WNC
Wistron NeWeb Corp.

AVNERA

SWA16-TX/RX
Module Datasheet
Mono/Stereo Wireless Audio System, based on the Avnera AV6100 IC

General Description

The SWA16 module family of products represents a new level of system integration offering customers fast time to market with a point-to-point mono, or stereo, wireless connection. These modules are optimized for low-cost, high-quality and ease-of-use.

The module incorporates Avnera's proprietary wireless audio protocol, designed from the ground up specifically for audio. It features low fixed latency, uncompressed CD quality mono or stereo audio, superior interference immunity and industry leading coexistence with WiFi – even at close proximity to a WiFi device.

The SWA16 module integrates all features necessary to complete a wireless stereo ro mono link, including AV6100 Wireless Audio Chip, printed diversity antenna, flash memory, interface connector and all passive components. Just supply 5 Volts and an I2S interface and you are ready to create a wireless audio link.

The module measures just 26 x 60 x 3.5 mm and is provided with a 24 pin FPC connector or pin header for connection to the system board.

The module is certified to FCC and CE standards.

Applications

- ✓ Wireless Subwoofers
- ✓ Stereo Wireless Rear Speakers
- ✓ Soundbar / Audio Video Receiver / BluRay
- ✓ Mono/Stereo Audio Channel Transmission

Ordering Options

SWA16-TX: Transmit module with digital audio input

SWA16- RX: Receive module with digital audio output

Features

- ✓ Audio Interfaces
  - ✓ I2S Digital Input / Output interface with >94dB end-to-end digital audio path
- ✓ Wireless Range
  - ✓ > 15m Non Line Of Sight (NLOS) range
  - ✓ > 50m Line Of Sight (LOS) range
- ✓ Frequency range: 2.4 GHz ISM band, continuous dynamic frequency selection
- ✓ Forward error correction coding, error detection, and audio-specific error concealment
- ✓ Dual printed PCB diversity antennas for multipath and fading mitigation
- ✓ Auto-search/synch and dynamic channel selection
- ✓ Low and fixed latency
- ✓ 24 pin FPC or pin header connector
- ✓ Sample rate converter: Support for 32 - 96kHz input sample rates
- ✓ Over-the-air firmware update 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, and remote control commands

We use diff. label colors to distinguish between TX and RX.

1　SWA16 Functional

The SWA16 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 hardware for the audio input (transmit) and audio output (receive) versions of the module is identical and only the firmware loaded on the module determines its function.

The highly integrated nature of the AV6100 transceiver IC results in few external components being required for the SWA16 module design. 2 Printed 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 balun connected to the AV6100 IC. A 16MHz crystal generates the AV6100 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 SWA16 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 SWA16 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 co-existence performance; Lower audio latency can

be achieved by using the low-latency 44.4KSps over the air sample rate.

1.1　Typical Sub-Woofer Implementation

A simple low cost implementation of a sub-woofer product design is shown in Figure 1. The sub amplifier consists of a PWM chip plus an output stage device, but no external MCU is required as the SWA16 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 SWA16 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 SWA16 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 SWA16 TX module is powered down) the SWA16 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 SWA16 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 SWA16 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.
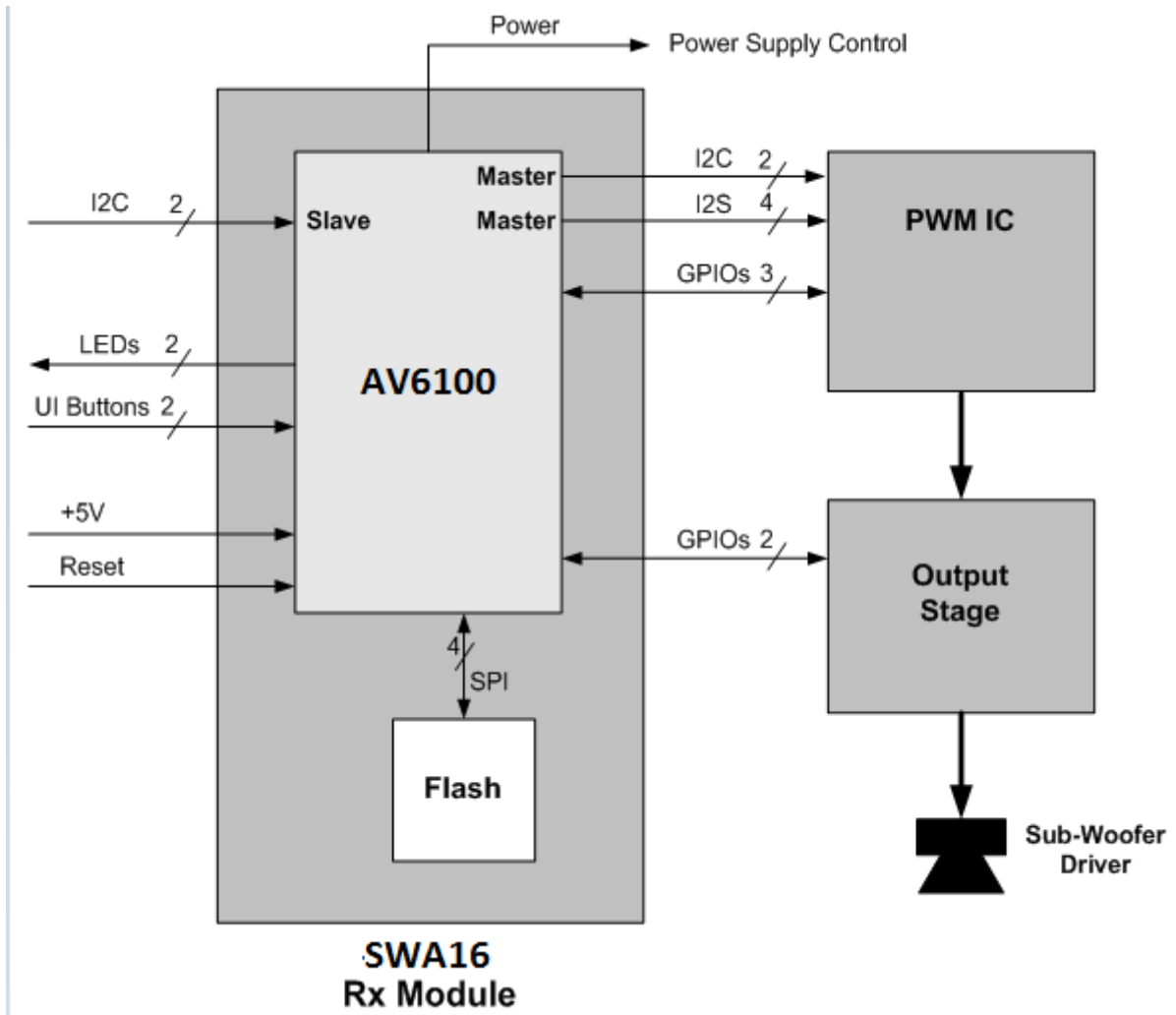
Figure 1: SWA16 RX Module Simple Sub-Woofer Implementation

1.2   SWA16 Module Connections

Signal Type	Description
+5V Supply	Single +5V +/10% supply rail to the module
Reset	Active low reset input. This pin is driven from an open collector/drain device such that it can pull to ground for the active reset state but, when released, must go to a high impedance state. If this input is driven high the internal reset circuit on the module 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 generated by the module on pin 16, or used as an input. Typically, as the AV6100 IC contains a sample rate converter, MCLK is not required to be supplied to the module when it is an I2S slave. CMOS 3.3 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 generated by the module on pin 16, or used as an input. Typically, as the AV6100 IC contains a sample rate converter, MCLK is not required to be supplied to the module when it is an I2S slave. CMOS 3.3 logic levels are used for all I2S signals.
I2C Slave Port	The I2C slave port is used for external host communication and during module test. 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. The SDA and SCL signal lines have pull ups internal to the module.
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 inputs or outputs.

2   SWA16 Connector Information

No	Pin Name	I/O	AV6100	Pin Description	SWA16 TX Module	SWA16 RX Module
1	VDD	-		+5V +/- 10%		
2	VDD	-		+5V +/- 10%		
3	GPIO	I/O	GPIO13 pin 28	Function defined by firmware application.	GPIO	ADOUT0 RX = output
4	GPIO	I/O	GPIO18 pin 43	Function defined by firmware application.	GPIO	GPIO
5	GPIO	I/O	GPIO19 pin 37	Function defined by firmware application.	GPIO	GPIO
6	Reset	I	Pin 24	Driven from open drain external source. Can be left open.	Reset	Reset
7	I2C_SCL_S / S_MISO	I/O	GPIO5 pin 44	I2C slave or SPI slave port	I2C_SCL_S	LED RED, firmware upgrade
8	I2C_SDA_S / S_MOSI	I/O	GPIO4 pin 45	I2C slave or SPI slave port	I2C_SDA_S	LED BLUE, firmware upgrade
9	I2C_SCL_M	O	GPIO22 pin 41	I2C master port or GPIO	GPIO	I2C_SCL_M
10	I2C_SDA_M	I/O	GPIO21 pin 42	I2C master port or GPIO	GPIO	I2C_SDA_M
11	S_SCLK	I	GPIO3 pin 46	SPI slave port or GPIO	GPIO	GPIO
12	GND	-		Ground	GND	GND
13	BCK1	I/O	GPIO15 pin 26	I2S port	BCLK1, TX module = input	POWER
14	WCLK1	I/O	GPIO16 pin 25	I2S port	LRCK1, TX module	GPIO
15	S_SSB	I	GPIO2 pin 47	SPI slave port or GPIO	GPIO	GPIO
16	MCLK	I/O	GPIO10 pin 31	I2S port or GPIO	GPIO/MCLK	RX = 12.288MHz output
17	ADIN1	I/O	GPIO14 pin 27	I2S port	ADIN1 TX = input	GPIO
18	M_SSB/GPIO17		GPIO6 pin 36/GPIO17 pin 48	SPI master port	GPIO	GPIO
19	N.C		GPIO7pin 35/GPIO1 pin 1	SPI master port	NC	NC
20	N.C		GPIO8 pin 34	SPI master port	NC	NC
21	N.C		GPIO9 pin 33	SPI master port	NC	NC
22	GPIO	I/O	GPIO11 pin 30	Function defined by firmware application.	LED1	BCLK0
23	GPIO	I/O	GPIO12 pin 29	Function defined by firmware application.	LED2	WCLK0
24	GND	-		Ground		

Table 1: SWA16 Connector Information

3   Electrical Specifications

3.1   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
Static Discharge Voltage[1]	-6kV	+6kV

Notes:

Note 1: ±6kV @ bottom test pads, 150pF/330ohms discharge per IEC/EN61000-4-2

3.2   Recommended Operating Range

PARAMETER	MIN	TYP	MAX	UNIT
+5V Supply pin voltage	4.5	5.0	5.5	V
Ambient Temperature (T_A)	0		60	ºC

3.3 Electrical Characteristics

Test Conditions: T_A=+25ºC, Vsupply=+5.0V

Table 2; SWA16 RF Transceiver Characteristics

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
RF Frequency Range		2405.35		2477.35	MHz
TX Output Power[1]			1.5		dBm
RX Sensitivity[2]		-91	-88	-85	dBm
Range (NLOS)			15		m
Range (LOS)			50		m

Note 1: Measured with the SWA16 Printed antenna disabled and test RF connector added.

Note 2: Measured with the SWA16 Printed antenna disabled and test RF connector added. Sensitivity is defined as the onset of 0.2% BLER Clock Error Rate.

Table 3; SWA16 Audio Characteristics

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

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

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

Table 4; SWA16 Audio Latency Characteristics

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
22.2KSps OTA Sample Latency	Standard Firmware		17		ms
44.4KSps OTA Sample Latency	Standard Firmware		14		ms
22.2KSps OTA Sample Latency	Low Latency Firmware		13.5		ms
44.4KSps OTA Sample Latency	Low Latency Firmware		8.5		ms

Table 5; SWA16 Current Characteristics

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
TX Module Configuration	Linked[1]		35		mA
TX Module Configuration	Searching[2]		22		mA
TX Module Configuration	FCC TX[3]		63		mA
RX Module Configuration	Linked[4]		35		mA
RX Module Configuration	Searching[5]		63		mA
RX Module Configuration	Standby[6]		16		mA
RX Module Configuration	FCC TX[7]		71		mA

Note 1: Specification represents an average current with the I2S clocks running. Peak current is ~ 2x the average.

Note 2: Searching is the average current where the TX module is not linked but is attempting to find a RX module to link with. Peak current is ~70mA.

Note 3: Continuous transmit mode for testing purposes. Peak current ~80mA.

Note 4: Specification represents an average current with the I2S clocks running. Peak current is ~ 2x the average.

Note 5: Searching is where the RX module is not linked but is attempting to find a TX module to link with. Peak current is ~ 80mA.

Note 6:. After the RX module has not been linked for > 30 seconds it will go to a duty cycling standby state reflected by this specification. Peak current is ~ 80mA.

Note 7: Continuous transmit mode for testing purposes. Peak current ~80mA.

3.4   I^{2}S Communication Interface Timing
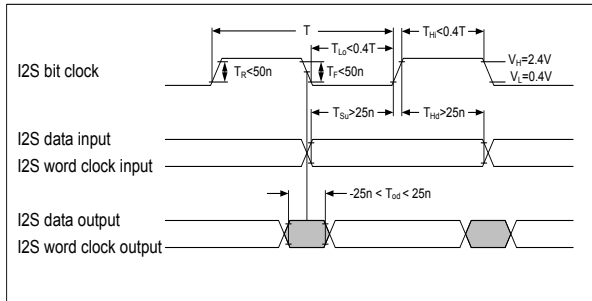
Table 6; SWA16 I2S Timing

		MIN	TYP	MAX	UNIT	NOTES
V$_L$	low voltage level	-0.3V	0.0V	0.4V	V	
V$_H$	high voltage level	2.4V	3.3V	3.6V	V	
T	clock period		325.5n		s	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			50n	s	Note 1
T$_F$	fall time			50n	s	Note 1
T$_{Su}$	setup time	25n			s	
T$_{Hd}$	hold time	25n			s	
T$_{Od}$	output delay	-25n		25n	s	
	bit clocks/word clock		64			

I2S protocol is "I2S Justified" as shown below.
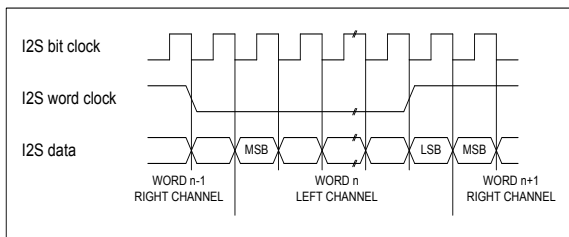
Note 1: The timing specified for the rise and fall times represents the edge rates on the module itself. The rise and fall times of the I2S signals are determined by ESD/EMI mitigation components on the modules, as well as external loading, and will be higher than the specified numbers

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3.5   I2C Master/Slave Communication Interface Timing (S_SCL, S_SDA)

The SWA16 has both I2C slave and master interfaces available with their respective pins S_SCL and S_SDA. The interfaces operate in I2C fast-mode and can receive and transmit at up to 400 kbit/s.

Bytes are 8 bits long and are transferred with the most significant bit (MSB) first. Each byte has to be followed by an acknowledge bit. The SWA16 will apply clock-stopping (by holding the clock line S_SCL LOW to force the master into a wait state) if necessary due to internal high-priority tasks.

The slave/master interface can be used both for writing (e.g. sending commands) or reading (e.g. requesting status).

The SWA16 slave interface responds to the 7-bit slave address 1000000 (0x40) as shown in Figure 2 below.
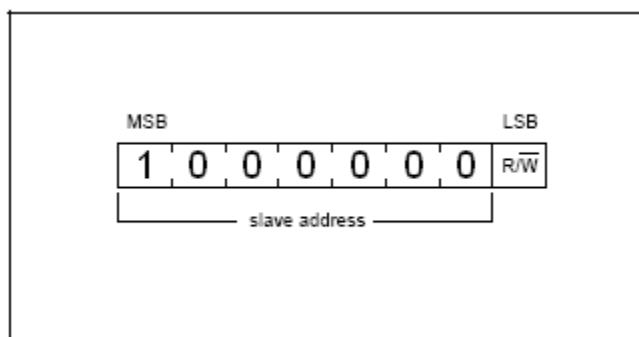
Figure 2: First Byte After the START Procedure

ELECTRICAL SPECIFICATIONS AND TIMING

Table 6; Characteristics of the S_SDA and S_SCL I/Os

PARAMETER	SYMBOL	FAST-MODE		UNIT
		MIN.	MAX.	
LOW level input voltage	V_{IL}	−0.3	0.8	V
HIGH level input voltage	V_{IH}	2.0	3.6	V
LOW level output voltage (open drain or open collector) at 1 mA sink current:	V_{OL}	0	0.4	V
Output fall time from V_{IHmin} to V_{ILmax} with a bus capacitance from 10 pF to 400 pF	t_{of}	0	250	ns
Pulse width of spikes which must be suppressed by the input filter	t_{SP}	0	50	ns
S_SCL clock frequency	f_{SCL}	0	400	kHz
LOW period of the S_SCL clock	t_{LOW}	1.3	–	µs
HIGH period of the S_SCL clock	t_{HIGH}	0.6	–	µs
Data hold time	$t_{HD;DAT}$	100	–	ns
Data set-up time	$t_{SU;DAT}$	100	–	ns
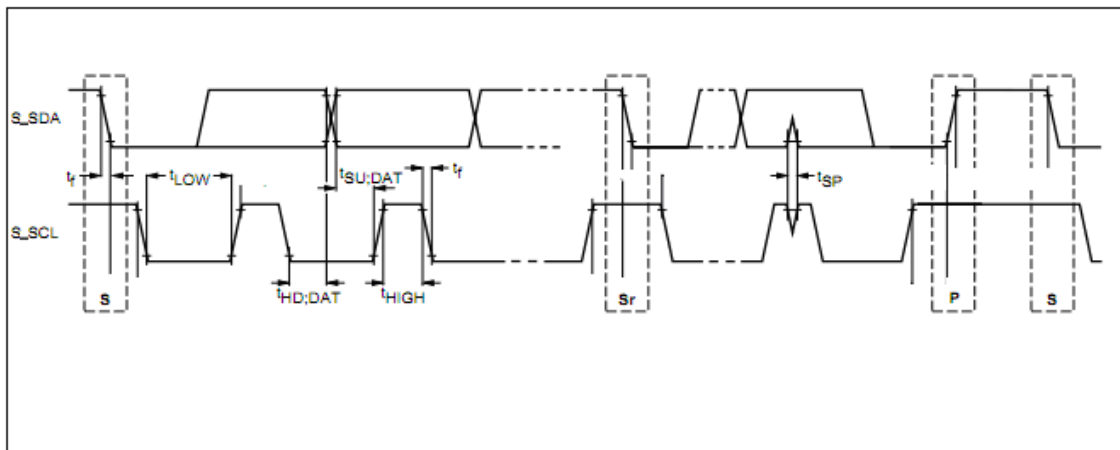
Figure 3: Definition of Timing for F/S-Mode Devices on the I^{2}C-Bus

Ordering Information

Table 7: SWA16 Module Ordering Information

Module Part Number	Option Code	Description
SWA16	-TX	Digital Input , FPC Connector, integrated printed antennas
SWA16	-RX	Digital Output, FPC Connector, integrated printed antennas

FCC Statement:

Federal Communication Commission Interference Statement
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.

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.

This device and its antenna(s) must not be co-located with any other transmitters except in accordance with FCC multi-transmitter product procedures.
Refering to the multi-transmitter policy, multiple-transmitter(s) and module(s) can be operated simultaneously without C2P.

IMPORTANT NOTE:
This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated.
Additional testing and certification may be necessary when multiple modules are used.
20cm minimum distance has to be able to be maintained between the antenna and the users for the host this module is integrated into. Under such configuration, the FCC radiation exposure limits set forth for an population/uncontrolled environment can be satisfied.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

USERS MANUAL OF THE END PRODUCT:
In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users manual: This device complies with Part 15 of 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.

LABEL OF THE END PRODUCT:
The final end product must be labeled in a visible area with the following " Contains TX FCC ID: NKR-SWA16 ". If the size of the end product is larger than 8x10cm, then the following FCC part 15.19 statement has to also be available on the label: This device complies with Part 15 of 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.

IC Statement:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables 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.

This device and its antenna(s) must not be co-located with any other transmitters except in accordance with IC multi-transmitter product procedures.
Refering to the multi-transmitter policy, multiple-transmitter(s) and module(s) can be operated simultaneously without reassessment permissive change.

Cet appareil et son antenne (s) ne doit pas être co-localisés ou fonctionnement en association avec une autre antenne ou transmetteur.

IMPORTANT NOTE:
IC Radiation Exposure Statement:
This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

This module is intended for OEM integrator. The OEM integrator is still responsible for the IC compliance requirement of the end product, which integrates this module.

USERS MANUAL OF THE END PRODUCT:
In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the IC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. 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.

LABEL OF THE END PRODUCT:
The final end product must be labeled in a visible area with the following " Contains TX IC : 4441A-SWA16 ".

Table for Filed Antenna

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)
1	WNC	SWA16	Printed Antenna	N/A	3.9
2	WNC	SWA16	Printed Antenna	N/A	3.5