

# **DM134B 、 DM135B**

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*Total Pages: 19*

## **16-Bit Constant Current LED Drivers with 3.3v ~ 5v Supply Voltage**



**SITI**

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## DM134B、DM135B

# 16-Bit Constant Current LED Drivers with 3.3v ~ 5v Supply Voltage

### General Description

The DM134B、DM135B are constant current drivers specifically designed for LED display applications. The value of constant current can be varied using an external resistor. The devices include a 16-bit shift register, latches, and constant current drivers on a single Silicon CMOS chip.

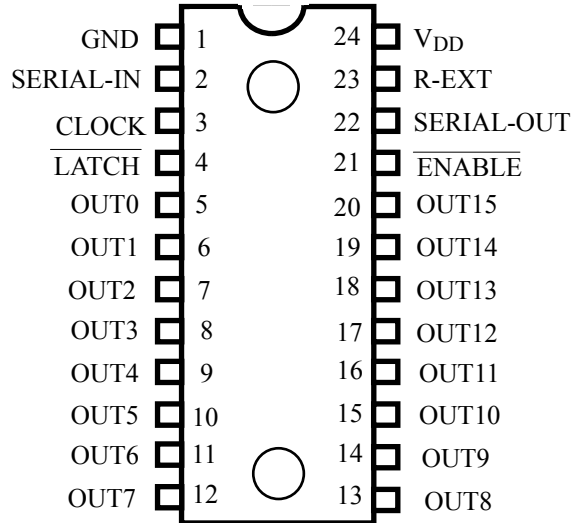
### Features

- 3.3V~5V CMOS Compatible Input
- Maximum Clock Frequency: 25MHz (Cascade Operation)
- Maximum Output Voltage: 17V
- Package: DIP24, SOP24, SSOP24, QFN32
- Package and Pin Layout: Pin layout and functionality are similar to those of the ST2221C. (Each characteristic value is different.)
- Constant Current Matching: (Ta = 25°C、VDD = 5.0V)
  - Chip-to-Chip: ± 10.0%
  - Bit-to-Bit:
    - DM134B: ± 4.0% @ IOUT = 30 ~ 90mA
    - ± 6.0% @ IOUT = 20 ~ 30mA
    - DM135B: ± 4.0% @ IOUT = 20 ~ 60mA
    - ± 6.0% @ IOUT = 5 ~ 20mA



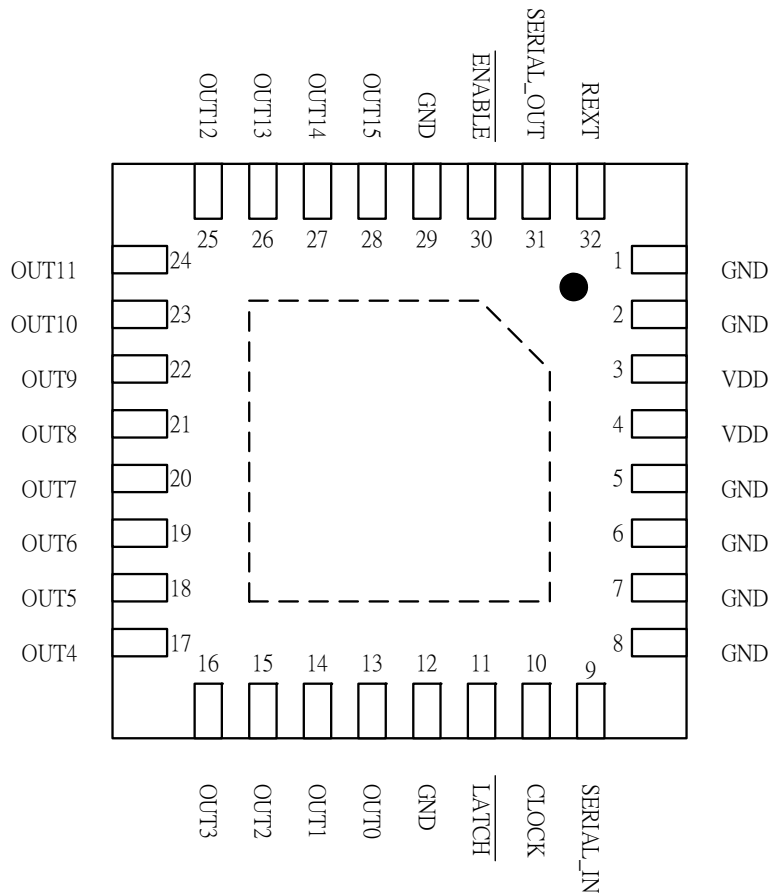
### Pin Connection (Top view)

DIP24、SOP24、SSOP24

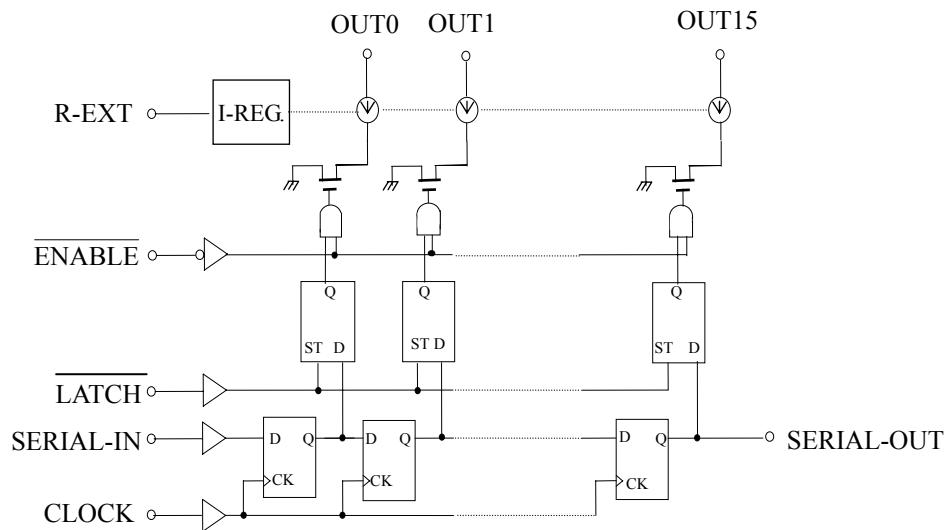


### Pin Connection (Bottom view)

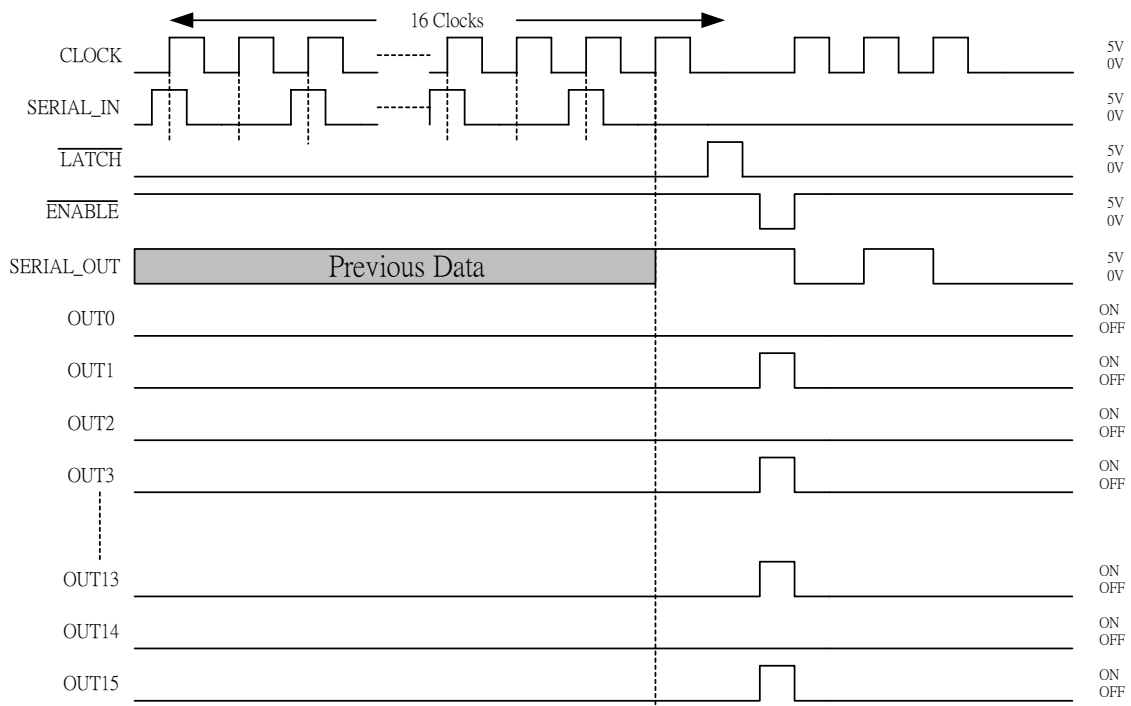
QFN32



## Block Diagram



## Timing Diagram



(Note) Latches are level sensitive (not edge triggered).

$\overline{\text{LATCH}}$ -terminal = H level, latches become transparent;  $\overline{\text{LATCH}}$ -terminal = L level, latches hold data.

$\overline{\text{ENABLE}}$ -terminal = H level, all outputs (OUT0~15) are off.

An external resistor is connected between R-EXT and GND for setting up the value of constant current.

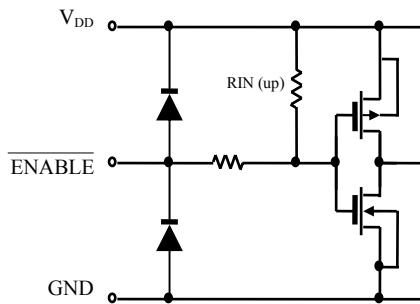
SERIAL-OUT changes state on the rising edges of clock.

## Pin Description

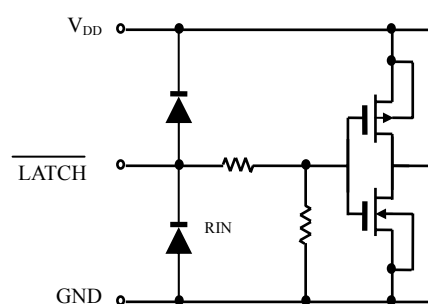
| PIN No. | PIN NAME                   | FUNCTION                                     |
|---------|----------------------------|--|
| 1       | GND                        | Ground terminal                              |
| 2       | SERIAL-IN                  | Input terminal of a data shift register      |
| 3       | CLOCK                      | Input terminal of a clock for shift register |
| 4       | $\overline{\text{LATCH}}$  | Input terminal of data strobe                |
| 5~20    | OUT0~15                    | Output terminals                             |
| 21      | $\overline{\text{ENABLE}}$ | Input terminal of output enable (active low) |
| 22      | SERIAL-OUT                 | Output terminal of a data shift register     |
| 23      | R-EXT                      | Input terminal of an external resistor       |
| 24      | $V_{DD}$                   | 5V Supply voltage terminal                   |

## Equivalent Circuit of Inputs and Outputs

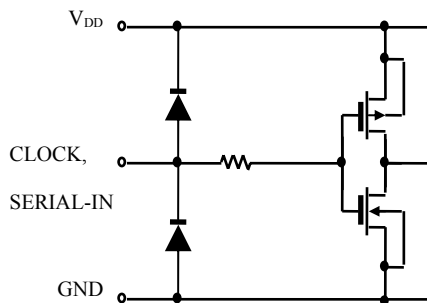
### 1. $\overline{\text{ENABLE}}$ terminal



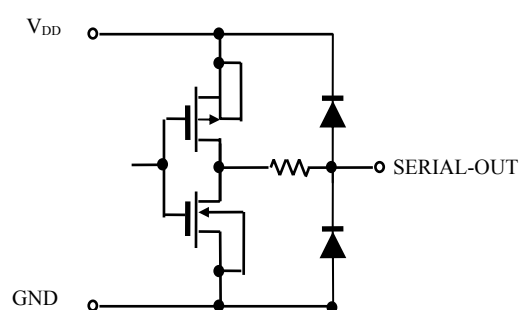
### 2. $\overline{\text{LATCH}}$ terminal



### 3. CLOCK, SERIAL-IN terminal



### 4. SERIAL-OUT terminal



### Maximum Ratings (Ta = 25°C, Tj(max) = 150°C)

| CHARACTERISTIC                         | SYMBOL   | RATING                   | UNIT |
|--|----------|--------------------------|------|
| Supply Voltage                         | VDD      | 0 ~ 7.0                  | V    |
| Input Voltage                          | VIN      | -0.4 ~ VDD+0.4           | V    |
| Output Current                         | IOUT     | 90 ( DM134B )            | mA   |
|  |          | 60 ( DM135B )            |      |
| Output Voltage                         | VOUT     | -0.3 ~ 17                | V    |
| Clock Frequency                        | fCLK     | 25                       | MHz  |
| GND Terminal Current                   | IGND     | 1440 ( DM134B )          | mA   |
|  |          | 960 ( DM135B )           |      |
| Power Dissipation<br>(On 4-layer PCB)  | PD       | 2.5 (DIP-24 : Ta=25°C)   | W    |
|  |          | 1.58 (SOP-24 : Ta=25°C)  |      |
|  |          | 1.39 (SSOP-24 : Ta=25°C) |      |
|  |          | 3.08 (QFN-32 : Ta=25°C)  |      |
| Thermal Resistance<br>(On 4-layer PCB) | Rth(j-a) | 50.0 (DIP-24)            | °C/W |
|  |          | 79.2 (SOP-24)            |      |
|  |          | 90.2 (SSOP-24)           |      |
|  |          | 40.6 (QFN-32)            |      |
| Operating Temperature                  | Topr     | -40 ~ 85                 | °C   |
| Storage Temperature                    | Tstg     | -55 ~ 150                | °C   |

### Recommended Operating Condition

| CHARACTERISTIC        | SYMBOL           | CONDITION         | MIN.              | TYP. | MAX.    | UNIT |
|-----------------------|------------------|-------------------|-------------------|------|---------|------|
| Supply Voltage        | VDD              | —                 | 3.0               | 5.0  | 5.5     | V    |
| Output Voltage        | VOUT             | —                 | —                 | —    | 17      | V    |
| Operating temperature | T <sub>OPR</sub> | —                 | -40               | —    | 85      | °C   |
| Output Current        | IOH              | SERIAL-OUT        | —                 | —    | 1.0     | mA   |
|                       | IOL              | SERIAL-OUT        | —                 | —    | -1.0    |      |
| Input Voltage         | VIH              | —                 | 0.7VDD            | —    | VDD+0.3 | V    |
|                       | VIL              | —                 | -0.3              | —    | 0.3VDD  |      |
| LATCH Pulse Width     | tw LAT           | VDD = 3.0 ~ 5.5 V | 15                | —    | —       | ns   |
| CLOCK Pulse Width     | tw CLK           |                   | 15                | —    | —       | ns   |
| Set-up Time for DATA  | tsetup(D)        |                   | 10                | —    | —       | ns   |
| Hold Time for DATA    | thold(D)         |                   | 5                 | —    | —       | ns   |
| Set-up Time for LATCH | tsetup(L)        |                   | 15                | —    | —       | ns   |
| Clock Frequency       | fCLK             |                   | Cascade operation | —    | —       | 25   |

### Electrical Characteristics (VDD = 5.0 V, Ta = 25°C unless otherwise noted)

| CHARACTERISTIC                       | SYMBOL         | CONDITION                         | MIN.                                  | TYP. | MAX.      | UNIT           |       |
|--------------------------------------|----------------|-----------------------------------|---------------------------------------|------|-----------|----------------|-------|
| Input Voltage "H" Level              | VIH            | —                                 | 0.7VDD                                | —    | VDD       | V              |       |
| Input Voltage "L" Level              | VIL            | —                                 | GND                                   | —    | 0.3VDD    |                |       |
| Output Leakage Current               | IOH            | VOH = 17 V                        | —                                     | —    | 1.0       | uA             |       |
| Output Voltage (S - OUT)             | VOL            | IOL = 1.0 mA                      | —                                     | —    | 0.4       | V              |       |
|                                      | VOH            | IOH = -1.0 mA                     | 4.6                                   | —    | —         |                |       |
| Output Current (Bit-Bit)             | $\Delta$ Iout  | VOUT = 1.2V<br>(1 channel on)     | REXT = 377 $\Omega$                   | —    | $\pm$ 1.5 | $\pm$ 4        | %     |
|                                      |                |                                   | REXT = 900 $\Omega$                   |      |           |                |       |
| Output Current (Chip-Chip)           | Iout           | VOUT = 1.2V<br>(1 channel on)     | REXT = 377 $\Omega$                   | 36.0 | 40.0      | 44.0           | mA    |
|                                      |                |                                   | REXT = 900 $\Omega$                   | 18.0 | 20.0      | 22.0           |       |
| Output Voltage Regulation            | IDM134B        | Vout = 1.2V ~ 5.0V<br>(% / Vout)  | REXT = 377 $\Omega$                   | —    | 0.1       | 0.5            | % / V |
|                                      | IDM135B        |                                   | REXT = 900 $\Omega$                   |      |           |                |       |
| Supply Voltage Regulation            | % / VDD        | Vdd = 3.0V ~ 5.5V                 | —                                     | 1    | 3         | % / V          |       |
| Reference Voltage Regulation         | $\Delta$ Vrext | Rext = 300 $\Omega$ ~ 3K $\Omega$ | —                                     | —    | $\pm$ 1   | % / K $\Omega$ |       |
| Pull-Up Resistor                     | RIN(up)        | —                                 | 150                                   | 300  | 600       | K $\Omega$     |       |
| Pull-Down Resistor                   | RIN(down)      | —                                 | 100                                   | 200  | 400       | K $\Omega$     |       |
| Supply Current "OFF"                 | Idd<br>(off)   | DM134B                            | REXT = OPEN, all outputs off          | —    | 2         | 4              | mA    |
|                                      |                |                                   | REXT = 210 $\Omega$ , all outputs off | —    | 14        | 28             |       |
|                                      |                | DM135B                            | REXT = OPEN, all outputs off          | —    | 2         | 4              |       |
|                                      |                |                                   | REXT = 300 $\Omega$ , all outputs off | —    | 14        | 28             |       |
| Supply Current "ON"                  | Idd<br>(on)    | DM134B                            | REXT = 630 $\Omega$ , all outputs off | —    | 5.5       | 11             |       |
|                                      |                |                                   | REXT = 210 $\Omega$ , all outputs on  | —    | 14        | 28             |       |
|                                      |                | DM135B                            | REXT = 300 $\Omega$ , all outputs on  | —    | 14        | 28             |       |
| REXT = 630 $\Omega$ , all outputs on | —              |                                   | 5.5                                   | 11   |           |                |       |



**Switching Characteristics** (Ta = 25 °C unless otherwise noted)

**DM134B**

| CHARACTERISTIC                      |             | SYMBOL           | CONDITION                         | MIN. | TYP. | MAX. | UNIT |
|-------------------------------------|-------------|------------------|-----------------------------------|------|------|------|------|
| Propagation Delay Time ("L" to "H") | ENABLE-OUTn | t <sub>PLH</sub> | VDD=5.0V<br>VIH=VDD<br>VIL=GND    | —    | 110  | 150  | ns   |
|                                     | CLK-SOUT    |                  |                                   | —    | 20   | 25   |      |
| Propagation Delay Time ("H" to "L") | ENABLE-OUTn | t <sub>PHL</sub> | REXT=420Ω<br>VL=5.0V<br>RL=107.5Ω | —    | 95   | 170  | ns   |
|                                     | CLK-SOUT    |                  |                                   | —    | 20   | 25   |      |
| Output Current Rise Time            |             | t <sub>or</sub>  | CL=15pF                           | —    | 600  | 800  | ns   |
| Output Current Fall Time            |             | t <sub>of</sub>  |                                   | —    | 45   | 60   | ns   |

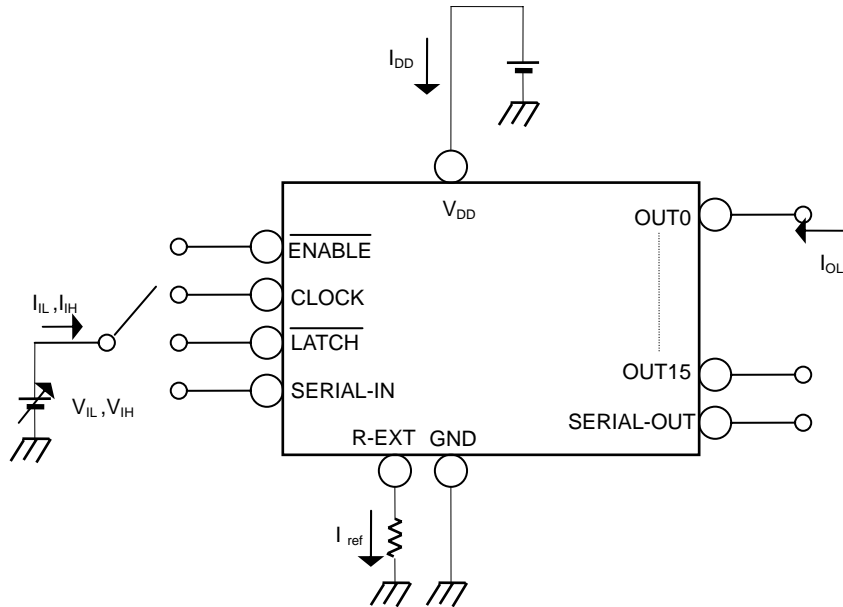
**DM135B**

| CHARACTERISTIC                      |             | SYMBOL           | CONDITION                       | MIN. | TYP. | MAX. | UNIT |
|-------------------------------------|-------------|------------------|---------------------------------|------|------|------|------|
| Propagation Delay Time ("L" to "H") | ENABLE-OUTn | t <sub>PLH</sub> | VDD=5.0V<br>VIH=VDD<br>VIL=GND  | —    | 20   | 40   | ns   |
|                                     | CLK-SOUT    |                  |                                 | —    | 20   | 25   |      |
| Propagation Delay Time ("H" to "L") | ENABLE-OUTn | t <sub>PHL</sub> | REXT=630Ω<br>VL=5.0V<br>RL=150Ω | —    | 30   | 60   | ns   |
|                                     | CLK-SOUT    |                  |                                 | —    | 20   | 25   |      |
| Output Current Rise Time            |             | t <sub>or</sub>  | CL=13pF                         | 25   | 50   | 100  | ns   |
| Output Current Fall Time            |             | t <sub>of</sub>  |                                 | 15   | 30   | 60   | ns   |

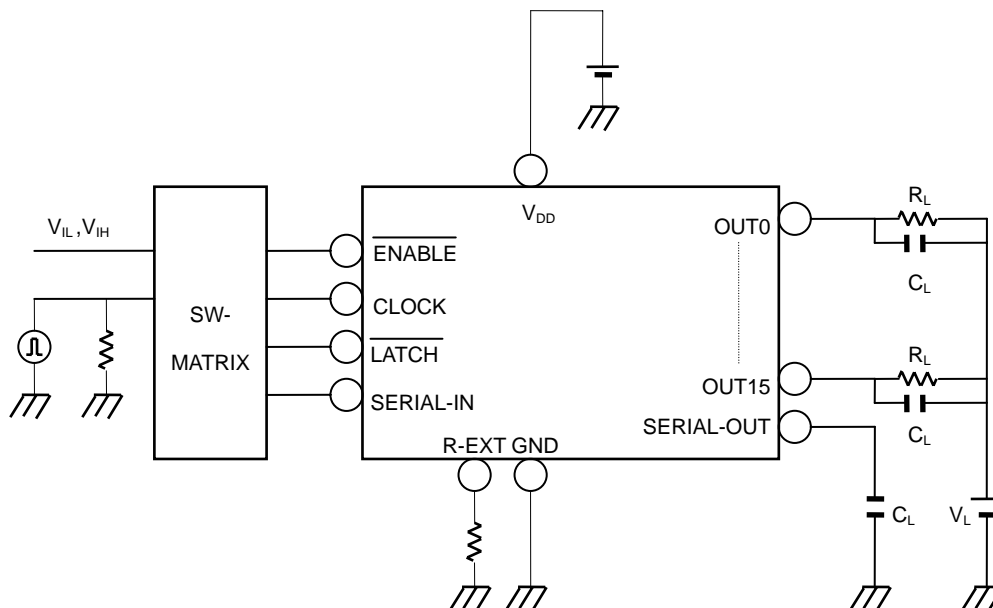


## Test Circuit

DC characteristic

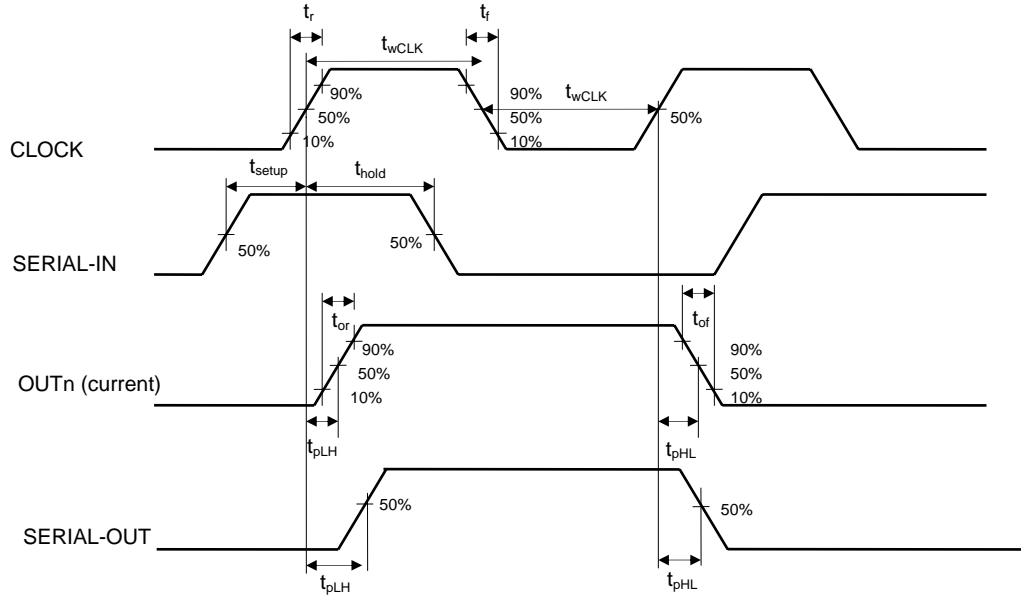


AC characteristic

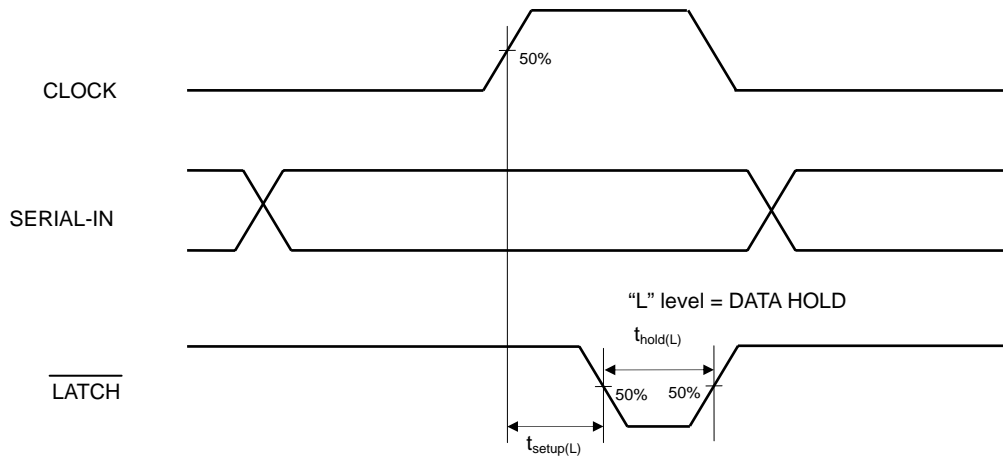


## Timing Diagram

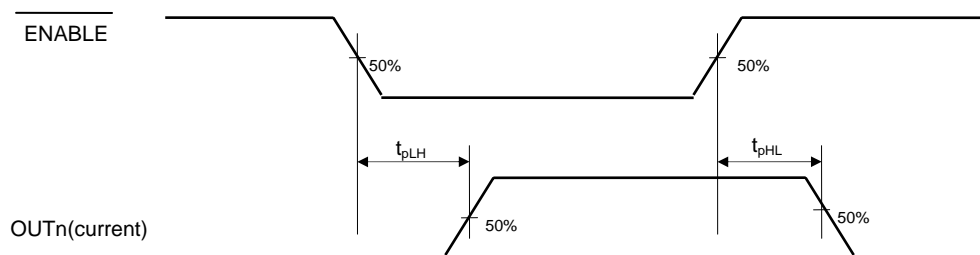
### 1. CLOCK-SERIAL-IN, SERIAL-OUT, OUTn (current)



### 2. CLOCK-LATCH



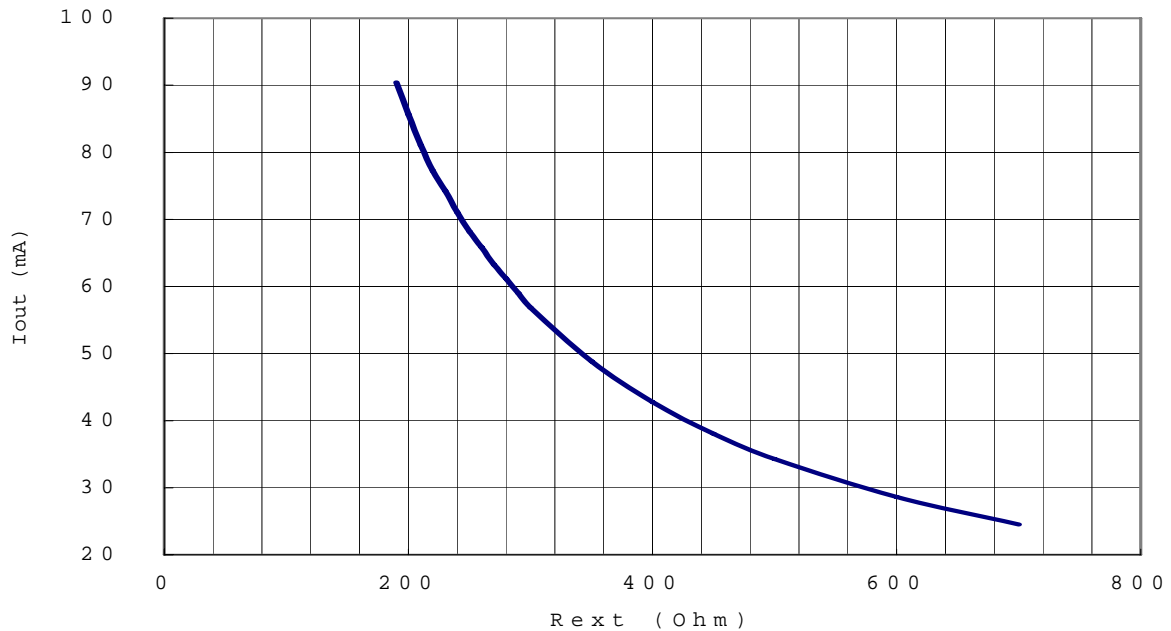
### 3. ENABLE-OUTn (current)



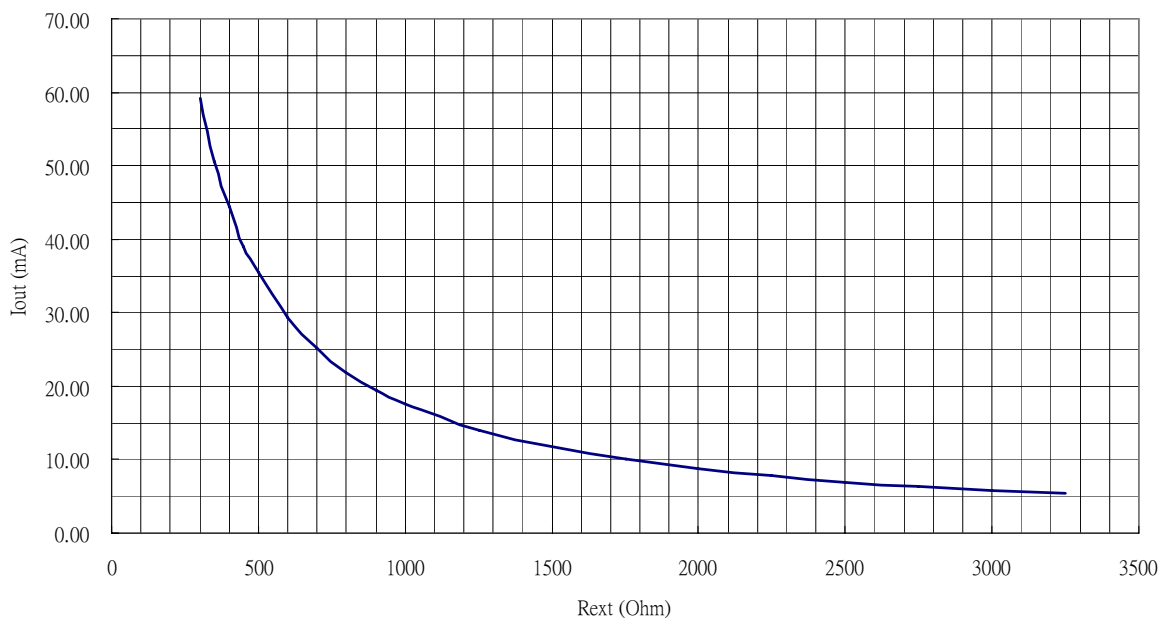


## Output Current vs. External Resistor

### DM134B



### DM135B



Conditions: V<sub>ref</sub>=1.28V

DM134B: I<sub>out</sub> ≈ V<sub>ref</sub> / R<sub>ext</sub> \* 13.1,

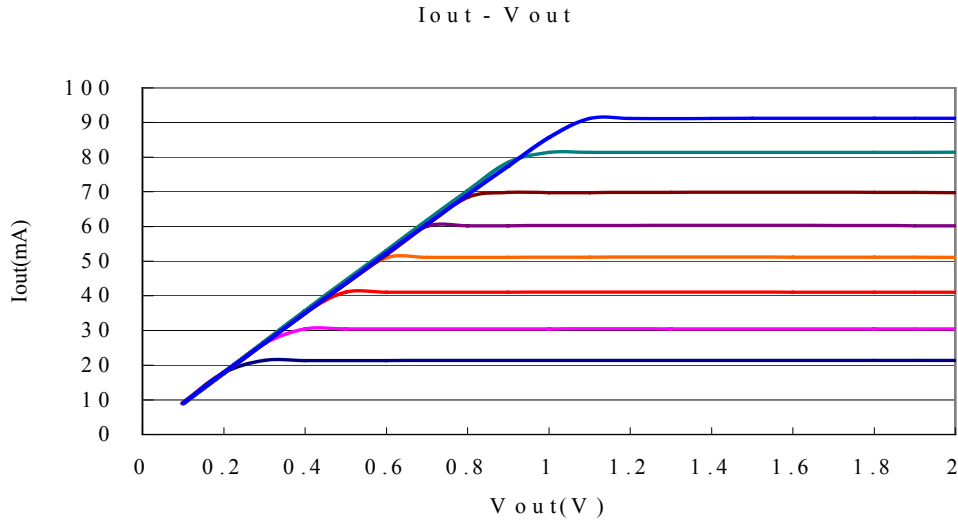
DM135B: I<sub>out</sub> ≈ V<sub>ref</sub> / R<sub>ext</sub> \* 13.7.

**Note:** The resistor should be placed as close to the R<sub>ext</sub> terminal as possible to avoid the noise influence.

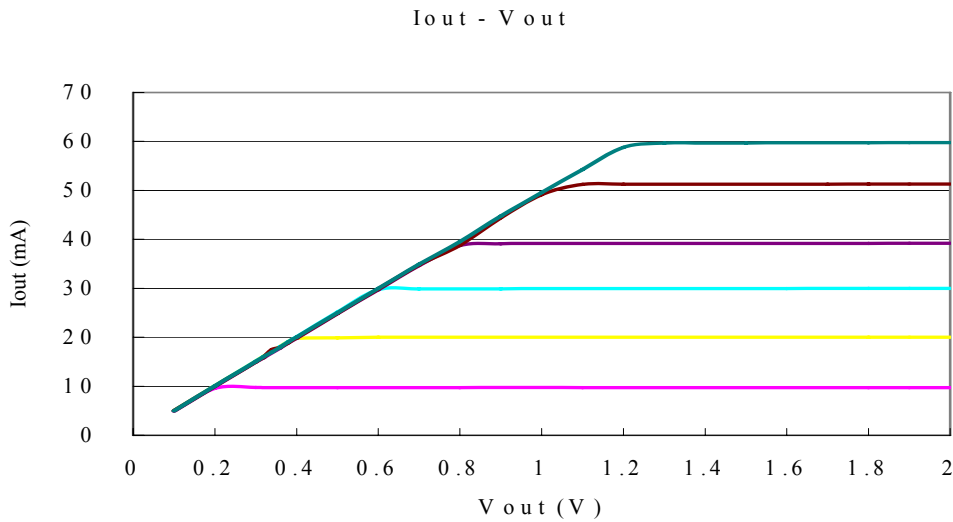


## Output Current Performance vs. Output Voltage

### DM134B

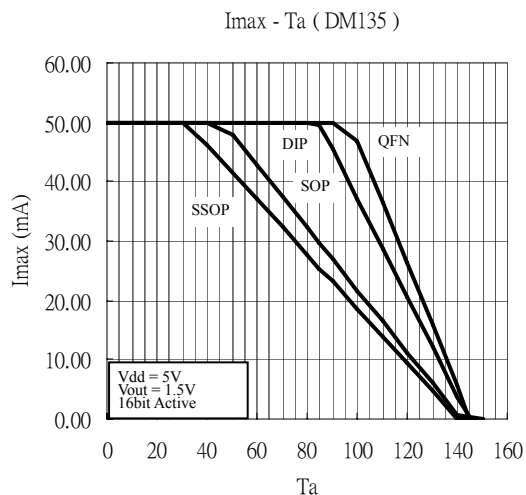
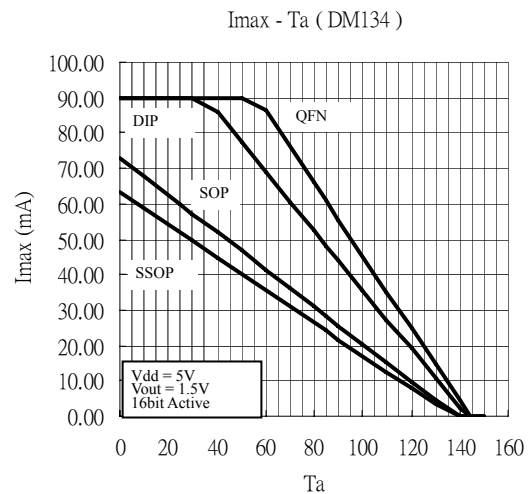
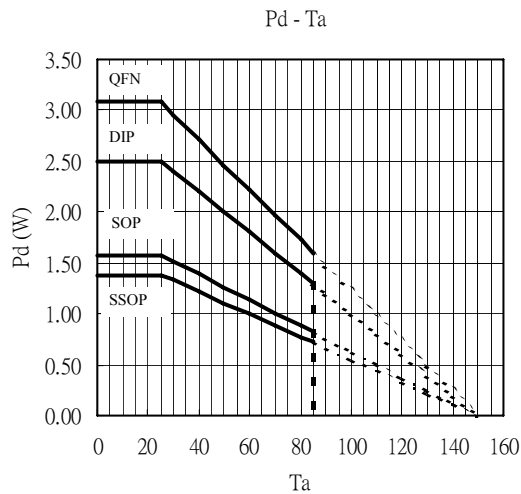


### DM135B



### Note:

In order to obtain a good constant current output, a suitable output voltage is necessary. Users can get related information about the minimum output voltage from the above graphs. Even under the same output current condition, the minimum output voltage required for each part is different.



### Note

As the power dissipation of a semiconductor chip is limited by its package and ambient temperature, this device requires a maximum output current given by an operating condition. The maximum allowable power consumption (Pd (max)) of this device is calculated as follows:

$$Pd(\max)(Watt) = \frac{(T_j(\text{junction temperature})(\max) - T_a(\text{ambient temperature}))(\text{°C})}{R_{th}(\text{°C/Watt})}$$

Based on the Pd (max), the maximum allowable current can be calculated as follows:

$$I_{out} = (Pd - V_{DD} \cdot I_{DD}) / (\# \text{ outputs} \cdot V_o \cdot \text{Duty})$$

## System Configuration Example

### [1] Output current ( $I_{OUT}$ )

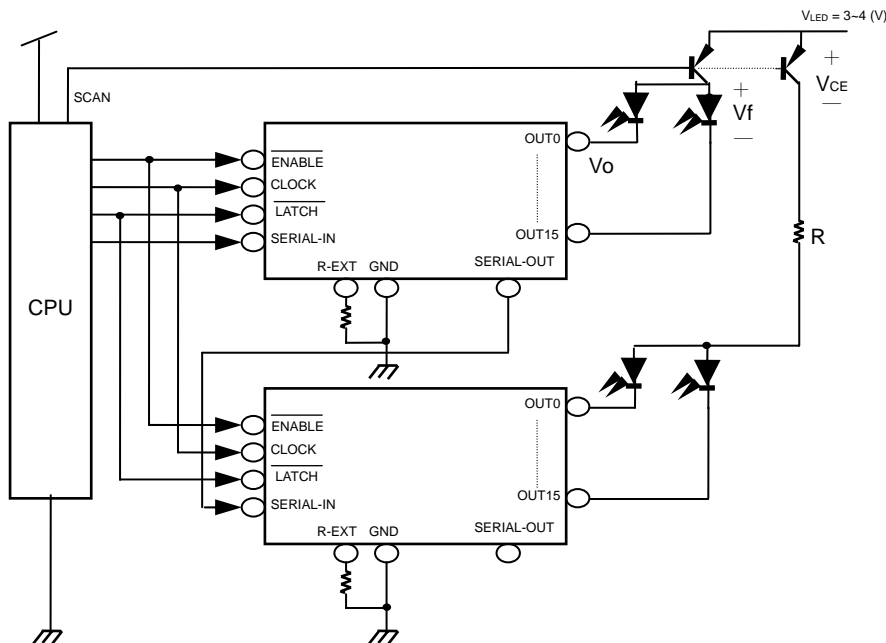
Sink current is set by the external resistor as shown in the figure of  $I_{out}$  vs.  $R_{ext}$ .

### [2] LED supply voltage ( $V_{LED}$ ) setup

$$V_{LED} = V_{CE} (T_r V_{sat}) + V_f (\text{LED forward voltage}) + V_o (\text{IC output voltage})$$

To prevent too much power from dissipating by the higher  $V_{LED}$  of the device, an additional R can be used to reduce the  $V_{out}$  when the outputs consume current is as follows:

$$R = \frac{V_{LED} - V_{CE} - V_f - V_o (\text{min})}{I_o (\text{max}) * \text{Bit}(\text{max})}$$



### Note

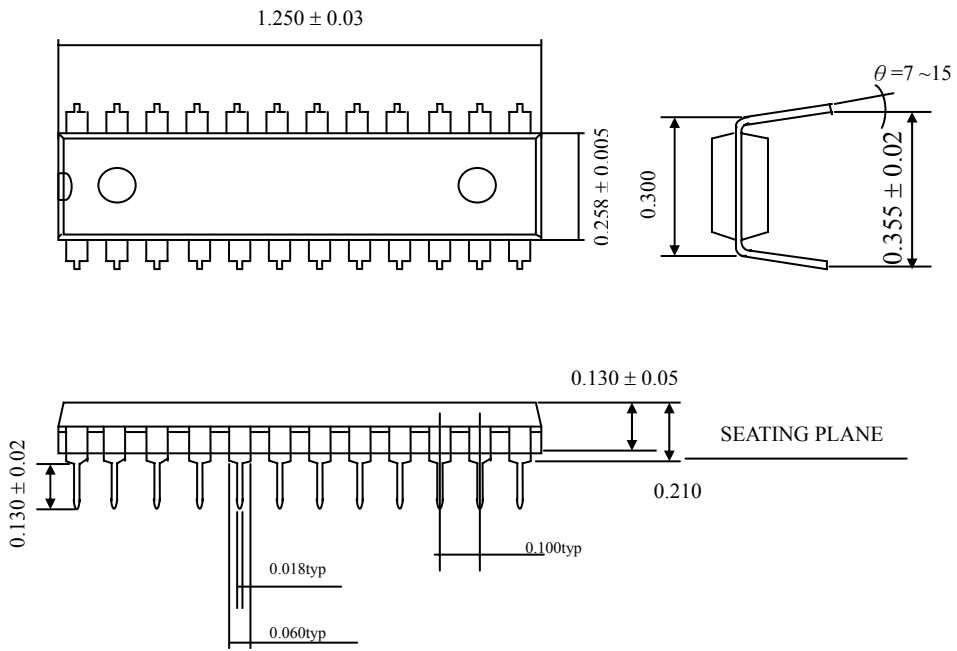
This device has only one ground pin shared by signal, output sink current, and power ground. It is advisable to pattern the ground layout with minimized inductance so that the switching noise induced by the input signals and the output sink current would not cause chip malfunction. To prevent drivers' outputs from damaging by overshoot stresses, it is also advisable not to turn off the drivers and scan transistors simultaneously. For the QFN package, the IC's thermal pad, which is internally connected to the bottom side of chip, should be connected to GND. In addition, a good PCB layout pattern of the thermal pad is required in order to have a better performance in thermal effect.



Package Outline

P-DIP 24

UNIT : INCH

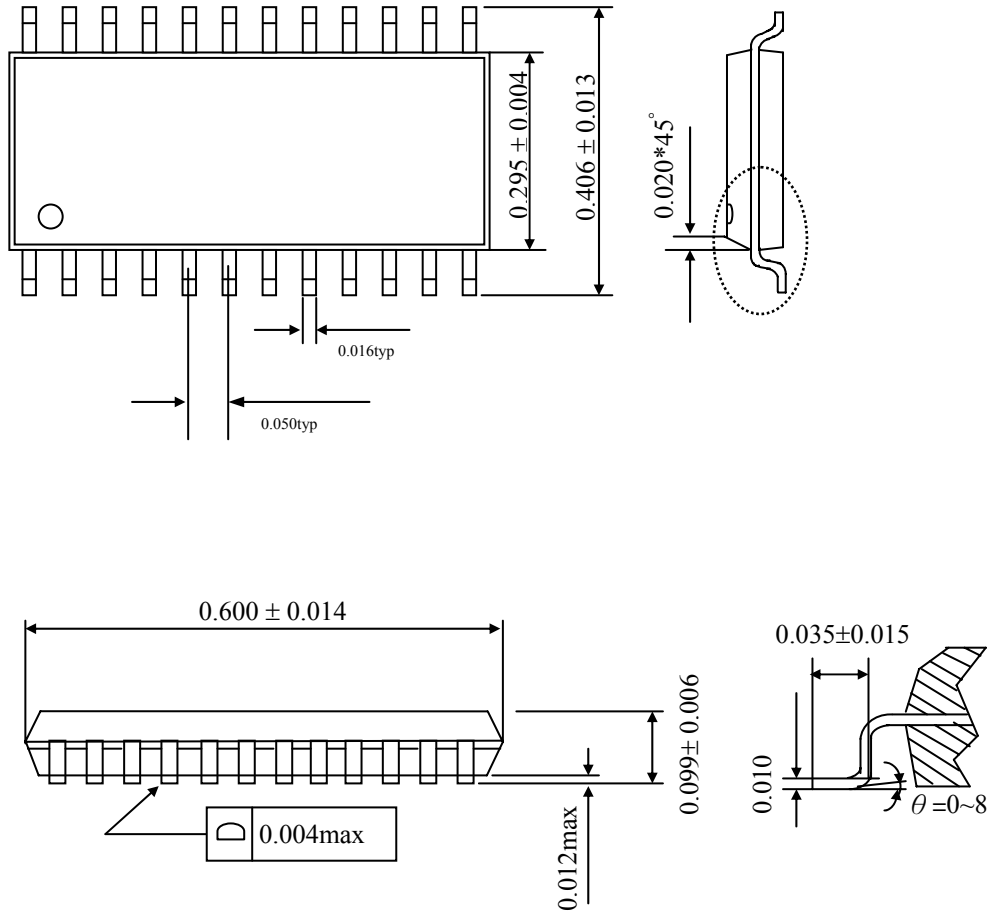




Package Outline

SOP24

UNIT : INCH



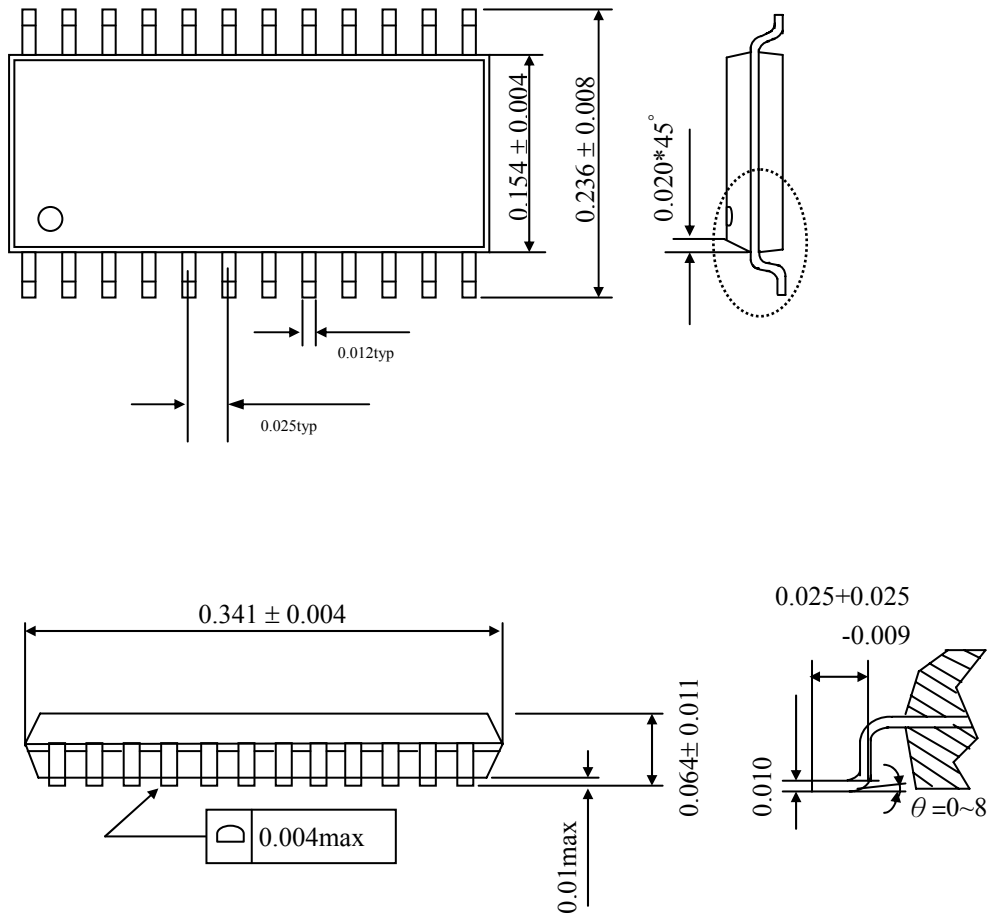




Package Outline

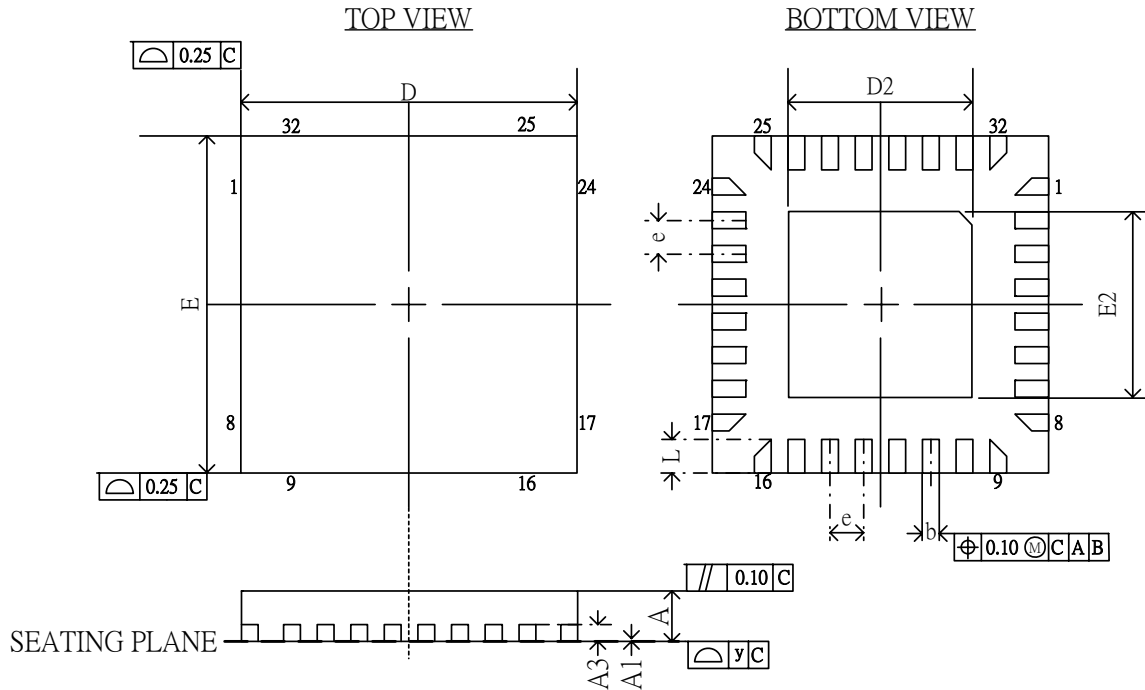
SSOP24

UNIT : INCH



Package Outline

QFN32



| SYMBOL | DIMENSION (mm) |      |      | DIMENSION (MIL) |        |        |
|--------|----------------|------|------|-----------------|--------|--------|
|        | MIN.           | NOM. | MAX. | MIN.            | NOM.   | MAX.   |
| A      | 0.70           | 0.75 | 0.80 | 27.6            | 29.5   | 31.5   |
| A1     | 0              | 0.02 | 0.05 | 0               | 0.79   | 1.97   |
| A3     | 0.25 REF       |      |      | 9.84 REF        |        |        |
| b      | 0.18           | 0.23 | 0.30 | 7.09            | 9.06   | 11.81  |
| D      | 5.00 BSC       |      |      | 196.85 BSC      |        |        |
| D2     | 1.25           | 2.70 | 3.25 | 49.21           | 106.30 | 127.95 |
| E      | 5.00 BSC       |      |      | 196.85 BSC      |        |        |
| E2     | 1.25           | 2.70 | 3.25 | 49.21           | 106.30 | 127.95 |
| e      | 0.50 BSC       |      |      | 19.69 BSC       |        |        |
| L      | 0.30           | 0.40 | 0.50 | 11.81           | 15.75  | 19.69  |
| y      | 0.10           |      |      | 3.94            |        |        |

Note: 1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M-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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