WS9501DLS

User manual

- Supports the global license-free ISM 433MHz band.
- Reception sensitivity no less than -120 dBm at an airspeed of 9.6kbps
- Support2-(G)FSKModulation method
- 3-5.3Wide voltage input
- 2x10-2.54 pin header interface, dimensions 45mm x 28mm x 10.5mm

Document Information		
Product Model	**WS9501DLS**	
Product Overview	EFR32FG23 Uart Module	
Document type	User manual	
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1	v1.0	Initial version	2022.08.09	
2	v2.0	Update format	2022.09.20	
3	v2.1	Update Frequency range	2023.06.14	

1 ProductOverview

1.1 ProductIntroduction

The WS9501, based on the EFR32FG23 SoC chip solution, is an ideal solution for sub-GHz "Internet of Things" applications in smart home, security, lighting, building automation, and metering systems. Its high-performance sub-GHz radio provides long-range communication while remaining resilient to interference from 2.4 GHz technologies such as Wi-Fi. This single-chip multi-core solution delivers outstanding security, ultra-low power consumption, and rapid wake-up times. It integrates internally a power amplifier, low-noise amplifier, SAW filter, low-pass filter, and other components, enabling longer communication ranges, superior harmonic suppression, and excellent anti-interference performance.

1.2 Features and functions

Features and functions
Support 433.1025-434.6025MHz
3—5.3Wide voltage input
Support2-(G)FSKModulation method
On-chip 20dBm PA, On-board LNA, SAW, Low-pass filter
3.3Maximum Emission Current under V Supply80mA
Sleep current below 5uA
Reception sensitivity no less than -120 dBm @ airspeed 9..6kbps
Airspeed0.625kbps-4 MbpsAdjustable
Software Function LBTPower-on self-test, with out-of-band suppression hardware measures.
Industrial-grade standard design, supports-40℃~85℃Long-term use
2x10-2.54Pin header interface, 45mm 28mm x 10.5mm size

1.3 Application scenario

Application scenarios
Construction machinery control Wait
Remote control
Smart home devices and industrial sensors, among others
Smart agricultural sensors
Wireless alarm security system
Building Automation Solutions
Healthcare products
Advanced Metering Infrastructure (AMI)

2 Pin definitions

	Pin name	Type	Description
1	GND	I	Power reference ground
2	GND	I	Power reference ground
3	TXD	O	The module sends data,Internal chipPA08,ExternalRecommendationAdd pull
4	SLEEP	I	Module sleep: High level—wake up; Low level—sleep.
5	RXD	I/O	The module receives data; internal chip PA0.6,External recommendationsAdd pull
6	WAKEUP	O	Module wake-up output, high-level wake-up
7	PA04	I/O	Reserved I/O
8	PA03	I/O	Reserved I/O
9	SWDIO	I/O	Module program burning interface
10	SWCLK	I	Module program burning interface
11	STATUS	O	Module status indicator output,Low level: Module idle High level: Module busy
12	Heartbeat	O	Module heartbeat output, output is100HertzSquare wave
13	M0	I	Mode 0 pin, internal chip PC01
14	PC02	I/O	General IO
15	M1	I	Mode 1 pin, internal chip PC03
16	nRESET	I	Module reset, active low

17	GND	I	Power reference ground
18	GND	I	Power reference ground
19	VDD1	I	Module power supplyInput
20	VDD2	I	Module power supplyInput
MAIN	ANT2	I/O	Main antenna,MMCXMother seat,Send and receiveOne piece
DIV	ANT1	I/O	Auxiliary antenna,MMCXMother seat,Does not come soldered by default.
M2.5	2.7mm hole		For non-metallic fixed screw holes, it is recommended to use M.2.5Screw
For detailed information on the pin definitions, software drivers, and communication protocols of the module, please refer to:Silicon LabsOfficialEFRA32FG32Datasheet			

3 Electricaland othersParameter

3.1 Limit parameters

Parameter	Symbol	MinimumValue	Maximum value	Unit
Power supply voltage	VCC	-0.3	6	V
Interface voltage	V_{IN}	-0.3	3.7	V
Storage temperature	T_{STG}	-40	85	Celsius

3.2 Work parameters

Parameter	Symbol	MinimumValue	Typical value	Maximum value	Unit
WorkVoltage	VCC	3	3.3	5.3	V
Communication level	V_{IN}	3	3.3	3.6	V
Operating temperature	T_{OP}	-40		85	Celsius

3.3 Radio frequencyPerformance parameters

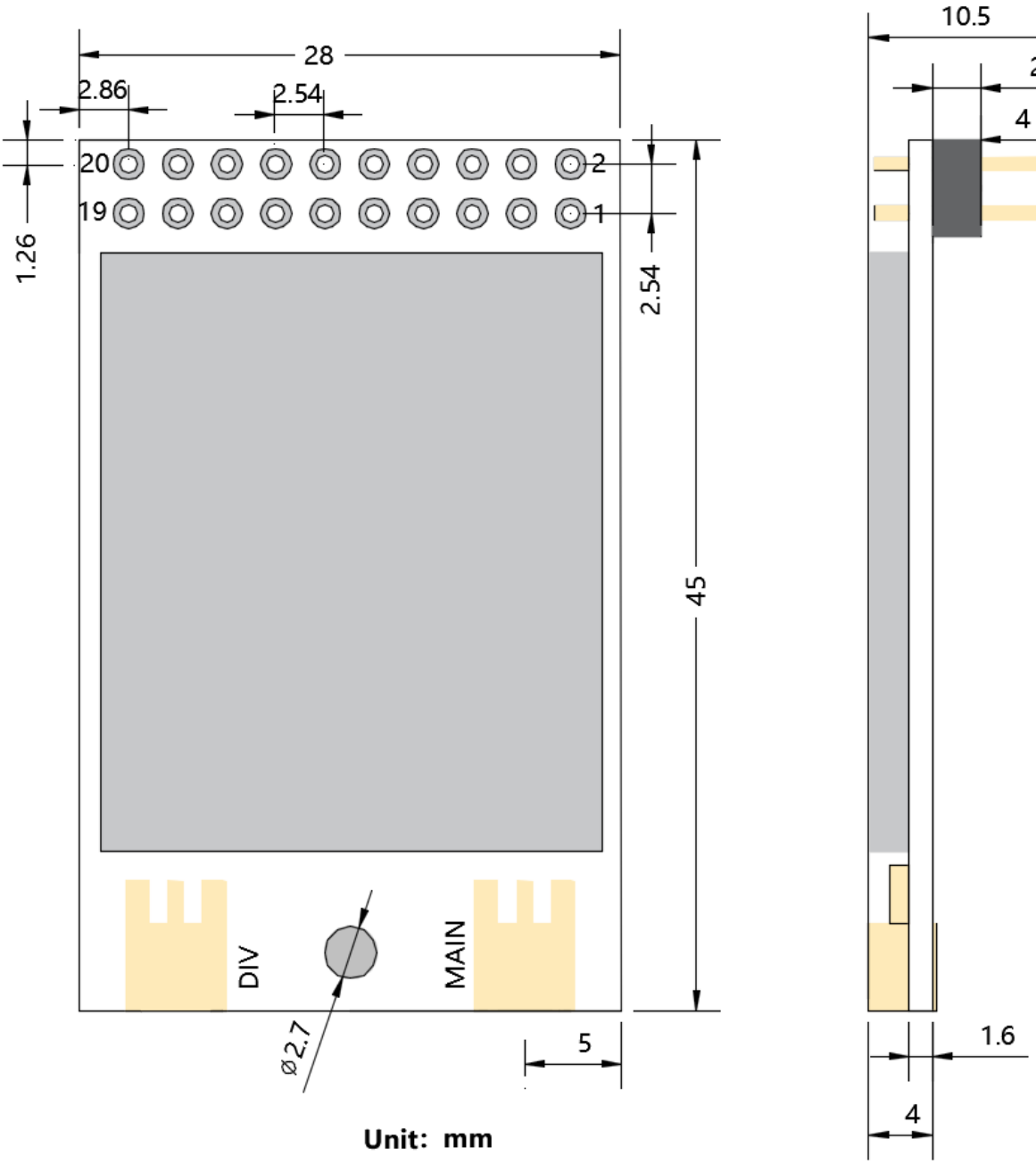
Parameter	Minimum value	Typical value	Maximum value	Unit	Note
Operating frequency band	433.1025	434	434.65	MHz	
Modulation method		2-GFSK		-	
Reception bandwidth	-	25	500	kHertz	
Maximum transmit power	18.5	19	20	dBm	
Reception sensitivity	-	-120	-	dBm	@5V 433.1025MHz, 2-GFSK,9.6 kilobits per second, ±3.3kHz deviation
LaunchCurrent	75	80	85	mA	@5V 20dBm
LaunchCurrent	18.5	21.5	24.5	mA	@5V 10dBm
ReceiveCurrent	16	17.5	20	mA	@5V 20dBm
Receive current	10	12	4	mA	@5V 10dBm

IdleCurrent	-	5	-	uA	@5V

3.4 Other parameters

Parameter	Description
Communication interface	UART
RF interface	MMCXMother seat
Packaging method	Direct insertionFormula
Interface method	2x10-2.54mm pin header
External dimensions	45*28*10.5mm

4 ModulePackage size



Unit: mm

FCC Statement

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.

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

This equipment complies with FCC 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.

Any company of the host which install this modular with Single modular approval should perform the test of radiated emission and spurious emission according to FCC Part 15C. requirement, Only if the test result comply with FCC Part 15C requirement, then the host can be sold legally.

FCC Radiation Exposure Statement

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

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.

OEM INTEGRATION INSTRUCTIONS:

This device is intended only for OEM integrators under the following conditions:

The module must be installed in the host equipment such that 20 cm is maintained between the antenna and users, and the transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the internal on-board antenna that has been originally tested and certified with this module. External antennas are not supported. As long as these 3 conditions above are met, further transmitter test will not be required.

However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.). The end-product may need Verification testing, Declaration of Conformity testing, a Permissive Class II Change or new Certification. Please involve a FCC certification specialist in order to determine what will be exactly applicable for the end-product.

Validity of using the module certification:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC/IC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID/IC of the module cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization. In such cases, please involve a FCC/IC certification specialist in order to determine if a Permissive Class II Change or new Certification is required.

Upgrade Firmware:

The software provided for firmware upgrade will not be capable to affect any RF parameters as certified for the FCC for this module, in order to prevent compliance issues.

End product labeling:

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains Transmitter Module FCC ID: 2BXHF-WS9501DLS Or Contains FCC ID: 2BXHF-WS9501DLS”

Information that must be placed in the end user manual:

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

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.

Explanation: This module meets the requirements of FCC Part 15C.

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: This module is only applicable to the 433.1025 MHz - 434.6025 MHz frequency band. It should be installed inside the main unit and kept at a distance of more than 20 cm from the human body. The use of the antenna requires compliance with Clause 2.7.

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 Snap fastener port designs, and this EUT has been shown the layout of trace design, antenna, connectors 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 – 20cm 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/IC (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, "Contains Transmitter Module FCC ID: 2BXHF-WS9501DLS Or Contains FCC ID: 2BXHF-WS9501DLS"

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.

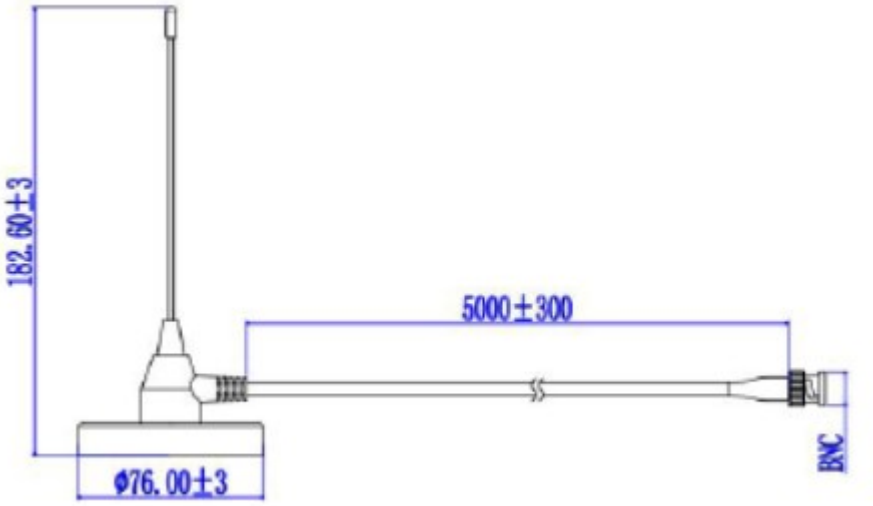
Explanation: This module employs four antennas, three external antennas and one internal antenna, and the antenna use which is unique.

Model A: STXPA187650BAB433

Type: Sucker antenna

Manufacturer: SHANGHAI ZHENYI COMMUNICATION TECHNOLOGY CO., LTD.

Antenna gain: 1dBi

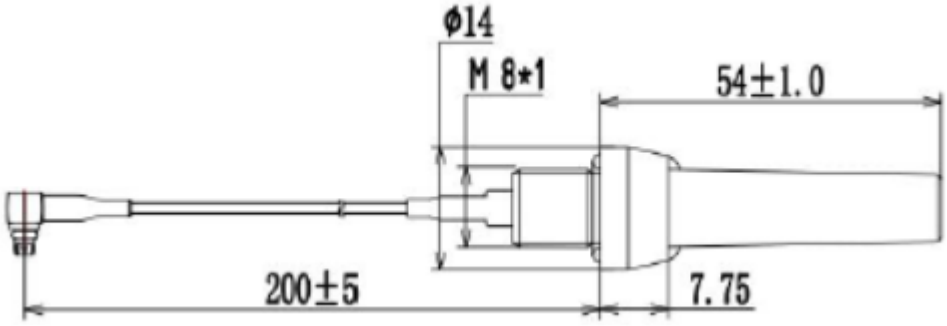


Model B: STDPA551420MBA433

Type: Dipole Antenna

Manufacturer: SHANGHAI ZHENYI COMMUNICATION TECHNOLOGY CO., LTD.

Antenna gain:-2dBi

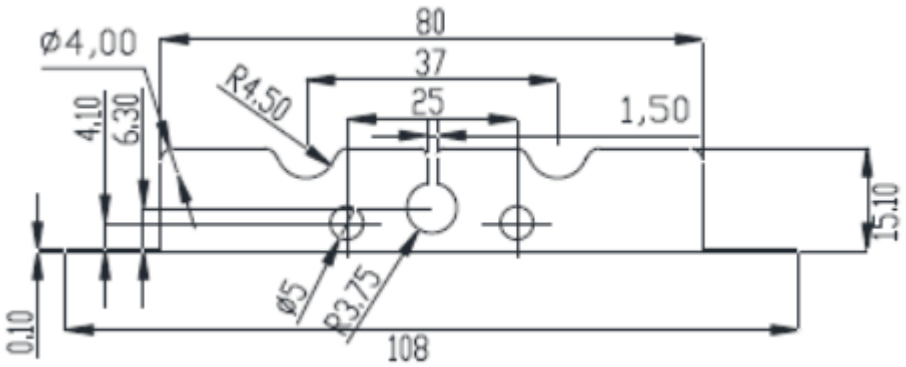


Model C: STDPA1357715MBA433

Type: Horn Antenna

Manufacturer: SHANGHAI ZHENYI COMMUNICATION TECHNOLOGY CO., LTD.

Antenna gain: 0.5dBi

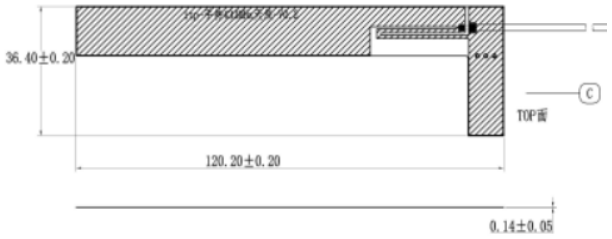


Model D: STDPA1357715MBA433

Type: FPC Antenna

Manufacturer: SHANGHAI ZHENYI COMMUNICATION TECHNOLOGY CO., LTD.

Antenna gain: -3.5 dBi



2.8 Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC/IC 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 Transmitter Module FCC ID: 2BXHF-WS9501DLS Or Contains FCC ID: 2BXHF-WS9501DLS”

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 shoule be evaluated by the FCC Subpart B.

IC Statement

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that can cause undesired operation of the device.

L'émetteur ou le récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique 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.

2.L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This radio transmitter [IC: 36001-WS9501DLS] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Le présent émetteur radio IC: 36001-WS9501DLS] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et en ayant un gain admissible maximal tel qu'indiqué. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

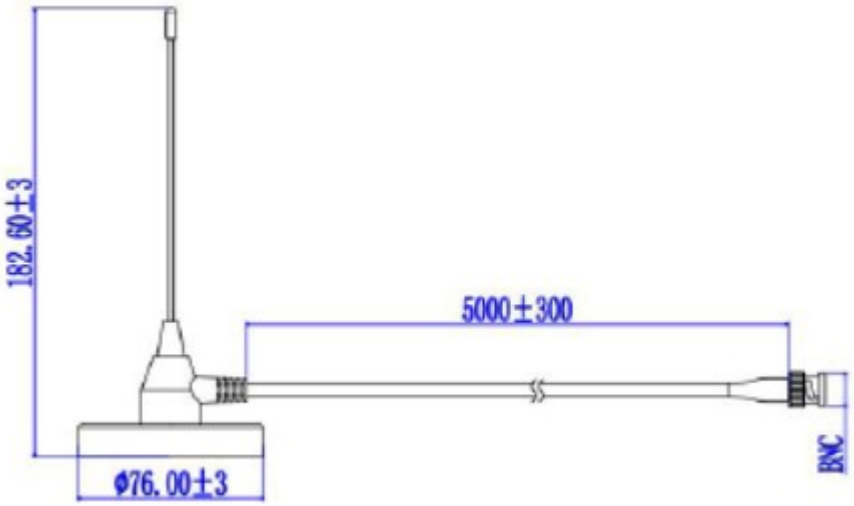
This module employs four antennas, three external antennas and one internal antenna, and the antenna use which is unique.
Ce module utilise quatre antennes, trois antennes externes et une antenne interne, avec un usage d'antennes unique.

Model A: STXPA187650BAB433

Type: Sucker antenna

Manufacturer: SHANGHAI ZHENYI COMMUNICATION TECHNOLOGY CO., LTD.

Antenna gain: 1dBi

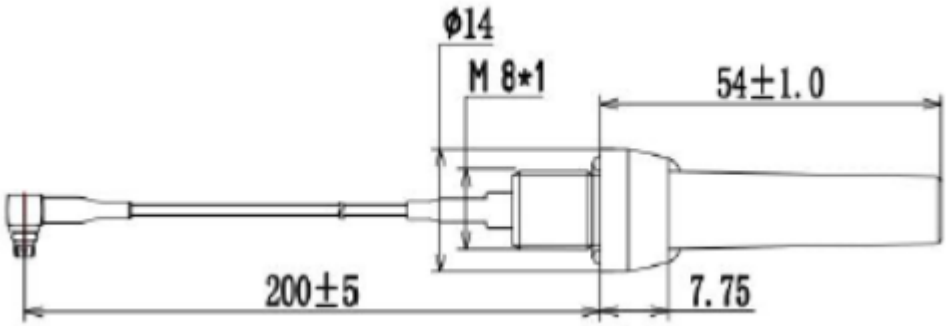


Model B: STDPA551420MBA433

Type: Dipole Antenna

Manufacturer: SHANGHAI ZHENYI COMMUNICATION TECHNOLOGY CO., LTD.

Antenna gain:-2dBi

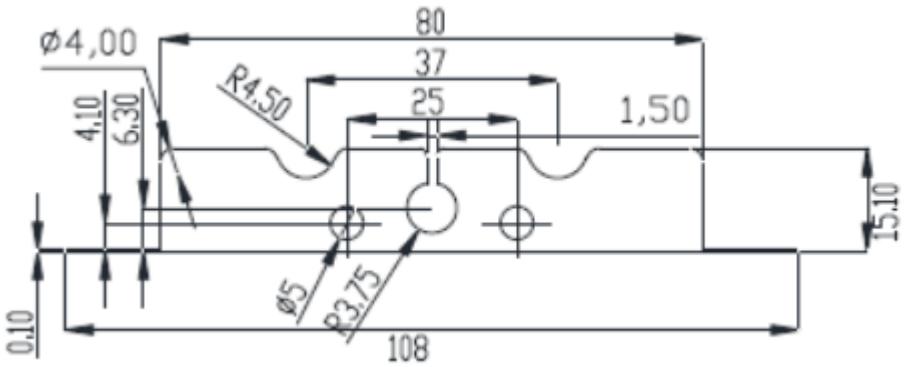


Model C: STDPA1357715MBA433

Type: Horn Antenna

Manufacturer: SHANGHAI ZHENYI COMMUNICATION TECHNOLOGY CO., LTD.

Antenna gain: 0.5dBi

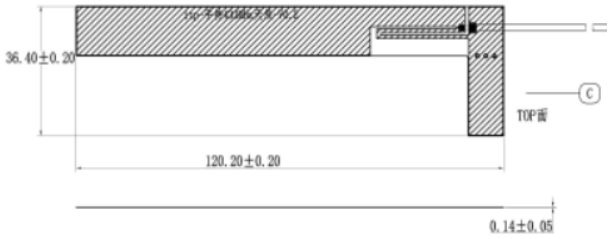


Model D: STDPA1357715MBA433

Type: FPC Antenna

Manufacturer: SHANGHAI ZHENYI COMMUNICATION TECHNOLOGY CO., LTD.

Antenna gain: -3.5 dBi



Radiation Exposure Statement

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

Ce module respecte les limites d'exposition aux rayonnements radiofréquences IC établies pour un environnement non contrôlé. Ce transmetteur ne doit pas être placé à proximité ou fonctionner conjointement avec une autre antenne ou un autre émetteur. Ce module doit être installé et utilisé en respectant une distance minimale de 20 cm entre le radiateur et le corps de l'utilisateur.

If the ISED identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

“Contains Transmitter Module IC: 36001-WS9501DLS Or Contains IC: 36001-WS9501DLS”

Si le numéro d'identification ISED n'est pas visible lorsque le module est installé dans un autre appareil, alors l'extérieur de l'appareil dans lequel le module est installé doit également afficher une étiquette indiquant le module intégré. Cette étiquette extérieure peut utiliser des formulations telles que les suivantes :

« Contient module émetteur IC : 36001-WS9501DLS ou contient IC : 36001-WS9501DLS »

When the module is installed inside another device, the user manual of the host must contain below warning statements;

1. This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RsS(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.

Lorsque le module est installé à l'intérieur d'un autre appareil, le manuel d'utilisateur de l'hôte doit contenir les avertissements suivants ;

1. Cet appareil contient un émetteur/récepteur exempt de licence conforme aux réglementations RsS(s) exemptes de licence de l'Innovation, Science and Economic Development Canada. Son fonctionnement est soumis aux deux conditions suivantes :

(1) Cet appareil ne doit pas provoquer d'interférences ; et

(2) Cet appareil doit accepter toute interférence, y compris celles pouvant entraîner un fonctionnement indésirable de l'appareil.

2. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product.

Toute modification ou changement non expressément approuvé par la partie responsable de la conformité pourrait annuler le droit de l'utilisateur d'exploiter l'équipement. Les appareils doivent être installés et utilisés strictement conformément aux instructions du fabricant, telles que décrites dans la documentation utilisateur fournie avec le produit.

Any company of the host device which install this modular with Single modular approval should perform the test of radiated emission and spurious emission according to RSS-210 requirement, Only if the test result comply with RSS-210 requirement，then the host can be sold legally.

Toute entreprise du dispositif hôte qui installe ce module avec une approbation modulaire unique doit effectuer les tests d'émission rayonnée et d'émission parasite conformément aux exigences de la norme RSS-210. Seul si les résultats des tests sont conformes aux exigences de la norme RSS-210, le dispositif hôte peut être vendu légalement.