AN5351
Application note

EVL80WLED-STCH03: 80W-1A primary side current loop control LED driver with STCH03 for street lighting applications

Introduction

The EVL80WLED-STCH03 (*Figure 1*) demonstration board implements a wide range 80 W - LED driver for street lighting applications with a primary current sensing control loop.

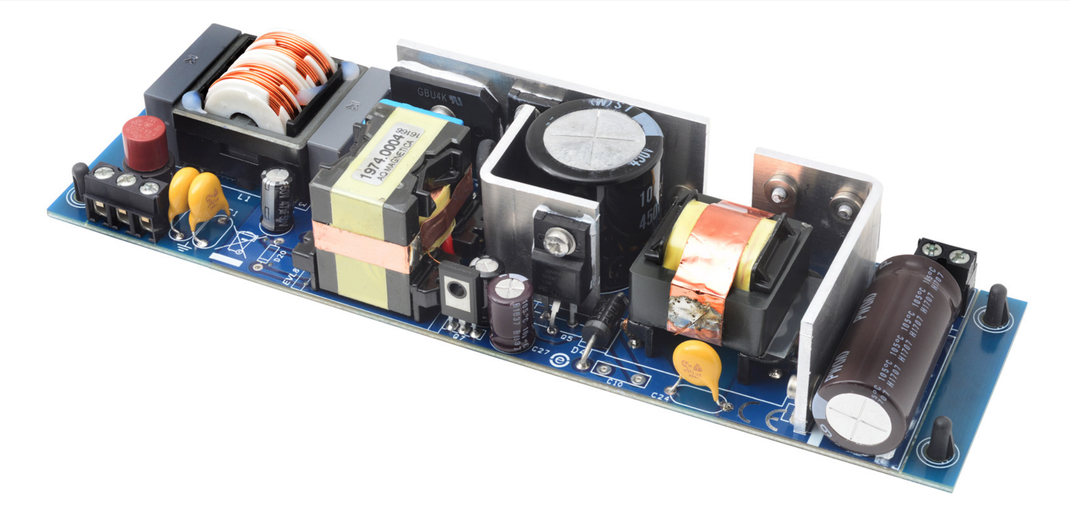
The LED driver is a fixed current source with a very fast start-up time, protections to short-circuit and to open load.

The board is optimized to supply an LED string load in the range from 40 V to 80 V with a fixed 1 A current source with a very low current ripple.

Due to current primary side STCH03 control loop, the output stage is composed of a simple diode rectification and the output capacitor.

Form factor is compatible with street lighting applications.

Figure 1. EVL80WLED-STCH03 demonstration board



Contents

List of tables

List of figures

1 LED driver main specifications

LED driver main features are listed below:

Universal Input Mains Range:	90÷265 Vac - Frequency 45 ÷ 65 Hz
Output voltage:	from 40V to 80 V at 1A continuous operation
Line regulation @ full load:	+-1%
Output current ripple:	<50mA @12 LED load (X42182 Seoul Semiconductor) - worst case
Output voltage ripple:	<1% pk pk
Startup:	<300ms
Mains harmonics:	According to EN61000-3-2 Class-C or JEITA-MITI Class-C
Open-load consumption:	< 0.5 W up to 265 Vac in Hic-up mode.
Efficiency:	>90 % @ full load
Protections:	LED short-circuit, LED string open, OVP
Conducted EMC:	Within EN55022-Class-B limits
Safety:	Meets EN60950
Dimensions:	50 x160 mm, 25 mm component maximum height
PCB:	Double side, 70 µm, FR-4, Mixed PTH/SMT
Suggested load	from 12 to 24 LEDs (3.4V typ Vdrop)

The circuit is made up of two stages: a front-end PFC using the L6563S with tracking boost function and a QR-flyback converter based on the STCH03. The flyback stage works as master and the PFC as a slave.

The STCH03 HV pin charges the C33 VDD capacitor and starts up the flyback converter. The auxiliary winding of the transformer and a peak detector produce a voltage in the range [15- 33] Vdc on C27 cap; then a voltage regulator (R71, D15, Q7) supplies the STCH03 and also powers up and supplies the L6563S.

To maximize the overall efficiency, the PFC makes use of the “Tracking Boost Option”. With this function implemented the PFC DC output voltage changes proportionally to the mains voltage [5].

The output secondary side stage is composed simply of a rectifier and a capacitor. In this design a double parallel STTH5L06FP has been used to maximize the overall efficiency and reduce thermal dissipation.

Considering a desired LED current of 1A, a unity transformer turn ratio and the internal STCH03 current gain Ki, the sense resistors Rs has been set using STCH03 formula [1]:

Equation 1

$$R_s := n \cdot \frac{K_i}{2 \cdot I_{LED}}$$

In this design five resistors of 0.47 R have been used in parallel to fix the LED current to about 1 A.

This current source could be modified as requested on the LED datasheet specification.

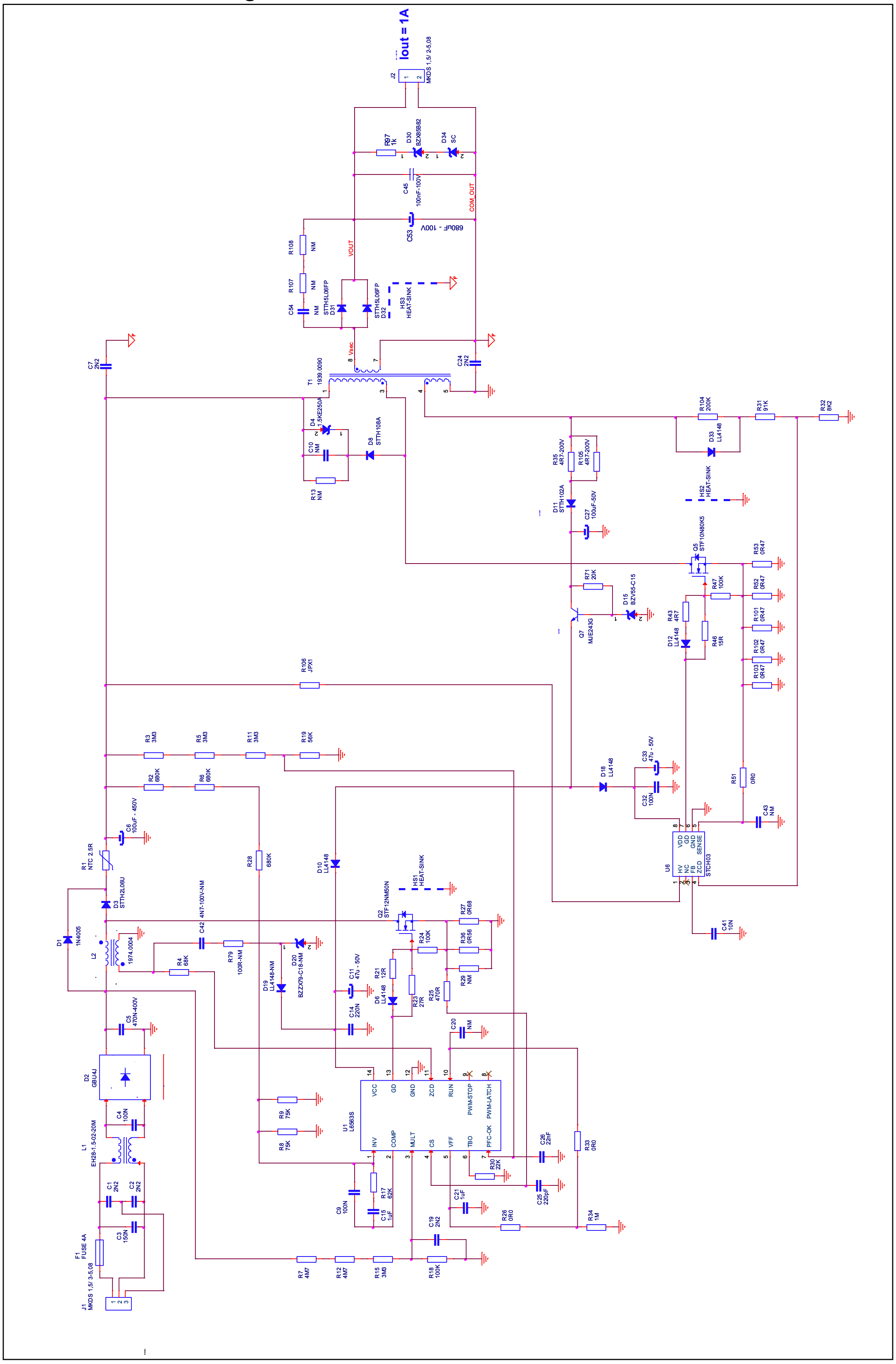
After selecting sense resistor R52, R53, R101,R102 and R103, the ZCD divider has been calculated using OVP and UVP formula from STCH03 datasheet [*1*].

Depending on the dynamic resistance of the LED string R_{Dtot}, the output capacitor C53 has been selected in order to maintain the current ripple below 50 mA pk-pk [*4*].

This demonstration board has been tested with the pn X42182 LED by Seoul Semiconductor.

The simplicity of the final two stage schematics can be appreciated in the following *Figure 2*.

Figure 2. EVL80WLED-STCH03 schematics



2 LED driver performances

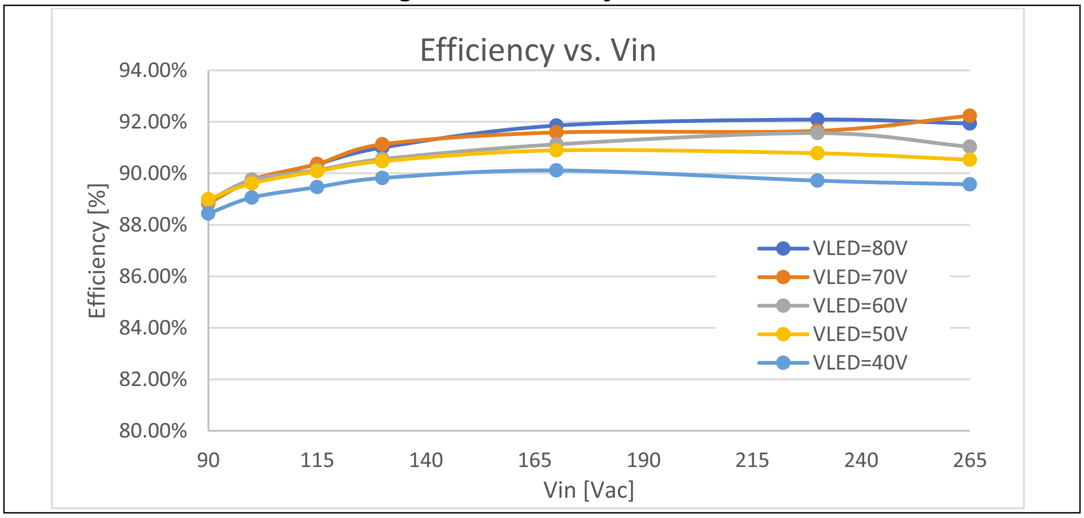
Table 1 shows the overall efficiency measured at the nominal mains voltages, powering an LED string as load from 24 LEDs to 12 LEDs.

Table 1. Overall efficiency at nominal mains input voltage varying the LED load

Vin [Vac]	LED n.	VLED [V]	ILED [A]	Pin [W]	Pout [W]	Effic. [%]	PF [-]	THD [%]
230Vac-50Hz	24	80.79	0.983	86.24	79.42	92.09%	0.993	2.13
	21	70.33	0.984	75.51	69.20	91.65%	0.997	2.25
	18	60.85	0.993	66.00	60.43	91.56%	0.987	2.60
	15	50.38	1.004	55.72	50.58	90.78%	0.980	3.29
	12	40.41	0.992	44.66	40.07	89.71%	0.957	3.80
	No load	**97Vpk**	-	**0.418**	**No load**	-	-	-
115Vac-60Hz	24	80.85	0.982	87.86	79.39	90.36%	0.998	2.50
	21	70.31	0.984	76.55	69.17	90.36%	0.998	2.62
	18	60.62	0.989	66.49	59.92	90.12%	0.998	2.80
	15	50.32	0.988	55.17	49.70	90.08%	0.998	2.63
	12	40.39	0.983	44.38	39.70	89.46%	0.992	3.55
	No load	**97Vpk**	-	**0.319**	**No load**	-	-	-

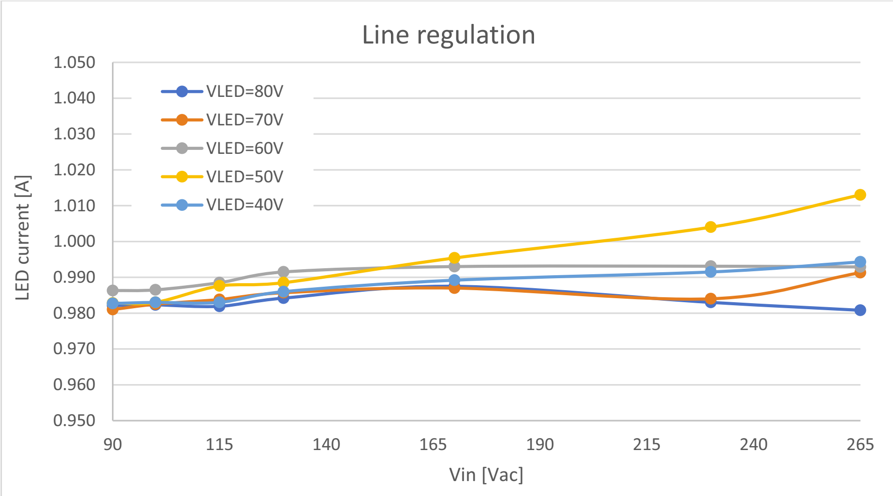
The efficiency characterization versus input mains has been done by applying a variable number of LEDs from a minimum of 12 to a maximum of 24 LEDs in order to test the driver performance in to the range from about 40 V to 80 V output.

Figure 3. Efficiency vs. Vin



At full load the efficiency is above the 90% at nominal voltages and remains very close to this value until half the load is applied (*Figure 3*).

Figure 4. Line regulation



The current loop is closed thanks to the primary side sensing of the STCH03. The current is constant (+-1%) in all the input-wide range. Also at half a load the regulation is still into +-1.7% (*Figure 4*).

In a typical LED application, the definition of ripple current must be carefully considered. We have defined a current ripple lower than 50 mA pk-pk, corresponding to about 5% of the average LED current.

This parameter depends only on two factors, one is linked to the dynamic resistance of the LED string R_{Dtot} load and the other to the output capacitor value of the converter C_o.

The following table shows the voltage and current ripple when applied first to a 23-LED string and then a 12-LED string.

Table 2. Current and voltage ripple at nominal input voltage varying the LED load

Vin [Vac]	VLED [V]	ΔVpk-pk [V]	Vripple [%]	ILED [A]	ΔI pk-pk [A]	Iripple [%]
115Vac/60Hz	80.01	0.046	<1%	0.982	0.003	0.30%
	40.68	0.059	<1%	0.990	0.014	1.42 %
230Vac/50Hz	80.01	0.120	<1%	0.984	0.012	1.23 %
	40.72	0.400	<1%	0.984	0.034	3.45 %

Consider that the value of the output capacitor depends on the load so it is important to know the final application of the converter. Here, the X42182 Seoul Semiconductor has been considered.

The form factor of the converter depends on the output capacitor size and, as a consequence, on the output current ripple specification.

In this application a 100 V-680 µF capacitor has been selected in order to maintain the current ripple below 50 mA, also with the minimum voltage drop admitted.

3 Harmonic content measurement

One of the main purposes of this converter is the correction of input current distortion, decreasing the harmonic contents below the limits of the actual regulation.

Therefore, the board has been tested according to the Japanese standard JEIDA-MITI Class-C and European standard EN61000-3-2 Class-C, at full load and both nominal input voltage mains.

Figure 5. EVL80WLED-STCH03 at 100Vac/50Hz compliance with JEIDA-MITI Class-C limits @ 24-LED load - PF=0.9980

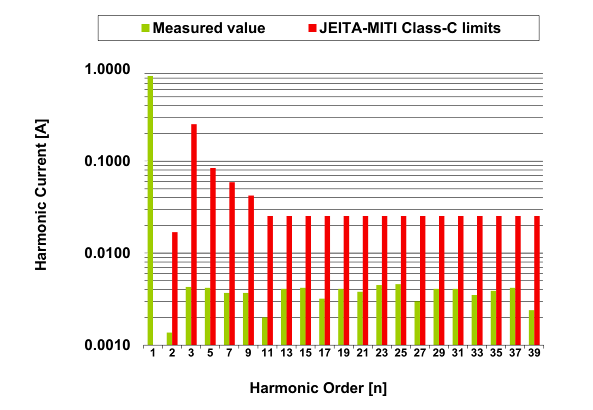
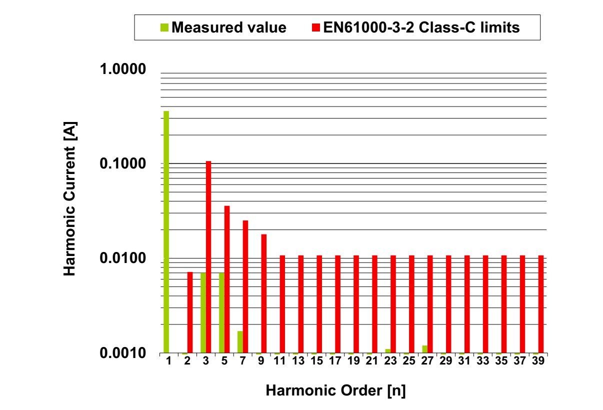
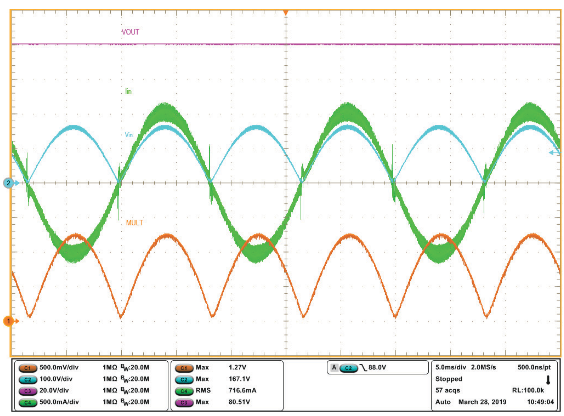


Figure 6. EVL80WLED-STCH03 at 230Vac/50Hz compliance with EN61000-3-2 Class-C limits @ 24-LED load - PF=0.9930



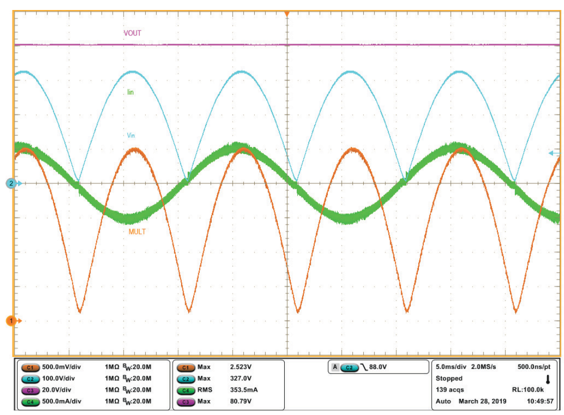
As shown in *Figure 5* and *Figure 6*, the circuit is capable of reducing the harmonics well below the limits of both regulations.

Figure 7. Mains voltage and current waveforms at 115V-60 Hz - full load - PF=0.998 THD=2.5%



CH1: MULT L6563S
CH2: Input voltage
CH3: VOUT
CH4: Input current

Figure 8. Mains voltage and current waveforms at 230V-50 Hz - full load - PF=0.993 THD=2.13%



CH1: MULT L6563S
CH2: Input voltage
CH3: VOUT
CH4: Input current

Thanks to the L6563S internal multiplier cell in the PFC input stage, a good power factor and very low THD have been reached. The good current shape could be observed in the input PFC current waveform (*Figure 7* and *Figure 8*).

Even decreasing the number of LED load, a very good PF (*Figure 9*) and THD (*Figure 10*) value could be observed.

Figure 9. Power factor vs. Vac and LED voltage drop

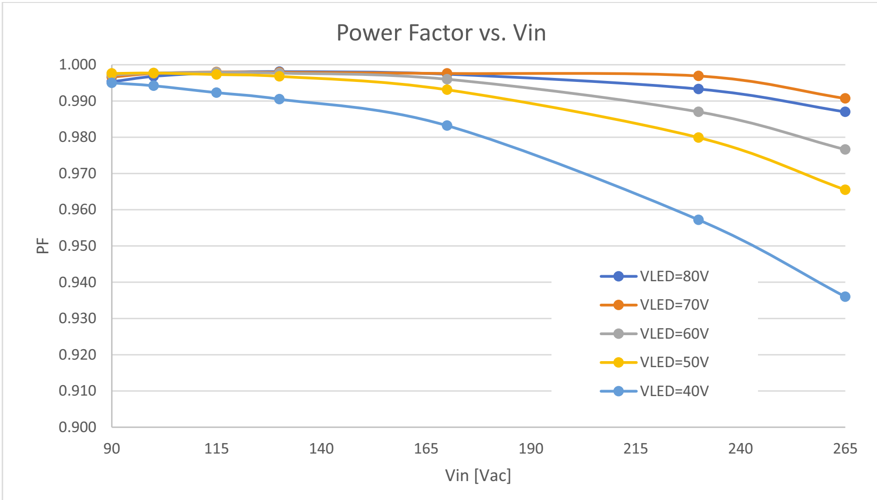
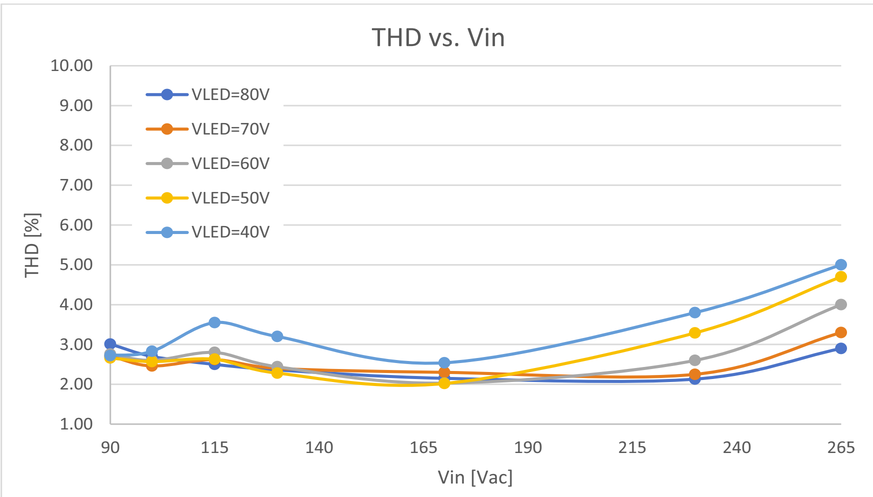


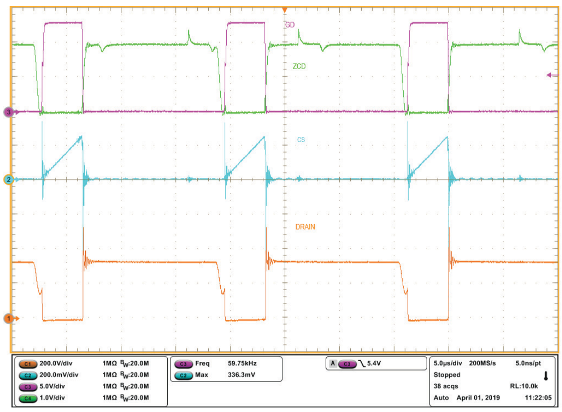
Figure 10. THD vs. Vac and LED voltage drop



4 STCH03 control waveforms

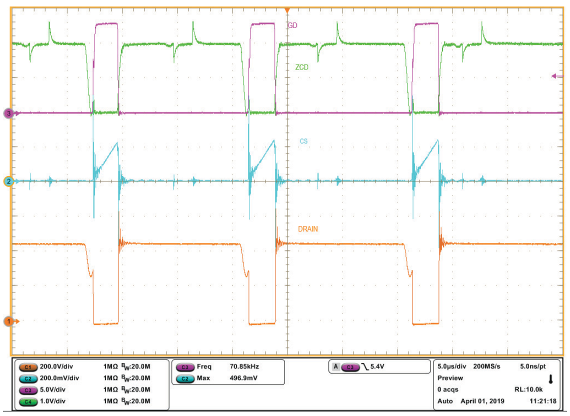
The flyback is working always in quasi-resonant mode also changing the output voltage from 80 V to 40 V because the current loop is working always at full load when a switching frequency is into the range from 40 kHz to 70 kHz (*Figure 11*, *Figure 12*, *Figure 13*, *Figure 14*).

Figure 11. 115Vac - 60Hz control signal at 1A - 24 LEDs - fsw=59.7kHz



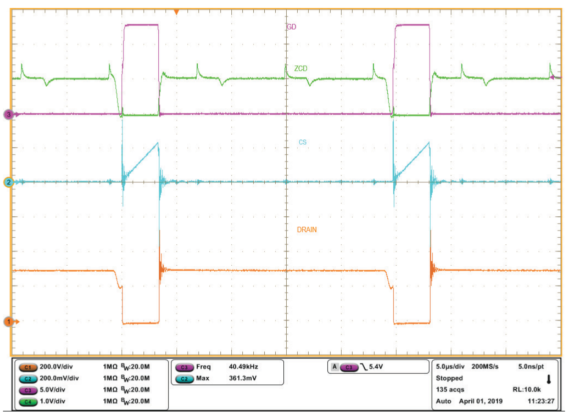
CH1: DRAIN
CH2: CS
CH3: GD
CH4: ZCD

Figure 12. 230Vac - 50Hz - control signal at 1A - 24 LEDs - fsw=70.85kHz



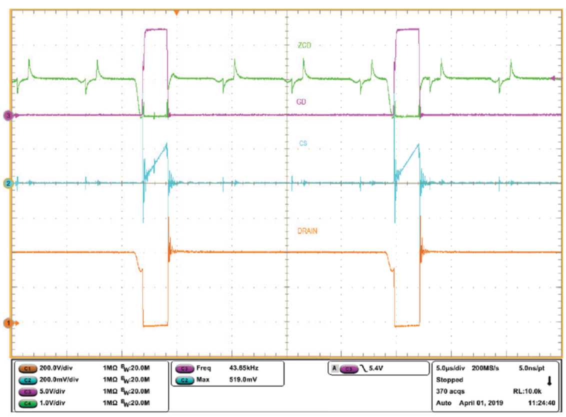
CH1: DRAIN
CH2: CS
CH3: GD
CH4: ZCD

Figure 13. 115Vac - 60Hz control signal at 1A - 12 LEDs - fsw=40.49kHz



CH1: DRAIN
CH2: CS
CH3: GD
CH4: ZCD

Figure 14. 230Vac - 50Hz - control signal at 1A - 12 LEDs - fsw=43.65khz

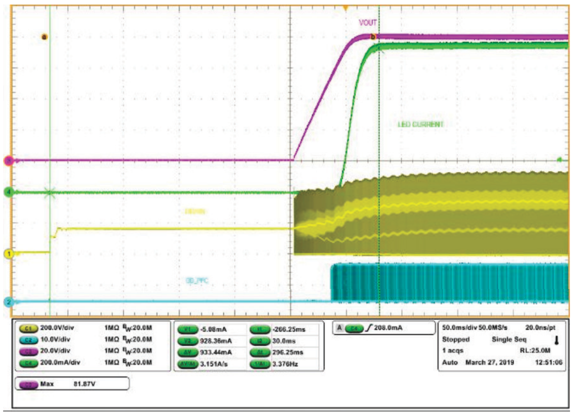


CH1: DRAIN
CH2: CS
CH3: GD
CH4: ZCD

5 Startup

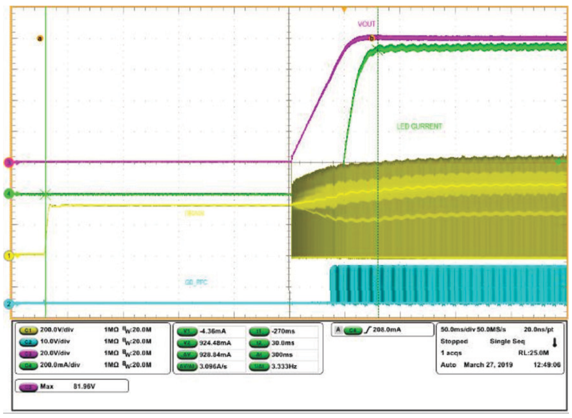
The waveforms relevant to the LED driver startup have been captured in *Figure 15* and *Figure 16*.

Figure 15. 115Vac - 60Hz - 1A 24 LEDs (80V) load - Tstartup<300ms



CH1: DRAIN Q5
CH2: GD_PFC
CH3: VOUT
CH4: LED current

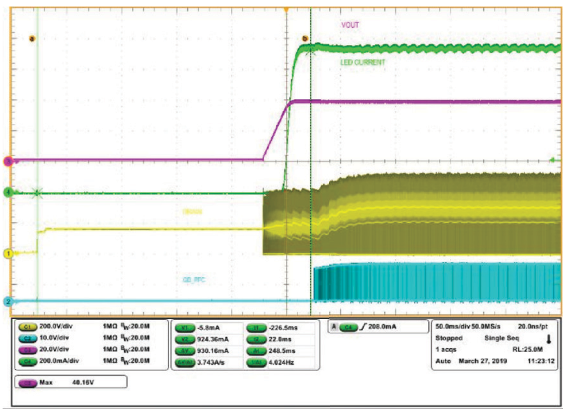
Figure 16. 230Vac - 50Hz - 1A 24 LEDs (80V) load - Tstartup<300ms



CH1: DRAIN Q5
CH2: GD_PFC
CH3: VOUT
CH4: LED current

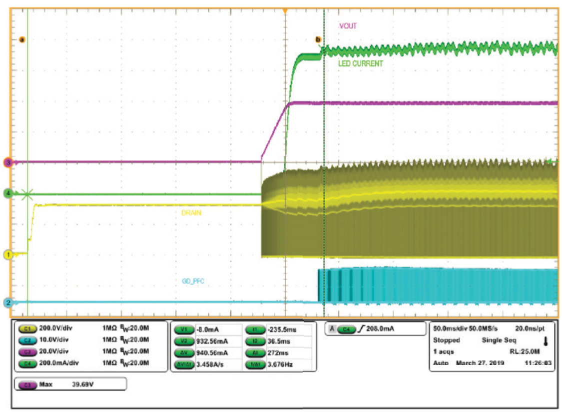
Due to the high current capability of the STCH03 HV startup [*1*], the LEDs' output current reaches the nominal value in less than 300 ms after power-up when a string of 24 LEDs corresponding to a voltage drop of 80 V is applied.

Figure 17. 115Vac - 60Hz - 1A 12 LEDs (40V) load - Tstartup<300ms



CH1: DRAIN Q5
CH2: GD_PFC
CH3: VOUT
CH4: LED current

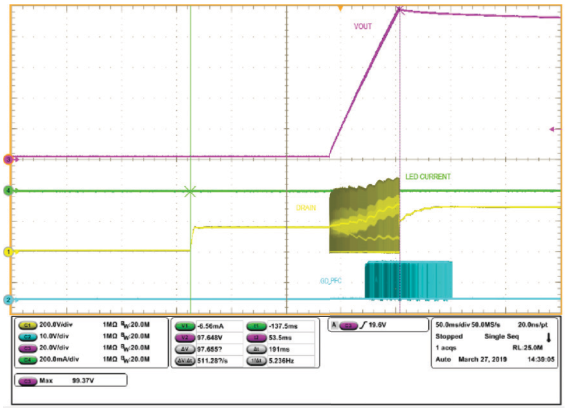
Figure 18. 230Vac - 50Hz - 1A 12 LEDs (40V) load - Tstartup<300ms



CH1: DRAIN Q5
CH2: GD_PFC
CH3: VOUT
CH4: LED current

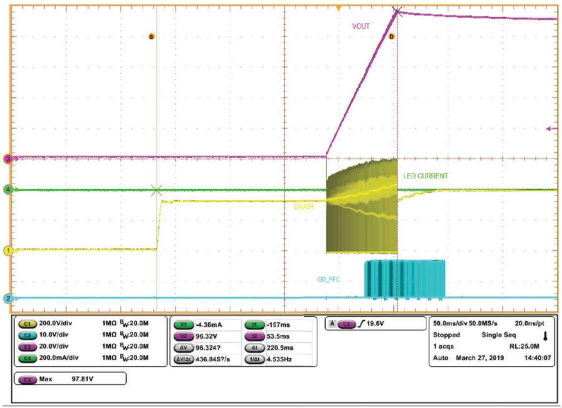
Start-up time could be considered as a constant even when a 12-LED load is applied that corresponds to 40 V (half load).

Figure 19. 115Vac - 60Hz - NO LOAD Tstartup<200ms



CH1: DRAIN Q5
CH2: GD_PFC
CH3: VOUT
CH4: LED current

Figure 20. 230Vac - 50Hz - NO LOAD Tstartup<250ms



CH1: DRAIN Q5
CH2: GD_PFC
CH3: VOUT
CH4: LED current

During a startup at no load the STCH03 OVP protection is triggered after less than 250 ms (*Figure 19*, *Figure 20*).

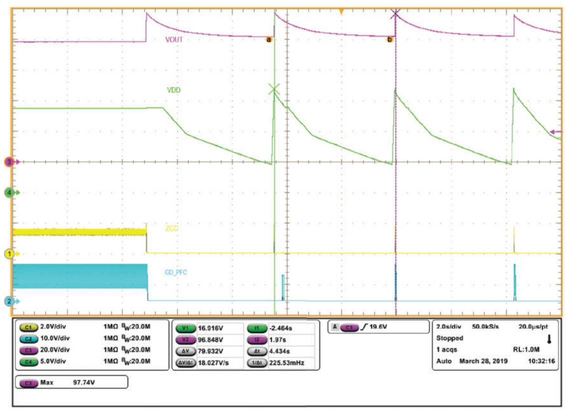
6 LED load disconnection and no load consumption

During load disconnection, the current loop is open but the output voltage is sensed thanks to the coupled auxiliary winding and the ZCD pin of the STCH03.

The divider has been set in order to detect OVP at an output level slightly below the output capacitor voltage rating (100 V).

When the LED string is disconnected the STCH03 OVP protection is triggered, the switching activity is stopped and the condition is maintained until VDD goes below VDDR restart voltage and then rises up again to VDD-ON thanks to the internal STCH03 HV startup (lower Ich level-see datasheet). Ultimately, this results in a low-frequency intermittent operation. Waveforms of the operation during burst mode are reported here following in *Figure 21* and *Figure 22*:

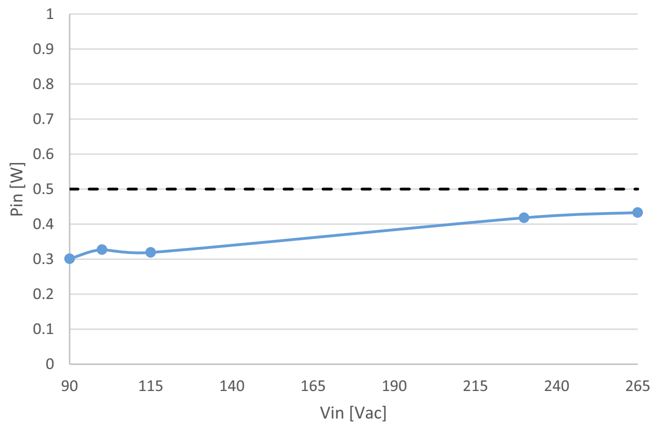
Figure 21. 24-LED load disconnection @ 115 Vac/60Hz



CH1: DRAIN Q5
CH2: GD_PFC
CH3: VOUT
CH4: VDD STCH03

After the OVP protection is triggered, the STCH03 goes into auto-restart mode with a very low pulse rating (about 5 sec.) due to the low charging current in this condition, the average input power consumption is below 0.5 W as requested in lighting regulations. The pulse rating could be modified acting on the VDD capacitor network and the Restart time is depending on this VDD discharging time.

Figure 22. No load consumption vs. Vin



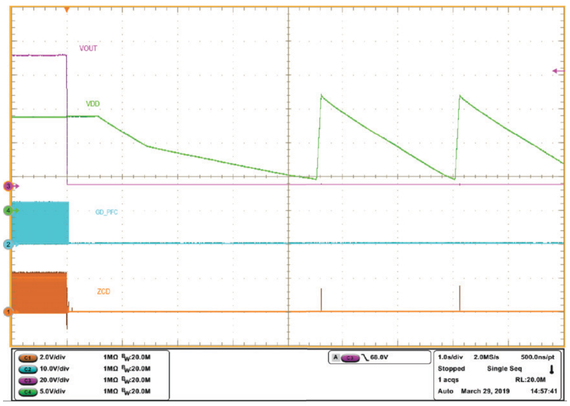
No load measurements have been done disconnecting the LED string from the board and measuring the input power by power meter integration (*Figure 22*).

7 Short-circuit and STCH03 UVP function

During a short of the output connector, all the energy stored in the output electrolytic capacitor C53 is discharged into the output side loop, and no current flows into the external LEDs, preventing their failure.

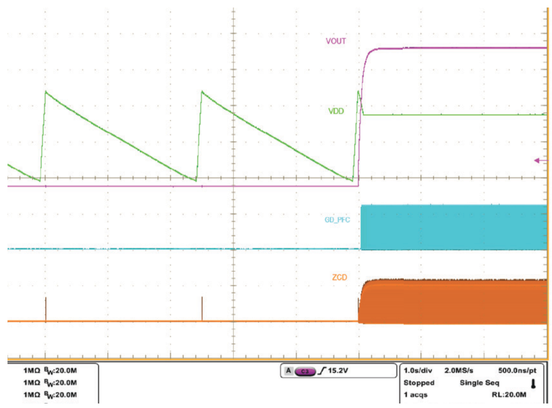
The output undervoltage function (UVP) of the STCH03 device protects the converter in case of the output short-circuit or for the CC-mode operation at low output voltage (lower than 22 V on the output), forcing the system into hiccup-mode [1].

Figure 23. Short-circuit at 115 Vac/60Hz



CH1: ZCD STCH03
CH2: GD_PFC
CH3: VOUT
CH4: VDD STCH03

Figure 24. Short-circuit removal at 115 Vac/60Hz



CH1: ZCD STCH03
CH2: GD_PFC
CH3: VOUT
CH4: VDD STCH03

The voltage on the ZCD at the end of the transformer's demagnetization is monitored and compared with an internal threshold, VUVP (0.55 V typ.). If the value goes below the threshold, an output undervoltage condition is assumed and the device enters into hiccup mode protection.

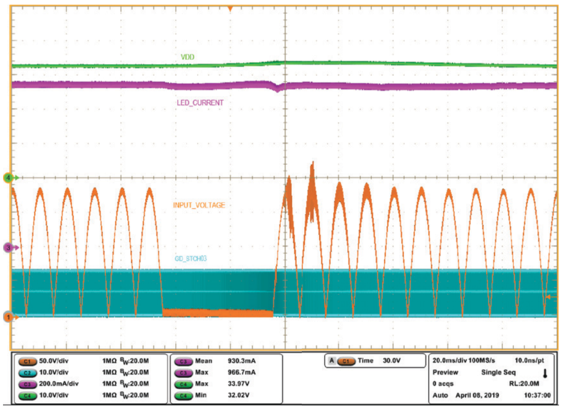
The behavior of the protection has been tested with positive results over the entire input voltage range; only the nominal conditions at 115 Vac have been reported in this application note (Figure 23, Figure 24).

8 Line sags and fast on-off

The circuit behavior during a mains sags sequence has been tested, varying the OFF time period of the line. *Figure 25*, *Figure 26*, *Figure 27* and *Figure 28* show the behavior during two missed cycles of 20 ms each (line is at 60 Hz at low mains and 50 Hz at high mains). First test has been done with 24-LED (maximum voltage admitted) and then repeated with 12-LED (minimum voltage admitted).

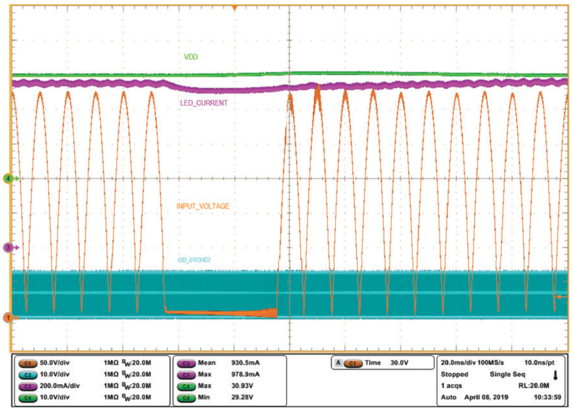
Light doesn't switch off.

Figure 25. 24-LED load - TOFF = 40 ms at 115Vac/60Hz - 0.954 A



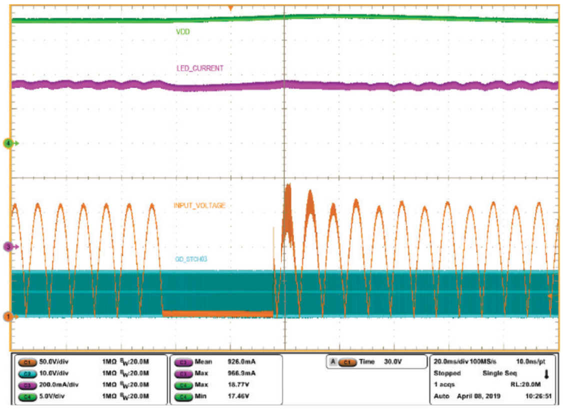
CH1: Input rectified mains
CH2: GD_STCH03
CH3: LED current
CH4: VDD STCH03

Figure 26. 24-LED load - TOFF = 40 ms at 230 Vac/50Hz - 0.954 A



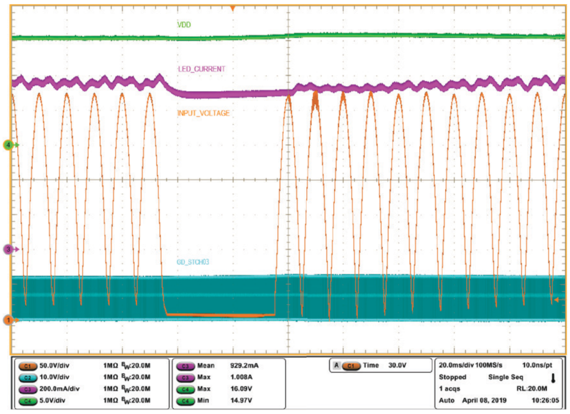
CH1: Input rectified mains
CH2: GD_STCH03
CH3: LED current
CH4: VDD STCH03

Figure 27. 12-LED load - TOFF = 40 ms at 115Vac/60Hz - 0.954 A



CH1: Input rectified mains
CH2: GD_STCH03
CH3: LED current
CH4: VDD STCH0

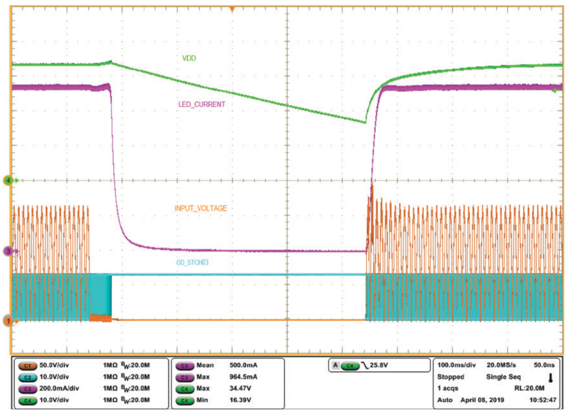
Figure 28. 12-LED load - TOFF = 40 ms at 230 Vac/50Hz - 0.954 A



CH1: Input rectified mains
CH2: GD_STCH03
CH3: LED current
CH4: VDD STCH0

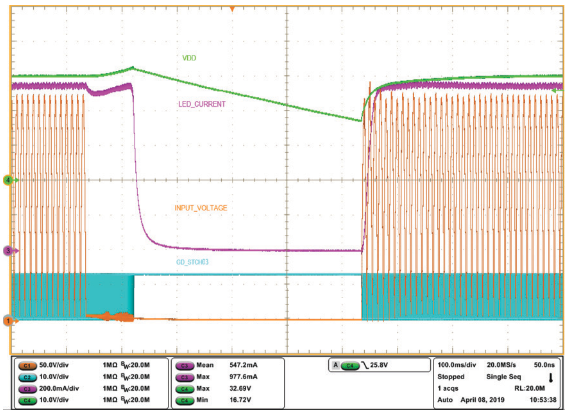
Figure 29 and *Figure 30* show the circuit behavior during a mains interruption of 500 ms, as in the case of a fast on-off-on cycle.

Figure 29. 24-LED load - TOFF = 500ms at 115Vac/60Hz - 0.954 A



CH1: Input rectified mains
CH2: GD_STCH03
CH3: LED current
CH4: VDD STCH0

Figure 30. 24-LED load - TOFF = 500ms at 230 Vac/50Hz - 0.954 A



CH1: Input rectified mains
CH2: GD_STCH03
CH3: LED current
CH4: VDD STCH0

If VCC doesn't discharge until its turn-off level during the missed cycles, the converter restarts immediately. In this case, light switches off and on following the mains fast on/off.

9 Conducted emission pre-compliance test

The following graphs show the average measurements of the conducted noise with a 24-LED load and nominal mains voltages.

The limits shown on the diagrams are those of EN55022 class-B, which is the most popular standard for European equipment.

As seen in *Figure 31*, *Figure 32*, *Figure 33* and *Figure 34*, good margins with respect to the limits are present in all test conditions.

Increasing the CX capacitor value of the EMI filter improves the safety margin but affects the PF. A compromise has been found in this design in order to get PF>0.98 also at high line.

Figure 31. 115 Vac/60 Hz - full load - phase

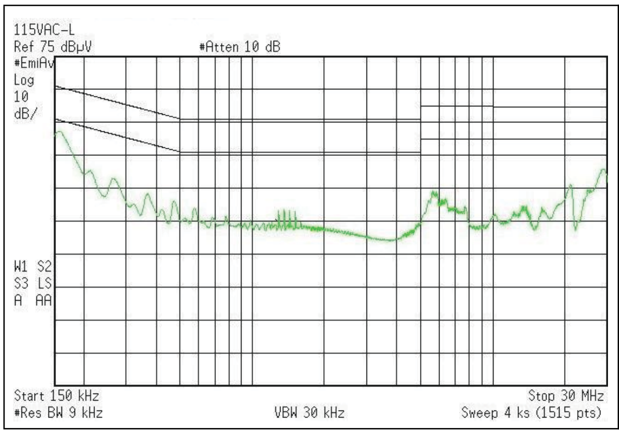


Figure 32. 115 Vac/60 Hz - full load - neutral

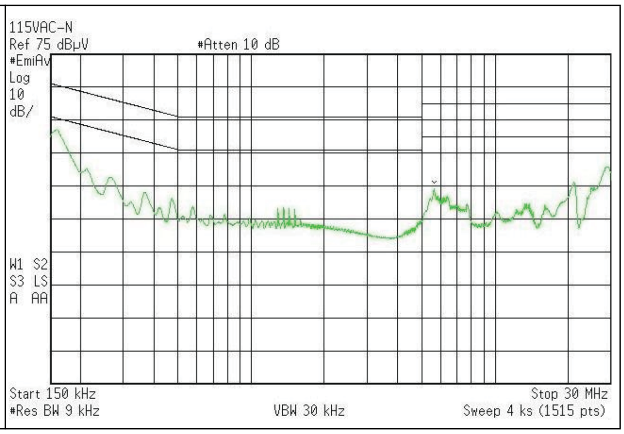


Figure 33. 230 Vac/50 Hz - full load - phase

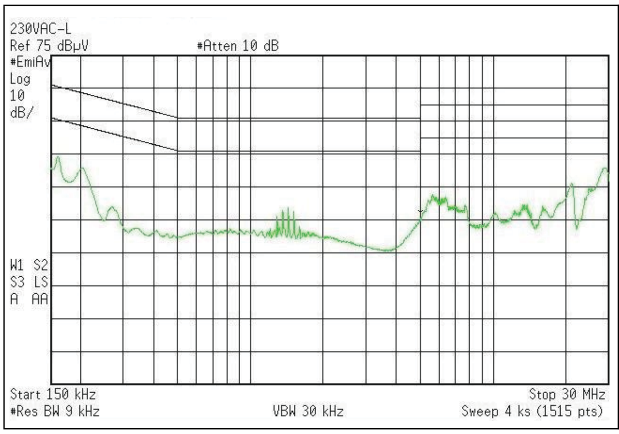
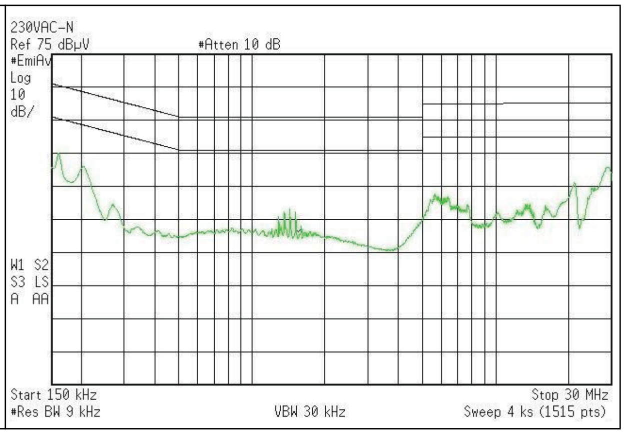


Figure 34. 230 Vac/50 Hz - full load - neutral



10 Thermal measurements

To check the reliability of the design, thermal mapping by means of an IR camera was carried out. *Figure 35* and *Figure 36* show thermal measurements on the component side of the board at nominal input voltages and full load.

Some pointers visible in the images placed across key components show the relevant temperature. *Table 2* provides the correlation between the measured points and components, for both thermal maps. The ambient temperature during both measurements was 25 °C. According to these measurement results, all components on the board function within their temperature limits.

Figure 35. 115Vac - 80V - 1A

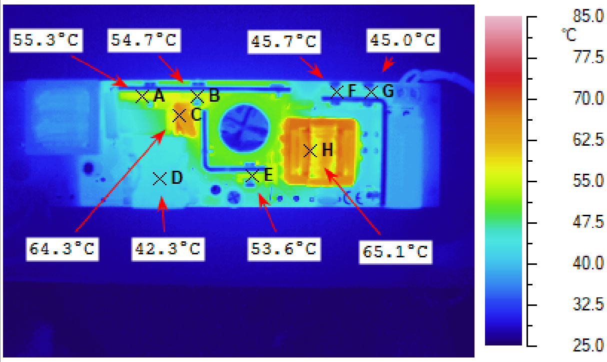


Figure 36. 230Vac - 80V - 1A

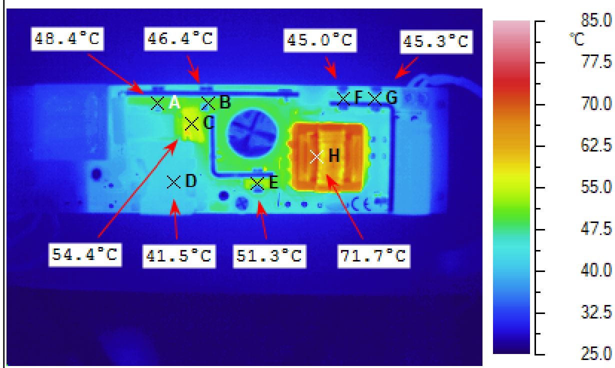


Table 3. Measured temperature @ 115 VAC/60Hz and 230 VAC/50Hz - 24-LED load

Point	Component	Temp. @ 115 VAC/60Hz - 80V - 1A	Temp.@ 230 VAC/50Hz - 80V - 1A
A	D2	**55.3** °C	**48.4** °C
B	Q2	**54.7** °C	**46.4** °C
C	NTC R1	**64.3** °C	**54.4** °C
D	L2	**42.3** °C	**41.5** °C
E	Q5	**53.6** °C	**51.3** °C
F	D31	**45.7** °C	**45.0** °C
G	D32	**45.0** °C	**45.3** °C
H	T1	**65.1** °C	**71.7** °C

11 PCB layout

Figure 37 and *Figure 38* show the layout of the PCB. The demonstration board has been designed to fit in a typical LED driver case for lamps so the maximum height is 25 mm, maximum length is 160 mm and the maximum width is less than 50 mm.

Of course the form factor could be further reduced depending on the capacitor value. Here a very narrow current ripple has been defined as a specification, but accepting a higher value, the capacitor size could be further reduced.

Figure 37. EVL80WLED-STCH03 bottom layer

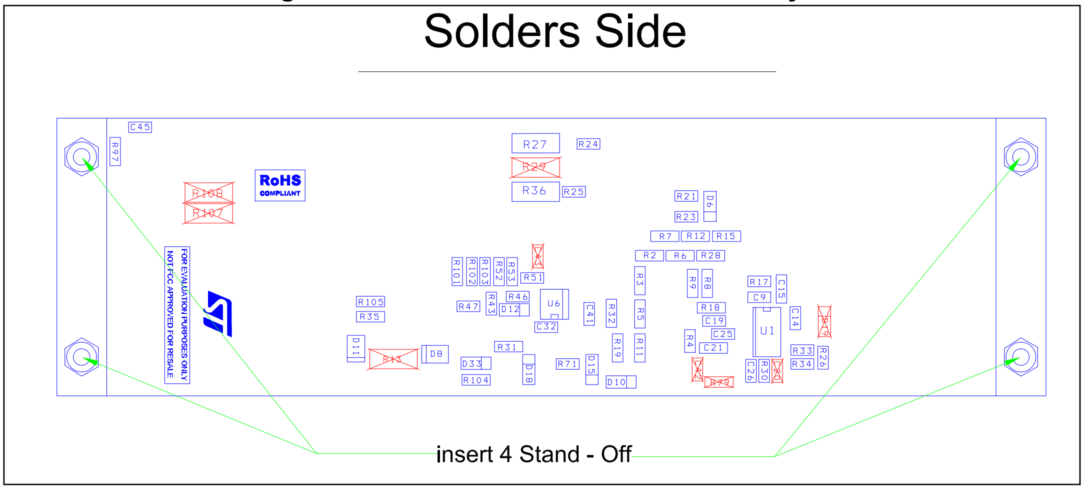
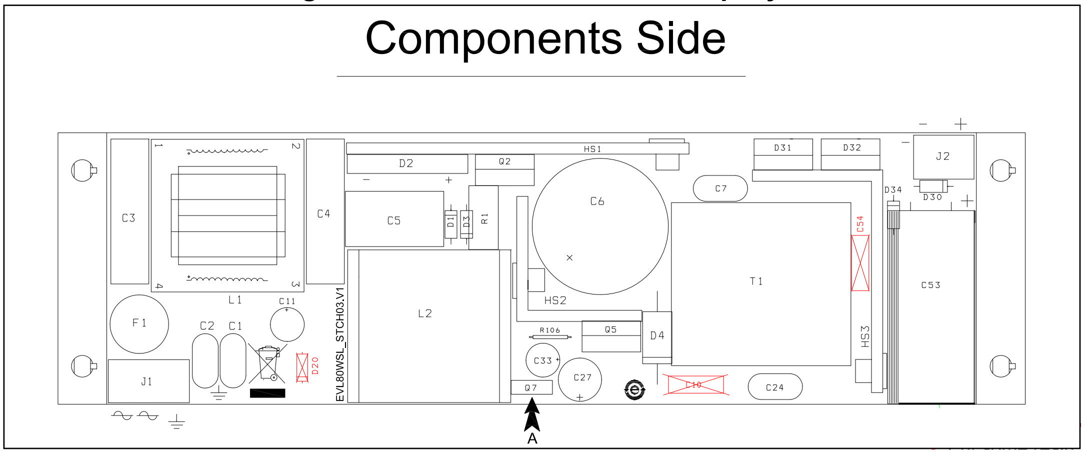


Figure 38. EVL80WLED-STCH03 Top layer



12 Bill of material

Table 4. EVL80WLED-STCH03 evaluation board bill of material

Part Reference	Value	Description	Supplier
C1	2n2-Y1	Y1 - safety cap. DE1E3KX222M	MURATA
C2	2n2-Y1	Y1 - safety cap. DE1E3KX222M	MURATA
C3	150N-X2	X2 - film cap safety cap 0.15uF 20% R463I315000M2K	KEMET
C4	100N-X2	X2 - film cap safety cap 0.1uF 20% R463I310000M1M	KEMET
C5	470N - 400V	400V - film cap - B32653A4474	EPCOS
C6	100u - 450V	450V - aluminium ELCAP - LLS series - 85°C	NIPPON-CHEMICON
C7	2n2-Y1	Y1 - safety cap. DE1E3KX222M	MURATA
C9	100N	50V CERCAP - general purpose	AVX
C11	47u - 50V	50V - aluminium ELCAP - YXF SERIES - 105°C	
C14	220N	50V CERCAP - general purpose	AVX
C15	1u	25V CERCAP - general purpose	AVX
C19	2N2	50V CERCAP - general purpose	AVX
C21	1uF	25V CERCAP - general purpose	AVX
C24	2n2-Y1	Y1 - safety cap. DE1E3KX222M	MURATA
C25	220p	50V CERCAP - general purpose	AVX
C26	22N	50V CERCAP - general purpose	AVX
C27	100uF-50V	Aluminium ELCAP - YXF series - 105°C	
C32	100N	50V CERCAP - general purpose	AVX
C33	47u - 50V	50V - aluminium ELCAP - YXF series - 105°C	RUBYCON
C41	10N	50V CERCAP - general purpose	AVX
C42	4N7-100V-NM	100V CERCAP - general purpose	AVX
C45	100n-100V		RS
C53	1000uF - 100V PW8000h	100V -105°C PW8000h	NICHICON
D1	1N4005	Rectifier - general purpose	ON SEMICONDUCTOR
D2	GBU4J	Glass Passivated Single-Phase Bridge Rectifier	VISHAY
D3	STTH2L06U	Ultrafast high voltage rectifier	STMICROELECTRONICS
D4	1.5KE250A	TRANSIL	STMICROELECTRONICS

Table 4. EVL80WLED-STCH03 evaluation board bill of material (continued)

Part Reference	Value	Description	Supplier
D6	LL4148	Fast switching diode	VISHAY
D8	STTH108A	Ultrafast high voltage rectifier	STMICROELECTRONICS
D10	LL4148	Fast switching diode	VISHAY
D11	STTH102A	Fast switching diode	STMICROELECTRONICS
D12	LL4148	Fast switching diode	VISHAY
D15	BZV55-C15		
D18	LL4148	Fast switching diode	VISHAY
D19	LL4148-NM	Fast switching diode	VISHAY
D20	BZZX79-C18-NM		
D30	BZX85B82	Zener diode 82V 1.3W	
D31	STTH5L06FP	Ultrafast high voltage rectifier	STMICROELECTRONICS
D32	STTH5L06FP	Ultrafast high voltage rectifier	STMICROELECTRONICS
D33	LL4148	Fast switching diode	VISHAY
F1	FUSE 4A	Fuse T4A - time delay	WICHMANN
HS0	HEAT-SINK		
HS1	HEAT-SINK		
HS2	HEAT-SINK		
HS3	HEAT-SINK		
J1	MKDS 1,5/3-5,08 HT BK	PCB TERM. BLOCK, SCREW CONN., PITCH 5MM - 3 W.	PHOENIX CONTACT
J2	MKDS 1,5/2-5,08 HT BK	PCB TERM. BLOCK, SCREW CONN., PITCH 5MM - 2 W.	PHOENIX CONTACT
JPX1	SHORT	SFR25 AXIAL STAND. FILM RES - 0.4W - 5% - 250ppm/°C	
L1	EH28-1.5-02-20M	Common Mode Choke	SCHAFFNER
L2	1974.0004	PFC inductor	AQ Magnetica
Q2	STF12NM50N	N-channel Power MOSFET	STMICROELECTRONICS
Q5	STF10N80K5	N-channel Power MOSFET	STMICROELECTRONICS
Q7	MJE243G	Complementary Silicon Power Plastic Transistors	NXP
R1	NTC 2.5R 20% 3W	NTC resistor P/N B57237S0259M000	EPCOS
R2	680K	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R3	3M3	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY

Table 4. EVL80WLED-STCH03 evaluation board bill of material (continued)

Part Reference	Value	Description	Supplier
R4	68K	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R5	3M3	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R6	680K	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R7	4M7	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R8	75K	SMD standard film RES - 1/8W - 1% - 100ppm/°C	VISHAY
R9	75K	SMD standard film RES - 1/8W - 1% - 100ppm/°C	VISHAY
R11	3M3	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R12	4M7	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R15	3M3	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R17	62K	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
R18	100K	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R19	56K	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R21	12R	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R23	27R	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R24	100K	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
R25	470R	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R26	0R0	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R27	0R33	RSMF1TB - metal film RES - 1W - 2% - 250ppm/°C	VISHAY
R28	680K	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R30	22K	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R31	91K	SMD standard film RES - 1/8W - 1% - 100ppm/°C	VISHAY

Table 4. EVL80WLED-STCH03 evaluation board bill of material (continued)

Part Reference	Value	Description	Supplier
R32	8K2	SMD standard film RES - 1/8W - 1% - 100ppm/°C	VISHAY
R33	0R0	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R34	1M	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R35	4R7-200V	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
R43	4R7	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
R46	15R	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
R47	100K	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
R51	0R	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
R52	0R47	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R53	0R47	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R71	20K	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
R79	100R-NM	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R97	1k	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R101	0R47	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R102	0R47	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R103	0R47	SMD standard film RES - 1/4W - 5% - 250ppm/°C	VISHAY
R104	200K	SMD standard film RES - 1/8W - 1% - 100ppm/°C	VISHAY
R105	4R7-200V	SMD standard film RES - 1/8W - 5% - 250ppm/°C	VISHAY
T1	1939.009	Power transformer	AQ Magnetica
U1	L6563S	Transition-mode PFC controller	STMICROELECTRONICS
U6	STCH03	Offline PWM controller	STMICROELECTRONICS

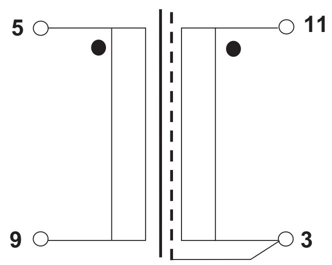
13 PFC coil specification

Figure 39. PFC inductor 1974.0004

TYPICAL APPLICATION

INDUCTOR FOR BUCK, BOOST AND BUCK-BOOST DC/DC CONVERTER, AVAILABLE ALSO IN HALF-BRIDGE, PUSH-PULL AND FULL-BRIDGE APPLICATIONS

CIRCUIT DIAGRAM

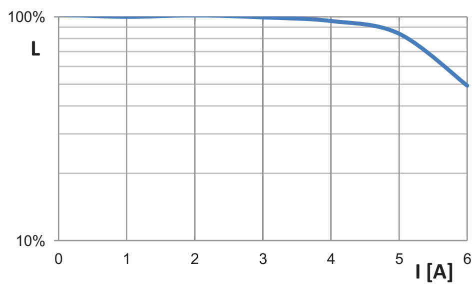


TO BE MOUNTED WITH RIGHT INSULATION BETWEEN PCB WIRINGS AND FERRITE CORE

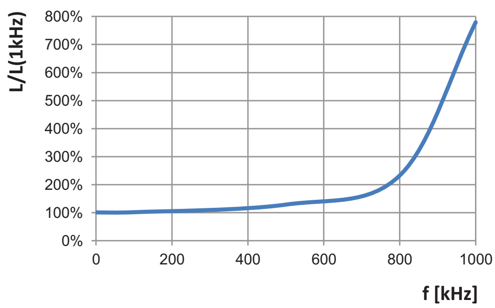
TECHNICAL DATA

INDUCTANCE *(MEASURE 1KHZ, TA 20°C)*	
PIN 5-9	520uH ±10%
PIN 11-3	7.4uH ±10%
RESISTANCE *(MEASURE D.C, TA 20°C)*	
PIN 5-9	267mΩ MAX
PIN 11-3	125mΩ MAX
OPERATING CURRENT *(MEASURE DC , TA 20°C)*	1.4A MAX
SATURATION CURRENT *(MEASURE DC, L ≥ 50%NOM, TA 20°C)*	6A MAX
RESONANCE FREQUENCY *(TA 20°C)*	850 KHZ NOM
OPERATING TEMPERATURE RANGE *(IR 1.4A MAX)*	-10°C÷+45°C
MAXIMUM DIMENSIONS	28x30 H25mm
WEIGHT	42g APPROX

INDUCTANCE VS CURRENT



INDUCTANCE VS FREQUENCY

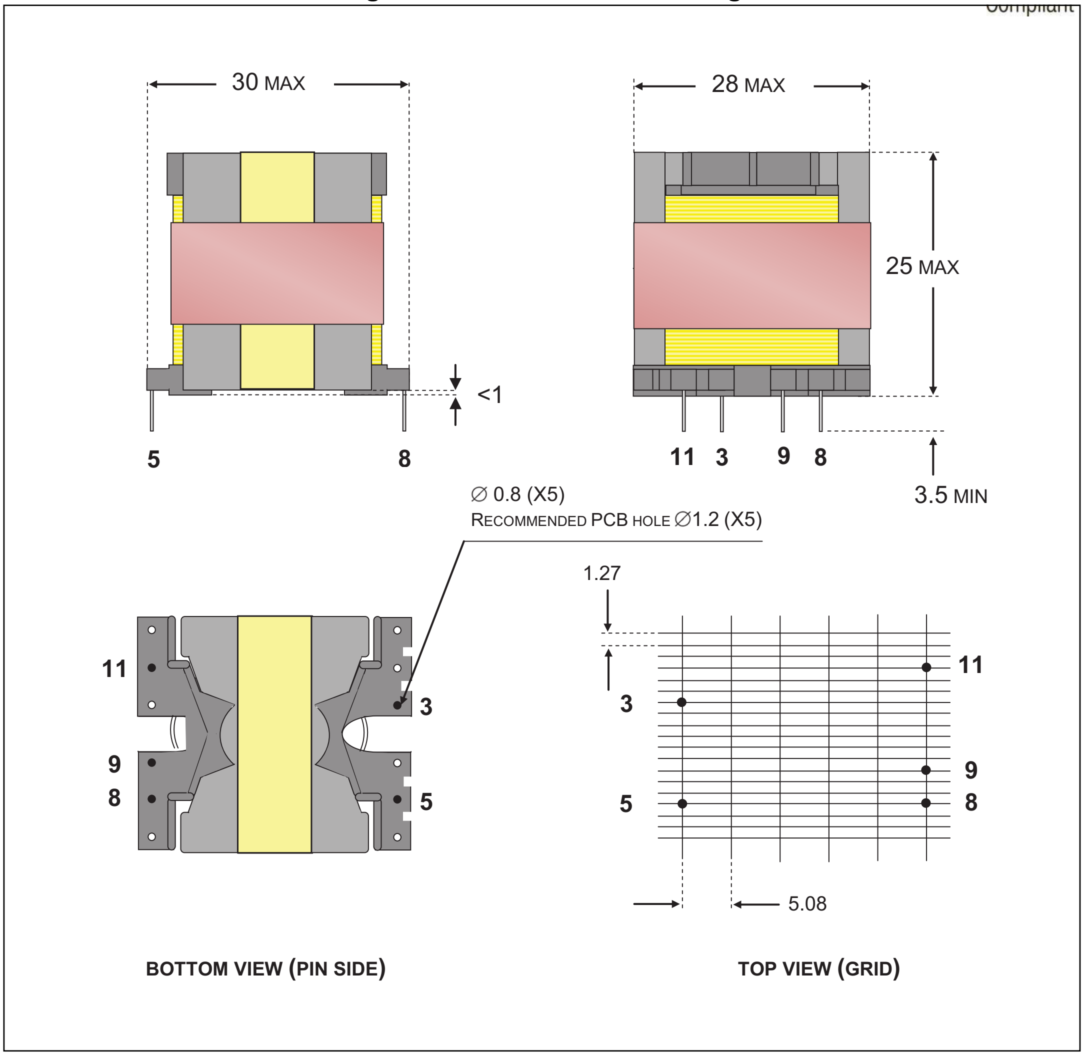


PIN DESCRIPTION

PIN(*)	*FUNCTION*	*PIN(*)*	*FUNCTION*
1	NOT PRESENT	7	NOT PRESENT
2	NOT PRESENT	8	NOT CONNECTED
3	AUXILIARY GROUND	9	PRIMARY +VB (100÷430VDC)
4	NOT PRESENT	10	NOT PRESENT
5	PRIMARY DRAIN/SOURCE	11	AUXILIARY WITH RATIO 10.45 (PRI/AUX)
6	NOT PRESENT	12	NOT PRESENT

(*)PIN WITH THE SAME SUBSCRIPT MUST BE CONNECTED TOGETHER ON PCB

Figure 40. Dimensional drawing



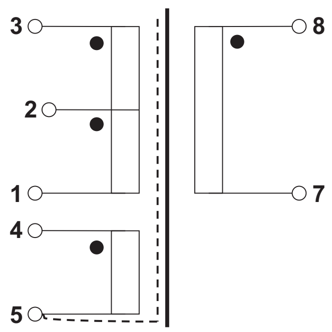
14 Transformer specification

Figure 41. Flyback transformer PN 1939.0090

TYPICAL APPLICATION

SWITCH MODE TRANSFORMER IN FLYBACK APPLICATION.

CIRCUIT DIAGRAM



TECHNICAL DATA

INDUCTANCE *(MEASURE 1KHZ, T_A 30°C)*	
PIN 3-1	356 µH ± 15%
PIN 4-5	37.5 µH ± 15%
PIN 8-7	359 µH ± 15%
RESISTANCE *(MEASURE D.C., T_A 30°C)*	
PIN 3-1	407 mΩ MAX
PIN 4-5	334 mΩ MAX
PIN 8-7	263 mΩ MAX
TURN RATIO *(MEASURE 10KHZ, WITH TOLERANCE ±0.5, T_A 30°C)*	
PIN 3-1 ⇔ 4-5	3.15 NOM
PIN 3-1 ⇔ 8-7	1.00 NOM
LEAKAGE INDUCTANCE *(MEASURE 3-1, 4÷9 S.C, F10KHZ, T_A 30°C)*	3.5 µH ± 10%
PARASITIC CAPACITANCE *(MEASURE 3-1, F 1.36MHZ, T_A 30°C)*	38.5 pF NOM
SATURATION CURRENT *(MEASURE 3-1, B_{SAT} 0.308T, T_A 30°C)*	3.2 A_P MAX
OPERATING CURRENT *(MEASURE 3-1, P_{MAX} 80W, F 65KHZ, T_A 30°C)*	2.75 A_P MAX
WORKING FREQUENCY *(P_{MAX} 80W, T_A 30°C)*	65 KHZ MIN
AMBIENT TEMPERATURE RANGE *(P_{MAX} 80W, WITH SELF T_{RISE} 45°C)*	-40°C ÷ +85°C
THERMAL CLASS	B
STORAGE TEMPERATURE RANGE	-40°C ÷ +85°C
PRIMARY TO SECONDARY INSULATION *(F 50HZ, DURATION 2", TA 30°C)*	4KV
MAXIMUM DIMENSIONS	33x30 H23.5mm
WEIGHT	35g APPROX

PIN FUNCTIONS

PIN	FUNCTION		PIN	FUNCTION	
1	PRIMARY +VB	390 ÷ 420V_{DC}	6	NOT CONNECTED	
2	PRY. CENTER TAP		7	SECONDARY GROUND	80V – 1.00A_{DC}
3	PRIMARY DRAIN		8	SECONDARY	
4	AUXILIARY	+25V - 20mA	9	NOT CONNECTED	
5	AUXILIARY GROUND & SHIELD				

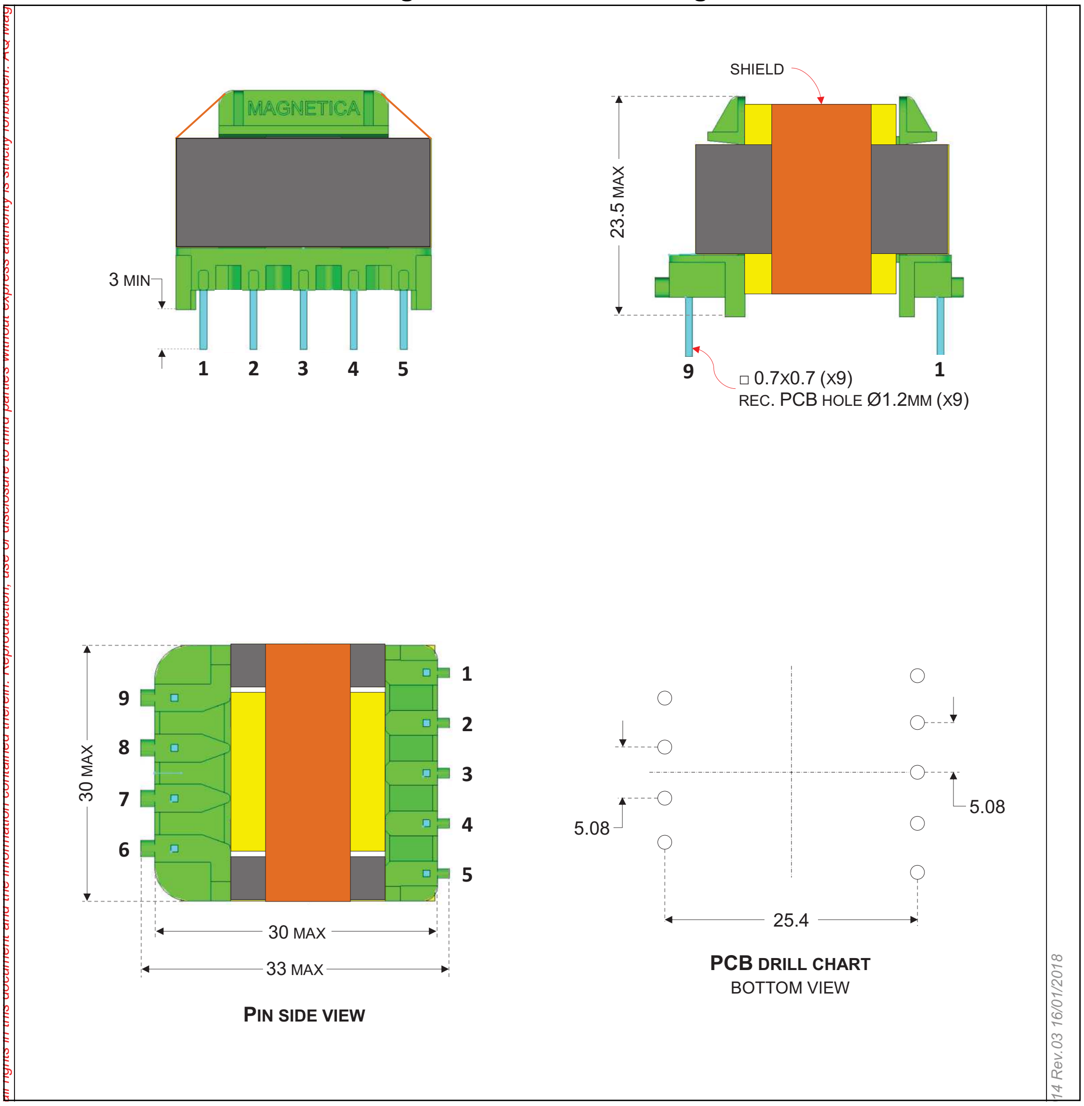


Figure 42. Overall drawing

15 References

1. STCH03 datasheet.
2. L6563S datasheet.
3. X42182 LED - datasheet (Seoul Semiconductor).
4. AN4314: “25 W wide-range high power factor buck-boost converter demonstration board using the L6564H”.
5. AN3027: “How to design a transition-mode PFC pre-regulator with the L6563S and L6563H”.

16 Revision history

Table 5. Document revision history

Date	Revision	Changes
06-Aug-2019	1	Initial release.