



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

Product Description

The SCT2168 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 120mA. The SCT2168 guarantees each output can endure maximum 17V DC voltage stress. The built-in shift registers and data latches making the SCT2168 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 SCT2168 will satisfy system which needs high volume data transmission to control the LED display.

Features

- ◆ 8 constant current sinker with LED power-supply voltage up to 17V
- ◆ Constant output current : 5 – 120mA@5V, 3 – 80mA@3.3V
- ◆ Excellent current regulation to load, supply voltage and temperature
- ◆ $\pm 1\%$ Current matching between outputs
- ◆ $\pm 3\%$ Current matching between ICs
- ◆ Fast output current control: Minimum PWM pulse width = 120ns
- ◆ All output current are programmed together using a single external resistor
- ◆ CMOS Schmitt trigger inputs with clock rate up to 25MHz
- ◆ Operating supply voltage range of 3.3V to 5.5V
- ◆ Built-in power on reset circuit forces all the outputs off while power on
- ◆ Built-in thermal protection function to prevent damage from over current operation
- ◆ Gradually 2ns delayed outputs to lower output switching noise
- ◆ Package: SOP16, SSOP16,SOP16W
- ◆ Applications: LED Displays, Variable Message Signs, LED Traffic Signs

Selector Guide

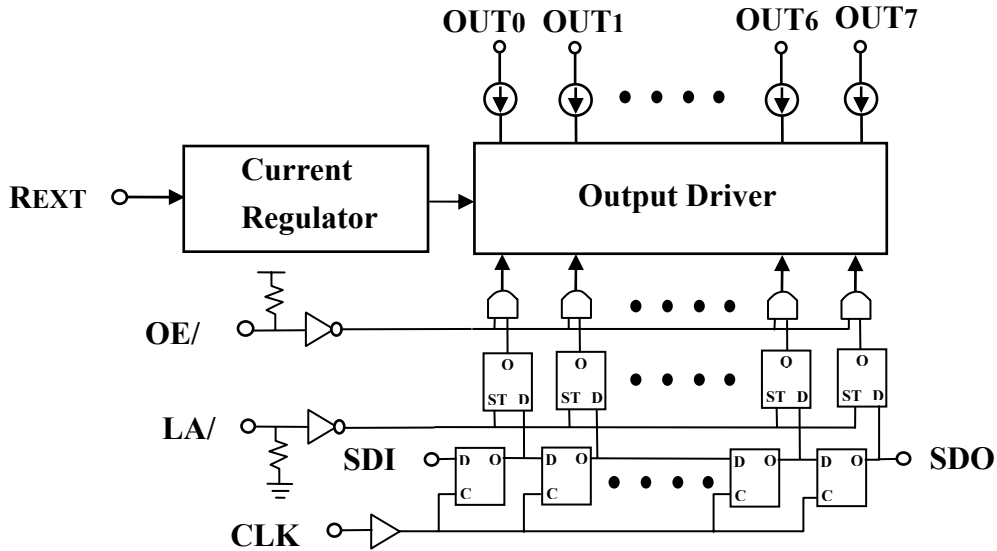
| Part | Number of Outputs | Max Output Current (mA) | Min PWM Pulse Width (ns) | Supply Voltage (V) |
|---------|-------------------|-------------------------|--------------------------|--------------------|
| SCT2110 | 8 | 180 | 100 | 5 |
| SCT2167 | 8 | 60 | 180 | 3.3/5 |
| SCT2168 | 8 | 120 | 120 | 3.3/5 |
| SCT2210 | 16 | 120 | 50 | 5 |
| SCT2026 | 16 | 90 | 120 | 5 |
| SCT2024 | 16 | 60 | 180 | 3.3/5 |

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Block Diagram



Pin Configuration

Ordering information

| | | | | |
|------|---|---|----|------|
| GND | 1 | ● | 16 | VDD |
| SDI | 2 | | 15 | REXT |
| CLK | 3 | | 14 | SDO |
| LA/ | 4 | | 13 | OE/ |
| OUT0 | 5 | | 12 | OUT7 |
| OUT1 | 6 | | 11 | OUT6 |
| OUT2 | 7 | | 10 | OUT5 |
| OUT3 | 8 | | 9 | OUT4 |

SCT2168

| Part Number | Package |
|-------------|--------------|
| SCT2168CSOG | Green SOP16 |
| SCT2168CSSG | Green SSOP16 |
| SCT2168CSWG | Green SOP16W |

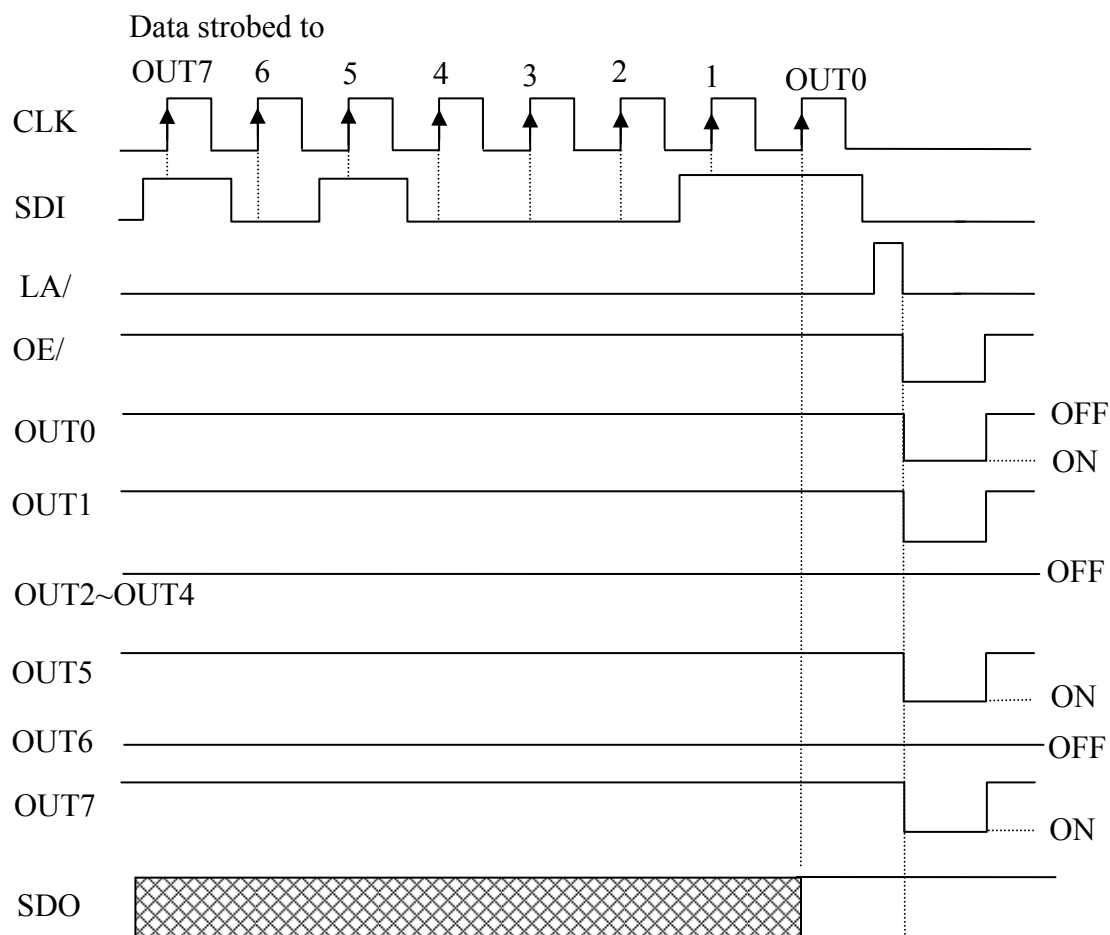
Terminal Description

| Pin No. | Pin Name | Function |
|---------|-------------|--|
| 1 | GND | Ground terminal. |
| 2 | SDI | Serial input terminal of data shift register. |
| 3 | CLK | Clock input terminal of shift register, data is sampled at the rising edge of CLK. |
| 4 | LA/ | Data is latched when LA/ is low. Data on shift register goes through when LA/ is high. |
| 5 ~ 12 | OUT0 ~ OUT7 | Output terminals with constant current. |
| 13 | OE/ | Input terminal of output enable signal. Output is enabled when OE/ is low. |
| 14 | SDO | Output terminal of serial-data output to the SDI of next SCT2168. |
| 15 | REXT | Input terminal used to connect an external resistor for setting up all output current. |
| 16 | VDD | Supply voltage terminal. |

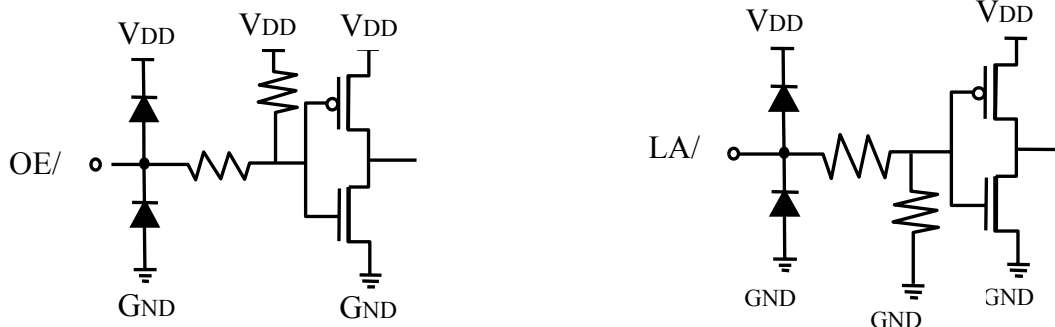
Truth Table

| CLK | LA/ | OE/ | SDI | OUT0 ~ OUT7 | SDO |
|-----|-----|-----|------|--------------------------|------|
| ↑ | H | L | Dn | Dn Dn-1 ---- Dn-6 Dn-7 | Dn-7 |
| ↑ | L | L | Dn+1 | No change | Dn-6 |
| ↑ | H | L | Dn+2 | Dn+2 Dn+1 ---- Dn-6 Dn-5 | Dn-5 |
| ↓ | X | L | Dn+3 | Dn+2 Dn+1 ---- Dn-6 Dn-5 | Dn-5 |
| ↓ | X | H | Dn+3 | Off | Dn-5 |

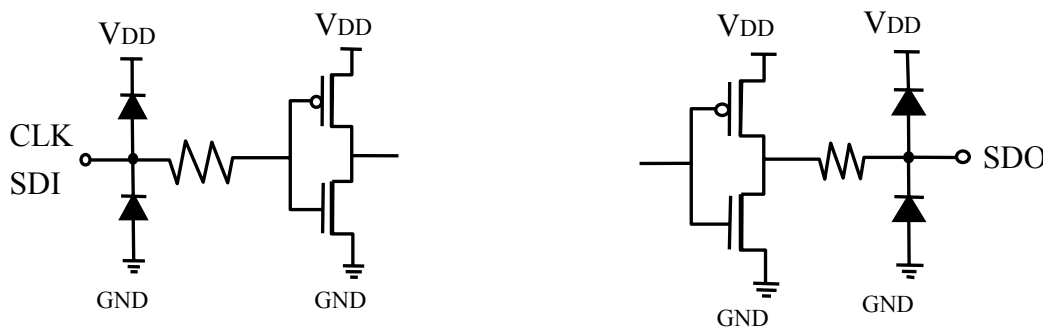
Timing Diagram



Equivalent Circuits of Inputs (1)



Equivalent Circuits of Inputs (2)



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} | 120 | mA/Channel |
| Output voltage | V_{OUT} | -0.2 ~ 17.0 | V |
| Total GND terminals current | I_{GND} | 960 | mA |
| Power Dissipation(on PCB) | P_{DI} | 1.47 | W |
| | P_{DII} | 1.79 | |
| | P_{DIII} | 1.07 | |
| Thermal Resistance(on PCB) | $R_{TH(j-a)I}$ | 85 | °C /W |
| | $R_{TH(j-a)II}$ | 70 | |
| | $R_{TH(j-a)III}$ | 117 | |
| Operating temperature | T_{OPR} | -40~+85 | °C |
| Storage temperature | T_{STG} | -55~+150 | °C |

● Type I : SOP16, II : SOP16W, III : SSOP16

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

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|-----------------|-----------|-------------------|-------------|------|-------------|------|
| Supply voltage | V_{DD} | - | 3 | - | 5.5 | V |
| Output voltage | V_{OUT} | Output OFF | - | - | 17 | V |
| Output voltage | V_{OUT} | Output ON | 1 | - | 4 | V |
| Output current | I_{OUT} | $V_{DD} = 3.3/5V$ | 5 | - | 60/90 | 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 | $V_{DD} = 3.3/5V$ | 120 | - | - | ns |

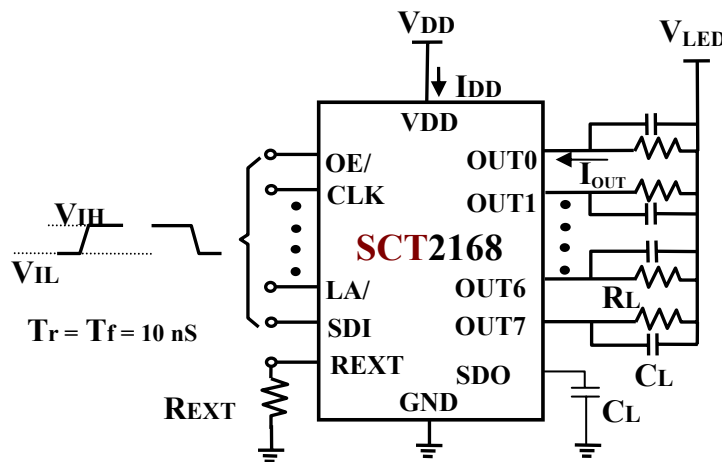
Electrical Characteristics ($V_{DD} = 3.3/5V$, $T_a = 25$ °C unless otherwise noted)

| 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} | $V_{DD} = 3.3/5V$, $I_{OH} = -1mA$ | 3.0/4.5 | - | - | V | |
| | V_{OL} | $V_{DD} = 3.3/5V$, $I_{OL} = +1mA$ | - | - | 0.4 | V | |
| Output leakage current | I_{OL} | $V_{OUT} = 17V$ | - | - | 0.5 | μA | |
| Output current | I_{OUT} | $V_{OUT} = 1.0V$, $R_{EXT} = 900\Omega$ | - | 42 | - | mA | |
| Current bit skew | dI_{OUT} | $I_{OUT} = 42mA$, $V_{OUT} = 1.0V$, $R_{EXT} = 900\Omega$ | - | ± 1 | ± 2 | % | |
| Output current | I_{OUT} | $V_{OUT} = 1.0V$, $R_{EXT} = 1860\Omega$ | - | 20 | - | mA | |
| Current bit skew | dI_{OUT} | $I_{OUT} = 20mA$, $V_{OUT} = 1.0V$, $R_{EXT} = 1860\Omega$ | - | ± 1 | ± 2 | % | |
| I_{OUT} vs. supply voltage regulation | $\%/dV_{DD}$ | $3V < V_{DD} < 5.5V$, $V_{OUT} > 1.0V$, $R_{EXT} = 900\Omega$ | - | - | ± 1 | %/V | |
| I_{OUT} vs. output voltage regulation | $\%/dV_{OUT}$ | $1V < V_{OUT} < 4V$, $I_{OUT} = 42mA$, $R_{EXT} = 900\Omega$ | - | ± 0.1 | ± 0.5 | %/V | |
| Pull-up resistor | $R_{in(up)}$ | OE/ | - | 500 | - | K Ω | |
| Pull-down resistor | $R_{in(down)}$ | LA/ | - | 500 | - | K Ω | |
| Thermal Shutdown | T_H | Junction Temp. | - | 160 | - | $^{\circ}C$ | |
| | T_L | | - | 110 | - | $^{\circ}C$ | |
| Supply current | OFF | $I_{DD(off)1}$ | $R_{EXT} = \text{Open}$, $V_{DD} = 3.3/5V$, $OUT_0 \sim OUT_7 = \text{Off}$ | - | 2 | 3 | mA |
| | | $I_{DD(off)2}$ | $R_{EXT} = 900\Omega$, $V_{DD} = 3.3/5V$, $OUT_0 \sim OUT_7 = \text{Off}$ | - | 5 | 7 | |
| | ON | $I_{DD(on)}$ | $R_{EXT} = 900\Omega$, $V_{DD} = 3.3/5V$, $OUT_0 \sim OUT_7 = \text{On}$ | - | 8 | 10 | |

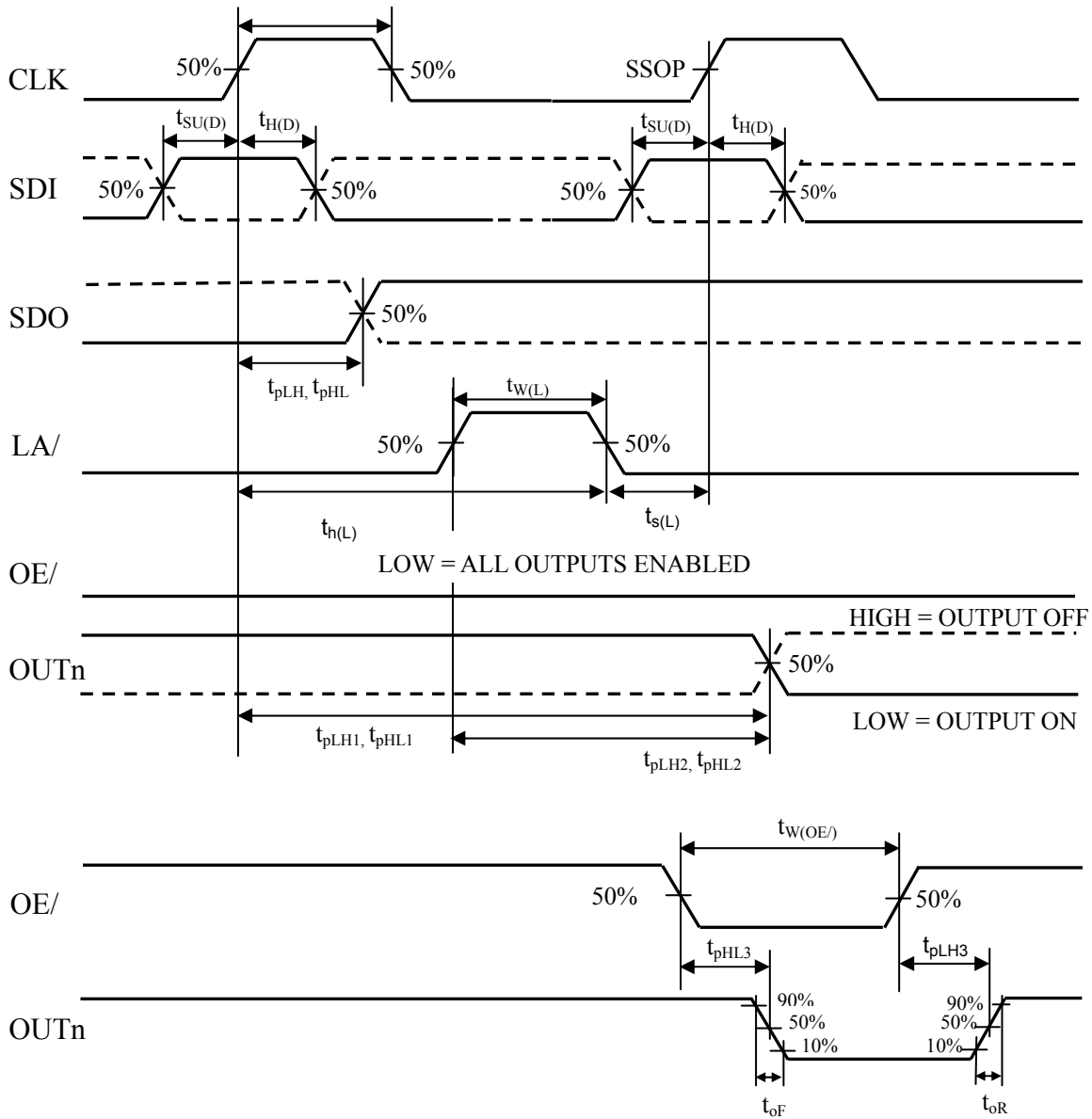
Switching Characteristics (Ta=25°C unless otherwise noted)

| Characteristic | | Symbol | Condition | Min. | Typ. | Max. | Unit | | |
|-------------------------------------|------------|---------------------|--|--|--|--|------|-----|----|
| Propagation Delay Time ("L" to "H") | CLK - OUTn | t _{pLH1} | V _{DD} = 3.3/5V V _{LED} = 5V V _{IH} = V _{DD} V _{IL} = GND R _{EXT} = 1860 Ω R _L = 180 Ω C _L = 10 pF | - | 80 | 100 | ns | | |
| | LA/ - OUTn | t _{pLH2} | | - | 80 | 100 | ns | | |
| | OE/ - OUTn | t _{pLH3} | | - | 80 | 100 | ns | | |
| | CLK - SDO | t _{pLH} | | - | 20 | 40 | ns | | |
| Propagation Delay Time ("H" to "L") | CLK - OUTn | t _{pHL1} | | V _{DD} = 3.3/5V V _{LED} = 5V V _{IH} = V _{DD} V _{IL} = GND R _{EXT} = 1860 Ω R _L = 180 Ω C _L = 10 pF | - | 80 | 100 | ns | |
| | LA/ - OUTn | t _{pHL2} | | | - | 80 | 100 | ns | |
| | OE/ - OUTn | t _{pHL3} | | | - | 80 | 100 | ns | |
| | CLK - SDO | t _{pHL} | | | - | 20 | 40 | ns | |
| Pulse Width | CLK | t _{w(CLK)} | | | V _{DD} = 3.3/5V V _{LED} = 5V V _{IH} = V _{DD} V _{IL} = GND R _{EXT} = 1860 Ω R _L = 180 Ω C _L = 10 pF | 20 | - | - | ns |
| | LA/ | t _{w(L)} | | | | 20 | - | - | ns |
| | OE/ | t _{w(OE/)} | | | | 120 | - | - | ns |
| Hold Time for LA/ | | t _{h(L)} | | | | V _{DD} = 3.3/5V V _{LED} = 5V V _{IH} = V _{DD} V _{IL} = GND R _{EXT} = 1860 Ω R _L = 180 Ω C _L = 10 pF | 5 | - | - |
| Setup Time for LA/ | | t _{s(L)} | 5 | | | | - | - | ns |
| Output Rise Time of Iout | | t _{oR} | - | | | | 80 | 100 | ns |
| Output Fall Time of Iout | | t _{oF} | - | | | | 80 | 100 | ns |
| Output Delay | | t _{dR} | OUT _{n+1} - OUT _n | | | | - | 2 | - |
| | | t _{dF} | | - | | | 2 | - | ns |
| Slow CLK rise time | | t _R | Cascade | - | | | - | 500 | ns |
| Slow CLK fall time | | t _F | | - | | | - | 500 | ns |

Test Circuit for Switching Characteristics

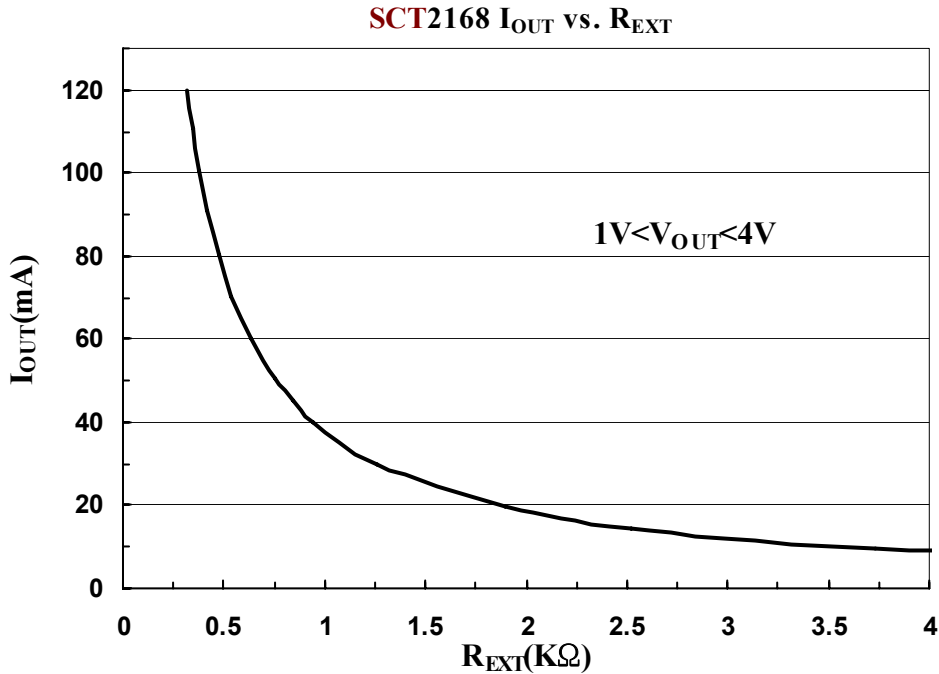


Timing Waveform



Adjusting Output Current

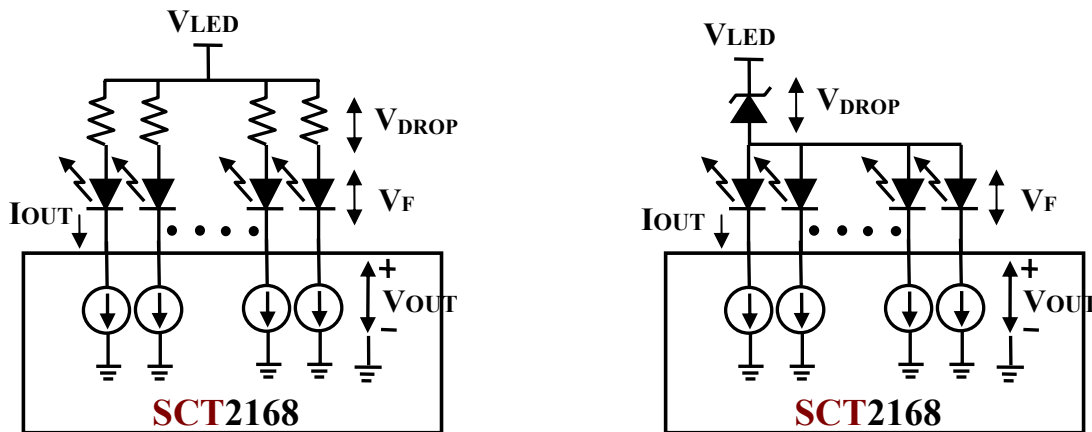
All SCT2168's output current (I_{OUT}) are set by one external resistor at pin R_{EXT} . The relationship between I_{OUT} and resistance R_{EXT} is shown as the following figure.



Also, when SCT2168's output voltage is set between 1 Volt and 4 Volt, the output current can be estimated approximately by: $I_{OUT} = 60(620 / R_{EXT})$ (mA)(chip skew ± 5). Thus the output current are all set to be about 42mA at $R_{EXT} = 900\Omega$.

Load Supply Voltage (V_{LED})

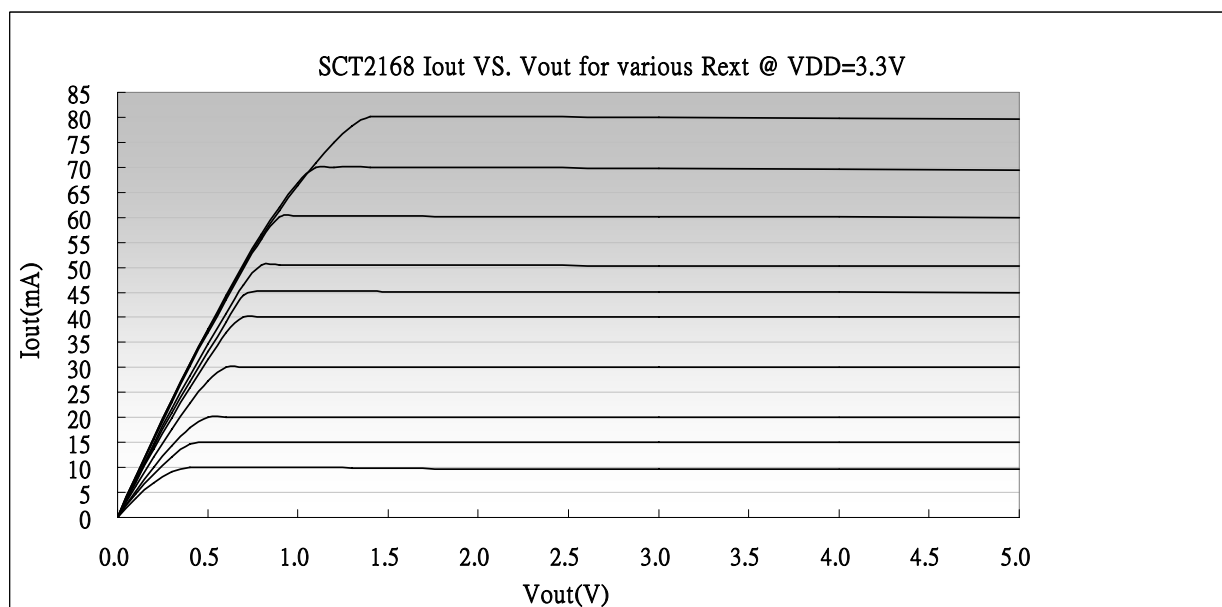
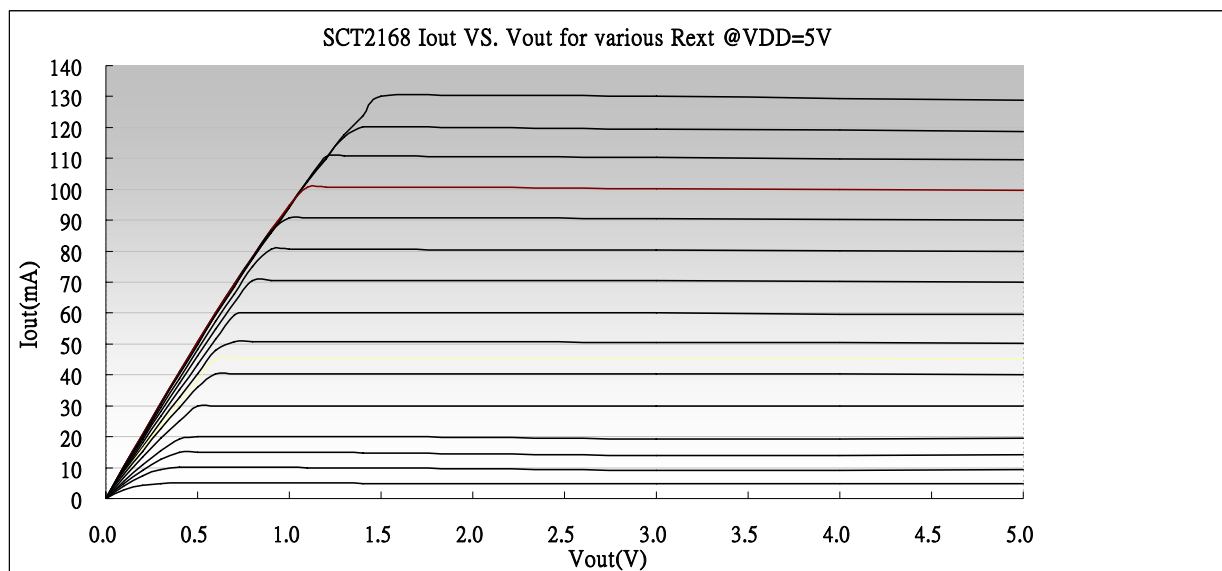
The SCT2168 can operate very well when V_{OUT} ranging from 1V to 4V. So it is recommended to use the lowest possible supply voltage or set a voltage reducer to reduce the V_{OUT} voltage. A voltage reducer lets $V_{OUT} = V_{LED} - V_{DROP} - V_F$. Resistors or Zener diode can be used in the applications as shown in the following figures.



Constant Current

The current characteristic of output stage is flat. The output current can be kept constant regardless of the variations of LED forward voltage when $V_{OUT} > 1.0V$.

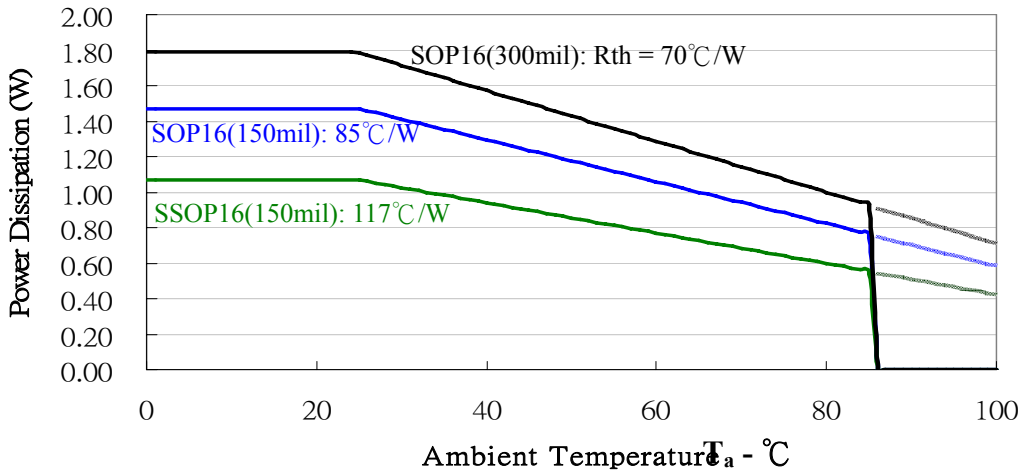
The relationship between I_{OUT} and V_{OUT} is shown as below:



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°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:

SCT2168 Max. Power Dissipation at Various Ambient Temperature

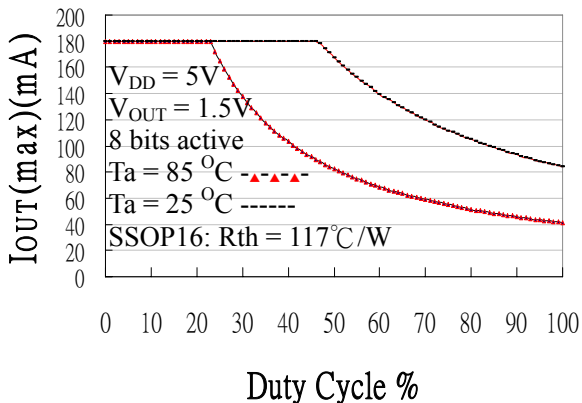
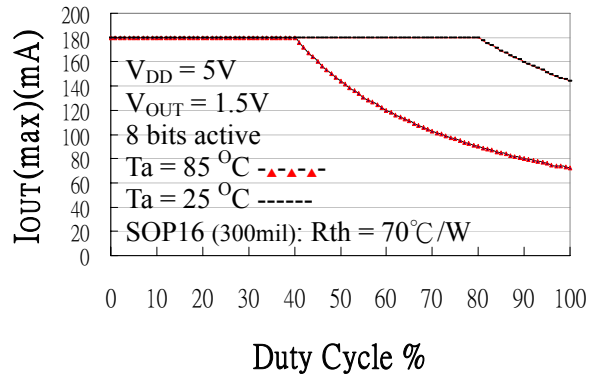
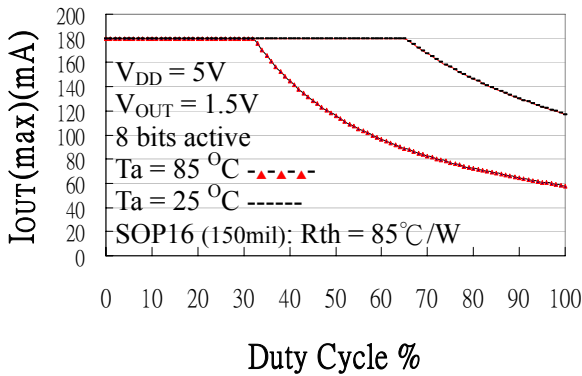


Limitation on Maximum Output Current

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

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

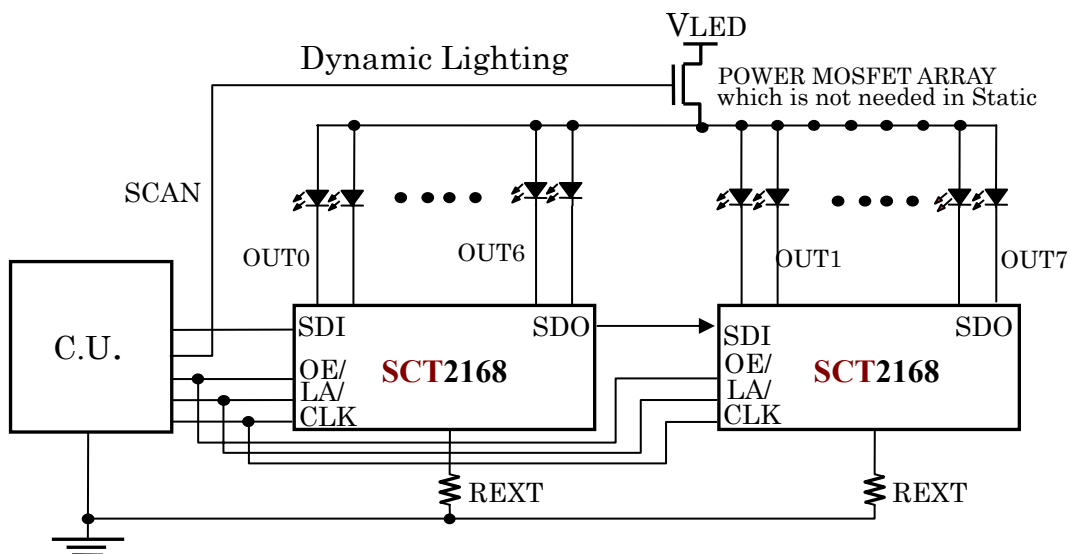
Where $T_{j(max)} = 150^\circ\text{C}$, $N = 8$ (all ON)



Over Temperature Shutdown

The SCT2168 contains thermal shutdown scheme to prevent damage from over heat. The internal thermal sensor turns off all outputs when the die temperature exceeds approximately $+160^{\circ}\text{C}$. The outputs are enabled again when the die temperature drops below approximately $+110^{\circ}\text{C}$.

Typical Application Circuits

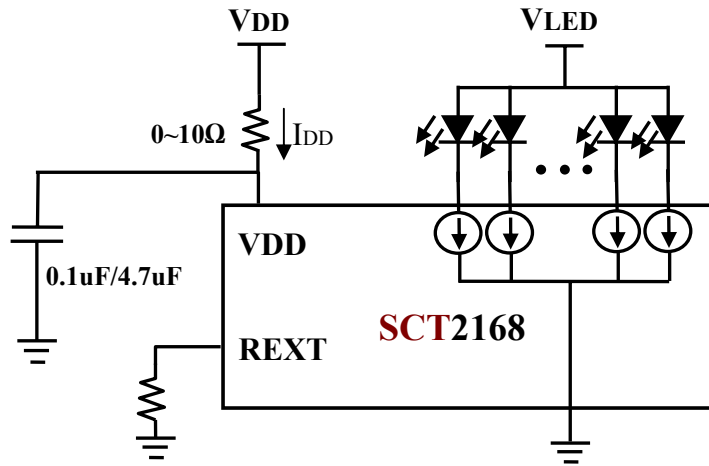


PCB Design Considerations

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

Decoupling Capacitor

Place a decoupling capacitor e.g. $0.1\mu\text{F}$ between VDD and GND pins of SCT2168. Locate the capacitor as close to the SCT2168 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 $4.7\mu\text{F}$ or more to each supply for every SCT2168. 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.

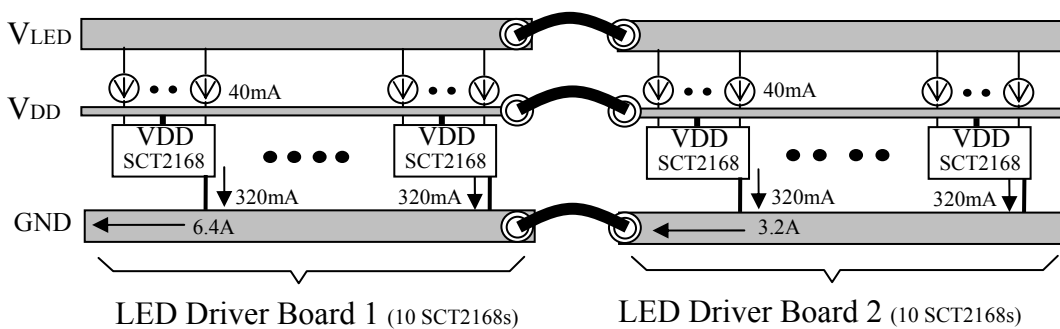


External Resistor (REXT)

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

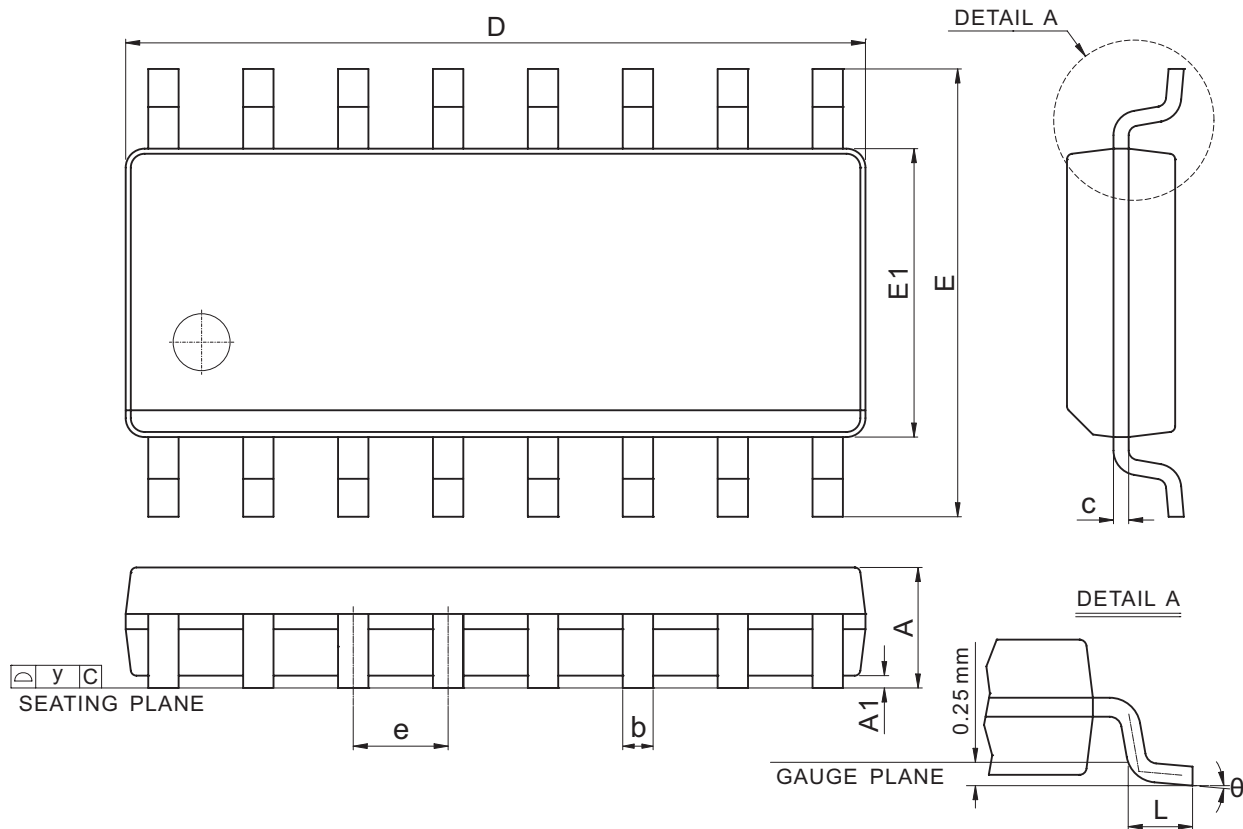
Power and Ground

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. less than 10Ω series in power input pin VDD of SCT2168 in conjunction with decoupling capacitor shunting the ICs is recommended. Separating and feeding the LED power from another supply terminal VLED is strongly recommended as well to get stable supply voltage at pins of VDD.



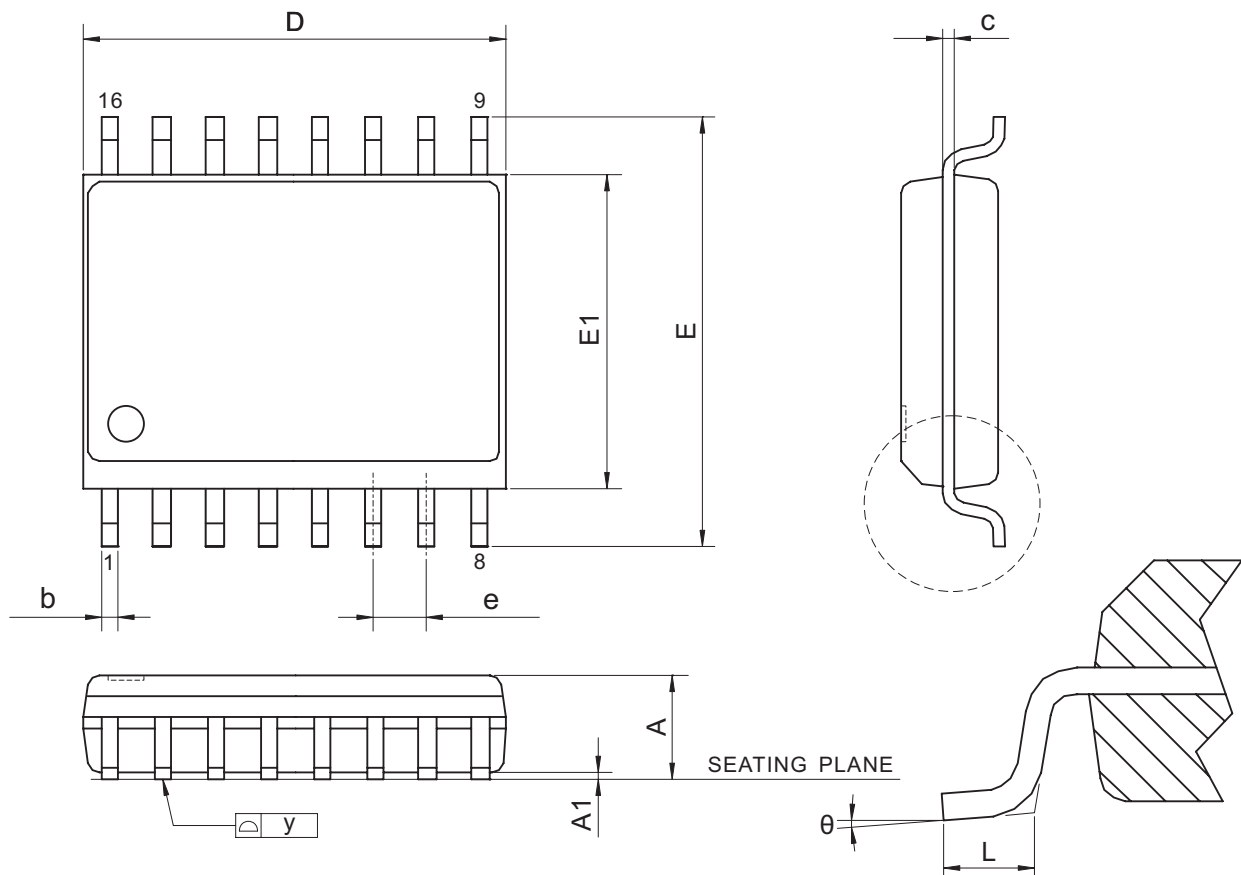
Package Dimension

SOP16([check up-to-date version](#))



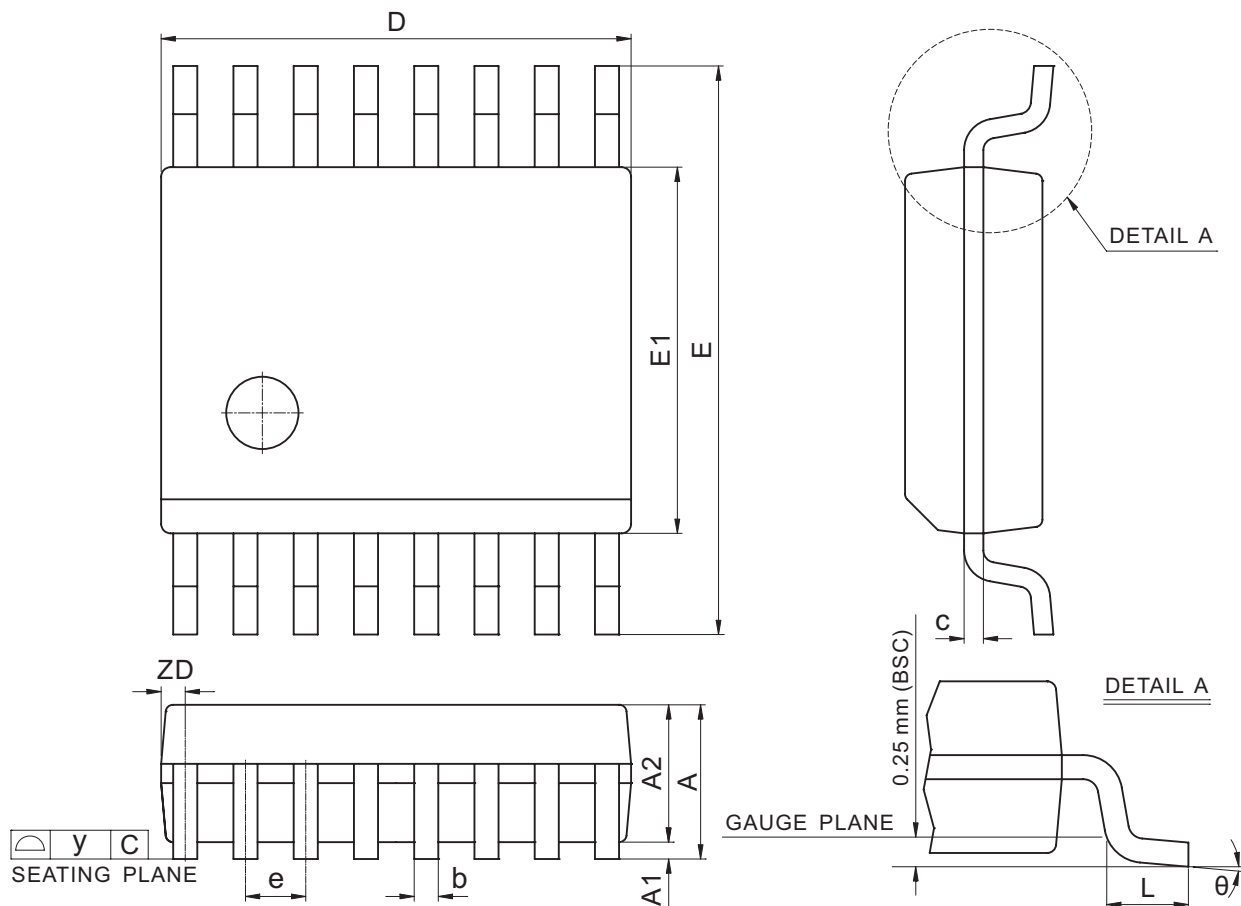
| Symbol | Dimension (mm) | | | Dimension (mil) | | |
|--------|----------------|------|-------|-----------------|------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 1.35 | - | 1.75 | 53.1 | - | 68.9 |
| A1 | 0.10 | - | 0.25 | 3.9 | - | 9.8 |
| b | 0.33 | - | 0.51 | 13.0 | - | 20.1 |
| c | 0.19 | - | 0.25 | 7.5 | - | 9.8 |
| D | 9.80 | - | 10.00 | 385.8 | - | 393.7 |
| E | 5.80 | - | 6.20 | 228.3 | - | 244.1 |
| E1 | 3.80 | - | 4.00 | 149.6 | - | 157.5 |
| e | 1.27 BSC | | | 50.0 BSC | | |
| L | 0.40 | - | 1.27 | 15.7 | - | 50.0 |
| θ | 0° | - | 8° | 0° | - | 8° |
| y | - | - | 0.10 | - | - | 3.9 |

SOP16W([check up-to-date version](#))



| Symbol | Dimension (mm) | | | Dimension (mil) | | |
|--------|----------------|------|-------|-----------------|------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 2.36 | - | 2.64 | 93.0 | - | 104.0 |
| A1 | 0.10 | - | 0.30 | 4.0 | - | 12.0 |
| b | - | 0.41 | - | - | 16.0 | - |
| c | - | 0.2 | - | - | 8.0 | - |
| D | 10.12 | - | 10.49 | 398.0 | - | 413.0 |
| E | 10.01 | - | 10.64 | 394.0 | - | 419.0 |
| E1 | 7.39 | - | 7.59 | 291.0 | - | 299.0 |
| e | - | 1.27 | - | - | 50.0 | - |
| L | 0.41 | - | 1.27 | 16.0 | - | 50.0 |
| θ | 0° | - | 8° | 0° | - | 8° |
| y | - | - | 0.10 | - | - | 4.0 |

SSOP16([check up-to-date version](#))



| Symbol | Dimension (mm) | | | Dimension (mil) | | |
|--------|----------------|------|------|-----------------|-------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 1.35 | 1.63 | 1.75 | 53.1 | 64.2 | 68.9 |
| A1 | 0.10 | 0.15 | 0.25 | 3.9 | 5.9 | 9.8 |
| A2 | - | - | 1.50 | - | - | 59.1 |
| b | 0.20 | - | 0.30 | 7.9 | - | 11.8 |
| c | 0.18 | - | 0.25 | 7.1 | - | 9.8 |
| D | 4.80 | 4.90 | 5.00 | 189.0 | 192.9 | 196.9 |
| E | 5.79 | 5.99 | 6.20 | 228.0 | 235.8 | 244.1 |
| E1 | 3.81 | 3.91 | 3.99 | 150.0 | 153.9 | 157.1 |
| e | 0.64 BSC | | | 25.0 BSC | | |
| L | 0.41 | 0.64 | 1.27 | 16.1 | 25.0 | 50.0 |
| y | - | - | 0.10 | - | - | 3.9 |
| ZD | 0.23 REF | | | 9.0 REF | | |
| θ | 0° | - | 8° | 0° | - | 8° |

Revision History ([check up-to-date version](#))

| Data Sheet Version | Remark |
|--------------------|-------------|
| V01_01 | New Release |

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[LYT4217E2](#) [LYT4218E2](#) [LYT4222E](#) [LYT4317E2](#) [LYT4321E](#) [LYT4323E](#) [LYT4324E3](#) [LYT4326E3](#) [TPS92020DR](#) [TPS92691PWPR](#)
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