APPENDIX H

: USER'S MANUAL

Wi-Fi 802.11b/g/n Module

Wi-Fi Linux Board Manual
for Air Conditioner

Warranty period: 2 years
A/S: 1544-7777, 1588-7777

Life's Good

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1. INTRODUCTION

1.1 Overview

Wi-Fi module is a high performance module with Wi-Fi and a micro processor including external memories and all peripheral components required. It is a complete solution designed to be function as a standalone communication module, serial cable replacement or as an easy to use Wi-Fi addition with a minimal resource need, to an existing system.

Wi-Fi module enables a cost efficient, high performance and feature rich client solution. It provides up to 72 Mbit/s data rate. The Wi-Fi module is a full fledge Linux computer that enables a multitude of advanced features. The Wi-Fi module can operate stand alone or connected to a host via the serial interface.

1.2 Key Features

MIPS based MCU
Integrated IP-stack
Single stream 1x1 802.11n
Data Rates:1,2,5.5,6,7.2,9,11,12,14.4,18,21.7,24,28.9,36,43.3,48,54,57.8,72,2 Mbps
Modulation: QPSK, 16QAM, 64QAM DBPSK, DQPSK, CCK, OFDM with BPSK
WEP and AES hardware encryption accelerator up to 128 bits
Soft AP
Linux support
Single Supply Voltage 5 V - 12 V
Small footprint
RoHS Compliant
Integrated Chip antenna
Temperature range -20 to + 70

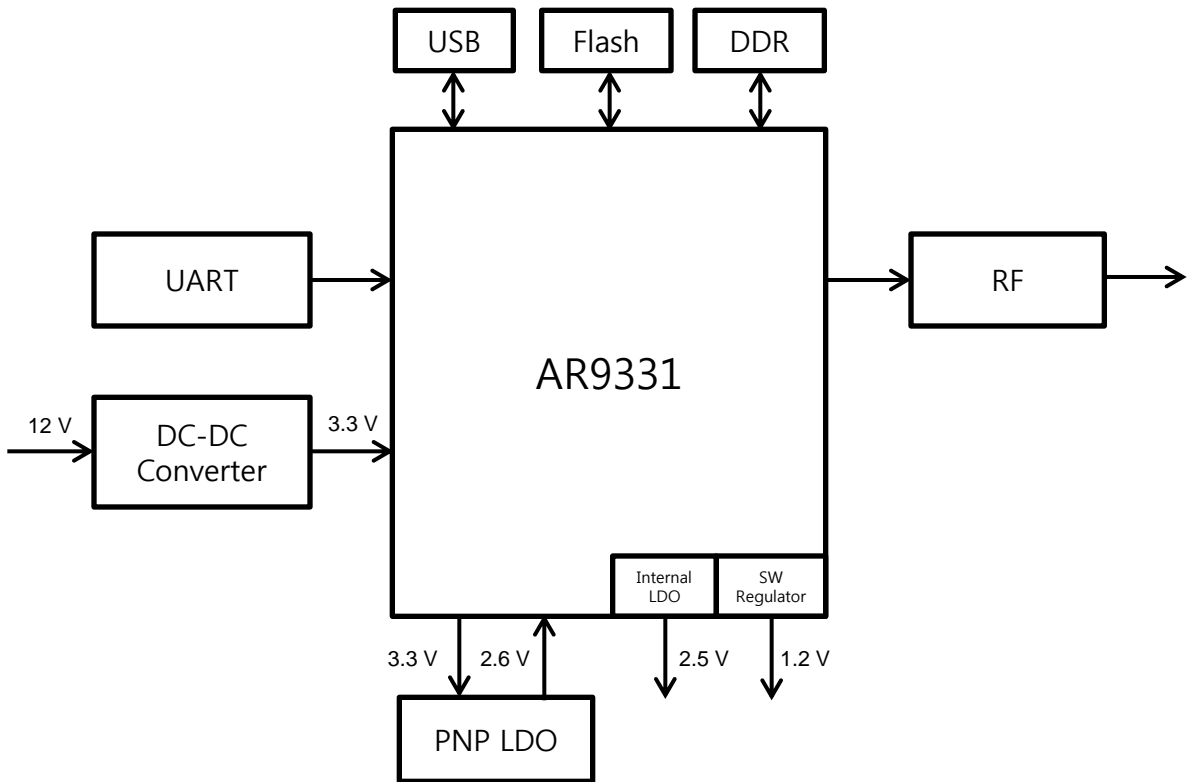# 2. HARDWARE ARCHITECTURE

2.1 Block Diagram

Figure 2-1 Block Diagram

3. ELECTRICAL DATA

3.1 Absolute maximum ratings

Table 3-1 Absolute maximum ratings. Exceeding any of the maximum ratings, even briefly lead to deterioraton in Performance or even destruction. Values indicates condition applied one at the time

Rating	Min.	Max.	Unit
Supply voltage	0	15	V
Input RF level		10	dBm
Storage temperature	-50	+125	˚C

3.2 Electro Static Discharge (ESD)

Wi-Fi module withstands ESD voltages up to 2000 V HBM (Human Body Model)
According to JESD22-A114 and up to 300 V MM (Machine Model) according to JESD22-A115.

3.3 Recommended operationg conditions

Table 3-2 Recommended operating conditions

Rating	Min.	Typ.	Max.	Unit
Supply Voltage V_{CC}	5.0	-	12.0	V
Operating temperature Wi-Fi module	-20	+25	+70	°C

3.4 Power Consumption

3.4.1 Current Consumption

Table 3-3 Current consumption in different modes MCU running at 400MHz and system clock at 100MHz.

Mode	Conditions	Parameter	Voltage	Min.	Typ.	Max.	Unit
All modes	Peak	V_{CC}	12 V			100	mA
TX [802.11b], 11 Mbps	25˚C	V_{CC}	12 V		100		mA
TX [802.11g], 54 Mbps	25˚C	V_{CC}	12 V		83		mA
TX [802.11n], MCS7	25˚C	V_{CC}	12 V		73		mA
RX [802.11b], 11 Mbps	25˚C	V_{CC}	12 V		47		mA
RX [802.11g], 54 Mbps	25˚C	V_{CC}	12 V		47		mA
RX [802.11n], MCS7	25˚C	V_{CC}	12 V		47		mA

3.4.2 Power Consumption

The power consumption is estimated for a scenario where the Wi-Fi module is in station mode and transmits 1% of the time.

Conditions : T_{amb}=25°C, VCC=12 V

Table 3.4 Power consumption in different modes. *Output power referred to antenna port n Wi-Fi module

Mode	Output Power*	Power Consumption	Comments
Station 11b	+10 ~ +15 dBm	780 mW	11 Mbit/s, MCU 400/100MHz
Station 11g	+3 ~ +17 dBm	782 mW	54 Mbit/s, MCU 400/100MHz
Station 11n	+3 ~ +16 dBm	781 mW	MCS7, MCU 400/100MHz

3.5 RF Performance(USA, Canada 2412 ~ 2462MHz)

VCC= 12 V, T_{amb}= -20 to +70°C, at antenna port on Wi-Fi module.

Table 3-5 RF Performance

Parameter	Conditions	Min.	Typical	Max.	Units
Frequency range		2412		2472	MHz
Transmitter performance					
Output power	802.11 b, Calibrated	+10		+15	dBM
Output power	802.11 g, Calibrated	+3		+17	dBM
Output power	802.11 n, Calibrated	+3		+16	dBM
EVM at +18 dBm	CCK, ch, 1- ch. 13		13		%
EVM at +12 dBm	CCK, ch. 14		31	35	%
EVM at +16 dBm	OFDM 802.11b/g		4.8		%
EVM at +15 dBm	OFDM 802.11b/g		3.4		%
EVM at +14 dBm	OFDM 802.11b/g		3.0		%
EVM at +15 dBm	OFDM 802.11n		3.7		%
EVM at +14 dBm	OFDM 802.11n		3.1		%
Receiver performance 11b/g					
Receiver sensitivity	DPSK 1 Mbit/s		-95		dBM
Receiver sensitivity	QDPSK 2 Mbit/s		-93		dBM
Receiver sensitivity	CCK/DPSK 5.5 Mbit/s		-91		dBM
Receiver sensitivity	CCK/BPSKK 11 Mbit/s		-88		dBM

|					
Receiver sensitivity	OFDM 6 Mbit/s		-91		dBM
Receiver sensitivity	OFDM 9 Mbit/s		-90		dBM
Receiver sensitivity	OFDM 12 Mbit/s		-88		dBM
Receiver sensitivity	OFDM 18 Mbit/s		-86		dBM
Receiver sensitivity	OFDM 24 Mbit/s		-83		dBM
Receiver sensitivity	OFDM 36 Mbit/s		-80		dBM
Receiver sensitivity	OFDM 48 Mbit/s		-76		dBM
Receiver sensitivity	OFDM 54 Mbit/s		-74		dBM
Receiver performance 11n					
Receiver sensitivity	OFDM/BPSK 7.2 Mbit/s		-90		dBM
Receiver sensitivity	OFDM/BPSK 14.4 Mbit/s		-88		dBM
Receiver sensitivity	OFDM/BPSK 21.7 Mbit/s		-86		dBM
Receiver sensitivity	OFDM/16-QAM 28.9 Mbit/s		-83		dBM
Receiver sensitivity	OFDM/16-QAM 43.4 Mbit/s		-79		dBM
Receiver sensitivity	OFDM/16-QAM 57.8 Mbit/s		-72		dBM
Receiver sensitivity	OFDM/16-QAM 65 Mbit/s		-70		dBM
Receiver sensitivity	OFDM/16-QAM 72.2 Mbit/s		-69		dBM

4. INTERFACES
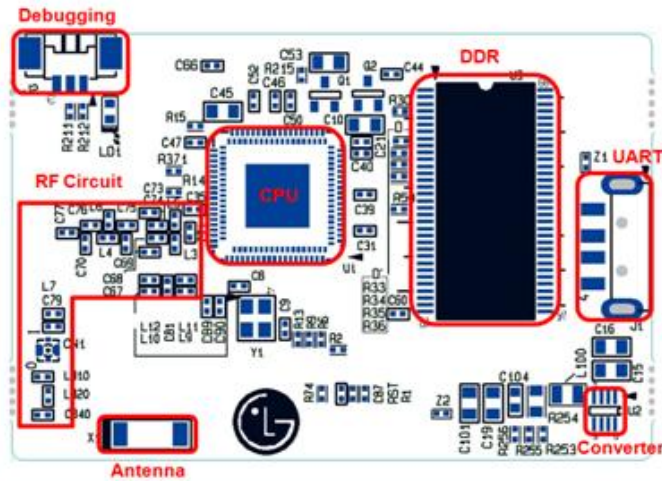
Figure 4-1 Wi-Fi module pins

4.1 UART Pin Configuration
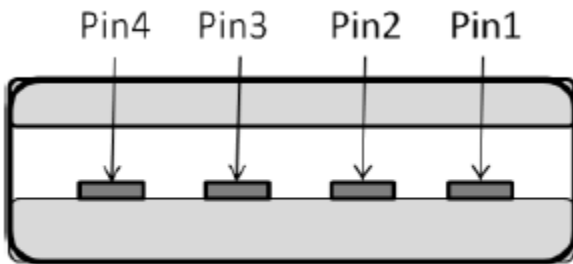
Front view

4.1.1 Pin assignments USB Type A male connector

Table 4-1 Pin Description for the USB Type A male connector

Pin	Function	Type	Description
1	V_{CC}	S	12 V power
2	UART_RX	I	RX
3	UART_TX	O	TX
4	GND	S	Ground

The UART_TX and UART_RX pins has an onboard level shifter to accept signal with voltage swings up to 5 V. To ensure good signal quality the signals needs to have a pull-up resistor on the connecting side.

Note: The pin out is not standard USB pin out the Wi-Fi module may be damaged if connected to a standard USB socket!

5. APPLICATION INFORMATION

5.1 Power Supply
Wi-Fi module should be powered by 5 V to 12 V supply on +, pin 1 of the USB type A male connector.

5.2 SDRAM
The Wi-Fi module has 32 Mbytes RAM

5.3 FLASH
The Wi-Fi module has 16 Mbytes FLASH

5.4 Linux Boot
The Linux boot takes about 20s to complete before the consol interface (USB) can be used.

5.5 Serial interface UART / USB
To communicate with the Wi-Fi module has UART / USB interfaces.

5.5.1 UART
This interface is used for user applications.

5.5.2 USB
The USB interface is use for configuration and debug

The pin order is as follows.
Pin 1: USB_DM(A50 on MCU)
Pin 2: USB_DP(B43 on MCU)
Pin 4: GND
Highest supported baud rate on this port is 115200.

5.6 RF interface
The Wi-Fi module has a high performance chip antenna as the primary RF interface.

5.7 Environmental statement
The Wi-Fi module is designed and manufactured to comply with the RoHS and Green directives.

6. TARGETED STANDARDS COMPLIANCE

6.1 IEEE / IETF

Table 6.1 Applicable IEEE standards

Standard	Revision	Description
802.11	802.11 R2003	Wi-Fi MAC& PHY
802.11b	802.11 R2003	High rate DSSS (5,5/11 Mbit/s)
802.11d	802.11 R2003	Operation in different regulatory domains
802.11e	D9,0 Aug. 2004	QoS enhancements
802.11g	-2003	Extended rate PHY (ERP-PBCC, DSS-OFDM)
802.11i	-2004	Security enhancements
802.11k	Draft 11.0, 2008	Wireless network management
802.11n	Spec released Oct 29^{tn} 2009	Longer Range, Faster Throughput
802.11r	Draft 9.0, 2008	Fast BSS transition
802.11h	1997 edition	Bridge tunneling
RFC1023	Inherent	Frame encapsulation

6.2 Wi-Fi

Table 6.2 Applicable Wi-Fi standards

Specification	Description	Revision
Wi-Fi 802.11b with WPA system inter Operability test plan for IEEE 802.11b devices	802.11b devices with WPA	2.1
Wi-Fi 802.11g with WPA system inter Operability test plan	802.11g devices with WPA	2.0

7. Notice

WARNING

This device is not available for laptop or similar portable system.

7.1 FCC (Certification)

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

FCC WARNING: This equipment may generate or use radio frequency energy. Changes or m odifications to this equipment may cause harmful interference unless the modifications are expressly approved in the instruction manual. The user could lose the authority to operate t his equipment if an unauthorized change or modification is made.

U.S. Regulatory Wireless Notice
This products emits radio frequency energy, but the radiated output power of this device is far below the FCC radio frequency exposure limits. Nevertheless, the device should be used in such a manner that the potential for human contact with the antenna during normal oper ation is minimized.

FCC Radiation Exposure Statement
This equipment compiles with FCC radiation exposure limits set forth an uncontrolled enviro nment.
This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Caution : Any changes or modifications to this device not explicitly approved by manufactur er could void your authority to operate this equipment.

End Product Labeling
The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: BEJPCRCUDT3" or "Contains FCC ID: BEJPCRCUDT3". Any similar wording that expresses the same meaning may be used. The Grantee may either provide such a label, an example of which must be included in the application for equipment authorization, or, must provide adequate instructions along with the module which explain this requirement. In the latter case, a copy of these instructions must be included in the application for equipment authorization.

7.2 IC (Certification)

This device complies with RSS-210 of the Industry Canada Rules.
Operation is subject to the following two conditions:
   1) this device may not cause interference and
   2) this device must accept any interference, including interference
      that may cause undesired operation of the device

IC Warning
This device complies with Industry Canada license-exempt RSS standard(s).
Operation is subject to the following two conditions:
(1) this device may not cause interference, and
(2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.
L'exploitation est autorisée aux deux conditions suivantes :
(1) l'appareil ne doit pas produire de brouillage, et
(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi,
même si le brouillage est susceptible d'en compromettre le fonctionnement.

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

NOTE: THE MANUFACTURER IS NOT RESPONSIBLE FOR ANY RADIO OR TV INTERFERENCE CAUSED BY UNAUTHORIZED MODIFICATIONS TO THIS EQUIPMENT. SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

End Product Labeling
The modular transmitter must be labeled with its own IC ID number, and, if the IC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module IC ID: 2703N-PCRCUDT3" or "Contains IC ID: 2703N-PCRCUDT3". Any similar wording that expresses the same meaning may be used. The Grantee may either provide such a label, an example of which must be included in the application for equipment authorization, or, must provide adequate instructions along with the module which explain this requirement. In the latter case, a copy of these instructions must be included in the application for equipment authorization.

7.3 CE (Certification)

Hereby, LG Electronics Inc. declares that this PCRCUDT4 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.