20mA 10VDC/265VAC
LED Driver Demoboard

HV9821DB2 Board Layout

Actual Board Size: 17mm x 26mm

Specifications

Parameter	Value
Input voltage	10~265VAC or 10-400VDC
Output current	20mA±15% at 230VAC
Output voltage	2.0~9.0V (1~3 white LEDs)
EMI limits	EN 55022 Level B
Surge immunity	EN 61000-4-5 (1kV line-line)
Power consumption	1W(max) (3 LEDs, 265VAC)
Load regulation	<3%
DC line regulation	<10% (20~400VDC)
Output ripple	<30% pk-pk
Life time	Non-Electrolytic
Output short circuit protection	No
Output open circuit protection	No
Dimensions	0.68" x 1.03" x 0.18" 17mm x 26mm x 4.6mm

General Description

The Supertex HV9821DB2 demonstrates the use of an HV9821 control IC in a wide input voltage range LED driver application targeted for industrial automation control backlighting. Its patent pending circuit accepts DC voltage input in the range of 10 to 400V, or AC input of 10 to 265VAC. The board can power a single 20mA LED or a string of 20mA LEDs up to 9.0V, consuming less then 1.0W of power under all input line conditions.

Depending on the line and load condition, the circuit can operate in three basic modes: 1) clamped buck converter mode; 2) buck converter mode; 3) resistive ballast mode.

The clamped mode occurs when $V_{IN} > V_Z$, Zener voltage of ZD1. The IC is programmed to operate at a variable switching frequency determined by a fixed off time of 20.5µs. In this mode, the voltage at OUT is limited to ~90V (Figure 4). However, the breakdown knee of ZD1 is only exceeded during the first 300ns of each pulse, when the HV9821 is sourcing ~10mA from its VZ output. The IC further transitions to a 100µA VZ current, and the OUT voltage drops accordingly.

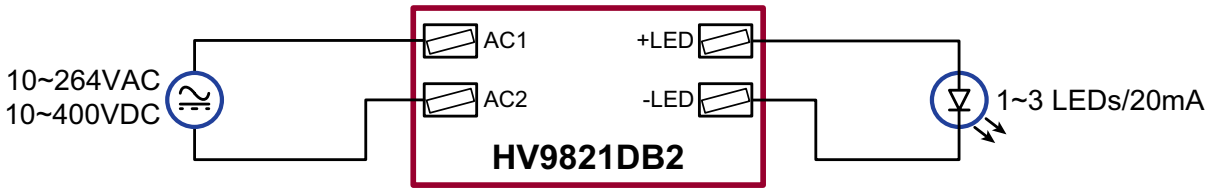
The buck converter mode (unclamped) occurs when $V_{IN} < V_Z$. In this mode, the circuit operates as a basic buck converter with the peak voltage at OUT equals V_{IN}.

The resistive ballast mode occurs when voltage at the RS input with respect to OUT cannot reach the 0.50V threshold. This occurs at input voltage that is not high enough to develop the corresponding current in the LEDs due to series resistance in the circuit (R_1, R_{ON} of the HV9821, the DCR of L1 and L_f). In this case, the HV9821 operates in the fully-on state with brief interruptions to replenish the charge in C_{DD}. The frequency of these restart attempts is determined by the capacitance value of C_{DD}.

An effort was made to satisfy the requirements of CISPR 11 (EN 55011) Level B, limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.

The connection diagram details the hookup of the board to the AC line. Note that the load is NOT galvanically isolated, and that measurements to the board require measurement techniques in common use with non-isolated off-line power supplies (isolation transformers, differential probes, etc).

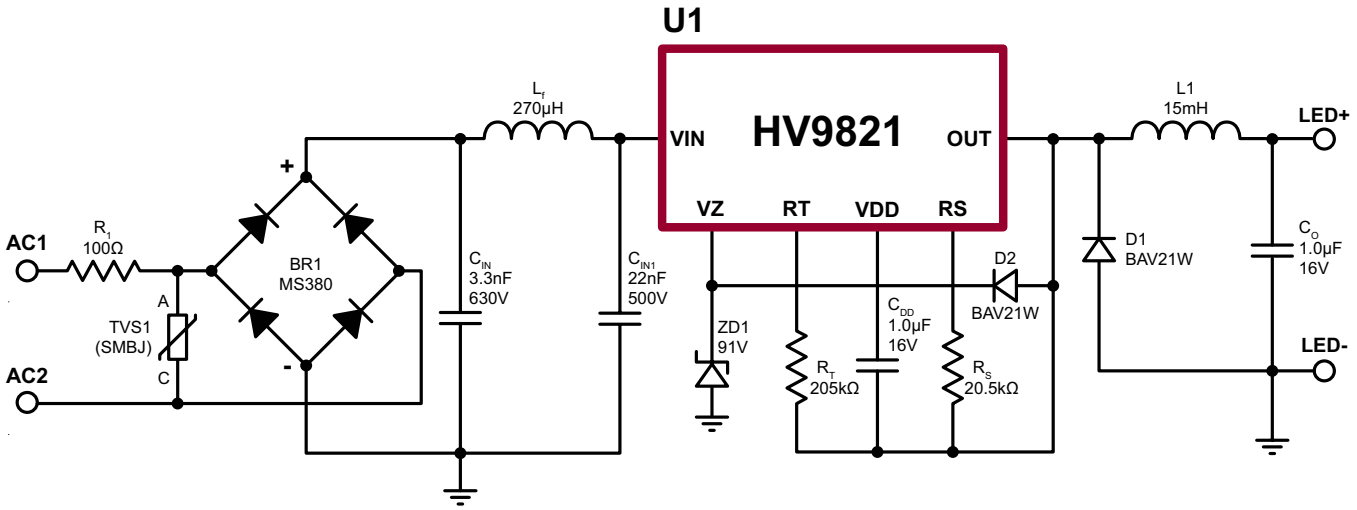
Connection Diagram



Connections

1. **Input Voltage:** Connect the AC line or DC input voltage to AC1 and AC2 as shown.
2. **LED String:** Connect the LED strings between LED+ and LED- as shown (anode of the string to LED+ and cathode to LED-)

Schematic Diagram



Typical Characteristics

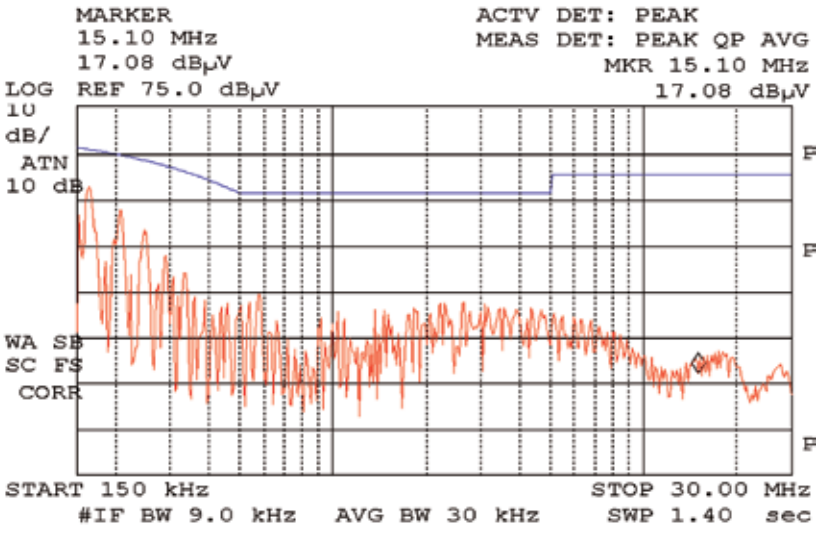


Figure 1. EMI characterization - conducted emissions (peak detector) vs. CISPR 11 Class B limits (quasi-peak).

Typical Characteristics

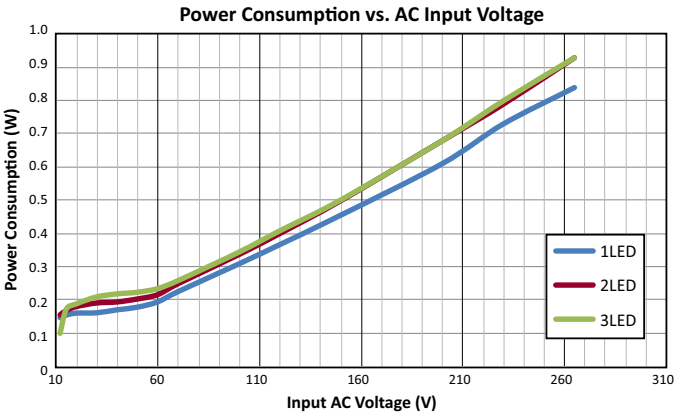


Figure 2. Power consumption with various LED loads.

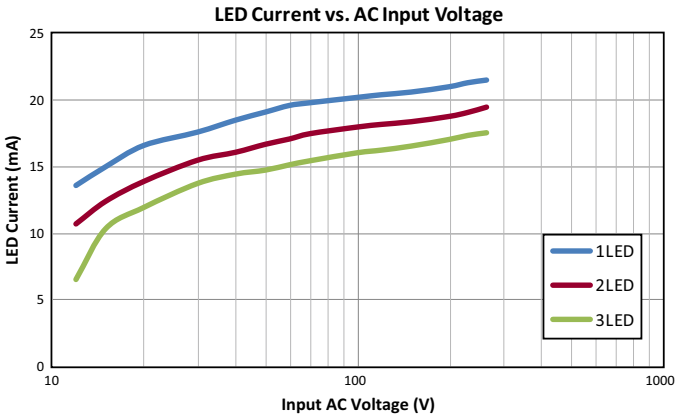


Figure 3. AC line voltage regulation of LED current.

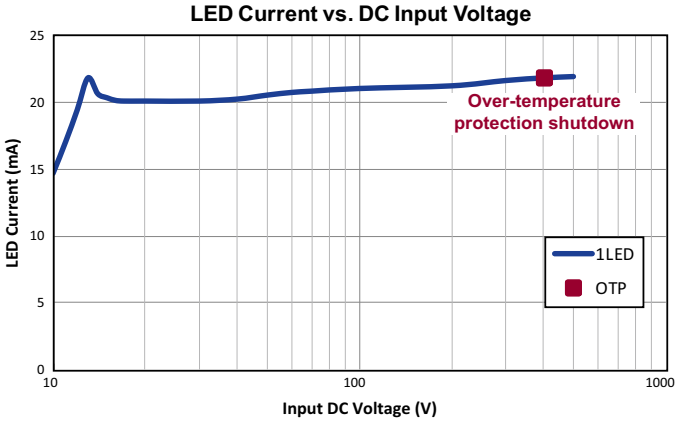


Figure 4. DC line voltage regulation of LED current.

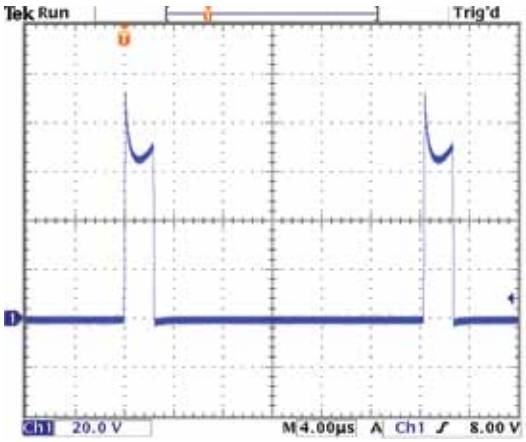


Figure 5. Switching voltage at OUT: clamped buck converter mode.

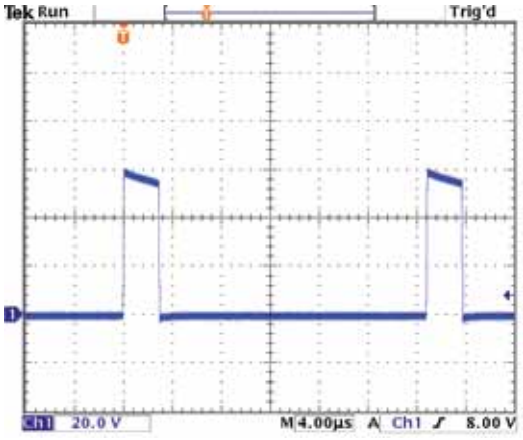


Figure 6. Switching voltage at OUT: unclamped buck converter mode.

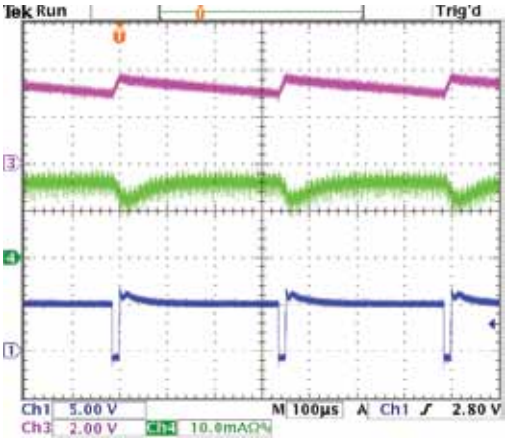


Figure 7. Resistive ballast mode. CH1: OUT voltage, CH3: VDD voltage w.r.t. OUT, CH4: LED current.

Bill of Materials

QTY	REF	DESCRIPTION	MFR	MFR P/N
1	BR1	Surface Mount Si-Bridge Rectifier	Diotec Semiconductor	MS380
1	C_{DD}	Capacitor: Ceramic 0.1µF, 16V, X7R, 10%	Kemet	C0603C104K4RACTU
1	C_{IN}	Capacitor: Ceramic 3.3µF, 630V, NPO, 5%	TDK Corporation	CGA5L4C0G2J332J
1	C_{IN1}	Capacitor: Ceramic 22µF, 500V, X7R, 10%	Johanson Dielectric, Inc.	501R18W223KV4E
1	C_O	Capacitor: Ceramic 1.0µF, 16V, X7R, 10%	Kemet	C0805C105K4RACTU
2	D1, D2	Diode: Switch, 200V, 250mW	Diodes, Inc.	BAV21W-7-F
1	L_f	Inductor: Wound 470µH, 25mA	Taiyo Yuden	LB2518T471K
1	L1	Inductor: Non-shielded, Power, 15mH	Bourns Inc.	SDR0503-153JL
1	R_1	Resistor: Anti-surge, 100Ω, 5%	Panasonic-ECG	ERJ-P08J101V
1	R_S	Resistor: 20.5kΩ, 1/10W, 1%	Yageo	RC0603FR-0720K5L
1	R_T	Resistor: 205kΩ, 1/10W, 1%	Yageo	RC0603FR-07205KL
1	TVS1	Diode: TVS 440V, 600W, Bidir, 5%	Littlefuse Inc.	SMBJ440CA
1	U1	IC: Wide Input Range LED Driver	Supertex, Inc.	HV9821K7-G
1	ZD1	Diode: Zener, 91V, 250mW	ON Semiconductor	MMSZ5270BT1G
1	BR1	Surface Mount Si-Bridge Rectifier	Diotec Semiconductor	MS380

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