

### 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 2121 components, to form a complete addressable 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.
- Port scanning frequency is of 2KHz. Data receiving and decoding can be completed through a signal line.
- When the refresh rate is 30fps, cascade quantity are not less than 1024 pixels.
- Data transmission speed up to 800Kbps.
- The color of the light is highly consistent, cost-effective.
- **Reverse power connection will not cause damage.**
- **No external electronic components (including capacitors) are required.**
- **Supports bidirectional signal input; DI and DO can be interchanged at will.**
- **Static power consumption is below 1  $\mu$  A, even a 3.3V power source also ensures constant-current operation.**

### Applications

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

### General description

WS2812B-2121-V6 is a intelligent control LED light source that the control circuit and RGB chip are integrated in a package of 2121 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.

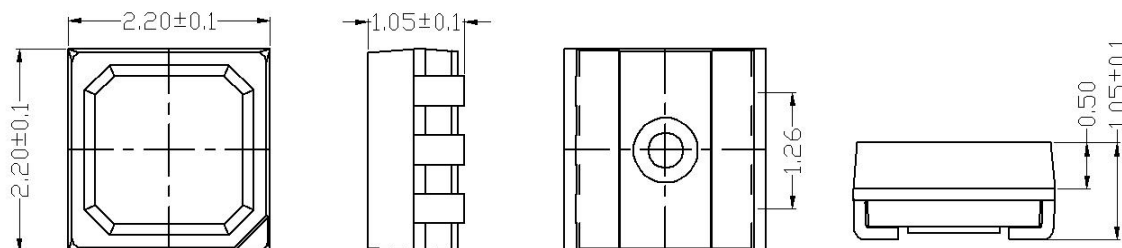
The data transfer protocol use single NZR communication mode. After the pixel power-on reset, the DIN port receive data from controller, the first pixel collect initial 24bit data then sent to the internal data latch, the other data which reshaping by the internal signal reshaping amplification circuit 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 > **280 $\mu$ s**, it won't cause wrong reset while interruption, it supports the lower frequency and inexpensive MCU.

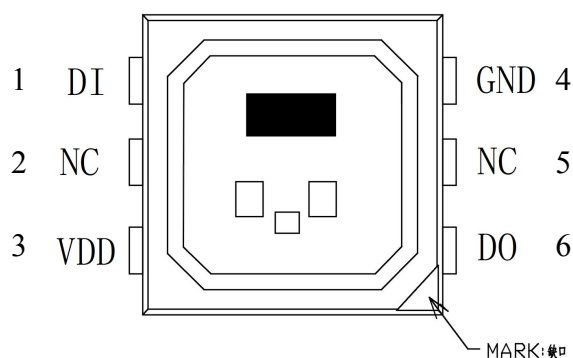
Refresh Frequency updates to **2KHz**, Low Frame Frequency and No Flicker appear in HD Video Camera, it improve excellent display effect.

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.

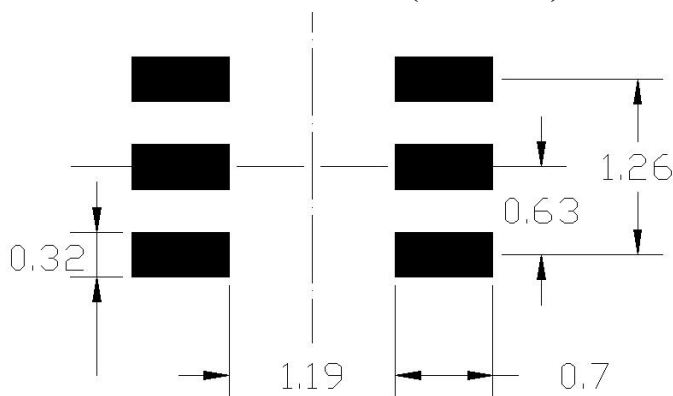
### Mechanical Dimensions



### PIN Configuration



### Recommended Pad Size (Unit: mm)



### PIN Function

| NO. | Symbol | PIN          | Function description          |
|-----|--------|--------------|-------------------------------|
| 1   | DIN    | DATA IN      | Control data signal input     |
| 2   | NC     | /            | NC                            |
| 3   | VDD    | POWER SUPPLY | Power supply                  |
| 4   | GND    | GROUND       | Ground,data & power grounding |
| 5   | NC     | /            | NC                            |
| 6   | DOUT   | DATA OUT     | Control data signal output    |

### Absolute Maximum Ratings (T<sub>A</sub>=25℃, V<sub>SS</sub>=0V)

| Parameter                           | Symbol           | Ratings                                     | Unit |
|-------------------------------------|------------------|---------------------------------------------|------|
| Power supply voltage                | V <sub>DD</sub>  | +3.3~+5.3                                   | V    |
| Logical Input Voltage               | V <sub>I</sub>   | V <sub>DD</sub> -0.7 ~ V <sub>DD</sub> +0.7 | V    |
| Operating Temperature               | T <sub>opt</sub> | -40 ~ +85                                   | ℃    |
| Storage Temperature (Bulk material) | T <sub>stg</sub> | -40 ~ +105                                  | ℃    |
| Storage Temperature (Whole reel)    | T <sub>stg</sub> | -40 ~ +70                                   | ℃    |

### 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                                                                                    |
|--------------------|----------|----------------|-----|----------------------|---------------|-----------------------------------------------------------------------------------------------|
| Input current      | $I_I$    | —              | —   | $\pm 1$              | $\mu\text{A}$ | $V_I=V_{DD}/V_{SS}$                                                                           |
| High Voltage Input | $V_{IH}$ | $0.55V_{DD}$   | —   | $V_{DD}+0.7\text{V}$ | V             | $D_{IN}$ , SET                                                                                |
| Low Voltage Input  | $V_{IL}$ | $-0.3\text{V}$ | —   | $0.7\text{V}$        | V             | $D_{IN}$ , SET                                                                                |
| LED Lifespan       | tled     | 50000          | —   | —                    | H             | Test current: 12mA<br>Test temperature: Room Temp. $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ |
| ESD                | —        | —              | 4   | —                    | KV            | HBM                                                                                           |

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

| Parameter               | Symbol    | Min | Tpy | Max | Unit          | Condition                                                                |
|-------------------------|-----------|-----|-----|-----|---------------|--------------------------------------------------------------------------|
| Transmission delay time | $t_{PLZ}$ | —   | —   | 300 | ns            | $CL=15\text{pF}$ , $D_{IN} \rightarrow D_{OUT}$ , $R_L=10\text{K}\Omega$ |
| Fall time               | $t_{THZ}$ | —   | —   | 120 | $\mu\text{s}$ | $CL=300\text{pF}$ , $OUTR/OUTG/OUTB$                                     |
| Input capacity          | $C_I$     | —   | —   | 15  | pF            | —                                                                        |

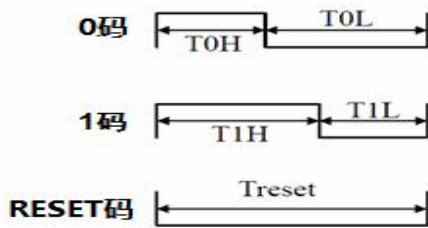
### LED Characteristics ( $T_A=25^{\circ}\text{C}$ , $V_{DD}=5\text{V}$ , $V_{SS}=0\text{V}$ )

| Parameter  | Symbol      | Color | Quiescent Current: 0.6mA |      |      |      | Condition<br>(Working current) |
|------------|-------------|-------|--------------------------|------|------|------|--------------------------------|
|            |             |       | Min.                     | Typ. | Max. | Unit |                                |
| Brightness | IV          | Red   | 320                      | 400  | 460  | mcd  | 12mA                           |
|            |             | Green | 820                      | 950  | 1100 |      |                                |
|            |             | Blue  | 120                      | 180  | 240  |      |                                |
| Wavelength | $\lambda_d$ | Red   | 620                      | 623  | 625  | nm   | 12mA                           |
|            |             | Green | 515                      | 517  | 520  |      |                                |
|            |             | Blue  | 465                      | 467  | 470  |      |                                |

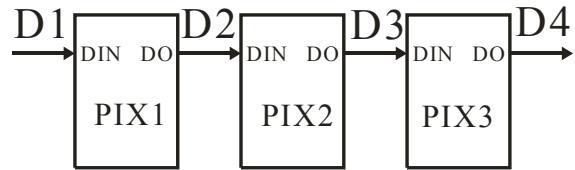
### Data Transfer Time

|                                                                    |                              |                       |
|--------------------------------------------------------------------|------------------------------|-----------------------|
| 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 $\mu\text{s}$    |
| Data cycle: $T_{0H}+T_{0L}$ , $T_{1H}+T_{1L} \geq 1.25\mu\text{s}$ |                              |                       |

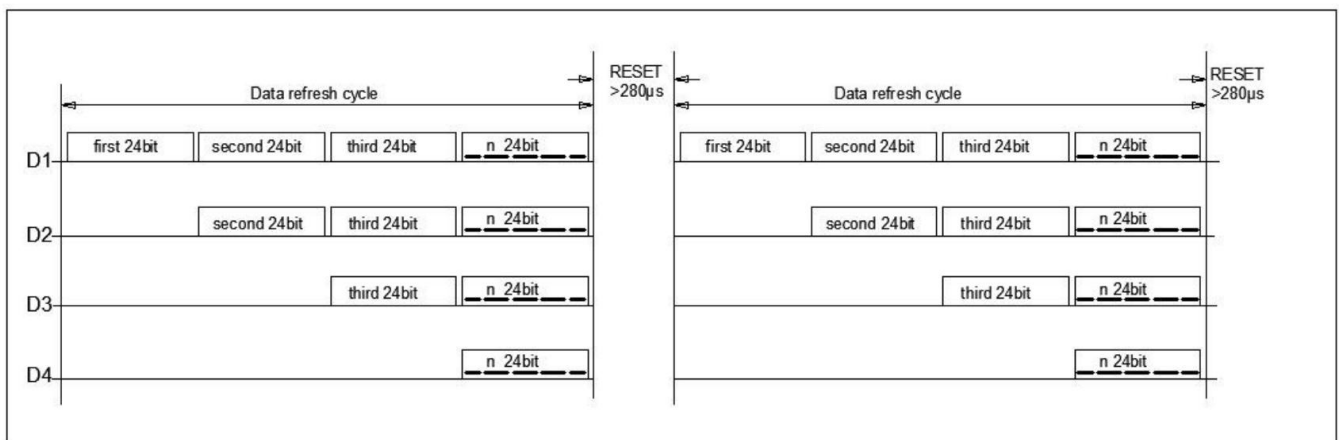
## Sequence Chart



## Cascade Method



## Data Transmission Method



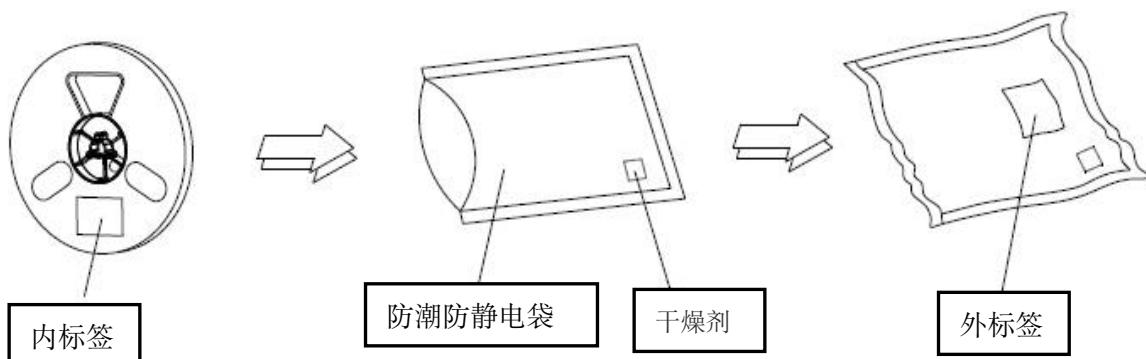
Note: The data of  $D1$  is send by MCU, and  $D2, D3, D4$  through pixel internal reshaping amplification to transmit.

## Composition of 24bit Data

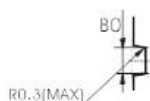
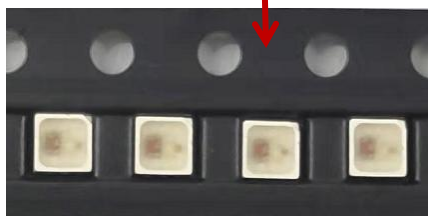
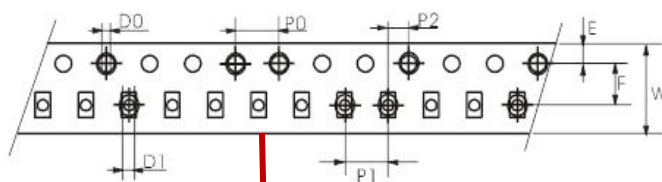
|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| G7 | G6 | G5 | G4 | G3 | G2 | G1 | G0 | R7 | R6 | R5 | 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.

### Packing (MPQ=4000pcs)

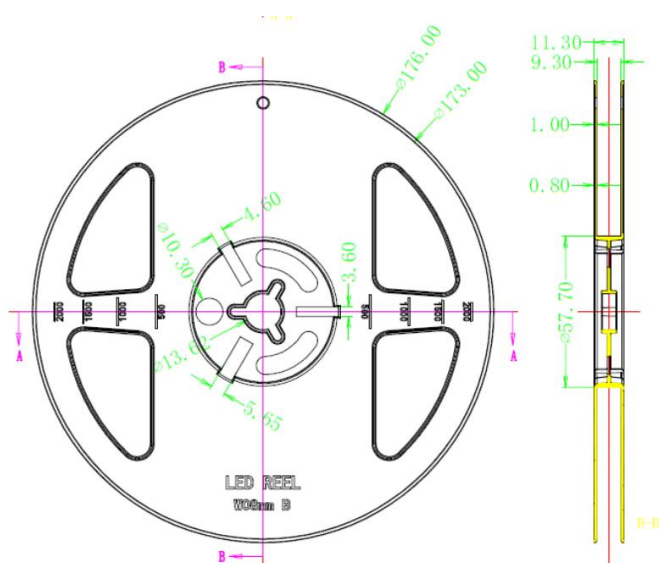


## Carrier tape and reel specifications



UNIT:MM

| SYMBOL | SPEC      |
|--------|-----------|
| B0     | 2.35±0.1  |
| P0     | 4.00±0.1  |
| P1     | 4.00±0.1  |
| P2     | 2.00±0.1  |
| T      | 0.18±0.1  |
| E      | 1.75±0.1  |
| F      | 3.50±0.1  |
| D0     | 1.50+0.1  |
| D1     | 1.00+0.1  |
| W      | 8.00±0.1  |
| 10P0   | 40.00±0.2 |



### 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  $\geq$  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;

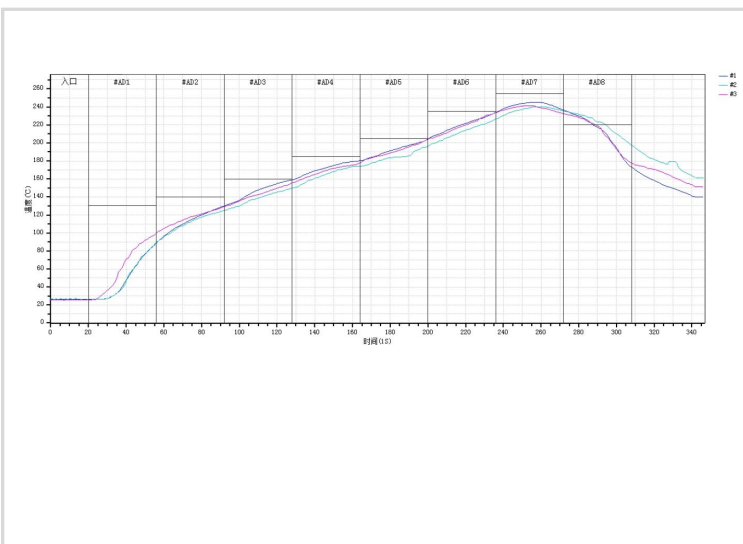
2.3.4 Bulk material LED, such as production surplus, machine material, maintenance material, can not be used directly if exposed to the air for a long time. It is recommended to be dehumidified and dried before being used.

Whole reel baking: 70 ~ 75°C \*  $\geq$ 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.

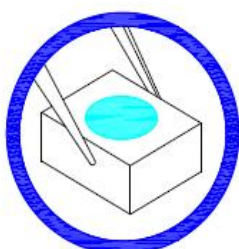
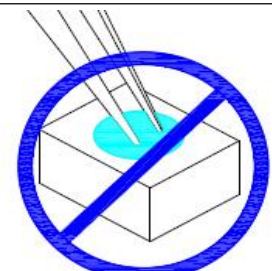
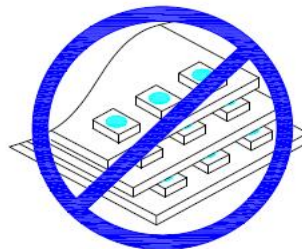
| Curve Description                         | Lead-free   |
|-------------------------------------------|-------------|
| 30°C ~ 150°C preheating slope             | 1 ~ 4 °C/s  |
| 30°C ~ 150°C preheating time              | 60 ~ 120 s  |
| 150°C to 200°C constant temperature slope | 0 ~ 3 °C/s  |
| 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. The above general guidelines may not be applicable to all PCB designs and reflow soldering configurations.

2. 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                    | 20251021 | 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