

35 W wide input range flyback converter using HVLED001A
quasi resonant Flyback controller and STF10LN80K5

Designs from our labs describe tested circuit designs from ST labs which provide optimized solutions for specific applications. For more information or support, visit www.st.com By Francesco Ferrazza, Santina Leo

Main components	
HVLED001A	QUASI RESONANT FLYBACK CONTROLLER
STF10LN80K5	N-channel 800 V, 0.55 Ohm typ., 8 A MDmesh K5 Power MOSFET in a TO-220FP package
STTH2003CT	ULTRAFAST RECOVERY RECTIFIER DIODE
STTH108	HIGH VOLTAGE ULTRAFAST RECTIFIER
STPS1H100A	HIGH VOLTAGE POWER SCHOTTKY RECTIFIER

Specification

- Input voltage: V_{in} : 90 - 305 Vrms, f: 45-66 Hz
- Output voltage: 48 V / 730 mA
- PFC / THD: 0.98 / 10% @ 230Vac, 0.99 / 6% @ 110Vac
- No-load: better than 400 mW @ 277 V_{in}
- Full load efficiency: 90%
- Short circuit protection with auto restart
- PCB board size: 130mm x 50mm single side PCB

Circuit description

The STEVAL-ILL069V2 is intended to provide a stable and insulated 48V voltage bus suitable to supply secondary side circuitry (e.g. LED current generators) for a total output power of 35W when a wide range of input voltages is applied at its input. An auxiliary 14V output is also present to supply small circuitries absorbing a maximum current of 20mA.

A very high power factor is obtained thanks to HVLED001A features. Input voltage variations, excessive input voltage (overvoltage like Surge or bursts) or very low input voltages are managed by some of the HVLED001A's protections, improving the reliability of the application.

Output short circuit and overload protections are auto restart for a safe operation in lighting environment.

Figure 2. Board Picture

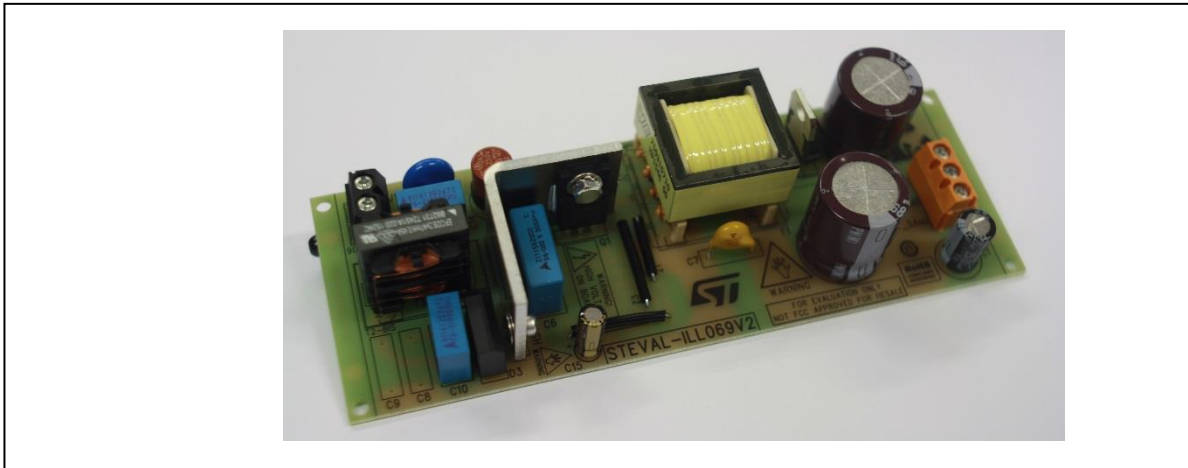
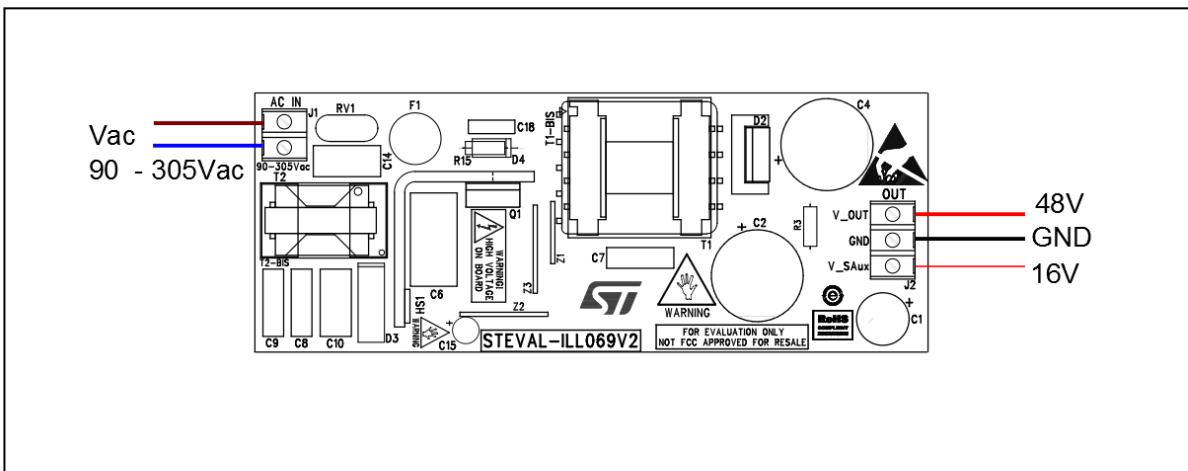


Figure 3. Board Connection



The design of this board starts with the selection of the proper transformer. The reflected voltage has been selected equal to 150 V in order to meet performances expectations (regulation and efficiency) and to allow the use of an 800 V mosfet with 305 Vac input voltage.

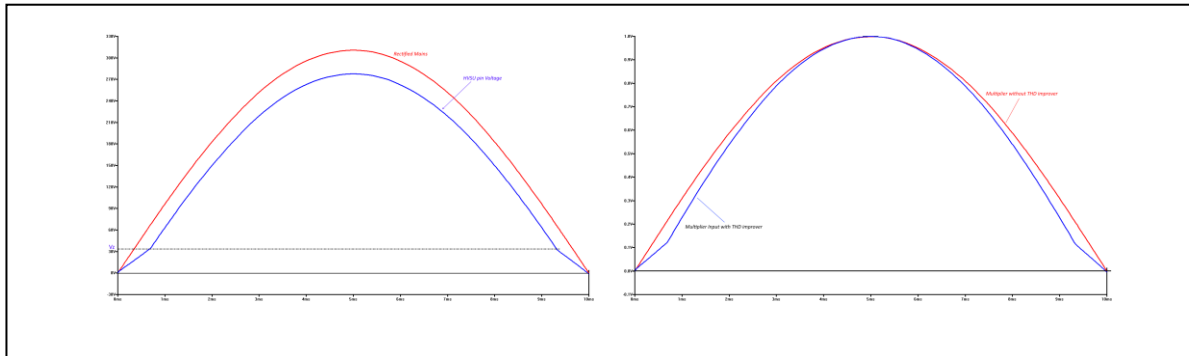
The value for primary inductance to guarantee a proper operation of the application must be selected higher than 240 μH . But, in order to obtain a better regulation, lower switching losses and safer EMC figure, a primary inductance higher than 500 μH should be selected: the adopted criteria is to obtain a demagnetization time longer than 3 μs when the current sense threshold is approximately equal to 300 mV (40% of the max current sense level).

Three transformers have been selected for T1: the codes are reported in Part List.

The theory of QR flybacks used to obtain a high power factor (4) states that an intrinsic THD exists. A robust method to reduce the THD to values lower than 10% is present on the board: D12 and R20 pre-distorts the input voltage pin of the HVLED001A. Figure 4 shows

the effect of the THD improver: the red line is the traditional envelop signal, while the blue line shows the improved envelop signal for current sense threshold.

Figure 4. THD improver before and after normalization



HVLED001A embeds a high accuracy reference voltage and a proprietary error amplifier able to control the output voltage reading the auxiliary winding connected to ZCD pin. A proper arrangement of both transformer winding arrangement and ZCD voltage divider are suggested to optimize the load and line regulation.

The auxiliary winding referred to the primary side is placed outer than secondary side power winding: doing so the auxiliary winding embraces entirely the magnetic field generated by secondary side current during demagnetization time.

The ZCD voltage divider includes a speed-up structure that contributes to the THD optimization: the size of the capacitor is set in order to have a time constant equal to 250ns ($\sim C11 * R5 // R6$)

The internal automatic bandwidth enhancer allows to limit the over-shootings and under-shootings at start-up and during transients well within the +/-12% of the rated value increasing the rise time and fall time of the FB pin voltage.

Output preloading circuitry, necessary to avoid voltage runaway at no load, consists on a Zener and a resistor: this selection helps to improve the operating efficiency without affecting the no load consumption. The no load voltage is set only by the Zener's value rather than by the ability of HVLED001A to control the no load voltage.

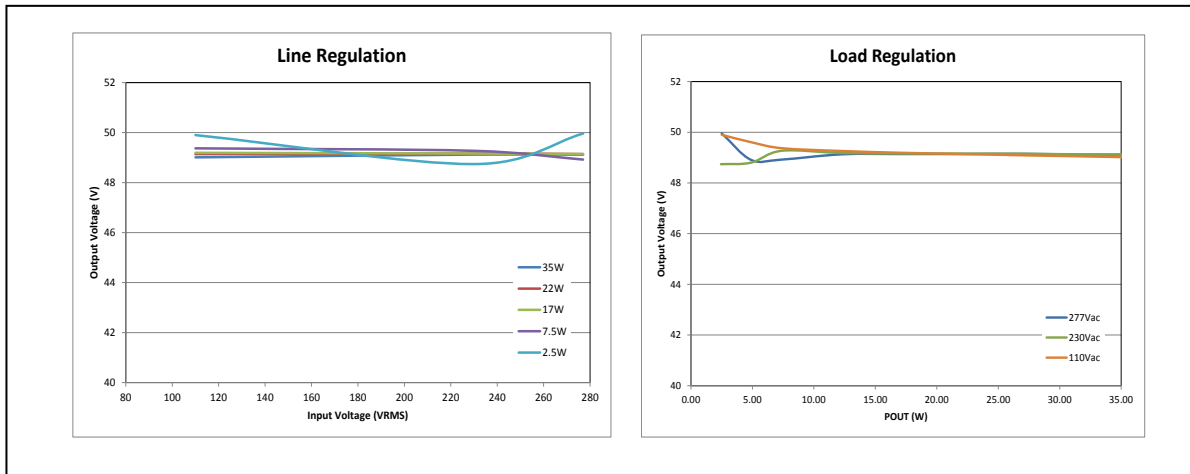
Actually, at no load the HVLED001A operates steadily in burst mode condition.

Measurement results

All following measurements have been made supplying the board using electronic AC source and loading it by an electronic load configured as a resistor emulator.

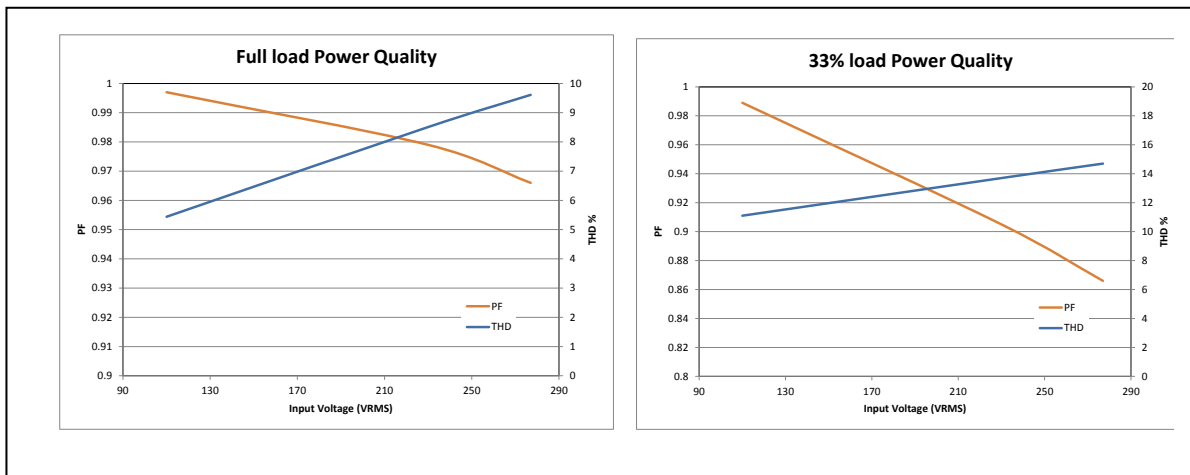
This evaluation board has been characterized in order to verify its line and load regulation characteristics to be within 2% of the target value when output power is higher than 10% of rated power and input voltage is within operating range.

Figure 5. Line and Load regulation (%)



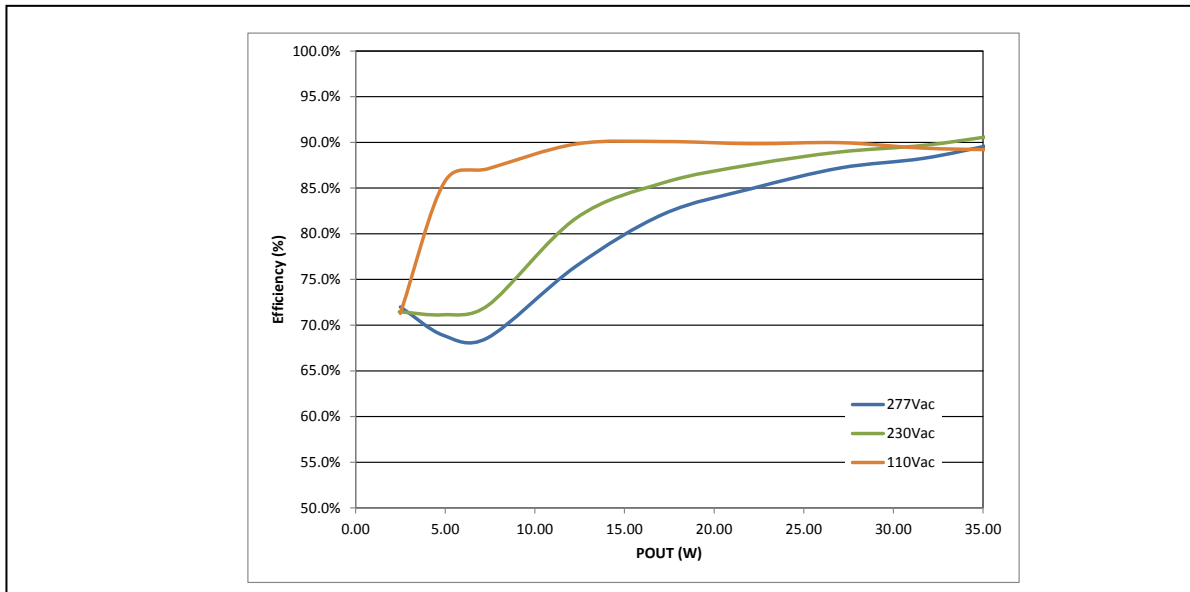
The Input power quality (PF and input current THD) and the efficiency are evaluated according to IEC61000-3-2 (Class C) at full load and 1/3 of the load.

Figure 6. Input power quality



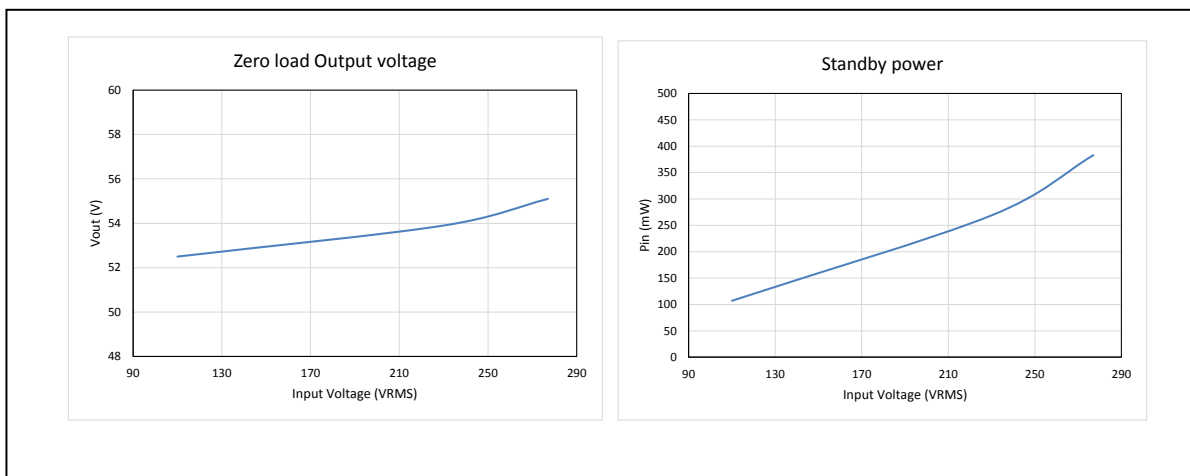
Efficiency of the application is another important parameter. Following graphs shows the board characteristics at different input voltage and output power.

Figure 7. Board's efficiency



In case of no load condition, the accuracy of the output voltage and the input power have been recorded and reported in following pictures.

Figure 8. No load condition parameters



Load transients have been evaluated as well: following waveforms shows the output voltage (Blue line) and control voltage (FB pin voltage, Red line).

Figure 9. Load transients

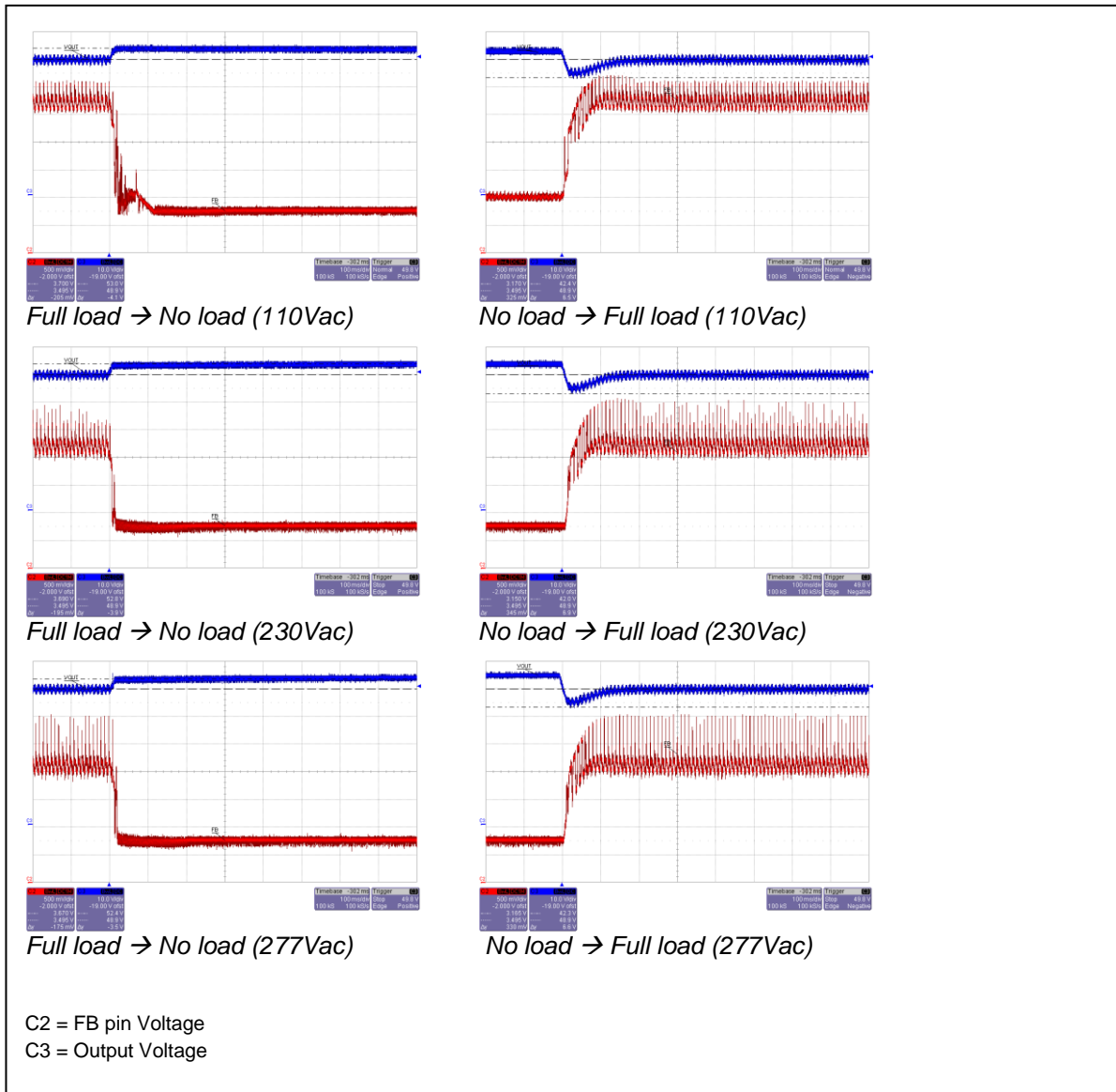
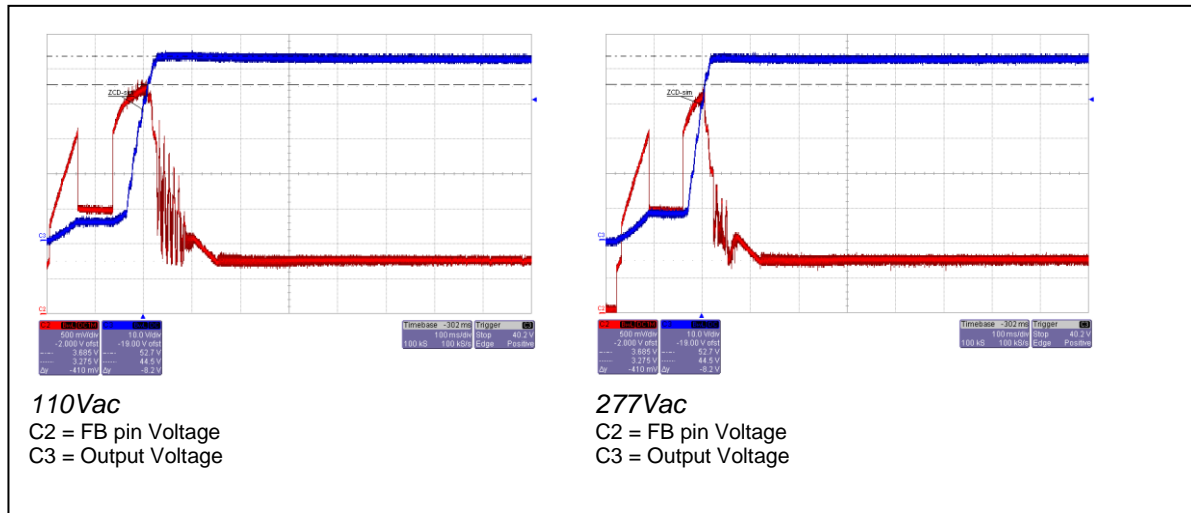


Figure 10. Start-up @ No Load



Variations

The board, as is, can deliver up to 50W in the limited range of input voltage between 180 Vac and 265 Vac without BOM variations.

Support material

Related design support material
DB2999: 35 W wide input range flyback converter using HVLED001A quasi resonant flyback controller and STF10LN80K5
STEVAL-ILL069V2 gerber files
STEVAL-ILL069V2 BOM
STEVAL-ILL069V2 schematics
Documentation
HVLED001A Datasheet
AN4932, HVLED001A – enhanced QR high power factor flyback controller for LED drivers
AN1059, Design equations of high-power-factor flyback converters based on the L6561

Revision history

Date	Version	Changes
24-Jan-2017	1	Initial release

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