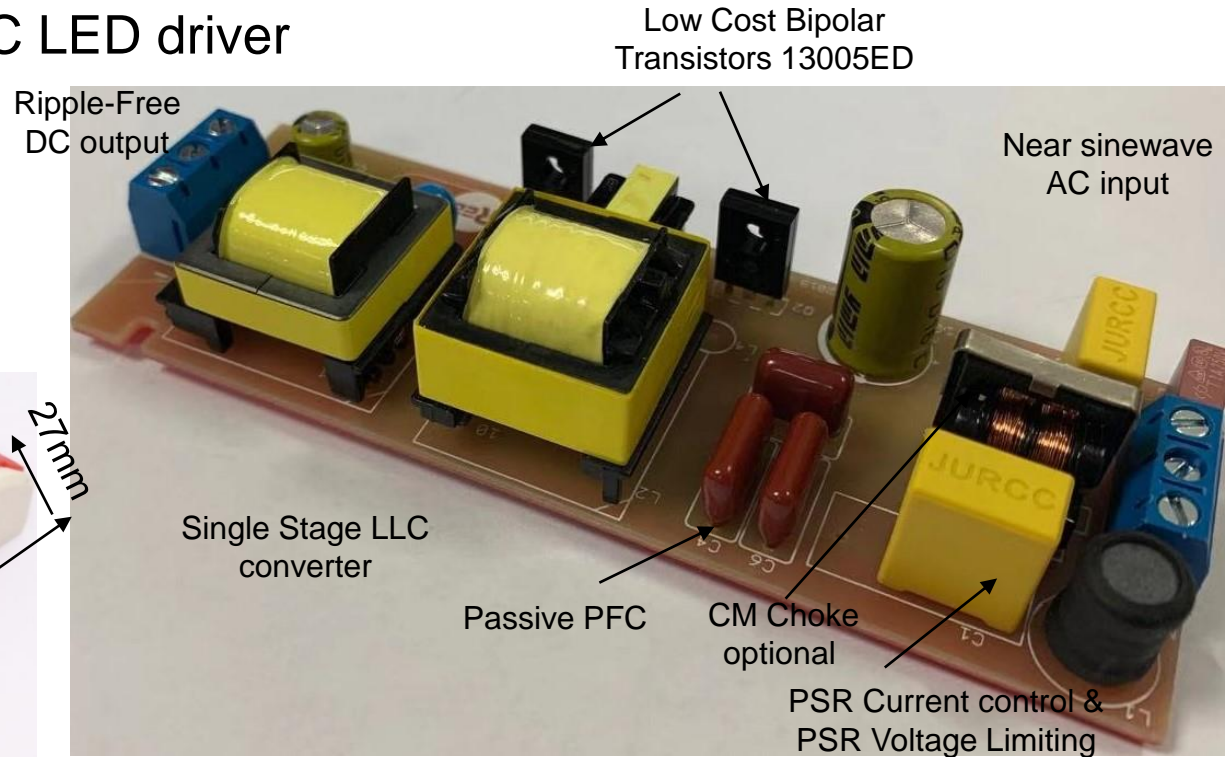




RED2433 50W LED Driver Design Report

February 2019

- Low-cost Flicker-free CC LED driver
- RED2433 controller IC
- Efficiency 91%
- High Power Factor >0.9
- 1.2A 32-40V output
- Low EMI

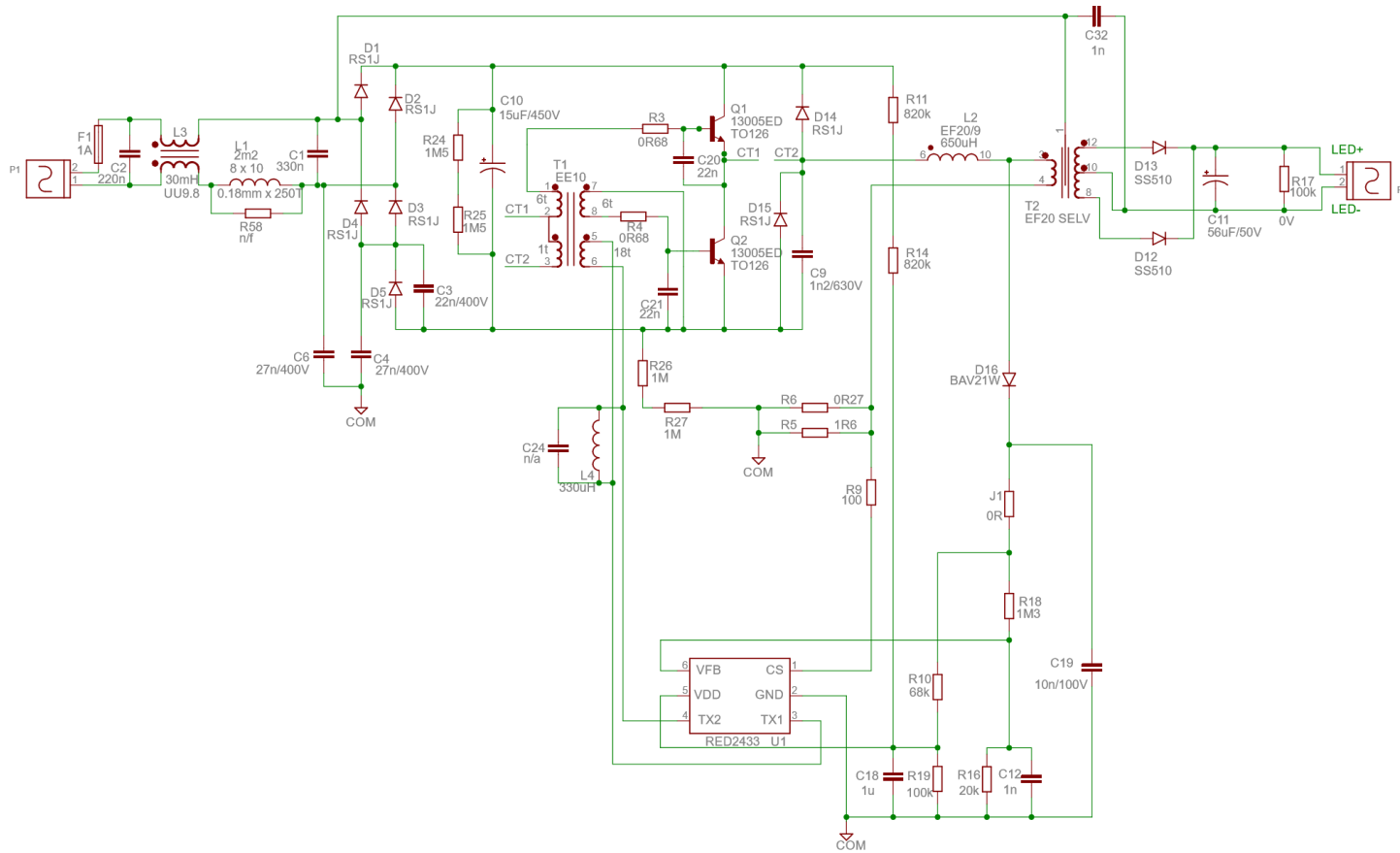


Specifications



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	1.2A \pm 5%	198 - 264VAC
LF Ripple (Flicker)	< 0.8%	230VAC, 40VDC
Harmonic compliance	220 - 240VAC	33-40V DC
Total Ripple	< 20%	230VAC, 40VDC
Time to light	< 150ms	230VAC, 40VDC
Efficiency	> 91%	230VAC, 40VDC
Power factor	> 0.97	230VAC, 40VDC
THD	< 10%	230VAC, 40VDC
No-load voltage	< 50V	264VAC
Protection	Overtemperature, short circuit, open circuit	
EMI test	7dB Margin	LED earthed, Driver floating
Surge	1kV DM , 2kV CM	
Ambient Temperature	-20 to 50°C	

Schematic



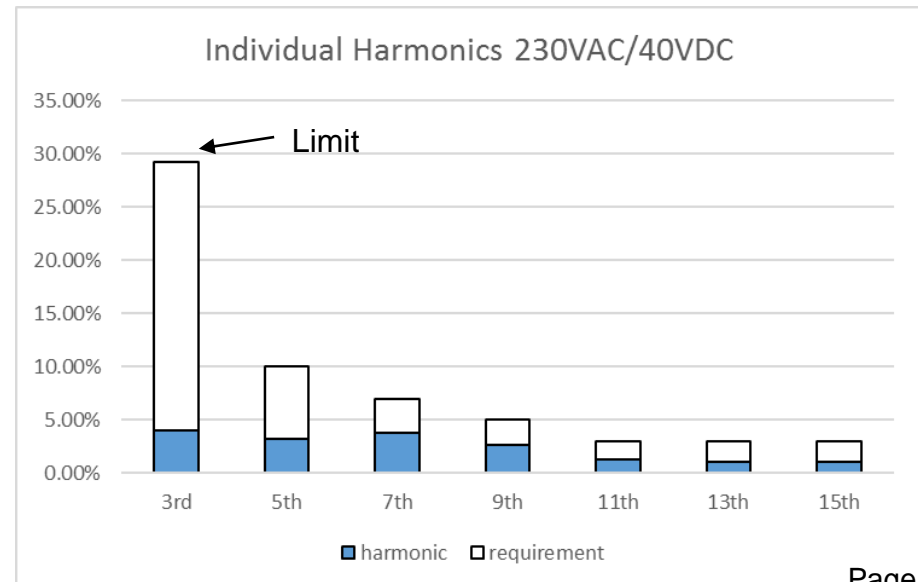
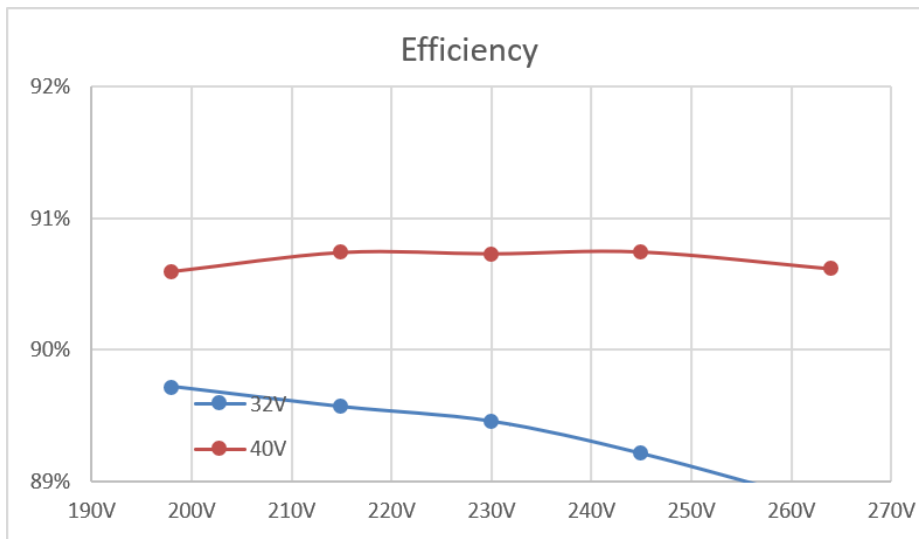
Code	Value	Description	Qty	Supplier	Part no.
C1	330n	X2 MKP 20% 275VAC	1	Tenta	
C2	220n	X2 MKP 20% 275VAC	1	Tenta	
C3	22n	MKP 5% 400VDC	1	Fara	
C4	39n	MKP 5% 400VDC	1	Fara	
C6	5n6	MKP 5% 400VDC	1	Fara	
C10	15u	ELEC 20% 450VDC	1	Aishi	
C11	56u	ELEC 20% 50VDC	1	Aishi	
C9	1n2	1206 NPO 5% 1000VDC	1	Murata	
C12	1n	0805 X7R 10% 50VDC	1	Samsung	
C19	10n	0805 X7R 10% 100VDC	1	Samsung	
C18	1u	0805 X7R 10% 16VDC	1	Samsung	
C20,21	22n	0805 X7R 10% 50VDC	2	Samsung	
C32	1n	Y-CAP	1		
D1,2,3,4,5,14,15	RS1J	SMA Fast Diode 600VDC 1A	7	TSC/Vishay	
D16	BAV21W	MiniMELF	1		
D12,13	SS510	SMC Schottky Diode 100VDC 5A	2	MIC	
F1	1A	Fuse	1		
L1	2m2H	8x10 Drum Core	1	Ningbo Eilux Electric	W10001
L2	718uH	EF20/9 Main Inductor	1		W20065
L3	30mH	UU9.8 Common mode (optional)			W30013
L4	330uH	0410 0.25W Axial	1		
R3,4	0R68	0805 0.06W 1.0%	2		
R5	1R6	1206 0.25W 1.0%	1		
R6	0R27	1206 0.25W 1.0%	1		
R7,11,14	820k	0805 0.125W 1.0%	3		
R9	100k	0805 0.06W 1.0%	1		
R10	100R	0805 0.06W 1.0%	1		
R16	68k	0805 0.06W 1.0%	1		
R17	20k	0805 0.06W 1.0%	1		
R18	100k	1206 0.25W 1.0%	1		
R24,25	1M5	1206 0.25W 1.0%	2		
R26,27,28	1M3	0805 0.06W 1.0%	1		
P1,P2	1M	0805 0.125W 1.0%	3		
Q1,Q2		Terminal 2 Pin	2		
T1	13005ED	TO126 4A NPN Transistor (Ts=2-2.5us)	2	Jilin Sino	
T2	EE10	Base Drive : 18:6:1 turns	1		W50031
T2*	EF20	Output Transformer	1		W40058
	EF20	Optional split-primary output transformer with common mode choke for higher efficiency			W40056
U1	RED2433	LLC LED controller IC	1	Redisem	
TOTAL			53		

Test Results



Output Voltage	32V					40V				
Input voltage	198V	215V	230V	245V	264V	198V	215V	230V	245V	264V
Output current	1216mA	1217mA	1218mA	1218mA	1218mA	1212mA	1216mA	1218mA	1220mA	1221mA
Input Power	43.37	43.48	43.57	43.69	43.90	53.57	53.65	53.70	53.78	53.90
Output Power	38.91	38.94	38.98	38.98	38.99	48.53	48.68	48.72	48.80	48.84
Efficiency	89.7%	89.6%	89.5%	89.2%	88.8%	90.6%	90.7%	90.7%	90.7%	90.6%
Power Factor	0.973	0.970	0.963	0.952	0.935	0.966	0.972	0.971	0.967	0.955
THD	10.8%	7.1%	7.6%	11.6%	16.8%	18.1%	10.6%	8.1%	6.6%	10.7%
Ripple (Flicker) @36V	0.70%	0.67%	0.61%	0.58%	0.58%					

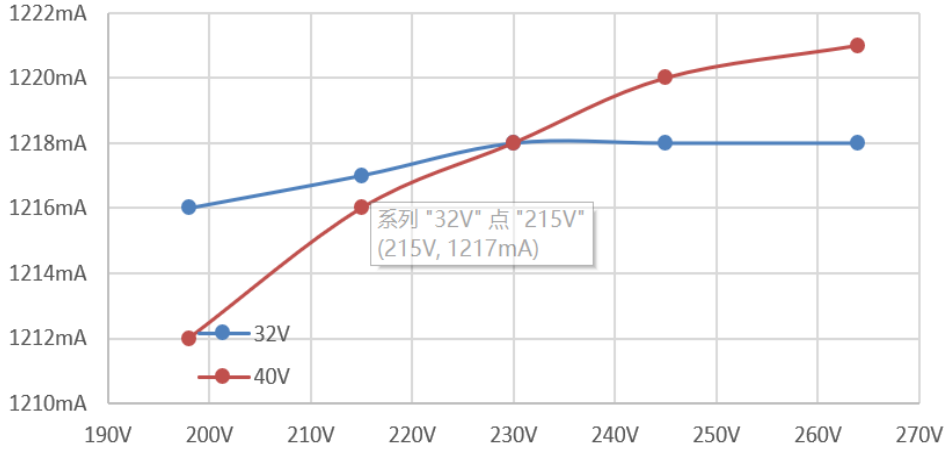
Test	Result	Condition
Peak no-load Voltage	48.00V	230VAC
Time To light	100ms	230VAC



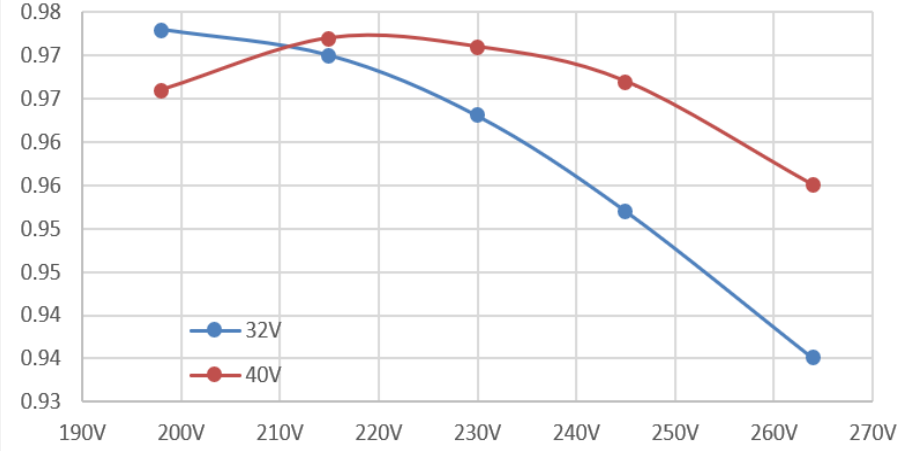
Test Results



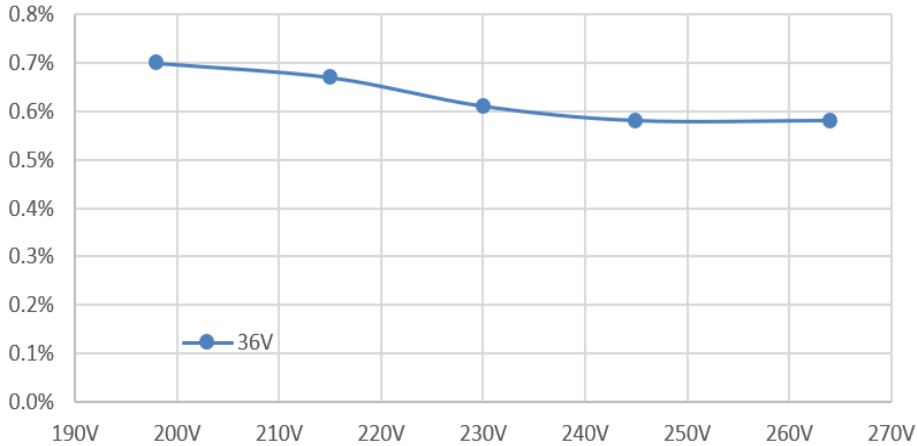
Current Regulation



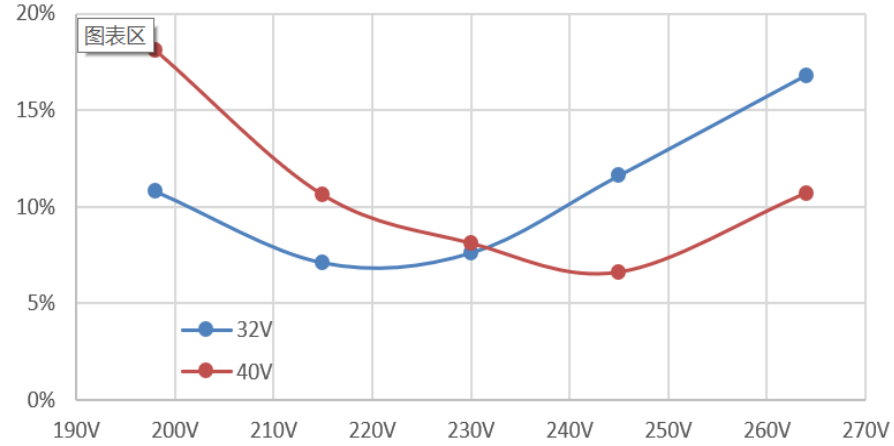
PF



Flicker



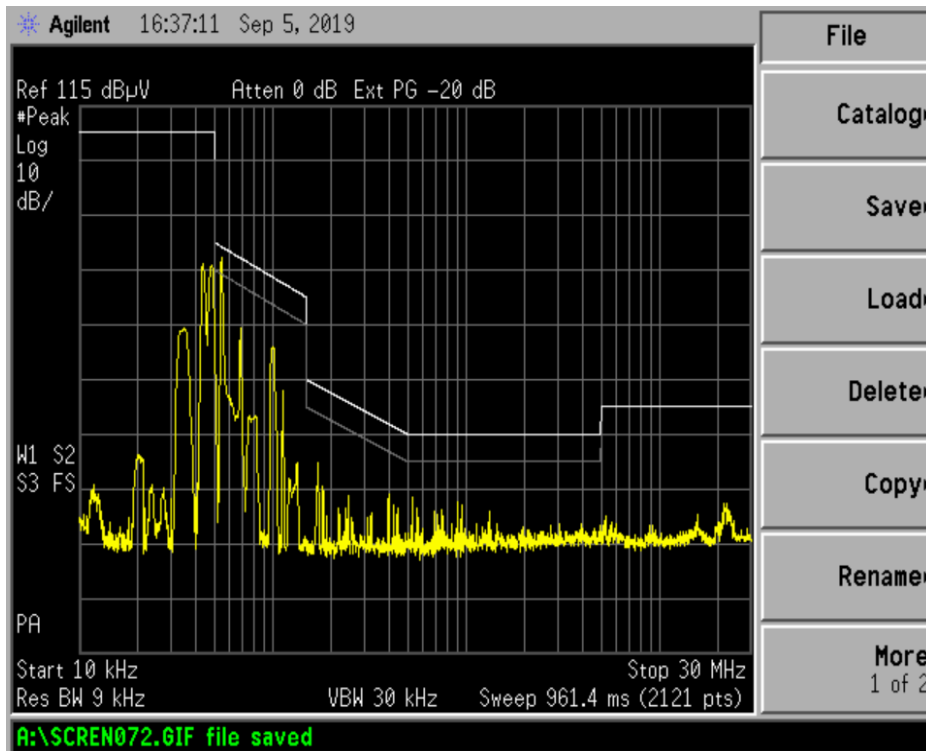
THD



Test Results – EMI & Surge

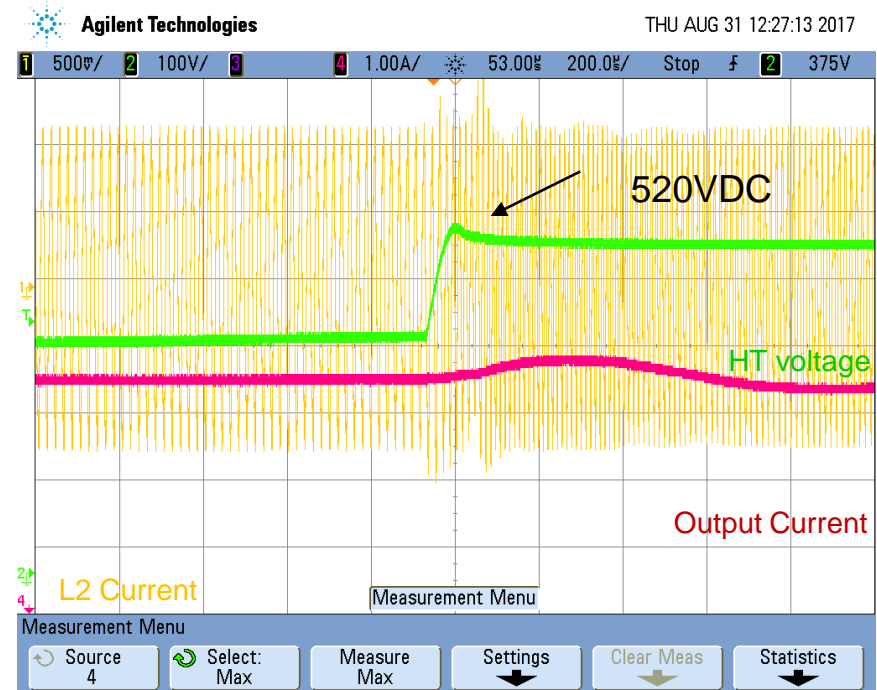


>6dB Margin EMI Pass



Conducted EMI 9k~30MHz
Driver and LED on earthed ground plane

1kV surge pass with margin



Plot of HT bus voltage and L2 (resonant) current during 1kV surge with fuse resistor 230VAC/36VDC

Test Results - Thermals

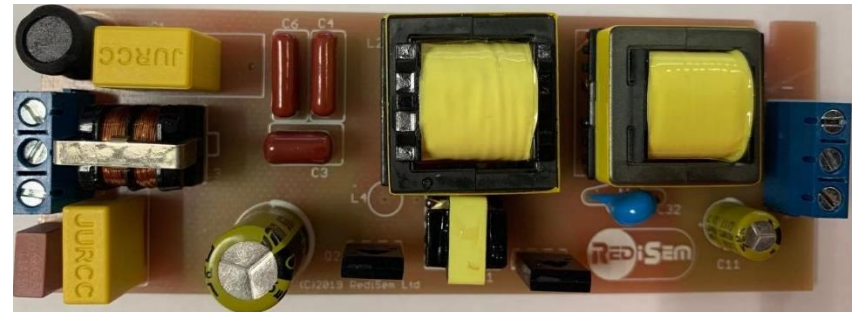
Test condition:

In a box in a heated oven
 $T_a = 45C$

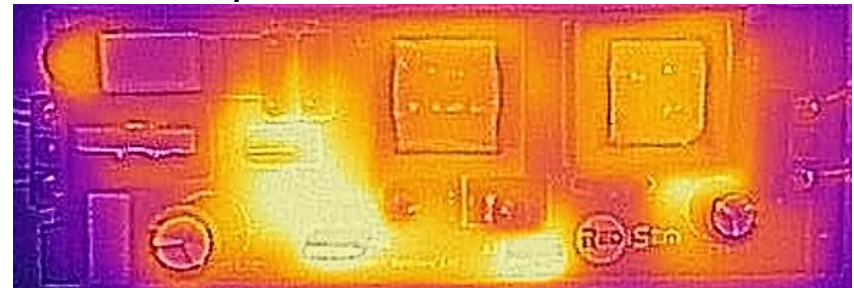
Thermal Results (cased)	198V 40V	264V 32V
T_a	50C	50C
Q1	102C	112C
Q2	101C	114C
L2 core	98C	110C
L2 winding	100C	113C
T2 core	101C	97C
T2 winding	105C	104C



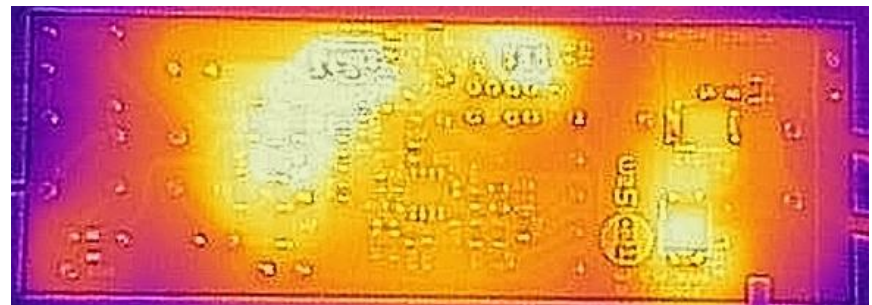
Test condition:



Open on the bench



Top side Thermal

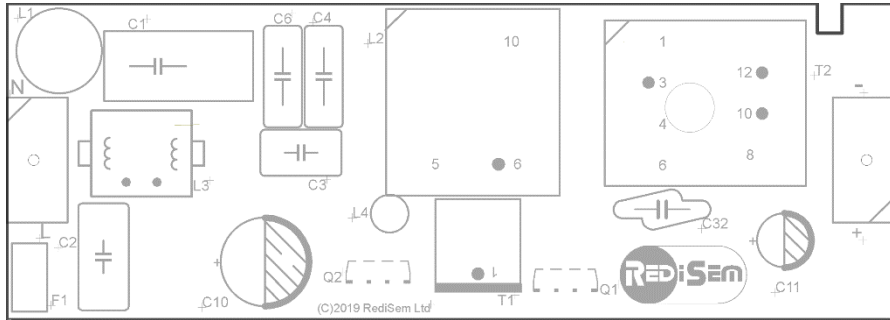


Bottom side Thermal

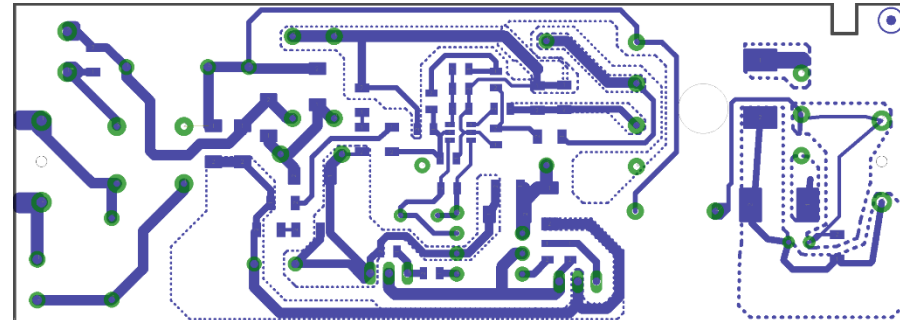
PCB layout



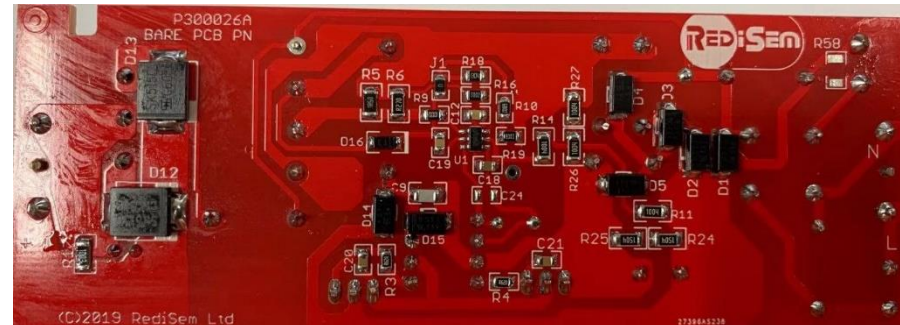
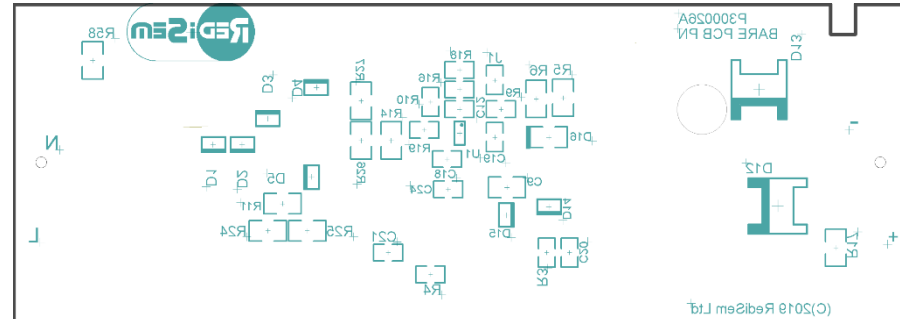
Top Side



Bottom Side

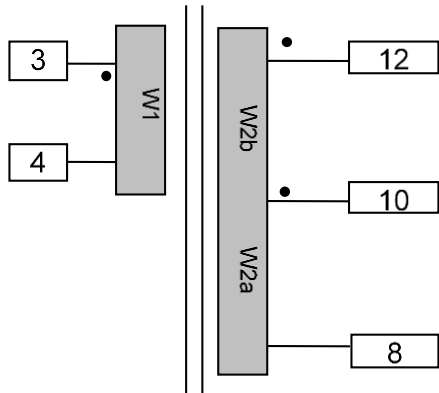


115mm

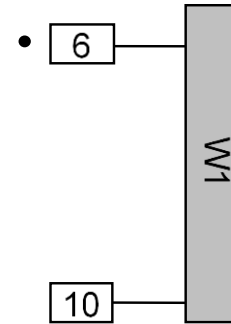


- Single sided PCB
- 1mm thick
- 1 Oz copper

Wound components



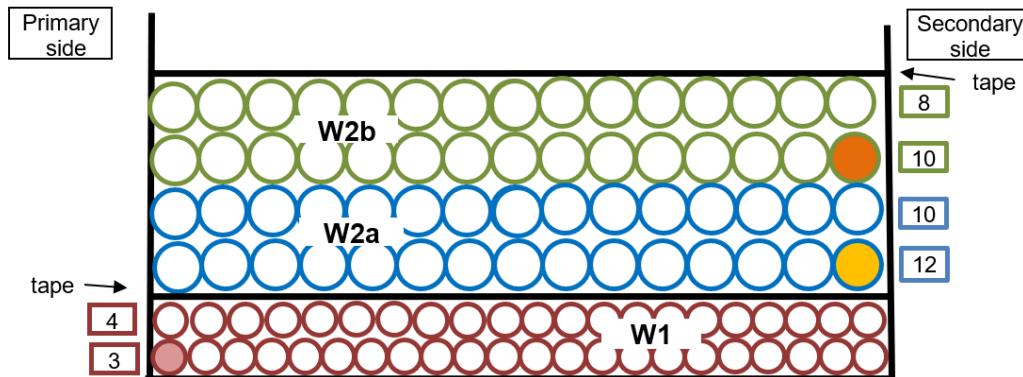
Transformer	
Core type	EF20
Material	P45



Inductor	
CoreType	EF20/20/9
Material	P45
Value	650uH

Winding	Turns	Start Pin	End Pin	Wire	Layers	Type	Purpose
W1	44	3	4	0.40mm	1	ECW	Primary
Tape	1						
W2a	25	12	10	0.45mm	1.5	TEXE	Secondary
W2b	25	10	8	0.45mm	1.5	TEXE	Secondary
Tape	1						

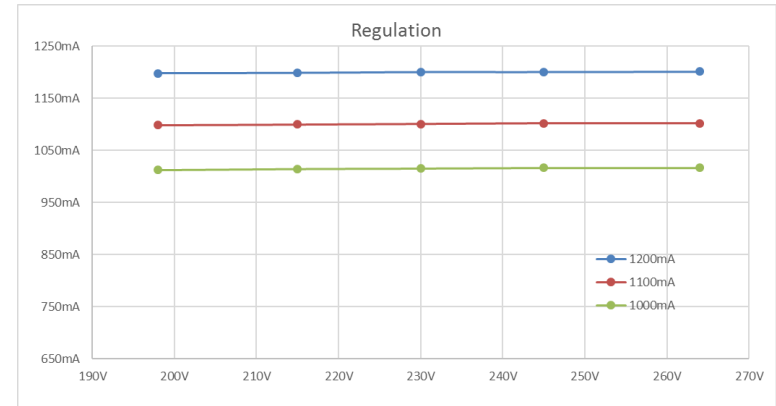
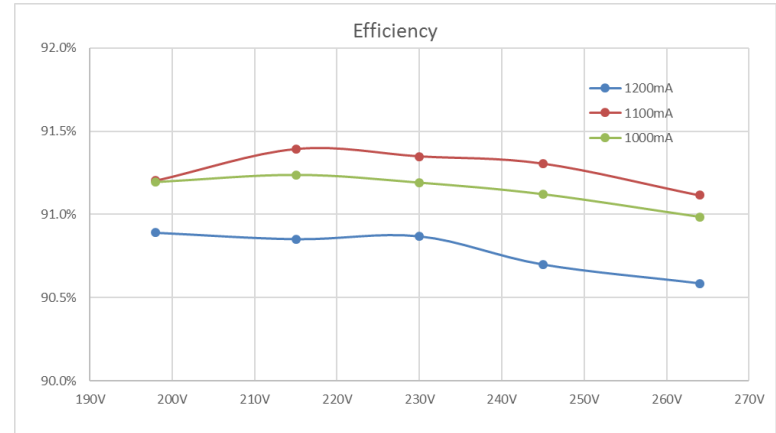
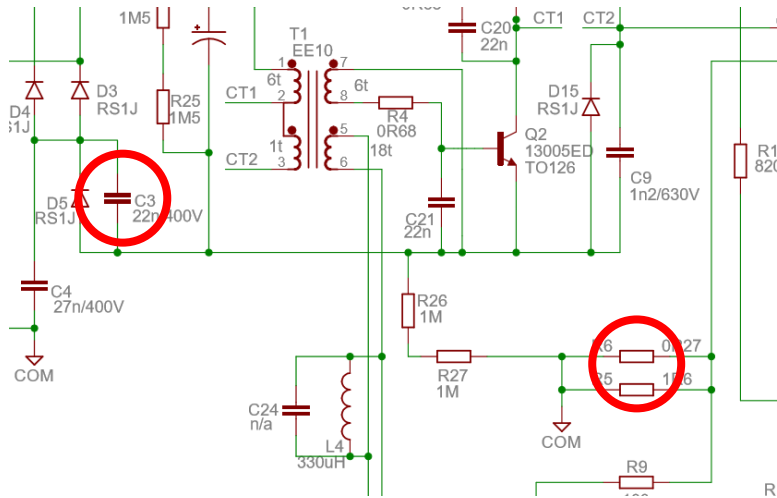
Winding	Turns	Wire	Inductance
W1	80T	0.1mm x 25strands	650uH +/- 3% ECW Grade 2



Modify output current



Only need to change boost capacitor & CS resistor to change output current from 1200mA to 1000mA



Design current	Changes		THD @ 230V & 36V	Efficiency @ 230V & 36V	Output range for good Harmonic	VHT @ 32V & 264VAC	Remarks
	C3	R5&6					
1200mA	22n	1R6 & 0R27	6.5%	90.9%	32 - 40V	420.9	Original driver
1100mA	22n	1R6 & 0R30	8.3%	91.3%	25 - 42V	409.8	
1000mA	18n	1R6 & 0R33	11.5%	91.2%	25 - 42V	409.4	

CM choke option

CM choke option for higher efficiency can be accomplished by using a split primary transformer.

>8dB Margin Pass

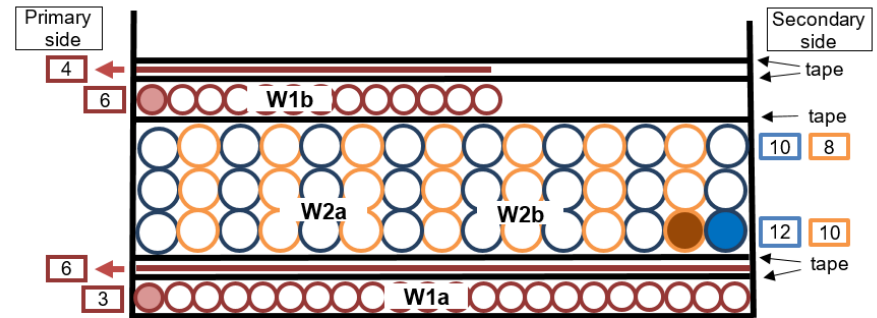
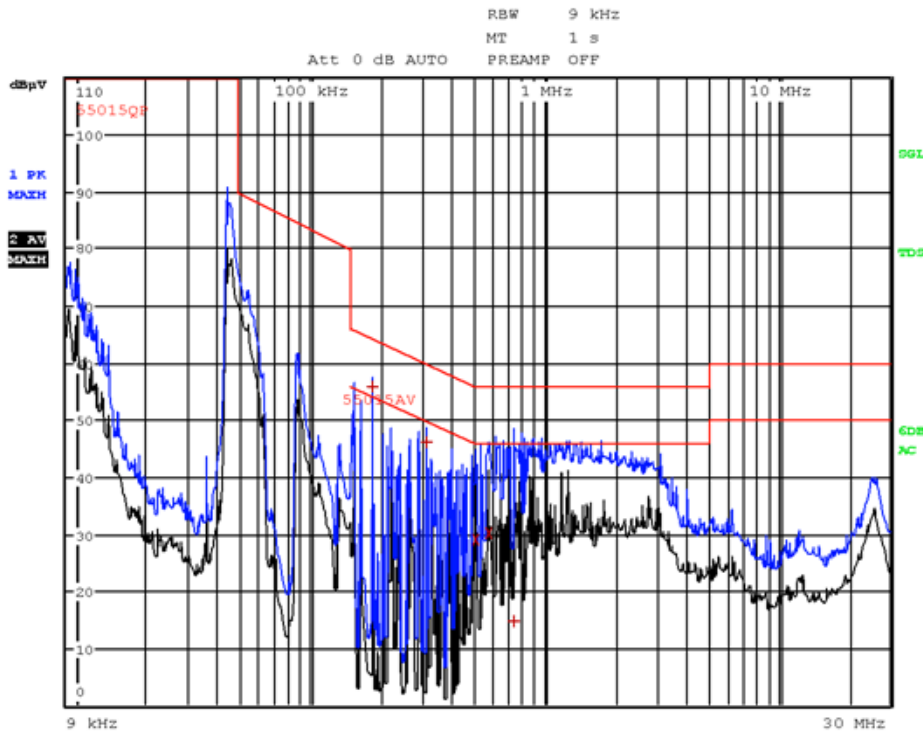


Figure 2: Transformer Winding Arrangement

Split Primary Transformer Winding

Conducted EMI 9k~30MHz
Driver located on LED panel

Basedrive Transformer



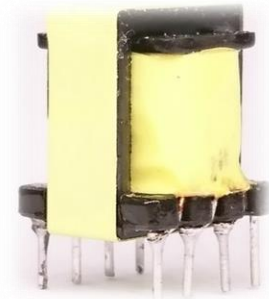
RediSem recommends ACME A062 T9x5x4

- Complete wound & varnished base-drive transformer
- Made to RediSem specs
- Qualified and tested turn-key solution



EE10 option for in-house manufacturing

- Base-drive transformer using EE10 core
- Contact RediSem for design information





RED2433

LED Controller for LLC converters

Features

- Advanced LED Controller IC for high efficiency low-cost LLC converters with bipolar transistors and integrated PFC
- PSR - +/-3% Primary Side Regulation of LED current and voltage with no Flicker
- Overtemperature output current foldback for high temperature survival
- Lowest output current ripple <0.3%. Flicker Index typically 0.0004
- Automatic dead-time control and capacitive mode protection
- Protection modes:
 - Overload
 - No-Load
 - Over-temperature fault latch & output current foldback
- Small SOT23-6 IC package



SOT23-6

Applications

- LED lamps with PFC
- High frequency CC LED drivers up to 80W

Order code

Part Number	Package	Packaging
RED2433AL-TR7	SOT23-6	Tape and reel

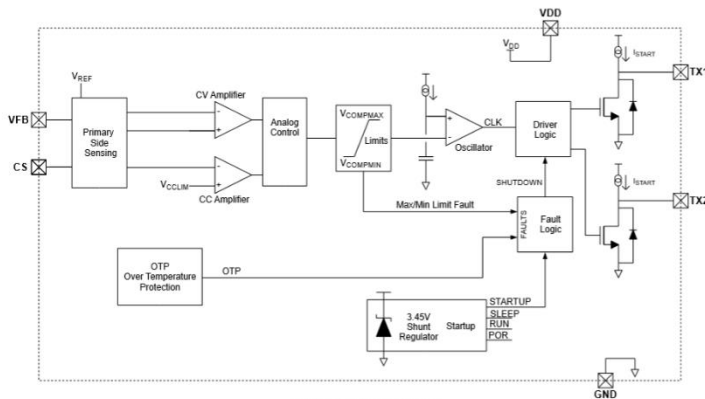


Figure 1: Block diagram



RED2433 LED LLC Controller

Device Pins

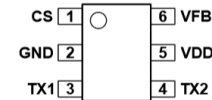
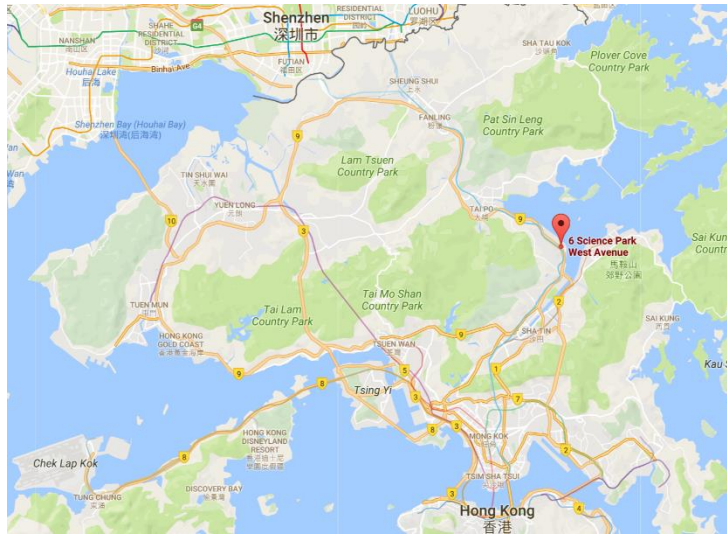


Figure 2: SOT23-6 pin connections (top view)

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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