

### Features and Benefits

- The IC control circuit and the LED point light source share one power supply.
- Control circuit and RGB chip are integrated in a **4020** package components, form a complete addressable pixel
- Built-in signal shaping circuit, After any pixel receives the signal, it undergoes waveform shaping before being output, ensuring that the waveform distortion of the line does not accumulate.
- Built-in electric reset circuit and power lost reset circuit.
- OUT R/G/B output gray level: 256 gray scale, complete 16777216 full color display effect.
- Port Refresh frequency is of 2KHz.
- Serial cascade interface, data receiving and decoding depend on just one signal line.
- When the refresh rate is 30fps, cascade number are not less than 1024 pixels.
- Send data at speeds of 800Kbps.
- The color of the light is highly consistent, cost-effective.
- **Reverse power connection will not cause damage.**
- **LED's rated operating voltage is 5V (Max. operating driving voltage mustn't exceed 7V), LED won't be damaged when the power supply is reversed.**
- **Static power consumption is below 1μA; 3.3 V power supply is supported.**

### Applications

- Consumer electronics.
- LED decorative lighting,
- Computer and peripheral equipment, game equipment, various electrical equipment field.

### General description

**WS2812C-4020-V6** is a intelligent control LED light source that the control circuit and RGB chip are integrated in a package of **4020** components. It internal include intelligent digital port data latch and signal reshaping amplification drive circuit. Also include a precision internal oscillator and a voltage programmable constant current control part, effectively ensuring the pixel point light color height consistent.

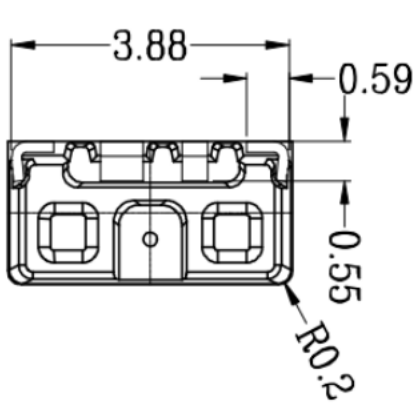
The data transfer protocol use Single-wire RZ protocol. After the pixel power-on reset, the DIN port receive data from controller, the first pixel collect initial 24bit data then sent to the internal data latch, the other data which reshaping by the internal signal reshaping amplification circuit sent to the next cascade pixel through the DO port. After transmission for each pixel, the signal to reduce 24bit. pixel adopt auto reshaping transmit technology, making the pixel cascade number is not limited the signal transmission, only depend on the speed of signal transmission.

**Refresh Frequency updates to 2KHz**, Low Frame Frequency and No Flicker appear in HD Video Camera, it improve excellent display effect.

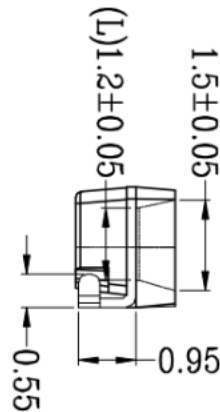
**RESET time > 280μs**, it won't cause wrong reset while interruption, supports the lower frequency and inexpensive MCU. LED with low driving voltage, environmental protection and energy saving, high brightness, scattering angle is large, good consistency, low power, long life and other advantages. The control chip integrated in LED above becoming more simple circuit, small volume, convenient installation.

## Mechanical Dimensions(unit:mm)

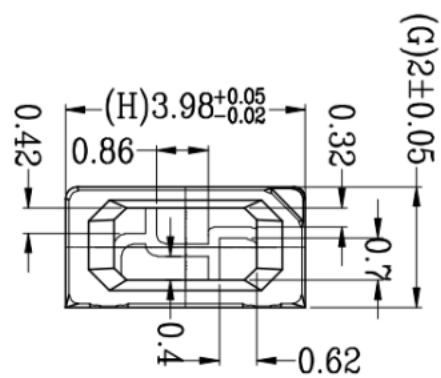
Tolerance:  $\pm 0.15\text{mm}$



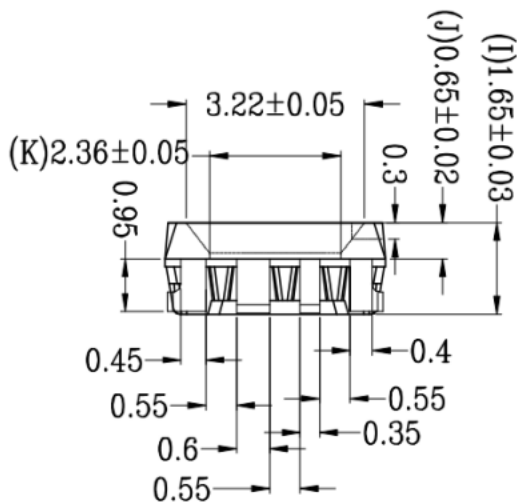
Side View



Side View

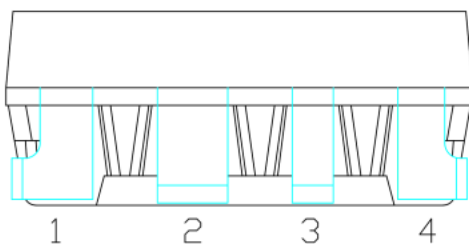


Top View



Side View

## PIN Configuration



**PIN Function**

| NO. | Symbol | PIN          | Function description          |
|-----|--------|--------------|-------------------------------|
| 1   | DIN    | DATA IN      | Control data signal input     |
| 2   | VDD    | POWER SUPPLY | Power supply                  |
| 3   | DOUT   | DATA OUT     | Control data signal output    |
| 4   | VSS    | GROUND       | Ground,data & power grounding |

**Absolute Maximum Ratings** ( $T_A=25^{\circ}\text{C}$ ,  $V_{SS}=0\text{V}$ )

| Parameter                          | Symbol    | Ratings        | Unit               |
|------------------------------------|-----------|----------------|--------------------|
| Power supply voltage               | $V_{DD}$  | +3.3~+5.3      | V                  |
| Logical Input Voltage              | $V_I$     | -0.3V~VDD+0.7V | V                  |
| Working temperature                | $T_{opt}$ | -40~+85        | $^{\circ}\text{C}$ |
| Storage temperature(bulk material) | $T_{stg}$ | -40~+105       | $^{\circ}\text{C}$ |
| Storage temperature(Whole reel)    | $T_{stg}$ | -40~+70        | $^{\circ}\text{C}$ |

**Electrical Characteristics** ( $T_A=25^{\circ}\text{C}$ ,  $V_{DD}=5\text{V}$ ,  $V_{SS}=0\text{V}$ )

| Parameter          | Symbol    | Min     | Tpy | Max      | Unit          | Conditions                                           |
|--------------------|-----------|---------|-----|----------|---------------|------------------------------------------------------|
| Quiescent current  | $I_o$     | —       | —   | 1        | $\mu\text{A}$ | No signal transmission,<br>RGB Channel is turned off |
| Output current     | $I_{out}$ | —       | 5   | —        | mA            | OUTR/OUTG/OUTB                                       |
| Input current      | $I_I$     | —       | —   | $\pm 1$  | $\mu\text{A}$ | $V_I=V_{DD}/V_{SS}$                                  |
| High Voltage Input | $V_{IH}$  | 0.55VDD | —   | VDD+0.7V | V             | D <sub>IN</sub> , SET                                |
| Low Voltage Input  | $V_{IL}$  | -0.3V   | —   | 0.7V     | V             | D <sub>IN</sub> , SET                                |

**Switching Characteristics** ( $T_A=25^{\circ}\text{C}$ ,  $V_{DD}=5\text{V}$ ,  $V_{SS}=0\text{V}$ )

| Parameter               | Symbol    | Min | Typ | Max | Unit          | Condition                                                                 |
|-------------------------|-----------|-----|-----|-----|---------------|---------------------------------------------------------------------------|
| Oscillation frequency   | $F_{osc}$ | —   | 800 | —   | KHz           | —                                                                         |
| Transmission delay time | $t_{PLZ}$ | —   | —   | 300 | ns            | $CL=15\text{pF}, \text{DIN} \rightarrow \text{DOUT}, RL=10\text{K}\Omega$ |
| Fall time               | $t_{THZ}$ | —   | —   | 120 | $\mu\text{s}$ | $CL=300\text{pF}, \text{OUTR}/\text{OUTG}/\text{OUTB}$                    |
| Data transmission rate  | $F_{MAX}$ | 600 | —   | —   | Kbps          | Duty cycle 50%                                                            |
| Input capacity          | $C_I$     | —   | —   | 15  | pF            | —                                                                         |

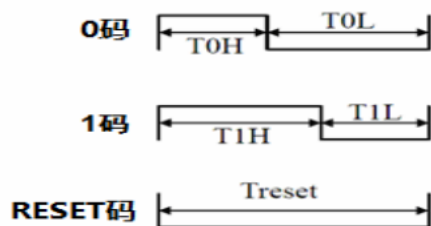
**LED Characteristics** ( $T_A=25^{\circ}\text{C}$ ,  $V_{DD}=5\text{V}$ ,  $V_{SS}=0\text{V}$ )

| Parameter  | Symbol      | Color | Min. | Typ. | Max. | Unit | Condition<br>(DC=5V) |
|------------|-------------|-------|------|------|------|------|----------------------|
| Brightness | IV          | Red   | 150  | --   | 200  | mcd  | 5mA                  |
|            |             | Green | 400  | --   | 600  |      |                      |
|            |             | Blue  | 100  | --   | 150  |      |                      |
| Wavelength | $\lambda_d$ | Red   | 625  | --   | 630  | nm   | 5mA                  |
|            |             | Green | 525  | --   | 530  |      |                      |
|            |             | Blue  | 470  | --   | 475  |      |                      |

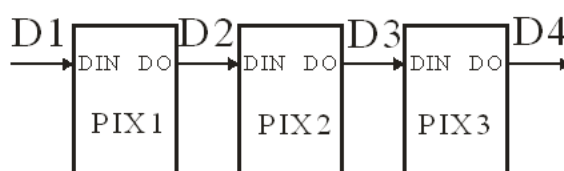
**Data Transfer Time**

|                   |                              |                        |
|-------------------|------------------------------|------------------------|
| T0H               | 0 code, high voltage time    | 220ns~380ns            |
| T1H               | 1 code, high voltage time    | 580ns~1 $\mu\text{s}$  |
| T0L               | 0 code, low voltage time     | 580ns~1 $\mu\text{s}$  |
| T1L               | 1 code, low voltage time     | 580ns~1 $\mu\text{s}$  |
| RES               | Frame unit, low voltage time | >280 $\mu\text{s}$     |
| T <sub>DATA</sub> | T1H+T1L、T0H+T0L              | $\geq 1.25\mu\text{s}$ |

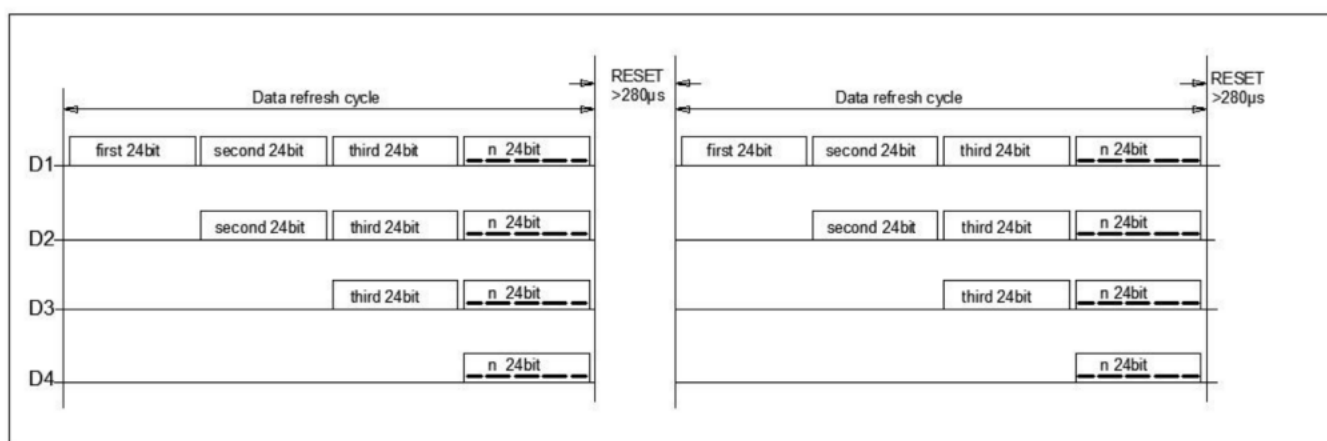
## Sequence Chart



## Cascade Method



## Data Transmission Method



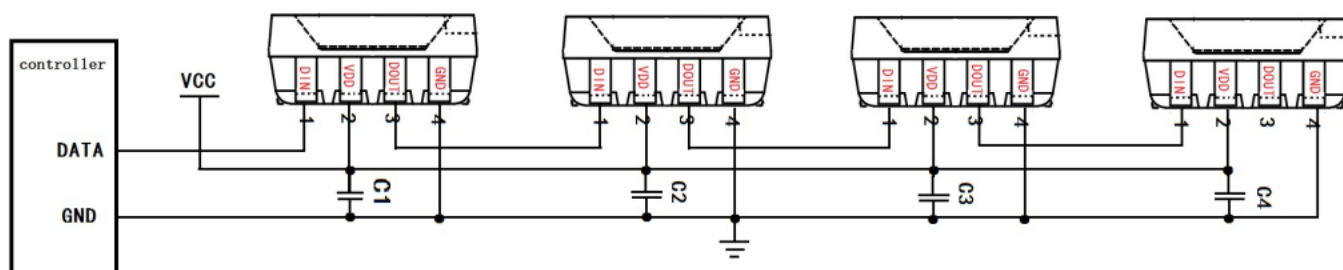
Note: The data of D1 is send by MCU, and D2, D3, D4 through pixel internal reshaping amplification to transmit.

## Composition of 24bit Data

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| G7 | G6 | G5 | G4 | G3 | G2 | G0 | R7 | R6 | R5 | R4 | R3 | R2 | R1 | R0 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

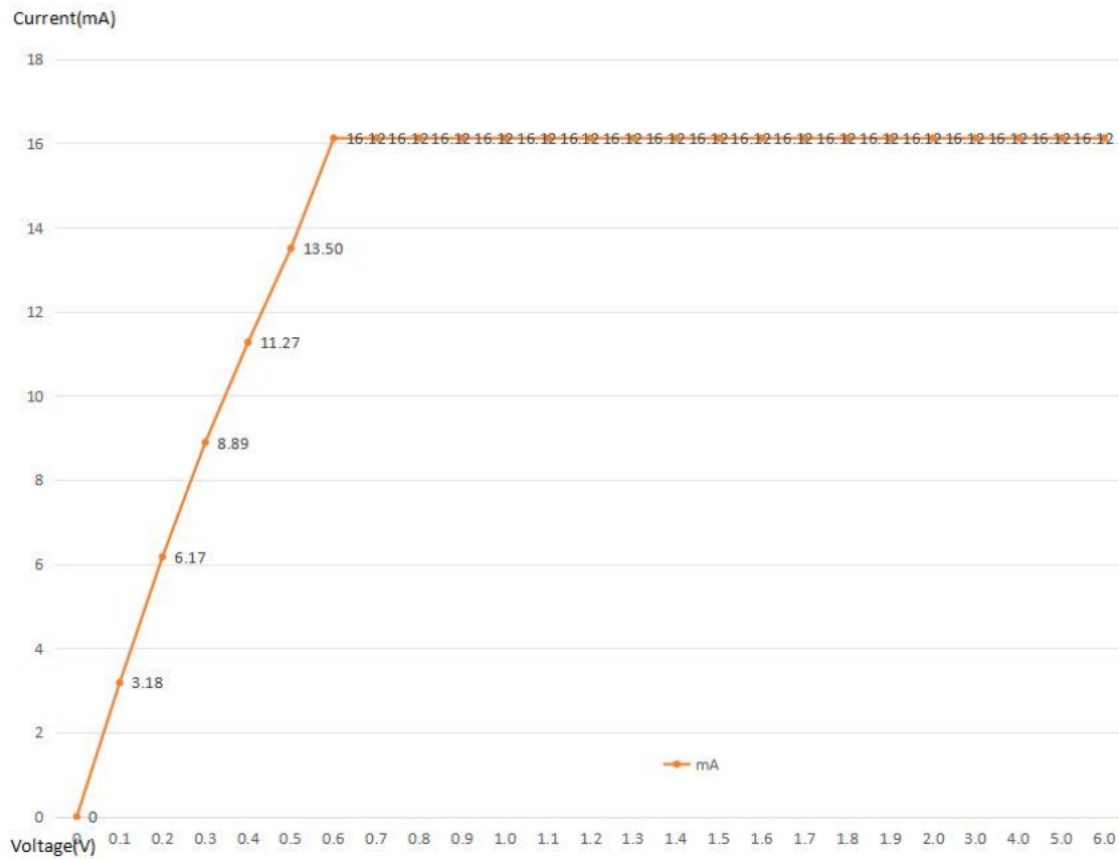
Note: Data transmit in order of GRB, high bit data at first.

## Typical Application Circuit:



Cn is the filter capacitor of the LED's VDD pin, Cn= 100nf.

## VF constant current curve



## Worldsemi Top SMD LED Using Instructions

### 1. Summary

To make the best use of WORLDSEMI's LED, please refer to the below precautions, they are of same usage method as other electronic components.

### 2. Cautions

#### 2.1. Dust & Cleaning

The surface of the LED is encapsulated with modified epoxy resin because it plays a very good role in protecting the optical performance and aging resistance. The modified epoxy resin is easy to stick with dust and must be kept clean. When there's a certain amount of dust on the surface of the LED, it won't affect brightness, but dust proof should be taken care of. Promoting the use of unsealed package in preference to others and the assembled LEDs should be placed in a clean container. Avoid using the organic solvents to clean the dust on the LED surface and it's necessary to confirm whether the cleaning fluid will dissolve the LED. Do not clean the LEDs by the ultrasonic. Some parameters affecting the LED performance must be evaluated if have no alternative but to the ultrasonic cleaning method, such as ultrasonic power, baking time and assembly conditions, etc.

#### 2.2. Moisture-proof packaging

TOP SMD LEDs are moisture sensitive components. LEDs are packaged in aluminum foil bag to prevent the LED from absorbing moisture during transport and storage. desiccant is placed in the bags to absorb moisture. If the LED absorbs moisture, then it evaporates and expands when in reflow process, which may break the colloid from the bracket and damage the optical performance of LED. For this reason, moisture-proof packaging is to prevent the from absorbing moisture during transport and storage. But usually the protection time can only maintain 1 ~ 2 months. During SMT, please refer to the definition of material moisture-proof Grade (MSL) stipulated by IPC/JEDECJ-STD-020 for MSL control. The moisture resistance rating of WORLDSEMI's LED is: **LEVEL 5a**.

**Tabel I - IPC/JEDEC J-STD-020 Moisture/Reflow Sensitivity Classification**

| MSL Level      | Workshop Life                |                    |
|----------------|------------------------------|--------------------|
|                | Time                         | Conditions         |
| LEVEL1         | Unlimited                    | ≤30°C/85%RH        |
| LEVEL2         | 1 Year                       | ≤30°C/60%RH        |
| LEVEL2a        | 4 Weeks                      | ≤30°C/60%RH        |
| LEVEL3         | 168 Hours                    | ≤30°C/60%RH        |
| LEVEL4         | 72 Hours                     | ≤30°C/60%RH        |
| LEVEL5         | 48 Hours                     | ≤30°C/60%RH        |
| <b>LEVEL5a</b> | <b>24 Hours</b>              | <b>≤30°C/60%RH</b> |
| LEVEL6         | Take-out and Use immediately | ≤30°C/60%RH        |

### 2.3 SMT Instruction:

2.3.1 It is recommended that opening the Vacuum plastic bag before SMT, and put the whole reel into the oven for dehumidification and drying (**Bake at 70 ~ 75°C ≧ 24H**);

2.3.2 From the led taken out of the oven to the completion of high temperature welding (including multiple reflow welding, tin immersion, wave soldering, heating maintenance and other high temperature operations/operations), the time period shall be controlled **within 24Hours** (Under condition of T<30°C, RH<60%);

2.3.3 After the LED paste is printed on the PCBA, SMT process should be completed as soon as possible, **it is recommended not to exceed 1H**;

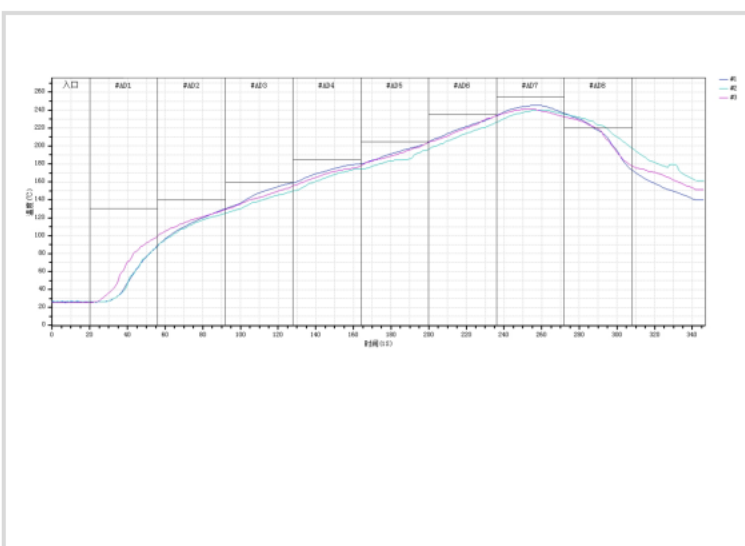
2.3.4 Bulk material LED, such as production surplus, machine material, maintenance material, can not be used directly if exposed to the air for a long time. It is recommended to be dehumidified and dried before being used.

**Whole reel baking: 70 ~ 75°C\* ≧24H or bulk led baking: 120°C\*4H.**

### 3. SMT Reflow Soldering

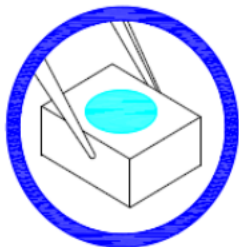
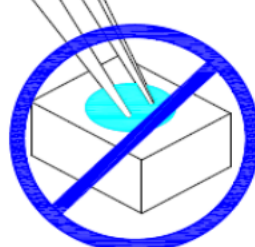
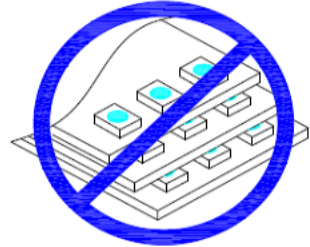
Refer to the parameters listed below, the experimental results prove that the TOP SMD LED meets the JEDEC J-STD-020C standards. As a general guideline, it is recommended to follow the SMT reflow temperature curve recommended by the solder paste manufacturer.

| Curve Description                         | Lead-free |
|-------------------------------------------|-----------|
| 30°C ~ 150°C preheating slope             | 1~4 °C/s  |
| 30°C ~ 150°C preheating time              | 60~120 s  |
| 150°C to 200°C constant temperature slope | 0~3 °C/s  |
| 150°C ~ 200°C constant temperature time   | 60~120 s  |
| LIQUID REGION temperature (TL)            | 217°C     |
| Peak Temperature (Tp)                     | 245°C     |
| Reflow slopeTime (tp)                     | 0~3 °C/s  |
| Reflow soldering time                     | 45~90 s   |
| Cooling Rate                              | -4~0 °C/s |
| Room Temperature to Peak Holding Time     | <6 min    |



Remarks: 1. All the above temperatures refer to the temperatures measured on the surface of the package body

### 4. Assembly Precautions

|                                                                                   |                                                                                                                  |                                                                                    |                                                                                     |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1. Clip the LED from its side.                                                    | 2. Neither directly touch the gel surface with the hand or sharp instrument, it may damage its internal circuit. | 3. Not to be double stacked, it may damage its internal circuit.                   | 4. Can not be stored in or applied in the acidic sites of PH<7.                     |
|  |                                 |  |  |

### Modify Record

| Version № | Status Bar | Modify Content Summary                                                                                 | Date     | Reviser       | Approved    |
|-----------|------------|--------------------------------------------------------------------------------------------------------|----------|---------------|-------------|
| V1.0      | N          | New(Upgrade from WS2812C-4020)                                                                         | 20260521 | He WenBin     | Yin HuaPing |
| V1.1      | M          | Logo update;<br>Add the Data transmission rate<br>Add recommend pad size<br>Add dimensional tolerances | 20260728 | Chen YongZhao | Yin HuaPing |
|           |            |                                                                                                        |          |               |             |
|           |            |                                                                                                        |          |               |             |
|           |            |                                                                                                        |          |               |             |

**Remarks:** Initial version: V1.0; Version number plus "0.1" after each revision;

Status bar: N--New, A--Add, M--Modify, D--Delete.

- Version number plus "0.1" if for add & modify parameters, eg. V1.0→ V1.1
- Major revision or many parameters modified, version number plus "1.0", eg. V1.0→ V2.0
- No version number is attached to Part Number