom]]		
	Antenna 4 (Additional)	PCB Antenna [Model name: AEi-RO-5500DP4-IPEX160]		
	Antenna 5 (Additional)	PCB Antenna [Model name: AEi-RO-5500DP4-IPEX250]		
ANTENNA GAIN	Antenna 1 (Basic)	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	4.299 dBi
			5 725 MHz ~ 5 825 MHz Band	5.634 dBi
	Antenna 2 (Additional)		5 150 MHz ~ 5 250 MHz Band	3.967 dBi
			5 725 MHz ~ 5 825 MHz Band	1.119 dBi
	Antenna 3 (Additional)		5 150 MHz ~ 5 250 MHz Band	1.169 dBi
			5 725 MHz ~ 5 825 MHz Band	4.358 dBi
	Antenna 4 (Additional)		5 150 MHz ~ 5 250 MHz Band	3.719 dBi
			5 725 MHz ~ 5 825 MHz Band	6.861 dBi
	Antenna 5 (Additional)		5 150 MHz ~ 5 250 MHz Band	4.290 dBi
			5 725 MHz ~ 5 825 MHz Band	5.904 dBi

FCC ID: 2AU4Y-LAON-INTERCOM

FCC Information to User

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

• Reorient or relocate the receiving antenna.
• Increase the separation between the equipment and receiver.
• Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
• Consult the dealer or an experienced radio/TV technician for help.

Caution

Modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Compliance Information : This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

IMPORTANT NOTE:

FCC RF Radiation Exposure Statement:

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

FCC MODULAR APPROVAL INFORMATION EXAMPLES for Manual

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference.

(2) This device must accept any interference received, including interference that may cause undesired operation.

CAUTION: Changes or modifications not expressly approved by the party responsible for

compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

Requirement per KDB996369 D03

2.2 List of applicable FCC rules

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.3
Explanation: This module meets the requirements of FCC part 15C(15.247).

2.3 Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer’ s instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in
5 GHz DFS bands.
Explanation: The EUT has a Chip Antenna, and the antenna use a permanently attached antenna which is not replaceable.

2.4 Limited module procedures

If a modular transmitter is approved as a “limited module,” then the module manufacturer is responsible for approving the host environment that the limited module is used with. The manufacturer of a limited module must describe, both in the filing and in the installation instructions, the alternative means that the limited module manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions. A limited module manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.
This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.
Explanation: The module is not a limited module.

2.5 Trace antenna designs

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects:
layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.
a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna);
b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency, the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered);
c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout;
d) Appropriate parts by manufacturer and specifications;
e) Test procedures for design verification; and
f) Production test procedures for ensuring compliance.
The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.
Explanation: Yes, The module with trace antenna designs, and This manual has been shown the layout of trace design, antenna, connectors, and isolation requirements.

2.6 RF exposure considerations

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person’s body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

Explanation: This module complies with FCC RF radiation exposure limits set forth for an uncontrolled

environment, This equipment should be installed and operated with a minimum distance of 20

centimeters between the radiator and your body." This module is designed to comply with the FCC

statement, FCC ID is: **2AU4Y-LAON-INTERCOM**

2.7 Antennas

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an “omni-directional antenna” is not considered to be a specific “antenna type”)).

For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product. The module manufacturers shall provide a list of acceptable unique connectors.

Explanation: The EUT has a Dipole Antenna, and only the supplied antennas can be used.

2.8 Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC rules. This includes advising host product manufacturers that they need to provide a physical or e-label stating “Contains FCC ID” with their finished product. See Guidelines for Labeling and User Information for RF Devices‐KDB Publication 784748.

Explanation: The host system using this module, should have label in a visible area indicated the

following texts: "Contains FCC ID: 2AU4Y-LAON-INTERCOM

2.9 Information on test modes and additional testing requirements5

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or

instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer’s determination that a module as installed in a host complies with FCC requirements.

Explanation: Top band can increase the utility of our modular transmitters by providing instructions

that simulates or characterizes a connection by enabling a transmitter.

2.10 Additional testing, Part 15 Subpart B disclaimer

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Explanation: The module without unintentional-radiator digital circuity, so the module does not

require an evaluation by FCC Part 15 Subpart B. The host should be evaluated by the FCC Subpart B.