

# ADT6610

## Data Sheet

*\* This specifications are subject to be changed without notice*

## Revision History

Version	Contents	Date
0.0	-. First Version	2011. 8. 25

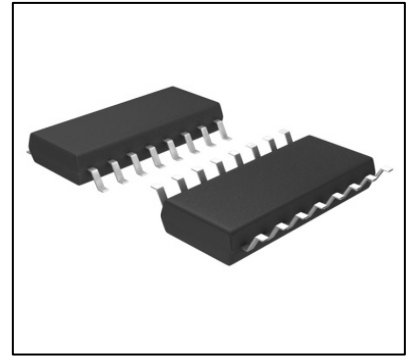
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## GENERAL DESCRIPTION

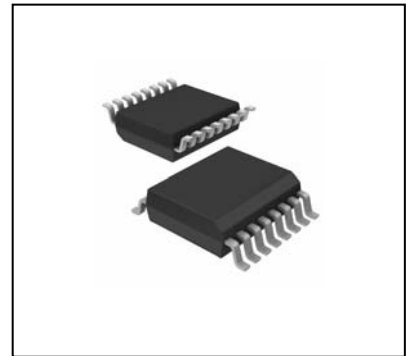
The ADT6610 is a 3-channel constant current LED driver that has a wide range of output currents. The ADT6610 controls LED brightness with a Pulse Width Modulation (PWM) scheme that gives the application the capability of displaying a billion colors in an RGB cluster. The maximum current is set by an external resistor.

## FEATURES

- Constant output current range : 5mA to 100mA with three external resistors
- 3 channel constant current LED sink driver for RGB LED clusters
- Two wire only transmission interface
  - Clock re-generation to recover the clock duty cycle
- 8/12/16bit grayscale PWM control
- Supply voltage range : 5 ~ 18V
- Embedded voltage regulator : VDD generation
- Maximum sinking output voltage : 18V
- 5V CMOS compatible input
- Package : SOP16, SSOP16
- Maximum serial input frequency : 10MHz
- Built in internal RC oscillator is 10MHz
- RoHS-compliant package



16SOP



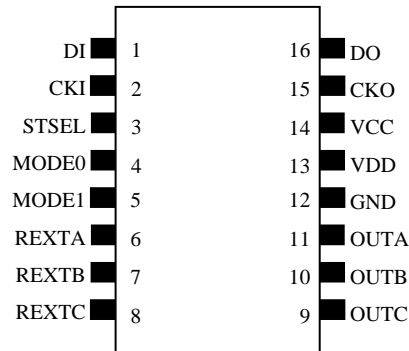
16SSOP

## APPLICATION

- Channel sign
- Architectural lighting
- LED curtain display or LED strip
- Neon sign replacement

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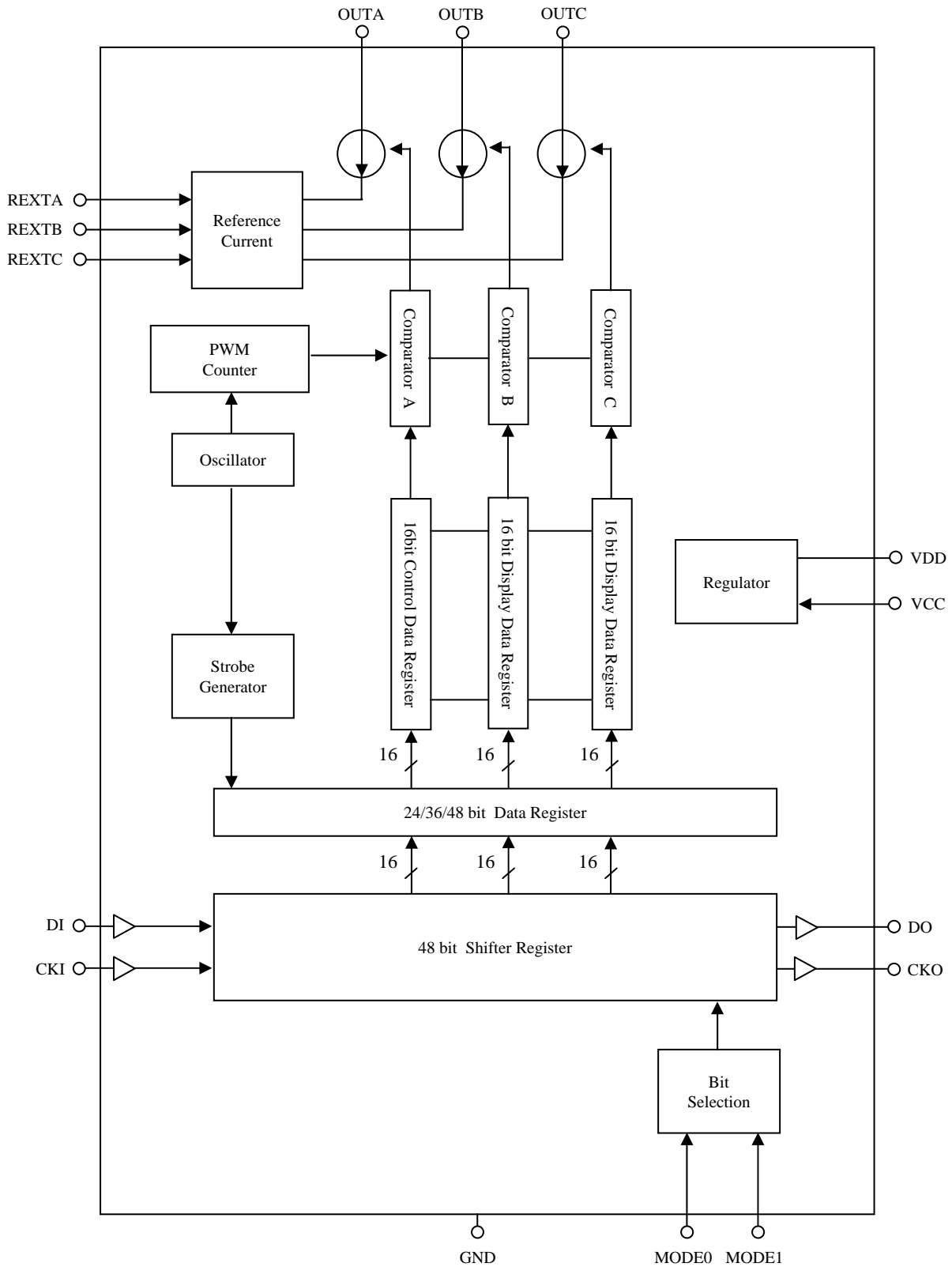
## PIN CONFIGURATION



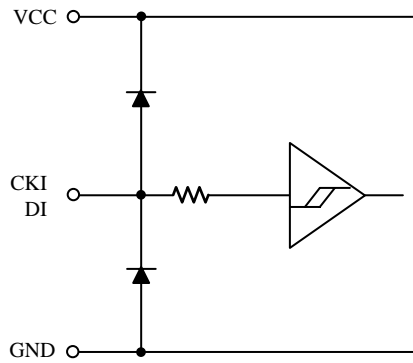
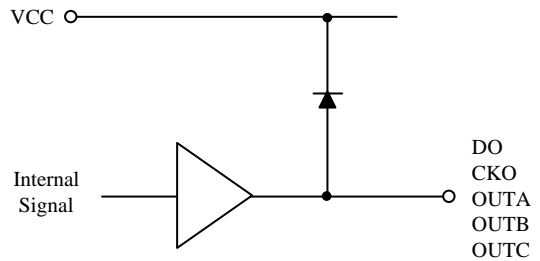
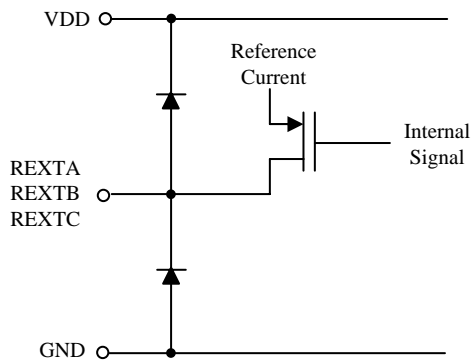
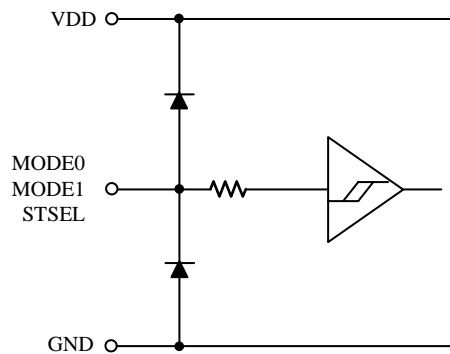
## PIN DESCRIPTION

PIN NO.	PIN NAME	FUNCTION		
1	DI	Input terminal for serial data input.		
2	CKI	Input terminal for serial clock input.		
3	STSEL	Waiting time selection pin for strobe signal.		
		L	20us	
		H	5ms	
4,5	MODE0, MODE1	Input data transfer mode selection.		
		MODE1	MODE0	descriptions
		L	L	8 bit luminance data transfer
		L	H	12 bit luminance data transfer
		H	L	Reserved
		H	H	16 bit luminance data transfer
6,7,8	REXTA, REXTB, REXTC	External resistors are connected between those pins and GND for driver current setting.		
9,10,11	OUTC, OUTB, OUTA	Output terminal for constant current output.		
12	GND	GND		
13	VDD	Regulator output voltage.		
14	VCC	High supply voltage.		
15	CKO	Output terminal for serial clock output.		
16	DO	Output terminal for serial data output when CKI is 'L'.		

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**BLOCK DIAGRAM**


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**EQUIVALENT CIRCUIT OF INPUTS AND OUTPUTS**
**CKI, DI terminal**

**DO, CKO, OUTA, OUTB, OUTC terminal**

**REXTA, REXTB, REXTC terminal**

**MODE0, MODE1, STSEL terminal**


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**ABSOLUTE MAXIMUM RATINGS** (Ta = 25°C, Note1)

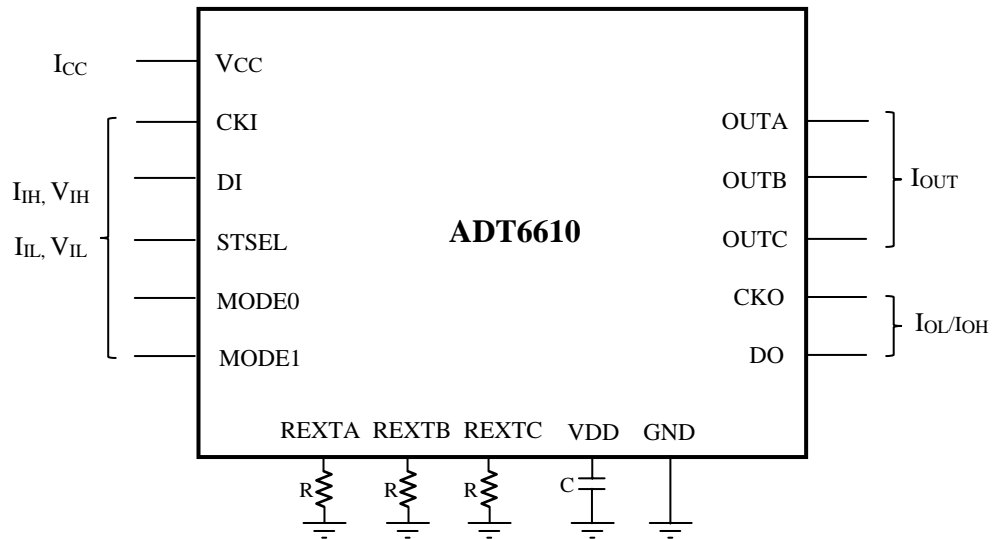
PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	VCC	0 ~ 20	V
Supply Voltage	VDD	0 ~ 7	V
Output Voltage	VOUT	-0.5 ~ 20	V
Output Current per Output Channel	IOUT	150	mA
Logic Input Voltage	VIN	-0.4 ~ VDD+0.4	V
GND Terminal Current	IGND	320	mA
Max Power Dissipation	PD <sub>MAX</sub> (SOP)	1.53	W
	PD <sub>MAX</sub> (SSOP)	1.22	W
Thermal resistance	Θ <sub>JA</sub> (SOP)	81.6	°C/W
	Θ <sub>JA</sub> (SSOP)	102.3	°C/W
Operating Temperature	Topr	-40 ~ 85	°C
Storage Temperature	Tstg	-65 ~ 150	°C
Junction Temperature	T <sub>JMAX</sub>	150	°C

Note1. Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device.

**ELECTRICAL CHARACTERISTICS**
**DC CHARACTERISTICS** (VDD = 5V, R=39kΩ, Ta = 25°C)

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT	
VCC Supply Voltage		V <sub>CC</sub>	10	15	18	V	
LED Driver Output Voltage		V <sub>OUT</sub>			18	V	
Voltage Regulator Output Voltage	V <sub>CC</sub> =10~18V	V <sub>DD</sub>	4.5	5.0	5.5	V	
Input Leakage Current		I <sub>Z</sub>	-1.0		1.0	uA	
Output Leakage Current	V <sub>DS</sub> =18V, All turn off	I <sub>oz</sub>			1.0	uA	
Input Voltage	“H” Level	V <sub>IH</sub>	0.8V <sub>DD</sub>	-	V <sub>DD</sub>	V	
	“L” Level	V <sub>IL</sub>	GND	-	0.2V <sub>DD</sub>	V	
Output Voltage	DO, CKO	I <sub>OL</sub> =5mA	V <sub>OL</sub>	-	-	0.2V <sub>DD</sub>	V
		I <sub>OH</sub> =-5mA	V <sub>OH</sub>	0.8V <sub>DD</sub>	-	-	V
LED Driver Output Current	V <sub>DS</sub> =1.5V	I <sub>OUT</sub>		60	100	mA	
Pin to Pin Deviation	I <sub>OUT</sub> =60mA	I <sub>PP</sub>		±1.5	±3	%	
Chip to Chip Deviation	I <sub>OUT</sub> =60mA	I <sub>CC</sub>		±3	±6	%	
Supply Voltage Regulation	I <sub>OUT</sub> =60mA, V <sub>CC</sub> =10~18V	%/V <sub>CC</sub>		±0.2	±0.5	%	
Supply Current	I <sub>OUT</sub> =60mA, V <sub>CC</sub> =18V	ICC		4	8	mA	

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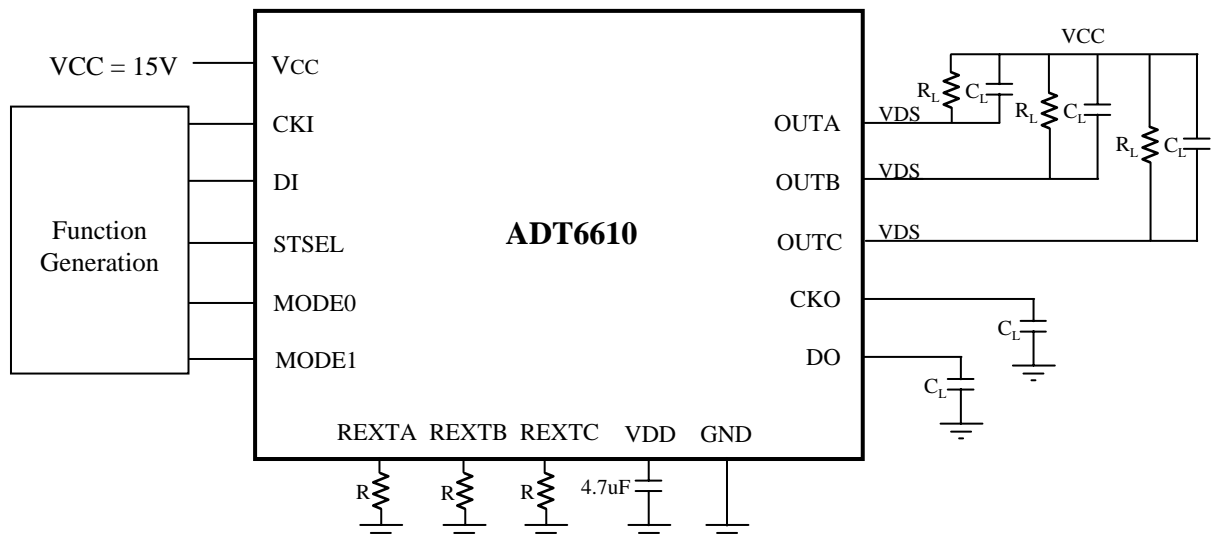
**TEST CIRCUIT for DC CHARACTERISTICS**


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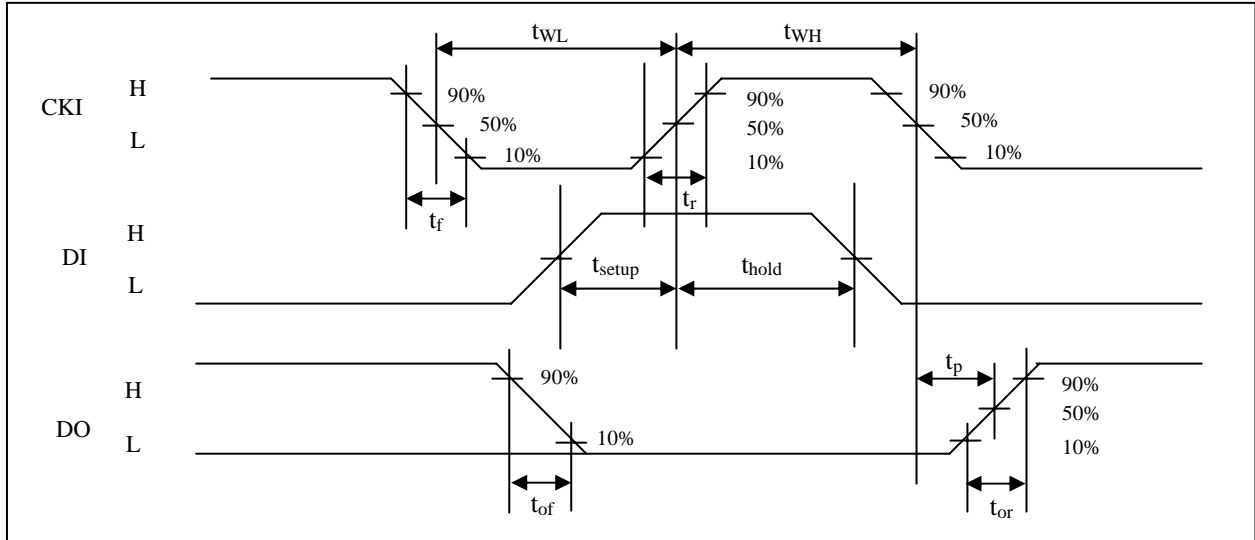
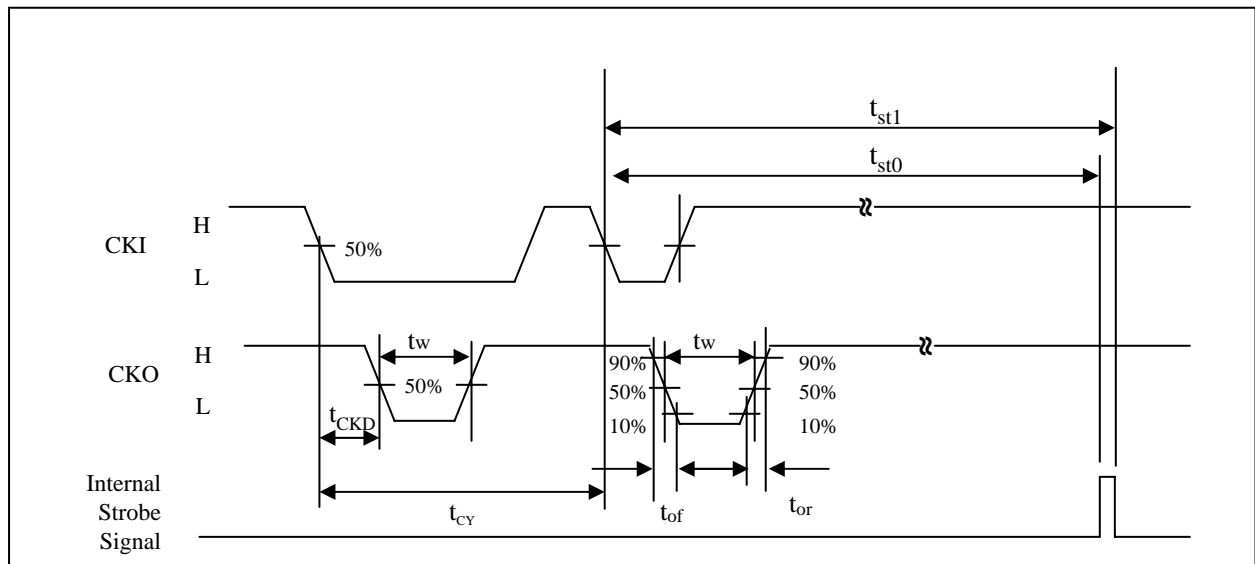


**ELECTRICAL CHARACTERISTICS ( Continued )**
**AC CHARACTERISTICS (VDD = 5V, Ta = 25°C)**

PARAMETER		TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time	CKI-DO	VCC = 15V VDD = 5.0V VIH = VDD - 0.5 VIL = 0.5V R = 39kΩ ( IOOUT = 60mA ) CL = 10pF RL = 200Ω VDS = 1.5V	$t_p$	-	8	20	ns
CKI Frequency			$f_{CKMAX}$	0.5	8	10	MHz
CKI Pulse Width			$t_{WH} / t_{WL}$	15	-	-	ns
Data Setup Time			$t_{setup}$	20	-	-	ns
Data Hold Time			$t_{hold}$	30	-	-	ns
DI Width			$t_{wsh}$	50	-	-	ns
			$t_{wsl}$	50	-	-	ns
Clock Delay	CKO		$t_{CKD}$	-	8	15	ns
Clock Width			$t_W$	10	30	-	ns
Clock Cycle			$t_{CY}$	100	-	-	ns
Maximum Clock Rise Time			$t_r$	-	-	10	ns
Maximum Clock Fall Time			$t_f$	-	-	10	ns
CKO, DO Output Rise Time			$t_{or}$	-	-	10	ns
CKO, DO Output Fall Time			$t_{of}$	-	-	10	ns
CKI Waiting Time for No Strobe STSEL=Low			$t_{st0}$			6	us
CKI Waiting Time for No Strobe STSEL=High			$t_{st0}$			1.5	ms
CKI Waiting Time for Strobe STSEL=Low			$t_{st1}$	20			us
CKI Waiting Time for Strobe STSEL=High			$t_{st1}$	5			ms

**TEST CIRCUIT for AC CHARACTERISTICS**


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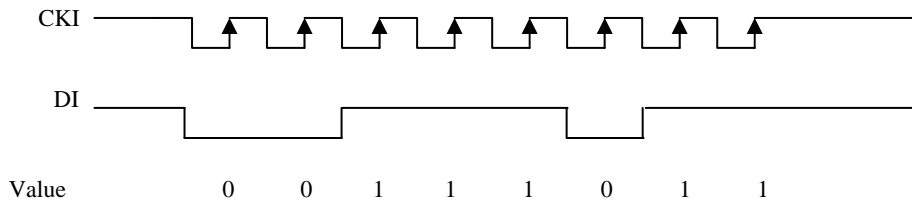
**TIMING WAVEFORM**
**CKI, DI, DO (Data Transmit)**

**CKI, CKO , Internal Strobe**


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## OPERATION PRINCIPLE

### Interface

The ADT6610 is a two-wire only transmission interface. It is similar to SPI interface (CKI, DI). The display data (DI) transfers at the rising edge of the clock (CKI). And the output data (DO) is out at the falling edge of the clock (CKI).



### Embedded Voltage Regulator

The ADT6610 has an embedded voltage regulator to regulate the high input supply voltage to 5V supply voltage for internal . The input voltage range is 10 ~ 18V, which is suitable for 12/16V system. The high supply voltage is connected the VCC, and the output of the regulator is connected to VDD. An external capacitor of 4.7uF should be connected between VDD and ground to stable the output voltage. When the input voltage is 5V, the VCC and VDD pins should be connecting.

### Setting the Gray Scale

The ADT6610 provides three selectable gray scale modes: 16bit gray scale mode, 12bit gray scale mode and 8bit gray scale mode. The 16bit gray scale mode provides 65,536 gray scales for each LED. The 12bit gray scale mode provides 4,096 gray scales for each LED. In addition, the ADT6610 also embedded with an oscillator as the clock of PWM counter to turn on output ports according to the gray scale data sent from the system controller.

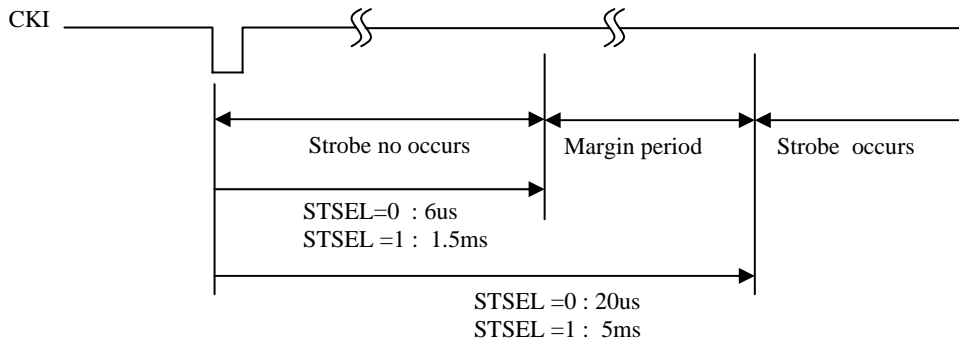
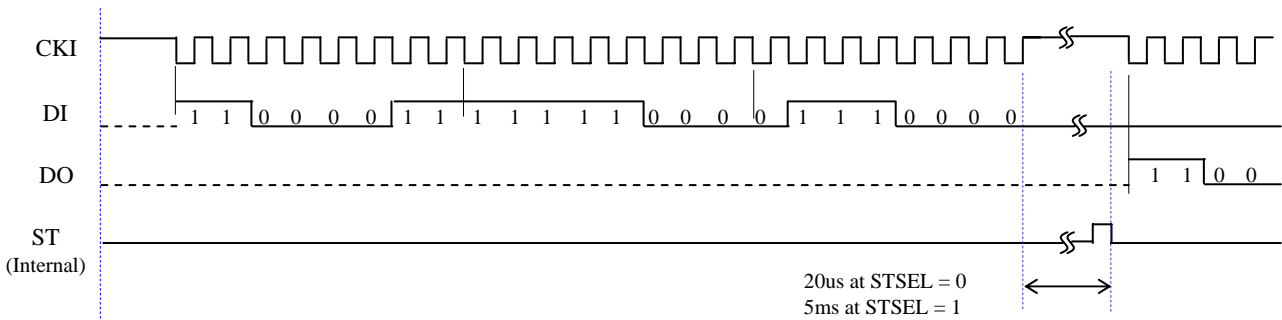
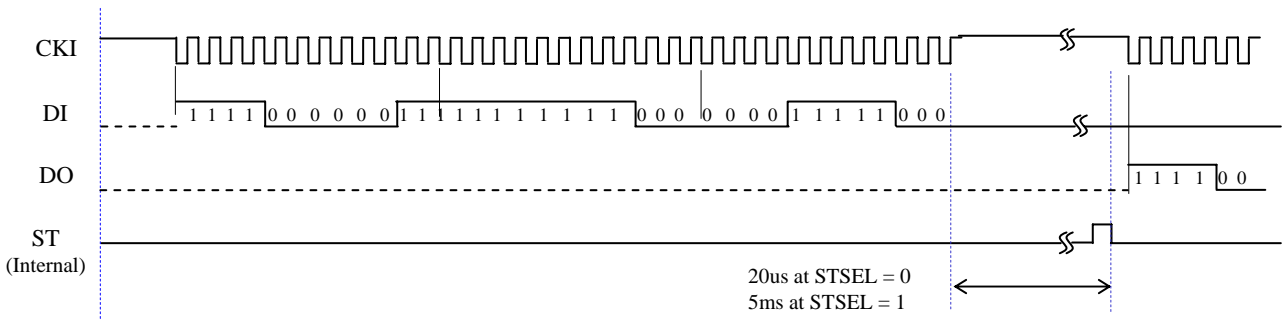
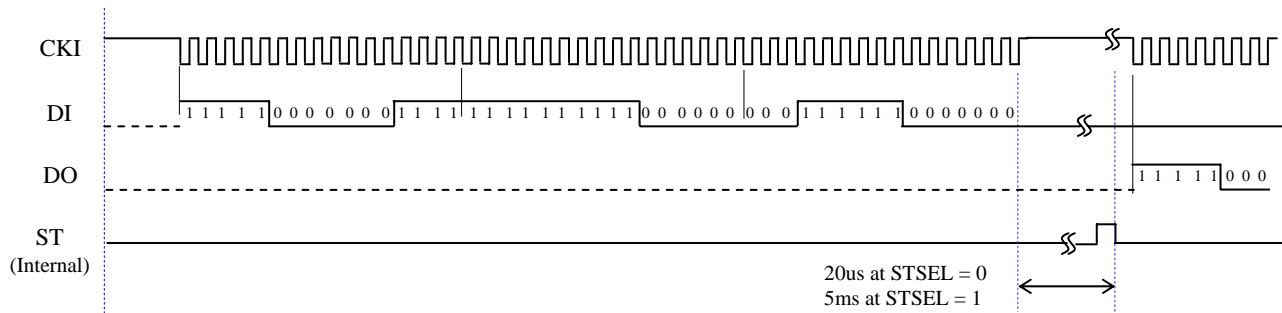
MODE0 pin	MODE1 pin	MODE
0	0	8bit interface mode
0	1	12bit interface mode
1	0	Inhibit
1	1	16bit interface mode

### Strobe Method

The ADT6610 provides two selectable strobe time. It is selected 20us or 5ms by STSEL pin. When the CLK high period is longer than 20us at STSEL low or 5ms at STSEL high, the gray scale data are fetched register by internal strobe signal.

STSEL pin	The CKI wait time for internal strobe signal
0	20us
1	5ms

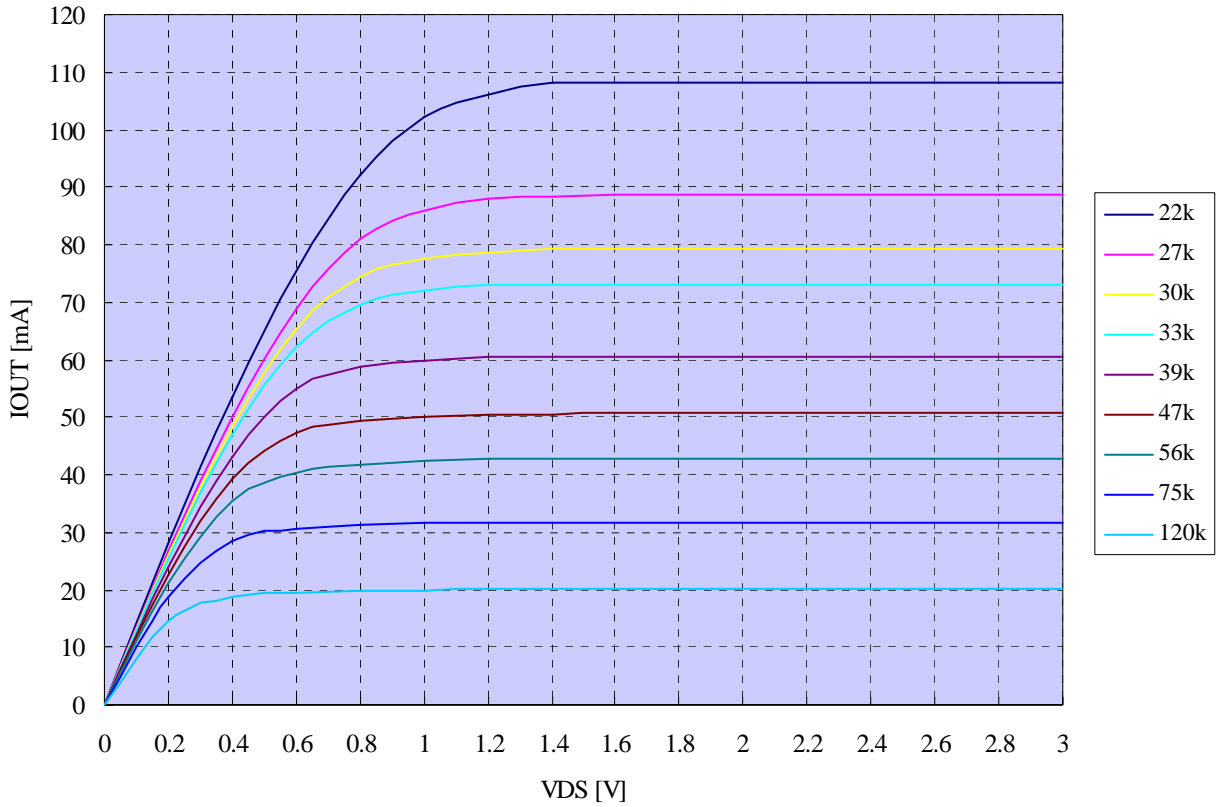
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**Strobe Waiting Time**

**Interface Timing Diagram for 8bit Gray Scale Mode ( MODE0=0 , MODE1 = 0)**
**A(7:0) = C3H, B(7:0) = F8H, C(7:0) = 70H**

**Interface Timing Diagram for 12bit Gray Scale Mode ( MODE0=1 , MODE1 = 0)**
**A(7:0) = F03H, B(7:0) = FF8H, C(7:0) = 0F8H**

**Interface Timing Diagram for 16bit Gray Scale Mode ( MODE0=1 , MODE1 = 1)**
**A(7:0) = F80FH, B(7:0) = FFC0H, C(7:0) = 1F80H**


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**CONSTANT OUTPUT CURRENT ( REXT=39k )**

The ADT6610 performs excellent current skew. The maximum current variation between channels is less than  $\pm 3\%$ , and that between ICs is less than  $\pm 6\%$ .



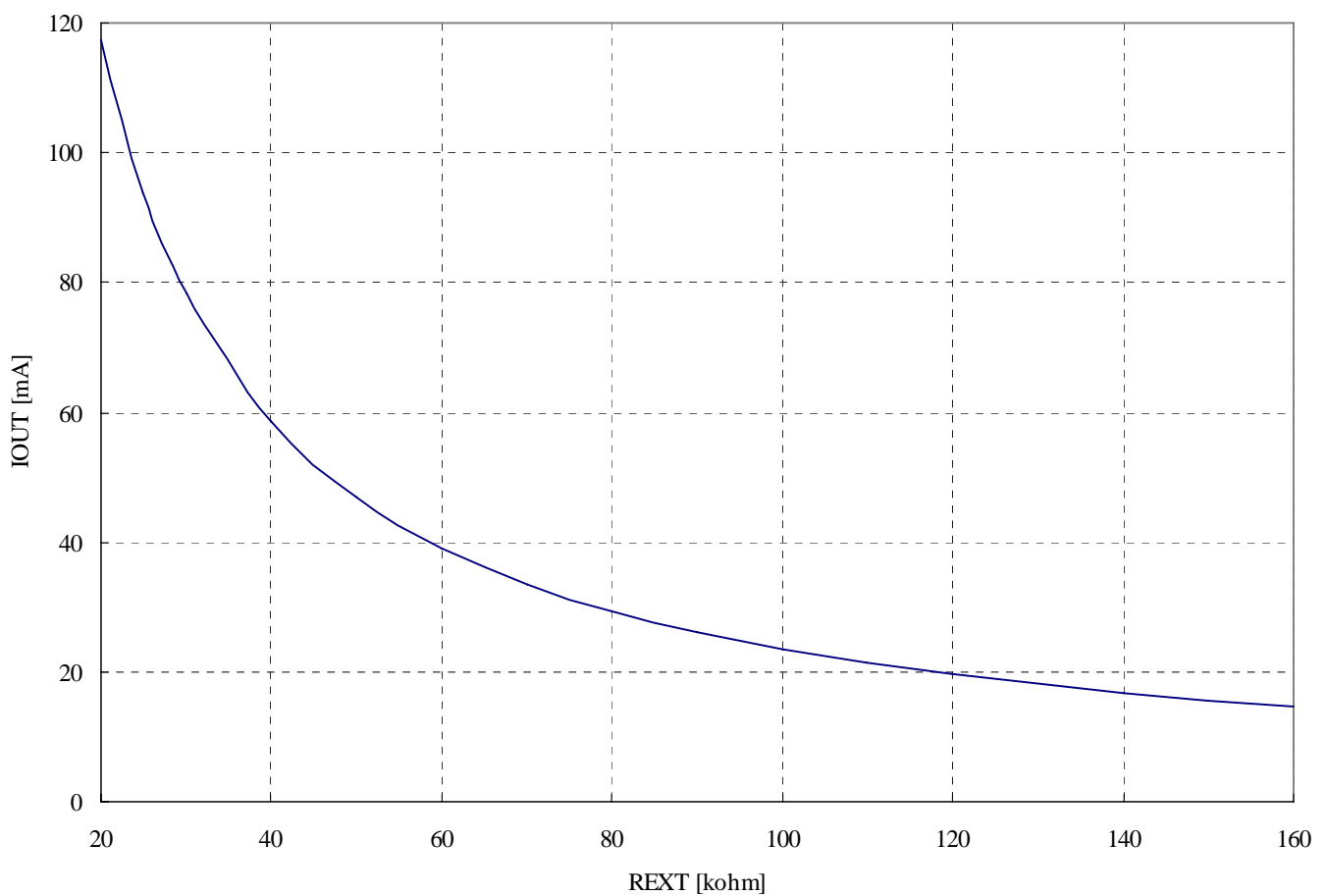
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## ADJUSTING OUTPUT CURRENT

The output current is determined by an external resistor. The relationship between  $I_{OUT}$  and  $R_{EXTA}$ ,  $R_{EXTB}$ ,  $R_{EXTC}$  are follows;

$$I_{OUT}[A] = 2350 / R_{EXT}$$

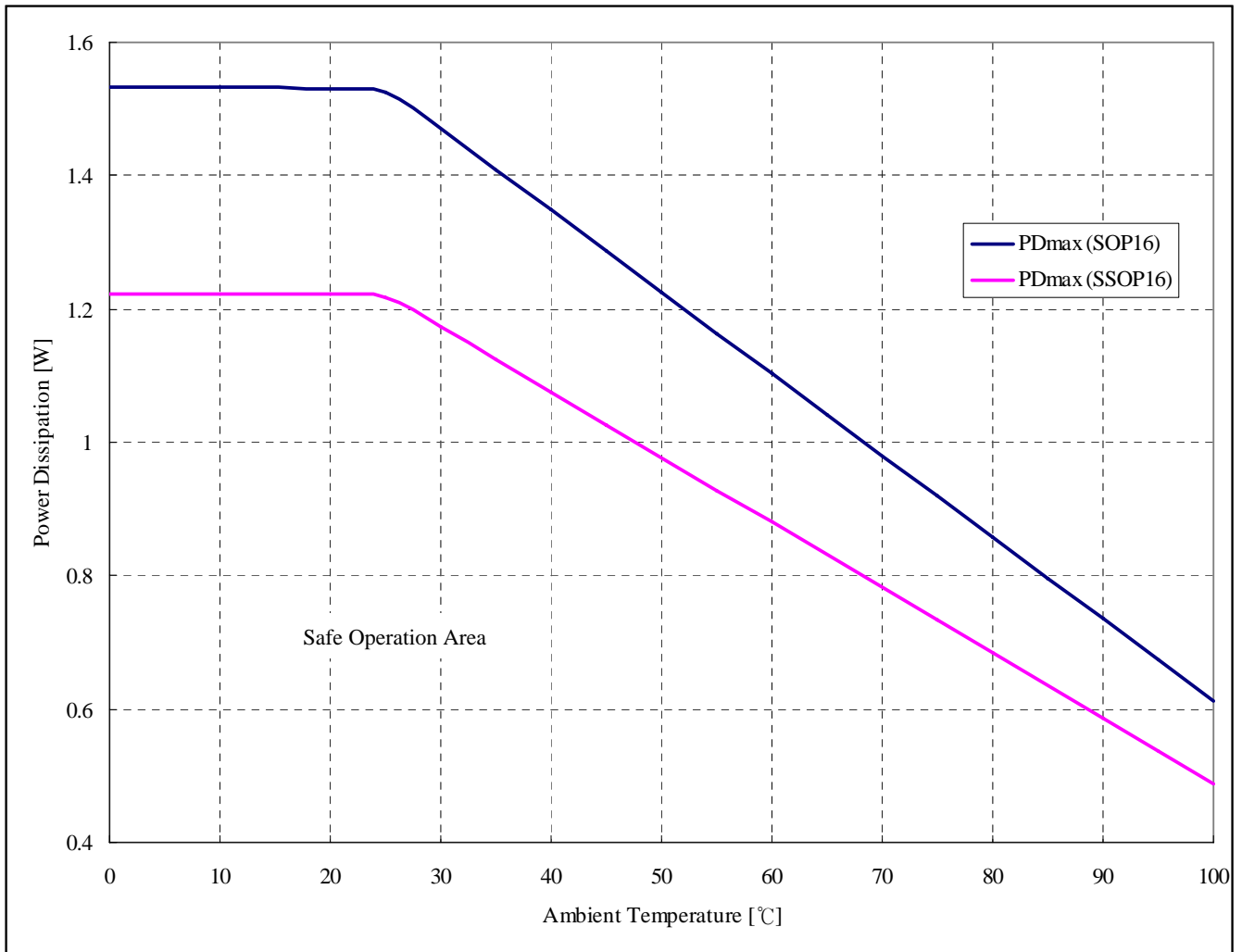
$$R_{EXT} = R_{EXTA}, R_{EXTB}, R_{EXTC}$$



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**PACKAGE POWER DISSIPATION( PD )**

The maximum power dissipation,  $PD_{MAX} = \frac{T_{JMAX} - T_A}{R_{\theta JA}}$ , decreases as the ambient temperature increases.



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## LOAD SUPPLY VOLTAGE( VLED )

The design of VLED should fulfill two targets

1. Less Power consumption and heat.
2. Sufficiently headroom for the LED and driver IC to operate in the constant current region.

The power dissipation in the driver is calculated by the equation.

$$PD = V_{DSA} \times I_{OUTA} + V_{DSB} \times I_{OUTB} + V_{DSC} \times I_{OUTC} + V_{CC} \times I_{CC}$$

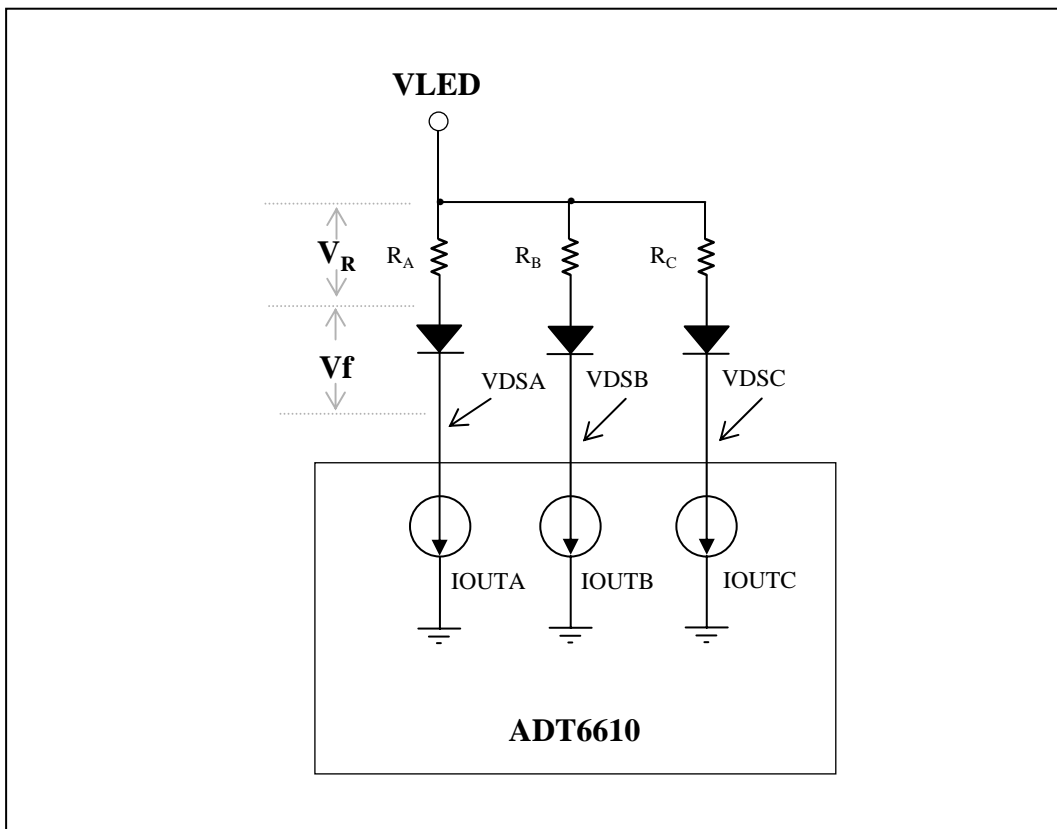
By the spec, the max  $V_{CC} = 18V$ , max  $I_{CC} = 8mA \Rightarrow 144mW$ .

If  $V_{DSA} = V_{DSB} = V_{DSC} = 1V$ ,  $I_{OUTA}=I_{OUTB}=I_{OUTC}=20mA$ .

PD is about 204mW.

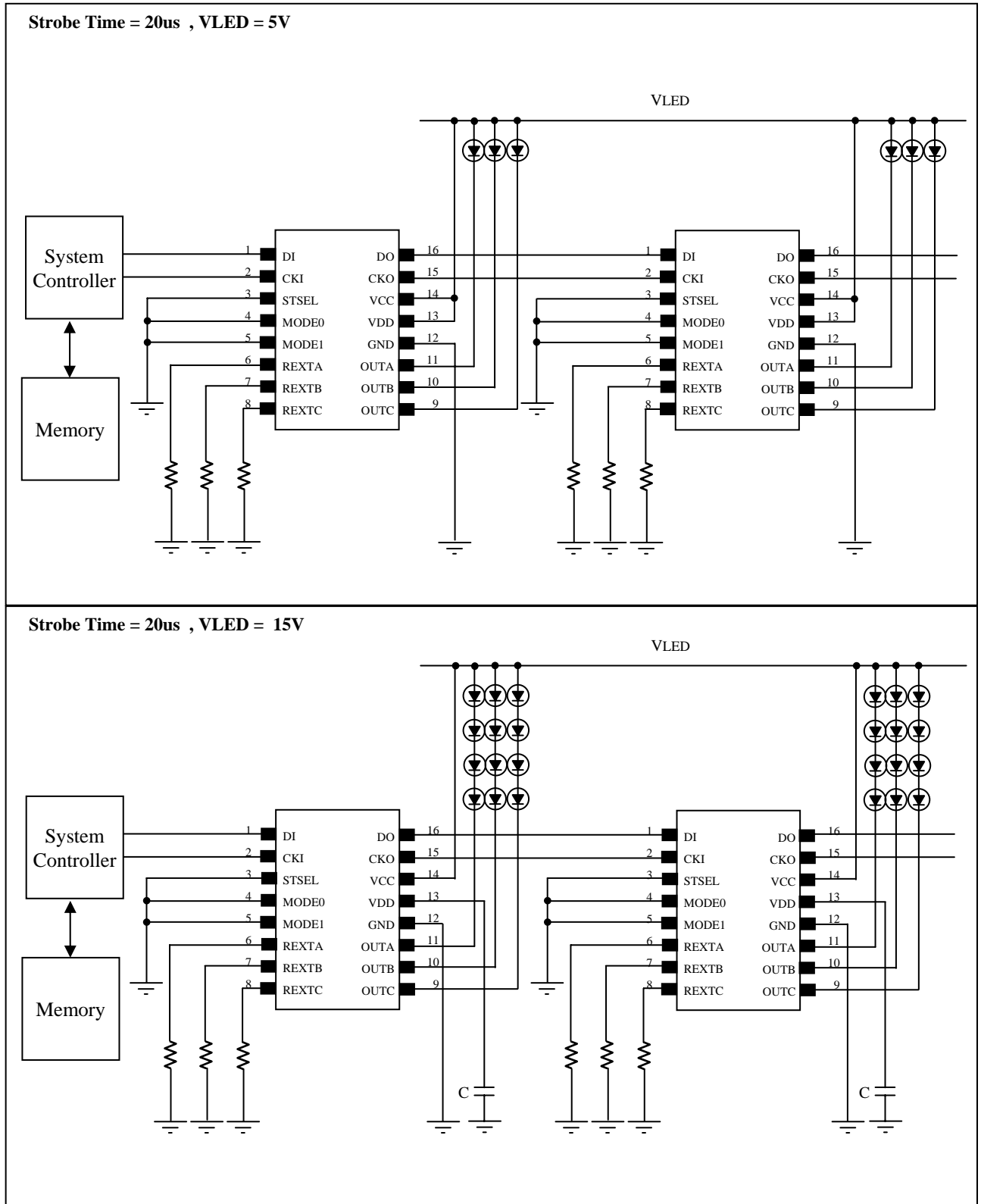
If  $V_{DSA}, V_{DSB}, V_{DSC}$  are over 1v then the power dissipation is more than 204mW.

This means, If  $V_{DSA}, V_{DSB}, V_{DSC}$  drops too much voltage on the driver, it is necessary to set external resistors(  $R_A, R_B, R_C$ ) to reduce the by  $V_R$ .



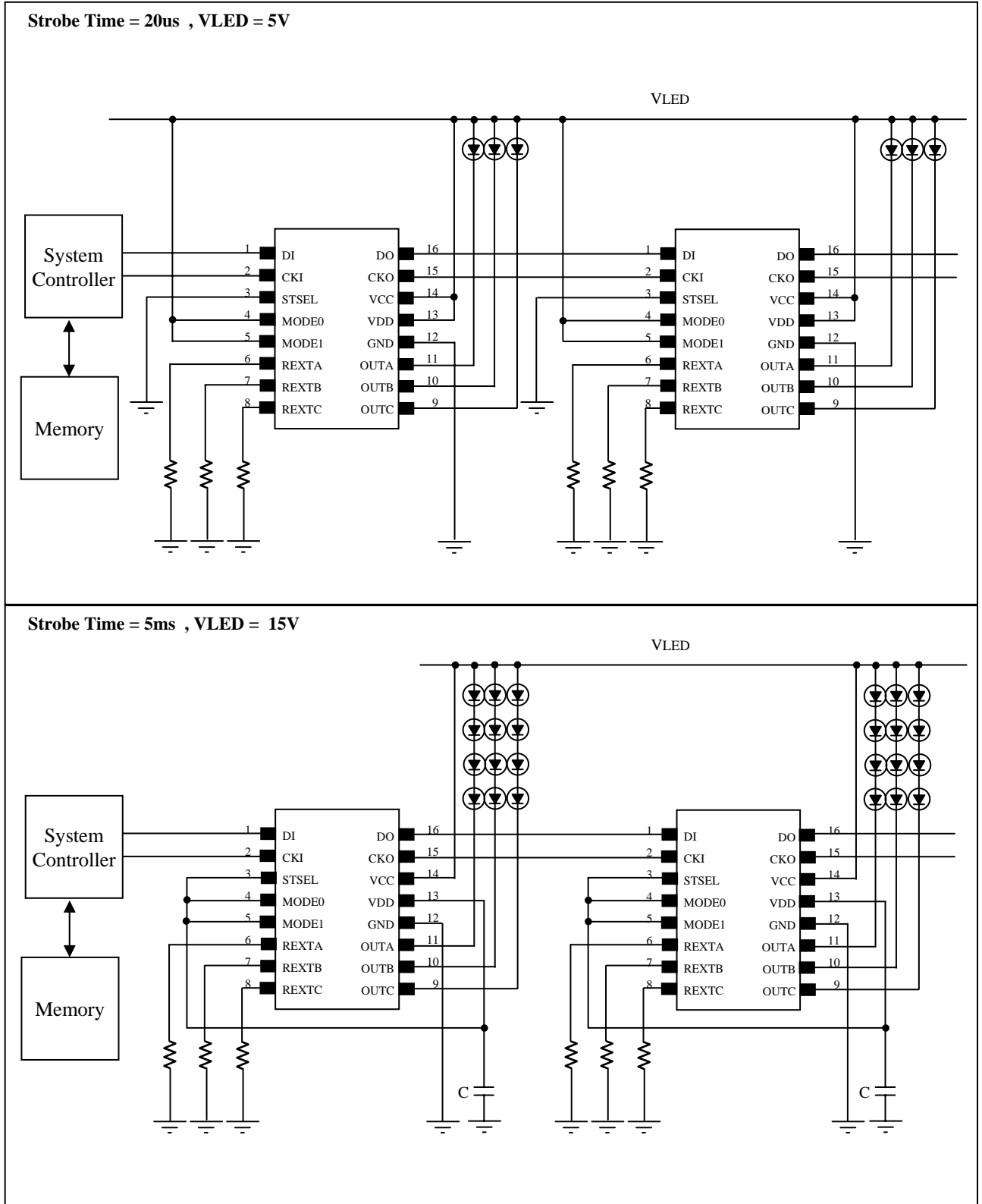
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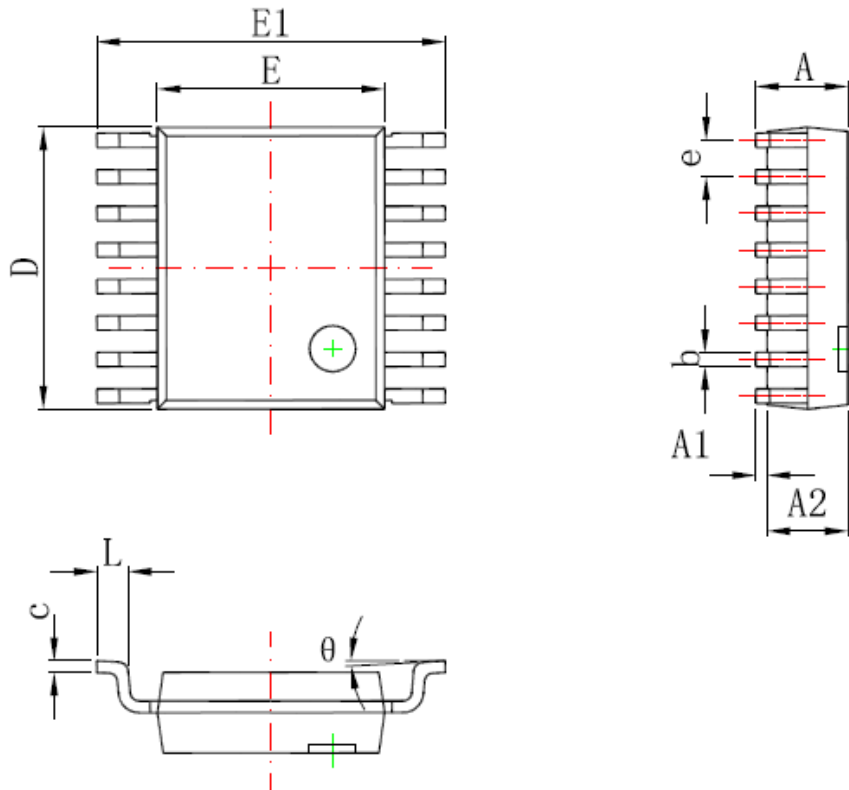
**TYPICAL APPLICATION**
**1) 8bit Luminance Data**


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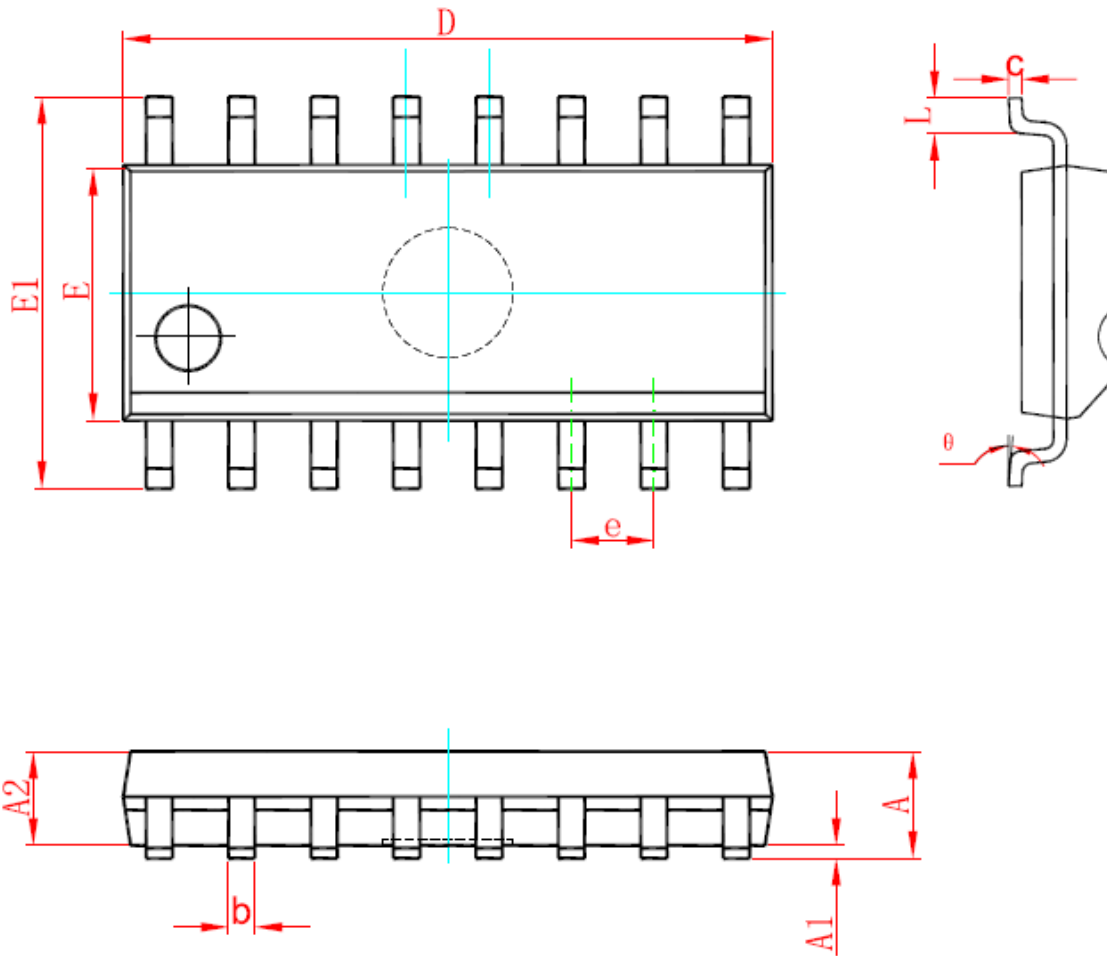
**TYPICAL APPLICATION ( Continued )**
**3) 16bit Luminance Data**


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**PACKAGE OUTLINE DIMENSION**
**SSOP16**


Symbol	Dimenstions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.200	0.300	0.008	0.012
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	0.635 (BSC)		0.025 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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**SOP16**


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	9.800	10.200	0.386	0.402
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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