Documentation

EVA4201/4301 – User Guide

Evaluation Board for
80W
Power Factor Corrected (PFC) Supply

Featured Products: PE4201/PE4301

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1. Revision History

Version	Date	Changes	Page
Initial Version V1.0	12/2008		
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2. Safety Instructions

Please take caution - the board operates at 405V DC and is directly plugged into the power network. Operating this Board requires an isolated transformer!

The EVA4201/4301 was designed to help understand and evaluate the features of two Power Factor Correction IC`s. Used external devices are standard components chosen for safe operation and do not represent a completely fine-tuned OEM application. The BOM (bill of material) for a final application may look slightly different.

The board can also be used with PEs high precision PFC ICs, the PE4202 and the PE4302.

3. Introduction

3.1 Features

The board is designed to support applications of our two PFC-IC's PE4201 and PE4301

PE4201
- Low Total Harmonic Distortion (THD)
- Low StartUp Current (<5µA)
- Low Operating Current (<450µA)
- Disable Function (<170µA)
- Under-Voltage Lockout with >8V Hysteresis
- Over voltage and Over current protection with separate Reference
- Reduced operating Frequency at low Output Power
- High Efficiency at high and low Output Power
- Internal Clamping Resistor at G
- fast Driver turn 'off'
- very fast Driver 'off' at over current sense
- Driver load up to 5nF

PE4301
- Wide Range Input
- Low Total Harmonic Distortion (THD)
- Low Operating Current (<550µA)
- Disable Function (<100µA)
- Under-Voltage Lockout with >8V Hysteresis
- Over voltage protection, Peak current protection and Open loop protection with separate Reference
- low Peak current protection threshold
- Operating Frequency between 40 kHz and 250 kHz dependent upon load
- High Efficiency at high and low Output Power
- Internal Clamping Resistor at Driver
- Soft start
- fast Driver Switch 'off'

Application with PE4201/PE4301
- Active power factor correction
- Switch mode power supplies

3.2 IC`s General Description

The **PE4201** and **PE4301** are wide input range controller ICs for active power factor correction converters. Both ICs provide many protection functions, such over voltage protection, open loop protection, supply under voltage lockout, output under voltage protection and peak current limit protection. These protection functions are working with separate reference.
The **PE4201** operates in the CRM with voltage mode PWM control and in DCM under light load condition. The maximum switching frequency is clamped with an internal delay circuit. Compensations for voltage loop are external.
The **PE4301** IC operates in the CCM with average current control. The switching frequency depends upon load. At high output load the frequency is low and with low load the frequency is high. The Compensation for voltage loop and soft start is external.
For more information refer to the datasheets.

4 How to design an application

4.1 Given board specification

PE4201/PE4301

The board setup in the original state has the following specification parameters. The following chapters show, what has to be changed to design an active PFC supply towards different parameters. Please take caution when calculating. Wrong device parameter calculation can damage the Evaluation board or other devices.

AC Line Input voltage	85 VAC ... 265 VAC
AC Line Frequency	47 ... 63Hz
Switching Frequency	40 ... 250 kHz
Output voltage	340 -405V DC (adjustable)
Output Load	max 80W
Over Voltage Threshold	416V DC

4.2 Calculating the Current

PE4201

The input power:

$$P_{in} = \frac{P_{out}}{\eta} = \frac{80W}{92\%} = 86{,}96W \qquad (1)$$

The input current:

$$I_{ACin\_LL} = \frac{P_{in} * D}{V_{AC}} = \frac{86{,}96W * 0{,}66}{110V} = 0{,}52A \qquad (2)$$

$$I_{ACin\_HL} = \frac{P_{in}}{V_{AC}} = \frac{86{,}96W}{265V} = 0{,}33A \qquad (3)$$

D… Duty Cycle at 110V

The peak current:

$$I_{pk\_LL} = 2 * \sqrt{2} * I_{ACin\_LL} = 2 * \sqrt{2} * 0{,}52A = 1{,}48A \qquad (4)$$

$$I_{pk\_HL} = 2 * \sqrt{2} * I_{ACin\_HL} = 2 * \sqrt{2} * 0{,}33A = 0{,}93A \qquad (5)$$

This peak current affects the component selection on the current sense resistor, Power-MOSFET, diode and inductor.

PE4301

The input power:

$$P_{in} = \frac{P_{out}}{\eta} = \frac{80W}{92\%} = 86{,}96W \qquad (6)$$

The input current:

$$I_{ACin\_LL} = \frac{P_{in}}{V_{AC}} = \frac{86{,}96W}{110V} = 0{,}40A \qquad (7)$$

$$I_{ACin\_HL} = \frac{P_{in}}{V_{AC}} = \frac{86{,}96W}{265V} = 0{,}33A \qquad (8)$$

The ripple current ΔI is set to 20%

$$\Delta I_{LL} = 0{,}2 * \sqrt{2} * I_{ACin\_LL} = 0{,}2 * \sqrt{2} * 0{,}40A = 0{,}11A \qquad (9)$$

$$\Delta I_{HL} = 0{,}2 * \sqrt{2} * I_{ACin\_HL} = 0{,}2 * \sqrt{2} * 0{,}33A = 0{,}093A \qquad (10)$$

The peak current:

$$I_{pk\_LL} = \sqrt{2} * I_{ACin\_LL} + \frac{\Delta I_{LL}}{2} = \sqrt{2} * 0{,}40A + \frac{0{,}22}{2} = 0{,}61A \qquad (11)$$

$$I_{pk\_HL} = \sqrt{2} * I_{ACin\_HL} + \frac{\Delta I_{LL}}{2} = \sqrt{2} * 0{,}33A + \frac{0{,}22}{2} = 0{,}51A \qquad (12)$$

This peak current affects the component selection on the current sense resistor, MOSFET, diode and inductor.

4.3 Inductor

PE4201

For CRM operation, the maximum 'on' time and the maximum 'off' time control the lowest frequency. The minimum CRM inductance $L_{(CRM)}$ at low and high line input voltage can be calculated as follows:

$$L_{(CRM)} = \frac{V_{out} - V_{in}}{V_{out}} * \frac{V_{in}}{I_{pk}} * \frac{1}{f} \quad (13)$$

$$L_{(CRM)} = \frac{405V - \sqrt{2} * 110V}{405V} * \frac{\sqrt{2} * 110V}{1{,}48A} * \frac{1}{40kHz} = 1623\mu H \quad (14)$$

$$L_{(CRM)} = \frac{405V - \sqrt{2} * 265V}{405V} * \frac{\sqrt{2} * 265V}{0{,}93A} * \frac{1}{40kHz} = 754\mu H \quad (15)$$

For high line voltage and high output power the inductor has to have a nominal inductance of 400µH. The switching frequency at low line voltage can be calculated according to equation (16):

$$f = \frac{V_{out} - V_{in}}{V_{out}} * \frac{V_{in}}{I_{pk}} * \frac{1}{L_{(CRM)}} \quad (16)$$

$$f = \frac{405V - \sqrt{2} * 110V}{405V} * \frac{\sqrt{2} * 110V}{1{,}48A} * \frac{1}{1623\mu H} = 39{,}9kHz \quad (17)$$

PE4301

For CCM operation, the maximum 'on' time and the maximum 'off' time control are the lowest frequencies. The minimum CCM inductance $L_{(CCM)}$ at low and high line input voltage can be calculated as follows:

Duty Cycle

$$D = \frac{V_{out} - V_{in}}{V_{out}} \quad (18)$$

$$D_{LL} = \frac{405V - \sqrt{2} * 110V}{405} V = 0{,}615 \quad (19)$$

$$D_{HL} = \frac{405V - \sqrt{2} * 265V}{405} V = 0{,}074 \quad (20)$$

CCM Inductor

$$L_{CCM} = \frac{\sqrt{2} * V_{in} * D}{f * \Delta I} \tag{21}$$

$$L_{CCM\_LL} = \frac{\sqrt{2} * 110V * 0{,}615}{40kHz * 0{,}11A} = 21425\,\mu H \tag{22}$$

$$L_{CCM\_HL} = \frac{\sqrt{2} * 265V * 0{,}074}{40kHz * 0{,}093A} = 7536\,\mu H \tag{23}$$

For high line voltage and high output power the inductor set to 8000µH.
The switching frequency at low line voltage obtains as:

$$f = \frac{\sqrt{2} * V_{in} * D}{L_{CCM} * \Delta I} \tag{24}$$

$$f = \frac{\sqrt{2} * 110V * 0{,}62}{8000\mu H * 0{,}11A} = 109{,}6kHz \tag{25}$$

4.4 Current Sense Resistor

PE4201

The current sense resistor provides the threshold voltage for the over-current protection function. The maximum inductor peak current is set to 1,48 A.

$$R_S = \frac{V_{SHPCP}}{I_{OCP}} = \frac{0{,}22V}{1{,}48A} = 0{,}15\Omega \tag{26}$$

R_{sense}=0,15 Ω

PE4301

$$R_S = \frac{V_{CSPCP}}{I_{OCP}} = \frac{0{,}95V}{0{,}61A} = 1{,}55\Omega \tag{27}$$

R_{sense}=1,55 Ω

For higher/lower output power the resistor RS has to be reduced/increased and the inductor has to be re-calculated.

2.5 Output Bypass Capacitor

PE4201/PE4301

The bypass capacitor on the output of the circuit has to be able to suppress the ripple of the switching frequency and the residues of the full-wave rectified input frequency (2 * f_{in}).

$$C_{out} = \frac{P_{out}}{V_{out}} * \frac{1}{\Delta V_{out}} * \frac{1}{f} \qquad (28)$$

It is recommended to use 4 * f_{in} to suppress the sine wave residues of the input voltage for calculation. The ripple shall be assumed to be at 5% of the output voltage.

$$\text{at 40W}: C_{out} = \frac{\sqrt{2} * 40W}{405V} * \frac{1}{0.05 * 405V} * \frac{1}{4 * 50Hz} = 34{,}2\mu F \qquad (29)$$

$$\text{at 80W}: C_{out} = \frac{\sqrt{2} * 80W}{405V} * \frac{1}{0.05 * 405V} * \frac{1}{4 * 50Hz} = 68{,}7\mu F \qquad (30)$$

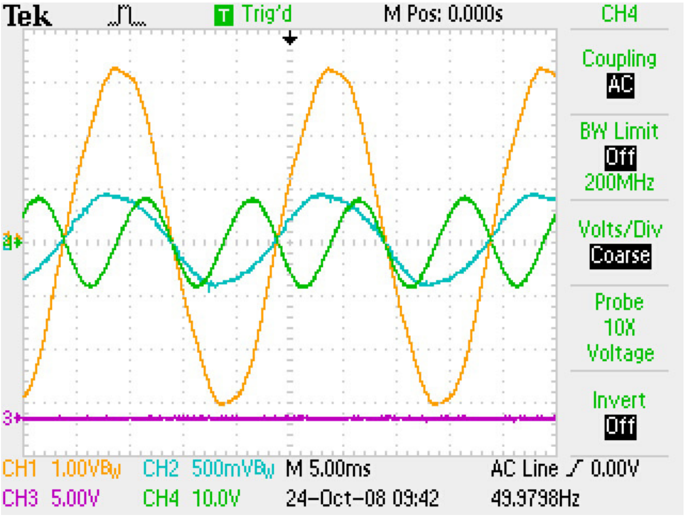
A capacitor with at least 47µF (C13) should be used. It has to withstand the maximum output voltage. The equivalent series resistance (ESR) of the capacitor shall not build up a voltage higher than half the ripple amplitude (2,5% of $V_{out\text{-}max}$) at peak-current.

$$R_C = \frac{\Delta V_{out}}{I_{peak}} = \frac{0{,}025 * 405V}{0{,}61A} = 16\Omega \qquad (31)$$

To reduce the ESR it is recommend to place a capacitor with small ESR in parallel to the high capacitance device. For 2% ripple at minimum switching frequencies the parallel capacitance can be calculated according to equation (23):

$$C_{out2} = \frac{80W}{405V} * \frac{1}{0.02 * 405V} * \frac{1}{40kHz} = 0{,}61\mu F \qquad (32)$$

The capacitor on the board is C12=100n/400V.



The figure shows the input voltage (230V~) in orange color, the current (I_{out}=0.20A) in blue color and the ripple of the output voltage in green color (only AC, C13=47µ, C6=0.1µ). The ripple is lower than 20V peak-to-peak (<5%).

Input Filter

PE4201/PE4301

A high-frequency has to be applied in the primary AC input to reduce reflections from and to the power grid.

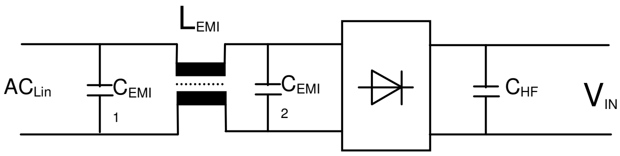


Figure 1: Input Filter

The capacitor C_{HF} following the bridge rectifier provides the peak current and reduces the voltage ripple. This is typical for a 330nF or for a 470nF capacitor. A high capacitance here will decrease the power factor (C1).
The L-C filter before the bridge rectifier has to suppress the switching frequency by about 20dB. The cut-off frequency shall be below 10kHz.

4.5 Error Amplifier Compensations

PE4201/PE4301

The output of the integrated error amplifier has to be filtered by means of an RC filter for frequency compensation.

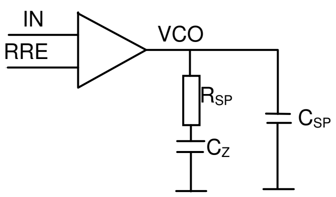


Figure 2: Error Amplifier Compensation

At the same time the capacitor C_{SP} ensures a soft start function. Capacitance can be calculated according to equation (33). The soft start time is set up at 30ms.

$$C_Z = \frac{t_{SS} * i_{VCOmax}}{V_{RREF}} = \frac{30ms * 20\mu A}{2{,}53V} = 237nF \tag{33}$$

C8=220nF shall be chosen here.

The frequency response should have a second pole slightly above twice the power grid frequency.
This is set up by R_{SP} and C_Z.

$$R_{SP} = \frac{1}{2\pi * f_Z * C_Z} = \frac{1}{2\pi * 100Hz * 220nF} = 6{,}028k \quad (34)$$

R4=5,6kOhm shall be chosen here.

The frequency of the second pole shall be at about 1/7 of the switching frequency. This defines the capacitance of C_{SP}.

$$C_{SP} = \frac{1}{2\pi * f_Z * R_{SP}} = \frac{1}{2\pi * 5{,}7kHz * 6k} = 4{,}6nF \quad (35)$$

C9=4,7nF shall be chosen here.

4.6 Self Biasing

PE4201/PE4301

Power supply of the PE4201/PE4301 during start up is provided through a high resistance resistor from the power grid input voltage. The maximum resistance has to be calculated resulting from the minimum input voltage and the required supply voltage of the PE4301 as well as the minimum required start up current.

$$R_{STUP} = \frac{\sqrt{2} * V_{in} - V_{ST}}{I_{ST}} = \frac{\sqrt{2} * 85V - 20V}{5\mu A} = 20Meg\Omega \quad (36)$$

To reduce start up time and account for leakage currents in the external diode the resistor is chosen to be 4MOhm. This is an experimental trade-off. Make sure the chosen resistor type has the proper power dissipation. Also, relatively high voltage over the resistor is to be accounted for (245V). It is recommended to use two 2MOhm resistors is series.

The capacitor on VDD has to provide power until the switching of the power-MOSFET has started and power will be provided from the help winding on the transformer. That can only happen after start-up and when the input voltage is at maximum level. At 50Hz this time t_{VDD} is about 10ms.
Current consumption calculates from the IC supply current and the loss in the power-MOSFET when switching.

Power consumption of the IC is <450µA. Power-MOSFET switching consumption consists of an ohmic part (resistor on ‘G’) and the dynamical part in the MOSFET. This is a charge changing process at the gate capacitance in the device.

Switching frequency will not be constant over an input frequency period. It can be assumed to be 150 kHz on average. Also the duty cycle factor will not be constant. For simplicity it can be assumed to be 50%.

A simplified but sufficient equation to calculate the dynamic and ohmic portion is given in equation (37) and (38) respectively.

$$I_{Gdyn} = C_G * f * U_{Gmax} = 1nF * 150kHz * 8,5V = 1,275mA \quad (37)$$

$$I_{Gohm} = \frac{U_{Gmax}}{R_G} * T = \frac{8,5V}{20k\Omega} * 0,5 = 0,2125mA \quad (38)$$

Total current consumption calculates according to equation (39).

$$I_{VDD} = I_{stat} + I_{Gdyn} + I_{Gohm} = 0,45mA + 1,275mA + 0,2125mA = 1,9375mA \quad (39)$$

From that the capacitance of C_{VVD} can be calculated:

$$C_{VDD} = \frac{I_{VDD} * t_{VDD}}{V_{ST} - V_{LO}} = \frac{1,94mA * 10ms}{22V - 8V} = 1,38\mu F \quad (40)$$

The help winding on the transformer has to provide between 20 ... 25V DC.
The Transformation Ration (TR) can be calculated according to equation (41):

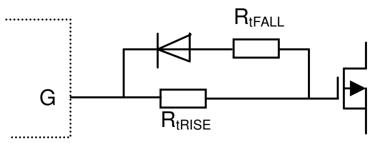
$$TR = \frac{V_{out}}{V_{VDD}} = \frac{405V}{22V} = 18,4 \quad (41)$$

4.7 EMI and Driver SlewRate

PE4201/PE4301

The driver slew rate can be influenced a network according to figure 3.

Figure 3: Network for Driver Slew Rate



R_{tFALL} determines the Slew Rate of the falling edge (in practice 4.7 to 6.8Ω). The diode should be a fast recovery Si-diode (MMSD914T1G).
R_{tRISE} determines the Slew Rate of the rising edge (to optimize to gate capacity of the used FET, 18 to 56 Ω). Caution has to be taken to meet EMI regulations.

4.8 Start-Up Bypass Rectifier

PE4201/PE4301

A diode (D_{BYPASS}) in parallel to the coil and the boost diode (D_{BOOST}) reduces the current through the coil during start-up. It also pre-charges the bypass capacitor on the output to the peak input voltage.
This reduces over voltage peaks and currents in the coil and so improves EMI parameters. It also protects the power-MOSFET from over voltage damage. To reduce the current through the diode a series resistor shall be used.

In the range up to 80W, there is no need to use a bypass diode; the current depends on C_{out} in addition with possible start current on the load. In case of C_{out}= 47µF there is a max. current about 9A in a time window of 4ms. The rectifier, inductors and boost- diode (R_{sense} – PE4301) can handle it for such a short time.

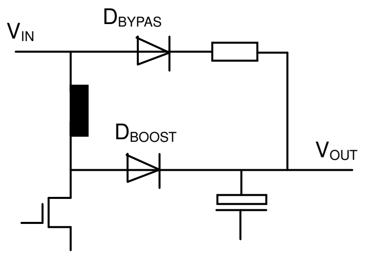


Figure 4: Bypass Rectifier

5 Description

The EVA4301-80 was designed to help understand and evaluate the features of the PE4201/PE4301 Power Factor Correction IC. Used external devices are standard components chosen for safe operation and do not represent a completely fine-tuned OEM application. The BOM (bill of material) for a final application may look slightly different.
The PE4201 is a wide input range controller IC for active power factor correction converters in CRMode with voltage mode PWM control.
The PE4301 is a wide input range controller IC for active power factor correction converters in CCMode with voltage mode frequency and PWM control.
Please take caution since the board operates at 405V DC.

5.1 Evaluation Board Specifications

AC Line Input voltage .... 85 Vac - 265 VAC
AC Line Frequency .... 47 – 65 Hz
Switching Frequency in the middle .... 40 – 170 kHz
Output voltage... 340- 405V DC
Output Load .... max. 80W
Over Voltage Threshold .... 416V DC
Efficiency (@230V / 80W)................................ 92%
Power Factor (@110V / 80W).......................... 0.965
Power Factor (@230V / 80W).......................... 0.990 (PE4301),
.... 0.988 (PE4201)
Operating Ambient Temp Range...................... 0 – +40 °C

5.2 Wire bridges

The board has been designed to provide evaluation support for the PE4301 as well as the PE4201 PFC ICs. For that reason the following wire bridges and components will have to be set properly.

	PE4201	PE4301
JP1	2_3	1_2
JP2	1_3	1_2
R2*, R11*, C12*	on Board	open
R7**, C11**, R23**	Open	on Board
R_{Sense}	4x1.0Ω/0.1W	3x4.7Ω/0.5W

5.3 Schematic

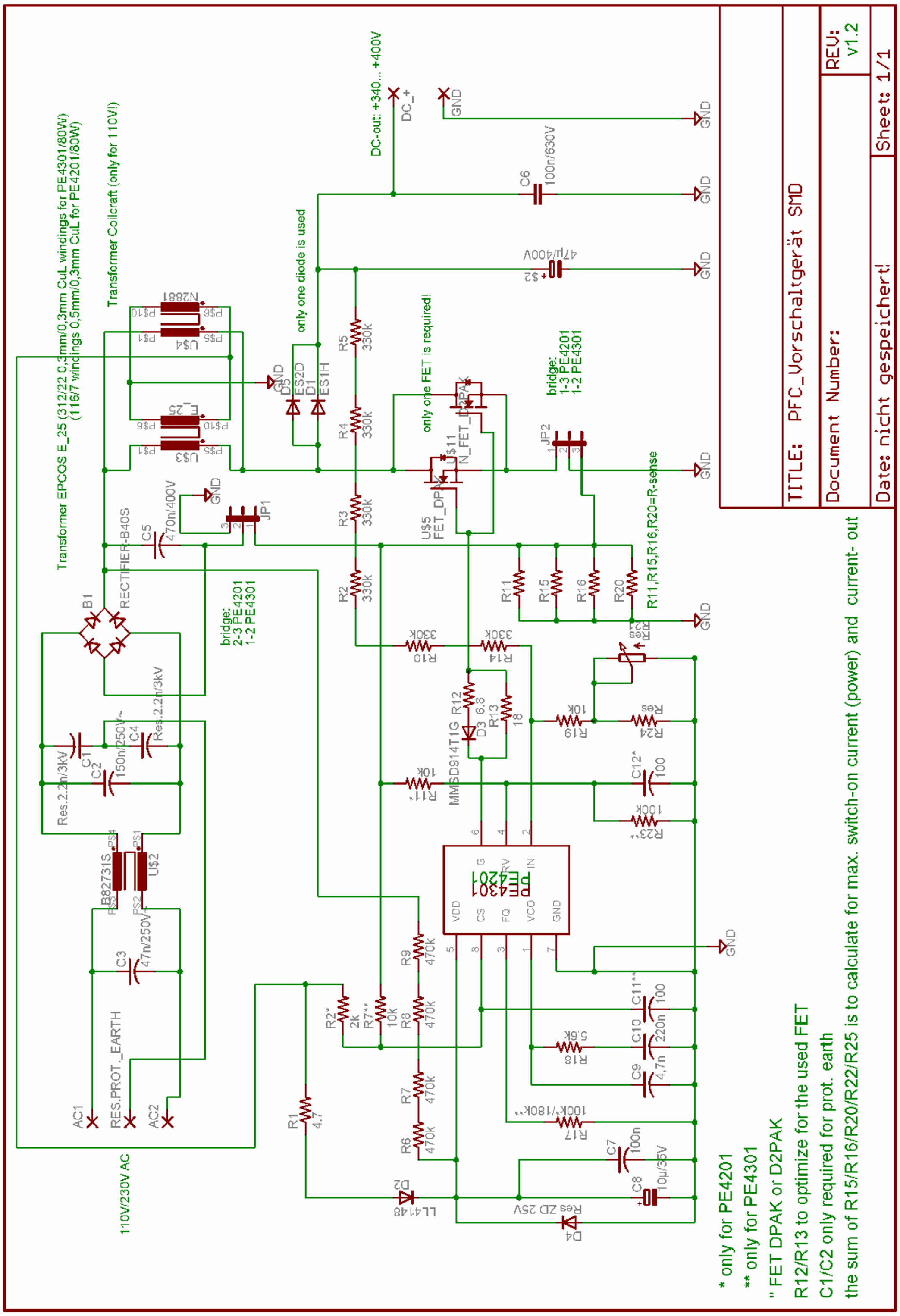


Figure 5: Board Schematic

5.4 Component Placement

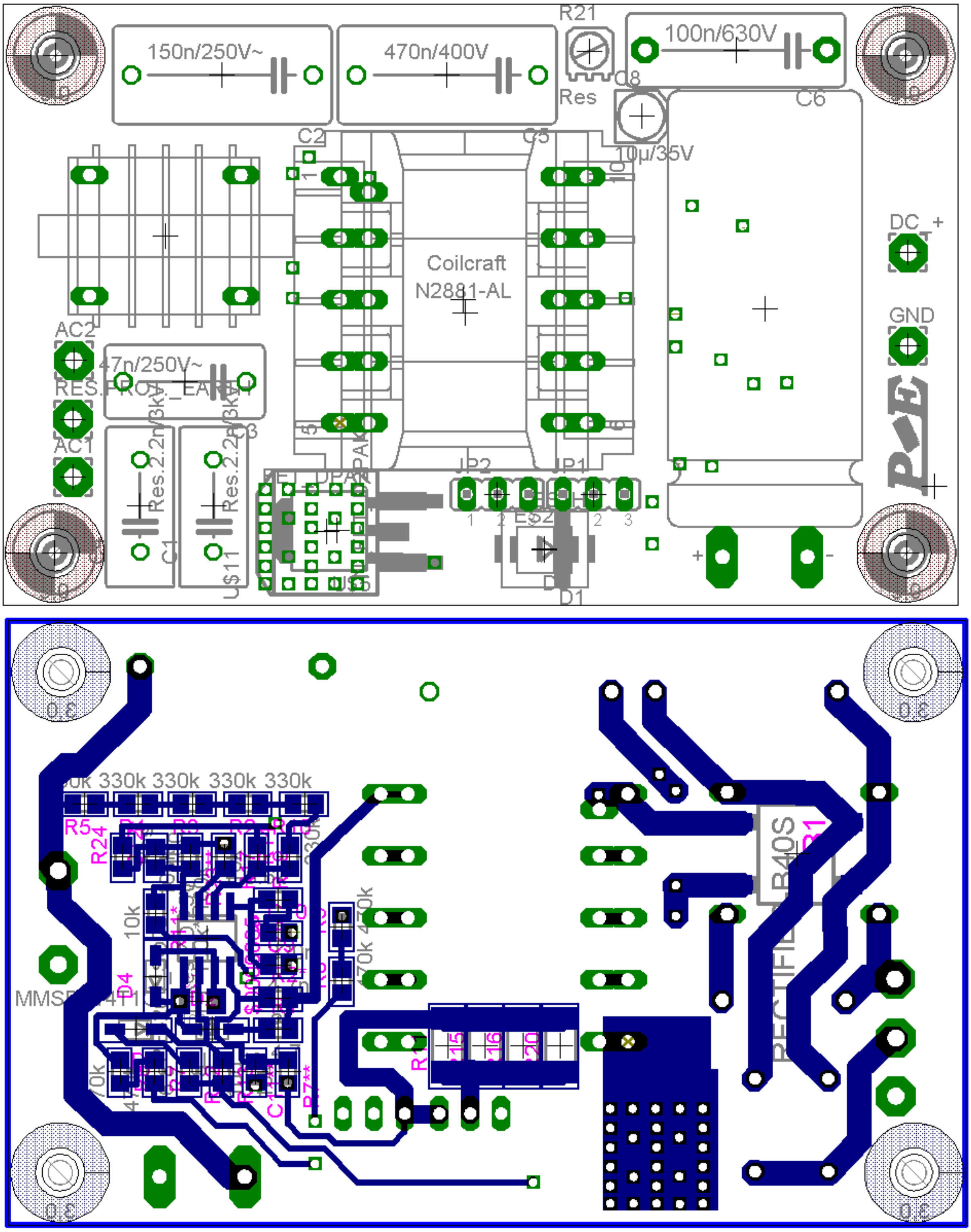


Figure 6: Board device population

5.5 Board Picture and Layout

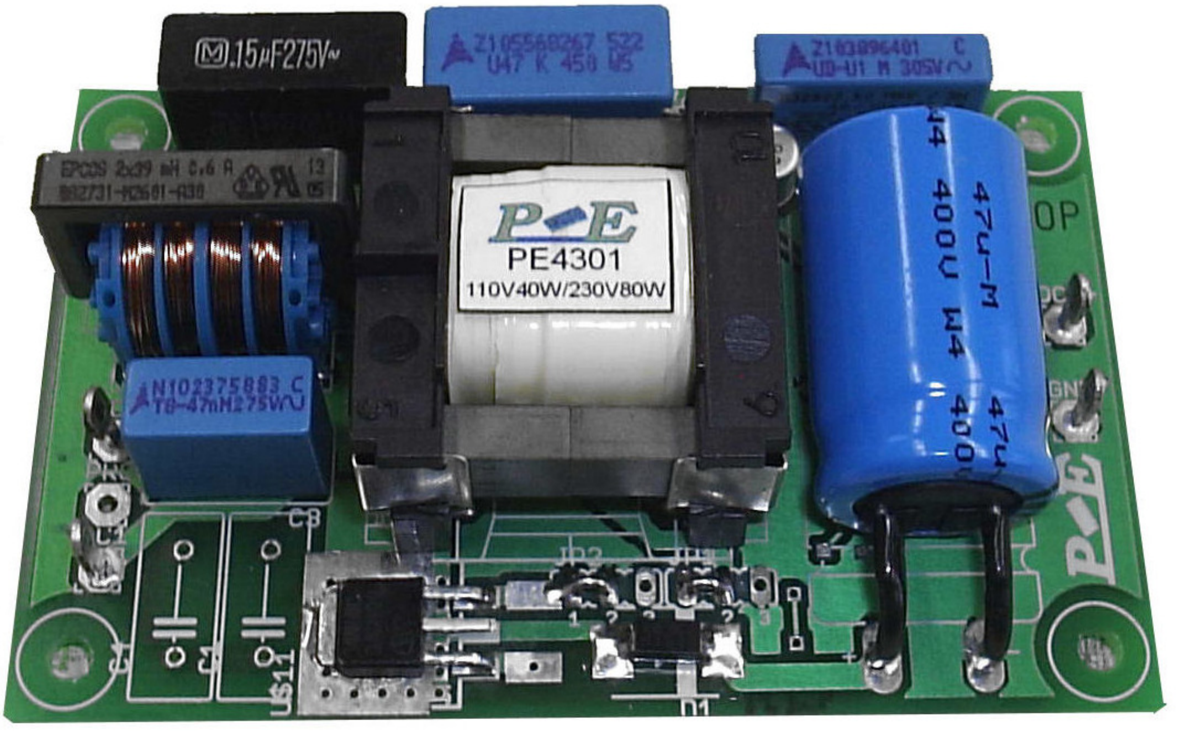


Figure 7: Board photograph (8cm x 5cm)

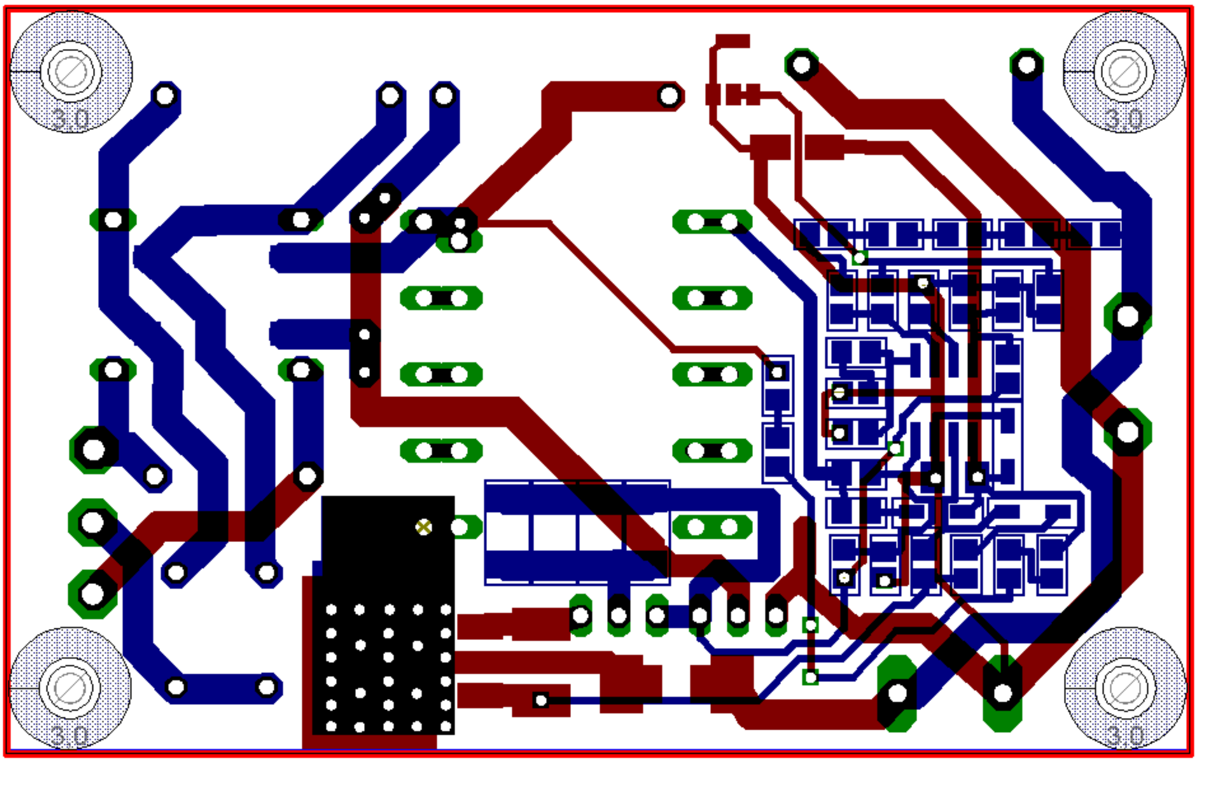


Figure 8: PCB Layout

5.6 Bill of Material

Nr.	Reference	Used	Description/Package	Vendor
IC	1	PE4X01 SO08	PE4X01 SO08	PE4201 or PE4301
C1,C4	2	2.2n/3kV	C2N2	Res. f. Prot. Earth
C2	1	150n/250V~	C150-084X183	
C3	1	47n/250V~	C102-064X133	
C5	1	470n/400V	C150-084X183	
C6	1	100n/630V	C15B6	
C7	1	100n	C1206K	
C8	1	10µ/35V	153CLV-0405	
C9	1	4,7n	C0805	
C10	1	220n	C0805	
C11**	1	100p	C0805	not for PE4201
C12*	1	100p	C0805	not for PE4301
C13	1	47µ/400V	VRH	horizontal
D1	1	ES1H	SMC	
D2, D3	2	MMSD914T1G	SOD123	
D4	1	Res ZD 25V	SOD123	
R1	1	4.7 Ω	R0805	
R2, R3, R4, R5, R10, R14	6	330k	R0805	
R2*	1	2k	R0805	not for PE4301
R6, R7, R8, R9	4	470k	R0805	
R7**	1	10k	R0805	not for PE4201
R11, R19	2	10k	R0805	
R12	1	4.7- 6.8 Ω	R0805	optimize for FET
R13	1	18 - 56 Ω	R0805	optimize for FET
R11, R15, R16, R20,	4	1Ω/4.7 Ω	R0805/R2010(PE4301)	dep. on max. power
R17	1	100k/180k	R0805	PE4201/PE4301
R18	1	5.6k	R0805	
R21	1	Res (5k adjustable r.)	PC25	adjust DC-OUT
R23	1	100k	R0805	
R24	1	Res (tbd)	R0805	alternativ for R21 fixed
U$1	1	B40S	B40S	rect. 1A/400V
U$2	1	B82731S	B82731S	39mH filter EPCOS®™
U$3	1	E 25 (EPCOS)	E25L	AL=91nH/n²
U$4	1	N2881	N2881AL Coilcraft®™	only for 110V
U$5	1	SPD07N60S5	DPAK	
U$11	1	IRF840	D2PAK	
$2	1	47µ/400V	VRH	horizontal
$0000	1	PE4X01 SO08	PE4X01 SO08	PE4201 or PE4301
C1,C4	2	2.2n/3kV	C2N2	Res. f. Prot. Earth
C2	1	150n/250V~	C150-084X183	
C3	1	47n/250V~	C102-064X133	

6 Operating

6.1 Caution

The Evaluation board has been designed to operate between 40VAC and 80VAC input power grid voltages and 405VDC output voltage.
Powering the board outside specified operating conditions will destroy devices and might cause severe damage and harm people.
The board has been designed for a maximum load of 80VA. Overloading the output will cause overheating and destruction of devices.
Devices can heat up to 50°C in normal operation mode. Take caution to not burn your fingers.
Security measures for high voltage operation have to be taken.

6.2 Load

Resistive and electronic continuous loads up to 80VA at 450VDC can be applied on the output. The load can be applied on the DC-OUT terminal. Pay attention to the polarity and wire diameter.

6.3 AC-Input

The Input voltage has to be applied on the AC-IN terminal. An isolation transformer is required, especially when other power grid supplied measurement devices (oscilloscope, voltmeter) are being used to prevent from electrical shock or device damage. Avoid personal contact with the board when powered. Be aware that capacitors hold charges even when power will be turned off. Discharge the output capacitor through the load or a high ohmic load resistor after power off.

6.4 Power-up Sequence

Before input voltage will be turned on, all measurement devices should be connected. It is recommended to slowly turn up the input voltage with a regulation transformer, usually in combination with a separation transformer. Be aware that capacitors hold charges even when power will be turned off. Make sure they will be discharged before disconnecting the measurement devices.
The board has no explicit measuring points. You can measure on the IC.
Pin of IC

7	GND:	Ground, reference potential for all measuring points
5	VDD:	supply voltage for PE4201/4301, 0..30VZC
8	AC (PE4201):	help winding voltage through 2kOhm, -50..25V
8	CS (PE4301):	negative voltage of current sensor (-0,9.. -1,2V)
3	RG (PE4201):	voltage on RG, 1,03V (internal reverence)
3	FQ (PE4301):	voltage on FQ, 1,03V (internal reverence)
1	VCO:	voltage on output of regulation amplifier, 0 ... 5,5V
4	SH (PE4201):	voltage over Shunt resistor, 0 ... 0,5V
4	RV (PE4301):	adjust slew rate of the duty cycle
2	IN:	voltage in loop back, V_{OUT}/160, 2,50 ... 2,65V
6	G:	voltage at IC-Pin G, power-MOSFET Gate driver voltage, typical 0 ... 8,5V
	Vout:	DCout +

7. List of Abbreviations

Abbreviation	Explanation
AC-IN	Input Voltage
AC_{Lin}	Input Current
BOM	Bill of material
CCM	Continuous Conduction Mode
C_{EMI}	Capacitor for EMI
C_G	Capacity of the gate (MOSFET)
C_{HF}	Capacitor for reduction of HF- transmitting
C_{out}	Output Capacitor
C_{out2}	Output Capacitor
C_{SP}	Cap. For
C_{VVD}	Cap. On Pin VDD
C_Z	Cap. On Current Sense
CRM	Critical Conduction Mode
D_{BOOST}	Boost- Diode
D_{BYPASS}	Bypass- Diode
DCM	Discontinuous Conduction Mode
DC-OUT	Output Voltage
EMI	Electromagnetic Interferences
ESR	Equivalent series resistance
G	Output to Gate (MOSFET)
IN	Feedback- Input for Output- Voltage
I_{OCP}	Max. Current for switching of MOSFET
I_{VCOmax}	Max. VCO- Voltage
I_{VDD}	IC- Current
$L_{(CCM)}$	Inductivity in CCM
$L_{(CRM)}$	Inductivity in CRM
L_{EMI}	Inductor to reduce EMI
PFC	Powerfactor- Correction
P_{in}	Input- Power
P_{out}	Output- Power
PWM	Pulse- Width- Modulation
R_G	Clamping Resistor
R_{STUP}	Start-Up Resistor
R_{tFALL}	Fall-Time of Voltage on Gate
R_{tRISE}	Rise- Time of Voltage on Gate
THD	Total Harmonic Distortion
TR	Transformation Ration
t_{VDD}	Time for Starting the IC
U_{Gmax}	Max. Voltage on Gate
VCO	Voltage Controlled Oscillator
V_{CSPCP}	Voltage of Peak- Current- Protection
VDD	Operating Voltage of the IC
V_{in}	Voltage on Pin “IN”
V_{LO}	Lock Out Voltage
V_{out}	Output Voltage
V_{RREF}	Internal Reference of the IC
V_{SHPCP}	Max. Voltage on Input Current Protection
V_{ST}	Start UP Voltage

8. Notes

9. Contact Addresses

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