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| --- | --- |
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# CH2601 数据手册

芯片开放社区
Open Chip Community

# 目录

# 一 概述

CH2601 是基于平头哥 32 位玄铁 CPU E906 的 RISC-V 生态芯片，它配置 512KB Flash，256KB SRAM 及丰富的片上外设，最高主频 220MHz，支持 AliOS Things 物联网操作系统、平头哥 YoC 软件平台及平头哥剑池开发工具(CDK)。

# 二 主要功能概述

- **CPU**
  - 32 位 CPU 玄铁 E906
  - 支持 48 个可嵌套中断源
- **存储资源**
  - 512KB XIP Flash
  - 64KB(DSRAM)+64KB(DSRAM)+64KB(DSRAM)+32KB(ISRAM)+32KB(ISRAM)
  - 8KB BOOTROM
  - 1KB EFuse
- **外设及特性**
  - **DMAC**
    - 8 通道
    - 8 硬件触发源
    - 支持单次/组合/区块不同的触发模式
  - **RTC**
    - 32 位计数器
    - 可产生中断
  - **PWM**
    - 12 输出/捕获通道
    - 6 组 PWM 发生器，每组配置 1 个 16 位计数器，2 个 PWM 比较器，1 个中断产生器
    - 每组 PWM 发生器包括 2 通道输出信号
    - 输入时钟分频系数支持 1, 2, 4, 8, 16, 32, 64 or 128
    - 每路 PWM 信号可单独使能/禁止

- 每路 PWM 输出信号极性可配置
- 16 位 PWM 计数器支持上升/下降技术模式
- 支持边缘捕获模式
- 可触发 ADC 采样

- **32 位看门狗计数器**
- **USB1.1 Device**
- **GPIO**
  - 每个 GPIO 可产生中断
  - 每个 GPIO 可单独配置上下拉
- **7 路 II2S**
- **12bit ADC**
  - 最高采样速率 2MSPS
  - 采样电压输入范围：AGND ≤ Vin ≤ AVDD
  - 支持单次采样、连续采样及外部信号触发采样模式
  - 采样结束可产生中断、可触发 DMA 传输
- **4 路 32 位定时器**
- **2 路 SPI 串行接口**
  - 支持主/从模式
  - 可触发 DMA 传输
- **1 路 I2C 串行接口**
  - 支持主/从模式
  - 可触发 DMA 传输
- **2 路 UART 串行接口**
  - 可触发 DMA 传输

- **复位电路**
  - **外部复位电路**
  - **看门狗复位**
  - **上电复位**
  - **掉电复位**
  - **CPU 软复位**
- **物理特性**
  - **SMIC 55nm ULL 生产工艺**
  - **220MHz 主频**

# 三 存储器及外设地址引射

## 3.1 存储器地址映射

Table 3-1 存储器地址映射表

| Address Range | Size | Usage |
|---|---|---|
| 0x0000_0000~0x0000_1FFF | 8KB | ROM for boot |
| 0x0800_0000~0x0800_FFFF | 64KB | Internal SRAM |
| 0x1800_0000~0x1FFF_FFFF | 128MB | QSPI0 |
| 0x2000_0000~0x2002_FFFF | 192KB | Internal SRAM |
| 0x4000_0000~0x4003_0FFF | 196KB | AHB Peripherals |
| 0x5000_0000~0x5004_FFFF | 320KB | APB0 Peripherals |
| 0x5005_0000~0x5FFF_FFFF | 256MB-320KB | Reserved |
| 0x6000_0000~0x6004_FFFF | 320KB | APB1 Peripherals |
| 0x6005_0000~0x6FFF_FFFF | 256MB-320KB | Reserved |
| 0x7000_0000~0x7FFF_FFFF | 256MB | Reserved |
| 0x8000_0000~0xAFFF_FFFF | 768MB | Bit Banding Controller |
| 0xB000_0000~0xDFFF_FFFF | 768MB | Reserved |
| 0xE000_0000~0xE000_DFFF | 56KB | Reserved |
| 0xE000_E000~0xE000_EFFF | 4KB | TCIP |
| 0xE000_F000~0xFFFF_FFFF | 512MB-60KB | Reserved |

## 3.2 外设地址映射

Table 3-2 外设地址映射表

| 地址范围 | IP 名 | 大小 | 描述 |
|---|---|---|---|
| AHB | | | |
| 0x0000_0000~0x0000_1FFF | ROM | 8KB | ROM |
| 0x0000_2000~0x0FFF_FFFF | - | 256MB-8KB | Reserved |
| 0x0800_0000~0x0800_7FFF | ISRAM0 | 32KB | Internal Inst SRAM |
| 0x0800_8000~0x0800_FFFF | ISRAM1 | 32KB | Internal Inst SRAM |

| | | | |
|---|---|---|---|
| 0x1000_0000~0x17FF_FFFF | - | 128MB | Reserved |
| 0x1800_0000~0x1FFF_FFFF | SUB1/QSPIC0 | 128MB | SUB1/QSPI0 MEM |
| 0x2000_0000~0x2000_FFFF | DSRAM0 | 64KB | Internal data SRAM |
| 0x2001_0000~0x2001_FFFF | DSRAM1 | 64KB | Internal data SRAM |
| 0x2002_0000~0x2002_FFFF | DSRAM2 | 64KB | Internal data SRAM |
| 0x2001_0000~0x3FFF_FFFF | - | 512MB-64KB | Reserved |
| 0x4000_0000~0x4000_0FFF | PMU | 4KB | Power Management |
| 0x4000_1000~0x4000_1FFF | DMA0 | 4KB | DMA0 Controller |
| 0x4000_1000~0x4003_FFFF | - | 256KB-8KB | Reserved |
| 0x4004_0000~0x4004_0FFF | USB | 4KB | USB |
| 0x4004_1000~0x4FFF_FFFF | - | 256MB-260KB | Reserved |
| 0x5000_0000~0x5004_FFFF | APB0 | 256KB | APB0 |
| 0x5005_0000~0x5FFF_FFFF | - | 256MB-256KB | Reserved |
| 0x6000_0000~0x6004_FFFF | APB1 | 256KB | APB1 |
| 0x6005_0000~0x7FFF_FFFF | - | 512MB-256KB | Reserved |
| 0x8000_0000~0xAFFF_FFFF | BBC | 512MB | Bit Banding Controller |
| 0xB000_0000~0xDFFF_FFFF | - | 768MB | Reserved |
| 0xE000_0000~0xE000_DFFF | - | 56KB | Reserved |
| 0xE000_E000~0xE000_EFFF | TCIP | 4KB | TCIP |
| 0xE000_F000~0xFFFF_FFFF | - | 512MB-60KB | Reserved |
| SUB1 | | | |
| 0x1800_0000~0x1FFF_FFFF | QSPIC0 | 128MB | QSPI MEM |
| APB0 | | | |
| 0x5000_0000~0x5000_03FF | TIM0 | 1KB | Timer 0 |
| 0x5000_0400~0x5000_07FF | TIM1 | 1KB | Timer 1 |
| 0x5000_0800~0x5000_3FFF | - | 14K | Reserved |
| 0x5000_4000~0x5000_43FF | RTC | 1KB | Real Time Clock |
| 0x5000_4400~0x5000_7FFF | - | 15K | Reserved |
| 0x5000_8000~0x5000_83FF | WDT | 1KB | Watch Dog |
| 0x5000_8400~0x5000_BFFF | - | 15KB | Reserved |

| | | | |
|---|---|---|---|
| 0x5000_C000~0x5000_C3FF | SPI0 | 1KB | SPI0 |
| 0x5000_C400~0x5000_FFFF | - | 15KB | Reserved |
| 0x5001_0000~0x5001_03FF | UART0 | 1KB | UART 0 |
| 0x5001_0800~0x5001_3FFF | - | 15KB | Reserved |
| 0x5001_4000~0x5001_43FF | I2C0 | 1KB | I2C 0 |
| 0x5001_4400~0x5001_7FFF | - | 15KB | Reserved |
| 0x5001_8000~0x5001_83FF | GPIO0 | 1KB | GPIO0 |
| 0x5001_8400~0x5001_BFFF | - | 15KB | Reserved |
| 0x5001_C000~0x5001_C3FF | PWM | 1KB | PWM |
| 0x5001_C400~0x5002_BFFF | - | 63KB | Reserved |
| 0x5002_C000~0x5002_C3FF | QSPIC0 | 1KB | QSPIC0 |
| 0x5002_C400~0x5003_7FFF | - | 47KB | Reserved |
| 0x5003_8000~0x5003_83FF | PWMR | 1KB | PWMR |
| 0x5003_8400~0x5003_BFFF | - | 15KB | Reserved |
| 0x5003_C000~0x5003_C3FF | EFUSE | 1KB | EFUSE |
| 0x5003_C400~0x5003_FFFF | - | 15KB | Reserved |
| 0x5004_0000~0x5004_03FF | I2S0 | 1K | I2S0 |
| 0x5004_0400~0x5004_07FF | I2S1 | 1K | I2S1 |
| 0x5004_0800~0x5002_3FFF | Reserved | 15K | Reserved |
| APB1 | | | |
| 0x6000_0000~0x6000_03FF | TIM2 | 1KB | Timer 2 |
| 0x6000_0400~0x6000_07FF | TIM3 | 1KB | Timer 3 |
| 0x6000_1000~0x6000_3FFF | - | 14KB | Reserved |
| 0x6000_C000~0x6000_C3FF | SPI1 | 1KB | SPI1 |
| 0x6000_C400~0x6000_FFFF | - | 15KB | Reserved |
| 0x6001_0000~0x6001_03FF | UART1 | 1KB | UART 1 |
| 0x6001_0800~0x6001_3FFF | - | 15KB | Reserved |
| 0x6001_4000~0x6001_40FF | I2S4 | 1KB | Reserved |
| 0x6001_4100~0x6001_41FF | I2S5 | 1KB | Reserved |

| | | | |
|---|---|---|---|
| 0x6001_4200~0x6001_42FF | I2S6 | 1KB | Reserved |
| 0x6001_4400~0x6001_7FFF | - | 15KB | Reserved |
| 0x6002_0000~0x6002_03FF | ADC | 1KB | AD converter |
| 0x6002_0400~0x6002_3FFF | - | 15KB | Reserved |
| 0x6002_4000~0x6002_43FF | ETB | 1KB | Event Trigger Block |
| 0x6002_4400~0x6002_7FFF | - | 15KB | Reserved |
| 0x6003_0000~0x6003_03FF | IOCTL | 1KB | IO Ctrl |
| 0x6003_0400~0x6003_43FF | - | 16KB | Reserved |
| 0x6004_0400~0x6004_07FF | I2S2(CODEC) | 1K | I2S2(CODEC) |
| 0x6004_0800~0x6004_0BFF | I2S3(CODEC) | 1K | I2S3(CODEC) |
| 0x6004_0C00~0x6004_3FFF | Reserved | 13K | Reserved |
| 0x6004_4000~0x6004_43FF | CODEC | 1K | CODEC(dummy) |
| 0x6004_4400~0x6004_7FFF | Reserved | 15K | Reserved |

## 3.3 TCIP 地址映射

Table 3-3 TCIP **地址映射表**

| Address Range | TCIP Name |
|---|---|
| 0xE000E010~0xE000E0FF | Core Timer |
| 0xE000E100~0xE000ECFF | Vector Interrupt Controller(VIC) |

# 四 芯片中断源

Table 3-1 CH2601 **中断源**

| Number | Interrupt Source |
|---|---|
| 0 | GPIO0 |
| 1 | CoreTim |
| 2 | TIM0-0 |
| 3 | TIM0-1 |
| 4 | REV |
| 5 | WDT |

| | |
|---|---|
| 6 | UART0 |
| 7 | UART1 |
| 8 | USB |
| 9 | I2C0 |
| 10 | I2C1 |
| 11 | SPI1 |
| 12 | SPI0 |
| 13 | RTC |
| 14 | I2S0 |
| 15 | ADC |
| 16 | I2S1 |
| 17 | DMA0 |
| 18 | PMU |
| 19 | PWM |
| 20 | PWMR |
| 21 | I2S2 |
| 22 | I2S3 |
| 23 | TIM1-0 |
| 24 | TIM1-1 |
| 25 | QSPIC0 |
| 26 | TIM2-0 |
| 27 | TIM2-1 |
| 28 | TIM3-0 |
| 29 | TIM3-1 |
| 30 | USBPHY |
| 31 | Wake up request |

# 五 时钟和复位

CH2601 时钟相关的管脚说明如下

Table 5-1 CH2601 **外部时钟**

| Clock | I/O | Pin Name | Freq(Hz) |
|---|---|---|---|
| 外部高速晶体时钟 | I | EHSCCLK | 12M~16M |
| 外部低速晶体时钟 | I | ELSCCLK | 32.768K |
| JTAG 时钟 | I | TCLK | <10M |
| I2C 时钟 | I/O | I2C0_CLK | 4M(Max) |
| SPI 主机时钟 | O | SPIM_CLK | <1/2 pclk |
| SPI 从机时钟 | I | SPIS_CLK | <1/10 Fpclk |

由上述时钟源驱动的内部时钟如下

Table 5-2 CH2601 **内部时钟**

| 时钟源 | 描述 | 频率 |
|---|---|---|
| EHS | External high speed clock | 12M~16M |
| IHS | Internal high speed clock | 48M |
| USBPHY CLK | USBPHY generate clock | 12M |
| ILS | Internal low speed clock | 32.768K |
| ELS | External low speed clock | 32.768K |
| PLL clock | Generated by PLL clock | 300M (Max) |
| CPU clock | Generated by HS clock | 220M (Max) |
| AHB clock | Generated by CPU clock | 220M (Max) |
| APB 0 clock | Generated by CPU clock | 110M (Max) |
| APB 1 clock | Generated by CPU clock | 110M (Max) |
| RTC clock | Driven by ELS clock | 1Hz |
| Coretim clock | Driven by MCLK | 220M (Max) |
| ADC clock | Driven by APB0 clock | APB0 clock |
| I2S clock | Driven by MCLK | 300M(MAX) |

CH2601 芯片内部复位及外部复位说明如下

Table 5-3 CH2601 **外部复位管脚**

| Reset | I/O | Pin Name | Description |
|---|---|---|---|
| 外部复位 | 输入 | MCURST | 系统复位，低电平有效 |

Table 5-4 CH2601 **内部复位管脚**

| 复位源 | 描述 |
|---|---|
| IP software reset | Software reset for function IP, generated by PMU |
| Low power reset | Reset power down domain, generated by low power mode |
| CPU software reset | Reset all chip, generated by CPU |
| WDT reset | Reset all chip, generated by WDT time out |
| POR reset | Reset all chip, generated by chip power on |
| BOD reset | Reset all chip, generated by chip voltage instability |

# 六 电气特性

## 6.1 极限参数

Table 6-1 CH2601 极限电气参数

| 参数 | 最小值 | 典型值 | 最大值 | 单位 |
|---|---|---|---|---|
| 内核电压 | - | 1.32 | - | V |
| 端口电压 | 2.9 | 3.3 | 3.6 | V |
| 工作温度范围 | -40 | 25 | 85 | °C |
| 贮存温度范围 | -40 | 25 | 125 | °C |

## 6.2 电气规格

测试条件（除特别注明外）：CPU 主频 = 196.608MHz，环境温度（Ta）=25℃。

### 6.2.1 模拟性能规格

电源供电 VDD = 3.3V

Table 6-2 CH2601 模拟性能规格表

| 测试项 | 参数 | 测试条件/描述 | Min | Typ | Max | 单位 |
|---|---|---|---|---|---|---|
| VDD 总功耗 | 正常工作模式 | Run | - | 40 | - | mA |
| LDO | AONLDO/PDLDO 输出电压 | 1.2V 模式 | - | 1.2 | - | V |
| | AONLDO 电流输出能力 | 1.2V 模式（drop 5%） | - | - | 10 | mA |
| | PDLDO 电流输出能力 | 1.2V 模式（drop 5%） | - | - | 70 | mA |
| | NRST VIL | 3.3V 供电 | - | 1.83 | - | V |
| | NRST VIH | 3.3V 供电 | - | 1.83 | - | V |

### 6.2.2 晶振放大器规格

电源供电 VDD = 3.3V

Table 6-3 CH2601 晶体规格

| 测试项 | 测试条件/描述 | 最小 | 典型 | 最大 | 单位 |
|---|---|---|---|---|---|
| 频率范围 | | - | 12 | - | MHz |
| 负载电容（根据晶振推荐值） | | - | 22pF | - | pF |

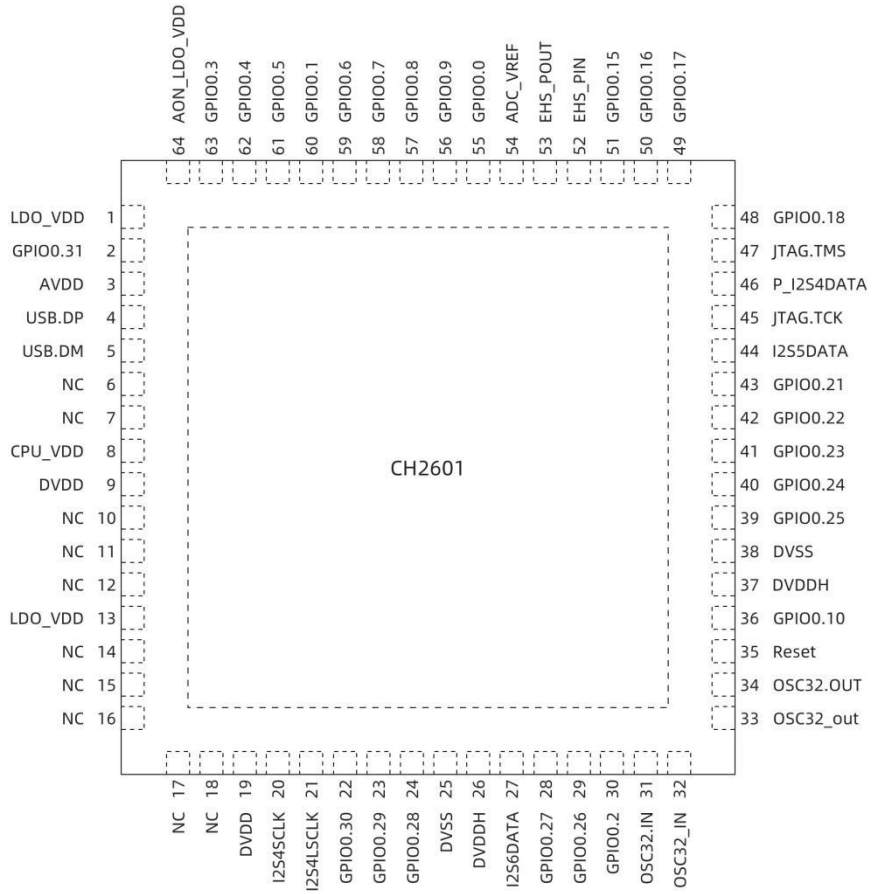
### 6.2.3 GPIO 输入输出规格

电源供电 VDD = 3.3V

Table 6-4 CH2601 GPIO **电气特性**

| 测试项 | 参数 | 测试条件/描述 | 典型值 | 单位 |
|---|---|---|---|---|
| GPIO | 输入低电平电压 | CMOS | 1780 | mV |
| | | Schmitt | 1720 | |
| | 输入高电平电压 | CMOS | 1820 | mV |
| | | Schmitt | 1950 | |
| | 输入迟滞 | Schmitt | 230 | mV |
| | 灌电流驱动能力（VSS+400mV） | 4mA 配置 | 4 | mA |
| | | 12mA 配置 | 12 | mA |
| | | 20mA 配置 | 20 | mA |
| | | 28mA 配置 | 28 | mA |
| | 拉电流驱动能力（VDD-400mV） | 4mA 配置 | 4 | mA |
| | | 12mA 配置 | 12 | mA |
| | | 20mA 配置 | 20 | mA |
| | | 28mA 配置 | 28 | mA |
| | 输入高电平漏电流 | | 14 | nA |
| | 输入低电平漏电流 | | 20 | nA |
| | 上拉电阻 | 10K 配置 | 10 | KΩ |
| | | 100K 配置 | 100 | |
| | 下拉电阻 | 10K 配置 | 10 | KΩ |
| | | 100K 配置 | 100 | |
| | 翻转频率 | CPU CLK=240MHz | | MHz |

# 七 芯片管脚说明

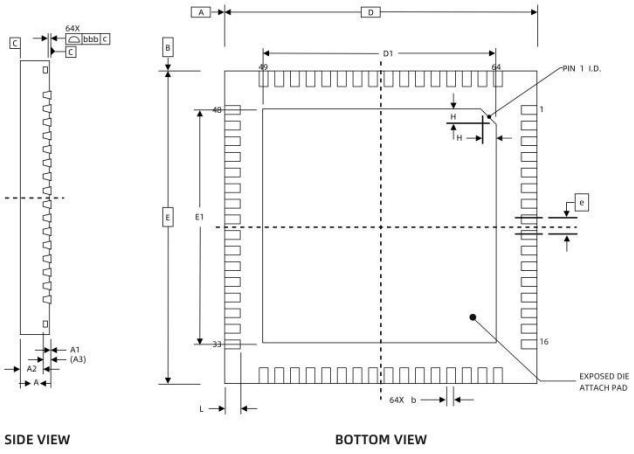



| 管脚编号 | 管脚名 | 默认功能 | 模拟功能 |
|---|---|---|---|
| 1 | LDO_VDD | | |
| 2 | PA31_I2SOSDA_PWMR_PWM8_UART0TX | GPIO0.31 | |
| 3 | AVDD | | |
| 4 | PUSB_DP (PA13_USBDP) | USB.DP | |
| 5 | PUSB_DM (PA14_USBDM) | USB.DM | |
| 6 | NC | | |
| 7 | NC | | |
| 8 | CPU_VDD | | |
| 9 | DVDD | | |
| 10 | NC | | |
| 11 | NC | | |
| 12 | NC | | |
| 13 | LDO_VDD | | |

| | | | |
|---|---|---|---|
| 14 | NC | | |
| 15 | NC | | |
| 16 | NC | | |
| 17 | NC | | |
| 18 | NC | | |
| 19 | DVDD | | |
| 20 | I2S4SCLK | | |
| 21 | I2S4LSCLK | | |
| 22 | PA30_I2S1WSCLK_UART1RTS_PWM7_SPI1MISO | GPIO0.30 | |
| 23 | PA29_I2S1SCLK_UART1CTS_PWM6_SPI1MOSI | GPIO0.29 | |
| 24 | PA28_I2S0WSCLK_UART1TX_PWM5_SPI1SCK | GPIO0.28 | |
| 25 | DVSS | | |
| 26 | DVDDH | | |
| 27 | I2S6DATA | | |
| 28 | PA27_I2S0SCLK_UART1RX_PWM4_SPI1CS | GPIO0.27 | |
| 29 | PA26_I2S1MCLK_UART0RTS_PWM3_SPI0MISO | GPIO0.26 | |
| 30 | PA2_I2S1SCLK_I2C0SCL_SPI1CS_PWM2 | GPIO0.2 | |
| 31 | PA11_OSC32IN | OSC32.IN | |
| 32 | OSC32_IN | | |
| 33 | OSC32_out | | |
| 34 | PA12_OSC32OUT | OSC32.OUT | |
| 35 | Reset | | |
| 36 | PA10_I2S0MCLK_UART0TX_SPI1MOSI_SPI1MISO | GPIO0.10 | ADC.A8 |
| 37 | DVDDH | | |
| 38 | DVSS | | |
| 39 | PA25_PWMR_UART0CTS_PWM2_SPI0MOSI | GPIO0.25 | |
| 40 | PA24_I2C0SDA_UART0RX_PWM1_SPI0SCK | GPIO0.24 | |
| 41 | PA23_I2C0SCL_UART0TX_PWM0_SPI0CS | GPIO0.23 | |
| 42 | PA22_UART0RTS_UART1RTS_I2S1SDA_I2C0SDA | GPIO0.22 | |
| 43 | PA21_UART0CTS_UART1CTS_I2S0SDA_I2C0SCL | GPIO0.21 | ADC.A15 |
| 44 | I2S5DATA | | |
| 45 | PA20_JTGTCK_UART1TX_I2S1WSCLK_I2C0SDA | JTAG.TCK | ADC.A14 |
| 46 | P_I2S4DATA | | |
| 47 | PA19_JTGTMS_UART1RX_I2S1SCLK_I2C0SCL | JTAG.TMS | ADC.A13 |
| 48 | PA18_UART0TX_SPI0MISO_I2S0WSCLK_PWM11 | GPIO0.18 | |
| 49 | PA17_UART0RX_SPI0MOSI_I2S0SCLK_PWM10 | GPIO0.17 | ADC.A11 |
| 50 | PA16_I2C0SDA_SPI0SCK_UART1TX_PWM5 | GPIO0.16 | ADC.A10 |
| 51 | PA15_I2C0SCL_SPI0CS_PWMR_PWM4 | GPIO0.15 | ADC.A9 |
| 52 | EHS_PIN | | |
| 53 | EHS_POUT | | |

| | | | |
|---|---|---|---|
| 54 | ADC_VREF | | |
| 55 | PA0_I2S0SCLK_SPI0CS_UART0RX_PWM0 | GPIO0.0 | ADC.VREFP |
| 56 | PA9_I2S1SDA_I2C0SDA_PWMR_PWM9 | GPIO0.9 | ADC.A7 |
| 57 | PA8_I2S0SDA_I2C0SCL_UART0RX_PWM8 | GPIO0.8 | ADC.A6 |
| 58 | PA7_I2S0WSCLK_PWMR_SPI1MISO_PWM7 | GPIO0.7 | ADC.A5 |
| 59 | PA6_I2S0SCLK_UART0TX_SPI1MOSI_PWM6 | GPIO0.6 | ADC.A4 |
| 60 | PA1_I2S0WSCLK_SPI0SCK_USRT0TX_PWM1 | GPIO0.1 | ADC.VREFN |
| 61 | PA5_I2S1SDA_SPI0MISO_UART1RTS_PWM5 | GPIO0.5 | ADC.A3 |
| 62 | PA4_I2S0SDA_SPI0MOSI_UART1CTS_PWM4 | GPIO0.4 | ADC.A2 |
| 63 | PA3_I2S1WSCLK_I2C0SDA_SPI1SCK_PWM3 | GPIO0.3 | ADC.A1 |
| 64 | AON_LDO_VDD | | |

# 八 封装尺寸




| FOR CUSTOMER ONLY | | | | |
|---|---|---|---|---|
| PACKAGE TYPE | QFN | | | |
| PIN COUNT | 64 | | | |
| DESCRIPTION | SYMBOL | MILLIMETER | | |
| | | MIN | NOM | MAX |
| TOTAL. THICKESS | A | 0.80 | 0.85 | 0.90 |
| STAND. OFF | A1 | – | 0.035 | 0.05 |
| MOLD THICKNESS | A2 | – | 0.65 | 0.67 |
| MATERIAL THICKNESS | A3 | – | 0.203 REF | – |
| PACKAGE SIZE | D | 7.9 | 8.0 | 8.1 |
| | E | 7.9 | 8.0 | 8.1 |
| EP SIZE | D1 | 5.9 | 6.0 | 6.1 |
| | E1 | 5.9 | 6.0 | 6.1 |
| LEAD LENGTH | L | 0.3 | 0.4 | 0.5 |
| LEAD PITCH | e | | 0.4 BSC | |
| LEAD WIDTH | b | 0.15 | 0.2 | 0.25 |
| LEAD POSITION OFFSET | aaa | | 0.07 | |
| LEAD COPLANARITY | bbb | | 0.08 | |
| PACKAGE EDGE PROFILE | ccc | | 0.1 | |
| MOLD FLATNESS | ddd | | 0.1 | |
| EP POSITION OFFSET | eee | | 0.1 | |
| | fff | | 0.05 | |
| PIN 1 DIMENSION | H | | 0.35 REF | |