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User Guide for
FEBFAN302HL_CH442v1
Evaluation Board

**FAN302HL 5V / 1A PSR Mobile Phone
Battery Charger**

**Featured Fairchild Product:
FAN302HL**

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about this Evaluation Board to:
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1. General Introduction

This document describes a 5W power supply using a FAN302HL device. This power supply is targeted for mobile phone battery chargers with a 10mW solution and requiring high efficiency.

To get the standby power consumption lower than 10mW at 230V_{AC}, the FAN302HL has functions to enhance the standby power consumption, including proprietary Burst Mode with lower operation current under light-load conditions and built-in HV startup circuitry in the IC side to reduce startup resistor power loss.

Using FAN302HL, a charger can be implemented with the few external components and minimized cost.

1.1. General Specification

Specification	Min.	Normal	Max.	Units
Input				
Voltage	90		264	V _{RMS}
Frequency	47		63	Hz
Output				
Output Voltage 1	4.75	5.00	5.25	V
Output Current 1	1.0	1.2	1.4	A
Total Output Power				
Full-Load Output Power	4.75	6.00	7.35	W

2. Function Check Report

Test Model	FEBFAN302HL_CH442v1
Test Date	March 2011
Test Temperature	Ambient
Test Equipment	AC source: 6800 AC POWER SOURCE Electronic Load: Chroma 63030 and 63102 Power Meter: WT210 Oscilloscope: LeCory 24Xs-A
Test Items	<ol style="list-style-type: none"> 1. Input current 2. Input wattage at no-load condition 3. Startup time 4. DC-output rising time 5. Line and load regulation 6. Efficiency 7. Output ripple and noise 8. Step response 9. Over power protection 10. Hold-up time 11. Short-circuit protection 12. Brownout test 13. V_{DD} voltage level

- | | |
|--|---|
| | <ul style="list-style-type: none"> 14. Voltage stress on MOSFET and rectifiers 15. Constant voltage (CV) and constant current (CC) curve 16. VS OVP test 17. OTP test 18. EMI test 19. Surge test 20. ESD test |
|--|---|

2.1. Input Current

2.1.1. Test Condition

Measure the AC input current at maximum loading.

2.1.2. Test Result

Input Voltage	Input Current (mA)	Specification
90V / 60Hz	120.20	
264V / 50Hz	51.57	

2.2. Input Wattage at No-load Condition

2.2.1. Test Condition

Measure the input wattage and output voltage at no load.

2.2.2. Test Result

Input Voltage	Input Wattage (mW)	Output Voltage (V)	Specification
90V / 60Hz	6.3	5.116	<10mW
115V / 60Hz	6.5	5.116	
230V / 50Hz	7.3	5.116	
264V / 50Hz	9.0	5.116	

2.2.3. Measured Waveforms

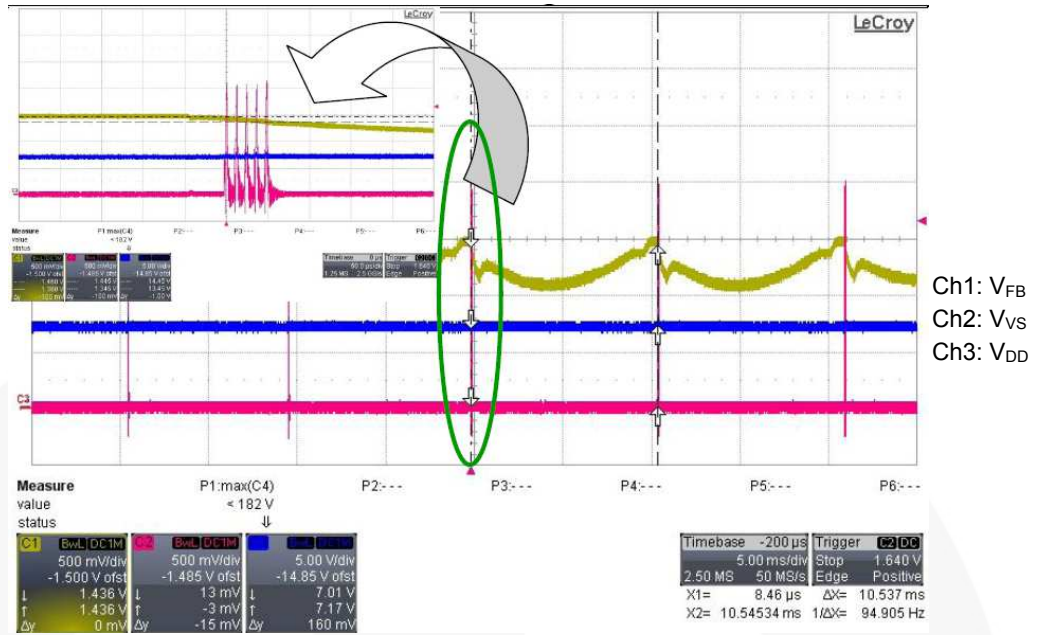


Figure 1. 90V / 60Hz at No Load

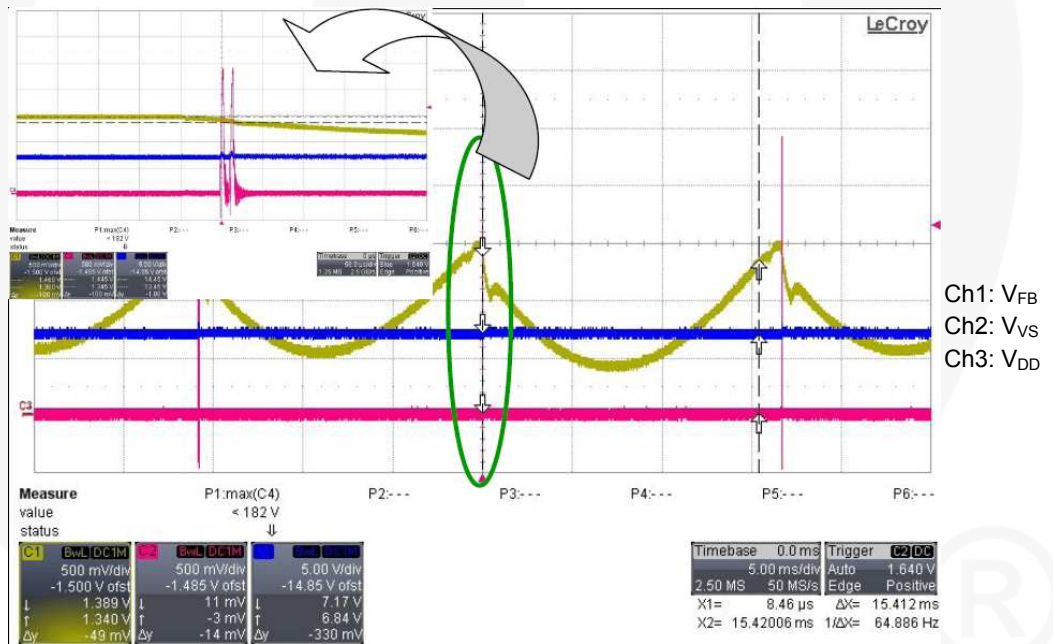


Figure 2. 264V / 50Hz at No Load

2.3. Startup Time

2.3.1. Test Condition

Set output at maximum loading. Measure the interval between AC plug-in and stable output.

2.3.2. Test Result

Input Voltage	Startup Time (ms)	Specification
90V / 60Hz	249	<3s
264V / 50Hz	236	

2.3.3. Measured Waveforms

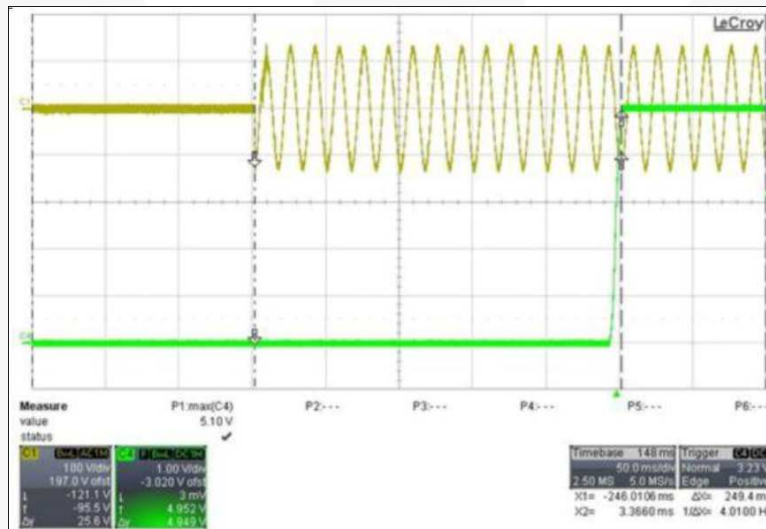


Figure 3. 90V / 60Hz at Maximum Load

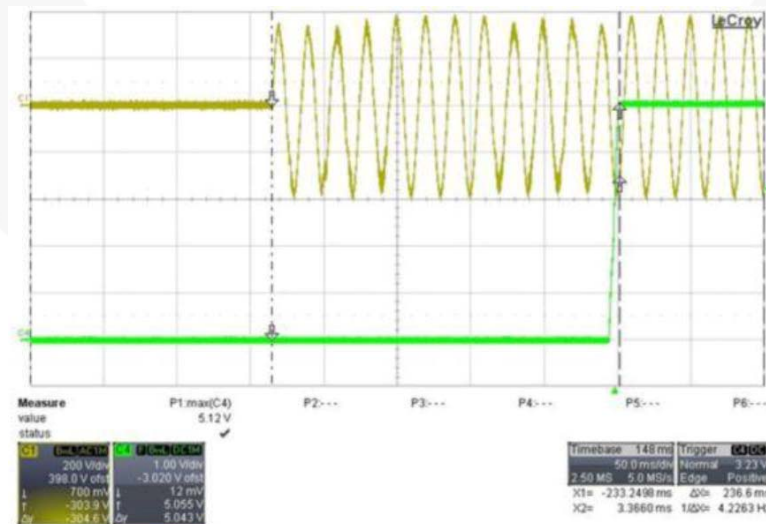


Figure 4. 264V / 50Hz at Maximum Load

2.4. DC Output Rising Time

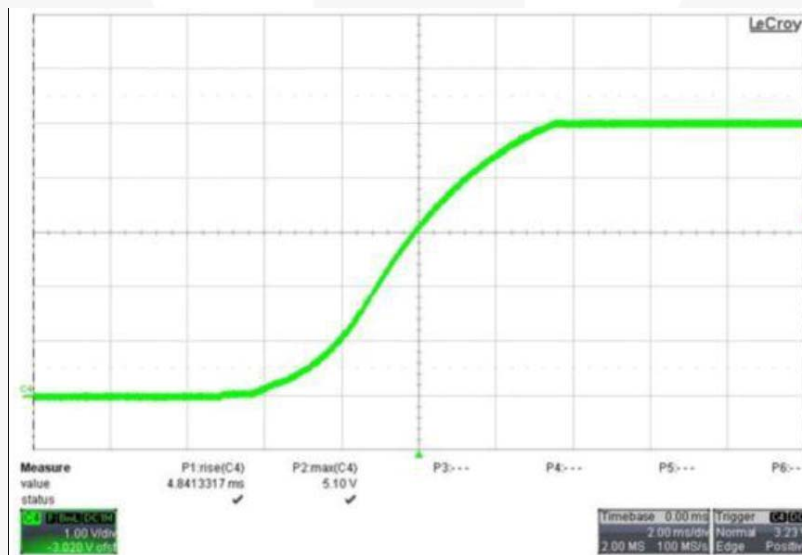
2.4.1. Test Condition

Set output at maximum loading and no loading. Measure the time interval between 10% and 90% output during startup.

2.4.2. Test Result

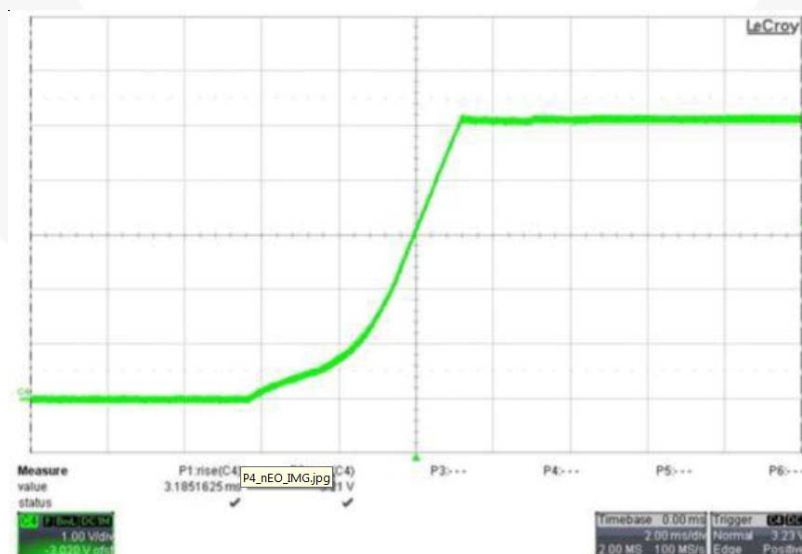
Input Voltage	Maximum Load (ms)	No Load (ms)	Specification
90V / 60Hz	4.841	3.185	<20ms
264V / 50Hz	4.882	3.229	

2.4.3. Measured Waveforms



Ch4: V_O

Figure 5. 90V / 60Hz at Maximum Load



Ch4: V_O

Figure 6. 90V / 60Hz at No Load

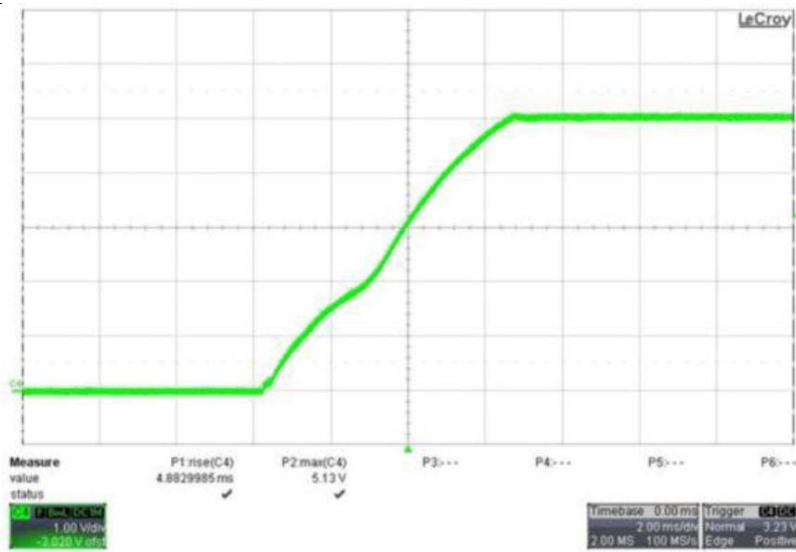


Figure 7. 264V / 50Hz at Maximum Load

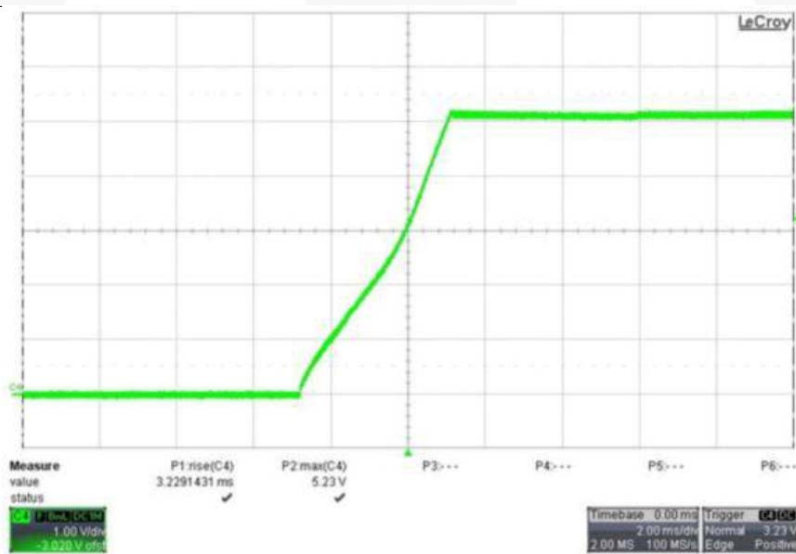


Figure 8. 264V / 50Hz at No Load

2.5. Line and Load Regulation

2.5.1. Test Condition

Measure line and load regulation as shown in the table below.

2.5.2. Test Result

Input Voltage	Output V at Max. Load (V)	Output V at Min. Load (V)	Load Regulation (%)	Specification
90V / 60Hz	4.990	5.116	2.46	
115V / 60Hz	4.994	5.116	2.38	
132V / 60Hz	4.998	5.116	2.31	
180V / 50Hz	5.006	5.112	2.07	
230V / 50Hz	5.018	5.112	1.84	
264V / 50Hz	5.022	5.112	1.76	
Line Regulation(%)	0.64	0.078		

2.6. Efficiency

2.6.1. Test Condition

Measure input wattage and output wattage at maximum load.

2.6.2. Test Result

Input Voltage	Input Wattage (W)	Output Wattage (W)	Efficiency (%)	Specification
90V / 60Hz	6.938	4.980	71.78	
115V / 60Hz	6.808	4.990	73.30	
132V / 60Hz	6.748	4.994	74.01	
180V / 50Hz	6.719	5.006	74.51	
230V / 50Hz	6.743	5.016	74.39	
264V / 50Hz	6.797	5.024	73.91	

2.6.3. Average Efficiency Test Result

Input Voltage	Efficiency(%)					Avg.	Spec.
	25% Load	50% Load	75% Load	100% Load			
115V / 60Hz	76.06%	75.34%	75.45%	73.30%	74.79%	Avg>68.17%	
230V / 50Hz	72.91%	73.52%	74.28%	74.39%	73.78%		

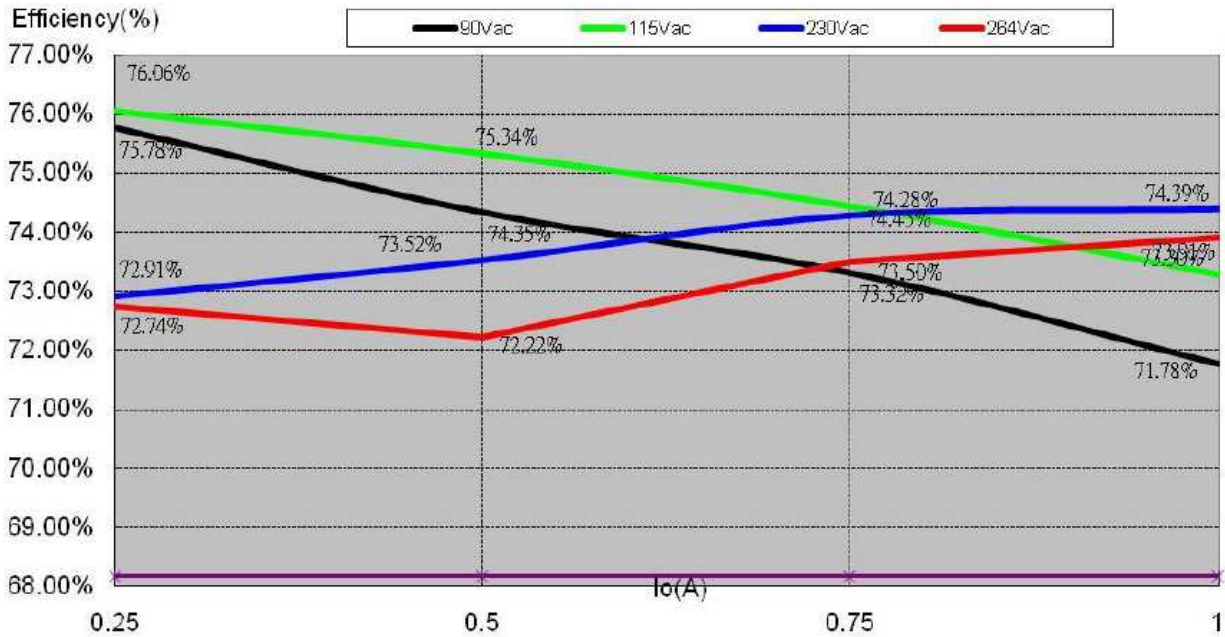


Figure 9. Efficiency Chart

2.7. Output Ripple and Noise

2.7.1. Test Condition

Ripple and noise are measured using a 20MHz bandwidth-limited oscilloscope with a 10 μ F capacitor paralleled with a high-frequency 0.1 μ F capacitor across each output.

2.7.2. Test Result

Input Voltage	Max. Load (mV)	Before Leaving Burst Mode (mV)	Min. Load (mV)	Spec.
90V / 60Hz	38	56	15	<150mV
115V / 60Hz	34	52	16	
230V / 50Hz	33	57	25	
264V / 50Hz	32	65	22	

2.7.3. Measured Waveforms

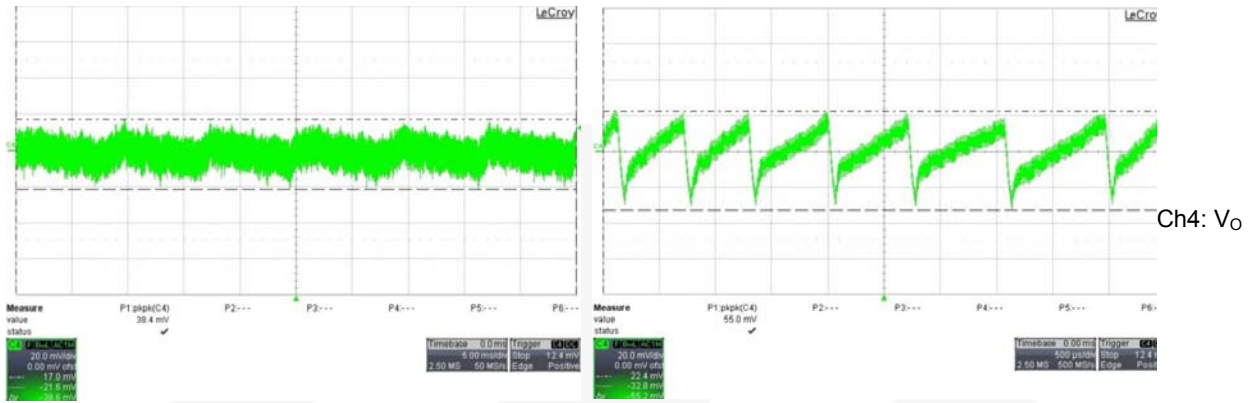


Figure 10. 90V / 60Hz at Maximum Load AC and Burst Ripple

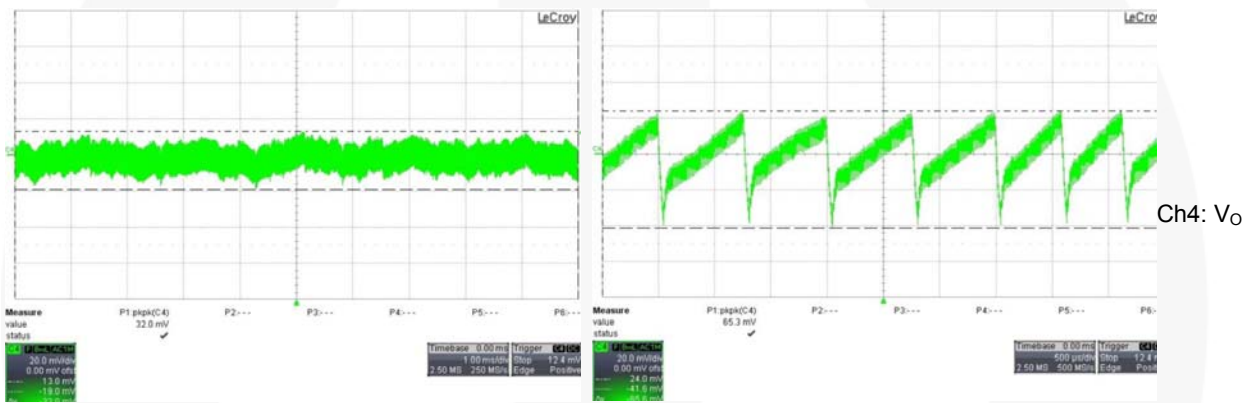


Figure 11. 264V / 50Hz at Maximum Load AC and Burst Ripple

2.8. Step Response

2.8.1. Test Condition

Dynamic loading (20%–80%) of the full load, 5ms duty cycle, 2.5A/ μ s rise/fall time).

2.8.2. Test Result

Input Voltage	Overshoot (mV)	Undershoot (mV)	Specification
115V / 60Hz	105.6	112.0	
230V / 50Hz	93.6	86.4	

2.8.3. Measured Waveforms

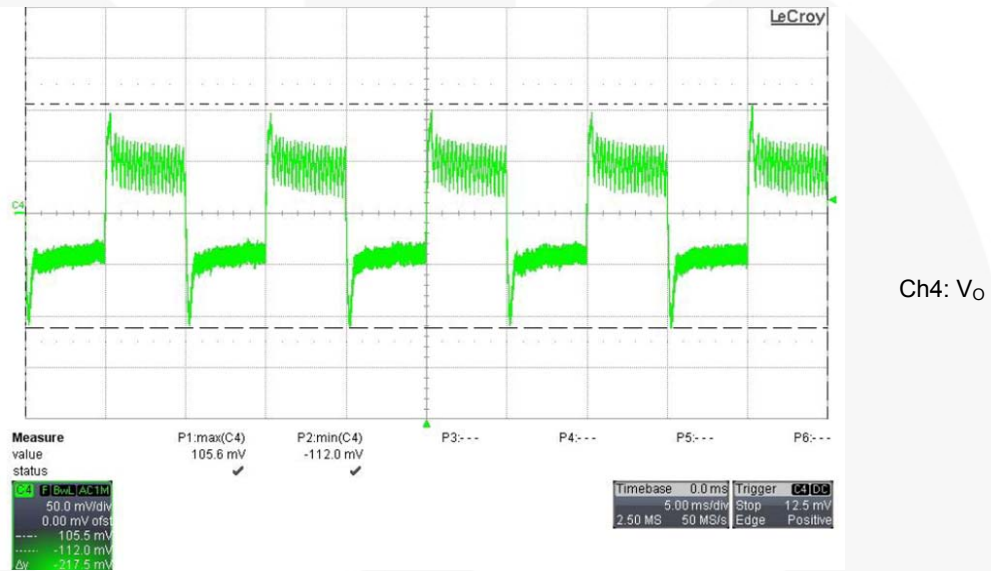


Figure 12. 115V / 60Hz at Step Response

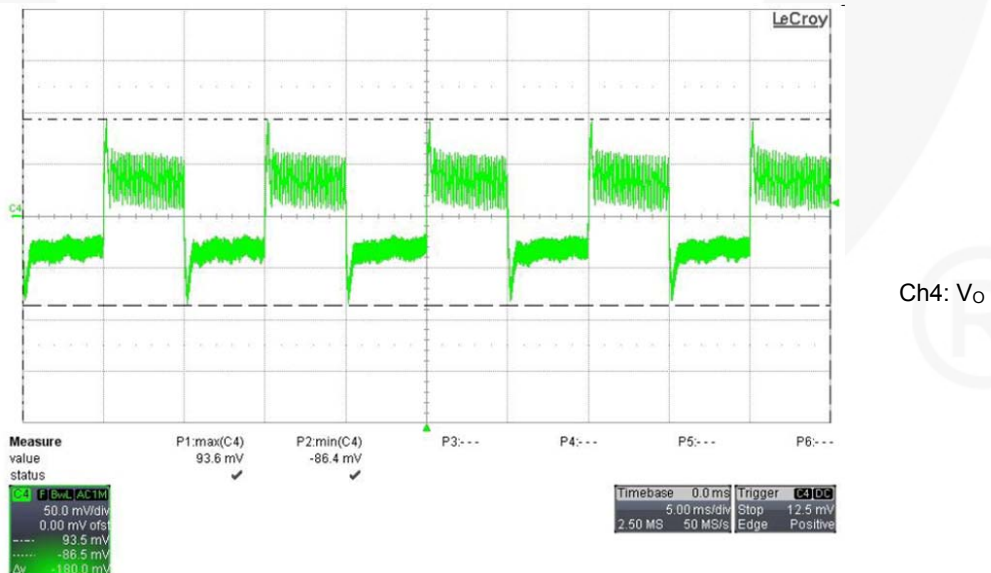


Figure 13. 230V / 50Hz at Step Response

2.9. Over-Power Protection

2.9.1. Test Condition

Increase output loading gradually. Measure the output maximum power.

2.9.2. Test Result

Input Voltage	Output Power (W)	Specification
90V / 60Hz	6.00 (4.932V / 1.216A)	
115V / 60Hz	6.05 (4.952V / 1.224A)	
230V / 50Hz	6.38 (4.958V / 1.290A)	
264V / 50Hz	6.40 (4.976V / 1.293A)	

2.10. Hold-up Time

2.10.1. Test Condition

Set output at maximum load. Measure the time interval between AC off and output voltage falling to the lower limit of the rated value. The AC waveform should be off at zero degrees.

2.10.2. Test Result

Input Voltage	Hold-up Time (ms)	Specification
90V / 60Hz	11.84	
115V / 60Hz	26.06	
230V / 50Hz	108.7	
264V / 50Hz	149.5	

2.10.3. Measured Waveforms

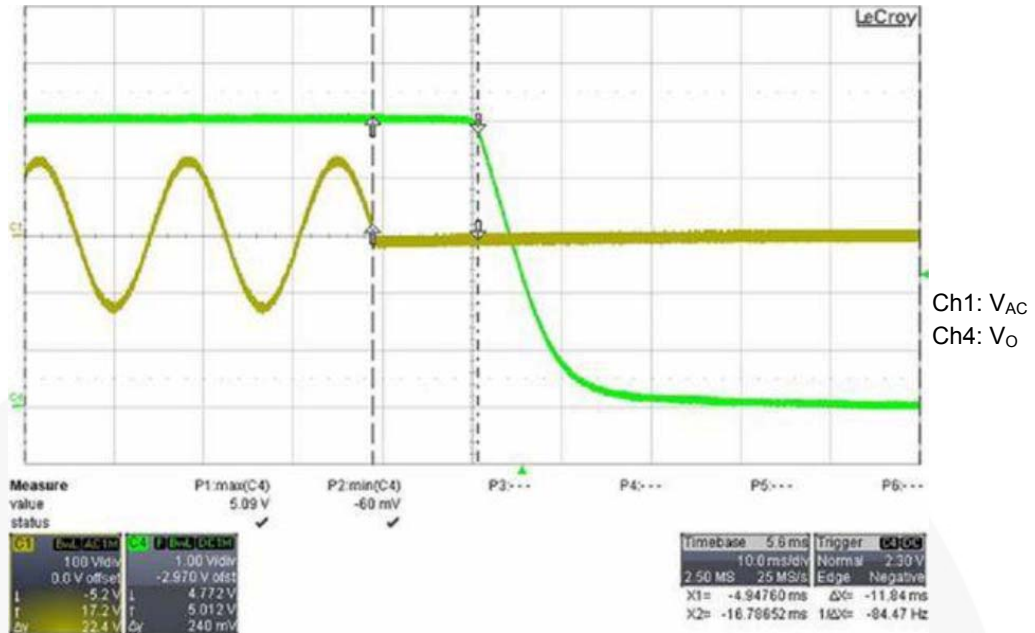


Figure 14. 90V / 60Hz at Maximum Load

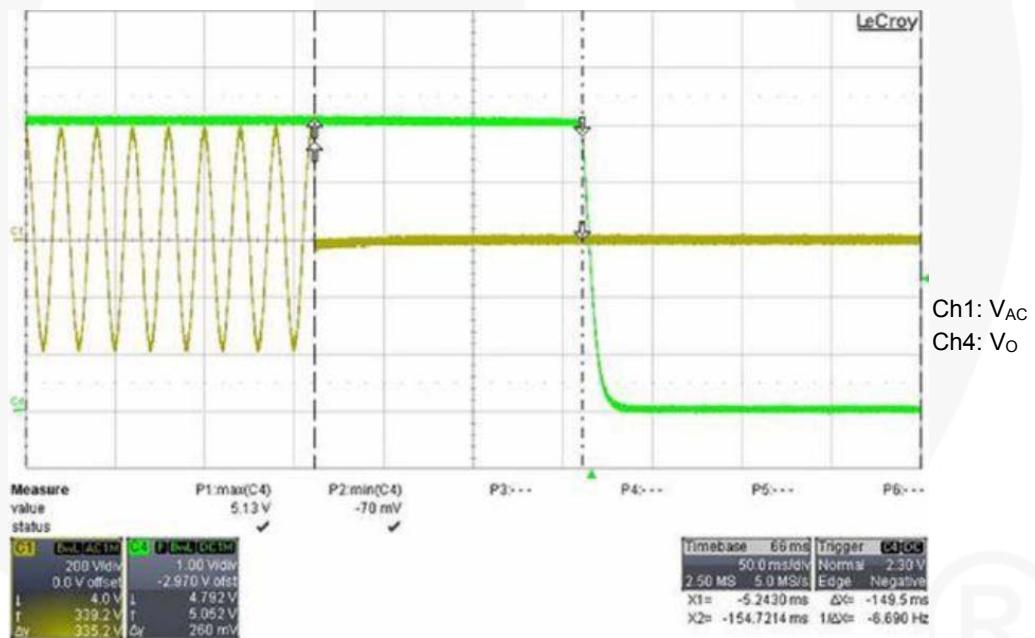


Figure 15. 264V / 50Hz at Maximum Load

2.11. Short-Circuit Protection

2.11.1. Test Condition

Short the output of the power supply. The power supply should enter “Hiccup” Mode protection with less than 2W input voltage.

2.11.2. Test Result

Input Voltage	Input Wattage at Maximum Loading (W)	Input Wattage at Minimum Loading (W)	Specification
90V / 60Hz	0.468	0.465	<2W
264V / 50Hz	0.93	0.95	

2.11.3. Measured Waveforms

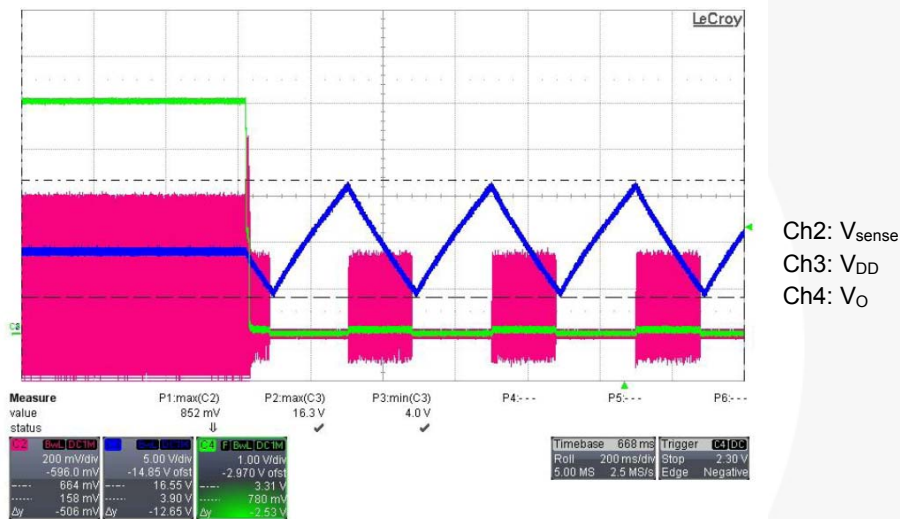


Figure 16. 90V / 60Hz at Maximum Load Short

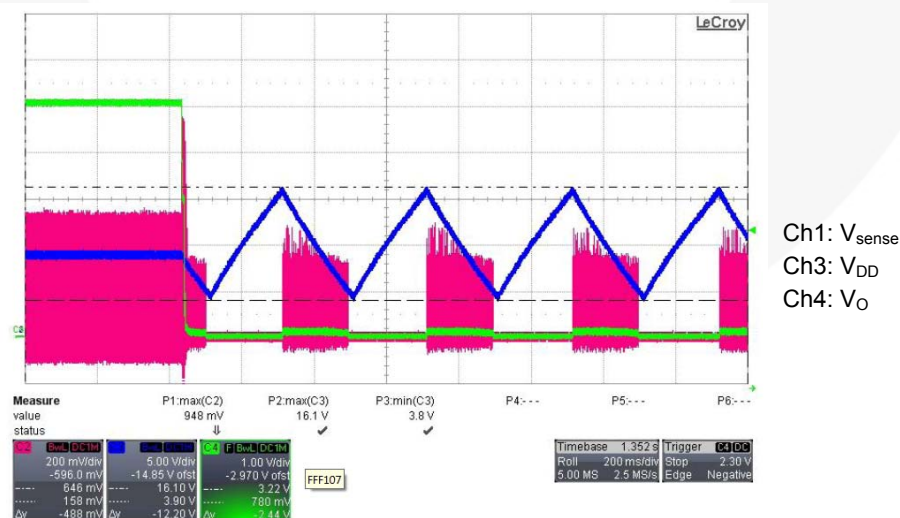


Figure 17. 264V / 60Hz at Maximum Load

2.12. Brownout Test

2.12.1. Test Condition

Set output at maximum loading. Decrease input voltage with 5V_{AC} step. Record input wattage and output voltage. After the output is off, increase the AC voltage gradually and record the recovery voltage.

2.12.2. Test Result

Input Voltage	Input Wattage (W)	Output Voltage (V)
90V / 60Hz	6.936	4.988
85V / 60Hz	6.962	4.978
80V / 60Hz	7.015	4.976
75V / 60Hz	7.076	4.972
70V / 60Hz	7.174	4.970
65V / 60Hz	7.290	4.966
60V / 60Hz	7.476	4.956
55V / 60Hz	7.413	4.870
50V / 60Hz	7.027	4.666
45V / 60Hz	6.501	4.420
40V / 60Hz	5.793	4.112
35V / 60Hz	4.677	3.642
30V / 60Hz	3.744	3.172
25V / 60Hz	0	0

Recovery Voltage	Input Wattage (W)	Output Voltage (V)
53V / 60Hz	7.331	4.822 / 0.967A
70V / 60Hz	7.162	4.974 / 1.00A

2.13. V_{DD} Voltage Level

2.13.1. Test Result

	Min. Load (V)	Max. Load (V)	Near OPP (V)	Output SC (Max. Value) (V)	Spec.
90V / 60Hz	7.110	8.819	8.829	16.30	<24V
264V / 50Hz	7.830	8.772	8.826	16.10	

2.13.2. Measured Waveforms

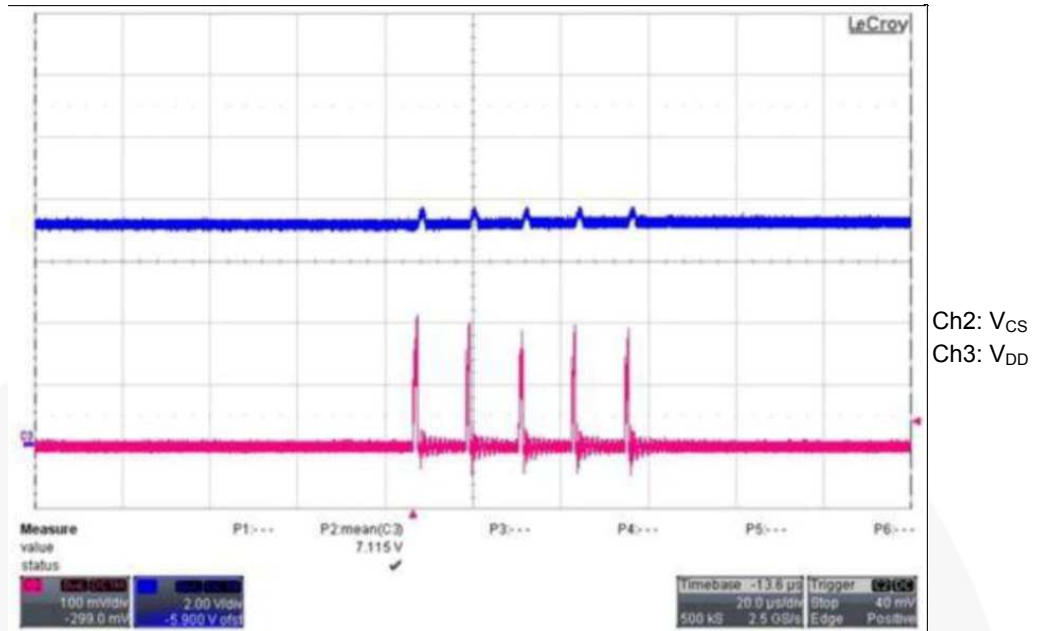


Figure 18. 90V / 60Hz at No Load

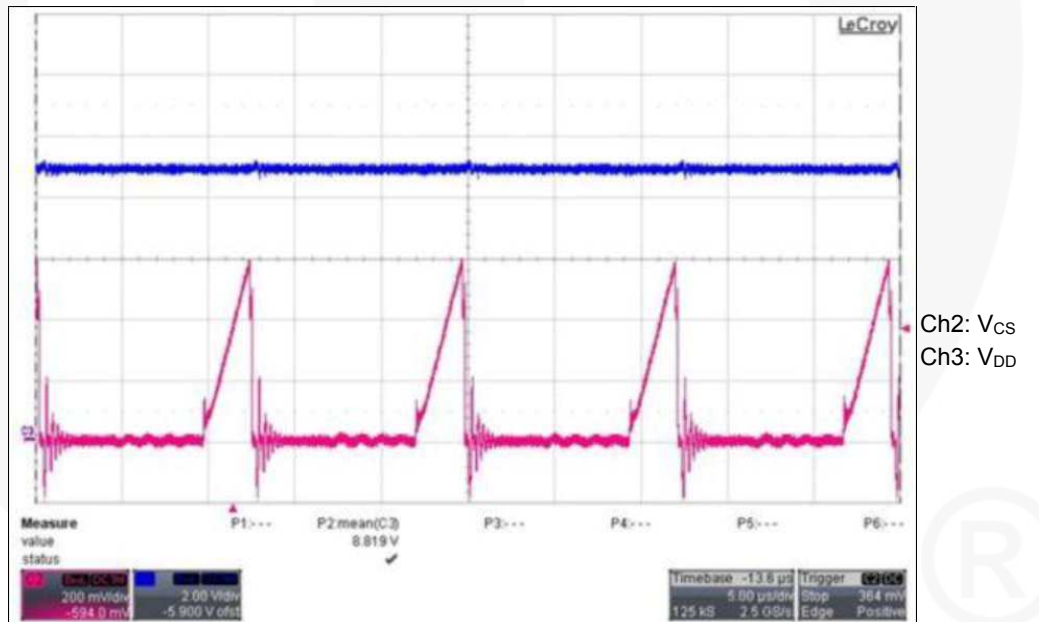


Figure 19. 90V / 60Hz at Maximum Load

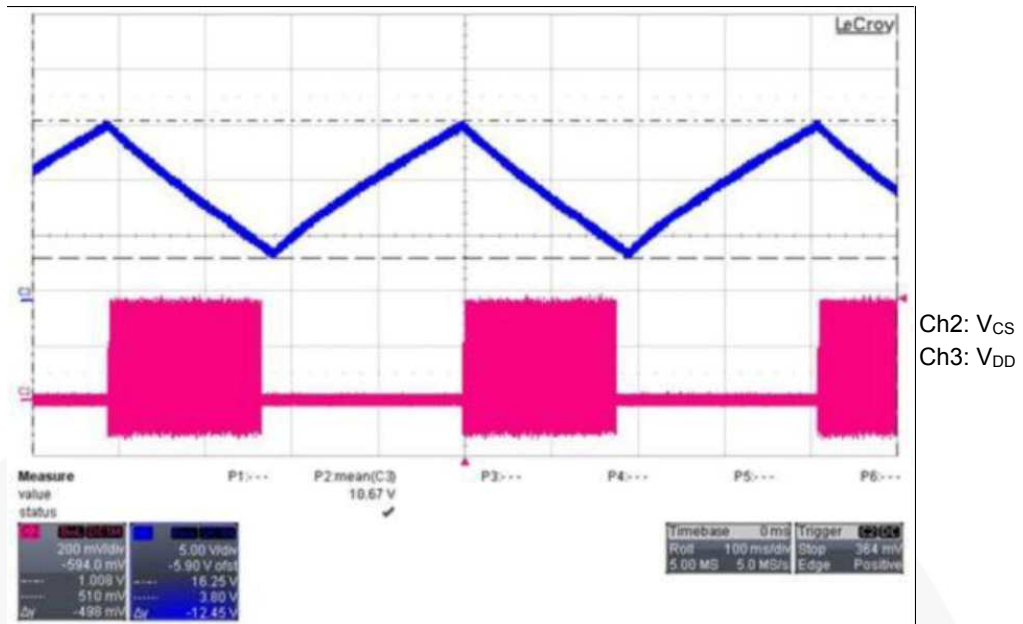


Figure 20. 90V / 60Hz at Short Circuit

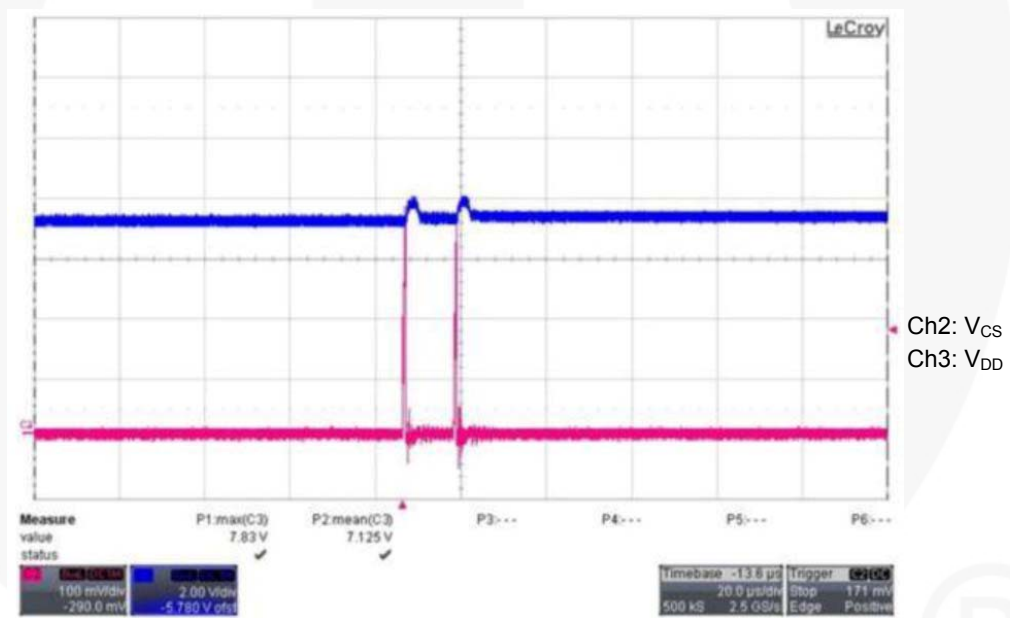


Figure 21. 264V / 50Hz at No Load

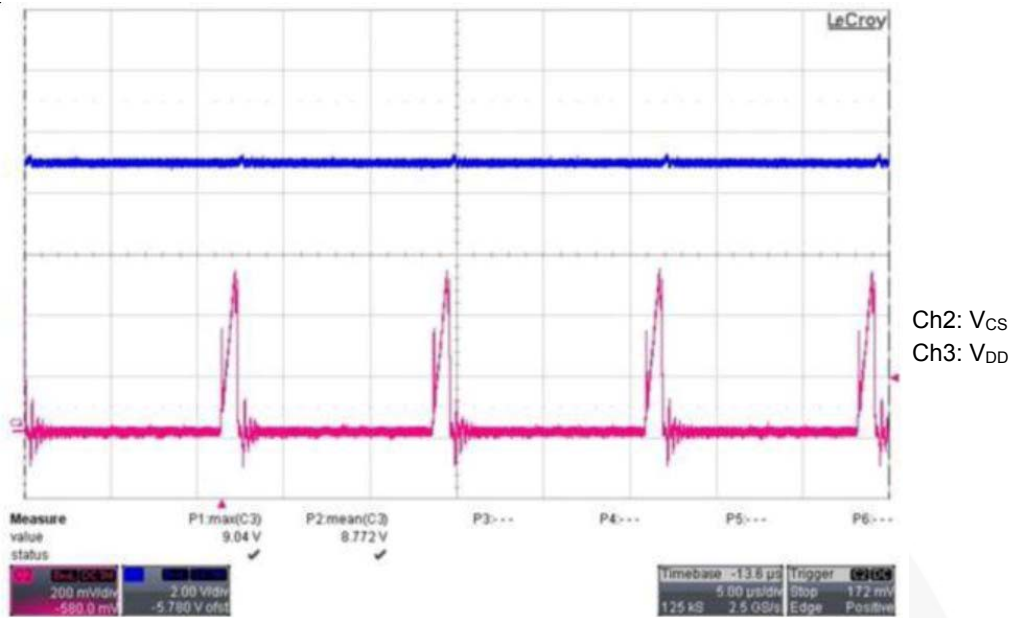


Figure 22. 264V / 50Hz at Maximum Load

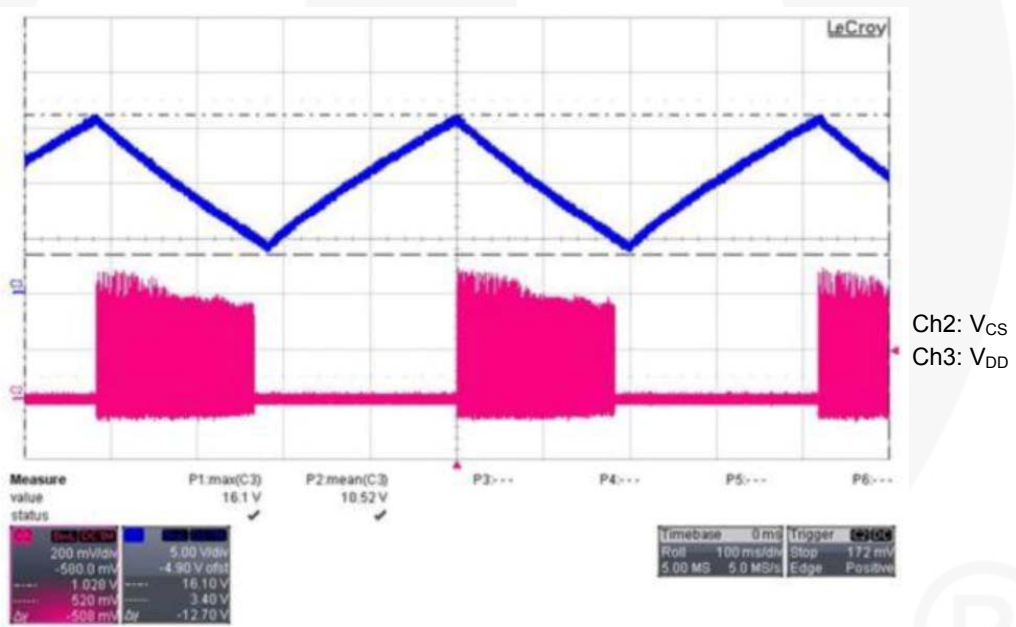


Figure 23. 264V / 50Hz at Short Circuit

2.14. Voltage Stress on MOSFET and Rectifiers

2.14.1. Test Condition

Measure the voltage stress on MOSFET and secondary rectifiers under conditions specified in Table 2.

2.14.2. Test Result

Condition	Stress on MOSFET	Rating	Stress on Output Rectifier	Rating
90V / 60Hz, Max. Load	378V	650V	16.2V	40V
90V / 60Hz, Max. Load, Startup	390V		17.1V	
90V / 60Hz, Max. Load, Output Short	384V		16.5V	
264V / 50Hz, Max. Load	614V		37.2V	
264V / 50Hz, Max. Load, Startup	634V		39.1V	
264V / 50Hz, Max. Load, Output Short	627V		37.8V	
264V / 50Hz, Max. Load Turns Off	621V		37.8V	

2.14.3. Measured Waveforms

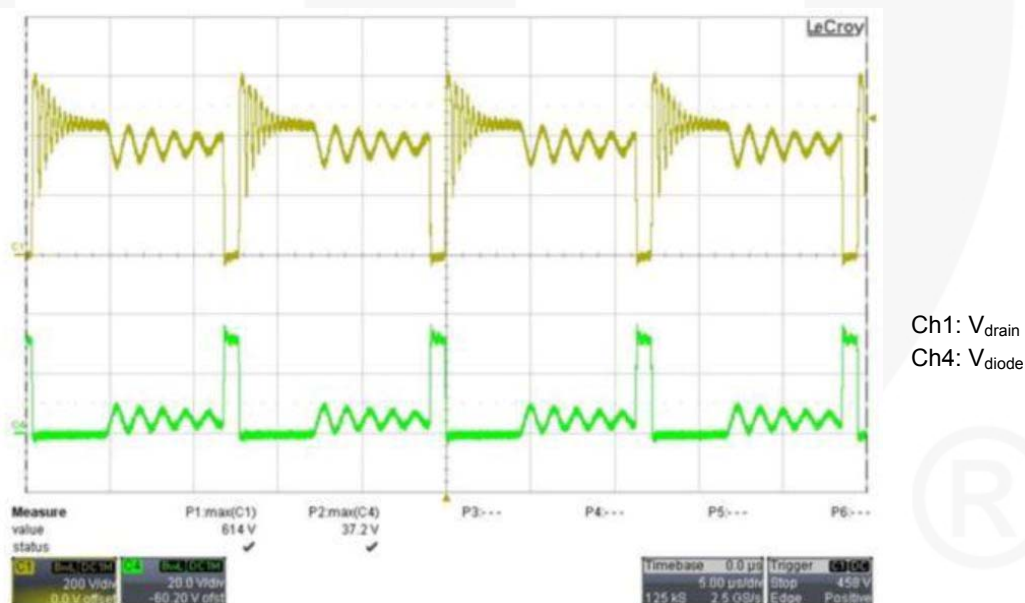
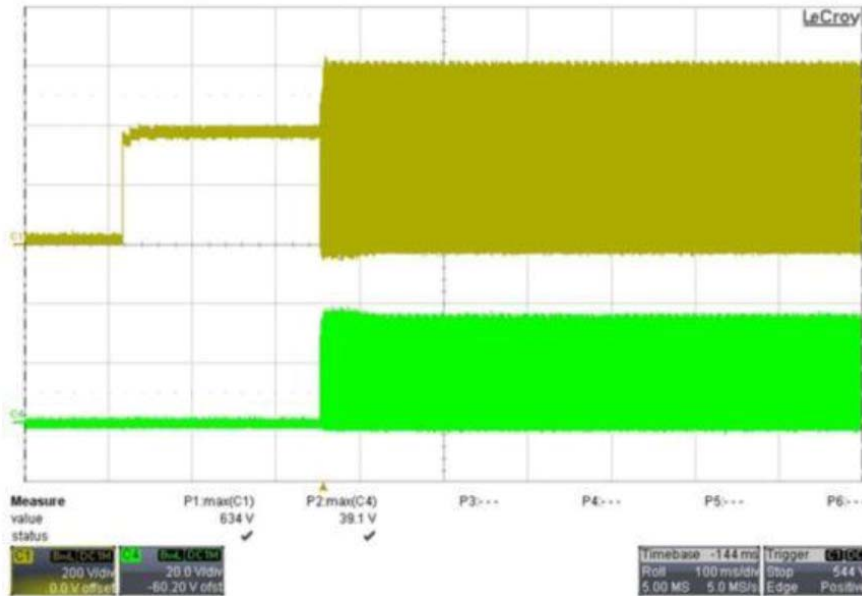


Figure 24. 264V / 50Hz at Maximum Load



Ch1: V_{drain}
Ch4: V_{diode}

Figure 25. 264V / 50Hz at Maximum Load Startup

2.15. Constant Voltage (CV) and Constant Current (CC) Curves

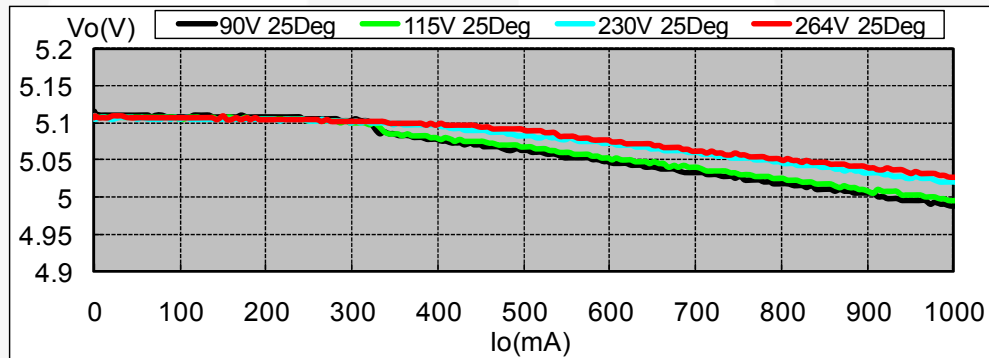


Figure 26. Constant Voltage Curve

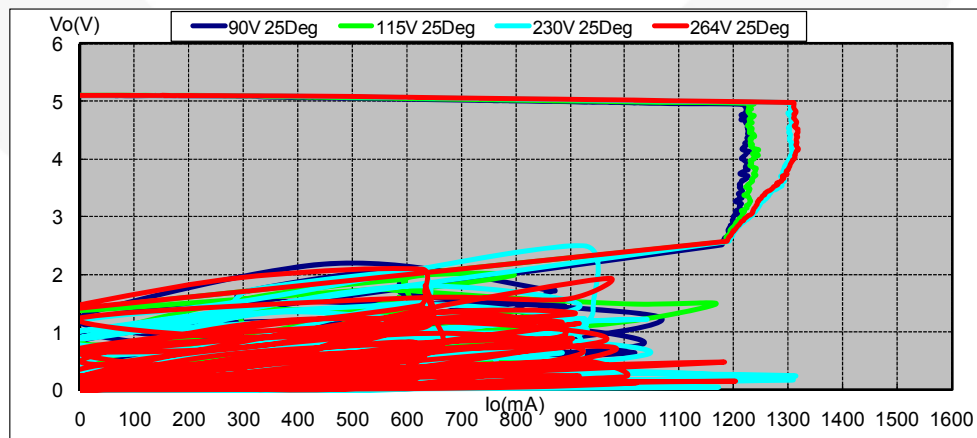


Figure 27. Constant Current Curve

2.16. V_S OVP Test

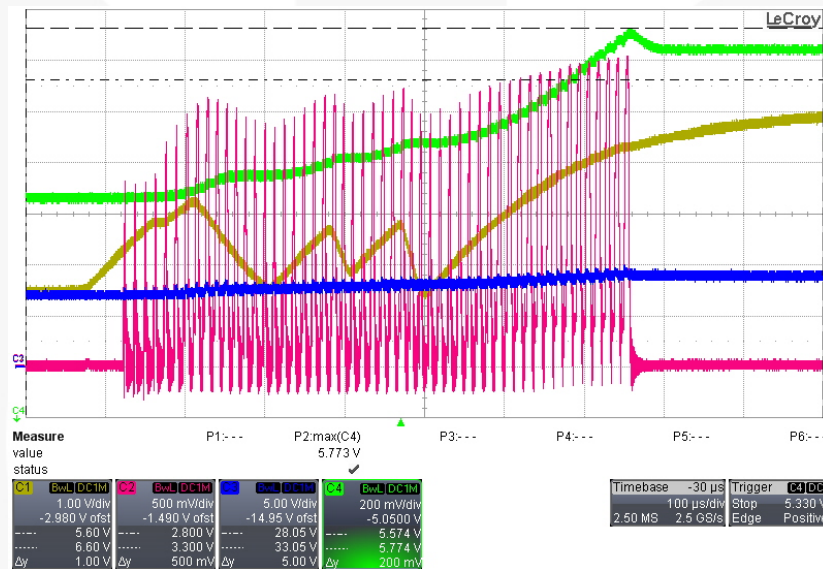
2.16.1. Test Condition

Measure the maximum output voltage when the secondary side feedback signal is disabled.

2.16.2. Test Result

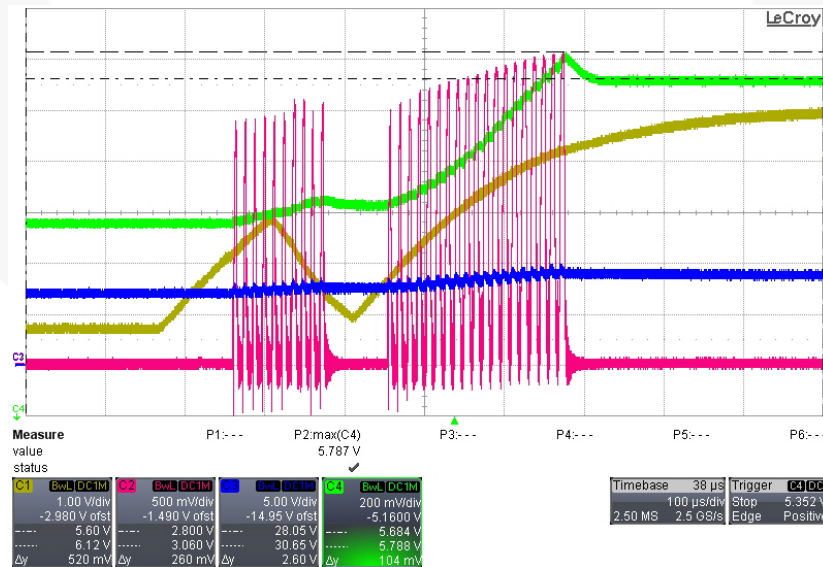
AC Line/ Loading	90V _{AC} Max. Load	90V _{AC} Min. Load	264V _{AC} Max. Load	264V _{AC} Min. Load
Max. V_O (V)	5.501V	5.773V	5.564V	5.787V

2.16.3. Measured Waveforms



CH1: V_{FB}
CH2: V_{VS}
CH3: V_{DD}
CH4: V_O

Figure 28. 90V_{AC} Minimum Load



CH1: V_{FB}
CH2: V_{VS}
CH3: V_{DD}
CH4: V_O

Figure 29. 264V_{AC} Minimum Load

2.17. Over-Temperature Protection Test (OTP)

2.17.1. Test Condition

Measure the output voltage and Gate when the IC temperature exceeds 140°C.

2.17.2. Test Result

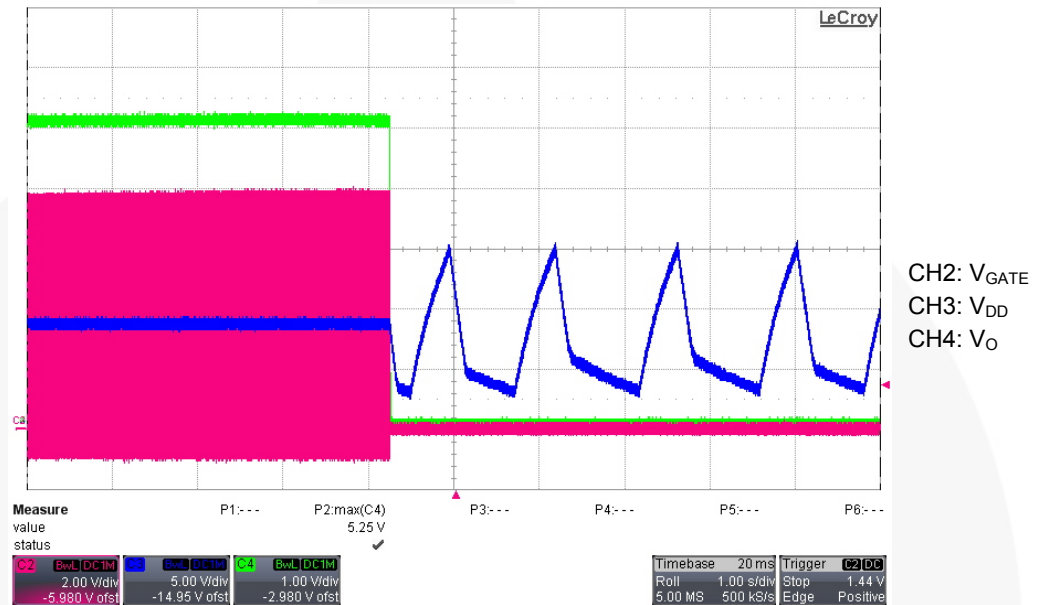


Figure 30. 90V_{AC} Maximum Load

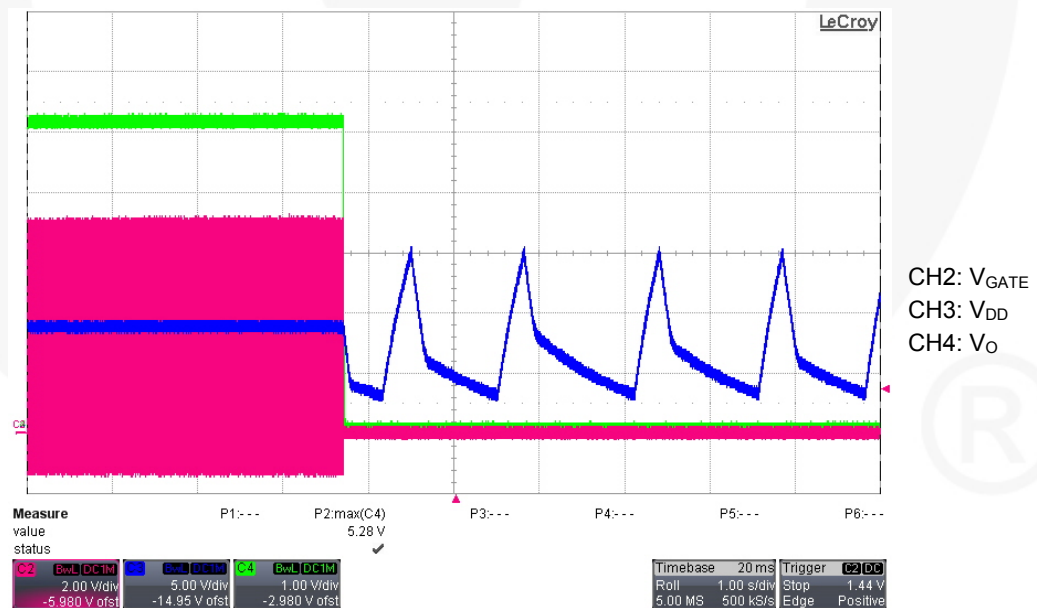
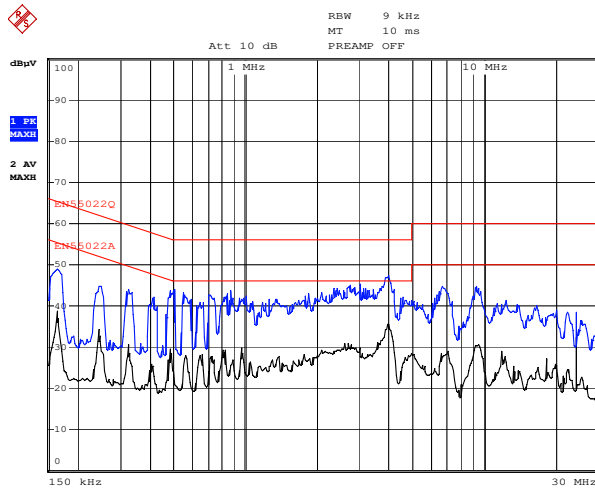


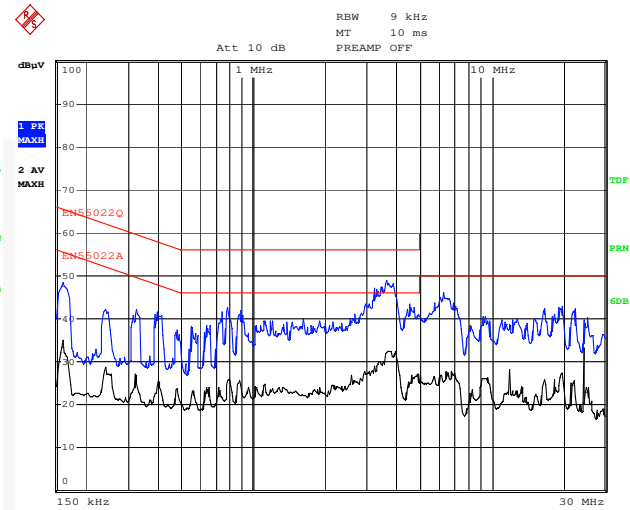
Figure 31. 264V_{AC} Maximum Load

2.18. EMI Test



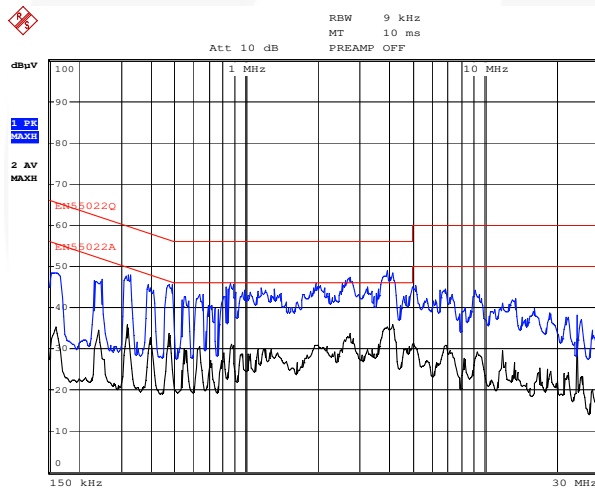
Date: 16.NOV.2010 20:12:04

Line at 115V_{AC}



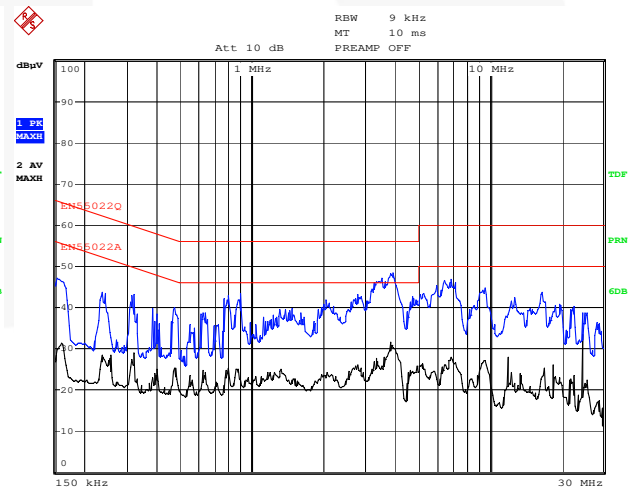
Date: 16.NOV.2010 20:14:04

Neutral at 115V_{AC}



Date: 16.NOV.2010 20:15:52

Line at 230V_{AC}



Date: 16.NOV.2010 20:17:41

Neutral at 230V_{AC}

Figure 32. Conduction EMI — Line and Neutral

2.19. Surge Test

Mode	Polarity	Phase	Voltage	Condition
L-PE	+/-	0°	4.4KV	PASS
	+/-	90°		PASS
	+/-	180°		PASS
	+/-	270°		PASS
N-PE	+/-	0°	4.4KV	PASS
	+/-	90°		PASS
	+/-	180°		PASS
	+/-	270°		PASS

2.20. ESD Test

Air Discharge (+/-16.5KV)		Contact Discharge (+/-8.8KV)	
PASS	PASS	PASS	PASS