GR551x FCC RSE认证说明

版本： **1.1**

发布日期： **2023-04-20**

深圳市汇顶科技股份有限公司

商标声明

GOODiX 和其他汇顶商标均为深圳市汇顶科技股份有限公司的商标。本文档提及的其他所有商标或注册商标，由各自的所有人持有。

免责声明

本文档中所述的器件应用信息及其他类似内容仅为您提供便利，它们可能由更新之信息所替代。确保应用符合技术规范，是您自身应负的责任。

深圳市汇顶科技股份有限公司（以下简称“GOODIX”）对这些信息不作任何明示或暗示、书面或口头、法定或其他形式的声明或担保，包括但不限于针对其使用情况、质量、性能、适销性或特定用途的适用性的声明或担保。GOODIX对因这些信息及使用这些信息而引起的后果不承担任何责任。

未经GOODIX书面批准，不得将GOODIX的产品用作生命维持系统中的关键组件。在GOODIX知识产权保护下，不得暗中或以其他方式转让任何许可证。

深圳市汇顶科技股份有限公司

总部地址：深圳市福田保税区腾飞工业大厦B座12-13层

电话：+86-755-33338828　　邮编：518000

网址：www.goodix.com

前言

编写目的

本文档描述了GR551x系列芯片在第三方实验室进行FCC（Federal Communications Commission，美国联邦通信）RSE（Radiated Spurious Emission，辐射杂散）认证时的要求及注意事项，旨在帮助客户顺利通过认证。

读者对象

本文适用于以下读者：

- 技术支持工程师
- 代理商
- 客户工程师
- 认证工程师

版本说明

本手册为第2次发布，对应的产品系列为GR551x。

修订记录

版本	日期	修订内容
1.0	2021-10-28	首次发布
1.1	2023-04-20	更新“认证注意事项”章节

目录

1 FCC RSE认证简介

对于带有蓝牙模块的设备，例如手机、笔记本、鼠标、键盘、音箱等，在申请FCC（Federal Communications Commission，美国联邦通信）认证时，需遵循FCC PART 15的法令要求。

本文介绍了GR551x系列芯片在FCC辐射杂散（Radiated Spurious Emission，以下简称RSE）认证中的要求及注意事项，有助于帮助用户顺利通过认证。

文中描述的辐射杂散频段范围为1 GHz ～ 25 GHz。如无特殊说明，其他认证项目，例如峰值功率谱密度、边带测试等，按照常规流程认证即可。

1.1 认证要求

FCC PART 15 Subpart C 15.209测试标准中，RSE限制性要求摘录如下：

§ 15.209 Radiated emission limits; general requirements.

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100**	3
88–216	150**	3
216–960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.

图 1-1 FCC PART 15 Subpart C 15.209摘录

说明:

- 40.0 dBμV/m：30 MHz ～ 88 MHz
- 43.5 dBμV/m：88 MHz ～ 216 MHz
- 46.0 dBμV/m：216 MHz ～ 960 MHz
- 54.0 dBμV/m：960 MHz以上

1.2 认证注意事项

FCC RSE认证具有峰值和均值要求。RSE均值必须以DCCF（Duty Cycle Compensation Factor，占空比补偿因子）换算的方式获取。操作说明简述如下。

1. 使用GRDirect Test Mode Tool，按需配置，使Bluetooth LE模组按照预制条件发出功率。

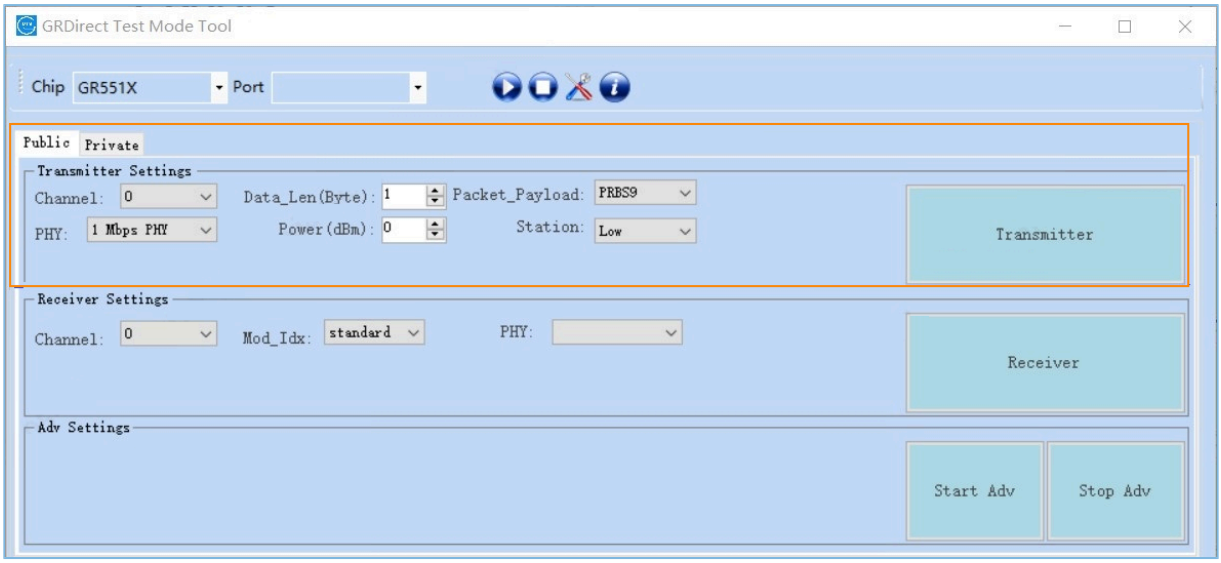
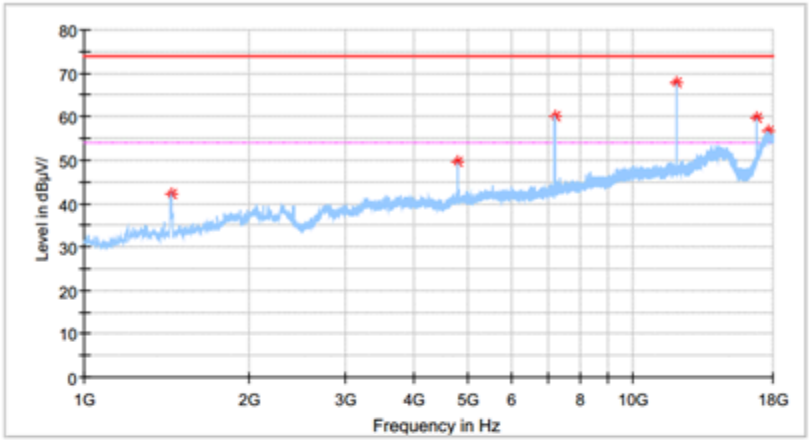


图 1-2 GRDirect Test Mode Tool配置参考

- Channel：选择需要测试的信道（0 ～ 39）
- Data_Len (Byte)：字节长度设置，选择“255”（最大值）
- Packet_Payload：数据类型设置，选择“PRBS9”
- PHY：可设置1 M、2 M、500 K或125 K，选择“1 Mbps PHY ”
- Power (dBm)：功率设置（单位dBm），选择“0”表示TX 功率为0 dBm
- Station：选择“Low”，若“PHY”设置为“1 Mbps PHY ”，对应占空比为11%；若“PHY”设置为“2 Mbps PHY ”，对应占空比为8%

2. 测量RSE峰值，参见2 FCC RSE峰值测量。
3. 根据RSE峰值测试结果，结合DCCF换算，得到的RSE均值（参见3 FCC RSE均值测量）和计算说明需写入实验室认证报告中，示例如下。



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1440.300000	42.18	74.00	31.82	200.0	H	265.0	1.2
4802.900000	49.67	74.00	24.33	200.0	H	151.0	11.8
7206.700000	60.08	74.00	13.92	150.0	H	44.0	15.3
12010.900000	67.71	74.00	6.29	150.0	H	36.0	21.1
16813.400000	59.62	74.00	14.38	150.0	H	226.0	24.5
17646.400000	56.79	74.00	17.21	150.0	H	113.0	29.2

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1440.300000	23.34	54.00	30.66	200.0	H	265.0	1.2
4802.900000	30.83	54.00	23.17	200.0	H	151.0	11.8
7206.700000	41.24	54.00	12.76	150.0	H	44.0	15.3
12010.900000	48.87	54.00	5.13	150.0	H	36.0	21.1
16813.400000	40.78	54.00	13.22	150.0	H	226.0	24.5
17646.400000	37.95	54.00	16.05	150.0	H	113.0	29.2

Calculate Duty Cycle Value:
T_{on}=144.23µs=0.144ms
T_p= 1.26 ms

Duty Cycle Corrected Factor =20*log(T_{on}/T_P)=20*log(0.144/1.26)= -18.84 dB
Average value = Peak value+ Duty Cycle Corrected Factor

图 1-3 测试报告示例

2 FCC RSE峰值测量

参考《ANSI C63.10-2020无证无线设备一致性测试标准规程》，按照第11.12.1、6.4、6.5和6.6章中的描述方法，可直接测试RSE峰值。

详细仪表设置请参考11.12.2.4章，如下图所示。

11.12.2.4 Peak measurement procedure

Peak emission levels are measured by setting the instrument as follows:

a) RBW = as specified in Table 16

b) VBW ≥ [3 × RBW].

c) Detector = peak.

d) Sweep time = No faster than coupled (auto) time.

e) Trace mode = max-hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time and number of sweep points may be lengthened for low duty cycle applications.)

Table 16—RBW as a function of frequency

Frequency	RBW
9 kHz to 150 kHz	200 Hz to 300 Hz
0.15 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1000 MHz	100 kHz to 120 kHz
>1000 MHz	1 MHz

If the peak detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

图 2-1 仪表设置参考

3 FCC RSE均值测量

FCC RSE均值测量有两种方式：

- 直接测量方式：适用于大多数无线设备。
- FCC RSE均值测量方式：GR551x推荐使用方式，适用于DTS（Data Transmission Service，数据传输服务）设备。

3.1 直接测量方式

按照《ANSI C63.10-2020 无照无线设备一致性测试标准规程》，第11.12.2.5.3章描述方法，设置仪表直接测量。

11.12.2.5.2.3 Reduced VBW averaging across ON and OFF times of the EUT transmission with max-hold

If continuous transmission of the EUT ($D \geq 98\%$) cannot be achieved and the duty cycle is not constant (duty cycle variations exceed ±2%), then the following procedure shall be used:

a) RBW = 1 MHz.

b) VBW ≥ 1 / T, where T is defined in 11.6. When the device operates with a protocol-limited duty factor the average value may be measured using VBW=1Hz provided that the device is being exercised at or above the maximum operational duty cycle during the measurement.

c) Video bandwidth mode or display mode:

1) The instrument shall be set so that video filtering is applied in the power domain. Typically, this requires setting the detector mode to Power averaging (rms) and setting the average-VBW type to power (rms).

2) As an alternative, the instrument may be set to linear detector mode. Ensure that video filtering is applied in linear voltage domain (rather than in a log or dB domain). Some instruments require linear display mode to accomplish this. Others have a setting for average-VBW type, which can be set to "voltage" regardless of the display mode.

d) Detector = peak.

e) Sweep time = No faster than coupled (auto) time.

f) Trace mode = max-hold.

g) Allow max-hold to run for at least [50 × (1 / D)] traces.

图 3-1 ANSI C63.10-2020文档摘录

3.2 DCCF换算方式

下文描述了DCCF换算的来源、方法以及测量示例。

3.2.1 依据及来源

FCC官方文档KDB558074 《符合FCC第15.247章数字传输系统、跳频扩频系统和混合系统设备的符合性测试指南》，明确提到DTS设备可以采用DCCF计算方式得到均值辐射杂散结果。

c) Test procedures for DTS device EMC and radio parameters, such as power, OBW, radiated and band-edge measurements, are described in the following subclauses, including cross-references to Clause 11 of ANSI C63.10.

In addition the following clarifications relative to ANSI C63.10 are also applicable.

1) Concerning 11.13 (Band-edge measurements) of ANSI C63.10:

The requirement in 11.13.1 that the DTS bandwidth (or EBW) edge falls within 2 MHz of the band edge applies only for use of the marker-delta method; use of the integration method is not subject to the same limitation.

2) For measuring output power of a device transmitting a wide-band noise-like signal (*i.e.,* digitally-modulated) where the peak power amplitude is a statistical parameter, the preferred methodology is to use integrated average power measurements, as described in 11.9.2 and 11.13.3 of ANSI C63.10. The peak integrated band power methods of 11.9.1.2 and 11.13.3.2 of ANSI C63.10 are not applicable for FCC compliance testing purposes.

3) Additional measurement procedures and the allowance for duty cycle for DTS device out-of-band measurements in a restricted band for protocol-limited devices is described in FAQ #3 in Section 11 of this document.

图 3-2 KDB558074文档摘录1

Question 3: What measurement methods are available for making average measurements on devices with protocol-limited duty cycles such as ZigBee devices (DTS devices certified under Section 15.247)?

Answer 3: Several measurement methods are available for making average measurements for radiated and antenna-port conducted spurious emissions provided that: (i) the spurious emissions fall in restricted bands, (ii) emission are temporally related to the fundamental, (iii) the maximum duty cycle used in determining the reduction factor is hardwired such that under no condition can it be changed or modified by either the device or end user, (iv) a documented justification for use of Section 15.35(c) including the measurements used to determine the worst-case duty cycle must be included in the test report, and (v) the duty cycle correction factor is the worst case operational duty cycle based on the maximum transmission time in any 100 msec period. If the above criteria are satisfied, one of the following measurement techniques may be used:

a) Applying a duty cycle correction to the Peak measurement – First, a Peak measurement is made using the Peak detector function of a spectrum analyzer. The spectrum analyzer settings should be such that it meets the requirements of 11.12.2.4 in ANSI C63.10 for making a Peak measurement. Then the operational duty cycle of the EUT may be subtracted from the Peak reading to derive the RMS average value. If the EUT supports more than one operational duty cycle the worst-case value should be used, *i.e.*, the highest operational duty cycle.

图 3-3 KDB558074文档摘录2

2019年TCBC（Telecommunication Certification Body Council，电信认证机构委员会）会议材料中对Q #3进行了进一步的解释说明。

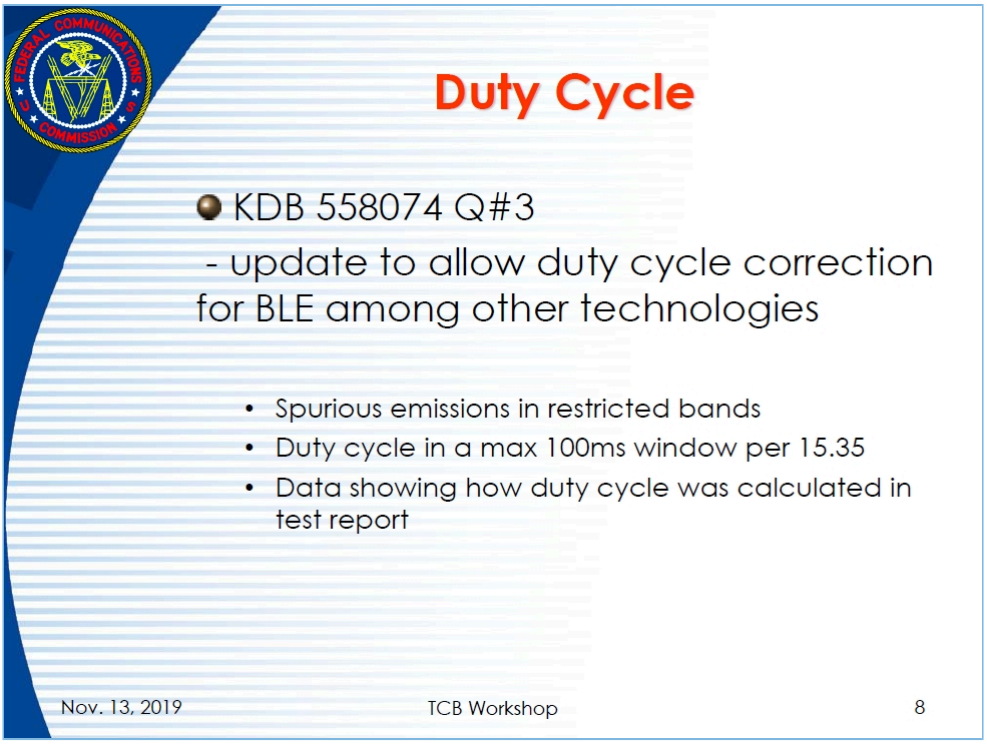


图 3-4 TCBC会议材料摘录

3.2.2 换算方法

《ANSI C63.10-2020无照无线设备一致性测试标准规程》第7.5章中规定了DCCF计算公式，也可参考1.2 认证注意事项中测试报告示例中的计算说明。

7.5 Procedure for determining the average value of pulsed emissions

Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 s (100 ms). In cases where the pulse train exceeds 0.1 s, the measured field strength shall be determined during a 0.1 s interval.[62] The following procedure is an example of how the average value may be determined. The average field strength may be found by measuring the peak pulse amplitude (in log equivalent units) and determining the duty cycle correction factor (in dB) associated with the pulse modulation as shown in Equation (10):

$$\delta(\mathrm{dB}) = 20\log(\Delta) \qquad (10)$$

where

δ is the duty cycle correction factor (dB)
Δ is the duty cycle (dimensionless)

This correction factor may then be subtracted from the peak pulse amplitude (in dB) to find the average emission. This correction may be applied to all emissions that demonstrate the same pulse timing characteristics as the fundamental emission (e.g., the fundamental and harmonic emissions). In cases where the pulse train is truly random or pseudo random, some regulatory agencies might accept a declaration by the manufacturer of the worst-case value of t_{ON}. The duty cycle correction is determined as follows:

[61] See 47 CFR 15.231 and 15.240(b).
[62] See 47 CFR 15.35(c).

图 3-5 ANSI C63.10-2020摘录1

占空比（△）描述及仪表设置方法，请参考《ANSI C63.10-2020 无照无线设备一致性测试标准规程》第11.6章，如下图所示。

11.6 Duty cycle (D), transmission duration (T), and maximum power control level

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be used to help ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (*T*) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed *T* at any time that data are being acquired (i.e., no transmitter OFF-time is to be considered).

When continuous transmission cannot be achieved and sweep triggering/signal gating cannot be implemented, alternative procedures are provided that can be used to measure the average power; however, they will require an additional measurement of the transmitter duty cycle (*D*). Within this subclause, the duty cycle refers to the fraction of time over which the transmitter is ON and is transmitting at its maximum power control level. The duty cycle is considered to be constant if variations are less than ±2%; otherwise, the duty cycle is considered to be nonconstant.

The term "maximum power control level" is intended to distinguish between operating power levels of the EUT and differences in power levels of individual symbols that occur with some modulation types such as quadrature amplitude modulation (QAM). During testing, the EUT is not required to transmit continuously its highest possible symbol power level. Rather, it should transmit all the symbols and should do so at the highest power control level (i.e., highest operating power level) of the EUT.

Measurements of duty cycle and transmission duration shall be performed using one of the following techniques:

a) A diode detector and an oscilloscope that together have a sufficiently short response time to permit accurate measurements of the ON and OFF times of the transmitted signal.

b) The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the ON and OFF times of the transmitted signal:

   1) Set the center frequency of the instrument to the center frequency of the transmission.

   2) Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.

   3) Set VBW ≥ RBW. Set detector = peak or average.

   4) The zero-span measurement method shall not be used unless both RBW and VBW are > 50/*T* and the number of sweep points across duration *T* exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring the duty cycle shall not be used if *T* ≤ 16.7 μs.)

图 3-6 ANSI C63.10-2020摘录2

3.2.3 测量示例

例如在某次GR551x FCC认证测试中，测得Ton=144.23 μs= 0.144 ms，Tp=1.26 ms，根据占空比（Duty Cycle Value）计算公式Duty Cycle Value=Ton/Tp，计算得到：Duty Cycle Value=11.43%。发射占空比测试图如下所示。

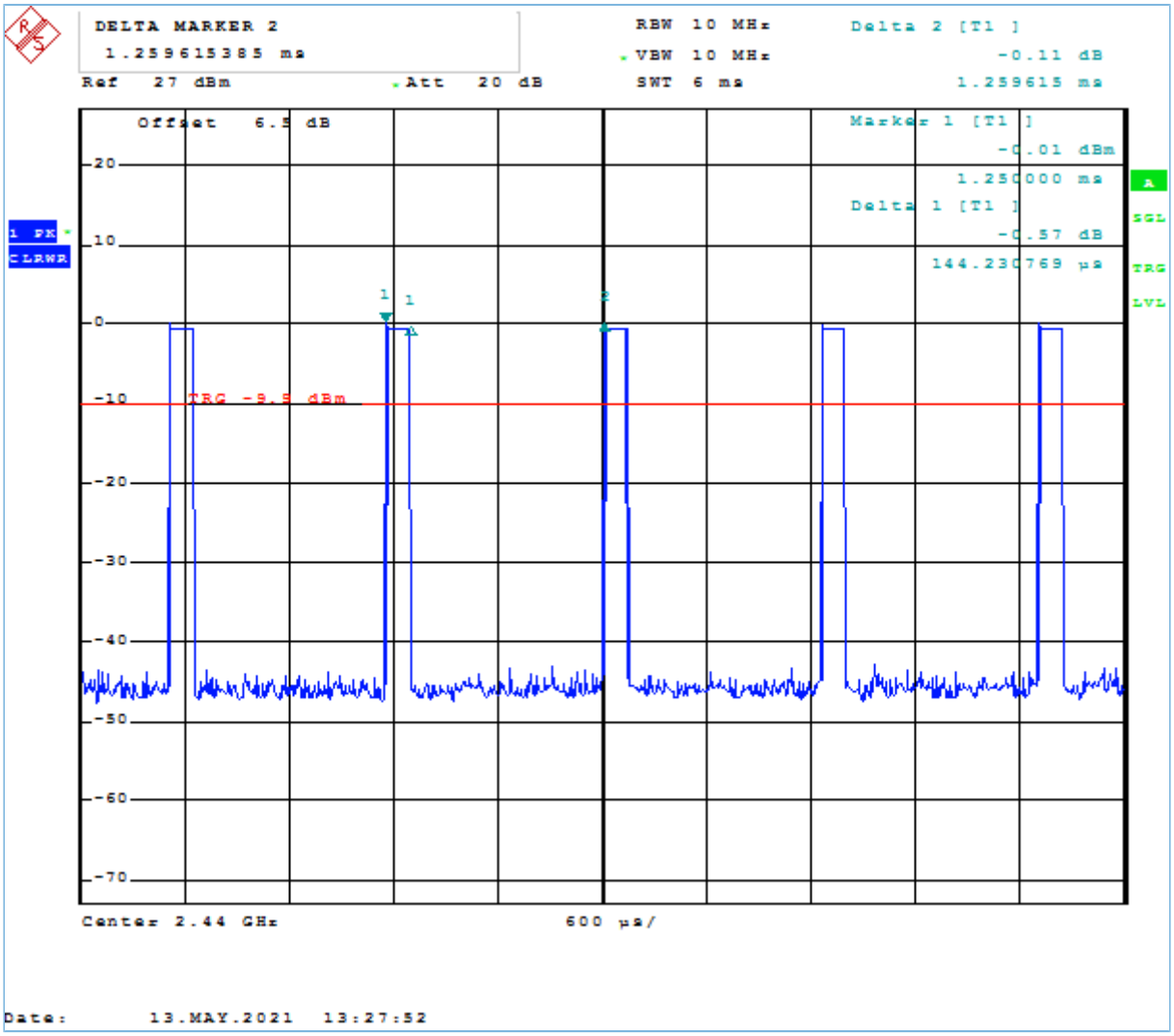


图 3-7 占空比测试图

获取FCC RSE均值步骤如下：

1. 直接测量，获取峰值

表 3-1 峰值参考

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1440.300000	42.18	74.00	31.82	200.0	H	265.0	1.2
4802.900000	49.67	74.00	24.33	200.0	H	151.0	11.8
7206.700000	60.08	74.00	13.92	150.0	H	44.0	15.3
12010.900000	67.71	74.00	6.29	150.0	H	36.0	21.1
16813.400000	59.62	74.00	14.38	150.0	H	226.0	24.5
17646.400000	56.79	74.00	17.21	150.0	H	113.0	29.2

2. 计算DCCF：DCCF =20 * log (Ton/Tp) = 20 * log (0.144/1.26) = -18.84 dB

3. 计算均值：均值 = 峰值+ DCCF

4. 换算得到以下均值。即将上表中MaxPeak减掉18.84 dB即可

表 3-2 均值参考

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1440.300000	23.34	54.00	30.66	200.0	H	265.0	1.2
4802.900000	30.83	54.00	23.17	200.0	H	151.0	11.8
7206.700000	41.24	54.00	12.76	150.0	H	44.0	15.3
12010.900000	48.87	54.00	5.13	150.0	H	36.0	21.1
16813.400000	40.78	54.00	13.22	150.0	H	226.0	24.5
17646.400000	37.95	54.00	16.05	150.0	H	113.0	29.2

4 机构参考

以下为目前可采用RSE DCCF测量的EMC实验室和TCB机构名单。

4.1 EMC实验室

表 4-1 EMC实验室名单

名称	地域	说明
微测检测	深圳	RSE Peak/Avg分别测试，同时接受峰值Peak-DCCF换算
MRT	苏州	
广电计量	成都、深圳，无锡，上海	
倍科	成都、深圳，东莞，昆山	

4.2 TCB机构

表 4-2 TCB机构名单

简称	全称	说明
ACB	American Certification Body, Inc.	明确支持： 采用Peak-DCCF换算均值杂散的方式进行认证
Aplus	APlus Labtech Co., Ltd.	
Timco	Timco Engineering Inc.	
BACL (Chengdu)	Bay Area Compliance Laboratories (Chengdu)	

5 术语与缩略语

表 5-1 术语与缩略语

名称	描述
ANSI	American National Standards Institute，美国国家标准学会
DCCF	Duty Cycle Compensation Factor，占空比补偿因子
DTM	Direct Test Mode，直接测试模式
DTS	Data Transmission Service，数据传输服务
EMC	Electromagnetic Compatibility，电磁兼容
FCC	Federal Communications Commission，美国联邦通信
RSE	Radiated Spurious Emission，辐射杂散
TCB	Telecommunication Certification Body, 电信认证机构
TCBC	Telecommunication Certification Body Council，电信认证机构委员会