Qualcomm Technologies, Inc.

WCN3620 Wireless Connectivity IC

Device Specification

September 2016

Qualcomm Technologies, Inc.
5775 Morehouse Drive
San Diego, CA 92121
U.S.A.

LM80-P0436-33 Rev. B

Revision history

Revision	Date	Description
B	September 2016	Updated for E part Removed references to Qualcomm Atheros
A	August 10, 2015	Initial release

Contents

Figures

Tables

1 Introduction

1.1 Documentation overview

Technical information for the WCN3620 is primarily covered by the documents listed in Table 1-1. All of these documents should be studied for a thorough understanding of the IC and its applications. Released WCN3620 documents are posted on https://developer.qualcomm.com/hardware/dragonboard-410c/tools and are available for download.

Table 1-1 Primary WCN3620 documentation

Document no.	Title/description

LM80-P0436-25	*WCN3620 Wireless Connectivity IC Design Guidelines*
	▪ Detailed functional and interface description for the WCN3620 IC
	▪ Key design guidelines are illustrated and explained, including:
	  ▫ Technology overviews
	  ▫ DC power distribution
	  ▫ Interface schematic details
	  ▫ PCB layout guidelines
	  ▫ External component recommendations
	  ▫ Ground and shielding recommendations

LM80-P0436-26	WCN3620 Layout Guidelines
LM80-P0436-28	WCN3620 Wireless Connectivity Design Example with 2G FEM + External Coupler
LM80-P0436-32	*WCN3620 Device Revision Guide* Provides a history of WCN3620 device revisions. This document explains how to identify the various device revisions, and discusses known issues (or bugs) for each revision and how to work around them.
LM80-P0436-33 (this document)	*WCN3620 Wireless Connectivity IC Device Specification* Conveys all WCN3620 IC electrical and mechanical specifications. Additional material includes pin assignments; shipping, storage, and handling instructions, printed circuit board (PCB) mounting guidelines, and part reliability. This document can be used by company purchasing departments to facilitate procurement.

Additional reference documents are listed in Section 1.2.

1.2 Reference documents

- IEEE 802.11n WLAN MAC and PHY, October 2009 + IEEE 802.11-2007 WLAN MAC and PHY, June 2007
- IEEE Std 802.11b, IEEE Std 802.11d, IEEE Std 802.11e, IEEE Std 802.11g, IEEE
- Std 802.11i: IEEE 802.11-2007 WLAN MAC and PHY, June 2007i
- Bluetooth Specification Version 4.0, December 17, 2009
- Bluetooth Radio Frequency TSS and TP Specification 1.2/2.0/2.0 + EDR/2.1/2.1 + EDR/3.0/3.0 + HS, August 6, 2009
- Bluetooth Low Energy RF PHY Test Specification, RF-PHY.TS/4.0.0, December 15, 2009

1.3 Document organization

This WCN3620 device specification is organized as follows:

Chapter 1 Provides an overview of the WCN3620 documentation, gives a high-level functional description of the device, lists the device features, and defines marking conventions, terms, and acronyms used throughout this document.

Chapter 2 Defines the device pin assignments.

Chapter 3 Defines the device electrical performance specifications, including absolute maximum and operating conditions.

Chapter 4 Provides IC mechanical information, including dimensions, markings, ordering information, moisture sensitivity, and thermal characteristics.

Chapter 5 Discusses shipping, storage, and handling of the WCN3620 devices.

Chapter 6 Presents procedures and specifications for mounting the WCN3620 device onto PCBs.

Chapter 7 Presents WCN3620 device reliability data, including a definition of the qualification samples and a summary of qualification test results.

1.4 WCN3620 device introduction

The WCN3620 IC integrates three different wireless connectivity technologies into a single device suitable for handsets and other mobile devices:

- Wireless local area network (WLAN) compliant with the IEEE 802.11 b/g/n specification
- Bluetooth (BT) compliant with the BT specification version 4.0 (BR/EDR+BLE)
- Worldwide FM radio, with Rx modes supporting the Radio Data System (RDS) for Europe and the Radio Broadcast Data System (RBDS) for the USA

The WCN3620 is a highly integrated IC using the 3.32 × 3.55 × 0.63 mm, 61-pin wafer-level nanoscale package (61 WLNSP) – and is supplemented by modem IC processing (such as the Qualcomm® Snapdragon™ 410E APQ8016E chipset, a device in the APQ chipset family) to create a wireless connectivity solution that reduces the part count and PCB area. The WCN3620 IC ensures hardware and software compatibility with Qualcomm Technologies Inc. (QTI) companion chipsets to simplify the design cycle and reduce the OEM time-to-market cycle.

The WCN3620 IC uses low-power 65 nm RF CMOS fabrication technology, making it perfectly suited for battery-operated devices where power consumption and performance are critical.

As illustrated in Figure 1-1, the WCN3620 device's major functional blocks are:

- A single-band WLAN RF
- BT radio (RF and digital processing)
- FM radio (RF and digital processing)
- Shared WLAN + BT RF front-end (RF FE) circuits
- Top-level support circuits that interface with the modem IC, buffer the XO input, generate the wireless connectivity network (WCN) internal clocks, and gate and distribute DC power to the other blocks

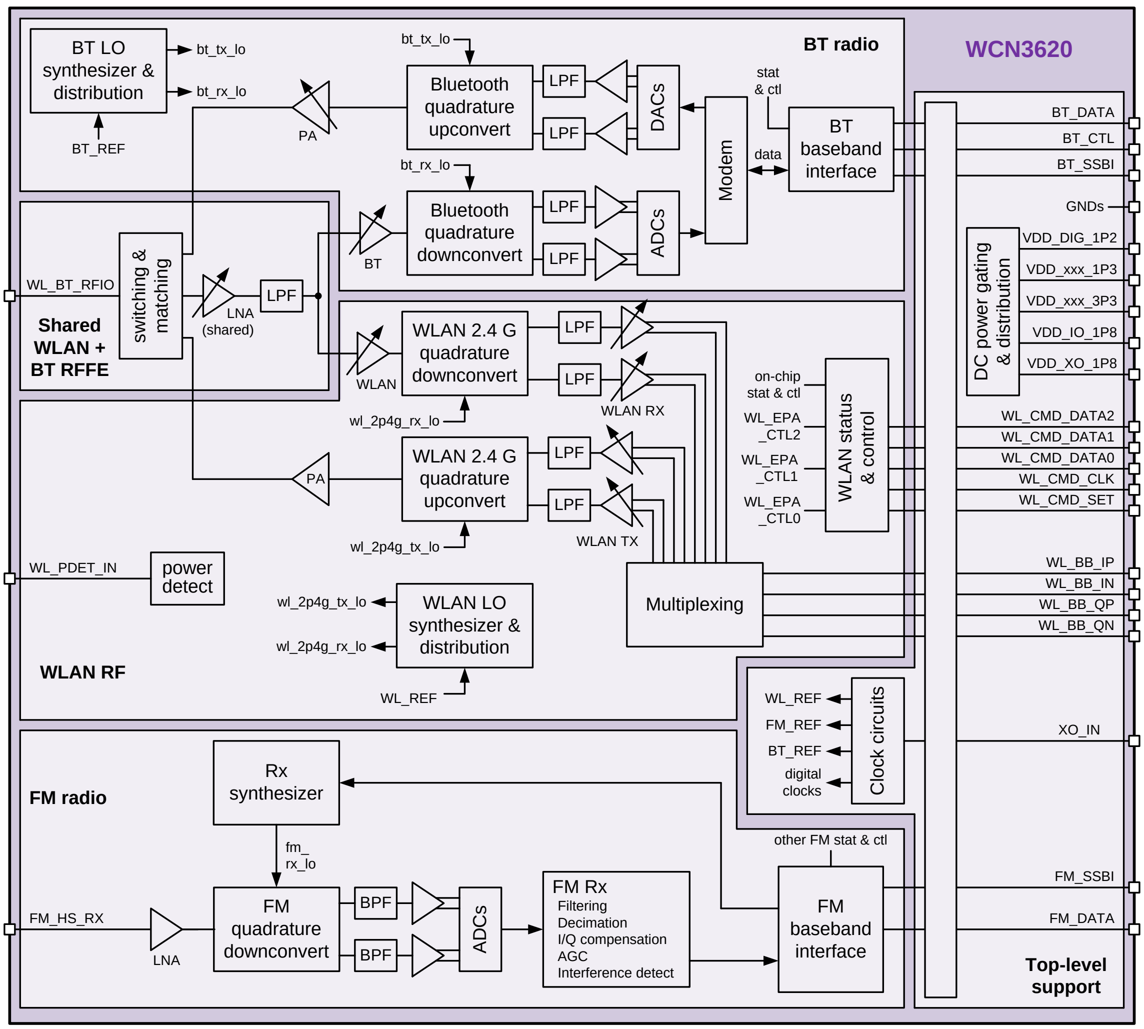


Figure 1-1 WCN3620 functional block diagram

Refer to the *WCN3620 Layout Guidelines* (LM80-P0436-26) for more detailed descriptions of each WCN3620 function and interface and guidelines for implementing the design. See - https://developer.qualcomm.com/hardware/snapdragon-410/tools.

1.5 WCN3620 features

NOTE: Some hardware features integrated within the WCN3620 IC must be enabled by software. See the latest revision of the applicable software release notes to identify the enabled features.

1.5.1 New features introduced into the WCN3620 IC

- 65 nm RF CMOS technology in the small 61 WLNSP
- Highly integrated front-end eliminates external PA and LNA matching, and antenna Tx/Rx switching.
- Support for ANT
- Support for the IEEE802.11b/g/n standard
- Single-band WLAN: 2.4 GHz RF transceivers
- Compliant with BT specification version 4.0
- Concurrent WLAN + BT reception in the 2.4 GHz band
- Lower power consumption
- Smaller IC footprint, lower parts count, and less PCB area overall

1.5.2 Summary of WCN3620 key features

Table 1-2 lists a summary of WCN3620 key features.

Table 1-2 Summary of WCN3620 features

Feature	WCN3620 capability
System-level	
Highly integrated	▪ Integrated WLAN, Bluetooth, and FM radio RF functionality ▪ Lower parts count and less PCB area overall ▪ Eliminates external PA, LNA matching, and antenna Tx/Rx switching
WLAN + Bluetooth	▪ Concurrent reception in the 2.4 GHz band ▪ PTA
Automated calibration	No external equipment required
Top-level support circuits	
Clock	▪ External source: 19.2 MHz ▪ Clock buffering, gating, and distribution to all other blocks
Modem IC interfaces	Manages all WLAN, Bluetooth, and FM interfaces
DC power	Gates and distributes power to all other blocks
WLAN RF (with modem IC digital processing)	
Single-band support	▪ 2.4 GHz RF transceiver ▪ Concurrent WLAN + BT reception in 2.4 GHz band ▪ LTE/ISM coexistence support
Simple host interfaces	4-line analog baseband interface with Rx/Tx multiplexing

Feature	WCN3620 capability
IEEE 802.11 compliance	b/g/n with companion modem IC
Integrated PAs and LNAs	High dynamic Tx power and excellent Rx sensitivity for extended range
Other solution-level features	▪ Wake-on-WLAN (WoWLAN) support ▪ MCS 0, 1, 2, 3, 4, 5, 6, and 7; up to 72 Mbps data rate ▪ Space-time block coding (STBC) support ▪ A-MPDU reception/retransmission and A-MSDU reception ▪ Support for A-MPDU aggregation ▪ Support for short guard interval ▪ Infrastructure and ad hoc operating modes ▪ SMS4 hardware encryption (for WAPI support) ▪ AP-mode hardware support ▪ Wi-Fi direct
Bluetooth radio	
Bluetooth spec compliance	BT 4.0 HS low energy
Highly integrated	Baseband modem and 2.4 GHz transceiver; improved Rx sensitivity
Simple host interfaces	▪ 2-line digital data interface supports Rx and Tx ▪ SSBI for status and control
Supported modulation	GFSK, π/4-DQPSK, and 8-DPSK (in both directions)
Connectivity	▪ Up to seven total wireless connections ▪ Up to 3.5 piconets (master, slave, and page scanning) ▪ One SCO or eSCO connection
Digital processing	▪ Support for BT + WLAN coexistence, including concurrent receive ▪ Support for all BR, EDR, and BLE packet types
RF Tx power levels	Class 1 and 2 power-level transmissions without external PA
FM radio	
Worldwide FM band support	76 to 108 MHz, with 50 kHz channel spacing
Highly integrated	▪ Baseband processing and RF transceiver ▪ Data system support ▪ Radio data system for Europe (RDS) ▪ Radio broadcast data system for USA (RBDS)
Simple host interfaces	▪ Single-line digital data interface ▪ SSBI for status and control
Rx support	▪ External wired-headset antenna ▪ Rx operation simultaneously with a phone connection
Highly automated	▪ Search and seek ▪ Gain control ▪ Frequency control ▪ Noise cancellation ▪ Soft mute ▪ High-cut control ▪ Mono/stereo blend ▪ Adjustment-free stereo decoder ▪ Programmable de-emphasis

Feature	WCN3620 capability
Fabrication technology and package	
Single die	65 nm CMOS
Small, thermal efficient package	61 WLNSP: 3.32 × 3.55 × 0.63 mm; 0.40 mm pitch

1.6 Terms and acronyms

Table 1-3 lists terms and acronyms commonly used throughout this document.

Table 1-3 Terms and acronyms

Term	Definition
16QAM	16-state quadrature amplitude modulation
64QAM	64-state quadrature amplitude modulation
8DPSK	8-state differential phase shift keying
ACL	Asynchronous connection-oriented link
ADC	Analog-to-digital converter
AGC	Automatic gain control
AP	Access point
APQ	Application processor Qualcomm
BB	Baseband
BER	Bit error rate
BLE	Bluetooth low energy
BMPS	Beacon-mode power save
BOM	Bill of materials
BPF	Bandpass filter
bps	Bits per second
BPSK	Binary phase shift keying
BR	Basic data rate
BT	Bluetooth
CCK	Complimentary code keying
CDM	Charged device model
CDMA	Code Division Multiple Access
DAC	Digital-to-analog converter
DBPSK	Differential binary phase shift keying
DEVM	Differential error vector magnitude
DNC	Do not connect
DQPSK	Differential quadrature phase shift keying
DTIM	Delivery traffic indication message

Term	Definition
EDR	Enhanced data rate
EIRP	Effective isotropic radiated power
eSCO	Extended synchronous connection-oriented
ESD	Electrostatic discharge
ESR	Effective series resistance
ETSI	European Telecommunications Standards Institute
EVM	Error vector magnitude
FBPR	Forbidden band power ratio
FCC	Federal Communication Commission
FDD	Frequency division duplexing
FEM	Front-end module
FM	Frequency modulation
GFSK	Gaussian frequency shift keying
HBM	Human-body model
HCI	Host controller interface
Hi-Z	High impedance
I/O	Input/output
kbps	Kilobits per second
LNA	Low-noise amplifier
LO	Local oscillator
LPF	Low-pass filter
LPO	Low-power oscillator
LPPS	Low-power page scan
LSBit or LSByte	Defines whether the LSB is the least significant bit or least significant byte. All instances of LSB used in this manual are assumed to be LSByte, unless otherwise specified.
MAC	Medium access controller
MCS	Modulation coding scheme
MPX	Multiplex
MRC	Master reference clock
MSBit or MSByte	Defines whether the MSB is the most significant bit or most significant byte. All instances of MSB used in this manual are assumed to be MSByte, unless otherwise specified.
NVM	Nonvolatile memory
OEM	Original equipment manufacturer
PA	Power amplifier
PCB	Printed circuit board
PCM	Pulse-coded modulation
PDA	Personal digital assistant

Term	Definition
PDET	Power detector
PER	Packet error rate
PHY	Physical layer
PLL	Phase-locked loop
PM	Power management
PMIC	Power management integrated circuit
PMP	Personal mobile player
PTA	Packet traffic arbitration
QAM	Quadrature amplitude modulation
QCA	Qualcomm Atheros (later referred to as Qualcomm Technologies, Inc.)
QoS	Quality of service
QPSK	Quadrature phase shift keying
RBDS	Radio broadcast data system for U.S.A.
RDS	Radio data system for Europe
RF	Radio frequency
RH	Relative humidity
RoHS	Restriction of hazardous substances
Rx	Receive, receiver
SBI	Serial bus interface
SCO	Synchronous connection-oriented
SMT	Surface-mount technology
SoC	System-on-Chip
Sps	Symbols per second (or samples per second)
SSBI	Single-wire SBI
STBC	Space-time block coding
T/R	Transmit/Receive
TDD	Time-division duplexing
TIM	Traffic indication map
TKIP	Temporal key integrity protocol
Tx	Transmit, transmitter
uAPSD	Unscheduled automatic power-save delivery
VoIP	Voice-over-internet protocol
WAN	Wide area network
WCN	Wireless connectivity network
WEP	Wired-equivalent privacy
WLAN	Wireless local area network

Term	Definition
WLNSP	Wafer-level nanoscale package
WMM	Wi-Fi multimedia
WMM-AC	Wi-Fi multimedia access categories
WoWLAN	Wake-on-WLAN
WPA	Wi-Fi protected access
XO	Crystal oscillator
ZIF	Zero intermediate frequency
π/4 DQPSK	π/4-rotated differential quadrature phase shift keying

1.7 Special marks

Table 1-4 defines special marks used in this document.

Table 1-4 Special marks

Mark	Definition
[ ]	Brackets ([ ]) sometimes follow a pin, register, or bit name. These brackets enclose a range of numbers. For example, DATA[7:4] may indicate a range that is 4 bits in length, or DATA[7:0] may refer to all eight DATA pins.
_N	A suffix of _N indicates an active low signal. For example, RESIN_N.
0x0000	Hexadecimal numbers are identified with an x in the number, for example, 0x0000. All numbers are decimal (base 10) unless otherwise specified. Non-obvious binary numbers have the term binary enclosed in parentheses at the end of the number, for example, 0011 (binary).
|	A vertical bar in the outside margin of a page indicates that a change was made since the previous revision of this document.

2 Pin Definitions

The WCN3620 device is available in the 61-pin wafer-level nanoscale package (61 WLNSP); see Chapter 4 for package details. A high-level view of the pin assignments is illustrated in Figure 2-1.

	1 GND		2 GND		3 VDD_BT_RF_1P3		4 VDD_BT_DA_3P3		5 WL_BT_RFIO		6 WL_CMD_SET
7 VDD_BT_VCO_1P3		8 GND				9 VDD_WL_2GLNA_1P3		10 GND		11 VDD_WL_2GPA_3P3	
	12 GND		13 VDD_BT_BB_1P3		14 GND						15 NC
16 VDD_BT_PLL_1P3		17 GND		18 BT_CTL		19 GND		20 GND		21 GND	
	22 VDD_IO_1P8		23 VDD_BT_FM_DIG_1P3		24 VDD_XO_1P8		25 GND		26 WL_CMD_DATA1		27 GND
28 BT_DATA		29 VDD_DIG_1P2		30 XO_IN				31 NC		32 GND	
	33 BT_SSBI		34 GND		35 GND		36 VDD_WL_LO_1P3				37 VDD_WL_2GPA_1P3
38 NC		39 GND		40 NC		41 FM_SSBI		42 GND		43 VDD_WL_UPC_1P3	
	44 GND		45 GND		46 FM_DATA		47 WL_BB_QN		48 WL_CMD_DATA0		49 WL_PDET_IN
50 FM_HS_RX		51 VDD_FM_VCO_1P3		52 VDD_FM_PLL_1P3		53 WL_BB_QP		54 WL_BB_IP		55 WL_CMD_DATA2	
	56 VDD_FM_RXFE_1P3		57 VDD_FM_RXBB_1P3		58 VDD_WL_PLL_1P3		59 WL_BB_IN		60 VDD_WL_BB_1P3		61 WL_CMD_CLK

WLAN | FM | BT | Shared functions | Top level | Power | Ground | No Connect

Figure 2-1 WCN3620 pin assignments (top view)

2.1 I/O parameter definitions

Table 2-1 I/O description (pad type) parameters

Symbol	Description
Pad attribute	
AI	Analog input (does not include pad circuitry)
AO	Analog output (does not include pad circuitry)
B	Bidirectional digital with CMOS input
DI	Digital input (CMOS)
DO	Digital output (CMOS)
Z	High-impedance (high-Z) output
Pad pull details for digital I/Os	
NP	Contains no internal pull
PU	Contains an internal pull-up device
PD	Contains an internal pull-down device
Pad voltages for digital I/Os	
DIO	Digital interfaces with the modem IC (VDD_IO = 1.8 V only)

2.2 Pin descriptions

Descriptions of all pins are presented in the following tables, organized by functional group:

Table 2-2 Pin descriptions – WLAN functions

Table 2-3 WLAN pad type vs. operating mode

Table 2-4 Pin descriptions – BT functions

Table 2-5 BT pad type vs. operating mode

Table 2-6 Pin descriptions – shared WLAN and BT RF front-end functions

Table 2-7 Pin descriptions – FM radio functions

Table 2-8 FM pad type vs. operating mode

Table 2-9 Pin descriptions – top-level support functions

Table 2-10 Pin descriptions – no connect pins

Table 2-11 Pin descriptions – power supply pins

Table 2-12 Pin descriptions – ground pins

Table 2-2 Pin descriptions – WLAN functions[1]

Pad no.	Pad name	Pad voltage	Pad type vs. operating mode			Functional description
			Active	Standby	Sleep	
RF input/output pins						
49	WL_PDET_IN	–	AI	AI	AI	WLAN Tx power detector input (2.4 GHz)
–	See Table 2-6 for shared WLAN + Bluetooth RF front-end pins					
Rx/Tx analog baseband interface with modem IC						
54	WL_BB_IP	–	AI, AO	AI, AO	AI, AO	WLAN baseband differential in-phase – positive (multiplexed Rx/Tx)
59	WL_BB_IN	–	AI, AO	AI, AO	AI, AO	WLAN baseband differential in-phase – negative (multiplexed Rx/Tx)
53	WL_BB_QP	–	AI, AO	AI, AO	AI, AO	WLAN baseband differential quadrature – positive (multiplexed Rx/Tx)
47	WL_BB_QN	–	AI, AO	AI, AO	AI, AO	WLAN baseband differential quadrature – negative (multiplexed Rx/Tx)

1. Refer to Table 2-1 I/O description (pad type) parameters for parameter and acronym definitions.

Table 2-3 WLAN pad type vs. operating mode[1]

Pad no.	Pad name	WLAN off BT/FM off	WLAN off BT/FM on	WLAN on BT/FM off	WLAN on BT/FM on	WLAN low-power mode BT/FM off	WLAN low-power mode BT/FM on	Notes
WLAN command interface with modem IC								
55	WL_CMD_DATA2	Z	DO-NP	DO-NP/ DI-PD	DO-NP/ DI-PD	Z	DO-NP	In active mode, the CMD_DATA lines will be to DO-NP, then changes to DO-PD when CMD_SET signal changes state
26	WL_CMD_DATA1	Z	DO-NP	DO-NP/ DI-PD	DO-NP/ DI-PD	Z	DO-NP	In active mode, the CMD_DATA lines will be to DO-NP, then changes to DO-PD when CMD_SET signal changes state
48	WL_CMD_DATA0	Z	DO-NP	DO-NP/ DI-PD	DO-NP/ DI-PD	Z	DO-NP	In active mode, the CMD_DATA lines will be to DO-NP, then changes to DO-PD when CMD_SET signal changes state
6	WL_CMD_SET	Z	DI-PD	DI-PD	DI-PD	Z	DI-PD	Z when WLAN/BT/FM is off or in power collapse, otherwise DI-PD
61	WL_CMD_CLK	Z	DI-PD	DI-PD	DI-PD	Z	DI-PD	Z when WLAN/BT/FM is off or in power collapse, otherwise DI-PD

1. Refer to Table 2-1 for parameter and acronym definitions.

Table 2-4 Pin descriptions – BT functions

Pad no.	Pad name	Pad voltage	Pad type vs. operating mode			Functional description
			Active	Standby	Sleep	
RF input/output pins						
–	See Table 2-6 for shared WLAN + BT RF front-end pins.					

1. Refer to Table 2-1 for parameter and acronym definitions.

Table 2-5 BT pad type vs. operating mode

Pad no.	Pad name	BT off FM off	BT off FM on	BT on, active FM off	BT on, active FM on	BT on, idle FM off	BT on, idle FM on	Notes
BT data interface with modem IC								
28	BT_DATA	Z	Z	B-PD	B-PD	B-PD/Z	B-PD/Z	Z when WLAN is off or in power collapse, otherwise P-PD
18	BT_CTL	Z	Z	DI-PD	DI-PD	DI-PD/Z	DI-PD/Z	Z when WLAN is off or in power collapse, otherwise DI-PD
BT status and control interface with modem IC								
33	BT_SSBI	Z	Z	B-PD	B-PD	B-PD/Z	B-PD/Z	Z when WLAN is off or in power collapse, otherwise B-PD

Table 2-6 Pin descriptions – shared WLAN and BT RF front-end functions

Pad no.	Pad name	Pad voltage	Pad type vs. operating mode			Functional description
			Active	Standby	Sleep	
RF input/output pins						
50	FM_HS_RX	–	AI	AI	AI	FM radio headset RF receiver input port

Table 2-7 Pin descriptions – FM radio functions

Pad no.	Pad name	Pad voltage	Pad type vs. operating mode			Functional description
			Active	Standby	Sleep	
RF input/output pins						
50	FM_HS_RX	–	AI	AI	AI	FM radio headset RF receiver input port

Table 2-8 FM pad type vs. operating mode

Pad no.	Pad name	BT off FM off	BT off FM on	BT on, active FM off	BT on, active FM on	BT on, idle FM off	BT on, idle FM on	Notes
FM data interface with modem IC								
46	FM_DATA	Z	B-PD	Z	B-PD	Z	B-PD	
FM status and control interface with modem IC								
46	FM_SSBI	Z	B-PD	Z	B-PD	Z	B-PD	

Table 2-9 Pin descriptions – top-level support functions

Pad no.	Pad name	Pad voltage	Pad type vs. operating mode			Functional description
			Active	Standby	Sleep	
30	XO_IN	–	AI	AI	AI	19.2 MHz reference clock input

Table 2-10 Pin descriptions – no connect pins

Pad no.	Pad name	Functional description
15, 31, 38, 40	NC	No connect

Table 2-11 Pin descriptions – power supply pins

Pad no.	Pad name	Functional description
23	VDD_BT_FM_DIG_1P3	Power for BT/FM digital circuits (1.3 V)
13	VDD_BT_BB_1P3	Power for BT baseband circuits (1.3 V)
16	VDD_BT_PLL_1P3	Power for BT PLL circuits (1.3 V)
3	VDD_BT_RF_1P3	Power for BT RF receiver circuits (1.3 V)
4	VDD_BT_DA_3P3	Power for BT driver amplifier circuits (3.3 V)
7	VDD_BT_VCO_1P3	Power for BT VCO circuits (1.3 V)
29	VDD_DIG_1P2	LDO load capacitor; power for WCN digital circuits (1.2 V)
52	VDD_FM_PLL_1P3	Power for FM PLL circuits (1.3 V)
57	VDD_FM_RXBB_1P3	Power for FM baseband receiver circuits (1.3 V)
56	VDD_FM_RXFE_1P3	Power for FM receiver front-end circuits (1.3 V)
51	VDD_FM_VCO_1P3	Power for FM VCO circuits (1.3 V)
22	VDD_IO_1P8	Power for WCN digital I/O circuits (1.8 V)
9	VDD_WL_2GLNA_1P3	Power for WLAN 2.4 GHz LNA circuits (1.3 V)
37	VDD_WL_2GPA_1P3	Power for WLAN 2.4 GHz PA circuits (1.3 V)
11	VDD_WL_2GPA_3P3	Power for WLAN 2.4 GHz PA circuits (3.3 V)
60	VDD_WL_BB_1P3	Power for WLAN baseband circuits (1.3 V)
36	VDD_WL_LO_1P3	Power for WLAN LO circuits (1.3 V)
58	VDD_WL_PLL_1P3	Power for WLAN PLL circuits (1.3 V)
43	VDD_WL_UPC_1P3	Power for WLAN upconverter circuits (1.3 V)
24	VDD_XO_1P8	Power for XO circuits (1.8 V)

Table 2-12 Pin descriptions – ground pins

Pad no.	Pad name	Functional description
1, 2, 8, 10, 12, 14, 17, 19, 20, 21, 25, 27, 32, 34, 35, 39, 42, 44, 45	GND	Ground

3 Electrical Specifications

3.1 Absolute maximum ratings

Operating the WCN3620 IC under conditions beyond its absolute maximum ratings (Table 3-1) could damage the device. Absolute maximum ratings are limiting values to be considered individually when all other parameters are within their specified operating ranges. Functional operation and specification compliance under any absolute maximum condition, or after exposure to any of these conditions, is not guaranteed or implied. Exposure could affect the device reliability.

Table 3-1 Absolute maximum ratings[1]

Parameter		Min	Max	Units
VDD_xxx_1P3	Power for WCN analog, digital, and RF core circuits	-0.5	3.0	V
VDD_IO_1P8	Power for WCN digital I/O circuits	-0.5	3.0	V
VDD_XO_1P8	Power for WCN XO circuits	-0.5	3.0	V
VDD_xxx_3P3	Power for WLAN and BT Tx PAs	-0.5	3.6	V
V_{IN}	Voltage applied to any non-power I/O pin[2]	-0.5	V_{DDX} + 0.3	V
ESD protection – see Section 7.1.				
Thermal considerations – see Section 7.1.				

1. The characters xxx are used in this table to indicate several missing characters in a power-supply pin's name. For example, the parameter values listed for VDD_xxx_1P3 apply to VDD_BT_FM_DIG_1P3, VDD_BT_BB_1P3, etc.
2. vDDX is the supply voltage associated with the input or output pin to which the test voltage is applied.

3.2 Operating conditions

Operating conditions include parameters under user control, such as the power-supply voltage and ambient temperature. If the absolute maximum ratings have never been exceeded, the WCN3620 device meets all performance specifications listed in Sections 3.3 through 3.10 when used within the operating conditions, unless otherwise noted in those sections.

Table 3-2 Operating conditions[1]

Parameter		Min	Typ	Max	Units
VDD_xxx_1P3	Power for WCN analog, digital, and RF core circuits	1.25	1.3	1.38	V
VDD_IO_1P8	Power for WCN digital I/O circuits	1.7	1.8	1.9	V
VDD_XO_1P8	Power for XO circuits	1.7	1.8	1.9	V
VDD_xxx_3P3	Power for WLAN and BT Tx PAs[2]	3.2	3.3	3.37	V
T_{OP}	Operating temperature	-30	25	85	°C

1. The characters xxx are used in this table to indicate several missing characters in a power-supply pin's name. For example, the parameter values listed for VDD_xxx_1P3 apply to VDD_BT_FM_DIG_1P3, VDD_BT_BB_1P3, etc.
2. WCN3620 VDD_xxx_3P3 can operate down to 3.0 V; however, some RF performances are not guaranteed.

3.3 DC power consumption

3.3.1 Power mode definitions

The WCN3620 DC power consumption, expressed in terms of supply current, is specified as the typical total input current into the device during an active operation. This is the current drawn from the primary power source that powers the internal regulator and other circuits.

Values specified in this section are estimates to use as general guidelines for WCN3620 IC product designs. The stated modes assume that the WLAN, Bluetooth + FM wireless technology circuits are operating in compliance with the applicable standards. The average power consumption values for different operating modes depend on the system state.

3.3.2 Power consumption

Table 3-3 lists the typical measured supply currents into the WCN3620. They are the average measurement based on operation at room temperature (+25ºC) using default settings and nominal supply voltages, such as VDD_XO_1P8 = 1.8 V, VDD_IO_1P8 = 1.8 V, VDD_xxx_1P3 = 1.3 V and VDD_xxx_3P3 = 3.3 V.

Table 3-3 Input power supply current from primary source

Mode	1.8 V I/O	1.8 V XO	VDD_xxx_1P3	VDD_xxx_3P3
Shutdown	1.35 µA	0.25 µA	10 µA	2 µA
BT current consumption				
BT Tx class 2, 4 dBm	550 µA	1.01 mA	53 mA	0
BT Tx class 1, 13 dBm	550 µA	1.01 mA	43 mA	46 mA
BT Rx	1.25 mA	1.01 mA	32 mA	0
FM current consumption				
FM Rx	–	–	13 mA	–
WLAN current consumption				
2.4 GHz				
2.4G, 11g, 54 Mbps, 16.8 dBm	0.78 mA	1.15 mA	110.45 mA	174.42 mA
2.4G, 11g, 6 Mbps, 18.8 dBm	0.76 mA	1.15 mA	119.72 mA	203.11 mA
2.4G, 11n, MCS7, 15.2 dBm	0.78 mA	1.15 mA	106.25 mA	149.70 mA
2.4G, 11n, MCS0, 17.8 dBm	0.76 mA	1.15 mA	113.12 mA	180.76 mA
2.4G, 11b, 20.8 dBm	0.68 mA	1.15 mA	111.37 mA	147.34 mA
2.4G, Rx	0.67 mA	1.15 mA	59.06 mA	0 mA

3.4 Power sequencing

The WCN3620 device requires the following powerup sequence:

- For APQ8016E: 1.3 V(S3) →1.8_IO (L5) →1.8V_XO(L7) →3.3V_PA (L9)
- For other platforms:
  a. Either VDD_XO_1P8 or VDD_IO_1P8
  b. Either VDD_xxx_1P3 or VDD_xxx_3P3

To power down the device, the following sequence is required:

- For APQ8016E: 3.3V_PA (L9) →1.8V_IO (L5) →1.8_XO (L7) →1.3V(S3)
- For other platforms:
  a. VDD_xxx_1P3 and VDD_xxx_3P3
  b. Either VDD_XO_1P8 or VDD_IO_1P8

NOTE: If 1.3 V is off before 3.3 V, the interval between 1.3 V off and 3.3 V off should be very short. Any leakage current can be ignored.

3.5 Digital logic characteristics

Specifications for the digital I/Os depend on the associated supply voltage (identified as V_{IO} in Table 3-4).

Table 3-4 Baseband digital I/O characteristics

Parameter		Comments	Min	Typ	Max	Units
V_{IH}	High-level input voltage		0.70 V_{IO}	–	V_{IO} + 0.3	V
V_{IL}	Low-level input voltage		-0.3	–	0.30 V_{IO}	V
V_{SHYS}	Schmitt hysteresis voltage		–	300	–	mV
I_{IH}	Input high leakage current	V_IN = V_{IO} max	-1.0	–	1.0	µA
I_{IL}	Input low leakage current	V_IN = 0 V; supply = V_{IO} max	-1.0	–	1.0	µA
R_{PULL}	Input pull resistor[1]	Up or down	TBD	375 k	TBD	kΩ
V_{OH}	High-level output voltage		V_{IO} - 0.4	–	V_{IO}	V
V_{OL}	Low-level output voltage		0	–	0.4	V
I_{OH}	High-level output current		1.0	–	–	mA
I_{OL}	Low-level output current		–	–	1.0	mA
C_{IN}	Input capacitance[2]		–	–	5	pF

1. Resistor values may drop by 50% when 3.0 V I/O is used.
2. Guaranteed by design but not 100% tested.

3.6 Timing characteristics

Specifications for the device timing characteristics are included, where appropriate, under each function’s section, along with its other performance specifications. Some general comments about timing characteristics are included here.

NOTE: All WCN3620 devices are characterized with actively terminated loads, so all baseband timing parameters in this document assume no bus loading. This is described further in Section 3.6.2.

3.6.1 Timing diagram conventions

Figure 3-1 shows the conventions used within timing diagrams throughout this document.

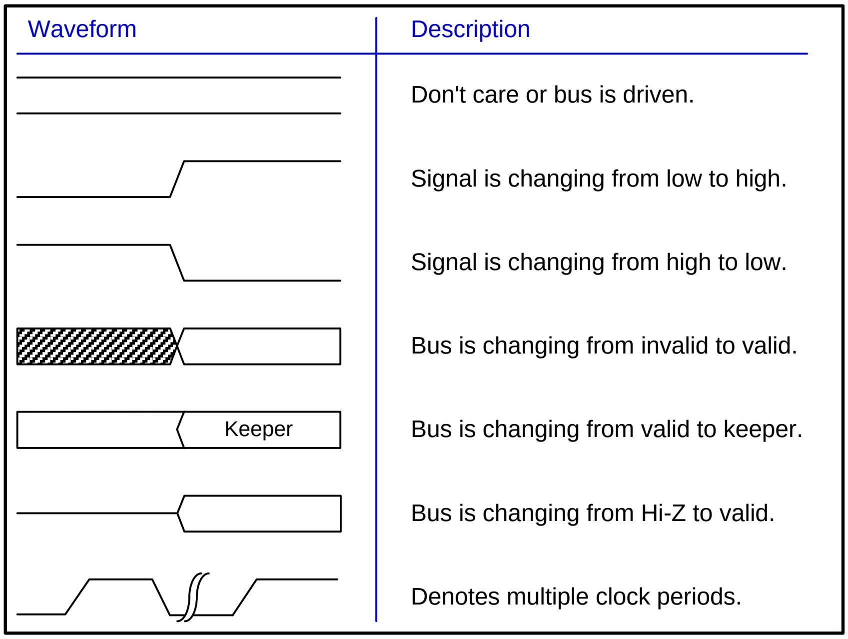


Figure 3-1 Timing diagram conventions

3.6.2 Rise and fall time specifications

The testers that characterize WCN3620 devices have actively terminated loads, making the rise and fall times quicker (mimicking a no-load condition). Figure 3-2 shows the impact that different external load conditions have on rise and fall times.

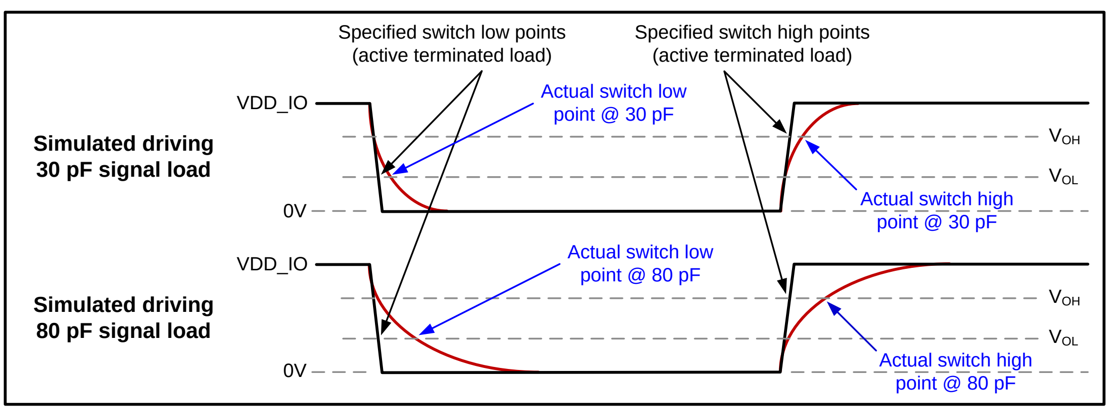


Figure 3-2 Rise and fall times under different load conditions

To account for external load conditions, rise or fall times must be added to parameters that start timing at the WCN device and terminate at an external device (or vice versa). Adding these rise and fall times is equivalent to applying capacitive load derating factors, and Table 3-5 lists the recommended derating factors.

Table 3-5 Capacitive load derating factors

Parameter	1.8 V I/O Drive = 2.0 mA	Units
Rise time, 10% to 90%	0.29 max	ns/pF
Fall time, 90% to 10%	0.19 max	ns/pF

3.7 Top-level support

Top-level support consists of the 5-wire interface, the master reference clock, and the DC power gate and distribution. Figure 3-3 shows the timing diagram for data input.

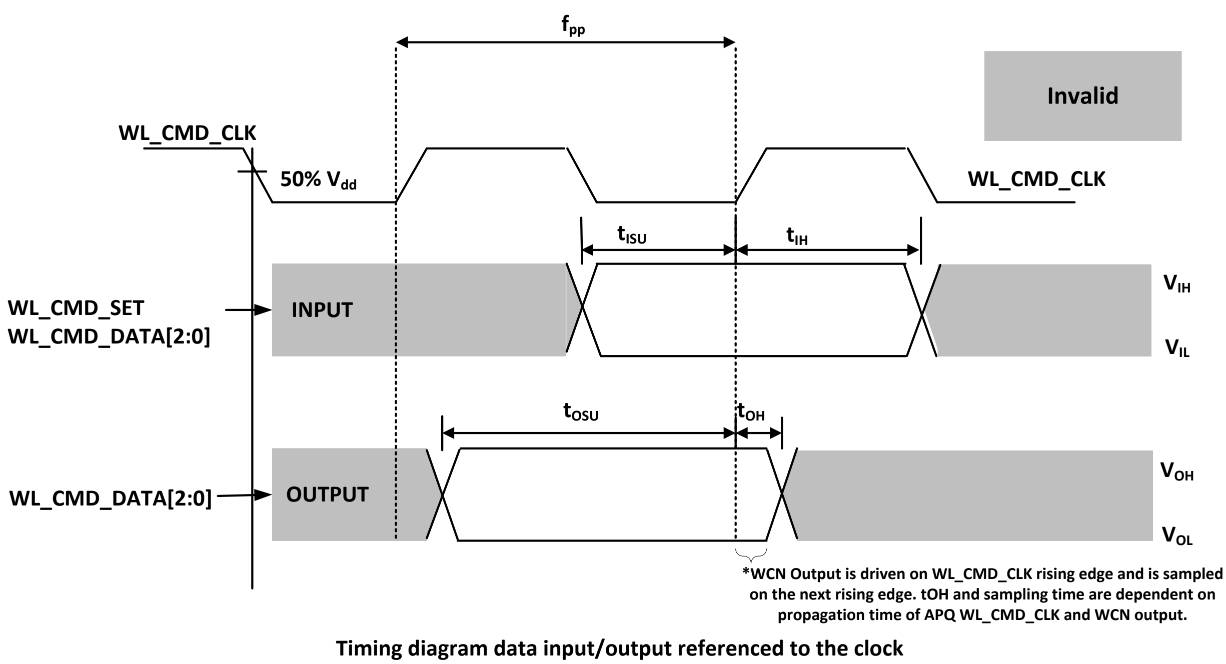


Figure 3-3 Timing diagram – data input

Table 3-6 WCN3620 read and write for 5-wire interface between the WCN3620 and APQ devices

Parameter	Symbol	Min	Units	Comments
Input setup time	t_{ISU}	3	ns	
Input hold time	t_{IH}	1	ns	
Output setup time	t_{OSU}	2	ns	
Output hold	t_{OH}	0.37	ns	

Table 3-7 Typical duty cycle

Frequency (f_{PP})	60 MHz[1]	30 MHz[1]	Units	Comments
Typical duty cycle	12.5/50[1]	25/50[2]	%	APQ chipset dependent[2]

1. The WL_CMD_CLK frequency can be 30 MHz or 60 MHz, depending on the command type.
2. For APQ devices, WLAN_CMD_CLK duty cycle is 50%.

3.7.1 I/O block

The WCN3620 device uses the 5-wire interface to configure the pull status and pull direction of WCN3620. This 5-wire interface also configures the WLAN portion of the WCN3620 device.

3.7.2 Master reference clock requirements

The WCN3620 device requires one 19.2 MHz clock signal generated externally by the PMIC. This master reference clock (MRC) is the timing source for all operational functions during active modes. When PMIC 19.2 MHz reference clock is used, that signal must be AC-coupled into the XO_IN pin.

Table 3-8 lists the MRC requirements.

Table 3-8 Reference requirements

Parameter	Condition	Min	Typ	Max	Units
19.2 MHz XO_IN					
Input frequency		–	19.2	–	MHz
Frequency variation over temperature/aging		-20	–	20	ppm
Duty cycle of input signal		43.5	50	55	%
Input voltage swing		0.8	–	2	V_{pp}
Input phase noise	f = 1 kHz	–	-130	-128	dBc/Hz
	f = 10 kHz	–	-144	-142	dBc/Hz
	f = 100 kHz	–	-151	-148	dBc/Hz
	f = 1 MHz	–	-152	-150	dBc/Hz
Input spur specification		–	–	-30	dBc

3.7.3 DC power gating and distribution

See Sections 3.3 and 3.4.

3.8 WLAN RF circuits

The following sections provide performance specifications for the WLAN RF transmitter and receiver circuits over the full operating power-supply voltage range and temperature range shown in Table 3-2. **Unless noted otherwise, all measurements are taken at the chip RF I/O pins** and all typical performance specifications, are based on operation at room temperature (+25°C) using default parameter settings and nominal supply voltages, such as VDD_xxx_1P3 = 1.3 V, VDD_IO_1P8 = 1.8 V, VDD_XO_1P8 = 1.8 V, and VDD_xxx_3P3 = 3.3 V. Maximum and minimum ratings are guaranteed specifications for production-qualified parts. The WCN3620 device complies with 802.11d requirements, where transmit output power is limited per country code. Figure 3-4 shows the RF connections of the WCN3620 device using an internal coupler as the default.

The WCN3620 device supports internal and external couplers. The default option in the WCN3620 device is with the internal coupler. For designs that require very tight output power variation range, an external coupler option is available. For more detailed information about the internal and external couplers, see *Application Note: WCN3620 WLAN Tx Coupler Selection and the Impact on CLPC Accuracy* (80-WL300-12).

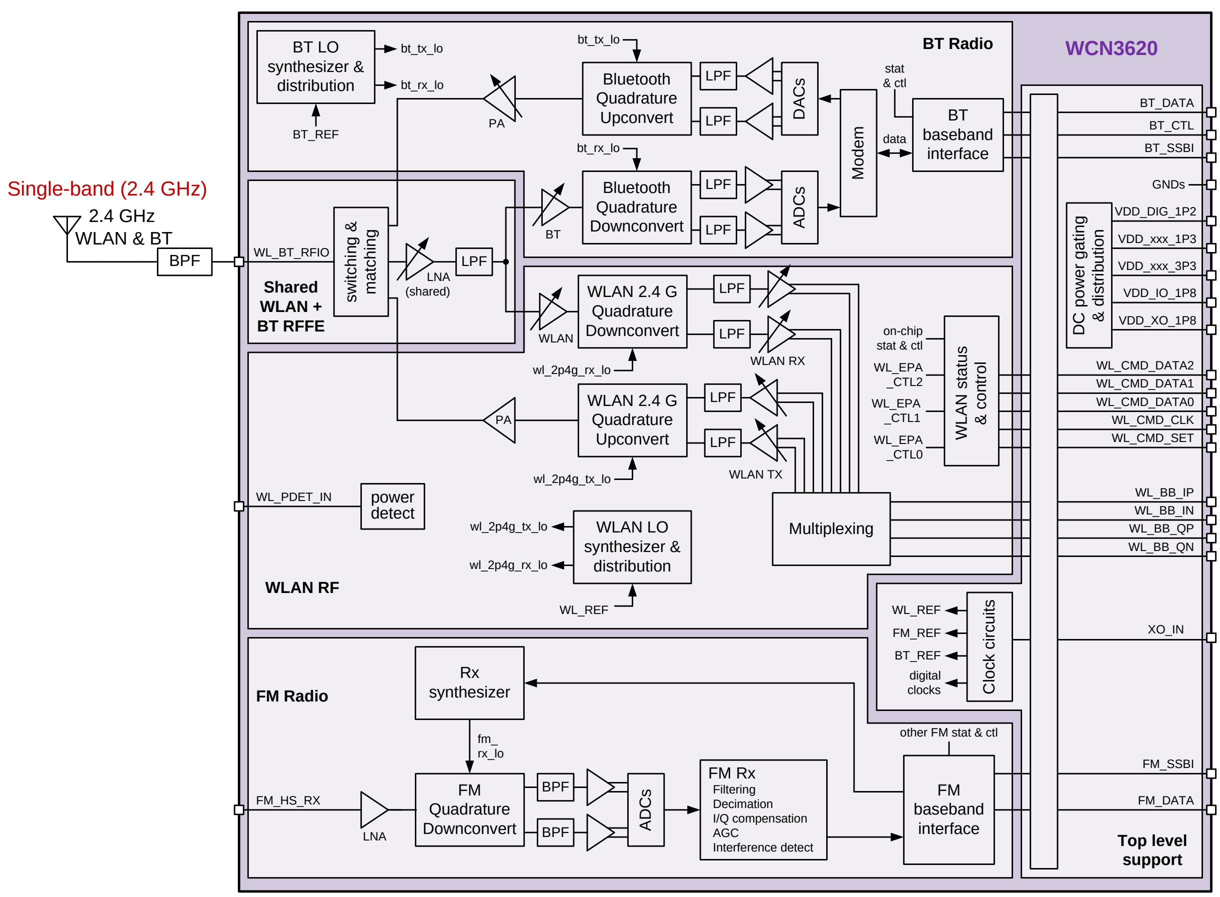


Figure 3-4 WCN3620 RF connections

3.8.1 WLAN RF Tx

The WCN3620 IC WLAN RF transmitter is specified for WLAN 802.11n standards, while guaranteeing FCC transmit-mask compliance across the band.

3.8.1.1 WLAN RF Tx performance

Table 3-9 WLAN RF Tx performance specifications

Parameter	Condition	Min	Typ	Max	Units
RF output frequency range		2.4	–	2.496	GHz
11b (1 Mbps)	Mask and EVM compliant	–	20.8	–	dBm
11b (11 Mbps)	Mask and EVM compliant	–	20.8	–	dBm
11g (6 Mbps)	Mask and EVM compliant	–	18.8	–	dBm
11g (54 Mbps)	Mask and EVM compliant	–	16.8	–	dBm
11n, HT20 (MCS0)	Mask and EVM compliant	–	17.8	–	dBm
11n, HT20 (MCS7)	Mask and EVM compliant	–	15.2	–	dBm
Tx output range at antenna	At any rate	8	–	20	dBm
Self-calibrated power control (SCPC)	At room temperature and VSWR ≤ 1.5:1	–	±2.0	–	dB
Closed-loop power control (CLPC) with external coupler	At room temperature and VSWR ≤ 1.5:1	–	±1.1	–	dB

Refer to the following IEEE 802.11 specifications for transmit spectrum limits:

- 802.11b mask (18.4.7.3)
- 802.11g mask (19.5.4)
- 802.11g EVM (17.3.9.6.3)
- 802.11n HT20 mask (20.3.21.1)
- 802.11n HT20 EVM (20.3.21.7.3)

3.8.2 WLAN 2.4 GHz RF Tx desensitization of WAN receivers

The WLAN transmissions can leak into the handset's wide area network (WAN) and GPS receivers and cause desensitization, potentially limiting concurrency. To evaluate concurrency limitations, the following factors were considered:

- WLAN to WAN
  a. Worst-case WLAN-to-WAN antenna isolation = 10 dB
  b. Tolerable WAN desensitization = 0.3 dB
  c. WAN receiver noise figure = 6 dB
- WLAN to GPS
  a. Worst-case WLAN-to-GPS antenna isolation = 10 dB
  b. Tolerable GPS receiver desensitization = 0.2 dB
  c. GPS receiver noise figure = 3 dB
- WLAN transmitter characteristics
  a. WLAN effective isotropic radiated power (EIRP) = 15 dBm
  b. A highly selective bandpass filter (integrated in a FEM) is shared by Tx and Rx

The resulting WLAN Tx requirements for WAN concurrency are summarized in Table 3-10.

Table 3-10 WLAN RF Tx emission specifications for WAN concurrency[1]

WAN or GPS band	Frequency range	Max Tx level in Rx band
GPS	1574 to 1577 MHz	-136 dBm/Hz
CDMA bands		
Cell (BC0)	869 to 894 MHz	-128 dBm/Hz
PCS (BC1)	1930 to 1990 MHz	-128 dBm/Hz
JCDMA (BC3)	832 to 870 MHz	-128 dBm/Hz
KPCS (BC4)	1840 to 1870 MHz	-128 dBm/Hz
IMT (BC6)	2110 to 2170 MHz	-128 dBm/Hz
AWS (BC15)	2110 to 2155 MHz	-128 dBm/Hz
GSM bands		
GSM 850	869 to 894 MHz	-128 dBm/Hz
GSM 900	925 to 960 MHz	-128 dBm/Hz
GSM 1800	1805 to 1880 MHz	-128 dBm/Hz
GSM 1900	1930 to 1990 MHz	-128 dBm/Hz

1. Specifications apply under the following conditions: 11g signal at 17.5 dBm, 45°C ambient temperature, over voltage, and over process.

3.8.3 WLAN RF Rx

The WCN3620 device WLAN RF receiver is specified for the WLAN 802.11n standard.

3.8.3.1 WLAN RF Rx performance

Table 3-11 WLAN RF Rx performance specifications

Parameter	Condition	Min	Typ	Max	Units
RF output frequency range		2.4	–	2.496	GHz
11b (1 Mbps)	At WCN3620	–	-97.8	–	dBm
11b (11 Mbps)	At WCN3620	–	-89.8	–	dBm
11g (6 Mbps)	At WCN3620	–	-91.8	–	dBm
11g (54 Mbps)	At WCN3620	–	-75.1	–	dBm
11n, HT20 (MCS0)	At WCN3620	–	-91.8	–	dBm
11n, HT20 (MCS7)	At WCN3620	–	-73.5	–	dBm

3.8.3.2 WLAN Rx desense due to WAN concurrency

The device's WAN transmissions can leak into the WLAN receiver and cause desensitization. Table 3-11 characterizes the WLAN desense due to WAN transmissions. The following conditions apply:

- The desensitization is limited to 1 dB in all test cases.
- The antenna isolation (WAN Tx to WLAN Rx) is assumed to be 10 dB in all cases.
- Only the WAN Tx channel power is included; other Tx levels such as harmonics and spurious emissions are not included.

Table 3-12 lists the sensitivity degradation for WLAN.

Table 3-12 WLAN 2 GHz sensitivity degradation with WAN blockers[1]

WAN, aggressor					WLAN, victim				WLAN desense			
Band		CH_ID	Frequency	WAN output power	Mode	Data rate	CH_ID	Frequency	WAN power at WLAN antenna	Coex filter attn[1]	WAN power at WCN 3660 input	Desense caused by blocker
WCDMA	BC1	9888	1977.6 MHz	23 dBm	11g	54 Mbps	6	2437 MHz	13 dBm	43 dB	-30 dBm	< 1.0 dB
	BC2	9538	1907.6 MHz	23 dBm					13 dBm	41 dB	-28 dBm	< 1.0 dB
	BC5	4233	846.6 MHz	23 dBm					13 dBm	40 dB	-27 dBm	< 1.0 dB
	BC8	2863	912.6 MHz	23 dBm					13 dBm	39 dB	-26 dBm	< 1.0 dB
GSM	GSM 850	251	848.8 MHz	33 dBm	11g	54 Mbps	6	2437 MHz	23 dBm	40 dB	-17 dBm	< 1.0 dB
	GSM 900	124	914.8 MHz	33 dBm					23 dBm	39 dB	-16 dBm	< 1.0 dB
	DCS 1800	885	1784.8 MHz	30 dBm					20 dBm	38 dB	-18 dBm	< 1.0 dB
	PCS 1900	810	1909.8 MHz	30 dBm					20 dBm	41 dB	-21 dBm	< 1.0 dB

1. Not a requirement, but attenuations measured on a particular board.

3.8.4 WLAN Tx power detector

The WCN3620 IC includes an integrated detector for monitoring WLAN transmissions near the high end of its dynamic range, thereby ensuring that the maximum level is achieved for each channel and data-rate configuration without exceeding spurious emission and EVM requirements. Three different operation scenarios are supported by the Tx power detector:

- Measurements based on the internal PA output
- Measurements based on the external PA output
- Bypass when using an external power detector – the external detector's output is connected to the WLAN_PDET_IN pin, which is multiplexed with the internal power detector's output to the power detect ADC input

Table 3-13 WLAN Tx power-detector performance specifications

Parameter	Comments	Min	Typ	Max	Units
Frequency range		2.400	–	5.850	GHz
Input RF power detector	Using external coupler only, no external power detect circuit.	-6	–	4.0	dBm
Input DC power detect voltage range	Using external coupler and external power detect	0.2	–	1.0	V
Output accuracy	Within 10 dB of the top segment of the dynamic range	-0.15 -0.25	– –	0.15 0.25	dB, at 25°C dB, across temperature
Output PDADC	Range of input RF power mapped to 8 bits	3	–	124	ADC counts
Output resolution	For every change in 1 dB in 10 dB of the top segment	10	–	–	ADC counts
Output response time[1]		–	4	–	µs
DC/RF turn-on time		–	–	2	µs
ADC common mode voltage		–	0.6	–	Bits

1. The signal subject to measurement is deterministic (always the same 4 µs segment within the WLAN preamble), so the expected response after 4 µs can be calibrated.

Additional comments pertaining to the WLAN Tx power detector:

- The output response is calibrated, so it does not need to be linear in dB or voltage.
- The DC offset error is compensated by software.
- The turn-on and turn-off times are programmable.

3.8.5 WLAN analog interface between APQ and WCN3620

The analog interface signals between the WLAN digital baseband of the wireless connectivity subsystem (WCS) in the APQ and WCN3620 devices are listed in Table 3-14. The I/Q baseband analog interface consists of four transmission lines shared between the Tx and Rx paths. In Tx mode these four lines are used to connect DAC output pins to Tx BBF input pins; the ADC input pins and Rx BBF output pins are in high-Z mode. For Rx mode, conversely, the four lines are used to connect the Rx BBF output pins to ADC input pins as the DAC outputs and Tx BBF inputs are in high-Z mode.

Table 3-14 Analog interface signals

Signal name	Direction (with respect to RF)	Description
WL_BB_IN	Analog I/O	Baseband analog I negative, multiplexed between TX_IN and RX_IN on the RF side. See Table 3-15.
WL_BB_IP	Analog I/O	Baseband analog I positive, multiplexed between TX_IP and RX_IP on the RF side. See Table 3-15.
WL_BB_QN	Analog I/O	Baseband analog Q negative, multiplexed between TX_QN and RX_QN on the RF side. See Table 3-15.
WL_BB_QP	Analog I/O	Baseband analog Q positive, multiplexed between TX_QP and RX_QP on the RF side. See Table 3-15.

The electrical specifications of the interface signals can be found in Table 3-15.

Table 3-15 Analog I/Q interface specifications

Specification	Comments	Min	Typ	Max	Units
Tx mode operation					
Tx I or Q input impedance for normal operation mode, single-ended	DC to 45 MHz	–	15 Ω || 1 pF	–	Ω
Tx I or Q input impedance for high-Z mode, single-ended	DC to 45 MHz	–	>1 M Ω || < 2 pF	–	Ω
Maximum interconnect capacitance I or Q, single ended[1]	External parasitic capacitance on I or Q inputs due to board routing, connector, etc.	–	–	7	pF
Amplitude droop in normal operation mode	At 45 MHz, due to Tx I or Q input impedance parasitic capacitance	–	–	0.1	dB
Mean I/Q phase imbalance	Measured up to 45 MHz	-0.2	–	0.2	Degree
Mean I/Q amplitude imbalance	Measured up to 45 MHz	-0.5	–	0.5	%
Tx mode, AC current positive or negative inputs (I or Q)		–	250	–	µApp
Tx mode, common mode voltage on either positive or negative input (I or Q)		–	0.3	–	V

Specification	Comments	Min	Typ	Max	Units
Rx mode operation					
Single-ended output impedance for normal operation (I or Q)	DC to 45 MHz	–	80	–	□
Single-ended output impedance for high-Z mode (I or Q)	DC to 45 MHz	–	>1 M Ω || < 2 pF	–	□
Rx I/Q output voltage range		0	–	1.6	Vpp
Amplitude droop in normal operation mode	At 45 MHz, due to Rx I or Q output impedance parasitic capacitance	–	–	0.1	dB
Mean I/Q phase imbalance	Measured up to 45 MHz	-0.2	–	0.2	Degree
Mean I/Q amplitude imbalance	Measured up to 45 MHz	-0.5	–	0.5	%
Common mode voltage on either positive or negative output (I or Q)		–	0.55	–	V
Rx drive capability Normal mode (driving internal ADC), single–ended		300 Ω || 8 pF			
Rx drive capability, resistive Test mode (driving external pin)	0 to 45 MHz	10	–	–	kΩ
Rx drive capability, capacitive Test mode (driving external pin)	0 to 40 MHz	–	–	1	pF
Maximum DC offset after calibration	Measured at BB IQ interface	-60	–	60	mV

1. 50 Ω strip transmission lines should be used for I/Q baseband analog interface signals.

3.9 Bluetooth radio

NOTE: WCN3620 also supports ANT features, since the ANT shares the same radio with Bluetooth BR. Compliance to Bluetooth basic rate specifications ensure ANT compliance as well.

3.9.1 Bluetooth RF Tx

Bluetooth RF transmitter specifications are listed according to three operating modes: the basic rate (Table 3-16), the enhanced data rate (Table 3-17), and low-energy mode (Table 3-18). All typical performance specifications, unless noted otherwise, are based on operation at room temperature (+25°C) using default parameter settings and nominal supply voltages.

Table 3-16 BT Tx performance specifications: basic rate, class[1]

Parameter	Comments	Min	Typ	Max	Units
RF frequency range[2]		2402	–	2480	MHz
RF output power (GFSK)	Max power setting	10.5	13[5]	15.5	dBm
Transmit power-control range[3]	Over multiple steps	30	–	–	dB
Transmit power-control step size[3]	Power change, each control step	2	–	8	dB
20 dB bandwidth	GFSK only	–	–	1	MHz
Adjacent channel power ▪ ±2 channels ▪ ±3 or more channels	At 1 MHz BW	 – –	 – –	 -20 -40	 dBm dBm
Frequency deviations: ▪ Normal ($\Delta f1_{avg}$) ▪ Packets exceeding 115 kHz ($\Delta f2_{max}$)		 140 99.9	 – –	 175 –	 kHz %
Frequency tolerance[3]		-75	–	+75	kHz
Carrier frequency drift ▪ Maximum drift rate within 50 µs ▪ Maximum length 1-slot packet ▪ Maximum length 3-slot packet ▪ Maximum length 5-slot packet		 -20 -25 -40 -40	 – – – –	 +20 +25 +40 +40	 kHz kHz kHz kHz
Tx noise power in mobile phone bands[4] ▪ 869 to 960 MHz ▪ 1570 to 1580 MHz ▪ 1805 to 1910 MHz ▪ 1930 to 1990 MHz ▪ 2010 to 2170 MHz	Measured without bandpass filter CDMA, GSM GPS GSM CDMA, WCDMA, GSM CDMA, WCDMA	 – – – – –	 -124 -143 -135 -135 -130	 – – – – –	 dBm/Hz dBm/Hz dBm/Hz dBm/Hz dBm/Hz

1. User measurement results could be affected by measurement uncertainty, as specified in Bluetooth TSS, Section 6.1.
2. Center frequency f = 2402 + k, where k is the channel number (all values in MHz).
3. Initial carrier frequency deviation from Tx center frequency before any packet information is transmitted.
4. This specification is required at room temperature (+25°C) and normal supply voltages only.
5. For ANT applications, RF output power is 4 dBm typical.

Table 3-17 BT Tx performance specifications: enhanced data rate[1]

Parameter	Comments	Min	Typ	Max	Units
RF frequency range[2]		2402	–	2480	MHz
RF output power[3]					
▪ π/4-DQPSK		–	11	–	dBm
▪ 8DPSK		–	11	–	dBm
EDR power-control step size[3]	Power change, each control step	2	–	8	dB
DEVM for π/4-DQPSK					
▪ > 99% of measured blocks		–	–	30	%
▪ RMS for any measured block		–	–	20	%
▪ Peak		–	–	35	%
DEVM for 8DPSK					
▪ > 99% of measured blocks		–	–	20	%
▪ RMS for any measured block		–	–	13	%
▪ Peak		–	–	25	%
In-band spurious emissions					
▪ ±1 MHz offset from center		–	–	-26	dBc
▪ ±2 MHz offset from center		–	–	-20	dBm
▪ ≥±3 MHz offset from center		–	–	-40	dBm
Frequency errors					
▪ Packet error (ω_i)	Initial error, all packets	-75	–	+75	kHz
▪ Block error (ω_o)	Error for RMS DEVM, all blocks	-10	–	+10	kHz
▪ Total error ($\omega_i + \omega_o$)	Total, all blocks	-75	–	+75	kHz
Tx noise power in mobile phone bands[4]	Measured without bandpass filter				
▪ 869 to 960 MHz	CDMA, GSM	–	-124	–	dBm/Hz
▪ 1570 to 1580 MHz	GPS	–	-143	–	dBm/Hz
▪ 1805 to 1910 MHz	GSM, DCS	–	-135	–	dBm/Hz
▪ 1930 to 1990 MHz	GSM, PCS, CDMA, WCDMA	–	-135	–	dBm/Hz
▪ 2010 to 2170 MHz	WCDMA	–	-130	–	dBm/Hz

1. User measurement results could be affected by measurement uncertainty, as specified in Bluetooth TSS.
2. Center frequency f = 2402 + k, where k is the channel number (all values in MHz).
3. EDR power measured in the GFSK header.
4. This specification is required at room temperature (+25°C) and normal supply voltages only.

Table 3-18 BT Tx performance specifications: low-energy mode

Parameter	Comments	Min	Typ	Max	Units
RF frequency range[1]		2402	–	2480	MHz
Average output power (PAVG)[2]	Maximum output power setting	–	4	–	dBm
In-band emissions f_{TX} ± 2 MHz f_{TX} ± (3 + n) MHz		 – –	 – –	 -20 -30	 dBm dBm
Modulation characteristics $\Delta f1_{avg}$ $\Delta f2_{max}$ ≥ 185 kHz $\Delta f1_{avg}/\Delta f1_{avg}$	Recorded over 10 test packets	 225 99.9 0.8	 – – –	 275 – –	 kHz % –
Carrier frequency offset and drift $f_n - f_{TX}$, n = 0, 1, 2, 3...k $\|f_0 - f_n\|$, n = 2, 3, 4...k $\|f_1 - f_0\|$ $\|f_n - f_{n-5}\|$, n = 6, 7, 8...k	fTX is the nominal Tx frequency	 -150 – – –	 – – – –	 +150 50 20 20	 kHz kHz kHz kHz

1. Center frequency f = 2402 + k, where k is the channel number (all values in MHz).
2. May set to any equivalent BR power level.

3.9.2 Bluetooth RF Rx

Bluetooth RF receiver specifications are listed according to three operating modes: the basic rate (Table 3-19), the enhanced data rate (Table 3-20), and low-energy mode (Table 3-21). All typical performance specifications, unless noted otherwise, are based on operation at room temperature (+25°C) using default parameter settings and nominal supply voltages.

Table 3-19 BT Rx performance specifications: basic rate[1]

Parameter	Comments	Min	Typ	Max	Units
RF frequency range [2]		2402	–	2480	MHz
Sensitivity	BER ≤ 0.1%	–	-95	-91	dBm
Maximum usable input[3]	BER ≤ 0.1%	0	–	–	dBm
Carrier-to-interference ratios (C/I)[3] ▪ Co-channel ▪ Adjacent channel (±1 MHz) ▪ Second adjacent channel (±2 MHz) ▪ Third adjacent channel (±3 MHz)	BER ≤ 0.1%	 – – – –	 – – – –	 11 0 -30 -40	 dB dB dB dB
Intermodulation[3, 4, 5]		-39	–	–	dBm

Parameter	Comments	Min	Typ	Max	Units
Out-of-band blocking[3, 6]	Measured without bandpass filter				
▪ Bluetooth					
▫ 30 to 2000 MHz		-10	–	–	dBm
▫ 2000 to 2400 MHz		-27	–	–	dBm
▫ 2500 to 3000 MHz		-27	–	–	dBm
▫ 3000 to 12750 MHz		-10	–	–	dBm
▪ Cellular blocking					
▫ CDMA2000		-7	–	–	dBm
▫ 410 to 420 MHz		-7	–	–	dBm
▫ 450 to 460 MHz		-7	–	–	dBm
▫ 479 to 484 MHz		-7	–	–	dBm
▫ 777 to 792 MHz		-7	–	–	dBm
▫ 806 to 849 MHz		-7	–	–	dBm
▫ 872 to 925 MHz		-7	–	–	dBm
▫ 1710 to 1785 MHz		-7	–	–	dBm
▫ 1850 to 1910 MHz		-7	–	–	dBm
▫ 1920 to 1980 MHz		-7	–	–	dBm
		-7	–	–	dBm
▪ GSM					
▫ 450 to 460 MHz		-1	–	–	dBm
▫ 479 to 484 MHz		-1	–	–	dBm
▫ 777 to 792 MHz		-1	–	–	dBm
▫ 824 to 849 MHz		-1	–	–	dBm
▫ 876 to 915 MHz		-1	–	–	dBm
▫ 1710 to 1785 MHz		-1	–	–	dBm
▫ 1850 to 1910 MHz		-1	–	–	dBm
▪ WCDMA					
▫ 1710 to 1785 MHz		-2	–	–	dBm
▫ 1850 to 1910 MHz		-2	–	–	dBm
▫ 1920 to 1980 MHz		-2	–	–	dBm

1. User measurement results could be affected by measurement uncertainty, as specified in Bluetooth TSS, Section 6.1.
2. Center frequency f = 2402 + k, where k is the channel number (all values in MHz).
3. This specification is required at room temperature (+25°C) and normal supply voltages only.
4. Maximum interferer level to maintain 0.1% BER; interference signals at 3 MHz and 6 MHz offsets.
5. Intermodulation performance specification is valid with minimum BPF insertion loss of 1.5 dB.
6. Continuous power in mobile phone bands, -67 dBm desired signal input level. The stated typical values in mobile phone bands are average values measured in accordance with Bluetooth TSS, with less than 24 exceptions.

Table 3-20 BT Rx performance specifications: enhanced data rate 1

Parameter	Comments	Min	Typ	Max	Units
RF frequency range [2]		2402	–	2480	MHz
Sensitivity ▪ π/4-DQPSK ▪ 8DPSK	BER ≤ 0.01%	 – –	 -95 -86	 -91 -84	 dBm dBm
Maximum usable input [3] ▪ π/4-DQPSK ▪ 8DPSK	BER ≤ 0.1%	 -15 -15	 – –	 – –	 dBm dBm
Carrier-to-interference ratios (C/I) [3] ▪ Co-channel ▫ π/4-DQPSK ▫ 8DPSK ▪ Adjacent channel (±1 MHz) ▫ π/4-DQPSK ▫ 8DPSK ▪ Second adjacent channel (±2 MHz) ▫ π/4-DQPSK ▫ 8DPSK ▪ Third adjacent channel (±3 MHz) ▫ π/4-DQPSK ▫ 8DPSK	Selectivity, BER ≤ 0.1%	 – – – – – – – –	 – – – – – – – –	 13 21 0 5 -30 -25 -40 -33	 dB dB dB dB dB dB dB dB

1. User measurement results could be affected by measurement uncertainty, as specified in Bluetooth TSS, Section 6.1.
2. Center frequency f = 2402 + k, where k is the channel number (all values in MHz).
3. This specification is required at room temperature (+25°C) and normal supply voltages only.

Table 3-21 BT Rx performance specifications: low-energy mode

Parameter	Comments	Min	Typ	Max	Units
RF frequency range [1]		2402	–	2480	MHz
Sensitivity		–	-98	–	dBm
Carrier-to-interference ratios (C/I) Co-channel Adjacent channel (±1 MHz) Second adjacent channel (±2 MHz) Third adjacent channel (±3 MHz)		 – – – –	 – – – –	 20 15 -17 -27	 dB dB dB dB
Out-of-band blocking 30 to 2000 MHz 2003 to 2399 MHz 2484 to 2997 MHz 3000 MHz to 12.75 GHz		 -10 -27 -27 -10	 – – – –	 – – – –	 dBm dBm dBm dBm

Parameter	Comments	Min	Typ	Max	Units
Intermodulation		-50	–	–	dBm
Maximum input signal level		0	–	–	dBm
PER report integrity		50	–	–	%

1. Center frequency f = 2402 + k, where k is the channel number (all values in MHz).

3.10 FM performance specifications

The WCN3620 FM performance specifications are defined in this section.

3.10.1 FM analog and RF performance specifications

The following sections provide performance specifications for the FM RF receiver and analog audio over the full operating power supply voltage range and temperature range shown in Table 3-2.

3.10.1.1 FM radio

Table 3-22 FM radio (with RDS) Rx performance specifications[1]

Parameter	Comments	Min	Typ	Max	Unit
RF-specific					
Input frequency range		76	–	108	MHz
Channel frequency step		– – –	50 100 200	– – –	kHz kHz kHz
RF input impedance FM_HS_RX	At 92.5 MHz input frequency	–	150 Ω // 10 pF	–	Ω
Sensitivity	Modulated with 1 kHz audio tone 22.5 kHz frequency deviation with 75 µs de-emphasis on Tester audio bandwidth: 300 Hz–15 kHz (A-weighted) 26 dB signal-to-noise ratio	–	-1	–	dBµV
RDS sensitivity	2 kHz RDS frequency deviation 95% of blocks decoded with no error Over 5000 blocks	–	15	–	dBµV
Receiver small signal selectivity ±200 kHz interference ±400 kHz interference	3.5 µV EMF wanted RF input signal level Modulated with 1 kHz audio tone 22.5 kHz frequency deviation Tester audio bandwidth: 300 Hz–15 kHz, (A-weighted) 26 dB signal-to-noise ratio	35 60	50 63	– –	dB dB

Parameter	Comments	Min	Typ	Max	Unit
In-band spurious rejection	1 mV wanted RF signal input level Modulated with 1 kHz audio tone 22.5 kHz frequency deviation Tester audio bandwidth: 300 Hz–15 kHz, (A-weighted) 26 dB signal-to-noise ratio	35	–	–	dB
Input third-order intercept point (IP3)		-18	–	–	dBm
Maximum RF input level	Maximum on-channel input level 76-108 MHz. Δf = 75 kHz, L = R, fmod = 1 kHz, pre/de-emph = 75 µs Note: THD ≤ 0.6% for mono and 1% for stereo at maximum RF input at room temperature.	118	–	–	dBµV
Seek/tune time	To within ±5 kHz of the final frequency	–	–	9	ms
Audio-specific					
De-emphasis time constant		– –	50 75	– –	µs µs
Audio (S + N)/N Mono	Modulated with 1 kHz audio tone 1 mV RF input signal level 22.5 kHz frequency deviation with 75 µs de-emphasis on Tester audio bandwidth: 300 Hz–15 kHz (A-weighted)	57	65	–	dB
Audio (S + N)/N Stereo	Modulated with 1 kHz audio tone 1 mV RF input signal level, 75 kHz frequency deviation with 75 µs de-emphasis on Tester audio bandwidth: 300 Hz–15 kHz (A-weighted)	53	58	–	dB
Audio total harmonic distortion (THD) Mono, 1 kHz, 75 kHz dev Mono, 1 kHz, 100 kHz dev Stereo, 3 kHz, 75 kHz dev	Modulated with 1 kHz audio tone 1 mV RF input signal level with 75 µs de-emphasis on Tester audio bandwidth: 300 Hz–15 kHz (A-weighted)	– – –	0.4 0.5 0.9	0.8 1 1.5	% % %
Audio frequency response low	Mono -3 dB point 0 dB at 1 kHz 1 mV RF input signal level 22.5 kHz frequency deviation with 75 µs pre-emphasis on	–	–	20	Hz
Audio frequency response high	Mono -3 dB point 0 dB at 1 kHz 1 mV RF input signal level 22.5 kHz frequency deviation with 75 µs pre-emphasis on	15	–	–	kHz

Parameter	Comments	Min	Typ	Max	Unit
Audio output mute attenuation Left Right Left and right	Modulated with 1 kHz audio tone 1 mV RF input signal level 22.5 kHz frequency deviation with 75 µs de-emphasis on Tester audio bandwidth: 300 Hz–15 kHz (A-weighted)	 80 80 80	 – – –	 – – –	 dB dB dB
Soft mute start level	3 dB mute attenuation	3	8	10	µV EMF
Soft mute attenuation at 1.4 µV EMF RF input signal level	Modulated with 1 kHz audio tone 22.5 kHz frequency deviation with 75 µs de-emphasis on Tester audio bandwidth: 300 Hz–15 kHz (A-weighted)	10	39	30	dB
AM suppression	Modulated with 1 kHz audio tone > 20 µV EMF RF input signal level 22.5 kHz frequency deviation with 75 µs de-emphasis on Tester audio bandwidth: 300 Hz–15 kHz (A-weighted) 30% AM modulation index	40	57	–	dB
Stereo channel separation SNC on	Modulated with 1 kHz audio tone 75 kHz frequency deviation 40 µV RF input signal level	4	10	16	dB
Stereo channel separation SNC off	Modulated with 1 kHz audio tone 75 kHz frequency deviation 30 µV RF input signal level	30	40	–	dB
Mono/stereo blend start voltage	1 dB stereo channel separation; SNC on	–	28	–	µV EMF
Mono/stereo switching hysteresis	SNC off; 1 kHz mod; 75 kHz dev; 9% pilot; R = 0, L = 1	–	3	–	dB

1. All RF input voltages are potential different across input unless EMF is explicitly stated.

Table 3-23 FM receiver selectivity[1, 2, 3, 4, 5, 6]

Category	Modulation type	Test frequencies (MHz)		Typical blocker input power (dBm)
		FM channel	WAN blocker	
NA700L	CDMA	99.9	698.5	-52
NA700L	CDMA	102.5	716.7	-52
NA700L	WCDMA	99.9	698.5	-47
NA700L	WCDMA	102.5	716.7	-47
NA700H	CDMA	87.5	786.7	-52
NA700H	CDMA	88.3	793.9	-52
NA700H	WCDMA	87.5	786.7	-47
NA700H	WCDMA	88.3	793.9	-47
US Cellular	GSM	91.7	824.5	-45
US Cellular	GSM	94.5	849.7	-45
US Cellular	CDMA	91.7	824.5	-42
US Cellular	CDMA	94.5	849.7	-42
US Cellular	WCDMA	91.7	824.5	-37
US Cellular	WCDMA	94.5	849.7	-37
GSM 900	GSM	97.9	880.3	-45
GSM 900	GSM	101.7	914.5	-45
CDMA 900	CDMA	97.9	880.3	-42
CDMA 900	CDMA	101.7	914.5	-42
WCDMA 900	WCDMA	97.9	880.3	-37
WCDMA 900	WCDMA	101.7	914.5	-37
UMTS 1500	WCDMA	84.1	1428.1	-37
UMTS 1500	WCDMA	85.5	1451.9	-37
GSM 1800	GSM	100.7	1710.3	-45
GSM 1800	GSM	105.1	1785.1	-45
PCS	GSM	97.5	1850.5	-45
PCS	GSM	100.7	1911.3	-45
PCS	CDMA	97.5	1850.5	-42
PCS	CDMA	100.7	1911.3	-42
PCS	WCDMA	97.5	1850.5	-37
PCS	WCDMA	100.7	1911.3	-37
IMT	CDMA	101.3	1922.7	-42
IMT	CDMA	104.3	1979.7	-42
IMT	WCDMA	101.3	1922.7	-37

Category	Modulation type	Test frequencies (MHz)		Typical blocker input power (dBm)
		FM channel	WAN blocker	
IMT	WCDMA	104.3	1979.7	-37
BT/WLAN	BT	104.5	2401.1	-43
BT/WLAN	BT	107.9	2479.3	-43
UMTS 2600	WCDMA	100.1	2500.1	-41
UMTS2 600	WCDMA	102.9	2570.1	-41

1. All levels are at chip input.
2. Wanted signal at 5 dBmV (-102 dBm 50 Ω or +10.8 dBmV EMF) input; fmod = 1 kHz, Df = 22.5 kHz SINAD = 26 dB, BAF = 300 Hz to 15 kHz (A-weighted) de-emphasis = 50 ms.
3. CDMA blocker is modulated reverse link. 1.2288 Mb/s chip rate.
4. WCDMA blocker is modulated reverse link. 3.84 Mb/s chip rate.
5. GSM blocker is modulated; MSK modulation; Gaussian filter BT = 0.3; fs = 270.8333 ks/s; and bursting 1/8 timeslots.
6. BT blocker is modulated with mod index = 0.315; bursting with DH1 packets.

3.10.2 FM RDS interrupt

At reset, the RDS interrupt signal is disabled. After reset, the host may enable the interrupt and set the NVM parameters associated with the interface. The software supports the following NVM parameters for configuring the interrupt behavior:

- Inactive mode: Tri-state or output
- Internal pull (if inactive mode is set to tri-state): Up, down, or no-pull

The FM RDS interrupt uses a digital I/O pin that receives power from the VDD_IO_1P8 supply. Its I/O performance specifications meet the requirements stated in Section 3.5.

4 Mechanical Information

4.1 Device physical dimensions

The WCN3620 is available in the 61 WLNSP that includes dedicated ground pins for improved grounding, mechanical strength, and thermal continuity. The 61 WLNSP has a 3.32 × 3.55 mm body with a maximum height of 0.63 mm. Pin 1 is located by an indicator mark on the top of the package. A simplified version of the 61 WLNSP outline drawing is shown in Figure 4-1.

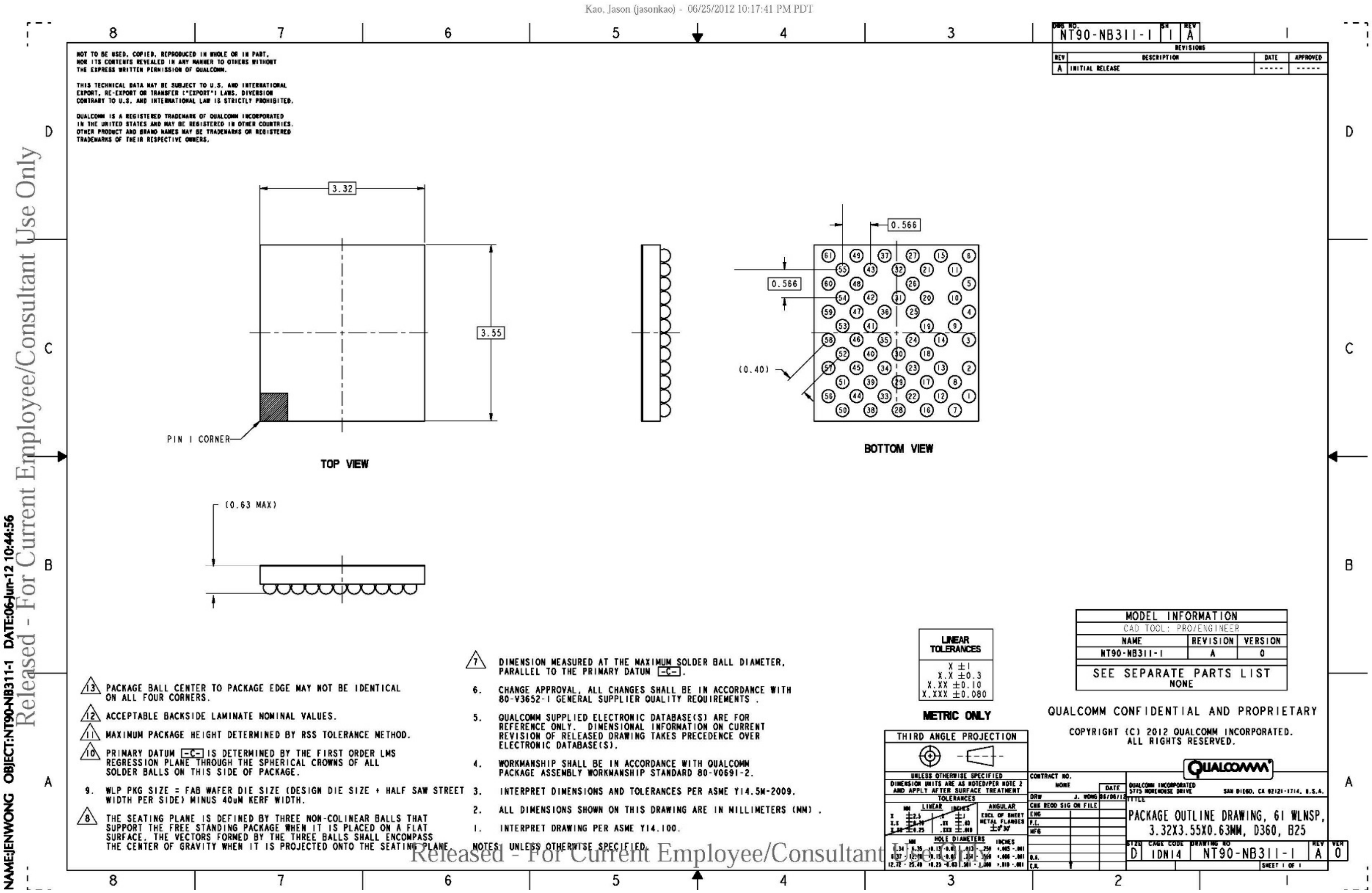


Figure 4-1 61WLNSP (3.32 × 3.55 × 0.63 mm) package outline drawing

This is a simplified outline drawing.

4.2 Part marking

4.2.1 Specification compliant devices

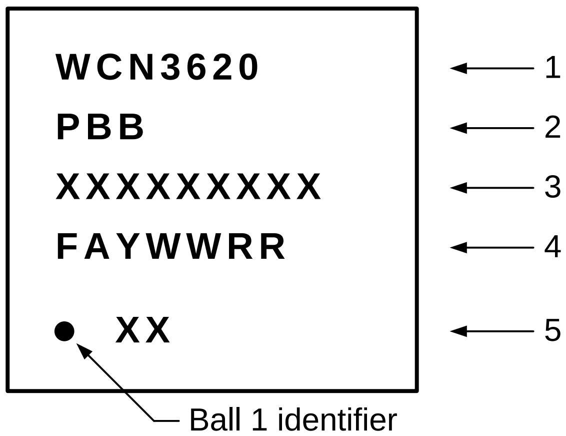


Figure 4-2 WCN3620 device marking (top view, not to scale)

Table 4-1 WCN3620 device marking line definitions

Line	Marking	Description
1	WCN3620	QTI.product name
2	PBB	P = Product configuration code ▪ See Table 4-2 for assigned values BB = Feature code ▪ See Table 4-2 for assigned values
3	XXXXXXXXX	XXXXXXXXX = traceability information
4	FAYWWRR	F = wafer fab location source code ▪ F = B for GF A = assembly (drop ball) site code ▪ A = C for ASE KH, Taiwan ▪ A = D for SCT3, Taiwan Y = single-digit year WW = work week (based on calendar year) RR = product revision – refer to Table 4-2
5	• XX	• = dot identifying pin 1 XX = traceability information

NOTE: For complete marking definitions of WCN3620 variants and revisions, refer to *WCN3620 Device Revision Guide* (LM80-P0436-34) at https://developer.qualcomm.com/hardware/snapdragon-410/tools.

4.3 Device ordering information

4.3.1 Specification compliant devices

This device can be ordered using the identification code shown in Figure 4-3 and the explanation below.

Device ID code ►	AAA-AAAA	— P	— CC	DDDDD	— EE	— RR	— S	— BB
Symbol definition ►	Product name	Config code	Number of pins	Package type	Shipping package	Product version	Source code	Feature code
Example ►	WCN-3620	— 0	— 61	WLNSP	— TR	— 00	— 0	— VV

Figure 4-3 Device identification code

Device ordering information details for all samples available to date are summarized in Table 4-2.

Table 4-2 Device identification code/ordering information details

WCN variant	P value	RR value	Date code (YWW)	S value[2]	BB value[3]
ES sample type					
WCN3620 ES1	0	03	–	0	VV
WCN3620 ES2	0	04	–	0	VV
	0	05	< 315	0	VV
CS sample type					
WCN3620 CS	0	05[1]	315	0	VV
	0	05	> = 316	0	VV
Other sample types will be included in future revisions of this document.					

1. There is a ;mix of ES and CS materials with YWW = 315.
   – All parts marked with Line 3 = 7R30661 and Line 5 = 01 and 02 are ES,
   – All parts marked with Line 3 = 7R30661 and Line 5 = 03, 04, 05, and 06 are CS.
2. S is the source configuration code that identifies all the qualified die fabrication source combinations available at the time a particular sample type were shipped.
3. BB is the feature code that identifies an IC’s specific feature set that distinguishes it from other versions or variants. Defined feature sets available at the time of this document’s release are:
   – VV = null set; all devices available at this time have the same feature set.

4.4 Device moisture-sensitivity level

Plastic-encapsulated surface mount packages are susceptible to damage induced by absorbed moisture and high temperature. A package's moisture-sensitivity level (MSL) indicates its ability to withstand exposure after it is removed from its shipment bag, while it is on the factory floor awaiting PCB installation. A low MSL rating is better than a high rating; a low MSL device can be exposed on the factory floor longer than a high MSL device. All pertinent MSL ratings are summarized in Table 4-3.

Table 4-3 MSL ratings summary

MSL	Out-of-bag floor life	Comments
1	Unlimited	≤ 30°C/85% RH; WCN3620 rating
2	1 year	≤ 30°C/60% RH
2a	4 weeks	≤ 30°C/60% RH
3	168 hours	≤ 30°C/60% RH
4	72 hours	≤ 30°C/60% RH
5	48 hours	≤ 30°C/60% RH
5a	24 hours	≤ 30°C/60% RH
6	Mandatory bake before use. After bake, must be reflowed within the time limit specified on the label.	≤ 30°C/60% RH

The latest IPC/JEDEC J-STD-020 standard revision for moisture-sensitivity qualification is being followed. *The WCN3620 devices are classified as MSL1; the qualification temperature was 250ºC.* This qualification temperature (250°C) should not be confused with the peak temperature within the recommended solder reflow profile (see Section 6.2.3 for further discussion).

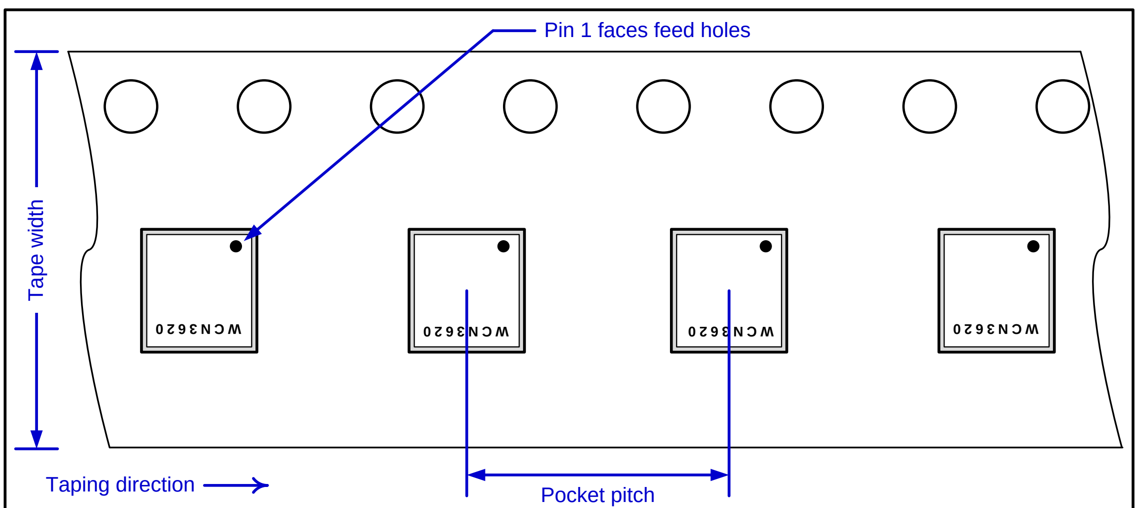
5 Carrier, Storage, and Handling Information

5.1 Carrier

5.1.1 Tape and reel information

All QTI carrier tape systems conform to EIA-481 standards.

A simplified sketch of the WCN3620 tape carrier is shown in Figure 5-1, including the proper part orientation, maximum number of devices per reel, and key dimensions.



Tape feed:	Single	Reel diameter:	330 mm	Tape width:	12 mm
Units per reel:	4000	Hub diameter:	178 mm	Pocket pitch:	8 mm

Figure 5-1 Carrier tape drawing with part orientation

Tape-handling recommendations are shown in Figure 5-2.

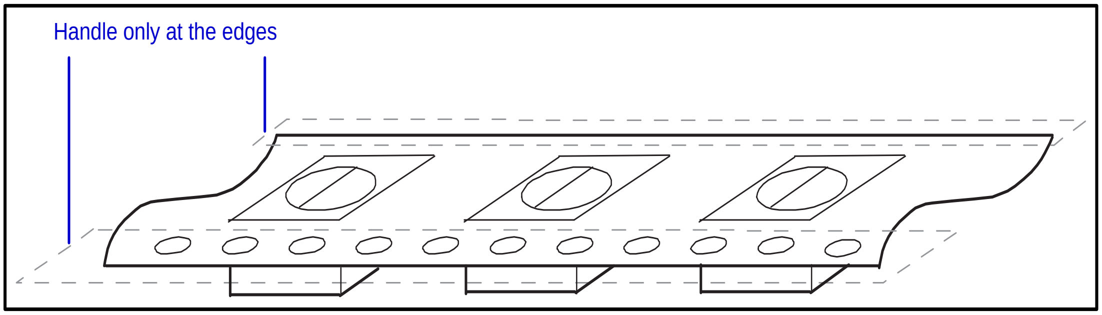


Figure 5-2 Tape handling

5.2 Storage

5.2.1 Bagged storage conditions

WCN3620 devices delivered in tape and reel carriers must be stored in sealed, moisture barrier, anti-static bags. The WCN3620 devices may be kept outside the moisture barrier bag on the factory floor indefinitely without detrimental moisture absorption.

5.3 Handling

Tape handling was discussed in Section 5.1.1. Other (IC-specific) handling guidelines are presented below.

Unlike traditional IC devices, the die within a wafer-level package is not protected by an overmold and there is no substrate; hence, these devices are relatively fragile.

NOTE: To avoid damage to the die due to improper handling, these recommendations should be followed:

- Do not use tweezers; a vacuum tip is recommended for handling the devices.
- Carefully select a pickup tool for use during the SMT process.
- Do not make contact with the device when reworking or tuning components located near the device.

5.3.1 Baking

Wafer-level packages such as the 61 WLNSP should not be baked.

5.3.2 Electrostatic discharge

Electrostatic discharge (ESD) occurs naturally in laboratory and factory environments. An established high-voltage potential is always at risk of discharging to a lower potential. If this discharge path is through a semiconductor device, destructive damage may result.

ESD countermeasures and handling methods must be developed and used to control the factory environment at each manufacturing site.

QTI IC products must be handled according to the ESD Association standard: ANSI/ESD S20.20-1999, *Protection of Electrical and Electronic Parts, Assemblies, and Equipment*.

Refer to Section 7.1 for the WCN3620 ESD ratings.

6 PCB Mounting Guidelines

6.1 RoHS compliance

The device is lead-free and RoHS-compliant. Its SnAgCu solder balls use SAC405 composition. These lead-free (or Pb-free) semiconductor products are defined as having a maximum lead concentration of 1000 ppm (0.1% by weight) in raw (homogeneous) materials and end products.

6.2 SMT parameters

This section describes the board-level characterization process parameters. It is included to assist customers with their SMT process development; it is not intended to be a specification for their SMT processes.

6.2.1 Land pad and stencil design

The land pattern and stencil recommendations presented in this section are based upon QTI internal characterizations for lead-free solder pastes on an eight layer PCB built primarily to the specifications described in JEDEC JESD22-B111.

Characterizing the land patterns according to each customer’s processes, materials, equipment, stencil design, and reflow profile prior to PCB production is recommended. Optimizing the solder stencil pattern design and print process is critical to ensure print uniformity, decrease voiding, and increase board-level reliability.

General land pattern guidelines:

- Non-solder-mask-defined (NSMD) pads provide the best reliability.
- Keep the solderable area consistent for each pad, especially when mixing via-in-pad and non-via-in-pad in the same array.
- Avoid large solder mask openings over ground planes.
- Traces for external routing are recommended to be less than or equal to half the pad diameter to ensure consistent solder joint shapes.

One key parameter that should be evaluated is the ratio of aperture area to sidewall area, known as the area ratio (AR). Square apertures are recommended for optimal solder paste release. In this case, a simple equation can be used relating the side length of the aperture to the stencil thickness (as illustrated and explained in Figure 6-1). Larger area ratios enable better transfer of solder paste to the PCB, minimize defects, and ensure a more stable printing process. Inter-aperture spacing should be at least as thick as the stencil, otherwise paste deposits may bridge.

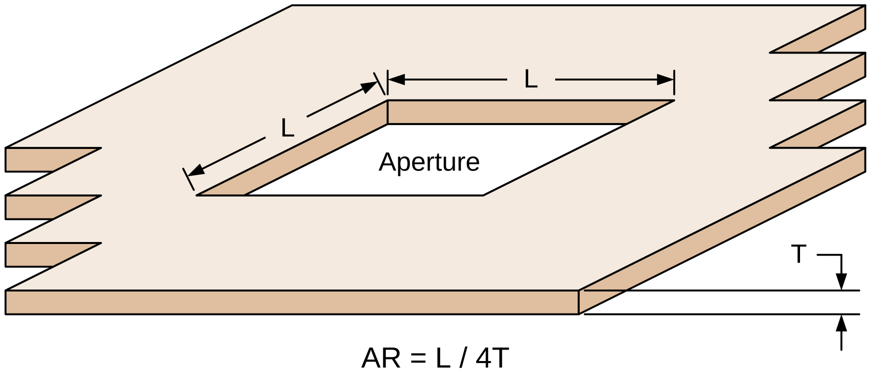


Figure 6-1 Stencil printing aperture area ratio (AR)

Guidelines for an acceptable relationship between L and T are listed below and illustrated in Figure 6-2:

- R = L/4T > 0.65 – best
- 0.60 ≤ R ≤ 0.65 – acceptable
- R < 0.60 – not acceptable

Stencil Aperture L (µm)	Stencil thickness, T (µm)							
	75	80	85	90	95	100	105	110
210	0.70	0.66	0.62	0.58	0.55	0.53	0.50	0.48
220	0.73	0.69	0.65	0.61	0.58	0.55	0.52	0.50
230	0.77	0.72	0.68	0.64	0.61	0.58	0.55	0.52
240	0.80	0.75	0.71	0.67	0.63	0.60	0.57	0.55
250	0.83	0.78	0.74	0.69	0.66	0.63	0..60	0.57
260	0.87	0.81	0.76	0.72	0.68	0.65	0.62	0.59

Figure 6-2 Acceptable solder paste geometries

QTI provides an example of a PCB land pattern and stencil design for the 61 WLNSP.

6.2.2 Reflow profile

Reflow profile conditions typically used by QTI for lead-free systems are listed in Table 6-1 and illustrated in Figure 6-3.

Table 6-1 Typical SMT reflow profile conditions (for reference only)

Profile stage	Description	Temp range	Condition
Preheat	Initial ramp	< 150°C	3°C/s max
Soak	Flux activation	150 to 190°C	60 to 75 s
Ramp	Transition to liquidus (solder paste melting point)	190 to 220°C	< 30 s
Reflow	Time above liquidus	220 to 245°C[1]	50 to 70 s
Cool down	Cool rate – ramp to ambient	< 220°C	6°C/s max

1. During the reflow process, the recommended peak temperature is 245°C (minimum). This temperature should not be confused with the peak temperature reached during MSL testing as discussed in Section 6.2.3.

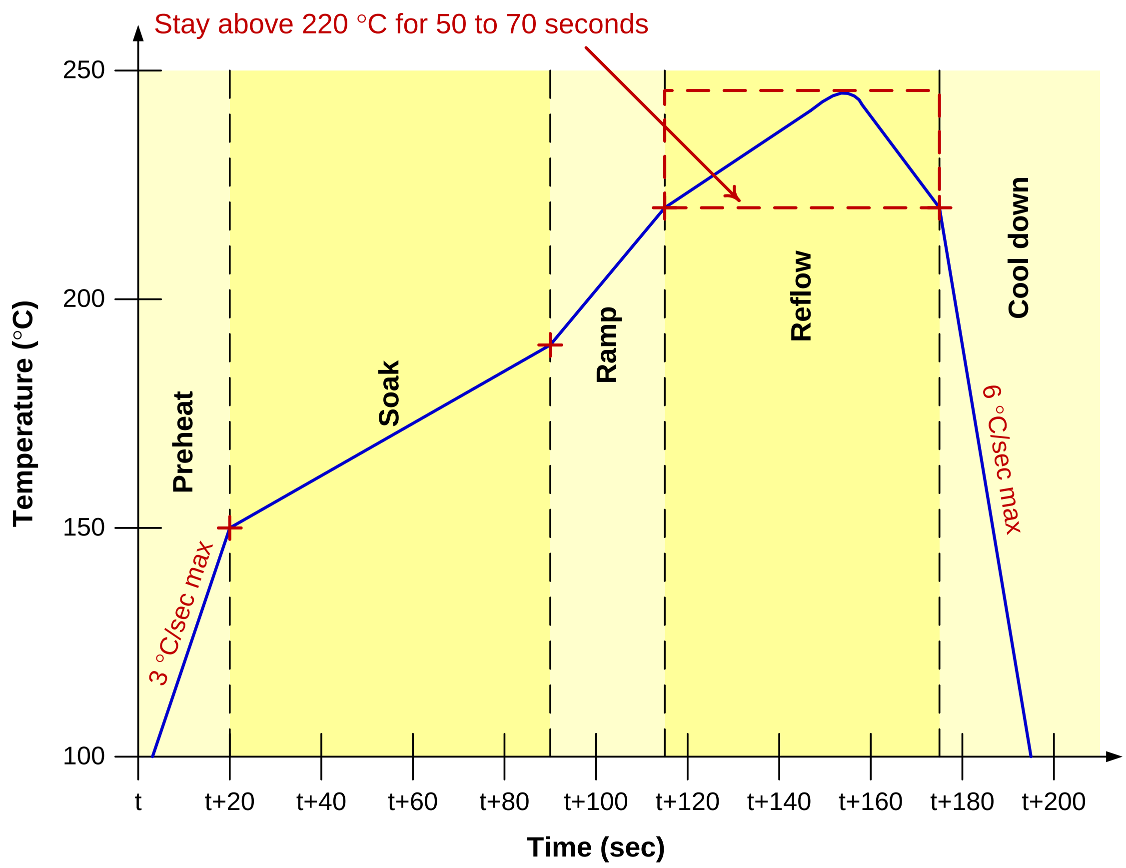


Figure 6-3 Typical SMT reflow profile

6.2.3 SMT peak package body temperature

This document states a peak package body temperature in three other places within this document, and without explanation they may appear to conflict. The three places are listed below, along with an explanation of the stated value and its meaning within that section's context.

1. Section 4.4 – *Device moisture-sensitivity level*

   WCN3620 devices are classified as MSL1 at 250°C. The temperature (250°C) included in this designation is the lower limit of the range stated for moisture resistance testing during the device qualification process as explained in #2 below.

2. Section 7.1 – *Qualification sample description*

   One of the tests conducted for device qualification is the moisture resistance test. Following J-STD-020-C, the device hits a peak reflow temperature that falls within the range of 260°C +0/-5°C (255°C to 260°C).

3. Section 6.2.2 – *Reflow profile*

   During a production board's reflow process, the temperature seen by the package must be controlled. Obviously the temperature must be high enough to melt the solder and provide reliable connections, but it must not go so high that the device might be damaged. The recommended peak temperature during production assembly is 245°C. This is comfortably above the solder melting point (220°C), yet well below the proven temperature reached during qualification (250°C or more).

6.2.4 SMT process verification

Verification of the SMT process prior to high-volume board assembly is recommended, including:

- In-line solder paste deposition monitoring
- Reflow profile measurement and verification
- Visual and x-ray inspection after soldering to confirm adequate alignment, solder voids, solder ball shape, and solder bridging
- Cross-section inspection of solder joints for wetting, solder ball shape, and voiding

6.3 Board-level reliability

Characterization tests were conducted to assess the device's board-level reliability, including the following physical tests on evaluation boards:

- Drop shock (JESD22-B111)
- Temperature cycling (JESD22-A104)
- Cyclic bend testing – optional (JESD22-B113)

7 Part Reliability

7.1 Reliability qualifications summary

Table 7-1 WCN3620 reliability qualification report for device from GF and WLNSP package from ASE-KH and SCT

Device qualification Tests, standards, and conditions	Sample # lots	Results
Average failure rate (AFR) in FIT (λ) failures per billion device hours	231 3 lots	λ= 29 FIT
Mean time to failure (MTTF) t = 1/λ (million hours)	231 3 lots	34
ESD – Human body model (HBM) rating JESD22-A114-B	3	Pass ±2000 V, all pins
ESD – Charged device model (CDM) rating JESD22-C101-D	3	Pass ±500 V, all pins
Latch-up (overcurrent test): EIA/JESD78 Trigger current: ±100 mA; temperature: 85°C	6	Pass
Latch-up (Vsupply overvoltage): EIA/JESD78 Trigger voltage: 1.5 × V; temperature: 85°C	6	Pass

Table 7-2 WCN3620 package qualification report for device from GF and WLNSP package from ASE-KH and SCT

Package qualification Tests, standards, and conditions	Sample # lots	Results (ASE)	Results (SCT)
Moisture resistance test (MRT): MSL 1; J-STD-020 3 x reflow cycles at 255 +5/-0°C	462 3 lots	Pass	Pass
Temperature cycle: JESD22-A104 Temperature: -55°C to +125°C; number of cycles: 1000 Minimum soak time at min/max temperature: 5 minutes Cycle rate: 2 cycles per hour (cph) Preconditioning: JESD22-A113 MSL: 1; reflow temperature: 255 +5/-0°C	231 3 lots	Pass	Pass
Unbiased highly accelerated stress test (UHAST) JESD22-A118 Preconditioning: JESD22-A113 MSL: 1; reflow temperature: 255 +5/-0°C	231 3 lots	Pass	Pass

Package qualification Tests, standards, and conditions	Sample # lots	Results (ASE)	Results (SCT)
High temperature storage life: JESD22-A103 Temperature 150°C, 1000 hours	78 3 lots	Pass	Pass
Physical dimensions: JESD22-B100-A Package outline drawing; NT90-N2742-1	15	Pass	Pass
Solder ball shear: JESD22-B117 After 10x reflow cycles 26°C -5/+0°C	40 balls (4 balls per sample × 10 samples)	Pass, All balls sheared in ductile mode.	Pass, All balls sheared in ductile mode.

7.2 Qualification sample description

Device characteristics

Device name: WCN3620

Package type: 61 WLNSP

Package body size: 3.32 × 3.55 × 0.63 mm

Lead count: 61

Lead composition: SAC405

Fab process: RF CMOS

Fab sites: Global Foundries

Assembly sites: ASE KH, Taiwan
SCT3, Taiwan

Solder ball pitch: 0.4 mm

A Exhibit 1

PLEASE READ THIS LICENSE AGREEMENT ("AGREEMENT") CAREFULLY. THIS AGREEMENT IS A BINDING LEGAL AGREEMENT ENTERED INTO BY AND BETWEEN YOU (OR IF YOU ARE ENTERING INTO THIS AGREEMENT ON BEHALF OF AN ENTITY, THEN THE ENTITY THAT YOU REPRESENT) AND QUALCOMM TECHNOLOGIES, INC. ("QTI" "WE" "OUR" OR "US"). THIS IS THE AGREEMENT THAT APPLIES TO YOUR USE OF THE DESIGNATED AND/OR ATTACHED DOCUMENTATION AND ANY UPDATES OR IMPROVEMENTS THEREOF (COLLECTIVELY, "MATERIALS"). BY USING OR COMPLETING THE INSTALLATION OF THE MATERIALS, YOU ARE ACCEPTING THIS AGREEMENT AND YOU AGREE TO BE BOUND BY ITS TERMS AND CONDITIONS. IF YOU DO NOT AGREE TO THESE TERMS, QTI IS UNWILLING TO AND DOES NOT LICENSE THE MATERIALS TO YOU. IF YOU DO NOT AGREE TO THESE TERMS YOU MUST DISCONTINUE AND YOU MAY NOT USE THE MATERIALS OR RETAIN ANY COPIES OF THE MATERIALS. ANY USE OR POSSESSION OF THE MATERIALS BY YOU IS SUBJECT TO THE TERMS AND CONDITIONS SET FORTH IN THIS AGREEMENT.

1.1 **License.** Subject to the terms and conditions of this Agreement, including, without limitation, the restrictions, conditions, limitations and exclusions set forth in this Agreement, Qualcomm Technologies, Inc. ("QTI") hereby grants to you a nonexclusive, limited license under QTI's copyrights to use the attached Materials; and to reproduce and redistribute a reasonable number of copies of the Materials. You may not use Qualcomm Technologies or its affiliates or subsidiaries name, logo or trademarks; and copyright, trademark, patent and any other notices that appear on the Materials may not be removed or obscured. QTI shall be free to use suggestions, feedback or other information received from You, without obligation of any kind to You. QTI may immediately terminate this Agreement upon your breach. Upon termination of this Agreement, Sections 1.2-4 shall survive.

1.2 **Indemnification.** You agree to indemnify and hold harmless QTI and its officers, directors, employees and successors and assigns against any and all third party claims, demands, causes of action, losses, liabilities, damages, costs and expenses, incurred by QTI (including but not limited to costs of defense, investigation and reasonable attorney's fees) arising out of, resulting from or related to: (i) any breach of this Agreement by You; and (ii) your acts, omissions, products and services. If requested by QTI, You agree to defend QTI in connection with any third party claims, demands, or causes of action resulting from, arising out of or in connection with any of the foregoing.

1.3 **Ownership.** QTI (or its licensors) shall retain title and all ownership rights in and to the Materials and all copies thereof, and nothing herein shall be deemed to grant any right to You under any of QTI's or its affiliates' patents. You shall not subject the Materials to any third party license terms (e.g., open source license terms). You shall not use the Materials for the purpose of identifying or providing evidence to support any potential patent infringement claim against QTI, its affiliates, or any of QTI's or QTI's affiliates' suppliers and/or direct or indirect customers. QTI hereby reserves all rights not expressly granted herein.

1.4 **WARRANTY DISCLAIMER.** YOU EXPRESSLY ACKNOWLEDGE AND AGREE THAT THE USE OF THE MATERIALS IS AT YOUR SOLE RISK. THE MATERIALS AND TECHNICAL SUPPORT, IF ANY, ARE PROVIDED "AS IS" AND WITHOUT WARRANTY OF ANY KIND, WHETHER EXPRESS OR IMPLIED. QTI ITS LICENSORS AND AFFILIATES MAKE NO WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THE MATERIALS OR ANY OTHER INFORMATION OR DOCUMENTATION PROVIDED UNDER THIS AGREEMENT, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR AGAINST INFRINGEMENT, OR ANY EXPRESS OR IMPLIED WARRANTY ARISING OUT OF TRADE USAGE OR OUT OF A COURSE OF DEALING OR COURSE OF PERFORMANCE. NOTHING CONTAINED IN THIS AGREEMENT SHALL BE CONSTRUED AS (I) A WARRANTY OR REPRESENTATION BY QTI, ITS LICENSORS OR AFFILIATES AS TO THE VALIDITY OR SCOPE OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT OR (II) A WARRANTY OR REPRESENTATION BY QTI THAT ANY MANUFACTURE OR USE WILL BE FREE FROM INFRINGEMENT OF PATENTS, COPYRIGHTS OR OTHER INTELLECTUAL PROPERTY RIGHTS OF OTHERS, AND IT SHALL BE THE SOLE RESPONSIBILITY OF YOU TO MAKE SUCH DETERMINATION AS IS NECESSARY WITH RESPECT TO THE ACQUISITION OF LICENSES UNDER PATENTS AND OTHER INTELLECTUAL PROPERTY OF THIRD PARTIES.

1.5 **LIMITATION OF LIABILITY.** IN NO EVENT SHALL QTI, QTI'S AFFILIATES OR ITS LICENSORS BE LIABLE TO YOU FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOST PROFITS, LOST SAVINGS, OR OTHER INCIDENTAL DAMAGES, ARISING OUT OF THE USE OR INABILITY TO USE, OR THE DELIVERY OR FAILURE TO DELIVER, ANY OF THE MATERIALS, OR ANY BREACH OF ANY OBLIGATION UNDER THIS AGREEMENT, EVEN IF QTI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THE FOREGOING LIMITATION OF LIABILITY SHALL REMAIN IN FULL FORCE AND EFFECT REGARDLESS OF WHETHER YOUR REMEDIES HEREUNDER ARE DETERMINED TO HAVE FAILED OF THEIR ESSENTIAL PURPOSE. THE ENTIRE LIABILITY OF QTI, QTI's AFFILIATES AND ITS LICENSORS, AND THE SOLE AND EXCLUSIVE REMEDY OF YOU, FOR ANY CLAIM OR CAUSE OF ACTION ARISING HEREUNDER (WHETHER IN CONTRACT, TORT, OR OTHERWISE) SHALL NOT EXCEED US$10.

2. **COMPLIANCE WITH LAWS; APPLICABLE LAW.** You agree to comply with all applicable local, international and national laws and regulations and with U.S. Export Administration Regulations, as they apply to the subject matter of this Agreement. This Agreement is governed by the laws of the State of California, excluding California's choice of law rules.

3. **CONTRACTING PARTIES.** If the Materials are downloaded on any computer owned by a corporation or other legal entity, then this Agreement is formed by and between QTI and such entity. The individual accepting the terms of this Agreement represents and warrants to QTI that they have the authority to bind such entity to the terms and conditions of this Agreement.

4. **MISCELLANEOUS PROVISIONS.** This Agreement, together with all exhibits attached hereto, which are incorporated herein by this reference, constitutes the entire agreement between QTI and You and supersedes all prior negotiations, representations and agreements between the parties with respect to the subject matter hereof. No addition or modification of this Agreement shall be effective unless made in writing and signed by the respective representatives of QTI and You. The restrictions, limitations, exclusions and conditions set forth in this Agreement shall apply even if QTI or any of its affiliates becomes aware of or fails to act in a manner to address any violation or failure to comply therewith. You hereby acknowledge and agree that the restrictions, limitations, conditions and exclusions imposed in this Agreement on the rights granted in this Agreement are not a derogation of the benefits of such rights. You further acknowledges that, in the absence of such restrictions, limitations, conditions and exclusions, QTI would not have entered into this Agreement with You. Each party shall be responsible for and shall bear its own expenses in connection with this Agreement. If any of the provisions of this Agreement are determined to be invalid, illegal, or otherwise unenforceable, the remaining provisions shall remain in full force and effect. This Agreement is entered into solely in the English language, and if for any reason any other language version is prepared by any party, it shall be solely for convenience and the English version shall govern and control all aspects. If You are located in the province of Quebec, Canada, the following applies: The Parties hereby confirm they have requested this Agreement and all related documents be prepared in English.