# RTL8811CU-CG

# Single-Chip IEEE 802.11a/b/g/n/ac 1T1R WLAN with USB 2.0 Interface

## DATASHEET

**(CONFIDENTIAL: Development Partners Only)**

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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.

## REVISION HISTORY

| Revision | Release Date | Summary |
|---|---|---|
| 0.1 | 2016/07/27 | Preliminary release. |
| 0.1r05 | 2016/9/06 | Modify general description and features |
| | | |

# Table of Contents

# List of Tables



# List of Figures

# 1. General Description

The Realtek RTL8811CU-CG is a highly-integrated IEEE 802.11 a/b/g/n/ac MAC/Baseband/RF WLAN single chip. For Wireless LAN (WLAN) operation, it supports 1-stream 802.11ac solution with Multi-user MIMO (Multiple-Input, Multiple-Output) STA mode with USB2.0 network interface controller.

The RTL8811CU-CG baseband implements multiuser Multiple-Input Multiple-Output (MIMO) Orthogonal Frequency Division Multiplexing (OFDM) STA mode with one transmit and one receive path (1T1R). Features include one spatial stream transmission, short Guard Interval (GI) of 400ns, spatial spreading, and support for variant channel bandwidths. Moreover, RTL8811CU-CG provides one spatial stream Space-Time Block Code (STBC) and Low Density Parity Check (LDPC) to extend the range of transmission. As the recipient, the RTL8811CU-CG also supports explicit sounding packet feedback that helps senders with beamforming capability.

For legacy compatibility, Direct Sequence Spread Spectrum (DSSS), Complementary Code Keying (CCK) and OFDM baseband processing are included to support all IEEE 802.11a, 802.11b and 802.11g data rates. Differential phase shift keying modulation schemes, DBPSK and DQPSK with data scrambling capability, are available. CCK provides support for legacy data rates, with long or short preamble. The high speed FFT/IFFT paths are combined with BPSK, QPSK, 16QAM, 64QAM and 256QAM modulation of the individual subcarriers. The compatible coding rate of 1/2, 2/3, 3/4, and 5/6 provides up to 433.3Mbps for IEEE 802.11ac with MIMO-OFDM.

The RTL8811CU-CG 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.

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.

The RTL8811CU-CG 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 RTL8811CU-CG MAC supports 802.11e for multimedia applications, 802.11i and WAPI (Wireless Authentication Privacy Infrastructure) for security, and 802.11n/ac for enhanced MAC protocol efficiency. Protocol efficiency is significantly improved by using packet aggregation techniques, such as A-MPDU with BA and A-MSDU. Power saving mechanisms, such as Legacy Power Save, U-APSD, and MIMO, can reduce the power wasted during idle time. They can also compensate for the extra power required to

transmit MIMO-OFDM. The RTL8811CU-CG provides simple legacy and 20MHz/40MHz/80MHz co-existence mechanism to ensure backward and network compatibility.

# 2. Features

### General Information

- 56pins QFN
- CMOS MAC, Baseband PHY and RF in a single chip for IEEE 802.11a/b/g/n/ac compatible WLAN
- Support 802.11ac 1x1,Wave-2 compliant with MU-MIMO STA mode
- Complete 802.11n MIMO solution for 2.4GHz and 5Ghz band
- Maximum PHY data rate up to 86.7Mbps using 20MHz bandwidth, 200Mbps using 40MHz bandwidth, and 433.3Mbps 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 USB 2.0 for WLAN controller
- USB LPM/Selective Suspend supported

### Standards Supported

- IEEE 802.11a/b/g/n/ac 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 DFS, 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 Block Acknowledgement (BA)
- Long NAV for media reservation with CF-End for NAV release
- PHY-level spoofing to enhance legacy compatibility
- Channel management and co-existence
- Multiple BSSID feature allows the RTL8811CU-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.
- WiFi NAN (Neighborhood Area Network) support
- WiFi FTM (Fine Time Measurement) supported
- WiFi TDLS (Tunneled Direct Link Setup) Supported

**Other Features**

- Supports Wake-On-WLAN via Magic Packet and Wake-up frame
- Transmit Beamforming
- Support S3/S4 AES/TKIP group key update
- Support Network List Offload
- CCA on secondary through RTS/CTS handshake.
- Support TCP/UDP/IP checksum offload

**Peripheral Interfaces**

- Up to 15 General Purpose Input/Output pins
- Three configurable LED pins (mux with GPIO pins)
- Generates 40MHz clock for peripheral chip.
- Single external power source 3.3V only

**PHY Features**

- IEEE 802.11ac OFDM
- IEEE 802.11n OFDM
- One Transmit and One Receive path
- 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, 150Mbps in 802.11n and 433.3bps in 802.11ac.
- Switch diversity used for DSSS/CCK
- Support STBC Receiving
- Support LDPC Transmitting
- Hardware antenna diversity
- 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. Application Diagrams

## *3.1. 11ac Dual-Band 1x1 RF Application*

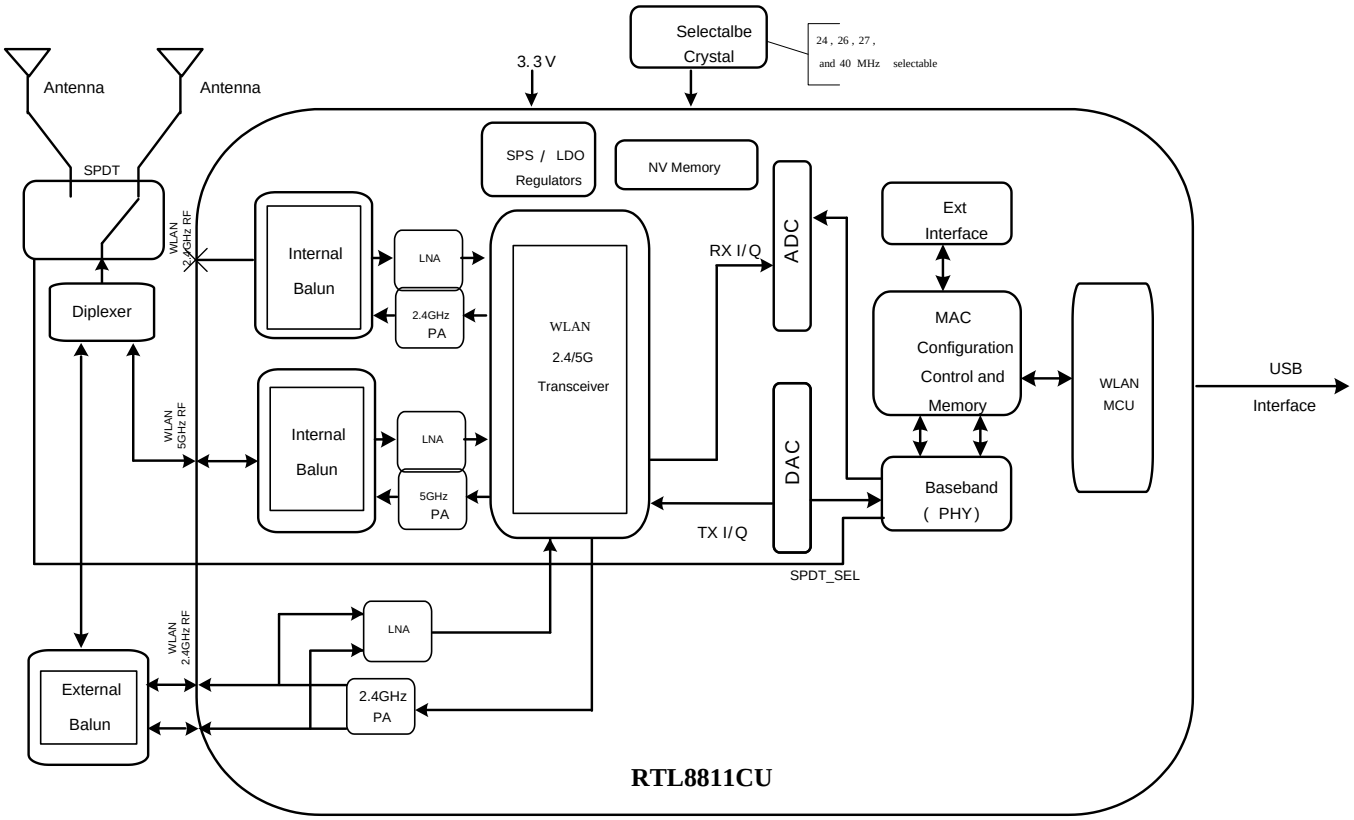


**Figure 1. Dual-Band MIMO 1x1 Solution(11ac 1x1 MAC/BB/RF + PA) Solution --- RTL8811CU-CG**

# 4. Pin Assignments

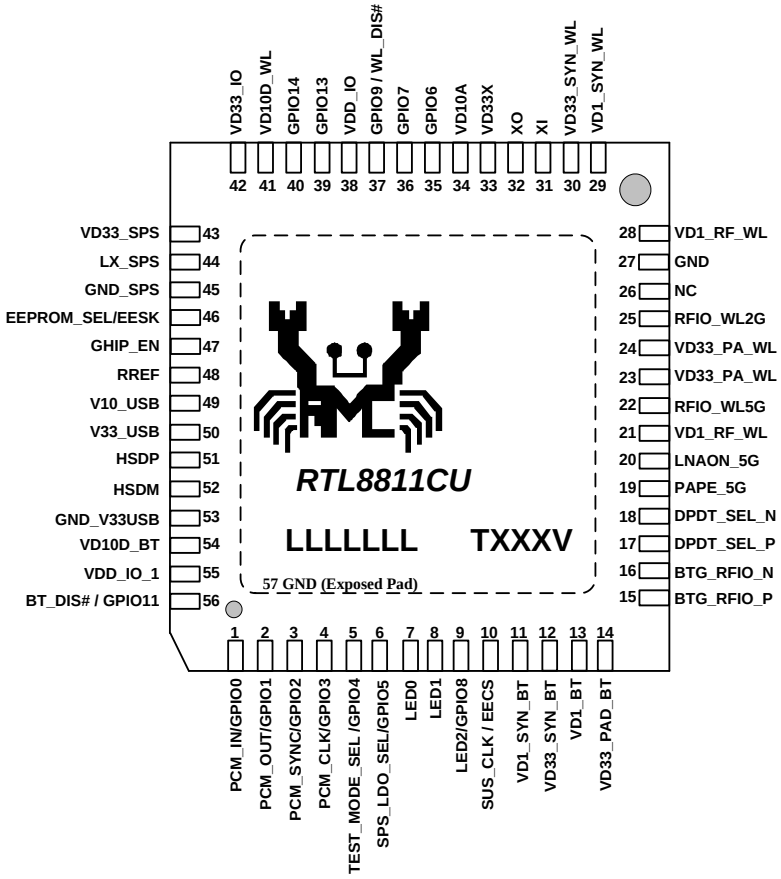


**Figure 2. Pin Assignments**

## *4.1. Package Identification*

**Figure 2**, 'Green' package is indicated by a 'G'. The location marked is indicated by 'T'. The version is shown in the location marked 'V', e.g.,.B=Version B

# 5. Pin Descriptions

The following signal type codes are used in the table 1 to 9,

I: Input

O: Output

I/O: Input/Output pin

P: Power pin

N/A: No Bonding pin

## 5.1. Power on Trap Pin

| Symbol | Type | Pin No. | Description |
|---|---|---|---|
| TEST_MODE_SEL | I | 5 | This pin is also shared with GPIO4<br>0: Normal operation mode<br>1: Test/debug mode |
| SPS_LDO_SEL | I | 6 | This pin is also shared with GPIO5<br>0: Internal switching regulator select<br>1: Internal LDO select |
| EEPROM_SEL | I | 46 | This pin is also shared with EESK pin<br>0: Internal NV memory select<br>1: External EEPROM select |

**Table 1. Power-On Trap Pins**

## 5.2. USB Transceiver Interface

| Symbol | Type | Pin No | Description |
|---|---|---|---|
| HSDP | I/O | 51 | High-Speed USB D+ Signal |
| HSDM | I/O | 52 | High-Speed USB D- Signal |

**Table 2. USB Transceiver Interface**

## 5.3. EEPROM Interface

| Symbol | Type | Pin No | Description |
|---|---|---|---|
| EECS | O | 10 | External EEPROM Chip Select |
| EESK | O | 46 | External EEPROM Clock |

**Table 3. EEPROM Interface**

## 5.4. RF Interface

| Symbol | Type | Pin No | Description |
|---|---|---|---|
| BTG_RFIO_P | I/O | 15 | BT/WLAN 2G RF Differential I/O P |
| BTG_RFIO_N | I/O | 16 | BT/WLAN 2G RF Differential I/O N |
| DPDT_SEL_P | O | 17 | External DPDT CONTROL |
| DPDT_SEL_N | O | 18 | External DPDT CONTROL |
| PAPE_5G | O | 19 | External 5G PAPE CONTROL |
| LNAON_5G | O | 20 | External 5G LNA CONTROL |
| RFIO_ WL5G | O | 22 | WLAN 5G RF I/O |
| RFIO_ WL2G | O | 25 | WLAN 2G RF I/O |

**Table 4. RF Interface**

## 5.5. LED Interface

| Symbol | Type | Pin No | Description |
|---|---|---|---|
| LED0 | O | 7 | LED Pin (Active Low) |
| LED1 | O | 8 | LED Pin (Active Low) |
| LED2 | O | 9 | LED Pin (Active Low), shared with GPIO8 |

**Table 5. LED Interface**

## 5.6. Power Management Handshake Interface

| Symbol | Type | Pin No | Description |
|---|---|---|---|
| WL_DIS# | I | 37 | Shared with GPIO9. This pin can externally shut down the RTL8811CU-CG WLAN function when WL_DIS# is pulled low. When this pin is pulled low, USB interface will be disabled.<br>This pin can also be configured as the WLAN Radio-off function with host interface remaining connected. |
| CHIP_EN | I | 47 | This Pin Can externally shut down the RTL8811CU-CG (No Extra Power Switch Required). When this function is not required, external pull high is required. |

**Table 6. Power Management Handshake Interface**

## 5.7. Clock and Other Pins

| Symbol | Type | Pin No | Description |
|---|---|---|---|
| XI | I | 31 | 26M/40MHz OSC Input<br>Input of 26M/40MHz Crystal Clock Reference |
| XO | O | 32 | Output of 26MHz/40MHz Crystal Clock Reference |
| SUS_CLK | I | 10 | Shared with EECS. External 32K or RTC clock input. |
| GPIO0 | I/O | 1 | General Purpose Input/ Output Pin |
| GPIO1 | I/O | 2 | General Purpose Input/ Output Pin |
| GPIO2 | I/O | 3 | General Purpose Input/ Output Pin |
| GPIO3 | I/O | 4 | General Purpose Input/ Output Pin |
| GPIO4 | I/O | 5 | General Purpose Input/ Output Pin |
| GPIO5 | I/O | 6 | General Purpose Input/ Output Pin |
| GPIO6 | I/O | 35 | General Purpose Input/ Output Pin |
| GPIO7 | I/O | 36 | General Purpose Input/ Output Pin |
| GPIO8 | I/O | 9 | General Purpose Input/ Output Pin |
| GPIO9 | I/O | 37 | General Purpose Input/ Output Pin |
| GPIO11 | I/O | 56 | General Purpose Input/ Output Pin |
| GPIO13 | I/O | 39 | General Purpose Input/ Output Pin |
| GPIO14 | I/O | 40 | General Purpose Input/ Output Pin |
| NC | | 26 | Not Connect |

**Table 7. Clock and Other Pins**

## 5.8. Power Pins

| Symbol | Type | Pin No | Description |
|---|---|---|---|
| LX_SPS | P | 44 | Switching Regulator Output |

| Symbol | Type | Pin No | Description |
|---|---|---|---|
| LX_SPS | P | 44 | Switching Regulator Output |
| VD33_SPS | P | 43 | Switching Regulator Input |
| VD33_IO | P | 42 | VDD3.3V for Digital IO |
| VDD_IO_1 | P | 55 | VDD for GPIO0~5 , GPIO11 |
| VDD_IO | P | 38 | VDD for GPIO9.EECS,CHIP_EN,GPIO6,GPIO7,GPIO13,GPIO14 |
| VD10D_WL | P | 41 | 1.05V for WLAN digital power |
| VD10D_BT | P | 54 | 1.05V for WLAN digital power |
| GND_SPS | P | 45 | Switching Regulator Ground |
| GND | P | 27 | GND |
| GND_V33USB | P | 53 | USB Ground |
| V10_USB | P | 49 | 1.05V for USB |
| V33_USB | P | 50 | 3.3V for USB |
| RREF | P | 48 | Precision Resistor for Bandgap |
| VD1_ BT | P | 13 | VDD 1.05V for BT RF |
| VD33_PAD_BT | P | 14 | VDD 3.3V for BT PAD |
| VD1_SYN_BT | P | 11 | VDD 1.05V for BT synthesizer |
| VD33_SYN_ BT | P | 12 | VDD 3.3V for BT synthesizer |
| VD33_PA_WL | P | 23 | VDD 3.3V for WLAN PA |
| VD33_PA_WL | P | 24 | VDD 3.3V for WLAN PA |
| VD1_RF_WL | P | 21 | VDD 1.05V for WLAN RF |
| VD1_RF_WL | P | 28 | VDD 1.05V for WLAN RF |
| VD1_SYN_WL_ | P | 29 | VDD 1.05V for WLAN synthesizer |
| VD33_SYN_WL | P | 30 | VDD 3.3V for WLAN synthesizer |
| VD33X | P | 33 | VDD 3.3V for crystal |
| VD10A | P | 34 | VDD 1.05V for crystal |

Table **8. Power Pins**

# 6. Electrical and Thermal Characteristics

## 6.1. Temperature Limit Ratings

| Parameter | Minimum | Maximum | Units |
|---|---|---|---|
| Storage Temperature | -55 | +125 | °C |
| Ambient Operating Temperature | 0 | 70 | °C |
| Junction Temperature | 0 | 125 | °C |

**Table 9. Temperature Limit Ratings**

## 6.2. DC Characteristics

### 6.2.1. Power Supply Characteristics

| Symbol | Parameter | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|
| VD33 | 3.3V I/O Supply Voltage | 3.0 | 3.3 | 3.6 | V |
| VD10 | 1.05V Core Supply Voltage | 0.945 | 1.05 | 1.155 | V |

**Table 10. DC Characteristics**

### 6.2.2. Digital IO Pin DC Characteristics

| Symbol | Parameter | Minimum | Normal | Maximum | Units |
|---|---|---|---|---|---|
| $V_{IH}$ | Input high voltage | 2.0 | 3.3 | 3.6 | V |
| $V_{IL}$ | Input low voltage | -- | 0 | 0.9 | V |
| $V_{OH}$ | Output high voltage | 2.97 | -- | 3.3 | V |
| $V_{OL}$ | Output low voltage | 0 | -- | 0.33 | V |

**Table 11. 3.3V GPIO DC Characteristics**

* 3.3V and 1.2V ripple < 100mV

# 7. Interface Timing Specification

## *7.1. USB Bus Timing during Power On Sequence*

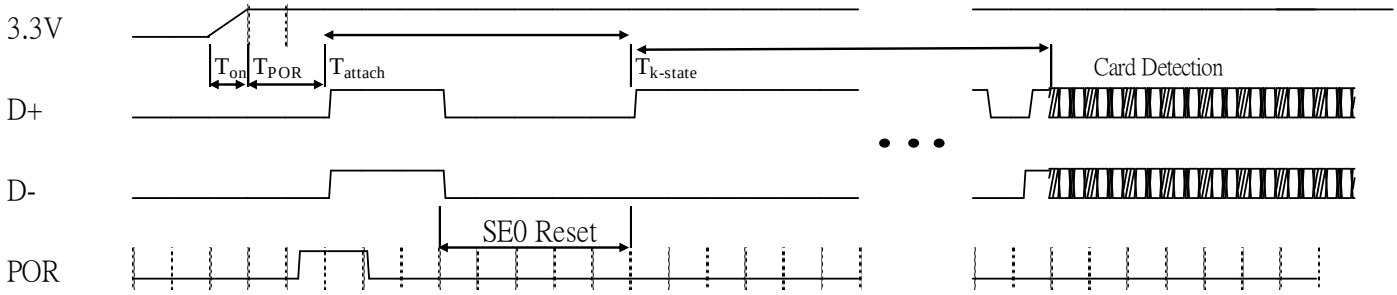


**Figure 3. RTL8811CU-CG USB Bus Power On Sequence**

**$T_{on}$:** The main power ramp up duration
**$T_{por}$:** The power on reset releases and power management unit executes power on tasks
**$T_{attach}$:** USB attach state
**$T_{k\text{-}state}$:** the duration from resister attached to USB host starting card detection procedure

***The power on flow description:***
After main 3.3V ramp up, the internal power on reset is released by power ready detection circuit and the power management unit will be enabled. The power management unit enables the internal regulator and clock circuits.
The power management unit also enables the USB circuits.
USB analog circuits attach resisters to indicate the insertion of the USB device

| | Unit | Min | Typical | Max |
|---|---|---|---|---|
| **$T_{on}$** | ms | -- | 1.5 | 5 |
| **$T_{por}$** | ms | -- | 2 | 10 |
| **$T_{attach}$** | ms | 2 | 7 | 15 |
| **$T_{k\text{-}state}$** | ms | 50 | 250 | -- |

**Table 12. The typical timing range**

# 8. Mechanical Dimensions

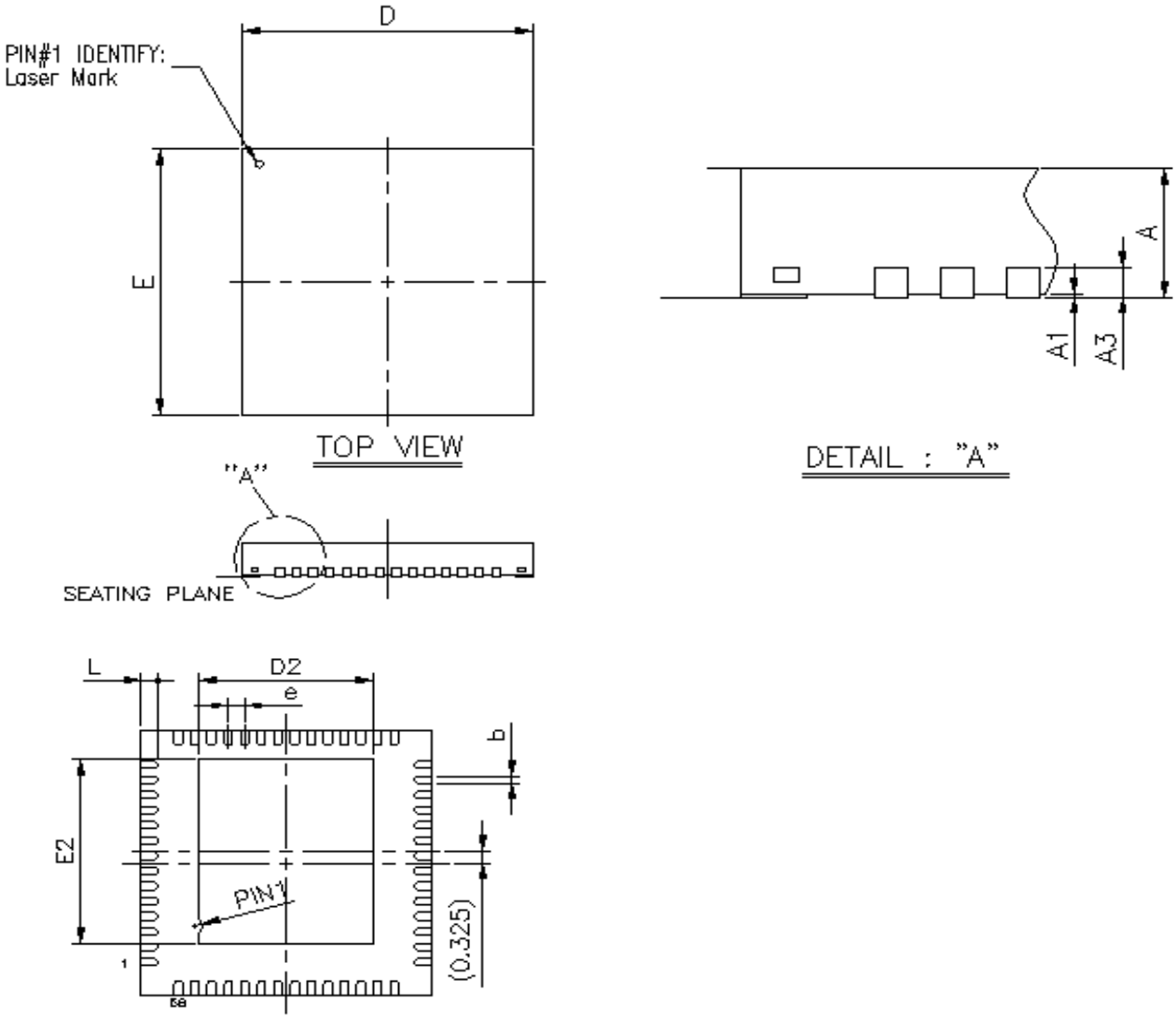


**Figure 4. Package Dimension**

## 8.1. Mechanical Dimensions Notes

| Symbol | Dimension in mm | | | Dimension in inch | | |
|---|---|---|---|---|---|---|
| | Min | Nom | Max | Min | Nom | Max |
| A | 0.80 | 0.85 | 0.90 | 0.031 | 0.033 | 0.035 |
| $A_1$ | 0.00 | 0.02 | 0.05 | 0.000 | 0.001 | 0.002 |
| $A_3$ | | 0.2 REF | | | 0.008 REF | |
| b | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 |
| D/E | | 7.00 BSC | | | 0.276 BSC | |
| $D_2$ | 4.10 | 4.20 | 4.30 | 0.161 | 0.165 | 0.169 |
| $E_2$ | 4.75 | 4.85 | 4.95 | 0.187 | 0.191 | 0.195 |
| e | | 0.40 BSC | | | 0.016 BSC | |
| L | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |

Notes：

1. CONTROLLING DIMENSION：MILLIMETER(mm).
2. REFERENCE DOCUMENTL：JEDEC MO-220.

**Table 13. Package Dimensions Notes**

# 9. Ordering Information

| Part Number | Package | Status |
|---|---|---|
| RTL8811CU-CG | QFN56 , 'Green' Package | To be available |

**Table 14. Ordering Information**

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