



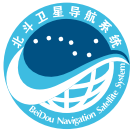
RFC of BeiDou RDSS with Adjacent Systems Services

13th Meeting of the International Committee on
Global Navigation Satellite Systems

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01

Current state of RFC of RDSS

The adjacent systems of BeiDou radio determination satellite service (RDSS) have the characteristics of wide distribution, large number, high power, and many spurious components, which make BeiDou RDSS face severe radio frequency compatible (RFC) challenges.

As far as the 4th generation mobile communication service (4G) is concerned, the useless emission outside its necessary bandwidth affects the RDSS in the way of in-band interference. Meanwhile, the useful transmission within its necessary bandwidth cannot be completely suppressed, and the residual power affects the RDSS in the way of out-of-band interference.

➤ Sampling test

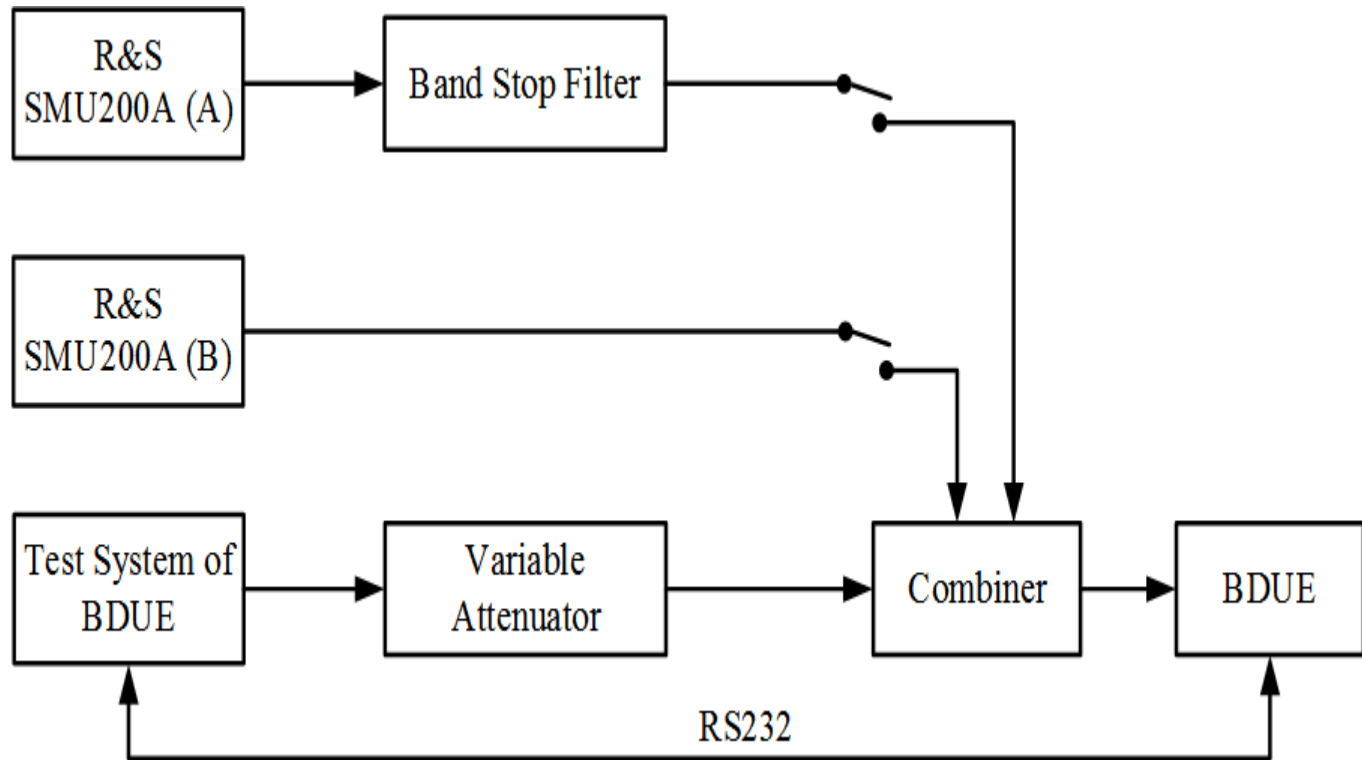


Figure 1 Block diagram of RFC test platform



- **minimum performance criteria of RDSS**

BER $\leq 10^{-5}$

acquisition time $\leq 1s$

acquisition probability $\geq 95\%$

- **7 types of BDUEs under test**

integrated vehicle-borne

separated vehicle-borne

dual-mode vehicle-borne

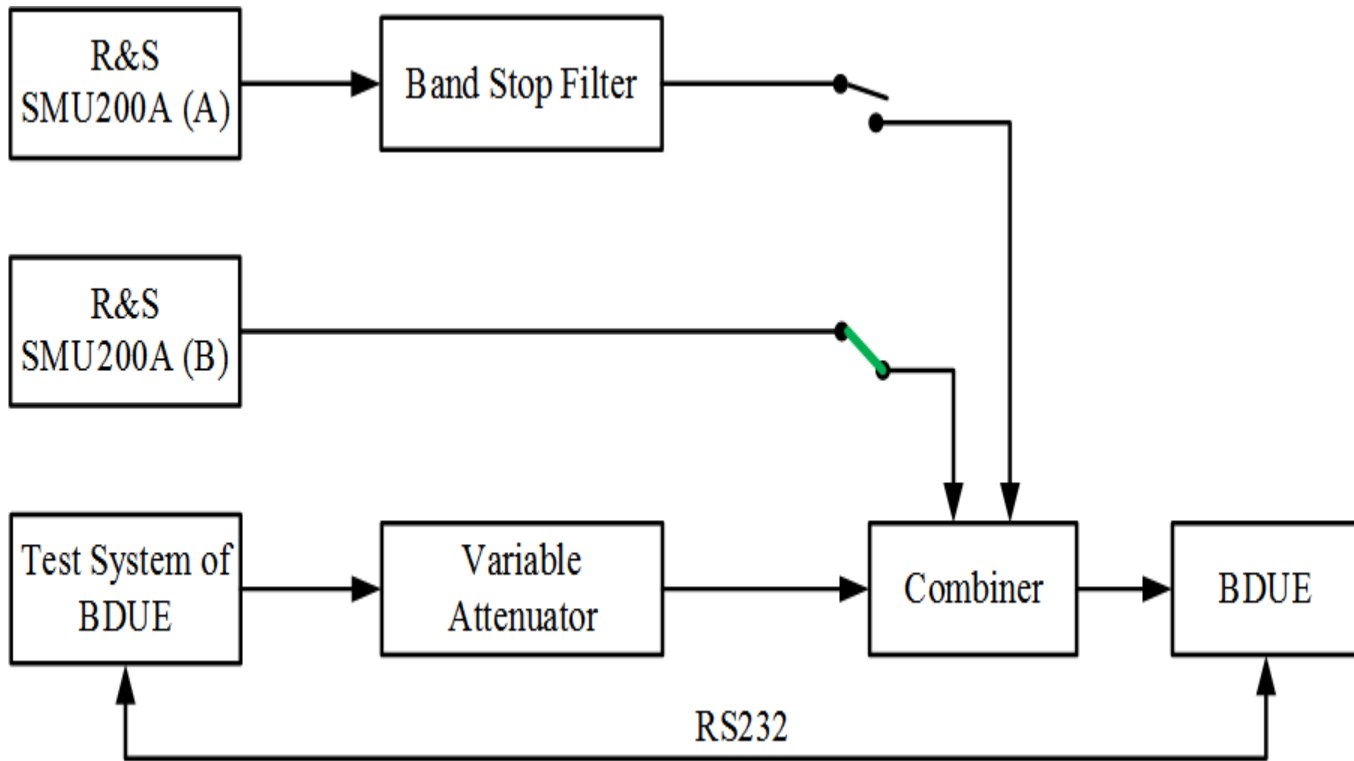
miniaturized handheld

BDS/GPS compatible handheld

command

one- and two-way timing

➤ **Power limit test for useless emission**



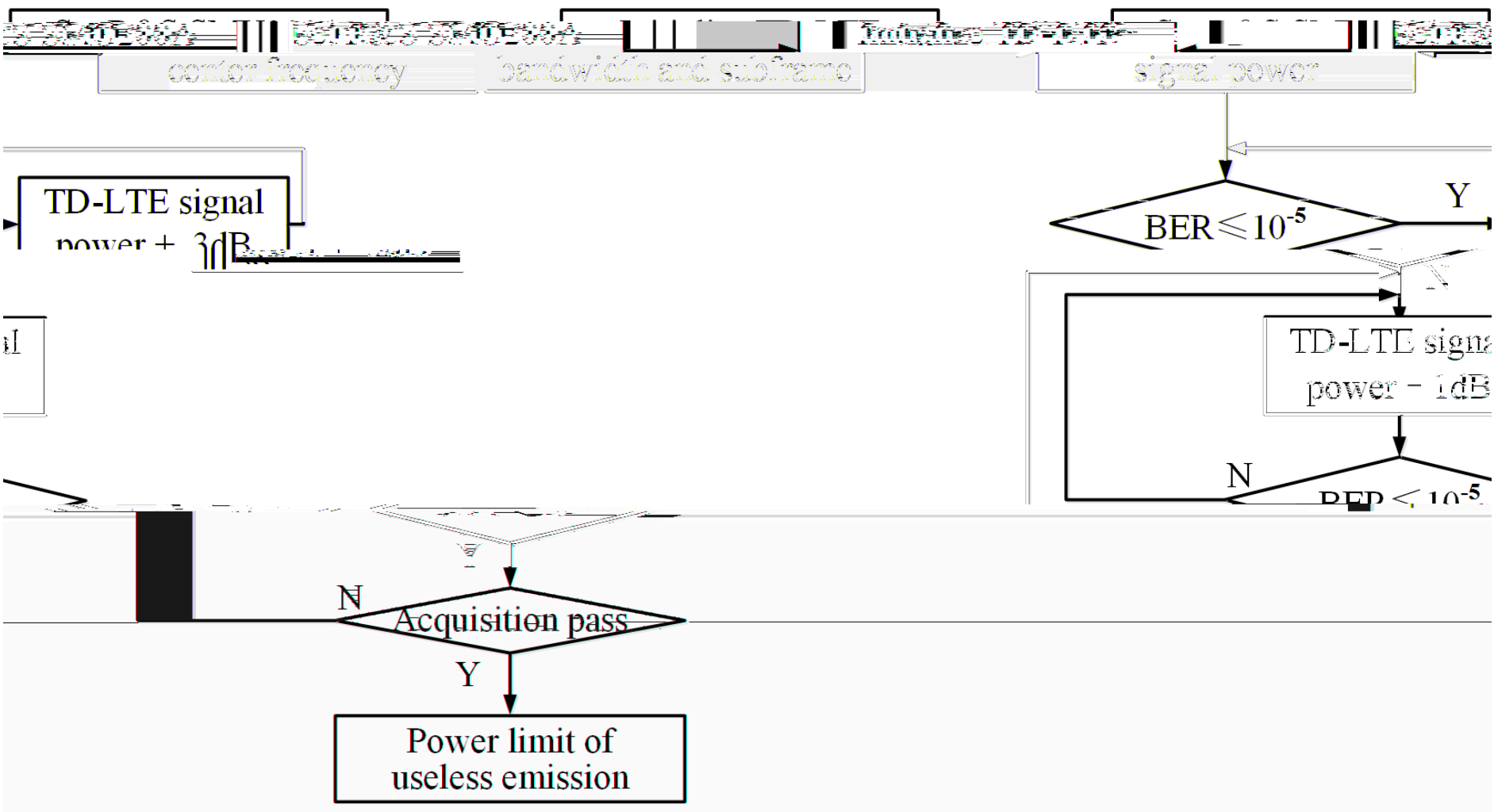
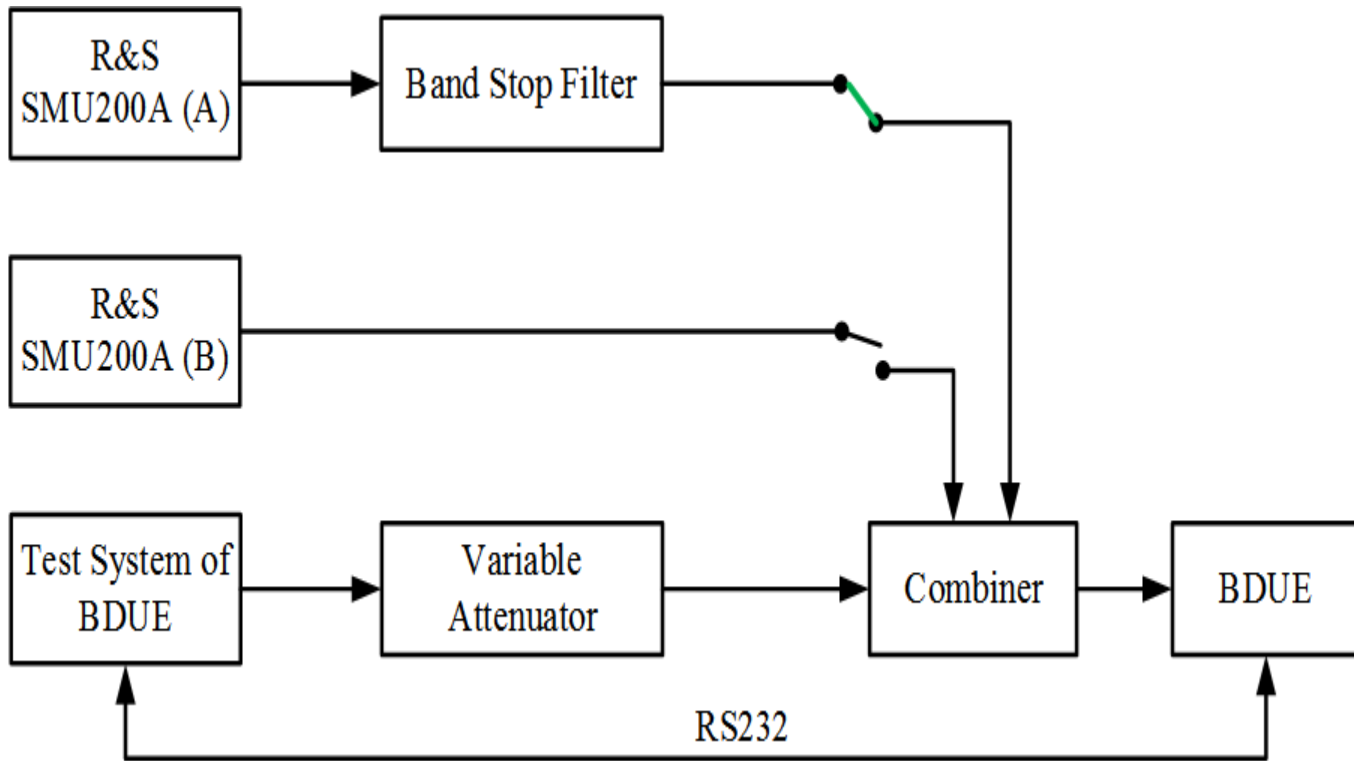


Figure 2 Test flow of power limit for useless emission

- **The R&S SMU200A channel B parameters are set as follows:**
 - ◆ bandwidth is 20MHz
 - ◆ uplink and downlink subframe proportion adopts configuration 2(D S U D D D)
 - ◆ special subframe adopts configuration 4 (downlink PTS: GP: uplink PTS = 12:1:1)
 - ◆ carrier frequency is 2491.75MHz
 - ◆ useless emission is simulated by scrambling of TD-LTE

➤ **Power limit test for useful transmission**



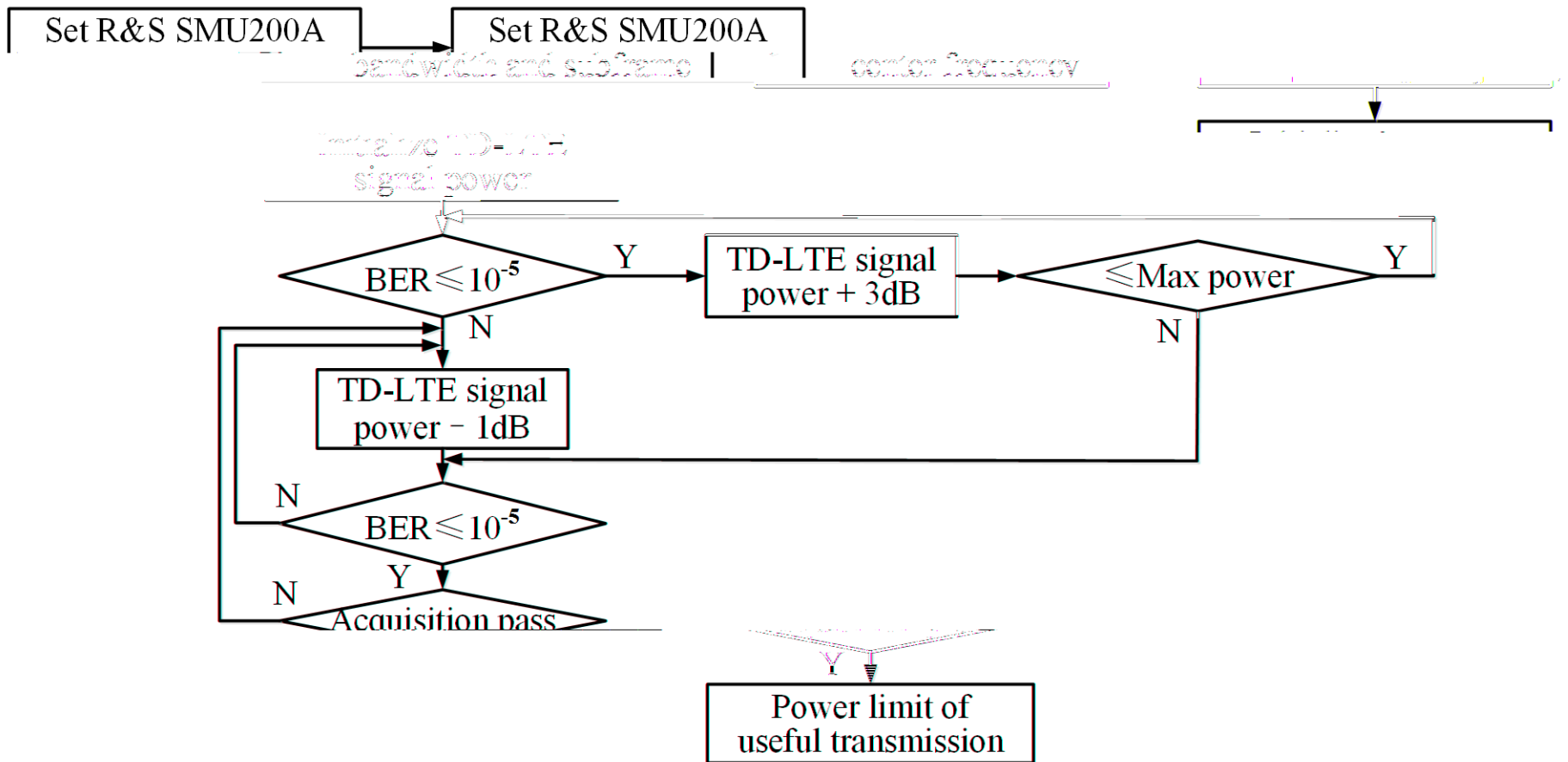
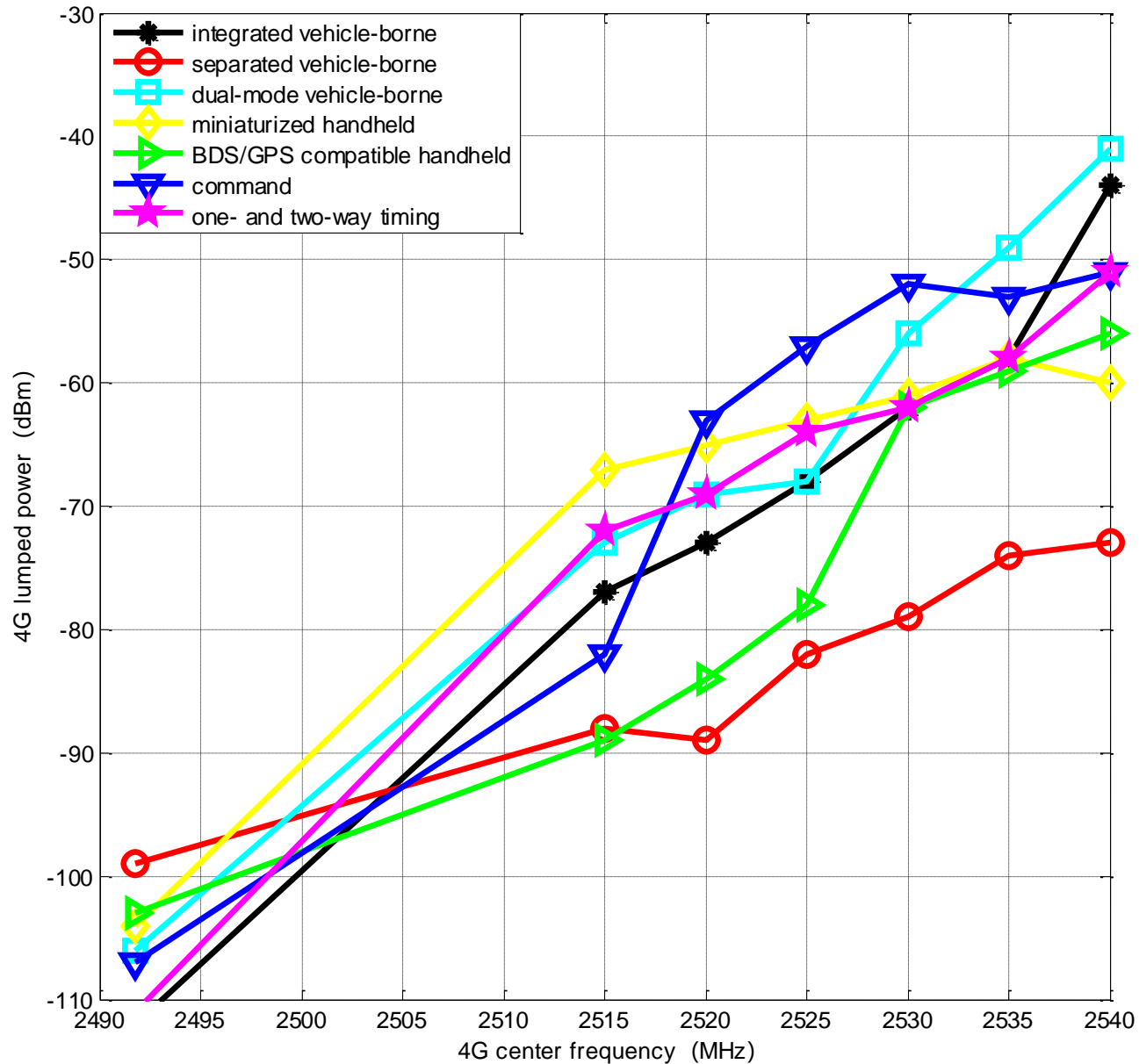


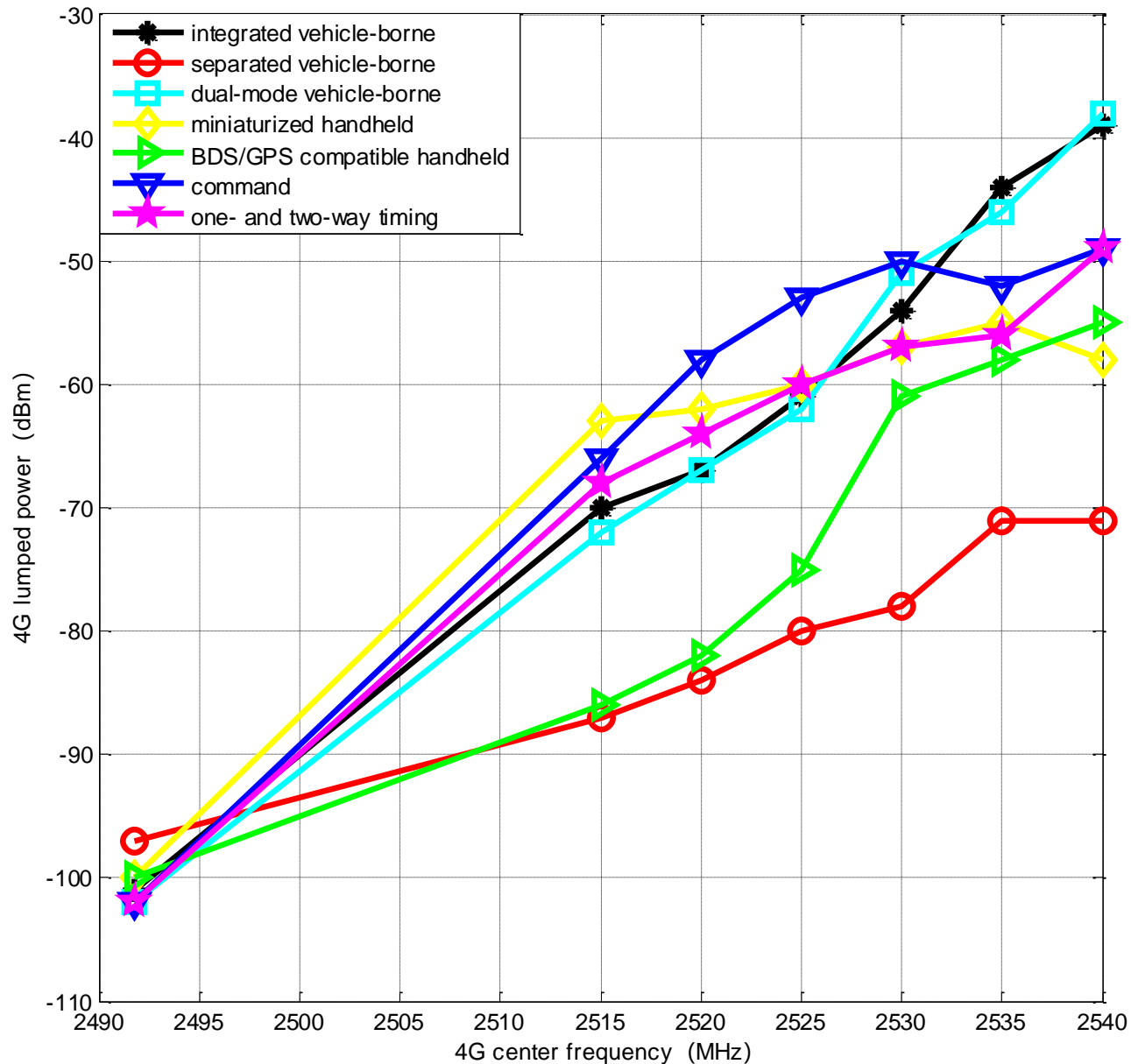
Figure 3 Test flow of power limit for useful transmission

- **The R&S SMU200A channel A parameters are set as follows:**
 - ◆ bandwidth is 20MHz
 - ◆ uplink and downlink subframe proportion adopts configuration 2(D S U D D D)
 - ◆ special subframe adopts configuration 4 (downlink PTS: GP: uplink PTS = 12:1:1)
 - ◆ carrier frequency is $f_i = 2515 + 5(i - 1)$ MHz

➤ Test result (@receiving sensitivity level)



➤ Test result (@receiving sensitivity level +1dB)



The further the center frequency of 4G away from BeiDou RDSS, **the greater** the tolerable power limit of BDUE.

There are some **differences** in the tolerable power limit of 7 types of BDUEs. For in-band interference, the maximum difference is 13dB; for out-of-band interference, it is 33dB.

02

RFC optimization of RDSS

In order to adapt to the application environment of strong interference and weak BeiDou RDSS signal, two effective ways should be adopted to optimize radio frequency compatibility (RFC) of BDUE:

- **expand** dynamic range
- **sharpen** frequency selectivity



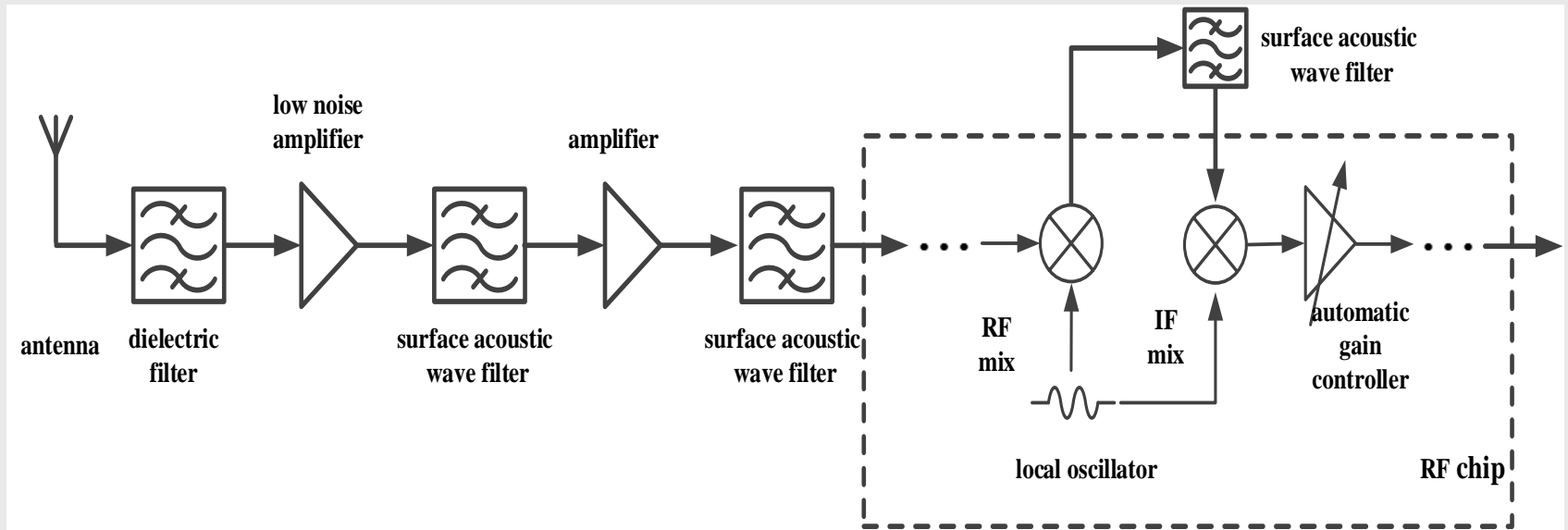
➤ RFC optimization of BDUE RF front-end

RFC optimization of BDUE should satisfy severe constraints

- RDSS link allowance $\approx 1\text{dB}$
- temperature range $\geq -40 \sim +70^{\circ}\text{C}$
- size $\leq 53\text{mm} \times 38\text{mm} \times 13\text{mm}$
- average power consumption $\leq 0.5\text{W}$
- cost ≤ 4500 yuan/chip



➤ RFC optimization of BDUE RF front-end



This scheme can realize integrated optimization of receiving and transmitting isolation, linear range extension, useless frequency attenuation and noise coefficient control, etc.



➤ RFC validation of BDUE sample

Table 1 Tolerable power limit of BDUE sample

4G center frequency (MHz)	2490	2500 / 2480	2510 / 2470	2520 / 2460	2530 / 2450	2540 / 2440	2550 / 2430	2560 / 2420
4G power limit (dBm)	-103	-103 / -96	-52 / -44	-42 / -42	-37 / -40	-37 / -40	-36 / -38	-36 / -38

The tolerable power limits of BDUE sample are 21 dB, 15 dB and 4 dB **higher than** maximum ones of preceding 7 BDUEs.

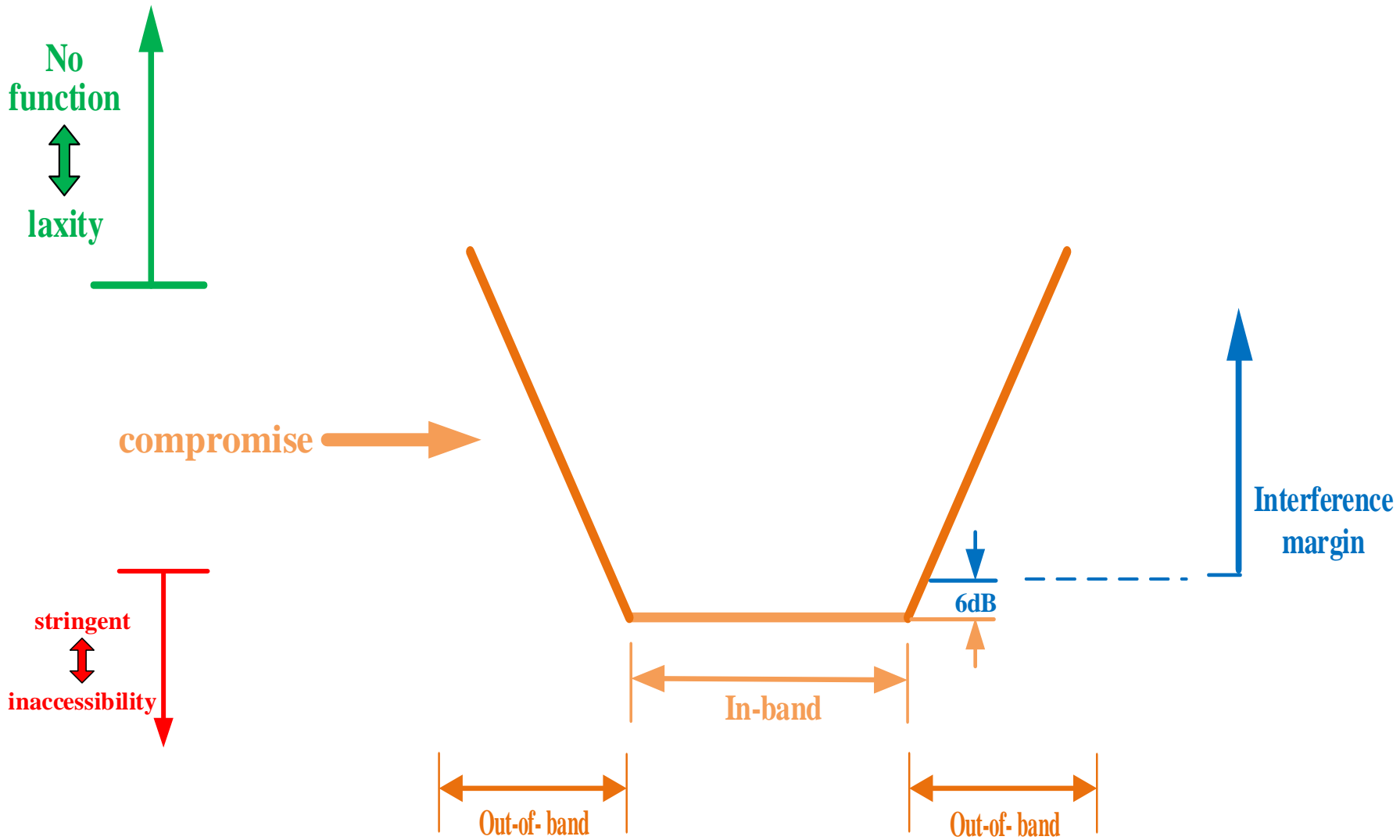
03

RFC suggestion for adjacent system service

➤ **Emission requirements for adjacent system**

Even though RFC optimization scheme optimizes BDUE RFC to its greatest extent, BDUE cannot withstand downlink signal and uplink signal time division multiplexing, let alone do electromagnetic emission of WLAN, MMDS and other adjacent systems.

It is urgent to promulgate and implement reasonable (i.e., a good compromise between stringent and laxity) emission requirements for adjacent system service.



The corresponding characteristic parameters are in-band start-stop frequency, in-band interference power limit (IPL), and out-of-band IPL slope, etc.

In order to ensure that the emission requirements for adjacent system is reasonable:

- ◆ in-band start-stop frequency is 2483.5~2500MHz
- ◆ in-band IPL is -125dBm/MHz
- ◆ out-of-band IPL slope is 2.2dBm/MHz

➤ Suggestion for adjacent system service

According to the requirements, the RFC suggestion, such as operating frequency, average power level of electromagnetic emission, out-of-band suppression level, safety protection distance and so on, can be drawn up.

For example, suggestion for 4G is as follows:

- ◆ operating frequency is 2520~2690MHz
- ◆ percentage of time that lumped average power is higher than $-59\text{dBm/MHz} \leq 1\%$ (in any 50% area of $500 \times 500\text{m}^2$ and 3m height)
- ◆ average power of out-of-band emission $\leq -125\text{dBm/MHz}$

04

Brief summary

This report is dedicated to RFC of BeiDou RDSS with adjacent systems services, and puts forward a bilateral way derived from the electromagnetic sensing element and electromagnetic interference source.

As for BeiDou RDSS, the multistage filter-amplifier cascade scheme is designed to optimize BDUE RFC, and then the technical requirement is determined.

As for adjacent systems services, the emission requirements having given “broken line” attributes are deduced, and the suggestion is offered accordingly.

THANK YOU!

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