

AW2015 带低电压充电指示功能的 RGB 呼吸灯控制器

特性

- 恒流驱动三路 LED 或单颗 RGB
 - 最大输出电流 4 级可配: 3/6/12/25.5mA
 - 每路独立 256 级电流可配, 支持 1600 万种配色
- 256 级 PWM 控制实现淡进淡出
 - 12bit PWM 分辨率
 - 线性或指数调整可选
- 自主呼吸灯控制
 - 3 组独立的 Pattern 控制器
 - 3 路 LED 可同步控制或单独控制
 - 多脉冲、多色彩和多模式自动切换
- 支持低电压充电状态自动指示
 - 无需 I²C 接口通讯
 - CHRG_F 引脚为高时直接启动呼吸灯输出
 - LED1 输出, 呼吸周期 5s
 - 最大输出电流 6mA
- 两线 I²C 接口, 400kHz 快速模式, 设备地址为 64H, 接口电压支持 1.8~3.3V
- SCL 引脚提供 Shut-down 控制
- 单电源供电, 2.4~5.5V
- 纤小的 1.2mm×1.2mm×0.37mm FC-QFN8L 封装

概要

AW2015 是一款带低电压充电指示和呼吸灯控制功能的共阳极、恒流驱动 RGB LED 驱动芯片, 最大输出电流 4 级可选: 3mA/6mA/12mA/25.5mA, 每路 LED 输出电流 256 级可配, 可实现 1600 万种配色。256 级 PWM 亮度调节实现淡进淡出, 12bit PWM 分辨率即使在低亮度时也能保持均匀细腻的亮度渐变效果。

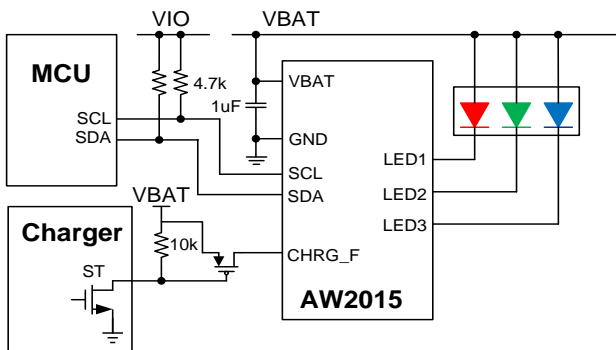
AW2015 支持低电压充电指示功能。当电池电压过低, 系统没有启动, 芯片无法通过 I²C 配置时, 若充电指示状态 CHRG_F 为高, 则自动开启默认呼吸灯功能, 呼吸效果为 LED1 (红灯) 输出, 周期为 5 秒, 最大输出电流为 6mA。

在 Shut Down 模式下, AW2015 内部电路全部关闭, 功耗小于 1μA; 在 Standby 模式下, AW2015 仅 I²C 接口工作, 功耗小于 10μA。

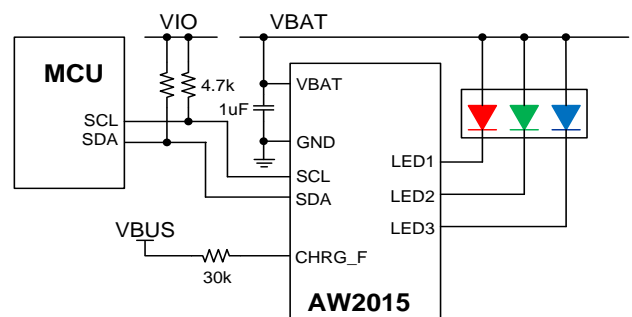
采用单电源供电, 工作电源范围为 2.4~5.5V。支持快速 I²C 接口, I²C 地址为 64H, 接口电压支持 1.8~3.3V。

芯片采用纤小的 1.2mm×1.2mm FC-QFN8L 封装, 占板面积小。

典型应用图



低电压充电指示应用图



电源插入指示应用图

AW2015 3 Channel LED Drivers with Auto Charging Indication

FEATURES

- 3-channel constant current LED drivers
 - 4-level I_{MAX} selections: 3/6/12/25mA
 - 256 current levels setting for each LED
 - Supports 256*256*256 color-mixing
- 256-level PWM dimming, 12-bit PWM resolution
- Support charging indication under low battery voltage condition
 - Directly start up breathing light on LED1 via pulling pin CHRG_F up to high
 - Breathing period: 5s
 - Max output current : 6mA
- Automatic breathing light with flexible pattern configuration and running mode
 - three independent pattern controllers
 - pulses repeating, multiple colors alternative
 - multiple patterns running successively or cyclically
- 400kHz fast I²C interface , 1.8V ~ 3.3V
- Single power supply, 2.4V~5.5V
- Low power consumption
 - Less than 1μA in shut down mode
 - Less than 10μA in standby mode
- FC-QFN8L 1.2mmx1.2mmx0.37mm package

GENERAL DESCRIPTION

AW2015 is a three channels constant current LED driver with auto charging indication function. The max output current is 4-level selectable among 3mA, 6mA, 12mA and 25mA. Each LED is 256 current levels configurable so as to achieve 256*256*256 color mixing. The 256-level dimming and 12 bits PWM resolution create fine and smooth dimming effect even in low brightness.

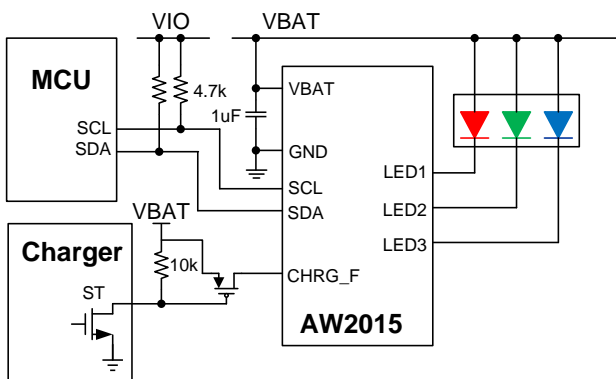
AW2015 can provide auto charging indication under the condition of low battery voltage. When the voltage of battery is too low, and the I²C interface can't work, the internal pattern controller will be activated if CHRG_F pin is high, and pin LED1 will output breathing effect with period of 5s and 6mA max current.

In shut down mode, AW2015 turn off all internal circuit and the consumption is less than 1μA. In standby mode, I²C interface works and the consumption is less than 10μA.

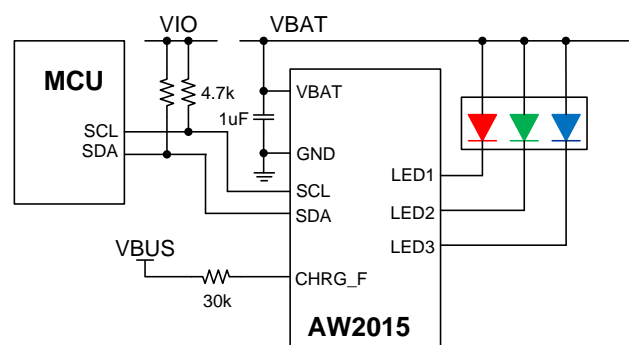
The device requires only 2.4V~5.5V single power supply. An I²C compatible interface in 400kHz fast mode is provided, the device address is 64h.

AW2015 is available in a ultra-thin 8 pin FC-QFN 1.2mm×1.2mm×0.37mm package.

TYPICAL APPLICATION CIRCUIT



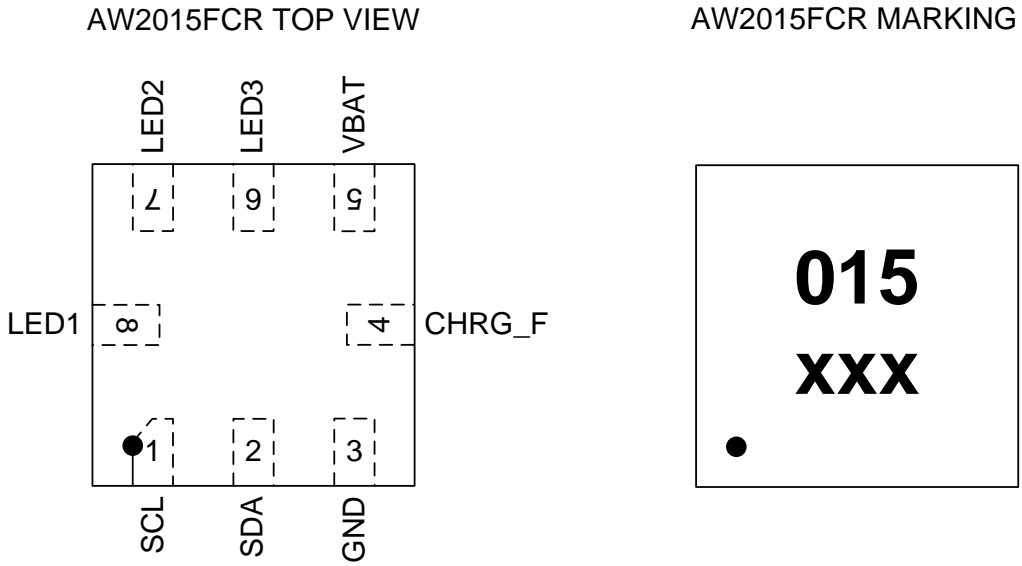
Charging Indicator Application



Adapter Plug In Indicator Application

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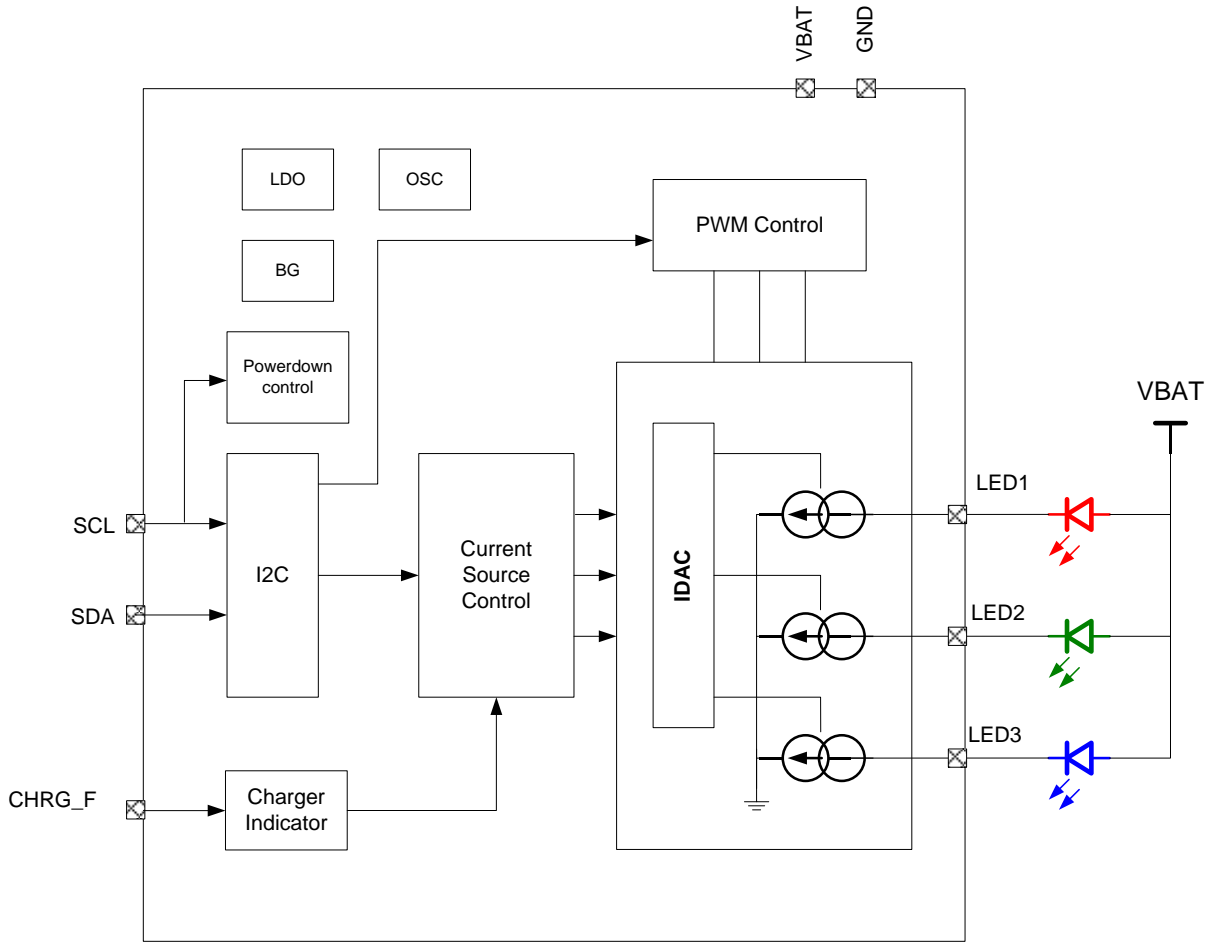
PIN CONFIGURATION AND TOP MARK



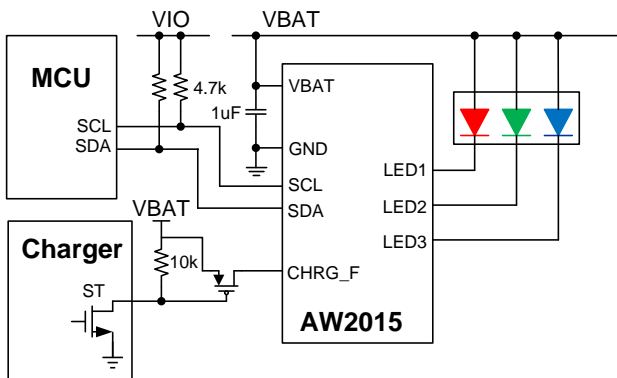
PIN DEFINITION

| No. | NAME | DESCRIPTION |
|-----|--------|---|
| 1 | SCL | Serial Clock Input for I ² C Interface |
| 2 | SDA | Serial Data I/O for I ² C Interface |
| 3 | GND | GND |
| 4 | CHRG_F | Charge Indicator Input |
| 5 | VBAT | Power Supply (2.4V-5.5V) |
| 6 | LED3 | LED3 Cathode Driver, anode connected to VBAT |
| 7 | LED2 | LED2 Cathode Driver, anode connected to VBAT |
| 8 | LED1 | LED1 Cathode Driver, anode connected to VBAT |

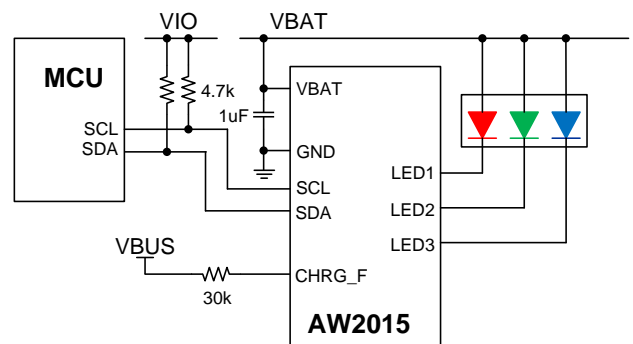
FUNCTIONAL BLOCK DIAGRAM



TYPICAL APPLICATION CIRCUITS



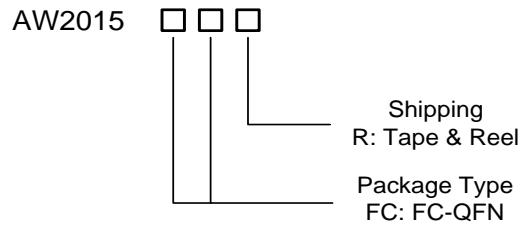
Charging Indicator Application



Adapter Plug In Indicator Application

ORDERING INFORMATION

| Part Number | Temperature | Package | Marking | Delivery Form |
|-------------|-------------|---------------------------------|------------|---------------|
| AW2015FCR | -40°C~85°C | 1.2mm×1.2mm×0.37mm FC-QFN-8L | 015 XXX | Tape and Reel |



ABSOLUTE MAXIMUM RATINGS(NOTE 1)

| PARAMETERS | | RANGE |
|--|-----------|----------------|
| Supply voltage range V_{BAT} | | -0.3V to 6.0V |
| Input voltage range | SCL, SDA, | -0.3V to 6.0V |
| | CHRG_F | -0.3V to 6.0V |
| | LED1~LED3 | -0.3V to 6.0V |
| Output voltage range | SDA | -0.3V to 6.0V |
| Junction-to-ambient thermal resistance θ_{JA} | | 122°C/W |
| Operating free-air temperature range | | -40°C to 85°C |
| Maximum Junction temperature T_{JMAX} | | 150°C |
| Storage temperature T_{STG} | | -55°C to 125°C |
| Lead Temperature (Soldering 10 Seconds) | | 260°C |
| ESD(NOTE 2) | | |
| HBM (human body model) | | 8000V |
| Latch-up | | |
| Test Condition: JEDEC STANDARD NO.78B DECEMBER 2008 | | 450mA |

NOTE1: Conditions out of those ranges listed in “absolute maximum ratings” may cause permanent damages to the device. In spite of the limits above, functional operation conditions of the device should within the ranges listed in “recommended operating conditions”. Exposure to absolute-maximum-rated conditions for prolonged periods may affect device reliability.

NOTE2: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: MIL-STD-883G Method 3015.7

ELECTRICAL CHARACTERISTICS

V_{BAT}=3.8V, T_A=25°C for typical values (unless otherwise noted)

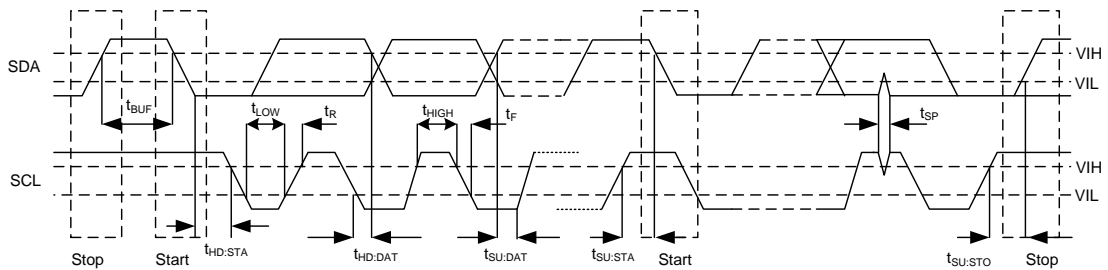
| Symbol | Description | Test Conditions | Min | Typ | Max | Units |
|----------------------------------|--------------------------------------|--|-----------------------|-----|-----|-------|
| Power supply | | | | | | |
| V _{BAT} | Input operation voltage | - | 2.4 | | 5.5 | V |
| I _{SHUTDOWN} | Current in Shutdown mode | SCL/ SDA =0V CHRG_F=0V (over 130ms) | | 0.1 | 1 | μA |
| I _{STANDBY} | Current in Standby mode | SCL/SDA=1.8V CHRG_F=0V | | 5 | 10 | μA |
| I _Q | Quiescent Current in Active mode | register CHIPEN=1 all LED off | | 80 | 100 | μA |
| I _{ACTIVE} | Current in Active mode | All channel set to 12.75mA | | 368 | | μA |
| | | LED1 set to 12.75mA LED2,LED3 off | | 203 | | |
| | | All channel set to 12.75mA T _{RISE} =2.1s, T _{ON} =0.04s T _{FALL} =2.1s, T _{OFF} =1s | | 140 | | |
| | | LED1 set to 12.75mA LED2,LED3 off T _{RISE} =2.1s, T _{ON} =0.04s T _{FALL} =2.1s, T _{OFF} =1s | | 106 | | |
| Digital Logical Interface | | | | | | |
| V _{IL} | Logic input low level | SDA,SCL | | | 0.4 | V |
| | | CHRG_F | | | 0.4 | |
| V _{IH} | Logic input high level | SDA,SCL | 1.3 | | | V |
| | | CHRG_F | V _{BAT} -0.2 | | | |
| I _{IL} | Low level input current | SDA,SCL | | 5 | | nA |
| I _{IH} | High level input current | SDA,SCL | | 5 | | nA |
| V _{OL} | Logic output low level | SDA, I _{OUT} =3mA | | | 0.4 | V |
| I _L | Output leakage current | SDA open drain | | | 1 | nA |
| I²C Interface | | | | | | |
| F _{SCL} | I ² C-BUS clock frequency | | | | 400 | kHz |
| T _{DEGLITCH} | SCL deglitch time | | | 200 | | ns |
| | SDA deglitch time | | | 250 | | ns |
| LED Driver | | | | | | |

| | | | | | | |
|--------------------|-------------------|---------------------------|-----|-----|-----|----|
| I _{ACC} | Current accuracy | I _{LED} =12.75mA | -5% | | +5% | % |
| I _{MATCH} | Matching accuracy | I _{LED} =12.75mA | -5% | | +5% | % |
| V _{DROP} | Dropout voltage | I _{LED} =12.75mA | | 50 | 80 | mV |
| F _{PWM} | PWM frequency | Register PWM_F=0 | 115 | 122 | 128 | Hz |
| | | Register PWM_F=1 | 230 | 244 | 256 | Hz |

NOTE5: The value is tested in default configuration.

I²C INTERFACE TIMING

| Parameter Name | | Min | Typ | Max | Units |
|-----------------------|---|-----|-----|-----|-------|
| F _{SCL} | Interface Clock frequency | | | 400 | kHz |
| T _{DEGLITCH} | Deglitch time | SCL | 200 | | ns |
| | | SDA | 250 | | ns |
| T _{HD:STA} | (Repeat-start) Start condition hold time | 0.6 | | | μs |
| T _{LOW} | Low level width of SCL | 1.3 | | | μs |
| T _{HIGH} | High level width of SCL | 0.6 | | | μs |
| T _{SU:STA} | (Repeat-start) Start condition setup time | 0.6 | | | μs |
| T _{HD:DAT} | Data hold time | 0 | | | μs |
| T _{SU:DAT} | Data setup time | 0.1 | | | μs |
| T _R | Rising time of SDA and SCL | | | 0.3 | μs |
| T _F | Falling time of SDA and SCL | | | 0.3 | μs |
| T _{SU:STO} | Stop condition setup time | 0.6 | | | μs |
| T _{BUF} | Time between start and stop condition | 1.3 | | | μs |



FUNCTIONAL DESCRIPTION

POWER_ON RESET

AW2015 provides a power-on reset feature that is controlled by VBAT supply voltage. When the VBAT supply voltage rises from 0V to 2.4V, the internal LDO starts to work. The reset signal will be generated to perform a power-on reset operation, which will reset all control circuits and configuration registers until the internal power voltage become stable.

The status bit STATUS.PUIS (register: 0x02 bit4) will be set to 1 when power-on reset operation occurs, which will be cleared by a read operation of STATUS register. Usually the STATUS.PUIS bit can be used to check whether a unexpected power-on event has taken place.

OPERATING MODE

In AW2015, pin SCL provides power down control. There are three work modes available: Shut-down, Standby and Active mode.

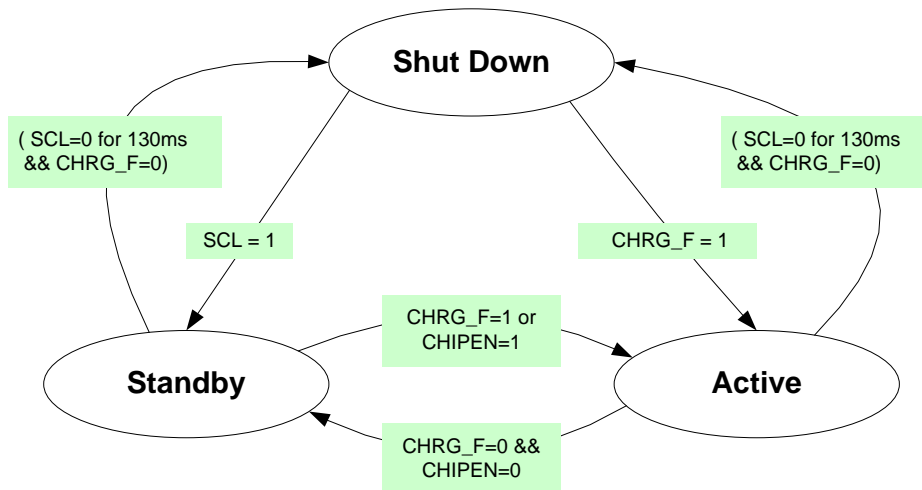


Figure 1. AW2015 operating mode transition

Shut-down Mode

AW2015 enters into the shut-down mode when CHRГ_F is low and SCL level is pulled to low for over 130ms (prevents system against wrong resets caused by electromagnetically influences)

In shut-down mode, AW2015 will reset all internal circuits and configuration register, all blocks inside AW2015 are basically switched off except the power on reset circuit and the SCL level detect circuit, and the current consumption is very low (< 1μA).

Standby Mode

AW2015 enters into standby mode when SCL level is pulled high from shut-down mode or CHRГ_F is low and CHIPEN is 0 from active mode. In standby mode, only part of internal circuit can work, the OSC still keep closed so that there is not internal clock, the LDO operates in low power state. The current consumption is less than 10μA.

In stand-by mode, the I²C interface is accessible, but only registers RSTIDR and GCR can be operated.

Active mode

When bit CHIPEN of GCR register is set to 1 in standby mode or CHRГ_F is high in shut down mode, AW2015 enters into active mode.

In active mode, the internal OSC starts to work to provide clock signal. User can configure the device to produce the pre-defined pattern lighting effects in pattern mode or turn each LED on or off directly.

When PWM level is low in fade-in and fade-out, only the OSC module works and the consumption is about

80uA(I_Q). So the average consumption of breathing is every low.

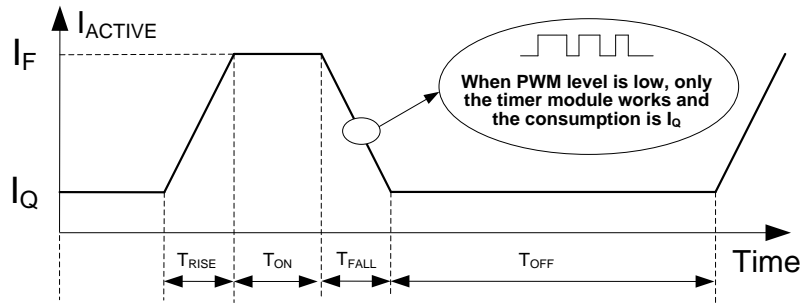


Figure 2. AW2015 consumption in active mode

Refer the following detailed formula (LED1/LED2/LED3 on)

$$I_{ACTIVE} = (I_F - I_Q) * \frac{(T_{RISE} + T_{FALL}) * 25\% + T_{ON}}{T_{RISE} + T_{ON} + T_{FALL} + T_{OFF}} + I_Q$$

| | | | | |
|----------------|-------|-------|-------|--------|
| IMAX | 3mA | 6mA | 12mA | 25.5mA |
| I _F | 223μA | 272μA | 368μA | 656μA |
| I _Q | 80μA | 80μA | 80μA | 80μA |

SOFTWARE RESET

Writing 0x55 to register RSTIDR (register: 0x00) via I²C interface will reset the AW2015 internal circuits and all configuration registers.

I²C INTERFACE

AW2015 supports the I²C serial bus and data transmission protocol in fast mode at 400 KHz. AW2015 operates as a slave on the I²C bus. Connections to the bus are made via the open-drain I/O pins SCL and SDA. The pull-up resistor can be selected in the range of 1k~10kΩ and the typical value is 4.7kΩ. AW2015 can support different high level (1.8V~3.3V) of this I²C interface.

Device Address

The I²C device address (7-bit) of AW2015 is 0x64, followed by the R/W bit (Read=1/Write=0).

Data Validation

When SCL is high level, SDA level must be constant. SDA can be changed only when SCL is low level.

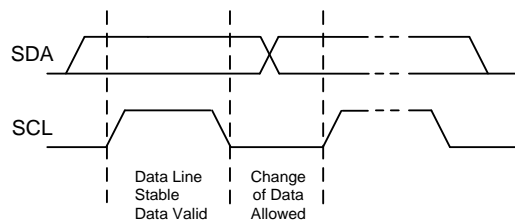


Figure 3. Data Validation Diagram

I²C Start/Stop

I²C start: SDA changes from high level to low level when SCL is high level.

I²C stop: SDA changes from low level to high level when SCL is high level.

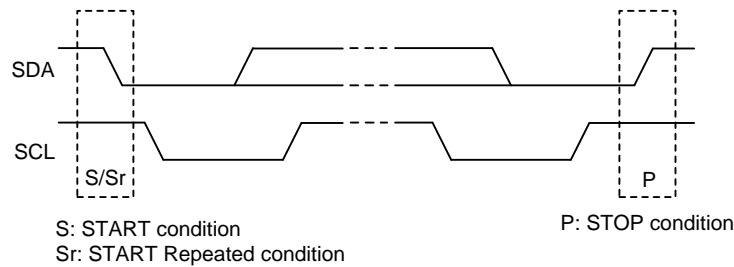


Figure 4. I²C Start/Stop Condition Timing

ACK (Acknowledgement)

ACK means the successful transfer of I²C bus data. After master sends 8bits data, SDA must be released; SDA is pulled to GND by slave device when slave acknowledges.

When master reads, slave device sends 8bit data, releases the SDA and waits for ACK from master. If ACK is send and I²C stop is not send by master, slave device sends the next data. If ACK is not send by master, slave device stops to send data and waits for I²C stop.

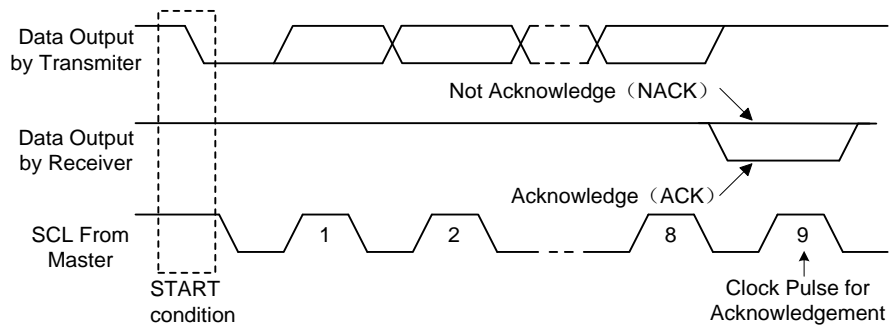


Figure 5. I²C ACK Timing

Write Cycle

One data bit is transferred during each clock pulse. Data is sampled during the high state of the serial clock (SCL). Consequently, throughout the clock’s high period, the data should remain stable. Any changes on the SDA line during the high state of the SCL and in the middle of a transaction, aborts the current transaction. New data should be sent during the low SCL state. This protocol allows a single data line to transfer both command/control information and data using the synchronous serial clock.

Each data transaction is composed of a Start Condition, a number of byte transfers (set by the software) and a Stop Condition to terminate the transaction. Every byte written to the SDA bus must be 8 bits long and is transferred with the most significant bit first. After each byte, an Acknowledge signal must follow.

In a write process, the following steps should be followed:

- a) Master device generates START condition. The “START” signal is generated by lowering the SDA signal while the SCL signal is high.
- b) Master device sends slave address (7-bit) and the data direction bit (r/w = 0).
- c) Slave device sends acknowledge signal if the slave address is correct.

- d) Master sends control register address (8-bit)
- e) Slave sends acknowledge signal
- f) Master sends data byte to be written to the addressed register
- g) Slave sends acknowledge signal
- h) If master will send further data bytes the control register address will be incremented by one after acknowledge signal (repeat step 6,7)
- i) Master generates STOP condition to indicate write cycle end

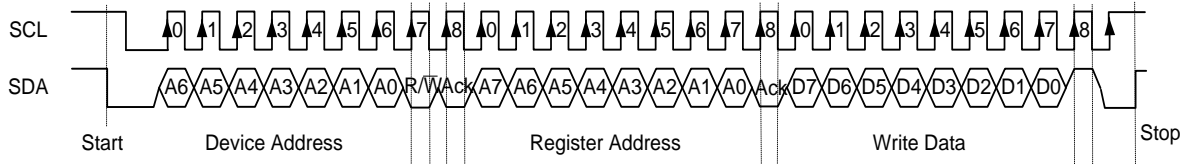


Figure 6. I²C Write Byte Cycle

Read Cycle

In a read cycle, the following steps should be followed:

- a) Master device generates START condition
- b) Master device sends slave address (7-bit) and the data direction bit (r/w = 0).
- c) Slave device sends acknowledge signal if the slave address is correct.
- d) Master sends control register address (8-bit)
- e) Slave sends acknowledge signal
- f) Master generates STOP condition followed with START condition or REPEAT START condition
- g) Master device sends slave address (7-bit) and the data direction bit (r/w = 1).
- h) Slave device sends acknowledge signal if the slave address is correct.
- i) Slave sends data byte from addressed register.
- j) If the master device sends acknowledge signal, the slave device will increase the control register address by one, then send the next data from the new addressed register.
- k) If the master device generates STOP condition, the read cycle is ended.

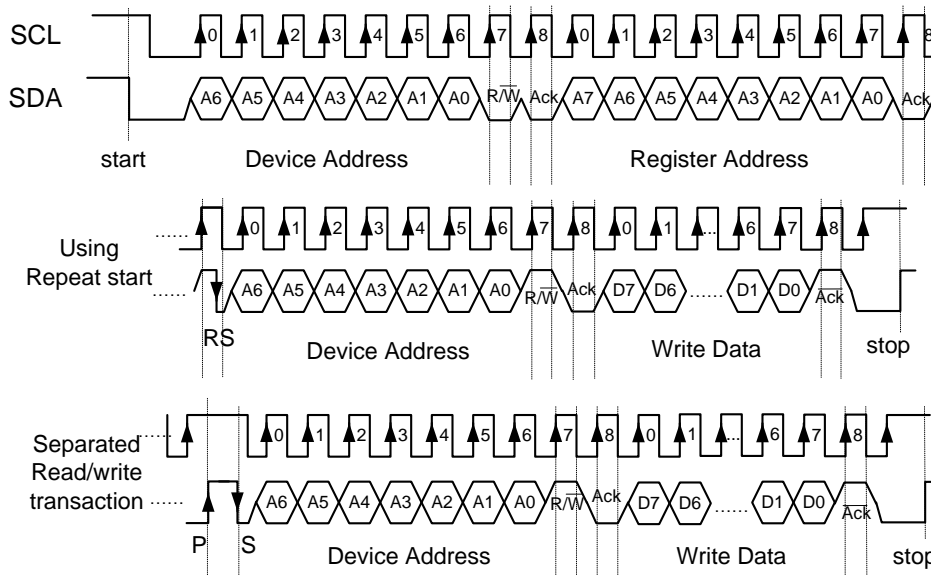


Figure 7. I²C Read Byte Cycle

LED DRIVER

AW2015 has three LED drivers to drive one RGB LED or three single-color LEDs. Each LED is driven by common-anode mode constant current source with duty cycle controlled by PWM. Both current and PWM can be configured via I²C interface.

LED Current

Globally, the maximum output current for three LEDs is 4-level selectable among 3mA, 6mA, 12mA and 25.5mA via register IMAX (register: 0x03). In general, IMAX is used to set the max brightness of LED output. For each LED, there is 256 current levels configurable via 8-bit register groups ILEDx_y (x=1~3, y=1~4). So in RGB application it is possible to combine into 256x256x256 color-mixing schemes totally to achieve so-called true-color effect.

Generally the current level register is used to form specified LED color for RGB application. AW2015 has 4 groups pre-defined current registers capable of forming 4 dedicated colors in true-color pattern scheme, in which up to 4 pre-defined colors can be configured to represent 4 kinds of message, more than one color can flash one by one successively in the same pattern when it's necessary to transmit more than one messages.

PWM Dimming Control

In AW2015, each LED current source is gated by a 256-level, 12bit resolution PWM signal to create fine dimming effect.

Each LED has an 8 bit PWM register PWMx (register: 0x1c, 0x1d, 0x1e) to control the duty cycle of constant current source. The ramp up and down are automatically implemented by PWM duty continuously adjusted to form a smooth LED current transition between ON and OFF state. The ramp slope, for rise and fall, are separately set via configuring the bit4~bit7 in pattern registers PATx_1 and PATx_2.

The ramping can be configured as linear and logarithmic curve by setting bit0~1 (PWMLOG) in register LEDCTR (register 0x08).

LED Control

Each LED of AW2015 can be independently configured to work or not via control bit LEDxEN.

- LEDxEN = 0, LEDx channel is disabled and no current output.
- LEDxEN = 1, LEDx channel is enabled to output lighting effect in different work mode.

By register configuration, AW2015 provides two types of LED control modes:

- Pattern control mode.

AW2015 contains three independent pattern controller and three groups of pattern parameter register to generate user-defined breathing lighting effect. In RGB application, one pattern controller control 3 LED simultaneously to produce true-color breathing lighting, and three groups of pattern parameter can be executed successively or cyclically. For LED-independent application, three pattern controller are allocated to three different LEDs respectively, each operates with individual pattern parameter, user can start or stop each pattern independently

- Manual control mode.
 User directly set the brightness level of each LED by configuring relative current level register and PWM level register via I²C interface. Usually it's recommended to modify the PWM level to set on or off. For each variation of PWM level register, the smoothly ramping effect is supported by setting FADE_IN bit and/or FADE_OUT bit in register LCFGx (x=1~3).

Pattern Control Mode

Breathing Lighting Control

When register bit LCFGx.LEDMD (register: 0x04, 0x05, 0x06 bit0) is set to 1, the corresponding LEDx operates in pattern mode.

User should configure the related pattern parameter registers according to actual timing requirements via I²C interface before starting pattern. The repeating times of pattern is configurable also, which may be 1~ 2048 or infinite according to setting of register PATx_T5 (x=1~4).

Single Pulse mode

Basically one pattern contains only one blinking, it's called as single pulse mode. In single pulse mode, the pattern parameters includes delay time, rise time, on time, fall time, off time and repeat times can be set by corresponding configuration registers (PATx_T1~T5), The meanings of basic single-pulse pattern parameters are shown in Figure and table below.

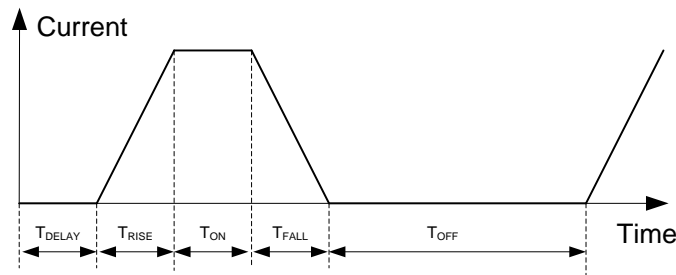


Figure 8. Basic single-pulse pattern parameter definition

| Symbol | Parameters | Min | Typ | Max | Unit |
|-------------|--------------------------------|-----|-----|-----|------|
| T_{DELAY} | Delay time until pattern start | 0 | | 8 | s |
| T_{RISE} | Rise time for dimming up | 0 | | 8 | s |
| T_{ON} | On time | 0 | | 8 | s |
| T_{FALL} | Fall time for dimming down | 0 | | 8 | s |
| T_{OFF} | Off time | 0 | | 8 | s |

Multi-pulse mode

A serial fast pulse blinking can be used to transmit message different from that carried by single pulse. In multi-pulse mode, up to 4 pulses are allowed during one color blinking. Besides the basic timing parameter defined in single-pulse mode, there are 2 additional parameter need to be set:

The number of multi-pulse is defined by setting bit4~5 (MPULSE) in register PATx_T4 (register: 0x33/0x38/0x3D), the actual blinking times is MPULSE+1.

The interval time between two adjacent pulses is defined by T SLOT, bit5~7 in PATx_T4 (register: 0x32/0x37/0x3C).

| Symbol | Parameter | Min | Typ | Max | Unit |
|------------|------------------------------------|-----|-----|-------|------|
| T_{SLOT} | Pause time between multiple pulses | 0 | | 1.024 | s |

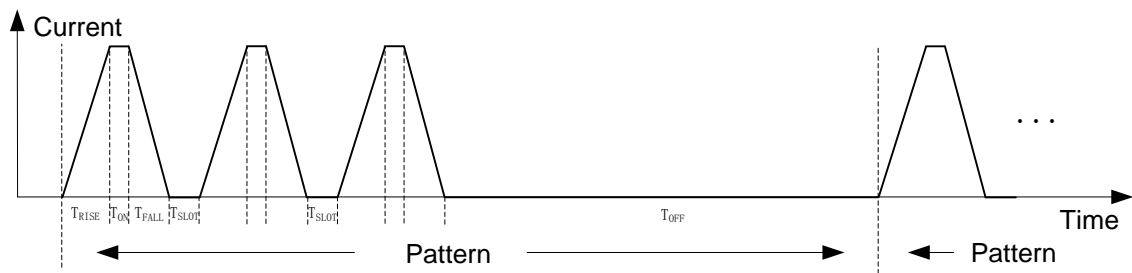


Figure 9. Multi-pulse pattern parameter definition

An example of multi-pulse pattern is shown below:

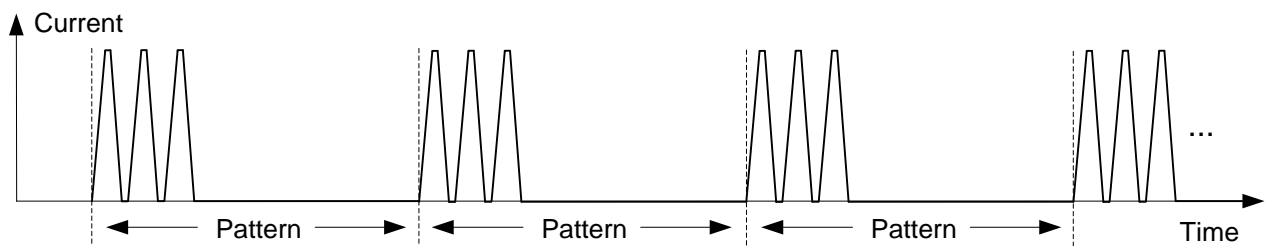


Figure 10. multi-pulse pattern example

Multi-color mode

Blinking with multiple different colors is allowed in one pattern period in RGB LED application, if different color is expected to carry different message.

In AW2015, the LED color is defined by LED current configure register ILEDx_y (x=1~3, y=1~4), there are 4 RGB current combination to generate 4 pre-defined colors for display. More than one of the 4 pre-defined colors can be chosen by setting CE1~CE4, bit0~bit3 in PATx_T4 (register:x32/0x37/0x3C), when CEx is set to 1, the color#x is allow to be displayed in current pattern.

If the color setting on CE1~CE4 is modified during current pattern is running, the updating of new color setting will not occur until present pattern period is over.

If both multi-pulse and multi-color is enabled simultaneously, every selected color will blink specified times before switching to another color, and the display order of color is always from color #1 to color #4.

An example of 4-color /single-pulse pattern is shown below, in which the CE1~CE4 are changed twice during pattern is running.

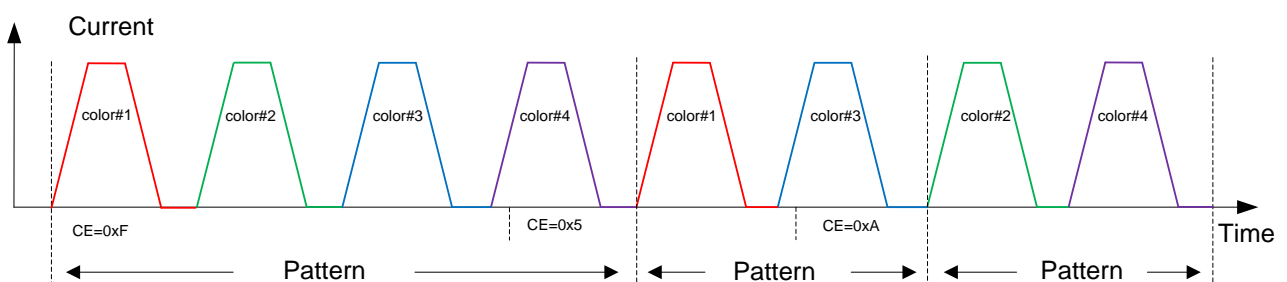


Figure 11. Example of multi-color mode and color scheme modification

True-color Breathing Lighting

In true-color breathing lighting application, the LEDMD, bit0 in LCFGx (register: 0x04, 0x05, 0x06), and the SYNC, bit3 in LEDCTR (register: 0x08 bit3) should be set to 1, three LED output share the same pattern controller to generate PWM dimming simultaneously. Multi-pulse, multi-color and multi-pattern modes are supported fully in this mode.

The RGB color is defined by LED current setting register ILEDx_y (x=1~3, y=1~4), there are 4 RGB current combination to generate 4 pre-defined color for display.

In true-color mode (SYNC=1), 3 groups of pattern timer parameters could be applied to defined 3 different breathing lighting effects, which can be executed successively or keep looping forever, without external processor involved to control every pattern switching. For each pattern, if PATx_T4.SW (register: 0x33, 0x38, 0x3E) is set to 1, the next pattern parameter will be loaded and started automatically after current pattern has finished.

The following table gives the current, pattern and the start/stop control source for each LED channel in true-color pattern mode.

| Channel | Current Configuration Register | Pattern used | Pattern Start | Pattern Stop |
|---------|--------------------------------|--|------------------------------------|------------------------------------|
| LED1 | ILED1_y | pattern #1, pattern #2, pattern #3 | Write 1 to register PATRUN bit0 | Write 1 to register PATRUN bit4 |
| LED2 | ILED2_y | | | |
| LED3 | ILED3_y | | | |

Note: Y=1~4, denotes 4 pre-defined color code (color #1, color #2, color #3 and color #4).

An example of single pulse and color pattern repeating in true-color pattern mode is depicted in the figure below.

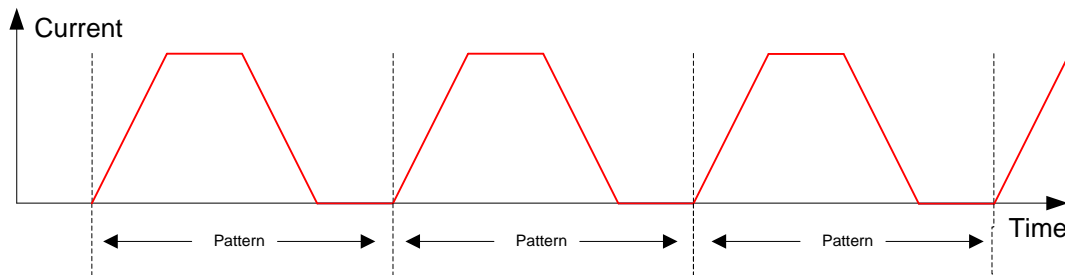


Figure 12. Example of single-pulse/single-color true-color pattern

The following figure is an example of multi pulse and multi color pattern repeating in true-color pattern mode.

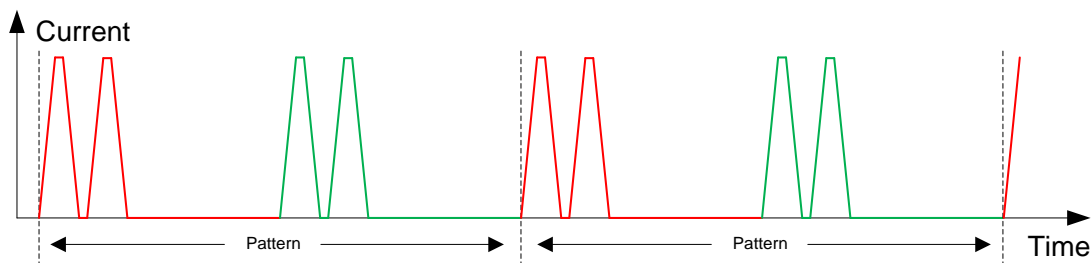


Figure 13. Example of 2-pulse/2-color in true-color pattern

The following figure is another example of three patterns running successively in true-color pattern mode.

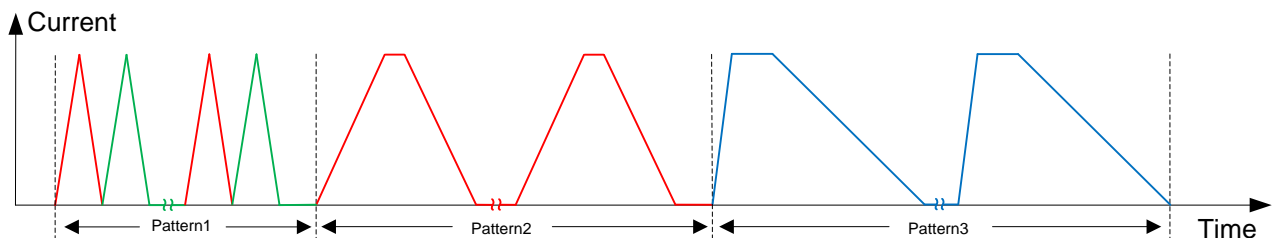


Figure 14. Example of 3 pattern running successively in true-color mode

Individual Breathing Lighting

In some application where three LED need blinking individually. When register bit LCFGx.LEDMD (register: 0x04, 0x05, 0x06 bit0) is set to 1, the corresponding LEDx operates in pattern mode. If register bit

LEDCTR.SYNC (register: 0x08 bit3) is 0, all pattern run in individually. In this mode, the 3 internal pattern controllers and 3 groups of pattern parameters are distributed to 3 LED channel respectively. Each LED can be controlled independently to blink according to its own pattern definition.

In this mode, multi-pulse pattern is supported, but multi-color is not supported, the bits CE1~CE4 in register PATx_T4 are ignored. Only registers ILEDx_1 is active for LED current setting, the other register including ILEDx_2, ILEDx_3 and ILEDx_4 are all useless.

The following table gives the current, pattern parameter and the start/stop control source selection for each LED channel in individual breathing lighting mode.

| Channel | Current Setting Register | Pattern used | Pattern Start | Pattern Stop |
|---------|--------------------------|--------------|------------------------|------------------------|
| LED1 | ILED1_1 (register: 0x10) | pattern #1 | write 1 to PATRUN bit0 | write 1 to PATRUN bit4 |
| LED2 | ILED2_1 (register: 0x11) | pattern #2 | write 1 to PATRUN bit1 | write 1 to PATRUN bit5 |
| LED3 | ILED3_1 (register: 0x12) | pattern #3 | write 1 to PATRUN bit2 | write 1 to PATRUN bit6 |

The following figure shows an example of 3 patterns run individually with different pattern parameters.

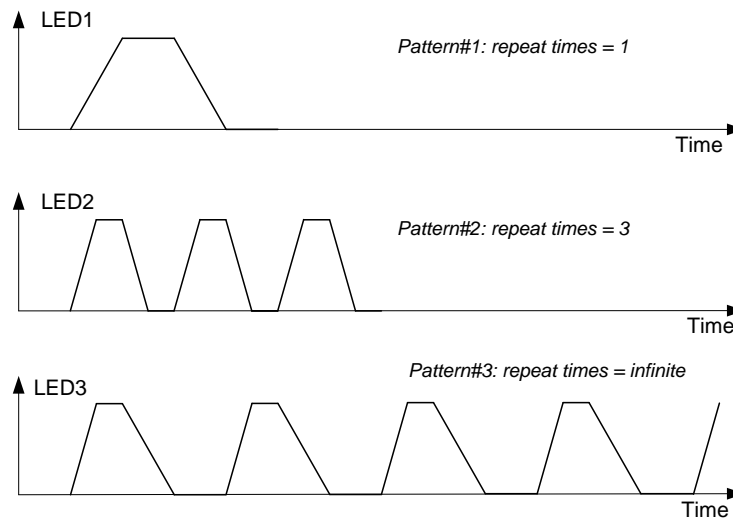


Figure 15. Example of Individual Pattern Mode

Manual Control Mode

When control bit LCFGx.LEDMD (register: 0x04, 0x05, 0x06 bit0) is set to 0, the corresponding LEDx is work in manual control mode.

In manual control mode, the LED lighting effects including color-mixed and brightness is directly configured by setting current/ PWM level register via I²C interface.

When LEDCTR.SYNC (register: 0x08, bit3) is set to 0, three LED are controlled individually, the PWM level and current for each is defined by PWM1/PWM2/PWM3 (register: 0x1C/0x1D/0x1E) and ILEDx_1 (register 0x10/0x11/0x12) respectively.

When LEDCTR.SYNC (register: 0x08, bit3) is set to 1, the output currents of three LED are defined by register ILEDx_1 respectively, but their PWM level are determined commonly by register PWM1. So user can change the brightness of all LED simultaneously by modifying the value of register PWM1 only.

| Channel | Current | Brightness | | Trise and Tfall time | |
|---------|---------|------------|--------|----------------------|------------|
| | | SYNC=0 | SYNC=1 | SYNC=0 | SYNC=1 |
| LED1 | ILED1_1 | PWM1 | PWM1 | PAT1_T1/T2 | PAT1_T1/T2 |
| LED2 | ILED2_1 | PWM2 | | PAT2_T1/T2 | |
| LED3 | ILED3_1 | PWM3 | | PAT3_T1/T2 | |

In manual control mode, auto dimming is supported. If LCFGx.FADE_OUT (register: 0x04, 0x05 0x06 bit2) is set to 1, automatic fade-out is enabled. If LCFGx.FADE_IN (register: 0x04, 0x05, 0x06 bit2) is set to 1, automatic fade-in is enabled. If a new value is set on PWMx register and auto dimming is enabled, the brightness of LED output ramp up/down smoothly, with its Trise and Tfall time defined by corresponding pattern

configuration (PATx_T1 and PATx_T2).

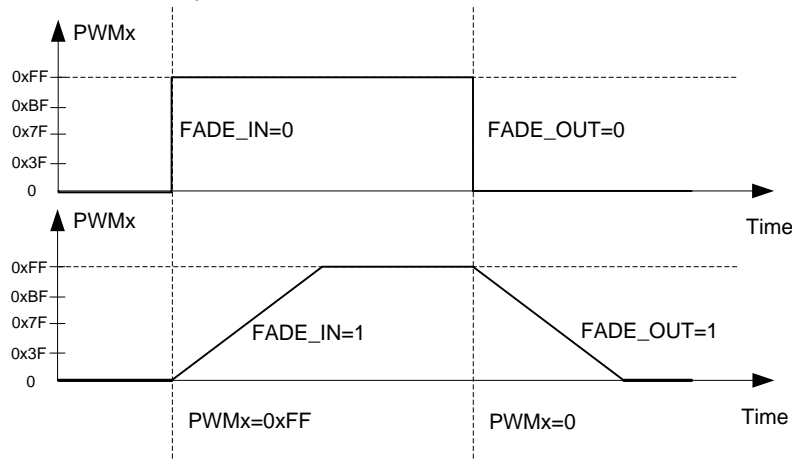


Figure 16. Manual Control Mode

Auto Charging Indication

In application of mobile phone, when battery voltage is too low and the PMU cannot work, the LED driver cannot be controlled by application processor via I²C interface. In this case, extra LED control circuit is necessary to be built in for charging status indication.

AW2015 provides the auto charging indication function for low battery voltage application. When the external USB power is inserts to phone, the pin CHRG_F is pulled high, AW2015 will enter active state automatically. The predefined pattern output only on pin LED1, the LED2 and LED3 keep off status. The pattern parameter is showed in figure below. The maximum current is 6mA, breathing period is about 5s. Once the CHRG_F pin goes low, the device comes back to shut-down state again and stops LED1 output.

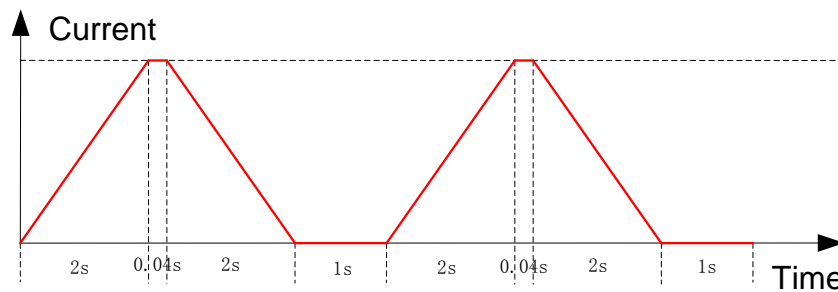


Figure 17. Auto Charging Indication Pattern Parameter

The auto charging indication function should be closed by configured register GCR.CHGDIS (register: 0x01 bit2) to 1 when the processor is able to configure AW2015 via I²C interface, then the lighting effects will have no relation with the CHRG_F status.

When special charger IC is used and pin CHRG_F is recommend to be connected to status pin of charger IC, the pin LED1 of AW2015 can indicate the real battery charging status.

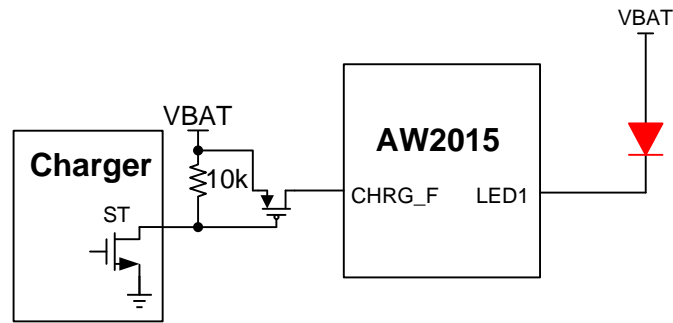


Figure 18. Real Charging Status Indication in special charger IC application

When no charger IC is applied, and battery charging is managed by PMU, no real charging status signal can be adapted, so the LED1 status can only indicate whether the USB power is plugged in or not. When the pull-up resistance is 30KΩ, VBUS range can be 5V - 15V.

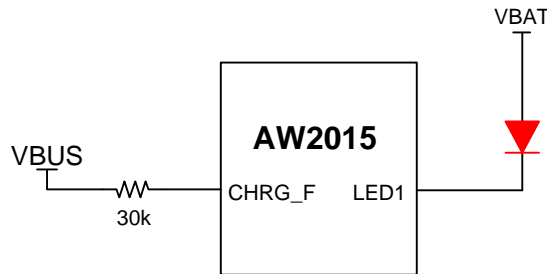


Figure 19. USB power Insertion status Indication in PMU charging control application

REGISTER DESCRIPTION

REGISTER LIST

| Addr (Hex) | Name | W/R | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|------------|---------|-----|---------|-------|--------|-------|--------|----------|---------|--------|--|
| 00 | RSTIDR | R | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | |
| 01 | GCR | WR | | | | | | PWM_F | CHGDIS | CHIPEN | |
| 02 | STATUS | R | | | PUIS | | - | LS2 | LS1 | LS0 | |
| 03 | IMAX | WR | | | | | | IMAX | | | |
| 04 | LCFG1 | WR | - | - | - | - | | FADE_OUT | FADE_IN | LEDMD | |
| 05 | LCFG2 | WR | - | - | - | - | | FADE_OUT | FADE_IN | LEDMD | |
| 06 | LCFG3 | WR | - | - | - | - | | FADE_OUT | FADE_IN | LEDMD | |
| 07 | LEDEN | WR | | - | - | - | - | LED3EN | LED2EN | LED1EN | |
| 08 | LEDCTR | WR | | | | - | - | SYNC | - | PWMLOG | |
| 09 | PATRUN | WR | - | STOP3 | STOP2 | STOP1 | - | RUN3 | RUN2 | RUN1 | |
| 10 | ILED1_1 | WR | ILED1_1 | | | | | | | | |
| 11 | ILED2_1 | WR | ILED2_1 | | | | | | | | |
| 12 | ILED3_1 | WR | ILED3_1 | | | | | | | | |
| 13 | ILED1_2 | WR | ILED1_2 | | | | | | | | |
| 14 | ILED2_2 | WR | ILED2_2 | | | | | | | | |
| 15 | ILED3_2 | WR | ILED3_2 | | | | | | | | |
| 16 | ILED1_3 | WR | ILED1_3 | | | | | | | | |
| 17 | ILED2_3 | WR | ILED2_3 | | | | | | | | |
| 18 | ILED3_3 | WR | ILED3_3 | | | | | | | | |
| 19 | ILED1_4 | WR | ILED1_4 | | | | | | | | |
| 1A | ILED2_4 | WR | ILED2_4 | | | | | | | | |
| 1B | ILED3_4 | WR | ILED3_4 | | | | | | | | |
| 1C | PWM1 | WR | PWM1 | | | | | | | | |
| 1D | PWM2 | WR | PWM2 | | | | | | | | |
| 1E | PWM3 | WR | PWM3 | | | | | | | | |
| 30 | PAT1_T1 | WR | TRISE | | | | TON | | | | |
| 31 | PAT1_T2 | WR | TFALL | | | | TOFF | | | | |
| 32 | PAT1_T3 | WR | TSLOT | | | | TDELAY | | | | |
| 33 | PAT1_T4 | WR | PATCTR | PATSW | MPULSE | | CE4 | CE3 | CE2 | CE1 | |
| 34 | PAT1_T5 | WR | REPTIM | | | | | | | | |
| 35 | PAT2_T1 | WR | TRISE | | | | TON | | | | |
| 36 | PAT2_T2 | WR | TFALL | | | | TOFF | | | | |
| 37 | PAT2_T3 | WR | TSLOT | | | | TDELAY | | | | |
| 38 | PAT2_T4 | WR | PATCTR | PATSW | MPULSE | | CE4 | CE3 | CE2 | CE1 | |
| 39 | PAT2_T5 | WR | REPTIM | | | | | | | | |
| 3A | PAT3_T1 | WR | TRISE | | | | TON | | | | |
| 3B | PAT3_T2 | WR | TFALL | | | | TOFF | | | | |
| 3C | PAT3_T3 | WR | - | | | | TDELAY | | | | |
| 3D | PAT2_T4 | WR | PATCTR | PATSW | MPULSE | | CE4 | CE3 | CE2 | CE1 | |
| 3E | PAT3_T5 | WR | REPTIM | | | | | | | | |

DETAILED REGISTER DESCRIPTION

RSTIDR, Chip ID and Software Reset Register

Address: 0x00, R/W, default: 0x31

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|----|----|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

| Bit | Symbol | Description |
|-----|--------|---|
| 7:0 | IDR | Chip ID, 0x31 Reset: write 0x55 to RSTIDR, reset internal logic and register |

GCR, Global Control Register

Address: 0x01, R/W, default: 0x00

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|-------|--------|--------|
| - | - | - | - | - | PWM_F | CHGDIS | CHIPEN |

| Bit | Symbol | Description |
|-----|--------|--|
| 2 | PWM_F | PWM Modulation Frequency Select 0: 122Hz PWM modulation 1: 245Hz PWM modulation |
| 1 | CHGDIS | Charge Indication Function Disable control 0: enable 1: disable |
| 0 | CHIPEN | Device operating Enable 0: Disable, the device is in standby state 1: Enable, the device enters active state |

STATUS Register

Address: 0x02, R/W, default: 0x10

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|------|---|-----|-----|-----|
| 0 | 0 | 0 | PUIS | - | LS3 | LS2 | LS1 |

| Bit | Symbol | Description |
|-----|--------|--|
| 4 | PUIS | Power Up Interrupt Status 0: No power-up reset has taken place 1: Power-up reset has taken place |
| 2 | LS3 | operating status indication for pattern controller 3 0: stop state 1: running state |
| 1 | LS2 | operating status indication for pattern controller 2 0: stop state 1: running state |
| 0 | LS1 | operating status indication for pattern controller 1 0: stop state |

1: running state

IMAX, LED Maximum Current Register

Address: 0x03, R/W, default: 0x01

| | | | | | | | |
|---|---|---|---|---|------|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | - | - | - | - | IMAX | | |

| Bit | Symbol | Description |
|-----|--------|--|
| 1:0 | IMAX | Maximum LED output Current Select 00: 3mA 01: 6.375mA 10: 12.75mA 11: 25.5mA |

LCFG1-3 LED Configure Register

LCFG1: Address: 0x04, R/W, default: 0x01

LCFG2: Address: 0x05, R/W, default: 0x00

LCFG3: Address: 0x06, R/W, default: 0x00

| | | | | | | | |
|---|---|---|---|---|----------|---------|-------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | - | - | - | - | FADE_OUT | FADE_IN | LEDMD |

| Bit | Symbol | Description |
|-----|----------|---|
| 2 | FADE_OUT | Fade-out enable control, only active in manual mode 0: PWM fade-out is disable, 1: PWM fade-out is enable, the dimming time decide by T _{FALL} |
| 1 | FADE_IN | Fade-in enable control, only active in manual mode 0: PWM fade-in is disable, 1: PWM fade-in is enable, the dimming time decide by T _{RISE} |
| 0 | LEDMD | LED Operating Mode Select. 0: Manual mode, LEDx is control directly by register ILEDx_1 and PWMx 1: Pattern mode |

LEDEN, LED Channel Enable Register

Address: 0x07, R/W, default: 0x01

| | | | | | | | |
|---|---|---|---|---|--------|--------|--------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | - | - | - | - | LED3EN | LED2EN | LED1EN |

| Bit | Symbol | Description |
|-----|--------|---|
| 2 | LED3EN | LED3 Enable 0: LED3 module stop work and LED3 out disable 1: LED3 output is enabled |
| 1 | LED2EN | LED2 Enable 0: LED3 module stop work and LED3 out disable |

- 1: LED2 output is enabled
- 0 LED1EN LED1 Enable
 0: LED3 module stop work and LED3 out disable
 1: LED1 output is enabled

LEDCTR, LED Control Register

Address: 0x08, R/W, default: 0x00

| | | | | | | | |
|---|---|---|---|------|---|--------|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | - | - | - | SYNC | - | PWMLOG | |

- Bit Symbol Description
- 3 SYNC LED Breathing Synchronous Mode Select
 0: 3 LED work in asynchronous mode with independent control
 1: 3 LED work in synchronous mode for RGB application.
- 1:0 PWMLOG PWM Logarithmic curve select
 0x: Log60
 10: Log10
 11: Linearity

PATRUN, Pattern Run/Stop Register

Address: 0x09, R/W, default: 0x00

| | | | | | | | |
|---|-------|-------|-------|---|------|------|------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | STOP3 | STOP2 | STOP1 | - | RUN3 | RUN2 | RUN1 |

- Bit Symbol Description
- 6 STOP3 Write 1, LED3 pattern stop if independent mode;
 The bit clears to 0 automatically after write 1.
- 5 STOP2 Write 1, LED2 pattern stop if independent mode;
 The bit clears to 0 automatically after write 1.
- 4 STOP1 Write 1, LED1 pattern stop if independent mode;
 Write 1, pattern stop if pattern mode;
 The bit clears to 0 automatically after write 1.
- 2 RUN3 Write 1, LED3 pattern run if independent mode;
 The bit clears to 0 automatically after write 1.
- 1 RUN2 Write 1, LED2 pattern run if independent mode;
 The bit clears to 0 automatically after write 1.
- 0 RUN1 Write 1, LED1 pattern run if independent mode;
 Write 1, pattern run if pattern mode;
 The bit clears to 0 automatically after write 1.

ILED1_y, LED1 Current Register

ILED1_1: Address: 0x10, R/W, default: 0xFF
 ILED1_2: Address: 0x13, R/W, default: 0x00
 ILED1_3: Address: 0x16, R/W, default: 0x00
 ILED1_4: Address: 0x19, R/W, default: 0x00

| | | | | | | | |
|---------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| ILED1_y | | | | | | | |

| | | |
|-----|---------|--|
| Bit | Symbol | Description |
| 2:0 | ILED1_y | LED1 Current Configure Register for 4 pre-defined colors, The LED1 output current value is $IMAX * ILED1_y / 255$. |

ILED2_y, LED2 Current Register

ILED2_1: Address: 0x11, R/W, default: 0x00
 ILED2_2: Address: 0x14, R/W, default: 0x00
 ILED2_3: Address: 0x17, R/W, default: 0x00
 ILED2_4: Address: 0x1A, R/W, default: 0x00

| | | | | | | | |
|---------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| ILED2_y | | | | | | | |

| | | |
|-----|---------|---|
| Bit | Symbol | Description |
| 7:0 | ILED2_y | LED2Current Configure Register for 4 pre-defined colors, The LED2 output current value is $IMAX * ILED2_y / 255$. |

ILED3_y, LED3 Current Register

ILED3_1: Address: 0x12, R/W, default: 0x00
 ILED3_2: Address: 0x15, R/W, default: 0x00
 ILED3_3: Address: 0x18, R/W, default: 0x00
 ILED3_4: Address: 0x1B, R/W, default: 0x00

| | | | | | | | |
|---------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| ILED3_y | | | | | | | |

| | | |
|-----|---------|--|
| Bit | Symbol | Description |
| 7:0 | ILED3_y | LED3 Current Configure Register, for 4 pre-defined colors The LED3 output current value is $IMAX * ILED3_y / 255$. |

PWM1/PWM2/PWM3 , PWM duty level Register

PWM1: Address: 0x1C, R/W, default:0xFF
 PWM2: Address: 0x1D, R/W, default:0x00
 PWM3: Address: 0x1E, R/W, default:0x00

| | | | | | | | |
|------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| PWMx | | | | | | | |

| | | |
|-----|--------|------------------------------|
| Bit | Symbol | Description |
| 7:0 | PWMx | PWM level for LEDx (x=1,2,3) |

PATx_T1, Time Parameter of Pattern x Register

PAT1_T1: Address: 0x30, R/W, default: 0x80

PAT2_T1: Address: 0x35, R/W, default: 0x00

PAT3_T1: Address: 0x3A, R/W, default: 0x00

| | | | | | | | |
|-------|---|---|---|-----|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| TRISE | | | | TON | | | |

| Bit | Symbol | Description | | | |
|-----|--------|-----------------------|-------|-------|------|
| 7:4 | TRISE | Rise Time of pattern: | | | |
| | | TRISE | Time | TRISE | Time |
| | | 0000 | 0s | 1000 | 2.1s |
| | | 0001 | 0.13s | 1001 | 2.6s |
| | | 0010 | 0.26s | 1010 | 3.1s |
| | | 0011 | 0.38s | 1011 | 4.2s |
| | | 0100 | 0.51s | 1100 | 5.2s |
| | | 0101 | 0.77s | 1101 | 6.2s |
| | | 0110 | 1.04s | 1110 | 7.3s |
| | | 0111 | 1.6s | 1111 | 8.3s |
| 3:0 | TON | On Time of pattern: | | | |
| | | TON | Time | TON | Time |
| | | 0000 | 0.04s | 1000 | 2.1s |
| | | 0001 | 0.13s | 1001 | 2.6s |
| | | 0010 | 0.26s | 1010 | 3.1s |
| | | 0011 | 0.38s | 1011 | 4.2s |
| | | 0100 | 0.51s | 1100 | 5.2s |
| | | 0101 | 0.77s | 1101 | 6.2s |
| | | 0110 | 1.04s | 1110 | 7.3s |
| | | 0111 | 1.6s | 1111 | 8.3s |

PATx_T2, Time Parameter of Pattern x Register

PAT1_T2: Address: 0x31, R/W, default: 0x86

PAT2_T2: Address: 0x36, R/W, default: 0x00

PAT3_T2: Address: 0x3B, R/W, default: 0x00

| | | | | | | | |
|-------|---|---|---|------|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| TFALL | | | | TOFF | | | |

| Bit | Symbol | Description | | | |
|-----|--------|-----------------------|------|-------|------|
| 6:4 | TFALL | Fall Time of pattern: | | | |
| | | TFALL | Time | TFALL | Time |

| | | | |
|------|-------|------|------|
| 0000 | 0s | 1000 | 2.1s |
| 0001 | 0.13s | 1001 | 2.6s |
| 0010 | 0.26s | 1010 | 3.1s |
| 0011 | 0.38s | 1011 | 4.2s |
| 0100 | 0.51s | 1100 | 5.2s |
| 0101 | 0.77s | 1101 | 6.2s |
| 0110 | 1.04s | 1110 | 7.3s |
| 0111 | 1.6s | 1111 | 8.3s |

2:0 TOFF Off Time of pattern:

| TOFF | Time | TOFF | Time |
|------|-------|------|------|
| 0000 | 0.04s | 1000 | 2.1s |
| 0001 | 0.13s | 1001 | 2.6s |
| 0010 | 0.26s | 1010 | 3.1s |
| 0011 | 0.38s | 1011 | 4.2s |
| 0100 | 0.51s | 1100 | 5.2s |
| 0101 | 0.77s | 1101 | 6.2s |
| 0110 | 1.04s | 1110 | 7.3s |
| 0111 | 1.6s | 1111 | 8.3s |

PATx_T3, Time Parameter of Pattern x Register

PAT1_T3: Address: 0x32, R/W, default: 0x00
 PAT2_T3: Address: 0x37, R/W, default: 0x00
 PAT3_T3: Address: 0x3C, R/W, default: 0x00

| | | | | | | | |
|---|-------|---|---|--------|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | TSLOT | | | TDELAY | | | |

| Bit | Symbol | Description |
|-----|--------|---------------------------|
| 6:4 | TSLOT | Slot Time Between Pulses: |
| | | TSLOT Time |
| | | 000 0ms |
| | | 001 130ms |
| | | 010 260ms |
| | | 011 380ms |
| | | 100 540ms |
| | | 101 670ms |
| | | 110 800ms |
| | | 111 1024ms |

3:0 TDELAY Startup Delay Time of Pattern:

| TDELAY | Time | TDELAY | Time |
|--------|-------|--------|------|
| 0000 | 0.04s | 1000 | 2.1s |

| | | | |
|------|-------|------|------|
| 0001 | 0.13s | 1001 | 2.6s |
| 0010 | 0.26s | 1010 | 3.1s |
| 0011 | 0.38s | 1011 | 4.2s |
| 0100 | 0.51s | 1100 | 5.2s |
| 0101 | 0.77s | 1101 | 6.2s |
| 0110 | 1.04s | 1110 | 7.3s |
| 0111 | 1.6s | 1111 | 8.3s |

PATx_T4, Time Parameter of Pattern x Register

PAT1_T4: Address: 0x33, R/W, default: 0x00

PAT2_T4: Address: 0x38, R/W, default: 0x00

PAT3_T4: Address: 0x3D, R/W, default: 0x00

| | | | | | | | |
|---------|--------|--------|---|-----|-----|-----|-----|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| PAT_CTR | PAT_SW | MPULSE | | CE4 | CE3 | CE2 | CE1 |

| Bit | Symbol | Description |
|-----|---------|--|
| 7 | PAT_CTR | Pattern running forever control 0: pattern run forever 1: pattern stop or switch to next pattern after repeating specified times. |
| 6 | PAT_SW | Pattern Switch enable, active only in true-color pattern mode. 0: Pattern switch is disabled 1: Pattern switch is enabled |
| 5:4 | MPULSE | Multiple Pulse mode selection. 00: single pulse 01: pulse repeats 2 times 10: pulse repeats 3 times 11: pulse repeats 4 times |
| 3 | CE4 | Color #4 display enable 0: Color#4 is masked 1: Color#4 is allow to display |
| 2 | CE3 | Color #3 display enable 0: Color#3 is masked 1: Color#3 is allow to display |
| 1 | CE2 | Color #2 display enable 0: Color#2 is masked 1: Color#2 is allow to display |
| 0 | CE1 | Color #1 display enable 0: Color#1 is masked 1: Color#1 is allow to display Note: if CE1~CE4 are all set to 0, Color #1 is displayed by default |

PATx_T5, Time Parameter of Pattern x Register

PAT1_T5: Address: 0x34, R/W, default: 0x00

PAT2_T5: Address: 0x39, R/W, default: 0x00

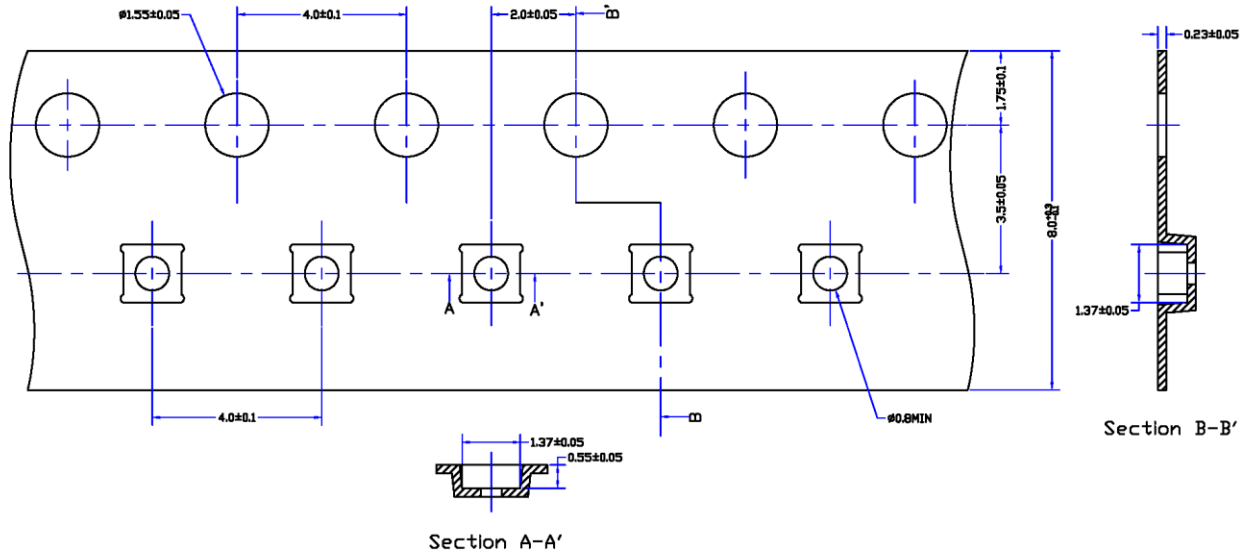
PAT3_T5: Address: 0x3E, R/W, default: 0x00

| | | | | | | | |
|--------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| REPTIM | | | | | | | |

| Bit | Symbol | Description |
|-----|--------|--|
| 7:0 | REPTIM | PATTERN Repeat Times |
| | | REPTIM [7] = 0: Pattern repeats REPTIM[6:0]+1 times |
| | | REPTIM [7] = 1: Pattern repeats (REPTIM[6:0]+1) * 16 times |

TAPE AND REEL INFORMATION

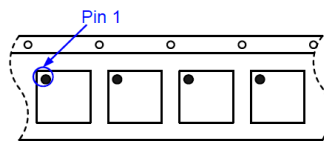
Carrier Tape



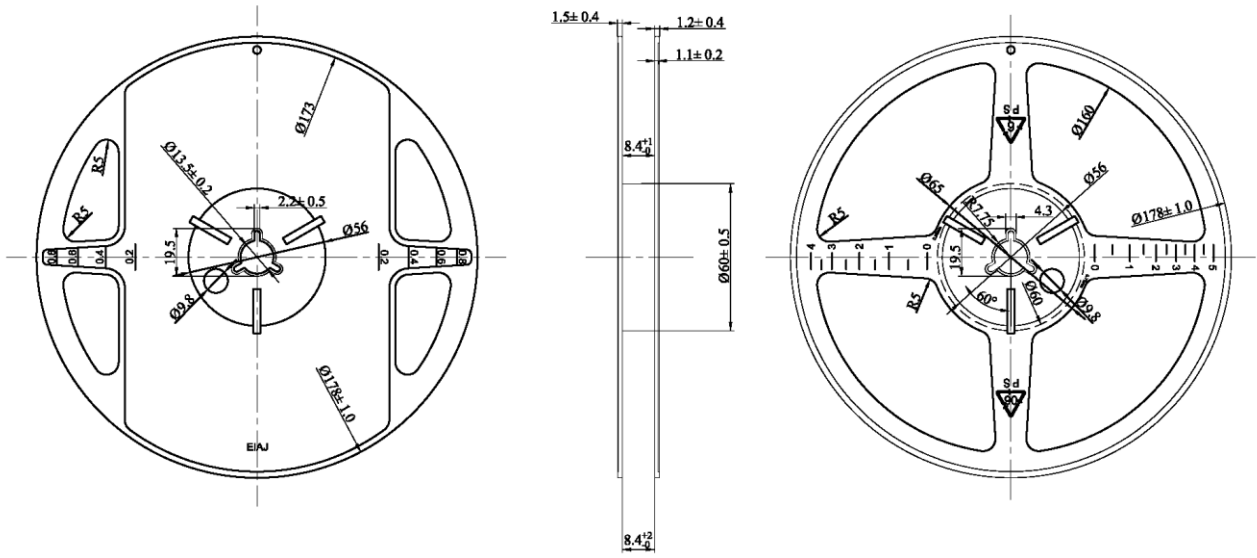
NOTES:

1. 10 pocket hole pitch cumulative tolerance ± 0.2
2. The meander of the tape is assumed with 1mm or less every 100mm between 250mm
3. MATERIAL: CONDUCTIVE POLYSTYRENE
4. ALL DIMS IN MM
5. There must not be foreign body adhesion and the state of the surface must be excellent
6. 17" PAPER—Reel, 125000 pockets(500m)
7. Surface resistance $1 \times 10^{11} (\text{max}) \text{ OHMS/SQ}$

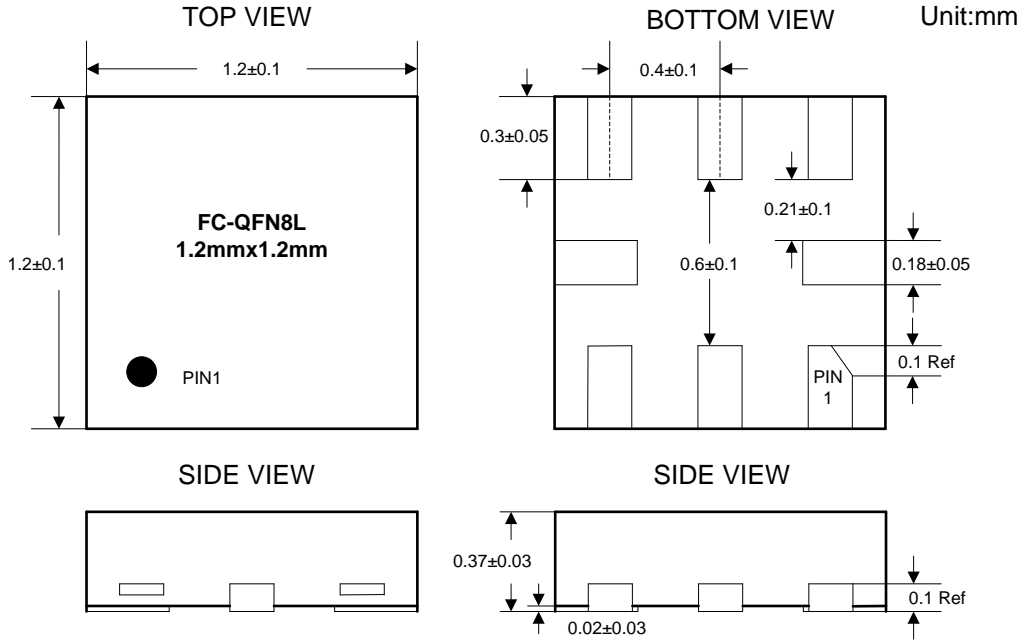
PIN1 Direction



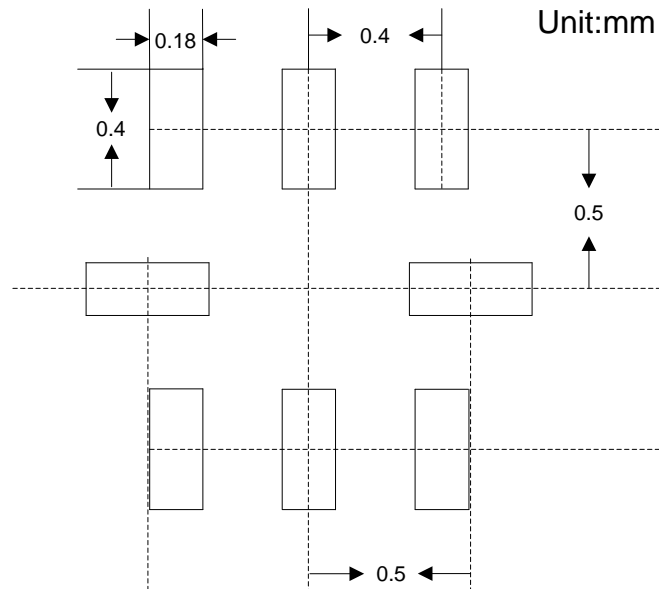
Reel



PACKAGE DESCRIPTION



RECOMMENDED LAND PATTERN



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