

Guideline to integrate components including RF functionality

Abstract

This document gives guidance to integrate components including RF functionality.

Contents

1	Contributors	3
2	Revision History.....	4
3	Scope and Use	6
4	References, Definitions and Abbreviations	7
5.	Incorporating pre-tested and qualified RF-components.....	9
5.1	Subgroups of RF-components.....	9
5.2	Preconditions for re-use of the Covered Functionality of pre-tested and qualified RF-components and modules	10
5.2.1	Voltage range	10
5.2.2	Temperature range	10
5.2.3	Antennas	11
5.3	Basic testing philosophy	12
5.3.1	RF-Integrated Circuits	12
5.3.2	RF-modules	12
5.4	Changes which may affect Covered Functionality	14
5.4.1	Hardware changes.....	14
5.4.2	Replacing the antenna port	14
5.4.3	Adding a power amplifier to increase the output power	15
5.4.4	Using a regulated power supply for the RF-module	15
5.5	Needed information in the RF components QPN	15

1 Contributors

Andreas Grünwaldt	7 layers
Harry Ward	BABT
James Cunningham	7 layers
Joerg Warken	Cetecom
Kurt Fischer ¹⁾	Hyper Corporation
Lars Nielsen	Motorola
Lars-Olov Johansson	Semko
Lothar Schmidt	Cetecom
Michael Klos	Cetecom
Ole Myrtue	Nokia TCC
Roland Becker ²⁾	ETS Dr. Genz
Staffan Bernström	Enea Realtime
Shoichi Kamata	Toshiba
Thomas Weise	Mikes BABT Product Service
Volker Propach	7 layers

- 1) Chairman of BTAB Working Group #1
- 2) Technical Editor of RF Guideline

DISCLAIMER AND COPYRIGHT NOTICE

The copyright in these specifications is owned by the Promoter Members of Bluetooth SIG, Inc. ("Bluetooth SIG"). Use of these specifications and any related intellectual property (collectively, the "Specification"), is governed by the Promoters Membership Agreement among the Promoter Members and Bluetooth SIG (the "Promoters Agreement"), certain membership agreements between Bluetooth SIG and its Adopter and Associate Members (the "Membership Agreements") and the Bluetooth Specification Early Adopters Agreements (1.2 Early Adopters Agreements) among Early Adopter members of the unincorporated Bluetooth special interest group and the Promoter Members (the "Early Adopters Agreement"). Certain rights and obligations of the Promoter Members under the Early Adopters Agreements have been assigned to Bluetooth SIG by the Promoter Members.

Use of the Specification by anyone who is not a member of Bluetooth SIG or a party to an Early Adopters Agreement (each such person or party, a "Member"), is prohibited. The legal rights and obligations of each Member are governed by their applicable Membership Agreement, Early Adopters Agreement or Promoters Agreement. No license, express or implied, by estoppel or otherwise, to any intellectual property rights are granted herein.

Any use of the Specification not in compliance with the terms of the applicable Membership Agreement, Early Adopters Agreement or Promoters Agreement is prohibited and any such prohibited use may result in termination of the applicable Membership Agreement or Early Adopters Agreement and other liability permitted by the applicable agreement or by applicable law to Bluetooth SIG or any of its members for patent, copyright and/or trademark infringement.

THE SPECIFICATION IS PROVIDED "AS IS" WITH NO WARRANTIES WHATSOEVER, INCLUDING ANY WARRANTY OF MERCHANTABILITY, NONINFRINGEMENT, FITNESS FOR ANY PARTICULAR PURPOSE, SATISFACTORY QUALITY, OR REASONABLE SKILL OR CARE, OR ANY WARRANTY ARISING OUT OF ANY COURSE OF DEALING, USAGE, TRADE PRACTICE, PROPOSAL, SPECIFICATION OR SAMPLE.

Each Member hereby acknowledges that products equipped with the *Bluetooth*TM wireless technology ("*Bluetooth* wireless Products") may be subject to various regulatory controls under the laws and regulations of various governments worldwide. Such laws and regulatory controls may govern, among other things, the combination, operation, use, implementation and distribution of *Bluetooth* wireless Products. Examples of such laws and regulatory controls include, but are not limited to, airline regulatory controls, telecommunications regulations, technology transfer controls and health and safety regulations. Each Member is solely responsible for the compliance by their *Bluetooth* wireless Products with any such laws and regulations and for obtaining any and all required authorizations, permits, or licenses for their *Bluetooth* wireless Products related to such regulations within the applicable jurisdictions. Each Member acknowledges that nothing in the Specification provides any information or assistance in connection with securing such compliance, authorizations or licenses. **NOTHING IN THE SPECIFICATION CREATES ANY WARRANTIES, EITHER EXPRESS OR IMPLIED, REGARDING SUCH LAWS OR REGULATIONS.**

ALL LIABILITY, INCLUDING LIABILITY FOR INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHTS OR FOR NONCOMPLIANCE WITH LAWS, RELATING TO USE OF THE SPECIFICATION IS EXPRESSLY DISCLAIMED. BY USE OF THE SPECIFICATION, EACH MEMBER EXPRESSLY WAIVES ANY CLAIM AGAINST BLUETOOTH SIG AND ITS PROMOTER MEMBERS RELATED TO USE OF THE SPECIFICATION.

Bluetooth SIG reserves the right to adopt any changes or alterations to the Specification as it deems necessary or appropriate and to adopt a process for adding new Bluetooth profiles after the release of the Specification.

2 Revision History

Revision	Date	Comments
0.1	2001-06-01	First draft
0.11	2001-06-08	First release to BTAB
0.12	2001-08-17	Error checking and additional Proposals
0.13	2001-09-18	Changes in chapter 4.2.2 and 4.4.4
0.2	2001-09-21	Minor corrections and changes in 4.2.3 antennas
0.25	2001-10-31	Changes in 4.2.3 antennas
0.30	2001-11-21	Changes in chapter 4.2.2 and 4.3.2
0.33	2001-12-05	Interim version with BTAB-agreed changes up to 4.2.1
0.33a	2001-12-20	Changes in chapter 4.2.2 and 4.3.2
0.33d	2002-01-24	Changes as agreed in RF Sub Group Phone bridge #1
0.33e	2002-01-31	Changes as agreed in RF Sub Group Phone bridge #2
0.40	2002-02-05	Changes as agreed in RF Sub Group Phone bridge #3
0.50	2002-02-07	<ul style="list-style-type: none">- Changes in section 3- Editorial change in sub clause 4.2.3
draft 1.0	2002-06-10	Cleaning up based on BQRB comments in clauses: <ul style="list-style-type: none">- 3, editorial change- 4, include References, Definitions and Abbreviations- 5.1, editorial change- 5.2, editorial change of the title- 5.2.1, editorial changes- 5.2.2, editorial change- 5.2.3, removal of reference to regulatory standards- 5.4, editorial change- 5.4.1, change PRD version from 0.9 to 1.0- 5.4.2, editorial change
1.03	2002-12-09	Replacement of the term "pre-qualified" by the term "pre-tested and qualified" in section 5.2.2

3 Scope and Use

This document is intended to become a recommendation in BTAB. It should help to find a common understanding about qualification requirements if pre-tested and qualified RF-chips or modules are implemented into End Products (or in special cases into another component/subsystem).

NOTICE: Each product or component is different. Each qualification decision should be judged in terms of: "Will products covered by the proposed listing comply with the Bluetooth System Specification, relevant test specification, and TCRL at the date of listing?"

In general, this guideline document may suggest situations in which qualification policies allow a test case to not be performed. However, the responsibility for this test decision rests with the manufacturer (who must sign the DoC) and the associated BQB (who is qualifying the System under Test).

The BQB has the right to request additional test cases to be performed as well as the right to make a negative listing decision even when presented with evidence that all test cases were passed if uncertainty remains concerning compliance. A negative listing decision by a BQB should be accompanied with a rationale as to the reason the BQB arrived at this decision; however, a BQB is never required to designate a product as qualified. The BQB may not delegate qualification authority; and in particular a BQB may not list a product based on a narrow interpretation of a BTAB guideline when uncertainty remains about the actual conformance of the product.

It remains the responsibility of the manufacturer to ensure that manufactured devices covered by the resulting listing remain compliant, in accordance with Bluetooth Qualification PRD policies.

A Member may appeal a BQB decision to BQRB via email to BQA@bluetooth.com. Comments on this document should be directed to bt-tab@bluetooth.org, citing "Subject: BTAB-WG1: RF Guideline comment".

4 References, Definitions and Abbreviations

References

Reference	Document	Revision
[1]	System Specification	1.1
[2]	Program Reference Document (PRD)	1.0
[3]	Test Specification Part A	0.91
[4]	Test Specification Part A-E	0.91

Definitions

Term	Definition
Module	A complete RF implementation with defined interfaces.
Temperature Profile	The characterization of temperature within the End Product at the location of the integrated component. This characterization will be done under high temperature and full load conditions.
Check	The procedure of verifying if a requirement is fulfilled. This can be done by testing, verifying engineering evidence, analysis or evaluation of documents.

Abbreviations

Term	Definition
BQB	Bluetooth Qualification Body
DoC	Declaration of Compliance
ICS	Implementation Conformance Statement
PRD	Program Reference Document
QPN	Qualified Product Notice

5. Incorporating pre-tested and qualified RF-components

5.1 Subgroups of RF-components

RF-components can be separated into the following subgroups:

1. RF Integrated Circuits

An RF Integrated Circuit qualification covers only the chip itself as implemented in a Reference Design. The manufacturer offers the Integrated Circuit to other manufacturers. The RF behavior is affected by external components and the implementation (Oscillator, VCO, PLL, PCB material, Baluns, Capacitors, antenna connectors, etc.).

2. RF modules

A RF module will be sold to end product manufacturers as a complete implementation with defined interfaces (dc power input, buffered data, antenna, reference oscillator, etc.). Normally additional external shielding would not be required for passing the test cases.

[These pre-tested and qualified modules are intended to be sold to other manufacturers who integrate them in the final products]

The following subgroups of modules are identified:

- 2.1 RF-module without oscillator integrated in module - internal antenna
- 2.2 RF-module with oscillator integrated in module - internal antenna
- 2.3 RF-module without oscillator integrated in module - external antenna
- 2.4 RF-module with oscillator integrated in module - external antenna

Note: A module would normally include functionality above RF for example Baseband, Link Manager and HCI functionality. Baseband physical tests are to be examined separately.

5.2 Preconditions for re-use of the Covered Functionality of pre-tested and qualified RF-components and modules

5.2.1 Voltage range

The supply voltage range of the integrated RF component (at the point of connection) in the End Product (over the temperature range of the End Product) shall remain within the range of the module/ component qualification.

If not, all extreme condition test cases need to be re-tested for the end product under extreme voltage conditions under high or low temperature condition.

5.2.2 Temperature range

In general the temperature range claimed for the product integrating the RF component shall be within the range of the pre-tested RF-component. Otherwise all test cases need to be tested again at relevant extreme test conditions.

Note: Integrating components/modules within host products like laptops and cellular handsets or other heat producing products can increase the temperature environment of the component/ module.

This would extend the required temperature range for the pre-tested and qualified component. It is up to the manufacturer and the BQB to determine the effective temperature range of the integrated component/module. Adaptation of the requested component's temperature range is up to the BQB according to class III changes described in PRD version 1.0.

A RF Module is pre-tested and qualified for a particular temperature range and therefore Covered Functionality is only applicable within this temperature range. If the RF Module is integrated into an End Product the environmental conditions the RF Module is exposed to are different to those the End Product itself is exposed to. It is possible to measure what temperature a RF Module will be exposed to by using temperature sensors (using a small thermal mass that does not influence the temperature equilibrium) or other adequate temperature measuring methods to establish the temperature range to which the RF module is exposed to. This temperature measurement, performed under worst case operating conditions, shall be submitted to the BQB as a test report as defined in the PRD.

In absence of a Temperature Profile test report (characterization of the temperature profile at the integration location of the component/ module) no reliable correlation between the temperatures in the End Product and the integrated RF module are known and it is impossible to demonstrate compliance with the RF specification

without testing of the End Product. Therefore the following test cases should be performed under worst case operation and examined by the BQB qualifying the End Product:

TRM/ CA/ 01/ C	Output Power, ETC
TRM/ CA/ 02/ C	Power Density, ETC
TRM/ CA/ 04/ C	TX Output Spectrum - Frequency Range, ETC
TRM/ CA/ 05/ C	TX Output Spectrum – 20 dB Bandwidth, ETC
TRM/ CA/ 06/ C	TX Output Spectrum - Adjacent Channel Power, ETC
TRM/ CA/ 07/ C	Modulation Characteristics, ETC
TRM/ CA/ 08/ C	Initial Carrier Frequency Tolerance, ETC
TRM/ CA/ 09/ C	Carrier frequency Drift, ETC
RCV/ CA/ 01/ C	Sensitivity – Single Slot Packet, ETC
RCV/ CA/ 02/ C	Sensitivity - Multi-Slot Packets, ETC

Note: The timing of the Baseband (TP/PHYS/TRX/BV-01-E/C) may need to be checked, see note under chapter 5.1.

5.2.3 Antennas

The antenna is an essential part of the reference design.

Radiated Spurious Emissions (TRC/ CA/ 01/ C) tests requiring use of an EUT antenna shall be tested with the antenna(s) of the End Product.

If an external antenna is used it shall be checked if the gain of the antenna used has the same or less antenna gain as the antenna of the reference design.

If an antenna with higher gain is used the TRM/ CA/ 01/ C (Output power) and TRM/ CA/ 04/ C (Frequency range) should be rechecked, because effective radiated isotropic power can exceed the limits.

5.3 Basic testing philosophy

5.3.1 RF-Integrated Circuits

The RF Integrated Circuit may not be considered pre-tested for Part A (RF) Covered Functionality. Part A (RF) testing is required when preparing to list a Bluetooth End Product integrating such a component.

5.3.2 RF-modules

A complete new TRC/ CA/ 01/ C (Out-of-Band radiated Spurious Emissions under normal conditions) is necessary. The justification for this requirement is given by the fact that the integration of the pre-tested and qualified RF Module into a larger external containment may cause different antenna characteristics for unwanted radiation of the RF Module itself. Furthermore it is the End Product, which is subject to the RF requirements as defined in the RF specification. Therefore even the existence of a separate shielding for RF Modules can not be considered as justification for waiving the spurious emission test cases.

It is not an objective of End Product qualification to demonstrate that the spurious emission performance of the integrated RF Module is not degraded, but rather that the End Product complies with all RF requirements including the Spurious Emission requirements as defined in test case TRC/ CA/ 01.

When integrating a pre-tested RF Module into an End product, conformance implications (risks) may result from design changes relative to the reference design tested. The following table shows the relationship between these design changes, possible conformance implications, test cases whose applicability might be affected, and conditions under which those affected test cases might continue to be accepted as part of Covered Functionality.

Change / integration into	Risk / Implication	Affected test cases	Conditions for not running the listed test cases
External oscillator added	Frequency drift and stability, spectrum, spurious emissions and receiver performance could be affected Baseband timing could be affected	TRM/CA/04/C TRM/CA/05/C TRM/CA/06/C TRM/CA/08/C TRM/CA/09/C TRC/CA/01/C RCV/CA/02/C RCV/CA/03/C RCV/CA/04/C TP/PHYS/TRX/BV-01-E/C (Master TX timing) and other appropriate Baseband physical test cases	Evidence proving that the external oscillator circuit signal and noise parameters are within the tested reference implementation specification.
Host with internal power regulator/supply	The host power supply may affect all RF parameters	All test cases	Evidence proving that the host power supply voltage is within the limits specified for the pre-tested module
Heat producing host	The temperature may affect all Physical parameters (RF and Baseband)	All RF test cases TP/PHYS/TRX/BV-01-E/C (Master TX timing) and other appropriate Baseband physical test cases	Evidence proving that the BT module is not exposed to temperatures exceeding the temperature range of the pre-tested module
Implementation in host where antenna gain or antenna port is changed	Antenna radiation pattern might change giving an increase in eirp.	TRM/CA/01/C TRM/CA/04/C	Evidence that the antenna gain change is within the margin of the pre-tested module
Adding shielding in the host to an unshielded module	Radiated power, spectrum, spurious emission and receiver performance	TRM/CA/01/C TRM/CA/04/C TRC/CA/01/C RCV/CA/04/C RCV/CA/06/C As a minimum	Evidence that the parametric data of the pre-tested module is not affected by the adding the shielding.

5.4 Changes which may affect Covered Functionality

The following changes in the reference design may affect the Covered Functionality (valid for RF modules as defined in chapter 5.1):

5.4.1 Hardware changes

Any hardware change of a RF module or in the reference design of a chip will be considered as a Class 3 change in accordance to the PRD version 1.0.

Note: A hardware change is not limited to the PCB layout. Changing the capacitors of the oscillator circuit for example will require retesting even if capacitors with same values are in use. They might have a completely different temperature behavior.

5.4.2 Replacing the antenna port

If the antenna port is replaced, the attenuation of the feed transmission line or cable shall be accounted for in the antenna gain. An adequate implementation shall be used (low insertion loss in connection); if not, TRM/ CA/ 01/ C (Output power; normal conditions only) shall be checked.

The Receiver Sensitivity test case using longest supported packet type (under normal conditions only) shall be tested again because test results do not contain data concerning the receiver sensitivity margin to the limit (-70 dBm). This test case verifies that the device operates correctly at -70 dBm input signal. If the component qualification verifies that sensitivity is better than -70 dBm, then inspection of insertion loss may be sufficient.

Cable and connector attenuation influences the radiated RF power and the receiver sensitivity level.

Note: Performing both above mentioned test cases (Output Power and Receiver Sensitivity) instead of evaluating the attenuation of the feed transmission line or cable and its associated shield termination may be more efficient and practical.

5.4.3 Adding a power amplifier to increase the output power

Complete RF testing is required unless the BQB has substantial evidence that some test cases do not need to be repeated.

5.4.4 Using a regulated power supply for the RF-module

If the host implementation places a regulated supply voltage within the voltage range of the pre-tested and qualified component it is not needed to test the device under extreme voltage conditions again. The regulated power supply voltage is considered acceptable and independent of host voltage variations (evidence under host full load conditions and temperature extremes is needed). If needed the RF re-testing should not be done over complete extreme voltage conditions but the full range of the temperature variation shall be covered.

5.5 Needed information in the RF components QPN

The following information shall appear in the pre-tested RF component's QPN to aid the BQB who qualifies the End Product:

- Covered Functionality (out of ICS and more)
- Component type: Integrated Circuit / Module
- Voltage and temperature range
- Maximum antenna gain
- Antenna used: external / internal / both
- Oscillator: external / internal

Note: The Voltage and temperature range is also required for BB components