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TND6332/D

45 W 24 V Power over Ethernet Flyback Converter

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REFERENCE DESIGN

Circuit Description

The design described herein is an Isolated 45 W power supply, Power over Ethernet input voltage range compatible, constant voltage power supply. When this demonstration board is used in conjunction with the NCP1096GEVB IEEE 802.3bt compliant demonstration board, use with Power over Ethernet applications within smart building designs can be achieved.

The featured power supply is a Fixed Frequency Flyback design utilizing ON Semiconductor NCP12700 PWM controller, the NCP4306 synchronous rectifier controller, FDMS86255 primary side MOSFET, and an FDMS86202 synchronous MOSFET. This design note provides the circuit schematic details, PCB and BOM for 45 W Power over Ethernet compatible power supply stage.

Key Features

- Power Over Ethernet Compatible Input Range from 37 V to 57 V
- High Full Load and Average Efficiency
- Very Low Ripple and Noise
- Smooth Startup Operation
- Low Parts Count
- Inherent SCP And OCP Protection
- Thermal and OVP Protection
- Multiple Probe Points for Evaluation

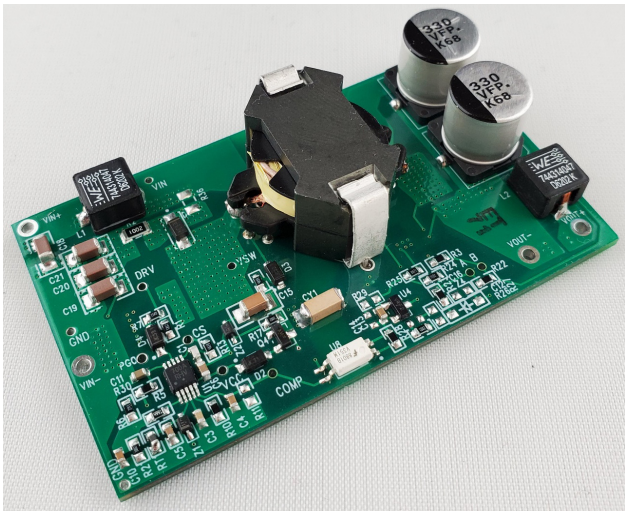

Figure 1. Full View of the Board

SPECIFICATIONS

Output Voltage	24 V
Nominal Current	1.9 A
Max Current	1.9 A
Min Current	Zero

ON Devices	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP12700 NCP4306 FDMS86255 FDMS86202	Smart Building, Internet of Things	37 V − 57 V	45 W	Fixed Frequency Flyback	Isolated (3 kV)

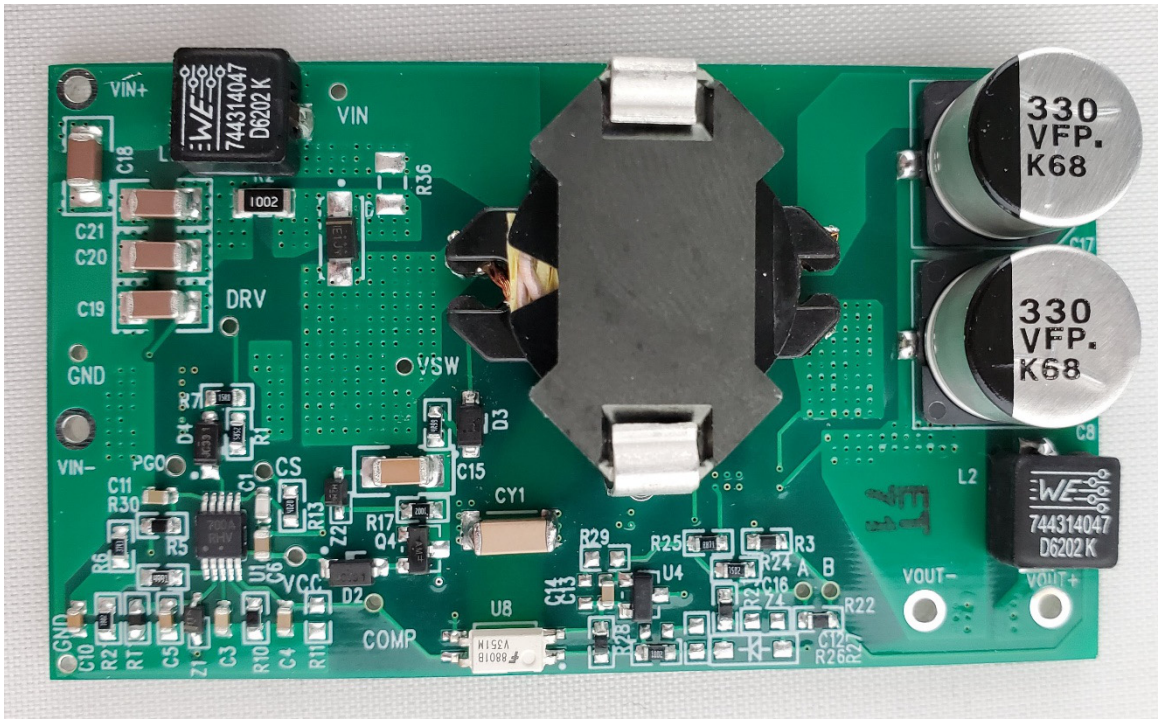

Figure 2. Top View of the Board

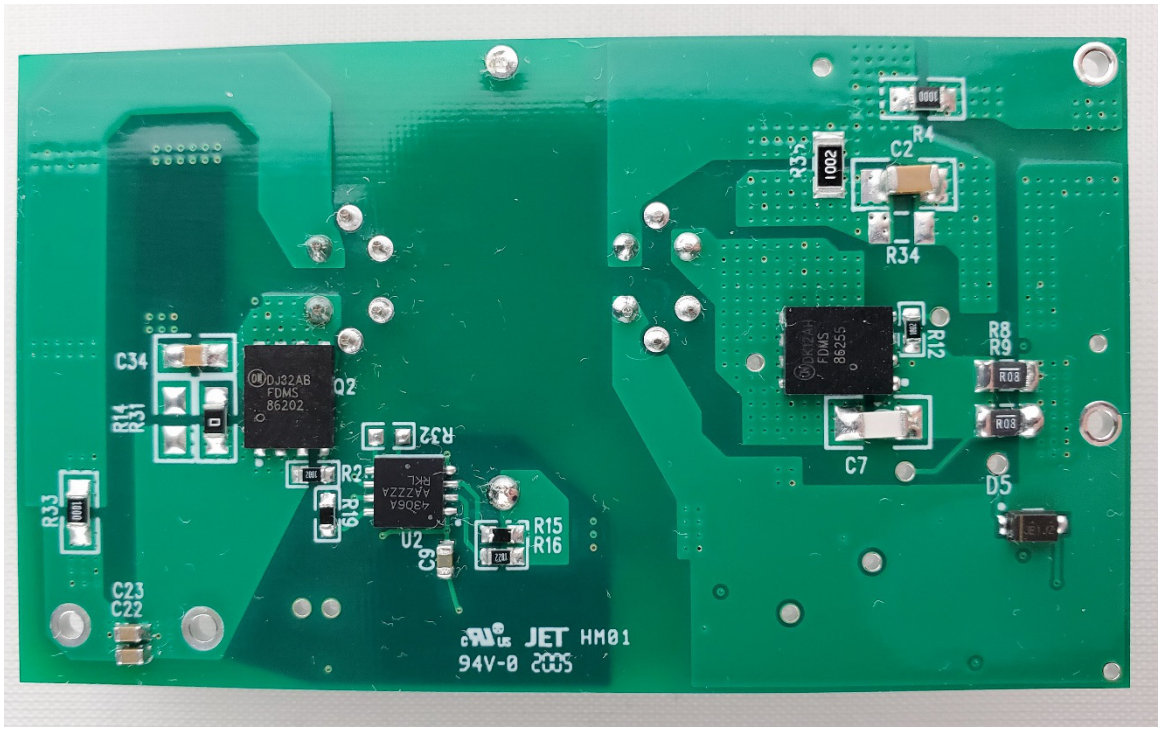

Figure 3. Bottom View of the Board

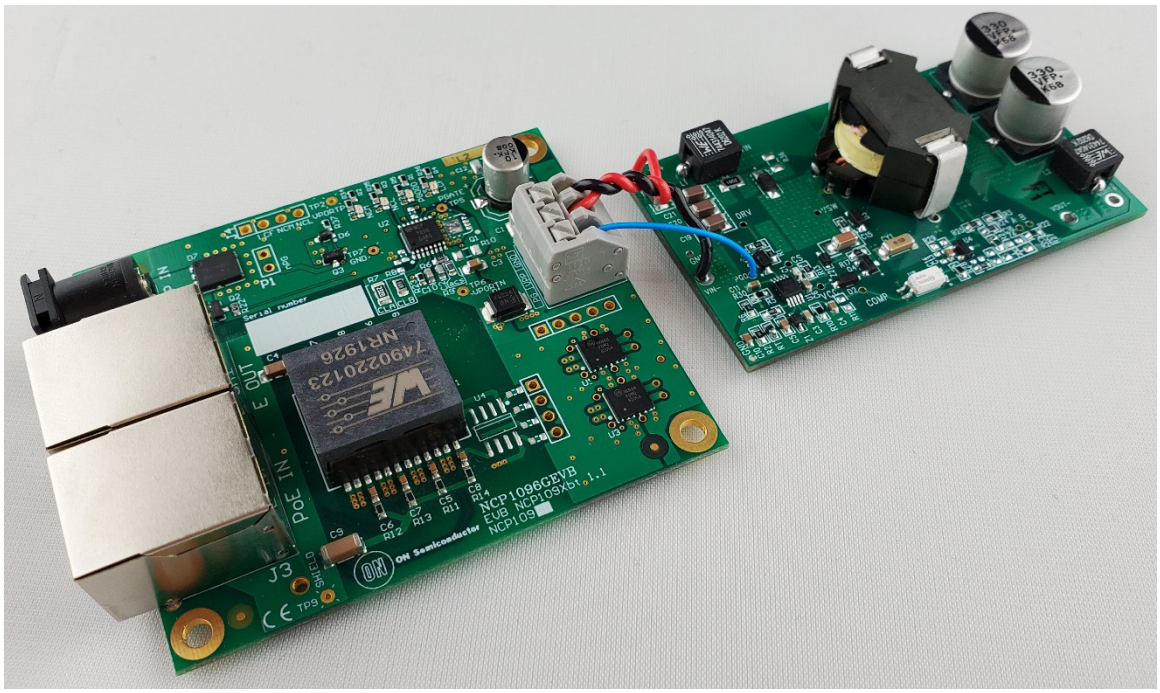

Figure 4. Power over Ethernet Complete Solution with NCP1096GEVB

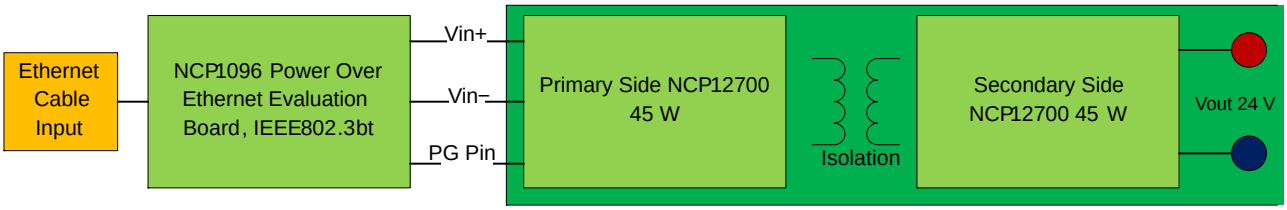

Figure 5. Power over Ethernet Complete Solution Block Diagram

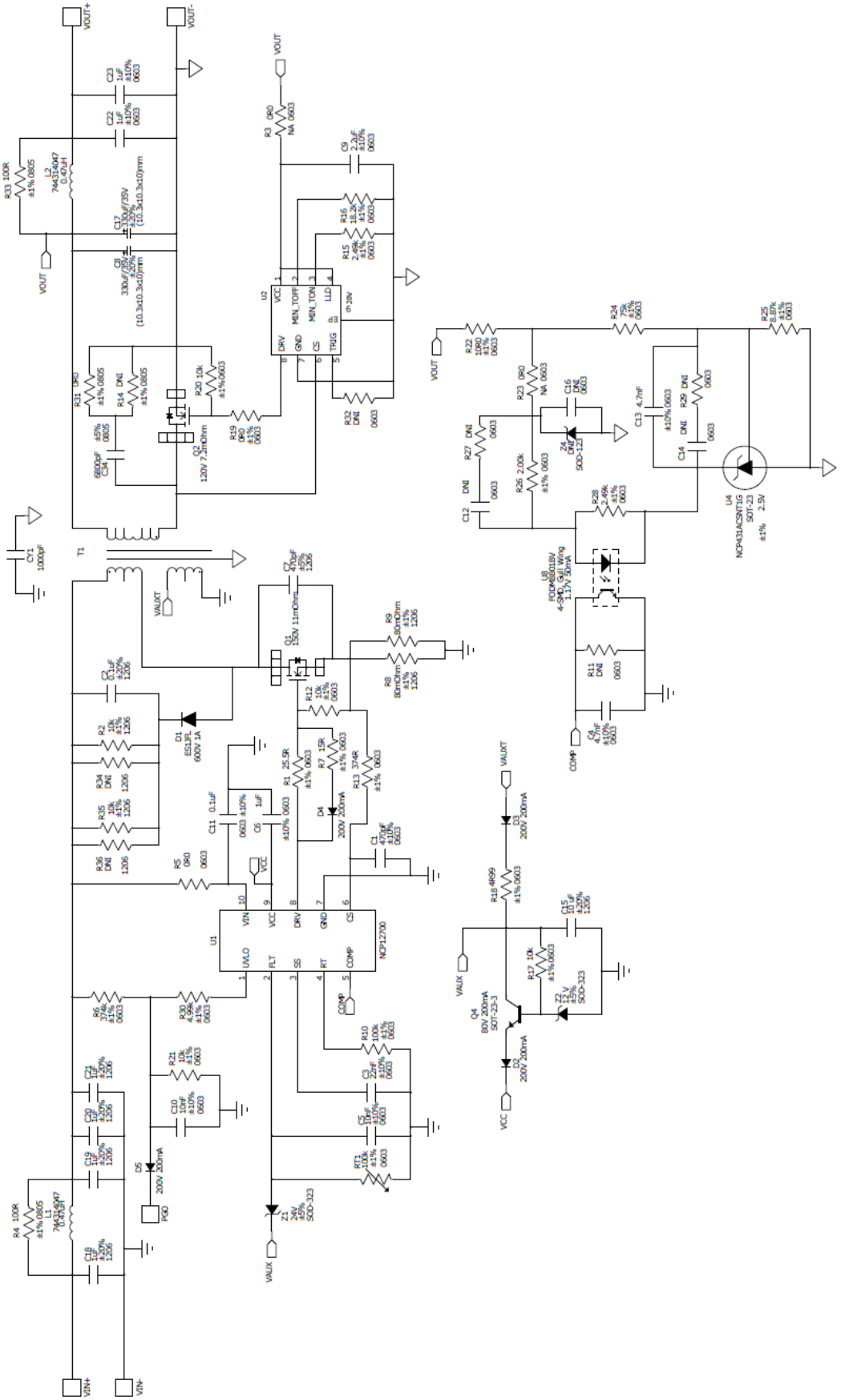

Figure 6. NCP12700 45 W Schematic

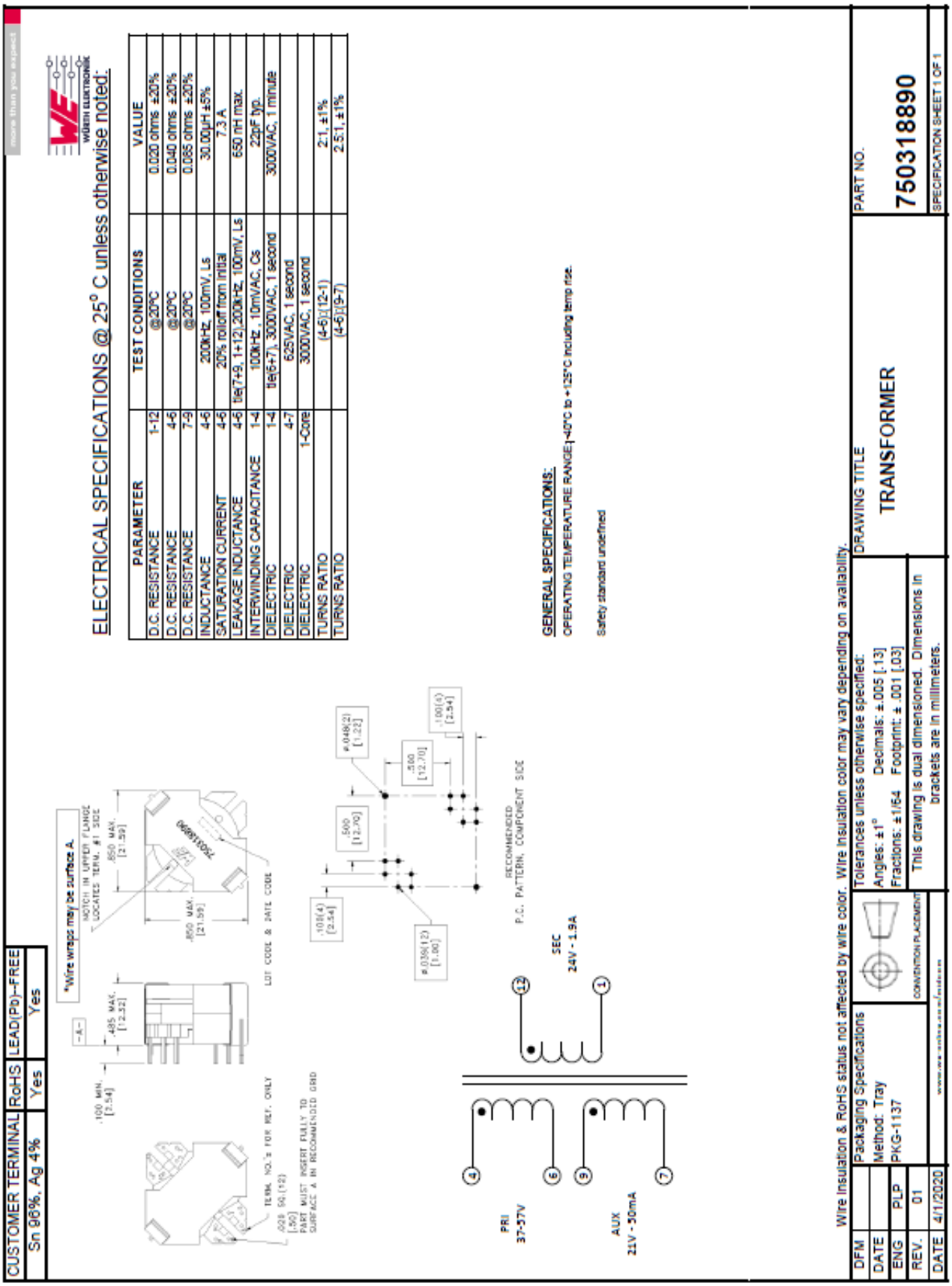

Figure 7. Transformer Spec Sheet

Layout

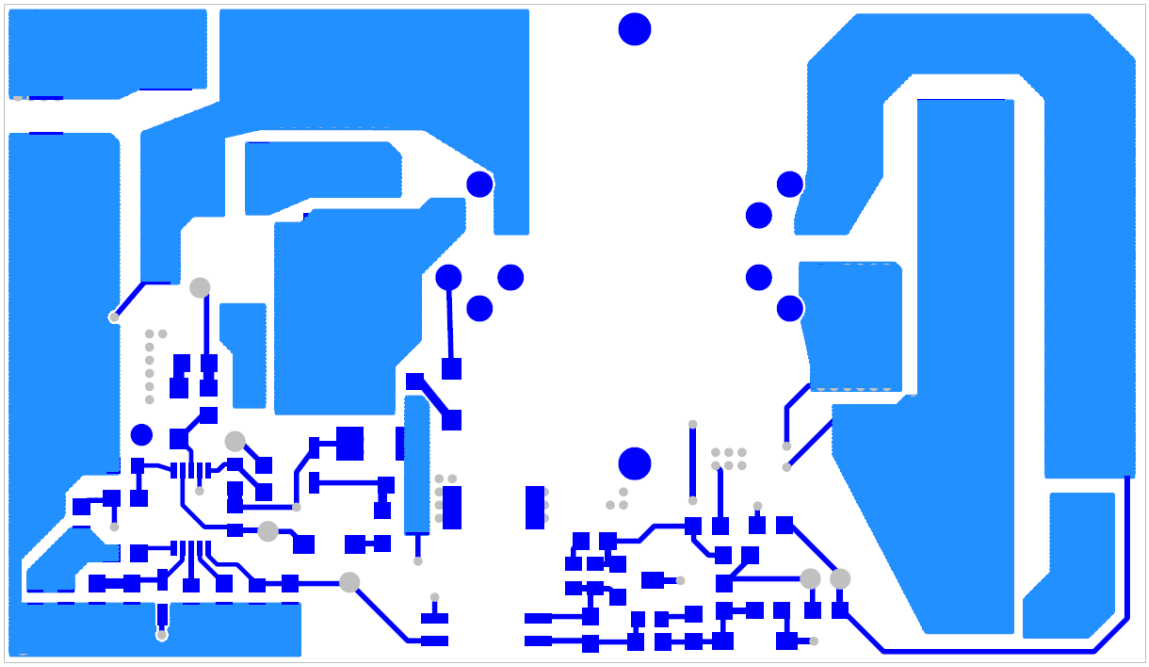

Figure 8. Layout Top Layer

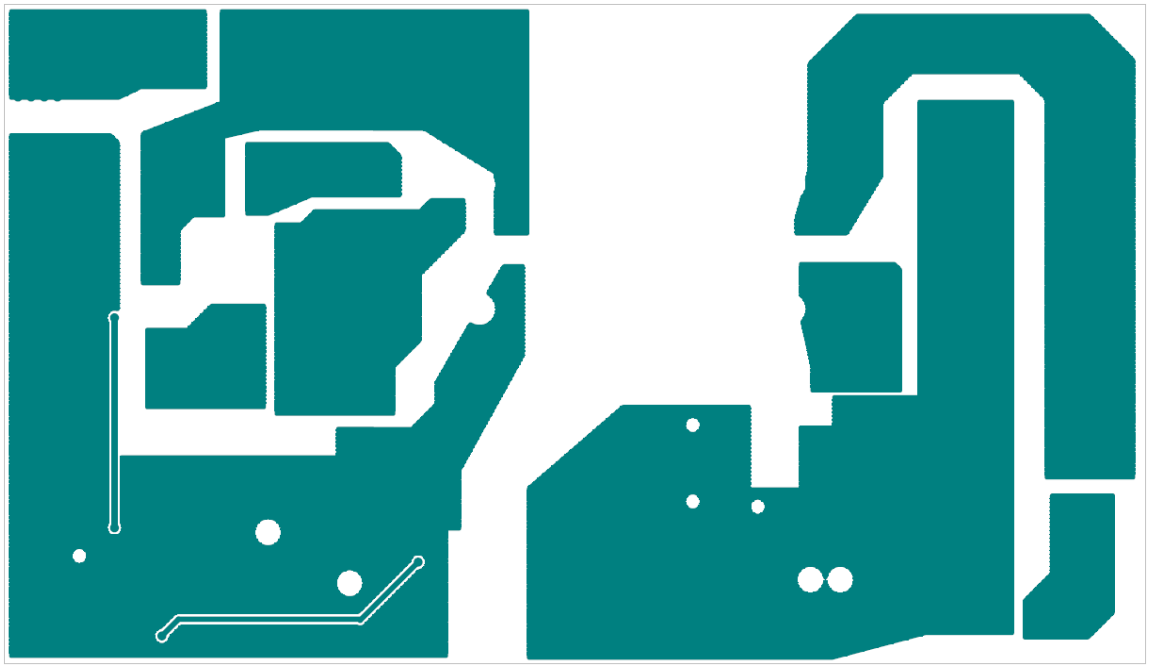

Figure 9. Layout Inner Layer 1

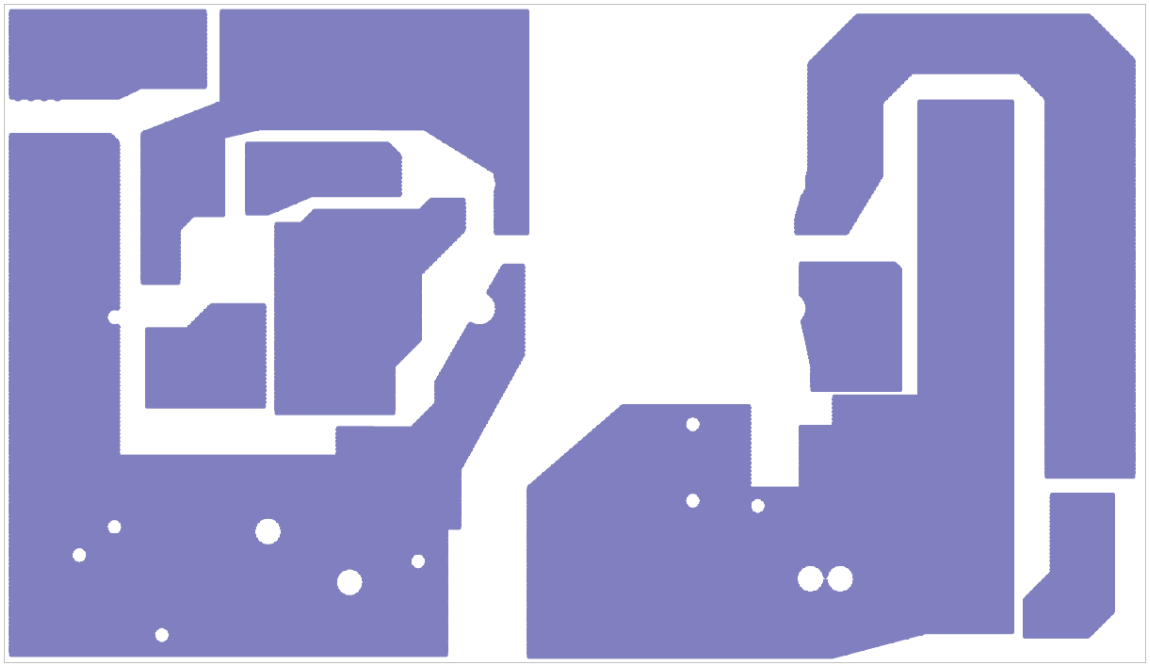

Figure 10. Layout Inner Layer 2

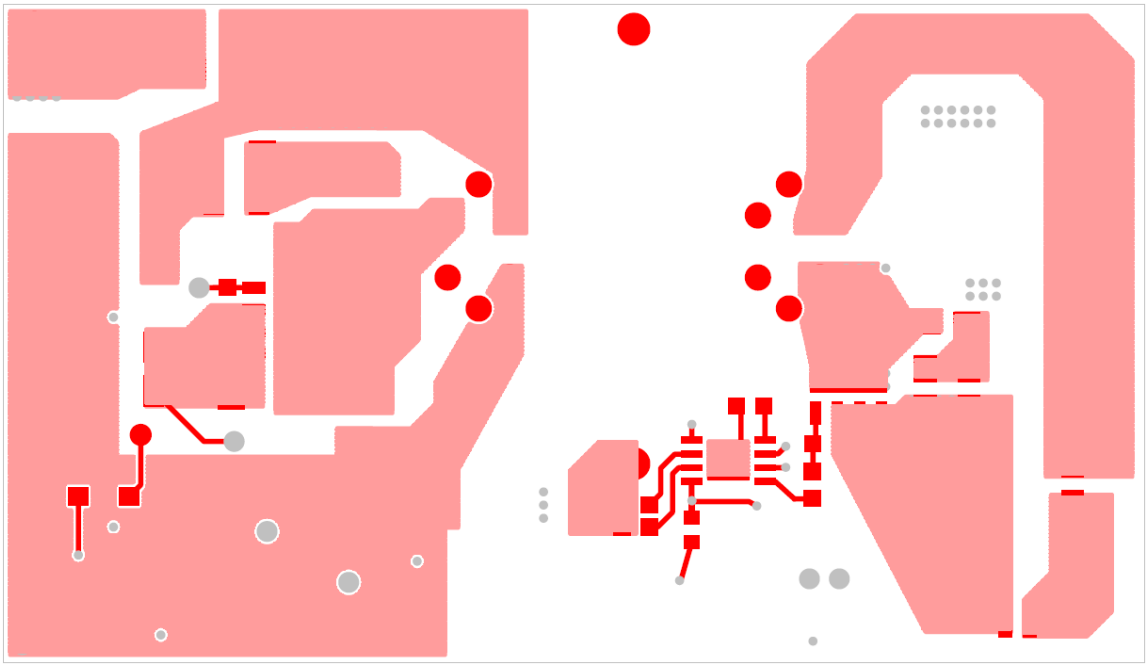

Figure 11. Layout Bottom Layer

Efficiency

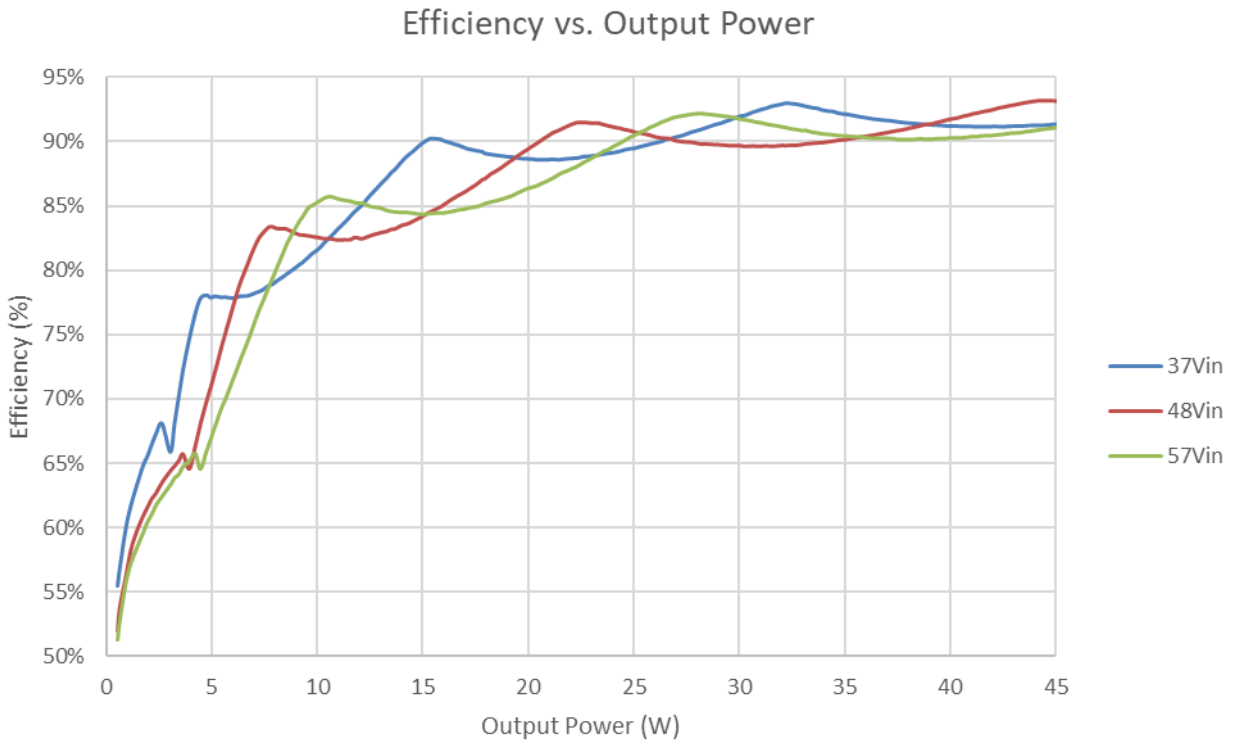

Figure 12. Efficiency Plot

Operating Waveforms

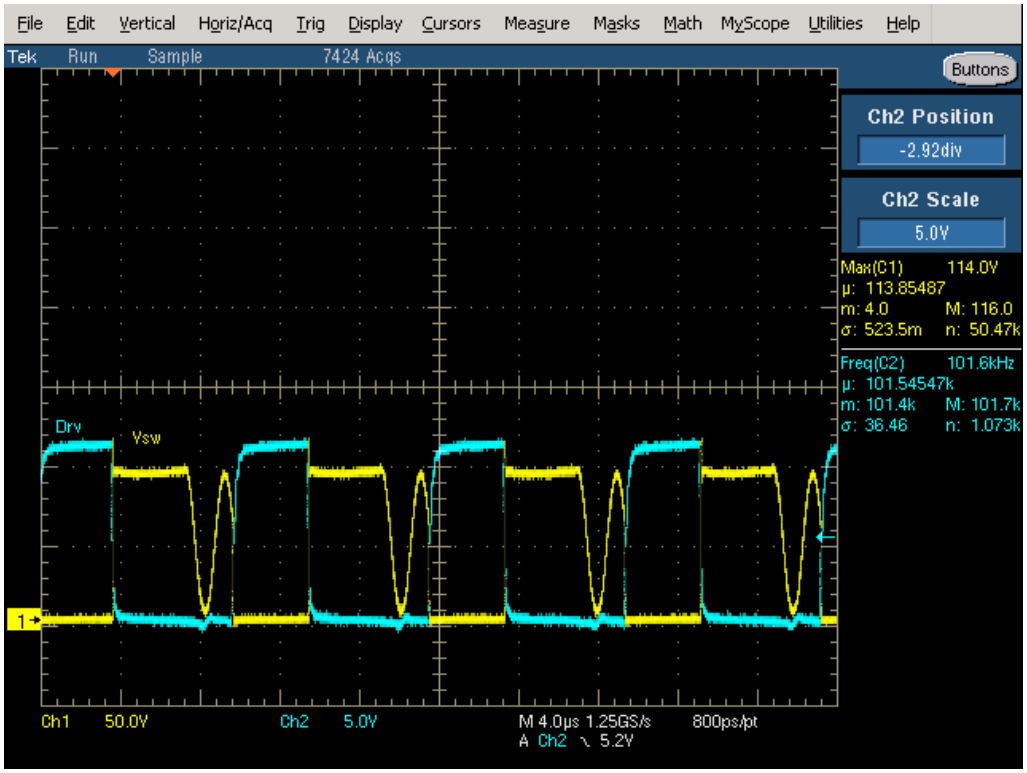

Figure 13. Normal Operating Waveform 48 Vin, 24 Vout, 1.9 A

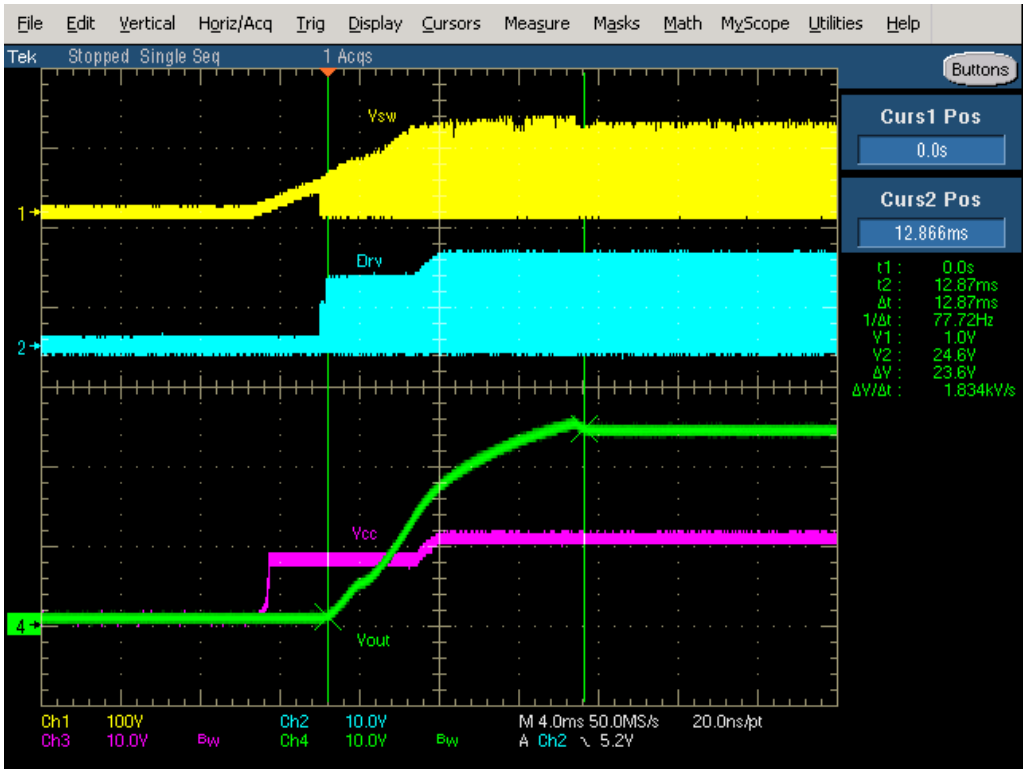

Figure 14. Full Load 48 Vin Startup Waveform

Full Load Output Ripple Waveforms

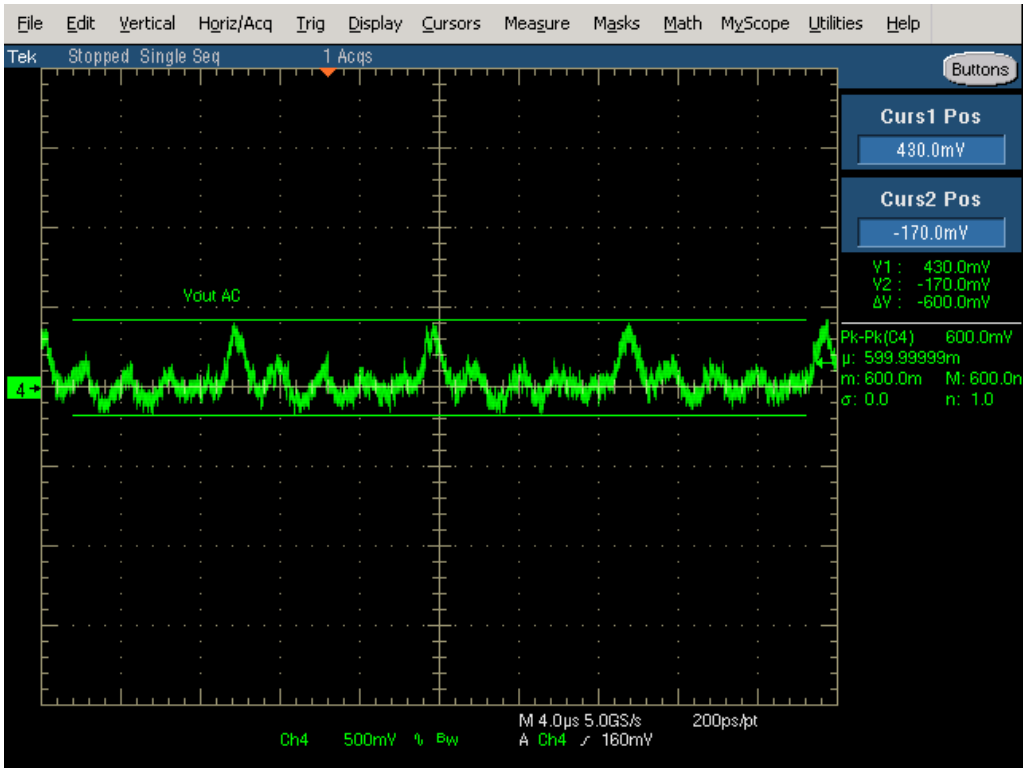

Figure 15. 37 Vin Output Ripple

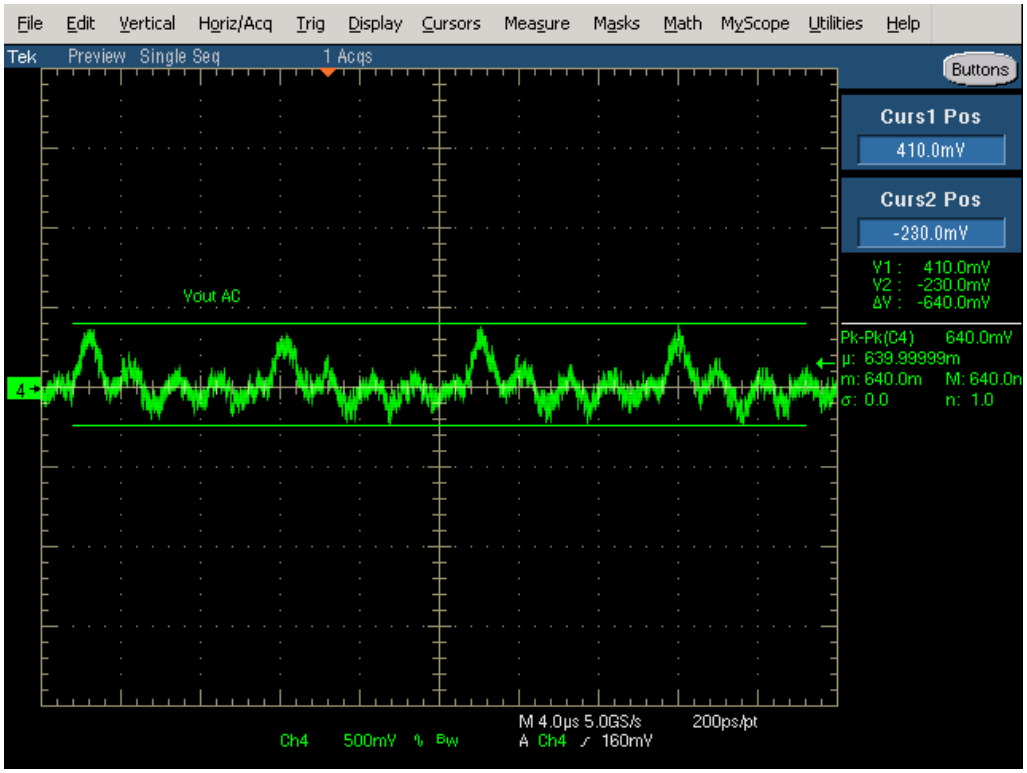

Figure 16. 48 Vin Output Ripple

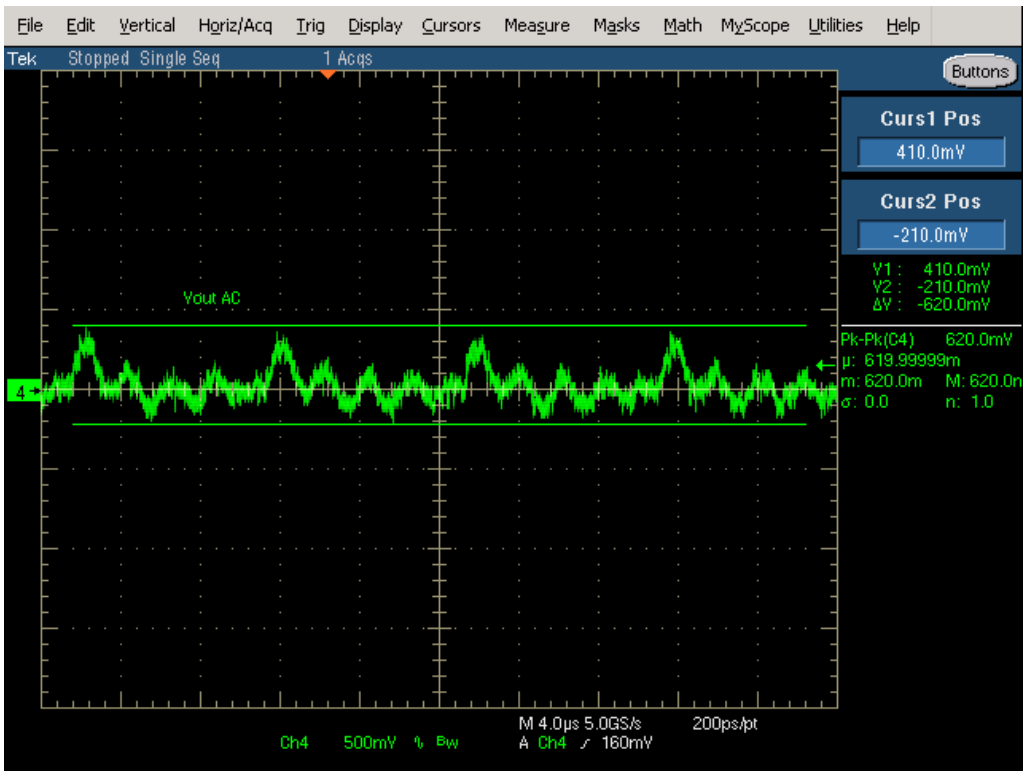

Figure 17. 57 Vin Output Ripple

Transient Response Waveforms (150 mA/μs, 20 ms, 0 – 1.9 A)

Figure 18. 37 Vin Transient Response

Figure 19. 48 Vin Transient Response

Figure 20. 57 Vin Transient Response

Feedback Bode Plots

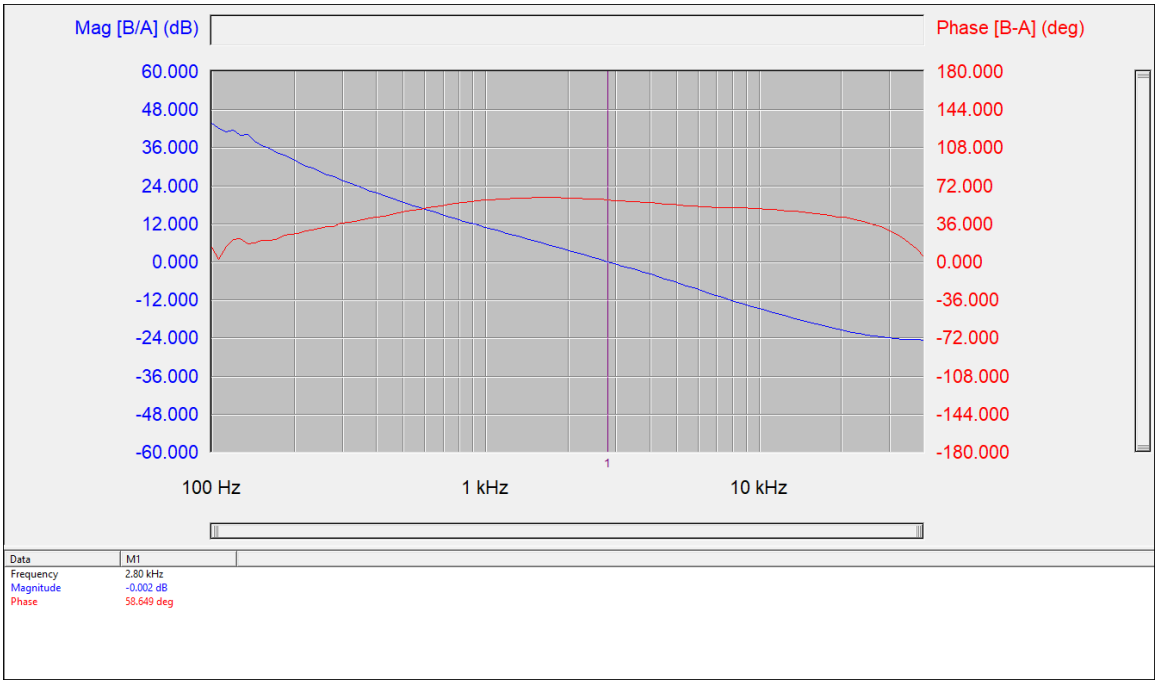

Figure 21. 37 Vin Bode Plot

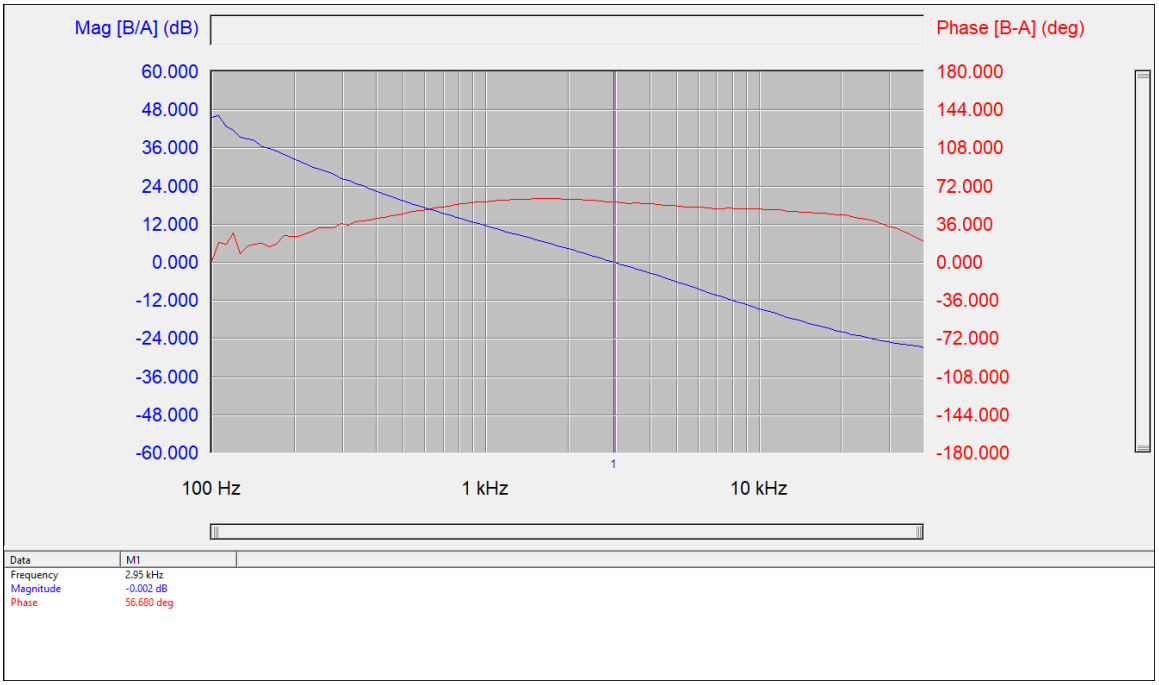

Figure 22. 48 Vin Bode Plot

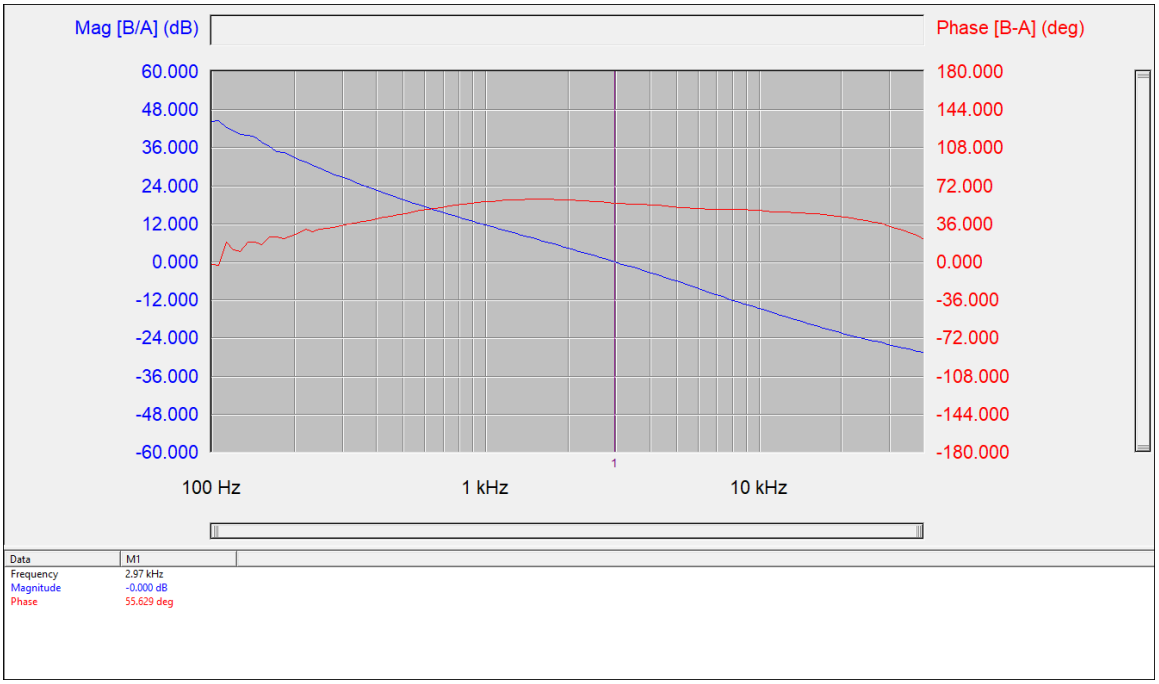

Figure 23. 57 Vin Bode Plot

Thermal Captures (Full Load)

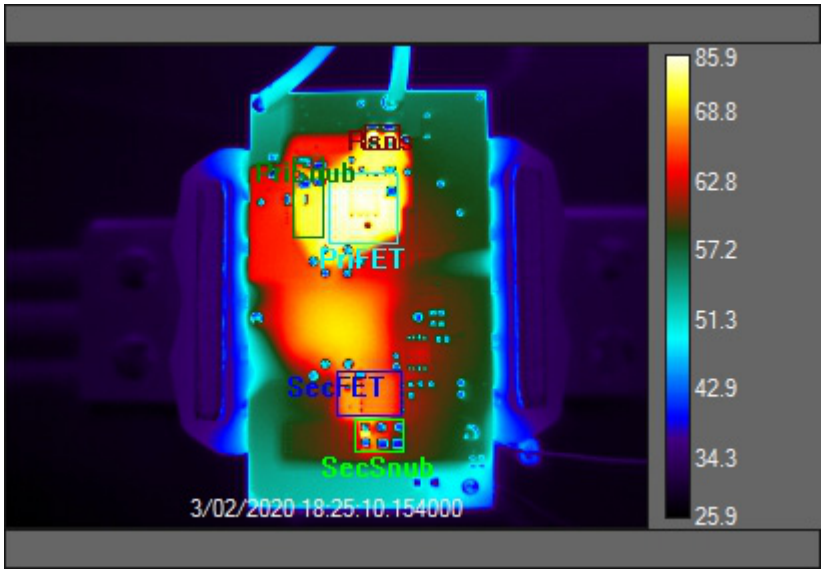

Figure 24. 37 Vin Thermals Bottom

	R Sense	Primary FET	Primary Snubber	Secondary FET	Secondary Snubber
Mean [C]	64.87	76.47	67.00	65.59	57.63
Max [C]	85.89	79.49	68.15	68.15	78.30

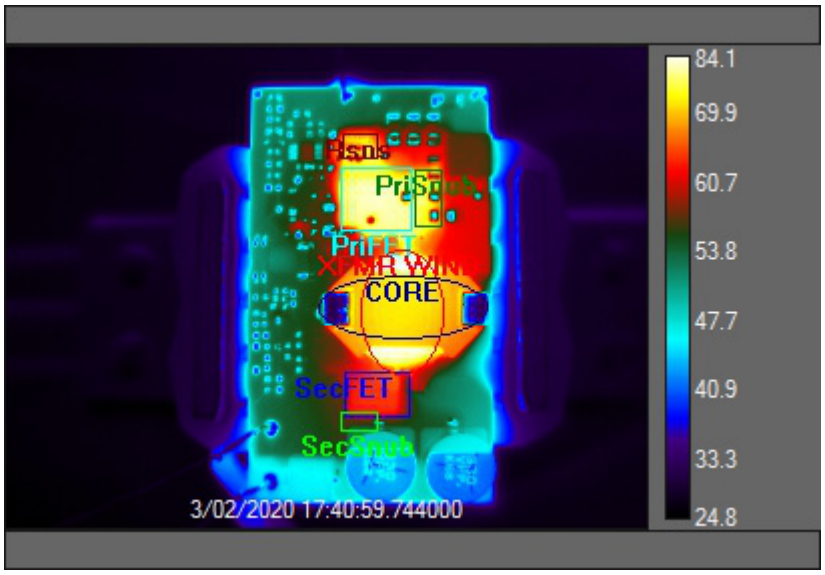

Figure 25. 37 Vin Thermals Top

	R Sense	Primary FET	Primary Snubber	Windings	Core	Secondary FET	Secondary Snubber
Mean [C]	68.89	72.90	67.62	71.35	63.82	61.83	55.54
Max [C]	71.58	75.02	74.12	84.10	71.21	71.58	60.49

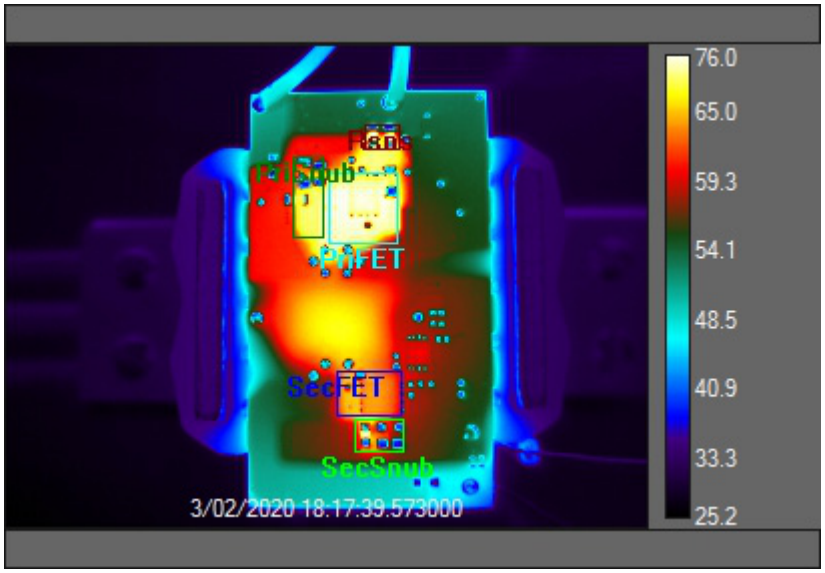

Figure 26. 48 Vin Thermals Bottom

	R Sense	Primary FET	Primary Snubber	Secondary FET	Secondary Snubber
Mean [C]	59.19	69.29	62.26	62.58	55.20
Max [C]	76.01	71.81	70.62	65.05	75.41

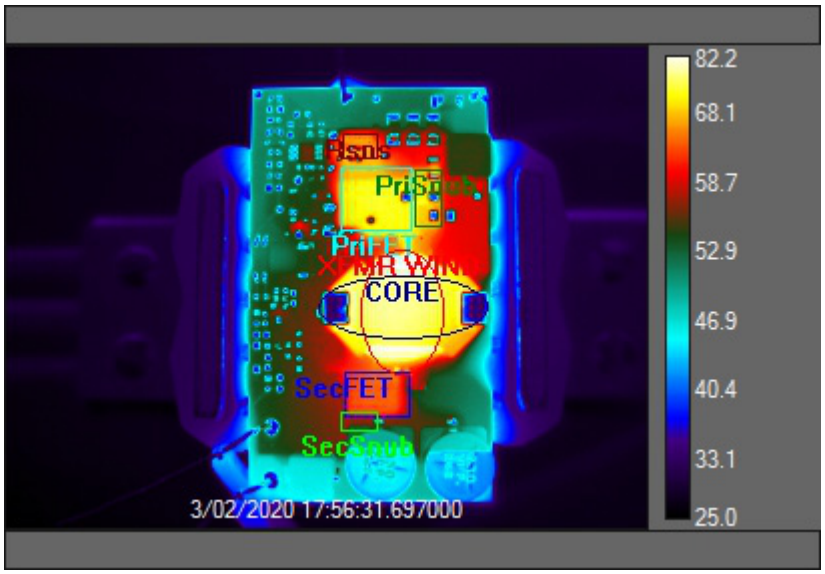

Figure 27. 48 Vin Thermals Top

	R Sense	Primary FET	Primary Snubber	Windings	Core	Secondary FET	Secondary Snubber
Mean [C]	64.86	68.02	63.80	71.22	64.30	61.93	55.44
Max [C]	68.25	70.04	70.12	82.22	72.24	64.87	60.15

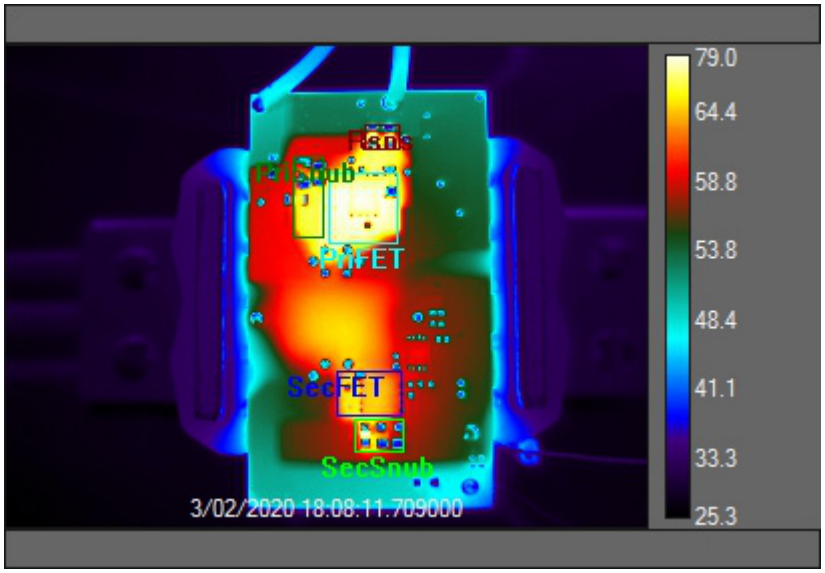

Figure 28. 57 Vin Thermals Bottom

	R Sense	Primary FET	Primary Snubber	Secondary FET	Secondary Snubber
Mean [C]	57.98	69.46	61.36	63.01	56.05
Max [C]	73.69	72.05	70.39	65.77	78.98

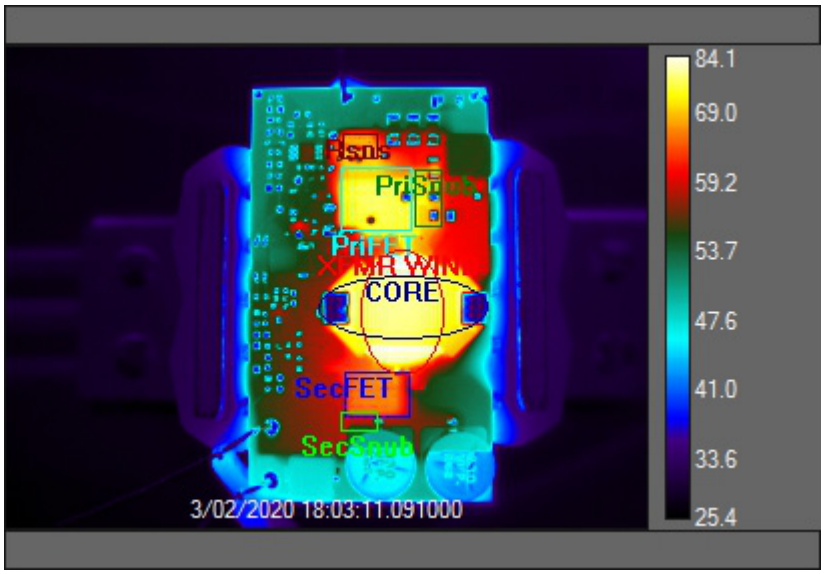

Figure 29. 57 Vin Thermals Top

	R Sense	Primary FET	Primary Snubber	Windings	Core	Secondary FET	Secondary Snubber
Mean [C]	66.15	69.87	64.75	72.71	65.38	64.05	57.18
Max [C]	69.23	72.11	71.62	84.10	73.25	67.16	62.17

BILL OF MATERIALS

Qty	Reference	Manufacturer Part Number	Value	Digikey Part Number
1	T1	750318890 Rev 01	30uH ML29D	
1	R5	CRCW06030000Z0EAC	0R0	541−4012−2−ND
2	R3 R23	CRCW06030000Z0EAC	0R0	541−4012−1−ND
1	R19	CRCW06030000Z0EA	0R0	541−0.0GCT−ND
1	R10	CRCW0603100KFKEAC	100k	541−3950−1−ND
1	R22	ERJ−3EKF10R0V	10R0	P10.0HCT−ND
4	R12 R17 R20−21	CRCW060310K0FKEB	10k	541−2978−1−ND
1	R7	CRCW060315R0FKEA	15R	541−15.0HCT−ND
1	R16	CRCW060318K2FKEA	18.2k	541−18.2KHCT−ND
1	R26	CRCW06032K00FKEAC	2.00k	541−3953−1−ND
2	R15 R28	CRCW06032K49FKEA	2.49k	541−4044−1−ND
1	R1	CRCW060325R5FKEA	25.5R	541−25.5HCT−ND
1	R13	CRCW0603374RFKEA	374R	541−34HCT−ND
1	R6	CRCW0603374KFKEA	374k	541−374KHCT−ND
1	R30	CRCW06034K99FKEAC	4.99k	541−3985−1−ND
1	R18	CRCW06034R99FKEA	4R99	541−4.99HHCT−ND
1	R24	CRCW060375K0FKEA	75k	541−75.0KHCT−ND
1	R25	CRCW08058K87FKEA	8.87k	541−8.87KCCT−ND
4	R11 R27 R29 R32		DNI	
1	CY1	502R29W102KV3E−****−SC	1000pF	709−1269−1−ND
1	C11	CGA3E3X7S2A104K080AB	0.1uF	445−6938−1−ND
1	C10	CGA3E2X7R1H103K080AA	10nF	445−5662−1−ND
3	C6 C22−23	CGA3E3X5R1H105K080AB	1uF	445−7878−1−ND
1	C9	GRM188R61H225KE11D	2.2uF	490−10733−1−ND
1	C3	CGJ3E2X7R1E223K080AA	22nF	445−8125−1−ND
1	C4	8.85012E+11	4.7nF	732−7957−1−ND
1	C13	C0603C472K5RACTU	4.7nF	399−1087−1−ND
1	C1	C0603C471J5GACTU	470pF	399−7922−1−ND
2	C12 C14		DNI	
1	C5	CGA3E2X7R1H103K080AA	10nF	445−5662−1−ND
1	C16		DNI	
1	C34	C0805C682K2RAC7800	6800pF	399−14628−1−ND
1	C2	C1206C104KARACTU	0.1uF	399−4674−1−ND
1	C15	CGA5L3X5R1H106M160AB	10 uF	445−12883−1−ND
4	C18−21	C3216X7R2A105K160AA	1uF	445−4467−1−ND
1	C7	C1206C471J2GACTU	470pF	399−8192−1−ND
2	C8 C17	EEE−FP1V331AP	330uF/35V	PCE4445TR−ND
4	D2−5	MMSD3070	200V 200mA	MMSD3070TR−ND
1	Q2	FDMS86202	120V 7.2mOhm	FDMS86202CT−ND
1	Q1	FDMS86255	150V 11mOhm	FDMS86255CT−ND
1	U8	FODM8801BV	1.17V 50mA	FODM8801BV−ND
2	L1−2	744314047	0.47uH	732−1155−1−ND
5	PGO VIN+ VIN− VOUT+ VOUT−	01−1036		
1	Q4	BSS64L	80V 200mA	BSS64LT1GOSCT−ND
1	Z2	MM3Z12VB	12 V	MM3Z12VBCT−ND
1	Z1	SZMM3Z24VT1G	24V	SZMM3Z24VT1GOSCT−ND

BILL OF MATERIALS (continued)

Qty	Reference	Manufacturer Part Number	Value	Digikey Part Number
1	Z4		DNI	
1	U1	NCP12700C		
1	U2	NCP4306AAAZZZAMN1TBG	20V	NCP4306AAAZZZAMN1TBGOSCT−ND
1	RT1	ERT−J1VV104J	100k	P10555CT−ND
1	R31	CRCW08050000Z0EAHP	0R0	541−0.0TBCT−ND
2	R4 R33	CRCW0805100RFKEAC	100R	541−3979−1−ND
1	R14		DNI	
1	D1	ES1JFL	600V 1A	ES1JFLCT−ND
1	U4	NCP431ACSNT1G	2.5V	NCP431ACSNT1GOSCT−ND
2	R2 R35	HRG3216P−1002−B−T1	10k	408−1949−2−ND
2	R8−9	WSL1206R0800FEA	80mOhm	WSLC−.08CT−ND
2	R34 R36		DNI	

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