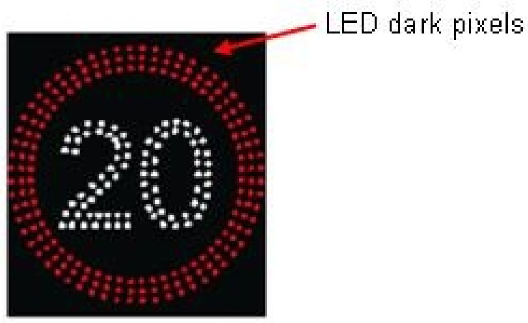
Driving LED Signage Efficiently

The worldwide energy shortage has raised public awareness on energy saving issues, and the revolutionary LED light source has therefore been widely adopted for its low power consumption, long life, environmental protection, and fast turn-on time features. As the LED brightness is adjusted by current, a constant current LED driver is necessary to keep uniform LED brightness. Furthermore, an LED driver with power saving functions becomes popular in order to meet the energy efficiency requirements in LED traffic sign and message sign applications.

Market Trend and Application
In LED traffic sign and message sign applications, only partial LEDs are turned on in a fixed area during a specific time period. As illustrated in Figure 1, the LEDs of the speed limit sign are turned off in the dark area, and the other LEDs are turned on in the red and white area. However, at the dark area, even if the LEDs are turned off, the LED drivers still keep working, which will consume unnecessary power over a long period of time and shorten the lifecycle of LED drivers.

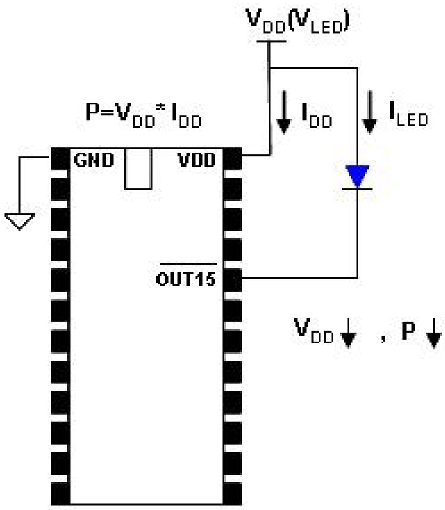


To maximize the energy efficiency of LED traffic signs and message signs, LED drivers are now designed with power saving functions. For example, when a car passes by, the LED speed limit sign will be turned on automatically to display the speed. When no car passes by, the LED speed limit sign will be turned off again. Under this condition, LEDs will not consume any power, and LED drivers with power saving functions, such as MBI5037, will automatically enter sleep mode, which only consume less than 0.1mW to dramatically reduce the total power consumption of the whole display panel. Also, the reduction of power dissipation on LED drivers helps improve the energy efficiency, and the methods may include reducing supply current (IDD), supply voltage (VDD), LED supply voltage (VLED), and sustaining voltage (VDS). The following equation helps calculate the power dissipation of LED drivers:

$P_{SD}=P_{DN}+P_{DM}$,
P_{SD}: Total power dissipation of LED drivers,
P_{DN}: Power dissipation of LED drivers which are in use,
where $P_{DN}=(I_{DD}xV_{DD})+(I_{OUT}xDutyxV_{DS}x16) \times N$, and N is the number of LED drivers which are in use
P_{DM}: Power dissipation of LED drivers which are not in use,
where $P_{DM}= I_{DD}xV_{DD} \times M$, and M is the number of LED drivers which are not in use.

In addition, the following equation helps calculate the power loss of an LED driver:
$P_{DRVLOSS} = P_{ALLDRV}-P_{USEDRV}$
$P_{DRVLOSS}$: Power loss of an LED driver
P_{ALLDRV}: Power consumption of all LED drivers
P_{USEDRV}: Power consumption of LED drivers which are driving the turned-on LEDs

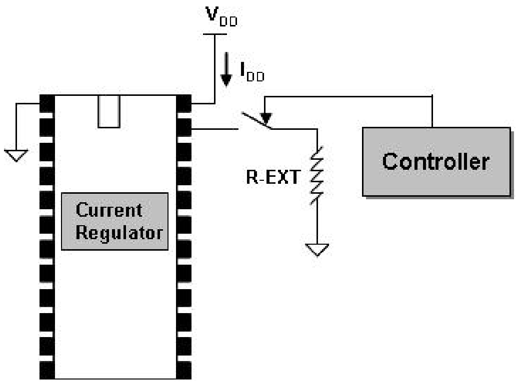
There are different ways to improve power efficiency of LED display systems, but there is also tradeoff within power efficiency, system cost and display quality. The following paragraphs introduce some of the common methods to improve power efficiency, and two of the methods, sleep mode and 0-Power mode, are already applied in devices such as Macroblock’s LED driver MBI5037 to improve the power efficiency without increasing the system cost or sacrificing the display quality.



Approaches for Improving Power Efficiency

Low Operation Voltage: Set the minimum supply voltage for LED drivers, i.e. 3V, to lower the power consumption. From the equation P=I*V, the lower supply voltage helps reduce the power consumption. However, when the VDD is connected to VLED, blue or green LEDs require higher supply voltage; therefore, this method is not always applicable for all application conditions.

(Figure 2. VDD is connected to VLED)



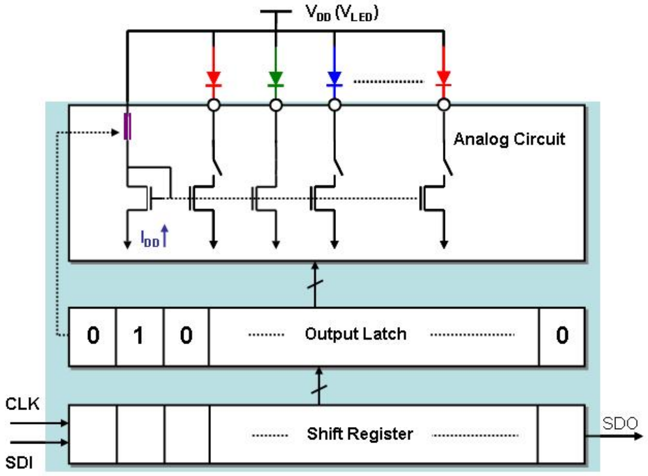
Floating R-EXT Pin: When the R-EXT pin is floating, the internal current regulator of an LED driver will be turned off, which may reduce 50% of the power. However, this method may increase the system cost and the complexity of system design, and furthermore, some LED drivers may not work properly with floating pins.

(Figure 3. When the R-EXT pin is floating)

Choosing High Brightness LEDs: High brightness LEDs increase higher luminous outputs. At the same luminance, LED drivers provide lower constant current to higher brightness LEDs than to conventional LEDs; therefore, LED drivers require lower supply current and the power consumption will also be decreased.

Sleep Mode Setting: LED drivers may enter or leave the sleep mode when receiving commands. In the sleep mode, digital circuits keep working while most of the analog circuits are turned off. Therefore, LED drivers consumes less than 0.1mW power to achieve power saving up to 99%. Since most of the analog circuits and few of the digital circuits enter the sleep mode, the supply current of LED drivers will reduce to 1% of the original supply current. Even in the sleep mode, LED drivers still allow serial input and output transmission for the flexibility of system operation.

Take the MBI5037 as an example. When the device enters sleep mode, it will not execute any error detection command except the wakeup command, but the shift register still keeps shifting data with the clock. In other words, it is possible that only some of the LED drivers on the same display panels are in the sleep mode and others are not, if the control signals are independent. MBI5037 will leave the sleep mode and resumes to work when receiving the command: one LE pulse containing 7 CLKs. When MBI5037 leaves the sleep mode, the output latch will be reset, i.e. OE is low-active, and the output switch is temporarily closed until MBI5037 is triggered by LE (falling edge) in 1ms, and the controller may start to deliver signals to LED drivers.



0-Power Mode Setting: The 0-Power mode is effective by setting the configuration register of LED drivers. When all the image data are "0", LED drivers will automatically enter the 0-Power mode, as illustrated in Figure 5. In the 0-Power mode, the analog circuits of LED drivers will also be turned off so that LED drivers can save the power up to 99%.

When LED drivers are in the 0-Power mode, LED drivers will not execute any error detection command except the wakeup command, but the shift register still keeps shifting data with the clock. When the non-zero data is latched, LED drivers will leave 0-Power mode automatically.

From the above mentioned methods for power efficiency improvement, sleep mode and 0-power mode settings are more applicable and flexible to improve the power efficiency for LED traffic sign and message sign applications. LED drivers adopted with these two methods can easily save the power of LED traffic signs or message signs without increasing the system cost and the complexity of system design.