

# Driving LEDs



Prior to the use of an LED, it is necessary to thoroughly comprehend its characteristics and adopt the most suitable system for stable light emission. In cases where a drive system different to that which we recommend is adopted, please be sure to carefully read the technical information and take appropriate measures according to each property.

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# Citizen Electronics recommends the constant current drive system to ensure stable light-emitting output and reliability

## 1. Introduction

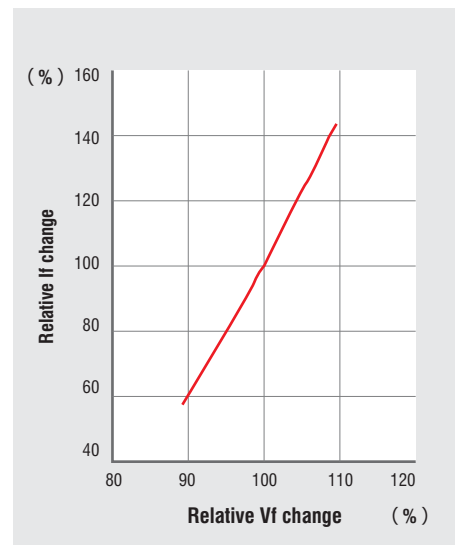
### Importance of understanding the characteristics of LEDs

Prior to driving an LED, which is a kind of semiconductor, it is necessary to thoroughly comprehend its characteristics because it has various elements. For example, the forward current 'If' varies widely with fluctuation in the forward voltage 'Vf'. In the case of Figure-1, a 10% rise in Vf results in an increase of If by more than 40% under constant temperature conditions.

The fluctuations in If have a significant influence on light emission and heat generation of LEDs. Especially, strict control of If is required for high-power LEDs used for lighting because they are driven by large current. In addition, the measures taken against heat release by an LED are a crucial factor as Vf varies with temperature.

When driving our LEDs, please be sure to read the relevant specifications and application notes and take appropriate measures according to their characteristics.

Figure-1 Vf - If characteristic



## 2. Constant current drive system ( recommended )

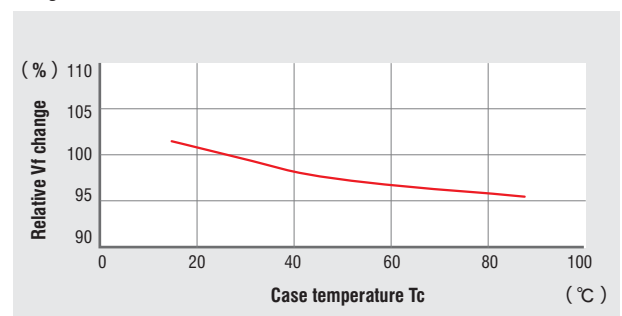
### For stable driving

The system that continues to supply a certain current to an LED even under the conditions that Vf varies with heat generation or other factors is said to be a 'constant current drive system'. This system allows relatively stable driving of LEDs even under changing environmental conditions or other parameters.

In general, an LED has a tendency for Vf, which applies a certain current to an LED, to decrease as the temperature increases. ( See Figure-2 )

Citizen Electronics recommends the constant current drive system to ensure stable light emitting output and reliability.

Figure-2 Tc -Vf characteristic



## Driving LEDs with constant voltage can make brightness unstable with changes in temperature

### 3. Constant voltage drive system

#### Cautions for constant voltage driving

Whereas the constant current drive system continues to supply a certain current to an LED, the system that continues supplying a certain voltage to an LED is said to be a 'constant voltage drive system'.

As described above, an LED has a tendency for  $V_f$ , which applies a certain current to an LED, to decrease as the temperature increases. In the case of Figure-2, when the case temperature  $T_c$  is 90°C, the same amount of current is achieved by approximately 5% lower  $V_f$  than that of the condition in which  $T_c$  is 25°C.

From another perspective, when an LED is operated with a certain voltage, the more the temperature increases, the larger the current that flows through the LED.

In cases of driving with a constant voltage, as shown in Figure-3, temperature changes lead to changes in  $V_f$  and current as the temperature of an LED is unstable due to variance in environmental temperature or other factors. Accordingly, the brightness of an LED can be unstable as it depends on current. Thus, when driving with a constant voltage is employed, an appropriate measure such as the connection of current control resistance needs to be implemented based on an assumption of the temperature in actual use.

■ Figure-3. Instability due to driving with constant current



### 4. Precautions for inrush current

#### Measures needed to prevent exceeding the maximum rating

When an LED is connected to capacitive load such as a capacitor, instantaneous inrush current may occur during on/off operations. For instance, this includes the case where the second side of energized power circuit is turned on/off. Citizen Electronics recommends usage that avoids the occurrence of inrush current as much as possible. In cases where the occurrence of inrush current is unavoidable, please be sure to take measures to prevent exceeding the absolute maximum rating of the relevant LED.

### 5. Connection between multiple LEDs

#### Series connection is recommended

When connecting multiple identical LED products, the series connection makes current flowing through LEDs uniform. Citizen Electronics recommends series connection to ensure stable light-emitting output and reliability. On the other hand, a parallel connection should be considered for  $V_f$  variation between LEDs. Some measures, such as the appropriate current regulation resistor being connected to each LED in series based on the temperature conditions in actual use, are required to apply even current to each LED with different  $V_f$  characteristics.

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