Zywyn

ZD850

1.5A High Power LED Driver

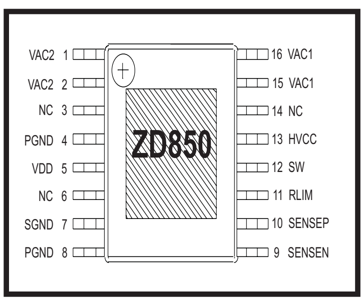
Features

- 4~16VAC on VAC1 and VAC2 with current up to 350mA
- 5~24VDC on VAC1 and VAC2 or on HVCC and PGND with current up to 800mA
- 5~24VDC on HVCC and PGND with current up to 1.5A
- For One to Five High-Power LEDs in series per string
- High Efficiency Output Design
- Over-Temperature Thermal Protection
- Over-Voltage Circuit Protection
- Thermally Enhanced 16-Lead Exposed TSSOP Green Package

Applications

- Offline LED Lamps and Fixtures
- DC/DC LED Driver
- Decorative Lighting
- MR16 Lighting
- Industrial Lighting
- Automotive Lighting

Pin Configuration



16-Pin Exposed TSSOP

General Description

The ZD850 is a constant off-time, high power LED driver IC using a Buck Converter Topology that is capable of driving up to 1.5A of output current. It operates from an input voltage range of 4VAC to 16VAC or 5VDC to 24VDC and generates a regulated programmable constant output current for high power LEDs. A patent pending design technique with AC/DC bridge rectifier, linear regulator and internal high voltage NDMOS power switch has been designed on-chip to reduce component count by eliminating the need for an external power switch and diode bridge. Based on high efficient PFM control design, the minimum Off-Time in the controlled frequency range is set at a typical 1.5µs, allowing a good LED current regulation over a wide range of supply voltage with respect to using conventional transformers or E-transformers. Built-in thermal and over-voltage circuitry protects the power transistors from excessive power dissipation.

The ZD850 is available in a thermally enhanced 16-pin exposed TSSOP green package.

Ordering Information

Part Number	Temperature Range	Package Type
ZD850LEY	–40°C to +85°C	16-Pin TSSOP
ZD850EVB	n/a	Blank EVB
ZD850MR	n/a	Evaluation Board
ZD850KIT	n/a	ZD850MR + 1Wx3 LEDs + E-Transformer

Please contact the factory for pricing and availabiliy on Tape-on-Reel option.

Typical Application

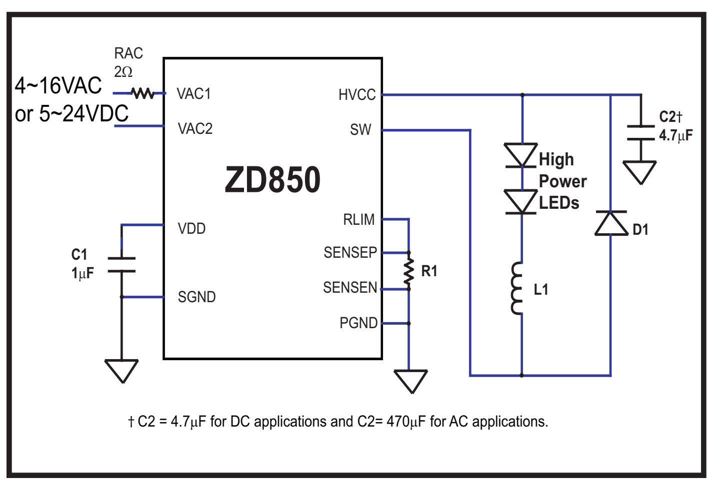


Figure 1. ZD850 driving High Power LEDs up to 1.5A

Absolute Maximum Ratings

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

VAC Input Voltage 18VAC
HVCC Input Voltage 30VDC
SW Voltage 30VDC

Extended Commercial
Operating Temperature .... –40°C to +85°C
Maximum Junction Temperature .... +125°C
Storage Temperature................................ –65°C to +150°C
Lead Temperature (Soldering, 10sec.) .... 300°C

Power Dissipation Per Package
16-pin Exposed TSSOP 3W
Package Thermal Resistance
Θ_{JA} .... 38°C/W
Θ_{JC} .... 10°C/W

Storage Considerations

Storage in a low humidity environment is preferred. Large high density plastic packages are moisture sensitive and should be stored in Dry Vapor Barrier Bags. Prior to usage, the parts should remain bagged and stored below 40°C and 60%RH. If the parts are removed from the bag, they should be used within 48 hours or stored in an environment at or below 20%RH. If the above conditions cannot be followed, the parts should be baked for four hours at 125°C in order remove moisture prior to soldering. Zywyn ships product in Dry Vapor Barrier Bags with a humidity indicator card and desiccant pack. The humidity indicator should be below 30%RH

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Electrical Characteristics

T_A = +25°C, VAC = 12VAC or 12VDC, C1 = 1μF, C2 = 4.7μF(VDC) or C2 = 470μF(VAC), unless otherwise noted.

Parameter	Condition	Min	Typ	Max	Units
AC Input Voltage, VAC	AC Input Frequency = 50/60Hz	4	12	16	V_{AC}
AC Input Voltage, VAC	AC Input Frequency = 20kHz~50kHz, E-Transformer		12	16	V_{AC}
DC Input Voltage VDC	Apply DC Voltage to HVCC or to AC Input Pins	5		24	V_{DC}
Quiescent Current				1	mA
SW Output Frequency				500	kHz
$R_{DS(ON)}$, M1	Switching Current @ 500mA		0.5		Ω
VDD Output Voltage	Supply voltage =12VAC/VDC, ILED = 350mA, I_{VDD_OUT}= 5mA	3.0	3.2	3.6	V
LED Output Current	4~16V AC Applied across VAC1 and VAC2 Pins			350	mA
LED Output Current	5~24VDC Applied across VAC1 and VAC2 or across HVCC and PGND Pins			800	mA
LED Output Current	5~16VDC Applied across HVCC and PGND Pins			1.5	A
Off-Time			1.5		μs
Thermal Shutdown			125		^oC

Block Diagram

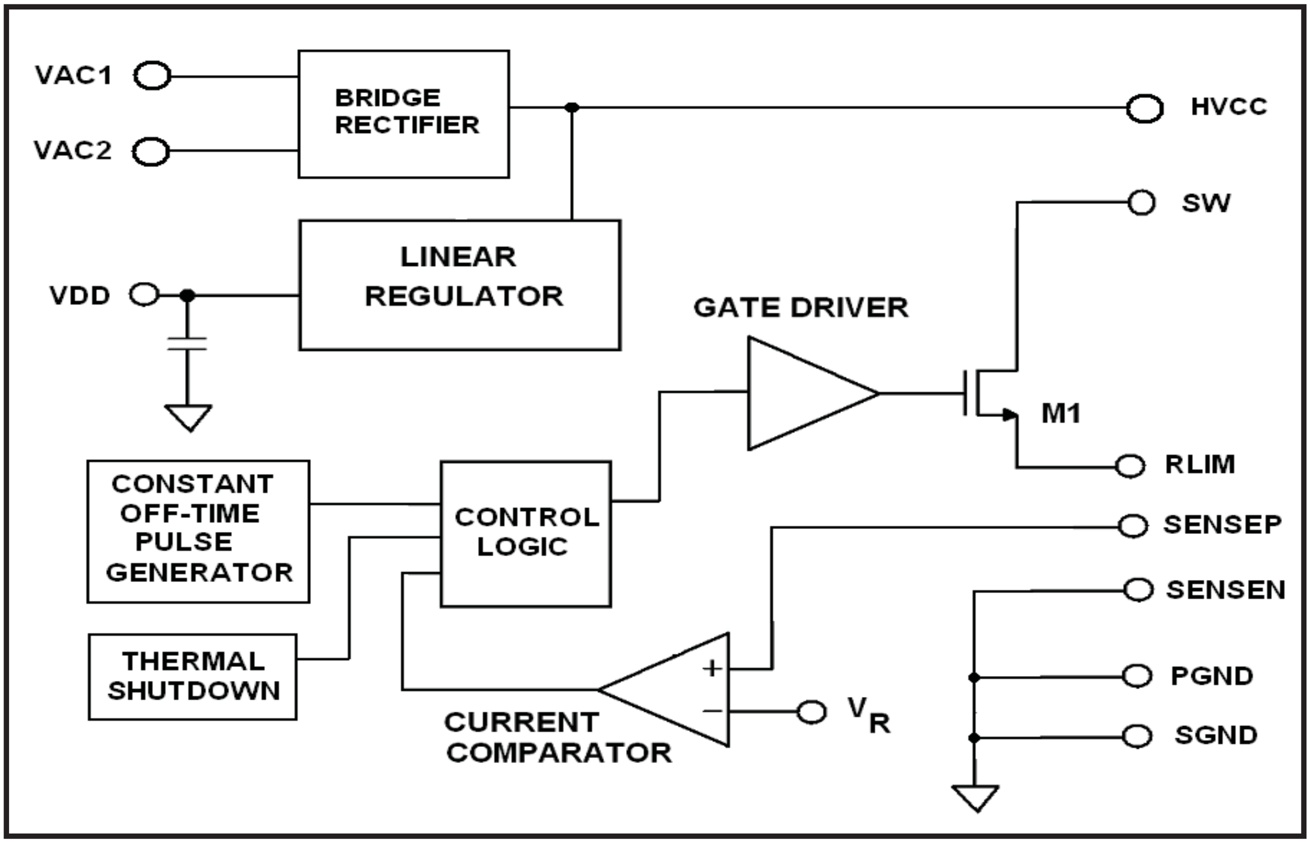


Fig.2. ZD850 Typical Block Diagram

Pin Description

Pin Number	Pin Name	Pin Function
1, 2	VAC2	AC Voltage Input1, from 4~16VAC or 5~24VDC.
15, 16	VAC1	AC Voltage Input2, from 4~16VAC or 5~24VDC.
13	HVCC	Rectified DC Voltage Output. This can be used as an input pin for a DC voltage range of 5V~24VDC when VAC1 and VAC2 are left open.
5	VDD	Internal Regulator Output, 3.2V(Typ). Decouple this pin with a 1μF capacitor.
11	RLIM	Output Current Level Resistor Input. Connects a resistor from this pin to ground sets the output current of the LED driver.
7	SGND	Signal Ground. Connects all small signal components to this ground.
4, 8	PGND	Power Ground. Connects high voltage decoupling capacitor to this ground.
12	SW	Switch Node.
10	SENSEP	Positive RLIM Sense Connection.
9	SENSEN	Negative RLIM Sense Connection.
3, 6, 14	NC	No Connect Pins. Must be left open.

Circuit Description

Device Operation of the ZD850

During the charging operation, the turning on of the internal power NDMOS stores the input energy in an inductor. When the NDMOS is turned off during the t_{OFF} time, the stored energy will deliver to the output through the fly-back diode D1, producing the ILED current through the LEDs.

Since ZD850 is designed with a high efficient constant off-time controlling technique, the t_{OFF} time is fixed at 1.5µs (typical), it is important to make sure the supply voltage is less than 2 times the forward voltage drop across the LEDs and the t_{ON} should be greater than t_{OFF}. The main reason for these limitations is to avoid the output current (ILED) from getting into an unstable and high ripple state, which results in an oscillation of the output current (ILED) at sub-harmonics of the switching frequency.

Setting the Output Current (ILED) with R1 (Sense Resistor)

Typically there is an error associated with the current sensing across R1 between SENSEP and SENSEN. This error is introduced by the difference between the peak and the average current in the inductor. A typical peak-to-peak ripple current in the inductor is 15% of ILED. The sense resistor should be calculated as

EQUATION 1A.

$$R1 = \left(\frac{0.2V}{I_{LED} + \frac{\Delta I_{RIPPLE}}{2}} \right)$$

UNDER AMBIENT TEMPERATURE OF 25ºC

where

0.2V is the typical SENSEP voltage.

I_{LED} = desired output current in Amps chosen by the user (Maximum 1.5A with DC voltage applied to HVCC and PGND. Maximum 800mA with DC voltage applied to VAC1/VAC2.)

ΔI_{RIPPLE} = % x ILED. A typical peak-to-peak ripple current in the inductor is 15% of ILED but can be varied to adjust to the available inductor. (See EQUATION 2)

EQUATION 1B.

$$R1 = \left(\frac{0.12V}{I_{LED} + \frac{\Delta I_{RIPPLE}}{2}} \right)$$

The ZD850 must have a proper heat dissipation to operate at EQUATION 1A when using the VAC1/VAC2 inputs. The ambient temperature must be kept at 25ºC and the case temperature must stay below 40ºC. EQUATION 1B is used if the case temperature exceeds 40ºC.

Inductor Selection

Higher values of inductance are recommended at higher supply voltage in order to minimize errors due to switching delays, which results in increased ripple and low efficiency. High value of inductance also results in a smaller change in output current (ILED) over the supply voltage range.

EQUATION 2.

$$L = \left(\frac{V_{LEDS} \times t_{OFF}}{\Delta I_{RIPPLE}} \right)$$

Where
$V_{LEDS} = V_{FORWARD\text{-}LED}$ x N
N = # of LEDs in series
t_{OFF} = 1.5µs
ΔI_{RIPPLE} = % x I_{LED}

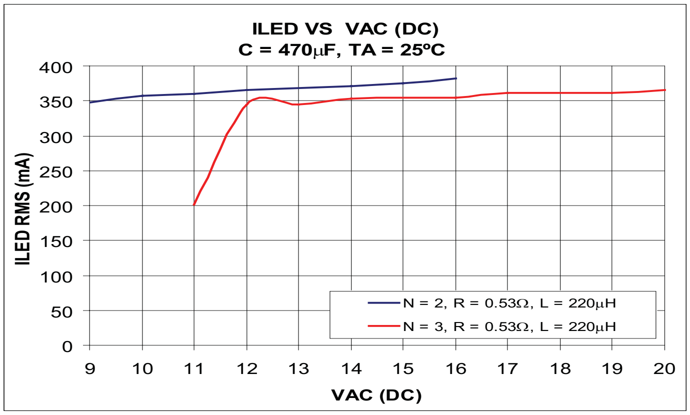
The inductor value depends on the ripple current in the LEDs. A typical of 15% ripple in the LED current is used in our calculations but can be varied to adjust to the available inductors. The peak current of the inductor will be I_{PEAK}=ILED x 1.075.

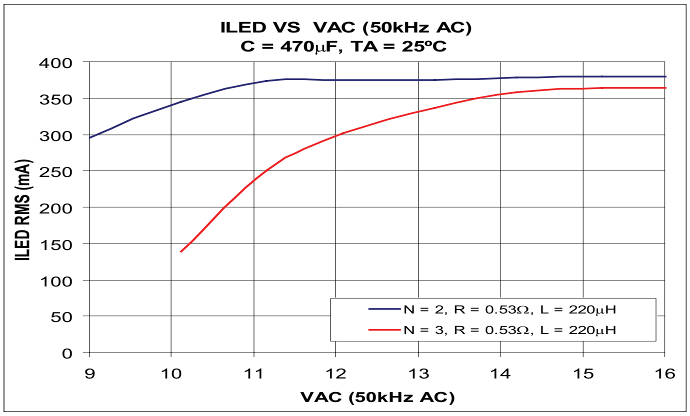
Diode Selection

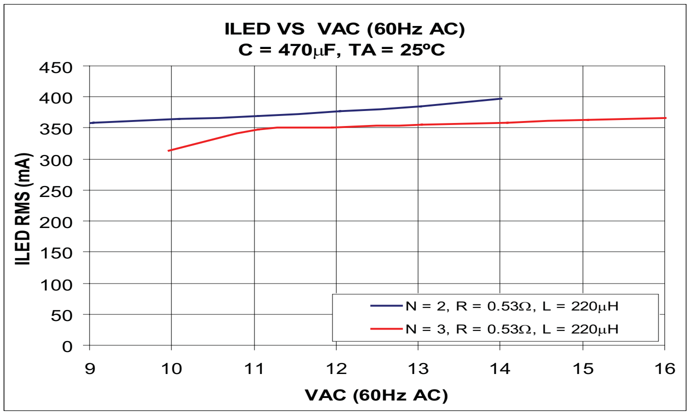
The diode D1 is used in the buck converter to help the inductor releasing the energy during the NDMOS off time to supply the ILED to the LED string. Since the maximum HVCC should be less than 24VDC, the reverse breakdown voltage of the diode should be greater than 40VDC and the average current through the diode should be 2 x ILED or greater.

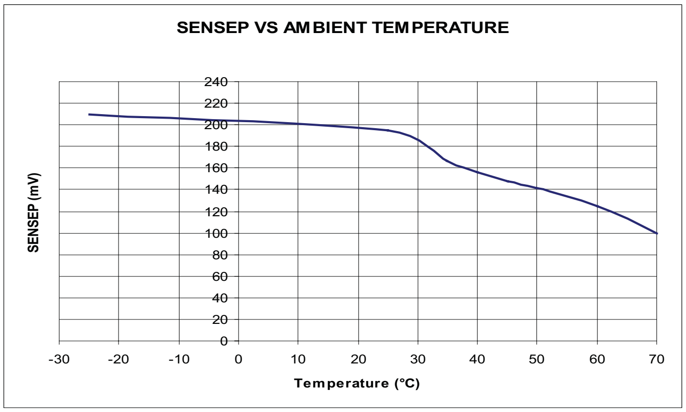
Typical Performance Characteristics

T_A = +25°C, $V_{Forward\text{-}LED}$ = 3.0V @ 300mA, N = # of LEDs in series, unless otherwise noted.



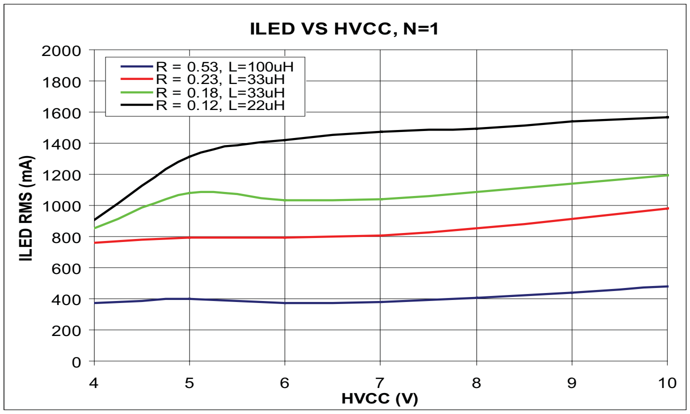


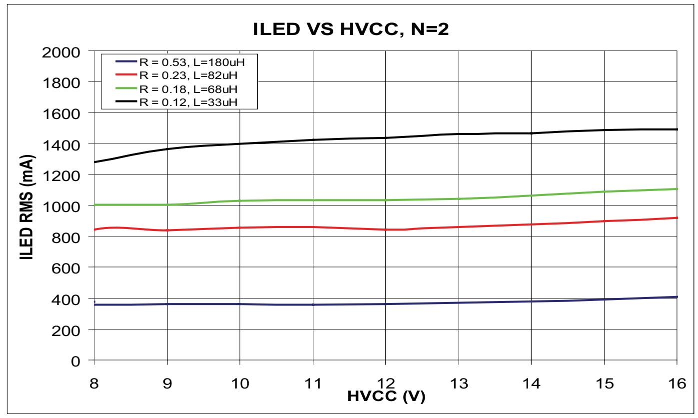


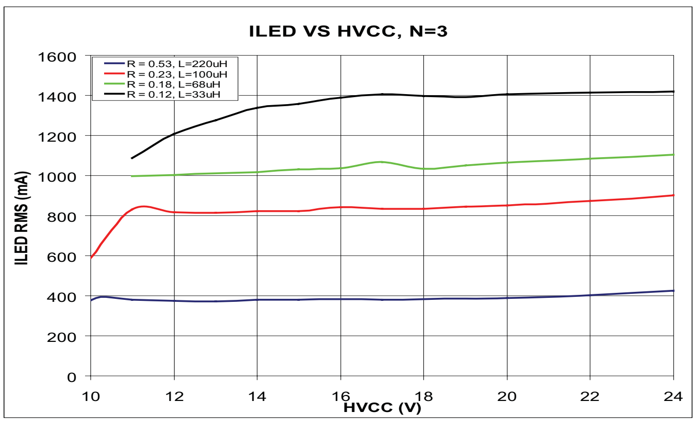


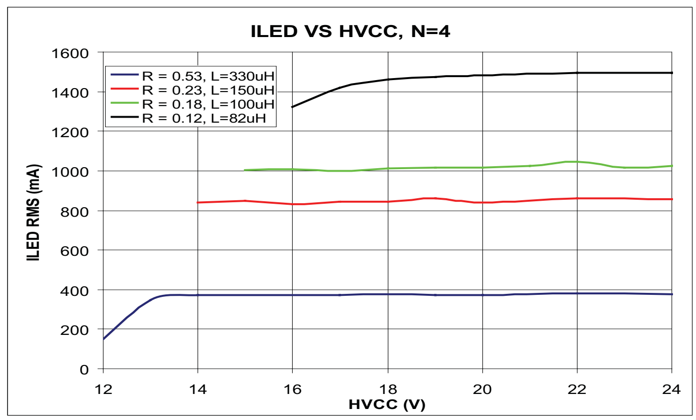
Typical Performance Characteristics

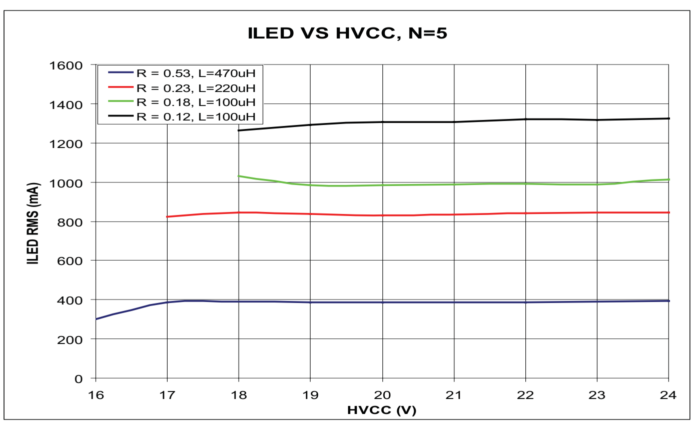
T_A = +25°C, $V_{Forward-LED}$ = 3.0V @ 300mA, N = # of LEDs in series, C2 = 4.7µF, unless otherwise noted.





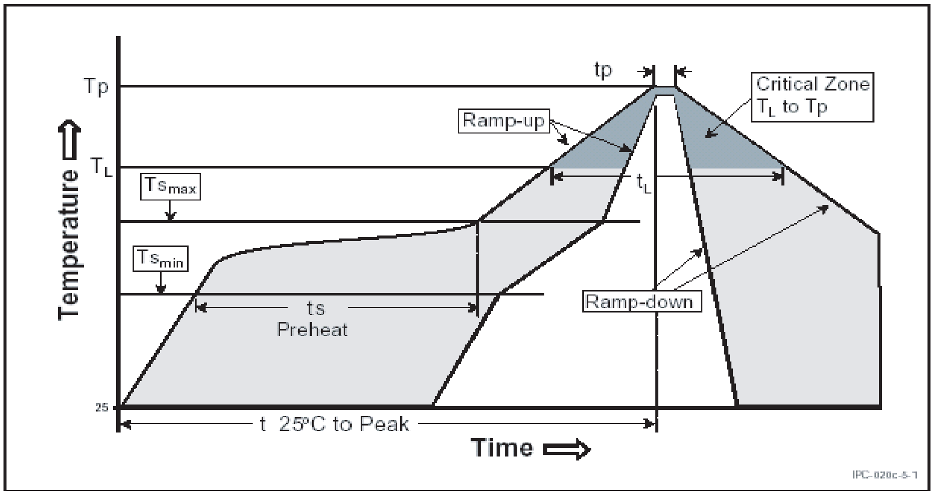






Green Package SMD IR Reflow Profile Information

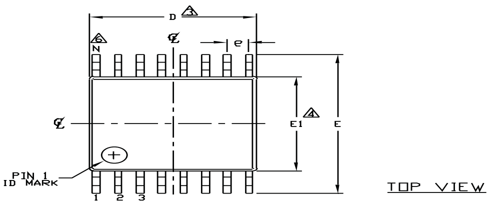
IR Reflow Profile Conditions

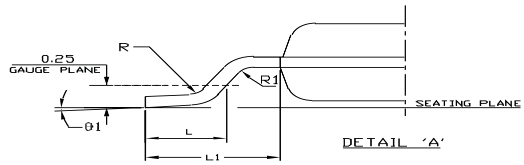


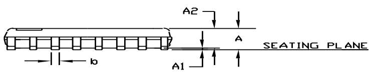
Profile Feature	JESD Sn-Pb Eutectic Assembly	JESD Pb-free Assembly
Average Ramp-Up Rate (T_{Smax} to T_P)	3°C/seconds max.	3°C/seconds max.
Pre-heat - Temperature Min (T_{Smin}) - Temperature Max (T_{Smax}) - Time (T_{Smin} to t_{Smax})	100°C 150°C 60~120 seconds	150°C 200°C 60~180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	183°C 60~150 seconds	217°C 60~150 seconds
Peak/Classification Temperature (T_P)	235°C+5/-0°C	255°C+5/-0°C
Time within 5°C of actual Peak Temperature (t_P)	10~30 seconds	20~40 seconds
Ramp-Down Rate	6°C/second max.	6°C/second max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.

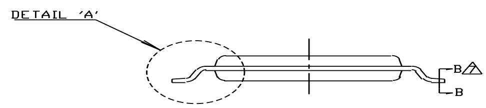
Zywyn Green Packages are Pb-free and RoHS compliance.

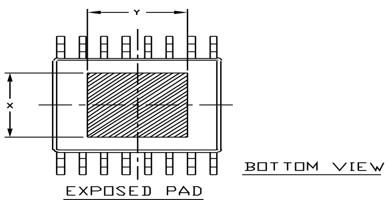
Package Information

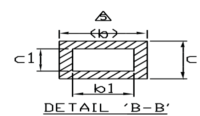












SYMBOL	14L TSSOP Thermally Enhanced		
	MIN	NOM.	MAX
A	—	—	1.20
A1	0.025	—	0.100
A2	0.80	0.90	1.05
D	4.9	5.0	5.1
E1	4.3	4.4	4.5
E	6.2	6.4	6.6
L	0.45	0.60	0.75
R	0.09	—	—
R1	0.09	—	—
b	0.19	—	0.30
b1	0.19	0.22	0.25
c	0.09	—	0.20
c1	0.09	—	0.16
θ1	0°	—	8°
L1	1.0 REF		
e	0.65 BSC		
N	14		
Ref.	Jedec MO-153 Issue C Variation ABT-1		
EP Area	Pad Size	X	Y
	Op 1	2.997	3.200

SYMBOL	16L TSSOP Thermally Enhanced		
	MIN	NOM.	MAX
A	—	—	1.20
A1	0.025	—	0.100
A2	0.80	0.90	1.05
D	4.9	5.0	5.1
E1	4.3	4.4	4.5
E	6.2	6.4	6.6
L	0.45	0.60	0.75
R	0.09	—	—
R1	0.09	—	—
b	0.19	—	0.30
b1	0.19	0.22	0.25
c	0.09	—	0.20
c1	0.09	—	0.16
θ1	0°	—	8°
L1	1.0 REF		
e	0.65 BSC		
N	16		
Ref.	Jedec MO-153 Issue C Variation ABT		
EP Area	Pad Size	X	Y
	Op 1	2.997	2.997

Notes

1. ALL DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. DIMENSION 'D' DOES NOT INCLUDE MOLD FLASH ,PROTRUSIONS OR GATE BURRS.
4. DIMENSION 'E1' DOES NOT INCLUDE INTERNAL FLASH OR PROTRUSION.
5. DIMENSION 'b' DOES NOT INCLUDE DAMBAR PROTRUSION.
6. "N" IS THE MAXIMUM NUMBER OF LEAD TERMINAL POSITIONS FOR THE SPECIFIED PACKAGE LENGTH.
7. CROSS SECTION B-B TO BE DETERMINED AT 0.10 TO 0.25MM FROM THE LEAD TIP.
8. EXPOSED PAD WILL BE DEPEND ON THE PAD SIZE OF THE L/F.

16-Pin Exposed TSSOP

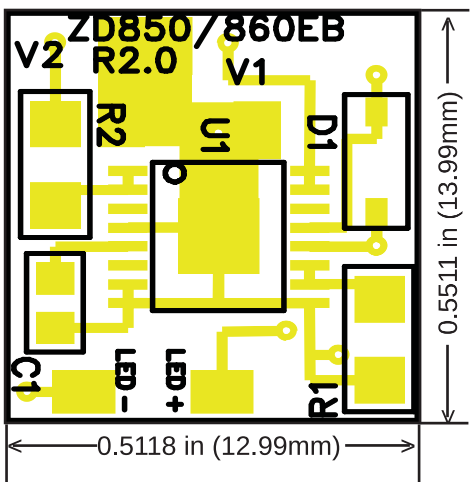
REV.	DESCRIPTION	DATE	BY	APPD
A	STANDARDIZED PACKAGE OUTLINE DRAWING NO. & GENERAL REVISION.	13/05/04	ANDREW	CE
0	ORIGINAL DRAWING.	06/08/99	ANDREW	CE

TOLERANCES: REFER TO THE SPECIFICATION ABOVE.
UNIT: MM
SCALE: NTS
SYMBOL

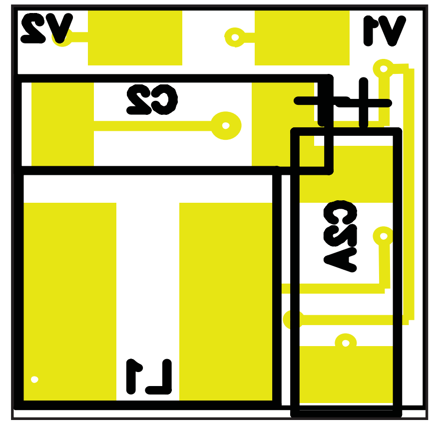
DESIGNED: ANDREW TAN	DATE:
APPD: KH TAN	DATE:
APPD: CW CHAI	DATE:
APPD: KEVIN	DATE:
APPD: WH LAI	DATE:
DWG. NO: PO-14/16TS-EP-MT	REV.: A

ZYWYN CORPORATION
14/16L TSSOP EXPOSED PACKAGE OUTLINE
SHEET NO : 1 OF 2.

Evaluation Board Information



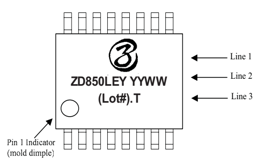
ZD850EVB Double-Layer Evaluation Board Component Side Layout Topview



ZD850EVB Evaluation Board Backside Layout Topview

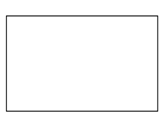
Part Marking Information

TOPSIDE MARK INSTRUCTIONS:



Line 1: Zywyn (logo)
Line 2: Zywyn Part Number "ZD850LEY", Space " ", Date Code (Prod Year & Week)
Line 3: Lot #, dot and Country ".T"
Note: Pin # 1 "△" Indicator Required if no mold dimple

BOTTOMSIDE MARK INSTRUCTIONS:



No backside marking

16-Pin Exposed TSSOP

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