EVBUM2732/D

90 W Type-C PD3.0 / QC4.0 Power Adapter Solution with WT6636F Evaluation Board User's Manual

ON Semiconductor®

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EVAL BOARD USER'S MANUAL

Circuit Description

This evaluation board manual describes a 90 W, Type C interface PD3.0, universal AC input, constant voltage power supply intended for smart phone, PAD and NB adaptor supporting PD3.0 or QC4.0,QC4.0+,PPS protocol, where isolation from the AC mains is required, and low cost, high efficiency, and low standby power are essential.

The featured power supply has an optional boost follower PFC combining an Active Clamp Flyback topology utilizing ON Semiconductor NCP1622 CrM VSFF PFC controller, NCP1568 ACF controller, NCP51530 high speed high−bridge driver, NCP4306D synchronous rectified controller, FCMT299N60 PFC Switching FET, FDMT800120DC synchronous MOSFET and NTMFS4C05 PD Switch MOSFET. This EVB manual provides the complete circuit schematic details, PCB and BOM for 90 W Type C Interface PD3.0 Power adapter solution which supports PD output (5 V / 3 A, 9 V / 3 A, 12 V / 3 A, 15 V / 3 A, 20 V / 4.5 A).

Key Features

- Universal AC Input Range (90 – 264 Vac)
- <75 mW Standby (5 V & 230 Vac) Power Consumption with No Cable Plug In
- High Efficiency at Full Load
- Inherent SCP and OCP Protection
- Quick Switching Off FET while unplugging Cable and Switching On FET at Vbus dropping to 5 V while plugging Cable again
- Optional Boost follower PFC Control
- Active Clamp Flyback Topology with Peak Current Mode Control
- High Frequency Operation
- High Power Density (1.27 W/cm^3)
- Support TYPE−C PD3.0 & QC4.0,QC4.0+,PPS Protocol
- Adaptive Output OVP and UVP
- Two Stage OCP for 15 V and 20 V Output
- Open Loop Protection
- Compact Profile with Board Size 63 x 63 x 21 mm

	PD Output Specification	QC Output Specification
Output Voltage	5 V, 9 V, 12 V, 15 V, 20 V	5 V, 9 V, 12 V
Nominal Current	5 V / 3 A, 9 V / 3 A, 12 V / 3 A, 15 V / 3 A, 20 V / 4.5A	5 V / 3 A, 9 V / 3 A, 12 V / 2.67 A
Max Current	5 V / 3 A, 9 V / 3 A, 12 V / 3 A, 15 V / 3 A, 20 V / 4.5A	5 V / 3 A, 9 V / 3 A, 12 V / 2.67 A
Min Current	Zero	Zero
Avg. Efficiency	>91% @ 20 V / 4.5 A at board end, 115 & 230 Vac	
Ripple	<150 mV @ 5 V	
Standby Power	<75 mW @ 5 V & 230 Vac (No cable plug in)	
Power Density	1.27 W/cm^3	
Protection	Adaptive UVP, OVP, SCP, OTP	
Size	63 mm x 63 mm x 21 mm	

ON Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1622AEC NCP1568B06ABDR2G NCP151530AMNTWG NCP4306AADZZZADR2G FCMT299N60 FDMT800120DC NTMFS4C05NT1G	Smart phone, PAD and NB adapter supporting PD3.0, QC4.0, QC4.0+, PPS	90 Vac to 264 Vdc	90 W	CrM PFC with VSFF control / Active clamp Flyback	Isolated (3 kV)

Block Diagram and Board Photos

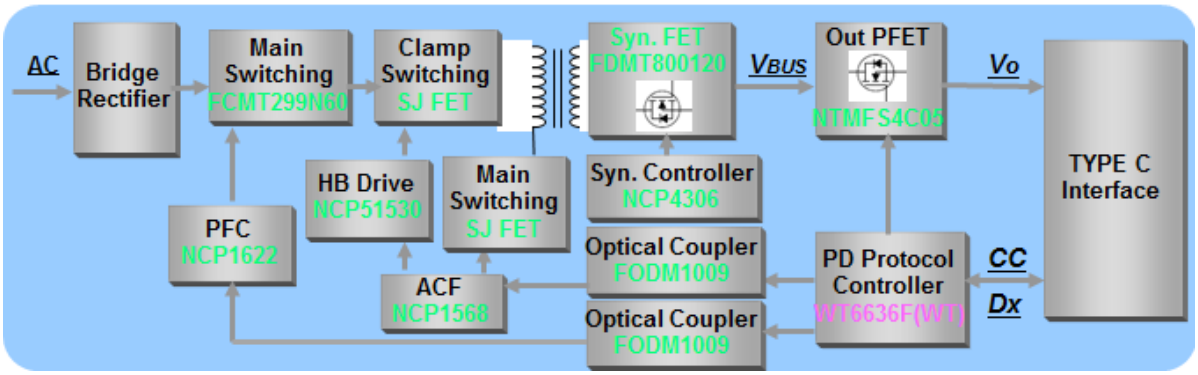
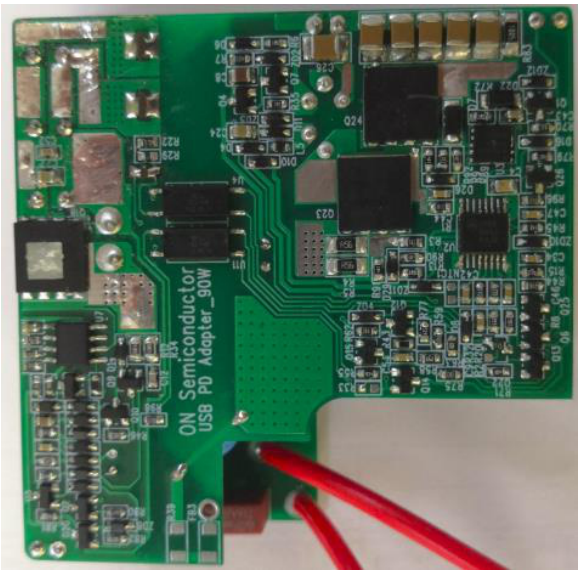
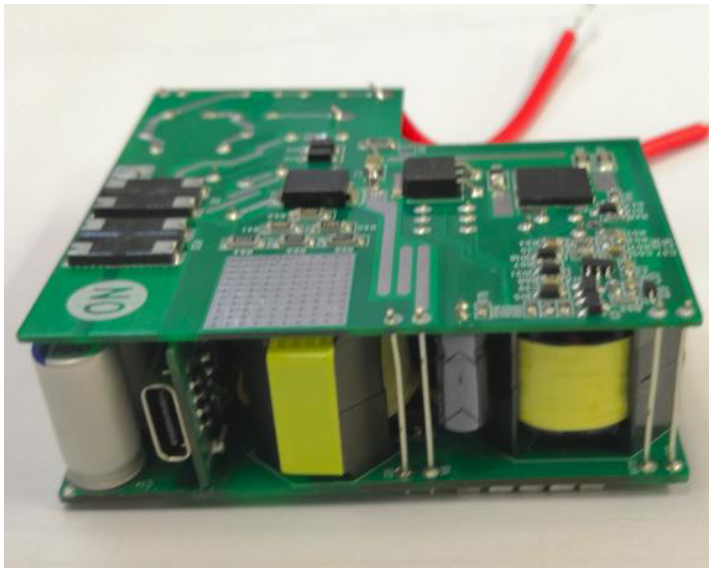


Figure 1. Overall Cycle of 90 W TYPE−C PD Adapter Solution



Top View of Evaluation Board



Side View of Evaluation Board

Figure 2. Evaluation Board Photos

CIRCUIT SCHEMATIC

Note: For detailed version, see separate Schematic PDF

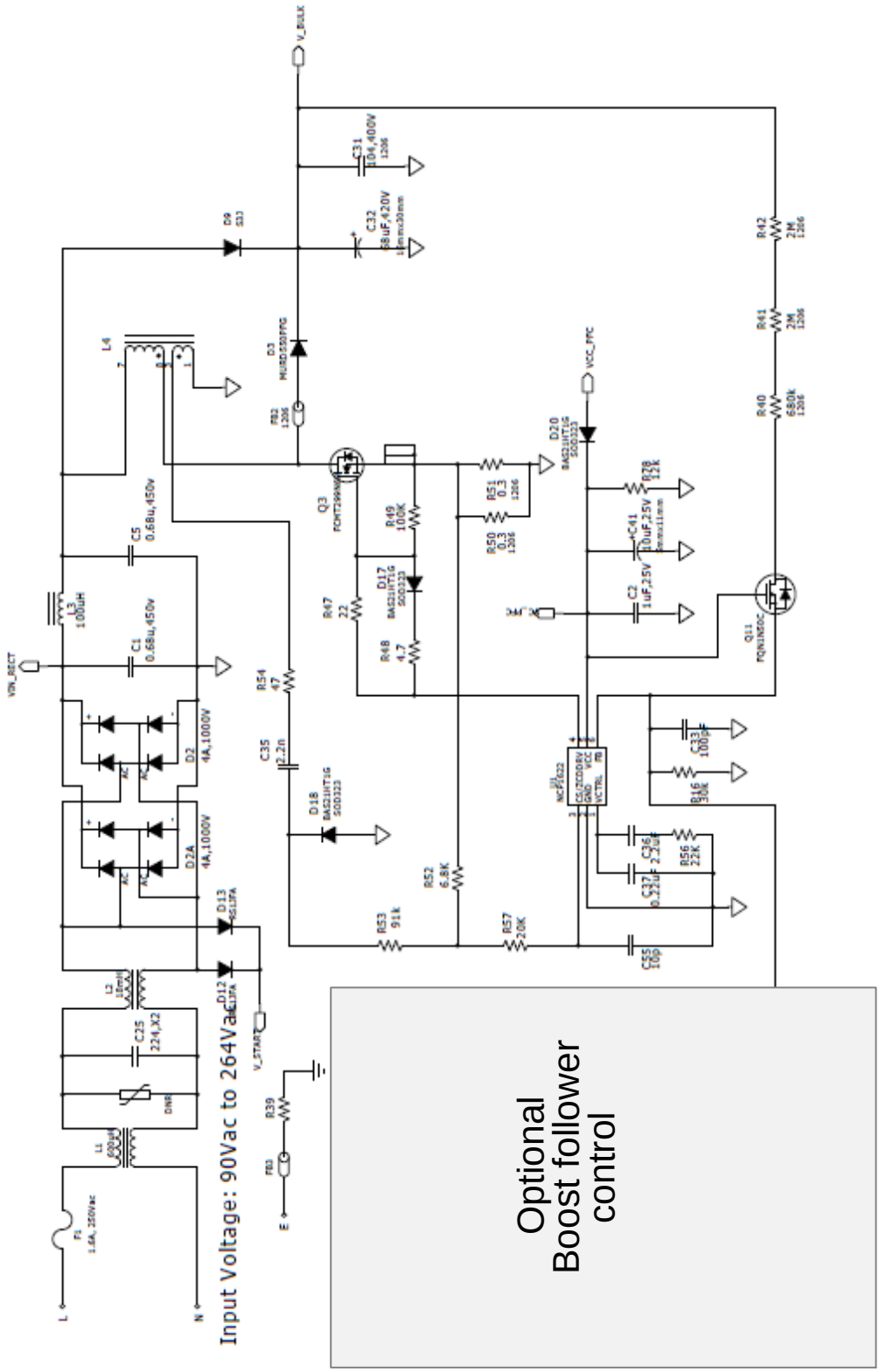


Figure 3. Circuit Schematic

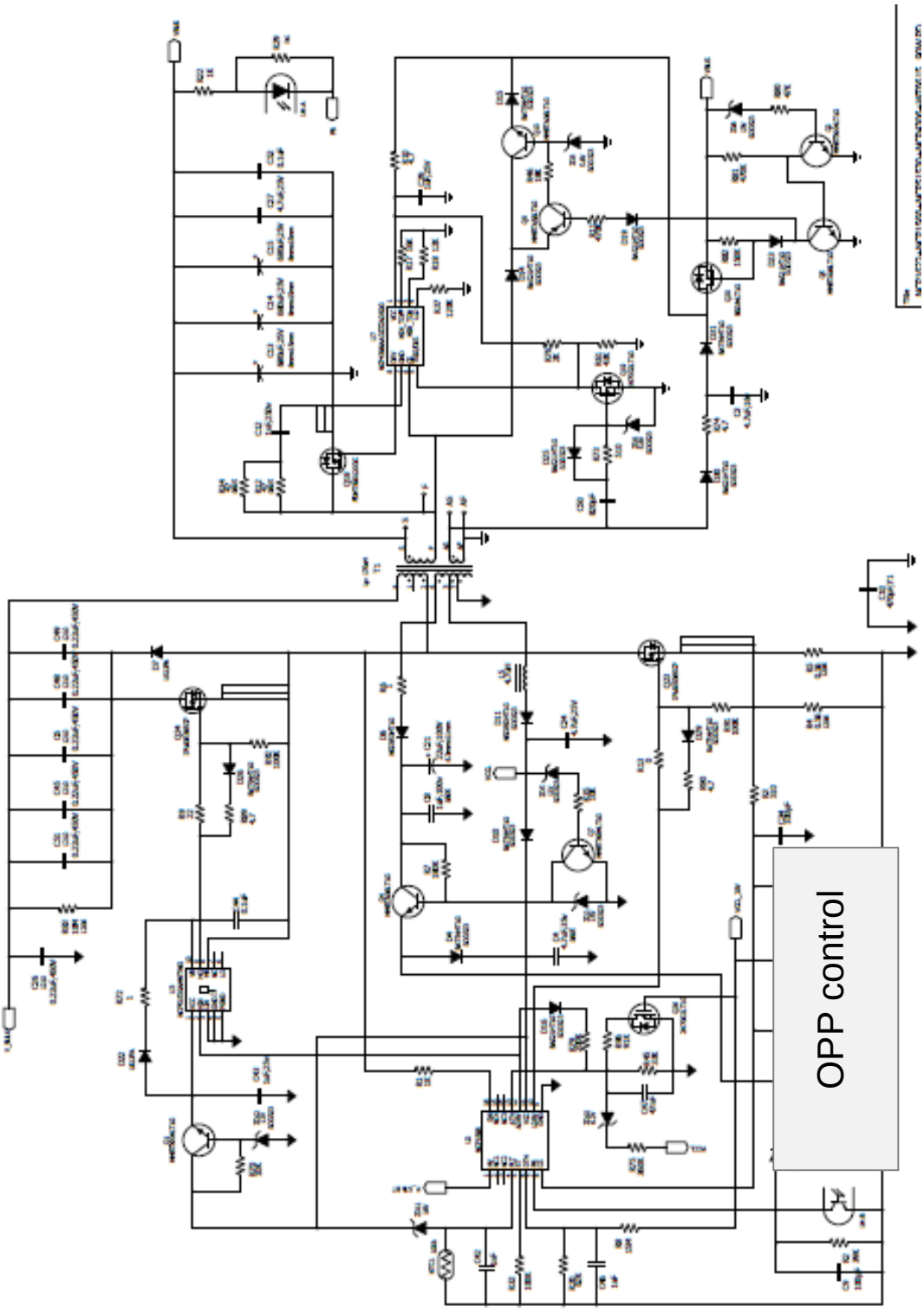


Figure 4. Circuit Schematic (continued)

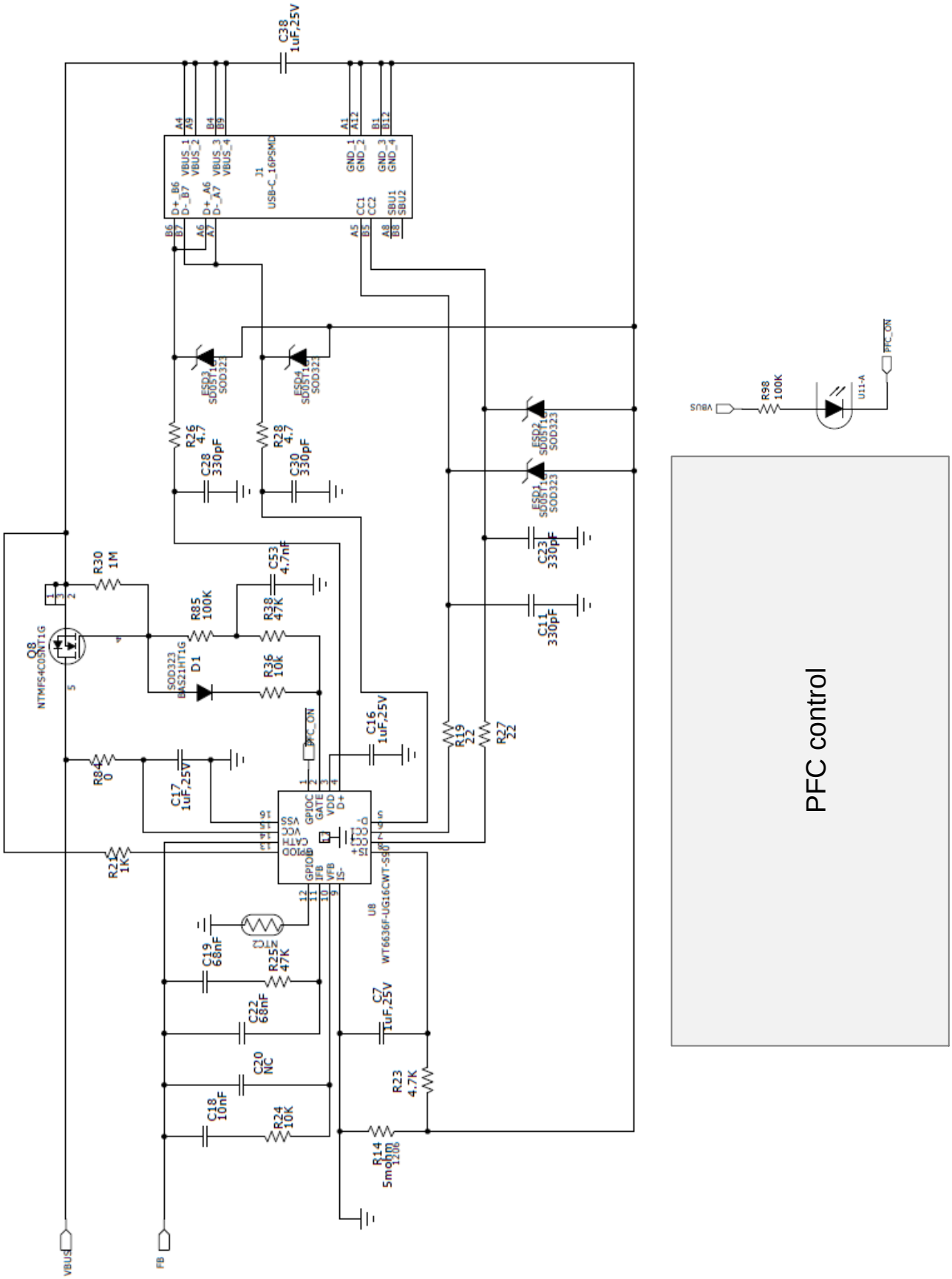


Figure 5. Circuit Schematic (continued)

PCB

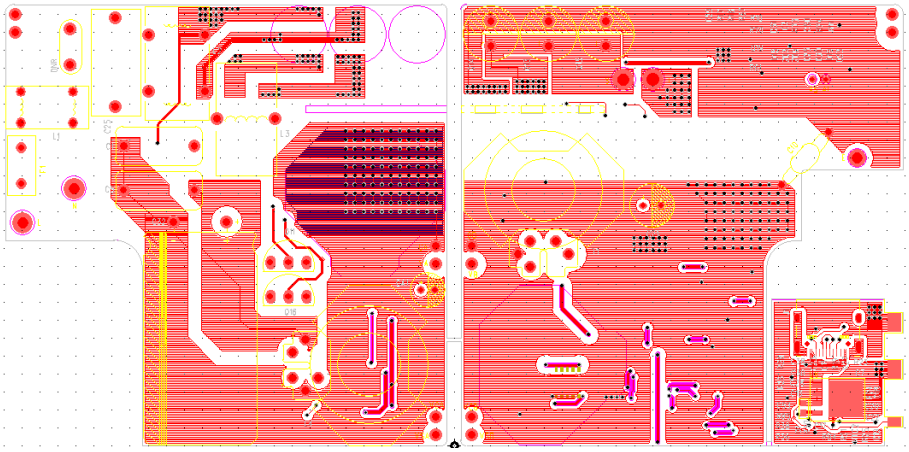


Figure 6. Top View of PCB

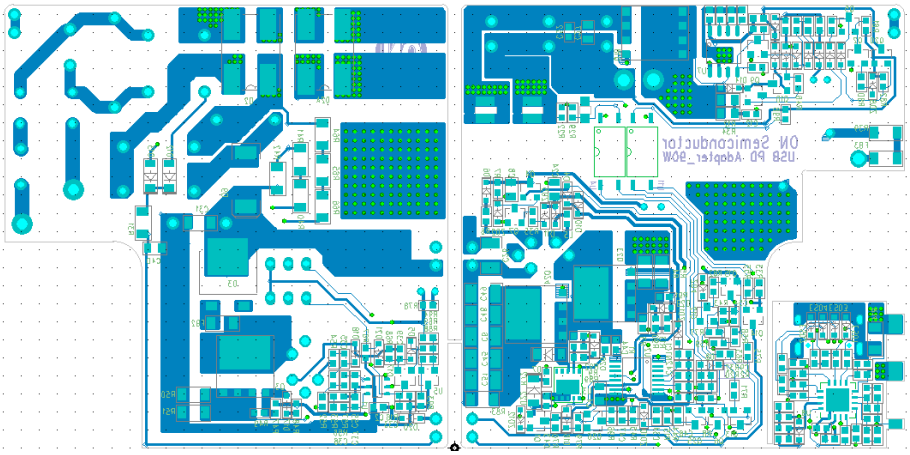


Figure 7. Bottom View of PCB

PFC Inductor Designs (available from Wurth Electronics)

Core Type: RM8
Core Material: PC95, TPW33 or equivalent
Bobbin: 6 Pin TH type bobbin
Bobbin vendor: TBI−208−05101.11XX (RM8−8P−TH−A0−11)Rev.1

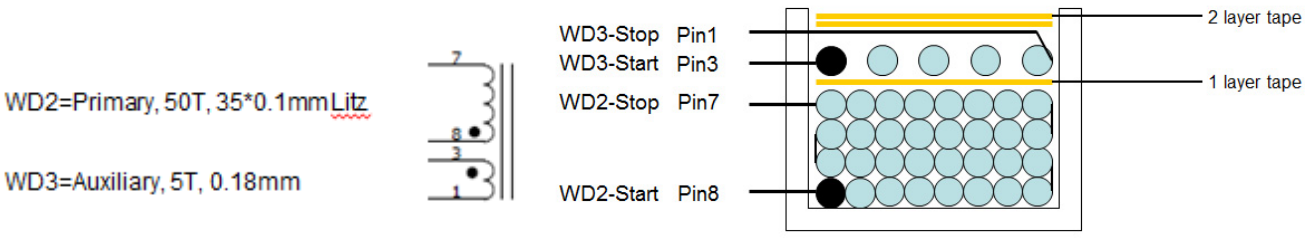


Figure 8.

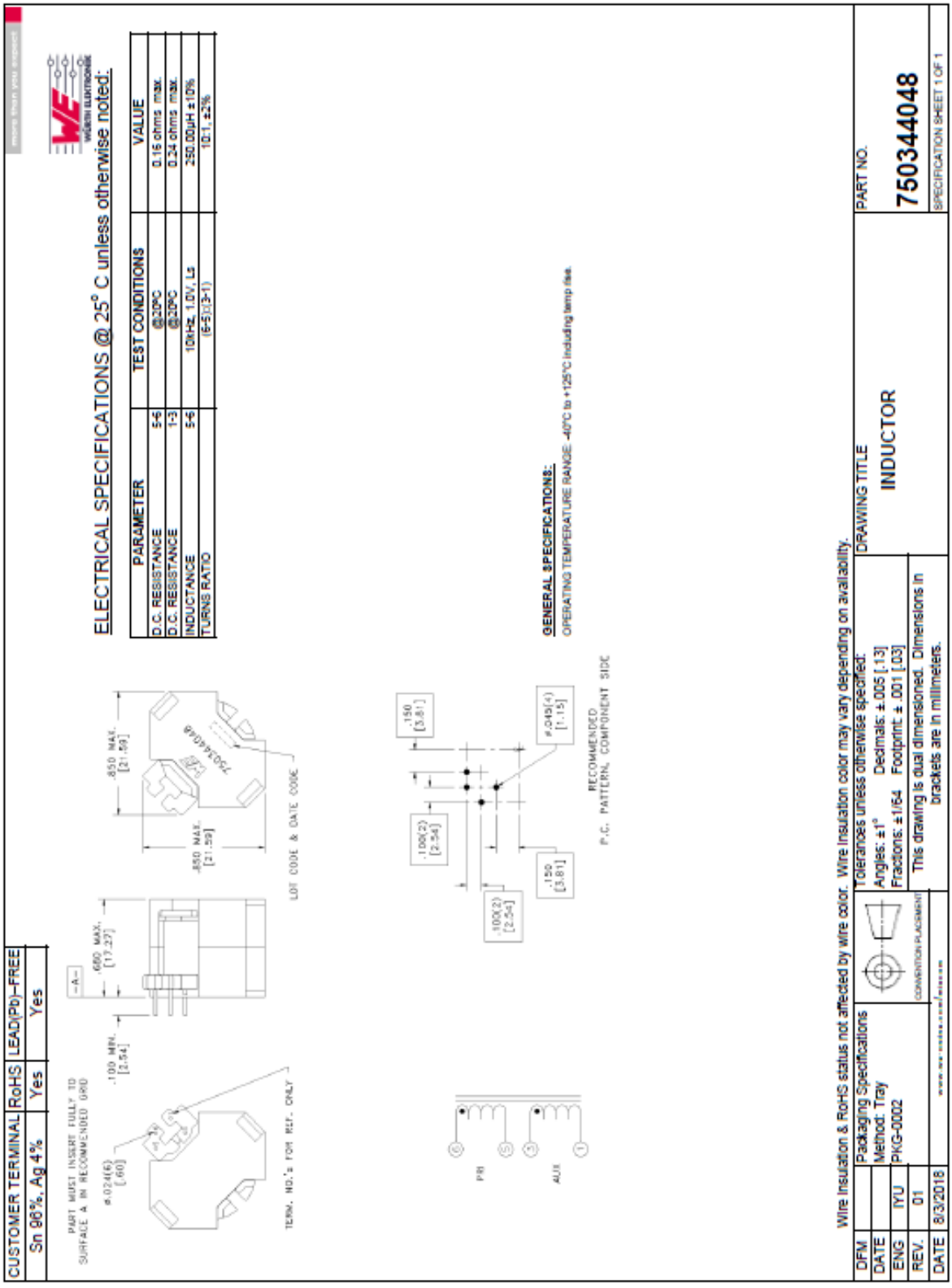

CUSTOMER TERMINAL
Sn 96%, Ag 4%
RoHS
Yes
LEAD(Pb)-FREE
Yes
ELECTRICAL SPECIFICATIONS @ 25° C unless otherwise noted:
PARAMETER
TEST CONDITIONS
VALUE
D.C. RESISTANCE 5-6 @20ºC 0.16 ohms max.
D.C. RESISTANCE 1-3 @20ºC 0.24 ohms max.
INDUCTANCE 5-6 10kHz, 1.0V, Ls 250.00µH ±10%
TURNS RATIO (6-5):(3-1) 10:1, ±2%
GENERAL SPECIFICATIONS:
OPERATING TEMPERATURE RANGE: -40°C to +125°C including temp rise.
PART MUST INSERT FULLY TO SURFACE A IN RECOMMENDED GRID
.100 MIN. [2.54]
.680 MAX. [17.27]
ø.024(6) [.60]
.850 MAX. [21.59]
LOT CODE & DATE CODE
TERM. NO.'s FOR REF. ONLY
.150 [3.81]
.100(2) [2.54]
ø.045(4) [1.15]
RECOMMENDED P.C. PATTERN, COMPONENT SIDE
PRI
AUX
Wire Insulation & RoHS status not affected by wire color. Wire Insulation color may vary depending on availability.
DFM
DATE
ENG
REV.
DATE
Packaging Specifications
Method: Tray
PKG-0002
IYU
01
8/3/2018
Tolerances unless otherwise specified:
Angles: ±1° Decimals: ± .005 [.13]
Fractions: ±1/64 Footprint: ± .001 [.03]
CONVENTION-PLACEMENT
This drawing is dual dimensioned. Dimensions in brackets are in millimeters.
DRAWING TITLE
INDUCTOR
PART NO.
750344048
SPECIFICATION SHEET 1 OF 1

Figure 9.

T1 Transformer Designs (available from Wurth Electronics)

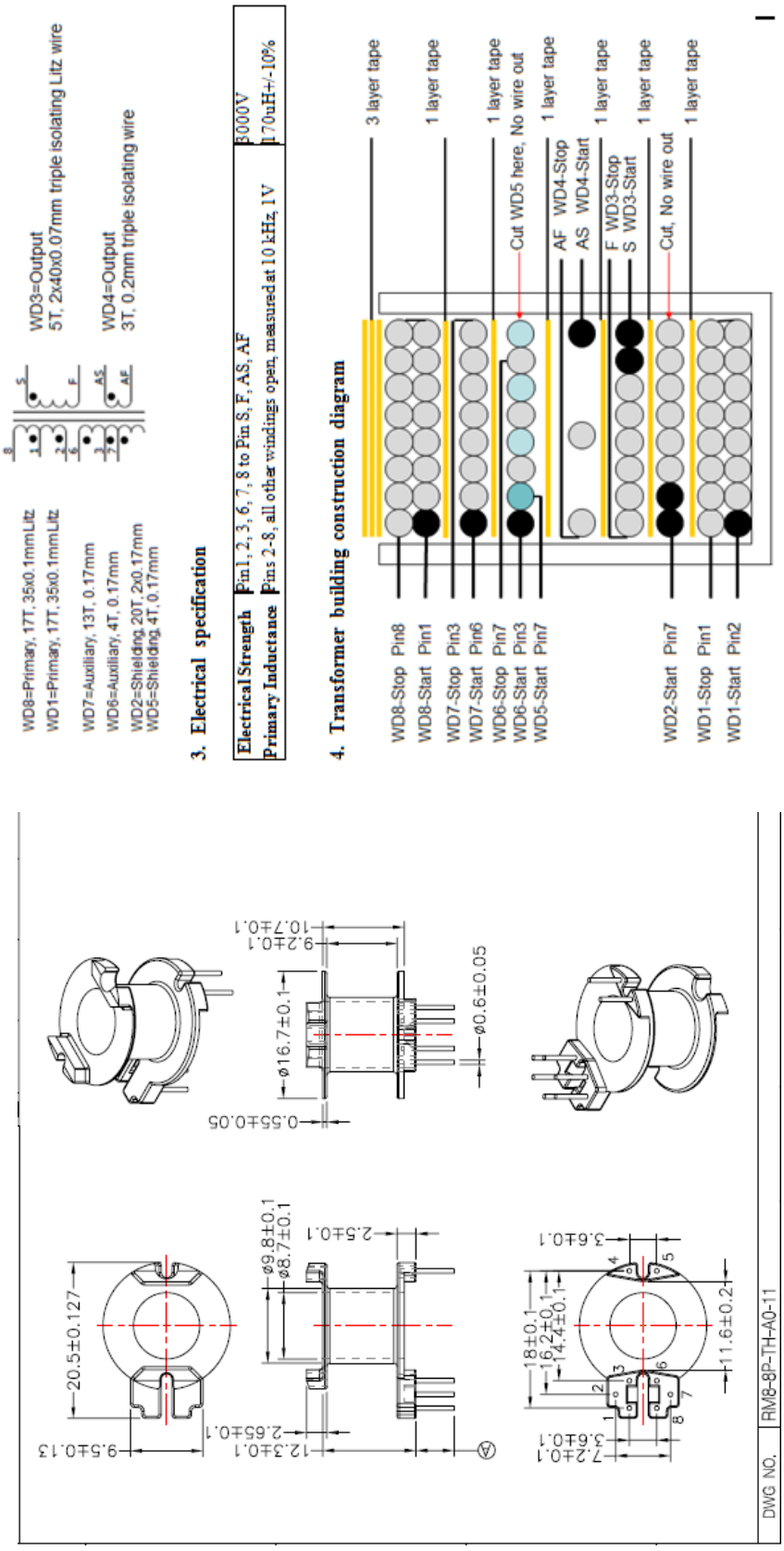


Figure 10.

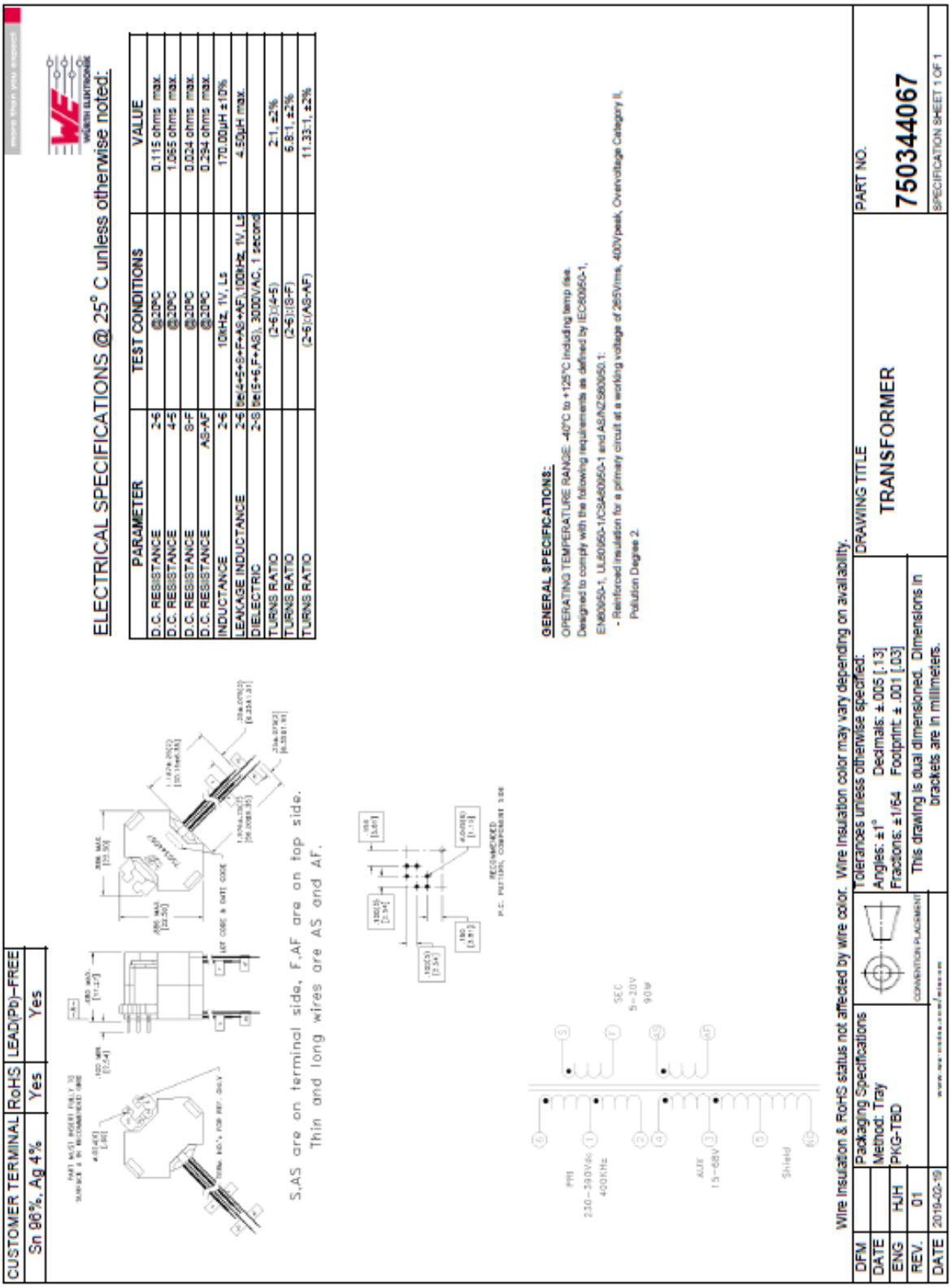

ELECTRICAL SPECIFICATIONS @ 25° C unless otherwise noted:
PARAMETER | TEST CONDITIONS | VALUE
D.C. RESISTANCE | 2-5 | @20°C | 0.115 ohms max.
D.C. RESISTANCE | 4-5 | @20°C | 1.065 ohms max.
D.C. RESISTANCE | 6-F | @20°C | 0.024 ohms max.
D.C. RESISTANCE | AS-AF | @20°C | 0.234 ohms max.
INDUCTANCE | 2-5 | 10kHz, 1V, Ls | 170.00µH ±10%
LEAKAGE INDUCTANCE | 2-5 | Ls(4+5+6+F+AS+AF), 100kHz, 1V, Ls | 4.50µH max.
DIELECTRIC | 2-5 | Ls(5+6,F+AS), 3000VAC, 1 second
TURNS RATIO | (2-5)/(4-5) | 2:1, ±5%
TURNS RATIO | (2-5)/(6-F) | 6.8:1, ±2%
TURNS RATIO | (2-5)/(AS-AF) | 11.33:1, ±2%
S,AS are on terminal side, F,AF are on top side.
Thin and long wires are AS and AF.
GENERAL SPECIFICATIONS:
OPERATING TEMPERATURE RANGE -40°C to +125°C including temp rise.
Designed to comply with the following requirements as defined by IEC60950-1,
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,
Pollution Degree 2.
CUSTOMER TERMINAL | RoHS | LEAD(Pb)-FREE
Sn 96%, Ag 4% | Yes | Yes
Wire Insulation & RoHS status not affected by wire color. Wire Insulation color may vary depending on availability.
DFM
DATE
ENG | HJH
REV. | 01
DATE | 2019-02-19
Packaging Specifications
Method: Tray
PKG-TBD
Tolerances unless otherwise specified:
Angles: ±1° Decimals: ± .005 [.13]
Fractions: ±1/64 Footprint: ± .001 [.03]
This drawing is dual dimensioned. Dimensions in brackets are in millimeters.
DRAWING TITLE
TRANSFORMER
PART NO.
750344067
SPECIFICATION SHEET 1 OF 1

Figure 11.

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

Test Condition: all efficiency are tested at board end

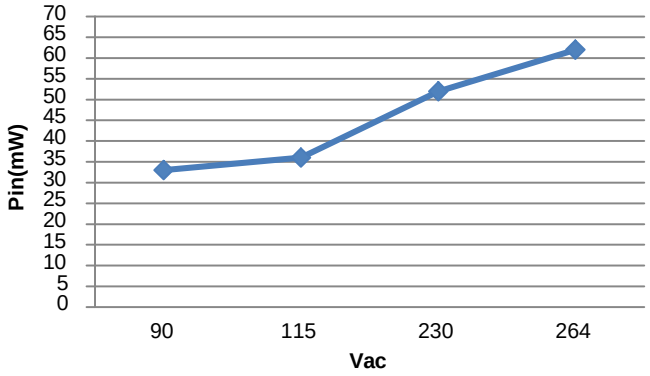


Figure 12.

10% Load and Average Efficiency

Test Condition: all efficiency are tested at board end

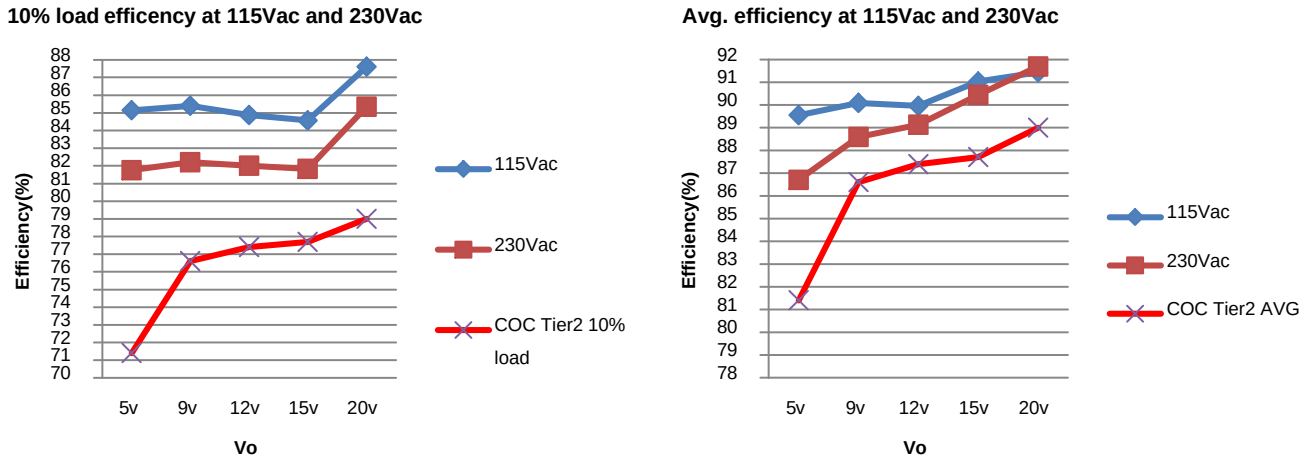


Figure 13. 10% Load and Average Efficiency

Efficiency vs. Output Load Curves

Test Condition: all efficiency are tested at board end

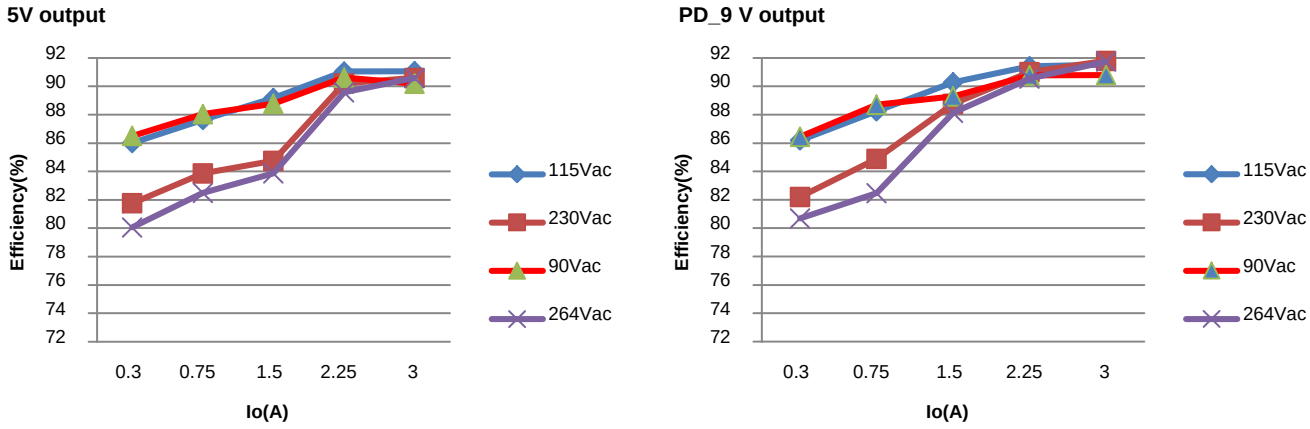


Figure 14. Efficiency vs. Output Load Curves

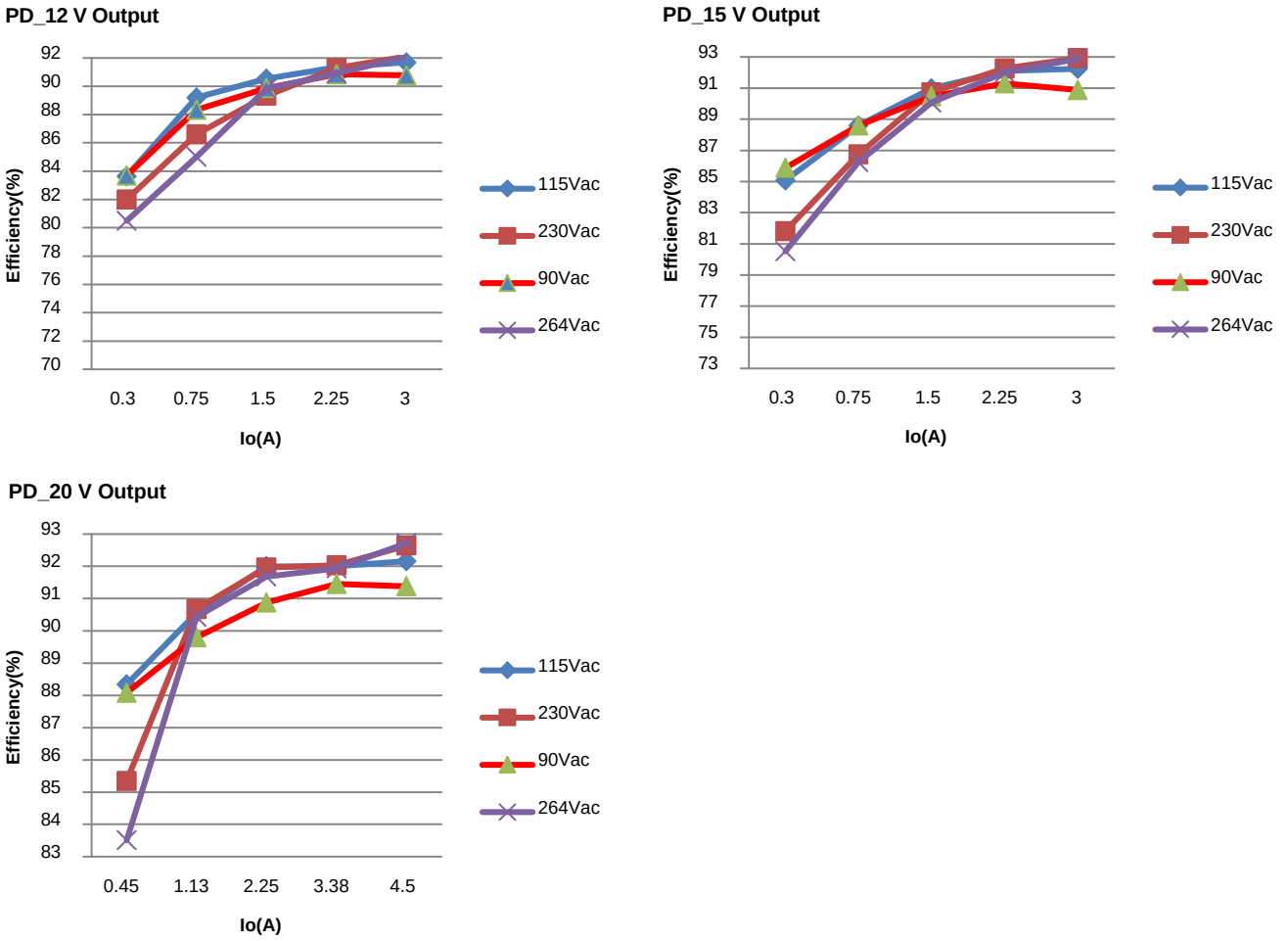


Figure 15. Efficiency vs. Output Load Curves (continued)

OCP

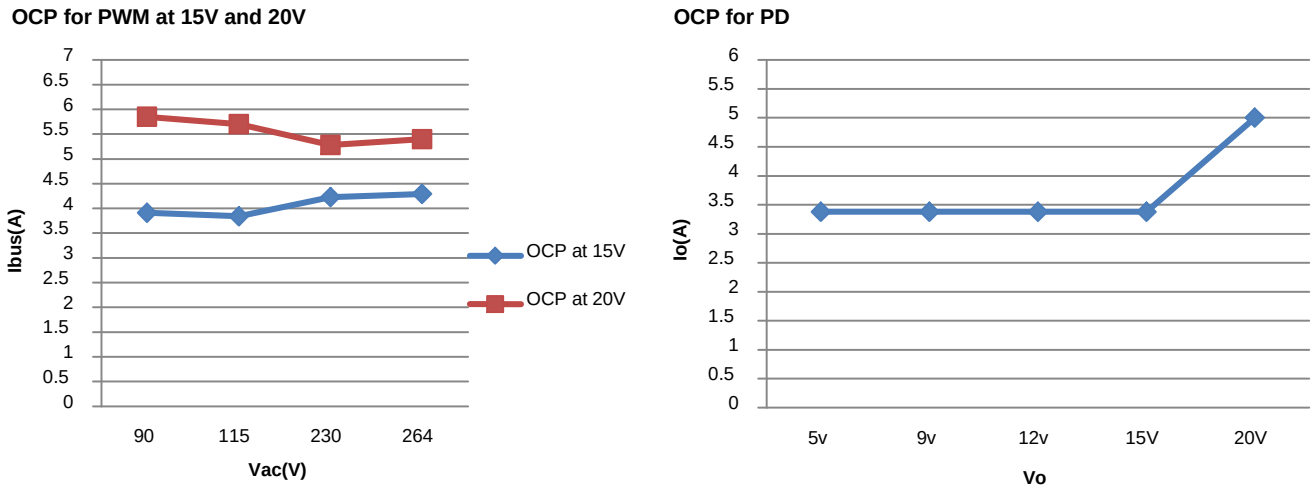


Figure 16. OCP Curves

(CH1: Vsyn−drain, CH4: Vo)

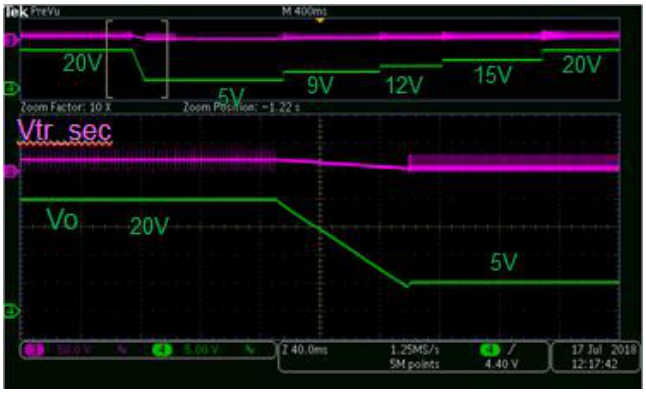


Figure 17. PD Voltage Change from 20 V to 5 V at 0 A

(CH1: Vsyn−drain, CH4: Vo)

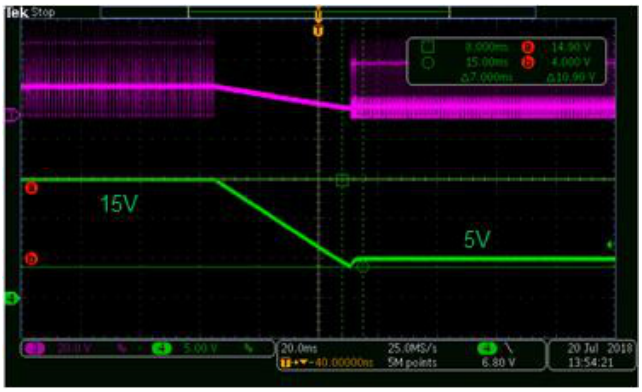


Figure 18. PD Voltage Change from 15 V to 5 V at 0 A

(CH1: Vsyn−drain, CH4: Vo)

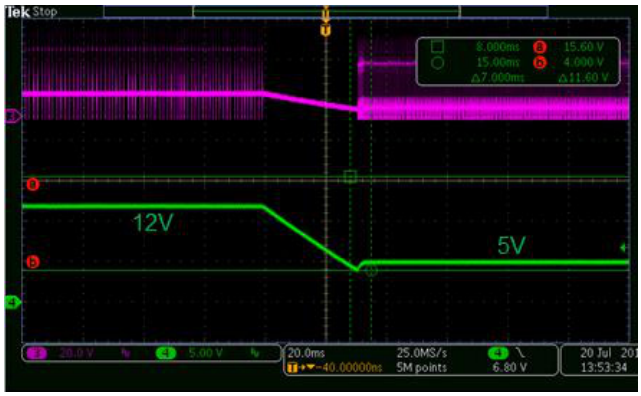


Figure 19. PD Voltage Change from 12 V to 5 V at 0 A

(CH1: Vsyn−drain, CH4: Vo)

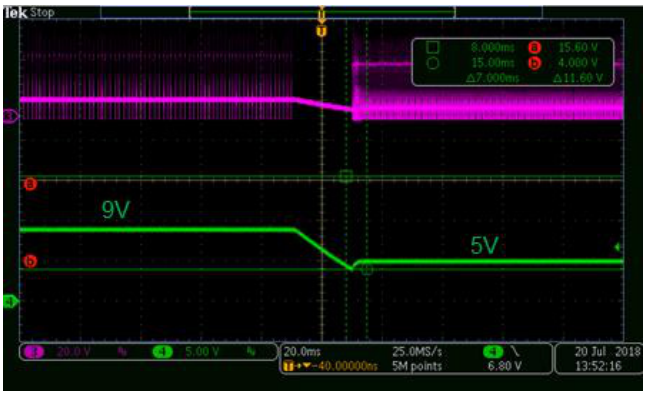
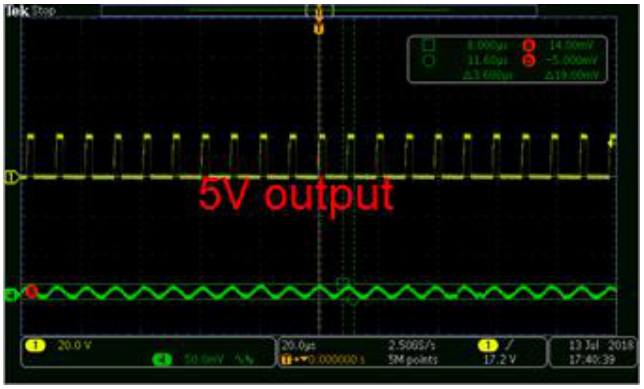


Figure 20. PD Voltage Change from 9 V to 5 V at 0 A

5 V, 3 A Output (CH4: Vo)



9 V, 3 A Output (CH4: Vo)

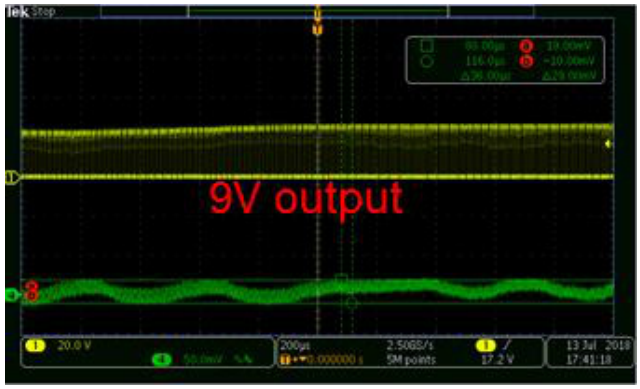
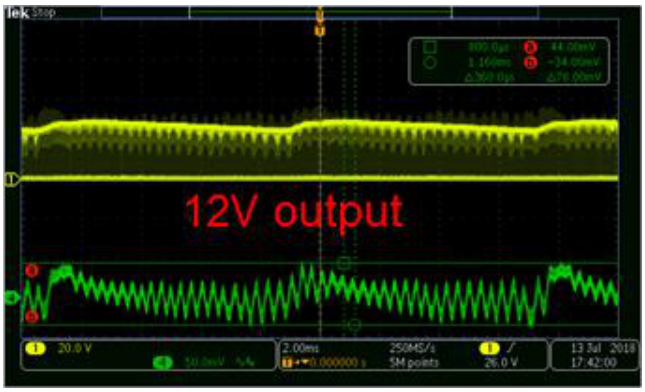


Figure 21. Output Ripple @ 90 Vac and 3 A Output

12 V, 3 A Output (CH4: Vo)



15 V, 3 A Output (CH4: Vo)

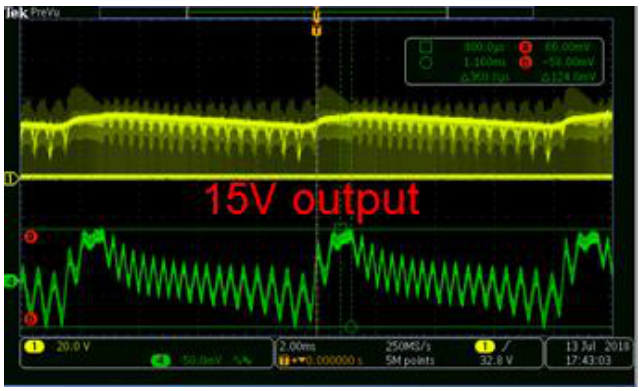


Figure 22. Output Ripple @ 90 Vac and 3 A Output

20 V, 2.5 A Output without PFC work (CH4: Vo)

20 V, 4.5 A Output with PFC work (CH4: Vo)

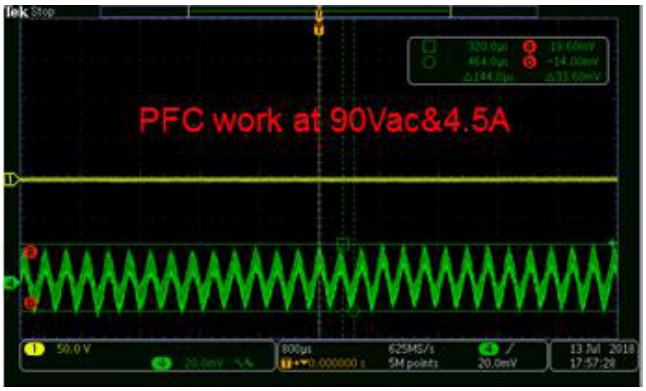
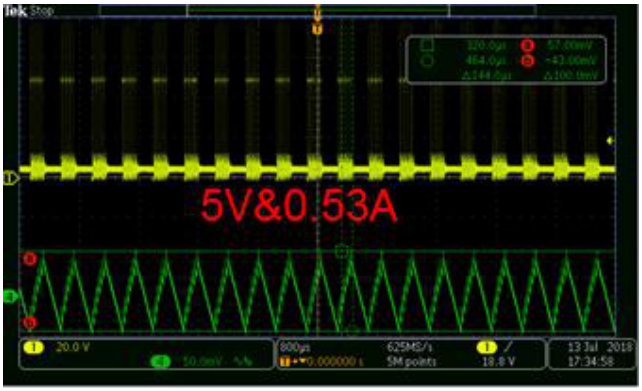


Figure 23. Output Ripple @ 90 Vac and 20 V Output

5 V, 0.53 A Output (CH1: Vsyn−drain, CH4: Vo)



9 V, 0.3 A Output (CH1: Vsyn−drain, CH4: Vo)

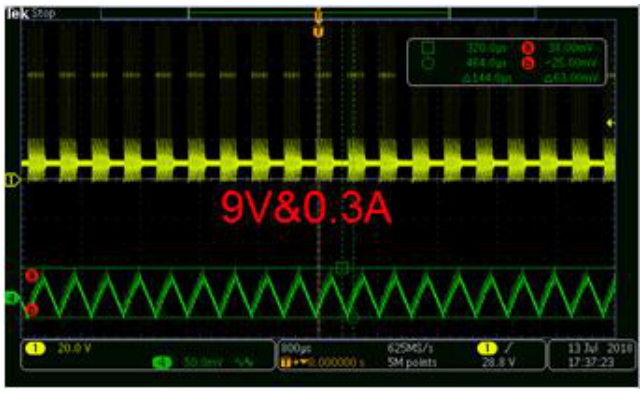
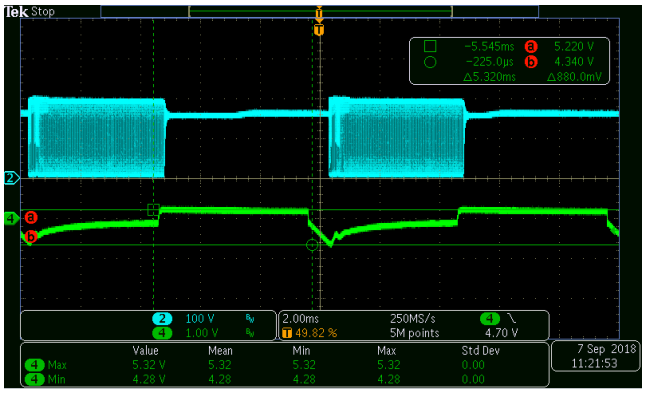


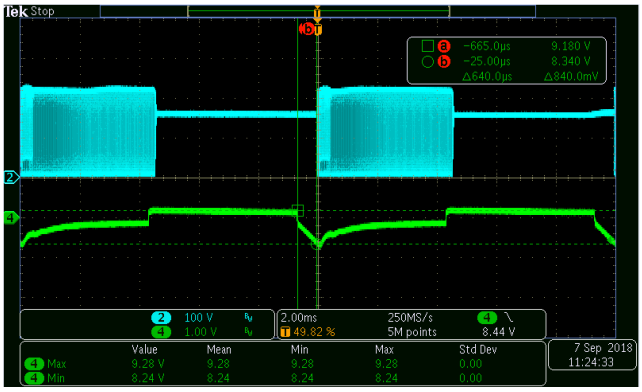
Figure 24. Output Max Skip Ripple @ 230 Vac

5 V (CH2: Vsw, CH4: Vo)



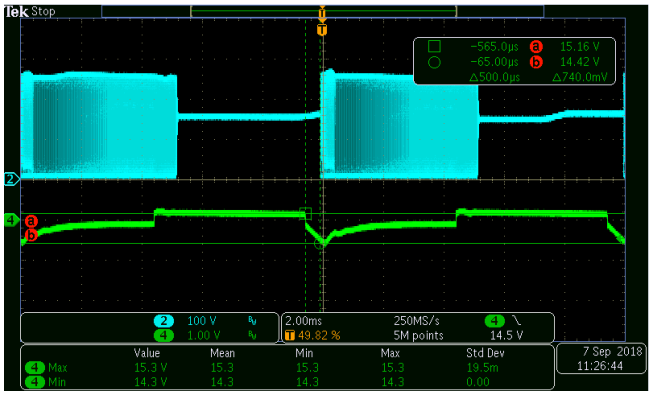
Test condition: 0 − 1.5 A, 10 ms cycle, 125 mA/µs, 1 m cable, tested at E−load

9 V (CH2: Vsw, CH4: Vo)



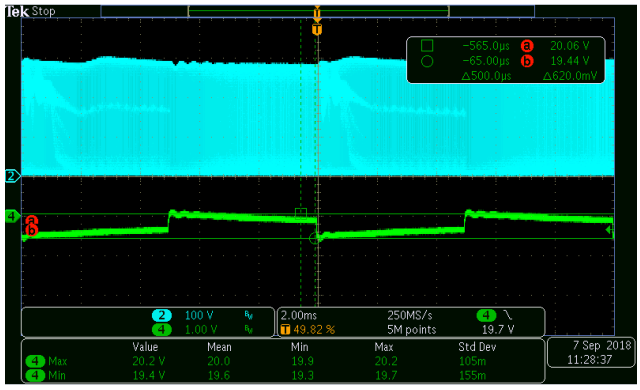
Test condition: 0 − 1.5 A, 10 ms cycle, 125 mA/µs, 1 m cable, tested at E−load

15 V (CH2: Vsw, CH4: Vo)



Test condition: 0 − 1.5 A, 10 ms cycle, 125 mA/µs, 1 m cable, tested at E−load

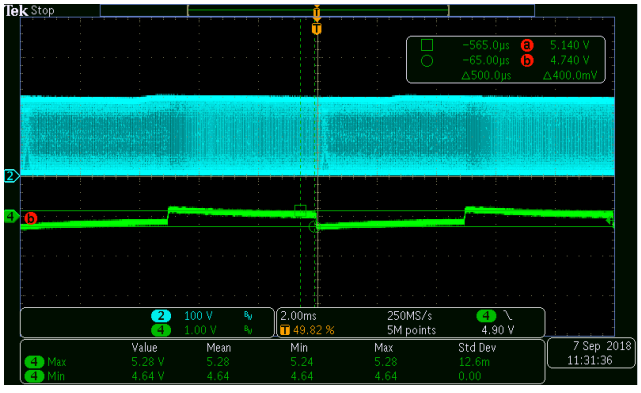
20 V (CH2: Vsw, CH4: Vo)



Test condition: 0 − 2.25 A, 10 ms cycle, 125 mA/µs, 1 m cable, tested at E−load

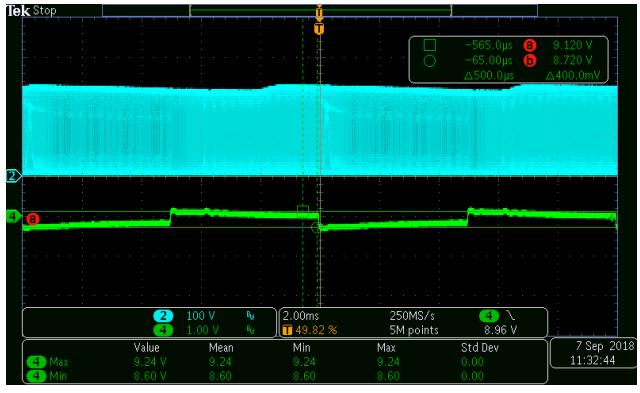
Figure 25. Dynamic Test between 0−50% Load @ 115 Vac Input

5 V (CH2: Vsw, CH4: Vo)



Test condition: 0.75 A − 2.25 A, 10 ms cycle, 125 mA/µs, 1 m cable, tested at E−load

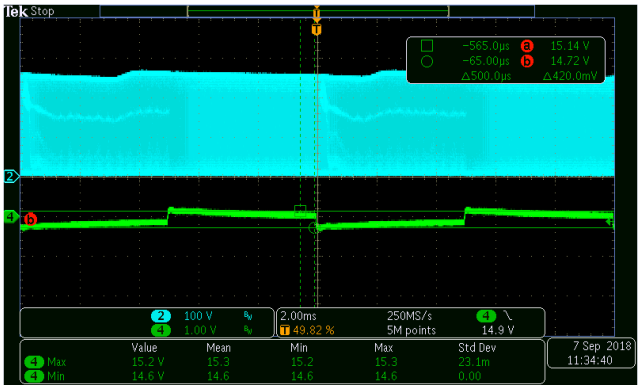
9 V (CH2: Vsw, CH4: Vo)



Test condition: 0.75 A − 2.25 A, 10 ms cycle, 125 mA/µs, 1 m cable, tested at E−load

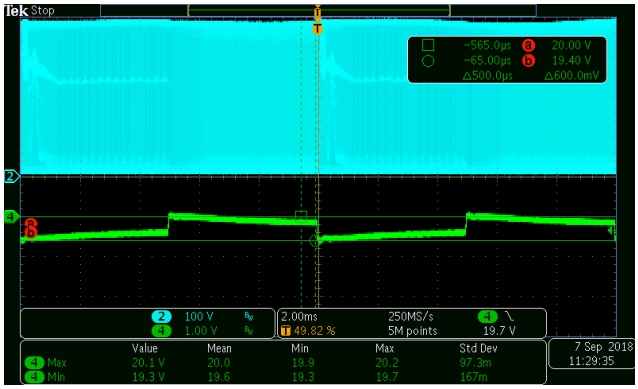
Figure 26. Dynamic Test between 25−75% Load @ 115 Vac Input

15 V (CH2: Vsw, CH4: Vo)



Test condition: 0.75 A − 2.25 A, 10 ms cycle, 125 mA/μs,
1 m cable, tested at E−load

20 V (CH2: Vsw, CH4: Vo)

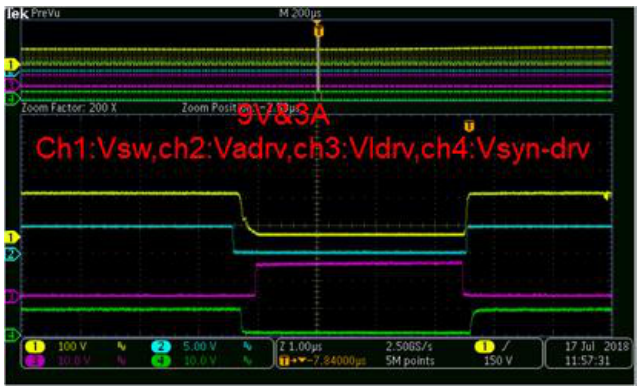


Test condition: 1.13 A − 3.38 A, 10 ms cycle, 125 mA/μs,
1 m cable, tested at E−load

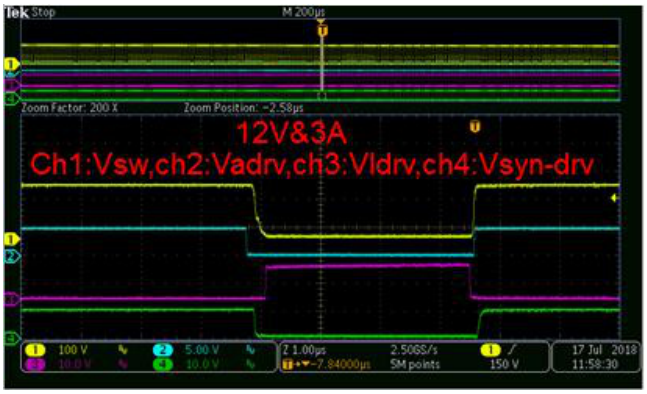
Figure 27. Dynamic Test between 25−75% Load @ 115 Vac Input (continued)

5 V, 3 A

9 V, 3 A



12 V, 3 A



15 V, 3 A

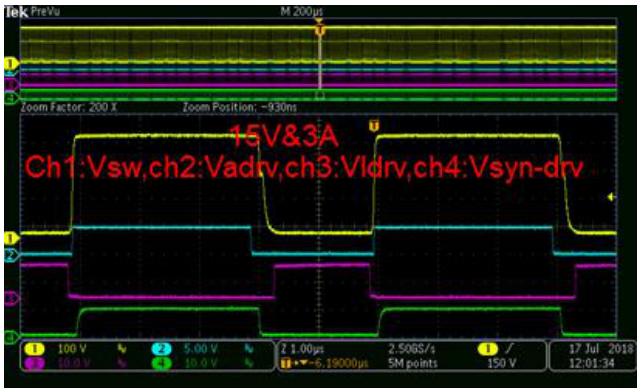
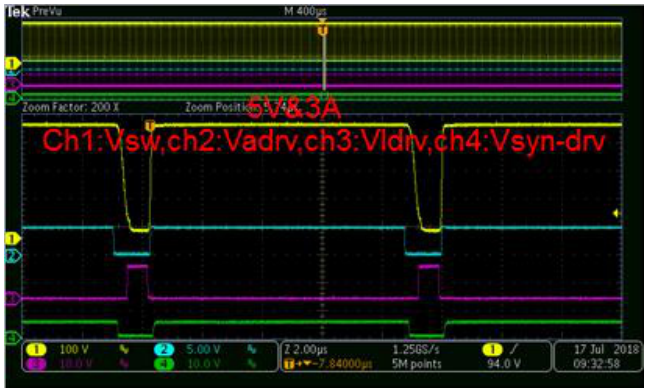


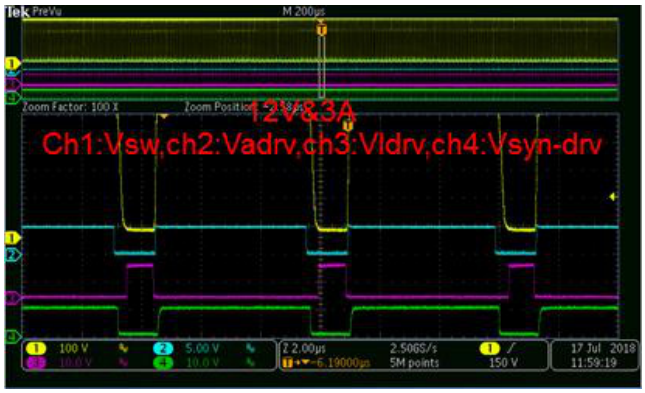
Figure 28. Key ACF Waveform @ 90 Vac Input

5 V, 3 A



9 V, 3 A

12 V, 3 A



15 V, 3 A

Figure 29. Key ACF Waveform @ 264 Vac Input

90 Vac and 4.5 A output

264 Vac and 4.5 A output

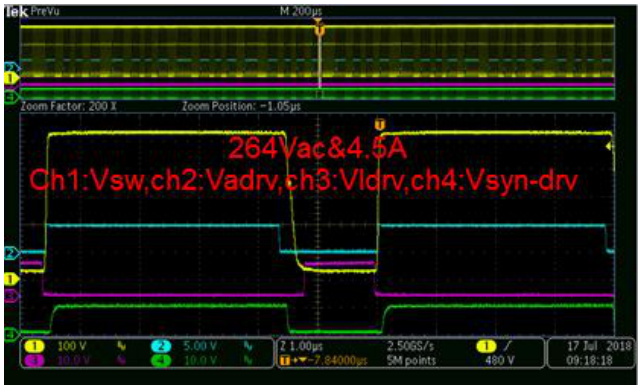
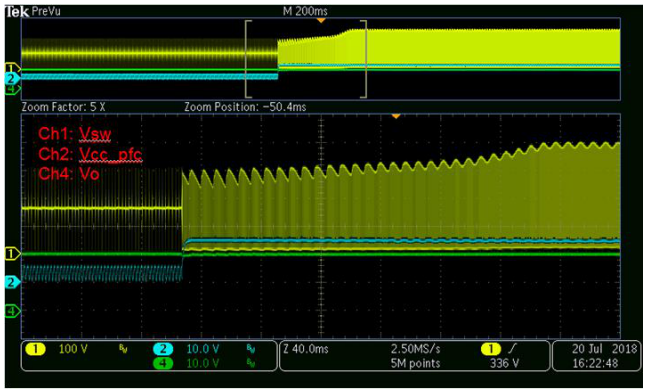


Figure 30. Key ACF Waveform @ 20 V Output

0 − 4.5 A load change



4.5 A − 0 load change

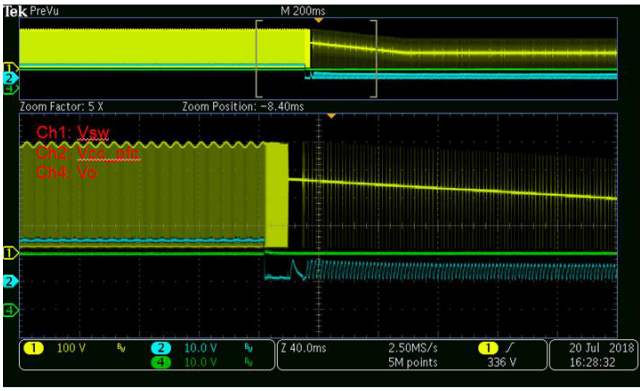


Figure 31. Load Change at 115 Vac and 20 V

264 Vac and 20 V (CH1: Vsw, CH2: Vsyn−drain)

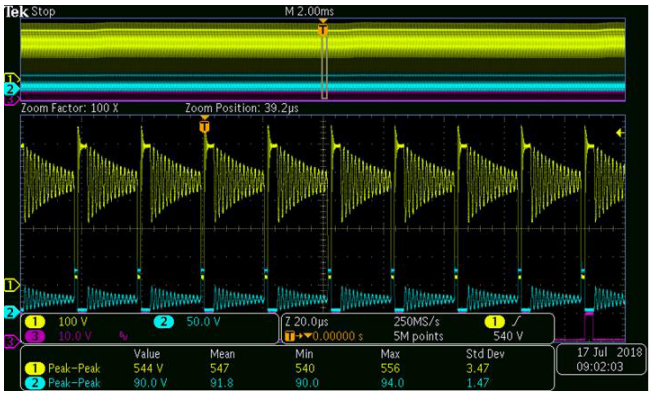
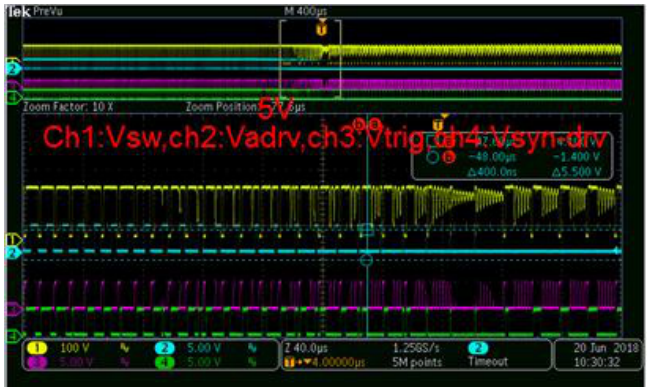


Figure 32. Max Voltage Stress in DCM

115 Vac and 5 V



115 Vac and 9 V

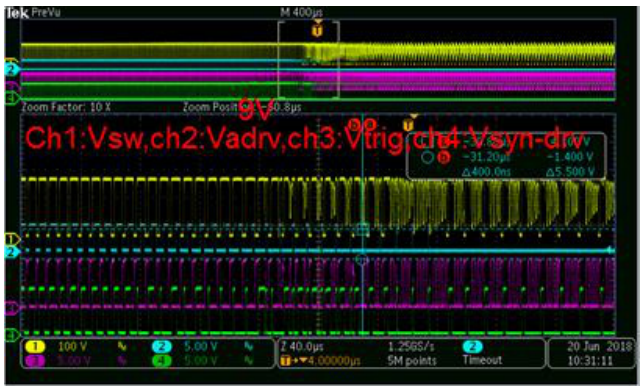


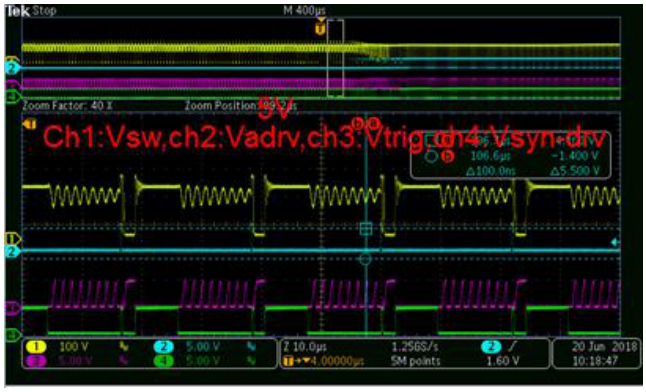
Figure 33. ACF to DCM Mode Transition

115 Vac and 15 V

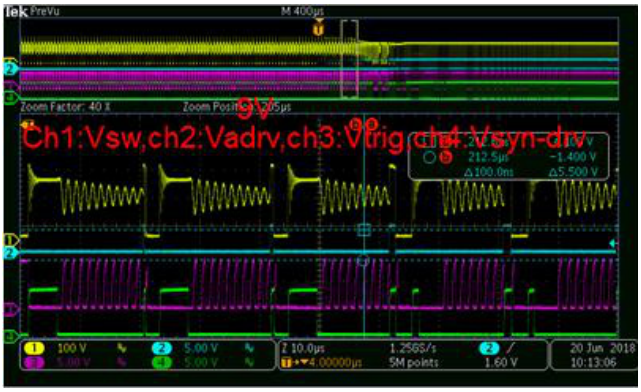
115 Vac and 20 V

Figure 34. ACF to DCM Mode Transition (continued)

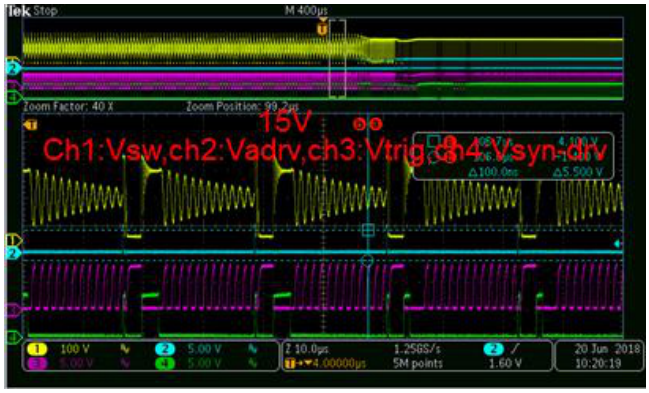
115 Vac and 5 V



115 Vac and 9 V



115 Vac and 15 V



115 Vac and 20 V

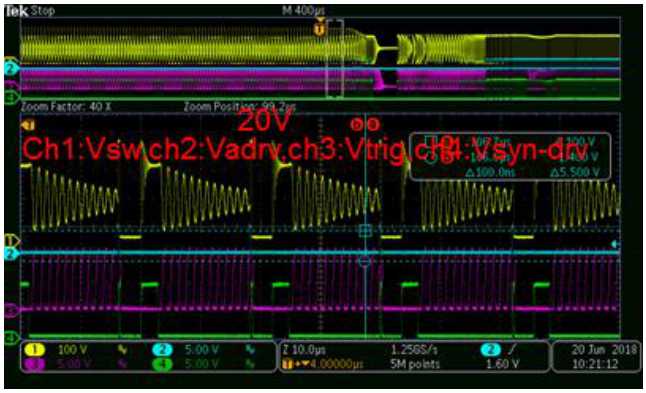


Figure 35. DCM to ACF Mode Transition

Table 1. THERMAL IMAGE @ 20 V / 4.5 A Output

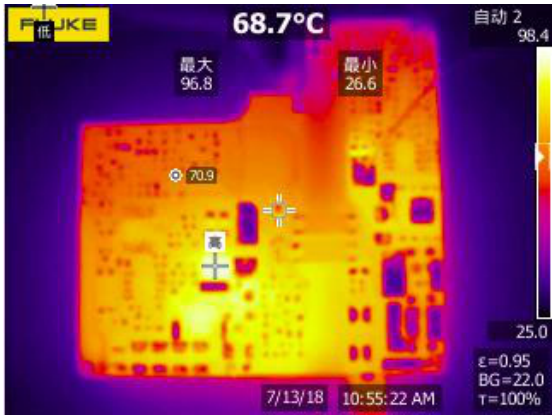
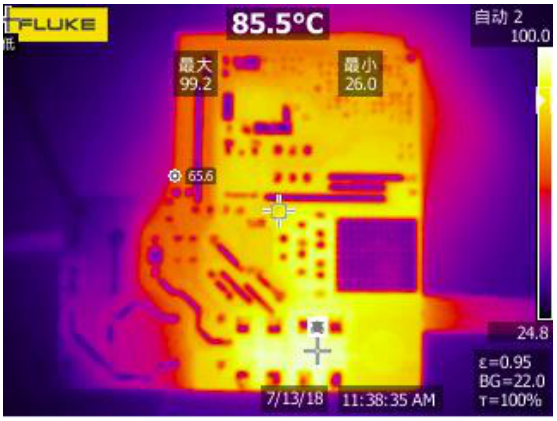
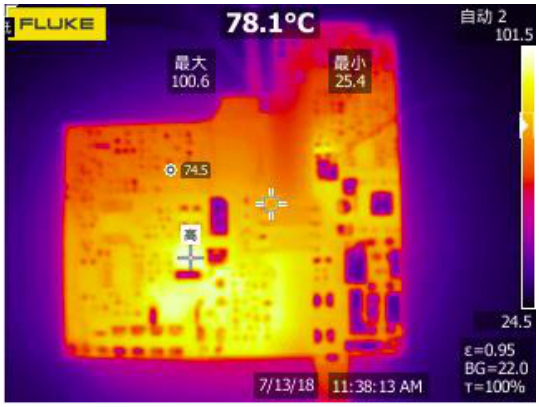
Input	PFC Side	ACF side
90 Vac		
115 Vac		

Table 1. THERMAL IMAGE @ 20 V / 4.5 A Output (continued)

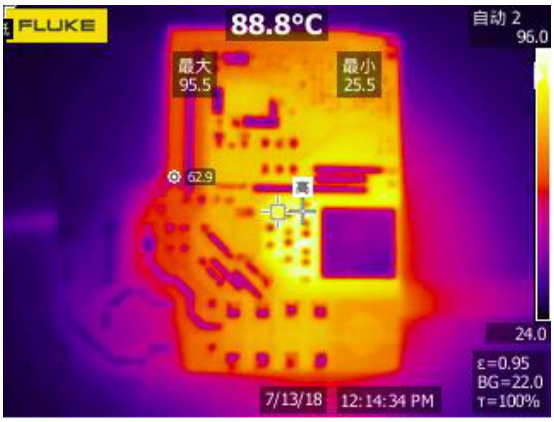
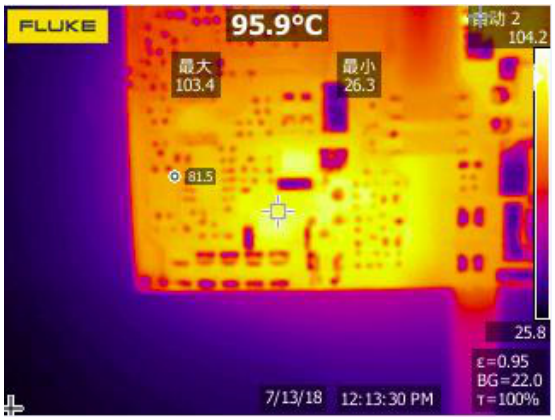
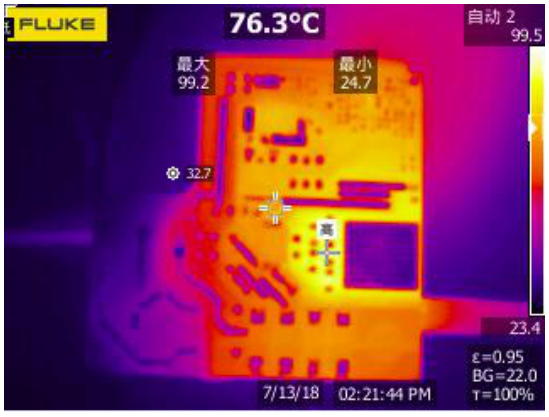
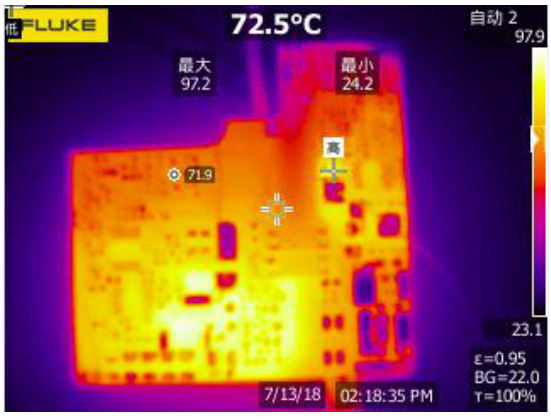
Input	PFC Side	ACF side
230 Vac		
264 Vac		

Table 2. BILL OF MATERIAL

Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
Q6 Q19 Q25−26	4	NMOSFET	c		SOT23	ON	2N7002LT1G	No	Yes
C39 C44 C52 C54	4	Capacitor, Ceramic, 50V, 10%	0.1uF		603	Wurth	/885012206095	Yes	Yes
C37	1	Capacitor, Ceramic, 25V, 10%	0.22uF,25V		603	Wurth	/885012206073	Yes	Yes
C6 C26 C45 C48 49 C51	6	Capacitor, Ceramic, Chip, 10%	0.22uF,450V		1210	TDK	C3225X7T2W224K	Yes	Yes
C1 C5	2		0.68u,450v		THT,10mm, 13mmx6mmx12 mm	Panasonic	ECWFD2W684Q	Yes	Yes
C9 C33−34	3	Capacitor, Ceramic, 50V, 10%	100pF		603	Wurth	/885012206077	Yes	Yes
C31	1	Capacitor, Ceramic, SMD, 5%	104,400V		1206	TDK	C3216X7T2W104K	Yes	Yes
C18	1	Capacitor, Ceramic, 50V, 10%	10nF		603	Wurth	/885012206089	Yes	Yes
C55	1	Capacitor, Ceramic, 50V, 10%	10pF		603	Wurth	/885012006051	Yes	Yes
C42 C46	2	Capacitor, Ceramic, 50V, 10%	1nF		603	Wurth	/885012206083	Yes	Yes
C12	1	Capacitor, Ceramic, 250V, 10%	1nF,250v		603	Wurth	/885342206003	Yes	Yes
C8	1	Capacitor, Ceramic, 100V, 10%	1uF,100v		805	TDK	C2012X7S2A105K	Yes	Yes
C2 C7 C16−17 C29 C38 C43	7	Capacitor, Ceramic, 25V, 10%	1uF,25V		603	Wurth	/885012206076	Yes	Yes
C35	1	Capacitor, Ceramic, 50V, 10%	2.2nF		603	Wurth	/885012206085	Yes	Yes
C36	1	Capacitor, Ceramic, 16V, 10%	2.2uF,16V		603	Wurth	/885012106018	Yes	Yes
C25	1	X2 capacitor, Safety standard approved, 10%	224,X2		THT, 12.5mm, 15mmx7mmx12 mm	Wurth	/890324024002	Yes	Yes
C11 C23 C28 C30	4	Capacitor, Ceramic, 50V, 10%	330pF		603	Wurth	/885012206080	Yes	Yes
C53	1	Capacitor, Ceramic, 50V, 10%	4.7nF		603	Wurth	/885012206094	Yes	Yes
C3	1	Capacitor, Ceramic, 16V, 10%	4.7uF,16v		603	TDK	C1608X6S1C475M	Yes	Yes
C4 C24 C27	3	Capacitor, Ceramic, 25V, 10%	4.7uF,25V		805	TDK	C2012X7R1E475K	Yes	Yes
C50	1	Capacitor, Ceramic, 50V, 5%	820pF		603	TDK	C1608C0G1H821J	Yes	Yes
C10	1	HV Ceramic Capacitor, safety standard approved, 10%	470pF,Y1		Lead type	TDK	CS65−B2GA101KYNK A	Yes	Yes
C47	1	Capacitor, Ceramic, 50V, 5%	47nF		603	Wurth	/885012206083	Yes	Yes
C19 C22	2	Capacitor, Ceramic, 50V, 10%	68nF		603	Wurth	/885012206094	Yes	Yes
C20	1	Capacitor, Ceramic, 50V, 10%	NC		603	std	Std	Yes	Yes
C40	1	Capacitor, Ceramic, Chip, 5%	nc		805	nc	nc	Yes	Yes
D2 D2A	2	Bridge Rectifier, 1000V, 4A	4A,1000V		Z4PAK	ZOWIE	Z4GP40MH	Yes	Yes
D9	1	General Rectifier	3A,600V		SMC	ON	S3J	No	Yes
DNR	1	Varistor, 10D471K	10D471K		TH	Wurth	820573011	Yes	Yes
D1 D8 D14 D16 D19 D23 D25 D30	8	Switching diode, SMD	0.2A,250V		SOD323	ON	BAS21HT1G	No	Yes
D4 D10 D15 D26 D29 D31	6	Switching diode, SMD	0.2A,30V		SOD323	ON	BAT54HT1G	No	Yes
D6,D11	2	Switching diode, SMD	0.2A,350V		SOD323	ON	NSD350HT1G	No	Yes
D12−13	2	Standard Rectifier, 0.8A, 600V	0.8A,600V		SOD123FL	ON	RS1JFA	No	Yes
D7 D22	2	Ultrafast Rectifier, 1A, 600V	1A,600V		SOD123FL	ON	US1JFA	No	Yes
D5 D17−18 D20 D21	5	Switching diode, SMD	0.2A,250V		SOD323	ON	BAS21HT1G	No	Yes
FB2	1	300ohm@100MHz			1206	Wurth	742792121	Yes	Yes
FB3	1	nc	nc		1206	nc	nc	Yes	Yes
L2	1	CM Filter, T type core	18mH		TH type	std	T12x8x7	Yes	Yes
L1	1	T type, 9*5*3, 0.5 wire	600uH		TH	std	T9*5*3	Yes	Yes
F1	1	Micro Fuse, 1.6A/250V	1.6A, 250Vac		Axial lead	Hollyfuse	5ET−016H	Yes	Yes
Q1−2 Q7 Q12−13	5	General NPN Transistor, SMD			SOT23	ON	MMBT3904LT1G	No	Yes
Q5 Q4 Q10	3	General NPN Transistor, SMD			SOT23	ON	MMBTA06LT1G	No	Yes
Q9	1	General PNP Transistor, SMD			SOT23	ON	MMBTA56LT1G	No	Yes
Q14−15 Q17	3	General PNP Transistor, SMD			SOT23	ON	MMBT3906LT1G	No	Yes
D3	1	Ultrafast Rectifier, 5A, 520V	5A, 520V		DPAK	ON	MURD550PFG	No	Yes
U5	1	PROGRAMMABLE PRECISION REFERENCE			SOT23	ON	NCP431ASNT1G	No	Yes
U2	1	ACF Controller			TSSOP16	ON	NCP1568S01DBR2G	No	Yes

Table 2. BILL OF MATERIAL (continued)

Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
U1	1	PFC Controller			TSOP6	ON	NCP1622AEC	No	Yes
U7	1	Syn. Rectified Controller			SO8	ON	NCP4306AADZZZADR2G	No	Yes
U3	1				DFN10	ON	NCP51530AMNTWG	No	Yes
NTC1	1	replaced by 13k resistor or nc	100k		603	Shunlord	SDNT1608X104J4250HTF	Yes	Yes
NTC2	1	replacerment of 100k resistor	100k		603	Shunlord	SDNT1608X104J4250HTF	Yes	Yes
U4 U11	2	optical coupler			LSOP4	ON	FODM1009	No	Yes
Q20	1		60V		SOT23	ON	BSS84LT1G	No	Yes
L3	1	Toroidal Line Choke,15.8x8.5,2.5A	100uH		TH type	Wurth	7447021	Yes	Yes
L5	1	SMD inductor	4.7uH		603	Shunlord	MCL1608S4R7MT	Yes	Yes
Q3	1	MOSFET, NChan, 600V			PQFN−4	ON	FCMT299N60	No	Yes
R13 R84	2	Resistor, Chip, 1/8W, 1%	0		603	Std	Std	Yes	Yes
R6 R72	2	Resistor, Chip, 1/8W, 1%	1		603	Std	Std	Yes	Yes
R15	1	Resistor, Chip, 1/8W, 1%	1.64K		603	Std	Std	Yes	Yes
R32 R49 R59 R85 R91−92 R98	7	Resistor, Chip, 1/8W, 1%	100K		603	Std	Std	Yes	Yes
R18 R24 R35 R62 R67 R70 R94	7	Resistor, Chip, 1/8W, 1%	10K		603	Std	Std	Yes	Yes
R36	1	Resistor, Chip, 1/8W, 1%	10k		603	Std	Std	Yes	Yes
R37	1	Resistor, Chip, 1/8W, 1%	120K		603	Std	Std	Yes	Yes
R78	1	Resistor, Chip, 1/8W, 1%	12K		603	Std	Std	Yes	Yes
R88	1	Resistor, Chip, 1/8W, 1%	130K		603	Std	Std	Yes	Yes
R63 R69 R82	3	Resistor, Chip, 1/8W, 1%	150K		603	Std	Std	Yes	Yes
R8	1	Resistor, Chip, 1/8W, 1%	15M		603	Std	Std	Yes	Yes
R17	1	Resistor, Chip, 1/8W, 1%	16K		603	Std	Std	Yes	Yes
R7	1	Resistor, Chip, 1/8W, 1%	180K		603	Std	Std	Yes	Yes
R46	1	Resistor, Chip, 1/8W, 1%	18K		603	Std	Std	Yes	Yes
R1 R21 R44	3	Resistor, Chip, 1/8W, 1%	1K		603	Std	Std	Yes	Yes
R22	1	Resistor, Chip, 1/8W, 1%,	1K		603	Std	Std	Yes	Yes
R30 R68	2	Resistor, Chip, 1/8W, 1%	1M		603	Std	Std	Yes	Yes
R79	1	Resistor, Chip, 1/8W, 1%	200K		603	Std	Std	Yes	Yes
R57	1	Resistor, Chip, 1/8W, 1%	20K		603	Std	Std	Yes	Yes
R9 R19 R27 R47	4	Resistor, Chip, 1/8W, 1%	22		603	Std	Std	Yes	Yes
R56	1	Resistor, Chip, 1/8W, 1%	22K		603	Std	Std	Yes	Yes
R58	1	Resistor, Chip, 1/8W, 1%	24K		603	Std	Std	Yes	Yes
R76	1	Resistor, Chip, 1/8W, 1%	2K		603	Std	Std	Yes	Yes
R55 R71	2	Resistor, Chip, 1/8W, 1%	300K		603	Std	Std	Yes	Yes
R16	1	Resistor, Chip, 1/8W, 1%	30K		603	Std	Std	Yes	Yes
R45	1	Resistor, Chip, 1/8W, 1%	33K		603	Std	Std	Yes	Yes
R75	1	Resistor, Chip, 1/8W, 1%	360K		603	Std	Std	Yes	Yes
R2	1	Resistor, Chip, 1/8W, 1%	39K		603	Std	Std	Yes	Yes
R10 R26 R28 R48 R74 R89−90	7	Resistor, Chip, 1/8W, 1%	4.7		603	Std	Std	Yes	Yes
R23	1	Resistor, Chip, 1/8W, 1%	4.7K		603	Std	Std	Yes	Yes
R61	1	Resistor, Chip, 1/8W, 1%	43K		603	Std	Std	Yes	Yes
R54	1	Resistor, Chip, 1/8W, 1%	47		603	Std	Std	Yes	Yes
R11 R81	2	Resistor, Chip, 1/8W, 1%	470K		603	Std	Std	Yes	Yes
R25 R38 R80	3	Resistor, Chip, 1/8W, 1%	47K		603	Std	Std	Yes	Yes
R3 R73	2	Resistor, Chip, 1/8W, 1%	510		603	Std	Std	Yes	Yes
R77	1	Resistor, Chip, 1/8W, 1%	510K		603	Std	Std	Yes	Yes
R93	1	Resistor, Chip, 1/8W, 1%	56K		603	Std	Std	Yes	Yes
R52	1	Resistor, Chip, 1/8W, 1%	6.8K		603	Std	Std	Yes	Yes
R20	1	Resistor, Chip, 1/8W, 1%	62K		603	Std	Std	Yes	Yes
R43	1	Resistor, Chip, 1/8W, 1%	75K		603	Std	Std	Yes	Yes
R53 R96	2	Resistor, Chip, 1/8W, 1%	91K		603	Std	Std	Yes	Yes
R29	1	Resistor, Chip, 1/8W, 1%,	nc		603	Std	Std	Yes	Yes

Table 2. BILL OF MATERIAL (continued)

Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
R33	1	Resistor, Chip, 1/8W, 1%	nc		603	Std	Std	Yes	Yes
R50−51	2	Resistor, Chip, 1/2W, 1%	0.3		1206	Panasonic	ERJ8BQFR30V	Yes	Yes
R4−5	2	Resistor, Chip, 1/2W, 1%	0.56		1206	Panasonic	ERJ8BQFR56V	Yes	Yes
R64	1	Resistor, Chip, 1/2W, 1%	100K		1206	Std	Std	Yes	Yes
R83	1	Resistor, Chip, 1/2W, 1%	10M		1206	Std	Std	Yes	Yes
R65−66	2	Resistor, Chip, 1/2W, 1%	160K		1206	Std	Std	Yes	Yes
R31	1	Resistor, Chip, 1/2W, 1%	1K		1206	Std	Std	Yes	Yes
R39	1	Resistor, Chip, 1/2W, 1%	nc		1206	Std	Std	Yes	Yes
R41−42	2	Resistor, Chip, 1/2W, 1%	2M		1206	Std	Std	Yes	Yes
R12 R34	2	Resistor, Chip, 1/5W, 1%	47		805	Std	Std	Yes	Yes
R14	1	Resistor, Chip, 1/2W, 1%	5mohm		1206	Std	Std	Yes	Yes
R40	1	Resistor, Chip, 1/2W, 1%	680K		1206	Std	Std	Yes	Yes
T1	1	RM8, 6Pin			TH type	WE−midcon	750344067	Yes	Yes
L4	1	RM8, 6Pin			TH type	WE−midcon	750344048	Yes	Yes
C41	1	size:5mmx11mm	10uF,25V		5mmx11mm	CapXon	KF Series	Yes	Yes
C21	1	size:6.3mmx11mm	22uF,100V		6.3mmx11mm	CapXon	KF Series	Yes	Yes
C13−15	3	size:8mmx15mm	680uF,25V		8mmx12mm	CapXon	PS681M025F080P	Yes	Yes
C32	1	size:16mmx30mm	68uF,420V		16mmx30mm	CapXon	KL680M420J300A00H	Yes	Yes
Q8	1	MOSFET, NChan, 3.4mohm			QFN5X6mm	ON	NTMFS4C05NT1G	No	Yes
Q18	1	MOSFET, NChan, 120V			PQFN8L	ON	FDMT800120DC	No	Yes
Q23−24	2	MOSFET, NChan, 600V			ThinPAK−8*8	INFINEON	IPL60R385CP	Yes	Yes
J1	1	Type C connector, SMT			SMD	CSCONN	CUS31738616001	Yes	Yes
U8	1	PD protocol controller			DFN5X5	Weltrend	WT6636F−UG16CWT−S90	Yes	Yes
ZD4	1	GENERIC ZENER−DIODE	10V		SOD323	ON	MM3Z10VT1G	No	Yes
ZD5	1	GENERIC ZENER−DIODE	11V		SOD323	ON	MM3Z11VT1G	No	Yes
ZD12	1	GENERIC ZENER−DIODE	12V		SOD323	ON	MM3Z12VT1G	No	Yes
ZD8	1	GENERIC ZENER−DIODE	13V		SOD323	ON	MM3Z13VT1G	No	Yes
ZD2	1	GENERIC ZENER−DIODE	15V		SOD323	ON	MM3Z15VT1G	No	Yes
ZD11	1	GENERIC ZENER−DIODE	16v		SOD323	ON	MM3Z16VT1G	No	Yes
ZD3 ZD9	2	GENERIC ZENER−DIODE	5.6V		SOD323	ON	MM3Z5V6T1G	No	Yes
ESD1−4	4	ESD protection device	5V		SOD323	ON	SD05T1G	No	Yes
ZD10	1	GENERIC ZENER−DIODE	6.2v		SOD323	ON	MM3Z6V2T1G	No	Yes

References

ON Semiconductor datasheet for NCP1622, NCP51530, NCP1568 and NCP4306
ON Semiconductor Design Notes DN05043
Weltrend Semiconductor datasheet for WT6636F

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