Zywyn ZD832

Universal TransformerFree™ AC-DC Constant Current LED Driver

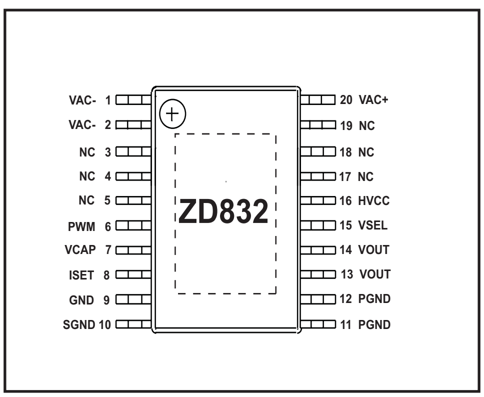
Features

- AC to DC Constant Current Driver
- No Transformer, No External Bridge Rectifier
- Universal Input Voltage Range of 85VAC to 125VAC or 180VAC to 240VAC
- 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, TransformerFree™ 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 125VAC, or 180VAC 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

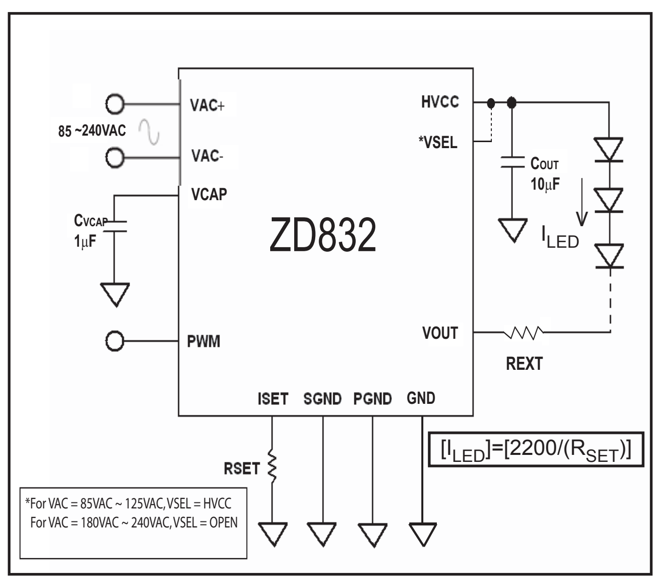


Figure 1. ZD832 driving a string of LEDs in series at a presetted constant current

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- = 110VAC (VSEL = HVCC) or 220VAC (VSEL = OPEN), 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-	VSEL = HVCC VSEL = OPEN	85 180	110 220	125 240	V_{AC} V_{AC}
High Voltage, HVCC DC Input applied to HVCC DC Output from HVCC	VSEL =HVCC un-connected VAC+ & VAC-, I_{LED}=5mA, VOUT=5V connected VAC+ & VAC-, I_{LED}=5mA, VOUT=5V	 120 120		 175 175	 V V
High Voltage, HVCC DC Input applied to HVCC DC Output from HVCC	VSEL = OPEN un-connected VAC+ & VAC-, I_{LED}=5mA, VOUT=5V connected VAC+ & VAC-, I_{LED}=5mA, VOUT=5V	 250 250		 340 340	 V V
LED Driver Output, VOUT	R_{SET}=733kΩ, I_{LED} = 3mA	5		30	V
LED Driver Output, VOUT	R_{SET}=110kΩ, I_{LED} = 20mA	5		25	V
LED Driver Output, VOUT	R_{SET}=73kΩ, I_{LED} = 30mA	7		18	V
Supply RMS Current, I_{VAC} Quiescent Current	 R_{SET}=110kΩ, PWM=5V, un-connected VOUT		 2	 5	 mA
LED Output Current Range, I_{LED}		3		33	mA
LED Output Current Min.	R_{SET}=733kΩ, PWM=5V, VOUT=3VDC to 30VDC	3			mA
LED Output Current Max.	R_{SET}=73kΩ, PWM=5V, VOUT=7VDC to 18VDC		30	33	mA
Output Current, I_{LED}	R_{SET}=110kΩ; [I_{LED}]=[2200/(R_{SET})] VOUT=5V to 10V VOUT=3V to 25V	 18.6 17	 20 20	 21.4 23	 mA mA
Output Leakage Current, $I_{LED-Leakage}$	PWM=0V, VOUT=5V		20	100	μA
PWM Signal Pin Input Voltage High Input Voltage Low Input Leakage Current	 PWM=0V or 5V	 2.0 	 1	 0.4 10	 V V μA
ISET Pin Regulated ISET Voltage, V_{ISET}		 1.1	 1.25	 1.3	 V

Block Diagram

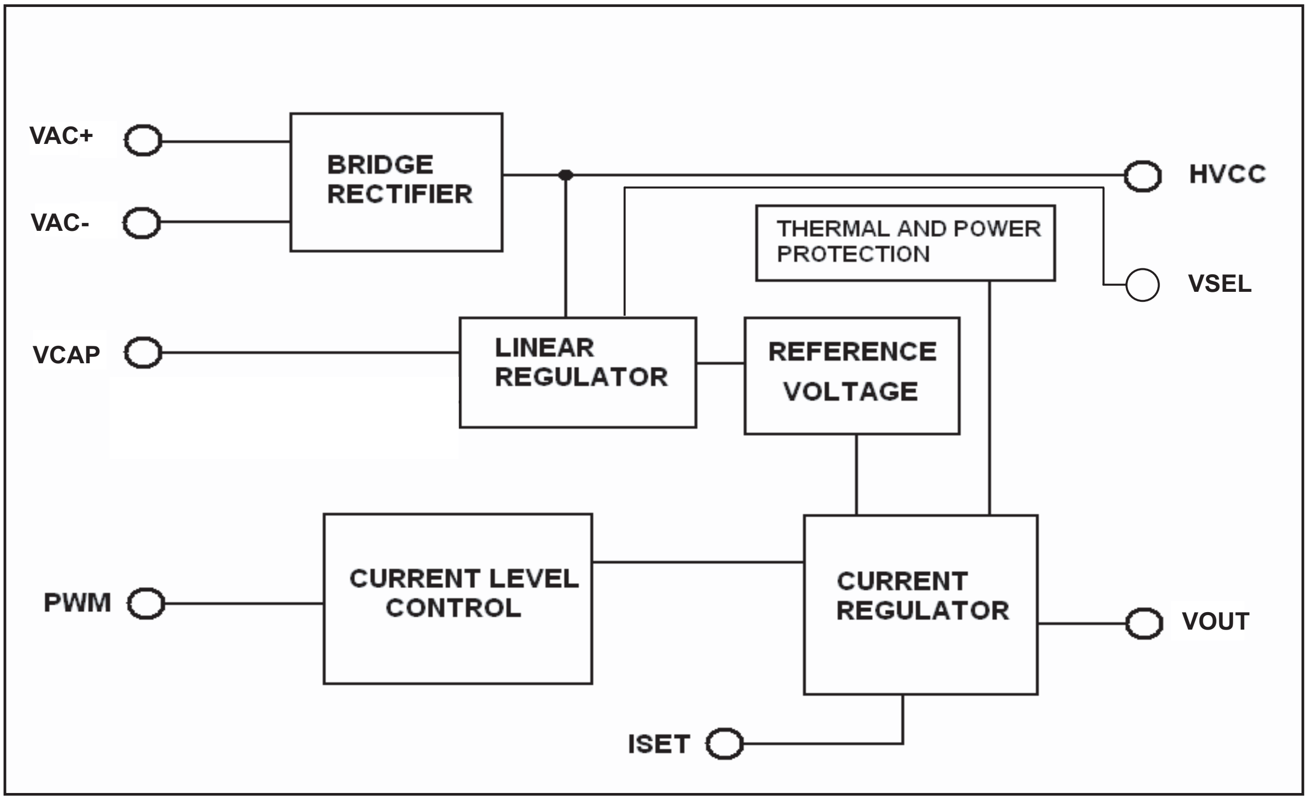


Fig.2. ZD832 Typical Block Diagram

Pin Description

Pin Number	Pin Name	Pin Function
1, 2	VAC-	High Voltage AC Input, from 85~125V_{AC} (VSEL=HVCC) or 180~240V_{AC} (VSEL=OPEN).
20	VAC+	High Voltage AC Input, from 85~125V_{AC} (VSEL=HVCC) or 180~240V_{AC} (VSEL=OPEN).
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.
9	GND	Substrate Ground. Must be connected to SGND (Pin #10)
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.
15	VSEL	VSEL = OPEN when the device is to operate for 220V_{AC} input. VSEL=HVCC (connect to HVCC pin) when the device is to operate for 110V_{AC} input.
16	HVCC	High Voltage Rectified DC Output from VAC+ & VAC-. Bypass HVCC with at least 10μF to PGND.
3, 4, 5, 17, 18, 19	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,

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

where,

HVCC = Average High Voltage Rectified DC. Please refer to Application Notes for expected values.
n = Number of LEDs connected in series.
V_f = Forward bias voltage of a single LED at specified I_{LED} level.
V_{OUT} = Average dropout voltage at VOUT pin, recommended to be set at $V_{OUT} \geq 7V$ for calculations.
I_{LED} = Regulated average 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}

Several design examples are shown in table below for reference, assuming the V_f of the LED is 3.3V at I_{LED}=30mA and C_{OUT} = 10µF.

VAC Input Voltage	$HVCC_{AVG}$ (V)	# of LEDs	Calculated V_{OUT}	R_{EXT} (Ω)	Power Rating (W)
110±3% VAC	133	37	10	Not required	N/A
110±3% VAC	133	35	10	270	0.5
220±2% VAC	279	81	12	Not required	N/A
220±2% VAC	279	78	12	270	0.5
240±2% VAC	309	90	12	Not required	N/A
240±2% VAC	309	87	12	270	0.5

Table 1 Design Examples.

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:

$[I_{LED}]=[2200/(RSET)]$

with a minimum value of RSET ≥ 73kΩ, which sets the I_{LED} to 30mA Max., and a maximum value of RSET ≤ 733kΩ,
which sets the minimum I_{LED} to 3mA (Refer to Figure 3). The maximum allowable capacitance at the ISET pin is 50pF.

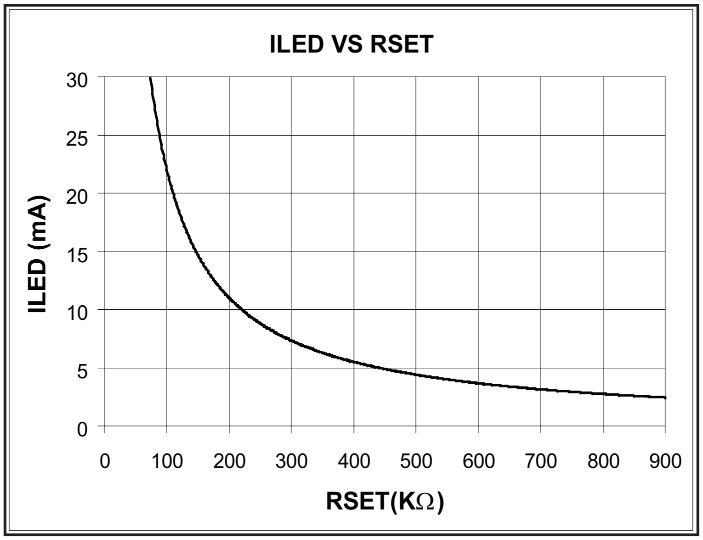


Figure 3. ILED vs RSET

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.

Voltage Select (VSEL)

The ZD832 can be operated from two banks of AC voltage range inputs; 85VAC~125VAC or 180VAC ~240VAC. To operate for 85VAC~125VAC, the VSEL (pin #15) must be connected to the HVCC (pin #16). To operate for 180VAC~240VAC, VSEL (pin #15) must be left OPEN.

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 733kΩ ≥ RSET ≥ 73kΩ. 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,

$$[I_{LED}]=[2200/(RSET)]$$

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.

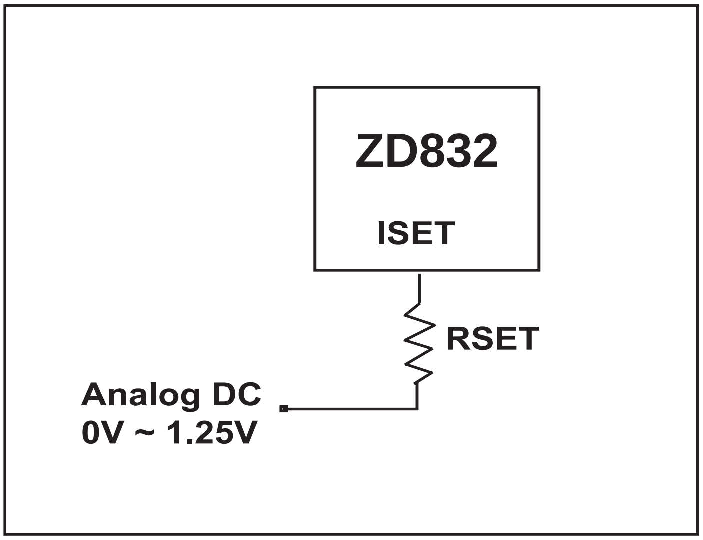


Figure 4. Analog dimming using analog DC voltage.

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Typical Applications

Please see Application Notes for more detailed information about the ZD832 applications.

Operation for 220VAC ±2% and 78 LEDs

An input voltage of 220V_{AC} ± 2% can be applied to VAC+ and VAC- pin. The average output at HVCC will be about 286V and the limiting REXT is set at 270Ω (See Table 1), assuming 78 LEDs in series with V_f of 3.3V are being used. Figure 5 shows the typical circuit.

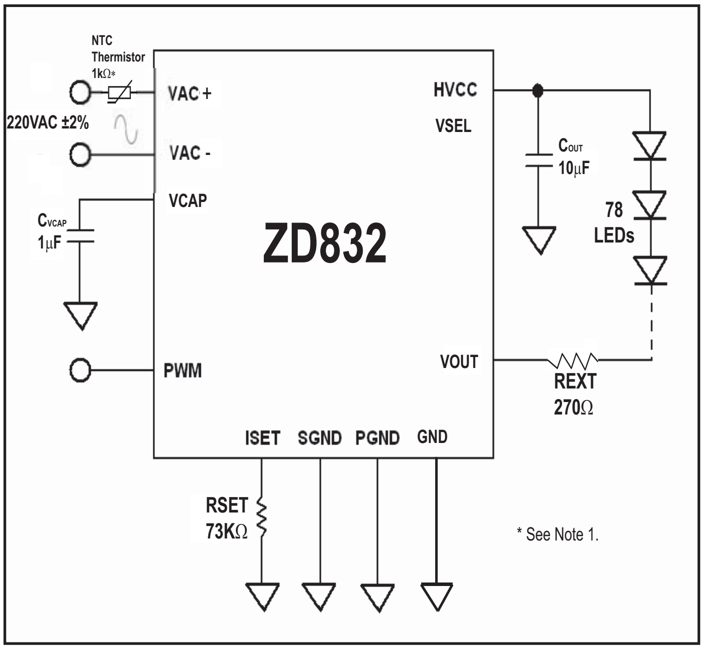


Figure 5. Driving 78 LEDs with the ZD832 from a power source of 220V_{AC} ± 2% with 30mA output current.

* Note 1. Using a thermistor (1KΩ/0.5W) in series with the AC+ input of the ZD832 will effectively limit the inrush charging current to the C_{OUT} at the HVCC pin during the start up of the AC supply without reducing the power efficiency.

When the AC supply is turned on, the thermistor is cool and provides about 1KΩ resistance at 25 °C and reduces the instant inrush current. When the inrush current drops to the steady-state current and flows through the thermistor, the thermistor dissipates heat and reduces it's resistance to about 100 Ω.

Due to the thermal characteristics of the thermistor, the duration between switching the AC supply ON and OFF should be more than 2 to 3 seconds to allow the thermistor to cool it's resistance back to 1KΩ to protect any further inrush current.

Operation for 220VAC ±2%and 40 LEDs

An input voltage of 220V_{AC} ± 2% can be stepped down by using an external RC circuit to about 110V_{AC} across VAC+ and VAC-. The average output at HVCC will be about 150V, assuming 40 LEDs in series with V_f of 3.3V are being used. Figure 6 shows the typical circuit

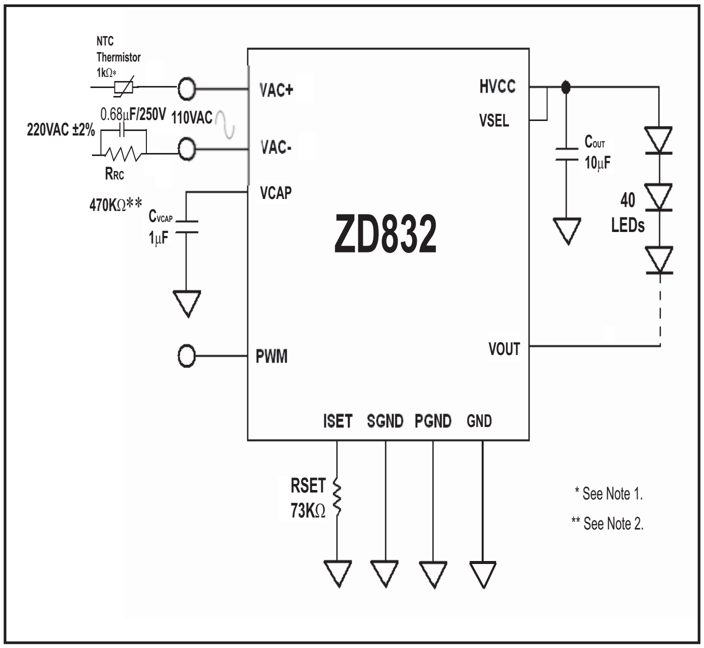


Figure 6. Driving 40 LEDs with the ZD832 from a power source of 220V_{AC} ± 2% with 30mA output current.

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

Typical Application cont.

Operation for VAC from 85VAC to 125VAC with tight constant current tolerance.

By adding 3 external components, the ZD832 can regulate a rectified DC voltage for a wider range of input voltage with a constant ILED current of ±6%.

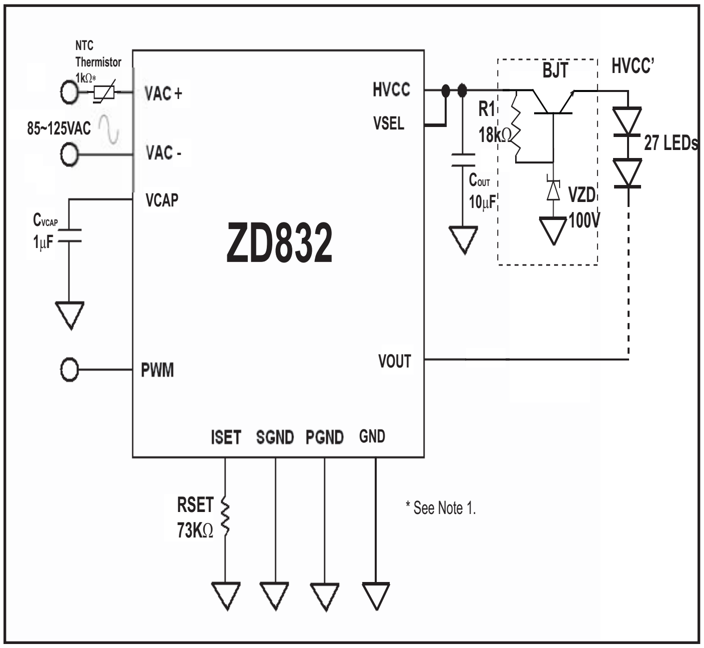


Figure 7. Driving the ZD832 from a power source of $85V_{AC}$ to $125V_{AC}$ with 30mA ± 6% output current.

An input voltage of 85~$125V_{AC}$ can be applied to VAC+ and VAC-. The output at HVCC is rectified at 100~$156V_{DC}$ and the external circuitry will start to regulate the HVCC' voltage to 93~$105V_{DC}$ when the HVCC minimum voltage is $100V_{DC}$ because of the 100V Zener diode and the NPN BJT. The number of LEDs depend on the application and the forward voltage of the LEDs and can be determined by the equation:

HVCC' - (n x $V_{Forward}$) = VOUT ≥ 7V (At $85V_{AC}$)

The BJT will help to keep the ZD832 from thermal shutdown by putting the extra voltage on the VCE of the BJT, keeping the VOUT ≤ 18V

The example in Figure 7 above uses 27 LEDs in series with V_f of 3.3V @30mA.

Operation for VAC from 180VAC to 240VAC with tight constant current tolerance.

By adding 3 external components, the ZD832 can regulate a rectified DC voltage for a wider range of input voltage with a constant ILED current of ±6%.

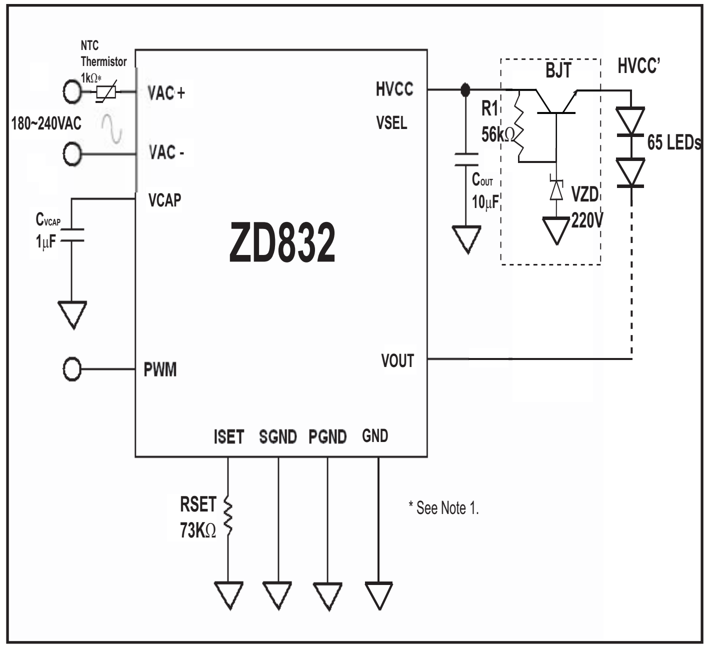


Figure 8. Driving the ZD832 from a power source of $180V_{AC}$ to $240V_{AC}$ with 30mA ± 6% output current.

An input voltage of 180~$240V_{AC}$ can be applied to VAC+ and VAC-. The output at HVCC is rectified at 227~$310V_{DC}$ and the external circuitry will start to regulate the HVCC' voltage to 219~$230V_{DC}$ when the HVCC minimum voltage is $220V_{DC}$ because of the 220V Zener diode and the NPN BJT. The number of LEDs depend on the application and the forward voltage of the LEDs and can be determined by the equation:

HVCC' - (n x $V_{Forward}$) = VOUT ≥ 7V (At $180V_{AC}$)

The BJT will help to keep the ZD832 from thermal shutdown by putting the extra voltage on the VCE of the BJT, keeping the VOUT ≤ 18V

The example in Figure 8 above uses 65 LEDs in series with V_f of 3.3V @30mA.

Typical Application cont.

Operation for 110VAC ±3% and 35 LEDs

An input voltage of $110V_{AC}$±3%can be applied to VAC+ and VAC-. The output at HVCC is rectified at $133V_{DC}$ and the limiting REXT is set be 270Ω, assuming 35 LEDs in series with V_f of 3.3V are being used. Figure 9 shows the typical circuit with VSEL connected to HVCC.

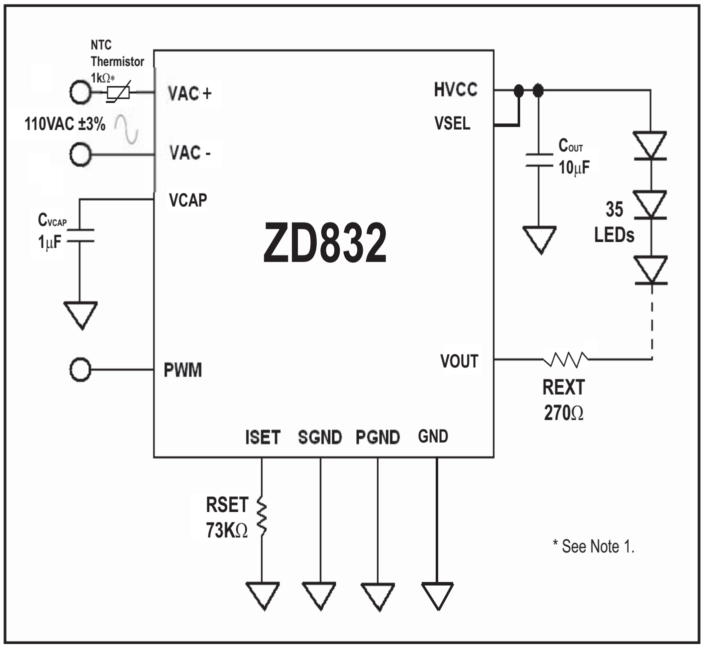
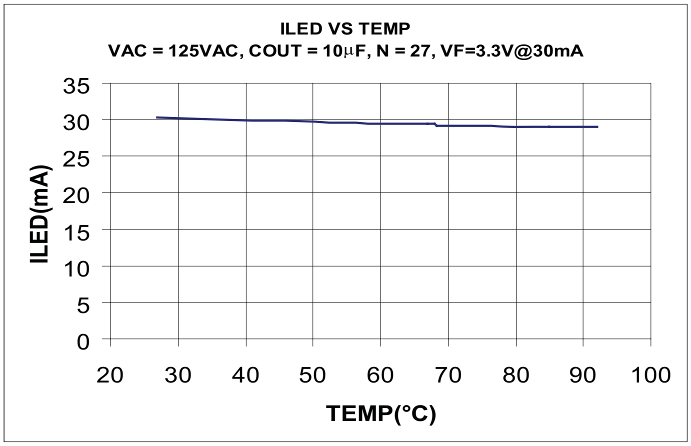
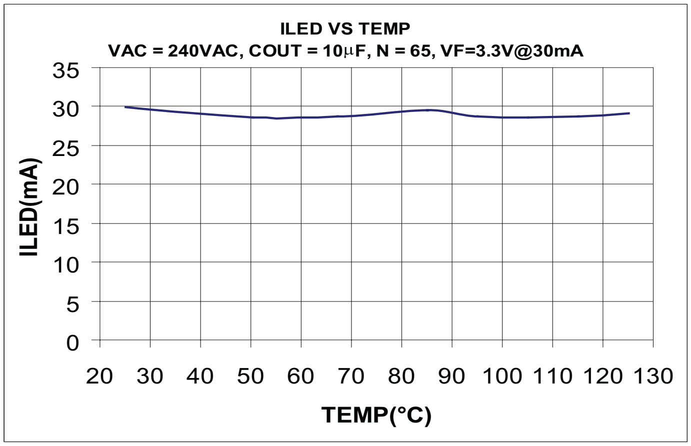


Figure 9. Driving the ZD832 from a power source of $110V_{AC}$±3% with 30mA output current.

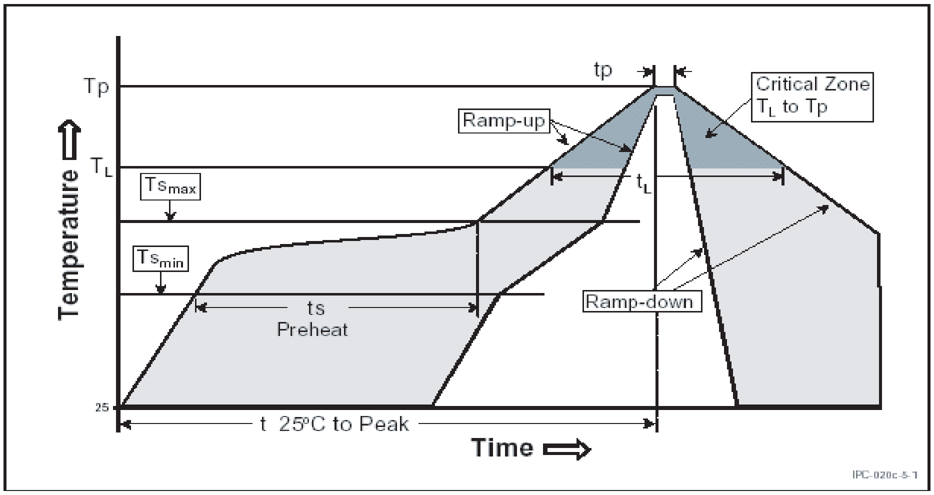
Typical Performance





Green Package SMD IR Reflow Profile Information

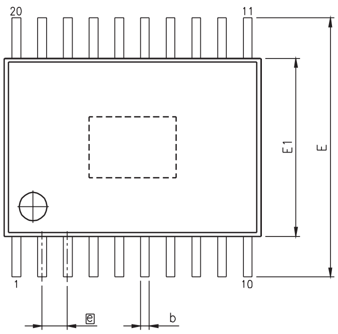
IR Reflow Profile Conditions

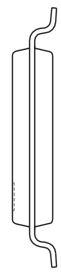


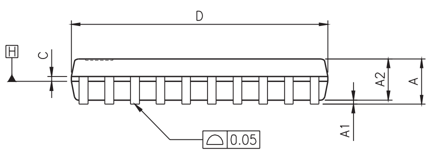
Profile Feature	JESD Sn-Pb Eutectic Assembly	JESD Pb-free Assembly
Average Ramp-Up Rate (T_{Smax} to T_P)	3°C/seconds max.	**3°C/seconds max.**
Pre-heat **- Temperature Min (T_{Smin})** **- Temperature Max (T_{Smax})** **- Time (T_{Smin} to t_{Smax})**	100°C 150°C 60~120 seconds	**150°C** **200°C** **60~180 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.**

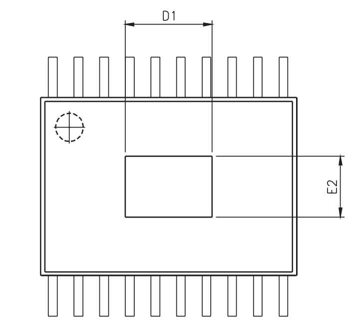
Zywyn Green Packages are Pb-free and RoHS compliance.

Package Information

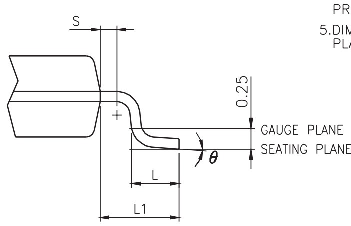








THERMALLY ENHANCED VARIATIONS ONLY



VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.20
A1 (4)	0.05	–	0.15
A2 (4)	0.80	0.90	1.05
b	0.19	–	0.30
C (4)	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 (4)	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 Q'TY:

繪圖: DWN: 施佩杏 日期: DATE: 5/3/06'	圖名: TITLE: PLASTIC THIN SHRINK SMALL OUTLINE PACKAGE DATA SHEET 20 LEADS
審校: CHK: 林正源 日期: DATE: 5/3/06'	圖號: DWG#: J1–0720U–001
核准: APPL: Erik 日期: DATE: 5/4/06'	圖檔: FILE: J1–0720U–001–05 版別: REV: 05 張數: Q'TY: 1

Evaluation Board Information

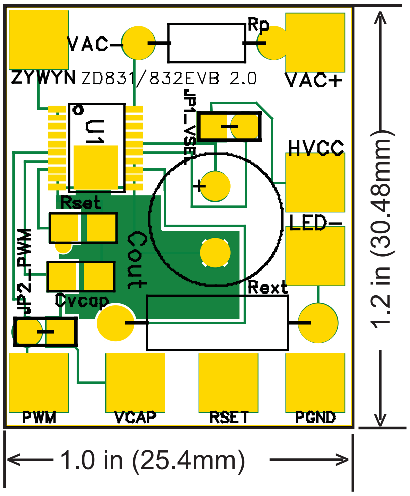


Figure 10. ZD832EVB Double-Layer Evaluation Board Front Side Layout

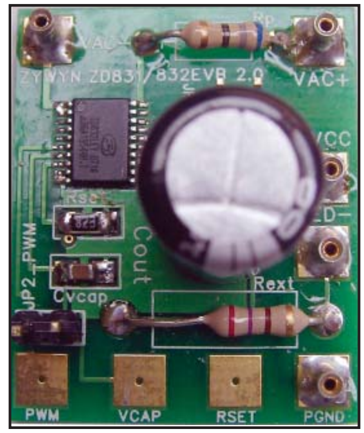
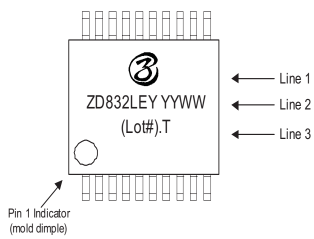


Figure 11. ZD832EVB Evaluation Board Component Side Topview

Part Marking Information

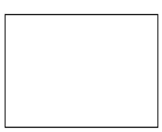
TOPSIDE MARK INSTRUCTIONS:



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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