Core System Package
Part A

Radio Specification

Test Suite Structure (TSS) and Test Purposes (TP) Specification 1.2

This document is a compilation of test cases for certification testing of the Bluetooth RF layer.

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CONTENTS

1 SCOPE

This Bluetooth document contains the Test Suite Structure (TSS) and Test Purposes (TP) to test the Bluetooth RF layer.

The objective of this test specification is to provide a basis for conformance tests for Bluetooth devices giving a high probability of air interface inter-operability between different manufacturer's Bluetooth devices.

2 NORMATIVE REFERENCES

This Bluetooth document incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Bluetooth document only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1]	Specification of the Bluetooth System, Core System Package, Volume 2, Part A
[2]	Specification of the Bluetooth System, Core System Package, Volume 3, Part D
[3]	ETS 300 328: "Radio Equipment and Systems (RES); Wideband transmission systems; Technical characteristics and test conditions for data transmission equipment operating in the 2,4 GHz ISM band and using spread spectrum modulation techniques"
[4]	FCC Part 15: CFR 47, Part 15 "Radio Frequency Device", Sections 15.205, 15.209, 15.247
[5]	PICS Proforma for Radio (RF)

3 DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

For the purpose of this Bluetooth document, the definitions given in Specification of the Bluetooth System, Volume 2, Part A apply. In addition, the following definitions apply:

Additional definitions in this test specification are given in the “Annex” on page 73[vol. 1].

3.2 ABBREVIATIONS

For the purpose of this Bluetooth document, the following abbreviations apply:

BT	Bluetooth
BER	Bit Error Ratio
EUT	Equipment Under Test
RF	Radio Frequency
ETSI	European Telecommunications Standards Institute
TC	Test Case
LMP	Link Manager Protocol
ISM	Industrial, Scientific and Medical
EIRP	Equivalent Isotropically Radiated Power
ICS	Implementation Conformance Statement
IXIT	Implementation Extra Information for Testing

4 TEST SUITE STRUCTURE

4.1 OVERVIEW

The Bluetooth RF is layer 1 of the Bluetooth protocol stack.

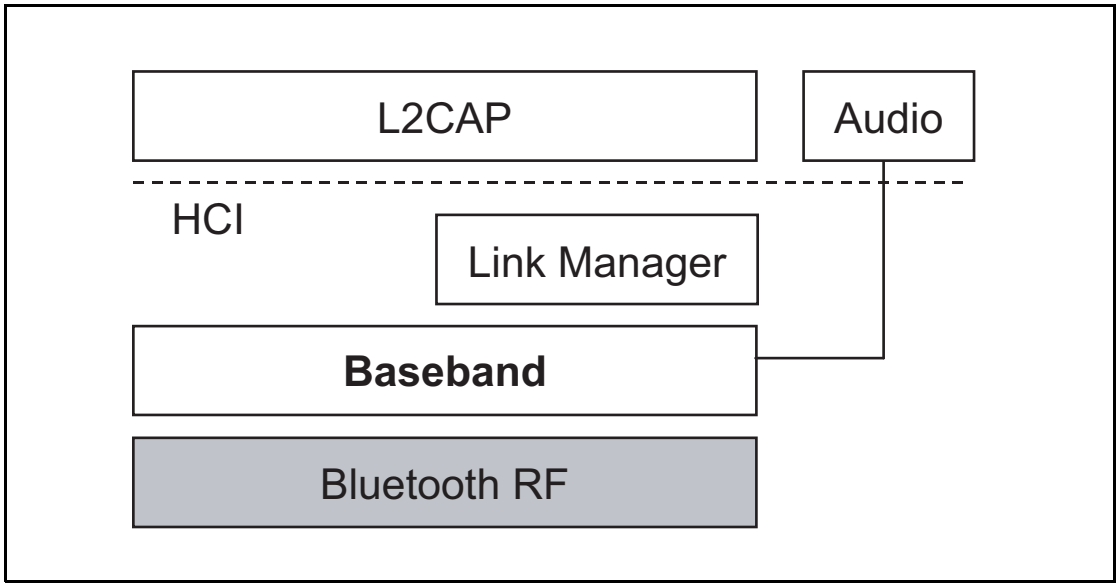

Figure 4.1: Bluetooth protocol stack, Basic Layers

4.2 TEST SUITE STRUCTURE (TSS)

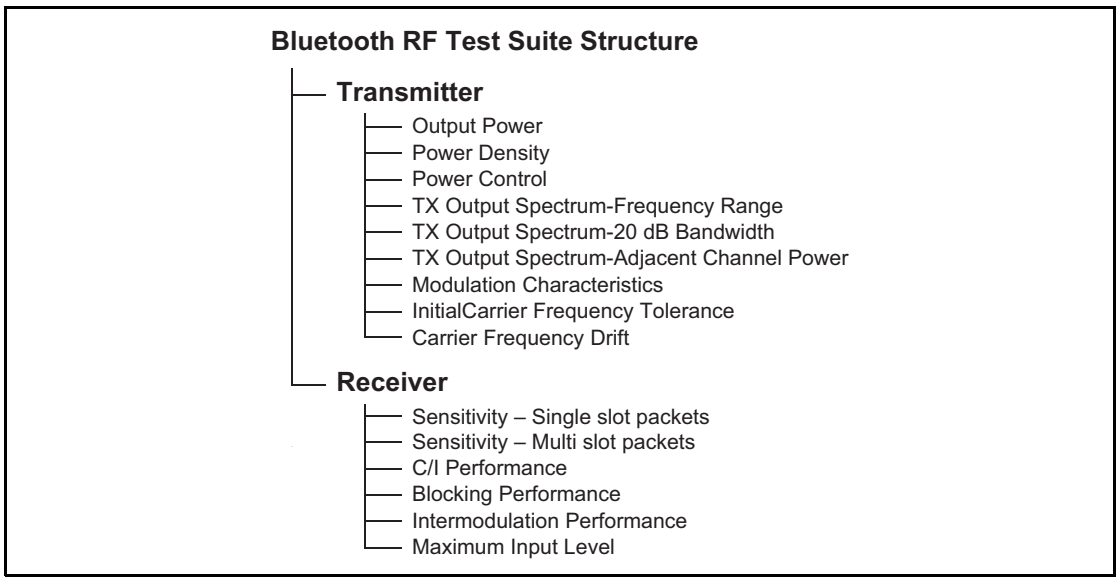

Figure 4.2: Test suite structure for Bluetooth RF

4.3 TEST GROUPS

The test groups are organized in 3 levels. The first level defines the protocol groups representing the protocol services. The second level, separates the protocol services in functional modules. The last level in each branch contains the standard ISO subgroups BV and BI (not shown in Figure 4.2 on page 39).

4.3.1 Protocol groups

The protocol group identifies the kind of test for Bluetooth RF test purposes:

- Transmitter
- Transceiver
- Receiver

4.3.2 Main test group

The main test groups are the capability group, the valid behavior group and the invalid behavior group.

4.3.2.1 Capability (CA) tests

This sub group provides testing of the major EUT capabilities aiming to insure that the claimed capabilities are correctly supported, according to the ICS.

4.3.2.2 Valid Behavior (BV) tests

This sub group provides testing to verify that the EUT reacts in conformity with the Bluetooth standard, after receipt or exchange of a valid Protocol Data Units (PDUs). Valid PDUs means that the exchange of messages and the content of the exchanged messages are considered as valid.

4.3.2.3 Invalid Behavior (BI) tests

This sub group provides testing to verify that the EUT reacts in conformity with the Bluetooth standard, after receipt of a syntactically or semantically invalid PDU.

5 TEST PURPOSES (TP)

5.1 INTRODUCTION

5.1.1 TP definition conventions

The TPs are defined following particular rules as shown in Table 5.1 on page 41.

TP Id	The TP Id is a unique identifier. It is specified according to the TP naming convention defined in the subclause below.
Reference	The reference should contain the references of the subject to be validated by the actual TP (Bluetooth Core specification reference, verified requirement(s)).
Initial Condition	The initial condition specifies in which state the IUT has to be in to apply to the actual TP.
Test Procedure	Describes the steps to be performed for this TP.
Test Condition	Describes under which conditions the test procedure should be performed.
Expected Outcome	Describes the expected outcome of the TP. If not stated otherwise the overall verdict “Pass” is given if all criteria are met (logical AND); “Fail” is given if at least one criterion is not met (logical OR.)
Uncertainties	If there exists any uncertainties for this TP, they are stated here.
Notes	Extra information for this TP.

Table 5.1: TP Definition Convensions

5.1.2 TP naming conventions

The identifier of the TP is built according to Table 5.2 on page 41.

Identifier:	**TP/<func>/<xx>-<nn>-<y>**	
<func> = function	TRM	Transmitter Tests
	TRC	Transceiver Tests
	RCV	Receiver Tests
<xx> = Type of testing	CA	Capability Tests
	BV	Valid Behaviour Tests
	BI	Invalid Behaviour Tests
<nn> = sequential number	(00-99)	Test Purpose Number

Table 5.2: TP Naming Conventions

Identifier:	TP/<func>/<xx>-<nn>-<y>	
<y> = Scope	C	Conformance test performed on dedicated Bluetooth Test system.
	E	Early product test; performed with standard equipment.
	I	Interoperability testing performed as product to product testing.

Table 5.2: TP Naming Conventions

5.1.3 TRM/CA/01/C (Output Power)

Verification of the maximum peak and average RF-output power.

- *Reference*

  ETS 300 328 (subclause 5.2.1),
  [Vol. 2, Part A] Section 3 on page 33.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back or TX mode.

  c) Hopping on.

  d) If EUT supports power control the tester sets the EUT's output power setting to maximum using LMP commands.

- *Test Procedure*

  a) Tester transmits longest supported DM or DH packet with full payload (1, 3 or 5 slot) with PRBS 9 as payload to the EUT. (See “Reference Signal Definition” on page 73.)

b) The spectrum analyzer settings shall be as follow:

- Center frequency: the lowest operating frequency
- Span: Zero Span
- Resolution Bandwidth: 3 MHz
- Video Bandwidth: 3 MHz
- Detector: Peak
- Mode: Maxhold
- Sweeptime: depending on packet type (one complete packet)
- Trigger: extern (to signalling unit.)

c) The first time the EUT transmits a burst on the spectrum analyzer center frequency it is triggered to make a sweep over the duration of the burst.

d) The tester records the highest power value P_{PK} in the trace.

e) Tester calculates average power P_{AV} over at least 20% to 80% of the duration of the burst (position of p0 defines the begin of the burst)
or
if the measuring system is not able to determine the p0 bit in the burst:
Tester calculates average power P_{AV} over at least 20% to 80% of the duration of the burst. (The duration of the burst is the time between the leading and trailing 3 dB points compared to the average power).

f) Repeat b) to e) while the analyzer centre frequency is set to:
the mid operating frequency; and the highest operating frequency.

These frequencies are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

NOTE: When using test equipment that can follow the hopping sequence the low, mid, and upper frequencies can be tested when hopped to.

g) Repeat step a) to f) for all country specific hopping modes.

h) Step a) to g) is repeated under extreme test conditions.

i) The antenna gain G (in dBi,) is added to the results (in dBm) measured in part a) to i) (only for verdicts 1) and 2) in “Expected Outcome” on page 44[vol. 1].)

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  1. P_{AV} < 100 mW (20 dBm) EIRP
  2. P_{PK} < 200 mW (23 dBm) EIRP
  3. If the EUT is a power class 1 equipment:
     P_{AV} > 1 mW (0 dBm)
  4. If the EUT is a power class 2 equipment:
     0.25 mW (-6 dBm) < P_{AV} < 2.5 mW (4 dBm)
  5. If the EUT is a power class 3 equipment:
     P_{AV} < 1 mW (0 dBm.)

- *Uncertanties*

- *Notes*

  In the ETS 300 328 the measurement method based on a combination with diode detector and oscilloscope is described. This measurement method is not up to date. An equivalent method for a Bluetooth device based on a spectrum analyser can be used as described in the previous chapter.

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

5.1.4 TRM/CA/02/C (Power Density)

Verification of the maximum RF-output power density.

- *Reference*

  ETS 300 328 (subclause 5.2.2).

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back or TX mode.

  c) Hopping on.

  d) If EUT supports power control the tester sets the EUT's output power setting to maximum using LMP commands.

- *Test Procedure*

  a) Tester transmits longest supported DM or DH packet with full payload (1, 3 or 5 slot) with PRBS 9 as payload to the EUT. (See “Reference Signal Definition” on page 73.)

  b) The spectrum analyzer settings shall be as follow:

  - Center frequency: 2441 MHz
  - Span: 240 MHz
  - Resolution Bandwidth: 100 kHz
  - Video Bandwidth: 100 kHz
  - Detector: Peak
  - Mode: Maxhold
  - Sweeptime: 1 sec per 100 kHz span
  - Trigger: freerun.

  If the measurement equipment is not able to store one sample for each 100 kHz frequency range, the span may be split for several measurements.

  c) A trace is done and the peak value of the trace is found.

  d) The spectrum analyzer is set to Zero Span, the center frequency is set to the frequency found in step c), and the sweep time is set to 1 minute. A single sweep shall be running.

  e) The power density is calculated as the peak value of the trace captured in step d).

  f) Step a) to e) is repeated under extreme test conditions.

  g) Repeat step a) to f) for all country specific hopping modes.

  h) The antenna gain G (in dBi,) is added to the results (in dBm) measured in part a) to g).

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  Power Density < 100 mW (20dBm) per 100 kHz EIRP.

- *Uncertanties*

- *Notes*

  In the ETS 300 328 the measurement method based on a combination with diode detector and oscilloscope is described. This measurement method is not up to date. An equivalent method for a Bluetooth device based on a spectrum analyser can be used as described in the previous chapter.

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

5.1.5 TRM/CA/03/C (Power Control)

Verification of the TX power control.

Interoperability.

If the EUT does not support power control, this test case is not applicable.

- *Reference*

  [Vol. 2, Part A] Section 3 on page 33.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back or TX mode.

  c) Hopping off.

  d) EUT transmits at maximum output power back to the tester.

- *Test Procedure*

  a) Tester sets EUT to lowest operating TX frequency using LMP commands.

  b) Tester transmits DH1 packets with PRBS.9 as payload to the EUT. (See “Reference Signal Definition” on page 73.)

  c) The spectrum analyzer settings shall be as follow:

  - Center frequency: the lowest operating frequency
  - Span: Zero Span
  - Resolution Bandwidth: 3 MHz
  - Video Bandwidth: 3 MHz
  - Detector: Peak
  - Mode: Maxhold
  - Sweeptime: one complete DH1 packet
  - Trigger: extern (to signalling unit.)

  d) The first time the EUT transmits a burst on the spectrum analyzer center frequency it is triggered to make a sweep over the duration of the burst.

  e) Tester calculates average power P_{AV} over at least 20% to 80% of the duration of the burst (position of p0 defines the begin of the burst)
  or
  if the measuring system is not able to determine the p0 bit in the burst:
  Tester calculates average power P_{AV} over at least 20% to 80% of the duration of the burst. (The duration of the burst is the time between the leading and trailing 3 dB points compared to the average power).

  f) Decrease EUT output power for one power step.

  The next measurement shall start after the EUT has reached the new power step (see IXIT statement, default value = 1 second, see “Test Case Mapping” on page 80[vol. 1].)

  g) Repeat step b) to f) until minimum possible output power step of the EUT is reached.

  h) Tester increases EUT's output power one step using LMP command.Repeat step b) to e). Step size is recorded by the tester.

i) Repeat step h) to the maximum possible output power setting of the EUT.

j) Repeat step b) to i) while the EUT receives (f_{RX}) / loops back (f_{TX}) at:
the mid operating frequency; and the highest operating frequency.

These frequencies are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

- *Test Condition*

  This test case must be performed at normal test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  Expected Outcome refer to the step size and to the minimum output power. The latter depends on the power class of the EUT.

  a) Step size of the power control: 2dB ≤ step size ≤ 8 dB

  b) For power class 1 equipment:
  At minimum power step: P_{AV} < 4dBm

- *Uncertanties*

- *Notes*

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

5.1.6 TRM/CA/04/C (TX Output Spectrum – Frequency range)

Verification if the emissions inside the operating frequency range are within the limits.

- *Reference*

  [Vol. 2, Part A] Section 2 on page 31,
  Regulatory Requirement 300 328 (subclause 5.2.3).

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back or TX mode.

  c) Hopping off.

  d) EUT transmits at maximum output power back to the tester.

- *Test Procedure*

  a) EUT is set to lowest TX frequency.

  b) Tester transmits longest supported DM or DH packet with full payload (1, 3 or 5 slot) with PRBS 9 as payload to the EUT. (See “Reference Signal Definition” on page 73.)

  c) The spectrum analyzer settings shall be set as:

  - Resolution bandwidth (RBW): 100 kHz
  - Video bandwidth: 300 kHz
  - Centre frequency: lowest supported TX frequency
  - Start frequency: see Table 5.3 on page 49
  - Stop frequency: see Table 5.3 on page 49
  - Detector: Peak
  - Mode: averaging
  - Sweep time: 2s (at least one burst per sample)
  - Trigger: extern (to signalling unit)
  - Number of sweeps: 50.

TX channel	Start frequency/MHz	Stop frequency/MHz
Lowest	2399	2405
Highest	2475	2485

Table 5.3: Start and Stop Frequency

  d) Find lowest frequency below the operating frequencies at which spectral power density drops below the level of –80 dBm/Hz e.i.r.p (-30 dBm if measured in a 100 kHz bandwidth). This frequency is called f_L. It shall be recorded in the test report.

e) Set EUT to transmit on highest TX frequency.

f) Set spectrum analyzer centre frequency to highest TX frequency. The other spectrum analyzer settings shall be as in step c).

g) Find highest frequency above the operating frequencies at which spectral power density drops below the level of –80 dBm/Hz e.i.r.p (-30 dBm if measured in a 100 kHz bandwidth). This frequency is called f_H. It shall be recorded in the test report.

h) Repeat steps b) to h) for all country specific operating frequency ranges supported by the EUT.

i) Repeat step a) to h) for extreme test conditions.

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  f_L, f_H within the allowed frequency band:

  2.4 GHz – 2.4835 GHz

- *Uncertanties*

- *Notes*

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

5.1.7 TRM/CA/05/C (TX Output Spectrum – 20 dB Bandwidth)

Verification if the emissions inside the operating frequency range are within the limits.

Regulatory Requirement FCC Part 15.247, a(1ii).

- *Reference*

  [Vol. 2, Part A] Section 3.2.1 on page 35.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back or TX mode.

  c) Hopping off.

  d) EUT transmits at maximum output power back to the tester.

- *Test Procedure*

  a) The EUT is set to transmit at:

  - the lowest operating frequency.

  The related receiving frequency is defined in "Frequencies for testing, loopback, hopping off" on page 75[vol. 1].

  b) Tester transmits longest supported DM or DH packet with full payload (1, 3 or 5 slot) with PRBS 9 as payload to the EUT. (See "Reference Signal Definition" on page 73.)

  c) The spectrum analyzer settings shall be as follow:

  - Resolution bandwidth (RBW): 10 kHz
  - Video bandwidth: 30 kHz
  - Center frequency: f_{TX} center (lowest TX operating frequency)
  - Span: 2.0 MHz
  - Detector: Peak
  - Mode: Maxhold
  - Sweep time: >= 1sec. per sweep.
  - Trigger: freerun
  - Number of sweeps: 10.

  d) Find the highest power value in the transmit channel (peak of the emission.)

e) Find lowest frequency below the operating frequency at which transmit power drops 20 dB below the level measured in step d). This frequency is called f_L. It shall be recorded in the test report.

f) Find highest frequency above the operating frequencies at transmit power drops 20 dB below the level measured in step d). This frequency is called f_H. It shall be recorded in the test report.

g) The difference between the frequencies $\Delta f := |f_H - f_L|$ measured in the former steps is the 20 dB bandwidth. It shall be recorded in the test report.

h) Repeat steps b) to g) while the EUT transmits (f_{TX}) at:

- the mid operating frequency; and
- the highest operating frequency.

These frequencies and the related RX frequencies are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

i) Repeat step a) to h) for extreme test conditions.

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  The Transmit spectrum shall fulfil the following mask:

  $$\Delta f = |f_H - f_L| \leq 1.0 \text{ MHz}$$

- *Uncertanties*

- *Notes*

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

5.1.8 TRM/CA/06/C (TX Output Spectrum – Adjacent channel power)

Verification if the emissions inside the operating frequency range are within the limits.

System performance.

- *Reference*

  [Vol. 2, Part A] Section 3.2.1 on page 35.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back or TX mode.

  c) Hopping off.

  d) EUT transmits at maximum output power back to the tester.

- *Test Procedure*

  The transmit frequency is defined by the index M (transmit frequency f(M) is calculated according to "Frequencies for testing" on page 74[vol. 1] substituting M for k). In the same way the measurement frequency is defined by the index N.

  a) EUT is set to transmit on (f_{TX}) = f(3) (M = 3.)

  b) Set N := 0.

  c) Tester transmits DH1 packets with PRBS 9 as payload to the EUT (See "Reference Signal Definition" on page 73.)

  d) The Spectrum Analyzer shall be set as follows:

  - Span: Zero Span
  - Center frequency: f(N) – 450 kHz
  - Resolution bandwidth: 100 kHz
  - Video bandwidth: 300 kHz
  - Detector: Average
  - Mode: maxhold
  - Sweep time: 100 ms
  - Number of sweeps: 10.

  e) Determine maximum value P_{TXn} of the trace.

  f) Increase centre frequency for 100 kHz.

  g) Repeat step e) to f) until centre frequency = f(N) + 450 kHz.

h) Calculate $P_{TX}(f) = \Sigma(P_{TXi})$, i = 1....10.

i) Increase centre frequency by 1 MHZ: N := N+1.

j) Repeat step c) to i) until f(N) is above the maximum TX frequency.

k) Set the EUT transmit frequency (f_{TX}) to:

- the mid operating frequency; and

- the frequency $f(M_{max} – 3)$ where $f(M_{max})$ corresponds to the highest operating frequency.

These frequencies (mid, high) and the related RX frequencies for polling are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

l) Set N := 0.

m)Repeat steps c) to j).

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  The EUT is transmitting on channel M and the adjacent channel power is measured on channel number N. N is chosen to cover the whole regulatory range, see “Operating frequency bands” on page 74[vol. 1].

  1. $P_{TX}(f) \leq – 20$ dBm for $|M-N| = 2$
  2. $P_{TX}(f) \leq – 40$ dBm for $|M-N| >= 3$

  For each operating frequency exceptions in up to three bands of 1 MHz width centered on a frequency which is an integer multiple of 1 MHz are allowed. They must however comply with an absolute value of –20 dBm.

- *Uncertanties*

- *Notes*

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

5.1.9 TRM/CA/07/C (Modulation Characteristics)

Verification of the modulation index.

Interoperability.

- *Reference*
  [Vol. 1, Part A] Section 3.1 on page 37.

- *Initial Condition*
  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.
  b) EUT in test mode loop back with whitening turned off or TX mode.
  c) Hopping off.
  d) EUT transmits at maximum output power back to the tester.

- *Test Procedure*
  a) EUT transmits (f_{TX}) at: lowest operating frequency
  b) Tester transmits longest supported DM or DH packet with full payload (1, 3 or 5 slot) with 11110000…-Bit pattern as payload.

  The measurement bandwidth of the tester shall be at least 1.3 MHz. Passband ripple to +- 550 kHz: shall be a maximum of 0.5 dB (peak to peak.)

  It is recommended that the test equipment should use a measurement filter with the following specification:

  Transition band minimum attenuations:

  +- 650 kHz: -3 dB

  +- 1 MHz: -14 dB

  +- 2 MHz: -44 dB

  c) Tester determines the position of bit p0 (see"Definition of the position of Bit p0" on page 79[vol. 1]) in the packets looped back by the EUT. This is the timing reference to identify the bits in the payload field.

d) Tester calculates for each "00001111" 8 bit sequence in the payload the average frequency over the frequency values of the 8 bits. To determine the correct deviation value of each bit it shall be oversampled at least four times. Then take the average over these at least four samples as the deviation for each bit. For each second, third, sixth and seventh of the 8 bits the deviation from the average frequency within the bit period is recorded as $\Delta f1_{max}$.

e) The average of all the $\Delta f1_{max}$ deviation values measured before is calculated, and recorded as $\Delta f1_{avg}$.

f) Tester transmits longest supported DM or DH packet with full payload (1, 3 or 5 slot) with 101010…-Bit pattern as payload.

g) Tester determines the position of bit p0 (see “Definition of the position of Bit p0” on page 79[vol. 1]) in the packets looped back by the EUT. This is the timing reference to identify the bits in the payload field.

h) Starting with the second payload bit, the STE calculates for each "01010101" 8 bit sequence in the payload the average frequency over these 8 bits. For each of the 8 bits the maximum deviation from this average within the bit period is recorded as $\Delta f2_{max}$.

i) The average of all the maximum deviation values measured before is calculated, and recorded as $\Delta f2_{avg}$.

j) Repeat step b) to i) for at least 10 packets.

k) Repeat steps b) to j) while the EUT transmits (f_{TX}) at:

- the mid operating frequency; and

- the highest operating frequency.

These frequencies and the related RX frequencies are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  The average of all frequency deviations $\Delta f1_{avg}$, as measured, shall be within 140 kHz and 175 kHz.

  Alt least 99.9% of all frequency deviations $\Delta f2_{max}$, as measured, shall be greater than 115 kHz.

The ratio of all frequency deviations $\Delta f2_{avg}$, as measured, and $\Delta f1_{avg}$ must not lie below 80%.

1. $140\ kHz \leq \Delta f1_{avg} \leq 175\ kHz$
2. $\Delta f2_{max} \geq 115\ kHz$ for at least 99.9% of all $\Delta f2_{max}$
3. $\frac{\Delta f2_{avg}}{\Delta f1_{avg}} \geq 0.8$

- *Uncertanties*

- *Notes*

  Whitening must be disabled while the test case is performed.

  Alternatively it is allowed to use TX mode instead of loop back mode for sending the 1010.. bit pattern and 1111000 … bit pattern, if possible.

  The figure of 99.9% was used to compensate the influence of the statistical distribution of the measured values as each single value is considered in the verdict.

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

  It is allowed for the tester to change the order of the test sequence in loopback and TX test mode. The tester can send and measure packets with either payload in any order.

5.1.10 TRM/CA/08/C (Initial Carrier Frequency Tolerance)

Verification of the transmitter carrier frequency accuracy

Interoperability.

- *Reference*

  [Vol. 2, Part A] Section 3.3 on page 36.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back or TX mode.

  c) Hopping on.

  d) EUT transmits at maximum output power back to the tester.

- *Test Procedure*

  a) EUT transmits DH1 packets with PRBS 9 as payload to the tester.

  b) Tester measures packets received at the lowest operating frequency. The measurement bandwidth of the tester shall be at least 1.3MHz. Passband ripple to +-550kHz: shall be a maximum of 0.5 dB (peak to peak.)

  It is recommended that the test equipment should use a measurement filter with the following specification:

  Transition band minimum attenuations:

  +- 650 kHz: -3 dB

  +- 1 MHz: -14 dB

  +-2 MHz: -44dB

  c) Tester determines the position of bit p0 (see “Definition of the position of Bit p0” on page 79[vol. 1]) in the packets looped back by the EUT. This is the timing reference to identify the bits in the payload field.

  d) The tester makes an integration of the packet’s 4 preamble bits and the first bit after the 4^{th} preamble bit on the EUT's f_{TX} channel. The measurement shall start at the center of the first preamble bit until the center of the first bit following the 4^{th} preamble bit.

  e) The EUT's carrier frequency shall be assumed to be the result of this integration done in d) and is named f_0.

  f) Repeat step b) to e) for at least 10 packets.

  g) Repeat steps c) to f) with packets measured:

  - the mid operating frequency; and

  - the highest operating frequency.

  (These frequencies can be found in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].)

  When using test equipment that can follow the hopping sequence the low, mid, and upper frequencies can be tested when hopped to.

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  Each of the EUT's carrier frequency f_0 as measured must be within ±75 kHz from the EUT's chosen nominal carrier frequency f_{TX}.

  $f_{TX} - 75\ kHz \leq f_0 \leq f_{TX} + 75\ kHz$.

- *Uncertanties*

- *Notes*

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

5.1.11 TRM/CA/09/C (Carrier Frequency Drift)

Verification of the transmitter centre frequency drift within a packet.

Interoperability.

- *Reference*

  [Vol. 2, Part A] Section 3.3 on page 36.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in loop back mode with whitening turned off or TX mode.

  c) Hopping on.

  It shall be defined after which time the measurement starts.

- *Test Procedure*

a) EUT transmits packets with a 1010-sequence as payload. All supported packets (DH1/3/5) with the longest supported payload length are used.

b) Tester measures packets received at the lowest operating frequency. The measurement bandwidth of the tester shall be at least 1.3MHz. Passband ripple to +-550KHz: shall be a maximum of 0.5dB (peak to peak.)

It is recommended that the test equipment should use a measurement filter with the following specification:

Transition band minimum attenuations:

+- 650 kHz: -3 dB

+- 1 MHz: -14 dB

+- 2 MHz: -44dB

c) Tester determines the position of bit p0 (see “Definition of the position of Bit p0” on page 79[vol. 1]) in the packets looped back by the EUT. This is the timing reference to identify the bits in the payload field.

d) The tester makes an integration of the packet’s 4 preamble bits and the first bit after the 4^{th} preamble bit on the EUT's f_{TX} channel. The measurement shall start at the center of the first preamble bit until the center of the first bit following the 4^{th} preamble bit. The EUT's carrier frequency shall be assumed to be the result of this integration and is named f_0.

e) Tester integrates the frequency deviations of every 10 bit symbols in the payload body (k-th measurement leads to f_k). The measurement shall start with the 2^{nd} payload bit, so that the first 10 bit block includes payload bit 2-11.

f) Repeat step b) to e) for at least 10 packets.

g) Repeat step b) to f) for all supported packet lengths (DH1/3/5 packets.)

h) Repeat steps c) to g with packets measured at:

- mid operating frequency; and

- highest operating frequency.

These frequencies can be found in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

When using test equipment that can follow the hopping sequence the low, mid, and upper frequencies can be tested when hopped to.

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  The transmitter centre frequency is not allowed to drift more than the limits given in Table 5.4 on page 61.

Type of Packet	Frequency Drift
One slot packet	±25 kHz
Three slot packet	±40 kHz
Five slot packet	±40 kHz

Table 5.4: Frequency Drift within a packet

The frequency drift limits apply to the difference between the average frequency of the 4 preamble bits f_0 and the average frequency of any 10 bits in the payload field of the returned packets f_k.

The maximum drift rate is 20000 Hz / 50 μs, anywhere in a packet.

The maximum drift rate applies to the difference between any two 10-bit groups separated by 50 μs within the payload field of the returned packets.

$|f_{k+5} - f_k| \leq 20000$ Hz, k=0 … max.

- *Uncertanties*

- *Notes*

  Whitening must be disabled while the test case is performed.

  The test case should be performed using loopback mode. If so, the test system must ensure that the testcase is not failed due to not correctly recognized return packets or payload failure, i.e: The test system must provide a means to check the correct packet type. In addition it is recommended that the payload content is checked as well if required.

  However, if it is required and the test system does not provide a means to distinguish packet types, the TX mode might be used instead if supported by both, test system and IUT.

5.1.12 RCV/CA/01/C (Sensitivity – single slot packets)

The sensitivity is tested using a non-ideal transmitter (one-slot packet). This test case defines the signal sent to the EUT in detail. The EUT must meet the required sensitivity for this non-ideal signal.

Interoperability.

- *Reference*

  [Vol. 2, Part A] Section 4.1 on page 37.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode. Loop back.

  c) Hopping off.

  d) EUT transmits at maximum output power back to the tester.

  e) The tester's transmit power is chosen such that the input power to the EUT receiver is – 70 dBm.

- *Test Procedure*

  a) EUT receives (f_{RX})/loops back (f_{TX}) at:

  - the lowest operating frequency.

  a) The tester continuously sends DH1 packets to the EUT. The Payload is PRBS 9.

  b) The properties of the packets are chosen according Table 5.5 on page 63. Beside those parameters the reference signal settings of “Reference Signal Definition” on page 73[vol. 1] have to be used. The tester transmits the first 20 ms using the first parameter set (see “Dirty Transmitter Single Slot Packets” on page 63[vol. 1]).The second 20 ms are transmitted with parameter set 2 and so forth. After the 10^{th} set of parameters has been used, the tester continues using the first set again.

  c) The returned packets are received and the BER is measured by the tester according to “Bit error rate (BER) measurements” on page 78[vol. 1] (minimum number of samples, 1 600 000 returned payload bits.)

d) Repeat steps b) to d) while the EUT receives (f_{RX}) /loops back (f_{TX}) at:

- the mid operating frequency; and
- the highest operating frequency.

These frequencies and the related RX frequencies are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

Set of Parameters	Carrier Frequency offset	Modulation index	Symbol timing error
1	75 kHz	0.28	- 20 ppm
2	14 kHz	0.30	- 20 ppm
3	- 2 kHz	0.29	+ 20 ppm
4	1 kHz	0.32	+ 20 ppm
5	39 kHz	0.33	+ 20 ppm
6	0 kHz	0.34	- 20 ppm
7	-42 kHz	0.29	- 20 ppm
8	74 kHz	0.31	- 20 ppm
9	-19 kHz	0.28	- 20 ppm
10	-75 kHz	0.35	+ 20 ppm

Table 5.5: Dirty Transmitter Single Slot Packets

Addtionaly, to the described dirty transmitter signal parameters in Table 5.5 on page 63, a synchronized sine wave frequency modulation (alternate packets will switch start phase between 0 and 180 degrees) with a deviation of ± 25kHz and a modulation frequency of 1,6kHz shall be modulated on the signal to realize the carrier frequency drift.

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  BER ≤ 0.1%(minimum number of samples, 1 600 000 returned payload bits.)

- *Uncertanties*

  It must be fixed if the measurement equipment can support a dirty transmitter as specified in this test case.

- *Notes*

  If suitable test equipment is available this test case should be done with hopping on.

5.1.13 RCV/CA/02/C (Sensitivity - multi-slot packets)

Multi-slot packets are sent to the EUT at the sensitivity level. (maximum allowed length)This test case defines the signal sent to the EUT in detail. The EUT must meet the required sensitivity for this non-ideal signal.

Interoperability.

- *Reference*

  [Vol. 2, Part A] Section 4.1 on page 37.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back.

  c) Hopping off.

  d) EUT transmits at maximum output power back to the tester.

  e) The tester's transmit power is chosen such that the input power to the EUT receiver is – 70 dBm.

- *Test Procedure*

  a) EUT receives (f_{RX})/loops back (f_{TX}) at the lowest operating frequency.

  b) The tester continuously sends DH5 packets (if 5-slot packets are not supported, but 3-slot packets are: DH3 packets are used instead) to the EUT.Payload is the PRBS 9.

  c) The properties of the packets are chosen according Table 5.6 on page 65. Beside those parameters the reference signal settings of “Reference Signal Definition” on page 73[vol. 1] have to be used. The tester transmits the first 20 ms using the first parameter set (see Table 5.6 on page 65). The second 20 ms are transmitted with parameter set 2 and so forth. After the 10^{th} set of parameters has been used the tester continues using the first set again.

d) The returned packets are received and the BER is measured by the tester according to “Bit error rate (BER) measurements” on page 78[vol. 1] (minimum number of samples, 1 600 000 returned payload bits.)

e) Repeat steps b) to d) while the EUT receives (f_{RX})/loops back (f_{TX}) (f_{TX}) at:

- the mid operating frequency; and
- the highest operating frequency.

These frequencies and the related RX frequencies are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

Set of Parameters	Carrier Frequency offset	Modulation index	Symbol timing error
1	75 kHz	0.28	- 20 ppm
2	14 kHz	0.30	- 20 ppm
3	- 2 kHz	0.29	+ 20 ppm
4	1 kHz	0.32	+ 20 ppm
5	39 kHz	0.33	+ 20 ppm
6	0 kHz	0.34	- 20 ppm
7	-42 kHz	0.29	- 20 ppm
8	74 kHz	0.31	- 20 ppm
9	-19 kHz	0.28	- 20 ppm
10	-75 kHz	0.35	+ 20 ppm

Table 5.6: Dirty Transmitter Multi Slot Packets

Addtionaly, to the described dirty transmitter signal parameters in Table 5.6 on page 65, a frequency modulation with a deviation of ± 40 kHz and a synchronized sine wave modulation frequency (alternate packets will switchstart phase between 0 and 180 degrees) of 500 Hz for 3 slot packets and 300 Hz for 5 slot packets shall be modulated on the signal to realize the carrier frequency drift.

- *Test Condition*

  This test case must be performed at normal and extreme test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  BER ≤ 0.1%(minimum number of samples, 1 600 000 returned payload bits.)

- *Uncertanties*

  It must be fixed if the measurement equipment can support a dirty transmitter as specified in this test case.

- *Notes*

  If suitable test equipment is available this test case should be done with hopping on.

5.1.14 RCV/CA/03/C (C/I performance)

Verification of the receiver's performance in presence of co-/adjacent channel interference

System performance.

- *Reference*

  [Vol. 2, Part A] Section 4.2 on page 37.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back.

  c) Hopping off.

  d) EUT transmits at maximum output power back to the tester.

  e) f_{image} is declared by the manufacturer of the EUT in the IXIT table (see "Test Case Mapping" on page 80[vol. 1].)

- *Test Procedure*

  a) EUT receives (f_{RX}) / loops back (f_{TX}) at low operating frequency (see Table 5.7 on page 67.)

  b) Tester transmits at the same time:

  - Wanted signal (Reference Bluetooth signal, see "Reference Signal Definition" on page 73[vol. 1]): DH1 packet with PRBS 9 as payload for interfering signal on Co-channel and adjacent 1 MHz and 2 MHz :10 dB over the reference sensitivity level (see "Definition of the reference sensitivity level" on page 79[vol. 1]), for interfering signal on all other frequencies: 3 dB over the reference sensitivity level.

  - Bluetooth modulated interfering signal with PRBS 15 as payload (see "Reference Signal Definition" on page 73[vol. 1]). This interfering signal is operating at $f_I = f_{RX}$. For the interference power level see Table 5.7 on page 67.

c) The returned packets are received and the BER is measured by the tester according to “Bit error rate (BER) measurements” on page 78[vol. 1] (minimum number of samples, 1 600 000 returned payload bits.)

d) Repeat step b) to c) for all frequencies f_I + k MHz, that are regular Bluetooth transmit frequencies.

e) Repeat step b) to d) for the wanted signal at the frequencies (Mid operating frequency, high operating frequency) that are specified in Table 5.7 on page 67.

Low operating frequency		Mid operating frequency		High operating frequency	
EUT f_{RX}	**EUT f_{TX}**	**EUT f_{RX}**	**EUT f_{TX}**	**EUT f_{RX}**	**EUT f_{TX}**
2405 MHz	2405 MHz	2441 MHz	2441 MHz	2477 MHz	2477 MHz

Table 5.7: Low, Mid, and High Operating Frequency

Interferer Frequency	Ratio	Wanted signal level P[dB] > reference sensitivity
Co-Channel interference, C/I co-channel	11 dB	10
Adjacent (1 MHz) interference, C/I_{1MHz}	0 dB	10
Adjacent (2 MHz) interference, C/I_{2MHz}	-30 dB	10
Adjacent (≥3 MHz) interference, $C/I_{\geq 3MHz}$	-40 dB	3
Image frequency Interference[1,2], C/I_{Image}	-9 dB	3
Adjacent (1 MHz) interference to in-band mirror frequency, $C/I_{Image \pm 1MHz}$	-20 dB	3

Table 5.8: Interferer and wanted signal settings

Note 1: In-band image frequency, declared by the manufacturer of the EUT.

Note 2: If the image frequency ≠ n*1 MHz, then the image reference frequency is defined as closest n*1 MHz frequency.

Note 3:. If two adjacent channel specifications from the above table are applicable to the same channel, the more relaxed specification applies

- *Test Condition*

  This test case must be performed at normal test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  BER ≤ 0.1 %

  Frequencies where the requirements are not met are called spurious response frequencies. For each RX frequency five spurious response frequencies are allowed at frequencies with a distance of ≥ 2 MHz from the wanted signal. On these spurious response frequencies a relaxed interference requirement C/I = -17 dB must be met.

- *Uncertanties*

- *Notes*

  N/A.

5.1.15 RCV/CA/04/C (Blocking performance)

Verification of the receiver's performance in presence of interference.

System performance.

- *Reference*

  [Vol. 2, Part A] Section 4.3 on page 38.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back.

  c) Hopping off.

  d) EUT: f_{RX}= f_{TX} = 2460 MHz.

  e) EUT transmits at maximum output power back to the tester.

- *Test Procedure*

  a) The tester continuously sends the wanted nominal signal (see "Reference Signal Definition" on page 73[vol. 1]) to the EUT.

  b) This wanted signal is transmitted at 3 dB over the reference sensitivity level (see "Definition of the reference sensitivity level" on page 79[vol. 1]) at f_{RX} = 2460 MHz.

c) DH1 packets are used. The Payload is PRBS 9.

d) Additionally the tester produces a continuos wave interfering signal at frequency f_I = 30 Mhz , at the EUT receiver input. The power levels of this interfering signal are 2 dB higher as defined in Table 5.9 on page 69.

e) Tester measures BER according to “Bit error rate (BER) measurements” on page 78[vol. 1] (minimum number of samples, 100 000 returned payload bits.) If the BER is measured to be > 0.1 %, the frequency of the blocking signal is recorded.

f) Repeat step a) to e) for 30 MHz ≤ f_I ≤ 12.75 GHz, where f_I is an integer multiple of 1 MHz.

g) The signal level of the blocking signal is set as in Table 8 at the EUT receiver input and the BER (minimum number of samples, 1 600 000 returned payload bits) is measured with the same nominal signal as in b) but for all frequencies found in e). If BER is measured to be > 0.1 % the frequency of the blocking signal is recorded.

h) The signal level of the blocking signal is reduced to –50 dBm at the EUT receiver input and the BER (minimum number of samples, 1 600 000 returned payload bits) is measured with the same nominal signal as in b) but for all frequencies found in g). If BER is measured to be > 0.1 % the frequency of the blocking signal is recorded.

Interfering Signal Frequency	Interfering Signal Power Level
30 MHz – 2000 MHz	-10 dBm
2000 – 2400 MHz	-27 dBm
2500 – 3000 MHz	-27 dBm
3000 MHz – 12.75 GHz	-10 dBm

Table 5.9: Power levels of the CW interfering signal

- *Test Condition*

  This test case must be performed at normal test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  BER ≤ 0.1% (minimum number of samples, 1 600 000 returned payload bits.)

  The number of frequencies recorded in step g) must not exceed 24 and the number of frequencies recorded in step h) must not exceed 5.

- *Uncertanties*

- *Notes*

5.1.16 RCV/CA/05/C (Intermodulation Performance)

Verification of the receiver's intermodulation characteristics.

System performance.

- *Reference*
  [Vol. 2, Part A] Section 4.4 on page 38.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back. Hopping off.

  c) $f_{TX} = f_{RX}$ during the test case.

  d) EUT transmits at maximum output power back to the tester.

- *Test Procedure*

  a) EUT is set to transmit and receive at lowest supported frequency.

  b) The tester continuously sends the wanted nominal signal (see "Reference Signal Definition" on page 73[vol. 1]) to the EUT. This wanted signal is transmitted at 6 dB over the reference sensitivity level (see "Definition of the reference sensitivity level" on page 79[vol. 1]) at f_{TX}. DH1 packets are used. The Payload is PRBS 9.

  c) Static sine wave signal at f_1 with a power level of –39 dBm.

  d) A Bluetooth modulated signal (see "Reference Signal Definition" on page 73[vol. 1]) at f_2 with a power level of –39 dBm and a payload of PRBS 15.

  e) Such that $f_{TX}=2f_1-f_2$ and $|f_2-f_1| = n * 1$ MHz, where n is 3,4 or 5. The value of n (for which the TC is performed) is declared by the manufacturer in the IXIT table (see PICS proforma for Radio (RF)).

  f) Measure BER according to "Bit error rate (BER) measurements" on page 78[vol. 1] (minimum number of samples, 1 600 000 returned payload bits.)

g) Repeat step b) to f) for the mid and highest operating frequencies f_{TX} supported by the EUT.
These frequencies are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

- *Test Condition*

  This test case must be performed at normal test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  BER ≤ 0.1%

- *Uncertanties*

- *Notes*

5.1.17 RCV/CA/06/C (Maximum Input Level)

Verification of the receiver performance.

Interoperability, System performance.

- *Reference*

  [Vol. 2, Part A] Section 4.5 on page 39.

- *Initial Condition*

  a) EUT is connected to the tester via 50 ohm connector or a temporary 50 ohm connector or if there is no antenna connector, via a suitable coupling device.

  b) EUT in test mode loop back.

  c) Hopping off.

  d) EUT transmits at maximum output power back to the tester.

- *Test Procedure*

  a) EUT receives (f_{RX}) / loops back (f_{TX}) at the lowest operating frequency.

  b) Tester sends DH1 packets with a nominal Bluetooth signal (see “Reference Signal Definition” on page 73[vol. 1]) (payload is the PRBS 9) continuously at –20 dBm power at the receiver input of the EUT.

  c) Tester measures BER according to “Bit error rate (BER) measurements” on page 78[vol. 1] (minimum number of samples, 1 600 000 returned payload bits.)

d) Repeat steps b) to c) while the EUT receives (f_{RX}) / loops back (f_{TX}) at:

- the mid operating frequency; and
- the highest operating frequency.

These frequencies are defined in “Frequencies for testing, loopback, hopping off” on page 75[vol. 1].

- *Test Condition*

  This test case must be performed at normal test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  BER ≤ 0.1 % (minimum number of samples, 1 600 000 returned payload bits.)

- *Uncertanties*

- *Notes*

6 ANNEX

6.1 REFERENCE SIGNAL DEFINITION

If not stated differently in the corresponding test cases, the EUT shall always transmit at the maximum output power and the tester shall transmit with a power between -60dBm and -40dBm at the EUT receiver input.

The modulated interfering signal shall be continuous modulated.

A Bluetooth modulated signal used as “wanted signal” and “interfering signal” is defined as:

- Modulation = GFSK
- Modulation index = 0.32 ±1%
- BT= 0.5 ±1%
- Bit Rate = 1 Mbps ±1 ppm
- Frequency accuracy better than ±1 ppm
- Free selectable Access Code
- Modulating Data for wanted signal = PRBS9
- Modulating Data for interfering signal = PRBS15

Additionally the signal shall follow the ramp up as shown in Figure 6.1 on page 74.

- t_{rampup} is the time taken for the output power from the signal generator to increase from below -40 dB to with +/- 3 dB of the final output power x dBm.
- $t_{settling}$ is the time taken for the output power from the signal generator to reach to within better than +/- 1 dB of the final output power x dBm.
- t_{PO} is the time at which the first bit of the preamble begins.

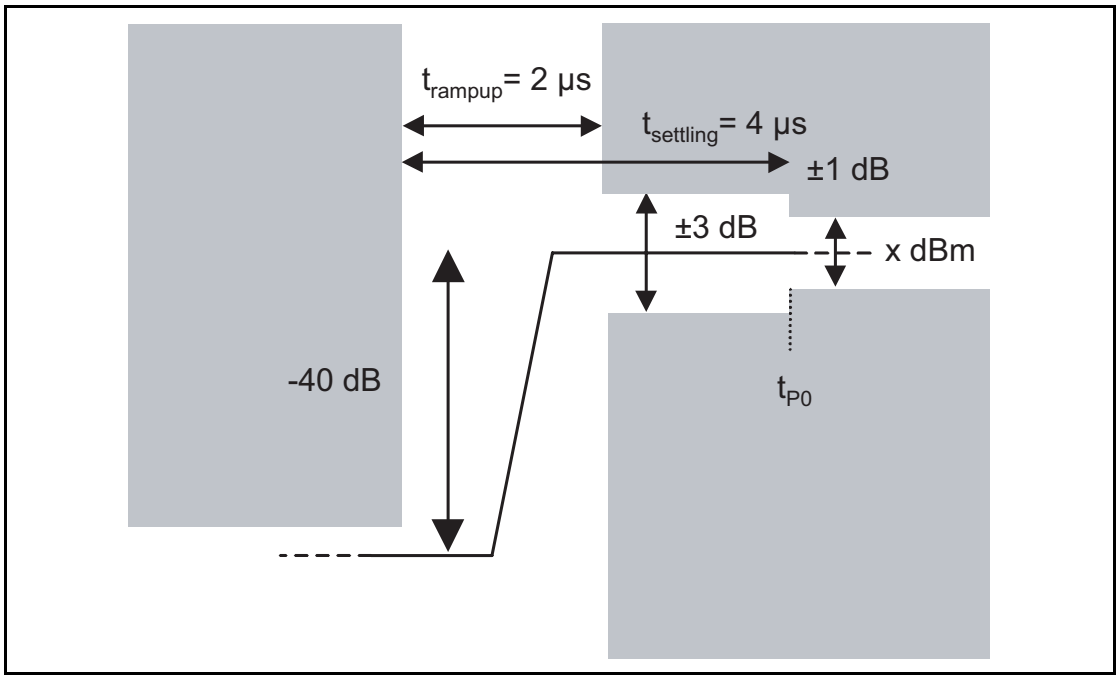

Figure 6.1: Ramp-up profile of signal generator used in Bluetooth RF testing

The lower limit of below –40 dB is very important since above this level, the signal would be of sufficient power to be detected by the receiver.

6.2 FREQUENCIES FOR TESTING

Unless otherwise stated frequency setting to one of the supported bands is sufficient. In this case the following rule applies:

- If the 79 hop sequence is supported, this shall be used.
- Otherwise either of the 23 hop sequences might be used.

6.2.1 Operating frequency bands

The Bluetooth system is operating in the 2.4 GHz ISM band. Although globally available, each country has specified a set of frequencies applicable for each country.

Geography	Regulatory Range	RF Channels used by Bluetooth
USA / Japan	2.400-2.4835 GHz	f =2402+k MHz, k = 0,…,78
Europe (except France)	2.400-2.4835 GHz	f =2402+k MHz, k = 0,…,78
France	2.4465-2.4835 GHz	f =2454+k MHz, k = 0,…,22

Table 6.1: Operating frequency bands

6.2.2 Frequencies for testing, loopback, hopping off

Several test cases of this RF Test Specification make use of the Bluetooth test-mode, loopback with hopping turned off. These test cases reference to this section and the EUT's receive and transmit frequencies are set according Table 6.2 on page 75 and Table 6.3 on page 75:

For transmit test cases:

	Low operating frequency		Mid operating frequency		High operating frequency	
Geography	**EUT f_{TX}**	**EUT f_{RX}**	**EUT f_{TX}[1]**	**EUT f_{RX}[1]**	**EUT f_{TX}**	**EUT f_{RX}**
USA/Japan Europe (except France)	2402 MHz	2480 MHz	2441 MHz	2402 MHz	2480 MHz	2402 MHz
France	2454 MHz	2476 MHz	2465 MHz	2454 MHz	2476 MHz	2454 MHz

Table 6.2: Frequencies for transmit test cases

For receive test cases:

	Low operating frequency		Mid operating frequency		High operating frequency	
Geography	**EUT f_{TX}**	**EUT f_{RX}**	**EUT f_{TX}**	**EUT f_{RX}**	**EUT f_{TX}**	**EUT f_{RX}**
USA/Japan Europe (except France)	2480 MHz	2402 MHz	2402 MHz	2441 MHz	2402 MHz	2480 MHz
France	2476 MHz	2454 MHz	2454 MHz	2465 MHz	2454 MHz	2476 MHz

Table 6.3: Frequencies for receive test cases

6.2.3 Frequencies for testing, TX-Test, hopping off

Some test cases of this RF Test Specification make use of the Bluetooth test-mode, TX-test, with hopping turned off. These test cases reference to this section and the EUT's transmit frequencies are set according Table 6.4 on page 76:

	Low operating frequency	Mid operating frequency	High operating frequency
Geography	**EUT f_{TX}**	**EUT f_{TX}**	**EUT f_{TX}**
USA/Japan Europe (except France)	2402 MHz	2441 MHz	2480 MHz
France	2454 MHz	2465 MHz	2476 MHz

Table 6.4: Frequencies TX-test, hopping off

6.3 NORMAL TEST CONDITIONS

All test cases must be performed under the following normal test conditions.

6.3.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:

- temperature: +15°C to +35°C
- relative humidity: 20 % to 75 %

The actual values during the tests shall be recorded in the test report.

When it is impracticable to carry out the tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be recorded in the test report.

6.3.2 Nominal Power source

6.3.2.1 Mains Voltage

The nominal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. The nominal voltage shall be declared voltage or any of the declared voltages for which the equipment was designed. The frequency of the test power source corresponding to the AC mains shall be within 2% of the nominal frequency.

6.3.2.2 Lead-acid battery power sources used on vehicles

When radio equipment is intended for operation from usual, alternator fed lead-acid battery power sources used on vehicles, then the nominal test voltage shall be 1,1 times the nominal voltage of the battery (6V, 12V, etc.)

6.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the nominal test voltage shall be as declared be the equipment manufacturer. This shall be recorded in the test report.

6.4 EXTREME TEST CONDITIONS

6.4.1 Extreme temperatures

The extreme temperature range is defined as the largest temperature range given by the combination of

- The minimum temperature range 0 °C to +35 °C
- The product operating temperature range declared by the manufacturer.

This extreme temperature range and the declared operating temperature range shall be recorded in the test report.

6.4.2 Extreme power source voltages

Tests at extreme power source voltages specified below are not required when the equipment under test is designed for operation as part of and powered by another system or piece of equipment. Where this is the case, the limit values of the host system or host equipment shall apply. The appropriate limit values shall be declared by the manufacturer and recorded in the test report.

6.4.2.1 Main voltage

The extreme test voltage for equipment to be connected to an AC mains source shall be the nominal mains voltage ±10%.

6.4.2.2 Lead-acid battery power source used on vehicles

When radio equipment is intended for operation from the usual type of alternator fed lead-acid battery power source used on vehicles, then extreme test voltage shall be 1.3 and 0.9 times the nominal voltage of the battery (6V, 12V etc.)

6.4.2.3 Power sources using other types of batteries

The lower extreme test voltage for equipment with power sources using the following types of battery, shall be:

a) for Leclanché, alkaline, or lithium type battery : 0.85 times the nominal voltage of the battery

b) for the mercury or nickel-cadmium types of battery: 0.9 times the nominal voltage of the battery.

In both cases, the upper extreme test voltage shall be 1.15 times the nominal voltage of the battery.

6.4.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources (primary or secondary), the extreme test voltages shall be those declared by the manufacturer; these shall be recorded in the test report.

6.5 BIT ERROR RATE (BER) MEASUREMENTS

BER measurements are carried out by comparing data in the payload fields transmitted by the tester with data in the payload fields received from the EUT (which is in test mode, loop back).

Payload as used in this Test Specification will mean the EUT transmitted data. Therefore, in order to count the 1,600,000 bits the tester should only count the Payload data and ignore Payload header and Payload-CRC.

If the EUT is unable to loop back a packet (e.g. sync not found or header check fails – see Test Mode Specification), this packet shall be disregarded from the BER measurement.

Let the number of payload bits counted in error be γ , let the number of payload bits received (via loop back) from the EUT be ξ, then:

, with $\xi \geq 1\ 600\ 000$

$$BER = \frac{\gamma}{\xi}$$

6.6 DEFINITION OF THE POSITION OF BIT p0

The start of bit p0, which is the first preamble bit, is defined to occur at the point in time 68 bit periods before the instant at which the modulated carrier passes through the nominal channel frequency immediately prior to the deviation corresponding to the first bit of the Access Code trailer for the EUT as defined in the Baseband Specification 4.2.

The position of the start of bit p0 is calculated using an averaging based on the position of all the zerocrossings in the packet:

For the **m** zero crossings in the packet, the **i'th** zero crossing time is **t(i)** in μs; this is the start of bit **p(i)**.

(1 <= **i** <= **m**).

The start of bit p0 is then:

$$t0 = \frac{1}{m}\sum_{i=1}^{m} t(i) - p(i) * \text{bit time}$$

with bit time is 1μs.

6.7 DEFINITION OF THE REFERENCE SENSITIVITY LEVEL

The reference sensitivity level is defined as –70 dBm.

6.8 ANTENNA GAIN

If it is necessary for Regulatory test purposes the TX peak antenna gain shall be used and declared by the manufacturer.

6.9 MEASUREMENT UNCERTAINTY

The following values of measurement uncertainty associated with each measurement parameter apply to all of the test cases described in this RF Test specification.

6.9.1 Conducted measurements:

- Absolute RF power (wanted channel) [1]: ± 1.2 dB
- Absolute RF power (for unwanted emissions in the BT band) [1]: ± 3 dB
- Absolute RF power (for unwanted emissions outside the BT band) [1]: ± 3 dB (4 dB) [2]

6.9.2 Relative RF power

- Relative RF power[1]: ± 1 dB

6.9.3 Radiated measurements

- Absolute RF power (wanted channel) [1]: ± 6dB
- Radiated emissions (for unwanted emissions)[1]: ± 6dB

6.9.4 Absolute radio frequency

- Absolute radio frequency: ± 5 kHz

6.9.5 Relative drift radio frequency

- Relative drift radio frequency: ± 1 kHz

6.9.6 Peak frequency deviation

- Peak frequency deviation: ± 4 kHz

“The measurement uncertainties of the used measurement equipment must be equal or better as described above. The verdicts of the TCs consider already these measurement uncertainties.”

NOTE: All figures reflect a 95 % confidence level.

Note 1: All values are tentative.

Note 2: 4 dB for frequencies above 4 GHz.

The values include the mismatch between the measurement equipment and the EUT or antenna gain uncertainty of the measurement equipment.

6.10 TEST CASE MAPPING

The test case mapping list shown below determines which test case is applicable depending on the supported features. The “support” column has to be filled out according to the supported feature. The feature list with their item numbers is derived from the PICS proforma for Radio (RF) document which includes the IXIT table as well. If a feature is supported according to the logical connection under “item”, the corresponding test case has to be performed.

For purpose and structure of the PICS/PIXIT proforma and instructions for completing the PICS/PIXIT proforma refer to the Bluetooth ICS and IXIT proforma document.

Item	Feature	Support	Test Case	Test Case Applicable
			Output Power	Yes
			Power Density	Yes
RF, 1/2	Power Control		Power Control	
			TX Output Spectrum - Frequency Range	Yes
			TX Output Spectrum - 20 dB Bandwidth	Yes
			TX Output Spectrum - Adjacent channel power	Yes
			Modulation Characteristics	Yes
			Initial Carrier Frequency Tolerance	Yes
			Carrier Frequency Drift	Yes
			Sensitivity (single slot packets)	Yes
RF, 1/4 OR RF, 1/5	3 or 5 slot packets		Sensitivity (multi slot packets)	
			C/I Performance	Yes
			Blocking Performance	Yes
			Intermodulation Performance	Yes
			Maximum Input Level	Yes

Table 6.5: Test Case Mapping