

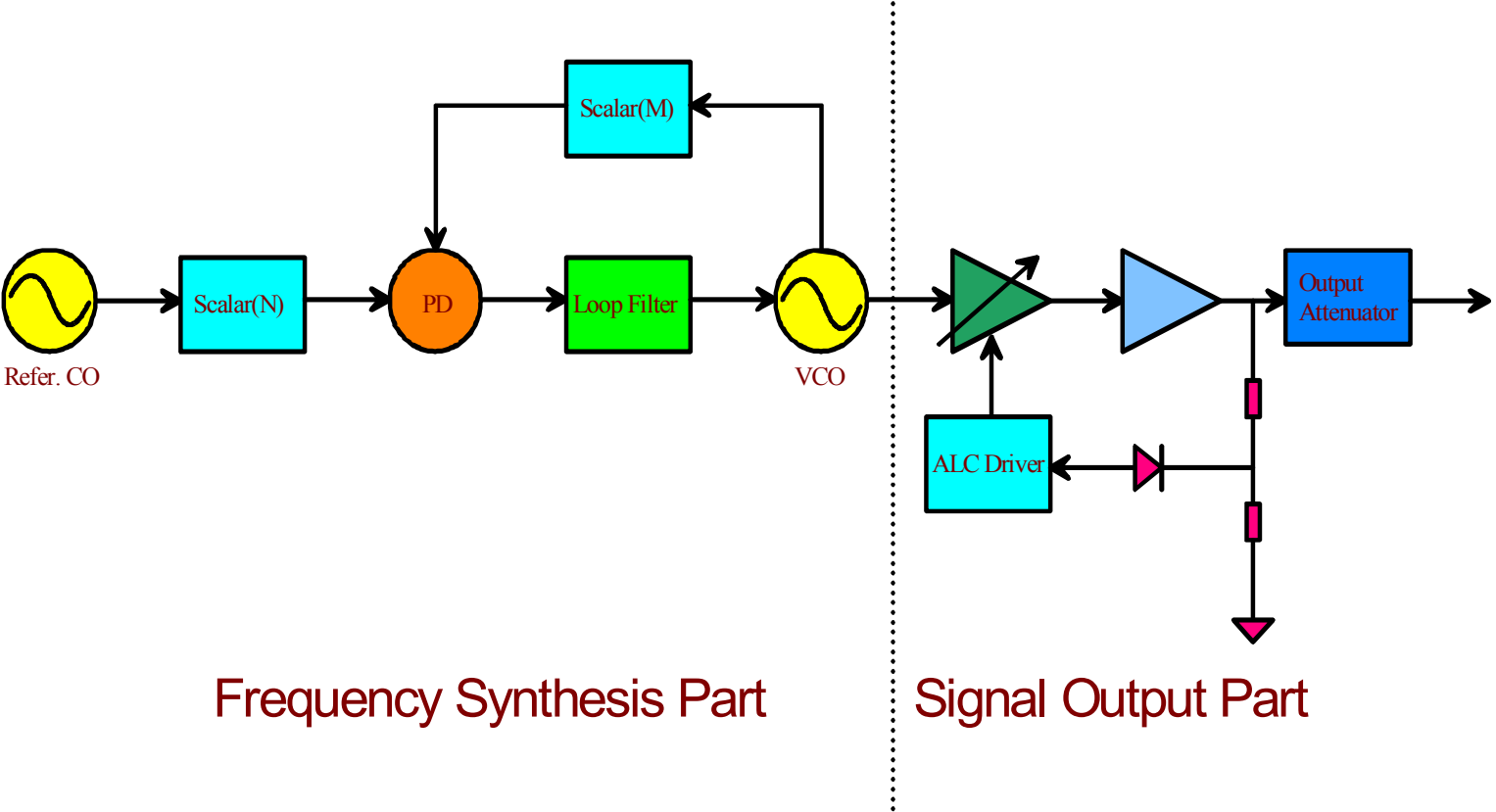
数字信号源SMU200A

www.rohde-schwarz.com.cn

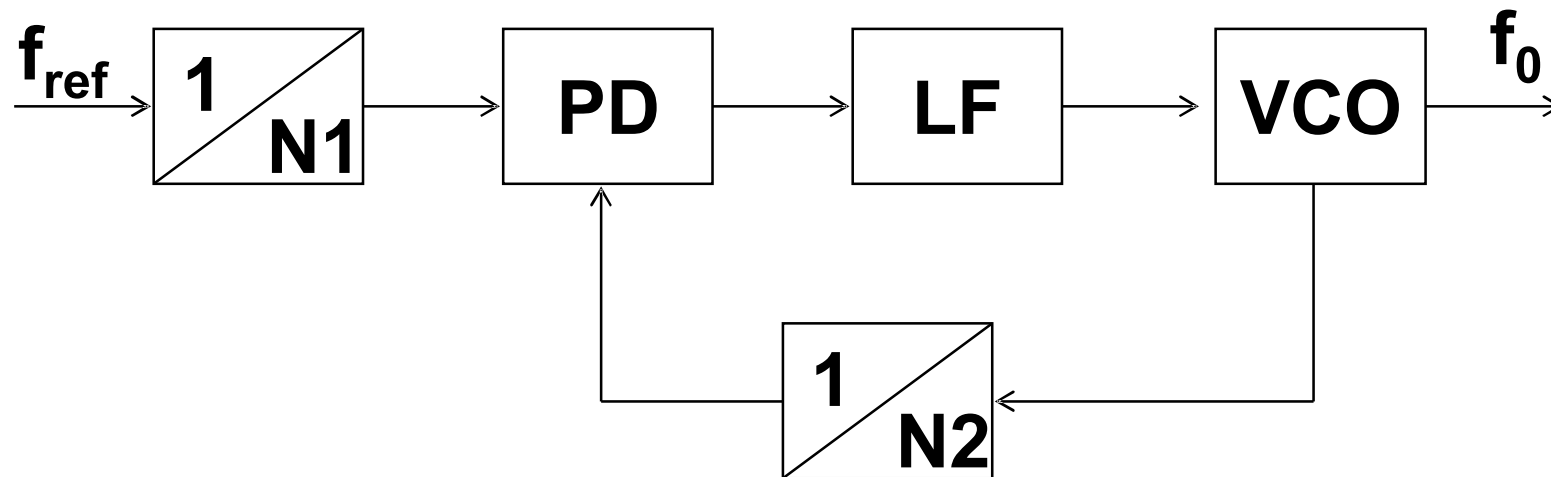
主要内容

- | 模拟信号源
- | I/Q调制与数字信号源（QPSK调制）
- | SMU200A介绍
- | 噪声产生
- | 信号衰落
- | 基带信号
- | 数字标准GSM/WCDMA
- | 任意波形发生器ARB
- | 信号源在接收机测试中的应用

模拟信号源的原理和结构



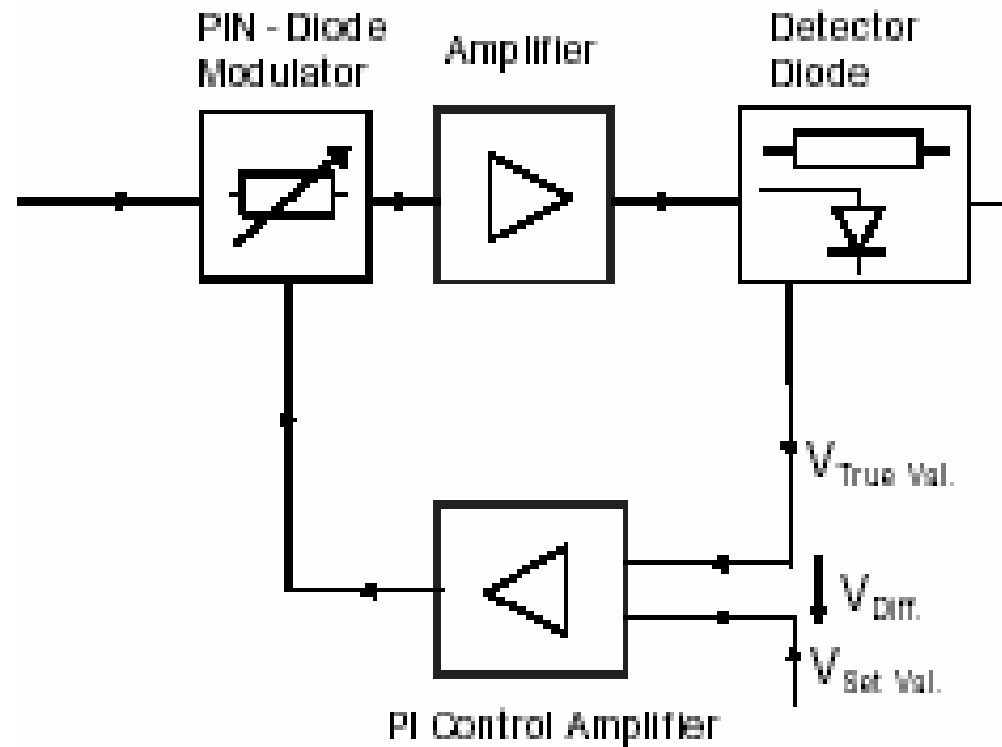
PLL: phase lock loop 锁相环



$$f_0/N_2 = f_{\text{ref}}/N_1$$
$$f_0 = f_{\text{ref}} * N_2/N_1$$

ALC:自动电平控制

ALC - Automatic Level Control

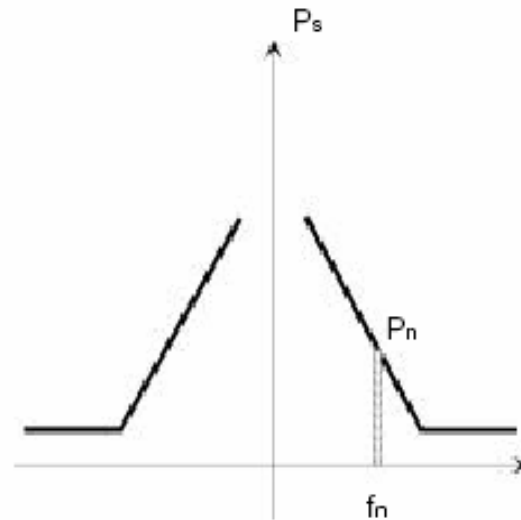


模拟调制

- | 调幅AM
- | 调频FM、调相PhM
- | 宽带调幅BBM
- | 脉冲调制PM

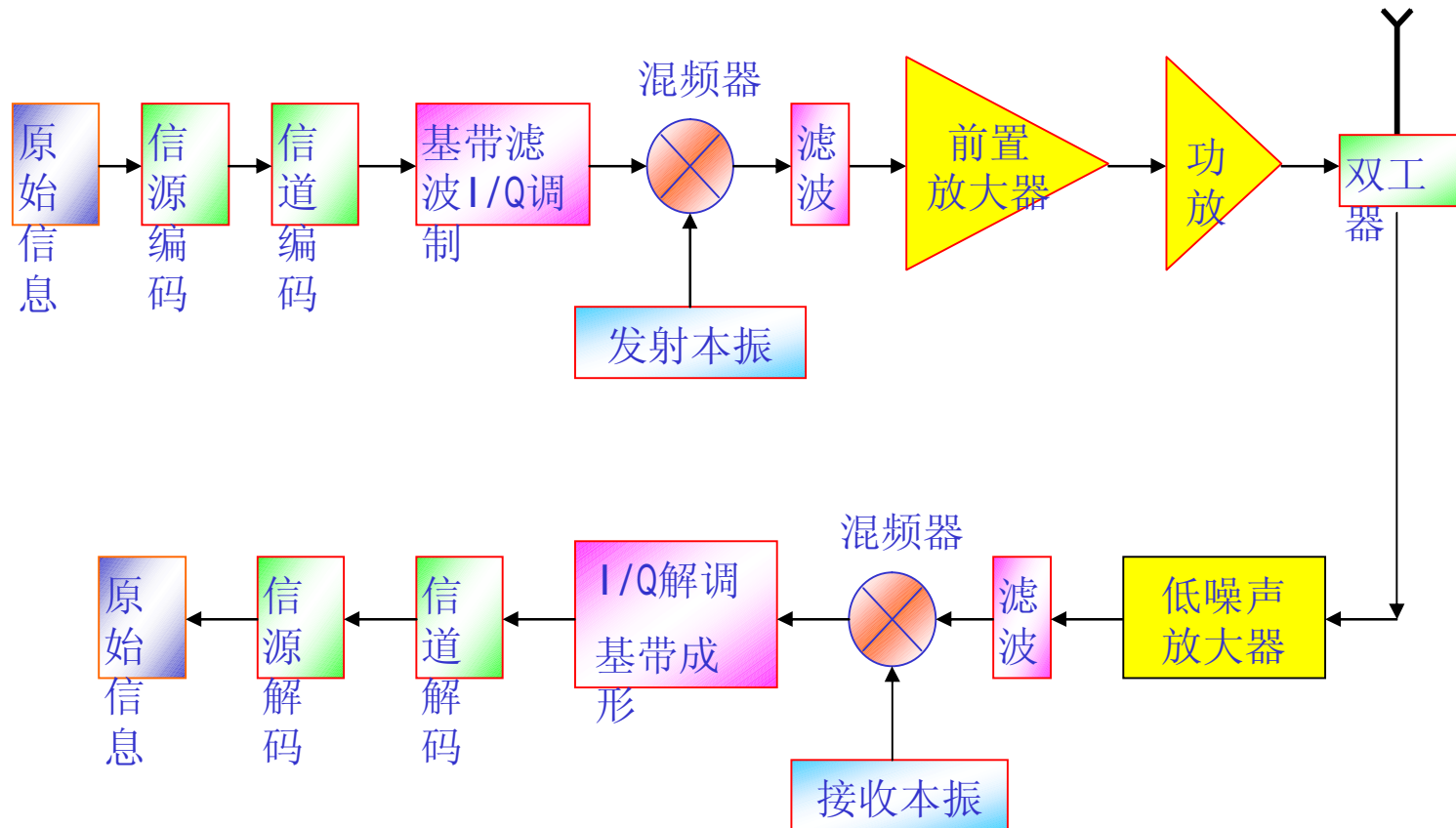
相位噪声

1. 相位噪声, 在偏离载波固定位置处 f_n , 单位带宽 1Hz 内的噪声功率 P_n 与信号总功率 P_s 的比值。
2. 相位噪声是反映单载波信号的频谱纯度
3. 单位为 $\text{dBc}/\text{Hz}@ f_n \text{ offset}$, 如 $-135\text{dBc}/\text{Hz}@10\text{kHz}$

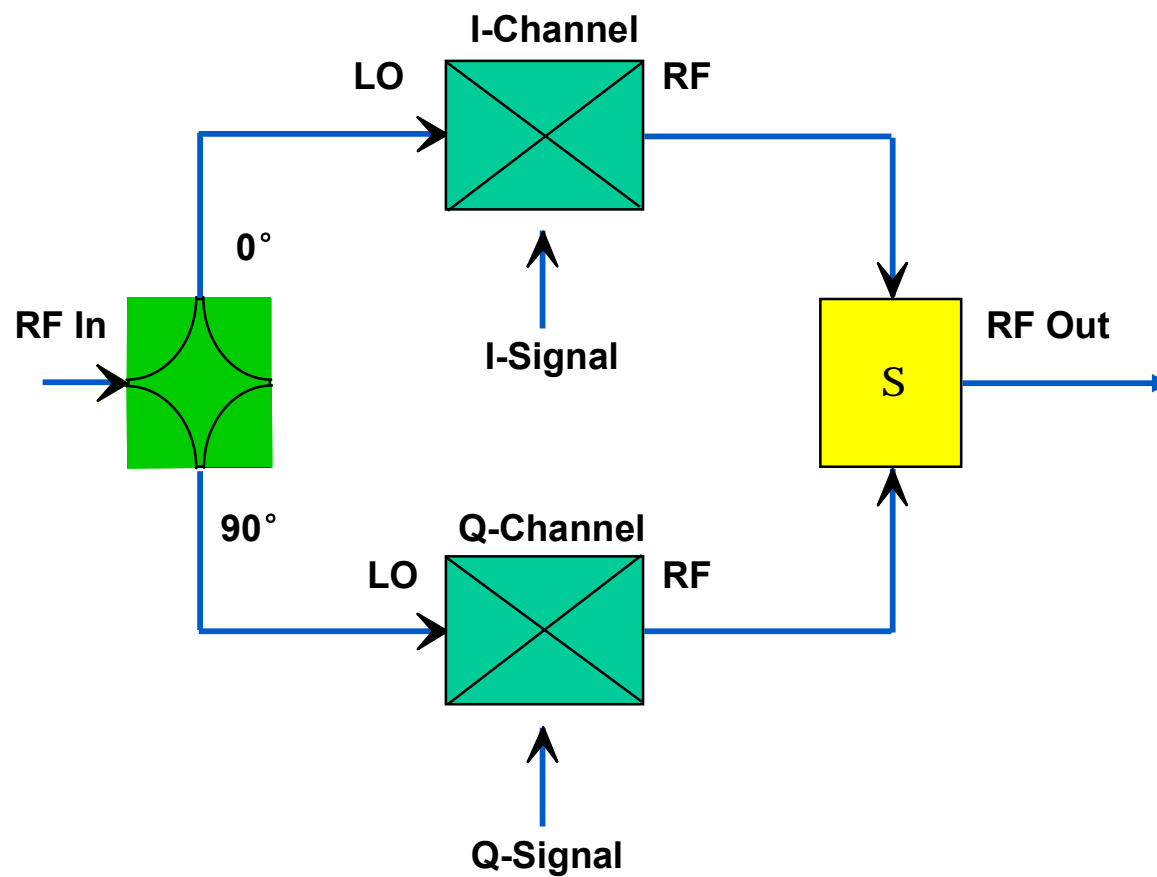


$$L(f) = 10 * \log \frac{P_n}{P_s}$$

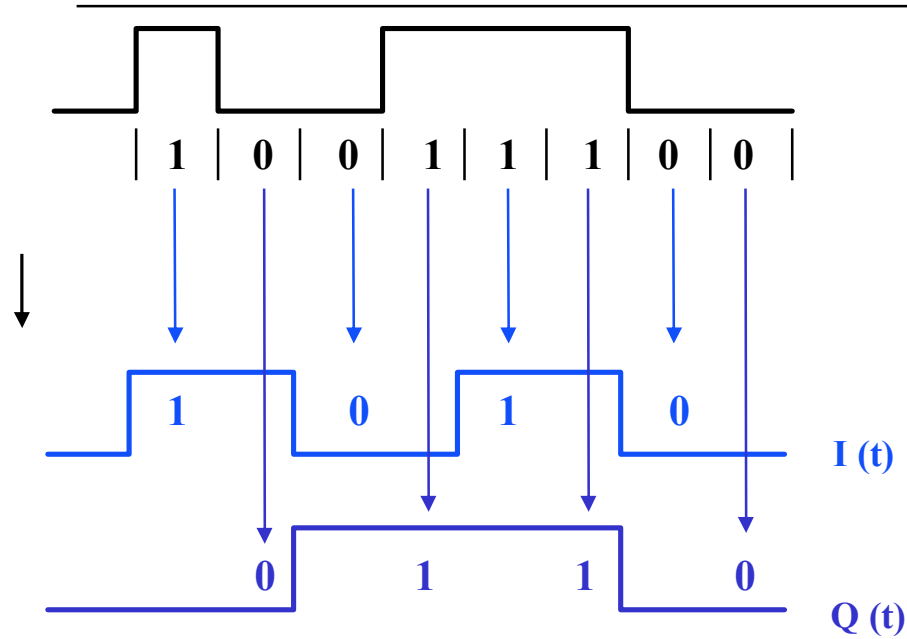
2、数字RF系统的构成



数字调制/IQ调制解调器



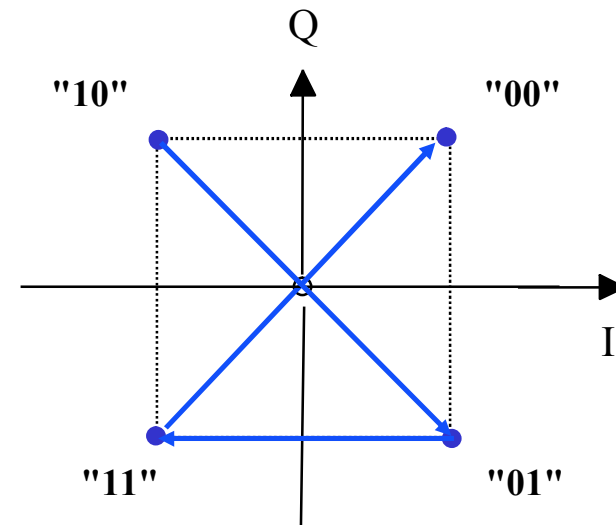
QPSK 正交相移键控



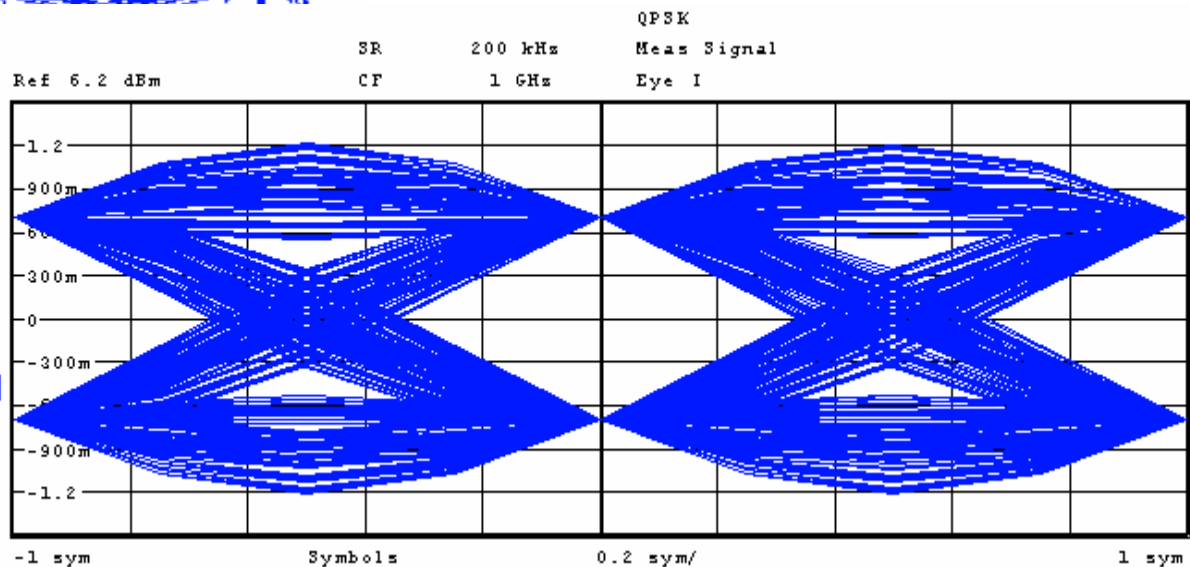
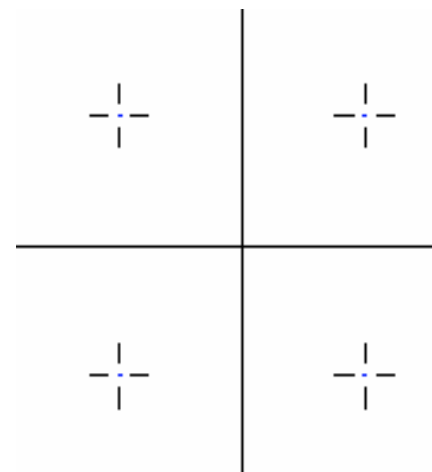
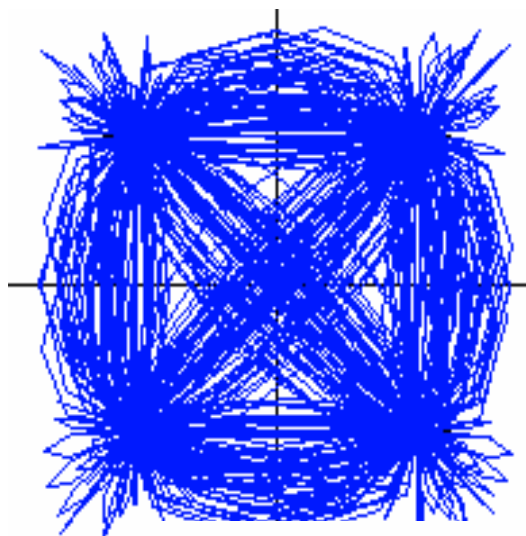
Serial / Parallel conversion of bits to Dibits = Symbols

10 01 11 00

Bit Sequence		Dibits		Transmitted Phase
1	2	I	Q	
0	0	0	0	45 °
1	0	1	0	135 °
1	1	1	1	225 °
0	1	0	1	315 °



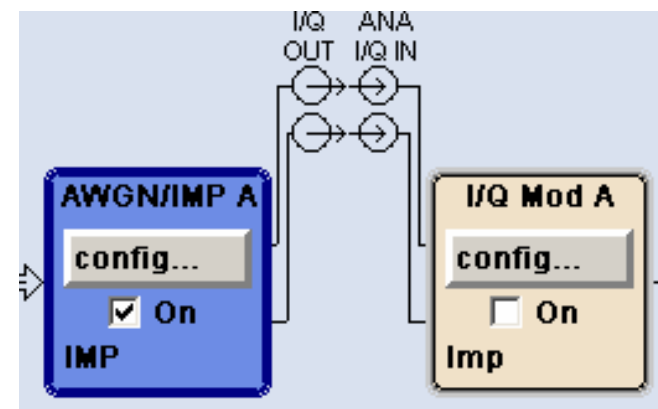
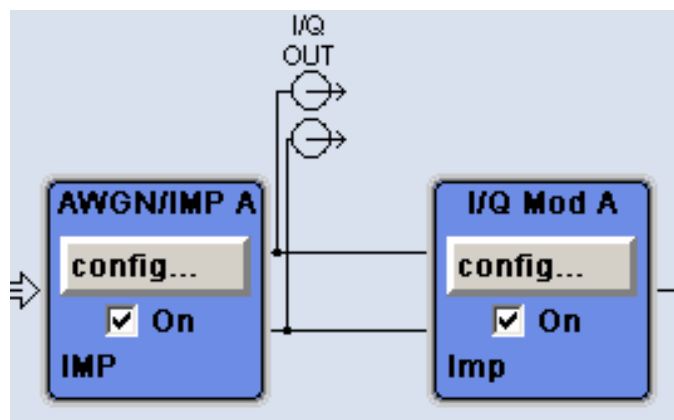
矢量图/星座图/眼图(QPSK)



矢量调制

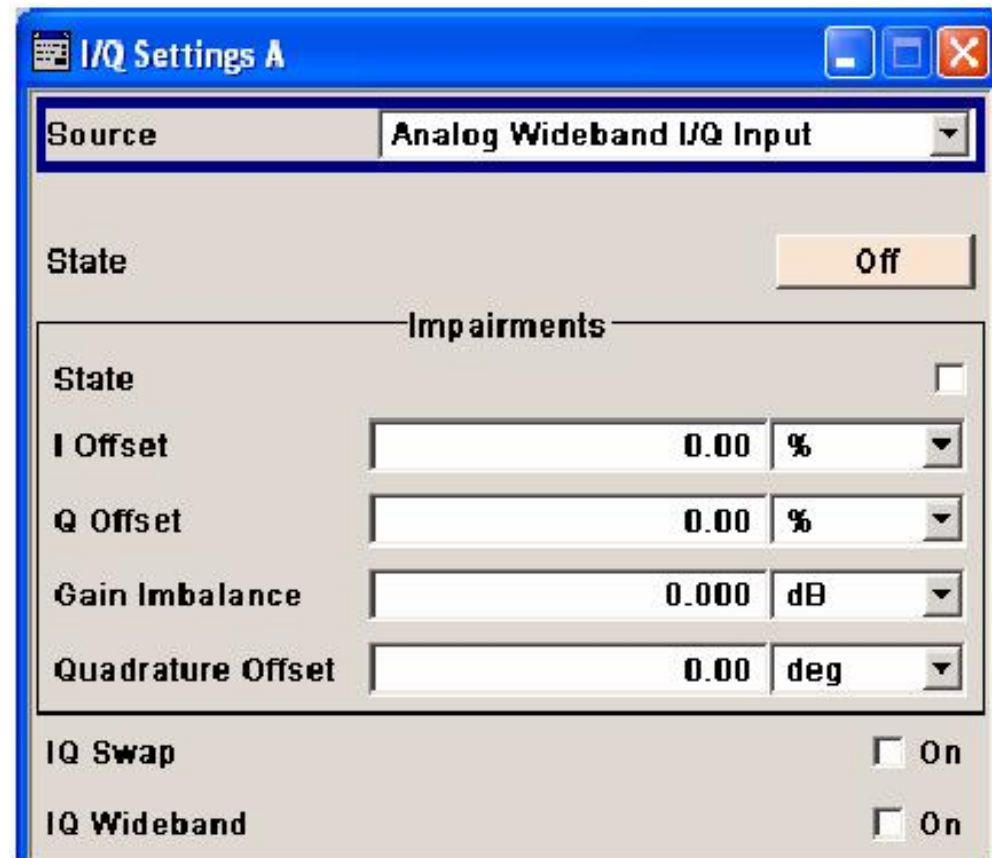
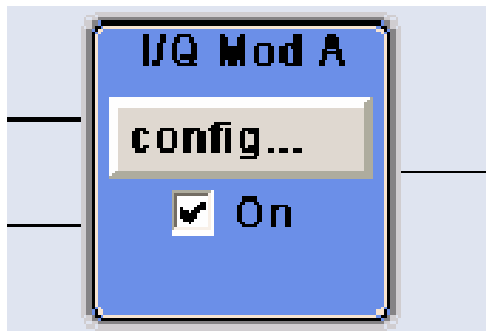
IQ调制器

- 良好的频谱纯度
- 低交叉调制
- 内部IQ调制：40MHz的基带信号带宽(-3dB), 80MHz射频带宽
- 外部IQ调制：200MHz射频带宽



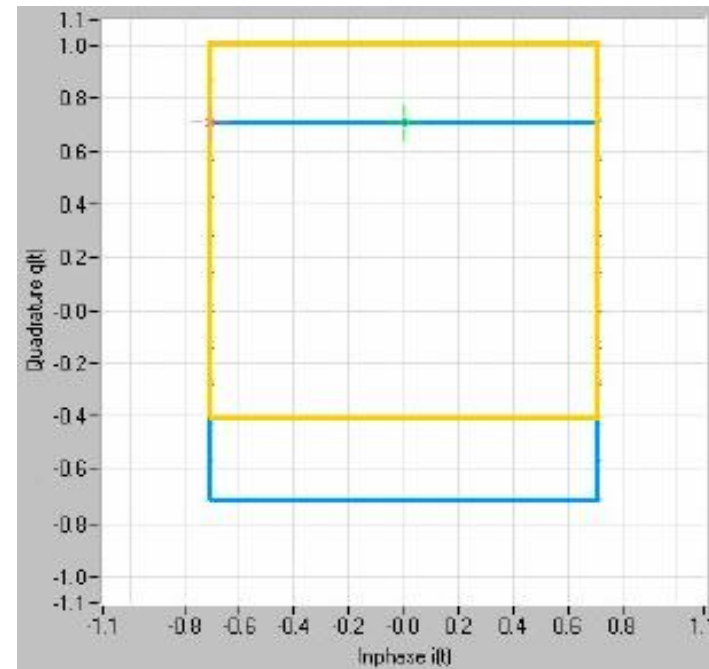
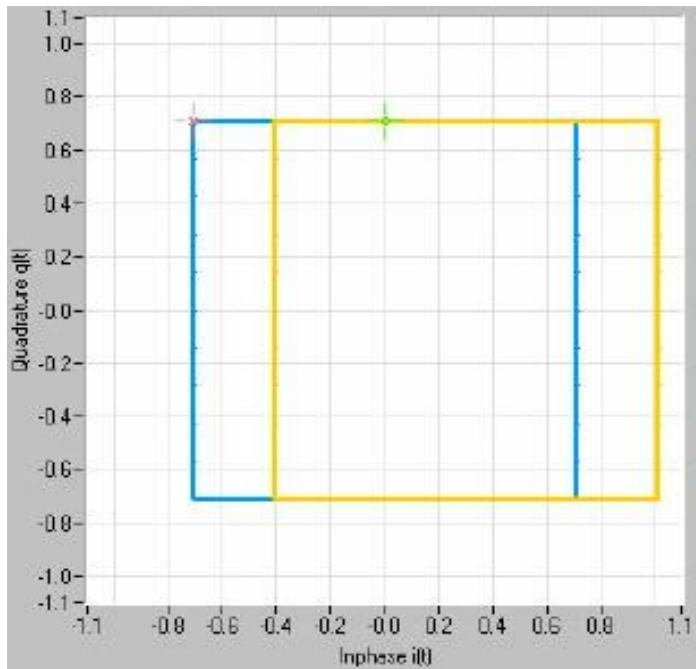
矢量调制

- | Analog IQ Impairment (在I/Q MOD模块中实现)
- | I Offset
- | Q Offset
- | Gain Imbalance
- | Quadrature Offset



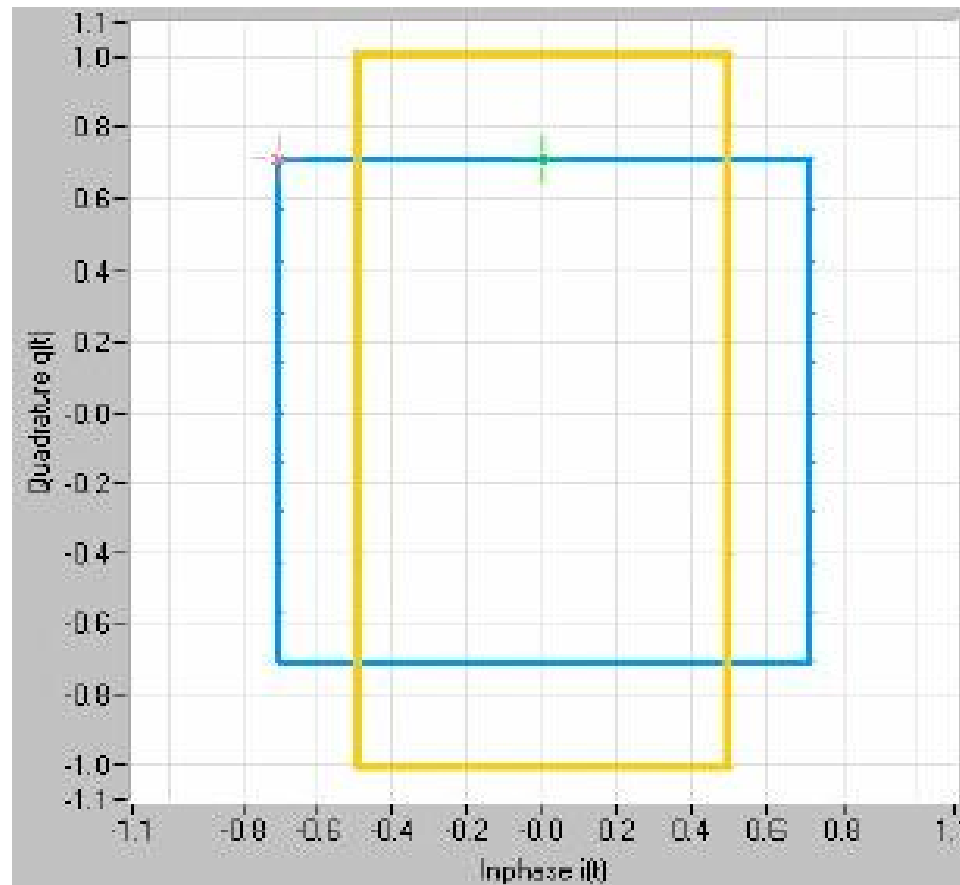
矢量调制

I/Q Offset



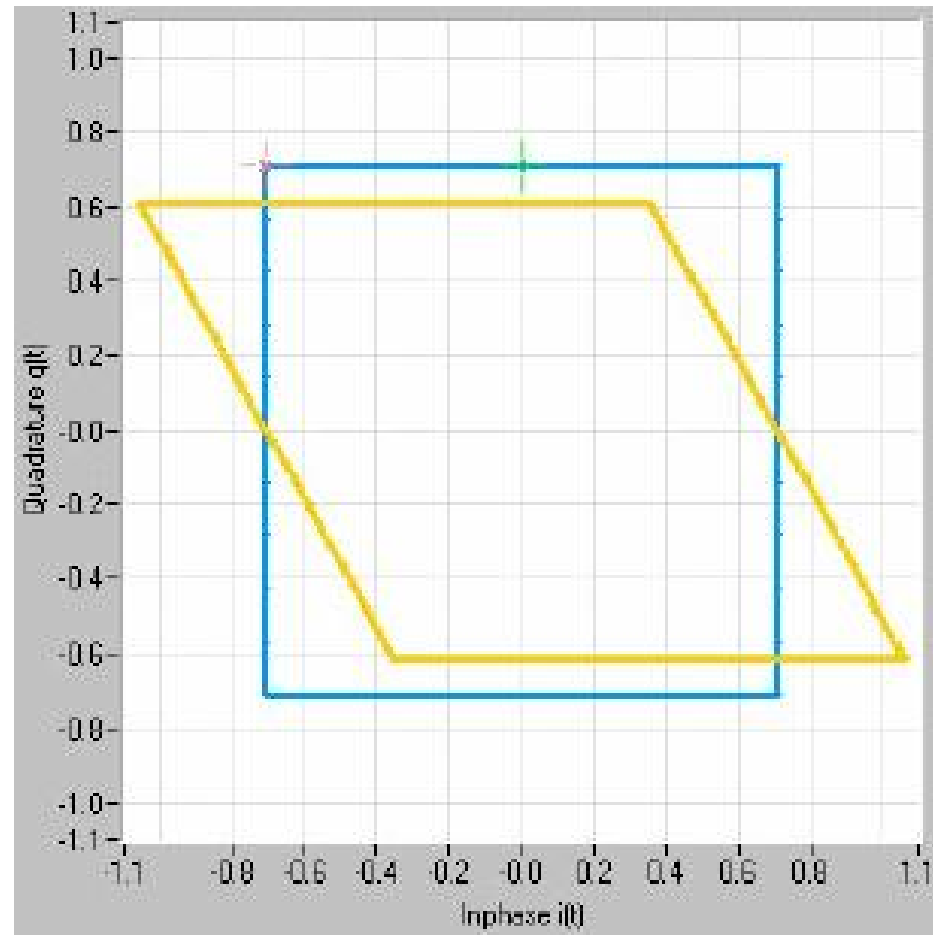
I Gain Imbalance

$$\text{Imbalance [dB]} = 20 \log (| \bar{\text{Gain}}_q | / | \bar{\text{Gain}}_i |)$$



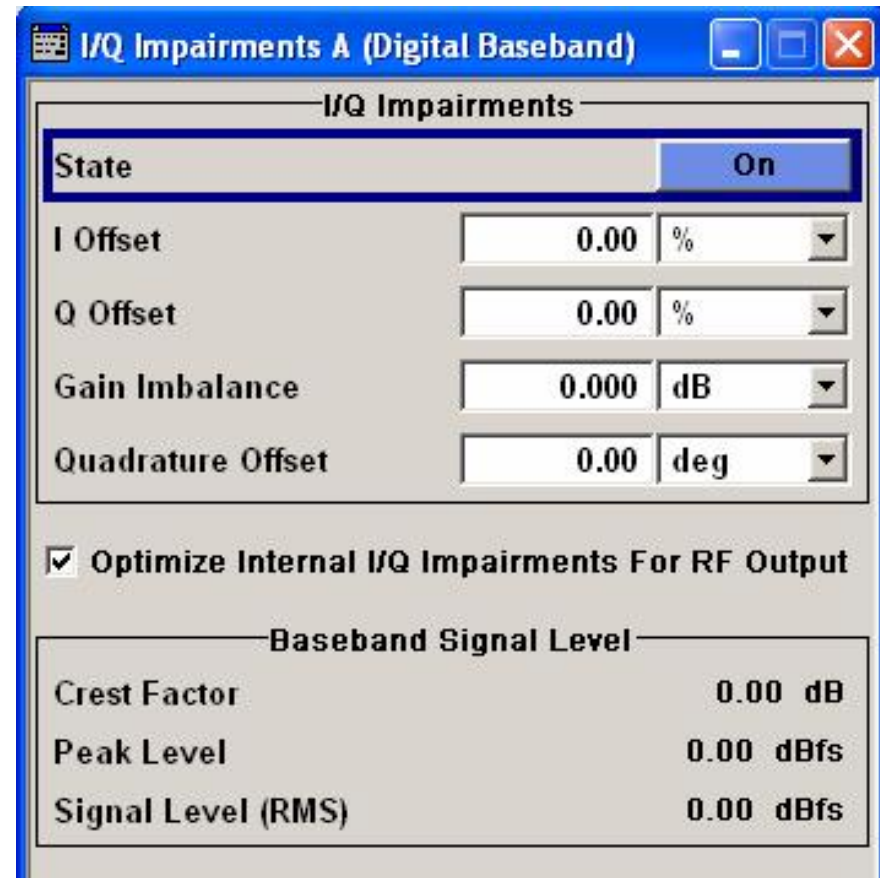
矢量调制

I Quadrature Offset

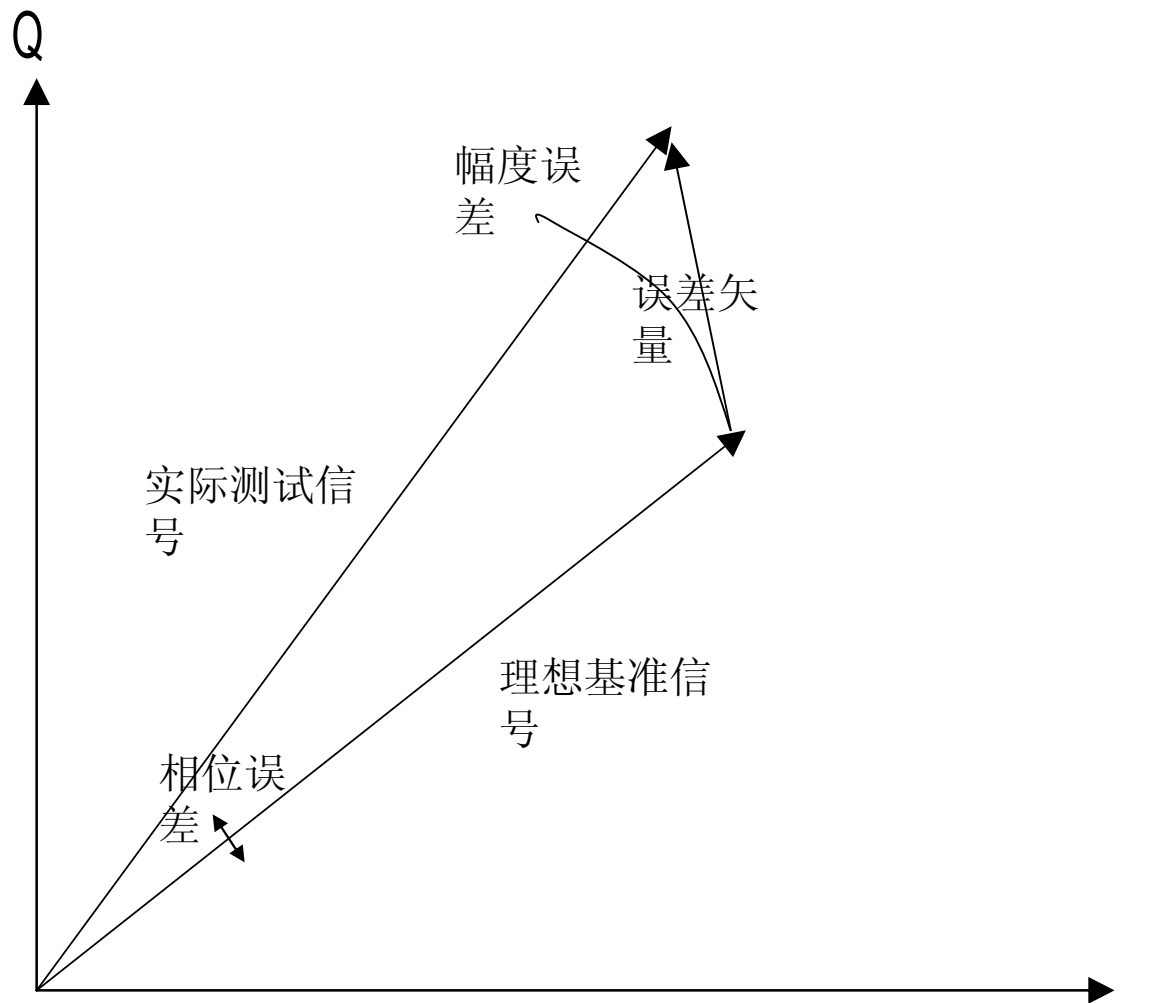


Impairments(Digital baseband)

- | 数字基带IQ impairments在AWGN/IMP模块中实现
- | 在内部产生的数字基带信号中加入IQ不理想性
 - IQ out输出，为被测件提供失真的IQ信号
- | 内部数字基带的IQ impairments可以和IQ调制器中的IQ impairments同时存在



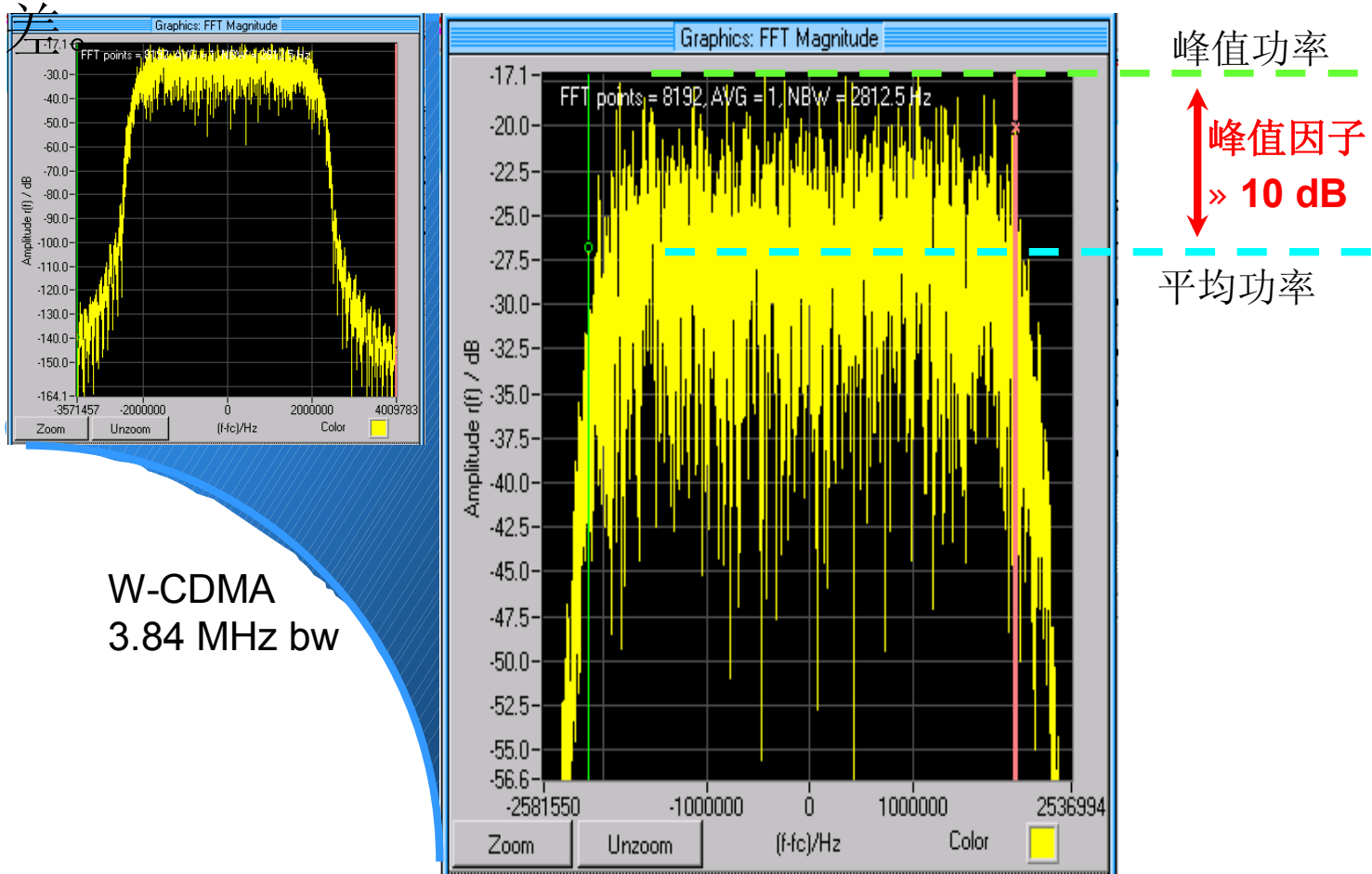
EVM: Error vector magnitude 矢量幅度误差



峰值因子 (crest factor)

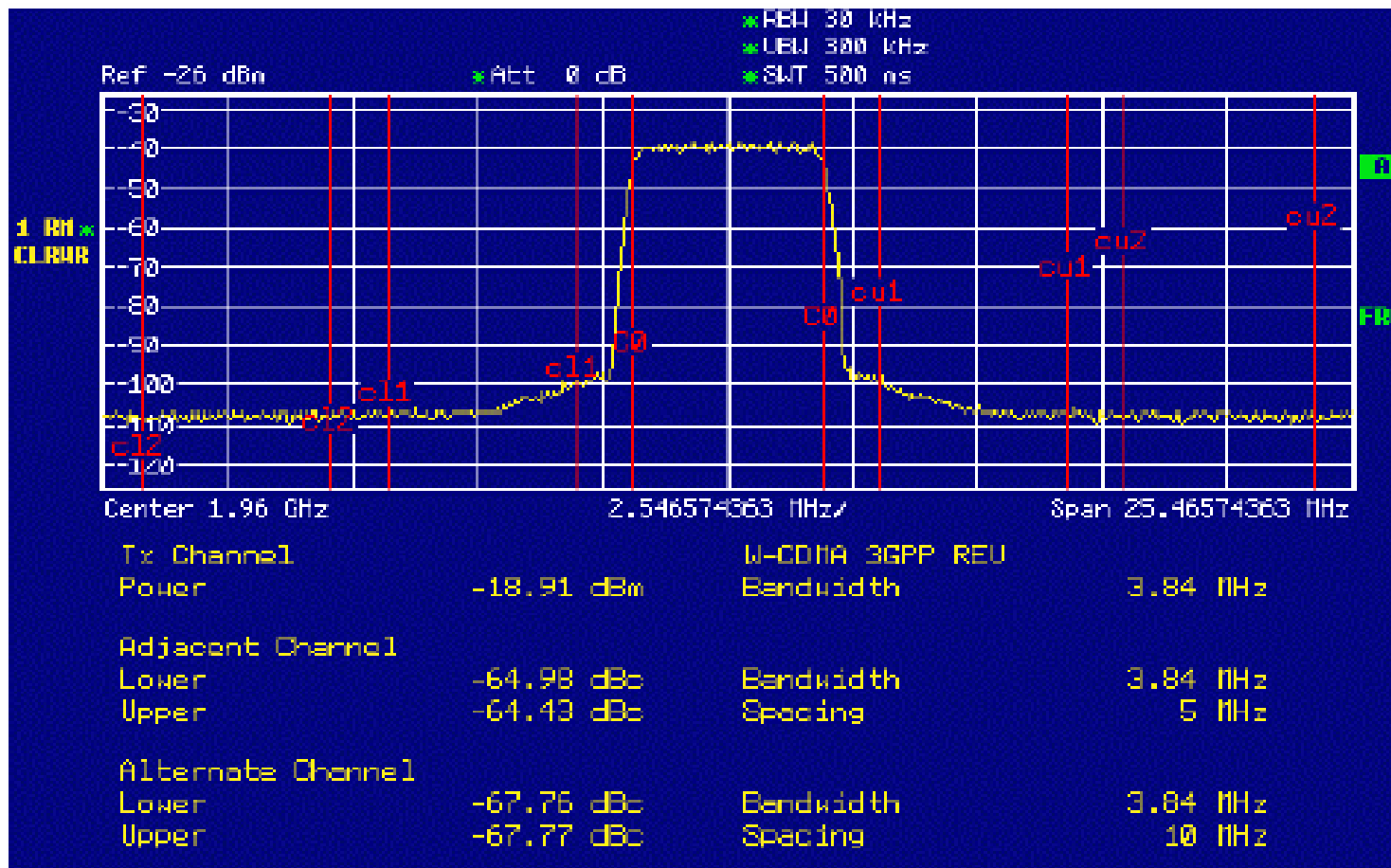


峰值因子，又称为峰均比，是峰值功率和平均功率之差



邻信道功率泄漏比ACLR

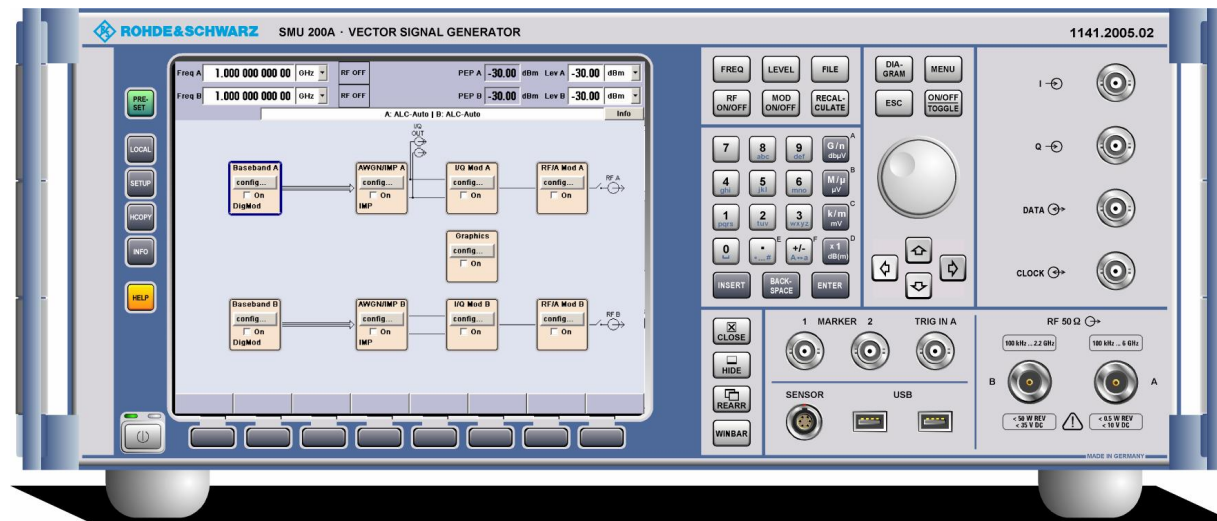
ACLR是主信号的功率与相邻信道的功率的比值,它反映宽带信号的频谱纯度.



概述

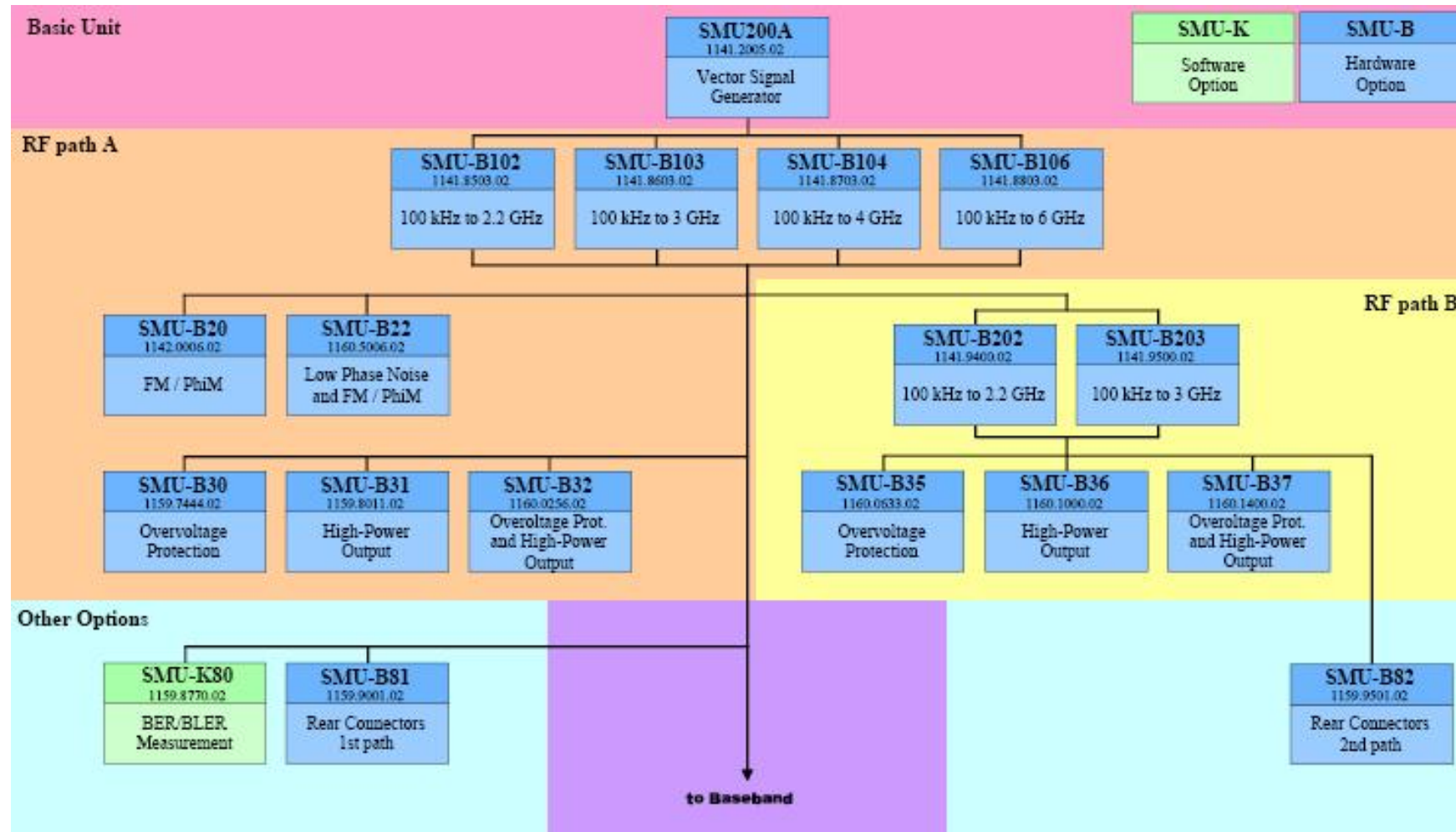


1 信号源的艺术---SMU200A



概述

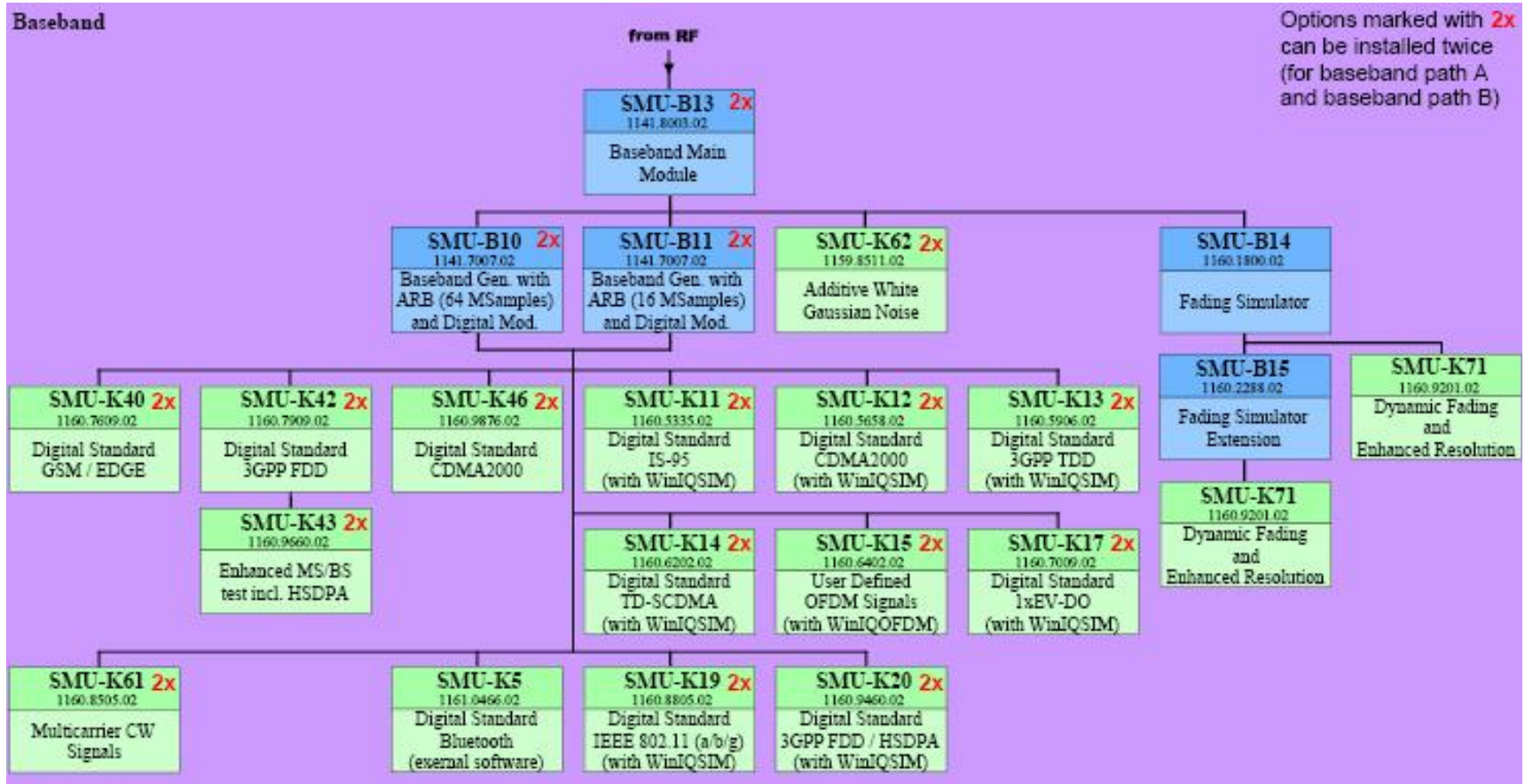
RF options (射频选项)



概述



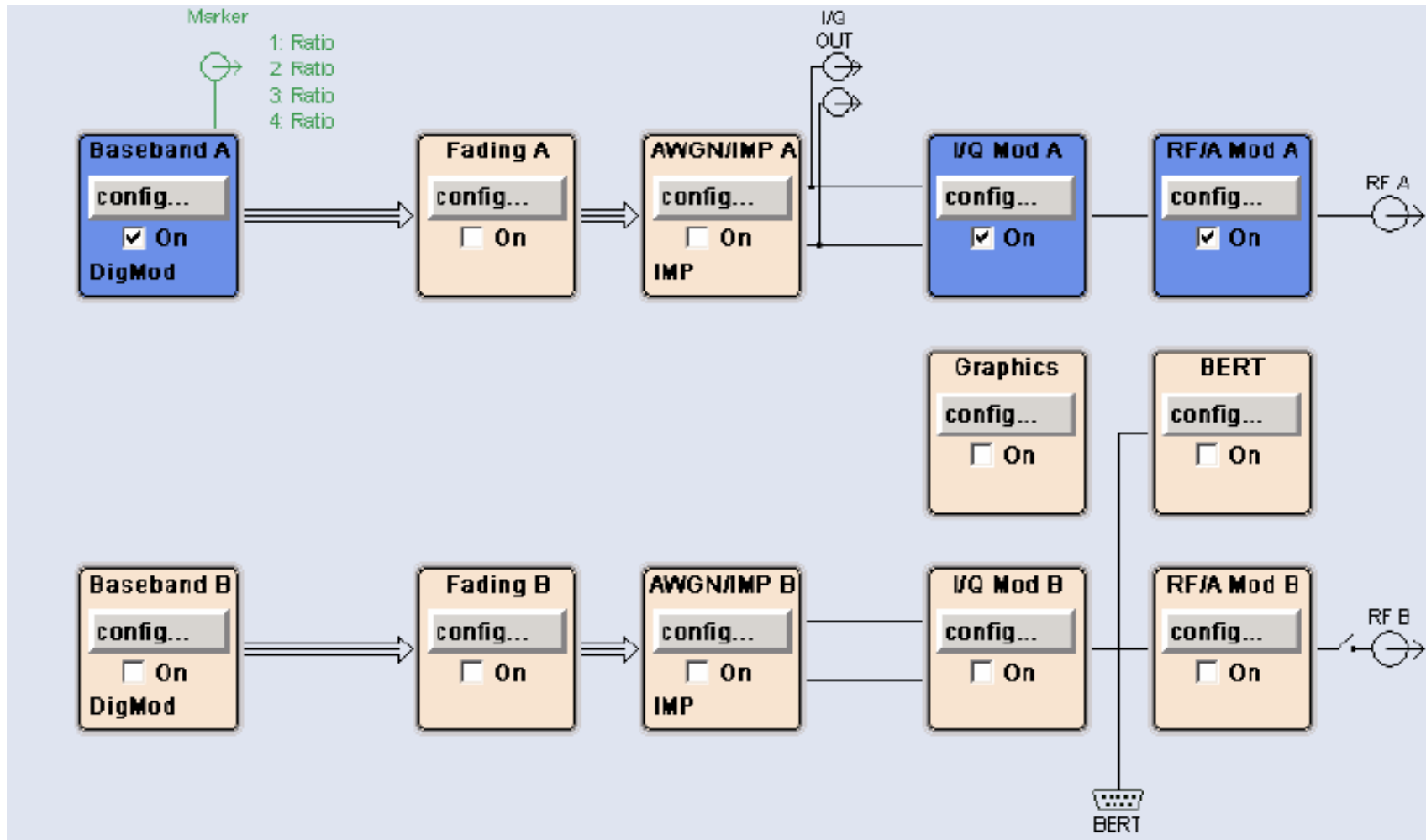
Baseband options(基带选件)



最小配置: SMU200A、SMU-B103、SMU-B13、SMU-B11

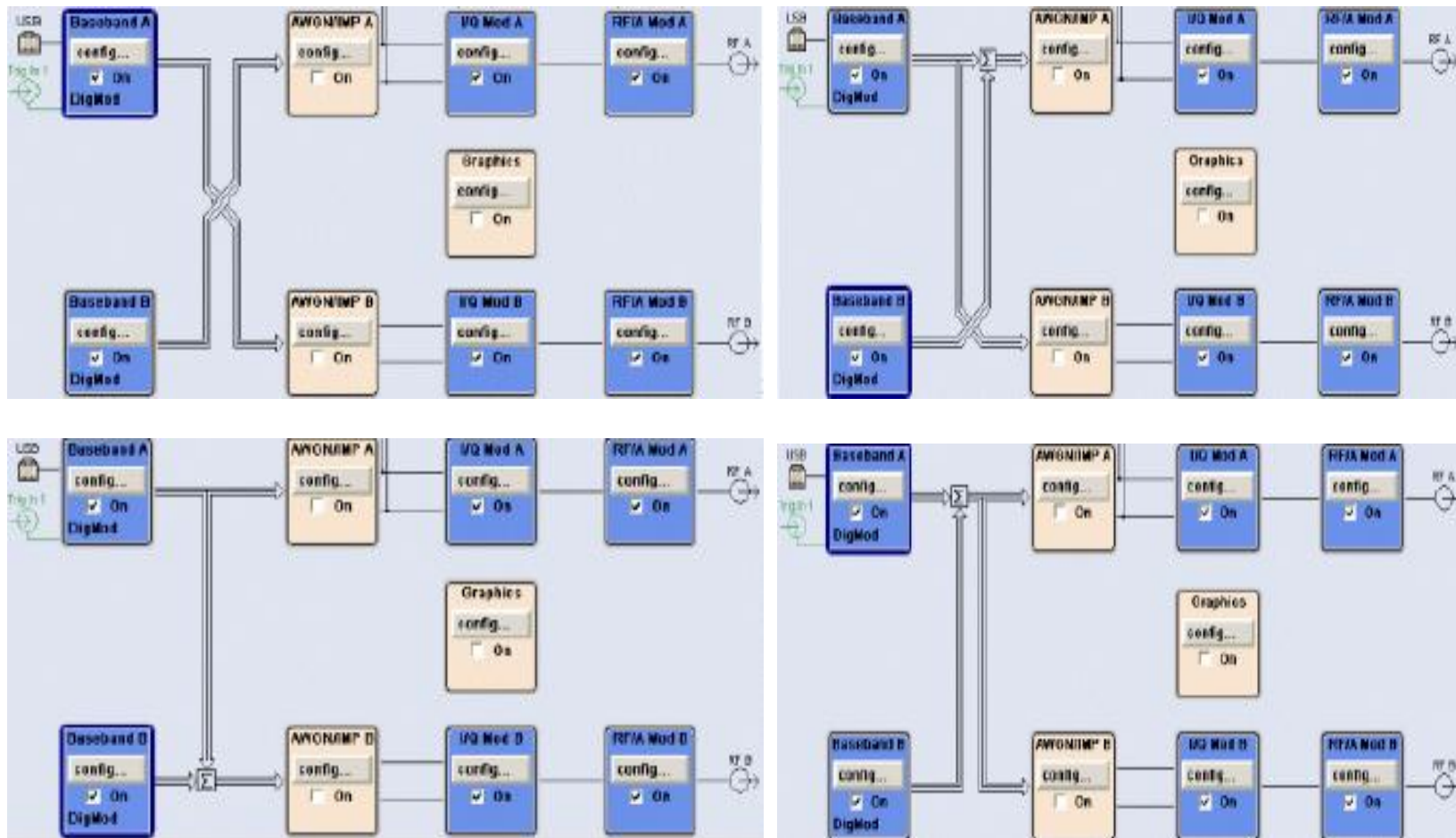
概述

I 结构框图



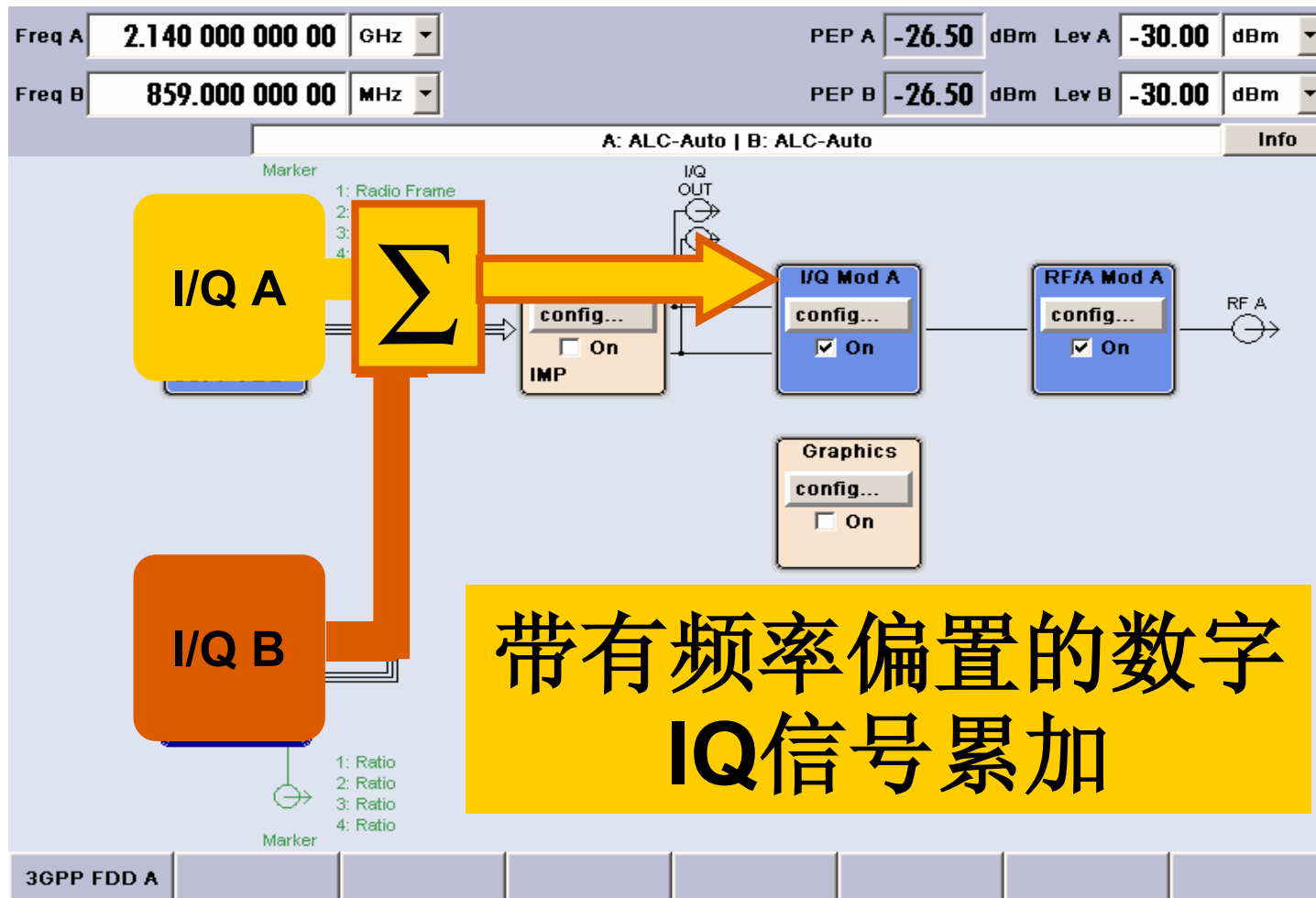
基带信号

灵活的基带信号配置

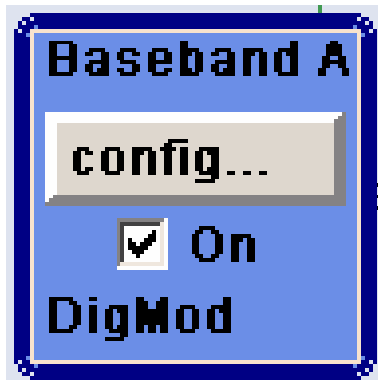


基带信号

I IQ信号的数字化叠加



通用数字调制



实时数字调制

ASK 高达 25 Msym/s

PSK 高达 25 Msym/s

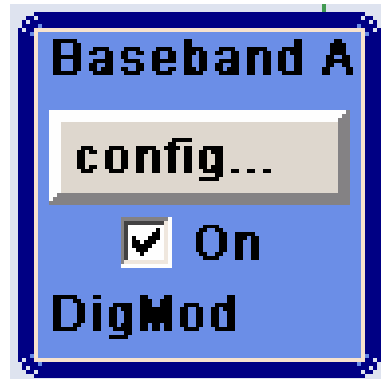
QAM 高达 25 Msym/s

FSK 高达 15 Msym/s

包含了所有重要的滤波器类型和编码方式

数字调制

| 数据源



PRBS

Patterns

Data and control lists

**External data
(serial, parallel, USB)**

- | AWGN发生器
- | I/Q不相关
- | 噪声信号的周期和选定的系统带宽相关

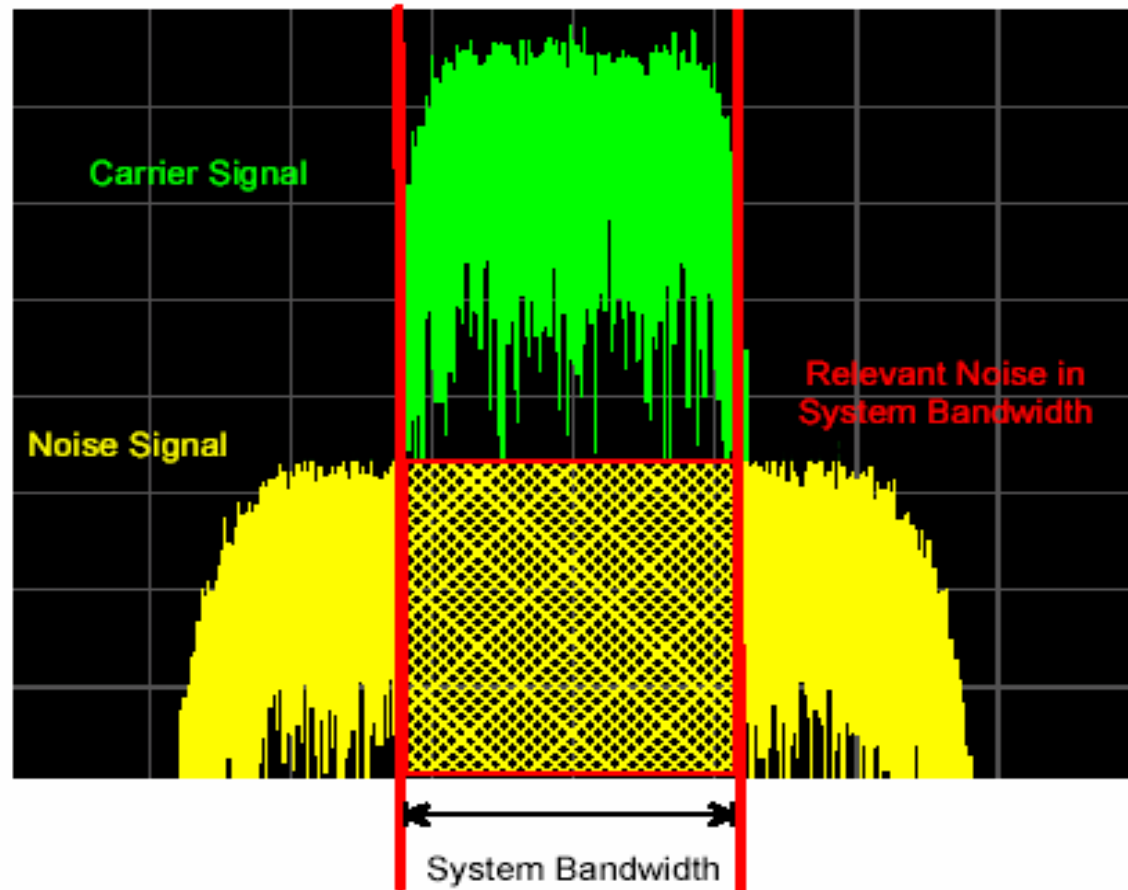
$$P \approx 1 \cdot 10^{13} / B_{\text{sys}}$$

对应3GPP，周期约为1月；对应GSM，约为427天

- | 两种模式：Additive Noise/Noise Only

噪声产生

| 系统带宽



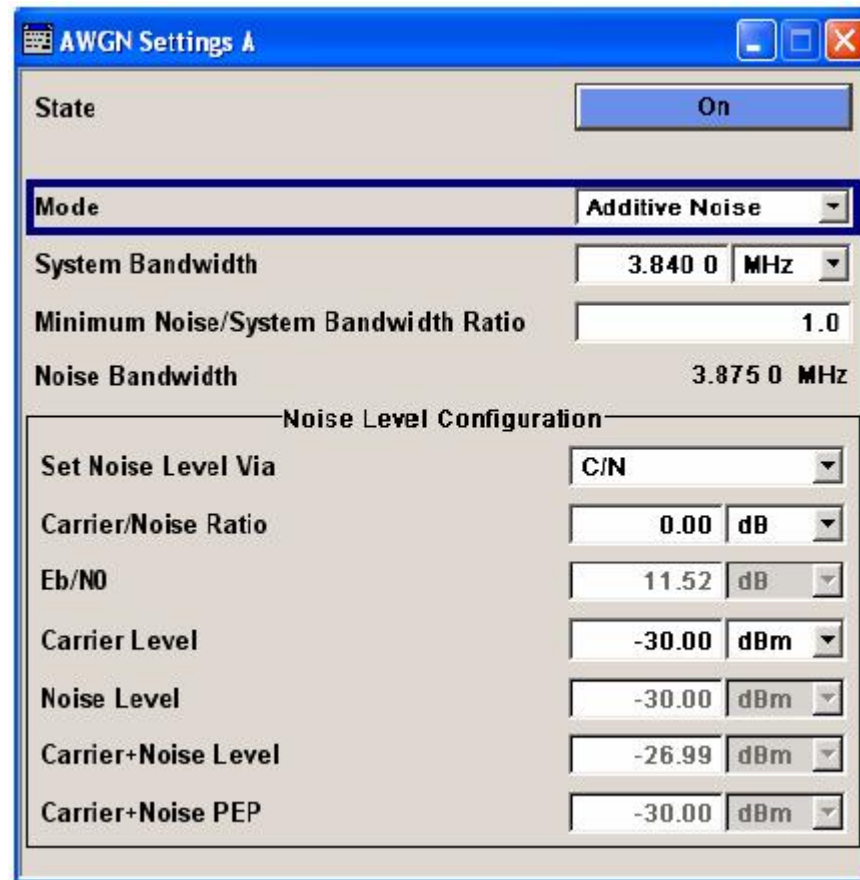
噪声产生

I C/N或Eb/No

$$\frac{C}{N} = \frac{E_b}{N_0} + 10 \log\left(\frac{f_b}{B_{sys}}\right)$$

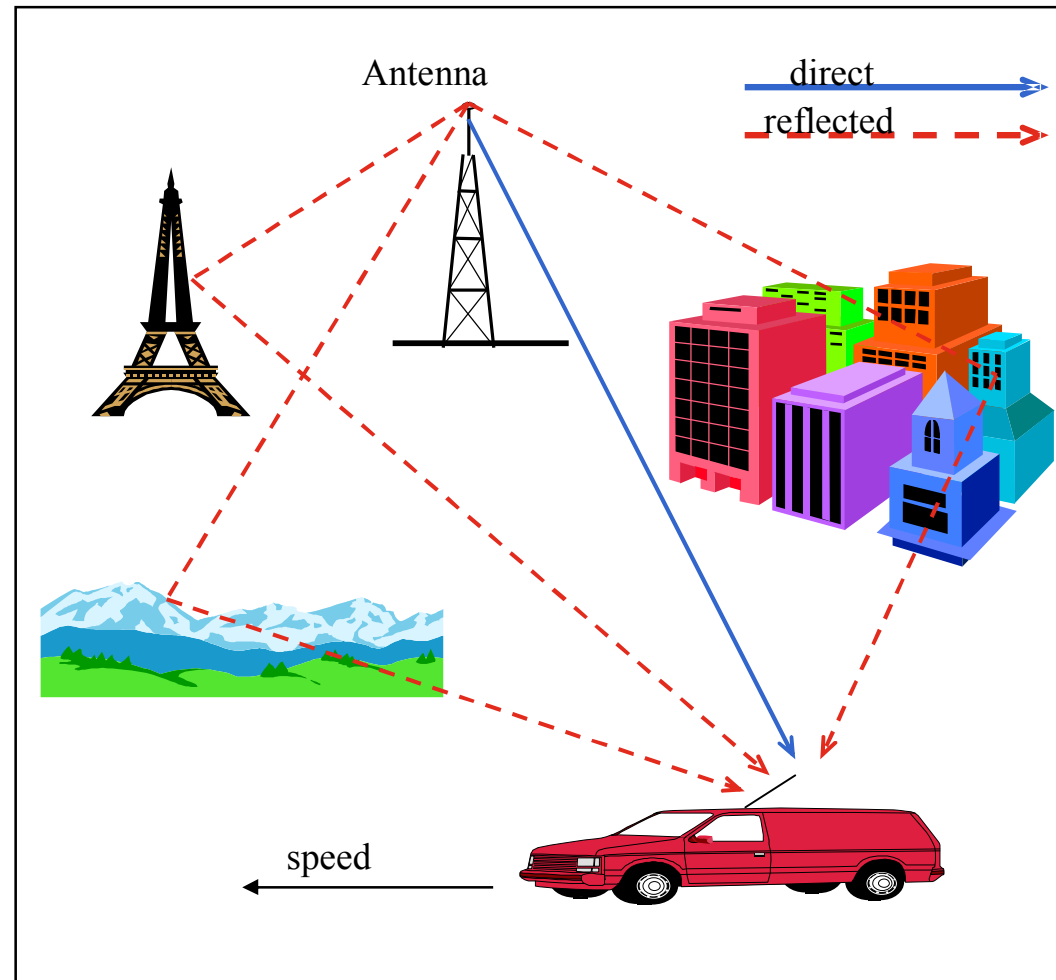
f_{bit} = Bit rate (Symbol rate x Modulation value)

B_{sys} = System bandwidth



衰落模拟

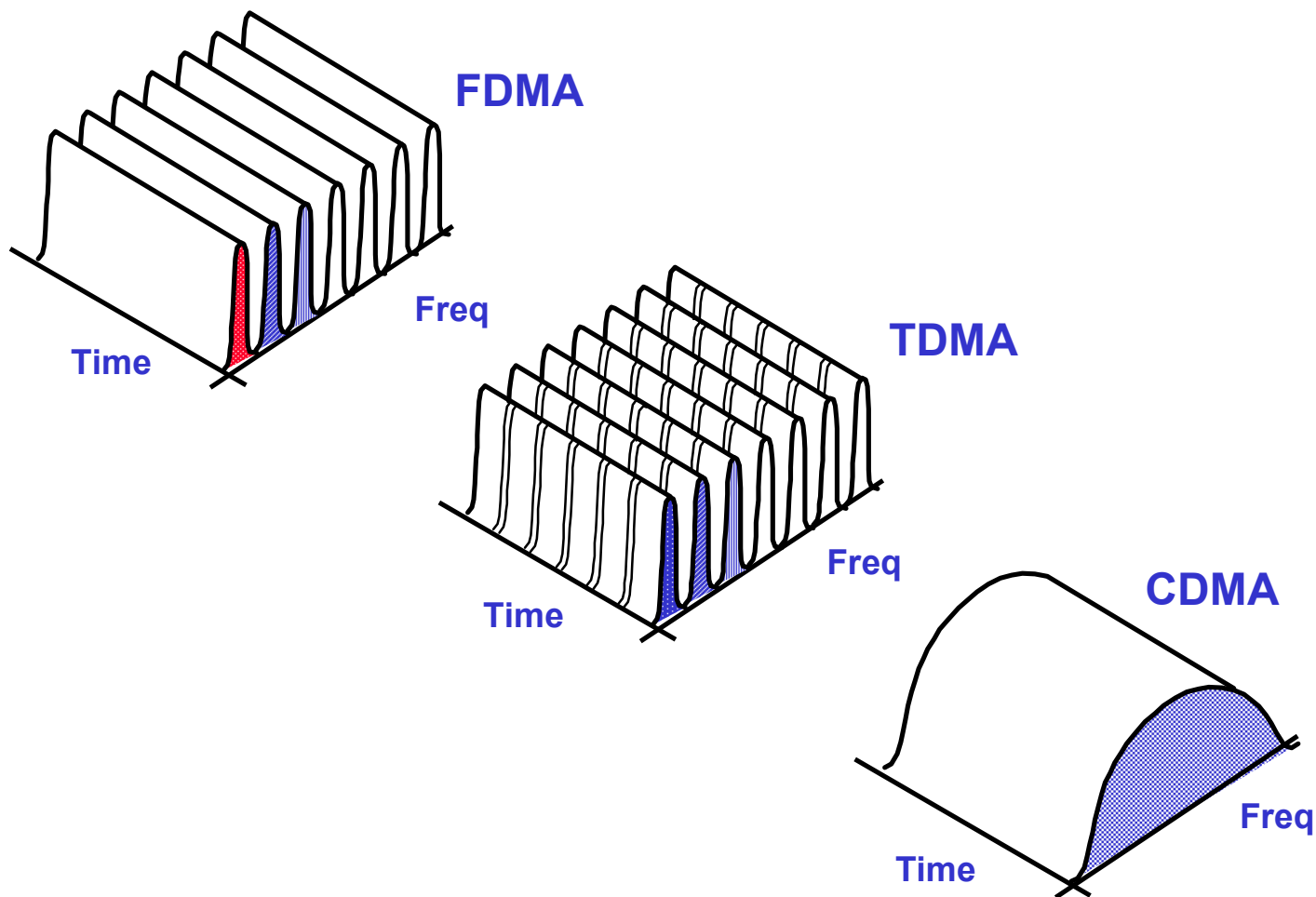
I 衰落



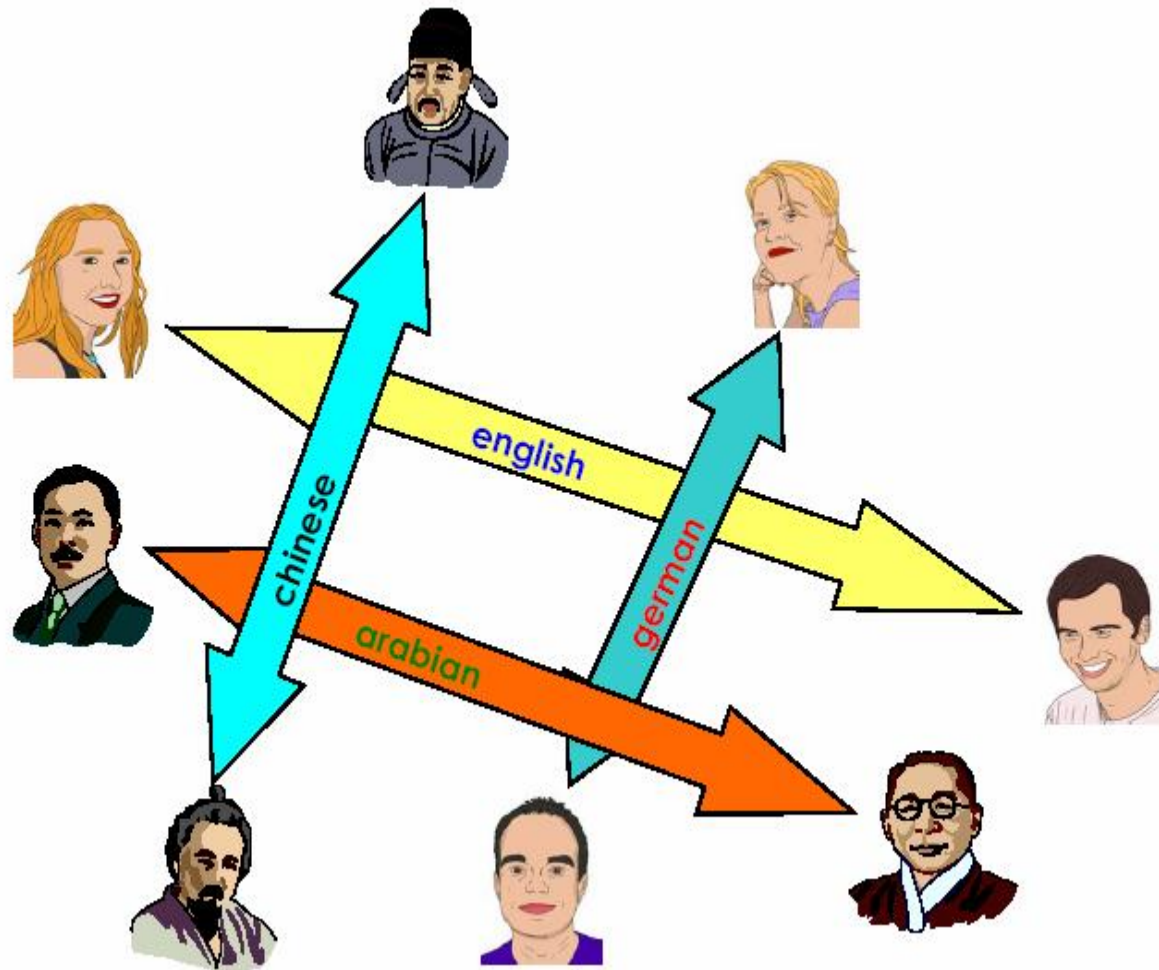
| 衰落的类型

- | 多普勒频移 由接收机的相对速度决定
- | 瑞利衰落 众多反射体所产生的散射信号，无直射波
- | 莱斯衰落 和瑞利衰落一样，但包含直射波
- | 对数正态 幅度慢变化，以幅度变化的对数值（高斯正态分布）和速度来定标

分址方式

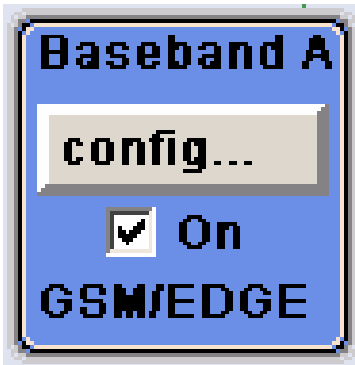


CDMA



数字标准

| 通信标准



GSM/EDGE (实时)



3GPP FDD (实时 + ARB)

cdmaOne

cdma2000

3GPP / W-CDMA TDD mode HCR

TD-SCDMA

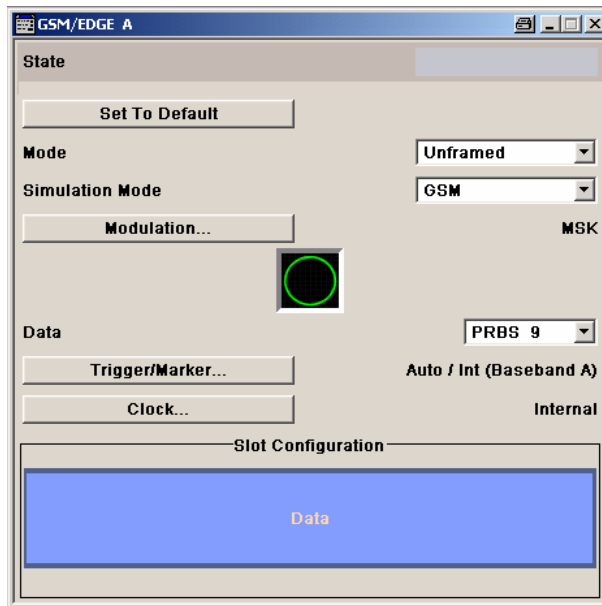
WinIQOFDM

cdma2000 1xEV-DO/DV

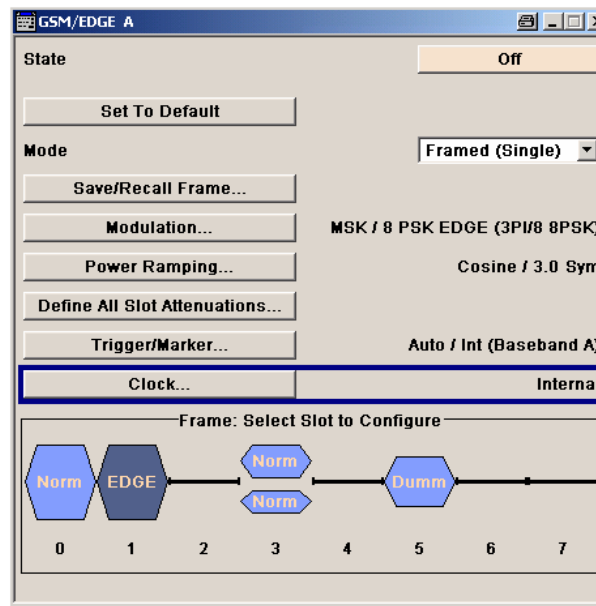
IEEE 802.11 (a/b/g)

数字标准

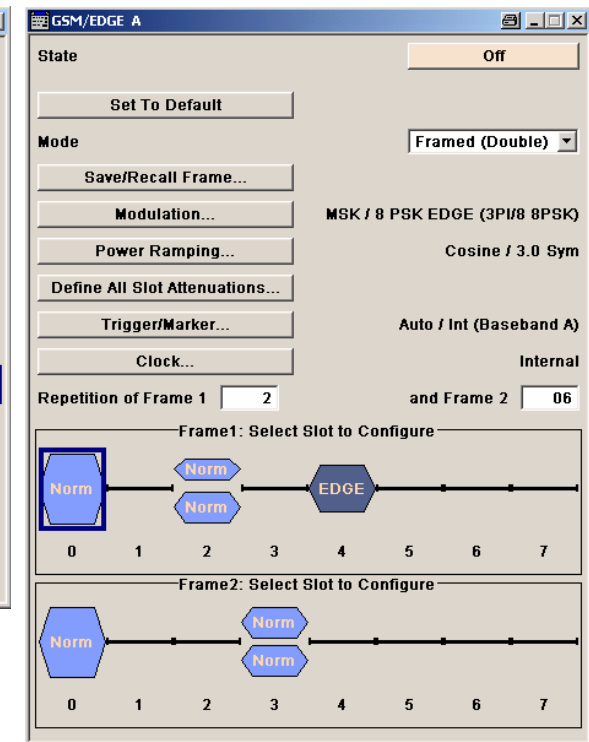
- | GSM
- | 3个不同的工作模式



Unframed



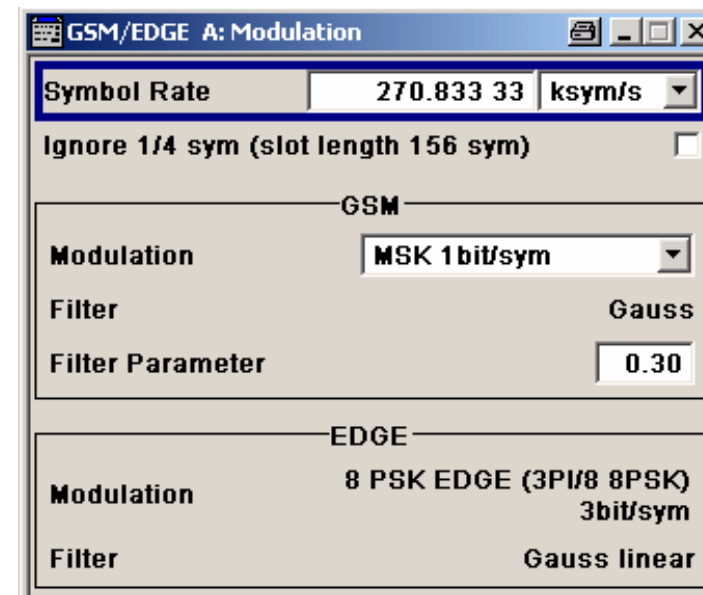
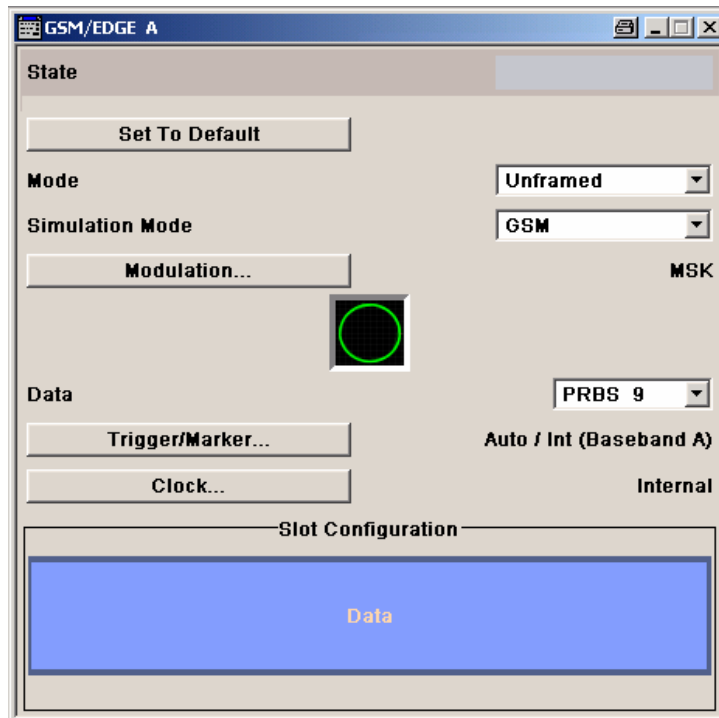
Framed (single)



Framed (double)

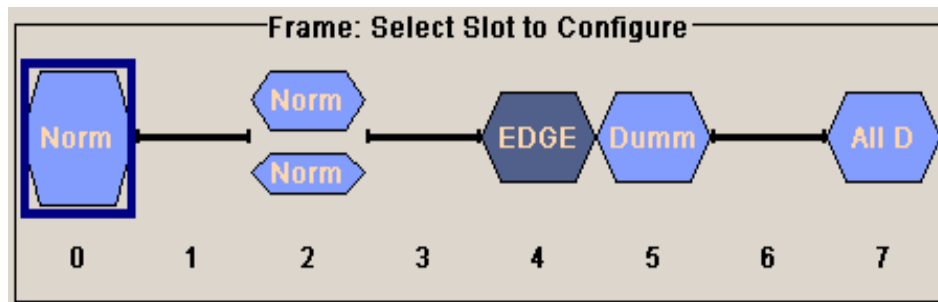
数字标准

- | GSM
- | Unframed 模式
- | 连续调制，无时隙结构
- | 调制 / 滤波器参数可选



数字标准

- | GSM
- | **“Framed (Single)”模式**
- | 设置调制和滤波器
- | 设置power ramping, 触发 / 标记和时钟
- | 设置数据 (Patterns, PN 9 to 23, Data List, External)
- | 定义7个时隙的衰减

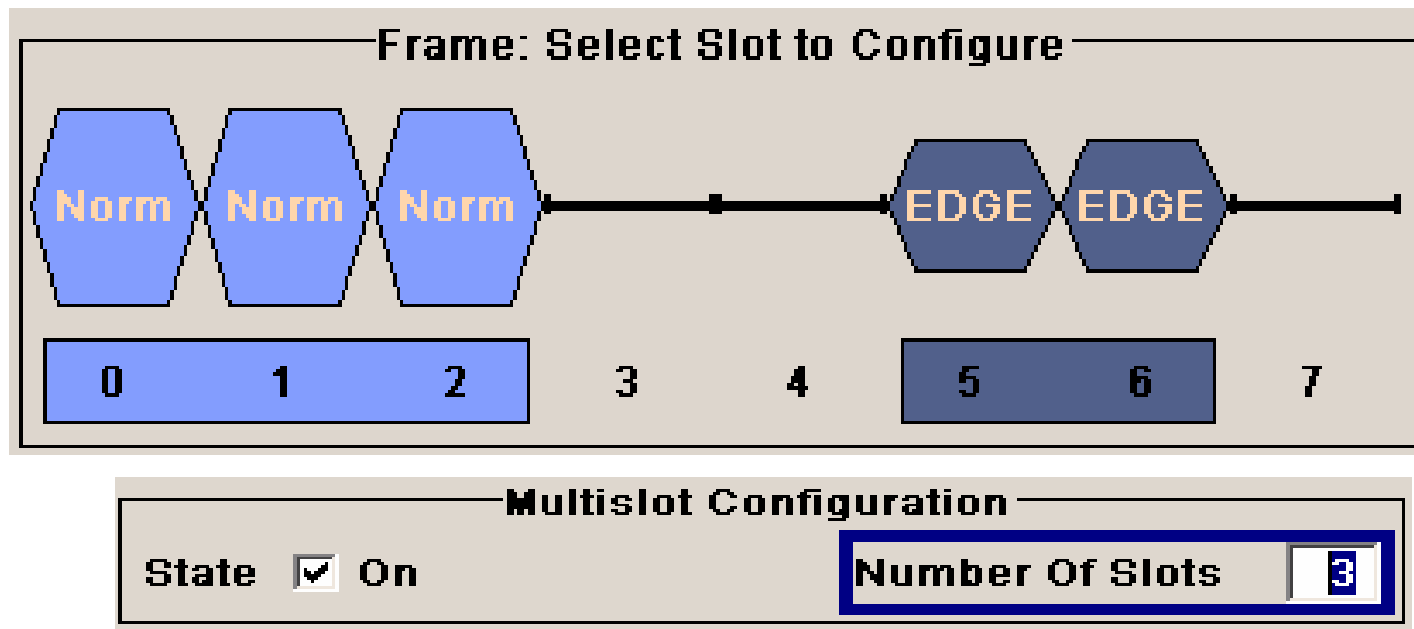


A4 A1 A6 A5 A2
 A3

A1	5.0	dB
A2	10.0	dB
A3	25.0	dB
A4	60.0	dB
A5	36.0	dB
A6	23.0	dB
A7	12.0	dB

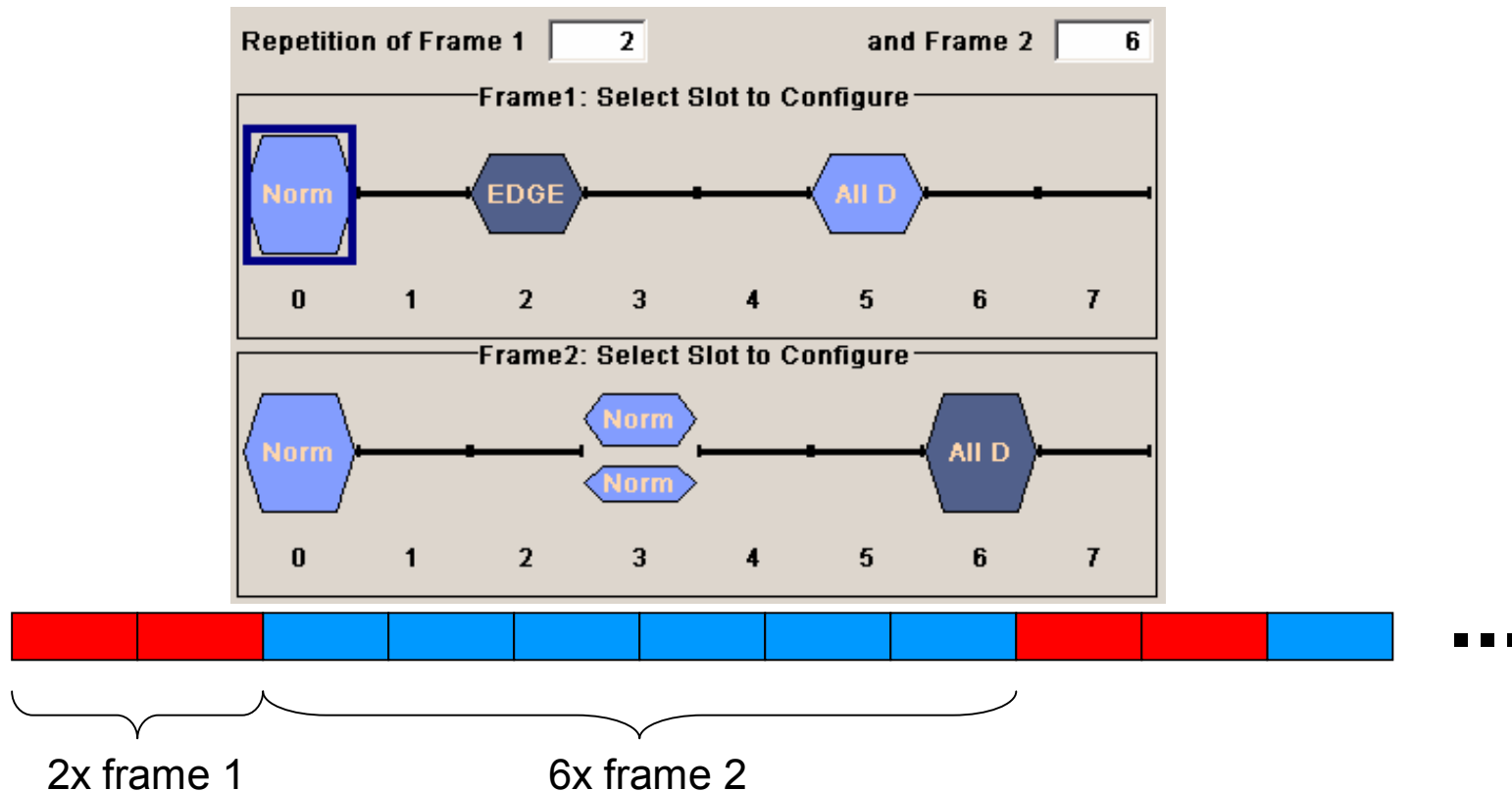
- | GSM
- | **“Framed (Single)”模式**
- | 支持所有标准规定的时隙类型
 - Normal (Full Rate)
 - Normal (Half rate)
 - EDGE
 - Synchronisation
 - Frequency Correction
 - Dummy
 - Access
 - All Data (GSM)
 - All Data (EDGE)

- | GSM
- | “Framed (Single)”模式
- | 多时隙的配置
 - 连续时隙的合成
 - 用于高数据速率服务



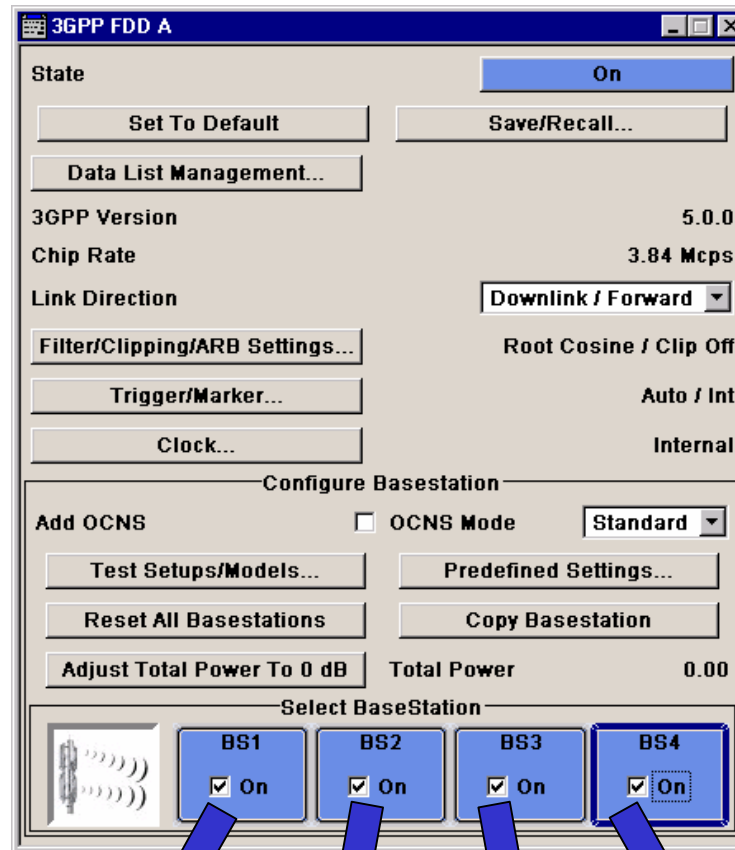
数字标准

- | GSM
- | 定义两个不同的帧结构
- | 两种帧结构的重复周期可以选择



数字标准

- | WCDMA
- | 下行信号

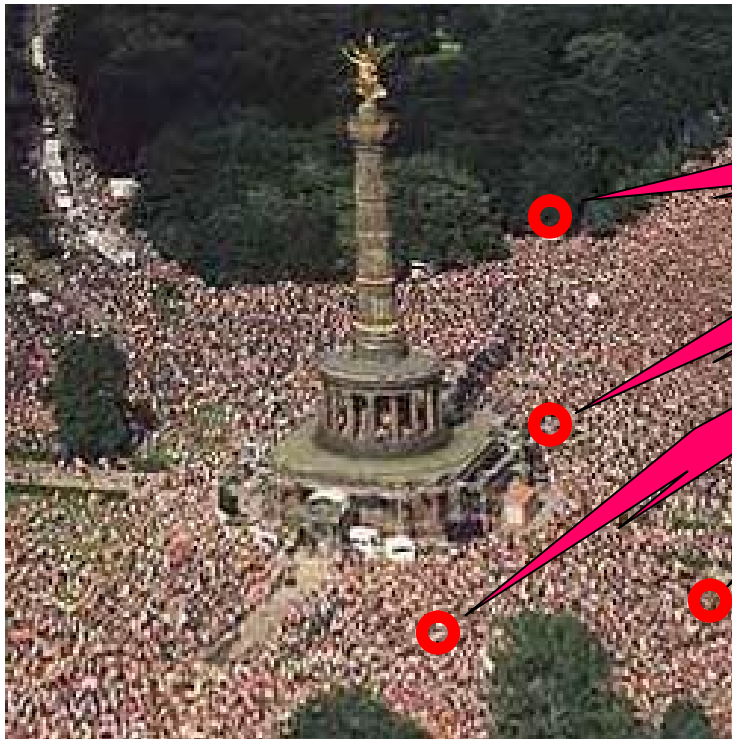


模拟4个基站



数字标准

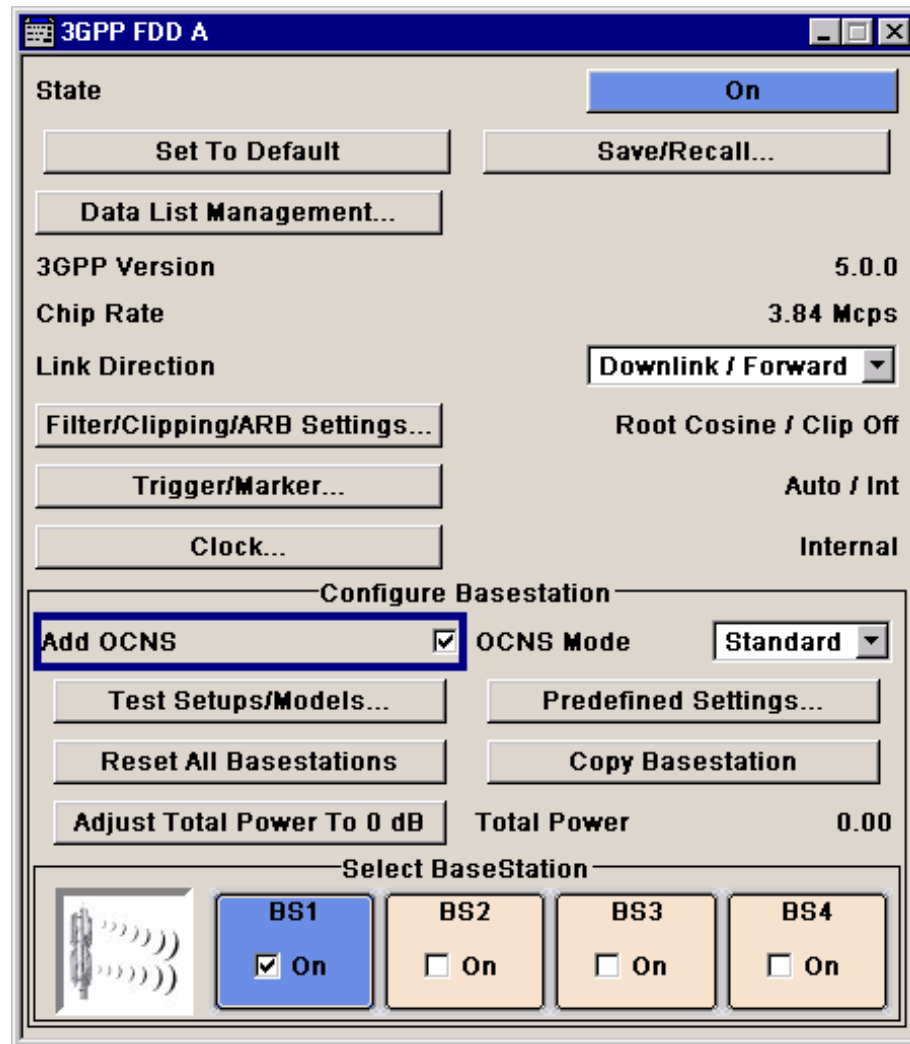
- | WCDMA
- | 4个带有信道编码的实时W-CDMA码道
- | 众多的背景噪声 (OCNS)



- 4个带有信道编码的实时W-CDMA码道
- 众多的背景噪声 (OCNS)

数字标准

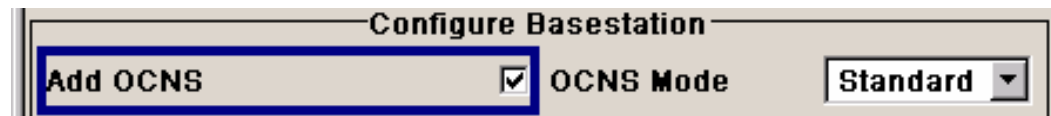
- | WCDMA
- | OCNS背景噪声



数字标准

- | WCDMA
- | OCNS背景噪声

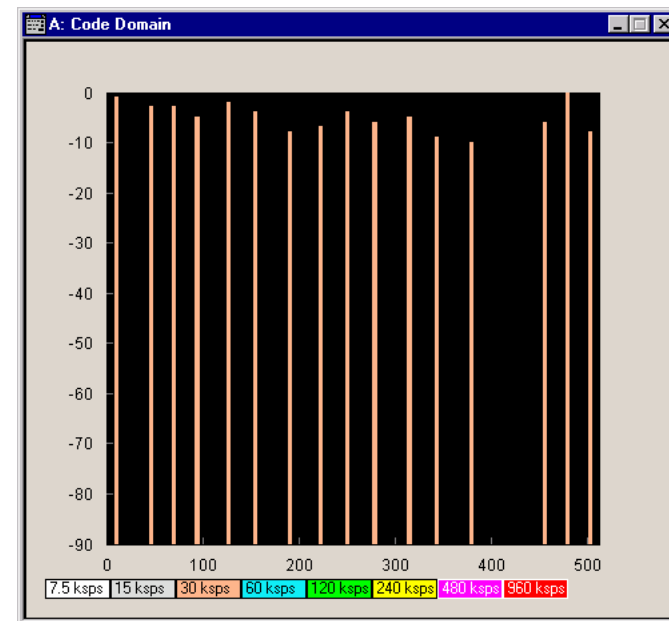
激活的 OCNS



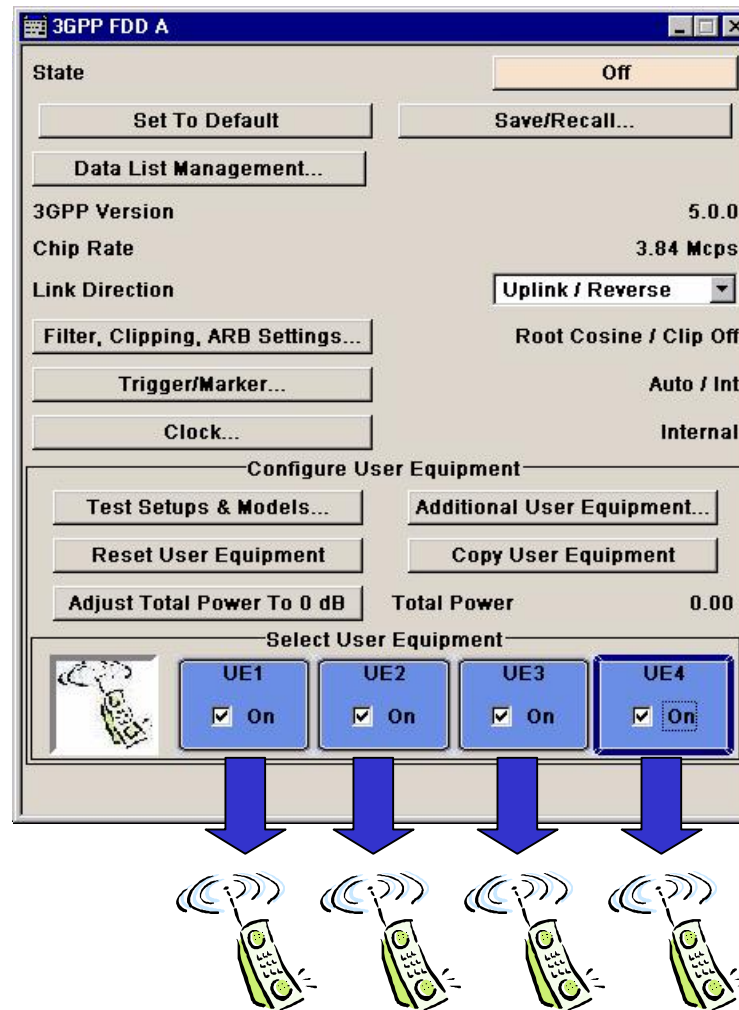
信道列表...

	Channel Type	Enh Set	Slot Fmt	Symb Rate / kspss	Ch Code	Pow / dB	Data	DList / Pattern	T Offs	DPCH Set	State	Do Conf
16	DPCH	No	#8	30	0	0.00	PN 9		0	Config...	Off	
17	DPCH	No	#8	30	0	0.00	PN 9		0	Config...	Off	
18	DPCH (OCNS)	No	#10	30	2	-1.00	PN 9		86	Config...	On	
19	DPCH (OCNS)	No	#10	30	11	-3.00	PN 9		134	Config...	On	
20	DPCH (OCNS)	No	#10	30	17	-3.00	PN 9		52	Config...	On	
21	DPCH (OCNS)	No	#10	30	23	-5.00	PN 9		45	Config...	On	
22	DPCH (OCNS)	No	#10	30	31	-2.00	PN 9		143	Config...	On	
23	DPCH (OCNS)	No	#10	30	38	-4.00	PN 9		112	Config...	On	
24	DPCH (OCNS)	No	#10	30	47	-8.00	PN 9		59	Config...	On	
25	DPCH (OCNS)	No	#10	30	55	-7.00	PN 9		23	Config...	On	
26	DPCH (OCNS)	No	#10	30	62	-4.00	PN 9		1	Config...	On	
27	DPCH (OCNS)	No	#10	30	69	-6.00	PN 9		88	Config...	On	
28	DPCH (OCNS)	No	#10	30	78	-5.00	PN 9		30	Config...	On	
29	DPCH (OCNS)	No	#10	30	85	-9.00	PN 9		18	Config...	On	
30	DPCH (OCNS)	No	#10	30	94	-10.00	PN 9		30	Config...	On	
31	DPCH (OCNS)	No	#10	30	125	-8.00	PN 9		61	Config...	On	
32	DPCH (OCNS)	No	#10	30	113	-6.00	PN 9		128	Config...	On	
33	DPCH (OCNS)	No	#10	30	119	0.00	PN 9		143	Config...	On	
34	DPCH	No	#8	30	0	0.00	PN 9		0	Config...	Off	
35	DPCH	No	#8	30	0	0.00	PN 9		0	Config...	Off	

...码域



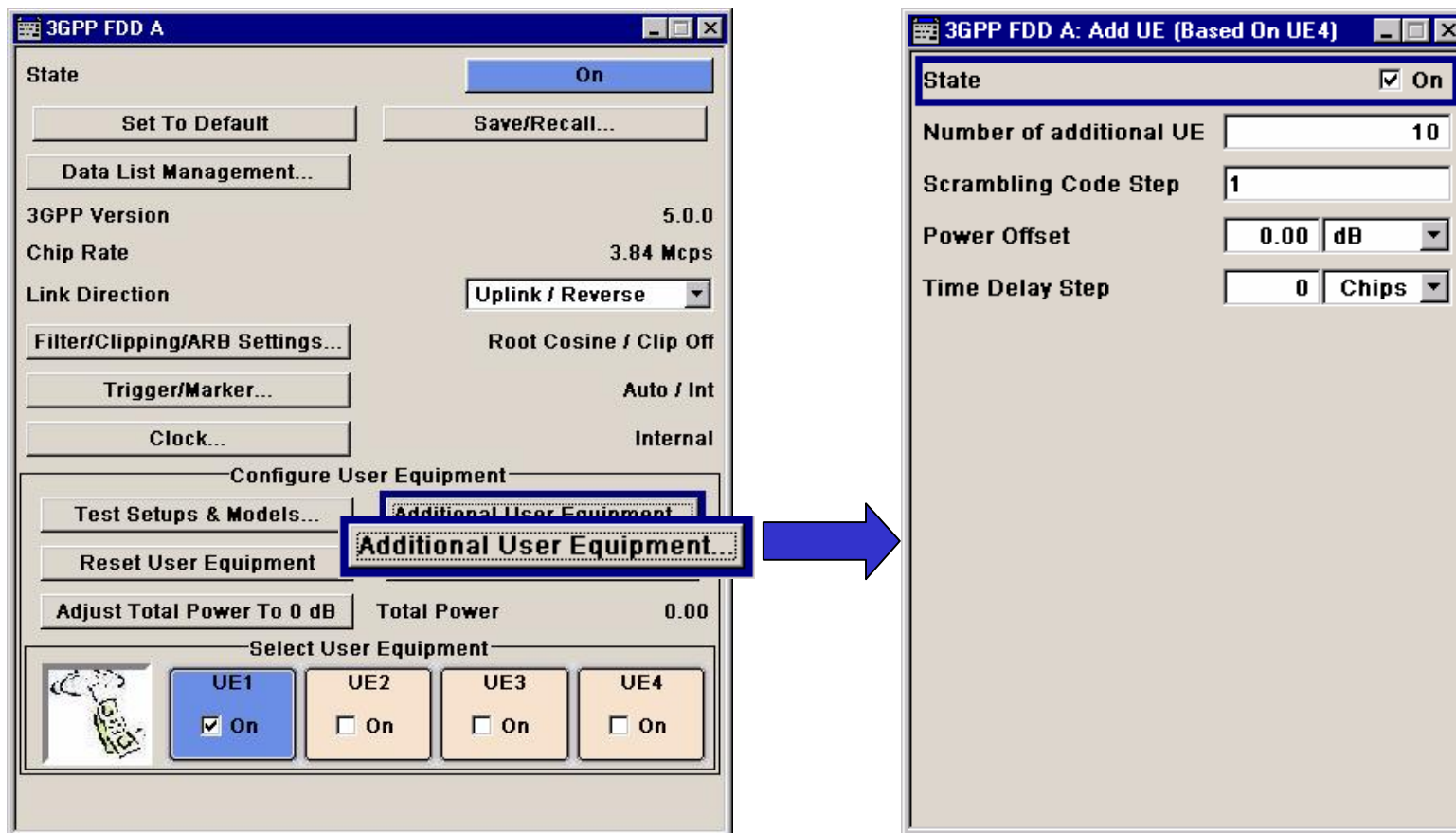
| WCDMA



模拟四个终端 (UE)

| WCDMA

附加用户



数字标准



- | WCDMA
- | 发射功率控制

	Channel Type	Enh Set	Slot Fmt	Symb Rate / kbps	Ch Code	Pow / dB	Data	DList / Pattern	T Off	Do Conf
10	DL-DPCCH	No	#0	7.5	0	0.00			0	Config... Off
11	DPCH	Config...	#8	30	0	0.00	PN 9		0	Config... Off
12	DPCH	Config...	#8	30	0	0.00	PN 9		0	Config... Off
13	DPCH	Config...	#8	30	0	0.00	PN 9		0	Config... Off
14	DPCH	No	#8	30	0	0.00	PN 9		0	Config... Off
15	DPCH	No	#8	30	0	0.00	PN 9		0	Config... Off
16	DPCH	No	#8	30	0	0.00	PN 9		0	Config... Off
17	DPCH	No	#8	30	0	0.00	PN 9		0	Config... Off



下行

TPC Settings

TPC Source: Pattern

TPC Pattern: 1011...

Read Out Mode: Continuous

Power Step: 1.00 dB

DPCCH Settings

TPC Data Source: All 0

Power: 0.00 dB

Read Out Mode: Continuous

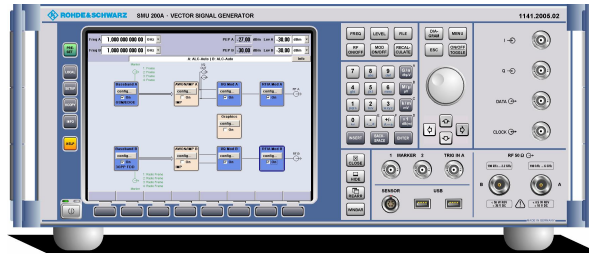
Power Step TPC: 0.00 dB

上行

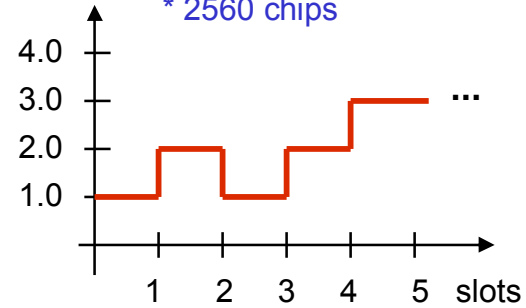
数字标准



SMU200A 模拟 BS



DUT 输出功率
* 2560 chips



Chan	Type	Enh	Slot	Symb	Chan	Pow/	Data	DList	Tim	DPCCH	State	DC
9		Sett	For	Rate	Code	dB		Pattern	Offs	Sett		
9	PDSCH	No	#0	15	0	0.00	PN 9		0	Config...	Off	●
10	DL-DPCCH	No	#0	7.5	0	0.00			0	Config...	Off	●
11	DPCH	Config...	#8	30	0	0.00	Config...		0	Config...	Off	●
12	DPCH	Config...	#8	30	0	0.00	Config...		0	Config...	Off	●
13	DPCH	Config...	#8	30	0	0.00	Config...		0	Config...	Off	●

3GPP FDD A BS-DPCCH (1/11)

Data 6	TPC 2	Data 28	Pilot 4
--------	-------	---------	---------

Slot Format: 8

TFCI: Use

TFCI: 0

Pilot Length: 4 Bit

Multi Code State: On

TPC Settings

TPC Source: Pattern

TPC Pattern: 1011...

Read Out Mode: Continuous

TPC For Output Power Control: (Mis-)Use

Power Step: 1.00 dB

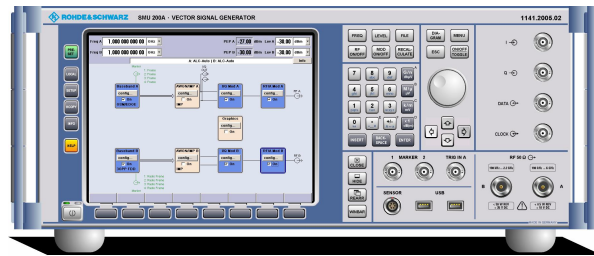
11 00 11 11

TPC pattern [bits]
11 power up
00 power down

数字标准



SMU200A 模拟 BS (Misuse TPC)

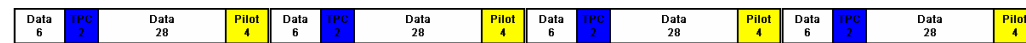
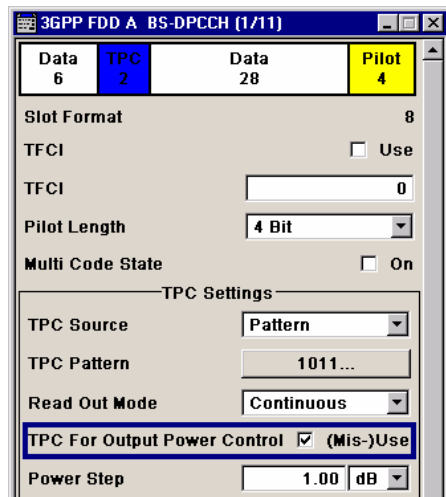


SMU200A 根据“Misuse TPC”设置来改变码域功率



SMU200A Misuse TPC settings

	Chan Type	Enh Sett	Slot Form	Symb Rate ksp/s	Chan Code	Pow/ dB	Data	DList Pattern	Tim Offs	DPCCH Sett	State	DC
9	PDSCH	No	#0	15	0	0.00	PN 9		0	Config...	Off	⊙
10	DL-DPCCH	No	#0	7.5	0	0.00			0	Config...	Off	⊙
11	DPCH	Config...	#8	30	0	0.00	Config...		0	Config...	Off	⊙
12	DPCH	Config...	#8	30	0	0.00	Config...		0	Config...	Off	⊙
13	DPCH	Config...	#8	30	0	0.00	Config...		0	Config...	Off	⊙

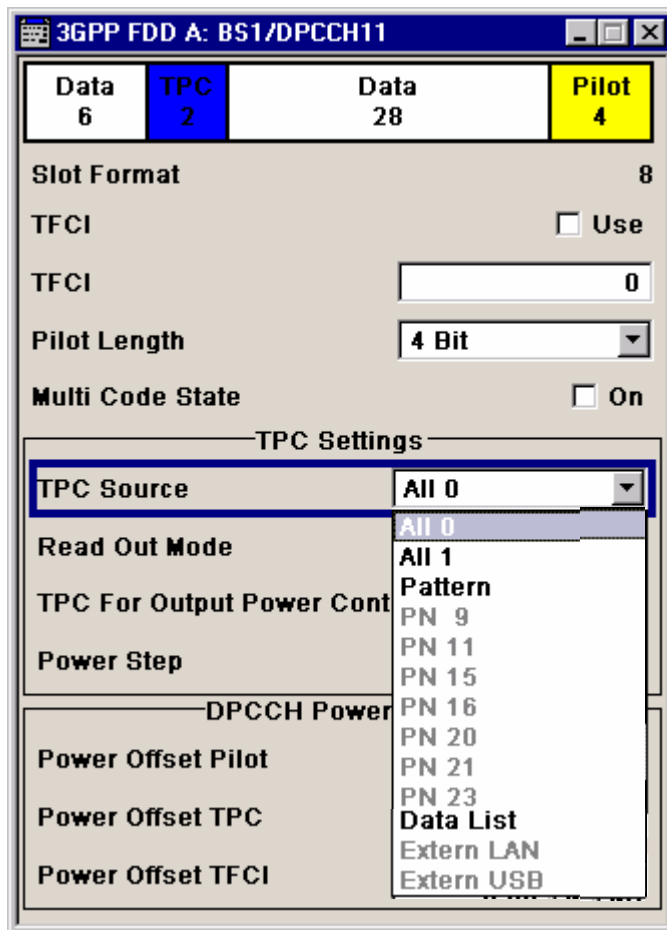


11 00 11 11

→ TPC bit stream i.e.: 1 0 1 1...
(1: power up; 0: power down)

数字标准

- | WCDMA
- | 发射功率控制

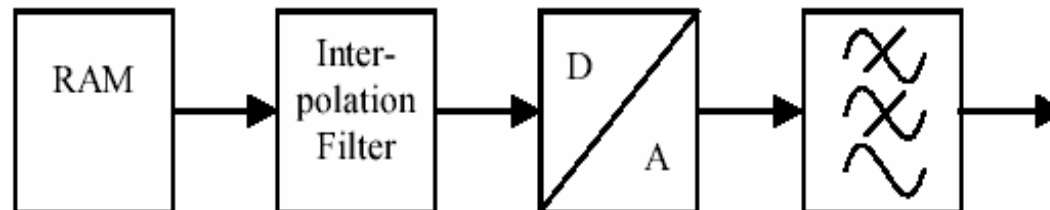


Data lists, external LAN and external USB can also be used as TPC information !

任意波形发生器

I SMU200A中的任意波形发生器ARB

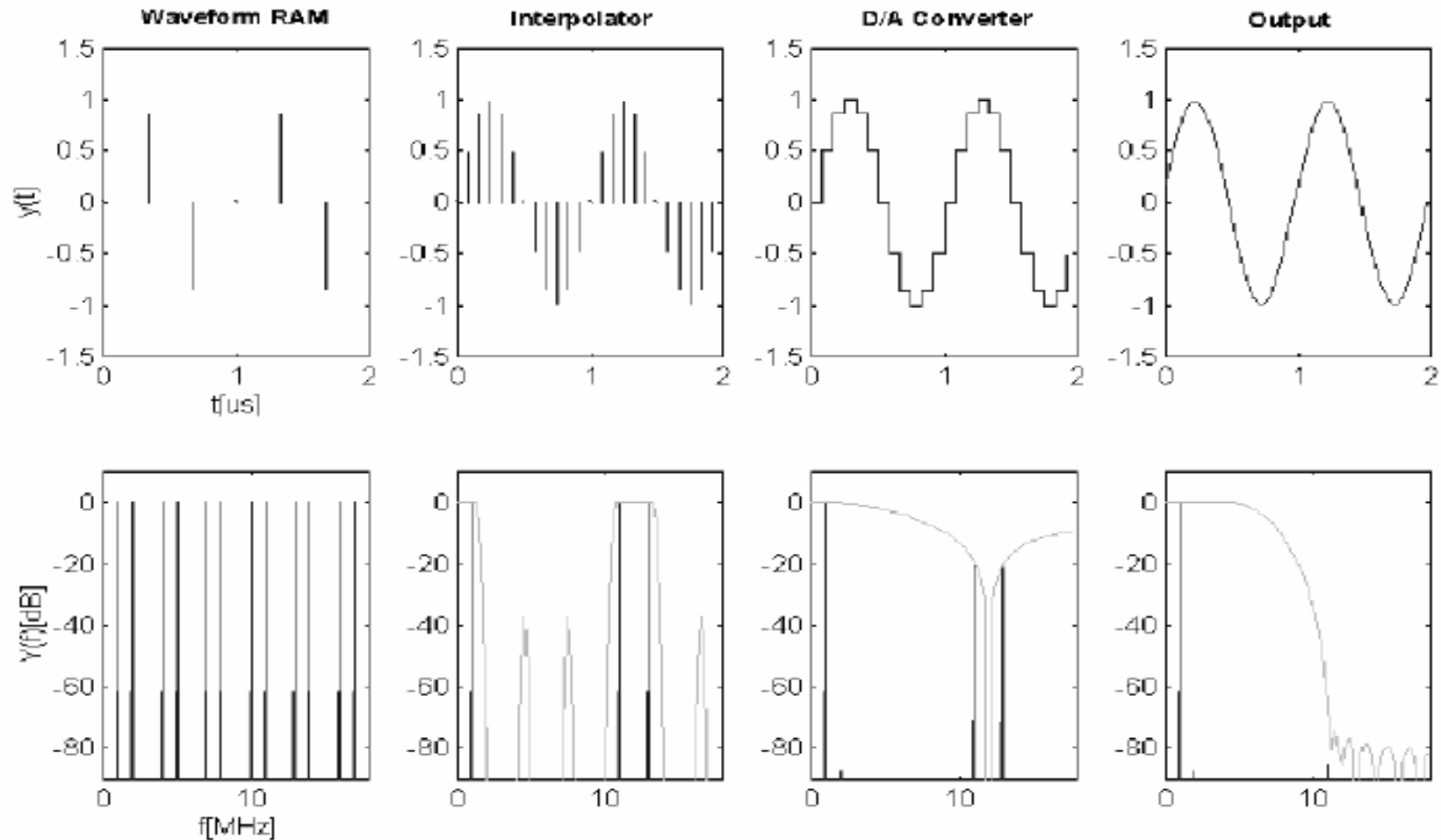
- F 波形输出存储器
- F 数字内插滤波器
- F D/A变换
- F 低通滤波器



任意波形发生器



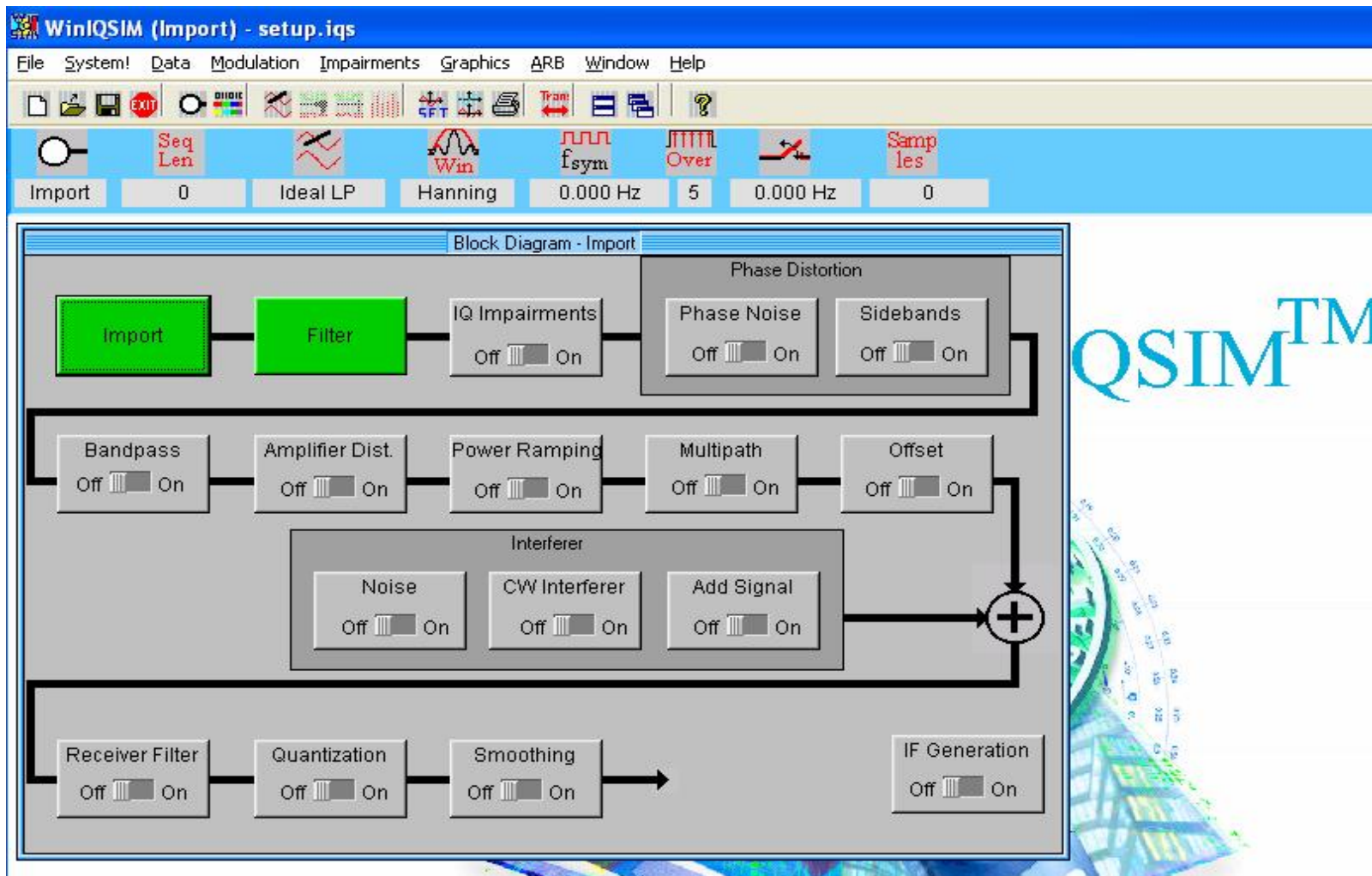
任意波形发生器ARB的工作过程



Winiqsim: 运行软件



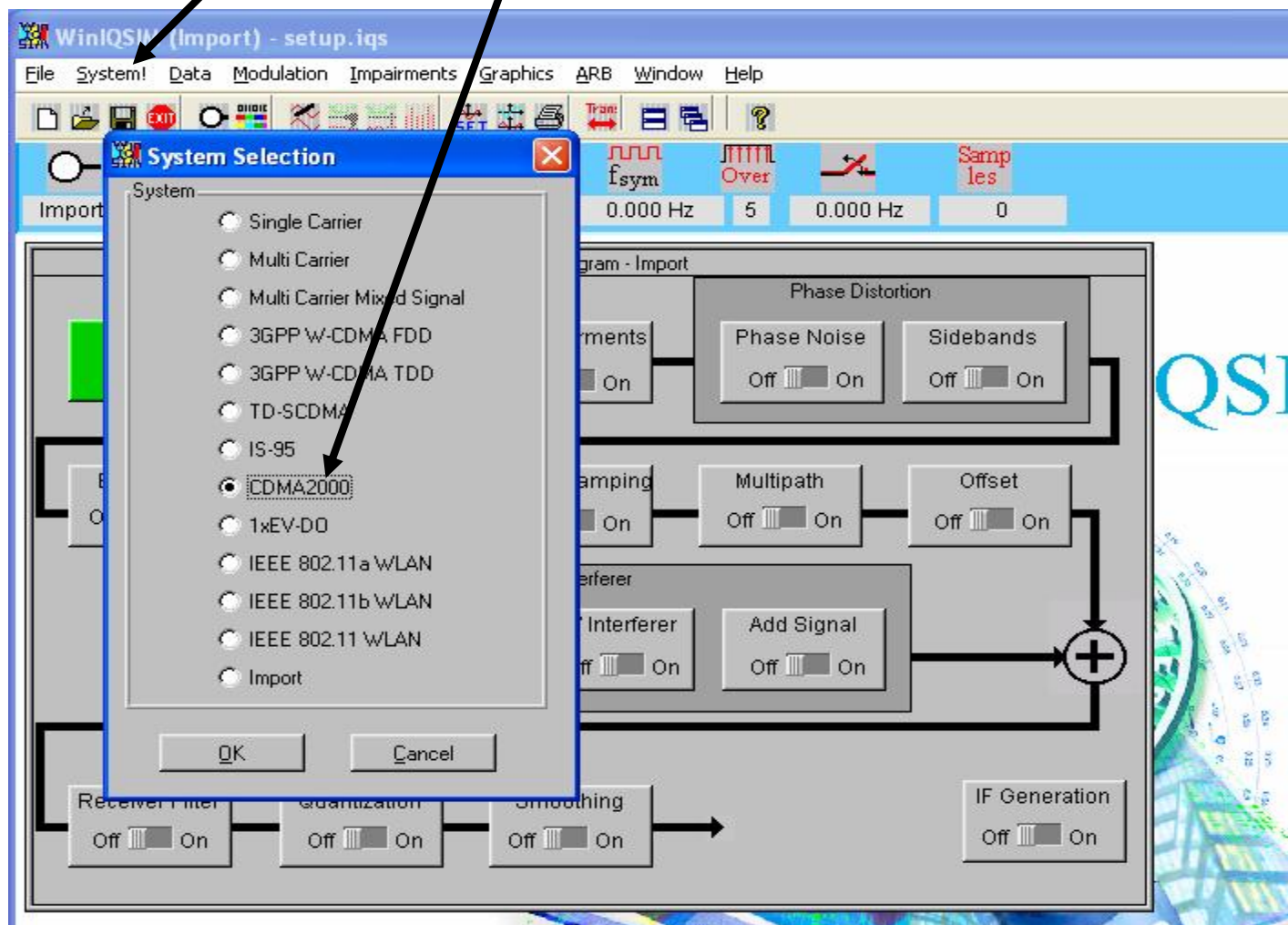
运行软件Winiqsim,出现如下界面



QSIM™

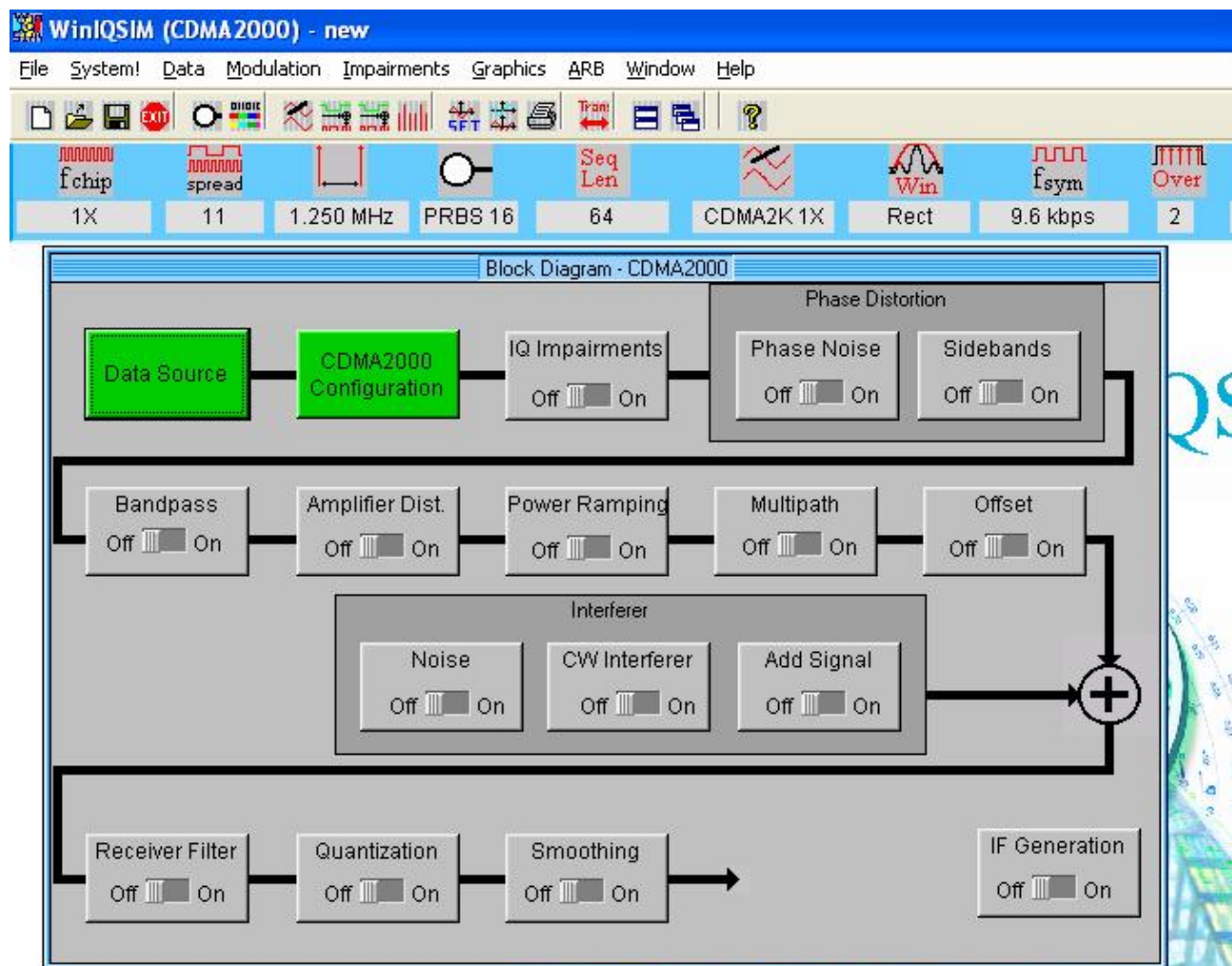
Winiqsim: systemà 选择标准

1 点击system，选择通信标准。（以CDMA2000为例）



WinIQsim:

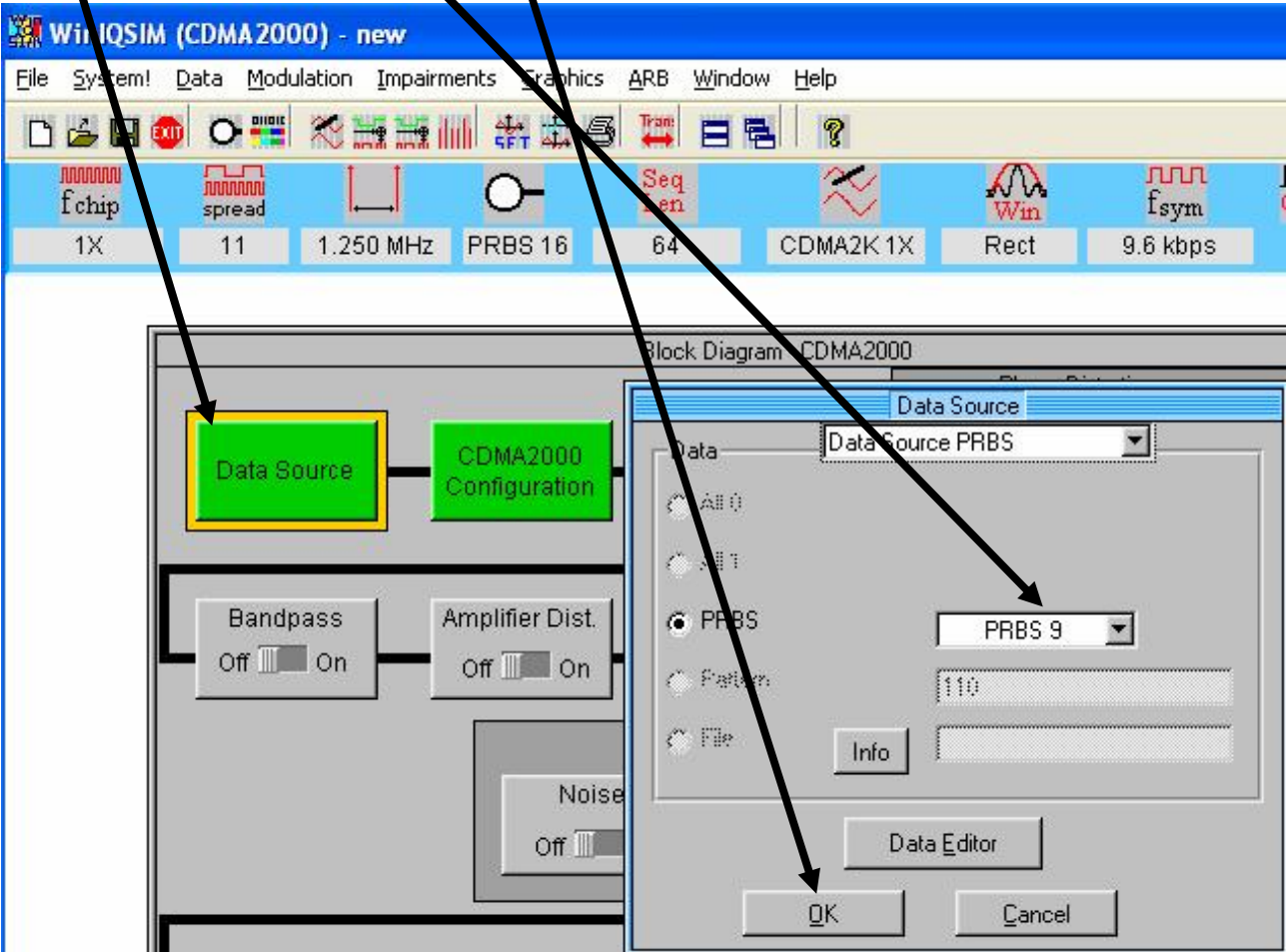
I 进入CDMA2000标准设置界面



Winiqsim

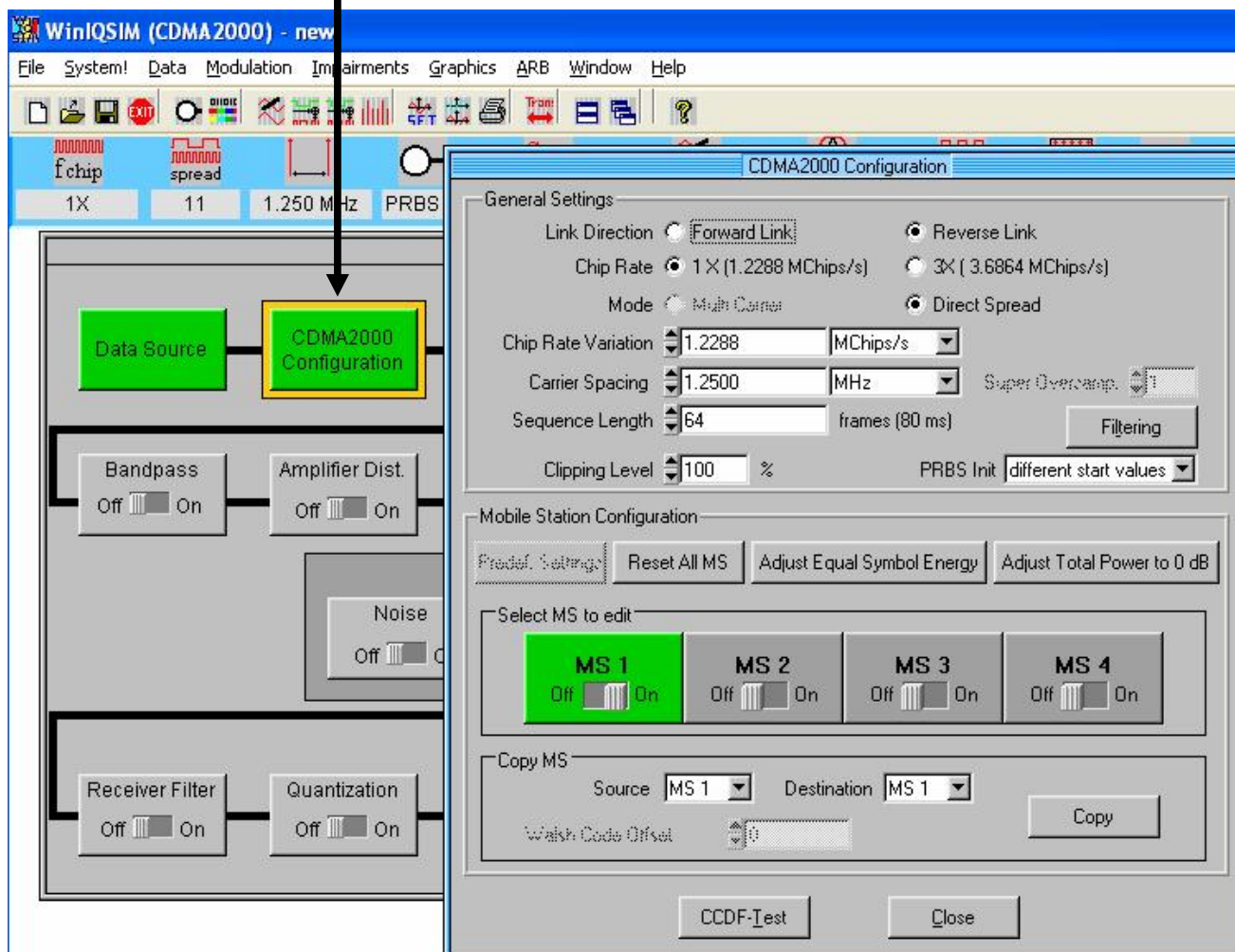


| Data source à PRBS9 à OK



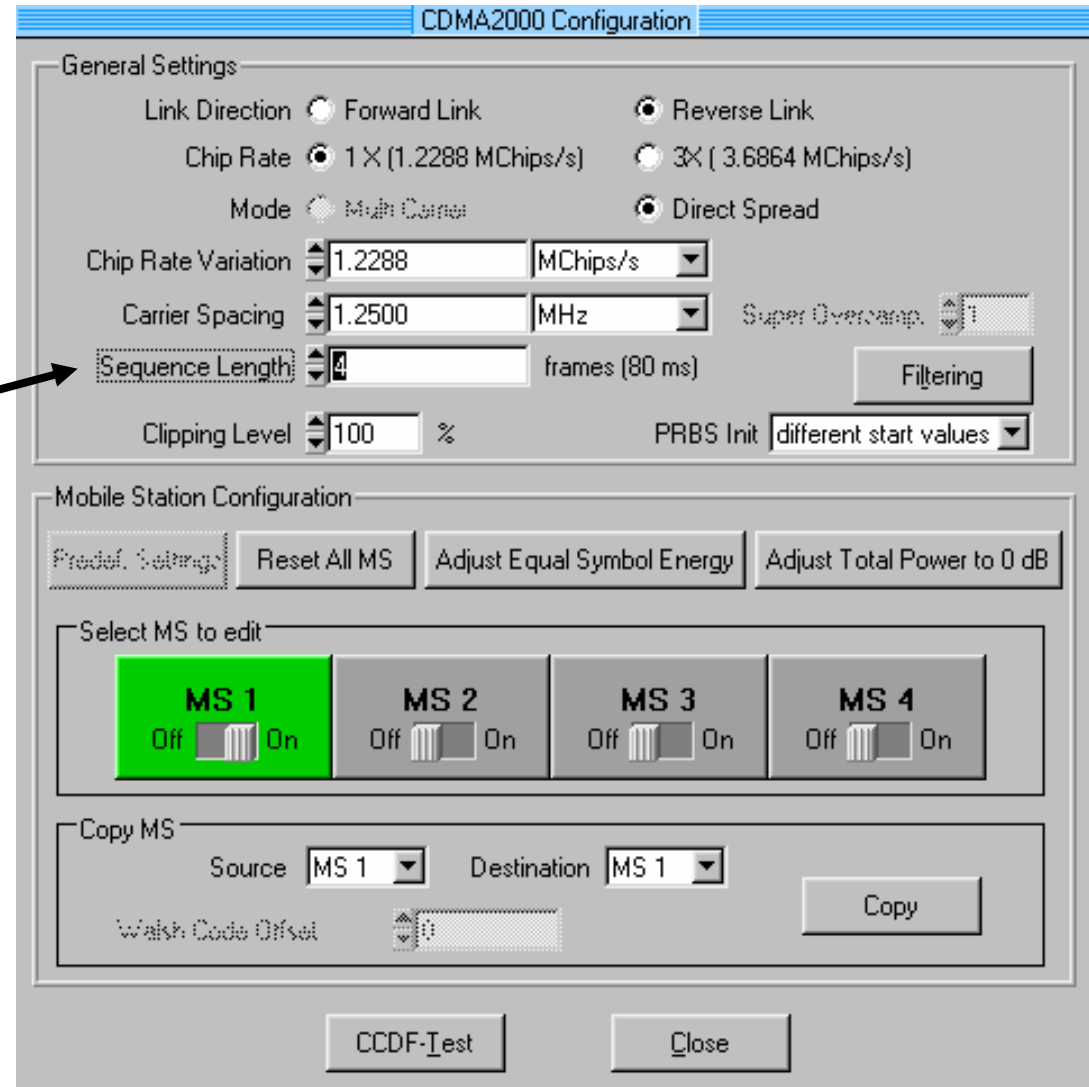
Winiqsim:

1 点击CDMA2000 configure进行详细设置



Winiqsim:

- | 反向信号
 - | 速率1.2288M
 - | 直接扩频
 - | 码片速率
 - | 载波间隔
 - | 序列长度: 4
 - | Clip
 - | PRBS初始化设置
- 以上设置一般都是默认的

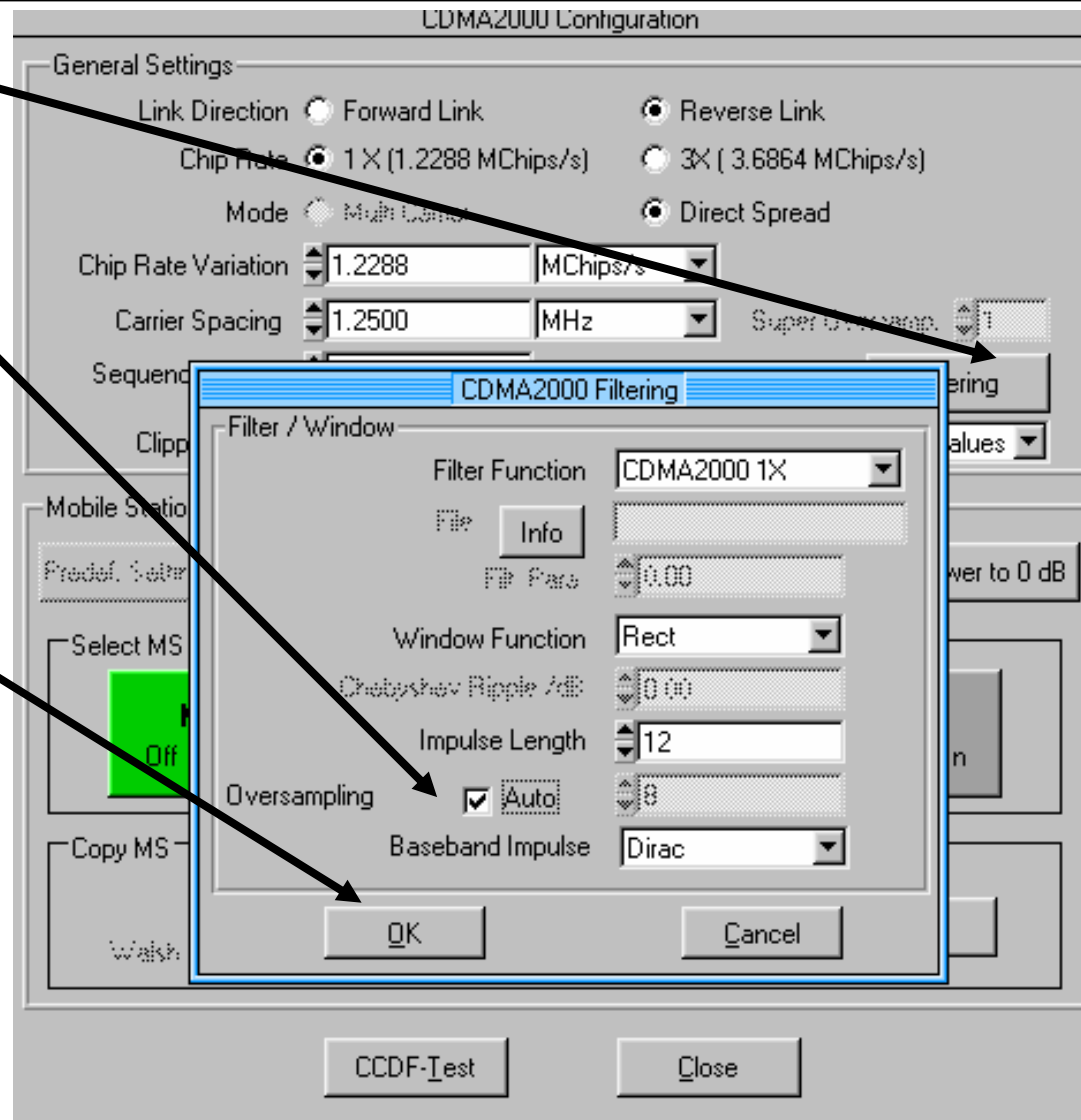


The screenshot shows the 'CDMA2000 Configuration' dialog box with the following settings:

- General Settings:**
 - Link Direction: Reverse Link
 - Chip Rate: 1 X (1.2288 MChips/s)
 - Mode: Direct Spread
 - Chip Rate Variation: 1.2288 MChips/s
 - Carrier Spacing: 1.2500 MHz
 - Super Overcomp.: 1
 - Sequence Length: 4 frames (80 ms)
 - Clipping Level: 100 %
 - PRBS Init: different start values
- Mobile Station Configuration:**
 - Buttons: Prefdef. Settings, Reset All MS, Adjust Equal Symbol Energy, Adjust Total Power to 0 dB
 - Select MS to edit: MS 1 (highlighted), MS 2, MS 3, MS 4
 - Copy MS: Source MS 1, Destination MS 1, Walk Code Offset 0
 - Buttons: CCDF-Test, Close

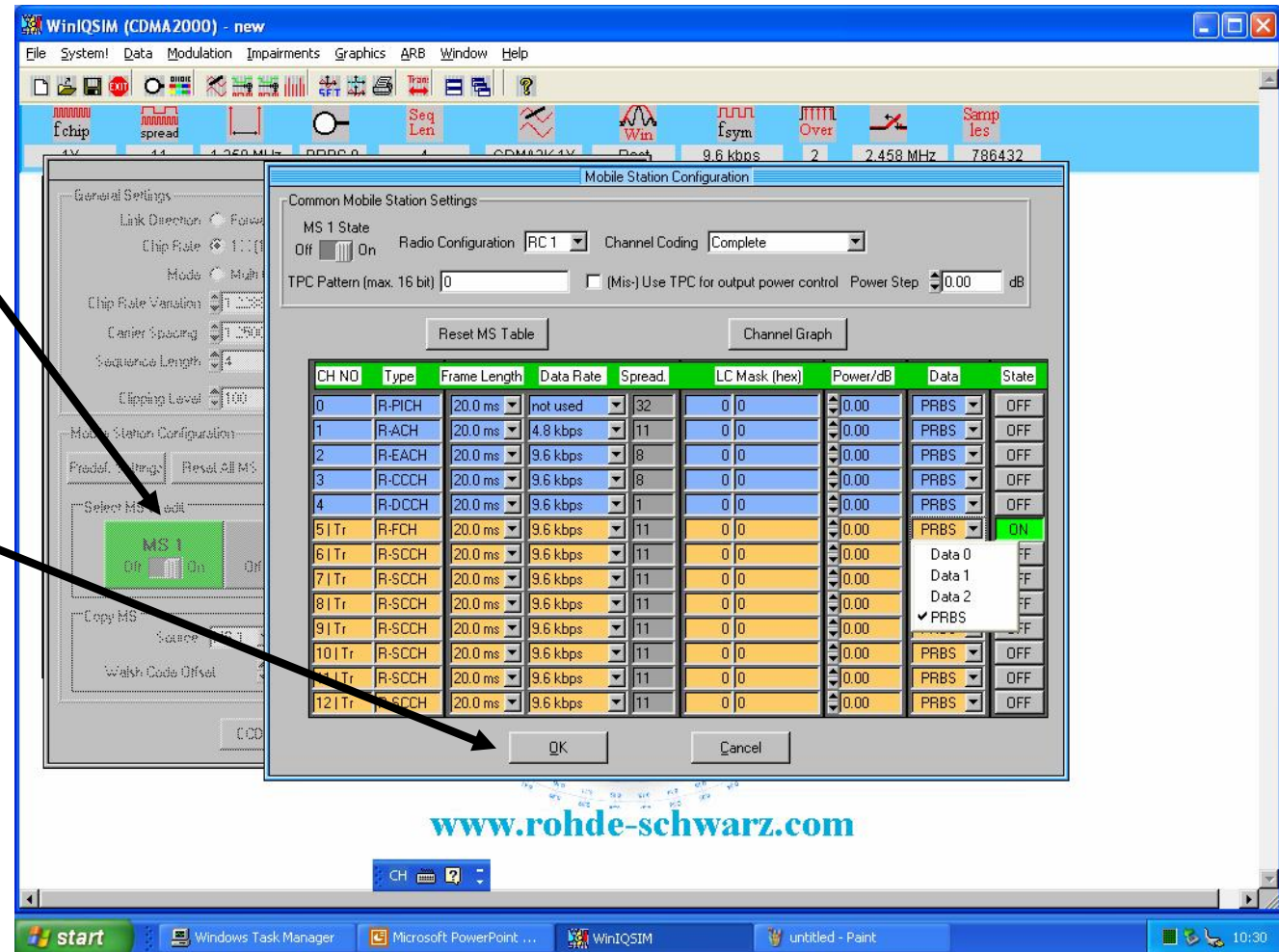
Winiqsim

- | Filtering设置
- | 根据标准选择滤波器。
- | Oversample: 设置为自动时为8，建议至少大于2。
- | 其余尽量采用缺省设置
- | 设置完后点击OK.



Winiqsim

- | 点击MS1，进入手机
- | 相关信息设置
- | RC1
- | 全信道编码
- | 配置了一个业务信道
- | 帧长度20ms
- | 数据速率9.6k
- | 数据为PRBS
- | 设置完后，点击OK



Mobile Station Configuration

Common Mobile Station Settings

MS 1 State: Off On

Radio Configuration: RC1

Channel Coding: Complete

TPC Pattern (max: 16 bit): 0

(Mis-) Use TPC for output power control

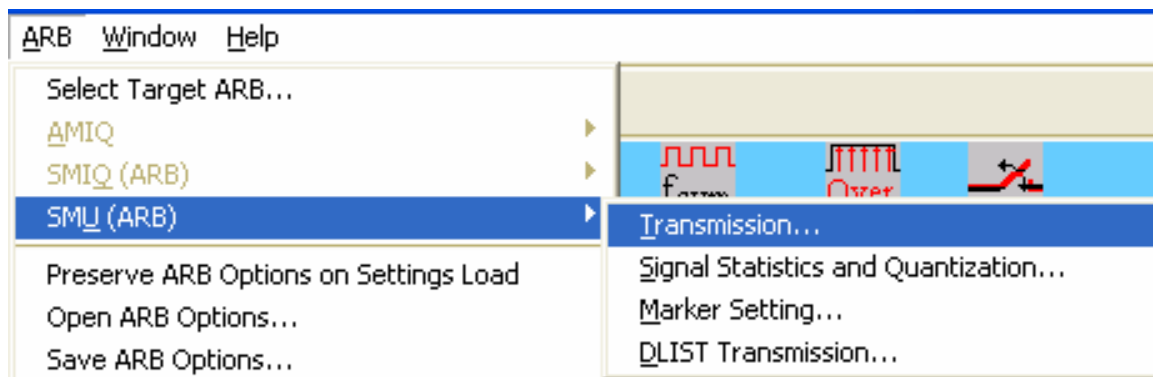
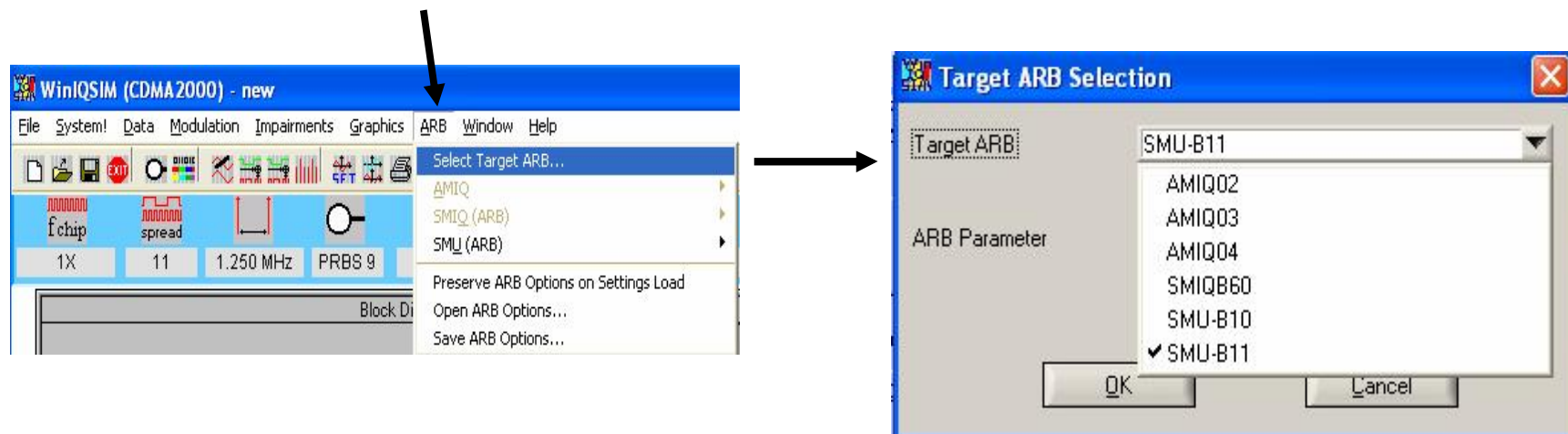
Power Step: 0.00 dB

CH NO	Type	Frame Length	Data Rate	Spread	LC Mask (hex)	Power/dB	Data	State
0	R-PICH	20.0 ms	not used	32	0 0	0.00	PRBS	OFF
1	R-ACH	20.0 ms	4.8 kbps	11	0 0	0.00	PRBS	OFF
2	R-EACH	20.0 ms	9.6 kbps	8	0 0	0.00	PRBS	OFF
3	R-CCCH	20.0 ms	9.6 kbps	8	0 0	0.00	PRBS	OFF
4	R-DCCH	20.0 ms	9.6 kbps	1	0 0	0.00	PRBS	OFF
5 Tr	R-FCH	20.0 ms	9.6 kbps	11	0 0	0.00	PRBS	ON
6 Tr	R-SCCH	20.0 ms	9.6 kbps	11	0 0	0.00	PRBS	OFF
7 Tr	R-SCCH	20.0 ms	9.6 kbps	11	0 0	0.00	PRBS	OFF
8 Tr	R-SCCH	20.0 ms	9.6 kbps	11	0 0	0.00	PRBS	OFF
9 Tr	R-SCCH	20.0 ms	9.6 kbps	11	0 0	0.00	PRBS	OFF
10 Tr	R-SCCH	20.0 ms	9.6 kbps	11	0 0	0.00	PRBS	OFF
11 Tr	R-SCCH	20.0 ms	9.6 kbps	11	0 0	0.00	PRBS	OFF
12 Tr	R-SCCH	20.0 ms	9.6 kbps	11	0 0	0.00	PRBS	OFF

www.rohde-schwarz.com

Winiqsim:

- | ARB → select target ARB → SMU-B11
- | ARB → SMU(ARB) → transmission

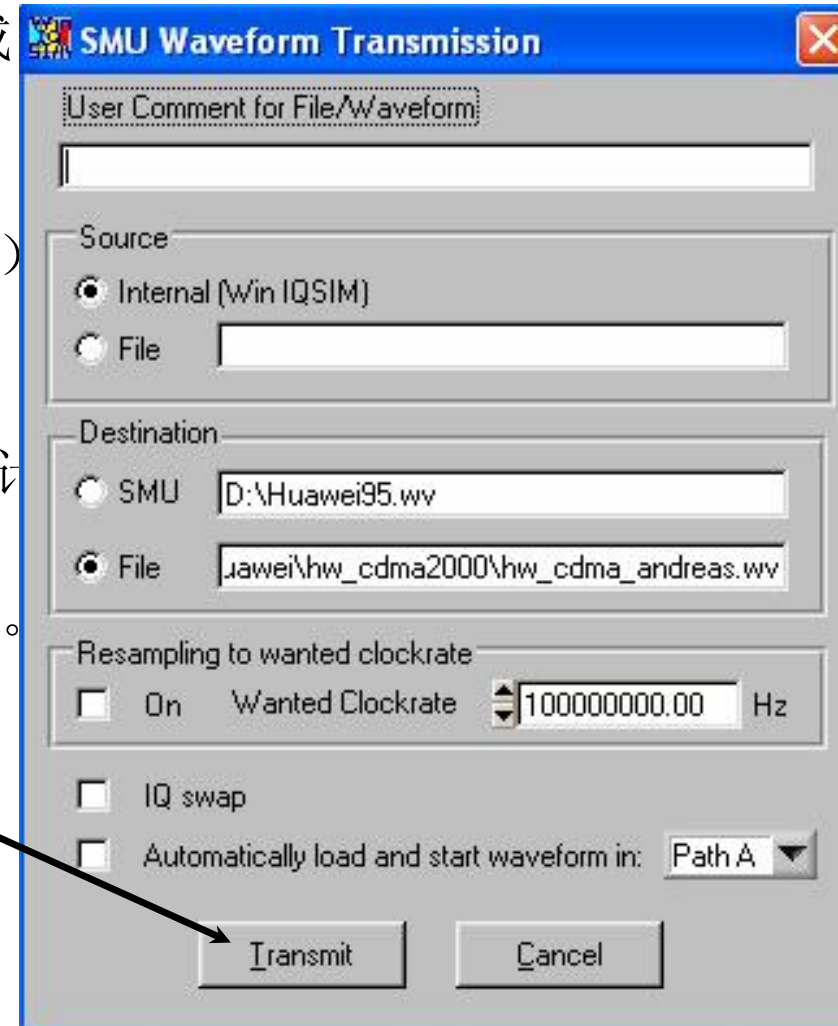


Winiqsim:

- | 将波形文件*.wv传送到仪表或者存储在计算机中。
- | User comment: 不添加说明
- | Source: Internal (Winiqsim)
- | Destination:

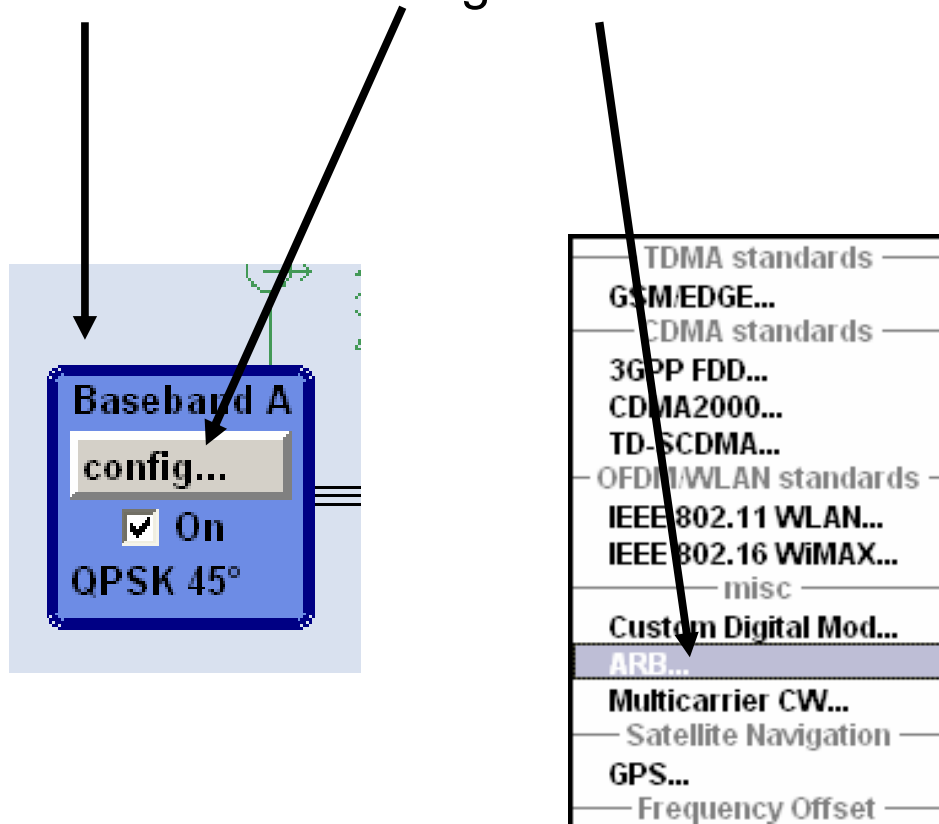
如通过GPIB卡直接传送到仪表，选SMU;如将波形文件存储在计算机中就指定一个路径。

其余设置项都不需要选择和设置。设置完成之后，transmit。



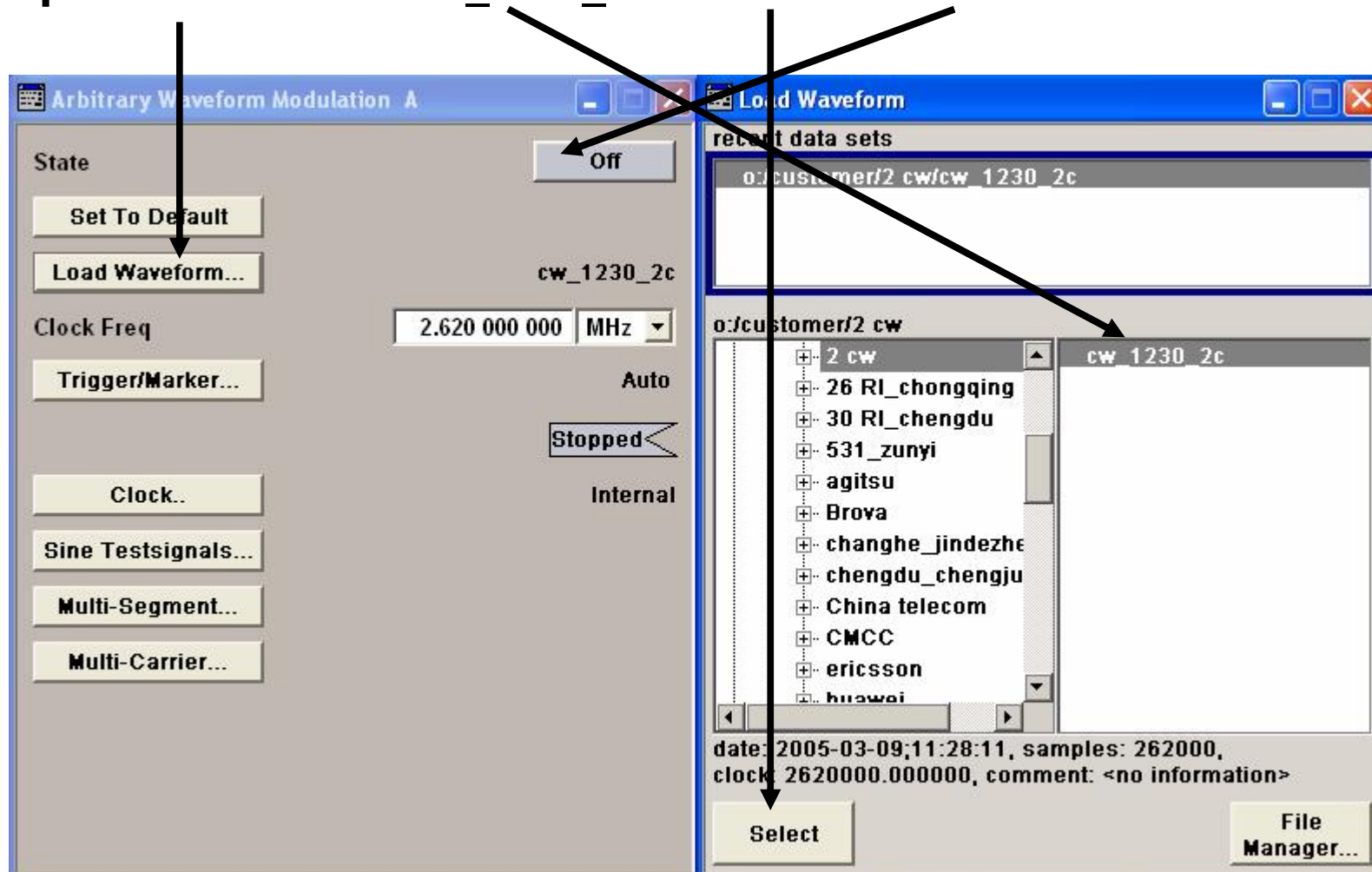
ARB:在仪器上操作

I Baseband à config à ARB



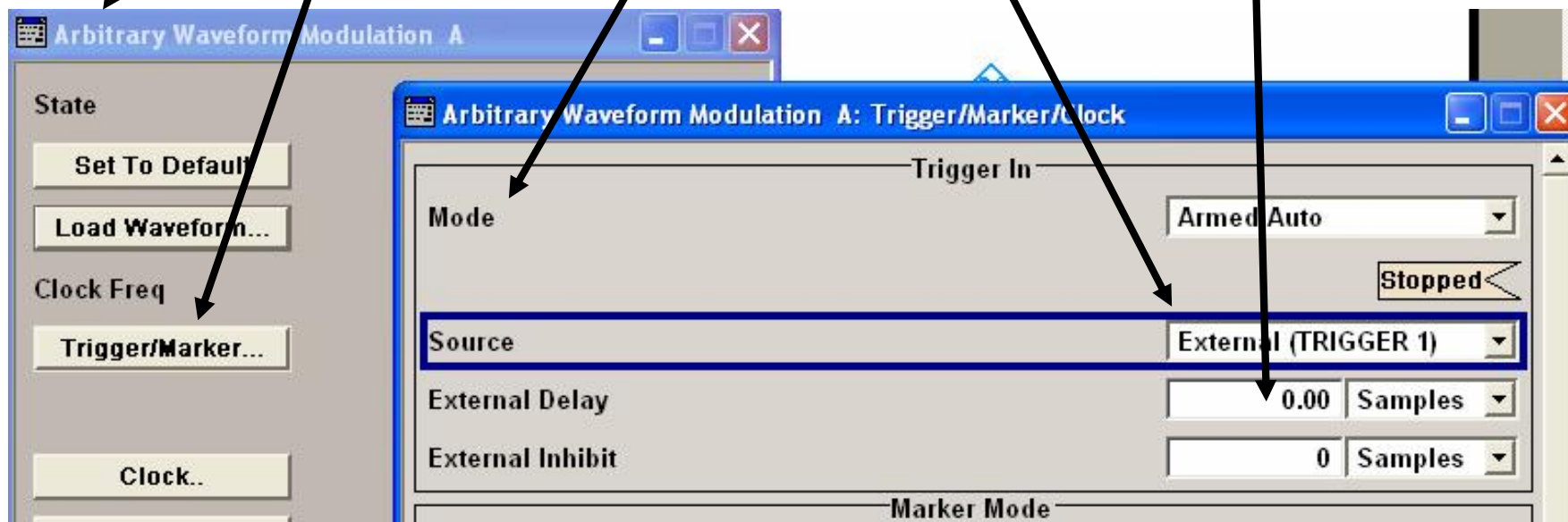
ARB在仪器上的操作

Load waveform → cw_1230_2c → Select → state On



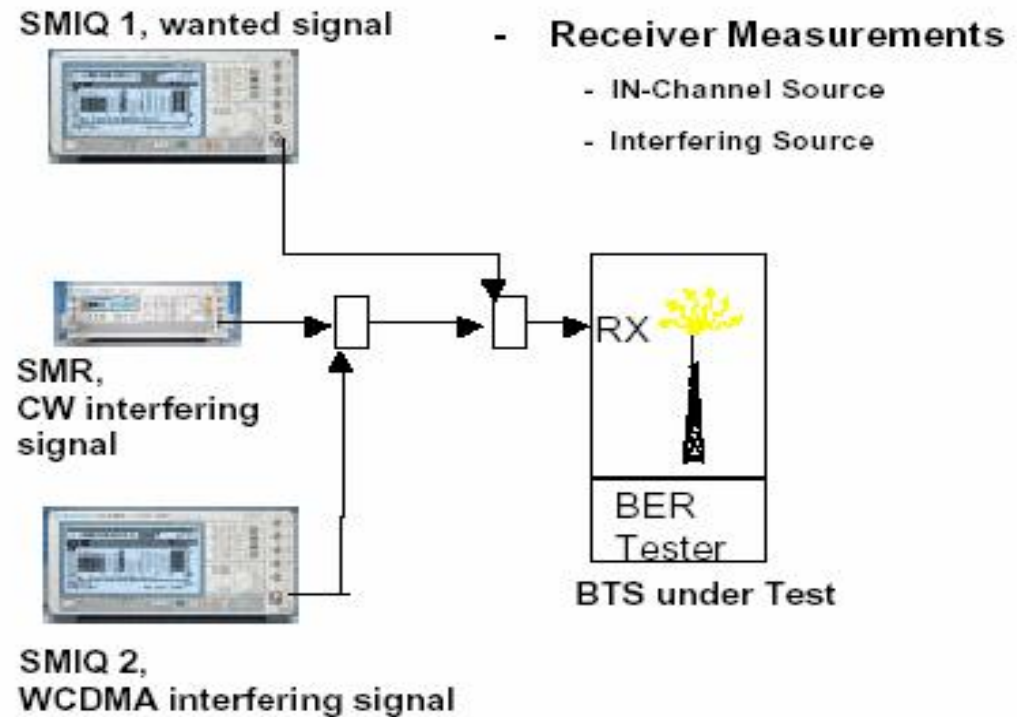
ARB在仪器上的操作

ARB → Trigger/Marker → Mode → Trigger source → delay

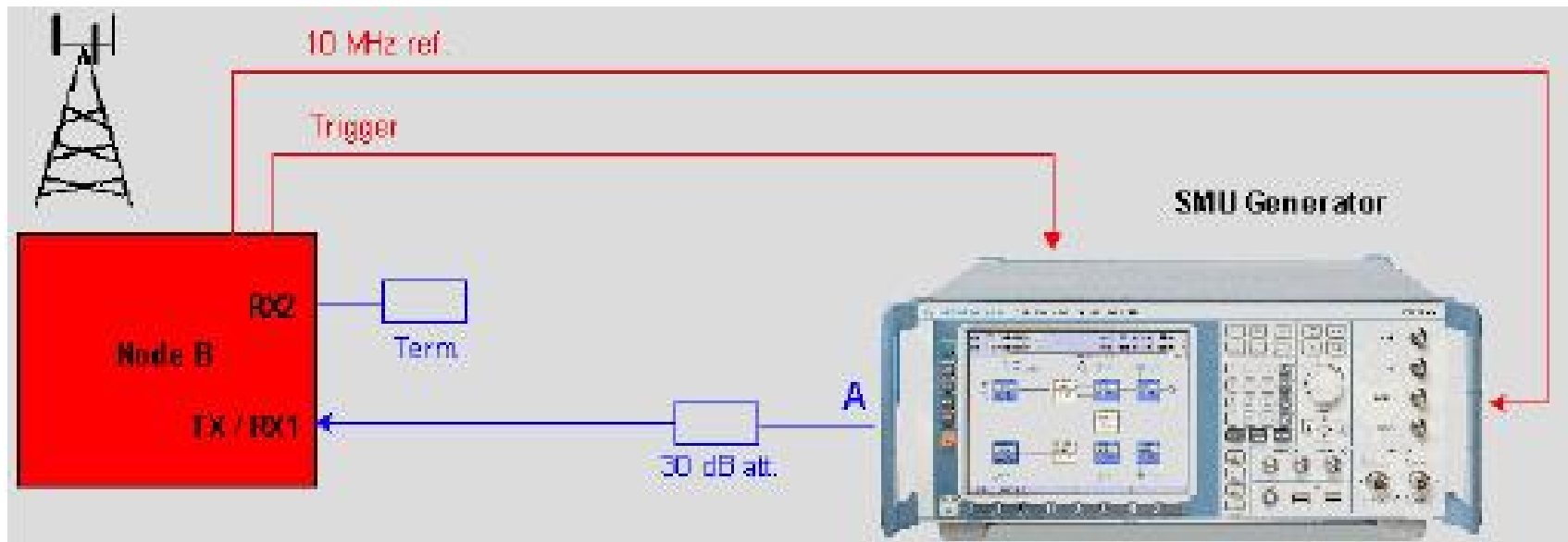


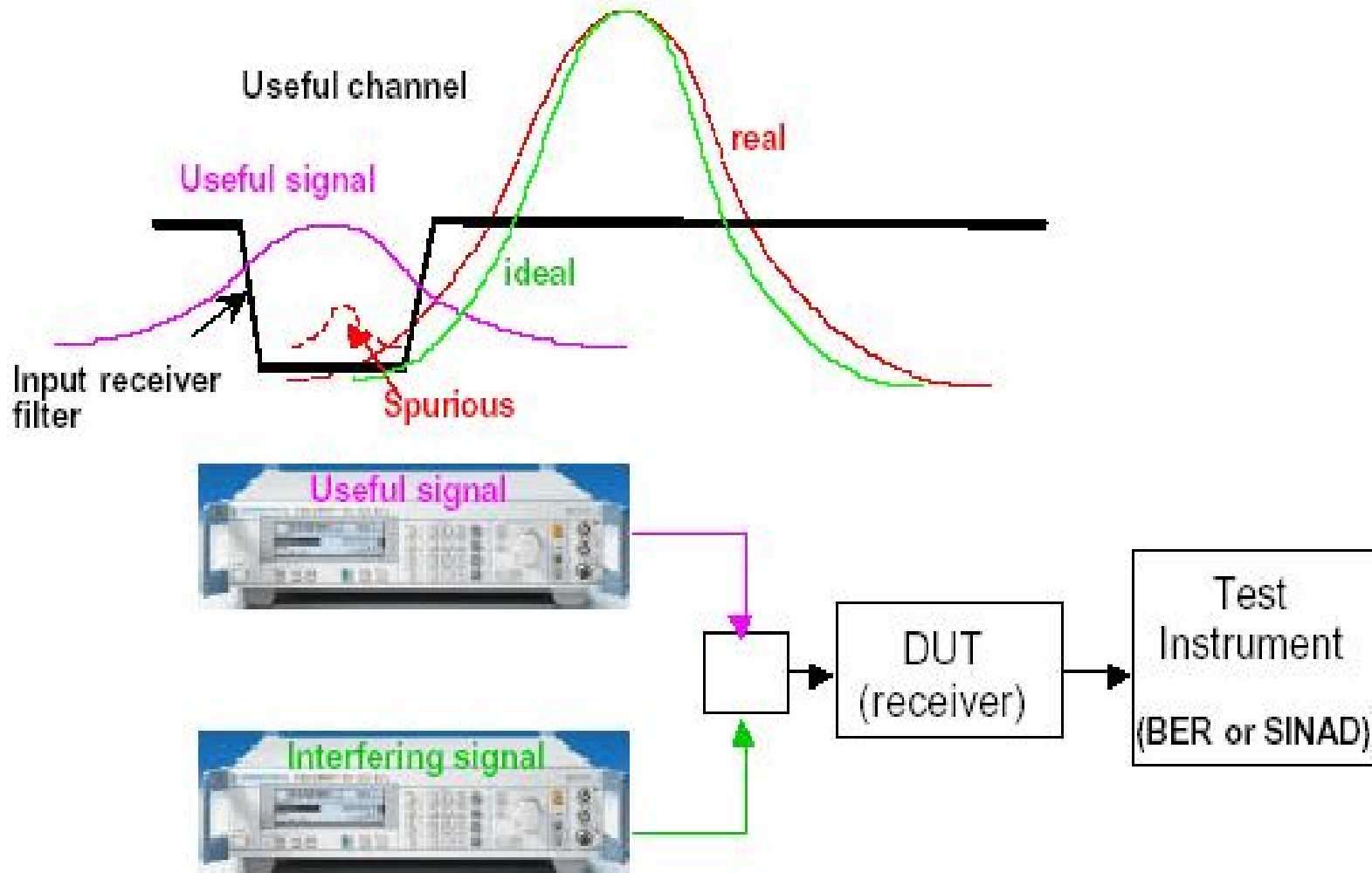
接收机测量

- | 灵敏度
- | 邻道选择性
- | 共信道抑制
- | 邻信道抑制
- | 交调抑制
- | 杂散响应抑制
- | 阻塞特性

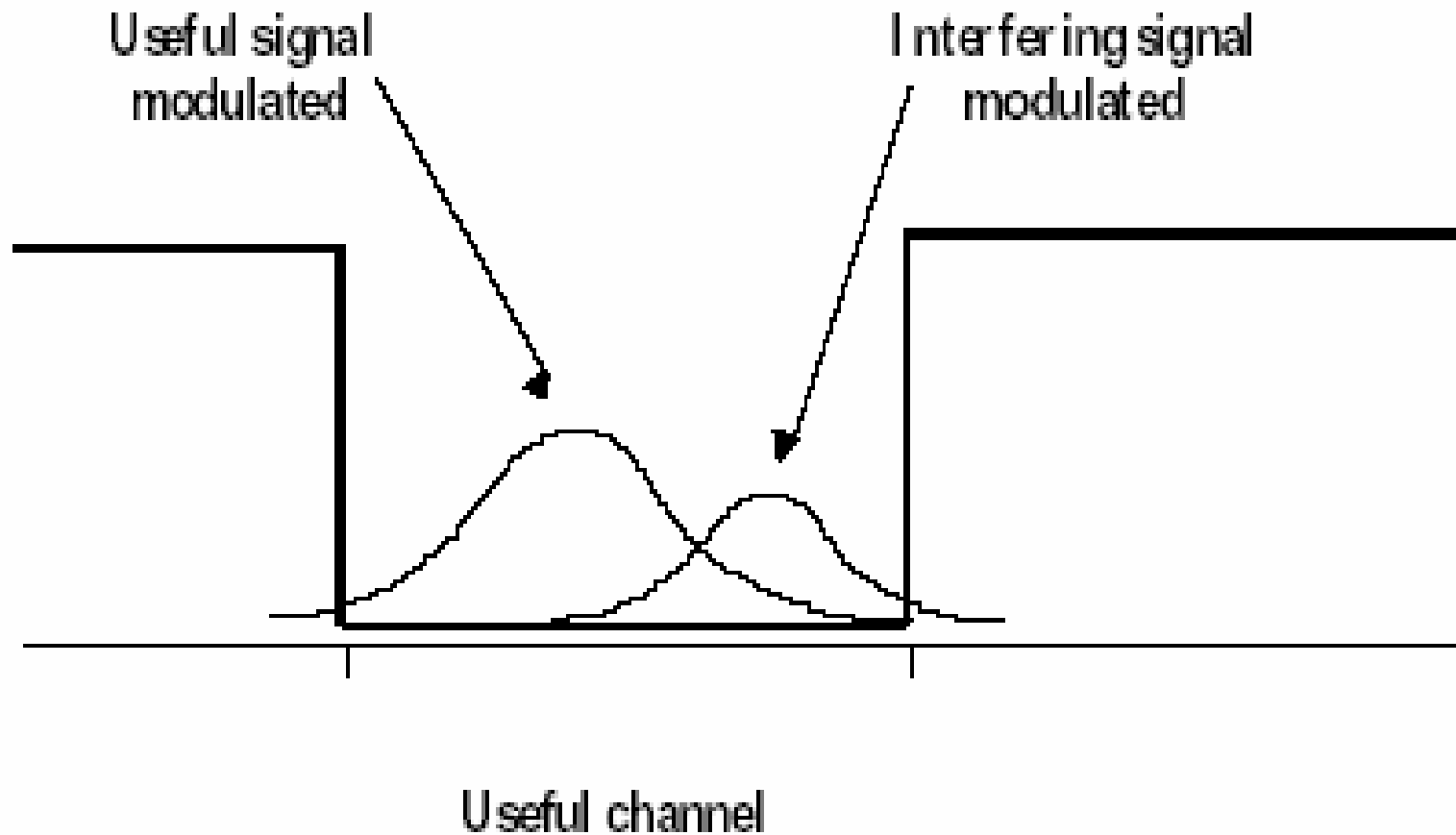


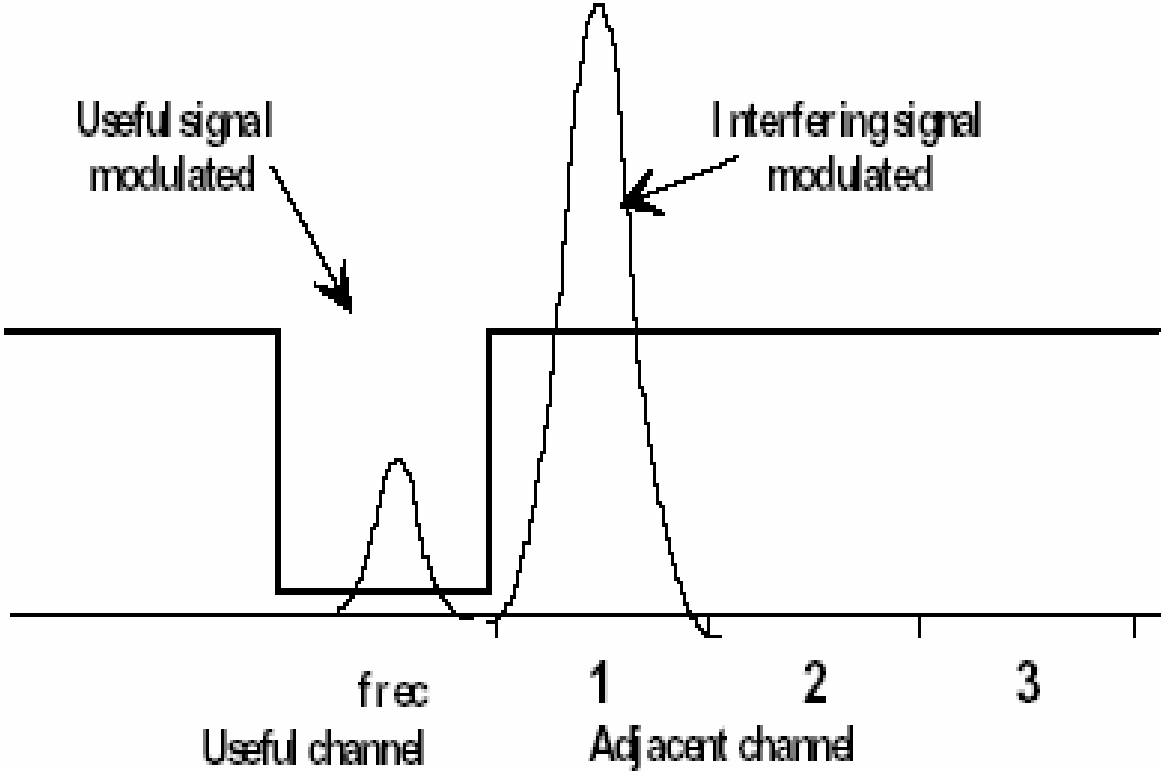
接收机测量 / 灵敏度(最小接收电平)
接收机测量 / 最大接收电平



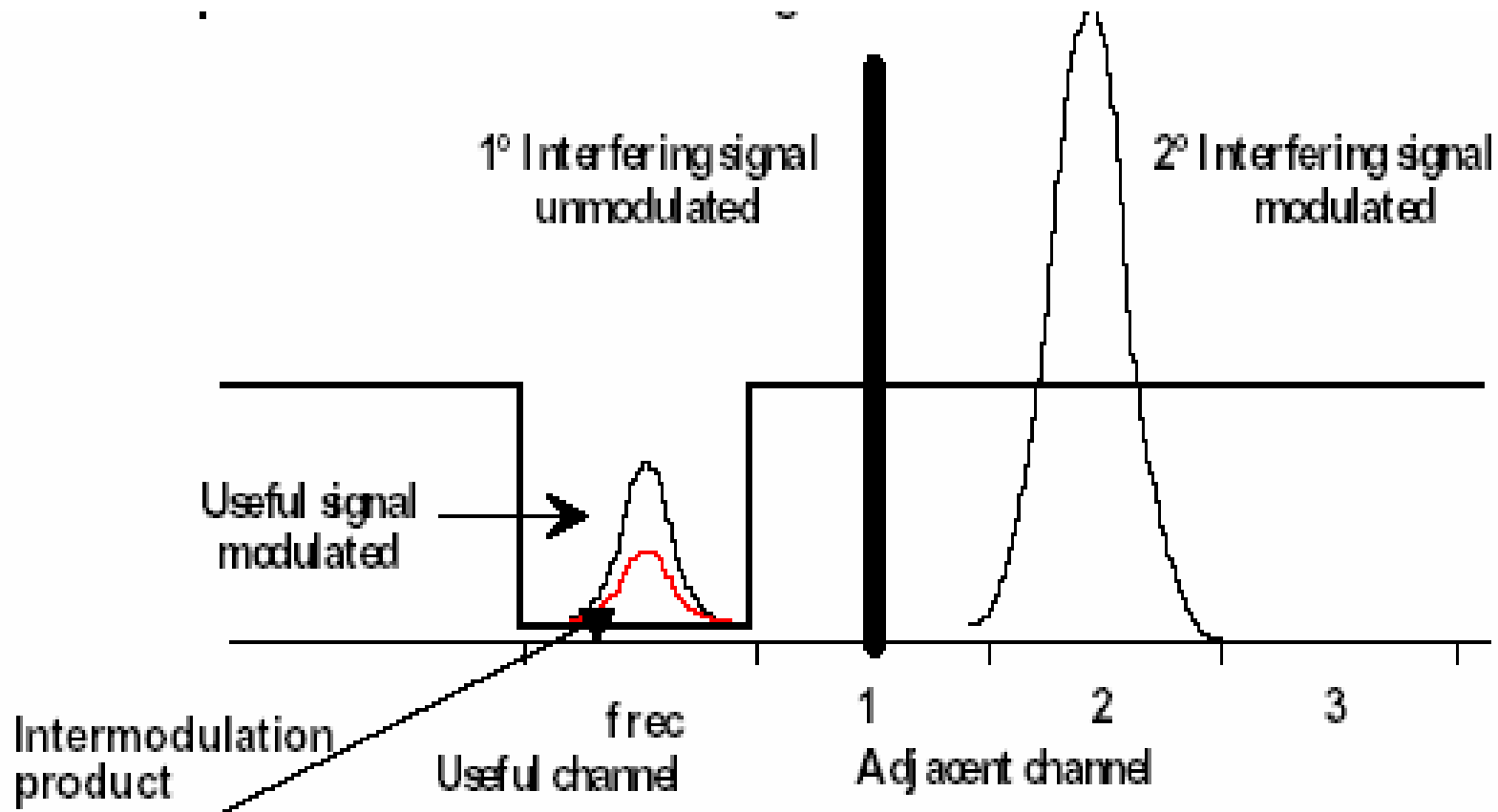


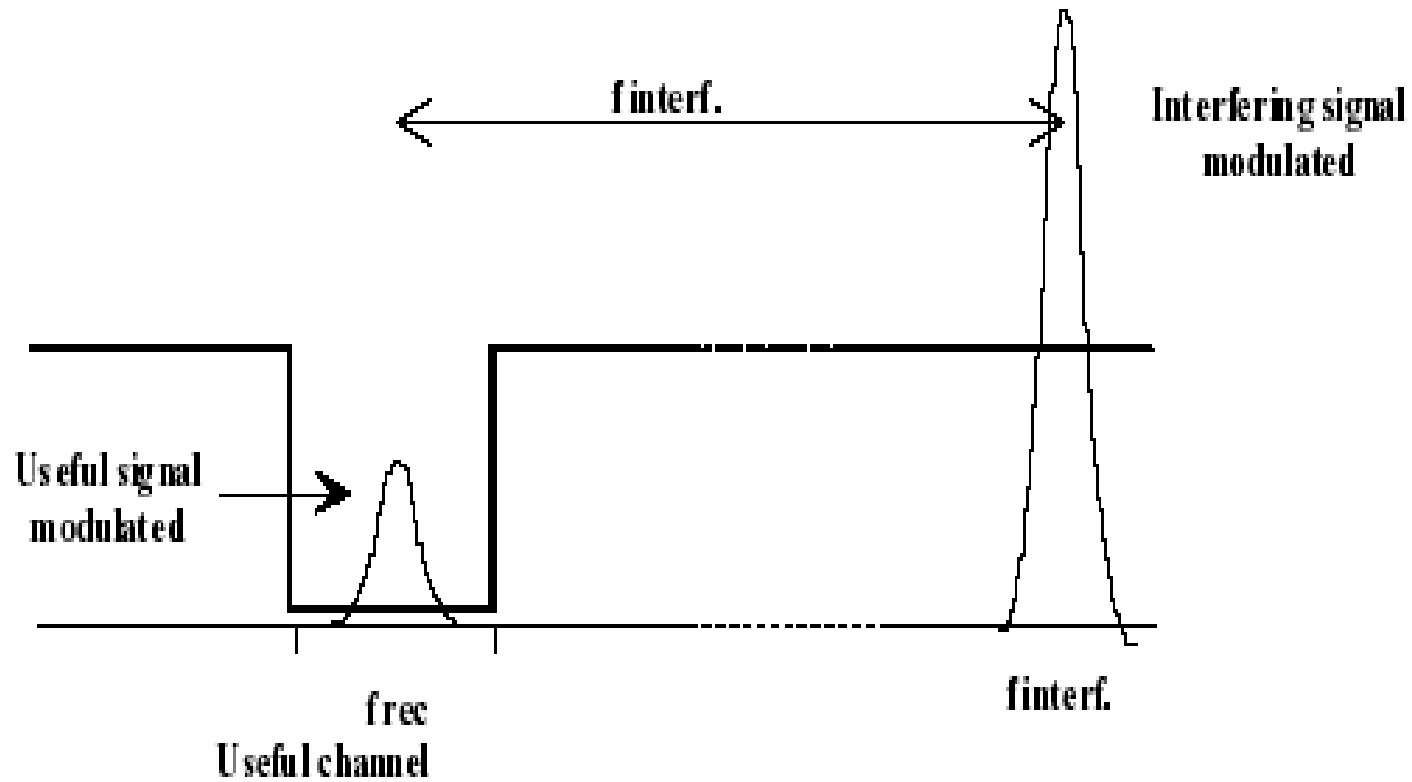
接收机测量/
共信道抑制、同频抑制



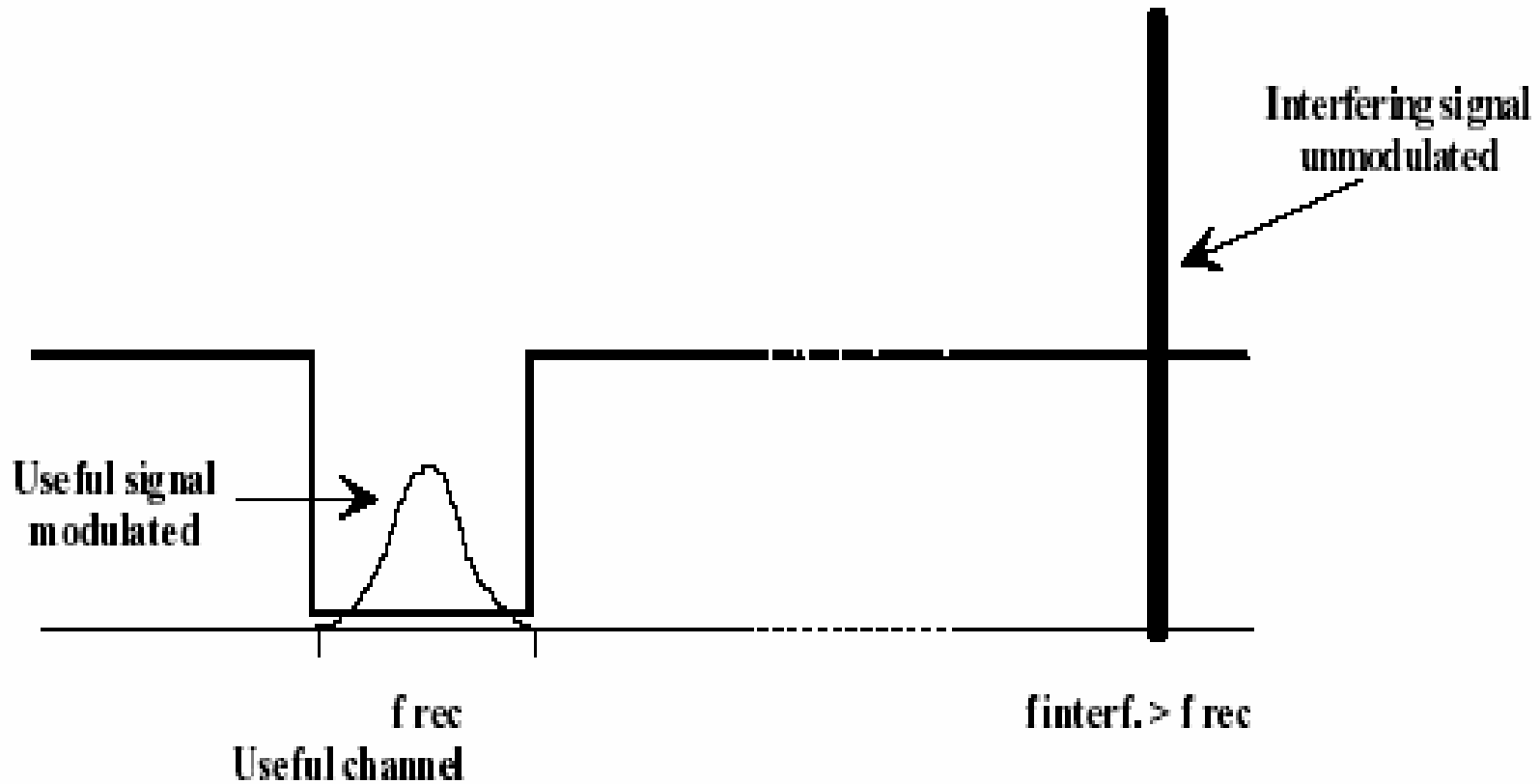


用来测试接收机在抑制几个RF信号的交调产物的性能





接收机测量 / 阻塞特性



感谢您的参与!