Qualcomm Technologies International, Ltd.

QCC711 Bluetooth Low Energy Hardware Design Guide

Reference

80-WL711-5 Rev. AF

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Revision history

Revision	Date	Change reason
AA	January 2022	Initial release.
AB	March 2023	Update to Table A-1 Item No. 4.
AC	July 07, 2023	Updated to QCC711.
AD	July 10, 2023	Updated to Production Information.
AE	April 2024	Updated to HTML.
AF	March 2025	Editorial updates.

Contents

Tables

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1 Introduction

This document describe the main points to consider when starting a design using QCC711, with a particular focus on printed circuit board (PCB) layout and component selection. An example application schematic and lists of preferred components are provided in QCC711 QFN PCB footprint - proposal.

When designing a system using QCC711, the board layout can influence end product performance. Qualcomm Technologies International, Ltd. (QTIL) recommends placing these PCB components in the following descending order of priority:

1. Bluetooth® radio frequency (RF) trace and pi network or band pass filter
2. Any switch-mode power supply (SMPS) components
3. Bluetooth RF decoupling
4. 32 MHz RF crystal (XTAL)
5. 32.768 kHz XTAL
6. VDD_DIG decoupling
7. Any serial peripheral interface (SPI) peripherals, while considering their fan-out
8. Any quad serial peripheral interface (QSPI) flash devices and decoupling
9. All other decoupling
10. Routing and placement of all other traces and components

NOTE For more detail and specific selection criteria about some of these components, see PCB component placement considerations.

PCB component placement considerations

Although the order of component placement directly around the QCC711 is important, it is also important to consider the whole product. QCC711 comes with a flexible internal multiplex for digital signals accessible on the programmable input/output (PIO)s. Available combinations have been chosen to aid PCB design during layout; several interfaces are available on more than one side of the quad-flat no-lead (QFN) package.

A customer product usually dictates the form factor and determines the location of key interfaces along with power input. Of these design elements, the RF antenna connection is the most important, because it needs to route with an uninterrupted 50 Ω trace to the QCC711 RF pin. With the orientation set, the position needs to leave space to route in signals to the PIOs. It is important not to route anything under the QCC711 trace or in XTAL placement locations.

Of the serial interfaces, SPI is the most challenging to route because it has the most wires, carries the fastest signals, and has limited PIO multiplexing. Once a decision has been made about which side of the the SPI will use, route in layout can start for the SMPS power supply and crystals.

The universal asynchronous receiver transmitter (UART) and inter-integrated circuit interface (I^2C) have more multiplexing options and should be considered next. Finally PIOs used for buttons or light-emitting diode (LED)s can be routed, because they are not timing critical and can take longer routes.

NOTE Try to place signal lines so that they do not disturb other sensitive circuits or cut ground planes creating electromagnetic compatibility (EMC) issues.

It is also important to route SWD pins so that QCC711 can be programmed and tested on a production line. It is also good practice to provision a VDD and VSS along with the test interface. Bringing out test pads for a UART can also help software testing and radio conformance validation if not already part of a product design.

2 QCC711 QFN PCB footprint - proposal

Figure 2-1 shows a QFN PCB footprint for QCC711.

NOTE Figure 2-1 is a proposal only; it has not been built or tested.

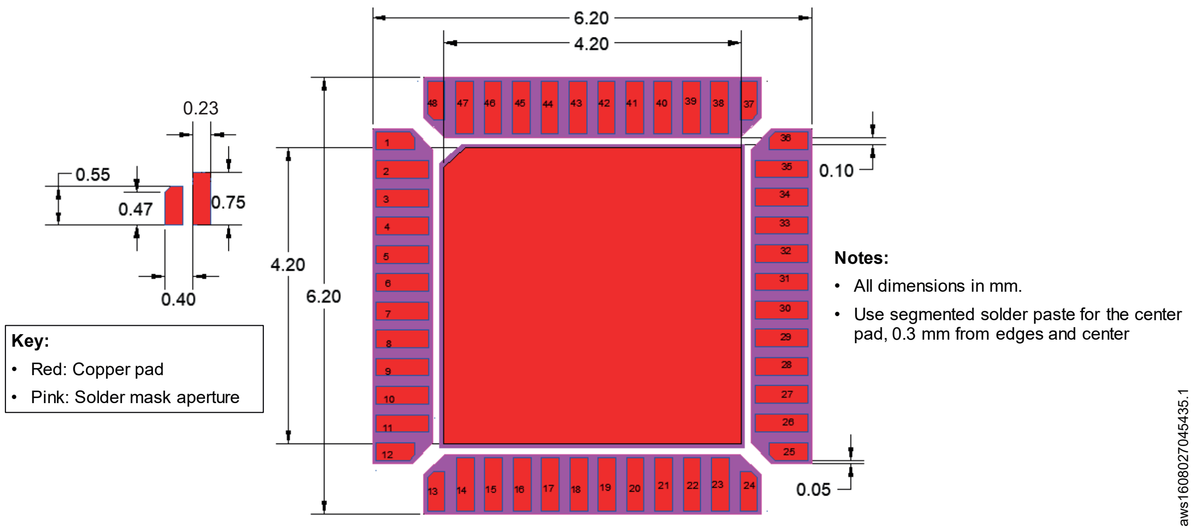

Figure 2-1 QCC711 PCB footprint - proposal

NOTE For more information about QCC711 packaging, see *QCC71x QFN 48-lead 5.6 x 5.6 mm Package Specification* (80-WL710-143).

A QCC711 example application schematic and BOM

QCC711 example application schematic

Figure A-1 shows the example application schematic for QCC711.

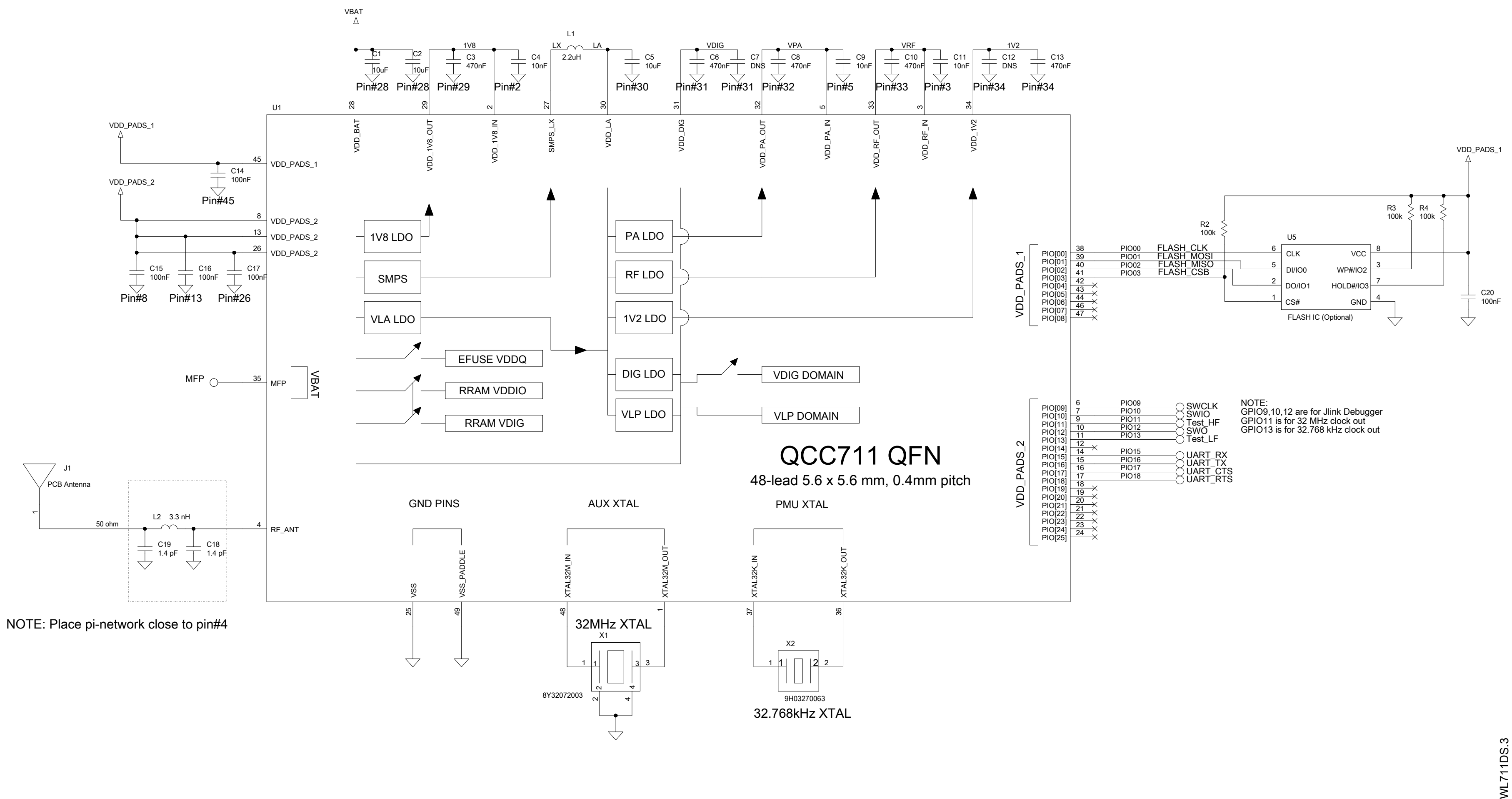

Figure A-1 QCC711 QFN example application schematic

QCC711 bill of materials

Table A-1 lists the bill of materials (BOM) of the system components for the QCC711 example application schematic shown in this document.

NOTE For clarity, the BOM excludes peripheral circuit components that are application dependent.

For more information about QCC711, see the *QCC711 Bluetooth Low Energy Data Sheet* (80-WL711-1).

Table A-1 QCC711 bill of materials

Item no.	Qty req.	Circuit ref.	Description	Value	Tolerance	Voltage	Material	Package	Manufacturer	Manufacturer's part no.
1	1	U1	QCC711 QFN 48-lead 5.6 x 5.6 x0.85 mm 0.4 mm pitch	QCC710 QFN	-	-	-	QFN 48-lead 5.6 x5.6 x 0.85mm 0.4 mm pitch	Q	QCC-711-0-MQFN48C-MT-03-0 or QCC-711-0-MQFN48C-TR-03-0
		X1	Crystal	32 MHz	±10 ppm	-	-	2.0 x 1.6 mm	Murata	XRCGB32M000F1H19R0
3	1	X2	Crystal	32.768 kHz	±3 ppm	-	-	3.2 x 1.5 mm	TXC	9H03270063
4	3	C1, C2, C5	Capacitor	10 µF	20%	10 V	X5R	0603	Murata	GRM155R61A106ME11D
5	5	C3, C6, C8, C10, C13	Capacitor	470 nF	10%	10 V	X5R	0402	Murata	GRM155R61A474KE15D
6	3	C4, C9, C11	Capacitor	10 nF	10%	6.3 V	X7R	0402	Murata	GRM155R70J103KA01D
7	4	C14, C15, C16, C17	Capacitor	100 nF	20%	10 V	X7R	0402	Murata	GRM155R71H104KE14D
8	1	L1	Inductor	2.2 µH	20%	-	-	0805	Samsung	CIGT201610EH2R2MNE
9	1	L2	Inductor	3.3 µH	+/- 0.1 nH	-	-	0201	Murata	LQP03TN3N3B02
10	2	C18, C19	Capacitor	1.4 pF	+/- 0.05 pF	25 V	C0G/NP0	0201	Murata	GJM0335C1E1R4WB01D

B Recommended SMPS components specification

This section describes the key specification requirements for the power inductor and capacitors to be used with QCC711.

B.1 Inductor specification

Table B-1 lists SMPS information relevant to the inductor choice.

Table B-1 SMPS inductor specification

Parameter	SMPS
Output voltage	1.35 V
Operation modes	PFM, ULP
PFM / ULP frequency	Dependent on load
PFM / ULP max load current	80 mA / 1 mA
Max inductor current in PFM/ULP modes	500 mA (independent of load)
Minimum inductor saturation current (current limit operational). **Note:** The inductor saturation current is the point where the inductance is 30% below the nominal value. This is not the inductor rated current.	500 mA
Nominal inductor value	2.2 µH (±20%)
Inductor ESR / DCR	100 mΩ, lower values are preferred for SMPS efficiency

B.2 Inductor selection considerations

Best switch mode efficiency is obtained by selecting an inductor with a low-resistance DCR. Alternatively, a high saturation current capability is good indicators of low loss. These two parameters tend to be correlated.

B.3 Recommended inductors

The parts in Table B-2 meet the specification detailed in this document and have been tested by QTIL.

Table B-2 SMPS recommended inductors

Manufacturer	Case (metric)	Part number
Samsung	2016	CIGT201610EH2R2MNE
Murata	0508 (imperial)	LQM21PN2R2NGC

B.4 SMPS capacitor specification

Table B-3 lists the SMPS capacitor specification.

Table B-3 SMPS capacitor specification

Parameter	VBAT 10 µF	VDD_LA 10 µF
Dielectric	X5R / X7R	
Package Size	0603 (imperial)	
Tolerance	±20%	
Max DC voltage derate	<30% at 3.6 V	<30% at 2.0 V
Rated voltage	≥6.3 V	≥6.3 V
Max ESR	<50 mΩ	

B.5 SMPS capacitor selection considerations

When selecting a capacitor check the reduction in capacitance versus direct current (DC) bias across the capacitor. Where a small body size is chosen relative to the nominal capacitance value then the derate must be checked as it can be significant, in some instances near 50%. A larger body size generally tends to alleviate the C_DC reduction.

C Recommended crystals specification

This section describes the key specification requirements for crystals to be used with QCC711.

C.1 32.768 kHz crystal performance specification

Table C-1 lists 32.768 kHz crystal performance specifications for QCC711.

NOTE Performance is to be met over operating temperature range unless otherwise stated.

Table C-1 QCC711 32.768 kHz crystal specification

Parameter	Min	Typ	Max	Units	Notes
Operating frequency	-	32.768	-	kHz	-
Mode of Vibration	Fundamental				AT-cut fundamental.
Initial frequency tolerance	-20	-	20	ppm	25°C ± 3°C.
Turnover	20	25	30	°C	-
Parabolic coefficient	-0.04	-	-	ppm/°C^2	-
Aging	-	-	3	ppm/year	-
Operating temperature	-40	-	85	°C	-
Storage temperature	-40	-	125	°C	-
Equivalent series resistance	-	-	90	kΩ	-
Motional capacitance	0.6	-	10	fF	-
Shunt capacitance	-	-	1.5	pF	-
Load capacitance	4	-	12.5	pF	-
Drive Level	-	-	1	µW	-
Insulation resistance	500	-	-	MΩ (100 V)	-

C.2 32.768 kHz crystal selection considerations

Best power consumption is obtained by using a crystal with the lowest possible matching load capacitance and equivalent series resistance (ESR). This permits a lower drive level setting of the driver circuit. The expectation is that changing from a typical 6 pF to 4 pF load capacitance crystal, could save approximately 28 nA in Deep Sleep mode. Optimal power consumption is obtained with a crystal with a 4 pF capacitance load.

C.3 32.768 kHz recommended crystals

NOTE The parts in Table C-2 meet the specification detailed in this document and have been tested by QTIL. Customers should satisfy themselves that the oscillator has sufficient margin in their design with any crystal resonator they select.

Table C-2 QCC711 32.768 kHz recommended crystals

Frequency	Temp. range	Package	C load	Manufacturer	Part number
32.768 kHz	-40°C / 85°C	3215	6 pF	TXC	9H03270063
32.768 kHz	-40°C / 85°C	3215	4 pF	TXC	9H03270095
32.768 kHz	-40°C / 85°C	3215	6 pF	Siward	XTL721-Q23-048 [a]
32.768 kHz	-40°C / 85°C	2012	4 pF	Siward	XTL741-Q23-057

[a] This component is the baseline for QCC711.

C.4 32 MHz crystal performance specification

Table C-3 lists performance to be met over operating temperature range unless otherwise stated.

Table C-3 Electrical requirements

Parameter	Description	Min	Typ	Max	Units	Notes
F_{nom}	Nominal fundamental frequency	-	32	-	MHz	-
C_P	Package capacitance (32 MHz)	-	1	2	pF	-
C_L	Load capacitance	-	6	10	pF	-
F_tol_nom	Frequency tolerance nominal	-10	-	10	ppm	At 25°C ± 3°C
F_tol_temp	Frequency stability over temperature	-10	-	10	ppm	Over specified temperature range with respect to frequency error at nominal
F_tol_aging	Frequency tolerance with aging at Ta = 25°C ± 3°C	-1	-	1	ppm/yr	1st year
F_tol_aging_10yrs	Total frequency tolerance with aging over 10 years	-10	-	10	ppm	-
ESR	Motional Resistance (32 MHz)	-	25	50	Ω	-
Drive Level	DL	-	100	200	µW	-

C.5 32 MHz crystal selection considerations

To meet the Bluetooth specification, it is important that the frequency tolerance of the 32 MHz clock stays within ±20 ppm for the lifetime of the product. A customer should remove initial frequency error at production test, by adjusting load capacitors. Load capacitor adjustment removes error introduced by the crystal, assembly, and parasitics; particularly for board and chip pin. Remaining tolerance should be provided to handle the effects of temperature and aging.

A number of crystals are recommended in Appendix C.6 that have a 6 pF load capacitance. These crystals have been proven to work with the default crystal oscillator settings. Other crystals may need adjustment of crystal oscillator settings to guarantee start-up and ensure that the crystal is not overdriven.

C.6 32 MHz recommended crystals

NOTE The parts in Table C-4 meet the specification detailed in this document and have been tested by QTIL. Customers should satisfy themselves that the oscillator has sufficient margin in their design with any crystal resonator they select.

Table C-4 QCC711 32 MHz recommended crystals

Frequency	Temp. range	Package	C load	Manufacturer	Part number
32 MHz	-40°C / 85°C	2016	6 pF	Murata	XRCGB32M000F1H19R0 [a]
32 MHz	-40°C / 85°C	2016	6 pF	TXC	8Y32072003
32 MHz	-40°C / 85°C	2016	6 pF	Siward	XTL501-Q23-045
32 MHz	-40°C / 85°C	2016	6 pF	KDS	1ZZNAE32000ZZ0C

[a] This component is the baseline for QCC711.

D RF matching network

When utilizing small form factor antennae used in portable products, a perfect match for the 50 Ohm RF port of the QCC711 is not always achievable and so a matching network is recommended.

In the later design cycles, if required, OEMs can recommend values to aid matching between the antenna and QCC711, or create a simple filter network for either emissions or immunity improvement. The following example schematic shows two shunt capacitors (1.4 pF) and a series inductor (3.3 nH) which can be very useful when optimizing for the best radio performance. This example combination also has good bandpass properties. Using the footprint of 0201 or 0402 is usually sufficient.

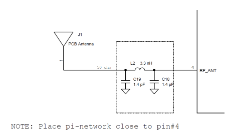

Figure D-1 Example schematic for RF matching network

E PIO allocation table

This section reviews the features available on PIOs, and maps available functions to the example application schematic.

In Table E-1, each row represents a physical PIO, while columns list features that can be selected. From available options, the design process involves selecting the following:

- SPI interface supported by `SE0 GPIO[8:4]` as well as `SE1 GPIO[20:16]`.
- Pins were then allocated for the optional external SPI flash from the dedicated Quad SPI Flash controller (configured in single/dual mode).
- Other ancillary controls from the processor populated the remaining pins.

NOTE In Table E-1, the design decisions described above are highlighted in bold. Other possible options are shown in regular font.

Table E-1 QCC711 PIO allocation table

Serial engine	SE0[a]	SE2[a]	SE1[a]	SE3				
PIO No.	**EP: 3-wire SPI (4-wire)**	**NFC: I²C**	**Test UART**	**DMA**	**Test/LED**	**Quad SPI flash**	**LED controller**	**Analog input**
0	-	se_2_port_0 _copy0	se_1_port_0 _copy0	se_3_port_0 _copy0	-	qspi_clk _copy0	led_blue _copy0	-
1	-	se_2_port_1 _copy0	se_1_port_1 _copy0	se_3_port_1 _copy0	-	qspi_mosi _copy0	led_red _copy0	-
2	-	se_2_port_2 _copy0	se_1_port_2 _copy0	se_3_port_2 _copy0	-	qspi_miso _copy0	led_green _copy0	-
3	-	se_2_port_3 _copy0	se_1_port_3 _copy0	se_3_port_3 _copy0	-	qspi_csb _copy0	led_white _copy0	-
4	se_0_port_0 _copy1	se_2_port_4 _copy0	se_1_port_4 _copy0	se_3_port_4 _copy0	-	qspi_io2 _copy0	led_white _copy1	-
5	**se_0_port_1 _copy1**	se_2_port_0 _copy1	**se_1_port_0 _copy1**	se_3_port_0 _copy1	-	qspi_io3 _copy0	led_blue _copy1	-
6	**se_0_port_2 _copy1**	se_2_port_1 _copy1	se_1_port_1 _copy1	se_3_port_1 _copy1	-	-	led_red _copy1	-
7	**se_0_port_3 _copy1**	se_2_port_2 _copy1	se_1_port_2 _copy1	se_3_port_2 _copy1	-	-	led_green _copy1	-
8	se_0_port_4 _copy1	se_2_port_3 _copy1	**se_1_port_3 _copy1**	se_3_port_3 _copy1	-	-	-	-
9	-	se_2_port_4 _copy1	se_1_port_4 _copy1	se_3_port_4 _copy1	**SWD_CLK**	-	-	-
10	-	se_2_port_0 _copy2	se_1_port_0 _copy2	se_3_port_0 _copy2	**SWD_DIO**	-	-	-
11	-	se_2_port_1 _copy2	se_1_port_1 _copy2	se_3_port_1 _copy2	**test_hf**	**qspi_clk _copy1**	-	-
12	-	se_2_port_2 _copy2	se_1_port_2 _copy2	se_3_port_2 _copy2	**SWD_SWO**	**qspi_mosi _copy1**	-	-
13	-	se_2_port_3 _copy2	se_1_port_3 _copy2	se_3_port_3 _copy2	**test_lf**	**qspi_miso _copy1**	-	-
14	-	se_2_port_4 _copy2	se_1_port_4 _copy2	se_3_port_4 _copy2	-	**qspi_csb _copy1**	-	-
15	-	se_2_port_0 _copy3	-	-	led_white _copy8	qspi_io2 _copy1	led_blue _copy3	-
16	-	se_2_port_1 _copy3	-	-	led_white _copy9	qspi_io3 _copy1	led_red _copy3	-

Table E-1 QCC711 PIO allocation table (cont.)

Serial engine	SE0[a]	SE2[a]	SE1[a]	SE3				
PIO No.	**EP: 3-wire SPI (4-wire)**	**NFC: I²C**	**Test UART**	**DMA**	**Test/LED**	**Quad SPI flash**	**LED controller**	**Analog input**
17	-	se_2_port_2 _copy3	-	-	led_white _copy10	-	led_green _copy3	-
18	-	se_2_port_3 _copy3	-	-	-	-	led_white _copy3	-
19	-	se_2_port_4 _copy3	-	-	-	-	led_white _copy5	-
20	-	-	-	-	-	-	led_white _copy6	-
21	-	**se_2_port_0 _copy4**	-	-	-	-	led_white _copy7	-
22	-	**se_2_port_1 _copy4**	-	-	-	-	led_blue _copy4	AMUX
23	-	se_2_port_2 _copy4	-	-	-	-	led_red _copy4	**AMUX**
24	-	se_2_port_3 _copy4	-	-	-	-	led_green _copy4	AMUX
25	-	se_2_port_4 _copy4	-	-	-	-	led_white _copy4	-

[a] A PIO function can be individually selected from each column.

F RF characterization

This section presents the QCC711 RF characterization results when using the QTIL evaluation board equipped with recommended components and compiled according to layout guidelines. The tests were conducted at room temperature (25 ºC). Details on the test environment and the results are listed in the following sections of this chapter.

F.1 Bluetooth radio characteristics: Low Energy 1 Ms/s

Table F-1 Transmitter performance, low energy 1 Ms/s

RF Characteristics		Notes	Min	Typ	Max	Specification	Units
Maximum RF transmit power		(1)	6.5	7.0	-	-20 to +10	dBm
In-band spurious emissions	$F=F_0 \pm 2$ MHz	(2)(3)	-	-42	-20	$\leq$-20	dBm
	$F=F_0 \pm 3$ MHz	(2)(3)	-	-49	-30	$\leq$-30	
	$F>F_0 \pm 3$ MHz	(2)(3)	-	-60	-30	$\leq$-30	
$\Delta f1_{avg.}$ maximum modulation			225	254	275	+225 to +275	kHz
$\Delta f2_{max.}$ minimum modulation			185	256	-	$\geq$185	kHz
$\Delta f2_{avg.}/\Delta f1_{avg.}$			0.8	0.97	-	$\geq$0.8	-
Maximum carrier frequency offset		(4)	-	4	150	$\leq$150	kHz
Maximum drift rate			-	3	20	$\leq$20	kHz/50 µs
Carrier drift			-	1	50	$\leq$50	kHz
2nd harmonic content		(5)	-	-33	-		dBm
3rd harmonic content		(5)	-	-48	-		dBm

1. Specified Min value is based on statistical variance and represents the absolute limit rather than expected performance.
2. Measured at F0 = 2440 MHz.
3. Exceptions in up to three bands are allowed. For exceptions, PTX $\leq$ -20 dBm.
4. Carrier frequency offset is dependent upon crystal frequency accuracy.
5. Conducted Measurement at RF port. Use of an appropriate filter will attenuate transmit harmonics.

Receiver Performance

Table F-2 Receiver performance, low energy 1 Ms/s

RF Characteristics		Notes	Min	Typ	Max	Specification	Units
Sensitivity at 30.8% PER	2402 MHz	(1)	-	-95.0	-93.0	≤-70	dBm
	2440 MHz	(1)	-	-95.0	-93.0	≤-70	
	2480 MHz	(1)	-	-94.5	-92.5	≤-70	
Sensitivity at 30.8% PER (Boost Mode)	2402 MHz	(1)	-	-98.0	-96.0	≤-70	dBm
	2440 MHz	(1)	-	-98.0	-96.0	≤-70	
	2480 MHz	(1)	-	-97.5	-95.5	≤-70	
Reported PER during PER Report Integrity test		(1)(2)	-	50	65.4	+50 to +65.4	%
Maximum received signal at 30.8% PER			-20	≥-9	-	≥-20	dBm
Adjacent channel selectivity C/I	$F<F_0$-3 MHz	(3)(4)	-	-52	-27	≤-27	dB
	$F=F_{image}$-1 MHz	(3)(4)	-	-34	-15	≤-15	
	$F=F_{image}$	(3)(4)	-	-20	-9	≤-9	
	$F=F_0$-1 MHz	(3)(4)	-	-9	15	≤15	
	$F=F_0$	(3)(4)	-	6	21	≤21	
	$F=F_0$+1 MHz	(3)(4)	-	-10	15	≤15	
	$F=F_0$+2 MHz	(3)(4)	-	-39	-17	≤-17	
	$F=F_0$+3 MHz	(3)(4)	-	-44	-27	≤-27	
	$F>F_0$+3 MHz	(3)(4)	-	-54	-27	≤-27	
Maximum level of intermodulation interferers		(5)	-50	-24	-	≥-50	dBm

1. Measured using test packets with 37 octet payload.
2. Measured in accordance with the RF-PHY/RCV-LE/CA/BV-07-C test. Random number of packets transmitted by tester of which 50% have corrupted CRCs. Wanted signal level is -30 dBm.
3. Up to five spurious response frequencies are allowed. For these spurious response frequencies, there is a relaxed interference requirement of C/I = -17 dBm.
4. Measured at F0 = 2440 MHz. QCC711 2.0 QFN48 has an IF of 1 MHz and Fimage= F0 – 2 MHz. Depending on crystal frequency, the fimage may be on either side of the carrier, which affects the test specification limits - see RF-PHY/RCV-LE/CA/BV-03-C in the Bluetooth v5.0 RF-PHY Test Specification.
5. Integrated in 100 kHz bandwidth and normalized to 1 Hz.

F.2 Bluetooth radio characteristics: Low Energy 2 Ms/s

Table F-3 Transmitter performance, low energy 2 Ms/s

RF Characteristics		Notes	Min	Typ	Max	Specification	Units
Maximum RF transmit power		(1)	6.5	7.0	-	-20 to +10	dBm
In-band spurious emissions	$F=F_0\pm4$ MHz	(2)(3)	-	-50	-20	≤-20	dBm
	$F=F_0\pm5$ MHz	(2)(3)	-	-54	-20	≤-20	
	$F=F_0\pm6$ MHz	(2)(3)	-	-56	-30	≤-30	
	$F>F_0\pm6$ MHz	(2)(3)	-	-62	-30	≤-30	
$\Delta f1_{avg.}$ maximum modulation			450	506	550	+450 to +550	kHz
$\Delta f2_{max.}$ minimum modulation			370	508	-	≥370	kHz
$\Delta f2_{avg.}/\Delta f1_{avg.}$			0.8	0.95	-	≥0.8	-
Maximum carrier frequency offset		(4)	-	4	150	≤150	kHz
Maximum drift rate			-	2	20	≤20	kHz/50 µs
Maximum carrier frequency drift			-	1	50	≤50	kHz
2nd harmonic content		(5)	-	-33	-		dBm
3rd harmonic content		(5)	-	-48	-		dBm

1. Specified Min value is based on statistical variance and represents the absolute limit rather than expected performance.
2. Measured at F0 = 2440 MHz.
3. Exceptions in up to three bands are allowed. For exceptions, PTX ≤ -20 dBm.
4. Carrier frequency offset is dependent upon crystal frequency accuracy.
5. Conducted measurement at RF port. Use of an appropriate filter will attenuate transmit harmonics.

Receiver performance

Table F-4 Receiver performance, low energy 2 Ms/s

RF Characteristics		Notes	Min	Typ	Max	Specification	Units
Sensitivity at 30.8% PER	2402 MHz	(1)	-	-90.5	-88.5	≤-70	dBm
	2440 MHz	(1)	-	-90.5	-88.5	≤-70	
	2480 MHz	(1)	-	-90.0	-88.0	≤-70	
Sensitivity at 30.8% PER (Boost Mode)	2402 MHz	(1)	-	-93.0	-91.0	≤-70	dBm
	2440 MHz	(1)	-	-93.0	-91.0	≤-70	
	2480 MHz	(1)	-	-93.0	-91.0	≤-70	
Reported PER during PER Report Integrity test		(1)(2)	-	50	65.4	+50 to +65.4	%

Table F-4 Receiver performance, low energy 2 Ms/s (cont.)

RF Characteristics		Notes	Min	Typ	Max	Specification	Units
Maximum received signal at 30.8% PER			-20	≥-9	-	≥-20	dBm
Adjacent channel selectivity C/I	$F<F_0$-6 MHz	(3)(4)	-	-52	-27	≤-27	dB
	$F=F_0$-6 MHz	(3)(4)	-	-43	-27	≤-27	
	$F=F_{image}$-2 MHz	(3)(4)	-	-27	-15	≤-15	
	$F=F_{image}$	(3)(4)	-	-11	15	≤15	
	$F=F_0$	(3)(4)	-	6	21	≤21	
	$F=F_0$+2 MHz	(3)(4)	-	-15	15	≤15	
	$F=F_0$+4 MHz	(3)(4)	-	-42	-17	≤-17	
	$F=F_0$+6 MHz	(3)(4)	-	-44	-27	≤-27	
	$F>F_0$+6 MHz	(3)(4)	-	-55	-27	≤-27	
Maximum level of intermodulation interferers		(5)	-50	-29	-	≥-50	dBm

1. Measured using test packets with 37 octet payload
2. Measured in accordance with the RF-PHY/RCV-LE/CA/BV-07-C test. Random number of packets transmitted by tester of which 50% have corrupted CRCs. Wanted signal level is -30 dBm.
3. Up to five spurious response frequencies are allowed. For these spurious response frequencies, there is a relaxed interference requirement of C/I = -17dB.
4. Measured at F0 = 2440 MHz. QCC711 2.0 QFN48 has an IF of 4/3 MHz and Fimage= F0 - 8/3 MHz. Depending on crystal frequency, the fimage may be on either side of the carrier, which affects the test specification limits – see RF-PHY/RCV-LE/CA/BV-09-C in the Bluetooth v5.0 RF-PHY Test Specification.
5. Integrated in 100 kHz bandwidth and normalized to 1 Hz.

G Production test access

Easy and accessible connection to some pins is critical for fast and reliable manufacturing. Manufacturing test access is often overlooked when working on a mass production product for the first time. Fast production lines use a 'needle board' or 'bed of nails' to make a temporary reliable connection to the product.

The QCC711 requires access to the SWD pins in order to program the application code, configure the Bluetooth address, and setup the crystals. In order to measure the frequency of the crystals, the QCC711 has the ability to present these on two GPIOs. The 32 kHz crystal is presented on GPIO13 (TEST_LF) and the 32 MHz is on GPIO11 (TEST_HF).

A VSS pin is required to reference these digital signals.

Typically, board configuration and testing are conducted before a power source is mounted and, therefore, a VDD is required.

NOTE The test fixture should ensure that there is no 'hot switching'. Whenever a board is inserted and removed, all signals should be open circuit. This is particularly important where are UART is connected as the data line can begin to power the QCC711 through the protection diodes of the pad ring.

More complex test platforms can also include voltage monitoring of power supplies and include the ability to force or sense signals on other pins. The scope of this depends on the expected level of production manufacturing failures, budget, design cost complexity, and tolerable shipping defect rates.

To prevent board twist in the clamping jig, pins should be symmetrically distributed. Normally, this can be achieved by inserting extra as a dummy or VSS.

Document references

Document	Reference
QCC71x QFN 48-lead 5.6 x 5.6 mm Package Specification	80-WL710-143
QCC711 Bluetooth Low Energy Data Sheet	80-WL711-1

Glossary

Term	Definition
DC	Direct current
EMC	ElectroMagnetic Compatibility
ESR	Equivalent series resistance
I^2C	Inter-integrated circuit interface
LED	Light-emitting diode
PCB	Printed circuit board
PIO	Programmable input/output, also known as general-purpose I/O
QFN	Quad-flat no-lead
QSPI	Quad serial peripheral interface (flash)
QTIL	Qualcomm Technologies International, Ltd.
RF	Radio frequency
SMPS	Switch-mode power supply
SPI	Serial peripheral interface
UART	Universal asynchronous receiver transmitter
XTAL	Crystal

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