FOR ENERGY EFFICIENT INNOVATIONS

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NCP1623A+NCP1343+NCP4307+GS-065-011
100W USB PD Solution

Yosun Jiamzhu

100W VSFF PWM And HF CCM/QR USB PD Adapter Solution

Value Proposition

This design used Onsemi's NCP1623A PFC and NCP1343 HF CCM/**QR F**lyback PWM controller plus GAN mos and NCP4307 synchronous rectified controller combining Onsemi's WT6633 PD controller for 100W USB PD adapter.

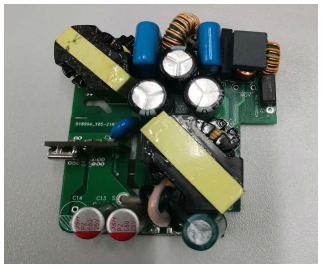
Specifications and Features

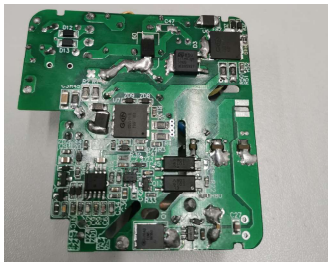
- AC input from 90V to 264V
- VSFF CRM PFC with 2 stage output voltage, 250V at LL and 390V at HL
- HF CCM/CRM PWM with 2x PEM supports more power transition without PFC working and 68uF PFC capacitor
- High Frequency Operation up to avg. 190KHz at 264Vac&full load and easy to be changed to GaN solution
- Quite skip and Flyback DCM operation with frequency foldback at no load&light load
- Output voltage 3.3V-21V
- Max Output power: 100W
- Support PD3.0, PPS, BC1.2 etc.
- Ripple&Noise: <60mV
- AVG efficiency:93 % at 115Vac&230Vac
- Full load efficiency: 93%&93.5% at 115Vac&230Vac and 20V3.25A
- Output precise OVP
- Output OCP, SCP
- Open loop protection
- Small size with compact design
- PCBA size: 60mmx60mmx19mm
- Adapter size: 65mmx65mmx28mm

Market & Applications

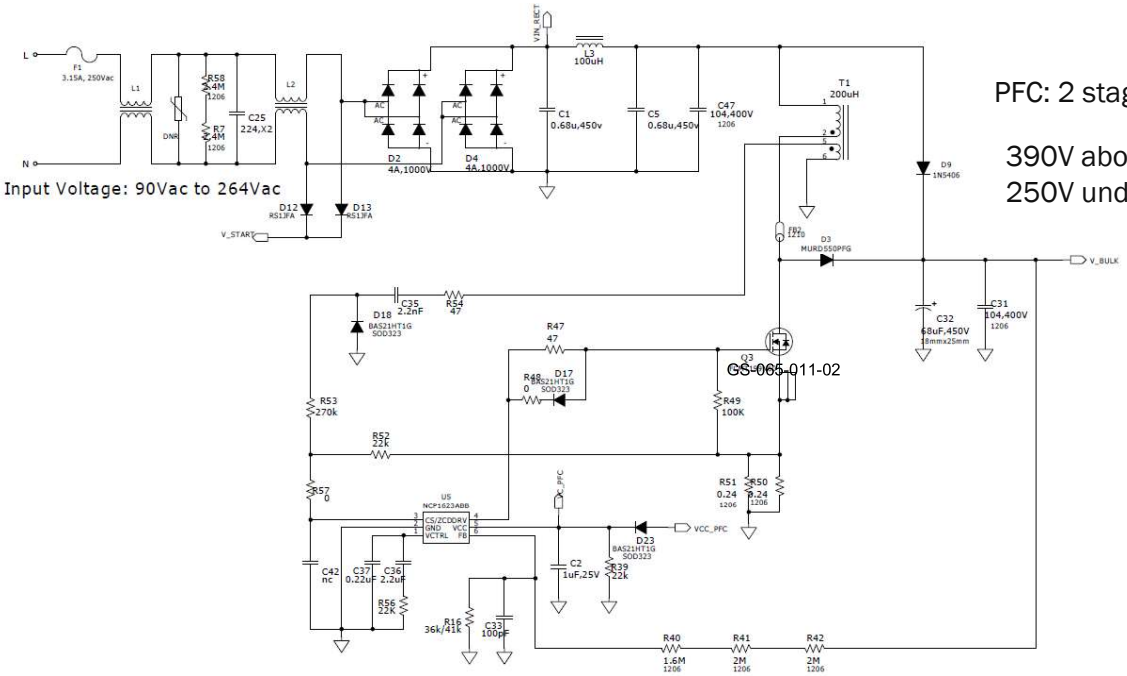
- Mobile phone Quick Charger
- Laptop computer

Demoboard Photo





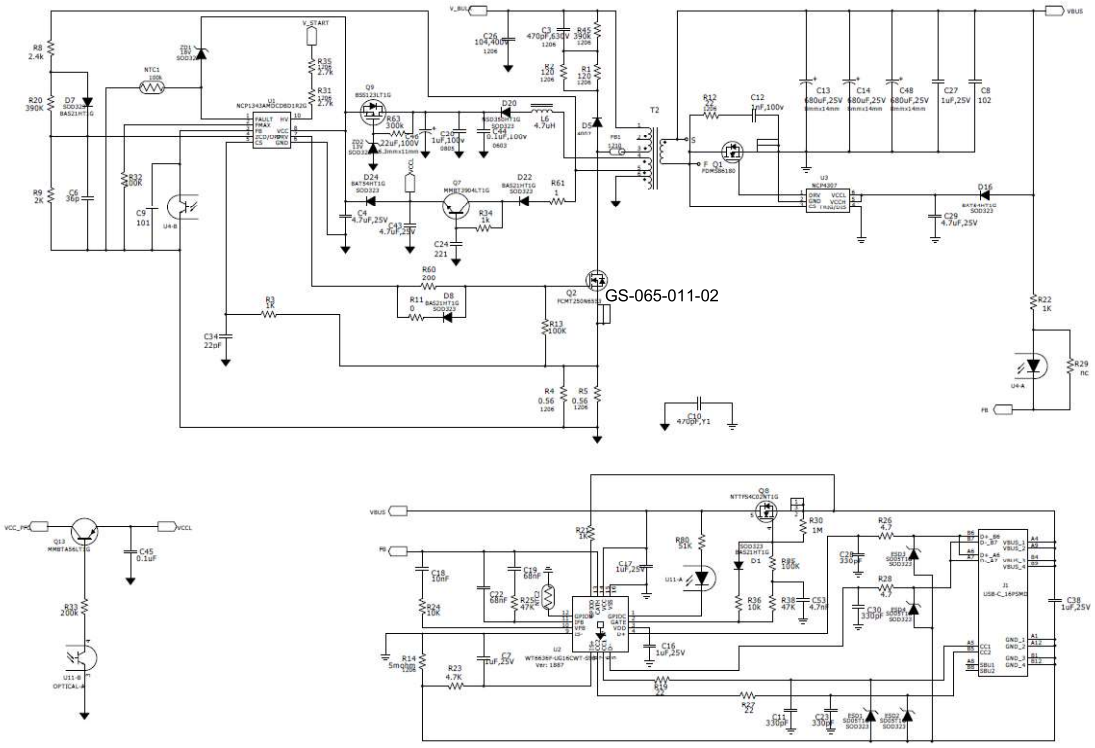
Schematic(PFC Portion)



PFC: 2 stage output

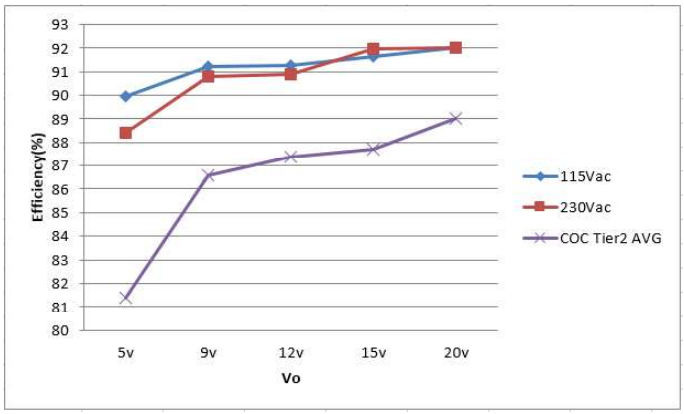
390V above 163Vac
250V under 146Vac

Schematic(PWM&Protocal Portion)

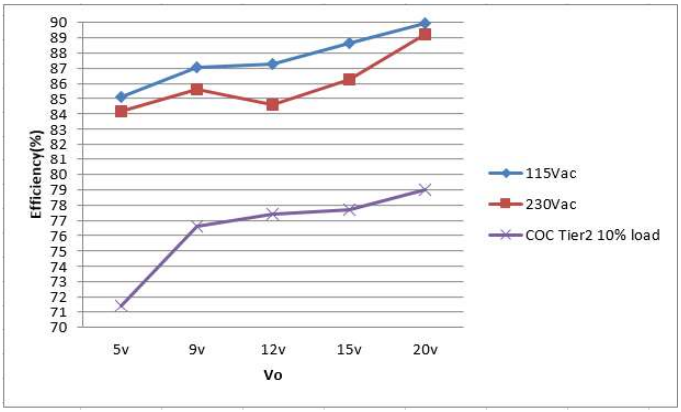


COC V5 Tier2 Specification and Average/Light Load Efficiency

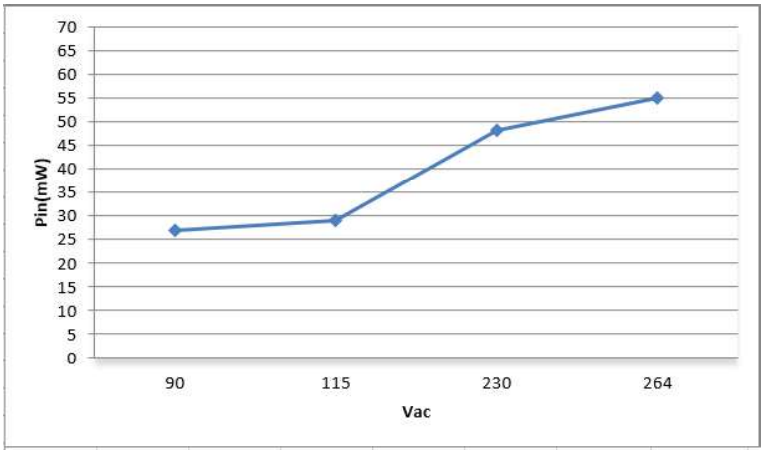
avg efficiency Vs COC V5 Tier2



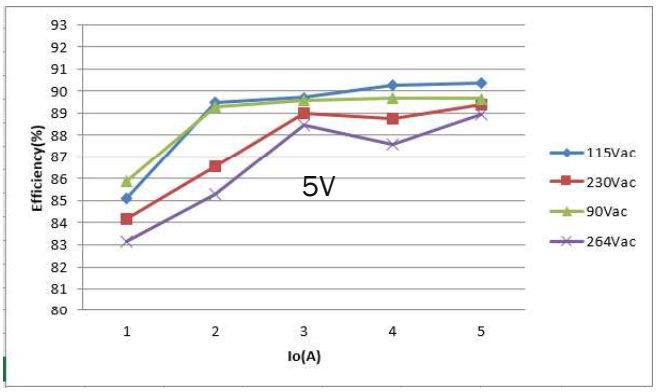
10% efficiency Vs COC V5 Tier2

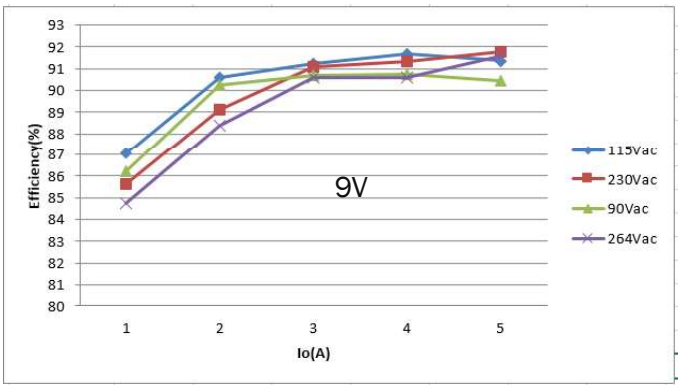


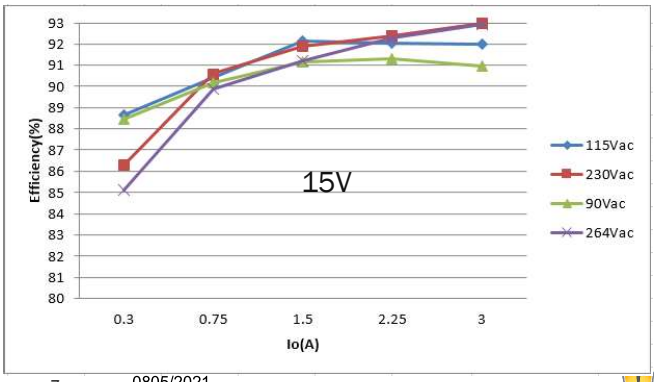
Standby Power

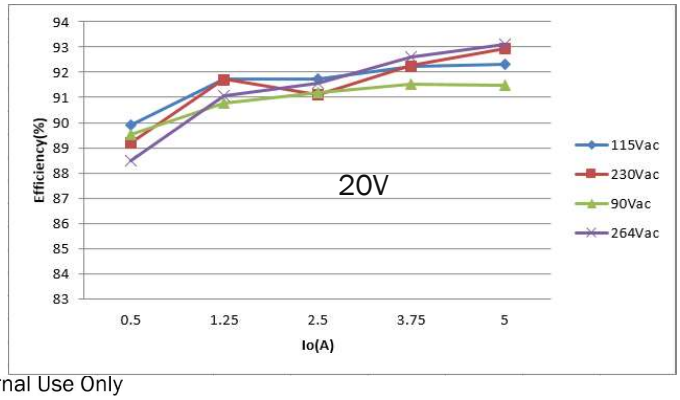


Efficiency Vs Load



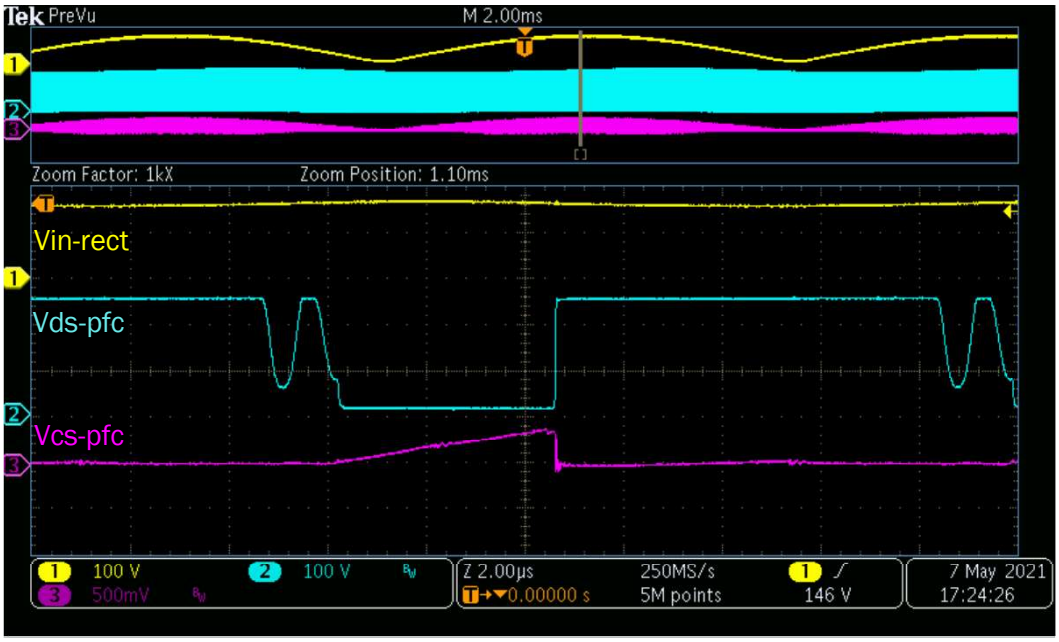






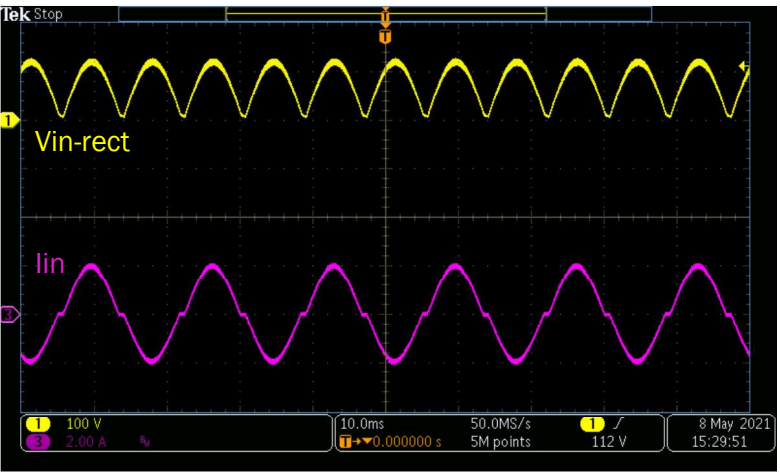
PFC Valley Switching

115Vac and 20V5A

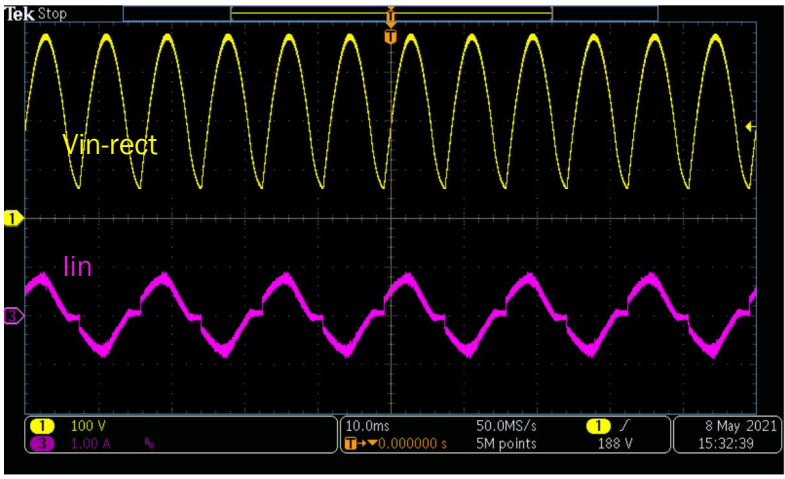


Input Current at LL and HL

90Vac and 20V5A

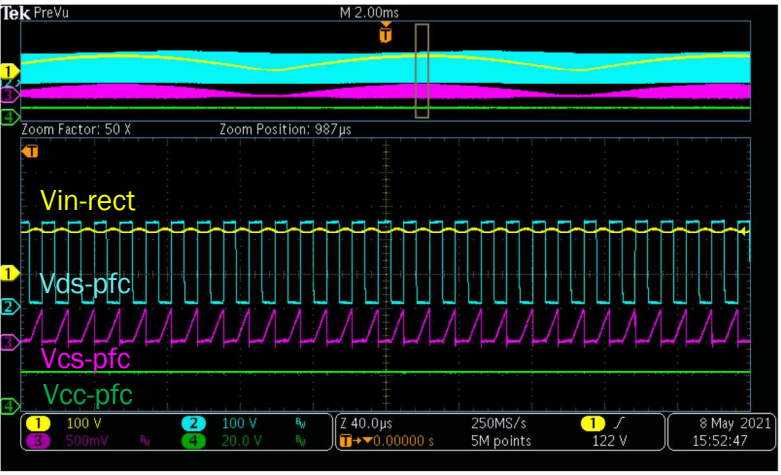


264Vac and 20V5A

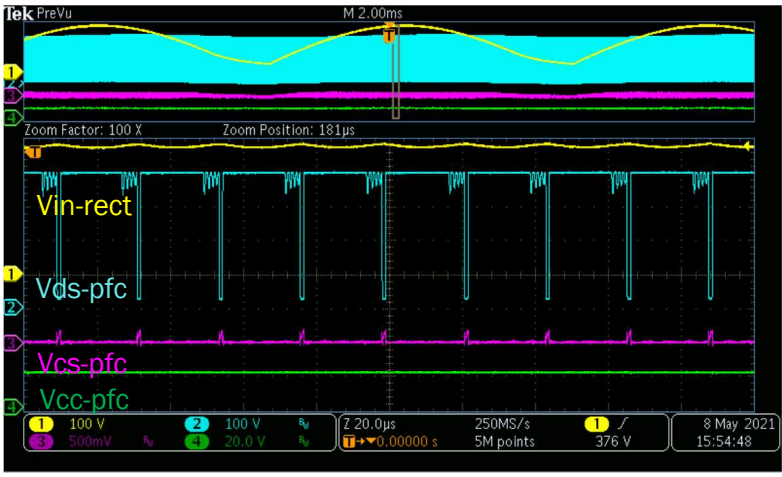


PFC Operation Waveform at LL and HL

90Vac and 20V5A



264Vac and 20V5A

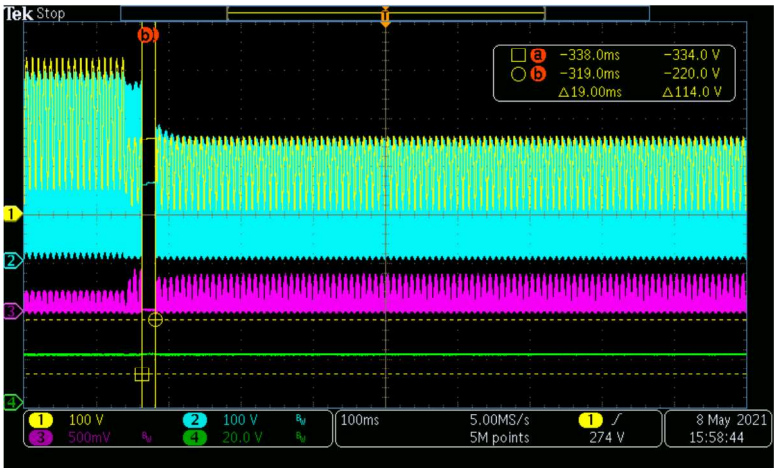


PFC LL to HL and HL to LL Change

115Vac to 230Vac at 20V5A

Ch1---Vin-rect
Ch2---Vds-pfc
Ch3---Vcs-pfc
Ch4---Vcc-pfc

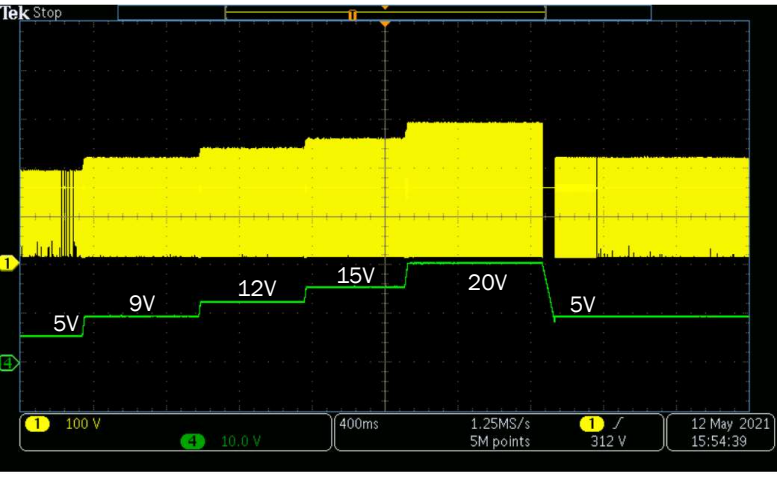
230Vac to 115Vac at 20V5A



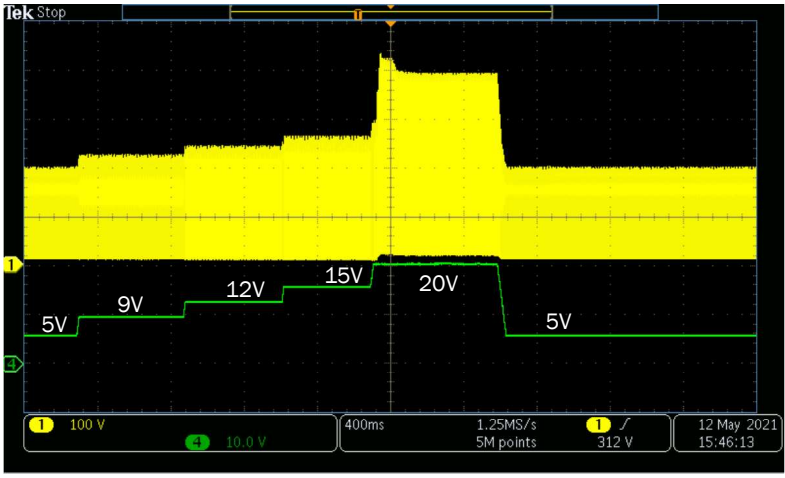
Ch1---Vin-rect
Ch2---Vds-pfc
Ch3---Vcs-pfc
Ch4---Vcc-pfc

PD Voltage Change

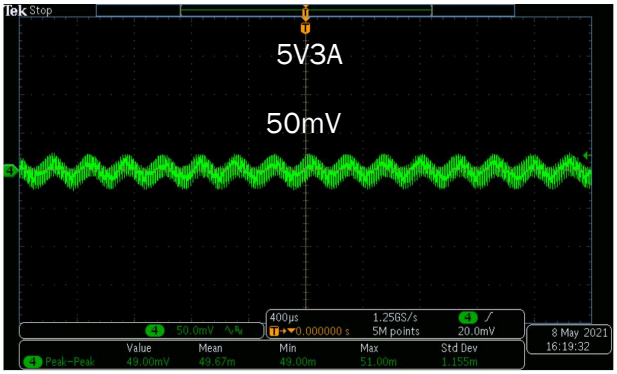
115Vac, no load

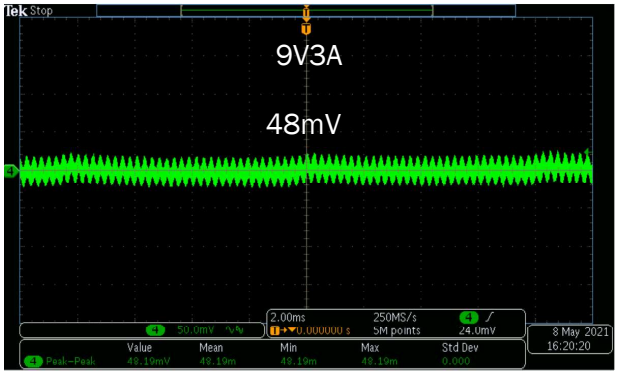


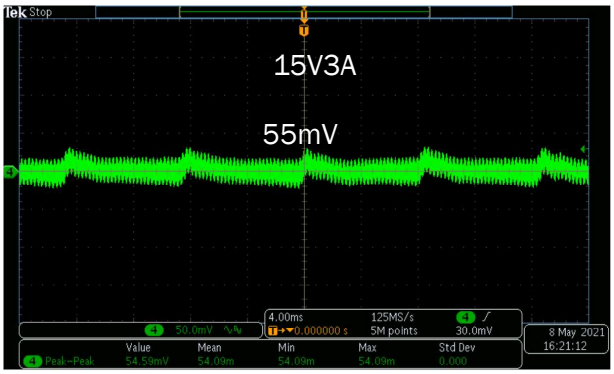
115Vac, 3A load

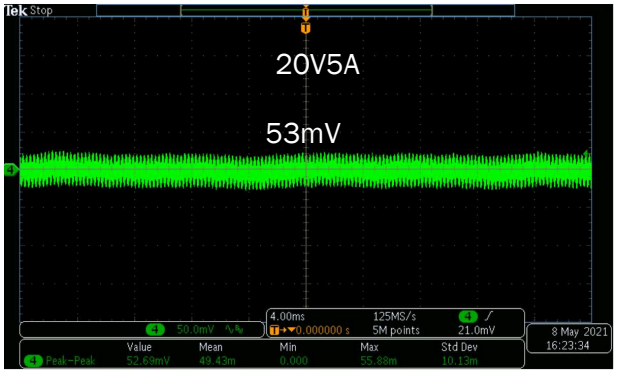


Ripple at 90Vac

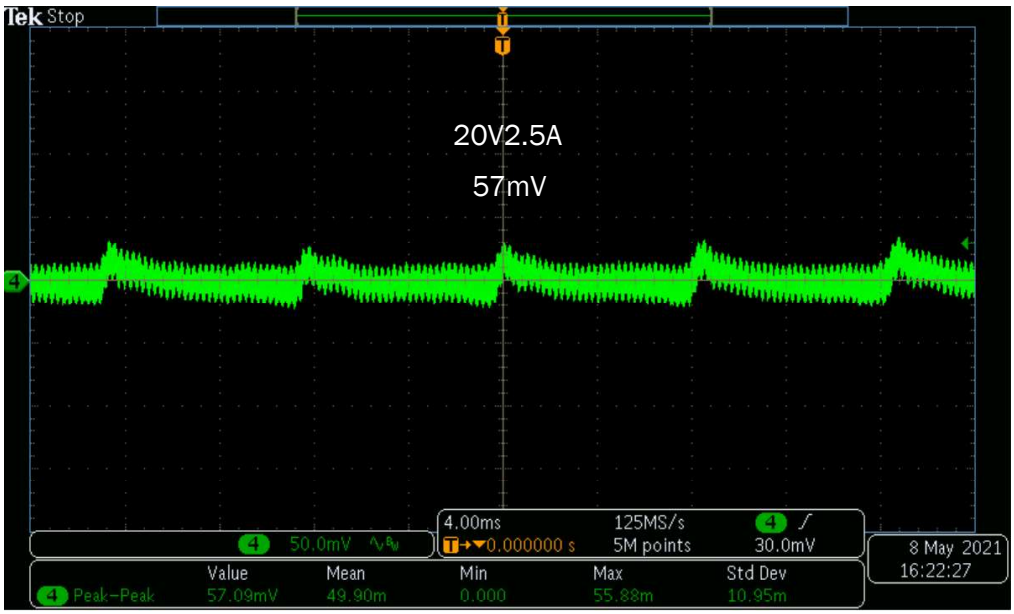






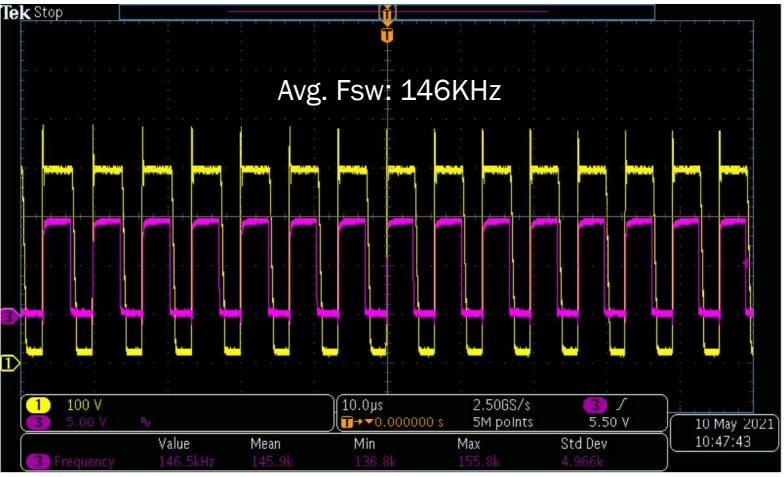


Output Ripple at 90Vac and 20V2.5A(Max Load Before PFC work)

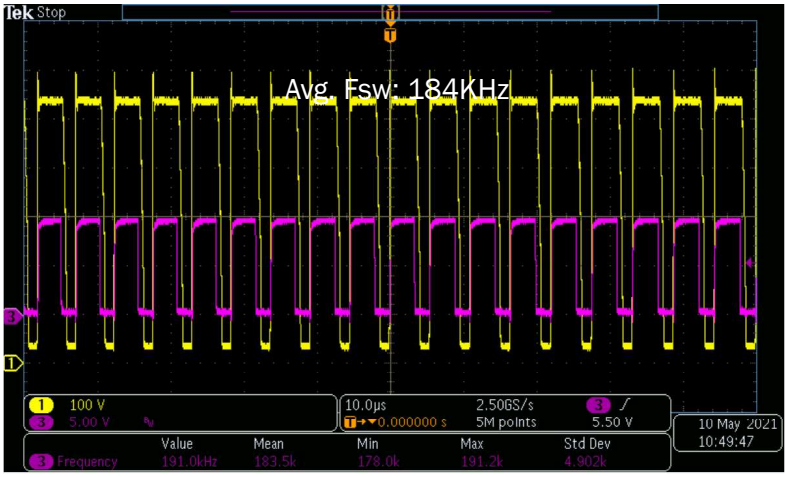


PWM Operation Frequency

90Vac and 20V5A

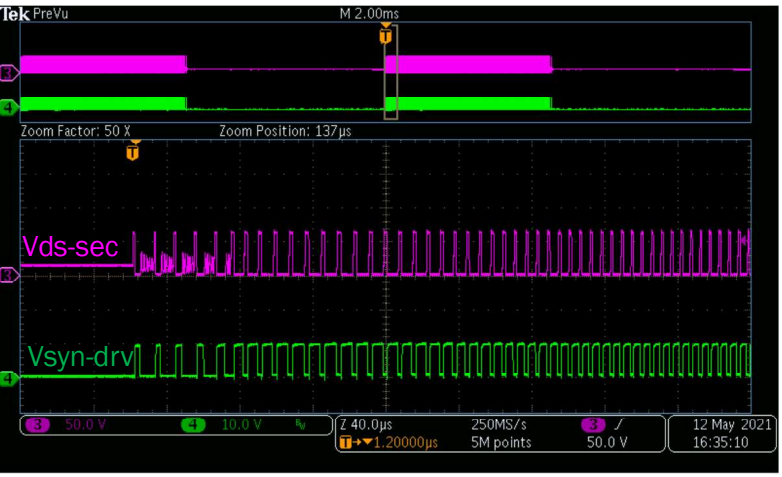


264Vac and 20V5A

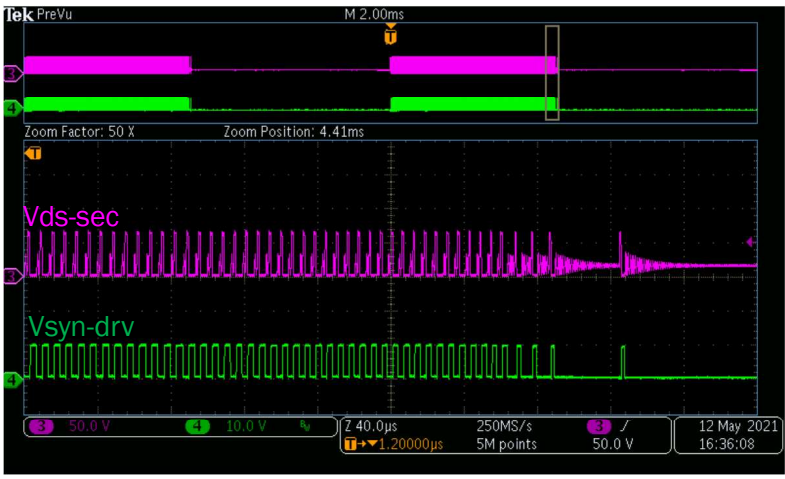


Syn. Drive During Load Transition at 264V

264Vac and 15V, 0-3A

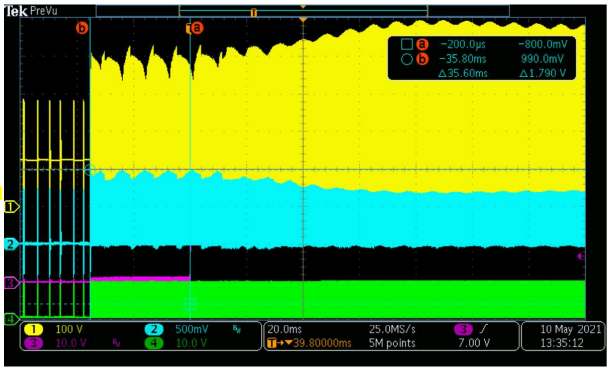


264Vac and 15V, 3A-0

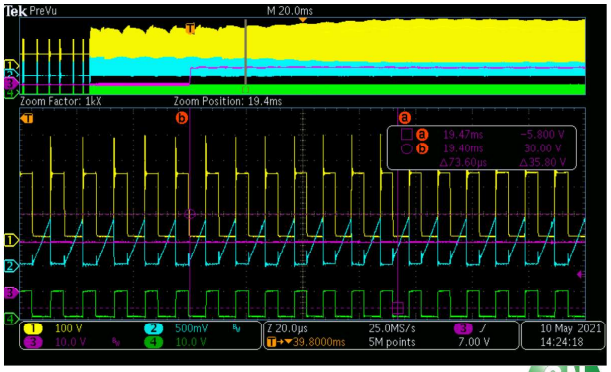


NCP1343 Transition Load from 0-5A at 90Vac and 20V

Vds-pwm
Vcs-pwm
Vcc-pfc
Vsyn-drv

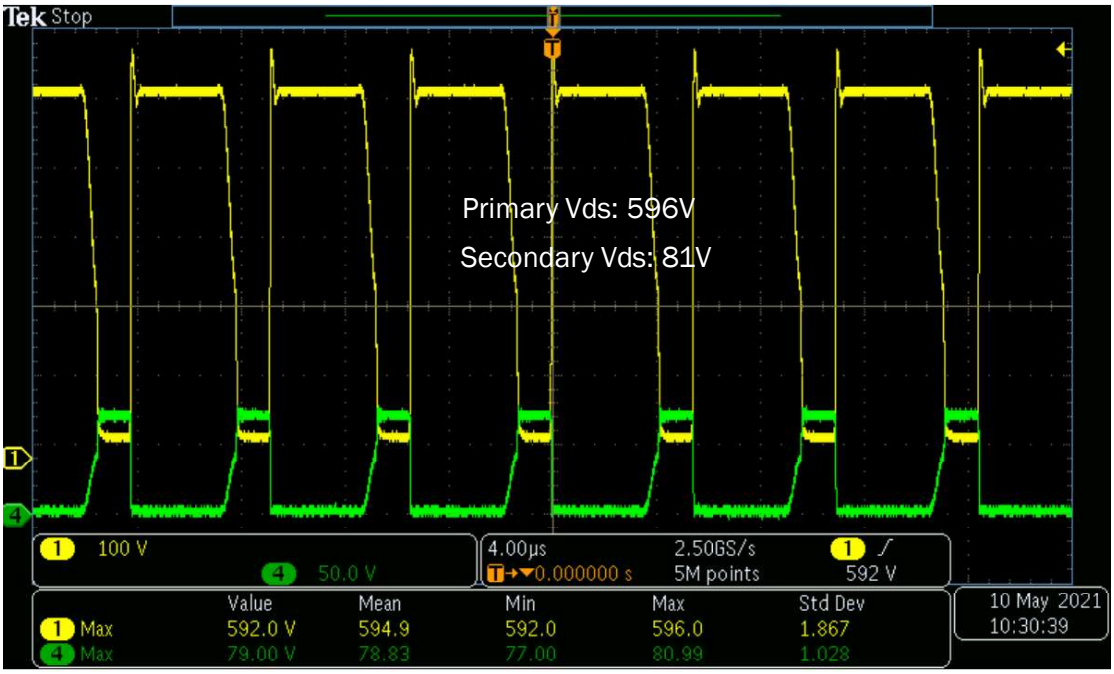


Vds-pwm
Vcs-pwm
Vcc-pfc
Vsyn-drv



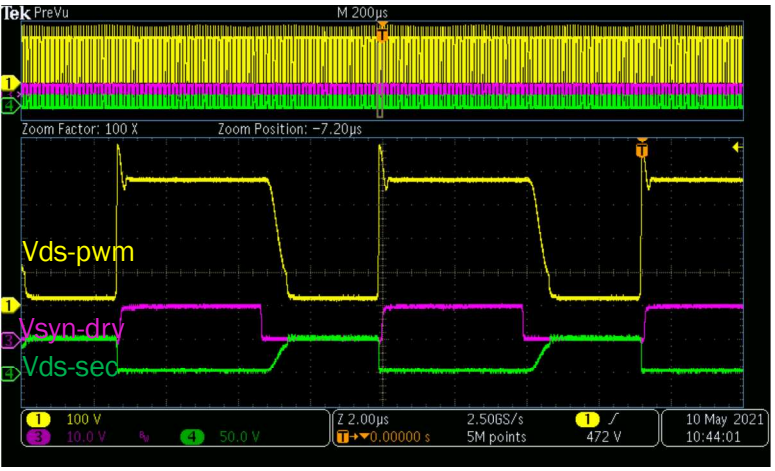
Primary FET and SEC. FET Stress at 264Vac&Full load

Normal operation, 264Vac, 20V5A

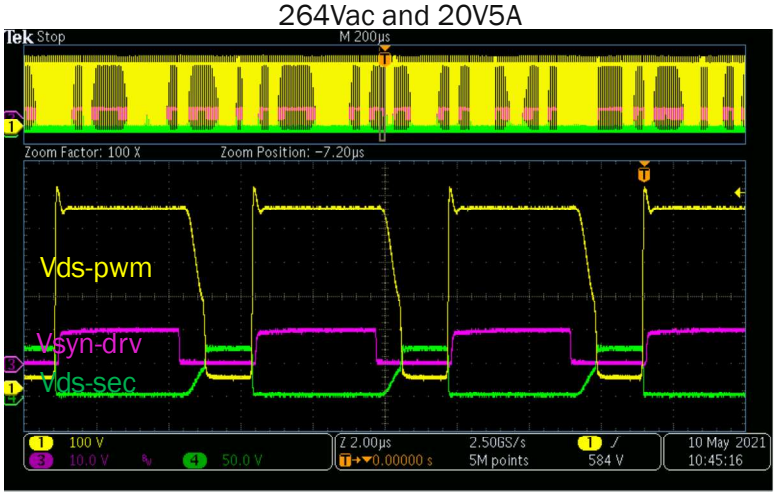


Pri.&Sec. Vds and Synchronous Drive Waveform

90Vac and 20V5A



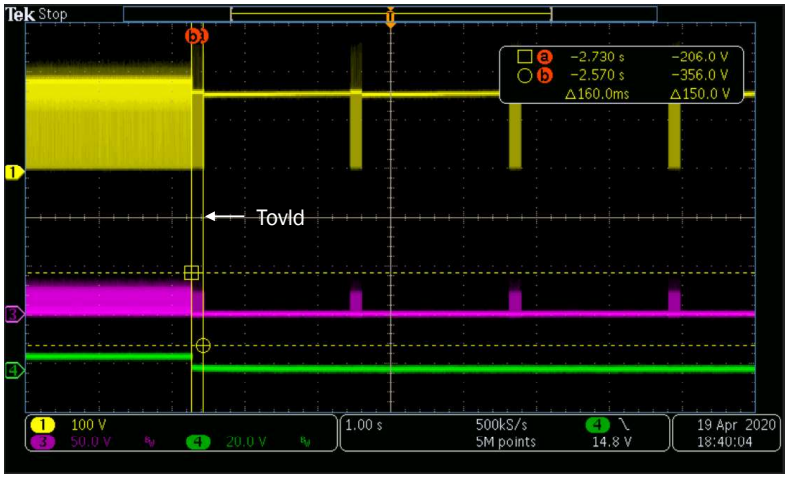
264Vac and 20V5A



Short Circuit Protection and Tovld, Tauto-recovery time

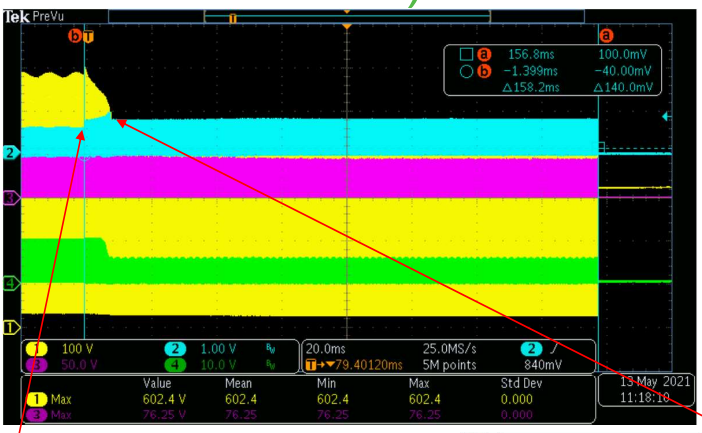
115Vac&5V

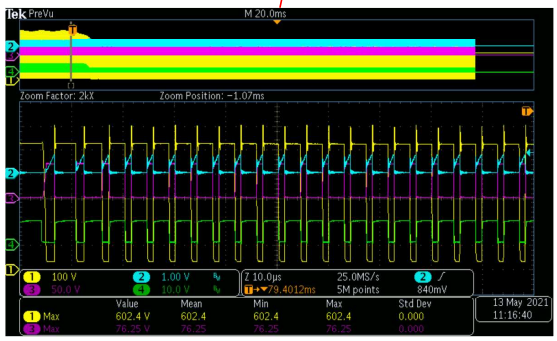
115Vac&5V

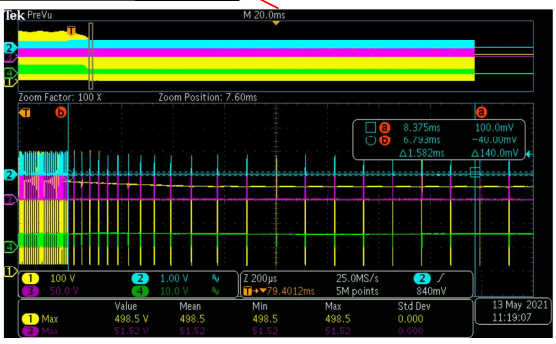


SCP at Vbus(230Vac and 20V5A)

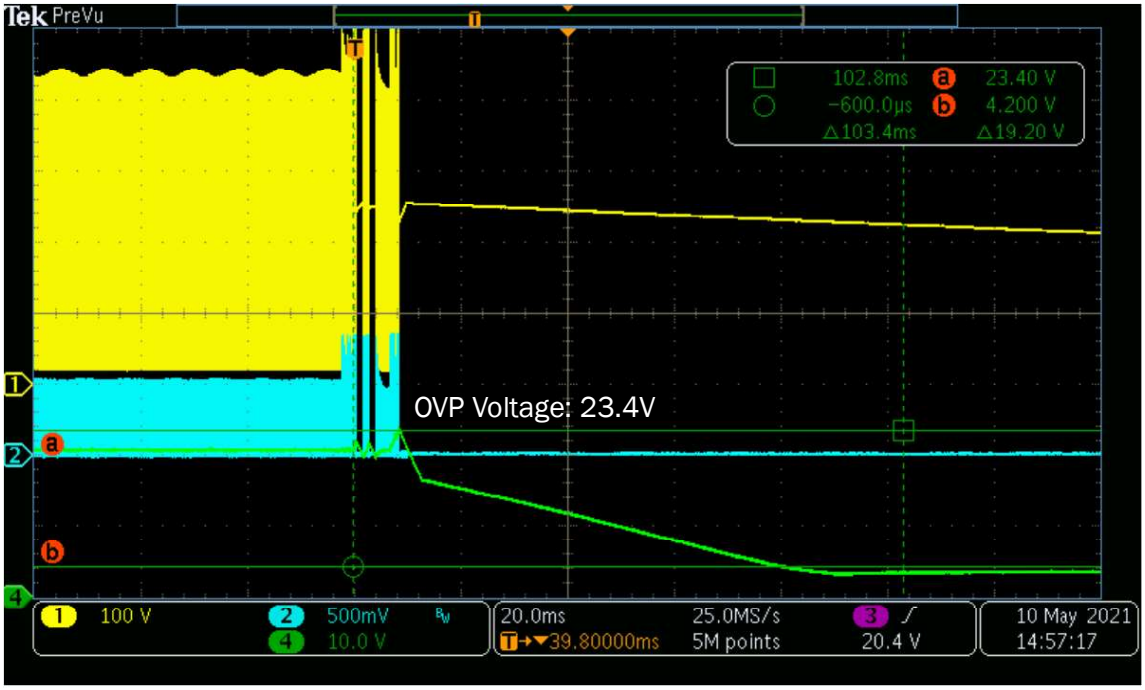
Ch1:Vds-pwm
Ch2: Vcs-pwm
Ch3: Vds-sec
Ch4: Vsyn-drv





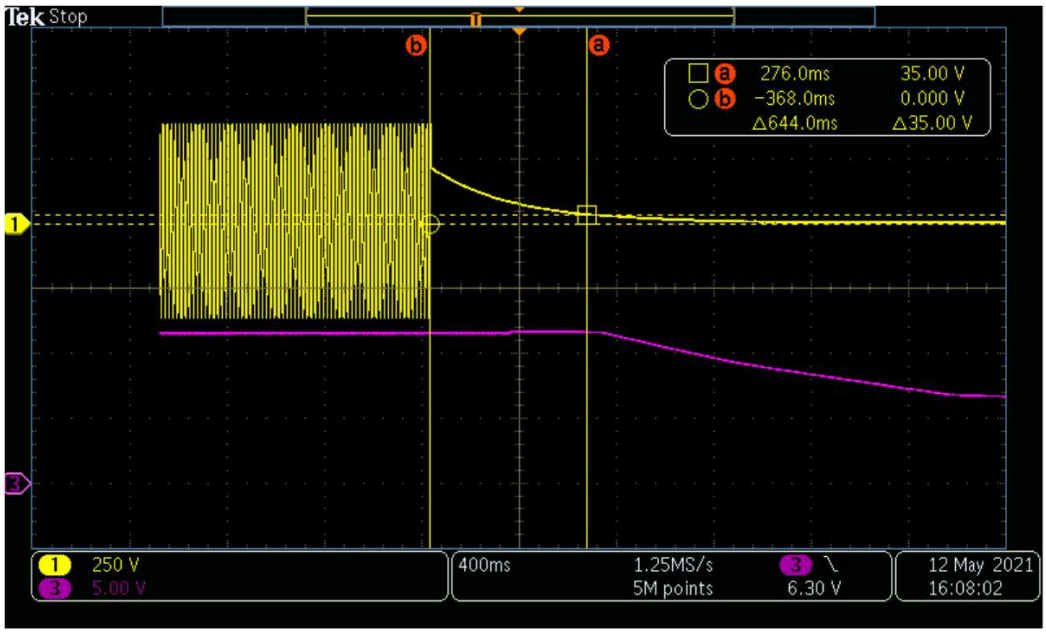


OVP Test



X2 Capacitor Discharge Test

264Vac and no load



EMI Test at 230Vac&Full Load

EMI TEST REPORT

parameter

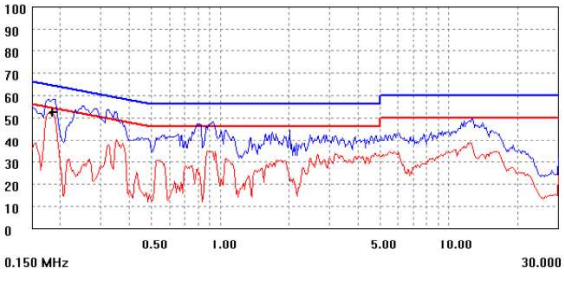
Organization:		Operator:		EUT:	
Place:		Time:	2021/5/11/17:32	Test equipment:	KH3962
Detector:	PK+AV	Test-time[ms]:	30	SN:	620883
Limit:	EN55022B	Transductor[PK/AV]:	PK / AV	JZ:	2,15,665
Remark:					

freq, step

Start(MHz)	End(MHz)	Step(MHz)
0.150	2.000	0.002
2.000	10.000	0.010
10.000	30.000	0.025

scan result

dBuV



final test

[AV]	freq[MHz]	lev[dBuV]	Lim[dBuV]	Δ[lev-Lim]
	0.185	52.3	54.3	-1.9

Line

EMI TEST REPORT

parameter

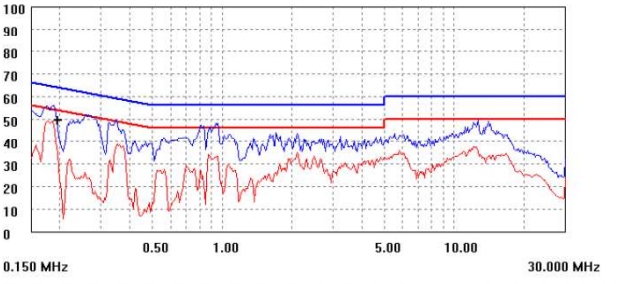
Organization:		Operator:		EUT:	
Place:		Time:	2021/5/11/17:27	Test equipment:	KH3962
Detector:	PK+AV	Test-time[ms]:	30	SN:	620883
Limit:	EN55022B	Transductor[PK/AV]:	PK / AV	JZ:	2,14,1438
Remark:					

freq, step

Start(MHz)	End(MHz)	Step(MHz)
0.150	2.000	0.002
2.000	10.000	0.010
10.000	30.000	0.025

scan result

dBuV



final test

[AV]	freq[MHz]	lev[dBuV]	Lim[dBuV]	Δ[lev-Lim]
	0.195	49.5	53.8	-4.3

Nature

EMI Test at 115Vac&Full Load

EMI TEST REPORT

parameter

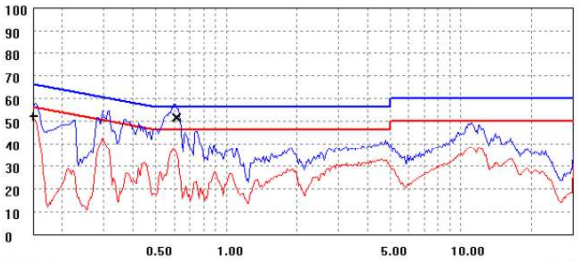
Organization:		Operator:		EUT:	
Place:		Time:	2021/5/11/17:39	Test equipment:	KH3962
Detector:	PK+AV	Test-time(ms):	30	SN:	620883
Limit:	EN55022B	Transductor[PK/AV]:	PK / AV	JZ:	2,15,666
Remark:					

freq, step

Start(MHz)	End(MHz)	Step(MHz)
0.150	2.000	0.002
2.000	10.000	0.010
10.000	30.000	0.025

scan result

dBuV



final test

(QP)	freq(MHz)	lev(dBuV)	Lim(dBuV)	Δ(lev-Lim)
	0.611	51.5	56.0	-4.5
(AV)	freq(MHz)	lev(dBuV)	Lim(dBuV)	Δ(lev-Lim)
	0.150	52.1	56.0	-3.9

Line

EMI TEST REPORT

parameter

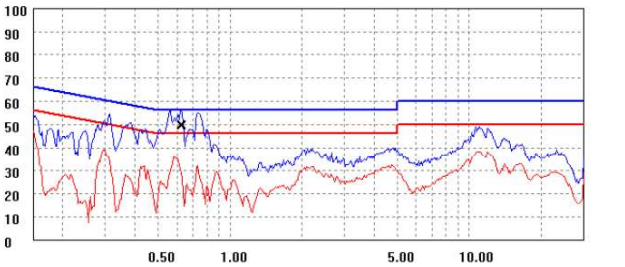
Organization:		Operator:		EUT:	
Place:		Time:	2021/5/11/17:44	Test equipment:	KH3962
Detector:	PK+AV	Test-time(ms):	30	SN:	620883
Limit:	EN55022B	Transductor[PK/AV]:	PK / AV	JZ:	2,15,664
Remark:					

freq, step

Start(MHz)	End(MHz)	Step(MHz)
0.150	2.000	0.002
2.000	10.000	0.010
10.000	30.000	0.025

scan result

dBuV



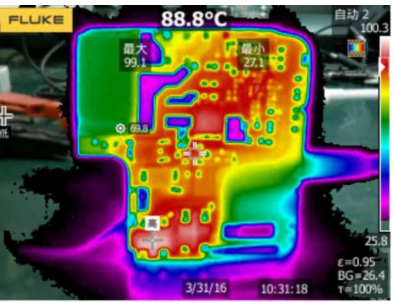
final test

(QP)	freq(MHz)	lev(dBuV)	Lim(dBuV)	Δ(lev-Lim)
	0.623	49.7	56.0	-6.3

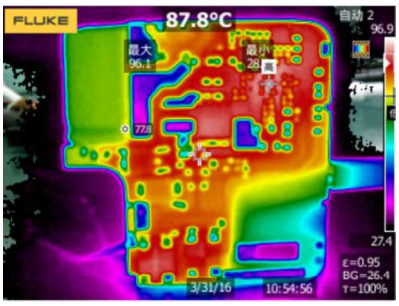
Nature

Thermal Camera(PCBA Test)

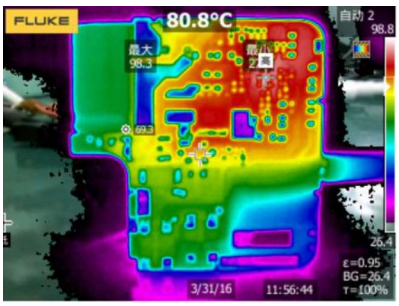
90Vac&20V5A



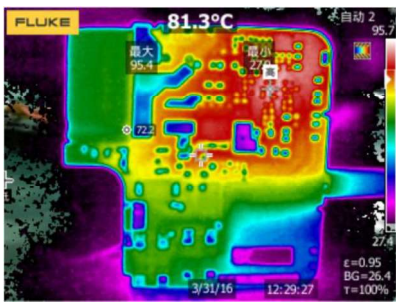
115Vac&20V5A

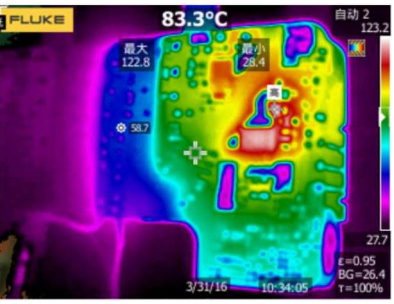


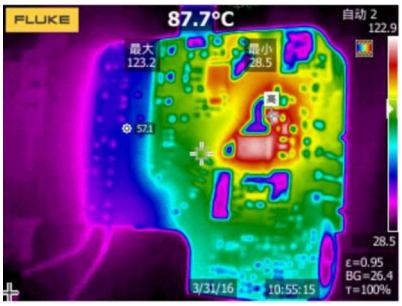
230Vac&20V5A

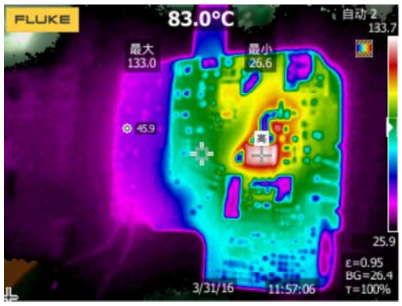


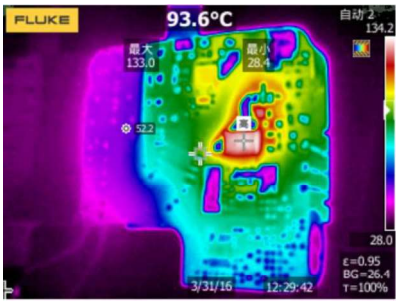
230Vac&20V5A







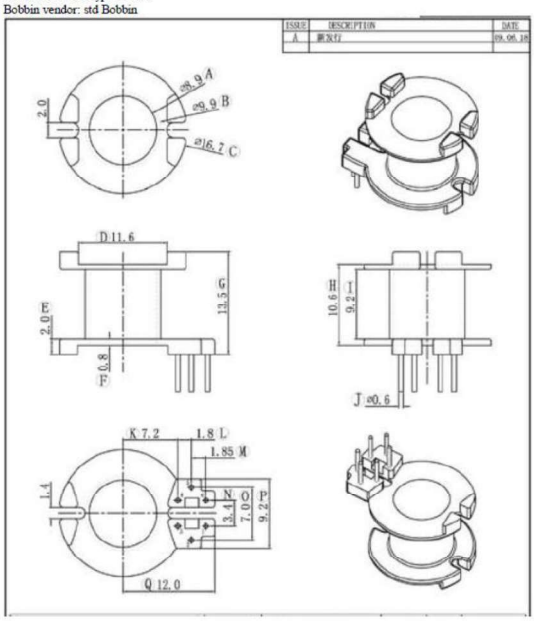




PFC Inductor Specification

1. Core and Bobbin

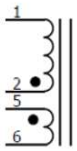
Core Type: RM8
Core material: 3C95(Ferroxcube)
Bobbin: 6Pin TH type bobbin
Bobbin vendor: std Bobbin



2. Electrical diagram

WD1=Primary, 40T, 30*0.1mm Litz

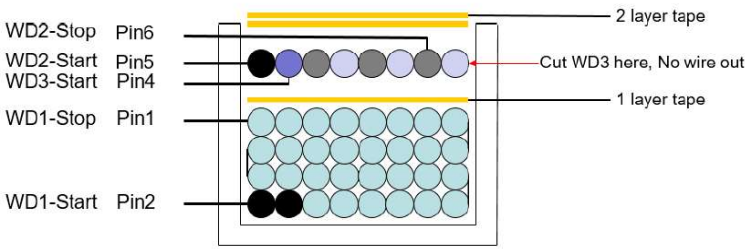
WD2=Auxiliary, 4T, 0.17mm
WD3=Shielding, 4T, 0.17mm



3. Electrical specification

Electrical Strength	Don't test	
Primary Inductance	Pins 1-2, all other windings open, measured at 10 kHz, 1V	200uH+/-10%

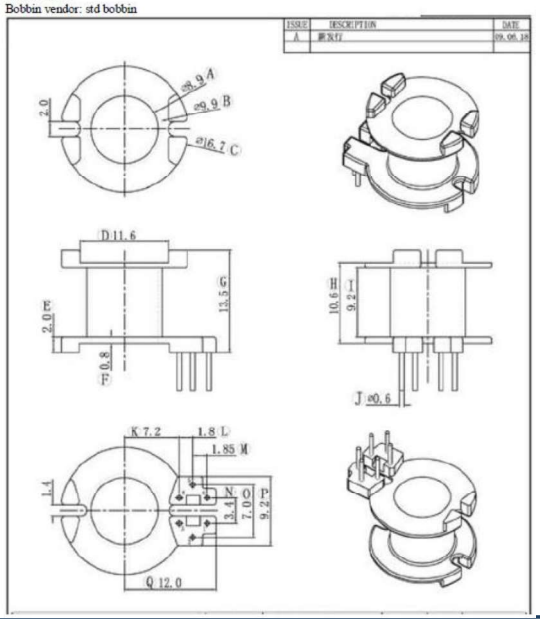
4. Transformer building construction diagram



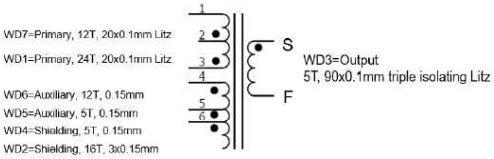
Transformer Specification

1. Core and Bobbin

Core Type: RM8
Core material: Ferroxcube 3C95
Bobbin: 6Pin
Bobbin vendor: std bobbin



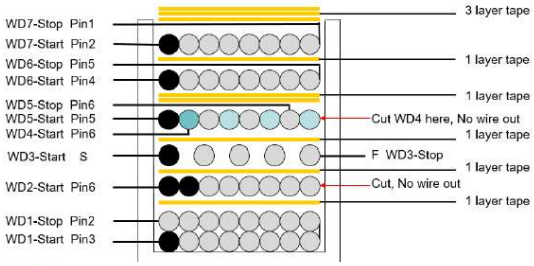
2. Electrical diagram

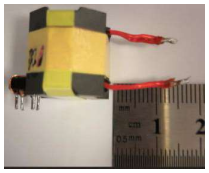


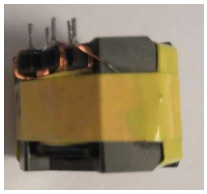
3. Electrical specification

Electrical Strength	Pin1, 2, 3, 4, 5, 6 to Pin S, F	3000V
Primary Inductance	Pins 1-3, all other windings open, measured at 10 kHz, 1V	220uH+/-10%

4. Transformer building construction diagram







5. Note

a. WD1,WD2,WD3,WD7 为一层密绕, WD4,WD5 绕组为双线并绕在一层，WD4/WD5 和 WD6 疏绕。
b. 飞线 S 从底部进,飞线 F 从顶部出。飞线 S 保留 1.5CM 的长度，飞线 F 保留 1CM 的长度（见图）
c. 磁芯外部顺绕线方向包一圈 7mm 宽铜带，铜带末端焊接闭合焊接并用导线把磁芯及铜带接 PIN8 地（见图）
d. 剪掉 Pin2 抽头多余的长度

Summary

- 2 stage PFC output and improve the efficiency at low line
- 2x PEM controller supports more large power transition while PFC starts to work at some power
- Comparing with QR controller, 68uF PFC capacitor is enough, so minimize capacitor's size and reduce cost