RG-IRT6110 Hardware Design Guide

V1.02

Ruijie Network co., Ltd.

Revision History

Table 1：Revision History

NUB.	Version	Date	Author	Description
1	V1.00	2018-1-8	ChenYanjun	Initial Release V1.0
2	V1.01	2018-04-16	DingSheng	
3	V1.02	2018-05-07	zhanjiakun	Reorganization

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1. Introduction

RG-IRT6110 is a LoRa-IoT module. It is designed to communicate with LoRa_gateway equipment using the LoRa-IoT radio protocol. The following Table1-1 shows the frequency bands of RG-IRT6110 module

Model	Uplink	Downlink
RG-IRT6110	470MHz to 490MHz	500MHz to 510MHz

Table1-1: RG-IRT6110 Module List

2. Functional Overview

RG-IRT6110 module provides the interconnection between LoRa_gateway networks and terminals, Figure 2-1 show the Network Architecture.

- Interconnection with LoRa_gateway
  - RG-IRT6110 module receives and processes signals sent from LoRa networks, and then sends commands or data to terminals for performing the operation and maintenance (O&M).
  - The module receives data and commands from terminals, transferring those data and commands to LoRa networks through LoRa_gateway, and then delivers them to network server(NS) and application servers (ASs).
- Interconnection with terminals
  - RG-IRT6110 module reads and uploads terminal data to the LoRa platform.
  - The module receives commands from the LoRa_gateway and performs O&M for terminals.

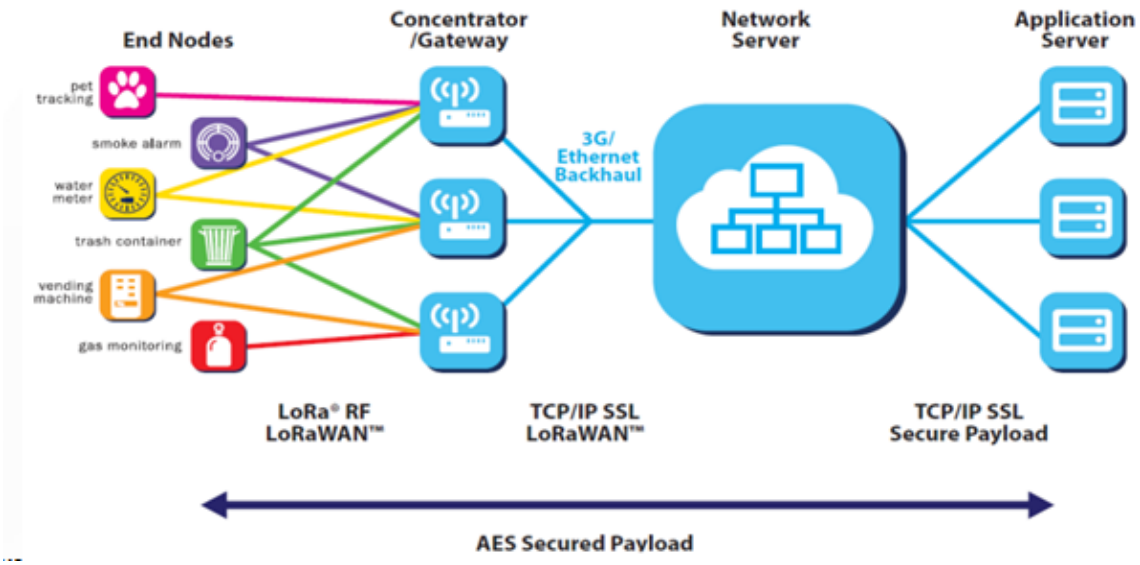

Figure 2-1: Network Architecture

2.1. Block Circuit Diagram

The following Figure2-2 shows a block diagram of RG-IRT6110 and illustrate the major functional parts.

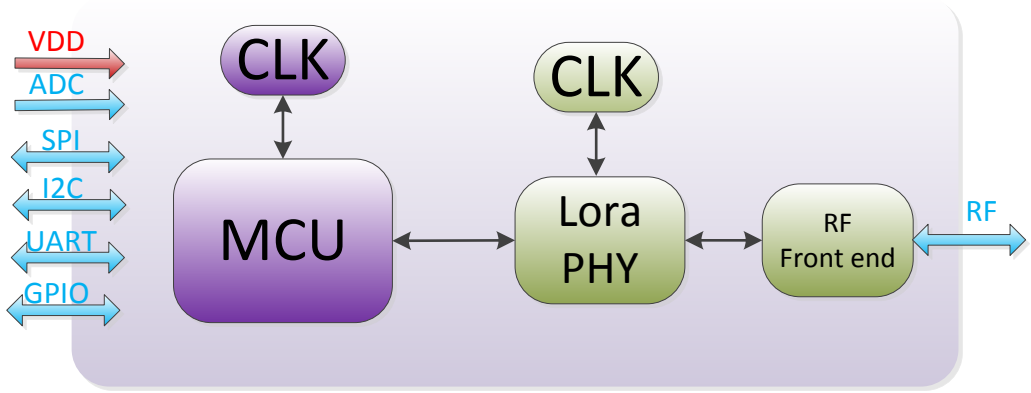

Figure2-2 Module Block Diagram

2.2. Operating Modes

Depends on the application firmware code, RG-IRT6110 behaves in three states.

- **ACTIVE mode**

  All of the functions are available and active in this mode.

- **POINT TO POINT mode**

  In point to point mode, the terminal can be upgraded with a handheld LoRa device.

- **SLEEP mode**

  In sleep mode, the LoRa module enters the low-power mode. At this time, the module does not interact with the data externally. To use it, the module needs to be woken up by the AT command.

3. Pin out and Definitions

3.1. Pin Assignment

The following figure shows the pin module, which provides 52-pin for external use.

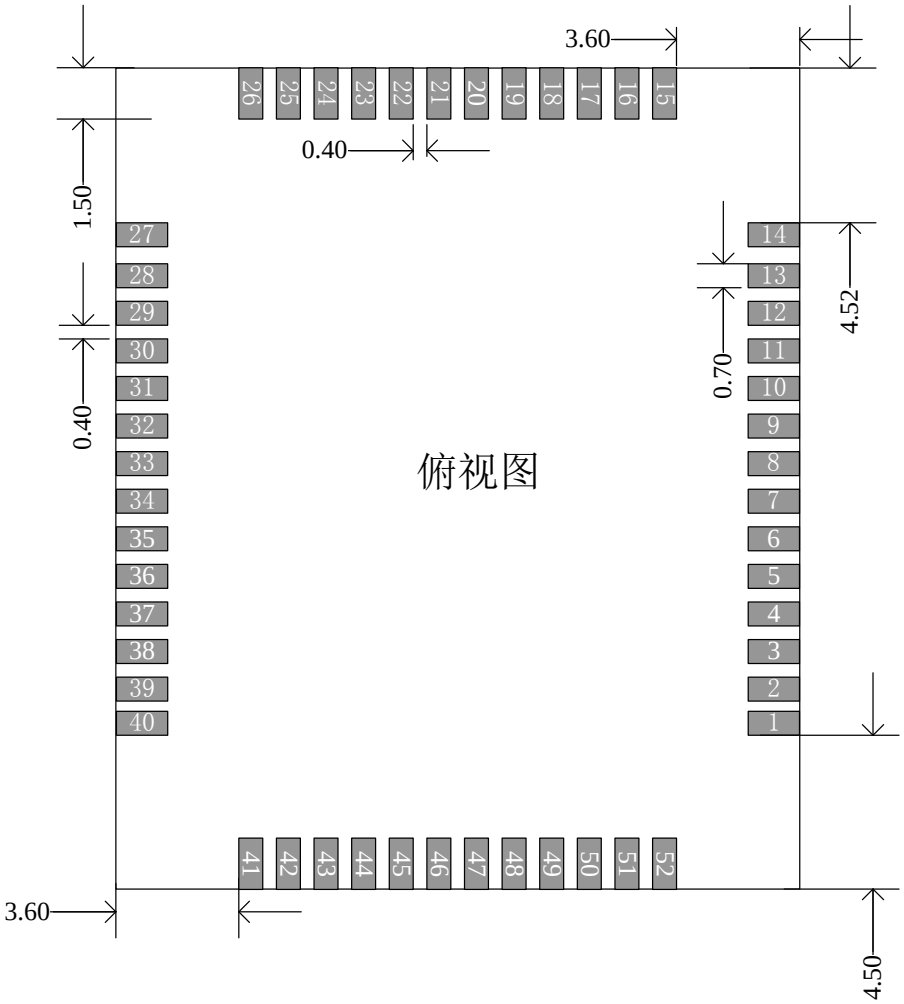

Figure3 -1: Sequence of RG-IRT6110 module pins

3.2. I/O Parameters Definition

Type	Description
DI	Digital input
DO	Digital output
I/O	Bidirectional input/output
AI	Analog input
AO	Analog output
PO	Power output
PI	Power input
OD	Open drain

Table 3-1: I/O Parameters Definition

3.3. Module Pin Definition

Power Supply

Pin Name	Pin No.	I/O Type	Description
VDD_3V3	17	PI	power supply of module: VDD_3V3 = 2.4V to 3.7V
GND	13, 18, 19, 20, 21, 23, 24, 26, 30, 32	N/A	Used for grounding

Reset Function

Pin Name	Pin No.	I/O Type	Description
RESET	38	DI	Module reset, ***Active Low，>100ms***

Network Status Indicator

Pin Name	Pin No.	I/O Type	Description
SYS_STATUS	42	DO	Network status indication

ADC Interface

Pin Name	Pin No.	I/O Type	Description
ADC	31	AI	General purpose analog to digital converter

UART Port

Pin Name	Pin No.	I/O Type	Description
UART1_TXD	1	DO	UART: data transmission
UART1_RXD	2	DI	UART: data receiving
UART1_CTS	3	DI	Data transmission allowed
UART1_RTS	4	DO	Data transmission request

Debug Port

Pin Name	Pin No.	I/O Type	Description
UART2_TXD	43	DO	Secondary UART: data transmission,
UART2_RXD	44	DI	Secondary UART: data receiving,

RF Interface

Pin Name	Pin No.	I/O Type	Description
ANT0	25	I/O	RF antenna pad

GPIO Pins

Pin Name	Pin No.	I/O Type	Description
GPIO	33,34,35,36	I/O	Reserved and GPIO connected to the MCU

Future Function

Pin Name	Pin No.	I/O Type	Description
RESERVED	29,49,50,51,52	I/O	For future use, connected to the MCU

SPI Port

Pin Name	Pin No.	I/O Type	Description
SPI_SS	5	DO	SPI: data enable

SPI_MISO	6	DI	SPI: data receiving
SPI_MOSI	7	DO	SPI: data transmission
SPI_SCLK	8	DO	SPI: data clock
Low-power Function			
Pin Name	**Pin No.**	**I/O Type**	**Description**
WAKEUP_OUT	37	DO	Wake-up signal output from the module (if the module receives the downlink data, it can be indicated by the signal)
WAKEUP_IN	39	DI	The input signal to wakes up the module
Reference Interface			
Pin Name	**Pin No.**	**I/O Type**	**Description**
Vlog_O	41	DO	Module output digital logic reference voltage
I2C PORT			
Pin Name	**Pin No.**	**I/O Type**	**Description**
I2C_SCL	45	DO	I2C: data clock
I2C_SDA	46	IO	I2C: data
Module programming PORT			
Pin Name	**Pin No.**	**I/O Type**	**Description**
SWDIO	47	DO	Module programming: data
SWCLK	48	IO	Module programming: data clock
NC			
Pin Name	**Pin No.**	**I/O Type**	**Description**
NC	9、10、11、12、14、15、16、22、27、28、40	NA	To be expanded

Table 3-2: Module Pin Definition

4. Application Note

4.1. Power Supply Design Consideration

The power ports in the RG-IRT6110 module include:

- Port VDD_3V3 for power supply
- Port VDD_MCU for IO power level

4.1.1. Power Supply Pins

Pin Name	Pin No.	I/O Type	Description
VDD_3V3	17	PI	power supply of module: VDD_3V3 = 2.4V to 3.7V
GND	13, 18, 19, 20, 21, 23, 24, 26, 30, 32	N/A	Used for grounding

4.1.2. Reference Design

You are advised to use the Low Dropout Regulator (LDO) or battery as the power supply. It is recommended that the LDO power current be greater than or equal to 300 mA.

Energy storage capacitance must be included in the LDO output to ensure that the voltage sag in case of large current is less than 0.1 V. Suggest to use a 100uf CAP or two 22uf TAN CAP for VDD_3V3

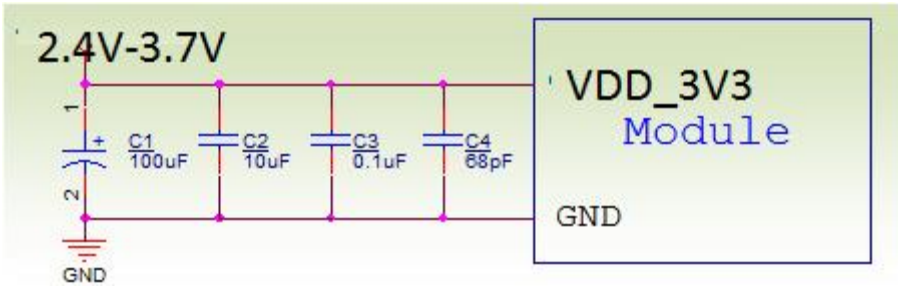

Figure 4-1: Recommended power supply circuit diagram

4.1.3. Power On and Down Sequence

4.1.3.1. Power on Sequence

The module can be automatically turned on by supplied power source to VDD_3V3 pins.

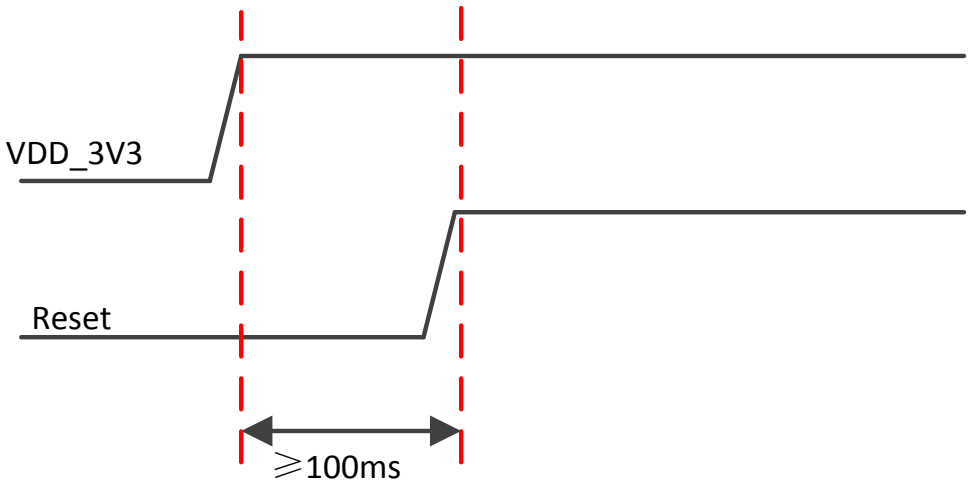

Figure4-2: Power on Sequence

4.1.3.2. Power off Sequence

The module can be automatically turned off by shut down the VDD_3V3 power supply.

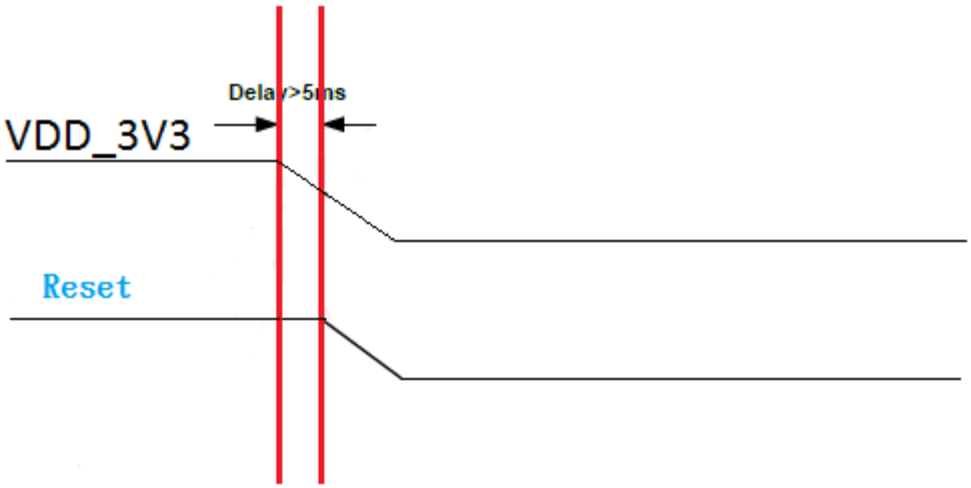

Figure4-4: Power off Sequence

4.1.4. Reset Signal

4.1.4.1. Reset Pin

Pin Name	Pin No.	I/O Type	Description
RESET	38	DI	Module reset, ***Active Low，>100ms***

4.1.4.2. Circuit Design Consideration

There is a power-on reset circuit in the module for inside MCU. If you want another MCU to control the module, you can connect the signal to your own MCU in the board for controlling the module to reset.

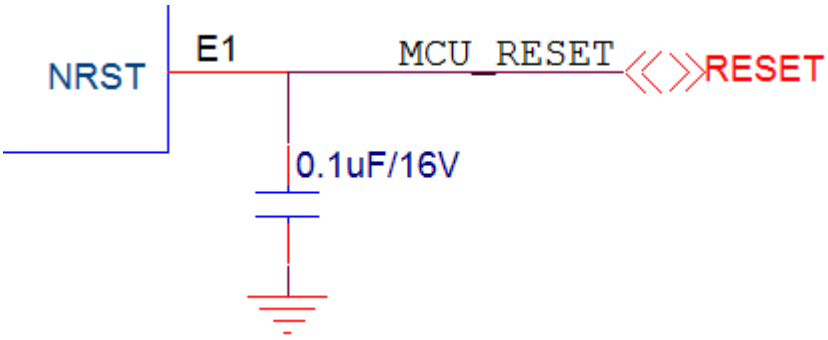

Figure4-3: Power off Sequence

4.2. UART Port

The RG-IRT6110 module provides two serial ports. UART2 is Lpuart used for module debug (using AT command), UART1 is used for serial communication with peripherals.

4.2.1. UART1 Port

UART1 is used for serial communication with peripherals as figure 4.4.1

Pin Name	Pin No.	I/O Type	Description
UART1_TXD	1	DO	UART: data transmission
UART1_RXD	2	DI	UART: data receiving
UART1_CTS	3	DI	Data transmission allowed
UART1_RTS	4	DO	Data transmission request

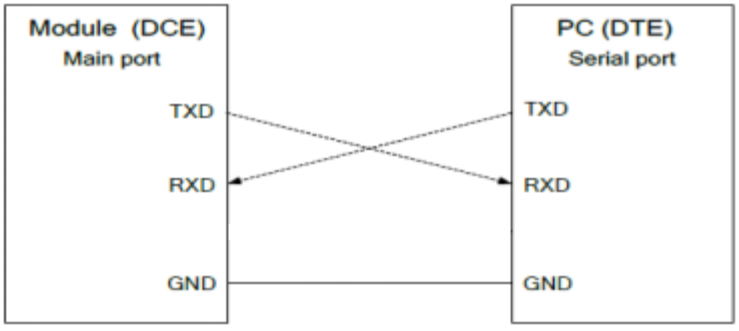

Figure4-4: Main Port Reference Connection

4.2.2. Debug Port

UART2 is used for module debug (using AT command),Debug port can only be used to capture the system's log with UE Log View tool and output the log. the reference connection is shown as figure 4.4.2. As Lpuart, UART2 also can wake up the module from sleep mode for uart tool.

Pin Name	Pin No.	I/O Type	Description
UART2_TXD	43	DO	Secondary UART: data transmission,
UART2_RXD	44	DI	Secondary UART: data receiving,

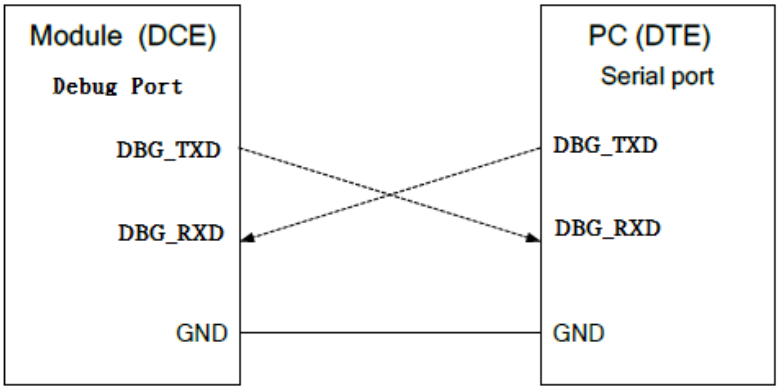

Figure4-5: Debug Port Reference Connection

4.3. ADC Port Design Considering

The RG-IRT6110 module provides a 12-bit ADC. 12-bit ADC 1.14 Msps up to 16 channels (down to 1.65 V)

Pin Name	Pin No.	I/O Type	Description
ADC	31	AI	General purpose analog to digital converter

4.4. Antenna Port Design Consideration

4.4.1. Pin Definition

ANT0	25	I/O	RF antenna pad
GND	24,26	N/A	Ground

4.4.2. Operation Band

Module	Up-link	Down-link
RG-IRT6110	470MHz to 490MHz	500MHz to 510MHz

4.4.3. Reference Design

4.4.3.1. Matching Circuit

The matching circuit is located between the passive antenna and radio frequency (RF) cable, and is used to optimize antenna standing wave parameters, to ensure that energies are effectively radiated.

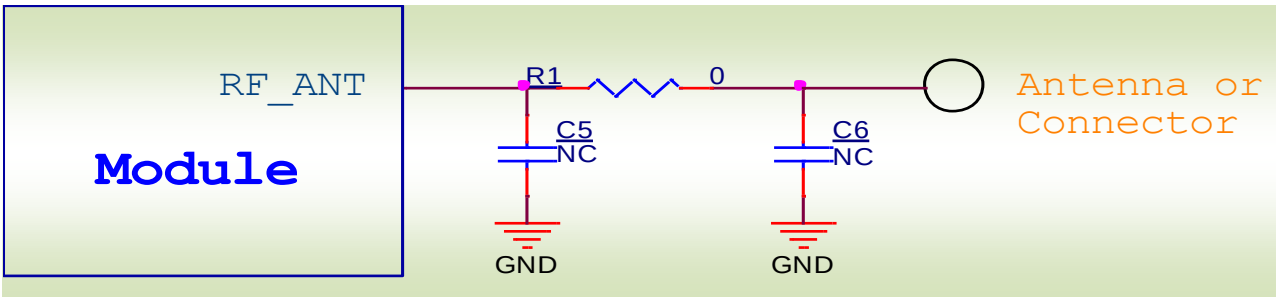

Figure4-6: Antenna Port Matching

4.4.3.2. RF_ANT to antenna RF trace PCB Design

The following lists the printed circuit board (PCB) layout design rules:

- The characteristic impedance of the transmission line must be 50 ohm.
- The PCB cable must be as short as possible to reduce antenna cable loss.
- The PCB cable must be routed as straight as possible and right-angle cable layout is not allowed. The PCB cable would be not connected to different layers through via hole.
- The PCB cable must have a good reference ground around, to avoid other signal lines close to the antenna cable without ground isolated.

4.4.4. Antenna requirements

The selected antenna must meet the following requirements:

Parameter	requirement
Frequency	470MHz~510MHz
VSWR	≤ 2
Gain (dBi)	≥ 0
Input power (dBm)	37
Input impedance (Ω)	50
Polarization type	Linear polarization

4.4.5. Operation Modes

The RG-IRT6110 module has three Operation modes, which can determine availability of functions for different levels of power-saving. That is shown as Table 4.8

The max power consumption of different mode as follow:

Item	Minimum	Typical	Maximum	Unit
TX(17±2dBm)	--	131	--	mA
Rx	--	23	--	mA
Sleep Mode	--	2.2	--	uA

Mode	Function	Description
Operation Modes	Connected_TX	① Wireless connection exists between the module and the LoRa_gateway, and uplink data is transmitted; ② The receiver does not work; ③ For the module, the maximum power
	Connected_RX	① Wireless connection exists between the module and the LoRa_gateway, and downlink data is transmitted; ② The transmitted does not work
Sleep Modes	Power Saving Mode	① the LoRa module enters the low-power mode. ② the module does not interact with the data externally. ③ When debugging, can wake up through UART2 input AT command;

5. RF Characteristic

RF parameters are defined at Module pins.

5.1. RF Transmitter Characteristics

Item	Min	Typ	Max	Unit	Comments
Maximum Transmit Power	/	17±2dBm	/	dBm	
Minimum Transmit Power	/	-136	/	dBm	125 kHz bandwidth,SF=12

5.2. RF Receiver Characteristics

Item	Min	Typ	Max	Unit	Comments
Max receivable input			10	dBm	
Sensitivity	/	-136		dBm	125 kHz bandwidth,SF=12

6. Electrical Characteristics

6.1. Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VDD_3V3	2.4	+3.7	V
Peak Current of Power Supply	0	0.15	A
Voltage at Digital Pins	-0.3	+3.3	V
Voltage at Analog Pins	-0.3	+3.3	V

Table6-1: Absolute Maximum Ratings

6.2. Operation and Storage Environment

Item	Minimum Value	Typical Value	Maximum Value	Unit
Operating temperature	–40	25	65	˚C
Storage temperature	–40	25	85	˚C
Operating Humidity	10		90	%
Storage Humidity	10		90	%

Table 6-2 Operation and Storage Environment

7. ESD

The module has no electrostatic discharge (ESD) protection measures, and its sensitive pins need external ESD protection. Appropriate ESD measures need to be added during the manufacturing/transporting/operation stages.

The table below shows the ESD requirements for the module.

Pin	Contact Discharge	Air Discharge	Unit
VDD_3V3	±5	±10	KV
ANT	±4	±8	KV
Other ports	±0.5	±1	KV

Table 7-1: ESD requirements for the RG-IRT6110 module

8. EMC

The signal integrity and power integrity issues caused by electromagnetic compatibility (EMC) need to be considered when you use the module to design. Below are some suggestions:

- The coupling of the module and other digital chips must be deployed remotely as far as possible, in order to avoid mutual interference.
- The power supply (CSS), clock, high-speed digital signals, EMI components, and RF simulation parts must be deployed remotely as far as possible.
- The CSS, clock, high-speed digital signals, EMI components, and antennas must be coupled remotely as far as possible in space.
- During cabling routing, RF reference ground, digital and analog areas should be separated, and all cables are routed in compliance with specified requirements to avoid mutual coupling between lines.
- The decoupling capacitor is placed near pins.

9. Package Description

23.6x19.9mm LGA Package Information from the TOP:

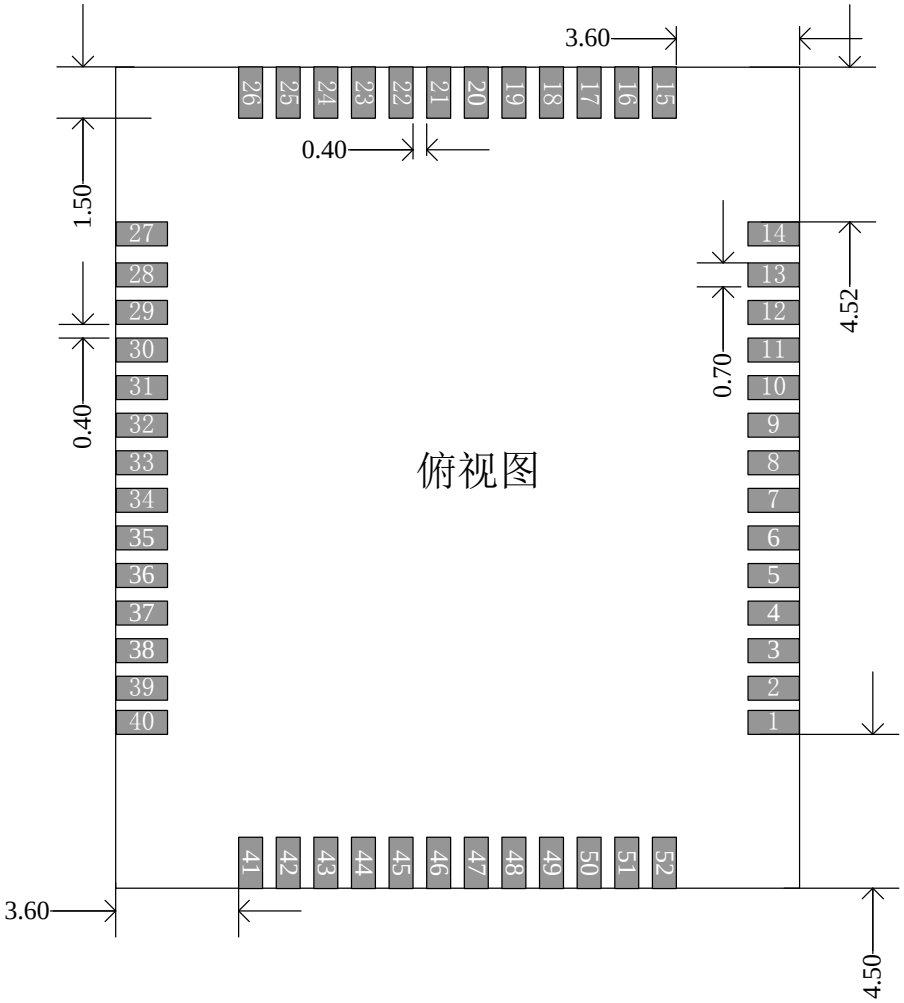

Figure 9-1: Package Information from Top

10. Recommend Reflow Profile

TPB-21 reflow profile	Min	Typ	Max	Unit
Temperature T_1	150			℃
Temperature T_2			200	℃
Temperature T_L		217		℃
Temperature T_p			260	℃
Time ts (T_1 to T_2)	60		120	sec
Time t (above T_L)	60		150	sec
Ramp Up Rate T_L to T_p			3	℃
Ramp Down Rate T_p to T_L			6	℃

Table 10-1: Reflow Profile Parameter

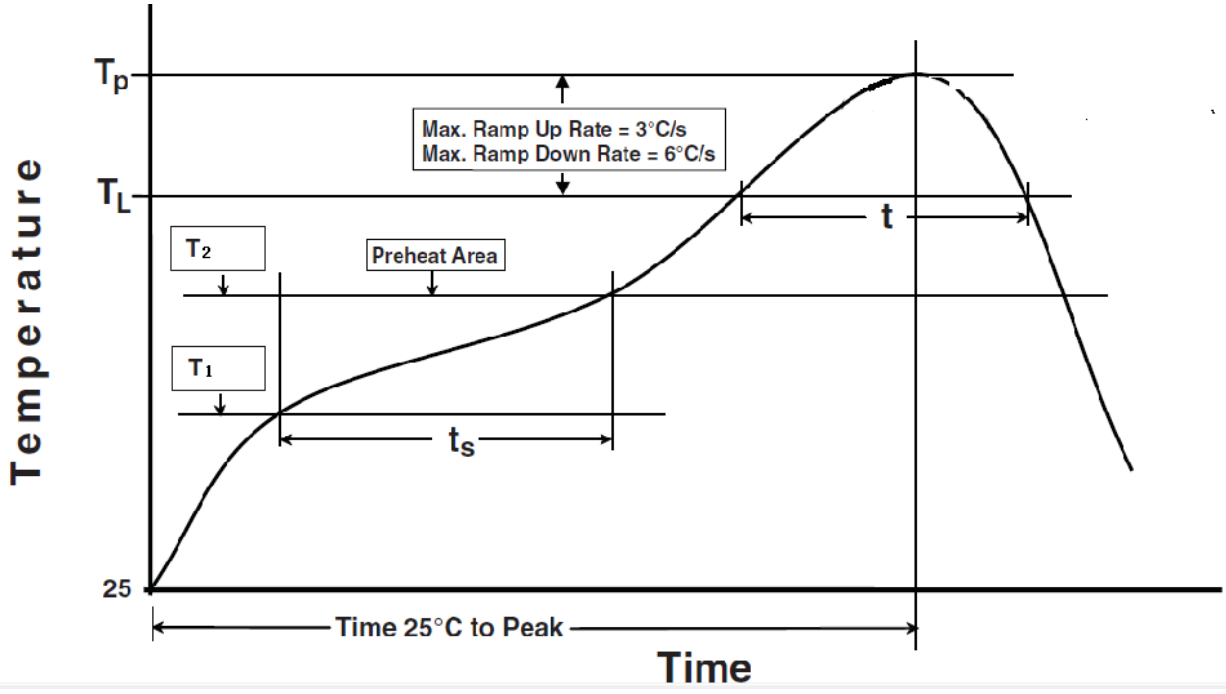

Figure 10-1: Reflow Soldering Thermal Profile

11. Product Information

Model	It displays the model name of the device.
SN	The serial number of the device.
IMEI	The IMEI number is used by a GSM network to identify the device.
D/C	It shows the date code that is used to identify when the device is being manufactured.

12. Ordering Information

Part Number	Description	Package Type	Operation Temp.
RG-IRT6110	470MHz-490MHz (Uplink) 500MHz-510MHz (Downlink)	Reel	-40~65℃

13. Acronyms or Abbreviations

AI	Analog Input
DI	Digital Input
DO	Digital Output
EMC	Electromagnetic Compatibility
EPC	Evolved Packet Core
ESD	Electrostatic Discharge
EVK	Evaluation Kit
LDO	Low Dropout Regulator
LoRa-IoT	Narrowband Internet of Things
RF	Radio Rrequency
UART	Universal Asynchronous Receiver/Transmitter
USIM	Universal Subscriber Identity Module