ACS0804

Compact Direct AC Line LED Driver with high PF and low THD using Only Two External Components

FEATURES

- Direct AC Line LED Driver with Only Two External Components
- Wide AC Input Range : 90~280VAC
- Compact LED Driver Module Size due to Minimal Number of External Components
- Integrated 4 High Voltage Constant Current Sinks
- TRIAC Dimmable (Leading/Trailing Edge)
- Rheostat Dimmable
- High Power Factor (above 0.99 in normal configuration)
- High Efficiency Greater than 90% in Optimized LED Configuration
- Adjustable LED Power with an External Resistor
- Low Harmonic Content (THD under 15% in normal configuration)
- Low Crest Factor (under 1.5 in normal LED configuration)
- LED Current Sinking Capability of up to 75mA$_{rms}$
- Compact SOIC 8LD Package (Other types available upon request)
- Flexible LED Forward Voltage, VF, Configuration
- Multiple LED Driver Configuration
- Over Temperature Protection

DESCRIPTION

The ACS0804 is a direct AC line LED driver with a minimal number of external components. In normal configuration, only two components are used. One resistor is to provide adjustable LED power and one capacitor is to provide a stable voltage to the internal shunt regulator.

The ACS0804 can be used with different types of TRIAC dimming control switches. Since the ACS0804 drives all LED current sink outputs based on the AC line level, whether the AC mains are controlled by a leading edge dimmer, a trailing edge dimmer or a AC level dimmer, the LED current closely follows the AC line and is perfectly in phase. It achieves the highest efficiency with high PF and low THD and makes the ACS0804 suitable for high-efficiency LED lighting systems. The ACS0804 can also be used with a rheostat dimmer switch which is suitable for desktop or indoor lamps.

Multiple ACS0804 drivers can be used together for over 10W LED lighting applications such as street lights, down lights, candle lights, and etc.

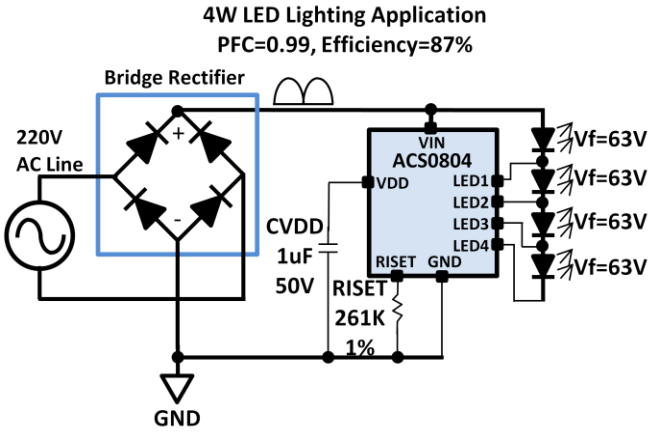
The ACS0804 includes over temperature protection by default. When the driver's junction temperature exceeds a specified thermal threshold(T_J=170°C), LEDs will shut down automatically and then recover automatically once the temperature drops below the thermal threshold. If this protection is not necessary to be adopted, the over temperature protection can be disabled by an internal programming. But without this protection, the lifetime of the ACS0804 can be reduced and irreparable damage can occur when it operates above its maximum junction temperature range($T_{J\text{-}MAX}$=150°C).

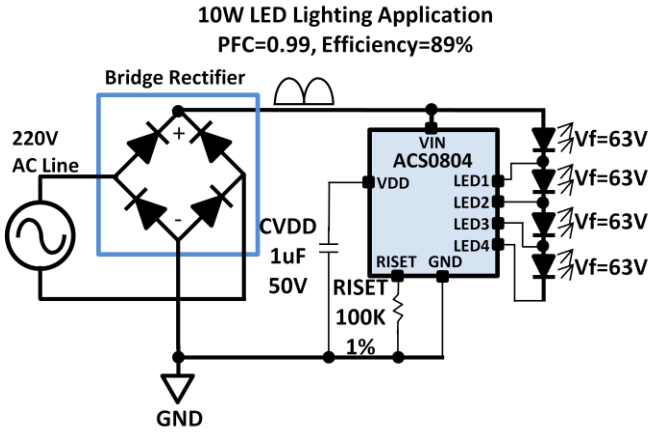
APPLICATIONS

- Direct AC Line LED Lighting Applications up to 10W.
- General solid state lighting.
- Small size LED lighting – Candle light, and etc.

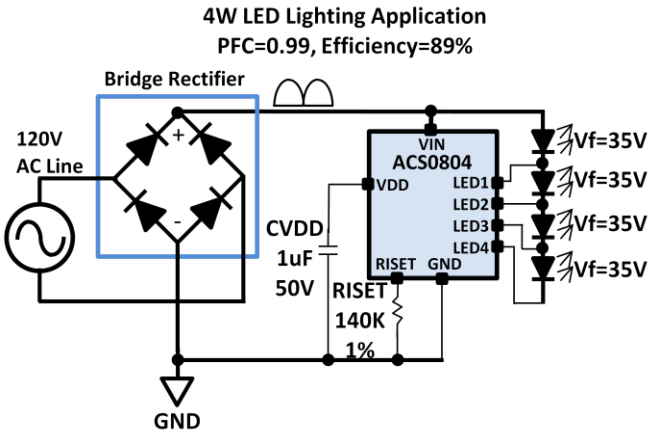
TYPICAL APPLICATION*

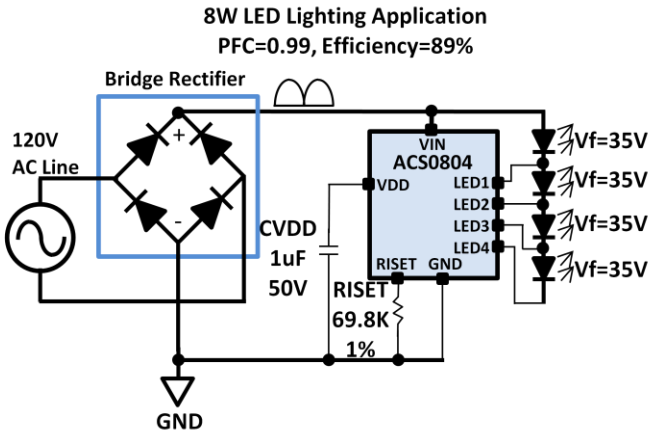
- 220VAC





- 120VAC





* Each forward voltage across each LED group is adjustable as needed.

ABSOLUTE MAXIMUM RATINGS

- VIN.....-0.3V to +500V
- LED1~3.....-0.3V to +500V
- LED4.....-0.3V to +200V
- RISET.....-0.3V to +6V
- Maximum Junction Temperature($T_{J\text{-}MAX}$).....+150˚C
- LED1, LED2, LED3, LED4 Current 60, 80, 100, 150mA

OPERATING CONDITION

- Junction Temperature(T_J).....-40˚C to +125˚C

ELECTRICAL CHARACTERISTICS

- Specifications are at T = 25˚C unless specified in conditions. VIN = 220VAC, RISET = 100kΩ, unless specified in conditions.
- LED forward current is based on LED forward voltage, VF=65V for each LED channel. Total LED forward voltage is 65V X 4 channels = 260V.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
VIN SUPPLY					
VIN Turn-on Voltage		13.7	14.7	15.7	V
VIN Turn-Off Voltage		12.5	13.5	14.5	V
VIN Hysteresis			1.2		V
VIN Quiescent Current	VIN = Max. 500V		0.75	1.2	mA
VDD OUTPUT					
VDD Voltage	VIN=20.0V	16	17	18	V
LED CURRENT					
RMS LED Current	Total VF=260V		47		mA
OVER TEMPERATURE PROTECTION					
OTP Temperature*			170		°C
THERMAL RESISTANCE					
θ_{JA} (EP-SOIC 8LD junction-to-air thermal resistance : PCB layer - 1S)**			91.78		°C/W
θ_{JA} (EP-SOIC 8LD junction-to-air thermal resistance : PCB layer - 2S2P)**			45.07		°C/W
LEAKAGE CURRENT					
LED1~4 Leakage Current	VLED1~3=500V, VLED4=200V, VIN=0V			1	uA

Table 1. Electrical Characteristics

* Internal over-temperature protection circuitry protects the device from permanent damage. LEDs shut down at the junction temperature, T_J=170°C(typ.).
** Junction-to-air thermal resistance is highly dependent on application and PCB layout. In application where the device dissipates high levels of power during operation, special care of thermal dissipation issues in PCB design must be taken.

ODERING INFORMATION

Order Number	Package Type	Top Mark	Supplied As
ACS0804S	SOIC-8LD	ACS0804S	2,500 Units, Tape and Reel

PIN CONFIGURATION (SOIC 8LD with EP)

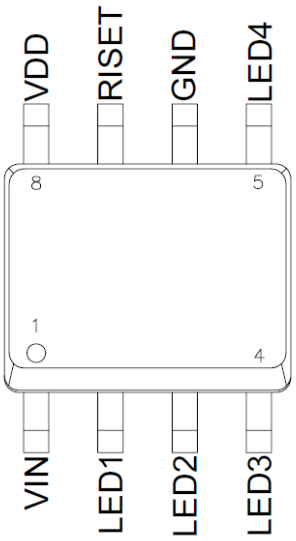


Figure 2. Pin configuration for SOIC 8LD

Pin Number	Pin Name	Description
1	VIN	Rectified AC Input Voltage
2,3,4,5	LED1~4	LED String Cathodes
6	GND	Ground Pin
7	RISET	LED Current Setting Pin
8	VDD	Shunt Regulator for Internal Circuitry
0	EP	Exposed thermal pad

Table 2. Pin Description for SOIC 8LD with EP

PIN FUNCTIONS

VIN: Rectified AC Input Voltage. Connect this pin to rectified AC voltage after a bridge rectifier.
VDD: Output Voltage. This pin supplies current to internal circuitry. A 17.4V shunt regulator is internally connected to this pin. A bypassing capacitor is recommended to be added to reduce noise from VIN.
RISET: Controls LED Current for each LED group. Refer to resistor setting equation to decide proper resistor value.

LED1-4: LED Channel Output. Connect the bottom cathodes of LED groups to these pins. Tie the pin(s) to GND if the corresponding string is not used.
GND: Ground. Tie this pin directly to local ground plane. This ground should not be tied to earth ground since it is non-isolated from AC mains.
EP: Exposed thermal pad. In package, EP is tied to GND inside IC.

BLOCK DIAGRAM

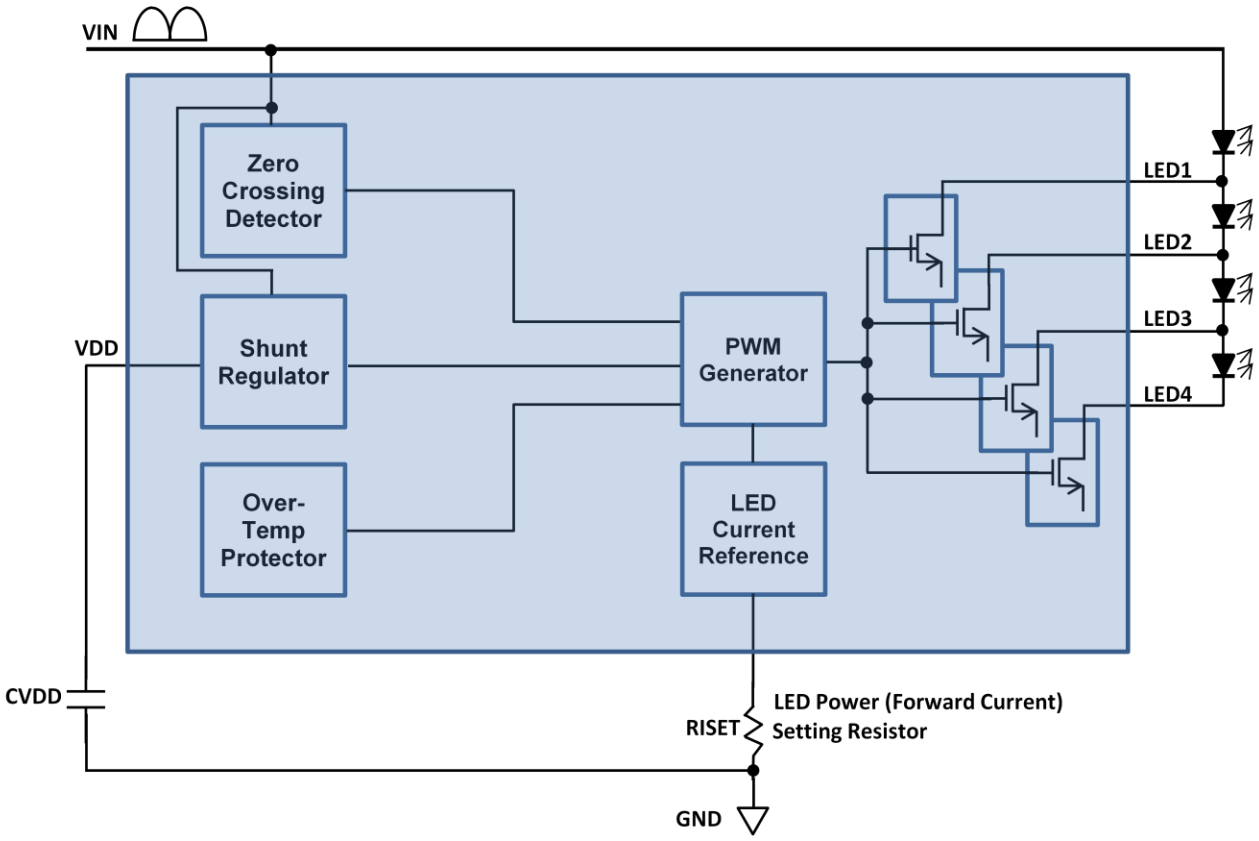


Figure 4. Block diagram of ACS0804

OPERATION

The ACS0804 can drive LED strings attached directly to the rectified AC mains using only two external components. With integrated high voltage current sinks, the ACS0804 provides compact LED lighting solution without requiring bulky and unreliable external components.

When the rectified AC line voltage, VIN, is higher than the internal reference level, each LED group turns on automatically when the corresponding current sink has its headroom. Each LED channel current sink increases up to the predefined current level for each current sink and maintains its level until the following channel's current sink reaches to its headroom. At any point in time domain, there is only one active LED channel. When the active channel is changed from one channel to the adjacent channel with change in AC line voltage, new active channel's current gradually increases while the existing active channel's current gradually decreases. This mutual compensation between two channels achieves smooth LED current change.

This smooth current transition reduces frequency harmonic content and improves power factor as well as EMI characteristics. By fully utilizing available headroom, the ACS0804 offers maximum power, high efficiency, power factor and low harmonic distortion. Typically, power factor is higher than 0.99 and THD is lower than 15%. The efficiency heavily depends on a LED configuration.

Components

Two required components are one resistor for the LED power setting and one capacitor for the internal regulator.

The resistor value can be calculated as follows.

$$RISET = \frac{VAC \times \mathbf{6{,}600}}{1.4 \times LEDPower}$$

Where, *VAC* is AC mains RMS level and *LED Power* is the required LED power. *6,600* factor in the equation is the current gain of the LED4 channel to the current through the RISET resistor. *1.4* factor in the equation is a crest factor for the normal LED configuration driven by the ACS0804. Depending on the LED configuration, the crest factor changes thus the actual RISET needs to be adjusted with respect to the LED configuration.

CVDD is used to have stabilize internal supply for IC operation. The recommended capacitor value is 1uF with 50V voltage rating.

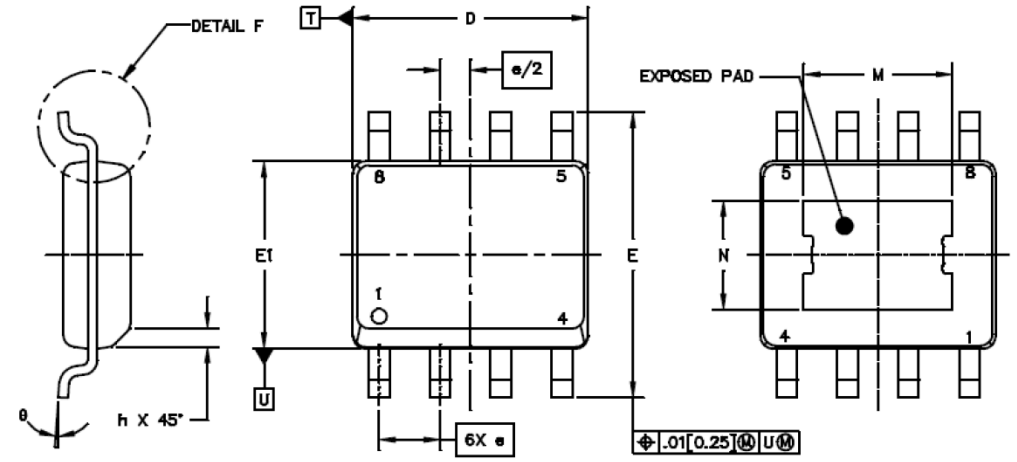
In the LED configuration, it is required to increase the total LED forward voltage, VF to improve efficiency. For example, compared to using 4 LEDs with VF of 60V(total VF = 60V X 4 channels=240V) for each LED channel, using 4 LEDs with VF of 65V(total VF = 65V X 4 channels = 260V) will improve the efficiency simply due to the higher total VF.

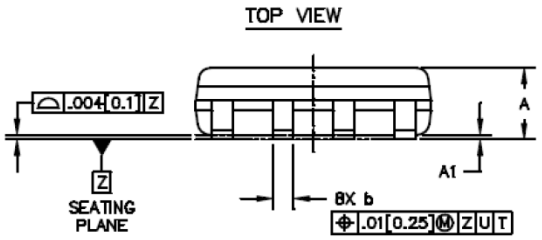
Each LED channel can have different VF. For example, if a user uses 144 LEDs with VF of 3V for 2ft fluorescent lamp replacement, the user can assign flexible number of LEDs for LED channels such as 25s2p-32s2p-6s2p-18s1p ("s" stands for LEDs in series and "p" stands for LEDs in parallel) or 18s2p-18s2p-18s2p-36s1p. One needs to consider having VF of LED1 channel higher than VIN turn-on voltage, which is 20V. If the VF of the LED1 channel is configured to be lower than VIN turn-on voltage, LED1 will not have the correct regulation level.

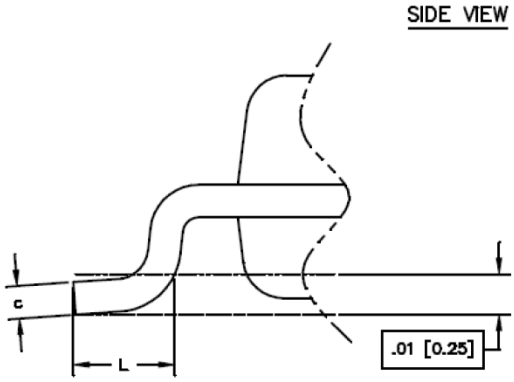
A good starting point for choosing a LED configuration is to have about 260V~280V of the total VF for 220VAC mains and 130V~140V of the total VF for 120VAC.

Good thermal management is required to achieve maximum performance and long life span of the ACS0804.

PACKAGE DESCRIPTION (SOIC 8LD with EP) / SOLDERING FOOTPRINT

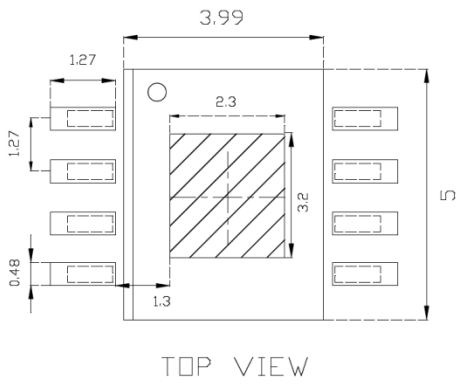


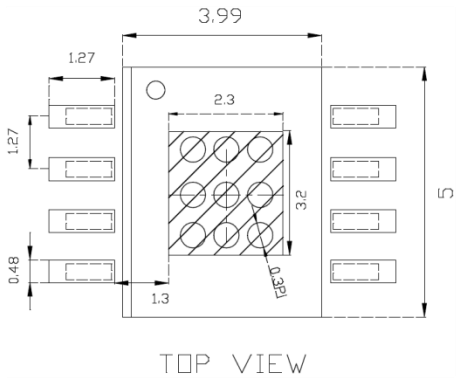




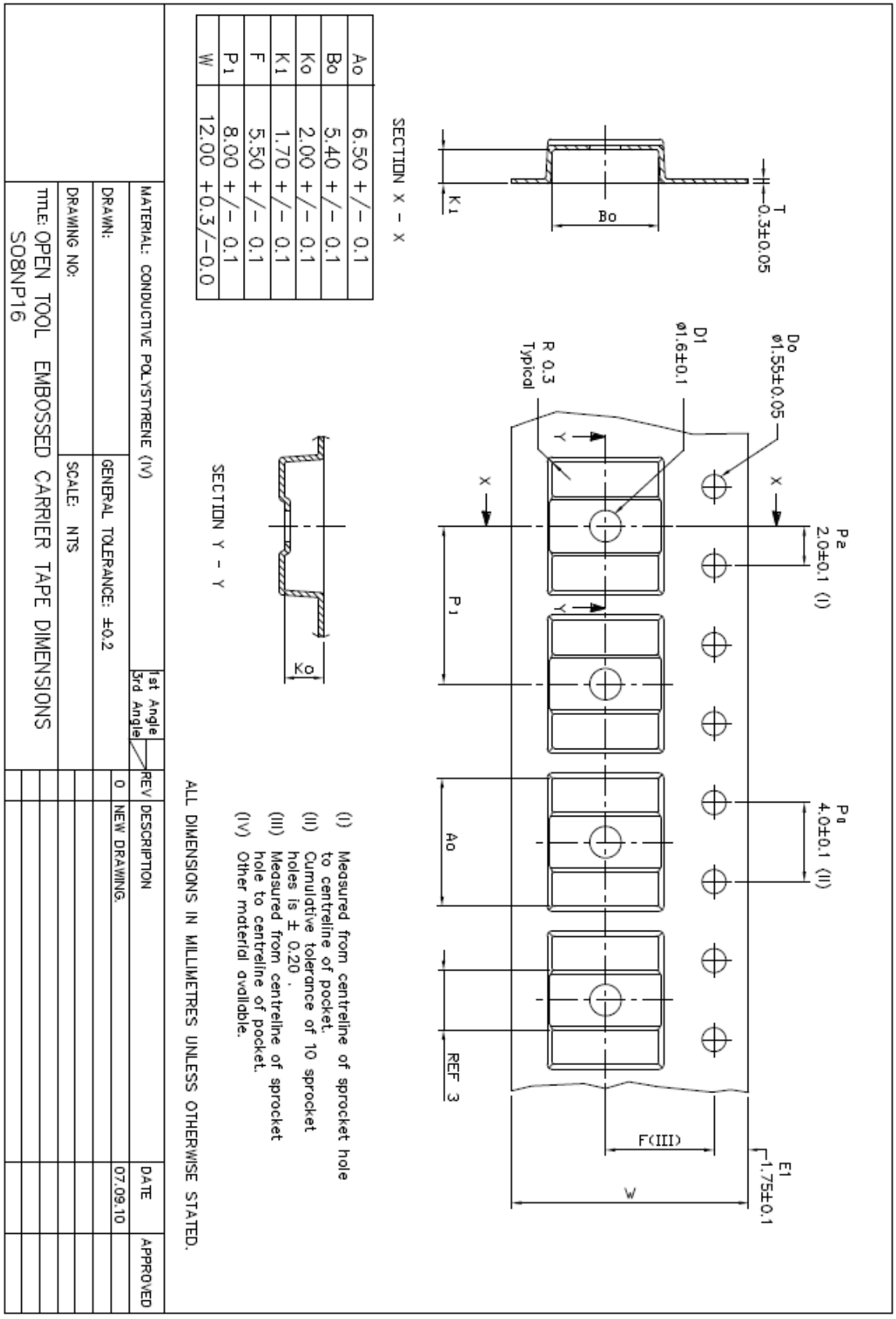
DETAIL F
ROTATED 90° CCW
SCALE: 30/1

	SYMBOL	MIN	NOM	MAX	MIN	NOM	MAX
TOTAL THICKNESS	A	.051		.067	1.30		1.70
STAND OFF	A1	.002		.006	0.05		0.15
LEAD WIDTH	b	.014		.019	0.36		0.48
L/F THICKNESS	c	.007		.010	0.18		0.25
BODY SIZE	D	.189		.197	4.80		5.00
	E1	.150		.157	3.81		3.99
	E	.228		.244	5.79		6.20
LEAD PITCH	e	.050 BSC			1.27 BSC		
	L	.016		.050	0.41		1.27
	h	.010		.020	0.25		0.51
	θ	0°		8°	0°		8°
EP SIZE	M	.118	.122	.126	3.00	3.10	3.20
	N	.086	.090	.094	2.18	2.29	2.39





TAPING DIMENSION



Ao	6.50 +/− 0.1
Bo	5.40 +/− 0.1
Ko	2.00 +/− 0.1
K1	1.70 +/− 0.1
F	5.50 +/− 0.1
P1	8.00 +/− 0.1
W	12.00 +0.3/−0.0

MATERIAL: CONDUCTIVE POLYSTYRENE (IV)

1st Angle / 3rd Angle

GENERAL TOLERANCE: ±0.2

DRAWN:

SCALE: NTS

DRAWING NO:

TITLE: OPEN TOOL EMBOSSED CARRIER TAPE DIMENSIONS SO8NP16

REV	DESCRIPTION	DATE	APPROVED
0	NEW DRAWING.	07.09.10	

REVISION HISTORY

Revision number	Changes
0.0	1. Rev 0.0 Created
0.1	1. Pin configuration has been changed. Pin 5 which was GND is swapped with Pin 6 which was LED4. 2. Electrical characteristics have been updated.
0.2	1. Over Temperature has been changed to 170°C. 2. RISET value calculation equation has been changed because the maximum LED current, RMS LED current, and corresponding crest factor have been changed. 3. EP-SOP 8L junction-to-air thermal resistance is added. 4. VDD quiescent current and RISET value are removed from EC table. 4. Taping dimension is added.
0.3	1. Added Max. current for LED1~4 in Abs. Max. Rating
2.0	1. Changed VDD range in EC table 2. Changed package dimension with clearer drawing 3. Added footprint 4. Minimum of VDD Iq current is removed in EC table 5. LED current sinking capability is added in Feature