# DD235

***Version*** : ***A.003***
***Issue Date*** : ***2008/02/21***
***File Name*** : ***SP-DD235-A.003.doc***
***Total Pages***: ***12***

## *8x3-bit Constant Current LED Driver*

SiTI

# DD235

## 8x3-bit Constant Current LED Driver

### General Description

DD235 is a 24 channel constant-current sink driver specifically designed for LED decorating and backlighting applications. This chip incorporates shift registers, data latches, and constant current circuitry on the silicon CMOS process. The constant current values are set by three external resistors (Rext_R, Rext_G and Rext_B) separately. Each channel can provide a maximum current of 60mA. The three enable terminals (EN_R, EN_G and EN_B) supply dimming applications and control eight channels independently.

### Features

- Maximum constant current output: 60mA
- Maximum output sustaining voltage: 17V
- Output enable terminal: 1MHz(max)
- Power supply voltage: 6V to 18V
- Over current protection
- Bit-to-bit skew : ±6% (max) Chip-to-chip skew : ±10% (max)

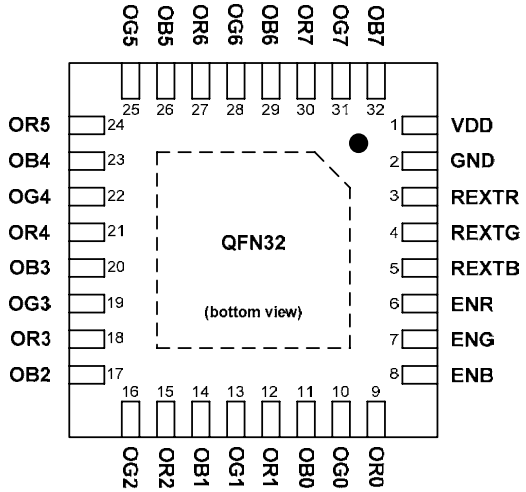
### Applications

- LED decorative lamps or bulbs
- LED backlighting applications

### Package Types

- QFN32 (with exposed pad)

## Pin Connection (Bottom View)

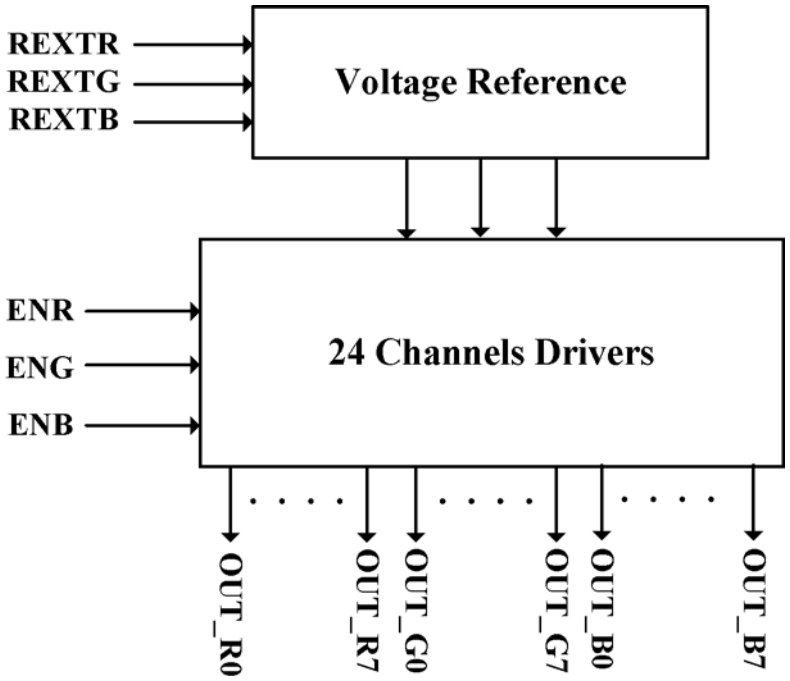



**The package of QFN32**

## Pin Description

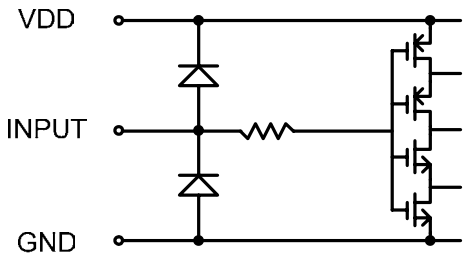
| PIN NAME | FUNCTION |
|---|---|
| VDD [1] | Supply voltage terminal |
| GND [2] | Ground terminal |
| ENR [6] | Output enable terminals:<br>**'H'** for all outputs are active ,<br>**'L'** for all outputs are turned off. |
| ENG [7] | |
| ENB [8] | |
| REXTR [3] | External resistors connected between REXT and GND for driver current setting |
| REXTG [4] | |
| REXTB [5] | |
| OR0~OR7 [9,12,15,18,21,24,27,30] | LED driver outputs |
| OG0~OG7 [10,13,16,19,22,25,28,31] | |
| OB0~OB7 [11,14,17,20,23,26,29,32] | |

## Block Diagram




## Equivalent Circuit of Inputs and Outputs

### 1. ENR, ENG, ENB terminals



## Maximum Ratings (Ta=25°C, Tj(max) = 120°C)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Supply Voltage | VDD | 18 | V |
| Input Voltage | VIN | 5 | V |
| Output Current | IOUT | 60 | mA |
| Output Voltage | VOUT | 17 | V |
| Input Enable Frequency | FEN | 1 | MHz |
| GND Terminal Current | IGND | 1500 | mA |
| Power Dissipation (4 layer PCB) | PD | 3.11 ( QFN32 : Ta=25°C) | W |
| Thermal Resistance | Rth(j-a) | 40.6 ( QFN32 ) | °C/W |
| Operating Temperature | Top | -40 ~ 85 | °C |
| Storage Temperature | Tstg | -55 ~ 150 | °C |

## Recommended Operating Condition

| CHARACTERISTIC | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Supply Voltage | VDD | — | 6 | | 18 | V |
| Output Voltage | VOUT | Driver On *1 | 1.0 | — | 0.5VDD | V |
| Output Voltage | VOUT | Driver Off *2 | — | — | 17 | |
| Output Current | IO | OUT | 5 | — | 60 | mA |
| Input Enable Voltage | VIH | VDD = 6V ~ 18V | 3 | — | VDD | V |
| | VIL | | -0.3 | — | 1 | |
| Input Enable Frequency | FEN | VEN>3V | DC | — | 1 | MHz |

## Electrical Characteristics (VDD = 6.0 V, Ta = 25°C unless otherwise noted)

| CHARACTERISTIC | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Input Voltage “H” Level | VIH | VDD=6~18V | 3 | — | VDD | V |
| Input Voltage “L” Level | VIL | | -0.3 | — | 1 | |
| Output Leakage Current | IOL | VOH = 17 V<br>VEN=0V | — | — | 1.0 | uA |
| Output Current Skew (Channel-to-Channel) *1 | IOL1 | VOUT = 1.0 V<br>Rrext = 5 KΩ | — | — | ±6 | % |
| Output Current Skew (Chip-to-Chip) *2 | IOL2 | | | | ±10 | % |

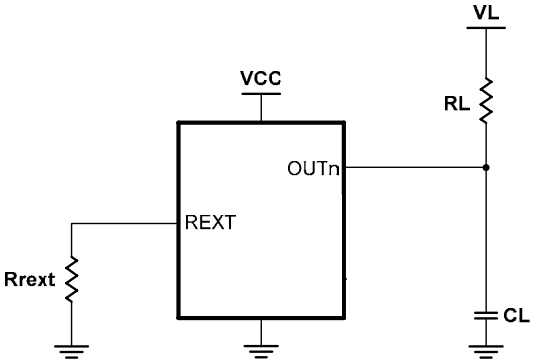
*1 Notice that the power dissipation is limited to its package and ambient temperature.
*2 The driver output voltage including any overshoot stress has to be compliant with the maximum voltage (17V).
*1 Channel-to-channel skew is defined as the ratio between (any Iout – average Iout) and average Iout, where average Iout = (Imax + Imin) / 2.
*2 Chip-to-Chip skew is defined as the range into which any output current of any IC falls.

| | | | | | | |
|---|---|---|---|---|---|---|
| Output Voltage Regulation | % / VOUT | Rrext = 5 KΩ<br>VOUT = 1 V ~ 3 V | — | ±0.1 | ±0.5 | % / V |
| Supply Voltage Regulation | % / VDD | Rrext = 5 KΩ | — | ±1 | ±4 | |
| Supply Current*3<br>VDD=6V<br>VDD=12V<br>VDD=18V | $I_{DD(off)}$ | REXT = OPEN,<br>all outputs off | — | 4.6<br>5.7<br>7.4 | — | mA |
| | $I_{DD(off)}$ | REXT=1.5KΩ(Iout=60mA),<br>all outputs off | — | 14.6<br>15.7<br>18.6 | — | |
| | $I_{DD(on)}$ | REXT=1.5KΩ(Iout=60mA),<br>all outputs on | — | 14.6<br>15.7<br>18.6 | — | |
| | $I_{DD(off)}$ | REXT = 5KΩ (Iout=21mA),<br>all outputs off | — | 4.8<br>5.9<br>7.7 | — | |
| | $I_{DD(on)}$ | REXT = 5KΩ (Iout=21mA),<br>all outputs on | — | 4.8<br>5.9<br>7.7 | — | |

## Switching Characteristics (VDD = 6.0V, Ta = 25°C unless otherwise noted)

| CHARACTERISTIC | | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| Propagation Delay<br>('L' to 'H') | EN-to-OUT | tpLH | VIH = VDD<br>VIL = GND<br>Rrext = 4.17 KΩ<br>VL = 1.0 V<br>RL = 0 Ω<br>CL*1 = 13 pF | — | 40 | — | ns |
| Propagation Delay<br>('H' to 'L') | EN-to-OUT | tpHL | | | 45 | | |
| Output Current Rise Time | | tor | | — | 15 | — | |
| Output Current Fall Time | | tof | | — | 8 | — | |
| Output Delay Time ($OUT_{(n)}$-to-$OUT_{(n+1)}$) | | tod | | — | 0.5 | — | |

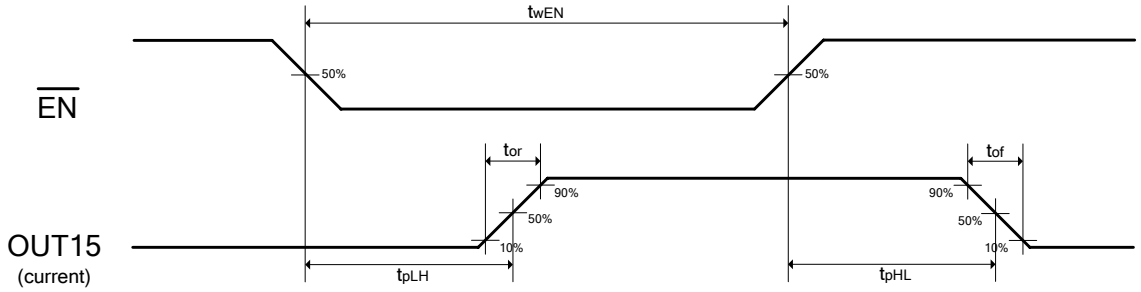
*3 IO excluded.
*1 CL means the probe capacitance of oscilloscope.



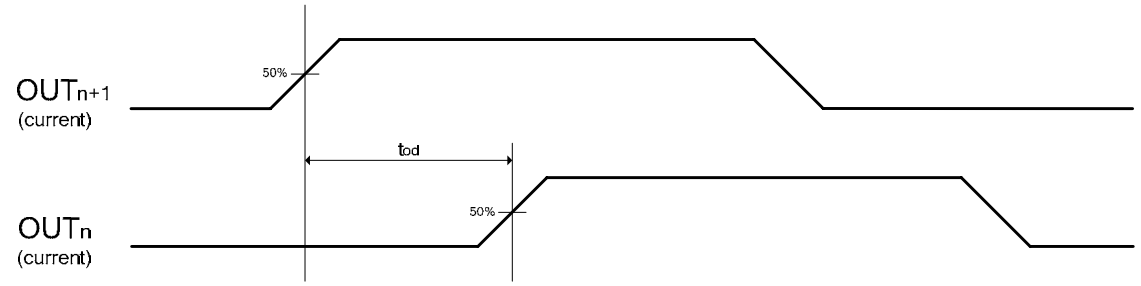

Switching Characteristics Test Circuit

## Timing Diagram

1. $\overline{EN}$-OUT




2. $OUT_{n+1}$-$OUT_n$

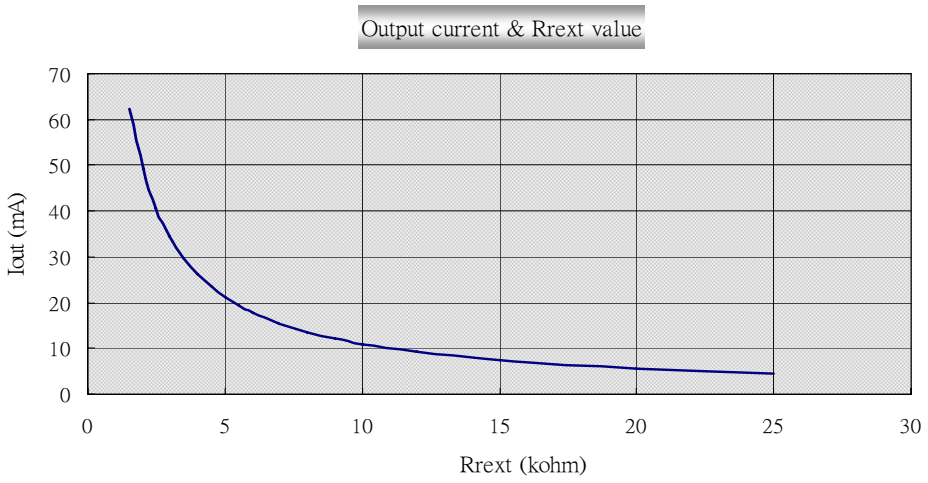


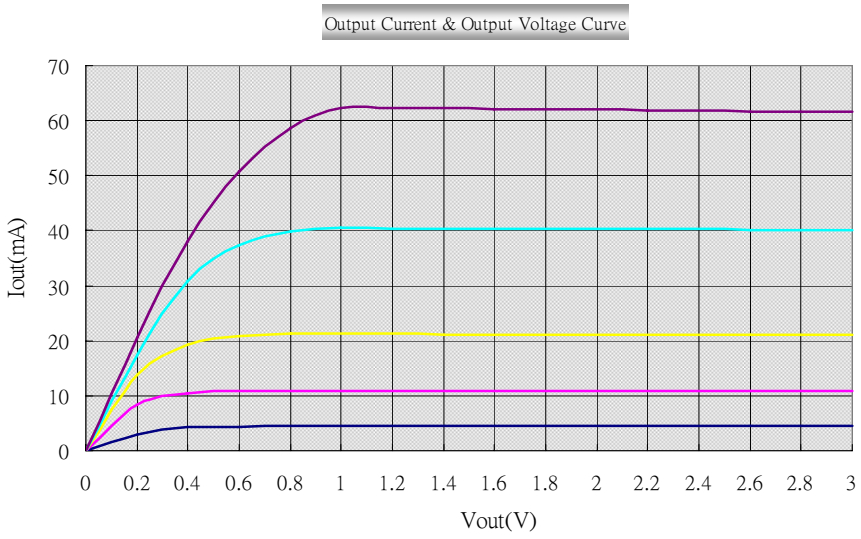
## Constant-Current Output

Constant-current value of each output channel is set by an external resistor connected between the REXT pin and GND. Varying the resistor value can adjust the current scale ranging from 5mA to 60mA. The reference voltage of REXT terminal (Vrext) is approximately 1.1V. The output current value is calculated roughly by the following equation:

$$Iout(mA) \cong \frac{Vrext(V)}{\mathrm{Re}\,xt(K\Omega)} \times M$$

| Iout(mA) | 5 | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| **M** | 101.4 | 99.5 | 97.1 | 94.6 | 92.1 | 89.5 | 83.1 |

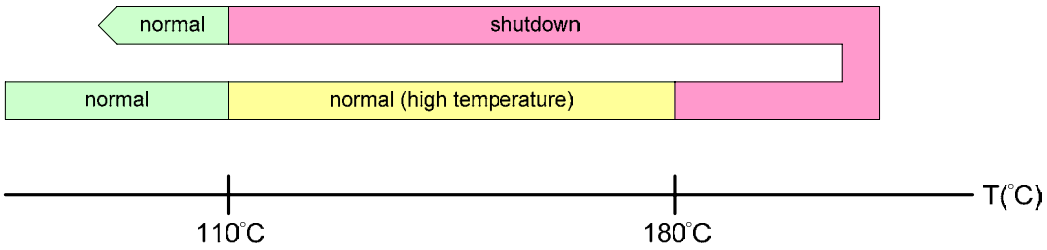



In order to obtain a good performance of constant-current output, a suitable output voltage is necessary. Users can get related information about the minimum output voltage above.

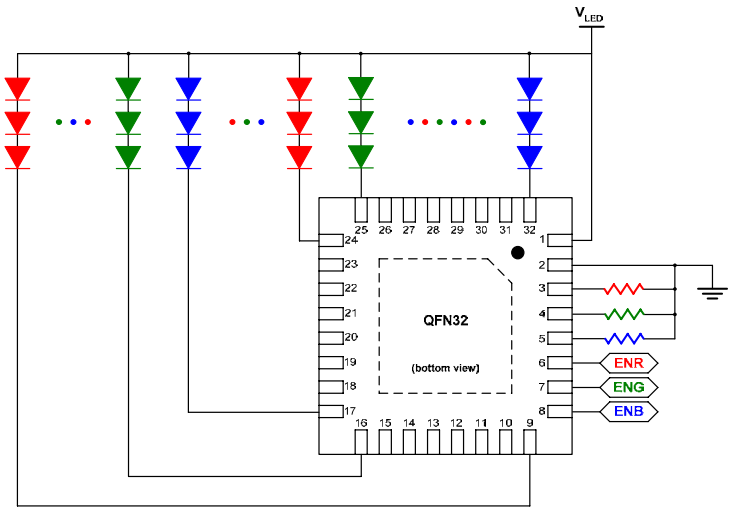
## Thermal Shutdown

During operation, when the junction temperature of the IC will reach approximately above 180℃, it will cause the driver to shutdown all the outputs. Basically, the IC will cool down and return to the safe operating temperature which is approximately below 110℃. DM13C will restart all the outputs at the same time. Operation in the thermal situation for a long time may cause chip damage permanently.




Relations between Thermal Shutdown and Junction Temperature

## Typical Application

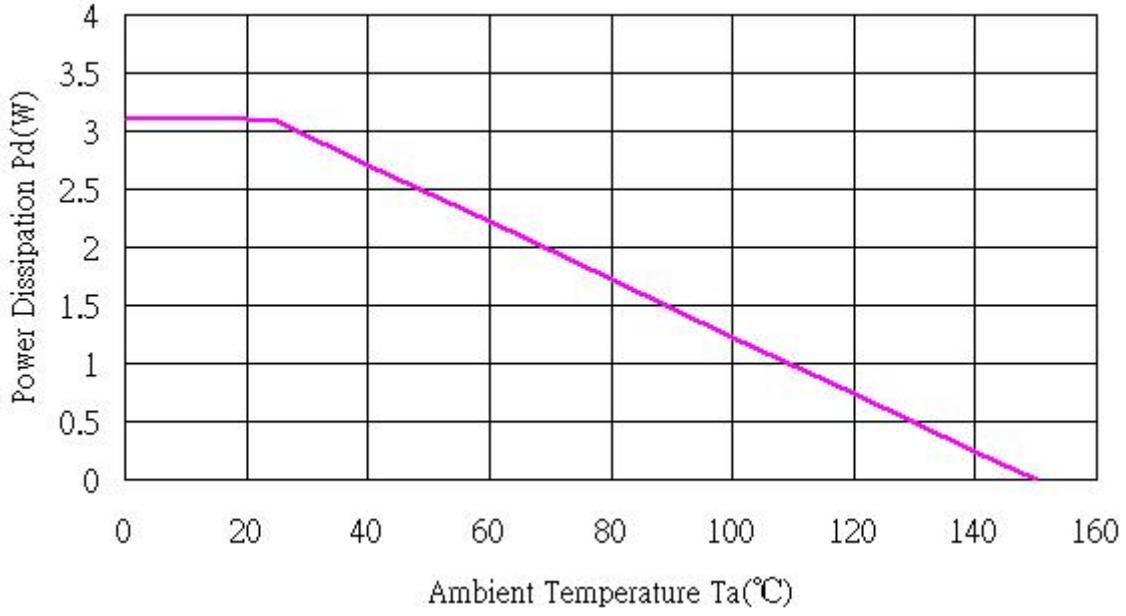


## Power Dissipation

The power dissipation of a semiconductor chip is limited to its package and ambient temperature, in which the device requires the maximum output current calculated for given operating conditions. The maximum allowable power consumption can be calculated by the following equation:

$$Pd(max)(Watt) = \frac{Tj(junction\ temperature)(max)(℃) - Ta(ambient\ temperature)(℃)}{Rth(junction\text{-}to\text{-}air\ thermal\ resistance)(℃/Watt)}$$

The relationship between power dissipation and operating temperature can be refer to the figure below:

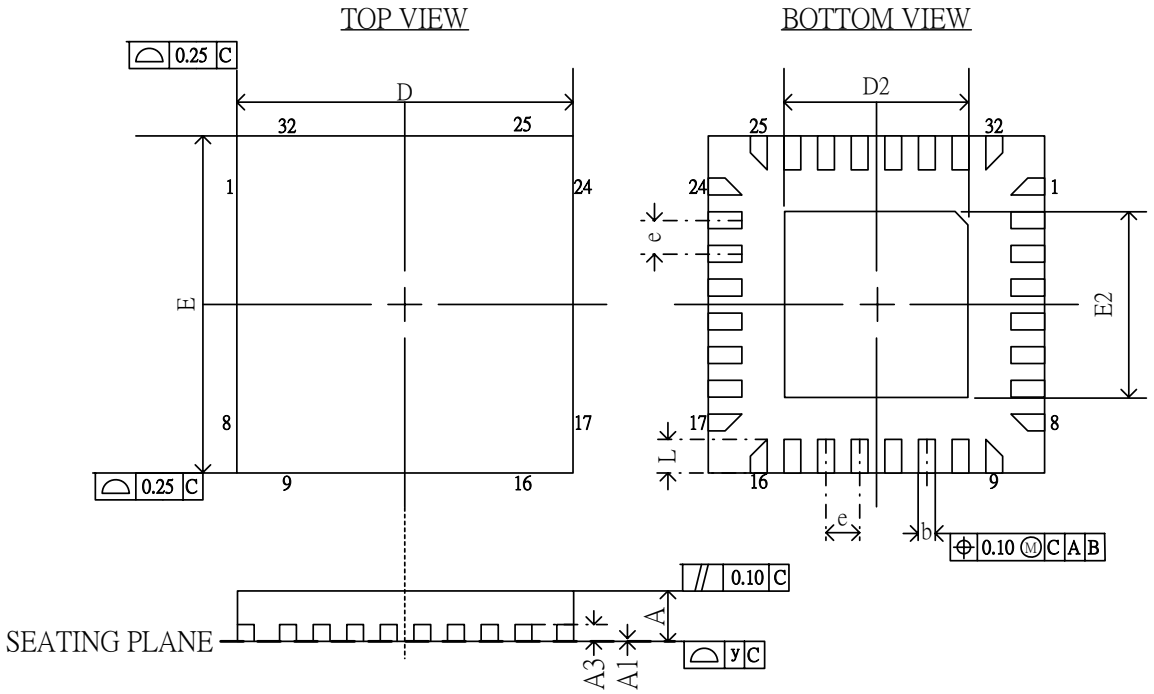



The power consumption of IC can be determined by the following equation and should be less than the maximum allowable power dissipation:

$$Pd(W) = V_{CC}(V) \times I_{DD}(A) + Vout0 \times Iout0 \times Duty0 + \cdots\cdots + Vout15 \times Iout15 \times Duty15 \leq Pd(max)(W)$$

# Package Outline Dimension

## *QFN32*




| | DIMENSIONS IN INCH | | DIMENSIONS IN MM | |
|---|---|---|---|---|
| SYMBOLS | MIN. | MAX. | MIN. | MAX. |
| A | 0.028 | 0.031 | 0.70 | 0.80 |
| A1 | 0 | 0.002 | 0 | 0.05 |
| A3 | 0.010TYP. | | 0.25TYP. | |
| b | 0.007 | 0.012 | 0.18 | 0.30 |
| D | 0.197TYP. | | 5.00TYP. | |
| D2 | 0.049 | 0.128 | 3 | 3.25 |
| E | 0.197TYP. | | 5.00TYP. | |
| E2 | 0.049 | 0.128 | 3 | 3.25 |
| e | 0.020 | | 0.50TYP. | |
| L | 0.012 | 0.020 | 0.30 | 0.50 |
| y | 0.004TYP. | | 0.10TYP. | |

Note: 1.DIMENSIONING AND TOLERANCING CONFORM TO ASME Y145.5M-1994.

2. REFER TO JEDEC STD. MO-220 WHHD-2 ISSUE A

The products listed herein are designed for ordinary electronic applications, such as electrical appliances, audio-visual equipment, communications devices and so on. Hence, it is advisable that the devices should not be used in medical instruments, surgical implants, aerospace machinery, nuclear power control systems, disaster/crime-prevention equipment and the like. Misusing those products may directly or indirectly endanger human life, or cause injury and property loss.

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