

# DL7612 LoRa Module

## Datasheet

Version: LoRa\_DL7612\_Datasheet\_V1.1

Date: 2018-07-30

## Document Revision Record

Version	Date	Description	
V0.1.1	2017-12-12	Preliminary version	Ming
V1.1	2018_07_30	Update pin definition	Ming

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## Introduction:

DL7612 is a low power,LoRaWAN based wireless communication module for 863-928MHz band. It integrated with Semtech SX1276 RF chip and ambiQ micro Apollo1 MCU, DL7612 can achieve a sensitivity of over -139dBm,The high sensitivity combined with the integrated +18.6dBm power amplifier yields industry leading link budget making it optimal for any application requiring range or robustness.



## Product Features

- LoRaWAN technique
- Frequency: ISM band, 863~928MHz Optional.
- High sensitivity: down to -139dBm
- +18.6dBm constant RF output
- 25mW RF transmission, 7 level adjustable
- Effective communication range : 3~5KM
- Ultral low power consumption, a single battery pack can work 3-5 years
- Small size designed for quick integration of end nodes to LoRaWAN
- Dimensions:22.0\*15.0\*2.7mm (W\*L\*H)
- RoHS compliant

## Application:

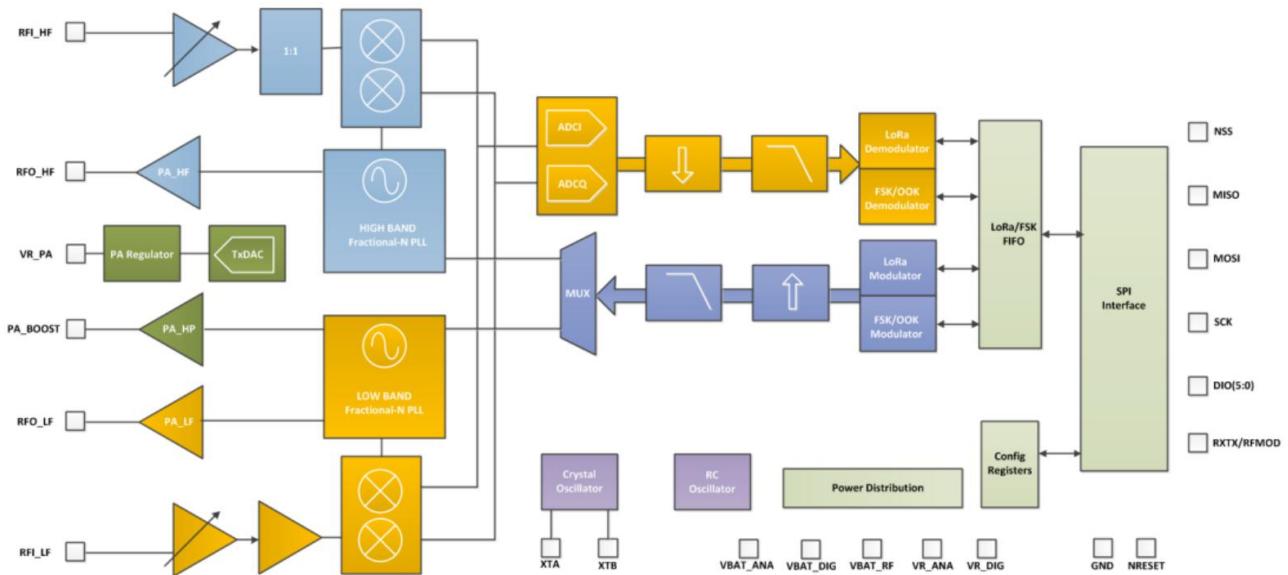
- Low power consumption IoT application
- Home and Building Automation
- Wireless Alarm and Security Systems
- Industrial Monitoring and Control
- Long range Irrigation Systems
- Smart Environmental Monitoring
- Smart Cities
- Smart Agriculture
- Automated Meter Reading
- Location Monitoring



## 1. General Description

The DL7612 incorporates the LoRa™ spread spectrum modem which is capable of achieving significantly longer range than existing systems based on FSK modulation. At maximum data rates of LoRa™ the sensitivity is 8dB better than FSK, but using a low cost bill of materials can improve receiver sensitivity. LoRa™ also provides significant advances in selectivity and blocking performance, further improving communication reliability. For maximum flexibility the user may decide on the spread spectrum modulation bandwidth (BW), spreading factor (SF) and error correction rate (CR). Another benefit of the spread modulation is that each spreading factor is orthogonal - thus multiple transmitted signals can occupy the same channel without interfering. This also permits simple coexistence with existing FSK based systems. The DL7612 offer bandwidth options ranging from 7.8 kHz to 500 kHz with spreading factors ranging from 6 to 12, and covering upper UHF bands.

### 1.1 Simplified Block Diagram



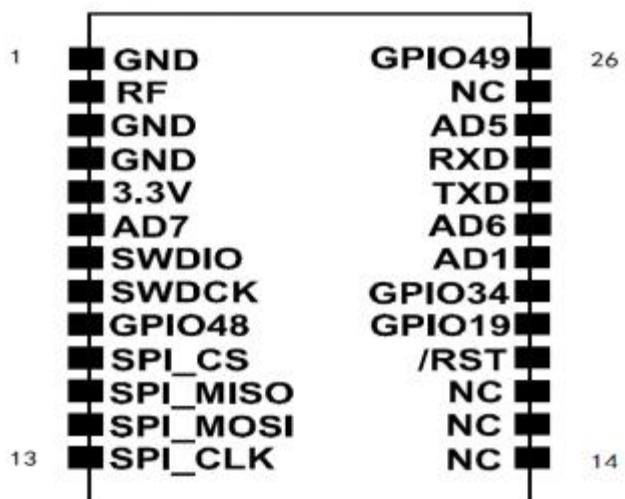
### 1.2 Product Versions

The features of the two product variants are detailed in following table.

No.	Part No.	Dimensions (mm)	Description	Remark
1	DL7612-E	17.8*16.5*2.7	863~870MHz band, Suitable for Europe	
2	DL7612-U	17.8*16.5*2.7	902~928MHz band, Suitable for America ,Australia, Asia, Korea, Japan etc...	

## 1.3 Pin Diagram

### 1.3.1 Pin Arrangement Diagram

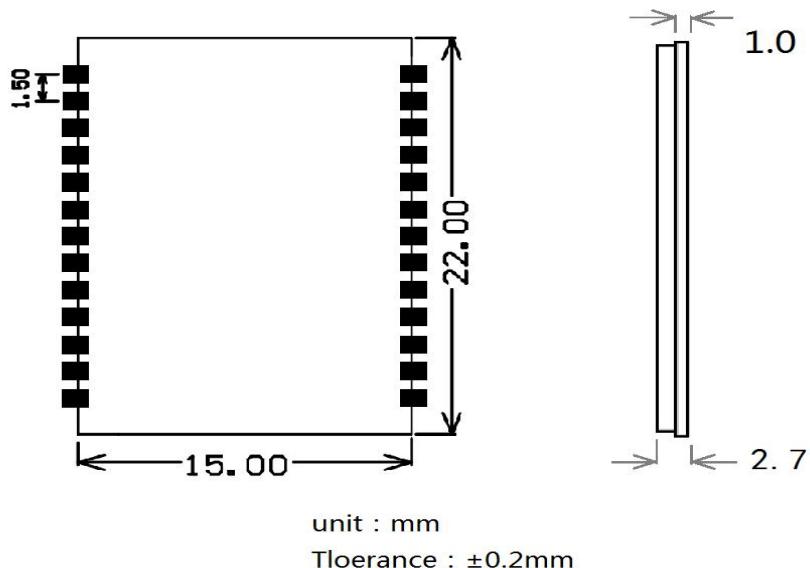


### 1.3.2 Pin Description

No.	Name	Description
1	GND	Ground
2	RF	RF Tx/Rx
3	GND	Ground
4	GND	Ground
5	3.3V	VCC_3.3V
6	AD7	AD in / GPIO
7	SWDIO	MCU Debug Port
8	SWDCK	MCU Debug Port
9	GPIO48	GPIO

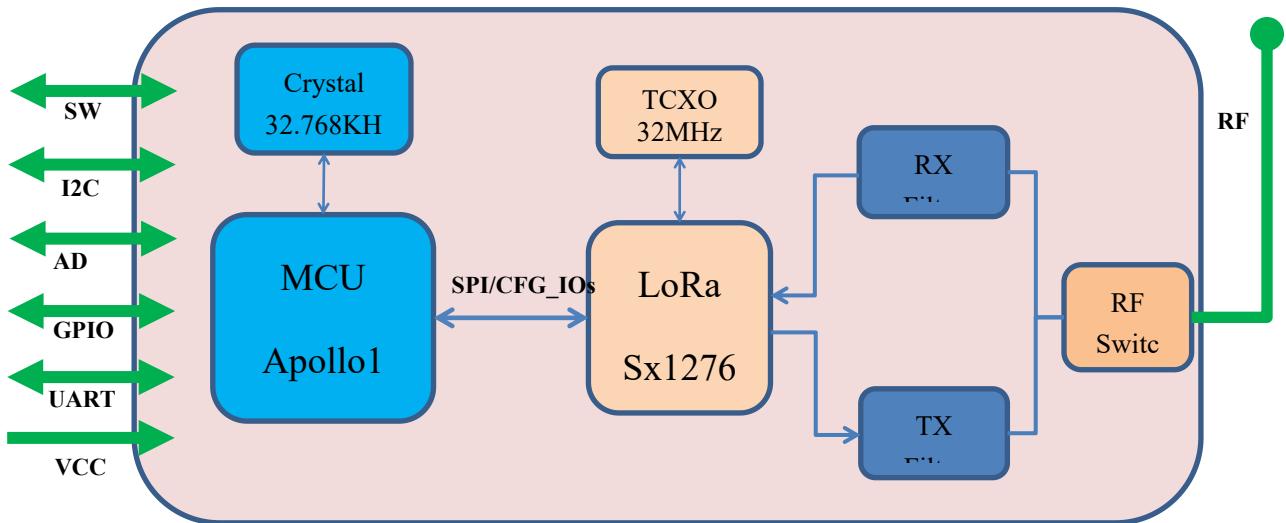
10	SPI_CS	SPI_CS
11	SPI_MISO	SPI_MISO
12	SPI_MOSI	SPI_MOSI / I2C_SDATA
13	SPI_CLK	SPI_CLK / I2C_SCLK
14	NC	Not Connected
15	NC	Not Connected
16	NC	Not Connected
17	/RST	Module Negative Reset
18	GPIO19	GPIO
19	GPIO34	GPIO
20	AD1	AD in / GPIO
21	AD6	AD in / GPIO
22	TXD	U(S)ART_TX
23	RXD	U(S)ART_RX
24	AD5	AD in / GPIO
25	NC	Not Connected
26	GPIO49	GPIO

### 1.3.3 Dimensions

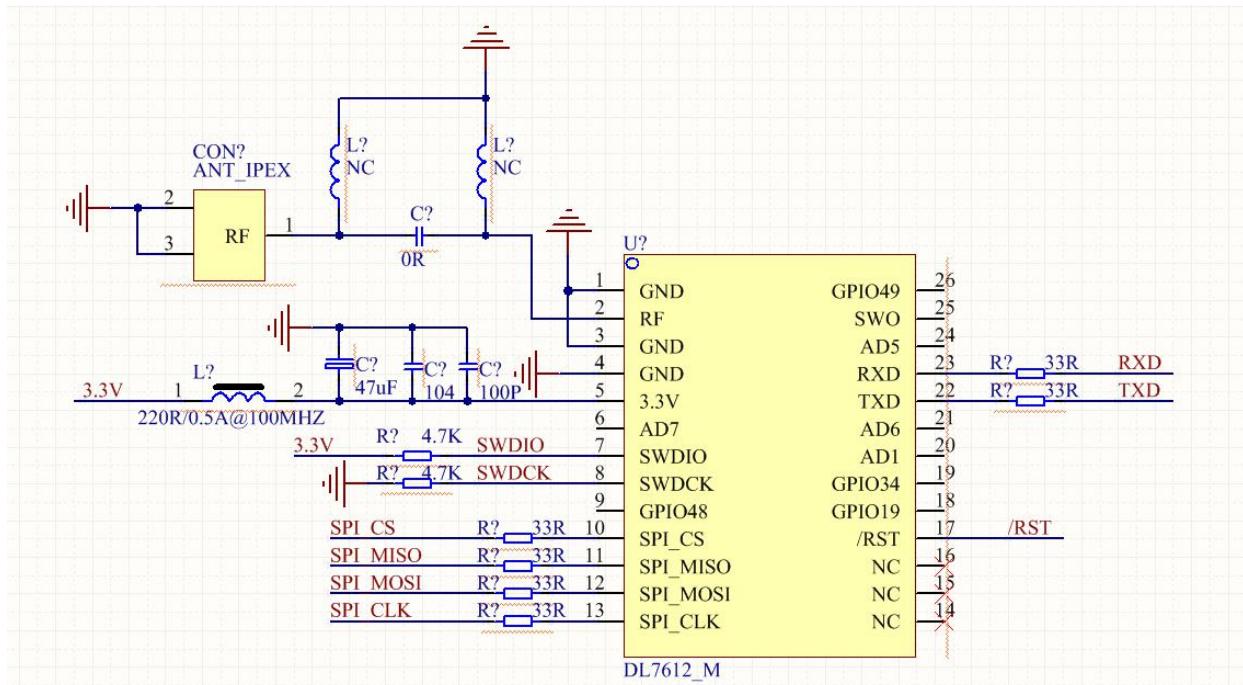


Item	Length	Width	Thickness	Unit	Remark
Size	22.0	15.0	2.7	mm	

## 1.4 Function Block Diagram



## 1.5 Reference Circuit



## 2. Electrical Characteristics

### 2.1. ESD Notice

DL7612 is a high performance radio frequency device. It satisfies:

- ✧ Class 2 of the JEDEC standard JESD22-A114 (Human Body Model) on all pins.
- ✧ Class III of the JEDEC standard JESD22-C101 (Charged Device Model) on all pins

It should thus be handled with all the necessary ESD precautions to avoid any permanent damage

## 2.2 Absolute Maximum Ratings

Exposure to absolute maximum ratings for extended periods may affect device reliability.

Table 1 Absolute Maximum Ratings.

Item	Min	TyP	Max	Unit
Supply Voltage	-0.3	+3.3	+3.9	V
Storage Temperature	-40		+125	°C

## 2.3

## Operating Range

Table 2 Operating Range

Item	Min	TyP	Max	Unit
Supply Voltage	+3.0	+3.3	+3.6	V
Operation Temperature	-40		+85	°C

## 2.4 Operating Environment

Table 3 Operatating Environment

Item	Description
Modulation	LoRa™
WAN Protocol	ISM Band – LoRa™
Operating Humidity	10%~90%
Dimensions	TYP. 22*15*2.7mm (W*L*H)
ESD	JEDEC JS-001 Standard ±1kV, Class 2

## 2.5.Electrical Specification

Supply voltage VDD = 3.3 V, temperature=25°C, FXOSC= 32 MHz, FRF = 863-870MHz/902-928MHz  
Pout =+ 18.6dBm, shared Rx and Tx path matching.

Item	Description
Frequency	863~870MHz/902-928MHz
Tx Power	+18.6dBm
Receive Sensitivity	Down to -139dBm
Supply Voltage	+3.3V
Average Tx Current	≤120mA
Sleeping Current	≤1uA
Average Rx Current	≤25mA
Link Budget	Up to 157.6dB

Table 4 Module Specification

## 2.5.1. Power Consumption

Table 5 Power consumption specification

Description	Conditions	Min	TyP	Max	Unit
Supply Current in Sleep Mode		-	0.2	1	uA
Supply Current in Standby Mode	Crystal oscillator enabled	-	1.6	1.8	mA
Supply Current in Receive Mode	LNA off	-	10.8	-	
	LNA on	-	11.5	-	mA
	RFOP = +17 dBm,	-	87	-	mA
	RFOP = +13 dBm,	-	29	-	mA
	RFOP = + 7 dBm,	-	20	-	mA

## 2.5.2 Frequency Synthesis

Table 6 Frequency Synthesizer Specification

Description	Conditions	Min	TyP	Max	Unit
Frequency Range	Programmable	863	-	870	
		902	-	928	MHz
Crystal Oscillator frequency	-	-	32	-	MHz

Crystal Oscillator wake-up time	-	-	250	-	us
Frequency synthesizer wake-up time to PLLock signal	From standby mode	-	60	-	us
Bit Rate, FSK		1.2	-	300	kbps
Bit Rate Accuracy, FSK	ABS	-	-	250	ppm
Bit Rate, OOK		1.2	-	32.768	kbps
Bit Rate, LoRa Mode	From SF6,BW500KHz To SF12,BW=7.8KHz	0.018	-	37.5	kbps
Frequency deviation, FSK		0.6	-	200	KHz

### 2.5.3. FSK / OOK Mode Receiver

All receiver tests are performed with  $\text{RxBw} = 10 \text{ kHz}$  (Single Side Bandwidth) as programmed in `RegRxBw`. Sensitivities are reported for a 0.1% BER (with Bit Synchronizer enabled), unless otherwise specified. Blocking tests are performed with an unmodulated interferer. The wanted signal power for the Blocking Immunity, ACR, IIP2, IIP3 and AMR tests is set 3 dB above the receiver sensitivity level.

Table 7 FSK / OOK Receiver Specification

Description	Conditions	Min	TyP	Max	Unit
LNA gain	FDA=5KHz, RB=1.2kbs	-	-121	-	dBm
	FDA=5KHz, RB=4.8kbs	-	-117	-	dBm
	FDA=40KHz, RB=38.4kbs	-	-107	-	dBm
	FDA=40KHz, RB=38.4kbs	-	-95	-	dBm
	FDA=62.5KHz, RB=250kbs***	-	-	-	dBm
OOK sensitivity, highest LNA gain	BR=4.8kbs/s	-	-117	-	dB
	BR=32kbs/s	-	-108	-	dB
Blocking immunity	offset=±1MHz	-	71	-	dB
	offset=±2MHz	-	76	-	dB
	offset=±10MHz	-	84	-	dB
RSSI Dynamic Range	AGC Enabled Min	-	-127	-	dBm
	Max	-	0	-	dBm

### 2.5.4. FSK / OOK Mode Transmitter

Table 8 FSK / OOK Transmitter Specification

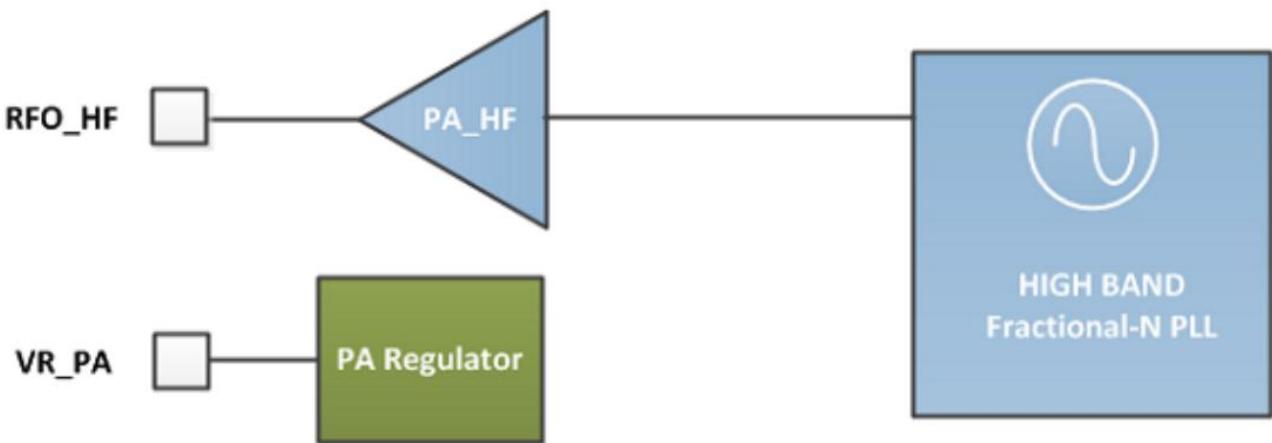
Description	Conditions	Min	TYP	Max	Unit
PA_RF output Power	Max	-	+14	-	dBm
	Min	-	-1	-	dBm
Transmitter Phase Noise	10KHz	-	-110	-	dB
	50KHz	-	-110	-	dB
	400KHz	-	-122	-	dB
	1MHz	-	-129	-	dBm

### 3. Transmitter Description

The transmitter of DL7612 comprises the frequency synthesizer, modulator (both LoRa™ and FSK/OOK) and power amplifier blocks, together with the DC biasing and ramping functionality that is provided through the VR\_PA block

#### 3.1. Architecture Description

The architecture of the RF front end is shown in the following diagram:



#### 3.2. RF Power Amplifiers

PA\_HF and PA\_LF are high efficiency amplifiers capable of yielding RF power programmable in 1 dB steps from -4 to +18.6dBm directly into a 50 ohm load with low current consumption. PA\_HF covers the lower bands (863-928MHz).

The output power is sensitive to the power supply voltage, and typically their performance is expressed at 3.3V.

PA Slect	Mode	Power Range	Pout Formula
0	PA_HF or PA_LF on RFO_HF or RFO_LF	-4dBm to +18.6dBm	Pout=Pmax-(15-OutputPower) Pmax=10.8+0.6 x MaxPower [dBm]

Table 9 Power Amplifier Mode Selection Truth Table

## Notes

- For +18.6dBm restrictions on operation please consult the following .
- To ensure correct operation at the highest power levels ensure that the current limiter *OcpTrim* is adjusted to permit delivery of the requisite supply current.
- If the PA\_BOOST pin is not used it may be left floating.

## 4. Receiver Description

### 4.1 Overview

DL7612 features a digital receiver with the analog to digital conversion process being performed directly following the LNA-Mixers block. The receiver also has automatic gain calibration, this improves the precision of RSSI measurement and enhances image rejection.

### 4.2 Receiver Enabled and Receiver Active States

In the receiver operating mode two states of functionality are defined. Upon initial transition to receiver operating mode the receiver is in the 'receiver-enabled' state. In this state the receiver awaits for either the user defined valid preamble or RSSI detection criterion to be fulfilled. Once met the receiver enters 'receiver-active' state. In this second state the received signal is processed by the packet engine and top level sequencer.

### 4.3 Automatic Gain Control In FSK/OOK Mode

The AGC feature allows receiver to handle a wide Rx input dynamic range from the sensitivity level up to maximum input level of 0dBm or more, whilst optimizing the system linearity.

Table 10 LNA Gain Control and Performances

RX input level (Pin)	Gain Setting	LnaGain	Relative LNA Gain [dB]	NF Lower/Higher Band [dB]	IIP3 Lower/Higher band [dBm]
Pin <= AgcThresh1	G1	'001'	0 dB	4/5.5/7	-15/-22/-11
AgcThresh1 < Pin <= AgcThresh2	G2	'010'	-6 dB	6.5/8/12	-11/-15/-6
AgcThresh2 < Pin <= AgcThresh3	G3	'011'	-12 dB	11/12/17	-11/-12/0

<b>AgcThresh3 &lt; Pin &lt;= AgcThresh4</b>	G4	'100'	-24 dB	20/21/27	2/3/9
<b>AgcThresh4 &lt; Pin &lt;= AgcThresh5</b>	G5	'110'	-26 dB	32/33/35	10/10/14
<b>AgcThresh5 &lt; Pin</b>	G6	'111'	-48 dB	44/45/43	11/12/14

## 4.4 RSSI in LoRa™ Mode

The RSSI values reported by the LoRa™ modem differ from those expressed by the FSK/OOK modem. The following formula shows the method used to interpret the LoRa™ RSSI values:

$$RSSI[dBm] = -137 + RSSI$$

## 5.List of AT Command

Pls take reference to document 《MAXIOT-DL7612&DL7811-AT-CMD-V1.6》

## 6.Package

Table 11 Packing information

Module	Package			Article number
	Form	QTY	Size	
DL7612	Tape & Reel	As required	As required	Undertermined
	Trays	As required	As required	Undetermined

## 7.Contact Us

Maxiott Ltd

Web: [www.maxiott.com](http://www.maxiott.com)

Tel:+86-755-2645-9429

Fax: +86-755-2947-6513

Office address : Room 302,3F, No. 16, Lane 1,Liuxian No.2 Road,  
Bao'an District. 518100 Shenzhen, China

## **Federal Communication Commission Statement (FCC, U.S.)**

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.

### **FCC Caution:**

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

## **IMPORTANT NOTES**

### **Co-location warning:**

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

### **OEM integration instructions:**

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

The transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as the 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.).

### **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 authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID 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.

### **End product labeling:**

The final end product must be labeled in a visible area with the following: "Contains Transmitter Module [FCC ID: 2ARPP-DL7612](#)".

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.

**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.

Antenna Specification:

Type: Cylindrical Antenna

Gain: 5dBi