



**User Guide for
FEBFAN6602R_CH10U40A
Evaluation Board**

Fairchild Computing Notebook Adapter

**Featured Fairchild Product:
FAN6602R**

*Direct questions or comments
about this evaluation board to:
“Worldwide Direct Support”*

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This user guide supports the evaluation kit for the FAN6602R. It should be used in conjunction with the FAN6602R datasheets as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at <https://www.fairchildsemi.com/>

1. Introduction

This document is an engineering report describing a 40 W power supply using the FAN6602R, which is targeted for notebook adapters. It also describes the simple, low cost and high performance reference design evaluation board.

The operating current in the FAN6602R is as small as 3 mA. The small operating current results in higher efficiency and reduces the VDD hold-up capacitance requirement. Once the FAN6602R enters deep-green mode, the operating current is reduce to 0.6 mA, thus assisting the power supply to easily meet the power conservation.

By using the FAN6602R, an adapter can be implemented with fewest external components and minimized cost.



2. Evaluation Board Specifications

All data in Table 1 was measured with 90 V_{AC}~264 V_{AC} line input at an ambient temperature of 25°C.

Table 1. Summary of Features and Performance

Specification		Min.	Max.	Unit
Input Voltage		90	264	V _{AC}
Input Frequency		47	63	Hz
Description	Design Spec.	Test Result		Comments
Output Voltage	18.05~19.95 V	0.9%		CV<±5% Regulation CC<±5% Regulation
Output Current Protection	2.5 ~3.5 A	2.93~3.02 A		
Input Power	< 100 mW	85 mW		264 V _{AC}
Ripple		345 mVp-p (Max.)		Measured at PCB End
Startup Time	< 2 S	1.8 S		Full Load
Dynamic	>18.5 V	18.7 V		Measure at PCB End
Voltage Stress	600 V	582 V		264 V _{AC}
	100 V	93 V		264 V _{AC}
Efficiency	Avg. 85.29%	89.09% at 115 V 89.16% at 230 V		Meets Energy Star v2.0.
Conducted EMI	Under 6 dB	3 dB Margin		Meets CISPER22B/EN55022B/IE C950/UL1950 Class II

3. Photographs



Figure 1. Photograph (W x L: 34 x 84 mm²) Top View



Figure 2. Photograph (W x L: 34 x 84 mm²) Bottom View



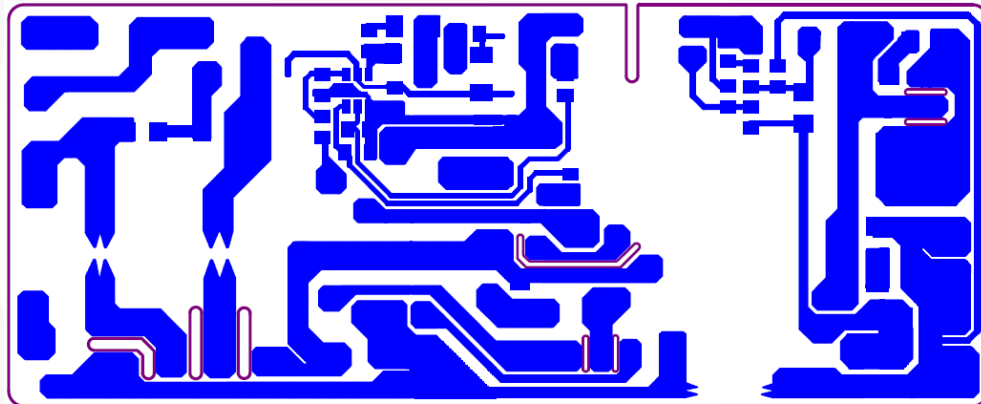
Figure 3. Photograph (H:24 mm) Side View

4. Printed Circuit Board



Top Overlay

Figure 4. Top View



Bottom Layer

Figure 5. Bottom View

5. Schematic

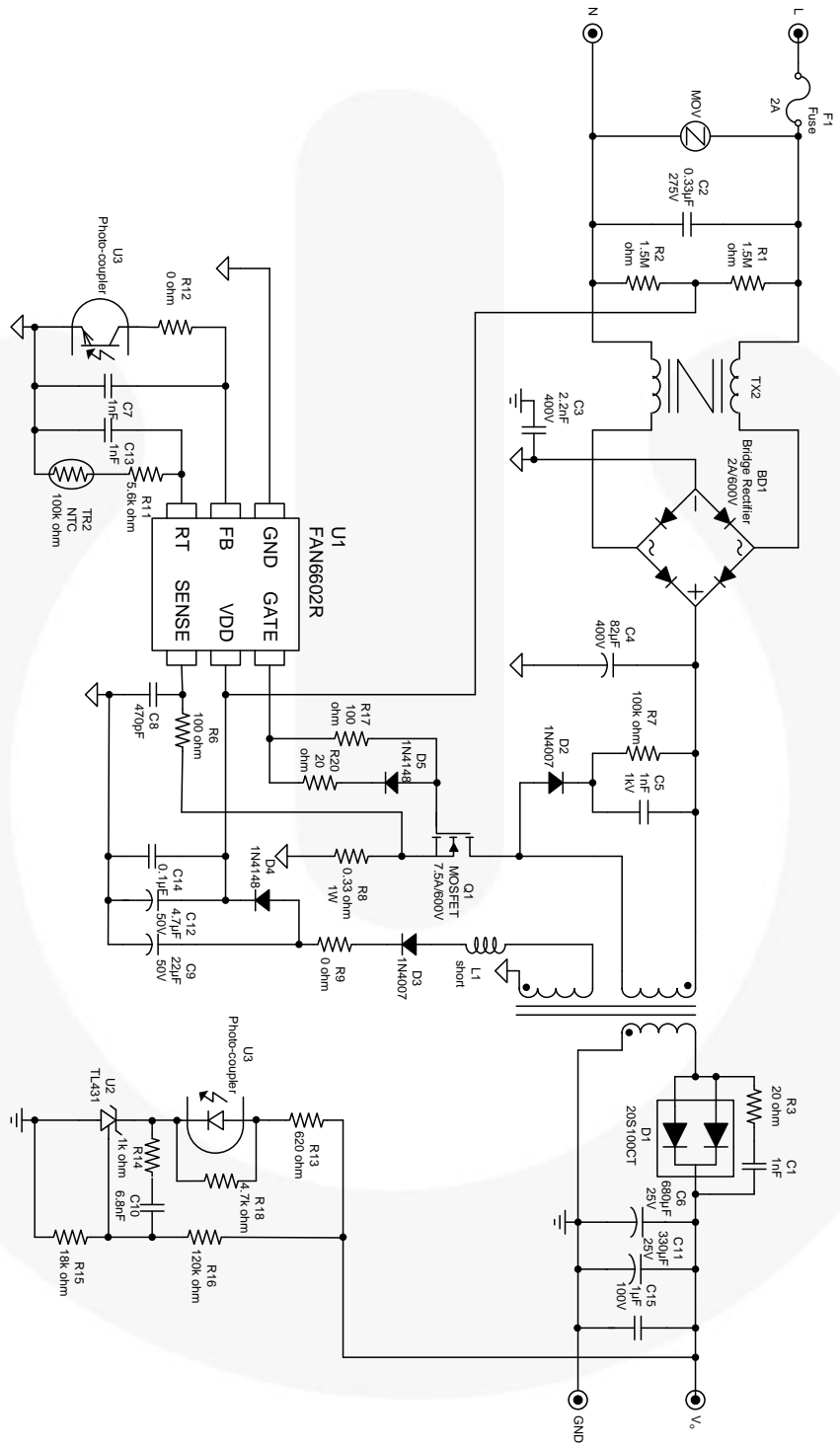


Figure 6. Evaluation Board Schematic



6. Bill of Materials

Part Specification	Package	Qty.	No.
JUMPER WIRE 0.8 ψ (mm)	REEL	8	JP0~JP4, NTC1, L1, L2
Metal-Oxide Resister 1 W 0.33 Ω \pm 10%	REEL	1	R8
SMD Resister 0805 0 Ω \pm 5%	REEL	1	R9, R12
SMD Resister 0805 20 Ω \pm 5%	REEL	1	R20
SMD Resister 0805 100 Ω \pm 5%	REEL	2	R6
SMD Resister 0805 620 Ω \pm 5%	REEL	1	R13
SMD Resister 0805 1 k Ω \pm 5%	REEL	1	R14
SMD Resister 0805 5.6 k Ω \pm 5%	REEL	1	R11
SMD Resister 0805 18 k Ω \pm 5%	REEL	1	R15
SMD Resister 0805 4k7 Ω \pm 5%	REEL	1	R18
SMD Resister 1206 20 Ω \pm 5%	REEL	1	R3
SMD Resister 1206 100 Ω \pm 5%	REEL	1	R17
SMD Resister 1206 100 k Ω \pm 5%	REEL	1	R7
SMD Resister 1206 120 k Ω \pm 5%	REEL	1	R16
SMD Resister 1206 1.5 M Ω \pm 5%	REEL	2	R1, R2
0805 X7R \pm 0% 1 nF 50 V	REEL	2	C7, C13
0805 X7R \pm 10% 470 pF 50 V	REEL	1	C8
0805 X7R \pm 10% 6.8 nF 50 V	REEL	1	C10
0805 X7R \pm 10% 0.1 μ F 50 V	REEL	1	C14
1206 X7R \pm 10% 1 nF 100 V	REEL	1	C1
1206 X7R \pm 10% 1 μ F 100 V	REEL	1	C15
Ceramic Capacitor 1 nF 1 kV	REEL	1	C5
Electrolytic Capacitor 82 μ F 400 V 105 $^{\circ}$ C	REEL	1	C4
Electrolytic Capacitor 680 μ F 25 V 105 $^{\circ}$ C	REEL	1	C6
Electrolytic Capacitor 22 μ F 50 V 105 $^{\circ}$ C	REEL	1	C9
Electrolytic Capacitor 330 μ F 25 V 105 $^{\circ}$ C	REEL	1	C11
Electrolytic Capacitor 4.7 μ F 50 V 105 $^{\circ}$ C	REEL	1	C12
X2 Capacitor 0.33 μ F 275 V \pm 10 %	REEL	1	C2
Y1 Capacitor 2.2 nF 250 V \pm 20 %	REEL	1	C3
MOV Oxide Varistor 471	REEL	1	MOV
Common Choke 25 mH \pm 10 %	SUMIDA (04291-T145)	1	TX2
Transformer RM-8 920 μ H	SUMIDA (10344-T018)	1	TR1
FUSE GLASS 250 V/2 A 36SG Slow-Blow	3.6 ψ x 10 mm	1	F1
NTC Resister 100 k Ω	REEL	1	TR2
SMD Diode 1 A/1000 V SOD-80	LL4148 REEL	2	D4, D5
Diode 1 A/700 V DO-41	1N4007 REEL	2	D2, D3

Continued on the following page...

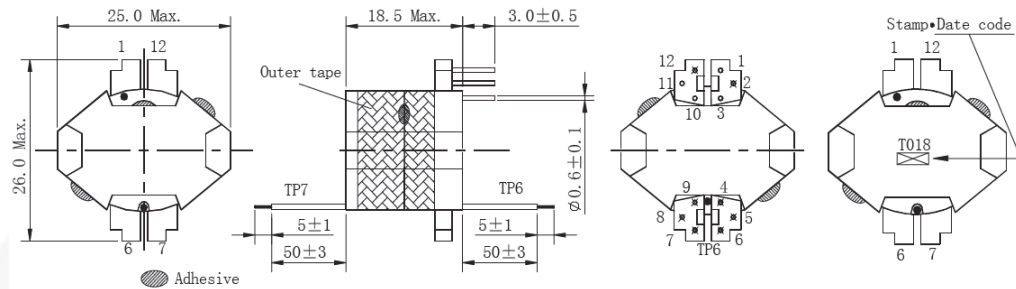


Part Specification	Package	Qty.	No.
Bridge Rectifier 2 A/600 V	2KBP06M	1	BD1
Schottky Diode 20 A/100 V TO-220	YM20S100CT	1	D1
MOSFET 7.5 A/600 V TO-220	FQP8N60C	1	Q1
REGULATOR $\pm 1\%$ TO-92	FAN431ACZ-AP	1	U2
Photo Coupler DIP	FOD817A	1	U3
PWM Controller SOT23-6L	FAN6602RM6X	1	U1
Heat Sink 55 x 20 x 1.5 mm	MCH0636	1	HS1
Heat Sink 11.5 x 24.9(L) x 17(H) x 1.5(W) mm	MCH0637	1	HS2
PCB PLM0068 REV0	For FAN6602R 40 W	1	

7. Transformer and Winding Specifications

- Core: RM-8
- Bobbin: RM-8

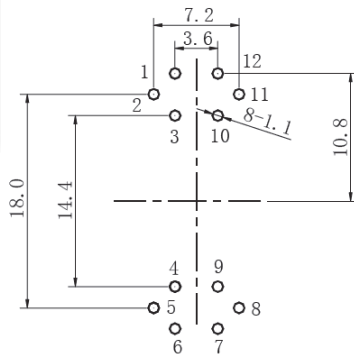
- Scope & Precautions
Refer to S-074-1511.
- Appearance



* Pin pitch shall be measured at the root of terminal.

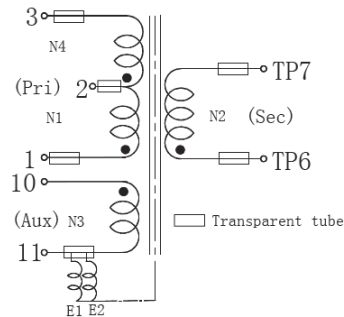
* Dimension without tolerance is reference value.

2-3. Recommended land pattern (mm)



3. Coil specification

3-1. Terminal Connection (Bottom view)



"●" indicates the winding start.

RoHS
compliance
Cd: Max. 0.01wt%
others: Max. 0.1wt%

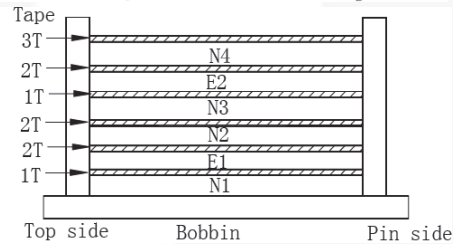


Figure 7. Transformer Specifications & Construction

Table 2. Winding Specifications

Winding	Terminal		Winding	Turns	Isolation Layer
	Start Pin	End Pin			Turns
N4	2	3	0.25 mm*1	33	4
Copper Shielding (E2)	11	Open	Copper Foil 0.025 mm	1.2	3
N3	10	11	0.25 mm*1	9	1
N2	TP6	TP7	0.5 mm*1	12	3
Copper Shielding (E1)	11	Open	Copper Foil 0.025 mm	1.2	3
N1	1	2	0.25 mm*1	33	2

Table 3. Electrical Characteristics

	Pin	Specification	Remark
Inductance	3 - 1	920 μ H \pm 10%	1 kHz, 1 V
Effective Leakage	3 - 1	50 μ H Max.	Short Other Pin

8. Test Conditions & Test Equipment

Table 4. Test Conditions & Test Equipment

Evaluation Board #	FEBFAN6602RM6X_CH10U40A
Test Date	2014-12-02
Test Temperature	25°C
Test Equipments	AC Power Source: 6800 AC POWER SOURCE Electronic Load: Chroma 63030 and 63102 Power Meter : WT210 Oscilloscope : LeCory 24Xs-A

9. Performance of Evaluation Board

9.1. Input Wattage at No Load Condition

Test Condition:

Measure the input wattage at no load condition.

Table 5. Test Results

Input Voltage	Input Wattage	Output Voltage
90 V _{AC} / 60 Hz	38 mW	19.27 V
115 V _{AC} / 60 Hz	42 mW	19.27 V
230 V _{AC} / 50 Hz	76 mW	19.27 V
264 V _{AC} / 50 Hz	85 mW	19.27 V

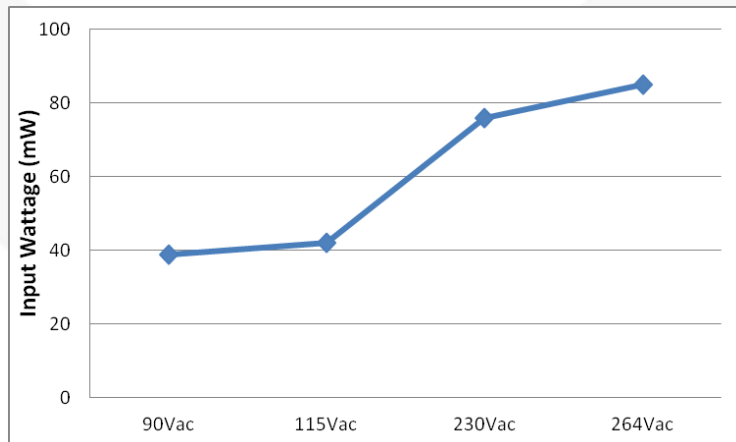


Figure 8. Input Wattage Curve

9.2. Startup Time

Test Condition:

Measure the time from the AC plug-in to nominal output voltage build-up at full load condition.

Table 6. Test Results

Input Voltage	Startup Time	Specification
90 V _{AC} / 60 Hz	1.8 s	<2 sec
264 V _{AC} / 50 Hz	0.537 s	<2 sec

Waveforms:

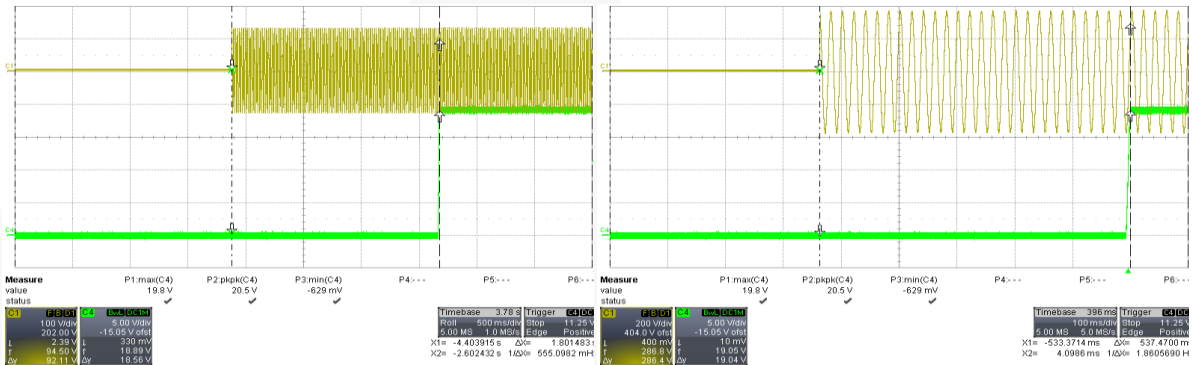


Figure 9. C1[V_{IN}], C4[V_O], 90 V_{AC} / 60 Hz

Figure 10. C1[V_{IN}], C4[V_O], 264 V_{AC} / 50 Hz

9.3. Hold-up Time

Test Condition

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

Table 7. Test Results

Input Voltage	Hold-up Time
90 V _{AC} / 60 Hz	7.9 ms
115 V _{AC} / 60 Hz	15.1 ms
230 V _{AC} / 50 Hz	83.9 ms
264 V _{AC} / 50 Hz	119 ms

Waveforms:

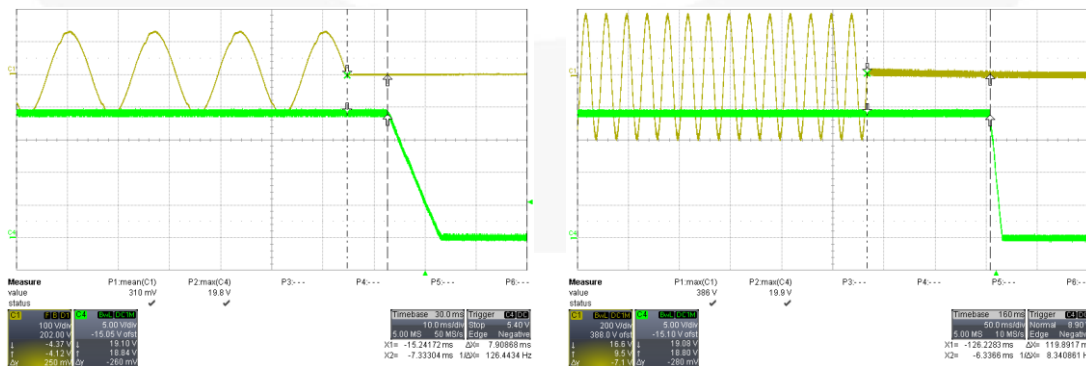


Figure 11. C1[V_{IN}], C4[V_O], 90 V_{AC} / 60 Hz

Figure 12. C1[V_{IN}], C4[V_O], 264 V_{AC} / 50 Hz

9.6. Dynamic Response

Test Condition

Dynamic loading (20%~80%), 50% duty cycle (5 ms), 2.5 A/ μ sec rise/fall time. Measured at PCB end.

Table 10. Test Results

Input Voltage	Overshoot	Undershoot	Specification
115 V _{AC} /60 Hz	262 mV	102 mV	
230 V _{AC} /50 Hz	301 mV	128 mV	

Waveforms:

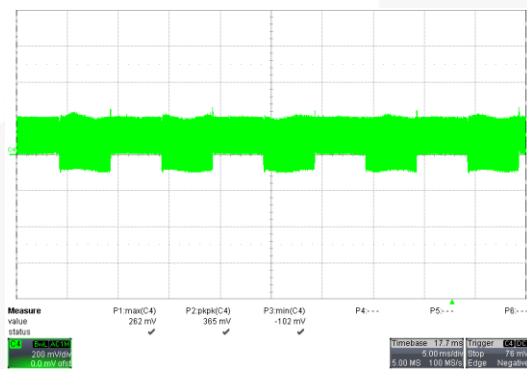


Figure 17. C4[V_O], 115 V_{AC} / 60 Hz

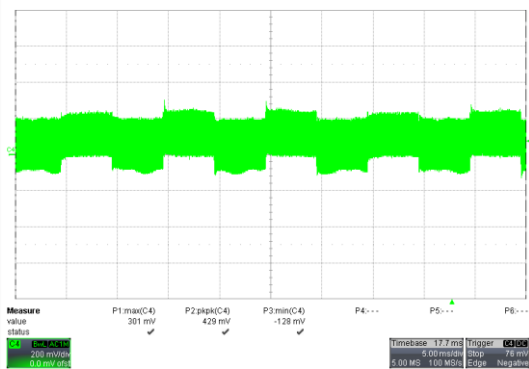


Figure 18. C4[V_O], 230 V_{AC} / 50 Hz

9.7. Output Ripple & Noise

Test Condition

Measure the output voltage ripple at full load condition at EVB end with 10 μ F electrolytic capacitor in parallel with 0.1 μ F MLCC.

Table 11. Test Results

Input Voltage	Full Load	Specification
90 V _{AC} / 60 Hz	345 mV _{P-P}	
115 V _{AC} / 60 Hz	312 mV _{P-P}	
230 V _{AC} / 50 Hz	292 mV _{P-P}	
264 V _{AC} / 50 Hz	299 mV _{P-P}	

Waveforms:

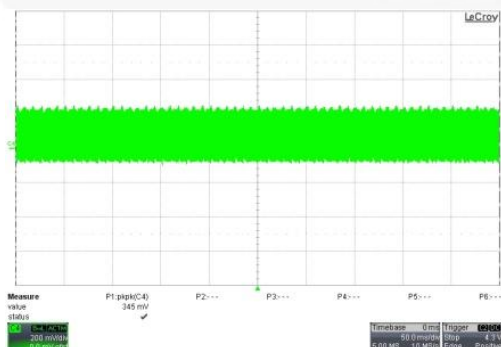


Figure 19. C4[V_O], 90 V_{AC} / 60 Hz

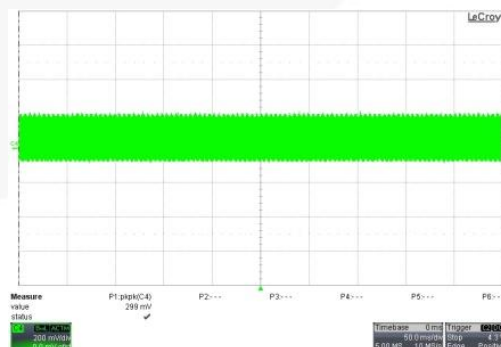


Figure 20. C4[V_O], 264 V_{AC} / 50 Hz

9.8. VDD Voltage Level

Test Condition

Measure VDD voltage at minimum, maximum loading and close over current protection point.

Table 12. Test Result

Input Voltage	Minimum load	Maximum load	Near OCP	Specification
90 V _{AC} / 60 Hz	12.45 V	14.8 V	16.4 V	< 22.5 V
264 V _{AC} / 50 Hz	12.6 V	14 V	15.4 V	

Waveforms:

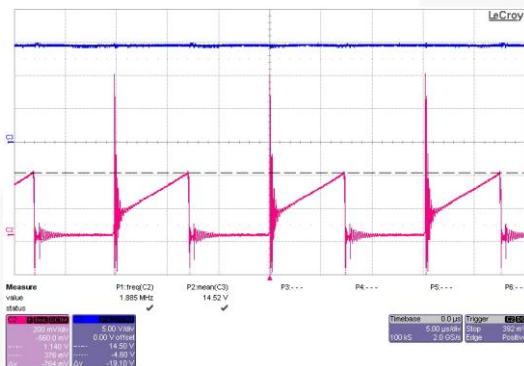


Figure 21. C2[V_{cs}], C3[V_{DD}] 90 V_{AC} / 60 Hz & Max. Load

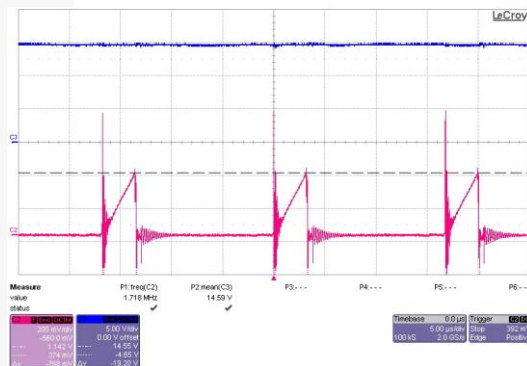


Figure 22. C2[V_{cs}], C3[V_{DD}] 264 V_{AC} / 50 Hz & Max. Load

9.9. Short-Circuit Protection (SCP)

Test Condition

Short output terminal, then the controller should enter hiccup mode protection with less than 10 ms.

Table 13. Test Results with Input Power

	Maximum Output Load	Minimum Output Load	Specification
90 V _{AC} / 60 Hz	7.18 ms	7.31 ms	< 10 ms
264 V _{AC} / 50 Hz	7.04 ms	7.14 ms	

Waveforms:

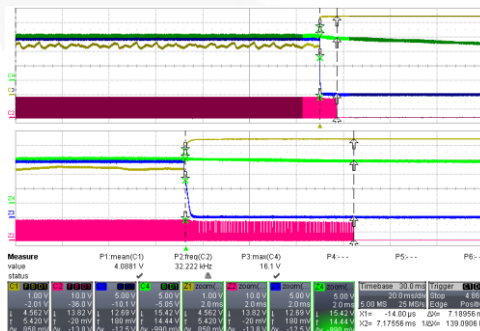


Figure 23. C1[FB], C2[GATE], C3[V₀], C4[V_{DD}], 90 V_{AC}/60 Hz

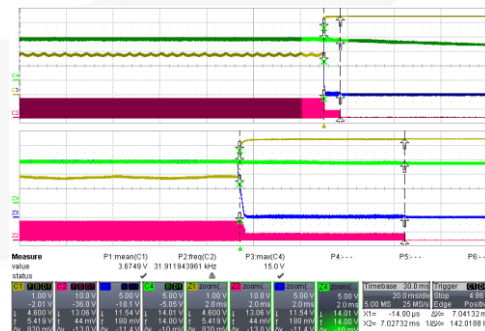


Figure 24. C1[FB], C2[GATE], C3[V₀], C4[V_{DD}], 264 V_{AC}/50 Hz

9.10. Overload Protection (OLP)

Test Condition:

Increase output loading gradually to trigger OLP and measure the debounce time.

Table 14. Test Results

Input Voltage	Minimum Load	Maximum Load	Specification
90 V _{AC} / 60 Hz	63.8 ms	64.1 ms	54 ms < t _{D-OLP} < 66 ms
264 V _{AC} / 50 Hz	63.5 ms	60.1 ms	

Waveforms:

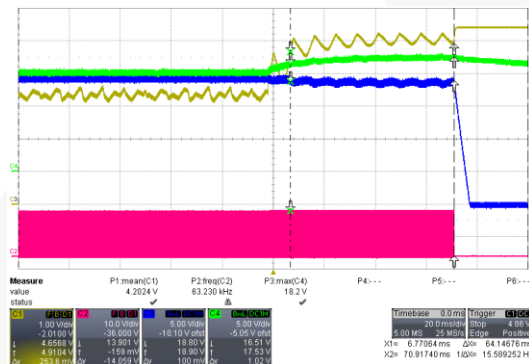


Figure 25. C1[FB], C2[GATE], C3[V_O], C4[V_{DD}],
90 V_{AC}/60 Hz

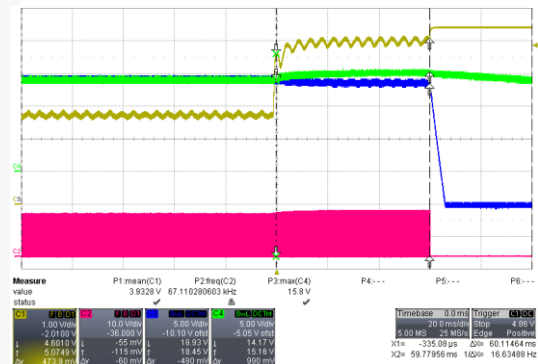


Figure 26. C1[FB], C2[GATE], C3[V_O], C4[V_{DD}],
264 V_{AC}/50 Hz

9.11. Voltage Stress on MOSFET & Rectifiers

Test Condition

Measure the voltage and current stress on MOSFET and secondary rectifier under below the conditions where the maximum voltage stress occurs.

Table 15. Test Results

		90 V _{AC} / 60 Hz	264 V _{AC} / 50 Hz	Specification
		Full Load	Full Load	
Normal	MOSFET	322 V	582 V	V _{DS} <600 V V _D <100 V
	Rectifier	55 V	86 V	
Short Circuit	MOSFET	294 V	502 V	
	Rectifier	28 V	93 V	

Waveform:

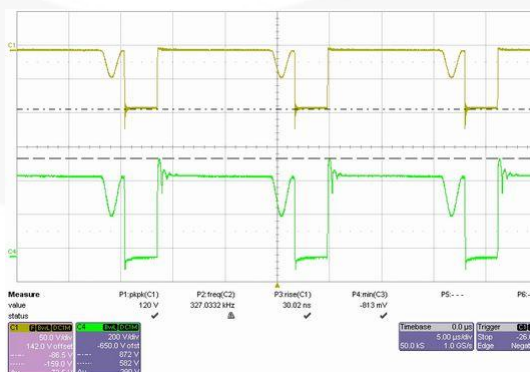


Figure 27. C1[V_{AK}], C4[V_{DS}] 264 V_{AC}/50 Hz, Full Load

9.12. Line & Load Regulation

Test Condition

Measure the line/load regulation according universal input and minimum to maximum loading.

Table 16. Test Results

Input Voltage	Output Voltage at Maximum Loading	Output Voltage at Minimum Loading	Load Regulation	Specification
90 V _{AC} / 60 Hz	19.11 V	19.276 V	0.8%	< ±5%
115 V _{AC} / 60 Hz	19.09 V	19.276 V	0.9%	
132 V _{AC} / 60 Hz	19.09 V	19.274 V	0.9%	
180 V _{AC} / 50 Hz	19.10 V	19.274 V	0.8%	
230 V _{AC} / 50 Hz	19.08 V	19.272 V	0.9%	
264 V _{AC} / 50 Hz	19.09 V	19.27 V	0.9%	
Line Regulation	0.13%	0.031%		

9.13. Efficiency

Test Condition

Measure the efficiency at universal input voltage and maximum loading.

Table 17. Test Results

Input Voltage	Output Voltage	Output Current	Input Wattage	Efficiency	Average Efficiency
90 V _{AC} / 60 Hz	19.224 V	0.52 A	11.26 W	88.78%	88.42%
	19.178 V	1.042 A	22.53 W	88.70%	
	19.134 V	1.571 A	33.97 W	88.49%	
	19.108 V	2.109 A	45.94 W	87.72%	
115 V _{AC} / 60 Hz	19.216 V	0.52 A	11.29 W	88.51%	89.09%
	19.188 V	1.044 A	22.36 W	89.59%	
	19.132 V	1.571 A	33.61 W	89.43%	
	19.088 V	2.109 A	45.32 W	88.83%	
230 V _{AC} / 50 Hz	19.226 V	0.52 A	11.29 W	88.55%	89.16%
	19.184 V	1.044 A	22.39 W	89.45%	
	19.138 V	1.571 A	33.66 W	89.32%	
	19.094 V	2.109 A	45.08 W	89.33%	
264 V _{AC} / 50 Hz	19.222 V	0.52 A	11.34 W	88.14%	88.85%
	19.174 V	1.044 A	22.61 W	88.53%	
	19.134 V	1.571 A	33.7 W	89.2%	
	19.128 V	2.094 A	44.74 W	89.53%	

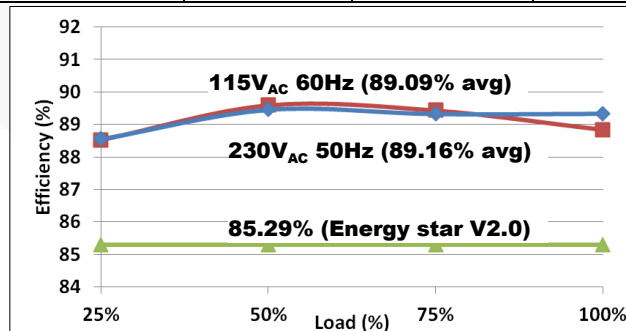


Figure 28. 4 Points Efficiency Curve

9.14. Over-Current Protection(OCP)

Test Condition

Increase output loading current gradually and measure the output maximum current.

Table 18. Test Results

Input Voltage	Over Current Protection	Specification
90 V _{AC} / 60 Hz	2.95 A	
115 V _{AC} / 60 Hz	3.02 A	
230 V _{AC} / 50 Hz	2.93 A	
264 V _{AC} / 50 Hz	2.96 A	

Curve:

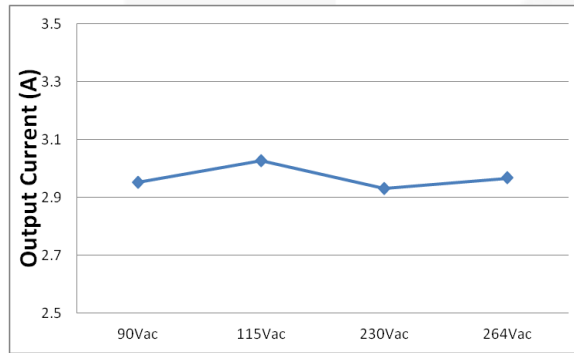


Figure 29. Output Current Protection Curve

9.15. Conducted Electromagnetic Interference (EMI)

Test Condition

- Frequency Range: 150 kHz – 30 MHz, Probe: 2-Line-LISN ENV216
- Signal Path: Receiver-2-Line-LISN ENV216, Detectors: Average
- Output Load: 9.025 Ω

Test Results:

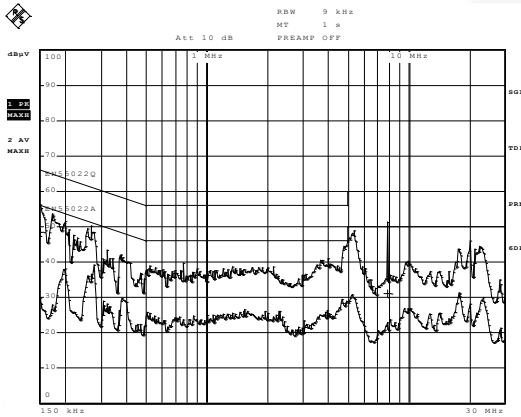


Figure 30. Line: 115 V_{AC} / 60 Hz

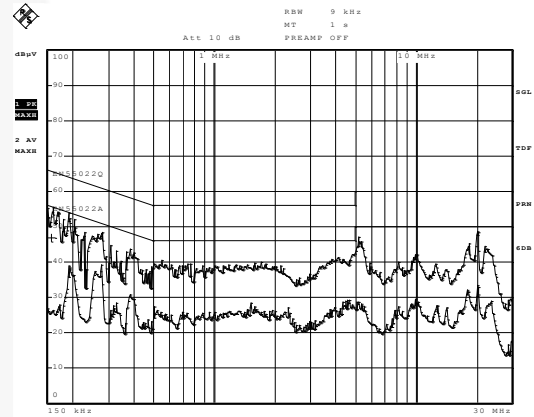


Figure 31. Neutral: 115 V_{AC} / 60 Hz

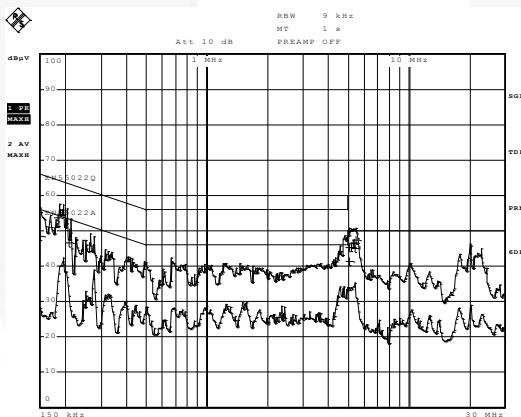


Figure 32. Line: 230 V_{AC} / 50 Hz

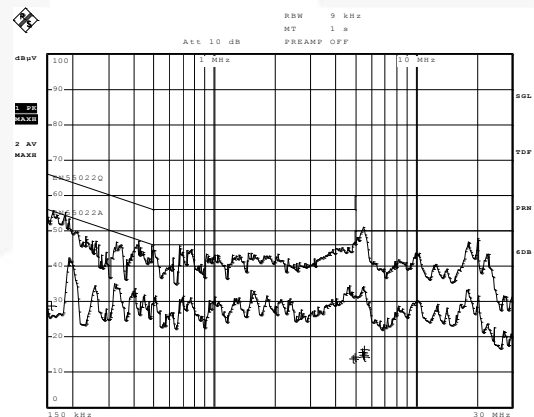


Figure 33. Neutral: 230 V_{AC} / 50 Hz

9.16. Surge Test

Test Condition

- 230 V_{AC} / 50 Hz, maximum load.
- N-PE / L-PE: (Positive & Negative) 1 kV ~ 4 kV, Phase 0°, 90°, 180°, 270°.
- L-N: (Positive & Negative) 500 V ~ 1 kV, Phase 0°, 90°, 180°, 270°.

Table 19. Test Results

	L-PE	N-PE	L-N
Result	±4.4 kV	±4.4 kV	±2 kV

9.17. ESD Test

Test Condition:

- 230 V_{AC} / 50 Hz, maximum load.
- Air discharge: (Positive & Negative) 8 kV ~ 16 kV, 20 times per level.
- Contact discharge: (Positive & Negative) 4 kV ~ 8 kV, 20 times per level.

Table 20. Test Result

	Air Discharge	Contact Discharge
Result	±16.5 kV	±8.8 kV



10. Revision History

Rev.	Date	Description
1.0	January 2015	Initial Release
1.1	June 2015	BOM updated, Figure 7 replaced, Table 2, 3,

WARNING AND DISCLAIMER

Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Users' Guide. Contact an authorized Fairchild representative with any questions.

This board is intended to be used by certified professionals, in a lab environment, following proper safety procedures. Use at your own risk. The Evaluation board (or kit) is for demonstration purposes only and neither the Board nor this User's Guide constitute a sales contract or create any kind of warranty, whether express or implied, as to the applications or products involved. Fairchild warrants that its products meet Fairchild's published specifications, but does not guarantee that its products work in any specific application. Fairchild reserves the right to make changes without notice to any products described herein to improve reliability, function, or design. Either the applicable sales contract signed by Fairchild and Buyer or, if no contract exists, Fairchild's standard Terms and Conditions on the back of Fairchild invoices, govern the terms of sale of the products described herein.

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FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

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