13 Transmitter

13.1 Frequency error and phase error

13.1.1 Definition and applicability

The frequency error is the difference in frequency, after adjustment for the effect of the modulation and phase error, between the RF transmission from the MS and either:

- the RF transmission from the BS, or
- the nominal frequency for the ARFCN used.

The phase error is the difference in phase, after adjustment for the effect of the frequency error, between the RF transmission from the MS and the theoretical transmission according to the intended modulation.

The requirements and this test apply to all types of GSM 900 and DCS 1 800 MS.

13.1.2 Conformance requirement

1. The MS carrier frequency shall be accurate to within 0,1 ppm, or accurate to within 0,1 ppm compared to signals received from the BS.

   1.1 Under normal conditions; GSM 05.10, 6.1.

   1.2 Under vibration conditions; GSM 05.10, 6.1; GSM 05.05, annex D D.2.3.

   1.3 Under extreme conditions; GSM 05.10, 6.1; GSM 05.05, 4.4; GSM 05.05, annex D D.2.1, D.2.2.

2. The RMS phase error (difference between the phase error trajectory and its linear regression on the active part of the time slot) for each burst shall not be greater than 5 degrees.

   2.1 Under normal conditions; GSM 05.05, 4.6.

   2.2 Under vibration conditions; GSM 05.05, 4.6; GSM 05.05, annex D D.2.3.

   2.3 Under extreme conditions; GSM 05.05, 4.6; GSM 05.05, annex D D.2.1, D.2.2.

3. The maximum peak deviation during the useful part of each burst shall not be greater than 20 degrees.

   3.1 Under normal conditions; GSM 05.05, 4.6.

   3.2 Under vibration conditions; GSM 05.05, 4.6; GSM 05.05, annex D D.2.3.

   3.3 Under extreme conditions; GSM 05.05, 4.6; GSM 05.05, annex D D.2.1, D.2.2.

13.1.3 Test purpose

1. To verify that the MS carrier frequency error does not exceed 0,1 ppm:

   1.1 Under normal conditions.

   1.2 When the MS is being vibrated.

   1.3 Under extreme conditions.

   NOTE: The transmit frequency accuracy of the SS is expected to be sufficient to ensure that the difference between 0,1 ppm absolute and 0,1 ppm compared to signals received from the BS would be small enough to be considered insignificant.

2 To verify that the RMS phase error on the useful part of the bursts transmitted by the MS does not exceed conformance requirement 2:

2.1 Under normal conditions.

2.2 When the MS is being vibrated.

2.3 Under extreme conditions.

3 To verify that the maximum phase error on the useful part of the bursts transmitted by the MS does not exceed conformance requirement 3.

3.1 Under normal conditions.

3.2 When the MS is being vibrated.

3.3 Under extreme conditions.

13.1.4. Method of test

NOTE: In order to measure the accuracy of the frequency and phase error a sampled measurement of the transmitted phase trajectory is obtained. This is compared with the theoretically expected phase trajectory. The regression line of the difference between the expected trajectory and the measured trajectory is an indication of the frequency error (assumed constant through the burst), whilst the departure of the phase differences from this trajectory is a measure of the phase error. The peak phase error is the value furthest from the regression line and the RMS phase error is the root mean square average of the phase error of all samples.

13.1.4.1 Initial conditions

A call is set up according to the Generic call setup procedure.

The SS commands the MS to hopping mode (table 6.1).

NOTE: It is not necessary to test in hopping mode but is done here as a simple means of making the MS change channel, it would be sufficient to test in non hopping mode and to make sure bursts are taken from a few different channels.

The SS activates ciphering mode.

NOTE: Ciphering mode is active during this test to give a pseudo-random bit stream to the modulator.

The SS commands the MS to complete the traffic channel loop back without signalling of erased frames (see 36.2.1.1).

The SS generates Standard Test Signal C1 of annex 5.

13.1.4.2 Procedure

a) For one transmitted burst, the SS captures the signal as a series of phase samples over the period of the burst. These samples are evenly distributed over the duration of the burst with a minimum sampling rate of 2/T, where T is the modulation symbol period. The received phase trajectory is then represented by this array of at least 294 samples.

b) The SS then calculates, from the known bit pattern and the formal definition of the modulator contained in GSM 05.04, the expected phase trajectory.

c) From a) and b) the phase trajectory error is calculated, and a linear regression line computed through this phase trajectory error. The slope of this regression line is the frequency error of the mobile transmitter relative to the simulator reference. The difference between the regression line and the individual sample points is the phase error of that point.

c.1) The sampled array of at least 294 phase measurements is represented by the vector:

$\varnothing_m = \varnothing_m(0)...\varnothing_m(n)$

where the number of samples in the array n+1 >= 294.

c.2) The calculated array, at the corresponding sampling instants, is represented by the vector:

$\varnothing_c = \varnothing_c(0)...\varnothing_c(n)$.

c.3) The error array is represented by the vector:

$\varnothing_e = \{\varnothing_m(0) - \varnothing_c(0)\}.....\{\varnothing_m(n) - \varnothing_c(n)\} = \varnothing_e(0)...\varnothing_e(n)$.

c.4) The corresponding sample numbers form a vector t = t(0)...t(n).

c.5) By regression theory the slope of the samples with respect to t is k where:

$$k = \frac{\sum_{j=0}^{j=n} t(j) * \varnothing_e(j)}{\sum_{j=0}^{j=n} t(j)^2}$$

c.6) The frequency error is given by k/(360 * γ), where γ is the sampling interval in s and all phase samples are measured in degrees.

c.7) The individual phase errors from the regression line are given by:

$\varnothing_e(j)$ - k*t(j).

c.8) The RMS value $\varnothing_e$ of the phase errors is given by:

$$\varnothing_e(RMS) = \left[\frac{\sum_{j=0}^{j=n} \{\varnothing_e(j) - k * t(j)\}^2}{n+1} \right]^{1/2}$$

d) Steps a) to c) are repeated for 20 bursts, not necessarily contiguous.

e) The SS instructs the MS to its maximum power control level, all other conditions remaining constant. Steps a) to d) are repeated.

f) The SS instructs the MS to the minimum power control level, all other conditions remaining constant. Steps a) to d) are repeated.

g) The MS is hard mounted on a vibration table and vibrated at the frequency/amplitudes specified in annex 1, TC4.

During the vibration steps a) to f) are repeated.

NOTE: If the call is terminated when mounting the MS to the vibration table, it will be necessary to establish the initial conditions again before repeating steps a) to f).

h) The MS is re-positioned on the vibration table in the two orthogonal planes to the plane used in step g). For each of the orthogonal planes step g) is repeated.

i) Steps a) to f) are repeated under extreme test conditions (see annex 1, TC2.2).

NOTE: The series of samples taken to determine the phase trajectory could also be used, with different post-processing, to determine the transmitter burst characteristics of 13.3. Although described independently, it is valid to combine the tests of 13.1 and 13.3, giving both answers from single sets of captured data.

13.1.5 Test requirements

13.1.5.1 Frequency error

For all measured bursts, the frequency error, derived in step c.6), shall be less than 10E-7.

13.1.5.2 Phase error

For all measured bursts, the RMS phase error, derived in step c.8), shall not exceed 5 degrees.

For all measured bursts, each individual phase error, derived in step c.7), shall not exceed 20 degrees.

13.2 Frequency error under multipath and interference conditions

13.2.1 Definition and applicability

The frequency error under multipath and interference conditions is a measure of the ability of the MS to maintain frequency synchronization with the received signal under conditions of Doppler shift, multipath reception and interference.

The requirements and this test apply to all types of GSM 900 and DCS 1 800 MS.

13.2.2 Conformance requirement

1. The MS carrier frequency error for each burst shall be accurate to within 0,1 ppm, or 0,1 ppm compared to signals received from the BS for signal levels down to 3 dB below the reference sensitivity level.

   1.1 Under normal conditions; GSM 05.10, 6/6.1.

   1.2 Under extreme conditions; GSM 05.10, 6/6.1; GSM 05.05 annex D D.2.1, D.2.2.

2. The MS carrier frequency error for each burst shall be accurate to within 0,1 ppm, or 0,1 ppm compared to signals received from the BS for 3 dB less carrier to interference ratio than the reference interference ratios (GSM 05.10, 6/6.1).

13.2.3 Test purpose

1. To verify that the MS carrier frequency error at reference sensitivity, under conditions of multipath and Doppler shift does not exceed 0,1 ppm + the frequency error due to the Doppler shift of the received signal and the assessment error in the MS.

   1.1 Under normal conditions.

   1.2 Under extreme conditions.

   NOTE: Although the conformance requirement states that frequency synchronization should be maintained for input signals 3 dB below reference sensitivity. Due to the Radio Link Failure counter this test condition cannot be established. Hence all tests in this section are conducted at reference sensitivity level.

2. To verify that the MS carrier frequency error, under interference conditions and TUlow fading profile, does not exceed 0,1 ppm + the frequency error due to the Doppler shift of the received signal and the assessment error in the MS.

NOTE: The test adds the effect of Doppler shift to the requirements as the conformance requirement refers to signals input to the MS receiver whereas the frequency reference for measurement will not take account of the Doppler shift.

13.2.4 Method of test

This test uses the same measurement process as test 13.1 for the MS operating under various RF conditions.

NOTE: The BA list sent on the BCCH and the SACCH will indicate at least six surrounding cells with at least one near to each band edge. It is not necessary to generate any of these BCCH but if they are provided none will be within 5 channels of the ARFCN used for the serving BCCH or TCH.

13.2.4.1 Initial conditions

The MS is brought into the idle updated state on a serving cell with BCCH in the mid ARFCN range.

13.2.4.2 Procedure

a) The level of the serving cell BCCH is set to 10 dB above the reference sensitivity level( ) and the fading function set to RA. The SS waits 30 s for the MS to stabilize to these conditions. The SS is set up to capture the first burst transmitted by the MS during call establishment. A call is initiated by the SS on a channel in the mid ARFCN range as described for the generic call set up procedure but to a TCH at level 10 dB above the reference sensitivity level( ) and fading function set to RA.

b) The SS calculates the frequency accuracy of the captured burst as described in test 13.1.

c) The SS sets the serving cell BCCH and TCH to the reference sensitivity level( ) applicable to the type of MS, still with the fading function set to RA and then waits 30 s for the MS to stabilize to these conditions.

d) The SS shall capture subsequent bursts from the traffic channel in the manner described in test 13.1.

NOTE: Due to the very low signal level at the MS receiver input the MS receiver is liable to error. The "looped back" bits are therefore also liable to error, and hence the SS does not know the expected bit sequence. The SS will have to demodulate the received signal to derive (error free) the transmitter burst bit pattern. Using this bit pattern the SS can calculate the expected phase trajectory according to the definition within GSM 05.04.

e) The SS calculates the frequency accuracy of the captured burst as described in test 13.1.

f) Steps d) and e) are repeated for 5 traffic channel bursts spaced over a period of not less than 20 s.

g) The initial conditions are established again and steps a) to f) are repeated but with the fading function set to HT100.

h) The initial conditions are established again and steps a) to f) are repeated but with the fading function set to TU50.

i) The initial conditions are established again and steps a) and b) are repeated but with the following differences:

- the levels of the BCCH and TCH are set to 18 dB above reference sensitivity level( ).
- two further independent interfering signals are sent on the same nominal carrier frequency as the BCCH and TCH and at a level 10 dB below the level of the TCH and modulated with random data, including the midamble.
- the fading function for all channels is set to TUlow.

j) The SS waits 100 s for the MS to stabilize to these conditions.

k) Repeat steps d) to f), except that at step f) the measurement period must be extended to 200 s and the number of measurements increased to 20.

l) The initial conditions are established again and steps a) to k) are repeated for ARFCN in the Low ARFCN range.

m) The initial conditions are established again and steps a) to k) are repeated for ARFCN in the High ARFCN range.

n) Repeat step h) under extreme test conditions (see annex 1, TC2.2).

13.2.5 Test requirements

The frequency error, with reference to the SS carrier frequency as measured in repeats of step e), for each measured burst shall be less than the values shown in table 13-1.

Table 13-1: Requirements for frequency error under multipath, Doppler shift and interference conditions

GSM 900		DCS 1 800	
Propagation condition	**Permitted frequency error**	**Propagation condition**	**Permitted frequency error**
RA250	+/- 300 Hz	RA130	+/- 400 Hz
HT100	+/- 180 Hz	HT100	+/- 350 Hz
TU50	+/- 160 Hz	TU50	+/- 260 Hz
TU3	+/- 230 Hz	TU1,5	+/- 320 Hz

13.3 Transmitter output power and burst timing

13.3.1 Definition and applicability

The transmitter output power is the average value of the power delivered to an artificial antenna or radiated by the MS and its integral 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. The timings are referenced to the transition from bit 13 to bit 14 of the Training Sequence ("midamble") before differential decoding. The timing of the modulation is referenced to the timing of the received signal from the SS.

The requirements and this test apply to all types of GSM 900 and DCS 1 800 MS.

13.3.2 Conformance requirement

1. The MS maximum output power shall be as defined in GSM 05.05, 4.1.1, first table, according to its power class, with a tolerance of +/- 2 dB under normal conditions; GSM 05.05, 4.1.1, first table.

2. The MS maximum output power shall be as defined in GSM 05.05, 4.1.1, first table, according to its power class, with a tolerance of +/- 2,5 dB under extreme conditions; GSM 05.05, 4.1.1, first table; GSM 05.05 annex D D.2.1, D.2.2.

3. The power control levels shall have the nominal output power levels as defined in GSM 05.05, 4.1.1, second table (for GSM 900) or third table (for DCS 1 800), from the lowest power control level up to the maximum output power corresponding to the class of the MS (for tolerance on maximum output power see conformance requirements 1), with a tolerance of +/- 3, 4 or 5 dB under normal conditions; GSM 05.05, 4.1.1, second or third table.

4. The power control levels shall have the nominal output power levels as defined in GSM 05.05, 4.1.1, second table (for GSM 900) or third table (for DCS 1 800), from the lowest power control level up to the maximum output power corresponding to the class of the MS (for tolerance on maximum

output power see conformance requirements 2), with a tolerance of +/- 4, 5 or 6 dB under extreme conditions; GSM 05.05, 4.1.1, second or third table; GSM 05.05 annex D D.2.1, D.2.2.

5. The output power actually transmitted by the MS at consecutive power control levels shall form a monotonic sequence and the interval between power control levels shall be 2 +/- 1,5 dB; GSM 05.05, 4.1.1.

6. The transmitted power level relative to time for a normal burst shall be within the power/time template given in GSM 05.05, annex B top figure:
   6.1 Under normal conditions; GSM 05.05, 4.5.2..
   6.2 Under extreme conditions; GSM 05.05, 4.5.2, GSM 05.05 annex D D.2.1, D.2.2.

7. When accessing a cell on the RACH and before receiving the first power command during a communication on a DCCH or TCH (after an IMMEDIATE ASSIGNMENT), all GSM and class and class 2 DCS 1 800 MS shall use the power control level defined by the MS_TXPWR_MAX_CCH parameter broadcast on the BCCH of the cell, or if MS_TXPWR_MAX_CCH corresponds to a power control level not supported by the MS as defined by its power class, the MS shall act as though the closest supported power control level had been broadcast. A Class 3 DCS 1 800 MS shall use the POWER_OFFSET parameter.

8. The transmissions from the MS to the BS, measured at the MS antenna, shall be 468,75 - TA bit periods behind the transmissions received from the BS, where TA is the last timing advance received from the current serving BS. The tolerance on these timings shall be +/- 1 bit period:

   8.1 Under normal conditions; GSM 05.10, 6.4.

   8.2 Under extreme conditions; GSM 05.10, 6.4, GSM 05.05 annex D D.2.1, D.2.2.

9. The transmitted power level relative to time for a random access burst shall be within the power/time template given in GSM 05.05, annex B bottom figure:

   9.1 Under normal conditions; GSM 05.05, 4.5.2.

   9.2 Under extreme conditions; GSM 05.05, 4.5.2, GSM 05.05 annex D D.2.1, D.2.2.

10 The MS shall use a TA value of 0 for the Random Access burst sent:

   10.1 Under normal conditions; GSM 05.10, 6.6.

   10.2 Under extreme conditions; GSM 05.10, 6.6, GSM 05.05 annex D D.2.1, D.2.2.

13.3.3 Test purpose

1. To verify that the maximum output power of the MS, under normal conditions, is within conformance requirement 1.

2. To verify that the maximum output power of the MS, under extreme conditions, is within conformance requirement 2.

3. To verify that all power control levels, relevant to the class of MS, are implemented in the MS and have output power levels, under normal conditions, within conformance requirement 3.

4. To verify that all power control levels have output power levels, under extreme conditions, within conformance requirement 4.

5. To verify that the step in the output power transmitted by the MS at consecutive power control levels is within conformance requirement 5 under normal conditions.

6. To verify that the output power relative to time, when sending a normal burst is within conformance requirement 6:

   6.1 Under normal conditions.

6.2 Under extreme conditions.

7. To verify that the MS uses the maximum power control level according to its power class if commanded to a power control level exceeding its power class.

8. To verify that, for normal bursts, the MS transmissions to the BS are timed within conformance requirement 8:

   8.1 Under normal conditions.

   8.2 Under extreme conditions.

9. To verify that the output power relative to time, when sending an access burst is within conformance requirement 9:

   9.1 Under normal conditions.

   9.2 Under extreme conditions.

10. To verify that, for an access burst, the MS transmission to the BS is timed within conformance requirement 10:

    10.1 Under normal conditions.

    10.2 Under extreme conditions.

13.3.4 Methods of test

Two methods of test are described, separately for:

1) equipment fitted with a permanent antenna connector and for

2) equipment fitted with an integral antenna, and which cannot be connected to an external antenna except by the fitting of a temporary test connector as a test fixture.

   NOTE: The behaviour of the MS in the system is determined to a high degree by the antenna, and this is the only transmitter test in this ETS using the integral antenna. Further studies are ongoing on improved testing on the integral antenna, taking practical conditions of MS use into account.

13.3.4.1 Method of test for equipment with a permanent antenna connector

13.3.4.1.1 Initial conditions

A call is set up by the SS according to the generic call set up procedure on a channel with ARFCN in the Mid ARFCN range, power control level set to Max power. MS TXPWR_MAX_CCH is set to the maximum value supported by the Power Class of the Mobile under test. For DCS 1 800 mobile stations the POWER_OFFSET parameter is set to 6 dB.

13.3.4.1.2 Procedure

a) Measurement of normal burst transmitter output power

   The SS takes power measurement samples evenly distributed over the duration of one burst with a sampling rate of at least 2/T, where T is the bit duration. The samples are identified in time with respect to the modulation on the burst. The SS identifies the centre of the useful 147 transmitted bits, i.e. the transition from bit 13 to bit 14 of the midamble, as the timing reference.

   The transmitter output power is calculated as the average of the samples over the 147 useful bits. This is also used as the 0 dB reference for the power/time template.

b) Measurement of normal burst timing delay

The burst timing delay is the difference in time between the timing reference identified in a) and the corresponding transition in the burst received by the MS immediately prior to the MS transmit burst sampled.

c) Measurement of normal burst power/time relationship

The array of power samples measured in a) are referenced in time to the centre of the useful transmitted bits and in power to the 0 dB reference, both identified in a).

d) Steps a) to c) are repeated with the MS commanded to operate on each of the power control levels defined, even those not supported by the MS.

e) The SS commands the MS to the maximum power control level supported by the MS and steps a) to c) are repeated for ARFCN in the Low and High ranges.

f) Measurement of access burst transmitter output power

The SS causes the MS to generate an Access Burst on an ARFCN in the Mid ARFCN range, this could be either by a handover procedure or a new request for radio resource. In the case of a handover procedure the Power Level indicated in the HANDOVER COMMAND message is the maximum power control level supported by the MS. In the case of an Access Burst the MS shall use the Power Level indicated in the MS_TXPWR_MAX_CCH parameter. If the power class of the MS is DCS 1 800 Class 3, the MS shall also use the POWER_OFFSET parameter.

The SS takes power measurement samples evenly distributed over the duration of the access burst as described in a). However, in this case the SS identifies the centre of the useful bits of the burst by identifying the transition from the last bit of the synch sequence. The centre of the burst is then five data bits prior to this point and is used as the timing reference.

The transmitter output power is calculated as the average of the samples over the 87 useful bits of the burst. This is also used as the 0 dB reference for the power/time template.

g) Measurement of access burst timing delay

The burst timing delay is the difference in time between the timing reference identified in f) and the MS received data on the common control channel.

h) Measurement of access burst power/time relationship

The array of power samples measured in f) are referenced in time to the centre of the useful transmitted bits and in power to the 0 dB reference, both identified in f).

i) Depending on the method used in step f) to cause the MS to send an Access Burst, the SS sends either a HANDOVER COMMAND with power control level set to 10 or it changes the System Information elements MS_TXPWR_MAX_CCH and for DCS 1 800 the POWER_OFFSET on the serving cell BCCH in order to limit the MS transmit power on the Access Burst to power control level 10 (+23 dBm for GSM 900 or +10 dBm for DCS 1 800) and then steps f) to h) are repeated.

j) Steps a) to i) are repeated under extreme test conditions (annex 1, TC2.2) except that the repeats at step d) are only performed for power control level 10 and the minimum power control level of the MS.

13.3.4.2 Method of test for equipment with an integral antenna

NOTE: If the MS is equipped with a permanent connector, such that the antenna can be disconnected and the SS be connected directly, then the method of section 13.3.4.1 will be applied.

The tests in this section are performed on an unmodified test sample.

13.3.4.2.1 Initial conditions

The MS is placed in the anechoic shielded chamber (annex 1, GC5) or on the outdoor test site, on an isolated support, in the position for normal use, at a distance of at least 3 metres from a test antenna, connected to the SS.

NOTE: The test method described has been written for measurement in an anechoic shielded chamber. If an outdoor test site is used then, in addition, it is necessary to raise/lower the test antenna through the specified height range to maximize the received power levels from both the test sample and the substitution antenna.

A call is set up by the SS according to the generic call set up procedure on a channel with ARFCN in the Mid ARFCN range, power control level set to Max power. MS_TXPWR_MAX_CCH is set to the maximum value supported by the Power Class of the Mobile under test. For DCS 1 800 mobile stations the POWER_OFFSET parameter is set to 6 dB.

13.3.4.2.2 Procedure

a) With the initial conditions set according to subclause 13.3.4.2.1 the test procedure in 13.3.4.1.2 is followed up to and including step i), except that in step a), when measurements are done at maximum power for ARFCN in the Low, Mid and High range, the measurement is made eight times with the MS rotated by n*45 degrees for all values of n in the range 0 to 7.

   The measurements taken are received transmitter output power measurements rather than transmitter output power measurements, the output power measurement values can be derived as follows.

b) Assessment of test site loss for scaling of received output power measurements.

   The MS is replaced by a half-wave dipole, resonating at the centre frequency of the transmit band, connected to an RF generator.

   The frequency of the RF signal generator is set to the frequency of the ARFCN used for the 24 measurements in step a), the output power is adjusted to reproduce the received transmitter output power averages recorded in step a).

   For each indication the power, delivered by the generator (in Watts) to the half-wave dipole, is recorded. These values are recorded in the form Pnc, where n = MS rotation and c = channel number.

   For each channel number used compute:

$$\text{Pac(Watts into dipole)} = \frac{1}{8} * \sum_{n=0}^{n=7} \text{Pnc}$$

   from which: Pac (Tx dBm) = $10\log_{10}$(Pac) + 30 + 2,15

   The difference, for each of the three channels, between the actual transmitter output power averaged over the 8 measurement orientations and the received transmitter output power at orientation n = 0 is used to scale the received measurement results to actual transmitter output powers for all measured power control levels and ARFCN, which can then be checked against the requirements.

c) Temporary antenna connector calibration factors (transmit)

   A modified test sample equipped with a temporary antenna connector is placed in a climatic test chamber and is linked to the SS by means of the temporary antenna connector.

   Under normal test conditions, the power measurement and calculation parts of steps a) to i) of 13.3.4.1.2 are repeated except that the repeats at step d) are only performed for power control level 10 and the minimum power control level of the MS.

NOTE: The values noted here are related to the output transmitter carrier power levels under normal test conditions, which are known after step b). Therefore frequency dependent calibration factors that account for the effects of the temporary antenna connector can be determined.

d) Measurements at extreme test conditions.

NOTE: Basically the procedure for extreme conditions is:

- the power/time template is tested in the "normal" way,

- the radiated power is measured by measuring the difference with respect to the radiated power under normal test conditions.

Under extreme test conditions steps a) to i) of 13.3.4.1.2 are repeated except that the repeats at step d) are only performed for power control level 10 and the minimum power control level of the MS.

The transmitter output power under extreme test conditions is calculated for each burst type, power control level and for every frequency used by adding the frequency dependent calibration factor, determined in c), to the values obtained at extreme conditions in this step.

13.3.5 Test requirements

a) The transmitter output power, under every combination of normal and extreme test conditions, for normal bursts and access bursts, at each frequency and for each power control level applicable to the MS power class, shall be at the relevant level shown in table 13-2 or table 13-3 within the tolerances also shown in table 13-2 or table 13-3.

GSM 900 only - begin

Table 13-2: GSM 900 transmitter output power for different power classes

Power class				Power control level	Transmitter output power	Tolerances	
2	3	4	5		dBm	normal	extreme
•				2	39	+/-2 dB	+/-2,5 dB
•	•			3	37	+/-3 dB*)	+/-4 dB*)
•	•			4	35	+/-3 dB	+/-4 dB
•	•	•		5	33	+/-3 dB*)	+/-4 dB*)
•	•	•		6	31	+/-3 dB	+/-4 dB
•	•	•	•	7	29	+/-3 dB*)	+/-4 dB*)
•	•	•	•	8	27	+/-3 dB	+/-4 dB
•	•	•	•	9	25	+/-3 dB	+/-4 dB
•	•	•	•	10	23	+/-3 dB	+/-4 dB
•	•	•	•	11	21	+/-3 dB	+/-4 dB
•	•	•	•	12	19	+/-3 dB	+/-4 dB
•	•	•	•	13	17	+/-3 dB	+/-4 dB
•	•	•	•	14	15	+/-3 dB	+/-4 dB
•	•	•	•	15	13	+/-3 dB	+/-4 dB
•	•	•	•	16	11	+/-5 dB	+/-6 dB
•	•	•	•	17	9	+/-5 dB	+/-6 dB
•	•	•	•	18	7	+/-5 dB	+/-6 dB
•	•	•	•	19	5	+/-5 dB	+/-6 dB

*) When the power control level corresponds to the power class of the MS, then the tolerances shall be 2,0 dB under normal test conditions and 2,5 dB under extreme test conditions.

GSM 900 only - end

DCS 1 800 only - begin

Table 13-3: DCS 1 800 transmitter output power for different power classes

Power class			Power control level	Transmitter output power	Tolerances	
1	2	3		dBm	normal	extreme
		•	29	36	+/-2,0 dB	+/-2,5 dB
		•	30	34	+/-3,0 dB	+/-4,0 dB
		•	31	32	+/-3,0 dB	+/-4,0 dB
•		•	0	30	+/-3,0 dB*)	+/-4 dB*)
•		•	1	28	+/-3 dB	+/-4 dB
•		•	2	26	+/-3 dB	+/-4 dB
•	•	•	3	24	+/-3 dB*)	+/-4 dB*)
•	•	•	4	22	+/-3 dB	+/-4 dB
•	•	•	5	20	+/-3 dB	+/-4 dB
•	•	•	6	18	+/-3 dB	+/-4 dB
•	•	•	7	16	+/-3 dB	+/-4 dB
•	•	•	8	14	+/-3 dB	+/-4 dB
•	•	•	9	12	+/-4 dB	+/-5 dB
•	•	•	10	10	+/-4 dB	+/-5 dB
•	•	•	11	8	+/-4 dB	+/-5 dB
•	•	•	12	6	+/-4 dB	+/-5 dB
•	•	•	13	4	+/-4 dB	+/-5 dB
•	•	•	14	2	+/-5 dB	+/-6 dB
•	•	•	15	0	+/-5 dB	+/-6 dB

*) When the power control level corresponds to the power class of the MS, then the tolerances shall be 2,0 dB under normal test conditions and 2,5 dB under extreme test conditions.

DCS 1 800 only - end

b) The difference between the transmitter output power at two adjacent power control levels, measured at the same frequency, shall not be less than 0,5 dB and not be more than 3,5 dB.

c) The power/time relationship of the measured samples for normal bursts shall be within the limits of the power time template of figure 13-1 at each frequency, under every combination of normal and extreme test conditions and at each power control level measured.

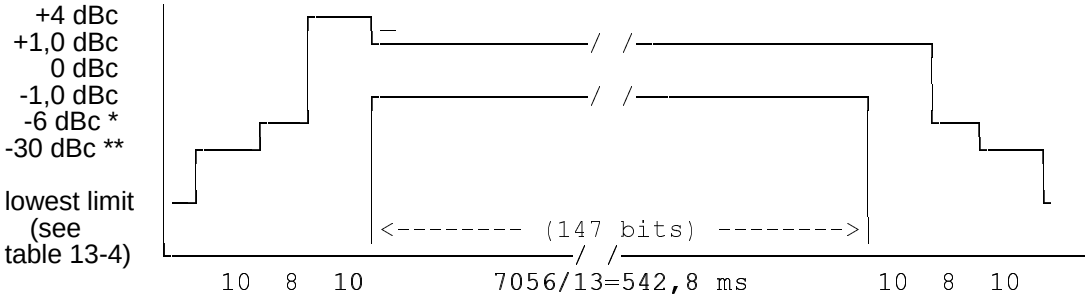

Figure 13-1: Power / time template for normal bursts

* For GSM900 MS: -4 dBc for power control level 16
-2 dBc for power control level 17
-1 dBc for power control levels 18 and 19
For DCS1800 MS: -4 dBc for power control level 11
-2 dBc for power control level 12
-1 dBc for power control levels 13, 14 and 15

** For GSM900 MS: -30 dBc or -17 dBm, whichever is the higher
For DCS1800 MS: -30 dBc or -20 dBm, whichever is the higher

Table 13-4: Lowest measurement limit for power / time template

	lowest limit
GSM900	-59 dBc or -54 dBm whichever is the highest, except for the timeslot preceding the active slot, for which the allowed level is equal to -59 dBc or -36 dBm, whichever is the highest
DCS1800	-48 dBc or -48 dBm whichever is the highest

d) All the power control levels, for the type and power class of the MS as stated by the manufacturer, shall be implemented in the MS.

e) When the transmitter is commanded to a power control level outside of the capability corresponding to the type and power class of the MS as stated by the manufacturer, then the transmitter output power shall be within the tolerances for the closest power control level corresponding to the type and power class as stated by the manufacturer.

f) The centre of the transmitted normal burst as defined by the transition of bits 13/14 of the midamble shall be 3 timeslot periods (1731 μs) +/- 1 bit period (+/- 3,69 μs) after the centre of the corresponding received burst.

g) The power/time relationship of the measured samples for access bursts shall be within the limits of the power time template of figure 13-2 at each frequency, under every combination of normal and extreme test conditions and at each power control level measured.

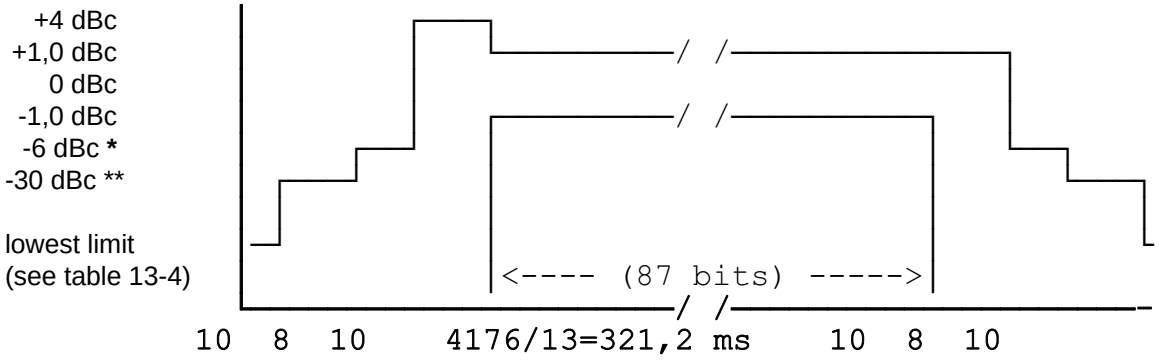

Figure 13-2: Power / time template for access burst

* For GSM900 MS: -4 dBc for power control level 16
-2 dBc for power control level 17
-1 dBc for power control levels 18 and 19
For DCS1800 MS: -4 dBc for power control level 11
-2 dBc for power control level 12
-1 dBc for power control levels 13, 14 and 15
** For GSM900 MS: -30 dBc or -17 dBm, whichever is the higher
For DCS1800 MS: -30 dBc or -20 dBm, whichever is the higher

h) The centre of the transmitted access burst shall be an integer number of timeslot periods less 30 bit periods relative to any CCCH midamble centre with a tolerance of +/- 1 bit period (+/- 3,69 μs).

13.4 Output RF spectrum

13.4.1 Definition and applicability

The output RF spectrum is the relationship between the frequency offset from the carrier and the power, measured in a specified bandwidth and time, produced by the MS due to the effects of modulation and power ramping.

The requirements and this test apply to all types of GSM 900 and DCS 1 800 MS.

13.4.2 Conformance requirement

1. The level of the output RF spectrum due to modulation shall be no more than that given in GSM 05.05, 4.2.1, table a) for GSM 900 or table b) for DCS 1 800, with the following lowest measurement limits:

   - -36 dBm below 600 kHz offset from the carrier,
   - -51 dBm for GSM 900 or -56 dBm for DCS 1 800 from 600 kHz out to less than 1 800 kHz offset from the carrier,
   - -46 dBm for GSM 900 or -51 dBm for DCS 1 800 at and beyond 1 800 kHz offset from the carrier,

   but with the following exceptions at up to -36 dBm:

   - up to three bands of 200 kHz width centred on a frequency which is an integer multiple of 200 kHz in the combined range 600 kHz to 6000 kHz above and below the carrier,
   - up to 12 bands of 200 kHz width centred on a frequency which is an integer multiple of 200 kHz at more than 6 000 kHz offset from the carrier.

   1.1 Under normal conditions; GSM 05.05, 4.2.1.

   1.2 Under extreme conditions; GSM 05.05, 4.2.1; GSM 05.05, annex D D.2.1, D.2.2.

2. The level of the output RF spectrum due to switching transients shall be no more than given in GSM 05.05, 4.2.2, table "a) Mobile Station:".

   2.1 Under normal conditions; GSM 05.05, 4.2.2.

   2.2 Under extreme conditions; GSM 05.05, 4.2.2; GSM 05.05 annex D D.2.1, D.2.2.

3. When allocated a channel, the power emitted by the MS, in the band 935 to 960 MHz shall be no more than -79 dBm, in the band 925 to 935 MHz shall be no more than -67 dBm and in the band 1 805 to 1 880 MHz shall be no more than -71 dBm except in five measurements in each of the bands 925 to 960 MHz and 1 805 to 1 880 MHz where exceptions at up to -36 dBm are permitted. Under normal conditions; GSM 05.05, 4.3.3.

13.4.3 Test purpose

1. To verify that the output RF spectrum due to modulation does not exceed conformance requirement 1.

   1.1 Under normal conditions.

   1.2 Under extreme conditions.

2. To verify that the output RF spectrum due to switching transients does not exceed conformance requirement 2 when a reasonable margin is allowed for the effect of spectrum due to modulation.

   2.1 Under normal conditions.

   2.2 Under extreme conditions.

3. To verify that the MS spurious emissions in the MS receive band do not exceed conformance requirement 3.

13.4.4 Method of test

13.4.4.1 Initial conditions

A call is set up according to the generic call set up procedure.

The SS commands the MS to hopping mode. The hopping pattern includes only three channels, namely one with an ARFCN in the Low ARFCN range, a second one with an ARFCN in the Mid ARFCN range and the third one with an ARFCN in the High ARFCN range.

NOTE 1: Although the measurement is made whilst the MS is in hopping mode, each measurement is on one single channel.

NOTE 2: This test is specified in hopping mode as a simple means of making the MS change channel, it would be sufficient to test in non hopping mode and to handover the MS between the three channels tested at the appropriate time.

The SS commands the MS to complete the traffic channel loop back without signalling of erased frames (see 36.2.1.1). This is to set a defined random pattern for the transmitter.

The SS sends Standard Test Signal C1 (annex 5) to the MS at a level of 23 dBµVemf( ).

13.4.4.2 Procedure

NOTE: When averaging is in use during frequency hopping mode, the averaging only includes bursts transmitted when the hopping carrier corresponds to the nominal carrier of the measurement.

a) In steps b) to h) the FT is equal to the hop pattern ARFCN in the Mid ARFCN range.

b) The other settings of the spectrum analyser are set as follows:

- Zero frequency scan
- Resolution bandwidth: 30 kHz
- Video bandwidth: 30 kHz
- Video averaging: may be used, depending on the implementation of the test

The video signal of the spectrum analyser is "gated" such that the spectrum generated by at least 40 of the bits 87 to 132 of the burst is the only spectrum measured. This gating may be analogue or numerical, dependent upon the design of the spectrum analyser. Only measurements during transmitted bursts on the nominal carrier of the measurement are included. The spectrum analyser averages over the gated period and over 200 or 50 such bursts, using numerical and/or video averaging.

The MS is commanded to its maximum power control level.

c) By tuning the spectrum analyser centre frequency to the measurement frequencies the power level is measured over 50 bursts at all multiples of 30 kHz offset from FT to < 1 800 kHz.

d) The resolution and video bandwidth on the spectrum analyser are adjusted to 100 kHz and the measurements are made at the following frequencies:

on every ARFCN from 1 800 kHz offset from the carrier to the edge of the relevant transmit band for each measurement over 50 bursts.

at 200 kHz intervals over the 2 MHz either side of the relevant transmit band for each measurement over 50 bursts.

at 200 kHz intervals over the band 925 - 960 MHz for each measurement over 50 bursts.

at 200 kHz intervals over the band 1805 - 1880 MHz for each measurement over 50 bursts.

e) The MS is commanded to its minimum power control level. The spectrum analyser is set again as in b).

f) By tuning the spectrum analyser centre frequency to the measurement frequencies the power level is measured over 200 bursts at the following frequencies:

FT	
FT + 100 kHz	FT - 100 kHz
FT + 200 kHz	FT - 200 kHz
FT + 250 kHz	FT - 250 kHz
FT + 200 kHz * N	FT - 200 kHz * N

where N = 2, 3, 4, 5, 6, 7, and 8
and FT = RF channel nominal centre frequency.

g) The spectrum analyser settings are adjusted to:

- Zero frequency scan
- Resolution bandwidth: 30 kHz
- Video bandwidth: 100 kHz
- Peak hold

The spectrum analyser gating of the signal is switched off.

The MS is commanded to its maximum power control level.

h) By tuning the spectrum analyser centre frequency to the measurement frequencies the power level is measured at the following frequencies:

FT + 400 kHz	FT - 400 kHz
FT + 600 kHz	FT - 600 kHz
FT + 1,2 MHz	FT - 1,2 MHz
FT + 1,8 MHz	FT - 1,8 MHz

where FT = RF channel nominal centre frequency.

The duration of each measurement (at each frequency) will be such as to cover at least 10 burst transmissions at FT.

i) Step h) is repeated for power control levels 7 and 11.

j) Steps b), f), g) and h) are repeated with FT equal to the hop pattern ARFCN in the Low ARFCN range except that in step g) the MS is commanded to power control level 11 rather than maximum power.

k) Steps b), f), g) and h) are repeated with FT equal to the hop pattern ARFCN in the High ARFCN range except that in step g) the MS is commanded to power control level 11 rather than maximum power.

l) Steps a) b) f) g) and h) are repeated under extreme test conditions (annex 1, TC2.2). except that at step g) the MS is commanded to power control level 11.

13.4.5 Test requirements

For absolute measurements, performed on a temporary antenna connector, in the frequency band 880 to 915 MHz or 1710 to 1785 MHz, the temporary antenna connector coupling factor, determined according to 13.3.4.2.2 and annex 1 GC7, for the nearest relevant frequency, will be used.

For absolute measurements, performed on a temporary antenna connector, in the frequency band 925 to 960 MHz, the temporary antenna connector coupling factor, will be as determined according to annex 1 GC7 for GSM 900 MS. For a DCS 1 800 MS 0 dB will be assumed.

For absolute measurements, performed on a temporary antenna connector, in the frequency band 1805 to 1880 MHz, the temporary antenna connector coupling factor, will be as determined according to annex 1 GC7 for DCS 1 800 MS. For GSM 900 MS 0 dB will be assumed.

The figures in the tables below, at the listed frequencies from the carrier (kHz), are the maximum level (dB) relative to a measurement in 30 kHz bandwidth on the carrier (reference GSM 05.05 section 4.2.1).

a) For the modulation sidebands out to less than 1 800 kHz offset from the carrier frequency (FT) measured in step c), f), h), j), k) and l) the measured power level in dB relative to the power level measured at FT, for all types of MS, shall not exceed the limits derived from the values shown in table 13-5 for GSM 900 or table 13-6 for DCS 1 800 according to the actual transmit power and frequency offset from FT. However any failures in the combined range 600 kHz to less than 1 800 kHz above and below the carrier may be counted towards the exceptions allowed in test requirements c) below.

Table 13-5a: GSM 900 Spectrum due to modulation out to less than 1 800 kHz offset

	power levels in dB relative to the measurement at FT				
Power level	**Frequency offset (kHz)**				
(dBm)	**0-100**	**200**	**250**	**400**	**600 to <1800**
39	+0,5	-30	-33	-60	-66
37	+0,5	-30	-33	-60	-64
35	+0,5	-30	-33	-60	-62
<= 33	+0,5	-30	-33	-60	-60
The values above are subject to the minimum absolute levels (dBm) below.					
	-36	-36	-36	-36	-51

Table 13-6: DCS 1 800 Spectrum due to modulation out to less than 1 800 kHz offset

	power levels in dB relative to the measurement at FT				
Power level	**Frequency offset (kHz)**				
(dBm)	**0-100**	**200**	**250**	**400**	**600 to <1800**
<= 36	+0,5	-30	-33	-60	-60
The values above are subject to the minimum absolute levels (dBm) below.					
	-36	-36	-36	-36	-56

NOTE 1: For frequency offsets between 100 kHz and 600 kHz the requirement is derived by a linear interpolation between the points identified in the table with linear frequency and power in dB relative.

b) For the modulation sidebands from 1 800 kHz offset from the carrier frequency (FT) and out to 2 MHz beyond the edge of the relevant transmit band, measured in step d), the measured power level in dB relative to the power level measured at FT, shall not exceed the values shown in table 13-7 according to the actual transmit power, frequency offset from FT and system on which the MS is designed to operate. However any failures in the combined range 1 800 kHz to 6 MHz above and below the carrier may be counted towards the exceptions allowed in test requirements c) below, and any other failures may be counted towards the exceptions allowed in test requirements d) below.

Table 13-7: Spectrum due to modulation from 1 800 kHz offset to the edge of the transmit band (wideband noise)

power levels in dB relative to the measurement at FT						
GSM900				DCS1800		
Power level (dBm)	Frequency offset kHz			Power level (dBm)	Frequency offset kHz	
	1800 to < 3000	3000 to < 6000	>= 6000		1800 to < 6000	>= 6000
39	-69	-71	-77	36	-71	-79
37	-67	-69	-75	34	-69	-77
35	-65	-67	-73	32	-67	-75
<= 33	-63	-65	-71	30	-65	-73
				28	-63	-71
				26	-61	-69
				<= 24	-59	-67
The values above are subject to the minimum absolute levels (dBm) below.						
	-46	-46	-46		-51	-51

c) Any failures (from a) and b) above) in the combined range 600 kHz to 6 MHz above and below the carrier should be re-checked for allowed spurious emissions. For each of the three ARFCN used, spurious emissions are allowed in up to three 200 kHz bands centred on an integer multiple of 200 kHz so long as no spurious emission exceeds -36 dBm. Any spurious emissions measured in a 30 kHz bandwidth which spans two 200 kHz bands can be counted towards either 200 kHz band, whichever minimizes the number of 200 kHz bands containing spurious exceptions.

d) Any failures (from b) above) beyond 6 MHz offset from the carrier should be re-checked for allowed spurious emissions. For each of the three ARFCN used, up to twelve spurious emissions are allowed so long as no spurious emission exceeds -36 dBm.

e) The MS spurious emissions in the bands 925 - 935 MHz, 935 - 960 MHz and 1 805 - 1 880 MHz, measured in step d), for all types of MS, shall not exceed the values shown in table 13-8 except in up to five measurements in the band 925 to 960 MHz and five measurements in the band 1 805 to 1 880 MHz where a level up to -36 dBm is permitted.

Table 13-8: Spurious emissions in the MS receive bands

Band (MHz)	Spurious emissions level (dBm)
925 to 935	-67
935 to 960	-79
1805 to 1880	-71

f) For the power ramp sidebands of steps h) and i) the power levels must not exceed the values shown in table 13-9 for GSM 900 or table 13-10 for DCS 1 800.

Table 13-9: GSM Spectrum due to switching transients

Power level	Maximum level for various offsets from carrier frequency			
	400 kHz	600 kHz	1200 kHz	1800 kHz
39 dBm	-13 dBm	-21 dBm	-21 dBm	-24 dBm
37 dBm	-15 dBm	-21 dBm	-21 dBm	-24 dBm
35 dBm	-17 dBm	-21 dBm	-21 dBm	-24 dBm
33 dBm	-19 dBm	-21 dBm	-21 dBm	-24 dBm
31 dBm	-21 dBm	-23 dBm	-23 dBm	-26 dBm
29 dBm	-23 dBm	-25 dBm	-25 dBm	-28 dBm
27 dBm	-23 dBm	-26 dBm	-27 dBm	-30 dBm
25 dBm	-23 dBm	-26 dBm	-29 dBm	-32 dBm
23 dBm	-23 dBm	-26 dBm	-31 dBm	-34 dBm
<= +21 dBm	-23 dBm	-26 dBm	-32 dBm	-36 dBm

Table 13-10: DCS 1 800 Spectrum due to switching transients

Power level	Maximum level for various offsets from carrier frequency			
	400 kHz	600 kHz	1200 kHz	1800 kHz
36 dBm	-16 dBm	-21 dBm	-21 dBm	-24 dBm
34 dBm	-18 dBm	-21 dBm	-21 dBm	-24 dBm
32 dBm	-20 dBm	-22 dBm	-22 dBm	-25 dBm
30 dBm	-22 dBm	-24 dBm	-24 dBm	-27 dBm
28 dBm	-23 dBm	-25 dBm	-26 dBm	-29 dBm
26 dBm	-23 dBm	-26 dBm	-28 dBm	-31 dBm
24 dBm	-23 dBm	-26 dBm	-30 dBm	-33 dBm
22 dBm	-23 dBm	-26 dBm	-31 dBm	-35 dBm
<= +20 dBm	-23 dBm	-26 dBm	-32 dBm	-36 dBm

NOTE 2: These figures are different from the requirements in GSM 05.05 because at higher power levels it is the modulation spectrum which is being measured using a peak hold measurement. This allowance is given in the table.

NOTE 3: The figures for table 13-9 and table 13-10 assume that, using the peak hold measurement, the lowest level measurable is 8 dB above the level of the modulation specification using the 30 kHz bandwidth gated average technique for 400 kHz offset from the carrier. At 600 and 1200 kHz offset the level is 6 dB above and at 1 800 kHz offset the level is 3 dB above. The figures for 1 800 kHz have assumed the 30 kHz bandwidth spectrum due to modulation specification at <1 800 kHz.

13.5 Intermodulation attenuation

13.5.1 Definition and applicability

The intermodulation attenuation is the ratio, in dB, of the power level of the wanted signal to the power level of the highest intermodulation component.

The requirements and this test apply to all types of DCS 1 800 MS.

13.5.2 Conformance requirement

The maximum level of any intermodulation product shall be no less than 50 dB below the level of the wanted signal when an interfering CW signal is applied, within the transmit band, at a frequency offset of 800 kHz and with a power level 40 dB below the power level of the wanted signal; GSM 05.05, 4.7.3.

13.5.3 Test purpose

To verify that the MS intermodulation attenuation is no less than conformance requirement 1.

13.5.4 Method of test

NOTE 1: When the measurements are performed precautions must be taken, so that non-linearities in the selective measuring device do not influence the results appreciably. Furthermore it should be ensured that intermodulation components which may be generated by non-linear elements in the test equipment (e.g. signal generator, circulators, selective measuring device) are sufficiently reduced. The RF transmit equipment under test and the test signal source should be physically separated in such a way that the measurement is not influenced by direct radiation.

NOTE 2: In the case of an MS which does not normally include an antenna connector, the coupling loss of the temporary antenna connector must be taken into account.

13.5.4.1 Initial conditions

The antenna output of the MS is connected to the SS via a coupling device, presenting to the MS a load with an impedance of 50 ohms. The coupling device may consist of a circulator with one port connected

by a coaxial cable to the output terminal of the MS, the second port correctly terminated with 50 ohms into a selective measuring device (e.g. a spectrum analyser) and the third port connected to the interfering test signal source via an isolator.

A call is set up by the SS according to the generic call set up procedure on a channel with ARFCN in the Mid ARFCN range, power control level set to Max power.

13.5.4.2 Procedure

a) The interfering test signal will be unmodulated and the frequency will be 800 kHz above the transmit frequency of the MS under test. the power level is adjusted to give the equivalent of 40 dB below the transmit power level of the MS, if both the MS transmit power and the interfering test signal were measured with a correct termination but with the other signal absent.

b) The frequency selective measuring device is set to measure peak hold in a bandwidth of 300 kHz. Any intermodulation components in the MS transmit band, are then measured.

c) Steps a) and b) are repeated with the test signal at a frequency 800 kHz below the transmitted frequency.

13.5.5 Test requirements

The level of each intermodulation component, in the MS transmit band, shall be no less than 50 dB below the level of the transmit power of the wanted MS carrier.