

# LED應用與驅動方式

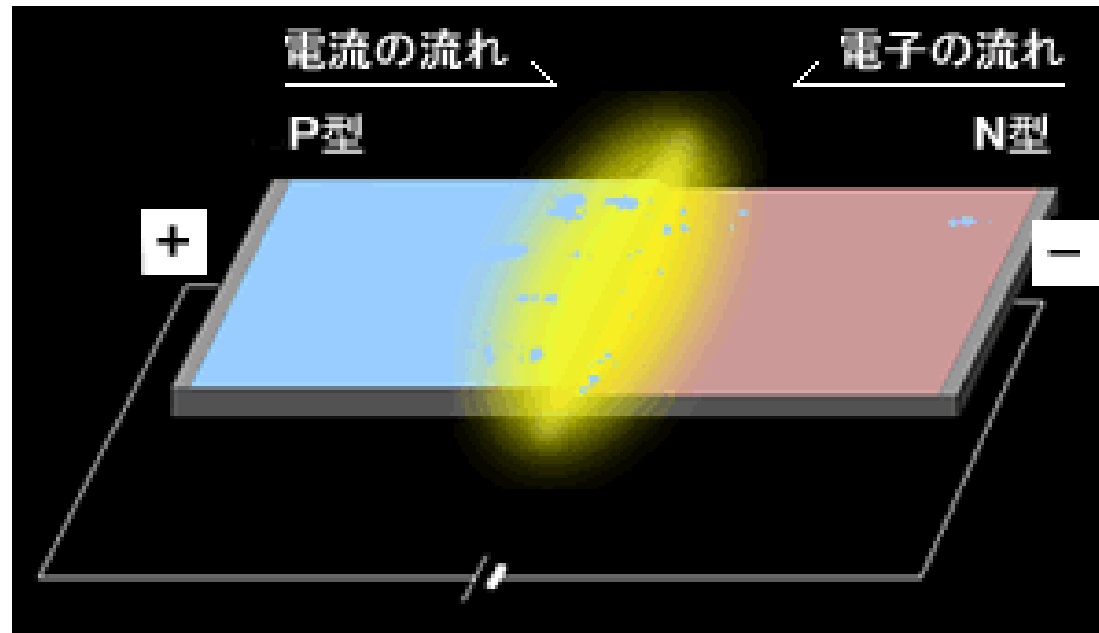
點晶科技

June 2008

# 大綱

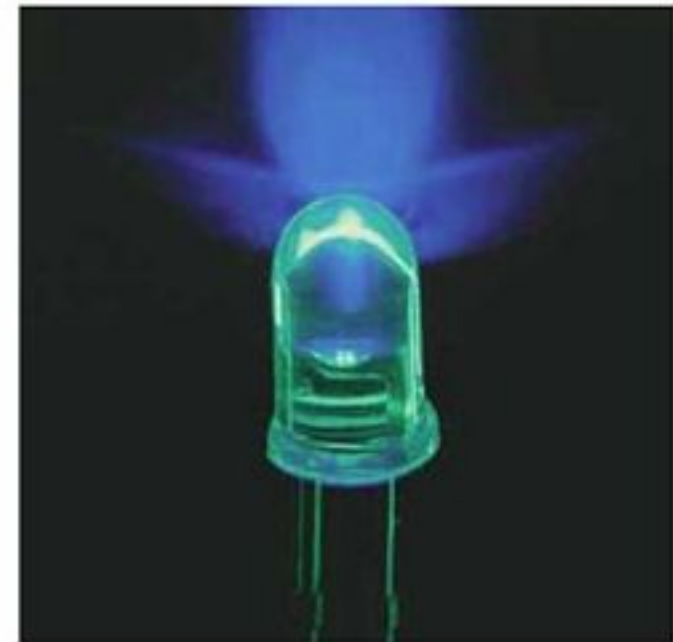
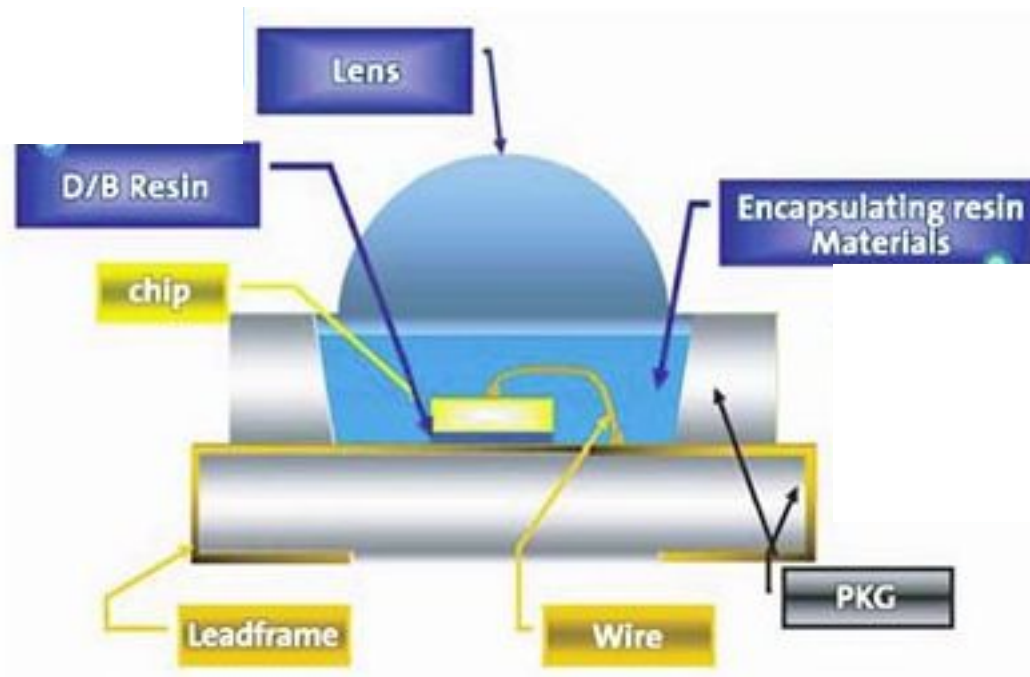
- LED 簡介
- LED 混色原理
- LED 驅動方式
- LED 應用實例
- Q&A

# LED—Light Emitting Diode (1)



LED是利用電能直接轉化為光能的原理，在半導體內正負極2個端子施加電壓，當電流通過，使電子與電洞於pn接面結合而產生光。

# LED—Light Emitting Diode (2)





# LED—Light Emitting Diode(3)

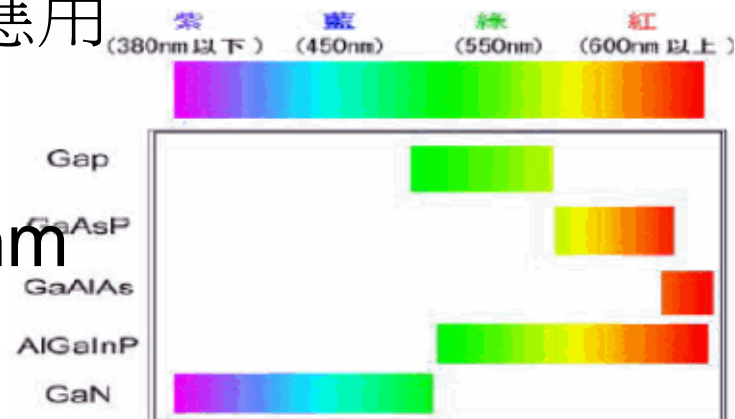
優點	說明	應用領域
點滅速度快	無須暖燈時間。白熾燈泡約需0.2秒，螢光燈更需數秒，LED只要100ns，可結合電腦控制。	煞車燈、號誌、舞台燈
耗電量低	耗電量僅傳統燈泡的10%	
元件壽命長	大於兩萬小時。	
體積微小	LED發光晶片極為細小，可以點線面搭配組合，且可以隨意與建築結構彈性結合。	建築照明、面發光照明器具
光指性強	一般日光燈或鹵素燈需具有特殊設計之反光板才可達到光之指向效果，LED有極高指向性。	重點照明、階梯燈、導引燈、警示燈、舞台燈。
功率微小化	單只LED消耗功率通常小於1W，發熱與功率成正比，此可應用於需避免高熱的場合。	櫥窗照明、博物館照明
低電壓 / 直流電驅動	LED半導體原件產品，可在低電壓與直流電下操作。可與太陽能作結合。	手電筒、與PCD機板結合之照明、顯微照明、太陽
耐震動		
混色機能強		
冷發光	無熱輻射光，紅外線會有熱效果，LED照明應用於此光譜，屬冷光源，不會因使用過久而發燙	醫學照明、食品照明、博物館照明。
無汞污染	環保光源（相對於CCFL等）	

# 如何選用LED

# LED 波長

- 可見光
  - 波長約介於380nm~790nm
  - 紅光約700nm, 綠光約540nm, 藍光約470nm
  - 各式背光,看板,交通號誌,應用

- 不可見光
  - 波長約介於850nm~1550nm
  - 遙控器紅外線應用



➔請使用可見光LED!!

# 封裝型式

- SMD 表面黏著型

- 體積小, 混光性佳

- 獨立控制6-pin/4pin 共陽型 RGB LED皆可

- 串接應用選6-pin RGB LED

- 點晶產品不適用4-pin 共陰型 RGB LED



- DIP 插鍵式

- 價格便宜, 加工容易

- 以戶外應用與指示燈為主



➔ 有空間限制時使用SMD LED, 否則二者皆可



# LED驅動電壓與電流

- 驅動電壓  $V_f$ 
  - 紅光約2V, 藍/綠/白光約3.3V
  - LED陽極端的電壓 $V_{led}$ 要大於 $V_f$ , LED才會亮
- 驅動電流  $I_f$ 
  - 依亮度選擇LED
  - 高亮度約20mA, 高功率至少100mA
  - 依LED的 $I_f$ 值, 設定驅動IC的輸出電流

→ 小心不要讓LED燒掉了!!

# 如何選用LED驅動晶片

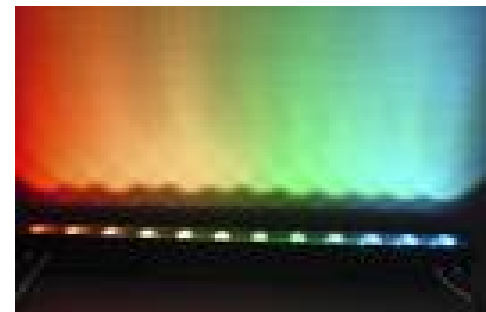
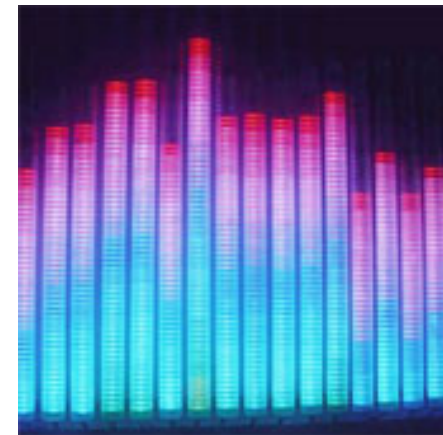
# 不具漸層效果的燈具控制

- 直接用電池或變壓器連接**LED**
  - 電池或變壓器的輸出電壓與電流要足以驅動**LED**
  - 用開關斷開或連接電源來控制**LED**的亮滅
- 只能做**LED**亮暗的控制
  - 無法達到多色漸層效果



# 具漸層效果的燈具控制

- 24-Channel Driver, DD235
- 1-Ch./3-Ch.High Power Driver, DD311/312/313
- 8\*3-Channel Driver, DM164



# 長串接控制

- 3-Channl PWM driver--DM413/DM412



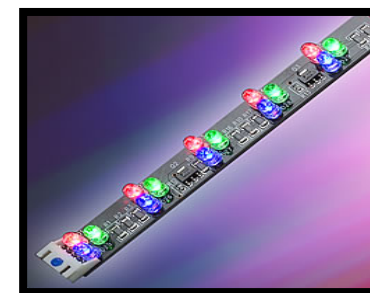
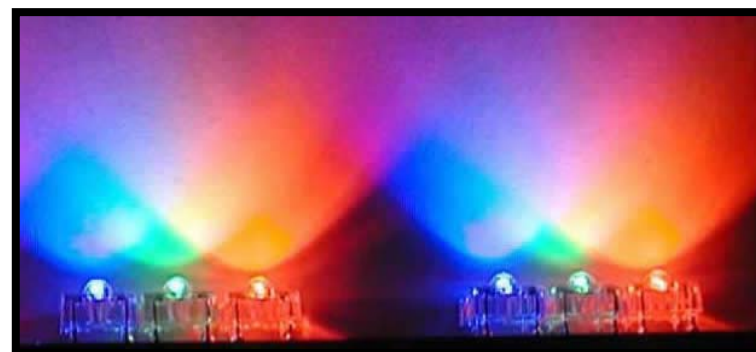
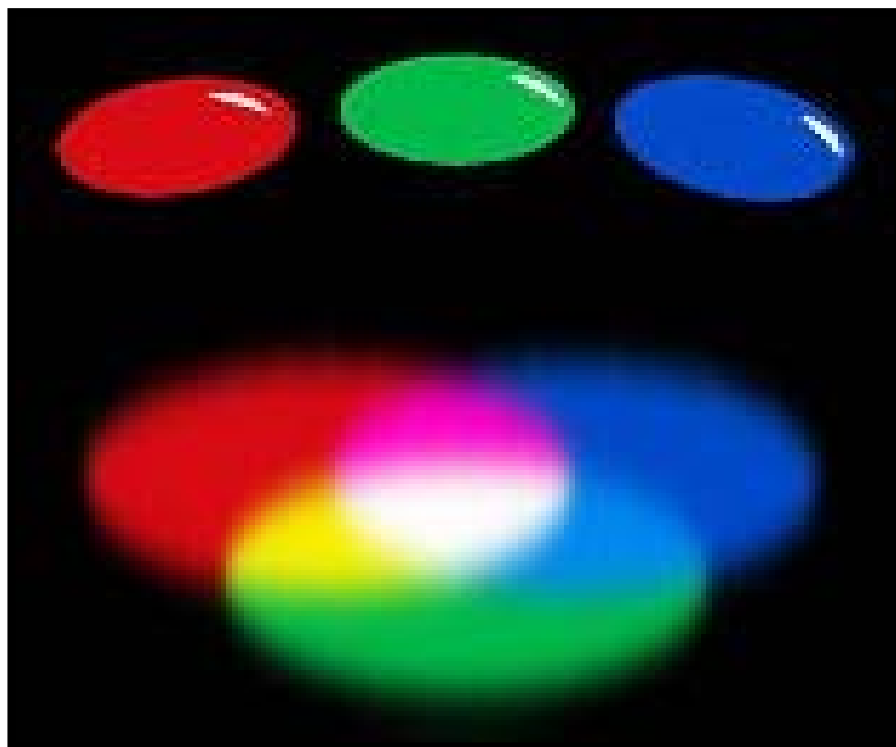
# 動畫或字幕

- 8/16-Channel Driver, DM11C/DM13C
- 16-Channel Driver, DM631/632/633/634



# LED混色原理

# LED三原色

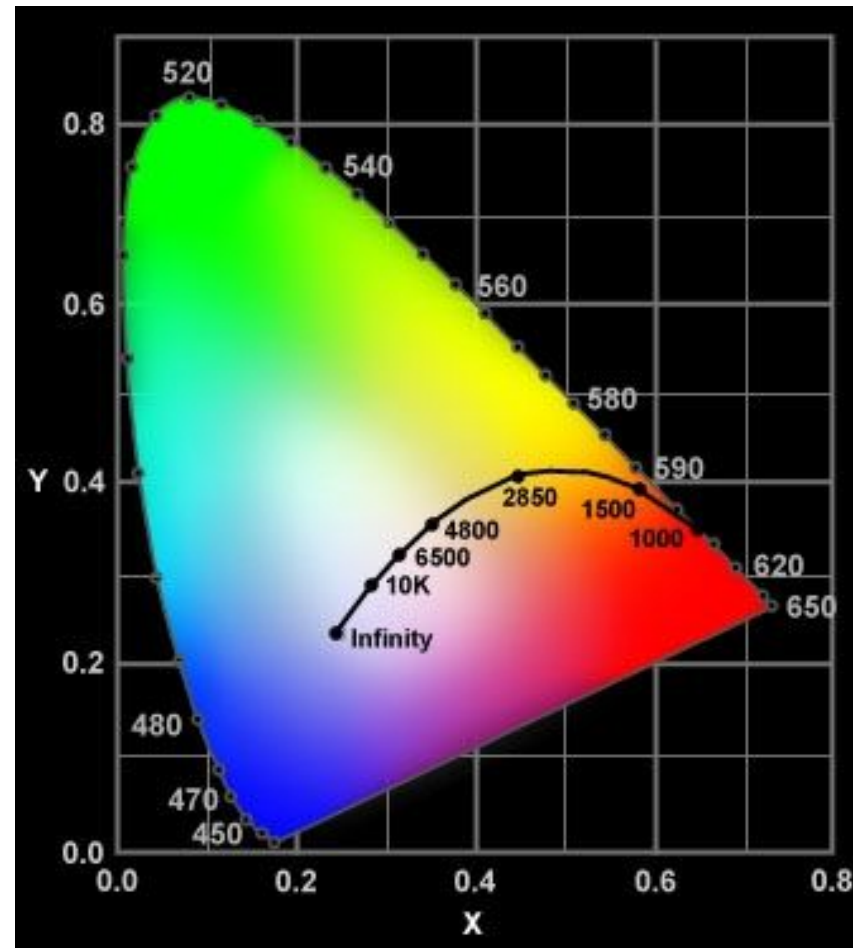


色彩3原色=Red、Green、Blue。  
色彩3補色=Yellow、Magenta、Cyan  
 $R+G+B=White$ 、 $R+G=Y$ 、 $R+B=M$ 、 $B+G=C$ 。



# CIE Color Space

- 國際照明委員會  
(International Commission on Illumination, CIE)
- CIE色度座標圖給定顏色混合的紅 (R)、綠 (G) 和藍 (B) 色光相對應數值來確定顏色。



# RGB色碼表(1)

FFEBFF	FFEBF5	FFEBEB	FFF5EB	FFFFEB	F5FFEB	EBFFEB	EBFFF5	EBFFFF	EBF5FF	EBEBFF	F5EBFF
FFCDFE	FFCDE5	FFCECD	FFE7CD	FEFFCD	E5FFCD	CDFFCE	CDFFE7	CDFEFF	CDE5FF	CECDFF	E7CDFF
FFAFFE	FFAFD6	FFB0AF	FFD8AF	FEFFAF	D6FFAF	AFFFB0	AFFFD8	AFFEFF	AFD6FF	B0AFFE	D8AFFE
FF91FE	FF91C7	FF9291	FFC991	FEFF91	C7FF91	91FF92	91FFC9	91FEFF	91C7FF	9291FF	C991FF
FF73FD	FF73B7	FF7573	FFBB73	FDF73	B7FF73	73FF75	73FFBB	73FDFF	73B7FF	7573FF	BB73FF
FF55FD	FF55A8	FF5755	FFAC55	FDF55	A8FF55	55FF57	55FFAC	55FDFF	55A8FF	5755FF	AC55FF
FF37FD	FF3799	FF3937	FF9D37	FDF37	99FF37	37FF39	37FF9D	37FDFF	3799FF	3937FF	9D37FF
FF19FC	FF1989	FF1C19	FF8F19	FCFF19	89FF19	19FF1C	19FF8F	19FCFF	1989FF	1C19FF	8F19FF
FA00F7	FA007A	FA0300	FA8000	F7FA00	7AFA00	00FA03	00FA80	00F7FA	007AFA	0300FA	8000FA
DC00D9	DC006B	DC0300	DC7100	D9DC00	6BDC00	00DC03	00DC71	00D9DC	006BDC	0300DC	7100DC
BE00BC	BE005D	BE0200	BE6100	BCBE00	5DBE00	00BE02	00BE61	00BCBE	005DBE	0200BE	6100BE
A0009E	A0004E	A00200	A05200	9EA000	4EA000	00A002	00A052	009EA0	004EA0	0200A0	5200A0

- <http://www.wahart.com.hk/rgb.htm>
- <http://rhinejo.myweb.hinet.net/home/color/color-cord.html>

# 數位的世界 – 2進制

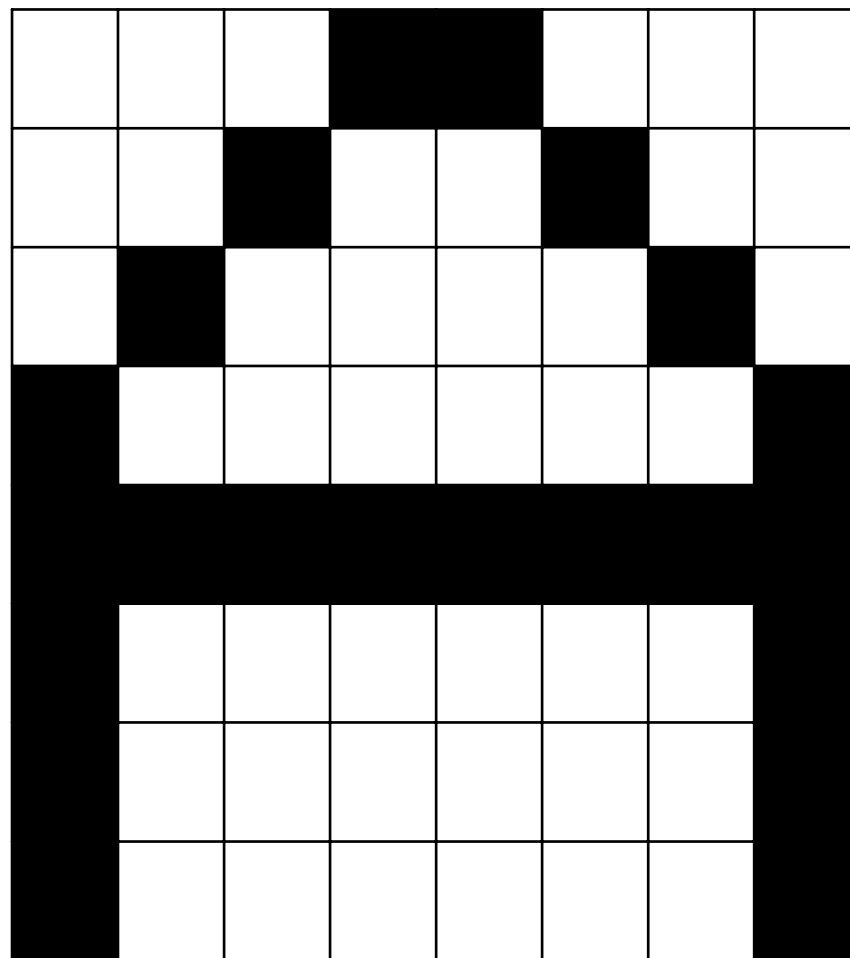
- 10進制
  - $234 = 2 * 10^2 + 3 * 10^1 + 4 * 10^0$
- 2進制
  - $101_2 = 1 * 2^2 + 0 * 2^1 + 1 * 2^0 = 5$
- 16進制
  - 0~F: 0 1 2 3 4 5 6 7 8 9 A B C D E F 分別表示 0~15
  - $B2D_{16} = 11 * 16^2 + 2 * 16^1 + 13 * 16^0 = 2861$
- 16進制轉2進制
  - $A8_{16} = \underline{1010} \underline{1000}_2$

## RGB色碼表(2)

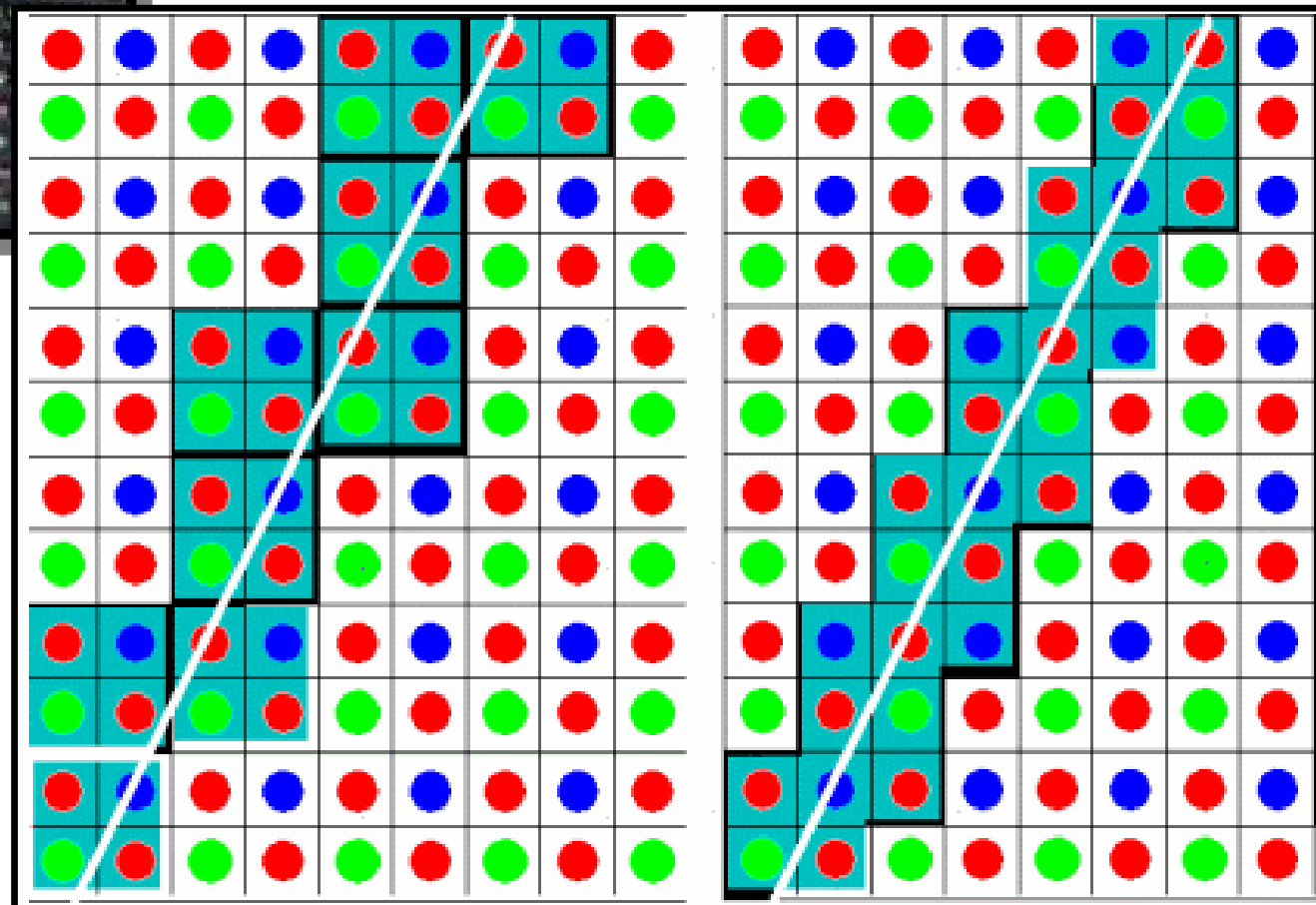
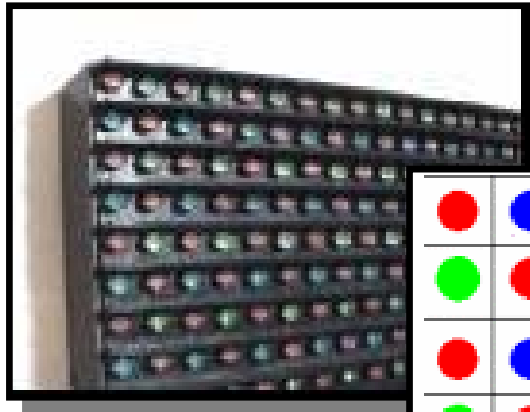
- 所有顏色皆有專屬代碼
  - 以16進位表現256色
  - 共六碼 (如: 99 FF 37 )
  - R :  $(9*16 + 9)=153 \rightarrow (153+1)/256 \sim 60.2\%$
  - G :  $(15*16 + 15)=255 \rightarrow (255+1)/256 \sim 100.0\%$
  - B :  $(3*16 + 7)=55 \rightarrow (55+1)/256 \sim 21.9\%$
- 24-bit全彩(R 8-bit + G 8-bit + B 8-bit )
  - $256 * 256 * 256 = 16,777,216$  色

# 圖案的形成

- 解析度
- Pixel 8x8為例

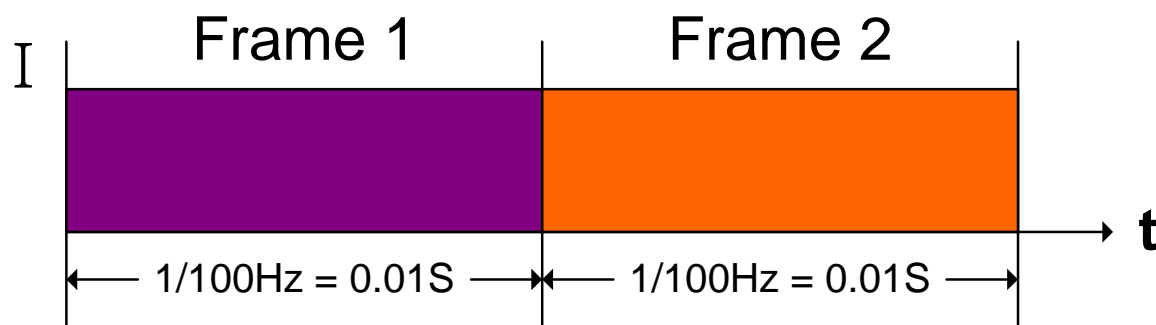


# LED點矩陣 (Dot Matrix)



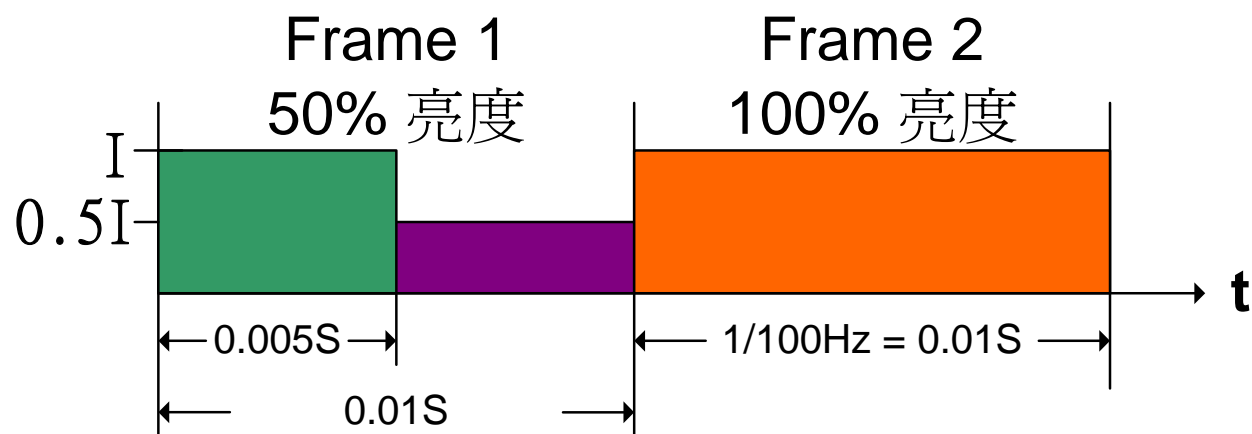
# 動畫

- 靜止的圖像如何變成運動的圖畫
  - 視覺暫留
- 畫面更新率 (Frame Rate : F)
  - 高於60Hz (Hz : 每秒變化的次數)
- 以100Hz為例



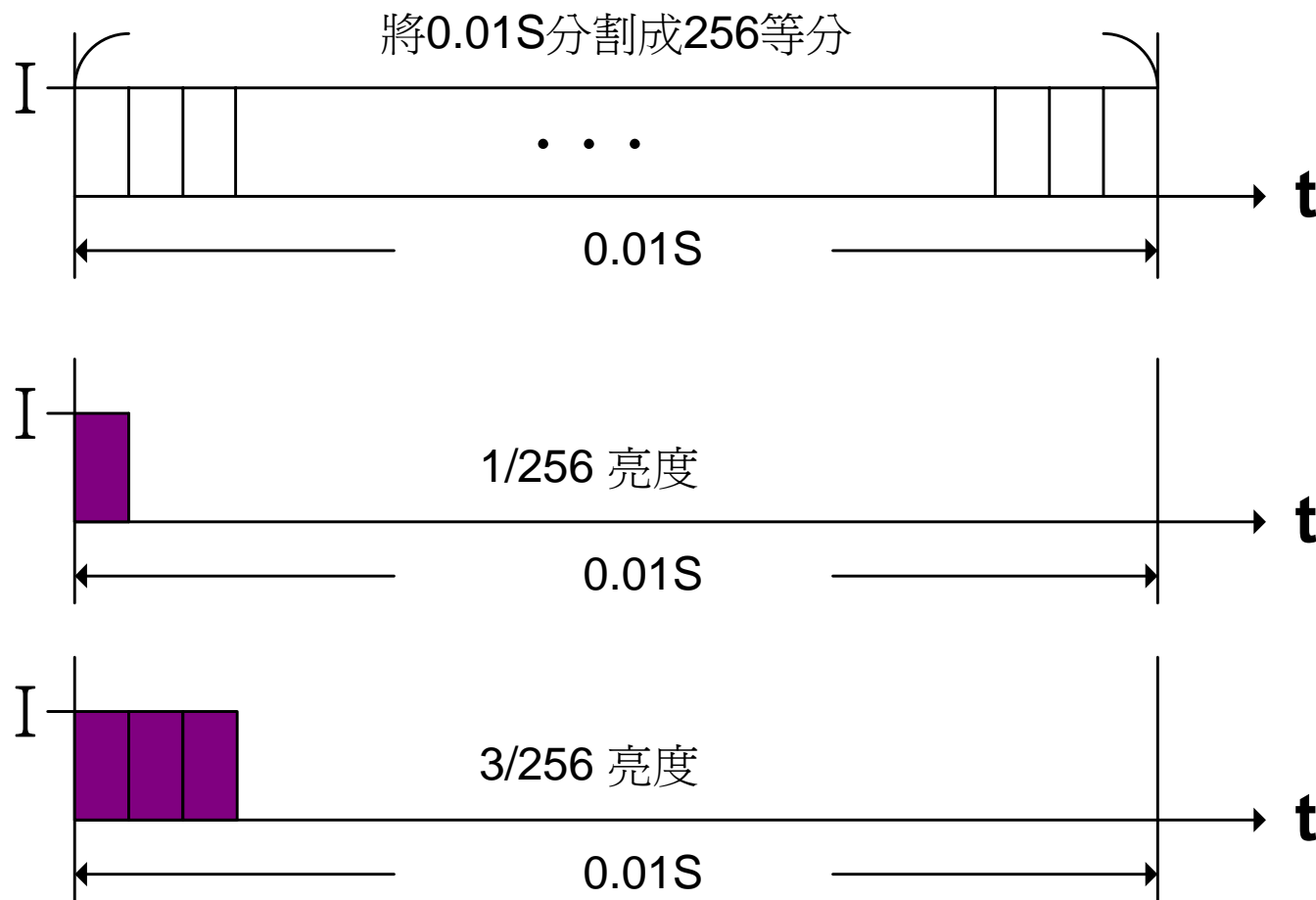
# 色彩的深淺變化

- LED的電性
  - 亮度與電流大小成正比
- 亮度調整
  - 調整電流
  - 脈衝寬度調變(PWM)





# 脈衝寬度調變(PWM)



# 爲什麼需要LED Driver

## 為何需要LED Driver??

- ↗ LED亮度與輸入電流成正比
- ↗ LED Vf 差異性可達20%

- 電流均一性 (Current Matching)
  - Bit to bit
  - Chip to chip
- 電流穩定性 (Current Regulation)
  - LED forward Voltage
  - Power Supply Voltage
- 反應速度 (Transient Response)
  - Tr/Tf
  - Clock Frequency

# Features of SiTI LED Driver

## Current Adjustment

- Constant Current Adjusted by External Resistor
- Global Brightness Control
- Dot Correction Adjustment
- PWM Gray Scale Adjustment

## Protection Circuitry

- Open/Short Detection
- Thermal Alarm/Shut Down
- OVP/OCP

## High Power Driving

- 500mA+ per Channel
- 17V / 36V of Output Voltage

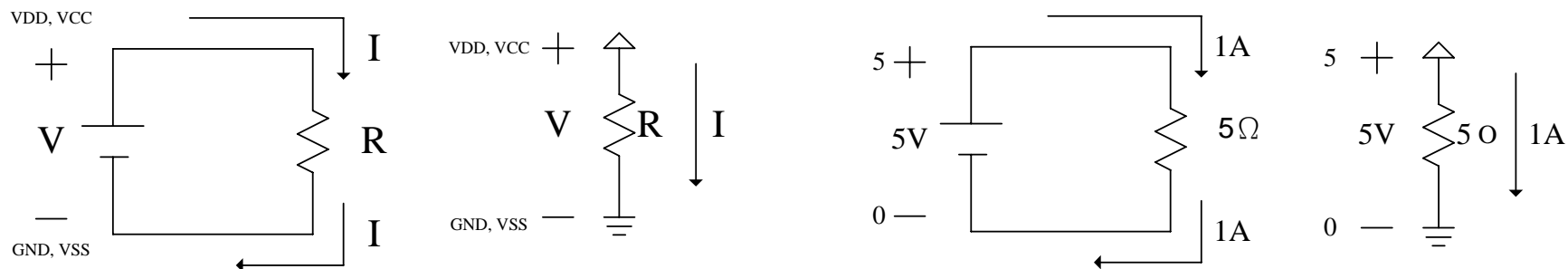
## Low Power Supply

- 3.3V~33V

# 基礎電學

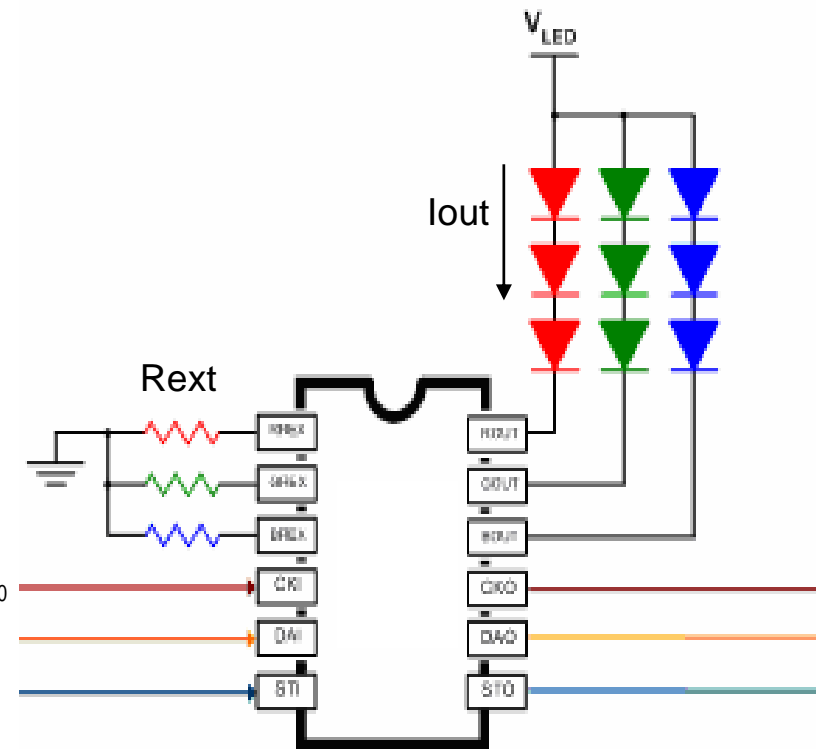
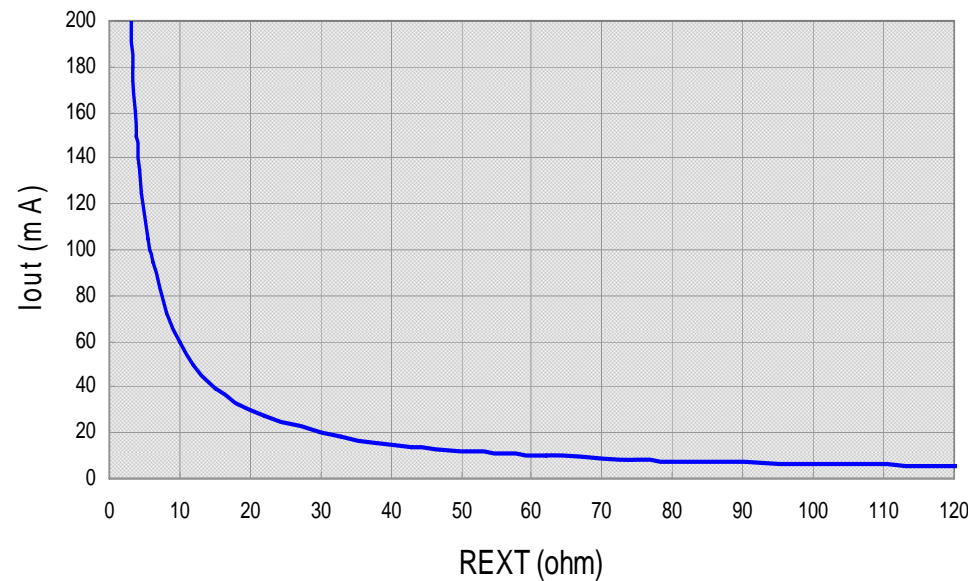
符號	名稱	單位	備註
V	電壓	V	電壓是一種差值
I	電流	A	
R	電阻	$\Omega$	
E	能量	J	
P	功率	W	每秒產生(消耗)多少能量

$$V = I * R, P = I * V = E / t$$



# 定電流設定 - 外掛電阻

Output Current as a Function of REXT value

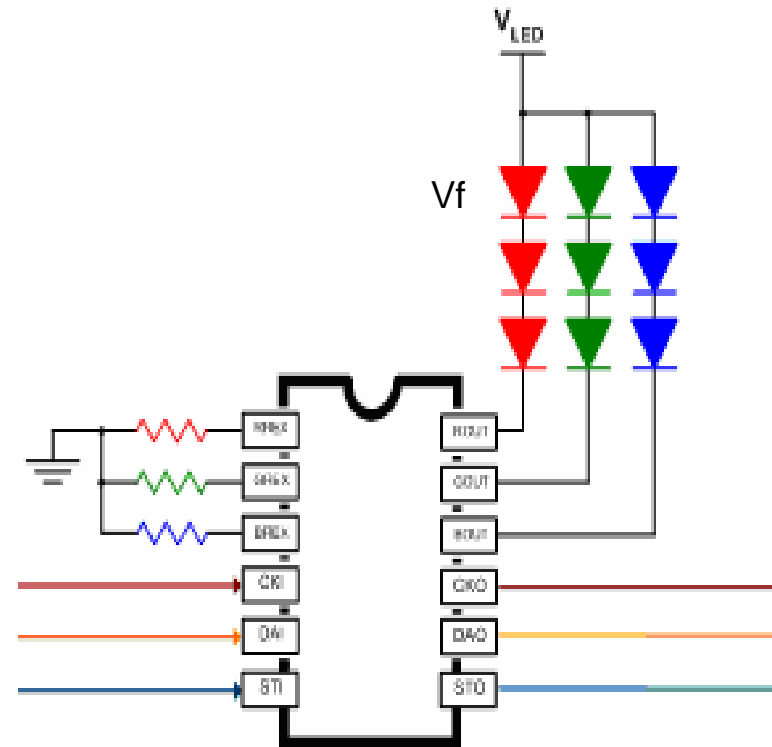
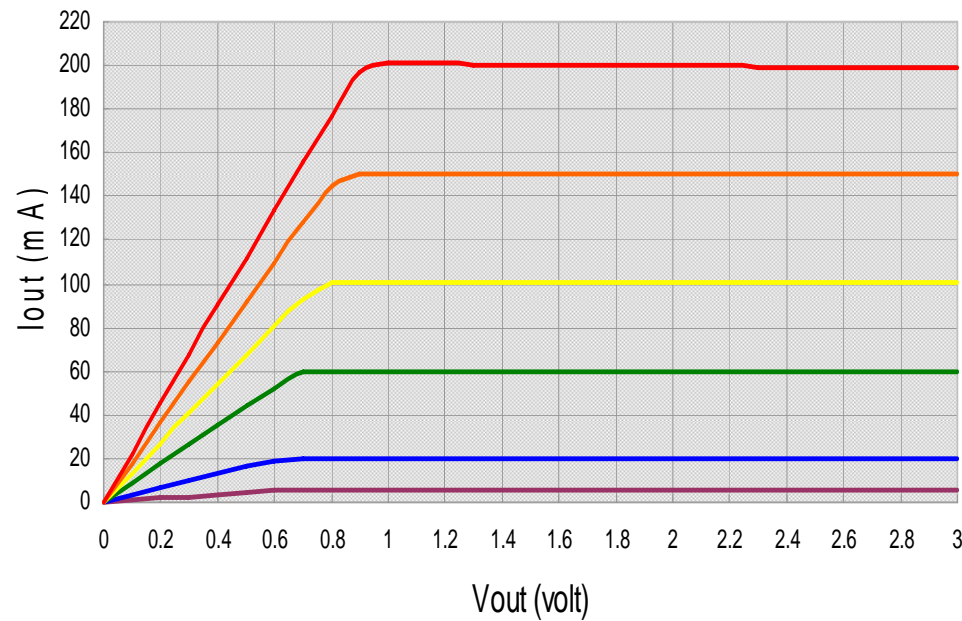


When setting Iout= 20mA,

Rext = 30ohm

# 定電流設定 - Min. Vout

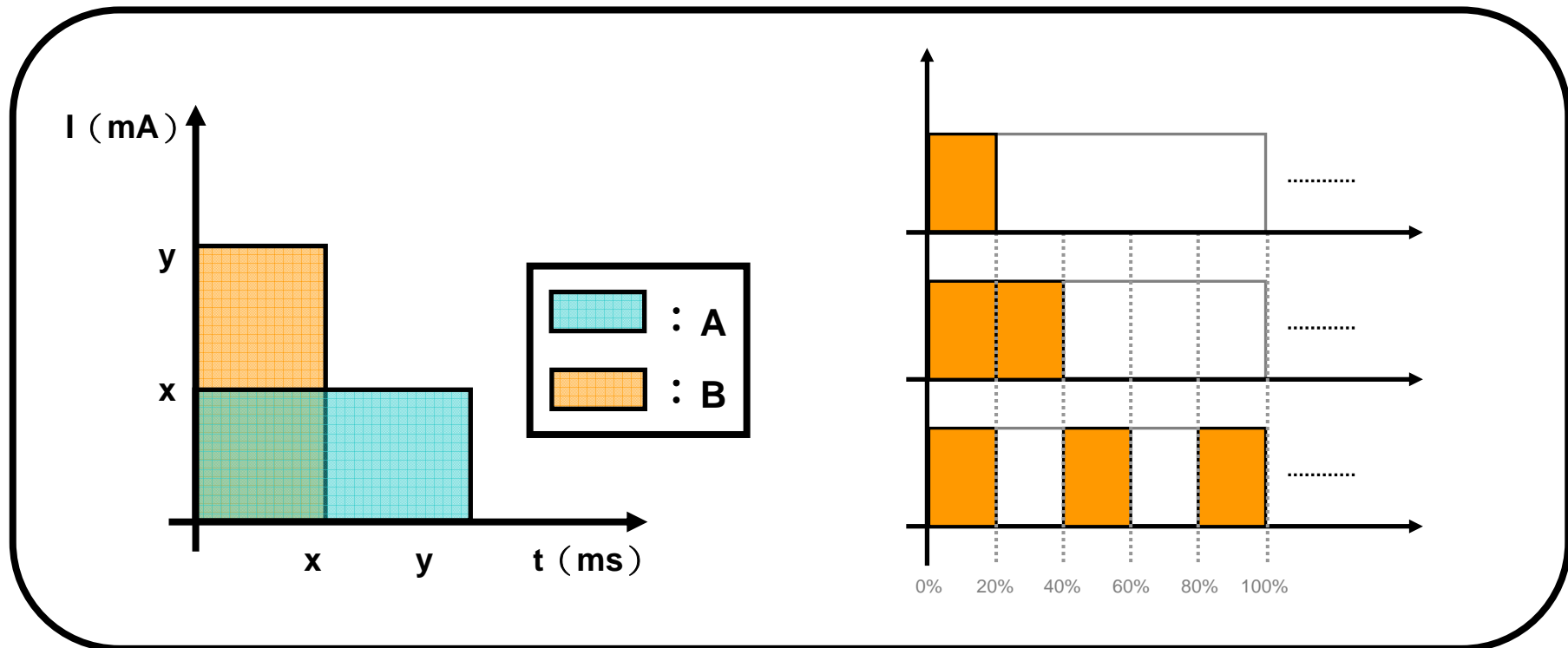
Output Current as a Function of Output Voltage



If Iout=100mA

Min. Vout = Vled - Vf = 0.8V

## LED : I · T · L (Luminance)

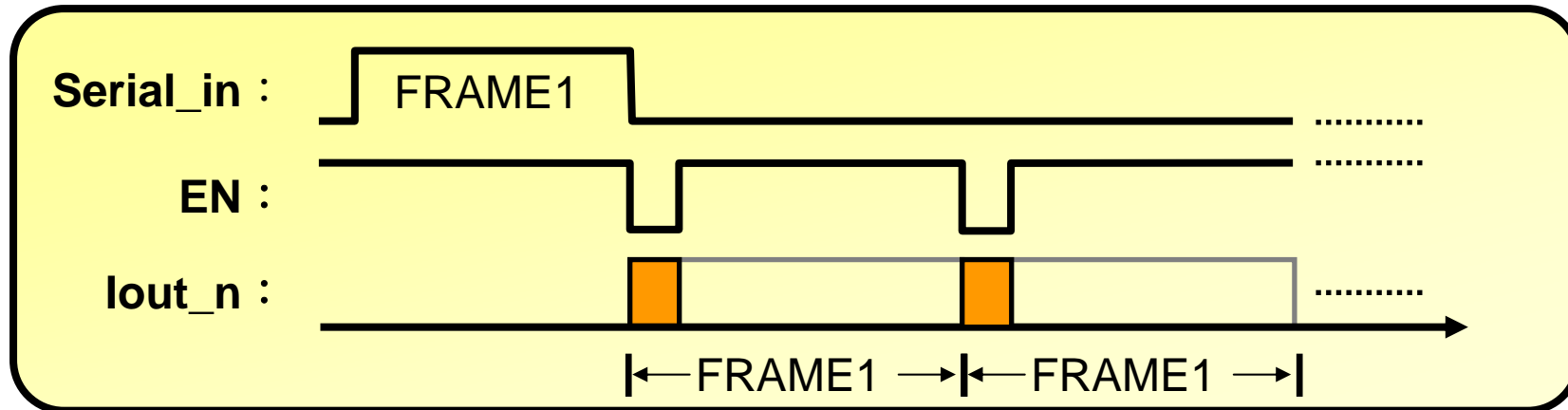


**Question :** A、B為兩面積相同之方塊，試問對人眼而言，那個較亮？

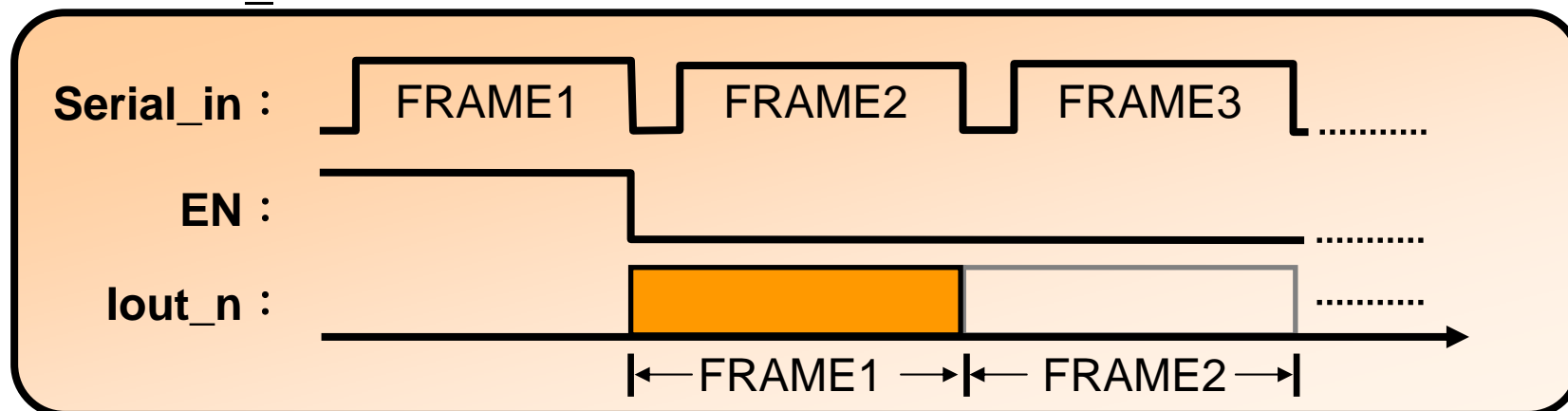


## 電流調整方式\_Digital

### □ EN Control



### □ Serial\_in Control

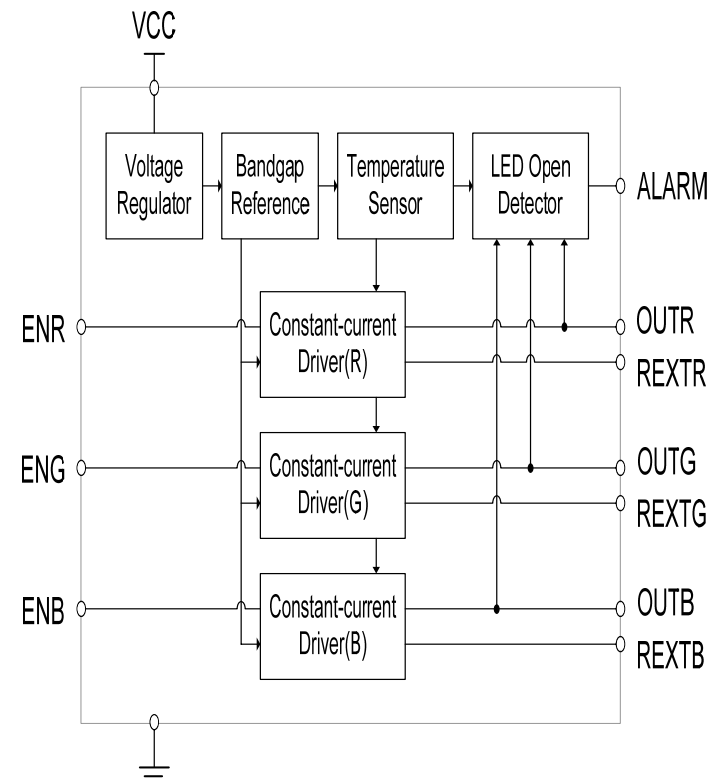
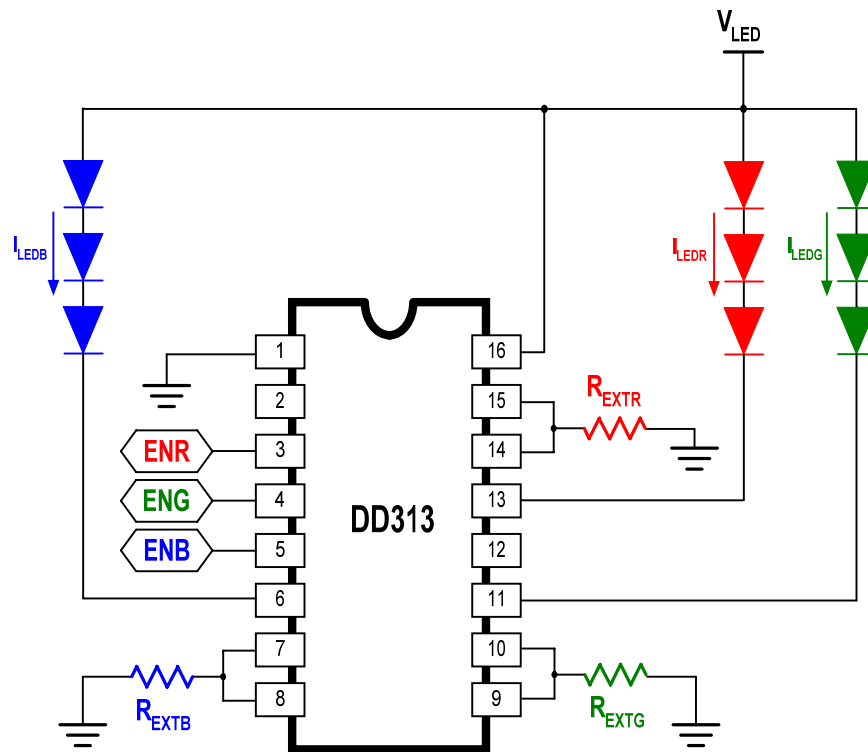




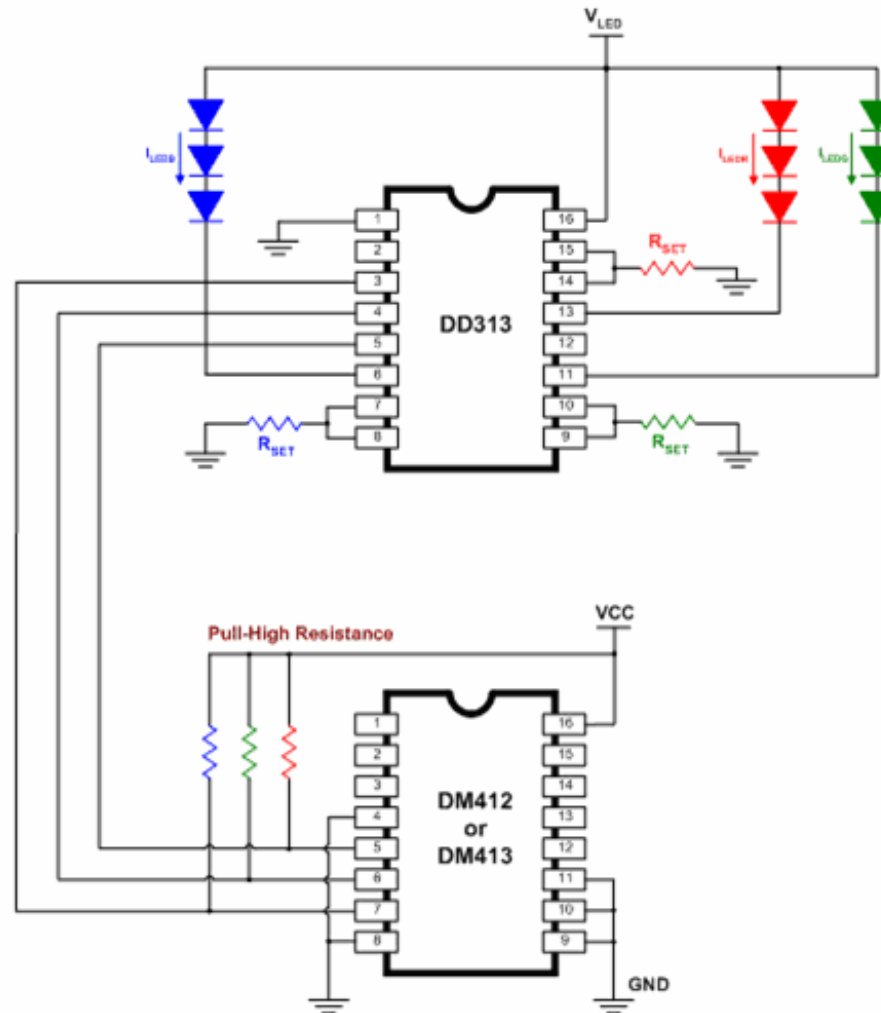
# High Power LED Driver

## DD313

# DD313 Block Diagram



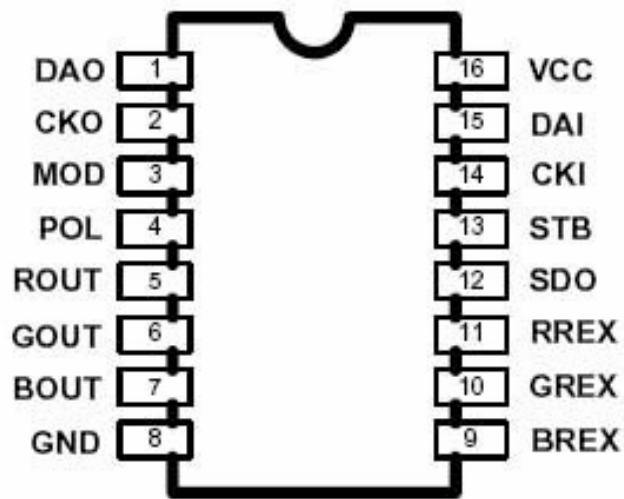
# DD313 Application Circuit



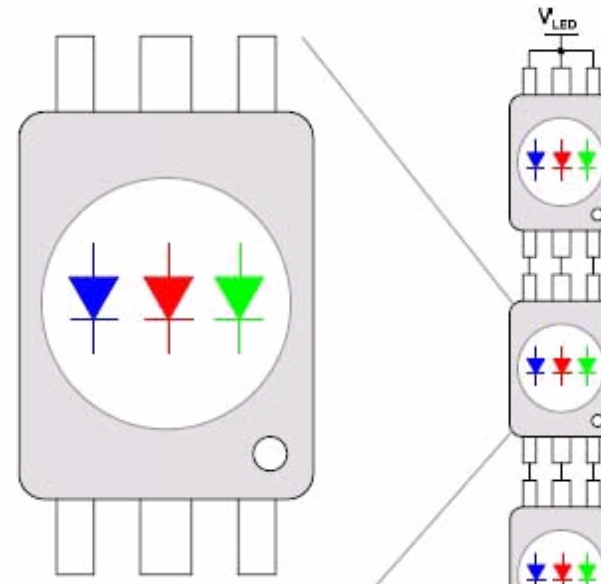


# Cascading Driver DM413

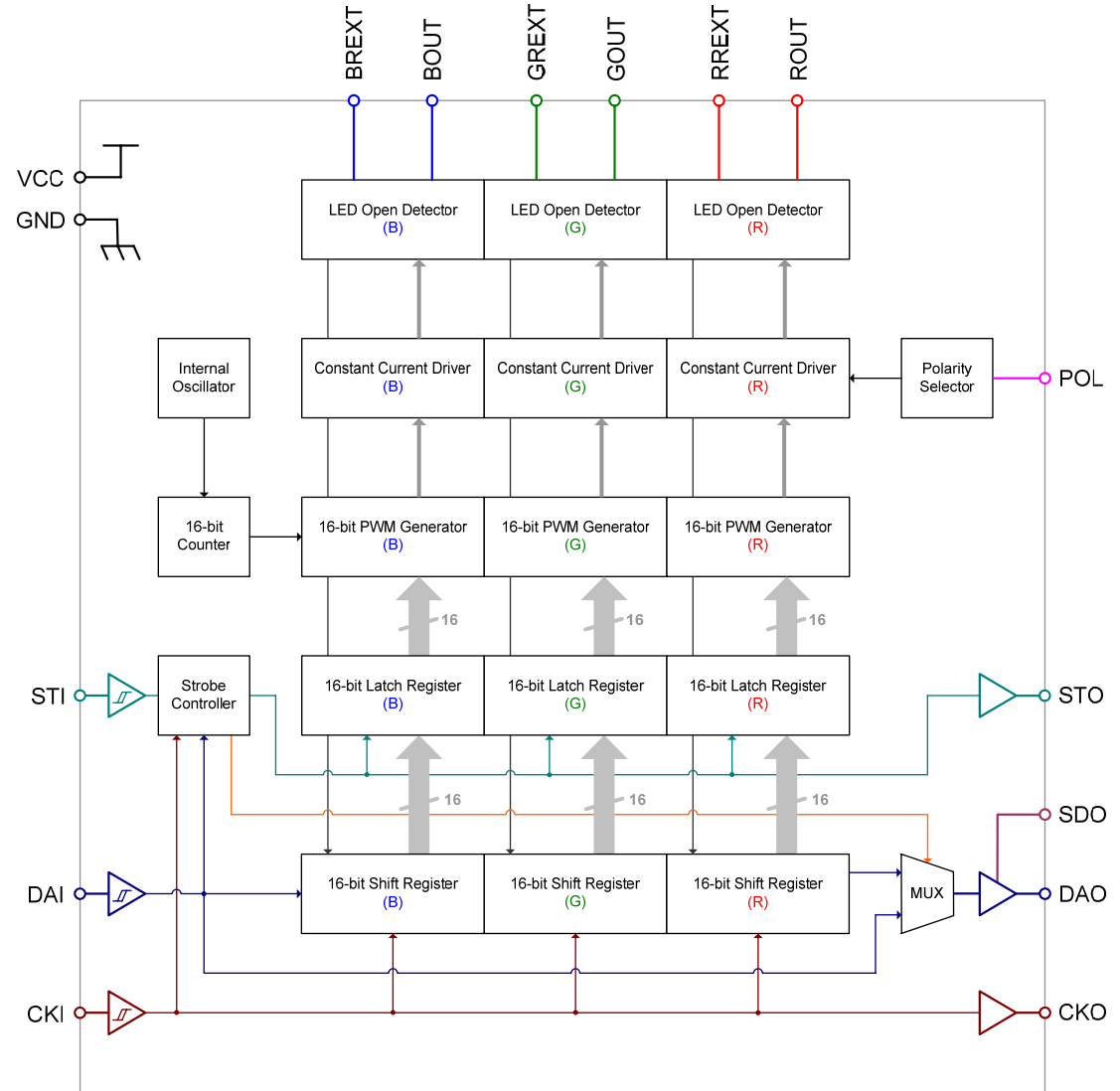
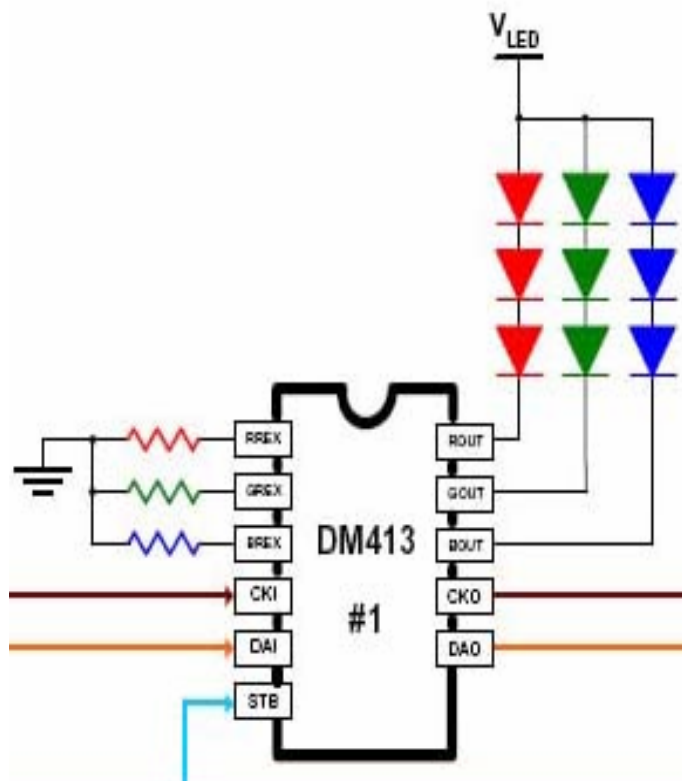
# RGB Cluster



+



# DM413 Block Diagram



# DM413 Input Data format

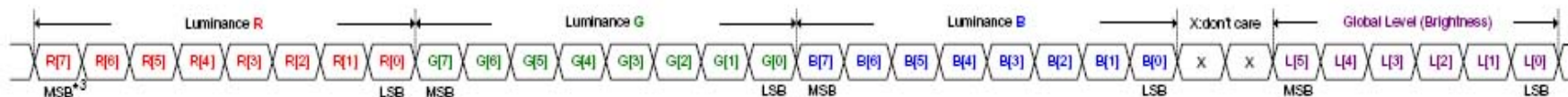
13-bits/5byte mode

$$\text{Active clocks per frame}^{*1} = \text{Luminance}[7:0] \times (\text{Correction}[4:0]^{*2} + 33)$$



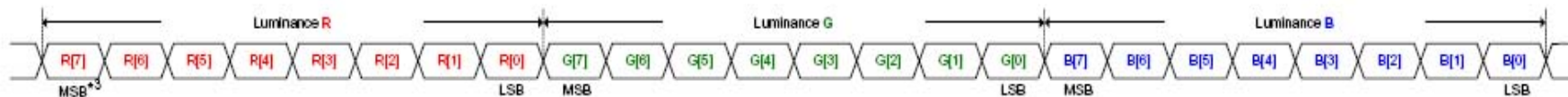
14-bits/4byte mode

$$\text{Active clocks per frame}^{*1} = \text{Luminance}[7:0] \times (\text{Global Level}[5:0] + 1)$$



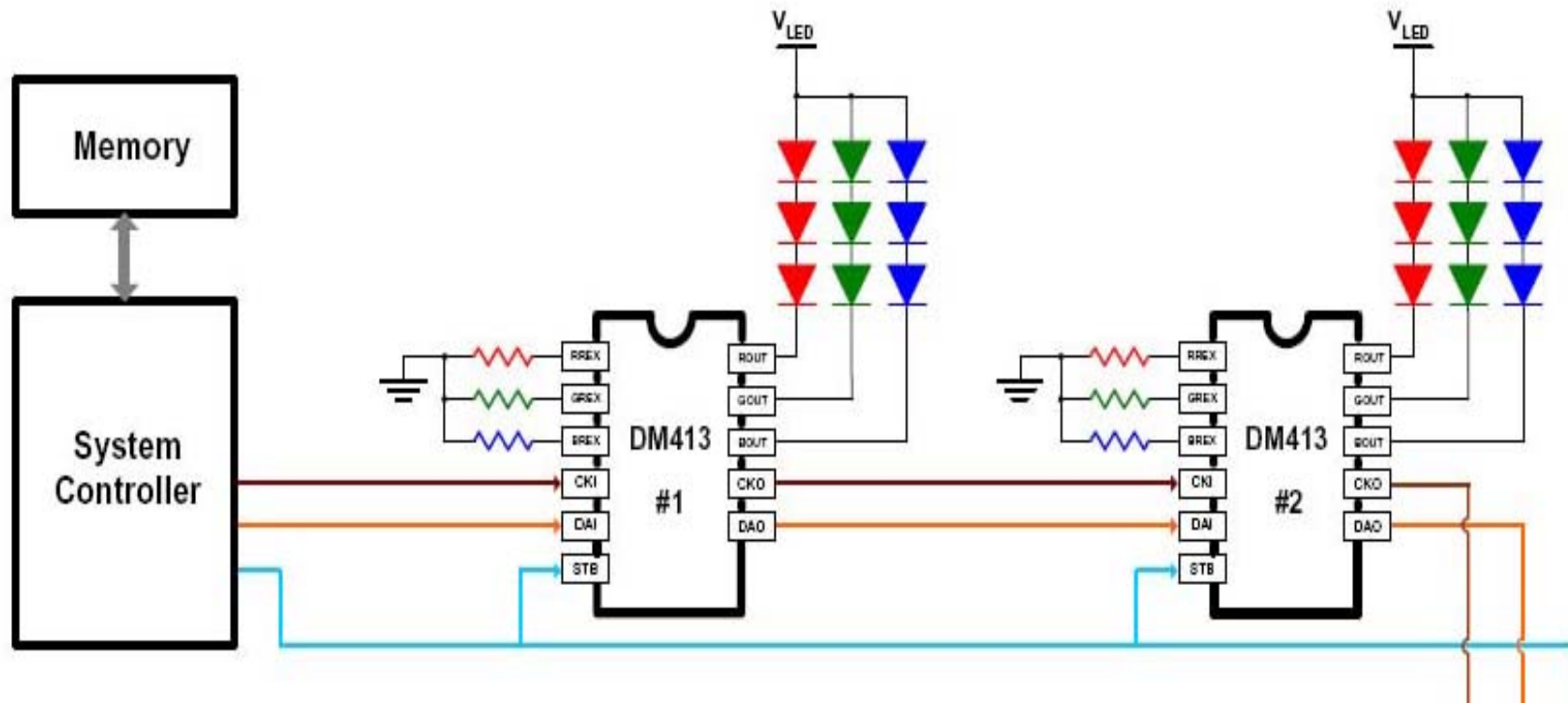
8-bits/3byte mode

$$\text{Active clocks per frame}^{*1} = \text{Luminance}[7:0] \times 64$$





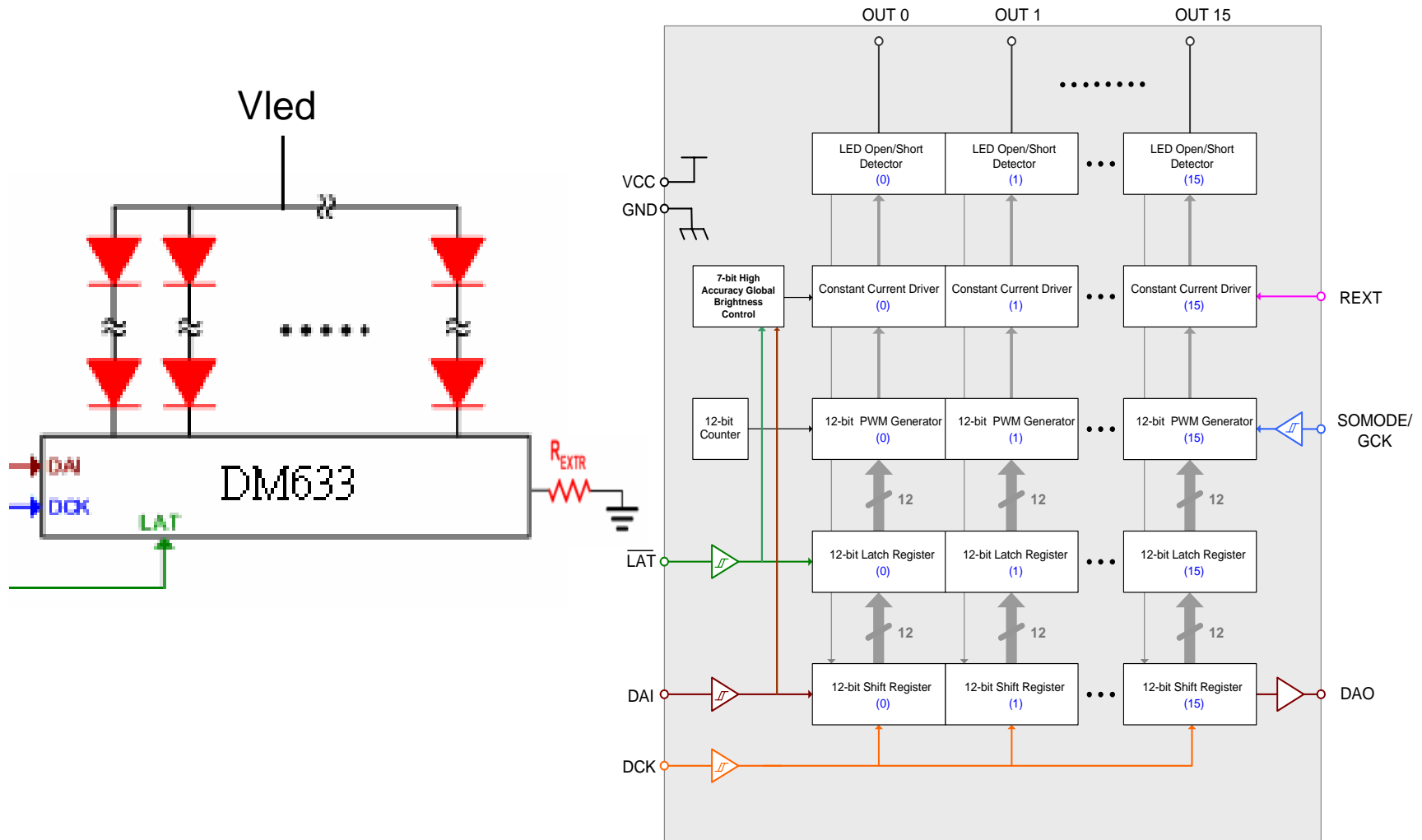
# DM413 Application Circuit



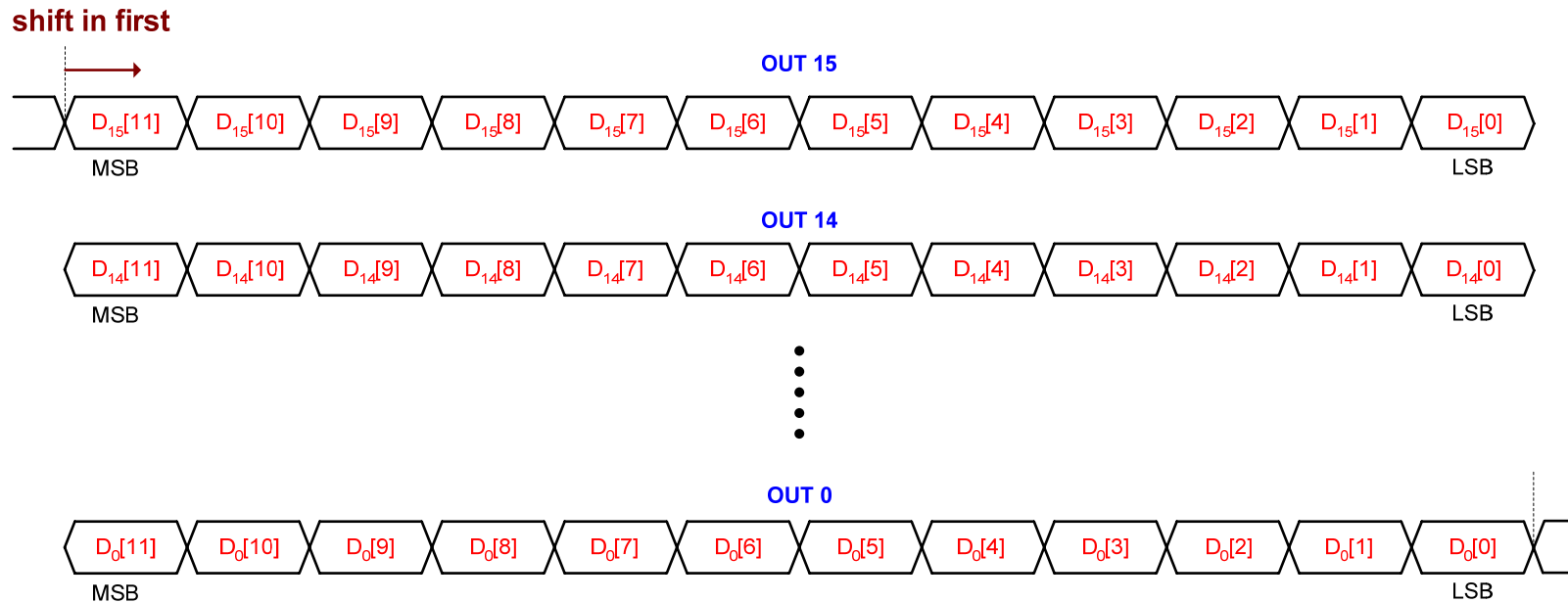


# PWM-Controlled Driver DM633

# DM633 Block Diagram

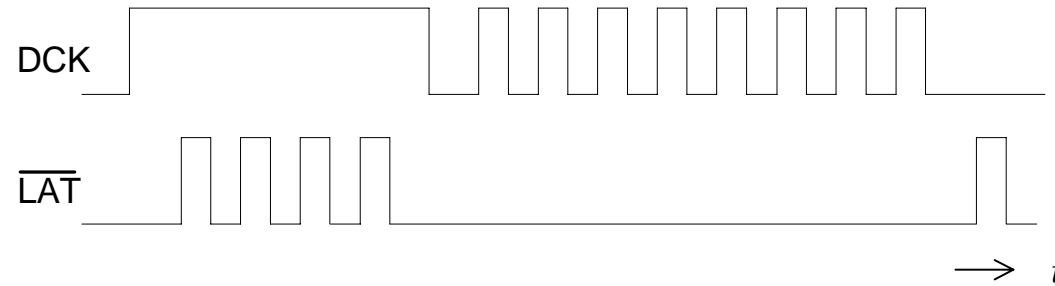


# DM633 Input Data Format

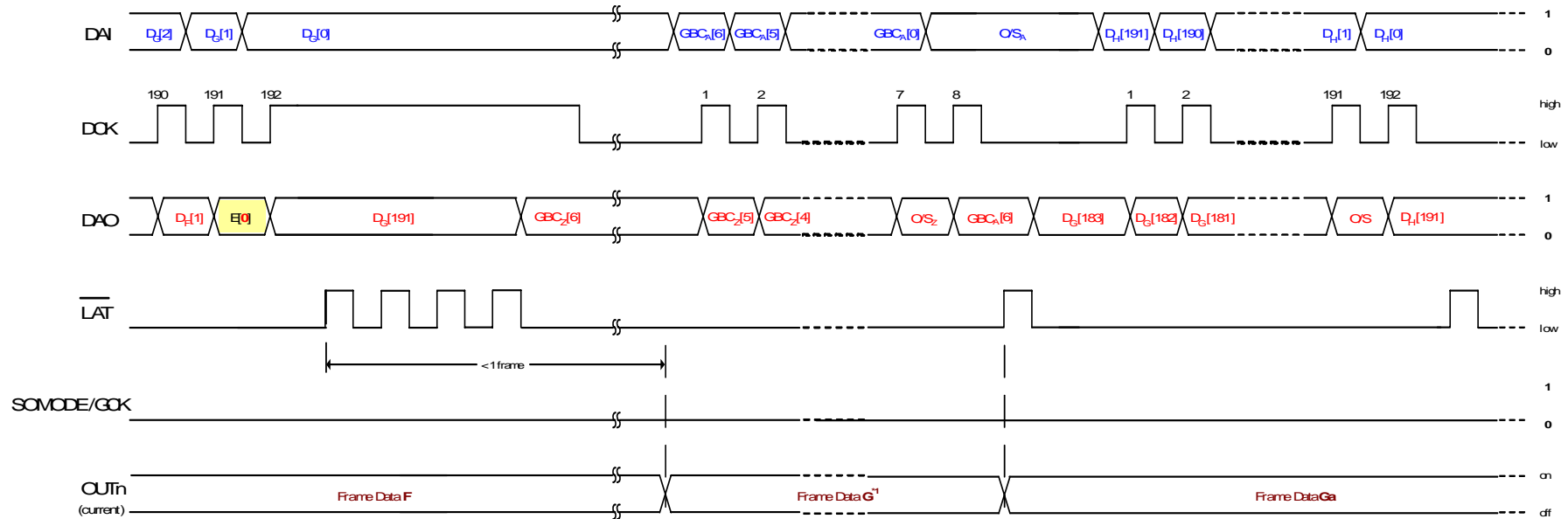


$$\text{Active width per frame(\%)} = \frac{D[11] \times 2^{11} + D[10] \times 2^{10} + D[9] \times 2^9 + D[8] \times 2^8 + D[7] \times 2^7 + D[6] \times 2^6 + D[5] \times 2^5 + D[4] \times 2^4 + D[3] \times 2^3 + D[2] \times 2^2 + D[1] \times 2^1 + D[0] \times 2^0}{4096}$$

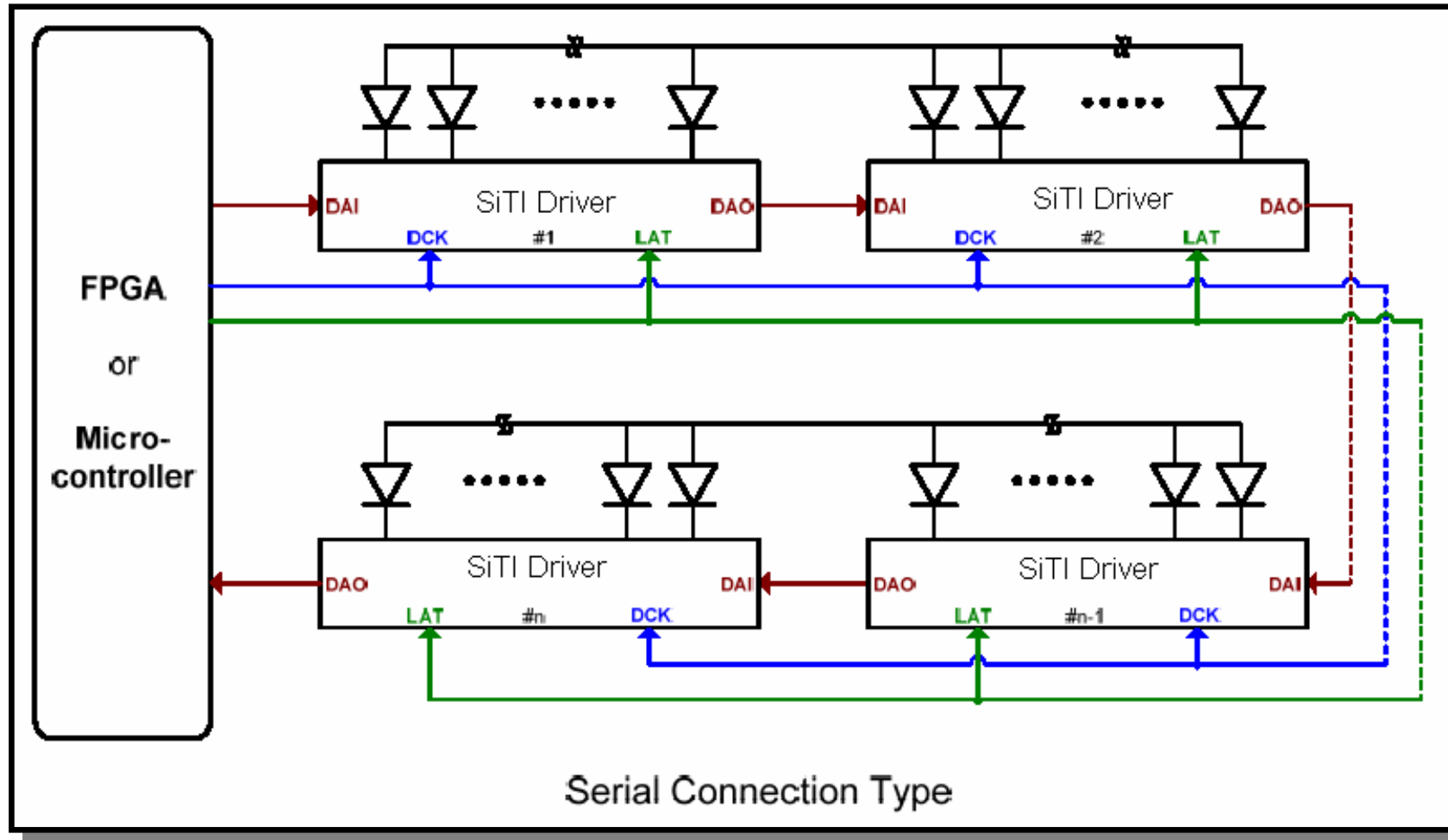
# DM633 Global Brightness Control



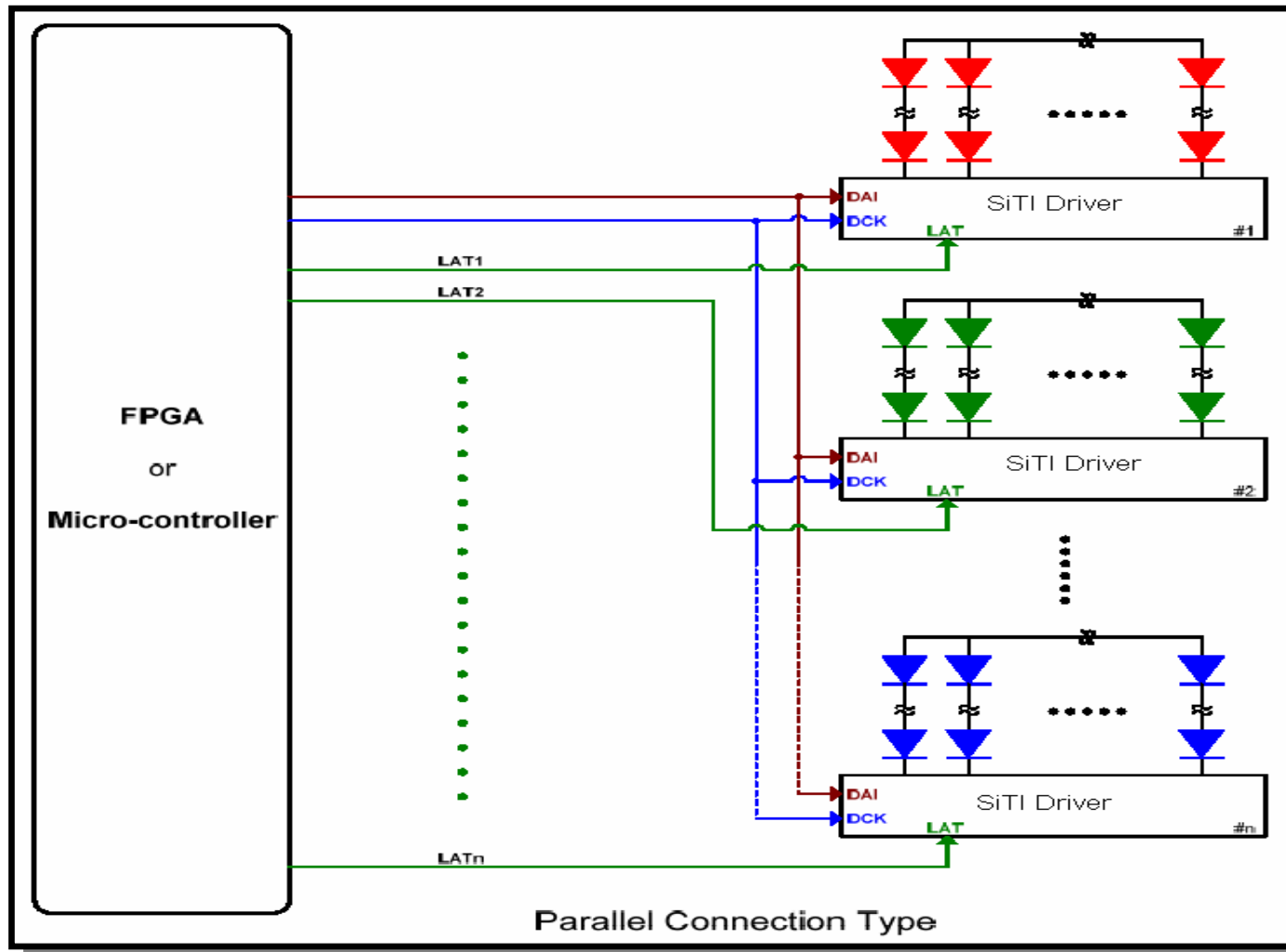
Timing Combination to set GBC data and O/S flag



# Application\_Serial Connection



# Application\_Parallel Connection

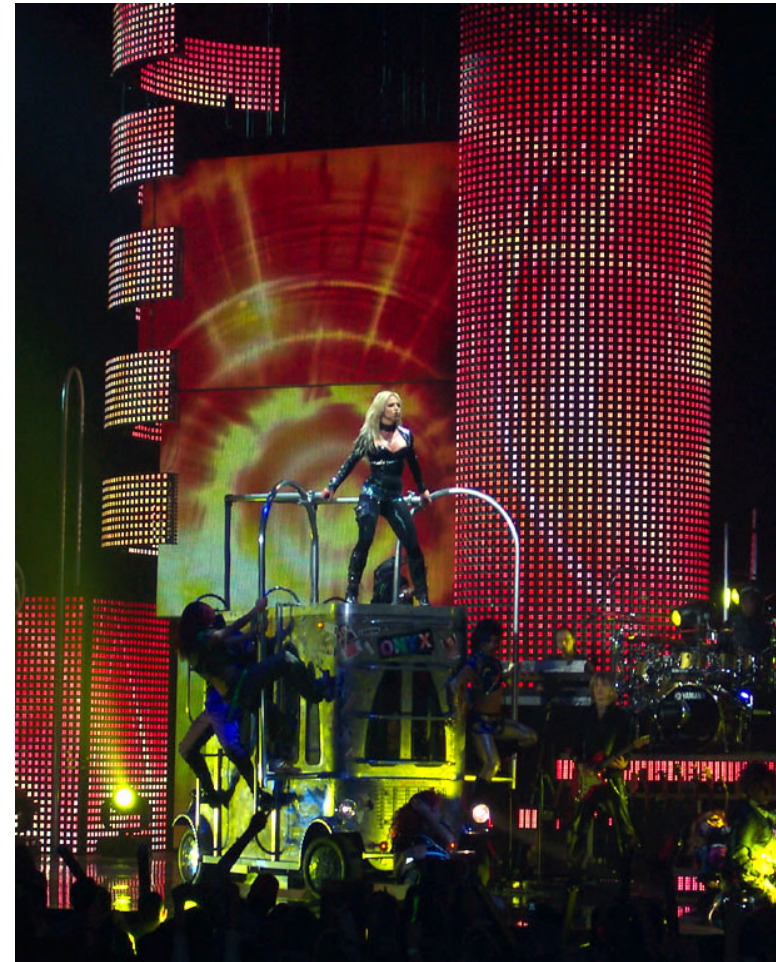






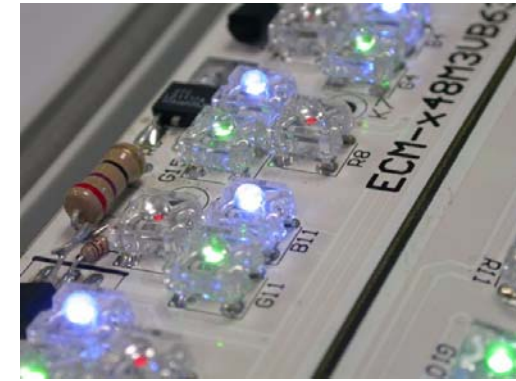
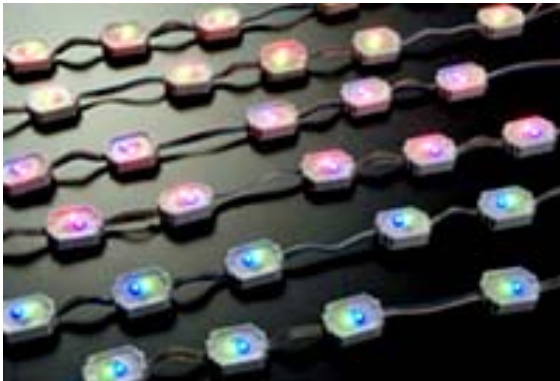
## Create A Dream World





## ***CONSTANT CURRENT LED DRIVERS***

### ***Application and Demo***



# *HIGH CONSTANT CURRENT LED DRIVER*

## *Application and Demo*



## Q&A

