TD-SCDMA 操作指南

码域/调制域测量：

（1） 设定中心频率

（2） 按屏幕下方 TDS-BS 热键，即可进入 TD-SCDMA 测试功能

（3） 在任何界面下，按屏幕下方[RESULTS]热键，即可切换到码域测量菜单

（4） 默认状态下，屏幕分为两部分，如图 1 所示：屏幕上半部分为 Screen A，显示的是当前时隙的码域功率示意图；下半部分为 Screen B，以数据表格（Result Summary）的形式显示当前的测量结果。如，EVM、PCDE 等等。

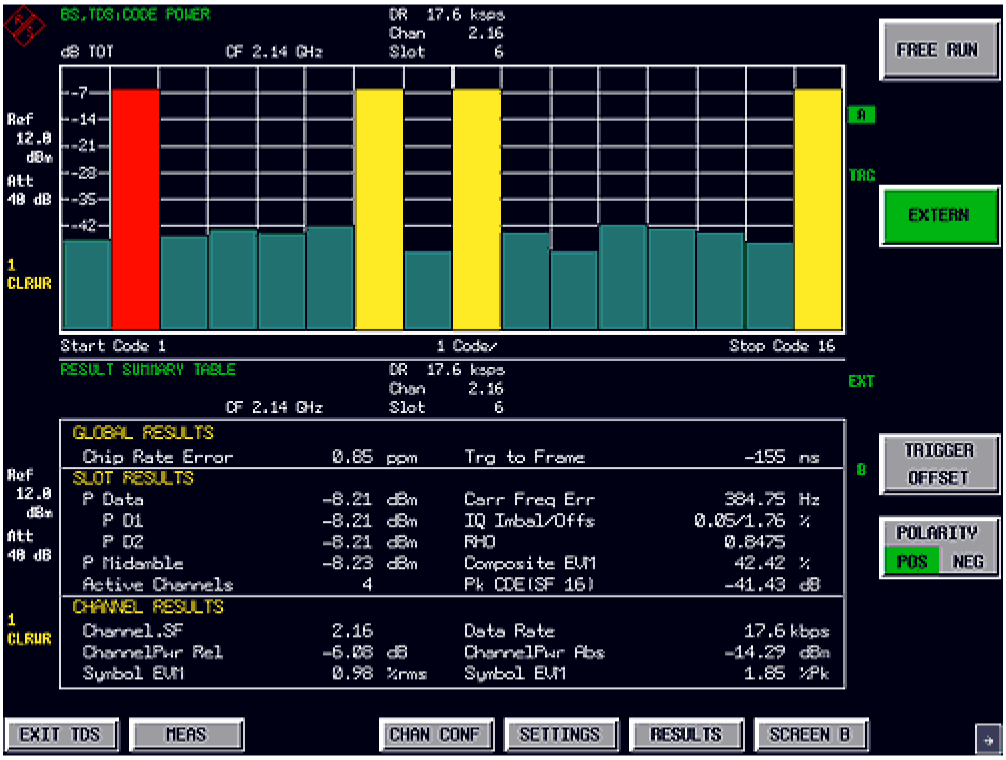


图 1　　TD-SCDMA 基站码域测量

数据表格分成 3 大块，各个指标的解释：

(1) Global Result 部分是信号的整体性能：

Chip Rate Error——码片速率误差，实际码片速率和 1.28Mcps 标准码片速率的误差，单位为 ppm。

Trg to Fram——触发信号到实际子帧开始的时间差。如果选择自由触发（Free Run），这一栏会没有数据显示，显示为“--”

(2) Slot Result 部分是当前选择的时隙内，所有码道的测量结果：

P Data————当前时隙内，数据部分的平均功率

PD1/PD2———当前时隙内，前半部分数据/后半部分数据的平均功率

P Midamble——中间码（训练序列）部分的功率

Active Channels——当前时隙内，激活的码道数量

Carrier Freq Err——载波频率误差

I/Q Imbal/Offs——I 和 Q 路信号的不平衡度/偏移

RHO————————波形质量因子

Composite EVM——复合 EVM

Pk CDE———————峰值码域误差

（3）Channel Result 部分是当前时隙内，被选中的码道（在 Screen A 中，用红色的方条表示）的测量结果。

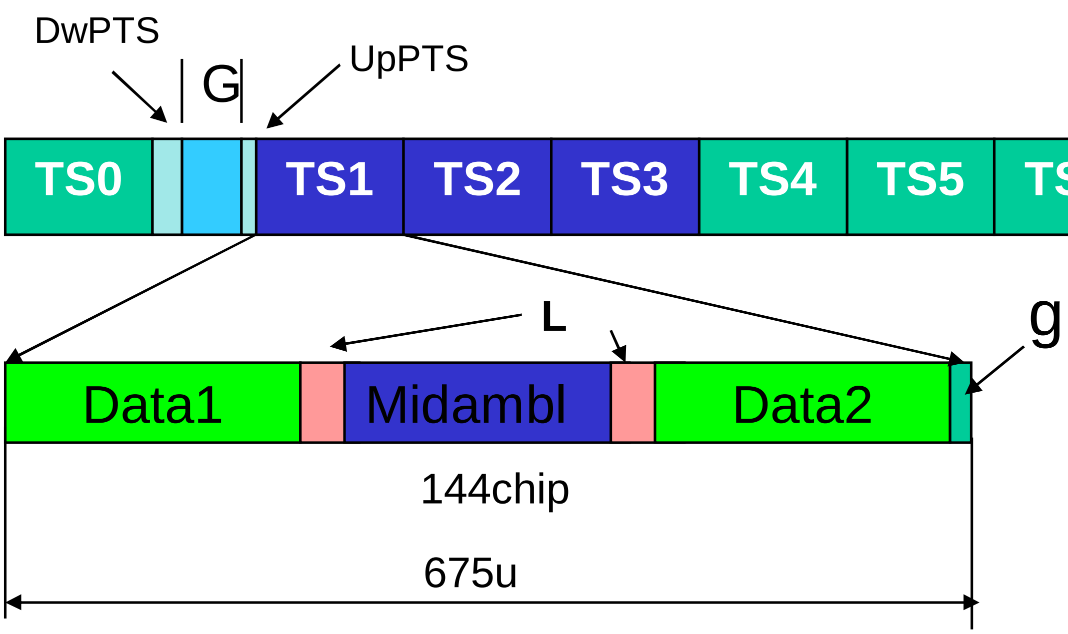
Channel SF——当前选中的码道的扩频因子序号/扩频比

Data Rate——当前码道的符号速率

Channel Power Rel——当前选中码道的相对功率，即当前选中码道功率占所在时隙总功率的比值，用 dB 表示

Channel Power Abs——当前选中码道的绝对功率，单位为 dBm

背景知识：TD-SCDMA 的帧结构和时隙结构：



每时隙由704 Chips组成，时长675us；业务和信令数据由两块组成（Data1和Data2），每个数据块分别由352 Chips组成；训练序列(Midamble)由144 Chips组成；保护间隔为16 Chips。

时隙和码道的选择：

由于TD-SCDMA信号既有时分复用，又有码分复用，因此不但要测每个时隙的指标，还要测每个时隙内，不同码道的信息。因此，要在不同的时隙和码道之间切换。

选择时隙的操作：

[RESULTS] **à** [SELECT] **à** [SELECT SLOT] **à** 屏幕上方会出现输入框，输入时隙号码，或用滚轮调节。

选择码道的操作：

[RESULTS] **à** [SELECT CHANNEL] **à** 直接用滚轮操作即可

参考电平和衰减器的调整：

为了在不同的输入功率下，准确的测量，必须调节频谱仪的衰减器和参考电平，FSx系列频谱仪提供了自动电平调整功能。该功能在频域测量（如ACLR、频谱发射模版等等）

[RESULTS] **à** [ADJUST REF]

频域测量功能

按面板上的*MEAS*键，或屏幕下方的[MEAS]热键，即可进入频域测量功能，此后，按[RESULTS]热键。即可切换回码域分析功能。

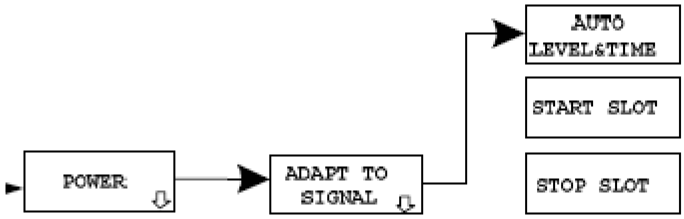
注意：由于TD-SCDMA信号是时分信号，而频域测量需要在有突发的时候进行，因此需要触发信号，即把信号源前面板上的MARK1输出通过BNC电缆，连接到频谱仪后面板上的GATE IN输入接口。进入频谱测量功能以后，频谱仪会自动切换到门限触发模式（Gated Trigger）

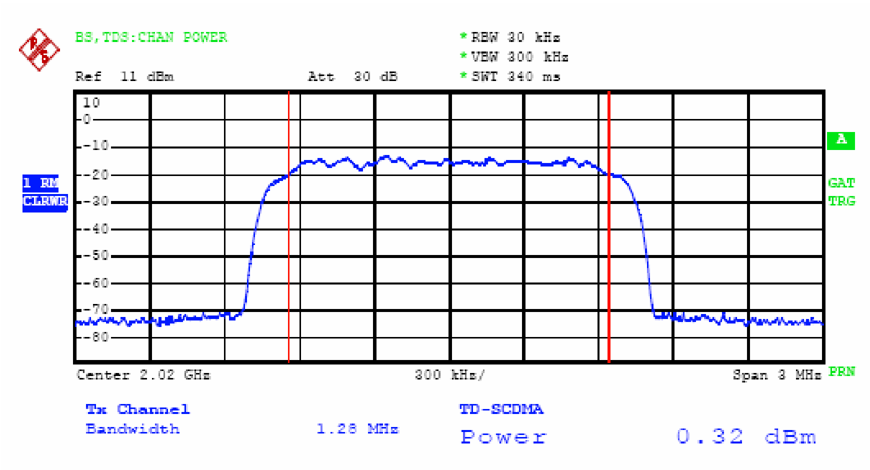
（1）单载波信道功率测量：

[MEAS] **à** [POWER] **à** [ADAPT TO SIGNAL] **à** [AUTO LEVEL & TIME]

其中[AUTO　LEVEL & TIME]的功能是调节衰减器和参考点频到最佳值

在[ADAPT　TO　SIGNAL]菜单下还有[START　SLOT]和[STOP　SLOT]两个选项，分别是用来选择测量的起始时隙号和终止时隙号。仪器会根据输入的起始/终止时隙号，自动计算出相应的触发参数（如触发延时、触发门限的长度），关于触发的详细说明请看本章的“背景知识”部分





（2）单载波邻信道功率测量：

[MEAS] à [ACLR] à [ADAPT　TO　SIGNAL] à [AUTO　LEVEL & TIME]

（3）　占用带宽的测量：

[MEAS] à [OCCUPIED BANDWITH] à [ADAPT TO SIGNAL] à [AUTO LEVEL& TIME]

背景知识：触发参数

由于 TD-SCDMA 是时分双工系统，通常在 1、2、3 时隙传输上行信号，4、5、6 时隙传输下行信号。也就是说，下行/上行信号不是连续发射的，是以突发（Burst）方式发射的。而在频域测量时，频谱仪并不知道 Burst 何时开始，何时结束。因此需要一个外部信号“通知”频谱仪，何时开始进行测量（触发延时）、测量多长时间（触发门限的长度）。

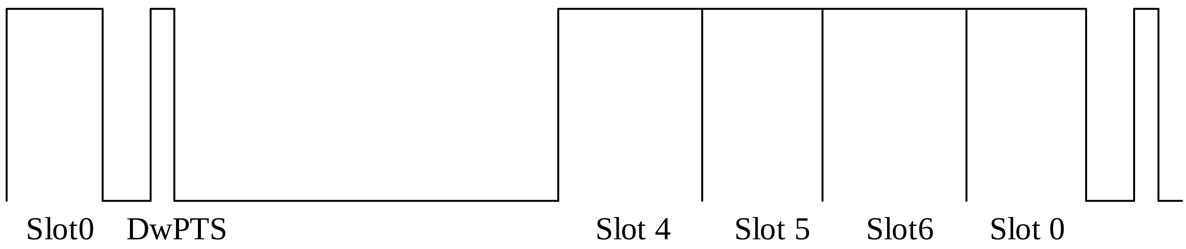


图 3　下行信号的包络功率示意图

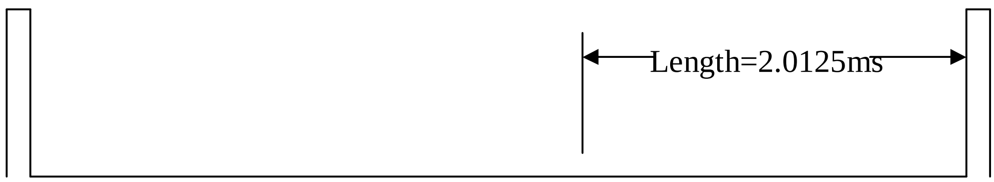
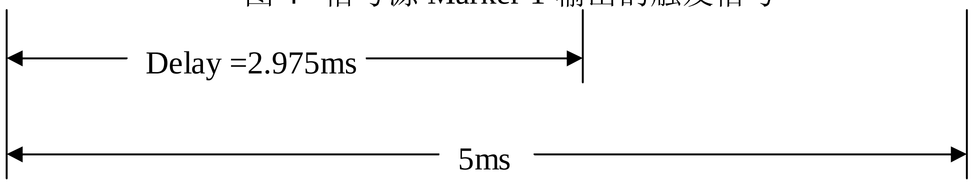


图 4　信号源 Marker 1 输出的触发信号



如图 3，是一个 TD-SCDMA 子帧的功率包络示意图，可以看出，只有 0、4、5、6 时隙是有信号的，而信号源在射频端口发出每一个子帧的开始的同时，会在 Marker 1 端口发出一个 3.3V，脉宽为几十纳秒的脉冲信号（这是默认设置，可以在信号源中设置每个 Marker 输出的波形），可以用这个信号触发频谱仪，通知频谱仪在接到这个信号后延迟 2.975ms 后开始测量（根据 TD-SCDMA 规范，可以算出第 4 个时隙的开始点距离子帧的开始点的时间为 2.975ms），测量时间为 2.0125ms（4、5、6 时隙的持续时间）。在每项测试的菜单里面都有[ADAPT TO SIGNAL] **à** [START SLOT]和[STOP SLOT]两个选项，可以分别设置测量的起始时隙（默认值为 4）和终止时隙（默认值为 6），仪器会根据设定值自动计算触发延时和触发门限长度。

（4）多载波 ACLR 测量：

固件版本在 V4.0 以上的 FSP/FSU/FSQ，可以在 TD 测试选件内部直接测试多载波 ACLR，方法如下（如图 5）：

1. MEAS **à** [MULT CARR]
2. 在[CP/ACP CONFIG]子菜单下面有很多选项可以设置诸如：载波数目、邻信道数目等等，解释如下：

[NO. OF ADJ CHAN]——邻信道的个数

[NO. OF TX CHAN]——传输信道的个数（即载波数目）

[CHANNEL BANDWIDTH]——信号带宽（默认值，不需改变）

[CHANNEL SPACING] ——信道间隔频率（默认值、不需改变）

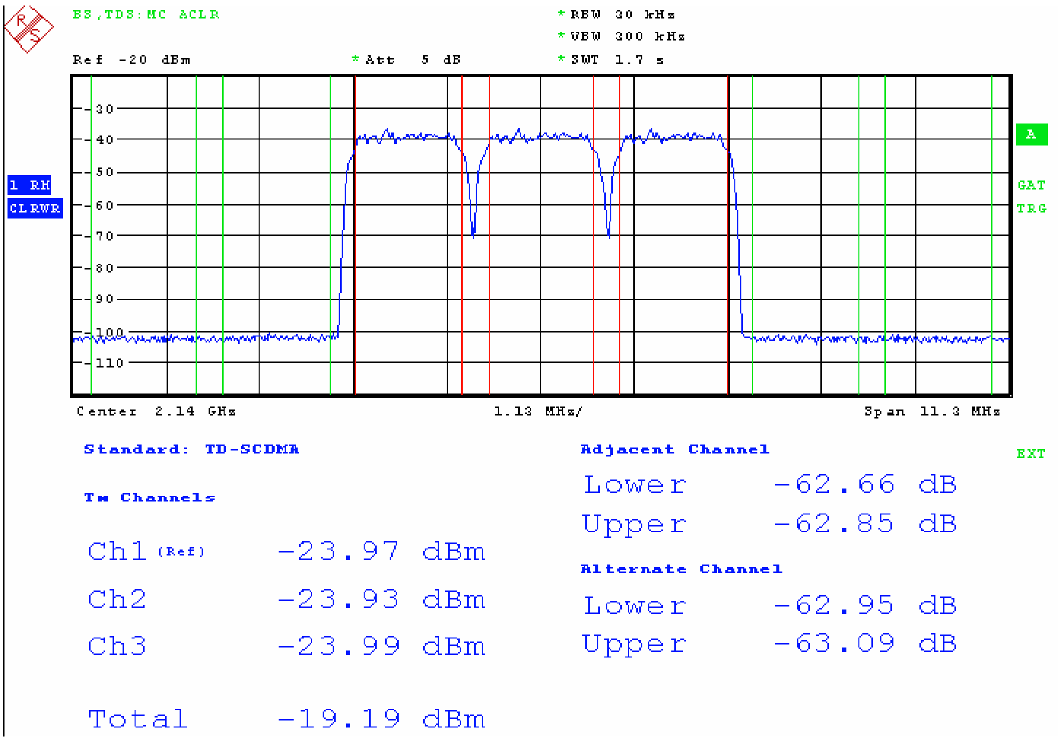


图 5　多载波 ACLR 测试结果

对于固件版本小于 V4.0 的，多载波 ACLR 现在必须在频谱模式下测试，因此要手工设置触发参数。操作如下：

1. 在频谱模式下，设置中心频率，频率跨度（SPAN）
2. MEAS à [MULT CARR] à [CP/ACP STANDARD] à 用滚轮选中 TD-SCDMA à [CP/ACP CONFIG]
3. 在[CP/ACP CONFIG]子菜单下面有很多选项可以设置诸如：载波数目、邻信道数目等等，解释如下：

    [NO. OF ADJ CHAN]——测量并显示邻信道的个数

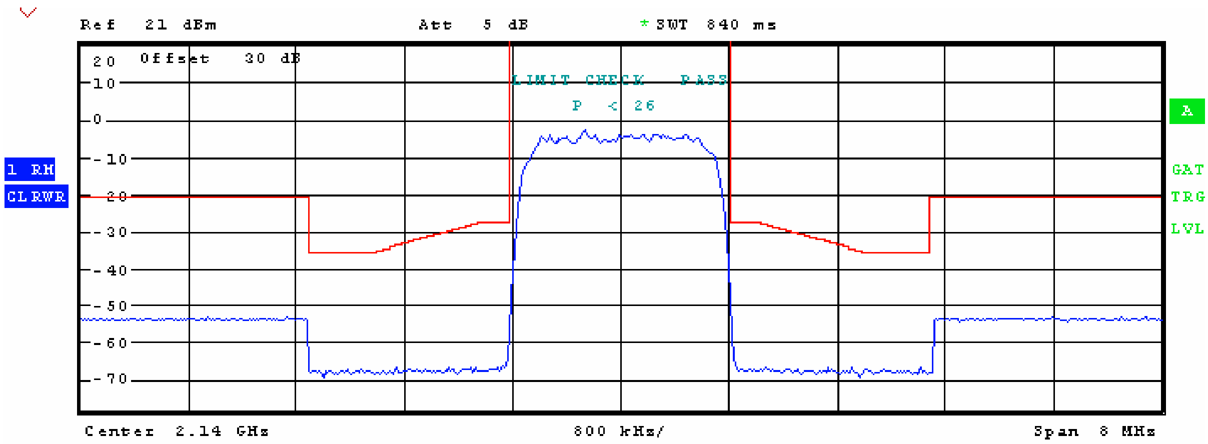
    [NO. OF TX CHAN] ——传输信道的个数（即载波数目）

    [CHANNEL BANDWIDTH] ——信号带宽（默认值，不需改变）

    [CHANNEL SPACING] ——信道间隔频率（默认值、不需改变）

（5）频谱发射模版（SEM）测量：

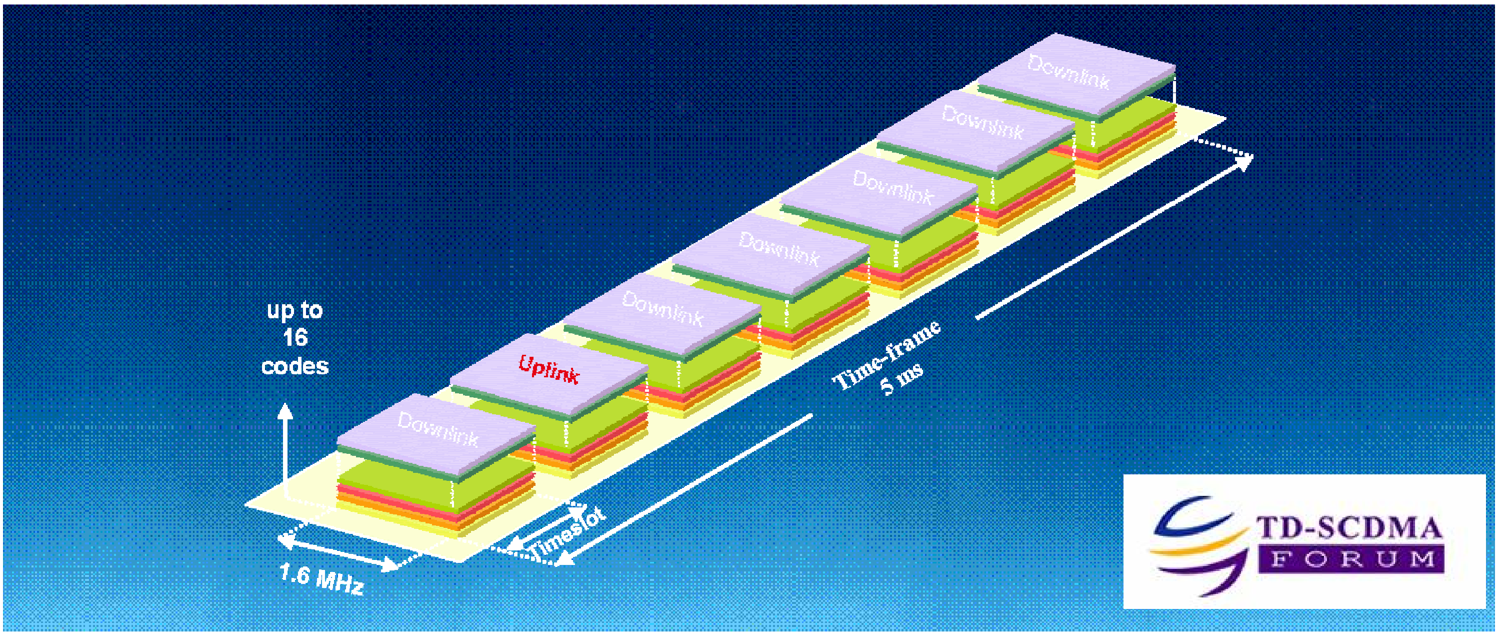
1. MEAS à [SPECTRUM EM MASK]
2. [LIST EVALUATION]，会在屏幕下方显示每一段的峰值点的频率和幅度其中[LIMIT LINE AUTO]功能会根据测得的信道功率，根据标准，自动选择相应的限制线，并在屏幕上显示是否通过（PASS/FAIL）



Tx Channel Bandwidth 1.6 MHz　　TD-SCDMA Power 10.95 dBm　　EXT

Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	PwrRel [dBc]	ΔLimit [dB]
-4.000 M	-2.300 M	1 M	2.136936 G	-53.64	-64.58	-32.64
-2.300 M	-1.815 M	30 k	2.138077 G	-67.82	-78.76	-31.82
-1.815 M	-1.015 M	30 k	2.138192 G	-68.76	-79.71	-32.83
-1.015 M	-815.000 k	30 k	2.139179 G	-48.69	-59.64	-20.69
815.000 k	1.015 M	30 k	2.140821 G	-49.05	-60.00	-21.05
1.015 M	1.815 M	30 k	2.141808 G	-68.11	-79.05	-32.18
1.815 M	2.300 M	30 k	2.142218 G	-67.62	-78.57	-31.62
2.300 M	4.000 M	1 M	2.143897 G	-53.59	-64.54	-32.59

Preliminary



Products: R&S®SMU, R&S®SMJ, R&S®FSP, R&S®FSU, R&S®FSQ, R&S®NRP, R&S®NPR-Z11, R&S®NRP-Z21

Tests on Single-Channel and Multichannel TD-SCDMA Base Station Power Amplifiers

Application Note 1MA103

This Application Note describes how to perform measurements on power amplifiers for TD-SCDMA base stations to specification TS 25.105 using Rohde & Schwarz generators, power meters and signal/spectrum analyzers. The TD-SCDMA application firmware for Rohde & Schwarz generators and analyzers as well as their outstanding performance facilitate efficient and rapid measurements.

ROHDE&SCHWARZ

Subject to change – Roland Minihold 12/2006 – 1MA 103_0e

Contents

1 Overview

To perform measurements compliant with TS25.105[9] on power amplifiers in TD-SCDMA base stations, the large dynamic range required in pulse mode operation is a special challenge for development and test engineers. This Application Note describes how to perform measurements on power amplifiers for TD-SCDMA base stations to specification TS 25.105 using Rohde & Schwarz generators, power meters and signal/spectrum analyzers. The TD-SCDMA application firmware for Rohde & Schwarz generators and analyzers as well as their outstanding performance facilitate efficient and rapid measurements.

2 TD-SCDMA Signal Overview

Time **D**ivision **S**ynchronous **C**ode **D**ivision **M**ultiple **A**ccess (TD-SCDMA) designates a mobile radio transmission method for 3G mobile communications developed by the China Wireless Telecommunication Standard group (CWTS, see http://www.cwts.org for details). The same frequency is used for transmissions in both directions with Time Domain Duplexing (TDD). Each resource (frequency, code and timeslot) can be used simultaneously by several base stations or user equipment, provided the scrambling codes differ. The standard is similar to the 3GPP TDD proposal, but with greater emphasis placed on GSM compatibility and with a chip rate limited to 1.28 Mcps. TD-SCDMA is included in the 3GPP Universal Terrestrial Radio Access (UTRA) as the UTRA-TDD option, called 1.28 Mcps TDD or Low Chip Rate (LCR) TDD. TD-SCDMA is a mobile radio standard in which available bandwidth is shared among subscribers according to frequency (FDMA), time (TDMA) and code (CDMA).

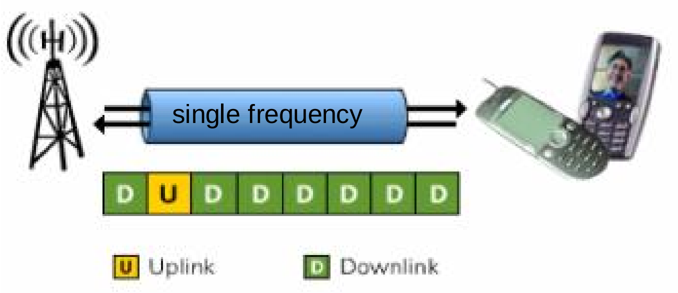


Fig. 1: Principle of TD-SCDMA channel access with TDMA in TDD mode

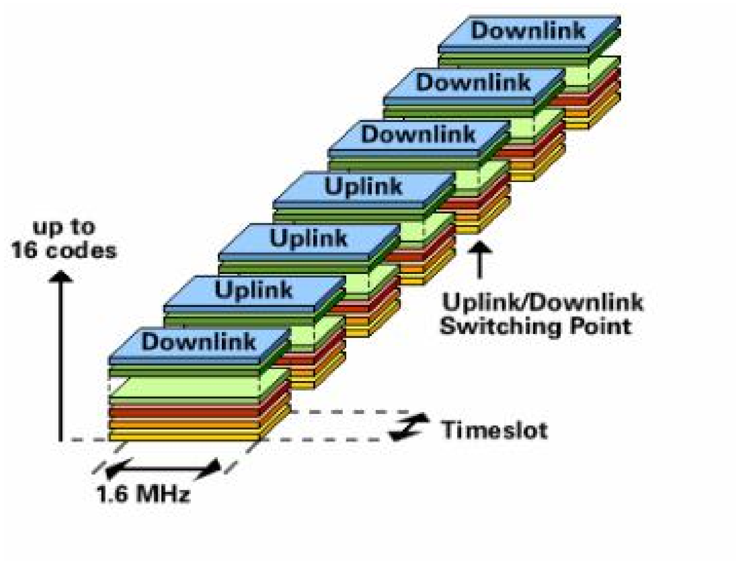


Fig. 2: Principle of TD-SCDMA code division multiple access

TD-SCDMA signal structure (frames and timeslots)

The TD-SCDMA signal is organized in frames of 5 ms length. Each frame comprises seven traffic timeslots (TS0 to TS6, each 0.675 ms) and two special timeslots (DwPTS and UpPTS) for synchronization.

TS0 is always allocated to the downlink, TS1 to the uplink. The other timeslots are divided between the two directions of transmission, the switching point being variable (the switching point separates the uplink slots from the downlink slots).

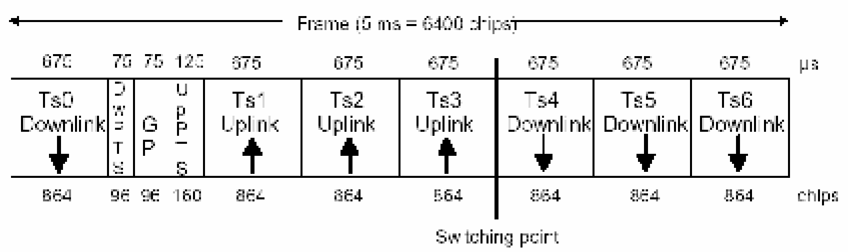


Fig. 3: Structure of a TD-SCDMA frame

For testing base station power amplifiers, the downlink slots are relevant. According to TS 25.105, the switching point is located between TS3 and TS4 and TS4, 5 and 6 are to be activated on the signal generator.

DwPTS and UpPTS

In the downlink pilot timeslot (DwPTS), the base station sends one of 32 possible 64-chip SYNC codes.

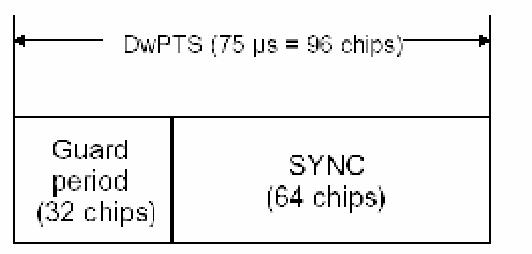


Fig. 4: DwPTS structure

The user equipment synchronizes to the base station using the same synchronization code (SYNC code), which also defines the value range for the scrambling code and the basic midamble code.

The uplink pilot timeslot (UpPTS) is sent by the user equipment to initiate a call with the base station and is therefore not relevant when testing TD-SCDMA base station power amplifiers.

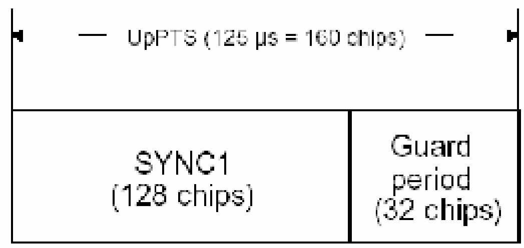


Fig. 5: UpPTS structure

See [1] – Chapter "Digital Standard TD-SCDMA: TD-SCDMA Signal Structure" for more detailed information.

3 Test Setups

The test setup shown in Fig. 6 is used to conduct the measurements described in this Application Note. An R&S®SMU or R&S®SMJ serves as a signal source and an R&S®FSU/FSQ or R&S®FSP carries out the signal analysis. An (optional) bi-directional coupler is used to couple out the forward and reflected signals at the input of the power amplifier under test.

To calculate the amplifier's VSWR, input power and reflected power are measured by sensor 1 and 2.

To measure the power amplifier's output power and gain (= (output power)/(input power)) with the maximum achievable accuracy, power sensor 3 is required. Although the absolute power measurement accuracy of an R&S®FSU or R&S®FSQ is excellent for a spectrum analyzer (0.3 dB absolute accuracy), the accuracy of a power meter, especially that of the R&S®NRP power meter, will always be better.

The marker 1 output (frame start) from the signal generator delivers the necessary trigger signal to the analyzer and the power meter. All measurements can be carried out in sync with the TDMA frame.

The R&S®NRP-Z21 sensors can be used without the power meter base unit as standalone measuring instruments and connected directly via R&S®NRP-Z4 USB adapters to a controller; the trigger signal must be fed to every power sensor via the BNC connectors of the R&S®NRP-Z4 USB adapters.

The analyzer and signal generator are locked by feeding the generator's reference output signal to the analyzer's reference input.

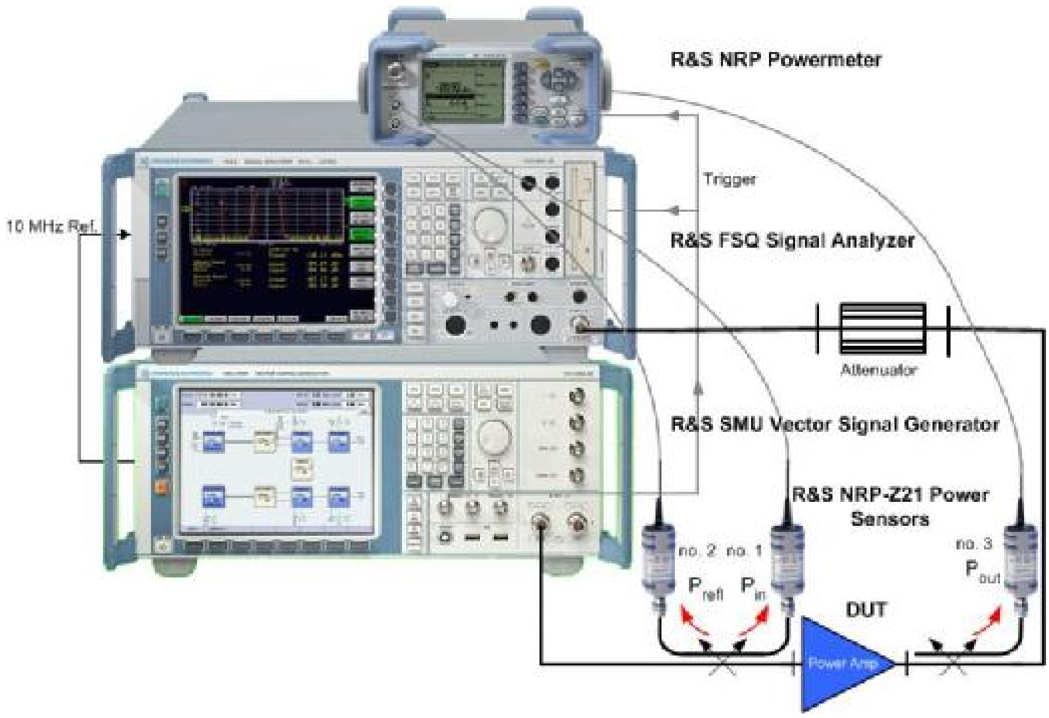


Fig. 6: Proposed test setup with optional power sensors

4 Conventions for Instrument Settings

Rohde & Schwarz generators and analyzers

The following conventions are used when referring to settings on Rohde & Schwarz generators and analyzers. Key strokes are in bold italics and softkey strokes in normal italics:

Convention	Description	Example
<***Key***>	Press a key on the front panel	***FREQ***
<*Softkey*>	Press a softkey	*MARKER –>PEAK*
<***Key***>:<*Softkey1*>*:* <*…* >*:…*	In a sequence of key strokes or softkey strokes, a colon is used as a separator	***MARKER:*** *MARKER –>PEAK*
<***nn unit***>	First enter the value using the numerical keypad, then complete the entry with the unit	***12 kHz***
<***nn ENTER***>	First enter the value via the numerical keypad, then complete the entry with the Enter key.	***TDS BS****: SETTINGS: SCRAMBLING CODE* ***1****:* ***ENTER***
(<Comment>)	Comments are enclosed in round brackets.	

Table 1: Conventions for instrument settings on R&S generators and analyzers

Power Meter R&S®NRP

The conventions are as above, with the important difference that numerical entries are made with softkeys and terminated with the ¿ ***Menu*** key. Delete the numerical entry field before entering numbers. Values in square brackets are not settings to be made, but results or information for the user.

Example:

PRESET:*PRESET*
FREQ*:[A]:[50MHz]*
DEL/TRIG 1*: 2.12:UNIT[GHz]*: ¿ ***Menu***

In the example, the UNIT softkey is used to toggle between the units "MHz" and "GHz".

5 Generating Test Signals

A suitable input signal is essential to test a base station amplifier. It can be provided by an appropriate TD-SCMDA base station unit (without PA module) or preferably a signal generator. Compared to a base station, the R&S®SMU or R&S®SMJ signal generators provide outstanding signal quality, significant greater flexibility and shorter setting times (especially with remote control by computer).

The R&S®SMU or R&S®SMJ settings to generate TD-SCDMA downlink test signals in line with TS 25.105 are described below. Specifically, these signals are:

- A single-carrier TD-SCDMA test signal; except for the multicarrier ACLR measurement, this signal is a prerequisite for all measurements described below
- A phase-coherent two-carrier TD-SCDMA test signal (R&S®SMU, with two baseband units only)
- A phase-coherent four-carrier TD-SCDMA test signal (ARB mode); this test signal is a prerequisite for the multicarrier ACLR measurement

The R&S®SMU-K50 or R&S®SMJ-K50 digital standard TD-SCDMA generator option is a prerequisite.

Note:

Only the generator settings that are specifically relevant to TD-SCDMA are described. Also, the frequency and the appropriate level must be set on the generator to obtain the rated amplifier output power.

Single-carrier signals

Signal generator operating sequence:

MENU

BASEBAND A CONFIG:

*TD-SCDMA….:STATE ON:**ENTER***

Predefined Settings:ACCEPT

The generator now outputs a TD-SCDMA signal for which the downlink slots 0, 4, 5 and 6 are active, as is the downlink pilot timeslot (DwPTS). The crest factor of the signal is approx. 5.4 dB. See Fig. 15 on page 24.

Check the frame structure in the menu:

*BASEBAND A CONFIG:TD-SCDMA:Cell1:**ENTER***

make any changes required.

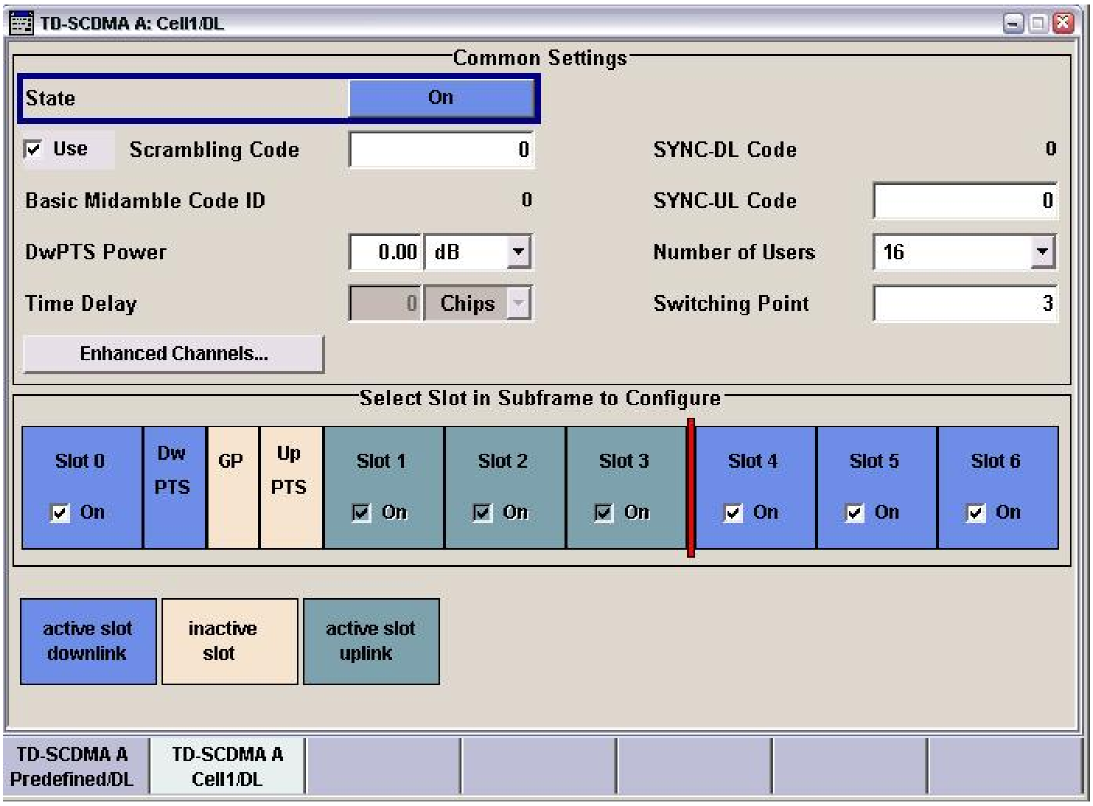
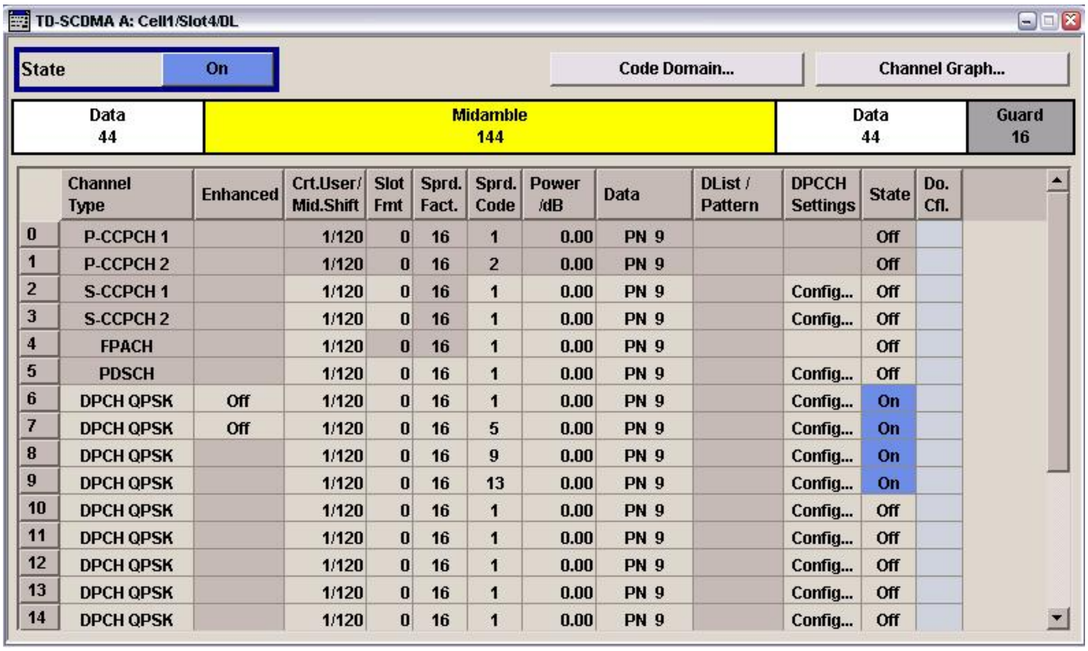


Fig. 7: R&S®SMU/SMJ user interface (TD-SCDMA, cell1, common settings)

Details of the slot structure (in this case slot 4) can be obtained with:

*BASEBAND A CONFIG:TD-SCDMA:Cell1:SLOT4:**ENTER***


TD-SCDMA A: Cell1/Slot4/DL

State: On | Code Domain... | Channel Graph...

Data 44	Midamble 144	Data 44	Guard 16

	Channel Type	Enhanced	Crt.User/ Mid.Shift	Slot Fmt	Sprd. Fact.	Sprd. Code	Power /dB	Data	DList / Pattern	DPCCH Settings	State	Do. Cfl.
0	P-CCPCH 1		1/120	0	16	1	0.00	PN 9			Off	
1	P-CCPCH 2		1/120	0	16	2	0.00	PN 9			Off	
2	S-CCPCH 1		1/120	0	16	1	0.00	PN 9		Config...	Off	
3	S-CCPCH 2		1/120	0	16	1	0.00	PN 9		Config...	Off	
4	FPACH		1/120	0	16	1	0.00	PN 9			Off	
5	PDSCH		1/120	0	16	1	0.00	PN 9		Config...	Off	
6	DPCH QPSK	Off	1/120	0	16	1	0.00	PN 9		Config...	On	
7	DPCH QPSK	Off	1/120	0	16	5	0.00	PN 9		Config...	On	
8	DPCH QPSK		1/120	0	16	9	0.00	PN 9		Config...	On	
9	DPCH QPSK		1/120	0	16	13	0.00	PN 9		Config...	On	
10	DPCH QPSK		1/120	0	16	1	0.00	PN 9		Config...	Off	
11	DPCH QPSK		1/120	0	16	1	0.00	PN 9		Config...	Off	
12	DPCH QPSK		1/120	0	16	1	0.00	PN 9		Config...	Off	
13	DPCH QPSK		1/120	0	16	1	0.00	PN 9		Config...	Off	
14	DPCH QPSK		1/120	0	16	1	0.00	PN 9		Config...	Off	

Fig. 8: Configuration of slot 4 (or 5, or 6); in each case, four data channels (DPCH) with a spreading factor of 16 are active

Multicarrier signals

The multicarrier control signal required depends on the specification of the multicarrier power amplifier. The Rohde & Schwarz generators provide the following two options:

Generation of a phase-coherent two-carrier TD-SCDMA signal (R&S®SMU with two baseband units only):

If there are two baseband units in the R&S®SMU, a phase-coherent two-carrier TD-SCDMA signal can be generated with the assistance of the TD-SCDMA application firmware.

Signal generator operating sequence:

MENU:

BASEBAND B CONFIG:

FREQ OFFSET: ***1.6 MHz***

SIGNAL ROUTING: ROUTE TO PATH A

TD-SCDMA….:STATE ON

Predefined Settings:ACCEPT

TRIGGER/MARKER:TRIGGER IN/MODE:ARMED/RETRIGGER :SOURCE:INTERNAL(BASBAND A)

BASEBAND A CONFIG:

TD-SCDMA….:STATE ON:

Predefined Settings:ACCEPT

RF/A-MOD:ON

Generation of a phase-coherent four-carrier TD-SCDMA signal (ARB mode):

TD-SCDMA multicarrier signals (except the two-carrier signal above) require the generator's arbitrary waveform (ARB) function. The example below illustrates the generation of a four-carrier TD-SCDMA signal. Other configurations with a different number of carriers or different carrier spacings are set analogously. To keep the crest factor of the sum signal down, a code spacing that is as large as possible is selected (**à** 32) for the four TD-SCDMA carriers.

This four-carrier TD-SCDMA signal is required as a test signal for the multicarrier ACLR measurement described in Chapter 6.

Signal generator operating sequence:

MENU

BASEBAND A CONFIG:TD-SCDMA…:STATE ON

: Predifined Settings:ACCEPT

:Generate Waveform File: \d(data)\tds_0

:Cell1: Scrambling Code: 32

:Generate Waveform File: \d(data)\tds_1

:Cell1: Scrambling Code: 64

:Generate Waveform File: \d(data)\tds_2

:Cell1: Scrambling Code: 96

:Generate Waveform File: \d(data)\tds_3

ESC

ARB….:MULTICARRIER….:Number of Carrier: 4

:Carrier Spacing: 1.6 MHz

:Crest Factor Mode: Minimize

: Signal Period Mode: Longest File Wins

:Carrier Table: 0:State ON: File: \ tds_0

:1:State ON: File: \ tds_1

:2:State ON: File: \ tds_2

:3:State ON: File: \ tds_3

Create and Load

:ARB….:State: ON

To trigger the connected measuring instruments (spectrum analyzer or power meter), the signal generator's marker 1 output must be set to the restart signal. In this case, the restart signal provides a frame trigger signal to start the frame.

:ARB:….:Trigger/Marker….:Marker Mode: Marker 1 Restart

Using the ARB function, the generator now outputs a four-carrier TD-SCDMA signal. Each of the carriers has a frame structure like the single-carrier TD-SCDMA signal described above and the carriers are synchronized.

The four carriers are symmetrical about the selected carrier frequency (f_c), the offsets being +/- 800 kHz and +/- 2.4 MHz. This must be taken into account when frequency settings are made on the spectrum or signal analyzer.

For code domain, the appropriate scrambling code (see below) must also be set on the analyzer if the carriers are to be demodulated correctly:

TD-SCDMA carrier	f_c – 2.4 MHz	f_c – 0.8 MHz	f_c + 0.8 MHz	f_c+2.4 MHz
Scrambling code	0	32	64	96

Table 2: Carrier frequencies and scrambling codes for the four-carrier TD-SCDMA signal described above

Note:

The crest factor of the four-carrier TD-SCDMA signal described previously is about 8.1 dB measured with the R&S®FSQ at a bandwidth of 20 MHz. This relatively small value for a four-carrier TD-SCDMA signal is obtained by means of different scrambling codes with large code spacing and the *minimize crest factor* setting in ARB mode.

To set a specific crest factor, use the "multicarrier CW" mode. In this mode, it is possible to generate a multicarrier signal with a total bandwidth similar to an unpulsed TD-SCDMA signal and then set a specific crest factor (function: "Target Crestfactor"). See [1], chapter " Multicarrier Continuous Wave".

6 TD-SCDMA Transmit Measurements

The single carrier TD-SCMDA test signal described in chapter 5, is required for the measurements below apart from multicarrier ACLR measurements, which require the four-carrier test sígnal.

Power meter measurements

Output power (TS 25.105 chap. 6.2) and gain

Accurate power measurement at the amplifier output is critical. The amplifier must deliver the requested nominal power and meet the specifications, for example for ACLR, at exactly that power. Even though modern spectrum analyzers such as the R&S®FSP, R&S®FSU or R&S®FSQ have an excellent absolute-power measurement accuracy (0.3 dB), a power meter will always be the first choice for best accuracy. The R&S®NRP with the R&S®NRP-Z11 or R&S®NRP-Z21 sensor is particularly well-suited for measurements on 3GPP signals. Up to four sensors can be connected to the power meter. The R&S®NRP-Z11(-Z21) sensors have a very high dynamic range of 90 dB. Modulation-dependent errors (due to the amplitude variation of the TD-SCDMA signal) are negligible. A typical measurement uncertainty can be as low as about 0.1 dB.

Measure Gain at nominal output power (nominal gain) when amplifying one or more TD-SCDMA signals. Measuring with a network analyzer which uses low-level sine signals may give misleading results. To achieve maximum accuracy use high performance directional couplers in combination with a power meter (see Fig. 6 on page 6).

Gain is calculated from the following formula:

Gain/dB =

output power level(dBm) – input power level (dBm) =

power level indication $_{\text{Sensor 3}}$(dBm) – power level indication $_{\text{Sensor 1}}$(dBm)

Note: This is just the basic formula. Variable coupling losses and the insertion loss of couplers also have to be taken into account.

In addition to nominal gain, gain variation within the transmit band and the out-of-band gain have to be measured too. Both can be measured with the test setup in Fig. 6.

Input return loss/input VSWR

Good input matching which means high input return loss or low VSWR is essential if the power amplifier is to have specific gain and a flat frequency response.

The magnitude of the input return loss is measured by the power meter with two sensors and a bi-directional coupler (see figure 6 on page 6, sensors 1 and 2). A bi-directional coupler with a high directivity (e.g. NARDA model 3022) in combination with R&S®NRP-Z11/Z21 power sensors ensures sufficiently low measurement uncertainties.

The input return loss is calculated from the following formula:

Input return loss (dB)=

input power level (dBm) – reflected input power level (dBm) =

power level indication $_{\text{Sensor 1}}$(dBm) – power level indication $_{\text{Sensor 2}}$(dBm)

Power meter setup:

Time gated mode (T'Gate) is recommended due to the TDMA structure of the signal. The correct setting for measurement channel A of the R&S®NRP power meter is described below. Set channels B or C analogously.

Operating sequence for the power meter:

PRESET*:PRESET: ¿* ***Menu:[Sensor]:*** *:Mode: T'GATE*

Start of Gate: 2.98:UNIT:[ms] ***:¿ Menu***

End of Gate: 4.99 [ms] ***:¿ Menu***

ESC:ESC:*Trigger:A External -*:***:¿ Menu***

FREQ*:[A]:[50MHz*:***]:DEL/TRIG 1****: 2.12 :UNIT:[GHz]****:¿ Menu***

ESC:*Offset xx*[1]*dB:Global*

ESC

The power meter now measures the power integrated over slots 4, 5 and 6.

[1] Enter an offset xx corresponding to the coupling loss at the measurement frequency introduced by the directional coupler used (see Fig. 6).

Measurements with spectrum analyzer/signal analyzer

Code domain power measurements: modulation accuracy (TS 25.105 chap. 6.8.2) and peak code domain error (TS 25.105 chap. 6.8.3)

The power amplifier may not take the base station's transmit modulation parameters (modulation accuracy and peak code domain error) outside specified limits. Degradation can be caused by compression to which the power amplifier is especially susceptible at the rated output power. The requirement for the base station is a modulation accuracy (EVM) of ≤12.5 % and a peak code domain error of ≤-28 dB. These two measured values plus others are displayed in the result summary of the code domain power analysis performed by the analyzer.

Operating sequence for the analyzer:

PRESET

AMPT*:NEXT Offset xy dB* (enter an offset according to the connected attenuator*)*

Ref Level: yz dB (set a ref level of 10 dB above the nominal power of the amplifier)

FREQ*: yy MHz* (enter required frequency)

(MORE): TDS BS

ADJUST REF LVL

The signal analyzer now performs the code domain analysis on slot 0 (default setting):

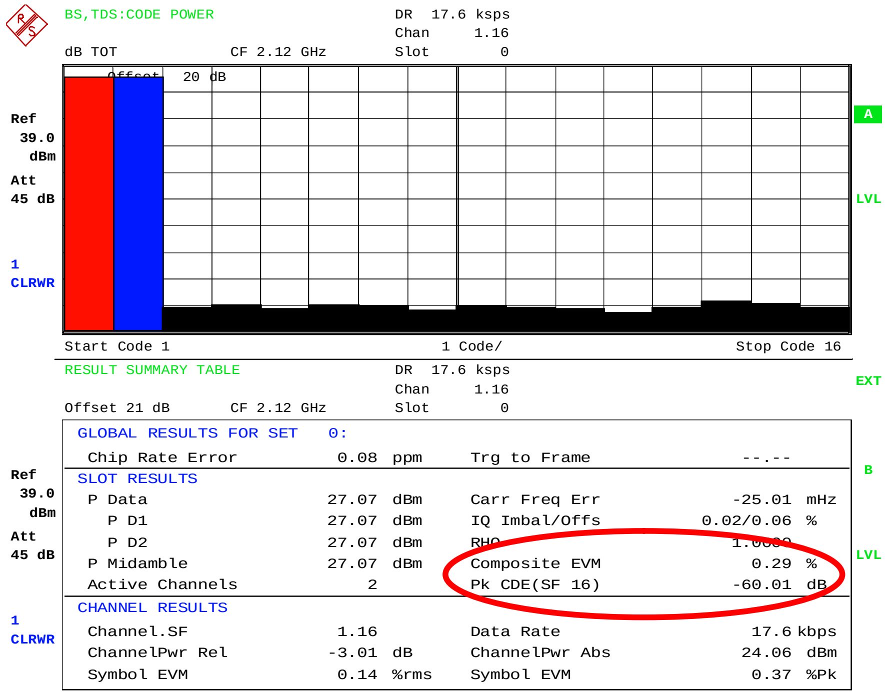


Fig. 9: Default setting for the code domain analysis with the code domain power displayed at the top and the result summary at the bottom (for slot 0)

The code channels P-CCPCH1 and P-CCPCH2 are turned on; all other code channels are turned off.

Under slot results, the result summary also includes the frequency error, the composite EVM (modulation accuracy) and the peak code domain error for slot 0. The symbol EVM (RMS and Pk value) for code channel 1 is shown under channel results.

Measurement on slot 5:

Code domain analysis can also be performed on one of the other slots by selecting its slot number.

Analyzer operating sequence (measurement on slot 5, starting from the previous setting):

SETTINGS:*CAPTURE SETTINGS:SELECT SLOT: 5:* ***ENTER***

Four data channels, each with a spreading factor of 16, are active. Compared with slot 0, the power is 3 dB higher (see the power displays for P data , P 01, P 02 and P midamble).

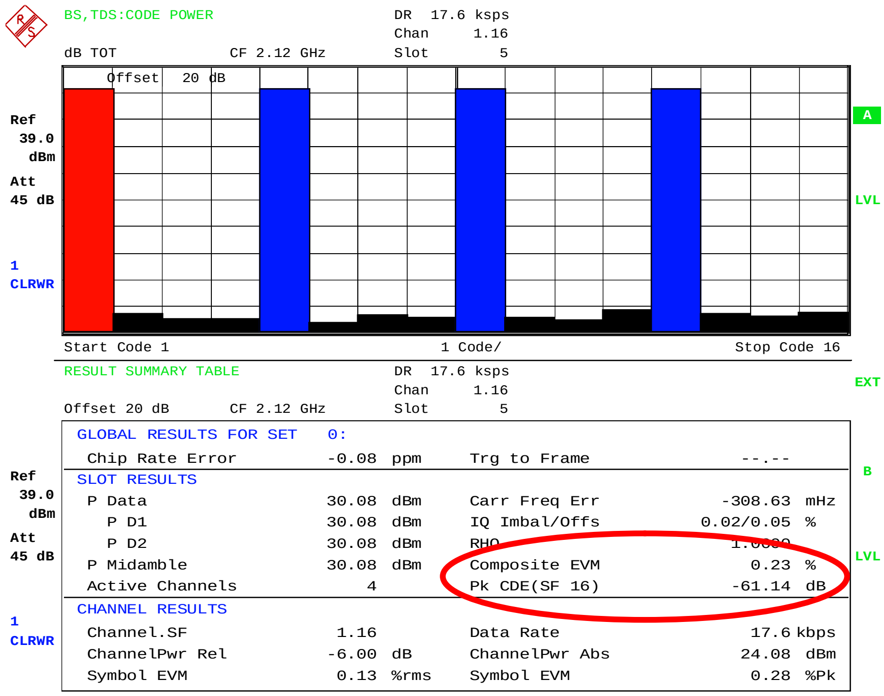


Fig. 10: Default setting for the code domain analysis with the code domain power displayed at the top and the result summary at the bottom (for slot 5)

Gating of analyzer for spectrum measurements:

TD-SCDMA signals are burst signals. To obtain stable results when spectrum measurements are made on burst signals, acquisition of measurement data can only be aquired when the slots are active. This is achieved by gating the analyzer. The analyzer sweeps or measures only when the slots are active.

Within the TD-SCDMA application firmware, the trigger/gate settings are set by default to measure slots 4 to 6 for all spectrum measurements such as POWER, ACLR, multicarrier ACLR, spectrum emission mask, occupied bandwidth, power vs time and signal statistics. The default settings are as follows:

Trigger:*Gate Settings*

Trigger External:Polarity POS

Gate Delay: 2.975 ms

Gate Length: 2.015 ms

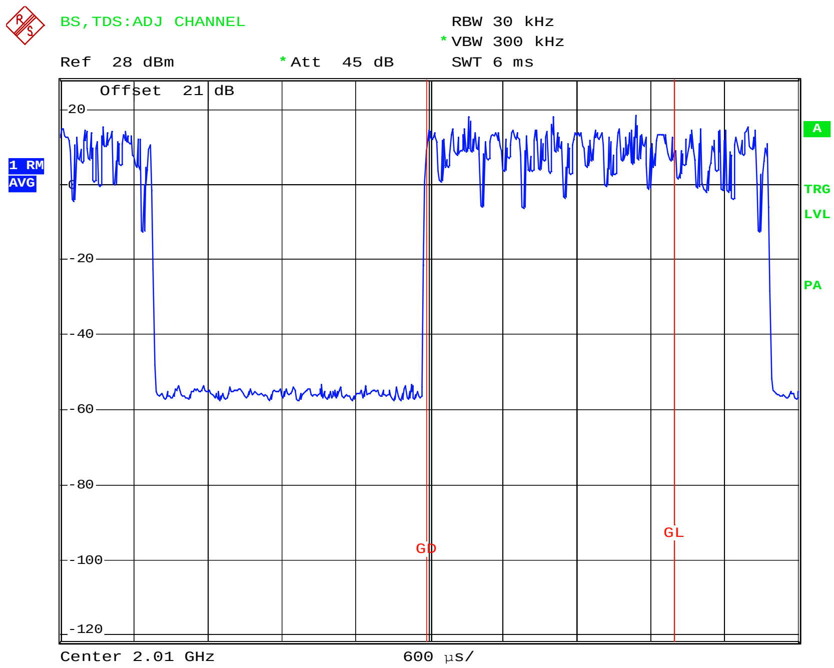


Fig. 11: Gate settings for TD-SCDMA (default setting)

To change to another slot adjust *START SLOT* and *STOP SLOT* within the *ADAPT TO SIGNAL* menu. All spectrum measurements as stated above are then carried out for that slot (or slots).

Output power (TS 25.105 chap. 6.2):

If no power meter is available, the measurement can be performed with the analyzer instead of the power meter. The power measurement provided by the TD-SCDMA application firmware performs a gated channel-power measurement by means of integrating the power in the frequency domain.

Operating sequence for the analyzer:

PRESET

AMPT:*NEXT Offset xy dB* (enter an offset according to the connected attenuator)

Ref Level: yz dB (set a ref level of 10 dB above the nominal power of the amplifier)

FREQ: *yy MHz* (enter required frequency)

MORE:MORE TDS BS

MEAS: POWER

ADAPT TO SIGNAL: AUTO LEVEL & TIME

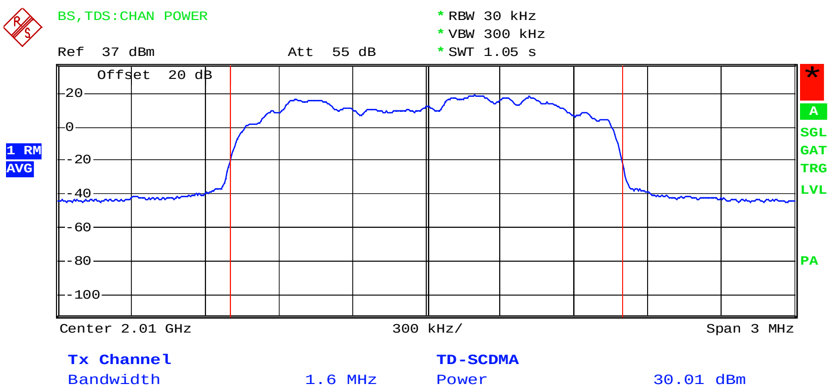


Fig. 12: Power measurement provided by the TD-SCDMA application software (integration in the frequency domain) at a spreading factor of 16 in slots 4, 5 and 6

Note:

The ripple in the spectrum is due to the constant midamble with a test signal required by TS25.105 chap. 6.2. With a spreading factor of 16 it has a length of 144 bits and is relatively long in comparison with the pseudo-random data bits (2 x 44 bits). By comparison, for spreading factor 1, the length of the data bits is 2 x 704 bits and the resulting spectrum has nearly no ripple.

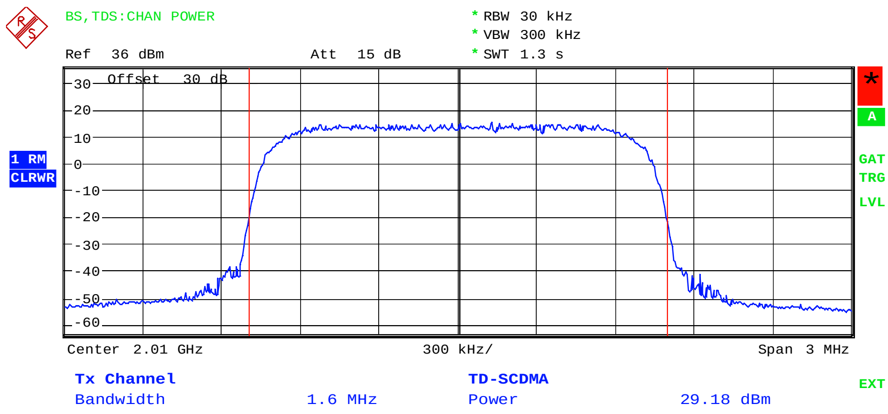


Fig. 13: Flat and symmetrical spectrum for a spreading factor of 1 in slots 4, 5 and 6

Quick power measurement in spectrum analysis mode using the time domain power function

As a further alternative, the power in slots of interest can also be determined in spectrum analysis mode with a zero span measurement (time domain power measurement). The measurement times are significantly reduced compared with measurements based on integration in the frequency domain.

Operating sequence for the analyzer:

PRESET

***AMPT**:NEXT Offset xy dB* (enter an offset according to the connected attenuator)

Ref Level: yz dB (set a ref level of 10 dB above the nominal power of the amplifier)

***FREQ**: yy MHz* (enter the required frequency)

***SPAN:** ZERO SPAN*

***TRIGGER:** EXTERN:POS*

***SWEEP:** SWEEPTIME MANUAL 6 ms*

***BW:** RES BW MANUAL 10 MHz*

***MEAS:** TIME DOMAIN POWER*

START LIMIT 2.98 ms

STOP LIMIT 4.99 ms

***TRACE:** DETECTOR: RMS*

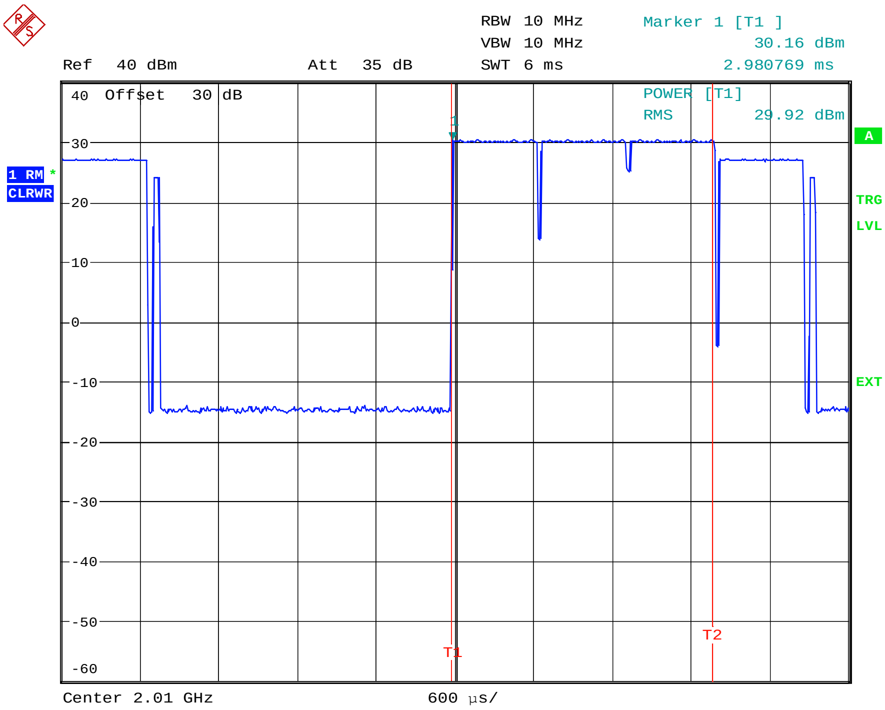


Fig. 14: Power measurement using the time domain power function in the spectrum analyzer mode

Crest factor measurement

Crest factor measurement is not stipulated in TS 25.105. Its main purpose is to check the test signal or the amplifier output signal. A change (reduction) in the crest factor of the amplifier output signal relative to the signal at the amplifier input indicates amplifier compression.

Rohde & Schwarz analyzers provide crest factor measurement as part of the Complementary Cumulative Distribution Function (CCDF) measurement. The CCDF curve is a plot of relative power versus probability. In the TD-SCDMA application firmware, the CCDF measurement is gated and only performed on selected slots. In the default state, these are slots 4, 5 and 6.

Operating sequence for the analyzer:

PRESET

***AMPT**:NEXT Offset xy dB* (enter an offset according to the connected attenuator)

Ref Level: yz dB (set a ref level of 10 dB above the nominal power of the amplifier)

***FREQ**: yy MHz* (enter required frequency)

MORE:MORE TDS BS

MEAS: SIGNAL STATISTICSß : CCDF

ADAPT TO SIGNAL: AUTO LEVEL & TIME

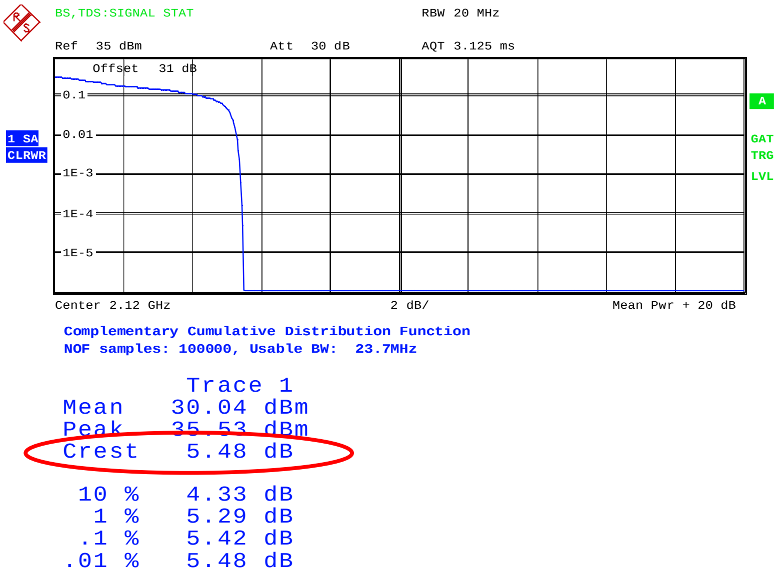


Fig. 15: Crest factor display as part of the CCDF measurement of the TD-SCDMA application firmware

Adjacent channel leakage power ACLR (TS 25.105 chap. 6.6.2.2)

For base stations, TS25.105 specifies an ACLR of >40 dB in the adjacent channel and an ACLR of >45 dB in the alternate channel. The ACLR of the base station power amplifier must be higher.

Performance of the R&S®SMU with R&S®FSU/FSQ

Using the analyzers noise correction function R&S®SMU with R&S®FSU/FSQ, ACLR values of typ. -66 dB in the adjacent channel, and -80 dB in the alternate channel are obtained, providing a more than sufficiently large margin for the values to be tested.

Operating sequence for the analyzer:

PRESET

***AMPT**:NEXT Offset xy dB* (enter an offset according to the connected attenuator)

Ref Level: yz dB (set a ref level of 10 dB above the nominal power of the amplifier)

***FREQ**: yy MHz* (enter required frequency)

MORE:MORE TDS BS

MEAS: ACLR

ADAPT TO SIGNAL: AUTO LEVEL & TIME

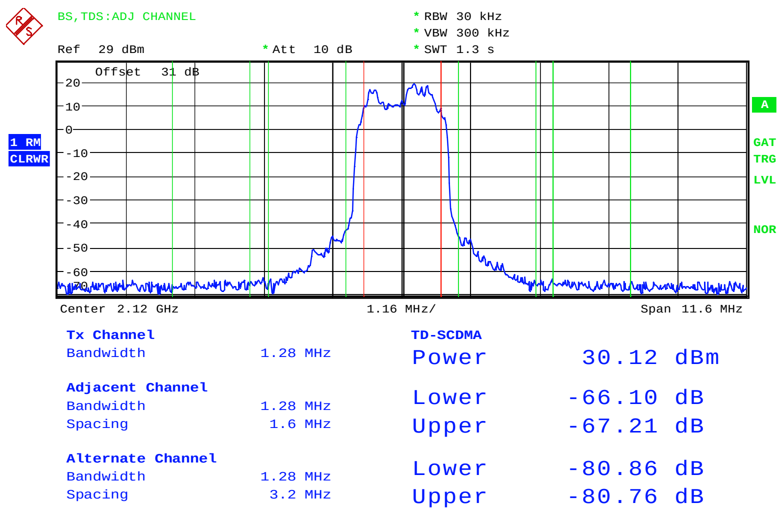


Fig. 16: Typical ACLR performance of the R&S®SMU with R&S®FSU/FSQ

Performance of the R&S®SMU with R&S®FSP

An adequate margin for the power amplifier's ACLR values can also be achieved with the R&S®SMU with R&S®FSP, typical values being -63 dB in the adjacent channel and -74 dB in the alternate channel.

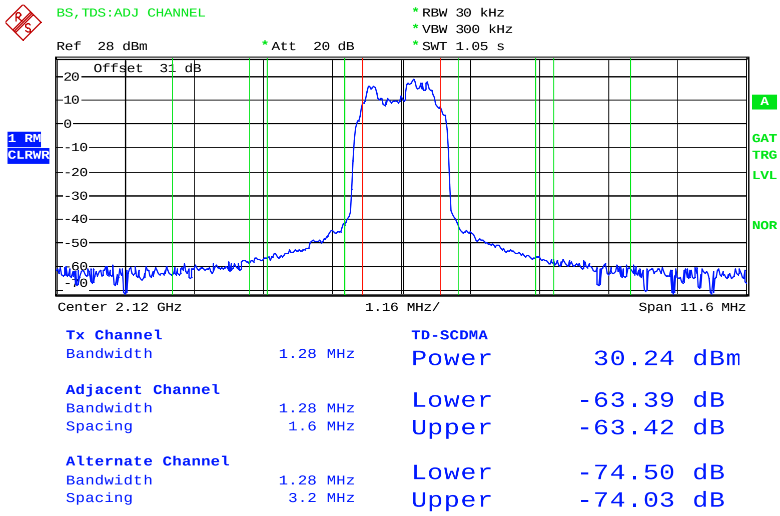


Fig. 17: R&S®SMU and R&S®FSP ACLR performance

Multicarrier ACLR (TS 25.105 chap. 6.6.2.2)

Power amplifiers for multicarrier base stations have e to meet particularly stringent requirements. According to TS 25.105, the ACLR limits of 40 dB (in the adjacent channel) and 45 dB (in the alternate channel) must be met by the carriers above and below the carriers in use.

To set up a suitable test signal (four-carrier signal) on the R&S®SMU or R&S®SMJ see chapter 5, page 12.

Operating sequence for the analyzer:

PRESET

***AMPT**:NEXT Offset xy dB* (enter an offset according to the connected attenuator)

Ref Level: yz dB (set a ref level of 10 dB above the nominal power of the amplifier)

***FREQ**: yy MHz* (enter required frequency)

MORE:MORE TDS BS

MEAS: ACLR

ADAPT TO SIGNAL: AUTO LEVEL & TIME

Additional setting on the R&S®SMU for optimal ACLR with multicarrier signals:

MENU:*IQ-Mod:IQ-Settings:Internal Baseband:Baseband Gain:* ***-3 dB.***

As a consequence, an R&S®SMU with R&S®FSU/FSQ achieves a typical ACLR performance of approximately 67 dB in the adjacent channel and 68 dB in the alternate channel.

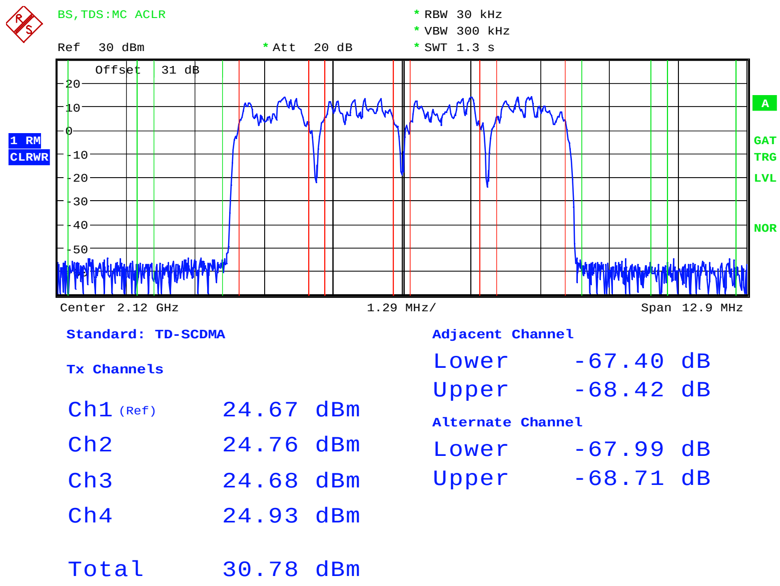


Fig. 18: Typical performance of an R&S®SMU with R&S®FSU/FSQ for adjacent channel measurements on a four-carrier TD-SCDMA signal

Spectrum emission mask (TS 25.105 chap. 6.6.2.1)

For some regions, TS25.105, chap. 6.6.2.1 stipulates a spectrum emission mask for single-carrier transmitters. This mask is illustrated schematically below. The limit lines depend on the maximum output power of the base station. There must be sufficient margin between the base station power-amplifier's spectrum emission curve and the limit lines.

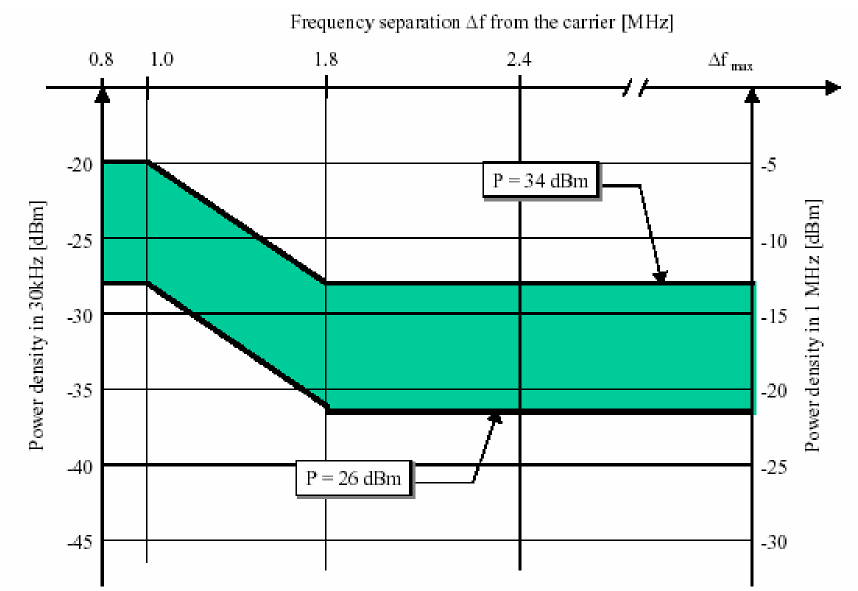


Fig. 19: Diagram showing the spectrum emission mask for TD-SCDMA base stations

To assess power emissions, the analyzer measures the signal power up to 2.3 MHz with a 30 kHz filter and from 2.3 MHz to 4 MHz with a 1 MHz filter. The curve obtained is compared with the limit line specified in TS 25.105 chap. 6.6.2.21 which depends on the base station's power (in this test setup the power amplifier's specified power).

Operating sequence for the analyzer:

PRESET

***AMPT**:NEXT Offset xy dB* (enter an offset according to the connected attenuator)

Ref Level: yz dB (set a ref level of 10 dB above the nominal power of the amplifier)

***FREQ**: yy MHz* (enter required frequency)

MORE:MORE TDS BS

MEAS: SPECTRUM EM MASK

ADAPT TO SIGNAL: AUTO LEVEL & TIME

The typical performance of the spectrum emission mask measurement for the R&S®SMU with R&S®FSU/FSQ or R&S®FSP at an amplifier output power of 30 dBm is shown in the two measurement diagrams below, including:

- The spectrum of the TD-SCDMA signal over slots 4 to 6
- The limit line complies with TS25.105 chap. 6.6.2.1.2 (table 6.4 A, output power: 26 dBm to 34 dBm)
- Information about limit-line violations (Pass/Fail information; in this case: Pass)

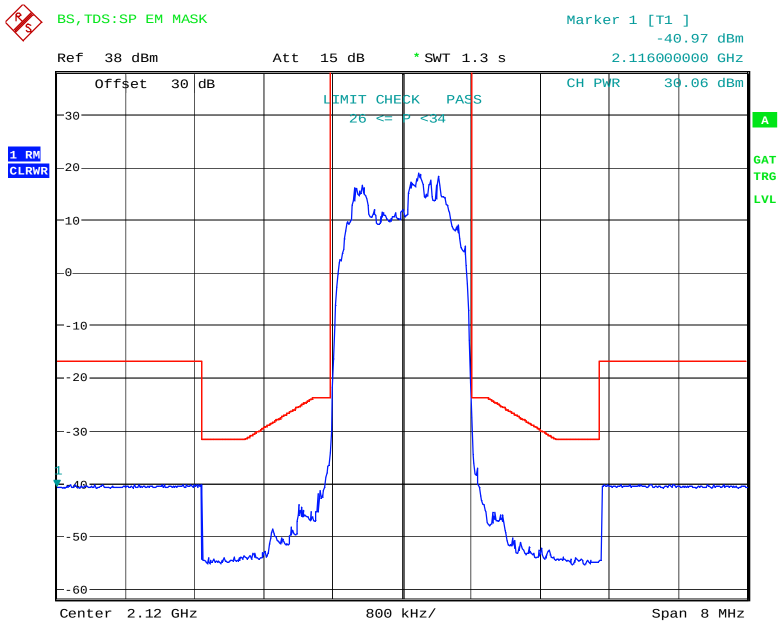


Fig. 20: Demonstration of the dynamic range for the spectrum emission mask measurement at 30 dBm using the R&S®SMU with R&S®FSU/R&S®FSQ

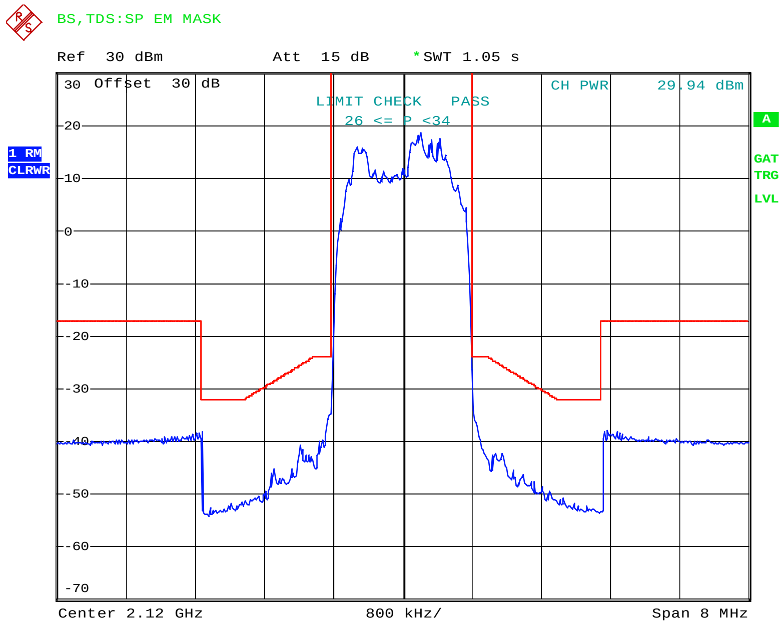


Fig. 21: Demonstration of the dynamic range for the spectrum emission mask measurement at 30 dBm using the R&S®SMU with R&S®FSP

Power vs time (transmit ON/OFF power TS 25.105 chap. 6.5)

TS 25.105 chapter 6.5 stipulates an extreme dynamic range for this test. During the transmit OFF period, an absolute level of -82 dBm (measured with the 1.28 MHz bandwidth) must not be exceeded.

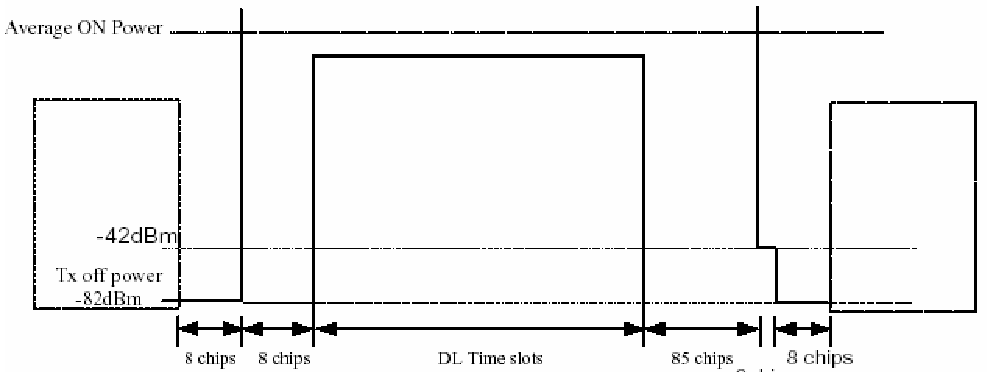


Fig. 22: Power vs time template in line with TS25.105

For an output power of +30 dBm, for example, this means a dynamic range of 112 dB at a measurement bandwidth of 1.28 MHz.

To achieve this, base station power amplifiers must have special design features, for example to turn off the amplifier's output signal. Measures must be taken to prevent the amplifier's input noise being amplified and fed to the output during the OFF period. (The noise from the signal generator used as the drive source is also suppressed in the OFF period as it would otherwise have a negative effect on the dynamic range that could be obtained.)

Rohde & Schwarz signal analyzers provide a high dynamic measurement mode [2] for the power versus time measurement. A preliminary measurement is used to determine the reference level of the selected ON timeslot (in the default state, slots 4, 5, 6). Using the reference level determined with *Auto Level&Time*, the power during the OFF time is measured keeping the attenuation as low as possible and with the preamplifier turned on. Each measurement is averaged over 100 subframes (default setting of the high dynamic measurement mode).

[2] The option R&S®FS-K25 "Electronic Attenuator and 20 dB Preamplifier" is required to obtain the maximum dynamic range in this case

Operating sequence for the analyzer:

PRESET

***AMPT**:NEXT Offset xy dB* (enter an offset according to the connected attenuator)

Ref Level: yz dB (set a ref level of 10 dB above the nominal power of the amplifier)

***FREQ**: yy MHz* (enter required frequency)

MORE:MORE TDS BS

MEAS: POWER VS TIME:HIGH DYNAMIC

ADAPT TO SIGNAL: AUTO LEVEL & TIME

START MEAS

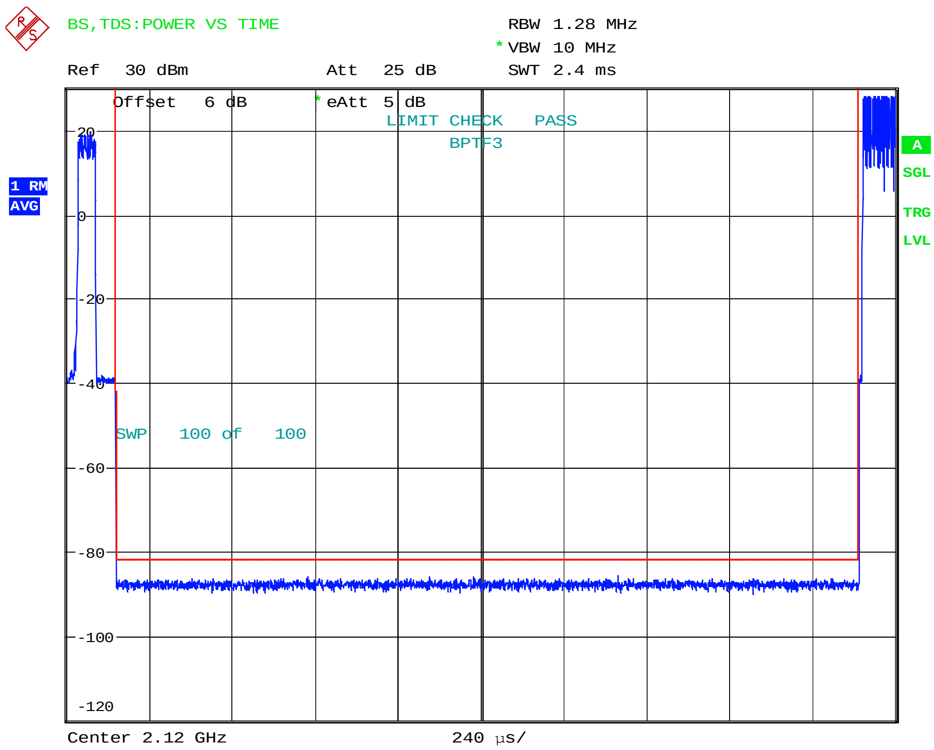


Fig. 23: Power vs time measurement with the R&S®FSU/Q; dynamic range at 25 dBm on the amplifier output

7 Glossary

ARB	Arbitrary
ACLR	Adjacent channel leakage power ratio
BS	Base station
CCDF	Complementary distributive distribution function
CWTS	China Wireless Telecommunication Standard group (http://www.cwts.org)
DL	Downlink
DwPTS	Downlink pilot timeslot
GP	Guard period
Mcps	Mega chips/s
TS1,TS2	Timeslot 1, 2
TDD	Time division duplexing
TD-SCDMA	**T**ime **d**ivision **s**ynchronous **c**ode **d**ivision **m**ultiple **a**ccess
UpPTS	Uplink pilot timeslot
UMTS	Universal mobile telecommunications system
UTRA	UMTS Terrestrial radio access

8 References

[1] Operating Manual R&S®SMU Vector Signal Generator 1007.9845.32-09-I
[2] Operating Manual R&S®SMJ Vector Signal Generator 1403.7458.32-04-IN
[3] Software Manual R&S®FS–K76 TD–SCDMA Base Station Test Application
Firmware 1300.7304.44-03
[4] Operating Manual R&S®NRP Power Meter 1144.1400.12-04-
[5] Data Sheet R&S®SMJ100A Vector Signal Generator PD 5213.5074.22
[6] Data Sheet R&S®SMATE Vector Signal Generator PD0758.1893.22
[7] Data Sheet R&S®SMU200A Vector Signal Generator PD 0758.0197.22
[8] Application Firmware R&S®FS–K76 1300.7304.44-03
[9] ETSI TS 125 105 V7.1.0 (2005-12)
[10] ETSI TS 125 142 V7.1.0 (2005-12)

9 Additional Information

Please send any comments or suggestions about this Application Note to **TM-Applications@rsd.rohde-schwarz.com**.

10 Ordering information

Power meter and options		
R&S® NRP	Power Meter	1138.3004.02
R&S® NRP-Z11 Diode Power Sensor	200 pW to 200 mW 10 MHz to 8 GHz	1138.3004.02
R&S® NRP-Z21 Diode Power Sensor	200 pW to 200 mW 100 MHz to 18 GHz	1137.6000.02
R&S® NRP-Z3	USB Adapter (active) with trigger port	1146.7005.02
Signal analyzer, spectrum analyzer and options		
R&S® FSP3	9 kHz to 3 GHz	1093.4495.03
R&S® FSP7	9 kHz to 7 GHz	1093.4495.07
R&S® FSP13	9 kHz to 13 GHz	1093.4495.13
R&S® FSP-B25	Electronic Attenuator, 0 dB to 30 dB, 5 dB steps, integrated preamplifier for FSP3 and FSP7	1129.7746.02
R&S® FSU3	20 Hz to 3.6 GHz	1129.9003.03
R&S® FSU8	20 Hz to 8 GHz	1129.9003.08
R&S® FSU26	20 Hz to 26.5 GHz	1129.9003.26
R&S® FSQ3	20 Hz to 3.6 GHz	1155.5001.03
R&S® FSQ8	20 Hz to 8 GHz	1155.5001.08
R&S® FSQ26	20 Hz to 26.5 GHz	1155.5001.26
R&S® FSU-B25	Electronic Attenuator and 20 dB Preamplifier (3.6 GHz)	1044.9298.02
R&S® FS-K76	3GPP TD-SCDMA BTS Application Firmware	1300.7291.02
Vector signal generator and otions		
R&S® SMU200A	Vector Signal Generator	1141.2005.02
R&S® SMU-B102	RF Path A: 100 kHz to 2.2 GHz	1141.8503.02
R&S® SMU-B103	RF Path A: 100 kHz to 3 GHz	1141.8603.02
R&S® SMU-B104	RF Path A: 100 kHz to 4 GHz	1141.8703.02
R&S® SMU-B106	RF Path A: 100 kHz to 6 GHz	1141.8803.02
R&S® SMU-B9	Baseband with ARB (128 Msample)	1404.1501.02
R&S® SMU-B10	Baseband with ARB (64 Msample)	1141.7007.02
R&S® SMU-B11	Baseband with ARB (16 Msample)	1159.8411.02
R&S® SMU-B13	Baseband Main Module	1141.8003.02
R&S® SMU-K50	Digital Standard TD-SCDMA	1161.0966.02
R&S® SMU-B31	High-Power Output	1159.8011.02
R&S® SMU-K250	Digital Standard TD-SCDMA (with WINIQSIM2™)	1408.6314.02
R&S® SMJ100A	Vector Signal Generator	1404.4507.02
R&S® SMJ-B103	RF Path B: 100 kHz to 3 GHz	1403.8502.02
R&S® SMJ-B9	Baseband with ARB (128 Msample)	1404.1501.02
R&S® SMJ-B10	Baseband with ARB (64 Msample)	1403.8902.02
R&S® SMJ-B11	Baseband with ARB (16 Msample)	1403.9009.02
R&S® SMJ-B13	Baseband Main Module	1403.9109.02
R&S® SMJ-K50	Digital Standard TD-SCDMA	1404.1660.02
R&S® SMJ-K250	Digital Standard TD-SCDMA (with WINIQSIM2™)	1404.1316.02

For additional information about power meters, signal generators, spectrum analyzers and signal analyzers, visit the Rohde & Schwarz website www.rohde-schwarz.com.

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