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Application Note

HW2171B Hardware Reference Design

revise history

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V1.0	2018-08-09 First edition	
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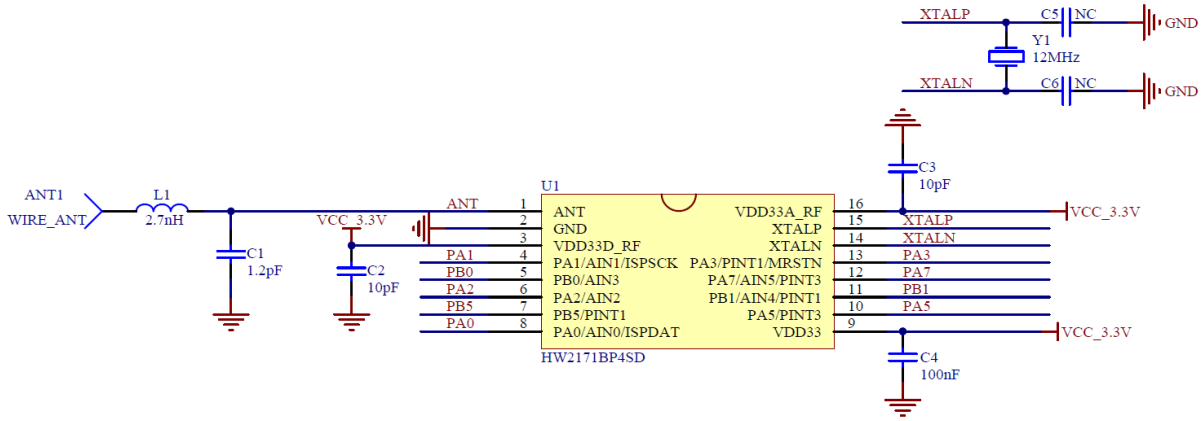
The first 1 Chapter schematics Reference Designs

HW2171B It is a highly integrated 2.4GHz wireless SOC Chip, on-chip integration of high-performance, low power consumption RF Transceivers and 8 Place OTP of MCU . Design principles given below with reference to FIG.



Map 1-1 HW2171B EVB SCH

HW2171B Reference circuit design system consists of a crystal oscillation circuit, RF matching network, and a digital power supply decoupling network IO Four parts, peripherals need only 6 Passive components can be composed of a wireless transceiver system completed.

Crystal oscillation circuit support 12MHz , 16MHz Passive crystal. Depending on application requirements, crystal selecting principle is as follows: crystal frequency tolerance (Frequency Tolerance), The smaller the frequency difference between the two transceivers, the telecommunications will significantly improve the success rate. So please try to use long-distance application tolerances passive crystal, recommended tolerance of ± 10ppm The passive crystal. Both sides of the crystal load capacitance not need to connect only to fine tune some of the more demanding applications in the frequency requirements, it is necessary to increase the capacitance. But note that the General Assembly lead crystal capacitance too weak, due to the different crystal parameters of different manufacturers, so the specific value to be determined by the actual debugging.

RF front-end RF matching network to complete the main harmonic suppression signal, the antenna terminal impedance matching functions, the selection of some components **It would have a greater impact on the communication, the RF front end L1 Inductance C1 Please try to use high capacitance Q High-frequency component value. have to be aware of is RF Matching parameters, there are two options, as shown in the following table:**

Program	L1	C1	Explanation
Inductance program	2.7nH	1.2pF	Only support wire antenna, emission power
Capacitance program	100pF	1.5pF	Support wire and PCB Antenna, transmission power smaller

table 1-1 RF Matching network parameter table element

HW2171B There are three sets of power, respectively, VDD33A_RF , VDD33D_RF with VDD33 , The first two groups belong RF section Power supply, the latter group belong MCU Part of the power, three inside the chip is not connected, an external connection needed. Power decoupling capacitors to filter out interference signals on the power supply.

Also, note that, PA3 Only do input, internal pull-up resistor only, no pull-down resistor.

Given below reference design BOM table:

Part	Designator	Footprint	Description
1.2pF	C1	0603	COG , ± 0.25pF
10pF	C2 , C3	0603	COG , ± 0.25pF
100nF	C4	0603	X7R , ± 10%
2.7nH	L1 Note	0603	Frequency multilayer inductors, ± 0.3nH
12MHz	Y1	-	Line passive crystal, ± 10ppm
HW2171B	U1	SOP16	2.4G SOC chip
IDC8	XS1	DC12	2.54mm Double-pin socket

table 1-2 HW2171B EVB BOM

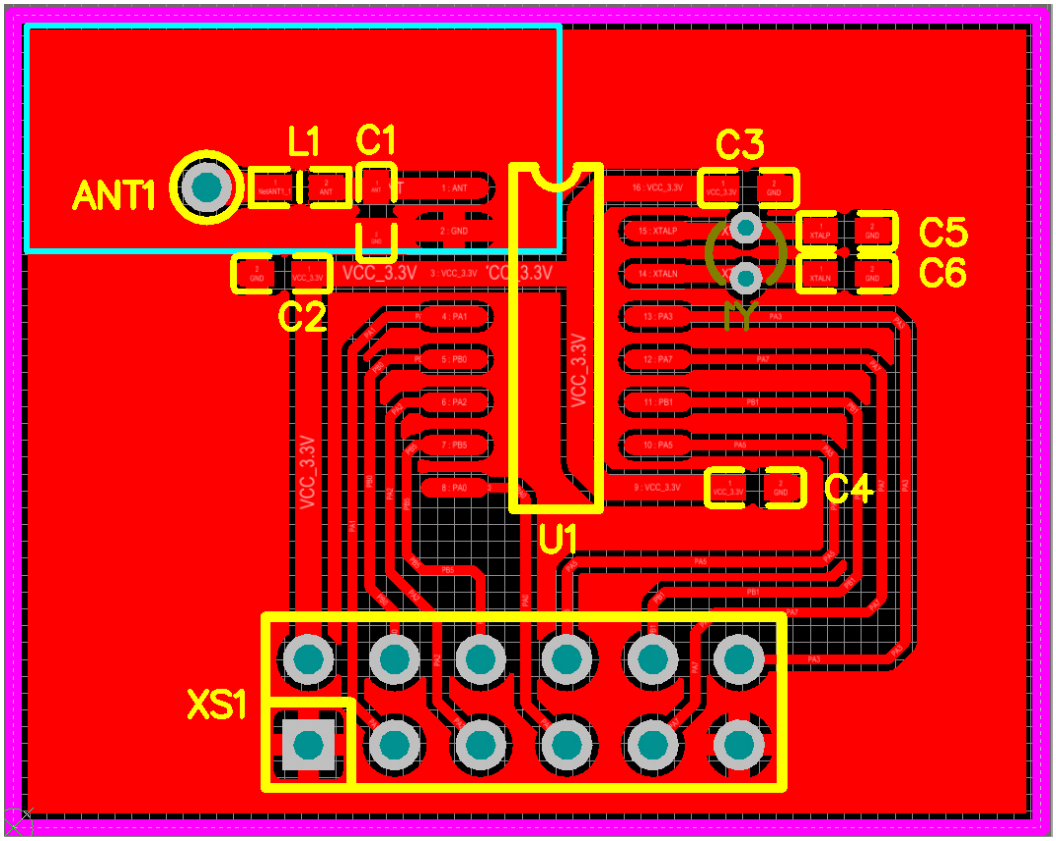
Note:(1) L1 Value of 2.7nH Inductance embodiment, only used for non-grounding wire antenna, and if a grounded PCB Antenna connection, capacitive scheme is recommended.

The first 2 chapter PCB Reference Design

twenty one Single panel PCB

HW2171B of PCB To dual panel, may be low-cost single panel. The former has a better performance, the latter

Low cost, but slight degradation in performance, but also for PCB The layout have higher requirements. Referring single panel design is given.



Map 2-1 HW2171B Single panel PCB

Single panel PCB Design Design Considerations:

1) Require special attention, RF components ANT1 , L1 with C1 Alignment between the straight line as much as possible and as short as possible, it is recommended A direction along the pin, not perpendicular to the pin direction. chip ANT foot(PIN1) Traces must go through C1 Before connecting L1 . C1 Chip capacitor as close as possible ANT foot(PIN1)with GND foot(PIN2).

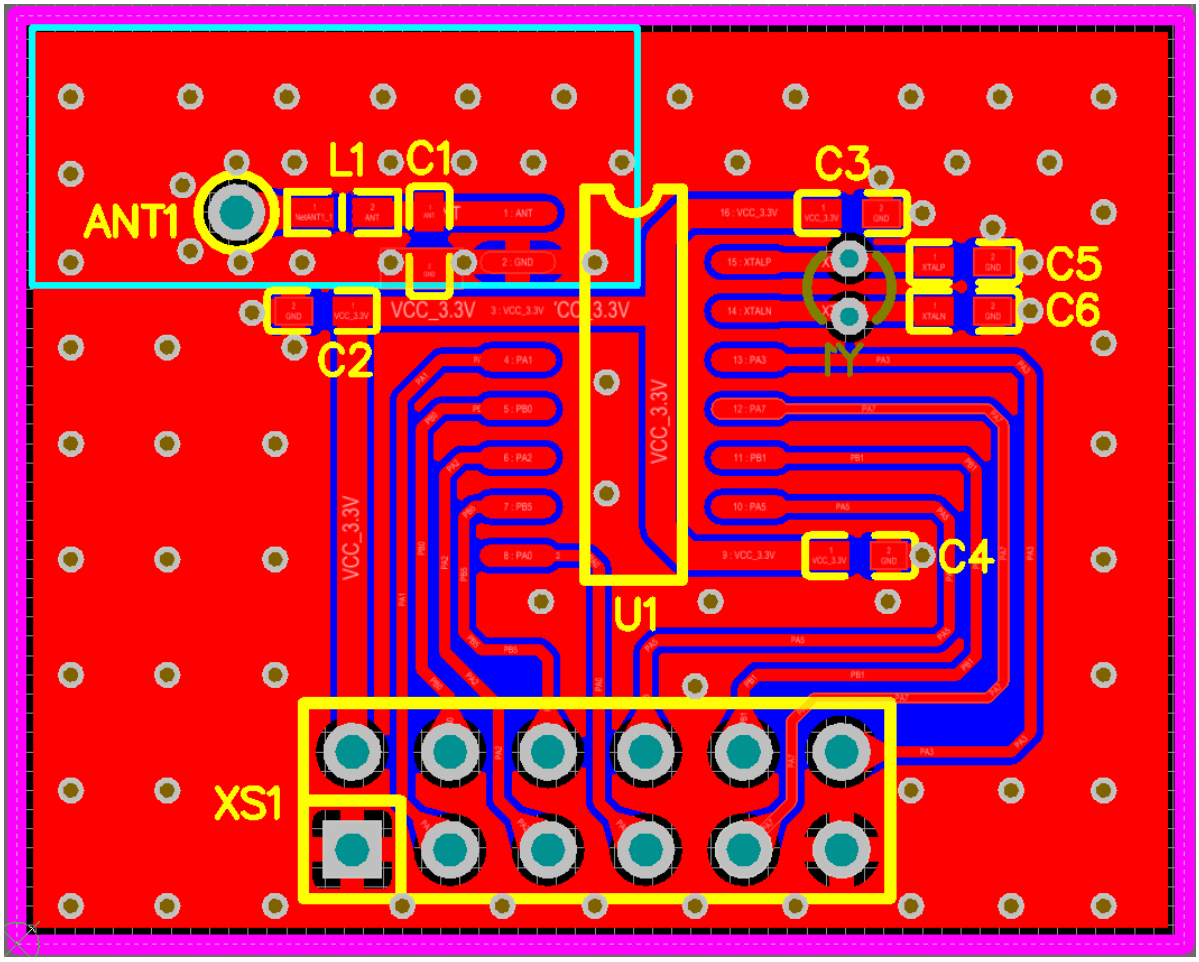
2) Since only one single-sided wiring layer, no separate ground plane, the ground plane of the area should be increased as much as possible, in particular, Chip GND foot(PIN2 Between the ground plane) and the RF circuit. Special attention is required, the RF ground plane (blue border region) need to maintain integrity in this region can only be paved, traces prohibited.

3) As far away from the crystal oscillation circuit and the digital RF circuit.

4) Filter capacitor C2 , C3 , C4 As close to the power pins.

twenty two Double panel PCB

According to FIG. 1-1 Typical Application Reference Design SCH FIG, can draw the corresponding PCB Fig. Referring dual-panel design is given.



Map 2-2 HW2171B Double panel PCB

Double panel PCB Design Design Considerations:

1) Require special attention, RF components ANT1 , L1 with C1 Alignment between the straight line as much as possible and as short as possible, it is recommended A direction along the pin, not perpendicular to the pin direction. chip ANT foot(PIN1) Traces must go through C1 Before connecting L1 . C1 To close as possible 1 Feet and 2 foot.

2) To ensure that the bottom of the RF circuit is complete ground plane (blue border region), the top and bottom in this zone is prohibited Traces, only paved ground, the area should be as large as possible. Further, the RF circuit should be around "the bag", and placed a number of ground vias to reduce the impedance ground plane. If the power of the digital portion of the bottom have to travel, to consider the alignment of the split ground plane should be as small as possible, and as far away from the RF circuit.

3) As far away from the crystal oscillation circuit and the digital RF circuit.

4) Filter capacitor C2 , C3 , C4 As close to the power pins.

The first 3 Zhang plate-making process

Due to the presence of high-frequency circuit, in the plate-making process needs to be considered PCB Factory impedance control parameters. Given below is a double panel making process parameters. Single panel due to the small layer of reference, the performance will decline, but still recommended the following design parameters.

Specifications plate	parameter
Sheet	FR4
Thickness Note	1.0mm
Power traces	25mil or 30mil
50 Ohm radio frequency trace width Note	20mil
Copper thickness	1.4mil (1 ounce)
RF ground laying pitch copper traces Note	5.3mil

table 3-1 PCB Platemaking process parameters

Note: To ensure alignment as radio frequency 50 Ohms, can be adjusted according to different thickness according to the following parameters. The following results Si9000 Simulated values for reference purposes only. Simulation hypothesis FR4 The dielectric constant 4.3 , Dielectric constant green oil 4.2 These parameters greater impact on the simulation results, the specific parameters please PCB The simulation confirmed the manufacturers themselves. If you need more accurate results, you need to PCB Manufacturers impedance test. It should be noted that, due to some PCB Limiting the plant process, which can do security thread pitch 6mil Above, therefore, in this case, the line spacing can be defined as 6mil or 7mil , Line width 20mil the above. Here are the recommended parameters of different thickness.

(1) If using the RF traces 20mil Width:

Thickness of 1.0mm When, plated copper ground trace spacing 5.3mil

Thickness of 1.2mm When, plated copper ground trace spacing 5.1mil

Thickness of 1.6mm When, plated copper ground trace spacing 5mil

(3) If using the RF traces 25mil Width:

Thickness of 1.0mm When, plated copper ground trace spacing 6.3mil

Thickness of 1.2mm When, plated copper ground trace spacing 6mil

Thickness of 1.6mm When, plated copper ground trace spacing 5.7mil

(3) If using the RF traces 30mil Width:

Thickness of 1.0mm When, plated copper ground trace spacing 7.6mil

Thickness of 1.2mm When, plated copper ground trace spacing 7.1mil

Thickness of 1.6mm When, plated copper ground trace spacing 6.6mil

The first 4 Chapter transmitter spurious radiation test

4. 1 FCC Spurious radiation emission certification test specification

for FCC Authentication, radiated spurious emission (hereinafter referred to as RSE) Value of the test signal power detection system may employ two kinds of acquiring: peak detection and average detector. The so-called average value detection means in the normal product to be tested to transmit data within a unit time is measured Average transmit signal power $P_{Average}$, And peak detector means the products being tested in the normal transmission data, the transmission signal measured projection hair(Burst) Maximum power P_{Peak}. according to FCC Certification standards, radiation in space 3 Meters away P_{Peak} Must not exceed 74dBuv / m , $P_{Average}$ Not exceed 54dBuv / m . Of particular note, according to FCC Certification specifications, product data should be transmitted in the normal Down test mode, rather than using a single carrier signal transmission test. by FCC Certification specifications can be seen, P_{Peak} And the upper limit $P_{Average}$ The upper limit of the difference is 20dB However, for the actual product, since the transmission of different data interval, the transmitter is turned on / off time Different ratios (i.e. different duty cycle), resulting in an actual P_{Peak} with $P_{Average}$ The difference is not 20dB . In general, can be measured by The amount of the transmitter is turned on, turn-off time, estimated according to the following formula:

$$P_{Average} = \frac{T_{ON}}{T_{ON} + T_{OFF}} P_{Peak}$$

among them, T_{ON} Opening time for the transmitter, T_{OFF} Off time for the launching authority, $P_{Average}$ It is the average power, P_{Peak} Peak Value power. For example, if T_{ON} = 2 ms , T_{OFF} = 0.5 ms , I.e. open, the duty cycle off-time is 4: 1 ,then $P_{Average} = 0.8 P_{Peak}$.

As described above, we will be appreciated that, if a continuous emission single carrier, since the maximum power is continuously transmitted, the measured $P_{Average} \approx P_{Peak}$, Usually occurs at this time P_{Peak} Value can be certified, and $P_{Average}$ Value can not be certified phenomenon. In addition, as If in the case of normal transmission data also appeared P_{Peak} Value can be certified, and $P_{Average}$ The value of the case can not be certified, you need to enter Further reduction in average power $P_{Average}$ Which to achieve this is to further reduce the transmitter on / off duty ratio. For example, you can increase Plus data transmission time interval (increasing the off time of the transmitter), or reduce the emission time data (transmitter ON time is reduced) and the like.

4. 2 CE Spurious radiation emission certification specification

for CE Certification, RSE Only the power of the test signal P_{Peak} Value is defined. according to CE Certification standards for 2.4G product of RSE , Which requires space radiation 3 Meters away P_{Peak} The upper limit value of the peak signal - 30dBm . have to be aware of is, CE with FCC Correct to RSE Signal strength test units are different, the former is dBm The latter is dB μ v / m The need for conversion to compare. Correct to 3 Rice field - 30dBm The signal intensity corresponding to 65.2dBuv / m . That is, for CE Certification, RSE of P_{Peak} Peak power The upper limit value 65.2dBuv / m ,Compared to FCC of 74dBuv / m , CE ratio FCC Standards should be stricter.

4. 3 HW2171B Spurious radiation-emitting panel through a single authentication instance

Here are based HW2171B Single panel emitted radiation stray inductance certified program instance.

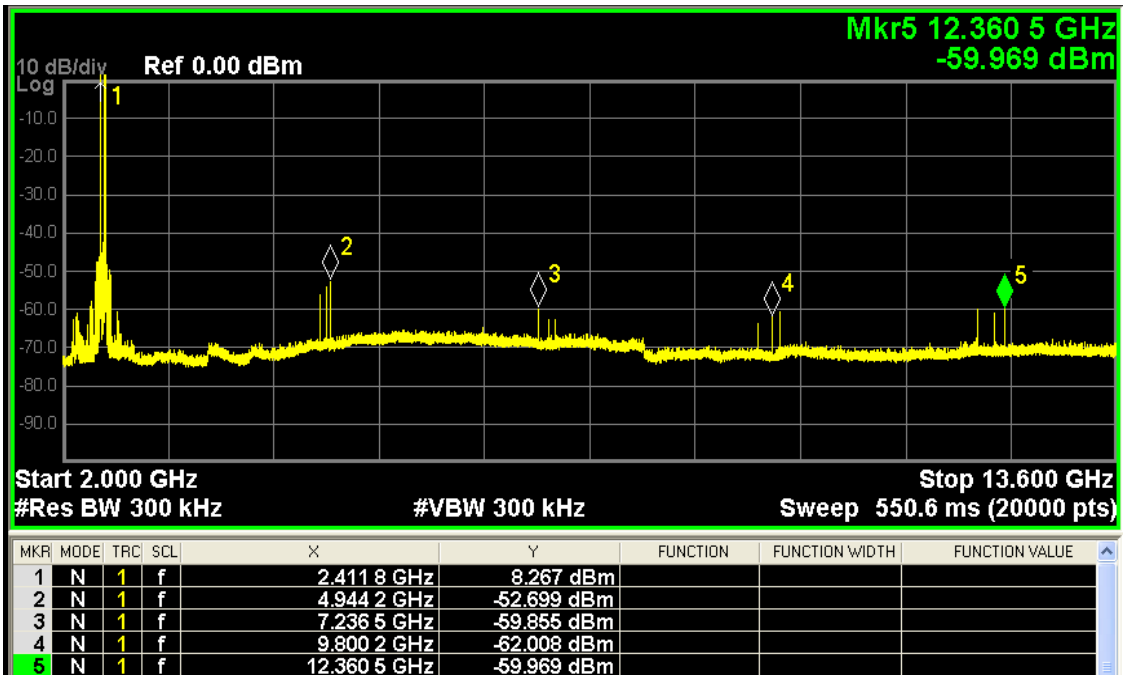
4. 3.1 Assessment Test

In order to improve the pass rate of the radiation-emitting spurious certified, the certification before sending laboratory tests, assessment test may be performed first. Evaluation tests include tests conducted spurious stray radiation and near-field testing.

4. 3. 1.1 Testing conducted spurious

Conducting Test Method: Set HW2171B In frequency hopping three low, middle and high channels take turns transmitting data, transmit power Set to the maximum transmit power. RF coaxial connection HW2171B Single panel and a spectrum analyzer. There are between the results of the test results conducted spurious radiation and stray some differences, particularly second harmonic spurious conduction and radiation spurious large difference, it is necessary to allow sufficient redundancy, or can not pass certification.

The following presents the test results conducted spurious.



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.411 8 GHz	8.267 dBm			
2	N	1	f	4.944 2 GHz	-52.699 dBm			
3	N	1	f	7.236 5 GHz	-59.855 dBm			
4	N	1	f	9.800 2 GHz	-62.008 dBm			
5	N	1	f	12.360 5 GHz	-59.969 dBm			

Map 4-1 Testing conducted spurious

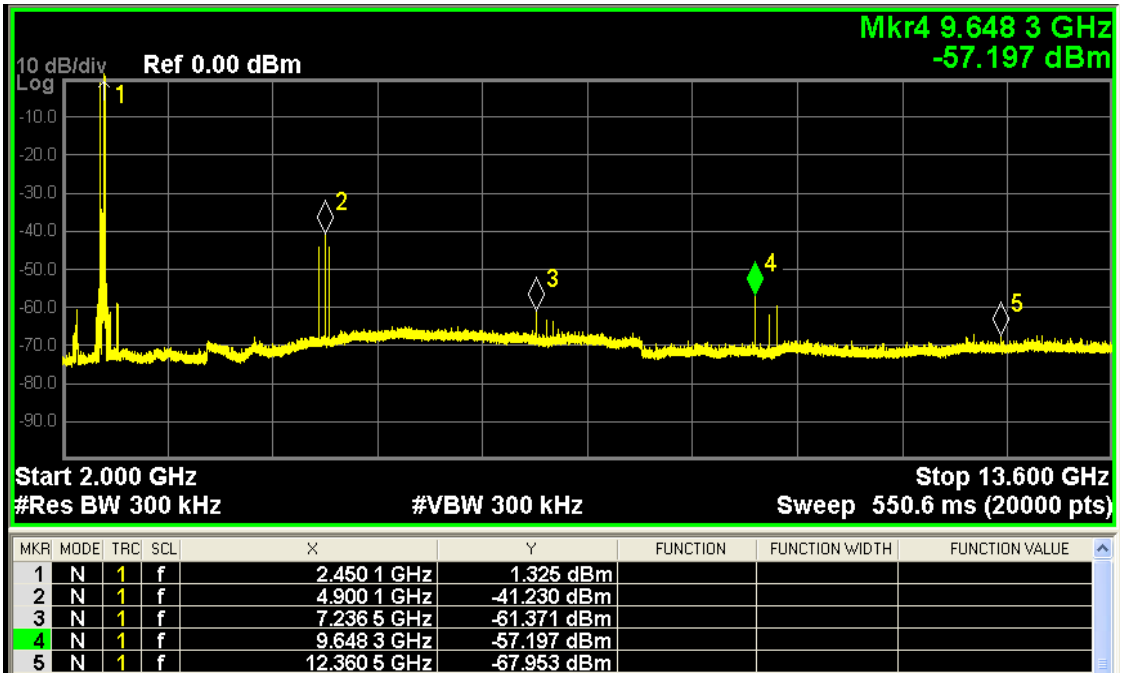
It is seen from the figure, the easiest Fail Conductive second harmonic spurs - 52dBm The following have been low enough.

4. 3. 1.2 Near-field stray radiation test

Near-field radiation spurious test method: Set HW2171B In frequency hopping three low, middle and high channels take turns transmitting data, Transmission power is set to the maximum transmit power. HW2171B Single-sided welding 3cm Long wire antenna. Close connection with the near-field spectrum analyzer test line HW2171B A single panel (mainly around the RF circuit and the RF chip), change direction repeatedly scanned. Test results are spurious near-field radiation laboratory test results and certification is relatively close, and therefore have better references.

Tip: Easy near-field test line can make, is to use a two SMA RF coaxial interface, retain the end SMA Head, another head cut off SMA While the outermost layer of plastic about ripping 2cm As a probe, and the shield cut metal wire layer, leaving only the innermost core and protective plastic. Further, the probe may be wrapped in the insulating material such as heat shrink tubing or an insulating bakelite, exposed metal shield to avoid influence the test results.

Near-field radiation is given below spurious test results.



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.450 1 GHz	1.325 dBm			
2	N	1	f	4.900 1 GHz	-41.230 dBm			
3	N	1	f	7.236 5 GHz	-61.371 dBm			
4	N	1	f	9.648 3 GHz	-57.197 dBm			
5	N	1	f	12.360 5 GHz	-67.953 dBm			

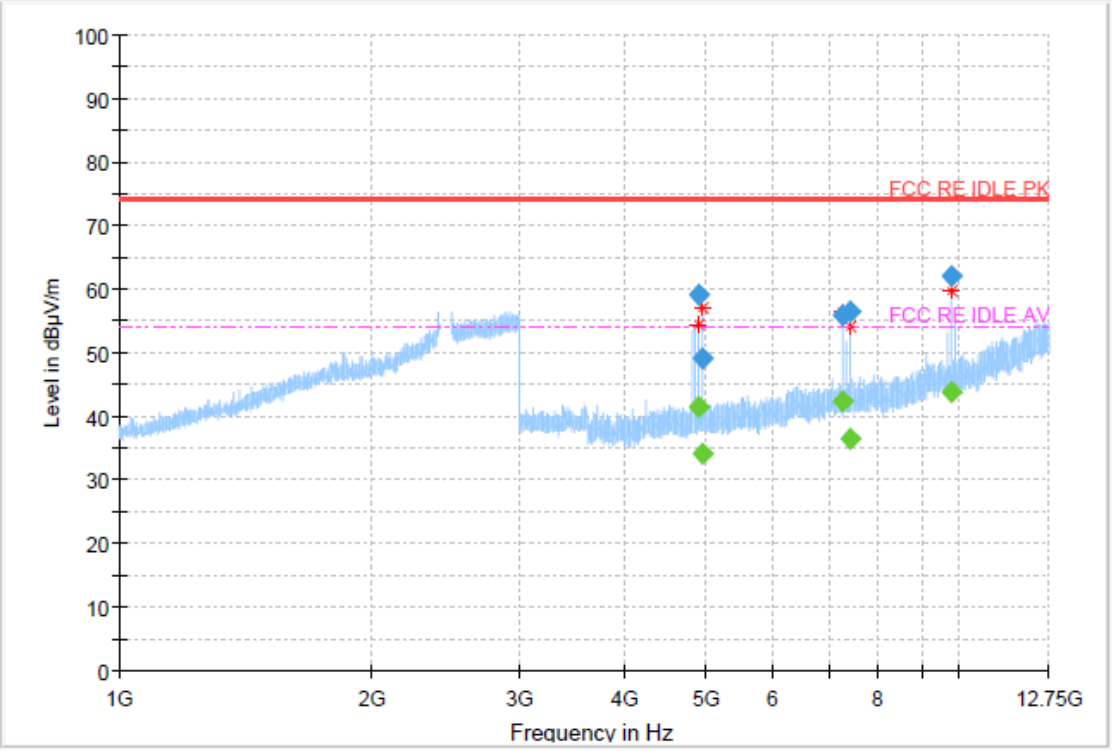
Map 4-2 Spurious radiation test

It is seen from the figure, although at the second harmonic conducted spurious - 52dBm The following, however spurious radiation has reached - 41dBm So, description of the second harmonic radiation is easy. In contrast, the higher harmonic harmonic radiation intensity is not large.

4. 3. 2 FCC Certification testing

After assessment test, if the test result margin is large enough, you can go to the certified laboratory microwave dark room for certification testing. Test subjects: Integrated HW2171B Wireless remote control single-sided machine, connected wire antenna. Test Methods: The battery powered remote control board, so that the boot HW2171B Transmit data in the normal mode. Test conditions: Set HW2171 Transmit power is the maximum power, transmission frequency is low, the transmission data constantly switching between three successive frequency points, a high channel. Since the strongest harmonic radiation of second and third harmonics, the sweep range setting from 1GHz To 12.75GHz .

FCC Certification testing results are shown in FIG.



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4883.817733	---	41.44	54.00	12.56	100.0	1000.000	155.0	V	-8.0	0.0
4883.817733	59.21	---	74.00	14.79	100.0	1000.000	155.0	V	-8.0	0.0
4944.495933	---	34.22	54.00	19.78	100.0	1000.000	155.0	H	324.0	0.3
4944.495933	49.01	---	74.00	24.99	100.0	1000.000	155.0	H	324.0	0.3
7236.165533	56.00	---	74.00	18.00	100.0	1000.000	155.0	H	104.0	4.7
7236.165533	---	42.37	54.00	11.63	100.0	1000.000	155.0	H	104.0	4.7
7415.748600	---	36.55	54.00	17.45	100.0	1000.000	155.0	H	80.0	5.0
7415.748600	56.50	---	74.00	17.50	100.0	1000.000	155.0	H	80.0	5.0
9767.938800	62.08	---	74.00	11.92	100.0	1000.000	155.0	V	141.0	9.3
9767.938800	---	43.70	54.00	10.30	100.0	1000.000	155.0	V	141.0	9.3

Map 4-3 Live FCC Certified RSE Test Results

Harmonic frequency(MHz)	The maximum peak (dB μ v / m)	average value(dB μ v / m)		The upper limit (dB μ v / m)	margin(dB)
2	4883	59.21	- -	74	14.79
	4883	- -	41.44	54	12.56
3	7236	56.00	- -	74	18.00
	7236	- -	42.37	54	11.63
4	9767	62.08	- -	74	11.92
	9767	- -	43.70	54	10.30

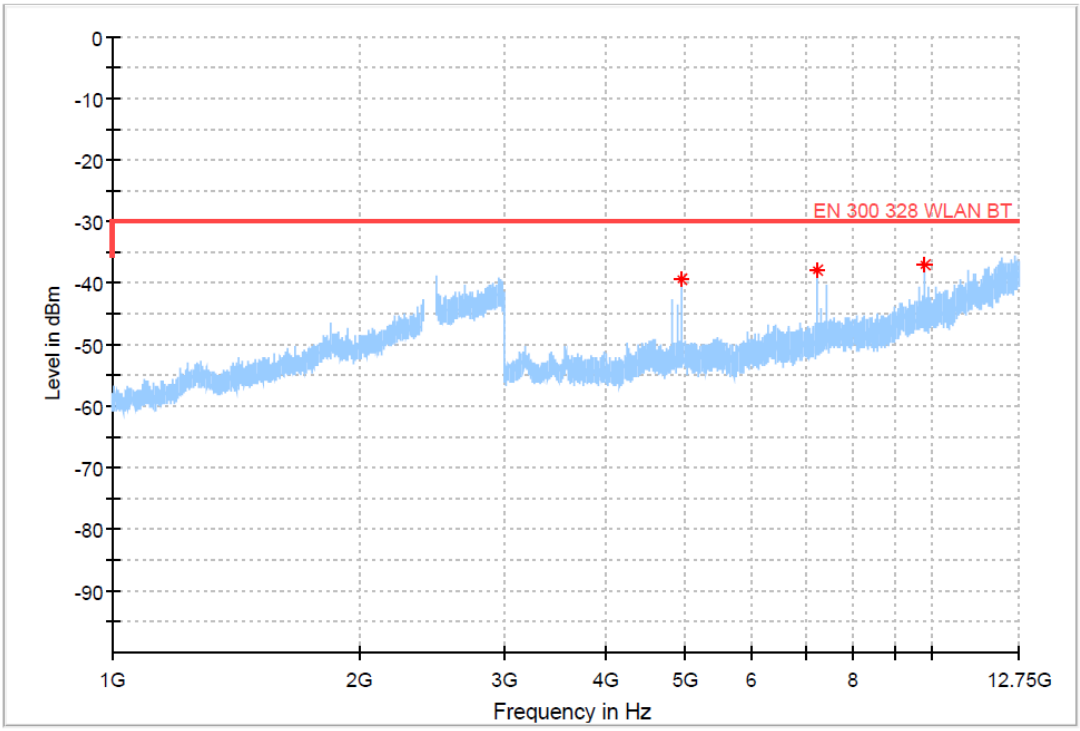
table 4-1 Live FCC Certified RSE Maximum

From the above table shows, there is also the smallest margin 10 More dB To meet FCC Through the certification requirements.

4. 3. 3 CE Certification testing

Test subjects: Integrated HW2171B Wireless remote control single-sided machine, connected wire antenna. Test Methods: The battery powered remote control board, so that the boot HW2171B Transmit data in the normal mode. Test conditions: Set HW2171 Transmit power is the maximum power, transmission frequency is low, the transmission data constantly switching between three successive frequency points, a high channel. Since the strongest harmonic radiation of second and third harmonics, the sweep range setting from 1GHz To 12.75GHz .

CE Certification testing results are shown in FIG.



Critical_Freqs

Frequency (MHz)	MaxPeak (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4944.500000	-39.47	-30.00	9.47	---	---	155.0	H	0.0	-96.3
7236.455357	-37.97	-30.00	7.97	---	---	155.0	H	90.0	-92.7
9768.187500	-36.94	-30.00	6.94	---	---	155.0	V	135.0	-88.2

Map 4-4 Live CE Certified RSE Test Results

According to the Test pattern As a result, select 2 Times, 3 Times, 4 Harmonics of the most High values, listed below :

Harmonic	frequency (MHz)	The maximum peak (dBm)	The upper limit (dBm)	margin(dB)
2	4944	-39.47	--30	9.47
3	7236	-37.97	--30	7.97
4	9768	-36.94	--30	6.94

table 4-2 Live CE Certified RSE Maximum

From the above table shows, the smallest margin also about 7dB To meet CE Through the certification requirements.