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## Design Note – DN05114/D

## NCP1568 USB-PD Evaluation Board

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1568 NCP51530 NCP4305 NCP4328 FDMS86202	USBPD Laptop Adapter	90Vac-265Vac	60 Watt	Active Clamp Flyback	Isolated (3kV)

### SPECIFICATIONS

<b>Output Voltage</b>	5, 9, 12, 15, 20 V
<b>Ripple</b>	1 V
<b>Nominal Current</b>	3 A
<b>Max Current</b>	3 A
<b>Min Current</b>	Zero

#### Circuit Description

This design notes describes a 60 W universal input 5 V, 9 V, 12 V, 15 V and 20 V output evaluation board for laptop adapters. This featured power supply is an active-clamp flyback topology utilizing ON Semiconductor's NCP1568 PWM controller, NCP51530 HB Driver, NCP4305 SR Controller and FDMS86202 SR FET. This design note provides complete circuit schematic, PCB, BOM and transformer information of the evaluation board. It also provide efficiency, transient response, output ripple and thermal data of the evaluation board.

This design utilized NCP1568 and NCP51530 for the active clamp flyback topology. Active clamp flyback topology effectively recycles the leakage energy. Another feature of this topology is the ZVS operation of the power MOSFETS. Because of no leakage losses and ZVS operation, this topology is suited for high frequency operation which results in size reduction of the transformer. Hence Active clamp flyback topology is well suited for high power density sub 100 W power supplies. A ZVS fixed switching frequency power converter also simplifies EMI design and can be easily designed to avoid interference with other sensitive circuits in the system.

NCP1568 is a highly integrated Ac-Dc PWM controller designed to implement an active clamp flyback topology. It features adaptive frequency scheme which optimizes frequency of operation and hence the efficiency over all load and input voltages. The NCP1568 features a HV startup circuit along. It also has integrated X2 discharge circuit.

NCP51530 is a 700 V high side and low side driver with 2 A current drive capability for AC-DC power supplies and inverters. NCP51530 offers best in class propagation delay, low quiescent current and low switching current at high frequencies of operation. This device is tailored for highly efficient power supplies operating at high frequencies.

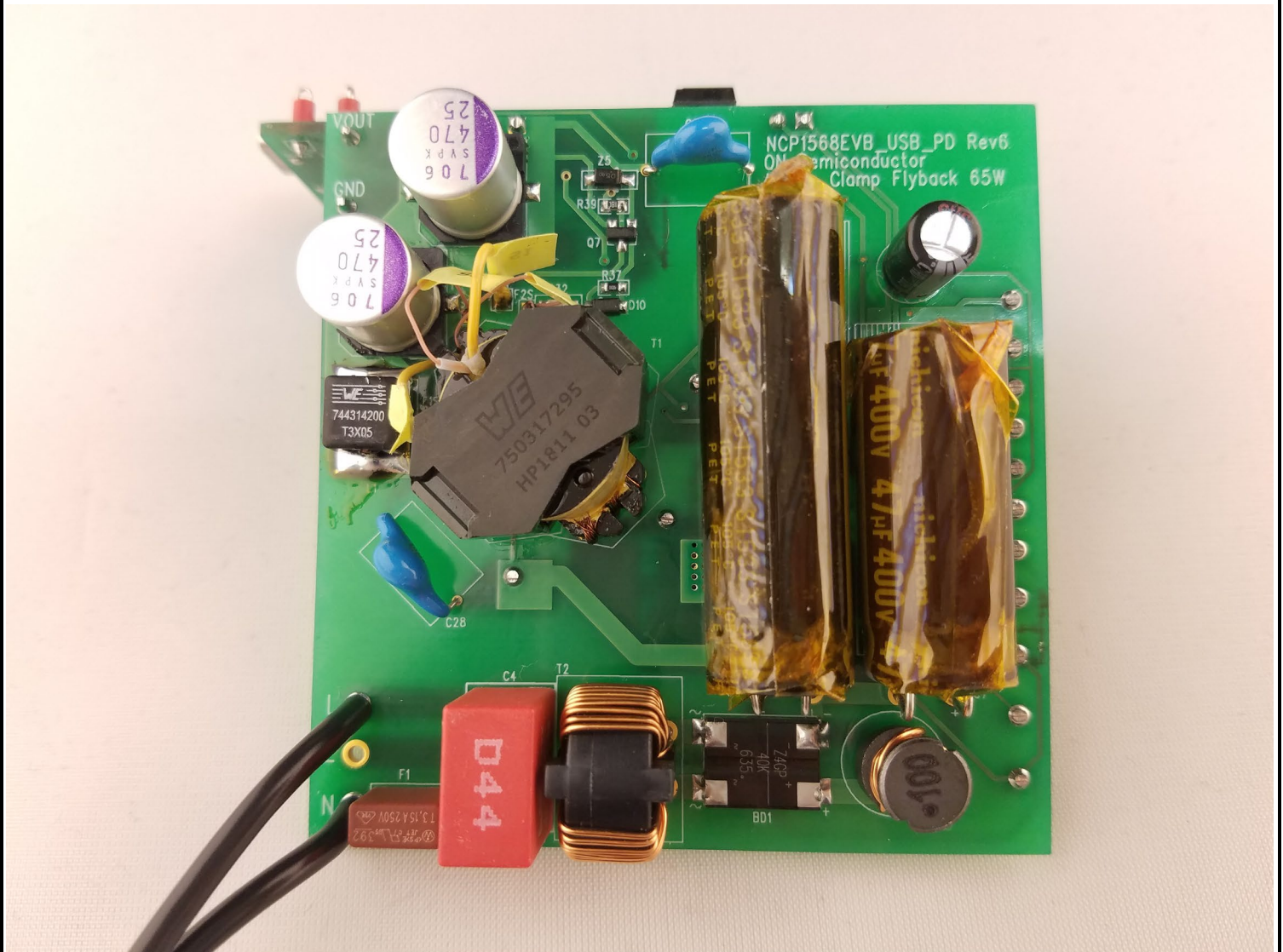
NCP4305 is high performance driver tailored to control a synchronous rectification MOSFET in switch mode power supplies.

NCP4328 is a secondary side SMPS controller with wide operating voltage range, designed for use in constant current and/or constant current regulation.

## Key Features

- Universal AC input operation (90 -265 Vac)
- High full load and average efficiency
- Low standby power
- Very low ripple and noise
- High frequency operation up to 450 kHz
- Inherent SCP and OCP protection
- Thermal and OVP protection
- Adaptive frequency operation based on AC input and output load conditions
- Adaptive ZVS operation.
- Smaller EMI components.
- Multiple probe points for evaluation
- Smooth startup operation

**DISCLAIMER:** This board is intended to emulate the output voltages of USB-PD through manual interaction. This board should not be used as a charging device for any USB-PD compatible device.



**Figure 1 Top View of the Demo Board**

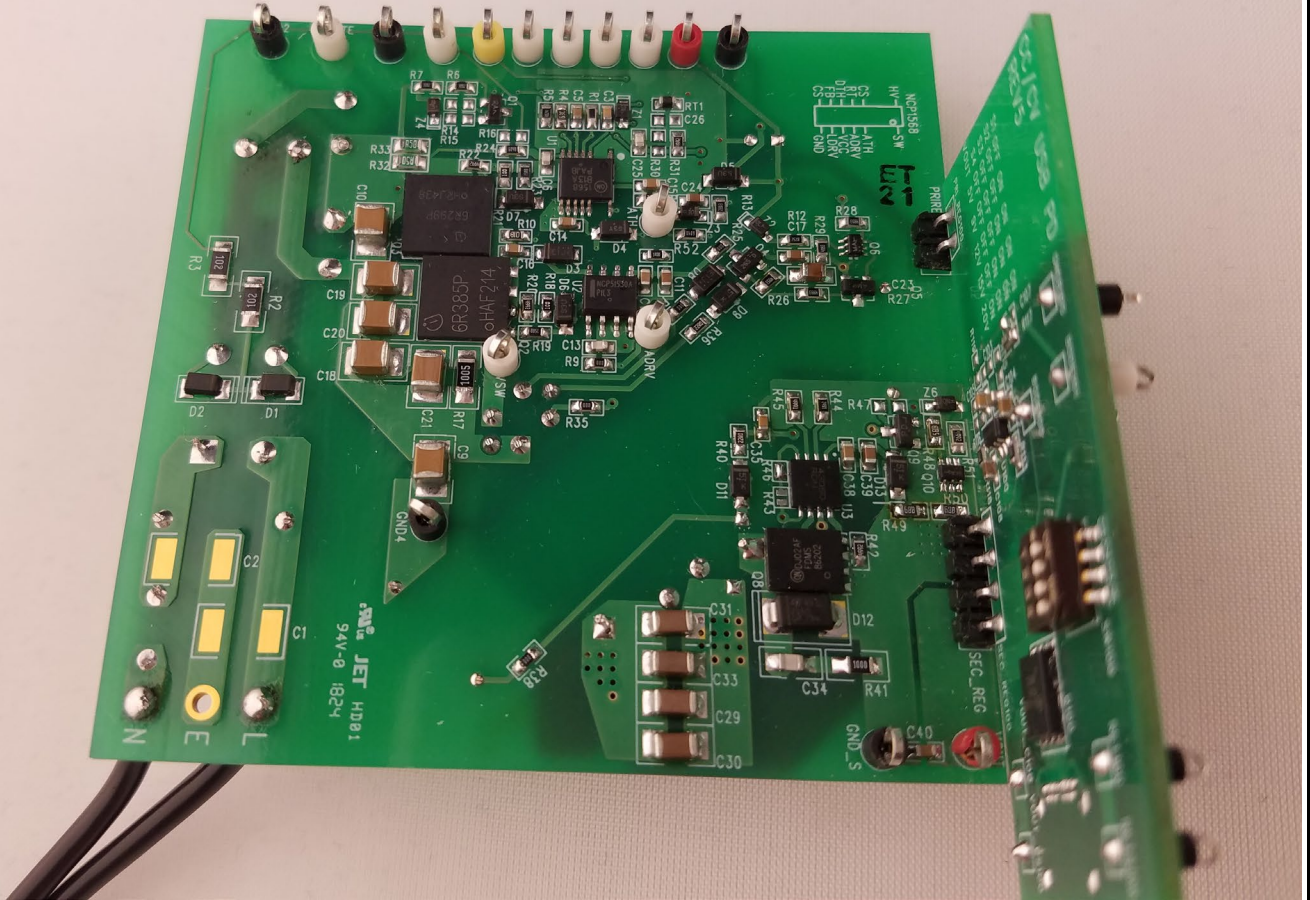


Figure 2 Bottom View of the Demo Board

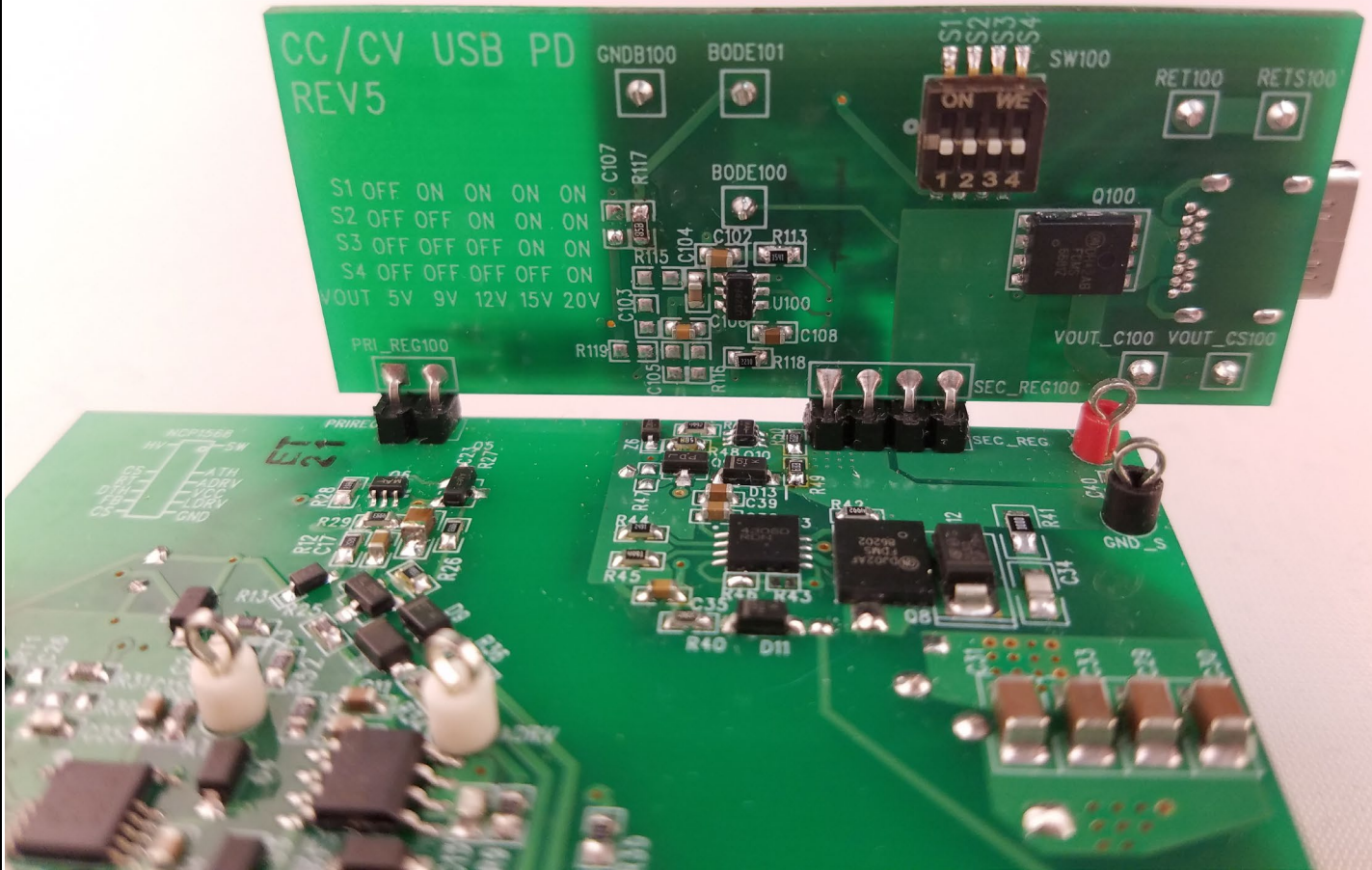


Figure 3 Bottom View of Daughter Card

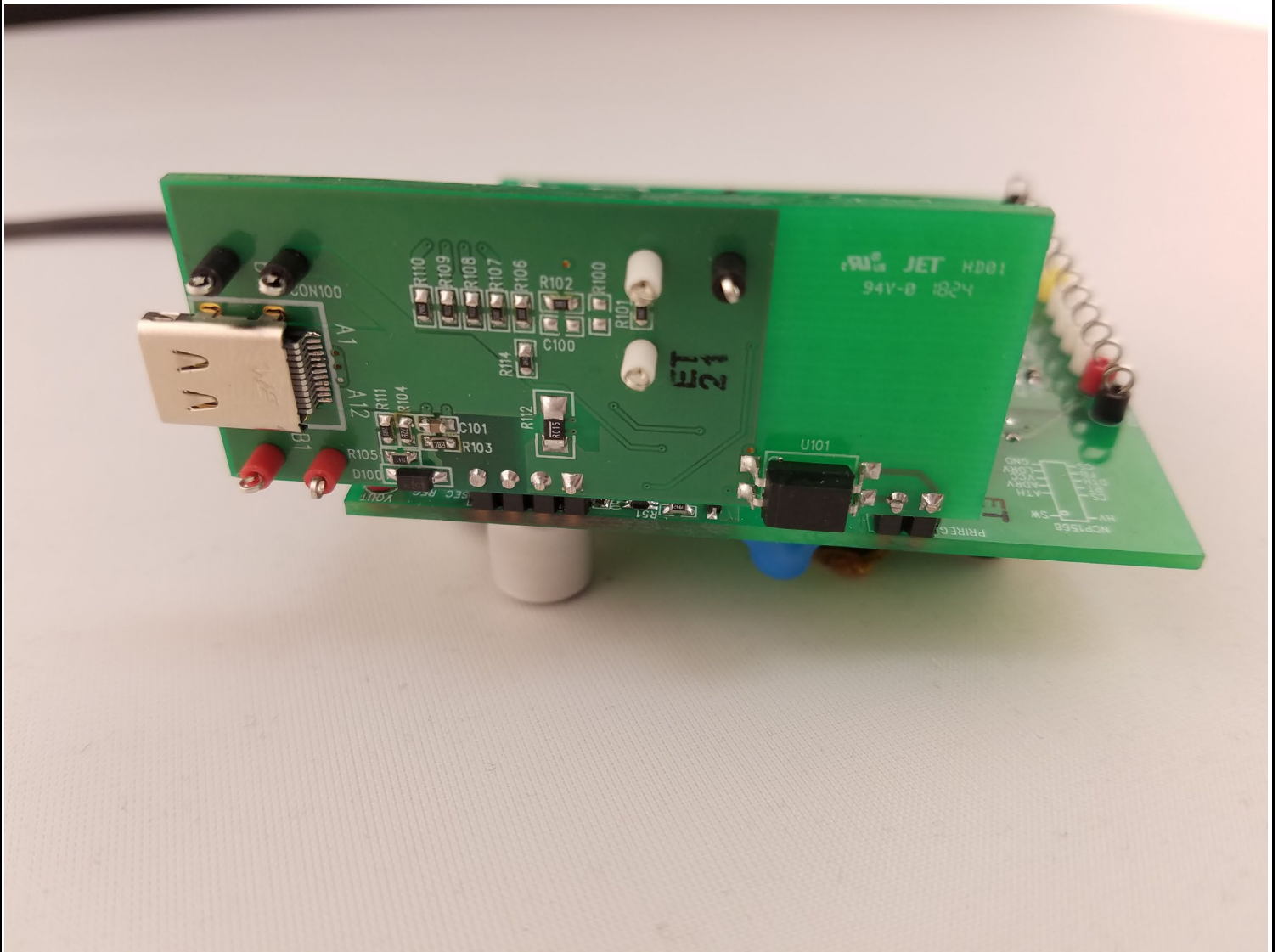
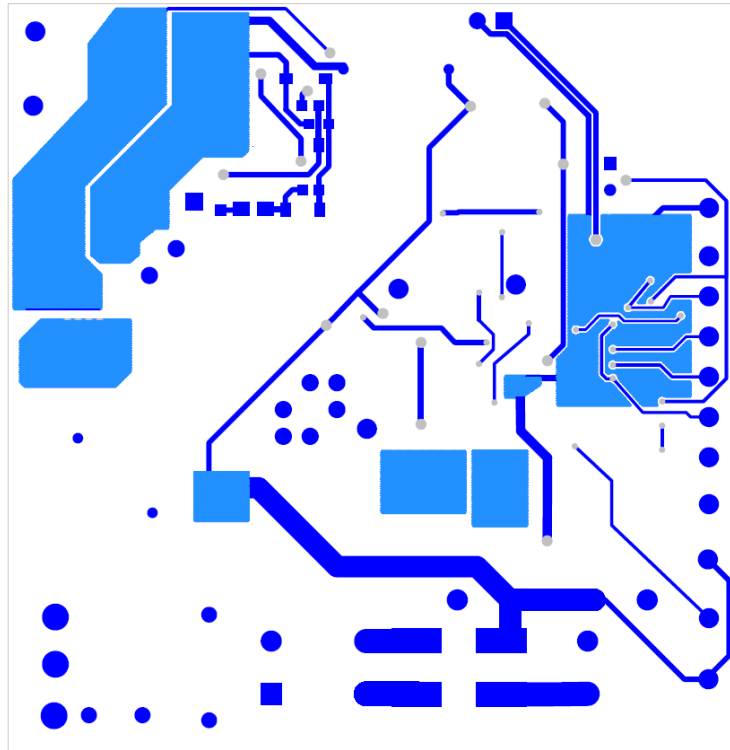


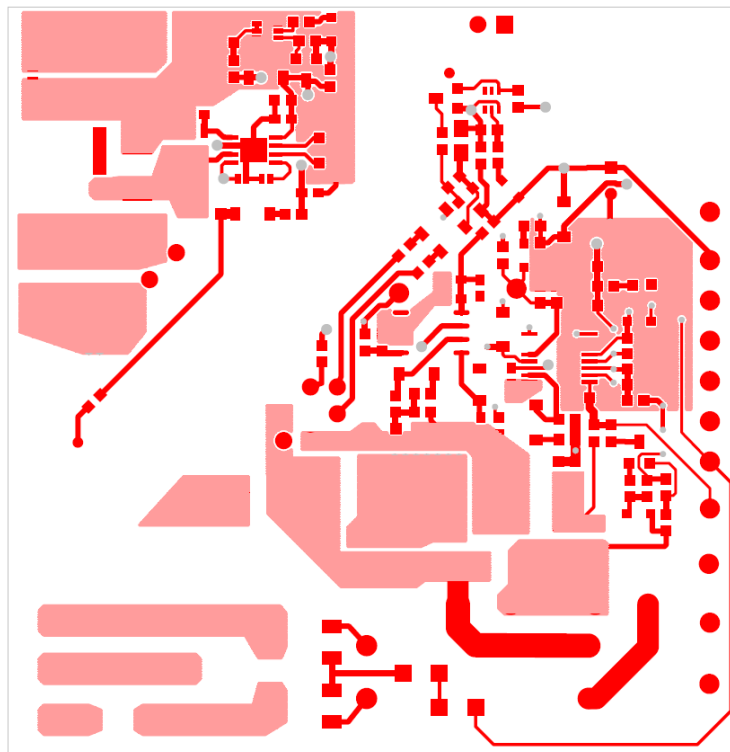
Figure 4 Top View of Daughter Card

Main Board Layout

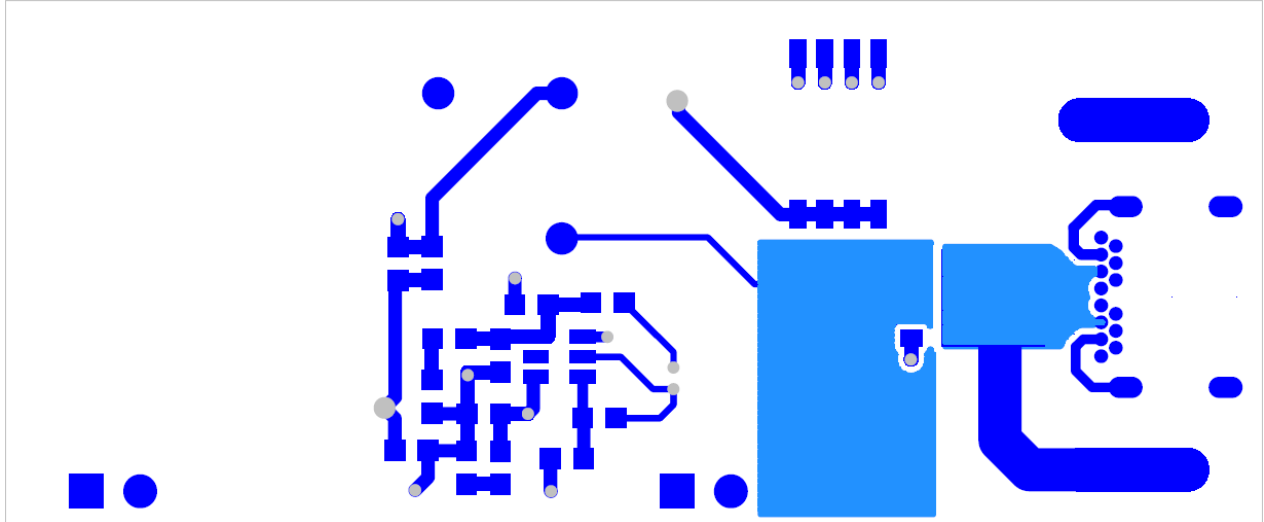
Top Layer



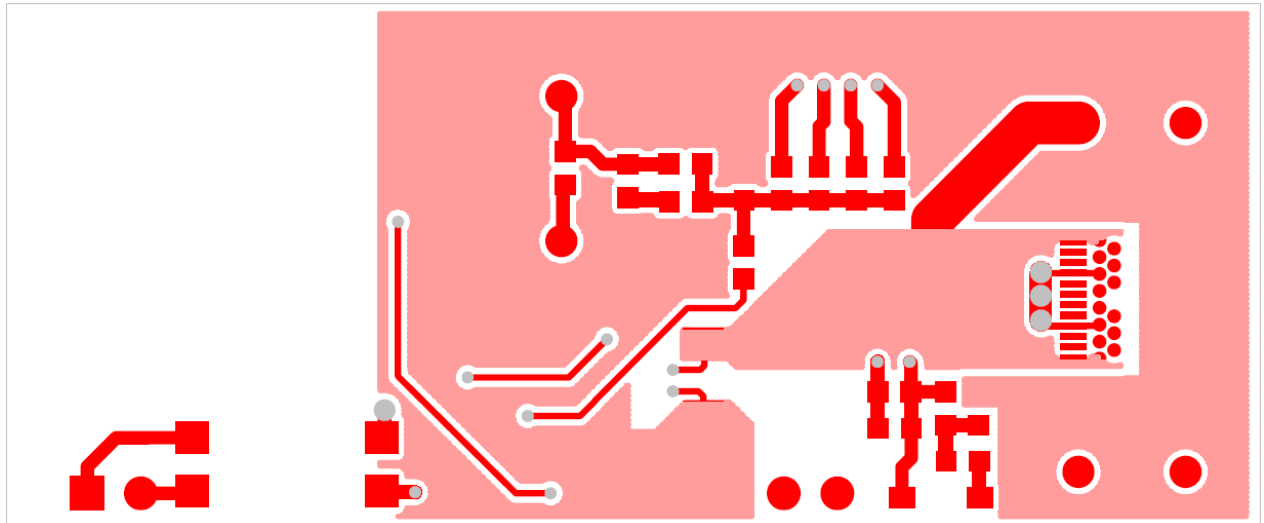
Bottom Layer



Daughter Board Layout



Top Layer

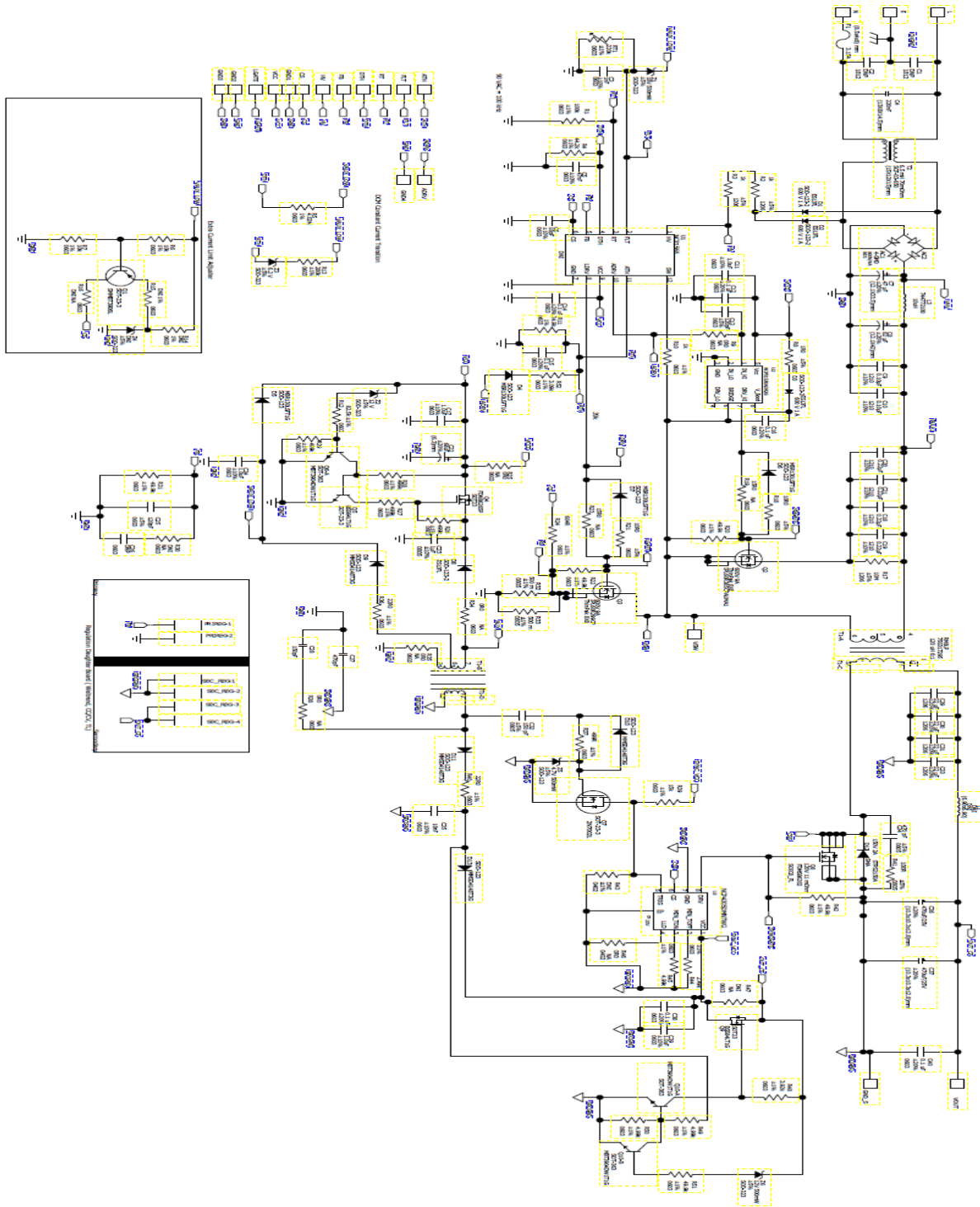


Bottom Layer



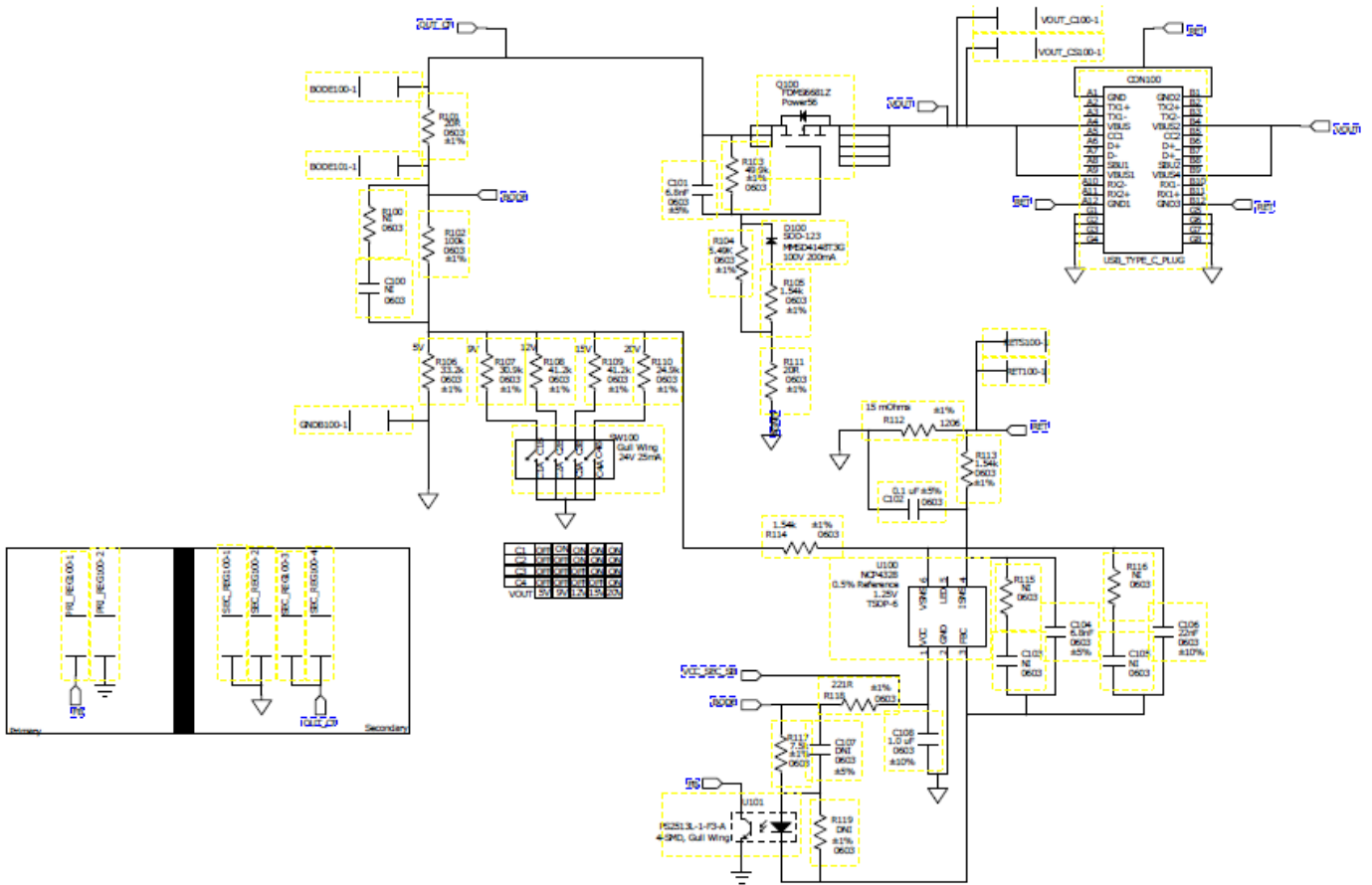
# Main Board Schematic

**NOTE:** For detailed version, see separate [Schematic PDF](#)



## Daughter Board Schematic

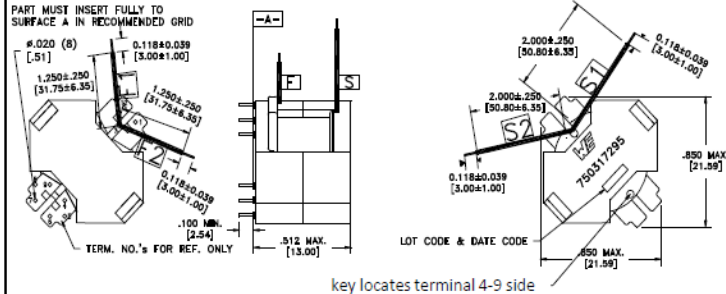
**NOTE:** For detailed version, see separate [Schematic PDF](#)



# Magnetic Design

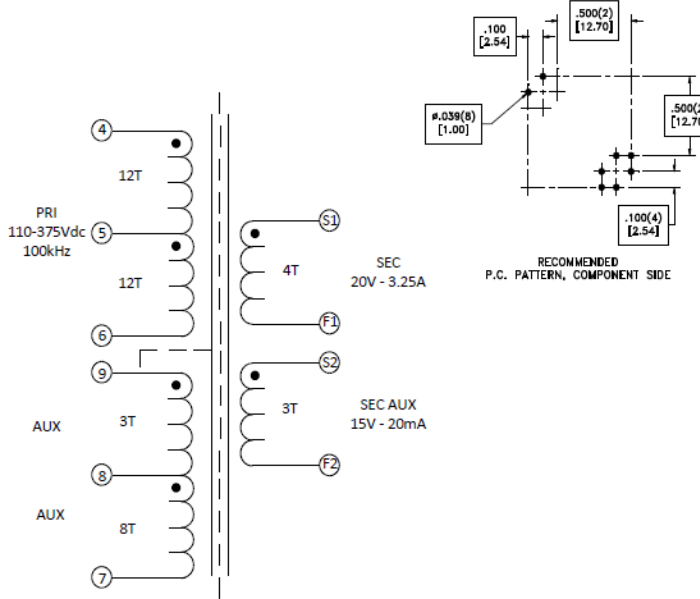
CUSTOMER TERMINAL	RoHS	LEAD(Pb)--FREE
Sn 96%, Ag 4%	Yes	Yes

more than you expect



## ELECTRICAL SPECIFICATIONS @ 25° C unless otherwise noted:

PARAMETER	TEST CONDITIONS	VALUE
D.C. RESISTANCE	4-6 @20°C	0.152 ohms ±10%
D.C. RESISTANCE	7-8 @20°C	0.335 ohms ±10%
D.C. RESISTANCE	8-9 @20°C	0.068 ohms ±20%
D.C. RESISTANCE	S1-F1 @20°C	0.016 ohms ±20%
D.C. RESISTANCE	S2-F2 @20°C	0.312 ohms ±10%
INDUCTANCE	4-6 10kHz, 100mV, Ls	120µH ±10%
SATURATION CURRENT	4-6 20% rolloff from initial	4.5A
LEAKAGE INDUCTANCE	tie(8+9, S1+S2+F1+F2), 100kHz, 100mV, Ls	4.0µH typ., 7.0µH max.
INTERWINDING CAPACITANCE	tie(4-5+6+8+9, S1+S2+F1+F2), 100kHz, 10mVAC, Cs	25.0pF typ.
DIELECTRIC	tie(4+9, S1+S2), 3750VAC, 1 second	3000VAC, 1 minute
URNS RATIO	(4-6):(8-7)	3:1, ±1%
URNS RATIO	(4-6):(9-8)	8:1, ±1%
URNS RATIO	(4-6):(S1-F1)	6:1, ±1%
URNS RATIO	(4-6):(S2-F2)	8:1, ±1%



## GENERAL SPECIFICATIONS:

OPERATING TEMPERATURE RANGE: -40°C to +125°C including temp rise.

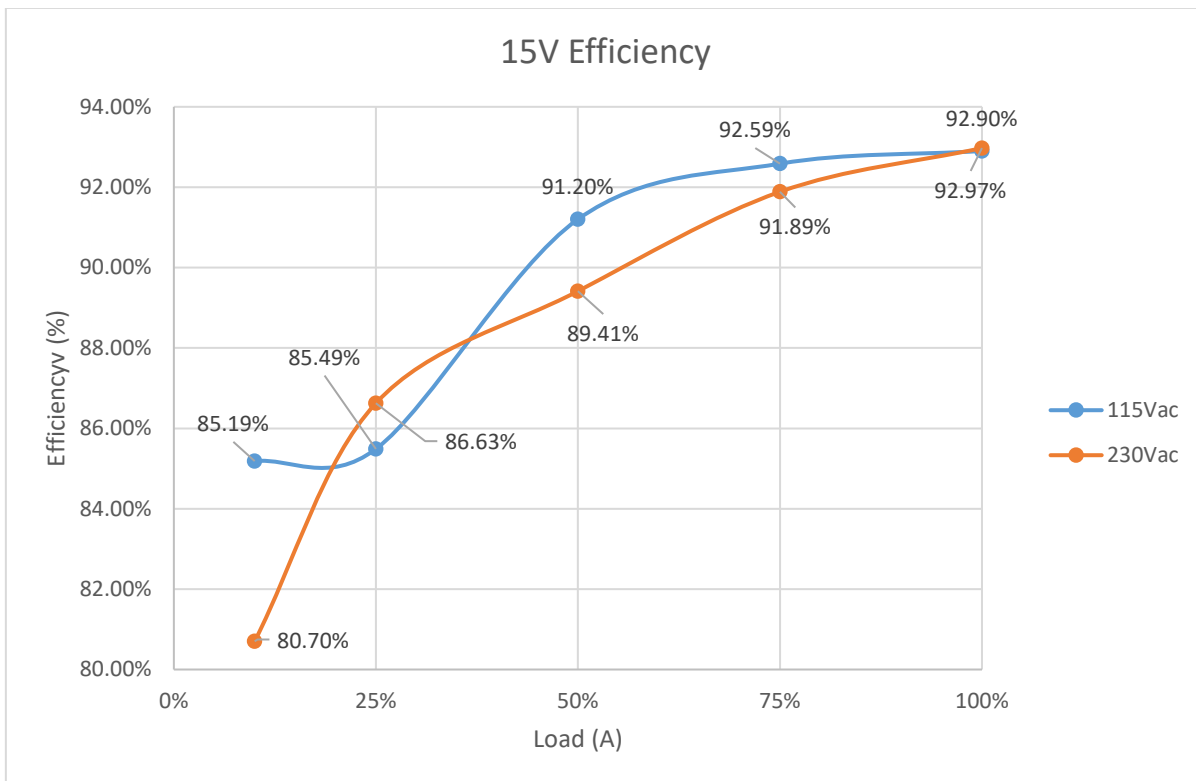
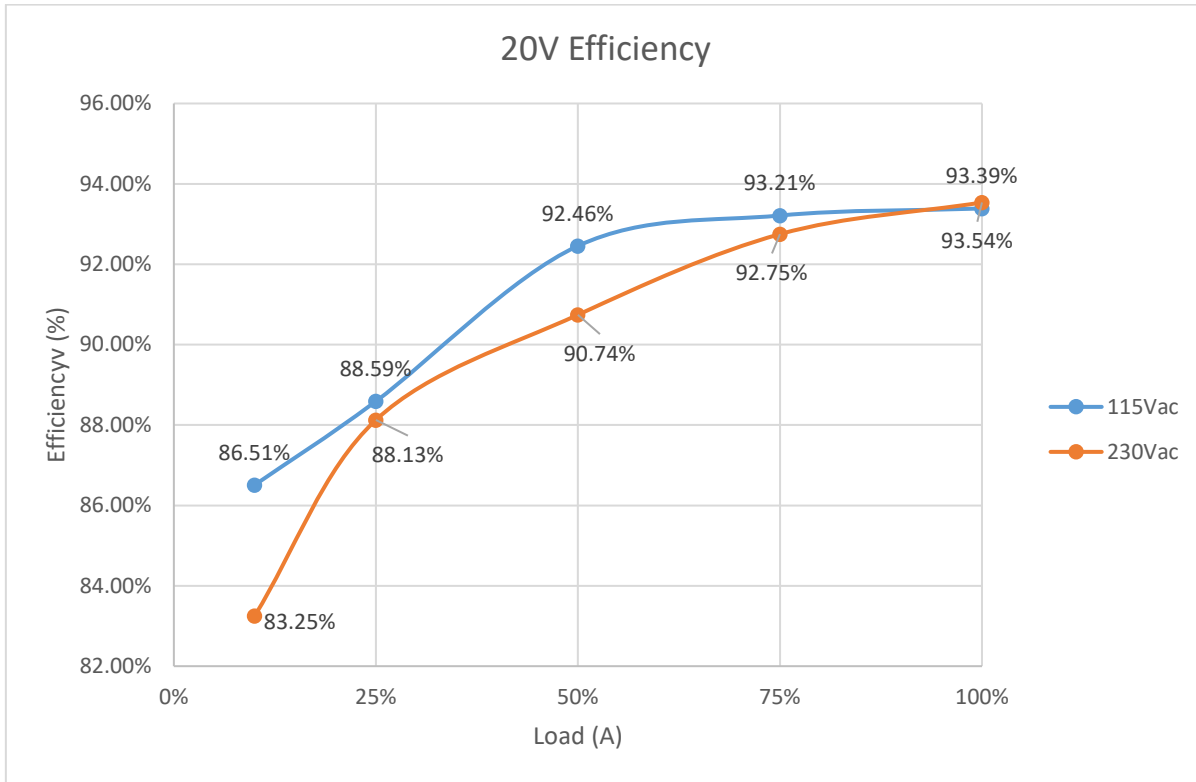
Designed to comply with the following requirements as defined by IEC60950-1, EN60950-1, UL60950-1/CSA60950-1 and AS/NZS60950.1:

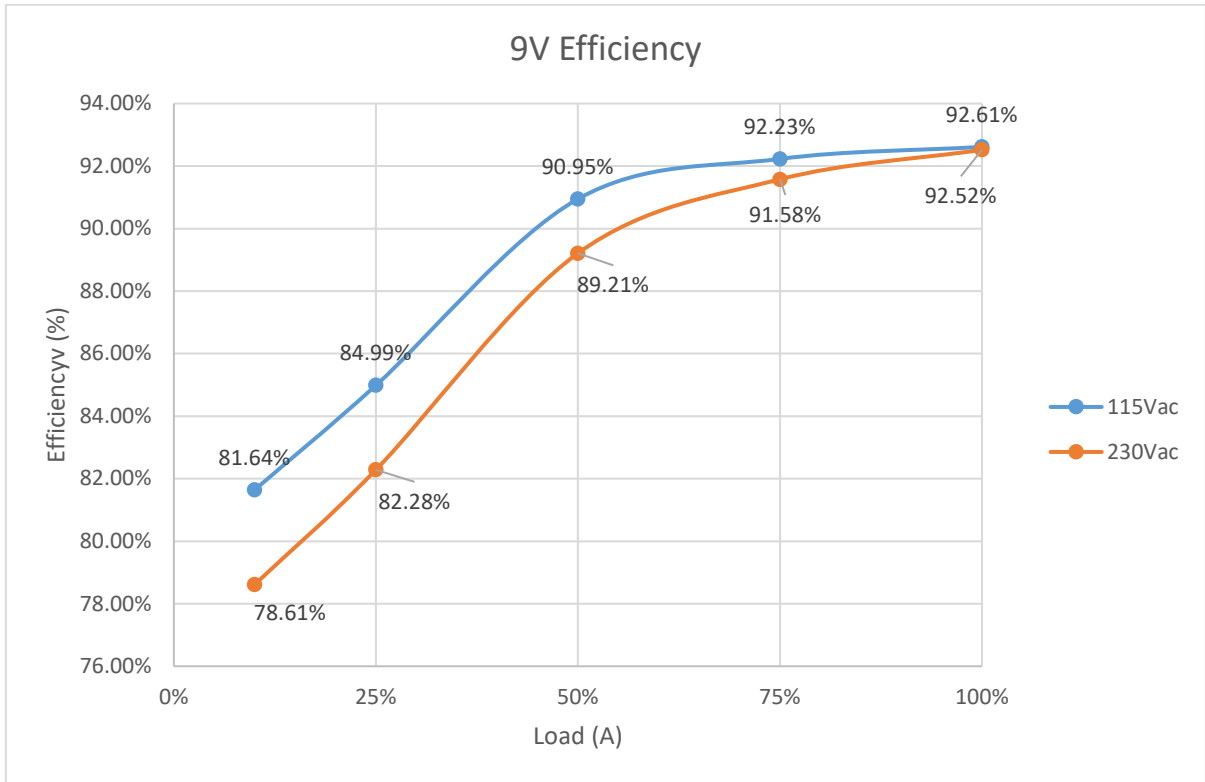
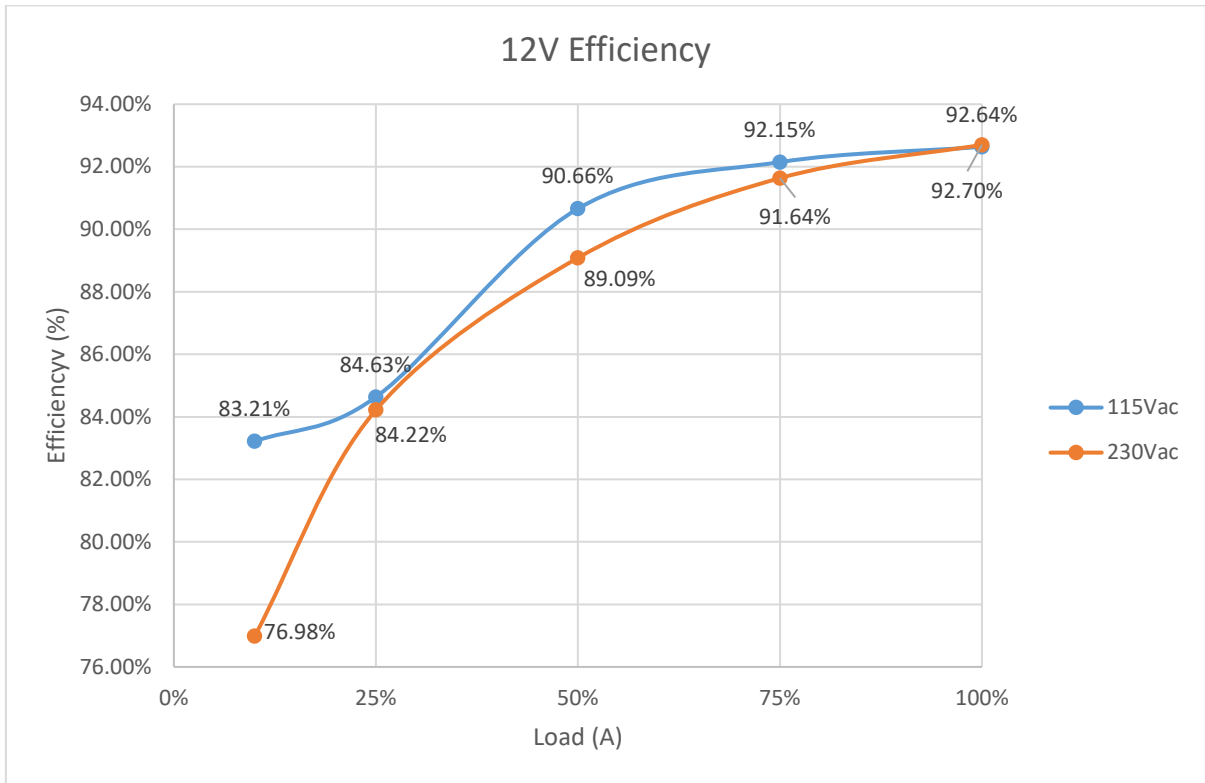
- Reinforced insulation for a primary circuit at a working voltage of 265Vrms, 400Vpeak, Overvoltage Category II.

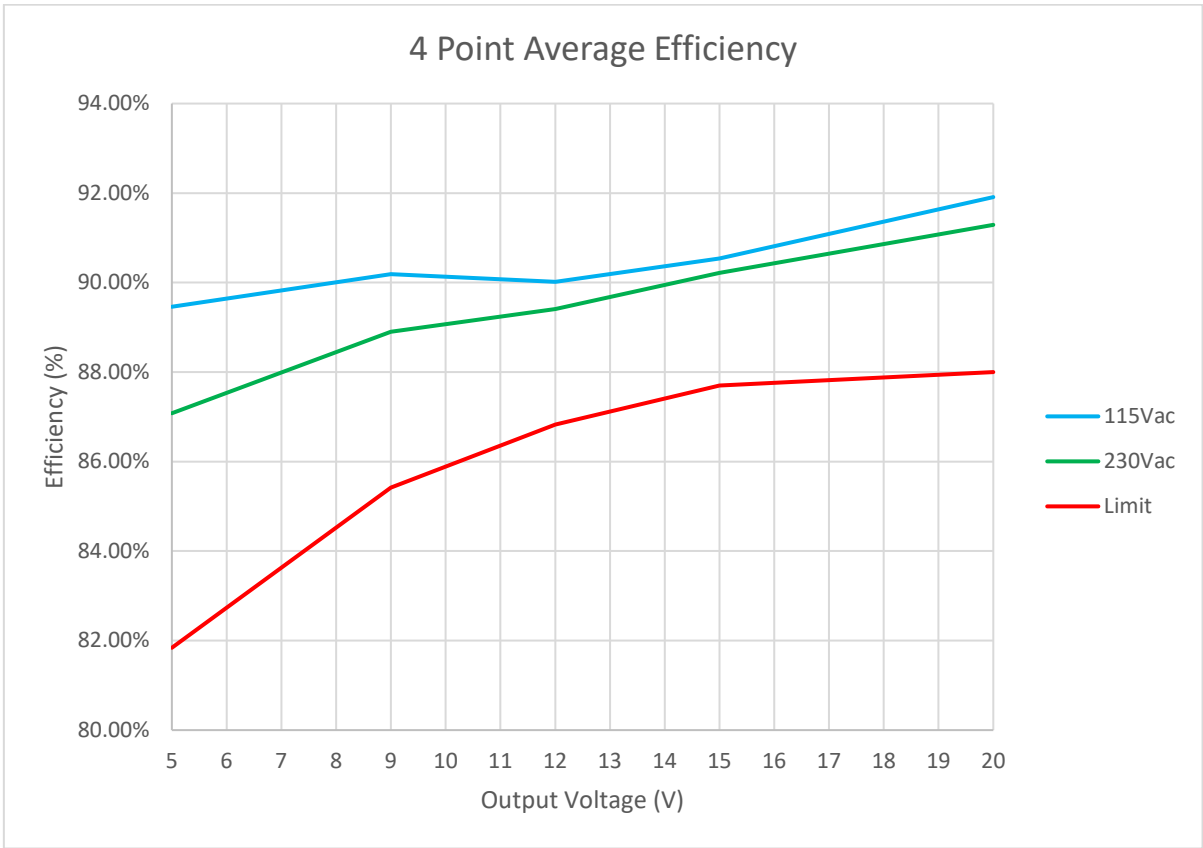
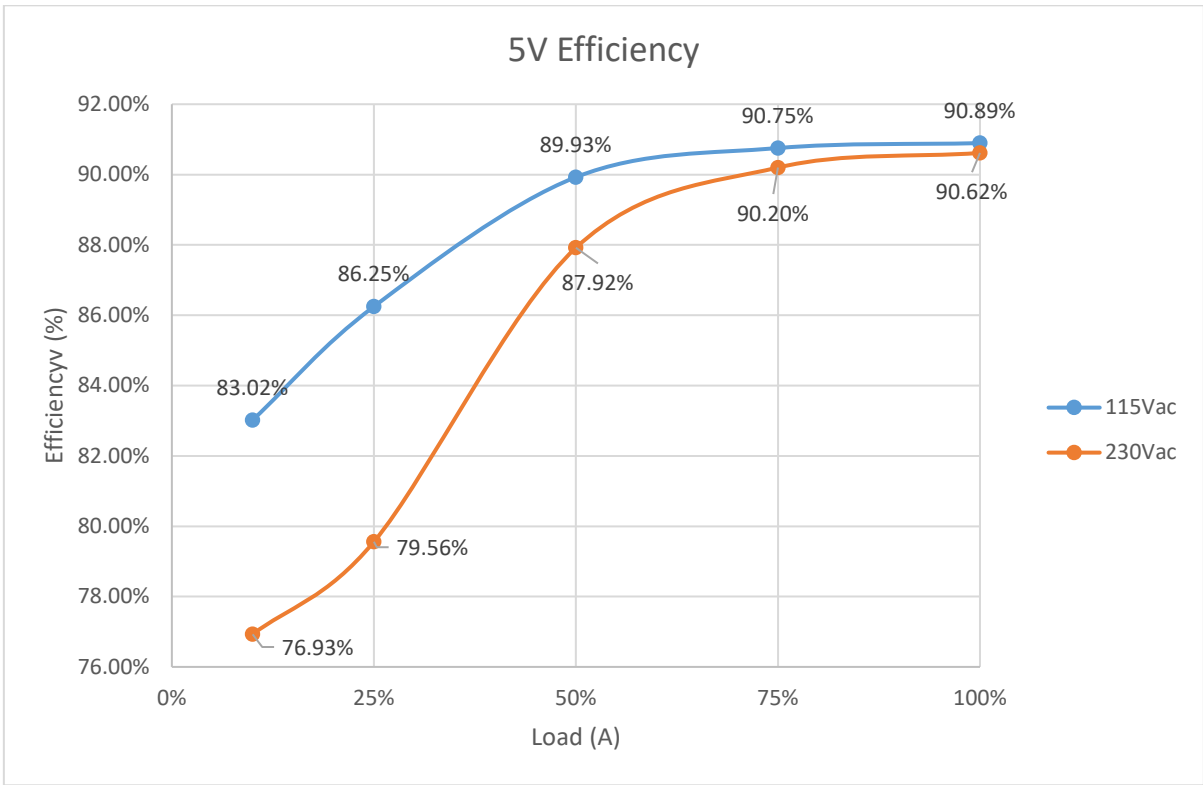
Wire insulation & RoHS status not affected by wire color. Wire insulation color may vary depending on availability.

DFM	Packaging Specifications		Tolerances unless otherwise specified:	DRAWING TITLE	PART NO.
DATE	Method: Tray		Angles: ±1° Decimals: ±.005 [.13]	<b>TRANSFORMER</b>	<b>750317295</b>
ENG	LJG	PKG-0002	Fractions: ±1/64 Footprint: ±.001 [.03]		
REV.	04		This drawing is dual dimensioned. Dimensions in brackets are in millimeters.		
DATE		www.we-online.com/midcom			

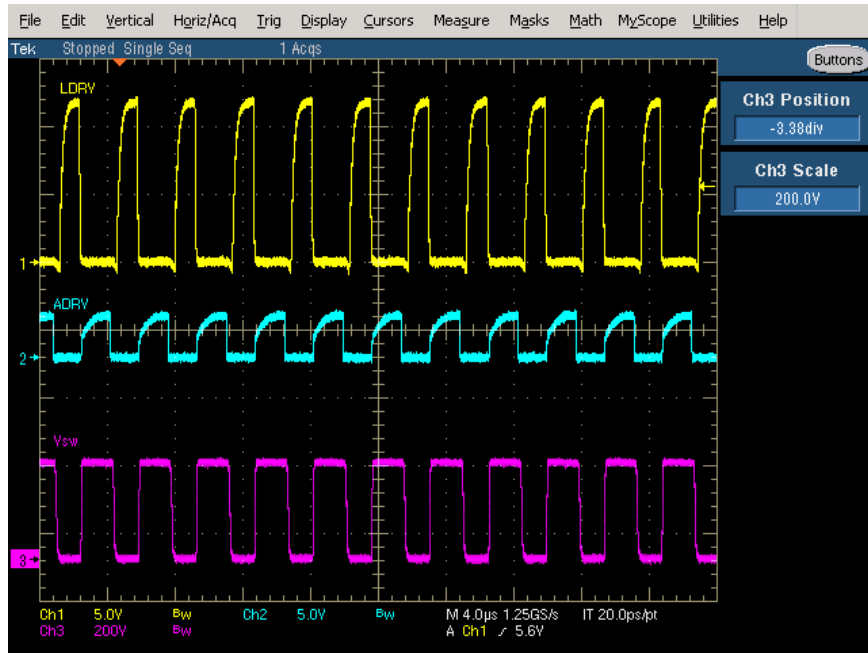
## Evaluation Board Efficiency Data



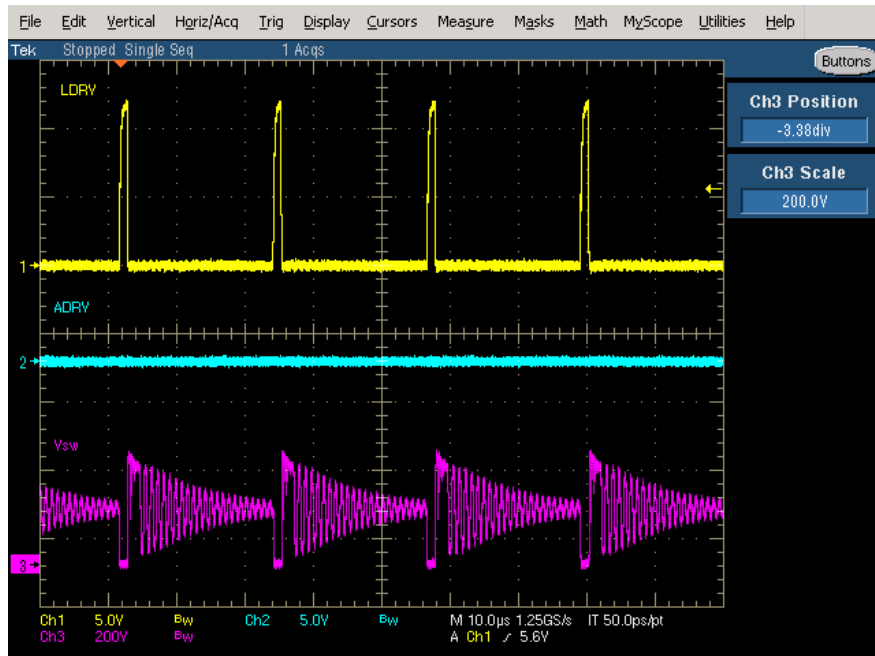




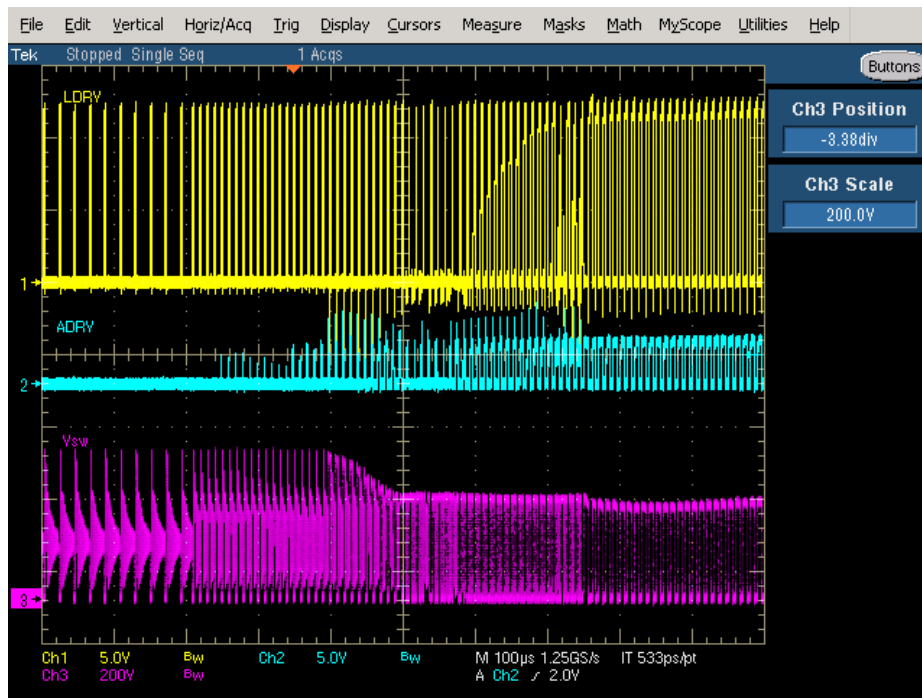
# Waveforms



**Figure 5 Steady State ACF Operation**



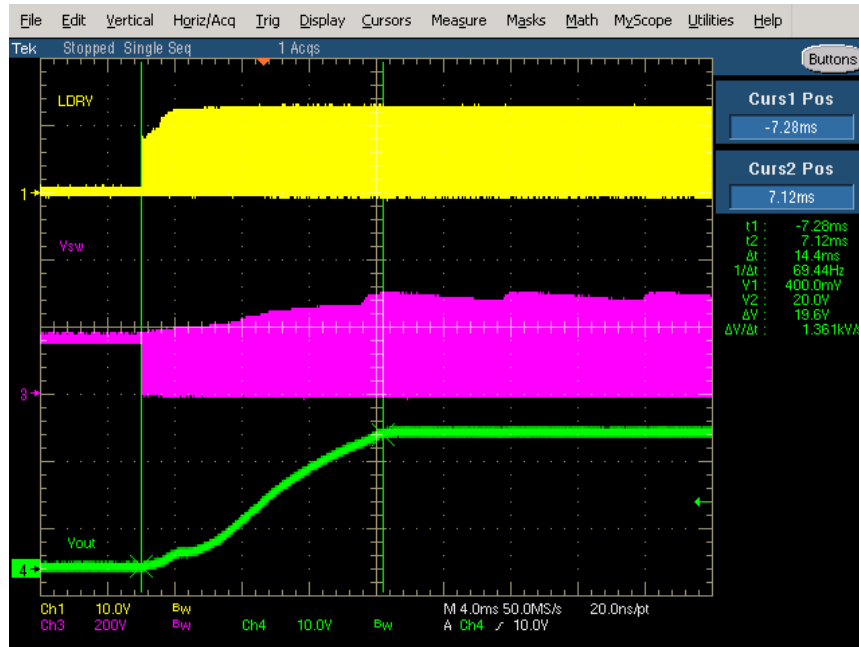
**Figure 6 Steady State DCM Operation**



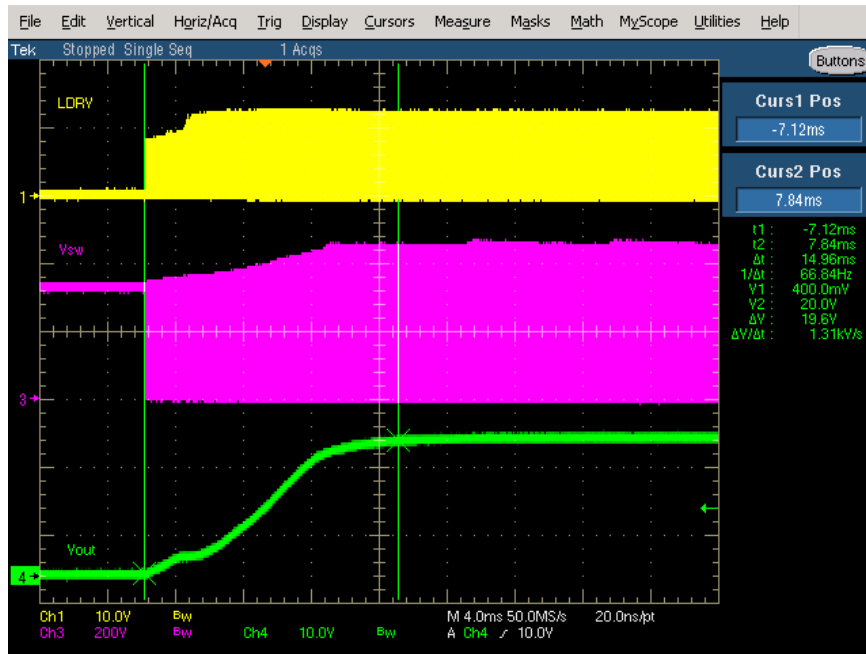
**Figure 7 DCM to ACF Transition**



## Full Load Startup



**Figure 8 115 Vac Input , 20 V Output - Full Load Startup Waveform**



**Figure 9 230 Vac Input , 20 V Output - Full Load Startup Waveform**

# Output Ripple

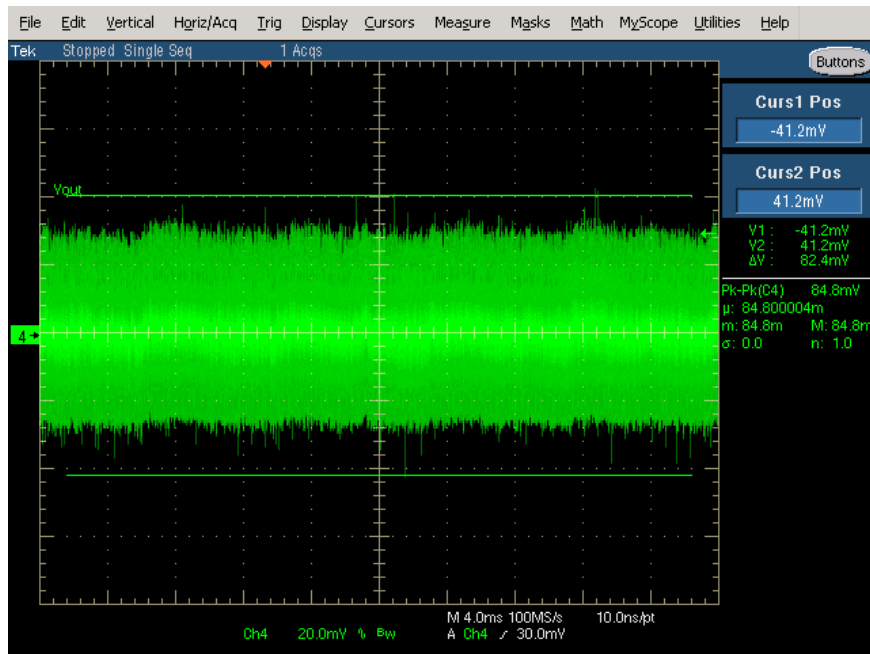


Figure 10 115 Vac 5 Vout Ripple

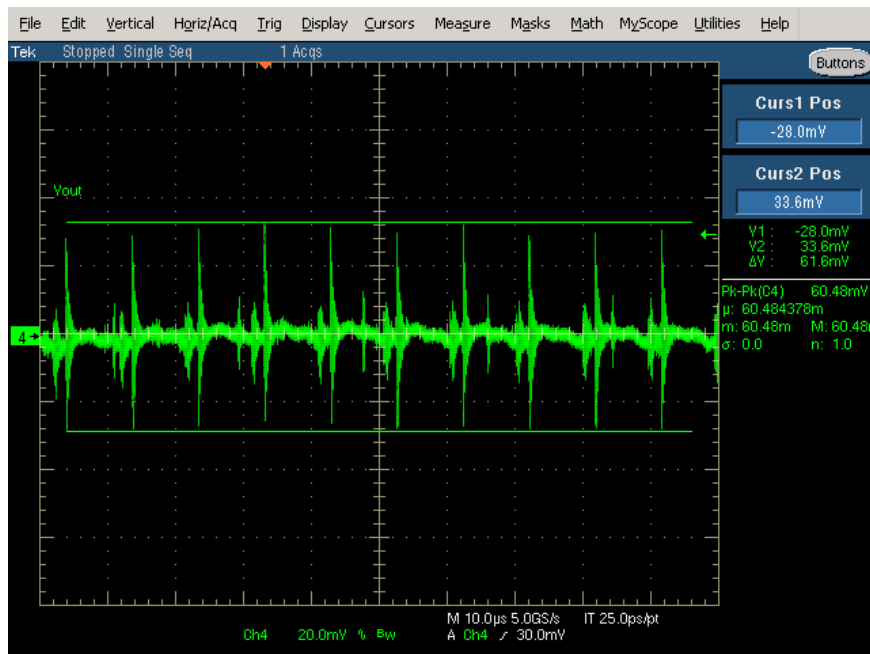
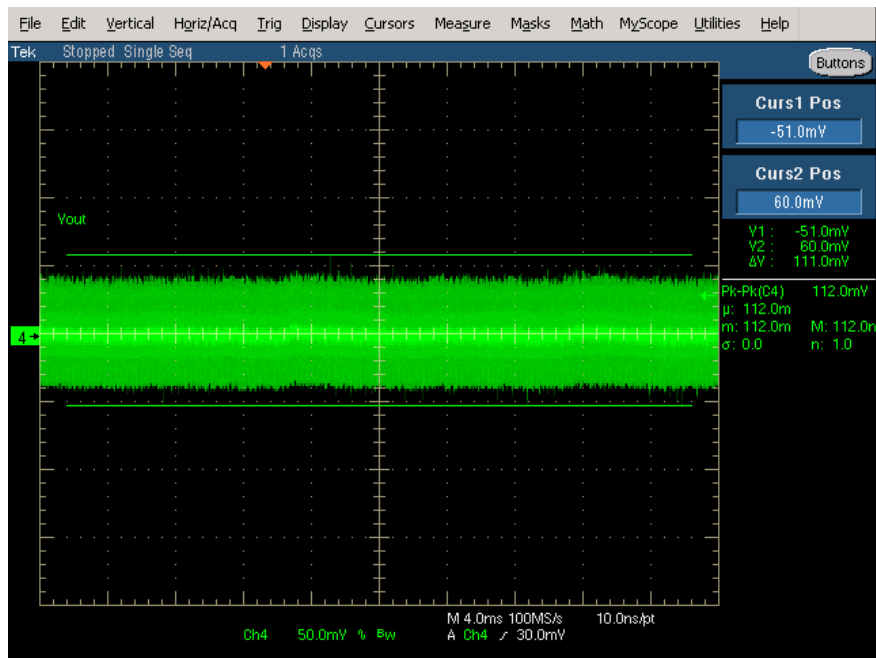
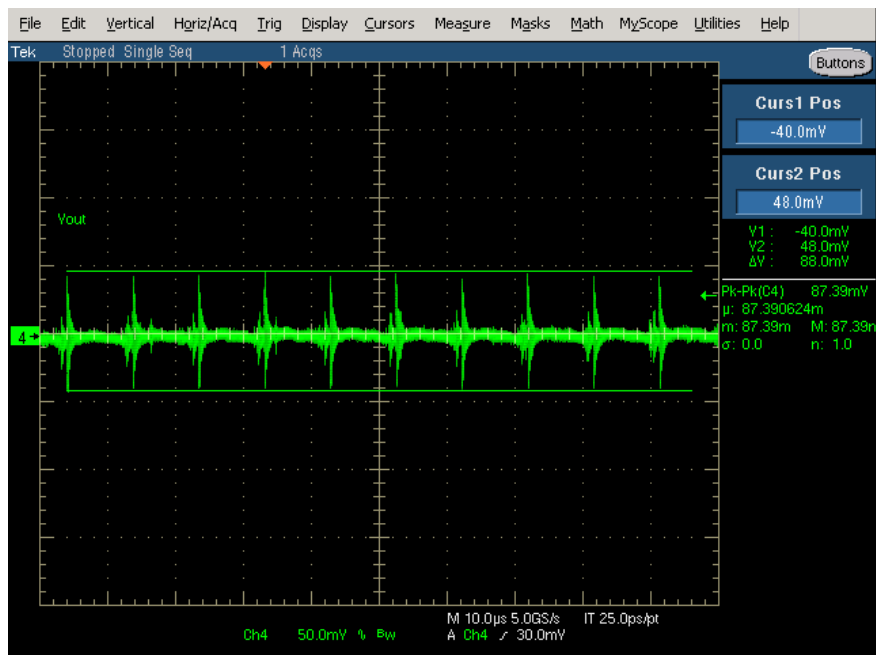


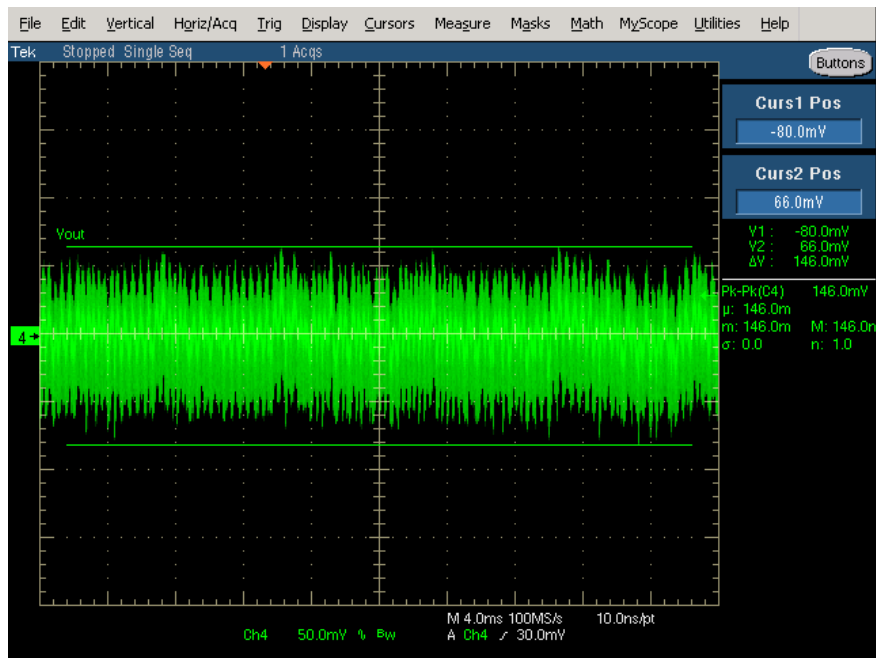
Figure 11 115 Vac 5 Vout Ripple Zoom



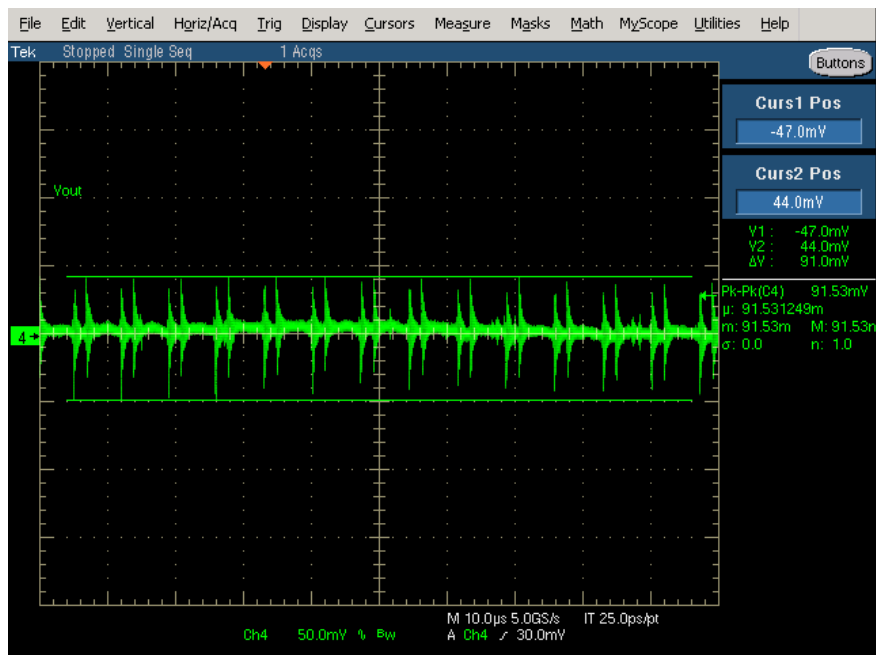
**Figure 12 230 Vac 5 Vout Ripple**



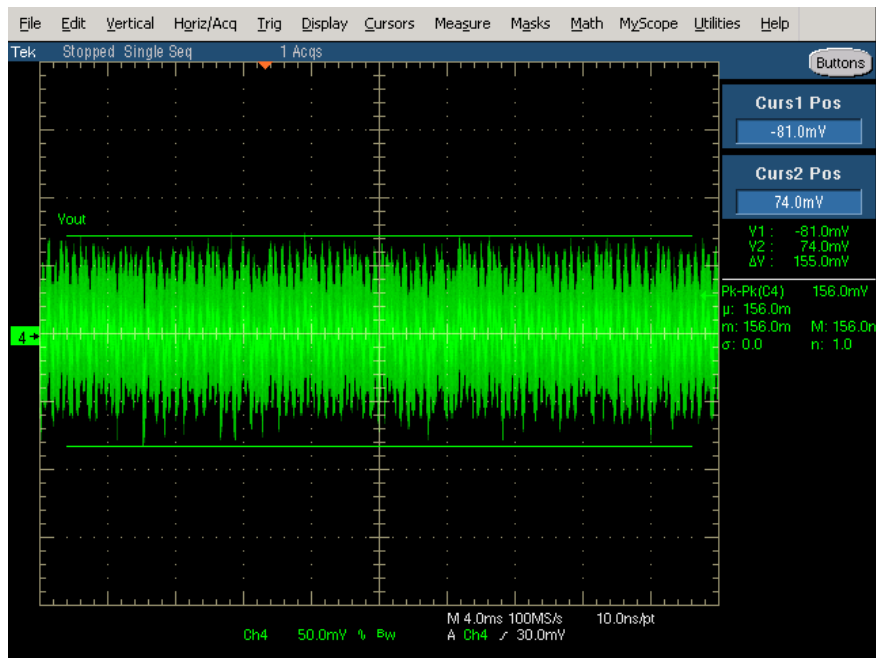
**Figure 13 230 Vac 5 Vout Ripple Zoom**



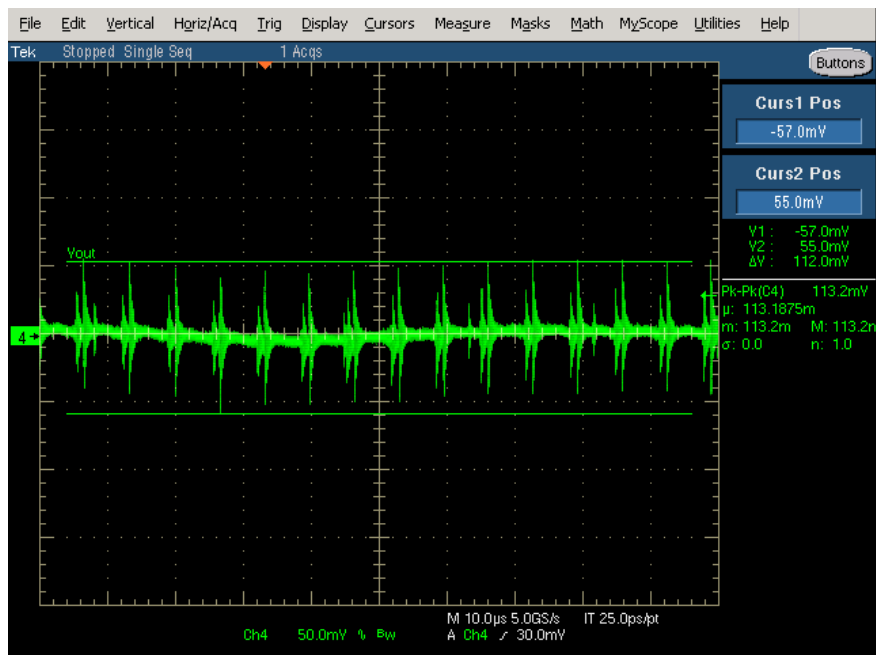
**Figure 14 115 Vac 9 Vout Ripple**



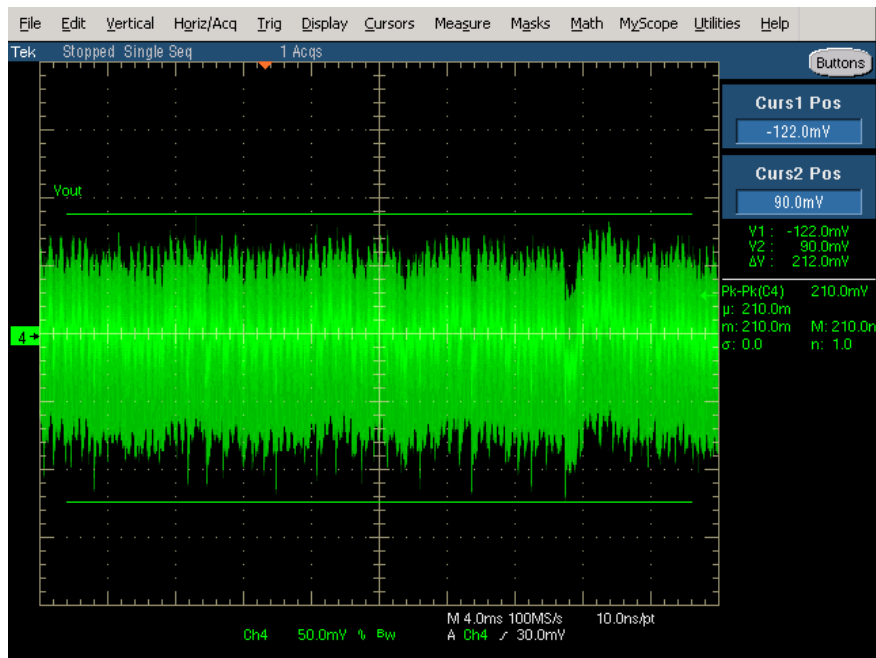
**Figure 15 115 Vac 9 Vout Ripple Zoom**



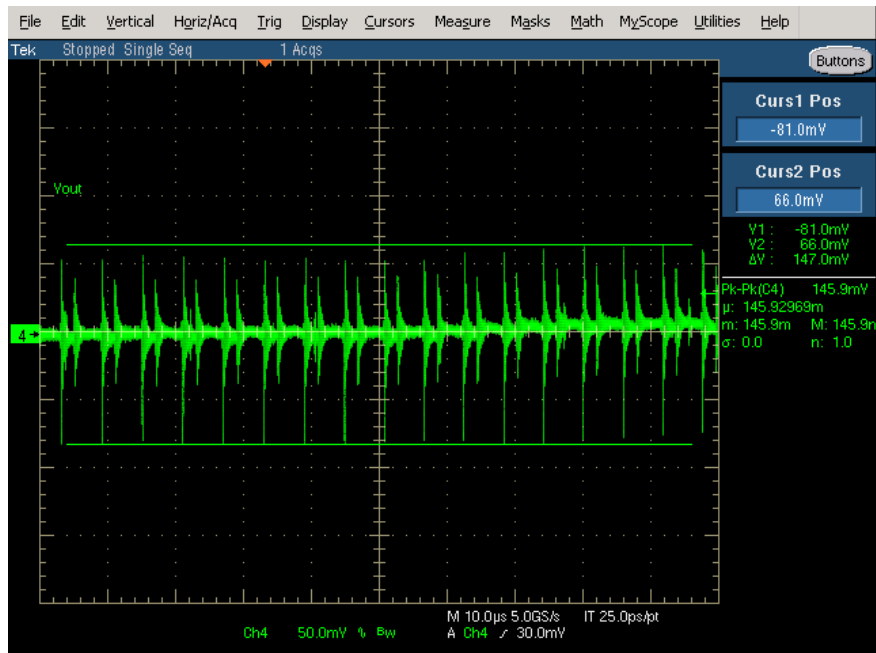
**Figure 16 230 Vac 9 Vout Ripple**



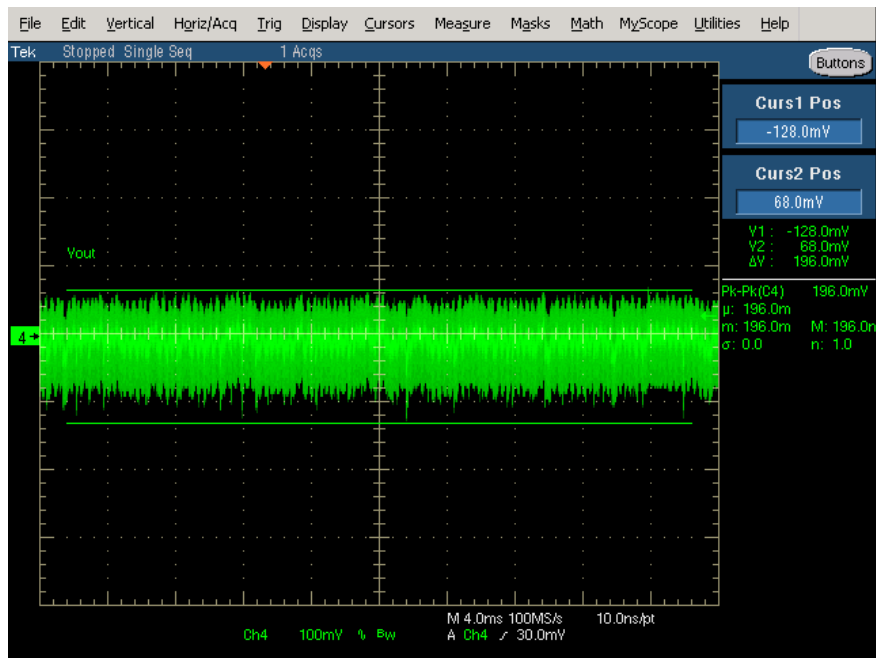
**Figure 17 230 Vac 9 Vout Ripple Zoom**



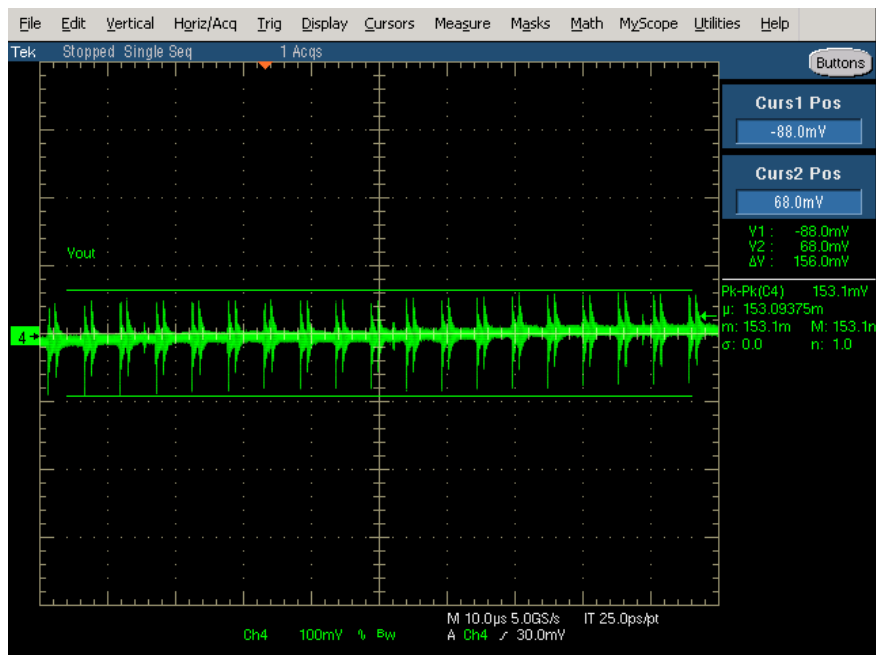
**Figure 18 115 Vac 12 Vout Ripple**



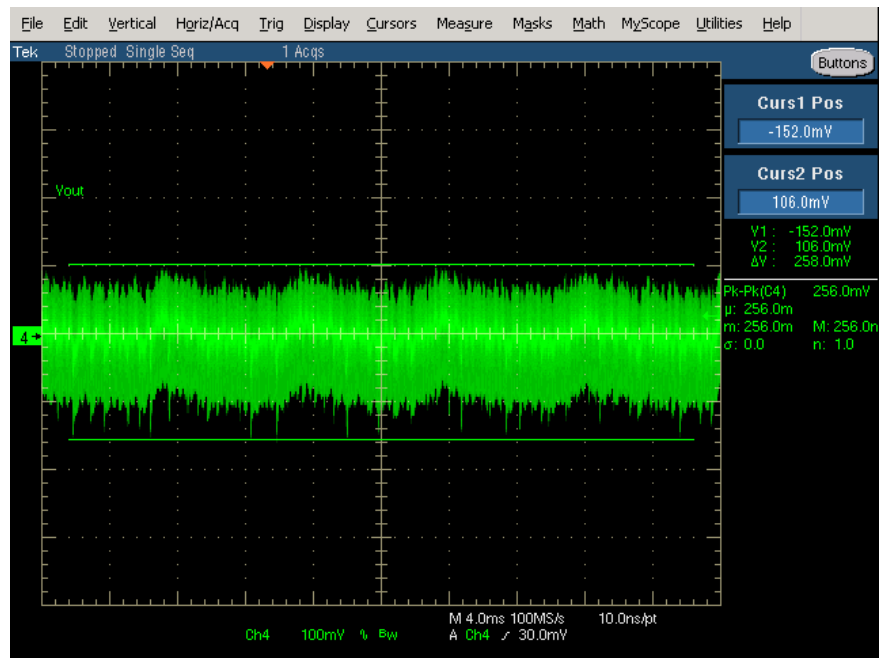
**Figure 19 115 Vac 12 Vout Ripple Zoom**



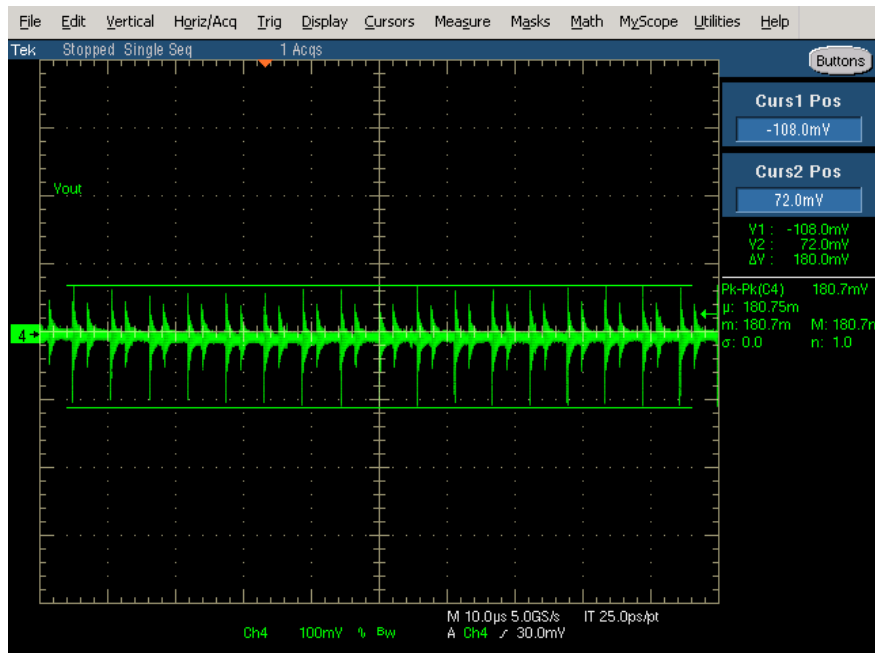
**Figure 20 230 Vac 12 Vout Ripple**



**Figure 21 230 Vac 12 Vout Ripple Zoom**

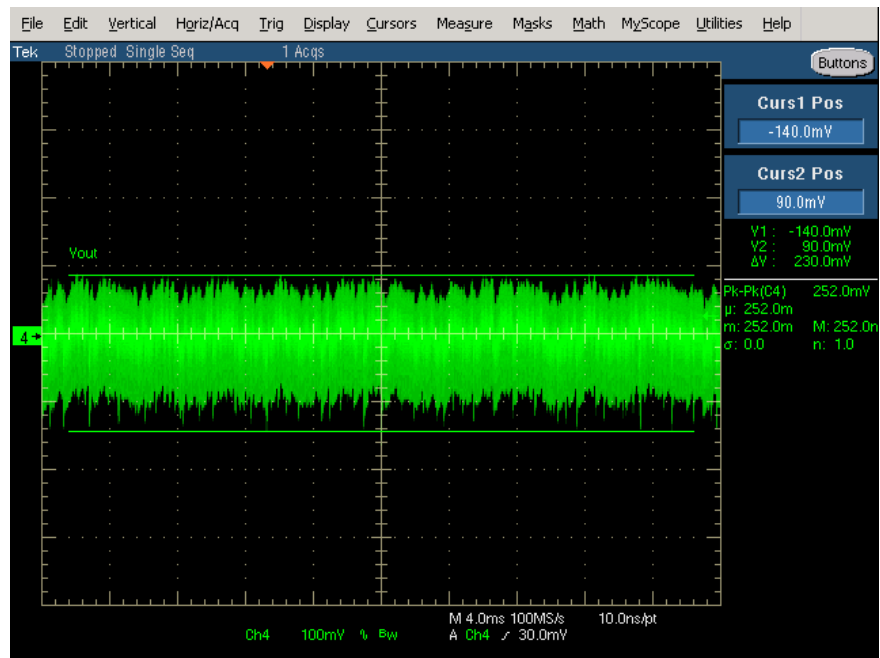


**Figure 22 115 Vac 15 Vout Ripple**

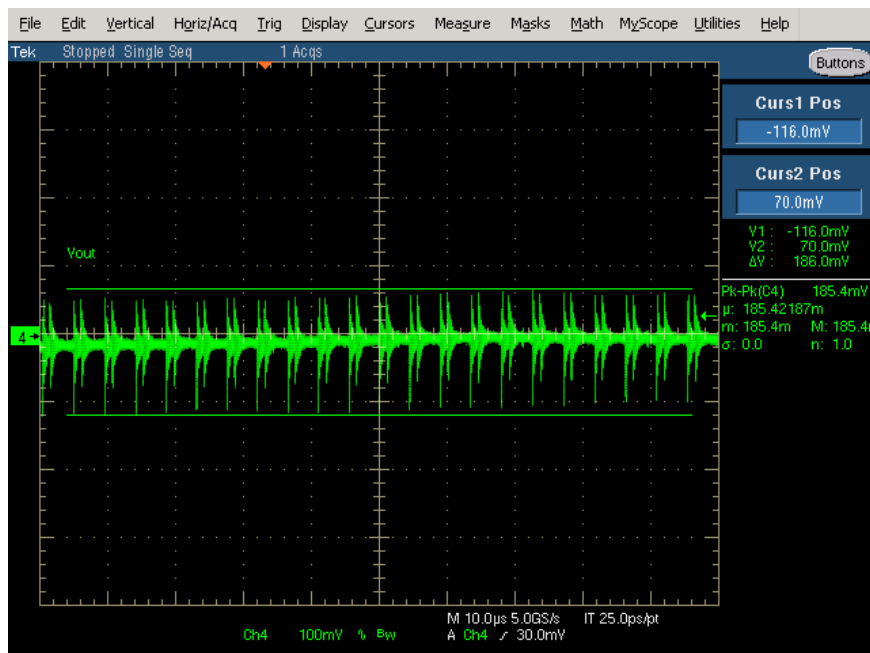


**Figure 23 115 Vac 15 Vout Ripple Zoom**

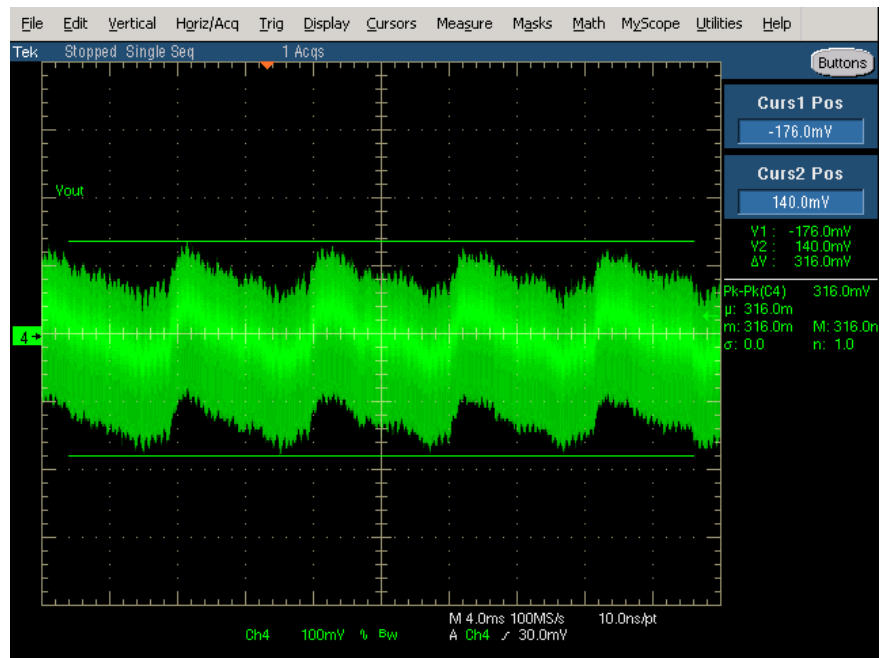




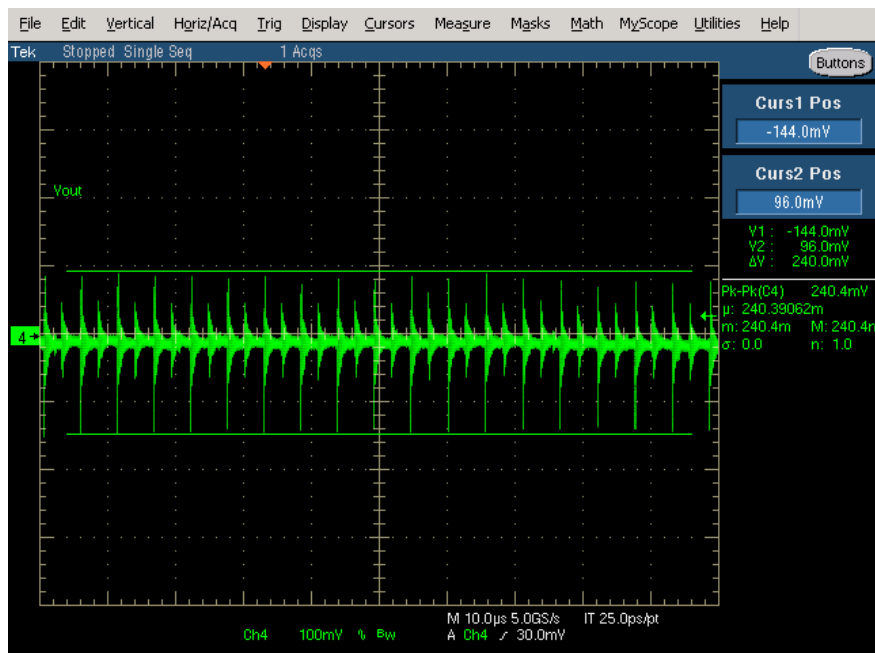
**Figure 24 230 Vac 15 Vout Ripple**



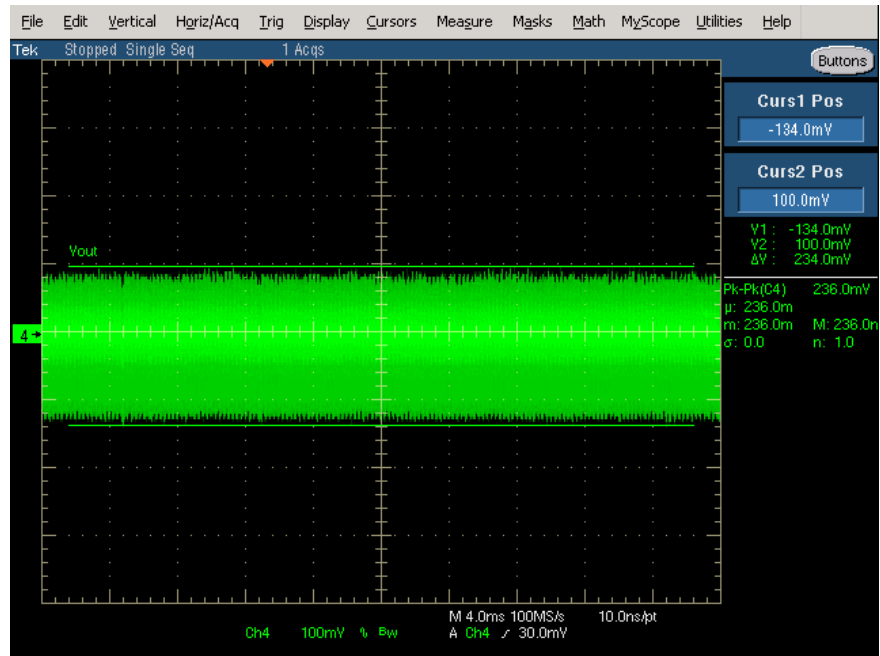
**Figure 25 230 Vac 15 Vout Ripple Zoom**



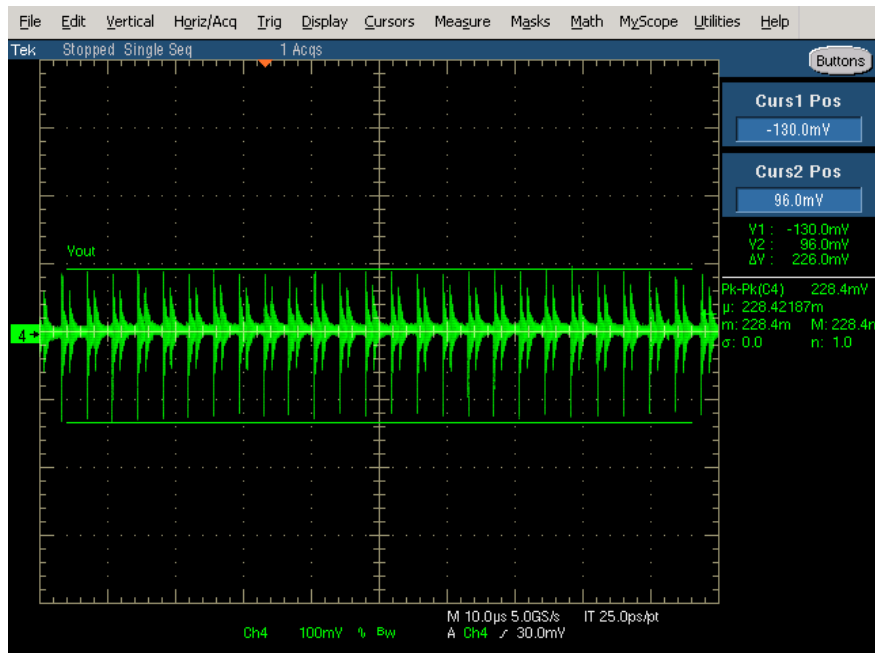
**Figure 26 115 Vac 20 Vout Ripple**



**Figure 27 115 Vac 20 Vout Ripple Zoom**



**Figure 28 230 Vac 20 Vout Ripple**



**Figure 29 230 Vac 20 Vout Ripple Zoom**

# Transient Response

(0.1A – 3A, 150 mA/us, 20 ms)

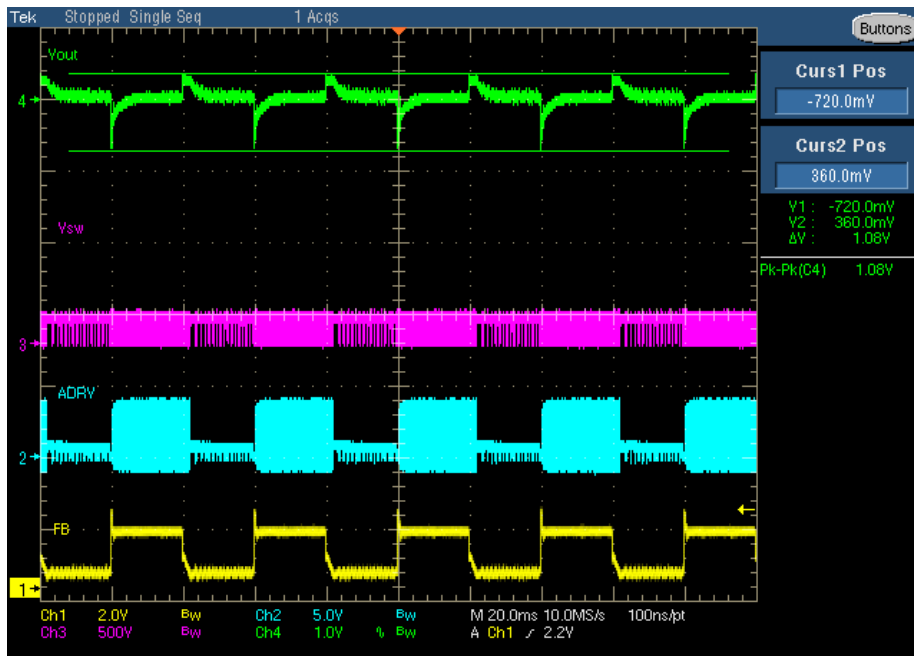


Figure 30 115 Vac 5 Vout Transient

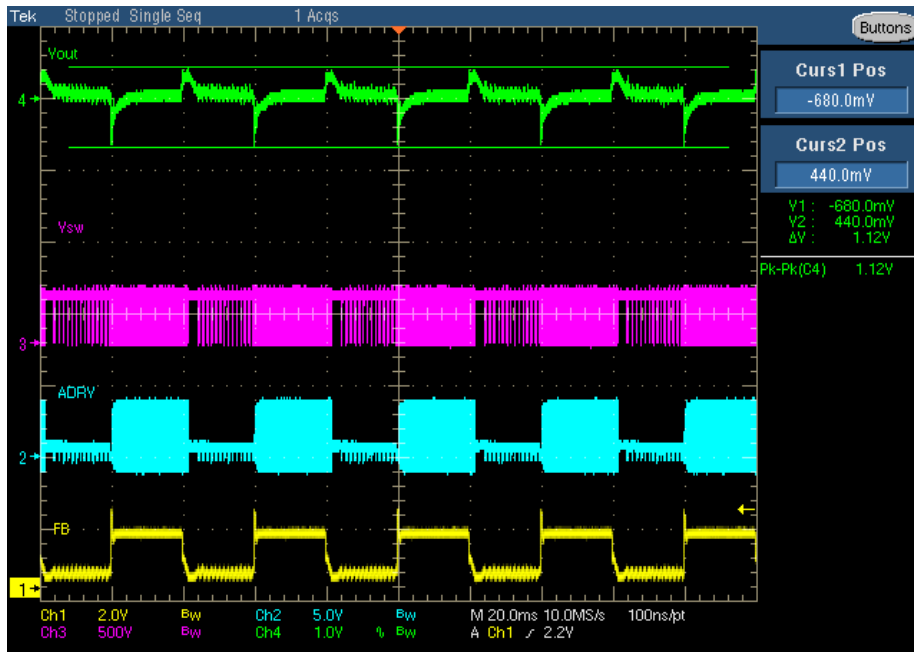
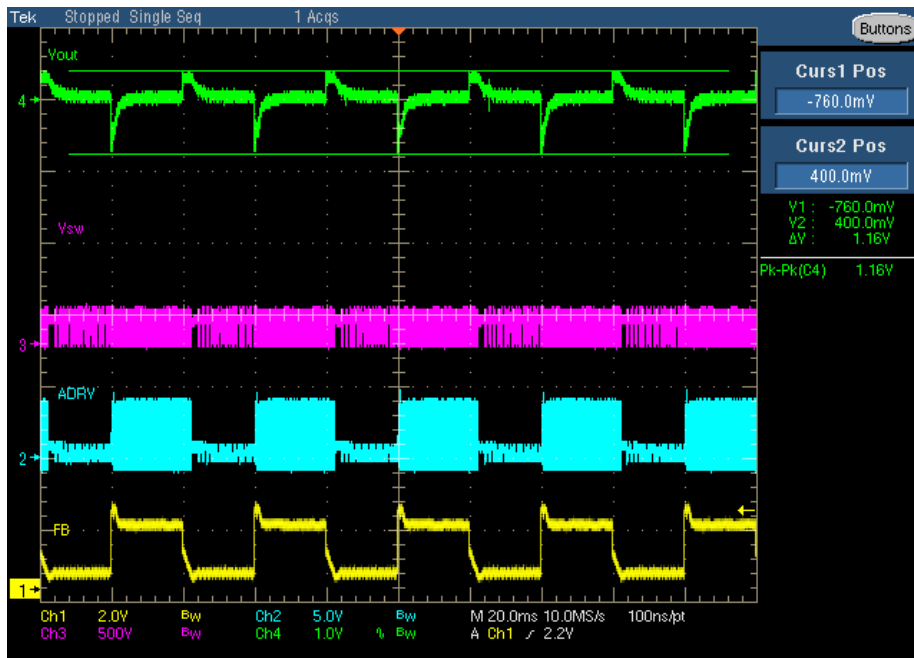
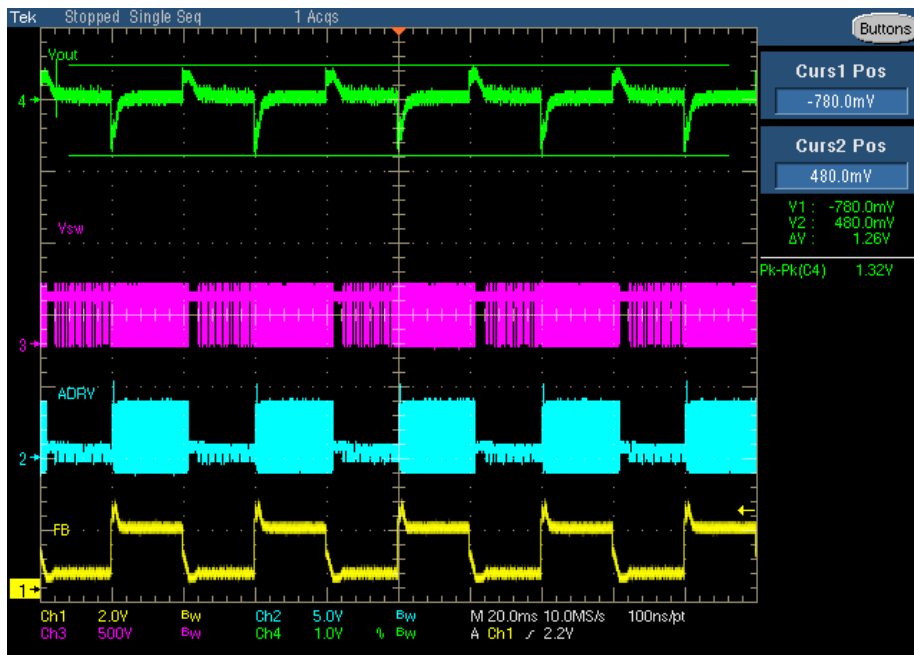


Figure 31 230 Vac 5 Vout Transient



**Figure 32 115 Vac 9 Vout Transient**



**Figure 33 230 Vac 9 Vout Transient**

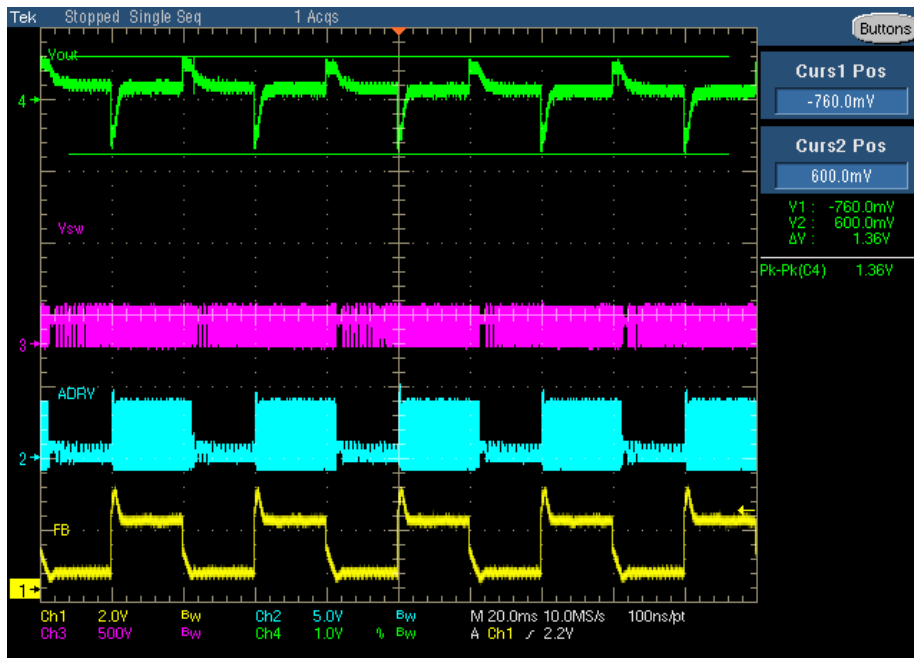


Figure 34 115 Vac 12 Vout Transient

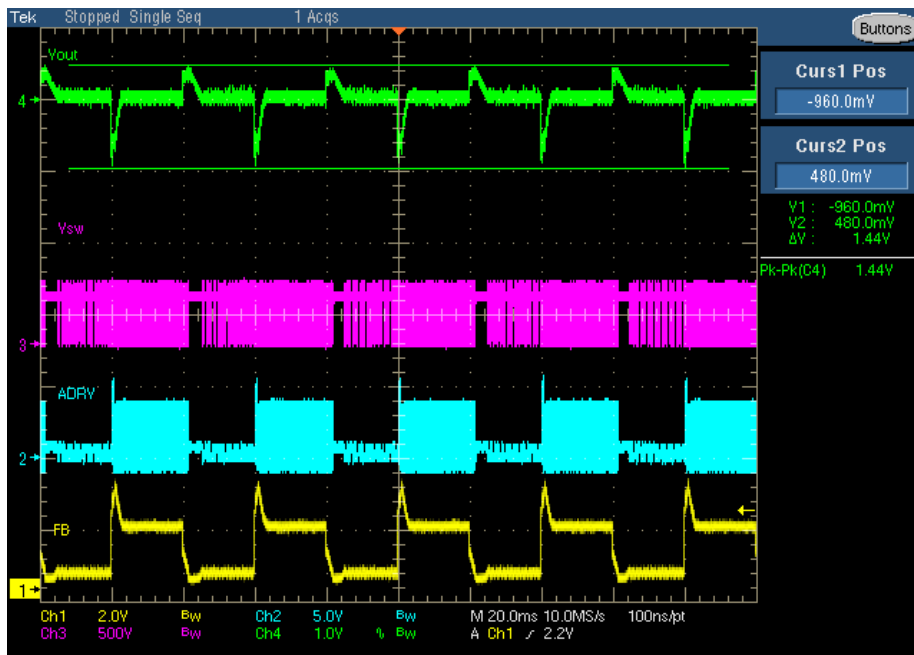
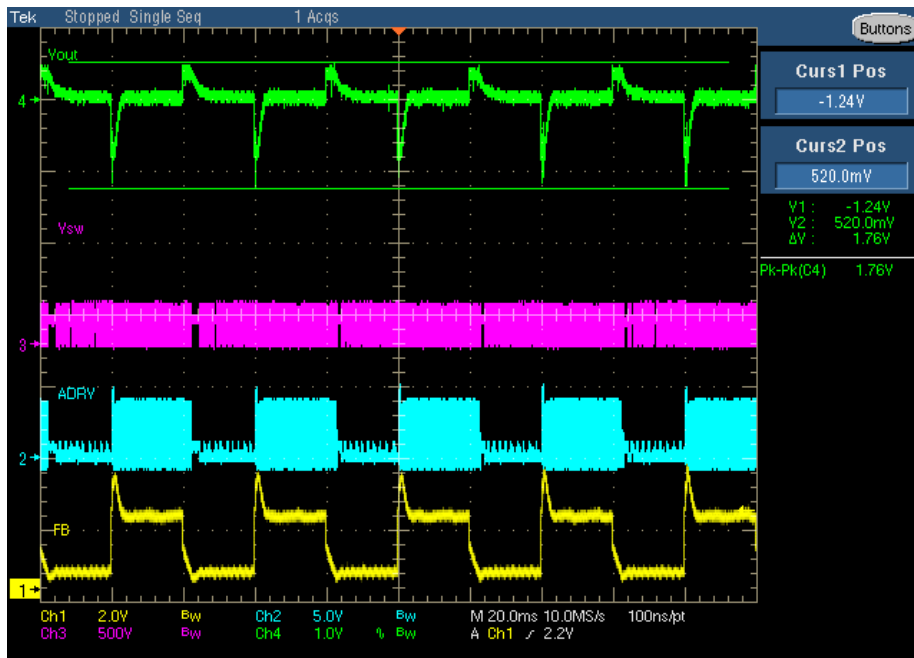
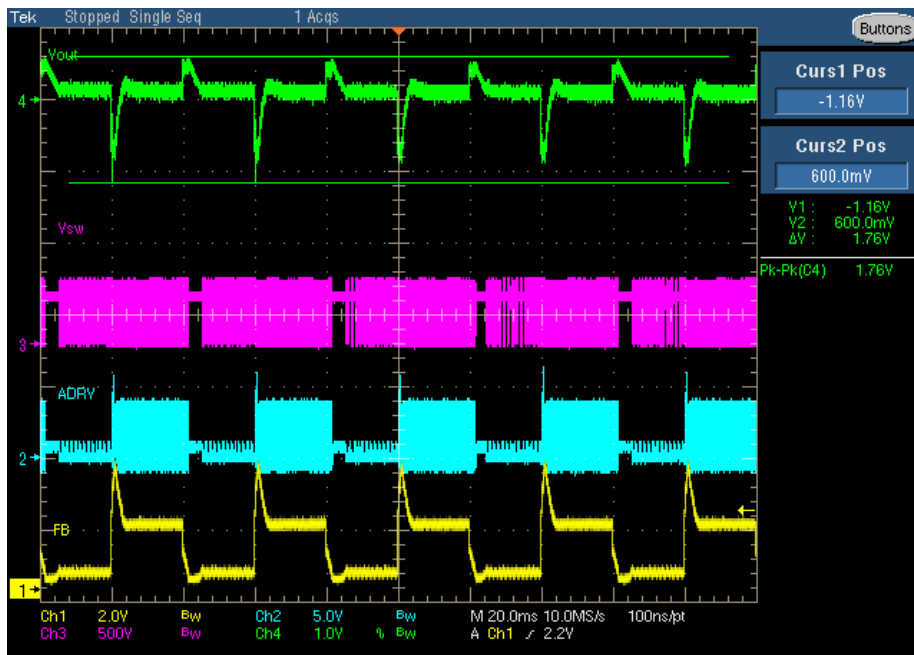


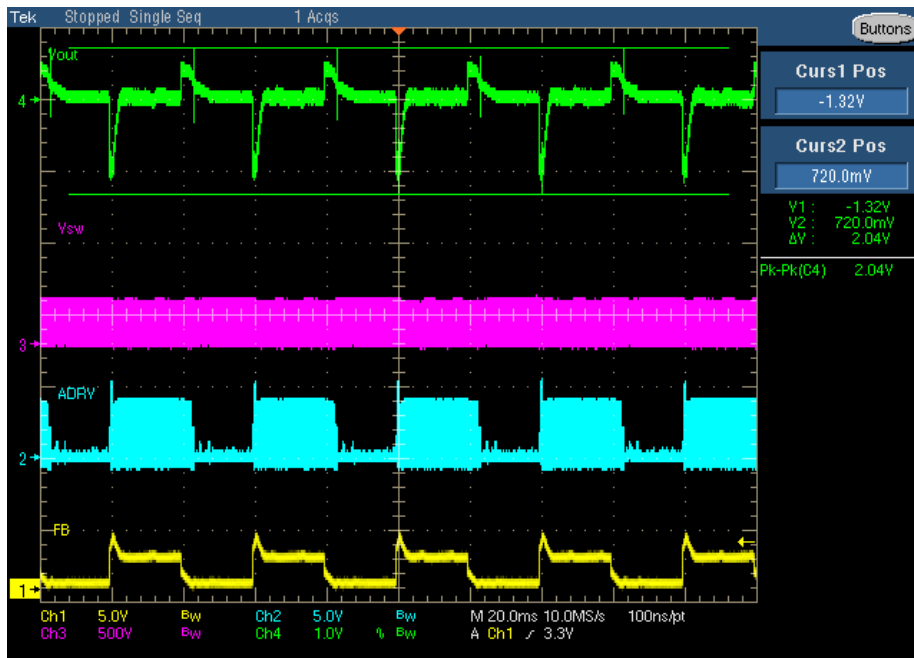
Figure 35 230 Vac 12 Vout Transient



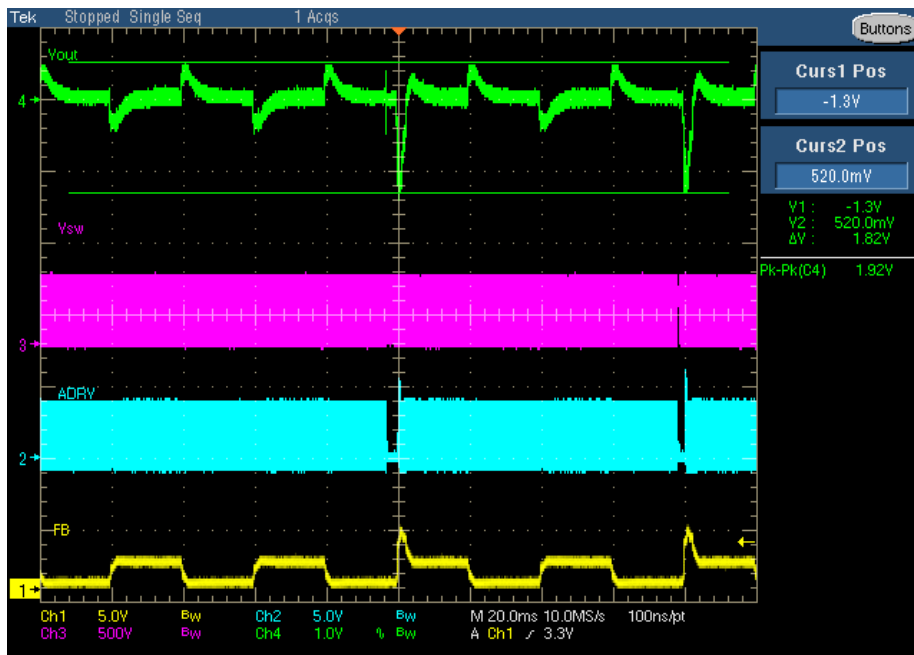
**Figure 36 115 Vac 15 Vout Transient**



**Figure 37 230 Vac 15 Vout Transient**



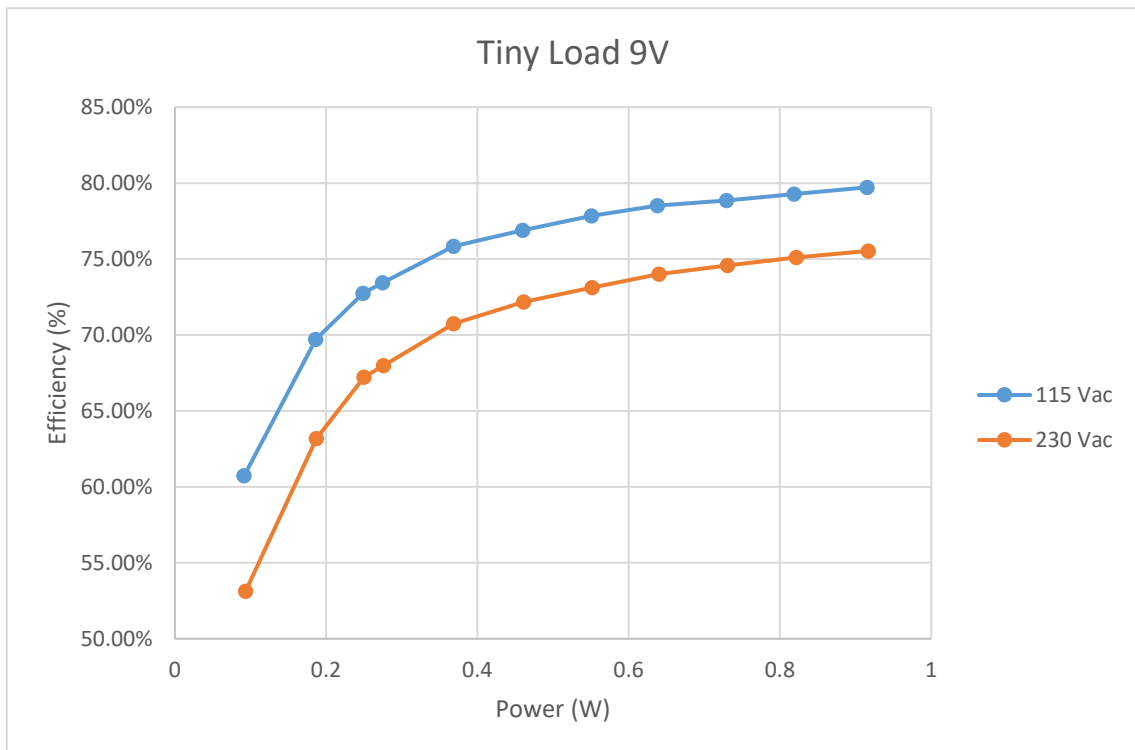
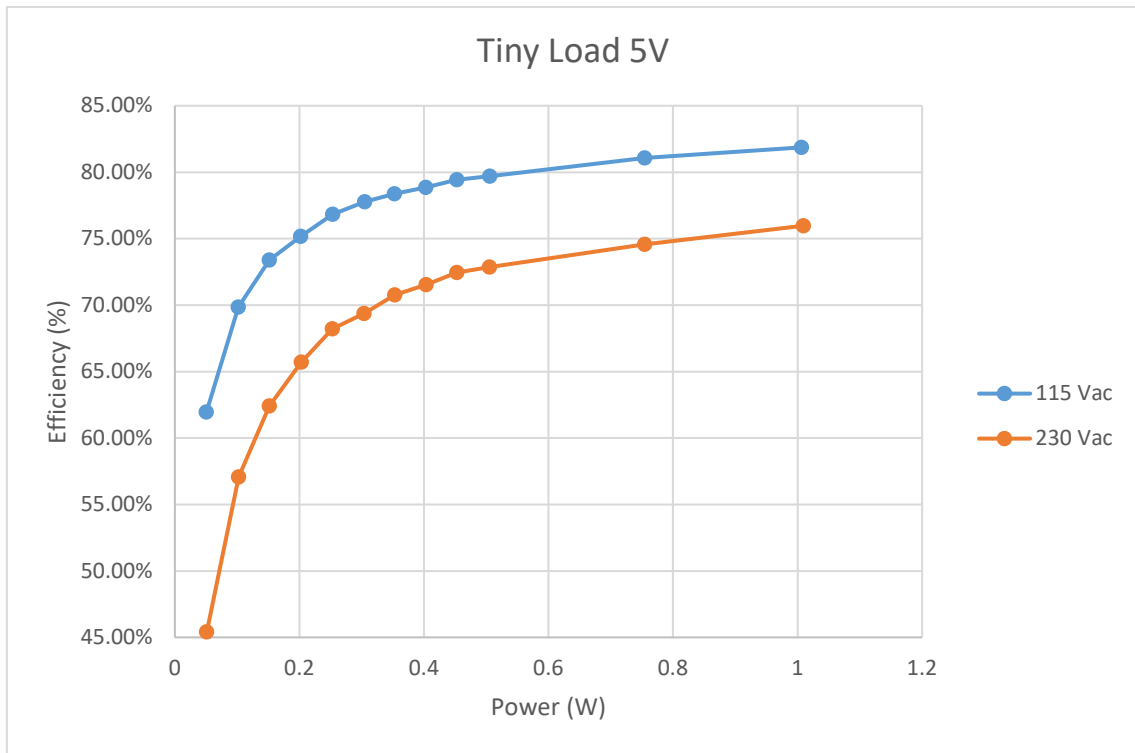
**Figure 38 115 Vac 20 Vout Transient**

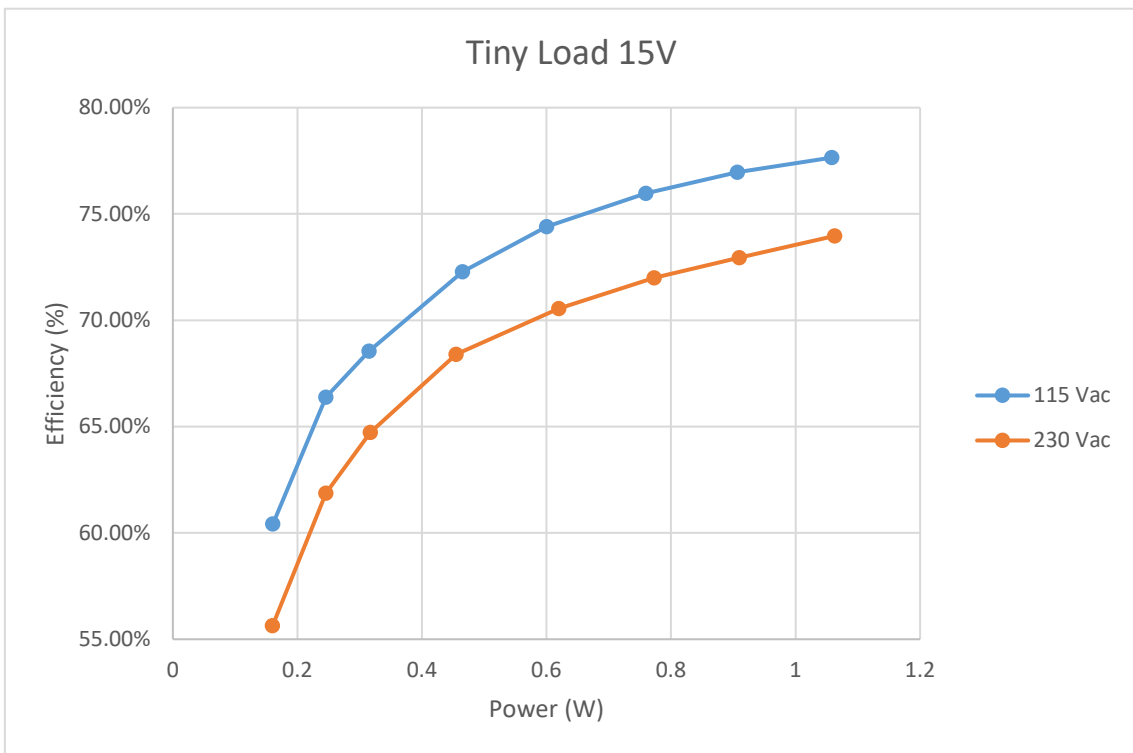
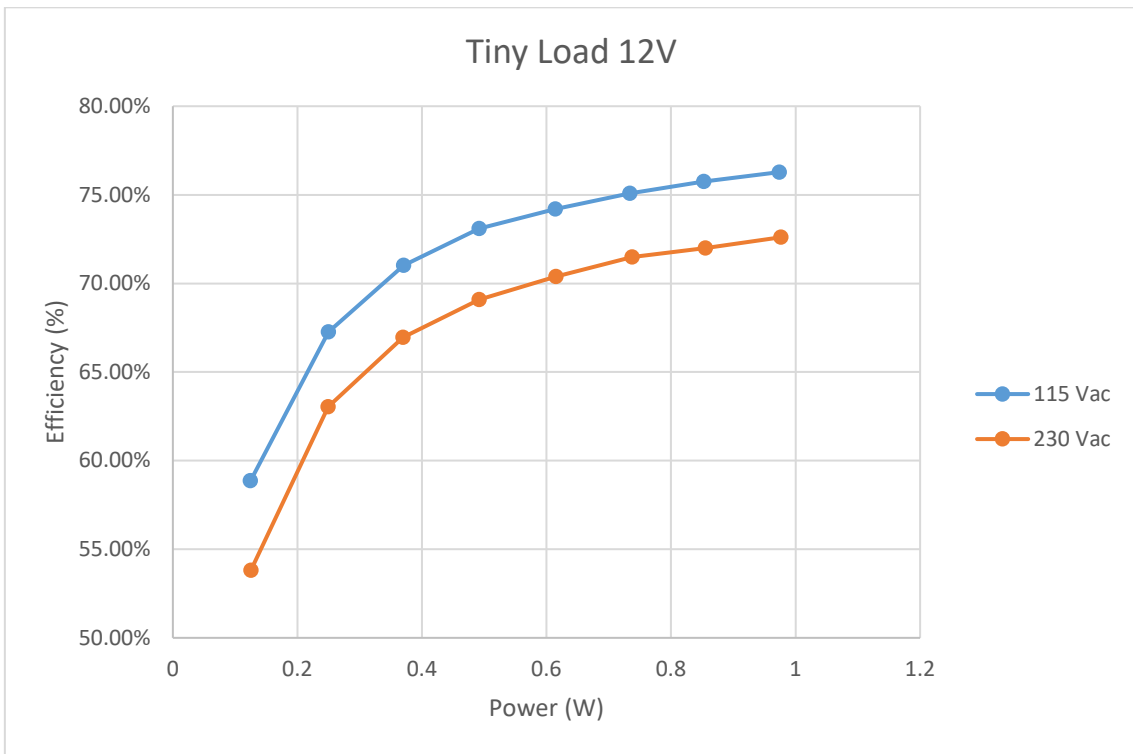


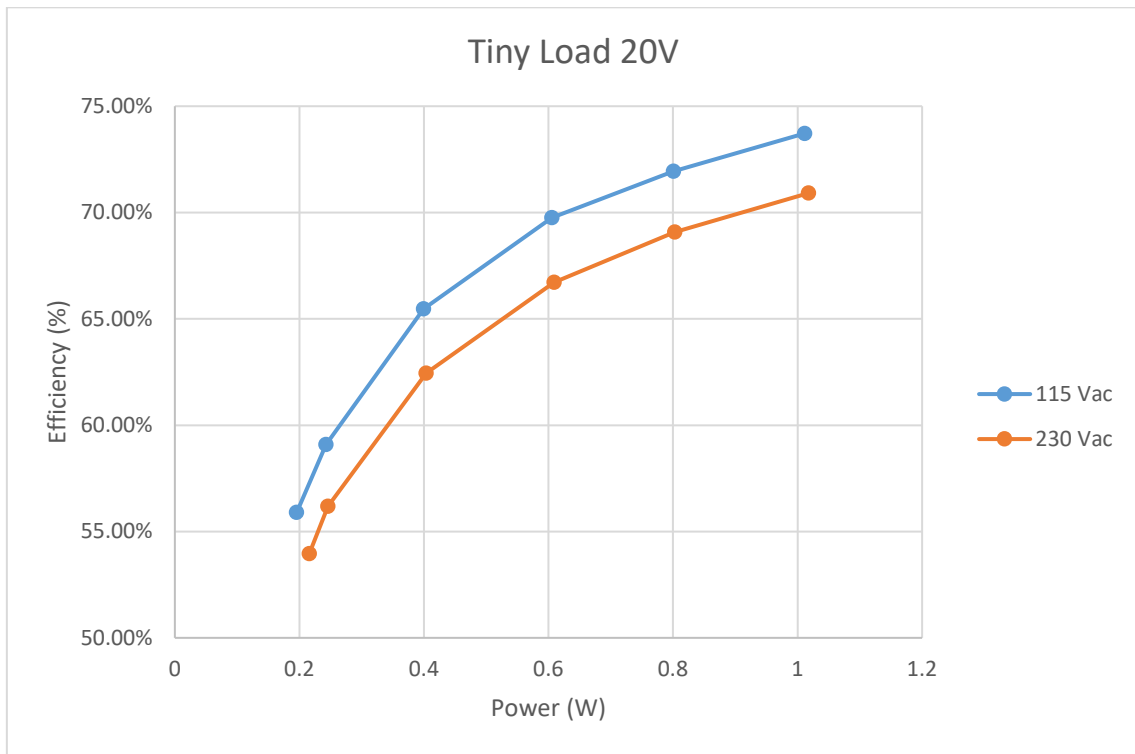
**Figure 39 230 Vac 20 Vout Transient**



# Tiny Load Data

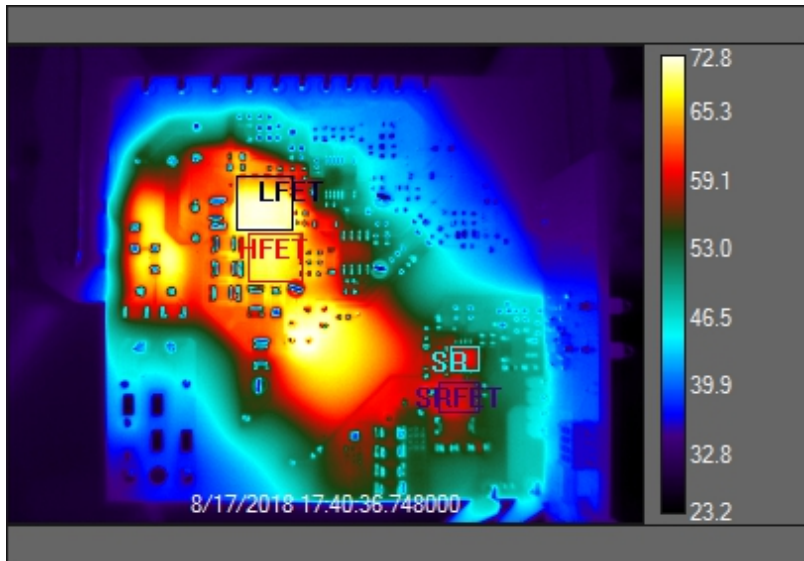




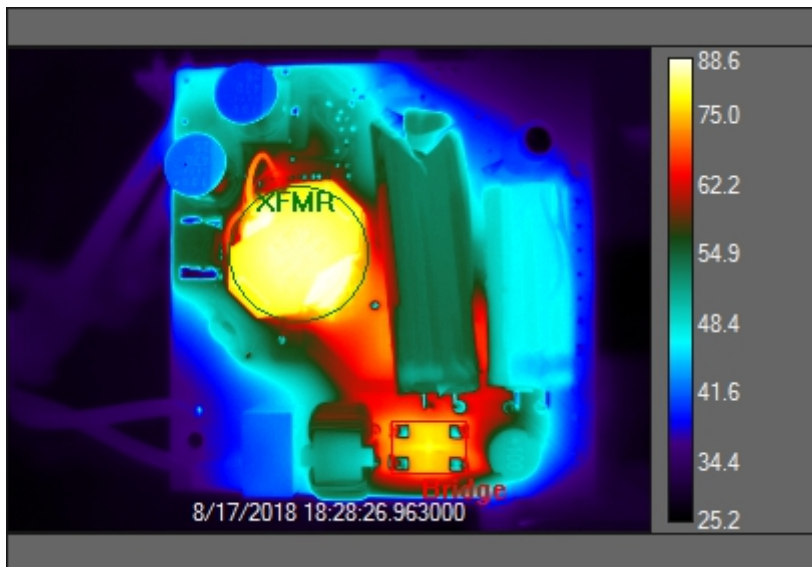


# Thermal Data

## 115 Vac Full Load

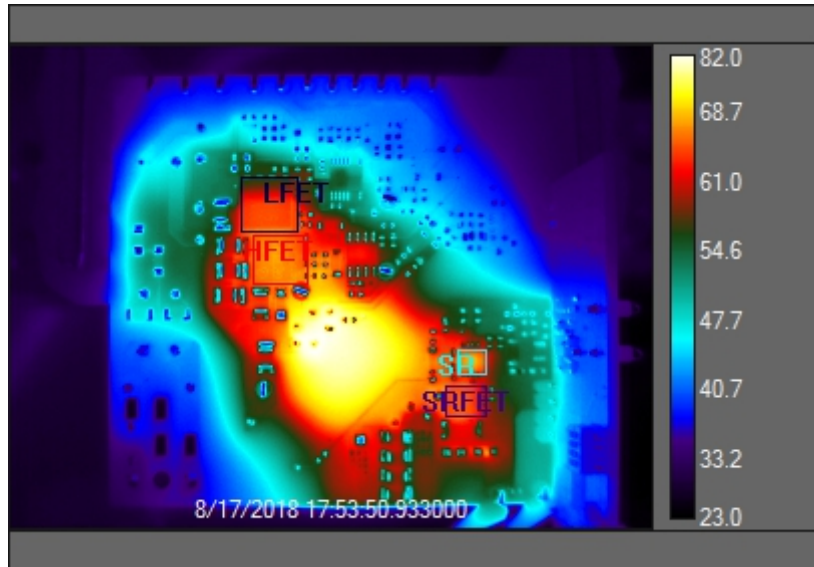


Statistic [units]	LFET	HFET	SR	SRFET
Mean [°C]	68.9	67.2	58.5	57.9
Std. Dev. [°C]	3.0	2.3	1.0	1.5
Center [°C]	(129.0, 78.5) 71.2	(134.5, 106.0) 68.5	(230.0, 157.0) 59.9	(227.0, 176.5) 58.9
Maximum [°C]	(131, 91) 72.6	(133, 100) 69.2	(231, 157) 60.0	(225, 176) 59.2
Minimum [°C]	(142, 66) 57.0	(147, 101) 48.0	(233, 162) 55.8	(236, 178) 50.6

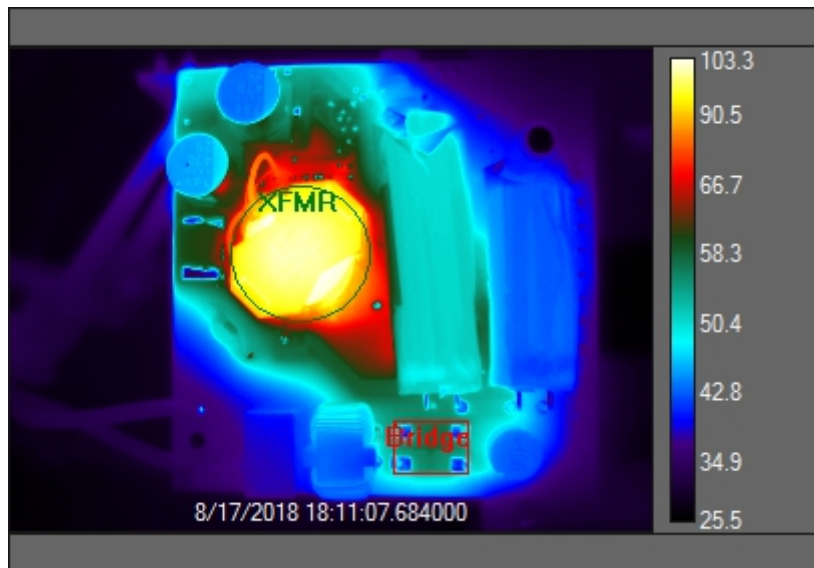


Statistic [units]	Bridge	XFMR
Mean [°C]	69.1	79.3
Std. Dev. [°C]	9.1	3.3
Center [°C]	(209.5, 198.0) 78.9	(144.5, 101.5) 80.7
Maximum [°C]	(209, 197) 78.9	(128, 85) 88.7
Minimum [°C]	(223, 192) 44.9	(112, 93) 59.7

## 230 Vac Full Load



Statistic [units]	LFET	HFET	SR	SRFET
Mean [°C]	61.7	65.4	65.1	63.2
Std. Dev. [°C]	2.9	1.9	1.3	1.7
Center [°C]	(129.0, 78.5) 63.7	(134.5, 106.0) 66.4	(230.0, 157.0) 67.0	(227.0, 176.5) 64.3
Maximum [°C]	(131, 91) 66.0	(141, 117) 67.2	(231, 157) 67.1	(222, 180) 64.7
Minimum [°C]	(142, 66) 53.6	(147, 101) 47.9	(236, 162) 61.3	(236, 178) 55.0



Statistic [units]	Bridge	XFMR
Mean [°C]	51.2	93.2
Std. Dev. [°C]	5.3	5.1
Center [°C]	(209.5, 198.0) 56.5	(144.5, 101.5) 96.2
Maximum [°C]	(192, 187) 57.9	(128, 85) 103.3
Minimum [°C]	(198, 192) 37.0	(112, 93) 65.7

### Bill of Materials Main Board

Reference	Qty	Description	Value	Voltage Rating	Footprint	Manufacturer	Manufacturer Part Number
Q7	1	NMOSFET	60V 115mA		SOT-23-3	ON Semiconductor	2N7002L
R9 R25 R34-35 R38	5	SMT Resistor	0R0		603	Vishay	CRCW06030000Z0EA
R1	1	SMT Resistor	100k		603	Panasonic	ERJ-3EKF1003V
R17	1	SMT Resistor	10M		1206	Vishay	CRCW120610M0JNEA
R18 R21	2	SMT Resistor	10R0		603	Vishay	CRCW060310R0JNEAC
R6-7	2	SMT Resistor	10k		603	Vishay	CRCW060310K0FKEA
R19 R23	2	SMT Resistor	15R0		603	Vishay	CRCW060315R0FKEAHP
R39	1	SMT Resistor	15k		603	Vishay	CRCW060315K0FKEA
R8	1	SMT Resistor	1R0		603	Vishay	CRCW06031R00JNEA
R10	1	SMT Resistor	1k		603	Vishay	CRCW06031K00FKEA
R2-3	2	SMT Resistor	1k		1206	Vishay	CRCW12061K00JNEA
R44	1	SMT Resistor	2.49k		603	Vishay	CRCW06032K49FKEA
R36 R40	2	SMT Resistor	22R0		603	Vishay	CRCW060322R0FKEAC
R11	1	SMT Resistor	24.9k		603	Vishay	CRCW060324K9FKEA
R13	1	SMT Resistor	280k		603	Vishay	CRCW0603280KFKEAHP
R52	1	SMT Resistor	3.09k		603	Vishay	CRCW0603K09FKEA
R48	1	SMT Resistor	3.92k		603	Vishay	CRCW06033K92FKEAHP
R5	1	SMT Resistor	4.02M		603	Vishay	CRCW06034M02FKEA
R45	1	SMT Resistor	4.99k		603	Vishay	CRCW06034K99FKEAC
R4	1	SMT Resistor	44.2k		603	Vishay	CRCW060344K2FKEA
R26-29	4	SMT Resistor	499k		603	Vishay	CRCW0603499KFKEAHP
R24	1	SMT Resistor	604R		603	Vishay	CRCW0603604RFKEA
R12	1	SMT Resistor	82.5k		603	Vishay	CRCW060382K5FKEA
R14-15	2	SMT Resistor	DNI		603	Vishay	CRCW06036K65FKEA
R16	1	SMT Resistor	DNI		603	Vishay	CRCW06030000Z0EA
R30 R47	2	SMT Resistor	DNI		603		DNI
D9-11 D13	4	Schottky Barrier Diodes	100V	100V	SOD-123	ON Semiconductor	MMSD4148T3G
D4-7	4	Schottky Barrier Diodes	30V 1A	30V	SOD-123	ON Semiconductor	MBR130LSFT1G
D8	1	High Voltage Diode	600 V 1 A	600 V	SOD-123-2	ON Semiconductor	ES1JFL
Q4	1	PMOSFET	150V		SOT23	ON Semiconductor	FDN86265P
Q9	1	PMOSFET	50V		SOT23	ON Semiconductor	BSS84LT1G
C12 C14- 16 C38 C40	6	SMT Ceramic Capacitor	0.1 uF	50V	603	TDK	C1608X7R1H104K080AA
C11	1	SMT Ceramic Capacitor	1.0uF	35V	603	TDK	C1608X5R1H105K080AB
C17 C24 C39	3	SMT Ceramic Capacitor	1.0uF	35V	603	TDK	C1608JB1H105K080AB
C35	1	SMT Ceramic Capacitor	10nF	50V	603	Kemet	C0603C103K5RACTU

Reference	Qty	Description	Value	Voltage Rating	Footprint	Manufacturer	Manufacturer Part Number
C13 C25	2	SMT Ceramic Capacitor	120pF	50V	603	Kemet	C0603C121J5GACTU
C6	1	SMT Ceramic Capacitor	18pF	25V	603	Kemet	C0603C180K3GACTU
C3	1	SMT Ceramic Capacitor	1nF	50V	603	Murata	GCM188R71H102KA37D
C5	1	SMT Ceramic Capacitor	47nF	50V	603	TDK	CGA3E2X7R1H473K080AA
C26	1	SMT Ceramic Capacitor	DNP		603		
C32	1	SMT Capacitor	150 pF	200V	805	AVX Corporation	08052A151JAT2A
C23	1	SMT Capacitor	1μF	100V	805	Taiyo Yuden	HMK212BC7105KG-TE
C34	1	SMT Capacitor	470 pF	200V	805	KEMET	08052C471J2GACTU
C9-10	2	SMT Capacitor	0.10μF	650V	1210	TDK Corporation	CGA6L1X7T2J104K160AC
C18-21	4	SMT Capacitor	0.22μF	450V	1210	TDK Corporation	C3225X7T2W224K200AA
C1-2	2	Y Capacitors	DNP	250Vac	1812		
C22	1	Aluminum Capacitor	68uF	50V	(6.3)mm	Panasonic	EEU-HD1H680B
C29-31 C33	4	Ceramic Capacitor SMT	22 uF	35V	1206	TDK	C3216X5R1V226M160AC
C4	1	X2 capacitor	220nF	275Vac	(13X8X14.5)mm	Wurth	890334023028
C36-37	2	Aluminum Polymer Cap	470uF/25V	25V	(10.3x10.3x12.8)mm	Nichicon	25SVPK470M
D1-3	3	High Voltage Diode	600 V 1 A	600 V	SOD-123-2	ON Semiconductor	ES1JFL
PRIREG	1	SIP Header	2		Through Hole	Wurth	61300211021
SEC_REG	1	SIP Header	2		Through Hole	Wurth Electronics Inc.	61300411021
Q2	1	600V MOSFET	600V 9A	600V	ThinPak 8X8	Infineon Technologies	IPL60R385CPAUMA1
Q3	1	600V MOSFET	600V 9A	600V	ThinPak 8X8	Infineon Technologies	IPL60R299CP
C28	1	Y Capacitors	150pF	30Vac	Radial, Disc	Murata	DE1B3KX151KN4AP01F
C27	1	Y Capacitors	470pF	250Vac	Radial, Disc	Murata	DE2B3KY471KN3AM02F
D12	1	Schottky Diodes	150V 2A	150V	SMA	STMicroelectronics	STPS2150A
C7	1	Aluminum Capacitor	47 μF	400V	(12.1X33.5)mm	Nichicon	UPZ2G470MHD
C8	1	Aluminum Capacitor	82 μF	400V	(12.1X42)mm	Rubycon	400BXW82MEFCG412.5X40
F1	1	FAST FUSE 2	3.15A		(8.5x4x8) mm	Littelfuse Inc.	39213150000
BD1	1	Bridge Rectifier	600V/4A	600V	4-SMD	ZOWIE	Z4GP40KH
T2	1	Common Mode Choke	6.5 mH 70mOhm		(15X12X15)mm	KEMET	SCF-03-650
L3	1	SMT Inductor	10uH		8.2mm	Wurth	744772100
L1	1	SMT Inductor	2 uH		(6.90x6.90)	Wurth	744314200
E	1	Green Test Point			Through Hole	E-Mark Inc	01-1036
L	1	White Test Point			Through Hole	E-Mark Inc	01-1013

Reference	Qty	Description	Value	Voltage Rating	Footprint	Manufacturer	Manufacturer Part Number
N	1	Black Test Point			Through Hole	E-Mark Inc	01-1015
Q6 Q10	2	Dual npn Transistor	40V 200mA		SOT-363	ON Semiconductor	MBT3904DW1T1G
Q5	1	NPN Transistor	80V 200mA	40V	SOT-23-3	ON Semiconductor	BSS64LT1G
Q1	1	PNP BJT	DNI		SOT-23-3	ON Semiconductor	DNI
Z2	1	Zener Diode	12 V		SOD-323	ON Semiconductor	MM3Z12VB
Z6	1	Zener Diode	12V 500mW		SOD-323	ON Semiconductor	MM3Z12VB
Z1	1	Zener Diode	18V 500mW		SOD-323	ON Semiconductor	MM3Z18VC
Z5	1	Zener Diode	4.7V 500mW		SOD-123	ON Semiconductor	MMSZ5230BT1G
Z3	1	Zener Diode	6.2 V		SOD-323	ON Semiconductor	MM3Z6V2C
Z4	1	Zener Diode	DNI		SOD-323	ON Semiconductor	MM3Z5V1C
Q8	1	Power NFET	120V 11 mOhm	120V	SOIC8_FL	ON Semiconductor	FDMS86202
U1	1	ACF PWM Controller	700V 2A	30V	Tssop 16	ON Semiconductor	NCP1568S02DBR2G
U3	1	Sync Rec	20V		DFN8	ON Semiconductor	NCP4305DMNTWG
U2	1	H Bridge Driver	600V 1.9A	20V	SOIC-8	ON Semiconductor	NCP51530ADR2G
RT1	1	SMT Resistor	220k		603	Murata Electronics North America	NCP18WM224J03RB
R46	1	SMT Resistor	0R0		402	Vishay	CRCW04020000Z0EDHP
R43	1	SMT Resistor	DNI		402	Panasonic	ERJ-2GE0R00X
R49-50	2	SMT Resistor	4.99k		603	Vishay	CRCW06034K99FKEAC
R20 R22 R31 R42 R51	5	SMT Resistor	49.9k		603	Vishay	CRCW060349K9FKEAC
R37	1	SMT Resistor	499R		603	Stackpole	RMCF0603FT499R
R41	1	SMT Resistor	100R		805	Vishay	CRCW0805100RJNEAC
R32-33	2	SMT Resistor	500 m		805	Susumu	RL1220S-R50-F
F1S SIS	2	RM8 T1 Connection					
F2S S2S	2	RM8 T1 Connection					
T1	1	Transformer	120 uH 6:1 / Material: ML29D		RM8LP	Wurth w/ Hitachi Metals	750317295
ADRV ATH VSW	3	Blue Test Point			Through Hole	E-Mark Inc	01-1017
DTH FB FLT LGATE RT CS	6	White Test Point			Through Hole	E-Mark Inc	01-1013
GND4 GND_S GND1-3	5	Black Test Point			Through Hole	E-Mark Inc	01-1015



Reference	Qty	Description	Value	Voltage Rating	Footprint	Manufacturer	Manufacturer Part Number
VCC VOUT	2	Red Test Point			Through Hole	E-Mark Inc	01-1178
HV	1	Yellow Test Point			Through Hole	E-Mark Inc	01-1013

## Bill of Materials Daughter Board

Reference	Qty	Value	Voltage Rating	Footprint	Description	Manufacturer	Manufacturer Part Number
C102	1	0.1 uF	25V	603	SMT Capacitor	AVX Corp	LD033C104KAB2A
C108	1	1.0 uF	50V	603	SMT Capacitor	Taiyo Yuden	UMK107AB7105KA-T
C106	1	22nF	50V	603	SMT Capacitor	Kemet	C0603X223K5RACTU
C101 C104	2	6.8nF	50V	603	SMT Capacitor	Kemet	C0603C682J5GACTU
C100 C103 C105	3	DNI		603	SMT Capacitor		DNI
C107	1	DNI		603	SMT Capacitor		DNI
U101	1	1.17V 50mA	80V	4-SMD, Gull Wing	Optoisolator	CEL	PS2513L-1-F3-A
BODE100-101	2	1		Through Hole	CONN HEADER	E-Mark	01-1014
GNDB100	1	1		Through Hole	CONN HEADER	E-Mark	01-1023
RET100 RETS100	2	1		Through Hole	CONN HEADER Black	E-Mark	01-1015
VOUT_C100 VOUT_CS100	2	1		Through Hole	CONN HEADER	E-Mark	01-1037
PRI_REG100	1	DNI			SIP Header		DNI
SEC_REG100	1	DNI			SIP Header		DNI
SW100	1	24V 25mA		Gull Wing	SWITCH SLIDE DIP	Würth	416131160804
D100	1	100V 200mA		SOD-123	DIODE GEN	ON Semiconductor	MMSD4148T3G
U100	1	1.25V		TSOP-6	Secondary Side CV/CC Secondary Side CV/CC Controller	On Semiconductor	NCP4328BSNT1G
Q100	1	30V		Power56	PMOSFET	ON Semiconductor	FDMS6681Z
R105 R113- 114	3	1.54k		603	SMT Resistor	Vishay	CRCW06031K54FKEA
R102	1	100k		603	SMT Resistor	Vishay	CRCW0603100KFKEA
R101 R111	2	20R		603	SMT Resistor	Stackpole	RNCP0603FTD20R0
R118	1	220R		603	SMT Resistor	Panasonic	ERJ-3EKF2200V
R110	1	24.9k		603	SMT Resistor	Vishay	CRCW060324K9FKEAC
R107	1	30.9k		603	SMT Resistor	Panasonic	ERJ-3EKF3092V
R106	1	33.2k		603	SMT Resistor	Vishay	CRCW060333K2FKEAC
R108-109	2	41.2k		603	SMT Resistor	Panasonic	ERJ-3EKF4122V
R103	1	49.9k		603	SMT Resistor	Vishay	CRCW060349K9FKEA
R104	1	5.49K		603	SMT Resistor	Vishay	CRCW06035K49FKEA
R117	1	7.5k		603	SMT Resistor	Vishay	CRCW06037K50FKEA
R100 R115- 116	3	DNI		603	SMT Resistor		DNI
R119	1	DNI		603	SMT Resistor	Vishay	DNI
R112	1	15 mOhms		1206	SMT Resistor	Vishay	WSP1206R0150FEA
CON100	1	1	24V	SMT_TH	USB C plug	Würth	632723300011

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