# 10路LED驱动器和GPIO控制器

## 10-CHANNEL LED DRIVER AND GPIO CONTROLLER

## ■ FEATURES

・Power supply range : 2.5V~5.5V

・10 multifunctional IOs, capable of LED driving (current-source dimming) or GPIO

・256 steps linear dimming in LED mode

・Any IO can be configured as an input or an output independently

・Interrupt function, 8μs deglitch, active low

・Standard I²C interface, 4 programmable device addresses

・1.8V/3.3V logic input (SDA, SCL, RSTN, IO)

・Shutdown function, active low

・Support 2 intelligent breathing mode: blinking and fading, breathing time is adjustable

・Pb-free Packages, QFN3×3-20L

・供电范围：2.5V~5.5V

・10个多功能IO，支持LED驱动或GPIO（电流源调光）

・LED模式下具有256阶线性调光

・任意IO可配置为独立的输入或输出

・中断功能，8μs防抖，低电平有效

・标准I2C接口，4个I2C器件地址可选

・支持1.8V/3.3V逻辑电平(SDA, SCL, RSTN, IO)

・具有关断功能，低电平有效

・支持两种智能呼吸模式: Blinking模式和Fading模式，呼吸时间可调，智能呼吸模式节省主控芯片功耗

・QFN3×3-20L，无铅封装

## ■ APPLICATIONS

・Cell Phone　　　　・Speakers

・Other Consumer electronics

・手机　　　　　・音箱

・其他消费类电子产品

## ■ DESCRIPTION

HTR3310 is a 10 multifunctional LED driver and GPIO controllerwith2.5V~5.5V power supply. Any of the 10 IOs can be configured as LED mode or GPIO mode. Meanwhile, any GPIO can be configured as an input or an output independently.

After power on, all the 10 IOs are configured as GPIO output as default, and their default states are decidedby AD0 and AD1. When the IOs are configured as inputs, they are continuously monitored for state changes with 8μs deglitch. State changes are indicated at the INTN output. Oncethe GPIO state are read through the I²C interface, the INTN output is cleared.

When the IOs are configured as LED mode, the LED driver's current, divided by 256 steps linear dimming, can be set between 0~$I_{MAX}$ by I²C interface. The default maximum current ($I_{MAX}$) is 37mA, and $I_{MAX}$ can be changed in GloCTL register.

HTR3310 supports breathing function to implement different lighting effects in a much easier way with two modes: blinking mode and fading mode.

HTR3310 is available in QFN3×3-20L package.

HTR3310是一款10路多功能LED驱动器和GPIO控制器,2.5V~5.5V电源供电。10个IO端口中的任何一个都可以配置为LED模式或GPIO模式。此外，任何GPIO都可以单独配置为输入或输出。

通电后，10个IO端口配置默认为GPIO输出，默认状态根据AD0和AD1决定。所有配置为输入的IO端口都会持续监控状态变化，并具有8μs的防抖动时间，IO口的变化由INTN输出指示。当GPIO状态通过I²C接口被读取时，INTN输出被清除。

当IO端口配置为LED模式时，可以通过I²C接口将LED驱动器的电流设置在0~$I_{MAX}$之间，并可以以该值除以256步进行线性调光。默认最大电流（$I_{MAX}$）为37mA，可在全局在控制寄存器中更改$I_{MAX}$。
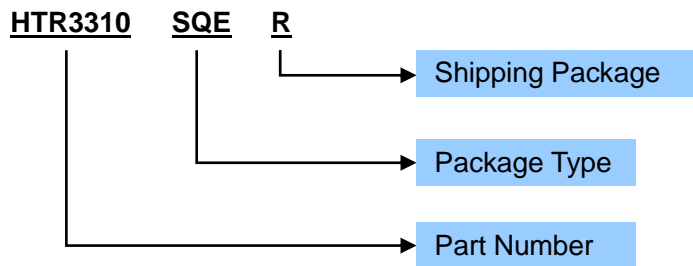
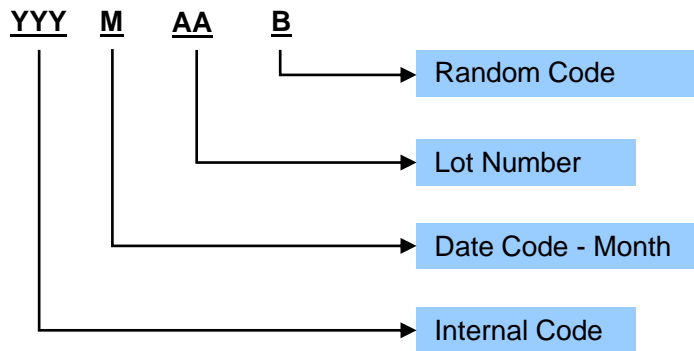HTR3310支持breathing功能，使其实现灯效变得更为容易，其有两种模式:blinking模式和fading模式。

HTR3310提供QFN3×3-20L封装

■ **ORDERING INFORMATION**

| Part Number | Package Type | Marking | Operating Temperature Range | Shipping Package / MOQ |
|---|---|---|---|---|
| HTR3310SQER | QFN3×3-20L (SQE) | HTR3310 YYYMAAB[1] | -40℃～85℃ | Tape and Reel (R) 5000PCS |

**Part Number**

HTR3310　　SQE　　R

→ Shipping Package

→ Package Type

→ Part Number

**Production Tracking Code**

YYY　M　AA　B

→ Random Code

→ Lot Number

→ Date Code - Month

→ Internal Code

■ **TYPICAL APPLICATION**
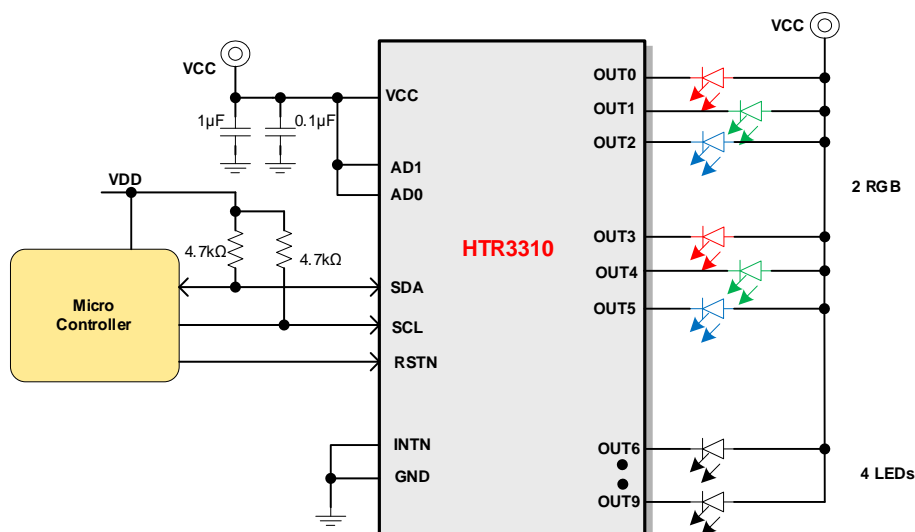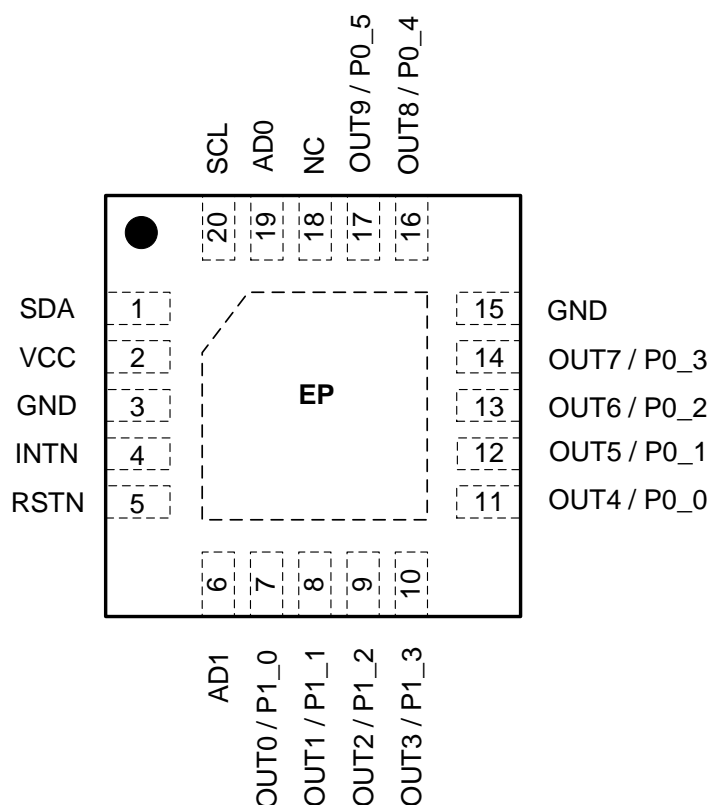


Once the LED anode is pulled to VCC, AD1 and AD0 terminals must be pulled to VCC to ensure that the default value of GPIO after POWER ON is High or Hi-Z so that the LEDsare not working unexpectedly. The default value of GPIO after POWER ON is decided by AD1 and AD0 terminals (see table 1).

当LED的阳极接VCC时，需将芯片的AD1/AD0接VCC，确保GPIO的上电默认状态为高或高阻，从而LED不会意外工作。GPIO的上电默认状态由AD1/AD0的电平决定，具体参看表1。

■ **TERMINAL CONFIGURATION**



■ **TERMINAL FUNCTION**

| Terminal No. | Name | Description |
|---|---|---|
| 1 | SDA | I²C serial data. I²C数据 |
| 2 | VCC | Power supply. 电源输入端. |
| 3,15 | GND | Ground. 地 |
| 4 | INTN | Interrupt output pin, open-drain, need external pull-up resistor; active low.<br>中断输出，开漏结构，需外部上拉电阻；低有效 |
| 5 | RSTN | Hardware reset pin, active low; internal 100 kΩ (typical) pull-down resistor.<br>硬件复位，低为复位；内部下拉100 kΩ（典型值）电阻 |
| 6 | AD1 | I²C device address, connect to VCC or GND，and control the default state of GPIO(see table 1)。<br>I²C器件地址选择，接VCC或GND，并设置GPIO状态（见表1）。 |
| 7~10 | P1_0 ~ P1_3<br>OUT0~OUT3 | GPIO mode default, input or output (push-pull), the state after power on is decided by AD1 and AD0 terminals. Can be configured as LED mode.Support intelligence breathing mode.<br>默认GPIO模式，输入或输出（推挽结构），上电默认状态由AD1和AD0决定。可设置为LED模式。支持智能呼吸模式。 |
| 11~12 | P0_0~P0_1<br>OUT4~OUT5 | GPIO mode default, input or output (open-drain (default) or push-pull), the state after power on is decided by AD1 and AD0 terminals. Can be configured as LED mode.Can be configured as LED mode. Support intelligence breathing mode.<br>默认GPIO模式，输入或输出（开漏结构（默认）或推挽结构），上电默认状态由AD1和AD0决定。可设置为LED模式。支持智能呼吸模式。 |
| 13~14 | P0_2~P0_3<br>OUT6~OUT7 | GPIO mode default, input or output(open-drain (default) or push-pull), the state after power on is decided by AD1 and AD0 terminals. Can be configured as LED mode.Can be configured as LED mode. |

| | | |
|---|---|---|
| | | 默认GPIO模式，输入或输出（开漏结构（默认）或推挽结构），上电默认状态由AD1和AD0决定。可设置为LED模式。 |
| 16~17 | P0_4~P0_5 OUT8~OUT9 | GPIO mode default, input or output(open-drain (default) or push-pull), the state after power on is decided by AD1 and AD0 terminals. Can be configured as LED mode. 默认GPIO，输入或输出（开漏结构（默认）或推挽结构），上电默认状态由AD1和AD0决定。可设置为LED模式。 |
| 18 | NC | No connection. 内部无连接。 |
| 19 | AD0 | I²C device address, connect to VCC or GND，and control the default state of GPIOs (see table 1)。 I²C器件地址选择，接VCC或GND，并设置GPIO状态（见表1）。 |
| 20 | SCL | I²C serial clock. I²C时钟 |
| EP | NC | Connect to the system ground for better thermal performance. 接地。 |

# ■ SPECIFICATIONS[1]

## ● Absolute Maximum Ratings[2]

| PARAMETER | Symbol | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Power supply voltage for VCC | VCC | -0.3 | | 6 | V |
| Voltage at SCL, SDA, AD0, AD1, INTN, RSTN, OUT0~OUT9 | $V_{IO}$ | -0.3 | | VCC | V |
| Moisture Sensitivity Level (MSL) | | | MSL3 | | |
| Ambient Operating Temperature | $T_A$ | -25 | | 85 | ℃ |
| Junction Temperature | $T_J$ | | | 150 | ℃ |
| Storage Temperature | $T_{STG}$ | -65 | | 150 | ℃ |
| ESD (HBM) | | | ±2 | | kV |

## ● Main Electrical Characteristics

Condition: $T_A$ = 25°C, VCC = 3.6V, unless otherwise specified

| PARAMETER | Symbol | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Supply voltage and current | | | | | | |
| Power supply voltage for VCC | VCC | | 2.5 | | 5.5 | V |
| Shutdown current | $I_{SD}$ | RSTN=GND | | 0.1 | | uA |
| **LED Driver** | | | | | | |
| Max current of LED drive | $I_{MAX}$ | Configure DIMx Reg. as FFH | | 37 | | mA |
| Dropout voltage on low 6 ports(OUT0~OUT5) | $V_{drop1}$ | $I_{OUT}$= 20mA | | 60 | | mV |
| Dropout voltage on high 4 ports(OUT6~OUT9) | $V_{drop2}$ | $I_{OUT}$=20mA | | 80 | | mA |
| **Digital pin output** | | | | | | |
| High-level output voltage (OUT0~OUT9) | $V_{OH}$ | $V_{CC}$=2.5V，$I_{SOURCE}$=10mA | | VCC-170 | | mV |
| | | $V_{CC}$=3.6V，$I_{SOURCE}$=20mA | | VCC-250 | | mV |
| | | $V_{CC}$=5V，$I_{SOURCE}$=20mA | | VCC-200 | | mV |
| Low-level output voltage (OUT0~OUT9) | $V_{OL}$ | $V_{CC}$=2.5V，$I_{SINK}$=10mA | | 90 | | mV |
| | | $V_{CC}$=3.6V，$I_{SINK}$=20mA | | 70 | | mV |
| | | $V_{CC}$=5V，$I_{SINK}$=20mA | | 60 | | mV |
| Low-level output voltage (SDA, INTN) | $V_{OL}$ | $V_{CC}$=2.5V，$I_{SINK}$=6mA | | 150 | | mV |
| | | $V_{CC}$=3.6V，$I_{SINK}$=6mA | | 100 | | mV |
| | | $V_{CC}$=5V，$I_{SINK}$=6mA | | 75 | | mV |
| **Digital pin input** | | | | | | |
| High-level input voltage | $V_{IH}$ | SCL,SDA,RSTN,AD0,AD1,OUT0~OUT9 | 1.4 | | | V |
| Low-level input voltage | $V_{IL}$ | | | | 0.4 | V |
| Input Current | $I_I$ | SCL,SDA,RSTN,AD0,AD1,OUT0~OUT9, $V_I$ = VCC or GND | -0.2 | | +0.2 | uA |
| Input Capacitance | $C_I$ | | | 3 | | pF |
| Internal pull-low resistor in RSTN PIN | $R_{RSTN}$ | Internal pull-low resistor in RSTN PIN | | 100k | | Ω |
| Pulse width that RSTN PIN can filter | $t_{SP\_RSTN}$ | RSTN=VCC | | 10 | | us |

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[1]Depending on parts and PCB layout, characteristics may be changed.

[2]Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute–maximum–rated conditions for extended periods may affect device reliability.

● **I²C Control Port**

| PARAMETER | Symbol | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Serial-Clock frequency | $f_{SCL}$ | | | 400 | kHz |
| Bus free time between a STOP and a START condition | $t_{BUF}$ | 1.3 | | | us |
| Hold time (repeated) START condition. After this period, the first clock pulse is generated. | $t_{h(STA)}$ | 0.6 | | | us |
| Setup time for a repeated START condition | $t_{su(STA)}$ | 0.6 | | | us |
| Setup Time for SCL to STOP condition | $t_{su(STO)}$ | 0.6 | | | us |
| Data hold time | $t_{h(DAT)}$ | 0 | | 0.9 | us |
| Setup Time, SDA to SCL | $t_{su(DAT)}$ | 100 | | | ns |
| Required Pulse Duration, SCL HIGH | $t_{HIGH}$ | 0.7 | | | us |
| Required Pulse Duration, SCL LOW | $t_{LOW}$ | 1.3 | | | us |
| Rise Time, SCL and SDA | $T_r$ | | | 300 | ns |
| Fall Time, SCL and SDA | $T_f$ | | | 300 | ns |
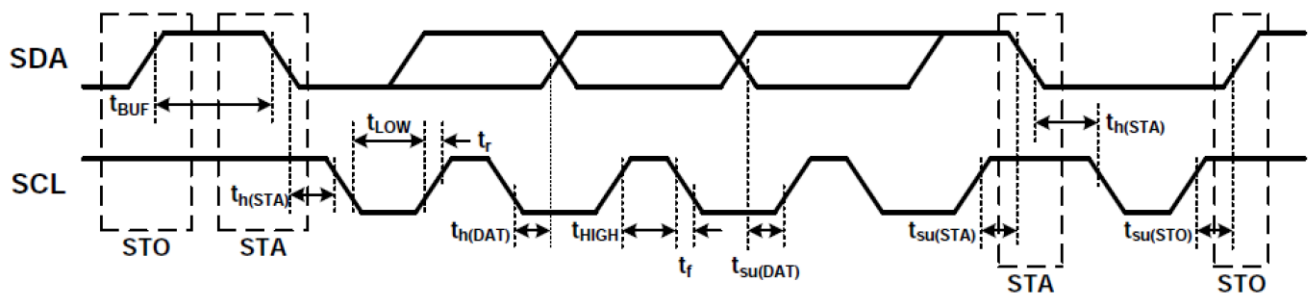
## ■ APPLICATION INFORMATION

HTR3310 is a 10 multifunctional LED driver and GPIO controller with 2.5V~5.5V power supply. Any of the 10 IOs can be configured as LED mode or GPIO mode. Meanwhile, any GPIO can be configured as an input or an output independently.

After power on, all the 10 IOs are configured as GPIO output as default, and their default states are decided by AD0 and AD1. When the IOs are configured as inputs, they are continuously monitored for state changes with 8μs deglitch. State changes are indicated at the INTN output. Once the GPIO state are read through the I²C interface, the INTN output is cleared.

When the IOs are configured as LED mode, the LED driver's current, divided by 256 steps linear dimming, can be set between 0~$I_{MAX}$ by I²C interface. The default maximum current ($I_{MAX}$) is 37mA, and $I_{MAX}$ can be changed in GloCTL register.

HTR3310 supports breathing function to implement different lighting effects in an much easier way with two modes: blinking mode and fading mode.

HTR3310是一款I²C接口、10路呼吸灯及10路扩展 GPIO 控制器，它包含10路双向 GPIO端口，其中每路可通过指令配置为 LED 驱动模式。在 GPIO 模式下，每一路 GPIO 可单独配置为输入或输出。

通电后，10个IO端口配置默认为GPIO输出，默认状态根据AD0和AD1决定。所有配置为输入的IO端口都会持续监控状态变化，并具有8μs的防抖动时间，IO口的变化由INTN输出指示。当GPIO状态通过I²C接口被读取时，INTN输出被清除。

当IO端口配置为LED模式时，可以通过I²C接口将LED驱动器的电流设置在0~$I_{MAX}$之间，并可以以该值除以256步进行线性调光。默认最大电流（$I_{MAX}$）为37mA，可在全局在控制寄存器中更改$I_{MAX}$。

HTR3310支持breathing功能，使其实现灯效变得更为容易，其有两种模式:blinking模式和fading模式。

### 1    Power On

Once HTR3310 is powered on, at least a 100μs delay is required before RSTN is pulled high. After RSTN is high, at least a 5ms delaty is required before I²C communication. The recommended power on sequence is as below.

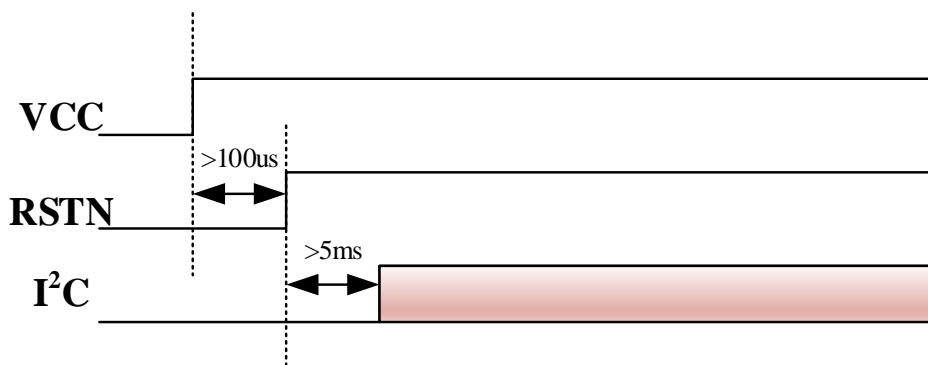通电后，RSTN拉高之前需要至少100μs的延迟。RSTN拉高后，I²C通信前至少需要等待5ms以上时间。以下是建议的时序。



Figure 1PowerOn Timing

### 2    GPIO Output

After power on, all the 10 IOs are configured as GPIO output as default, and the states are decided by AD0 and AD1 (see table 1 for detail). GPIO P1 (OUT0/P1_0 ~ OUT3/P1_3) is Push-Pullstructure; the default of GPIO P0 (OUT4/P0_0 ~ OUT9/P0_5) is Open-Drainstructure and can be configured as Push-Pull structure. Once in Open-Drain stucture, the GPIO needs pull-up resistor.

上电后，10 路 IO 口默认为 GPIO 模式的输出状态，其输出状态可通过 AD1、AD0 脚进行配置，具体配置方式见表 1。P1 (OUT0/P1_0 ~ OUT3/P1_3) 端口为 Push-Pull 结构；P0 (OUT4/P0_0 ~ OUT9/P0_5) 端口默认为 Open-Drain 结构，可通过配置全局控制寄存器设定为 Push-Pull 结构。GPIO 设置为 Open-Drain 结构时，需外接上拉电阻。

Table1Default State of IOs decided by AD1 and AD0 terminals

| AD1 | AD0 | P1 (OUT0/P1_0 ~ OUT3/P1_3) | P0 (OUT8/P0_4 ~ OUT9/P0_5) | P0 (OUT4/P0_0 ~ OUT7/P0_3) |
|-----|-----|------|------|------|
| GND | GND | 0 | 0 | 0 |
| GND | VCC | 1 | 0 | Hi-Z |
| VCC | GND | 0 | Hi-Z | 0 |
| VCC | VCC | 1 | Hi-Z | Hi-Z |

## 3    GPIO Input or Output Selection

The register In/Out_P0 and In/Out_P1 can configure IOs as input or output. Each bit of the register is corresponding to each IO, the bit set '1' as input, '0' as output. The default value is '0' as output.

In/Out_P0 和 In/Out_P1 设定端口为输入、输出状态。寄存器每一 Bit 对应某个 GPIO 端口，该 bit 置'1'代表输入状态，置'0'代表输出状态。默认值为 0，输出状态。

## 4    GPIO Input

The state of GPIO can be read through I²C in the register Input_P0 and Input_P1. The GPIO support 1.8V logic input.

通过 I²C 接口读 Input_Port0 和 Input_Port1 可获得当前 GPIO 端口逻辑状态。GPIO 口支持 1.8V 逻辑输入。

## 5    Interrupt Function

HTR3310will monitor IO state once IOis configured as input GPIO, and GPIO interrupt function is enabled.The change of input GPIO status(from high-level to low-level or from low-level to high-level,with 8us internal deglitch) can trigger a low state of INTN terminal. INTN is open-drain output, active low, which needs external pull-up resistor.

When the GPIO input status (Input_P0, Input_P1) is read through the I²C interface, the interrupt can be cleared. When a certain GPIO port is configured to output mode, or the interrupt enable is disabled, the change of its state will not cause interrupt.

The interrupt caused by the change of P0 status can only be cleared by reading register Input_P0, and one caused by the change of P1 status can only be cleared by reading register Input_P1. Meawhile, the interrupt can also be cleared by reset.

The interrupt sequence is as below.

一旦 IO 配置为 GPIO 输入，且 GPIO 中断功能启用，HTR3310 将监控 IO 状态。输入 GPIO 状态的改变（由低变高或由高变低，8μs 去抖动处理）会触发 INTN 脚的拉低。INTN 是开漏输出，低电平有效，需要外部上拉电阻器。

通过 I²C 接口读取 GPIO 输入状态（Input_P0 和 Input_P1）时，可以清除中断。将某一路 GPIO 口配置成输出模式、或关闭其中断使能后，则其状态的变化不会产生中断。

由 P0 口变化产生的中断，只能通过读 Input_P0 寄存器清除；由 P1 口变化产生的中断，只能通过读 Input_P1 寄存器清除。另外，还可通过复位功能清除中断。
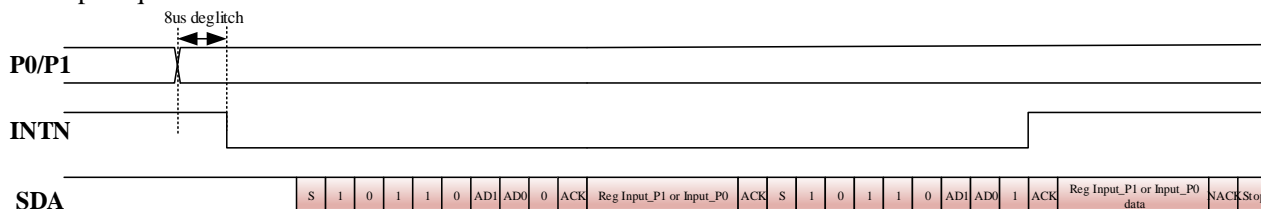
中断时序如下图。



Figure 2 Interrupt Sequence

## 6 LED Mode

HTR3310can be set as anco-anode current source LED driver through reg 12h and 13h. LED driver's $I_{MAX}$ is configured by GloCTL (ISEL) register, with 4 different levels. The default $I_{MAX}$ is 37mA.

Each IO can also carry out 256 step linear dimming through DIMx register, see table 2.

The Dropout performance of the 6 LED Ports (OUT0~OUT5) is optimized, so that they are capable of driving LED backlights.

HTR3310 可通过 12H 和 13H 寄存器设置为共阳恒流型 LED 驱动器。驱动电流的最大值（$I_{MAX}$）为 37mA（典型），并可通过寄存器 GloCTL (ISEL)设置，共有 4 档。

每一路 LED 还可以通过 DIM 寄存器进行 256 步线性调光，见表 2。

OUT0~OUT5 这 6 路的驱动能力做了优化，在驱动 LED 背光时建议选取这几路。

Table2 256 LED dimming

| DIMx bit | | | | | | | | DIMMING |
|---|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | OFF |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | $1/255 \times I_{MAX}$ |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | $2/255 \times I_{MAX}$ |
| | | | | …… | | | | …… |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | $253/255 \times I_{MAX}$ |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | $254/255 \times I_{MAX}$ |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | $255/255 \times I_{MAX}$ |

## 7 I²C Communication

The HTR3310 device has a bidirectional I²C interface that is compatible with the Inter IC (I²C) bus protocol and supports both 100-kHz and 400-kHz data transfer rates. This is a slave-only device that does not support a multi-master bus environment or wait-state insertion.

The I2C bus employs two signals, SDA (data) and SCL (clock), to communicate between integrated circuits in a system using serial data transmission. The address and data 8-bit bytes are transferred most-significant bit (MSB) first. In addition, each byte transferred on the bus is acknowledged by the receiving device with an acknowledge bit. Each transfer operation begins with the master device driving a start condition on the bus and ends with the master device driving a stop condition on the bus. The bus uses transitions on the data terminal (SDA) while the clock is at logic high to indicate start and stop conditions. A high-to-low transition on SDA indicates a start, and a low-to-high transition indicates a stop. Normal data-bit transitions must occur within the low time of the clock period.

The master generates the 7-bit slave address and the read/write (R/W) bit to open communication with another device and then waits for an acknowledge condition. The device holds SDA low during the acknowledge clock period to indicate acknowledgment. When this occurs, the master transmits the next byte of the sequence. Each device is addressed by a unique 7-bit slave address plus R/W bit (1 byte). All compatible devices share the same signals via a bi-directional bus using a wired-AND connection.

Use external pull-up resistors for the SDA and SCL signals to set the logic-high level for the bus.

HTR3310 I²C接口支持双向传输，该接口与I²C总线协议兼容，并支持100 kHz和400 kHz数据传输速率。这是一个从设备，不支持多主机的总线环境，及等待状态下的插入。

I²C总线具有两个信号，SDA（数据）和SCL（时钟），在系统中的器件之间使用串行数据传输进行通信。地址和数据的8位字节首先传输最高有效位（MSB）。此外，总线上传输的每个字节由接收设备用确认位（ACK）进行确认。每个传输操作从主设备驱动总线上的启动条件开始，并以主设备驱动总线上的停止条件结束。当时钟处于逻辑高电平时，总线使用数据终端（SDA）上的转换来指示启动和停止条件。SDA上的高到低转换表示开始，低到高转换表示停止。正常的数据位转换必须在时钟为低时发生。

主机生成7位从机地址和读/写（R/W）位，以打开与另一个设备的通信，然后等待确认条件。在应答时钟周期内，设备保持SDA低，以指示确认。当发生这种情况时，主机发送序列的下一个字节。每个设备有唯一的7位从机地址加上R/W位（1字节）。所有兼容设备通过并联的总线共享信息。

SDA和SCL需通过外部上拉电阻截至逻辑高电平。
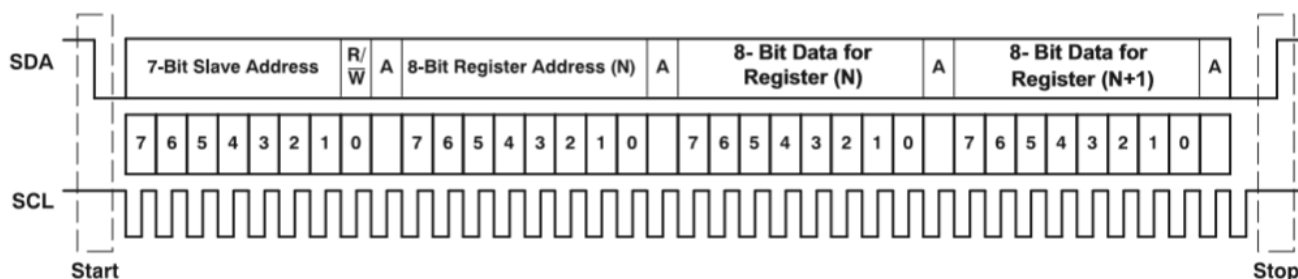
Figure 3Typical I2C Sequence
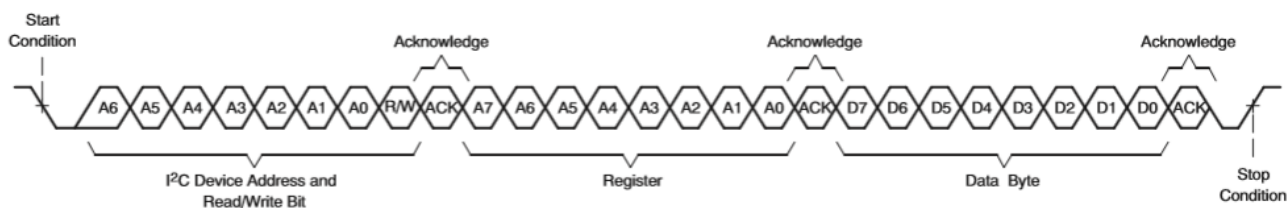


Figure 4I²C Writing
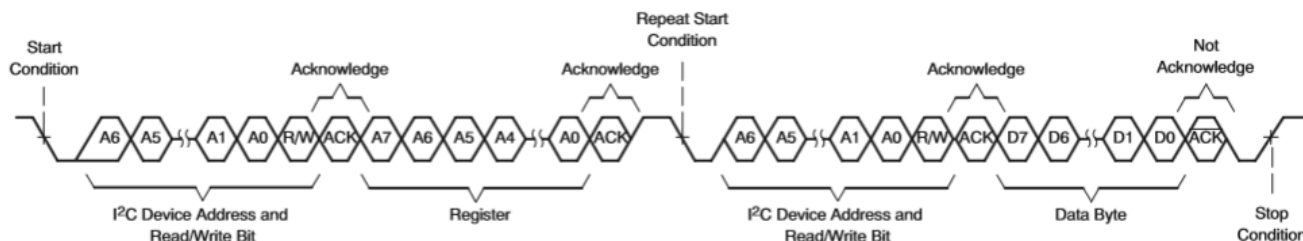


Figure 5I²C Reading

## 8    Device Address

The device address of HTR3310 can be set by AD1 and AD0 terminals, see as below.

HTR3310 器件地址由引脚 AD1、AD0 设置，如下表。

Table3Device Address

| 1 | 0 | 1 | 1 | 0 | AD1 | AD0 | R/W |
|---|---|---|---|---|-----|-----|-----|

## 9    Reset Function

There are 3 different ways of reset the registers of HTR3310 into default value: Re-poweron, hardware reset and software reset.

HTR3310 支持三种复位模式：重新上电、硬件复位和软复位。三种复位模式均能将寄存器复位至默认值。

**Hardware Reset**

Hardware reset timing is as below.

**硬件复位**

硬件复位时序如下图。
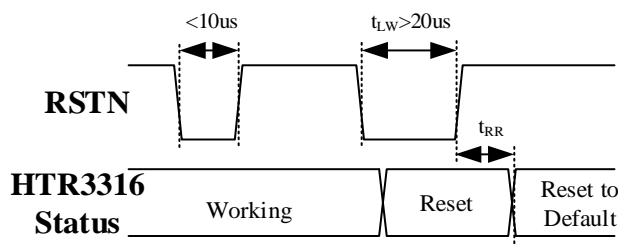


Figure 6 Hardware Reset Timing

Table4Hardware Reset Parameter

| Parameter | | Condition | min | typ | max | unit |
|---|---|---|---|---|---|---|
| $t_{LW}$ | Reset pulse low level width | VCC=2.4V~5.5V，T=-40℃~125℃ | 20 | | | us |
| $t_{RR}$ | Reset recovery time | | 1 | | | us |

**NOTE:**

1. An internal deglitch is integrated to avoid unexpected reset caused by interference on RSTN terminal.

2. After reset, all registers resume to default. The interrupt (INTN) is cleared and pulled up by external pull-up resistor.

3. During a valid reset when low level of RSTN is longer than 20us, any unexpected interference with high-level of less than 10ns will be filtered.

**Software Reset**

Software reset is also available for HTR3310. Writing 00h to the register7Fh will trigger a reset. After the software reset command is sent through the I²C interface, it takes at least 1ms to acknowledge the next I²C command.

**10  Breathing Function**

Breathing function is integrated in HTR3310 to implement different lighting effects in an much easier way. OUT0~OUT5 supprts breathing function, and Two different modes can be selected in this function: blinking and fading.

### 10.1  Blinking mode

In blinking mode, HTR3310 will blink the LED to breath automaticlly. The following steps shows how to set the blinking mode.

(1) Set OUTx into LED mode (register 12h, 13h), enable breathing function (register 14h), and select blinking mode (register 04h, 05h);

(2) Configure timing paramter, including the delay time before starting blinking (register 17h~1Ch), the fade in and out time (reg 15h), On and off time (reg 16h);

(3) Enable the bit GO in reg 11h to starting blinking automatically;

(4) The blinking can be exit by disabling blinking function (reg 14h) or set the corresponding channel into fading mode (reg 04h, 05h). The former will exit blinking mode immediatetly, and the latter will exit blinking mode after finishing the blinking period.

注意：

1. 硬件复位引脚（RSTN）内置了防抖动电路,以避免有 RSTN 引脚外部干扰误触发 Reset。

2. 复位后，寄存器恢复到默认状态。中断状态（INTN）被清除，由外部上拉电阻将其拉高。

3. 在复位脉冲的低电平期间，防抖动电路也将起作用，小于 10ns 的高脉冲将被滤除。

HTR3310 同时支持软复位模式，可通过 I²C 接口对寄存器 7Fh 写数据 00h。通过 I²C 接口发送软件复位命令后，至少需要 1ms 后，HTR3310 才能识别下一个 I²C 命令。

HTR3310 具有 Breathing 功能，使其实现灯效变得更为容易。 OUT0~OUT5 支持 breathing 功能，该功能具有两种模式，分别是 blinking 模式和 Fading 模式。

在 blinking 模式下，HTR3310 会自动以类似呼吸状态闪烁 LED。您可以通过以下步骤设置 blinking 模式。

(1) 设置 OUTx 进入 LED 模式(寄存器 12h、13h)，开启呼吸功能(寄存器 14h)，选择 blinking 模式(寄存器 04h、05h);

(2) 配置相关时间参数，包括开始闪烁前的延迟时间(寄存器 17h~1Ch)，淡入淡出时间(寄存器 15h)，On / off 时间(reg 16h);

(3) 使能 reg 11h 中的 GO 位，LED 开始自动呼吸闪烁;

(4) 关闭 blinking 功能(reg 14h)，或设置相应通道为 fading 模式(reg 04h, 05h)，可退出 blinking 模式。前者可立即退出，后者需要结束当前 blinking 周期后退出。

### 10.2 Fading mode

In fading mode, writing 1 in the corresponding bit of reg 02h and 03h means fading in and remaining bright for the LED channel, writing 0 in the corresponding bit of reg 02h and 03h means fading out and remaining dark for the LED channel.The following steps shows how to set the fading mode.

(1) Set OUTx into LED mode (register 12h, 13h), enable breathing function (register 14h), and select fading mode (register 04h, 05h);

(2) Configure timing paramter, including the fade in and out time (reg 15h);

(3) Control the conresponding bit of reg 02h and 03h to start fading in or fading out; a writing of any bit of reg 02h and 03h will result a fading in or fading out of all channels (OUT0~OUT5);

(4) The fading can be exit by disabling breathing function (reg 14h).

在 fading 模式下，reg 02h 和 03h 对应位写 1 则该 LED 通道渐渐亮（Fading in）起并保持亮常，reg 02h 和 03h 对应位写 0 则该 LED 通道渐渐暗下（fading out）并保持常暗。您可以通过以下步骤设置 fading 模式。

(1) 设置 OUTx 进入 LED 模式(寄存器 12h、13h)，开启呼吸功能(寄存器 14h)，选择 fading 模式(寄存器 04h、05h)；

(2) 配置相关时间参数，包括淡入淡出时间(寄存器 15h)；

(3) 控制 reg02h, 03h 中相应位，开始渐亮或渐暗；写其中的任意 bit 位将会带来所有通道（OUT0~OUT5）的一次 Fading in 或 Fading out；

(4) 关闭 fading 模式(reg 14h)，可退出 Fading 模式。

## 11 Register Map

Table5 Register Map

| Register Address | R/W | Name | Function | Default Value |
|---|---|---|---|---|
| 00h | R | Input_P0 | Input state of P0 (OUT4/P0_0 ~ OUT9/P0_5) terminals | Determined by OUT4/P0_0 ~ OUT9/P0_5 |
| 01h | R | Input_P1 | Input state of P1 (OUT0/P1_0 ~ OUT3/P1_3) terminals | Determined by OUT0/P1_0 ~ OUT3/P1_3 |
| 02h | R/W | Output_P0 | Output state of P0(OUT4/P0_0 ~ OUT9/P0_5) terminals<br><br>Or Control fade in or out in fading mode for OUT4~OUT5 | see table 1 |
| 03h | R/W | Output_P1 | Output state of P1(OUT0/P1_0 ~ OUT3/P1_3) terminals<br><br>Or Control fade in or out in fading mode for OUT0~OUT3 | see table 1 |
| 04h | R/W | In/Out_P0 | Configure P0(OUT4/P0_0 ~ OUT9/P0_5) as input or output<br><br>Or configure OUT4~OUT5 in blinking or fading mode | 00h |
| 05h | R/W | In/Out_P1 | Configure P1(OUT0/P1_0 ~ OUT3/P1_3) as input or output<br><br>Or configure OUT0~OUT3 inblinking or fading mode | 00h |
| 06h | R/W | Int_P0 | Enable interrupt function of P0(OUT4/P0_0 ~ OUT9/P0_5) terminals | 00h |
| 07h | R/W | Int_P1 | Enable interrupt function of P1(OUT0/P1_0 ~ OUT3/P1_3) terminals | 00h |
| 11h | R/W | GloCTL | Configure P0 output structure, and global $I_{MAX}$ | 00h |
| 12h | R/W | P0_Mode | Configure P0(OUT4/P0_0 ~ OUT9/P0_5) as LED or GPIO mode | FFh |
| 13h | R/W | P1_Mode | Configure P1(OUT0/P1_0 ~ OUT3/P1_3) as LED or GPIO mode | FFh |
| 14h | R/W | Breath_EN | Enable breathing function for OUT0~OUT5 | 00h |
| 15h | R/W | Fade_Time | Configure Fade in and fade out time for breathing function | 00h |
| 16h | R/W | On_Off_Time | Configure On and off time in blinking mode | 00h |
| 17h | R/W | OUT0_Delay | Configure delay time before start blinking in blinking mode for OUT0 | 00h |
| 18h | R/W | OUT1_Delay | Configure delay time before start blinking in blinking mode for OUT1 | 00h |
| 19h | R/W | OUT2_Delay | Configure delay time before start blinking in blinking mode for OUT2 | 00h |
| 1Ah | R/W | OUT3_Delay | Configure delay time before start blinking in blinking mode for OUT3 | 00h |
| 1Bh | R/W | OUT4_Delay | Configure delay time before start blinking in blinking mode for OUT4 | 00h |
| 1Ch | R/W | OUT5_Delay | Configure delay time before start blinking in blinking mode for OUT5 | 00h |
| 20h | W | DIM0 | Dimingcontrol of OUT0 terminal | 00h |
| 21h | W | DIM1 | Diming control of OUT1 terminal | 00h |
| 22h | W | DIM2 | Diming control of OUT2 terminal | 00h |
| 23h | W | DIM3 | Diming control of OUT3 terminal | 00h |
| 24h | W | DIM4 | Diming control of OUT4 terminal | 00h |
| 25h | W | DIM5 | Diming control of OUT5 terminal | 00h |
| 26h | W | DIM6 | Diming control of OUT6 terminal | 00h |
| 27h | W | DIM7 | Diming control of OUT7 terminal | 00h |

| 28h | W | DIM8 | Diming control of OUT8 terminal | 00h |
|-----|---|------|--------------------------------|-----|
| 29h | W | DIM9 | Diming control of OUT9 terminal | 00h |
| 7Fh | W | Reset | Software reset | 00h |
| others | - | - | Reserved. Do not write | - |

**Register Address: 00h, Input_P0,Input state of P0 terminals (default value is determined by each GPIO status)**

| Bit | Label | Default | Description |
|-----|-------|---------|-------------|
| 7:6 | - | - | Bit7~bit6, reserved |
| 5 | Input_P0_5 | x | The current logic status of P0_5 terminals: 0-low level；1-high level<br>P0_5 端口引脚当前逻辑状态。0-低电平；1-高电平 |
| 4 | Input_P0_4 | x | The current logic status of P0_4 terminals: 0-low level；1-high level<br>P0_4 端口引脚当前逻辑状态。0-低电平；1-高电平 |
| 3 | Input_P0_3 | x | The current logic status of P0_3 terminals: 0-low level；1-high level<br>P0_3 端口引脚当前逻辑状态。0-低电平；1-高电平 |
| 2 | Input_P0_2 | x | The current logic status of P0_2 terminals: 0-low level；1-high level<br>P0_2 端口引脚当前逻辑状态。0-低电平；1-高电平 |
| 1 | Input_P0_1 | x | The current logic status of P0_1 terminals: 0-low level；1-high level<br>P0_1 端口引脚当前逻辑状态。0-低电平；1-高电平 |
| 0 | Input_P0_0 | x | The current logic status of P0_0 terminals: 0-low level；1-high level<br>P0_0 端口引脚当前逻辑状态。0-低电平；1-高电平 |

**Register Address: 01h, Input_P1, Input state of P1 terminals (default value is determined by each GPIO status)**

| Bit | Label | Default | Description |
|-----|-------|---------|-------------|
| 7:4 | - | - | Bit7~bit4, reserved |
| 3 | Input_P1_3 | x | The current logic status of P1_3 terminals: 0-low level；1-high level<br>P1_3 端口引脚当前逻辑状态。0-低电平；1-高电平 |
| 2 | Input_P1_2 | x | The current logic status of P1_2 terminals: 0-low level；1-high level<br>P1_2 端口引脚当前逻辑状态。0-低电平；1-高电平 |
| 1 | Input_P1_1 | x | The current logic status of P1_1 terminals: 0-low level；1-high level<br>P1_1 端口引脚当前逻辑状态。0-低电平；1-高电平 |
| 0 | Input_P1_0 | x | The current logic status of P1_0 terminals: 0-low level；1-high level<br>OUT0 端口引脚当前逻辑状态。0-低电平；1-高电平 |

Registers 00h,01h reflect the logic status of the GPIO terminals, regardless of whether the pin is defined as an input or an output. They can only be readbut not written by I²C interface. The default value of the two registers are determined by the externally applied logic level.

Bits 5 to 0 of register 00h correspond to the input status of P0_5 to P0_0 terminals, bits 3 to 0 of 01h correspond to the input status of P1_3 to P1_0 terminals.

寄存器（00h，01h）用以反映 GPIO口当前的逻辑状态，不论该 GPIO 口是配置为输入模式还是输出模式。该寄存器仅支持读操作；写操作无效。其默认值由外部引脚电平决定。

寄存器 00h 的第 5 至第 0 位依次对应 P0_5~ P0_0 的输入状态，01h 的第 3 至第 0 位依次对应 P1_3~ P1_0 的输入状态。

**Register Address: 02h, Output_P0, Output state of P0(OUT4/P0_0 ~ OUT9/P0_5) terminals Or Control fade in or out in fading mode for OUT4~OUT5 (default Refer to Table1)**

| Bit | Label | Default | Description |
|-----|-------|---------|-------------|
| 7:6 | - | - | Bit7~bit6, reserved |
| 5 | Output_OUT9 | see Table1 | Set the output status of OUT9/P0_5 terminals. 0-low level; 1-high level<br>设置 OUT9/P0_5 端口引脚输出值。0-输出低电平；1-输出高电平 |

| 4 | Output_OUT8 | see Table1 | Set the output status of OUT8/P0_4 terminals. 0-low level; 1-high level |
| | | | 设置 OUT8/P0_4 端口引脚输出值。0-输出低电平；1-输出高电平 |
| 3 | Output_OUT7 | see Table1 | Set the output status of OUT7/P0_3 terminals. 0-low level; 1-high level |
| | | | 设置 OUT7/P0_3 端口引脚输出值。0-输出低电平；1-输出高电平 |
| 2 | Output_OUT6 | see Table1 | Set the output status of OUT6/P0_2 terminals. 0-low level; 1-high level |
| | | | 设置 OUT6/P0_2 端口引脚输出值。0-输出低电平；1-输出高电平 |
| 1 | Output_OUT5 | see Table1 | Set the output status of OUT5/P0_1 terminals. 0-low level; 1-high level; |
| | | | Control fade in or out in fading mode for OUT5: 1->0-fading out; 0->1-fading in |
| | | | 设置 OUT5/P0_1 端口引脚输出值。0-输出低电平；1-输出高电平 |
| | | | 在 fading 模式控制 OUT5 的渐亮和渐暗：1->0-渐暗；0->1-渐亮 |
| 0 | Output_OUT4 | see Table1 | Set the output status of OUT4/P0_0 terminals. 0-low level; 1-high level |
| | | | Control fade in or out in fading mode for OUT4: 1->0-fading out; 0->1-fading in |
| | | | 设置 OUT4/P0_0 端口引脚输出值。0-输出低电平；1-输出高电平 |
| | | | 在 fading 模式控制 OUT4 的渐亮和渐暗：1->0-渐暗；0->1-渐亮 |

**Register Address: 03h, Output_P1, Output state of P1(OUT0/P1_0~OUT3/P1_3) terminals Or Control fade in or out in fading mode for OUT0~OUT3 (default Refer to Table1)**

| Bit | Label | Default | Description |
|---|---|---|---|
| 7:4 | - | - | Bit7~bit4, reserved |
| 3 | Output_OUT3 | see Table1 | Set the output status of OUT3/P1_3 terminals. 0-low level; 1-high level |
| | | | Control fade in or out in fading mode for OUT3: 1->0-fading out; 0->1-fading in |
| | | | 设置 OUT3/P1_3 端口引脚输出值。0-输出低电平；1-输出高电平 |
| | | | 在 fading 模式控制 OUT3 的渐亮和渐暗：1->0-渐暗；0->1-渐亮 |
| 2 | Output_OUT2 | see Table1 | Set the output status of OUT2/P1_2 terminals. 0-low level; 1-high level |
| | | | Control fade in or out in fading mode for OUT2: 1->0-fading out; 0->1-fading in |
| | | | 设置 OUT2/P1_2 端口引脚输出值。0-输出低电平；1-输出高电平 |
| | | | 在 fading 模式控制 OUT2 的渐亮和渐暗：1->0-渐暗；0->1-渐亮 |
| 1 | Output_OUT1 | see Table1 | Set the output status of OUT1/P1_1 terminals. 0-low level; 1-high level; |
| | | | Control fade in or out in fading mode for OUT1: 1->0-fading out; 0->1-fading in |
| | | | 设置 OUT1/P1_1 端口引脚输出值。0-输出低电平；1-输出高电平 |
| | | | 在 fading 模式控制 OUT1 的渐亮和渐暗：1->0-渐暗；0->1-渐亮 |
| 0 | Output_OUT0 | see Table1 | Set the output status of OUT0/P1_0 terminals. 0-low level; 1-high level |
| | | | Control fade in or out in fading mode for OUT0: 1->0-fading out; 0->1-fading in |
| | | | 设置 OUT0/P1_0 端口引脚输出值。0-输出低电平；1-输出高电平 |
| | | | 在 fading 模式控制 OUT0 的渐亮和渐暗：1->0-渐暗；0->1-渐亮 |

**Register Address: 04h, In/Out_P0, Configure P0(OUT4/P0_0~OUT9/P0_5) as input or output, Or configure OUT4~OUT5 in blinking or fading mode (default 00h)**

| Bit | Label | Default | Description |
|---|---|---|---|
| 7:6 | - | - | Bit7~bit6, reserved |
| 5 | In/Out_OUT9 | 0 | Configure OUT9/P0_5 terminals as input or output. 0-output; 1-input |
| | | | 设置 OUT9/P0_5 端口为输入或输出。0-输出模式；1-输入模式 |
| 4 | In/Out_OUT8 | 0 | Configure OUT8/P0_4 terminals as input or output. 0-output; 1-input |
| | | | 设置 OUT8/P0_4 端口为输入或输出。0-输出模式；1-输入模式 |
| 3 | In/Out_OUT7 | 0 | Configure OUT7/P0_3 terminals as input or output. 0-output; 1-input |
| | | | 设置 OUT7/P0_3 端口为输入或输出。0-输出模式；1-输入模式 |
| 2 | In/Out_OUT6 | 0 | Configure OUT6/P0_2 terminals as input or output. 0-output; 1-input |
| | | | 设置 OUT6/P0_2 端口为输入或输出。0-输出模式；1-输入模式 |
| 1 | In/Out_OUT5 | 0 | Configure OUT5/P0_1 terminals as input or output. 0-output; 1-input |

| | | | Configure OUT5 in blinking or fading mode if breathing function is enabled. 0-fading mode; 1-blinking mode. |
|---|---|---|---|
| | | | 设置 OUT5/P0_1 端口为输入或输出。0-输出模式；1-输入模式 |
| | | | 在 breathing 功能开启时设置 OUT5 进入 blinking 或 fading 模式。0-fading 模式；1-blinking 模式 |
| 0 | In/Out_OUT4 | 0 | Configure OUT4/P0_0 terminals as input or output. 0-output; 1-input |
| | | | Configure OUT4 in blinking or fading mode if breathing function is enabled. 0-fading mode; 1-blinking mode. |
| | | | 设置 OUT4/P0_0 端口为输入或输出。0-输出模式；1-输入模式 |
| | | | 在 breathing 功能开启时设置 OUT4 进入 blinking 或 fading 模式。0-fading 模式；1-blinking 模式 |

**Register Address: 05h, In/Out_P1, Configure P1(OUT0/P1_0~OUT3/P1_3) as input or output, Or configure OUT0~OUT3 in blinking or fading mode (default 00h)**

| Bit | Label | Default | Description |
|---|---|---|---|
| 7:4 | - | - | Bit7~bit4, reserved |
| 3 | In/Out_OUT3 | 0 | Configure OUT3/P1_3 terminals as input or output. 0-output; 1-input |
| | | | Configure OUT3 in blinking or fading mode if breathing function is enabled. 0-fading mode; 1-blinking mode |
| | | | 设置 OUT3/P1_3 端口为输入或输出。0-输出模式；1-输入模式 |
| | | | 在 breathing 功能开启时设置 OUT3 进入 blinking 或 fading 模式。0-fading 模式；1-blinking 模式 |
| 2 | In/Out_OUT2 | 0 | Configure OUT2/P1_2 terminals as input or output. 0-output; 1-input |
| | | | Configure OUT2 in blinking or fading mode if breathing function is enabled. 0-fading mode; 1-blinking mode |
| | | | 设置 OUT2/P1_2 端口为输入或输出。0-输出模式；1-输入模式 |
| | | | 在 breathing 功能开启时设置 OUT2 进入 blinking 或 fading 模式。0-fading 模式；1-blinking 模式 |
| 1 | In/Out_OUT1 | 0 | Configure OUT1/P1_1 terminal as input or output. 0-output; 1-input |
| | | | Configure OUT1 in blinking or fading mode if breathing function is enabled. 0-fading mode; 1-blinking mode. |
| | | | 设置 OUT1/P1_1 端口为输入或输出。0-输出模式；1-输入模式 |
| | | | 在 breathing 功能开启时设置 OUT1 进入 blinking 或 fading 模式。0-fading 模式；1-blinking 模式 |
| 0 | In/Out_OUT0 | 0 | Configure OUT0/P1_0 terminal as input or output. 0-output; 1-input |
| | | | Configure OUT0 in blinking or fading mode if breathing function is enabled. 0-fading mode; 1-blinking mode. |
| | | | 设置 OUT0/P1_0 端口为输入或输出。0-输出模式；1-输入模式 |
| | | | 在 breathing 功能开启时设置 OUT0 进入 blinking 或 fading 模式。0-fading 模式；1-blinking 模式 |

**Register Address: 06h, Int_P0, Enable interrupt function of P0(OUT4/P0_0~OUT9/P0_5) terminals (default 00h)**

| Bit | Label | Default | Description |
|---|---|---|---|
| 7:6 | - | - | Bit7~bit6, reserved |
| 5 | Int_OUT9 | 0 | Enable interrupt function of OUT9/P0_5 terminals. 0-enabled; 1-disabled |
| | | | OUT9/P0_5 口中断使能。0-中断使能；1-中断不使能 |
| 4 | Int_OUT8 | 0 | Enable interrupt function of OUT8/P0_4 terminals. 0-enabled; 1-disabled |
| | | | OUT8/P0_4 口中断使能。0-中断使能；1-中断不使能 |
| 3 | Int_OUT7 | 0 | Enable interrupt function of OUT7/P0_3 terminals. 0-enabled; 1-disabled |
| | | | OUT7/P0_3 口中断使能。0-中断使能；1-中断不使能 |
| 2 | Int_OUT6 | 0 | Enable interrupt function of OUT6/P0_2 terminals. 0-enabled; 1-disabled |
| | | | OUT6/P0_2 口中断使能。0-中断使能；1-中断不使能 |
| 1 | Int_OUT5 | 0 | Enable interrupt function of OUT5/P0_1 terminals. 0-enabled; 1-disabled |

| | | | OUT5/P0_1 口中断使能。0-中断使能；1-中断不使能 |
|---|---|---|---|
| 1 | Int_OUT4 | 0 | Enable interrupt function of OUT4/P0_0 terminals. 0-enabled; 1-disabled |
| | | | OUT4/P0_0 口中断使能。0-中断使能；1-中断不使能 |

**Register Address: 07h, Int_P1, Enable interrupt function of P0(OUT0/P1_0~OUT3/P1_3) terminals (default 00h)**

| Bit | Label | Default | Description |
|---|---|---|---|
| 7:4 | - | - | Bit7~bit4, reserved |
| 3 | Int_OUT3 | 0 | Enable interrupt function of OUT3/P1_3 terminal. 0-enabled; 1-disabled |
| | | | OUT3/P1_3 口中断使能。0-中断使能；1-中断不使能 |
| 2 | Int_OUT2 | 0 | Enable interrupt function of OUT2/P1_2 terminal. 0-enabled; 1-disabled |
| | | | OUT2/P1_2 口中断使能。0-中断使能；1-中断不使能 |
| 1 | Int_OUT1 | 0 | Enable interrupt function of OUT1/P1_1 terminal. 0-enabled; 1-disabled |
| | | | OUT1/P1_1 口中断使能。0-中断使能；1-中断不使能 |
| 1 | Int_OUT0 | 0 | Enable interrupt function of OUT0/P1_0 terminal. 0-enabled; 1-disabled |
| | | | OUT0/P1_0 口中断使能。0-中断使能；1-中断不使能 |

**Register Address: 11h, GloCTL, Configure P0 output structure, and global IMAX (default 00h)**

| Bit | Label | Default | Description |
|---|---|---|---|
| D7 | GO | 00 | Writing 1 to start blinking in blinking mode |
| D6:D5 | Reserved | 00 | Reserved, 00 only |
| D4 | P0_Structure | 0 | Configure P0 (OUT4/P0_0~OUT9/P0_5) output structure. 设置 P0 口输出结构 |
| | | | 0: P0 port is Open-Drain structure; P0 口为 Open-Drain |
| | | | 1: P0 port is Push-Pull structure; P0 口为 Push-Pull 模式 |
| D3:D2 | Reserved | 00 | Reserved, 00 only |
| D1:D0 | ISEL | 00 | Set the 256 step dimming range. 设置 256 步调光范围 |
| | | | 00：0~$I_{MAX}$ |
| | | | 01：0~( $I_{MAX} \times 3/4$) |
| | | | 10：0~( $I_{MAX} \times 2/4$) |
| | | | 11：0~( $I_{MAX} \times 1/4$) |

**Register Address: 12h, P0_Mode, Configure P0(OUT4/P0_0~OUT9/P0_5) as LED or GPIO mode (default FFh)**

| Bit | Label | Default | Description |
|---|---|---|---|
| 7:6 | - | - | Bit7~bit6, reserved |
| 5 | OUT9_Mode | 1 | Configure mode of OUT9/P0_5 terminals. 配置 OUT9/P0_5 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |
| 4 | OUT8_Mode | 1 | Configure mode of OUT8/P0_4 terminals. 配置 OUT8/P0_4 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |
| 3 | OUT7_Mode | 1 | Configure mode of OUT7/P0_3 terminals. 配置 OUT7/P0_3 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |
| 2 | OUT6_Mode | 1 | Configure mode of OUT6/P0_2 terminals. 配置 OUT6/P0_2 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |
| 1 | OUT5_Mode | 1 | Configure mode of OUT5/P0_1 terminals. 配置 OUT5/P0_1 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |

| 0 | OUT4_Mode | 1 | Configure mode of OUT4/P0_0 terminals. 配置 OUT4/P0_0 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |

**Register Address: 13h, P1_Mode, Configure P1(OUT0/P1_0~OUT3/P1_3) as LED or GPIO mode (default FFh)**

| Bit | Label | Default | Description |
|---|---|---|---|
| 7:4 | - | - | Bit7~bit4, reserved |
| 3 | OUT3_Mode | 1 | Configure mode of OUT3/P1_3 terminals. 配置 OUT3/P1_3 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |
| 2 | OUT2_Mode | 1 | Configure mode of OUT2/P1_2 terminals. 配置 OUT2/P1_2 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |
| 1 | OUT1_Mode | 1 | Configure mode of OUT1/P1_1 terminals. 配置 OUT1/P1_1 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |
| 0 | OUT0_Mode | 1 | Configure mode of OUT0/P1_0 terminals. 配置 OUT0/P1_0 为 LED 或 GPIO 模式 |
| | | | 1: GPIO; |
| | | | 0: LED |

**Register Address: 14h, Breath_EN, Enable breathing function for OUT0~OUT5 (default 00h)**

| Bit | Label | Default | Description |
|---|---|---|---|
| 7:6 | - | - | Bit7~bit6, reserved |
| 5 | Breath_EN5 | 0 | Enable breathing function for OUT5. 0: disable; 1: enable |
| | | | 使能 OUT5 的 breathing 功能。0: 关闭；1：开启 |
| 4 | Breath_EN4 | 0 | Enable breathing function for OUT4. 0: disable; 1: enable |
| | | | 使能 OUT4 的 breathing 功能。0: 关闭；1：开启 |
| 3 | Breath_EN3 | 0 | Enable breathing function for OUT3. 0: disable; 1: enable |
| | | | 使能 OUT3 的 breathing 功能。0: 关闭；1：开启 |
| 2 | Breath_EN2 | 0 | Enable breathing function for OUT2. 0: disable; 1: enable |
| | | | 使能 OUT2 的 breathing 功能。0: 关闭；1：开启 |
| 1 | Breath_EN1 | 0 | Enable breathing function for OUT1. 0: disable; 1: enable |
| | | | 使能 OUT1 的 breathing 功能。0: 关闭；1：开启 |
| 0 | Breath_EN0 | 0 | Enable breathing function for OUT0. 0: disable; 1: enable |
| | | | 使能 OUT0 的 breathing 功能。0: 关闭；1：开启 |

**Register Address: 15h, Fade_Time, Configure Fade in and fade out time for breathing function(default 00h)**

| Bit | Label | Default | Description | |
|------|---------|---------|-------------|-------------|
| 7:6 | - | - | Bit7~bit6, reserved | |
| 5:3 | Fade_out | 000 | Fade out time. 渐暗时间设置 | |
| | | | 000: 0ms | 001: 315ms |
| | | | 010: 630ms | 011: 1260ms |
| | | | 100: 2520ms | 101: 5040ms |
| | | | 110: 0ms | 111: 0ms |
| 2:0 | Fade_in | 000 | Fade in time. 渐亮时间设置 | |
| | | | 000: 0ms | 001: 315ms |
| | | | 010: 630ms | 011: 1260ms |
| | | | 100: 2520ms | 101: 5040ms |
| | | | 110: 0ms | 111: 0ms |

**Register Address: 16h, On_Off_Time, Configure On and off time in blinking mode (default 00h)**

| Bit | Label | Default | Description | |
|------|----------|---------|-------------|-------------|
| 7:6 | - | - | Bit7~bit6, reserved | |
| 5:3 | Off_time | 000 | Set off time for blinking mode. Blinking 模式下的常暗时间 | |
| | | | 000: 0ms | 001: 315ms |
| | | | 010: 630ms | 011: 1260ms |
| | | | 100: 2520ms | 101: 5040ms |
| | | | 110: 10080ms | 111: 20160ms |
| 2:0 | On_time | 000 | Set on time for blinking mode. Blinking 模式下的常亮时间 | |
| | | | 000: 0ms | 001: 315ms |
| | | | 010: 630ms | 011: 1260ms |
| | | | 100: 2520ms | 101: 5040ms |
| | | | 110: 10080ms | 111: 20160ms |

**Register Address: 17h~1Ch, OUTx_Delay, Configure delay time before start blinking in blinking mode for OUTx; 17h for OUT0, 18h for OUT1, … , 1Ch for OUT5(default 00h)**

| Bit | Label | Default | Description | |
|------|-----------|---------|-------------|-------------|
| 7:0 | OUTx_Delay | 000 | delay time before start blinking in blinking mode. Blinking 模式下开始闪烁前的延迟时间 | |
| | | | 00h: 0ms | 01h: 315ms |
| | | | 02h: 630ms | 03h: 1260ms |
| | | | … | |
| | | | 110: 80325ms | FFh: 80640ms |

**Register Address: 20h~2Fh, DIMx, 256 step dimming control register (default 00h)**

| Address | Name | Default | Description |
|---------|------|---------|-------------|
| 2xh | DIMx | 00h | Diming Control ofOUTx, See Table 5 and table 2. |

**Register Address: 7Fh, Software reset register (default 00h)**

| Address | Name | Default | Description |
|---------|-------|---------|-------------|
| 7Fh | Reset | 00h | Write 00h to generate a software reset. 写 00h 则进行软件复位. |

# ■ PACKAGE OUTLINE

Top View

Side View

Bottom View

Side View
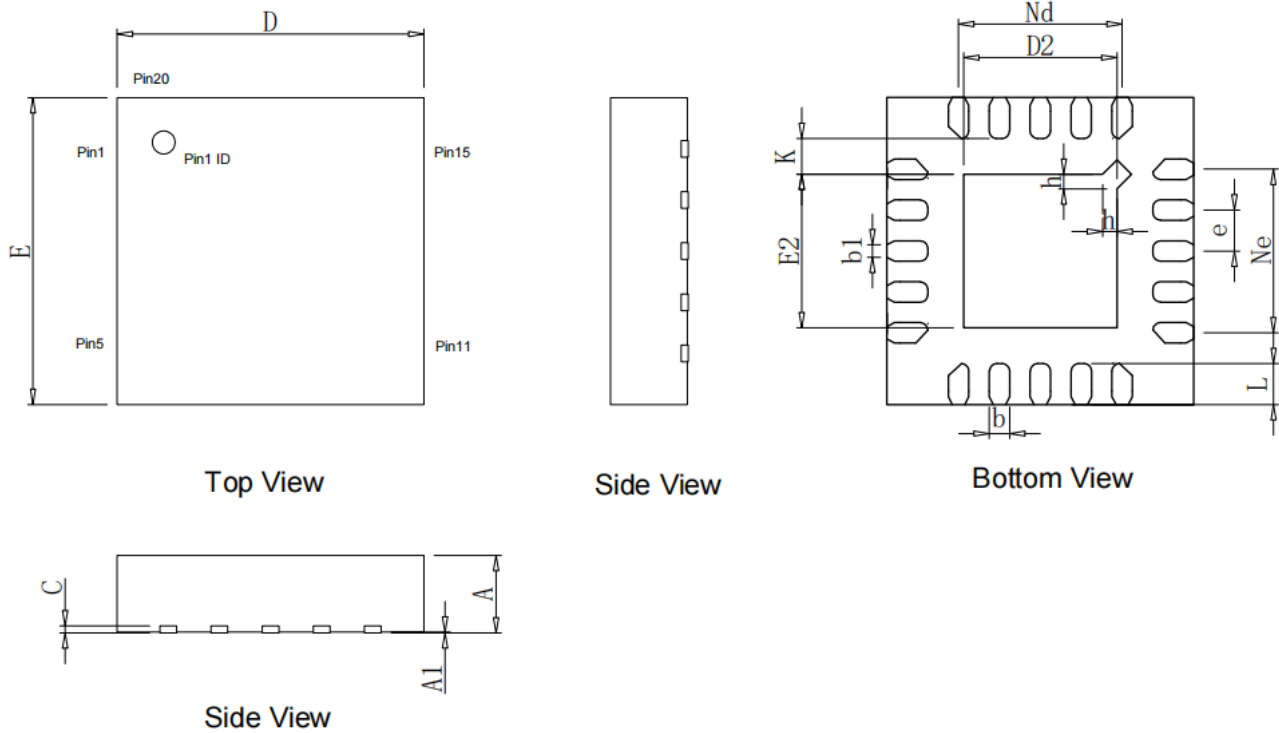
| Symbol | Dimensions in Millimeters | | |
|--------|------|------|------|
| | Min. | NOM | Max. |
| A | 0.65 | 0.75 | 0.85 |
| A1 | - | 0.02 | 0.05 |
| C | 0.203REF | | |
| D | 2.90 | 3.00 | 3.10 |
| E | 2.90 | 3.00 | 3.10 |
| D2 | 1.45 | 1.50 | 1.55 |
| E2 | 1.45 | 1.50 | 1.55 |
| K | 0.350 TYP. | | |
| b | 0.15 | 0.20 | 0.25 |
| b1 | 0.120 REF. | | |
| e | 0.40 BSC | | |
| Ne | 1.6 BSC | | |
| Nd | 1.6 BSC | | |
| L | 0.35 | 0.40 | 0.45 |
| h | 0.15 | 0.20 | 0.25 |

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