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REV	DESCRIPTION		DATE	AUTHOR
1.0	RFQ		01/28/10	Vinh Le
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Orthus Radio Integration Guide

	Mid Power APN RF functional specifications

DOC. NO: 00-J948B0-FS04	Page 1 of 24

Signature Approval of Document

MOTOROLA

Required Approvals

Program Manager xxx	____________________	Date:	__________
Electrical, Mechanical & RF Engineering Platform Manager Morteza Zarrabian	____________________	Date:	__________
Product Manager xxx	____________________	Date:	__________

Optional Approvals

System Engineering Vinh Le	____________________	Date:	__________
RF Engineering Nhan Nguyen	____________________	Date:	__________

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1 Functional summary

1.1 Overall radio summary

The Orthus radio is a dual band radio which can be configured to work at 2.4GHz or at 5.2GHz. The Orthus radio is based on Atheros XB92 reference design that is a 2x2 MIMO supporting 1 and 2 spatial streams. There are only two antennas for the radio. The Orthus radio is based on XB92 base band chipset AR9280 from Atheros with the radio front end redesigned such that the radio will have better transmit power than the Atheros XB92 reference design. The radio has two operation modes: 3.3V and 5.0V. In the 5.0V mode, the radio is designed to transmit more power than the 3.3V in 2.4G band. More details are described later on in this document. The Orthus radio will be used in three different AP products: MCN, NCAP, and high power NCAP (HP-NCAP).
The following section highlights a few modes of the radio:

- Data rates supported in 802.11b modes are: 1Mbps, 2Mbps, 5.5Mbps, and 11Mbps.
- Data rates supported in 802.11g modes are: 6Mbps, 9Mbps, 12Mbps, 18Mbps, 24Mbps, 36MBps, 48Mbps, and 54Mbps.
- Data rates supported in 802.11n draft 2.0 modes: MCS0 through MCS15.
- Channel bandwidth: 20 MHz or 40 MHz.
- Frequency band: 2.4 GHz and 5.2 GHz.
- Short guard support for HT40.
- STBC support in single spatial stream mode.
- Configurable transmit power mode: medium and high power (3.3V or 5.0V)
- Typical RF transmit power per antenna, high power mode, 11Mbps: +28dBm, 2.4G.
- Typical RF transmit power per antenna, normal power mode, 11Mbps: +22dBm, 2.4G.
- Typical RF transmit power per antenna, normal power mode, 6Mbps: +21dBm, 5.2G.
- Interface: PCI-E.

1.2 Radio PHY Supported feature highlights

HT PHY Layer Features/Functions	Supported	Not supported
20 MHz Channel Bandwidth	X	
40 MHz Channel Bandwidth	X	
Short preamble		
Short/Long guard for HT20	Long guard	Short guard
Short/Long guard for HT40	X	
Legacy Frame Format	X	
Mixed Mode (High Throughput) Frame Format	X	
Green Field Frame Format		X
40 MHz Mode	X	
Convolutional Coding	X	
Low Density Parity Check Coding (LDPC)		X
Open Loop Spatial Division Multiplexing (SDM)	X	
Closed Loop Transmit Beam forming (TxBF)		X
Space Time Blocking Code (STBC)	X	
800ns Guard Interval	X	
400ns Guard Interval	X	
1 Spatial Stream	X	
2 Spatial Stream	X	
3 Spatial Stream		X
4 Spatial Stream		X

Number of transmitters	2	
Number of receivers	2	

Figure 1-PHY supported features

2.1 Antenna ports

The radio will have two U.FL antenna connectors. The radio can transmit on one or two antennas depending on the operating modes. Furthermore, the radio can receive on one or two antennas as well.

2.2 Temperature range

This radio will be characterized and will maintain RF electrical specifications as stated here when the radio is used in the MCN, NCAP or HP-NCAP. Please refer to the mechanical functional specification of the respective AP.

2.3 Radio power supply

Description	MIN	TYP	MAX	Unit	Comments/Notes
5.0 V Supply voltage	4.85	5.0	5.15	Vdc	5.0 V nominal, 3% variation
3.3 V Supply voltage	3.2	3.3	3.4	Vdc	3.3V nominal, 3% variation

Figure 2-Power supply specifications

2.3.1 Average power consumption

The average power consumption is specified as below. In this configuration, the Orthus radio is set to transmit at maximum power at the given data rate.

Item	Radio mode	Power consumption (RMS) max
1	3.3V	2.5W
2	5.0V	8W

Figure 3-RSM current and power consumption

2.4 RF channel bandwidth

The RF signal bandwidth shall be configurable to 20MHz, or 40MHz at 2.4 GHz band and 5.2 GHz band.

2.5 Channel allocation and frequency operating range

2.5.1 2.4 GHz band

The 2.4 GHz operating frequency ranges from 2.312 GHz to 2.472 GHz. In addition to that, 2.484 GHz can also be selected. Normally, channel center frequencies are tunable in 5 MHz steps and are define as follows:

$$\textit{Channel center frequency} = 2407 + 5n \quad \text{(MHz)}$$

Where,

$$n = 1,2,\ldots 11$$

Common operating channels are:

Channel	Center frequency (MHz)
1	2412
2	2417
3	2422
4	2427
5	2432
6	2437
7	2442
8	2447
9	2452
10	2457
11	2462
12	2467
13	2472
14	2484

Figure 4-2.4 GHz channel

2.5.2 5.2 GHz band

The 5.2 GHz operating frequency ranges are as below. This radio will NOT support 4.9GHz band. The supported frequency range is listed as follows:

Band	Frequency (GHz)
UNII-1	5.15-5.25 GHz
UNII-2	5.25-5.35 GHz
UNII-3	5.470-5.725 GHz
UNII-4	5.725-5.850
Europe	5.15-5.25 GHz 5.25-5.35 GHz 5.47-5.725 GHz
Japan	5.15-5.25 GHz 5.25-5.35 GHz 5.470-5.725 GHz

Figure 5-5.2 GHz frequency operating range

The exact center channel frequency for operation can be determined by using the following formula:

Channel center frequency = 5000 + n*5 (MHz)

Where n=0,1,…,200

2.6 Transmitter operation

2.6.1 Spectrum mask

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The Orthus radio shall be designed to meet IEEE recommendation for spectrum mask. For the 20MHz operation, the spectrum mask will conform the IEEE standard in 802.11n draft 2.0 as defined in 21.3.20.1. Please refer to the draft 2.0 for more details.

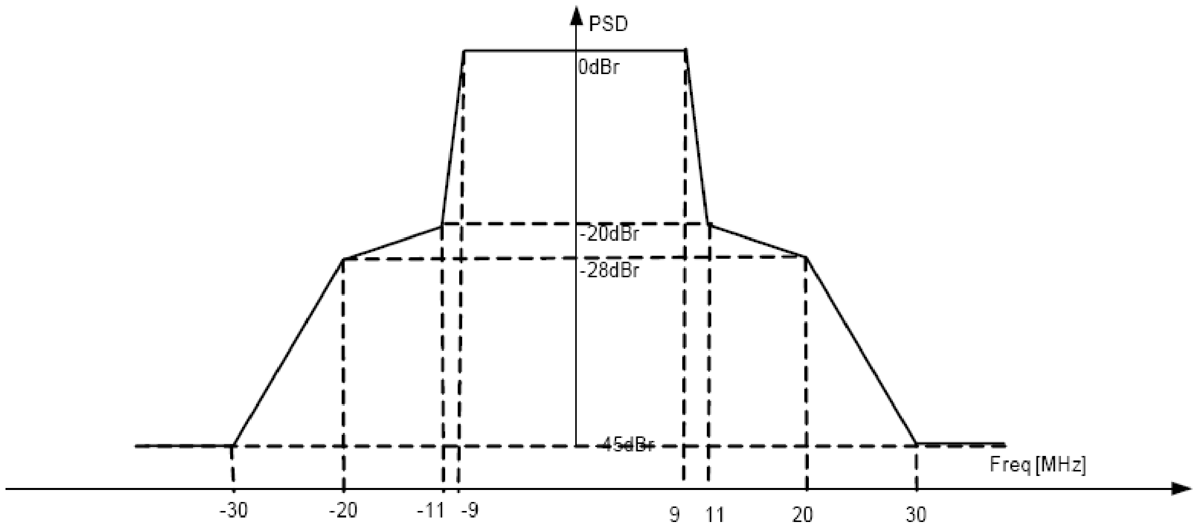

Figure 6-20MHz spectrum mask

When transmitting in a 20 MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset and –45 dBr at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure n64 (Transmit spectral mask for 20 MHz transmission). The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth. The mask for 40MHz RF signal is shown below:

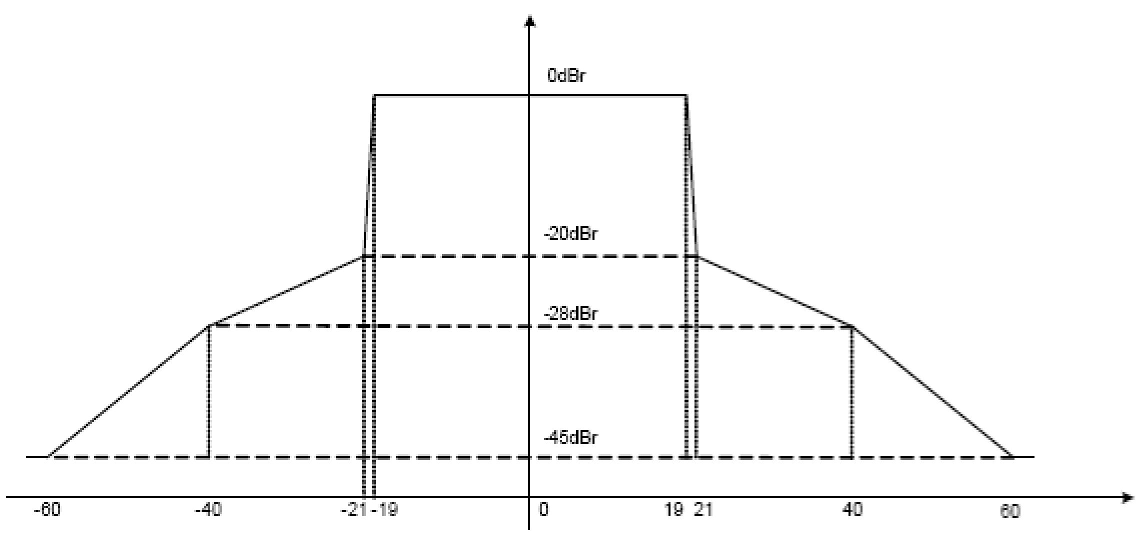

Figure 7-40MHz spectrum mask

2.6.2 Spectral flatness

The transmit spectral flatness will conform the 802.11n draft as specified in section 20.3.20.2.
In a 20 MHz channel and in corresponding 20 MHz transmission in a 40 MHz channel, the average energy of the constellations in each of the spectral lines –16 to –1 and +1 to +16 shall deviate no more than ± 2 dB from their average energy. The average energy of the constellations in each of the spectral lines –28 to –17 and +17 to +28 shall deviate no more than +2/–4 dB from the average energy of spectral lines –16 to –1 and +1 to +16.
In a 40 MHz transmission (excluding HT duplicate format and non-HT duplicate format) the average energy of the constellations in each of the spectral lines –42 to –2 and +2 to +42 shall deviate no more than ± 2 dB from their average energy. The average energy of the constellations in each of the spectral lines –43 to –58 and +43 to +58 shall deviate no more than +2/–4 dB from the average energy of spectral lines –42 to –2 and +2 to +42.

2.6.3 Transmit power range and accuracy

This radio will have an adjustable output power range from +4dBm to +28dBm in 0.5 dB step. Per Atheros radio calibration procedure as well as per base band chipset design, this radio shall be designed to maintain an average transmit power accuracy of +/-2dB per antenna.
The method for determining the average transmitted power accuracy is calculated as follows:
When the ideal transmitted power is set by software, the output RF power of the radio is measured simultaneously by the MIMO Litepoint Iqnxn test set (or equivalent) for a given data rate on all channels, all frequency bands. The actual measured output power is subtracted from the ideal settings to obtain the errors for each level. The errors at each level are then averaged over all channels in the given band. This calculation shall be performed for each transmit chain.

2.6.4 Transmit center frequency tolerance

The transmitter center frequency tolerance shall be ±20 ppm maximum.

2.6.5 RX Symbol clock frequency tolerance

This table below lists the minimum requirements for the radio by the IEEE standard. The actual radio shall be able to accommodate +/- 50ppm.

Mode Of Operation	IEEE Stability Requirements	Radio spec (min)
802.11a	+/-20ppm frequency stability vs. temperature and aging.	+/- 40ppm
802.11b	+/-25ppm frequency stability vs. temperature and aging.	+/-50ppm
802.11g	+/-25ppm frequency stability vs. temperature and aging.	+/-50ppm

Figure 8-Symbol clock frequency tolerance

2.6.6 Modulation accuracy (EVM), DSSS rates

Modulation accuracy shall meet the minimum requirements by IEEE 802.11 draft 2.0.

The following table lists the EVM requirements for direct sequence spread spectrum data rates which use 802.11b waveforms:

Data rate (Mbps)	EVM (minimum)
1	35%

2	35%
5.5	35%
11	35%

Figure 9- Transmit modulation accuracy (EVM) for DSSS rates

2.6.7 Modulation accuracy (EVM), OFDM rates

The following table lists the EVM requirements for OFDM data rates which use 802.11a, 802.11g, and 802.11n draft 2.0 waveforms:

Data rate(Mbps)	Relative constellation error (dB) (minimum)
6	-5
9	-8
12	-10
18	-13
24	-16
36	-19
48	-22
54	-25

Figure 10-EVM specifications for OFDM 802.11 a/g rates

Modulation	Code rate	Relative constellation error (dB) (minimum)
BPSK	½	-5
QPSK	½	-10
QPSK	¾	-13
16-QAM	½	-16
16-QAM	¾	-19
64-QAM	½	-22
64-QAM	¾	-25
64-QAM	5/6	-28

Figure 11-Transmit modulation accuracy (EVM) for HT rates

2.6.8 Phase noise

Normally, the phase noise effect has already part of the transmit EVM specifications. However, the receiver local oscillator can still affect the receive signal quality.

Item	Max	Unit
Integrated phase noise	1.5	Degree rms

Figure 12-Phase noise specification

2.6.9 VCO turn around settling time

The VCO shape should be similar to the plot below or better for backward compatibility with older Motorola products. Specifically, during transient transition from transmit to receive, or from receive to transmit, the VCO frequency shall not change more than 20 KHz over 20us counting from the start of the turnaround packet.

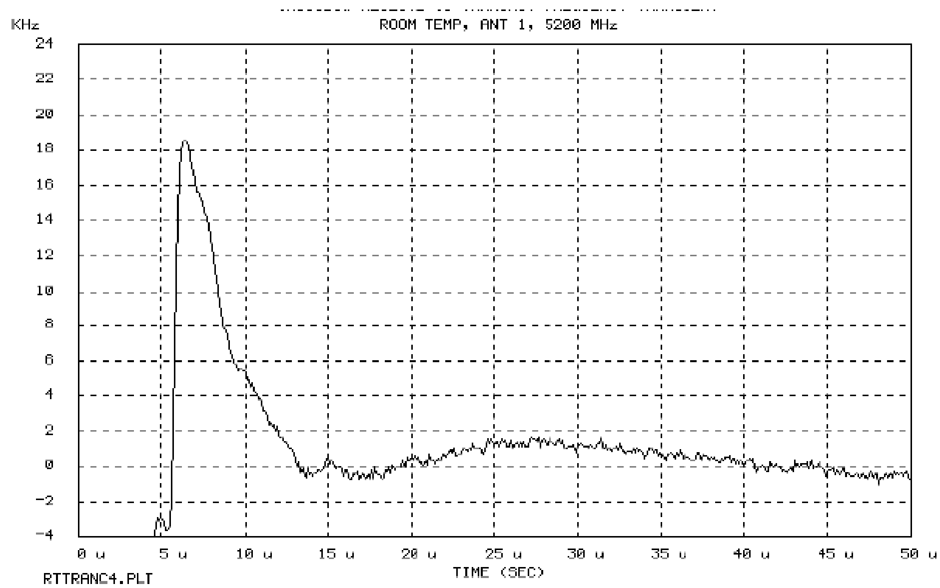

Figure 13-VCO frequency transient

2.6.10 Transmit emissions

Item	Description	MIN	MAX	Unit	Comments
206	Receive emissions		-57	dBm	30 MHz to 1 GHz
207	Receive emissions		-47	dBm	1 GHz to 12 GHz
301	Transmit signal spectrum		-30	dBc	Relative to constant TX at Fc ±11MHz
			-50		For f_c–22MHz ≤ f ≤ f_c–11MHz and f_c+11MHz ≤ f ≤ f_c+22MHz.
302	Band-edge spurious signals		-41	dBm	1 MHz RBW, 1 KHz VBW, max hold, Transmitting 11 MB/sec packets at any channel 1 through 11: measure in 2300-2390 MHz, 2483.5-2500 MHz, 4/5-5.25 GHz, and 7.25-7.75 GHz. (FCC 15.205: restricted bands). Antenna to have 0 dBi gain.
302a	Band-edge Spurious signals		-30	dBm	ETSI
307	Key click/spectral re-growth		10	dBr	Measurements to be made using a 100 kHz resolution bandwidth and a 30 KHz video bandwidth. dBr means dB relative to the SINx/x peak.

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Figure 14-Transmit emission specifications

2.6.11 Load stability

The transmitter will be unconditionally stable under infinite VSWR, and all phases.

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2.6.12 Conducted transmit power

Due to the EVM and side-lobe requirements, the maximum transmit power will vary with data rates. The figures below shows typical transmit power for each transmitted chain for both 2.4GHz and 5.2GHz operation. The transmit power listed here are characterized based on EVM purpose only. The final AP transmit power depends on the result of regulatory test for each country.
As mentioned in beginning of the document, the radio has two modes: 3.3V and 5.0V mode. The transmit power for 5.2G is the same in both modes whereas the transmit power for the 2.4G band is boosted. The two tables below lists the difference.

The conducted transmit power is specified as the power measured at the Orthus radio connector and not at the antenna chassis of the AP. Average transmit power is a number typically seen when measured on an arbitrary radio. The conducted transmitted power is subject to vary as defined by transmit power variation specification in section 2.6.3

Orthus Radio transmit power 3.3V mode		Modulation	Code Rate		Average transmit power	Average transmit power
Rates (Mbps)	MCS			Bandwidth	2.4G band	5.2G band
1		BPSK		20MHz	22	NA
2		QPSK		20MHz	22	NA
5.5		BPSK		20MHz	22	NA
11		QPSK		20MHz	22	NA
6		BPSK	½	20MHz	22	21
9		BPSK	¾	20MHz	22	21
12		QPSK	½	20MHz	22	21
18		QPSK	¾	20MHz	22	21
24		16-QAM	½	20MHz	22	21
36		16-QAM	¾	20MHz	21	20
48		64-QAM	2/3	20MHz	20	19
54		64-QAM	¾	20MHz	19	18
	MCS0/MCS8	BPSK	½	HT20/40	22	21
	MCS1/MCS9	QPSK	½	HT20/40	22	21
	MCS2/MCS10	QPSK	¾	HT20/40	22	21
	MCS3/MCS11	16-QAM	½	HT20/40	22	21
	MCS4/MCS12	16-QAM	¾	HT20/40	21	21
	MCS5/MCS13	64-QAM	2/3	HT20/40	20	20
	MCS6/MCS14	64-QAM	¾	HT20/40	19	19
	MCS7/MCS15	64-QAM	5/6	HT20/40	18	18

Figure 15-Transmit power specification, 3.3V mode

Orthus Radio transmit power 5.0V mode		Modulation	Code Rate		Average transmit power	Average transmit power
Rates (Mbps)	MCS			Bandwidth	2.4G band	5.2G band
1		BPSK		20MHz	28	NA
2		QPSK		20MHz	28	NA
5.5		BPSK		20MHz	28	NA
11		QPSK		20MHz	28	NA
6		BPSK	½	20MHz	28	21
9		BPSK	¾	20MHz	28	21
12		QPSK	½	20MHz	28	21
18		QPSK	¾	20MHz	28	21
24		16-QAM	½	20MHz	27	21
36		16-QAM	¾	20MHz	26	20
48		64-QAM	2/3	20MHz	25	19
54		64-QAM	¾	20MHz	24	18
	MCS0/MCS8	BPSK	½	HT20/40	28	21
	MCS1/MCS9	QPSK	½	HT20/40	27	21
	MCS2/MCS10	QPSK	¾	HT20/40	27	21
	MCS3/MCS11	16-QAM	½	HT20/40	26	21
	MCS4/MCS12	16-QAM	¾	HT20/40	26	21
	MCS5/MCS13	64-QAM	2/3	HT20/40	25	20
	MCS6/MCS14	64-QAM	¾	HT20/40	24	19
	MCS7/MCS15	64-QAM	5/6	HT20/40	23	18

Figure 16-Transmit power specification, 5.0V mode

2.7 Receiver operation

2.7.1 Receiver input sensitivities

The receiver sensitivity is independent of 3.3V mode or 5.0V mode. The two tables below show the desired performance for the radio. The sensitivity is a number averaged over all channels in a given band.

A	B	C	D
2400 Mhz band			Typical radio receiver sensitivity (dBm)
Rates	MCS indices	Rate type	
1		LEGACY	-94
2			-93

5.5			-91
11			-90
6			-92
9			-92
12			-91
18			-89
24			-85
36			-83
48			-79
54			-77
	MCS0	HT20	-92
	MCS1		-89
	MCS2		-87
	MCS3		-84
	MCS4		-81
	MCS5		-77
	MCS6		-76
	MCS7		-74
	MCS8		-92
	MCS9		-88
	MCS10		-86
	MCS11		-83
	MCS12		-81
	MCS13		-76
	MCS14		-75
	MCS15		-73
	MCS0	HT40	-88
	MCS1		-86
	MCS2		-84
	MCS3		-82
	MCS4		-79
	MCS5		-74
	MCS6		-72
	MCS7		-71
	MCS8		-88
	MCS9		-85
	MCS10		-83
	MCS11		-81
	MCS12		-78
	MCS13		-73
	MCS14		-71
	MCS15		-70

Figure 17-Typical receiver sensitivity for Orthus radio, 2400Mhz band

A	B	C	D
5200 Mhz band			Typical radio

			receiver sensitivity (dBm)
Rates	MCS indices	Rate type	
6		LEGACY	-94
9			-94
12			-93
18			-91
24			-87
36			-84
48			-80
54			-79
	MCS0	HT20	-94
	MCS1		-92
	MCS2		-90
	MCS3		-86
	MCS4		-83
	MCS5		-79
	MCS6		-77
	MCS7		-75
	MCS8		-91
	MCS9		-88
	MCS10		-85
	MCS11		-83
	MCS12		-80
	MCS13		-75
	MCS14		-74
	MCS15		-72
	MCS0	HT40	-91
	MCS1		-88
	MCS2		-86
	MCS3		-83
	MCS4		-80
	MCS5		-75
	MCS6		-74
	MCS7		-73
	MCS8		-88
	MCS9		-85
	MCS10		-83
	MCS11		-80
	MCS12		-76
	MCS13		-72
	MCS14		-70
	MCS15		-68

Figure 18-Typical receiver sensitivity for Orthus radio, 5200Mhz band

2.7.2 Adjacent channel rejection

The adjacent channel rejection is measured by setting the desired signal's strength 3 dB above the rate-dependent sensitivity specified in the radio receiver minimum sensitivity, and raising the power of the interfering signal until 10% Packet Error Rate (PER) is caused for a PSDU length of 4096 bytes for 1000 packets. The power difference between the interfering and the desired channel is the corresponding adjacent channel rejection. The interfering signal in the adjacent channel shall be a conformant OFDM signal, unsynchronized with the signal in the channel under test.
For more detail about the setup requirements, please read the 802.11n draft section 21.3.21.2

Waveform	Data rate (Mbps)	Modulation	Coding rate	Adjacent channel rejection (dB) per 802.11 a/b/g/n draft 2.0 standard	Adjacent channel rejection (dB) per actual hardware	Non-adjacent channel rejection (dB) per 802.11 a/b/g/n draft 2.0 standard	Non-adjacent channel rejection (dB) per actual hardware
DSSS							
	1			35	Meet standard requirement		Not applicable
	2			35	Meet standard requirement		Not applicable
	5.5			35	Meet standard requirement		Not applicable
	11			35	Meet standard requirement		Not applicable
OFDM							
		BPSK	½	16	Meet standard requirement	32	Meet standard requirement
		QPSK	½	13	Meet standard requirement	29	Meet standard requirement
		QPSK	¾	11	Meet standard requirement	27	Meet standard requirement
		16-QAM	½	8	Meet standard requirement	24	Meet standard requirement
		16-QAM	¾	4	Meet standard requirement	20	Meet standard requirement
		64-QAM	½	0	Meet standard requirement	16	Meet standard requirement
		64-QAM	¾	-1	Meet standard requirement	15	Meet standard requirement
		64-QAM	5/6	-2	Meet standard requirement	14	Meet standard requirement

Figure 19-Adjacent Channel and non-adjacent channel rejection specification

2.7.3 Non-adjacent channel rejection

The setup is similar to adjacent channel rejection specification. Please refer to Figure 19-Adjacent Channel and non-adjacent channel rejection specification

2.7.4 Receiver maximum input signal level

The receiver shall provide a maximum PER of 10% at an PSDU length of 1000 bytes for a maximum input level of –10 dBm measured at the antenna for any baseband modulation.

2.7.5 Receive inter-modulation distortion

IEEE does not specify this value. However, the radio interception point will be measured, and calculated. The receiver interception point should reflect an acceptable performance for normal usage of the Orthus AP.

2.7.6 Receiver channel power indicator (RCPI)

The receive channel power indicator also known as RSSI definition is described as follows. The RCPI indicator is a measure of the received RF power in the selected channel. This parameter shall be a measure by the PHY sublayer of the received RF power in the channel measured over the entire received frame. The received power shall be the average over all receive chains. RCPI shall be a monotonically increasing, logarithmic function of the received power level defined in dBm. The allowed values for the Received Channel Power Indicator (RCPI) parameter shall be an 8 bit value in the range from 0 through 220, with indicated values rounded to the nearest 0.5 dB as follows:
— 0: Power not > -110 dBm
— 1: Power = -109.5 dBm
— 2: Power = -109.0 dBm
— and so on up to
— 220: Power not < 0 dBm
— 221-254: reserved
— 255: Measurement not available
where

*RCPI = int{(Power in dBm +110)*2} for 0 dbm > Power > -110 dBm (21-76)*

Accuracy for each measurement shall be +/- 5dB (95% confidence interval) within the specified dynamic range of the receiver. The measurement shall assume a receiver noise equivalent bandwidth equal to the channel bandwidth multiplied by 1.1.

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2.7.7 Data rates and modes supported

Besides the legacy rates for 11 a/g, the following rates are supported. Specifically, MCS0 through MCS15 are supported with both types of guard intervals (800ns, and 400ns). In combinations of 20MHz and 40MHz channel bandwidth, there are multiple data rates possible. The figures below summarizes the modes in high throughput modes.

Table 20-28—Symbols used in MCS parameter tables

Symbol	Explanation
N_{SS}	Number of spatial streams
R	Coding rate
N_{BPSC}	Number of coded bits per single carrier (total across spatial streams)
$N_{BPSCS}(i_{SS})$	Number of coded bits per single carrier for each spatial stream, $i_{SS} = 1,...,N_{SS}$
N_{SD}	Number of data subcarriers
N_{SP}	Number of pilot subcarriers
N_{CBPS}	Number of coded bits per OFDM symbol
N_{DBPS}	Number of data bits per OFDM symbol
N_{ES}	Number of BCC encoders for the DATA field
N_{TBPS}	Total bits per subcarrier

Table n82—Rate dependent parameters for mandatory 20 MHz, N_{SS} =1 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI see NOTE
0	BPSK	1/2	1	52	4	52	26	6.5	7.2
1	QPSK	1/2	2	52	4	104	52	13.0	14.4
2	QPSK	3/4	2	52	4	104	78	19.5	21.7
3	16-QAM	1/2	4	52	4	208	104	26.0	28.9
4	16-QAM	3/4	4	52	4	208	156	39.0	43.3
5	64-QAM	2/3	6	52	4	312	208	52.0	57.8
6	64-QAM	3/4	6	52	4	312	234	58.5	65.0
7	64-QAM	5/6	6	52	4	312	260	65.0	72.2
NOTE—Support of 400 ns guard interval is optional on transmit and receive									

Table n83 (Rate-dependent parameters for optional 20 MHz, NSS = 2 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 20 MHz, N_{SS} = 2 MCSs with N_{ES} = 1.

Table n83—Rate-dependent parameters for optional 20 MHz, N_{SS} = 2 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI See NOTE
8	BPSK	1/2	1	52	4	104	52	13.0	14.4
9	QPSK	1/2	2	52	4	208	104	26.0	28.9
10	QPSK	3/4	2	52	4	208	156	39.0	43.3
11	16-QAM	1/2	4	52	4	416	208	52.0	57.8
12	16-QAM	3/4	4	52	4	416	312	78.0	86.7
13	64-QAM	2/3	6	52	4	624	416	104.0	115.6
14	64-QAM	3/4	6	52	4	624	468	117.0	130.0
15	64-QAM	5/6	6	52	4	624	520	130.0	144.4
NOTE—The 400 ns GI rate values are rounded to 1 decimal place									

Figure 20-Supported data rates for 20MHz bandwidth

Table n86—Rate-dependent parameters for optional 40 MHz, N_{SS} = 1 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI
0	BPSK	1/2	1	108	6	108	54	13.5	15.0
1	QPSK	1/2	2	108	6	216	108	27.0	30.0
2	QPSK	3/4	2	108	6	216	162	40.5	45.0
3	16-QAM	1/2	4	108	6	432	216	54.0	60.0
4	16-QAM	3/4	4	108	6	432	324	81.0	90.0
5	64-QAM	2/3	6	108	6	648	432	108.0	120.0
6	64-QAM	3/4	6	108	6	648	486	121.5	135.0
7	64-QAM	5/6	6	108	6	648	540	135.0	150.0

Table n87 (Rate-dependent parameters for optional 40 MHz, NSS = 2 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 40 MHz, N_{SS} = 2 MCSs with N_{ES} = 1.

Table n87—Rate-dependent parameters for optional 40 MHz, N_{SS} = 2 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI
8	BPSK	1/2	1	108	6	216	108	27.0	30.0
9	QPSK	1/2	2	108	6	432	216	54.0	60.0
10	QPSK	3/4	2	108	6	432	324	81.0	90.0
11	16-QAM	1/2	4	108	6	864	432	108.0	120.0
12	16-QAM	3/4	4	108	6	864	648	162.0	180.0
13	64-QAM	2/3	6	108	6	1296	864	216.0	240.0
14	64-QAM	3/4	6	108	6	1296	972	243.0	270.0
15	64-QAM	5/6	6	108	6	1296	1080	270.0	300.0

Figure 21-Support data rates for 40MHz bandwidth

RF exposure 20 cm statement

This device complies with FCC radiation exposure limits set forth for an uncontrolled environment. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna shall not be less than 20cm during normal operation.

Antenna Installation information

Reference antennas have been used during the approval process for the radio card.

Specific details of the reference antenna used for testing is detailed in the table below.

Important Note:

Use of an antenna which is the same ‘type’ (eg. Dipole) and has a gain equal to or less that the reference antenna can be used without recertification.

Note: The Adapter cable must be considered as it is part of the system gain.

Use of an alternative antenna, different ‘type’ or same ‘type’ but higher gain will invalidate the country approvals. Under this instant the system integrator is responsible for re-evaluating the end product and obtaining separate approvals.

Type	Motorola P/N					5GHz				
		Peak Gain	Cable Loss (external)	Cable Loss (internal)	Net Peak Gain	Peak Gain	Cable Loss (external)	Cable Loss (internal)	Net Peak Gain	
Dipole	ML-2452-APA2-01	7	0	1.3	5.7	7	0	1.5	5.5	Antenna 1
	ML-2452-HPA5-036	2.9	0.8	1.3	0.8	4.9	1.1	1.5	2.3	
	ML-5299-APA1-01R	N/A				2	0	1.5	0.5	
	ML-5299-HPA1-01R	N/A				5	0.84	1.5	2.66	
	ML-2499-HPA3-01R	4.6	1.3	1.3	2	N/A				
	ML-2499-APA2-01R	2	0	1.3	0.7	N/A				
	ML-2452-APA2GA1-01	2	0	1.3	0.7	1	0	1.5	-0.5	
Panel	ML-2452-PNA5-01R	4.50	0.31	1.3	2.89	5.00	0.60	1.5	2.90	Antenna 2
Patch	ML-2452-PTA3M3-036	4.92	0.92	1.3	2.7	8.97	1.97	1.5	5.5	Antenna 3
	ML-5299-PTA1-0R	N/A				5	2	1.5	1.5	
	ML-2499-SD3-01R	4.8	1.3	1.3	2.2	N/A				
PIFA_MCN	MCN PIFA	2	0	0	2	4.5	0	0	4.5	Antenna 4
PIFA_NCAP	NCAP PIFA	3	0	0	3	6	0	0	6	Antenna 5

Part 15.21 user warning

Any changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate this equipment.

Part 15.19 a 3

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Part 15.105 B

This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiated radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.