

Enli Incorporation

SPECIFICATION and USER MANUAL

11ax/AC/A/B/G/N (WIFI 6) 2T2R Dual Band Simultaneous
Full Size MPCIE wireless card

ENLI Product ordering no. : ENL-M654DBS-MPCIE

Model No. : WM-1431

Date : 2022, Dec 12th (Ver. #: 0.16)

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1. General Description

1.1. Product Overview

WM-1431 is a 802.11ax Dual Band Mini PCIe wireless module, backward compatible with 802.11ac/a/b/g/n, the module was built based on MaxLinear WAV654 chipset (previous chipset named Intel WAV 654), which provide advanced 2x2x2 Concurrent Dual Band 802.11ax Wi-Fi systems. They are designed to support very high throughput, low latency, extra low host CPU consumption and enhanced reach and coverage. The PCIe 3.0 interface and Super Thick MAC acceleration allow the MaxLinear Home Wi-Fi Chipset WAV600 Series device to be connected to any network or media processor with minimal CPU load impact on the host processor, even with the maximum throughput of a 2x2 + 2x2 802.11ax system (up to 2.5 Gbps effective throughput).

WM-1431 supports 2T2R (2x2) Wi-Fi 6 technology, which runs up to 2,402Mbps at 5G or runs up to 574Mbps at 2.4G in theory. The WM-1431 supports 20/40 bandwidth in 2.4GHz band and 20/40/80/160 MHz bandwidth in 5GHz band.

1.2. Key Feature of WM-1431 DBDC Module

The major standard features provided by the **WM-1431** solution are:

- IEEE 802.11a/b/g/n/ac/ax compliant
- 2 spatial streams in 2.4 GHz and 2 spatial streams in 5 GHz
- Up to 4 TX/RX antennas
- Concurrent Dual Band (CDB) of 5 GHz + 2.4 GHz bands, 2x2x2
- Supports up to 160 MHz bandwidth (BW) in 5 GHz band and 40 MHz BW in 2.4 GHz band
- Supports OFDMA modulations up to QAM-1024 – Up to 3 Gbps PHY rate (2.4 Gbps (2x2 5 GHz) + 0.6 Gbps (2x2 2.4 GHz mode))
- Explicit beamforming (with compressed feedback)
- LDPC
- TX STBC
- DL Multi User MIMO; DL and UL MU-OFDMA
- TWT
- BSS Coloring / Spatial Reuse

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The key differentiating features of the **WM-1431** solution are:

- Enhanced maximum likelihood modem
- Optimal channel estimation using Singular Value Decomposition (SVD)
- Advanced link adaptation
- Full CDB 2x2x2
- On-the-fly Super Thick MAC
 - Providing the ability to transmit over 600K PPS and last microsecond decision for transmission details.
 - Reaching the theoretical limit for throughput versus packet size, for packet sizes 512 bytes and above.
- Advanced QoS
- Enhanced debug abilities – local and remote

1.3. Typical Application

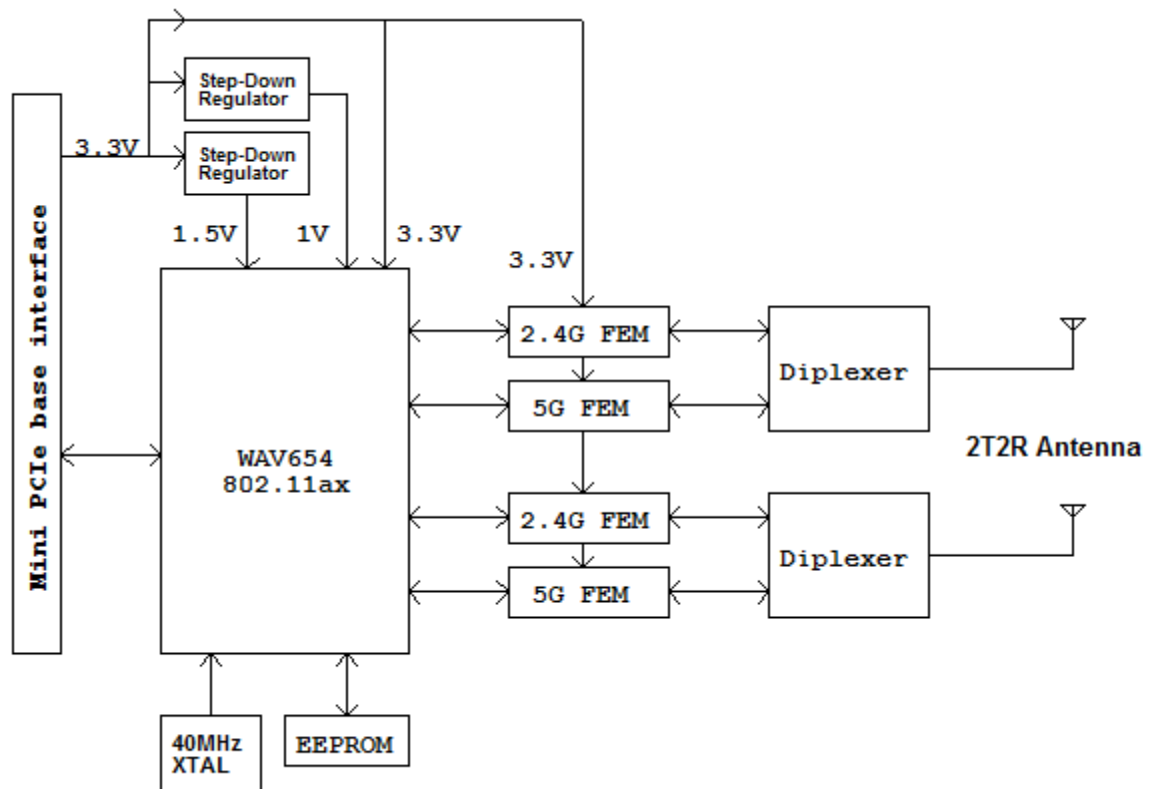
The main use case for **WM-1431** is as a PCIe* add-on Card with Mini-PCIe interface for Gateway (GW) solutions, with high end application and crowded connection demand, the module is expected to be used for SMB, industrial communication and media Gateway etc.

2. Product Specification

2.1. Main Component

- Intel WAV654
- Built-in EEPROM
- 4Layers PCB, size: 30mm x 50.95mm

2.2. Block Diagram



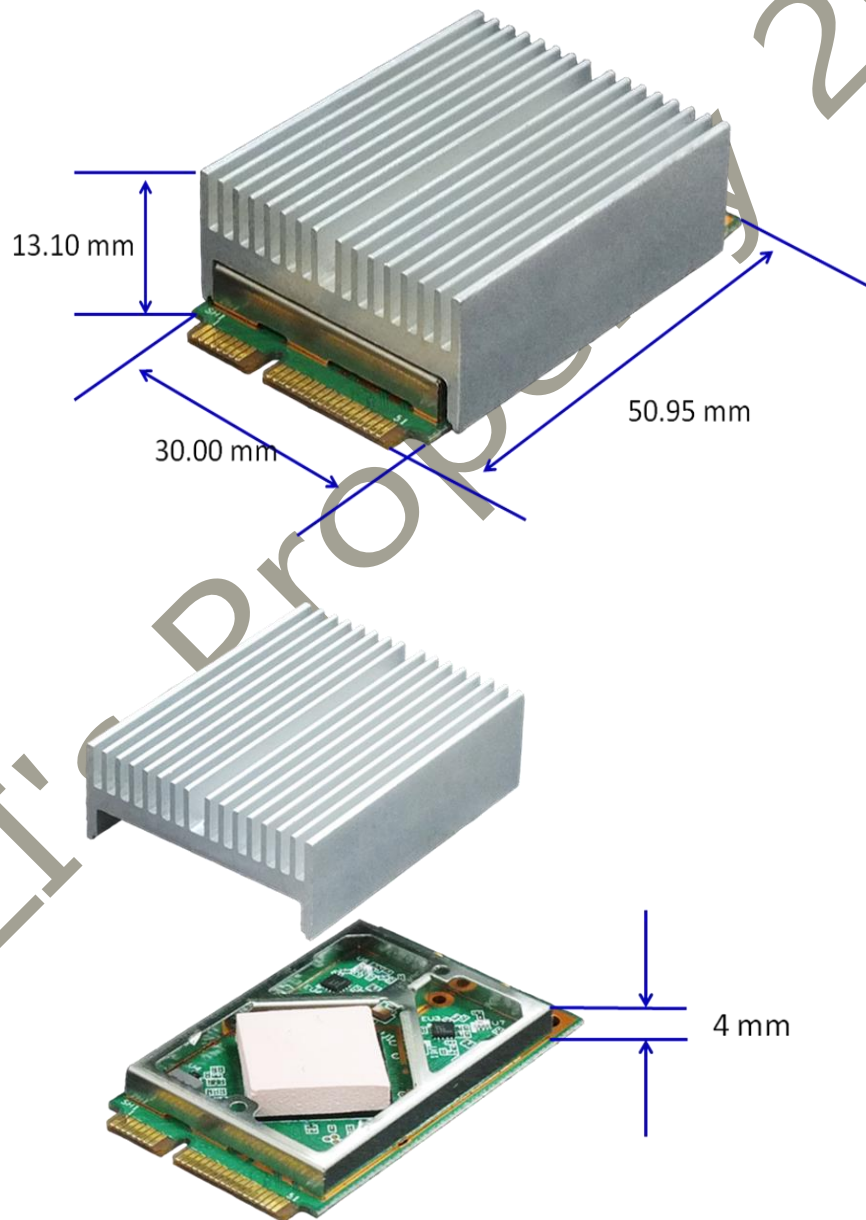
2.3. Product Specification

- RF: Intel WAV654
- 4Layers PCB, 30mm x 50.95mm
- IPEX x 2 (for External Antenna)
- Shielding Cover: Shielding cover and shielding frame

Standard	802.11ax/ac/a/b/g/n
Chipset	Intel WAV654
Host Interface	Standard Mini PCIe Interface
Operating Frequency	2.412 ~ 2.462 GHz; 5.180 ~ 5.825 GHz
Features	Supports 20/40/80/160 MHz at 5 GHz Supports 20/40 MHz at 2.4 GHz Data rates of up to 2402 Mbps in 802.11ax 160 MHz bandwidth at 5GHz band Data rates of up to 574 Mbps in 802.11ax 40 MHz bandwidth at 2.4GHz band
Operating Voltage	DC 3.3V
Antenna Connectors	2 x I-PEX Connectors for External Antennas
Power Consumption	Less than 8.25W
PCB dimensions	PCB 4Layers, 30mm x 50.95mm
Operating Temperature	-10°C to +70°C Note: 1. Suggested operating temperature is -10°C to 50°C. 2. If operating temperature is not within suggested operating temperature, additional thermal pad between WM-1431 bottom side and host main board is required. Temperature on host board under module cannot be over +70°C 3. Detailed Thermal report can be requested via sales team if needed.

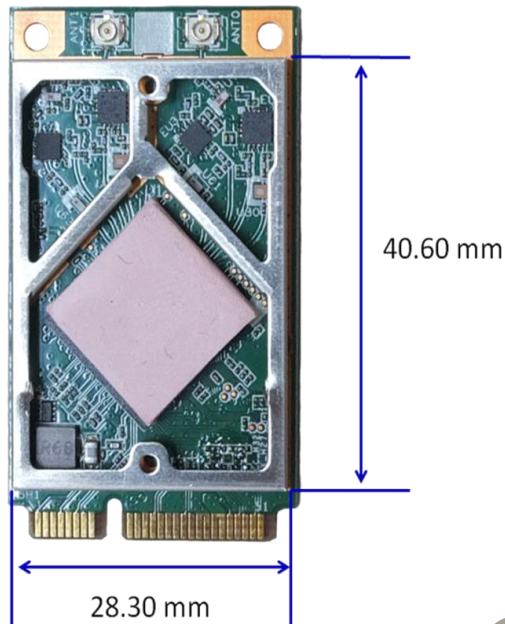
2.5. Product Outlook

Unit	mm (millimeter)	
Tolerance	Dimension Range	Tolerance
	1-6 (mm)	$\pm 0.1\text{mm}$
	6-18 (mm)	$\pm 0.2\text{mm}$
	18-50 (mm)	$\pm 0.3\text{mm}$
	50-120 (mm)	$\pm 0.45\text{mm}$



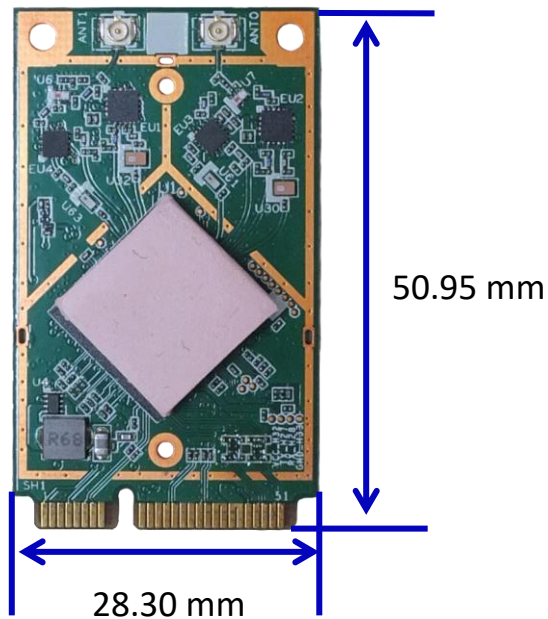
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2.6. 2.4.1 Shielding Frame



2.7. 2.4.2 PCB

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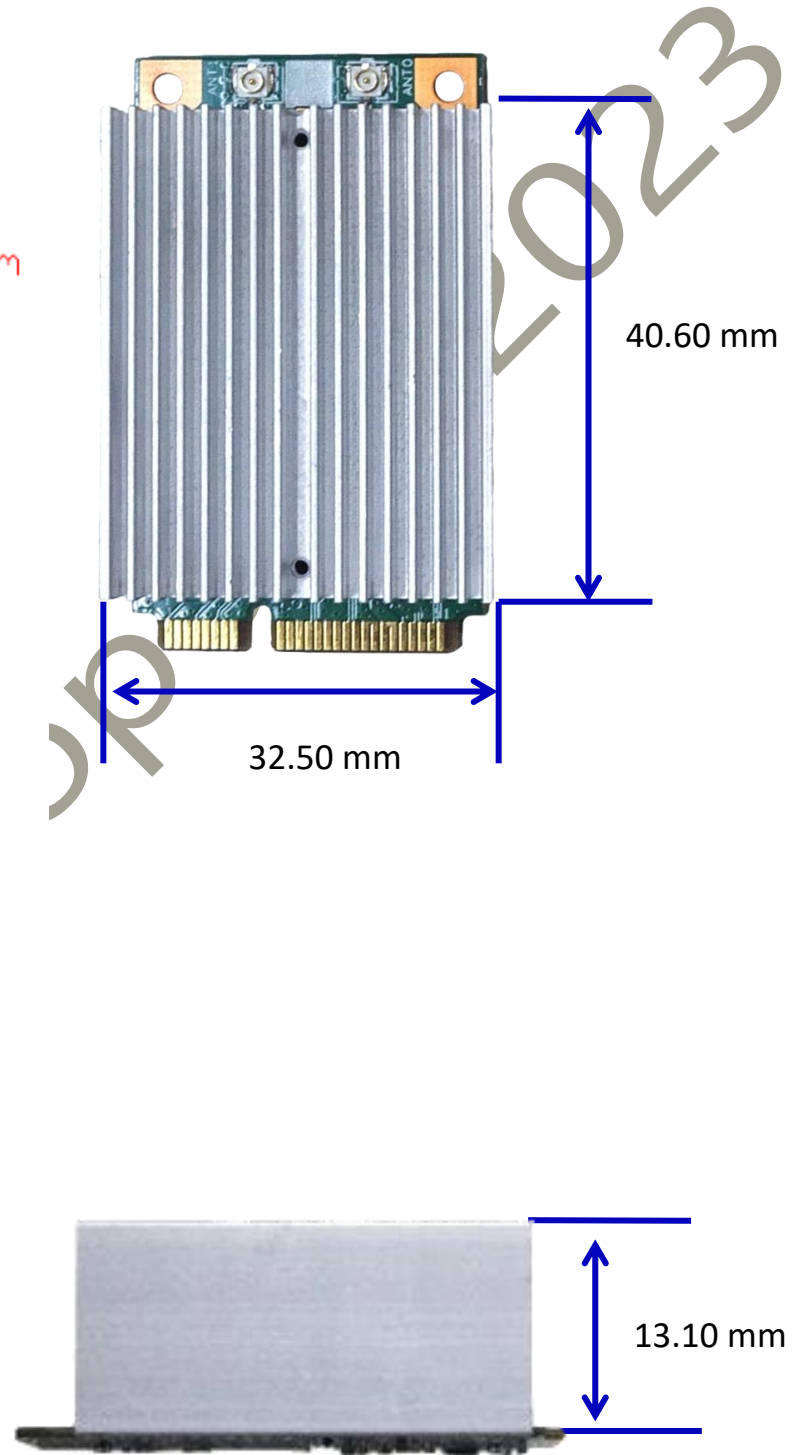
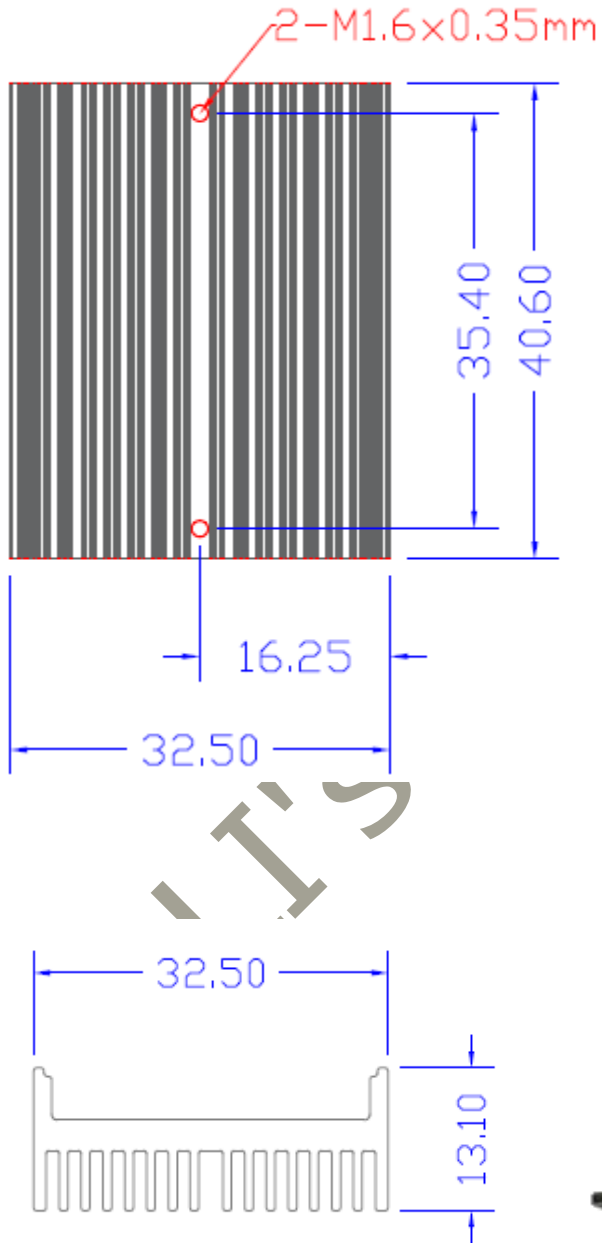


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2.8. 2.4.3 Heat Sink



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2.9. Mini PCIe Pin Definition

Mini PCIe Connector Pin Assignment			
Top Side		Bottom Side	
51	Reserved	52	VDD_3V3
49	Reserved	50	GND
47	Reserved	48	NC
45	Reserved	46	LED1
43	GND	44	LED0
41	VDD_3V3	42	LED2
39	VDD_3V3	40	GND
37	GND	38	NC
35	GND	36	NC
33	PCIE0_TX0_P	34	GND
31	PCIE0_TX0_N	32	NC
29	GND	30	NC
27	GND	28	NC
25	PCIE0_RX0_P	26	GND
23	PCIE0_RX0_N	24	VDD_3V3
21	GND	22	PCIE0_PERST
19	NC	20	W_DISABLE
17	NC	18	GND
Mechanical Key			
15	GND	16	NC
13	PCIE0_REFCLK_P	14	NC
11	PCIE0_REFCLK_N	12	NC
9	GND	10	NC
7	PCIE0_CLKREQ_N	8	NC
5	NC	6	NC
3	NC	4	GND
1	PCIE0_WAKE_N	2	VDD_3V3

2.10.PCB Dimension

- PCBA Dimension: 4Layers, 30mm x 50.95mm
- Height limitation: 12.5 mm from M.2 PCB surface
- Heat sink allows maximum 35mm x 50.95mm, total height 12.5mm from PCB surface
- Height limitation on the other side (under the PCB): 1.4mm

Mechanism design will be provided in later versions.

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 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.

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

RF exposure statements

This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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 32 centimeters between the radiator and your body or nearby persons.

CFR 47 FCC PART 15 SUBPART C (15.247) and SUBPART E (15.407) has been investigated. It is applicable to the modular transmitter.

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.

This radio transmitter 2AWKZ-WM1431 has been approved by Federal Communications Commission 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.

Unique antenna connector must be used on the Part 15 authorized transmitters used in the host product.

Antenna Type	Brand	Antenna Model	Maximum Gain (dBi)		Remark
			2.4 GHz	5GHz	
Panel antenna	LYNwave	ALX18P-222AA1-00	6.4 dBi	4.2 dBi	
Panel antenna	LYNwave	ALX18P-222AA1-01	2.6 dBi	5.2 dBi	
Dipole	KINSUN	6603303081	2.18 dBi	3.58 dBi	
Dipole	WIESON	ARY121-0348-008-00	1.75 dBi	1.9 dBi	
Dipole	ARISTOTLE	RFA-25-C2M2-M10-1	2.56 dBi	1.81 dBi	
Dipole	ARISTOTLE	RFA-25-C2M2-U-M70	2.56 dBi	1.81 dBi	
Dipole	WANSIH	WSS038	4.1 dBi	5.23 dBi	

If the FCC 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 FCC ID:2AWKZ-WM1431” Or “Contains FCC ID:2AWKZ-WM1431”

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and 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. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

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.

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

Industry Canada statement:

This device complies with Industry Canada license-exempt RSSs. 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;
- 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Caution:

- 1) The device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
- 2) For devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;
- 3) For devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits specified for point-to-point and non-point-to-point operation as appropriate; and

Avertissement:

- 1) Le dispositif fonctionnant dans la bande 5150-5250 MHz est réservé uniquement pour une utilisation à l'intérieur afin de réduire les risques de brouillage préjudiciable aux systèmes de satellites mobiles utilisant les mêmes canaux;
- 2) Le gain maximal d'antenne permis pour les dispositifs avec antenne(s) amovible(s) utilisant les bandes 5250-5350 MHz et 5470-5725 MHz doit se conformer à la limitation P.I.R.E.;
- 3) Le gain maximal d'antenne permis pour les dispositifs avec antenne(s) amovible(s) utilisant la bande 5725-5850 MHz doit se conformer à la limitation P.I.R.E. spécifiée

pour l'exploitation point à point et non point à point, selon le cas.

Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 32cm between the radiator & your body.

Déclaration d'exposition aux radiations:

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 32 cm de distance entre la source de rayonnement et votre corps.

This radio transmitter (IC: 26176-WM1431 has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device. Le présent émetteur radio (IC: 26176-WM1431 a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés cidessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Antenna Type	Brand	Antenna Model	Maximum Gain (dBi)		Remark
			2.4 GHz	5GHz	
Panel antenna	LYNwave	ALX18P-222AA1-00	6.4 dBi	4.2 dBi	
Panel antenna	LYNwave	ALX18P-222AA1-01	2.6 dBi	5.2 dBi	
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Dipole	ARISTOTLE	RFA-25-C2M2-U-M70	2.56 dBi	1.81 dBi	
Dipole	WANSIH	WSS038	4.1 dBi	5.23 dBi	

If the ISSED certification 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 IC: 26176-WM1431".

Si le numéro de certification ISDE n'est pas visible lorsque le module est installé à l'intérieur d'un autre appareil, alors l'extérieur de l'appareil dans lequel le module est installé doit également afficher une étiquette faisant référence au module inclus. Cette étiquette extérieure peut utiliser un libellé comme celui-ci: " Contient IC: 26176-WM1431".

Plaque signalétique du produit final:

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 26176-WM1431 ".

Manual Information To the End User:

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.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module. Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manue

Must use the device only in host devices that meet the FCC/ISED RF exposure category of mobile, which means the device is installed and used at distances of at least 32cm from persons.

The end user manual shall include FCC Part 15 /ISED RSS GEN compliance statements related to the transmitter as show in this manual.

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B, ICES 003.

Host manufacturer is strongly recommended to confirm compliance with FCC/ISED

requirements for the transmitter when the module is installed in the host.

Must have on the host device a label showing Contains FCC ID: 2AWKZ-WM1431,
Contains IC:26176-WM1431

The use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual.

If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

L'hôte doit utiliser l'instrument uniquement dans des dispositifs qui répondent à la fcc / (catégorie d'exposition rf mobile, ce qui signifie le dispositif est installé et utilisé à une distance d'au moins 32 cm de personnes.

le manuel de l'utilisateur final doit inclure la partie 15 / (fac rss gen déclarations de conformité relatives à l'émetteur que de montrer dans ce manuel.

le fabricant est responsable de la conformité de l'hôte, le système d'accueil avec le module installé avec toutes les autres exigences applicables du système comme la partie 15 b, ices - 003. accueillir le fabricant est fortement recommandé de confirmer la conformité avec les exigences de la fcc / (émetteur lorsque le module est installé dans l'hôte.

le dispositif d'accueil doivent avoir une étiquette indiquant contient FCC ID:2AWKZ-WM1431, contient IC : 26176-WM1431