Off-Line PFC Current Source Controller

Introduction

The HV9906DB6 is a power factor corrected (PFC) LED driver demo board that uses the Supertex HV9906 IC. The power converter of the demo board consists of an input buck-boost stage with an integrated energy storage capacitor and an output buck stage. The output voltage polarity is negative. Due to its double down conversion topology, the converter can operate directly off AC line to produce low-voltage output. By using an integrated non-electrolytic energy storage capacitor, the converter can achieve high power factor, low harmonic distortion of the input AC current while maintaining nearly DC output current.

HV9906DB6 demo board features power factor correction to PF>0.95. The board is optimized for driving a 350mA, 7W LED array. Output 120Hz current ripple is designed to be <30%. However, it can be improved by selecting a larger energy storage capacitor if needed.

Features

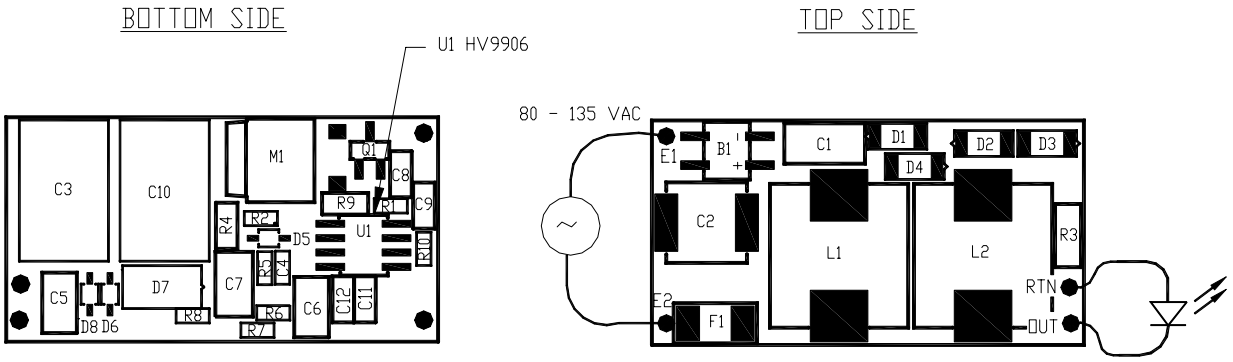
- Off-Line Transformerless Power Conversion
- Power Factor Correction to PF>0.95
- Soft Start
- Low Inrush Current on Start

Specification

Input Voltage	80 to 135VAC, 47-63 Hz or 100 to 200VDC
Output Current	350mA ±10%
Output Voltage	20V max.
Power Factor	>0.95
Total AC Line Harmonic Distortion (THD)	<15%
Efficiency	75% typ.*

* at Vo=20V, Io=0.35A, Vin=120VAC

Board Layout and Connections



WARNING!!!
Do not connect to scope ground or to the ground of other earth-grounded instruments. Doing so will short the AC line, resulting in damage to the circuit and/or instruments. Either use an isolation transformer on the AC line, use a differential probe, or use a floating, battery-powered instrument to make measurements.

WARNING!!!
No galvanic isolation. Dangerous voltages are present when connected to the AC mains.

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Instructions

OUT, RTN

Connect your LED to these terminals. Make sure that it is connected in the polarity shown on the diagram above.

E1, E2

Connect 80 to 135VAC line source to these terminals. The input is fuse protected to 0.5A.

Setting Output Current

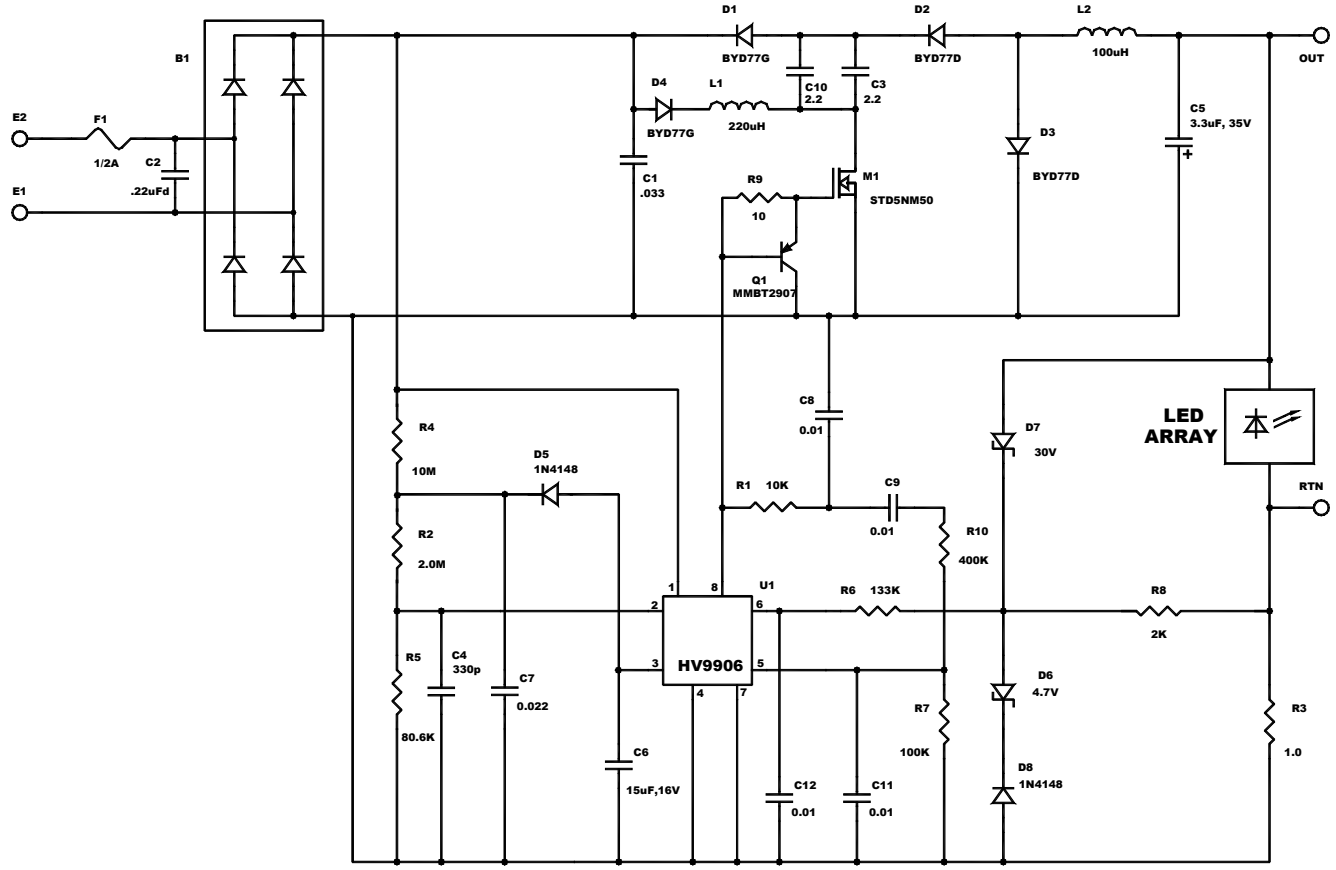
Output current is preset to 350mA for this board. Output current can be re-programmed by selecting R3 according to the following equation:

$$\mathbf{I_{OUT}} = \frac{\mathbf{R6} + \mathbf{R8} - \mathbf{R7}}{\mathbf{R7} \cdot \mathbf{R3}} \cdot 1\mathbf{V}$$

Controlling Output Current Ripple

Output current ripple (120Hz) can be controlled by selecting an appropriate value of an energy storage capacitor C3/C10. Larger value of C3/C10 improves power factor and THD as well.

Schematic Diagram



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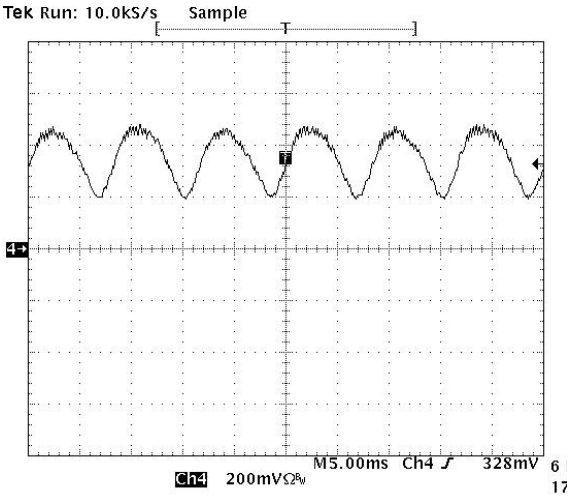
Typical Performance Characteristics

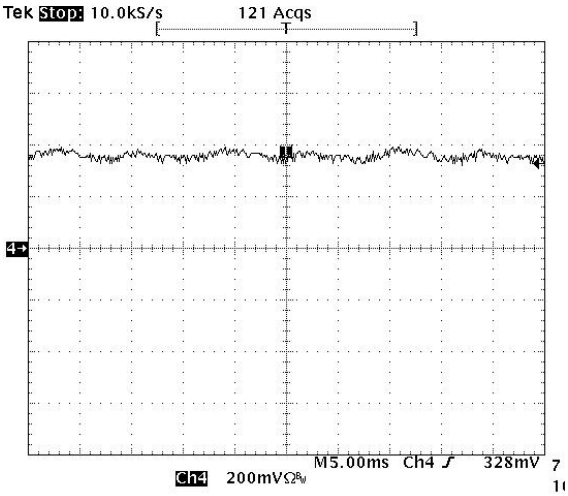
Output Current

(Io = 350mA, Vo = 20V, Vin = 120VAC)



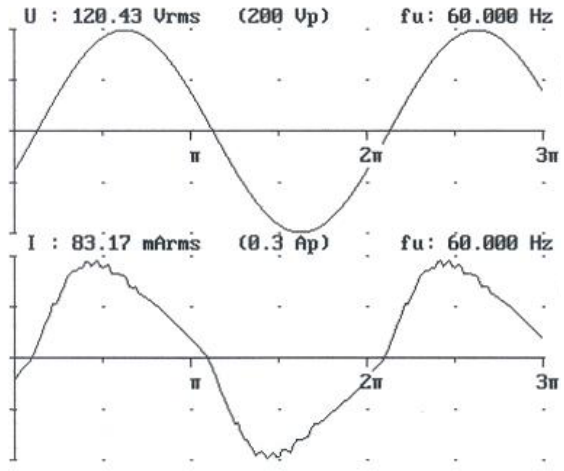
Output Current

(Io = 350mA, Vo = 20V, Vin = 120VAC, C3+C10 = 20uF)



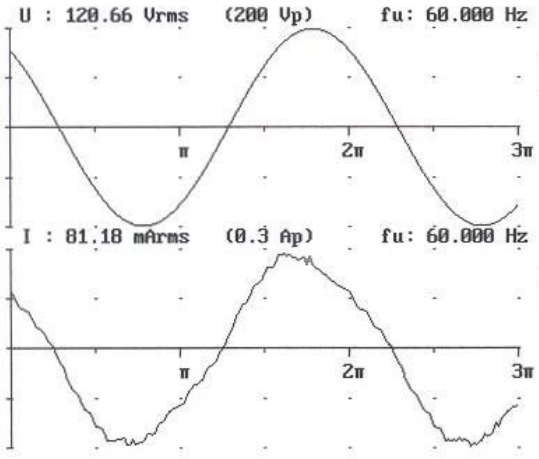
Input AC Voltage and Current

(Io = 350mA, Vo = 20V, Vin = 120VAC)



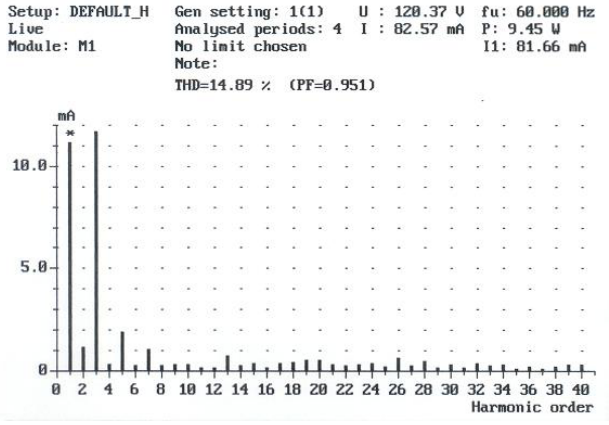
Input AC Voltage and Current

(Io = 350mA, Vo = 20V, Vin = 120VAC, C3+C10 = 20uF)



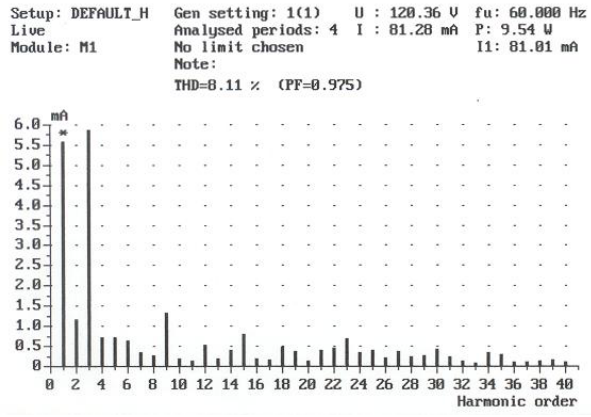
AC Current Harmonics

(Io = 350mA, Vo = 20V, Vin = 120VAC)



AC Current Harmonics

(Io = 350mA, Vo = 20V, Vin = 120VAC, C3+C10 = 20uF)



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Parts List

Item	Reference	Part	Package	Manufacturer	Part No.
1	B1	Diode Bridge	SMD DF-S	Diodes Incorporated or equivalent	DF04S
2	C1	0.033 uF, 100V, 10%	SMD1913	Panasonic Pen Film	ECW-U2333KC9
3	C2	0.22uF, 250V, 10%	SMD2825	Panasonic Pen Film	ECW-U2224KCV
4	C3	2.2 uF, 100V, 10%	SMD3827	ITW Paktron	225K100ST4T
5	C10	2.2 uF, 100V, 10%	SMD3827	ITW Paktron	225K100ST4T
6	C4	0.1uF, 16V, 5%	SMD1210	Panasonic PPS Film	ECH-U1C104JB5
7	C5	3.3 uF, 35V, 10%, Tantalum	SMD3528	Kemet or equivalent	
8	C6	15 uF, 16V, 10%, Tantalum	SMD3528	Kemet or equivalent	
9	C7	0.022uF Ceramic X7R 50V	SMD1206	Panasonic or equivalent	
10	C8	0.01uF, 16V	SMD0805	Panasonic or equivalent	ECH-U1C103JX5
11	C9	0.01uF, 16V	SMD0805	Panasonic or equivalent	ECH-U1C103JX5
12	C12	0.01uF, 16V	SMD0805	Panasonic or equivalent	ECH-U1C103JX5
13	C11	0.01uF, 16V	SMD0805	Panasonic or equivalent	ECH-U1C103JX5
14	D1	Ultra Fast, 400V, 2A	SOT-87	Philips	BYD77G
15	D2	Ultra Fast, 200V, 2A	SOT-87	Philips	BYD77D
16	D3	Ultra Fast, 200V, 2A	SOT-87	Philips	BYD77D
17	D4	Ultra Fast, 400V, 2A	SOT-87	Philips	BYD77G
18	D5	1N4148	SOD323	On Semi or equivalent	1N4148
19	D6	Zener, 4.7V	SOD323	Diodes Inc. or equivalent	BZT52C4V7S
20	D7	Zener, 30V	SMD DL-41	Diodes Inc. or equivalent	ZM4751A
21	D8	1N4148	SOD323	On Semi or equivalent	1N4148
22	F1	1/2A, Slow Blow	SMD2410	Littelfuse	R452.500
23	L1	220uH, 1.1A	SMD	Sumida	CDRH127-221MC
24	L2	100uH, 1.7A	SMD	Sumida	CDRH127-101MC
25	M1	MOSFET, 500V, 7.5A, 0.7Ω	D-Pak	ST Microelectronics	STD5NM50
26	Q1	BJT, PNP	SOT23	On Semi or equivalent	MMBT2907
27	R1	10.0K, 1%	SMD0603	Panasonic or equivalent	
28	R2	2.0M, 1%	SMD0603	Panasonic or equivalent	
29	R3	1.0, 1%	SMD1206	Panasonic or equivalent	
30	R4	10.0M, 1%	SMD0805	Panasonic or equivalent	
31	R5	80.6K, 1%	SMD0603	Panasonic or equivalent	
32	R6	133K, 1%	SMD0603	Panasonic or equivalent	
33	R7	100K, 1%	SMD0603	Panasonic or equivalent	
34	R8	2K, 1%	SMD0603	Panasonic or equivalent	
35	R9	10.0, 5%	SMD0805	Panasonic or equivalent	
36	R10	400K, 1%	SMD0603	Panasonic or equivalent	
37	U1	PWM/PFM IC	SOIC8	Supertex, Inc.	HV9906

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