# WS2812C-4020
## Intelligent control LED integrated light source

## Features and Benefits

- The control circuit and the LED share the only power source.
- Control circuit and RGB chip are integrated in a package of 4020 components, to form a complete addressable **side-view** pixel.
- Built-in signal reshaping circuit, after wave reshaping to the next driver, ensure wave-form distortion not accumulate.
- Built-in electric reset circuit and power lost reset circuit.
- Each pixel of the three primary color can achieve 256 brightness display, completed 16777216 color full color display, and scan frequency is of 2KHz.
- Cascading port transmission signal by single line.
- Any two point the distance not more than 3m transmission signal without any increase circuit.
- 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 supply will not damage.

## Applications

- Full-color module, Full color soft lights a lamp strip.
- LED decorative lighting, Indoor/outdoor LED video irregular screen.

## General description

WS2812C-4020 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 programmable constant current control part, effectively ensuring the pixel point light color height consistent.

The data transfer protocol use single NZR communication mode. 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.

RESET time>**280μs** , it won't cause wrong reset while interruption, it supports the lower frequency and inexpensive MCU.

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

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.

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## Mechanical Dimensions（Unit:mm）
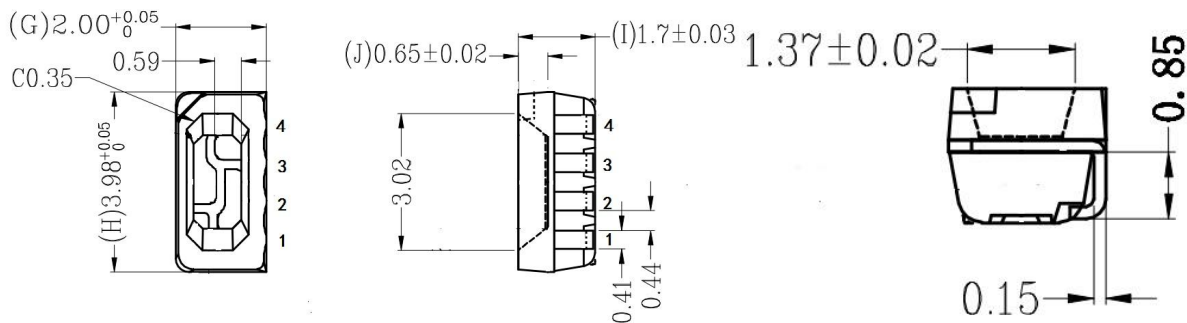


## Recommend Solder Pad Design（Unit:mm）
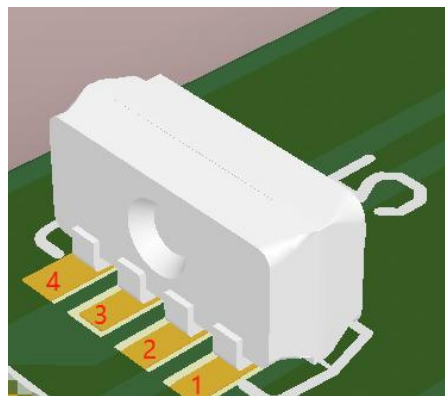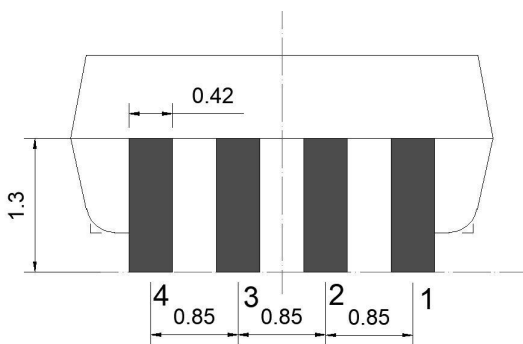


## PIN Function

| NO. | Symbol | PIN Name | Function description |
|---|---|---|---|
| 1 | DIN | Data In | Control data signal input |
| 2 | VDD | VDD | Power supply LED |
| 3 | DOUT | Data Out | Control data signal output |
| 4 | VSS | GND | Signal grounding & Power grounding |

## Absolute Maximum Ratings

| Parameter | Symbol | Ratings | Unit |
|---|---|---|---|
| Power supply voltage | $V_{DD}$ | +3.7~+5.3 | V |
| Logical Input Voltage | $V_I$ | -0.3V～VDD+0.7V | V |
| Operation junction temperature | Topt | -25～+85 | ℃ |
| Storage temperature range | Tstg | -40~+105 | ℃ |

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## Electrical Characteristics （$T_A$=-20～+70℃, $V_{DD}$=4.5～5.5V, $V_{SS}$=0V, unless otherwise specified）

| Parameter | Symbol | Min | Tpy | Max | Unit | Conditions |
|---|---|---|---|---|---|---|
| Input current | $I_I$ | —— | —— | ±1 | µA | $V_I$=$V_{DD}$/$V_{SS}$ |
| High level input | $V_{IH}$ | 0.7$V_{DD}$ | —— | VDD+0.7V | V | $D_{IN}$, SET |
| Low level input | $V_{IL}$ | -0.3V | —— | 0.7V | V | $D_{IN}$, SET |

## Switching Characteristics （$T_A$=-20～+70℃, $V_{DD}$=4.5～5.5V, $V_{SS}$=0V, unless otherwise specified）

| Parameter | Symbol | Min | Tpy | Max | Unit | Condition |
|---|---|---|---|---|---|---|
| Transmission delay time | $T_{PLZ}$ | —— | —— | 300 | ns | CL=15pF, DIN→DOUT, RL=10KΩ |
| Fall time | $T_{THZ}$ | —— | —— | 120 | µs | CL=300pF, OUTR/OUTG/OUTB |
| Input capacity | $C_I$ | —— | —— | 15 | pF | —— |

## LED Characteristics

| Parameter | Symbol | Color | Quiescent Current＜0.5mA | | | Unit | Condition (Working current) |
|---|---|---|---|---|---|---|---|
| | | | Mini | Typ | Max | | |
| Brightness | IV | RED | 150 | -- | 200 | mcd | 5mA |
| | | GREEN | 400 | -- | 600 | | |
| | | BLUE | 100 | -- | 150 | | |
| Wavelength | λd | 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~1µs |
| T0L | 0 code, low voltage time | 580ns~1µs |
| T1L | 1 code, low voltage time | 580ns~1µs |
| RES | Frame unit, low voltage time | >280µs |
| Data Cycle：T1H+T1L、T0H+T0L≥1.25µs | | |

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## Sequence Chart



0 code — T0H, T0L

1 code — T1H, T1L

RET code — Treset
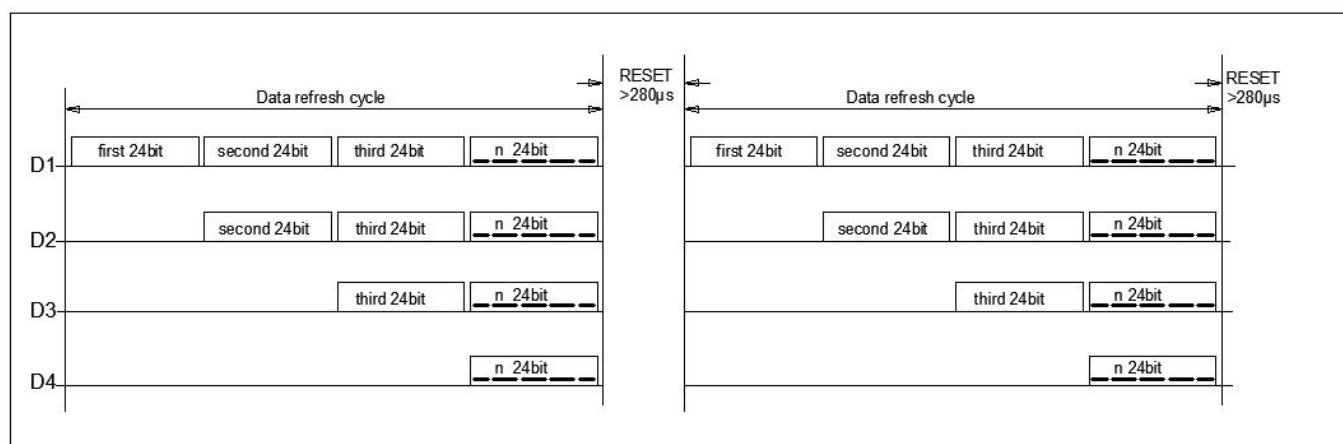
## Cascade Method



D1 → DIN DO PIX1 → D2 → DIN DO PIX2 → D3 → DIN DO PIX3 → D4
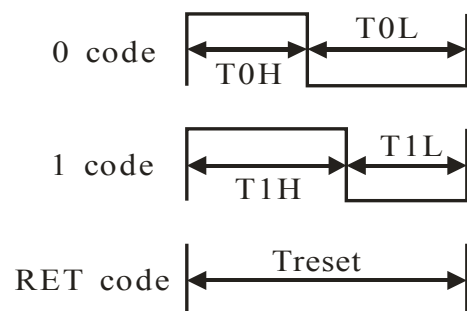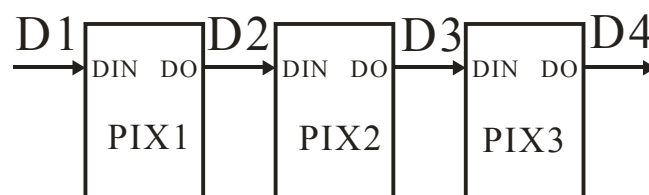
## Data Transmission Method



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 | G1 | 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.

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**Typical Application Circuit**



Remarks: According to the quality of power supply,please connect a filter capacitor in parallel between VDD and GND, the recommended value is 100nf.

# 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.

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2.2. Moisture-proof packaging

TOP SMD LEDs are moisture sensitive components. LEDs are packaged in aluminum foil bag to prevent the from absorbing moisture during transport and storage. A 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. 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℃/85%RH |
| LEVEL2 | 1 Year | ≤30℃/60%RH |
| LEVEL2a | 4 Weeks | ≤30℃/60%RH |
| LEVEL3 | 168 Hours | ≤30℃/60%RH |
| LEVEL4 | 72 Hours | ≤30℃160%RH |
| LEVEL5 | 48 Hours | ≤30℃/60%RH |
| LEVEL5a | 24 Hours | ≤30℃/60%RH |
| LEVEL6 | Take-out and Use immediately | ≤30℃/60%RH |

2.3 SMT requirements

2.3.1 It is recommended to unpack the LED before SMT and put the whole roll in the oven for dehumidification and drying (70～75℃ baking≧24H)；

2.3.2 The product is taken out from the oven to the completion of high-temperature soldering (including multiple reflow soldering, immersion tin, wave soldering, heating maintenance and other high-temperature operations/operations), the time period is controlled within 24 (under T<30℃, RH<60% conditions) ;

2.3.3 After the LED is attached to the PCBA after printing the solder paste, the SMT should be completed as soon as possible, and it is recommended not to exceed 1H;

2.3.4 Bulk LEDs such as production surplus, machine throwing materials, maintenance materials, etc., should not be used directly if they are exposed to the air for a long time. It is recommended to use them after dehumidification and drying. Whole roll baking: 70～75℃＊ ≧24H or bulk baking: 120℃＊4H.

**3. SMT Reflow**

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.
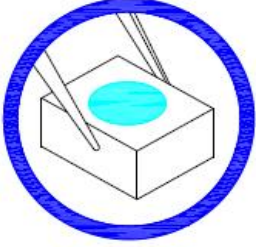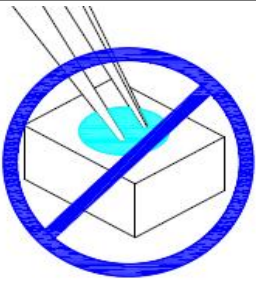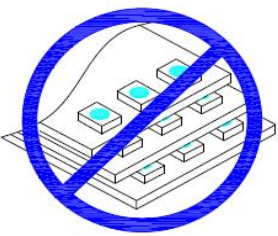
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| Temperature curve description | Range |
|---|---|
| 30 ℃ ~ 150 ℃ preheating slope | 1～4 ℃/s |
| 30 ℃ ~ 150 ℃ preheating time | 60～120 s |
| Constant temperature slope of 150 ℃ ~ | 0～3 ℃/s |
| Constant temperature time of 150 ℃ ~ | 60～120 s |
| LIQUID REGION temperature | 217℃ |
| Peak Temperature (Tp) | 245℃ |
| Reflow slope | 0～3 ℃/s |
| Reflow time | 45-90 s |
| cooling rate | -4～0 ℃/s |
| Room Temperature to Peak Holding | <6min |
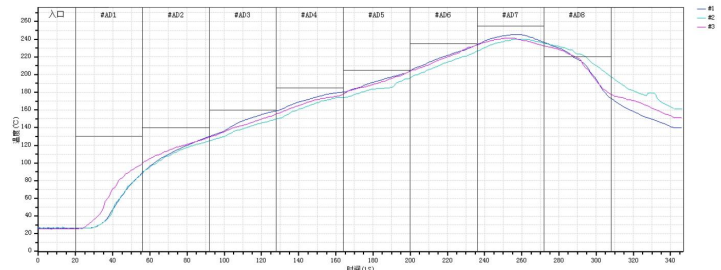
Remarks: 1. These general guidelines may not apply to all PCB designs and reflow soldering configurations.

2. All temperatures referred are 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. |
|  |  |

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**Modify Record**

| Version № | Status Bar | Modify Content Summary | Date | Reviser | Approved |
|---|---|---|---|---|---|
| V1.0 | N | New | 20180913 | Shen JinGuo | Yin HuaPing |
| V1.1 | M | Parameters correction | 20190125 | Shen JinGuo | Yin HuaPing |
| V1.2 | M | Revised recommended pads and revised SMT instructions | 20190708 | Shen JinGuo | Yin HuaPing |
| V1.3 | M | Detail parameter correction | 20220531 | Yu XingHui | Yin HuaPing |

Remarks:   N--New, A--Add, M--Modify, D--Delete

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