JW JOULWATT

JW1237C

Adaptive 100/120Hz Current Ripple Remover With High Voltage MOSFET Integrated

Parameters Subject to Change Without Notice

DESCRIPTION

JW®1237C integrated with 600V NMOSFET, is used to drive a LED string, and remove the 100/120Hz LED current ripple on AC/DC power by a capacitor between VC and GND.

The adaptive technology ensures minimum power dissipation on JW1237C while removing LED current ripple.

Specially designed algorithms support the good compatibility for dimming and electronic load applications. The adaptive technics of JW1237C ensure minimum power dissipation while removing LED current ripple.

JW1237C allows user to setup maximum LED current, which protects NMOSFET from being damaged when LED short connected or hot-plug. JW1237C also allows users to setup the maximum cathode voltage of LED string, which could help limit the power dissipation on chip.

JW1237C has multi-protection functions which largely enhance the safety and reliability of the system, including VIN UVLO, short-circuit protection, LED open protection, and over temperature protection.

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FEATURES

● Adaptive 100/120Hz current ripple remover
● 600V high voltage NMOSFET integrated
● Compatible with dimming and electronic load applications
● Built-in zener diode for input voltage clamping
● VG output voltage high to 10V
● Programmable amplitude of LED current ripple
● Programmable maximum cathode voltage of LED
● Programmable maximum LED current
● Short protection
● Over temperature protection
● ESOP8 Package

APPLICATIONS

● LED lighting

TYPICAL APPLICATION
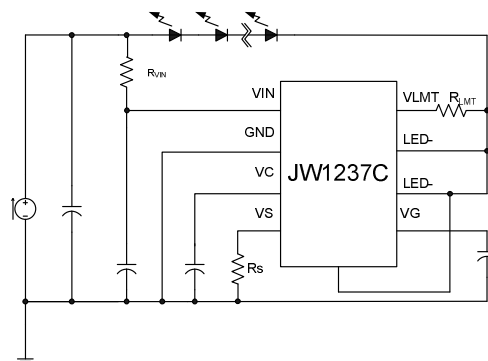
ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL[1]	BULK	TRAY	PACKAGE	TOP MARKING[2]
JW1237CESOP#PBF	JW1237CESOP#TRPBF	-	-	ESOP8	JW1237C XXXXXXX

Notes：

1) JW ☐☐☐☐ ☐☐☐ #TRPBF
   - PB Free
   - Tape and Reel(If ″TR″ is not shown, it means tube)
   - Package Code
   - Part No.

2) Line 1 of top marking means Part No., and the line 2 of top marking means Date Code.

PIN CONFIGURATION

TOP VIEW

VLMT	1		8	VIN
VS	2		7	VC
NC	3	0 LED-	6	GND
LED-	4		5	VG

ESOP8
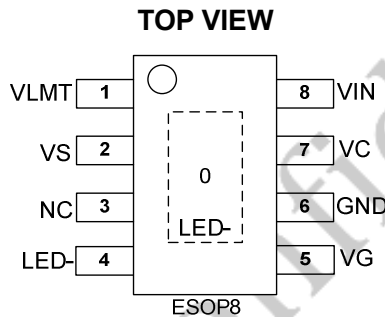
ABSOLUTE MAXIMUM RATING[1]

VIN clamp voltage.. 36V

VG 20V

VS, VC, VLMT .... -0.3V to 6V

LED-... 600V

Junction Temperature[2][3].. 150ºC

Lead Temperature ….. 260ºC

Storage Temperature ….. -65ºC to +150ºC

RECOMMENDED OPERATING CONDITIONS

Junction Temperature (T_J).. -40ºC to 125ºC

THERMAL PERFORMANCE[4] θ_{JA} θ_{JC}

ESOP8…... 50 ...10ºC/W

Note：

1) Exceeding these ratings may damage the device.

2) The JW1237C guarantees robust performance from -40°C to 150°C junction temperature. The junction temperature range specification is assured by design, characterization and correlation with statistical process controls.

3) The JW1237C includes thermal protection that is intended to protect the device in overload conditions. Thermal protection is active when junction temperature exceeds the maximum operating junction temperature. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.

4) Measured on JESD51-7, 4-layer PCB.

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ELECTRICAL CHARACTERISTICS

VIN = 18V, TA = 25°C, unless otherwise stated.							
Item	**Symbol**	**Condition**	**Min.**	**Typ.**	**Max.**	**Units**
VIN clamp voltage	V_{IN_CLP}		29	32	35	V
VIN operation current	I_{IN}	17V<VIN<27V	0.24	0.3	0.58	mA
VIN startup voltage threshold	V_{IN_ST}		15	16.5	18	V
VIN UVLO threshold	V_{IN_UVLO}			11.5		V
Maximum VG output voltage	V_{VG}		9	10.5	12	V
VC startup current	I_{VCST}	VC short to GND when startup	0.45	0.65	0.85	mA
VLMT reference voltage	V_{VLMTR}		1.85	2.05	2.25	V
NMOSFET drain voltage limit	V_{D_CLP}	Drain voltage of NMOSFET when voltage limit is trigged. R_{LIMIT}=100K.	3.7	4.4	5.1	V
SHORT protection threshold	V_{TH_SHORT}	Drain voltage of NMOSFET when SHORT is trigged. R_{LIMIT}=100K.	5	6	7.5	V
SHORT protection delay time[5]	TSPD			160		us
SHORT protection hold time	TSPH			800		ms
VS voltage limit	V_{VS}		0.210	0.235	0.260	V
MOS R_{dson}	R_{dson}	V_{gs}=10V			4.5	Ω
Breakdown Voltage	BV		600			V

5) Guaranteed by design

PIN DESCRIPTION

Pin No.	Name	Description
1	VLMT	LED- Voltage Limit and SHORT protection Programming
2	VS	LED current sensing input
3	NC	Not connected
4	LED-	Connect to the Cathode of LED string
5	VG	NMOSFET GATE Cap
6	GND	Ground
7	VC	LED Current Ripple Programming
8	VIN	Power Supply
0 (exposed PAD)	LED-	Connect to the Cathode of LED string

BLOCK DIAGRAM

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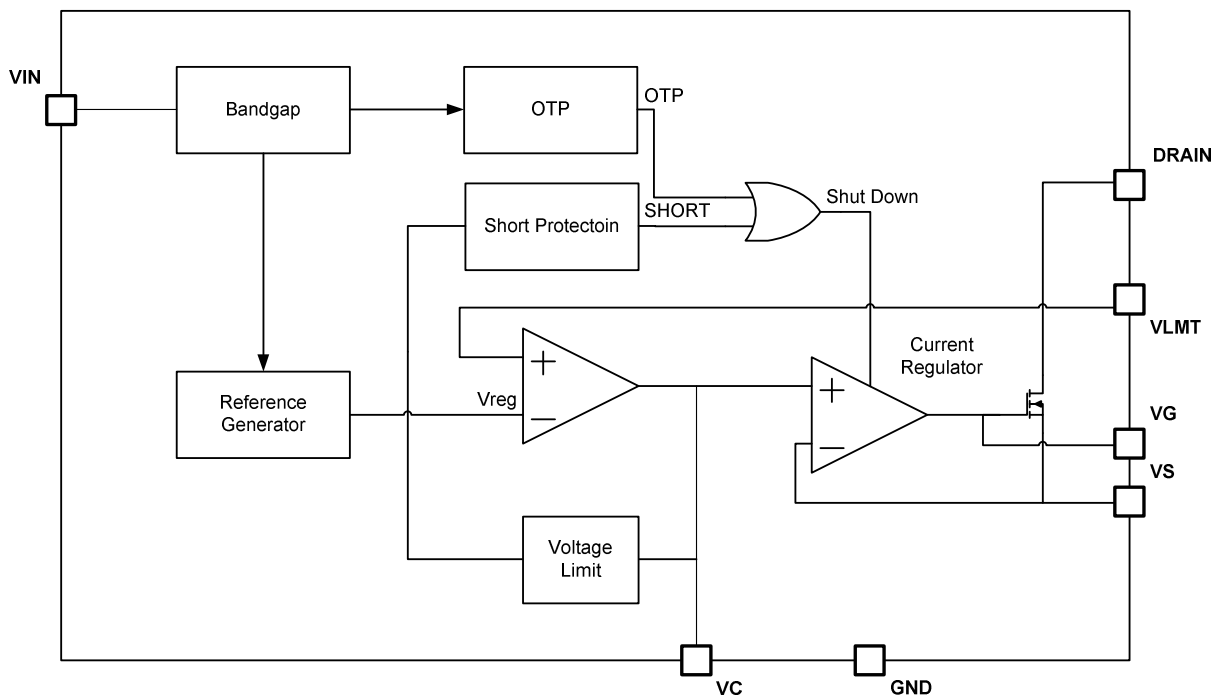
TYPICAL PERFORMANCE CHARACTERISTICS

Vin= 220Vac , Vout =450V , Iout =50mA , Cout=10µF/500V, TA = +25°C, unless otherwise noted

Steady State

4ms/div

Start up

100ms/div

Power off

100ms/div

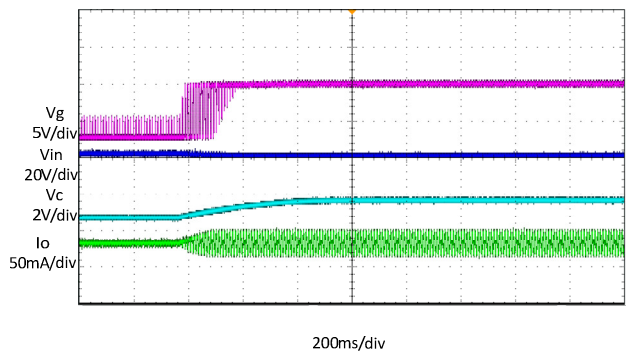### SCP

200ms/div

Fast on/off

200ms/div

OTP

200ms/div
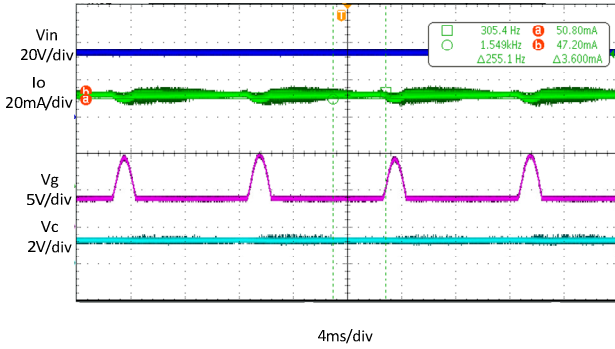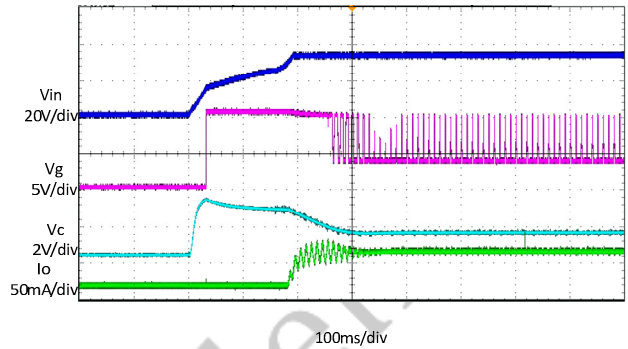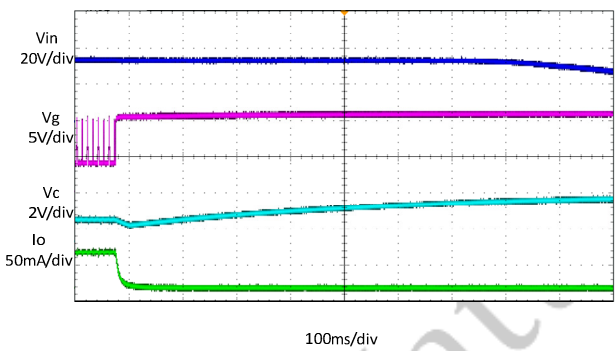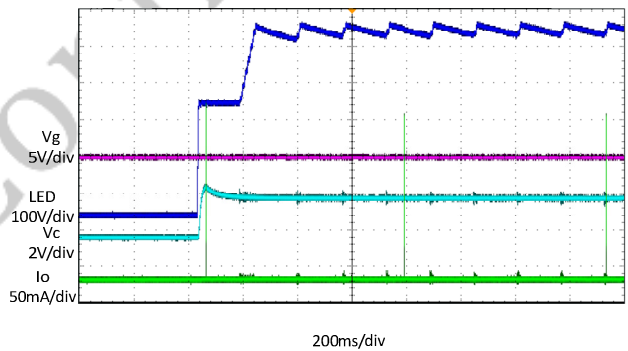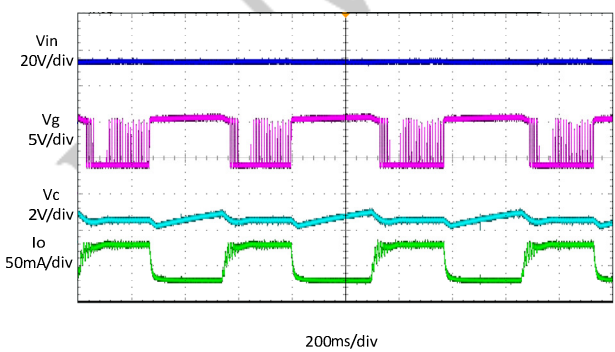
FUNCTIONAL DESCRIPTION

JW1237C is used to drive a LED string, and remove the 100/120Hz LED current ripple on AC/DC power.

Theory of Operation

The LED string and JW1237C are both supplied by an AC/DC current source. The LED- pin is connected to the cathode of LED string. A sensing resistor R_{SENSE} is connected between the VS and GND.

JW1237C transfers the LED current ripple to voltage ripple, and ensures the constant voltage across LED string and the current flow through LED string.

The scalable adaptive function of JW1237C can regulate the cathode voltage of LED string to minimum to improve the efficiency of the system.

Current Ripple Removing

The capacitor C_C between VC and GND is an integration capacitor. JW1237C transform the voltage on C_C to a reference voltage. The current regulator regulates the voltage on R_{SENSE} equal to the reference voltage.

The relationship between the voltage on C_C and R_S is shown as following:

$$V_{RS} = I_{LED} * R_{SENSE} = V_{VC} / 10$$

C_C should be large enough in order to remove the current ripple of the LED string. However, too large capacitor may slow down the dynamic response.

Adaptive Regulation

The voltage on C_C is controlled by monitoring the operation state of integrated NMOSFET. The efficiency of system is relatively low when NMOSFET is working in the saturation region. C_C is charged to raise the V_{VC} and I_{LED}, then the output voltage of power supply is reduced, and

the voltage drop on NMOSFET decreases. Conversely, when NMOSFET is working in the linear region, LED current regulation loop is open. C_C is discharged to reduce the V_{VC} and I_{LED}, then the output voltage of power supply is raised, and the LED current regulation loop is close.
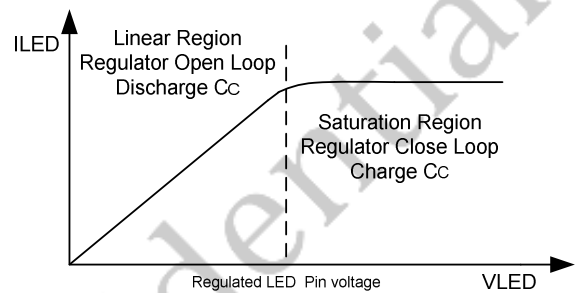
The Voltage of LED- Limit

The voltage ripple on LED- pin maybe very large when the current ripple is removed, which would bring large power dissipation on chip. The resistor between LED-pin and VLMT pin can setup the limit value of the voltage of LED- pin.
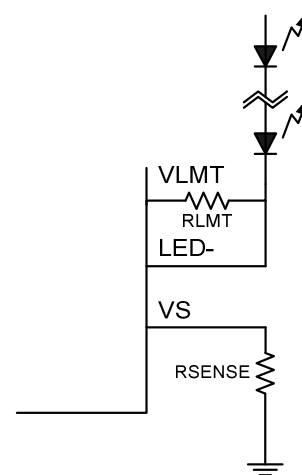
The limit threshold is calculated as below:

$$V_{limit} = 2V + R_{LMT} * 20uA$$

LED Current Limit

The voltage of VS pin is limited internally. So the current limitation is V_{VS}/R_S.

Current limit can protect the chip when LED is short connected or HOT-PLUG.

The function of current limit is higher priority than LED- voltage limit. It means that the voltage of LED- pin is not limited when LED current exceed current limit threshold.

LED Short Protection

JW1237C detect SHORT by R_{LMT}. When the voltage of LED- pin exceeds the SHORT PROTECTION THRESHOLD and the state holds for more than 160us, JW1237C considers the LED string is SHORT connected and shuts down. The SHORT state is reset after 800ms. The SHORT PROTECTION THRESHOLD is calculated as:

$$V_{THSCP} = 2V + R_{LMT}* 40uA$$
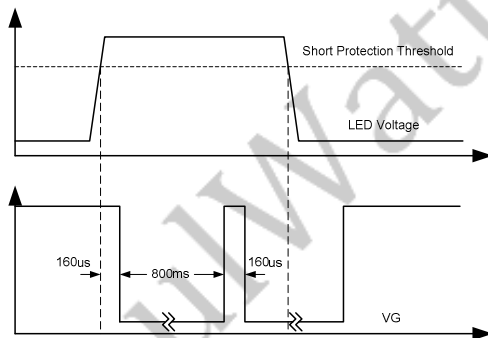
Over Thermal Protection

JW1237C monitors operation temperature. When the temperature is higher than 147℃, the chip pulls up VG voltage and makes the power MOSFET in fully on state. Ripple remove function will be disabled until the temperature decreases to 122℃.

## Ripple Removing in Dimming and Electronic Load Applications

JW1237C has a lower OVP threshold, which enables a wider ripple removing range. To have smooth dimming performance and good compatibility with electronic load, VC will be pulled-up slowly when OVP trigged.

PCB Design Guideline

1. The bypass capacitor of VIN should be placed as close as possible to the VIN pin and GND pin of IC.
2. The area of LED current loop should be as small as possible.

APPLICATION INFORMATION

JW1237C design guide:
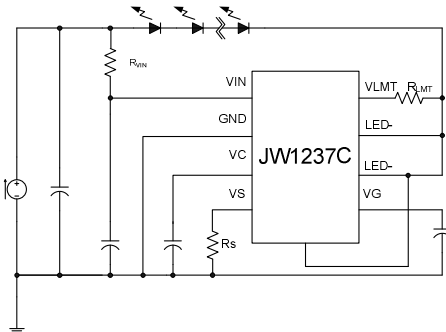
1. Because of the 30V zener integrated and the 16V V_{IN} start threshold, the value of R_{VIN} may satisfy the following conditions:

$$R_{VIN} < \frac{V_F - 16V}{0.5mA}$$

V_F: the voltage of LED

2. The maximum voltage of VS pin is 0.23V in order to limit the maximum output current especially in the short circuit condition. The value of R_S can be calculated as below:

$$R_S < \frac{0.23V}{I_{LED}}$$

I_{LED}: the output current of the pre-driver

3. When the voltage of LED- reaches V_{SCP} which is set by the R_{LMT}, JW1237C pulls down the VIN then turns off the MOSFET. In order to ensure nothing will be damaged in the short circuit condition, the value of R_{LMT} must satisfy the following conditions:

$$V_{OVP} - V_F < V_{SCP} < V_F$$

$$V_{SCP} < V_{INSTART} = R_{VIN} * 0.5mA + 16V$$

$$V_{SCP} = 2V + 40uA * R_{LMT}$$

V_{OVP}: the output voltage when the pre-driver is open.

V_{SCP}: the threshold of JW1237C short circuit protection.

$V_{INSTART}$: the output voltage of the pre-driver when the VIN of JW1237C is 16V.

4. The value of the capacitor between VC and GND can determine the final amplitude of the current ripple. It should be large enough in order to remove the current ripple of the LED string. However, too large capacitor may slow down the dynamic response. In normal condition, 1uF or 2.2uF is relatively reasonable.

5. To ensure JW1237C work properly, the R_{DSON} of MOSFET must be less than $3R_S$. The MOSFET will endure a large power shorting the output on the moment, so the appropriate package and R_{DSON} of the MOSFET is necessary.

6. When short the LED, there is an overshoot on the drain of the MOSFET. The breakdown voltage of the MOSFET must be higher than V_{OVP}. A diode connected to LED+&LED- can reduce the overshoot when short.

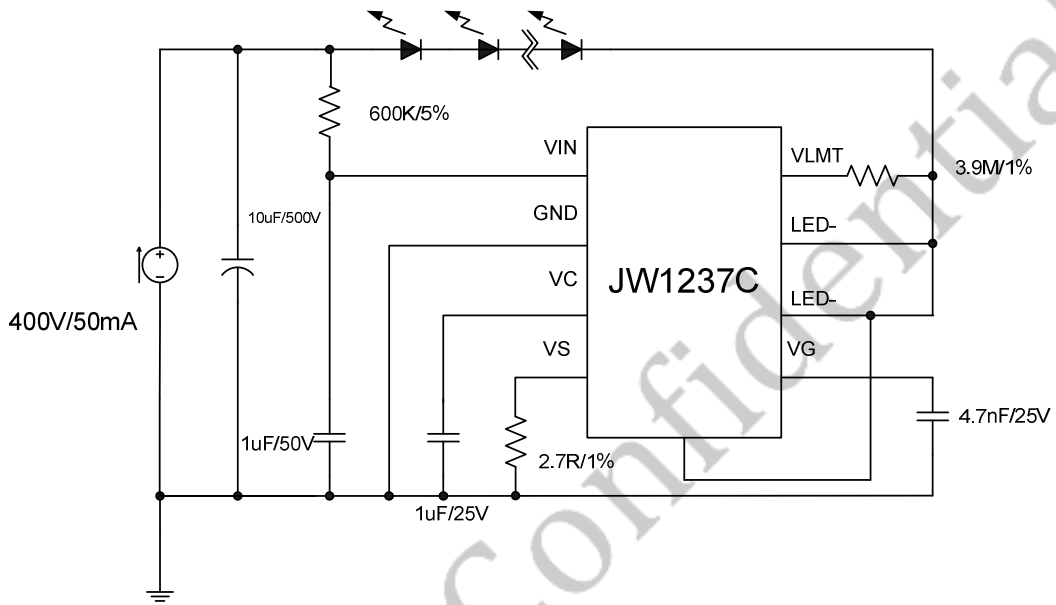7. Electronic load is not recommended in the debug/burn-in.
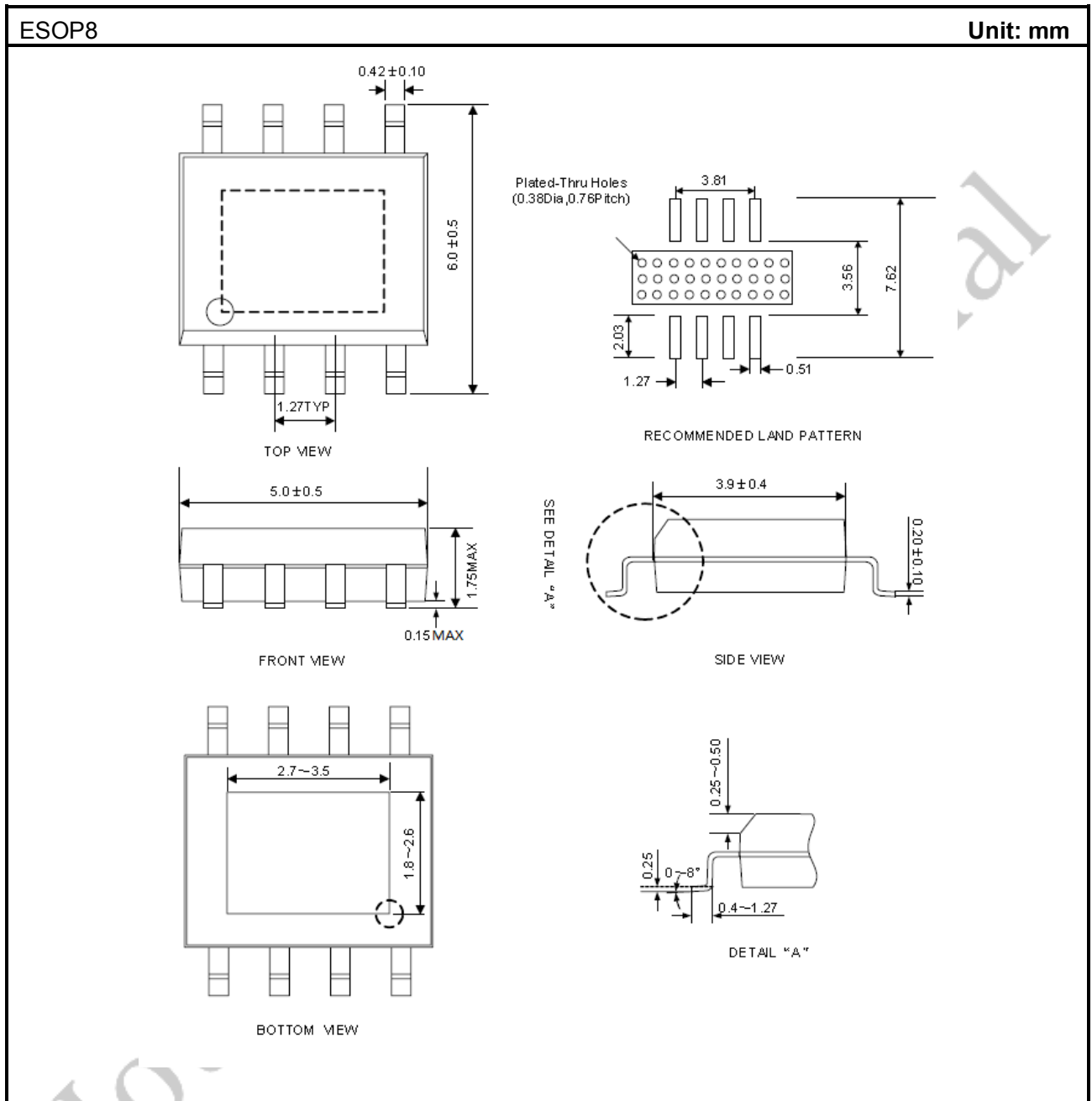
REFERENCE DESIGN

Reference：

V$_{IN}$: 400V

I$_{IN}$: 50mA

Current ripple:<5%

PACKAGE OUTLINE

ESOP8	Unit: mm

TOP VIEW

RECOMMENDED LAND PATTERN

FRONT VIEW

SIDE VIEW

BOTTOM VIEW

DETAIL "A"

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