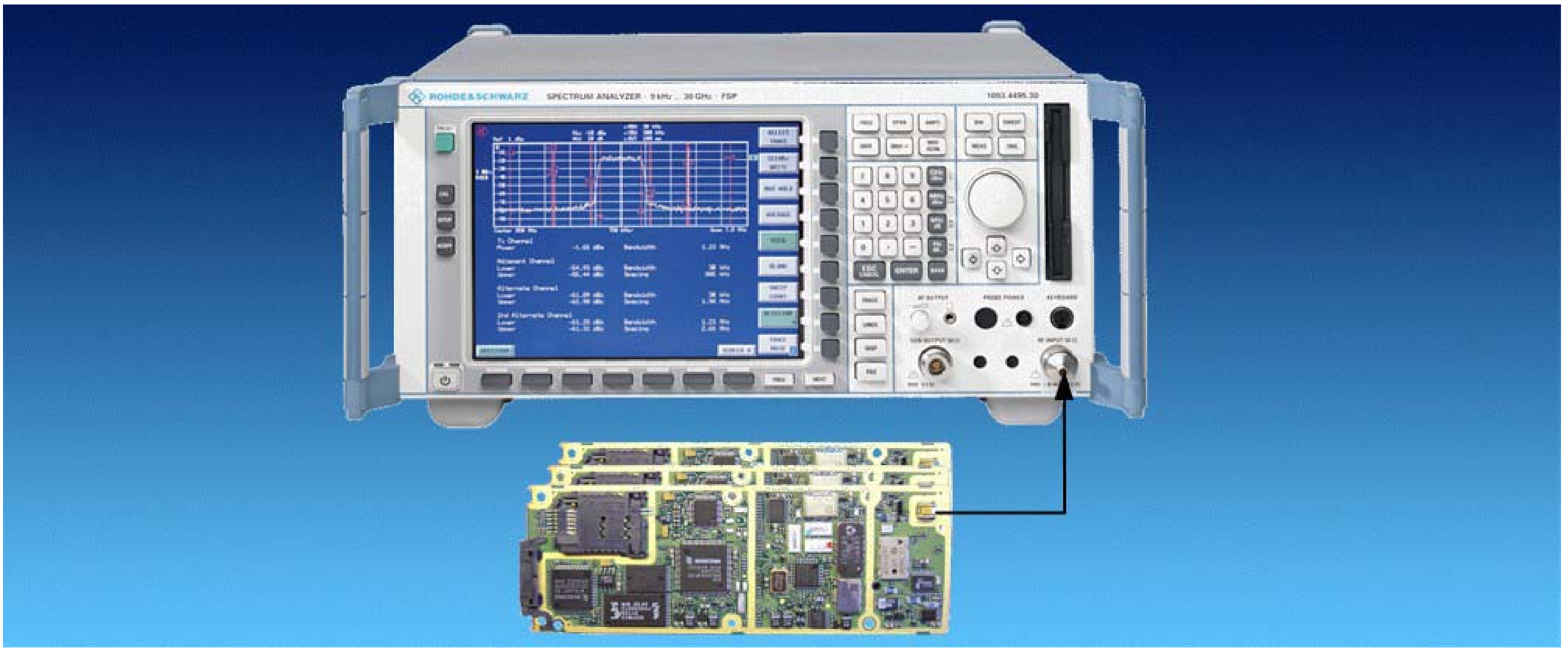

Products: R&S FSP

Fast and Accurate Test of Mobile Phone Boards

Application Note

Short test times in conjunction with accurate and repeatable measurement results are essential when testing and calibrating mobile phones at board level. The R&S® FSP Spectrum Analyzer offers wide dynamic range, stable and accurate results within shortest sweep time, making it the ideal choice for high-volume production testing. The utilisation of both the *list mode* feature and the *marker list* function for the Spectrum Analyzer R&S® FSP, with its unsurpassed measurement speed via remote control are demonstrated in this application note.

ROHDE & SCHWARZ

Subject to change – R.Minihold 08/2003 – 1MA65_1

Contents

1 Overview

The latest mobile phones require in general besides some functional tests, frequency checks of the local oscillator and TX-level calibration at board level. The TX-level calibration has to be done over a wide dynamic range and at different frequencies. Also the adjacent channel power (ACP) performance at rated output power has to be verified.

The frequency checks usually consist of a few frequency measurements. Due to the large number of power measurement points versus frequency and level for the TX-level calibration, the test instrument's speed for power measurement is most important to keep the total test time down. The FSP [1)] with its digital channel filters offers unsurpassed test speed with power and channel power measurement in two special remote-controlled modes that are called "List" mode" and "Marker List" function. These modes are described in detail with programming examples. The results of benchmark tests achieved with measurements conforming to the most important Mobile Standards are also given.

2 Fast frequency measurement

With standard frequency counters the measurement time is dependent on its resolution. If for example a frequency has to be measured with 1Hz resolution the measurement time is 1 s.

The R&S FSP however uses an advanced frequency counting algorithm which is capable to count the input frequency with a resolution down to 0.1 Hz within a measurement time of only about 20 ms. This fast frequency counting algorithm works if the resolution filter is digital: either with a normal filter up to a bandwidth of 100 kHz or with any channel filter or RRC filter. See also: [2], chapter "Setting the Bandwidth and Sweep Time".

[1)] FSP with order No.:1164.4391.xx

How to select a Channel- or RRC-filter:

Manual setting:

BW:*FILTER TYPE: CHANNEL* or

BW: *FILTER TYPE: RRC*

Remote setting:

BAND: TYPE CHAN or

BAND: TYPE RRC

3 Shortest power measurement time

In general, for power measurements with a spectrum analyzer like the R&S FSP, the shortest measurement time at a reasonable repeatability of results (which is also dependent on the signal's waveform) is achieved by means of a zero span measurement in combination with an RMS detector[1].

Figure 1: R&S FSP Spectrum Analyzer

If channel power or adjacent power in a certain bandwidth or with a special weighting characteristic has to be measured, these filters have to be provided by the spectrum analyzer. Normally spectrum analyzers only have synchronously tuned gaussian shaped filters, which cannot be utilised for channel power measurement in the time domain (exception: GSM/EDGE, there are no special filter types required). Therefore the time consuming integrated bandwidth method in frequency domain has to be used for channel power measurement by standard spectrum analyzers.

The R&S FSP however provides digital channel and RRC filters conforming to all relevant mobile phone standards like 3GPP WCDMA, IS95, CDMA2000 and NADC.

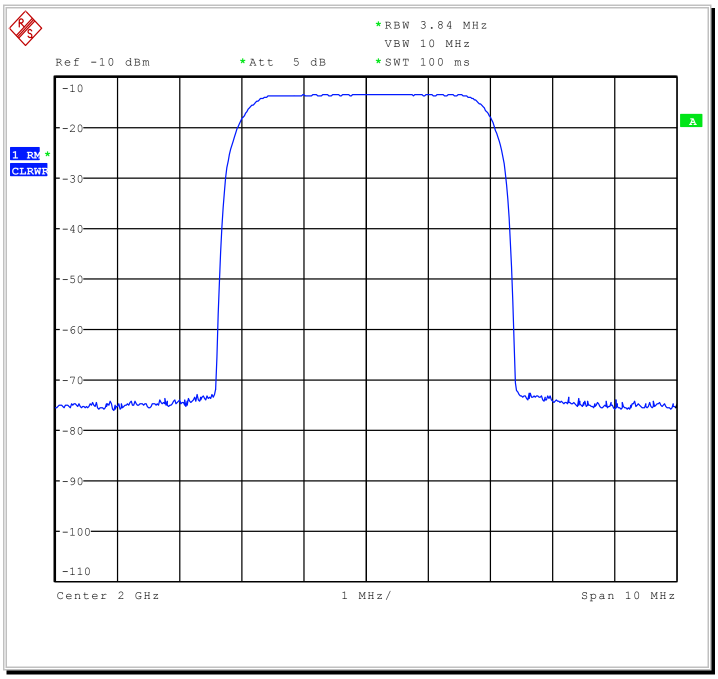

Figure 2: Digital WCDMA RRC filter of FSP

Therefore it provides much quicker channel power measurements to a given degree of repeatability of results (approximately by a factor of 5) [1].

Thus the R&S FSP can be operated as a fast , selective power meter.

Measurement personalities for all important mobile phone standards like GSM/EDGE, IS95, CDMA2000, Bluetooth and WCDMA FDD also support measurements in the modulation domain if required.

4 Remote control in 'quick' mode

In addition to the standard remote control mode, there are two special remote control modes which provide the fastest level and channel power measurements in zero span:

List Mode:

Quickest level measurements in time domain over frequency are achieved by means of the "List Mode"[2, chapter *SENSe:LIST Subsystem*]. A predefined list of measurement points with an individual set of frequencies, reference levels, attenuator settings, bandwidth settings and sweep times can be loaded and run with a minimum amount of delay. This is the optimum mode for level measurements over frequency or over level (linearity). The list mode is also useful for quick and flexible channel and adjacent channel power measurements. Also, harmonics etc. can be measured without using time consuming mode switching.

Only two commands are necessary to program the "List mode":

1. ***[SENSe<1|2>:]LIST:POWer:SET*** *<PEAK meas>,<RMS meas>,<AVG meas>, <trigger mode>,<trigger slope>,<trigger offset>,<gate length>*

This command defines the constant settings for the list during multiple power measurement. Parameters *<PEAK meas>*, *<RMS meas>* and *<AVG meas>* define, which measurements are to be performed at the same time at the frequency point. Correspondingly, one, two or three results per frequency point are returned for the *SENS:LIST:POW?* command.

2. ***SENSe:LIST:POWer?*** *<analyzer freq>,<ref level>,<rf att>,<el att>,<filter type>,<rbw>,<vbw>,<meas time>,<trigger level>,...*

This commands sets up the individual settings for each list point (frequency, reference level, attenuation, electronic attenuation, filter type, resolution and video bandwidth, measurement time and trigger level) and queries the results. Up to 200 list points are possible. The result is a list whose length is dependent on the number of points and the constant settings (one, two or three results per points) is output.

Below is a **programming example** for measuring channel power, adjacent and alternate channel power in list mode according to CDMA2000 at a 824 MHz/13 dBm CDMA 2000 reverse link signal. The FSP delivers the results within **22 ms**.

```
SENS:LIST:POW:SET OFF,ON,OFF,IMM,Pos,0,0

SENS:LIST:POW? 824MHz,18dBm,30dB,Off,CFIL,1.2288MHz,10MHz,2.5ms,0,
               822.02MHz,18dBm,30dB,Off,CFIL,30kHz ,10MHz,0.1ms,0,
               823.15MHz,18dBm,30dB,Off,CFIL,30kHz ,10MHz,0.1ms,0,
               824.85MHz,18dBm,30dB,Off,CFIL,30kHz ,10MHz,0.1ms,0,
               825.98MHz,18dBm,30dB,Off,CFIL,30kHz ,10MHz,0.1ms,0
```

As an example the FSP outputs the absolute power results in dBm measured at the above list points:

12.9269104004, -45.969442749, -38.5750350952, -39.057559967, -44.6161766052

Marker List Mode (*MSummary* mode):

To achieve the quickest remote controlled measurement of power ramping (e.g. GSM power control levels within one or two frames) utilise the marker list function (*MSummary* mode [2], chapter *CALCulate:MARKer* subsytem. To program the "MSummary" mode the following GPIB command is used:

CALCulate<1|2>:MARKer<1 to 4>:FUNCtion:MSUMmary? *<time offset of first pulse>, <measurement time>, <period>, < # of pulses to measure>*

This command evaluates a previously recorded trace to determine the power of a sequence of pulses or power steps having the same time interval. The time offset of the first pulse to the trigger signal (e.g. the video trigger), measurement time, measurement period and number of pulses (steps) are setable.

Programming Example:

The power of all 16 time intervals of 2 consecutive GSM Frames with increasing power control level at every slot are read out with a single command. The FSP delivers these results within a time of **only 25 ms** (starting at INIT command):

```
SYST:DISP:UPD OFF
INIT:CONT OFF
FREQ:CENT 0.8902GHz
FREQ:SPAN 0Hz
DISP:WIND:TRAC:Y:RLEV 15dBm
INP:ATT 30dB
SENS:SWE:TIME 0.009232s
TRIG:SOURCE VIDEO
TRIG:LEV:VID 80PCT
BAND:RES 1MHz;VID 3MHz
DET RMS
INIT
CALC:MARK:FUNC:MSUM? 50US,450US,576.9US,16
```

As an example the FSP outputs the following 16 absolute power results in dBm:

7.72988796234,5.75467452374,3.73965836145,1.74126459639,
-0.25951137526,-2.26396174325,-4.30056134636,-6.31047265892,
-8.28953715685,-10.2544023070,-12.2363962180,-14.2539521546,
-16.2958406340,-18.3125828542,-20.2973986495,-22.3136450278

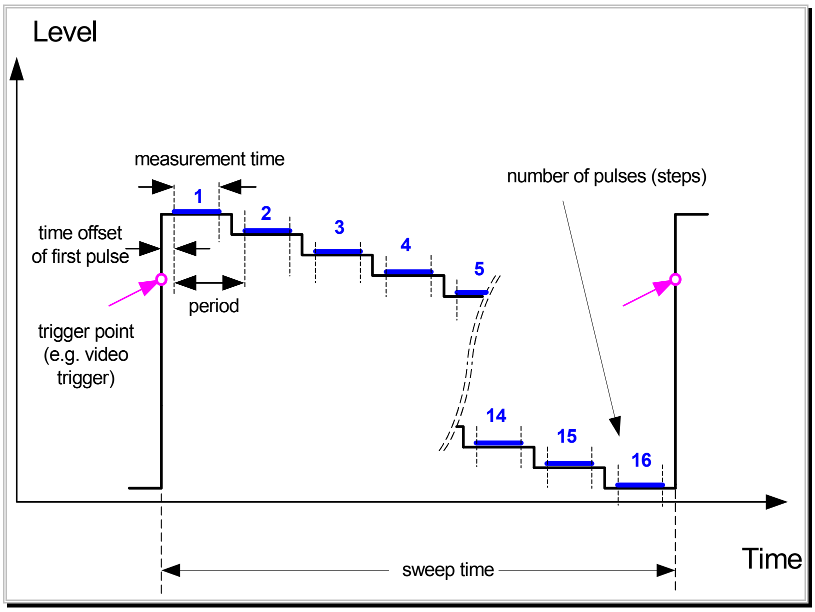

Figure 3: Example for using the "MSummary" function. All 16 power levels are queried with one command.

Synchronisation with Device Under Test (DUT):

An essential performance criterion to be met by automatic test systems is to minimise the time overhead for the entire test relative to the net measurement time. A typical test compromises the following steps:

1. Setting the spectrum analyzer (frequency, level, bandwidth, etc.)

2. Setting the DUT e.g. activating its output signal

3. Starting measurement on the analyzer

(e.g. command: ***INIT*** or in list mode command: ***SENSe:LIST:POWer? ..)***

4. Generation of trigger signal; test system waits for ready signal from analyzer

5. Reading measured data from analyzer

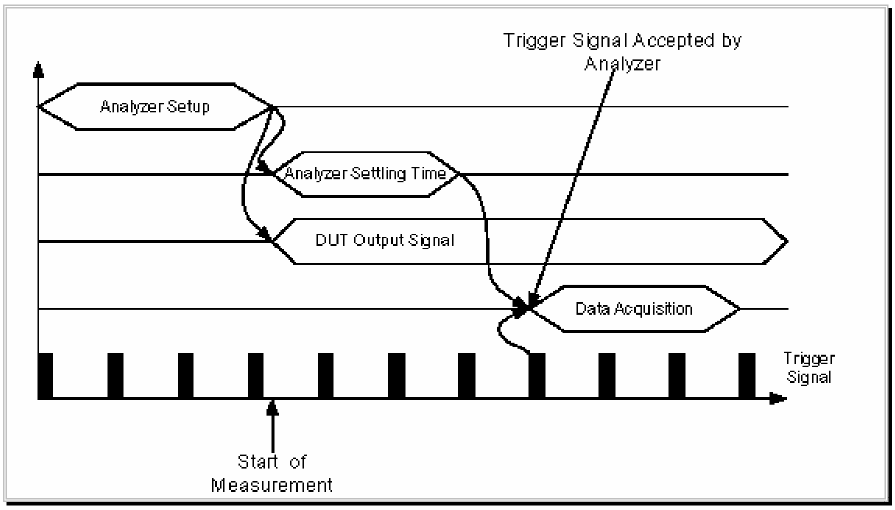

Figure 4: Test with stationary test signal and periodic trigger signal

After step 3 (starting measurement on the analyzer), hardware settling times are allowed for the analyzer before data acquisition is started. Trigger signals during the analyzer's settling time are ignored. The analyzer will respond to the first trigger signal received after its settling time.

This behaviour is not critical in most cases, as long as the trigger signal is periodic and the test signal is stationary.

If the data acquisition is to be started by a single trigger event (such as a customer's test sequence controller) it is mandatory that settling times on the analyzer have elapsed before the trigger signal is sent. Otherwise, the trigger signal will not be identified as a request for data acquisition, and the subsequent query of measured data will result in a timeout on the controller. To minimise this overhead, the optional Trigger Port R&S FSP-B28 supplies a signal that indicates the analyzer's readiness to collect measured data. The signal is reset on detection of the next trigger signal. In this way, a handshake is established between the analyzer and the DUT and between the analyzer and the test sequence controller. This ensures reliable measurements and reduces the time overhead to the settling time actually needed by the analyzer.

See also the FSP Manual Trigger Port Option R&S FSP-B28 for further information [3].

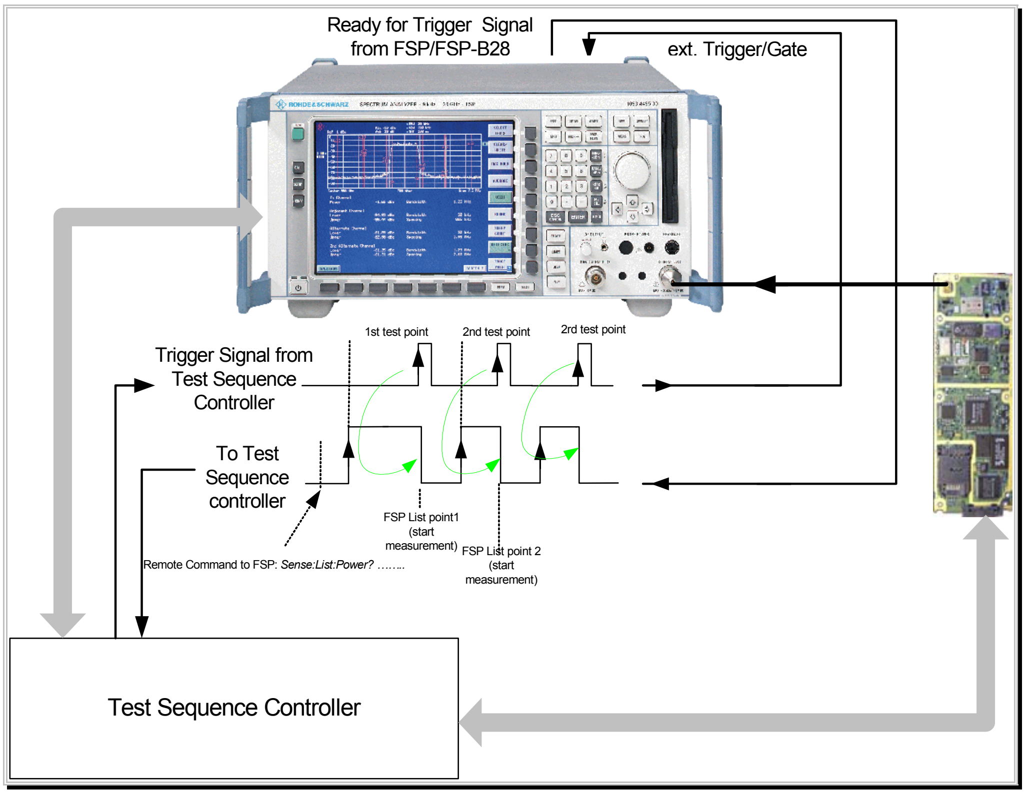

Figure 5: Test Setup for using the Ready for Trigger Signal (Option FSP-B28)

5 Table of Test Time Results

In the following table measurement times are shown according to different Mobile Standards for different measurement scenarios:

- Channel Power measurement
- Channel Power, Adjacent Channels and Alternate Channels
- 10 Channel Power measurement points over frequency
- 10 Channel Power measurement points over level (with range switching)

Measurement Time					
	CDMA One	**NADC** (1 Burst 6.67 ms)	**GSM** (1 Burst 577us)	**CDMA2000 1x**	**WDCMA Rev Link**
Channel Power	**6ms** SWT 2.5 ms	**10ms**	**3ms**	**6ms** SWT 2.5 ms	**4ms** SWT:2ms
Channel Power, Adj. Channel Power & Alt. Channel Power	**22ms** SWT 2.5/0.1/0.1 ms	**51ms**	**16ms** **(26 ms** Complete Transient Spectrum**)**	**22ms** SWT 2.5/0.1/0.1 ms	**20ms** SWT 2ms/1/1ms
10 power measurements at 1 freq	**52ms** [1)] SWT 2.5ms	**92ms** [1)]	**30ms** [1)]	**52ms** [1)] SWT 2.5 ms	**34 ms** [1)] SWT 2ms
power measurements at 10 frequencies at same power	**53ms** SWT 2.5 ms	**100ms**	**26ms**	**53ms** SWT 2.5 ms	**44ms** SWT 2ms

[1)] Number of different ranges used: 3

Table 1: Achievable minimum test times for different standards and measurements

Remarks:

The stated test times are valid for repeatability of 2-sigma = 0.1 dB in the main channel and 0.5 dB in the adjacent channels (sine signals in the adjacent channels).

GPIB transfer time and acquisition times are included, DUT settling time is excluded.

Bursted measurements are carried out over 1 timeslot (6.67 ms with NADC and 577 µs with GSM).

The measurement time values are valid for the FSP models (1164.4391.xx).

6 Literature

1. Application Note 1EF41_0E: "Measurement of Adjacent Channel Leakage Power on 3GPP W-CDMA Signals with the FSP"

2. Operating Manual Spectrum Analyzer R&S FSP 3/FSP 13/FSP30/FSP40

3. Manual to Trigger Port Option R&S FSP-B28

7 Additional Information

Please contact TM-Applications@rsd.rohde-schwarz.com for comments and further suggestions. We can also provide individual benchmarks according to your measurement needs. Please mail to

TM-Applications@rsd.rohde-schwarz.com

8 Ordering information

Spectrum Analyzer and Options		
R&S FSP 3	9 kHz to 3 GHz	1164.4391.03
R&S FSP 7	9 kHz to 7 GHz	1164.4391.07
R&S FSP 13	9 kHz to 13 GHz	1164.4391.13
R&S FSP 30	9 kHz to 30 GHz	1164.4391.30
R&S FSP 40	9 kHz to 40 GHz	1164.4391.40
R&S FSP-B28	Trigger port	1162.9915.02

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München · P.O.B 80 14 69 · D-81614 München ·
Telephone +49 89 4129 -0 · Fax +49 89 4129 - 13777 · Internet: http://www.rohde-schwarz.com