Power Control ICs

EVALLED-TDA4863G-40W

Single Stage High PF Flyback Converter for Offline LED Supply

TDA4863G
TLE4305G

Application Note

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TDA4863G

Revision History: 2009-12-15, Revision 1.0

Previous Version: --/--

Page	Subjects (major changes since last revision)

Contents

1 Content

The EVALLED-TDA4863G-40W is a demoboard to demonstrate the concept of a single stage PFC+Flyback converter using the TDA4863G and the CC-CV control chip TLE4305G in a LED driving application.

2 Evaluation Board

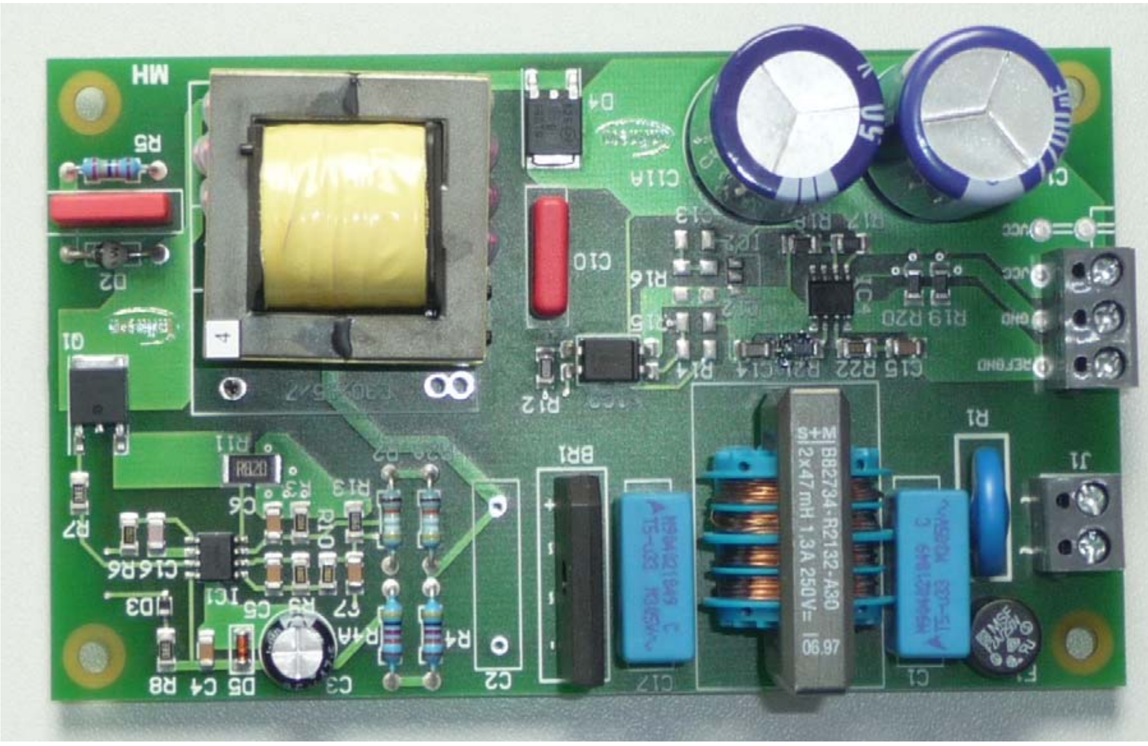

Figure 2-1 EVALLED-TDA4863G-40W

3 List of Features

- High Efficiency of ~90%
- High Power Factor up tp 0.98 and low THD
- Low System BOM, trough Single Stage Concept
- +/- 2% Accuracy Constant-Current Constant-Voltage Regulation
- Cycle-By-Cycle Peak Current Limitation
- Low In-Rush Current
- VCC Over and Under-Voltage Protection

4 Technical Specification

Table 4-1 provides a summary of the EVALLED-TDA4863G-40W performance specification.

Table 4-1 Performance Specification

Specification	Min	Typ	Max	Unit
Input Voltage	180	230[1)]	270	AC V
Output Voltage	15	22	26	V
Output Current	-2%		+2%	mA
Output Power			40	W
Output Ripple		+-15%		A

1) for a maximum ouput power of 20W the input voltage range is univerasl (90 V - 270 V)

5 Operation

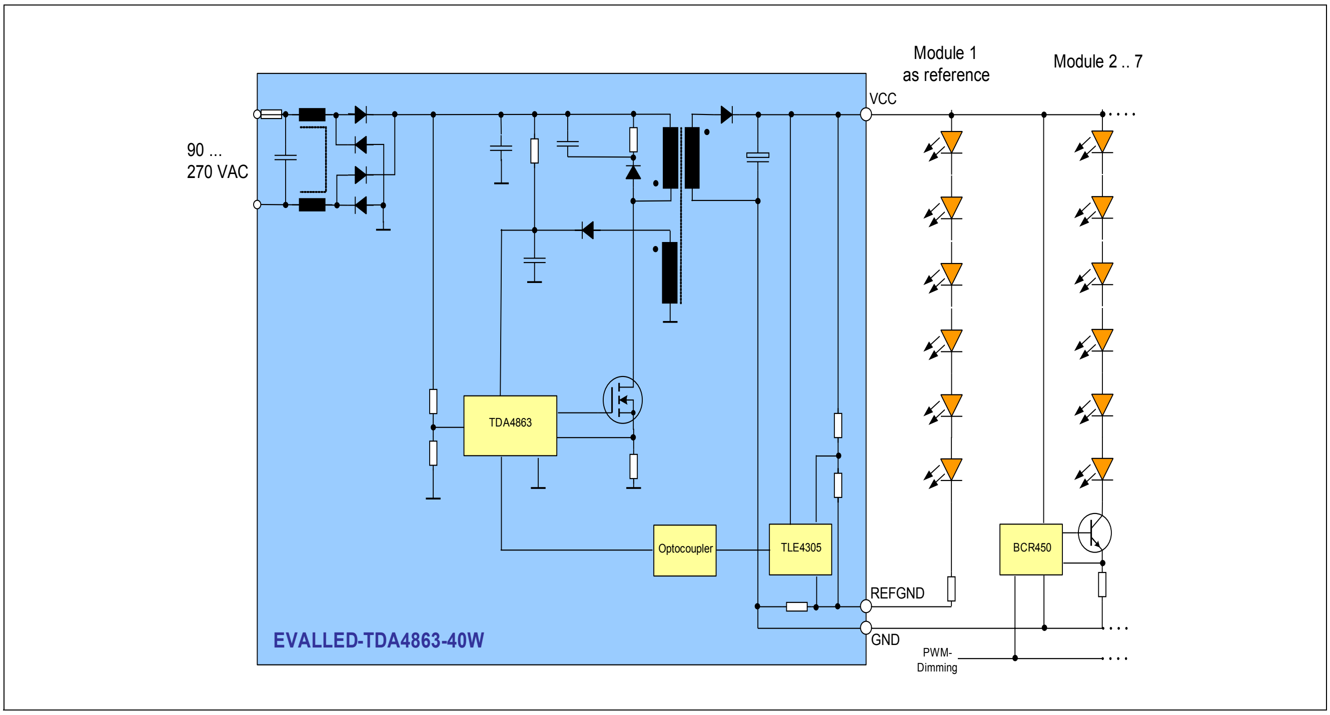

Figure 5-1 Basic Application Schematic

5.1 Basic Operation

The topology of the EVALLED-TDA4863G-40W is in principal a peak-current mode, quasi-resonant flyback converter. The current on the primary side is sensed via the sense resistor (R11). If this current reaches the thershold (Ipk), the main switch (MOSFET Q1) is turned off. Zero current detection is done via the auxilliary winding of the transformer. If zero current on the secondary winding of the transformer is detected the main switch is turned on. Figure 5-2 shows the switching waveforms. The blue curve is the voltage on the sense resistor and red curve the source-drain voltage at the main switch. This auxilliray winding is also used to supply the controller. For detailed information on the dimesoning of the transformer, sense resistor and snubber circuit see also [3] .

To achieve a high power factor the peak current (Ipk) is modulated in a way to follow the rectified mains input voltage. The input voltage is sensed via a resistive devider (R2,R2A, R3) and this signal is multiplied with the feedback signal via the multiplier in the TDA4863G ([1]). This modulation of the peak current modulates the input current to follow the input voltage and allows for a very good power factor. Please see Chapter 6.6 for measurement result of the power factor and harmonic distortion.

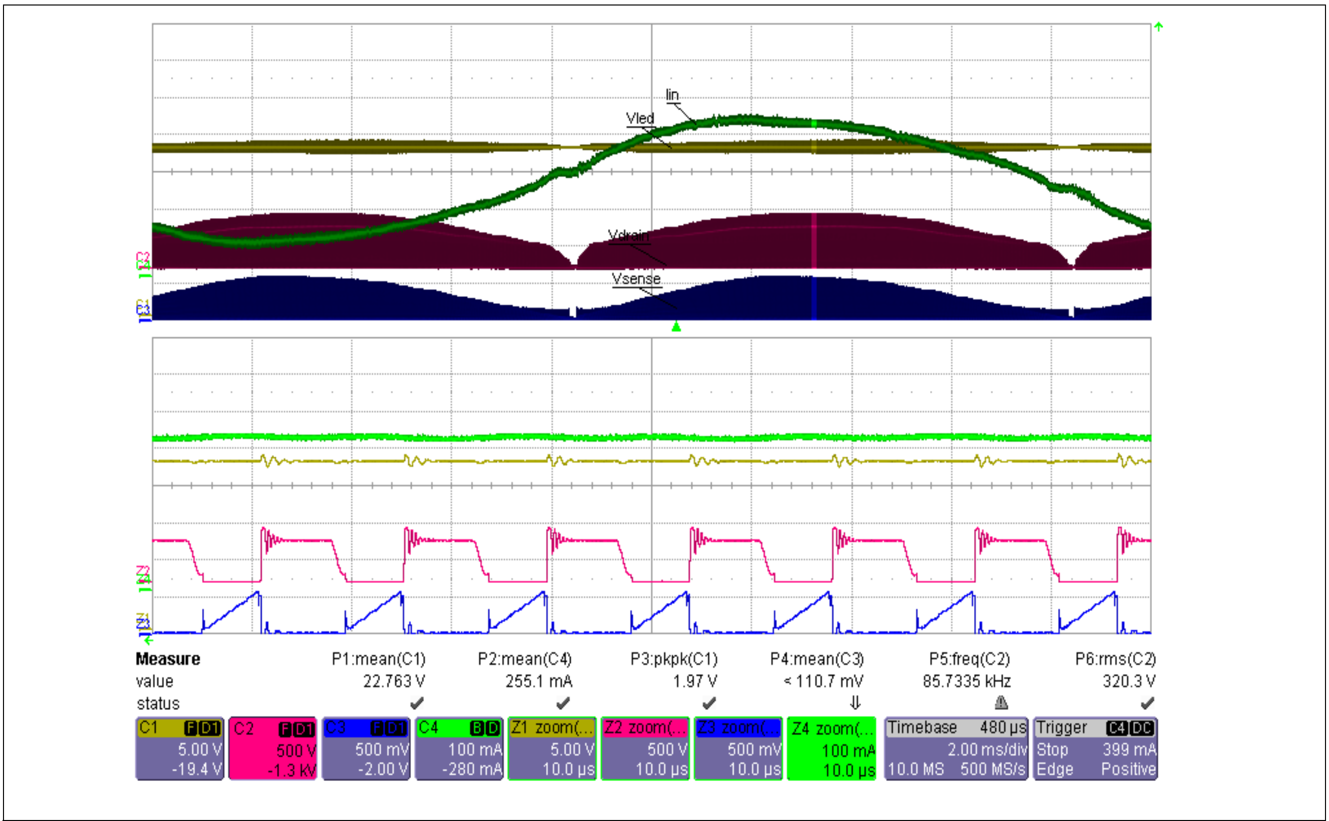

Figure 5-2 Typical switching waveforms at 230 Vac mains voltage: Input Current (green), Output Voltage

5.2 Output Control

The EVALLED-TDA4863G-40W allows for constant-current output control. For this control the TLE4305G is used on the secondary side to measure the output current and feedback the control signal via the optocoupler. The current is measured via the sense resistor (R19,R20) on the secondary site. To minimize the losses in the sense resistor, the TLE4305G allows for a very low sense voltage of 0.2 V. Additionally the TLE4305G measures the output voltage and switches to a constant-voltage regulation in case the output voltage exceeds the limit set by the resistive divider (R17,R18). The time constants for the cc and cv regulation loop can be set independently with the capacitors (C14,C15) and the resistors (R21,R22).

It is necessary that the current regulation time constant is lower than the mains AC frequency. On the other side the voltage regulation must be fast, to avoid an overshoot at startup.

The current regulation is set for 350mA. This is true for a load connected between VCC and REFGND. Additional LED strips can be connected between VCC and GND. These additional loads are not seen by the current regulator.

6 Setup and Results

6.1 Input / Output Connector description

6.1.1 J1 - Vin

Input connector for AC supply. Please see **Table 4-1**for the maximum input voltage.

6.1.2 VCC

VCC is the positive output connector.

6.1.3 GND

GND is the negative output connector. Connect all load to this connector which should **not** be current regulated.

6.1.4 REFGND

REFGND is the negative output connector. The load which is connected between VCC and REFGND is monitored and controlled to allow constan current.

6.2 Setup

For operation of the board connect the connector J1 to an AC voltage (see **Table 4-1** for input voltage range). Please be aware that high voltages of up to 800 V will be accessable on the board.

6.3 Power Up

The EVALLED-TDA4863G-40W utilizes a startup resistor (see R4, R4A in **Figure 8-1**) for the first system startup (see **Figure 6-1**). As soon as the VCC voltage at the TDA4863G reaches the threshold it starts operating. The start-up time is ~2 seconds. To reduce the start-up time a smaller startup resistor can be choosen. Be aware, that this will have a negative impact on the efficiency.

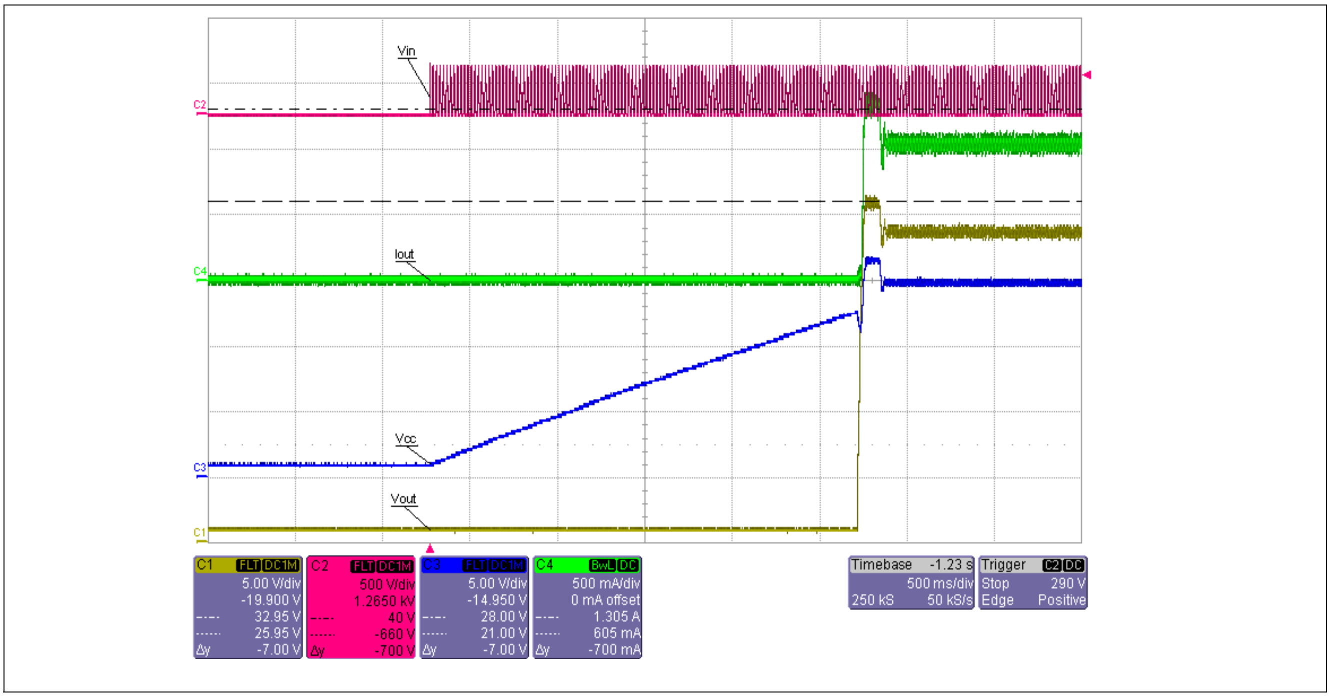

Figure 6-1 Startup: Mains Input Voltage (red), VCC at controller (blue), Output Current (green), and Output Voltage (yellow)

As already noted in **Chapter 5.2** there two different time constants for the current regulation and the voltage regulation. This can be seen in **Figure 6-2**. During startup the output voltage rises till it is limited by the constant voltage regulation of the TLE4305G with a small time constant. After ~100ms the constant current regulation which has a much higher time constant takes over and the output current is regulated.

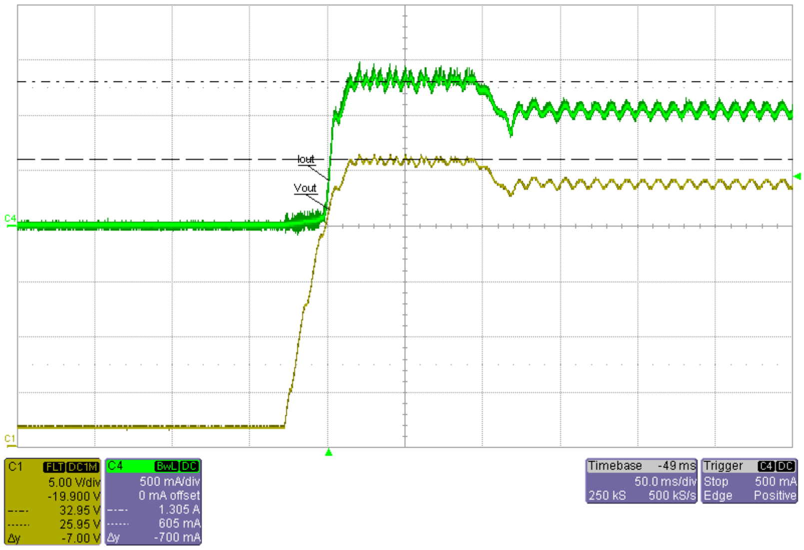

Figure 6-2 Startup: Output Current (green), and Output Voltage (yellow)

6.4 Output Ripple

In this topology the mains AC frequency is filtered on the secondary side of the flyback converter. This allows for a design with no high voltage electrolytic capacitors. The 100Hz/120Hz ripple of the output current is a function of the output power and the output capacitor (C11A, C11B). For 40W output power the ripple is +-15%

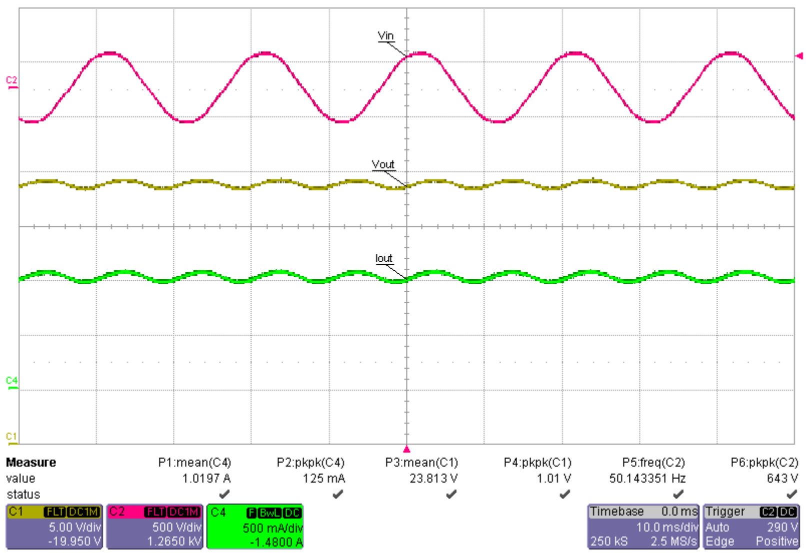

Figure 6-3 Typical Waveforms: Iput Voltage (red), Output Current (green) and Output Voltage (yellow)

6.5 Efficiency

The principle of a quasi-resonant flyback converter allows for a good efficiency of ~90%. **Figure 6.5** shows the efficiency as function of input voltage for different output power levels.

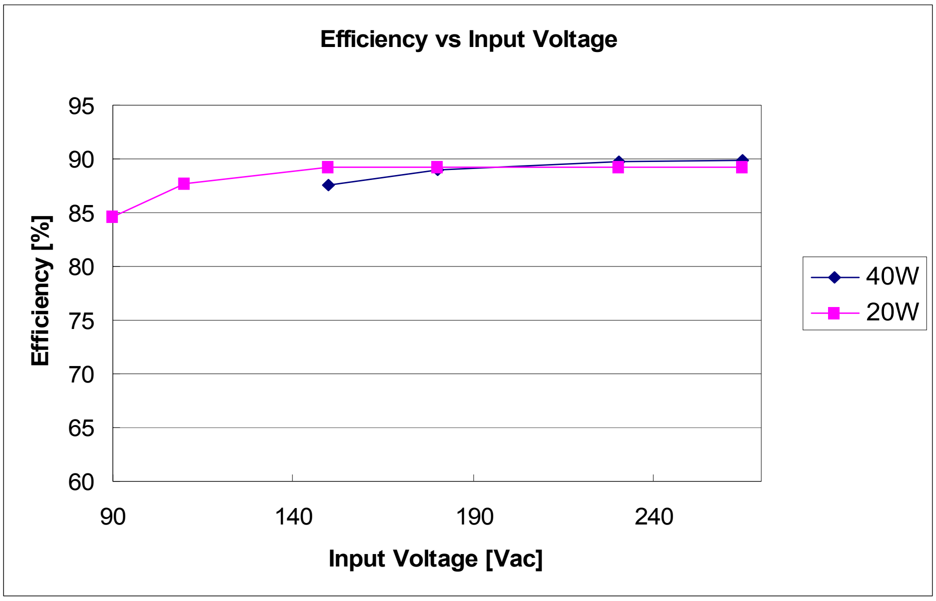

Figure 6-4 Efficiency over input voltage

6.6 Power Factor Correction

As discussed in **Chapter 5.1** the operation principle allows for a very good power factor, which is mostly limited by the input filter. **Figure 6-5** and **Figure 6-6** show the input voltage and current waveforms, the power factor and the harmonic distorsion for 110 V and 230 V AC input voltage respectively. **Figure 6-7** shows the power factor as function of input voltage and output power.

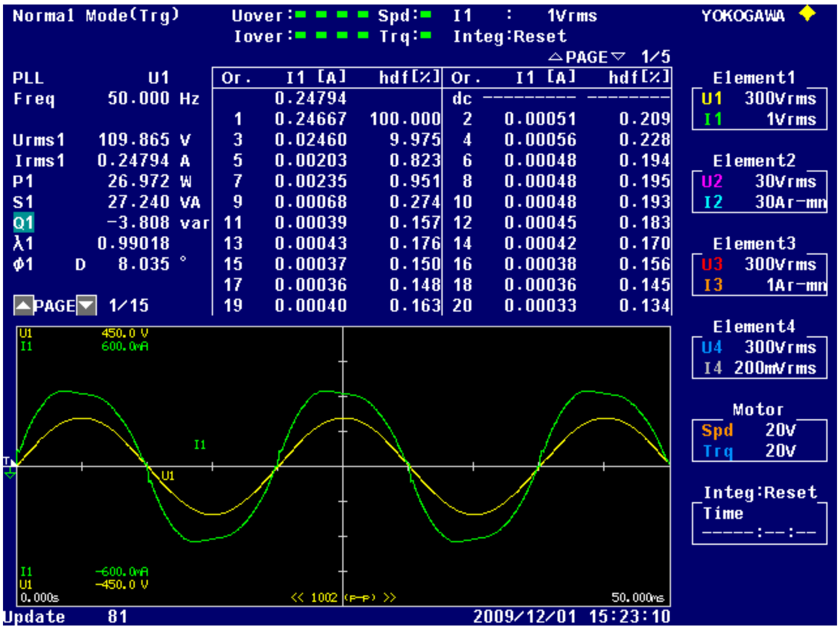

Figure 6-5 Power Factor and THD at 110 Vac input voltage and 25W output power

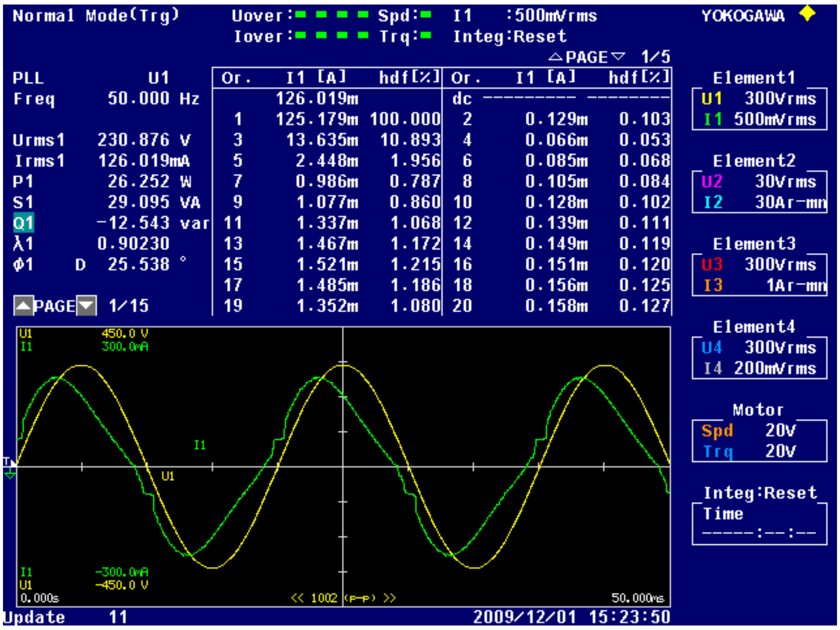

Figure 6-6 Power Factor and THD at 230 Vac input voltage and 25W output power

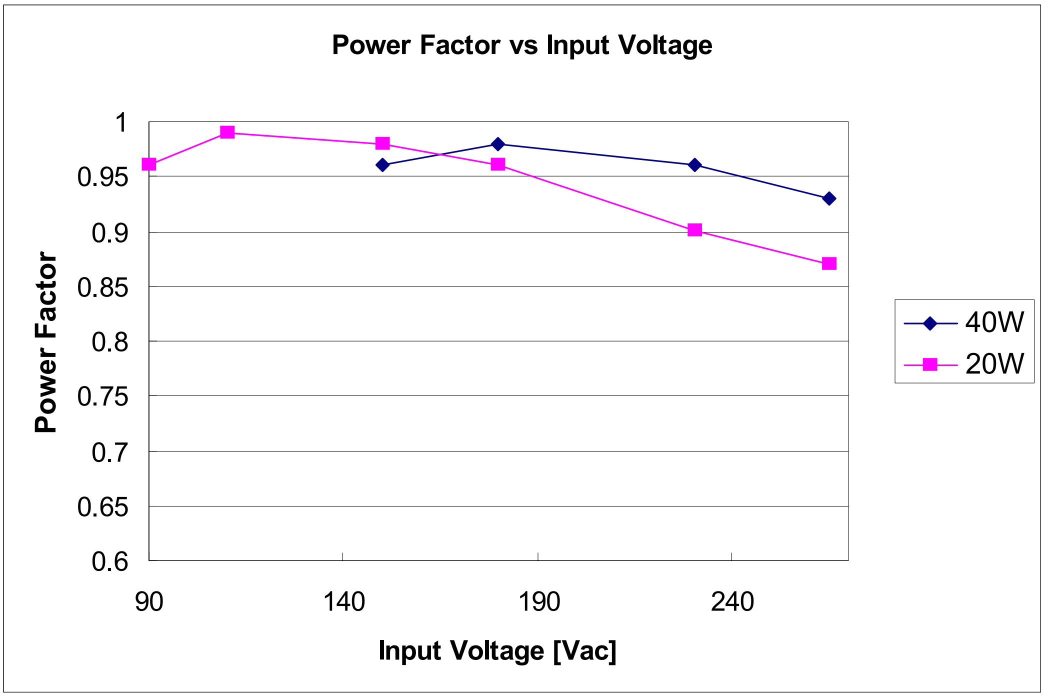

Figure 6-7 Power Factor as function of the input voltage

6.7 EMI

The soft switching and inherent jittering of the topology allow for an EMI spectrum compliant to the norm with an low BOM input filter design.

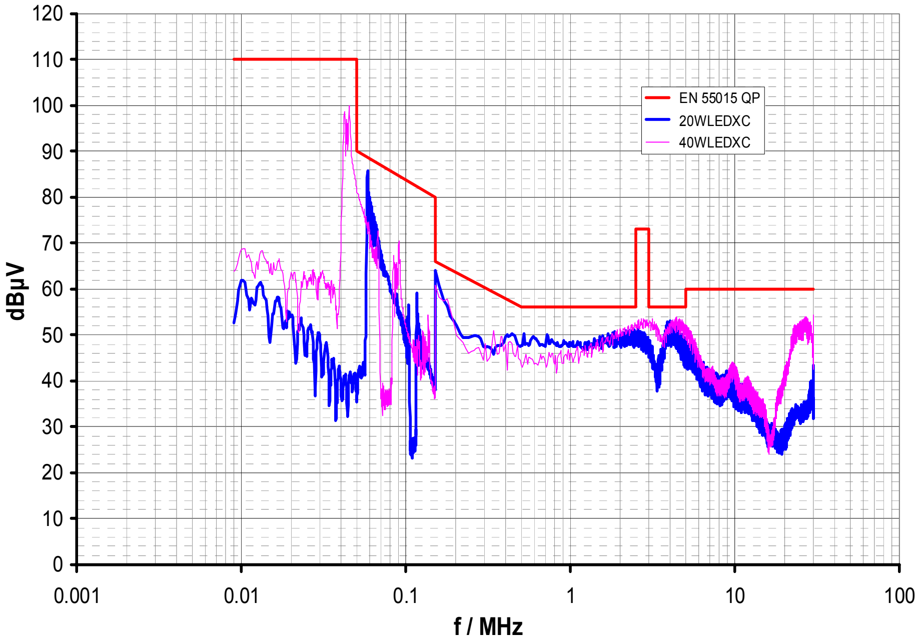

Figure 6-8 EMI Spectrum: C1 and C17 440nF, L1 2x47mH

7 Board Layout

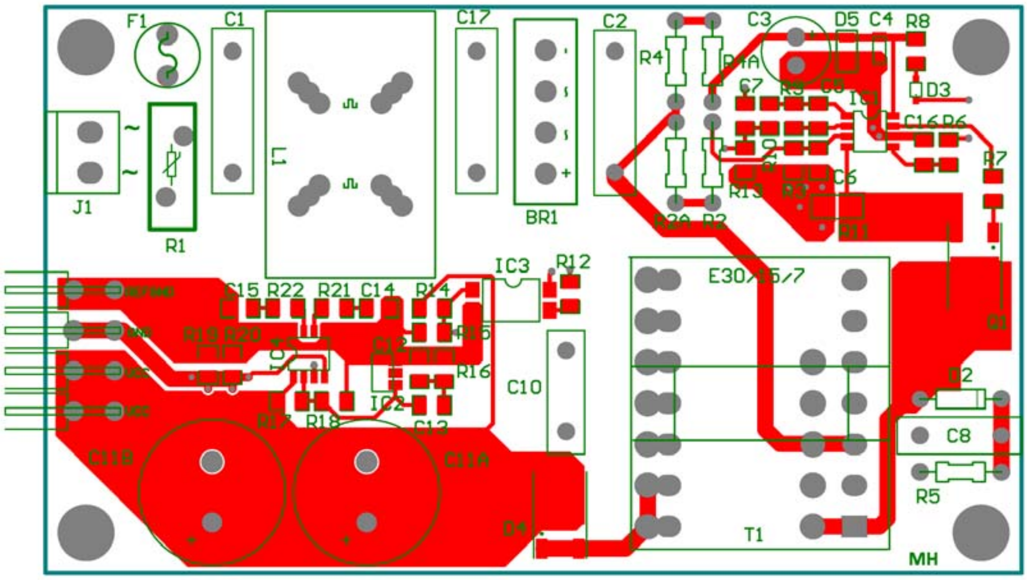

Figure 7-1 **EVALLED-TDA4863G-40W** Top Layer Routing

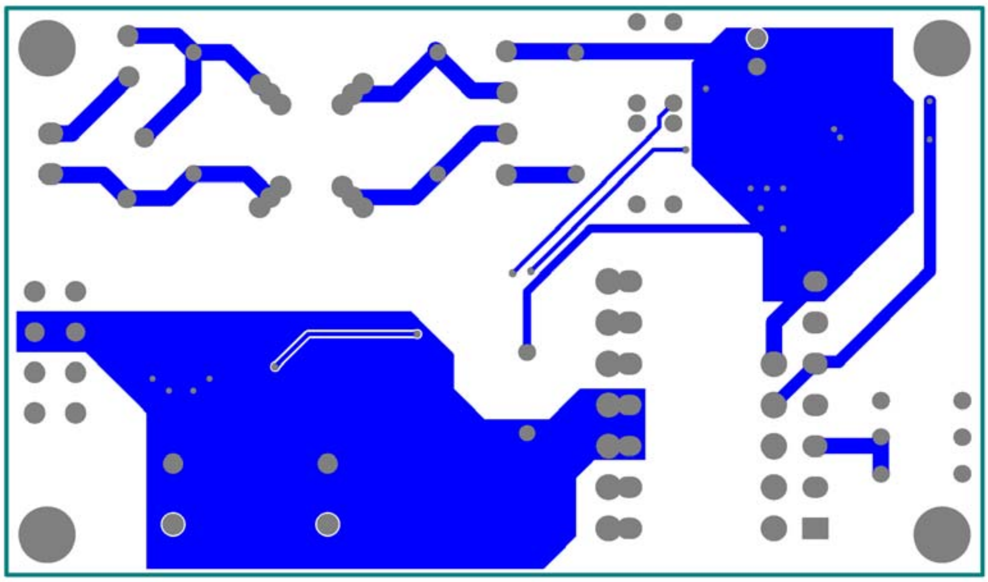

Figure 7-2 **EVALLED-TDA4863G-40W** Bottom Layer Routing

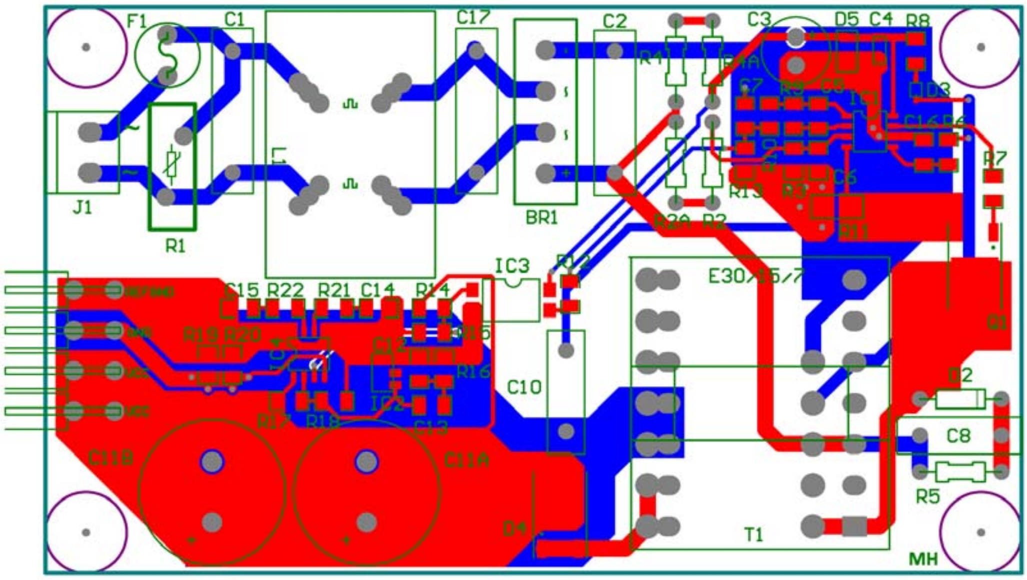

Figure 7-3 **EVALLED-TDA4863G-40W** Composite Layer View

8 Schematic and BOM

8.1 Schematic

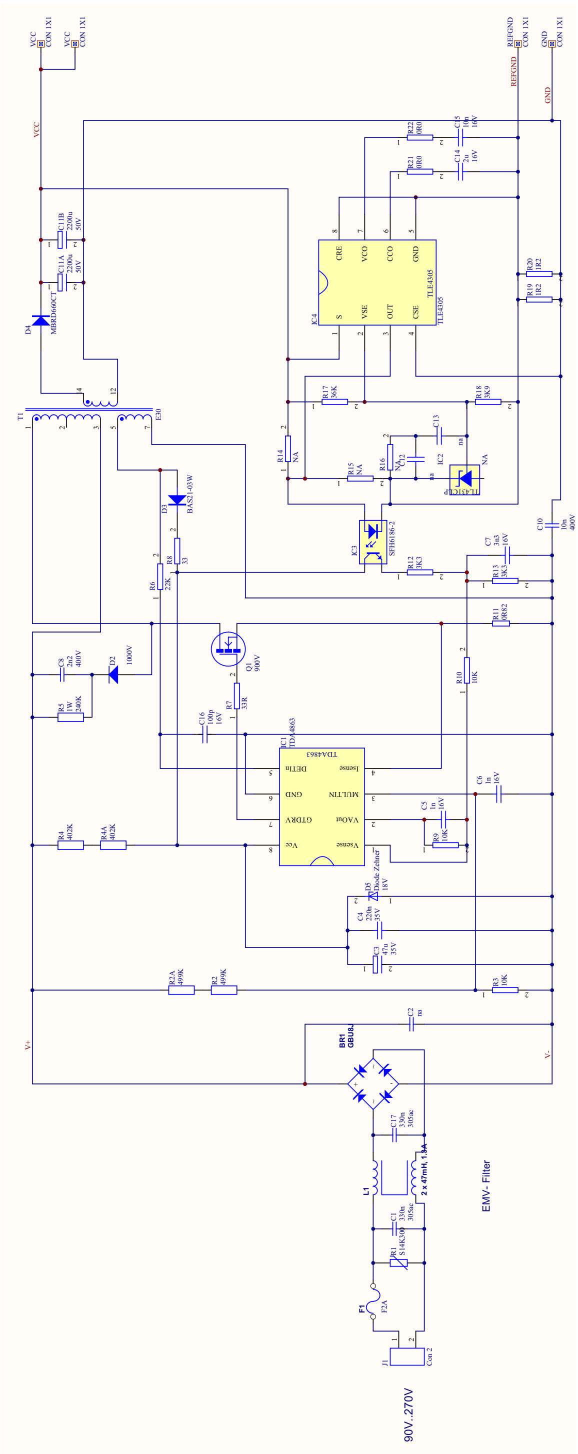

Figure 8-1 EVALLED-TDA4863G-40W Schematic

8.2 Bill of Materials

Designator	Value	Rated Voltage	Designator	Value	Rated Voltage
BR1	GBU8J		L1	2x47mH, 1.3A	
C1	330n	305ac	Q1	IPD90R1K2C3	
C2	na		R1	S14K300	
C3	47u	35V	R2	499K	
C4	220n	35V	R2A	499K	
C5	1n	16V	R3	10K	
C6	1n	16V	R4	402K	
C7	3n3	16V	R4A	402K	
C8	2n2	400V	R5	240K	
C10	10n	400V	R6	22K	
C11A	2200u	50V	R7	33R	
C11B	2200u	50V	R8	33	
C12	na		R9	10K	
C13	na		R10	10K	
C14	2u	16V	R11	0R82	
C15	10n	16V	R12	3K3	
C16	100p	16V	R13	3K3	
C17	330n	305ac	R14	NA	
D2	1000V		R15	NA	
D3	BAS21-03W		R16	NA	
D4	6A	60V	R17	36K	
D5		18V	R18	3K9	
F1	F2A		R19	1R2	
IC1	TDA4863		R20	1R2	
IC2	TL431CLP		R21	0R0	
IC3	SFH6186-2		R22	0R0	
IC4	TLE4305		T1	WE 750845240	

Figure 8-2 EVALLED-TDA4863G-40W Bill Of Materials

8.3 Transformer

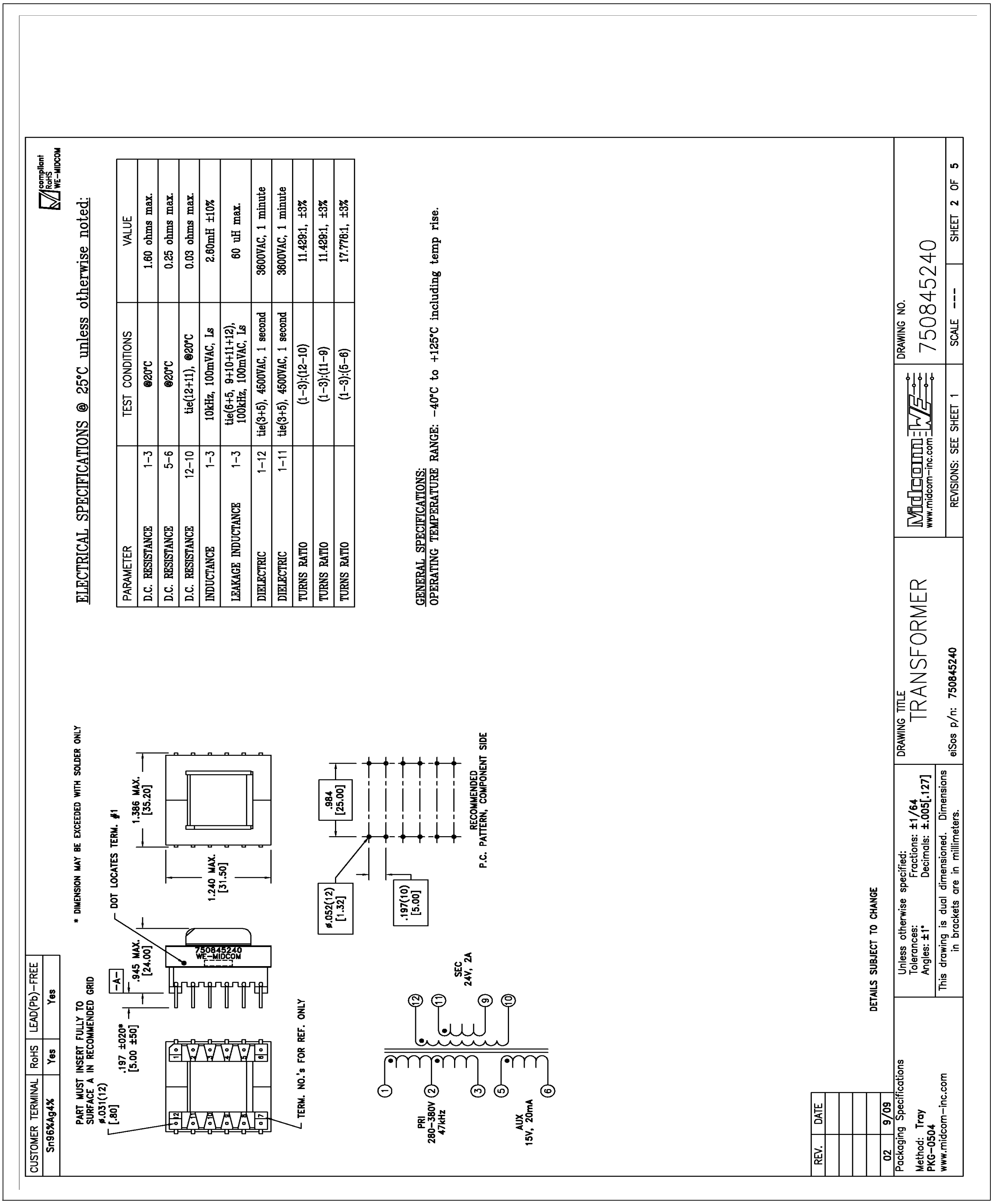

Figure 8-3 **EVALLED-TDA4863G-40W** Trafo Design

References

[1] **TDA4863** datasheet at **www.infineon.com**

[2] **TLE4205G** datasheet at **www.infineon.com**

[3] **Quasi Resonant Flyback** Application Note at **www.infineon.com**

[4] **Quasi Resonant Flyback** Design Tips at **www.infineon.com**

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