

# REALTEK

## RTL8723AE

### 802.11b/g/n RTL8723AE Combo miniCard User's Manual

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**Realtek Semiconductor Corp.**

No. 2, Innovation Road II, Hsinchu Science Park, Hsinchu 300, Taiwan

Tel.: +886-3-578-0211. Fax: +886-3-577-6047

[www.realtek.com.tw](http://www.realtek.com.tw)

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**USING THIS DOCUMENT**

This document is intended for the software engineer’s reference and provides detailed programming information.

Though every effort has been made to ensure that this document is current and accurate, more information may have become available subsequent to the production of this guide. In that event, please contact your Realtek representative for additional information that may help in the development process.

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# 1. General Description

## 1.1. RTL8723AE

The Realtek RTL8723AE is a highly integrated single-chip 802.11n Wireless LAN (WLAN) PCI Express network interface controller with integrated Bluetooth 2.1/3.0/4.0 USB interface controller. It combines a WLAN MAC, a 1T1R capable WLAN baseband, and RF in a single chip. The RTL8723AE provides a complete solution for a high-performance integrated wireless and Bluetooth device.

The integration provides better coordination between 802.11 and Bluetooth, and with sophisticated dynamic power control and packet traffic arbitration, RTL8723AE is able to provide the best coexistence performance.

RTL8723AE also integrates RF/PA/LNA for both 802.11n and Bluetooth so that the number of external components is reduced to minimum. The 802.11 part supports 150Mbps PHY rate and delivers reliable throughput from an extended distance.

The Bluetooth part supports latest 3.0+HS/4.0+LE operation and provides smooth user experience under all usage scenarios. Optimized RF architecture and baseband algorithms provide superb performance and lowest power consumption.

# 2. Features

## 2.1 General

- n 68-pin QFN
- n CMOS MAC, Baseband PHY, and RF in a single chip for IEEE 802.11b/g/n compatible WLAN
- n Complete 802.11n solution for 2.4GHz band
- n 72.2Mbps receive PHY rate and 72.2Mbps transmit PHY rate using 20MHz bandwidth
- n 150Mbps receive PHY rate and 150Mbps transmit PHY rate using 40MHz bandwidth
- n Compatible with 802.11n specification
- n Backward compatible with 802.11b/g devices while operating in 802.11n mode
- n Qualified Bluetooth v2.1+EDR and v3.0+HS Systems
- n Support for v4.0 Bluetooth Low Energy
- n Integrated class1, class2, and class3 PA and modem in Bluetooth Controller

## Standards Supported

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- n IEEE 802.11b/g/n compatible WLAN
- n IEEE 802.11e QoS Enhancement (WMM)
- n IEEE 802.11h TPC, Spectrum Measurement
- n 802.11i (WPA, WPA2). Open, shared key, and pair-wise key authentication services
- n Cisco Compatible Extensions (CCX) for WLAN devices

**Host Interface**

- n Complies with PCI Express Base Specification Revision 1.1 for WLAN
- n Complies with USB1.1 Specification for Bluetooth

**WLAN MAC Features**

- n Frame aggregation for increased MAC efficiency (A-MSDU, A-MPDU)
- n Low latency immediate High-Throughput Block Acknowledgement (HT-BA)
- n Long NAV for media reservation with CF-End for NAV release
- n PHY-level spoofing to enhance legacy compatibility
- n Power saving mechanism
- n Channel management and co-existence
- n Multiple BSSID feature allows the RTL8723AE to assume multiple MAC identities when used as a wireless bridge
- n Transmit Opportunity (TXOP) Short Inter-Frame Space (SIFS) bursting for higher multimedia bandwidth

**WLAN PHY Features**

- n IEEE 802.11n OFDM
- n One Transmit and one Receive path (1T1R)
- n 20MHz and 40MHz bandwidth transmission
- n Short Guard Interval (400ns)
- n DSSS with DBPSK and DQPSK, CCK modulation with long and short preamble
- n OFDM with BPSK, QPSK, 16QAM, and 64QAM modulation. Convolutional Coding Rate: 1/2, 2/3, 3/4, and 5/6

- n Maximum data rate 54Mbps in 802.11g and 150Mbps in 802.11n
- n Switch diversity for DSSS/CCK
- n Hardware antenna diversity
- n Selectable receiver FIR filters
- n Programmable scaling in transmitter and receiver to trade quantization noise against increased probability of clipping
- n Fast receiver Automatic Gain Control (AGC)
- n On-chip ADC and DAC

**BT Controller**

- n Integrated MCU to execute Bluetooth protocol stack
- n Support 3 SCO links simultaneously
- n Support 3 scatternets
- n Enhanced BT/WIFI Coexistence Control to improve transmission quality in different profiles
- n Bluetooth Low Energy Dual Mode support

**Bluetooth Transceiver Features**

- n Fast AGC control to improve receiving dynamic range
- n Support AFH to dynamically detect channel quality to improve transmission quality
- n Integrated internal class1, class2, and class3 PA
- n Bluetooth 3.0 compliant
- n Bluetooth Low Energy supported
- n Integrated 32K oscillator

**Peripheral Interfaces**

- n General Purpose Input/Output (11 pins)
- n 4-wire EEPROM control interface (93C46)
- n Three configurable LED pins
- n Configurable Bluetooth Coexistence Interface

## 1.2. Environmental

### 1.2.1. Operating

Operating Temperature: 0 to 70 °C  
 Relative Humidity: 5-90% (non-condensing)

### 1.2.2. Storage

Temperature: -55 to 125 °C  
 Relevant Humidity: 5-95% (non-condensing)

## 1.3. Functional Specifications

**Table 1. Functional Specifications**

<b>Standards</b>	<b>WiFi:</b> IEEE 802.11b, IEEE 802.11g, Draft IEEE 802.11n, IEEE 802.11d, IEEE 802.11e, IEEE 802.11h, IEEE 802.11i <b>BT:</b> BT v3.0, v4.0
<b>Bus Interface</b>	<b>WiFi:</b> PCI Express <b>BT:</b> USB
<b>Form Factor</b>	Half Size Mini Card
<b>Data Rate</b>	<b>802.11b:</b> 11, 5.5, 2, 1 Mbps; <b>802.11g:</b> 54, 48, 36, 24, 18, 12, 9, 6 Mbps <b>802.11n:</b> MCS 0 to 7 for HT20MHz; MCS 0 to 7 for HT40MHz <b>BT:</b> 1/2/3 Mbps
<b>Media Access Control</b>	<b>WiFi:</b> CSMA/CA with ACK <b>WiFi + BT:</b> AFH, Time Division
<b>Modulation Techniques</b>	<b>802.11b:</b> CCK, DQPSK, DBPSK <b>802.11g:</b> 64 QAM, 16 QAM, QPSK, BPSK <b>802.11n:</b> BPSK, QPSK, 16-QAM, 64-QAM <b>BT:</b> GFSK, $\pi/4$ DQPSK, 8DPSK

<b>Network Architecture</b>	<b>WiFi:</b> Ad-hoc mode (Peer-to-Peer ) Infrastructure mode
<b>Operating Channel</b>	<b>WiFi 2.4GHz:</b> 11: (Ch. 1-11) – United States 13: (Ch. 1-13) – Europe 13: (Ch. 1-14) – Japan <b>BT 2.4GHz:</b> Ch. 0 ~78
<b>Frequency Range</b>	2.400GHz ~ 2.4835 GHz
<b>Security</b>	<b>WiFi :</b> WPA, WPA-PSK, WPA2, WPA2-PSK, WEP 64bit & 128bit, IEEE 802.11x, IEEE 802.11i <b>BT:</b> Simple Paring
<b>Operating Voltage</b>	3.3 V ±9% I/O supply voltage



## 1.4. Warning

### 4.5.1 Federal Communication Commission Interference 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 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.

**FCC Caution:** Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

#### **IMPORTANT NOTE:**

FCC Radiation Exposure Statement:

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.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

IEEE 802.11b or 802.11g operation of this product in the U.S.A. is firmware-limited to channels 1 through 11.

**This device is intended only for OEM integrators under the following conditions:**

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna,

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

**IMPORTANT NOTE:** In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

**End Product Labeling**

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains FCC ID: TX2-RTL8723AE”.

**Manual Information To the End User**

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

## 4.5.2 Industry Canada Statement

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

French translation:

Ce dispositif est conforme à la norme CNR-210 d'Industrie Canada applicable aux appareils radio exempts de licence. Son fonctionnement est sujet aux deux conditions suivantes: (1) le dispositif ne doit pas produire de brouillage préjudiciable, et (2) ce dispositif doit accepter tout brouillage reçu, y compris un brouillage susceptible de provoquer un fonctionnement indésirable.

**IMPORTANT NOTE:**

**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 20cm between the radiator & your body.

French translation:

NOTE IMPORTANTE: (Pour l'utilisation de dispositifs mobiles)

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

**This device is intended only for OEM integrators under the following conditions:**

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna,

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

French translation :

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

- 1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs, et
- 2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne,

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

**IMPORTANT NOTE:** In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the IC authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate IC authorization.

French translation:

**NOTE IMPORTANTE:**

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

**End Product Labeling**

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 6317A-RTL8723AE".

French translation:

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 6317A-RTL8723AE".

**Manual Information To The End User**

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

French translation:

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.

Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

### **DETACHABLE ANTENNA USAGE**

This device has been designed to operate with an antenna having a maximum gain of 3.5 dBi. Antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter (IC: 6317A-RTL8723AE / Model:RTL8723AE) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Ce dispositif a été conçu pour fonctionner avec une antenne ayant un gain maximal de 3.5dBi. Une antenne à gain plus élevé est strictement interdite par les règlements d'Industrie Canada. L'impédance d'antenne requise est de 50 ohms.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio (IC: 6317A-RTL8723AE / Modèle: RTL8723AE) a été approuvé par Industrie

Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

**Approved antenna(s) list**

No.	Brand	Model	Type	Gain
1	JOYMAX	TWF-614XMPXX-500 (Main) TWF-614XMPXX-500 (Aux)	Dipole	3 3
2	LYNwave	ALA110-222050-150010 (Main) ALA110-222050-150010 (Aux)	PIFA	3.5 3.5
3	ACON	APP8P-700186 (Main) APP8P-700185 (Aux)	PIFA	1.84 0.07
4	ACON	APP8P-700188 (Main) APP8P-700187 (Aux)	PIFA	1.84 0.07
5	WHAYU	C435-520042-A (Main) C435-520045-A (Aux)	PIFA	1.91 1.88
6	WHAYU	C435-520044-A (Main) C435-520043-A (Aux)	PIFA	1.96 1.97
7	WNC	25.90A1E.001 (Main) 25.90A1F.001 (Aux)	PIFA	1.89 -0.90
8	YAGEO	25.90A1E.011 (Main) 25.90A1F.011 (Aux)	PIFA	1.94 1.78
9	WNC	25.91370.021 (Main) 25.91371.021 (Aux)	PIFA	0.51 0.58
10	YAGEO	25.91370.011 (Main) 25.91371.011 (Aux)	PIFA	1.06 0.16
11	Quanta	DQ6GC200100 (Main) DQ6GC200200 (Aux)	PIFA	0.1 -0.4
12	Tyco	25.90A4C.021 (Main) 25.90A4D.021 (Aux)	PIFA	0.06 0.18
13	WNC	25.90A4C.001 (Main) 25.90A4D.001 (Aux)	PIFA	1.52 -0.60
14	YAGEO	25.90A4C.011 (Main) 25.90A4D.011 (Aux)	PIFA	0.93 -0.17
15	ACON	25.90929.001 (Main) 25.90930.001 (Aux)	PIFA	-0.04 1.16
16	Ethertronics Inc.	25.90934.001 (Main) 25.90935.001 (Aux)	PIFA	0.60 -0.59
17	WNC	25.90919.001 (Main) 25.90920.001 (Aux)	PIFA	0.87 -0.93
18	Tyco	25.90A2G.021 (Main) 25.90A2H.021 (Aux)	PIFA	-0.38 1.04

19	WNC	25.90A2G.001 (Main) 25.90A2H.001 (Aux)	PIFA	1.23 0.29
20	YAGEO	25.90A2G.011 (Main) 25.90A2H.011 (Aux)	PIFA	0.48 -1.37
21	Amphenol	C-2238-11-000-26 (Main) C-2239-11-000-26 (Aux)	PIFA	-1.31 -3.09
22	Amphenol	C-1952-11-000-26 (Main) C-1953-11-000-26 (Aux)	PIFA	0.35 -1.20
23	Foxconn	WDAN-LFNZ3001-DH (Main) WDAN-LFNZ3002-DH (Aux)	PIFA Coupling Type Inverted F	1.14 0.61
24	Tyco	1556219-1 (Main) 1556220-1 (Aux)	PIFA	0.64 -0.92
25	ACON	APP8P-700189 (Main) APP8P-700190 (Aux)	PIFA	2.00 0.13
26	ACON	APP8P-700191 (Main) APP8P-700192 (Aux)	PIFA	2.00 0.13
27	Tyco	1556216-1 (Main) 1556215-1 (Aux)	PIFA	0.64 -0.92
28	Quanta	DQ6GC300100 (Main) DQ6GC300200 (Aux)	PIFA	-1.3 0.7
29	Amphenol	C-2381-11-000-26 (Main) C-2382-11-000-26 (Aux)	PIFA	-1.54 -2.93
30	Foxconn	WDAN-LWSN3001-DH (Main) WDAN-LWSN3002-DH (Aux)	PIFA Coupling Type Inverted F	0.87 0.49
31	WNC	25.90A1E.001 (Main) 25.90A1F.001 (Aux)	PIFA	1.94 -0.85
32	Quanta	QADC FL8_WL_M (Main) QADC FL8_WL_A (Aux)	PIFA	0.1 -0.3
33	YAGEO	25.90A4W.001 (Main) 25.90A4V.001 (Aux)	PIFA	0.07 -0.06
34	FOXLINK	25.90A4W.011 (Main) 25.90A4V.011 (Aux)	PIFA	1.98 1.97
35	Quanta	QADC PS3_WL_M (Main) QADC PS3_WL_A (Aux)	PIFA	-0.1 0.0
36	Quanta	QADCFL3_WL_M (Main) QADCFL3_WL_A (Aux)	PIFA	-0.1 -0.1
37	Quanta	QADCGC5_WL_M (Main) QADCGC5_WL_A (Aux)	PIFA	0.4 -1.0
38	Quanta	DQ6GC200100 (Main) DQ6GC200200 (Aux)	PIFA	0.1 -0.4
39	Quanta	QADCGC6_WL_M (Main) QADCGC6_WL_A (Aux)	PIFA	0.7 1.2
40	Quanta	QADCPS1_WL_M (Main) QADCPS1_WL_A (Aux)	PIFA	-0.5 -1.4

41	ACON	25.90700.001 (Main) 25.90702.001 (Aux)	PIFA	-1.21 1.27
42	ACON	25.90800.001 (Main) 25.90802.001 (Aux)	PIFA	1.37 1.21
43	Amphenol	C-1334-11-000-26 (Main) C-1335-11-000-26 (Aux)	PIFA	-0.37 -2.64
44	WNC	25.90979.001 (Main) 25.90980.001 (Aux)	PIFA	0.77 0.74
45	Mag.Layers	FPA-2423-25GC1-A1 PCA-2111-25GC1-A1	PIFA	1.77 2.17
46	WNC	WNC005 (Main) WNC005 (Aux)	PIFA	-2.76 -3.64
47	WNC	WNC001 (Main) WNC001 (Aux)	PIFA	-1.10 1.76
48	WNC	WNC001 (Main) WNC001 (Aux)	PIFA	0.31 -0.75
49	Tyco Holdings (Bermuda) VII Ltd.	TBN003 (Main) TBN003 (Aux)	PIFA	-1.11 -1.11
50	WNC	WNC004 (Main) WNC004 (Aux)	PIFA	2.40 1.50
51	WNC	WNC002 (Tx1) WNC002 (Tx2)	PIFA	1.18 1.75
52	WNC	WNC003 (Main) WNC003 (Aux)	PIFA	0.52 1.07
53	Hitachi Cable, Ltd	HFT40 (Tx1) HFT40 (Tx2)	PIFA	0.58 1.12
54	Hitachi Cable, Ltd	HFT60 (Tx1) HFT60 (Tx2)	PIFA	-1.65 -0.92
55	Hitachi Cable, Ltd	HBY07 (Tx1) HBY07 (Tx2)	PIFA	2.19 -0.33
56	Hitachi Cable, Ltd	HBY051 (Tx1) HBY051 (Tx2)	PIFA	2.91 2.82
57	Hitachi Cable, Ltd	HBY052 (Tx1) HBY052 (Tx2)	PIFA	0.27 0.02
58	Hitachi Cable, Ltd	HBY061 (Tx1) HBY061 (Tx2)	PIFA	1.30 2.42
59	Hitachi Cable, Ltd	HBY062 (Tx1) HBY062 (Tx2)	PIFA	-1.04 -1.19
60	Hitachi Cable, Ltd	HFT65 (Tx1) HFT65 (Tx2)	PIFA	-1.74 1.16
61	Hitachi Cable, Ltd	HCT01 (Main) HCT01 (Aux)	PIFA	0.87 1.94
62	FOXCONN	WDAN-TQ (Tx1) WDAN-TQ (Tx2)	PIFA	-0.43 -0.7
63	ethertronics	5002011-1 (Tx1) 5002012-1 (Tx2)	PIFA	0.12 -3.87
64	ethertronics	5002015-1 (Tx1) 5002016-1 (Tx2)	PIFA	0.76 0.59



65	ethertronics	5010011-1 (Tx1) 5010012-1 (Tx2)	PIFA	-1.76 -2.61
66	ethertronics	5010015-1 (Tx1) 5010016-1 (Tx2)	PIFA	-0.84 -2.07
67	ACON	AMP6P (Tx1) AMP6P (Tx2)	PIFA	0.00 1.89
68	WNC	81.EJZ15.G52 (Main) 81.EJZ15.G52 (Aux)	PIFA	-1.08 -0.62
69	WNC	81.EJT15.GJC (Main) 81.EJT15.GJC (Aux)	PIFA	-0.58 -1.26
70	WNC	81.EJT15.GGW (Tx1) 81.EJT15.GGW (Tx2)	PIFA	0.21 0.77
71	WNC	81.EJZ15.G53 (Tx1) 81.EJZ15.G53 (Tx2)	PIFA	-0.78 -2.14
72	QUANTA	AN-070-G(R) AN-070-G(L)	PIFA	-0.7 -1.9
73	QUANTA	AN-070-G(R) AN-070-G(L)	PIFA	-0.3 -1.9
74	QUANTA	AN-120-F(R) AN-120-F(L)	PIFA	-0.4 -0.3
75	QUANTA	AN-120-F(R) AN-120-F(L)	PIFA	-1.8 -4.4
76	WHAYU	C435-520023-A (Main) C435-520024-A (Aux)	PIFA	1.74 1.56
77	WNC	81.EJZ (Main) 81.EJZ (Aux)	PIFA	-0.67 -0.35
78	WNC	81.EJT (Main) 81.EJT (Aux)	PIFA	-0.40 -1.91
79	JEM	IA-100193 (Main) IA-100194 (Aux)	PIFA	1.27 -1.27
80	Tyco Holdings (Bermuda) VII Ltd. Taiwan Branch	TBN008 (Tx1) TBN008 (Tx2)	PIFA	-0.10 -0.92
81	Smart Approach Co., Ltd.	03-FR021-026 (Main) 03-FR021-026 (Aux)	PIFA	1.51 1.56
82	Hitachi Cable	HBV17 (Tx1) HBV17 (Tx2)	PIFA	-0.36 0.97
83	Hitachi Cable, Ltd	HFT60 (Tx1) HFT60 (Tx2)	PIFA	2.97 0.90
84	Smart Approach Co., Ltd.	03-FR021-020 (Main) 03-FR021-020 (Aux)	PIFA	1.66 1.83
85	WHAYU INDUSTRIAL CO.,LTD	MSA-00005A (Main) MSA-00005A (Aux)	PIFA	-2.12 -2.49
86	Tyco	TBN008 (Tx1) TBN008 (Tx2)	PIFA	-2.60 -0.26
87	Tyco	TBN007 (Tx1) TBN007 (Tx2)	PIFA	1.98 1.97

88	Tyco Electronics Japan G.K.	TBN009 (Tx1)	PIFA	0.22
		TBN009 (Tx2)		0.33
89	Tyco Electronics Japan G.K.	TBN010 (Tx1)	PIFA	1.68
		TBN010 (Tx2)		1.45
90	Smart Approach.Co.,Ltd	03-FR021-016 (Tx1)	PIFA	2.32
		03-FR021-016 (Tx2)		0.49
91	Foxconn	WDAN-T1WM (Tx1)	PIFA	1.47
		WDAN-T1WM (Tx2)		1.38
92	Foxconn	WDAN-T1AM1001-DH (Tx1)	PIFA	2.58
		WDAN-T1AM1002-DH (Tx2)		1.39
93	WNC	WNC003 (Main)	PIFA	-0.10
		WNC003 (Aux)		2.30
94	TE Connectivity	1556465-1 TBN003 (Tx1)	PIFA	-0.23
		1556466-1 TBN003 (Tx2)		-0.49
95	ACON	APP8P-700341 (Main)	PIFA	1.10
		APP8P-700342 (Aux)		1.99
96	Smart Approach	SE-ECLA1-001 (Main)	PIFA	2.53
		SE-ECLA1-002 (Aux)		2.92
97	WNC	81.EK515.G13 (Main)	PIFA	0.30
		81.EK515.G14 (Aux)		0.39
98	Favortron CO.,LTD (FVC)	N01001205001 (Tx1)	PIFA	2.81
		N01001206001 (Tx2)		1.97
99	Favortron CO.,LTD (FVC)	W270HUQ-WiMAX-1	PIFA	2.85
		W270HUQ-WiMAX-2		1.87
100	Favortron CO.,LTD (FVC)	N01001193001 (Tx1)	PIFA	2.97
		N01001193001 (Tx2)		0.9
101	Favortron CO.,LTD (FVC)	N01001199001 (Tx1)	PIFA	2.73
		N01001199001 (Tx2)		2.87
102	Well Green	SKW24WMPB01+A (Tx1)	PIFA	-1.63
		SKW24WMPB01+A (Tx2)		-0.99
103	Favortron CO.,LTD (FVC)	N01001218001 (Tx1)	PIFA	2.53
		N01001218001 (Tx2)		2.28
104	Well Green	SKM11WMPB03+A (Tx1)	PIFA	-1.84
		SKM11WMPB02+D (Tx2)		-2.93
105	Favortron CO.,LTD (FVC)	E5120-WiMAX-1	PIFA	2.7
		E5120-WiMAX-2		2.19
106	Favortron CO.,LTD (FVC)	B5100-WiMAX-1	PIFA	1.58
		B5100-WiMAX-2		1.75
107	Well Green	SKW31WMPB01+A (Tx1)	PIFA	-1.07
		SKW31WMPB01+A (Tx2)		-0.64
108	WhaYu	C680-520279-A (Tx1)	PIFA	1.09
		C680-520279-A (Tx2)		-0.55
109	WhaYu	C680-520278-A (Tx1)	PIFA	1.92
		C680-520277-A (Tx2)		-1.03
110	Wellshine	DQ67KJQUT35 (Tx1)	PIFA	2.03
		DQ67KJQUT36 (Tx2)		0.05
111	ZTX	ZTX-A162-Q18000-00 (Tx1)	PIFA	2.014
		ZTX-A162-Q18000-00 (Tx2)		1.742

112	Well Green	SK81WMPB01+A (Tx1) SK81WMPB02+A (Tx2)	PIFA	1.79 0.66
113	Wellshine	DQ67KJQUT33 (Tx1) DQ67KJQUT33 (Tx2)	PIFA	1.17 -0.06
114	Tyco Holding (Bermuda) VII Ltd.	TBN001 (Main) TBN001 (Aux)	PIFA	3.45 2.41
115	tyco	TBN005 TBN006	PIFA	2.09 3.40
116	Tyco Electronic AMPKK	TBN004 (Main) TBN004 (Aux)	PIFA	0.28 -0.83
117	Hitachi	HFS23	PIFA	-0.8
118	Hitachi	HFS40	PIFA	0.64
119	Quanta	AS-070-F (Tx1) AS-070-F (Tx2)	PIFA	-0.5 -1.9
120	ACON	DQ60APM6P02(APM6P-700091) (Main) DQ60APM6P02(APM6P-700091) (Aux)	PIFA	-0.7 -0.29
121	ACON	DQ60APM6P03(APM6P-700092) (Main) DQ60APM6P03(APM6P-700092) (Aux)	PIFA	-0.6 -1.02
122	Quanta Computer Inc	37LX6AATP00 (Tx1) 37LX6AATP00 (Tx2)	PIFA	1.8 -0.3
123	Quanta Computer Inc	37LX7AATP00 (Tx1) 37LX7AATP00 (Tx2)	PIFA	0.3 1.7
124	Quanta Computer Inc	3ASP8AATP20 (Tx1) 3ASP8AATP20 (Tx2)	PIFA	1.0 0.2
125	Quanta Computer Inc	35AX6AATP10 (Tx1) 35AX6AATP10 (Tx2)	PIFA	0.7 -1.4
126	Foxconn	WDAN-HMCH1401-DH/79010T000-600-G (Tx1) WDAN-HMCH1402-DH/79010SY00-600-G (Tx2)	PIFA	-0.99 -0.09
127	Yageo	CAN43130WIFO04921/79010SQ00-011-G (Tx1) CAN43130WIFO04922/79010SR00-011-G (Tx2)	PIFA	0.23 1.53
128	WHAYU	C107-520757-A/79010T100-12S-G (Tx1) C107-520756-A/79010SS00-12S-G (Tx2)	PIFA	-0.18 2.58
129	Foxconn	WDAN-HMCH1501-DH/79010SW00-600-G (Tx1) WDAN-HMCH1502-DH/79010SV00-600-G (Tx2)	PIFA	-0.35 0.38
130	ACON	AMP8P-700186 (Main) AMP8P-700187 (Aux)	PIFA	1.96 1.91

131	Amphenol	FL5202-11-001-C (Tx1) FL5202-11-001-C (Tx2)	PIFA	-1.41 -0.77
132	Amphenol	IV5233-15-003-C (Tx1) IV5233-15-002-C (Tx2)	PIFA	0.54 -0.53
133	Amphenol	IV5218-11-002-C (Tx1) IV5218-11-001-C (Tx2)	PIFA	0.55 0.31
134	Amphenol	FX5170-15-004-C (Tx1) FX5170-15-001-C (Tx2)	PIFA	0.76 -2.11
135	HON HAI	WDAN-HMEDW005-DH (Tx1) WDAN-HMEDW005-DH (Rx2)	PIFA	-1.85 1.33
136	WNC	6036B0086802 (Tx1) 6036B0087102 (Tx2)	PIFA	-1.30 -0.49
137	WNC	6036B0088203 (Main) 6036B0088303 (Aux)	PIFA	0.50 0.12
138	WNC	6036B0088203 (Main) 6036B0088303 (Aux)	PIFA	1.21 -0.07
139	WNC	6036B0087303 (Main) 6036B0087203 (Aux)	PIFA	2.34 1.28
140	WNC	6036B0091201 (Main) 6036B0091401 (Aux)	PIFA	-1.11 -0.95
141	YAGEO	CAN43130LIIN03863 (Tx1) CAN43130LIIN03864 (Tx2)	PIFA	-2.69 -1.09
142	YAGEO	6036B0091202 (Tx1) 6036B0091402 (Tx2)	PIFA	0.80 0.25
143	YAGEO	CAN43130LIIN03841 (Tx1) CAN43130LIIN03842 (Tx2)	PIFA	1.46 0.95
144	YAGEO	6036B0088401 (Tx1) 6036B0088501 (Tx2)	PIFA	0.61 0.71
145	ACON	APM8P-700018 (Tx1) APM8P-700019 (Tx2)	PIFA	2.66 2.27
146	WNC	81.EK515.G15 (Main) 81.EK515.G16 (Aux)	PIFA	2.36 1.13
147	ACON	APM8P-700016 (Main) APM8P-700017 (Aux)	PIFA	2.79 0.74
148	NISSEI ELECTRIC CO., LTD	3209970 (Rx) 3210002 (Tx)	PIFA	1.88 1.26
149	ACON	25.90598.001 (Rx) 25.90597.001 (Tx)	PIFA	1.17 1.04
150	WNC	25.90587.001 (Rx) 25.90586.001 (Tx)	PIFA	1.94 0.59
151	ACON	25.90653.001 (Rx) 25.90654.001 (Tx)	PIFA	-0.42 -0.13
152	WNC	25.90649.001 (Rx) 25.90650.001 (Tx)	PIFA	-0.52 0.31
153	Foxconn	024-01F0-2242 (Rx) 024-01F0-2243 (Tx)	PIFA	1.16 -0.88


154	NISSEI ELECTRIC CO., LTD	3176658 (Rx) 3176674 (Tx)	PIFA	-0.83 -0.61
155	Foxconn	WDAN-L1WK1001-DF (Rx) WDAN-L1WK1002-DF (Tx)	PIFA	1.71 1.43
156	Hitachi	HMT14-MAIN (Rx) HMT14-AUX (Tx)	PIFA	1.82 1.54
157	ACON	25.90700.001 (Rx) 25.90702.001 (Tx)	PIFA	-1.21 1.27
158	ACON	25.90800.001 (Rx) 25.90802.001 (Tx)	PIFA	1.37 1.21
159	ACON	APM6P-700033 (Rx) APM6P-700034 (Tx)	PIFA	-0.96 -0.86
160	Amphenol Taiwan Corporation	14G152168231LV (Rx) 14G152168131LV (Tx)	PIFA	-1.85 -1.60
161	ACON	APM6P-700027 (Rx) APM6P-700029 (Tx)	PIFA	-1.32 -0.23
162	TYCO	2023940-1 (Rx) 2023944-1 (Tx)	PIFA	-2.39 1.52
163	ACON	APM6P-700028 (Rx) APM6P-700030 (Tx)	PIFA	-1.16 -0.74
164	Tyco Holding (Bermuda) VII Ltd.	2023946-1 (Rx) 2023950-1 (Tx)	PIFA	-0.58 -0.11
165	Amphenol SAA	LX-0980-11-000-R (Rx) LX-0983-11-000-R (Tx)	PIFA	1.61 1.57
166	NISSEI ELECTRIC CO., LTD	3172525 (Rx) 3172566 (Tx)	PIFA	1.35 1.99
167	Amphenol	LX0970-11-000-R (Rx) LX0968-11-000-R (Tx)	PIFA	1.47 1.68
168	FOXCONN	WDAN-L1ML3001-DF (Rx) WDAN-L1ML3002-DF (Tx)	PIFA	-0.40 1.10
169	NISSEI ELECTRIC CO., LTD	3172467 (Rx) 3172509 (Tx)	PIFA	0.54 1.80
170	ACON	25.90675.001 (Rx) 25.90676.001 (Tx)	PIFA	-0.39 0.64
171	WNC	25.90669.001 (Rx) 25.90670.001 (Tx)	PIFA	-1.53 1.32
172	ACON	AWP6P (Main) AWP6P (Aux)	PIFA	-0.19 -0.99

### 4.5.3 NCC 警語

經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前項合法通信，指依電信法規定作業之無線電通信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

本模組於取得認證後將依規定於模組本體標示審合格籤。

系統廠商應於平台上標示「本產品內含射頻模組： XXXyyyLPDzzzz-x (NCC ID)」字樣。

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#### **Realtek Semiconductor Corp.**

##### **Headquarters**

No. 2, Innovation Road II, Hsinchu Science Park,

Hsinchu, 300, Taiwan, R.O.C.

Tel: 886-3-5780211 Fax: 886-3-5776047

[www.realtek.com.tw](http://www.realtek.com.tw)