Core System Package

Radio Frequency

Test Suite Structure (TSS) and Test Purposes (TP) Specification 1.2/2.0/2.0 + EDR/ 2.1/2.1 + EDR/3.0/3.0 + HS/4.0

This document defines the TSS and TP for qualification testing of the Bluetooth® Wireless Technology Radio layer.

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RF.TS/4.0.2

CONTENTS

1 SCOPE

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

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.

The following revisions are applicable to this document.

Revision	Date	Description
D5r3	2003-11-05	Original Release
D10R00	2004-03-03	Re-partitioned to match Main Specification Volume/Part partitioning.
1.2.1	2004-03-25	Editorial changes. Changed document numbering and revision number to conform with legacy system.
1.2.2	2004-07-01	Changed page numbering to begin part with page 1 and made editorial changes to accommodate Vol. 1, Part A.
1.2.3	2004-08-24	Incorporated TSE 522 changing TP TRM/CA/06/C
2.0.E.0	2004-10-19	Incorporated changes for V2.0 + EDR
2.0.E.1	2004-10-28	Editorial correction to TP RCV/CA/10/C
2.0.E.2	2004-11-04	First version for 1.2/2.0/2.0 + EDR available for qualification
2.0.E.3	2005-03-21	Incorporate TSE 686 for the TCMT test cases TRM/CA/10/C, TRM/CA/11/C, TRM/CA/12/C, TRM/CA/13/C, RCV/CA/07/C, RCV/CA/08/C, RCV/CA/09/C, RCV/CA/10/C. Incorporate TSE 687 for RCV/CA/08/C. Incorporate TSE 688 for TRM/CA/13/C. Incorporate TSE 689 for TRM/CA/11/C. Incorporate TSE 690 for RCV/CA/07/C.
2.0.E.4	2005-10-14	TSE 719: Explicitly state EUT to support power control for TRM/CA/10-C Changed globally Bluetooth Specification V1.2 [Vol.2, Part A] to [1] to refer to Normative Reference first item.
2.1.E.0	2006-12-27	Change document identifier from 2.0.E to 2.1.E TSE 1809: TRM/CA/11-C: Change reference to Appendix C in the RF spec. Update references to include v1.2 and 2.0/2.1 core refreezes Removed “Uncertainties” section
2.1.E.1	2007-08-23	TSE 2264: TCMT: change descriptions, remove blanks
2.1.E.2	2008-04-30	TSE 2099: RCV/CA/01/C,RCV/CA/02/C, RCV/CA/07/C clarification of timing symbol TSE 2416: TRM/CA/01/C: change hopping to optional

2.1.E.3r0	2008-11-05	TSE 2473: RCV/CA/03/C, RCV/CA/09/C: Test condition update TSE 2482: TRM/CA/13/C: Update Expected Outcome TSE 2492: RCV/CA/03/C: Remove column in Table 5.7 TSE 2505: TRM/CA/01-C, TRM/CA/02-C. Add clarification to Notes.
21.E.3	2008-12-08	Prepare for publication.
2.1.E.4r0	2009-02-22	New test case TRM/CA/14/C for EPC Updated TCMT to match TPG
3.0.H.0/ 2.1.E.4	2009-04-17	Prepare for publication.
3.0.H.1r0	2009-06-22 2009-08-06	TSE 2700: TRM/CA/05/C: Updated Test procedure and expected outcome. TSE 2482: TRM/CA/06/C: Update Expected Outcome TSE 3083: RCV/CA/03/C, RCV/CA/09/C: Test condition update
3.0.H.1	2009-08-06	Prepare for publication.
4.0.2.r0	2010-12-12	TSE 3153: TRM/CA/14/C: update Test procedure. TSE 3154:TRM/CA/01/C, TRM/CA/03/C, TRM/CA/14/C: update test procedure TSE 3156: TRM/CA/01/C, TRM/CA/03/C: update test procedure TSE 3195: TRM/CA/14/C: update test procedure TSE 3285: TRM/CA/05/C: fix spectrum expression TSE 3407:RCV/CA/03/C, RCV/CA/09/C: update Expected outcome TSE 3409: TRM/CA/09/C: Update Expect Outcome TSE 3455: TRM/CA/05/C: see TSE 3285 TSE 3678: Section 6.5.2
4.0.2	2011-07-18	Prepare for publication.

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. The normative references listed below represent the most current versions as of the date of publication of this document. The most current version of a listed reference should be used unless a specific version is noted in the list.

[1]	Specification of the Bluetooth System v1.2 Core System Package, Volume 2, Part A
[2]	Specification of the Bluetooth System v1.2, 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)
[6]	Specification of the Bluetooth System v2.0+ EDR/v2.1 + EDR/3.0 + HS, Core System Package, Volume 2, Part A

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 Volume 1, Part A, Test Strategy and Terminology Overview.

Mathematical conventions used in this document comply with the definitions given in Volume 1, Part A, Test Strategy and Terminology Overview.

3.2 ABBREVIATIONS

For the purpose of this Bluetooth document, the abbreviations given in Volume 1, Part A, Test Strategy & Terminology Overview are applicable.

4 TEST SUITE STRUCTURE

4.1 OVERVIEW

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

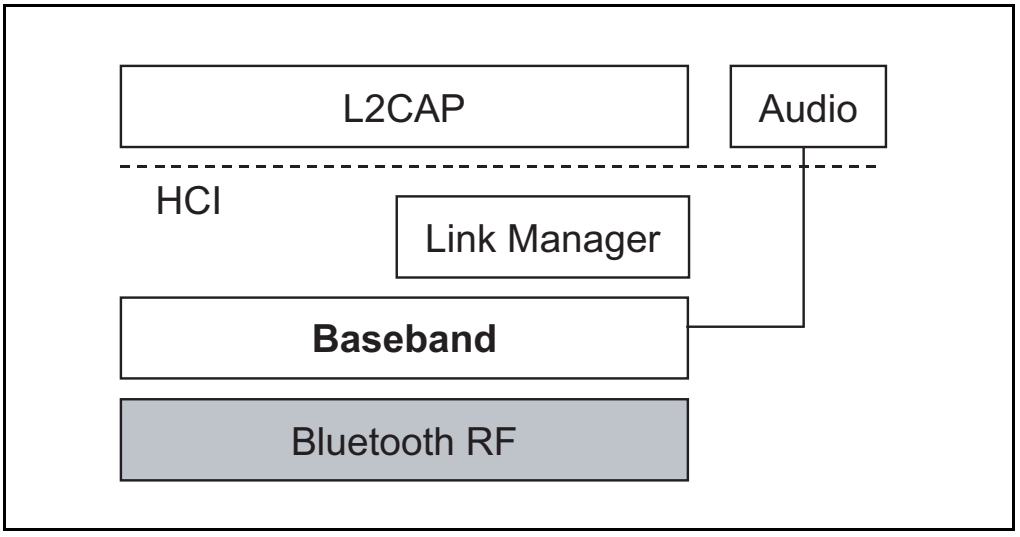

Figure 4.1: Bluetooth protocol stack, Basic Layers

4.2 TEST SUITE STRUCTURE (TSS)

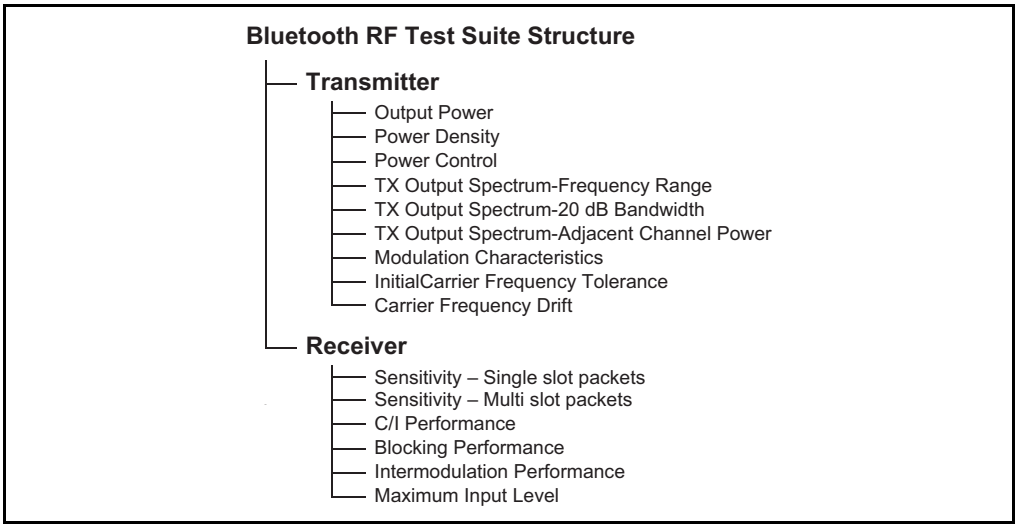

Figure 4.2: Test suite structure for Bluetooth RF

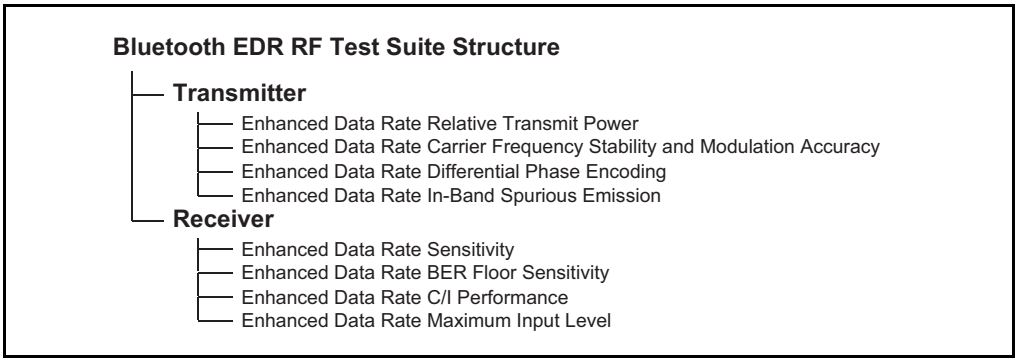

Figure 4.3: Test suite structure for Bluetooth EDR RF

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 4.3 on page 10).

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.

4.3.3 Conformance

When conformance to this profile is claimed, all mandatory features, as well as optional and conditional capabilities for which support is indicated in the ICS, are subject to verification as part of the Bluetooth qualification program.

A single successful test experiment may not constitute a pass verdict. In order to provide a foundation for interoperability it is necessary that a qualified product consistently and repeatedly pass any of the mandated tests.

If a member finds an issue with the test case as described in the test specification, or has issues with the utilized test system, the member is required to notify the responsible party with an errata request such that the issue may be addressed.

4.4 PROVISIONAL RF TESTING

Certain deviations from the test procedures shall be permitted for an interim period, as specified in Section 6.2, ’Provisional RF Testing (EDR)’ on page 63.

5 TEST PURPOSES (TP)

5.1 INTRODUCTION

5.1.1 TP definition conventions

The TPs are defined following the particular rules of TP Definition Conventions in Test Strategy & Terminology Overview, Volume 1 Part A.

5.1.2 TP naming conventions

The identifier of the TP: TP/<feat>/<xx>-<nn>-<y> is built according to the standard defined by "TP Naming Conventions" in Test Strategy & Terminology Overview, Volume 1 Part A.

Features/ functions tested for this specification are:

Identifier	Feature Identifier <feat>
Transmitter Tests	TRM
Transceiver Tests	TRC
Receiver Tests	RCV

Table 5.1: 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),
  [1], [6] Section 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 on or off.

  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 61.)

b) If Hopping is off, EUT transmits at lowest operating TX frequency.

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: Clear/Write
- Sweeptime: depending on packet type (one complete packet)
- Trigger: extern (to signalling unit.)

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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

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 Section •, 'Expected Outcome' on page 13.)

- *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.)

- *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 analyzer 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.

  The test limits stated in mW and dBm are not always identical; therefore, the test limit in mW applies.

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

Verification of the maxim 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 61.)

  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.

- *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.

  The dBm and mW test limits stated are not exactly identical and the mW test limits applies.

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*

  [1], [6] Section 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) 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 61.)

  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: Clear/Write
  - Sweeptime: one complete DH1 packet
  - Trigger: extern (to signalling unit.)

  d) 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).

  e) 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 Section 6.11, 'Test Case Mapping' on page 71.)

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

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

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

  i) 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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

- *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

- *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*

  [1], [6] Section 3
  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 61.)

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 5.2 on page 19
- Stop frequency: see Table 5.2 on page 19
- 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 5.2: 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

- *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*

  [1] Section 3.2.1
  [6] Section 3.1.2.1

- *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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

  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 61.)

  c) The spectrum analyzer settings shall be as follows:

  - Resolution bandwidth (RBW): 10 kHz
  - Video bandwidth: 30 kHz
  - Center frequency: f_{TX} center (lowest TX operating frequency)
  - Span: 3.0 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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

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:

  1. If the highest power value measured in step d) is equal or higher than 0 dBm:

  f = |fH - fL| ≤ 1.0 MHz

  2. If the highest power value measured in step d) is lower than 0 dBm:

  f = |fH - fL| ≤ 1.5 MHz

- *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*

  [1] Section 3.2.1
  [6] Section 3.1.2.1

- *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*

  The transmit frequency is defined by the index M (transmit frequency f(M) is calculated according to Section 6.3, 'Frequencies for testing' on page 63 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 61.)

  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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

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 Section 6.3.1, 'Operating frequency bands' on page 63.

  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, M exceptions in up to three bands are allowed where $|M-N| \geq 3$. For exceptions, Ptx (f) ≤ -20 dBm.

- *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*

  [1] Section 3.1
  [6] Section 3.1.1

- *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 Section 6.7, ’Definition of the position of Bit p0’ on page 70) 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 Section 6.7, 'Definition of the position of Bit p0' on page 70) 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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

- *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.

  At 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. $\frac{\Delta f2_{avg}}{\Delta f1_{avg}} \geq 0.8$

- *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*

  [1] Section 3.1
  [6] Section 3.1.1

- *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 Section 6.7, 'Definition of the position of Bit p0' on page 70) 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 4th 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 4th 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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.)

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}.

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

- *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*

  [1] Section 3.1
  [6] Section 3.1.1

- *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 Section 6.7, 'Definition of the position of Bit p0' on page 70) 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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

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 5.3 on page 31.

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

Table 5.3: 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 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=1 … max.

- *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 TRM/CA/10/C (EDR Relative Transmit Power)

This test ensures the difference in average transmit power during frequency modulated [GFSK] and phase modulated [DPSK] portions of a packet is within an acceptable range.

Interoperability

- *Reference*

[6] Section 3.2.4

- *Initial Condition*

a) EUT is connected to tester via a 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, with whitening off.

c) Hopping off (transmit and receive frequencies are defined in section 6.3.2).

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

- *Test Procedure*

a) EUT transmits longest supported $\pi/4$-DQPSK packet type (2-DHx or 2-EVx) with maximum length payload containing PRBS9.

b) EUT transmits at lowest operating TX frequency.

c) The spectrum analyser shall be set as follows:

Center frequency: EUT transmit frequency

Span: Zero Span

Resolution Bandwidth: 3 MHz

Video Bandwidth: 3 MHz

Detector: Average (Sample may also be used)

Mode: Clear Write (continuous update)

Sweeptime: depending on packet type (one complete packet)

Trace Average: 10

d) Tester calculates average power P_{GFSK} over at least 80% of the GFSK portion (Access Code & Header period) of the packet.

e) Tester calculates the average power P_{DPSK} over at least 80% of the DPSK portion of the packet (Synchronization sequence and payload)

f) Repeat step d) to f) while the EUT transmits at:

- the mid operating frequency; and

- the highest operating frequency.

g) If power control is supported, repeat steps c) through f) with EUT transmitting minimum output power. If the EUT does not support power control, continue to step h).

h) If 8DPSK modulation is supported by the EUT, repeat steps b) to h) while the EUT transmits longest supported 8DPSK packet type (3-DHx or 3-EVx) with maximum length payload containing PRBS9.

- *Test Conditions*

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

- *Expected Outcome*

For all pairs of results: $(P_{GFSK} - 4dB) < P_{DPSK} < (P_{GFSK} + 1dB)$

- *Notes*

5.1.13 TRM/CA/11/C (EDR Carrier Frequency Stability and Modulation Accuracy)

This test verifies the transmitter carrier frequency stability and modulation accuracy.

Interoperability, System performance

- *Reference*

[6] Sections 3.2.1.4 and 3.2.3

- *Initial Condition*
    a) EUT is connected to tester via a 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, with whitening off.
    c) Hopping off (transmit and receive frequencies are defined in section 6.3.2).
    d) EUT transmits at maximum output power back to the tester.
- *Test Procedure*
    a) EUT transmits the longest supported $\pi/4$-DQPSK packet type (2-DH1, 2-DH3, 2-DH5, 2-EV3, or 2-EV5). The user payload bytes contain PRBS9 pseudo-random data. The number of user payload bytes is 31 for 2-DH1 packets, 58 for 2-EV3 packets, 356 for 2-DH3 packets, 358 for 2-EV5 packets or 656 for 2-DH5 packets.
    b) EUT transmits at the lowest operating frequency.
    c) Tester calculates the initial center frequency error for a packet transmitted by the EUT using the following method applied to the basic rate portion of the packet:
        i. Tester determines the start time of the first preamble bit p_0 using the measurement method.
        ii. Tester calculates the frequency deviations at the bit centres (referenced to p_0) of the packet header bits, relative to the ideal carrier frequency.
        iii. Tester selects those bits from the header that have the same value as both the previous and following bits so are not significantly affected by inter-symbol interference (there will be at least 18 bits of this type). The tester may also select other

bits from the header , but the frequency deviations of these bits must be compensated to remove inter-symbol interference.

iv. Tester calculates the average frequency deviation $\Delta\omega_1$ of those selected packet header bits that represent a transmitted '1'.

v. Tester calculates the average frequency deviation $\Delta\omega_2$ of those selected packet header bits that represent a transmitted '0'.

vi. Tester calculates the initial frequency error $\omega_i = (\Delta\omega_1+\Delta\omega_2)/2$.

d) Tester compensates the Enhanced Data Rate portion of the packet for the initial frequency error ω_i of the packet.

e) Tester applies a square-root raised cosine measurement filter with a roll-off factor of 0.4 and a 3 dB bandwidth of ±500 kHz to the Enhanced Data Rate portion of the packet.

f) Tester partitions the output of the measurement filter into non-overlapping blocks of 50 µsecs beginning at the nominal start of the synchronization symbol following the reference symbol and finishing at the nominal end of the final payload CRC symbol (the number of user payload bytes has been chosen to make this an integral number of blocks).

g) For each block, tester calculates the sampling phase ε_0 and frequency error ω_0 for the RMS DEVM for the block, as defined Appendix C of the Enhanced Data Rate RF Specification (note that this computation includes information from the symbol immediately before the block in order to generate the 50 differential error vectors). The frequency error ω_0 and the RMS DEVM for each block are recorded.

h) For each block, tester calculates the DEVM for each symbol in the block using the sampling phase ε_0 and frequency error ω_0 for the block as calculated in step g). The DEVM for each symbol is recorded.

i) Repeat steps c) to h) for further packets transmitted by the EUT until a total of 200 blocks have been measured (any remaining blocks from the end of the final packet should be discarded).

j) Repeat steps b) to i) while the EUT transmits at:

i. The mid operating frequency; and

ii. The highest operating frequency

k) If 8DPSK modulation is supported by the EUT, repeat steps b) to j) using the longest supported 8DPSK packet type (3-DH1, 3-DH3, 3-DH5, 3-EV3, or 3-EV5). The user payload bytes contain PRBS9 pseudo-random data. The number of user payload bytes is 11 for 3-DH1 packets, 88 for 3-EV3 packets, 536 for 3-DH3 packets, 538 bytes for 3-EV5 packets or 986 for 3-DH5 packets.

- *Test Condition*

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

- *Expected Outcome*

  If the EUT does not support 8DPSK modulation then the outcomes based on this modulation do not apply.

  All values as measured must fulfil the following conditions:

  1. Carrier frequency stability:

     -75 kHz $\leq \omega_i \leq$ +75 kHz, for all packets

     -75 kHz $\leq (\omega_i + \omega_0) \leq$ +75 kHz, for all blocks

     -10 kHz $\leq \omega_0 \leq$ +10 kHz, for all blocks

  2. RMS DEVM:

     RMS DEVM $\leq$ 0.20, for all π/4-DQPSK blocks

     RMS DEVM $\leq$ 0.13, for all 8DPSK blocks

  3. Peak DEVM:

     DEVM $\leq$ 0.35 for all π/4-DQPSK symbols

     DEVM $\leq$ 0.25 for all 8DPSK symbols

  4. 99% DEVM:

     DEVM $\leq$ 0.30, for 99% of π/4-DQPSK symbols

     DEVM $\leq$ 0.20, for 99% of 8DPSK symbols

- *Notes*

  The tester must check that the correct packet type (for loop back and TX test modes) and payload (for loop back test mode only) have been transmitted by the EUT; any invalid packets should be discarded to avoid corruption of the measurements.

  For measurements based on basic rate symbols:

  -The requirements on the measurement bandwidth of the tester are the same as used in TRM/CA/07/C Modulation Characteristics.

  -The method for measuring the position of bit p_0 in the basic rate signal is that same as used in TRM/CA/07/C Modulation Characteristics.

  -The minimum sampling rate for the basic rate portion of the packet is 8 samples per bit period in order to obtain a sufficiently accurate estimate of the initial frequency error (interpolation may be used to obtain this sampling rate from a lower initial sampling rate).

  -It is recommended that the tester uses combinations of UAP and AM_ADDR values that result in non-whitened packet headers with at least five 1's and at least five 0's (including the HEC, but prior to FEC) to ensure a good estimate of initial carrier frequency.

  For measurements based on Enhanced Data Rate symbols:

  -The number of user payload bytes has been chosen to be as close as possible to the maximum packet size, subject to the constraint that

the synchronization symbols, the two payload header bytes (for n-DHx packets), the user payload and the two CRC bytes constitute an integer number of DEVM blocks. This ensures that the modulation accuracy of all symbols, other than the trailer symbols, is measured.

-The PRBS9 pseudo random generator is initialized with a seed of all ones at the beginning of each test packet. The first PRBS9 output bit represents the least significant bit of the first user payload byte.

-The definition of the square-root raised cosine measurement filter is given in [RF Spec]. The measurement filter frequency response must be accurate of ±0.25 dB up to 0.65 MHz from the carrier frequency and must provide at least 40 dB suppression for frequencies more than 0.8 MHz from the carrier frequency. The measurement filter requirement is referenced to the connector on the EUT, so includes the contributions due to all aspects of the signal processing applied by the tester.

-The tester must give an RMS DEVM of less than 3% and a Peak DEVM of less than 8% when a test signal from a reference signal generator is applied and the defined test procedure is followed. This requirement must be met when the test signal has any frequency error up to ±75 kHz and any symbol rate error up to ±20 ppm.

5.1.14 TRM/CA/12/C (EDR Differential Phase Encoding)

Verification that the modulator correctly differential phase encodes the data.

Interoperability

- *Reference*

  [6] Section 3.2.1.2

- *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 TX mode with whitening turned off

  c) Hopping off (transmit and receive frequencies are defined in section 6.3.2).

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

- Test Procedure

  a) EUT transmits 2-DH1 or 2-EV3 packets to the tester with maximum length payload containing PRBS9.

  b) EUT transmits at lowest operating frequency.

  c) Tester demodulates 100 packets and compares each payload with the expected PRBS9 data.

d) If 8DPSK modulation is supported by the EUT repeat steps b) and c) using 3-DH1 or 3-EV3 packets with maximum length payload containing PRBS9.

- *Test Condition*

  This test is performed under normal test conditions.

- Expected Outcome

  The expected outcome of this test is zero errors detected by the tester in 99% of the packets.

- Notes

  The PRBS9 pseudo random generator is initialized with a seed of all ones at the beginning of each test packet. The first PRBS9 output bit represents the least significant bit of the first user payload byte.

5.1.15 TRM/CA/13/C (EDR In-band Spurious Emissions)

Verification that the level of unwanted signals from the DPSK transmitter, within the frequency range used by the device, is below the required level.

System Performance

- *Reference*

  [6] Section 3.2.2.1

- *Initial Condition*

  a) EUT is connected to tester via a 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, with whitening off.

  c) Hopping off (transmit and receive frequencies are defined in section 6.3.2).

  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 Section 6.3, (substituting M for k). In the same way the measurement frequency is defined by the index N. N is chosen to cover the whole regulatory range, see section 6.3.1.

  a) Tester transmits longest supported π/4-DQPSK packet type (2-DHx or 2-EVx) with maximum length payload containing PRBS9.

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

  c) Set N := 0

  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: Max Hold

  Gating: Edge

  Gating Delay, Length: Adjust to include the guard period, the DPSK portion of the packet and the power down ramp

  Sweep time: Setting dependent on packet length (one complete packet)

  Number of sweeps: 10

  If |M-N| > 1,

  i) Set center frequency to f(N) - 450kHz and set n := 1

  ii) Determine maximum value P_{TXn} of the trace

  iii) Increase center frequency by 100 kHz and set n := n+1

  iv) Repeat steps ii) and iii) until center frequency > f(N) + 450kHz

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

  e) If (M-N) = +1,

  i) Set center frequency to f(N) - 450kHz and set n := 1

  ii) Determine maximum value PTXn of the trace

  iii) Increase center frequency by 100 kHz and set n := n+1

  iv) Repeat steps ii) and iii) until center frequency > f(N) – 50kHz

  v) Calculate $P_{TX-26dB}$ (f) = Sum(P_{Txi})/5, i = 1....5

  f) If (M-N) = 0,

  i) Set center frequency to f(N) - 450kHz and set n := 1

ii) Determine maximum value P_{TXn} of the trace

iii) Increase center frequency by 100 kHz and set n := n+1

iv) Repeat steps ii) and iii) until center frequency > f(N) + 450kHz

v) Calculate P_{TXref} (f) = max(P_{TXi}), i = 1....10

g) If (M-N) = -1,

i) Set center frequency to f(N) + 50kHz and set n := 1

ii) Determine maximum value P_{TXn} of the trace

iii) Increase center frequency by 100 kHz and set n := n+1

iv) Repeat steps ii) and iii) until center frequency > f(N) + 450kHz

v) Calculate $P_{TX-26dB}$ (f) = Sum(P_{Txi})/5, i = 1....5

h) Set N := N+1

i) Repeat steps d) to h) until f(N) is above the maximum TX frequency.

j) Repeat steps c) to i) with the EUT transmit frequency (f_{TX}) set to:

-The mid operating frequency; and

-The frequency f(M_{max-3}), where f(M_{max}) is the highest operating frequency

These frequencies and the related receive frequencies are defined in section 6.3.2.

k) If 8DPSK modulation is supported by the EUT, repeat steps b) to j) while the EUT transmits longest supported 8DPSK packet type (3-DHx or 3-EVx) with maximum length payload containing PRBS9.

- *Test Conditions*

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

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

  1. $P_{TX-26dB}$ (f) $\leq$ P_{TXref} -26 dB for |M-N| = 1
  2. P_{TX} (f) $\leq$ – 20 dBm for |M-N| = 2
  3. P_{TX} (f) $\leq$ – 40 dBm for |M-N| $\geq$ 3.

  For each operating frequency, M exceptions in up to three bands are allowed where |M - N| $\geq$ 3. For exceptions, Ptx(f) $\leq$ -20 dBm.

- *Notes*

  This test is similar to TRM/CA/06/C except here the measurement is gated to cover only the DPSK portion of the packet.

5.1.16 TRM/CA/14/C (Enhanced power control)

Verification of the TX Enhanced power control.

Interoperability.

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

- *Reference*

  [6] Section 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 may be used, whitening off.

  c) Hopping off.

  d) The tester puts the EUT at maximum output power using the LMP_power_control_req PDU with the power adjustment_req set to "go to max."

- *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 61.)

  c) The spectrum analyzer settings shall be as follows:

  - Center frequency: the lowest operating frequency
  - Span: Zero Span
  - Resolution Bandwidth: 3 MHz
  - Video Bandwidth: 3 MHz
  - Detector: Peak
  - Mode: Clear/Write
  - Sweeptime: one complete packet as selected under step b)
  - Trigger: extern (to signaling unit.)

  d) Tester calculates average power PAV over at least 20% to 80% of the duration of GFSK header of the burst (position of p0 defines the beginning of the burst).

  e) Repeat steps b) to e) for the EUT transmitting 2-DH1 and 3-DH1 packet types (EDR packets) if they are supported.

f) Tester uses the power change request LMP command to decrease the EUT output power for one power step.

The next measurement shall start after the Tester has received the power change response for the power change request from the EUT.

g) Repeat step b) to g) until minimum output power of the EUT is indicated by the Power change response for all supported modulations.

The power step size of each modulation, if the response indicates a power change for the modulation, and the difference between the GFSK header of the different modulations, are recorded for each step.

h) Tester uses the power change request LMP command to increases the EUT output power one step.

The next measurement shall start after the Tester has received the power change response for the power change request from the EUT.

i) Repeat step b) to f) and i) until the maximum output power of the EUT is indicated by the Power change response for all modulation supported.

The power step size of each modulation, if the response indicates a power change for the modulation, and the difference between the GFSK header of the different modulations, are recorded for each step.

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

These frequencies are defined in Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

- *Test Condition*

  This test case must be performed at normal test conditions.

- *Expected Outcome*

  Pass Verdict

  All values as measured must fulfil the following conditions.

  Expected outcome depends on the power class of the EUT.

  a) Step size for the enhanced power control requests for all supported modulations 2dB ≤ step size ≤ 8 dB.

  b) The power differences between GFSK headers of the supported modulations at every stage within 10dB (≤10dB).

c) For power class 1 equipment: At minimum power step of all supported modulations: $P_{AV} \leq 4dBm$.

d) The Maximum power level for each of the supported modulations measured in stage e) at the start of the test is within +/- 3dB of the power measured at the end of the test sequence when the IUT has reported maximum power for each of the supported modulations.

Fail verdict:

All other conditions that do not meet the Pass criteria.

- *Notes*

  The test case should be performed using loopback mode. If so, the test system must ensure that the test case 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.

5.1.17 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*

  [1] Section 4.1

  [6] Section 4.1.1

- *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 5.4 on page 43. Beside those parameters the reference signal settings of Section 6.1, 'Reference Signal Definition' on page 61 have to be used. The tester transmits the first 20 ms using the first parameter set (see Section Table 5.4:, 'Dirty Transmitter Single Slot Packets' on page 43).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 Section 6.6, 'Bit error rate (BER) measurements' on page 67 (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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

Set of Parameters	Carrier Frequency offset	Modulation index	Symbol Time Period 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 5.4: Dirty Transmitter Single Slot Packets

Additionally, to the described dirty transmitter signal parameters in Table 5.4 on page 43, 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.)

- *Uncertainties*

  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.

5.1.18 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*

  [1] Section 4.1

  [6] Section 4.1.1

- *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 5.5 on page 46. Beside those parameters the reference signal settings of Section 6.1, 'Reference Signal Definition' on page 61 have to be used. The tester transmits the first 20 ms using the first parameter set (see Table 5.5 on page 46). 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 Section 6.6, 'Bit error rate (BER) measurements' on page 67 (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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

Set of Parameters	Carrier Frequency offset	Modulation index	Symbol Time Period 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 Multi Slot Packets

Additionally, to the described dirty transmitter signal parameters in Table 5.5 on page 46, 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.)

- *Uncertainties*

  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.

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

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

System performance.

- *Reference*

  [1] Section 4.1
  [6] Section 4.1.1

  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 Section 6.11, 'Test Case Mapping' on page 71.)

- *Test Procedure*

  a) EUT receives (f_{RX}) / loops back (f_{TX}) at low operating frequency (see Table 5.6 on page 48.)

  b) Tester transmits at the same time:

  - Wanted signal (Reference Bluetooth signal, see Section 6.1, 'Reference Signal Definition' on page 61): 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 Section 6.8, 'Definition of the reference sensitivity level' on page 70), for interfering signal on all other frequencies: 3 dB over the reference sensitivity level.

  - Bluetooth modulated interfering signal with PRBS 15 as payload (see Section 6.1, 'Reference Signal Definition' on page

61). This interfering signal is operating at $f_I = f_{RX}$. For the interference power level see Table 5.7 on page 48.

c) The returned packets are received and the BER is measured by the tester according to Section 6.6, 'Bit error rate (BER) measurements' on page 67 (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 5.6 on page 48.

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 5.6: Low, Mid, and High Operating Frequency

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

Table 5.7: 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 Table 5.7 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 BER is greater than 10-3 are called spurious response frequencies. For each RX frequency, five spurious response frequencies are allowed. On these spurious response frequencies a relaxed interference requirement C/I = -17 dB must be met. This relaxation does not apply to the following measurements:

  a) Co-Channel interference, $C/I_{co\text{-}channel}$

  b) Adjacent (1 MHz) interference, $C/_{1MHz}$

  c) Image frequency Interference, C/I_{Image}

- *Notes*

  N/A.

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

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

System performance.

- *Reference*

  [1] Section 4.3
  [6] Section 4.1.3

- *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.

  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 Section 6.1, 'Reference Signal Definition' on page 61) to the EUT.

  b) This wanted signal is transmitted at 3 dB over the reference sensitivity level (see Section 6.8, 'Definition of the reference sensitivity level' on page 70) 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 5.8 on page 50.

e) Tester measures BER according to Section 6.6, 'Bit error rate (BER) measurements' on page 67 (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 5.8: 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.

- *Notes*

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

Verification of the receiver's intermodulation characteristics.

System performance.

- *Reference*

  [1] Section 4.4
  [6] Section 4.1.4

- *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 Section 6.1, 'Reference Signal Definition' on page 61) to the EUT. This wanted signal is transmitted at 6 dB over the reference sensitivity level (see Section 6.8, 'Definition of the reference sensitivity level' on page 70) 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 Section 6.1, 'Reference Signal Definition' on page 61) 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 Section 6.6, 'Bit error rate (BER) measurements' on page 67 (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 Section 6.3.2, 'Frequencies for testing, loopback, hopping off' on page 63.

- *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%

- *Notes*

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

Verification of the receiver performance.

Interoperability, System performance.

- *Reference*

  [1] Section 4.5
  [6] Section 4.1.5

- *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 Section 6.1, 'Reference Signal Definition' on page 61) (payload is the PRBS 9) continuously at –20 dBm power at the receiver input of the EUT.

  c) Tester measures BER according to Section 6.6, 'Bit error rate (BER) measurements' on page 67 (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 Section 6.3.2, 'Frequencies

for testing, loopback, hopping off' on page 63.

- *Test Condition*

  This test case must be performed at normal test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions.

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

- *Notes*

  N/A

5.1.23 RCV/CA/07/C (EDR Sensitivity)

Verification of the receiver sensitivity for the 10^{-4} bit error rate using a non-ideal transmitter.

Interoperability

- *Reference*

  [6] Section 4.2.1

- *Initial Condition*

  a) EUT is connected to the tester via a 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, whitening on.

  c) Hopping off (transmit and receive frequencies are defined in section 6.3.2).

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

- *Test Procedure*

  a) The tester continuously sends π/4-DQPSK packets with the longest supported packet type (2-DHx or 2-EVx) and with maximum length payload containing PRBS9.

  b) The tester transmit power is chosen such that the input power to the EUT receiver is -70dBm, measured over the DPSK modulated portion of the packets.

  c) The EUT receives (f_{RX}) at:

  - the lowest operation frequency

  d) The properties of the packets are chosen according to Table 5.9. Except for these parameters the reference signal settings of Annex 6.1 Reference Signal Definition are used. The tester

transmits the first 20 packets using the first parameter set of Table 1.The second 20 packets are transmitted with parameter set 2 and so forth. After the third set of parameters has been used, the tester continues using the first set again.

e) The returned packets are received and the BER is measured by the tester according to Section 6.6, 'Bit error rate (BER) measurements' on page 67. After 1 600 000 bits have been received the BER is compared with threshold $7 \cdot 10^{-5}$. If the BER is less than this threshold then the tester shall proceed to step g) otherwise the tester shall proceed to step f).

f) Sampling shall be continued until a minimum number of 16 000 000 bits payload bits are returned.

g) Repeat steps d) to f) while the EUT receives (f_{RX}) at:

- the mid operating frequency
- the highest operating frequency

If 8DPSK is supported by the EUT then repeat steps b) to g) while the tester continuously sends 8DPSK packets with the longest supported packet type (3-DHx or 3-EVx) and with maximum length payload containing PRBS9.

Set of Parameters	Carrier Offset Frequency	Symbol Time Period Error
1	0 kHz	0 ppm
2	+65 kHz	+20 ppm
3	-65 kHz	-20 ppm

Table 5.9: Dirty Transmitter for Enhanced Data Rate Packets

Note: Additionally to the described dirty transmitter signal parameters in the above table, a frequency modulation with a deviation of ±10 kHz and a synchronized sine wave modulation period of 100 μs shall be modulated onto the signal starting at the beginning of the DPSK synchronization word to realize the worst case transmitter carrier frequency stability. The frequency modulation shall alternately switch starting phase between 0 and 180 degrees for successive packets.

- *Test Condition*

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

- *Expected Outcome*

  All values as measured must fulfil the following conditions at low, medium and high frequencies:

  Either

  BER $\leq 7 \cdot 10^{-5}$ after 1 600 000 bits (step e)

  or

  BER $\leq 10^{-4}$ after 16 000 000 bits (step f)

- *Notes*

  N/A

5.1.24 RCV/CA/08/C (EDR BER Floor Performance)

Verification of the receiver performance for the 10^{-5} bit error rate.

Interoperability

- *Reference*

  [6] Section 4.2.2

- *Initial Condition*

  a) EUT is connected to the tester via a 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, whitening on.

  c) Hopping off (transmit and receive frequencies are defined in section 6.3.2).

  d) The EUT shall transmit at maximum output power back to the tester.

- *Test Procedure*

  a) The tester continuously sends $\pi/4$-DQPSK packets, according to Annex 6.1 Reference Signal Definition, with the longest supported packet type (2-DHx or 2-EVx) and with maximum length payload containing PRBS9.

  b) The tester transmit power is chosen such that the input power to the EUT receiver is -60dBm, measured over the DPSK modulated portion of the packets.

  c) The EUT receives (f_{RX}) at:

  - the lowest operation frequency

  d) The returned packets are received and the BER is measured by the tester according to Section 6.6, 'Bit error rate (BER) measurements' on page 67. After 8 000 000 bits have been received the BER is compared with the threshold $7 \cdot 10^{-6}$. If the

BER is less than this threshold then the tester shall proceed to step f) otherwise the tester shall proceed to step e).

e) Sampling shall be continued until a minimum of 160 000 000 payload bits are returned.

f) Repeat step d) and e) while the EUT receives (f_{RX}) at:

- the mid operating frequency
- the highest operating frequency

g) If 8DPSK is supported by the EUT then repeat steps b) to f) while the tester continuously sends 8DPSK packets, according to Annex 6.1 Reference Signal Definition, with the longest supported packet type (3-DHx or 3-EVx) and with maximum length payload containing PRBS9.

- *Test Condition*

  The test case must be performed at normal test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions at low, medium and high frequencies.

  Either

  BER $\leq 7 \cdot 10^{-6}$ after 8 000 000 bits (step d)

  or

  BER $\leq 10^{-5}$ after 160 000 000 bits (step e).

- *Notes*

  N/A

5.1.25 TP/RCV/CA/09/C (EDR C/I Performance)

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

System performance

- *Reference*

  [1] Section 4.2
  [6] Section 4.2.3

- *Initial Condition*

  a) EUT is connected to the tester via a 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, whitening on.

  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.

- *Test Procedure*

a) The tester continuously sends as the wanted signal π/4-DQPSK packets, according to Section 6.1, 'Reference Signal Definition' on page 61, with the longest supported packet type (2-DHx or 2-EVx) and with maximum length payload containing PRBS9.

b) The EUT receives (f_{RX}) at:

- the lowest operation frequency + 3 MHz

c) The tester transmit power at the input of the EUT (wanted signal) measured over the DPSK modulated portion of the packets is:

• -60dBm for the interfering signal on the co-channel or at ±1MHz or ±2MHz adjacent channel

• -67dBm for the interfering signal on all other frequencies

d) The interfering signal shall be continuously modulated using PRBS15 data. For co-channel measurements, the interferer shall use the same modulation as the wanted signal and its properties shall be as defined in Section 6.1, 'Reference Signal Definition' on page 61. For adjacent channel measurements, the interferer shall use GFSK modulation as defined in Section 6.1 on page 61. For interferer power levels see Table 5.10.

e) The returned packets are received and the BER is measured by the tester according to Section 6.6. The minimum number of samples shall be 1 600 000 returned payload bits.

f) Repeat steps c) to e) with the interferer at all regular Bluetooth frequencies.

g) Repeat steps c) to f) while the EUT receives (f_{RX}) at:

- the mid operating frequency

- the highest operating frequency – 3 MHz

h) If 8DPSK is supported by the EUT then repeat steps b) to g) while the tester continuously sends 8DPSK packets, according to Annex 6.1 Reference Signal Definition, with the longest supported packet type (3-DHx or 3-EVx) and with maximum length payload containing PRBS9.

The EUT transmit frequency is on the same channel as its receive frequency.

Frequency of Interference	**2Mbps (π/4-DQPSK) C/I ratio**	**3Mbps (8dpsk) C/I ratio**
Co-Channel interference, $C/I_{co\text{-}channel}$	13 dB	21 dB
Adjacent (1 MHz) interference [1], C/I_{1MHz}	0 dB	5 dB
Adjacent (2 MHz) interference [1], C/I_{2MHz}	-30 dB	-25 dB
Adjacent (≥3 MHz) interference [1], $C/I_{\geq 3MHz}$	-40 dB	-33 dB
Image frequency Interference [1] [2] [3], C/I_{Image}	-7 dB	0 dB
Adjacent (1 MHz) interference to in-band image frequency [1] [2] [3], $C/I_{Image \pm 1MHz}$	-20 dB	-13 dB

Table 5.10: Interference Performance

1. If two adjacent channel specifications from Table 5.10 are applicable to the same channel, the more relaxed specification applies.
2. If the image frequency is not equal to n*1 MHz, then the image reference frequency is defined as the closest n*1 MHz frequency.
3. In-band image frequency.

Test Condition

The test case must be performed at normal test conditions.

- *Expected Outcome*

  1. All values as measured must fulfil the following conditions.

     BER 0.1 %

  Frequencies where the BER is greater than 10^{-3} are called spurious response frequencies. For each RX frequency, five spurious response frequencies are allowed. On these spurious response frequencies a relaxed interference requirement C/I = -15 dB for π/4-DQPSK and C/I = -10 dB for 8DPSK shall be met.

  This relaxation does not apply to the following measurements:

  a) Co-Channel interference, $C/I_{co\text{-}channel}$

  b) Adjacent (1 MHz) interference, C/I_{1MHz}

  c) Image frequency Interference, C/I_{Image}

- *Notes*

  NA

5.1.26 RCV/CA/10/C (EDR Maximum Input Level)

Verification of the receiver performance at the maximum specified input signal level.

Interoperability, System performance

- *Reference*

  [1] Section 4.5
  [6] Section 4.2.4

- *Initial Condition*

  a) EUT is connected to the tester via a 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, whitening on.

  c) Hopping off (transmit and receive frequencies are defined in section 6.3.2).

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

- *Test Procedure*

  a) The tester continuously sends $\pi/4$-DQPSK packets with the longest supported packet type (2-DHx or 2-EVx) and with maximum length payload containing PRBS9.

  b) The tester transmit power is chosen such that the input power to the EUT receiver is -20dBm, measured over the DPSK modulated portion of the packets.

  c) The EUT receives (f_{RX}) at:

  - the lowest operation frequency

  d) The returned packets are received and the BER is measured by the tester according to Section 6.6, 'Bit error rate (BER) measurements' on page 67. The minimum number of samples shall be 1 600 000 returned payload bits.

  e) Repeat step d) while the EUT receives (f_{RX}) at:

  - the mid operating frequency
  - the highest operating frequency

  f) If 8DPSK is supported by the EUT then repeat steps b) to e) while the tester continuously sends 8DPSK packets with the longest supported packet type (3-DHx or 3-EVx) and with maximum length payload containing PRBS9.

- *Test Condition*

  The test case must be performed at normal test conditions.

- *Expected Outcome*

  All values as measured must fulfil the following conditions:

BER $\leq 10^{-3}$

- *Notes*
  N/A

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 62.

- 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.

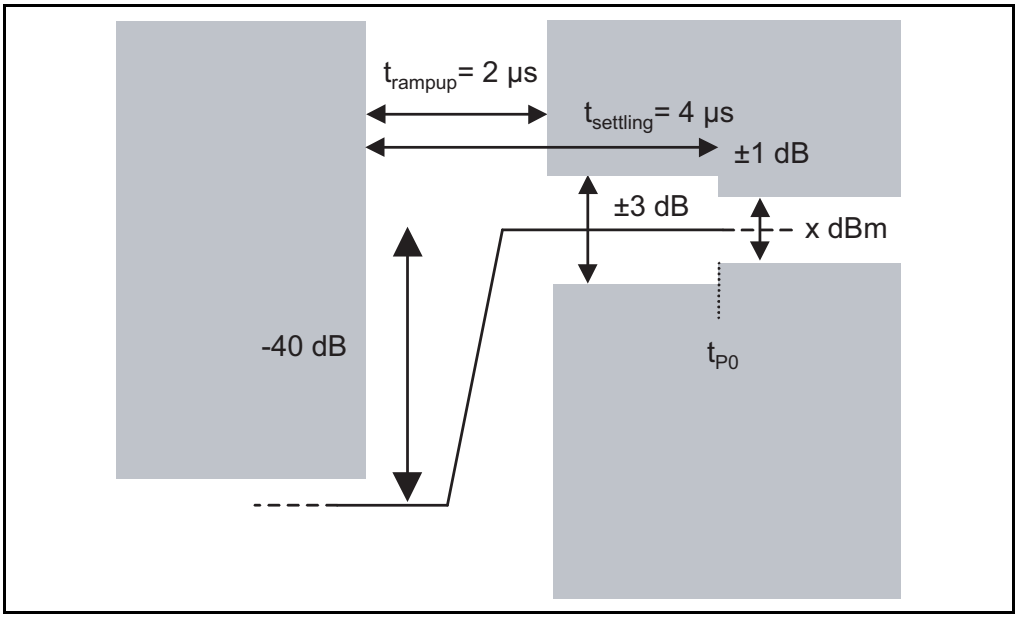

Figure 6.1: Ramp-up profile of signal generator used in Bluetooth RF testing

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.

6.1.1 2 Mbps Reference Signal (EDR)

A 2 Mbps Bluetooth signal used as "wanted" or "interfering signal" is defined as:

Modulation: π/4-DQPSK

Symbol Rate = 1 Msym/s ±1 ppm

Frequency accuracy better than ±1 ppm

Modulating Data for wanted signal = PRBS9

Modulating Data for interfering signal = PRBS15

RMS Differential Error Vector Magnitude < 5%

Average power over the GFSK and DPSK portions of the packet shall be equal to within ±1 dB

6.1.2 3 Mbps Reference Signal (EDR)

A 3 Mbps Bluetooth signal used as "wanted" or "interfering signal" is defined as:

Modulation: 8DPSK

Symbol Rate = 1 Msym/s ±1 ppm

Frequency accuracy better than ±1 ppm

Modulating Data for wanted signal = PRBS9

Modulating Data for interfering signal = PRBS15

RMS Differential Error Vector Magnitude < 5%

Average power over the GFSK and DPSK portions of the packet shall be equal to within ±1 dB

6.2 PROVISIONAL RF TESTING (EDR)

Measurement of RF performance in accordance with the RF test cases may not be possible until appropriate test equipment, with loop back capability, is available. Therefore, certain deviations from the specified test procedures shall be permitted for an interim period. These deviations cease to be permitted for a particular test case when this test case is made active in Category A as indicated in a released Test Case Reference List (TCRL).

The permitted test procedure deviations are as follows:

- Non loop back testing may be used.
- The EUT may be configured for a test case by any suitable means.
- Whitening may be disabled.
- Frequency hopping may be disabled.
- For receiver bit error measurements, the bit error rate may be calculated and reported by any suitable means.

For each test case, all deviations from the specified test procedure shall be documented by the manufacturer.

6.3 FREQUENCIES FOR TESTING

6.3.1 Operating frequency bands

The Bluetooth system is operating in the 2.4 GHz ISM band. .

6.3.2 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

Regulatory Range	RF Channels used by Bluetooth
2.400-2.4835 GHz	f =2402+k MHz, k = 0,…,78

Table 6.1: Operating frequency bands

section and the EUT's receive and transmit frequencies are set according Table 6.2 on page 64 and Table 6.3 on page 64:

For transmit test cases:

Low operating frequency		Mid operating frequency		High operating frequency	
EUT f_{TX}	EUT f_{RX}	EUT f_{TX}[1]	EUT f_{RX}[1]	EUT f_{TX}	EUT f_{RX}
2402 MHz	2480 MHz	2441 MHz	2402 MHz	2480 MHz	2402 MHz

Table 6.2: Frequencies for transmit test cases

For receive test cases:

Low operating frequency		Mid operating frequency		High operating frequency	
EUT f_{TX}	EUT f_{RX}	EUT f_{TX}	EUT f_{RX}	EUT f_{TX}	EUT f_{RX}
2480 MHz	2402 MHz	2402 MHz	2441 MHz	2402 MHz	2480 MHz

Table 6.3: Frequencies for receive test cases

6.3.3 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 65:

Low operating frequency	Mid operating frequency	High operating frequency
EUT f_{TX}	**EUT f_{TX}**	**EUT f_{TX}**
2402 MHz	2441 MHz	2480 MHz

Table 6.4: Frequencies TX-test, hopping off

6.4 NORMAL TEST CONDITIONS

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

6.4.1 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.

6.4.2 Nominal Power source

6.4.2.1 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.

6.4.2.2 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.)

6.4.2.3 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.

6.5 EXTREME TEST CONDITIONS

6.5.1 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.

6.5.2 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.

6.5.2.1 Main voltage

The lower extreme test voltage for equipment to be connected to an AC mains source shall be ≤ 0.9 times the nominal mains voltage.

The upper extreme test voltage for equipment to be connected to an AC mains source shall be ≥ 1.1 times the nominal mains voltage.

6.5.2.2 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 volt-

age shall be ≥ 1.3 and ≤ 0.9 times relative to the nominal voltage of the battery (6V, 12V etc.)

6.5.2.3 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.

6.5.2.4 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.

6.6 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. If the tester does not support the loop back method of measuring BER for 2 Mbps or 3 Mbps, it is allowed to use an alternative measurement method as specified in Section 6.2.

Payload as used in this Test Specification will mean the EUT transmitted data. Only Payload data is counted for the BER measurement. The Payload header and Payload CRC are ignored.

If the EUT is unable to loop back a packet (e.g. sync not found or header check fails), this packet shall be disregarded from the BER measurement. The EUT shall regenerate the payload CRC based on the actual received payload bits.

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:

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

For BER sensitivity testing and floor testing an Early Exit option applies. If the early exit option is exercised the required number of bits (ξ) and BER Limit are given in Table 6.5 and Table 6.6.

BER Limit	ξ
$7 \cdot 10^{-5}$	1 600 000
$7 \cdot 10^{-6}$	8 000 000

Table 6.5: Number of Bits for BER Limit with Early Exit

For the following BER limits the following values of ξ shall apply:

BER Limit	ξ
10^{-3}	1 600 000
10^{-4}	16 000 000
10^{-5}	160 000 000

Table 6.6: Number of Bits for BER Limit without Early Exit

6.7 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 zero crossings 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.

6.8 DEFINITION OF THE REFERENCE SENSITIVITY LEVEL

The reference sensitivity level is defined as –70 dBm.

6.9 ANTENNA GAIN

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

6.10 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.

6.10.1 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]

6.10.2 Relative RF power

- Relative RF power[1]: ± 1 dB

6.10.3 Radiated measurements

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

6.10.4 Absolute radio frequency

- Absolute radio frequency: ± 5 kHz

6.10.5 Relative drift radio frequency

- Relative drift radio frequency: ± 1 kHz

6.10.6 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.

6.11 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/proforma and instructions for completing the PICS/PIXIT proforma refer to the Bluetooth PICS-PIXIT Proforma document.

Item	Feature	Support	Test Case	Test Case Applicable
RF, 1/9	Default GFSK RF Test		Output Power TRM/CA/01/C	Yes
RF, 1/9	Default GFSK RF Test		Power Density TRM/CA/02/C	Yes
RF, 1/4 AND 1/9	Power Control		Power Control TRM/CA/03/C	
RF 1/9	Default GFSK RF Test		TX Output Spectrum - Frequency Range TRM/CA/04/C	Yes
RF, 1/9	Default GFSK RF Test		TX Output Spectrum - 20 dB Bandwidth TRM/CA/05/C	Yes
RF, 1/9	Default GFSK RF Test		TX Output Spectrum - Adjacent channel power TRM/CA/06/C	Yes
RF, 1/9	Default GFSK RF Test		Modulation Characteristics TRM/CA/07/C	Yes
RF, 1/9	Default GFSK RF Test		Initial Carrier Frequency Tolerance TRM/CA/08/C	Yes
RF, 1/9	Default GFSK RF Test		Carrier Frequency Drift TRM/CA/09/C	Yes
RF, 1/9	Default GFSK RF Test		Sensitivity (single slot packets) RCV/CA/01/C	Yes
RF, 1/9 AND (RF, 1/6 OR RF, 1/7)	Multi Slot		Sensitivity (multi slot packets) RCV/CA/02/C	
RF, 1/9	Default GFSK RF Test		C/I Performance RCV/CA/03/C	Yes
RF, 1/9	Default GFSK RF Test		Blocking Performance RCV/CA/04/C	Yes
RF, 1/9	Default GFSK RF Test		Intermodulation Performance RCV/CA/05/C	Yes

Item	Feature	Support	Test Case	Test Case Applicable
RF, 1/9	Default GFSK RF Test		Maximum Input Level RCV/CA/06/C	Yes
RF, 1/10 OR RF, 1/11	Default EDR RF Test		EDR Relative Transmit Power TRM/CA/10/C	
RF, 1/10 OR RF, 1/11	Default EDR RF Test		EDR Carrier Frequency Stability and Modulation Accuracy TRM/CA/11/C	
RF, 1/10 OR RF, 1/11	Default EDR RF Test		EDR Differential Phase Encoding TRM/CA/12/C	
RF, 1/10 OR RF, 1/11	Default EDR RF Test		EDR In-band Spurious Emissions TRM/CA/13/C	
RF, 1/10 OR RF, 1/11	Default EDR RF Test		EDR Sensitivity RCV/CA/07/C	
RF, 1/10 OR RF, 1/11	Default EDR RF Test		EDR BER Floor Performance RCV/CA/08/C	
RF, 1/10 OR RF, 1/11	Default EDR RF Test		EDR C/I Performance RCV/CA/09/C	
RF, 1/10 OR RF, 1/11	Default EDR RF Test		EDR Maximum Input Level RCV/CA/10/C	
RF, 1/12	Enhanced Power Control		Enhanced Power Control TRM/CA/14/C	