



FEB-L001

Evaluation Board Test Report

Application for LED Lighting
(FAN7529 Evaluation Board Rev 1.00)

May 1, 2009



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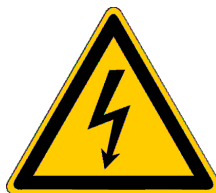
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1.2. Warning

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 BOM. Contact an authorized Fairchild representative with any questions.



2. Introduction

This document describes the proposed solution for an universal LED ballast using the FAN7529 CRM PFC controller. The input voltage range is $90V_{RMS} - 265V_{RMS}$ and there is one DC output with a constant current of 700mA @ 24Vmax.

This document contains general description of FAN7529, the power supply specification, schematic, bill of materials and the typical operating characteristics.

2.1. General Description of FAN7529

The FAN7529 is an active power factor correction (PFC) controller for boost PFC applications that operates in critical conduction mode (CRM). It uses the voltage mode PWM that compares an internal ramp signal with the error amplifier output to generate MOSFET turn-off signal. Because the voltage-mode CRM PFC controller does not need rectified AC line voltage information, it saves the power loss of the input voltage sensing network necessary for the current-mode CRM PFC controller.

2.2. Features of FAN7529

- ✓ .Voltage mode PWM : No input voltage sensing for power factor correction
- ✓ Controlled on-time PWM, Programmable max. on-time (MOT)
- ✓ Precise output over voltage protection ($\pm 2\%$)
- ✓ Output over-voltage clamping protection
- ✓ Voltage sensing OVP high sensing resistor can be used
- ✓ Programmable maximum on-time (MOT)
- ✓ Open feedback protection and disable function(65uA)
- ✓ Vcc shut-down circuit is unnecessary
- ✓ Low start-up current : 40uA
- ✓ Low operating current : 2.5mA, (FAN7529)
- ✓ Internal RC filter for current sensing
- ✓ 8-DIP and 8-SOP package



2.3. Internal Block Diagram of FAN7529

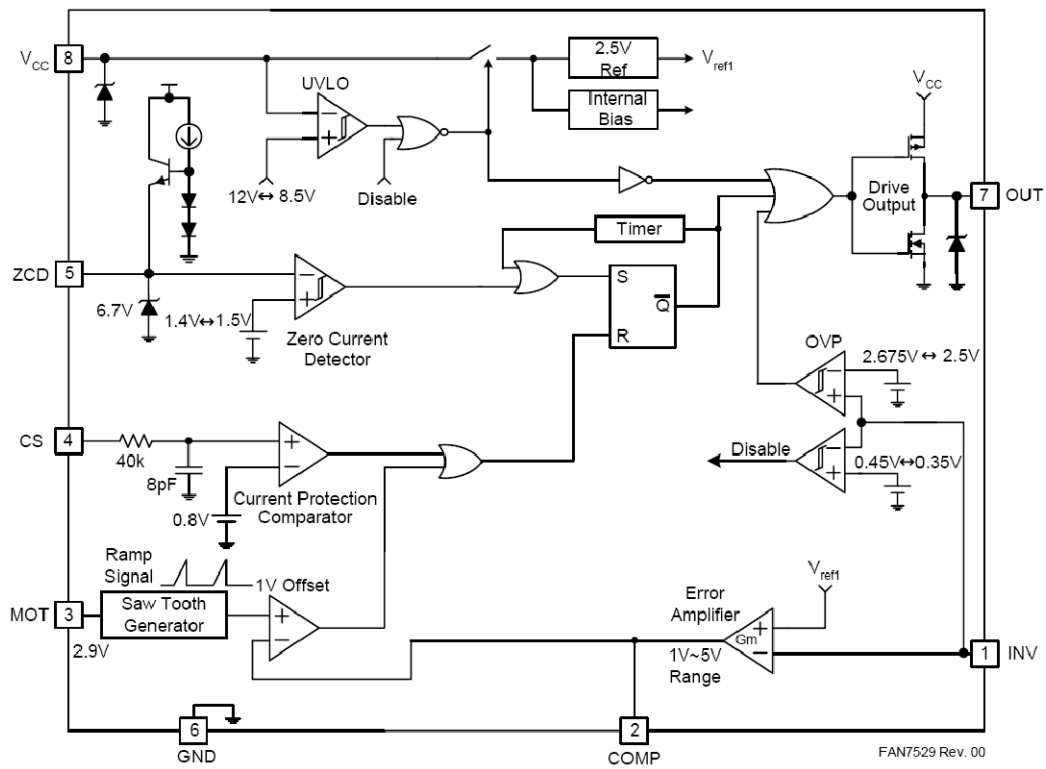


Fig. 1. Internal Block Diagram of FAN7529



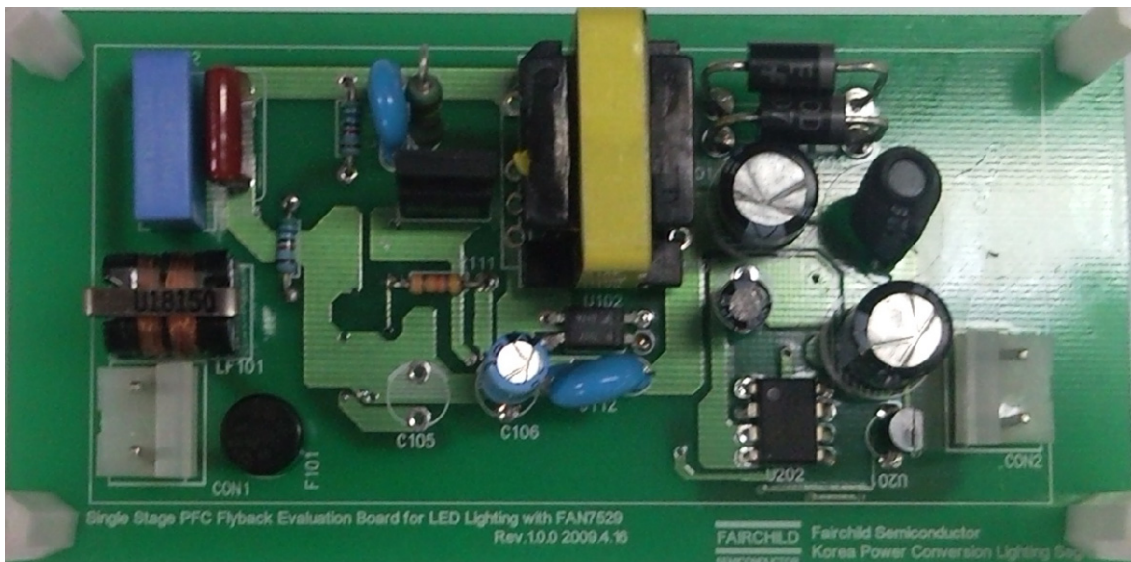
3. General Specifications for Evaluation Board

Table 1. Evaluation Board specifications for LED Lighting Bulb

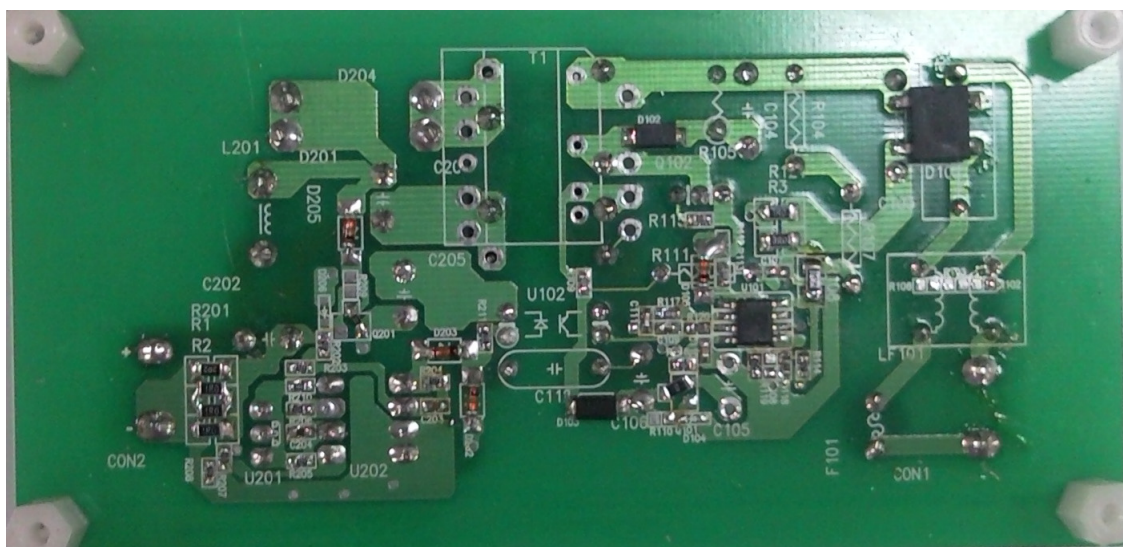
Main controller	FAN7529
Input Voltage range	90 ~ 265 V _{AC}
Input Voltage Frequency	47~63Hz
Rated output power	16.8W
Rated output voltage	24V
Rated output current	0.7A
Application	LED Lighting Bulb

All data of the evaluation board were measured under a condition where the board was enclosed in a case and external temperature was around 25°C.

3.1. A photograph of the Evaluation Board



(a) Top view

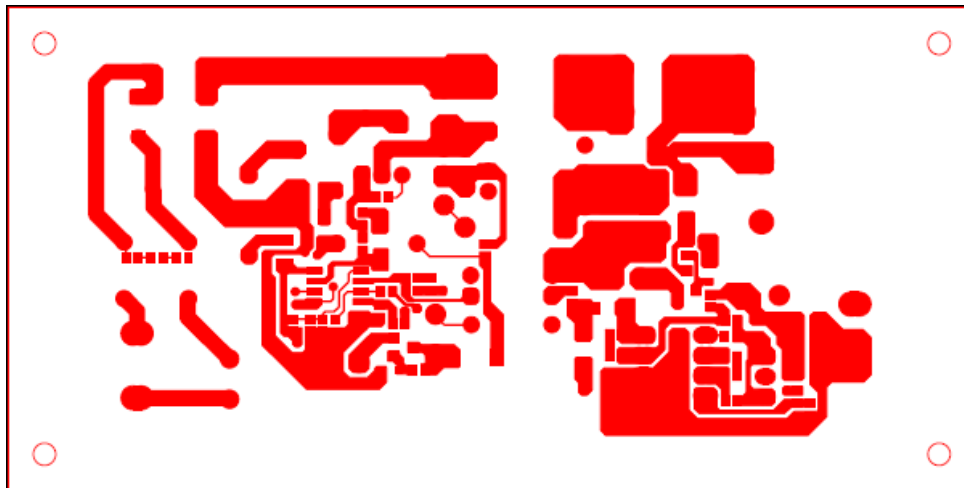


(b) bottom view

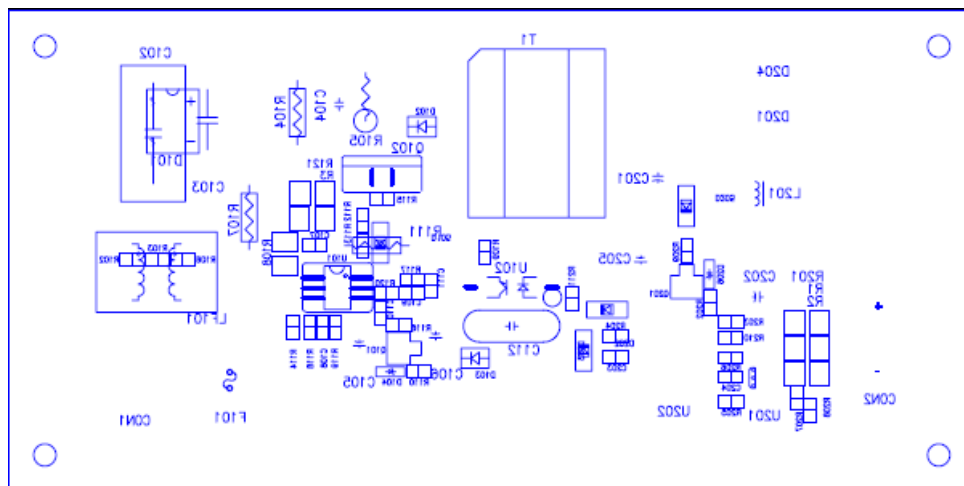
Fig. 2. Photograph of evaluation board



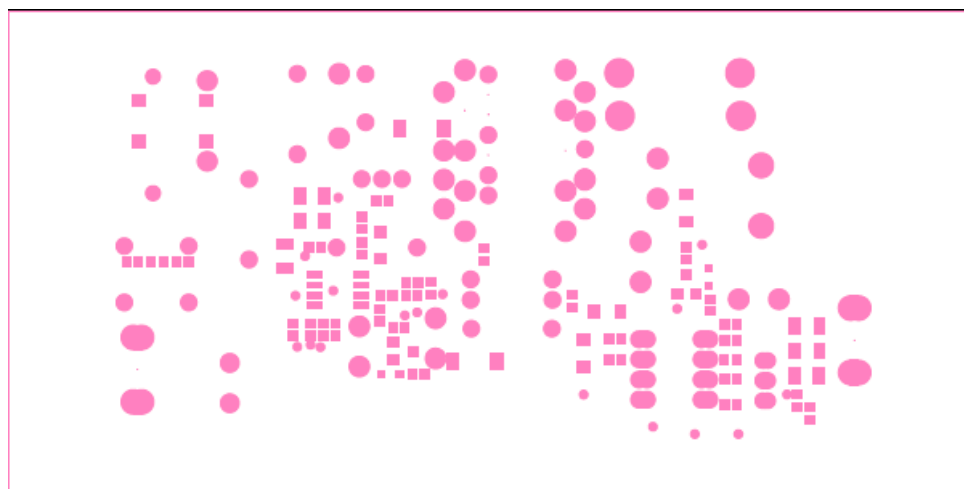
3.2. Printed Circuit Board



(a) Bottom Pattern

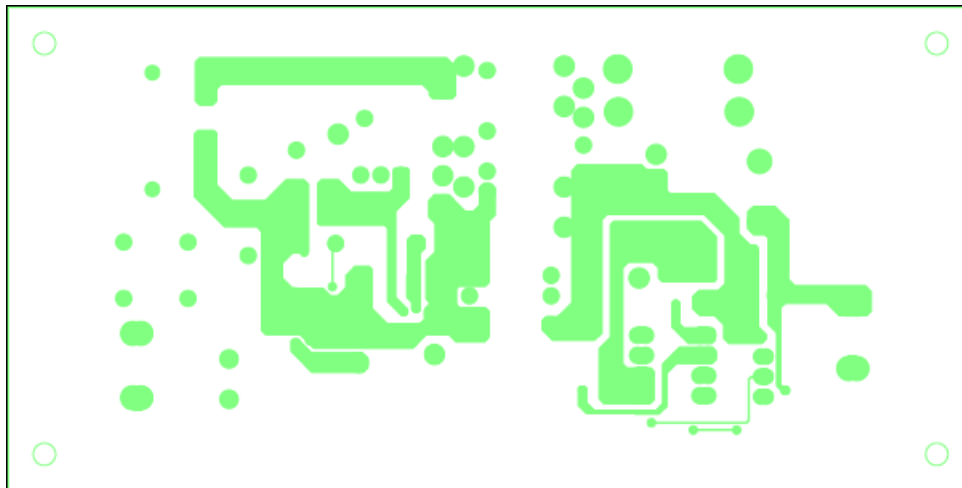


(b) Bottom silk

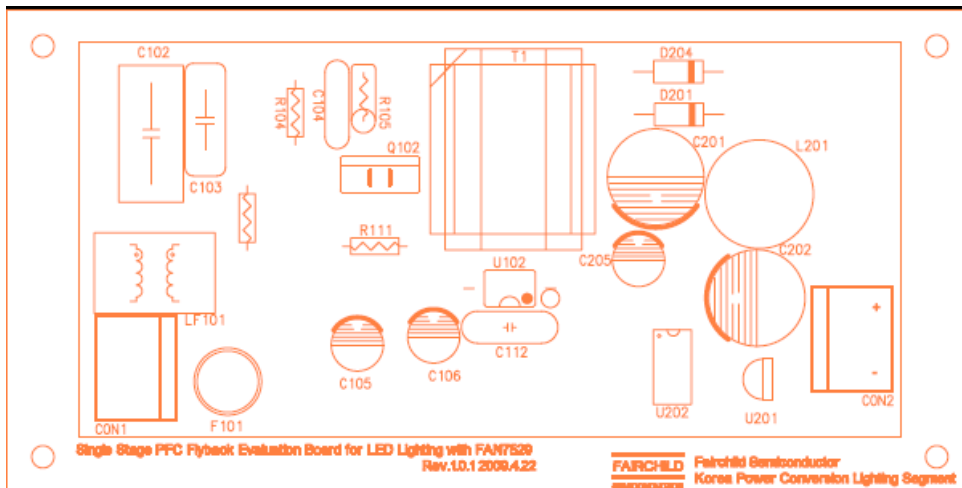


(c) Bottom solder mask

Fig. 3. Bottom side PCB of the evaluation board.



(a) Top Pattern



(b) Top silk



(c) Top solder mask

Fig. 4. Top side PCB of the evaluation board.



3.3. Schematic of the Evaluation Board

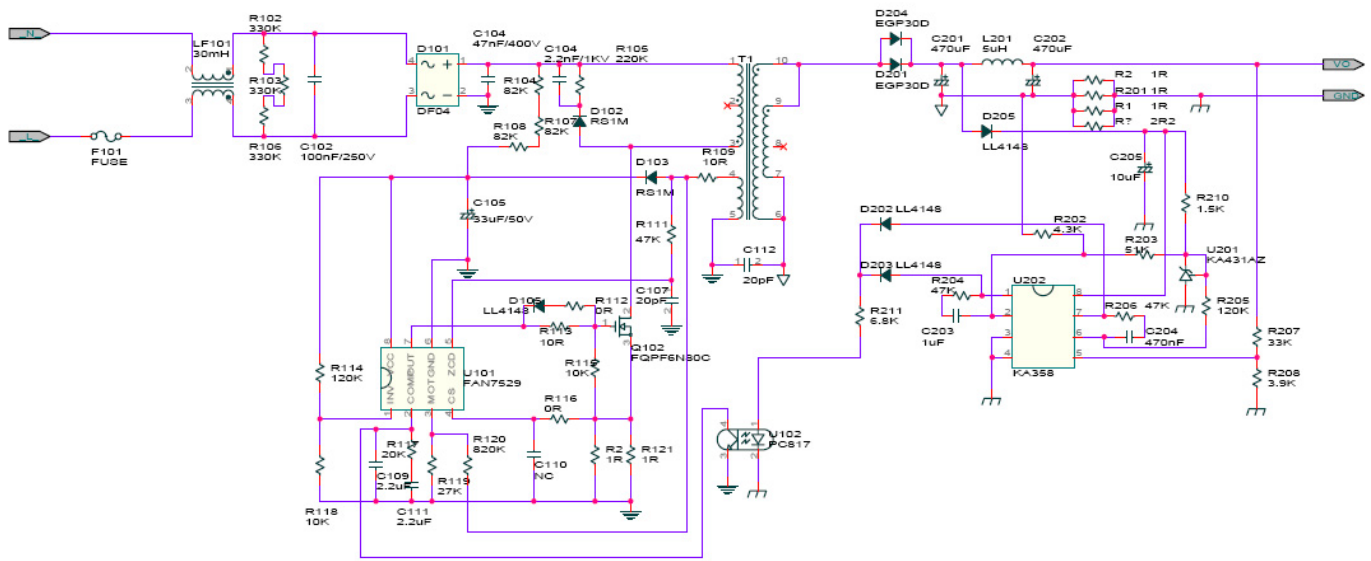


Fig. 5.Schematic of the Evaluation Board



3.4. Bill of Materials

Table 2. Bill of materials of the evaluation board.

Item Number	Part Reference	Value	Quantity	Description (Manufacturer)
1	U101	FAN7529	1	CRM PFC controller (Fairchild Product)
2	U102	FOD817	1	Opto-coupler (Fairchild Product)
3	U201	KA431	1	Shunt regulator (Fairchild Product)
4	U202	KA358A	1	Dual OP Amp (Fairchild Product)
5	Q102	FQPF8N80C	1	800V/8A MOSFET (Fairchild Product)
6	D101	DF04	1	1.5A SMD bridge diode (Fairchild Product)
7	D102, D103	RS1M	2	1000V/1A Ultra fast recovery diode (Fairchild Product)
8	D201, D204	EGP30D	2	200V/3A Ultra fast recovery diode (Fairchild Product)
9	D105, D202, D203, D205	LL4148	4	General purpose diode (Fairchild Product)
10	R112, R116	0Ω	2	SMD Resistor 0805
11	R210	1.5KΩ	1	SMD Resistor 0805
12	R16	150KΩ	1	SMD Resistor 0805
13	R115, R118	10KΩ	2	SMD Resistor 0805
14	R109, R113	10Ω	2	SMD Resistor 0805
15	R114, R205	120KΩ	2	SMD Resistor 0805
16	R1, R121, R2, R201, R3	1Ω	5	SMD Resistor 1206
17	R	2.2Ω	1	SMD Resistor 1206
18	R117	20KΩ	1	SMD Resistor 0805
19	R105	220KΩ	1	2W
20	R119	27KΩ	1	SMD Resistor 0805
21	R208	3.9KΩ	1	SMD Resistor 0805
22	R102, R103, R106	330KΩ	3	SMD Resistor 0805
23	R207	33KΩ	1	SMD Resistor 0805
24	R202	4.3KΩ	1	SMD Resistor 0805
25	R204, R206	47KΩ	2	SMD Resistor 0805
26	R203	51KΩ	1	SMD Resistor 0805
27	R211	6.8KΩ	1	SMD Resistor 0805
28	R120	820KΩ	1	SMD Resistor 0805
29	R104, R107	82KΩ	2	0.25W
30	R108	82KΩ	1	SMD Resistor 1206
31	R111	47	1	0.25W
32	C102	100nF/250V	1	X – Capacitor
33	C103	47nF/400V	1	Film Capacitor
34	C104	2.2nF/1KV	1	Ceramic capacitor
35	C106	33uF/50V	1	Electrolytic capacitor
36	C107	20pF	1	SMD Capacitor 0805
37	C109, C111	2.2uF	2	SMD Capacitor 0805
38	C201, C202	470uF/35V	2	Electrolytic capacitor
39	C203	1uF	1	SMD capacitor 0805



Item Number	Part Reference	Value	Quantity	Description (Manufacturer)
40	C204	470nF	1	SMD capacitor 0805
	C112	2.2nF	1	Y-Capacitor
41	C205	6.8uF/50V	1	Electrolytic capacitor
42	LF101	30mH	1	Line filter
43	L201	5uH	1	
44	F101	2A/250V	1	
45	T1	EE2525S	1	720uH



3.5. Transformer and Winding Specifications

Core : EE2525

Bobbin : 10pin

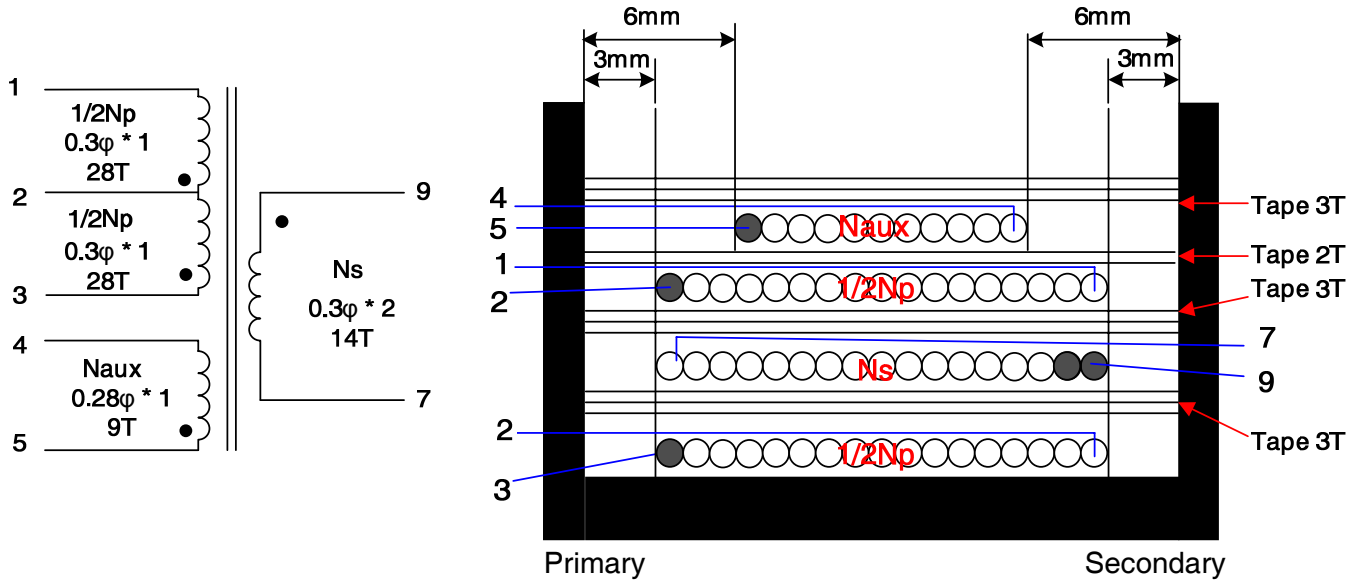


Fig. 6. Transformer specifications & construction.

Table 3. Winding specifications.

No	Winding	Pin(S → F)	Wire	Turns	Winding Method
1	1/2Np	3 → 2	0.3φ×1	28 Ts	Solenoid winding
2	Insulation : Polyester Tape t = 0.025mm, 1Layers				
3	Ns	9 → 7	0.3φ×2	14 Ts	Solenoid winding
4	Insulation : Polyester Tape t = 0.025mm, 3Layers				
5	1/2Np	2 → 1	0.3φ×1	28 Ts	Solenoid winding
6	Insulation : Polyester Tape t = 0.025mm, 3Layers				
7	Naux	5 → 4	0.3φ×1	9 Ts	Center Solenoid winding
8	Insulation : Polyester Tape t = 0.025mm, 3Layers				

Table 4. Electrical Characteristics.

	Pin	Spec.	Remark
Inductance	4 – 5	720uH ±7%	1kHz, 1V
Leakage	4 - 5	10 uH Max	Short all output pins



4. Test Condition & test equipment

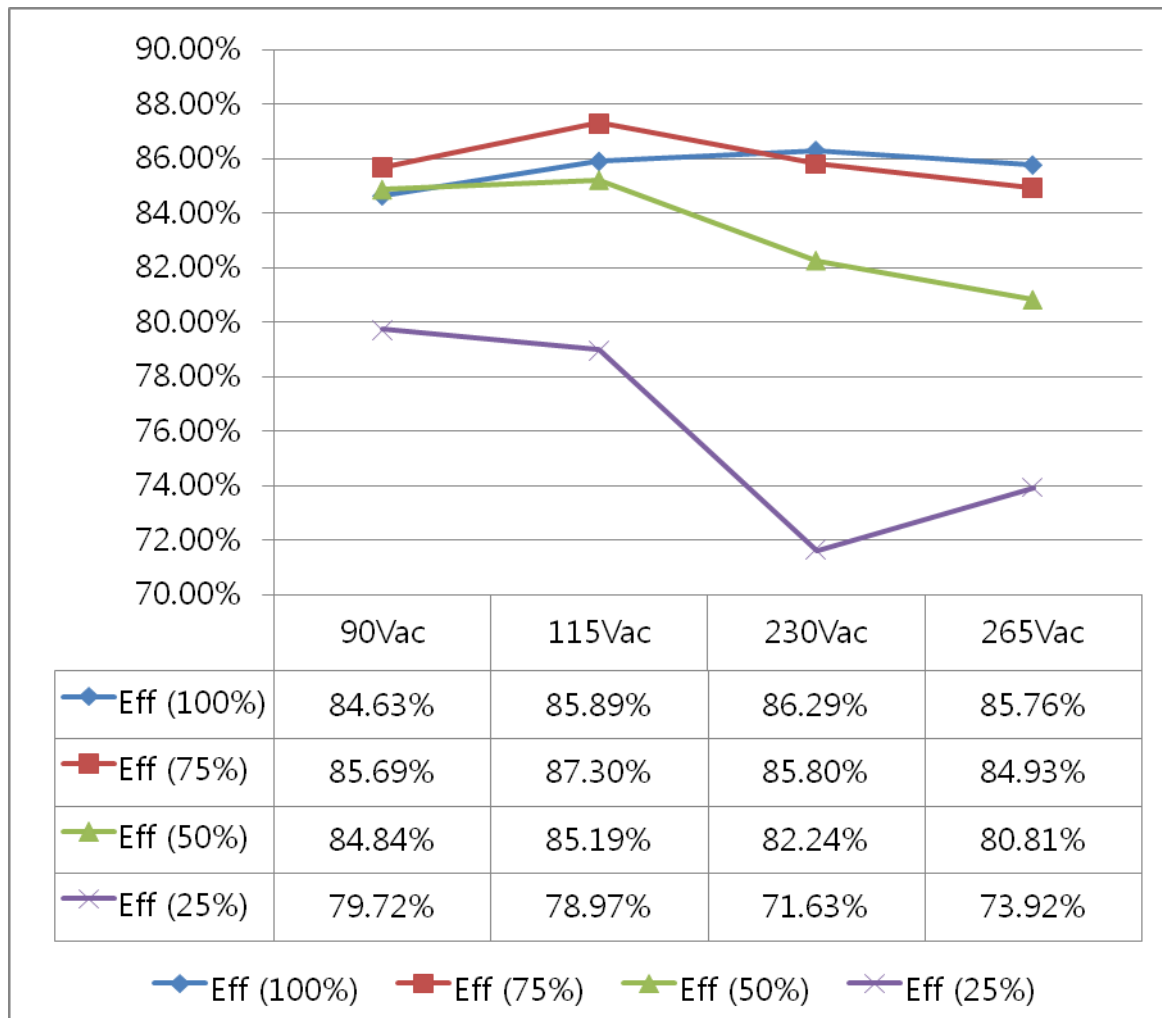
Table 5.test condition & test equipment

Ambient Temperature	T _A = 25°C
Test Equipment	AC Source : ES2000S by NF Electronic Load : PLZ334W by Kikusui Power Meter : PZ4000 by Yokogawa Oscilloscope : Wave-runner 104Xi by LeCroy Thermometer : MV200 by Yokogawa

5. Electrical Performances

5.1. Efficiency

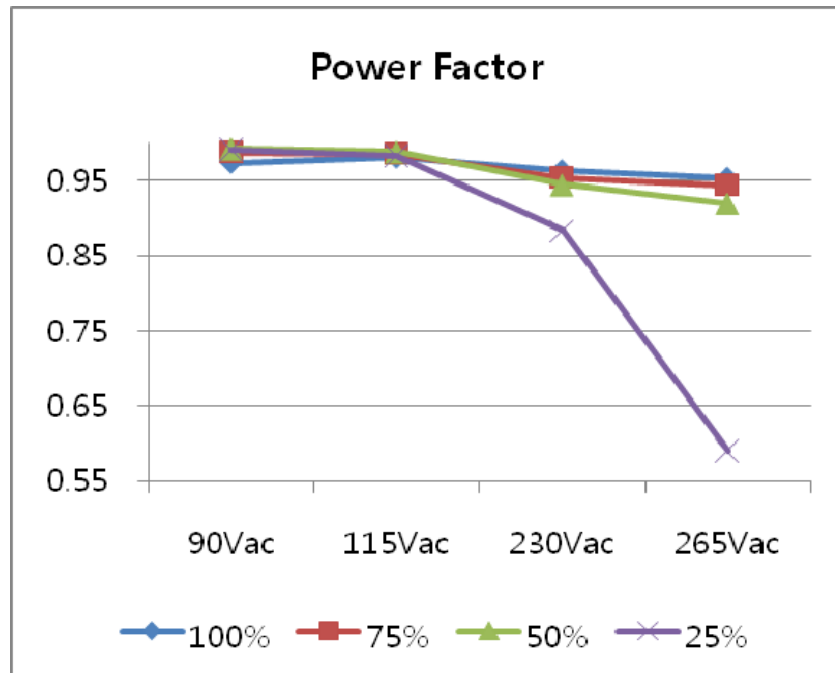
- ✓ Tested at 25%, 50%, 75%, 100% output current and 90Vac, 115Vac, 230Vac, 265Vac input voltage condition.
- ✓ Test results shows over 84% efficiency at full load condition & universal input condition.





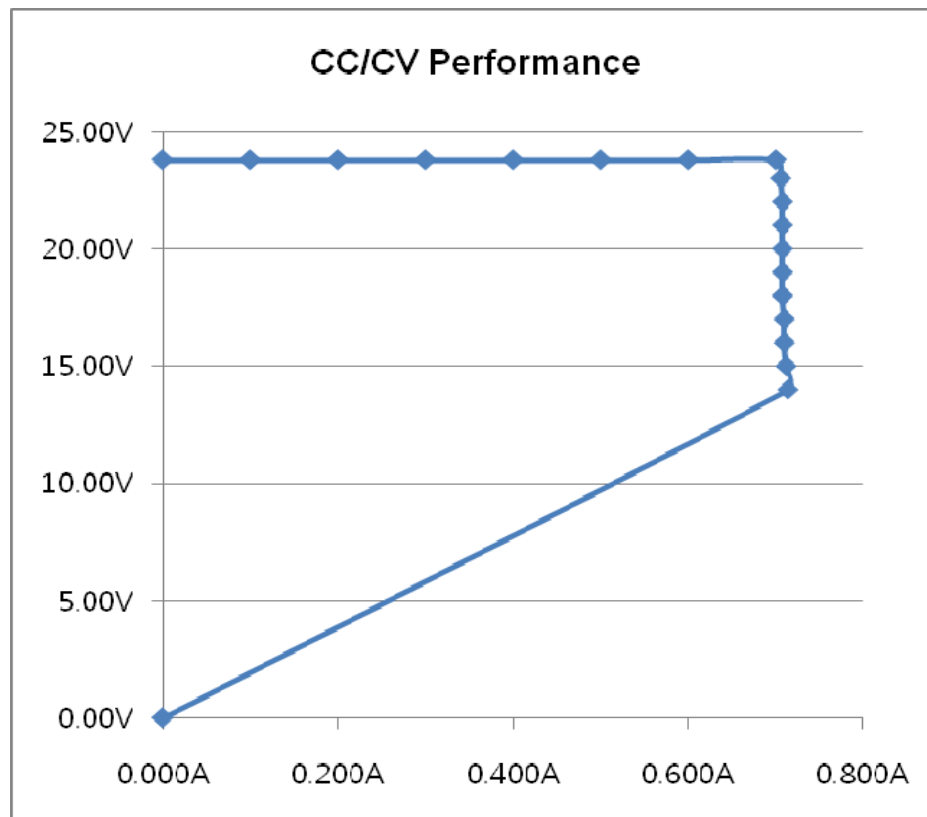
5.2. Power Factor

- ✓ Tested at 25%, 50%, 75%, 100% output current and 90Vac, 115Vac, 230Vac, 265Vac input voltage condition.



5.3. Constant current performance

- ✓ Tested with electrical load at CR mode
- ✓ Load current : from 0mA to UVLO

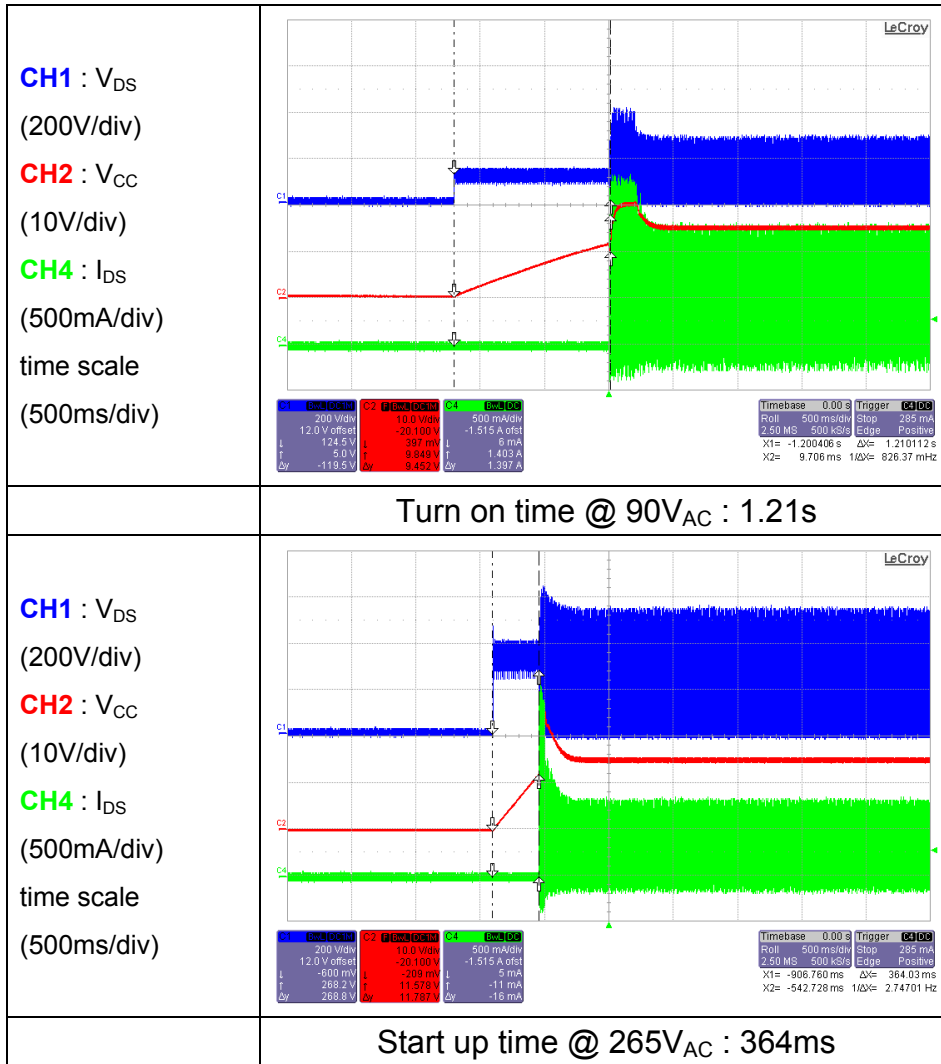




5.4. Operation Waveforms

5.4.1. Start up

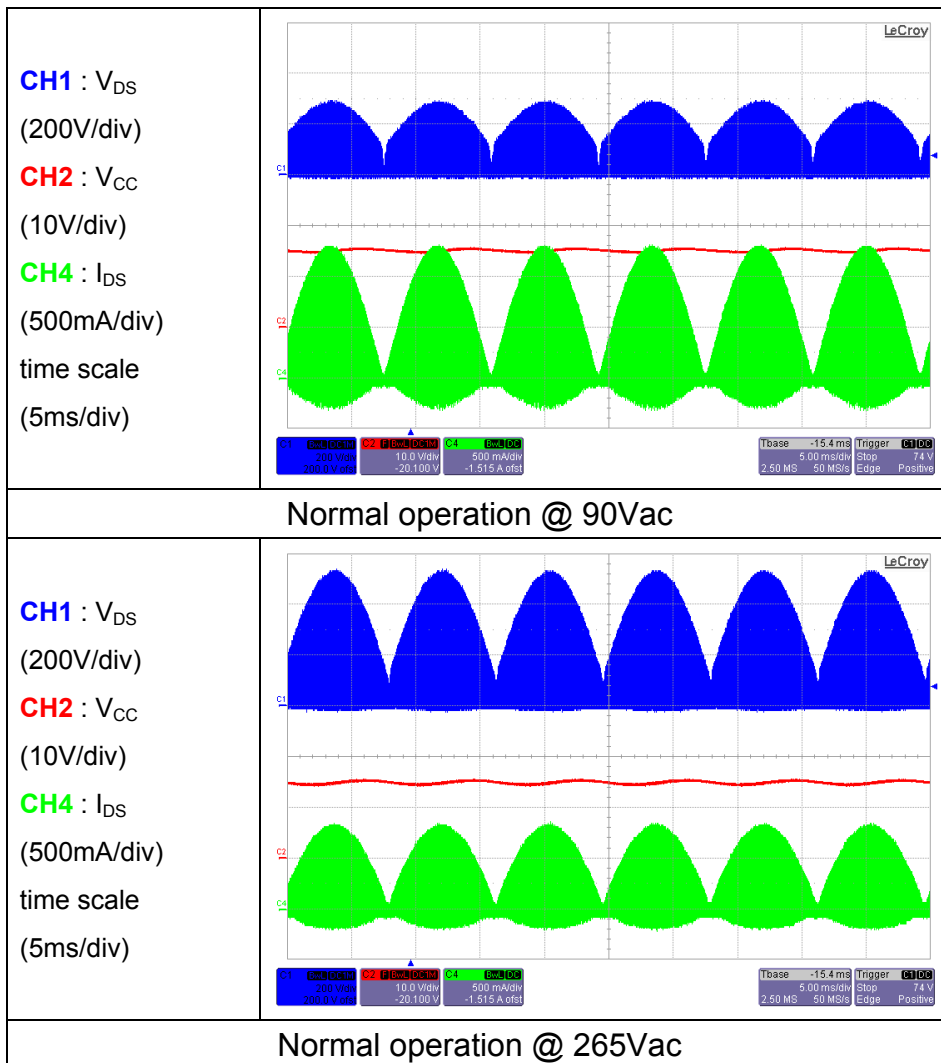
- ✓ Tested at load current 700mA and input voltage 90Vac and 265Vac.
- ✓ CH3 and CH4 stand for output voltage across output terminal V_O , input voltage across input terminal V_{AC} respectively.





5.4.2. Normal Operation

- ✓ Normal operation test performed at full load condition & $V_{in} = 90/265V_{ac}$
- ✓ CH1, CH2 and CH4 stand for drain voltage V_{DS} , V_{CC} voltage across V_{CC} pin, MOSFET I_{DS} respectively.

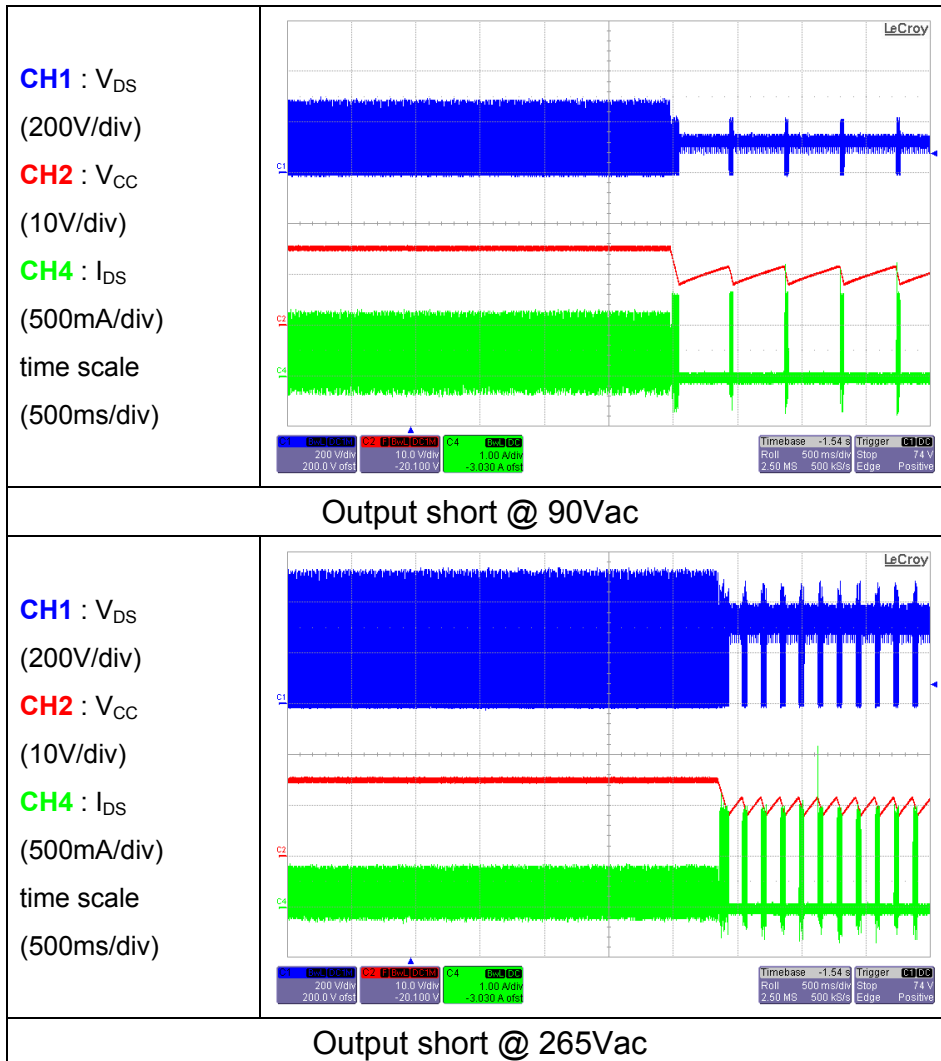




5.4.3. Protection & voltage stress

5.4.4. Output short protection

- ✓ Output short test performed at full load condition & $V_{in} = 90/265V_{ac}$
- ✓ CH1, CH2 and CH4 stand for drain voltage V_{DS} , V_{CC} voltage across V_{CC} pin, MOSFET I_{DS} respectively.



- ✓ when output terminal shorted to ground, UVLO triggered & auto restarts repeatedly



5.4.5. Voltage stress at switches

- ✓ Voltage stress tests are performed at full load & $V_{in} = 90/265V_{ac}$ condition

	Full load 90Vac	Full load 265Vac
CH1 : V_{DS} (200V/div) CH2 : V_{CC} (10V/div) CH4 : I_{DS} (500mA/div) time scale (500ms/div)		
Start up	$V_{DS,Max} : 426V$	$V_{DS,Max} : 650V$
CH1 : V_{AK} (50V/div) time scale (50ms/div)		
Normal op.	$V_{AK,Max} : 87V$	$V_{AK,Max} : 141V$