OEM Integrators / User Manual

1. Introduction

The ATM100 module offers customers fast time to market with a mono, or stereo, wireless audio connection. The module is optimized for low-cost, high-quality, easy-to-use wireless audio solutions for wireless subwoofer or wireless rear speaker applications.

Avnera's proprietary wireless system takes a new approach to wireless audio. The wireless protocol was designed from the ground up and delivers uncompressed mono or stereo audio, with fixed latency over the air, without interference issues, and with industry leading WiFi coexistence – even at close proximities to a WiFi device.

Avnera-enabled wireless modules offer a low-touch, easy-to-integrate wireless audio solution and enables fast time to market by eliminating concerns about compliance, antenna tuning, and board optimization.

Modules based on Avnera's AV6210 silicon provide breakthrough wireless audio functionality with fixed low-latency point-to-point transport of uncompressed mono/stereo PCM audio data supporting a wide range of input sample rates. A single I2S digital audio port is used for the module audio input/output.

2. Feature

- Product Size
    - Module Size (mm): 40.4 (W) X 26.0 (L) X 3.2 (H)
    - Antenna Type : PCB Printed Antenna
- Audio Interfaces
    - I2S Digital Input/Output interface with >94dB end-to-end digital audio path

- 2.4 GHz ISM band, continuous dynamic channel selection
- Forward error correction coding, error detection, and audio-specific error concealment
- Dual onboard printed PCB antennas for multipath and fading mitigation
- Auto-search/synch and dynamic channel selection
- Low, fixed latency of less than 20ms for typical audio applications
- 24 pin FPC or pin header connector
- Sample rate converter: Support for 32 - 96kHz input sample rates
- Over-the-air upgrade capability
- Customizable firmware for simple, low-cost, sub-woofer amplifier implementations
- General purpose over-the-air (OTA) serial interface:

  > 11 kbps, bi-directional, full duplex

- Support for amplifier control data, meta-data data, and remote commands
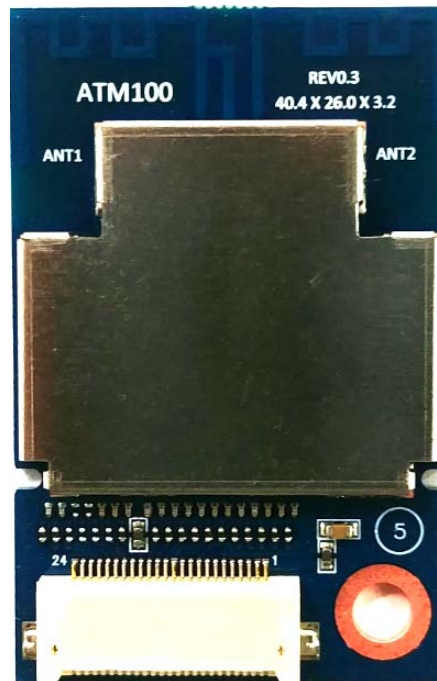
3. General Function

The ATM100 module is available in 2 variations; digital input transmitter module or digital output receiver module. There is a separate I2S port for digital audio input and output functions and either of these can be configured to be a master or a slave – only the input or output port can be active at any time. In addition, MCLK can be generated from the module, or input to the module as required by the system application.

The highly integrated nature of the AV6210 transceiver IC results in few external components being required for the ATM100 module design. 2 PCB antennas are used to achieve increased range, and to offer diversity, and the simple RF path consists only of the antennas, associated tuning components, the RF switch and a LC balun connected to the AV6210 IC. A 16MHz crystal generates the AV6210 system clock signal used as the basis for all RF and digital audio signals. In addition, a 2Mb flash memory stores the factory based firmware, as well as firmware upgrade images and configuration parameters. The module firmware enables upgrades to be performed by the I2C slave interface or over-the-air. The module can be controlled from an external host device via the I2C interface. The I2C master port allows the module to control other system audio devices such as a sub-woofer amplifier system without having to add another MCU to the product design. Up to a maximum of 17 GPIOs are supported with the ATM100 module including I2C and I2S signals. This large number of GPIOs can be leveraged to Implement low cost sub-woofer designs as outlined below.

The ATM100 module offers a standard and low latency firmware with different over the air sample rate. While the standard 22.2KSps over the air sample rate optimizes audio quality and WiFi coexistence performance; Lower audio latency can be achieved by using the low-latency 44.4KSps over the air sample rate.

Typical Sub-Woofer Implement
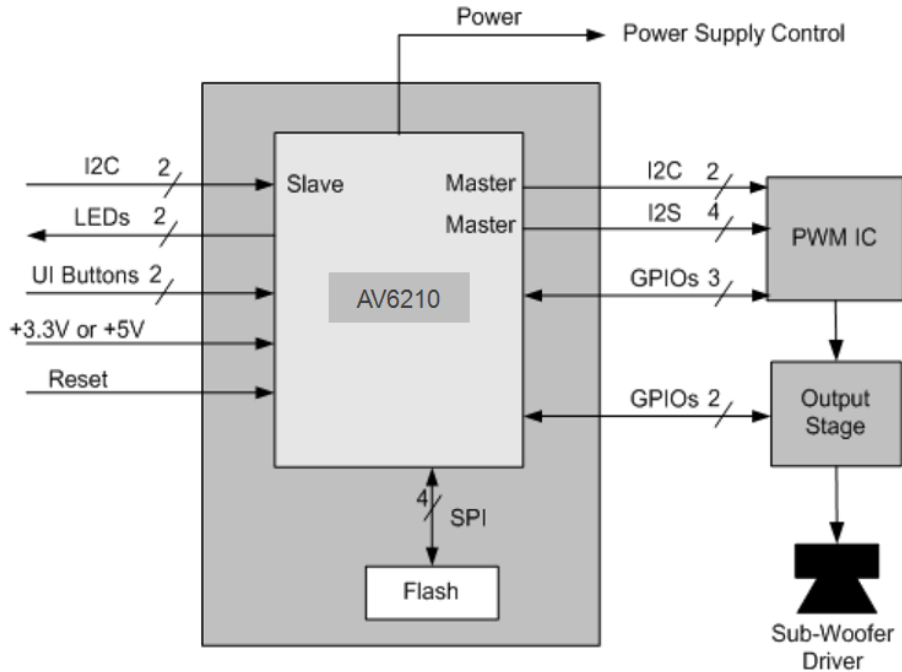
A simple low cost implementation of a sub-woofer product design is shown in Figure 2. The sub amplifier consists of a PWM chip plus an output stage device, but no external MCU is required as the ATM100 RX module performs the control function using the I2C master communication port in conjunction with multiple GPIOs. +5V power and

an optional reset signal are supplied to the ATM100 RX module and I2C slave communication can be used to control the module if required. Several GPIOs can be used to drive LEDs, or to connect to UI buttons. Typically 2 LEDs may be used and 1 button for pairing purposes. Another button could be used, for example, to implement a "bass enhance" feature. Another GPIO can be used to control the main power supply for the unit. The ATM100 RX module will remain always powered up but a GPIO control line is used to enable/disable the higher voltage rail for the amplifier output circuitry. If the wireless link is lost (when the sound bar, or ATM100 TX module is powered down) the ATM100 RX module can, after a timeout period, power down the amplifier section to conserve power and to help meet energy start requirements.

The I2C master port from the ATM100 RX module can communicate, control, and initialize external audio ICs such as the PWM chip in this example.

Other GPIOs can be used to detect fault conditions (over temperature etc) and notify the module. The audio is routed from the ATM100 RX module to the amplifier circuit with the I2S output port which can be configured as either a master or a slave as required. MCLK can also be generated from the SWA RX module as a ~12.288MHz clock if required.

I/O interfaces description

I/O interfaces	Description
+5.0V supply	The ATM100 module is configured to accept a nominal +5.0V supply.
Reset	Active low reset input. This pin is driven from an open collector/drain device such that it can be pulled to ground for the active reset state but, when released, must go to a high impedance state. This pin should not be actively driven high, as the AV5100 internal reset circuit will not operate correctly.
I2S In Port	The I2S input port can be configured as a master or slave. Consequently BCLK and LRCK can be either inputs or outputs. In addition, MCLK can be sourced by the module. Since the AV5100 IC contains a sample rate converter, MCLK is not required to be supplied to the module when it

	is an I2S slave. CMOS 3.3V logic levels are used for all I2S signals.
I2S Out Port	The I2S output port can be configured as a master or slave. Consequently BCLK and LRCK can be either inputs or outputs. In addition, MCLK can be sourced by the module. Since the AV5100 IC contains a sample rate converter, MCLK is not required to be supplied to the module when it is an I2S slave. CMOS 3.3V logic levels are used for all I2S signals.
I2C Slave Port	The I2C slave port can be used for external host communication and for module testing. It is assumed that external pull up resistors are connected at the I2C master communicating with the module.
I2C Master Port	The I2C master port is used to communicate with external audio devices such as a sub-woofer amplifier or rear speaker. It is assumed that external pull up resistors are included on the application board.
GPIOs	3.3V CMOS logic level GPIOs available to connect to other devices, or to use as UI supporting GPIOs for LED and button support. All supported GPIOs can be configured as outputs or inputs with configurable pull-ups/pull-downs.

4. Electrical Specifications

Absolute Maximum Ratings

Absolute Maximum Ratings (AMR) are stress ratings only. AMR corresponds to the maximum value that can be applied without leading to instantaneous or very short-term unrecoverable hard failure (destructive breakdown). Stresses beyond those listed under AMR may cause permanent damage to the device.

Functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Range" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may adversely affect device reliability.

Device functional operating limits and guaranteed performance specifications are given under Electrical Characteristics at the test conditions specified.

CONDITION	MIN	MAX
+5V Supply Voltage Input	-0.3V	6.0V
Input Voltage Range – Digital Inputs	-0.3V	3.6V
Operating Temperature	-10ºC	+70ºC
Storage Temperature	-20ºC	+80ºC

Recommended operating Range

PARAMETER	MIN	TYP	MAX	UNIT
VDD, +5V Supply pin voltage	4.5	5.0	5.5	V
Ambient Temperature (TA)	0		60	℃

Electrical Characteristics – DC

PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
TX Module Configuration	Linked		35		mA
TX Module Configuration	Searching		22		mA
TX Module Configuration	Continuous TX		63		mA
RX Module Configuration	Linked		35		mA

Electrical Characteristics – RF TX/RX

Operating Conditions: VDD = 4.5 to 5.5V, TA = 0°C to +60 °C, RF Freq = 2403.35-2477.35MHz, measured at RF test connector. Typical specifications at TA = 25°C, VDD = 5.0V

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
RF Channel Frequency Range		2403.35		2477.35	MHz
TX Output power			2.5		dBm
RX Sensitivity			-88.7		dBm
Range (NLOS)			15		m
Range (LOS)			50		m

Notes;

1) Sensitivity is defined as the onset of 0.2% BLER Clock Error Rate.

Electrical Characteristics – Audio

Operating Conditions: VDD = 4.5 to 5.5V, TA = 0°C to +60 °C, RF Freq = 2403.35-2477.35MHz, measured at RF test connector. Typical specifications at TA = 25°C, VDD = 5.0V

PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
Frequency Response[1]		20		10K	Hz
Gain Flastness[2]	0dB Input/Output Gain		±0.2		dB
SNR	I2S Input/Output		94		dB
THD+N			94		dB

Notes;

1) 16 bit audio, 22.2KSps over-the-air sample rate firmware build

2) 16 bit audio, 22.2KSps over-the-air sample rate firmware build – 10KHz frequency response

Electrical Characteristics – Audio latency

Operating Conditions: VDD = 4.5 to 5.5V, TA = 0°C to +60 °C, RF Freq = 2403.35-2477.35MHz, measured at RF test connector. Typical specifications at TA = 25°C, VDD = 5.0V

PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
22.2KSps OTA Sample latency	Standard Firmware		17		ms
44.4KSps OTA Sample latency	Standard Firmware		14		ms

Antenna Characteristics

PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
Frequency Range		2400		2480	MHz
VSWR	ANT1		1.92:1		
	ANT2		2.23:1		
Peak Gain			4.8		dBi
Efficiency	ANT1		70.2		%
	ANT2		63.8		%
Isolation			-14		dB
Impedance			50		Ω

I/O Pin Description

| No	Pin Name	I/O	Description	AVM100 TX Module	AVM100 RX Module
1	VDD	PWR	+5.0V input supply voltage		
2	VDD	PWR	+5.0V input supply voltage		
3	GPIO	I/O	Function defined by firmware application	GPIO	ADOUT0 RX = Output
4	GPIO	I/O	Function defined by firmware application	GPIO	GPIO
5	GPIO	I/O	Function defined by firmware application	GPIO	GPIO
6	Reset	I	Driven from open drain external source. Can be left open	Reset	Reset
7	I2C_SCL_S / S_MISO	I/O	I2C slave or SPI slave port	I2C_SCL_S	LED RED, firmware upgrade
8	I2C_SDA_S / S_MOSI	I/O	I2C slave or SPI slave port	I2C_SDA_S	LED RED, firmware upgrade
9	I2C_SCL_M	O	I2C master or GPIO	GPIO	I2C_SCL_M
10	I2C_SDA_M	I/O	I2C master or GPIO	GPIO	I2C_SCL_M
11	S_SCLK	I	SPI slave port or GPIO	GPIO	GPIO
12	GND	GND	Ground		
13	BCK1	I/O	I2S port	BCLK1, TX module = Input	POWER
14	WCLK1	I/O	I2S port	WCLK1, TX module = Input	GPIO
15	S_SSB	I	SPI slave port or GPIO	GPIO	GPIO
16	MCLK	I/O	I2S port or GPIO	GPIO/MCLK	RX = 12.000MHz output
17	ADIN1	I/O	I2S port	ADIN1, TX module = Input	GPIO
18	M_SSB/GPIO17	O	SPI master port or GPIO	GPIO	GPIO
19	M_SCLK/GPIO1	O	SPI master port or GPIO	GPIO	GPIO
20	M_MOSI	O	SPI master port	NC	NC
21	M_MISO	I	SPI master port	NC	NC
22	GPIO	I/O	Function defined by firmware application	LED1	BCLK0
23	GPIO	I/O	Function defined by firmware application	LED2	WCLK0
24	GND	GND	Ground		

I2S Communication Interface Timing
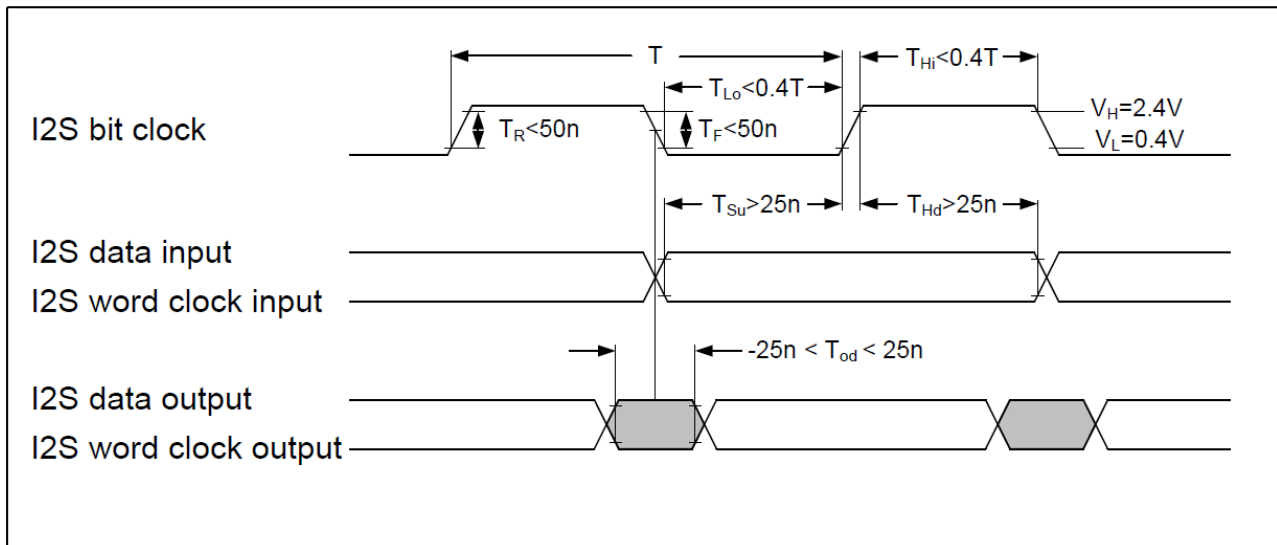
I2S Interface Timing

	Parameter	MIN	TYP	MAX	UNIT	Notes
V_L	Low voltage level	-0.3	0	0.4	V	
V_L	High voltage level	2.4	3.3	3.6	V	
T	Clock period		325.5		ns	1/3.072MHz
T_{LO}	Clock low period	0.4T		0.6T		
T_{HI}	Clock high period	0.4T		0.6T		
T_R	Rise time			50	ns	
T_F	Fall time			50	ns	
T_{Su}	Setup time	25			ns	
T_{Hd}	Hold time	25			ns	
T_{Od}	Output delay	-25		25	ns	
	Bit clocks/Word clock		64			

I2S protocol is "I2S Justified" as shown below.
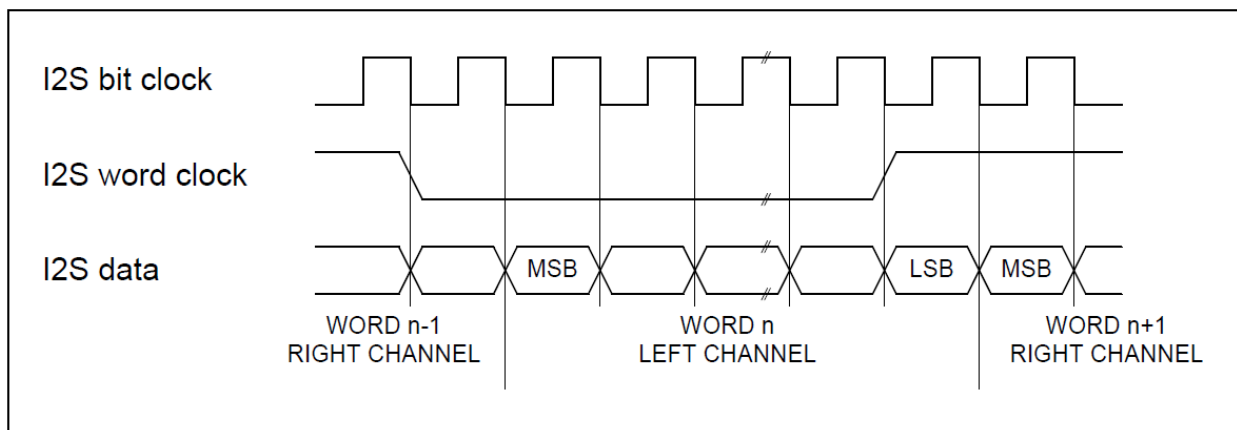
5. I2C Slave Communication Interface Timing
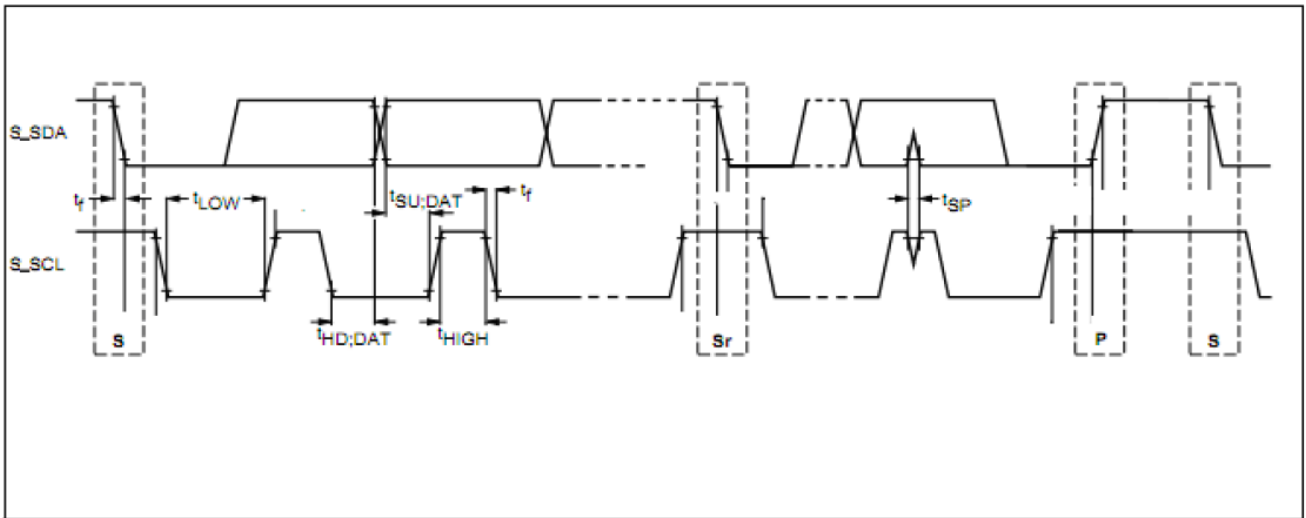
I2C Slave Interface Timing (Fast-Mode)

Parameter		MIN	MAX	UNIT
V_{IL}	Low level input voltage	-0.3	0.8	V
V_{IH}	High level input voltage	2.0	3.6	V
V_{OH}	Low level output voltage At 1mA sink current	0	0.4	V
t_{of}	Output fall time from V_{IHmin} to V_{ILmax} with a bus capacitance from 10pF to 400pF	0	250	ns
t_{SP}	Pulse width of spike which must be suppressed by the input filter	0	50	ns
f_{SCL}	S_SCL clock frequency	0	400	KHz
t_{LOW}	Low period of the S_SCL clock	1.3		ns
T_{HIGH}	High period of the S-SCL clock	0.6		ns
$t_{HD};DAT$	Data hold time	100		ns
$T_{SU};DAT$	Data set-up time	100		ns

6. Notice

FCC, IC Statement

This AUDIO TRANSCEIVER has been granted modular approval for mobile applications. OEM integrators for host products may use the module in their final products without additional FCC / IC (Industry Canada) certification if they meet the following conditions. Otherwise, additional FCC / IC approvals must be obtained.

- The host product with the module installed must be evaluated for simultaneous transmission requirements.

- The user's manual for the host product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC / IC RF exposure guidelines.

- To comply with FCC / IC regulations limiting both maximum RF output power and human exposure to RF radiation, use this module only with the included onboard antenna.

- A label must be affixed to the outside of the host product with the following statements:
Product Name : AUDIO TRANSCEIVER
Contains FCCID: **2ABA2ATM100**
Contains IC: **11534A-ATM100**

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

This equipment has been tested and found to comply within 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 different circuit from that to which the receiver is connected
• Consult the dealer or an experienced radio/TV technician for help.

Device Classifications

Since host devices vary widely with design features and configurations module integrators shall follow the guidelines below regarding device classification and simultaneous transmission, and seek guidance from their preferred regulatory test lab to determine how regulatory guidelines will impact the device compliance. Proactive management of the regulatory process will minimize unexpected schedule delays and costs due to unplanned testing activities.

The module integrator must determine the minimum distance required between their host device and the user's body. The FCC provides device classification definitions to assist in making the correct determination. Note that these classifications are guidelines only; strict adherence to a device classification may not satisfy the regulatory requirement as near-body device design details may vary widely. Your preferred test lab will be able to assist in determining the appropriate device category for your host product and if a KDB or PBA must be submitted to the FCC.

Note, the module you are using has been granted modular approval for mobile applications. Portable applications may require further RF exposure (SAR) evaluations. It is also likely that the host / module combination will need to undergo testing for FCC Part 15 regardless of the device classification. Your preferred test lab will be able to assist in determining the exact tests which are required on the host / module combination.

FCC Definitions

Portable: (§2.1093) — A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is / are within 20 centimeters of the body of the user.

Mobile: (§2.1091) (b) — A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. Per §2.1091d(d)(4) In some cases (for example, modular or desktop transmitters), the potential conditions of use of a device may not allow easy classification of that device as either Mobile or Portable. In these cases, applicants are responsible for determining minimum distances for compliance for the intended use and installation of the device based on evaluation of either specific absorption rate (SAR), field strength, or power density, whichever is most appropriate.

Simultaneous Transmission Evaluation

This module has **not** been evaluated or approved for simultaneous transmission as it is impossible to determine the exact multi-transmission scenario that a host manufacturer may choose. Any simultaneous transmission condition established through module integration into a host product **must** be evaluated per the requirements in KDB447498D01(8) and KDB616217D01,D03 (for laptop, notebook, netbook, and tablet applications).

These requirements include, but are not limited to:

- Transmitters and modules certified for mobile or portable exposure conditions can be incorporated in mobile host devices without further testing or certification when:

- The closest separation among all simultaneous transmitting antennas is ≥20 cm,

Or

- Antenna separation distance and MPE compliance requirements for **ALL** simultaneous transmitting antennas have been specified in the application filing of at least one of the certified transmitters within the host device. In addition, when transmitters certified for portable use are incorporated in a mobile host device, the antenna(s) must be ≥5 cm from all other simultaneous transmitting antennas.

- All antennas in the final product must be at least 20 cm from users and nearby persons.

OEM Instruction Manual Content

Consistent with §2.909(a), the following text must be included within the user's manual or operator instruction guide for the final commercial product *(OEM-specific content is displayed in italics.)*

Operating Requirements and Conditions:

The design of *(Product Name)* complies with U.S. Federal Communications Commission (FCC) guidelines respecting safety levels of radio frequency (RF) exposure for Mobile devices.

Note: In the case where the Host / Module combination has been re-certified the FCCID shall appear in the product manual as follows:

FCCID: *(Include Standalone FCC ID)*

Mobile Device RF Exposure Statement (If Applicable):

RF Exposure - This device is only authorized for use in a mobile application. At least 20 cm of separation distance between the transmitting antenna device and the user's body must be maintained at all times.

Caution Statement for Modifications:

Caution: Any changes or modifications to the equipment not expressly approved by the party responsible for compliance could void user s authority to operate the equipment.

FCC Part 15 Statement (Only Include if FCC Part 15 is Required on the End Product):

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. *(OEM must follow Part 15 guidelines (§15.105 and §15.19) to determine additional statements required in this section for their device class)*

Note 2 : 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, including interference that may cause undesired operation of the device.

a. That module is limited to OEM installation ONLY.

b. That OEM integrators are responsible for ensuring that the end-user has no manual instructions to remove or install module.

c. That module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).

d. That separate approval is required for all other operating configurations, including portable

configurations with respect to Part 2.1093 and different antenna configurations.

e. That grantee shall provide guidance to the host manufacturer for compliance with Part 15 subpart B requirements.

Information

Le présent appareil est conforme aux CNR d'Industrie Canada applicable aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même

si le brouillage est susceptible d'en compromettre le fonctionnement.

Cet équipement est conforme aux limites d'exposition aux rayonnements énoncées pour un environnement non contrôlé et respecte les règles les radioélectriques (RF) de la FCC lignes directrices d'exposition et d'exposition aux frequencies radioélectriques (RF) CNR-102 de l'IC. Cet équipement émet une énergie RF très faible qui est considérée conforme sans évaluation du débit d'absorption spécifique (DAS).

CE Statement

Hereby, WISOL CO., LTD declares that the radio equipment type AUDIO TRANSCEIVER is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the providing datasheet or approval sheet.

The antenna(s) must be installed such that a minimum separation distance of at least 20 cm is maintained between the radiator (antenna) and all persons at all times. This device must not be collocated or operating in conjunction with any other antenna or transmitter.