# REALTEK

ALC4030
(PN: ALC4030-CG/ALC4030-CGT)

## USB2.0 AUDIO CODEC
## WITH HARDWARE EQUALIZER

## DATASHEET

Rev. 1.6
12  December  2019

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## TRADEMARKS

## USING THIS DOCUMENT

This document is intended for the hardware and software engineer's general information on the Realtek ALC4030 USB2.0 Audio Codec.

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.

## REVISION HISTORY

| Revision | Release Date | Summary |
|---|---|---|
| 0.1 | 2017/05/24 | First release. |
| 1.0 | 2017/12/19 | Update part features |
| 1.1 | 2018/03/13 | Update part feature and status |
| 1.2 | 2018/04/16 | Add T&R part |
| 1.3 | 2019/06/18 | Update block diagram |
| 1.4 | 2019/07/08 | Update block diagram |
| 1.5 | 2019/12/03 | Update block diagram<br>Update pin assignment |
| 1.6 | 2019/12/12 | Update block diagram for remove UART function. |

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# 1. General Description

The ALC4030 is a single-chip USB 2.0 audio codec with embedded USB 2.0 to I2C and digital microphone interface for high analog and digital audio performance. The ALC4030 integrates stereo analog input and output, USB, I2C and digital microphone interfaces, to support a standard USB audio device class designed for all major commercial operating systems, e.g., Windows, Linux, and Android.

The ALC4030 features a Class-G type ultra-low-power cap-saving headphone amplifier. It is a high efficiency audio amplifier with an integrated Class-G voltage converter that enhances efficiency at low output power. The ALC4030 integrates a USB 2.0 function controller and USB transceiver optimized for a high data transfer rate, a high speed MCU (Micro Processor Unit), DC-to-DC regulators, digital I2C control interface, and SPI interface into a single chip.

# 2.    Features

## 2.1.   General Hardware Features

■ Digital-to-Analog Converter with 95dBA SNR

■ Analog-to-Digital Converter with 94dBA SNR

■ One stereo DAC supports 8/16/24/32/44.1/48/96KHz Sample Rate, 16/24-bit

■ One stereo and mono ADCs support 8/16/24/32/44.1/48/96KHz Sample Rate, 16/24-bit

■ Class-G type headphone output without DC blocking capacitors

■ Hardware EQ function for playback path (HPFx2, BPFx3, LBFx1, Biquadx1 )

■ Hardware EQ function for recording path (LPFx1, HPFx1, BPFx4)

■ Single-ended analog microphone inputs with pre-amplifiers (0/20/30dB)

■ Low noise microphone and programmable MICBIAS voltage level

■ Audio jack detection feature

■ 4-Button Headset in-line with customizable multi-function control support

■ Stereo digital microphone interfaces

■ Embedded 64K Byte flash and 16K Byte OTP for F/W programming

■ One I2C control interface, supports master mode

■ SPI connection to serial flash for switching code and configuration of customized parameters

■ Built-in Analog LDO

■ 48-pin QFN 'Green' package

## 2.2.   USB Controller Features

■ Compliant with USB Specification 2.0 Full-Speed and High-Speed transfer mode

■ Compliant with USB Audio Class Specification Rev1.0 and Rev2.0

■ Supports Selective Suspend mode

- Support jack detection, headset's 4-button detection and GPIOs Remote wakeup function in suspend mode

- Internal PLL supports non-crystal design

## 2.3.  Micro Controller Unit

- On-chip high-performance and low-power MCU

- Software controlled connection to USB bus for re-enumeration

- Internal programmable memory support for various Realtek codec and audio configurations

- Watchdog control for MCU reset and interrupt

- Configurable VID (Vendor ID), PID (Product ID) and serial number string from external serial flash

## 2.4.  Configurable GPIO Pins

- Programmable inputs and outputs for control purposes

- Toggle PWM LED driver and controller upon firmware or custom driver customizations

## 2.5.  Software Features

- No custom audio driver required

- USB Audio Class compliant; operates with native driver in Microsoft Windows XP, VISTA, Windows 7, Windows 8, Windows 8.1, and Windows 10

- Realtek custom audio driver provides certified logo driver for Microsoft Windows XP, VISTA, Windows 7, Windows 8, 8.1, and Windows 10

# 3. System Applications

- USB Docking Station for Notebook, Tablet, PCs

- Embedded USB audio applications

- USB headset, headphone, microphone, speaker and generic accessory audio
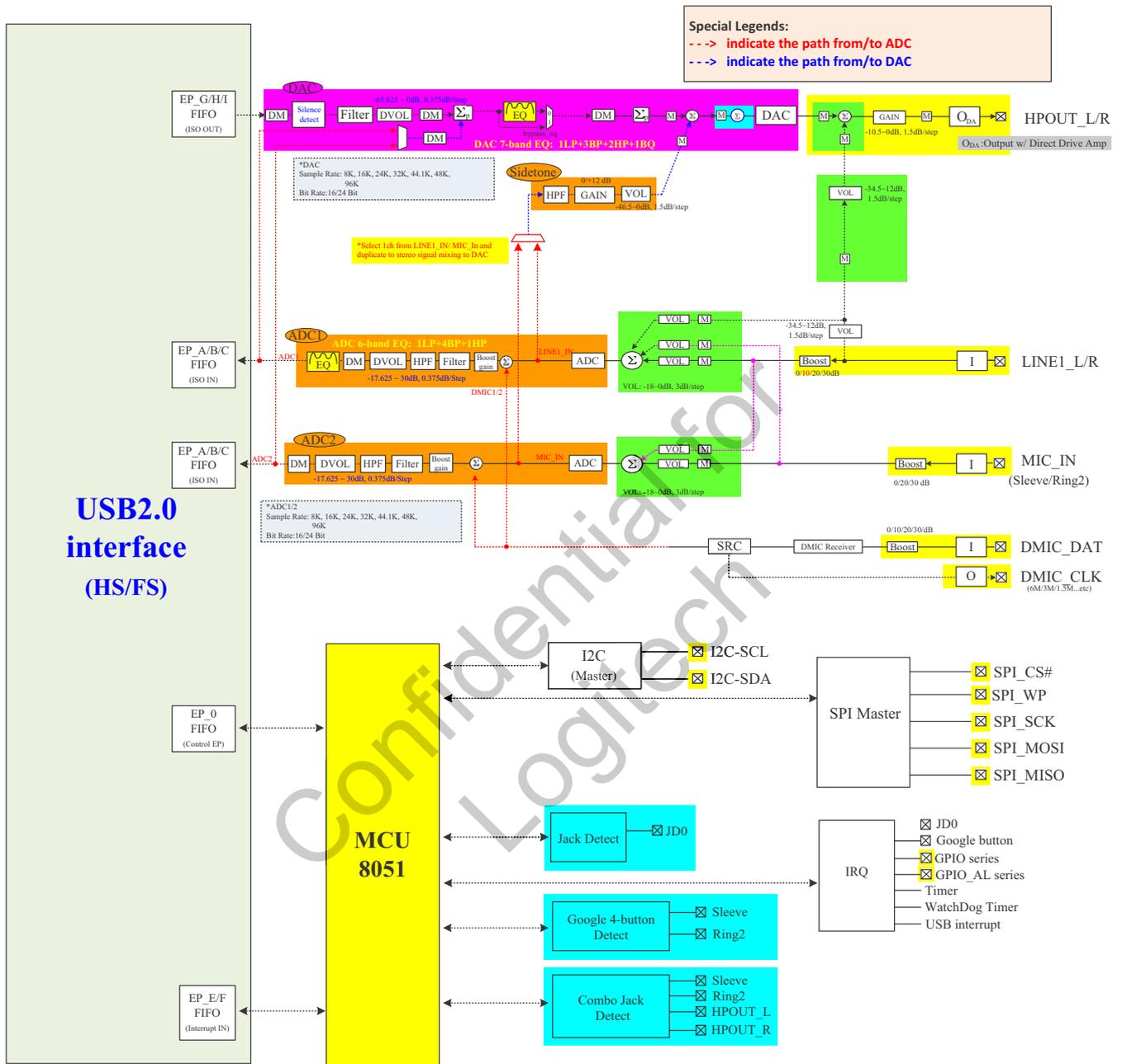
# 4. Block Diagram



Figure 1. Block Diagram

# 5. Pin Assignments

## 5.1. Pin Assignments Figure
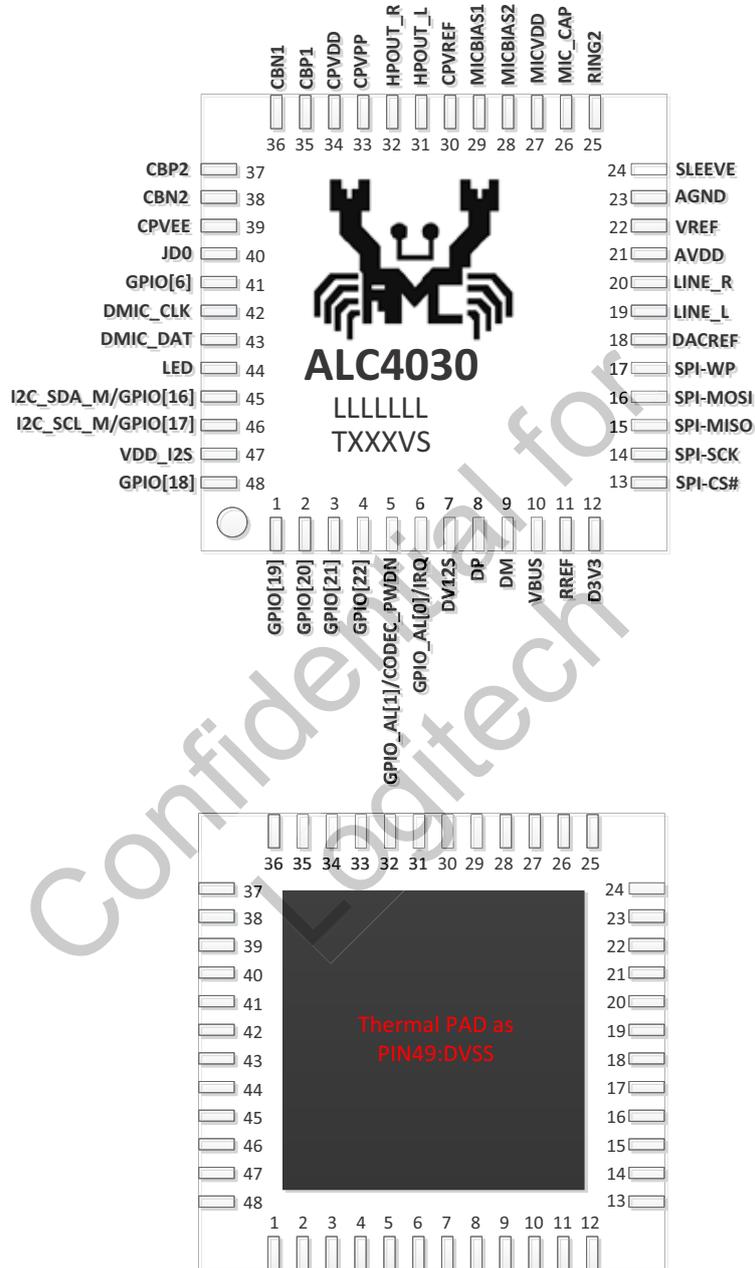


**Figure 2.    Pin Assignments**

## 5.2. Package and Version Identification

Green package is indicated by a 'G' in the location marked 'T' in 'TXXXVS' in Figure 2.

# 6.    Pin Descriptions

## 6.1.   I/O Type Description

Table 1.    I/O Type Description

| I/O Type | Description |
|---|---|
| I | Input |
| O | Output |
| IH | Input with internal pull-up 200K |
| IL | Input with internal pull-down 200K |
| IO | Input/Output |
| IOH | Input/Output with internal pull-up 200K |
| IOL | Input/Output with internal pull-down 200K |
| IOSH | Input/Output with Schmitt trigger |
| IO-U | USB related IO |
| CLK | Clock related IO |
| PWR-O | Power output pin |
| PWR-I | Power input pin |
| GND | Ground related pin |

## 6.2.   USB Transceiver Interface

Table 2.    USB Transceiver Pins

| Name | Type | Pin No. | Description |
|---|---|---|---|
| DP | IO-U | 8 | USB D+ signal |
| DM | IO-U | 9 | USB D- signal |
| RREF | - | 11 | External Reference. Requires 1% precision 6.25k/6.2k resistor to ground |
| - | | | Total: 3 Pins |

## 6.3.  GPIO, SPI Serial Flash, DMIC Interface

**Table 3.    GPIO, SPI Serial Flash, DMIC Interface**

| Name | Type | Pin No. | Description |
|---|---|---|---|
| GPIO_AL[1] /Codec_PWDN | IO | 5 | General purpose input and output; operates even in USB suspend mode |
| GPIO_AL[0] /IRQ | IO | 6 | General purpose input and output; operates even in USB suspend mode |
| SPI-WP# | O | 17 | SPI serial flash write protected |
| SPI-MOSI | O | 16 | Serial data in to internal flash |
| SPI-MISO | I | 15 | Serial data out from internal flash |
| SPI-SCK | O | 14 | Clock signal to internal flash |
| SPI-CS# | O | 13 | Chip select to internal flash |
| LED | O | 44 | LED controller |
| DMIC_DAT | I | 43 | DMIC clock |
| DMIC_CLK | O | 42 | Secondary DMIC data |
| GPIO[6] | IO | 41 | General purpose input and output |
| JD0 | I | 40 | Jack detection |
| - | | | Total: 12 Pins |

## 6.4.  I2C Interface

**Table 4.    I2C Interface**

| Name | Type | Pin No. | Description |
|---|---|---|---|
| I2C_SDA_M /GPIO[16] | IO | 45 | I2C Bus Data – Master /General purpose input and output |
| I2C_SCL_M /GPIO[17] | IO | 46 | I2C Bus clock– Master /General purpose input and output |
| - | | | Total: 2 Pins |

## 6.5.  GPIO Interface

**Table 5.    I2S Interface**

| Name | Type | Pin No. | Description |
|---|---|---|---|
| GPIO[19] | IO | 1 | General purpose input and output |
| GPIO[20] | IO | 2 | General purpose input and output |
| GPIO[21] | IO | 3 | General purpose input and output |
| GPIO[22] | IO | 4 | General purpose input and output |
| GPIO[18] | IO | 48 | General purpose input and output |
| - | | | Total: 5 Pins |

Note: when GPIO[16] and GPIO[17] are for I2C function, which GPIO[18] ~ GPIO[22] can't support GPIO function.

## 6.6. Analog I/O Pins

**Table 6.    Analog I/O Pads**

| Name | Type | Pin No. | Description | Characteristic Definition |
|---|---|---|---|---|
| RING2 | I | 25 | Combo jack microphone input | Analog input |
| SLEEVE | I | 24 | Combo jack microphone input | Analog input |
| LINE_L | I | 19 | Line input left channel | Analog input |
| LINE_R | I | 20 | Line input right channel | Analog input |
| HPOUT_R | O | 32 | Headphone output Right channel | Analog output |
| HPOUT_L | O | 31 | Headphone output Left channel | Analog output |
| - | | | Total: 6 Pins | |

## 6.7. Filter/Reference

**Table 7.    Filter/Reference Pads**

| Name | Type | Pin No. | Description | Characteristic Definition |
|---|---|---|---|---|
| VREF | - | 22 | Analog I/O reference voltage | 4.7uF Capacitor to analog ground |
| CPVREF | - | 30 | Analog I/O reference voltage | Connected to analog ground |
| MICBIAS1 | O | 29 | MIC BIAS Voltage output | Programmable Analog DC output |
| MICBIAS2 | O | 28 | MIC BIAS Voltage output | Programmable Analog DC output |
| MIC_CAP | - | 26 | Microphone input reference voltage | 10uF Capacitor to analog ground |
| DACREF | - | 18 | DAC/ADC reference voltage | 4.7uF Capacitor to analog ground |
| CBN1 | - | 36 | Charge pump Bucket Capacitor | 2.2µF capacitor to CPN1 |
| CBP1 | - | 35 | Charge pump Bucket Capacitor | 2.2µF capacitor to CPP1 |
| CBN2 | - | 38 | Charge pump Bucket Capacitor | 2.2µF capacitor to CPN2 |
| CBP2 | - | 37 | Charge pump Bucket Capacitor | 2.2µF capacitor to CPP2 |
| - | | | Total: 10 Pins | |

## 6.8. Power/Ground

**Table 8.    Power/Ground Pins**

| Name | Type | Pin No. | Description |
|---|---|---|---|
| DV12S | PWR-O | 7 | Regulated 1.2V output for core power |
| D3V3 | PWR-O | 12 | 3.3V power output from integrated VBUS-to-3.3V regulator and I/O interface |
| VBUS | PWR-I | 10 | USB bus 5.0V power input for integrated multiple regulators. This power pin can accept 3.3V of USB power input for 3.3V system |
| VDD_I2S | PWR-O | 47 | VDD_I2S for companion I2S IO power |
| AVDD | PWR-O | 21 | Analog power |
| CPVPP | PWR-O | 33 | Charge Pump Positive Voltage Output |
| CPVDD | PWR-O | 34 | Charge Pump Voltage Output |
| CPVEE | PWR-O | 39 | Charge Pump Negative Voltage Output |
| MICVDD | PWR-O | 27 | Microphone bias power |
| AGND | GND | 23 | Analog ground |
| - | | | Total: 10 Pins |

# 7. Electrical Characteristics

## 7.1. Absolute Maximum Ratings

**Table 9. Absolute Maximum Ratings**

| Parameter | Symbol | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|
| Power Supplies<br>  Digital Power | VBus | -0.3 | 5.0 | 5.5 | V |
| Ambient Operating Temperature | Ta | 0 | - | +70 | $^{o}$C |
| Storage Temperature | Ts | -40 | - | +125 | $^{o}$C |
| **ESD (Electrostatic Discharge)** | | | | | |
| - | Susceptibility Voltage | | | | |
| All Pins | Pass 2500V | | | | |

## 7.2. Recommended Operation Condition

**Table 10. Operation Condition**

| Symbol | Description | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| VBus | Supply Voltage | 4.5 | 5 | 5.5 | V |

## 7.3. DC Characteristics

**Table 11. DC Characteristics**

| Symbol | Description | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $V_{IH}$ | Input Voltage High | 2 | - | 3.3 | V |
| $V_{IL}$ | Input Voltage Low | -0.5 | - | 0.8 | V |
| $V_{OH}$ | Output Voltage High | 2.4 | - | - | V |
| $V_{OL}$ | Output Voltage Low | - | - | 0.4 | V |
| $I_{OH}$ | Output Current High | - | - | 4 | mA |
| $I_{OL}$ | Output Current Low | - | - | 4 | mA |

## 7.4. Analog Performance

Standard Test Conditions

Tambient=25°C, VBUS=5.0V ±5%

1kHz input sine wave; Sampling frequency=48kHz; 0dB=1Vrms

10KΩ/50pF load; Test bench Characterization BW: 20Hz~22kHz

**Table 12.  Analog Performance**

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Full-Scale Input Voltage | | | | |
| All ADC (Gain=0dB) | - | 0.6 | - | Vrms |
| Line Input | | 0.6 | | |
| MIC Input | | 0.6 | | |
| Full-Scale Output Voltage | - | | - | |
| All DAC (Gain=0dB) | - | 1.0 | - | |
| Headphone Out @10KΩ load | - | 1.0 | - | Vrms |
| Headphone Out @32Ω load | - | 1.0 | - | |
| Headphone Out @16Ω Load | - | 0.9 | - | |
| SNR (A Weighted) | | | | |
| ADC | - | 94 | - | |
| DAC | - | 95 | - | |
| Headphone Out @16Ω Load | - | 95 | - | dB FSA |
| Headphone Out @32Ω Load | - | 95 | - | |
| MIC_IN to Stereo ADC with 0dB | - | 93 | - | |
| LINE_IN to stereo ADC with 0dB | - | 93 | - | |
| Total Harmonic Distortion Plus Noise, THD+N | | | | |
| ADC | - | -84 | - | |
| DAC | - | -85 | - | dB FS |
| Headphone Out @16Ω Load | - | -81 | - | |
| Headphone Out @32Ω Load | - | -81 | - | |
| Frequency Response | | | | |
| ADC (-3dB lower edge, -1dB higher edge) | 10 | - | 0.454*Fs | Hz |
| DAC (-3dB lower edge, -1dB higher edge) | 10 | - | 0.454*Fs | |
| Crosstalk | - | -80 | - | dB |
| Current consumption @ Idle(only for HID without Audio) | - | 30 | - | mA |
| Current consumption @ Active(*1) | - | 45 | - | mA |
| Current consumption @ Suspend | - | 490 | - | µA |

*Note: FSA=Full-Scale with A-weighting filter. FS=Full-Scale.*

*Note 1: only DAC to headphone out@32ohm 1mW output power*

# 8.  Mechanical Dimensions

## 8.1.  Mechanical Dimensions – QFN 48 6x6mm Outline
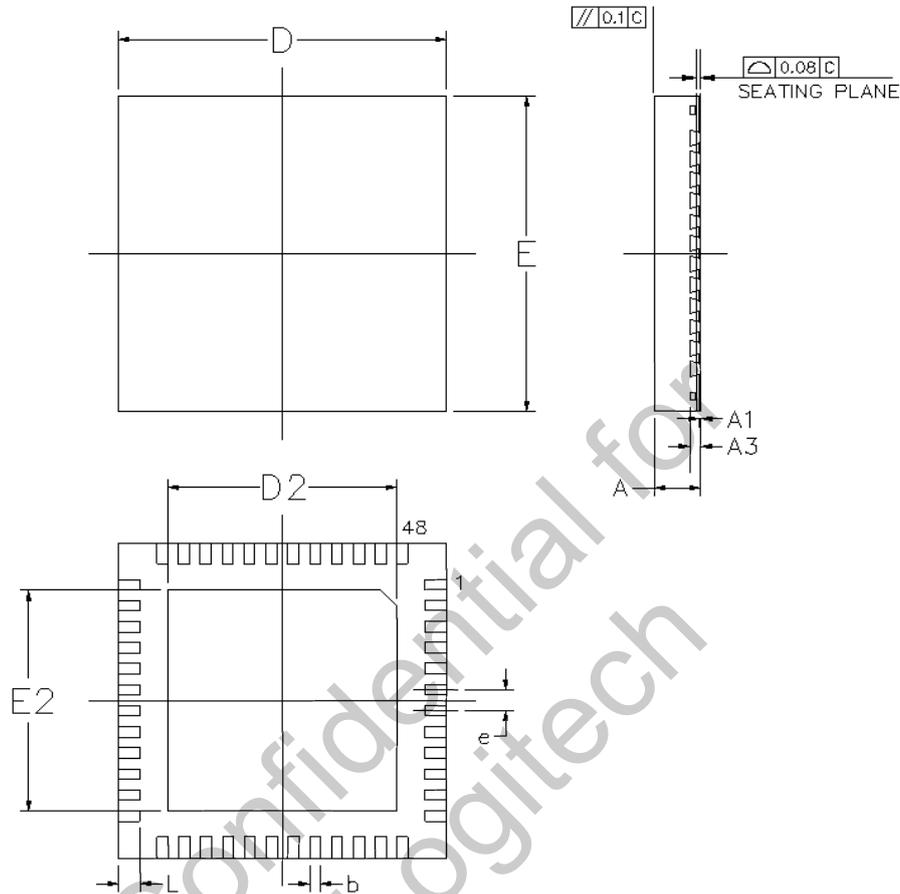


## 8.2.  Mechanical Dimensions Notes

| Symbol | Dimension in mm | | | Dimension in inch | | |
|---|---|---|---|---|---|---|
| | Min | Nom | Max | Min | Nom | Max |
| A | 0.75 | 0.85 | 1.00 | 0.030 | 0.034 | 0.039 |
| A₁ | 0.00 | 0.02 | 0.05 | 0.000 | 0.001 | 0.002 |
| A₃ | 0.20 REF | | | 0.008 REF | | |
| b | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 |
| D/E | 6.00BSC | | | 0.236BSC | | |
| D2/E2 | 4.15 | 4.4 | 4.65 | 0.163 | 0.173 | 0.183 |
| e | 0.40BSC | | | 0.016BSC | | |
| L | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |

Notes: CONTROLLING DIMENSION: MILLIMETER (mm).
REFERENCE DOCUMENT: JEDEC MO-220

# 9.    Application Circuits

To guarantee the best compatibility and performance quality in hardware design with specific requirements, please contact Realtek to receive the latest application circuits. Any modification made to the reference circuits is recommended to be reviewed by Realtek. Realtek may update the latest application circuits without modifying this datasheet.

# 10.    Ordering Information

### Table 13.    Ordering Information

| Part Number | Package | Status |
|---|---|---|
| ALC4030-CG | MQFN-48 'Green' Package (6mm x 6mm) | MP |
| ALC4030-CGT | MQFN-48 'Green' Package (6mm x 6mm) | MP |

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