User Guide for

FEBFAN302HL_CH442v1

Evaluation Board

FAN302HL 5V / 1A PSR Mobile Phone Battery Charger

Featured Fairchild Product:

FAN302HL

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Fairchild Semiconductor.com

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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	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

	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

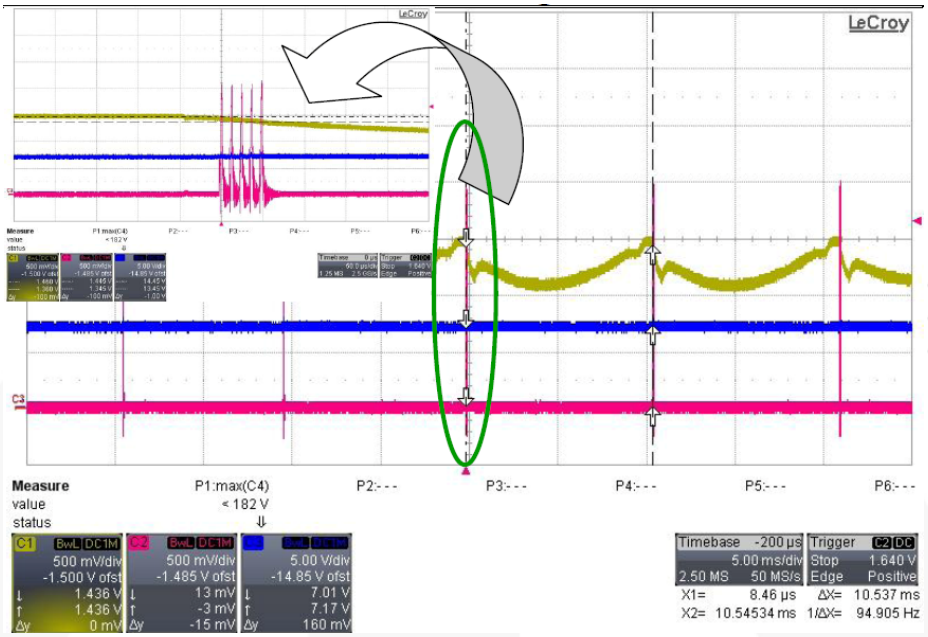


Figure 1. 90V / 60Hz at No Load

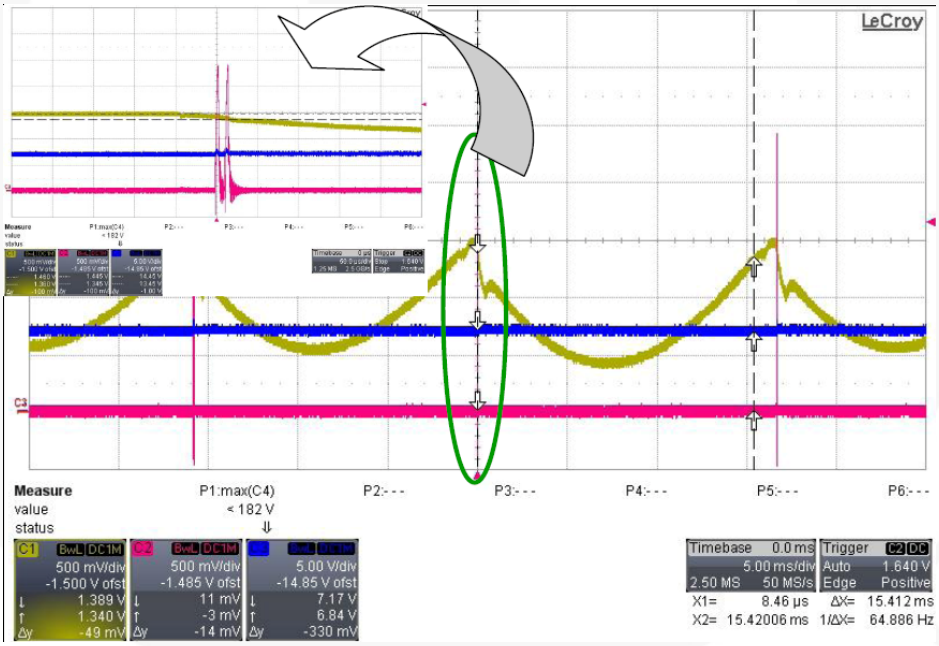


Figure 2. 264V / 50Hz at No Load

2.3. Startup Time

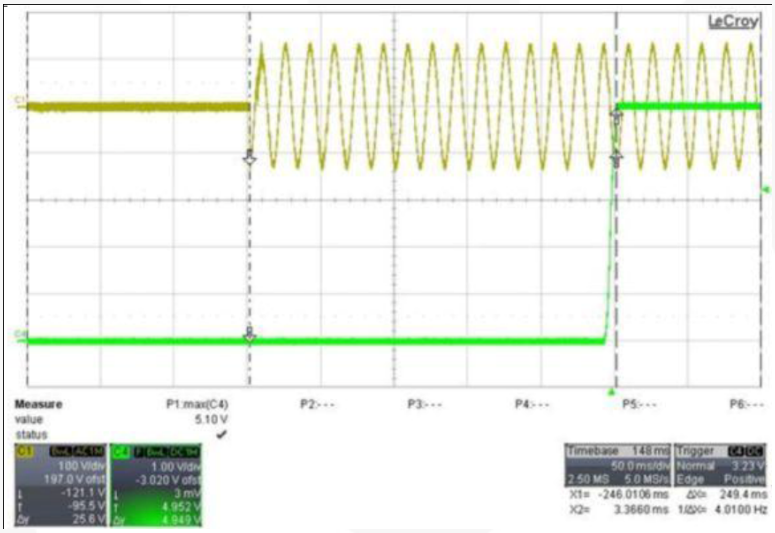
2.3.1. Test Condition

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

2.3.2. Test Result

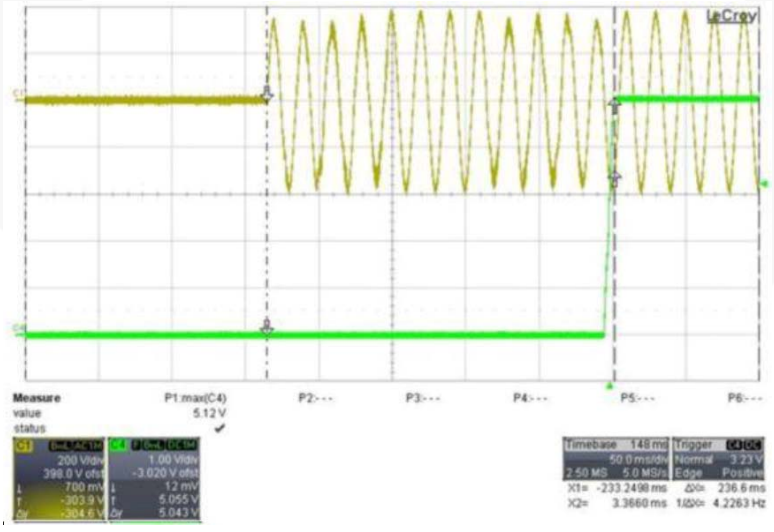
Input Voltage	Startup Time (ms)	Specification
90V / 60Hz	249	<3s
264V / 50Hz	236	

2.3.3. Measured Waveforms



Ch1: V_{AC}
Ch4: V_O

Figure 3. 90V / 60Hz at Maximum Load



Ch1: V_{AC}
Ch4: V_O

Figure 4. 264V / 50Hz at Maximum Load

2.4. DC Output Rising Time

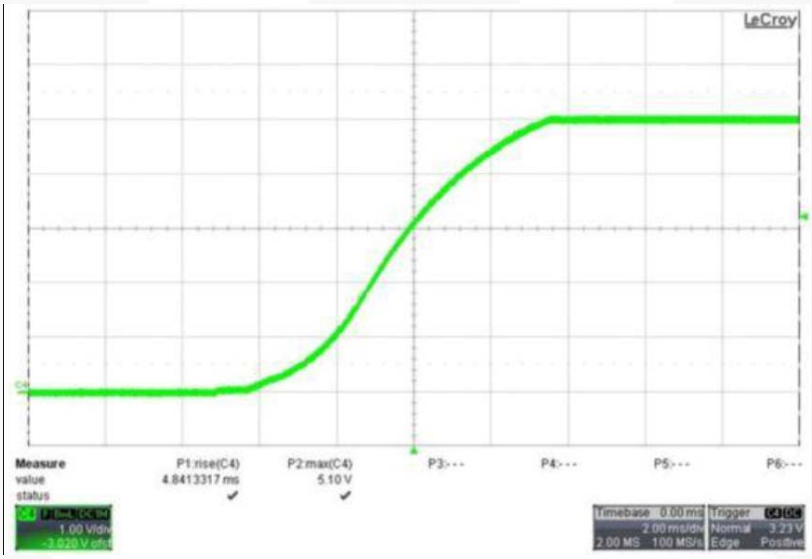
2.4.1. Test Condition

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

2.4.2. Test Result

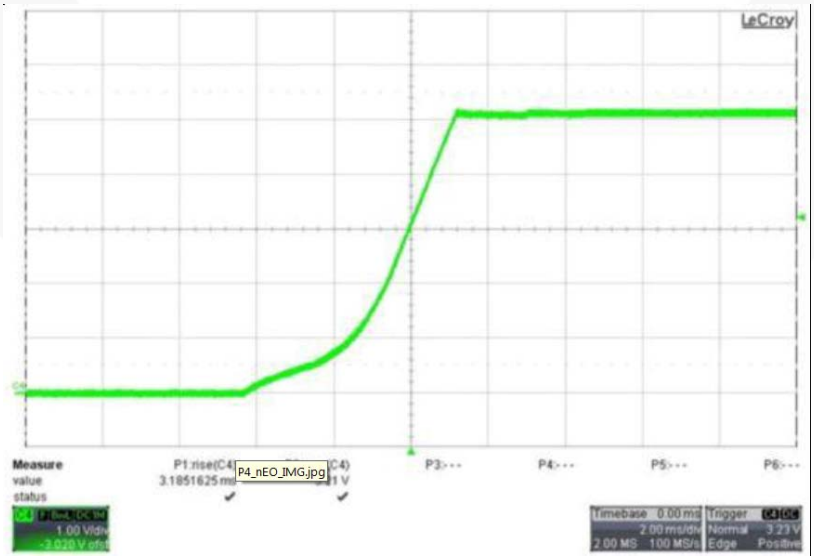
Input Voltage	Maximum Load (ms)	No Load (ms)	Specification
90V / 60Hz	4.841	3.185	<20ms
264V / 50Hz	4.882	3.229	

2.4.3. Measured Waveforms



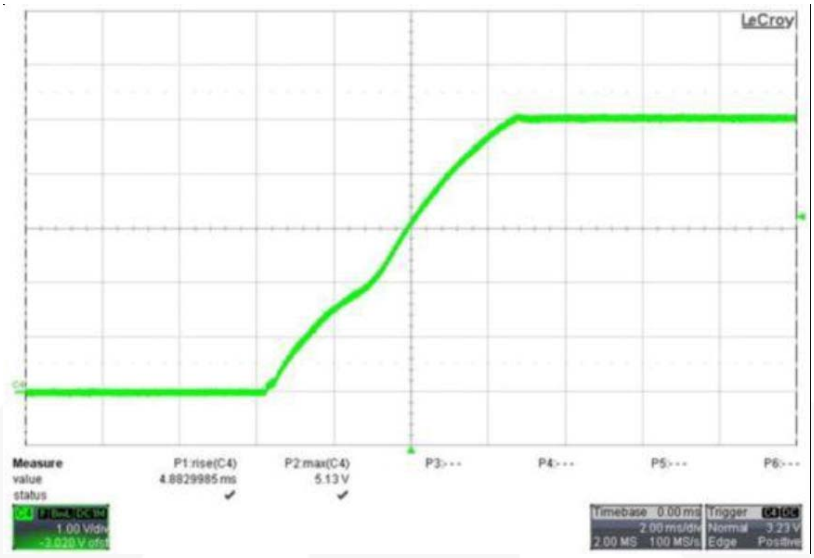
Ch4: V_O

Figure 5. 90V / 60Hz at Maximum Load



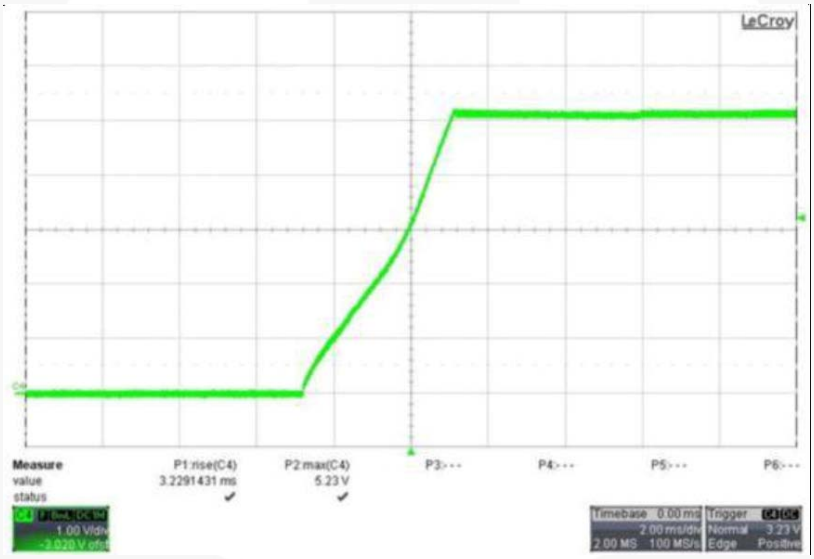
Ch4: V_O

Figure 6. 90V / 60Hz at No Load



Ch4: V_O

Figure 7. 264V / 50Hz at Maximum Load



Ch4: V_O

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

	Efficiency(%)					
Input Voltage	25% Load	50% Load	75% Load	100% Load	Avg.	Spec.
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%	

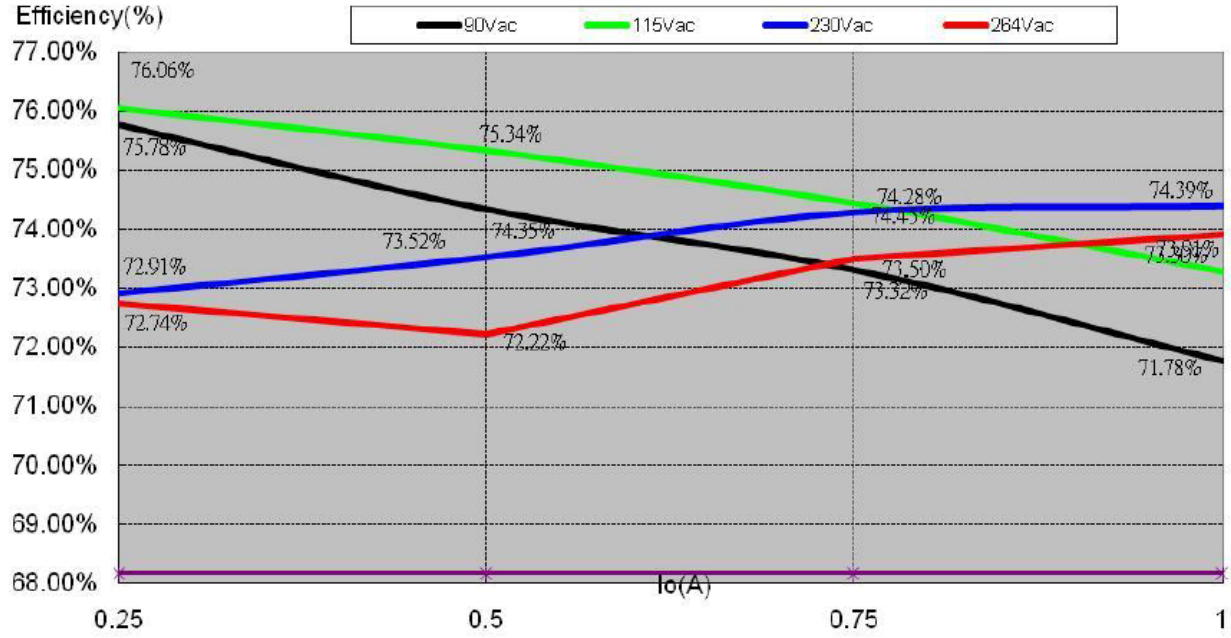


Figure 9. Efficiency Chart

2.7. Output Ripple and Noise

2.7.1. Test Condition

Ripple and noise are measured using a 20MHz bandwidth-limited oscilloscope with a 10μF capacitor paralleled with a high-frequency 0.1μF 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

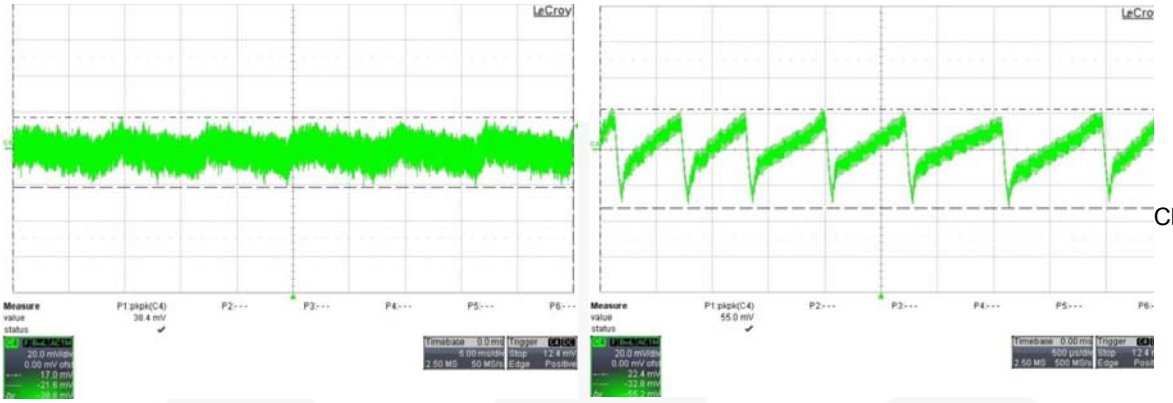


Figure 10. 90V / 60Hz at Maximum Load AC and Burst Ripple

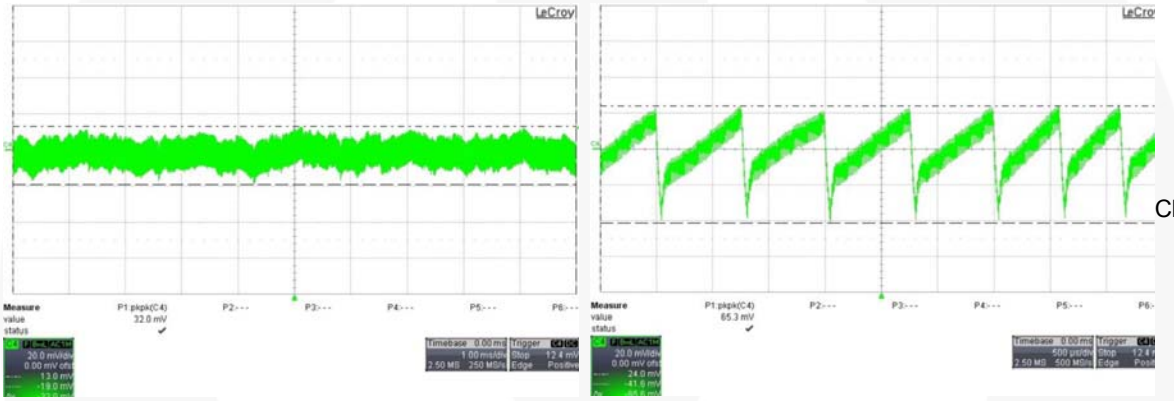


Figure 11. 264V / 50Hz at Maximum Load AC and Burst Ripple

2.8. Step Response

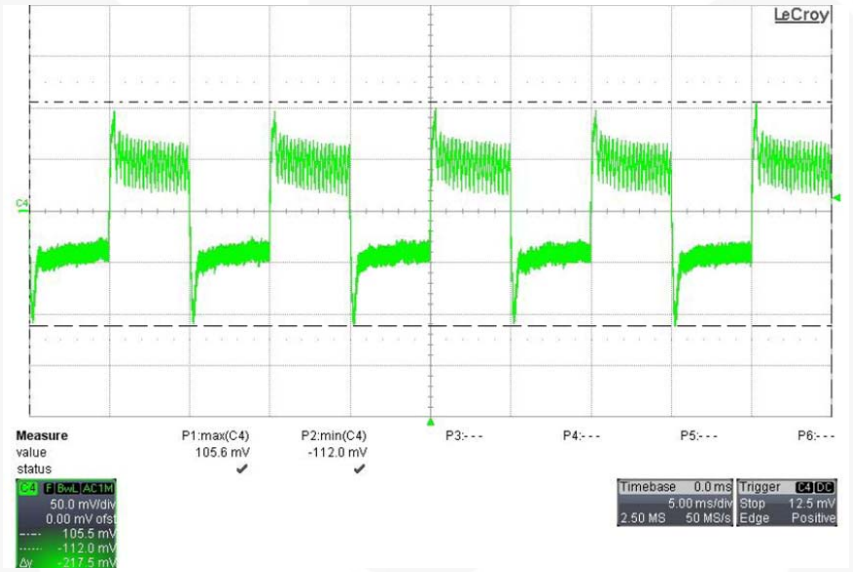
2.8.1. Test Condition

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

2.8.2. Test Result

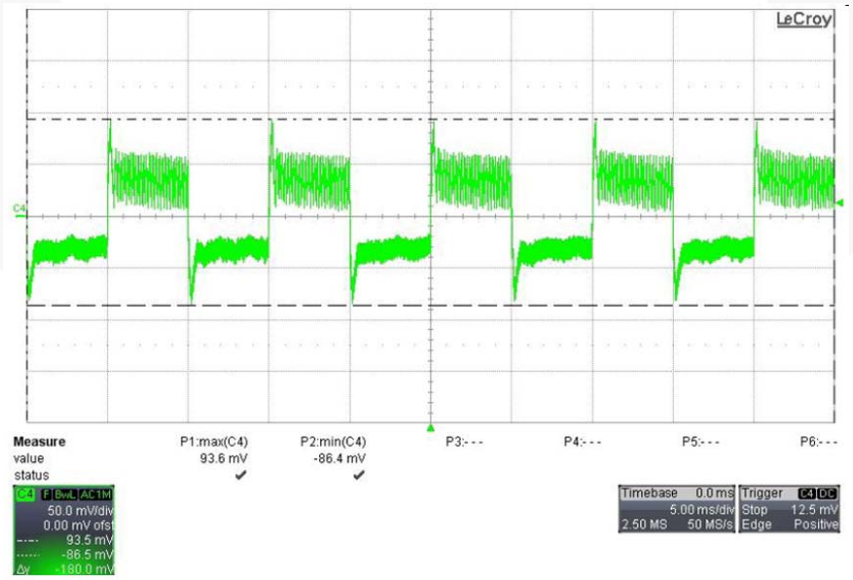
Input Voltage	Overshoot (mV)	Undershoot (mV)	Specification
115V / 60Hz	105.6	112.0	
230V / 50Hz	93.6	86.4	

2.8.3. Measured Waveforms



Ch4: V_O

Figure 12. 115V / 60Hz at Step Response



Ch4: V_O

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

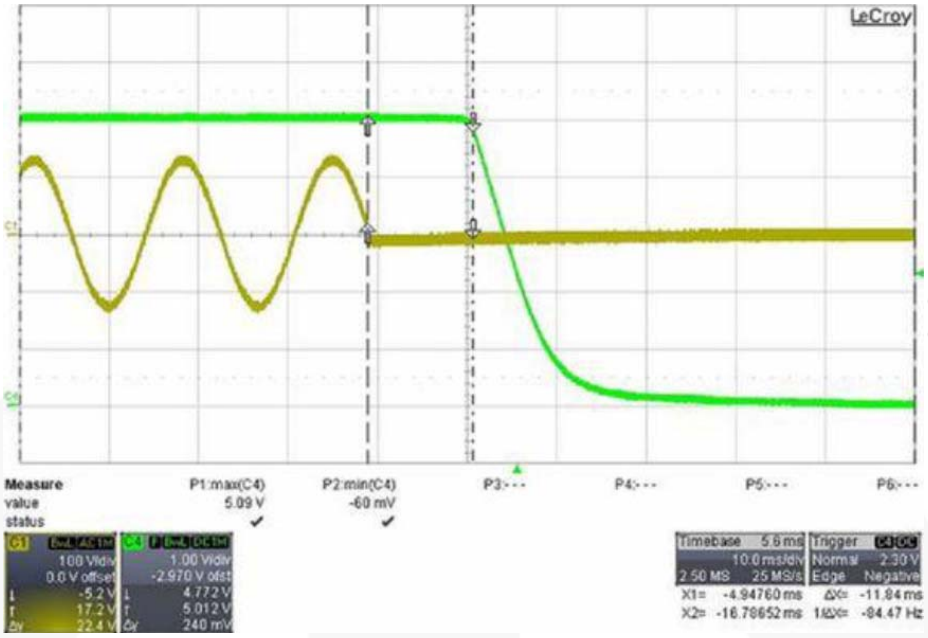
2.10.1. Test Condition

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

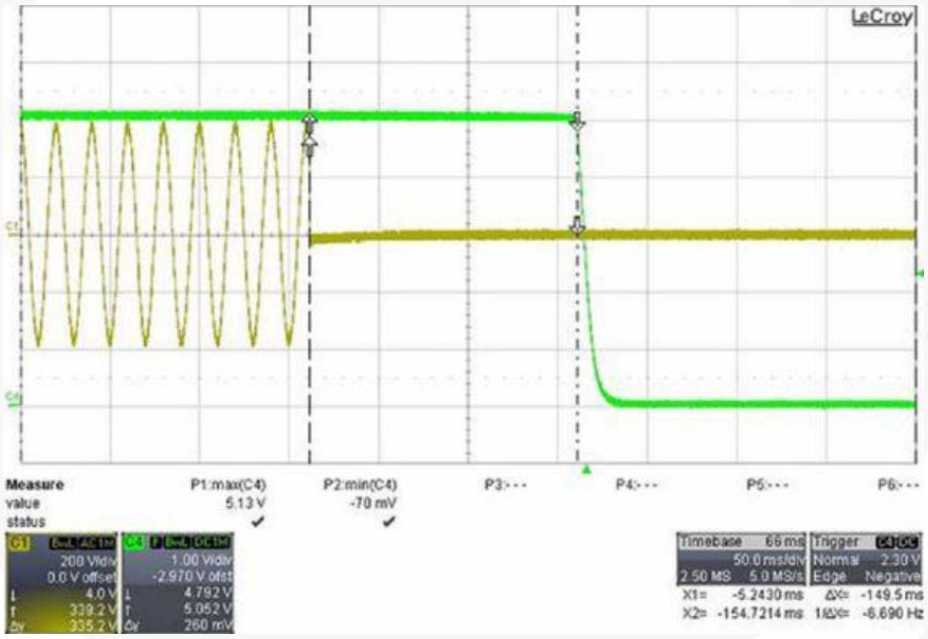
Input Voltage	Hold-up Time (ms)	Specification
90V / 60Hz	11.84	
115V / 60Hz	26.06	
230V / 50Hz	108.7	
264V / 50Hz	149.5	

2.10.3. Measured Waveforms



Ch1: V_{AC}
Ch4: V_O

Figure 14. 90V / 60Hz at Maximum Load



Ch1: V_{AC}
Ch4: V_O

Figure 15. 264V / 50Hz at Maximum Load

2.11. Short-Circuit Protection

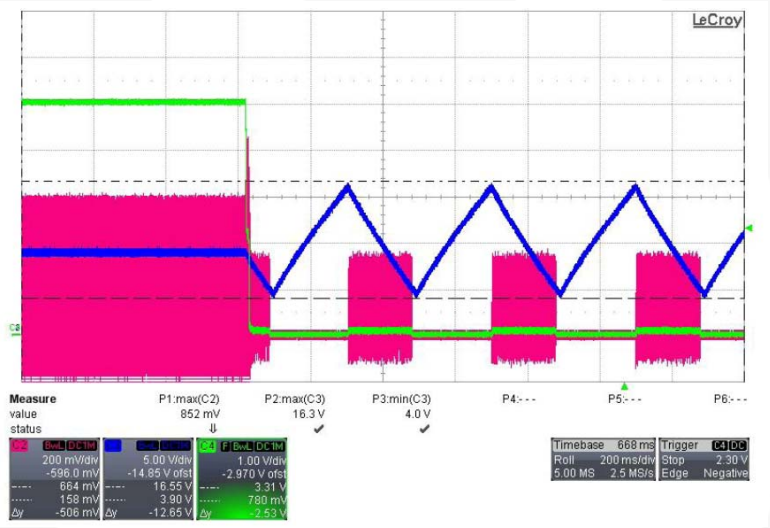
2.11.1. Test Condition

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

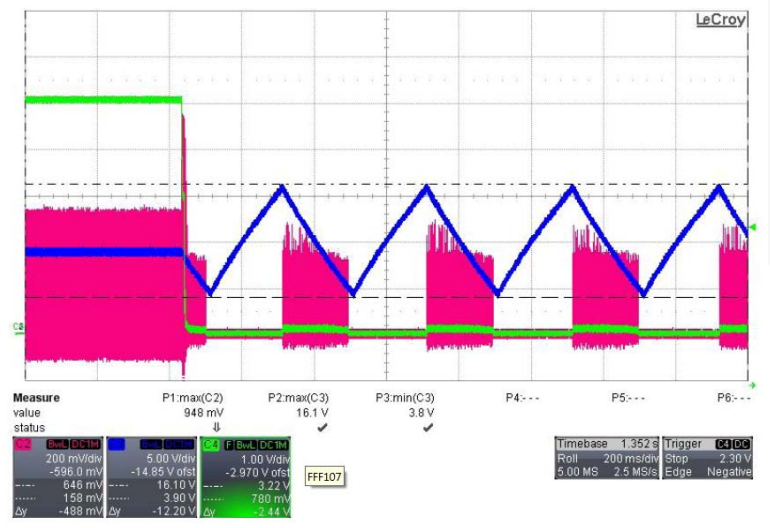
Input Voltage	Input Wattage at Maximum Loading (W)	Input Wattage at Minimum Loading (W)	Specification
90V / 60Hz	0.468	0.465	<2W
264V / 50Hz	0.93	0.95	

2.11.3. Measured Waveforms



Ch2: V_{sense}
Ch3: V_{DD}
Ch4: V_O

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



Ch1: V_{sense}
Ch3: V_{DD}
Ch4: V_O

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

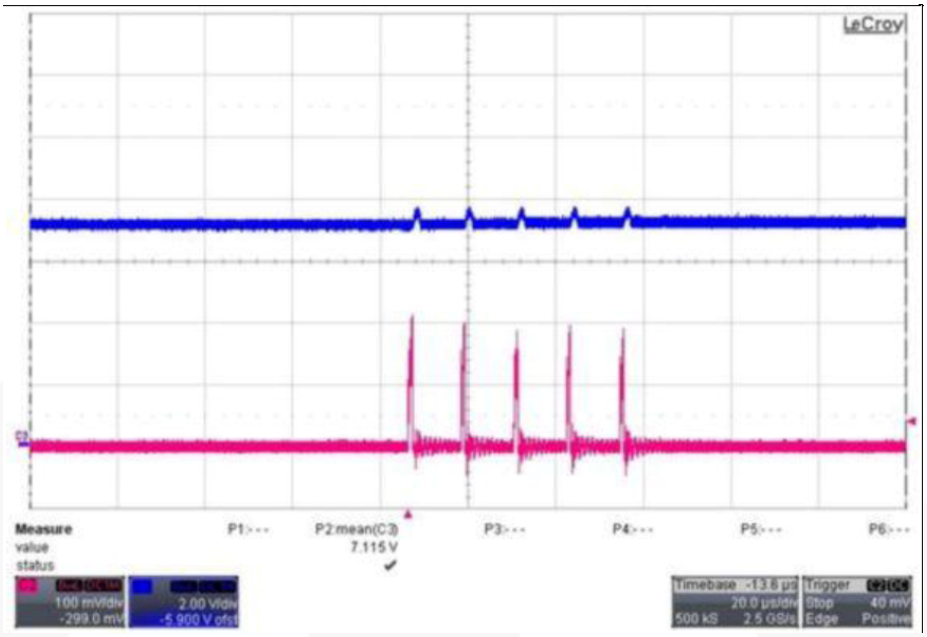
Recovery Voltage	Input Wattage (W)	Output Voltage (V)
53V / 60Hz	7.331	4.822 / 0.967A
70V / 60Hz	7.162	4.974 / 1.00A

2.13. V_{DD} Voltage Level

2.13.1. Test Result

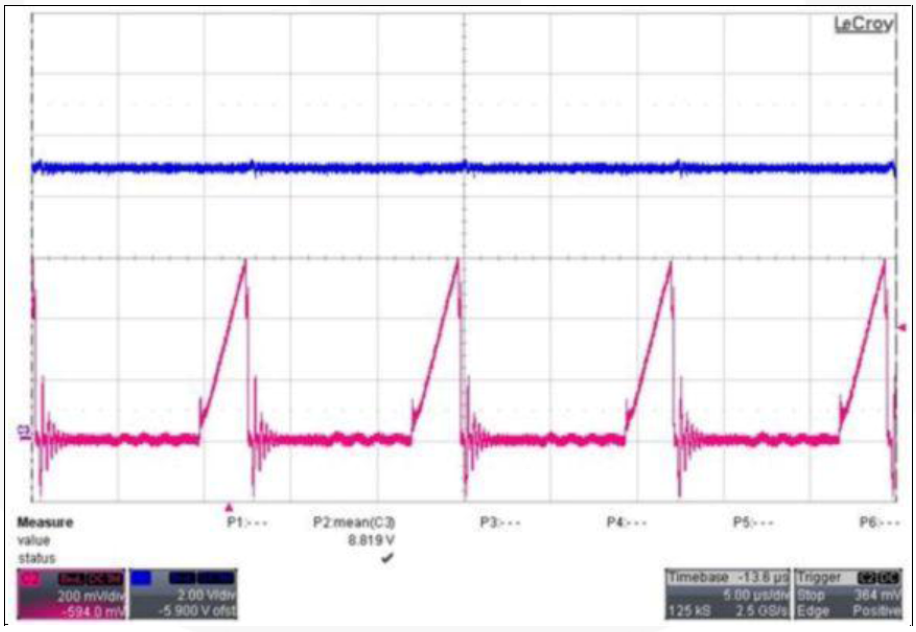
	Min. Load (V)	Max. Load (V)	Near OPP (V)	Output SC (Max. Value) (V)	Spec.
90V / 60Hz	7.110	8.819	8.829	16.30	<24V
264V / 50Hz	7.830	8.772	8.826	16.10	

2.13.2. Measured Waveforms



Ch2: V_{CS}
Ch3: V_{DD}

Figure 18. 90V / 60Hz at No Load



Ch2: V_{CS}
Ch3: V_{DD}

Figure 19. 90V / 60Hz at Maximum Load

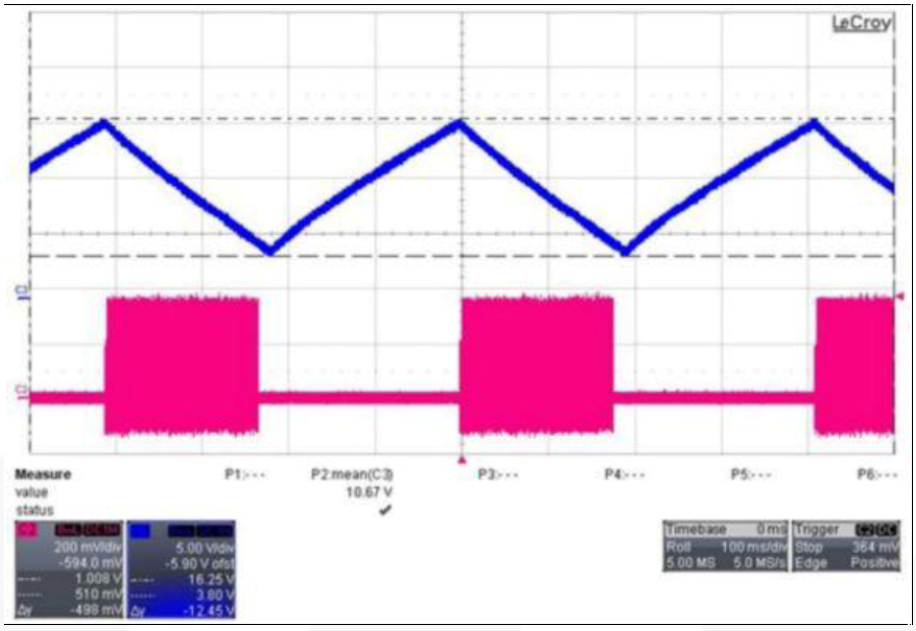


Figure 20. 90V / 60Hz at Short Circuit

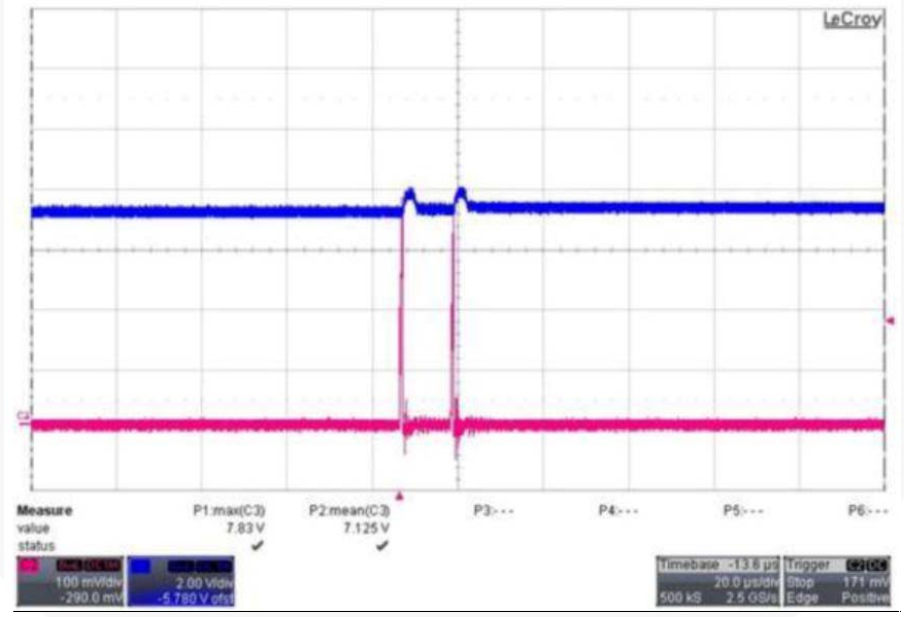
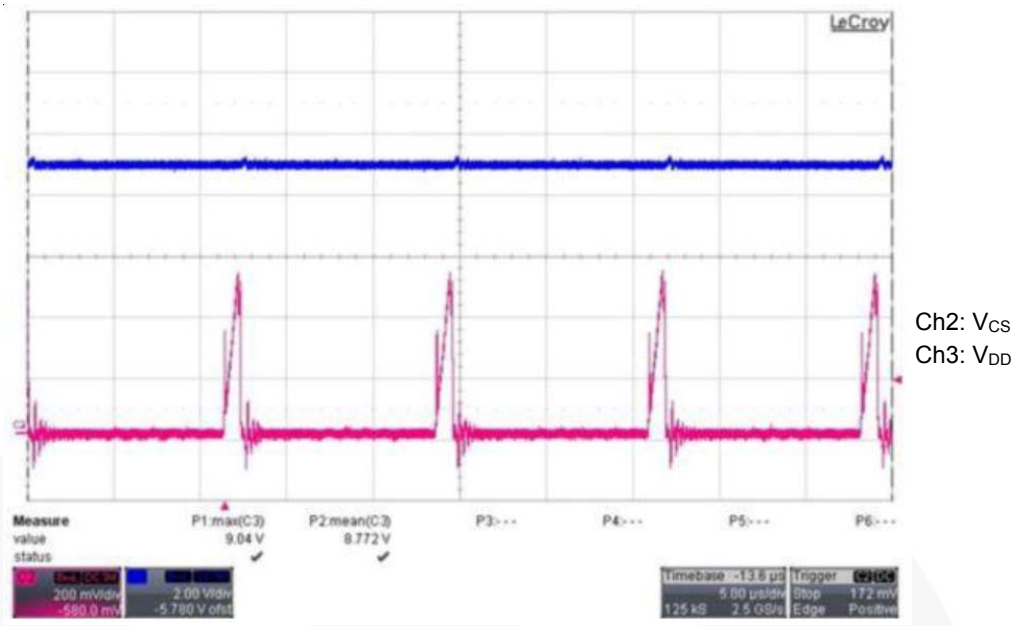
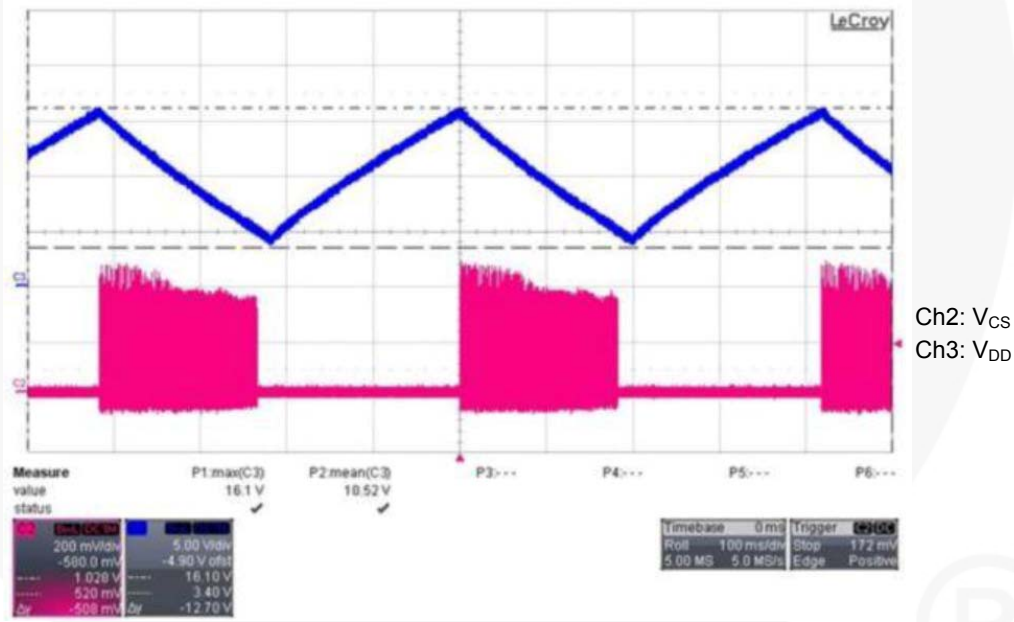


Figure 21. 264V / 50Hz at No Load



Ch2: V_{CS}
Ch3: V_{DD}

Figure 22. 264V / 50Hz at Maximum Load



Ch2: V_{CS}
Ch3: V_{DD}

Figure 23. 264V / 50Hz at Short Circuit

2.14. Voltage Stress on MOSFET and Rectifiers

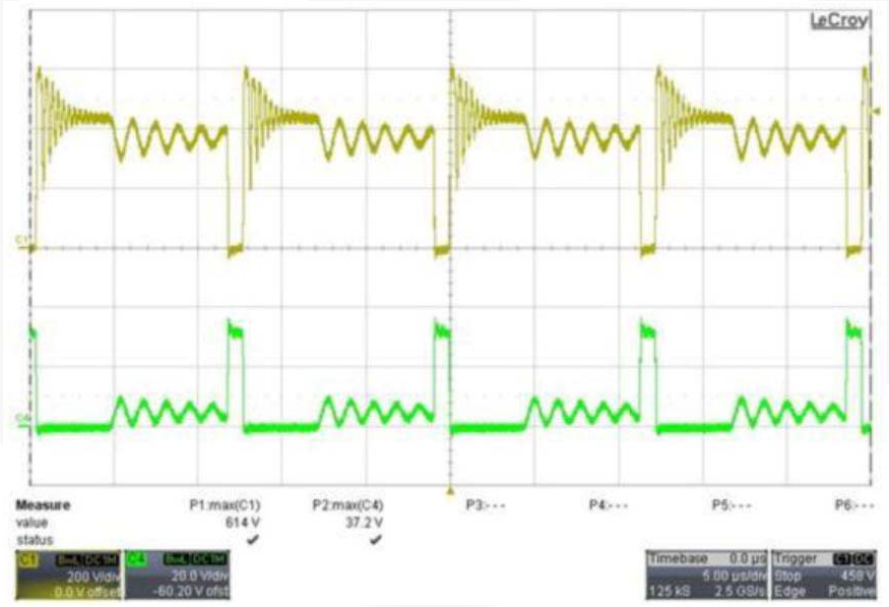
2.14.1. Test Condition

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

2.14.2. Test Result

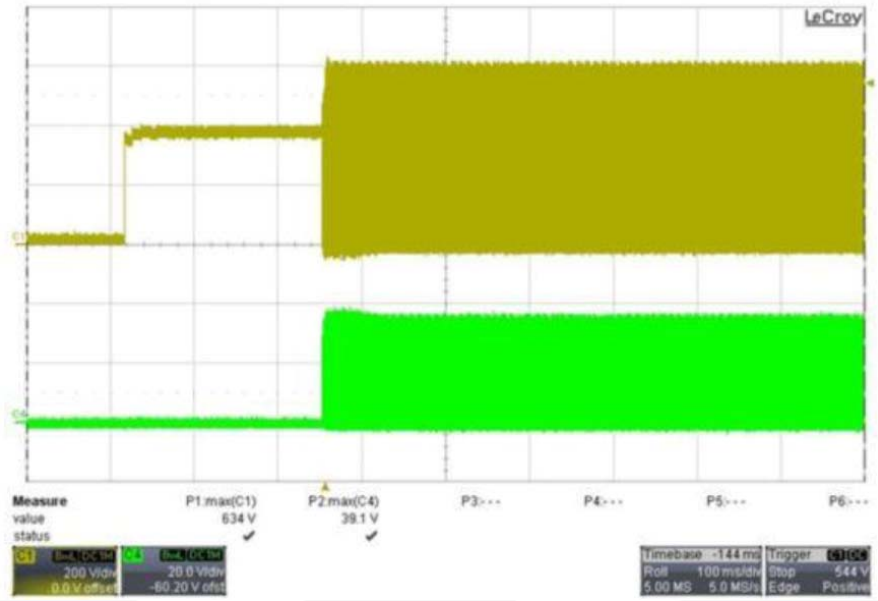
Condition	Stress on MOSFET	Rating	Stress on Output Rectifier	Rating
90V / 60Hz, Max. Load	378V	650V	16.2V	40V
90V / 60Hz, Max. Load, Startup	390V		17.1V	
90V / 60Hz, Max. Load, Output Short	384V		16.5V	
264V / 50Hz, Max. Load	614V		37.2V	
264V / 50Hz, Max. Load, Startup	634V		39.1V	
264V / 50Hz, Max.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

2.14.3. Measured Waveforms



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

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

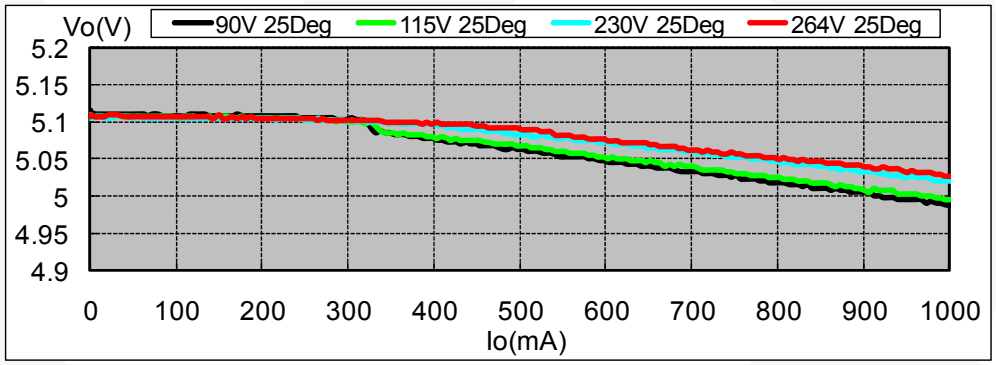


Figure 26. Constant Voltage Curve

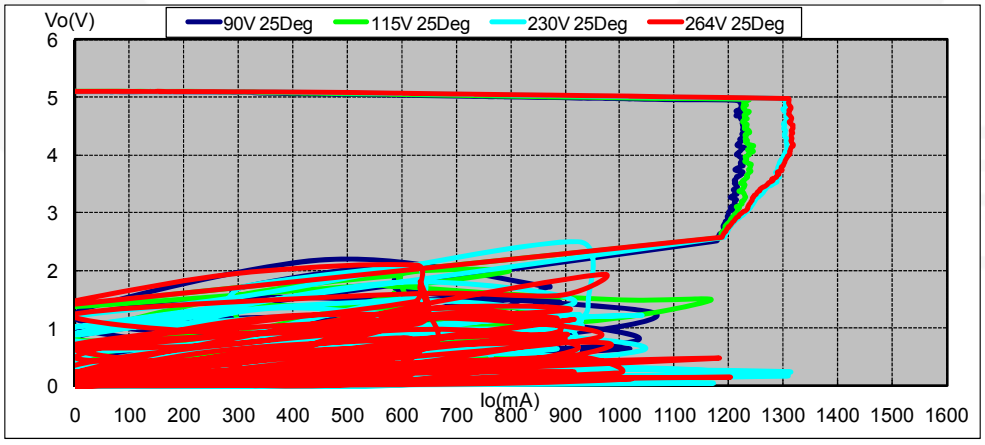


Figure 27. Constant Current Curve

2.16. V_S OVP Test

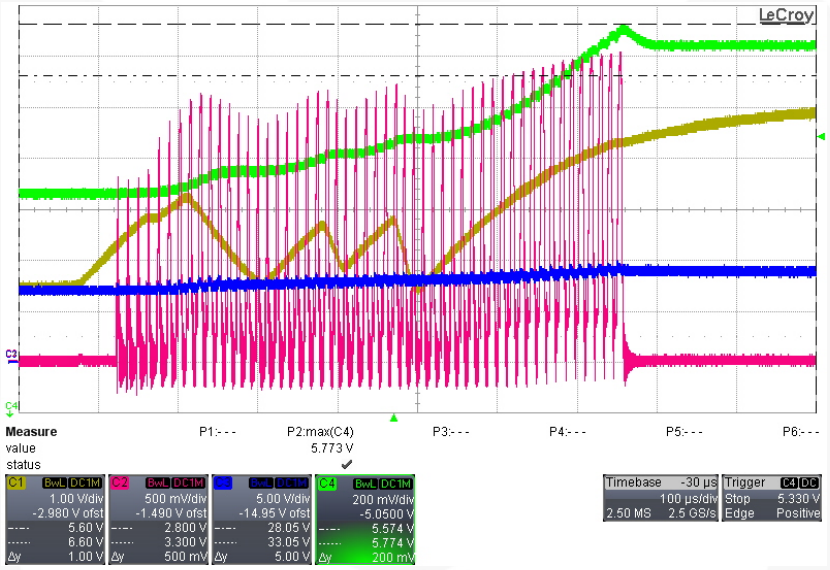
2.16.1. Test Condition

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

2.16.2. Test Result

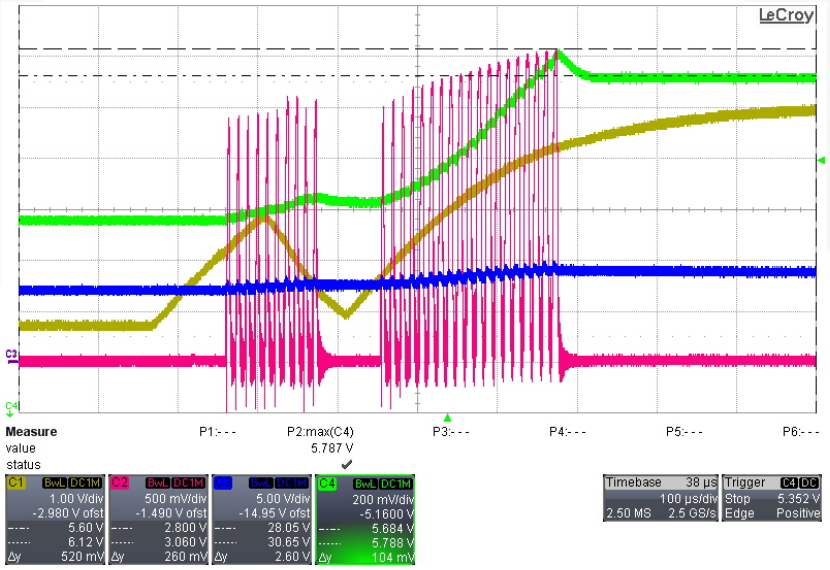
AC Line/ Loading	90V_{AC} Max. Load	90V_{AC} Min. Load	264V_{AC} Max. Load	264V_{AC} Min. Load
Max. V_O (V)	5.501V	5.773V	5.564V	5.787V

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

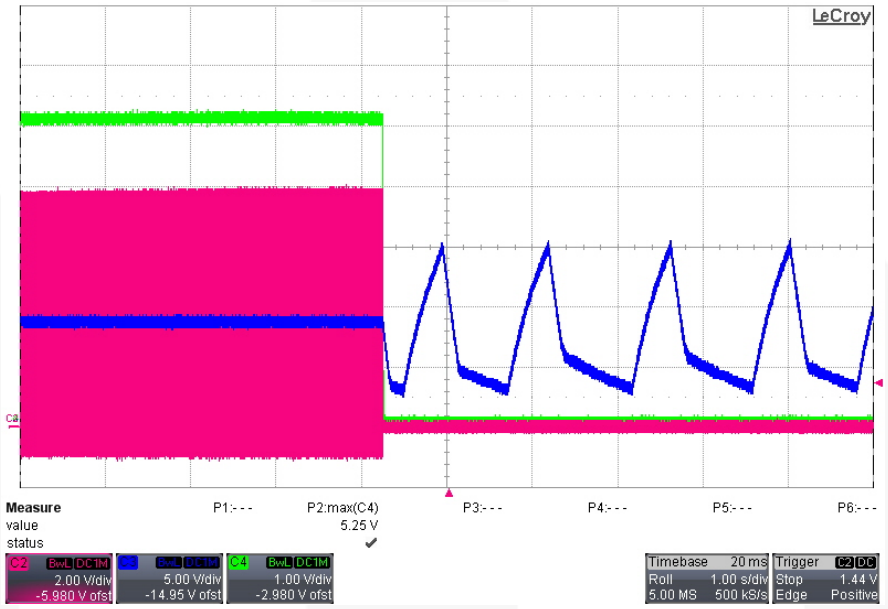
Figure 29. 264V_{AC} Minimum Load

2.17. Over-Temperature Protection Test (OTP)

2.17.1. Test Condition

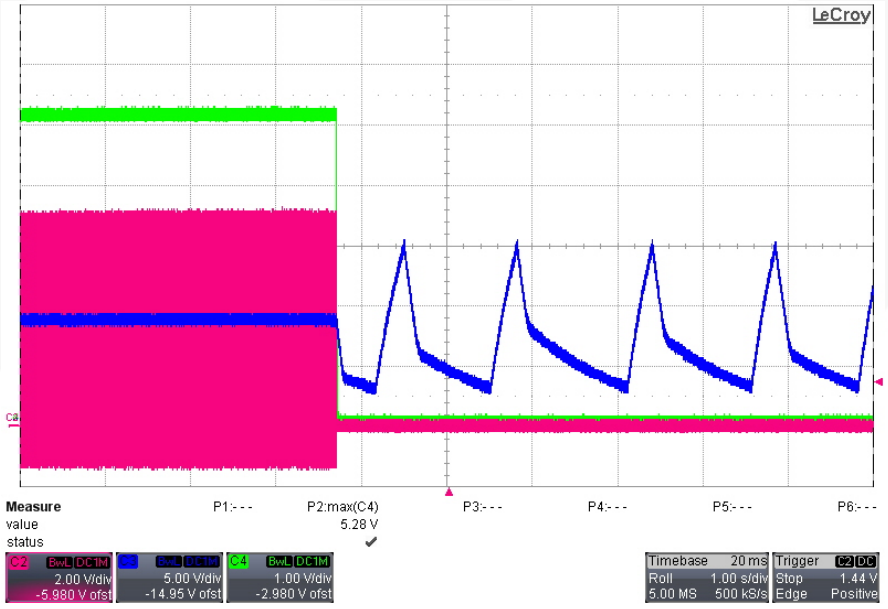
Measure the output voltage and Gate when the IC temperature exceeds 140°C.

2.17.2. Test Result



CH2: V_{GATE}
CH3: V_{DD}
CH4: V_O

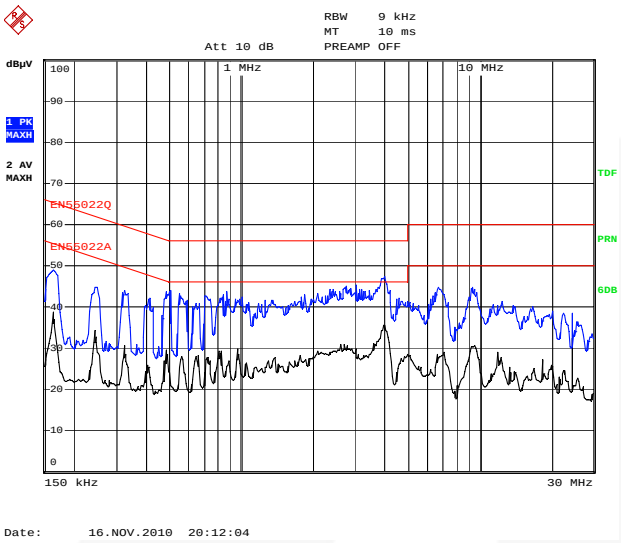
Figure 30. 90V_{AC} Maximum Load



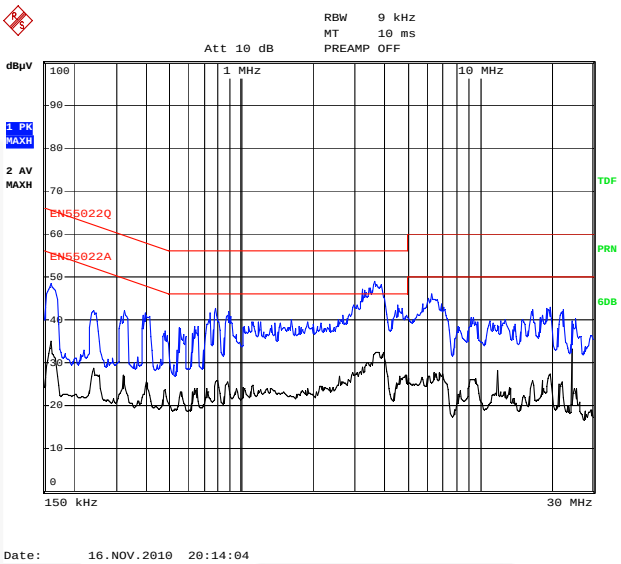
CH2: V_{GATE}
CH3: V_{DD}
CH4: V_O

Figure 31. 264V_{AC} Maximum Load

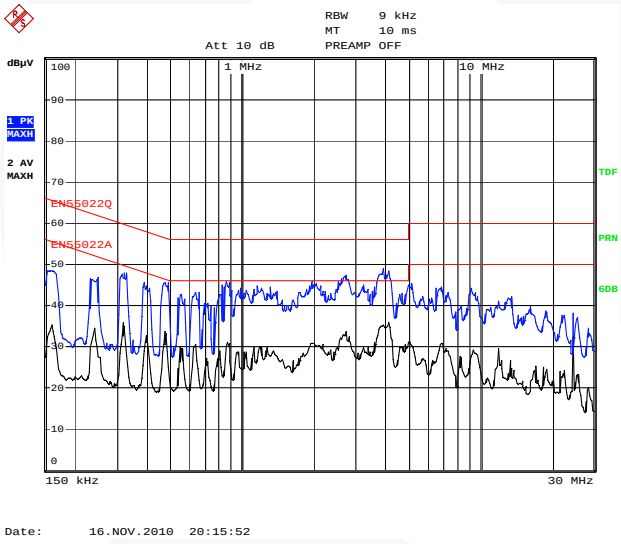
2.18. EMI Test



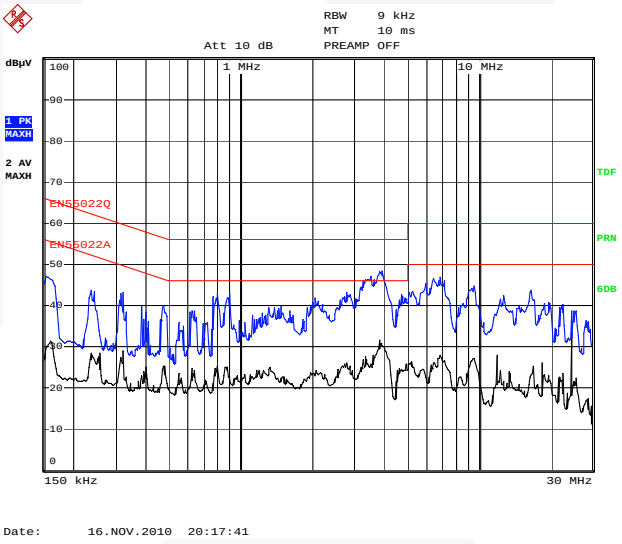
Line at 115V$_{AC}$



Neutral at 115V$_{AC}$



Line at 230V$_{AC}$



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

3. Photographs

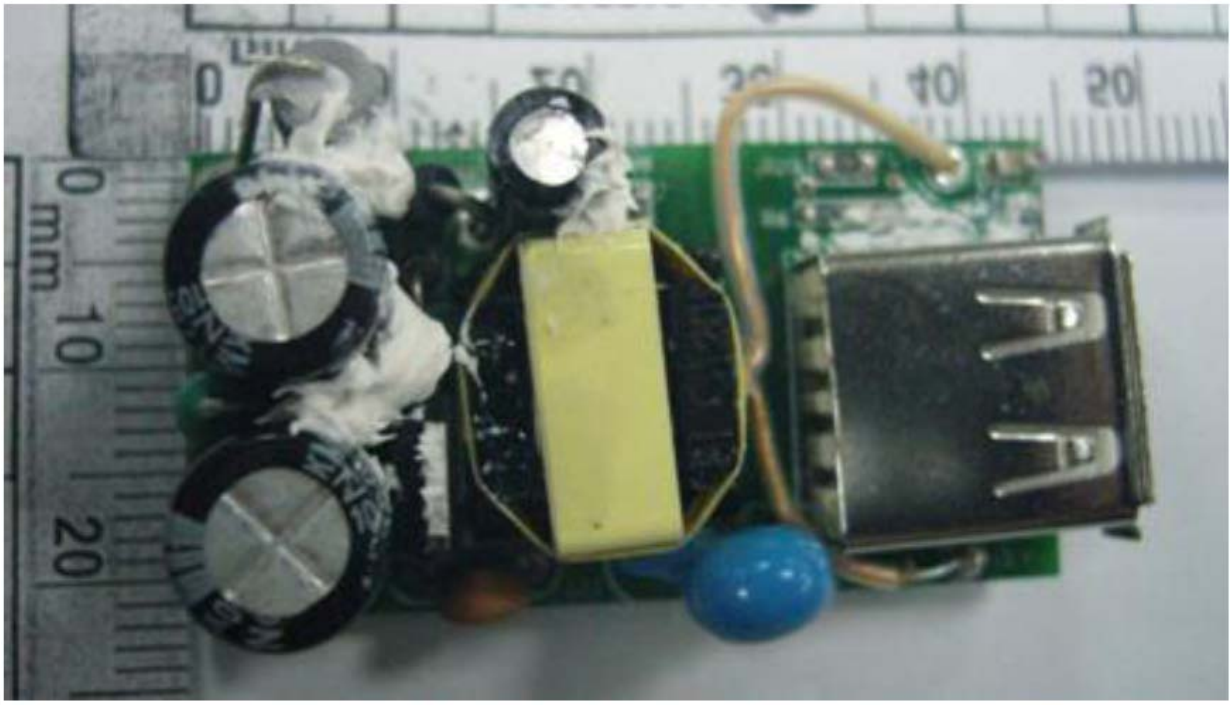


Figure 33. Front Side

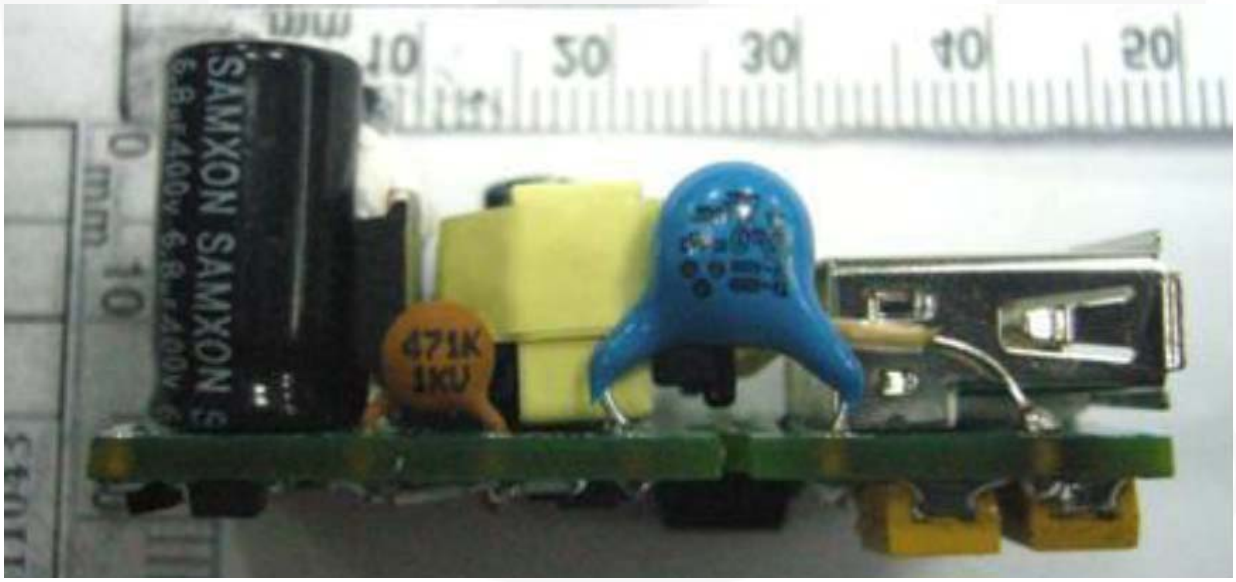


Figure 34. Flank Side / Side View

4. Schematic

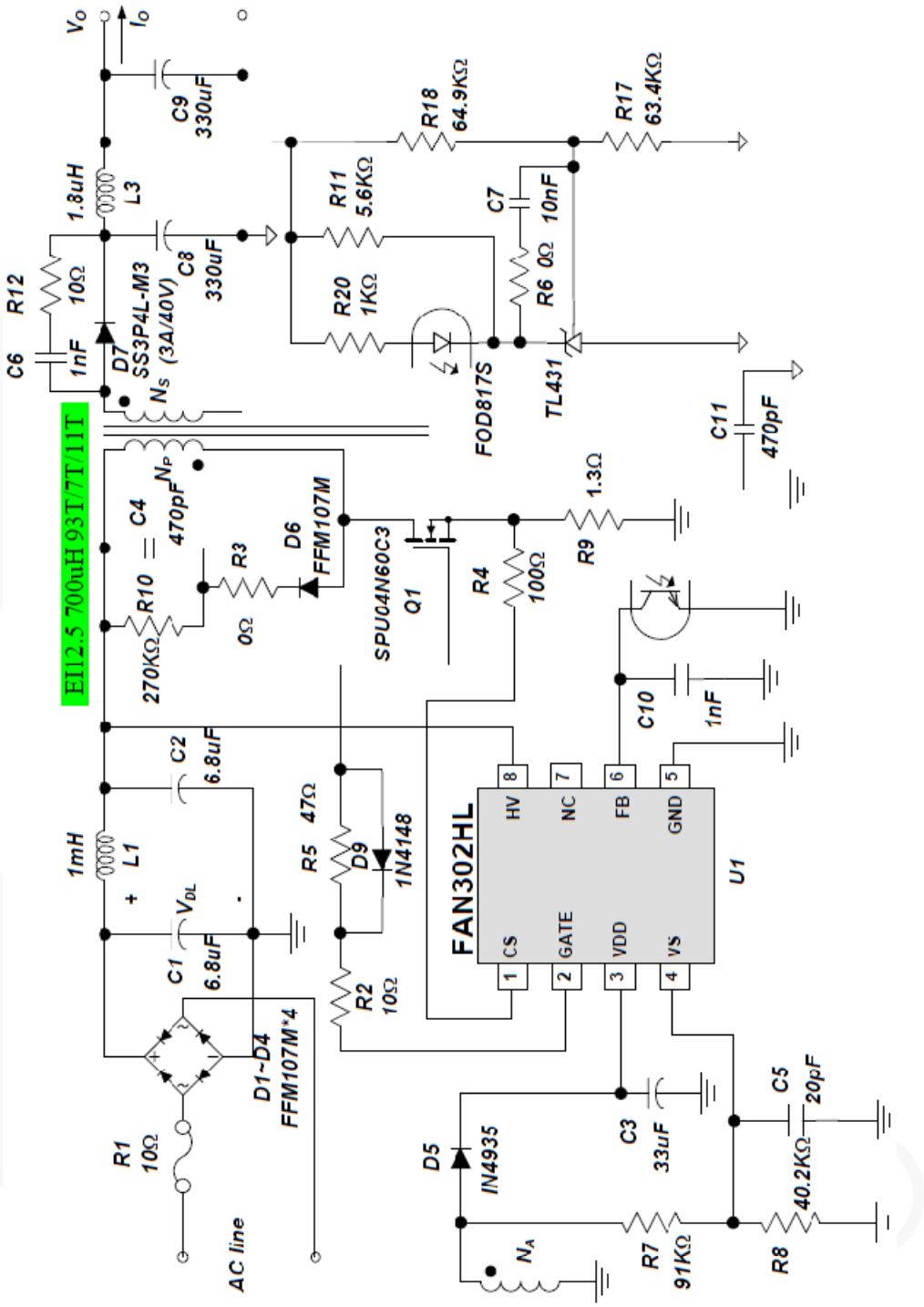


Figure 35. Circuit Schematic

5. PCB Layout

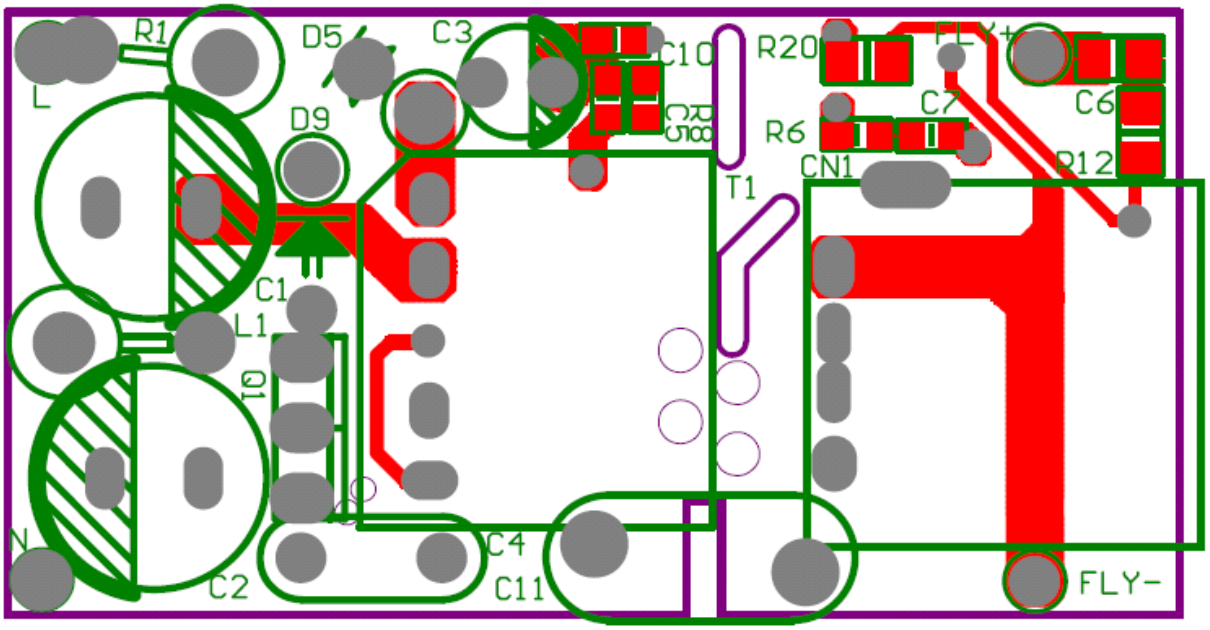


Figure 36. Front Side

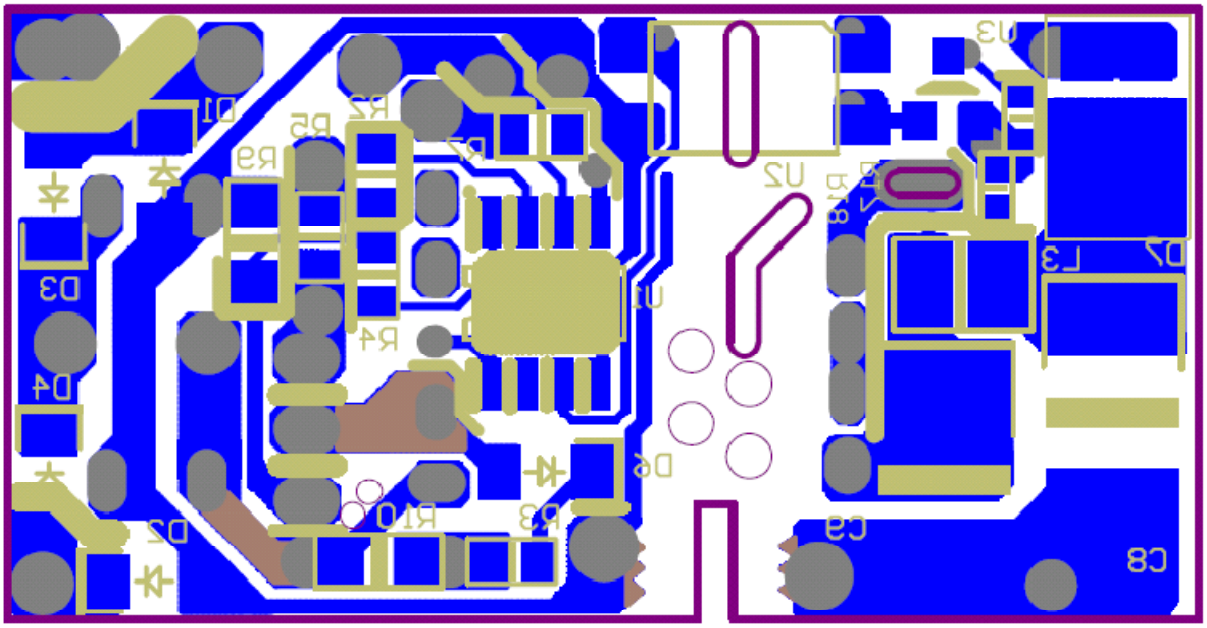


Figure 37. Back Side

6. Bill of Materials

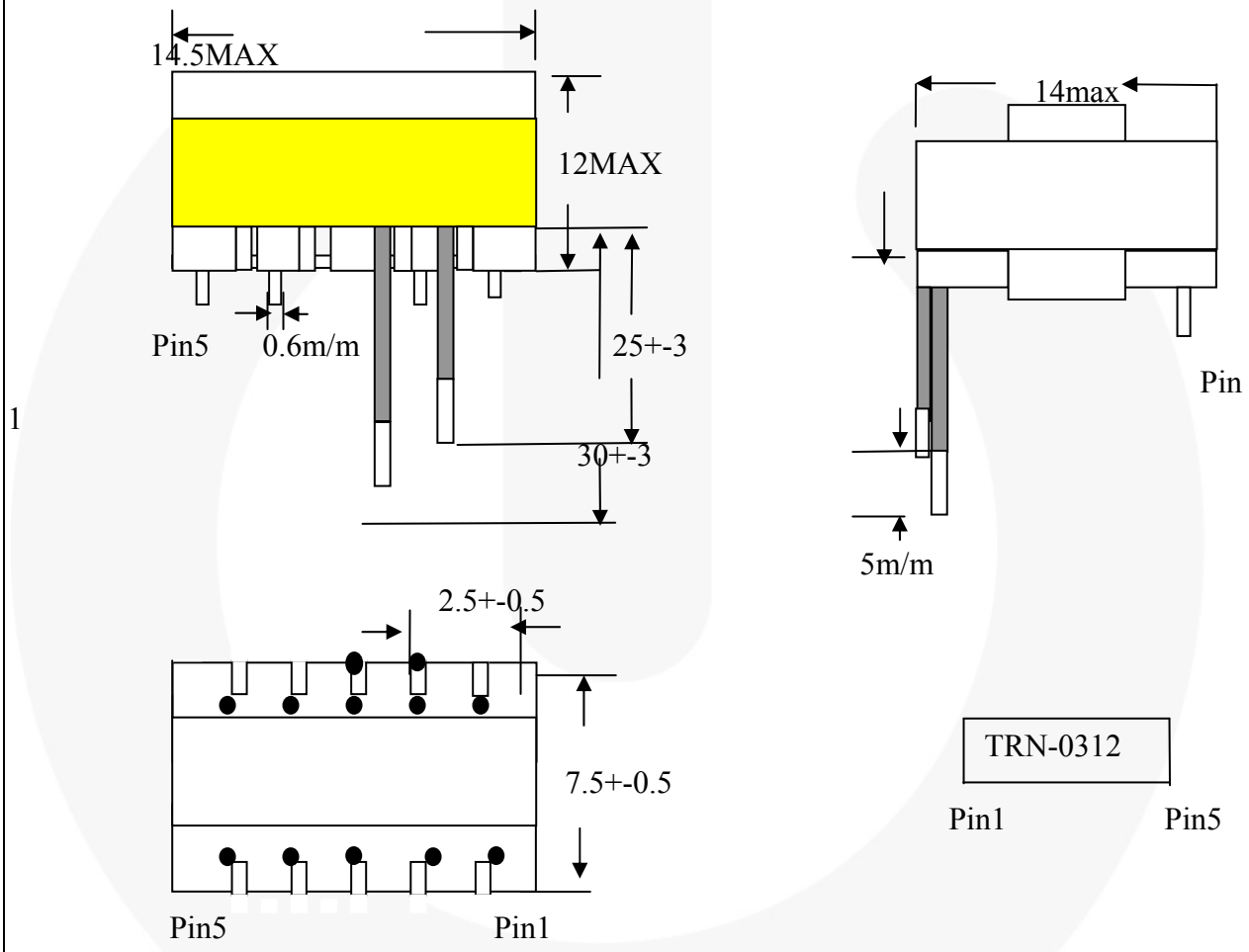
Component	Qty	Part No.	Manufacturer	Reference
Chip Resistor 0603 0Ω±5%	1			R6
Chip Resistor 0603 40K2Ω±1%	1			R8
Chip Resistor 0603 63K4Ω±1%	1			R17
Chip Resistor 0603 64K9Ω±1%	1			R18
Chip Resistor 0805 0Ω±5%	1			R3
Chip Resistor 0805 10Ω±5%	2			R2 R12
Chip Resistor 0805 47Ω±5%	1			R5
Chip Resistor 0805 100Ω±5%	1			R4
Chip Resistor 0805 1KΩ±5%	1			R20
Chip Resistor 0805 5K6Ω±1%	1			R11
Chip Resistor 0805 91KΩ±5%	1			R7
Chip Resistor 1206 1Ω3±5%	1			R9
Chip Resistor 1206 270KΩ±5%	1			R10
Wire Wound Resistor 1W 10Ω ±5%	1			R1
Ceramic Capacitor 471P 1KV +80/-20%	1			C4
0603 MLCC X7R ±10% 20P 50V	1			C5
0603 MLCC X7R ±10% 102P 50V	1			C10
0603 MLCC X7R ±10% 103P 50V	1			C7
0805 NPO ±5% 102P 50V	1			C6
SMD TANTALUM Capacitor D 330μ 10V +/-20%	2	TAJ-293D	AVX	C8 C9
Electrolytic Capacitor 6μ8 400V 105◦	2	8*16 KM	JACKCON	C1 C2
Electrolytic Capacitor 33μ 50V 105◦	1	5*11 LHK	JACKCON	C3
Y1 Capacitor 471P 400V ±20%	1	D7xF7xT9.5mm		C11
SMD 1.8μH GS43-1R8M	1	TRN0311	GANGSONG	L3
Fixed Inductor 1mH ±10%	1	EC36-102K		L1
Transformer EI-12.5 700μH	1	TRN0312	SEN HUEI	
SMD Diode 3A/40V SMPC (TO-277A)	1	SS3P4L-M3	VISHAY	D7
Diode 1A/200V DO-41 TAPING	1	1N4935	FAIRCHILD	D5
SMD Diode 1A/1000V SOD-123	5	FFM107-M	FORMOSA	D1 D2 D3 D4 D6
Diode 0.2A/100V DO-35	1	1N4148	FAIRCHILD	D9
SMD REGULATOR SOT-23 ±1%	1	KA431SAMF2TF	FAIRCHILD	U3
MOS 4.5A/650V TO-251	1	SPU04N60C3	INFINEON	Q1
Phototransistor Output Opto-coupler SMDIP-B	1	FOD817S	FAIRCHILD	U2
PWM Controller SOP8	1	FAN302HLMY	FAIRCHILD	U1
USB 4411-02003L	1		DINTEK	CN1
PCB PLM0110 REV1	1	For FAN302HL 5W 2*5		

7. Transformer Specification

7.1. Specification Approval

Customer	SYSTEM GENERAL CORP.			P/N:	TRN-0312
DATE	06/18/2011	Version	A	Page	1/4

1.DIMENSION： Unit：mm



Note：

1.Remove Pin 3、6、7、8、9、10

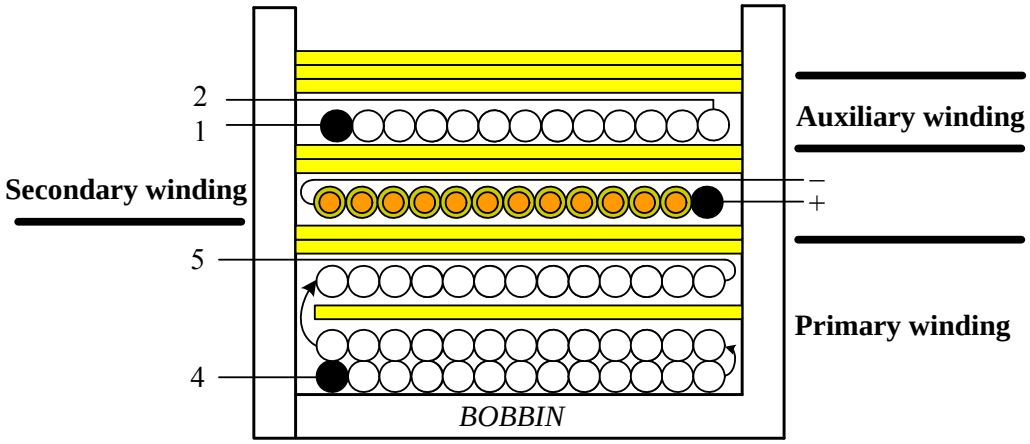
2. N2 fly+ line is 30mm of 5mm+/-3mm for soldering - fly- line is 25m/m of 5mm+/-3mm for soldering.

3.Core assembly is completed have the wire of ϕ0.18 loose 5Ts and package of three turns tape.

UNIT	m/m	DRAWN	CHECK	TITLE	TRANS
TEL	(02)29450588	Ci wun Chen	Guo long Huang	IDENT N O.	TRN-0312
FAX	(02)29447647	SEN HUEI INDUSTRIAL CO., LTD.		D W G N O.	I1201
No.26-1, Lane 128, Sec. 2, Singnan Rd., Jhonghe City, Taipei County 235, Taiwan (R.O.C.)					

Customer	SYSTEM GENERAL CORP.			P/N:	TRN-0312
DATE	03/18/2011	Version	A	Page	2/4

2.Schematic :



NO	TERMINAL		WIRE	Ts	INSULATION
	S	F			Ts
W1	4	5	2UEW 0.1*1	26	0
				25	1
				24	0
				18	2
W2	Fly+	Fly-	TEX-E 0.45*1	7	2
W3	1	2	2UEW 0.18*1	11	0
			CORE ROUNDING TAPE		3
			Core		0
W4	2	-	2UEW 0.18*1	5	2
			CORE ROUNDING TAPE		3

Notes:

1. W1 is four winds, each wind of turns refers to above turns, need one added insulating tape between the one and two layer.
2. W2 is wound two layer and uses triple insulated wire, end of positive fly line is 3cm; the end of negative fly line is 2.5cm.
3. W3 is spares winding in one layer.
4. W4 is wound in the core of the outermost layer and sparse winding.

UNIT	m/m	DRAWN	CHECK	TITLE	TRANS
TEL	(02)29450588	Ci wun Chen	Guo long Huang	IDENT N O.	TRN-0312
FAX	(02)29447647	SEN HUEI INDUSTRIAL CO.,LTD.		D W G N O.	
No.26-1, Lane 128, Sec. 2, Singnan Rd., Jhonghe City, Taipei County 235, Taiwan (R.O.C.)					

Customer	SYSTEM GENERAL CORP.			P/N:	TRN-0312
DATE	03/18/2011	Version	A	Page	3/4

3.Electrical Specification:

3.1 Inductance test： at 100KHz ,1V

Pin4 to Pin5：700 μH ± 7% (650μH Min. – 750μH Max.)

3.2 Hi-pot test：

AC 3.0K V /60Hz/5mA hi-pot for one minute between primary and secondary.
AC 1.5K V /60Hz/5mA hi-pot for one minute between primary and core.
AC 1.5K V /60Hz/5mA hi-pot for one minute between secondary and core.

3.3 Insulation test：

The insulation resistance is between primary and secondary and windings and core measured by DC
500V, must be over 100 MΩ.

3.4 Terminal strength：

1.0 Kg on terminals for 30 seconds, test the breakdown.

UNIT	m/m	DRAWN	CHECK	TITLE	TRANS
TEL	(02)29450588	Ci wun Chen	Guo long Huang	IDENT NO.	TRN-0312
FAX	(02)29447647	SEN HUEI INDUSTRIAL CO.,LTD.		DWG NO.	
No.26-1, Lane 128, Sec. 2, Singnan Rd., Jhonghe City, Taipei County 235, Taiwan (R.O.C.)					

Customer	SYSTEM GENERAL CORP.			P/N:	TRN-0312
DATE	03/18/2011	Version	A	Page	4/4

MATERALS LIST：

COMPONENT	MATERIAL	MANUFACTURER	FILE NO.
1. Bobbin	Phenolic 94V-0,T373J,150□	EI-12.5.(TF-1613) Chang Chun plastics Co., Ltd	E59481(S)
2. Core	PC-40,BH2,2E6 3C85,NC-2H,	Ferrite core EI-12.5 TDK,Tokin.Tomita.Philip.Nicera.	
3. Wire	UEWE 130□	Tai-I electric wire ＆cable Co., LTD	E85640（S）
	UEW-2 130□	Jung Shing wire Co., LTD	E174837
	UEW-B 130□	Chuen Yih wire Co., LTD	E154709（S）
	TEX-E 105□/120□	Furukawa electric Co., LTD	E206440
4. Varnish	BC-346A 180□	John C Dolph Co., LTD	E51047（M）
	468-2FC 130□	Ripley resin engineering co inc.	E81777（N）
5. Tape t=0.064mm	31CT 130□	Nitto denk corp.	E34833（M）
	Polyester 3M #1350(b) 130□	Minnesota mining ＆MFG Co., LTD CTI material group	E17385（N）
6. Tube	Teflon tube TFL 150V,200□	Great holding industriat Co., LTD	E156256（S）
7. Terminals	Tin coated- Copper wire	Will for special wire CORP.	
8. Shield	Copper foil	Hitachi cable lid. (copper foil: 0.025t x7mm)	

UNIT	m/m	DRAWN	CHECK	TITLE	TRANS
TEL	(02)29450588	Ci wun Chen	Guo long Huang	IDENT N O.	TRN-0312
FAX	(02)29447647	SEN HUEI INDUSTRIAL CO.,LTD.		D W G N O.	
No.26-1, Lane 128, Sec. 2, Singnan Rd., Jhonghe City, Taipei County 235, Taiwan (R.O.C.)					

8. Revision History

Rev.	Date	Description
1.0.0	November, 2011	Initial release

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