

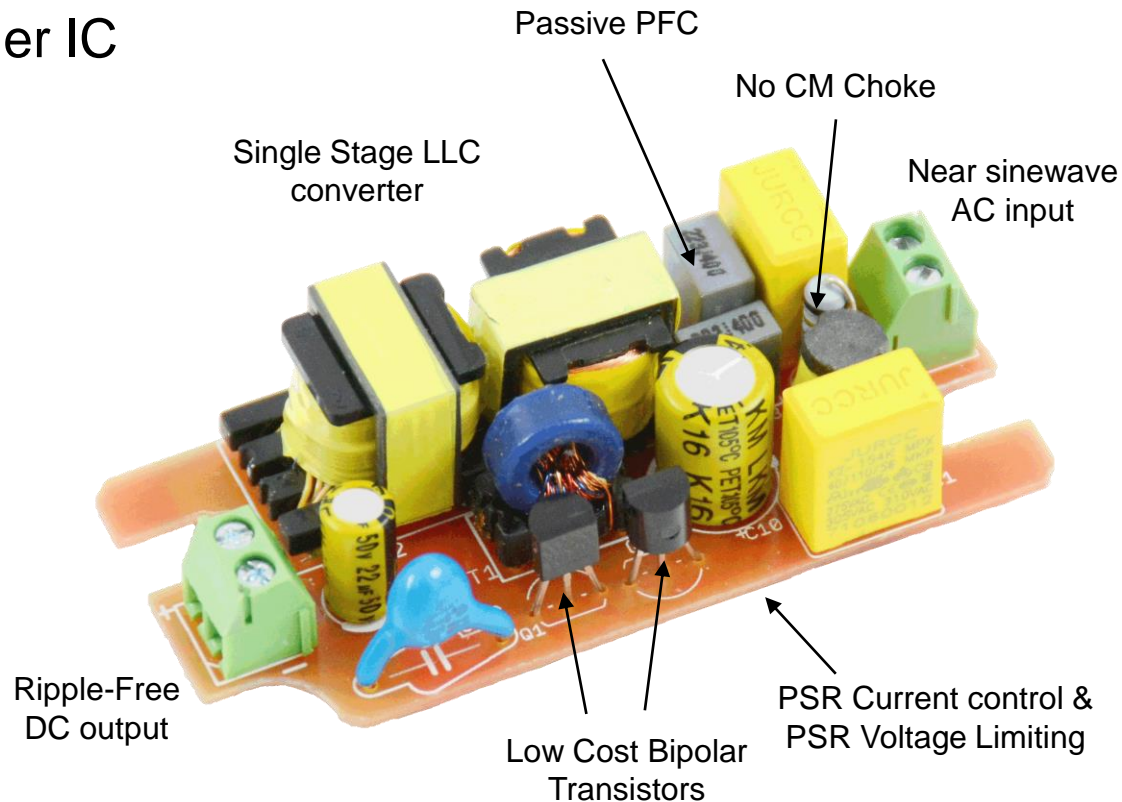
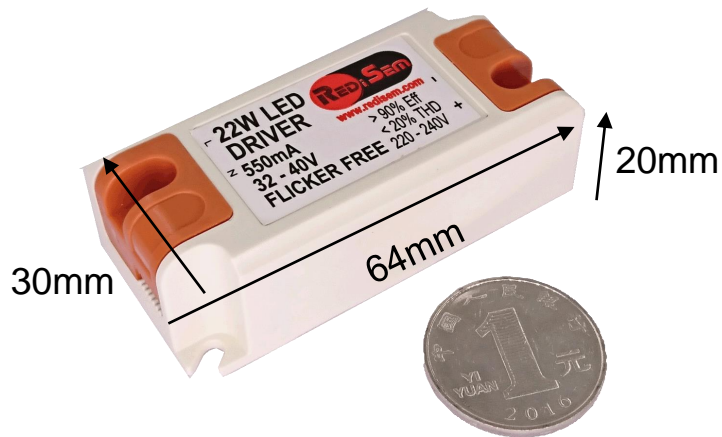


RED2421

22W 550mA LED Driver

Design Report

- Low-cost Flicker-free CC LED driver
- RED2421 SOT23-6 Controller IC
- Efficiency 90.2%
- High Power Factor >0.9
- 550mA 32-40V output
- Low EMI – no CM choke
- Optimized for COB/Panel

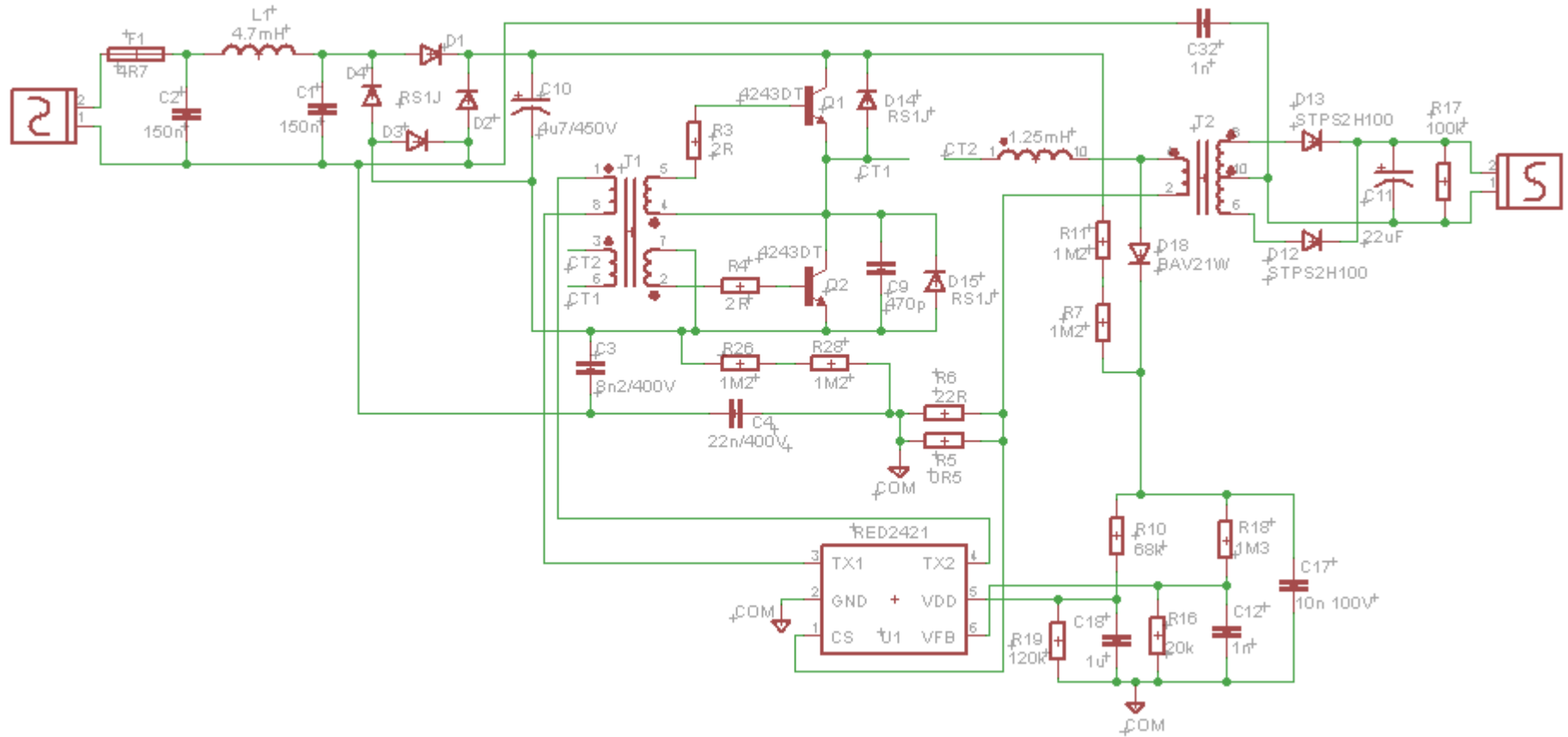


Specifications



Specification	Value	Test condition
Input voltage 50Hz	198 - 264VAC	Functional specifications
Input functional range	170 - 320VAC	5 minute survival
Output voltage	32 - 40V	198 - 264VAC
Output current	550mA \pm 5%	198 - 264VAC
LF Ripple (Flicker)	<2%	230VAC, 40VDC
Harmonic compliance IEC 61000-3-2	220 - 240VAC	33-39V DC
Total Ripple	< 20%	230VAC, 40VDC
Time to light	< 200ms	230VAC, 40VDC
Efficiency	> 90%	230VAC, 40VDC
Power factor	> 0.9	230VAC, 40VDC
THD	< 10%	230VAC, 40VDC
No-load voltage	< 60V	264VAC
Protection	Overtemperature, short circuit, open circuit	
EMI test	6dB margin	LED earthed, Driver floating
Surge	1kV DM, 2kV CM	
Ambient Temperature	-20 to 50°C	

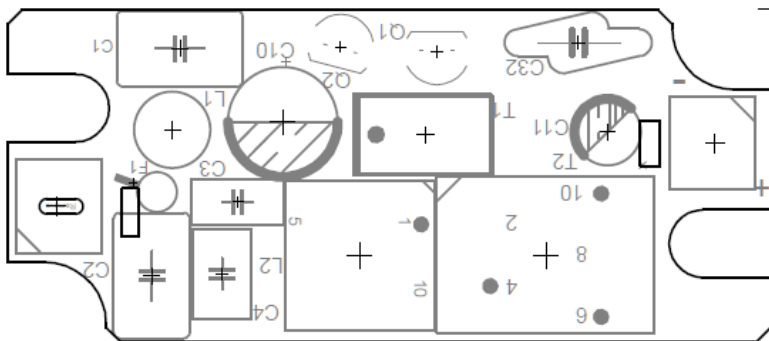
Schematic



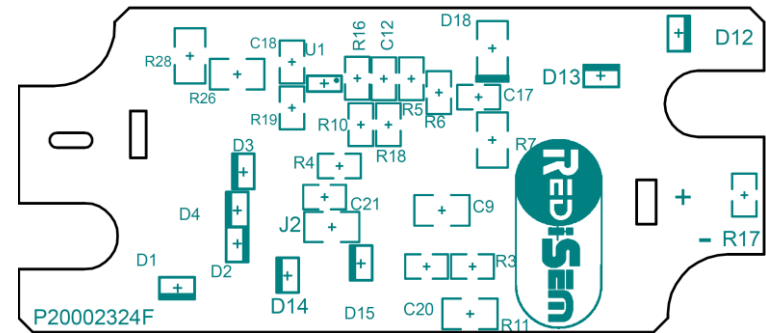
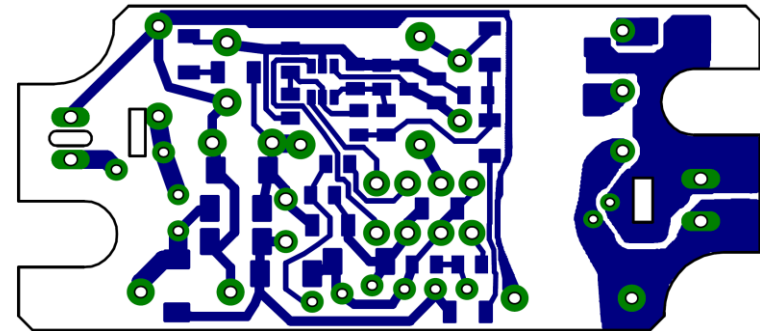
Code	Value	Description	Qty
C1	150n	X2 MKP 20% 275VAC	1
C2	150n	X2 MKP 20% 275VAC	1
C3	8n2	MKP 5% 400VDC	1
C6	22n	MKP 5% 400VDC	1
C9	470p	1206 NPO 5% 630VDC	1
C10	4u7	ELEC 20% 450VDC	1
C11	22u	ELEC 20% 50VDC	1
C12	1n	0805 X7R 10% 50VDC	1
C17	10n	0805 X7R 10% 100VDC	1
C18	1u	0805 X7R 10% 16VDC	1
C32	1n	Y-CAP	1
D1,2,3,4,14,15	RS1J	SMA Fast Diode 600VDC	6
D12,D13	STPS2H100	Schottky Diode, 100V 2A	2
D16	BAV21W	MiniMELF	1
L1	4m7H	6 x 8 Drum Core	1
L2	1m25H	Main Inductor EE13	1
F1	4R7	Fuse resistor 4R7	1
R3,4	2R	0805 0.06W 1.0%	2
R5	22R	1206 0.25W 1.0%	1
R6	0R5	1206 0.25W 1.0%	1
R7, 11, 26, 28	1M2	1206 0.25W 1.0%	4
R10	68k	0805 0.06W 1.0%	1
R16	20k	0805 0.06W 1.0%	1
R17	100k	0805 0.06W 1.0%	1
R18	1M3	0805 0.06W 1.0%	1
R19	120k	0805 0.06W 1.0%	1
P1,P2		Terminal 2 Pin	2
Q1,Q2	3DD4243DT	NPN (Ts=2-2.5us) TO92 2A	2
T1	T9x5x4	Base Drive: 18:6:6:1 turns	1
T2	EE13	Output Transformer	1
U1	RED2421	Low Ripple LED controller IC	1
TOTAL			43

PCB layout

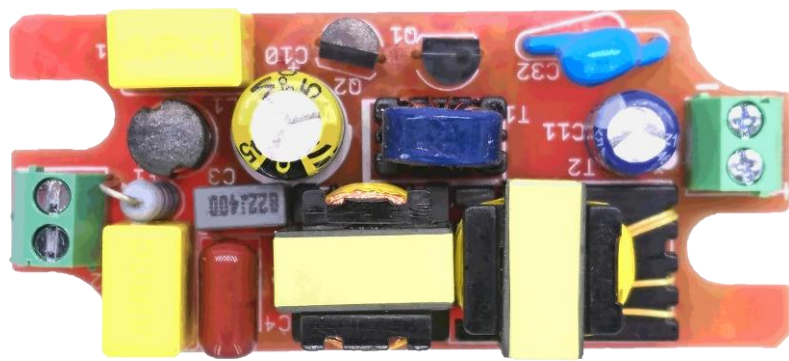
Top Side



Bottom Side

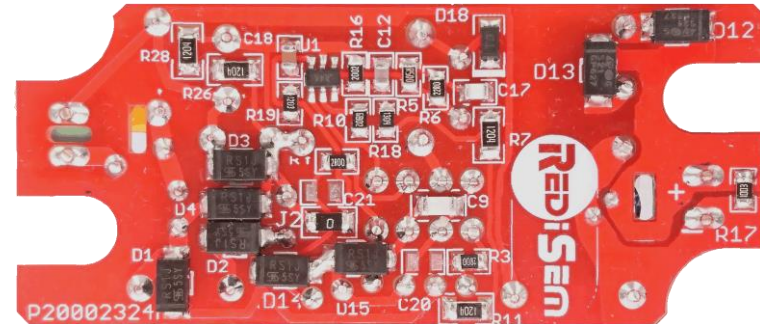


27mm



62mm

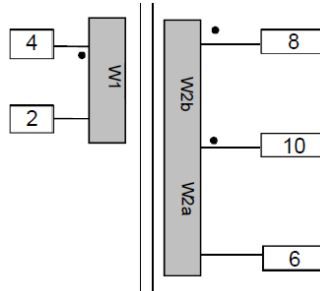
- Single sided PCB
- 1mm thick
- 1 Oz copper



Transformer Construction



Transformer	
Core type	EE13 PC47
Bobbin Type	EE13 SELV 5+5
Pri	62t x1s x 0.2mm ECW
Pri Inductance	5mH ±25%
Sec1&2	35t x 1s x 0.25mm TEXE



Winding	Turns	Start Pin	End Pin	Wire	Layers	Type	Purpose
W1	62	4	2	0.2mm	2	ECW	Primary
Tape	1						
W2a	35	8	10	0.25mm	2.3	TEXE	Secondary
W2b	35	10	6	0.25mm	2.3	TEXE	Secondary
Tape	1						

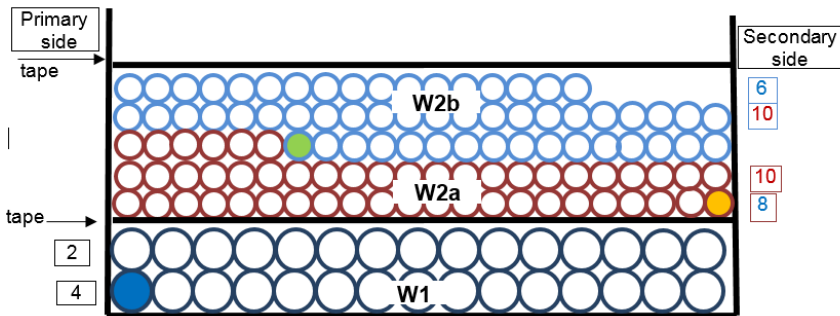
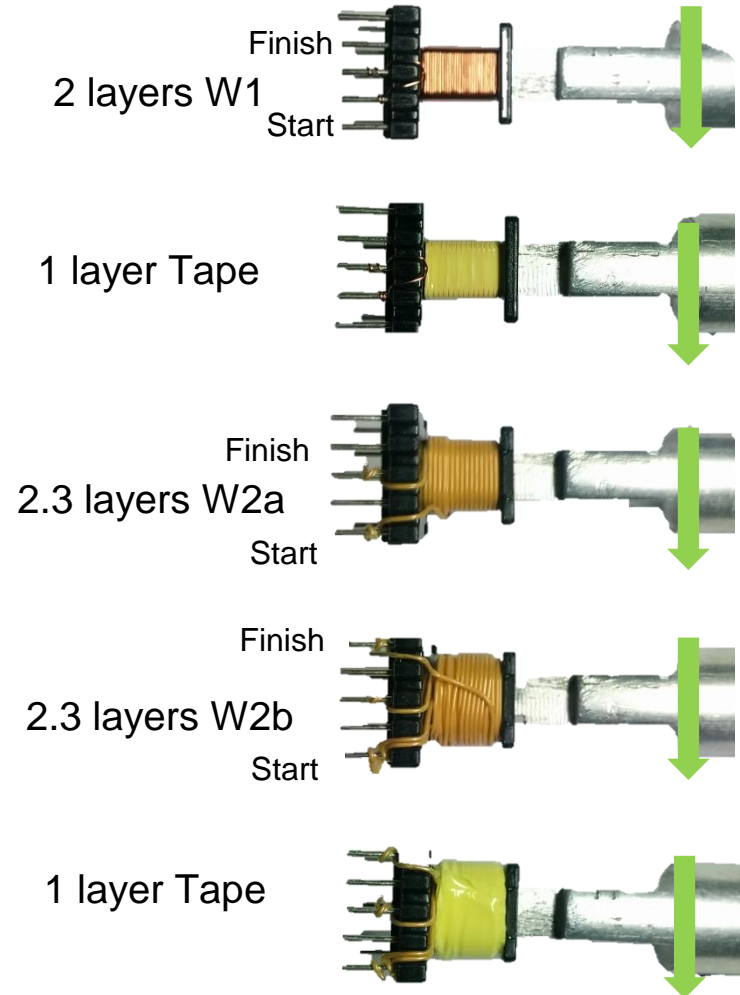


Figure 2: Transformer Winding Arrangement

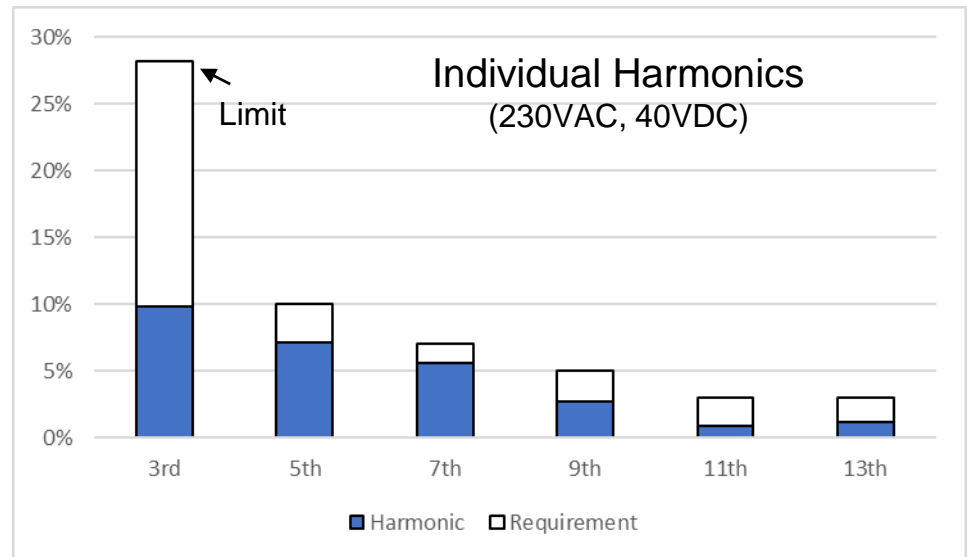
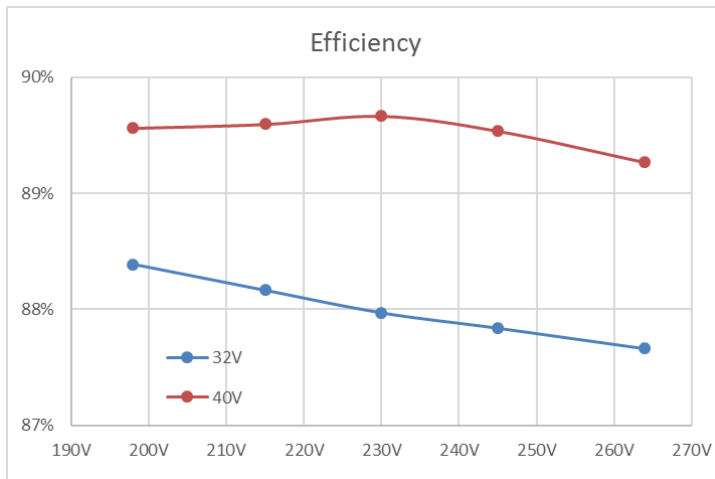


Test Results

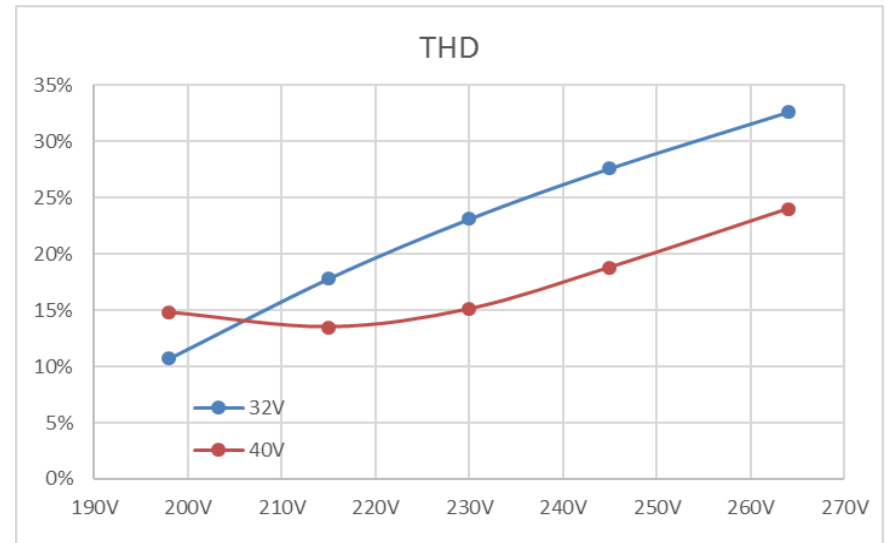
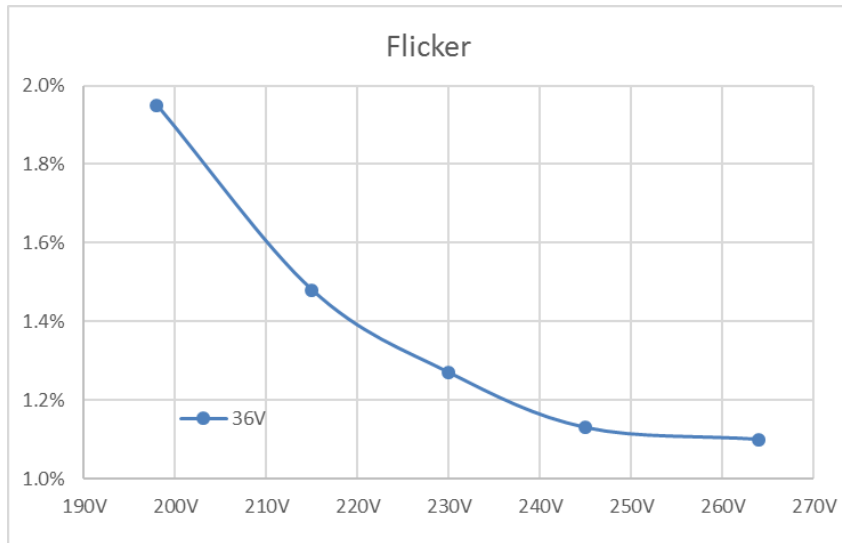
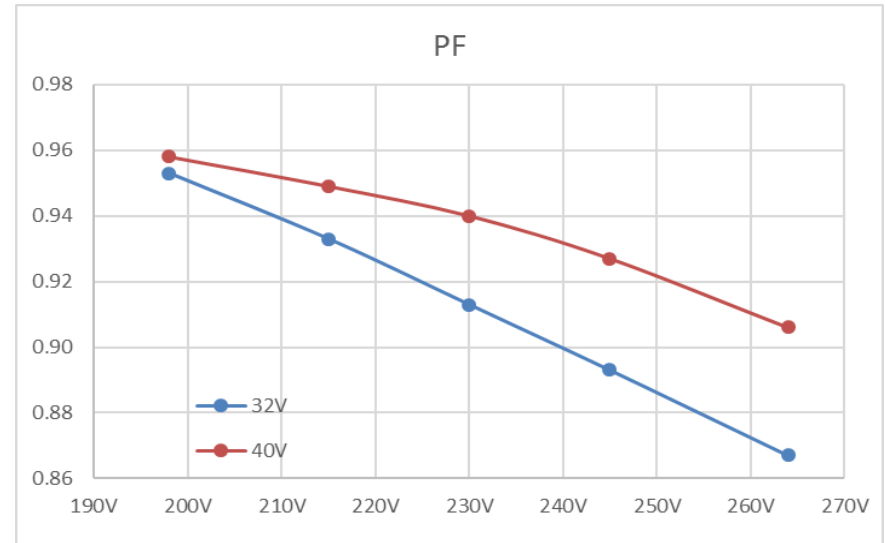
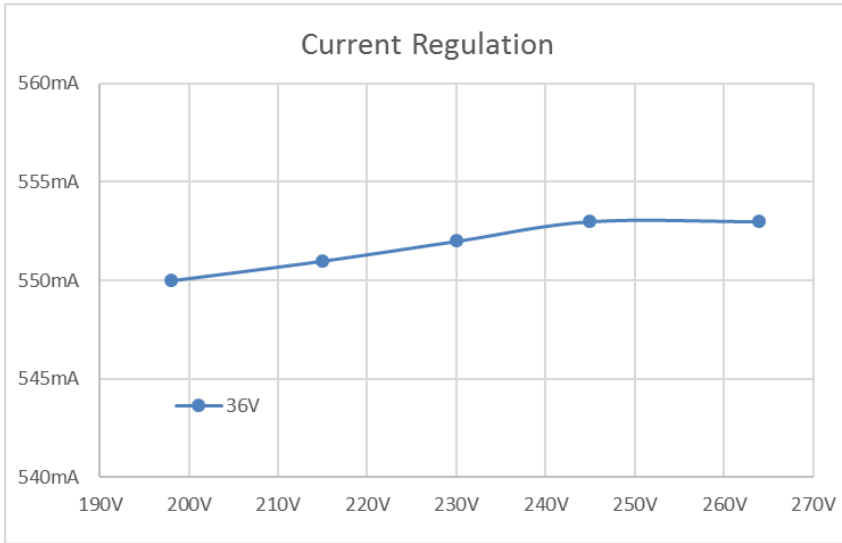


Output Voltage	32V					40V				
Input voltage	198V	215V	230V	245V	264V	198V	215V	230V	245V	264V
Output current	548mA	548mA	549mA	549mA	549mA	532mA	549mA	551mA	552mA	553mA
Input Power	19.84	19.89	19.97	20.00	20.04	23.76	24.51	24.58	24.66	24.78
Output Power	17.54	17.54	17.57	17.57	17.57	21.28	21.96	22.04	22.08	22.12
Efficiency	88.4%	88.2%	88.0%	87.8%	87.7%	89.6%	89.6%	89.7%	89.5%	89.3%
Power Factor	0.953	0.933	0.913	0.893	0.867	0.958	0.949	0.940	0.927	0.906
THD	10.7%	17.8%	23.1%	27.6%	32.6%	16.3%	13.8%	16.0%	19.5%	24.0%
Ripple (Flicker) @36V	1.95%	1.48%	1.27%	1.13%	1.10%					

Test	Result	Condition
Peak no-load Voltage	45.00V	230VAC
Time To light	140ms	230VAC



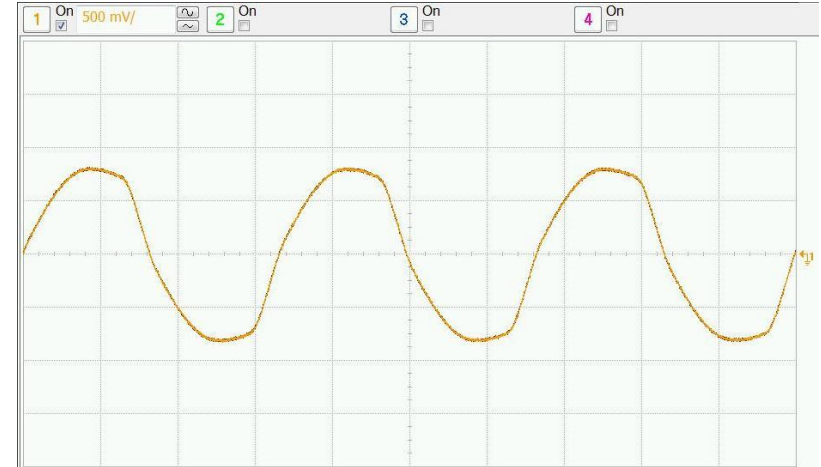
Test Results



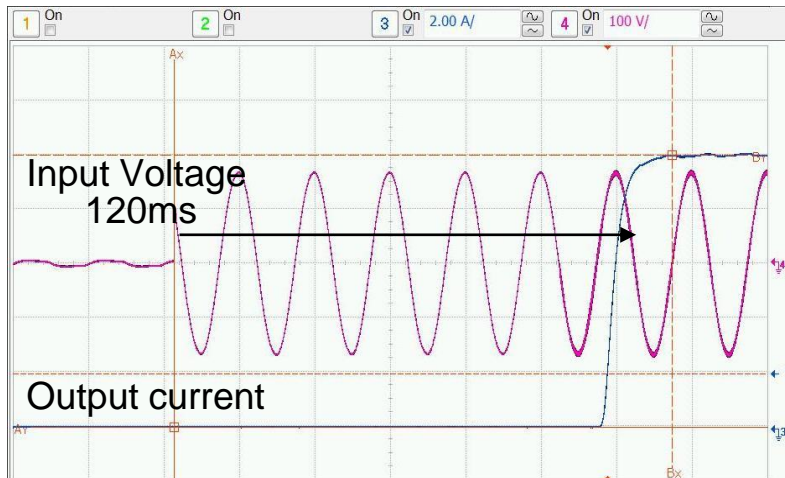
Test Results - Plots



Collector current and voltage



Inductor current 230VAC, 40VDC



Time To light 230VAC, 40VDC



Input current and output flicker current

Test Results – EMI & Surge



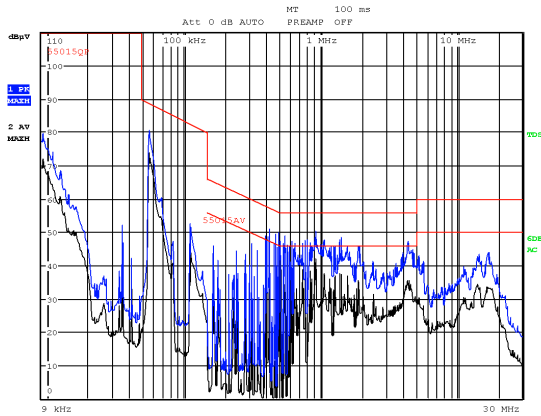
Conducted Test Setup



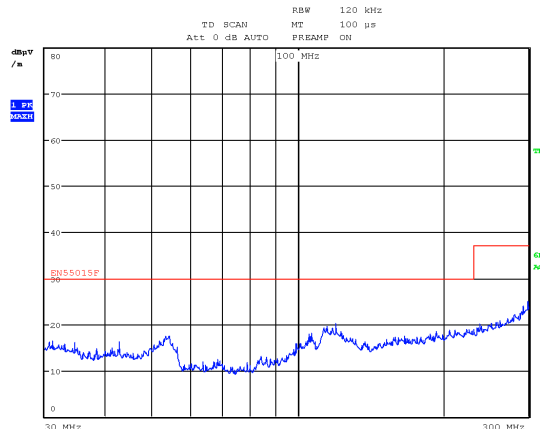
Radiated Test Setup



>10dB Margin EMI Pass

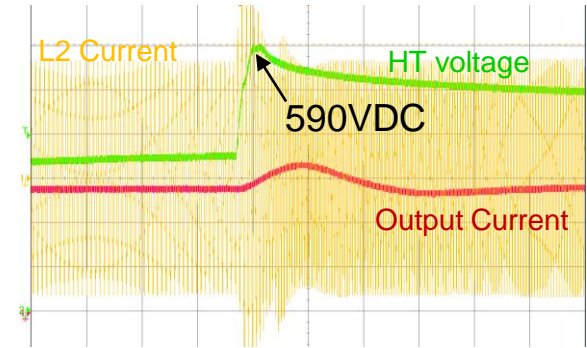


Conducted 9k~30MHz



Radiated 30M~300MHz

1kV surge pass with margin



Plot of HT bus voltage and L2 (resonant) current during 1.2kV surge with fuse resistor

Test Results - Thermals



Test condition:

In a box in a heated oven
 $T_a = 50C$

Thermal Results (cased)	198V 40V	264V 32V
T_a	50C	50C
Q1	105C	110C
Q2	102C	110C
L2 core	98C	113C
L2 winding	98C	118C
T2 core	108C	107C
T2 winding	109C	106C

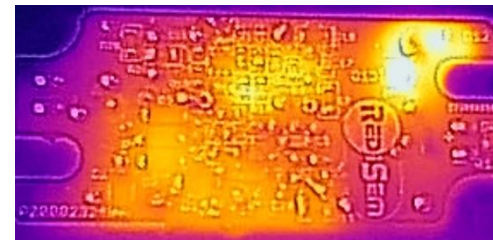


Test condition:

Open on the bench



Top side Thermal



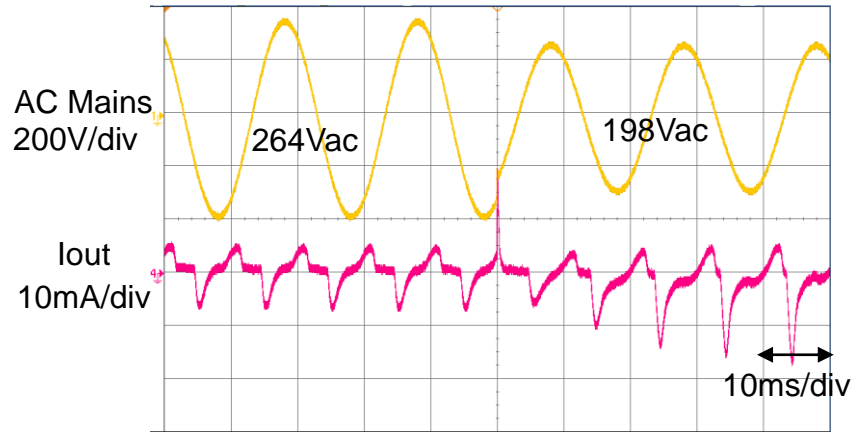
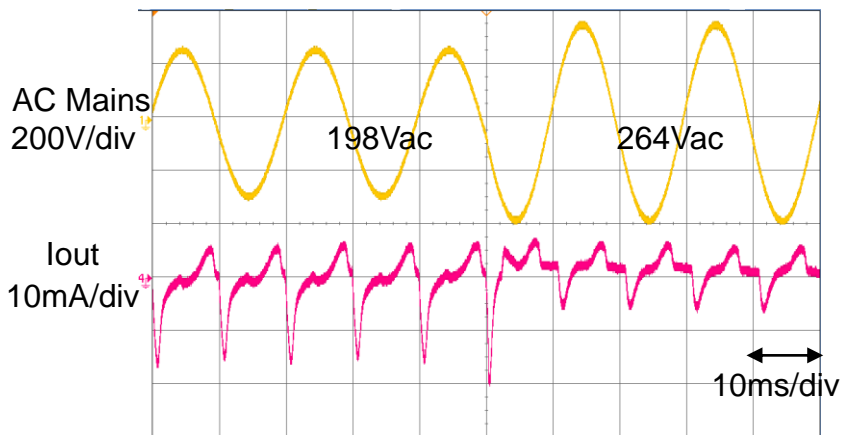
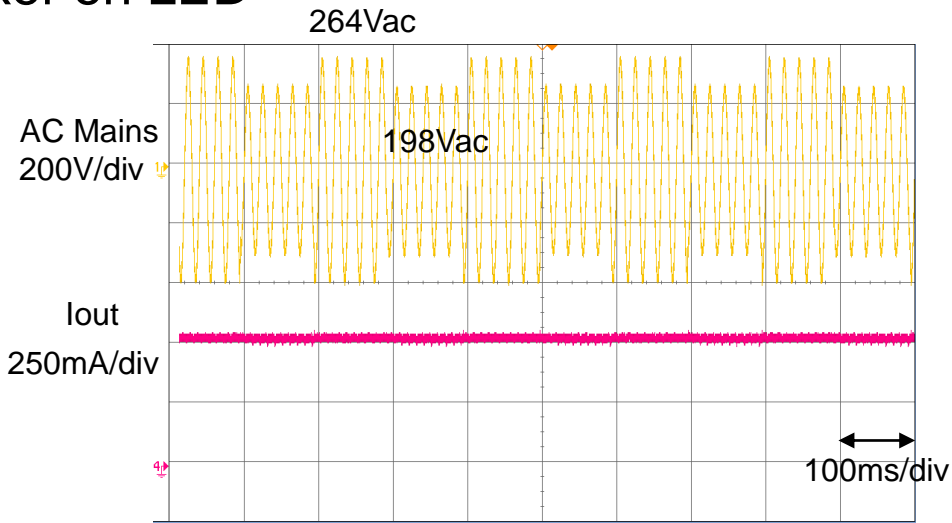
Bottom side Thermal

Test Results – AC transients



AC Mains transient 198Vac - 264Vac every 100ms

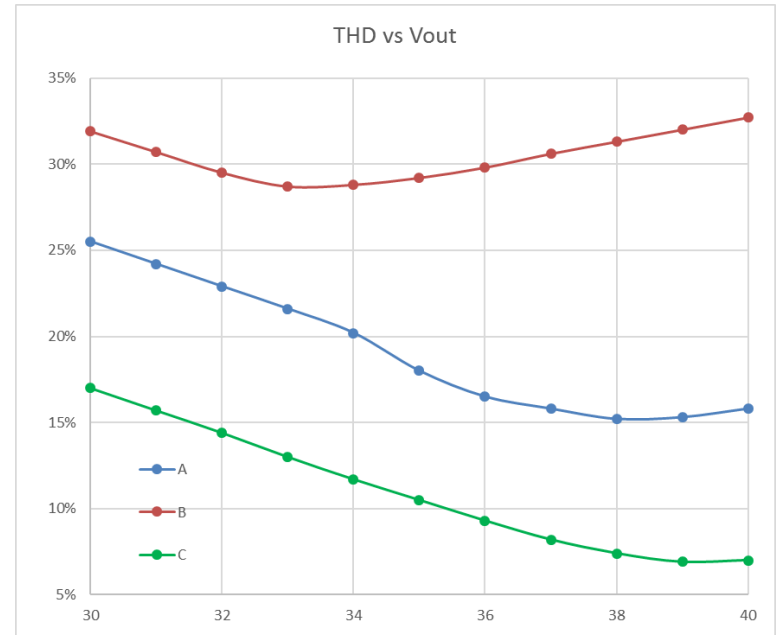
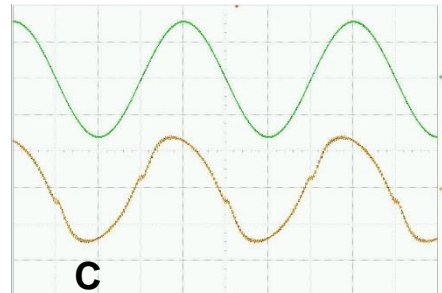
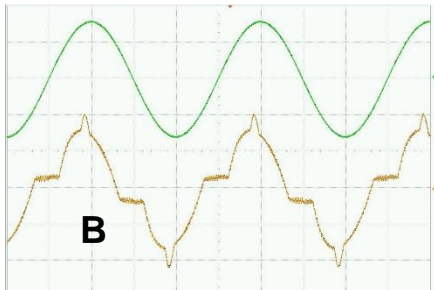
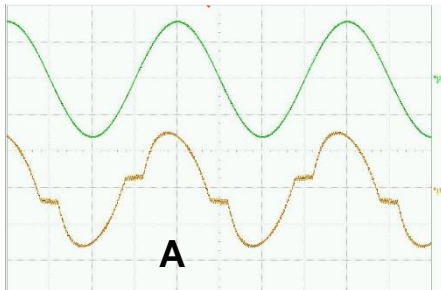
Result: No flicker on LED



Upgrades – Different THD

Simple modifications for better THD - Change charge pump capacitors as below:

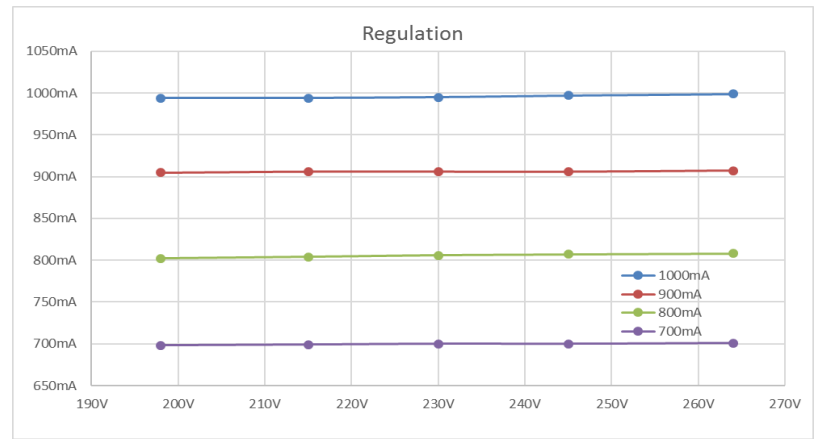
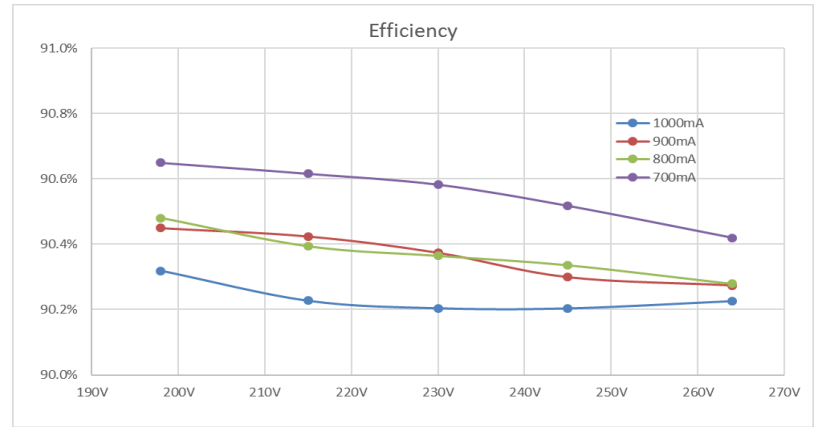
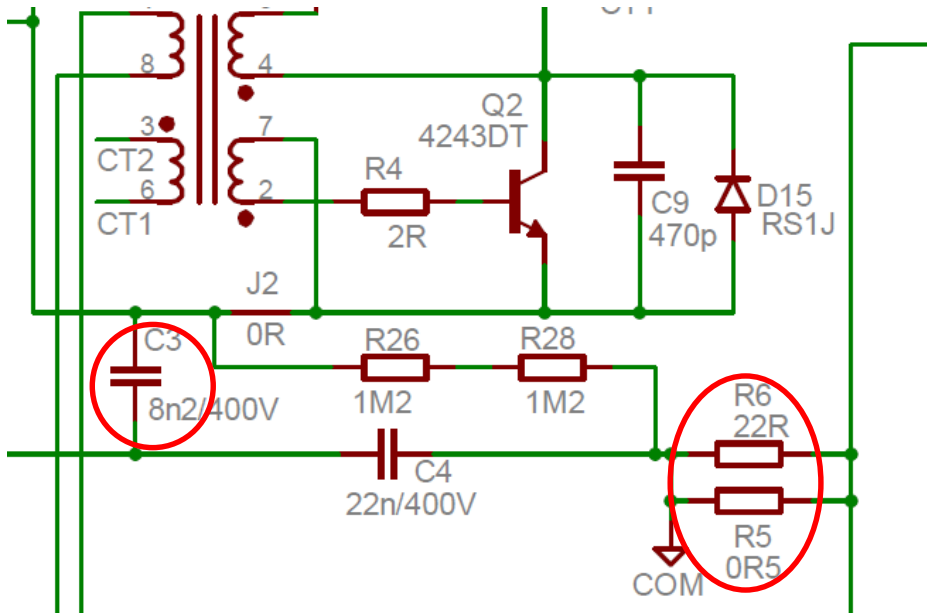
Test unit	Harmonic	C3	C4	THD @ 36Voutput	VHT @ 264Vac 32Vdc	Remarks
A (original)	Class C	8n2	22n	16.5%	398V	Optimized efficiency design
B	Class D	12n	22n	29.8%	376V	Pass Class D
C	Class C	4n7	22n	9.3%	441V	THD < 10%, hotter, so consider larger case & magnetics



AC input current @ 230VAC, 36V

Modify output current

Only need to change boost capacitor & CS resistor to change output current from 550mA to 400mA



Design current	Changes		THD @ 230V & 36V	Efficiency @ 230V & 36V	Max. output Pass Class C Harmonic	VHT @ 32V & 264VAC	Remarks
	C3	R5&6					
550mA	8n2	0R 5 and 22R	12.8%	88.4%	40V	401V	Original driver
500mA	6n8	0R 56	18.5%	90.5%	40V	398V	Efficiency rises as power reduces
450mA	5n6	0R 68 and 5R 6	18.5%	91.6%	40V	401V	Can reduce C 10 to 3.3uF
400mA	4n7	0R 68	20.0%	92.3%	39V	397V	Can change Q1,2 to 4242

RED2421 Datasheet



RED2421

Low Power LED Controller for LLC converters

Features

- Advanced LED Controller IC for high efficiency low-cost LLC converters with bipolar transistors and integrated PFC
- PSR - +/-5% Primary Side Regulation of LED current and voltage with no Flicker
- 50% duty cycle, variable frequency control of resonant half-bridge
- Automatic dead-time control and capacitive mode protection
- Protection modes:
 - Overload
 - No-Load
 - Over-temperature
- Low output capacitance allows live LED connection
- Very low output current ripple – 0.5%
- Small SOT23-6 IC package



SOT23-6

Applications

- High frequency CC LED drivers up to 22W
- Optimized for low-cost passive PFC
- Pin compatible with RED2401

Order code

Part Number	Package	Packaging
RED2421AL-TR7	SOT23-6	Tape and reel

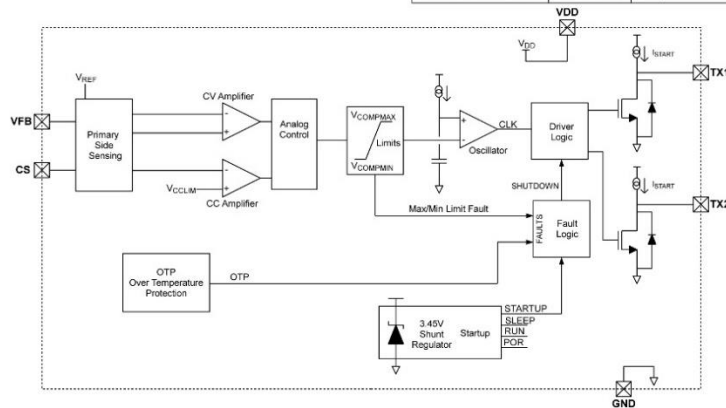


Figure 1: Block diagram



RED2421 LED LLC Controller

Device Pins

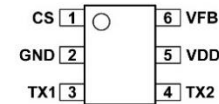
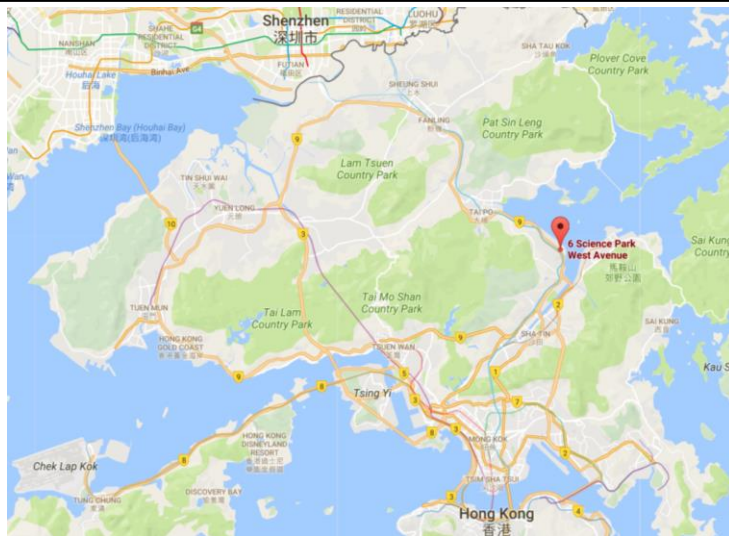


Figure 2: SOT23-6 pin connections (top view)

Pin Functions

Pin #	Name	Function
1	CS	PSR Current Sense input provides output current regulation and cycle-by-cycle over-current protection. The CS pin is connected to the half-bridge current sense resistor
2	GND	Chip ground.
3	TX1	Output to control transformer.
4	TX2	Output to control transformer.
5	VDD	IC Power Supply pin – nominally 3.45V
6	VFB	PSR Feedback input for output voltage regulation. Connect to primary sense winding.

Contact details



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