



8-bit Serial-In/Parallel-Out Constant-Current LED Driver

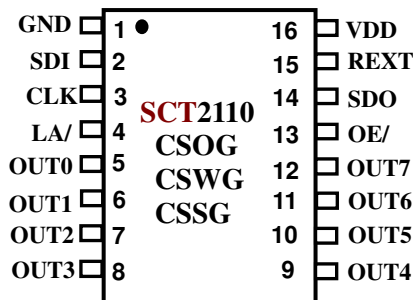
Product Description

The SCT2110 serial-interfaced LED driver sinks 8 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 160mA. The SCT2110 guarantees each output can endure maximum 17V DC voltage stress. The built-in shift registers and data latches making the SCT2110 effective solution in driving LED display. The output enable function gates all 8 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 SCT2110 will satisfy system which needs high volume data transmission to control the LED display.

Features

- ◆ 8 constant-current outputs rate at 17V
- ◆ Constant current range: 5 – 160mA
- ◆ Excellent current regulation to load, supply voltage and temperature
- ◆ ±3% Current matching between outputs
- ◆ ±6% Current matching between ICs
- ◆ Fast output current control: Minimum PWM pulse width = 100ns
- ◆ 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: SOP16 and SSOP16
- ◆ Applications: LED Displays, Variable Message Signs, LED Traffic Signs

Pin Configurations



Ordering Information

| Part Number | Package |
|-------------|-------------------------|
| SCT2110CSOG | Pb free SOP16 (150 mil) |
| SCT2110CSWG | Pb free SOP16 (300 mil) |
| SCT2110CSSG | Pb free SSOP16 |

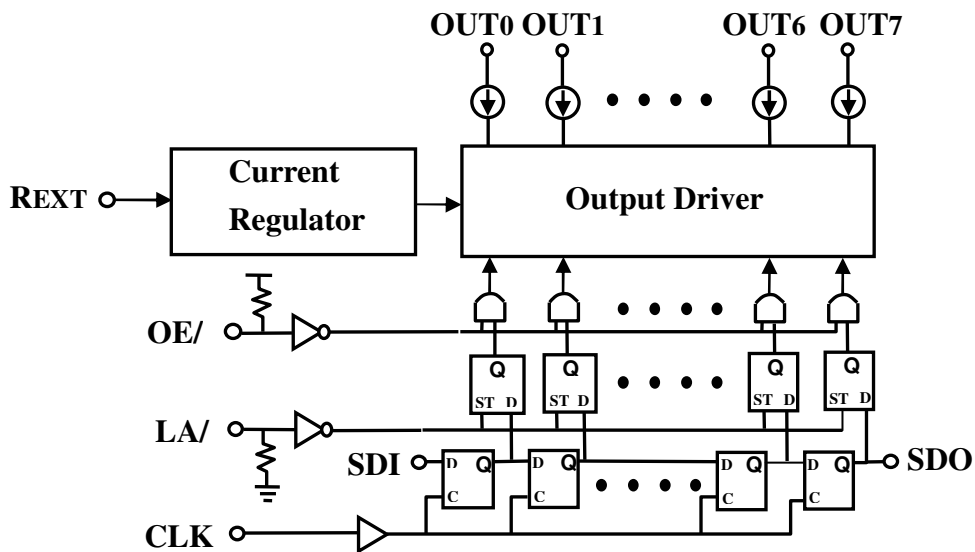
StarChips Technology, Inc.

4F, No.5, Technology Rd., Science-Based Industrial Park, Hsin-Chu, Taiwan, R.O.C.
Tel: +886-3-577-5767 # 555 Fax : +886-3-577-6575 service@starchips.com.tw

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 -12 | OUT[0:7] | Open-drain, constant-current outputs. |
| 13 | OE/ | Output enable signal. Output is enabled when OE/ is forced to low. |
| 14 | SDO | Output terminal of serial-data output to the SDI of next SCT2110. |
| 15 | REXT | Used to connect an external resistor for setting up all output current. |
| 16 | VDD | Supply voltage terminal. |

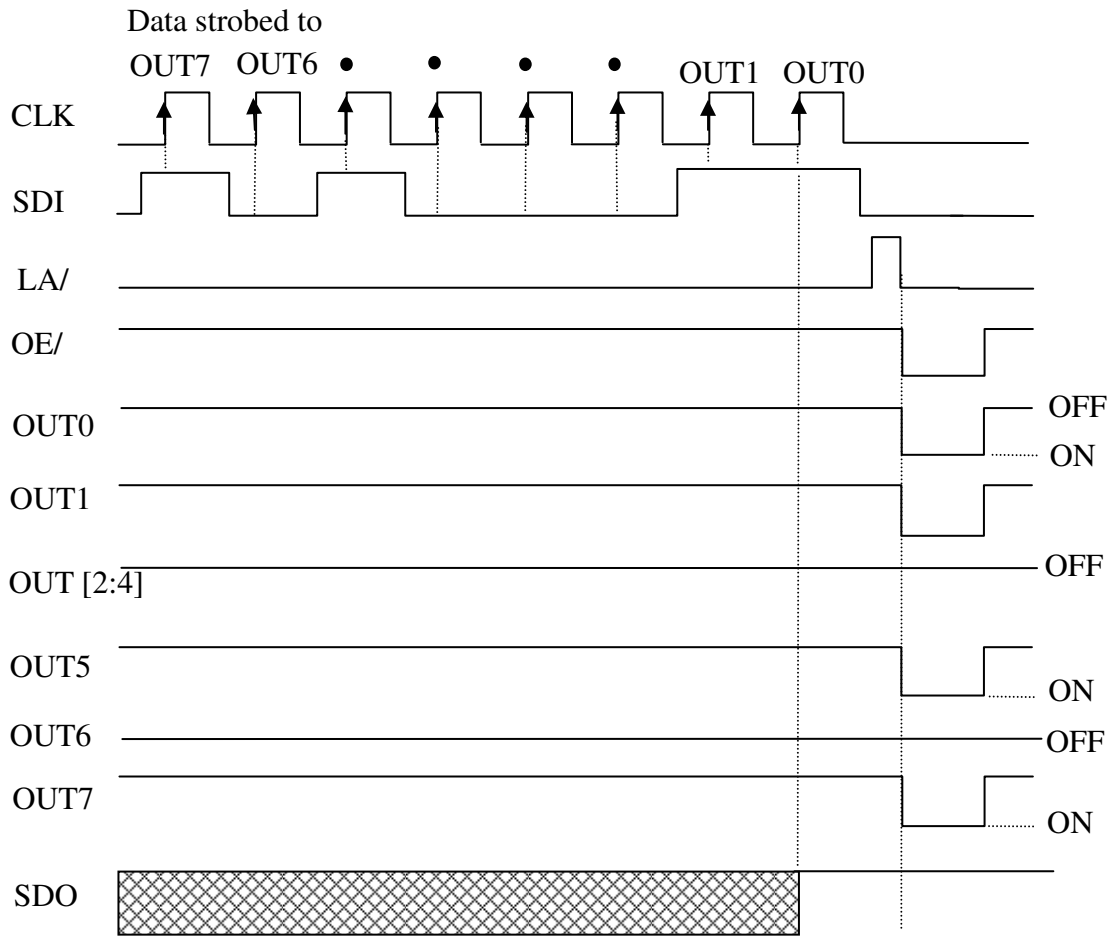
Block Diagram



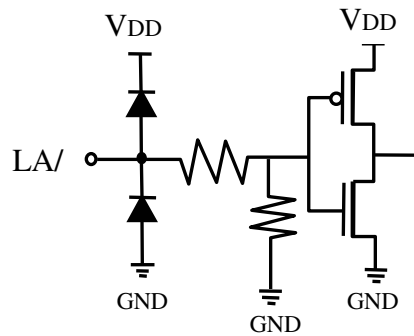
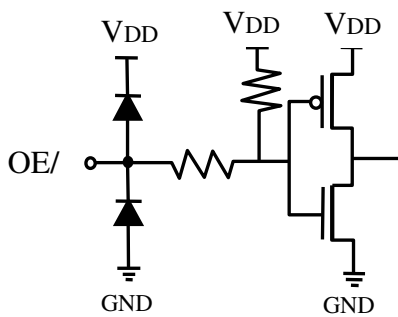
Truth Table

| CLK | LA/ | OE/ | SDI | OUT0 ~ OUT7 | SDO |
|-----|-----|-----|------------------|--|------------------|
| | H | L | D _n | D _n D _{n-1} ---- D _{n-6} D _{n-7} | D _{n-7} |
| | L | L | D _{n+1} | No change | D _{n-6} |
| | H | L | D _{n+2} | D _{n+2} D _{n+1} ---- D _{n-4} D _{n-5} | D _{n-5} |
| | X | L | D _{n+3} | D _{n+2} D _{n+1} ---- D _{n-4} D _{n-5} | D _{n-5} |
| | X | H | D _{n+3} | Off | D _{n-5} |

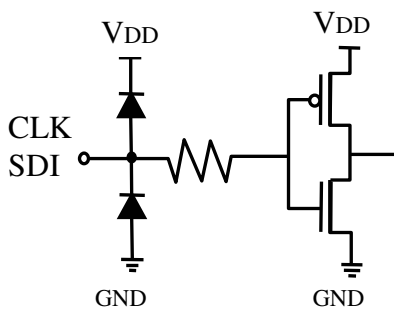
Timing Diagram



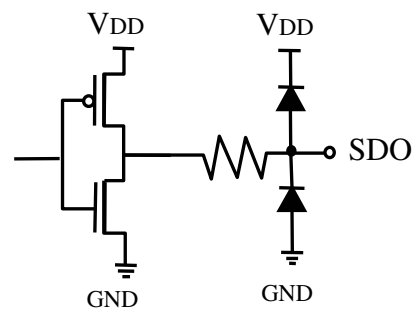
Equivalent Circuits of Inputs (1)



Equivalent Circuits of Inputs (2)



Equivalent Circuits of Output



Maximum Ratings (Ta = 25°C)

| Characteristic | | Symbol | Rating | Unit |
|-----------------------------|----------------|----------------------|-----------------------------|------------|
| Supply Voltage | | V _{DD} | 7.0 | V |
| Input Voltage | | V _{IN} | -0.2 ~ V _{DD} +0.2 | V |
| Output Current | | I _{OUT} | 180 | mA/Channel |
| Output Voltage | | V _{OUT} | -0.2 ~ 17.0 | V |
| Total GND Terminals Current | | I _{GND} | 1200 | mA |
| Power Dissipation | SOP16 (150mil) | P _D | 1.47 | W |
| | SOP16 (300mil) | | 1.79 | |
| | SSOP16 | | 1.07 | |
| Thermal Resistance | SOP16 (150mil) | R _{TH(j-a)} | 85 | °C/W |
| | SOP16 (300mil) | | 70 | |
| | SSOP16 | | 117 | |
| Operating Temperature | | T _{OPR} | -40~+85 | °C |
| Storage Temperature | | T _{STG} | -55~+150 | °C |

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

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|-----------------|-------------------|---------------------|--------------------|------|--------------------|------|
| Supply Voltage | V _{DD} | - | 4.5 | - | 5.5 | V |
| Output Voltage | V _{OUT1} | Output OFF | - | - | 17 | V |
| Output Voltage | V _{OUT2} | Output ON | 1 | - | 4 | V |
| Output Current | I _{OUT} | V _{DD} =5V | 5 | - | 160 | mA |
| Input Voltage | V _{IH} | Input Signals | 0.7V _{DD} | - | V _{DD} | V |
| | V _{IL} | Input Signals | 0 | - | 0.3V _{DD} | V |
| OE/ Pulse Width | t _w | V _{DD} =5V | 100 | - | - | 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)

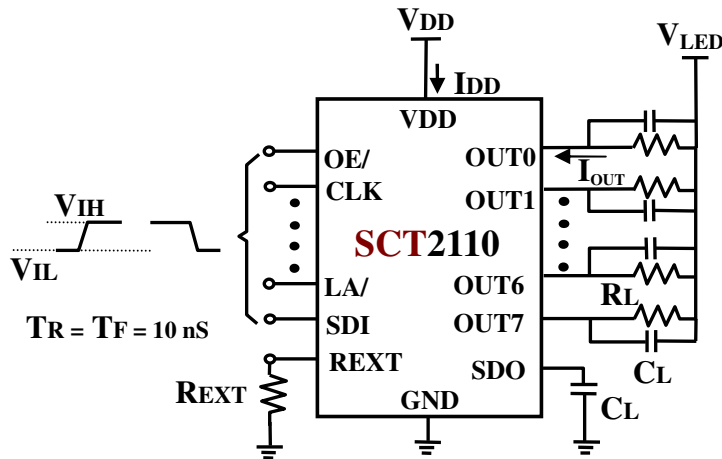
| Characteristic | | Symbol | Condition | Min. | Typ. | Max. | Unit |
|------------------------------------|-----|----------------|--|-------------|------|-------------|------------|
| Input Voltage | | V_{IH} | - | $0.7V_{DD}$ | - | V_{DD} | V |
| | | V_{IL} | - | 0 | - | $0.3V_{DD}$ | V |
| SDO Output 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 | μA |
| Output Current | | I_{OUT} | $V_{OUT} = 1V$, $R_{EXT} = 900\Omega$ | - | 42 | - | mA |
| Current Bit Skew* | | dI_{OUT1} | $V_{OUT} = 1V$, $R_{EXT} = 900\Omega$ | - | - | ± 3 | % |
| Current Chip Skew | | dI_{OUT2} | $V_{OUT} = 1V$, $R_{EXT} = 900\Omega$ | - | - | ± 6 | % |
| I_{OUT} vs. V_{DD} Regulation | | $\%/dV_{DD}$ | $4.5V < V_{DD} < 5.5V$, $V_{OUT} > 1V$, $R_{EXT}=900\Omega$ | - | - | ± 2 | %/V |
| I_{OUT} vs. V_{OUT} Regulation | | $\%/dV_{OUT}$ | $1V < V_{OUT} < 4V$ $I_{OUT}=42mA$, $R_{EXT}=900\Omega$ | - | - | ± 1 | %/V |
| Pull-up Resistor | | R_{up} | OE/ | - | 650 | - | K Ω |
| Pull-down Resistor | | R_{down} | LA/ | - | 650 | - | K Ω |
| 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 [0:7]=Off | - | 7 | 9 | mA |
| | | $I_{DD}(off)2$ | $R_{EXT} = 900\Omega$, $V_{DD} = 5V$ OUT [0:7]=Off | - | 10 | 12 | |
| | ON | $I_{DD}(on)$ | $R_{EXT} = 900\Omega$, $V_{DD} = 5V$ OUT [0:7]=On | - | 11 | 13 | |

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

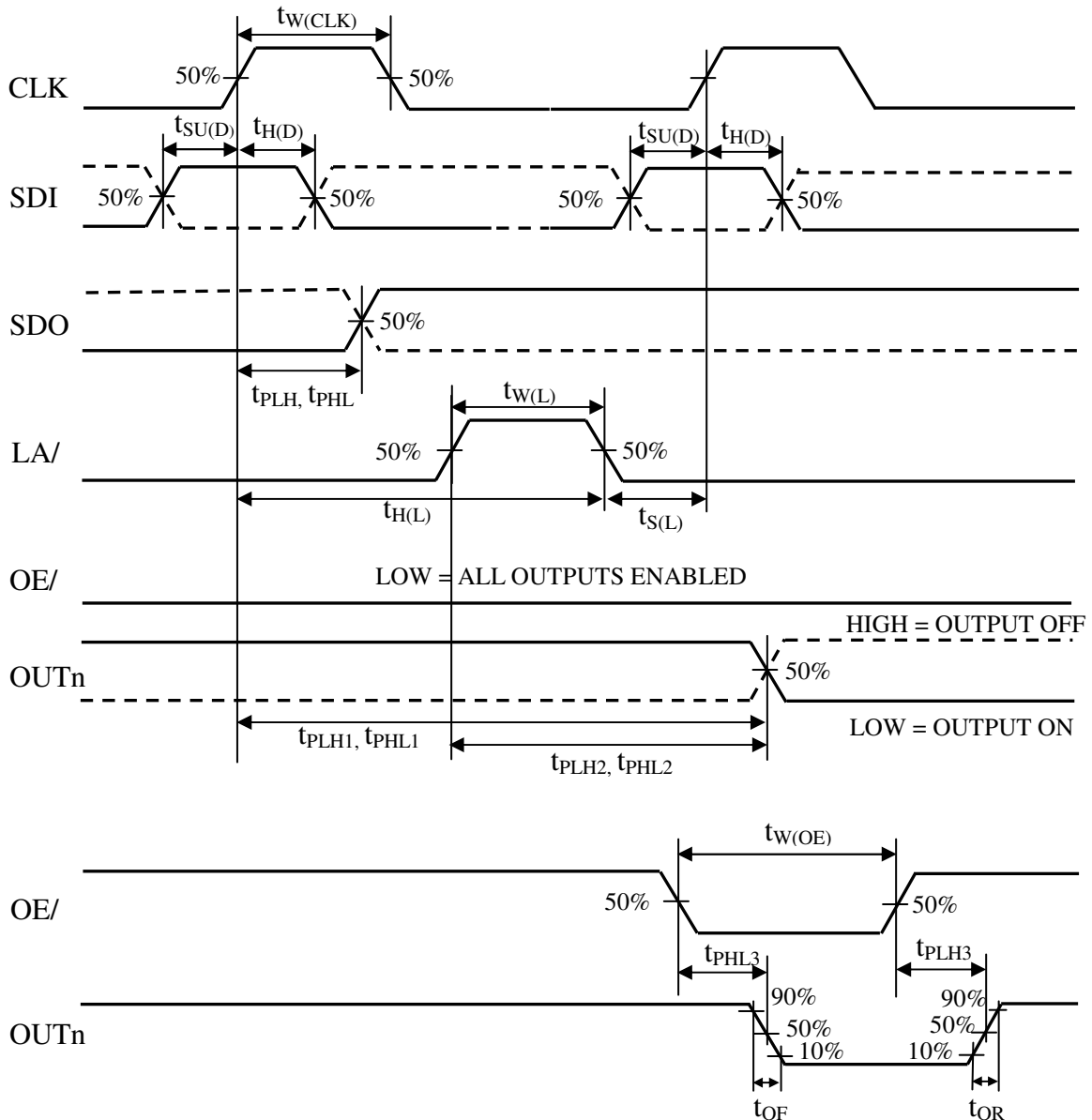
Switching Characteristics ($T_a=25^\circ C$ unless otherwise noted)

| Characteristic | | Symbol | Condition | Min. | Typ. | Max. | Unit |
|-------------------------------------|------------|--------------|---|------|------|------|------|
| Propagation Delay Time ("L" to "H") | CLK - OUTn | t_{PLH1} | $V_{DD} = 5V$ $V_{LED} = 5V$ $V_{IH} = V_{DD}$ $V_{IL} = GND$ $R_{EXT} = 900\Omega$ $R_L = 90\Omega$ $C_L = 10\text{ pF}$ | - | 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/ | $t_{W(OE)}$ | | 100 | - | - | 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} | | - | 15 | 30 | ns |
| Output Fall Time of I_{OUT} | | t_{OF} | | - | 15 | 30 | ns |
| Slow CLK rise time | | t_R | | - | - | 500 | ns |
| Slow CLK fall time | | t_F | Cascade | - | - | 500 | ns |

Test Circuit for Switching Characteristics

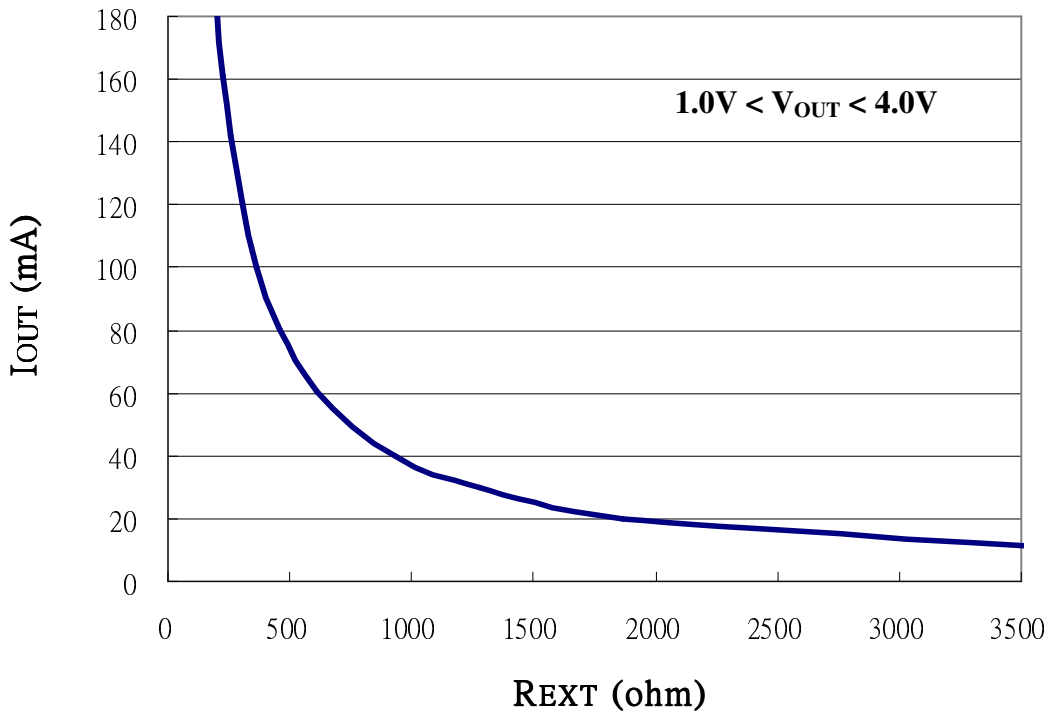


Timing Waveform



Adjusting Output Current

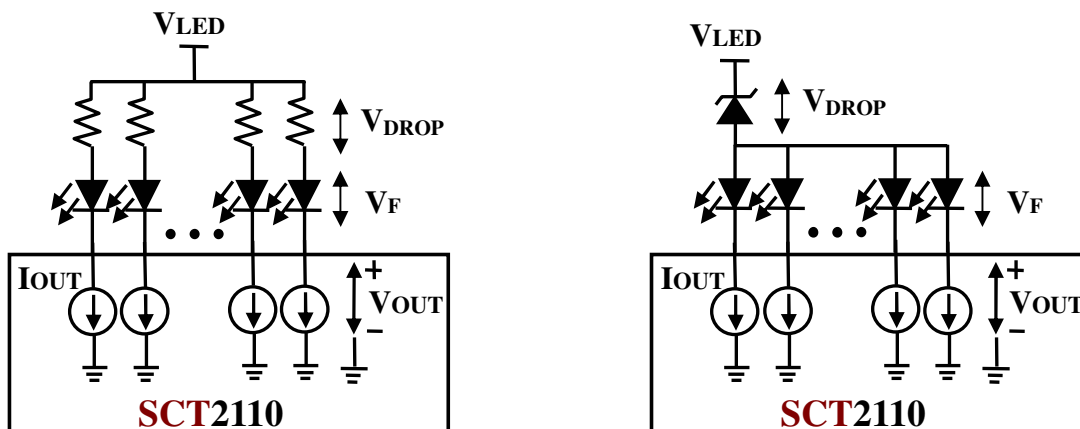
All SCT2110's output current (I_{OUT}) are set by one external resistor at pin REXT. The relationship between I_{OUT} and resistance R_{EXT} is shown as the following figure.



Also, when SCT2110's output voltage is set between 1 Volt and 4 Volt, the output current I_{OUT} can be set by the formula: $I_{OUT} = 60(630 / R_{EXT})$ (mA). Thus the output currents are all set to 42mA ($\pm 6\%$) by set the reference value $R_{EXT} = 900\Omega$.

Load Supply Voltage (V_{LED})

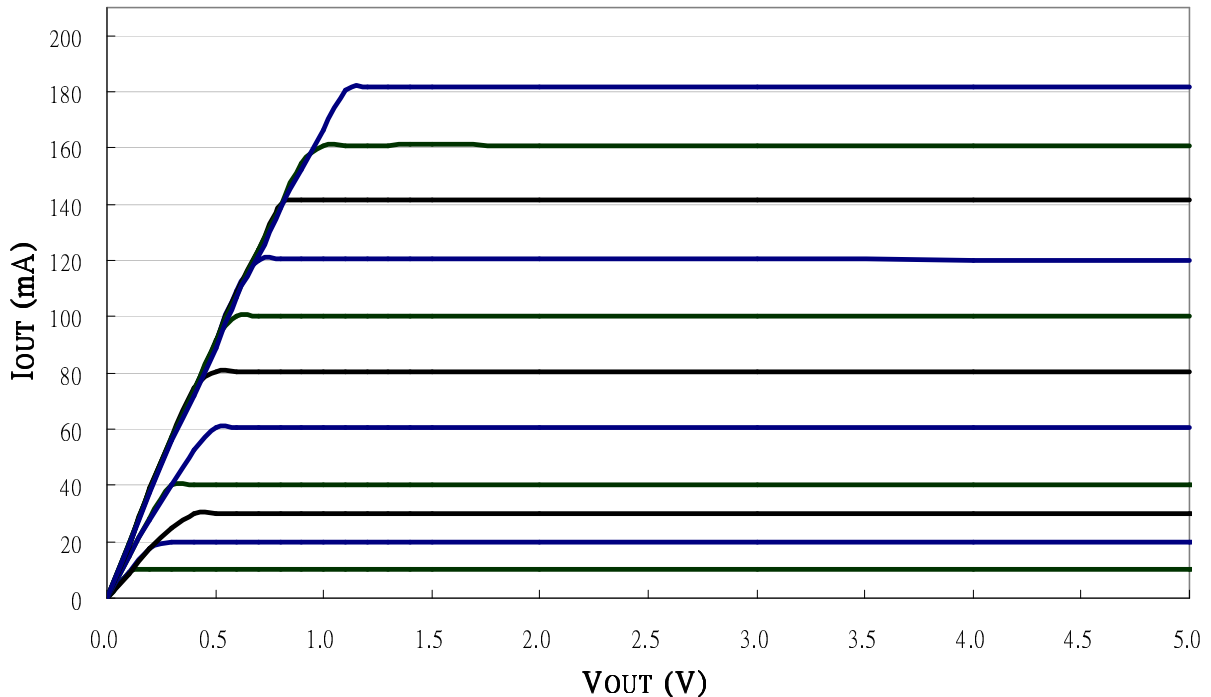
The SCT2110 can be operated very well when V_{OUT} ranging from 1V to 4V. So it is recommended to use the lowest possible supply voltage or set a voltage reducer to reduce the V_{OUT} voltage and then reduce the power dissipation of SCT2110. A voltage reducer lets $V_{OUT} = V_{LED} - V_{DROP} - V_F$, 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:

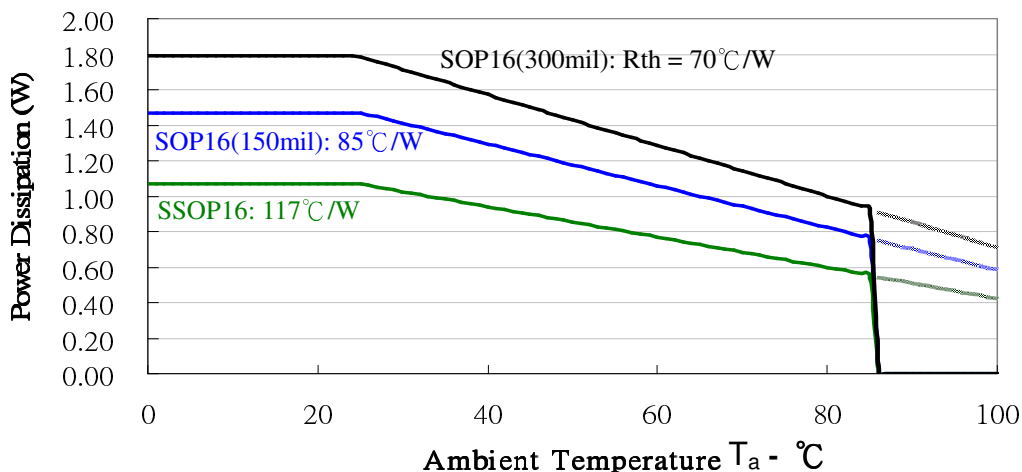
SCT2110 I_{OUT} v.s. V_{OUT} for various R_{EXT}



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:

SCT2110 Max. Power Dissipation at Various Ambient Temperature

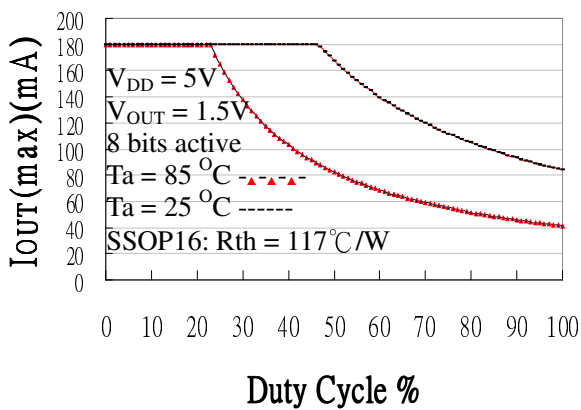
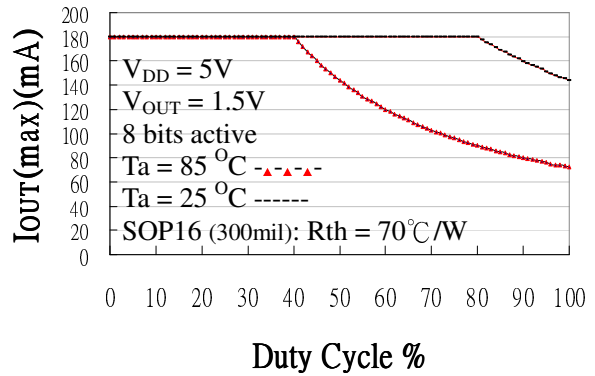
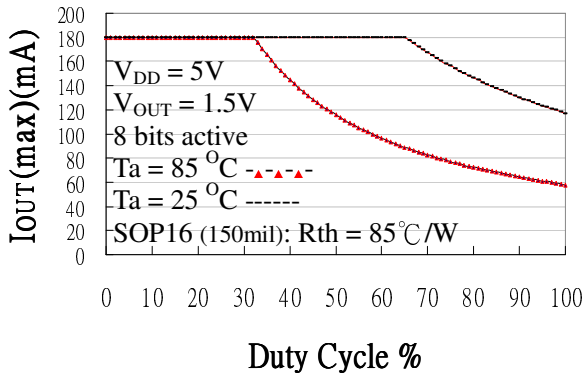


Limitation on Maximum Output Current

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

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

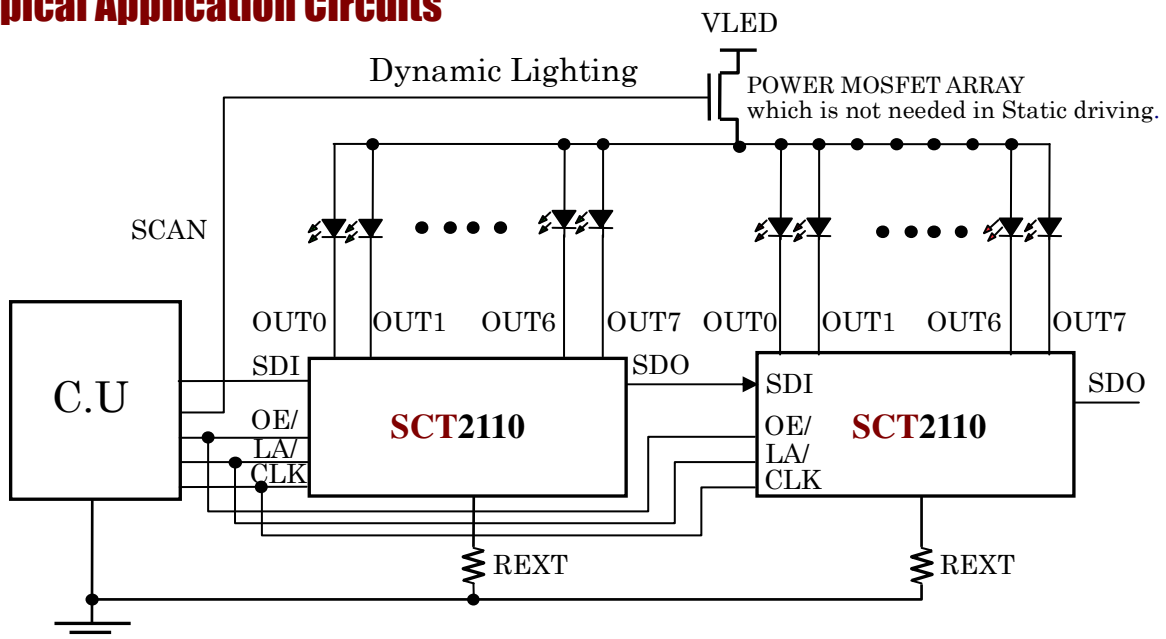
Where $T_{j(max)} = 150^\circ\text{C}$, $N = 8$ (all ON)



Over Temperature Shutdown

The SCT2110 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°C. The outputs are enabled again when the die temperature drops below approximately +130°C.

Typical Application Circuits

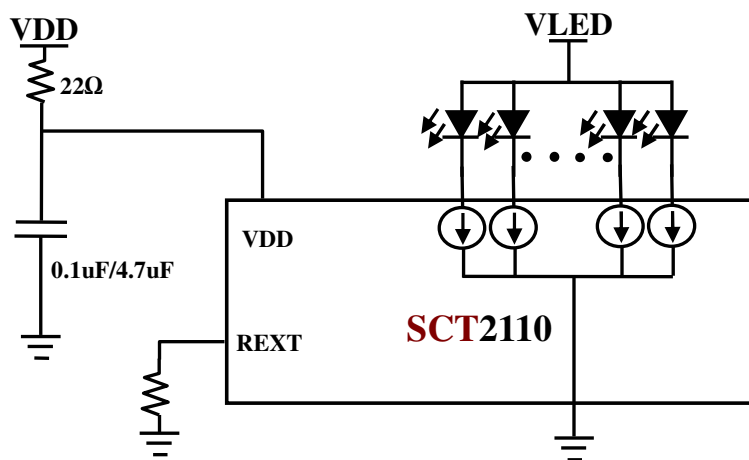


PCB Design Considerations

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 SCT2110. Locate the capacitor as close to the SCT2110 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 SCT2110. 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.

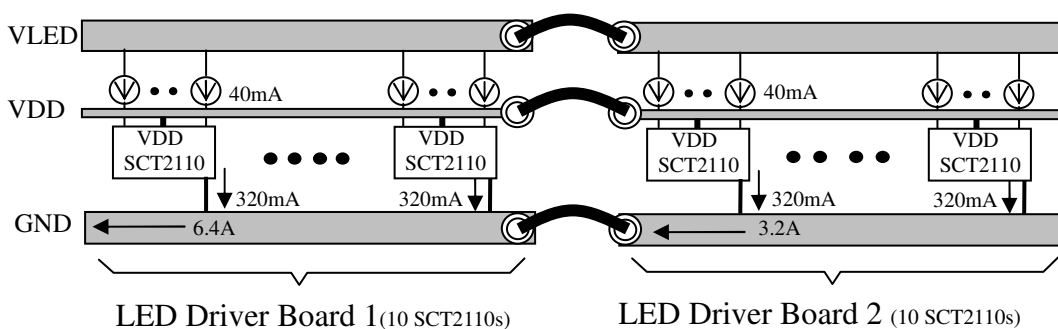


External Resistor (REXT)

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

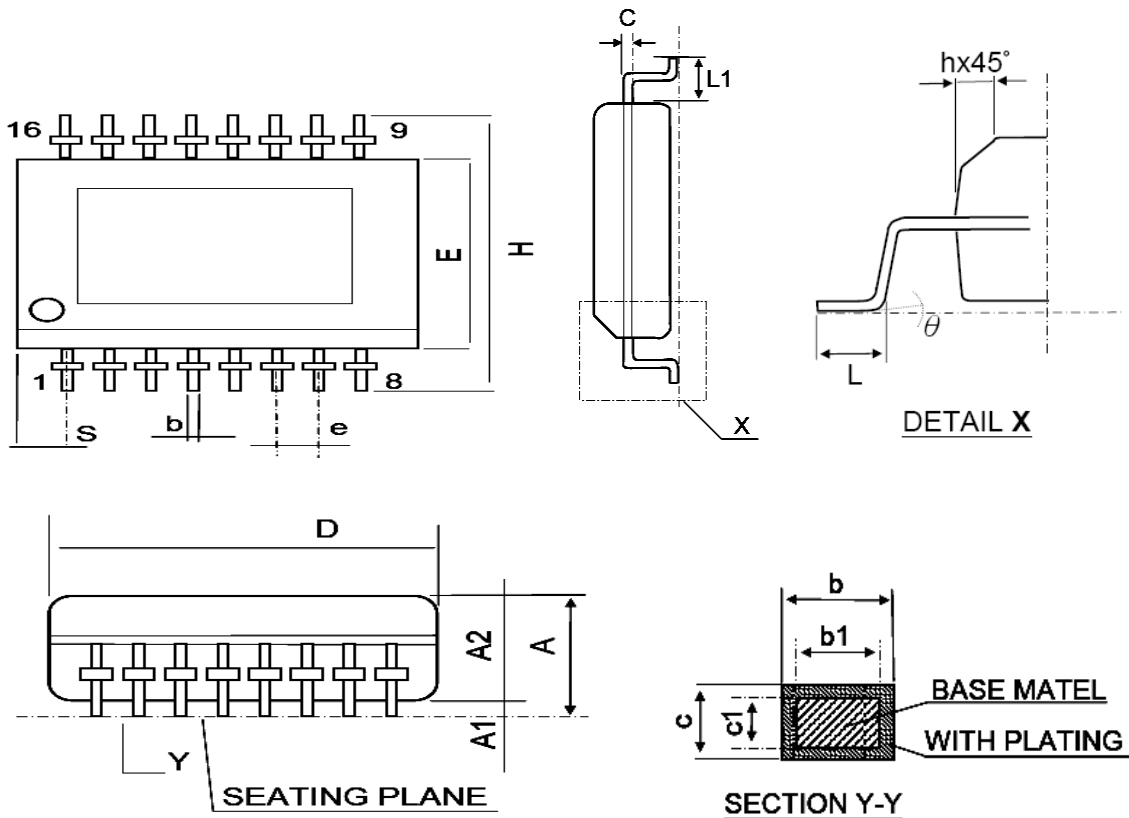
Power and Ground

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 SCT2110 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.



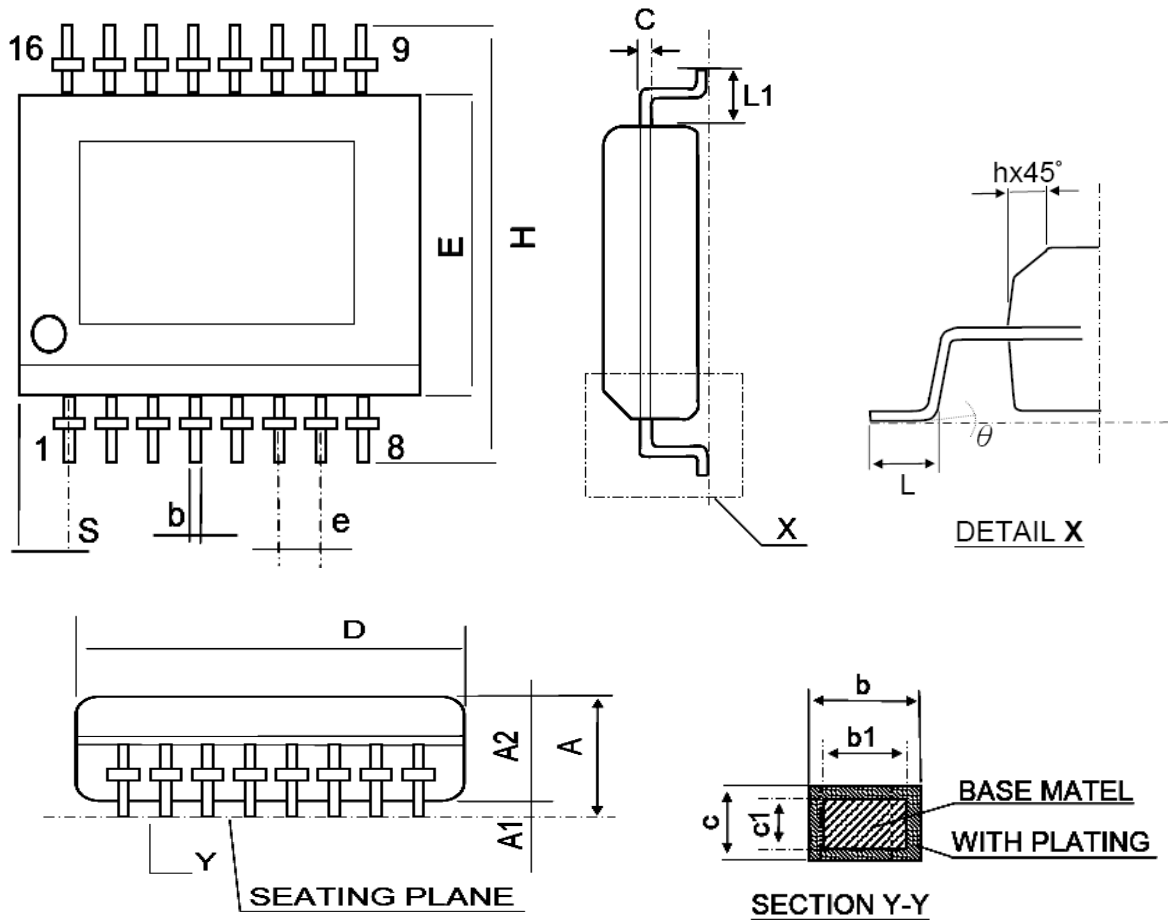
Package Dimension

SOP16 (150 mil)



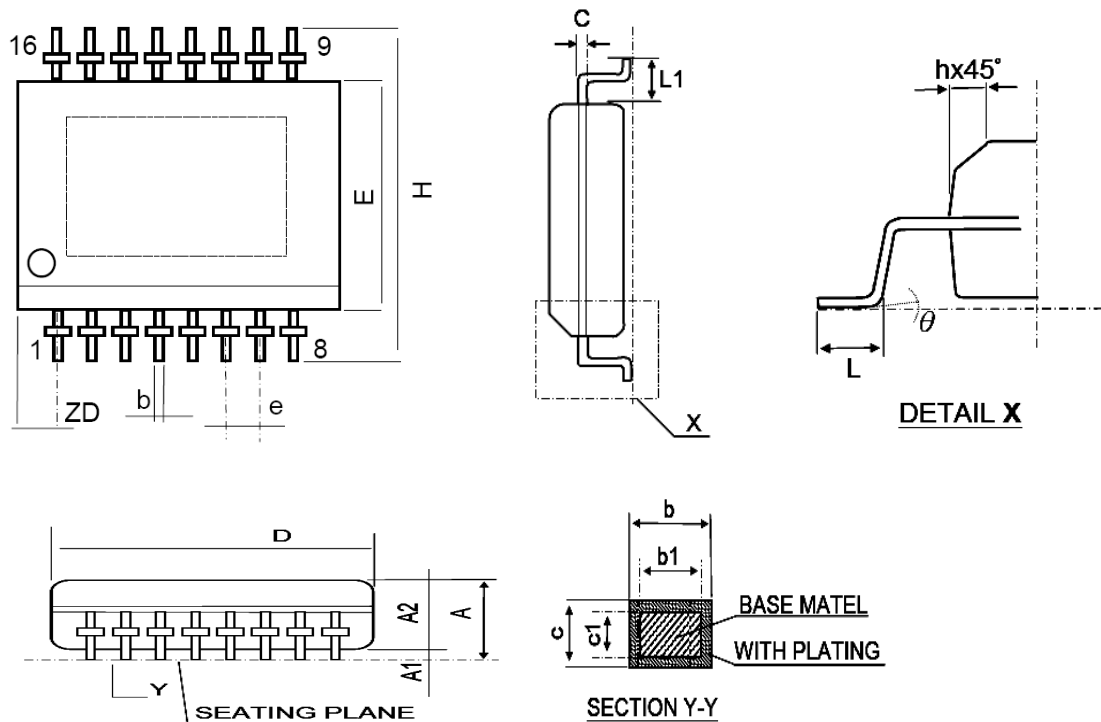
| SYMBOL | DIMENSION (mm) | | | DIMENSION (mil) | | |
|----------|----------------|-------|-------|-----------------|-----|-----|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.35 | 1.60 | 1.75 | 53 | 63 | 69 |
| A1 | 0.10 | 0.15 | 0.25 | 4 | 6 | 10 |
| A2 | 1.25 | 1.45 | 1.55 | 49 | 57 | 61 |
| b | 0.33 | 0.406 | 0.51 | 13 | 16 | 20 |
| b1 | 0.33 | | 0.49 | 13 | | 19 |
| c | 0.19 | 0.203 | 0.25 | 7.5 | 8 | 10 |
| c1 | 0.19 | | 0.23 | 7.5 | | 9 |
| D | 9.80 | 9.90 | 10.00 | 386 | 390 | 394 |
| E | 3.80 | 3.90 | 4.00 | 150 | 154 | 157 |
| e | 1.27 BSC | | | 50 BSC | | |
| H | 5.80 | 6.00 | 6.20 | 228 | 236 | 244 |
| h | 0.25 | 0.42 | 0.50 | 10 | 17 | 20 |
| L | 0.40 | 0.66 | 1.27 | 16 | 26 | 50 |
| L1 | 1.00 | 1.05 | 1.10 | 39 | 41 | 43 |
| S | 0.30 | 0.505 | 0.70 | 12 | 20 | 28 |
| Y | | | 0.075 | | | 3 |
| θ | 0° | | 8° | 0° | | 8° |

SOP16 (300 mil)



| 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 |
| A2 | | | 2.34 | | | 92 |
| b | 0.33 | 0.406 | 0.51 | 13 | 16 | 20 |
| b1 | 0.33 | | 0.49 | 13 | | 19 |
| c | 0.19 | 0.203 | 0.25 | 7.5 | 8 | 10 |
| c1 | 0.19 | | 0.23 | 7.5 | | 9 |
| D | 10.11 | 10.29 | 10.50 | 398 | 405 | 413 |
| E | 7.39 | 7.62 | 7.65 | 291 | 300 | 301 |
| e | 1.27 BSC | | | 50 BSC | | |
| H | 10.00 | 10.31 | 10.65 | 394 | 406 | 419 |
| h | 0.25 | 0.42 | 0.50 | 10 | 17 | 20 |
| L | 0.40 | 0.66 | 1.27 | 16 | 26 | 50 |
| L1 | 1.00 | 1.05 | 1.10 | 39 | 41 | 43 |
| S | 0.30 | 0.505 | 0.70 | 12 | 20 | 28 |
| Y | | | 0.075 | | | 3 |
| θ | 0° | | 8° | 0° | | 8° |

SSOP16



| 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 | 0.254 | 0.30 | 8 | 10 | 12 |
| b1 | 0.20 | 0.254 | 0.28 | 8 | 10 | 11 |
| c | 0.18 | 0.203 | 0.25 | 7 | 8 | 10 |
| c1 | 0.18 | 0.203 | 0.23 | 7 | 8 | 9 |
| D | 4.80 | 4.90 | 5.00 | 189 | 193 | 197 |
| E | 3.80 | 3.90 | 4.00 | 150 | 154 | 157 |
| e | 0.635 BSC | | | 25 BSC | | |
| H | 5.80 | 6.00 | 6.20 | 228 | 236 | 244 |
| 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 | 0.23 REF | | | 9 REF | | |
| Y | | | 0.075 | | | 3 |
| θ | 0° | | 8° | 0° | | 8° |

Revision History

| Data Sheet Version | Remark |
|--------------------|---------------|
| V03_01 | Upgrade spec. |

Information provided by StarChips Technology is believed to be accurate and reliable. Application circuits shown, if any, are typical examples illustrating the operation of the devices. StarChips can not assume responsibility and any problem raising out of the use of the circuits. StarChips reserves the right to change product specification without prior notice.

StarChips Technology, Inc. www.starchips.com.tw
 4F, No.5, Technology Rd., Science-Based Industrial Park, Hsin-Chu, Taiwan, R.O.C. Tel: +886-3-577-5767 # 555