Controlling Luminous Intensity of LEDs

I. Outline

It is very important to control the luminous intensity of LED depending on the application.
This note explains two methods of controlling luminous intensity with Nichia LEDs by:
1) Adjusting current value 2) Pulse-width modulation (PWM)

II. Adjusting current value

Changing the current supply to the LED can directly control the luminous intensity as shown by the graph below.

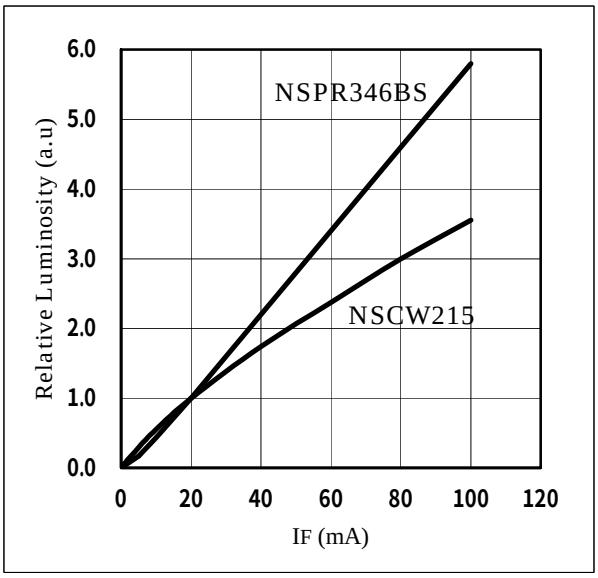

Figure 1 Forward Current vs. Relative Luminosity of NSCW215 (White) and NSPR346BS (Red)

i) Please refer to Figure 1 for NSCW215 (White LED).

a) The Figure 1 shows:

I_F = 20mA : Relative Luminosity (a.u.) 1.0
I_F = 40mA : Relative Luminosity (a.u.) 1.7
I_F = 80mA : Relative Luminosity (a.u.) 3

The luminous intensity is directly related to the current.

b) Also the Figure 1 shows:

The intensity of NSCW215 (White) is not a linear function of current.
The intensity of NSPR346BS (Red) is a linear function of current.
This is because of the characteristic difference in blue* and red dice.
*White LEDs contain blue dice.

Figure. 2 shows luminous intensity rank table of NSCW215.

Rank [mcd]		
R	S	T
Typ.	Typ.	Typ.
430	600	860

Figure. 2 Luminous Intensity of NSCW215 (Ta=25 ° IF=20mA)

As for rank S, the luminous intensity is 600mcd at 20mA.

The following is derived from II-i)-a) in page 1/3,

20mA 600mcd x 1 = 600mcd

40mA 600mcd x 1.7 = 1,020mcd

80mA 600mcd x 3 = 1,800mcd

ii) Shift of Chromaticity Coordinate

Although the luminous intensity can be controlled by changing forward current, the change in forward current will also change the color of the LED.

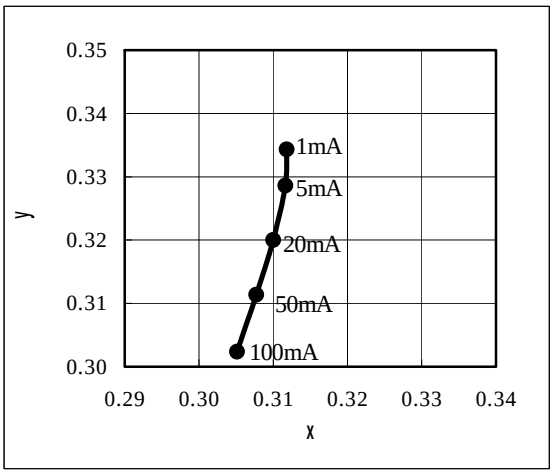

Figure 3：Forward current vs. Chromaticity NSCW215

Figure 3 shows:

・The chromaticity coordinate changes according to the change in forward current. (1mA-100mA)

III. Pulse-Width Modulation (PWM)

As explained in II, luminous intensity can be modified by controlling the current to the LED. However, this causes the color of the LED to shift. This section explains how to change luminous intensity without changing the color of the LED.

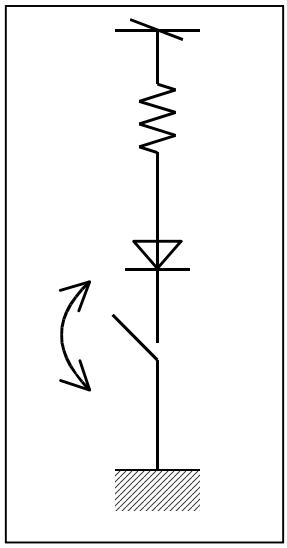

Figure 4：Circuit Diagram

The Figure 4 shows the examples of a circuit with a "switch" which opens and closes the circuit. Essentially turning the LED on and off. As we understand from motion pictures, the human eye has a limit of 60 frames per second. By increasing the frequency to 100 frames per second you can deceive the eye into believing a pulsing light source is constantly on.

Additionally, by modulating the amount of time "on" and "off" the luminous intensity can be controlled. To increase intensity one must increase the time "on". To decrease intensity one must decrease the time "on". Please refer to Figure 5:

Figure 5 shows the relation between current value and time.

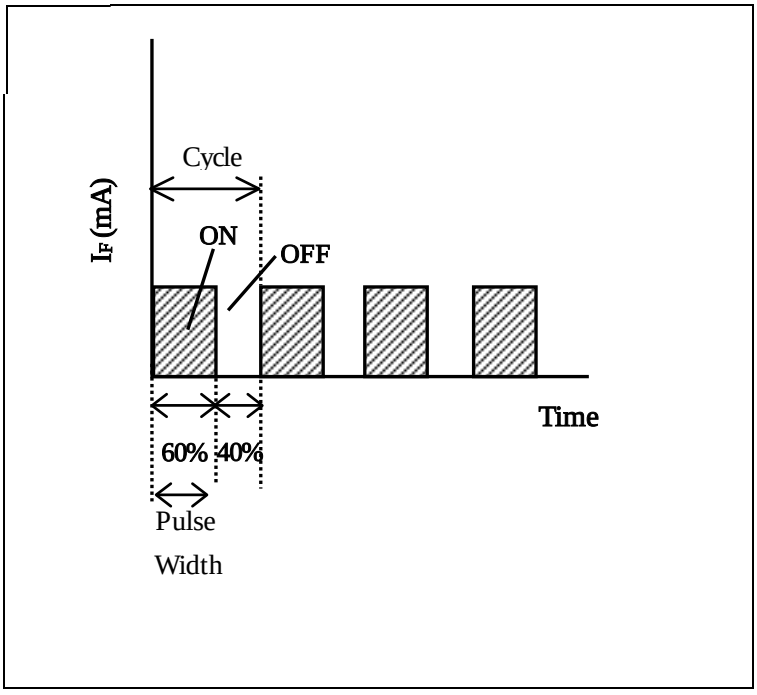

Figure 5：Pulse-width modulation (PWM)

The shaded portion shows the time period of "on." The color of the LED is not changed because the current value is constant. One cycle is composed of one "on" and one "off" time period. The period of time that the current flows in one cycle is called a pulse width. Duty ratio refers to the ratio of pulse width in one cycle. Figure 5 shows: 60/100 (60%) of duty ratio.