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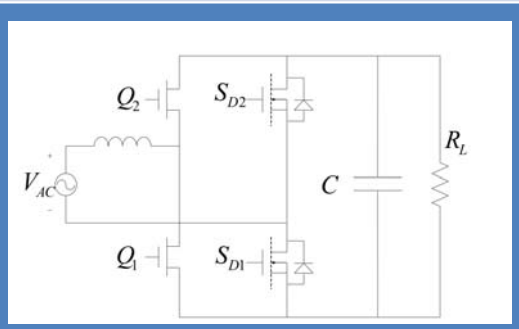
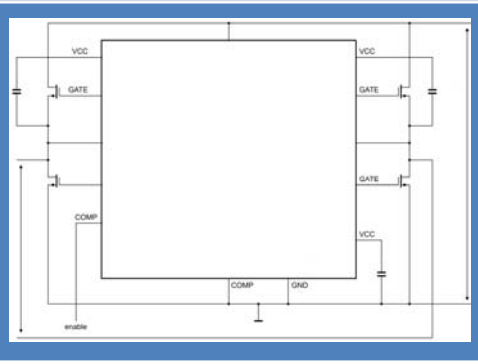
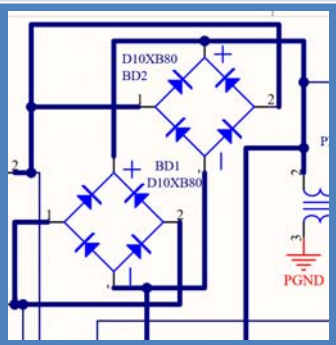
Yannis Electronics Co., Ltd.

研騰國際企業股份有限公司

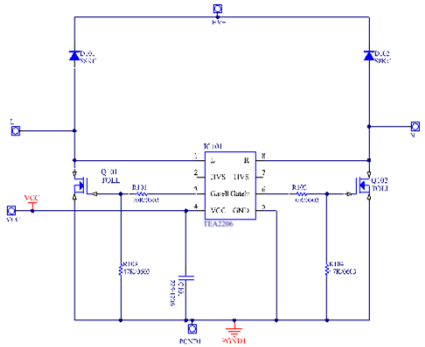
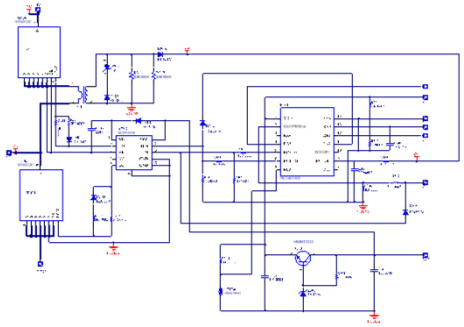
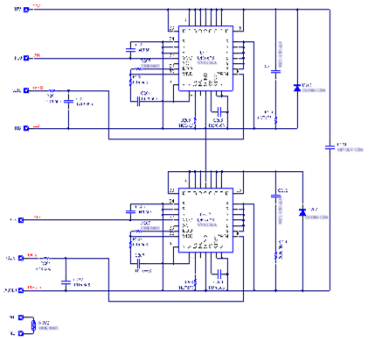
320W

Current Topology

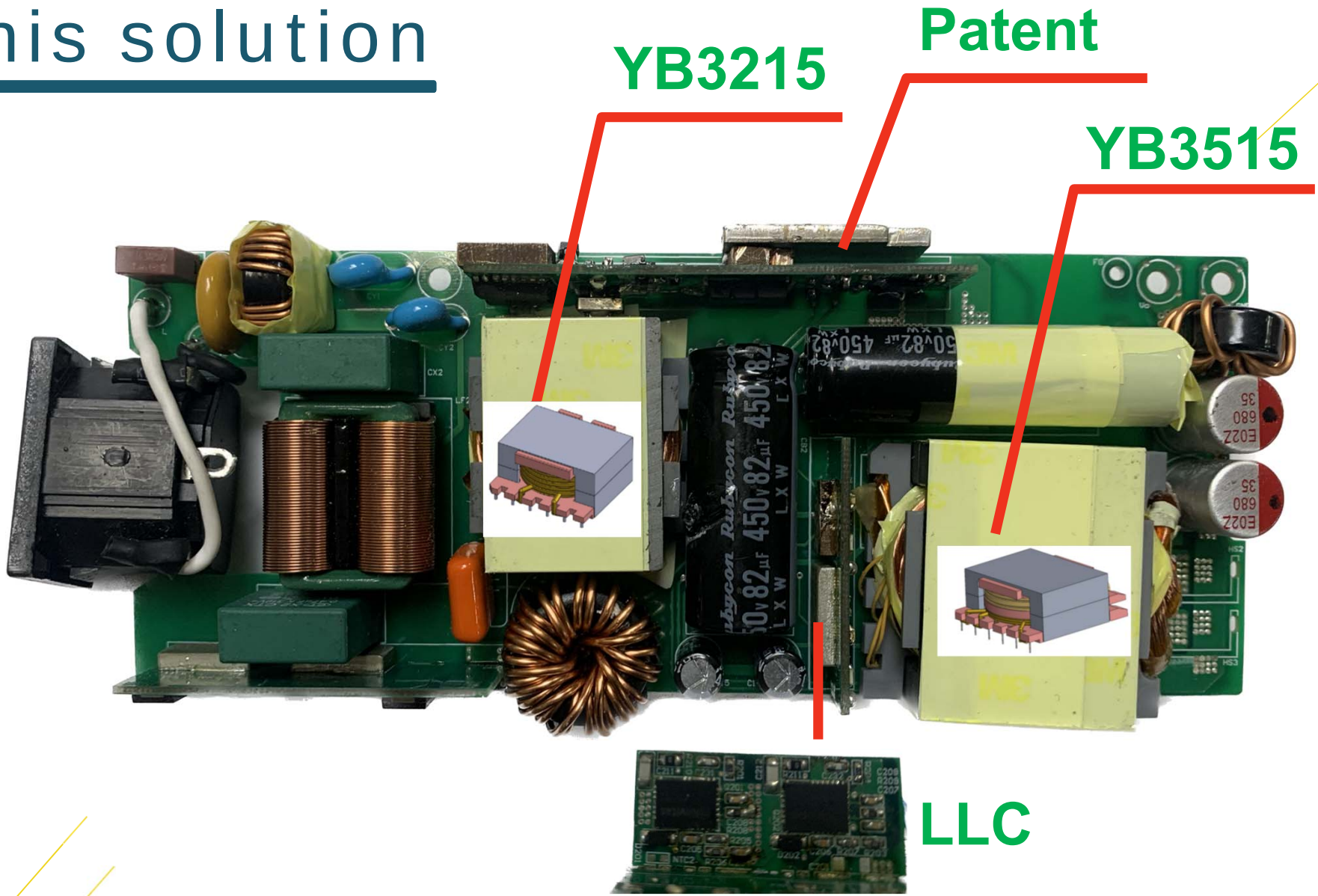
Totem pole PFC + LLC	Active Bridge + Single PFC + LLC	Bridge + Single PFC + LLC
Cost: middle IC selectivity is low and high technical content EMI, Surge difficult to solve Efficiency: best	Cost: High Simple to design Efficiency: middle	Cost: Low Simple to design Efficiency: low
		

Yannis Topology

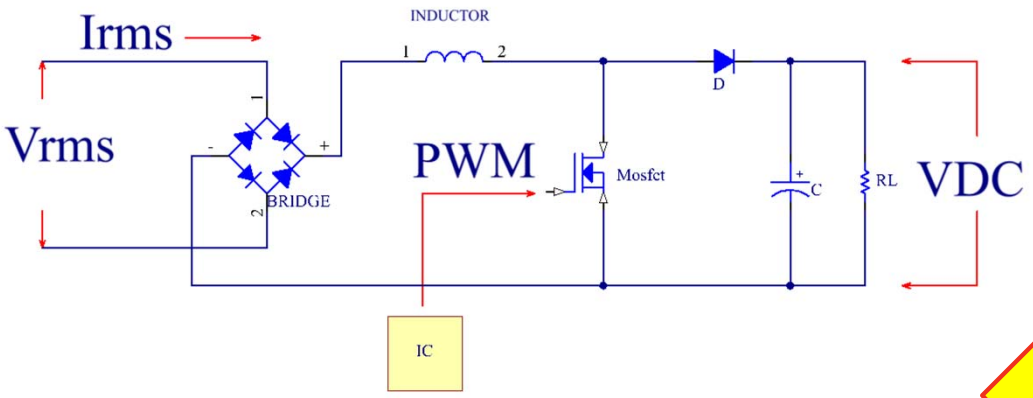
Active Half Bridge + Single PFC + LLC
The topology is cheaper than Active Full Bridge
The topology is more reliable than Totem Pole PFC

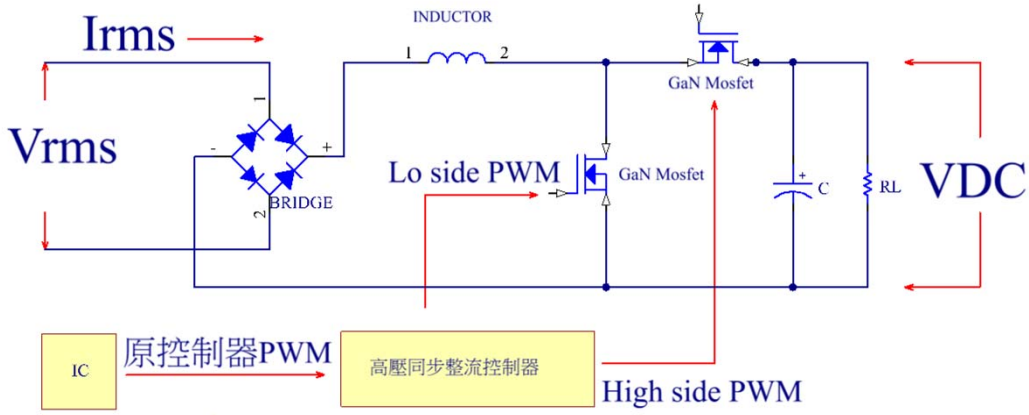
Active Half Bridge 2 Mosfet 2 Diode	Single PFC Boost Diode changed to GaN Mosfet	LLC
		

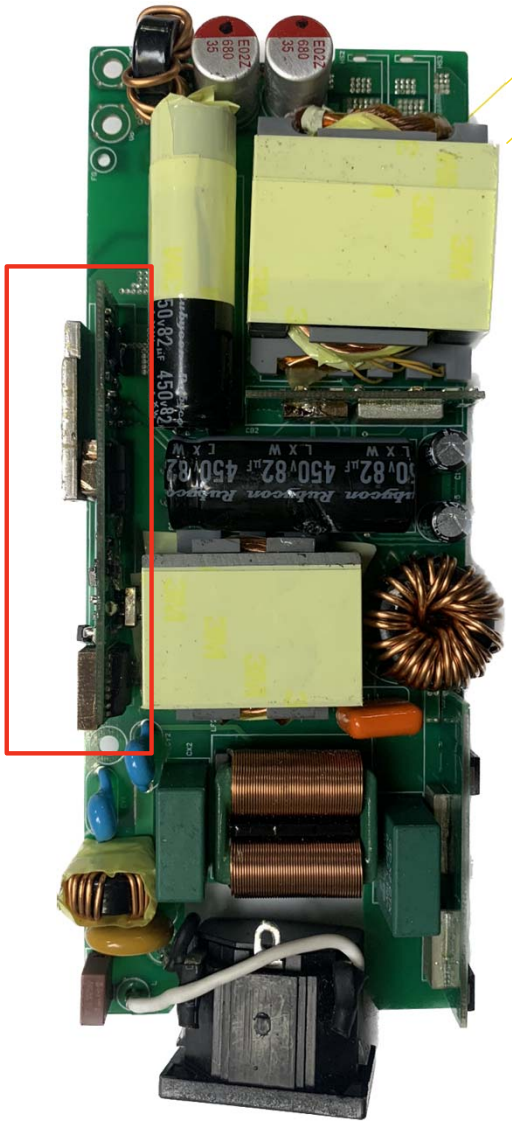
Yannis solution



Yannis's patent

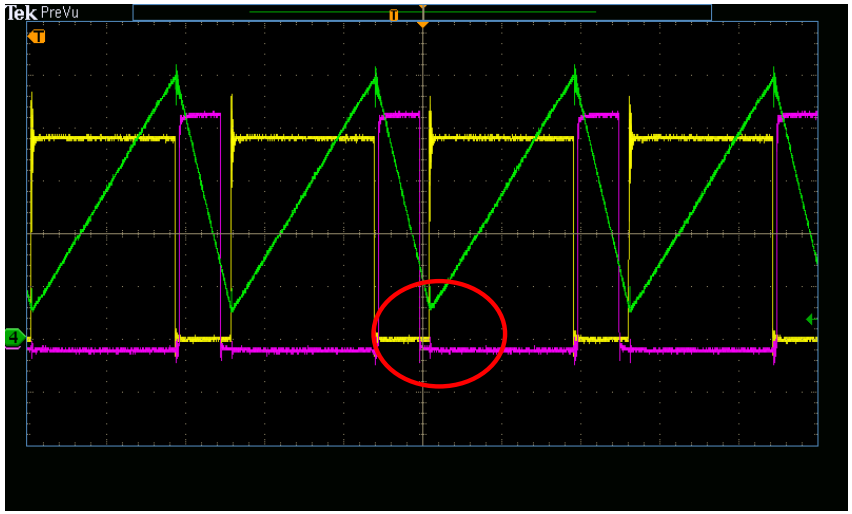




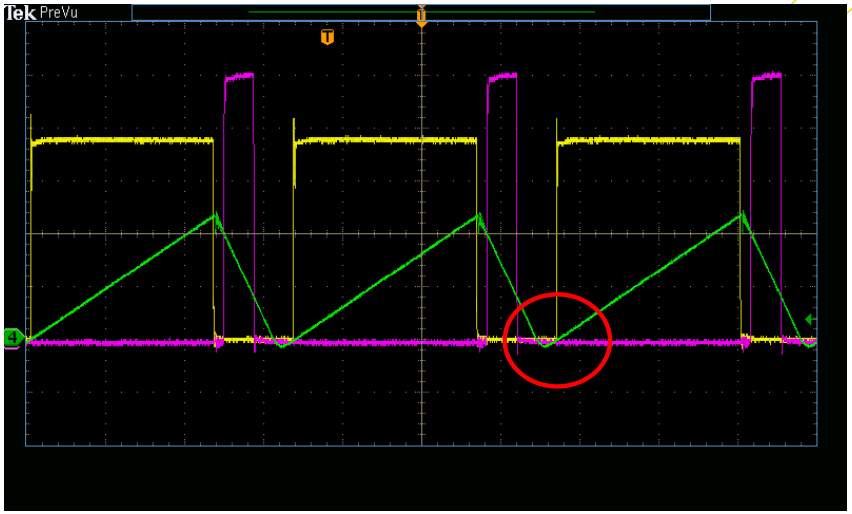


Yannis's patent

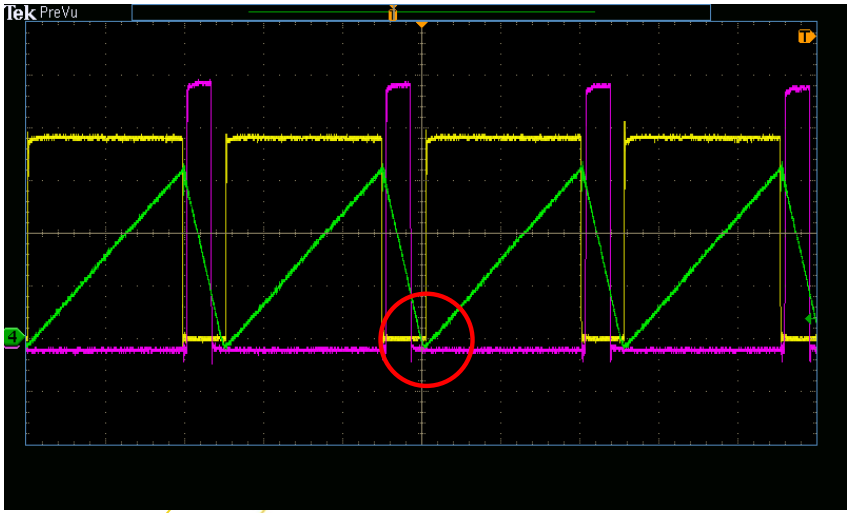
Yannis's patent can support 3 modes of PFC switching



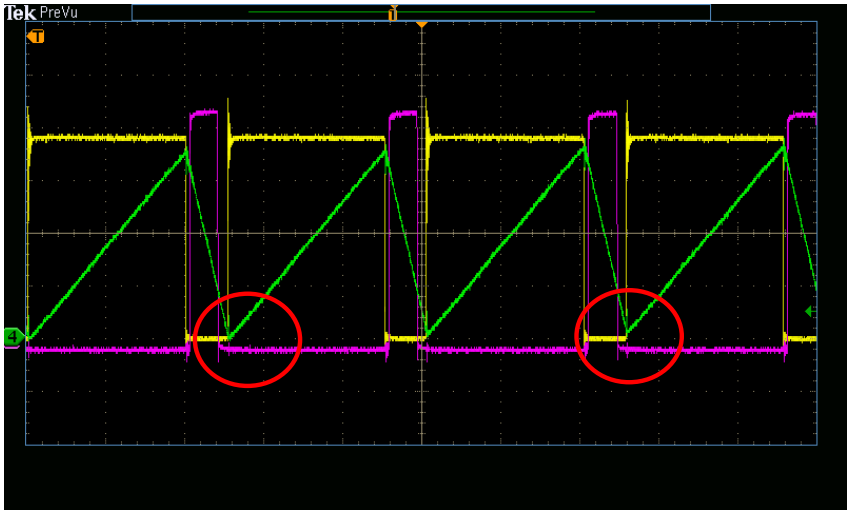
CCM



DCM



QR



QR-CCM

PFC stage Efficiency

Without Patent

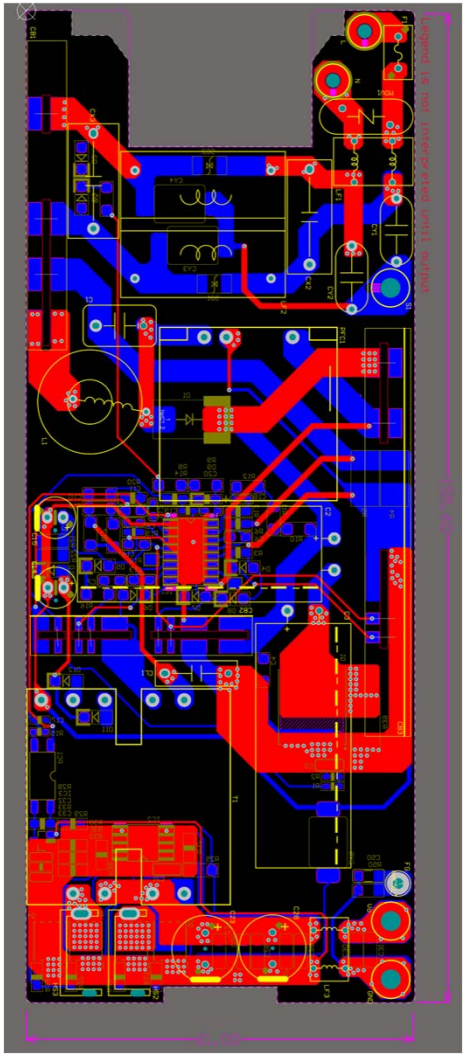
Loading Condition	DCout		Pout	AC Input				Pd	Efficiency
	V	I		Vin	Iin	PF	Pin		
90Vac 100% maximum load	384.624V	0.8504A	327.08425W	89.527V	3.89A	0.973	339.72W	12.6357504W	96.28%
90Vac 75% maximum load	384.985V	0.65A	250.24025W	89.645V	2.913A	0.9927	259.3W	9.05975W	96.51%
90Vac 50% maximum load	385.08V	0.4406A	169.666248W	90.59V	1.93A	0.9957	174.91W	5.243752W	97.00%
90Vac 25% maximum load	384.978V	0.2108A	81.1533624W	89.912V	0.933A	0.9942	83.483W	2.3296376W	97.21%
90Vac 10% maximum load	384.958V	0.0902A	34.7232116W	89.785V	0.402A	0.9932	35.875W	1.1517884W	96.79%

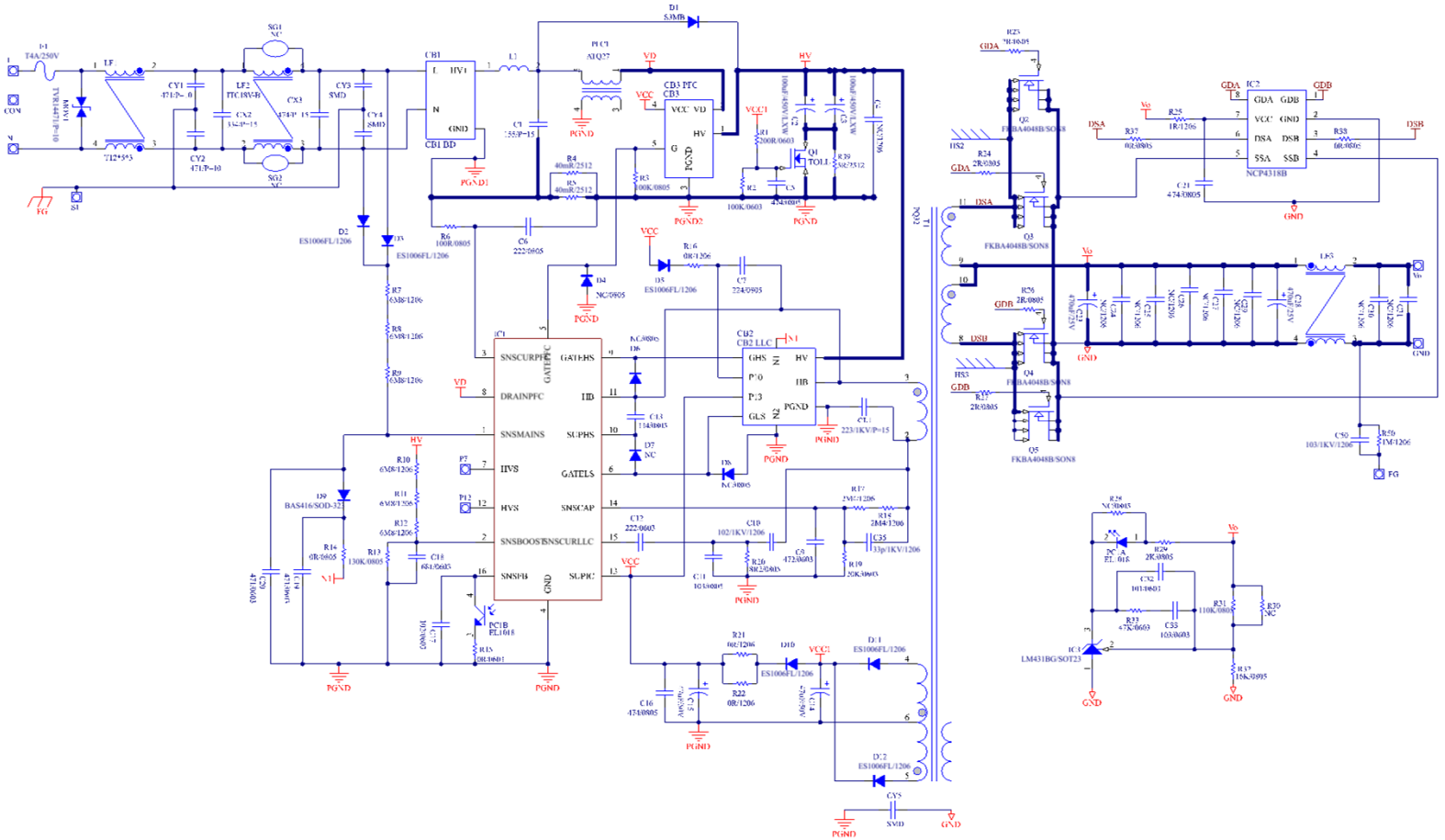
0.32% improvement

With Patent

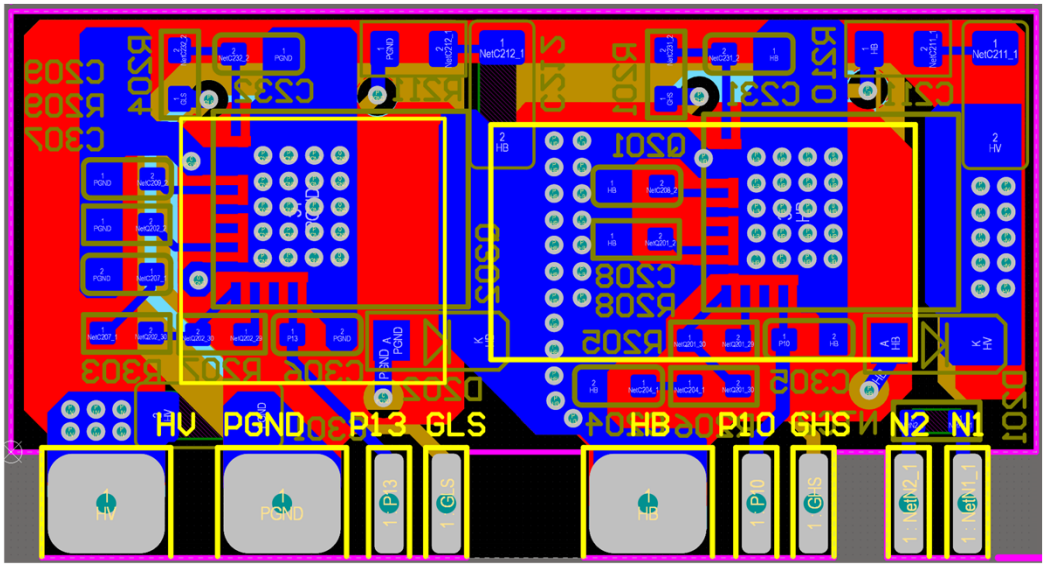
Loading Condition	DCout		Pout	AC Input				Pd	Efficiency
	V	I		Vin	Iin	PF	Pin		
90Vac 100% maximum load	385.132V	0.8504A	327.516253W	89.526V	3.811A	0.9939	339.04W	11.5237472W	96.60%
90Vac 75% maximum load	384.927V	0.6506A	250.433506W	89.648V	2.895A	0.9952	258.3W	7.8664938W	96.95%
90Vac 50% maximum load	384.89V	0.4412A	169.813468W	89.776V	1.949A	0.9963	174.37W	4.556532W	97.39%
90Vac 25% maximum load	385.089V	0.2114A	81.4078146W	89.912V	0.933A	0.9955	83.52W	2.1121854W	97.47%
90Vac 10% maximum load	384.88V	0.0902A	34.716176W	89.783V	0.403A	0.9933	36.014W	1.297824W	96.40%

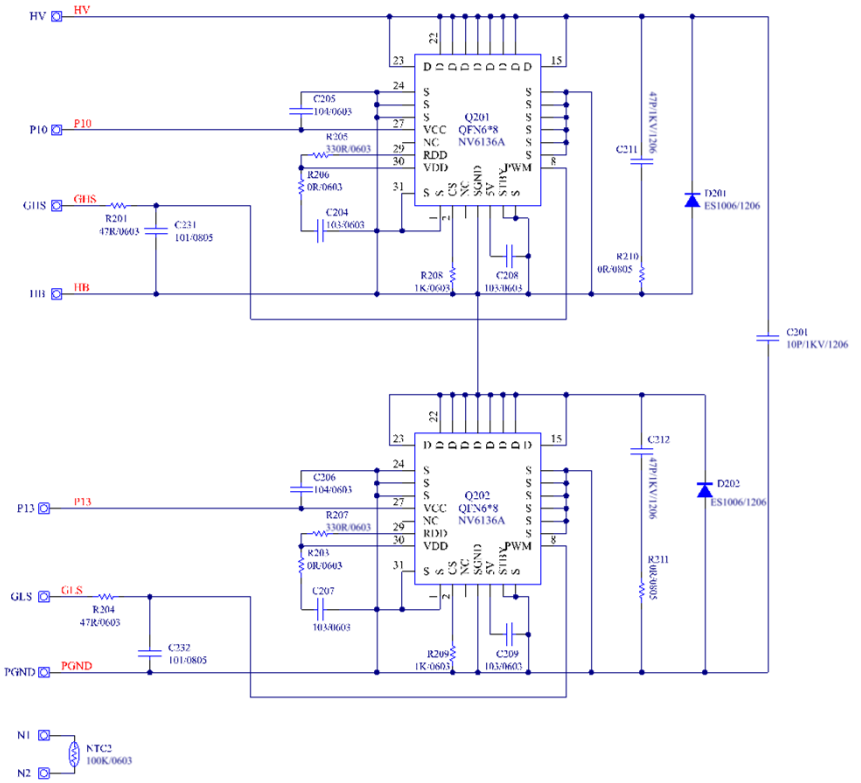
Main Board





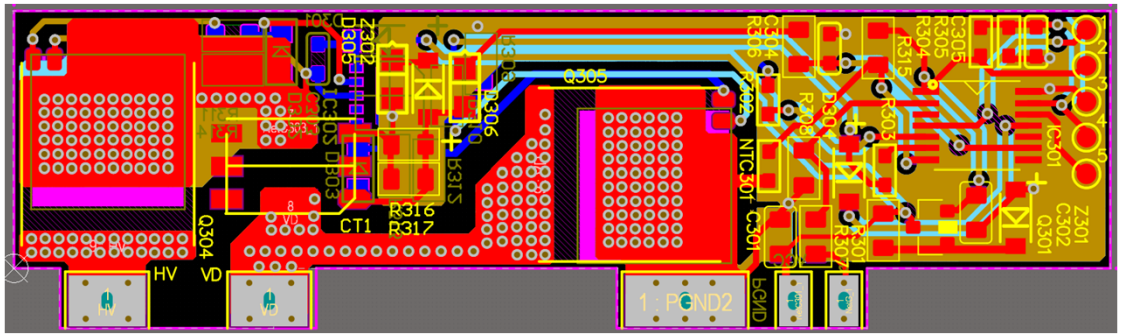
LLC Daughter Board

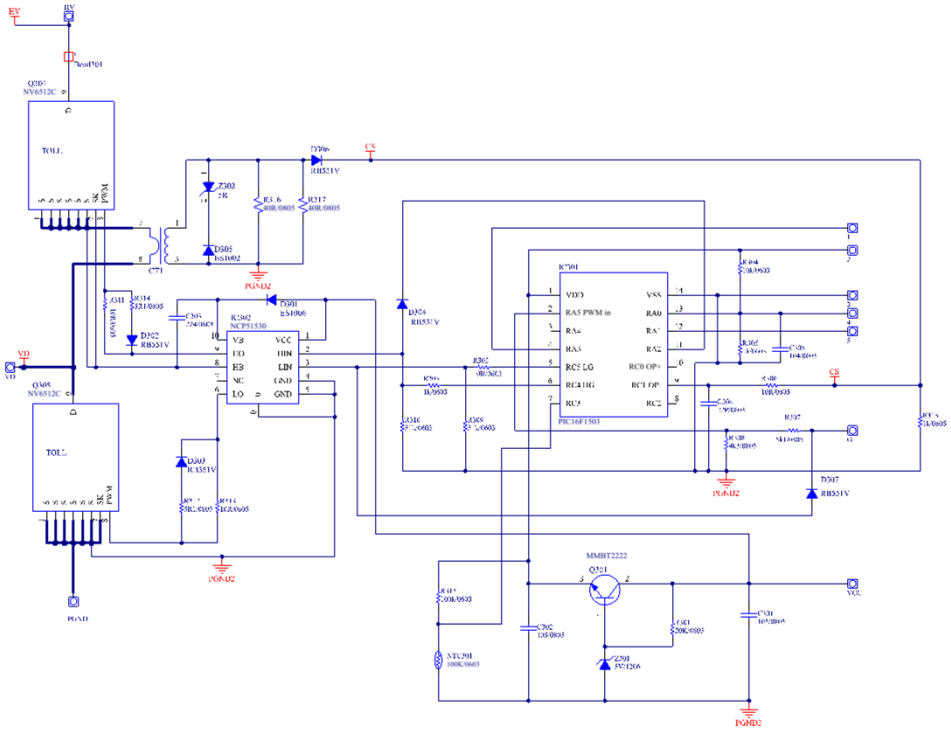




	Part#	Package QFN(mm)	Rdson (typ,mR)	Id (A,100°C)	Ipulsh-10uS (A,25°C)
GaNFast	NV6125	6*8	170mR	8	16
	NV6127		125mR	12	24
GaNSense	NV6136A	6*8	175mR	8	16
	NV6138A		125mR	12	24

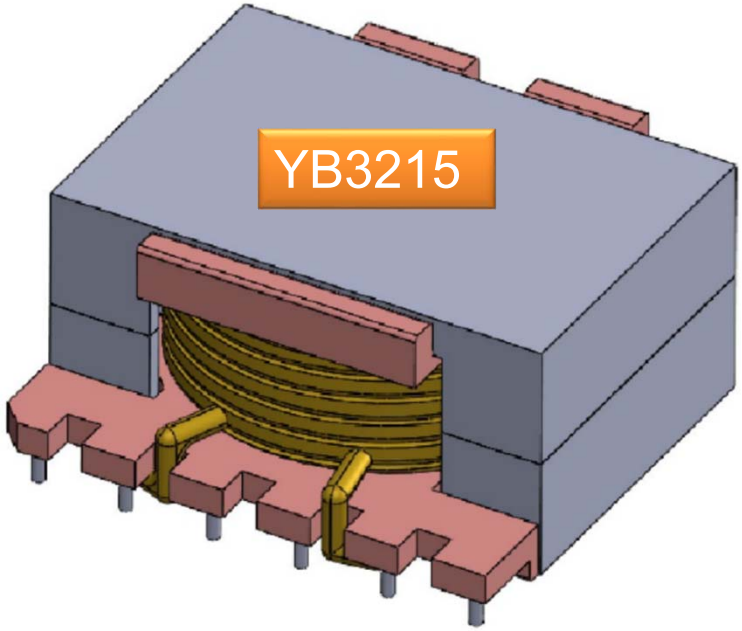
PFC Daughter Board





	Part#	Package QFN(mm)	Rdson (typ,mR)	Id (A,100°C)	Ipulsh-10uS (A,25°C)
GaNSafe	NV6512C	TOLL-4L	55mR	28	76
	NV6513		45mR	34	93
GaNFast	NV6127	6*8	125mR	12	24
	NV6128		70mR	20	40

PFC Inductance



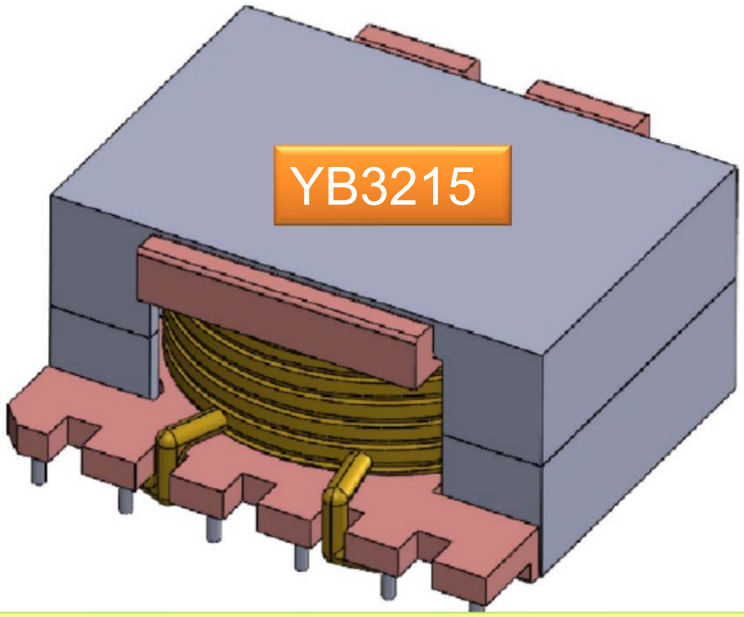
$$1.Lb = \frac{\eta \times Vpk^2 \times (Vo - Vpk)}{4 \times Po \times Vol \times fs,\min}$$

$$2.Ipk \frac{4 \times Po}{\sqrt{2} \times Vrms,\min \times \eta}$$

$$3.Nb = \frac{Lb \times ipk}{Bm \times Ae}$$

$$4.Naux = \frac{V_{ZCD} \times 1.2}{Vo2 - \sqrt{2} \times Vrms,\max} \times Nb$$

PFC Inductance



Using the 3-mode(CCM, QR and DCM) can reduce the PFC Inductance size.
As evidenced by the calculation equation in the diagram on the right.

Input and output parameters			
VAC_min	90	Vac	minimum mains input voltage (rms)
VAC_max	264	Vac	maximum mains input voltage (rms)
Vboost_min	380	Vdc	minimum PFC output voltage
Vboost_nom	400	Vdc	nominal PFC output voltage
Po_nom	320	W	nominal total system output power
Po_max	320	W	maximum total system output power
eff	0.92		efficiency PFC + LLC
Pin	347.8	W	input power

PFC operation type			
PFC operation type	DCM/QR		

PFC inductor calculations DCM/QR operation			
Ip_max	12.02	A	maximum peakcurrent (incl +10%)
Fs_min	100000	Hz	Fs_min at Vboost_min
L_acmin	70	uH	calculated inductance at VAC_min
L_acmax	60	uH	calculated inductance at VAC_max
L	69	uH	chosen inductance
Ae	0.000110	m^2	effective area
Bmax	0.300	T	Bmax core (prevent saturation)
Np	25.1		minimum number of turns
Np_corr	28		chosen number of primary turns
Bmax_calc	0.269	T	

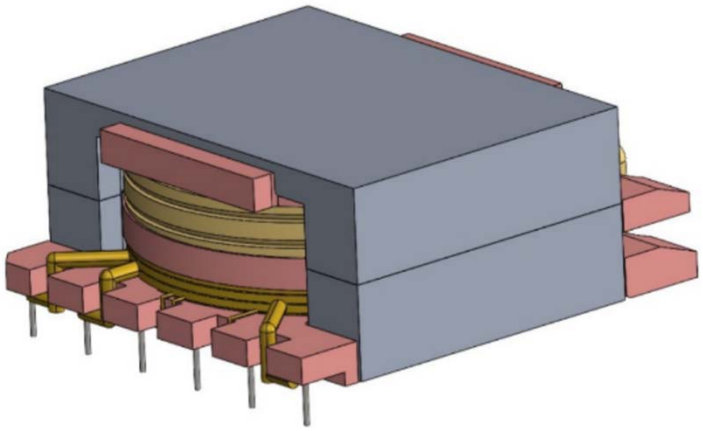
Normal
DCM/QR mode
Bmax=0.269T

Input and output parameters			
VAC_min	90	Vac	minimum mains input voltage (rms)
VAC_max	264	Vac	maximum mains input voltage (rms)
Vboost_min	380	Vdc	minimum PFC output voltage
Vboost_nom	400	Vdc	nominal PFC output voltage
Po_nom	640	W	nominal total system output power
Po_max	640	W	maximum total system output power
eff	0.92		efficiency PFC + LLC
Pin	695.7	W	input power

PFC inductor calculations CCM Fixed Frequency operation (not applicable)			
Current ripple target	150	%	
Fixed switching frequency	90000	Hz	
L_acmin	63.9	uH	calculated inductance at VAC_min
Ip_max	17.60	A	maximum peak current
L	65	uH	chosen inductance
Ae	0.000110	m^2	effective area
Bmax	0.380	T	Bmax core (prevent saturation)
Np	27.4		minimum number of turns
Np_corr	28		chosen number of primary turns
Bmax_calc	0.371	T	

Peak load
CCM mode
Bmax=0.371T

Transformer



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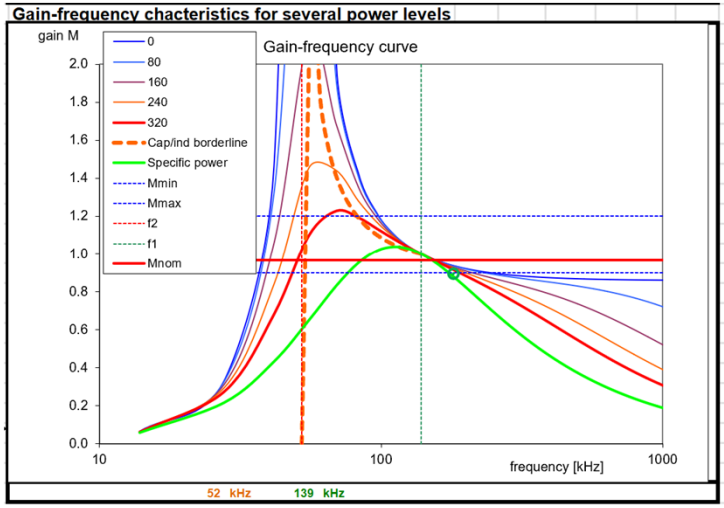

29:3:3
LM=280uH
Lr=40uH
Cr=333

Input & Output			
Vin_nom	400	V	Nominal input voltage.
Vin_max	400	V	Max input voltage.
Vin_min	380	V	Min input voltage.
Vout_max	20	V	Max output voltage.
Iout_max	16	A	Max output current.
Pout_max	320.00	W	Max output power

Transformer			
Ns	3	T	Number of secondary turns.
Naux	2	T	Number of auxilary turns
Np	29	T	Number of primary turns.
Ae	105	mm^2	Effective crossectional core area.
Lp	280	uH	Total primary inductance = Lm + Lr
Lr	40	uH	Leakage inductance of transformer.
Lm	240	uH	Magnetic inductance of transformer.
Bmax	300	mT	Max. core excitation limit @ 100C
Gain_1	0.97		Full Load Gain @ Vin_max (1.00~1.03 is recommended)
Gain_2	1.02		Full Load Gain @ Vin_min
Nt	9.7		Turn Ratio of Np/Ns.
N	8.9		Effective Turn Ratio
I_Lm	1.3	A	Max Lm peak current.
I_Lpk	2.85	A	Max Resonant peak current.
Lm	240	uH	Maganetic inductance of transformer.
	100	ns	estimated dead time
Ton_max	3.51	us	Max on time @ resonant freq.
B_opr.	120	mT	Operation flux density level.
B_ratio	40.1	%	Ratio of Saturation.

Resonant Tank			
Lr	40.0	uH	Value of resonant inductance.
Cr	33	nF	Value of resonant capacitance.
Vcr_min	-107.6	V	Minimum voltage over Cr.
Vcr_max	292.4	V	Maximum voltage over Cr.
fr.1	139	kHz	Resonant freq. of Lr & Cr.
fr.2	52	kHz	Resonant freq. of Lm+Lr & Cr.
RL	1.25	Ohm	Resistive equivalant of max. output load.
RLac	1.01	Ohm	AC output resistor
Q	0.37		Quality factor of resonant tank @ max load.

Welcome to YANNIS

We look forward to a thriving business relationship.

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