# 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
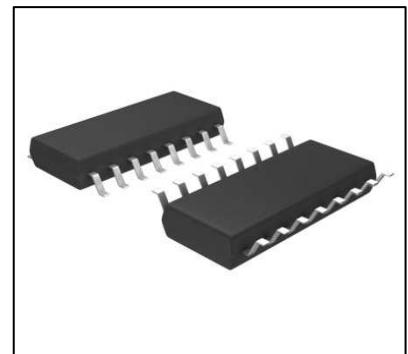
16SOP

16SSOP

APPLICATION

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

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

PIN CONFIGURATION

```
         ┌─────────────┐
   DI ■──┤ 1        16 ├──■ DO
  CKI ■──┤ 2        15 ├──■ CKO
STSEL ■──┤ 3        14 ├──■ VCC
MODE0 ■──┤ 4        13 ├──■ VDD
MODE1 ■──┤ 5        12 ├──■ GND
REXTA ■──┤ 6        11 ├──■ OUTA
REXTB ■──┤ 7        10 ├──■ OUTB
REXTC ■──┤ 8         9 ├──■ OUTC
         └─────────────┘
```
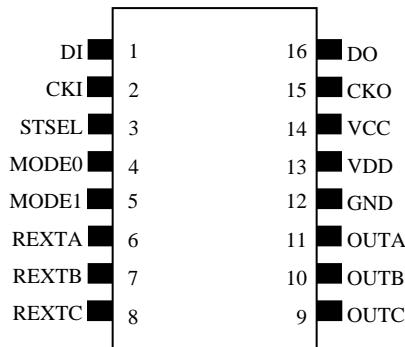
PIN DESCRIPTION

| 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".		

* This specifications are subject to be changed without notice

BLOCK DIAGRAM
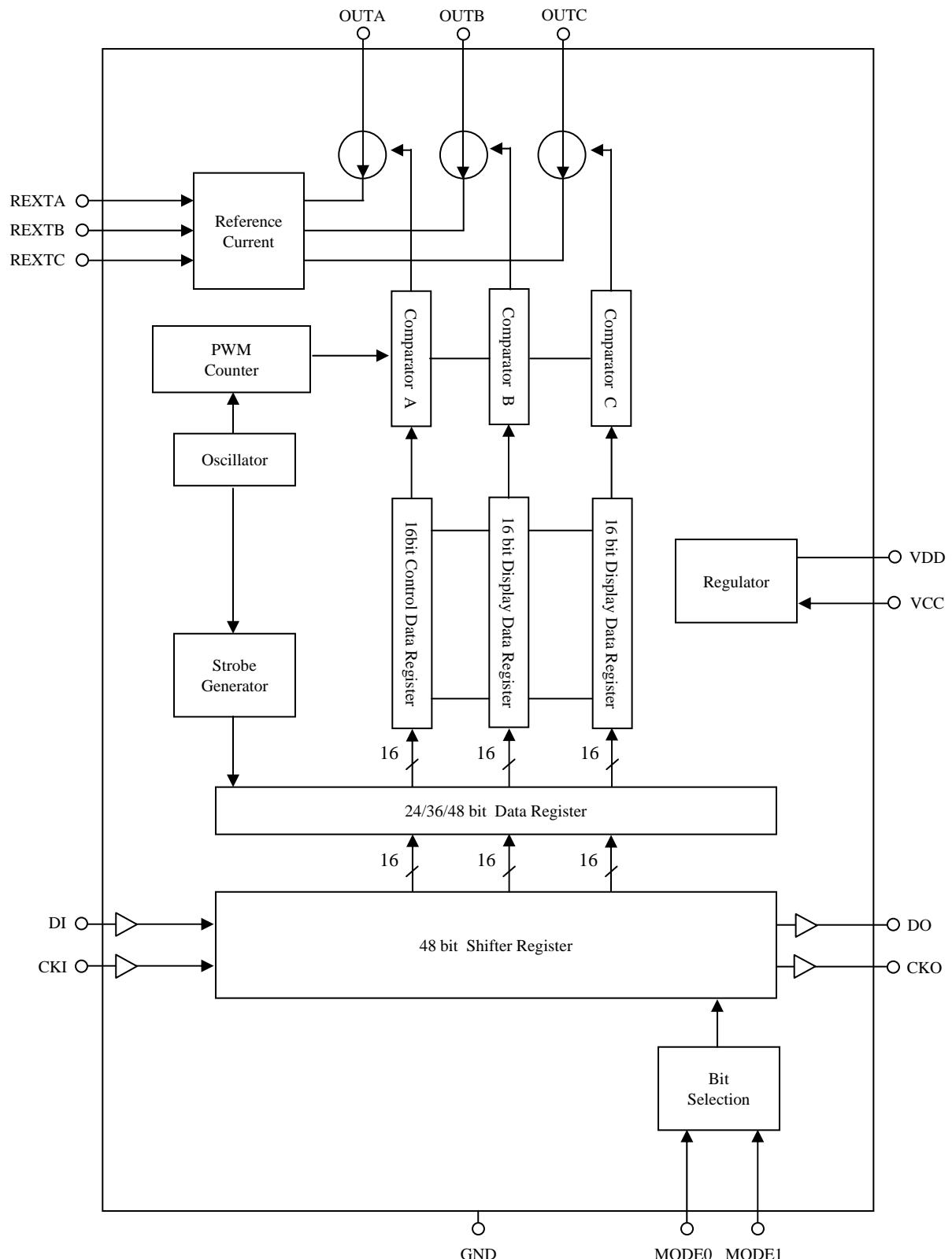

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# EQUIVALENT CIRCUIT OF INPUTS AND OUTPUTS

CKI, DI terminal
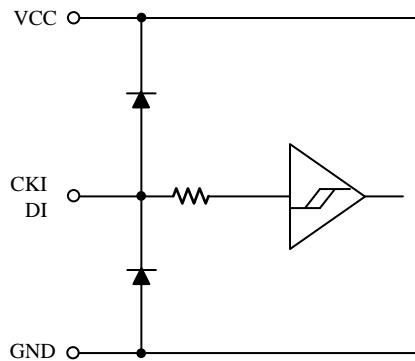
DO, CKO,OUTA,OUTB,OUTC terminal
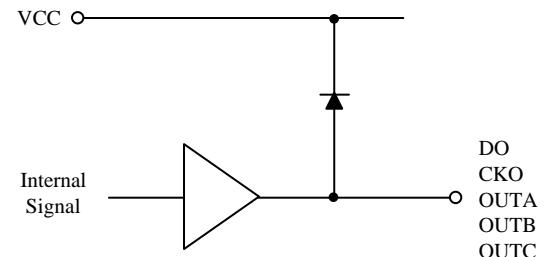
REXTA, REXTB, REXTC terminal
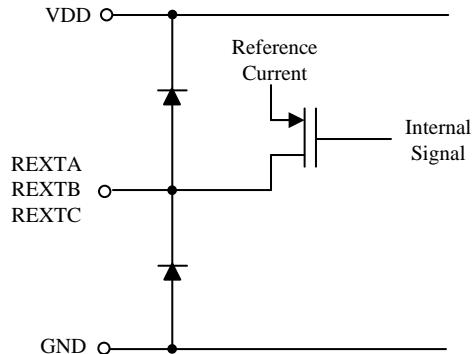
MODE0, MODE1, STSEL terminal
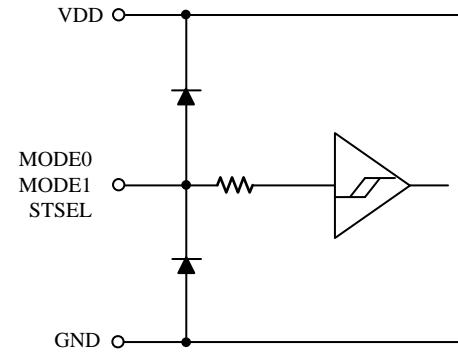
* This specifications are subject to be changed without notice

ABSOLUTE MAXIMUM RATINGS (Ta = 25ºC, 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_{MAX} (SOP)	1.53	W
	PD_{MAX} (SSOP)	1.22	W
Thermal resistance	Θ_{JA} (SOP)	81.6	℃/W
	Θ_{JA} (SSOP)	102.3	℃/W
Operating Temperature	Topr	-40 ~ 85	℃
Storage Temperature	Tstg	-55 ~ 150	℃
Junction Temperature	T_{JMAX}	150	℃

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 = 25ºC)

| PARAMETER		TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
VCC Supply Voltage			V_{CC}	10	15	18	V
LED Driver Output Voltage			V_{OUT}			18	V
Voltage Regulator Output Voltage		V_{CC}=10~18V	V_{DD}	4.5	5.0	5.5	V
Input Leakage Current			Iz	-1.0		1.0	uA
Output Leakage Current		VDS=18V, All turn off	Ioz			1.0	uA
Input Voltage	"H" Level		V_{IH}	0.8VDD	-	VDD	V
	"L" Level		V_{IL}	GND	-	0.2VDD	V
Output Voltage	DO, CKO	IOL=5mA	V_{OL}	-	-	0.2VDD	V
		IOH=-5mA	V_{OH}	0.8VDD	-	-	V
LED Driver Output Current		VDS=1.5V	I_{OUT}		60	100	mA
Pin to Pin Deviation		IOUT=60mA	I_{PP}		±1.5	±3	%
Chip to Chip Deviation		IOUT=60mA	I_{CC}		±3	±6	%
Supply Voltage Regulation		IOUT=60mA, V_{CC}=10~18V	%/V_{CC}		±0.2	±0.5	%
Supply Current		IOUT=60mA, V_{CC}=18V	ICC		4	8	mA

This specifications are subject to be changed without notice

## TEST CIRCUIT for DC CHARACTERISTICS
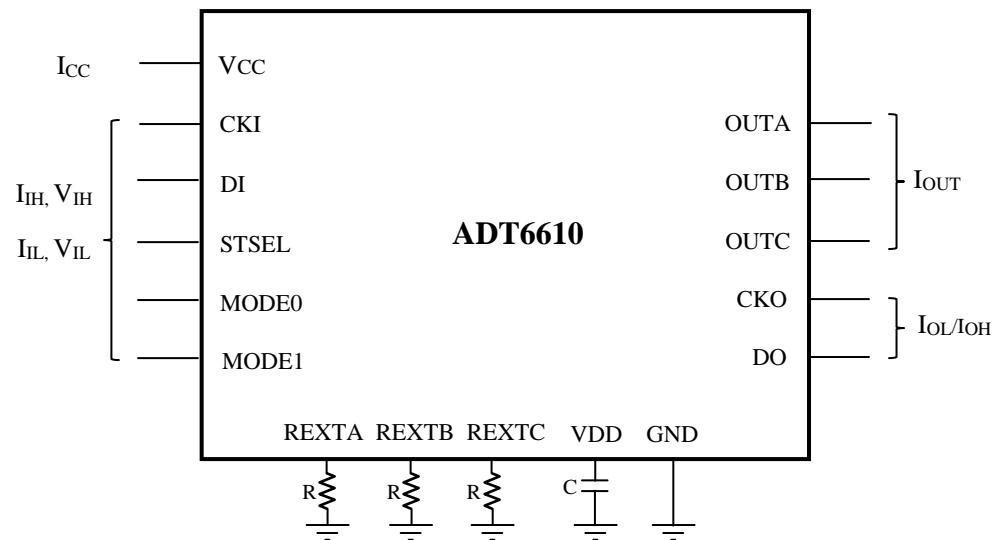
* This specifications are subject to be changed without notice

ELECTRICAL CHARACTERISTICS (Continued)

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

PARAMETER		TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time	CKI-DO		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		VCC = 15V	t_{wsh}	50	-	-	ns
		VDD = 5.0V	t_{wsl}	50	-	-	ns
Clock Delay		VDD = 5.0V	t_{CKD}	-	8	15	ns
Clock Width	CKO	VIH = VDD - 0.5	t_W	10	30	-	ns
Clock Cycle		VIL = 0.5V	t_{CY}	100	-	-	ns
Maximum Clock Rise Time		R = 39kΩ	t_r	-	-	10	ns
Maximum Clock Fall Time		(IOUT = 60mA)	t_f	-	-	10	ns
CKO, DO Output Rise Time		CL = 10pF	t_{or}	-	-	10	ns
CKO, DO Output Fall Time		RL = 200Ω	t_{of}	-	-	10	ns
CKI Waiting Time for No Strobe STSEL=Low		VDS = 1.5V	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
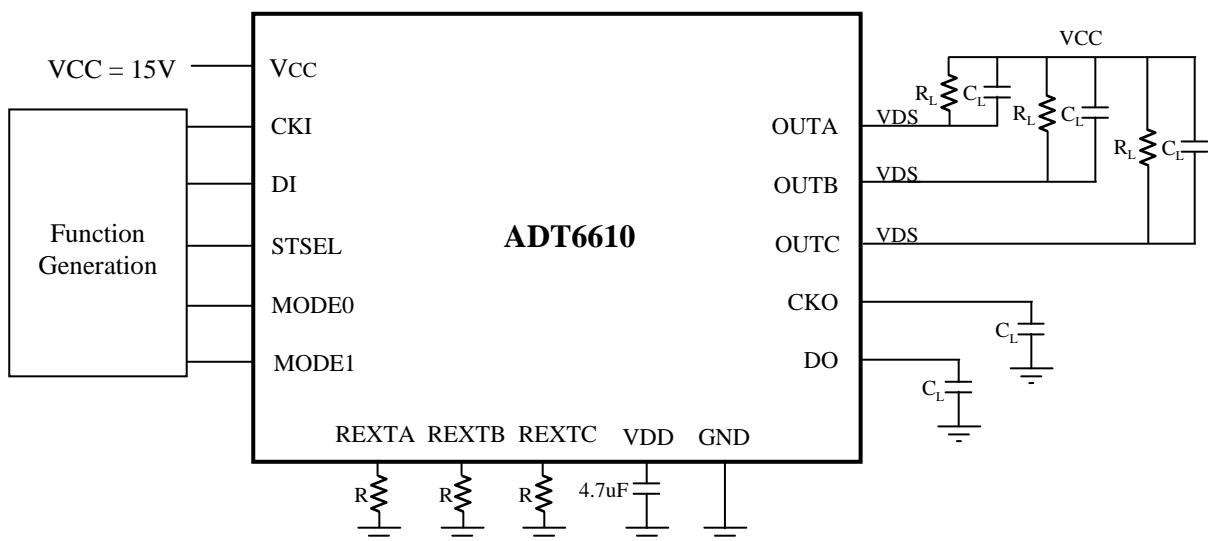
This specifications are subject to be changed without notice

TIMING WAVEFORM

CKI, DI, DO (Data Transmit)
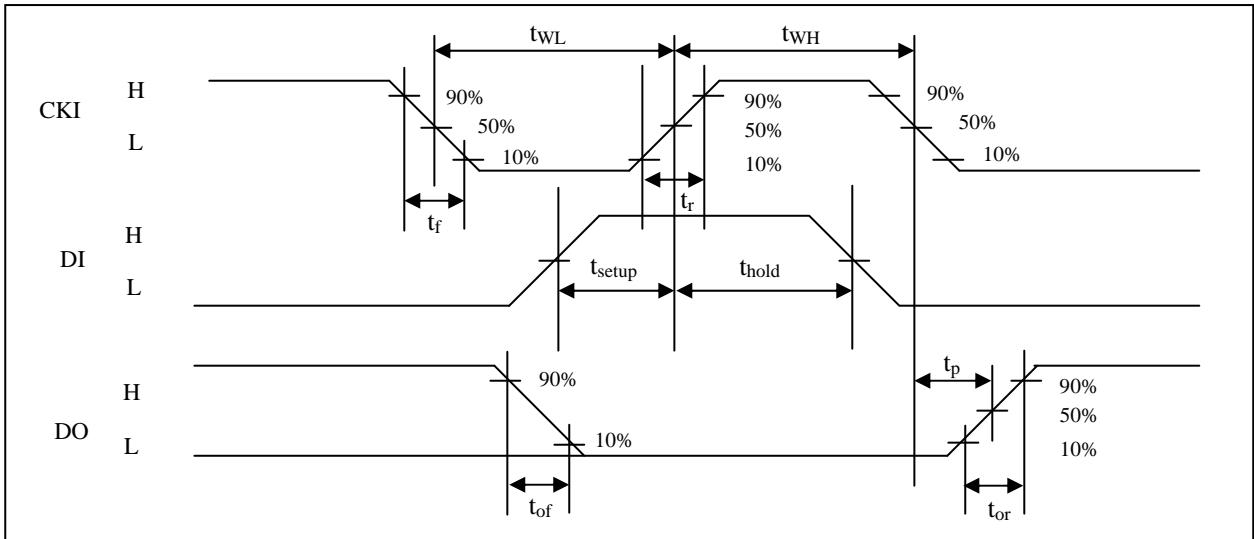

CKI, CKO , Internal Strobe
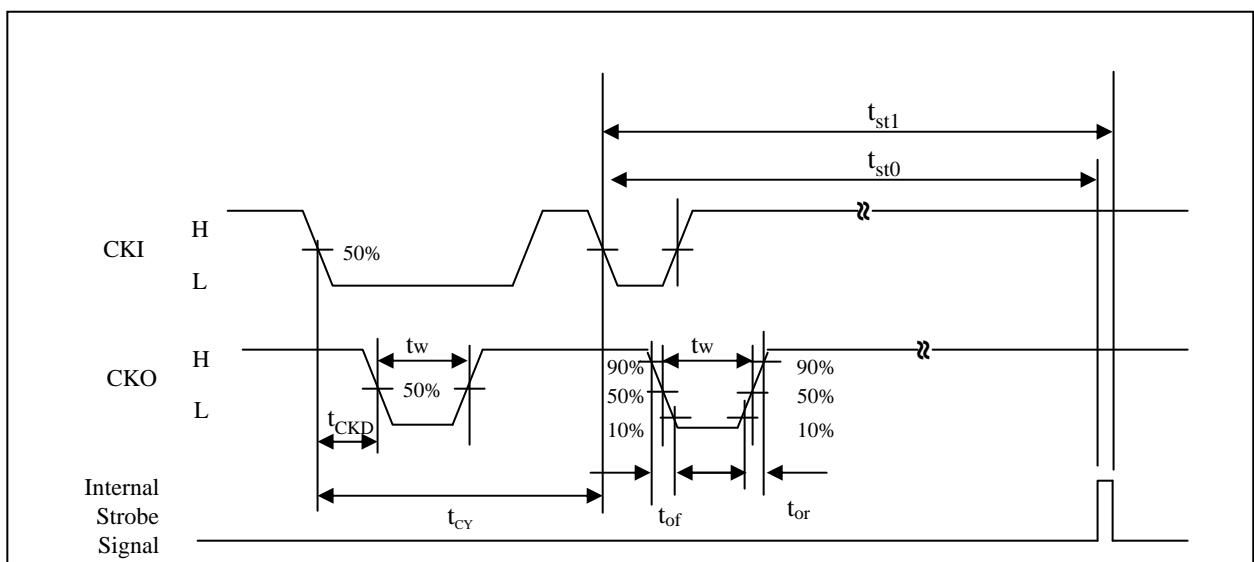
* This specifications are subject to be changed without notice

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).

CKI								
DI								
Value	0	0	1	1	1	0	1	1
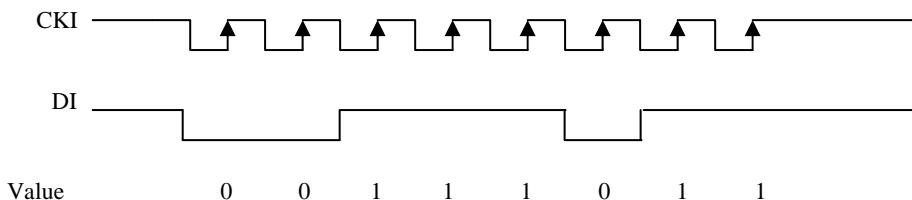
Embedded Voltage Regulator

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

* This specifications are subject to be changed without notice

**Strobe Waiting Time**
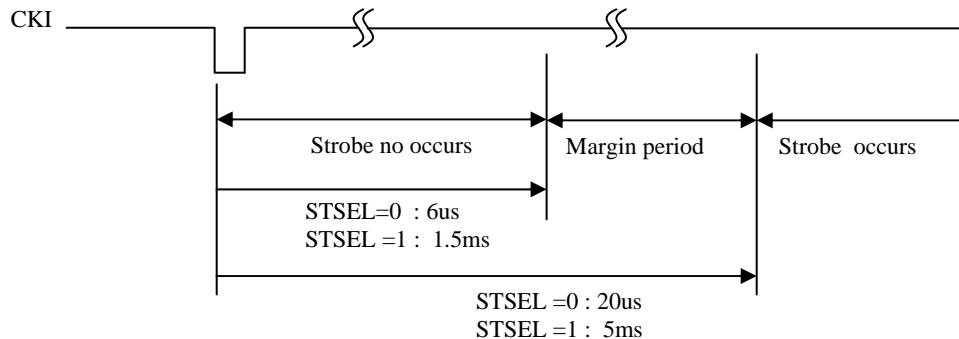
Interface Timing Diagram for 8bit Gray Scale Mode (MODE0=0 , MODE1 = 0)
   A(7:0) = C3H, B(7:0) = F8H, C(7:0) = 70H
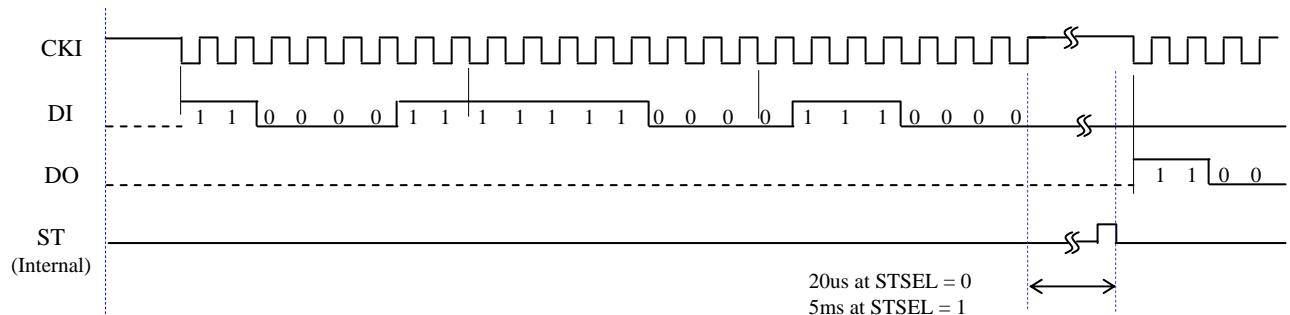
Interface Timing Diagram for 12bit Gray Scale Mode (MODE0=1 , MODE1 = 0)
     A(7:0) = F03H, B(7:0) = FF8H, C(7:0) = 0F8H
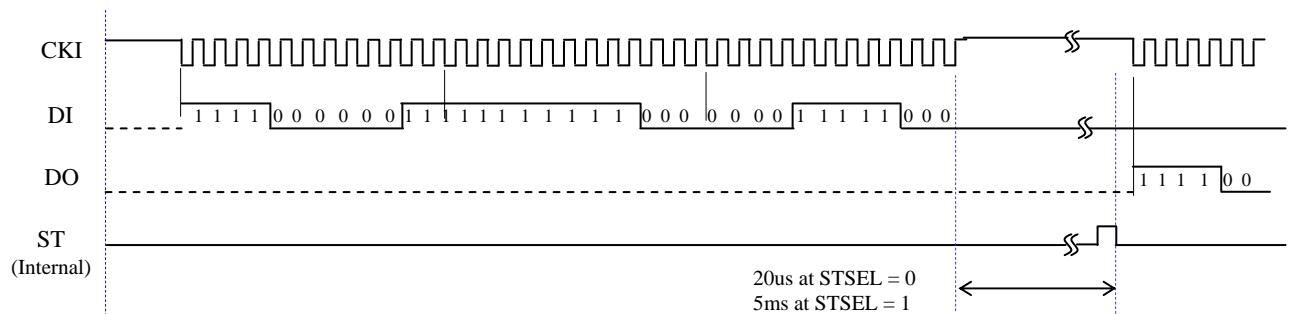
**Interface Timing Diagram for 16bit Gray Scale Mode (MODE0=1 , MODE1 = 1)**
     A(7:0) = F80FH, B(7:0) = FFC0H, C(7:0) = 1F80H
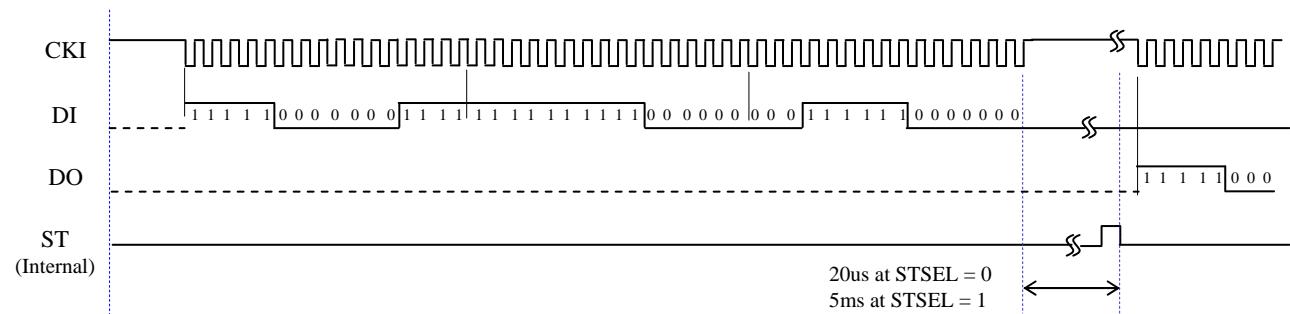
* This specifications are subject to be changed without notice

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 $\pm 6\%$.
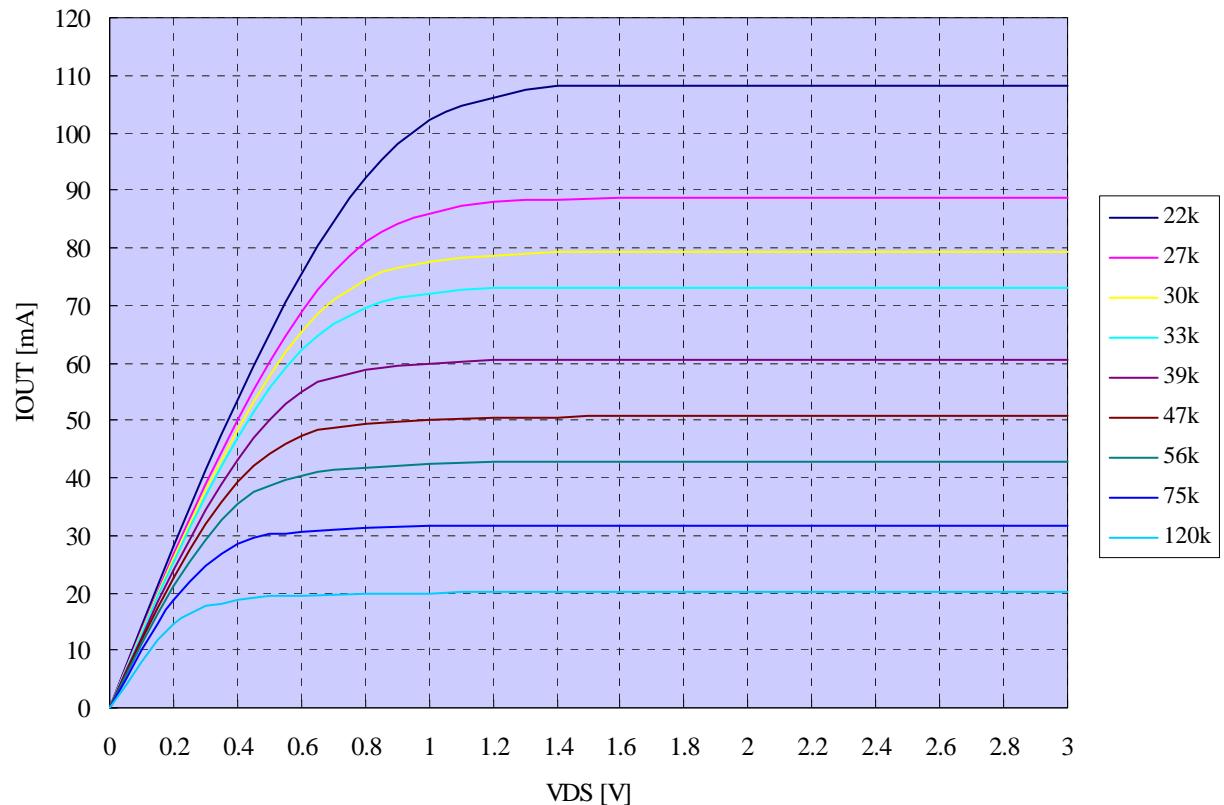
* This specifications are subject to be changed without notice

ADJUSTING OUTPUT CURRENT

The output current is determined by an external resistor. The relationship between I_{OUT} and REXTA,REXTB,

REXTC are follows;

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

R_{EXT} = REXTA, REXTB, REXTC
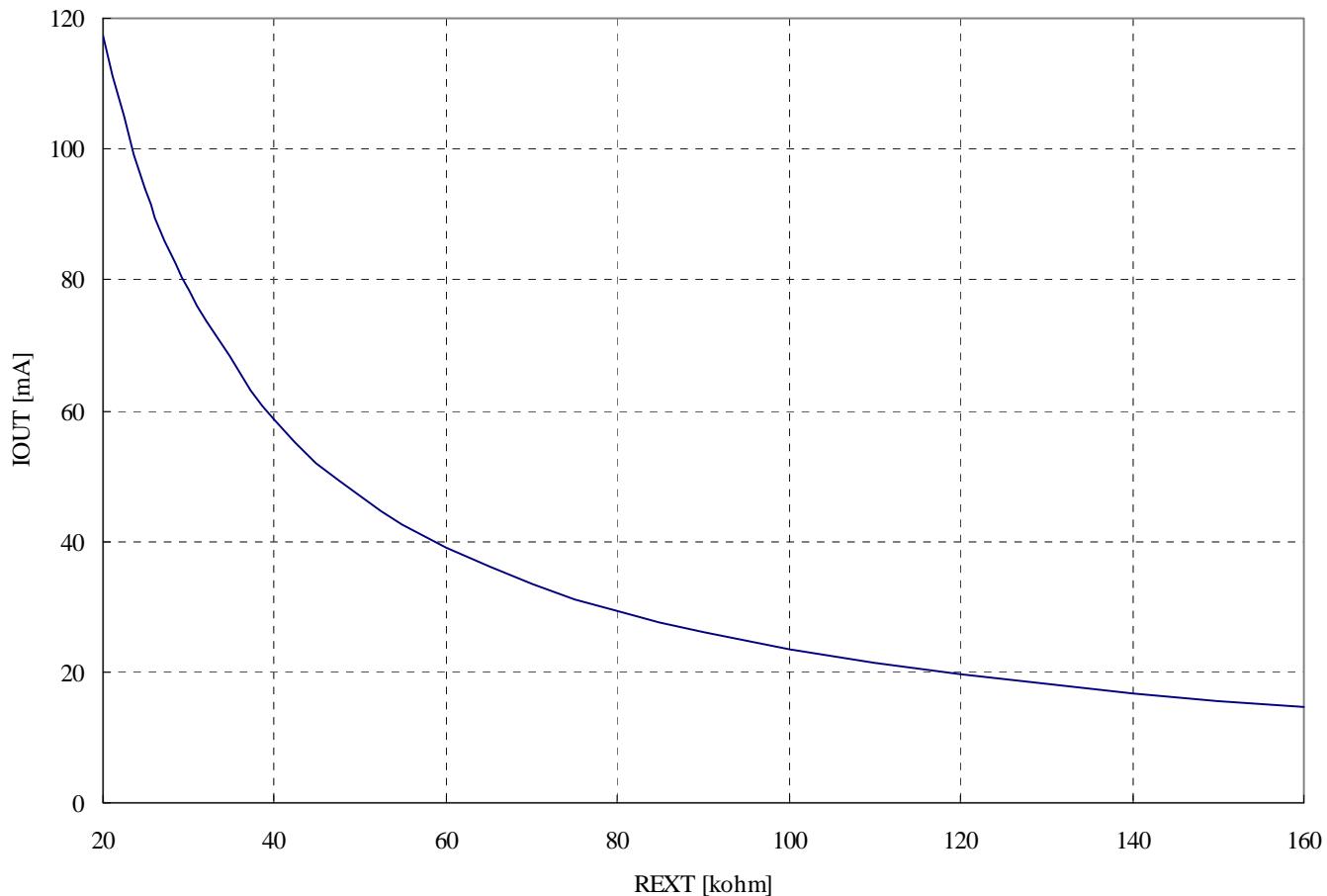
This specifications are subject to be changed without notice

PACKAGE POWER DISSIPATION(PD)

The maximum power dissipation, $PD_{MAX} = \dfrac{T_{JMAX} - T_A}{R_{\theta JA}}$, decreases as the ambient temperature increases.
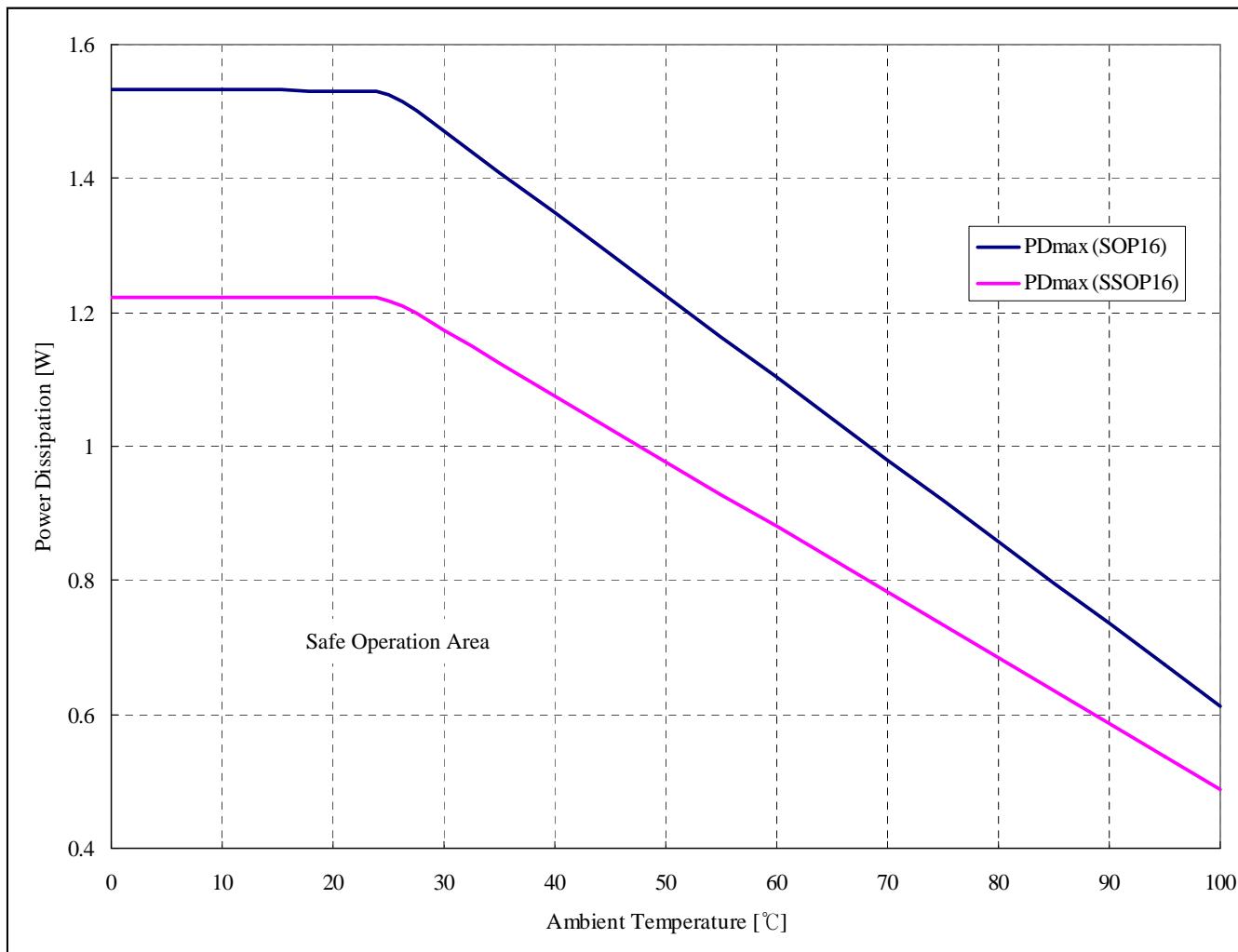
This specifications are subject to be changed without notice

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 = VDSA x IOUTA + VDSB x IOUTB + VDSC x IOUTC + VCC x ICC

By the spec, the max VCC = 18V, max ICC = 8mA => 144mW.
If VDSA = VDSB = VDSC = 1V, IOUTA=IOUTB=IOUTC=20mA.
PD is about 204mW.
If VDSA,VDSB,VDSC are over 1v then the power dissipation is more than 204mW.
This means, If VDSA,VDSB,VDSC drops too much voltage on the driver, it is necessary
to set external resistors(RA,RB,RC) to reduce the by V_R.
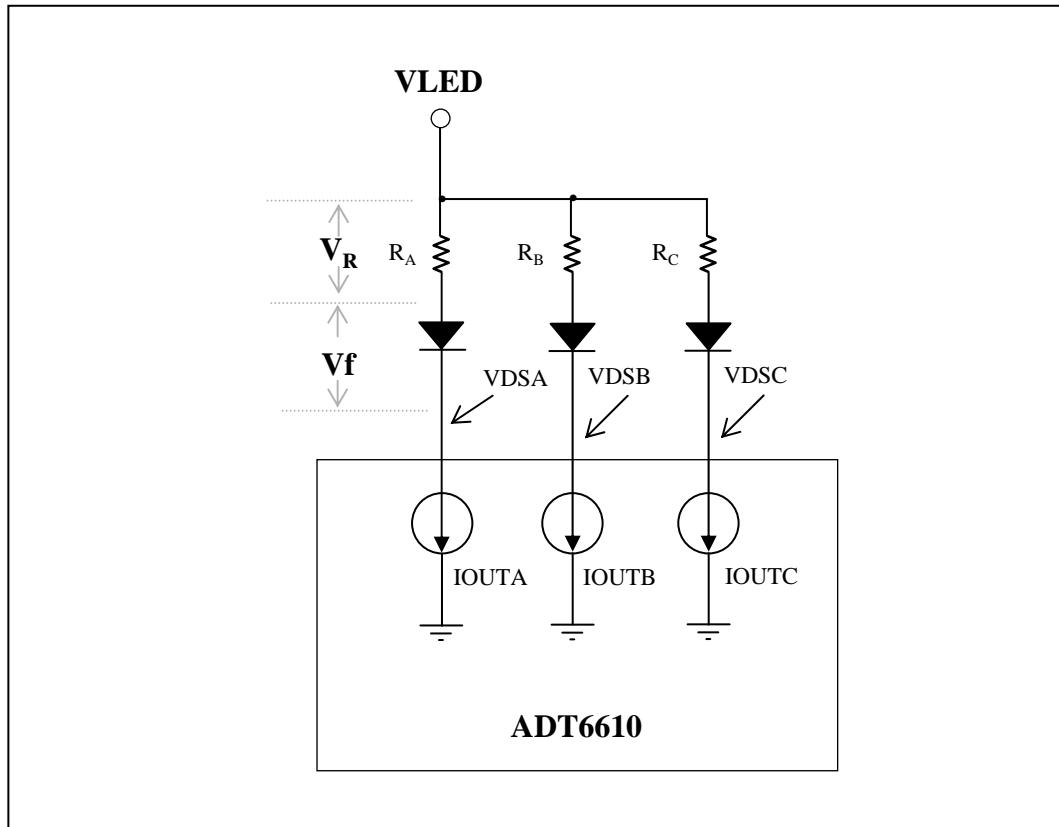
TYPICAL APPLICATION

1) 8bit Luminance Data

Strobe Time = 20us , VLED = 5V
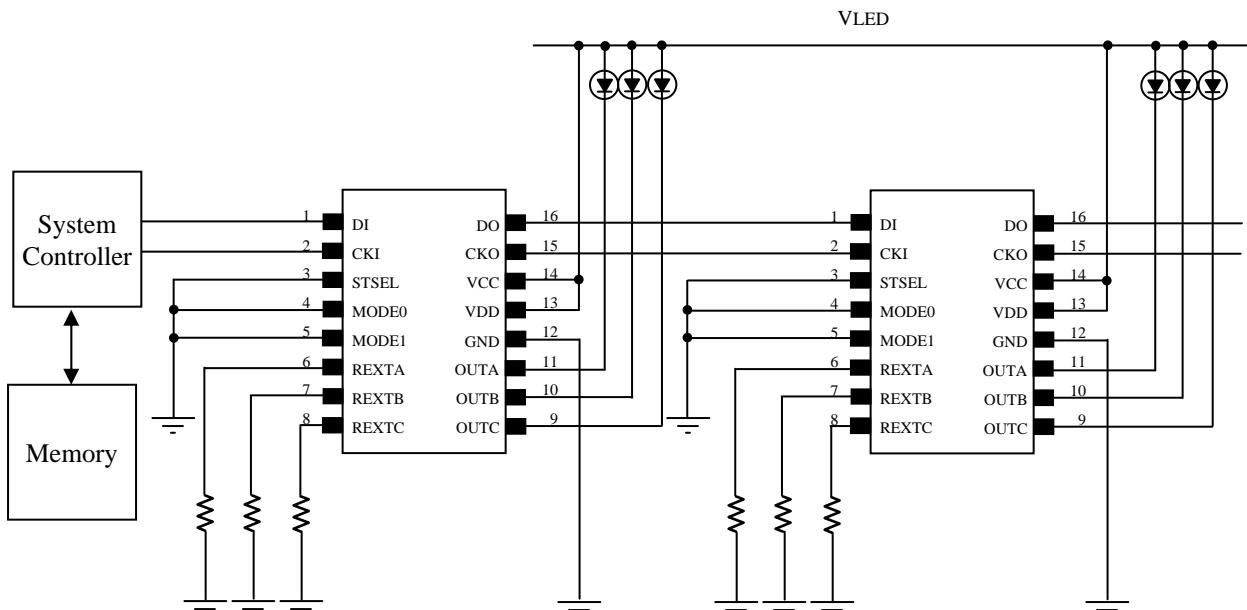
Strobe Time = 20us , VLED = 15V
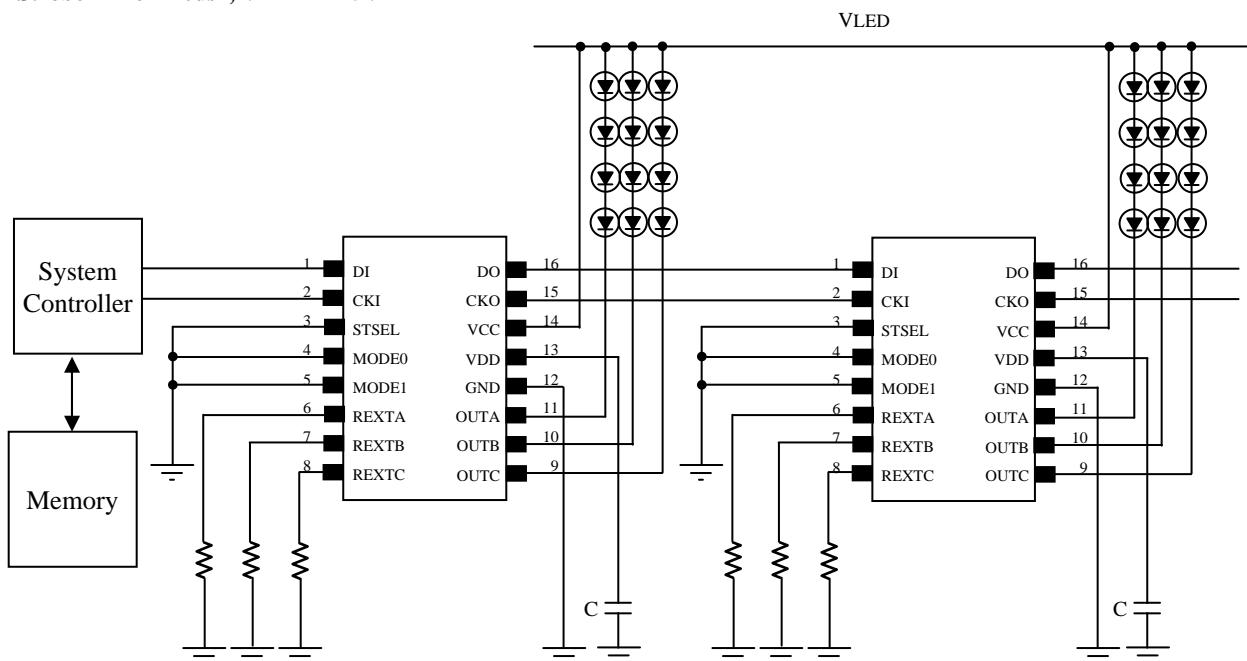
* This specifications are subject to be changed without notice

TYPICAL APPLICATION (Continued)

2) 12bit Luminance Data

Strobe Time = 5ms , VLED = 5V
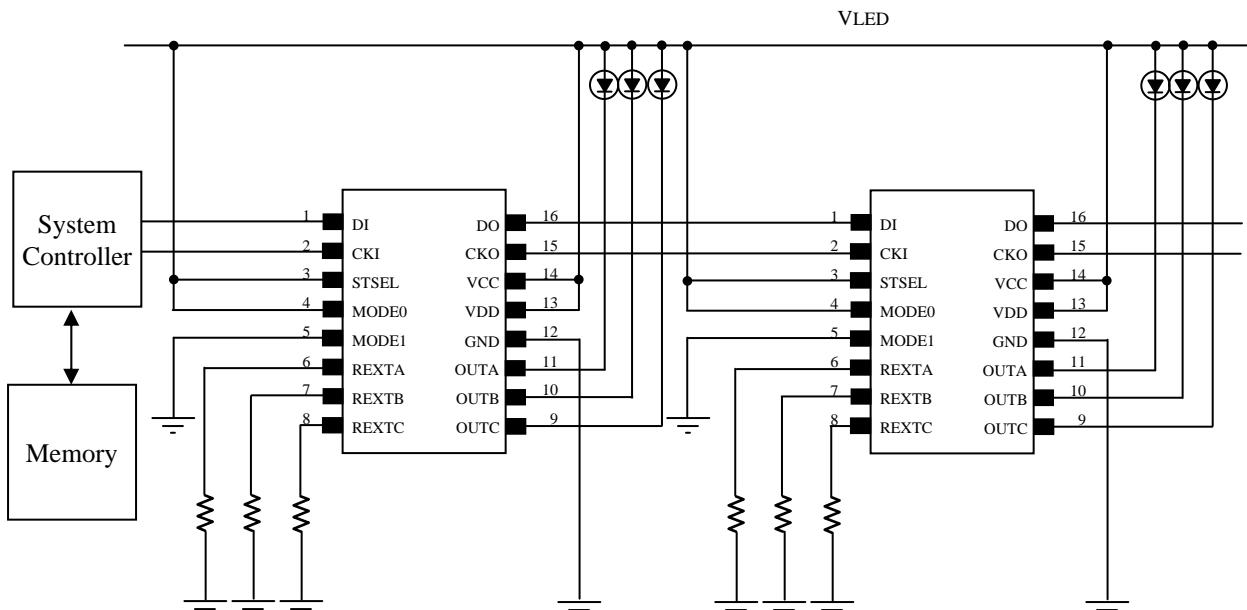
Strobe Time = 5ms , VLED = 15V
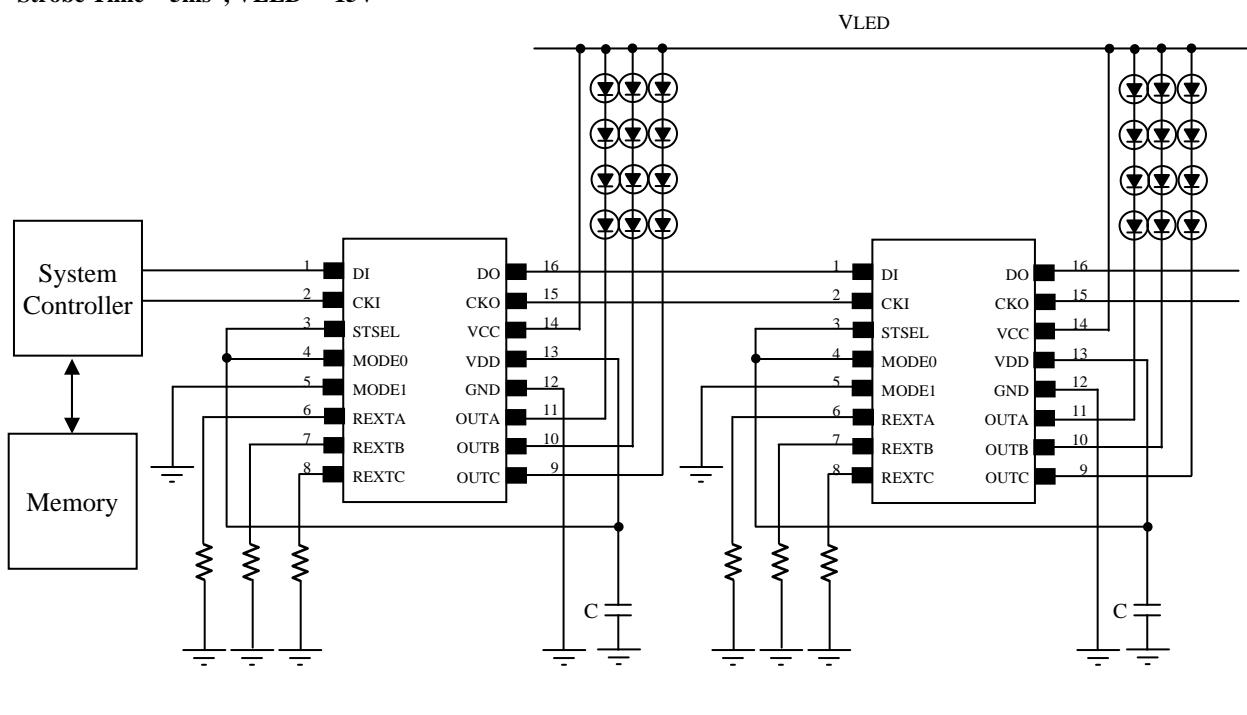
* This specifications are subject to be changed without notice

TYPICAL APPLICATION (Continued)

3) 16bit Luminance Data
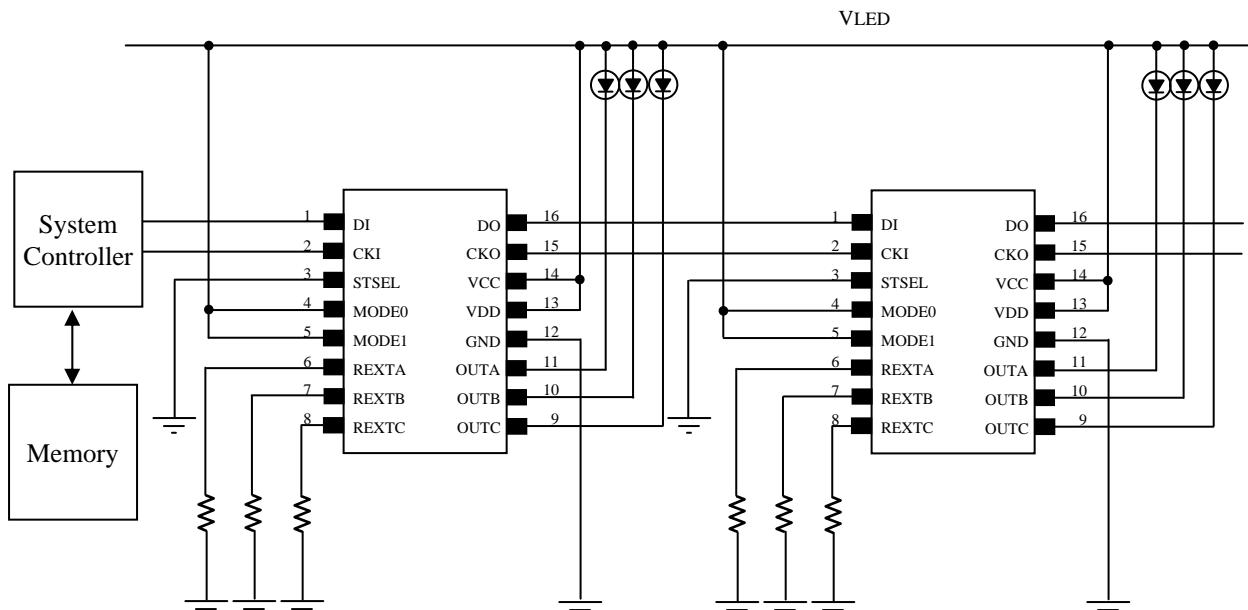
Strobe Time = 20us , VLED = 5V

Strobe Time = 5ms , VLED = 15V
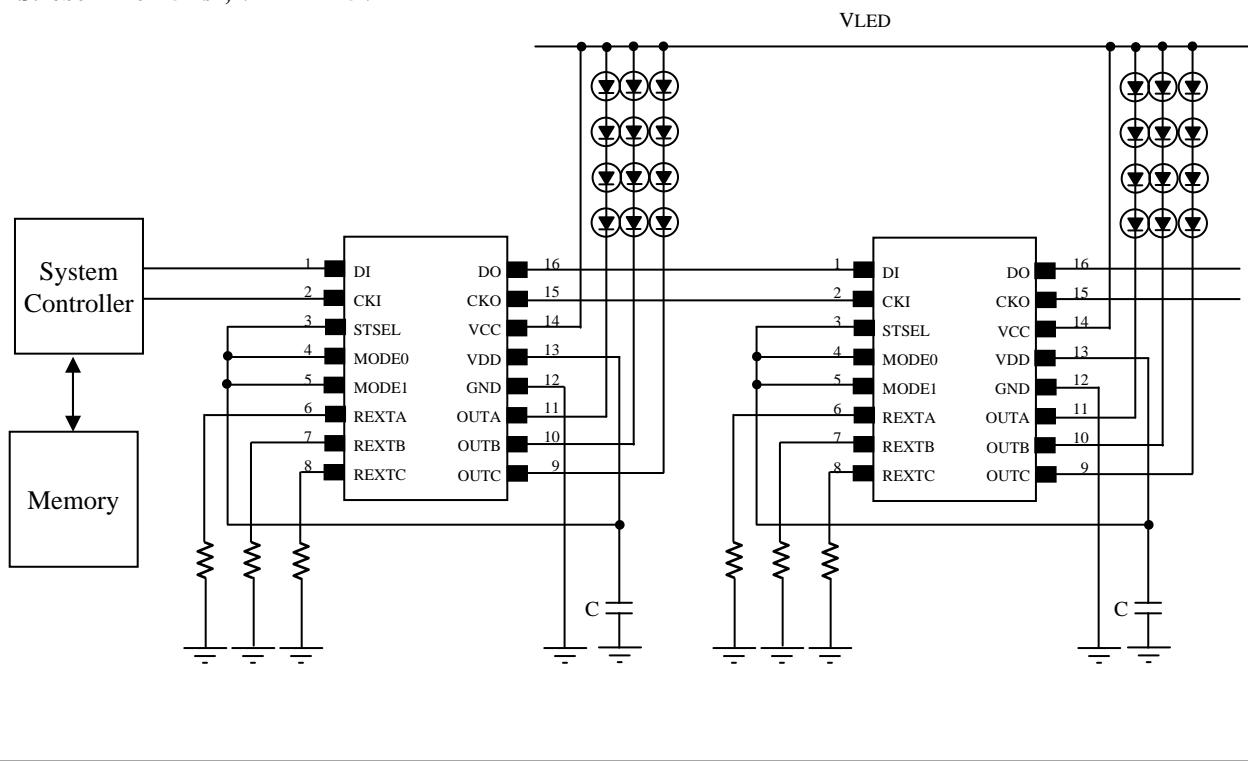
* This specifications are subject to be changed without notice

PACKAGE OUTLINE DIMENSION

SSOP16
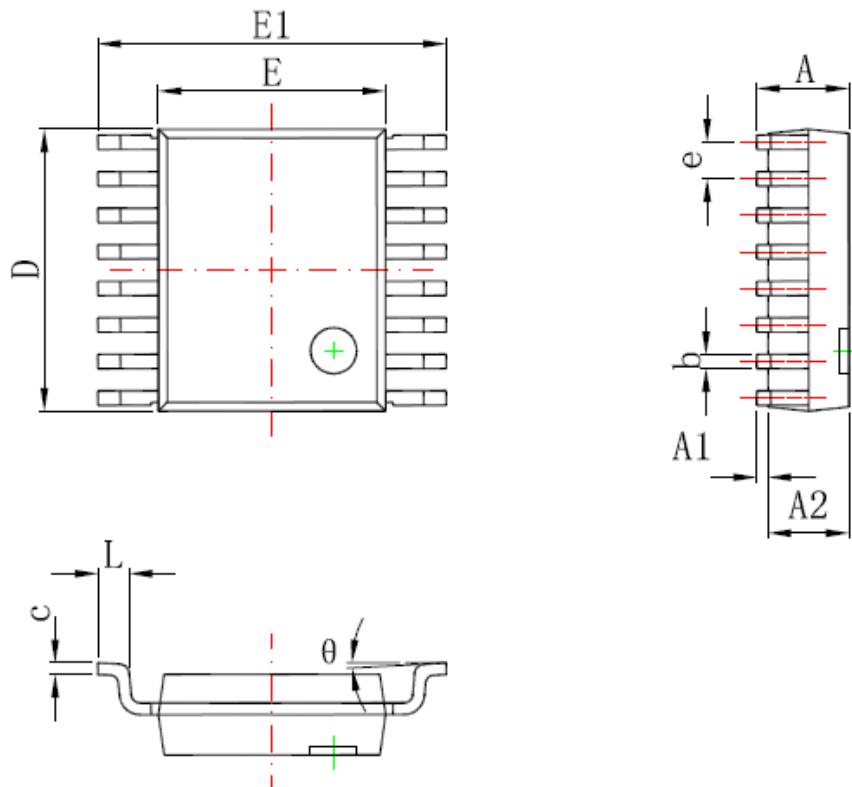
Symbol	Dimenstions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.200	0.300	0.008	0.012
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	0.635 (BSC)		0.025 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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SOP16
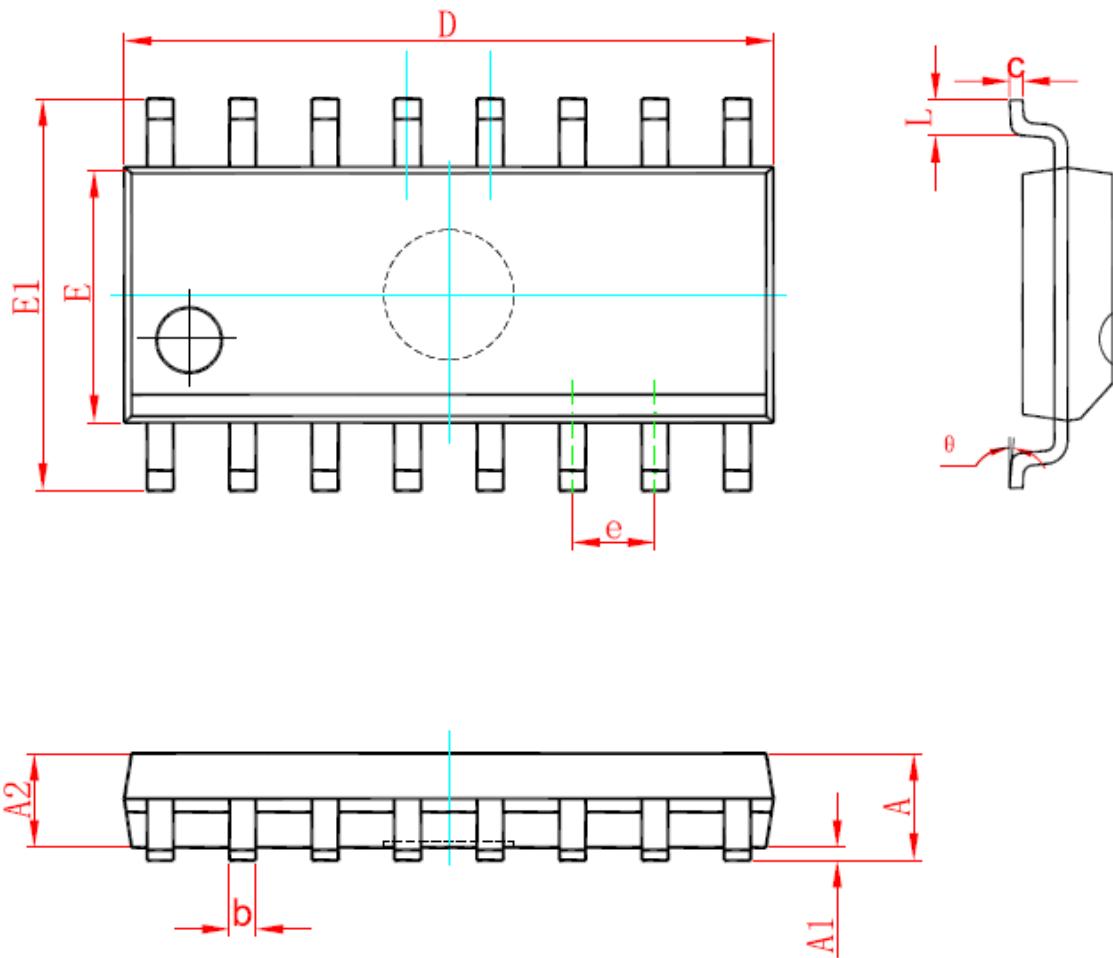
Symbol	Dimenstions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	9.800	10.200	0.386	0.402
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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