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

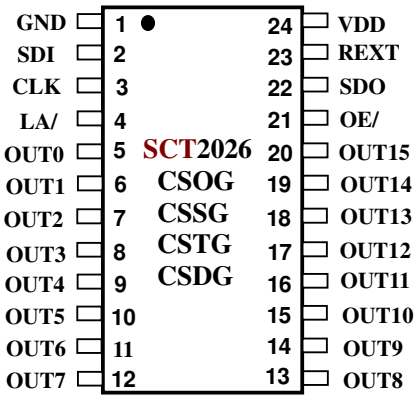
Product Description

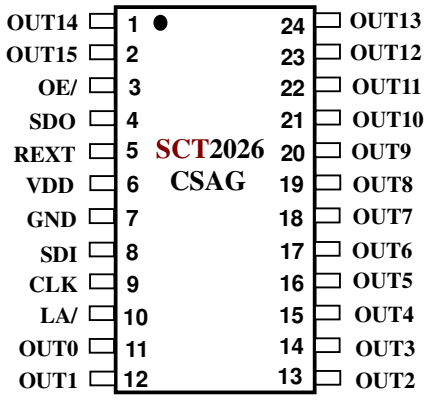
The SCT2026 serial-interfaced LED driver sinks 16 LED clusters with constant current to keep the uniform intensity of LED displays. In applications, an external resistor is used to set the full-scale constant output current from 5mA up to 90mA. The SCT2026 guarantees each output can endure maximum 17V DC voltage stress. The built-in shift registers and data latches making the SCT2026 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 SCT2026 will satisfy system which needs high volume data transmission to control the LED display.

Features

- 16 constant-current outputs rate at 17V
- Constant output current range: 5 – 90mA
- Excellent current regulation to load, supply voltage and temperature
- ±2% Current matching between outputs
- ±5% 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 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

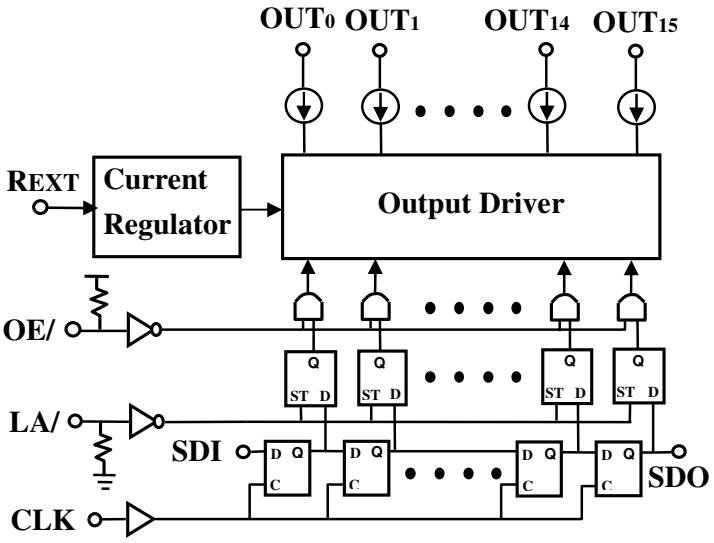




Terminal Description

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 SCT2026.
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
SCT2026CSOG	Pb free SOP24
SCT2026CSSG	Pb free SSOP24
SCT2026CSAG	Pb free SSOP24
SCT2026CSTG	Pb free SSOP24-1.0
SCT2026CSDG	Pb free SDIP24

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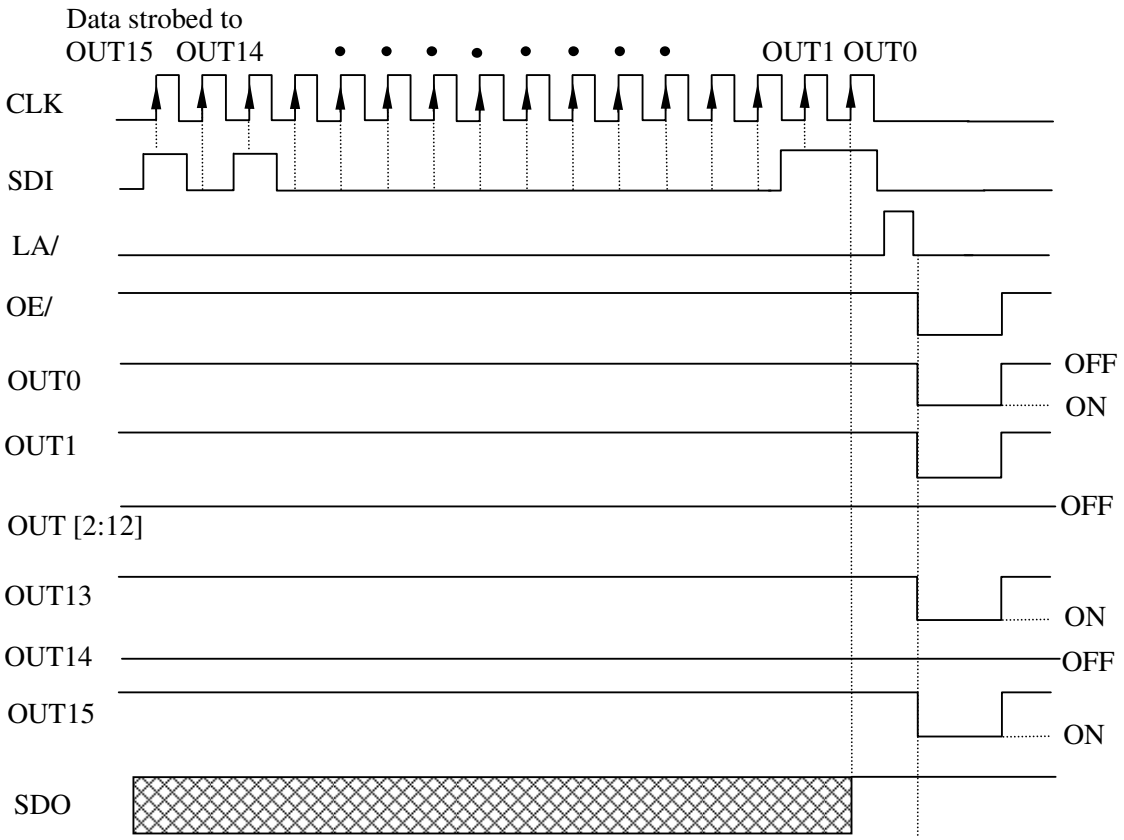
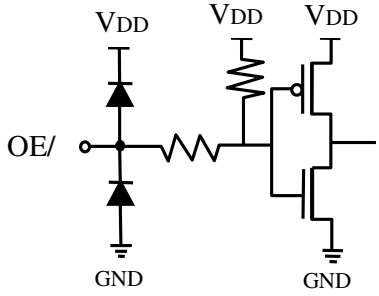
Truth Table

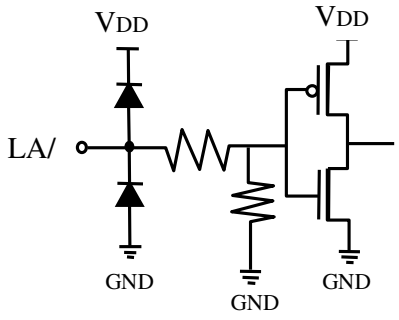
CLK	LA/	OE/	SDI	OUT0 ~ OUT15	SDO
↑	H	L	Dn	Dn Dn-1 ---- Dn-14 Dn-15	Dn-15
↑	L	L	Dn+1	No change	Dn-14
↑	H	L	Dn+2	Dn+2 Dn+1 ---- Dn-12 Dn-13	Dn-13
↓	X	L	Dn+3	Dn+2 Dn+1 ---- Dn-12 Dn-13	Dn-13
↓	X	H	Dn+3	Off	Dn-13

Timing Diagram

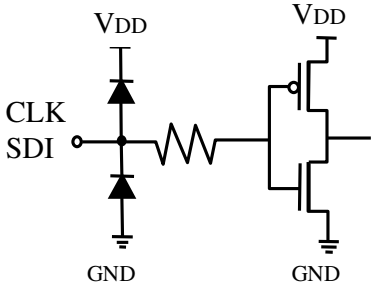


Equivalent Circuits of Inputs (1)

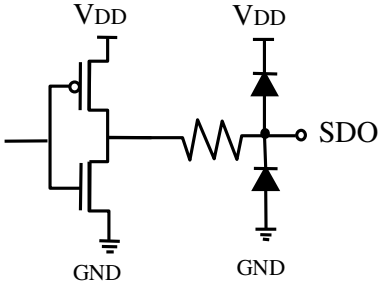




Equivalent Circuits of Inputs (2)



Equivalent Circuits of Output



Maximum Ratings (TA = 25℃)

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}	90	mA / Channel
Output Voltage		V_{OUT}	-0.2 ~ 17.0	V
Total GND Terminals Current		I_{GND}	1200	mA
Power Dissipation	SOP24	P_D	2.05	W
	SSOP24		1.49	
	SSOP24-1.0		1.84	
	SDIP24		2.08	
Thermal Resistance	SOP24	$R_{TH(j-a)}$	61	℃ / W
	SSOP24		84	
	SSOP24-1.0		68	
	SDIP24		60	
Operating Temperature		T_{OPR}	-40~+85	℃
Storage Temperature		T_{STG}	-55~+150	℃

Stresses beyond those listed under "Maximum Ratings" may cause permanent damage to the device.

Exposure to the maximum rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions (TA= -40 to 85℃ 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	-	60	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	120	-	-	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
SCT2168	8	120	120	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, TA=25℃ 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}=900Ω	-	21	-	mA
Current Bit Skew(Note 1)		dI_{OUT1}	V_{OUT}=1V, R_{EXT}=900Ω	-	-	±2	%
Current Chip Skew		dI_{OUT2}	V_{OUT}=1V, R_{EXT}=900Ω	-	-	±5	%
I_{OUT} vs. V_{DD} Regulation		%/dV_{DD}	4.5V < V_{DD} < 5.5V, V_{OUT} > 1V, R_{EXT}=900Ω	-	-	±1	%/V
I_{OUT} vs. V_{OUT} Regulation		%/dV_{OUT}	1V < V_{OUT} < 4V I_{OUT}=21mA, R_{EXT}=900Ω	-	±0.1	±0.5	%/V
Pull-up Resistor		R_{up}	OE/	-	500	-	KΩ
Pull-down Resistor		R_{down}	LA/	-	500	-	KΩ
Thermal Shutdown		T_H	Junction Temperature	-	160	-	℃
		T_L		-	110	-	℃
Supply Current	OFF	$I_{DD(off)1}$	R_{EXT} =Open, V_{DD} = 5V OUT [0:15]=Off	-	3	4	mA
		$I_{DD(off)2}$	R_{EXT} = 900Ω, V_{DD} = 5V OUT [0:15]=Off	-	6	8	
	ON	$I_{DD(on)}$	R_{EXT} = 900 Ω, V_{DD} = 5V OUT [0:15]=On	-	9	11	

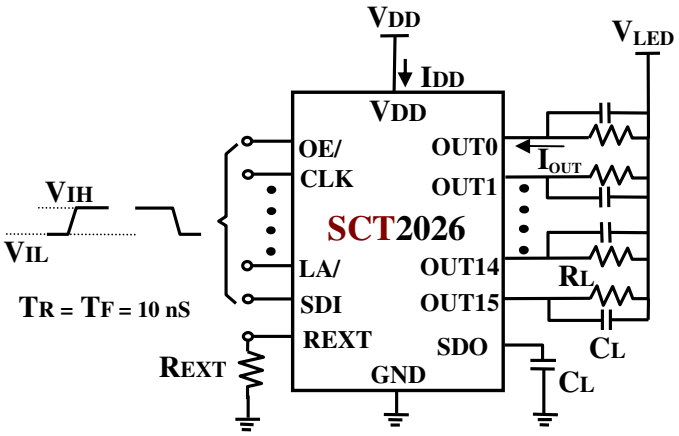
Note 1: Bit Skew=(I_{OUT}-I_{AVG})/I_{AVG}, where I_{AVG}=(I_{max} + I_{min})/2

Switching Characteristics (TA=25℃ unless otherwise noted)(Note 2)

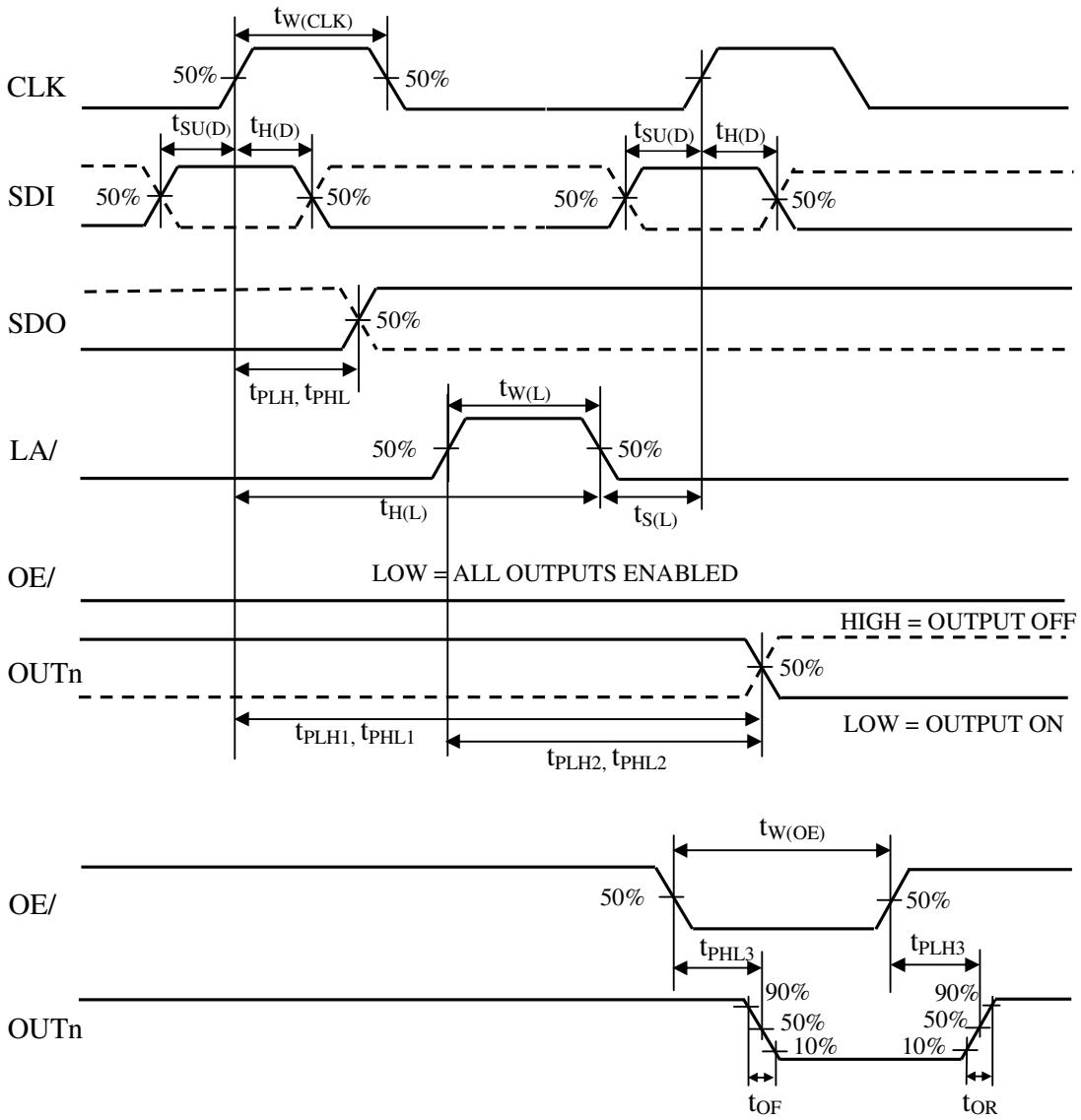
Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time (“L” to “H”)	CLK - OUTn	t_{PLH1}	V_{DD} = 5V V_{LED} = 5V V_{IH} = V_{DD} V_{IL}= GND R_{EXT} = 900 Ω R_L = 180 Ω C_L = 10 pF	-	60	80	ns
	LA/ - OUTn	t_{PLH2}		-	80	100	ns
	OE/ - OUTn	t_{PLH3}		-	80	100	ns
	CLK - SDO	t_{PLH}		-	15	30	ns
Propagation Delay Time (“H” to “L”)	CLK - OUTn	t_{PHL1}		-	60	80	ns
	LA/ - OUTn	t_{PHL2}		-	80	100	ns
	OE/ - OUTn	t_{PHL3}		-	60	80	ns
	CLK - SDO	t_{PHL}		-	15	30	ns
Pulse Width	CLK	$t_{W(CLK)}$		20	-	-	ns
	LA/	$t_{W(L)}$		20	-	-	ns
	OE/	$t_{W(OE)}$		120			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}		-	60	80	ns
Output Fall Time of I_{OUT}		t_{OF}		-	60	80	ns
Slow CLK rise time Slow CLK fall time		t_R	Cascade	-	-	500	ns
		t_F		-	-	500	ns

Note 2: All parameter tested at T_A=25℃. Specifications over temperature are guaranteed by design.

Test Circuit for Switching Characteristics

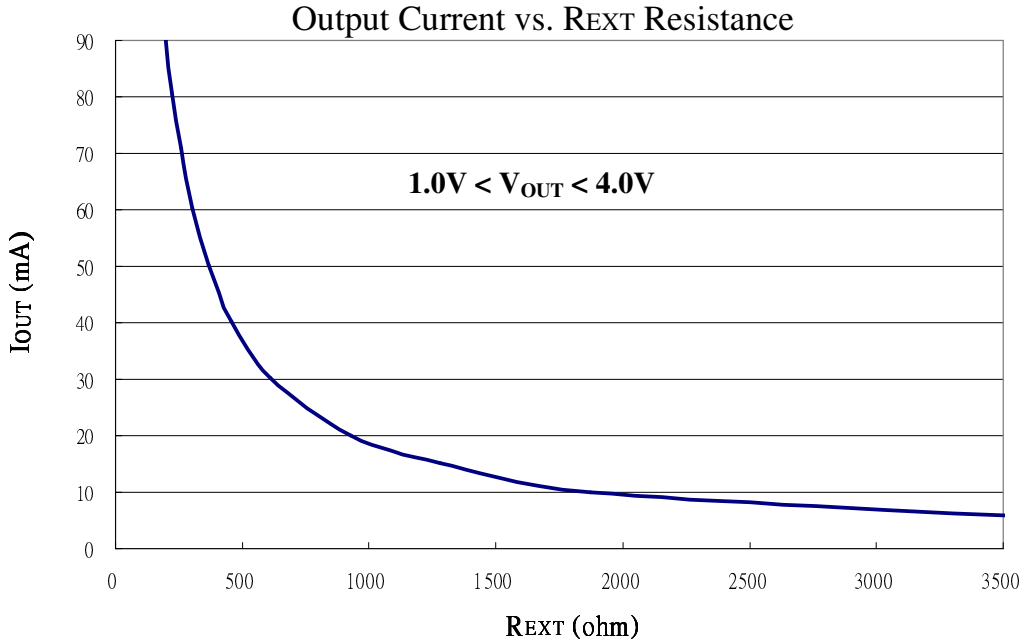


Timing Waveform



Adjusting Output Current

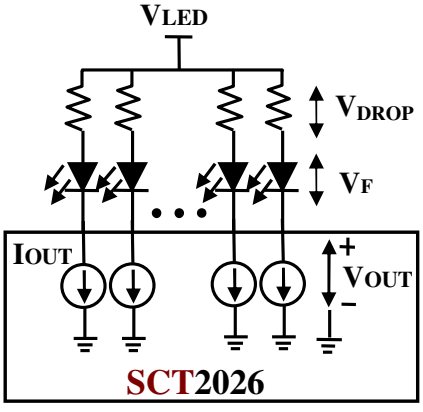
All SCT2026's output current (I_{OUT}) are set by one external resistor at pin REXT. The relationship between I_{OUT} and resistance R_{EXT} is shown as the following figure.

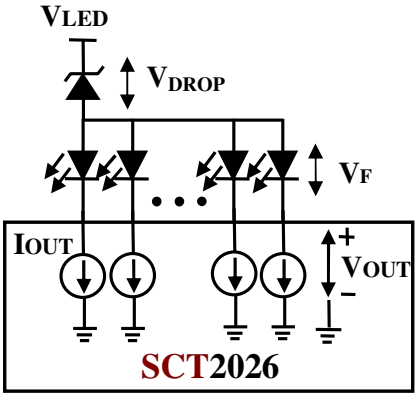


Also, when SCT2026's output voltage is set between 1V and 4V, the output current I_{OUT} can be set by the formula: $I_{OUT} = 30(630 / R_{EXT})$ mA. Thus the output currents are all set to 21mA (±5%) by set the reference value $R_{EXT} = 900\Omega$.

Load Supply Voltage (V_{LED})

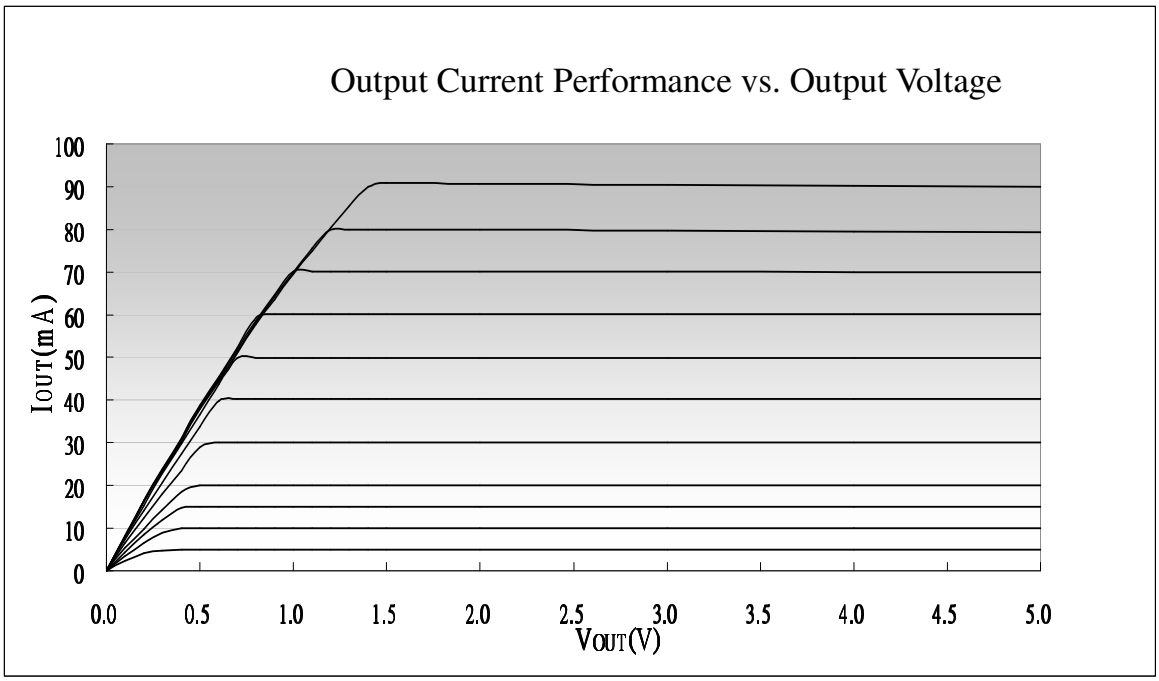
The SCT2026 can be operated very well when VOUT ranging from 1V to 4V. It is recommended to use the lowest possible supply voltage VLED or set a voltage reducer to reduce the VOUT voltage and then reduce the power dissipation of SCT2026. A voltage reducer lets $V_{OUT} = V_{LED}–V_{DROP}–V_F$, Resistors or Zener diode can be used in the applications as shown in the following figures.





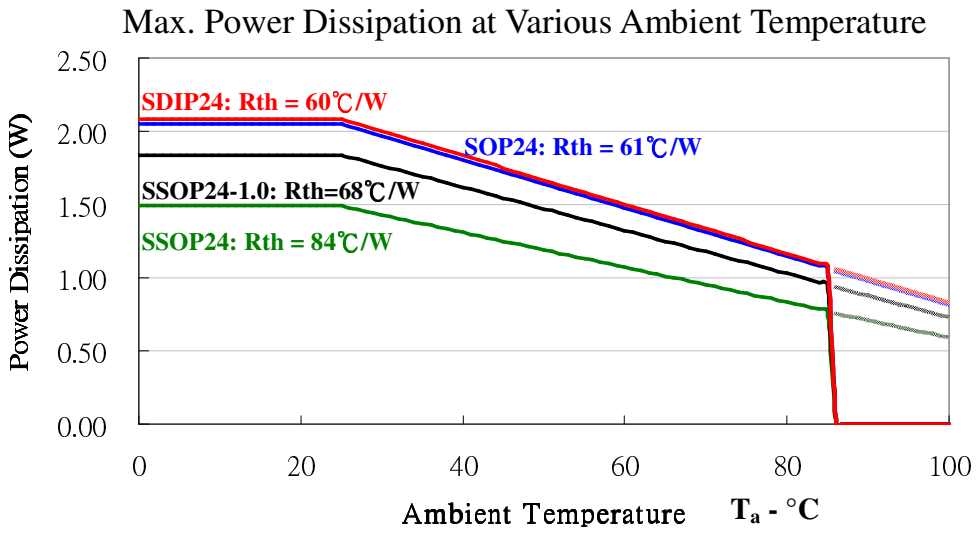
Output Characteristics

The current characteristic of output stage is flat. The output current IOUT which less than 90mA can be kept constant regardless of the variations of LED forward voltage when VOUT > 1.4V. The relationship between IOUT and VOUT is shown as below:



Power Dissipation

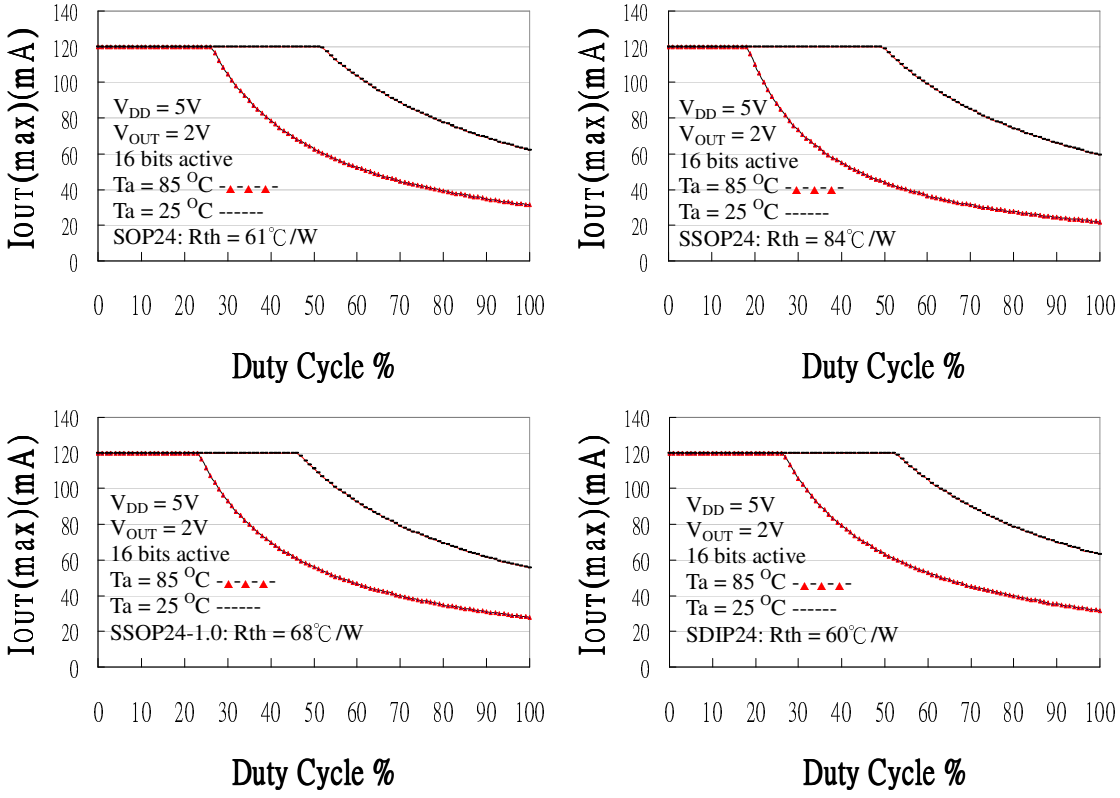
The power dissipation (P_D) of a semiconductor chip is limited by its package and ambient temperature. The maximum allowable power dissipation $P_{D(max)}$ is determined by $P_{D(max)}=(T_{j(max)} - T_a)/R_{th(j-a)}$ where $T_{j(max)}$: maximum chip junction temperature, usually considered as 150℃, T_a: 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:

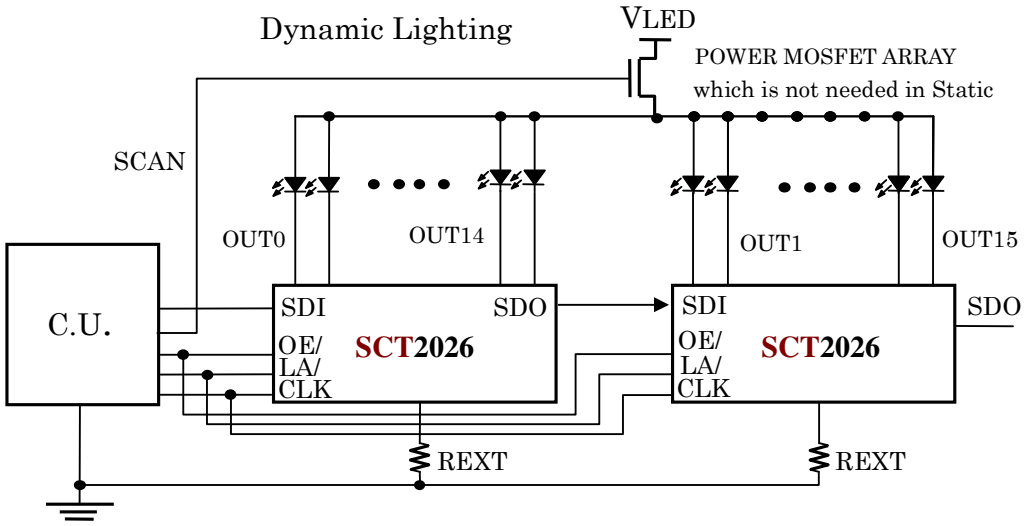
$I_{OUT(max)}=(((T_{j(max)}-T_a)/R_{th(j-a)})-(V_{DD}*I_{DD}))/V_{OUT}/Duty/N$ Where $T_{j(max)}=150℃$, N=16(all ON)



Over Temperature Shutdown

The SCT2026 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℃. The outputs are enabled again when the die temperature drops below approximately +110℃.

Typical Application Circuits

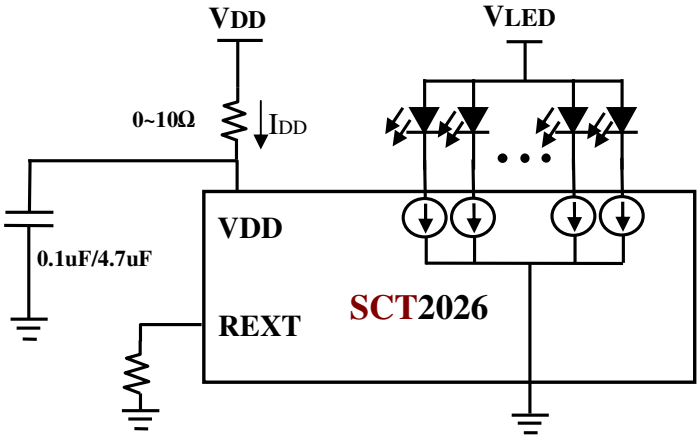


PCB Design Considerations

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 SCT2026. Locate the capacitor as close to the SCT2026 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 SCT2026. 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.

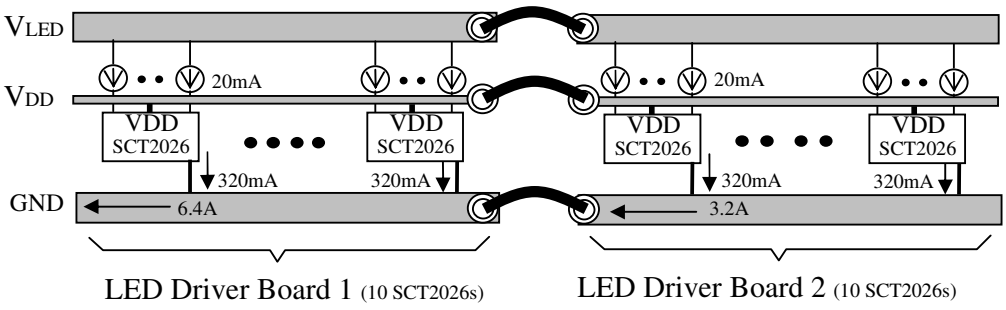


External Resistor (REXT)

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

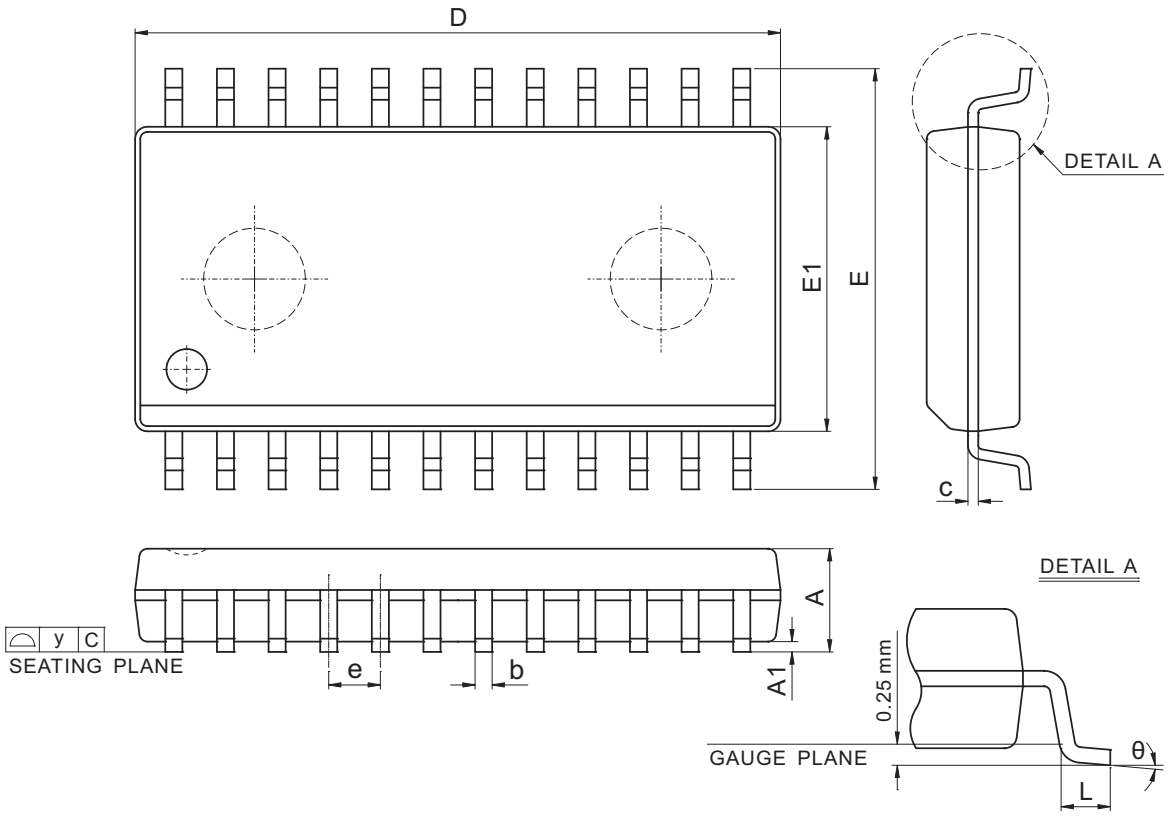
Power and Ground

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. from 0 to 10Ω series in power input pin VDD of SCT2026 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.



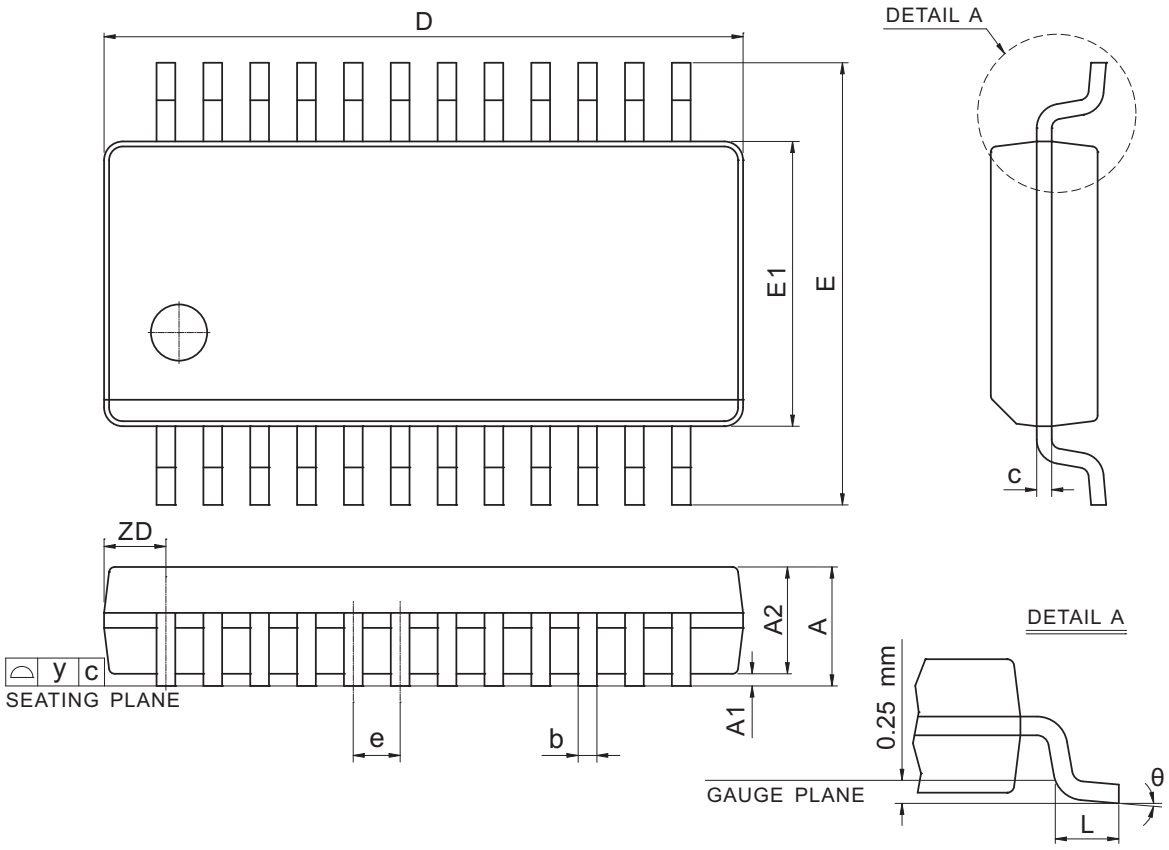
Package Dimension

SOP24(check up-to-date version)



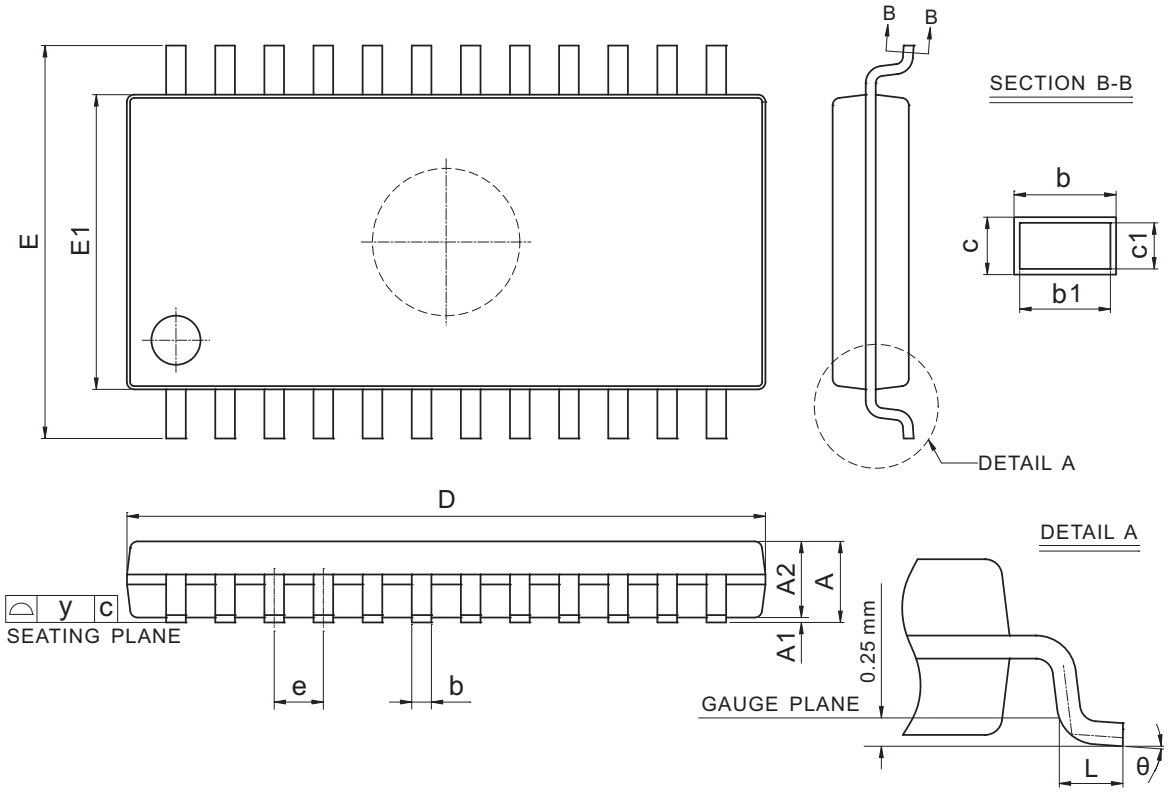
Symbol	Dimension (mm)			Dimension (mil)		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	2.35	-	2.65	92.5	-	104.3
A1	0.10	-	0.30	3.9	-	11.8
b	0.33	-	0.51	13.0	-	20.1
c	0.23	-	0.32	9.1	-	12.6
D	15.20	-	15.60	598.4	-	614.2
E	10.00	-	10.65	393.7	-	419.3
E1	7.40	-	7.60	291.3	-	299.2
e	1.27 BSC			50.0 BSC		
L	0.40	-	1.27	15.7	-	50.0
θ	0°	-	8°	0°	-	8°
y	-	-	0.10	-	-	3.9

SSOP24(check up-to-date version)



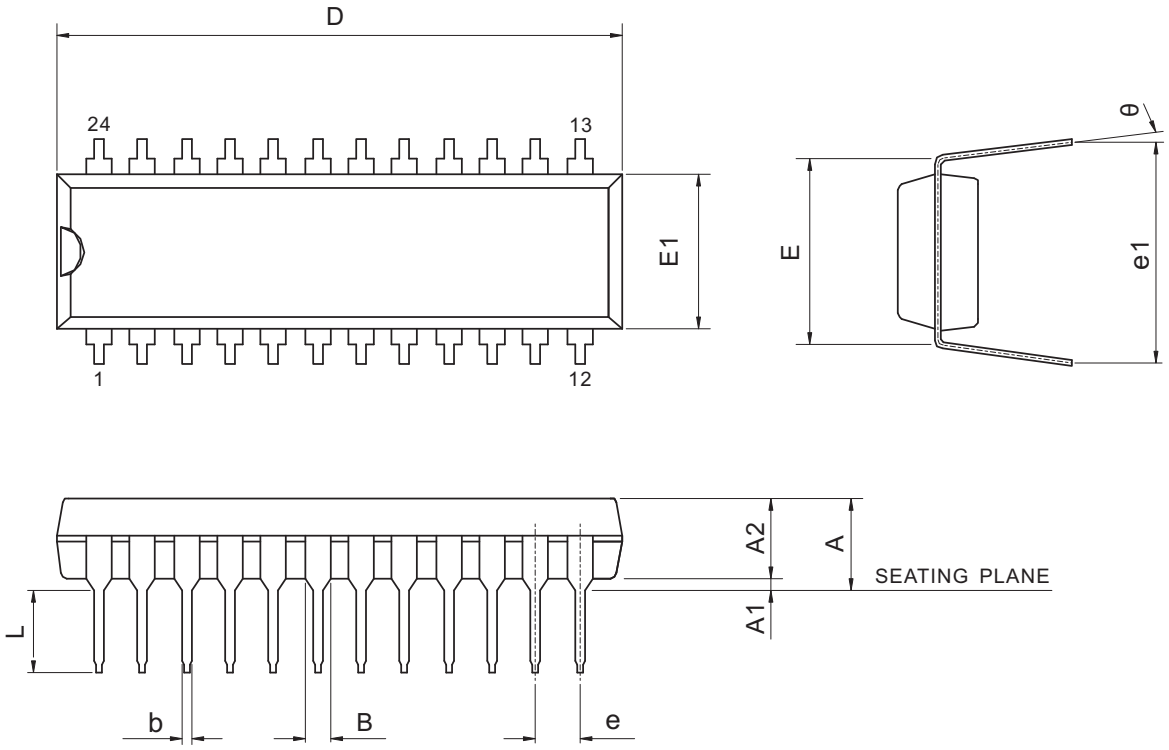
Symbol	Dimension (mm)			Dimension (mil)		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.35	1.63	1.75	53.1	64.2	68.9
A1	0.10	0.15	0.25	3.9	5.9	9.8
A2	-	-	1.50	-	-	59.1
b	0.20	-	0.30	7.9	-	11.8
c	0.18	-	0.25	7.1	-	9.8
D	8.56	8.66	8.74	337.0	340.9	344.1
E	5.79	5.99	6.20	228.0	235.8	244.1
E1	3.81	3.91	3.99	150.0	153.9	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	0.84 REF			33.0 REF		
θ	0°	-	8°	0°	-	8°

SSOP24-1.0(check up-to-date version)



Symbol	Dimension (mm)			Dimension (mil)		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.90	-	-	74.8
A1	0.05	0.10	0.15	2.0	3.9	5.9
A2	1.30	1.50	1.70	51.2	59.1	66.9
b	0.30	0.40	0.52	11.8	15.7	20.5
b1	0.30	0.40	0.50	11.8	15.7	19.7
c	0.10	0.15	0.27	3.9	5.9	10.6
c1	0.10	0.15	0.25	3.9	5.9	9.8
D	12.80	13.00	13.20	503.9	511.8	519.7
E	7.70	8.00	8.30	303.1	315.0	326.8
E1	5.80	6.00	6.20	228.3	236.2	244.1
e		1.00 BSC			39.4 BSC	
L	0.25	0.45	0.65	9.8	17.7	25.6
y	-	-	0.10	-	-	3.9
θ	0°	-	10°	0°	-	10°

SDIP24(check up-to-date version)



Symbol	Dimension (mm)			Dimension (mil)		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	5.33	-	-	210.0
A1	0.38	-	-	15.0	-	-
A2	3.18	3.30	3.43	125.0	130.0	135.0
b	-	0.46	-	-	18.0	-
B	-	1.02	-	-	40.0	-
e	-	1.78	-	-	70.0	-
D	22.35	22.86	23.37	880.0	900.0	920.0
E	-	7.62	-	-	300.0	-
E1	6.22	6.35	6.48	245.0	250.0	255.0
e1	8.51	9.02	9.53	335.0	355.0	375.0
L	2.92	3.30	3.81	115.0	130.0	150.0
θ	0°	7°	15°	0°	7°	15°

Revision History (check up-to-date version)

Data Sheet Version	Remark
V03_01	P5,9,12-15 updated

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