



6.5W LED Driver Using UPSR100

Subject

UPSR100 LED Driver Demo Board Manual- Low Line



Key features:

- AC Input Range 90Vac/60Hz~132Vac60/Hz
- DC Output 21Vdc / 0.3A
- Average Efficiency > 76%
- Short Circuit Protection and Open Loop Protection.

Revision History

Revised Date	Version	Reason/Issue
2013/12/27	A	



6.5W LED Driver Using UPSR100

Contents Index		Page
1	LED Driver Demo Board Specification	3
1.1.	Input Characteristics	3
1.2.	Output Characteristics	3
1.3.	Performance Specifications	3
1.4.	Protection Function	3
1.5.	Environment	3
2	LED Driver Demo Board Information	4
2.1.	Schematic	4
2.2.	BOM	4,5
2.3.	Module Dimension	5
2.4	Transformer Design	6
2.4.1	Transformer Specification.	6
2.4.2	Transformer Diagram.	6
3	Performance Evaluation	7
3.1.	Input Characteristics	8
3.1.1	Input Current	8
3.1.2	Efficiency at Full Load	8
3.2.	Output Characteristics	9
3.2.1.	Output Current Regulation	9
3.2.2.	Ripple & Noise	9
3.2.3.	Start-Up Time and Hold-Up Time	10
3.2.3.1	Start-Up Time	10
3.2.3.2	Hold-Up Time	10
3.3.	Protection	11
3.3.1.	Open Loop Protection	11
3.3.2.	Short Circuit Protection	11
3.4.	Thermal Testing	11
4	Other Important Waveforms-Full Load 7 LED	12
4.1.1	Waveform $V_{ce}; I_{ce}; V_{cc}; V_{fb}$ @90Vac/60Hz, Full Load-7 LED	12
4.1.2	Waveform $V_{ce}; I_{ce}; V_{cc}; V_{fb}$ @115Vac/60Hz, Full Load-7 LED	12
4.1.3	Waveform $V_{ce}; I_{ce}; V_{cc}; V_{fb}$ @132Vac/60Hz, Full Load-7 LED	12
4.2.	$V_{ce}(\max); I_{ce}; V_{ak}(\max)$ Operating@Start / Normal / Output Short	13
4.2.1	Start up at Full Load-7 LED Waveform : $V_{ce}; I_{ce}; V_{ak}$	13
4.2.2	Normal Operation at Full Load Waveform : $V_{ce}; I_{ce}; V_{ak}$	13
4.2.3	Output Short to Ground Waveform : $V_{ce}; I_{ce}; V_{ak}$	14



6.5W LED Driver Using UPSR100

1. LED Driver Demo Board Specification

1.1. Input Characteristics

- AC input voltage range 90Vac~132Vac
- AC input frequency 60Hz

1.2. Output Characteristics

- Output Voltage 21.8V
- Max. load current 0.3A

1.3. Performance Specifications

- Maximum Output Power 6.5W
- Average Efficiency >76%
- Current Line Regulation <1%
- Current Load Regulation <5%
- Current Ripple & Noise < 40mA

1.4. Protection Function

- Short Circuit Protection Shut down and Auto Recover
- Open Loop Protection Limit to 28V Output and Auto Recover

1.5. Environment

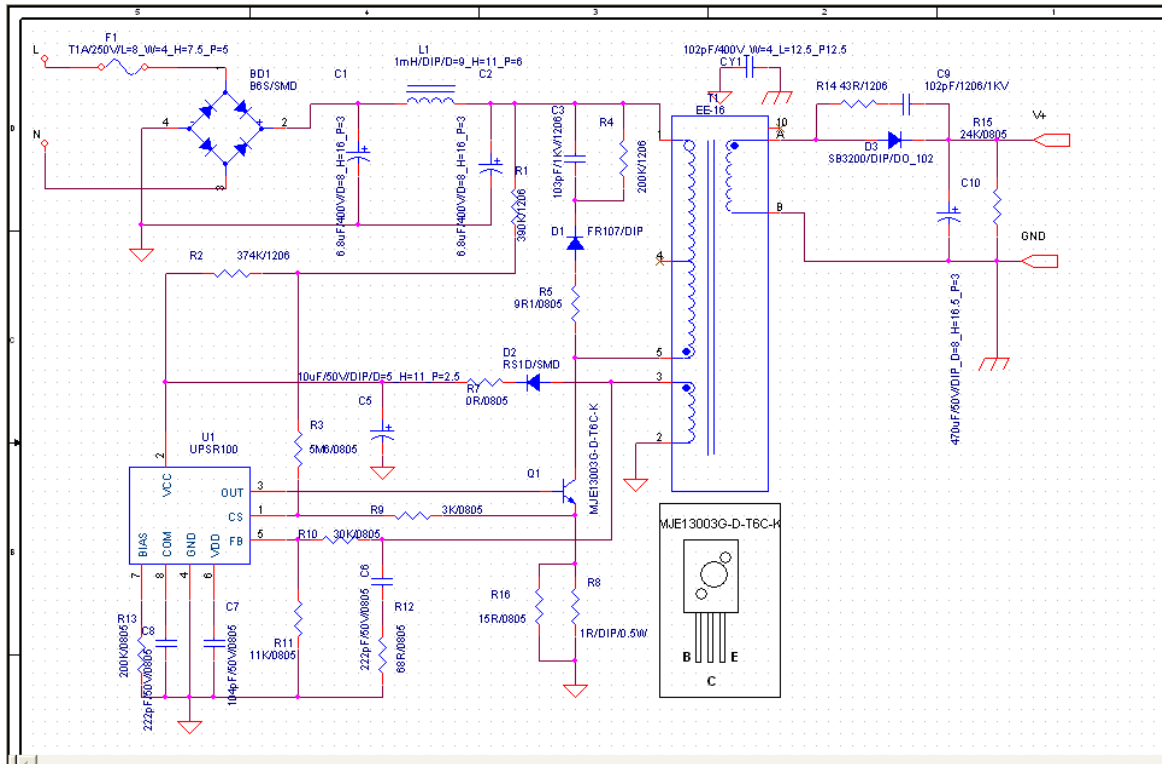
- Operation Temperature 0°C to 70 °C
- Operation Humidity 20% to 90% R.H
- Storage Temperature -40°C to 60 °C
- Storage Humidity 0% to 90% R.H



6.5W LED Driver Using UPSR100

2. LED Driver Demo Board Information

2.1. Schematic



2.2. BOM

No.	Position	Description	Quantity
1	C2,C1	Capacitor aluminum electrolytic 6.8uF/400V, 105°C ,±20%.	2
2	C3	Capacitor Ceramic 103pF/1KV/1206, ±10%	1
3	C5	Capacitor aluminum electrolytic 10uF/50V/DIP,105°C,±20%.	1
4	C6,C8	Capacitor Ceramic 222pF/50V/X7R /0805, ±10%	2
5	C7	Capacitor Ceramic104pF/50V/Y5V /0805,+80%;-20%	1
6	C9	Capacitor Ceramic 102pF/X7R /0805, ±10%	1
7	C10	Capacitor aluminum electrolytic 470uF/50V/DIP,105°C,±20%.	1
8	CY1	Capacitor, Y1, 102pF/400V, 105°C,±20%	1
9	D1	Diode FR107/DIP, Fast Diode, 1A/1000V.	1
10	D2	Diode RS1D/SMD/SMA, Fast Diode, 1A/200V.	1
11	D3	Diode SB3200/DIP/DO_102 ,Schottky Diode 3A/200V.	1
12	BD1	Bridge Diode B6S /SMD, 0.5A/600V .	1
13	F1	Fuse T1A/250V	1
14	L1	Inductor 1mH/DIP	1



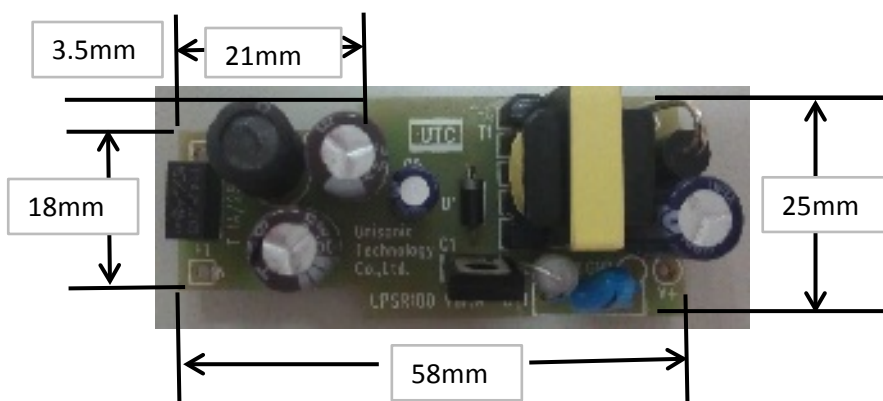
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15	Q1	Bipolar Transistor ;UTC MJE13003G-D-T6C-K/DIP/TO126C/RankD	1
16	R1	Resistor 390K/1206 ,1/4W,±5%	1
17	R2	Resistor 374K/1206 ,1/4W,±1%	1
18	R3	Resistor 5M6/0805 ,1/8W,±5%	1
19	R4	Resistor 200K/1206 ,1/4W,±5%	1
20	R5	Resistor chip , 9R1/0805 ,1/8W,±5%	1
21	R7	Resistor chip , 0R/0805 ,1/8W,±5%	1
22	R8	Resistor DIP , 1R/DIP ,0.5W,±5%	1
23	R9	Resistor chip 3K/0805 ,1/8W,±5%	1
24	R10	Resistor chip 30K/0805 ,1/8W,±5%	1
25	R11	Resistor chip 11K/0805,1/8W,±5%	1
26	R12	Resistor chip 68R/0805 ,1/8W,±5%	1
27	R13	Resistor chip 200k/0805 ,1/8W,±5%	1
28	R15	Resistor chip 24K/0805 ,1/8W,±5%	1
29	R16	Resistor chip 15R/0805 ,1/8W,±5%	1
30	U1	IC UTC UPSR 100-SOP-8	1
31			1

2.3. Module Dimension



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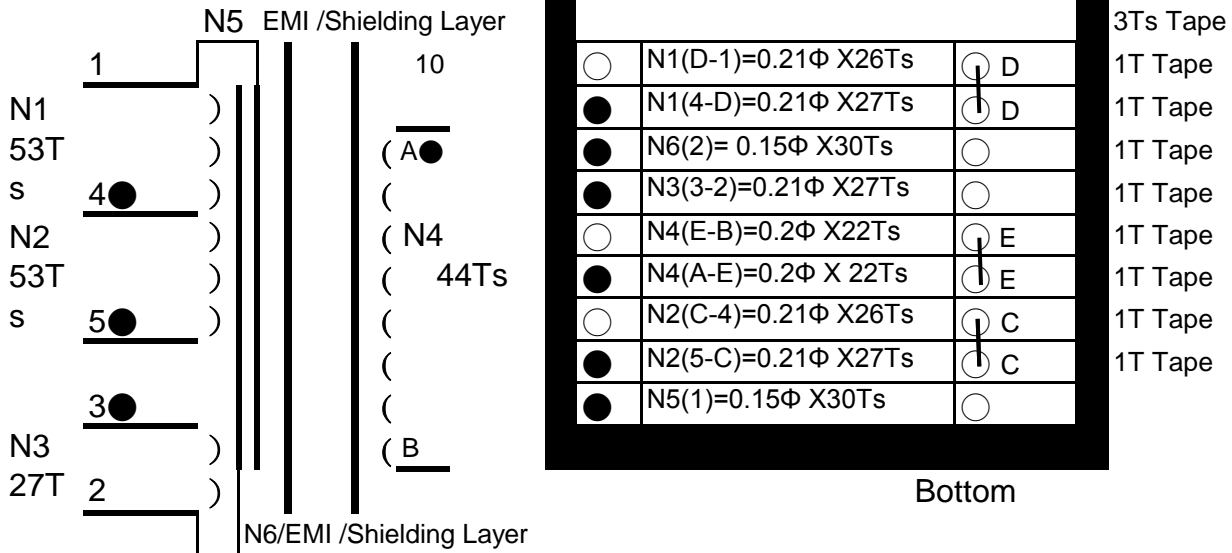
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2.4. Transformer Design

2.4.1. Transformer Specification

- 1) Bobbin: EE16 -10 Pin
- 2) Core material : PC40 (TDK) or equivalent.
- 3) Lm 1-5: 1.2mH,±10% (1KHz)

2.4.2. Transformer Diagram



Transformer Winding Data

Layer	Winding	Material	Start	Turns	Finish
1	N5	0.15Φ 2 UEW	1	30	EMI /Shielding
2	Tape	Tape		1	
3	N2	0.21Φ 2 UEW	5	27	C
4	Tape	Tape		1	
5	N2	0.21Φ 2 UEW	C	26	4
6	Tape	Tape		1	
7	N4	Triple Insulated Wire 0.2Φ	A	22	E
8	Tape	Tape		1	
9	N4	Triple Insulated Wire 0.2Φ	E	22	B
10	Tape	Tape		1	
11	N3	0.21Φ 2 UEW	3	27	2
12	Tape	Tape		1	
13	N6	0.15Φ 2 UEW	2	30	EMI /Shielding
14	Tape	Tape		1	
15	N1	0.21Φ 2 UEW	4	27	D
16	Tape	Tape		1	
17	N1	0.21Φ 2 UEW	D	26	1
18	Tape	Tape		3	



6.5W LED Driver Using UPSR100

3. Performance Evaluation

This document presented here is to describe the Demo Board Module performance.
The measuring data are tested at the board end.

The Summarized Result :

Item	Test result
1. Input Characteristics	
Efficiency- 7 LED	>76%
2. Output characteristics	
Output Typical Power	6.5W
Output Typical Voltage	21.83V
Output Typical Current	0.30A
Current Line Regulation	0.97%
Current Load Regulation	4.50%
Ripple & Nnoise	37.6mA
3. Protection	
Short Circuit Protection	Shut Down and Auto Recovery
Open Loop Protection	Limit to 23.9V and Auto Recover.

Test Equipment:

Item	Vendor	Model No:
1.AC Source	Chroma	61602
2.Digital Power meter	Chroma	66202
3.Electronic Load	Chroma	63102
4.Digital Oscilloscope	Tektronics	DPO3014
5.Multi-meter	Keithley	2000
6.Thermal meter	Opex	PT-3S



6.5W LED Driver Using UPSR100

3.1. Input Characteristics

3.1.1 Input Current- 7LED

Table 1 Input Current @ Full Load 7 LED

Input	I _{rms} (mA)	PF
90Vac/60Hz	166.8	0.534
115Vac/60Hz	143.6	0.489
132Vac/60Hz	134.1	0.457

3.1.2 Efficiency Operation at Full Load 7 LED

Table 2 Efficiency :Operation at 7 LEDs;6 LEDs;5 LEDs each.

Input Voltage	Pin(mW)			Vo(V)			Io(mA)			Efficiency(%)		
	7 LED	6 LED	5 LED	7LED	6LED	5 LED	7 LED	6 LED	5 LED	7LED	6LED	5 LED
90Vac/60Hz	8.33	7.39	6.29	21.80	18.82	15.79	302.00	309.54	315.93	79.03	78.83	79.31
115Vac/60Hz	8.58	7.50	6.34	21.83	18.83	15.79	304.08	310.06	315.65	77.37	77.85	78.61
132Vac/60Hz	8.67	7.63	6.53	21.84	18.82	15.79	304.94	310.73	315.83	76.82	76.64	76.37

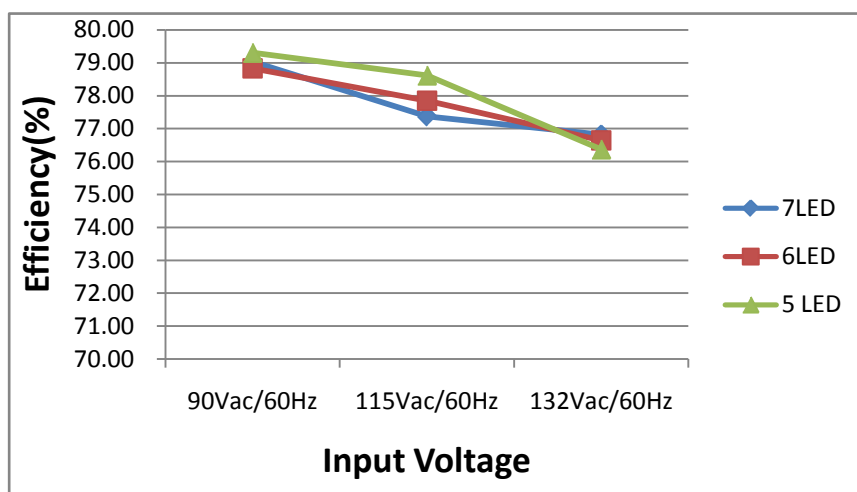


Fig1 Input Voltage Vs Efficiency



6.5W LED Driver Using UPSR100

3.2 Output Characteristics

3.2.1 Output Current Regulation

Table 3 Line Regulation and Load Regulation

Input Voltage	Output Current(mA)			Load Regulation
	21.8V(7 LED)	18.8V(6 LED)	15.8V(5 LED)	
90Vac/60Hz	302.00	309.54	315.93	4.50%
115Vac/60Hz	304.08	310.06	315.65	
132Vac/60Hz	304.94	310.73	315.83	
Line Regulation	0.97%			

3.2.2 Ripple & Noise-7LED

Table 4 Ripple & Noise

Input Voltage	Ripple & Noise(mA)
90Vac/60Hz	10.8
115Vac/60Hz	10.4
132Vac/60Hz	37.6

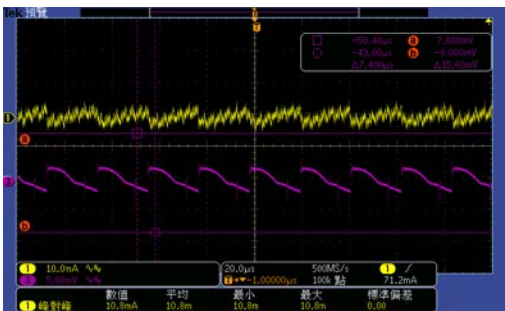


Fig.2 Ripple & Noise 90Vac/60Hz

CH1 Current Waveform ,CH3 Voltage Waveform

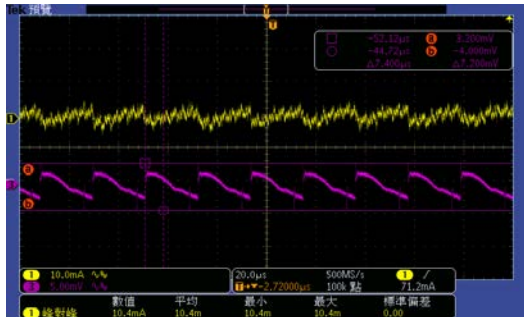


Fig.3 Ripple & Noise 132Vac/60Hz

CH1 Current Waveform ,CH3 Voltage Waveform



6.5W LED Driver Using UPSR100

3.2.3 Start- Up Time and Hold-Up Time-7 LED

3.2.3.1 Start- up Time

Table 5 . Start- up Time

Input Voltage	Start-Up Time (s)	Remark
90Vac/60Hz	2.59	Fig.4
115Vac/60Hz	1.74	—
132Vac/60Hz	1.37	Fig.5

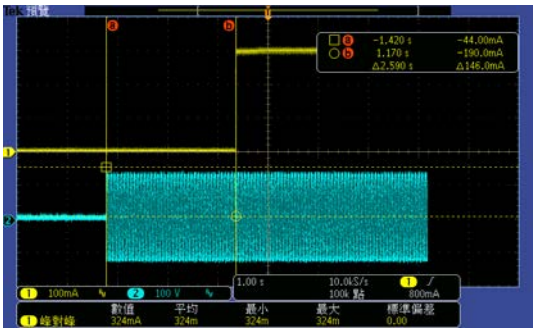


Fig.4 90Vac / 60Hz,Start Up

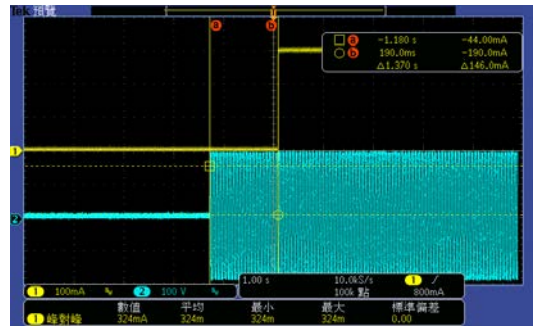


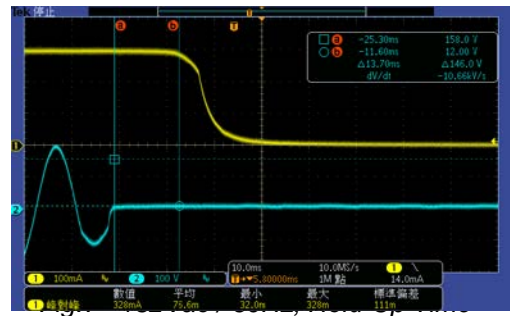
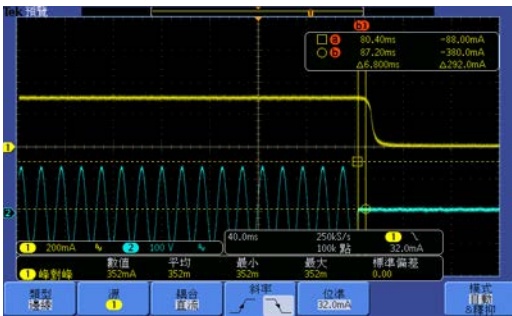
Fig.5 132Vac / 60Hz,Start Up

CH1 Current Waveform ,CH2 AC Voltage Waveform CH1 Current Waveform ,CH2 AC Voltage Waveform

3.2.3.2 Hold- up Time

Table 6 Hold- up Time

Input Voltage	Hold-Up Time (ms)	Remark
90Vac/60Hz	6.80	Fig.6
115Vac/60Hz	12.80	—
132Vac/60Hz	13.70	Fig.7



CH1 Current Waveform ,CH2 AC Voltage Waveform CH1 Current Waveform ,CH2 AC Voltage Waveform



6.5W LED Driver Using UPSR100

3.3 Protection

3.3.1 Open Loop Protection- 7 LED

When LED connection is opened , the Output will be limited to 23.97V. Once the condition is removed, and the power will be back to normal output Voltage .

Table 7 Open Loop Protection Voltage

Input Voltage	Open Loop Protection (V)
90Vac/60Hz	23.97
115Vac/60Hz	23.90
132Vac/50Hz	23.88

3.4 Short Circuit Protection: 7 LED

When Short Circuit Protection condition is removed and the power automatically recover

Table 8 Short Circuit Protection

Input Voltage	Pi(mW)	Board Status	Remark
90Vac/60Hz	22	No Damage	
115Vac/60Hz	33	No Damage	
132Vac/50Hz	45	No Damage	

3.4. Thermal Testing - 7 LED

Plastic ABS Case measured Room Temperature 36°C .
(Case Dimension 61mmX35mmX120mm).

Table 9 Thermal Testing

Input	UPSR100	Transistor	Transformer	Schottky
90Vac/60Hz	56°C	60°C	64°C	82°C
115Vac/60Hz	60°C	63°C	63°C	81°C
132Vac/50Hz	58°C	58°C	65°C	81°C



6.5W LED Driver Using UPSR100

4. Other Important Waveforms-Full 7 LED

4.1.1. Waveform Vce;Ice;Vcc,Vfb @90Vac/60Hz, Full Load-7 LED

Measuring Data:Vce=194Vp-p; Ice=510mA p-p;Vcc=14.6V;Vfb=11V; Frequency:46.73KHz

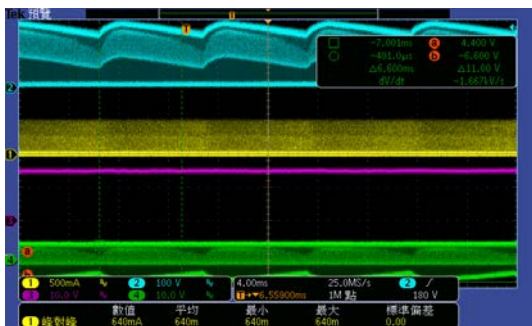


Fig.8 90Vac/60Hz, Full Load



Fig.9 90Vac/60Hz, Full Load Spread

4.1.2. Waveform :Vds;Ids @115Vac/60Hz, Full Load- 7 LED

Measuring Data:Vce=232Vp-p; Ice=500mA p-p;Vcc=14.6V;Vfb=12.4V; Frequency:46.73KHz

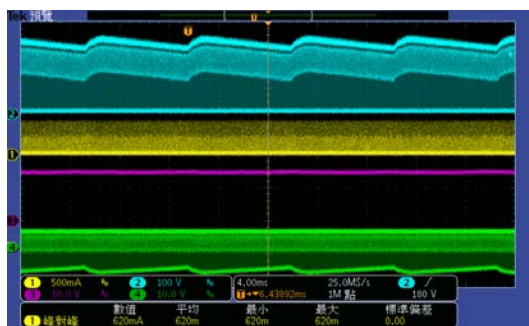


Fig.10. 115Vac/60Hz, Full Load

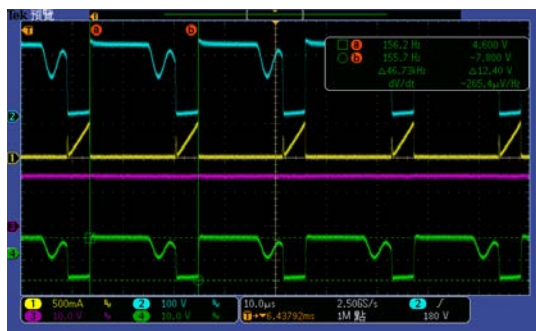


Fig.11. 115Vac/60Hz, Full Load Spread

4.1.3. Waveform :Vds;Vsense @132Vac/60Hz, Full Load-7 LED

Measuring Data:Vds=250Vp-p; Vsense=510mA p-p;Vcc=14.6V;Vfb=13.6V; Frequency:46.95KHz

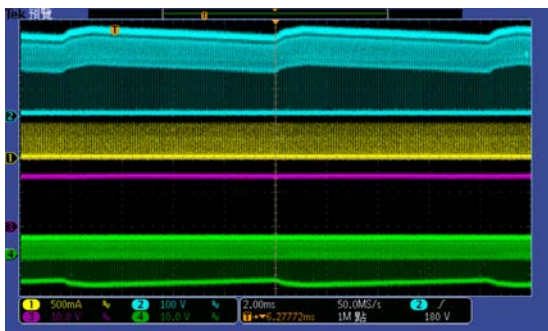


Fig.12. 132Vac/60Hz, Full Load



Fig.13. 132Vac/60Hz, Full Load Spread



6.5W LED Driver Using UPSR100

4.2. Vce(max) ;Ice; Vak(max) Operating@Start / Normal / Output Short cocnditio

Table 10 Measuring Data at Full Load-7 LED, Operating Start/ Normal / Output Short Test.

Test Item	Input voltage	Ice(mA)	Vce(max)	Vak(max)	Spec.	Remark
Start up at full load	132V/60HZ	560	270	120	1.Vceo<40 0V 2.Vak<200 V	Fig14
Normal at full load	132V/60HZ	540	250	112		Fig15
Short at full load	132V/60HZ	540	214	96		Fig16

4.2.1. Start up at Full Load-7 LED Waveform :Vce ;Ice; Vak- 7 LED

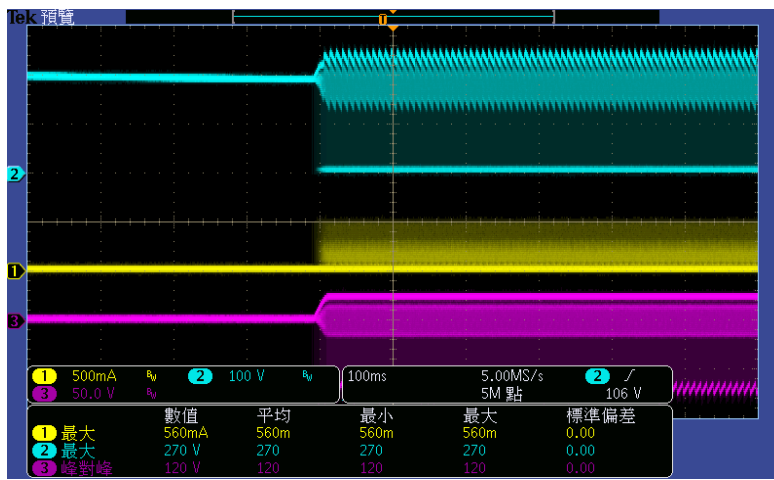


Fig.14 132Vac / 60Hz, Start up at Full load. Vds ;Ice; Vak

4.2.2. Normal Operation at Full Load Waveform :Vce ;Ice; Vak - 7 LED



Fig.15 132Vac / 60Hz, Normal Operation at Full load. Vds ;Ice; Vak

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4.2.3 Output Short to Ground Waveform :Vce ;Ice; Vak - 7 LED

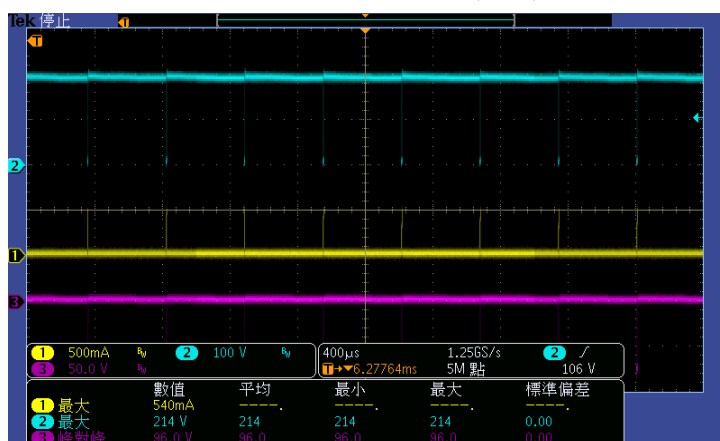


Fig.16 132Vac / 60Hz, Output Short to Ground Waveform Vce ;Ice; Vak