High- PF Linear Dimmable LED driver

--- iW3989-20

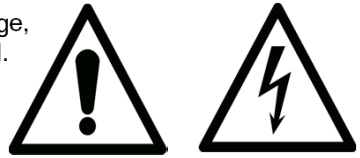
General Design Specification:

1. **AC Input Range: 90-135V_{AC}**
2. **DC Output: 115V/100mA**
3. **PF>0.9 @120V_{AC}**
4. **Linear Dimming**

…personal
…portable
…connected

Warning

Warning
This evaluation board is powered either by the AC mains voltage or a low AC or DC voltage. When powered by the AC mains voltage, the evaluation board generates non-insulated high voltages on exposed pins and pads on both the top and bottom of the PC board. Contact with these may produce electrical shock, burn, and/or fire hazards, resulting in risk of property damage, personal injury, and/or death. When the design indicates isolation, the output(s) is electrically isolated from the AC mains input voltage.



When the evaluation board is powered, never touch the board or its electrical circuits since they may be operating at high voltages that can cause an electrical shock hazard.

WORK AREA AND PERSONAL SAFETY
This board should be used in a test area/laboratory specifically designed and designated for working with, and evaluating high-voltage electrical devices. Only trained and qualified professional personnel with experience, knowledge and training in the use of high-voltage electrical circuits should use this evaluation board. Trained personnel must use required personal protective equipment and required laboratory equipment when working with the evaluation board.

The professional personnel operating this evaluation board and the test area/laboratory in which it is operated must be qualified according to the local regulations, guidelines and labor laws applicable to working with non-isolated mains voltages and high voltage circuits.

An isolated housing is highly recommended when using this evaluation board.

Use this evaluation board at your own risk.

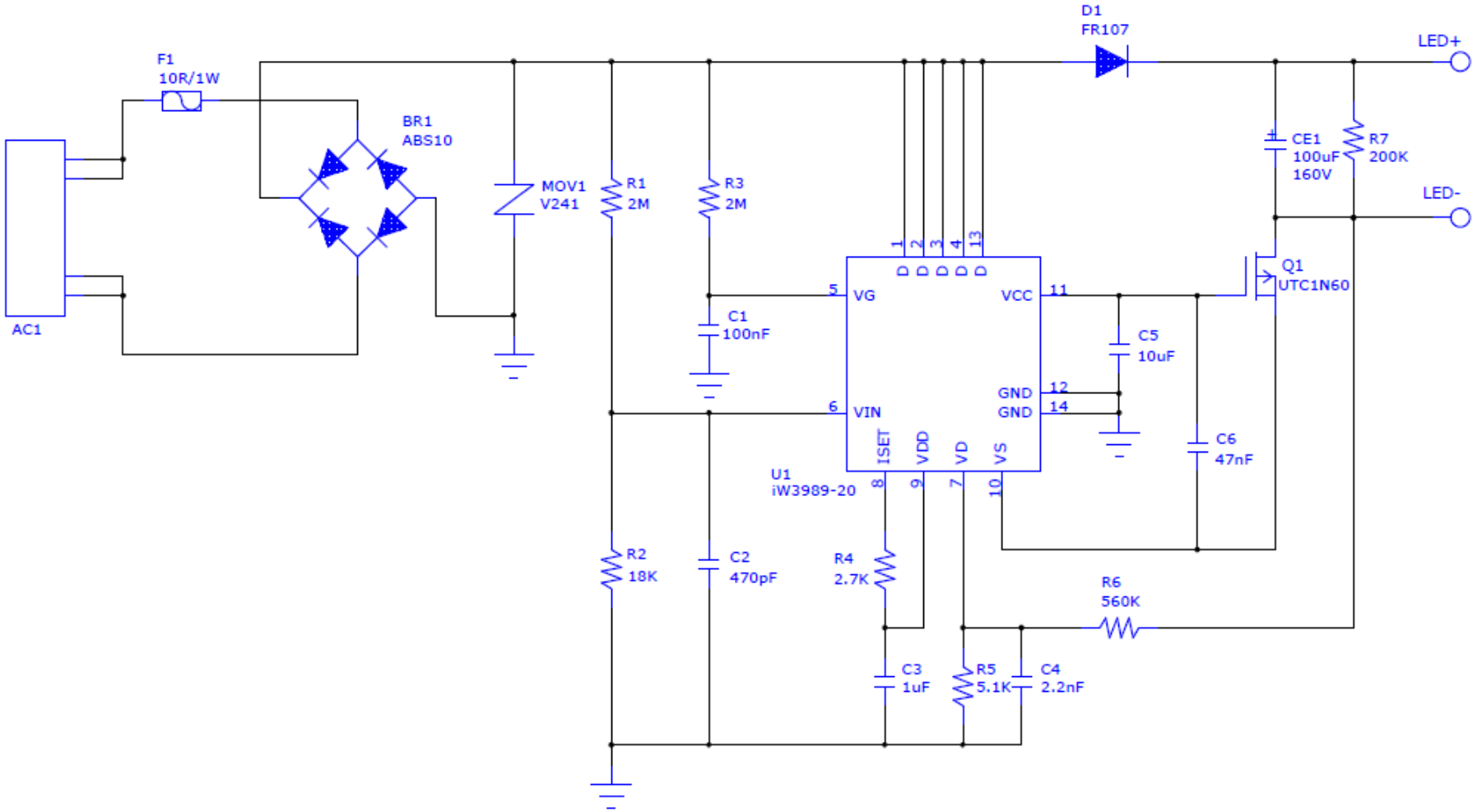
TO BE USED FOR EVALUATION PURPOSES ONLY
This board is intended for evaluation purposes only and not intended for commercial use in an end product. Any other use is strictly prohibited by Dialog Semiconductor.

NOT AGENCY APPROVED
This evaluation board has not been agency tested or approved for safety, technical performance, and/or regulatory requirements, such as electromagnetic interference or other technical regulatory or safety requirements.

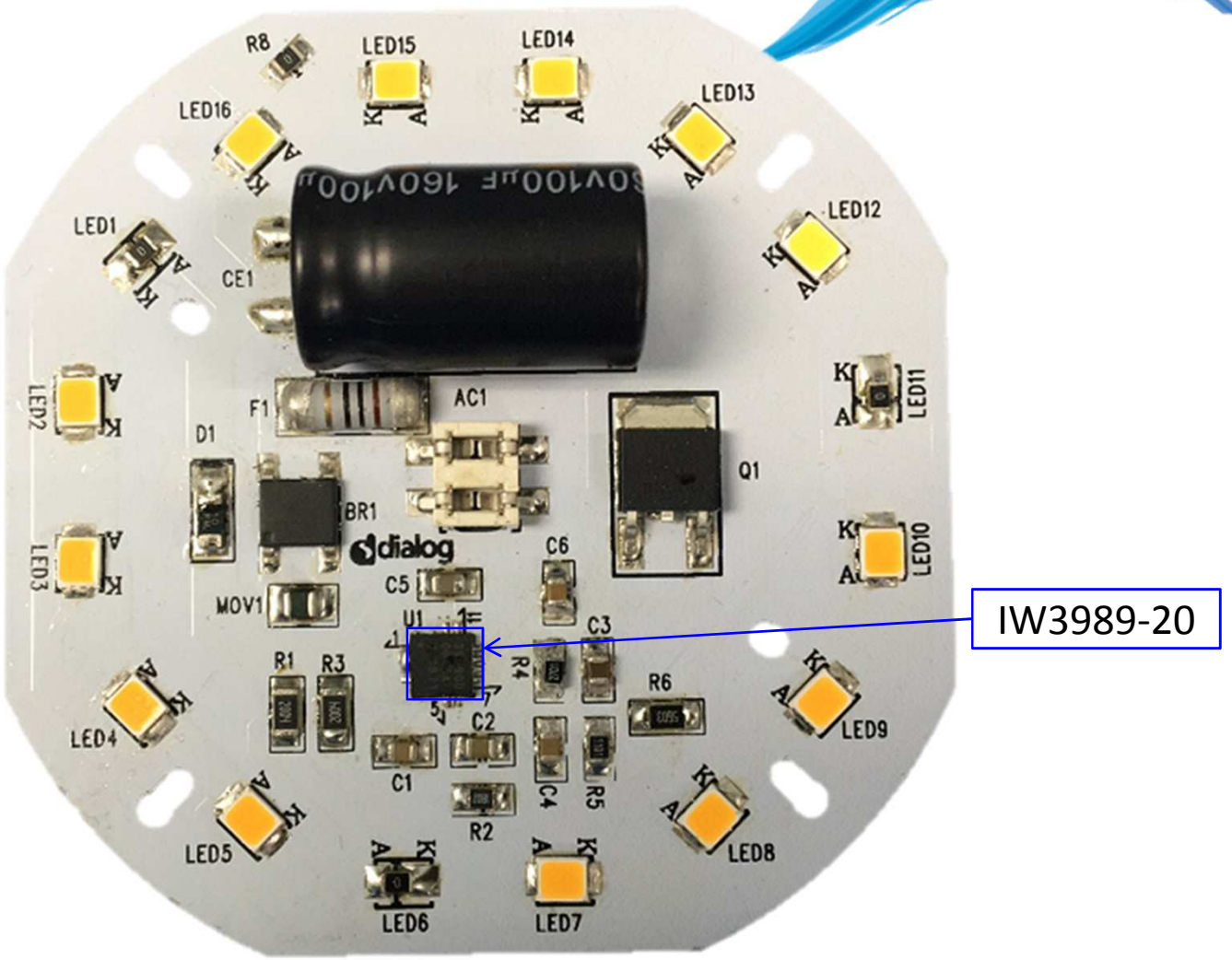
1. Specification

Description		Symbol	Min	Typ	Max	Units	Comment
Input							
Voltage		V_{IN}	90	120	135	V_{AC}	2 Wire
Frequency		f_{LINE}		60		Hz	
Open-load Input Power (135V_{AC})						W	
Output							
Const Current	Output Voltage	V_{OUT_CV}		115		V	
	Output Current	I_{OUT_CV}		100		mA	
Total Output Power							
Continuous Output Power		P_{OUT}		11.5		W	
Over Current Protection		I_{OUT_MAX}				A	
Efficiency		η		>70		%	Measured at end of PCB@120V/ac
Power Fact		*PF*	0.9				Measured @ 120V/ac
Turn on Delay Time					0.5	Sec	
Conducted EMI				Meet EN55015B			Output (-) is floating
Surge test			2.5			KV	0.5uS/100KHz Ring wave
Operation temperature		T_{opr}		40		° C	

2. Schematic


D1
FR107
LED+
F1
10R/1W
BR1
ABS10
CE1
100uF
160V
R7
200K
LED-
MOV1
V241
R1
2M
R3
2M
Q1
UTC1N60
AC1
C1
100nF
VG
VCC
C5
10uF
VIN
GND
GND
U1
iW3989-20
ISET
VDD
VD
VS
C6
47nF
R2
18K
C2
470pF
R4
2.7K
R6
560K
C3
1uF
R5
5.1K
C4
2.2nF

3. Circuit Board Photograph



4. Bill of Materials

Item	Qty.	Ref.	Description
1	1	U1	iW3989-20, QFN4*4
2	1	CE1	100uF, 160V, E-CAP, Φ12.5mm X 20mm
3	1	C1	100nF, 50V, X7R, SMD-0805
4	1	C2	470PF, 50V, X7R, SMD-0805
5	1	C3	1uF, 16V, X7R, SMD-0805
6	1	C4	2.2nF, 50V, X7R, SMD-0805
7	1	C5	10uF, 16V, X7S, SMD-0805
8	1	C6	47nF, 50V, X7R, SMD-0805
9	1	BR1	ABS8, 1A800V, Rectifier Bridge TSC
10	1	D1	M7(1N4007),1A1000V,SOD-123
11	1	Q1	UTC1N60G, 600V/1A, TO-252
12	1	FR1	10R/1W, Fuse resistor, SMD
13	2	R1, R3	2MΩ ±1%, SMD-1206
14	1	R2	18KΩ ±1%, SMD-0805
15	1	R4	2.7KΩ ±1%, SMD-0805
16	1	R5	5.1KΩ ±1%, SMD-0805
17	1	R6	560KΩ ±1%, SMD-1206
18	1	R7	200KΩ ±5%, SMD-1206
19	1	MOV1	SFI0806SV241, 240V, SMD-0806
20	1	Al	Al board, 1.2mm, λ=2

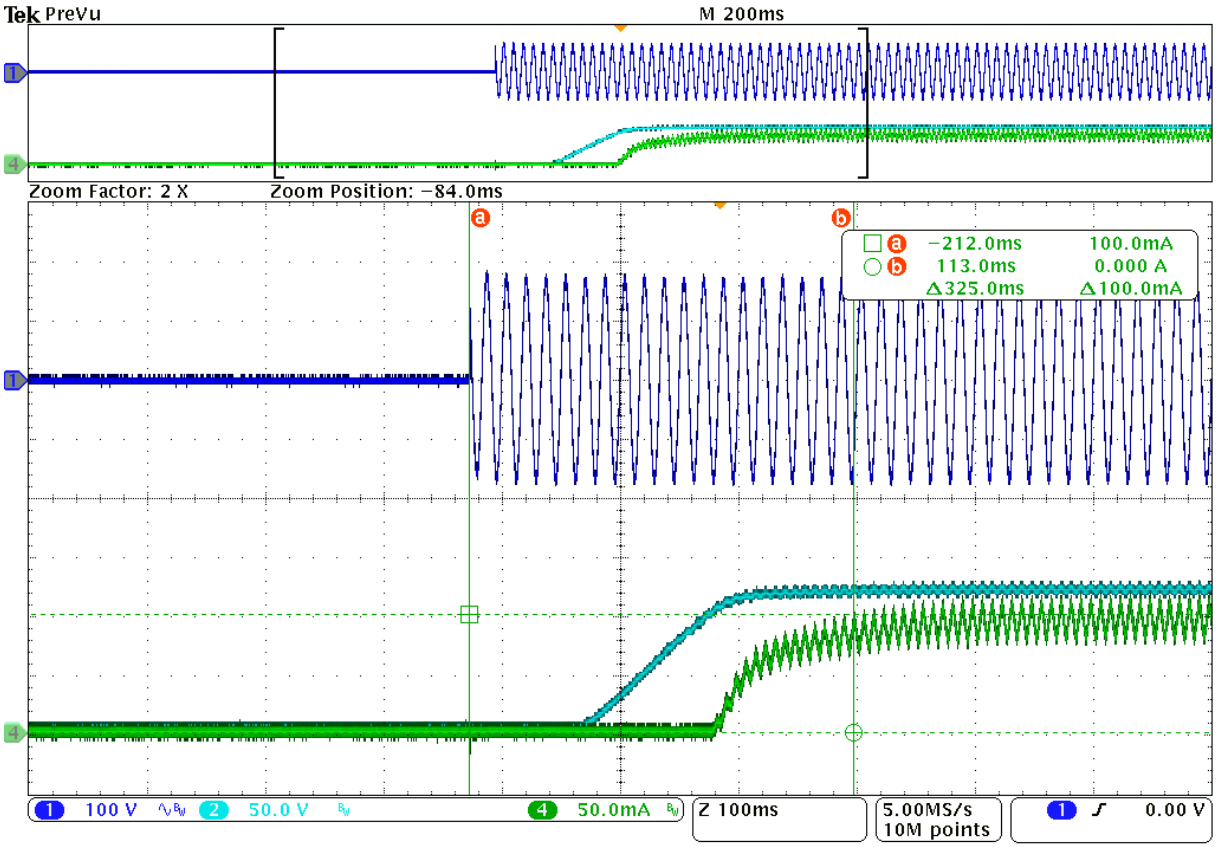
5. Regulation and Efficiency Measurement

Test condition: 90~135Vac with LED load

Input Voltage (Vac)	Input Power (W)	Input Current (mA)	PF	Vout (Vdc)	Iout (mA)	Efficiency (%)
90	9.80	155.3	0.701	111.5	77.3	87.95
95	12.74	177.8	0.755	113.6	97.0	86.49
100	13.60	167.4	0.813	113.9	99.9	83.67
105	13.92	155.5	0.852	113.7	98.9	80.78
110	14.32	148.1	0.878	113.7	98.4	78.13
115	14.71	142.4	0.897	113.7	98.1	75.83
120	15.11	138.0	0.912	113.7	97.8	73.59
125	15.55	134.7	0.923	113.8	97.7	71.50
135	15.94	126.3	0.935	113.6	95.0	67.70

6. Turn-on Delay Time

Test condition: 120Vac with LED load



CH1 : AC Input Voltage

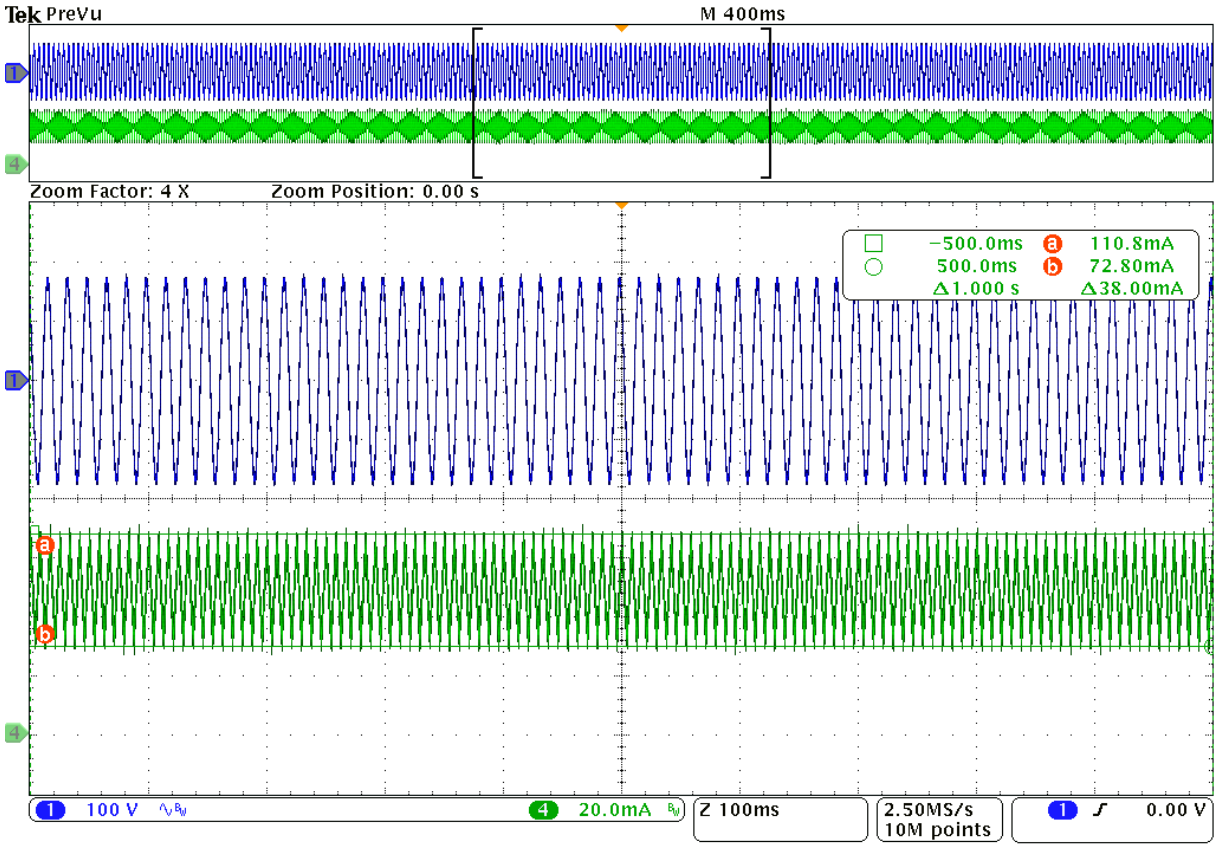
CH2 : Output Voltage

CH4 : Output Current

Turn on delay time: 325.0mS

7. Output ripple current

Test condition: 120Vac with LED load



CH1 : AC Input Voltage

CH4 : Output Current

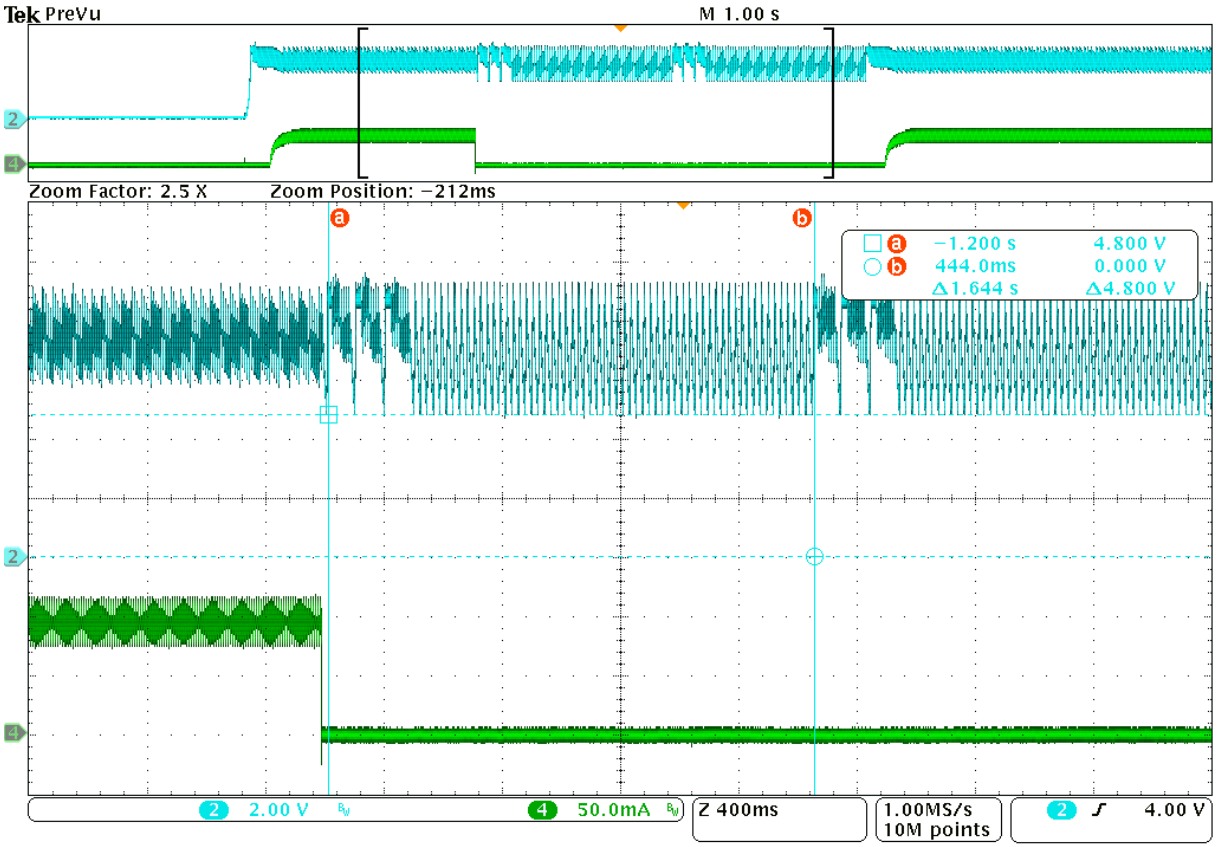
Output cap: 100uF/160V

PF>0.9

Ipp : 38.0 mA

8. Output short test

Test condition: 120Vac with LED load



CH2 : Vcc

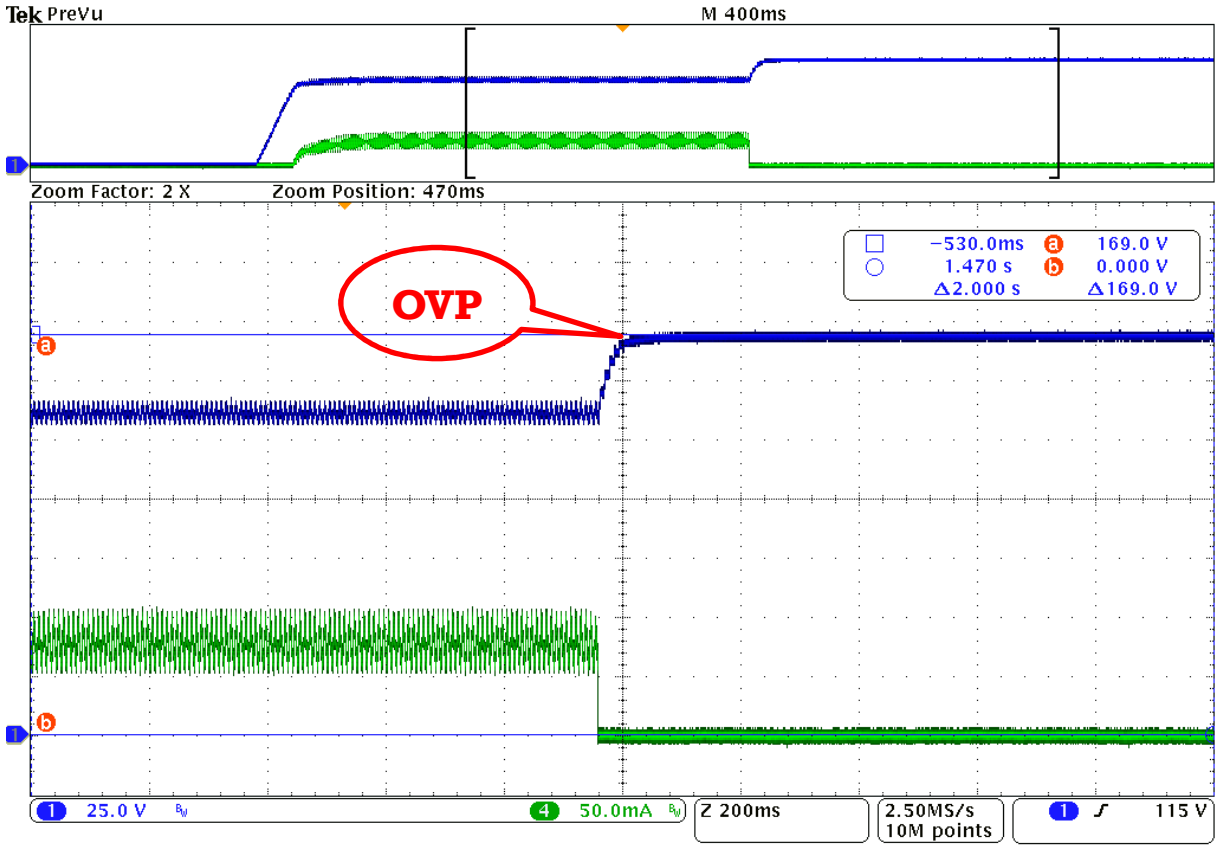
CH4 : Output Current

Pin/max=3.2W

When output short occur, it will trigger IC's protection, IC will work re-start. After remove this condition, power board will recovery output.

9. Output open test

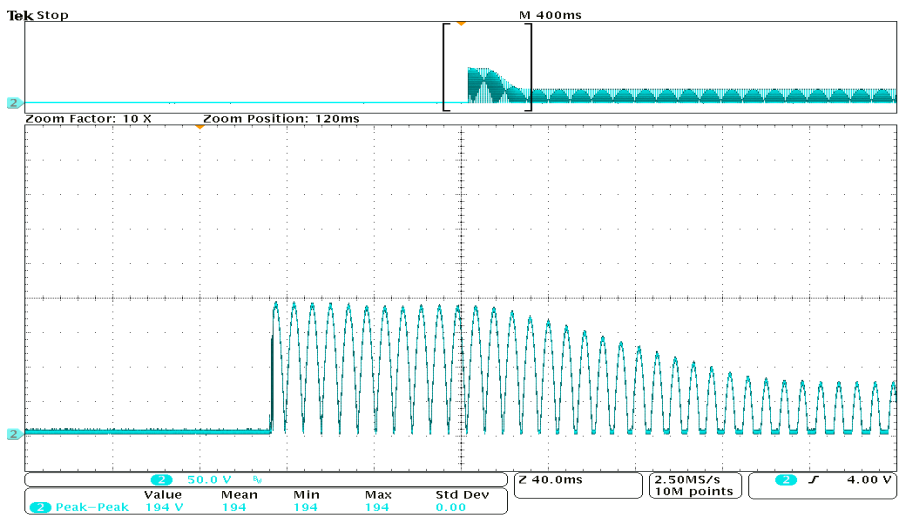
Test condition: 120Vac with LED load



CH1 : Output Voltage
CH4 : Output Current

Vout/max= 169V
Pin/max=0.32W
Output capacitor:100uF/160V

10. Vds of Linear Mosfet



Test Condition: 135Vac with LED load

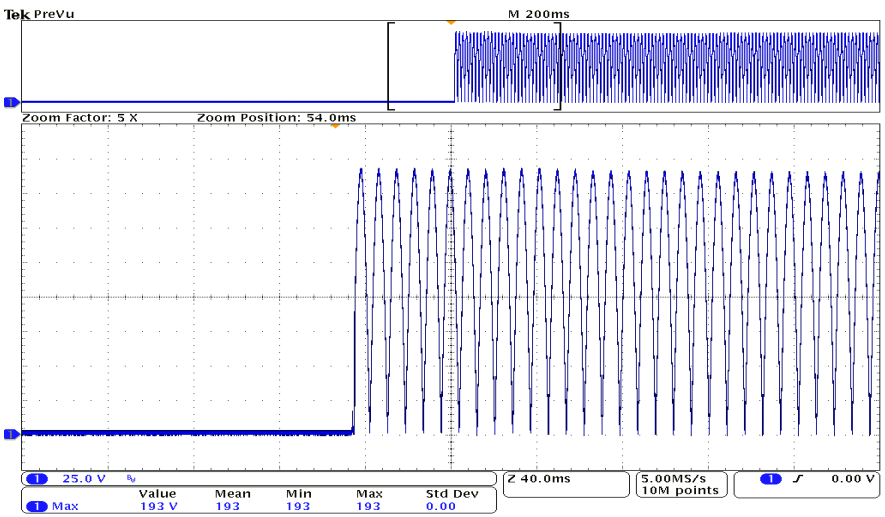
Result:

V_{HV_MAX}= 194V

Voltage of Mosfet UTC1N60 is 600V.

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		V_{DSS}	600	V
Gate-Source Voltage		V_{GSS}	±30	V
Avalanche Current (Note 2)		I_{AR}	1.0	A
Drain Current	Continuous	I_D	1.0	A
	Pulsed (Note 2)	I_{DM}	4.0	A
Avalanche Energy	Single Pulsed (Note 3)	E_{AS}	50	mJ
	Repetitive (Note 2)	E_{AR}	4.5	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	4.0	V/ns
Power Dissipation	SOT-223	P_D	10	W
	TO-251/TO-251S TO-251S2/TO-252		30	W
	TO-92		3	W
	DFN5060-8		14	W
Junction Temperature		T_J	+150	°C
Operating Temperature		T_{OPR}	-55 ~ +150	°C
Storage Temperature		T_{STG}	-55 ~ +150	°C

11. Vds of Bleeder Mosfet



Test Condition: 135Vac with LED load

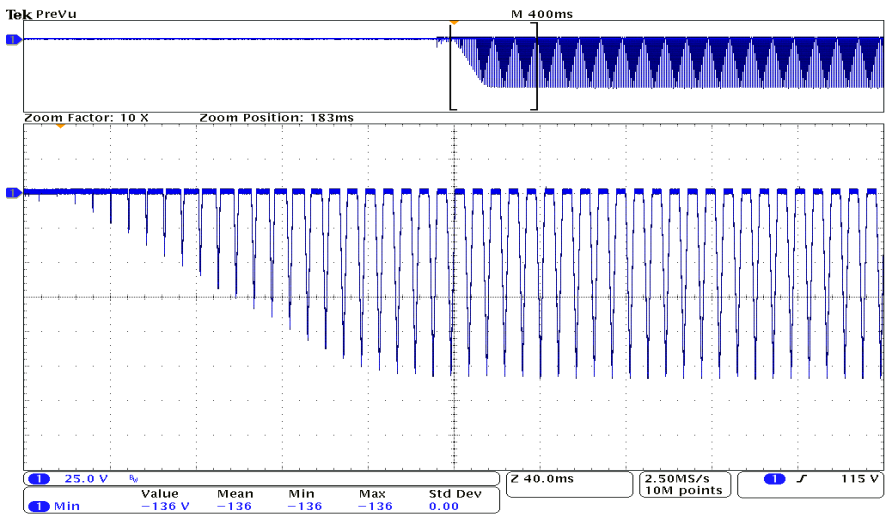
Result:

V_{HV_MAX}= 193V

Voltage of Mosfet Vds is 500V.

Parameter	Symbol	Value	Units
D		500	V
V_G		-0.3 to 30	V
V_{IN}		-0.3 to 7	V
V_D		-0.3 to 7	V
V_{DD}		-0.3 to 7	V
I_{SET}		-0.3 to 7	V
V_S		-0.3 to 12	V
V_{CC}		-0.3 to 12	V
ESD Rating (HBM)		±2000	V
Storage temperature range		-65 to +150	°C
Maximum junction temperature		150	°C

12. Output Rectifier Waveform



Test Condition:135Vac with LED load

Result:

$V_{R\,(pk-pk)}$=136V

Voltage of output rectifier diode M7 is 1000V.

Characteristic	Symbol	M1	M2	M3	M4	M5	M6	M7	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	5 0	100	200	400	600	800	1000	V
RMS Reverse Voltage	$V_{R(RMS)}$	3 5	70	140	280	420	560	700	V
Average Rectified Output Current @T_L = 100°C	I_O	1.0							A
Non-Repetitive Peak Forward Surge Current 8.3ms Single half sine-wave superimposed on rated load (JEDEC Method)	I_{FSM}	30							A
Forward Voltage @I_F = 1.0A	V_{FM}	1.10							V
Peak Reverse Current @T_A = 25°C At Rated DC Blocking Voltage @T_A = 125°C	I_{RM}	5.0 200							μA
Typical Junction Capacitance (Note 1)	C_j	15							pF
Typical Thermal Resistance (Note 2)	$R_{\theta JL}$	30							K/W
Operating and Storage Temperature Range	T_j, T_{STG}	-65 to +150							°C

13. Thermal Test

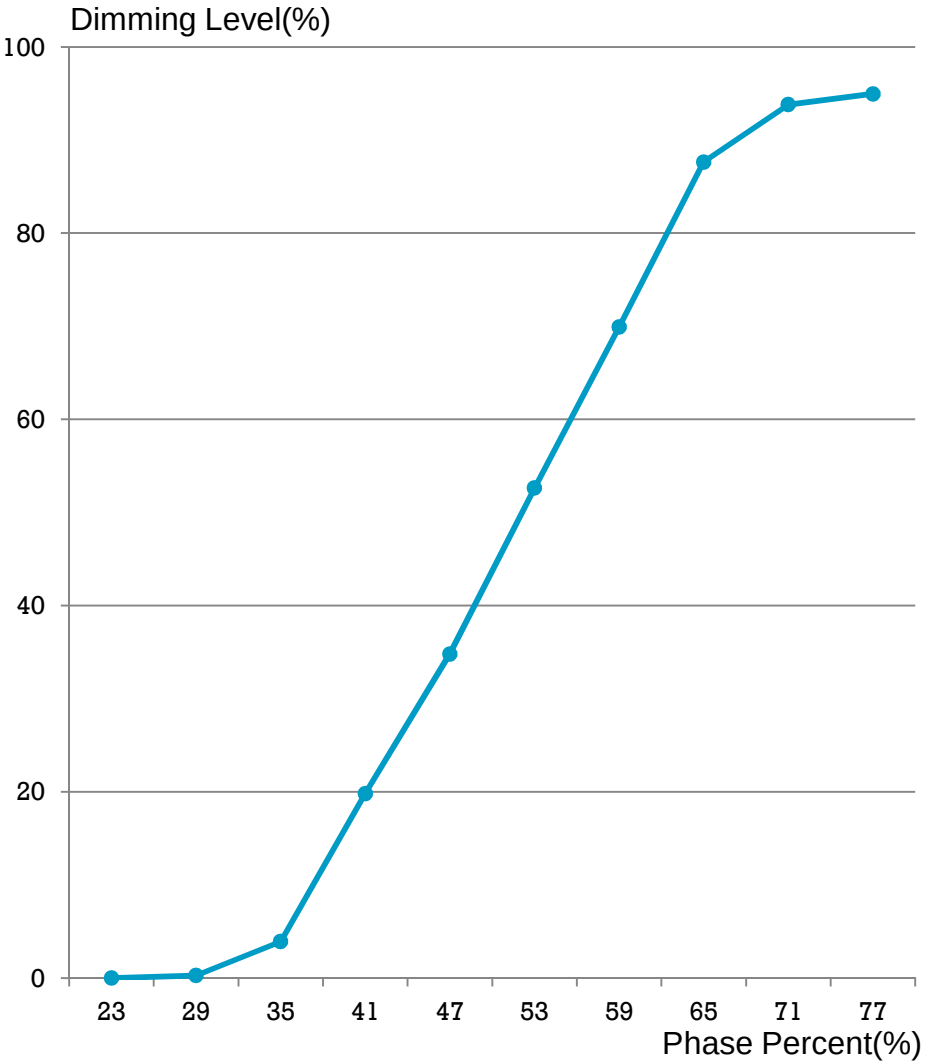
Test condition: 120Vac with LED load.

Component		No Dimmer		LE Dimmer	
Part	Description	Room temp (°C)	UL bulb (°C)	Room temp (°C)	UL bulb (°C)
IC(QFN)	iW3989-30	81.0	99.3	80.9	102.3
MOS	CS1N60	86.7	105.7	84.3	105.8
Al	Al Board	78.8	97.4	76.3	97.8
CE1	100uF/160V	75.0	91.6	72.8	92.1

Test with LED system as below:

14. Dimming curve with leading edge dimmer

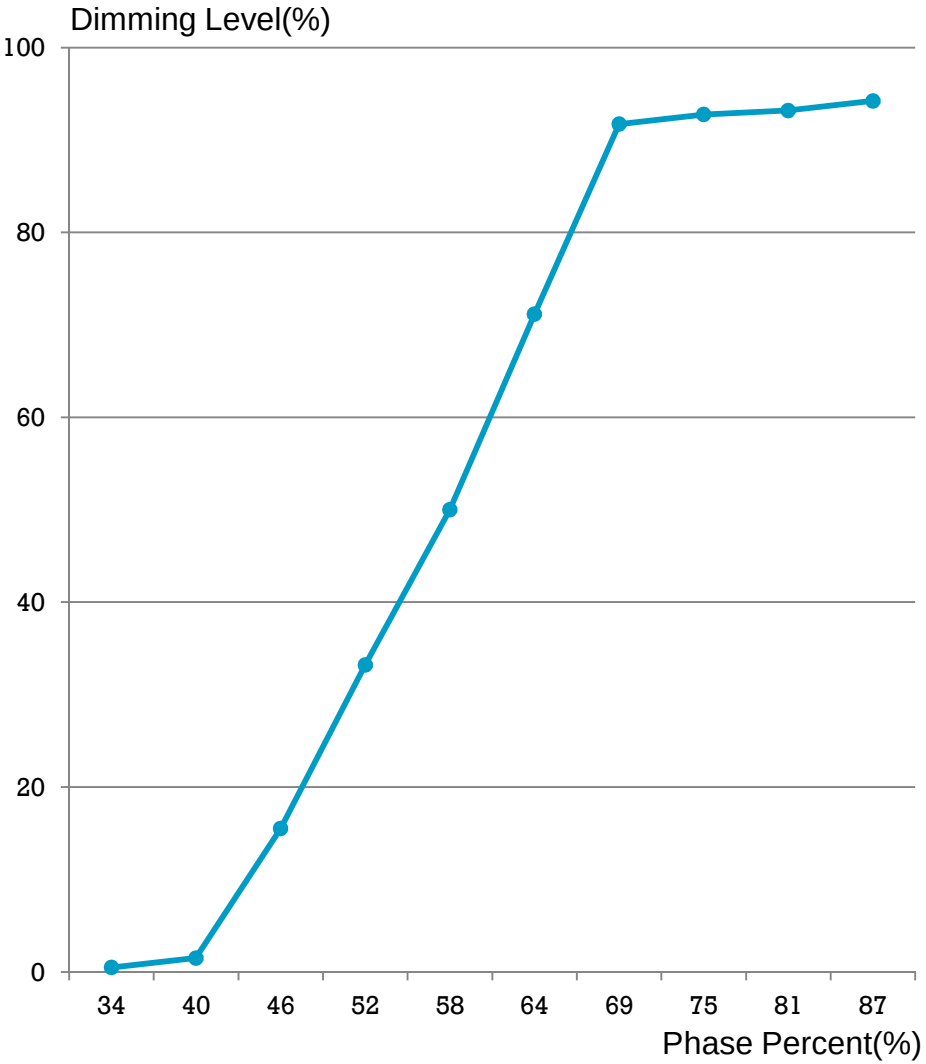
Test condition: 120Vac with LEVITRON 6681(Box 2-5)



Dimmer Scale	Vin Phase (mS)	Phase percent (%)	Output Current（mA）	Dimming Level(%)
1	1.92	23	0	0
2	2.42	29	0.26	0
3	2.92	35	3.73	4
4	3.42	41	18.9	20
5	3.92	47	33.2	35
6	4.42	53	50.2	53
7	4.92	59	66.7	70
8	5.42	65	83.6	88
9	5.92	71	89.5	94
10	6.40	77	90.6	95

15. Dimming curve with trailing edge dimmer

Test condition: 120Vac with LEVITON 6615(Box2-4)



Dimmer Scale	Vin Phase (mS)	Phase percent (%)	Output Current（mA）	Dimming Level(%)
1	2.84	34	0.46	0
2	3.33	40	1.44	2
3	3.82	46	14.8	16
4	4.31	52	31.7	33
5	4.80	58	47.7	50
6	5.29	64	67.9	71
7	5.78	69	87.5	92
8	6.27	75	88.5	93
9	6.78	81	88.9	93
10	7.27	87	89.9	94

16. Dimming performance

No.	Man.	MPN	Start*	Min*	Max*	Min	Max	Note
Iout=95.4mA								
1	LEVITRON	6602	0.22	0	90.1	0%	94.4%	
2	LUTRON	DVLL-153P	0.28	0	89.2	0%	93.5%	
3	LEVITRON	120V600W	0.20	0	89.5	0%	93.8%	
4	COOPER	600W	2.48	0	95.4	0%	100%	
5	LUTRON	TG600P	0.31	0	89.2	0%	93.5%	
6	LUTRON	DV600P	2.80	0	90.0	0%	94.3%	
7	LUTRON	LG600P	0.86	0	89.4	0%	93.7%	
8	DingChung	500W	0.88	0	90.1	0%	94.4%	
9	LUTRO.N	SCL-153P	1.39	0	89.2	0%	93.5%	
10	LUTRON		0.22	0	88.8	0%	93.1%	
11	LUTRON	CTCL-153P	1.29	0	88.8	0%	93.1%	
12	LEVITORN	6615	0.35	0	90.2	0%	94.5%	
13	LEVITRON	6681	0.22	0	90.7	0%	95.1%	
14	LUTRON	LGCL-153P	0.30	0	89.5	0%	93.8%	
15	LEVITRON	600	0.30	0	89.0	0%	93.3%	

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- Assumes all responsibility for using this evaluation board in a test area or laboratory which is qualified and/or certified according to the local regulations, guidelines and labor laws applicable to working with non-isolated mains voltages and high voltage circuits
- Understands that this evaluation board has not been agency tested or approved for safety, technical performance, and/or regulatory requirements, by any agency. This includes electromagnetic interference or other technical regulatory or safety testing and certifications.

The power to be...

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