Happiness • Sharing • Technology

BL-R8812AF1

Product Specification

IEEE 802.11a/ b/g/n/ac 2T2R USB2.0 WiFi Module

Version: 0.1

Customer			
Date			
Model Name	BL-R8812AF1		
Part NO.			
Blink Approve Field			
ENGINEER	**QC**	**SALES**	
Customer Approve Field			
ENGINEER	**QC**	**MANUFACTORY**	**PURCHASING**

1. Introduction

BL-R8812AF1 is based on realtek RTL8812AU, is a WLAN 11ac Dual Band module, which fully supports the features and functional compliance of IEEE 802.11 a/b/g/n/ac standards. This documentation describes the engineering requirements specification.

1.1 RF module Overview

The general HW architecture for the module is shown in Figure 1. This WLAN Module design is based on Realtek RTL8812AU. It is a highly integrated single-chip MIMO(Multiple In Multiple Out) Wireless LAN (WLAN) USB2.0 network interface controller complying with the 802.11ac specification. It combines a MAC, a 2T2R capable baseband, and RF in a single chip. The RTL8812AU provides a complete solution for a high throughput performance wireless client.

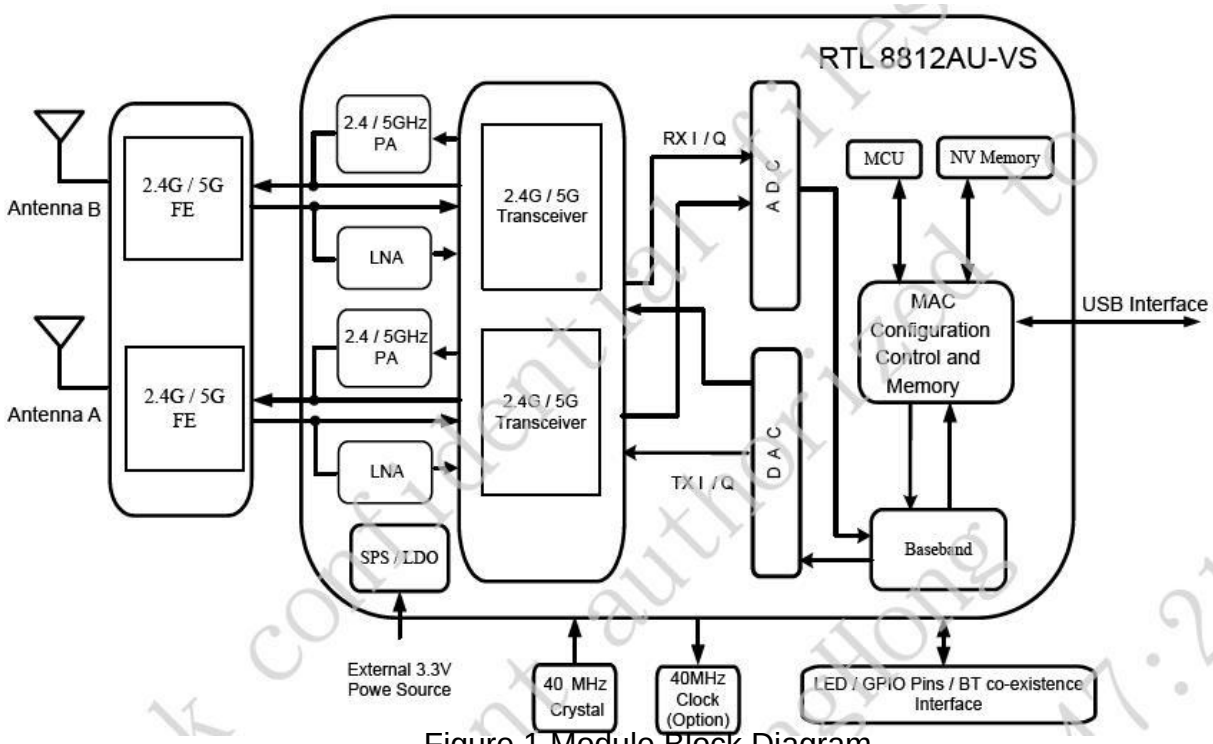


Figure 1 Module Block Diagram

1.2 Specification reference

This specification is based on additional references listed below.
_ IEEE Std. 802.11a
_ IEEE Std. 802.11b
_ IEEE Std. 802.11g
_ IEEE Std. 802.11n
_ IEEE Std. 802.11ac

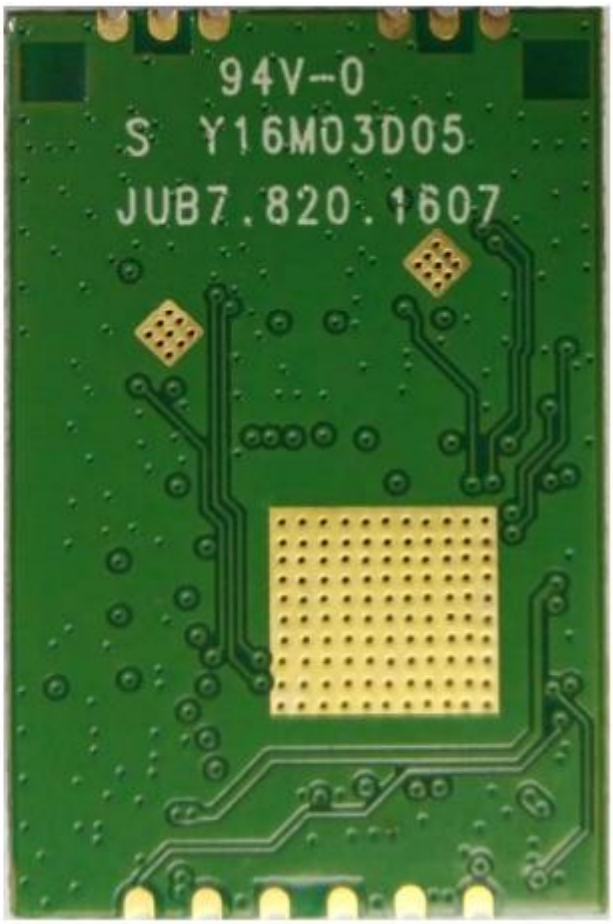
1.3 System Functions

Table1: General Specification as below:

Main Chipset	Realtek RTL8812AU-VS
Operating Frequency	2.4GHz & 5GHz
Wi-Fi Standard	802.11a/b/g/n/ac
Modulation	11b: DBPSK, DQPSK and CCK and DSSS 11a/g: BPSK, QPSK, 16QAM, 64QAM and OFDM 11n: BPSK, QPSK, 16QAM, 64QAM and OFDM
Host Interface	USB2.0
PCB Stack	4-layers design
Dimension	Typical，27.00mm x 17.80mm x 3.5mm
Operation Temperature	0℃ to +60℃
Storage Temperature	-25℃ to +85℃
Operation Voltage	3.3V +/-10%

2. Product Picture

TOP VIEW



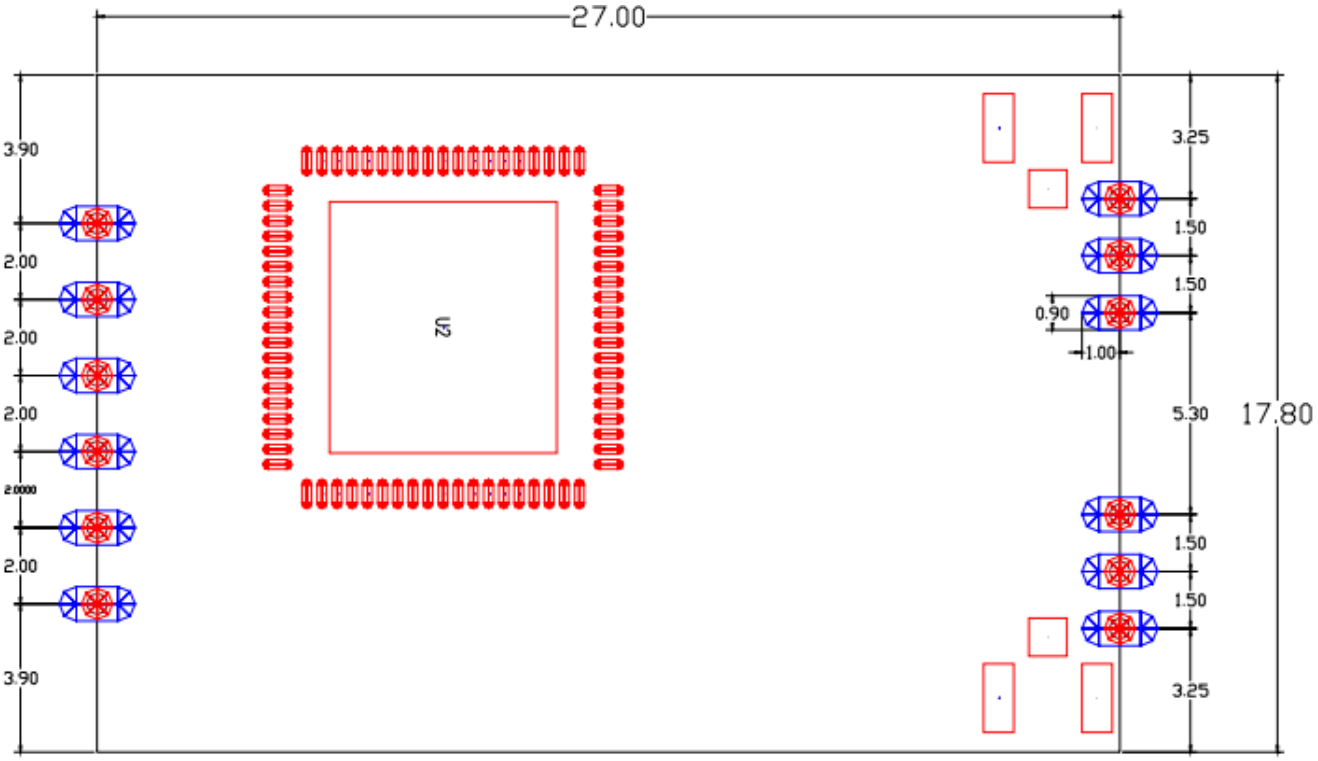
BOTTOM VIEW

Note: the picture is for reference only, and the information such as supplier's logo and batch number will not be fixed in the back character.

2. Mechanical Specification

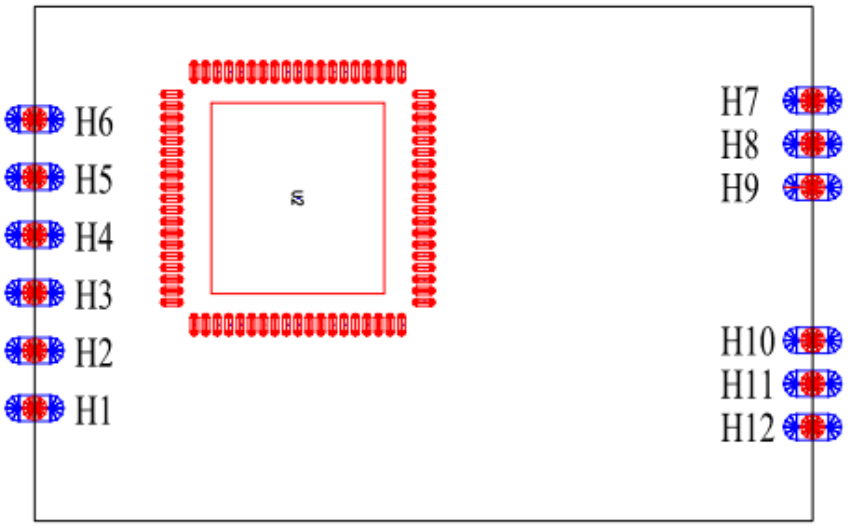
2.1 Mechanical Outline Drawing

Typical Dimension (L x W x H): 27.00 x17.8 x3.5mm



NOTE1:General tolerance ±0.15mm unless otherwise stated

2.2Pin definition



Pin #	Name	Pin #	Name	Pin #	Name
1	PDN	5	GND	9	GND
2	VDD(3.3V)	6	LED	10	GND
3	DM-	7	GND	11	NC
4	DP+	8	NC	12	GND

3. Electrical Specification

This Specification is based-on conductive DVT testing result. The extreme condition include overall temperature (0℃,+25℃,+60℃) and overall voltage (3.0V,3.3V,3.6V).

3.1 IEEE 802.11a Section:

Items	Contents				
Specification	IEEE802.11a				
Mode	OFDM				
Channel	CH36 to CH165				
Data rate	6, 9, 12, 18, 24, 36, 48, 54Mbps				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 13dBm Target (For Each antenna port)	11	13	15	dBm	
2. Spectrum Mask @ Target Power					
1) at fc +/-11MHz	-	-	-20	dBr	
2) at fc +/-20MHz	-	-	-28	dBr	
3) at fc > +/-30MHz	-	-	-40	dBr	
3. Constellation Error(EVM) @ Target Power					
1) 6Mbps	-	-	-5	dB	
2) 9Mbps	-	-	-8	dB	
3) 12Mbps	-	-	-10	dB	
4) 18Mbps	-	-	-13	dB	
5) 24Mbps	-	-	-16	dB	
6) 36Mbps	-	-	-19	dB	
7) 48Mbps	-	-	-22	dB	
8) 54Mbps	-	-30	-25	dB	
4. Frequency Error	-20		20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) 6Mbps (PER ≤10%)	-	-85	-82	dBm	
2) 9Mbps (PER ≤10%)	-	-84	-81	dBm	
3) 12Mbps (PER ≤10%)	-	-82	-79	dBm	
4) 18Mbps (PER ≤10%)	-	-80	-77	dBm	
5) 24Mbps (PER ≤10%)	-	-77	-74	dBm	
6) 36Mbps (PER ≤10%)	-	-73	-70	dBm	
7) 48Mbps (PER ≤10%)	-	-69	-66	dBm	
8) 54Mbps (PER ≤10%)	-	-68	-65	dBm	
6. Maximum Input Level (PER ≤10%)	-30	-	-	dBm	

3.2 IEEE 802.11b Section:

Items	Contents				
Specification	IEEE802.11b				
Mode	DSSS / CCK				
Channel	CH1 to CH13				
Data rate	1, 2, 5.5, 11Mbps				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 17dBm Target (For Each antenna port)	15	17	19	dBm	
2. Spectrum Mask @ Target Power					
1) fc +/-11MHz to +/-22MHz	-	-	-30	dBr	
2) fc > +/-22MHz	-	-	-50	dBr	
3. Constellation Error(EVM) @ Target Power					
1) 1Mbps	-	-	-10	dB	
2) 2Mbps	-	-	-10	dB	
3) 5.5Mbps	-	-	-10	dB	
4) 11Mbps	-	-20	-10	dB	
4. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) 1Mbps (FER ≦8%)	-	-83	-76	dBm	
2) 2Mbps (FER ≦8%)	-	-80	-76	dBm	
3) 5.5Mbps (FER ≦8%)	-	-79	-76	dBm	
4) 11Mbps (FER ≦8%)	-	-76	-76	dBm	
6. Maximum Input Level (FER ≦8%)	-10	-	-	dBm	

3.3 IEEE 802.11g Section:

Items	Contents				
Specification	IEEE802.11g				
Mode	OFDM				
Channel	CH1 to CH13				
Data rate	6, 9, 12, 18, 24, 36, 48, 54Mbps				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
2. Power Levels					
1) 15dBm Target (For Each antenna port)	13	15	17	dBm	
3. Spectrum Mask @ Target Power					
1) at fc +/-11MHz	-	-	-20	dBr	
2) at fc +/-20MHz	-	-	-28	dBr	
3) at fc > +/-30MHz	-	-	-40	dBr	
4. Constellation Error(EVM) @ Target Power					
1) 6Mbps	-	-	-5	dB	
2) 9Mbps	-	-	-8	dB	
3) 12Mbps	-	-	-10	dB	
4) 18Mbps	-	-	-13	dB	
5) 24Mbps	-	-	-16	dB	
6) 36Mbps	-	-	-19	dB	
7) 48Mbps	-	-	-22	dB	
8) 54Mbps	-	-30	-25	dB	
5. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
6 Minimum Input Level Sensitivity(each chain)					
1) 6Mbps (PER ≤10%)	-	-85	-80	dBm	
2) 9Mbps (PER ≤10%)	-	-84	-79	dBm	
3) 12Mbps (PER ≤10%)	-	-82	-77	dBm	
4) 18Mbps (PER ≤10%)	-	-80	-75	dBm	
5) 24Mbps (PER ≤10%)	-	-77	-72	dBm	
6) 36Mbps (PER ≤10%)	-	-73	-68	dBm	
7) 48Mbps (PER ≤10%)	-	-69	-64	dBm	
8) 54Mbps (PER ≤10%)	-	-68	-63	dBm	
6. Maximum Input Level (PER ≤10%)	-20	-	-	dBm	

3.4 IEEE 802.11n HT20 (2.4G) Section:

Items	Contents				
Specification	IEEE802.11n HT20 @ 2.4GHz				
Mode	OFDM				
Channel	CH1 to CH13				
Data rate (MCS index)	MCS0/1/2/3/4/5/6/7/8/9/10/11/12/13/14/15				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 14dBm Target (For Each antenna port)	12	14	16	dBm	
2. Spectrum Mask @ Target Power					
1) at fc +/-11MHz	-	-	-20	dBr	
2) at fc +/-20MHz	-	-	-28	dBr	
3) at fc > +/-30MHz	-	-	-45	dBr	
3. Constellation Error(EVM) @ Target Power					
1) MCS0	-	-	-5	dB	
2) MCS1	-	-	-10	dB	
3) MCS2	-	-	-13	dB	
4) MCS3	-	-	-16	dB	
5) MCS4	-	-	-19	dB	
6) MCS5	-	-	-22	dB	
7) MCS6	-	-	-25	dB	
8) MCS7	-	-31	-28	dB	
4. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) MCS0 (PER ≤10%)	-	-85	-82	dBm	
2) MCS1 (PER ≤10%)	-	-84	-79	dBm	
3) MCS2 (PER ≤10%)	-	-82	-77	dBm	
4) MCS3 (PER ≤10%)	-	-80	-74	dBm	
5) MCS4 (PER ≤10%)	-	-76	-70	dBm	
6) MCS5 (PER ≤10%)	-	-72	-66	dBm	
7) MCS6 (PER ≤10%)	-	-70	-65	dBm	
8) MCS7 (PER ≤10%)	-	-69	-64	dBm	
6. Maximum Input Level (PER ≤10%)	-20	-	-	dBm	

3.5 IEEE 802.11n HT20 (5G) Section:

Items	Contents				
Specification	IEEE802.11n HT20 @ 5GHz				
Mode	OFDM				
Channel	CH36 to CH165				
Data rate (MCS index)	MCS0/1/2/3/4/5/6/7/8/9/10/11/12/13/14/15				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 12dBm Target (For Each antenna port)	10	12	14	dBm	
2. Spectrum Mask @ Target Power					
1) at fc +/-11MHz	-	-	-20	dBr	
2) at fc +/-20MHz	-	-	-28	dBr	
3) at fc > +/-30MHz	-	-	-45	dBr	
3. Constellation Error(EVM) @ Target Power					
1) MCS0	-	-	-5	dB	
2) MCS1	-	-	-10	dB	
3) MCS2	-	-	-13	dB	
4) MCS3	-	-	-16	dB	
5) MCS4	-	-	-19	dB	
6) MCS5	-	-	-22	dB	
7) MCS6	-	-	-25	dB	
8) MCS7	-	-31	-28	dB	
4. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) MCS0 (PER ≤10%)	-	-85	-82	dBm	
2) MCS1 (PER ≤10%)	-	-84	-79	dBm	
3) MCS2 (PER ≤10%)	-	-82	-77	dBm	
4) MCS3 (PER ≤10%)	-	-80	-74	dBm	
5) MCS4 (PER ≤10%)	-	-76	-70	dBm	
6) MCS5 (PER ≤10%)	-	-72	-66	dBm	
7) MCS6 (PER ≤10%)	-	-70	-65	dBm	
8) MCS7 (PER ≤10%)	-	-69	-64	dBm	
6. Maximum Input Level (PER ≤10%)	-30	-	-	dBm	

3.6 IEEE 802.11n HT40 (2.4G) Section:

Items	Contents				
Specification	IEEE802.11n HT40 @ 2.4GHz				
Mode	OFDM				
Channel	CH3 to CH11				
Data rate (MCS index)	MCS0/1/2/3/4/5/6/7/8/9/10/11/12/13/14/15				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 14dBm Target (For Each antenna port)	12	14	16	dBm	
2. Spectrum Mask @ Target Power					
1) at fc +/-21MHz	-	-	-20	dBr	
2) at fc +/-40MHz	-	-	-28	dBr	
3) at fc > +/-60MHz	-	-	-45	dBr	
3. Constellation Error(EVM) @ Target Power					
1) MCS0	-	-	-5	dB	
2) MCS1	-	-	-10	dB	
3) MCS2	-	-	-13	dB	
4) MCS3	-	-	-16	dB	
5) MCS4	-	-	-19	dB	
6) MCS5	-	-	-22	dB	
7) MCS6	-	-	-25	dB	
8) MCS7	-	-31	-28	dB	
4. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) MCS0 (PER ≤ 10%)		-85	-79	dBm	
2) MCS1 (PER ≤ 10%)		-82	-76	dBm	
3) MCS2 (PER ≤ 10%)		-79	-74	dBm	
4) MCS3 (PER ≤ 10%)		-77	-71	dBm	
5) MCS4 (PER ≤ 10%)		-72	-67	dBm	
6) MCS5 (PER ≤ 10%)		-69	-63	dBm	
7) MCS6 (PER ≤ 10%)		-68	-62	dBm	
8) MCS7 (PER ≤ 10%)	-	-66	-61	dBm	
6. Maximum Input Level(PER ≤ 10%)	-20	-	-	dBm	

3.7 IEEE 802.11n HT40 (5G) Section:

Items	Contents				
Specification	IEEE802.11n HT40 @ 5GHz				
Mode	OFDM				
Channel	CH38 to CH163				
Data rate (MCS index)	MCS0/1/2/3/4/5/6/7/8/9/10/11/12/13/14/15				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 12dBm Target (For Each antenna port)	10	12	14	dBm	
2. Spectrum Mask @ Target Power					
1) at fc +/-21MHz	-	-	-20	dBr	
2) at fc +/-40MHz	-	-	-28	dBr	
3) at fc > +/-60MHz	-	-	-45	dBr	
3. Constellation Error(EVM) @ Target Power					
1) MCS0	-	-	-5	dB	
2) MCS1	-	-	-10	dB	
3) MCS2	-	-	-13	dB	
4) MCS3	-	-	-16	dB	
5) MCS4	-	-	-19	dB	
6) MCS5	-	-	-22	dB	
7) MCS6	-	-	-25	dB	
8) MCS7	-	-31	-28	dB	
4. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) MCS0 (PER ≤10%)		-85	-79	dBm	
2) MCS1 (PER ≤10%)		-82	-76	dBm	
3) MCS2 (PER ≤10%)		-79	-74	dBm	
4) MCS3 (PER ≤10%)		-77	-71	dBm	
5) MCS4 (PER ≤10%)		-72	-67	dBm	
6) MCS5 (PER ≤10%)		-69	-63	dBm	
7) MCS6 (PER ≤10%)		-68	-62	dBm	
8) MCS7 (PER ≤10%)	-	-66	-61	dBm	
6. Maximum Input Level(PER ≤10%)	-30	-	-	dBm	

3.8 IEEE 802.11ac HT20 Section:

Items	Contents				
Specification	IEEE802.11ac HT20 @ 5GHz				
Mode	OFDM				
Channel	CH36 to CH165				
Data rate (MCS index)	Nss1 MCS0/1/2/3/4/5/6/7/8 Nss2 MCS0/1/2/3/4/5/6/7/8				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 11dBm Target (For Each antenna port)	9	11	13	dBm	mcs8
2. Spectrum Mask @ Target Power					
1) at fc +/-11MHz	-	-	-20	dBr	
2) at fc +/-20MHz	-	-	-28	dBr	
3) at fc > +/-30MHz	-	-	-40	dBr	
3. Constellation Error(EVM) @ Target Power					
1) Nss1 MCS0	-	-	-5	dB	
2) Nss1 MCS1	-	-	-10	dB	
3) Nss1 MCS2	-	-	-13	dB	
4) Nss1 MCS3	-	-	-16	dB	
5) Nss1 MCS4	-	-	-19	dB	
6) Nss1 MCS5	-	-	-22	dB	
7) Nss1 MCS6	-	-	-25	dB	
8) Nss1 MCS7	-	-	-27	dB	
9) Nss1 MCS8	-	-34	-30	dB	
4. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) Nss1 MCS0 (PER ≤10%)	-	-85	-82	dBm	
2) Nss1 MCS1 (PER ≤10%)	-	-82	-79	dBm	
3) Nss1 MCS2 (PER ≤10%)	-	-80	-77	dBm	
4) Nss1 MCS3 (PER ≤10%)	-	-77	-74	dBm	
5) Nss1 MCS4 (PER ≤10%)	-	-73	-70	dBm	
6) Nss1 MCS5 (PER ≤10%)	-	-69	-66	dBm	
7) Nss1 MCS6 (PER ≤10%)	-	-68	-65	dBm	
8) Nss1 MCS7 (PER ≤10%)	-	-67	-64	dBm	
9) Nss1 MCS8 (PER ≤10%)		-62	-59	dBm	
6. Maximum Input Level (PER ≤10%)	-30	-	-	dBm	

3.9 IEEE 802.11ac HT40 Section:

Items	Contents				
Specification	IEEE802.11ac HT40 @ 5GHz				
Mode	OFDM				
Channel	CH38 to CH159				
Data rate (MCS index)	Nss1 MCS0/1/2/3/4/5/6/7/8/9 Nss2 MCS0/1/2/3/4/5/6/7/8/9				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 10dBm Target (For Each antenna port)	8	10	12	dBm	mcs9
2. Spectrum Mask @ Target Power					
1) at fc +/-21MHz	-	-	-20	dBr	
2) at fc +/-40MHz	-	-	-28	dBr	
3) at fc > +/-60MHz	-	-	-40	dBr	
3. Constellation Error(EVM) @ Target Power					
1) Nss1 MCS0	-	-	-5	dB	
2) Nss1 MCS1	-	-	-10	dB	
3) Nss1 MCS2	-	-	-13	dB	
4) Nss1 MCS3	-	-	-16	dB	
5) Nss1 MCS4	-	-	-19	dB	
6) Nss1 MCS5	-	-	-22	dB	
7) Nss1 MCS6	-	-	-25	dB	
8) Nss1 MCS7	-	-	-27	dB	
9) Nss1 MCS8	-	-	-30	dB	
10) Nss1 MCS9	-	-35	-32	dB	
4. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) Nss1 MCS0	-	-82	-79	dBm	
2) Nss1 MCS1	-	-79	-76	dBm	
3) Nss1 MCS2	-	-77	-74	dBm	
4) Nss1 MCS3	-	-74	-71	dBm	
5) Nss1 MCS4	-	-70	-67	dBm	
6) Nss1 MCS5	-	-66	-63	dBm	
7) Nss1 MCS6	-	-65	-62	dBm	
8) Nss1 MCS7	-	-64	-61	dBm	
9) Nss1 MCS8	-	-59	-56	dBm	
10) Nss1 MCS9	-	-57	-54	dBm	
6. Maximum Input Level (PER ≤ 10%)	-30	-	-	dBm	

3.10 IEEE 802.11ac HT80 Section:

Items	Contents				
Specification	IEEE802.11ac HT80 @ 5GHz				
Mode	OFDM				
Channel	CH42 to CH155				
Data rate (MCS index)	Nss1 MCS0/1/2/3/4/5/6/7/8/9 Nss2 MCS0/1/2/3/4/5/6/7/8/9				
TX Characteristics	Min.	Typ.	Max.	Unit	Remark
1. Power Levels					
1) 10dBm Target (For Each antenna port)	8	10	12	dBm	mcs9
2. Spectrum Mask @ Target Power					
1) at fc +/-41MHz	-	-	-20	dBr	
2) at fc +/-80MHz	-	-	-28	dBr	
3) at fc > +/-120MHz	-	-	-40	dBr	
3. Constellation Error(EVM) @ Target Power					
1) Nss1 MCS0	-	-	-5	dB	
2) Nss1 MCS1	-	-	-10	dB	
3) Nss1 MCS2	-	-	-13	dB	
4) Nss1 MCS3	-	-	-16	dB	
5) Nss1 MCS4	-	-	-19	dB	
6) Nss1 MCS5	-	-	-22	dB	
7) Nss1 MCS6	-	-	-25	dB	
8) Nss1 MCS7	-	-	-27	dB	
9) Nss1 MCS8	-	-	-30	dB	
10) Nss1 MCS9	-	-35	-32	dB	
4. Frequency Error	-20	-	20	ppm	
RX Characteristics	Min.	Typ.	Max.	Unit	
5. Minimum Input Level Sensitivity(each chain)					
1) Nss1 MCS0	-	-79	-76	dBm	
2) Nss1 MCS1	-	-76	-73	dBm	
3) Nss1 MCS2	-	-74	-71	dBm	
4) Nss1 MCS3	-	-71	-68	dBm	
5) Nss1 MCS4	-	-67	-64	dBm	
6) Nss1 MCS5	-	-63	-60	dBm	
7) Nss1 MCS6	-	-62	-59	dBm	
8) Nss1 MCS7	-	-61	-58	dBm	
9) Nss1 MCS8	-	-56	-53	dBm	
10) Nss1 MCS9	-	-54	-51	dBm	
6. Maximum Input Level (PER ≤ 10%)	-30	-	-	dBm	

4 Software Requirements

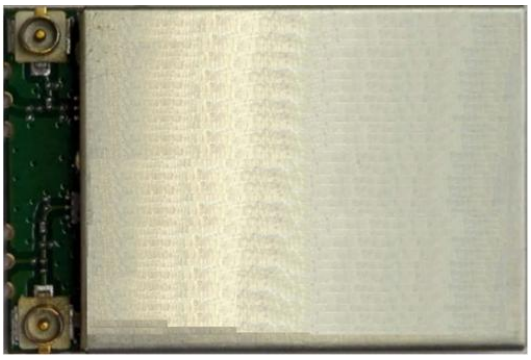
The driver supports the following operating systems: Linux, Microsoft Windows XP, Vista and Win7.

5. Product application

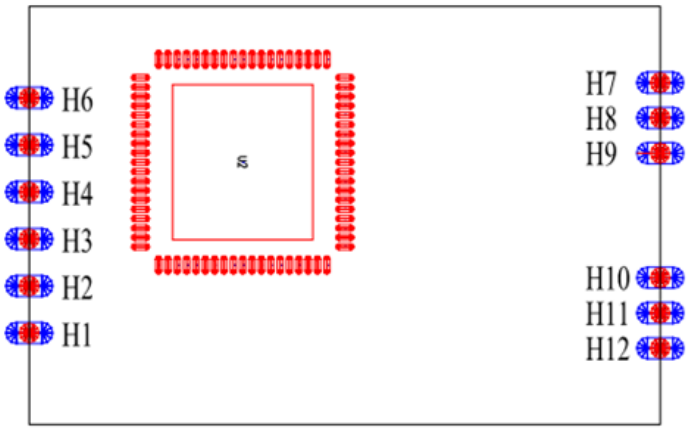
Consumer electronic devices (DTV,DVD players, wireless router,Blu-ray players.etc.)

6 installation

1. product should not collocate with other radio
2. host label should content modular FCC ID:2AL6K- R8812AF1
3. If you buy this module, you use should be satisfied for the antenna:
   a: the antenna type:connect to the external antenna through the connector
   See the picture for details.



   b: the antenna gain:≤6dBi
4. installation:
   (a) please pay the attention on The position of the welding foot of the module.See below for details:



Pin #	Name	Pin #	Name	Pin #	Name
1	PDN	5	GND	9	GND
2	VDD(3.3V)	6	LED	10	GND
3	DM-	7	GND	11	NC
4	DP+	8	NC	12	GND

   (b) According to the requirements, the corresponding welding on the client's main board.

FCC Statement

This equipment 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 radiate 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.

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.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.