RF-2400PA

High-Performance 20dBm 2.4GHz RF Module Datasheet

1、Overview

RF-2400PA is on the basis of RF-2400 series module from INHAOS, consist a 20dBm 2.4G RF PA modules, suitable for long-distance communication.

RF-2400PA adopts the BK2421 chip, is completely identical with the interface sequence of RF-2400 P/W, with a stronger power supply(power supply need 3.3V & 300mA), the user can directly use RF-2400PA replace RF-2400P or RF-2400W, without making any changes.

RF-2400PA can communication with RF-2400 and RF-2410 series product which has launched by INHAOS.

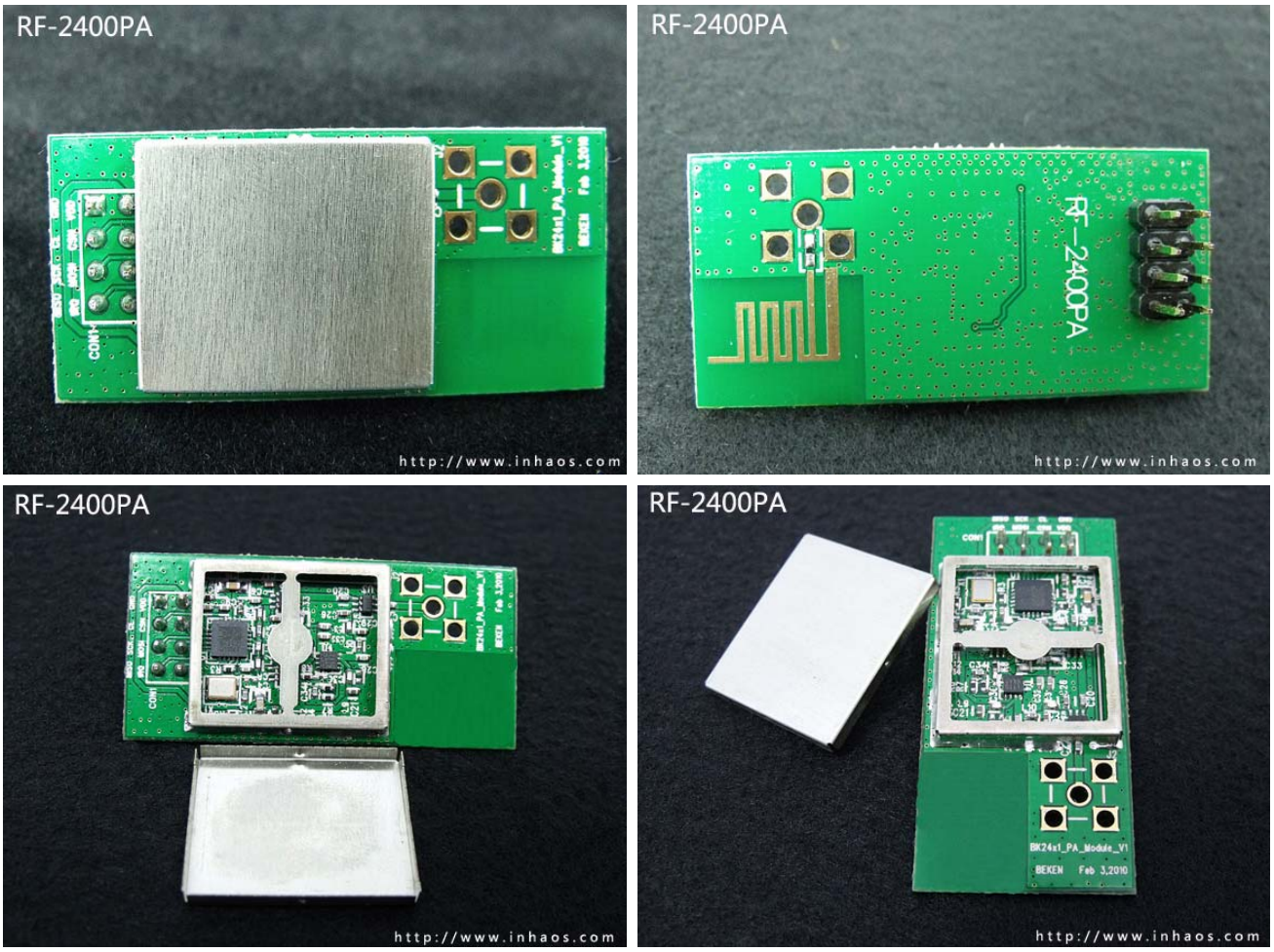
RF-2400PA module have a onboard PIFA antenna and a SMA connector, users can through a 0R resistor choose to use PIFA antenna or SMA external antenna, PIFA antenna efficiency slightly low, but the basic do not take up space, SMA external antenna gain high, communication distance is farther.

V1.1 2012-4-9: User need to modify 3 values in BANK1, please see chapter 7.

2、Features

- RF-2400PA provide two antenna connectors: on-board PIFA antenna or external 50Ohm antenna through the SMA
- Operation band: 2400-2483.5MHz ISM band
  Transmission rate: 1Mbps or 2Mbps
- Maximum output power: > 23dBm
- Antenna max input power: + 5dBm
- Valid data length of Receive/Transmit 1 ~ 32 bytes
- 6 data pipes for 1:6 start network
- Power supply 1.9 V-3.6 V, prefer power supply: 3.3V 300mA
- SPI interface with maximum 8MHz clock
- adopt the GFSK modulation significantly improves the sensitivity of the chips
- By control BK2421 power, realized the output power adjustment, the maximum output 22 dBm
- Consumes 17mA at 1 Mbps with Receive mode
- Consumes 3uA for POWERDOWN mode, 50uA for standby-I mode
- Open transmission distance of about 300 m (for reference only)
- Can be directly replace RF-2400P/W (attention: the power supply need be able to provide more than 300mA current)
- Onboard RF switch, do not need MCU to process it

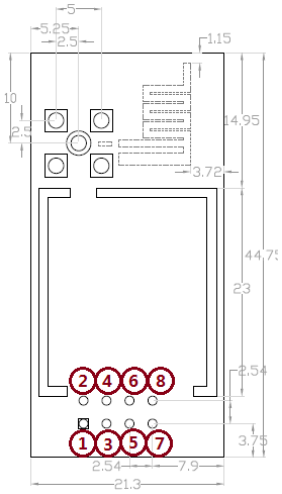
3、Physical picture of RF-2400PA



4、Applications

Wireless access system
Fire & Security system
Remote control device
Intelligent toys
Telemetry
Car alarm
Industrial sensors
Wireless data communication
Intelligent sports equipment
Wireless mouse, keyboard, game joystick

5、RF-2400PA Module Pin Information

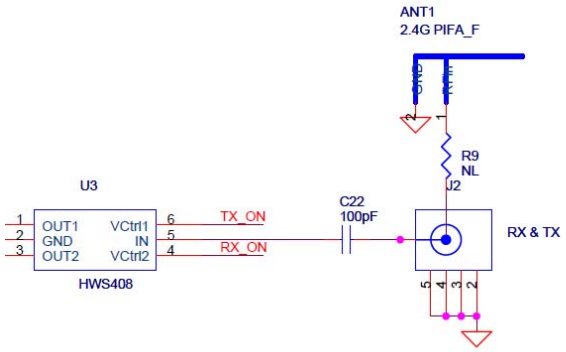


RF-2400PA Pin Information

No.	Name	Function Description
1	GND	Ground (0V)
2	VCC	Power Supply，3.3V 300mA
3	CE	Chip Enable, active RX/TX mode, low active
4	CSN	SPI chip select
5	SCK	SPI clock
6	MOSI	Master output, Slave input
7	MISO	Master input, Slave output
8	IRQ	Maskable interrupt pin, Active low

6、Antenna selection

RF-2400 PA choose the antenna through 0R resistor, the user can choose on-board PIFA antenna or external SMA antenna.

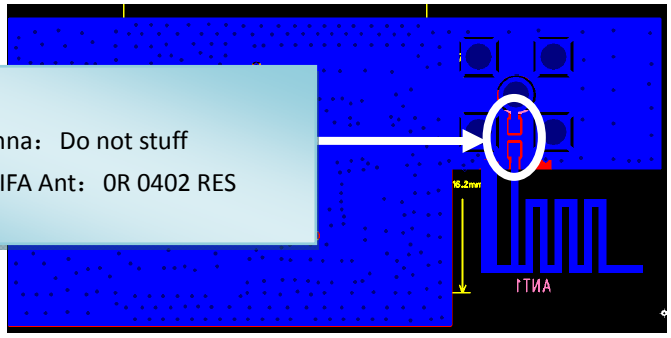


Antenna output part shown in the circuit diagram.
RF signal is coupled to the J2 SMA connector through the C22 100pF, and connected to the on-board PIFA antenna through the R9.

When need on-board PIFA antenna, solder a 0R resistor in R9, In this case, the SMA connector can't connect any external load, otherwise, it will destroy the antenna impedance matching.

When need external SMA antenna, must remove R9, please avoiding two antennas hanging on RF output circuit at the same time.

R9：
Use SMA Antenna： Do not stuff
Use Onboard PIFA Ant： 0R 0402 RES



Notes:

J2 SMA connector is not the standard configuration, when sold, this position is blank, if need to buy SMA connector, please contact us.

Default R9 sold with solder 0R resistor, the user can directly use on-board PIFA antenna, if the user don't need solder this resistance, please contact us before purchasing.

7、BANK0 and BANK1 Modify

In order to smooth the use of RF - 2400PA , please make the following changes on the BANK1 :

```
const  UINT8  Bank1_Reg0_13[14][4]={
//Low byte first
        {0x40,      0x4B,      0x01,      0xE2},
        {0xC0,      0x4B,      0x00,      0x00},
        {0xD0,      0xFC,      0x8C,      0x02},
        {0xf9,      0x00,      0x39,      0x41},  //for  PA
        {0xC1,      0x9E,      0x9A,      0x0B},  //for  PA

        {0x24,      0x06,      0x7F,      0xA6},
        {0x00,      0x00,      0x00,      0x00},
        {0x00,      0x00,      0x00,      0x00},
        {0x00,      0x00,      0x00,      0x00},

//High byte first
        {0x00,      0x00,      0x00,      0x00},
        {0x00,      0x00,      0x00,      0x00},
        {0x00,      0x00,      0x00,      0x00},
        {0x00,      0x12,      0x73,      0x00},
        {0x36,      0xB4,      0x80,      0x00},
};

const  UINT8  Bank1_Reg14[]=
{
        0x41,0x20,0x08,0x04,0x81,0x20,0xCF,0xF7,0xFE,0xFF,0xFF
};
```

Power configuration not more than 0dBm

```
const  UINT8  Bank0_Reg[BANK0_REG_LIST_CNT][3]={
    {CONFIG, 0x0F}, //Power  up,  PRX
    {EN_AA, 0x00}, //Disable  all  pipe  Auto  ACK
    {EN_RXADDR, 0x01}, //Enable  data  pipe  0
    {SETUP_AW, 0x03}, //Address  width  =  5Bytes
    {SETUP_RETR,0x1f}, //Retransmit,  =  500us,  15 次
    {RF_CH, 20}, //Channel
    {RF_SETUP, 0x05}, //1Mbps  data  rate,  output  power=0dBm
    {STATUS, 0x70}, //
    {OBSERVE_TX,0x00},
    {CD, 0x00},
    {RX_ADDR_P2,0xc3},
    {RX_ADDR_P3,0xc4},
    {RX_ADDR_P4,0xc5},
    {RX_ADDR_P5,0xc6},
    {RX_PW_P0, 0x20},
    {RX_PW_P1, 0x20},
    {RX_PW_P2, 0x20},
    {RX_PW_P3, 0x20},
    {RX_PW_P4, 0x20},
    {RX_PW_P5, 0x20},
    {FIFO_STATUS,0x11}
};

const  UINT8  Bank0_RegAct[BANK0_REGACT_LIST_CNT][2]  =  {
    {DYNPD, 0x01}, //Enable  pipe  0,  Dynamic  payload  length
    {FEATURE, 0x04} //EN_DPL=  1,  EN_ACK_PAY  =  0,  EN_DYN_ACK  =  0
};
```

8、Adjust output power

RF-2400PA is based on RF-2400P, add a RF PA with fixed gain, user can change the BK2421 power registers to change the output power.

The typical gain of RF PA is 26 dB, different power supply lead to different gain, the following is RF-2400PA module actual output power with different power supply.

The maximum power output of BK2421 is + 5dBm, in this case, the RF PA output level will be overload, in actual application, user should avoid output + 5dBm, limit the output power less than 0dBm. In order to ensure that the RF PA can work stable.

Power supply(V)	BK2421PA level	Power(dBm)	2nd hamonic(dBm)	3rd hamonic(dBm)	current(mA)
3.6V	3	22.7	-24.4	-32	200
	2	22.3	-27	-34	187
	1	18.2	-36	-50	160
	0	13	-45	-50	139
3.3V	3	21.3	-27.1	-30	167
	2	20.6	-29.7	-33	154
	1	17.2	-36.2	-48	119
	0	13.2	-42.6	-51	99
3V	3	20.8	-28	-29	157
	2	20	-31	-32	143
	1	16	-34	-49	93
	0	12	-42	-51	74
2.7V	3	19.2	-25	-28	128
	2	16	-26	-31	87.6
	1	7.5	-30	-41	51
	0	5	-36	-47	35

9、Notes

INHAOS has full RF matching and debugging on the RF-2410PA to ensure the best performance , in the applications, users still need to pay attention to the following items:

9.1: about the power supply

RF-2400 series of typical voltage supply is 1.9 ~ 3.6 V, in actual use, we suggest using 3.3 V power supply voltage, and ensure that can provide more than 300mA of the current.

9.2： About the interface levels

Module of IO level compatible both TTL and CMOS stand, if want to use 5V system, we suggest series 100 ohm resistor to IO port for overload protect.

9.3： RF modules position in the machine

In the overall layout, make sure no metal objects 10mm around the antenna. It's better to right point to RF receiving or transmitting direction. Module should be placed horizontally in the machine

9.4：About PCB design

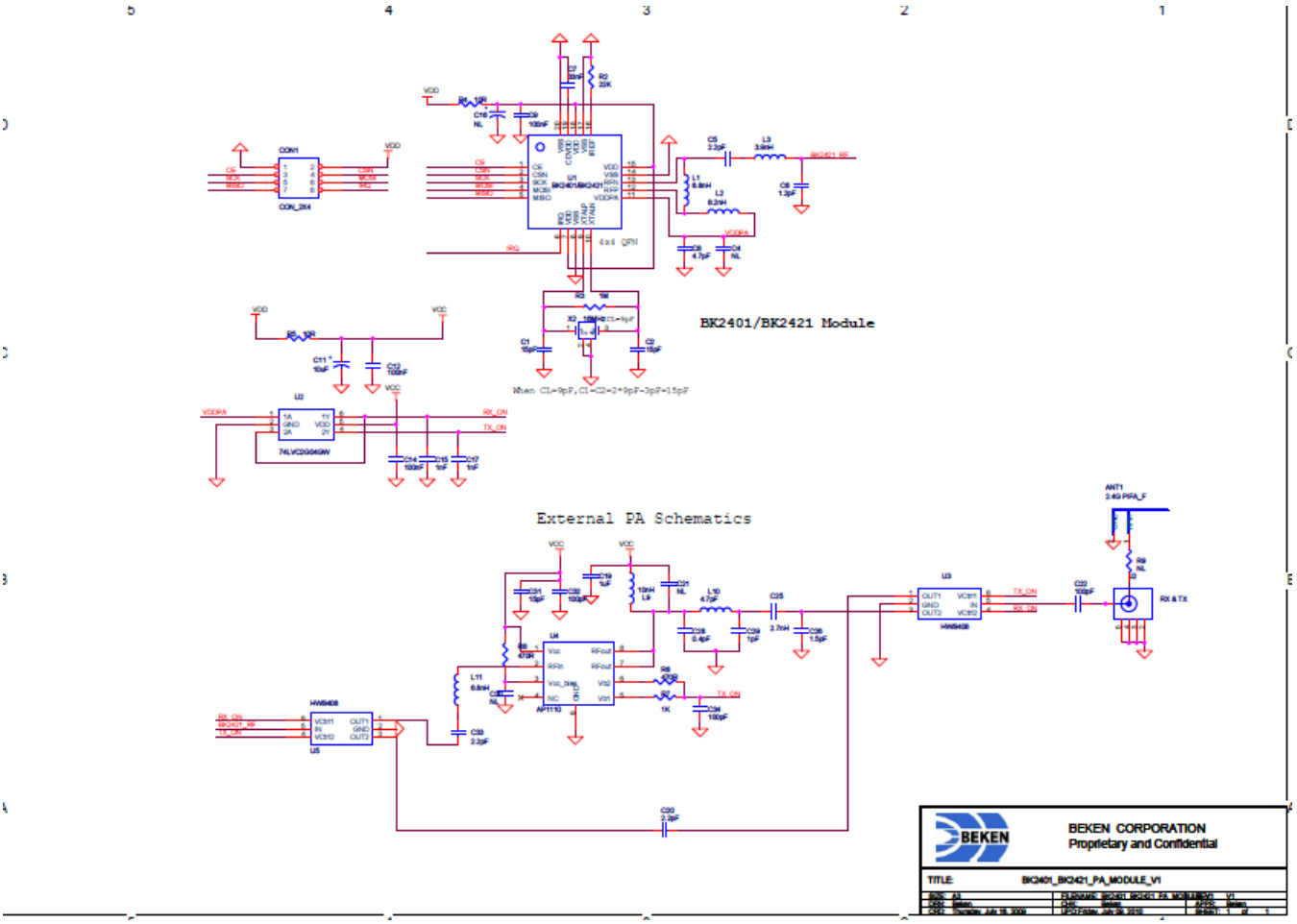
In the PCB design, no part or circuit can be placed under the antenna. It must be emptied with no copper..

10、Electrical parameters

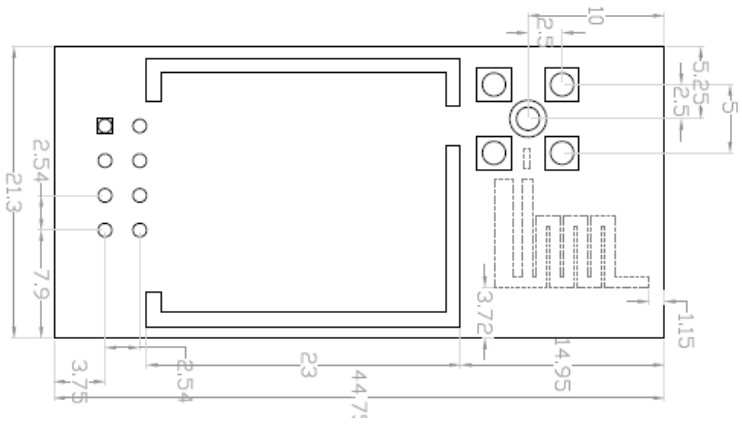
Name	Parameter	Min	Typical	Max	Unit	Comment
	Operating Condition					
VDD	Voltage	1.9	3.3	3.6	V	3.3V is best
TEMP	Temperature	-40	+27	+86	°C	
	Digital input Pin					
VIN	High level	0.7VDD		5.25	V	
VIL	Low level	VSS		0.3VDD	V	
	Digital output Pin					
VOH	High level(IOH=-0.25mA)	VDD-0.3		VDD	V	
VOL	Low level(IOL=0.25mA)	0		0.3	V	
	Normal Condition					
IVDD	Power Down current			3	uA	
IVDD	Standby-I current			50	uA	
IVDD	Standby-II current			400	uA	
	Normal RF condition					
FOP	Operating frequency	2400		2527	MHz	
FXTAL	Crystal frequency		16		MHz	
RFSK	Air data rate	1		2	Mbps	
	Transmitter					
PRF	Output power	-20	20	23	dBm	
PBW	Modulation 20dB bandwidth(2Mbps)		2.5		MHz	
PBW	Modulation 20dB bandwidth(1Mbps)		1.3		MHz	
PRF1	Out of band emission 2MHz		-20		dBm	
PRF2	Out of band emission 4MHz		-40		dBm	
IVDD	Current at -40dBm output power		TBD		mA	
IVDD	Current ata-30dBm output power		TBD		mA	
IVDD	Current ata-30dBm output power		TBD		mA	
IVDD	Current ata-25dBm output power		TBD		mA	
IVDD	Current ata-10dBm output power		TBD		mA	
IVDD	Current ata-0dBm output power		TBD		mA	
IVDD	Current ata-5dBm output power		TBD		mA	
	Receiver					
IVDD	Current(2Mbps)		TBD			
IVDD	Current(1Mbps)		TBD			
Max_Input	1E-3 BER		10			
RXSENS	1E-3 BER sensitivity(2Mbps)		-82			

RXSENS	1E-3 BER sensitivity(1Mbps)		-85			
C/ICO	Co-channel C/I(2Mbps)		4			
C/I1ST	ACS C/I 2MHz(2Mbps)		-5			
C/I2ND	ACS C/I 4MHz(2Mbps)		-20			
C/I3RD	ACS C/I 6MHz(2Mbps)		-25			
C/ICO	Co-channel C/I(1Mbps)		4			
C/I1ST	ACS C/I1MHz(1Mbps)		4			
C/I2ND	ACS C/I 2MHz(1Mbps)		-18			
C/I3RD	ACS C/I 3MHz(1Mbps)		-19			

11、Schematic



12、RF-2400PA Mechanical Dimensions (Unit: mm)



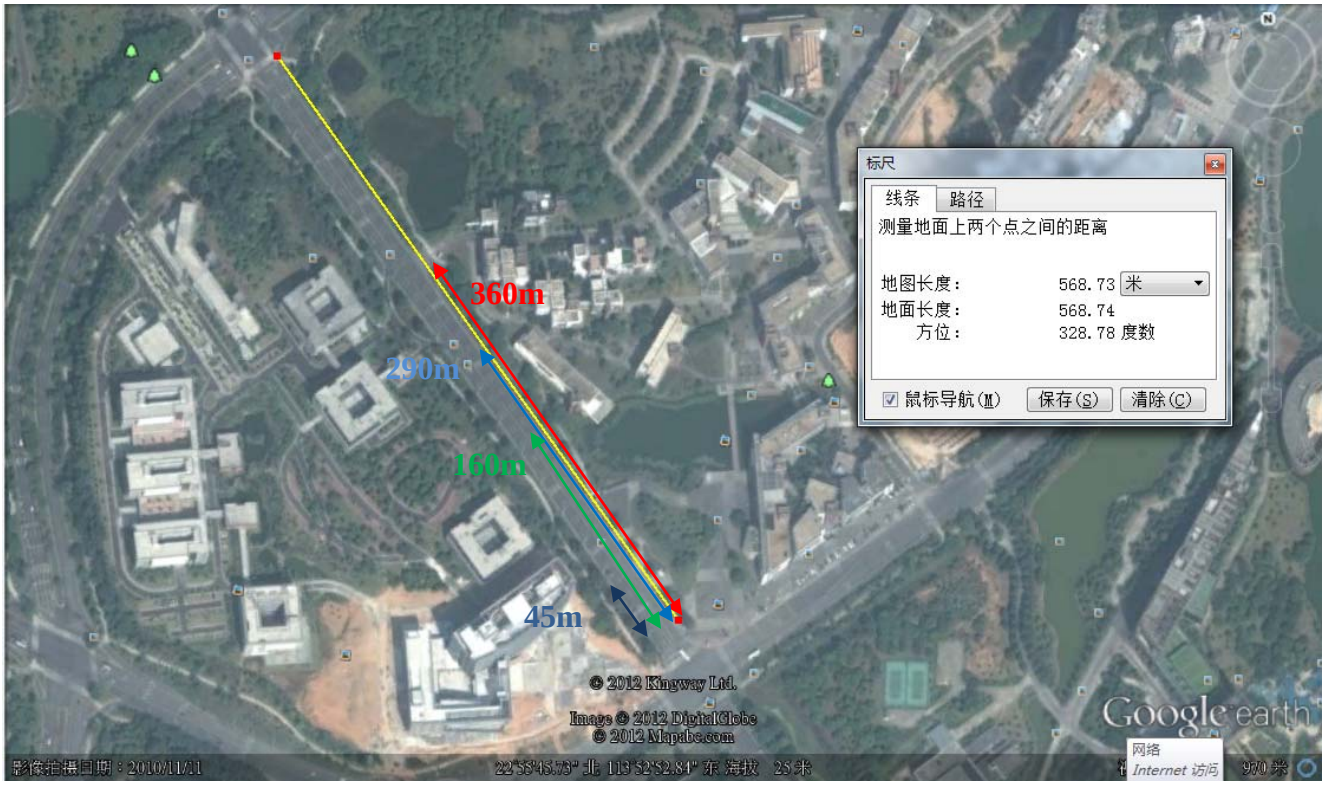
13、Recommended SMA antenna

Here we used for testing SMA antenna, test results please see Chapter 14

1, 5dBi SMA Antenna , INHAOS Part number: **AT2400-1901RS-5dBi**

2, 2dbi Antenna , INHAOS Part number: **AT2400-0101RS-2dBi**

14、RF-2400PA Distance test



Test condition:

Outdoor, face to face , 1Mbps , Enable Auto ACK , Max resent = 15

Test Result:

360 m	RF-2400PA with 5dBi SMA Antenna
290 m	RF-2400PA with 2dBi SMA Antenna
160 m	RF-2400PA Onboard PIFA Antenna
45 m	RF-2400P with Onboard PIFA Antenna

Important Note:

1 , the test is carried out in outdoor open environment conditions , the practical application of use in different environments may cause the distance difference .

2 , This test is carried out in a fixed location and face-to-face conditions, if the module is in motion , may result in very different distance .

3 , the test is the basic communication test , plus a reasonable software retransmission protocols and frequency hopping anti-jamming protocol , the distance a very good improvement .

15、Reference

1, RF-2400 series module manual——C51
2, RF-2400 series module manual——avr
3, External PA Reference Design for BK2401_BK2421_V1.0
4, BK2401_BK2421Hardware Reference Designv3.0

16、Revision History

Version	Date	Page	Description
V10	2012-2-20		initialize
V11	2012-4-9		1, Modify BANK0 and BANK1 value 2, Add SMA Antenna information 3, Add distance test result

Declare

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