點晶科技
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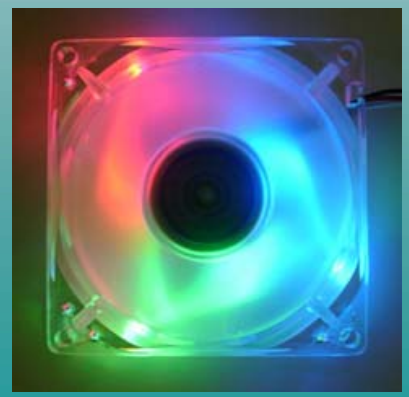
LED Dot Matrix
Constant Current Driver IC

APPLICATION ENGINEER：徐國峰

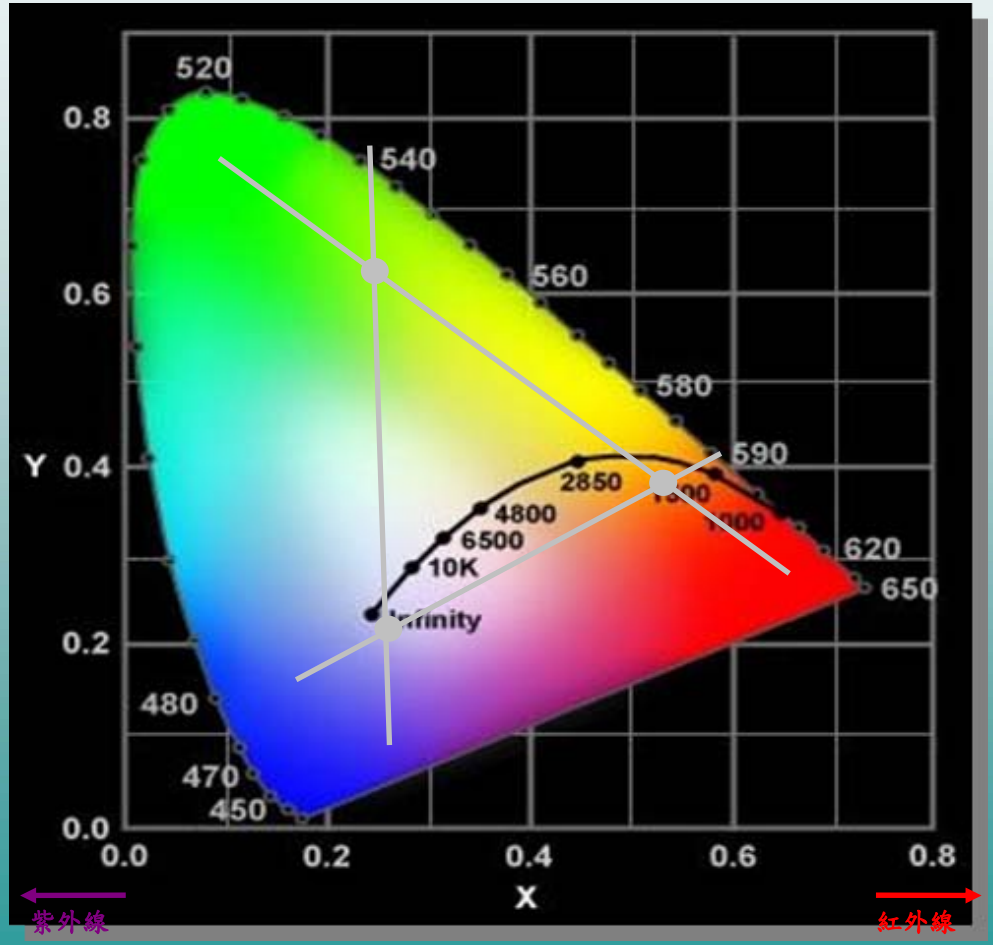
Summary

- RGB CIE Color Space
- LED Introduction
- LED Driver Introduction
- LED Driver Application



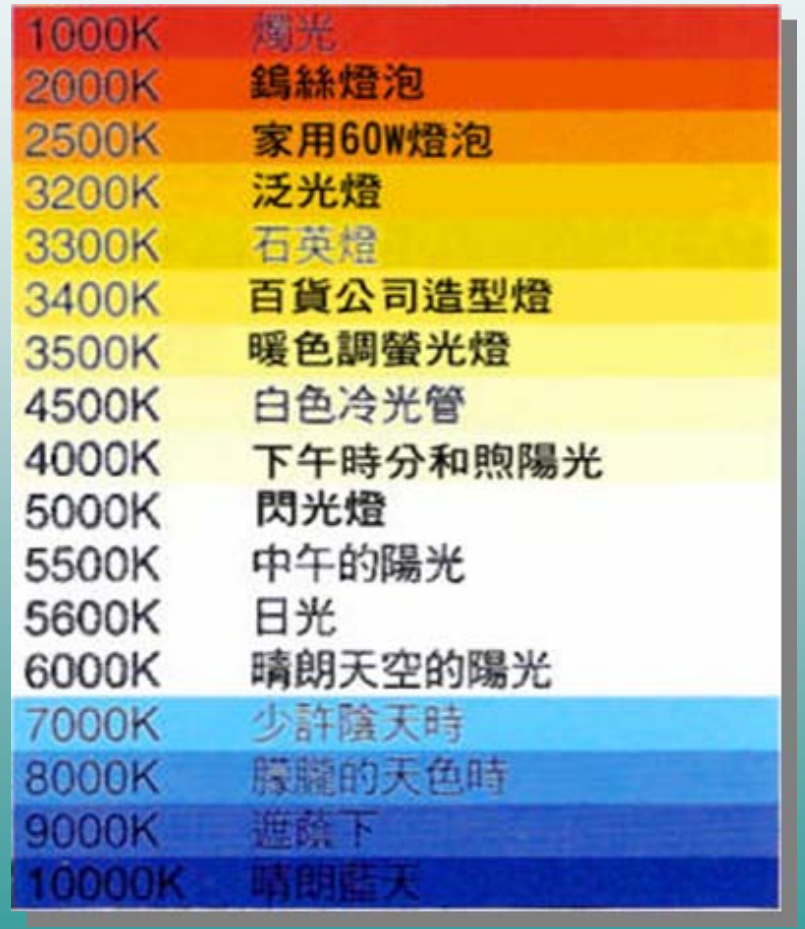
RGB CIE Color Space

CIE：Commision Internationable de IEclairage

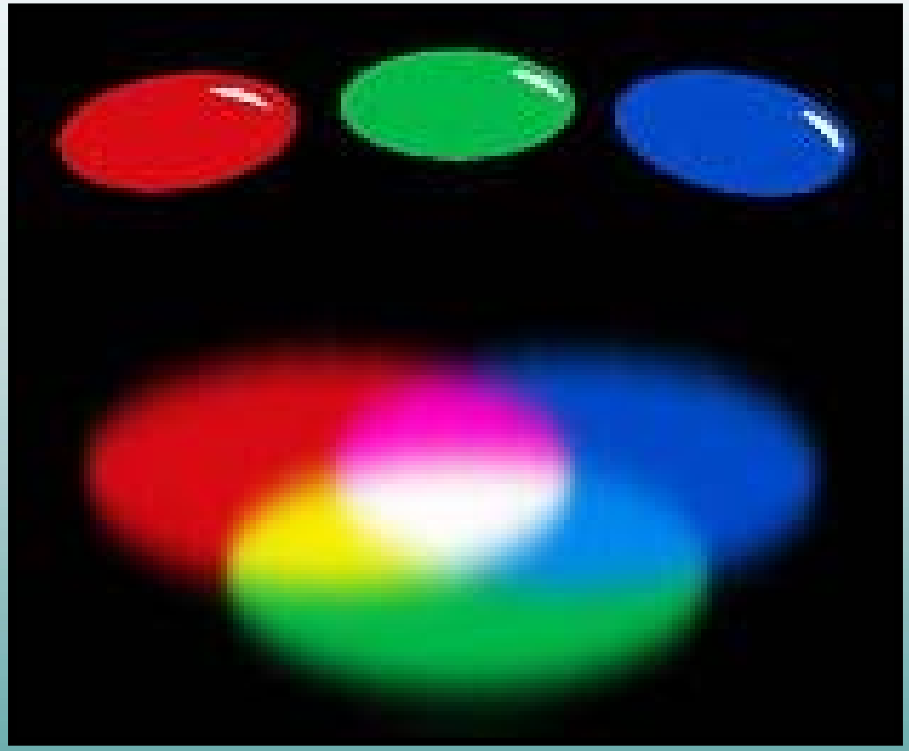


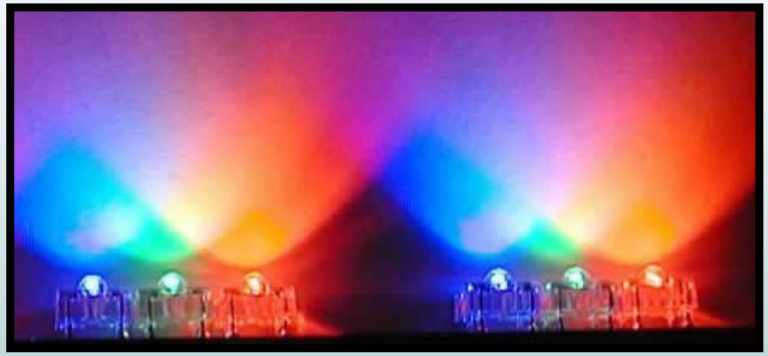
RGB CIE Color Space

- 絕對溫度 K
  - **William Thomson Baron Kelvin 1824-1907**
  - 測量一黑體（例如：低溫鐵塊）不斷升溫後所散發出來的波長光線轉以顏色呈現之結果



R+G+B = ?

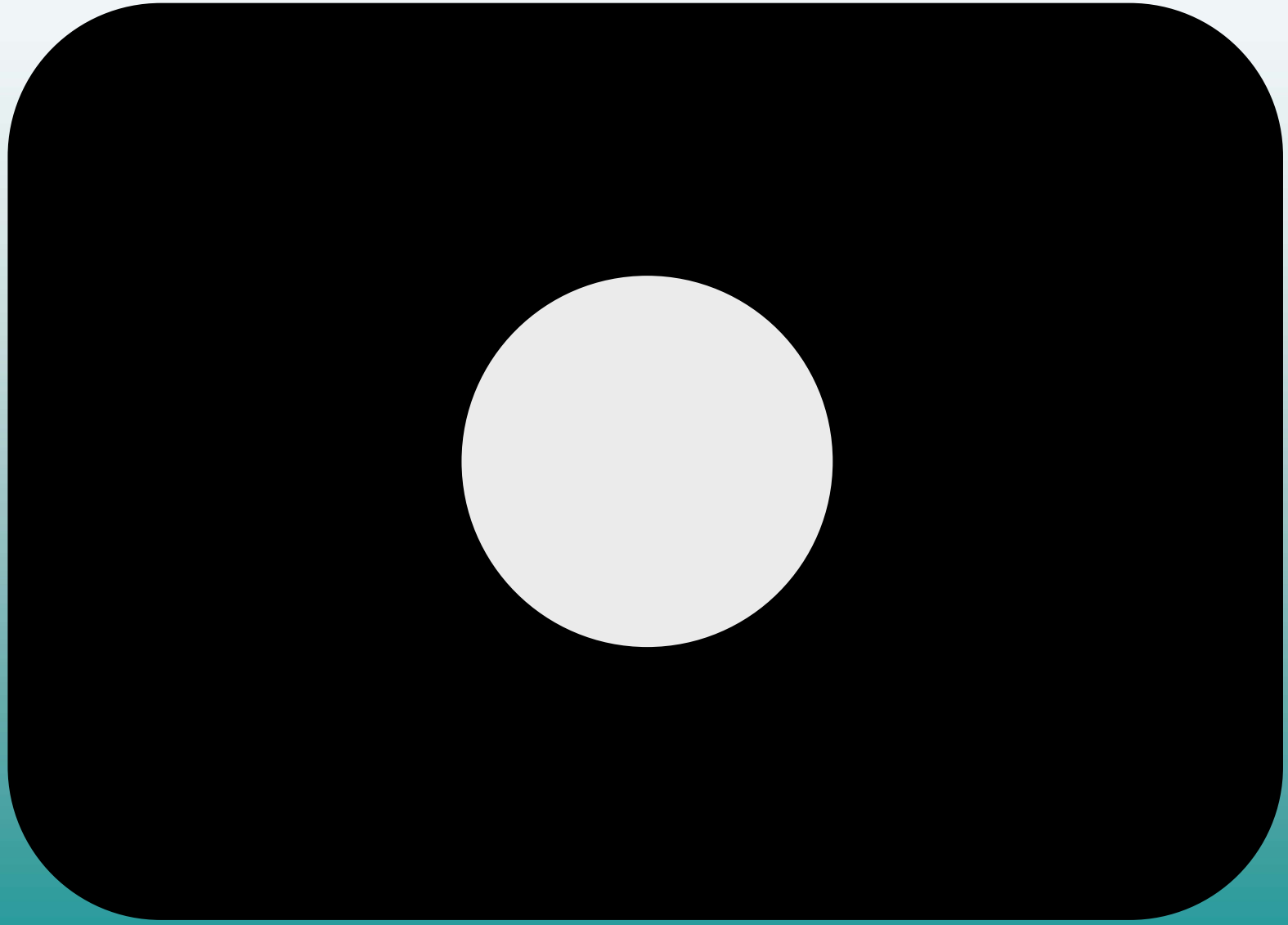


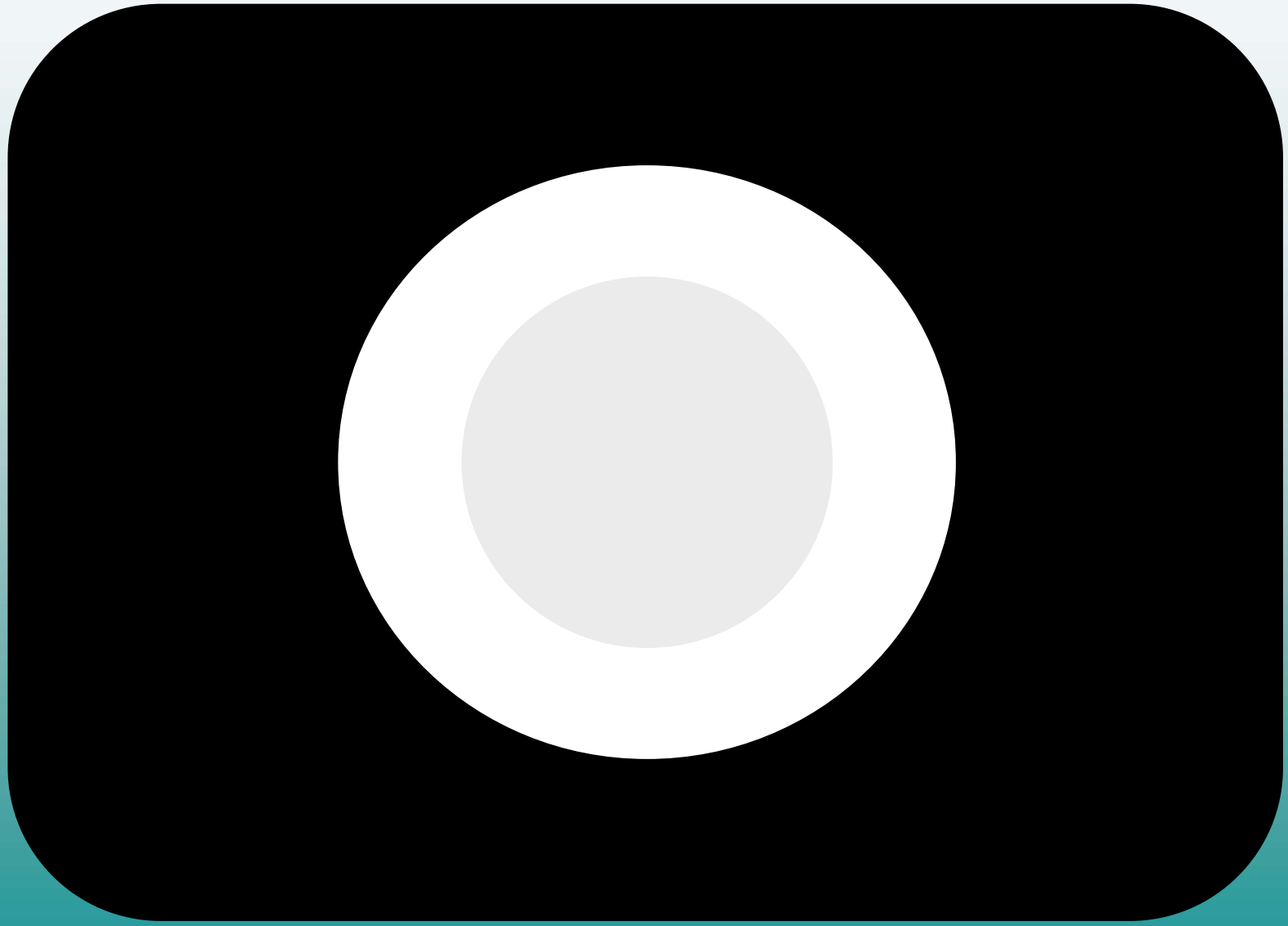


色彩3原色=Red、Green、Blue。

色彩3補色=Yellow、Magenta、Cyan

R+G+B=White、R+G=Y、R+B=M、B+G=C。





Light Emitting Diode：LED

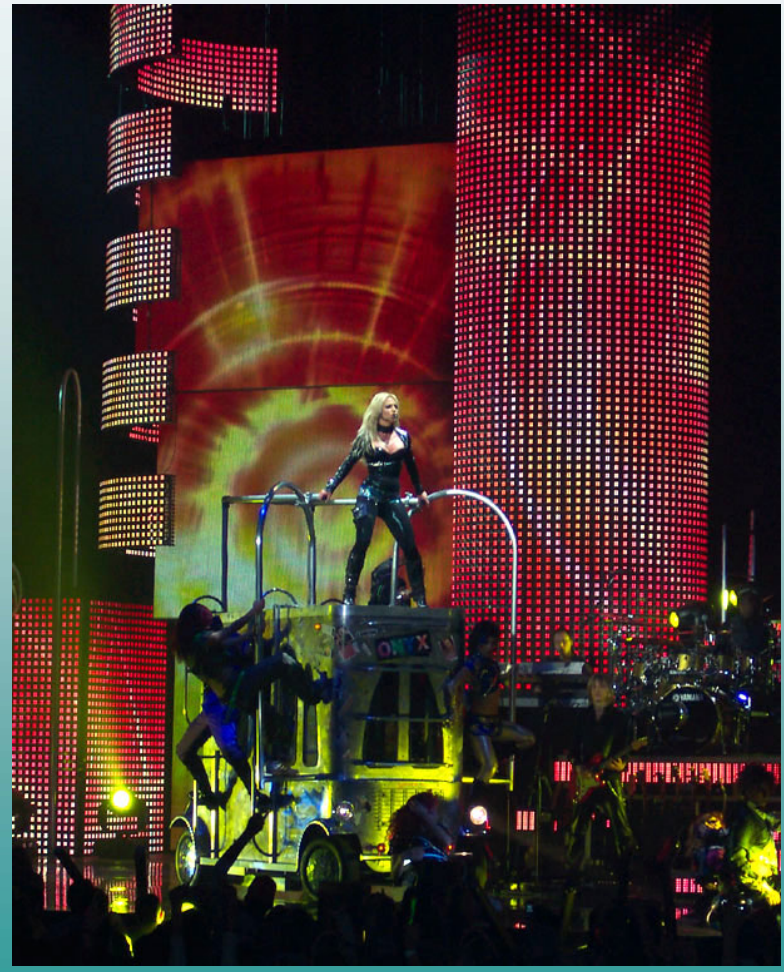
LED種類		
可見光	一般LED（亮度<1cd）	室內看板、字幕機等
	高亮度LED（亮度>1cd）	裝飾照明、室外看板、交通號誌等
不可見光	紅外線LED等	家電遙控器、自動門感應器等

Light Emitting Diode：LED

優點	說明	應用領域
點滅速度快	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%，據PIDA的資料，若台灣25%的白熾燈泡及100%的日光燈被白光LED所取代，則每年可省下110億度電力，相當於1座核能電廠的年發電量。要達成100W的發光效率，日光燈每年花費約61.5美元，LED僅需其費用的7分之1。	
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、顯微照明、太陽能照明燈。
元件壽命長	大於兩萬小時。	
體積微小	LED發光經片極為細小，可以點線面搭配組合，且可以隨意與建築結構彈性結合。容易配合應用需求製成極小或陣列式的元件。	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。
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）	
單色性佳		
混色機能強		
耐震動		
耐天候考驗		

Light Emitting Diode ：LED

Light Emitting Diode ：LED



Light Emitting Diode : LED

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

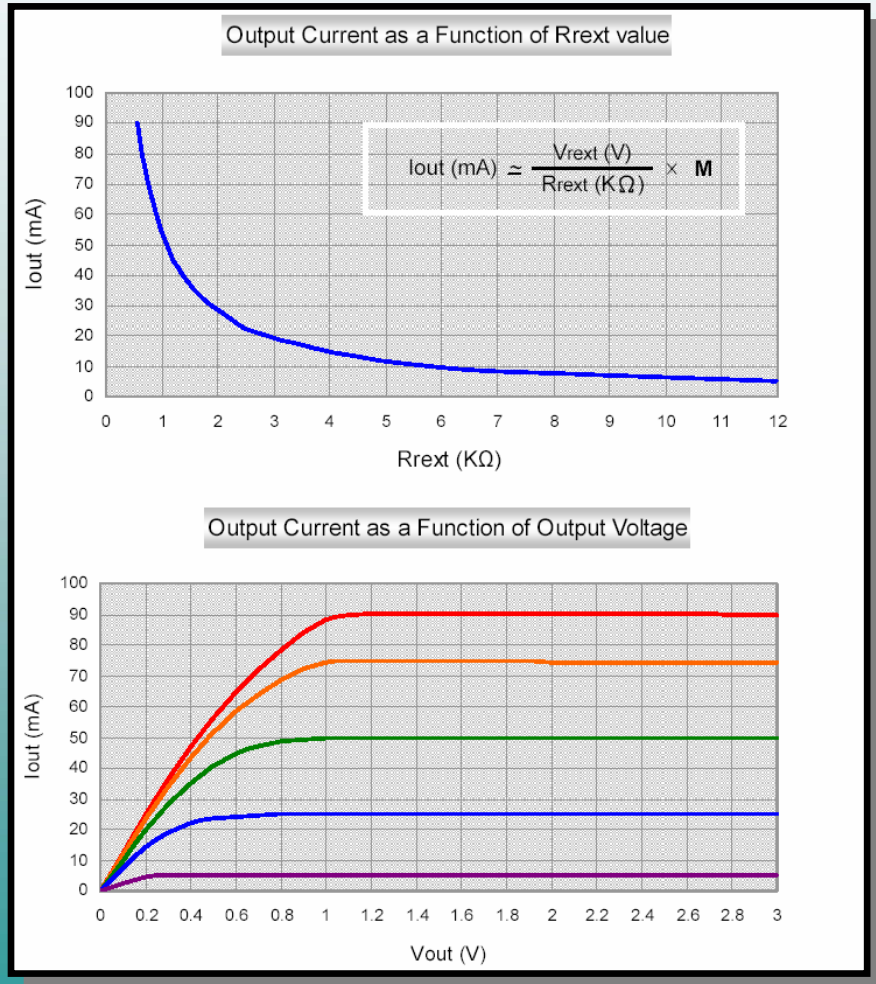
Power Supply Voltage

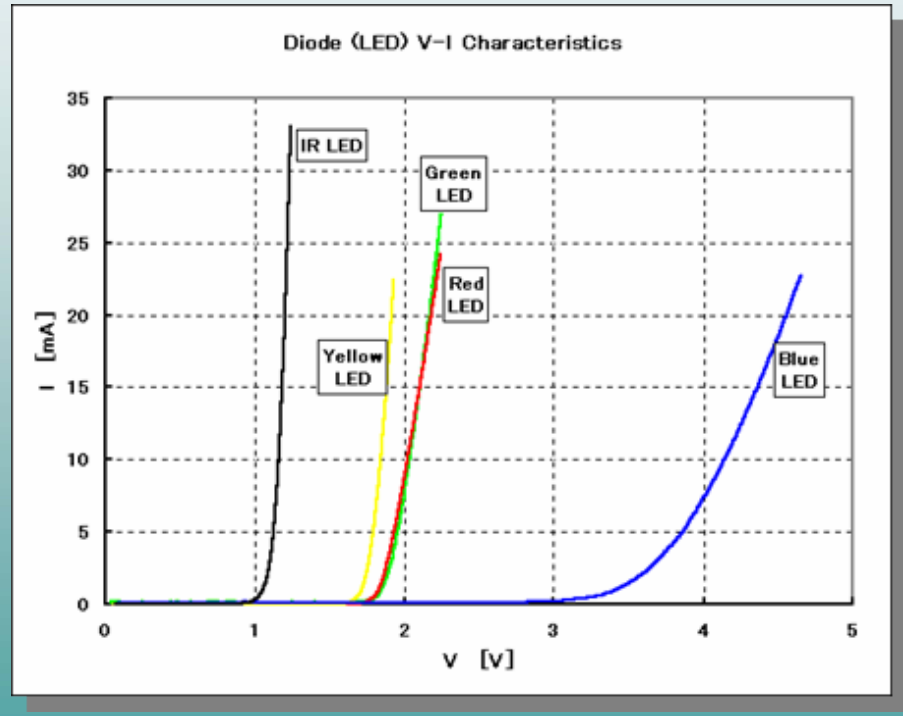
☑反應速度 (Transient Response)

Tr/Tf

Clock Frequency

爲何需要LED Driver??



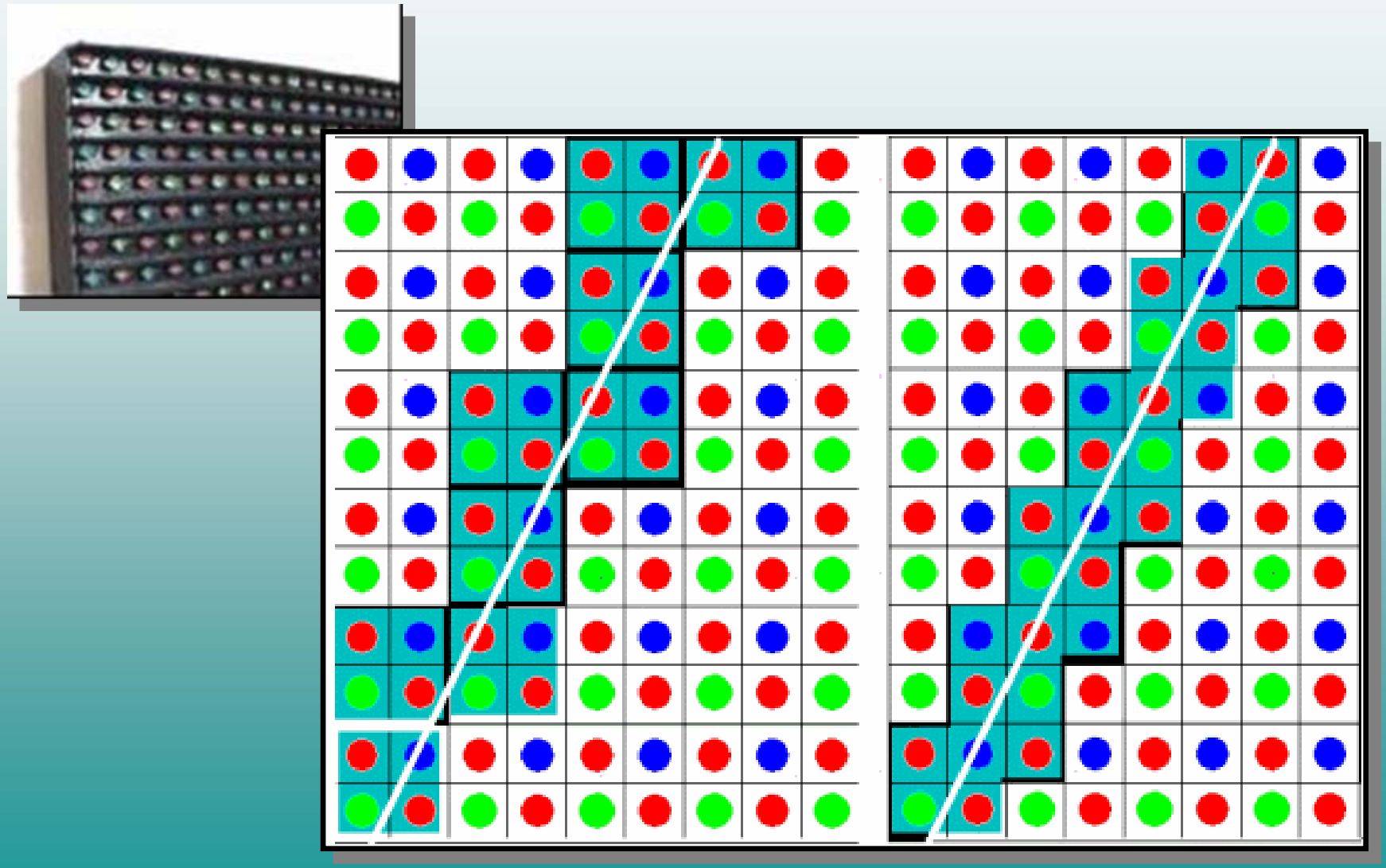


何謂 PURE DRIVER

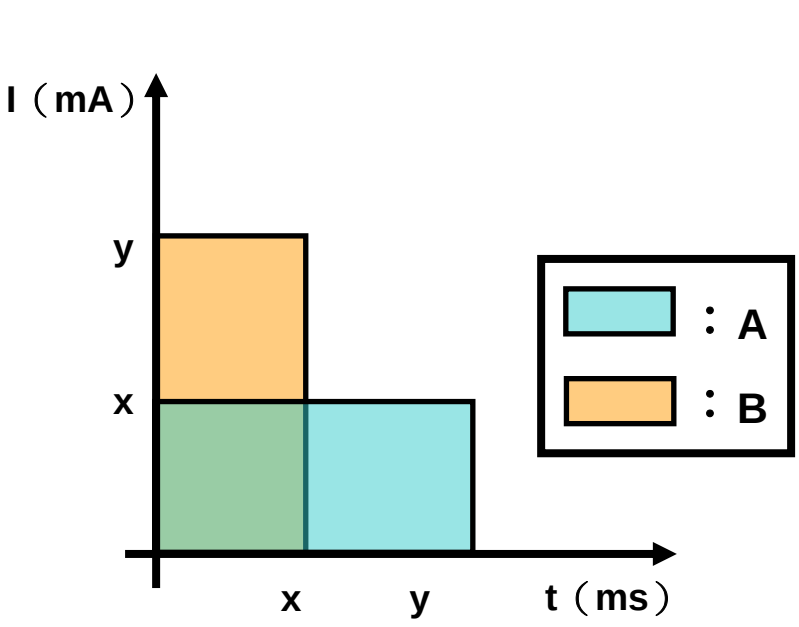
- **BASIC FEATURE**
  - **Constant current outputs**
  - **Maximum output voltage**
  - **Maximum clock frequency**
  - **Power supply voltage**
  - **Bit-bit skew**
  - **Chip-chip skew**

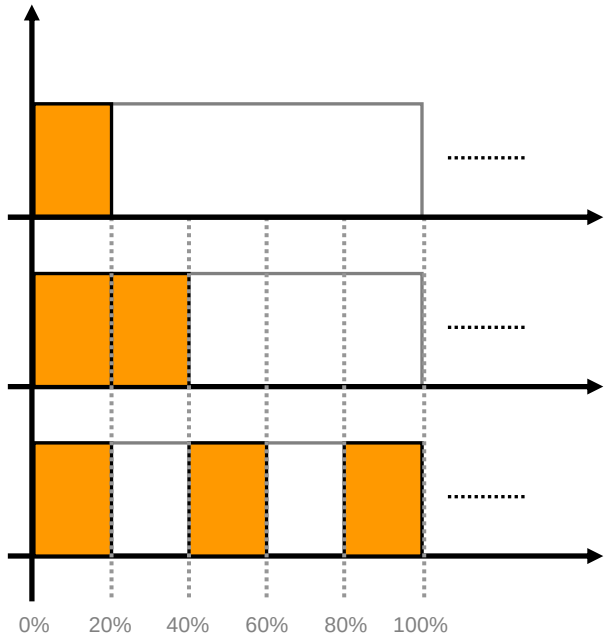
- **Built-in LED open / short detection**
- **Over temperature protection：thermal shutdown**
- **16-bit grayscale**
- **7-bit Dot correction**
- **8-bit Global brightness control**

點矩陣（Dot Matrix）



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？

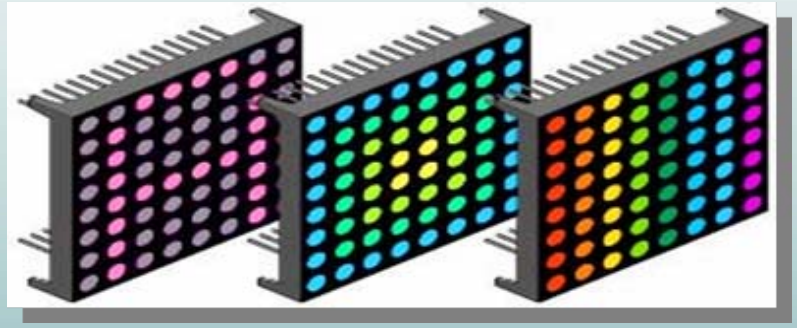
SKEW

SKEW：使用於LED Driver，其表示之意義為Output電流的偏移率。

$$SKEW = \frac{IAVG - IMIN}{IAVG} \times 100\% \text{.....} (\%)$$

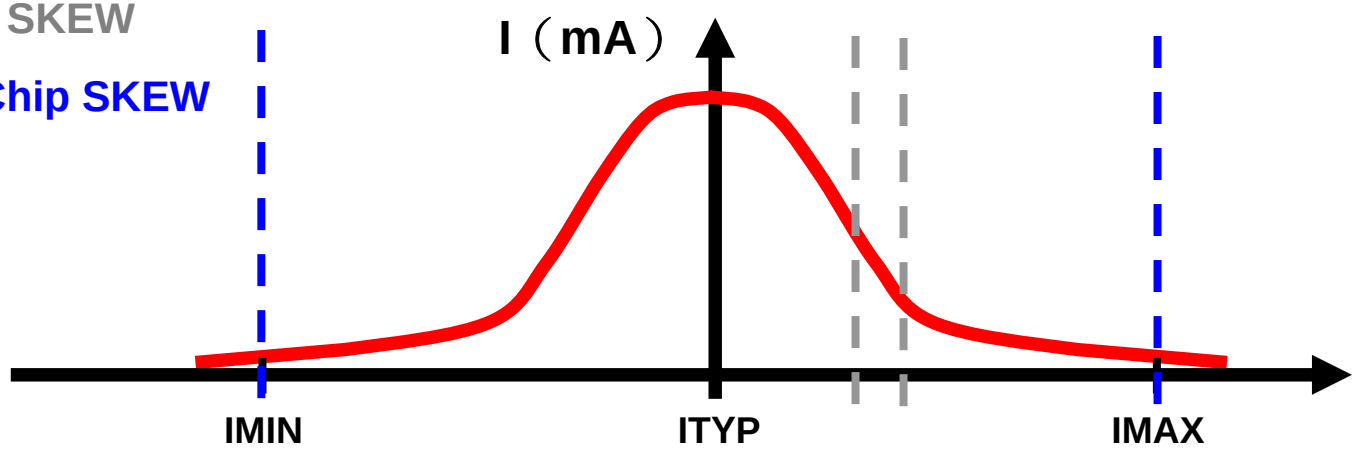
$$IAVG = \frac{IMAX + IMIN}{2} \text{.....} (mA)$$

$$\Rightarrow SKEW = \frac{IMAX - IMIN}{IMAX + IMIN} \times 100\% \text{.....} (\%)$$



Bit-Bit SKEW

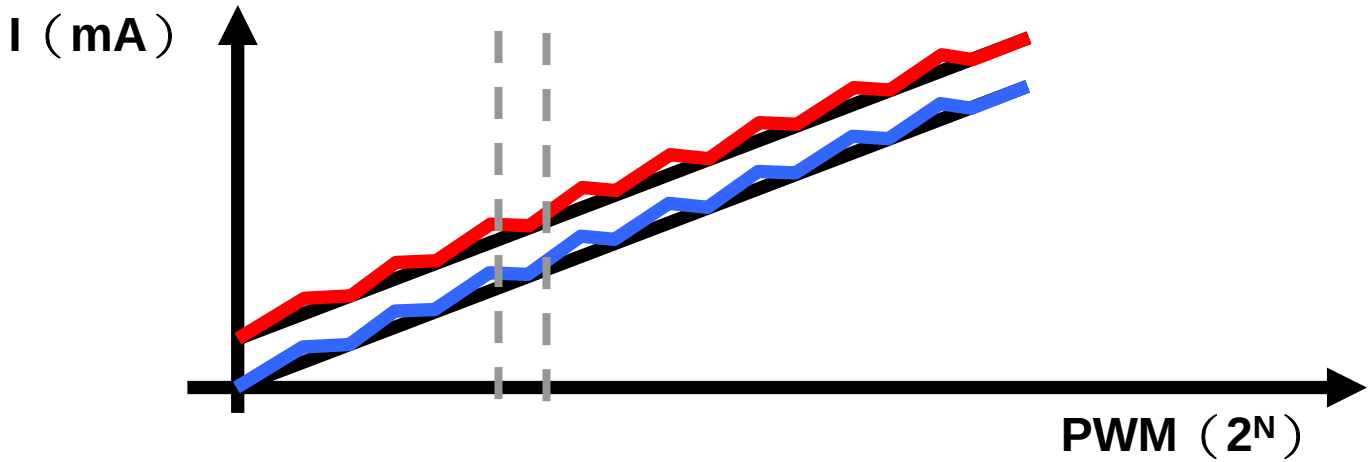
Chip-Chip SKEW



DNL

DNL（Differential nonlinearity error）：PWM電流非線性度的差異。

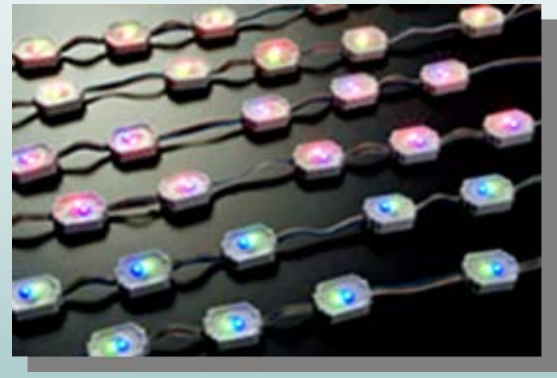
DNL= （IoutM-IoutN）/ （Iout_n / 2^n）



DM13C FEATURES

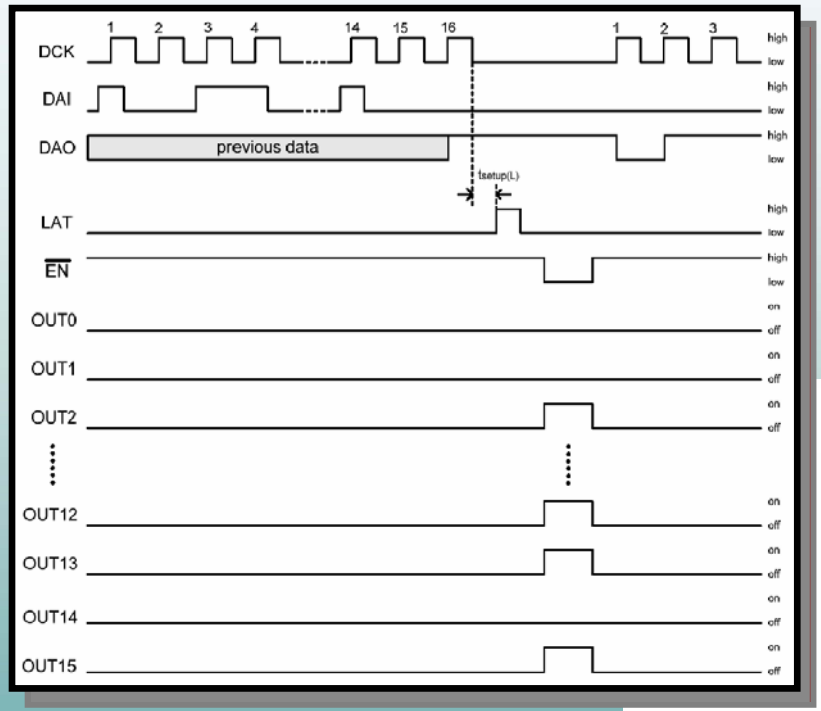
❑BASIC FEATURE

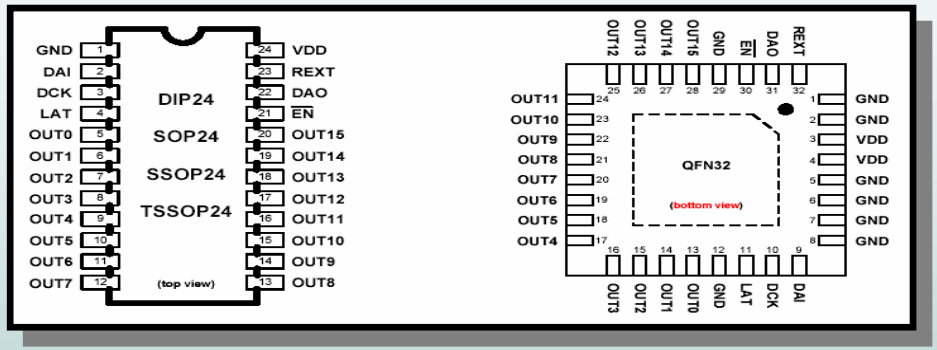
- –Constant current outputs：5mA～90mA
- –Maximum output voltage：17V
- –Maximum clock frequency：25MHz
- –Power supply voltage：3.3V～5.0V
- –Bit-bit skew：±3%
- –Chip-chip skew：±6%

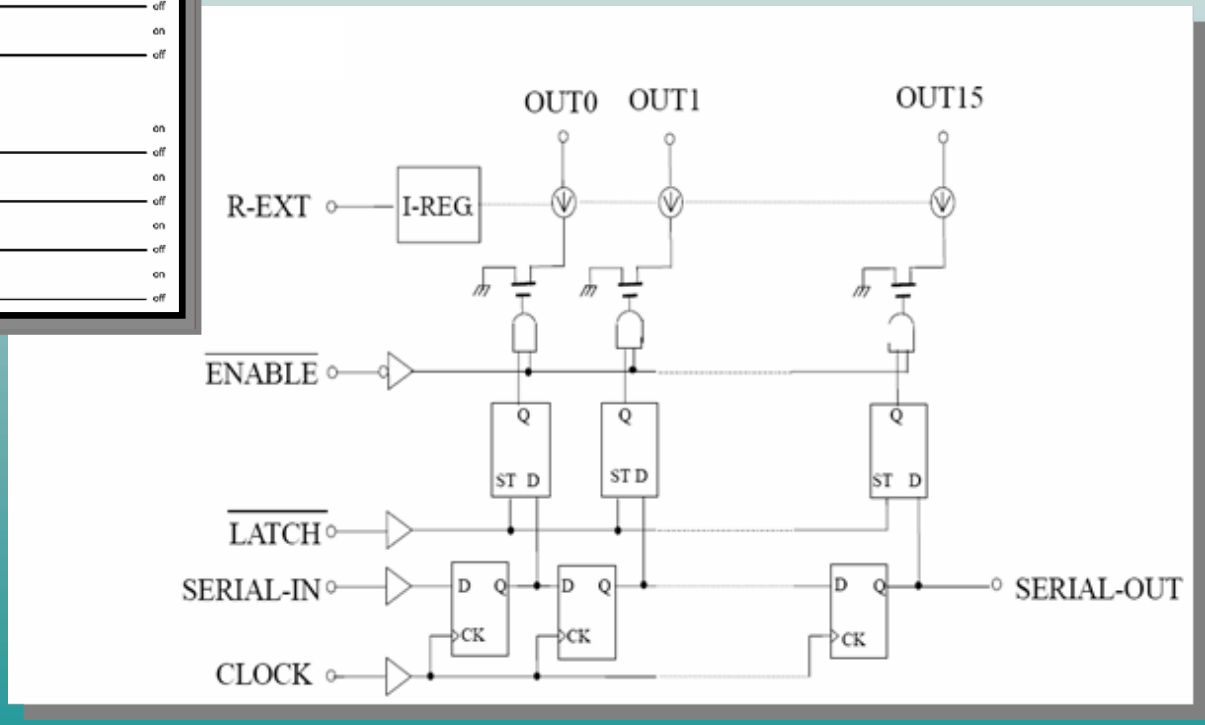


- – Built-in LED open / short detection
- – Over temperature protection：thermal shutdown
- – 16-bit grayscale
- – 7-bit Dot correction
- – 8-bit Global brightness control

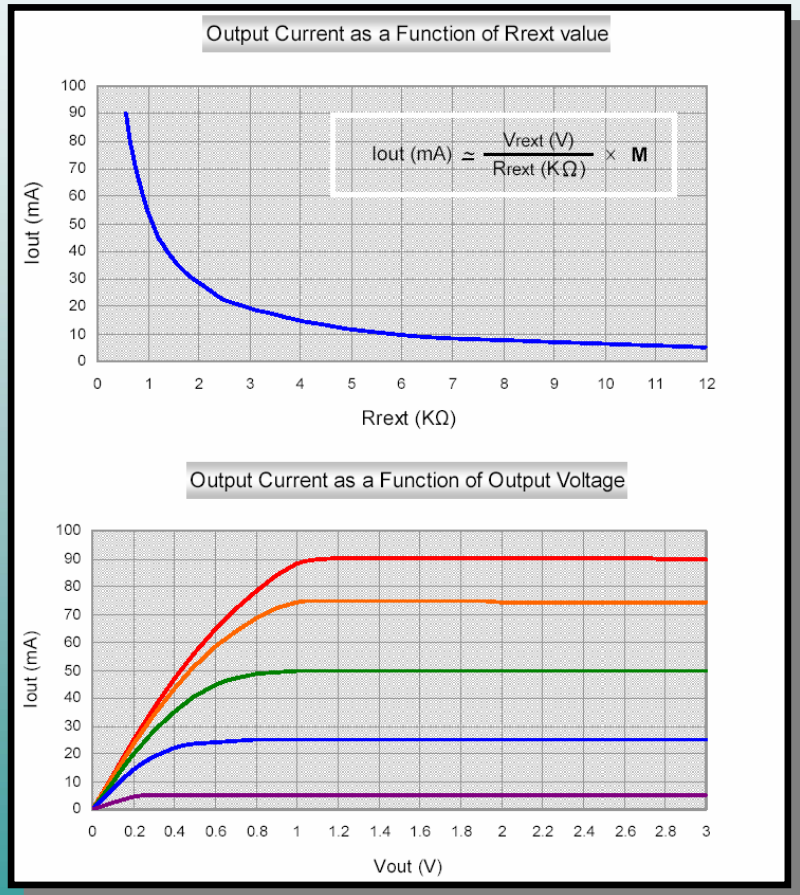
DM13C_Block Diagram

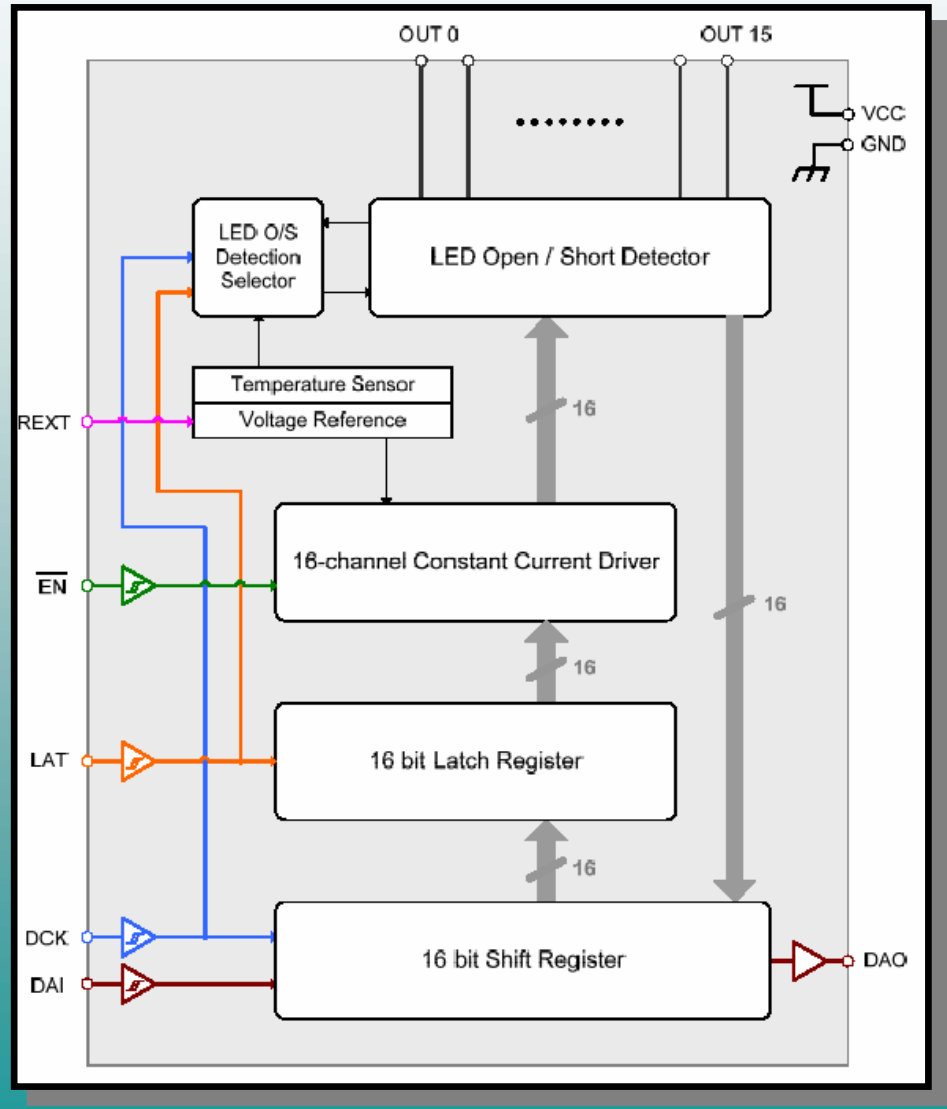






DM13C_Block Diagram

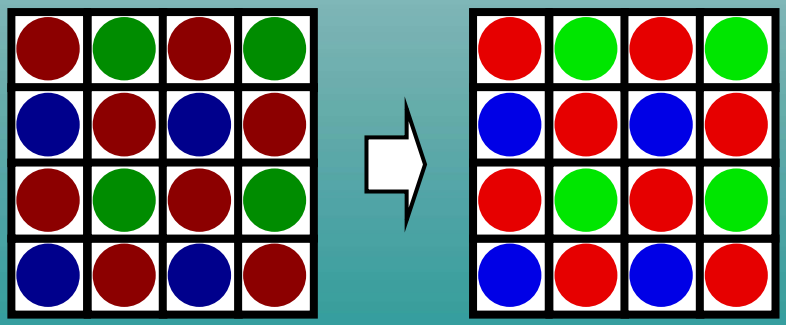


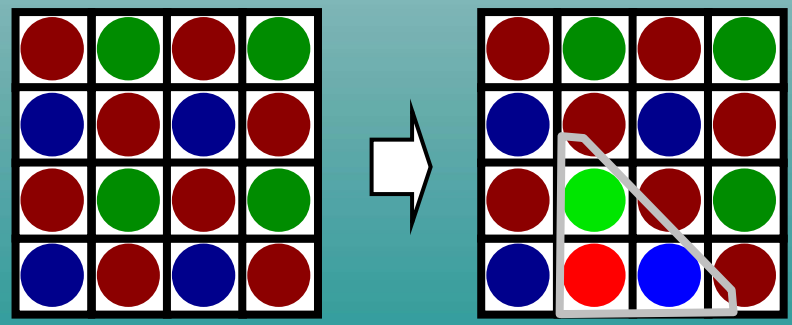


電流調整方式

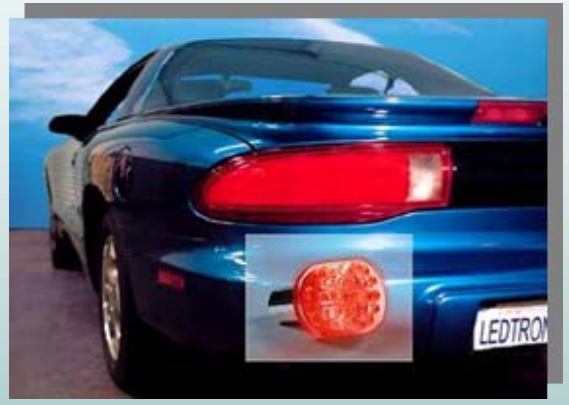
- 外掛電阻（Rext）
- EN Control
- GBC

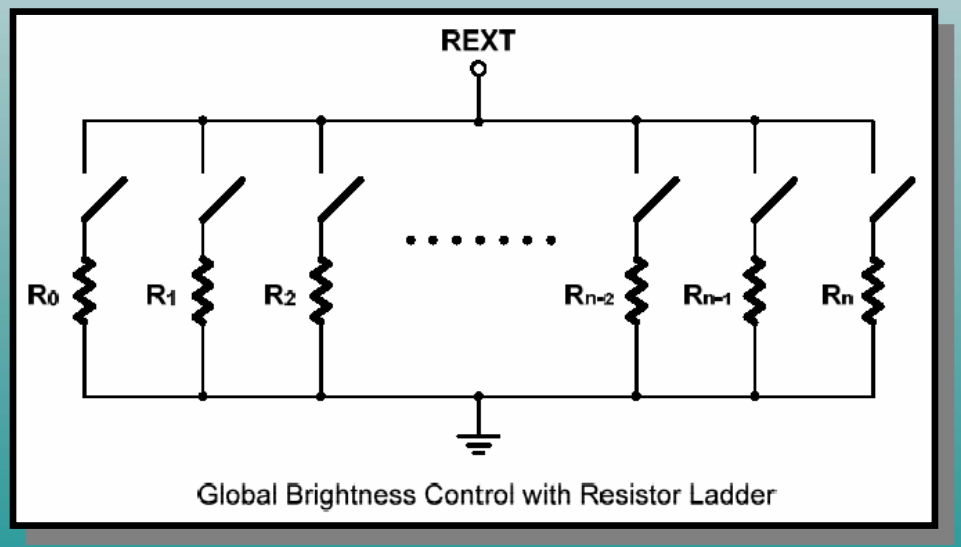
- Serial_in Control（Gray scale）
- Dot correction



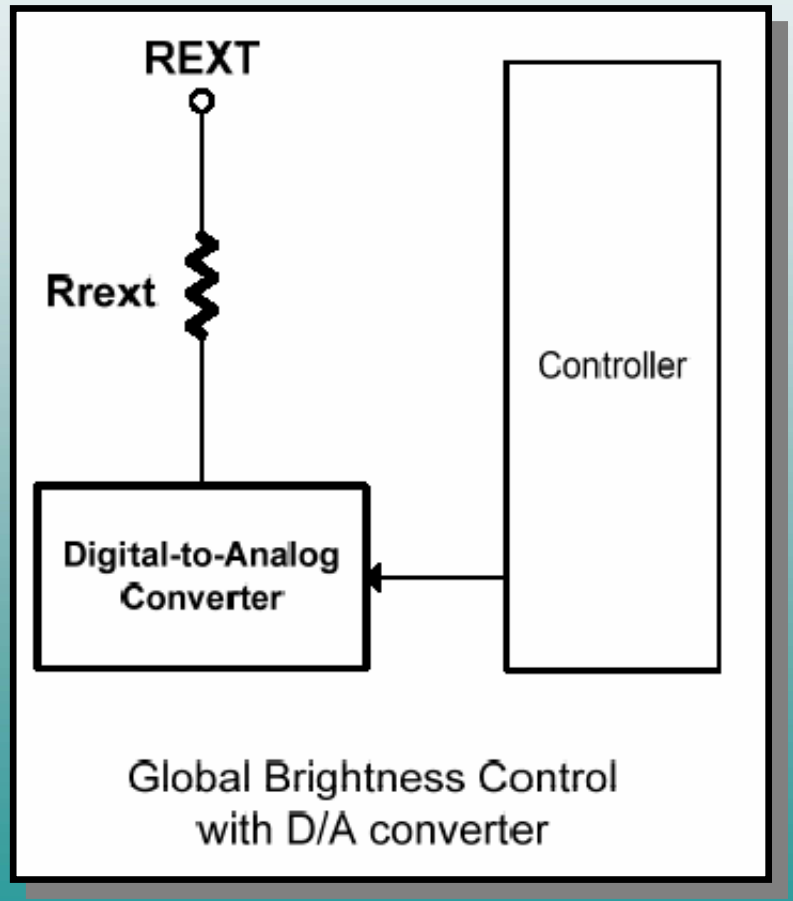


電流調整方式_REXT





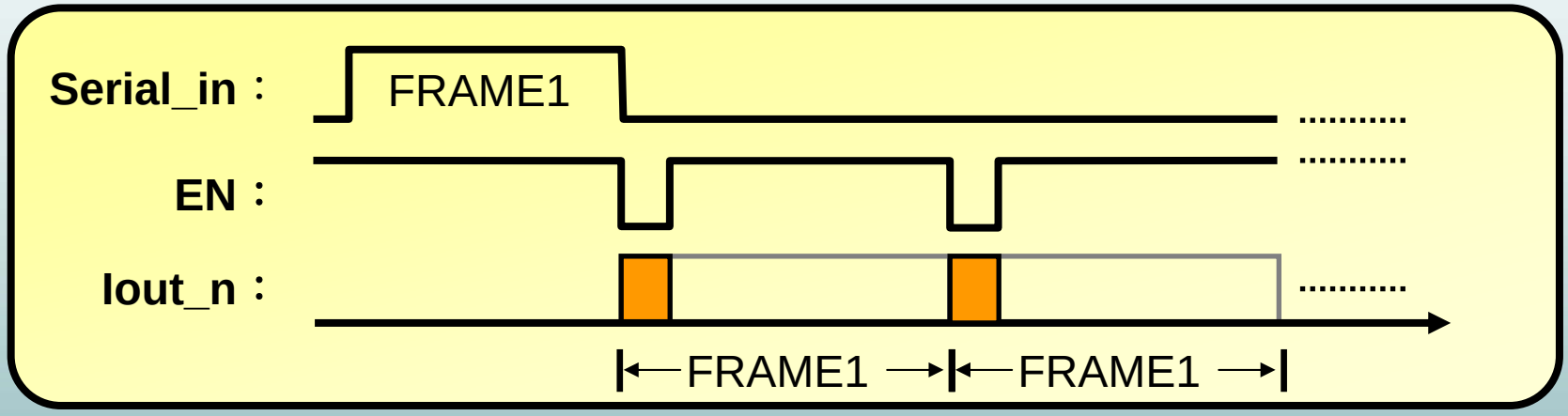
Global Brightness Control with Resistor Ladder



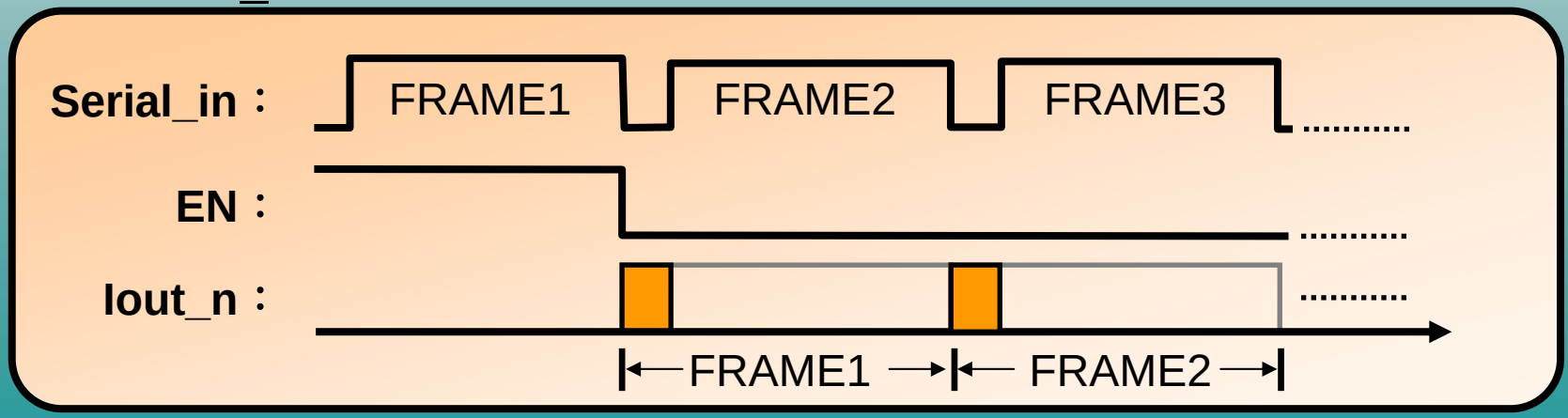
Global Brightness Control with D/A converter

電流調整方式_Digital

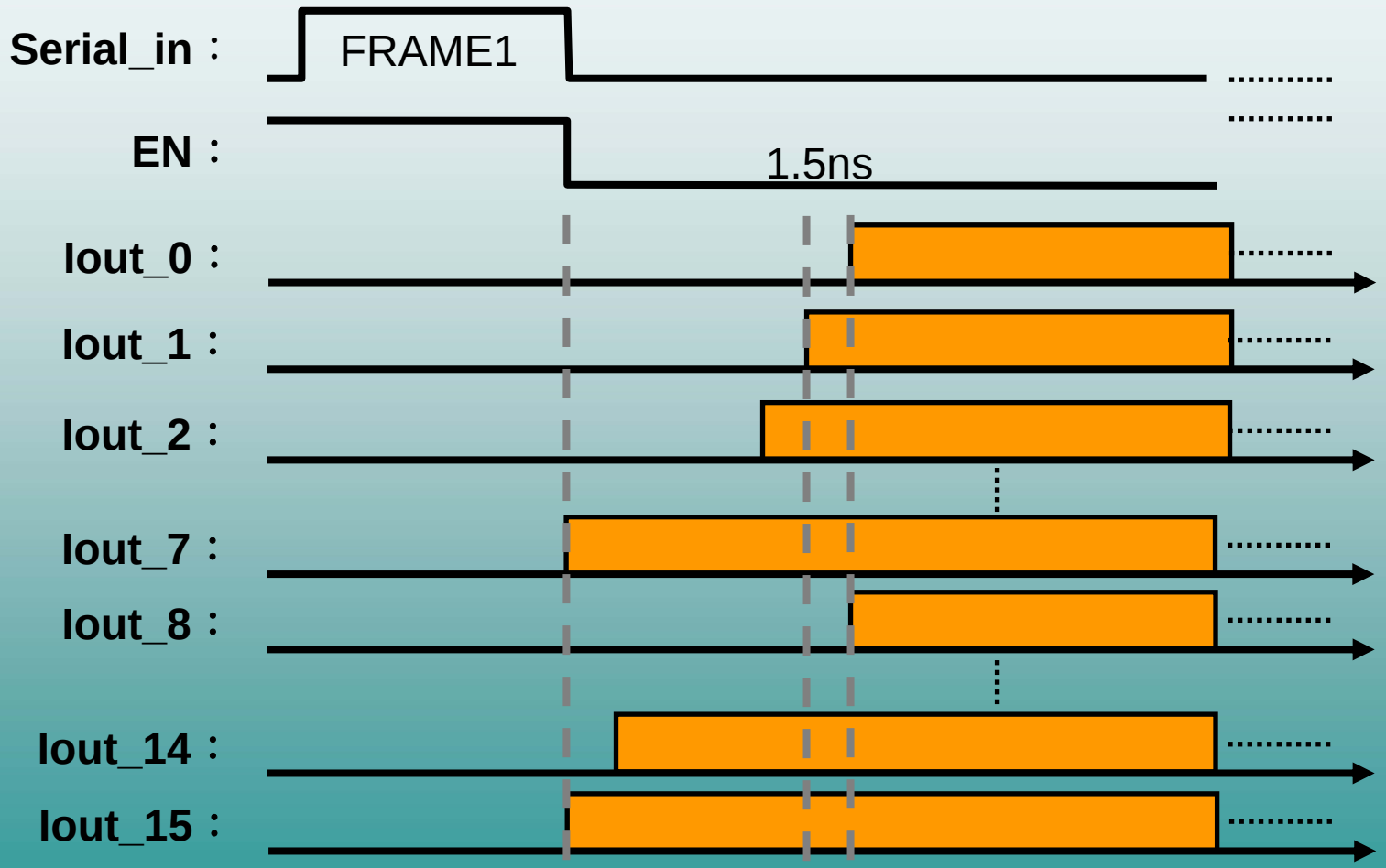
❑ EN Control



❑ Serial_in Control



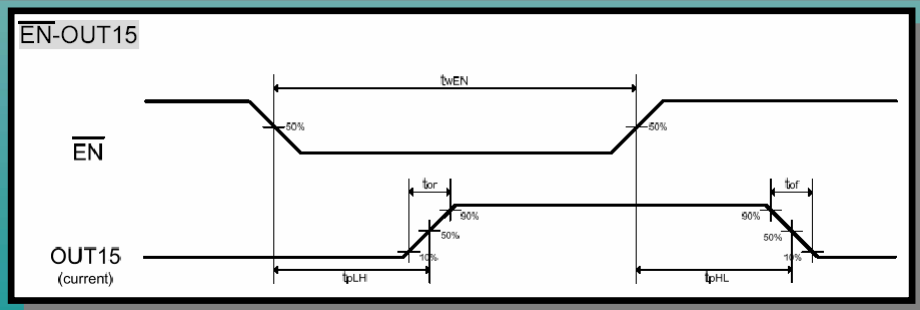
DM13C_Outputs Delay



DM13C_Transient Response

Switching Characteristics (VCC = 5.0V, Ta = 25°C unless otherwise noted)

CHARACTERISTIC		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation Delay (‘L’ to ‘H’)	EN-to-OUT15	tpLH	VIH = VCC VIL = GND Rrext = 2.2 KΩ VL = 5.0 V RL = 180 Ω CL*1 = 13 pF	—	16	—	ns
	LAT-to-OUT15			—	28.5	—	
	DCK-to-DAO			—	18	—	
Propagation Delay (‘H’ to ‘L’)	EN-to-OUT15	tpHL		—	18	—	
	LAT-to-OUT15			—	20.5	—	
	DCK-to-DAO			—	16	—	
Output Current Rise Time		tor		—	17	—	
Output Current Fall Time		tof		—	15	—	
Output Delay Time ($OUT_{(n)}$-to-$OUT_{(n+1)}$)		tod		—	2.2	—	



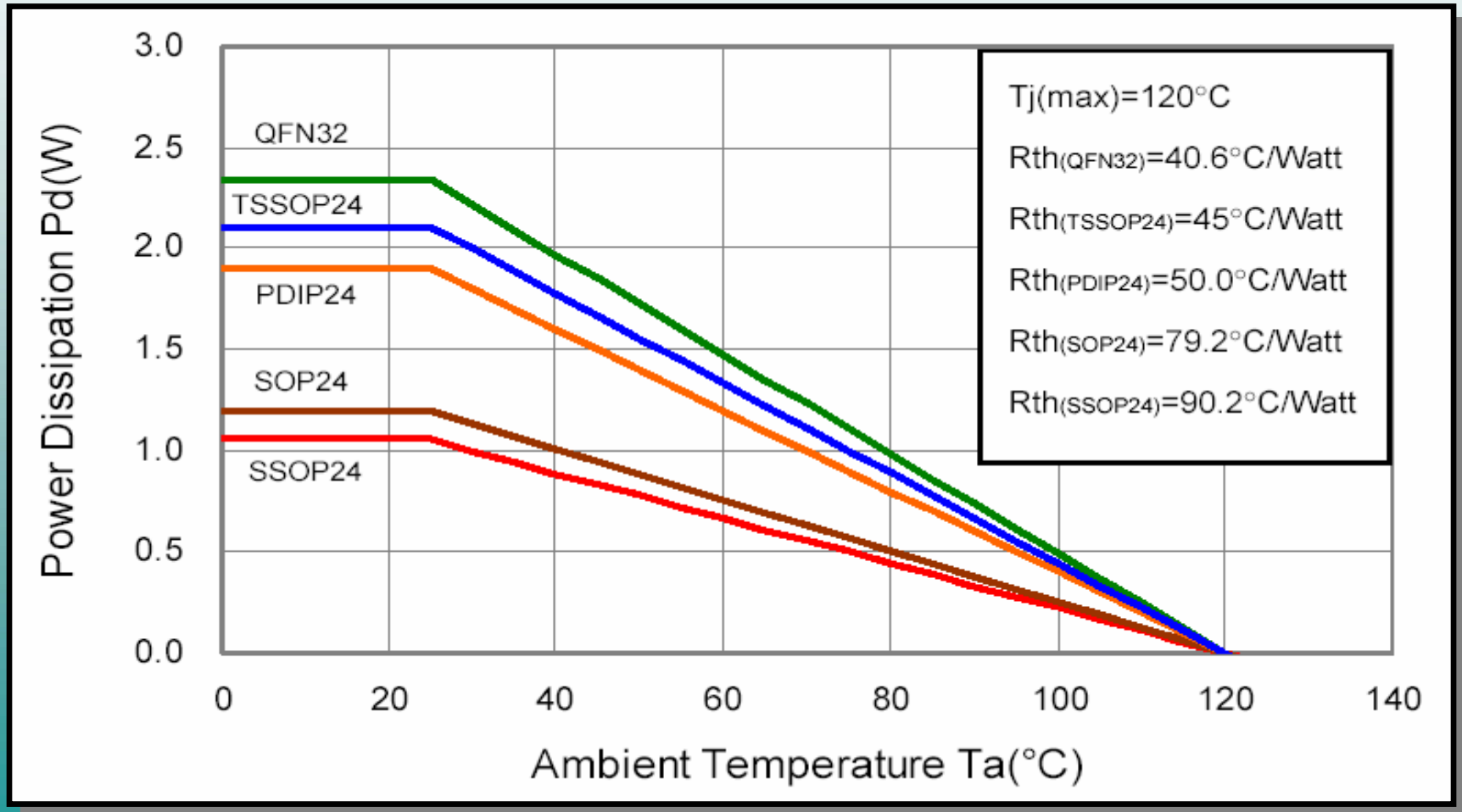
DM13C_Power Dissipation

Maximum Ratings (Ta=25°C, Tj(max) = 120°C)

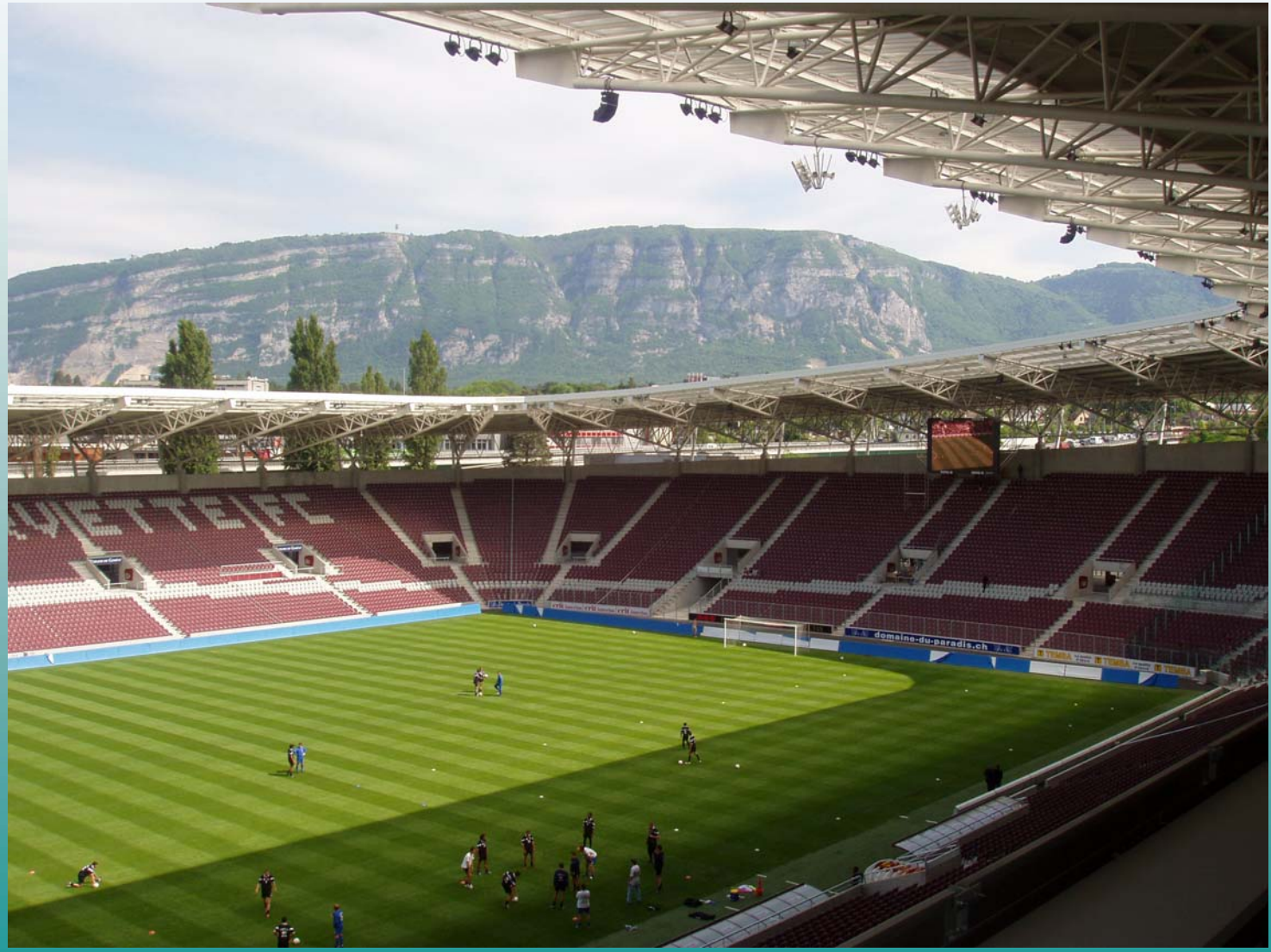
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	VCC	-0.3 ~ 7.0	V
Input Voltage	VIN	-0.3 ~ VCC+0.3	V
Output Current	IOUT	100	mA
Output Voltage	VOUT	-0.3 ~ 17	V
Input Clock Frequency	FDCK	25	MHz
GND Terminal Current	IGND	1600	mA
Power Dissipation (4 layer PCB)	PD	2.34 (QFN32 : Ta=25°C)	W
		2.11 (TSSOP24 exposed pad: Ta=25°C)	
		1.90 (PDIP24 : Ta=25°C)	
		1.20 (SOP24 : Ta=25°C)	
		1.05 (SSOP24 : Ta=25°C)	
Thermal Resistance	Rth(j-a)	40.6 (QFN32)	°C/W
		45 (TSSOP24 exposed pad)	
		50.0 (PDIP24)	
		79.2 (SOP24)	
		90.2 (SSOP24)	
Operating Temperature	Top	-40 ~ 85	°C
Storage Temperature	Tstg	-55 ~ 150	°C

DM13C_Power Dissipation

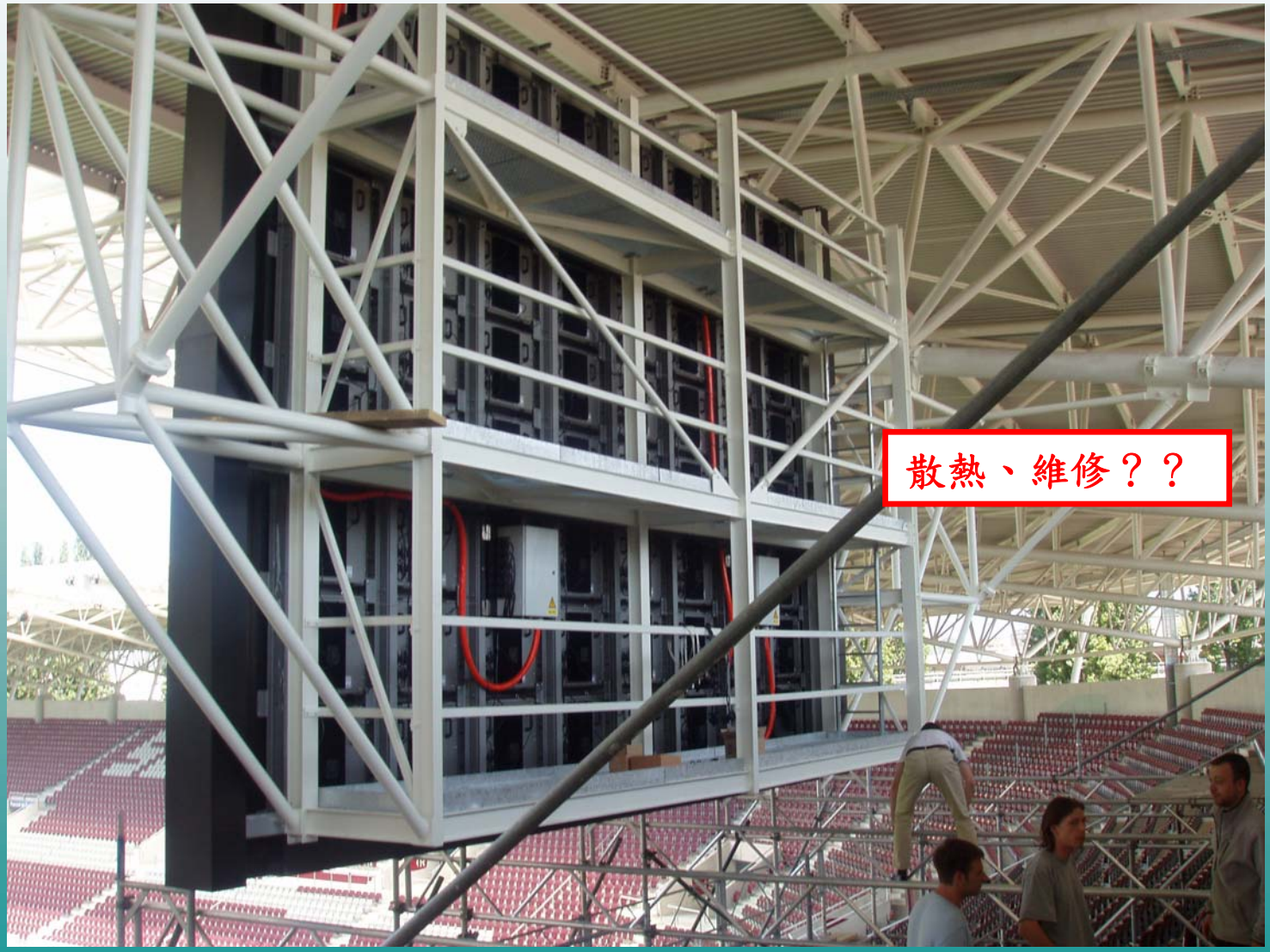
$$Pd(W) = Vcc(V) \times I_{DD}(A) + Vout0 \times Iout0 \times Duty0 + \cdots\cdots + Vout15 \times Iout15 \times Duty15 \leq Pd(max)(W)$$



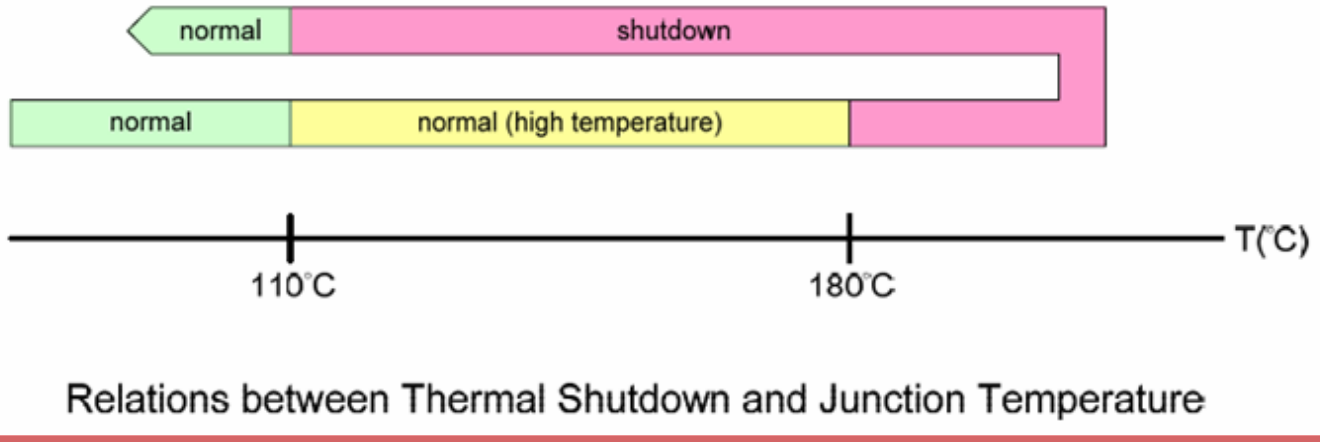
Display Panel



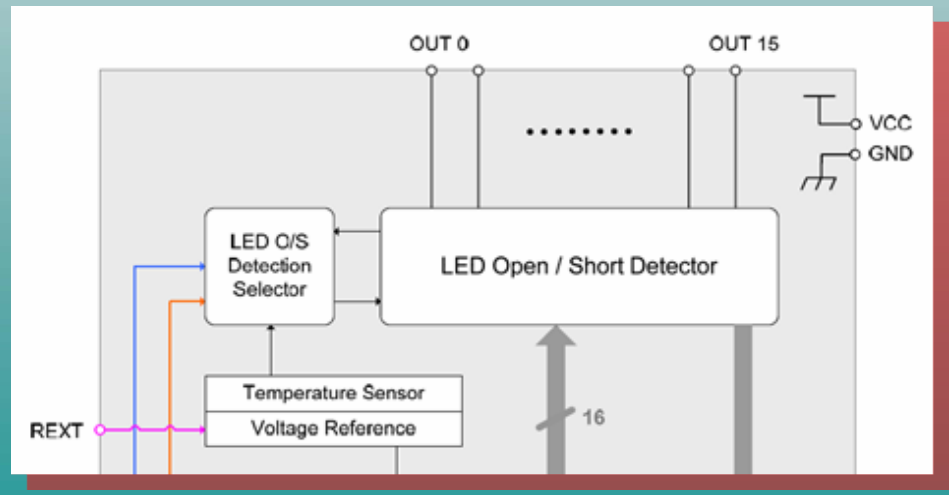
Display Panel



DM13C_Thermal Shutdown



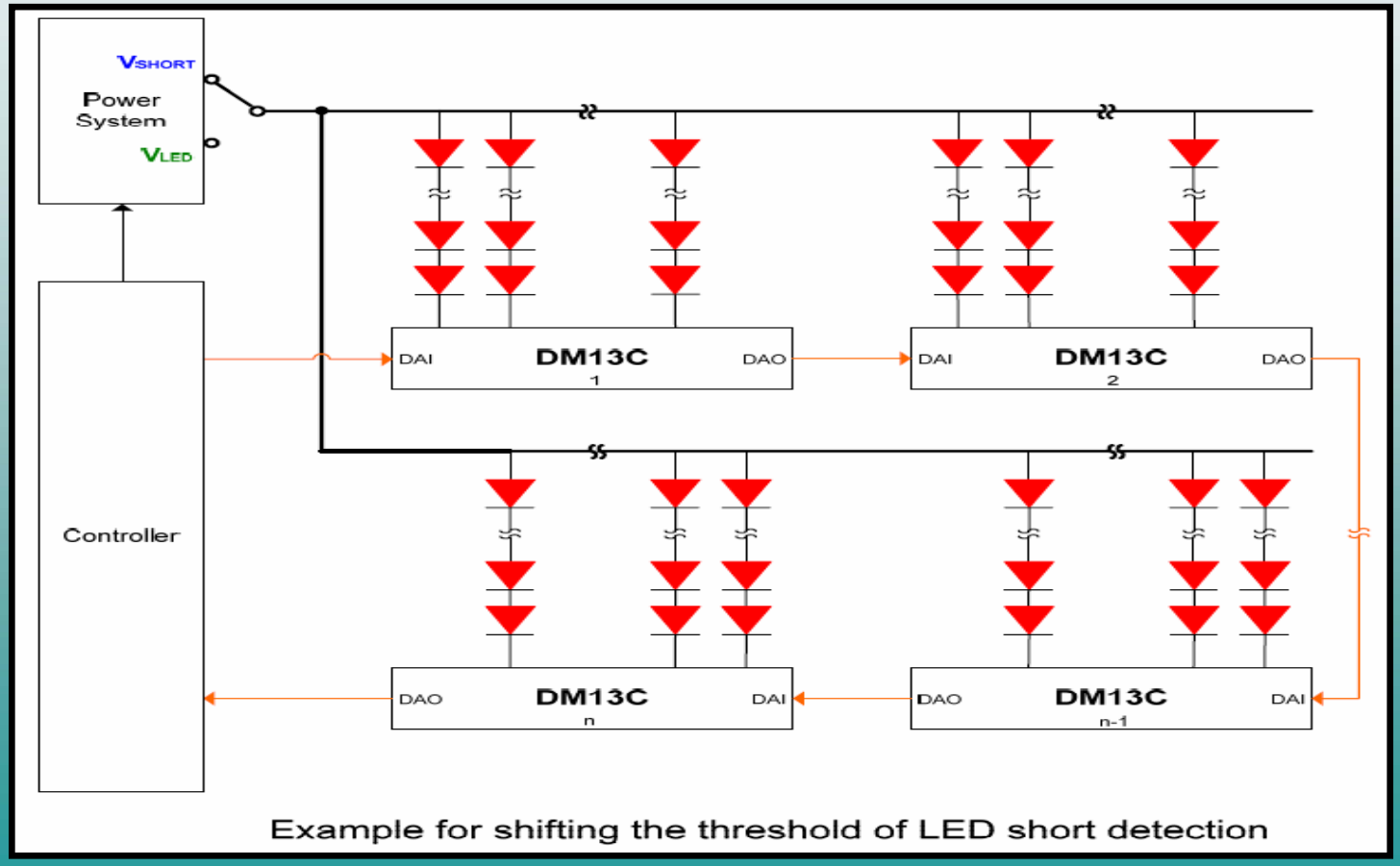
Relations between Thermal Shutdown and Junction Temperature



DM13C_OPEN / Short Detection

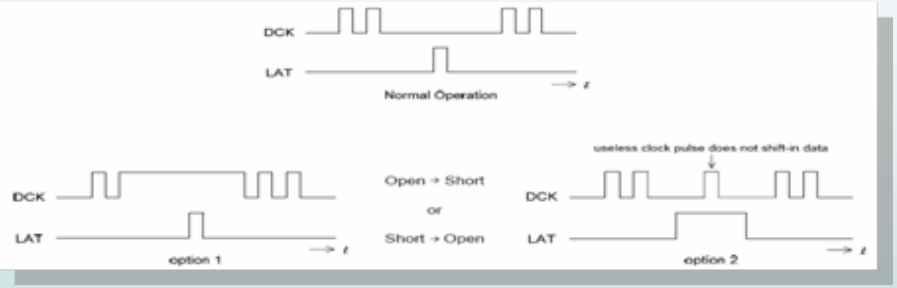
LED Open Detection Threshold：0.3V

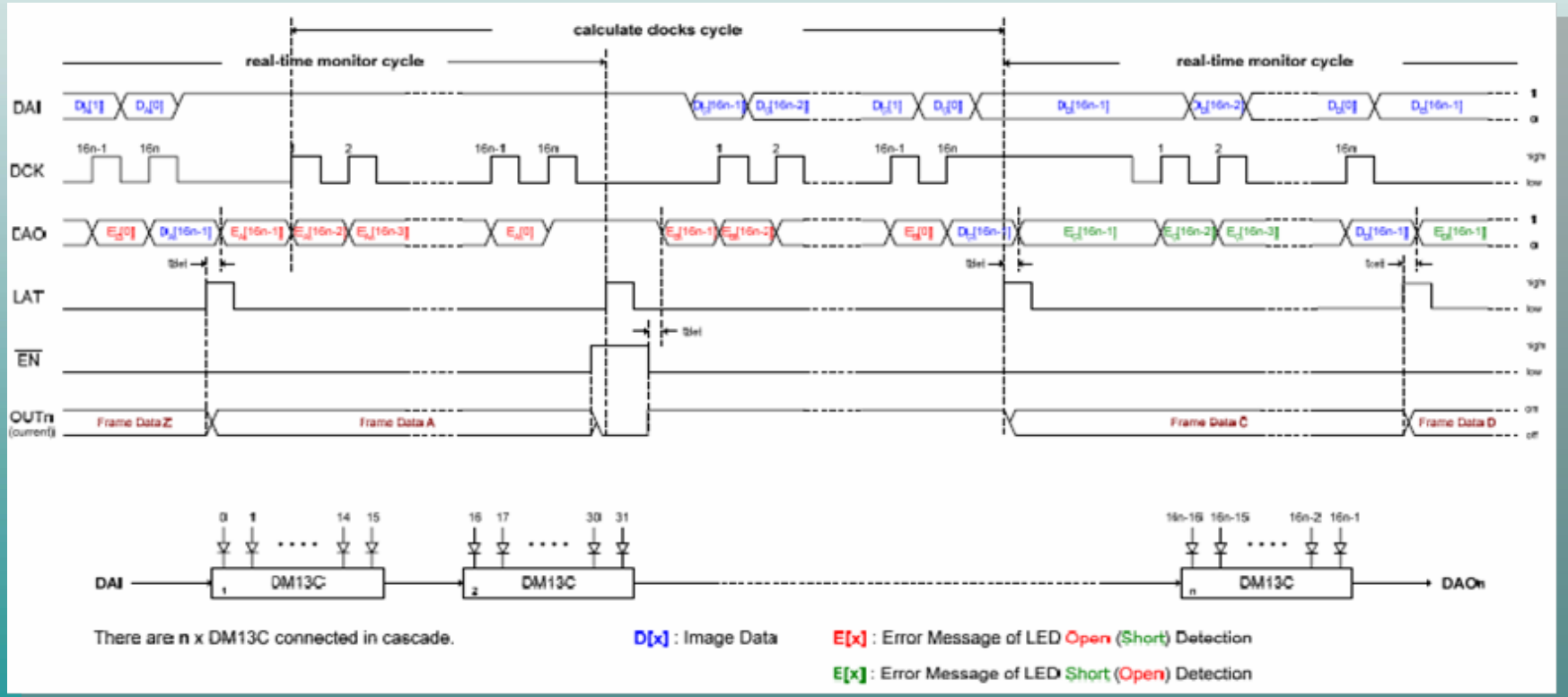
LED Short Detection Threshold：0.5VCC



Example for shifting the threshold of LED short detection

DM13C_OPEN / Short Detection

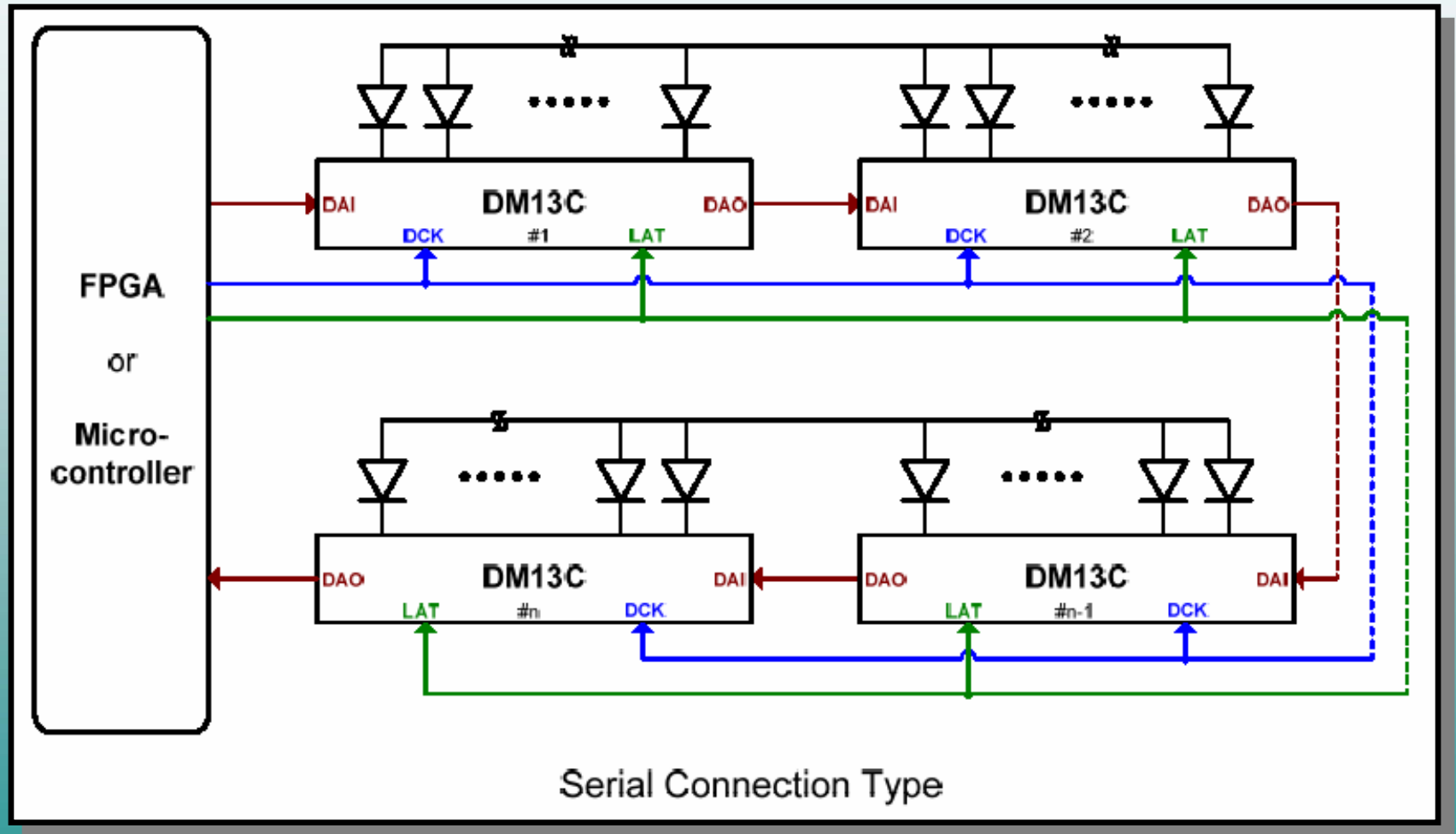




Display Panel

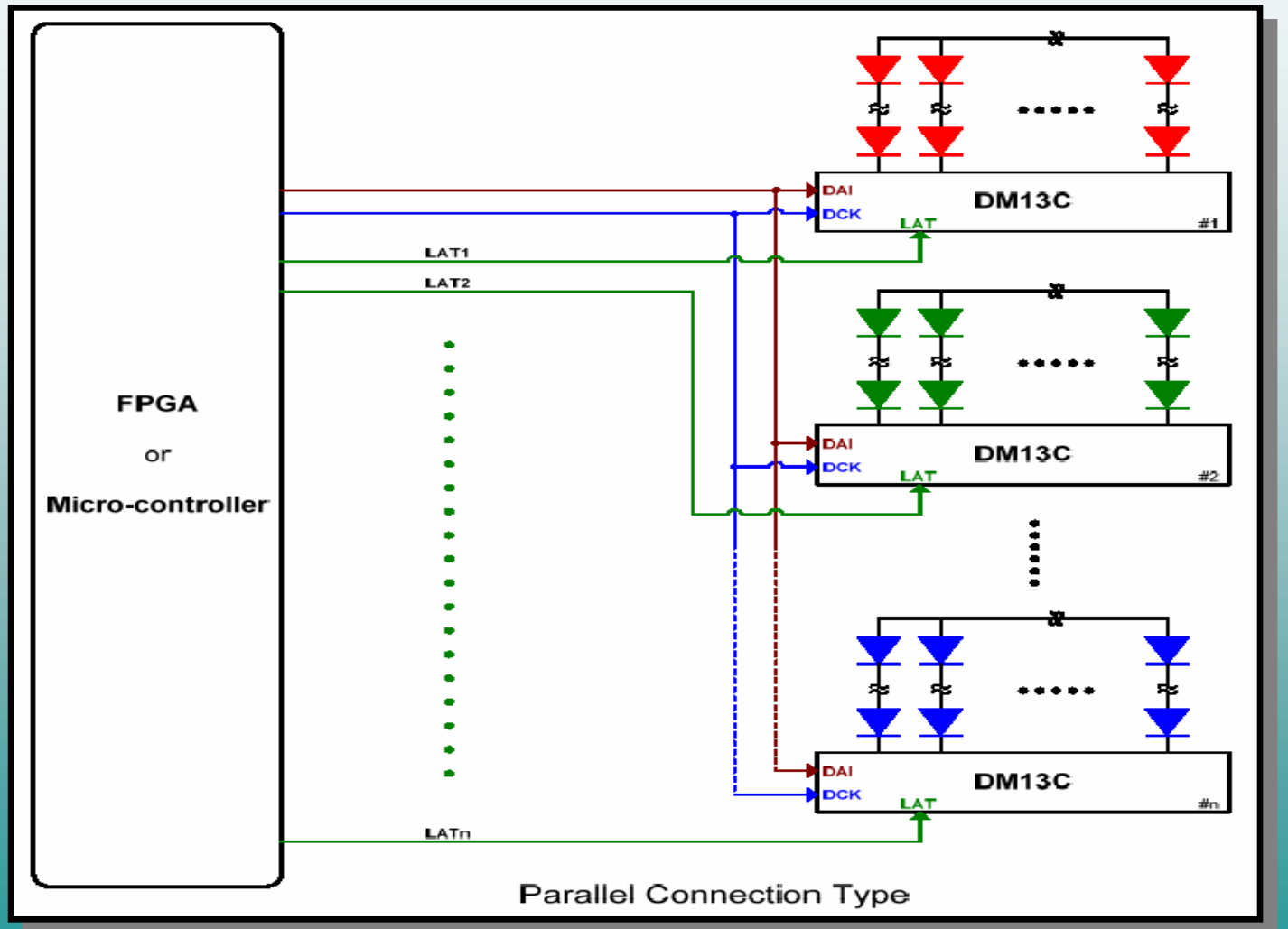
Mitsubishi (Japan)
MLB Atlanta Braves Home Field
Atlanta, USA

Application_Serial Connection

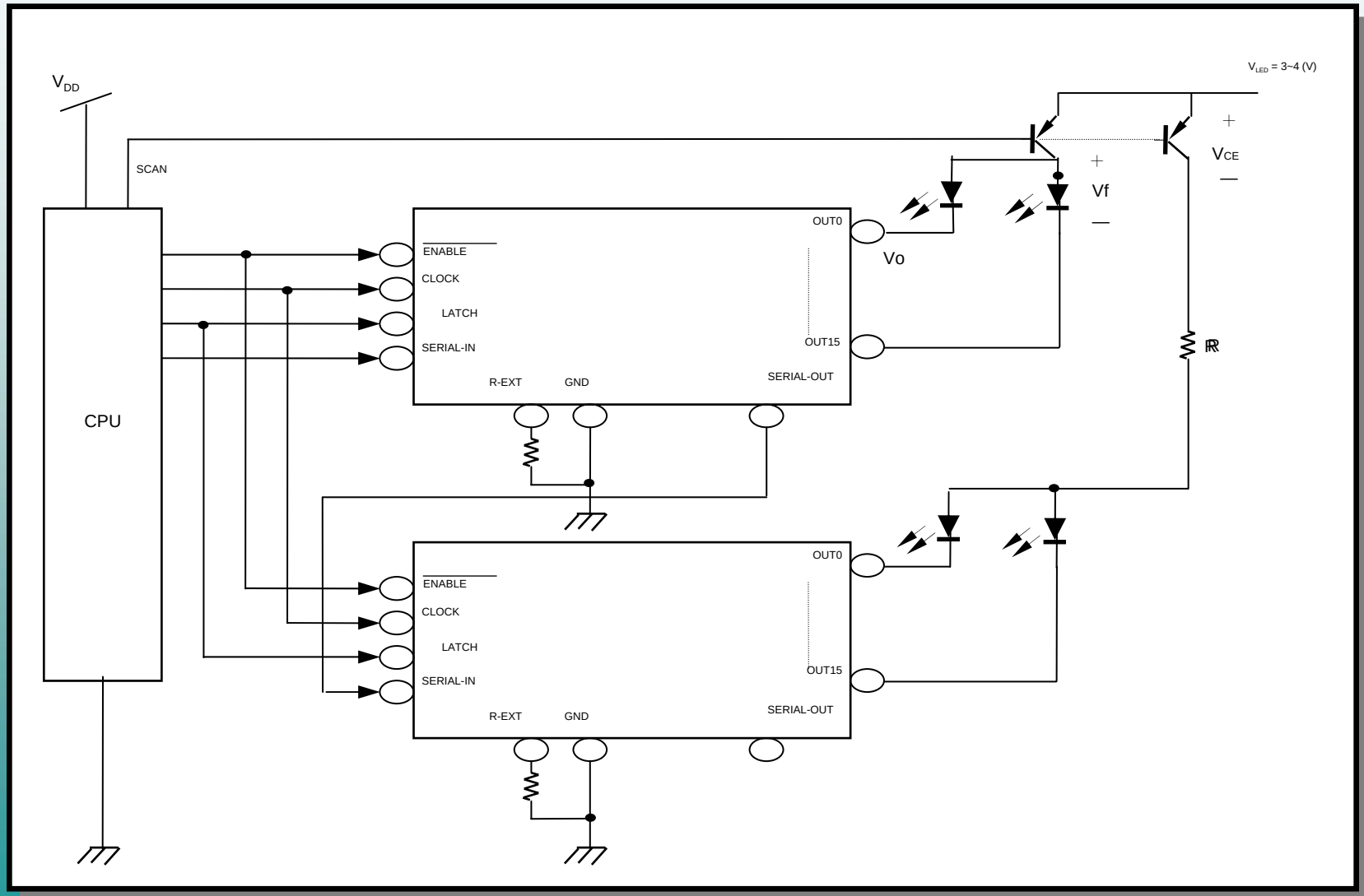


Serial Connection Type

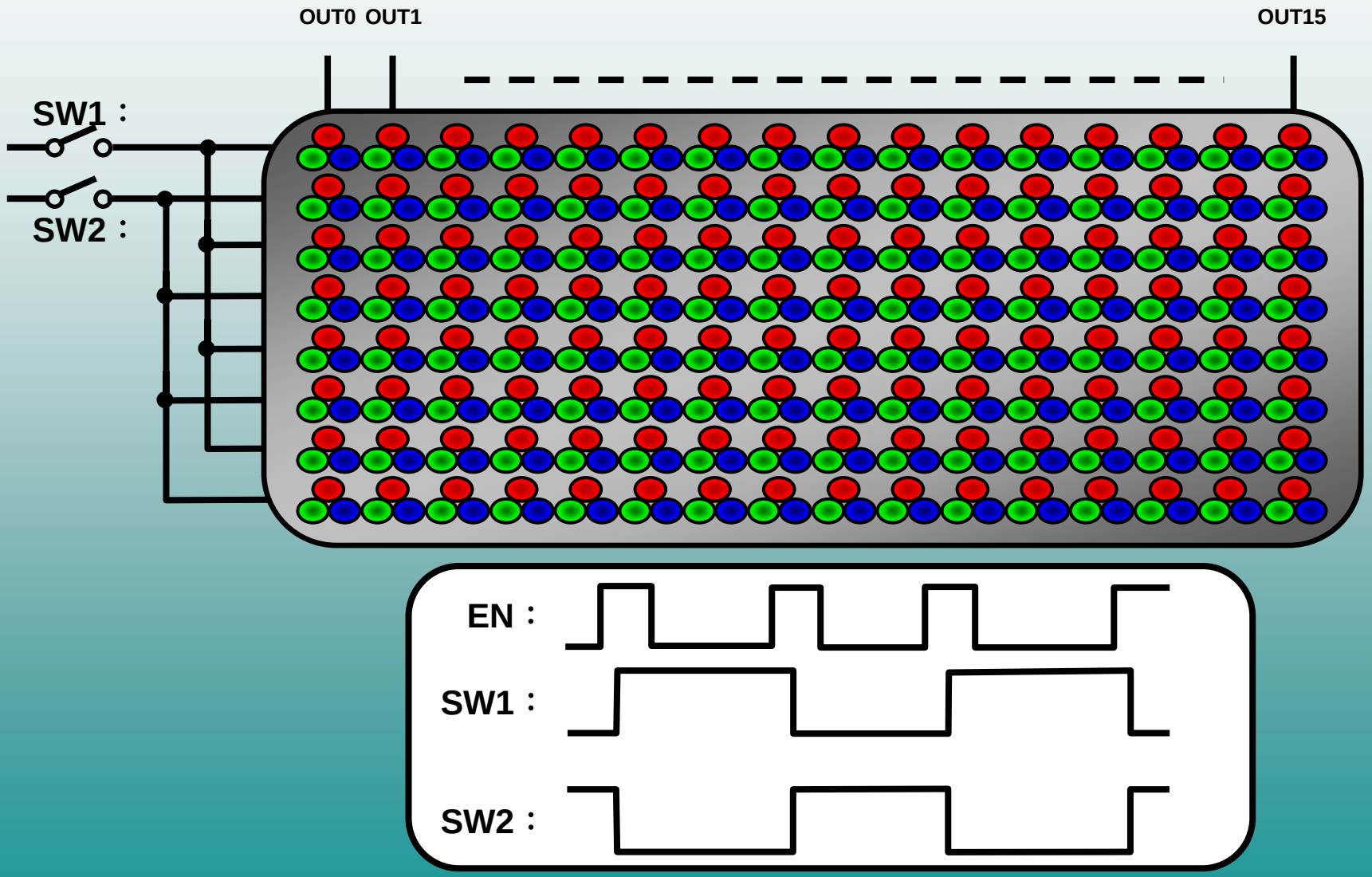
Application_Parallel Connection



Application_SCAN



Application_SCAN



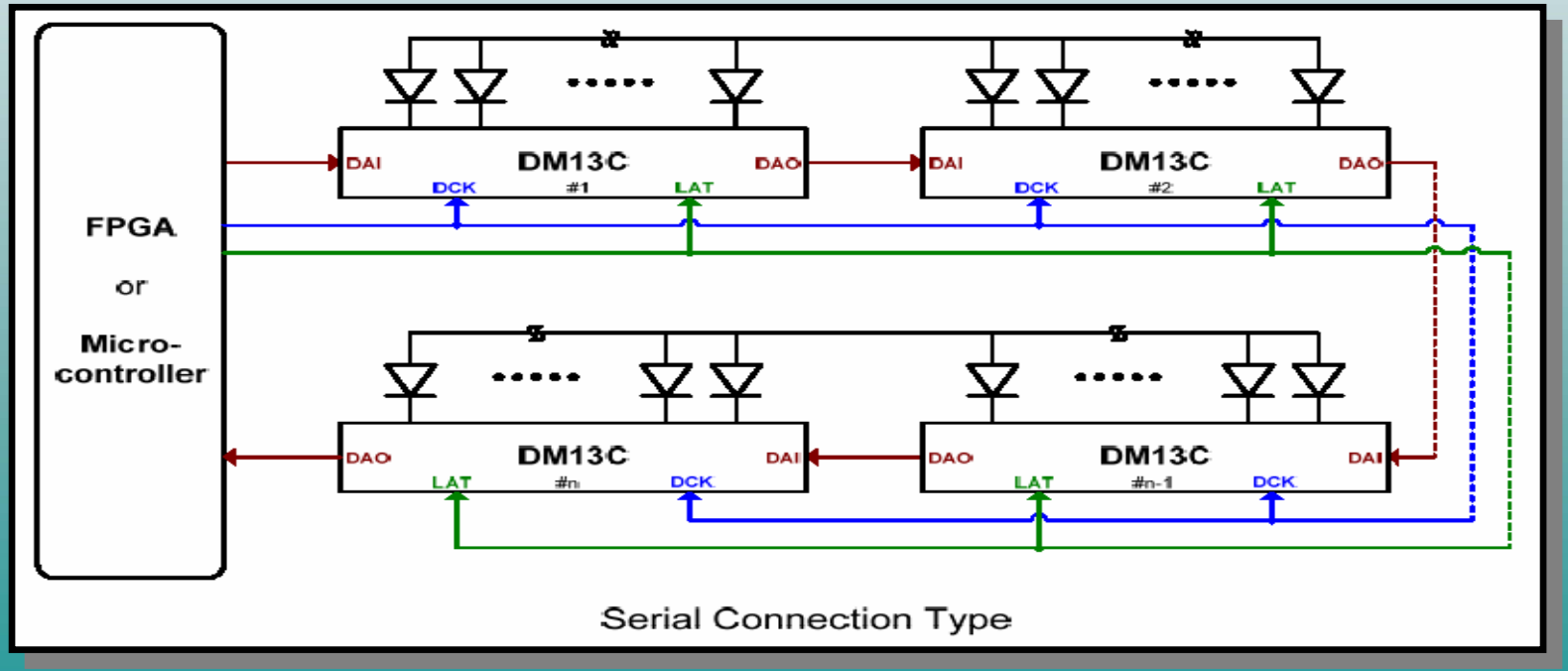
Try It

- **Serial 2 DM13C**

  =>跑馬燈

  =>32 CH Grayscale（漸層）

  =>Global Grayscale



Serial Connection Type

Create A Dream World

Q&A