42V 15 ~ 350mA Linear Constant Current LED Driver with PWM Dimming Control

GENERAL DESCRIPTION

The SLM411A is a wide input range, high precision constant current LED driver which provides cost-effective solution for advertising light boxes, landscape lighting and other LED illumination application. For most applications, SLM411A only need one current setting resistor from SET to GND, and one ceramic bypass capacitor from V_{IN} to GND, no aluminum capacitor, Schottky diode or inductor needed. The dimming range will be greater than 1024:1 at 100Hz dimming frequency. PWM frequency can be set between 100Hz~20kHz. This dimming solution can be designed to be noise free making it an ideal choice for household and commercial lighting products.

Excellent line/load regulation guarantees customer can achieve high lighting performance under dynamic input/output voltage situations.

For high current application, several SLM411A can be connected in parallel to obtain high power output. Meanwhile , the SLM411A will automatically reduce linearly the output current when the die temperature reached 135°C, this method avoid LED bar blinking.

SLM411A is available in SOT23-6 and a thermal enhanced SOIC8-EP package. It is rated for −40°C to +125°C junction temperature range.

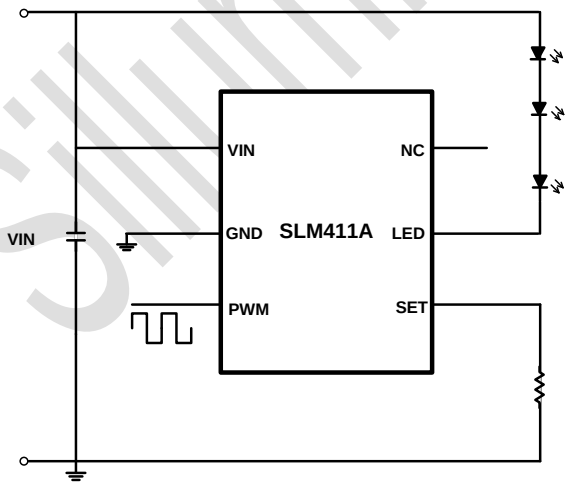
FEATURES

- Linear Constant Current LED Driver
- Wide Input Voltage Range from 4.5V to 42 V
- 15 ~ 350mA Adjustable Output Current
- ±1% SET voltage accuracy
- Support up to 20KHz PWM Dimming
- Obtain Larger Output Current by in Parallel
- ±5% Output Current Accuracy
- Less than 0.1%/V Line and Load Regulation
- Over Temperature Protection, Current Derating
- SOT23-6 and SOIC8-EP Package

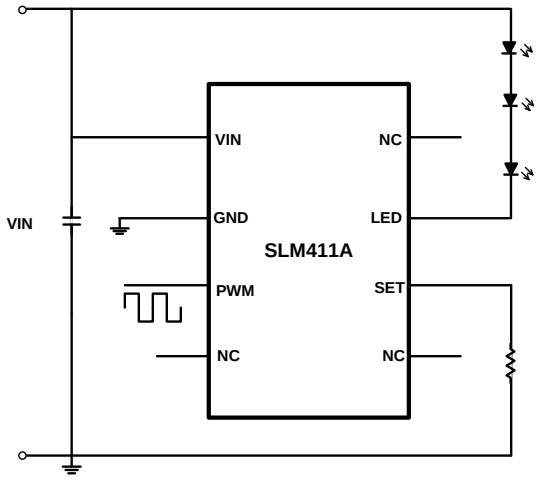
APPLICATIONS

- Signage Large Format LED Backlighting Module
- Dimming LED Strip
- Dimming Flexible LED Strip
- Industrial Lighting (Building / Parking Lot / Office / Warehouse)
- Landscape Lighting
- Ideal Current Source

TYPICAL APPLICATION CIRCUIT



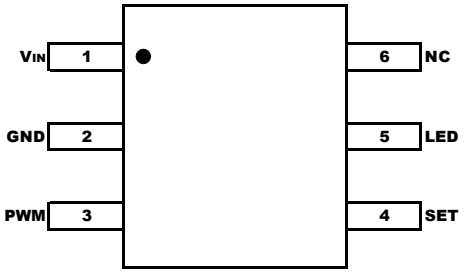
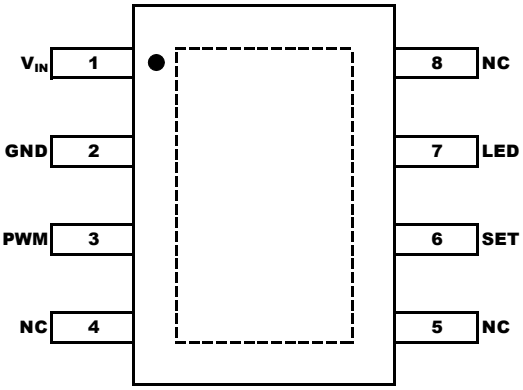
SOT23-6



SOIC8-EP

Figure 1 Typical Application Circuit

PIN CONFIGURATION

Package	Pin Configuration (Top View)
SOT23-6	
SOIC8-EP	

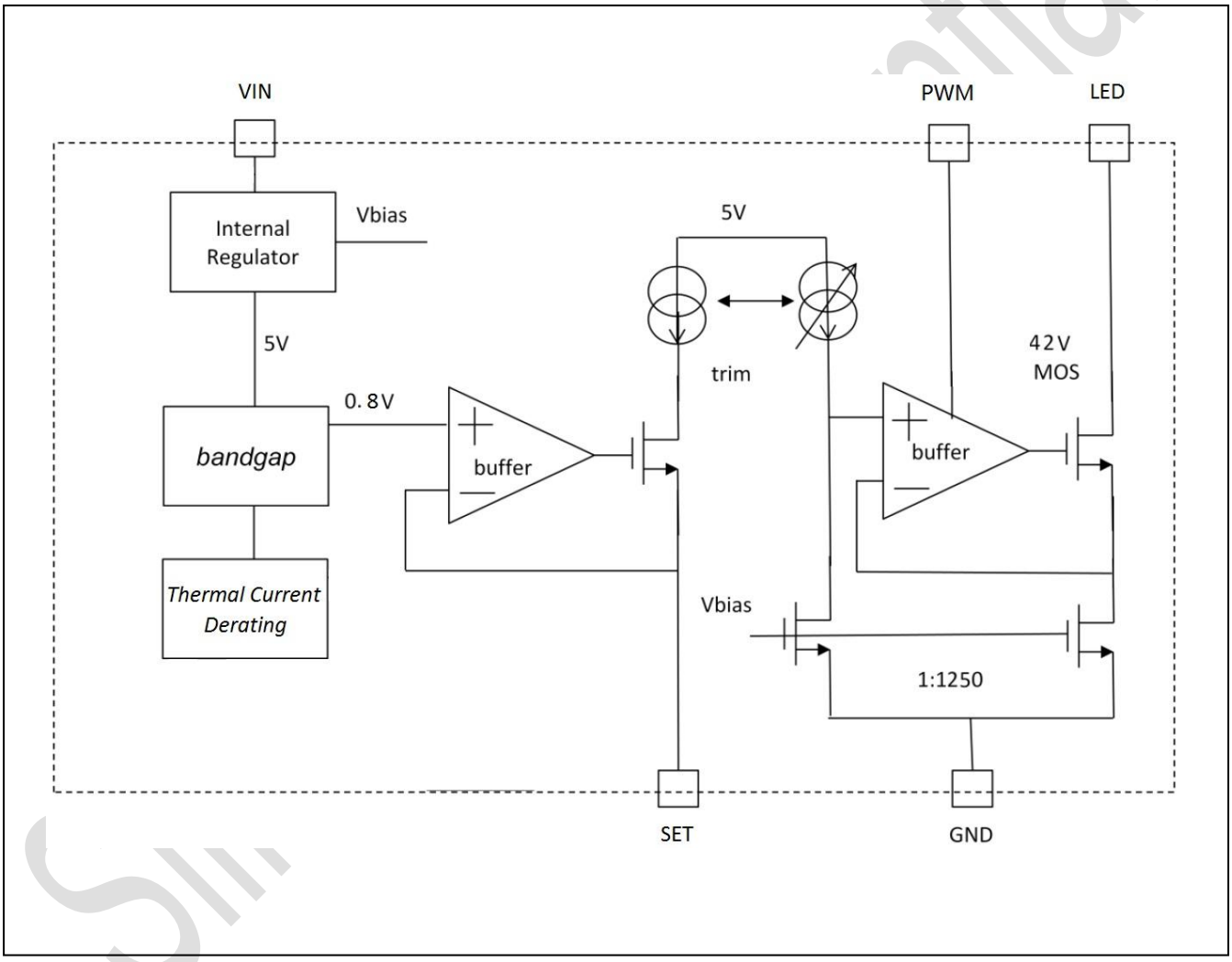
PIN DESCRIPTION

SOT23-6	SOIC8-EP	Pin	Description
1	1	V_{IN}	Power Input
2	2	GND	Ground
3	3	PWM	PWM input signal from MCU
6	4, 5, 8	NC	No Connection
4	6	SET	Current setting pin, connect an external resistor ground to set LED current
5	7	LED	Connect to LED cathode
	EP	EP	Exposed Paddle. Connect to a large-area ground plane for improved power dissipation. Do not use as the only ground connection for the device.

ORDERING INFORMATION
Industrial Range: -40°C to +125°C

Order Part No.	Package	QTY
SLM411AAC-7GTR	SOT23-6	3000/Reel
SLM411ACB-13GTR	SOIC8-EP	2500/Reel
SLM411ACB-GT	SOIC8-EP	100/Tube

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

V_{IN}, PWM, LED to Ground			-0.3V ~ 48V
SET to Ground			-0.3V ~ 6.5V
Sink Current			380mA
Total power dissipation, P_{TOT}		SOT23-6	0.7w (T_S ≤100°C)
		SOIC8-EP	1.6w (T_S ≤100°C)
Maximum junction temperature, T_{JMAX}			150°C
Storage temperature range, T_{STG}			-65° ~ +150°C
Operating temperature range, T_A			-40°C ~ +125°C
Package Thermal Resistance	Junction to Ambient, R_{th-JA}	SOT23-6	150 °C/w
		SOIC8-EP	60 °C/w
	Junction to Case, R_{th-JC}	SOT23-6	40 °C/w
		SOIC8-EP	15 °C/w
ESD (HBM)			2000 V
ESD (CDM)			200 V
ESD (FICDM)			1500 V
Latch-up			+/- 100mA

Note:
Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

Test condition is T_A = −40°C ~ +125°C. Typical values are at T_A = 25°C, unless otherwise specified.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V_{IN}	Input voltage operation range		4.5		42	V
I_Q	Chip quiescent current	V_{IN}>=5V	200	250	350	uA
I_P	Sink current	V_{IN}>=5V	15		350	mA
I_{SKEW}	Sink current accuracy	V_{IN}=5V, V_{LED}=3V			5	%
I_{LK}	Output leakage current	V_{IN}=0V, V_{LED}=42V			1	uA
V_{LED_MIN}	Minimum drop out voltage	V_{IN}>=5V，I_{LED}=20mA		0.30		V
		V_{IN}>=5V，I_{LED}=60mA		0.35		
		V_{IN}>=5V，I_{LED}=150mA		0.6		
		V_{IN}>=5V，I_{LED}=200mA		0.8		
		V_{IN}>=5V，I_{LED}=350mA		1.0		
LDR	Sink current line regulation	V_{IN}=5V, V_{LED} from 3V to 42V		0.1		%/V
LNR	Sink current load regulation	V_{IN} from 5V to 42V, V_{LED}=3V		0.1		%/V
TR	Temperature regulation	V_{IN}=5V, V_P=3V		0.1		%/10°C
V_{IH}	PWM Logic “1” input voltage	V_{IN}>=5V	1.4			V
V_{IL}	PWM Logic “0” input voltage	V_{IN}>=5V			0.4	
f_{REQ}	PWM Dimming frequency		0.1		20	kHz
DR	Dimming ratio	At 500Hz dimming		1024		
t_R	Dimming Rising Time	At 500Hz dimming	2	3	4	us
t_F	Dimming Falling Time	At 500Hz dimming	25	30	35	ns

t_D	Dimming Propagation Delay	At 500Hz dimming	1	2	3	us
T_{CD}	Thermal current derating temperature			135		°C
T_{SD}	Thermal shutdown temperature			160		°C

APPLICATION INFORMATION

With a simple circuit, the SLM411A provides the constant current sourcing and maintain the current for all LEDs in serial connection.

Package Thermal Resistance

For continuous conduction mode of operation, the absolute maximum junction temperature must not be exceeded. The maximum power dissipation depends on several factors: the thermal resistance of the IC package θ_{JA}, PCB layout, airflow surrounding the IC, and difference between junction and ambient temperature.

The maximum power dissipation can be calculated using the following formula:

$$P_{D(MAX)}=\frac{T_{J(MAX)}-T_A}{\theta_{JA}}$$

where $T_{J(MAX)}$ is the maximum operating junction temperature,
T_A is the ambient temperature, and
J_A is the junction to ambient thermal resistance.

The recommended maximum operating junction temperature, T_J, is 125°C and so maximum ambient temperature is determined by the SLM411's junction to ambient thermal resistance, θ_{JA}.
θ_{JA}, is layout dependent and the SLM411A's θ_{JA} in SOT23-6 and SOIC8-EP on a 51 x 51mm double layer PCB with 2oz copper standing in still air is approximately 150°C/W and 60°C/W respectively. Therefore the maximum power dissipation at TA = +25°C is:

$$P_D(MAX)=\frac{125-25}{150}=0.7w \text{ --- SOT23-6}$$

$$P_D(MAX)=\frac{125-25}{60}=1.6w \text{ --- SOIC8-EP}$$

As the ambient temperature increases and/or the PCB area reduces, the maximum allowable power dissipated by the SLM411A will decrease.

Output Current Setting
The output current of SLM411A is set by an external resistor. The output current can be figured out by following equation.

$I_{LED} = (1000/R_{SET})$ A

For example, if 5kOhm external resistor is connected to SET pin, the output current is set to 200mA.

System Design Optimization to Reduce Power Loss
SLM411A is a linear constant current driver. While this device is designed in lighting system, the heat generation should be considered. Generally, the higher current designed in system, the higher power will suffer by this device. To reduce the power consuming by SLM411A and to increase the whole system efficiency, the drop voltage across SLM411A should be minimized. The following design note can reduce the heat generation from SLM411A in the condition of keeping the required output constant current and the needed supply voltage (normal operation condition).

A. Drop the power supply voltage as low as possible in the normal operation condition.
B. Get the LEDs in current loop as many as possible in the normal operation condition.
C. Get a voltage sharing resistor in series in current loop.
D. It suggests to connect a small SMD type capacitor (0.1uF~10uF) between V_{IN} and GND pin. That will greatly improve the stability of system.

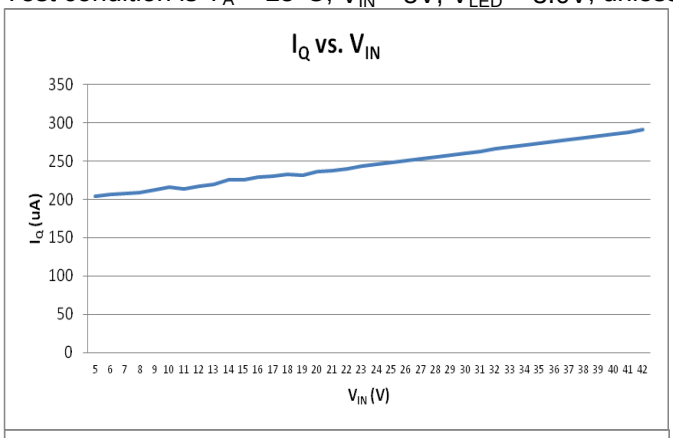
Thermal Protection: Current Derating

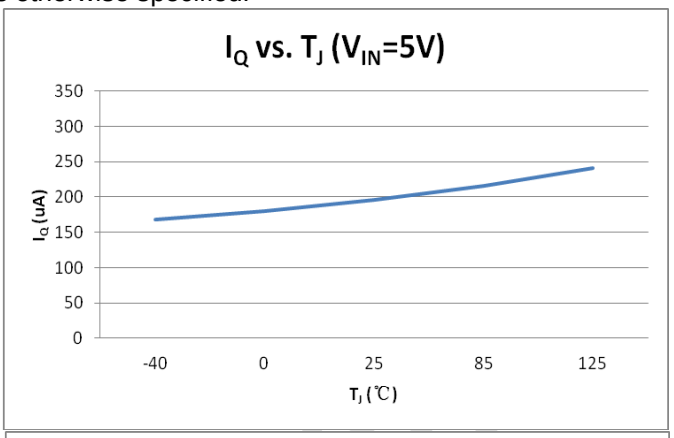
Extreme junction temperature can be the result of high current operation, poor circuit board design, or high ambient temperature. Current derating function is designed with SLM411A to protect the silicon and system over temperature.

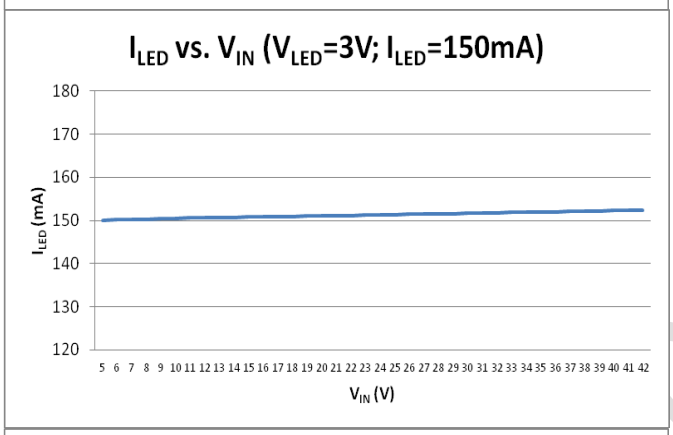
If SLM411A junction temperature rises above 135°C, the thermal derating function is activated. The output sink current will start to decrease linearly to achieve system thermal balance. In extreme thermal case, sink current will become 0 when SLM411A junction temperature exceeds 160°C.

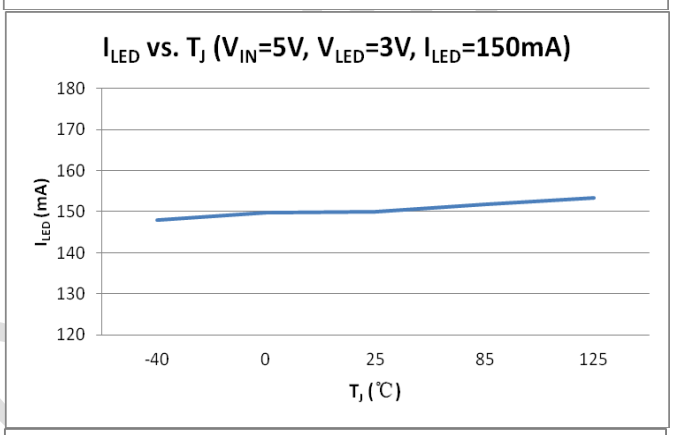
TYPICAL OPERATING CHARACTERISTICS

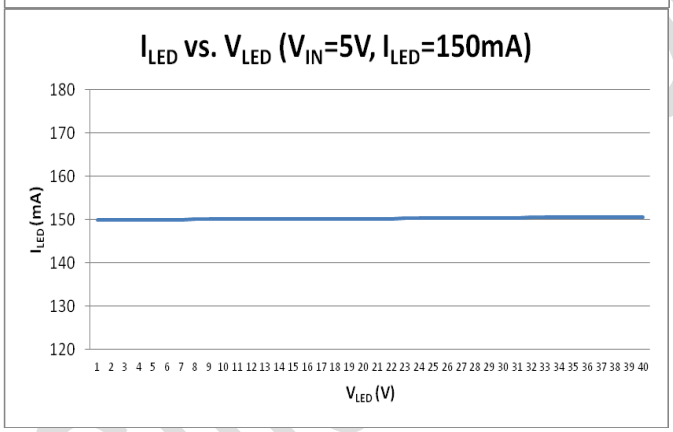
Test condition is T_A = 25°C, V_{IN} = 5V, V_{LED} = 3.0V, unless otherwise specified.

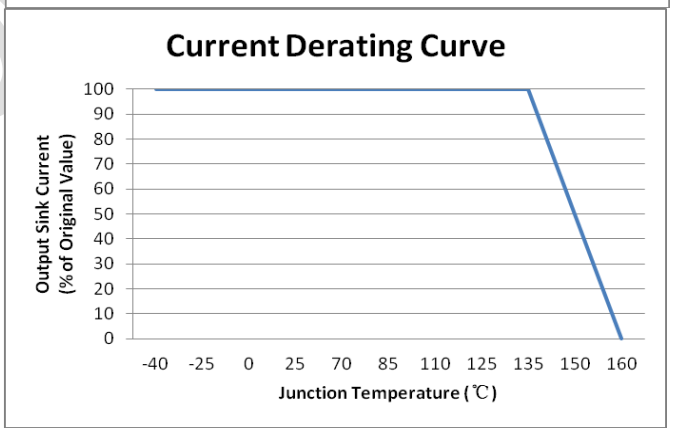












CLASSIFICATION REFLOW PROFILES

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (Tsmin) Temperature max (Tsmax) Time (Tsmin to Tsmax) (ts)	150°C 200°C 60-120 seconds
Average ramp-up rate (Tsmax to Tp)	3°C/second max.
Liquidous temperature (TL) Time at liquidous (tL)	217°C 60-150 seconds
Peak package body temperature (Tp)*	Max 260°C
Time (tp)** within 5°C of the specified classification temperature (Tc)	Max 30 seconds
Average ramp-down rate (Tp to Tsmax)	6°C/second max.
Time 25°C to peak temperature	8 minutes max.

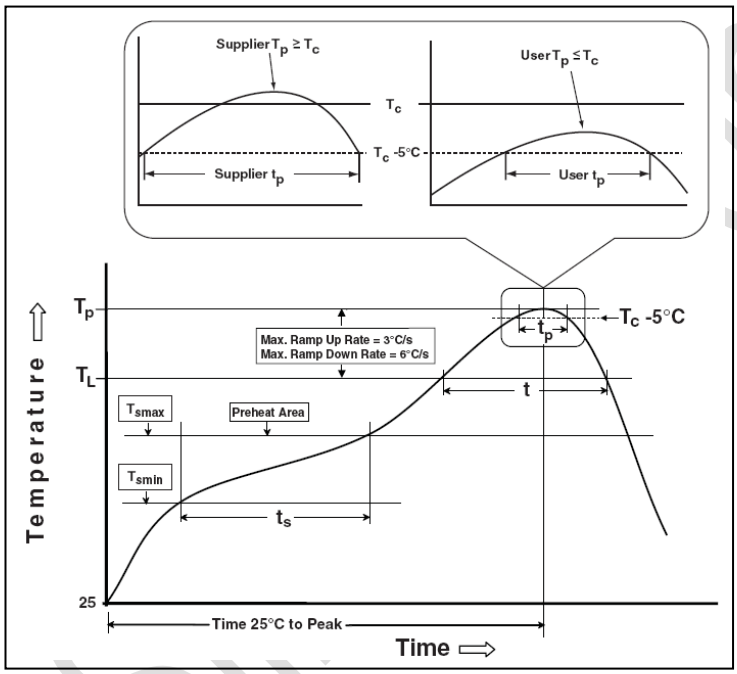
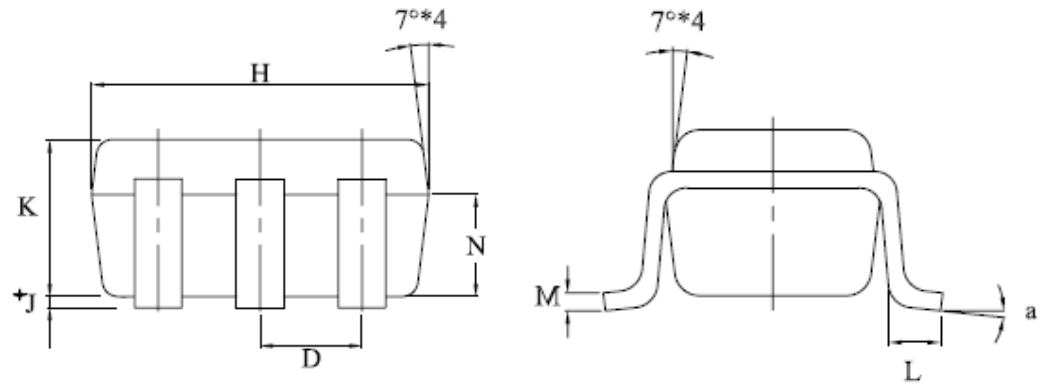
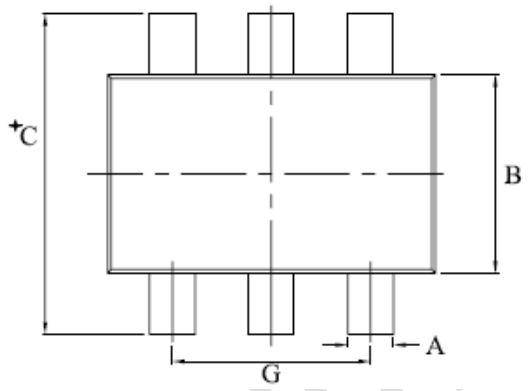


Figure 2 Classification Profile

PACKAGE INFORMATION

SOT23-6

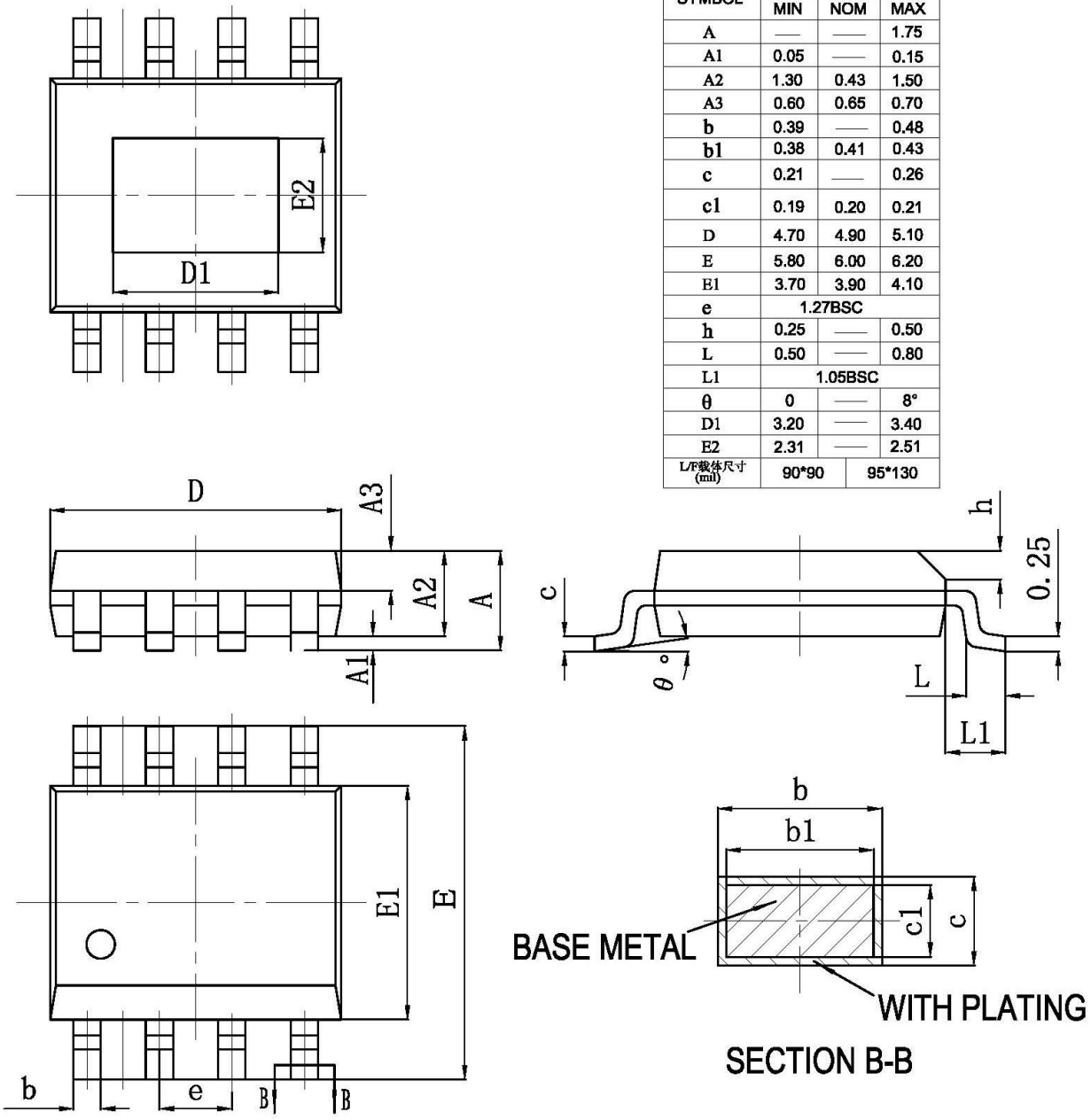




Dim	Min	Max	Typ
*A	035	0.50	0.38
B	1.50	1.70	1.60
*C	2.70	3.00	2.80
D		0.95	
G		1.90	
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
a		8°	
All Dimension in mm			

Note: All dimensions in millimeters unless otherwise stated.

SOIC8-EP



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.05	—	0.15
A2	1.30	0.43	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.48
b1	0.38	0.41	0.43
c	0.21	—	0.26
c1	0.19	0.20	0.21
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05BSC		
θ	0	—	8°
D1	3.20	—	3.40
E2	2.31	—	2.51
L/F载体尺寸 (mil)	90*90		95*130

Note: All dimensions in millimeters unless otherwise stated.

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