Engineering Test & Characterization Report

FAN6961 50W LED DRIVER POWER

Featured FSC Products: **FAN6961, FQPF8N80C, FYPF2010DN**

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1. Introduction

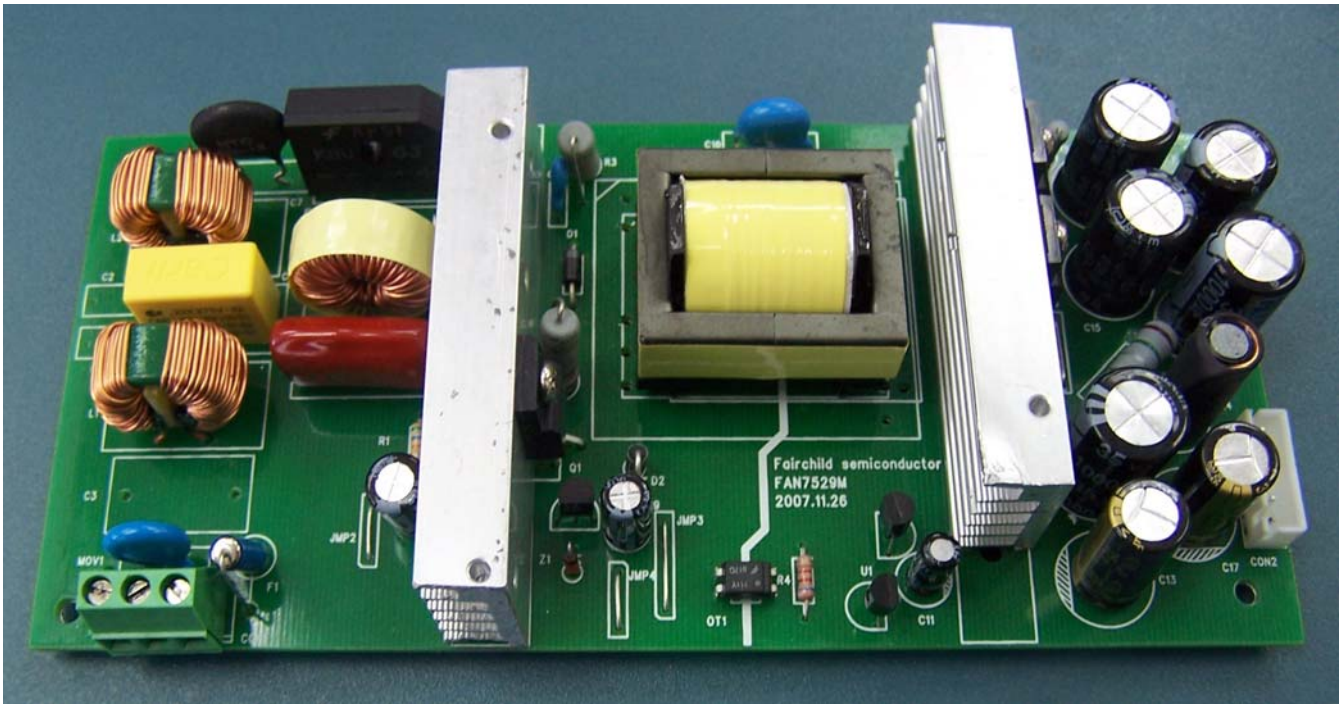
1.1 Product Description

This document describes the performances of a 50 W reference board, with wide-range operation voltage and single stage power-factor-correction (PFC). The demo board utilizes a single stage PFC solution which can get a quite high PF value and improve the efficiency of the power.

This solution utilizes a common CRM PFC IC to control a traditional Flyback topology, which can decrease the cost a lot and get a high efficiency. The topology operates at a various frequency with the input voltage change, which ensure the input current to follow the input voltage and improve the PF value. It must be noticed that the input rectifier capacitor should be small so that the input voltage is very close to the rectified sinusoid. The solution optimized the ratio of performance and price, further more the structure and the design is quite easy. The Power Supply mainly utilizes the semiconductor components of Fairchild, for example: Fairchild FAN6961 – An advanced PFC controller, Fairchild FQPF8N80C –A planar stripe DMOS technology Mosfet, Fairchild FYPF2010–A shottky diode. The output is 24V-2A.

This document contains some important information (e.g. Schematic, Bill of Materials, Transformer documentation, Printed circuit layout and electrical performance data). Additional soft copy of the above item could also be obtained from the related sales channels of Fairchild (or visit ***http://www.fairchildsemi.com***).

1.2 Finished Assembly



2. Electrical Requirements

2.1 Input Requirements

Voltage range: 90 to 264 Vac
Frequency: 47 to 63 Hz
Power Factor: ≥0.9

2.2 Output Requirements

Voltage (V)			Regulation	Ripple Voltage (V)	Current (A)	
Min	Nom	Max			Min	Max
22.8	24	25.2	5%	1.5	0.1	2

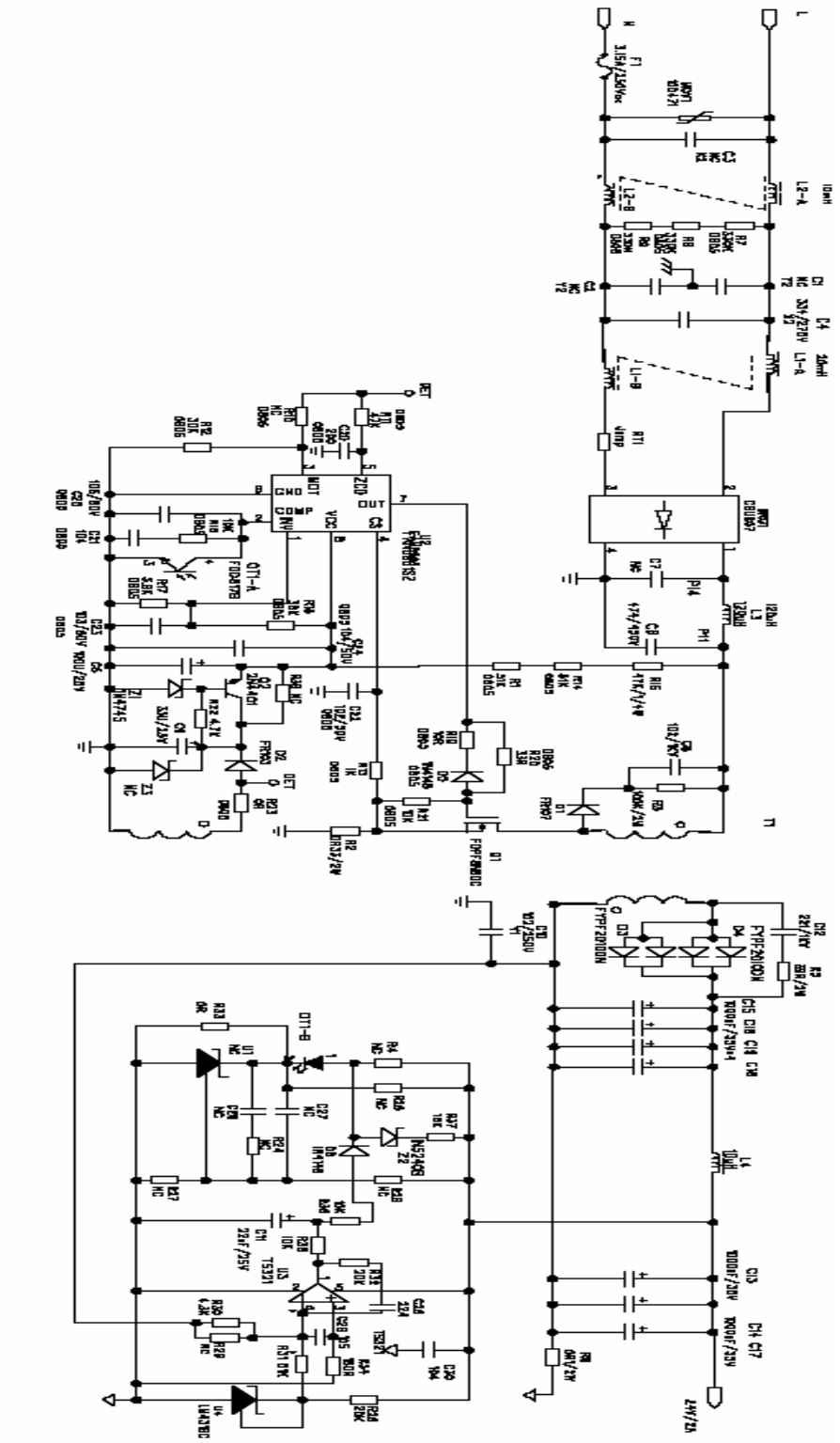
2.3 Output efficiency

The efficiency of the power supply can be better than 80%(full load condition) at all the range of input voltage.

3. Solution

3.1 Schematic

FAN6961 signal stage SCH



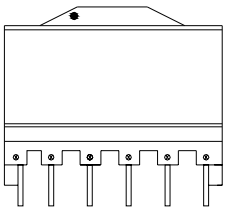
3.2 Circuit description

The circuit consists of a simple Flyback topology, whose control is implemented through the Fairchild's FAN6961 controller, which operates on CRM(critical continuously mode) and needs very few external components. CRM operation ensures low turn-on losses in the MOSFET and the high PF reduces dissipation in the rectifier bridge. Twice-mains-frequency ripple on the output: unavoidable if a high PF is desired. A large output capacitance will reduce its amount. Speeding up the control loop may lead to a compromise between a reasonably low output ripple and a PF still reasonably high; This circuit also can be implement constant current control by the secondary operational amplify.

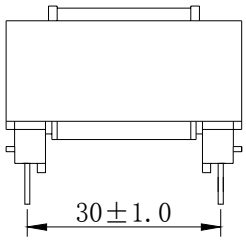
3.3 Magnetic components specification

3.3.1 T1 specification

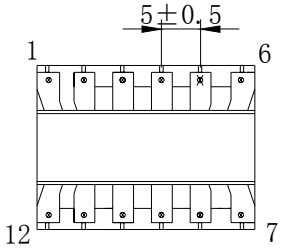
Sketch chart



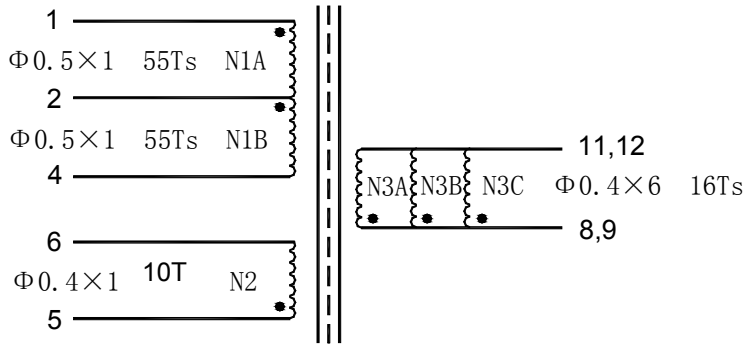
Main view



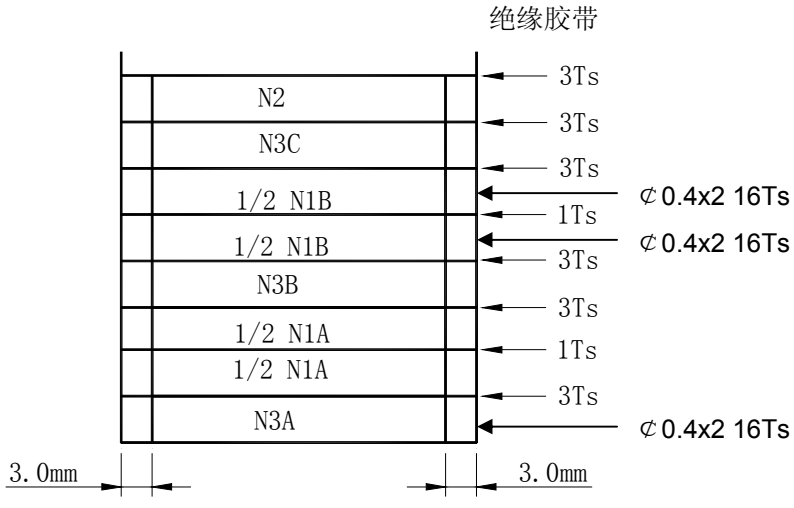
Side view



Bottom view



Theory diagram



winding diagram

Material：
1.Magnetic Core： TDK PC40 & SAMWHA PL-7 ER2834S
2.Bobbin：EER2834 horizontal 12pin，Pin distance 5mm, Row distance 30mm

Electrical performance：
1.Inductance：L(1—4)= 800 - 850uH
2.Leakage inductance ： less than 20uH

Winding request：
1.Winding should be tight, no cross and filled in the whole window averagely；
2.The gap should be gotten through rubbing the center pole;
3.Three layer insulating tape should be placed between primary and secondary；
4.Pin3,10 should be cut after varnishing, Pin2 should be cut half；
5.Pin1 should be highlighted with white point on the bobbin.

3.4 Bill Of Material

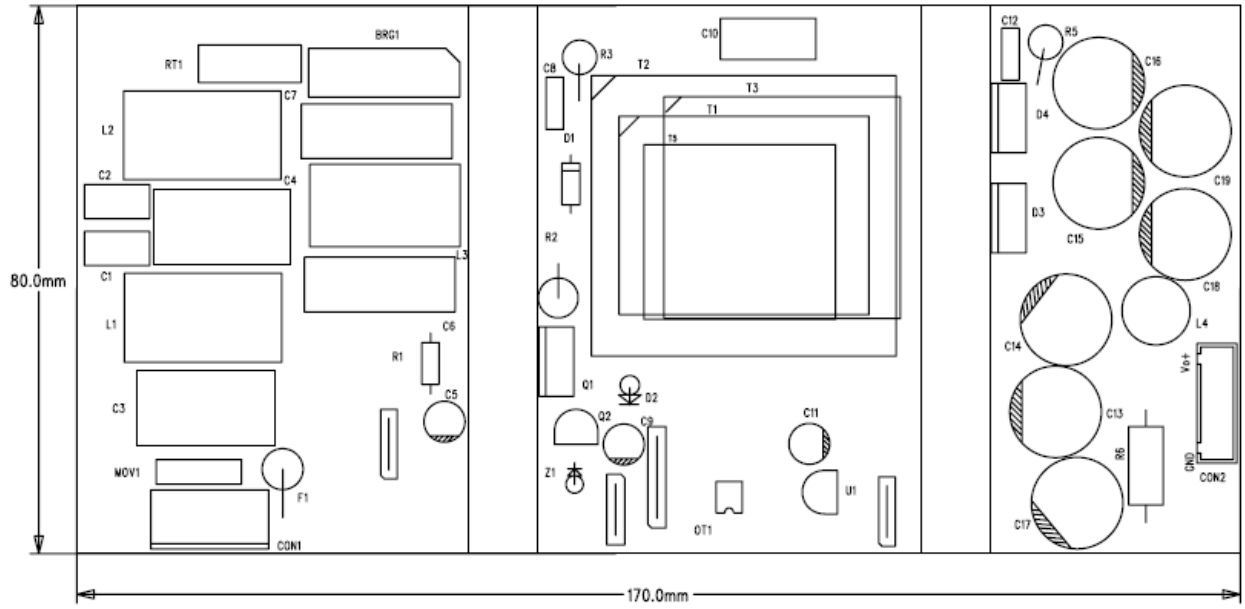
ITEM	NAME	QUANTITY	SEPC	DECAL
1	BRG1	1	KBU4K	
2	C20	1	20pF/50V	SMD0805
3	C21	1	1uF/25V	
4	C22	1	102/50V	
5	C23	1	473/50V	
6	C24,	1	104/50V	
7	C25,C28	2	224/50v	
8	C27,C29	1	105/50V	
9	C26,C27,C7,C3,R4,R24,R25 R27,R28,U1,R10,R29	1	NC	
10	C12	1	221/1KV	Ceramic Capacitor
11	C8	1	102/1KV	Ceramic Capacitor
12	C1,C2	2	102/250Vac	Y2
13	C10	1	102/250Vac	Y1
14	C6	1	474/450V	Film Capacitor
15	C4	1	224/250Vac	X2
16	C13,C15,C16,C18,C19 C14,C17,	7	1000uF/35V	Electric Capacitor
18	C5	1	100uF/25V	Electric Capacitor
19	C9	1	33uF/50V	Electric Capacitor
20	C21	1	22uF/50V	Electric Capacitor
21	CON1	1	3Pin	Input terminal
22	CON2	1	6Pin	Output terminal
23	D1	1	FR107	DO-41
24	D2	1	FR103	DO-41
25	D5,D6	1	1N4148	LL34
26	D3,D4	2	FYPF2010DN	T0-220
27	F1	1	3.15A/250Vac	
28	U2	1	FAN7529M	SO-8
29	L3	1	120Uh(T60-26)	Difference inductor
30	L4	1	10uH	Stick inductor
31	L1,L2	2	30mH	Common inductor
32	MOV1	1	10D471	MOV
33	OT1	1	FOD817B	Opto couple
34	Q1	1	FQPF8N80C	TO-220
35	Q2,	1	2N4401	TO-92
36	R1,R14,R31	1	51K	SMD0805
37	R22,R30	1	4.3K	
38	R7,R8,R9	3	330K	
39	R12,R17	2	30K	
40	R11,	1	47K	
41	R13,	1	1K	
42	R16,	1	5K1	

43	R18	1	36K	
44	R26,R32	2	20K	
45	R19,	1	10R	
46	R20	1	33R	
47	R21,R35,R36	1	10K	
48	R23,R34	2	0R	
49	R15,	1	47K	1/4W
50	R3	1	100K/2W	2W
51	R5	1	22R/2W	2W
52	R6	1	0R1/2W	2W
53	R2	1	0R33	2W
54	RT1	1	5D-13	NTC
55	T1	1	EER2834S	Tansformer
56	U4	1	LM431SC	Regulator
57	Z1	1	15V	Zener diode
58	Z2	1	6.8V	Zener diode

3.5 PCB layout

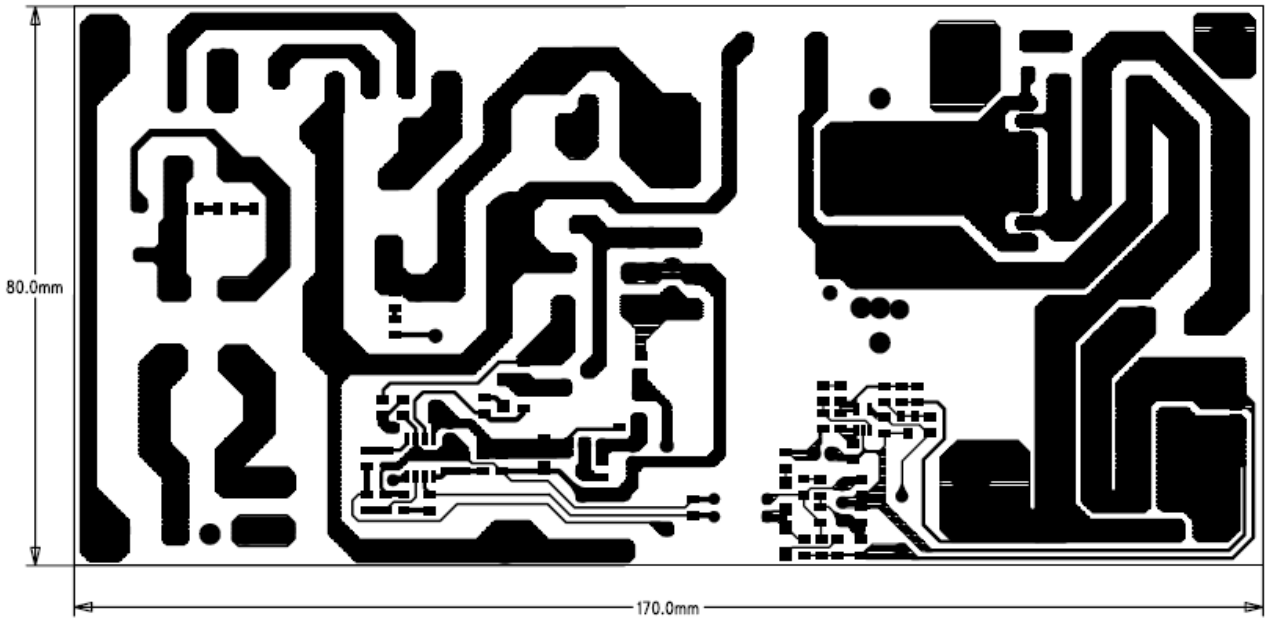
The PCB is a single sided board made of CEM-1 with 1oz copper.

Top Silkscreen/component placement of pcb layout.



Bottom Silkscreen/component placement of pcb layout.

Bottom layer viewed from the top of the board.



4. Test Results

4.1 Line and load Regulation

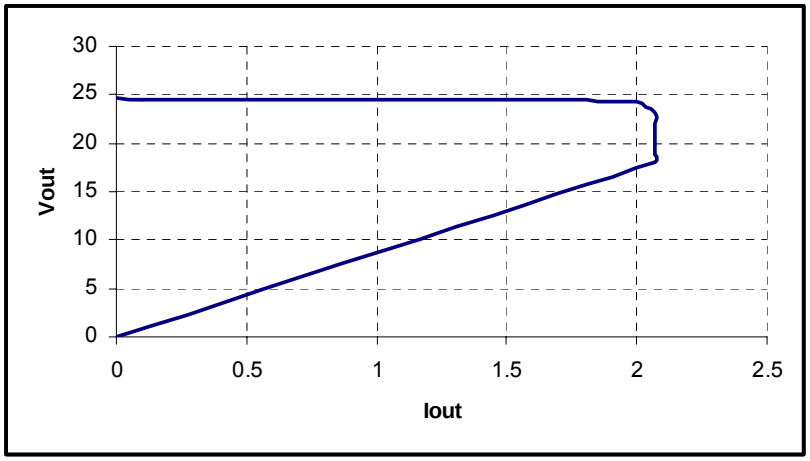
Input Voltage	Load condition	24Voutput(V)
		22.8-25.2V
90Vac	24V/0.1A	24.57
	24V/1A	24.42
	24V/2A	24.24
110Vac	24V/0.1A	24.61
	24V/1A	24.51
	24V/2A	24.22
220Vac	24V/0.1A	24.62
	24V/1A	24.59
	24V/2A	24.25
264Vac	24V/0.1A	24.58
	24V/1A	24.54
	24V/2A	24.24

4.2 Efficiency

The efficiency is tested at full load and all range voltage

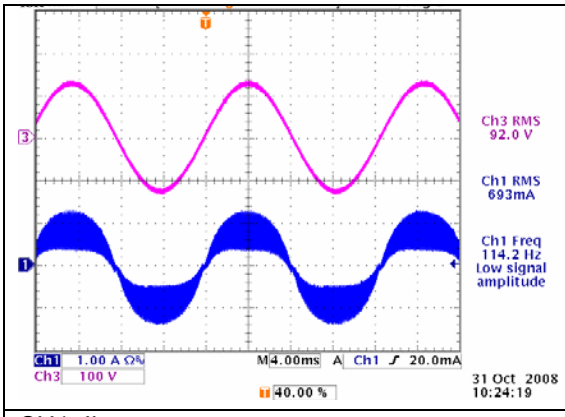
Input Voltage	PF	THD(%)	Output Power(w)	Input Power(w)	Efficiency(%)
90Vac	0.989	12.21	48.91	58.8	83.17
110Vac	0.987	14.22	48.91	57.5	85.05
220Vac	0.953	21.88	48.91	57.2	85.50
264Vac	0.936	23.26	48.91	57.9	84.46

4.3 CV&CV Regulation Curve

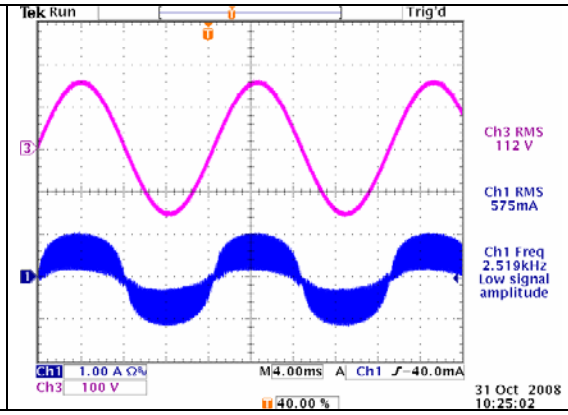


4.4 Operation waveform

90 Vac input, fullload, Vin-Iin

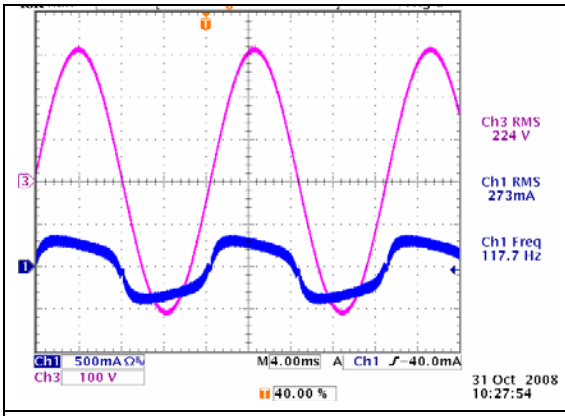


110Vac input, fullload, Vin-Iin

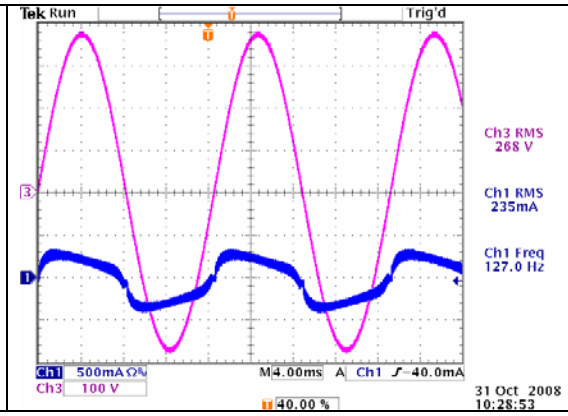


CH1: Iin
CH2: Vin

220Vac input, fullload, Vin-Iin

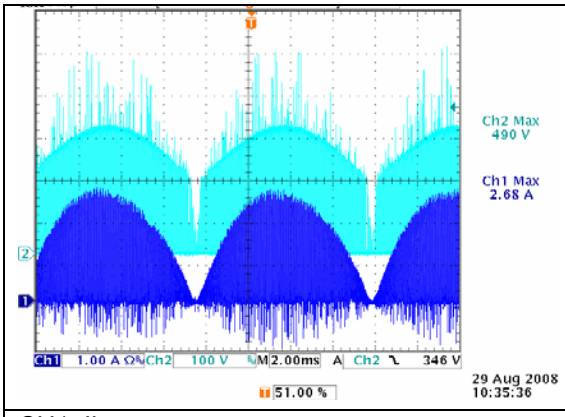


264Vac input, fullload, Vin-Iin

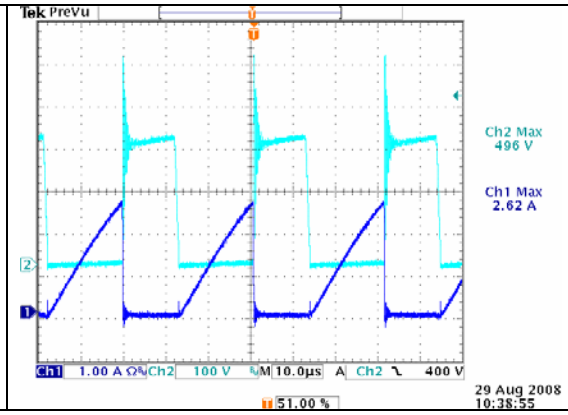


CH1: Iin
CH2: Vin

90Vac input, fullload, Vds(Q1)_MAX=490V
Id_MAX=2.68A

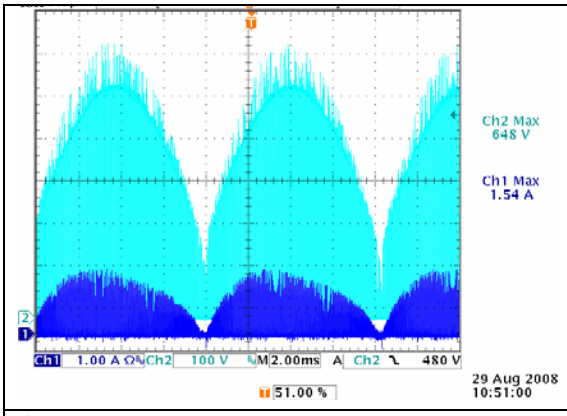


90Vac input, fullload, Vds(Q1)_MAX=496V
Id_MAX=2.62A

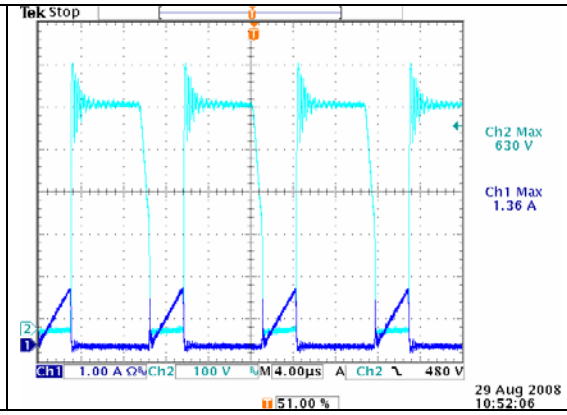


CH1: Iin
CH2: Vin

264Vac input ,fullload, Vds(Q1)=648V
Id_MAX=1.54A

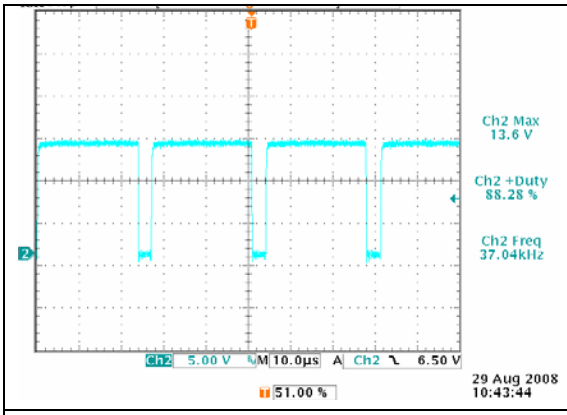


264Vac input ,fullload, Vds(Q1)=630V
Id_MAX=1.36A

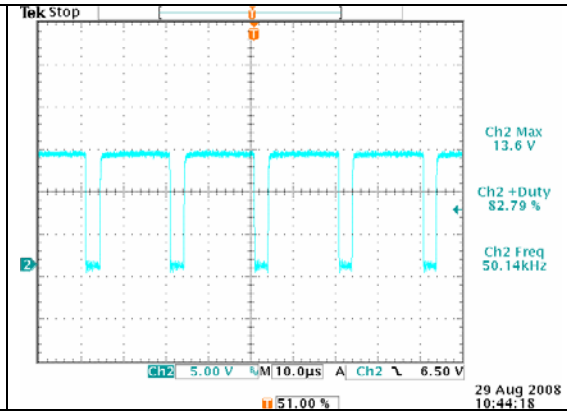


CH1: Iin
CH2: Vin

90Vac input, fullload, Vgs(Q1),D_MAX=88.28%

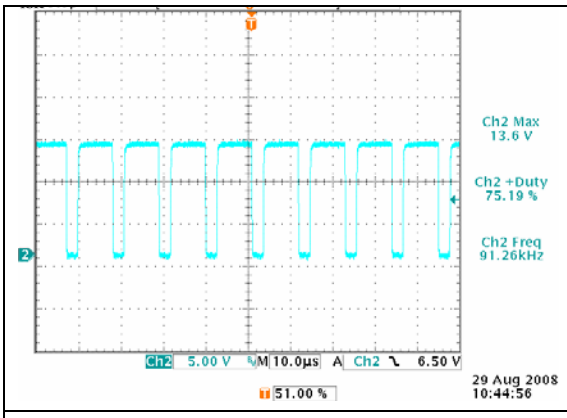


110Vac input, fullload, Vgs(Q1),D_MAX=82.79%

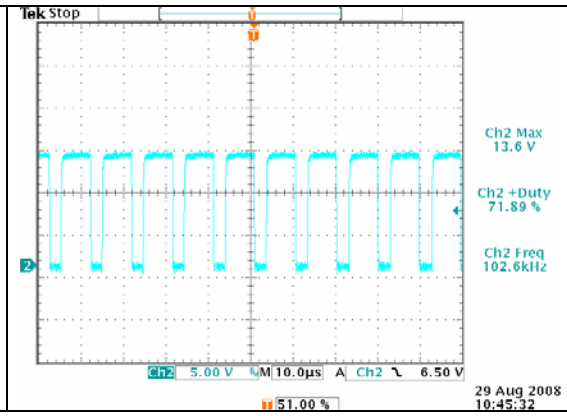


CH1: Iin

220Vac input, fullload, Vgs(Q1) , D_MAX=75.19%

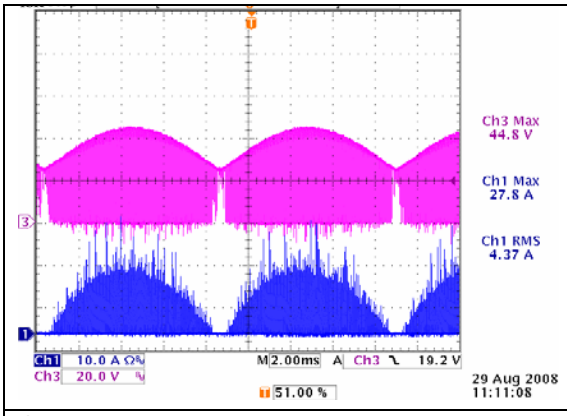


264Vac input, fullload, Vgs(Q1) , D_MAX=71.89%

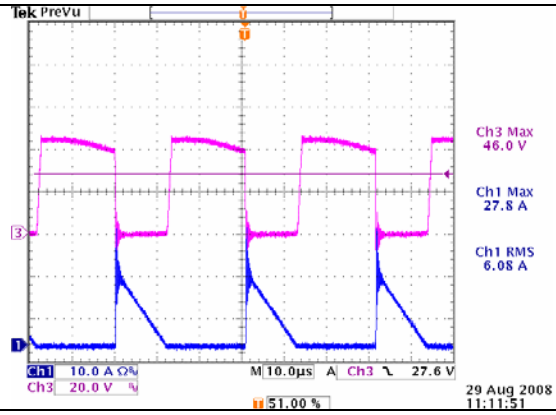


CH1: Iin

90Vac input, voltage and current stress of secondary rectifier diode

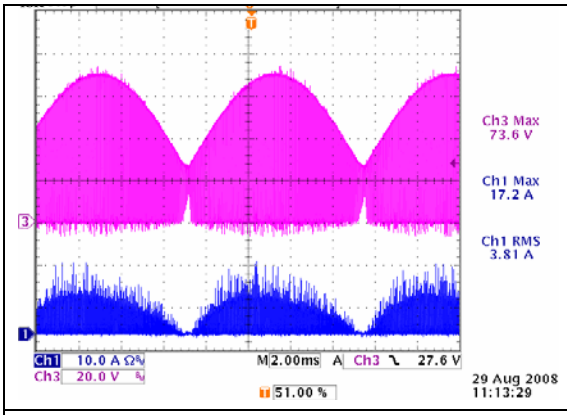


90Vac input, voltage and current stress of secondary rectifier diode

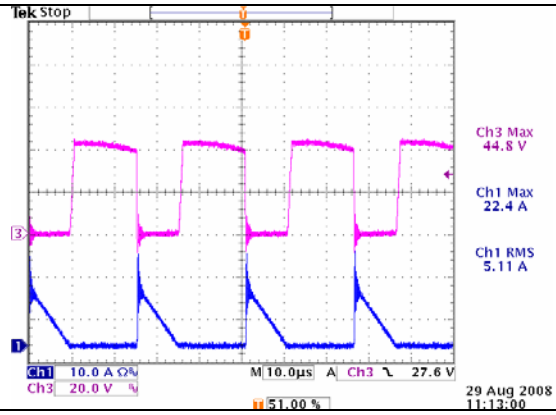


CH1: Io_diode
CH3: Vdiode_sec

110Vac input, voltage and current stress of secondary rectifier diode

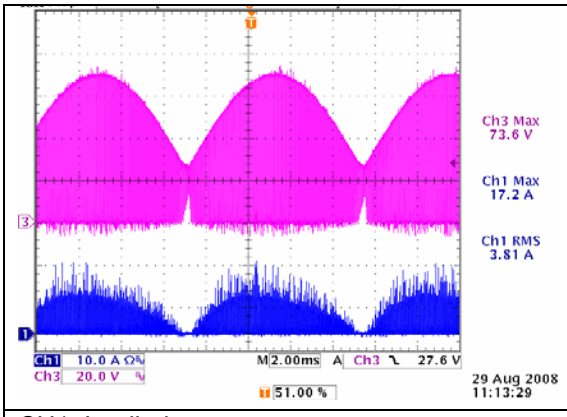


110Vac input, voltage and current stress of secondary rectifier diode

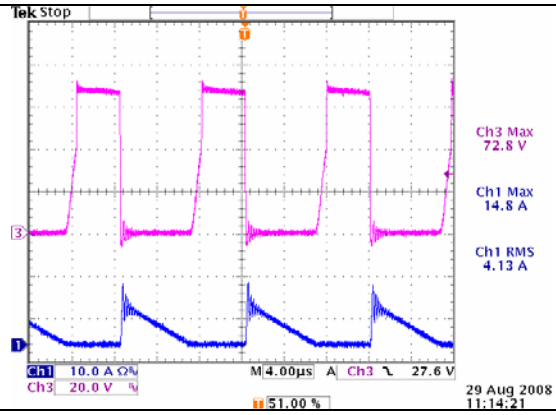


CH1: Io_diode
CH3: Vdiode_sec

220Vac input, voltage and current stress of secondary rectifier diode

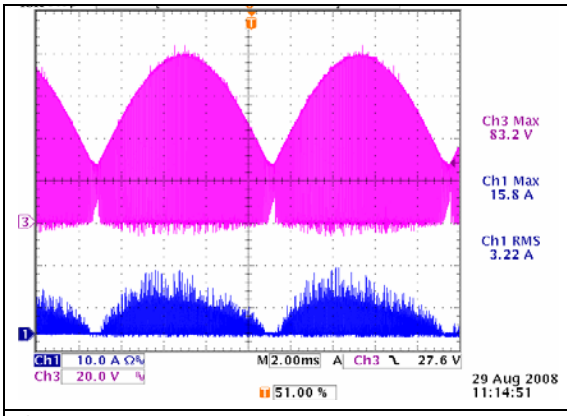


220Vac input, voltage and current stress of secondary rectifier diode

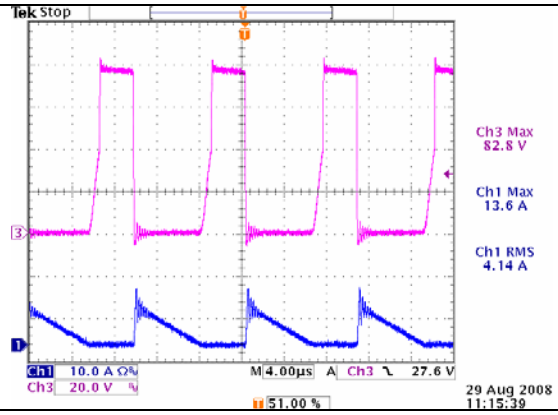


CH1: Io_diode
CH3: Vdiode_sec

264Vac input, voltage and current stress of secondary rectifier diode

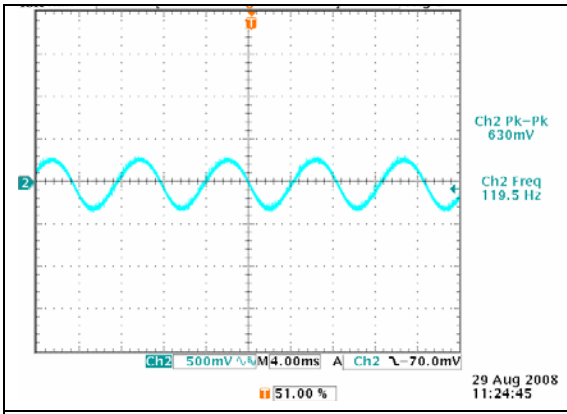


264Vac input, voltage and current stress of secondary rectifier diode

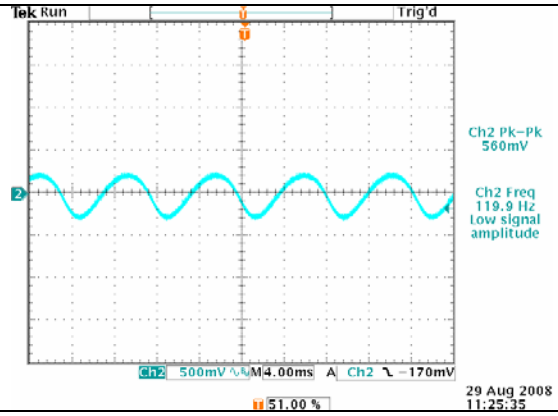


CH1: Io_diode
CH3: Vdiode_sec

90Vac input, full load, ripple current and noise(60Hz)

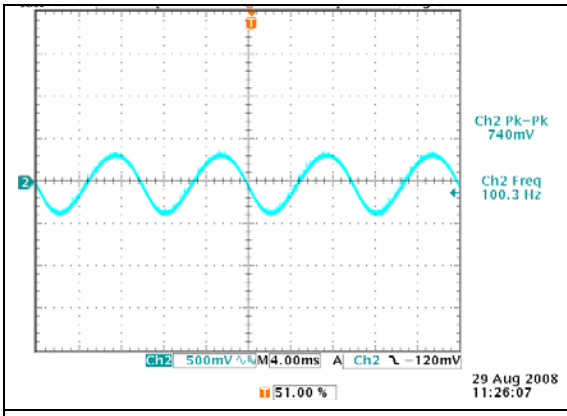


264Vac input, full load, ripple current and noise(60Hz)

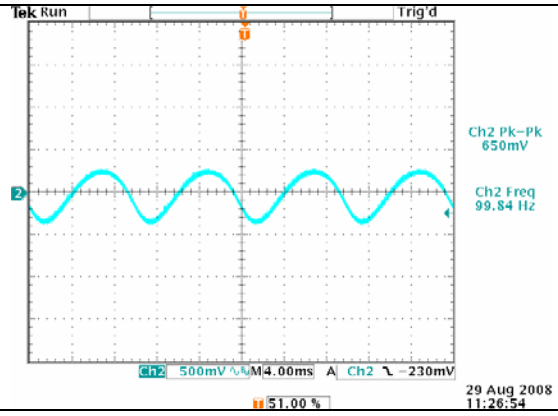


CH2:Vripple

264Vac input, full load, ripple current and noise(50Hz)



90Vac input, full load, ripple current and noise(50Hz)

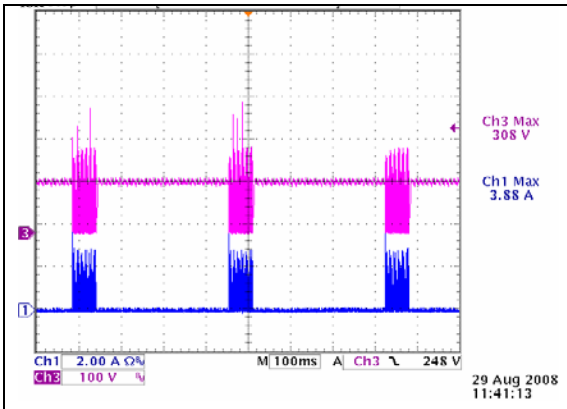
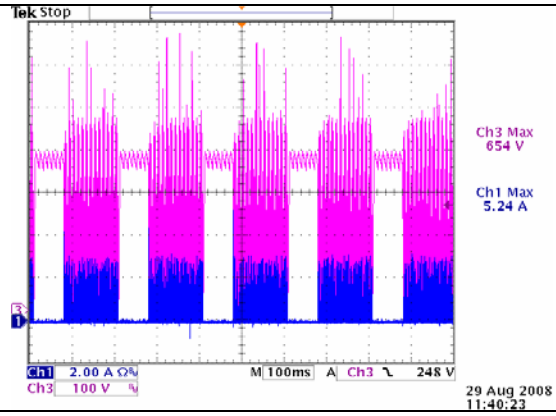


CH2:Vripple

4.5 Protection

4.5.1 Output Short Test

If one or two channel of the output 24V is shorted, the power will shut down and when the fault is removed, the power will recovery.

90Vac input	264Vac input
	
CH1: Ids CH3: Vds	

Featured Products

5.1 FAN6961

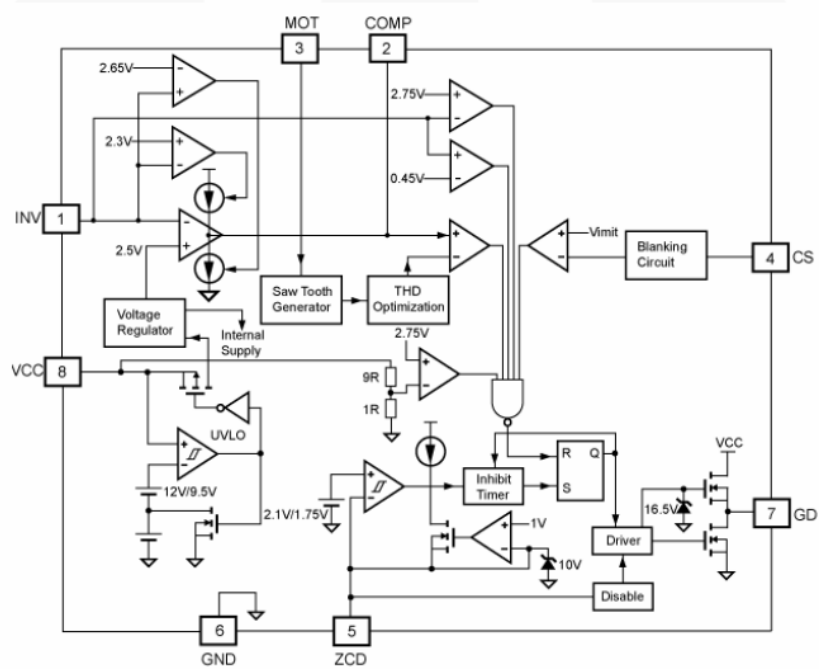
5.1.1 Product Description

The SG6961 is an 8-pin boundary mode PFC controller IC intended for controlling PFC pre-regulators. The SG6961 has many new features. It provides a controlled on-time to regulate the output DC voltage and achieve natural power factor correction. The maximum on-time of the external switch is programmable to ensure safe operation during AC brownouts. An innovative multi-vector error amplifier is built in to provide rapid transient response and precise output voltage clamping. A built in circuit will disable the controller if the output feedback loop is opened. The start up current is lower than 20uA and the operating current has been shrunk to under 4.5mA. The supply voltage can be up to 20 volts, maximizing application flexibility.

5.1.2 Main Features

- Boundary Mode PFC Controller
- Low Input Current THD
- Controlled On-Time PWM
- Zero-Current Detection
- Cycle-by-Cycle Current Limiting
- Leading-Edge Blanking instead of RC Filtering
- Low Start-up Current (10uA TYP.)
- Low Operating Current (4.5mA TYP.)
- Feedback Open Loop Protection
- Programmable Maximum On-Time (MOT)
- Output Over-Voltage Clamping Protection
- Clamped Gate Output Voltage 16.5V

5.1.3 Internal Block Diagram



Warning and Disclaimer

WARNING AND DISCLAIMER

This Evaluation Board may employ high voltages so appropriate safety precautions should be used when operating this board. Replace components on the Evaluation Board only with those parts shown on the parts list in the User's Guide. Contact an authorized Fairchild representative with any questions. The Evaluation board 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 of implied, as to the applications or products involved. Fairchild warranties that its products will meet Fairchild's published specifications but does not guarantee that its products will work in any specific application. Fairchild reserves the right to makes 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 Stand Terms and Conditions on

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