Zywyn

Advance Product Information
ZD832

Universal Transformerless AC-DC Constant Current LED Driver

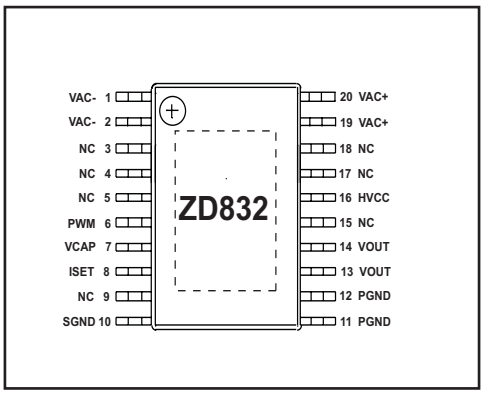
Features

- AC to DC Constant Current Driver
- No Transformer, No External Bridge Rectifier
- 85VAC to 240VAC Input Voltage Range
- Programmable up to 30mA Constant Output Current
- PWM or Analog Dimming Control
- Over-Temperature Protection
- Over-Voltage Limiting on Internal Power Transistor
- High Voltage Static Circuit Design With No EMI
- Thermally Enhanced 20-Lead Exposed TSSOP Green Package

Applications

- Offline LED Lamps and Fixtures
- LCD Panel Display Backlighting
- Avionics Displays
- Decorative Lighting
- Industrial Lighting

Pin Configuration



20-Pin Exposed TSSOP

WARNING! This is a high voltage application circuit where Galvanic Isolation is not provided. Dangerous voltages are present when connected to the AC line. It is the responsibility of the engineer employing the ZD832 to ensure adequate safeguards are put in place to protect the end user from electrical hazardous shock.

General Description

The ZD832 is a high voltage, transformerless AC-DC constant current driver for driving a string of white or RGB LEDs in series. It operates from an universal input voltage of 85VAC to 240VAC and generates a programmable constant output current. The high operating voltage of ZD832, along with its linear control architecture eliminates the need for an external inductor, transformer and rectifying diode bridge. The output current level is set by a single resistor and can be set as high as 30mA. Dimming control can be accomplished by using pulse-width modulation signal with varying duty cycle on the PWM pin or by applying an analog DC voltage on the ISET pin. Thermal and over-voltage circuitry protects the internal power transistors from excessive power dissipation.

The ZD832 is available in a thermally enhanced 20-pin exposed TSSOP green package.

Ordering Information

Part Number	Temperature Range	Package Type
ZD832LEY	–40°C to +85°C	20-EP TSSOP
ZD832EVB	n/a	Evaluation Board

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

Typical Application

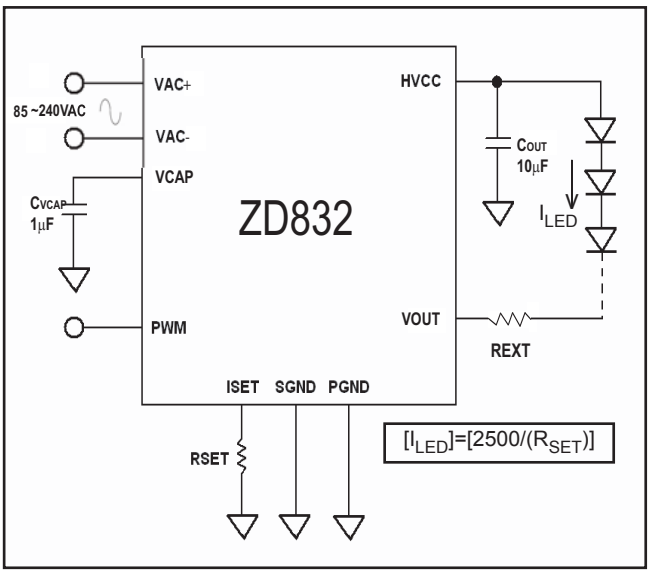


Figure 1. ZD832 driving a string of LEDs in series at a presetted constant current

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 280VAC
PWM Voltage..... +6V
V_{OUT} Voltage ..... +100V

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
20-pin Exposed TSSOP 2.50W
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

The information furnished by Zywyn has been carefully reviewed for accuracy and reliability. Its application or use, however, is solely the responsibility of the user. No responsibility of the use of this information become part of the terms and conditions of any subsequent sales agreement with Zywyn. Specifications are subject to change without the responsibility for any infringement of patents or other rights of third parties which may result from its use. No license or proprietary rights are granted by implication or otherwise under any patent or patent rights of Zywyn Corporation.

Electrical Characteristics

T_A = +25°C, VAC+ & VAC- = 240VAC, SGND = PGND = 0V, C_{OUT} to PGND = 10µF (rated at 350V), C_{VCAP} to SGND = 1µF (rated at 10V), PWM = 5V; unless otherwise noted.

Parameter	Condition	Min	Typ	Max	Units
AC Input Voltage, VAC+ & VAC-		85		240	V_{AC}
High Voltage, HVCC					
DC Input applied to HVCC	un-connected VAC+ & VAC-, I_{LED}=5mA, VOUT=5V	120		340	V
DC Output from HVCC	connected VAC+ & VAC-, I_{LED}=5mA, VOUT=5V	120		340	V
Supply RMS Current, I_{VAC} Quiescent Current	R_{SET}=125kΩ, PWM=5V, un-connected VOUT		2	5	mA
LED Output Current Range, I_{LED}		3		30	mA
Output Current, I_{LED}	R_{SET}=125KΩ; $[I_{LED}]=[2500/(R_{SET})]$				
	VOUT=5V to 10V	18.6	20	21.4	mA
	VOUT=3V to 30V	17	20	23	mA
Output Leakage Current, $I_{LED-Leakage}$	PWM=0V, VOUT=5V		20	100	µA
PWM Signal Pin					
Input Voltage High		2.0			V
Input Voltage Low				0.4	V
Input Leakage Current	PWM=0V or 5V		1	10	µA
ISET Pin					
Regulated ISET Voltage, V_{ISET}		1.1	1.25	1.3	V

Block Diagram

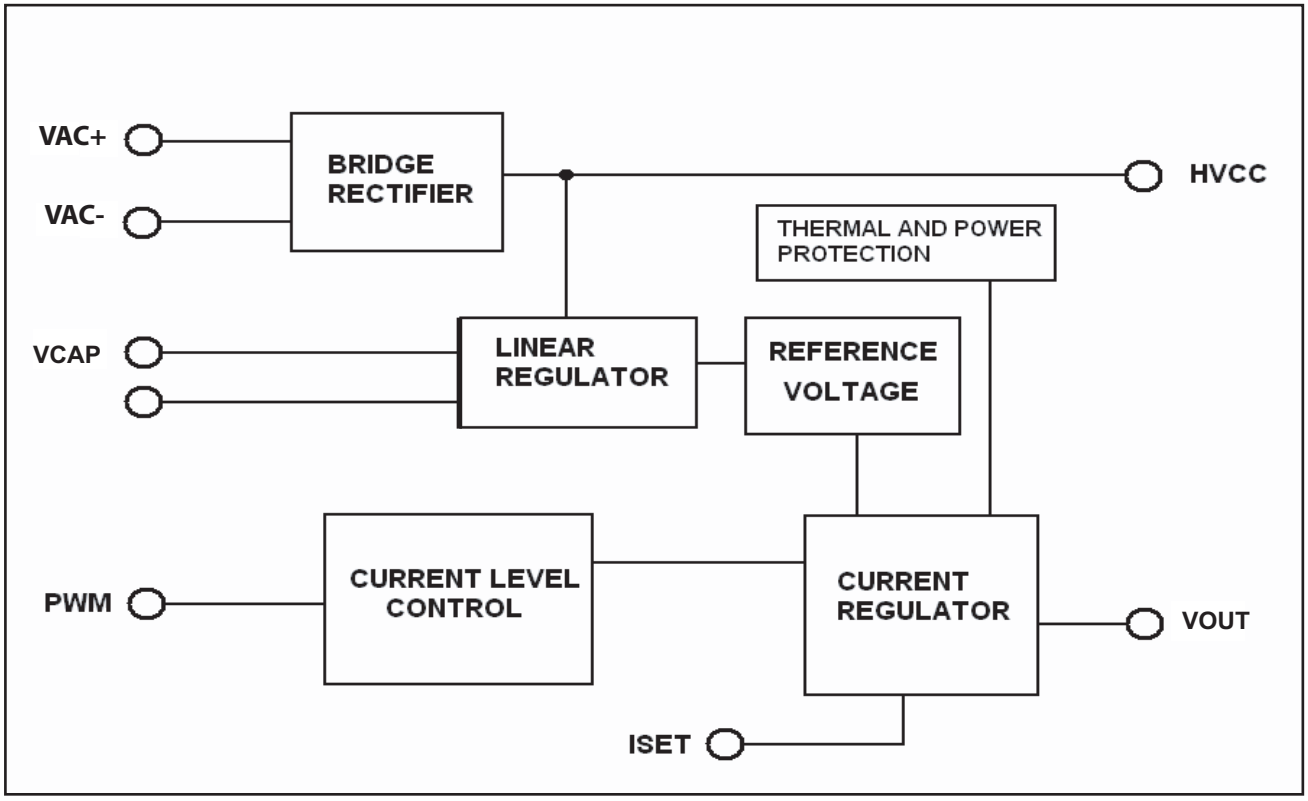


Fig.2. ZD832 Typical Block Diagram

Pin Description

Pin Number	Pin Name	Pin Function
1, 2	VAC-	High Voltage AC Input, from 85~240V_{AC}.
19, 20	VAC+	High Voltage AC Input, from 85~240V_{AC}.
6	PWM	LED Control Pin, Pulse-width Modulated or logic high/low Input.
7	VCAP	Internal Regulator Output. Bypass this pin with a 1μF capacitor to SGND.
8	ISET	LED Current Setting Pin. Connect RSET from ISET to PGND to set the LED current.
10	SGND	Signal Ground. Connects all small signal components to this ground.
11, 12	PGND	Power Ground. Connects high voltage decoupling capacitor to this ground.
13, 14	VOUT	LED Driver open-drain Output. Constant current sinking outputs rated for 100V.
16	HVCC	High Voltage Rectified DC Output from VAC+ & VAC-. Bypass HVCC with at least 10μF to PGND.
3, 4, 5, 9, 15, 17, 18	NC	No Connect Pins. Must be left open and unconnected.

Circuit Description

The Limiting Resistor R_{EXT}

To protect excessive power dissipation on the internal power transistor, an external resistor R_{EXT} may be required to maintain the V_{OUT} within the range of 3V and 30V. The formula for the limiting resistor R_{EXT} should be used to calculate the resistor value in series with the LEDs as follows,

$R_{EXT} = (HVCC - n \cdot V_{FORWARD-LED} - V_{OUT})/I_{LED}$

where,

HVCC = High Voltage Rectified DC, typically $\sqrt{2} \cdot V_{AC}$
n = Number of LEDs connected in series.
$V_{FORWARD-LED}$ = Forward bias voltage of a single LED.
V_{OUT} = Voltage at VOUT pin, typically 5V
I_{LED} = Regulated LED current, ranges from 3mA to 30mA.

Use the following formula to make sure R_{EXT} has adequate power rating tolerance:
$P_{REXT} = (I_{LED})^2 \cdot R_{EXT}$

where
P_{REXT} = Power dissipated by R_{EXT}
I_{LED} = Regulated LED current, ranges from 3mA to 30mA.

The maximum number of driven LEDs per string is shown in table below for reference, assuming the forward bias voltage of LED is 3.2V, V_{OUT} = 5V, C_{OUT} = 10μF, and I_{LED} = 30mA:

VAC Input Voltage	Max. Number of LEDs	R_{EXT} (Ω)	Power Rating (W)
85 VAC	35	66.7	0.25
100 VAC	41	126	0.25
120 VAC	50	100	0.25
200VAC	85	100	0.25
220VAC	92	286	0.25
240VAC	100	366	0.25

Selecting External Component RSET to Set I_{LED} Current

The ZD832 uses an external resistor, RSET, to set the constant LED current, I_{LED}. I_{LED} is determined by the formula:

$[I_{LED}]=[2500/(RSET)]$

with a minimum value of RSET ≥ 83KΩ, which sets the I_{LED} to 30mA, and a maximum value of RSET ≤ 833KΩ, which sets the minimum I_{LED} to 3mA (Refer to Figure 3). The maximum allowable capacitance at the ISET pin is 50pF.

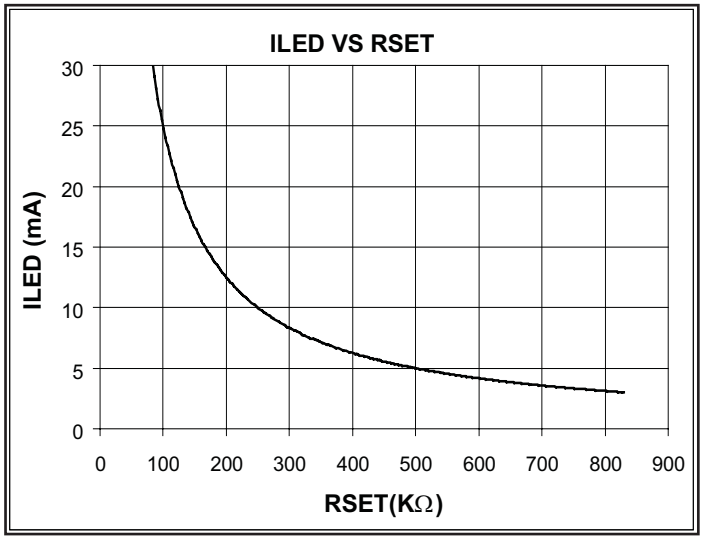


Figure 3. ILED vs RSET

Circuit Description

Over-Voltage Protection

The ZD832 contains an internal over-voltage protection circuitry, which will reduce output current amplitude (current fold-back) passing through the internal power transistor when VOUT is exceeding 50V. Typical operating range of VOUT should be from 3V to 30V.

Thermal Protection

The ZD832 contains an internal temperature sensor that shuts down the output regulator when the die temperature exceeds +150 º C. The constant current output is enabled again when the die temperature drops below +140 º C. This characteristic is evident when the LEDs are cycling between ON and OFF as the device repeatedly overheats and cools off.

No EMI

The ZD832 is a complete static circuit design with high voltage isolation supported by robust proprietary processing technology. The I_{LED} constant current is generated without the use of internal high frequency switching devices or regulators. This eliminates the high frequency EMI interference concerns and it does not require any additional EMI filtering circuits.

Fuse

The internal bonding circuitry of the VAC+ and VAC- pins of the ZD832 are configured to stand for a 1.0A internal fuse.

LED Dimming

PWM Dimming

The output string of series LEDs can be dimmed by applying an input pulse-width modulated signal (50Hz to 5kHz) to the PWM pin. This allows for a wide range of dimming gradient. The dimming is proportional to the PWM duty cycle, which can range from 10% to 90%. The device is in shutdown mode when PWM is at LOGIC LOW "0" state, and is fully-on when PWM is at a LOGIC HIGH "1" state.

Analog Voltage Dimming

To allow for LED current amplitude adjustment as well as linear dimming, ISET can be connected to an analog voltage through a resistor, RSET, where RSET is in the range of 833KΩ ≥ RSET ≥ 83KΩ. The ISET pin is typically regulated at 1.25V.

As shown in figure 4, when the DC voltage is set at 0V for example, the I_{LED} current is positioned at its default value which is calculated from the equation,

$$[I_{LED}]=[2500/(RSET)]$$

Increasing the DC voltage from 0V to 1.25V will dim the LEDs in linear proportion with decreased in the I_{LED} current. Setting the DC voltage at midpoint upon device power-up can control the dimming up and down function.

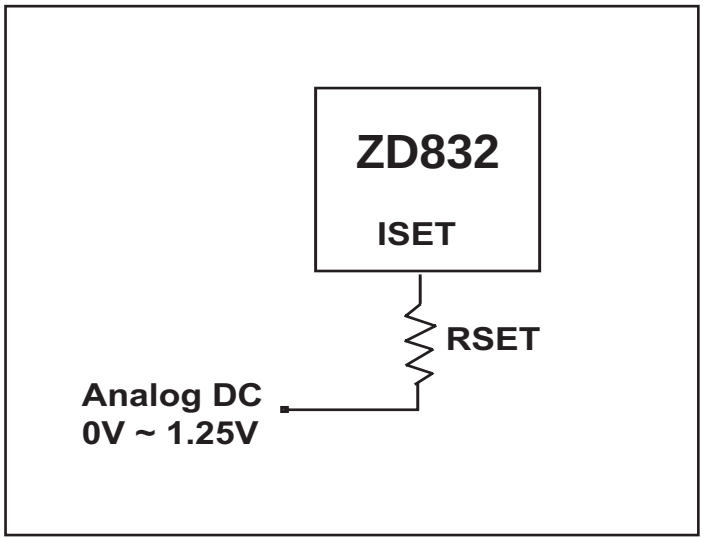


Figure 4. Analog dimming using analog DC voltage.

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Application Note

Operation for VAC from 200V~240V and 100 LEDs

An input voltage of 240V_{AC} can be applied to VAC+ and VAC- pin. The output at HVCC will be at 336V_{DC} (240V •√2) and the limiting REXT is set at 550Ω, assuming 100 LEDs in series with V_f of 3.2V are being used. Figure 5 shows the typical circuit.

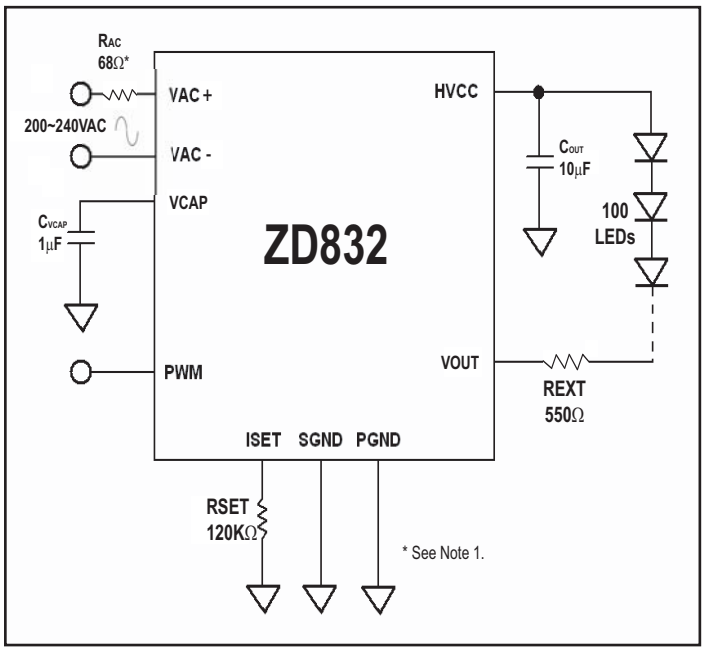


Figure 5. Driving 100 LEDs with the ZD832 from a power source of 240V_{AC} with 20mA output current.

* Note 1. A non-flammable metal-film resistor, R_{AC}, should beused to limit inrush current spikes during start-up and transient voltage induced in the AC-power line by incidental lightning strike. In normal operations, the AC current does not exceed 30mA_{RMS}, and a 47Ω-82Ω, 0.25W reistor provides sufficient current limiting.

Operation for VAC from 200V~240V and 30 LEDs

An input voltage of 240V_{AC} can stepped down by using an external RC circuit to about 100V_{AC} across VAC+ and VAC-. The output at HVCC is rectified at 142V_{DC} (100V •√2) and the limiting REXT is set be 220Ω, assuming 30 LEDs in series with V_f of 3.2V are being used. Figure 6 shows the typical circuit

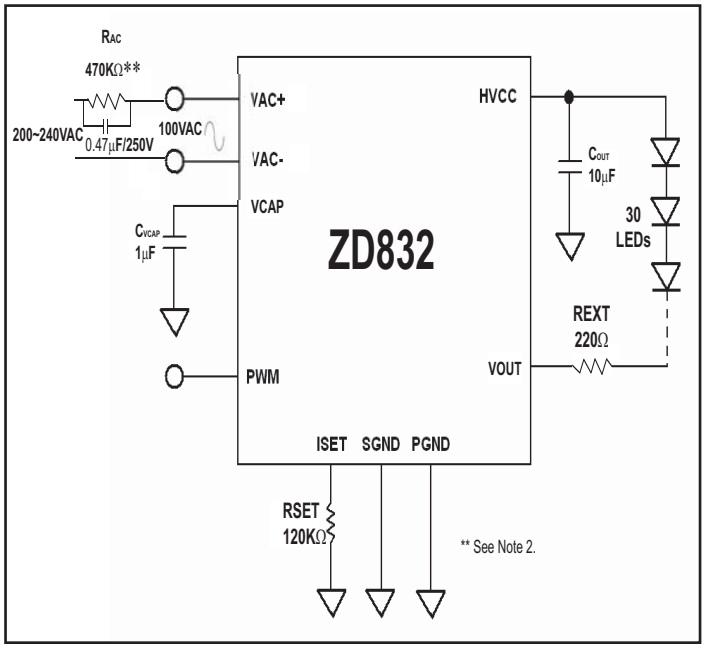
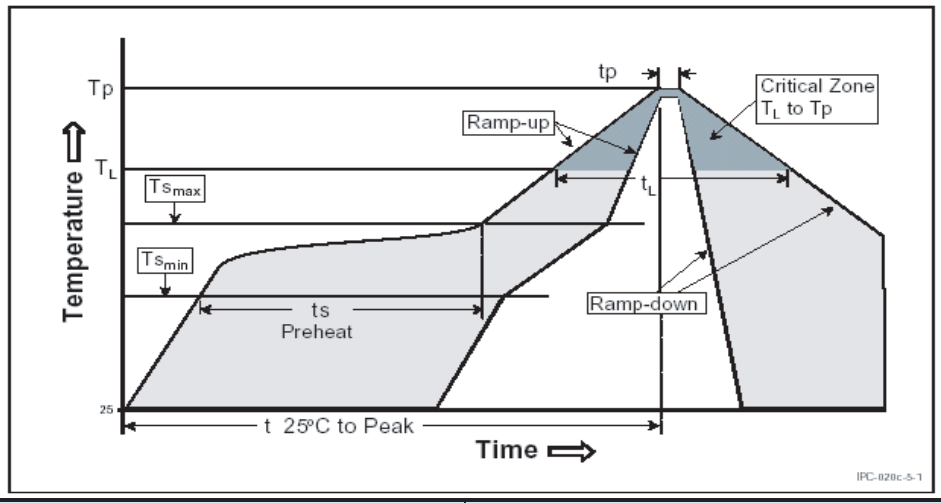


Figure 6. Driving 30 LEDs with the ZD832 from a power source of 240V_{AC} with 20mA output current.

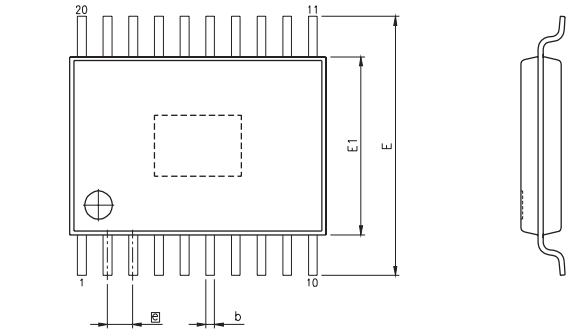
** Note 2. R_{AC} should be in the range of 390KΩ~680KΩ, 0.25W when used in the external RC circuit.

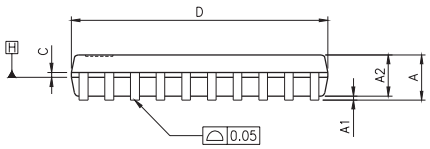
Green Package SMD IR Reflow Profile Information

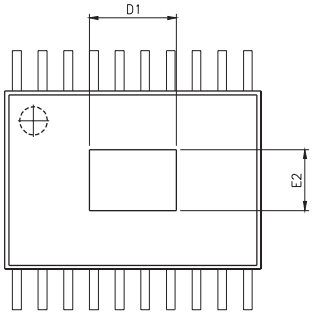
IR Reflow Profile Conditions		
Profile Feature	JESD Sn-Pb Eutectic Assembly	**JESD Pb-free Assembly**
Average Ramp-Up Rate (T_{Smax} to T_P)	3°C/seconds max.	**3°C/seconds max.**
Pre-heat **- Temperature Min (T_{Smin})** **- Temperature Max (T_{Smax})** **- Time (T_{Smin} to t_{Smax})**	 100°C 150°C 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.

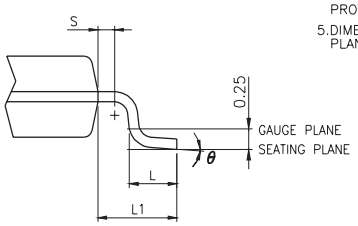
Package Information







THERMALLY ENHANCED VARIATIONS ONLY



VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.20
A1	0.05	–	0.15
A2	0.80	0.90	1.05
b	0.19	–	0.30
C	0.09	–	0.20
D	6.40	6.50	6.60
E1	4.30	4.40	4.50
E	6.40 BSC		
e	0.65 BSC		
L1	1.00 REF		
L	0.50	0.60	0.75
S	0.20	–	–
θ	0°	–	8°

△3 THERMALLY ENHANCED DIMENSIONS(SHOWN IN MM)

PAD SIZE	E2	D1
118X16E	2.70 REF	3.77 REF

NOTES:

△2 1. JEDEC OUTLINE : MO-153 AC/MO-153 ACT(THERMALLY ENHANCED VARIATIONS ONLY)

2. DIMENSION 'D' DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE.

3. DIMENSION 'E1' DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 PER SIDE.

4. DIMENSION 'b' DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 MM TOTAL IN EXCESS OF THE 'b' DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD IS 0.07 MM.

5. DIMENSIONS 'D' AND 'E1' TO BE DETERMINED AT DATUM PLANE H .

20-Pin Exposed TSSOP

ZYWYN CORPORATION

3RD ANGLE SYS.	比例 SCALE:	材質 MTRL:	製程 FINISH:	數量 QTY:
繪圖: 施佩杏 DWN: 日期: 5/3/06	圖名: PLASTIC THIN SHRINK SMALL OUTLINE PACKAGE DATA SHEET 20 LEADS TITLE:			
審核: 林正源 CHK: 日期: 5/3/06	圖號: J1-0720U-001 DWG#			
核准: Erik APPL: 日期: 5/4/06	圖檔: J1-0720U-001-05 FILE:	版別: REV: 05	張數: QTY: 1	

Evaluation Board Information

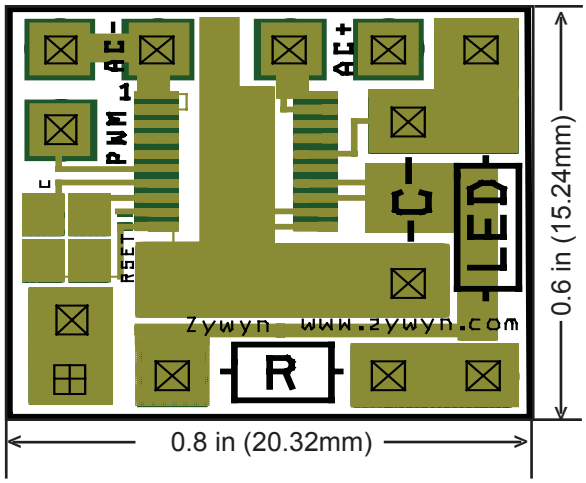


Figure 7. ZD832EVB Single-Layer Evaluation Board Component Side Layout

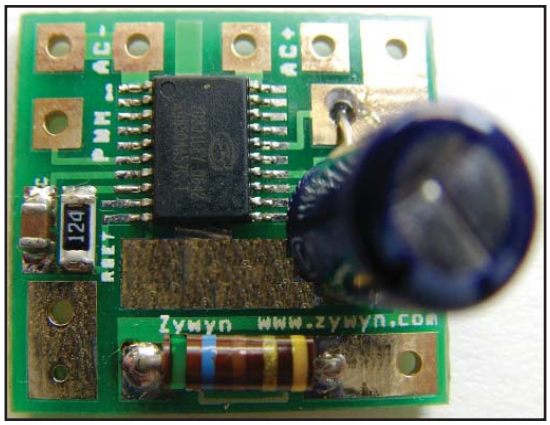
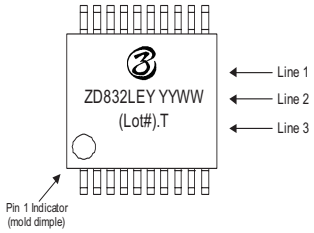


Figure 8. ZD832EVB Evaluation Board Component Side Topview

Part Marking Information

TOPSIDE MARK INSTRUCTIONS:



Line 1: Zywyn (logo)
Line 2: Zywyn Part Number "ZD832LEY", 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.

20-Pin Exposed TSSOP

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