



## 16-bit Serial-In/Parallel-Out Constant-Current LED Driver

### Product Description

The SCT2210 serial-interfaced LED driver sinks 16 LED clusters with constant current to keep the uniform intensity of LED displays. In applications, an external resistor is used to set the full-scale constant output current from 5mA up to 90mA. The SCT2210 guarantees each output can endure maximum 17V DC voltage stress. The built-in shift registers and data latches making the SCT2210 effective solution in driving LED display. The output enable function gates all 16 outputs on and off, and is fast enough to be used as PWM input for LED intensity control. Since the serial data input rate can be reached up to 25MHz, the SCT2210 will satisfy system which needs high volume data transmission to control the LED display.

### Features

- ◆ 16 constant-current outputs rate at 17V
- ◆ Constant current range: 5 – 90mA
- ◆ Excellent current regulation to load, supply voltage and temperature
- ◆  $\pm 3\%$  Current matching between outputs
- ◆  $\pm 6\%$  Current matching between ICs
- ◆ Fast output current control: Minimum PWM pulse width = 50ns
- ◆ All output current are programmed together using a single external resistor
- ◆ CMOS Schmitt triggered inputs
- ◆ High serial data transfer rate: 25MHz
- ◆ Operating supply voltage range of 4.5V to 5.5V
- ◆ Built-in power on reset and thermal protection function
- ◆ Package: SOP24, SSOP24 and SDIP24
- ◆ Applications: LED Displays, Variable Message Signs, LED Traffic Signs

### Pin Configurations

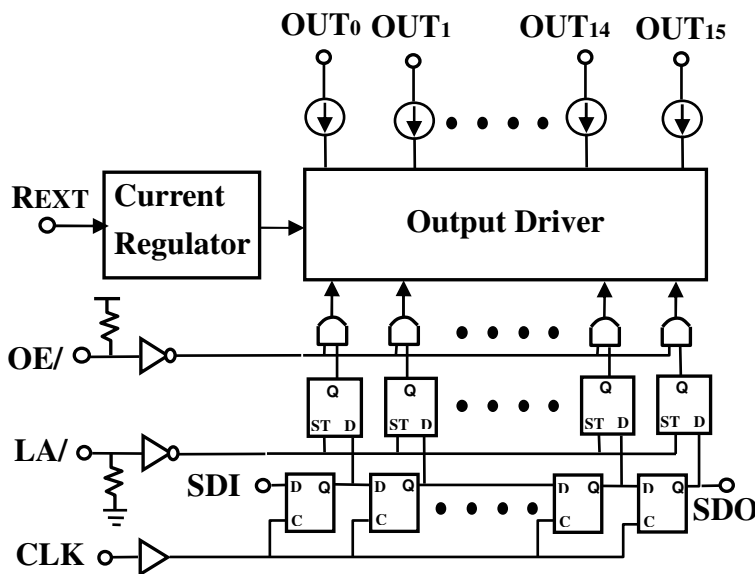
GND	1	●	24	VDD
SDI	2		23	REXT
CLK	3		22	SDO
LA/	4		21	OE/
OUT0	5	<b>SCT2210</b>	20	OUT15
OUT1	6	CSOG	19	OUT14
OUT2	7	CSSG	18	OUT13
OUT3	8	CSTG	17	OUT12
OUT4	9	CSDG	16	OUT11
OUT5	10		15	OUT10
OUT6	11		14	OUT9
OUT7	12		13	OUT8

OUT14	1	●	24	OUT13
OUT15	2		23	OUT12
OE/	3		22	OUT11
SDO	4		21	OUT10
REXT	5	<b>SCT2210</b>	20	OUT9
VDD	6	CSAG	19	OUT8
GND	7		18	OUT7
SDI	8		17	OUT6
CLK	9		16	OUT5
LA/	10		15	OUT4
OUT0	11		14	OUT3
OUT1	12		13	OUT2

**Terminal Description**

Pin	Name	Function
1	GND	Ground terminal.
2	SDI	Serial input of data shift register.
3	CLK	Clock input of shift register, data is sampled at the rising edge of CLK.
4	LA/	Input terminal of data strobe. Data is latched when LA/ is low. And data on shift register goes through when LA/ is high.
5 -20	OUT[0:15]	Open-drain, constant-current outputs.
21	OE/	Output enable signal. Output is enabled when OE/ is forced to low.
22	SDO	Output terminal of serial-data output to the SDI of next SCT2210.
23	REXT	Used to connect an external resistor for setting up all output current.
24	VDD	Supply voltage terminal.

**Block Diagram**



**Ordering Information**

Part	Package
SCT2210CSOG	Pb free SOP24
SCT2210CSSG	Pb free SSOP24
SCT2210CSAG	Pb free SSOP24
SCT2210CSTG	Pb free SSOP24-1.0
SCT2210CSDG	Pb free SDIP24

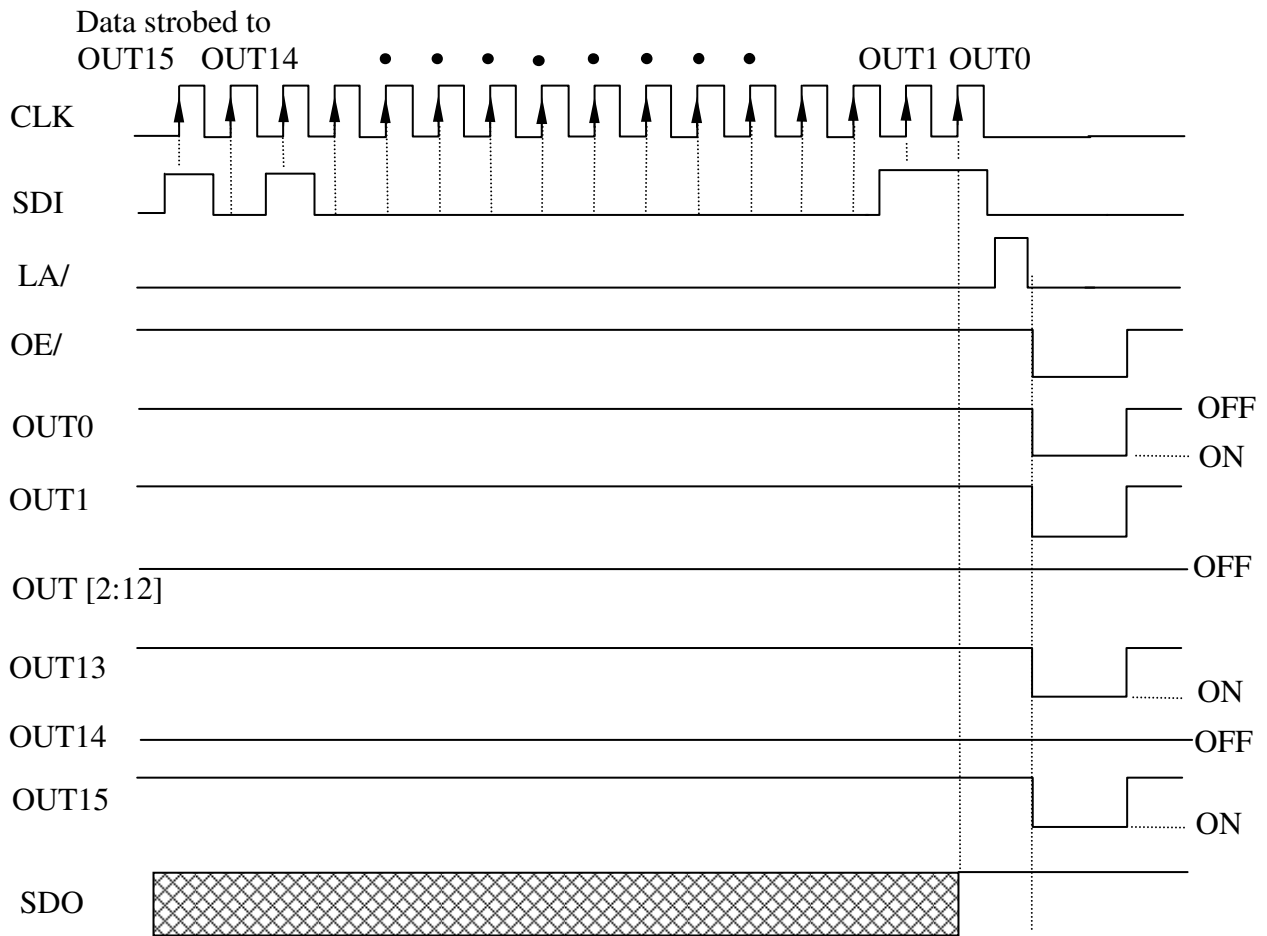
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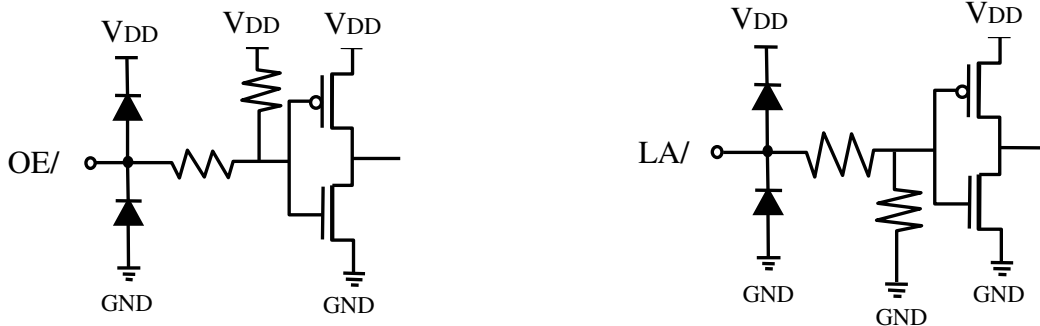
**Truth Table**

CLK	LA/	OE/	SDI	OUT0 ~ OUT15	SDO
↑	H	L	D <sub>n</sub>	D <sub>n</sub> D <sub>n-1</sub> ---- D <sub>n-14</sub> D <sub>n-15</sub>	D <sub>n-15</sub>
↑	L	L	D <sub>n+1</sub>	No change	D <sub>n-14</sub>
↑	H	L	D <sub>n+2</sub>	D <sub>n+2</sub> D <sub>n+1</sub> ---- D <sub>n-12</sub> D <sub>n-13</sub>	D <sub>n-13</sub>
↓	X	L	D <sub>n+3</sub>	D <sub>n+2</sub> D <sub>n+1</sub> ---- D <sub>n-12</sub> D <sub>n-13</sub>	D <sub>n-13</sub>
↓	X	H	D <sub>n+3</sub>	Off	D <sub>n-13</sub>

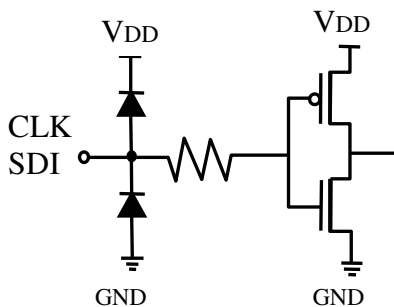
**Timing Diagram**



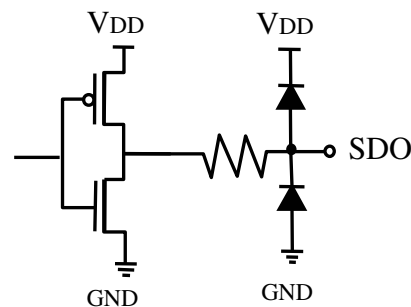
**Equivalent Circuits of Inputs (1)**



**Equivalent Circuits of Inputs (2)**



**Equivalent Circuits of Output**



**Maximum Ratings** (Ta = 25°C)

Characteristic		Symbol	Rating	Unit
Supply Voltage		V <sub>DD</sub>	7.0	V
Input Voltage		V <sub>IN</sub>	-0.2 ~ V <sub>DD</sub> +0.2	V
Output Current		I <sub>OUT</sub>	120	mA/Channel
Output Voltage		V <sub>OUT</sub>	-0.2 ~ 17.0	V
Total GND Terminals Current		I <sub>GND</sub>	1200	mA
Power Dissipation	SOP24	P <sub>D</sub>	2.05	W
	SSOP24		1.49	
	SSOP24-1.0		1.84	
	SDIP24		2.08	
Thermal Resistance	SOP24	R <sub>TH(j-a)</sub>	61	°C/W
	SSOP24		84	
	SSOP24-1.0		68	
	SDIP24		60	
Operating Temperature		T <sub>OPR</sub>	-40~+85	°C
Storage Temperature		T <sub>STG</sub>	-55~+150	°C

**Recommended Operating Conditions** (Ta= -40 to 85°C unless otherwise noted)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	V <sub>DD</sub>	-	4.5	-	5.5	V
Output Voltage	V <sub>OUT1</sub>	Output OFF	-	-	17	V
Output Voltage	V <sub>OUT2</sub>	Output ON	1	-	4	V
Output Current	I <sub>OUT</sub>	V <sub>DD</sub> =5V	5	-	90	mA
Input Voltage	V <sub>IH</sub>	Input Signals	0.7V <sub>DD</sub>	-	V <sub>DD</sub>	V
	V <sub>IL</sub>	Input Signals	0	-	0.3V <sub>DD</sub>	V
OE/ Pulse Width	t <sub>w</sub>	V <sub>DD</sub> =5V	50	-	-	ns

**Selector Guide**

Part	Number of Outputs	Max Output Current (mA)	Min PWM Pulse Width (ns)	Supply Voltage (V)
SCT2110	8	180	100	5
SCT2167	8	60	180	3.3/5
SCT2210	16	120	50	5
SCT2026	16	90	120	5
SCT2024	16	60	180	3.3/5

**Electrical Characteristics** ( $V_{DD}=5V$ ,  $T_a=25^\circ C$  unless otherwise noted)

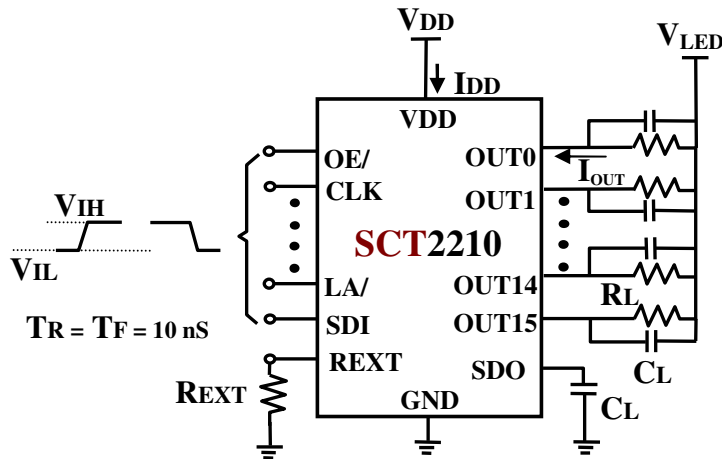
Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Input Voltage		$V_{IH}$	-	$0.7V_{DD}$	-	$V_{DD}$	V
		$V_{IL}$	-	0	-	$0.3V_{DD}$	V
SDO Output Voltage		$V_{OH}$	$V_{DD}=5V$ , $I_{OH} = -1mA$	4.6	-	-	V
		$V_{OL}$	$V_{DD}=5V$ , $I_{OL} = +1mA$	-	-	0.4	V
Output Leakage Current		$I_{OL}$	$V_{OUT} = 17V$	-	-	0.5	$\mu A$
Output Current		$I_{OUT}$	$V_{OUT}=1V$ , $R_{EXT}=900\Omega$	-	21	-	mA
Current Bit Skew*		$dI_{OUT1}$	$V_{OUT}=1V$ , $R_{EXT}=900\Omega$	-	-	$\pm 3$	%
Current Chip Skew		$dI_{OUT2}$	$V_{OUT}=1V$ , $R_{EXT}=900\Omega$	-	-	$\pm 6$	%
$I_{OUT}$ vs. $V_{DD}$ Regulation		$\%/dV_{DD}$	$4.5V < V_{DD} < 5.5V$ , $V_{OUT} > 1V$ , $R_{EXT}=900\Omega$	-	-	$\pm 2$	%/V
$I_{OUT}$ vs. $V_{OUT}$ Regulation		$\%/dV_{OUT}$	$1V < V_{OUT} < 4V$ $I_{OUT}=21mA$ , $R_{EXT}=900\Omega$	-	-	$\pm 1$	%/V
Pull-up Resistor		$R_{up}$	OE/	-	650	-	K $\Omega$
Pull-down Resistor		$R_{down}$	LA/	-	650	-	K $\Omega$
Thermal Shutdown		$T_H$	Junction Temperature	-	170	-	$^\circ C$
		$T_L$		-	130	-	$^\circ C$
Supply Current	OFF	$I_{DD}(off)1$	$R_{EXT} = \text{Open}$ , $V_{DD} = 5V$ $OUT [0:15]=\text{Off}$	-	7	9	mA
		$I_{DD}(off)2$	$R_{EXT} = 900\Omega$ , $V_{DD} = 5V$ $OUT [0:15]=\text{Off}$	-	9	11	
	ON	$I_{DD}(on)$	$R_{EXT} = 900\Omega$ , $V_{DD} = 5V$ $OUT [0:15]=\text{On}$	-	10	12	

\*Bit Skew= $(I_{OUT}-I_{AVG})/I_{AVG}$ , where  $I_{AVG}=(I_{max}+I_{min})/2$

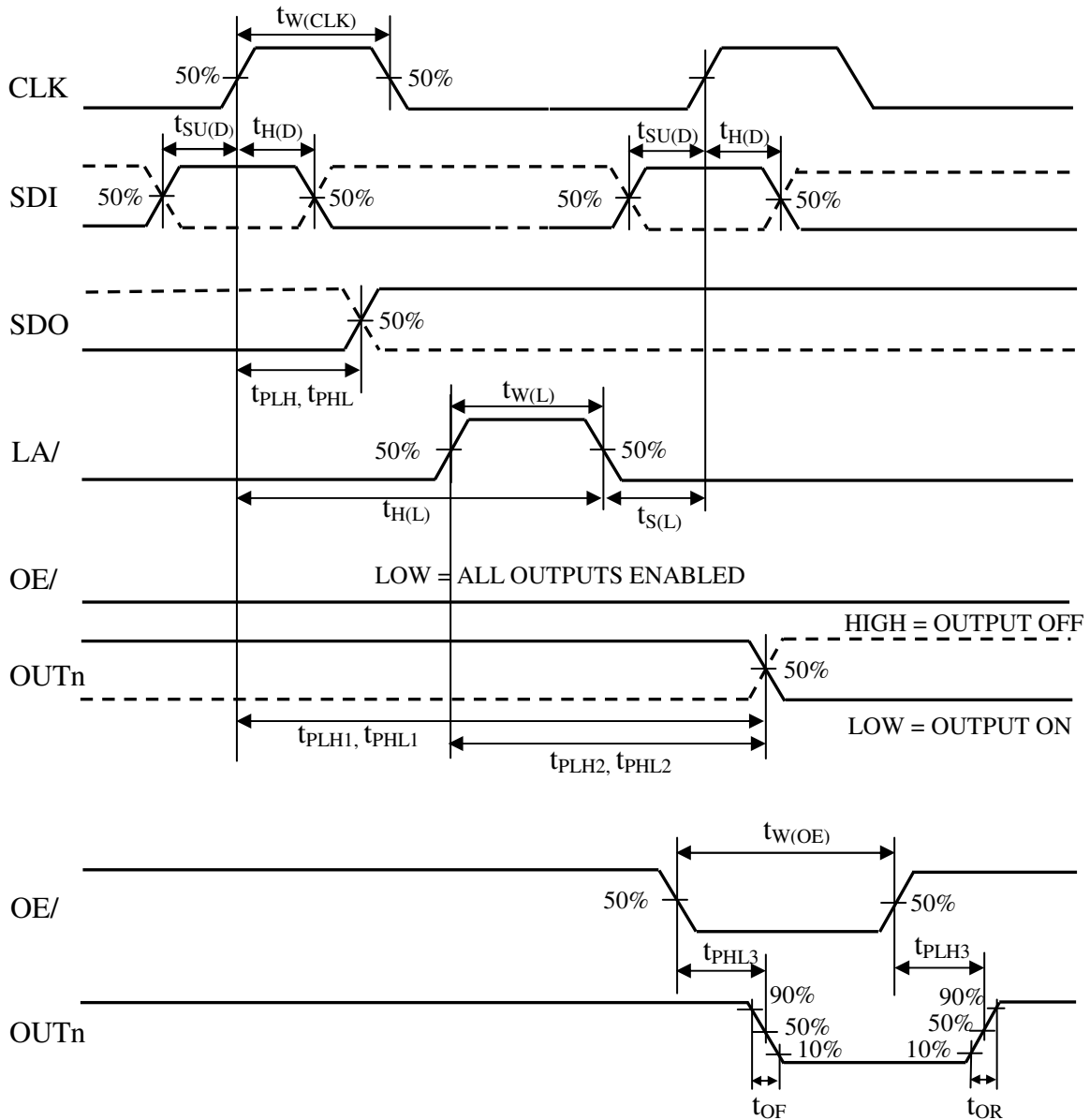
**Switching Characteristics** ( $T_a=25^\circ C$  unless otherwise noted)

Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time ("L" to "H")	CLK - OUTn	$t_{PLH1}$	$V_{DD} = 5V$ $V_{LED} = 5V$ $V_{IH} = V_{DD}$ $V_{IL} = GND$ $R_{EXT} = 900\Omega$ $R_L = 180\Omega$ $C_L = 10pF$	-	30	60	ns
	LA/ - OUTn	$t_{PLH2}$		-	100	150	ns
	OE/ - OUTn	$t_{PLH3}$		-	50	100	ns
	CLK - SDO	$t_{PLH}$		-	15	20	ns
Propagation Delay Time ("H" to "L")	CLK - OUTn	$t_{PHL1}$		-	40	60	ns
	LA/ - OUTn	$t_{PHL2}$		-	100	150	ns
	OE/ - OUTn	$t_{PHL3}$		-	30	60	ns
	CLK - SDO	$t_{PHL}$		-	15	20	ns
Pulse Width	CLK	$t_{W(CLK)}$		20	-	-	ns
	LA/	$t_{W(L)}$		20	-	-	ns
	OE/	$t_{W(OE)}$		50	-	-	ns
Hold Time for LA/		$t_{H(L)}$		5	-	-	ns
Setup Time for LA/		$t_{S(L)}$		5	-	-	ns
Output Rise Time of $I_{OUT}$		$t_{OR}$		-	10	20	ns
Output Fall Time of $I_{OUT}$		$t_{OF}$		-	10	20	ns
Slow CLK rise time		$t_R$		Cascade	-	-	500
Slow CLK fall time		$t_F$	-		-	500	ns

**Test Circuit for Switching Characteristics**

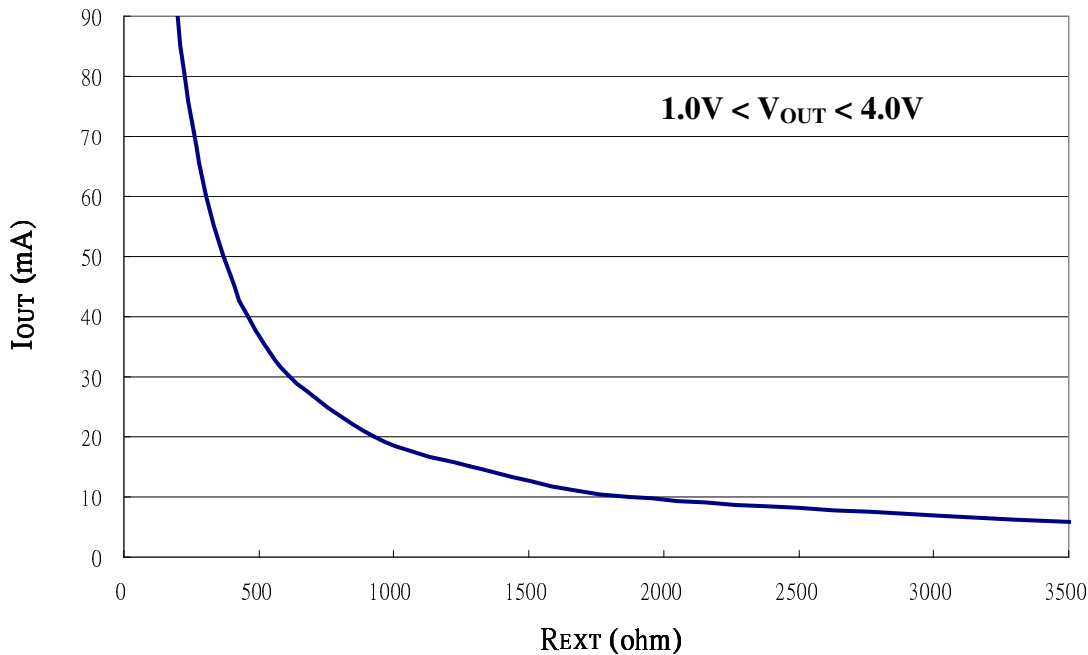


**Timing Waveform**



### Adjusting Output Current

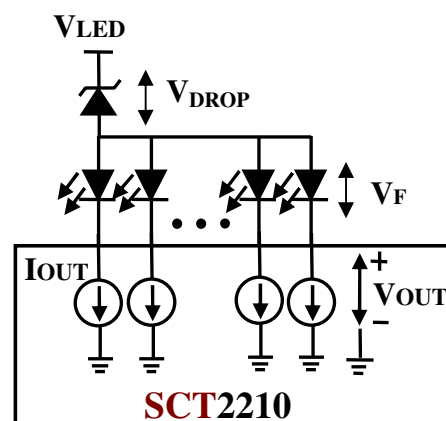
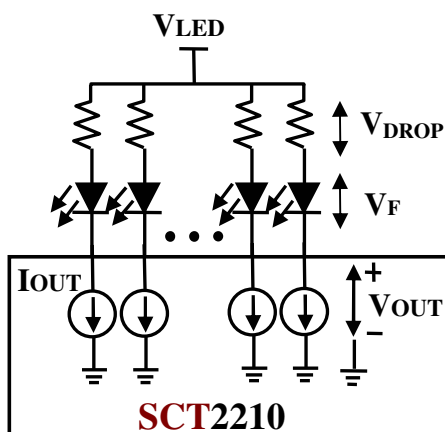
All SCT2210's output current ( $I_{OUT}$ ) are set by one external resistor at pin REXT. The relationship between  $I_{OUT}$  and resistance  $R_{EXT}$  is shown as the following figure.



Also, when SCT2210's output voltage is set between 1V and 4V, the output current  $I_{OUT}$  can be set by the formula:  $I_{OUT} = 30(630 / R_{EXT})$  mA. Thus the output currents are all set to 21mA ( $\pm 6\%$ ) by set the reference value  $R_{EXT} = 900\Omega$ .

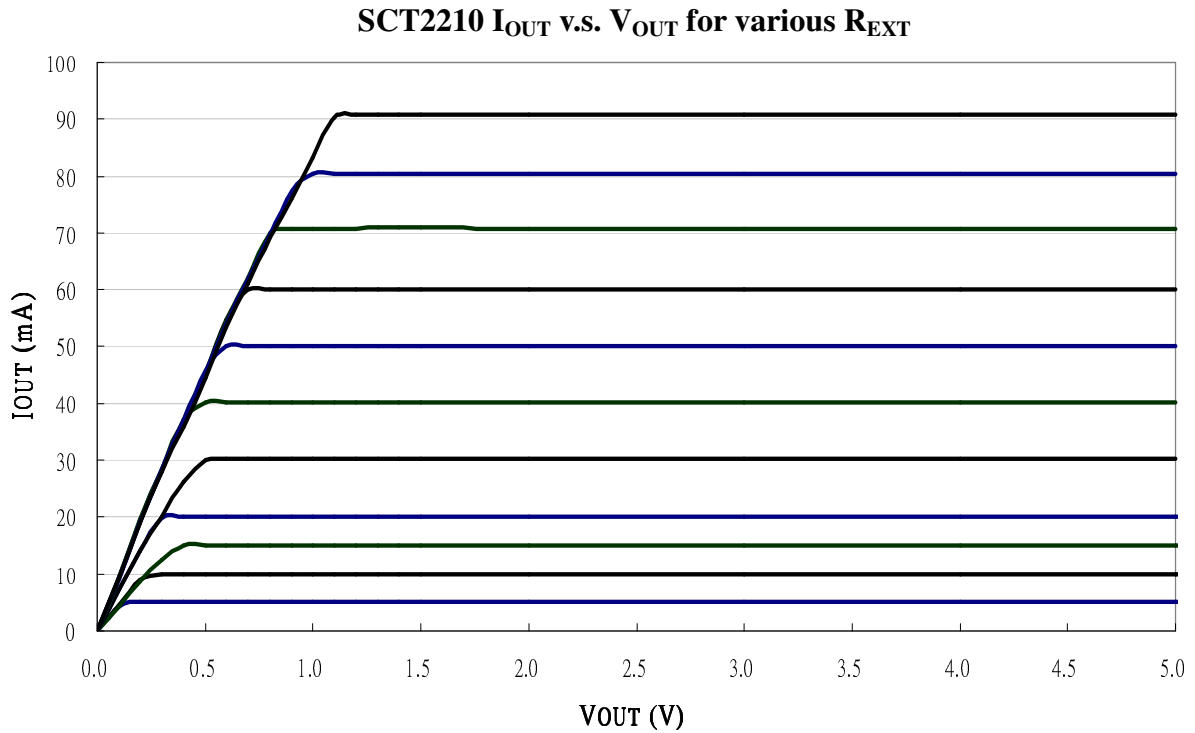
### Load Supply Voltage ( $V_{LED}$ )

The SCT2210 can be operated very well when  $V_{OUT}$  ranging from 1V to 4V. So it is recommended to use the lowest possible supply voltage or set a voltage reducer to reduce the  $V_{OUT}$  voltage and then reduce the power dissipation of SCT2210. A voltage reducer lets  $V_{OUT} = V_{LED} - V_{DROP} - V_F$ , Resistors or Zener diode can be used in the applications as shown in the following figures.



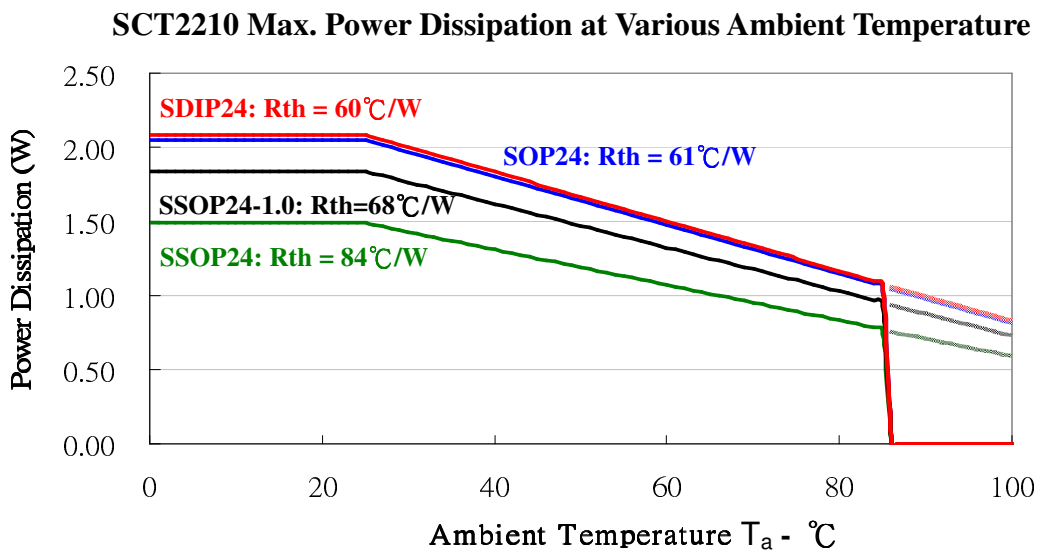
### Output Characteristics

The current characteristic of output stage is flat. The output current can be kept constant regardless of the variations of LED forward voltage when  $V_{OUT} > 1.0V$ . The relationship between  $I_{OUT}$  and  $V_{OUT}$  is shown as below:



### Power Dissipation

The power dissipation ( $P_D$ ) of a semiconductor chip is limited by its package and ambient temperature. The maximum allowable power dissipation  $P_{D(max)}$  is determined by  $P_{D(max)} = (T_{j(max)} - T_a) / R_{th(j-a)}$  where  $T_{j(max)}$ : maximum chip junction temperature, usually considered as  $150^\circ C$ ,  $T_a$ : ambient temperature,  $R_{th(j-a)}$ : thermal resistance of the package. The relationship between  $P_{D(max)}$  and  $T_a$  is shown as the below figure:



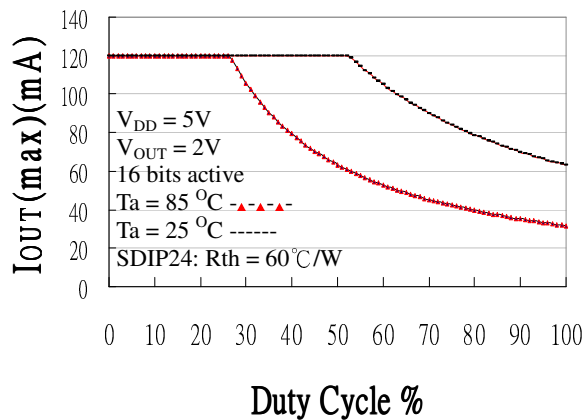
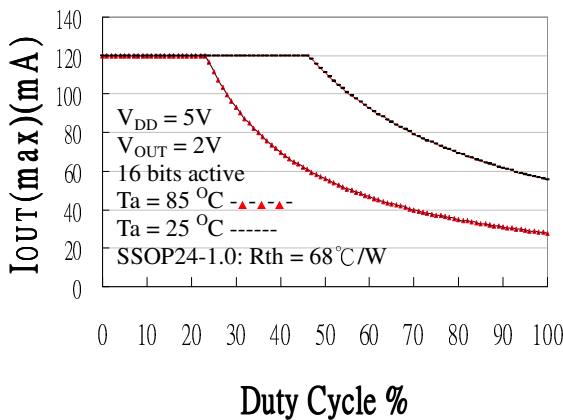
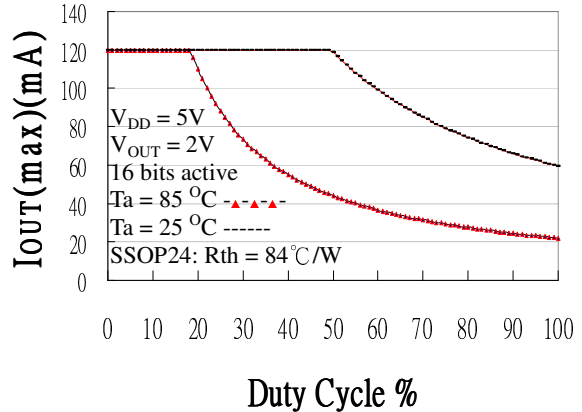
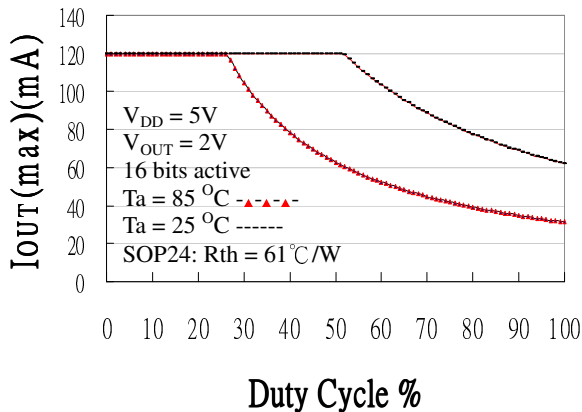


### Limitation on Maximum Output Current

The maximum output current vs. duty cycle is estimated by:

$$I_{OUT(max)} = \frac{((T_{j(max)} - T_a) / R_{th(j-a)}) - (V_{DD} * I_{DD})}{V_{OUT} / Duty / N}$$

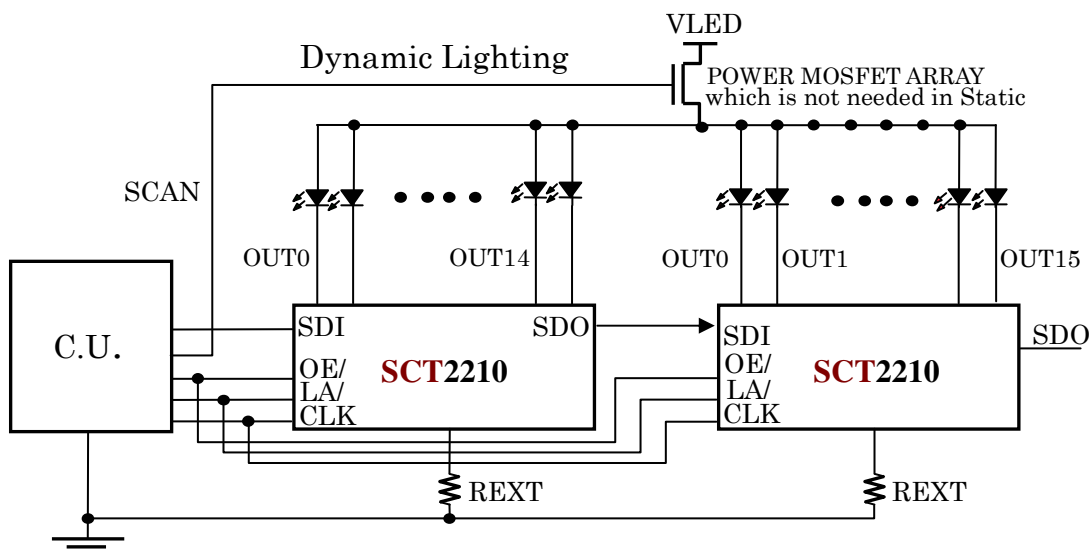
Where  $T_{j(max)} = 150^{\circ}C$ ,  $N = 16$  (all ON)



### Over Temperature Shutdown

The SCT2210 contains thermal shutdown scheme to prevent damage from over heat. The internal thermal sensor turns off all outputs when the die temperature exceeds approximately  $+170^{\circ}C$ . The outputs are enabled again when the die temperature drops below approximately  $+130^{\circ}C$ .

### Typical Application Circuits

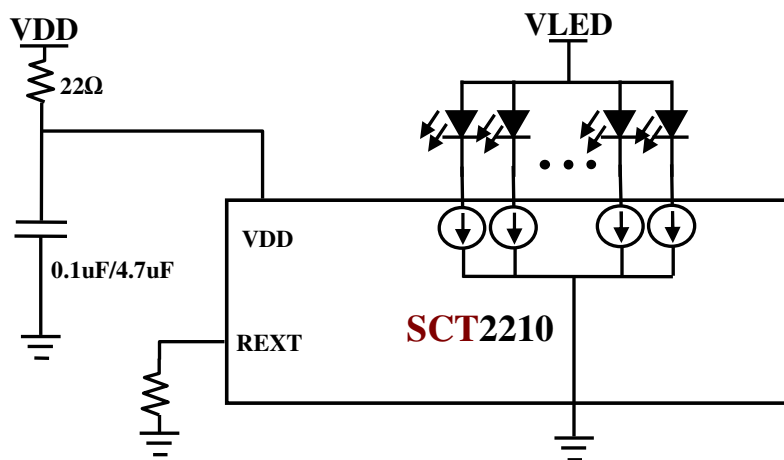


## PCB Design Considerations

Use the following general guide-line when designing printed circuit boards (PCB) :

### Decoupling Capacitor

Place a decoupling capacitor e.g. 0.1uF between VDD and GND pins of SCT2210. Locate the capacitor as close to the SCT2210 as possible. This is normally adequate for static LED driving. For dynamic scan or PWM applications, it is necessary to add an additional capacitor of 4.7uF or more to each supply for every SCT2210. The necessary capacitance depends on the LED load current, PWM switching frequency, and serial-in data speed. Inadequate VDD decoupling can cause timing problems, and very noisy LED supplies can affect LED current regulation.

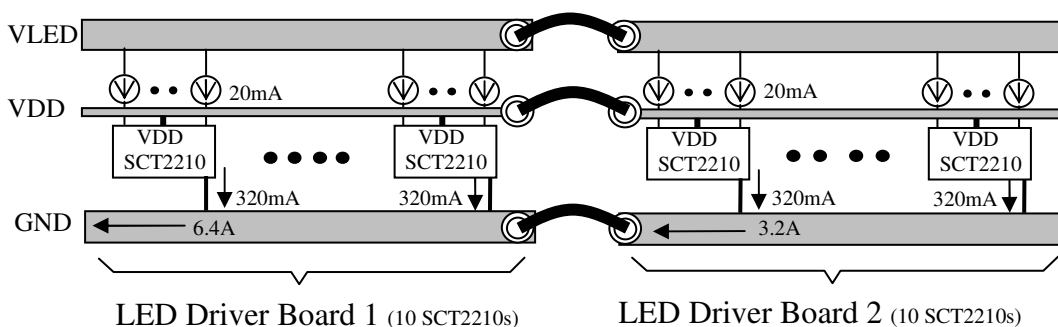


### External Resistor (REXT)

Locate the external resistor as close to the REXT pin as possible to avoid the noise influence.

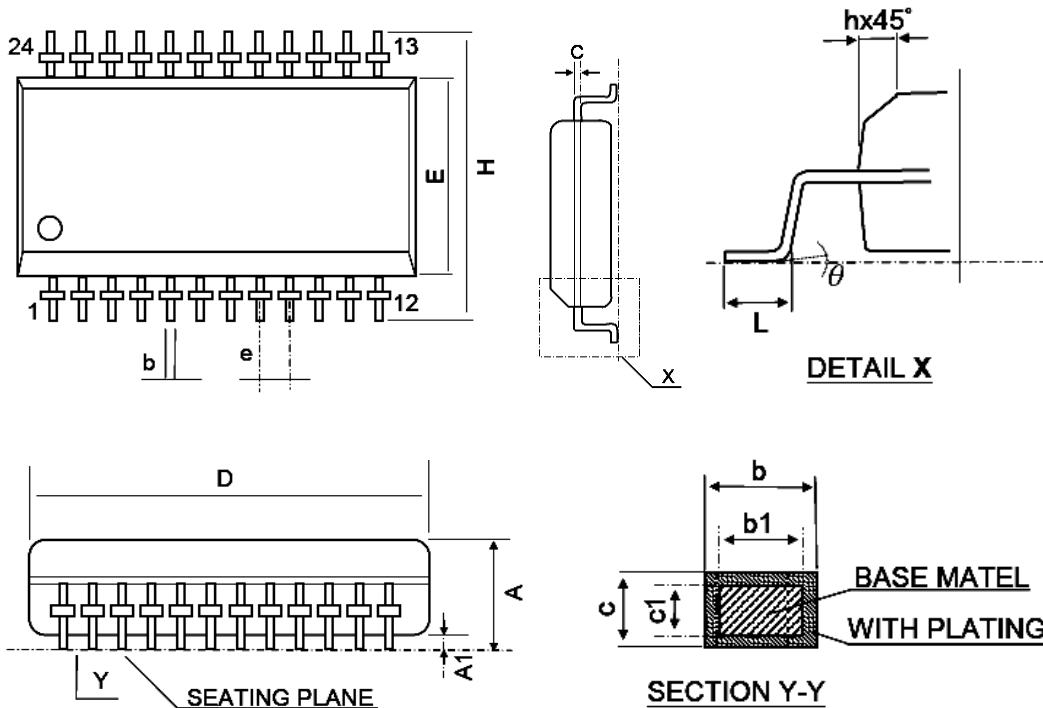
### Power and Ground

Maximizing the width and minimizing the length of VDD and GND trace improve efficiency and ground bouncing by effect of reducing both power and ground parasitic resistance and inductance. A small value of resistor e.g. 22Ω series in power input pin VDD of SCT2210 in conjunction with decoupling capacitor shunting the ICs is recommended. Separating and feeding the LED power from another stable supply terminal VLED is strongly recommended.



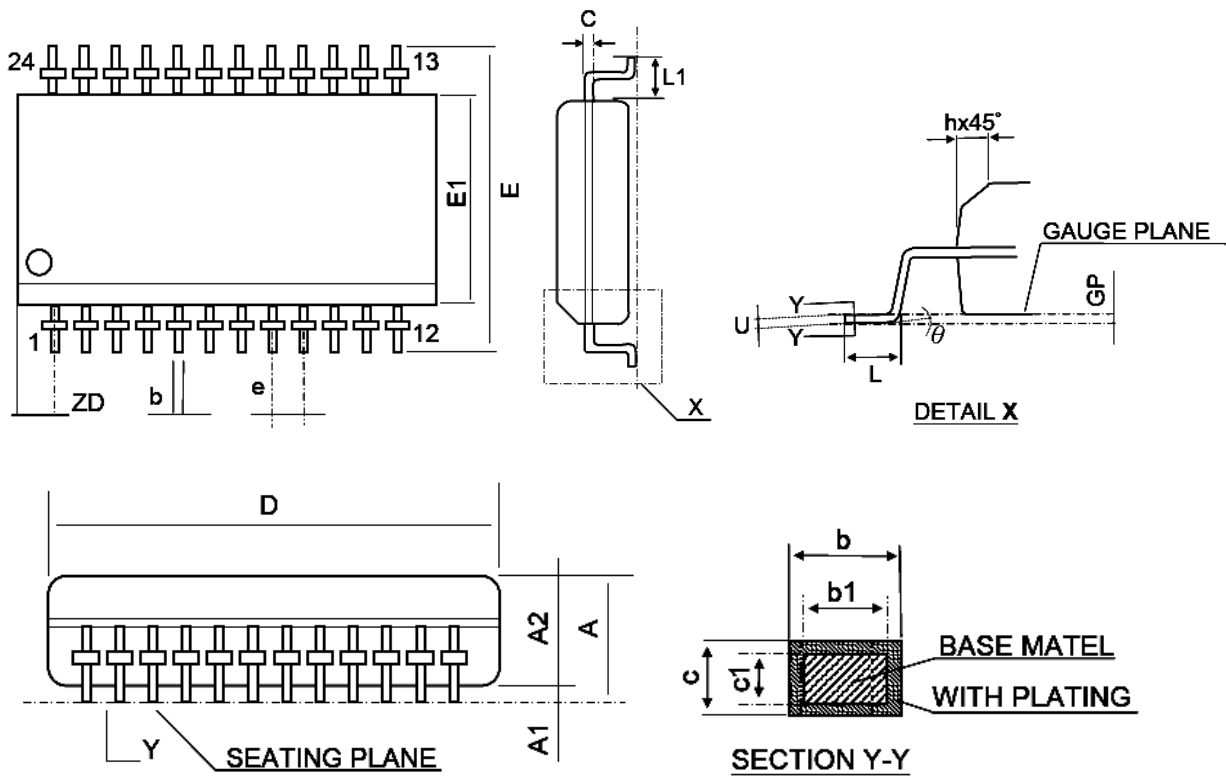
**Package Dimension**

SOP24



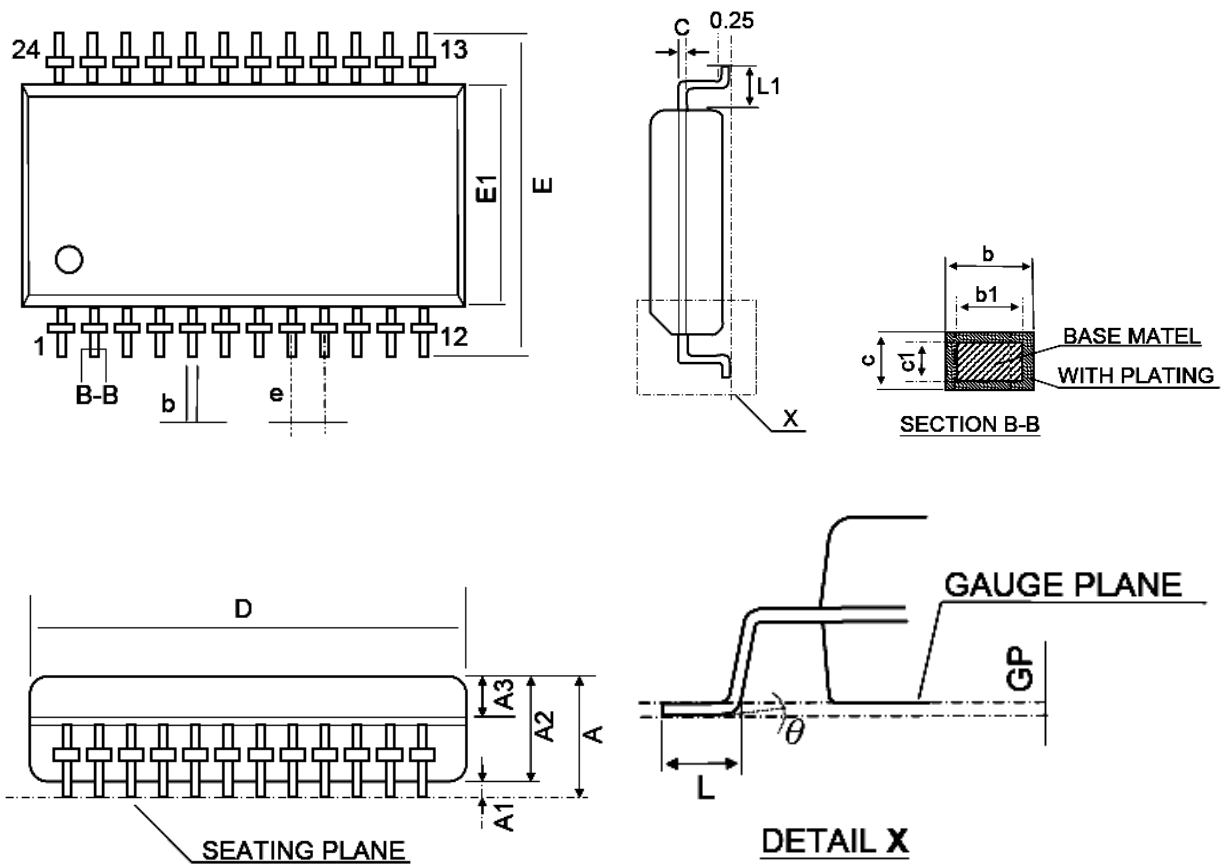
SYMBOL	DIMENSION (mm)			DIMENSION (mil)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	2.36	2.54	2.64	93	100	104
A1	0.10	0.20	0.30	4	8	12
b	0.35	0.406	0.48	14	16	19
b1	0.35		0.46	14		18
c	0.23	0.254	0.31	9	10	12
c1	0.23		0.29	9		11
D	15.20	15.29	15.60	598	602	614
E	7.40	7.50	7.60	291	295	299
e	1.27 BSC			50 BSC		
H	10.00	10.31	10.65	394	406	419
h	0.25	0.66	0.75	10	26	30
L	0.51	0.76	1.02	20	30	40
Y			0.075			3
theta	0°		8°	0°		8°

SSOP24



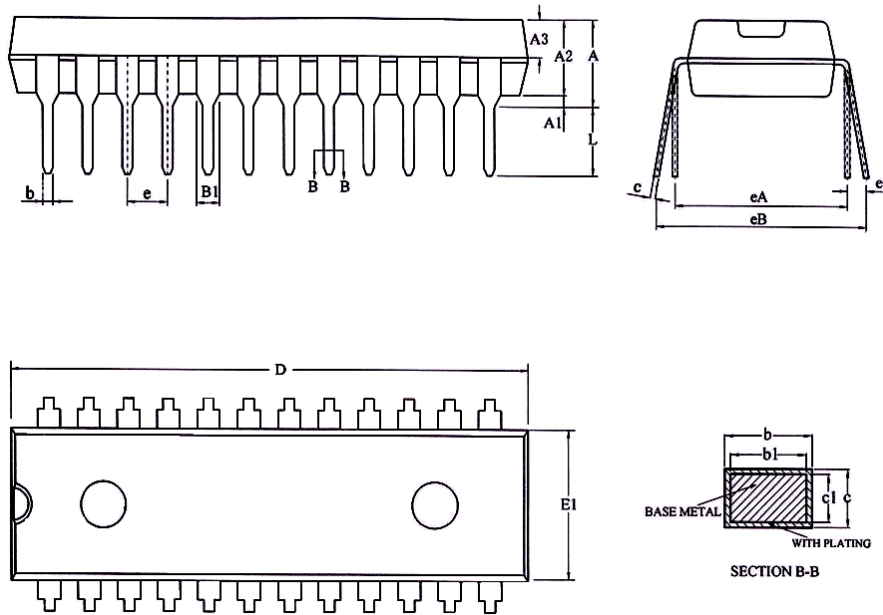
SYMBOL	DIMENSION (mm)			DIMENSION (mil)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.60	1.75	53	63	69
A1	0.10	0.15	0.25	4	6	10
A2			1.50			59
b	0.20		0.30	8		12
b1	0.20	0.254	0.28	8	10	11
c	0.18		0.25	7		10
c1	0.18	0.203	0.23	7	8	9
D	8.56	8.66	8.74	337	341	344
E	5.80	6.00	6.20	228	236	244
E1	3.80	3.90	4.00	150	154	157
e	0.635 BSC			25 BSC		
h	0.25	0.42	0.50	10	17	20
L	0.40	0.635	1.27	16	25	50
L1	1.00	1.05	1.10	39	41	43
ZD	0.838 REF			33 REF		
Y			0.10			4
θ	0°		8°	0°		8°

SSOP24-1.0



SYMBOL	DIMENSION (mm)			DIMENSION (mil)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	2.20	-	-	87
A1	0.10	0.20	0.30	4	8	12
A2	1.60	1.80	2.00	63	71	79
A3	0.62	0.82	0.92	24	32	36
b	0.39	-	0.47	15	-	19
b1	0.38	0.40	0.43	15	16	17
c	0.15	-	0.20	6	-	8
c1	0.14	0.15	0.16	5.5	6	6.5
D	12.80	13.00	13.20	504	512	520
E	7.70	7.90	8.10	303	311	319
E1	5.80	6.00	6.20	228	236	244
e	1.00 BSC			39 BSC		
L	0.35	0.45	0.55	14	18	22
L1	0.95 BSC			37 BSC		
θ	0°	-	8°	0°	-	8°

SDIP24



SYMBOL	DIMENSION (mm)			DIMENSION (mil)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	3.60	3.80	4.00	142	150	157
A1	0.30	-	-	12	-	-
A2	3.10	3.30	3.50	122	130	138
A3	1.42	1.52	1.62	56	60	64
b	0.44	-	0.53	17	-	21
b1	0.43	0.46	0.48	17	18	19
B1	1.00 BSC			39 BSC		
c	0.25	-	0.31	10	-	12
c1	0.24	0.25	0.26	9	10	11
D	22.70	22.90	23.10	894	902	909
E1	6.40	6.60	6.80	252	260	268
e	1.778 BSC			70 BSC		
eA	7.62 BSC			300 BSC		
eB	7.62	-	9.50	300	-	374
eC	0	-	0.94	0	-	37
L	3.00	-	-	118	-	-

**Revision History**

Data Sheet Version	Remark
V03_01	Upgrade spec.

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