

ON Semiconductor

Is Now

onsemi™

To learn more about onsemi™, please visit our website at
www.onsemi.com

onsemi and **onsemi** and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi** product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.



ON Semiconductor

45W TYPE-C PD2.0 Power Adapter Solution

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1340B3 NCP43080D NTMFS6B03 ATP104	Smart phone, PAD and NB adapter supporting PD2.0 and QC2.0	90Vac to 264Vac	45W	Flyback	Isolated (3 kV)

	PD Output Specification	QC Output Specification
Output Voltage	5V, 9V, 12V, 15V, 20V	5V, 9V, 12V
Nominal Current	5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/2.25A	5V/3A, 9V/3A, 12V/3A
Max Current	5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/2.25A	5V/3A, 9V/3A, 12V/3A
Min Current	zero	zero

Avg. Efficiency	>90% @ 20V/2.25A at board end, 115&230Vac
Ripple	<100mV
Standby Power	<30mW @ 5V&230Vac (No cable plug in)
Power Density	1.15W/cm ³
Protection	Adaptive UVP, OVP, OVP, SCP, OTP
Size	57mmx36mmx19mm

Circuit Description

This design note describes a 45 watt, Type C interface PD2.0, universal AC input, constant voltage power supply intended for smart phone, PAD and NB adaptor supporting PD2.0 or QC2.0 protocol, where isolation from the AC mains is required, and low cost, high efficiency, and low standby power are essential.

The featured power supply is a simple QR flyback topology utilizing ON Semiconductor's NCP1340B3 HF PWM controller, NCP43080D synchronous rectified controller, NTMFS6B03 synchronous MOSFET and ATP104 Switch MOSFET. This Design Note provides the complete circuit schematic details, PCB and BOM for 45W Type C Interface PD2.0 Power adapter solution which supports PD output (5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/2.25A).

This design combined with CanYon's CY2211 PD2.0 protocol controller to provide PD2.0 and QC2.0 functions. This design also proposes a dual auxiliary power supply to supply PWM

controller, the PWM controller is supplied by high voltage auxiliary voltage at low output voltage and supplied by low voltage auxiliary voltage at high output voltage and also shuts down zener bias of high voltage Vcc while low voltage auxiliary voltage supplies controller.

This design also uses synchronous rectified controller to provide high efficiency and also uses an external Vcc pulse regulator to supply synchronous controller to ensure controller can works below 4v.

Key Features

- Universal AC input range (90 – 264 Vac)
- Very low standby (5V & 230Vac) power consumption with no cable plug in
- Very low ripple and noise
- Inherent SCP and OCP protection
- High operation frequency up to 150kHz
- High power density (1.15 W/cm³)
- Quick switching off FET while unplugging cable and switching on FET at Vbus dropping to 5v while plugging cable again
- Quasi-Resonant current mode control with Valley Switching
- Valley lockout avoids audible noise at valley jumping operation
- Support TYPE-C PD2.0&QC2.0 protocol
- Adaptive Output OVP and UVP
- Open loop protection
- Board size: 57mmx36mmx19mm

Block Diagram and BOARD Photos

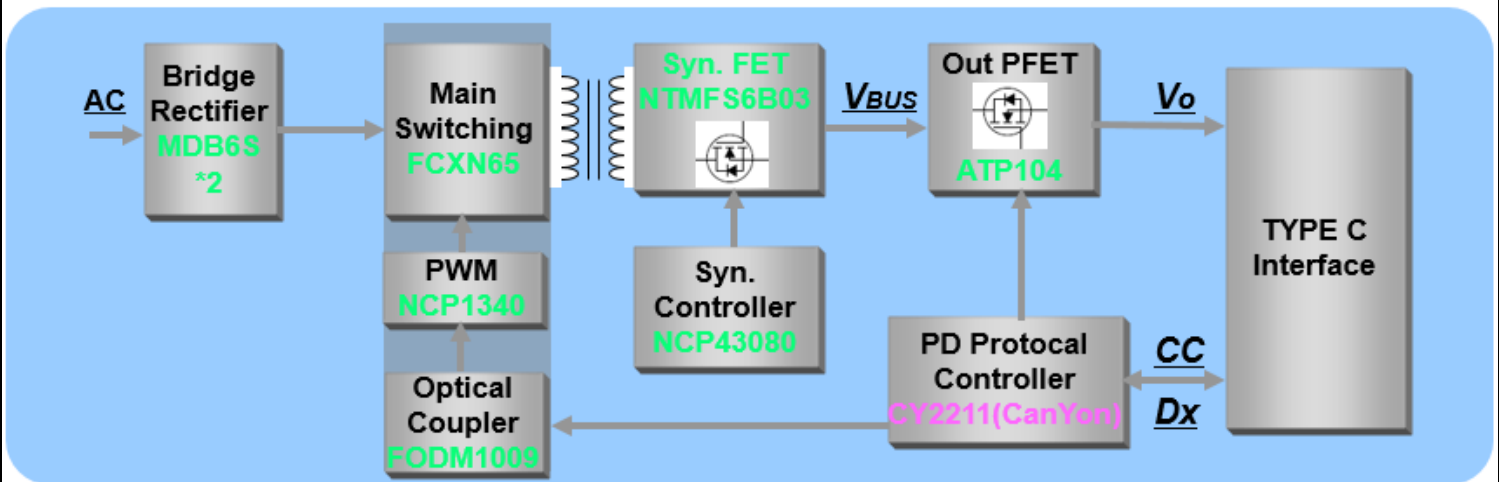


Figure 1, Overall cycle of 45W TYPE-C PD adapter Solution

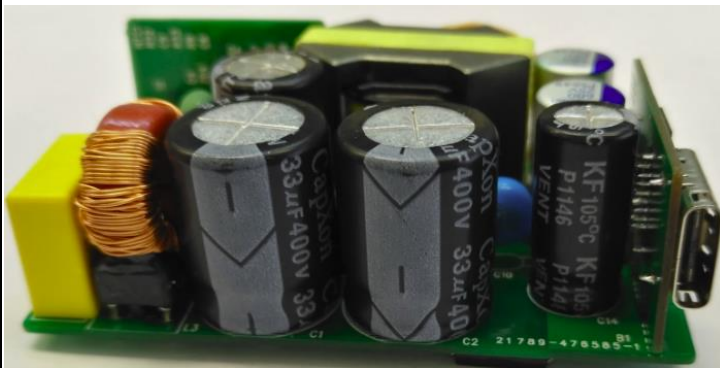


Figure 2, Side view 1 of demoboard

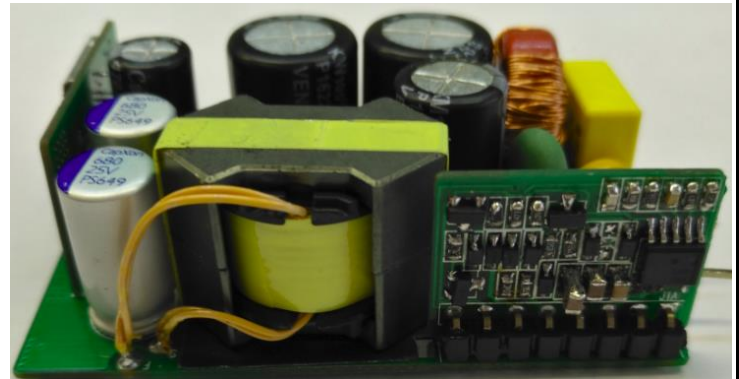
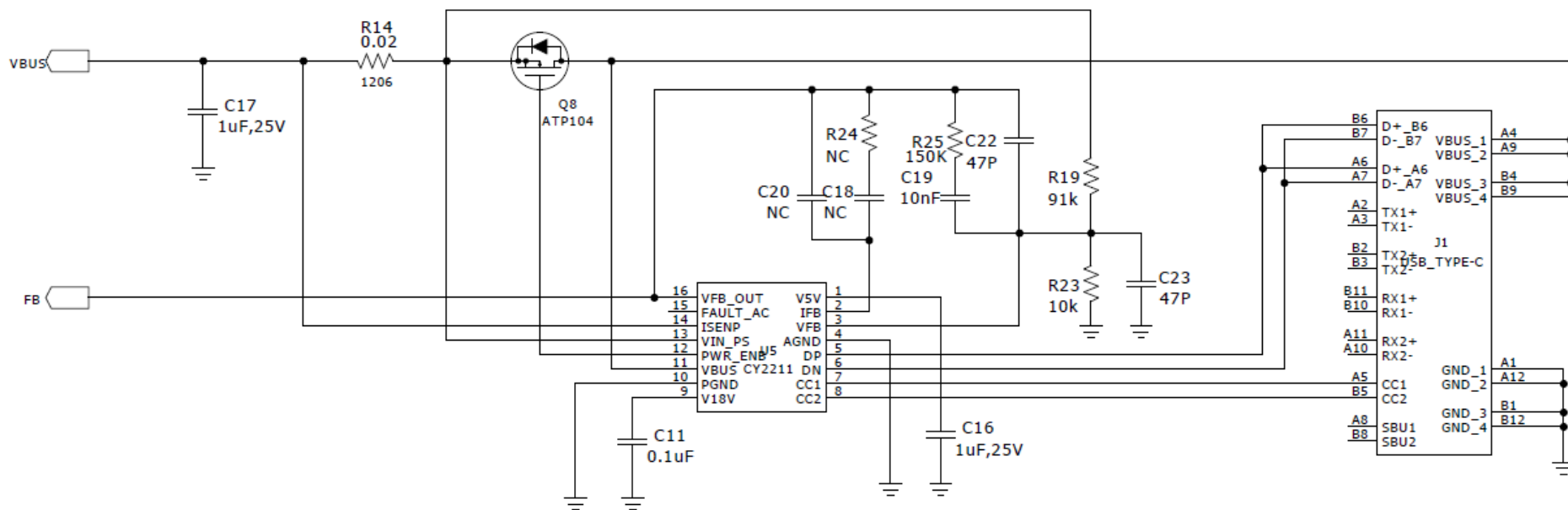


Figure 3, Side view 2 of demoboard

DN05100/D Circuit Schematic (Continued)



DN05100/D
PCB (Continued)

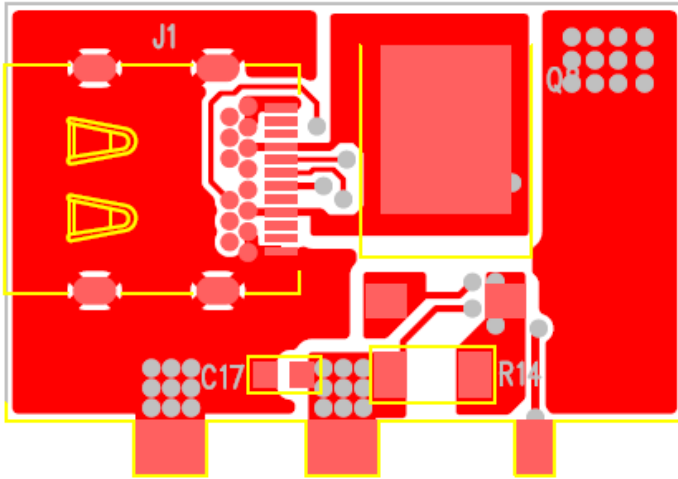


Figure 7, Top View of PD control board (CY2211)'s PCB

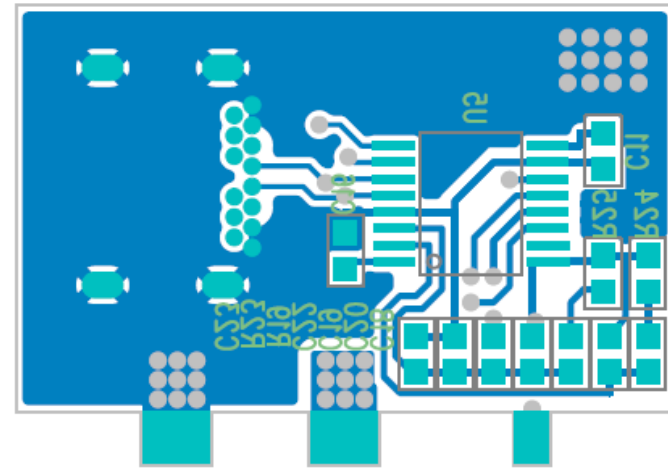



Figure 8, Bottom View of PD control board (CY2211)'s PCB

DN05100/D

T1 Transformer Designs (Available from Würth Electronics)

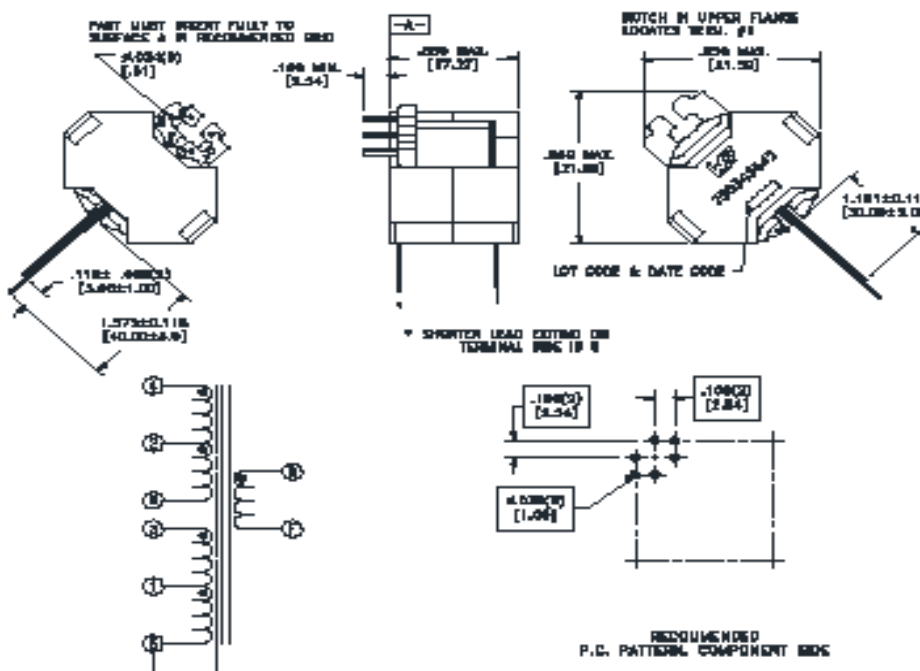
CUSTOMER TERMINAL	RoHS	LEAD(Pb)-FREE	
Sn 98%, Ag 4%	Yes	Yes	



ELECTRICAL SPECIFICATIONS @ 25° C unless otherwise noted:


PARAMETER	TEST CONDITIONS	VALUE
D.C. RESISTANCE	S-F @20°C	0.020 ohms max.
D.C. RESISTANCE	3-1 @20°C	0.325 ohms max.
D.C. RESISTANCE	1-5 @20°C	0.220 ohms max.
D.C. RESISTANCE	4-6 @20°C	0.585 ohms max.
INDUCTANCE	4-6 10kHz, 1V, Ls	360.00µH ±10%
LEAKAGE INDUCTANCE	4-6 tie(1+3+5+8+F), 100kHz, 100mV, Ls	6µH max.
DIELECTRIC	1-8 tie(1+6), 3750VAC, 1 second	3000VAC, 1 minute
DIELECTRIC	S-CORE 3750VAC, 1 second	3000VAC, 1 minute
TURNS RATIO	(4-6):(3-1)	4.33:1, ±2%
TURNS RATIO	(4-6):(1-5)	6.5:1, ±2%
TURNS RATIO	(4-6):(8-F)	6.5:1, ±2%

GENERAL SPECIFICATIONS:
 OPERATING TEMPERATURE RANGE: -40°C to +125°C including temp rise.
 Designed to comply with the following requirements as defined by IEC60050-1, EN60950-1, UL60950-1/CSA60950-1 and AS/NZS60950.1:
 - Reinforced insulation for a primary circuit at a working voltage of 265Vrms, 400Vpeak, Overvoltage Category II.



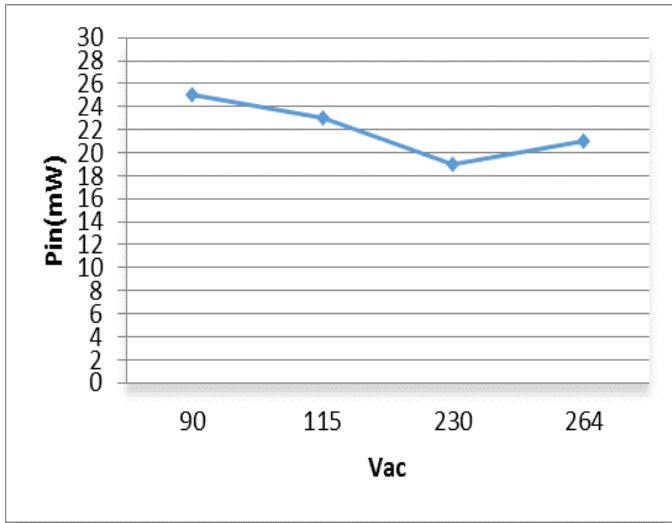
Key dimensions and notes from drawings:
 - PART MUST BEHOLD FULLY TO SURFACE & IN REINFORCED DRD: 4.05 ± 0.05 [0.16]
 - SWITCH IN UPPER FLANGE LOCATED TERM. #1: 2.04 ± 0.05 [0.80]
 - SHORTER LEAD EXTING ON TERMINAL BING TP 8: 1.57 ± 0.118 [0.0625 ± 0.0045]
 - RECOMMENDED P.C. PATTERN COMPONENT BDC: 4.03 ± 0.05 [1.00], 1.98 ± 0.05 [0.78], 1.98 ± 0.05 [0.78]

Wire Insulation & RoHS status not affected by wire color. Wire Insulation color may vary depending on availability.

DFM	Packaging Specifications	 CONVENTION PLACEMENT	Tolerances unless otherwise specified: Angles: ±1° Decimals: ±.005 [.13] Fractions: ±1/64 Footprint: ±.001 [.03]	DRAWING TITLE	PART NO.
DATE	Method: Tray		This drawing is dual dimensioned. Dimensions in brackets are in millimeters.	TRANSFORMER	750343542
ENG	NWA				
REV.	00				
DATE	4/11/2017				

Standby Power at 5V Output (Cable unplug) @ 90 Vac to 264 Vac Input

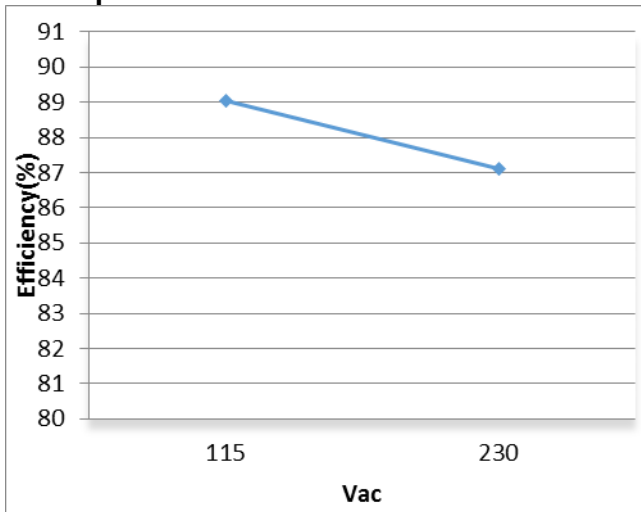
Test condition: all efficiency are tested at board end



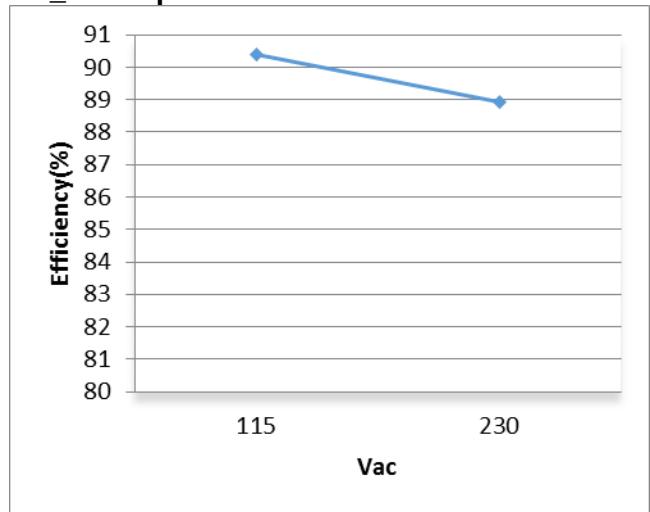
Average Efficiency @ 115 Vac & 230 Vac Input

Test condition: all efficiency are tested at board end

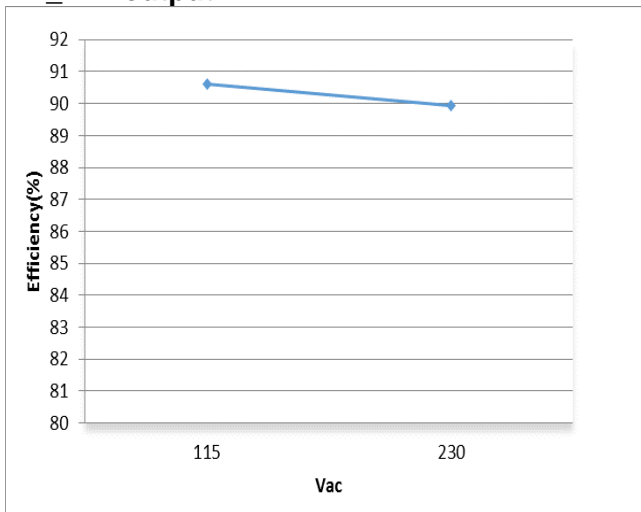
5V output



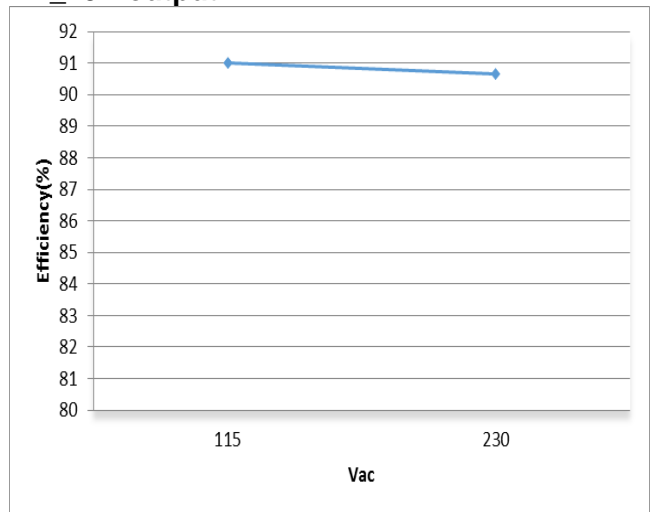
PD_9V output



PD_12V output



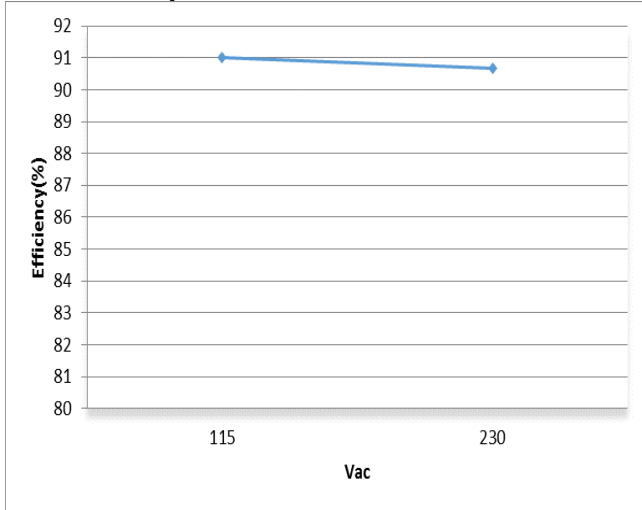
PD_15V output



Average Efficiency @ 115 Vac & 230 Vac Input (Continued)

Test condition: all efficiency are tested at board end

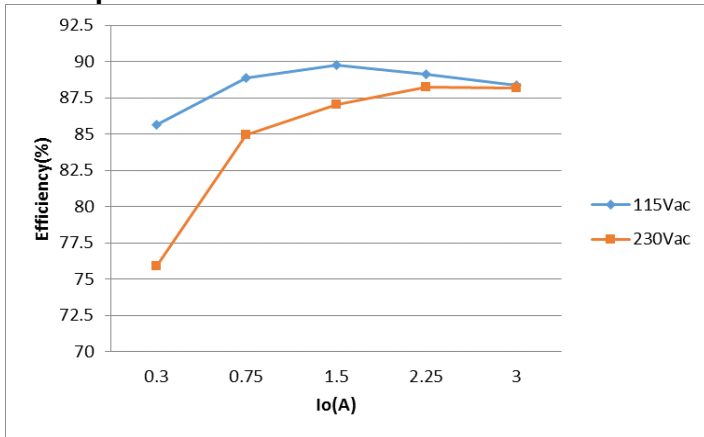
PD_20V output



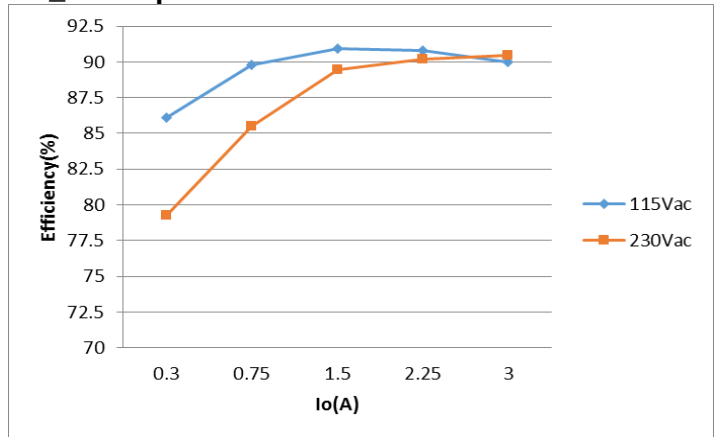
Efficiency vs Output Load Curves @ 115 Vac & 230 Vac Input

Test condition: all efficiency are tested at board end

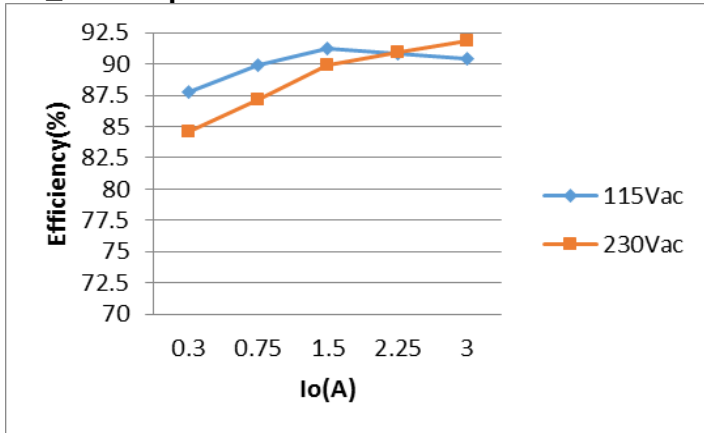
5V output



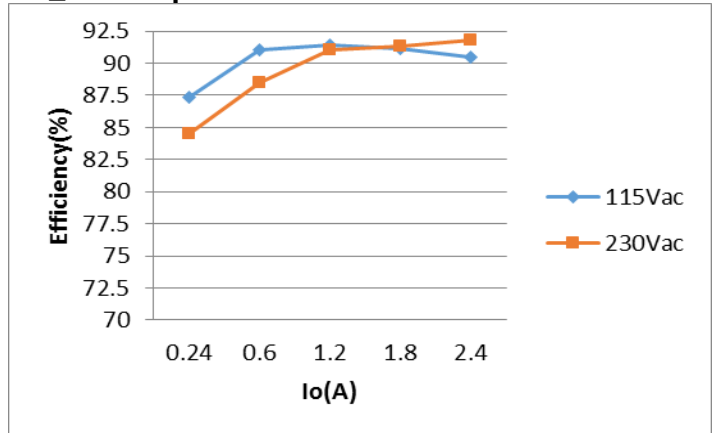
PD_9V output



PD_12V output



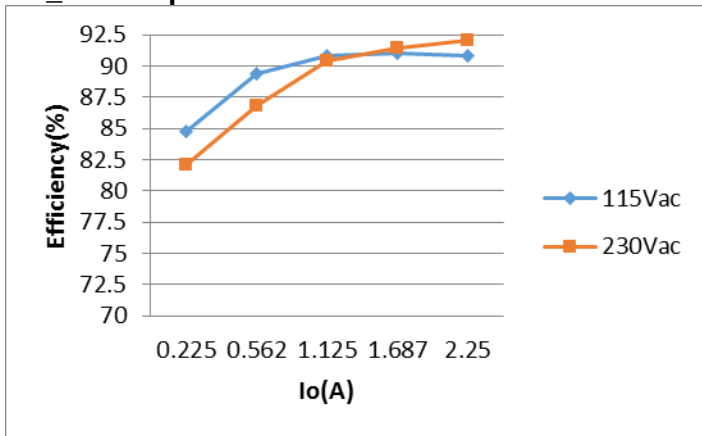
PD_15V output



Efficiency vs Output Load Curves @ 115 Vac & 230 Vac Input (Continued)

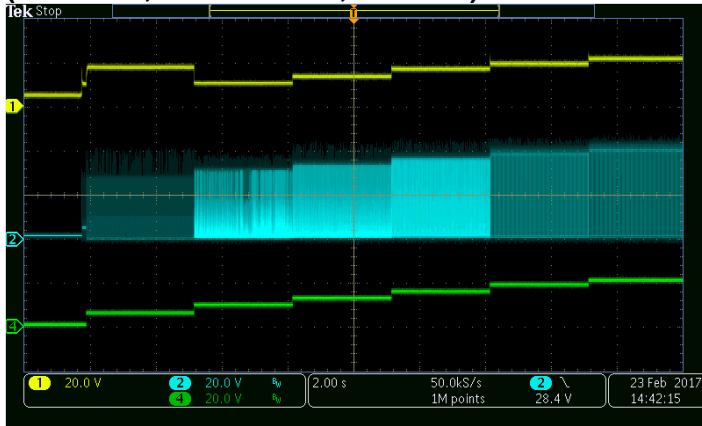
Test condition: all efficiency are tested at board end

PD_20V output



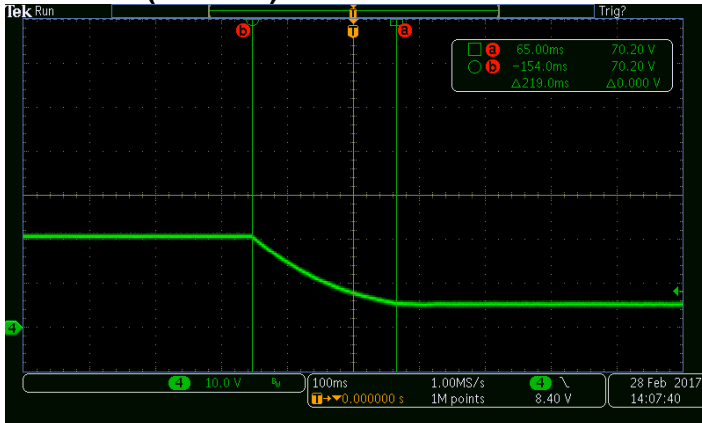
Power On and PD Voltage Change (5V > 9V > 12V > 15V > 18V > 20V)

(CH1: Vcc, CH2: Vte sec, CH4: Vo)



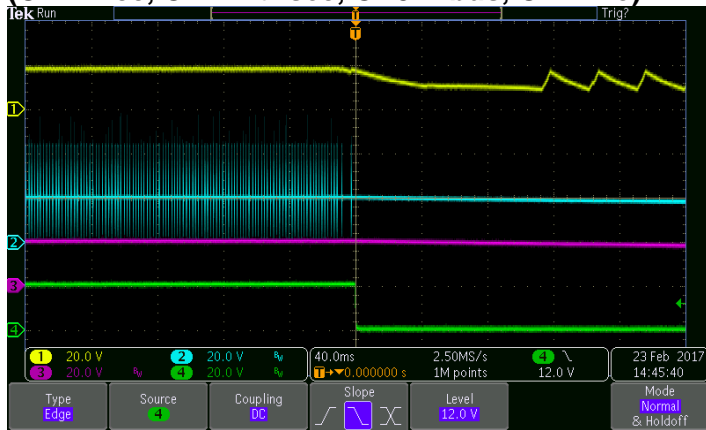
PD Transition with PD Emulator

20V to 5V (CH4: Vo)



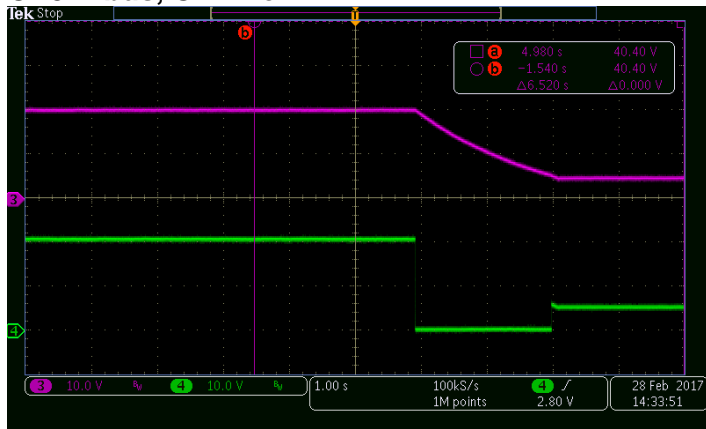
Discharge Time @ Unplug cable

PD (20V to 5V)
 (CH1: Vcc, CH2: Vtr sec, CH3: Vbus, CH4: Vo)



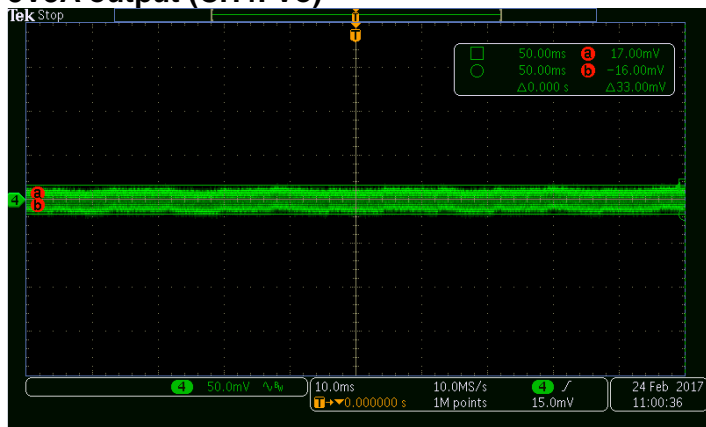
Quick Unplug/Plug Cable

CH3: Vbus, CH4:Vo

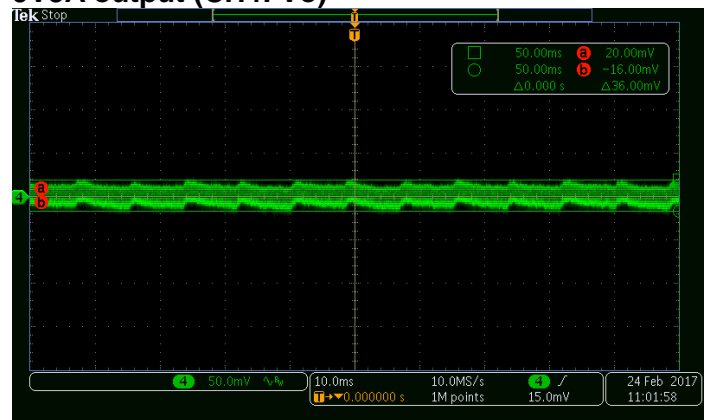


Output Ripple @ 90 Vac Input, 3A Output

5V3A output (CH4: Vo)

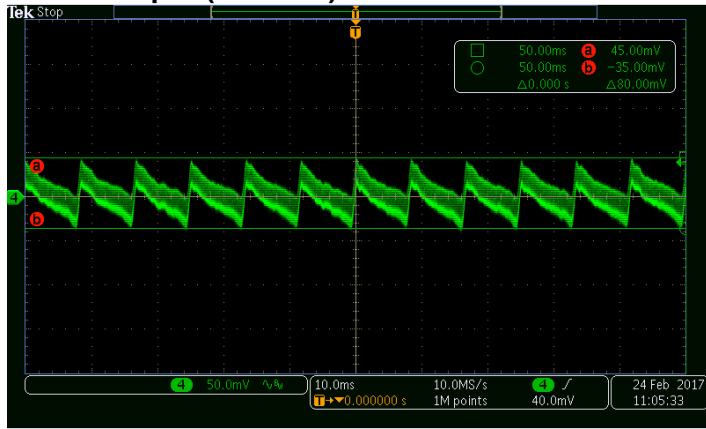


9V3A output (CH4: Vo)

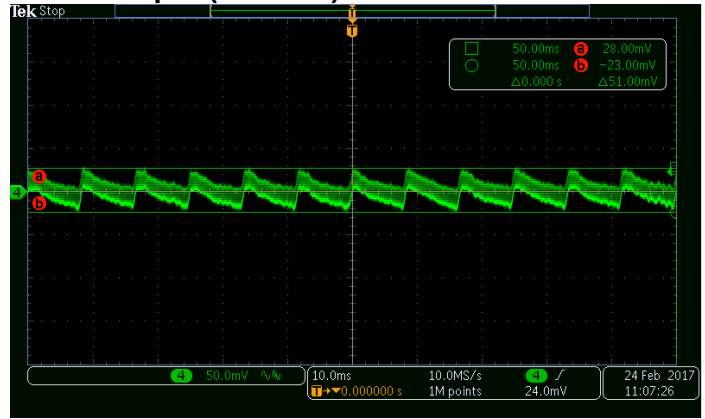


Output Ripple @ 90 Vac Input, 3A Output (Continued)

15V3A output (CH4: Vo)

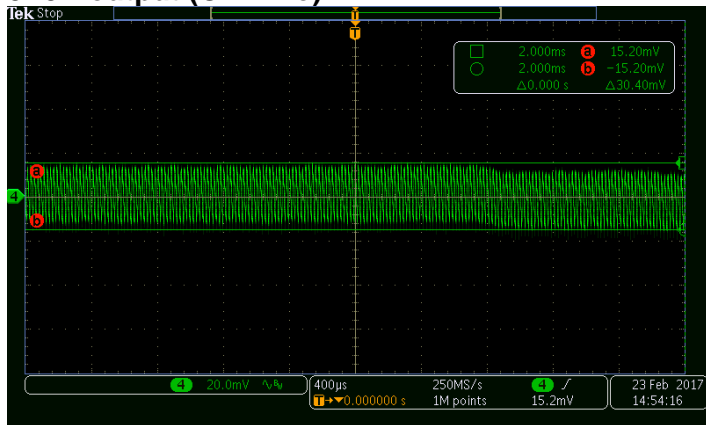


20V3A output (CH4: Vo)

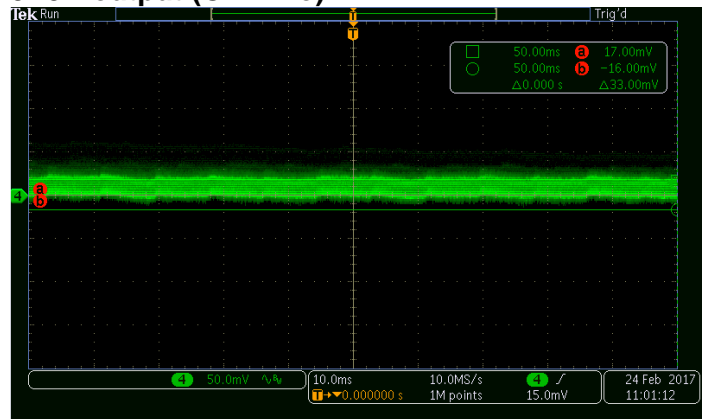


Output Ripple @ 115 Vac Input, 3A Output

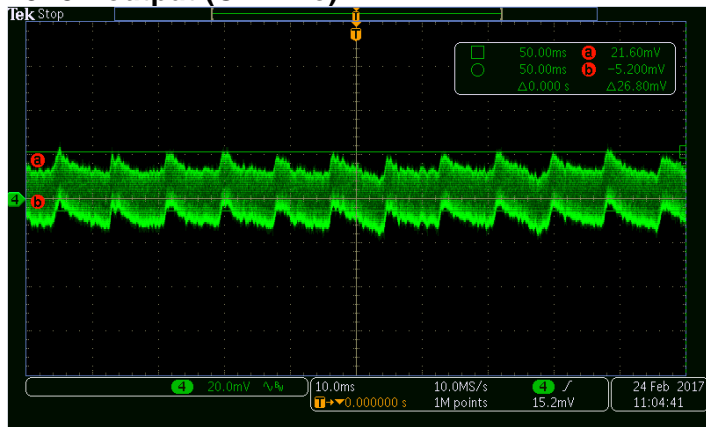
5V3A output (CH4: Vo)



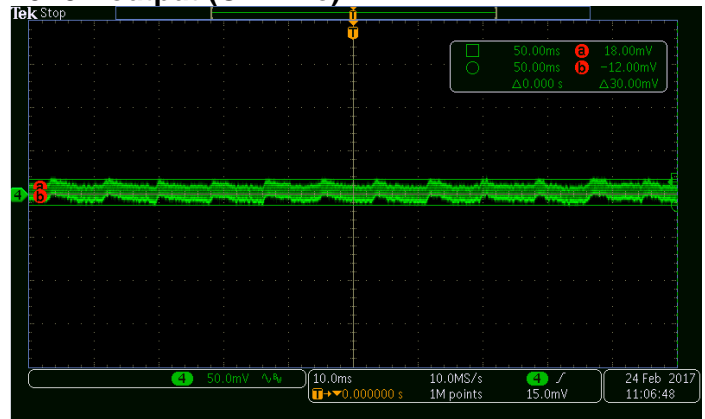
9V3A output (CH4: Vo)



15V3A output (CH4: Vo)

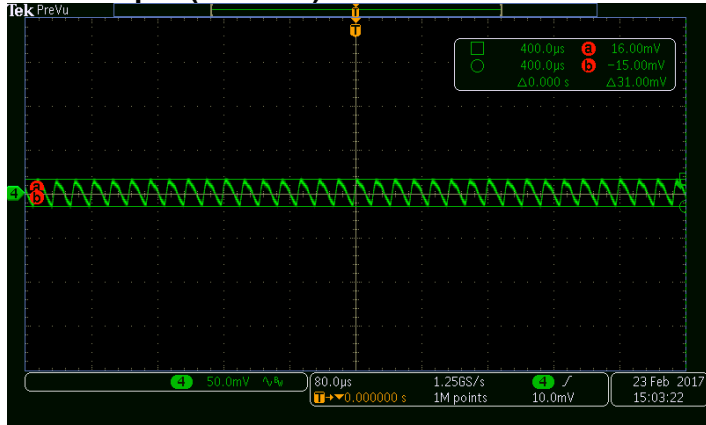


20V3A output (CH4: Vo)

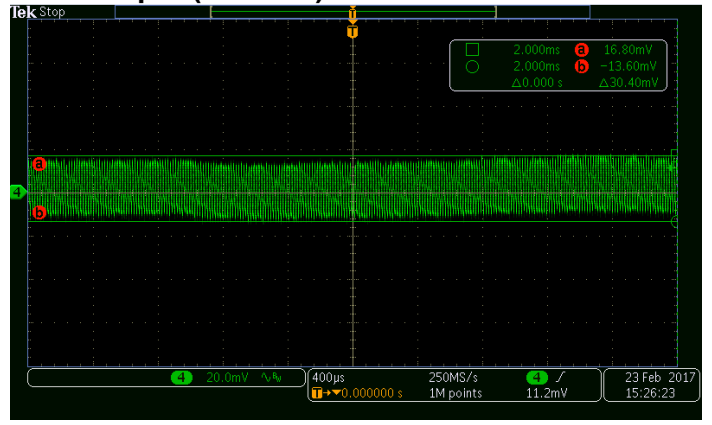


Output Ripple @ 230 Vac Input, 3A Output

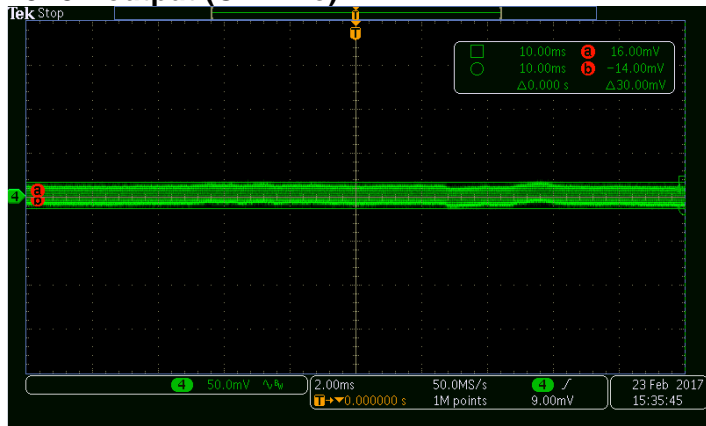
5V3A output (CH4: Vo)



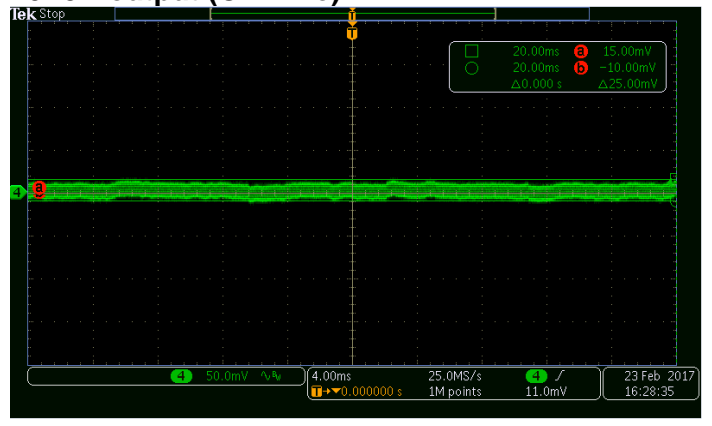
9V3A output (CH4: Vo)



15V3A output (CH4: Vo)

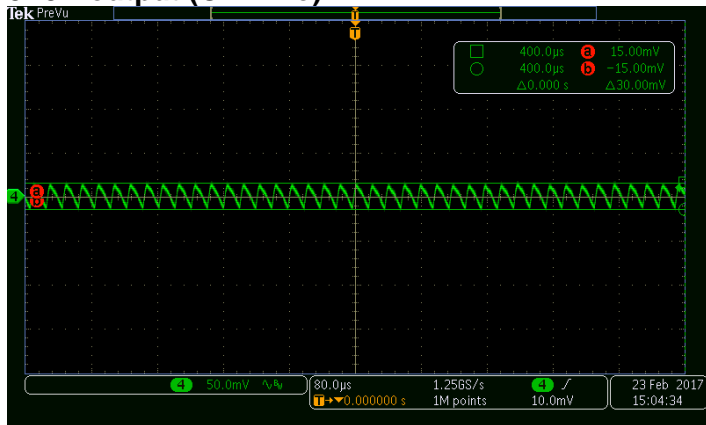


20V3A output (CH4: Vo)

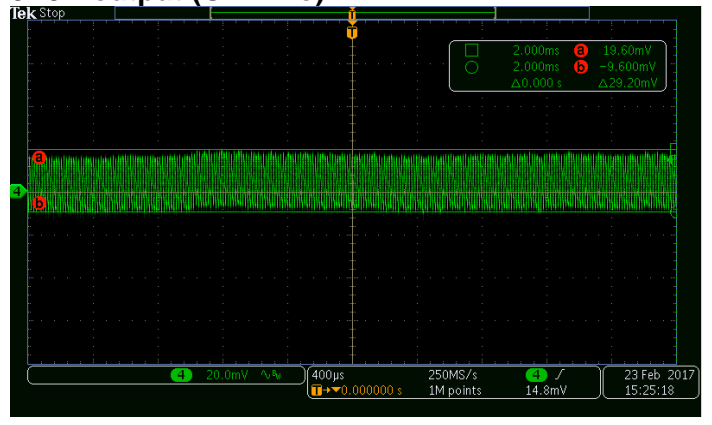


Output Ripple @ 264 Vac Input, 3A Output

5V3A output (CH4: Vo)

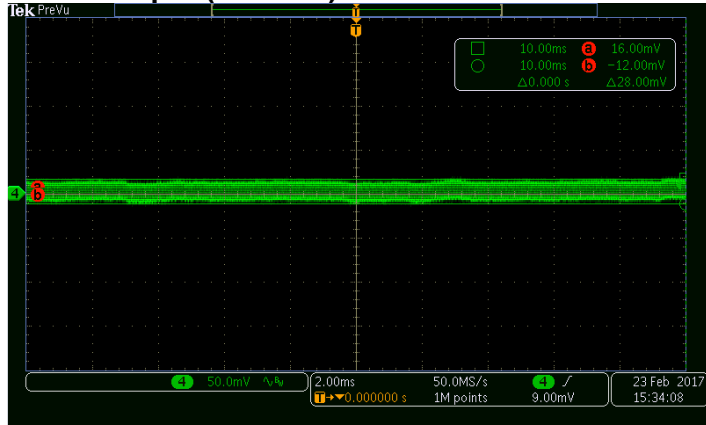


9V3A output (CH4: Vo)

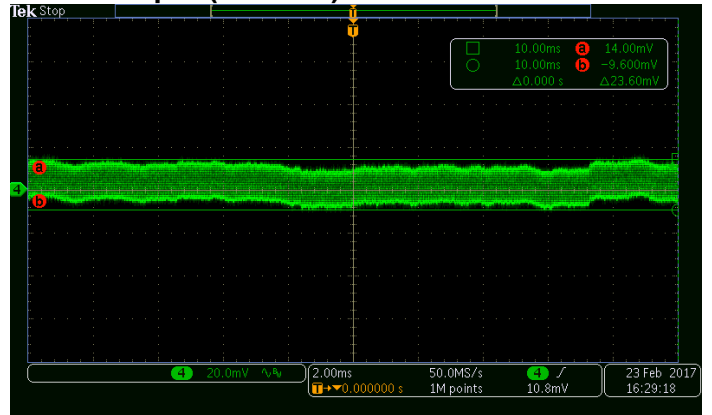


Output Ripple @ 264 Vac Input, 3A Output (Continued)

15V3A output (CH4: Vo)

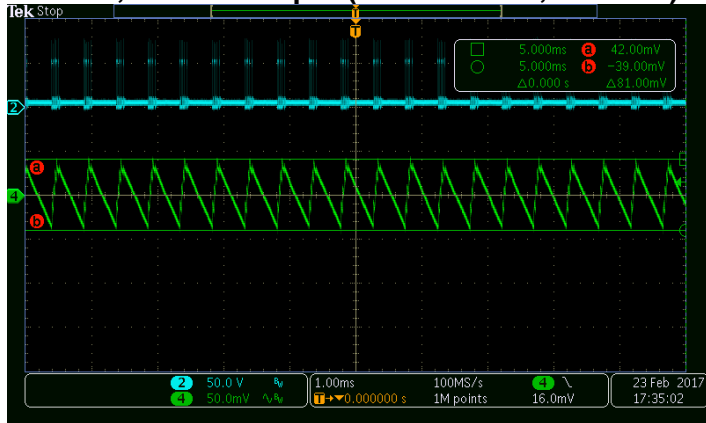


20V3A output (CH4: Vo)

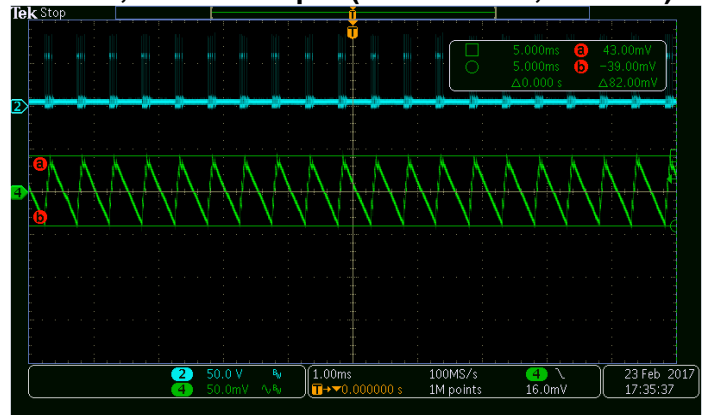


Output Ripple @ High Line & Light Load

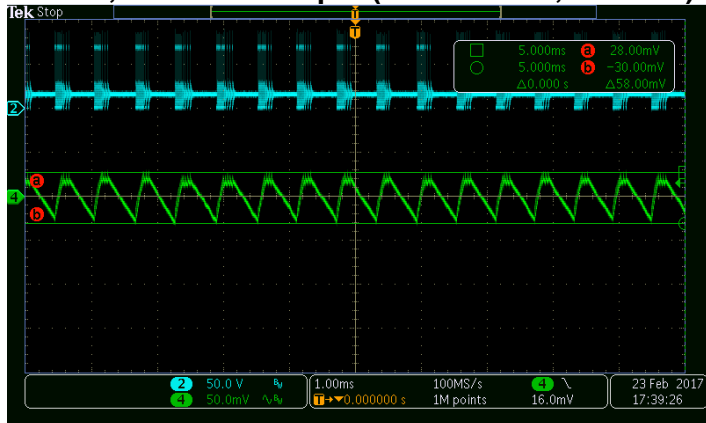
230Vac, 5V/0.3A output (CH2: Vtr sec, CH4: Vo)



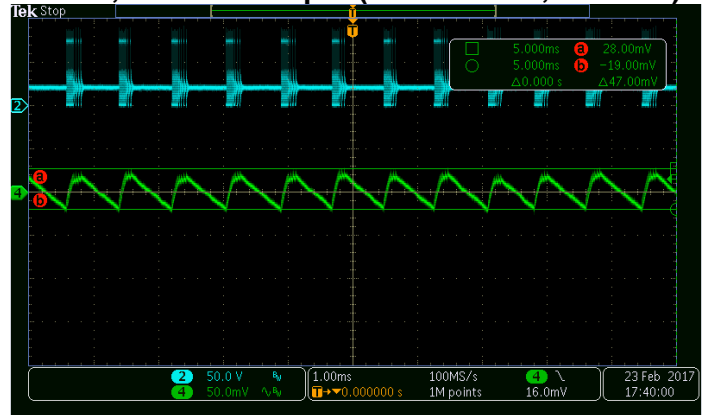
264Vac, 5V/0.3A output (CH2: Vtr sec, CH4: Vo)



264Vac, 15V/0.15A output (CH2: Vtr sec, CH4: Vo)

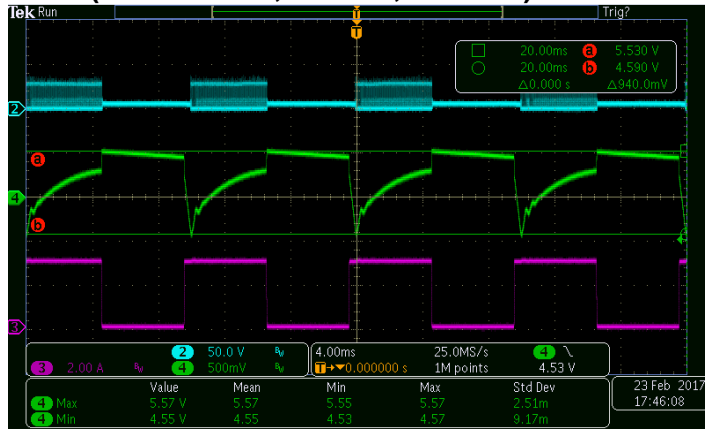


264Vac, 20V/0.1A output (CH2: Vtr sec, CH4: Vo)

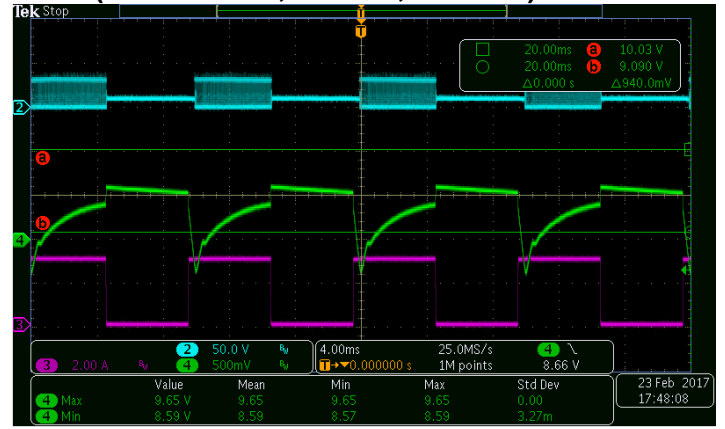


Dynamic Test @ 115 Vac Input

5V3A (CH2: Vtr sec, CH3: Io, CH4: Vo)



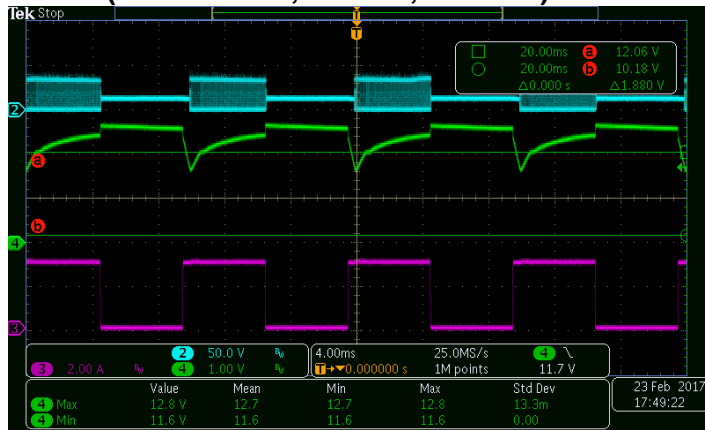
9V3A (CH2: Vtr sec, CH3: Io, CH4: Vo)



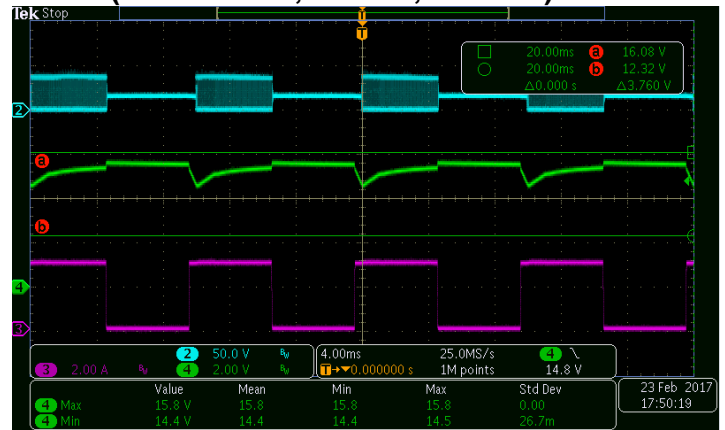
Test condition: 0-3A, 10mS cycle, 125mA/Us
1m cable, tested at E-load

Test condition: 0-3A, 10mS cycle, 125mA/Us
1m cable, tested at E-load

12V3A (CH2: Vtr sec, CH3: Io, CH4: Vo)



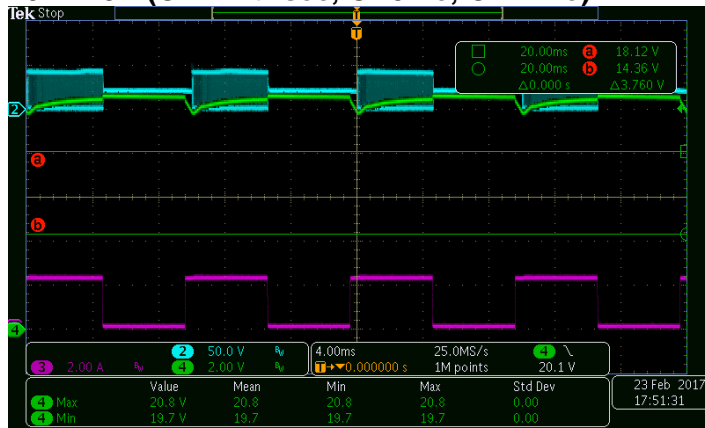
15V3A (CH2: Vtr sec, CH3: Io, CH4: Vo)



Test condition: 0-3A, 10mS cycle, 125mA/Us
1m cable, tested at E-load

Test condition: 0-3A, 10mS cycle, 125mA/Us
1m cable, tested at E-load

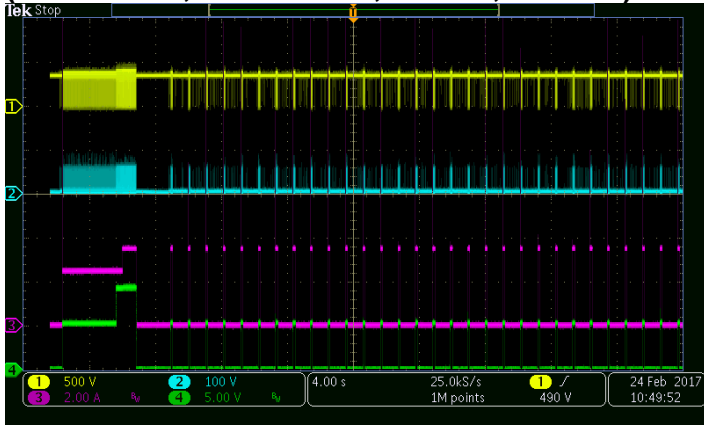
20V2.25A (CH2: Vtr sec, CH3: Io, CH4: Vo)



Test condition: 0-2.25A, 10mS cycle, 125mA/Us
1m cable, tested at E-load

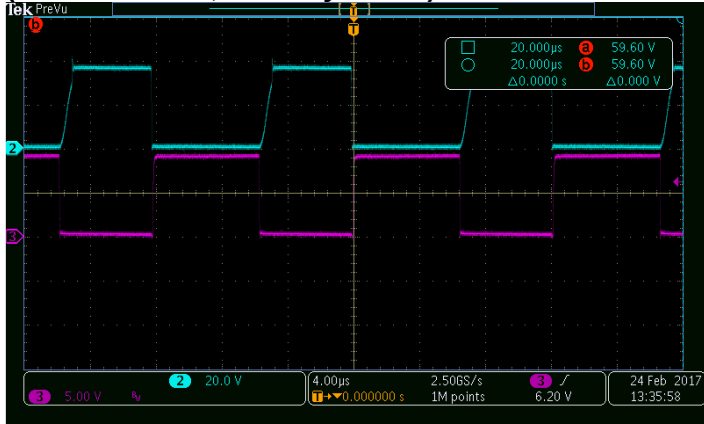
OCV @ 264 Vac Input, 9 Vdc Output

(CH1: Vdrain, CH2: Vtr sec, CH3: Io, CH4: Vo)

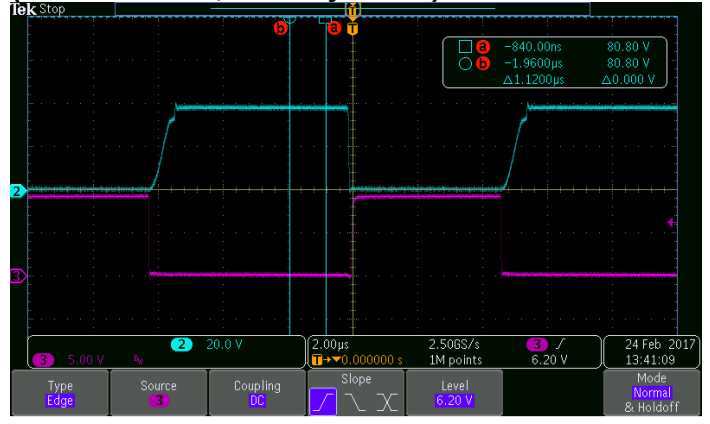


Synchronic Drive

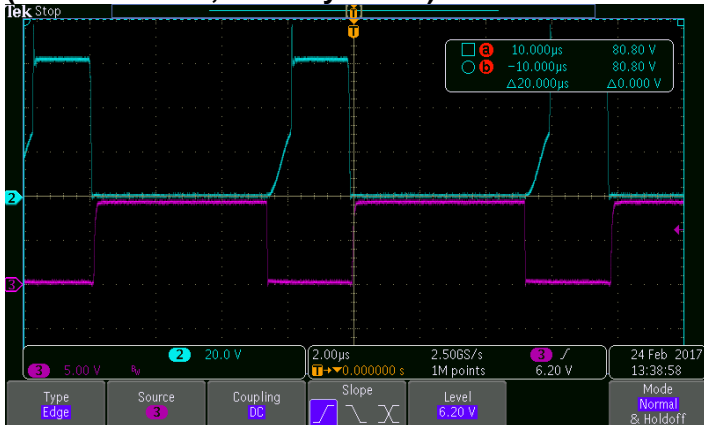
115 Vac input, 15V3A output
(CH2: Pri PWM, CH3: Syn DRV)



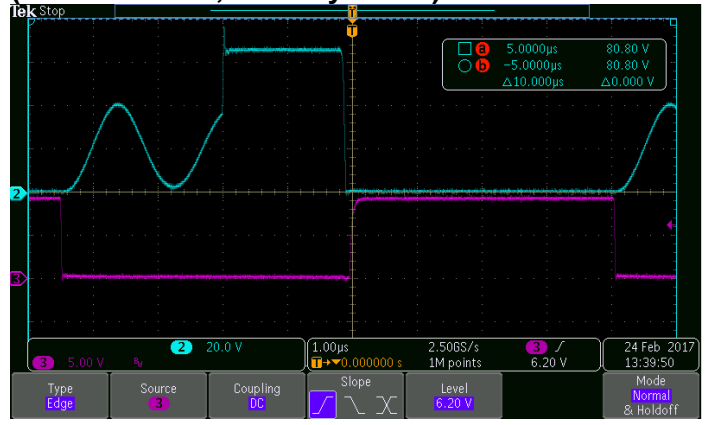
115 Vac input, 20V2.25A output
(CH2: Pri PWM, CH3: Syn DRV)



230 Vac input, 15V3A output
(CH2: Pri PWM, CH3: Syn DRV)

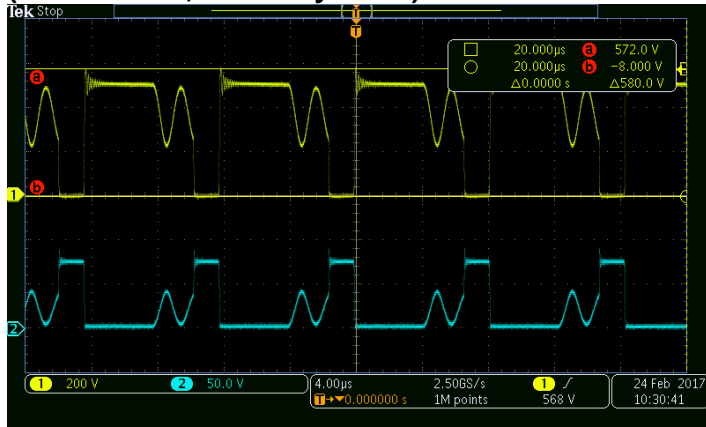


230 Vac input, 20V2.25A output
(CH2: Pri PWM, CH3: Syn DRV)



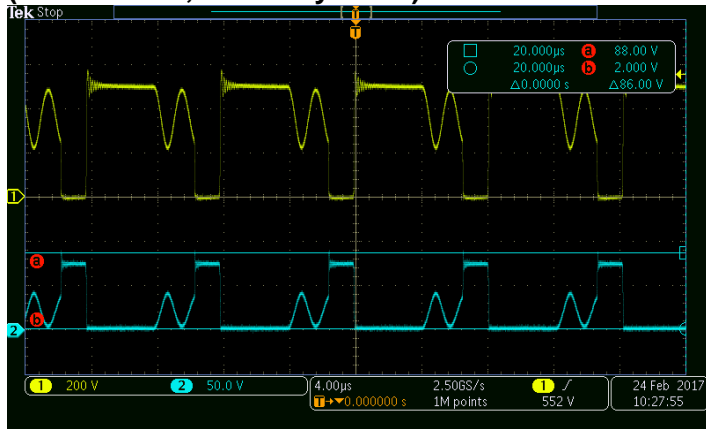
Primary FET Drain Voltage @ 264 Vax input, 20V2.25A output

(CH1: Vdrain, CH3: Vsyn FET)



Synchronic FET Drain Voltage @ 264 Vax input, 20V2.25A output

(CH1: Vdrain, CH3: Vsyn FET)



Thermal Image @ 20V2.25A Output

Input	Component Side	Back side
90 Vac		
115 Vac		
230 Vac		
264 Vac		

**DN05100/D
BOM**

Item	Qty	Reference	Type	Part Name	MFR	Value	Package	Description
1	1	C11	Ceramic Capacitor	std	std	0.1uF	603	Capacitor, Ceramic, 50V, 10%
2	1	C9	Ceramic Capacitor	Std	std	102	603	Capacitor, Ceramic, 50V, 10%
3	1	C26	Ceramic Capcitor	C3216X7T2W104K	TDK	104, 400V	1206	Capacitor, Ceramic, SMD, 5%
4	1	C19	Ceramic Capacitor	Std	std	10nF	603	Capacitor, Ceramic, 50V, 10%
5	1	C12	Ceramic Capacitor	C1608C0G2A102J	TDK	1nF, 100v	603	Capacitor, Ceramic, SMD, 5%
6	5	C15-17 C24 C27	Ceramic Capacitor	C1608X7R1E105K	TDK	1uF, 25V	603	Capacitor, Ceramic, 25V, 10%
7	1	C8	Ceramic Capacitor	C3216X7S2A225K	TDK	2.2uF, 100v	1206	Capacitor, Ceramic, 100V, 10%
8	1	C21	Ceramic Capacitor	C3216X7S2A225K	TDK	2.2uF, 100v	1206	Capacitor, Ceramic, 100V, 10%
9	1	C4	Ceramic Capacitor	C2012X7R1V475K	TDK	4.7uF, 35v	805	Capacitor, Ceramic, 35V, 10%
10	1	C3	Ceramic Capcitor	C3216C0G2J471J	TDK	470pF, 630V	1206	Capacitor, Ceramic, Chip, 5%
11	1	C10	Ceramic Capcitor	CS65-B2GA101KYNKA	TDK	470pF, Y1	Lead type	HV Ceramic, safety standard approved, 10%
12	2	C22-23	Ceramic Capacitor	Std	std	47P	603	Capacitor, Ceramic, 50V, 10%
13	1	C6	Ceramic Capacitor	Std	std	47p	603	Capacitor, Ceramic, 50V, 10%
14	1	C25	X2 Capcitor	/890334022017	Wueth	683, X2	THT, 7.5mm	X2 capacitor, Safety standard approved, 10%
15	2	C18 C20	Ceramic Capacitor	Std	std	NC	603	Capacitor, Ceramic, 50V, 10%
16	1	U5	PD controller	CY2211	CanYon		TSSOP16	CanYon PD protocol controller
17	1	D1//D3	Bridge rectifier	MDB6S	FSC	1A, 600V	Micro-DIP	Bridge Rectifier, 600V, 1A
18	1	DNR	Varistor	820573011	Wurth	10D471K	TH	Varistor, 10D471K
19	1	D6	Switching diode	BAS21HT1G	Vishay	0.2A, 250V	SOD323	Switching diode, SMD
20	4	D7 D10-11 D16	Switching diode	BAS21HT1G	ON	0.2A, 250V	SOD323	Switching diode, SMD
21	1	D4	Switching diode	BAT54HT1G	ON	0.2A, 30V	SOD323	Switching diode, SMD
22	1	D5	Ultrafast rectifier	US1JFA	ON (FSC)	0.8A, 600V	SOD123FL	Standard Rectifier, 0.8A, 600V
23	2	D12-13	Standard rectifier	RS1JFA	ON (FSC)	0.8A, 600V	SOD123FL	Standard Rectifier, 0.8A, 600V
24	2	D2 D14	Switching diode	BAS21HT1G	ON	NC	SOD323	Switching diode, SMD
25	1	D8	Switching diode	BAS21HT1G	ON	0.2A, 250V	SOD323	Switching diode, SMD
26	1	FB	Ferrite bead	UPZ2012E102-1R5TF	Sunlord/Wueth		805	1000ohm@100MHz
27	1	FB1	Ferrite bead	UPZ2012E601-2R0TF	Sunlord/Wueth		805	600ohm@100MHz
28	1	L3	Common filter	744821110	Wueth	10mH	TH type	CM Filter, T type core
29	1	L1	Common filter	150-1327	Wurth-Mi	500uH	TH	T type, 6.3x3x3, 11T, 0.2mmx2 in parallel winding
30	1	F1	Fuse	20T-016H	Hollyfus	1.6A, 250Vac	Axial lead	Micro Fuse, 1.6A/250V
31	1	Q4	NPN Transistor	MMBTA06LT1G	ON		SOT23	General NPN Transistor, SMD

**DN05100/D
BOM (Continued)**

Item	Qty	Reference	Type	Part Name	MFR	Value	Package	Description
32	2	Q6-7	NPN Transistor	MMBT3904LT1G	ON		SOT23	General NPN Transistor, SMD
33	1	Q3	NPN Transistor	MMBTA06LT1G	ON	NC	SOT23	General NPN Transistor, SMD
34	1	Q5	PNP Transistor	MMBT3906LT1	ON		SOT23	GENERAL PURPOSE PNP SILICON TRANSISTOR
35	1	U3	Syn. rectified co	NCP43080DDR2G	ON		S08	Syn. Rectified Controller
36	1	U1	PWM Controller	NCP1340B3D1R2G	ON		SOP9	PWM controller
37	1	NTC1	NTC	std	std	13k	603	13k 0603 resistor as a replacement
38	1	NTC	NTC	SPNL09D2R5MBI	Sunlord	2.5ohm	lead type	9mm Die, 2.5ohm
39	1	U4	Optical coupler	FODM1009	ON(FSC)		LSOP4	optical coupler, standard SOP package
40	1	Q8	PMOS	ATP104-TL-H	ON	-30V, 8.4mA	ATPAK	PMOS
41	1	L2	Axial leaded fixed	7447462470	Würth	47uH		Axial leaded fixed inductor
42	1	Q2	MOSFET	IPL60R385CP	Infineon		THINKPAK	MOSFET, NChan, 600V
43	1	R6	Resistor	Std	Std	1	603	Resistor, Chip, 1/8W, 1%
44	1	R13	Resistor	Std	Std	100K	603	Resistor, Chip, 1/8W, 1%
45	1	R7	Resistor	Std	Std	100k	603	Resistor, Chip, 1/8W, 1%
46	1	R35	Resistor	Std	Std	10K	603	Resistor, Chip, 1/8W, 1%
47	1	R8	Resistor	Std	Std	10k	603	Resistor, Chip, 1/8W, 1%
48	2	R18 R23	Resistor	Std	Std	10k	603	Resistor, Chip, 1/8W, 1%
49	1	R25	Resistor	Std	Std	150K	603	Resistor, Chip, 1/8W, 1%
50	1	R17	Resistor	Std	Std	18k	603	Resistor, Chip, 1/8W, 1%
51	1	R3	Resistor	Std	Std	1K	603	Resistor, Chip, 1/8W, 1%
52	1	R22	Resistor	Std	Std	1K	603	Resistor, Chip, 1/8W, 1%,
53	1	R9	Resistor	Std	Std	2k	603	Resistor, Chip, 1/8W, 1%
54	1	R11	Resistor	Std	Std	300	603	Resistor, Chip, 1/8W, 1%
55	1	R33	Resistor	Std	Std	39k	603	Resistor, Chip, 1/8W, 1%
56	2	R10 R34	Resistor	Std	Std	4.7	603	Resistor, Chip, 1/8W, 1%
57	1	R15	Resistor	Std	Std	47k	603	Resistor, Chip, 1/8W, 1%
58	1	R32	Resistor	Std	Std	68K	603	Resistor, Chip, 1/8W, 1%
59	1	R20	Resistor	Std	Std	750k	603	Resistor, Chip, 1/8W, 1%
60	1	R16	Resistor	Std	Std	75k	603	Resistor, Chip, 1/8W, 1%
61	1	R19	Resistor	Std	Std	91k	603	Resistor, Chip, 1/8W, 1%
62	1	R24	Resistor	Std	Std	NC	603	Resistor, Chip, 1/8W, 1%

References

ON Semiconductor datasheet for NCP1340/43080/, NTMFS6B03, ATP104

ON Semiconductor Design Notes DN05043

CanYon semiconductor datasheet for CY2211

Disclaimer: ON Semiconductor is providing this design note “AS IS” and does not assume any liability arising from its use; nor does ON Semiconductor convey any license to its or any third party’s intellectual property rights. This document is provided only to assist customers in evaluation of the referenced circuit implementation and the recipient assumes all liability and risk associated with its use, including, but not limited to, compliance with all regulatory standards. ON Semiconductor may change any of its products at any time, without notice.

Design note created by; e-mail: david.dou@onsemi.com