

Introduction

This document provides a guideline for the execution of the ETSI radio certification tests of Zigbee / Matter™ / Bluetooth® Low Energy modules using QPG6105 chips. This document focusses on Zigbee / Matter certification for the ETSI regulatory domain.

At start of the radio certification test the applicable PHY can be selected in the Radio Control Console software [1].

This document is based on, and compliant with, the technical requirements given in ETSI EN 300 328 v2.2.2, see [3].

! **Obtaining regulatory certifications is the responsibility of the end customer.**

Table of Contents

1	Device under Test (DUT).....	2
2	Block Diagrams and Functional Description.....	2
2.1	General Description.....	2
2.2	Power Regulation.....	2
2.3	Frequency Synthesis and Modulation.....	3
2.4	RF Interface.....	3
3	Radio Information.....	3
3.1	Applicable Standard.....	3
3.2	Receiver category.....	3
3.3	Medium Utilization.....	4
3.4	Zigbee / Matter Frequency Range.....	4
3.5	Frequency Generation Scheme.....	4
3.5.1	TX mode.....	4
3.5.2	RX mode.....	4
4	Operating Manual.....	5
4.1	System Setup.....	5
4.2	Quick Start Guide at Terminal Emulator.....	7
5	RF Testing.....	8
5.1	Select the PHY Mode.....	8
5.2	Select RF Port/Antenna.....	8
5.3	Set-Up Procedure for TX Modes.....	8
5.3.1	Configure Board Support Package.....	8
5.3.2	Enable Low Out-of-Band Spurious Mode.....	8
5.3.3	Select Output Power Level.....	9
5.3.4	Select RF Channel.....	9
5.3.5	Turn TX on, (Un-)modulated CW.....	9
5.4	Transmit Packets.....	9
5.4.1	Set-up Procedure for RX Mode.....	10
5.4.2	Select RF Channel.....	10
5.4.3	Turn RX On.....	10
5.4.4	Print Packets Sent/Received in RF4CE.....	10
6	Annex E.....	11

1 Device under Test (DUT)

This certification guide has been customized for the following product:

Type: QPE6105A
 Model: 19644_QPE6105a_Module
 H/W Revision: 0.60 onwards
 S/W Revision: PTC_QPG6105_10DBM_CFG_B_v1.9.0.0.dll

2 Block Diagrams and Functional Description

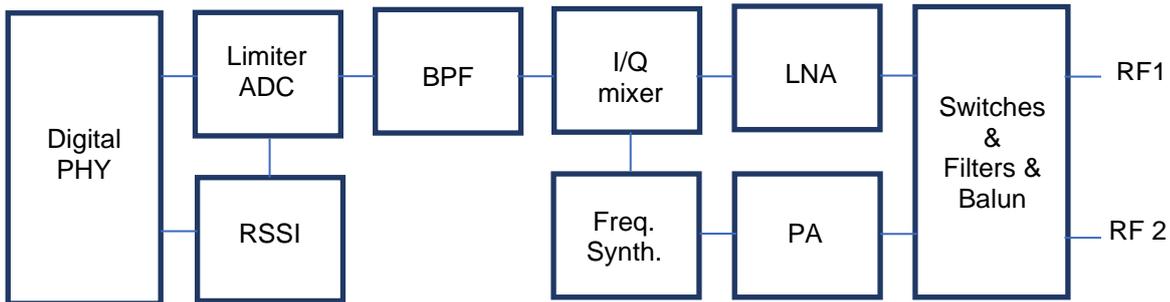


Figure 1: Block Diagram of the QPG6105 Chip

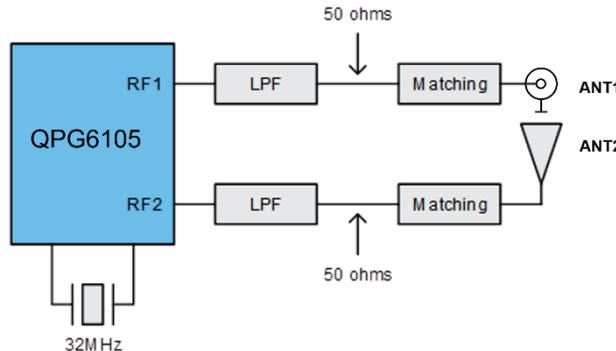


Figure 2: RF Block Diagram of the QPE6105A Module with one Embedded Antenna and one Antenna Pin

2.1 General Description

The QPG6105 chip is an **IEEE 802.15.4 / Bluetooth® Low Energy** Multi-Protocol Multi-Channel Communications Chip for ultra-low power wireless communications for remote controls. It is compliant with the IEEE Standard 802.15.4 for RF4CE Zigbee, and the Bluetooth Core Specification v 5.3 for Bluetooth Low Energy. In IEEE 802.15.4 communications, as used for Zigbee and Matter, antenna diversity offers additional robustness in a crowded wireless 2.4 GHz environment.

2.2 Power Regulation

The QPG6105 chip has an integrated power management system using a Global Low Dropout Regulator (GLDO). This generates an internal 1.8 V power supply. The internal 1.8 V power rail is used to supply separate local LDO regulators feeding RF/analog and digital blocks. The local LDOs used to supply RF/analog blocks are specially designed to have high power supply rejection ratio (PSRR) to suppress the supply ripples.

In case the external supply voltage is too low to deliver the 1.8V internal supply voltage, the QPE6105A will reset and consequently stop all RF communication. This means that RF frequency and RF modulation will be independent from the supply voltage.

2.3 Frequency Synthesis and Modulation

The QPG6105 chip uses a FLL circuit with a VCO operating at 2 times the transmit frequency. The VCO is directly modulated by digital signal processor (DSP). The modulation is fully compatible with the offset quadrature phase- shift keying (O-QPSK) as required by the IEEE802.15.4 standard, and with different settings it also supports MSK modulation as used by BLE.

The receiver uses a low intermediate frequency (IF) scheme, where the IF frequency is 2 MHz. The formula to calculate the VCO frequency in RX mode can be found in section 3.5.2.

2.4 RF Interface

The QPG105 has two RF outputs: RF1 and RF2. Both RF ports are bidirectional and will be used for both transmit (TX) and receive (RX) mode. The antenna ports outputs are 50 Ω single ended. Only one antenna is used for RX or TX at the time (i.e., not supporting MIMO).

3 Radio Information

3.1 Applicable Standard

ETSI EN 300 328 V2.2.2 as mentioned in [3].

Verify with the test house which version of the standard to use.

The modulation can be considered as non-FHSS, see paragraph “4.21 Wideband Data Transmission equipment types” in ref [3].

3.2 Receiver category

See paragraphs in ref [3]:

4.2.3.2.1	<p>Receiver category 1: adaptive equipment with a maximum RF output power greater than 10 dBm e.i.r.p. NOTE: Non-adaptive equipment is categorized as receiver category 2 or receiver category 3.</p>
4.2.3.2.2	<p>Receiver category 2:</p> <ul style="list-style-type: none"> • non-adaptive equipment with a Medium Utilization (MU) factor greater than 1 % and less than or equal to 10 % (irrespective of the maximum RF output power); or • equipment (adaptive or non-adaptive) with a maximum RF output power greater than 0 dBm e.i.r.p. and less than or equal to 10 dBm e.i.r.p.
4.2.3.2.3	<p>Receiver category 3:</p> <ul style="list-style-type: none"> • non-adaptive equipment with a maximum Medium Utilization (MU) factor of 1 % (irrespective of the maximum RF output power); or • equipment (adaptive or non-adaptive) with a maximum RF output power of 0 dBm e.i.r.p.

The receiver class for most applications is Category 2.

The maximum TX output power of the QPG6105 chip is 10 dBm. The max. gain of the embedded antenna is -3 dBi, so the device will stay within the 10 mW/MHz spectral density requirement. An external antenna can be connected to the module antenna pin. The gain of this antenna should stay below 0 dBi at 10 dBm TX power level to stay within the 10 mW/MHz spectral density requirement. It is possible within Receiver Category 2 to use an antenna with higher gain if power is backed off.

NOTE: The IEEE 802.15.4 2.4 GHz OQPSK modulation as used for Zigbee and Matter allows to certify with 11 dBm EIRP without violating the 10 mW/MHz spectral density limit of ref [3]. An example of such an application is when an external antenna is used with 1 dBi gain at 10 dBm TX power. In such a case the Receiver Category will be Category 1.

3.3 Medium Utilization

See ref. [3] paragraph 4.3.2.5

The Medium Utilization (MU) factor is a measure to quantify the number of resources (Power and Time) used by non-adaptive equipment. The Medium Utilization factor is defined by the formula:

$$\text{MU} = (\text{Pout} / 100 \text{ mW}) \times \text{DC}$$

where:

MU is Medium Utilization.

Pout is the RF output power as expressed in mW.

DC is the Duty Cycle expressed in %.

For non-adaptive non-frequency hopper spread spectrum modulation the limit is defined in paragraph 4.3.2.5.3 of ref. [3].

The maximum Medium Utilization factor for non-adaptive non-FHSS equipment shall be 10 %.

In the case of Receiver Category 2, with a maximum TX power of 10 dBm EIRP which complies with 10 mW even with 100% DC, the MU will never exceed 10%. This implies that it is not needed to measure the MU, medium utilization, or to measure adaptivity.

In case it is chosen to certify according to Receiver Class 1 (11 dBm EIRP using external antenna) the maximum TX duty cycle for an end node in a 100 ms observation interval occurs when 4 maximum length packets are transmitted. The maximum packet length is 133 bytes (127 bytes payload + 4 bytes preamble + 1 bytes SFD + 1 byte length indication).

The length of 1 byte is 32 μ s, so the max. packet length is **133 * 32 = 4256 μ s.**

The maximum duty cycle in Zigbee / Matter End Node mode is **(4 * 4256) \div 100 = 17 %.**

3.4 Zigbee / Matter Frequency Range

The Zigbee / Matter PHY supports 16 RF-channels; these channels are the following IEEE802.15.4 channel numbering. These RF channels have center frequencies of 2400 + (k-10) * 5 MHz, where k = 11, ..., 26. “k” is the channel number.

The frequencies are:

- CH 11 2405 MHz
- CH 12 2410 MHz
-
- CH 26 2480 MHz

3.5 Frequency Generation Scheme

3.5.1 TX mode

The local oscillator operates on 2 times the TX frequency. The local oscillator is directly modulated.

3.5.2 RX mode

The local oscillator operates on (Fo + 2) * 2, where Fo is frequency of the RF channel [MHz].

4 Operating Manual

4.1 System Setup

Test software allowing to control the radio is distributed via Radio Control Software packages ref [1] and [2]. These packages consist of a Radio Control Console (RCC) PC application and Product Test Component (PTC) firmware binaries. Below figure shows the high-level overview of the system.

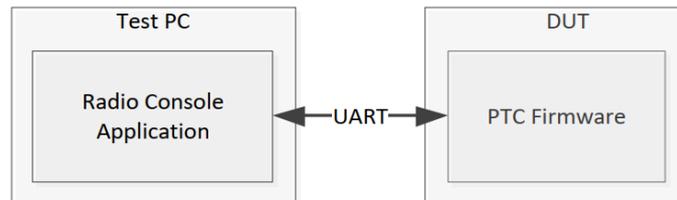


Figure 3: System Setup

The PTC firmware [2] should be flashed to the processor of the DUT. The RCC application can be started by means of the RadioConsoleControl.exe executable.



Figure 4: QPE6105a Module on Radio Adaptor Board

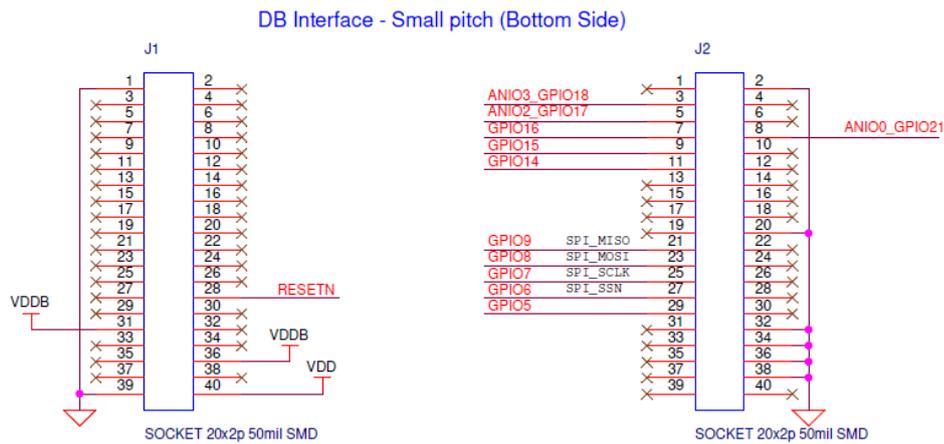
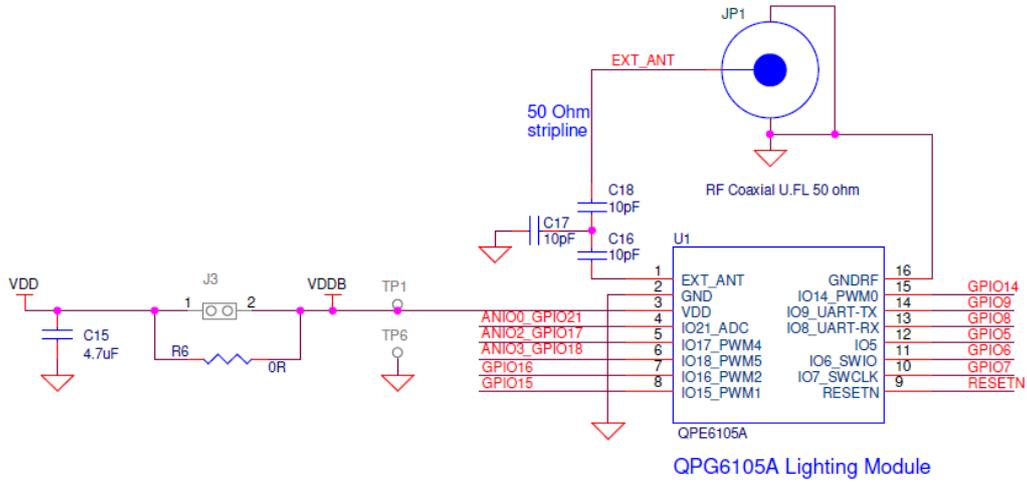


Figure 5: Pinout QPE6105A Radio Adaptor Board

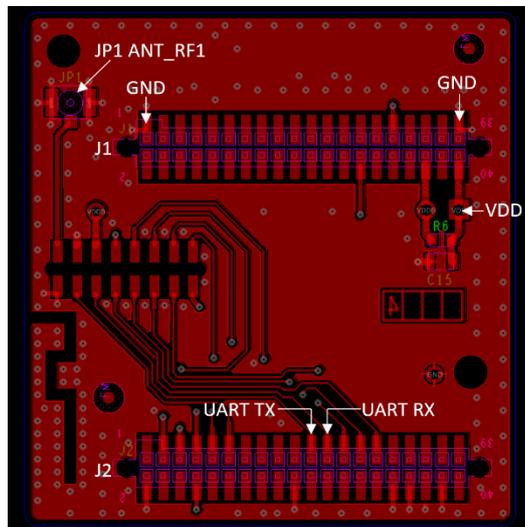


Figure 6: Connecting Power Supply and UART Interface on Radio Adaptor Board

Connecting power supply and UART interface on adaptor board:

- JP1 UFL connector for ANT_RF1
- J1 pin 1, 39 GND
- J2 pin 2, 20, 32, 34, 36, 38 GND
- J2 pin 21 J2 GPIO9 UART TX, Data from target to the tester
- J2 pin 23 J2 GPIO8 UART RX, Data from tester to the target
- J1 pin 40 VDD 1.8 ~ 3.6 V; nominal voltage is 3.0V

4.2 Quick Start Guide at Terminal Emulator

The commands required to perform the Certification Test are listed in Table 1 below. For information on the full command set of this application, see [1].

At start of the test the intended PHY needs to be selected. Please use the “PHY” command to do this.
 In case of issues (e.g., non-responsive device) please repeat the power up cycle.

Table 1: Radio Control Console Command Set

Commands	Descriptions
H	Show Help on all possible commands
PHY BLE/RF4CE	Select the BLE or RF4CE (Zigbee) PHY.
I	Print the current settings/state of the chip
AN 0	Select antenna port.
CH 20	Set channel to channel 20 “CH [space] 20”, channel 0 to 39 can be selected.
W 10	Set TX power to 10 dBm. Supported W inputs: 10 to -24 in steps of 1 dB
CW U	Configure DUT to send Continuous Unmodulated wave
CW M	Configure DUT to send Continuous Modulated wave
SETCW ON/OFF	Start/stop Continuous Wave (CW) transmission
RX ON/OFF	Switch on/off receiver
RXP ON/OFF	Switch ON/OFF display of received packets
P	Show packet statistics
R	Reset packet statistics
TX <number>	Transmits packets with a payload from SETTXDATA command.
TXR <number>	Transmit packets with random payload. The number of packets, transmission
PACKETLENGTH	Set packet length in bytes.
SETTXDATA	6..250 character string where each character is interpreted as a hexadecimal value
MR <number>	Number of retries 0 to 5.

5 RF Testing

Devices for certification tests are loaded with PTC software. With this software, it is possible to perform all radio tests. Detailed instructions on how to use this software can be found in ref [1]

5.1 Select the PHY Mode

Make sure that RF4CE is selected:

- PHY RF4CE select RF4CE (default)

5.2 Select RF Port/Antenna

Select antenna port:

- AN 0 Select RF1 port, this port is connected to the external antenna pin
- AN 1 Select RF2 port, this port is connected to the embedded antenna

5.3 Set-Up Procedure for TX Modes

5.3.1 Configure Board Support Package

Recommend copying paste the command in the Console window.

- WR 0x008e 0x007

To verify if the correct data is written, the following command can be used:

- RR 0x008e will display content of register 0x008e

5.3.2 Enable Low Out-of-Band Spurious Mode

In this mode the modulating signal is filtered to reduce the out-of-band emissions. To enable the filter the following commands should be executed. The commands are register writes in the radio chip volatile memory, so the information needs to be rewritten after a power cycle.

```
WR 0x0120 0
WR 0x0121 0
WR 0x0122 0
WR 0x0123 0
WR 0x0124 0
WR 0x0125 0
WR 0x0126 2
WR 0x0127 6
WR 0x0128 14
WR 0x0129 28
WR 0x012a 50
WR 0x012b 74
WR 0x012c 95
WR 0x012e 104
WR 0x012f 0
```


5.4.1 Set-up Procedure for RX Mode

Before the RX test, please make sure TX is OFF, to be sure RESET the DUT by power cycling and restarting the Radio Control Console application (see also section 5.1).

5.4.2 Select RF Channel

See 5.3.4 to select an RF channel.

5.4.3 Turn RX On

At the console enter:

- RX ON
- RXP ON to enable display of packets received

5.4.4 Print Packets Sent/Received in RF4CE

- RX OFF
- P print number of received packets
- R reset the number of the sent/received counter

6 Annex E

(copied from ref[3])

The information below is provided as example only.

NOTE: comments are in red.

Annex E (informative): Application form for testing

E.1 Introduction

Notwithstanding the provisions of the copyright clause related to the text of the present document, ETSI grants that users of the present document may freely reproduce the application form pro forma in this annex so that it can be used for its intended purposes and may further publish the completed application form.

The form contained in this annex may be used by the manufacturer to comply with the requirement contained in clause 5.4.1 to provide the necessary information about the equipment to the test laboratory prior to the testing. It contains product information as well as other information which might be required to define which configurations are to be tested, which tests are to be performed as well the test conditions.

This application form should form an integral part of the test report.

E.2 Information as required by ETSI EN 300 328 V2.2.2, clause 5.4.1

In accordance with ETSI EN 300 328, clause 5.4.1, the following information is provided by the manufacturer.

a) The type of wideband data transmission equipment:

- FHSS
- non-FHSS (select non-FHSS)

b) In case of FHSS: (not applicable)

- In case of non-Adaptive FHSS equipment:
The number of Hopping Frequencies:
- In case of Adaptive FHSS equipment:
The maximum number of Hopping Frequencies:
The minimum number of Hopping Frequencies:
- The (average) dwell time:

c) Adaptive/non-adaptive equipment:

- non-adaptive Equipment
- adaptive Equipment without the possibility to switch to a non-adaptive mode
- adaptive Equipment which can also operate in a non-adaptive mode

(Select non-adaptive equipment, as EIRP power stays below 10 dBm, there is no need to prove adaptivity, so simplifies testing.

d) In case of adaptive equipment:

The maximum Channel Occupancy Time implemented by the equipment: ms

- The equipment has implemented an LBT mechanism
 - In case of non-FHSS equipment:
 - The equipment is Frame Based equipment
 - The equipment is Load Based equipment
 - The equipment can switch dynamically between Frame Based and Load Based equipment
The CCA time implemented by the equipment: μs
 - The equipment has implemented a DAA mechanism
 - The equipment can operate in more than one adaptive mode

e) In case of non-adaptive Equipment:

The maximum RF Output Power (e.i.r.p.): ...10..... dBm (see paragraph 3.2)

The maximum (corresponding) Duty Cycle: ...17..... % (17 % in End Node mode, 80 % absolute max in Router mode)

Equipment with dynamic behaviour, that behaviour is described here. (e.g. the different combinations of duty cycle and corresponding power levels to be declared):

.....
.....
.....

f) The worst case operational mode for each of the following tests:

- RF Output Power
Default TX power of 10 dBm and -3 dBi antenna gain (when using embedded antenna, in case of external antenna adjust Power Spectral Density statement below)
- Power Spectral Density
10 + -3 = 7 dBm EiRP (PSD in 1 MHz BW)
- Duty cycle, Tx-Sequence, Tx-gap
see paragraph 5.4
- Accumulated Transmit time, Frequency Occupation & Hopping Sequence (only for FHSS equipment)
- Hopping Frequency Separation (only for FHSS equipment)
- Medium Utilization
10 mW /100 mW * 17% = 1.7% End Node Mode
- Adaptivity & Receiver Blocking
Receiver class 2 for most applications, see 3.3
- Nominal Channel Bandwidth
5 MHz
- Transmitter unwanted emissions in the OOB domain
< -30 dBm/MHz
- Transmitter unwanted emissions in the spurious domain
<< -30 dBm/MHz
- Receiver spurious emissions
<< -47 dBm

g) The different transmit operating modes (tick all that apply):

- Operating mode 1: Single Antenna Equipment
 - Equipment with only one antenna
 - Equipment with two diversity antennas but only one antenna active at any moment in time
 - Smart Antenna Systems with two or more antennas, but operating in a (legacy) mode where only one antenna is used (e.g. IEEE 802.11™ legacy mode in smart antenna systems)

- Operating mode 2: Smart Antenna Systems - Multiple Antennas without beam forming
 - Single spatial stream/Standard throughput/(e.g. IEEE 802.11™ legacy mode)
 - High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 1
 - High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 2

NOTE 1: Add more lines if more channel bandwidths are supported.

- Operating mode 3: Smart Antenna Systems - Multiple Antennas with beam forming
 - Single spatial stream/Standard throughput (e.g. IEEE 802.11™ legacy mode)
 - High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 1
 - High Throughput (> 1 spatial stream) using Nominal Channel Bandwidth 2

NOTE 2: Add more lines if more channel bandwidths are supported.

h) In case of Smart Antenna Systems:

- The number of Receive chains:
- The number of Transmit chains:
 - symmetrical power distribution
 - asymmetrical power distribution

In case of beam forming, the maximum (additional) beam forming gain: dB

NOTE: The additional beam forming gain does not include the basic gain of a single antenna.

i) Operating Frequency Range(s) of the equipment:

- Operating Frequency Range 1: ..2405..... MHz to2480..... MHz
- Operating Frequency Range 2: MHz to MHz

NOTE: Add more lines if more Frequency Ranges are supported.

j) Nominal Channel Bandwidth(s):

- Nominal Channel Bandwidth 1: ..5..... MHz
- Nominal Channel Bandwidth 2: MHz

NOTE: Add more lines if more channel bandwidths are supported.

k) Type of Equipment (stand-alone, combined, plug-in radio device, etc.):

- Stand-alone
- Combined Equipment
- Plug-in radio device
- Other

l) The normal and the extreme operating conditions that apply to the equipment:

Normal operating conditions (if applicable):

Operating temperature: ...20... °C (room temperature 0 ~ 50 degrees)

Other (please specify if applicable):

Extreme operating conditions:

Operating temperature range: Minimum: -40 °C Maximum ...125...°C

Other (please specify if applicable): Minimum: Maximum

Details provided are for the:

- stand-alone equipment
- combined equipment
- test jig

m) The intended combination(s) of the radio equipment power settings and one or more antenna assemblies

Antenna Type:

- Integral Antenna (information to be provided in case of conducted measurements)

Antenna Gain:-3..... dBi (option to use external antenna on module pin)

If applicable, additional beamforming gain (excluding basic antenna gain): dB

- Temporary RF connector provided (optional by using rigid coax)
- No temporary RF connector provided
- Dedicated Antennas (equipment with antenna connector)
 - Single power level with corresponding antenna(s)
 - Multiple power settings and corresponding antenna(s)

Number of different Power Levels:

Power Level 1: dBm

Power Level 2: dBm

Power Level 3: dBm

NOTE 1: Add more lines in case the equipment has more power levels.

NOTE 2: These power levels are conducted power levels (at antenna connector).

(The antennas used on the Qorvo remote control reference design(s) are embedded antennas with gain ≤ 3 dBi.)

- For each of the Power Levels, provide the intended antenna assemblies, their corresponding gains (G) and the resulting e.i.r.p. levels also taking into account the beamforming gain (Y) if applicable

Power Level 1: dBm

Number of antenna assemblies provided for this power level:

Assembly #	Gain (dBi)	e.i.r.p. (dBm)	Part number or model name
1			
2			
3			
4			

NOTE 3: Add more rows in case more antenna assemblies are supported for this power level.

Power Level 2: dBm

Number of antenna assemblies provided for this power level:

Assembly #	Gain (dBi)	e.i.r.p. (dBm)	Part number or model name
1			
2			
3			
4			

NOTE 4: Add more rows in case more antenna assemblies are supported for this power level.

Power Level 3: dBm

Number of antenna assemblies provided for this power level:

Assembly #	Gain (dBi)	e.i.r.p. (dBm)	Part number or model name
1			
2			
3			
4			

NOTE 5: Add more rows in case more antenna assemblies are supported for this power level.

n) The nominal voltages of the stand-alone radio equipment or the nominal voltages of the combined equipment or test jig in case of plug-in devices:

- Details provided are for the:
- stand-alone equipment
 - combined equipment
 - test jig
- Supply Voltage
- AC mains State AC voltage V
 - DC State DC voltage V

In case of DC, indicate the type of power source

- Internal Power Supply
- External Power Supply or AC/DC adapter
- Battery
- Other:

o) Describe the test modes available which can facilitate testing:

.....

.....

.....

p) The equipment type (e.g. Bluetooth®, IEEE 802.11™, IEEE 802.15.4™, proprietary, etc.):
.....IEEE 802.15. 2.4 GHz OQPSK.....

q) If applicable, the statistical analysis referred to in clause 5.4.1 q)
(to be provided as separate attachment)

r) If applicable, the statistical analysis referred to in clause 5.4.1 r)
(to be provided as separate attachment)

s) Geo-location capability supported by the equipment:

- Yes
 - The geographical location determined by the equipment as defined in clause 4.3.1.13.2 or clause 4.3.2.12.2 is not accessible to the user
- No

E.3 Configuration for testing (see clause 5.3.2.3 of ETSI EN 300 328 V2.2.2)

From all combinations of conducted power settings and intended antenna assembly(ies) specified in clause 5.4.1 m), specify the combination resulting in the highest e.i.r.p. for the radio equipment.

Unless otherwise specified in ETSI EN 300 328, this power setting is to be used for testing against the requirements of ETSI EN 300 328. In case there is more than one such conducted power setting resulting in the same (highest) e.i.r.p. level, the highest power setting is to be used for testing. See also ETSI EN 300 328, clause 5.3.2.3.

Highest overall e.i.r.p. value: ...10..... dBm	
Corresponding Antenna assembly gain:-3..... dBi	Antenna Assembly #:embedded....
Corresponding conducted power setting:10..... dBm (also the power level to be used for testing)	Listed as Power Setting # W 10

(The antenna used in the Qorvo module reference design is an embedded antennas with gain of – 3 dBi)

E.4 Additional information provided by the manufacturer

E.4.1 Modulation

ITU Class(es) of emission: ...2.2 M G1D DC (Offset-QPSK with code division multiplexing).....

Can the transmitter operate unmodulated? yes no

E.4.2 Duty Cycle

The transmitter is intended for: Continuous duty
 Intermittent duty
 Continuous operation possible for testing purposes

E.4.3 About the UUT

The equipment submitted are representative production models
 If not, the equipment submitted are pre-production models?
 If pre-production equipment are submitted, the final production equipment will be identical in all respects with the equipment tested

If not, supply full details
.....

E.4.4 Additional items and/or supporting equipment provided

- Spare batteries (e.g. for portable equipment)
- Battery charging device
- External Power Supply or AC/DC adapter
- Test jig or interface box
- RF test fixture (for equipment with integrated antennas)
- Combined equipment Manufacturer:
- Model #:
- Model name:
- User Manual
- Technical documentation (Handbook and circuit diagrams)

(This Certification guide maybe part of the technical documentation)

References

- [1] User Manual for Radio Control Console; Qorvo document GP_P864_UM_16380_PTC_Overview
- [2] Radio Control SW Package; Qorvo document GP_P864_SW_16383
- [3] ETSI EN 300 328 v2.2.2.
Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz band;
Harmonised Standard for access to radio spectrum
- [4] Product Test Component Release note; Qorvo document
GP_P864_RN_12462_ProductTestComponentReleaseNotes
- [5] Antenna Pattern report
GP_P1246_TR_20019_RD_Lighting_QPG6105_Antenna_Pattern_Measurements.xlsx
- [6] Bill of Material QPE6105a
GP_P1246_BOM_19644_RD_Lighting_QPG6105
- [7] Schematic QPE6105a
GP_P1246_HW_19642_RD_Lighting_QPG6105_SCH
- [8] PCB design files QPE6105a
GP_P1246_HW_19643_RD_Lighting_QPG6105_PCB
- [9] Bill of Material QPE6105a Radio Adaptor Board
GP_P345_BOM_19687_QPE6105A_Radio_Board
- [10] Schematic QPE6105a Radio Adaptor Board
GP_P345_HW_19685_QPE6105A_Radio_Board_SCH
- [11] PCB design files QPE6105a Radio Adaptor Board
GP_P345_HW_19686_QPE6105A_Radio_Board_PC
- [12] FCC Certification guide Zigbee / Matter™ mode
GP_P335_UM_20020_FCC_Certification_Guide_QPE6105a__IoT_Controller_Zigbee_Mode.pdf
- [13] FCC Certification guide Bluetooth Low Energy mode
GP_P335_UM_20021_FCC_Certification_Guide_QPE6105a__IoT_Controller_BLE_Mode.pdf
- [14] ETSI Certification guide Bluetooth Low Energy mode
GP_P335_UM_20256_ETSI_Certification_Guide_QPE6105a__IoT_Controller_BLE_Mode.pdf

Abbreviations

ADC	Analog-to-Digital Converter
BPF	Band-Pass Filter
BLE	Bluetooth Low Energy
CW	Continuous Wave
DUT	Device Under Test
GLDO	Global Low Dropout Regulator
LDO	Low Dropout Regulator
LNA	Low-Noise amplifier
LPF	Low-Pass Filter
PTC	Product Test Component
RCC	Radio Control Console
RCU	Remote Control Unit
VCO	Voltage Controlled Oscillator



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Document History

Version	Date	Section	Changes
0.01	2 Apr 2023		1 st Draft
0.10	18 Apr 2023		reviewed
0.20	19 Jun 2023	all	Minor textual and format changes.
0.21	19 Jun 2023	header	Title changed.
1.0	1 Aug 2023	all	Released version.