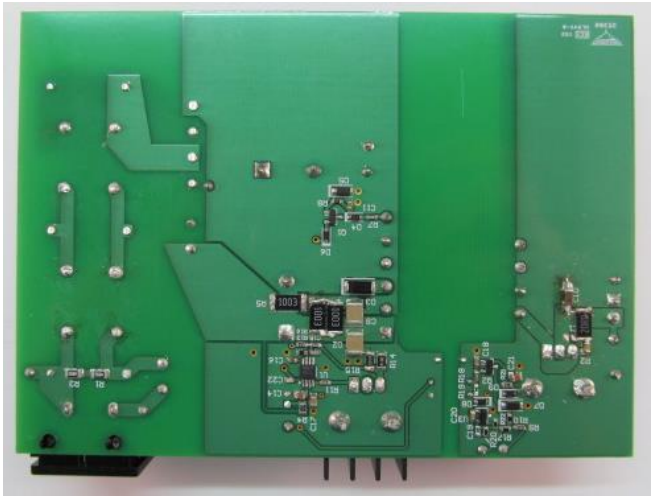
Test Report: PMP21549
75/150-W Flyback reference design for audio applications

Description

The flyback reference design uses the cost effective LM5021 AC-DC current-mode PWM controller. Universal line input is converted to a 28-V output. The supply is designed for sustained operation at 75-W and is rated for peaks up to 150-W. This range is ideal for the power requirements of audio signals. It is also tested for conductive EMI compliance.



1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Line Input Voltage Range	90 to 265 VAC
Line Input Frequency	50 to 60Hz
Output Voltage/Current	28 V at 2.75 A/ 5.5 A
Nominal Switching Frequency	109.8 kHz

1.2 Required Equipment

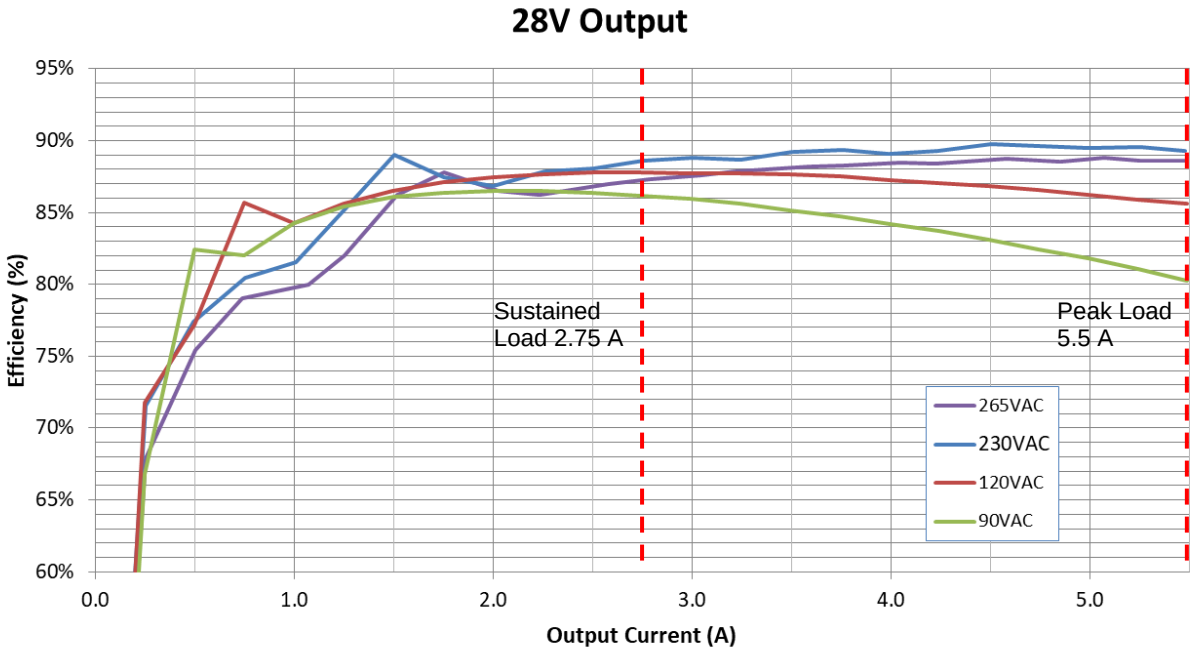
- AC voltage source
- AC power meter
- Electronic load
- Multi-meters
- Oscilloscope

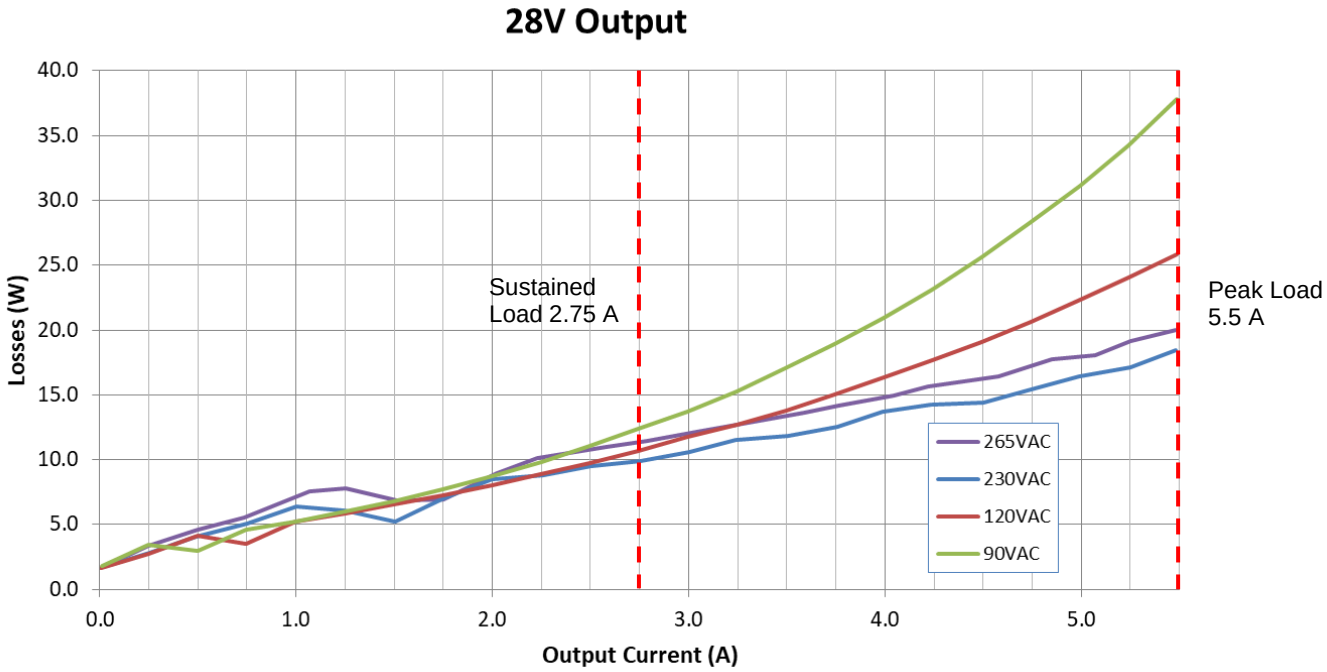
1.3 Considerations

It should be noted that the snubber circuit on this board generates a large amount of heat. For future designs, larger copper pours should be placed around the resistors (R5, R6). Additional resistors can also be added in parallel to help dissipate the heat.

2 Testing and Results

2.1 Efficiency Graphs





2.2 Efficiency Data

2.2.1 265VAC, 50Hz

VOUT (V)	IOUT (A)	POUT (W)	PIN (W)	PF	EFFICIENCY	PLOSS (W)
28.3400	0.0150	0.4251	2.1700	0.1330	19.59%	1.7449
28.3400	0.2500	7.0850	10.4390	0.3150	67.87%	3.3540
28.3400	0.5000	14.1700	18.7810	0.3870	75.45%	4.6110
28.3400	0.7370	20.8866	26.4200	0.4140	79.06%	5.5334
28.3400	1.0710	30.3521	37.9400	0.4430	80.00%	7.5879
28.3400	1.2520	35.4817	43.2600	0.4530	82.02%	7.7783
28.3400	1.5140	42.9068	49.7400	0.4630	86.26%	6.8332
28.3400	1.7500	49.5950	56.5100	0.4720	87.76%	6.9150
28.3400	2.0240	57.3602	66.3300	0.4830	86.48%	8.9698
28.3400	2.2300	63.1982	73.3100	0.4910	86.21%	10.1118
28.3400	2.5770	73.0322	83.9900	0.5000	86.95%	10.9578
28.3400	2.7870	78.9836	90.4600	0.5050	87.31%	11.4764
28.3400	3.0400	86.1536	98.3200	0.5100	87.63%	12.1664
28.3400	3.2120	91.0281	103.6400	0.5140	87.83%	12.6119
28.3400	3.5870	101.6556	115.2700	0.5210	88.19%	13.6144
28.3400	3.7610	106.5867	120.7300	0.5250	88.29%	14.1433
28.3400	4.0440	114.6070	129.5700	0.5290	88.45%	14.9630
28.3400	4.2200	119.5948	135.2800	0.5320	88.41%	15.6852
28.3400	4.5800	129.7972	146.2600	0.5380	88.74%	16.4628
28.3400	4.8500	137.4490	155.1900	0.5420	88.57%	17.7410
28.3400	5.0700	143.6838	161.7700	0.5450	88.82%	18.0862
28.3400	5.2500	148.7850	167.9400	0.5470	88.59%	19.1550
28.3400	5.4800	155.3032	175.2900	0.5510	88.60%	19.9868

2.2.2 230VAC, 50Hz

VOUT (V)	IOUT (A)	POUT (W)	PIN (W)	PF	EFFICIENCY	PLOSS (W)
28.0331	0.0154	0.4317	2.1299	0.1210	20.27%	1.6982
28.0331	0.2538	7.1148	9.9461	0.2590	71.53%	2.8313
28.0328	0.4907	13.7557	17.7790	0.2960	77.37%	4.0233
28.0333	0.7493	21.0053	26.1050	0.3180	80.46%	5.0997
28.0324	1.0044	28.1557	34.5170	0.3350	81.57%	6.3613
28.0320	1.2503	35.0484	41.1270	0.3450	85.22%	6.0786
28.0311	1.5023	42.1111	47.3000	0.3540	89.03%	5.1889
28.0304	1.7489	49.0224	56.0390	0.3650	87.48%	7.0166
28.0309	1.9965	55.9638	64.4410	0.3740	86.84%	8.4772
28.0308	2.2582	63.2992	72.0680	0.3820	87.83%	8.7688
28.0299	2.5026	70.1477	79.6520	0.3890	88.07%	9.5043
28.0303	2.7526	77.1562	87.0820	0.3960	88.60%	9.9258
28.0297	3.0020	84.1450	94.7240	0.4020	88.83%	10.5790
28.0295	3.2394	90.7988	102.3600	0.4080	88.71%	11.5612
28.0294	3.5032	98.1926	110.0500	0.4140	89.23%	11.8574
28.0291	3.7555	105.2634	117.8200	0.4190	89.34%	12.5566
28.0288	3.9876	111.7674	125.4700	0.4250	89.08%	13.7026
28.0293	4.2330	118.6479	132.8900	0.4300	89.28%	14.2421
28.0284	4.5012	126.1613	140.5900	0.4350	89.74%	14.4287
28.0288	4.7436	132.9572	148.3800	0.4400	89.61%	15.4228
28.0284	4.9908	139.8839	156.3000	0.4440	89.50%	16.4161
28.0276	5.2488	147.1112	164.2100	0.4490	89.59%	17.0988
28.0271	5.4786	153.5491	171.9800	0.4530	89.28%	18.4309

2.2.3 120VAC, 60Hz

VOUT (V)	IOUT (A)	POUT (W)	PIN (W)	PF	EFFICIENCY	PLOSS (W)
28.0346	0.0081	0.2271	1.8814	0.2290	12.07%	1.6543
28.0343	0.2463	6.9048	9.6174	0.3400	71.80%	2.7126
28.0337	0.4972	13.9383	18.0550	0.3760	77.20%	4.1167
28.0328	0.7476	20.9573	24.4480	0.3960	85.72%	3.4907
28.0322	0.9984	27.9874	33.2080	0.4170	84.28%	5.2206
28.0320	1.2488	35.0063	40.8920	0.4330	85.61%	5.8857
28.0312	1.4934	41.8618	48.3860	0.4470	86.52%	6.5242
28.0309	1.7444	48.8972	56.1390	0.4600	87.10%	7.2418
28.0304	1.9952	55.9263	63.9270	0.4710	87.48%	8.0007
28.0302	2.2456	62.9445	71.7950	0.4820	87.67%	8.8505
28.0298	2.4961	69.9651	79.7210	0.4910	87.76%	9.7559
28.0294	2.7420	76.8566	87.5660	0.5000	87.77%	10.7094
28.0286	2.9925	83.8756	95.6290	0.5090	87.71%	11.7534
28.0284	3.2424	90.8792	103.5900	0.5170	87.73%	12.7108
28.0277	3.4935	97.9148	111.6800	0.5250	87.67%	13.7652
28.0271	3.7439	104.9305	119.9200	0.5320	87.50%	14.9895
28.0269	3.9942	111.9452	128.2700	0.5380	87.27%	16.3248
28.0263	4.2389	118.8007	136.4800	0.5440	87.05%	17.6793
28.0257	4.4902	125.8408	144.9500	0.5490	86.82%	19.1092
28.0250	4.7419	132.8918	153.4900	0.5550	86.58%	20.5982
28.0245	4.9911	139.8730	162.2000	0.5600	86.23%	22.3270
28.0237	5.2419	146.8975	170.9600	0.5650	85.93%	24.0625
28.0232	5.4872	153.7689	179.6000	0.5690	85.62%	25.8311

2.2.4 90VAC, 60Hz

VOUT (V)	IOUT (A)	POUT (W)	PIN (W)	PF	EFFICIENCY	PLOSS (W)
28.0344	0.0096	0.2704	2.0851	0.2870	12.97%	1.8147
28.0336	0.2458	6.8902	10.3180	0.3810	66.78%	3.4278
28.0329	0.4976	13.9478	16.9250	0.4140	82.41%	2.9772
28.0325	0.7479	20.9641	25.5490	0.4450	82.05%	4.5849
28.0320	0.9983	27.9836	33.1970	0.4680	84.30%	5.2134
28.0312	1.2486	34.9991	40.9820	0.4860	85.40%	5.9829
28.0308	1.4944	41.8881	48.6710	0.5020	86.06%	6.7829
28.0302	1.7436	48.8723	56.6000	0.5160	86.35%	7.7277
28.0298	1.9950	55.9183	64.6210	0.5290	86.53%	8.7027
28.0291	2.2462	62.9602	72.7560	0.5390	86.54%	9.7958
28.0285	2.4959	69.9572	81.0040	0.5490	86.36%	11.0468
28.0281	2.7414	76.8348	89.1910	0.5570	86.15%	12.3562
28.0275	2.9920	83.8587	97.5810	0.5660	85.94%	13.7223
28.0267	3.2426	90.8783	106.1600	0.5740	85.61%	15.2817
28.0260	3.4929	97.8912	114.9400	0.5810	85.17%	17.0488
28.0251	3.7434	104.9096	123.8500	0.5870	84.71%	18.9404
28.0244	3.9937	111.9212	132.8900	0.5930	84.22%	20.9688
28.0235	4.2389	118.7883	141.9000	0.5980	83.71%	23.1117
28.0223	4.4892	125.7974	151.4200	0.6030	83.08%	25.6226
28.0213	4.7405	132.8339	161.1300	0.6070	82.44%	28.2961
28.0200	4.9915	139.8617	170.9800	0.6110	81.80%	31.1183
28.0189	5.2422	146.8800	181.1500	0.6140	81.08%	34.2700
28.0170	5.4875	153.7423	191.5500	0.6170	80.26%	37.8077

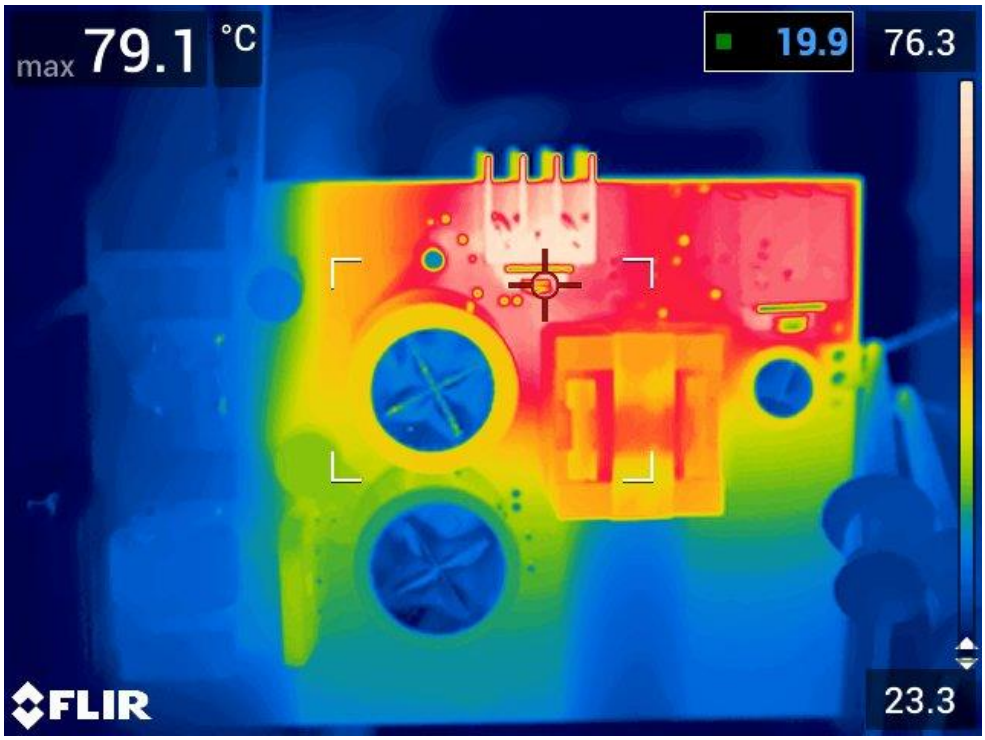
2.3 Standby Power

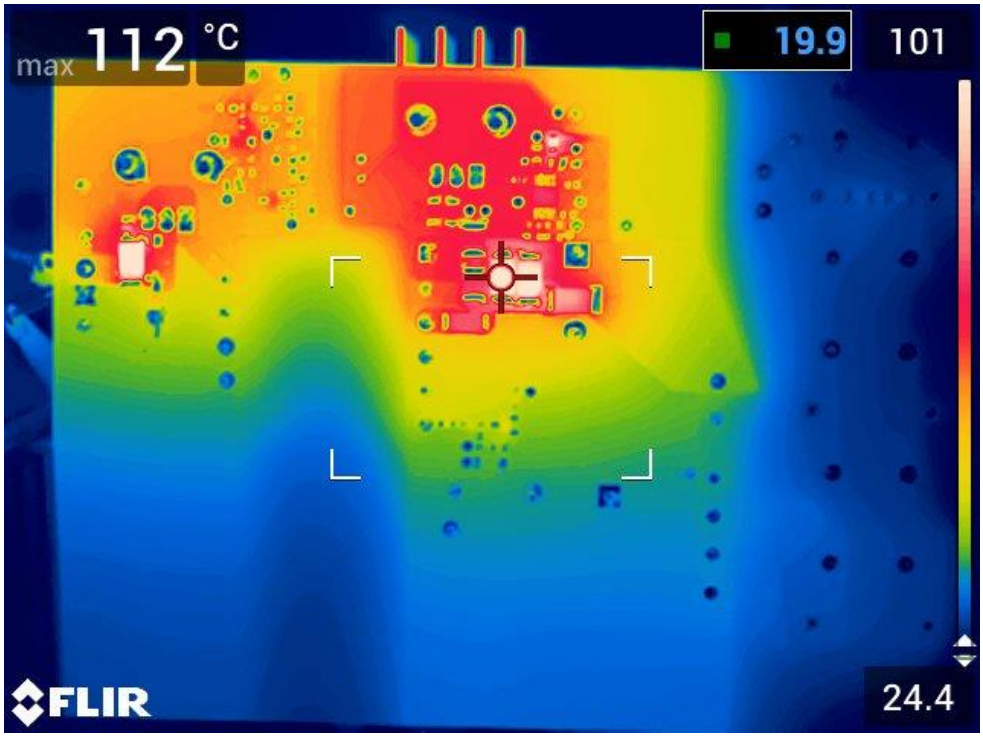
Vin RMS (V)	Line Frequency (Hz)	Pin (W)
90	60	1.818
120	60	1.631
230	50	1.764
265	50	1.901

2.4 Thermal Images

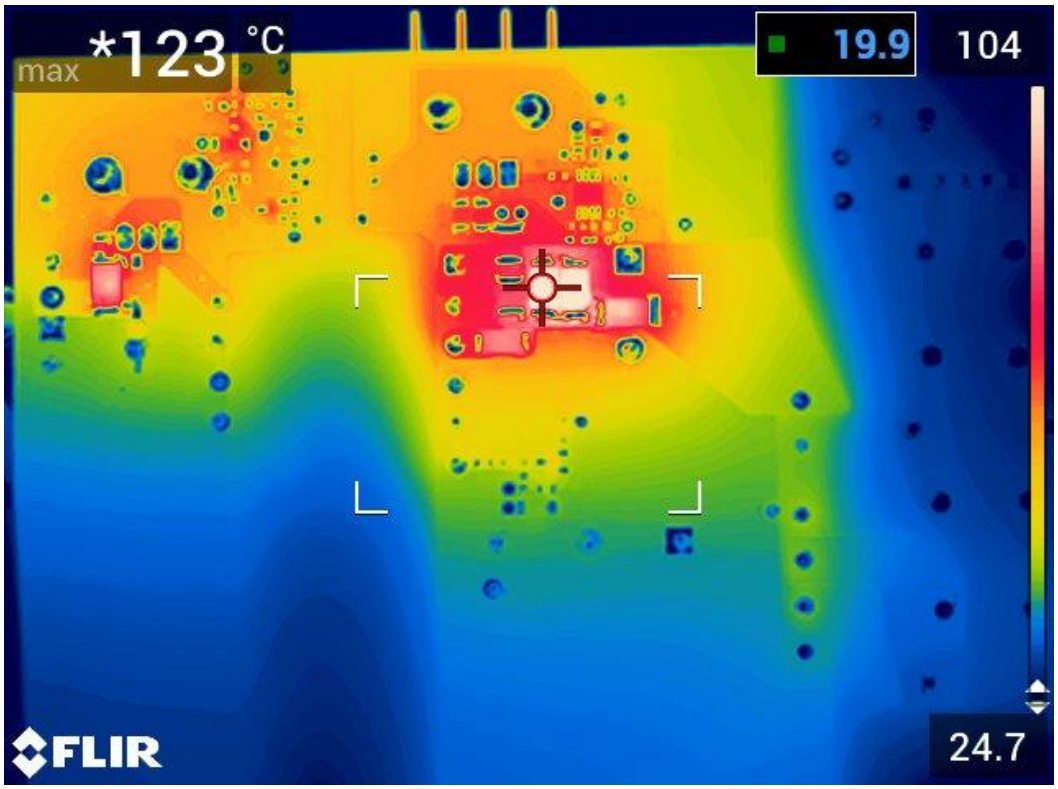
Thermal images captured at an ambient temperature of 23 ºC, with no airflow, after 30 minutes of power on time.

2.4.1 230VAC, 28V/2.75A Output

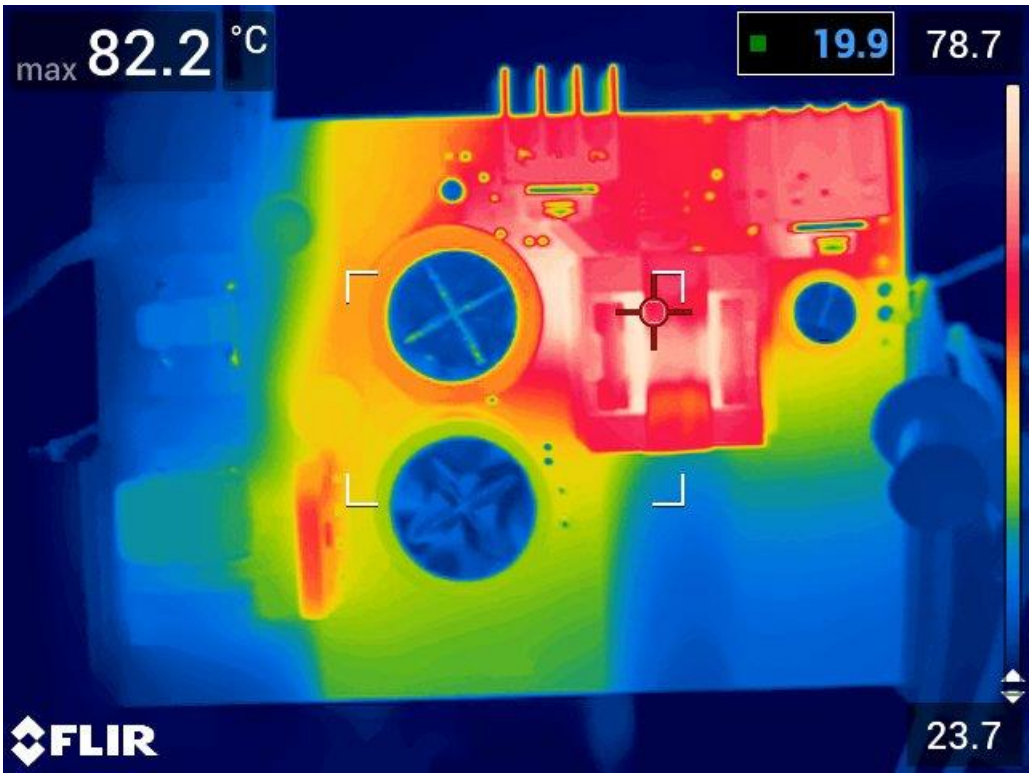


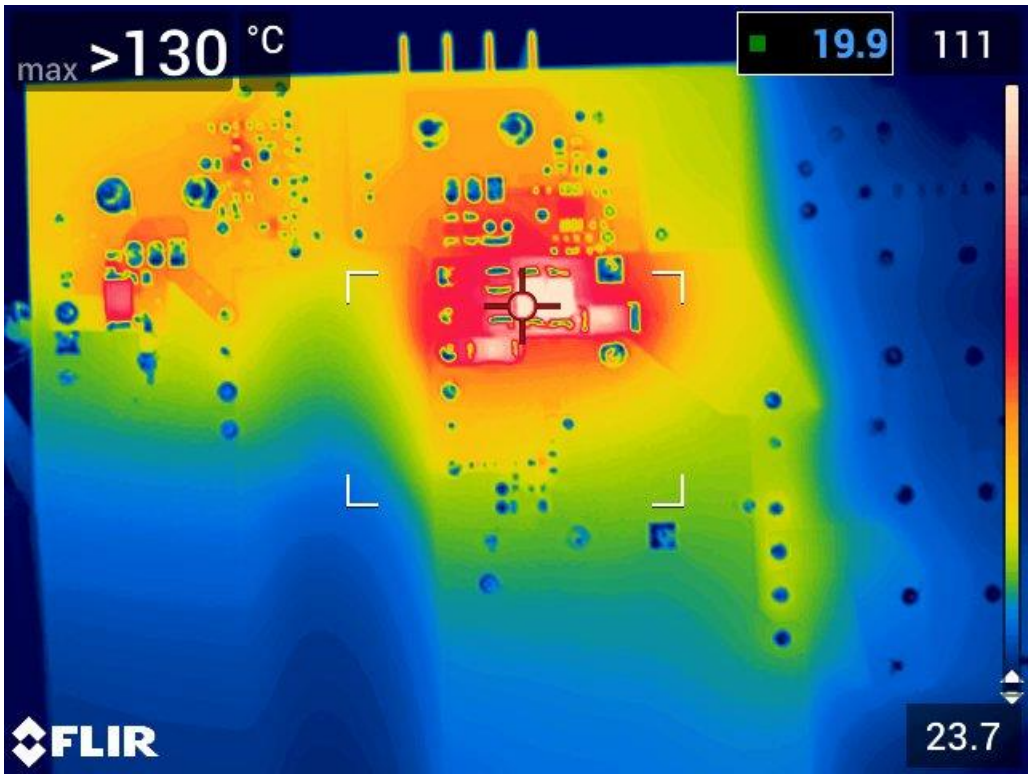


2.4.2 120VAC, 28V/2.75A Output



2.4.3 90VAC, 28V/2.75A Output

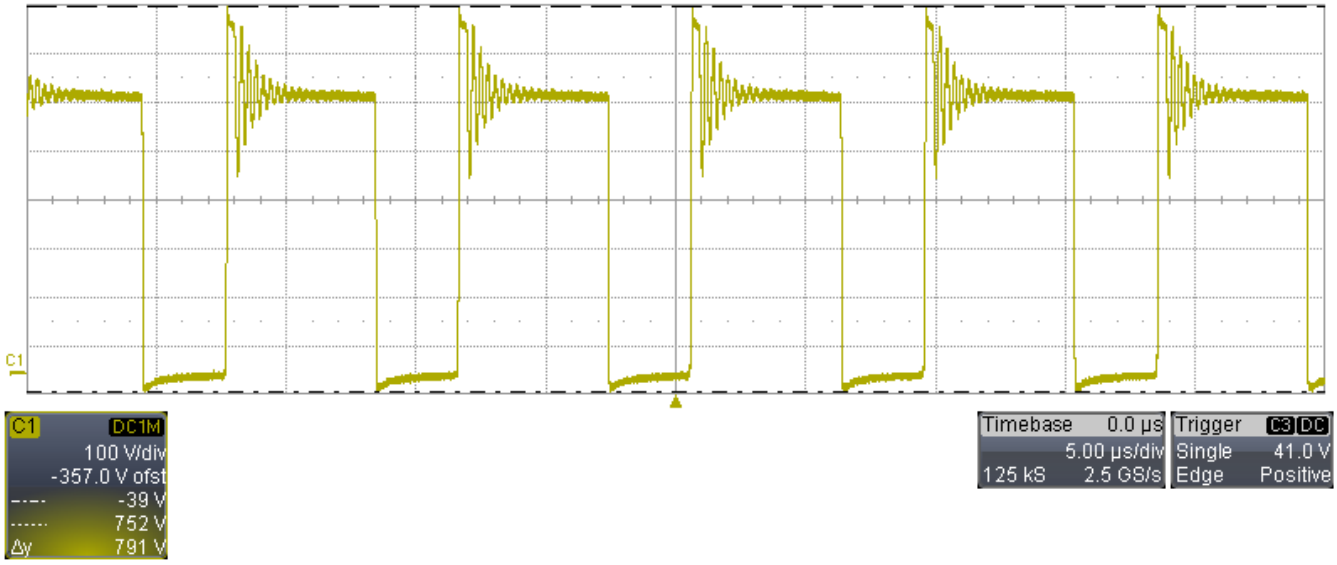




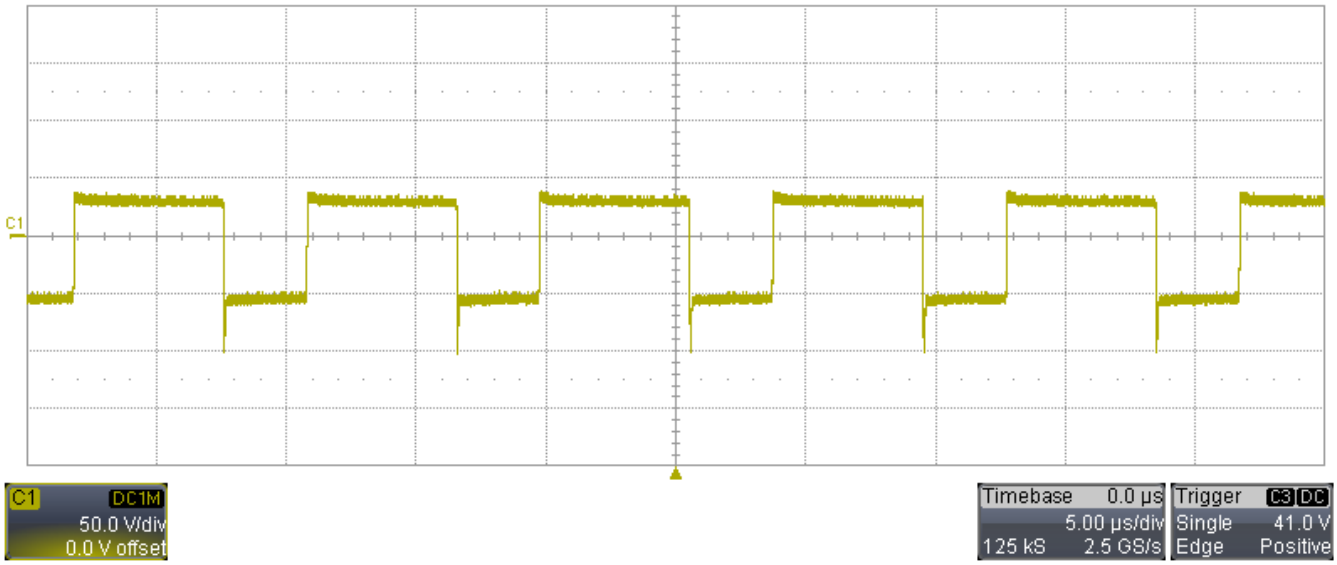
3 Waveforms

3.1 Switching

3.1.1 Vds of Primary FET (Q3), 265VAC Input, 28V/5.5A Output

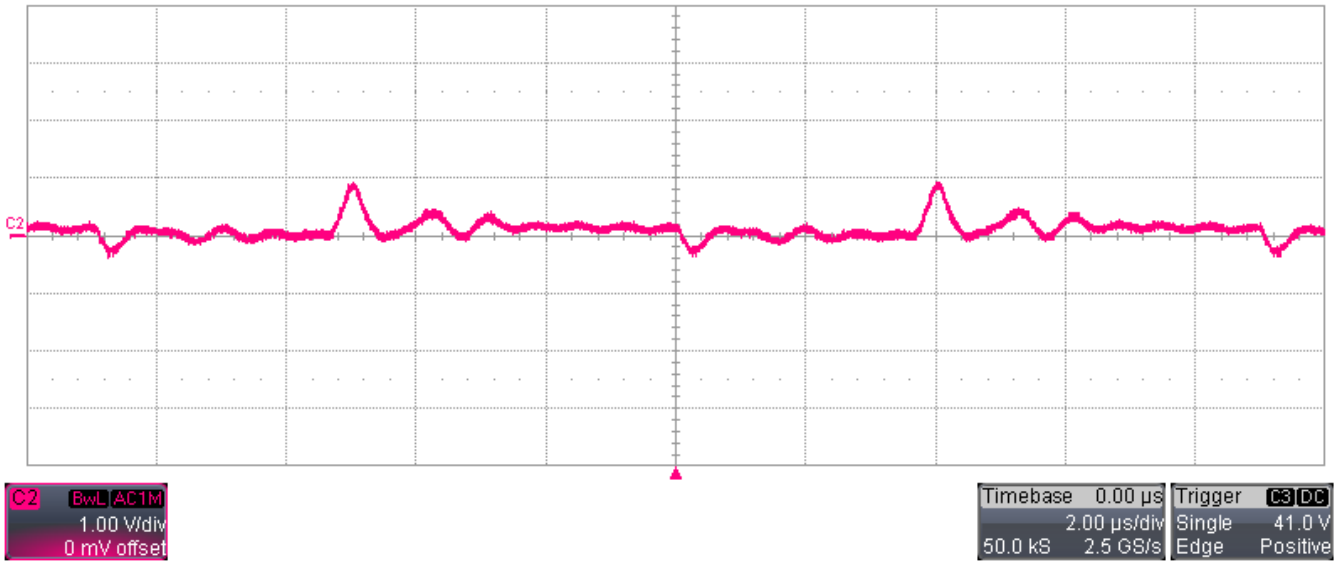


3.1.2 Voltage across Output Rectifier (D2), 265VAC Input, 28V/5.5A Output

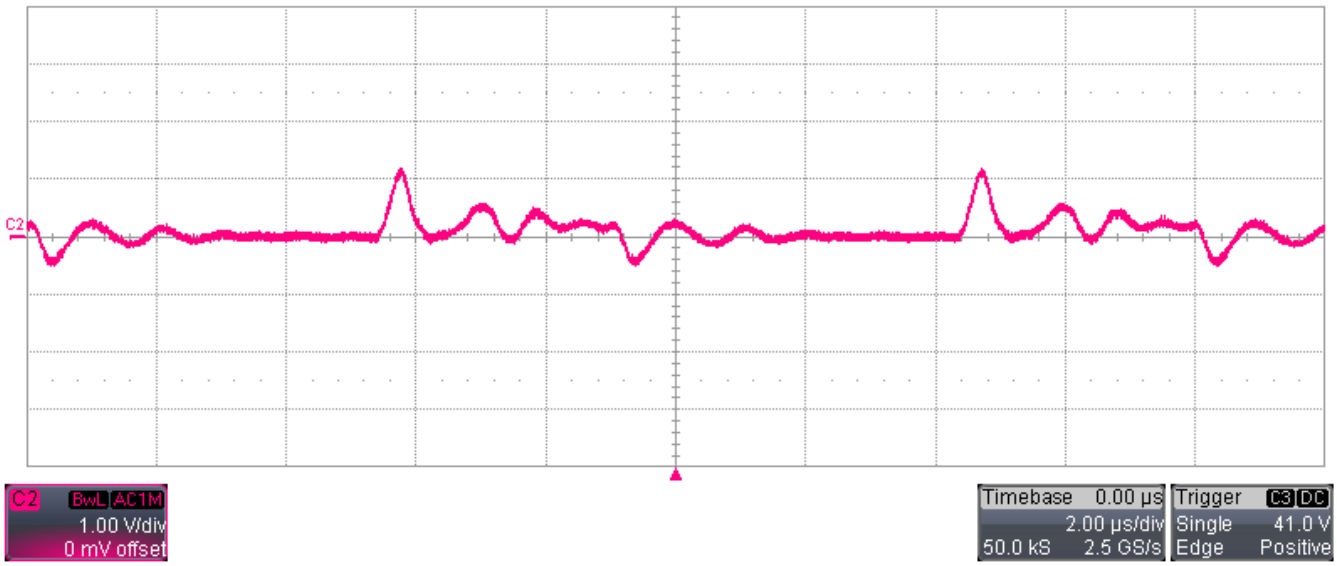


3.2 Output Voltage Ripple

3.2.1 230VAC Input, 28V/5.5A Output

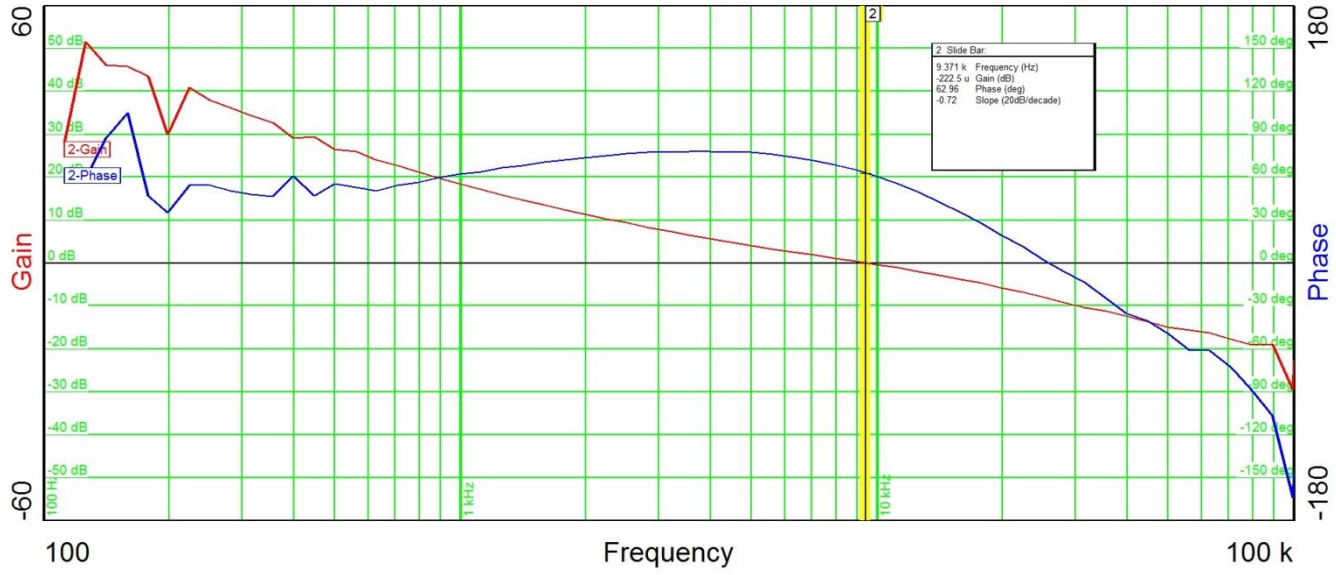


3.2.2 120VAC Input, 28V/5.5A Output

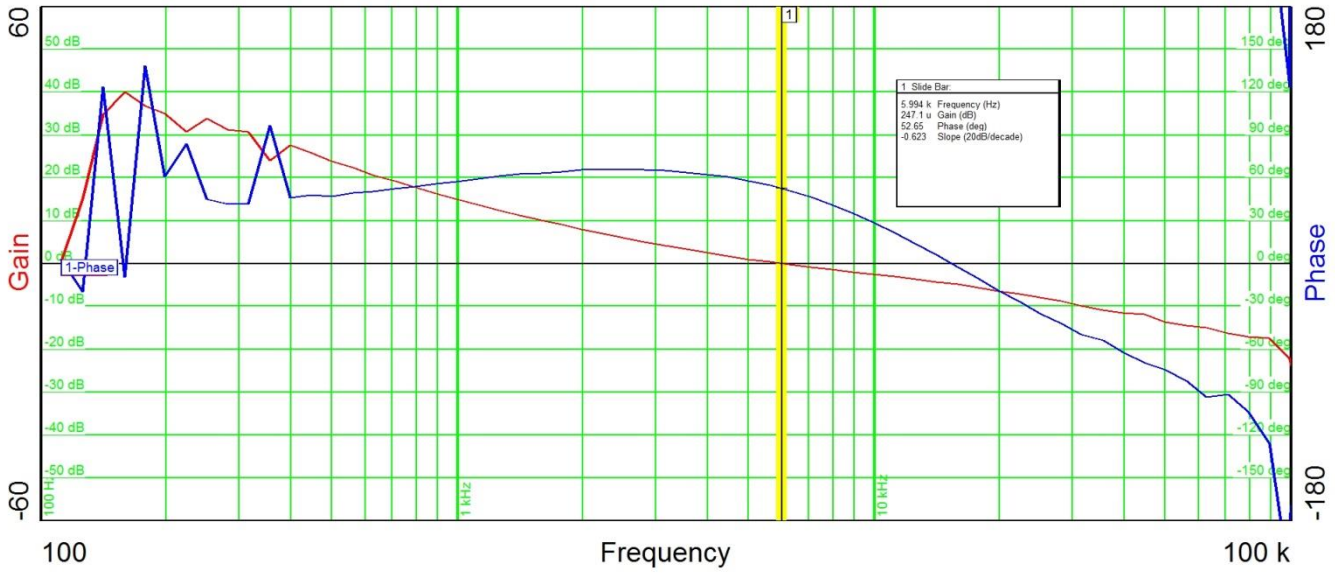


3.3 Bode Plot

3.3.1 230VAC Input, 28V/5.5A Output

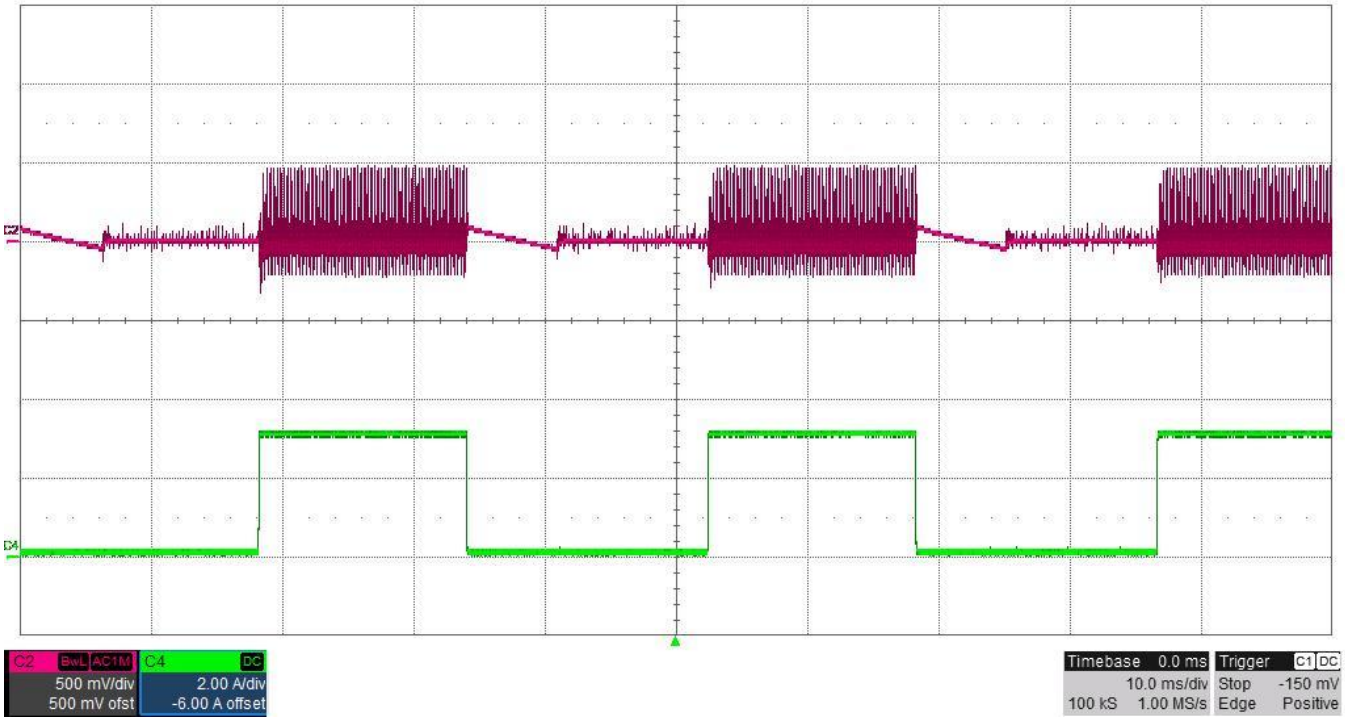


3.3.2 120VAC Input, 28V/5.5A Output

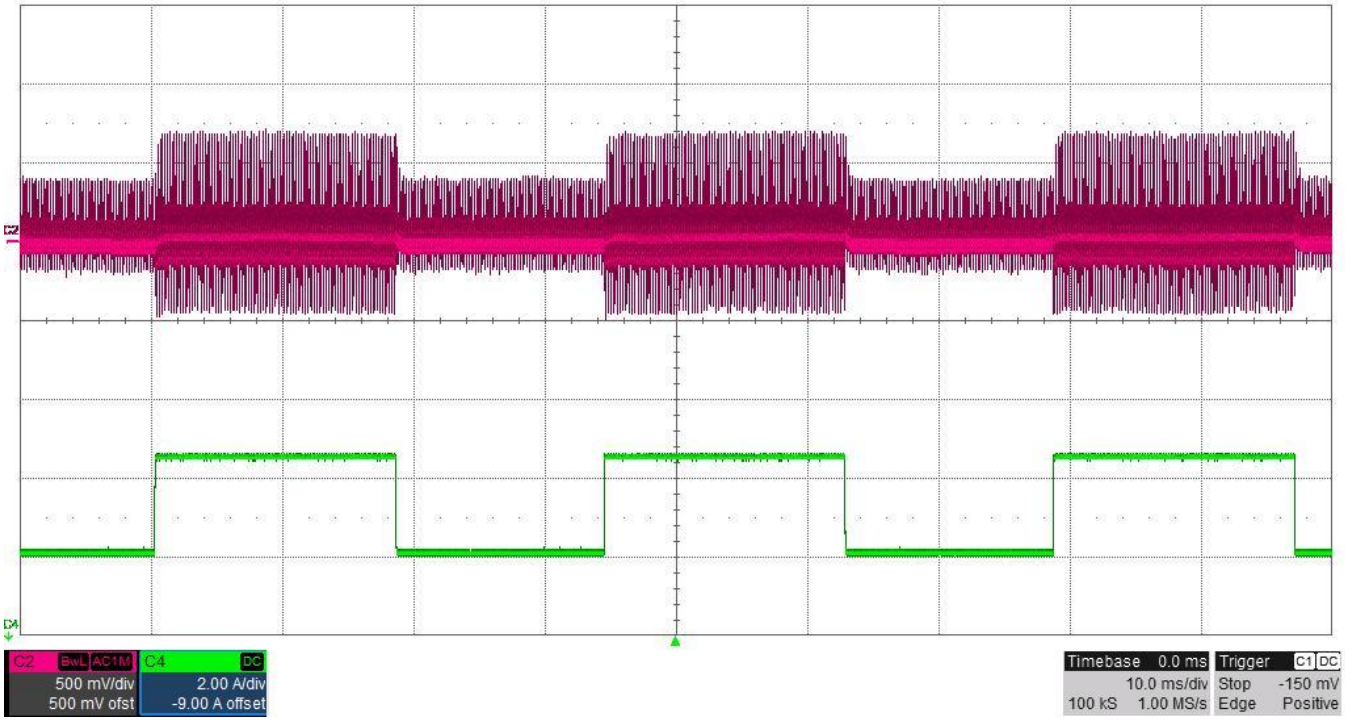


3.4 Load Transients

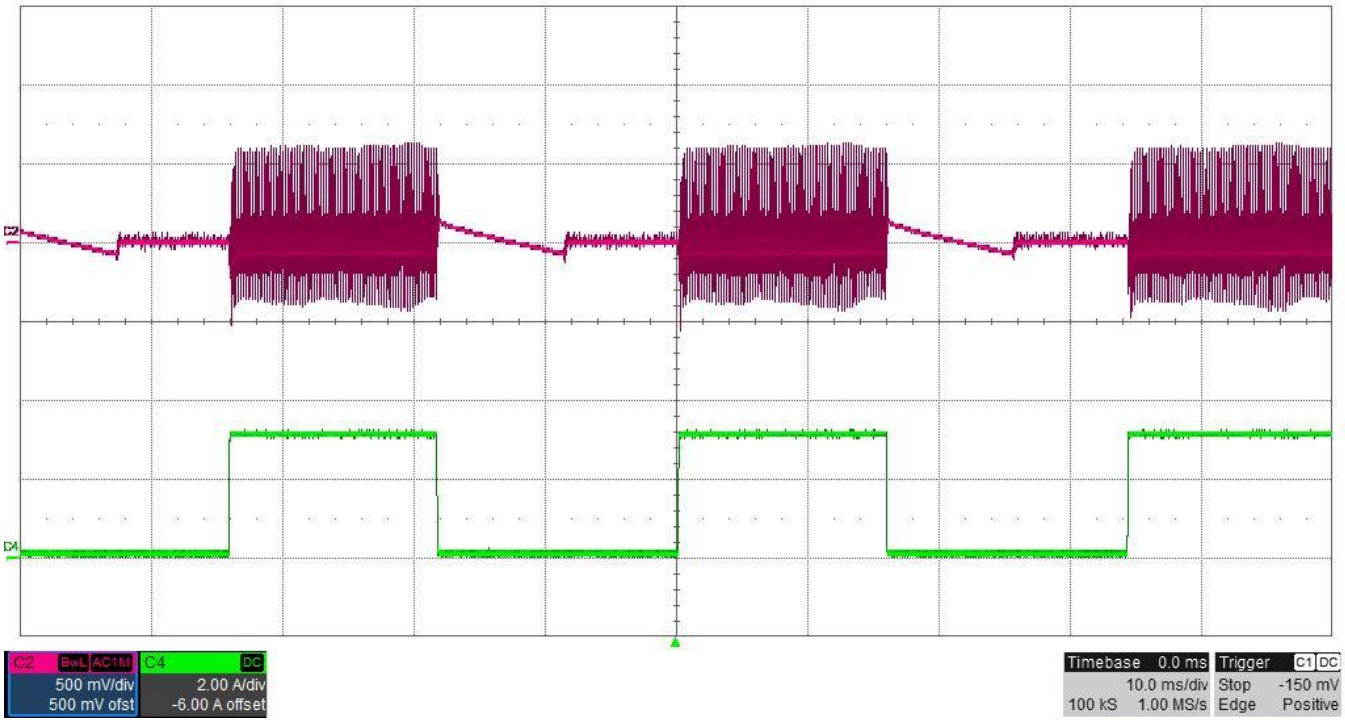
3.4.1 230VAC Input, 0A to 3A, 28V Output



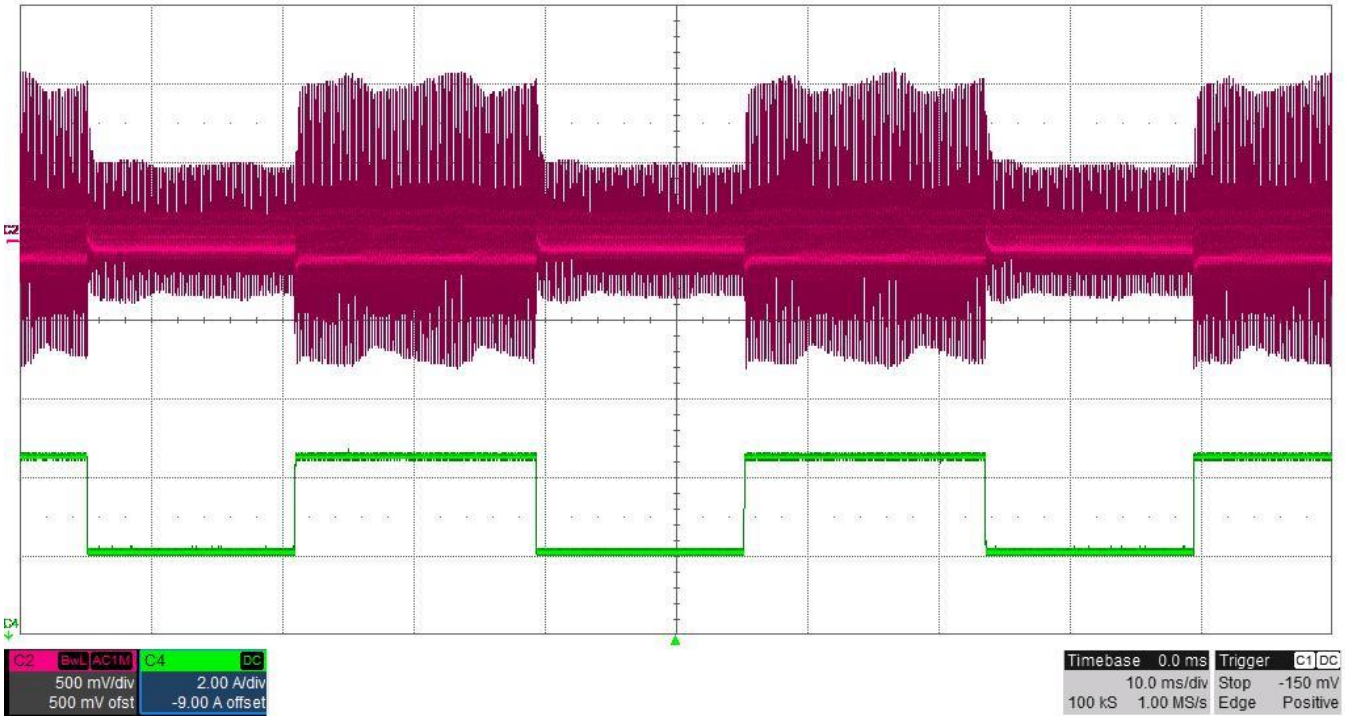
3.4.2 230VAC Input, 3A to 5.5A, 28V Output



3.4.3 120VAC Input, 0A to 3A, 28V Output

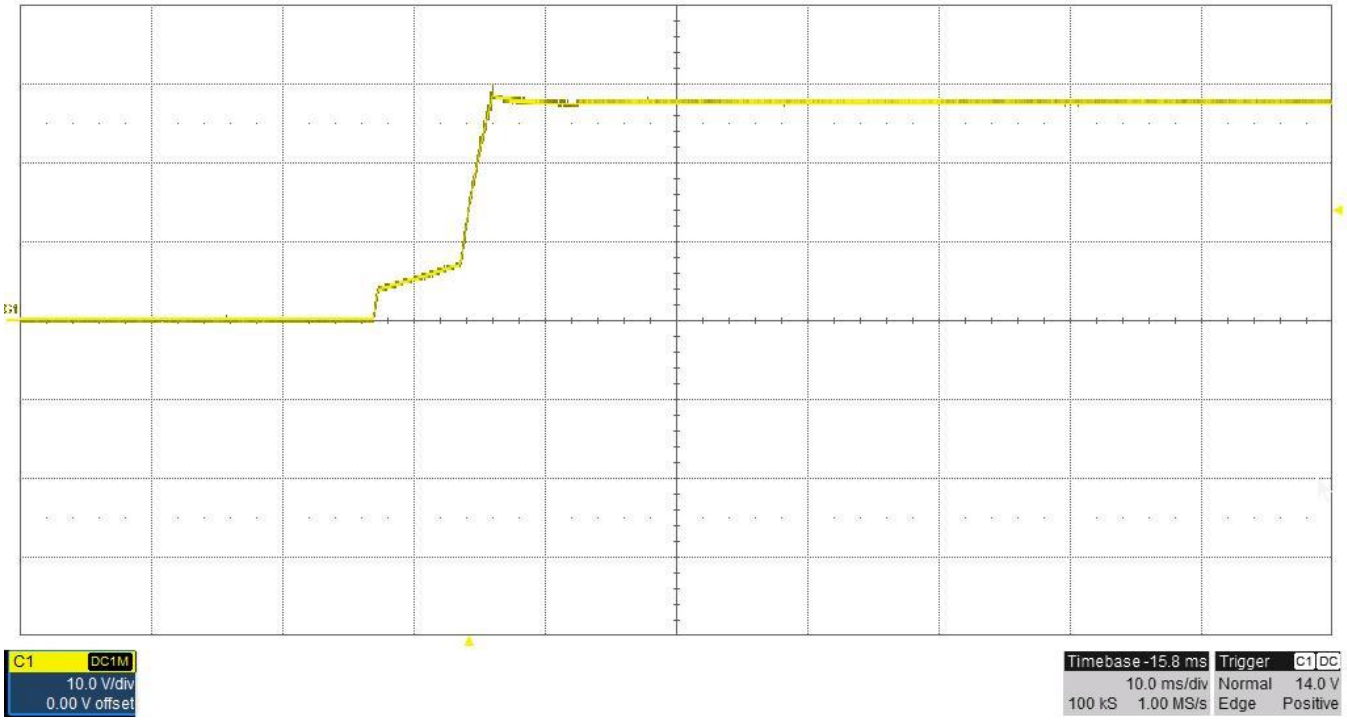


3.4.4 120VAC Input, 3A to 5.5A, 28V Output

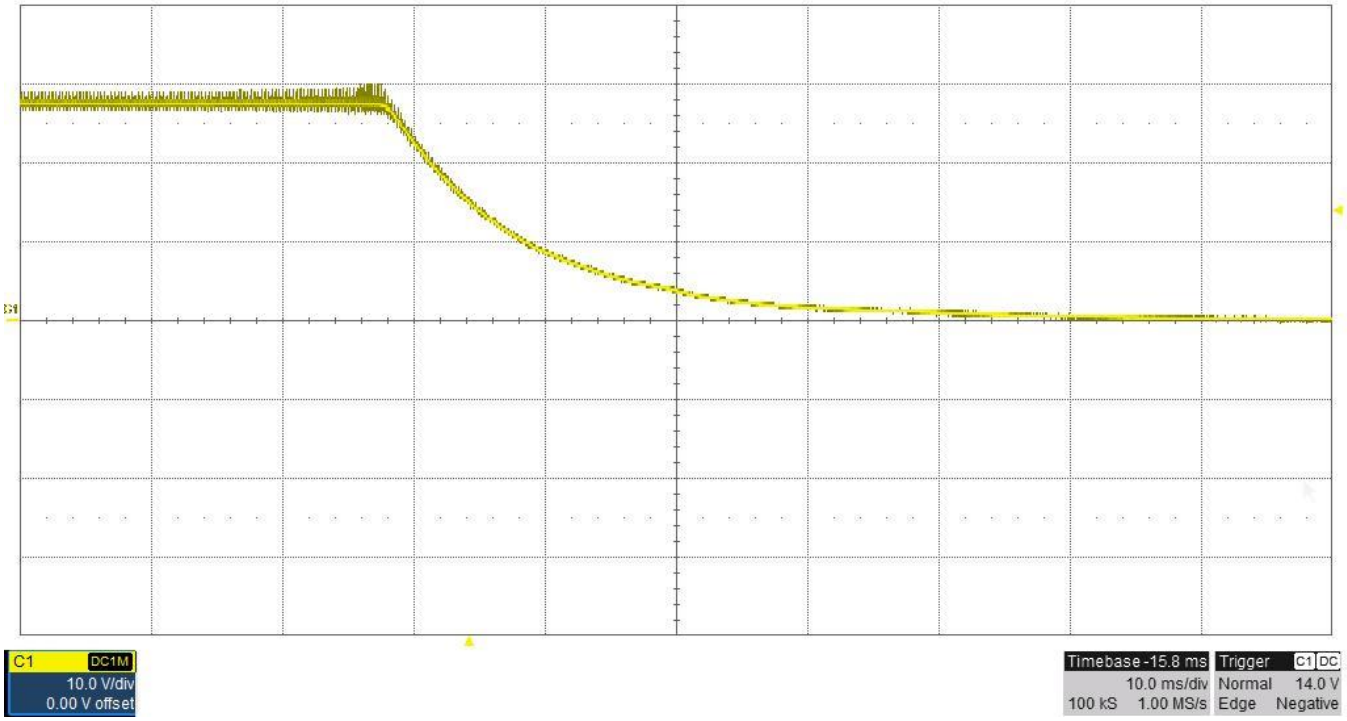


3.5 Start/Stop Sequence

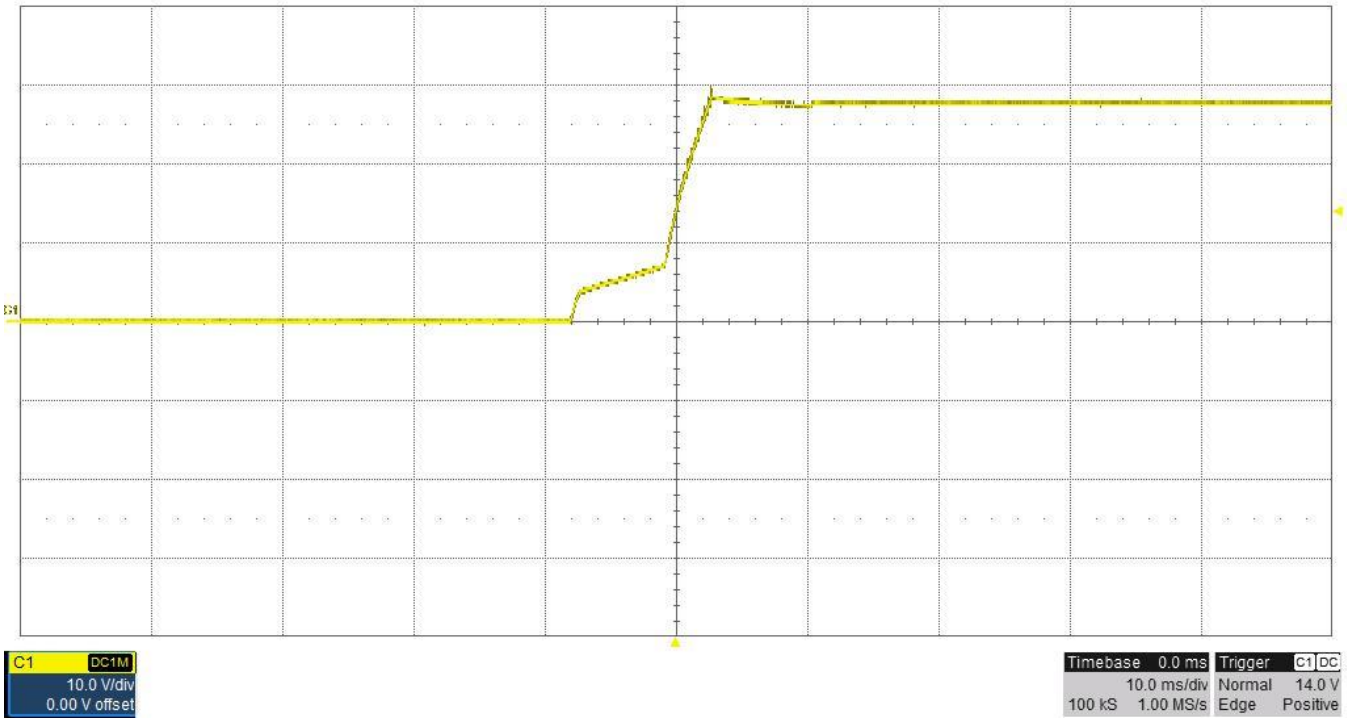
3.5.1 230VAC Input, Start Unloaded



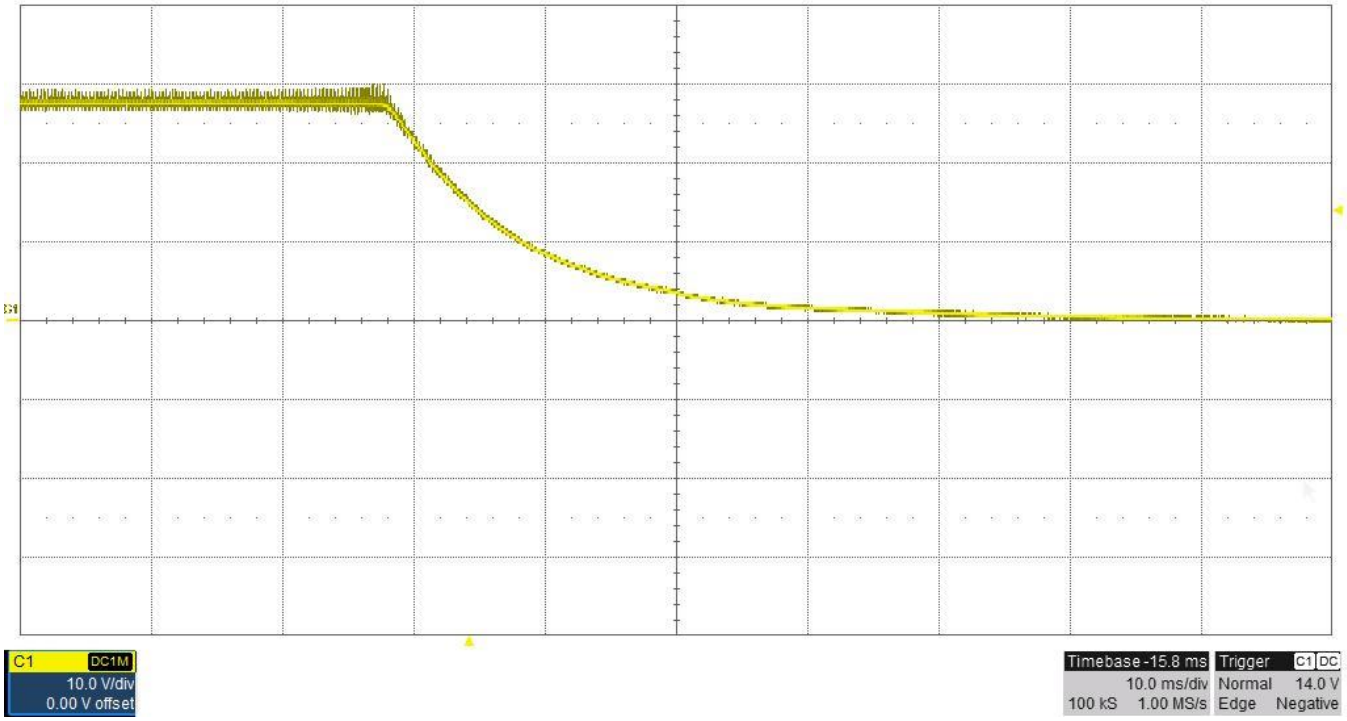
3.5.2 230VAC Input, Stop Full Load



3.5.3 120VAC Input, Start Unloaded

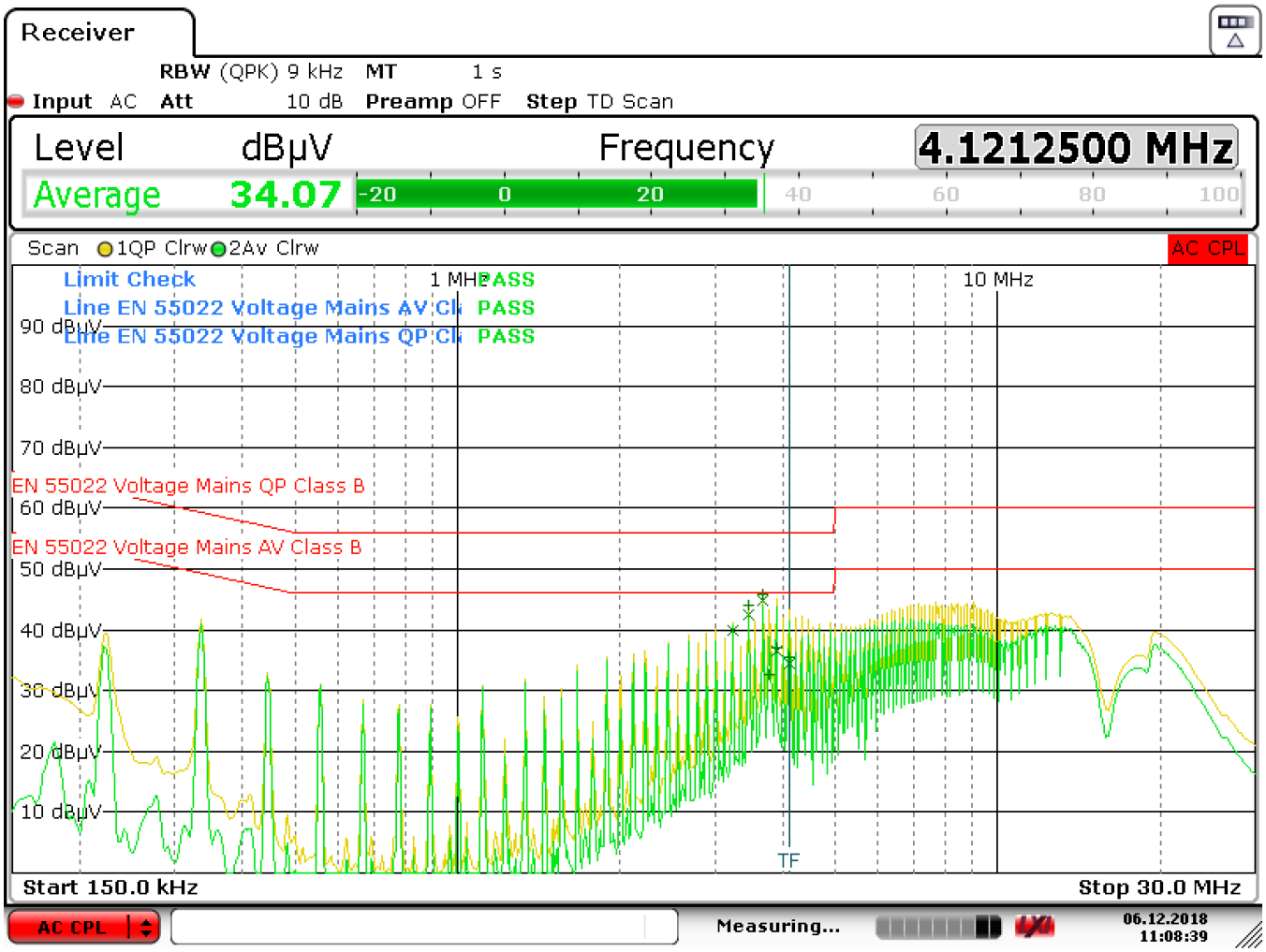


3.5.4 120VAC Input, Stop Full Load



3.6 Conducted EMI

3.6.1 230 VAC/50 Hz Input, Full Load, Earthed Line



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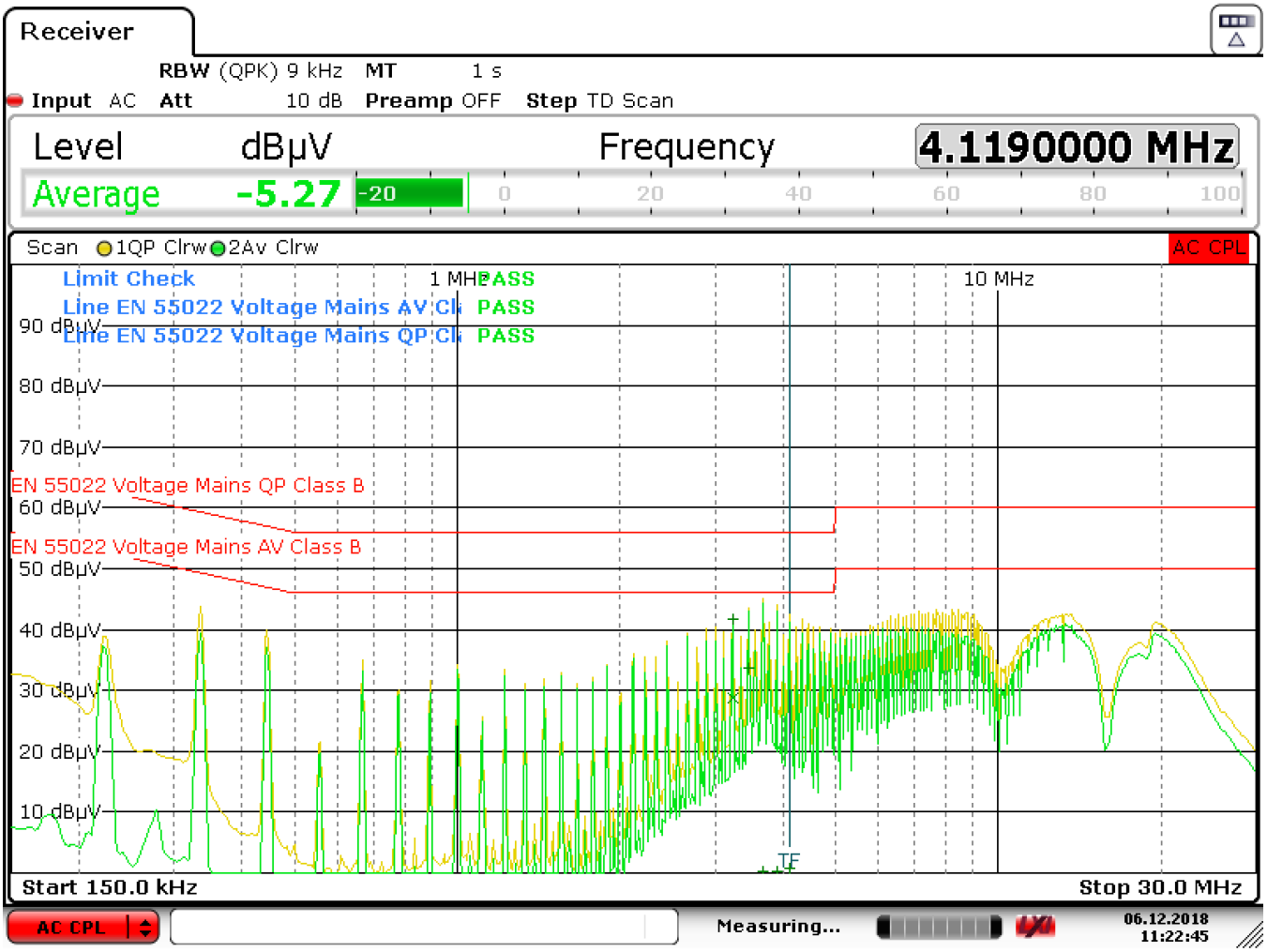
3.6.2 230 VAC/50 Hz Input, Full Load, Earthed Neutral



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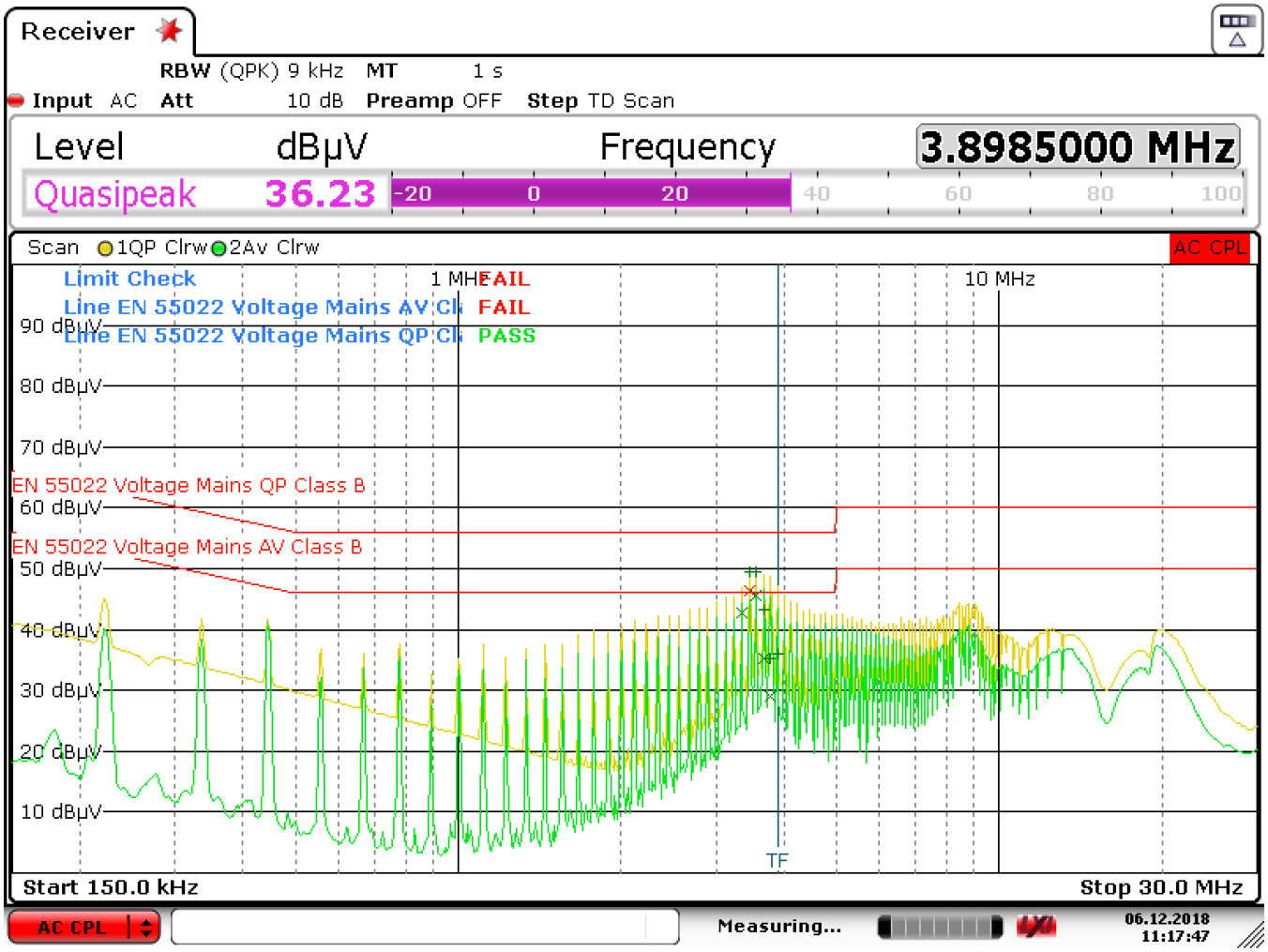
3.6.3 120 VAC/60 Hz Input, Full Load, Earthed Line



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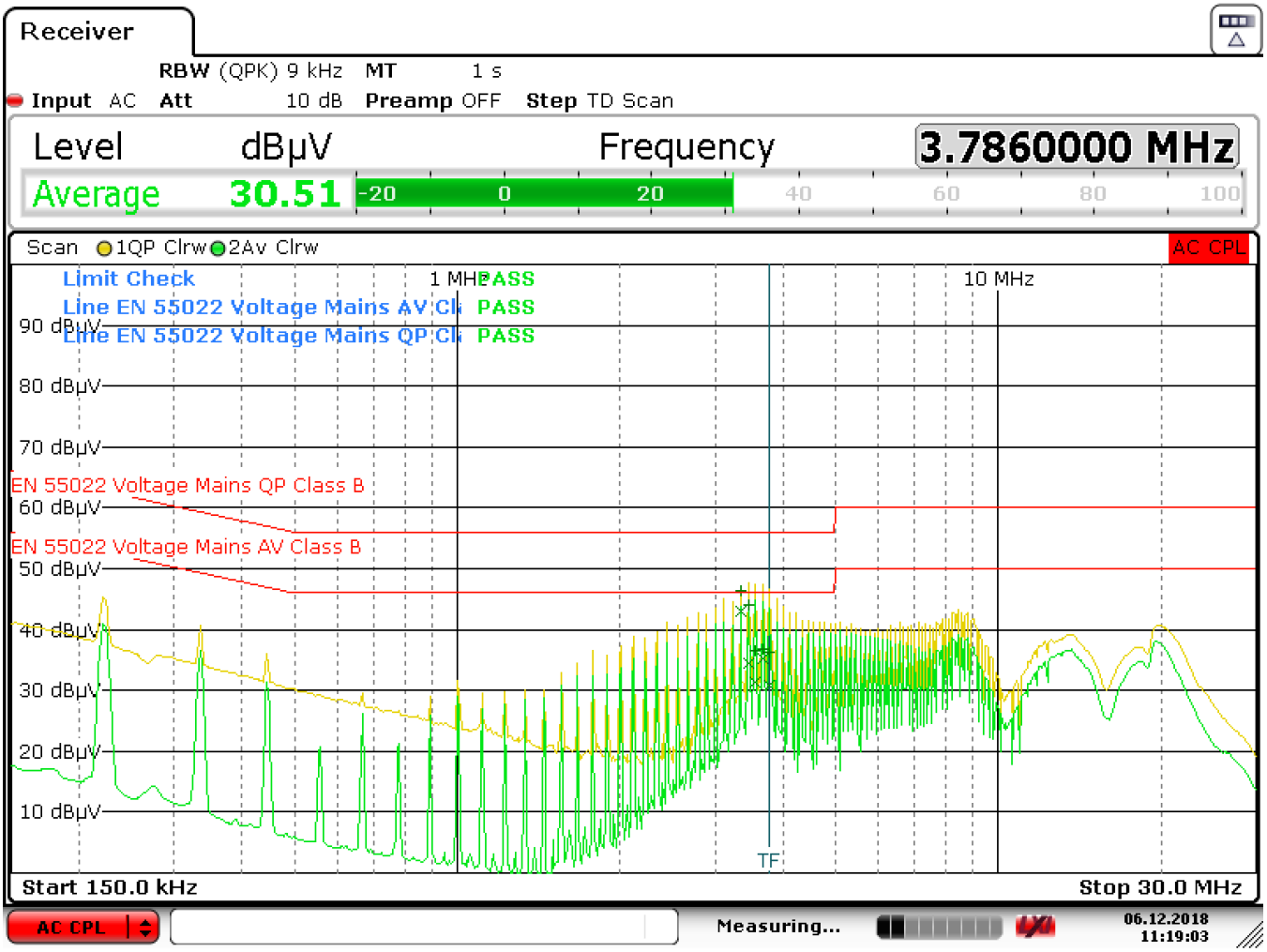
3.6.4 120 VAC/60 Hz Input Full Load, Earthed Neutral



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