**TSG-RAN Working Group 4 (Radio) meeting #6**
**South Queensferry, Scotland, 26 - 29 July 1999**

***TSGR4#6(99)382***

**Agenda Item:** 8.8

**Source:** Rohde & Schwarz, Siemens AG

**Title:** Proposed amendments to TS 25.142, subclause 6.3: Frequency stability

**Document for:** Decision

---

# 1 Background

As already explained in other papers, see Tdocs R4-99368 and R4-99381, Rohde & Schwarz and Siemens AG are currently reviewing the present test descriptions contained in the existing drafts for TDD conformance testing, which are

TS 25.142: Base station conformance testing (TDD)
and
TS 34.122: Terminal Conformance Specification, Radio Transmission and Reception (TDD).

Annex 1 of the present contribution contains a revised test description of the BS parameter "Frequency stability".

The proposed test procedure is based on the application of a global in-channel Tx test method. Therefore, a definition of this test method is given in Annex 2 of this contribution. Note that the global in-channel Tx test method is not only applicable to the frequency stability test, but also enables the measurement of all other relevant parameters that describe the in-channel quality of the output signal of the Tx under test in a single measurement process.

# 2 Proposal

It is proposed that the test description for BS frequency stability given in Annex 1 of this contribution should replace the present text in subclause 6.3 of TS 25.142.

In addition, it is proposed to incorporate Annex XX given in Annex 2 of this contribution into TS 25.142.

# 6.3 Frequency stability

## 6.3.1 Definition and applicability

Frequency stability is the ability of the BS to transmit at the assigned carrier frequency.

The requirements in this subclause shall apply to base stations intended for general-purpose applications.

## 6.3.2 Conformance requirements

The BS frequency stability shall be within [± 0,05 ppm].

The reference for this requirement is TS 25.105 subclause 6.3.1.

## 6.3.3 Test purpose

The test purpose is to verify the accuracy of the carrier frequency across the frequency range and under normal and extreme conditions.

## 6.3.4 Method of test

### 6.3.4.1 Initial conditions

(1) The transmitter under test and all other transmitters of the base station (if any) are switched on.
(2) The power of the transmitters not under test (if any) are controlled down.
(3) Connect the tester to the BS antenna connector.
(4) Set the parameters of the transmitted signal according to table 6.3.4.1.1.

**Table 6.3.4.1.1 Parameters of the transmitted signal for frequency stability test**

| Parameter | Value/description |
|---|---|
| TDD Duty Cycle | TS i; i = 1,2, ..., 15:<br>on, if i is odd;<br>off, if i is even. |
| Number of DPCH in each active TS | [1] |
| Base station power | maximum, according to manufacturer's declaration |
| Data content of DPCH | real life<br>(sufficient irregular) |

### 6.3.4.2 Procedure

(1) Measure the frequency error delta f across one burst (time slot), by applying the global in-channel Tx test method described in Annex XX
(2) Repeat step (1) for 200 bursts (time slots)
(3) Run steps (1) and (2) for RF channels Low / Mid / High.

## 6.3.5 Test requirements

For all measured bursts (time slots), the frequency error, derived according to subclause 6.3.4.2, shall not exceed 0,5 x 10E-7.

# Annex XX: Global in-channel Tx test

## XX.1 General

The global in-channel Tx test enables the measurement of all relevant parameters that describe the in-channel quality of the output signal of the Tx under test in a single measurement process.

## XX.2 Definition of the process

### XX.2.1 Basic principle

The process is based on the comparison of the actual **output signal of the Tx under test**, received by an ideal receiver, with a **reference signal**, that is generated by the measuring equipment and represents an ideal error free received signal. All signals are represented as equivalent (generally complex) baseband signals.

### XX.2.2 Output signal of the Tx under test

The output signal of the Tx under test is recorded through a matched filter (RRC 0.22, correct in shape and in position on the frequency axis) at one sample per chip.

Depending on the parameter to be evaluated, it is appropriate to represent the recorded signal in one of the following two different forms:

Form1 (representing the physical signal in the entire measurement interval):
one vector **Z**, containing N = n x m complex samples;
with
n: number of symbols in the measurement interval;
m: number of chips per symbol.

Form 2 (derived from form 1 by separating the samples into symbol intervals):
n time sequential vectors **z** with m complex samples, where each vector comprises a symbol interval.

### XX.2.3 Reference signal

The reference signal is constructed by the measuring equipment according to the relevant Tx specifications, filtered by a matched filter and sampled at the Inter-Symbol-Interference-free instants.
Depending of the parameter to be evaluated, it is appropriate to represent the reference set of samples in one of the following three different forms:

Form1 (representing the physical signal in the entire measurement interval):
one vector **R**, containing N = n x m complex samples;
with
n: number of symbols in the measurement interval;
m: number of chips per symbol.

Form 2 (derived from form 1 by separating the samples into symbol intervals)
n time-sequential vectors **r** with m complex samples, where each vector comprises a symbol interval.

(Note: Clarification is needed in case of a multi-code with multi-rate signal)

Form 3 (derived from form 2 by separating the samples into code signals)

n sequential expressions $\sum_{i=1}^{k} \mathbf{rc}_i$ ,
with
k: number of codes;
a single summand $\mathbf{rc}_i$ representing the vector of one code i, containing m complex samples of the symbol interval

## XX.2.4 Provisions in case of multi code signals

In case of multi code signals, the code multiplex shall contain only orthogonal codes. (Otherwise non-orthogonal codes must be eliminated (e.g. by time-windowing the measurement interval or switch off).

## XX.2.5 Classification of measurement results

The measurement results achieved by the global in-channel Tx test can be classified into two types:

Results of type 1, where the error-free parameter has a non-zero magnitude. These parameters are:
RF Frequency
(Chip Frequency )
Power
Code Domain Power (in case of multi code)
Timing (only for MS)

Results of type 2, where the error-free parameter has value zero. These parameters are:
Error Vector Magnitude
Peak Code Domain Power Error

## XX.2.6 Process definition to achieve results of type 1

The reference signal is varied with respect to the parameters mentioned in subclause XX.2.5 under "results of type 1" in order to achieve best fit with the recorded signal under test (output signal of the Tx under test, filtered and sampled according to subclause XX.2.2). Best fit is achieved when the RMS difference value between the signal under test and the varied reference signal is an absolute minimum. The varied reference signal in this best fit case will be called **R'**
The varied parameters leading to **R'**represent directly the wanted results of type 1. These measurement parameters are expressed as deviation from the reference value with dimensions same as the reference value.

In case of multi code, the type-1-parameters (frequency, (chip frequency) and timing) are varied commonly for all codes such that the process returns one frequency-error, (one chip-frequency error), one timing error.
(These parameters are <u>not</u> varied on the individual codes signals such that the process returns k frequency errors... . (k: number of codes) ).
Only the type-1-parameters (code powers) are varied individually such that the process returns k code powers (k: number of codes)

## XX.2.7 Process definition to achieve results of type 2

The difference between the signal under test (**Z**; see subclause XX.2.2) and the reference signal after the minimum process (**R'**, see subclause XX.2.6) is the error vector **E** versus time:

$$\mathbf{E} = \mathbf{Z} - \mathbf{R'}$$

Depending on the parameter to be evaluated, it is appropriate to represent **E** in one of the following two different forms:

<u>Form1</u> (representing the physical error signal in the entire measurement interval)
One vector **E**, containing N = n x m complex samples;
with
n: number of symbols in the measurement interval
m: number of chips per symbol

<u>Form 2</u> (derived from form 1 by separating the samples into symbol intervals)
n time-sequential vectors **e** with m complex samples comprising one symbol interval

**E** gives results of type 2 applying the two algorithms defined in subclauses XX2.7.1 an XX2.7.2.

### XX.2.7.1 Error Vector Magnitude

The Error Vector Magnitude EVM is calculated according to the following steps:

(1) Take the error vector **E** defined in subclause XX.2.7 (form 1) and calculate the RMS value of **E** chip-wise over the entire measurement interval; the result will be called RMS(**E**).

(2) Take the reference vector **R** defined in subclause XX2.3 (form 1) and calculate the RMS value of **R** chip-wise over the entire measurement interval; the result will be called RMS(**R**)

(3) Calculate EVM according to

$$\mathrm{EVM} = \frac{\mathrm{RMS}(\mathbf{E})}{\mathrm{RMS}(\mathbf{R})} \,\mathrm{x}\, 100\%$$

(here, EVM is relative and expressed in %)

### XX.2.7.2 Peak Code Domain Power Error

The Peak Code Domain Power Error is calculated according to the following steps:

(1) Take the error vectors **e** defined in subclause XX.2.7 (form 2) and the reference vectors $\mathbf{rc}_i$ defined in subcluase XX.2.3 (form 3) and calculate the inner product of **e** and $\mathbf{rc}_i$ chip-wise over the symbol duration for all symbols of the measurement interval and for all permitted codes of the code space.
This gives a matrix of format k x n, each value representing an error voltage connected with a specific symbol and a specific code, which can be exploited in a large variety.
k: number of codes
n: number of symbols in the measurement interval

(2) Calculate k RMS values, each RMS value unifying n symbols within one code.
(This values can be called "absolute Code-EVMs" [Volt].)

(3) Find the peak value among the k "absolute Code-EVMs".
(This value can be called "absolute Peak-Code-EVM" [Volt].)

(4) Calculate the following term:

$$10\lg \frac{(\text{absolute Peak - Code} - \text{EVM})^2}{(\mathrm{RMS}(\mathbf{R}))^2} \ \mathrm{dB}\,.$$

This term is called Peak Code Domain Power Error (a relative value in dB).

(5) If the values RMS(**r**) are not constant during the measurement interval, Peak Code Domain Power Error should be expressed absolutely instead by the term:

$$\frac{(\text{absolute Peak} - \text{Code} - \text{EVM})^2}{50\,\text{Ohm}}$$

This term is called Absolute Peak Code Domain Power Error [Watt or dBm]

## XX.3 Applications

This process is applicable to the following paragraphs:

6.3 Frequency Stability
6.4 Output Power Dynamics
6.5 Transmit OFF Power
6.9 Modulation Accuracy
(Chip Frequency)