Conformity and Interoperability Training

Homologation Procedures and Type Approval Testing for Mobile Terminals

ITU C&I Programme

Training Course on Testing Mobile Terminal

Schedule

- RF Tests (Functional) – 2G Technology
- RF Tests (Functional) – 3G Technology
- RF Tests (Functional) – 4G Technology
- RF Tests (Functional) – Wi-Fi Technology
- RF Tests (Functional) – Bluetooth Technology

Schedule

RF Tests (Functional) – 2G Technology

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

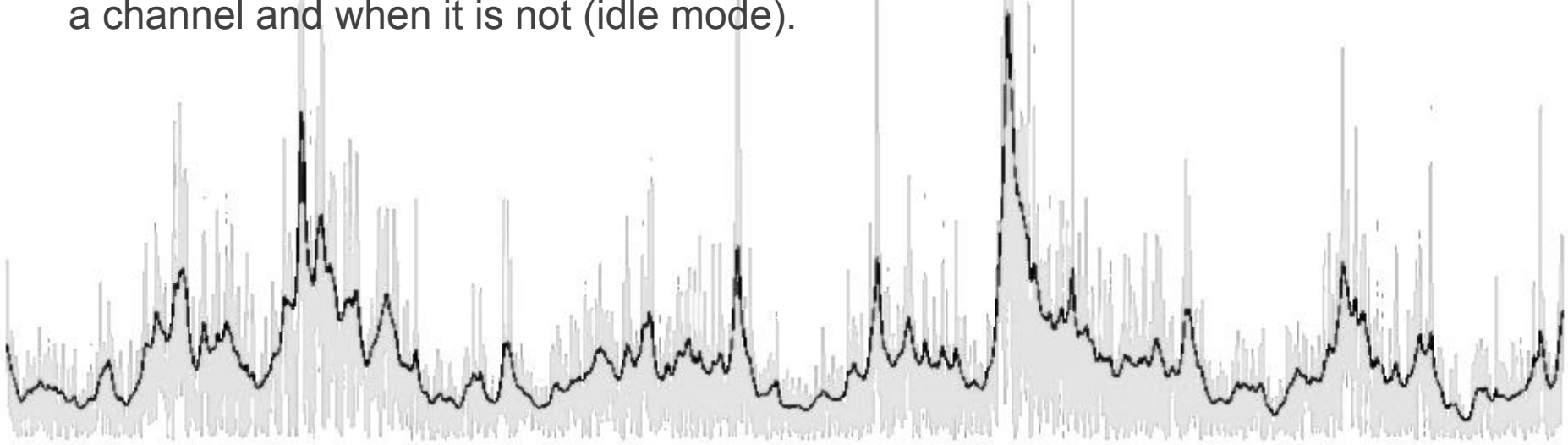
RF Tests (Functional) – 2G Technology

12.1 Conducted Spurious Emissions

Definition: Conducted spurious emissions, when the MS has been allocated a channel, are emissions from the antenna connector at frequencies other than those of the carrier and sidebands associated with normal modulation.

Test purpose: To verify that conducted spurious emissions from the UE do not exceed the conformance requirements. These conducted spurious emissions will be measured in the frequency band 100 kHz to 12,5 GHz.

Note: Test must be run in two different situations: When the UE is allocated in a channel and when it is not (idle mode).



RF Tests (Functional) – 2G Technology

12.2 Radiated Spurious Emissions

Definition: Radiated emissions from the entire UE structure.

Test purpose: Verify if the spurious emissions radiated from the UE exceed conformity requirements in normal voltage conditions.

Note: Test must be run in two different situations: When the UE is allocated in a channel and when it is not (idle mode).

RF Tests (Functional) – 2G Technology

13.1 Frequency Error and Phase Error

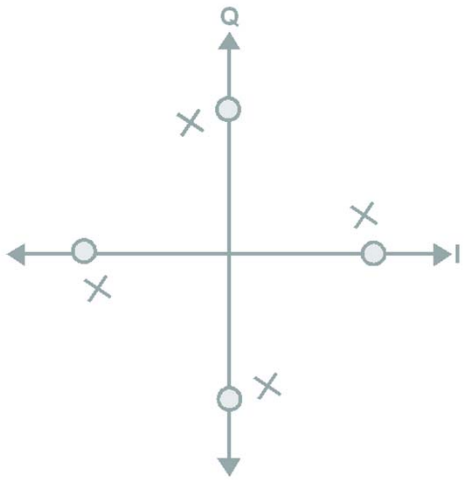
13.16.1 Frequency Error and Phase Error in GPRS Multislot Configuration

Definition: The frequency error is the difference in frequency between the RF transmission from the UE and the nominal frequency for the channel used.

The phase error is the difference in phase between the RF transmission from the UE and the theoretical transmission according to the intended modulation.

Test purpose: To verify that:

- The UE carrier frequency error does not exceed 0.1 ppm
- The phase error does not exceed 5 degrees



RF Tests (Functional) – 2G Technology

13.17.1 Frequency Error and Modulation Accuracy in EGPRS Configuration

Definition: The frequency error is the difference in frequency between the RF transmission from the UE and the nominal frequency for the channel used.

The phase error is the difference in phase between the RF transmission from the UE and the theoretical transmission according to the intended modulation.

The magnitude of the error vector is called Error Vector Magnitude (EVM). The error vector between the vector representing the transmitted signal and the vector representing the error-free modulated signal defines modulation accuracy.

RF Tests (Functional) – 2G Technology

13.17.1 Frequency Error and Modulation Accuracy in EGPRS Configuration

Test purpose: To verify that:

- The EU carrier frequency error does not exceed 0,1 ppm
- The phase error does not exceed 5 degrees
- The RMS EVM over the useful part of any burst of the 8-PSK modulated signal does not exceed 9,0% under normal conditions
- The peak EVM values of at least 200 bursts of the 8-PSK modulated signal are ≤ 30%
- The 95:th-percentile value of any burst of the 8-PSK modulated signal is ≤ 15 %
- The Origin Offset Suppression for any 8PSK modulated signal does not exceed 30 dB

RF Tests (Functional) – 2G Technology

13.3 Transmitter Output Power and Burst Timing

Definition: The transmitter output power is the average value of the power delivered to an artificial antenna, over the time that the useful information bits of one burst are transmitted.

The transmit burst timing is the envelope of the RF power transmitted with respect to time.

Power control is the capacity the UE has to adjust output power in response to Node B commands.

Test purpose: To verify that:

- The maximum output power is within conformance requirements
- All power control levels, relevant to the class of UE, are implemented within conformance requirements
- The difference between consecutive PCLs is within limits
- The output power relative to time, when sending a normal burst, is within conformance requirements
- The output power relative to time, when sending an access burst, is within conformance requirements

RF Tests (Functional) – 2G Technology

13.3 Transmitter Output Power and Burst Timing

RF Tests (Functional) – 2G Technology

13.16.2 Transmitter Output Power in GPRS Multislot Configuration

13.17.3 EGPRS Transmitter Output Power

Definition: The transmitter output power is the average value of the power delivered to an artificial antenna, over the time that the useful information bits of one burst are transmitted.

The transmit burst timing is the envelope of the RF power transmitted with respect to time.

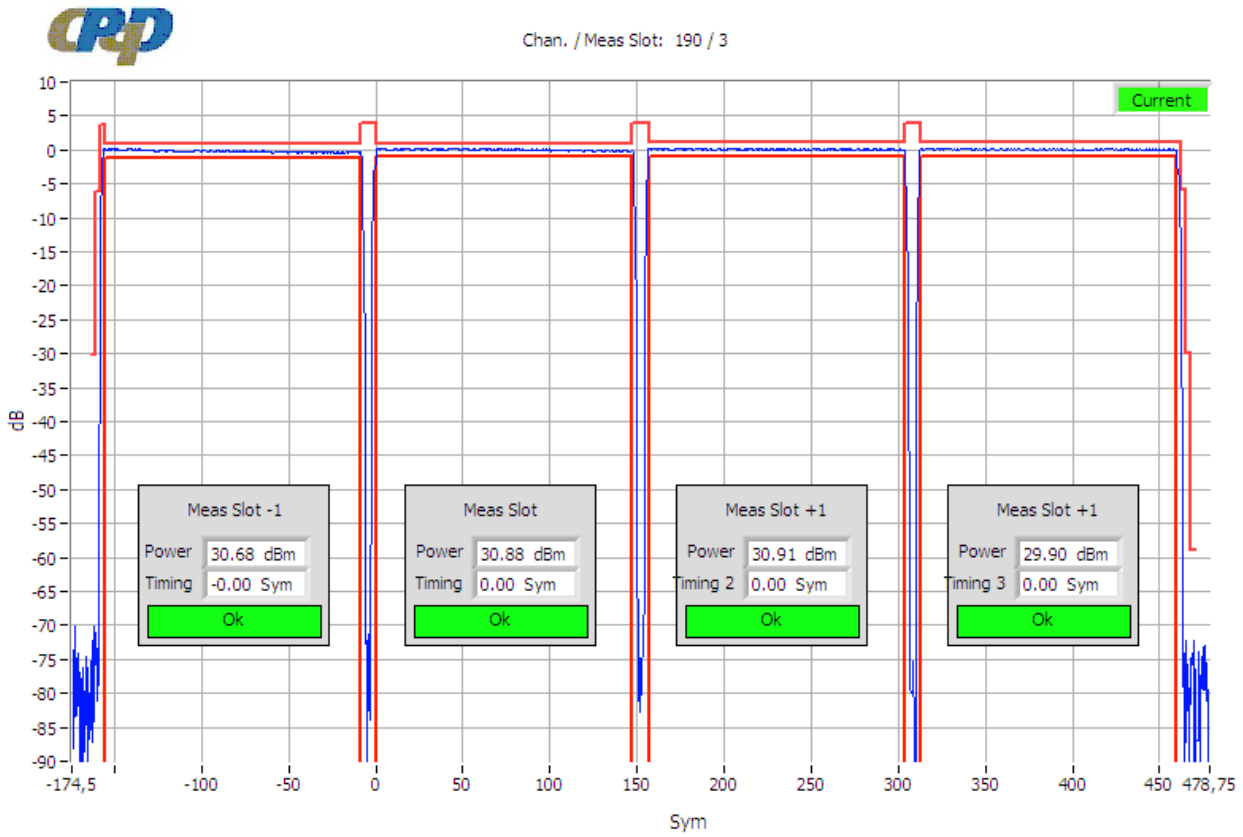
Power control is the capacity the UE has to adjust output power in response to Node B commands.

Test purpose: To verify that:

- The maximum output power is within conformance requirements
- All power control levels, relevant to the class of UE, are implemented within conformance requirements
- The difference between consecutive PCLs is within limits
- The output power relative to time, when sending a normal burst, is within conformance requirements

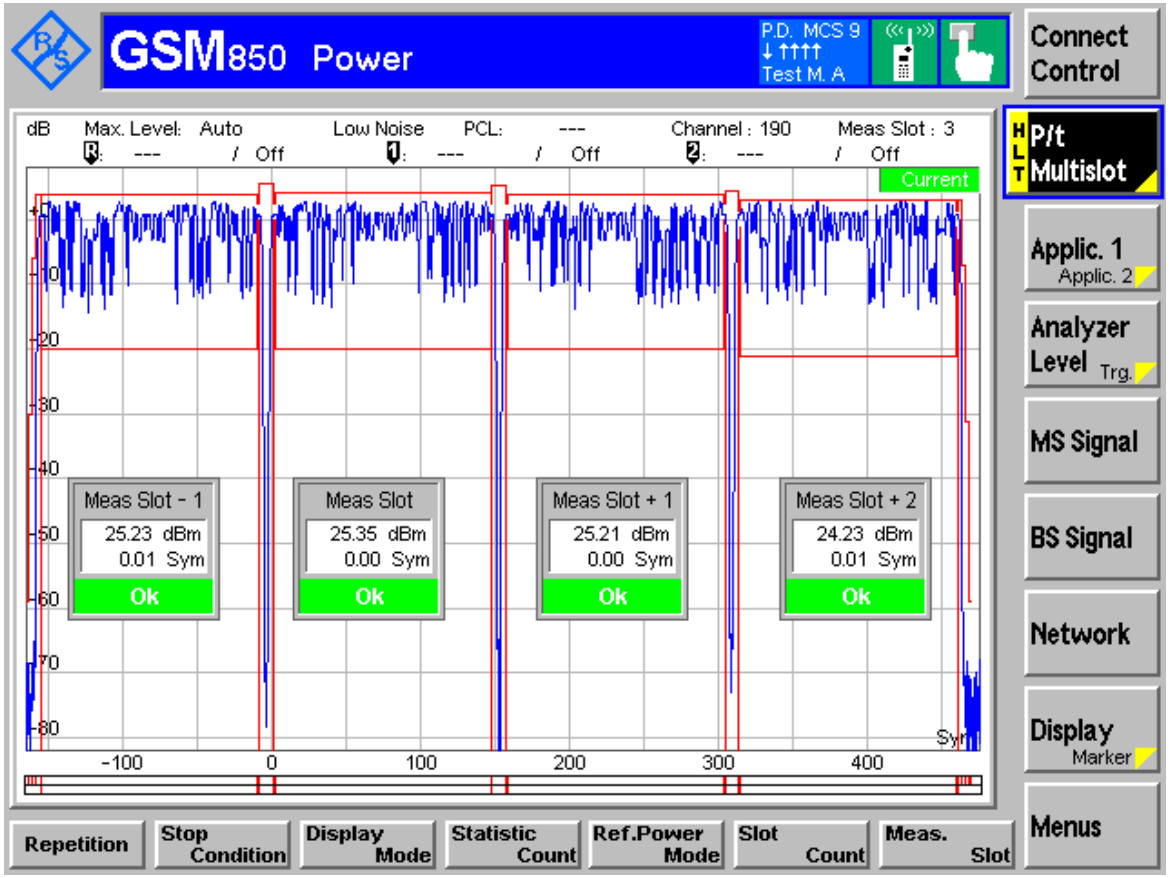
RF Tests (Functional) – 2G Technology

13.16.2 Transmitter Output Power in GPRS Multislot Configuration



RF Tests (Functional) – 2G Technology

13.17.3 EGPRS Transmitter Output Power



Schedule

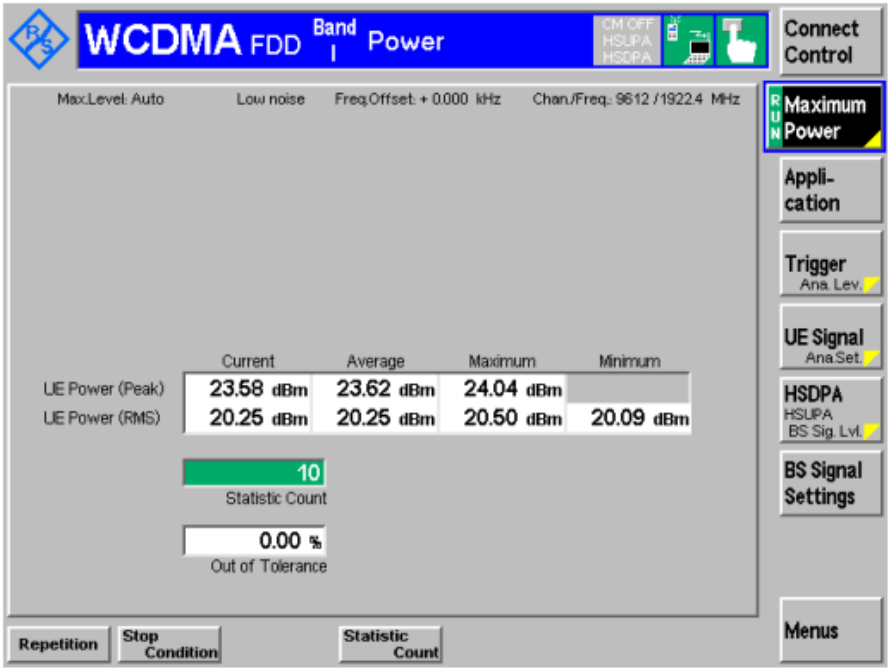
RF Tests (Functional) – 3G Technology

RF Tests (Functional) – 3G Technology

5.2 Maximum Output Power

Definition: The maximum output power is a measure of the maximum power the UE can transmit. The nominal maximum output power and its tolerance are defined according to the Power Class of the UE.

Test purpose: To verify that the error of the UE maximum output power does not exceed the range prescribed by the nominal maximum output power and tolerance.



RF Tests (Functional) – 3G Technology

5.2AA Maximum Output Power with HS-DPCCH

5.2B Maximum Output Power with HS-DPCCH and E-DCH

Definition: The maximum output power with HS-DPCCH (HSDPA) and HS-DPCCH and E-DCH (HSUPA) and its tolerance are defined according to the Maximum Power Reduction (MPR) for the nominal maximum output power.

The maximum output power with HS-DPCCH / HS-DPCCH and E-DCH is a measure of the maximum power the UE can transmit when HS-DPCCH / HS-DPCCH and E-DCH is fully or partially transmitted during a DPCCH timeslot. The measurement period shall be at least one timeslot.

Test purpose: To verify that the error of the UE maximum output power with HS-DPCCH (HSDPA) and with HS-DPCCH and E-DCH (HSUPA) does not exceed the range prescribed by the maximum output power and tolerance in table 5.2AA.2 and table 5.2B.5, respectively, from the ETSI TS 34 121-1 standard.

An excess maximum output power may interfere with other channels or other systems. A small maximum output power decreases the coverage area.

RF Tests (Functional) – 3G Technology

5.2C UE Relative Code Domain Power Accuracy

5.2D UE Relative Code Domain Power Accuracy for HS-DPCCH and E-DCH

Definition: The UE Relative code domain power accuracy is a measure of the ability of the UE to correctly set the level of individual code powers relative to the total power of all active codes. The measure of accuracy is the difference between two dB ratios:

UE Relative CDP accuracy = (Measured CDP ratio) – (Nominal CDP ratio)

where:

Measured CDP ratio = 10*log((Measured code power) / (Measured total power of all active codes))

Nominal CDP ratio = 10*log((Nominal CDP) / (Sum of all nominal CDPs))

The nominal CDP of a code is relative to the total of all codes and is derived from beta factors.

RF Tests (Functional) – 3G Technology

5.2C UE Relative Code Domain Power Accuracy

Test purpose: To verify that the UE relative code domain power accuracy meets the requirements given in table 5.2C.4 (HSDPA) and table 5.2D.8 (HSUPA).

Table 5.2C.4: UE relative code domain power accuracy test requirements

Nominal CDP ratio	Accuracy (dB)
≥ -10 dB	±1.7
-10 dB to ≥ -15 dB	±2.3
-15 dB to ≥ -20 dB	±2.9

Table 5.2D.8: UE relative code domain power accuracy test requirements

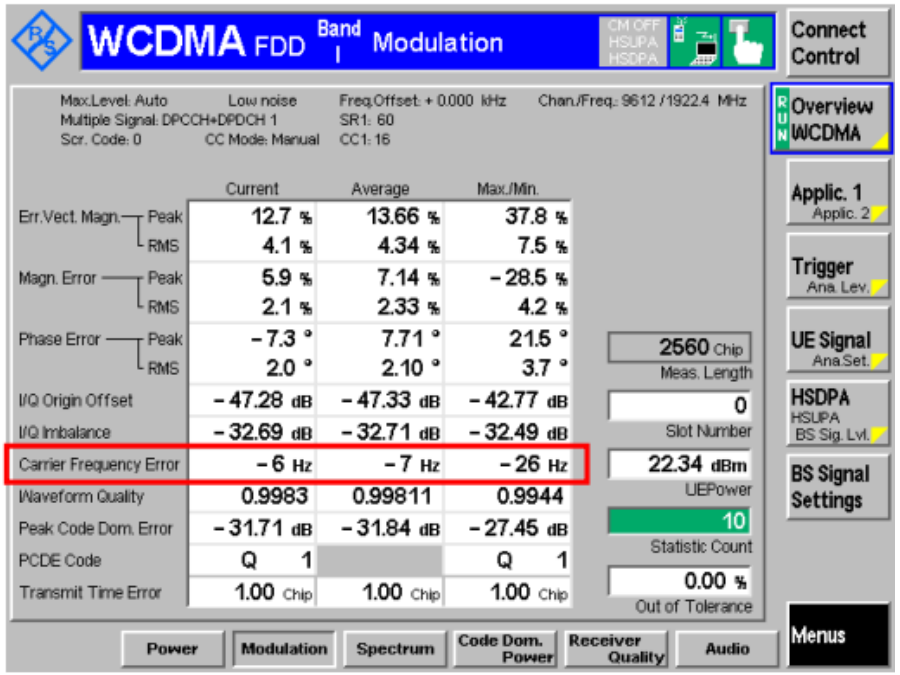
Nominal CDP ratio	Accuracy (dB)
≥ -10 dB	±1.7
-10 dB to ≥ -15 dB	±2.3
-15 dB to ≥ -20 dB	±2.9

RF Tests (Functional) – 3G Technology

5.3 Frequency Error

Definition: The frequency error is the difference between the RF modulated carrier frequency transmitted from the UE and the assigned frequency.

Test purpose: To verify that the UE carrier frequency error does not exceed ±0,1 ppm.



RF Tests (Functional) – 3G Technology

5.4.1 Open Loop Power Control in the Uplink

Definition: Open loop power control in the uplink is the ability of the UE transmitter to set its output power to a specific value. This function is used for PRACH transmission and based on the information from Node B using BCCH and the downlink received signal power level of the CPICH. The information from Node B includes transmission power of CPICH and uplink interference power level.

The power measured by the UE of the received signal and the signalled BCCH information are used by the UE to control the power of the UE transmitted signal with the target to transmit at the lowest power acceptable for proper communication.

The test stresses the ability of the receiver to measure the received power correctly over the receiver dynamic range.

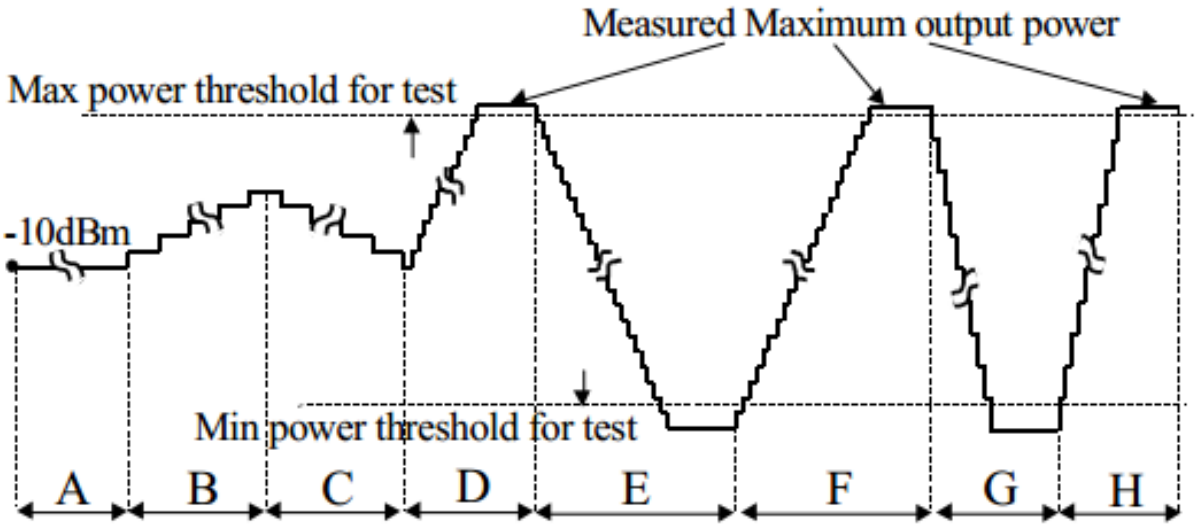
Test purpose: The test purpose is to verify that the UE open loop power control tolerance does not exceed ±9 dB (normal conditions) or ±12 dB (extreme conditions).

RF Tests (Functional) – 3G Technology

5.4.2 Inner Loop Power Control in the Uplink

Definition: Inner loop power control in the uplink is the ability of the UE transmitter to adjust its output power in accordance with one or more TPC commands received in the downlink.

The power control step is the change in the UE transmitter output power in response to a single TPC command, TPC_cmd, derived at the UE. An excess error of the inner loop power control decreases the system capacity.



RF Tests (Functional) – 3G Technology

5.4.2 Inner Loop Power Control in the Uplink

Test purpose: To verify that the UE inner loop power control size and response is meet to the described value shown in clause 5.4.2.2.

To verify that TPC_cmd is correctly derived from received TPC commands.

Table 5.4.2.2: Transmitter aggregate power control tolerance

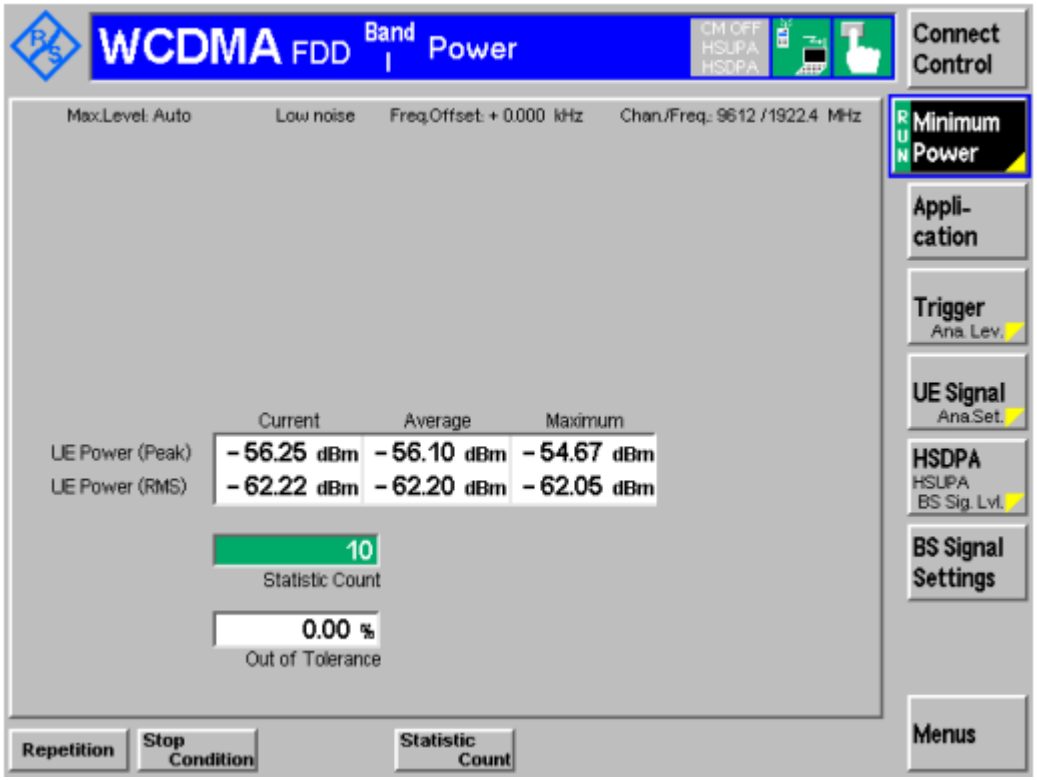
TPC_cmd group	Transmitter power control range after 10 equal TPC_cmd group (all units are in dB)				Transmitter power control range after 7 equal TPC_cmd groups (all units are in dB)	
	1 dB step size		2 dB step size		3 dB step size	
	Lower	Upper	Lower	Upper	Lower	Upper
+1	+8	+12	+16	+24	+16	+26
0	-1	+1	-1	+1	-1	+1
-1	-8	-12	-16	-24	-16	-26
0,0,0,0,+1	+6	+14	N/A	N/A	N/A	N/A
0,0,0,0,-1	-6	-14	N/A	N/A	N/A	N/A

RF Tests (Functional) – 3G Technology

5.4.3 Minimum Output Power

Definition: The minimum controlled output power of the UE is when the power control setting is set to a minimum value.

Test purpose: To verify that the UE minimum transmit power is less than -50 dBm.



RF Tests (Functional) – 3G Technology

5.5.1 Transmit OFF Power

5.5.2 Transmit ON/OFF Time Mask

Definition: Transmit OFF power is defined as the RRC filtered mean power when the transmitter is off. The transmit OFF power state is when the UE does not transmit or during periods when the UE is not transmitting DPCCH due to discontinuous uplink DPCCH transmission.

The time mask for transmit ON/OFF defines the ramping time allowed for the UE between transmit OFF power and transmit ON power.

Test purpose: To verify that the transmit OFF power is less than –56 dBm.

To verify that the power ON/OFF ratio of the PRACH shown in figure 5.5.1 meets the requirements given in table 5.5.2.2.

RF Tests (Functional) – 3G Technology

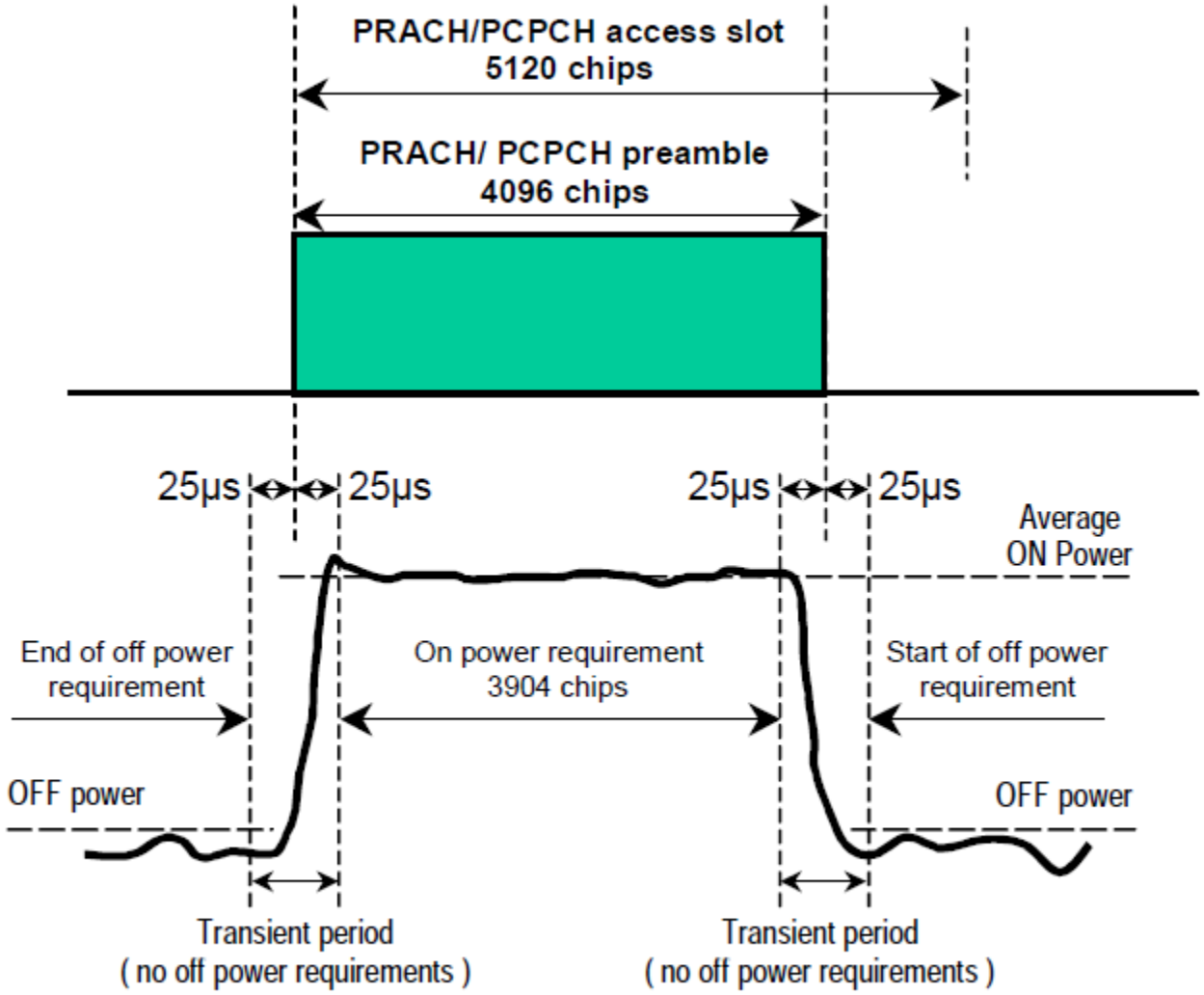


Figure 5.5.1: Transmit ON/OFF template for PRACH preambles

RF Tests (Functional) – 3G Technology

5.7 Power Setting in Uplink Compressed Mode

Definition: A change of output power is required during uplink compressed frames since the transmission of data is performed in a shorter interval.

Test purpose: To verify that the changes in uplink transmit power in compressed mode are within the prescribed tolerances.

Excess error in transmit power setting in compressed mode increases the interference to other channels, or increases transmission errors in the uplink.

RF Tests (Functional) – 3G Technology

5.7A HS-DPCCH power control

Definition: The transmission of ACK / NACK or CQI over the HS-DPCCH may cause transmission power in the uplink to vary.

The ratio of the amplitude between the DPCCH and the Ack/Nack and CQI respectively is signalled by higher layers.

Test purpose: To verify that the changes in uplink transmit power when transmitting the HS-DPCCH (Ack/Nack and CQI) and the power between HS-DPCCH transmissions are within the allowed power step tolerances as shown in table 5.7A.2 and 5.7A.3 of the ETSI TS 34121-1 standard.

RF Tests (Functional) – 3G Technology

5.7A HS-DPCCH power control

Table 5.7A.2: Transmitter power test requirements for TPC_cmd=0

Sub-test in table C.10.1.4	Power step	Nominal Power step size, ΔP [dB]	Rounded Power step size, ΔP [dB]	Transmitter power step Tolerance [dB]	Allowed Transmitter power step range [dB]
3	1	6.14	6	+/- 2.3	3.7 to 8.44
	2	-1.38	-1	+/- 0.6	-1.98 to -0.4
	3	-4.76	-5	+/- 2.3	-7.3 to -2.46
	4[1]	0	0	+/- 0.6	-0.6 to 0.6
	5	4.76	5	+/- 2.3	2.46 to 7.3
	6	1.38	1	+/- 0.6	0.4 to 1.98
	7	-6.14	-6	+/- 2.3	-8.44 to -3.7
	8[1]	0	0	+/- 0.6	-0.6 to 0.6
	9	4.76	5	+/- 2.3	2.46 to 7.3
	10	-4.76	-5	+/- 2.3	-7.3 to -2.46
	11[1]	0	0	+/- 0.6	-0.6 to 0.6
NOTE 1: Two test points.					

Ensaios de conformidade – Tecnologia 3G

5.7A HS-DPCCH power control

Table 5.7A.3: Transmitter power test requirements for TPC_cmd=1

Sub-test in table C.10.1.4	Power step	Nominal Power step size, ΔP [dB]	Rounded Power step size, ΔP [dB]	Transmitter power step Tolerance [dB]	Allowed Transmitter power step range [dB]
3	1	6.14	6	+/- 2.3	3.7 to 8.44
	2	-1.38	-1	+/- 0.6	-1.98 to -0.4
	3[3]	No requirements	No requirements	NA	No requirements
	4	-4.76	-5	+/- 2.3	-7.3 to -2.46
	5[1]	1	1	+/- 0.6	0.4 to 1.6
	6	4.76	5	+/- 2.3	2.46 to 7.3
	7[3]	No Requirements	No requirements	NA	No requirements
	8	1.38	1	+/- 0.6	0.40 to 1.98
	9	-6.14	-6	+/- 2.3	-8.44 to -3.7
	10[2]	1	1	+/- 0.6	0.4 to 1.6
	11	4.76	5	+/- 2.3	2.46 to 7.3
	12	-4.76	-5	+/- 2.3	-7.3 to -2.46
	13[2]	1	1	+/- 0.6	0.4 to 1.6

NOTE 1: Three test points.
NOTE 2: Two test points.
NOTE 3: In these test points rel-6 UE performs additional power scaling due to changes in allowed MPR, and therefore there are no requirements specified for transmitter power steps.

RF Tests (Functional) – 3G Technology

5.9 Spectrum Emission Mask

Definition: The spectrum emission mask of the UE applies to frequencies, which are between 2,5 MHz and 12,5 MHz away from the UE centre carrier frequency. The out of channel emission is specified relative to the RRC filtered mean power of the UE carrier.

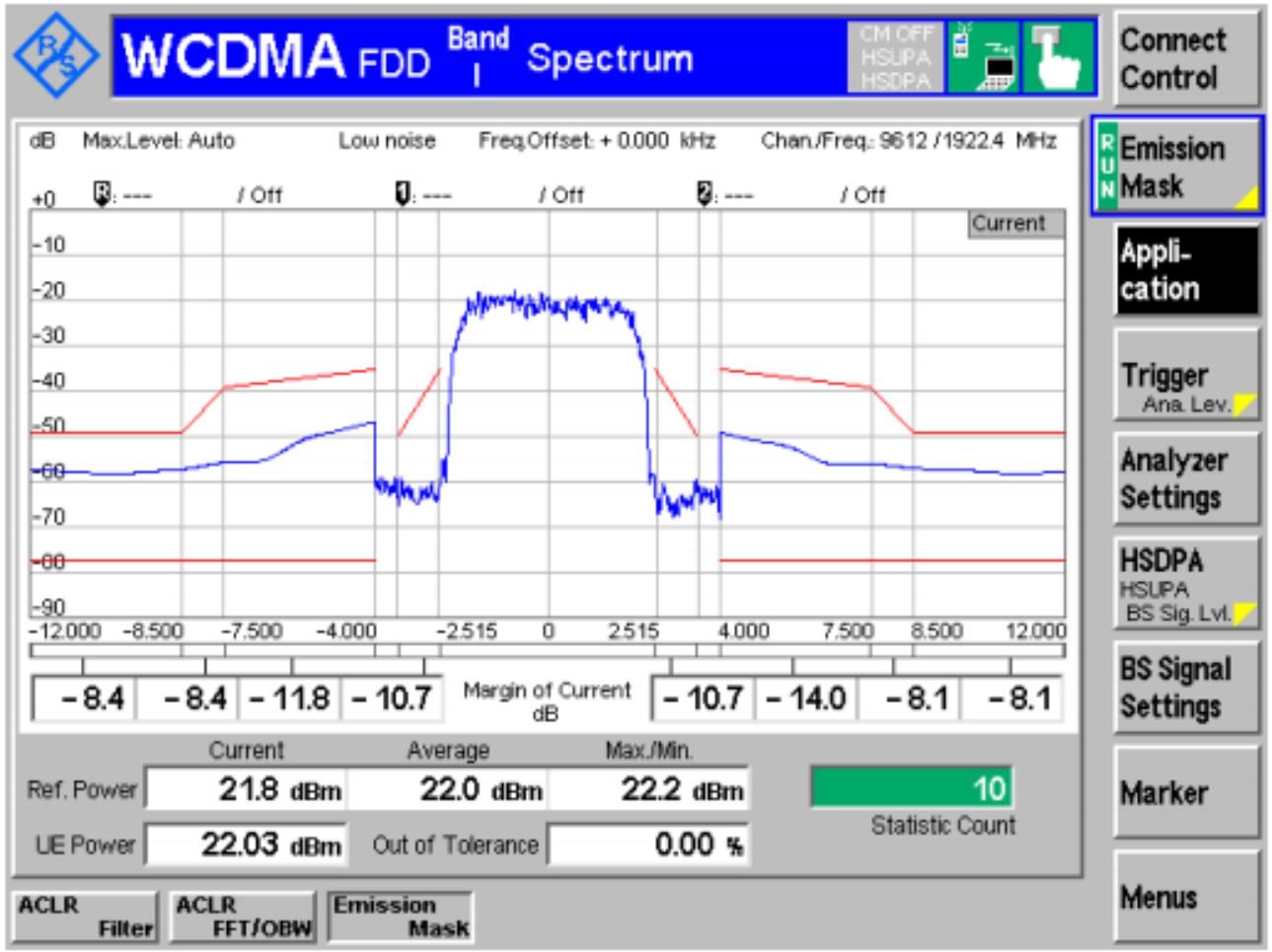
Test purpose: To verify that the power of UE emission does not exceed the prescribed limits shown in table 5.9.1.

Table 5.9.1: Spectrum Emission Mask Requirement

Δf in MHz (Note 1)	Minimum requirement (note 2)		Measurement bandwidth
	Relative requirement	Absolute requirement	
2.5 - 3.5	$\left\{-35-15\cdot\left(\frac{\Delta f}{MHz}-2.5\right)\right\}dBc$	-71.1 dBm	30 kHz (note 3)
3.5 - 7.5	$\left\{-35-1\cdot\left(\frac{\Delta f}{MHz}-3.5\right)\right\}dBc$	-55.8 dBm	1 MHz (note 4)
7.5 - 8.5	$\left\{-39-10\cdot\left(\frac{\Delta f}{MHz}-7.5\right)\right\}dBc$	-55.8 dBm	1 MHz (note 4)
8.5 - 12.5 MHz	-49 dBc	-55.8 dBm	1 MHz (note 4)

RF Tests (Functional) – 3G Technology

5.9 Spectrum Emission Mask



RF Tests (Functional) – 3G Technology

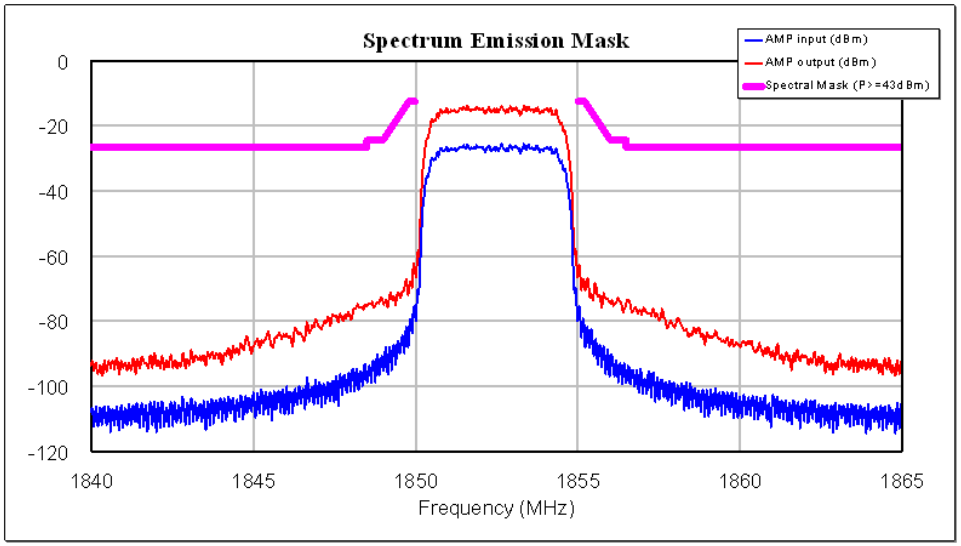
5.9A Spectrum Emission Mask with HS-DPCCH

5.9B Spectrum Emission Mask with E-DCH

Definition: The spectrum emission mask of the UE applies to frequencies, which are between 2,5 MHz and 12,5 MHz away from the UE centre carrier frequency. The out of channel emission is specified relative to the RRC filtered mean power of the UE carrier.

Test purpose: To verify that the power of UE emission does not exceed the prescribed limits shown in table 5.9A.1, even in the presence of the HS-DPCCH.

To verify that the power of UE emission does not exceed the prescribed limits shown in table 5.9B.1, even in the presence of the E-DCH.

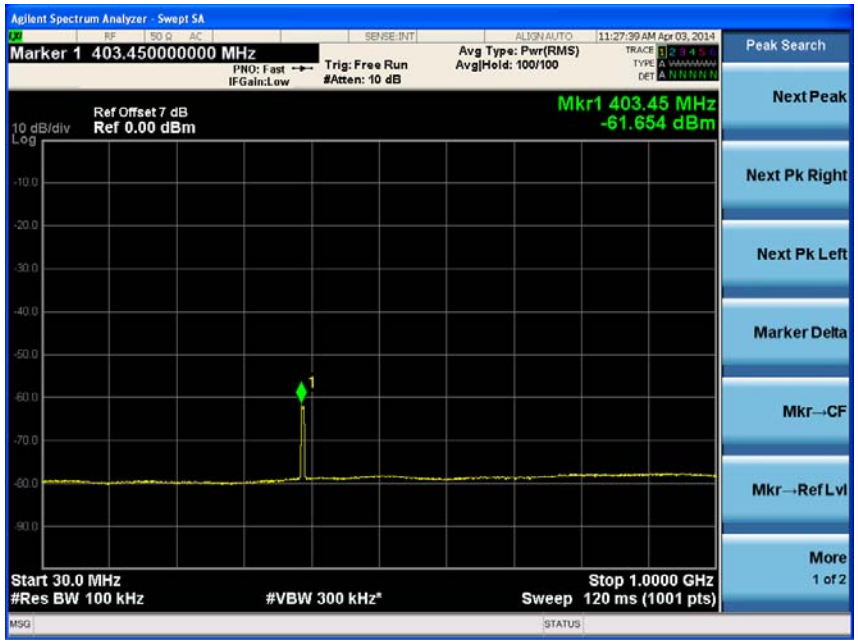


RF Tests (Functional) – 3G Technology

5.11 Spurious Emissions

Definition: Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

Test purpose: To verify that the UE spurious emissions do not exceed described value shown in table 5.11.1a and table 5.11.1b.



RF Tests (Functional) – 3G Technology

5.13.1 Error Vector Magnitude (EVM)

5.13.1A Error Vector Magnitude (EVM) with HS-DPCCH

5.13.1AA Error Vector Magnitude (EVM) and Phase Discontinuity with HS-DPCCH

Definition: The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %.

Phase discontinuity for HS-DPCCH is the change in phase due to the transmission of the HS-DPCCH. In the case where the HS-DPCCH timeslot is offset from the DPCCH timeslot, the period of evaluation of the phase discontinuity shall be the DPCCH timeslot that contains the HS-DPCCH slot boundary.

Test purpose: To verify that the EVM does not exceed 17.5 %

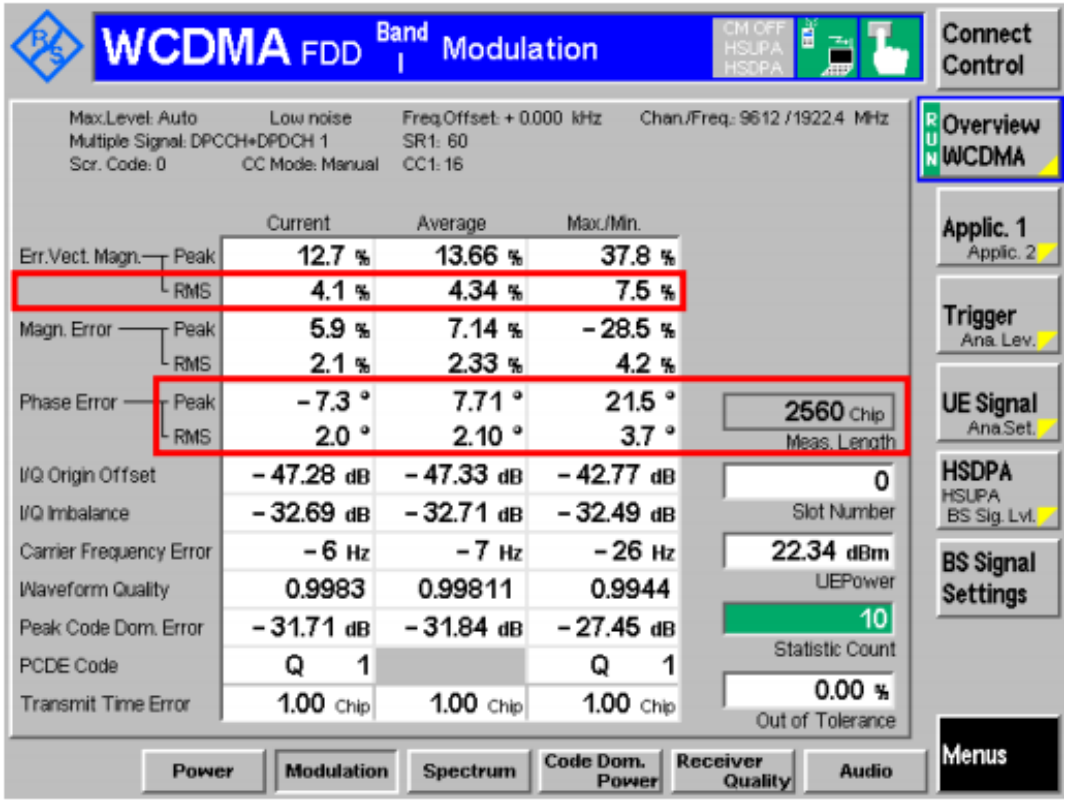
To verify that HSDPA phase discontinuity does not exceed 30 degrees.

RF Tests (Functional) – 3G Technology

5.13.1 Error Vector Magnitude (EVM)

5.13.1A Error Vector Magnitude (EVM) with HS-DPCCH

5.13.1AA Error Vector Magnitude (EVM) and Phase Discontinuity with HS-DPCCH



RF Tests (Functional) – 3G Technology

5.13.2A Relative Code Domain Error with HS-DPCCH

5.13.2B Relative Code Domain Error with HS-DPCCH and E-DCH

Definition: The Relative Code Domain Error is computed by projecting the error vector onto the code domain. Only the code channels with non-zero betas in the composite reference waveform are considered for this requirement.

Test purpose: To verify that the Relative Code Domain Error does not exceed the values in table 5.13.2B.9 for the beta values defined in table 5.13.2B.8.

Table 5.13.2B.9: Relative Code Domain Error test requirement

ECDP dB	Relative Code Domain Error dB
-21 < ECDP	≤ -15.5
-30 ≤ ECDP ≤ -21	≤ -36.5 – ECDP
ECDP < -30	No requirement

Schedule

RF Tests (Functional) – 4G Technology

RF Tests (Functional) – LTE Technology

6.2.2 UE Maximum Output Power

Definition: Measure maximum power UE can transmit.

Test purpose: To verify that the error of the UE maximum output power does not exceed the range prescribed by the specified nominal maximum output power and tolerance.

RF Tests (Functional) – LTE Technology

6.2.3 Maximum Power Reduction (MPR)

Definition: The number of RB identified in Table 6.2.2.3-1 is based on meeting the requirements for adjacent channel leakage ratio and the maximum power reduction (MPR).

Test purpose: To verify that the maximum output power is within the range prescribed by the nominal maximum output power and tolerance in Table 6.2.3.5-1.

RF Tests (Functional) – LTE Technology

6.2.5 Configured UE Transmitted Output Power

Definition: Configured transmitted power is the capacity the UE transmitter has to adjust output power in response to Node B commands.

Test purpose: To make sure the UE does not exceed the minimum between the maximum allowed E-UTRAN *uplink* power and the maximum UE power, according to its power class. The maximum output power measured shall not exceed the values specified in table 6.2.5.5-1.

Table 6.2.5.5-1: P_{CMAX} configured UE output power

	Channel bandwidth / maximum output power					
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Measured UE output power test point 1	-10 dBm ± 7.7					
Measured UE output power test point 2	10 dBm ± 6.7					
Measured UE output power test point 3	15 dBm ± 5.7					
Note: In addition note 2 in Table 6.2.2.3-1 shall apply to the tolerances.						

RF Tests (Functional) – LTE Technology

6.3.2 Minimum Output Power

Definition: The minimum output power is defined as the mean power in one sub-frame (1 ms).

Test purpose: Verify the UE's ability to transmit with output power below the value prescribed in test requirements, when value has been set for a minimum value. The minimum output power measured shall not exceed the values specified in table 6.3.2.5-1.

Table 6.3.2.5-1: Minimum output power

	Channel bandwidth / minimum output power / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Minimum output power	-39 dBm					
Measurement bandwidth (Note 1)	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz
Note 1: Different implementations such as FFT or spectrum analyzer approach are allowed. For spectrum analyzer approach the measurement bandwidth is defined as an equivalent noise bandwidth.						

RF Tests (Functional) – LTE Technology

6.3.4.1 ON/OFF Time Mask

Definition: The time mask for transmit ON/OFF defines the ramping time allowed for the UE between transmit OFF power and transmit ON power.

Test purpose: To verify that the general ON/OFF time mask meets the requirements given in table 6.3.4.1.5-1.

Table 6.3.4.1.5-1: General ON/OFF time mask

	Channel bandwidth / minimum output power / measurement bandwidth					
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Transmit OFF power	-48.5 dBm					
Transmission OFF Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz
Expected Transmission ON Measured power	-14.8 ± 7.5	-10.8 ± 7.5	-8.6 ± 7.5	-5.6 ± 7.5	-3.9 ± 7.5	-2.6 ± 7.5

RF Tests (Functional) – LTE Technology

6.5.1 Frequency Error

Definition: This test verifies the ability of both the receiver and the transmitter to process frequency correctly.

Receiver: to extract the correct frequency from the stimulus signal, offered by the System simulator, under ideal propagation conditions and low level.

Transmitter: to derive the correct modulated carrier frequency from the results, gained by the receiver.

Test purpose: The UE modulated carrier frequency shall be accurate to within ±0.1 PPM observed over a period of one time slot (0.5ms) compared to the carrier frequency received from the E-UTRA Node B.

RF Tests (Functional) – LTE Technology

6.5.2.1 Error Vector Magnitude (EVM)

Definition: The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %.

The basic EVM measurement interval in the time domain is one preamble sequence for the PRACH and is one slot for the PUCCH and PUSCH in the time domain. When the PUSCH or PUCCH transmission slot is shortened due to multiplexing with SRS, the EVM measurement interval is reduced by one symbol, accordingly. The PUSCH or PUCCH EVM measurement interval is also reduced when the mean power, modulation or allocation between slots is expected to change.

Test purpose: The PUSCH EVM derived in E.4.2 shall not exceed 17.5% for QPSK and BPSK, 12,5% for 16 QAM.

The PUCCH EVM shall not exceed 17.5%.

The PRACH EVM shall not exceed 17.5%.

RF Tests (Functional) – LTE Technology

6.5.2.2 Carrier Leakage

Definition: Carrier leakage (the I/Q origin offset) is an interference caused by crosstalk or DC offset and expresses itself as unmodulated sine wave with the carrier frequency. It is an interference of approximately constant amplitude and independent of the amplitude of the wanted signal. I/Q origin offset interferes with the centre sub carriers of the UE under test (if allocated), especially, when their amplitude is small. The measurement interval is defined over one slot in the time domain.

Test purpose: The purpose of this test is to exercise the UE transmitter to verify its modulation quality in terms of carrier leakage, according to table 6.5.2.2.5-1.

Table 6.5.2.2.5-1: Test requirements for Relative Carrier Leakage Power

LO Leakage	Parameters	Relative Limit (dBc)
	3.2 dBm ±3.2dB	-24.2
	-26.8 dBm ±3.2dB	-19.2
	-36.8dBm±3.2dB	-9.2

RF Tests (Functional) – LTE Technology

6.5.2.3 In-Band Emissions for Non Allocated RB

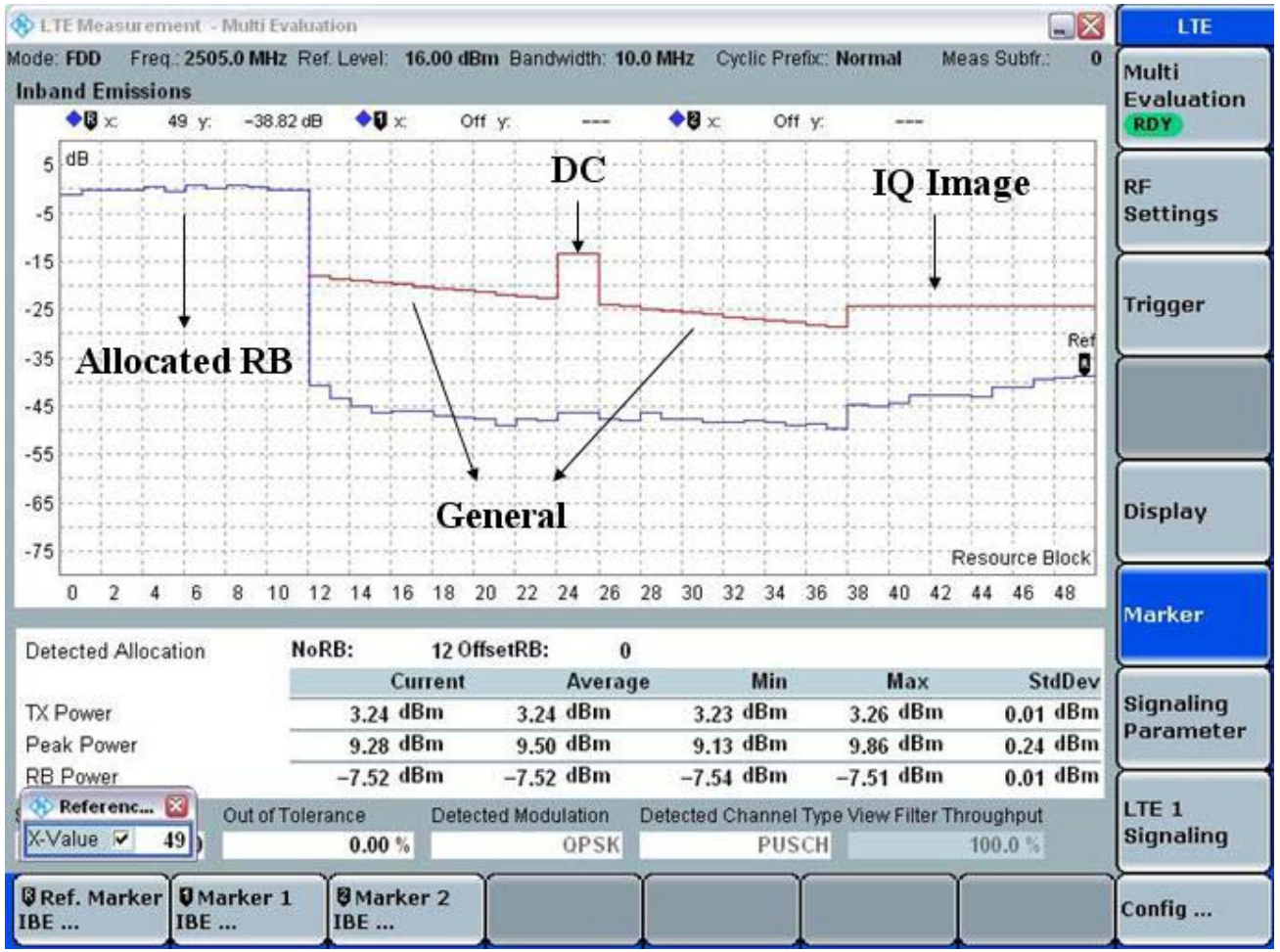
Definition: The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

The in-band emission is defined as the average across 12 sub-carrier and as a function of the RB offset from the edge of the allocated UL transmission bandwidth. The in-band emission is measured as the ratio of the UE output power in a non-allocated RB to the UE output power in an allocated RB. The basic in-band emissions measurement interval is defined over one slot in the time domain.

Test purpose: To verify that the relative in-band emissions do not exceed the values specified in table 6.5.2.3.5-1.

RF Tests (Functional) – LTE Technology

6.5.2.3 In-Band Emissions for Non Allocated RB



RF Tests (Functional) – LTE Technology

6.6.1 Occupied Bandwidth

Definition: Occupied bandwidth is a measure of the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel.

Test purpose: To verify that the UE occupied bandwidth for all transmission bandwidth configurations supported by the UE are less than their specific limits.

Table 6.6.1.2-1: Occupied channel bandwidth

	Occupied channel bandwidth / channel bandwidth					
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Channel bandwidth [MHz]	1.4	3	5	10	15	20

RF Tests (Functional) – LTE Technology

6.6.2.1 Spectrum Emission Mask

Definition: The spectrum emission mask of the UE applies to frequencies (ΔfOOB) starting from the edge of the assigned E-UTRA channel bandwidth. For frequencies greater than (ΔfOOB) as specified in Table 6.6.2.1.3-1 the spurious requirements in clause 6.6.3 are applicable.

Test purpose: To verify that the power of any UE emission shall not exceed specified lever for the specified channel bandwidth.

Table 6.6.2.1.3-1: General E-UTRA spectrum emission mask

Spectrum emission limit (dBm)/ Channel bandwidth							
Δf_{OOB} (MHz)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Measurement bandwidth
± 0-1	-10	-13	-15	-18	-20	-21	30 kHz
± 1-2.5	-10	-10	-10	-10	-10	-10	1 MHz
± 2.5-2.8	-25	-10	-10	-10	-10	-10	1 MHz
± 2.8-5		-10	-10	-10	-10	-10	1 MHz
± 5-6		-25	-13	-13	-13	-13	1 MHz
± 6-10			-25	-13	-13	-13	1 MHz
± 10-15				-25	-13	-13	1 MHz
± 15-20					-25	-13	1 MHz
± 20-25						-25	1 MHz

RF Tests (Functional) – LTE Technology

6.6.2.3 Adjacent Channel Leakage Power Ratio

Definition: ACLR is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency at nominal channel spacing.

Test purpose: To verify that UE transmitter does not cause unacceptable interference to adjacent channels in terms of Adjacent Channel Leakage Power Ratio.

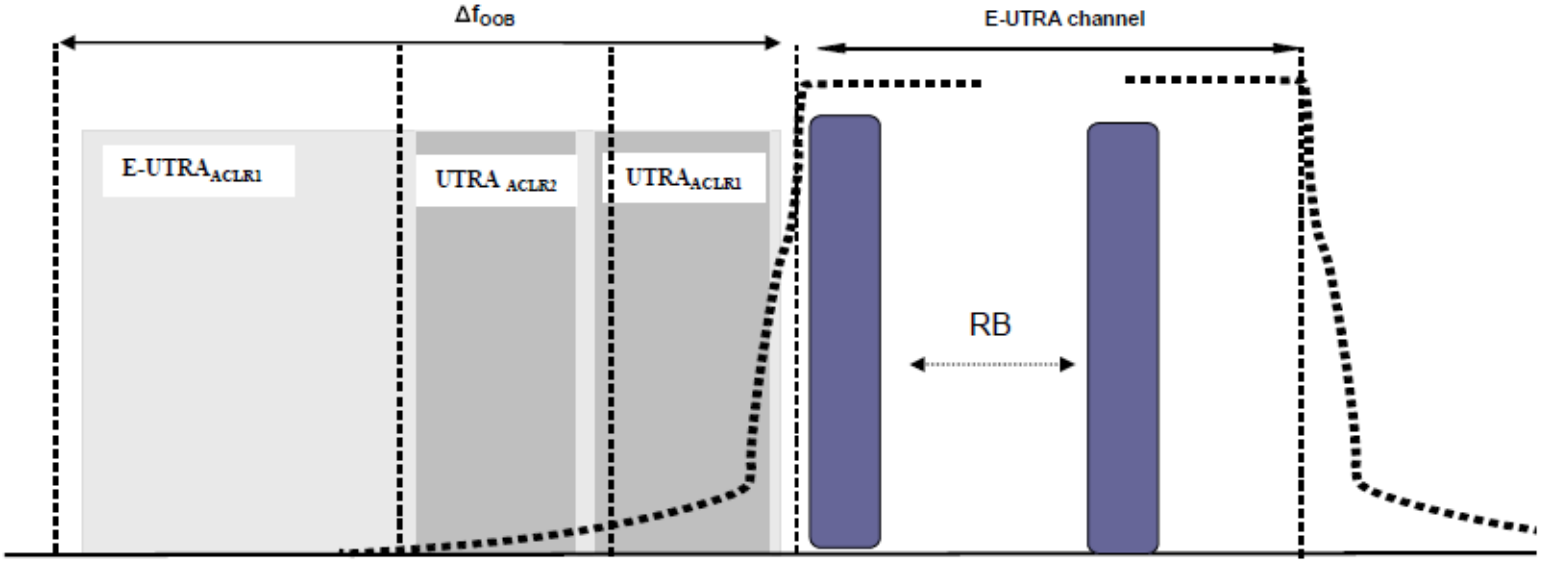


Figure 6.6.2.3.3-1: Adjacent Channel Leakage Power Ratio requirements

RF Tests (Functional) – LTE Technology

6.6.3.1 Transmitter Spurious Emissions

Definition: Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions.

Test purpose: To verify that UE transmitter does not cause unacceptable interference to other channels or other systems in terms of transmitter spurious emissions, according to table 6.6.3.1.3-2.

Table 6.6.3.1.3-2: Spurious emissions limits

Frequency Range	Maximum Level	Measurement Bandwidth
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz

Schedule

RF Tests (Functional) – Wi-Fi Technology

RF Tests (Functional) – Wi-Fi Technology 2.400-2.483,5 MHz and 5.725-5.850 MHz

Maximum Transmitter Output Power

Definition: Maximum transmitter output power is the measurement of the maximum power the UE can transmit.

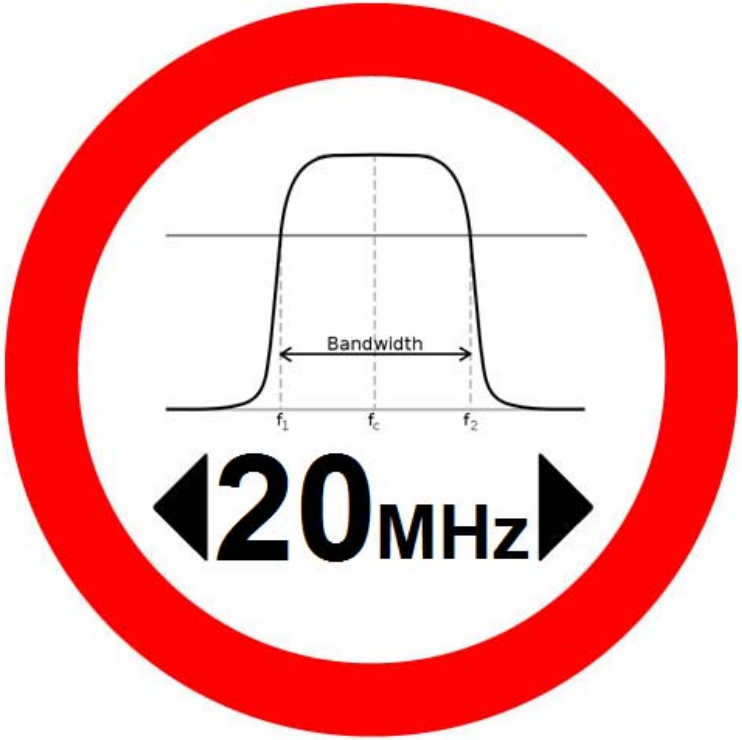
Test purpose: Verify, according to item II of article 41 in section IX, that maximum transmitter output power cannot exceed 1 Watt.

RF Tests (Functional) – Wi-Fi Technology 2.400-2.483,5 MHz and 5.725-5.850 MHz

Maximum Width of Occupied Hop Channel Range at 6 dB

Definition: Occupied bandwidth is a 6 db bandwidth measurement of the transmission peak signal in the assigned channel.

Test purpose: Verify, according to item I of article 41 in section IX that the bandwidth, at 6 db, must be at least 500 kHz.

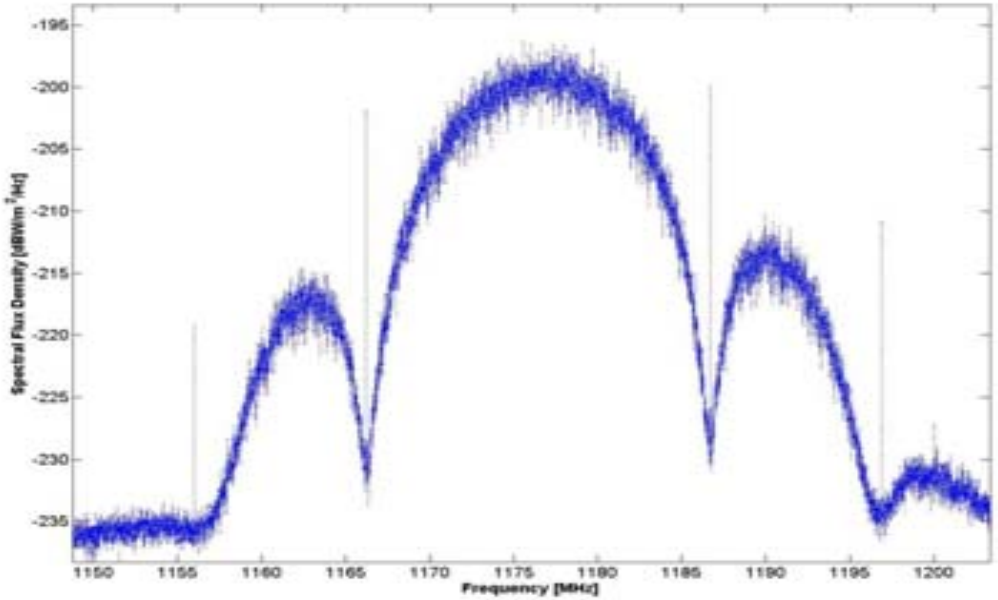


RF Tests (Functional) – Wi-Fi Technology 2.400-2.483,5 MHz and 5.725-5.850 MHz

Peak Power Density in any 3 kHz Range

Definition: Spectral power density describes how the energy of a signal or a time series shall be distributed with the frequency.

Test purpose: Verify, according to item II of article 41 in section IX that the spectral power density peak, in any 3 kHz range, during any continuous transmission time interval, shall never exceed 8 dBm.



RF Tests (Functional) – Wi-Fi Technology 2.400-2.483,5 MHz and 5.725-5.850 MHz

Spurious Emissions

Definition: Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products.

Test purpose: Verify, according to item III of article 41 in section IX, that produced radiofrequency power, in any 100 kHz bandwidth outside any one of the bands in which the system is operating, must be at least 20 dB below the maximum power produced in a 100 kHz interval, within the operating range.

RF Tests (Functional) – Wi-Fi Technology 5.470-5.725 MHz

Maximum Transmitter Output Power

Definition: Maximum transmitter output power is the measurement of the maximum power the UE can transmit.

Test purpose: Verify, according to item I of article 47 in section X, that maximum transmitter output power cannot exceed 250 mW.

RF Tests (Functional) – Wi-Fi Technology 5.150-5.350 MHz and 5.470-5.725 MHz

Mean EIRP

Definition: Equivalent radiated isotropic power mean is the average of the arithmetic product of the power suppled to the antenna and its gain.

Test purpose: Verify, according to item II of articles 46 and 47 of section X, that the EIRP mean value is limited to a maximum 200 mW (for an operating range of 5,150-5,350 MHz) and 1 W (for an operating range of 5,470-5,725 MHz).

RF Tests (Functional) – Wi-Fi Technology 5.150-5.350 MHz and 5.470-5.725 MHz

7 – EIRP Spectral Density Mean Value

Definition: The EIRP spectral density describes the power contributed to the wave by a frequency, considering the gain of the transmitting antenna.

Test purpose: Verify, according to item III of articles 46 and 47 of section X, that the EIRP spectral mean value is limited to a maximum of 10 mW/MHz (for an operating range of 5,150-5,350 MHz) and 50 mW/MHz (for an operating range of 5,470-5,725 MHz).

RF Tests (Functional) – Wi-Fi Technology 5.150-5.350 MHz and 5.470-5.725 MHz

Spurious Emissions

Definition: Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products.

Test purpose: Verify, according to article 48 in section X, that spurious emissions or those outside any of the operating ranges shall be inferior to the EIRP limit of -27dBm/MHz.

RF Tests (Functional) – Wi-Fi Technology 5.150-5.350 MHz and 5.470-5.725 MHz

Transmit Power Control (TPC)

Definition: Equipment without the TCP mechanism shall be exceptionally allowed. In this case, the EIRP mean value shall be limited to 100 mW for equipment operating in the 5,150-5,350 MHz band and limited to 500 mW range for equipment operating in the 5,470-5,725 MHz band.

Test purpose: Verify, according to article 49 in section X, that the UE allows dynamic selection of transmission power and assures a mitigating factor of at least 3dB.

RF Tests (Functional) – Wi-Fi Technology 5.150-5,350 MHz and 5,470-5,725 MHz

Dynamic Frequency Selection (DFS)

Definition: In the 5,250-5,725 MHz ranges, the Broadband Wireless Access System for Local Networks shall use the dynamic frequency selection mechanism. This frequency range is exclusively reserved for military radars, however, it can be used by Wi-Fi devices provided they have a device able to detect when a radar signal is operating in the same frequency.

Test purpose: Verify, according to article 50 in section X, that:

I - time taken to verify channel availability does not exceed 60 seconds and no transmission shall begin before channel availability has been verified;

II – one channel availability has been verified and its occupancy has been identified, this channel shall be subject to a 30-minute non-occupancy period;

III – for equipment operating at a maximum EIRP of less than 200 mW, the DFS mechanism shall be able to detect interfering signals below the –62 dBm threshold, calculated during an average interval of 1 microsecond;

RF Tests (Functional) – Wi-Fi Technology 5.150-5.350 MHz and 5.470-5.725 MHz

Dynamic Frequency Selection (DFS)

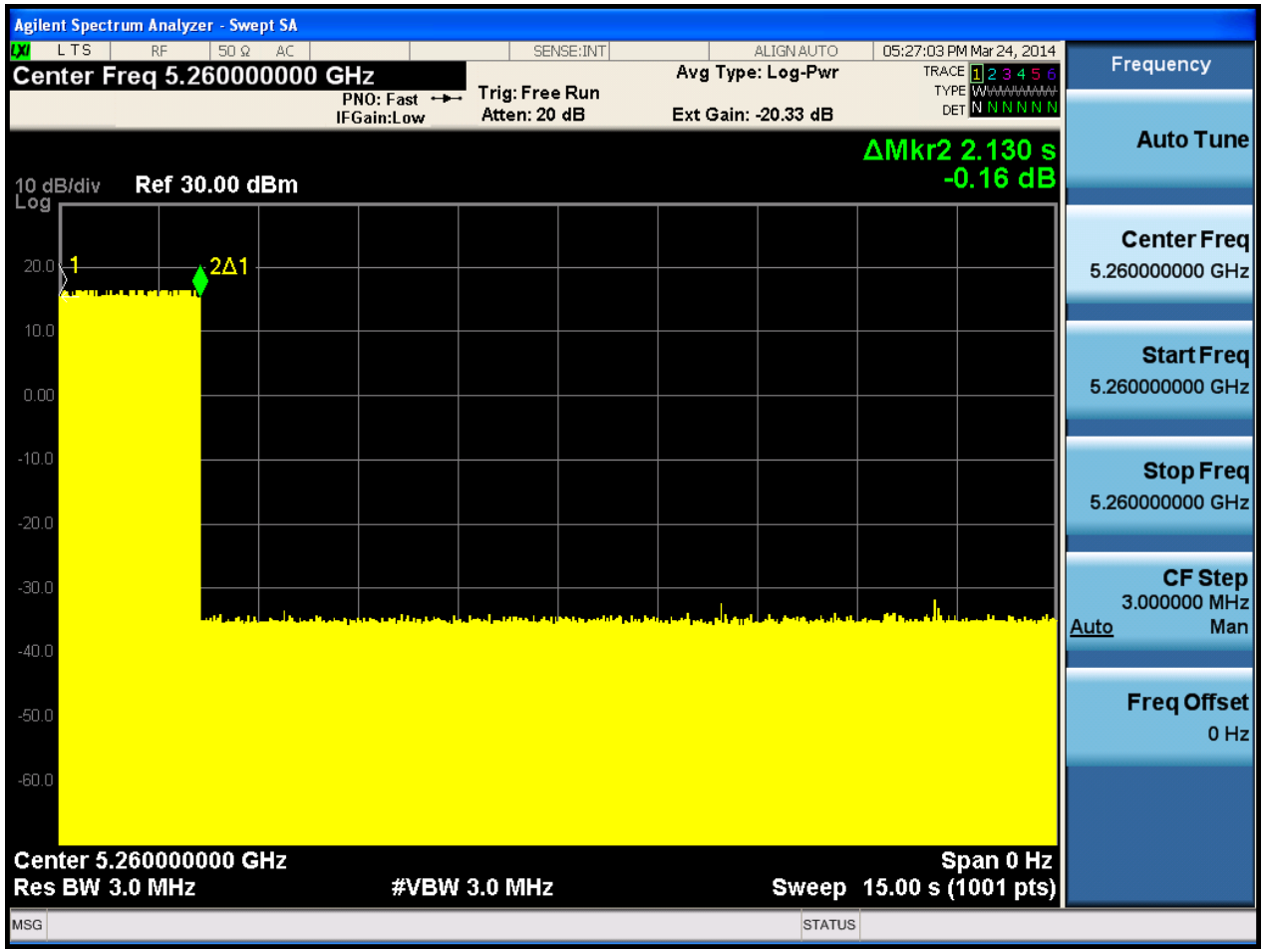
IV – for equipment operating at a maximum EIRP of between 200mW and 1 W, the DFS mechanism shall be able to detect interfering signals below the –64 dBm threshold, calculated during an average interval of 1 microsecond;

V – in case an interfering signal with a value above the DFS detection threshold, all transmissions on the channel in question shall stop within 10 seconds.

NOTE: The use of the DFS mechanism in the 5,150-5,250 MHz band, however, the use of this mechanism is not mandatory in this band.

RF Tests (Functional) – Wi-Fi Technology 5.150-5.350 MHz and 5.470-5.725 MHz

Dynamic Frequency Selection (DFS)



Schedule

RF Tests (Functional) – Bluetooth Technology

RF Tests (Functional) – Bluetooth Technology

Separating Carrier Frequencies in Hop Channels

Definition: Pseudo-random frequency hops separated by channels are used to minimize data transmission interference.

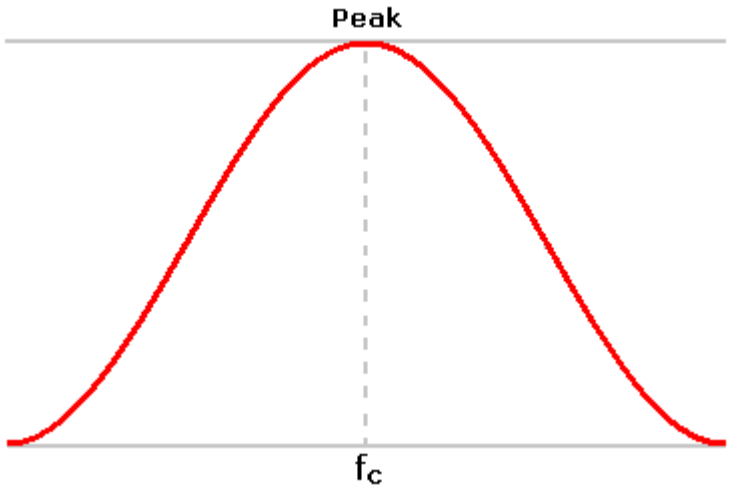
Test purpose: Verify, according to item I of article 40 in section IX, that the hop channel RF carriers are separated by a minimum 25 kHz or by the width of the hop channel at 20 dB, whichever value is greater.

RF Tests (Functional) – Bluetooth Technology

Maximum Transmitter Output Power Peak

Definition: Maximum transmitter output power is the measurement of the maximum power the UE can transmit.

Test purpose: Verify, according to item VII-d and VII-e of article 40 in section IX, that for systems utilizing less than 75 hop radiofrequencies, maximum transmitter output power peak is limited to 125 mW, and for systems using 75 or less radiofrequencies, maximum transmitter output power peak is limited to 1 Watt.

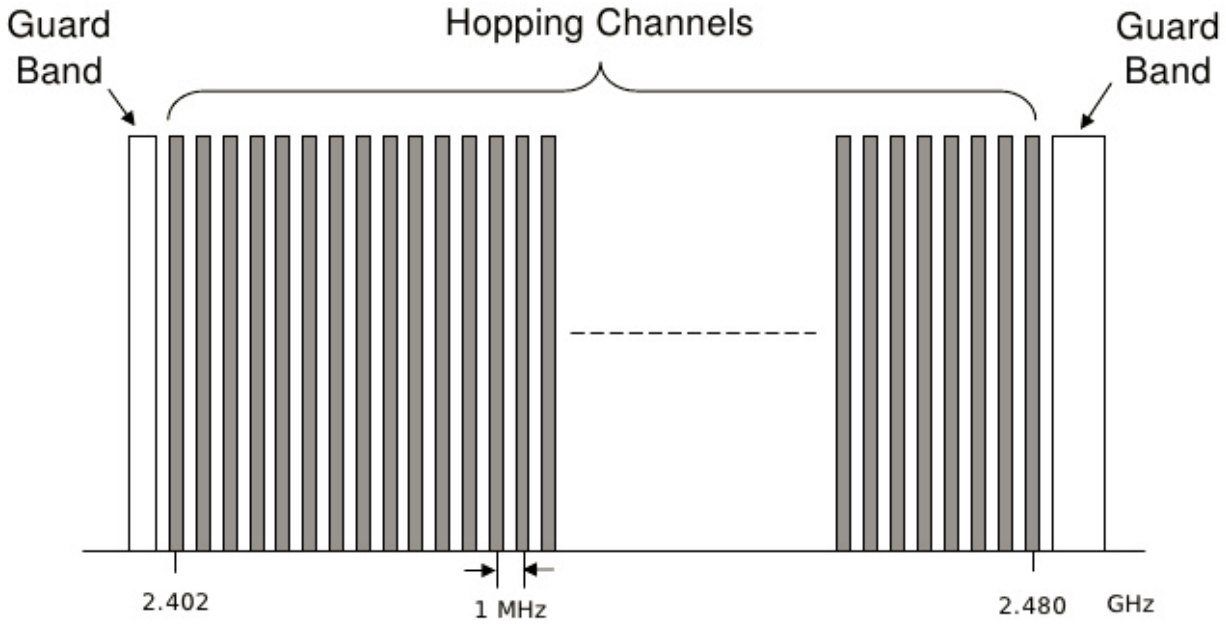


RF Tests (Functional) – Bluetooth Technology

Hop Frequencies

Definition: Count hop frequency channels within the specified range.

Test purpose: Verify, according to item VII-a of article 40 in section IX, that the system is using at least 15 non-coinciding hop frequencies.

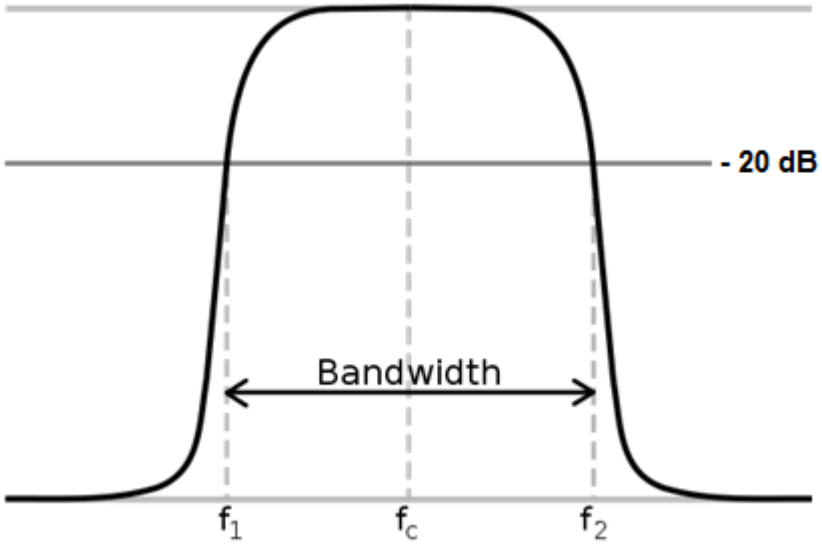


RF Tests (Functional) – Bluetooth Technology

Maximum Width of Occupied Hop Channel Range at 20 dB

Definition: Occupied hop channel bandwidth is a 20 dB bandwidth measurement of the transmission peak signal in the assigned channel.

Test purpose: Verify, according to item I of article 40 in section IX, the hop channel bandwidth at 20 dB.



RF Tests (Functional) – Bluetooth Technology

Mean Occupancy Time of Any Frequency

Definition: Measure hop channel mean occupancy time.

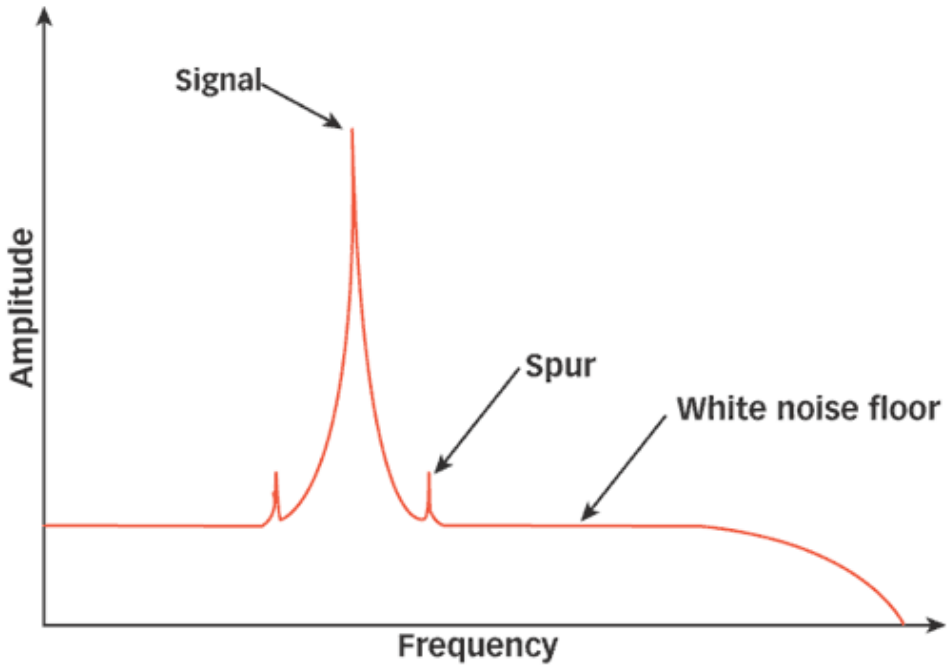
Test purpose: Verify, according to item VII-b of article 40 in section IX, that the mean occupancy time of any radiofrequency does not exceed 0.4 seconds in a 0.4 s interval multiplied by the number of hop channels utilized.

RF Tests (Functional) – Bluetooth Technology

Spurious Emissions

Definition: Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products.

Test purpose: Verify, according to article 44 in section IX, that produced radiofrequency power, in any 100 kHz bandwidth outside any one of the bands in which the system is operating, must be at least 20 dB below the maximum power produced in a 100 kHz interval, within the operating range.



Thank You!

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