RTL8812AE

Half Mini-Card User's Manual

Rev. 1.0
29 November 2012

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

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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.

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1. General Description

The Realtek RTL8812AE is a highly integrated single-chip MIMO (Multiple In, Multiple Out) Wireless LAN (WLAN) PCI Express network interface controller complying with the wireless very high throughput IEEE 802.11ac Draft 2.0 and high throughput 802.11n specification. The RTL8812AE provides a complete solution for a high-performance wireless client and also supports WiFi Direct feature that can easily build a WiFi P2P PAN network.

The RTL8812AE baseband implements Multiple Input, Multiple Output (MIMO) Orthogonal Frequency Division Multiplexing (OFDM) with two transmit and two receive paths (2T2R). Features include two spatial stream transmissions, short Guard Interval (GI) of 400ns, spatial spreading, and support for 20MHz, 40MHz and 80MHz channel bandwidth. Moreover, RTL8812AE provides one spatial stream space-time block code (STBC), Transmit Beamforming (TxBF) and Low Density Parity Check (LDPC) to extend the range of transmission. At the receiver, extended range and good minimum sensitivity is achieved by having receiver diversity up to 2 antennas. As the recipient, the RTL8812AE also supports explicit sounding packet feedback that helps senders with beamforming capability. With 2 independent RF blocks, the RTL8812AE can perform fast roaming without link interruption.

For legacy compatibility, Direct Sequence Spread Spectrum (DSSS), Complementary Code Keying (CCK) and OFDM baseband processing are included to support all IEEE 802.11b, 802.11g and 802.11a data rates. Differential phase shift keying modulation schemes, DBPSK and DQPSK with data scrambling capability are available, and CCK provides support for legacy data rates, with long or short preamble. The high speed FFT/IFFT paths, combined with BPSK, QPSK, 16QAM, 64QAM and 256QAM modulation of the individual subcarriers, and rate compatible coding rate of 1/2, 2/3, 3/4, and 5/6, provide up to 866.7Mbps for IEEE 802.11ac MIMO OFDM.

The RTL8812AE builds in an enhanced signal detector, an adaptive frequency domain equalizer, and a soft-decision Viterbi decoder to alleviate severe multi-path effects and mutual interference in the reception of multiple streams. For better detection quality, receive diversity with Maximal-Ratio-Combine (MRC) applying up to two receive paths is implemented. Robust interference detection and suppression are provided to protect against Bluetooth, cordless phone, and microwave oven interference.

Receive vector diversity for multi-stream application is implemented for efficient utilization of the MIMO channel. Efficient IQ-imbalance, DC offset, phase noise, frequency offset, and timing offset compensations are provided for the radio frequency front-end. Selectable digital transmit and receive FIR filters are provided to meet transmit spectrum mask requirements and to reject adjacent channel interference, respectively.

The RTL8812AE supports fast receiver Automatic Gain Control (AGC) with synchronous and asynchronous control loops among antennas, antenna diversity functions, and adaptive transmit power control functions to obtain better performance in the analog portions of the transceiver.

The RTL8812AE MAC supports 802.11e for multimedia applications, 802.11i and WAPI (Wireless Authentication Privacy Infrastructure) for security, and 802.11n/802.11ac Draft 2.0 for enhanced MAC protocol efficiency. Using packet aggregation techniques such as A-MPDU with BA and A-MSDU, protocol efficiency is significantly improved. Power saving mechanisms such as Legacy Power Save, U-APSD, and MIMO power saving reduce the power wasted during idle time, and compensate for the extra power required to transmit MIMO OFDM. The RTL8812AE provides simple legacy, 20MHz/40MHz/80MHz co-existence mechanisms to ensure backward and network compatibility.

2. Features

General

- QFN76 9x9mm package
- CMOS MAC, Baseband PHY and RF in a single chip for IEEE 802.11a/b/g/n/ac Draft 2.0 compatible WLAN
- 802.11ac MIMO solution for 5G band
- Complete 802.11n MIMO solution for 2.4GHz and 5Ghz band
- 2x2 MIMO technology for extended reception robustness and exceptional throughput
- Maximum PHY data rate up to 173.3 Mbps using 20MHz bandwidth, 400Mbps using 40MHz bandwidth, and 866.7Mbps using 80MHz bandwidth.
- Backward compatible with 802.11a/b/g devices while operating at 802.11n data rates
- Backward compatible with 802.11a/n devices while operating at 802.11ac data rates.

Host Interface

- Complies with PCI Express Base Specification Revision 1.1

Standards Supported

- IEEE 802.11a/b/g/n/ac Draft 2.0 compatible WLAN
- IEEE 802.11e QoS Enhancement (WMM)
- IEEE 802.11i (WPA, WPA2). Open, shared key, and pair-wise key authentication services
- IEEE 802.11h TPC, Spectrum Measurement
- IEEE 802.11k Radio Resource Measurement
- WAPI (Wireless Authentication Privacy Infrastructure) certified.
- Cisco Compatible Extensions (CCX) for WLAN devices

MAC Features

- Frame aggregation for increased MAC efficiency (A-MSDU, A-MPDU)
- Low latency immediate High-Throughput Block Acknowledgement (HT-BA)
- Long NAV for media reservation with CF-End for NAV release
- PHY-level spoofing to enhance legacy compatibility
- MIMO power saving mechanism
- Channel management and co-existence
- Multiple BSSID feature allows the RTL8812AE-CG to assume multiple MAC identities when used as a wireless bridge
- Transmit Opportunity (TXOP) Short Inter-Frame Space (SIFS) bursting for higher multimedia bandwidth
- WiFi Direct supports wireless peer to peer applications.

Other Features

- Supports Wake-On-WLAN via Magic Packet and Wake-up frame
- Transmit Beamforming
- CCA on secondary through RTS/CTS handshake.
- Support TCP/UDP/IP checksum offload

Peripheral Interfaces

- Up to 12 General Purpose Input/Output pins
- Three configurable LED pins (mux with GPIO pins)
- Configurable Bluetooth Coexistence Interface (mux with GPIO pins)
- Generates 40MHz clock for peripheral chip.
- Single external power source 3.3V only

PHY Features

- IEEE 802.11ac MIMO OFDM
- IEEE 802.11n MIMO OFDM
- Two Transmit and Two Receive paths
- 5MHz / 10MHz / 20MHz / 40MHz / 80MHz bandwidth transmission
- Support 2.4Ghz and 5Ghz band channels
- Short Guard Interval (400ns)
- Sounding packet.
- DSSS with DBPSK and DQPSK, CCK modulation with long and short preamble
- OFDM with BPSK, QPSK, 16QAM, 64QAM and 256QAM modulation. Convolutional Coding Rate: 1/2, 2/3, 3/4, and 5/6
- Maximum data rate 54Mbps in 802.11g, 300Mbps in 802.11n and 866.7Mbps in 802.11ac.
- OFDM receive diversity with MRC using up to 2 receive paths. Switch diversity used for DSSS/CCK
- Support STBC
- Support LDPC
- Hardware antenna diversity
- Selectable digital transmit and receiver FIR filters
- Programmable scaling in transmitter and receiver to trade quantization noise against increased probability of clipping
- Fast receiver Automatic Gain Control (AGC)
- On-chip ADC and DAC
- Build-in both 2.4GHz and 5GHz PA
- Build-in both 2.4GHz and 5GHz LNA

3. Product specifications

3.1. Environmental

3.1.1. Operating

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

3.1.2. Storage

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

3.2. Functional Specifications

Table 1. Functional Specifications

Standards	IEEE 802.11a/b/g/n/e/i/h/k/r/draft-ac
Bus Interface	PCI Express
Form Factor	Half Size Mini Card
Data Rate	**802.11b:** 11, 5.5, 2, 1 Mbps; **802.11g:** 54, 48, 36, 24, 18, 12, 9, 6 Mbps **802.11n:** MCS 0 to 15 for HT20MHz; MCS 0 to 15 for HT40MHz **802.11ac:** MCS 0 to 8 for HT20MHz; MCS 0 to 9 for HT40MHz; MCS 0 to 9 for HT80MHz
Media Access Control	CSMA/CA with ACK
Modulation Techniques	***802.11b***: CCK, DQPSK, DBPSK ***802.11a/g/n***: 64 QAM, 16 QAM, QPSK, BPSK ***802.11ac***: 256QAM, 64 QAM, 16 QAM, QPSK, BPSK
Network Architecture	***WiFi***: Ad-hoc mode (Peer-to-Peer) Infrastructure mode

Operating Channel	***WiFi 2.4GHz:*** 11: (Ch. 1-11) – United States 13: (Ch. 1-13) – Europe 14: (Ch. 1-14) – Japan ***WiFi 5GHz:*** 20MHz band width : Ch 36, 40, 44, 48, Ch 52, 56, 60, 64, Ch 100, 104, 108, 112, 116, 120, 124, 128,132,136, 140, Ch 149,153, 157,161, 165. 40MHz band width : Ch 38, 46, Ch 54, 62, Ch 102, 110, 118, 126, 134, Ch 151, 159. 80MHz band width : Ch 42 Ch 58 Ch 105, 122 Ch 155.
Frequency Range	2.400GHz ~ 2.4835 GHz 5.1500GHz ~ 5.3500GHz 5.4700GHz ~ 5.7250GHz 5.7250GHz ~ 5.8500GHz
Security	WPA, WPA-PSK, WPA2, WPA2-PSK, WEP 64bit & 128bit, IEEE 802.11x, IEEE 802.11i
Operating Voltage	3.3 V ±9% I/O supply voltage

3.3. Warning

3.3.1 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.

Operations in the 5.15-5.25GHz band are restricted to indoor usage only.
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,
3.)For all products market in US, OEM has to limit the operation channels in CH1 to CH11 for 2.4G band by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change.

As long as 3 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-RTL8812AE”.

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.

3.3.2 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

This device has been designed to operate with an antenna having a maximum gain of 5dBi.
Antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the EIRP is not more than required for successful communication.

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.

This device is intended only for OEM integrators

under the following conditions:

The transmitter module may not be co-located with any other transmitter or antenna.

As long as conduction above is 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.). The antenna must be installed such that 20 cm is maintained between the antenna and users.

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.

End Product Labeling

The final end product must be labeled in a visible area with the following: “Contains IC : 6317A-RTL8812AE”.

Manual Information That Must be Included

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 user’s manual for OEM Integrators must include the following information in a prominent location “IMPORTANT NOTE: To comply with FCC RF exposure compliance requirements. The antenna must not be co-located or operating in conjunction with any other antenna or transmitter”.

3.3.3 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。

5.25 ~ 5.35GHz 限室內使用

Note:

1. 本模組於取得認證後將依規定於模組本體標示審合格籤。
2. 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。

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