Experiment 9: Power Supply

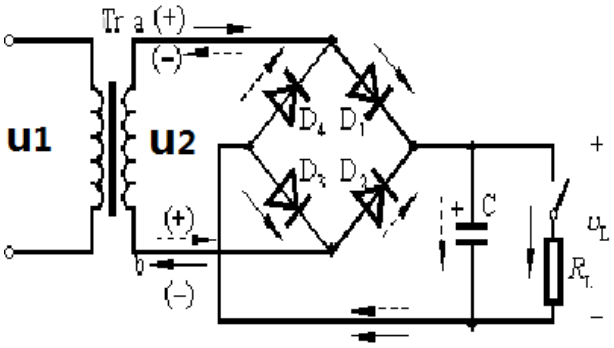
16231235 李谨杰 Table number：23

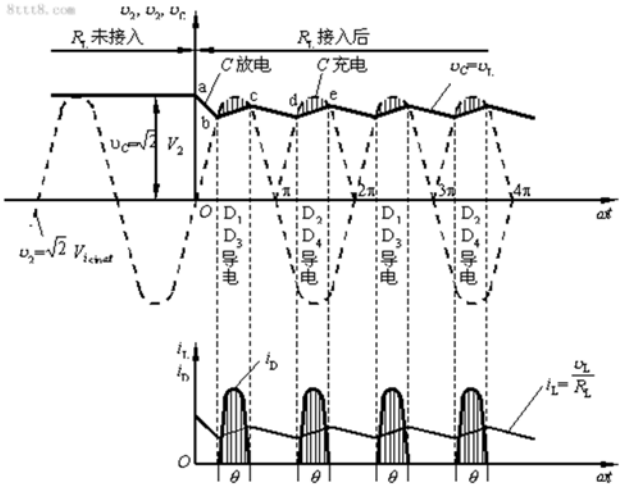
Aim

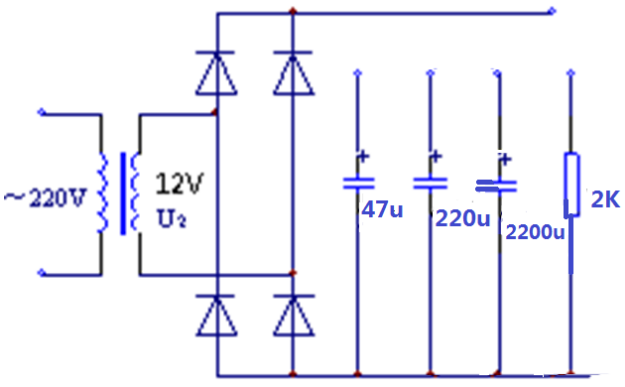
1. To understand voltage transformation, rectification and smoothing, the structure of adjustable and fixed output voltage of DC regulated power supply.
2. To learn to measure the performance specifications of DC power supply.
3. To understand the working principle of the series transistor regulator.
4. To understand the principle of switched mode power supply
5. To study to use a DC/DC convertor(L4960)

Principle

1. The linear DC regulated power supply is made up of five parts: line voltage transformation, rectification, smoothing, adjustable voltage regulator, and integrated regulator as following.
2. Rectification and smoothing







Rectification and smoothing

$$\overline{U_d} = \frac{\sqrt{2}U_2}{(1+\frac{1}{4fR_LC})} \qquad U_{\sim} = \frac{\overline{U_d}}{4\sqrt{3}fCR_L} \qquad S = \frac{U_{\sim}}{\overline{U_d}} = \frac{1}{4\sqrt{3}fCR_L}$$

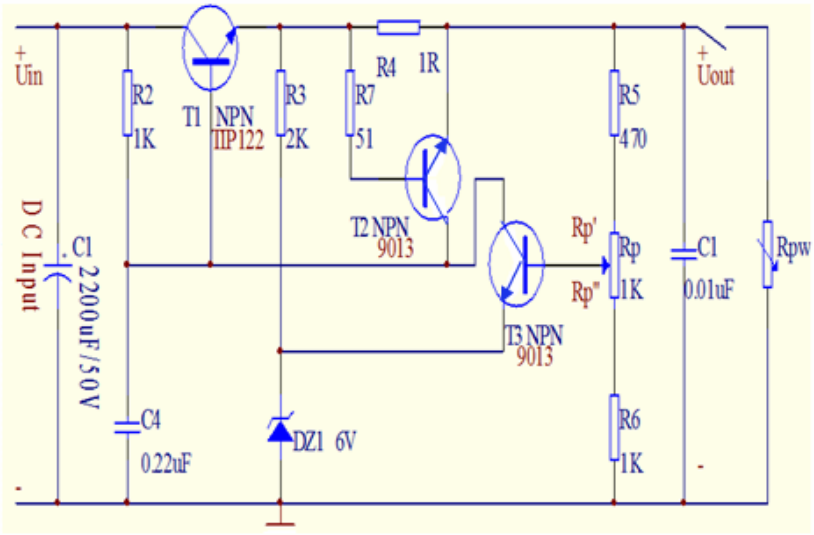
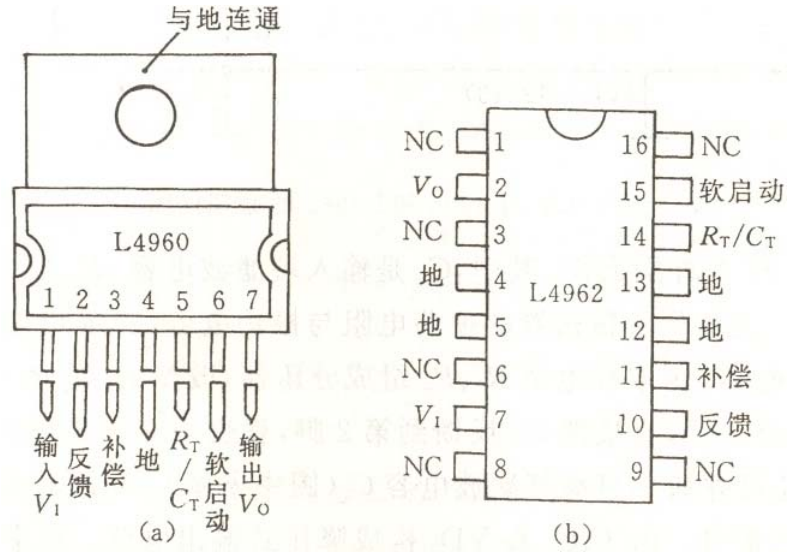
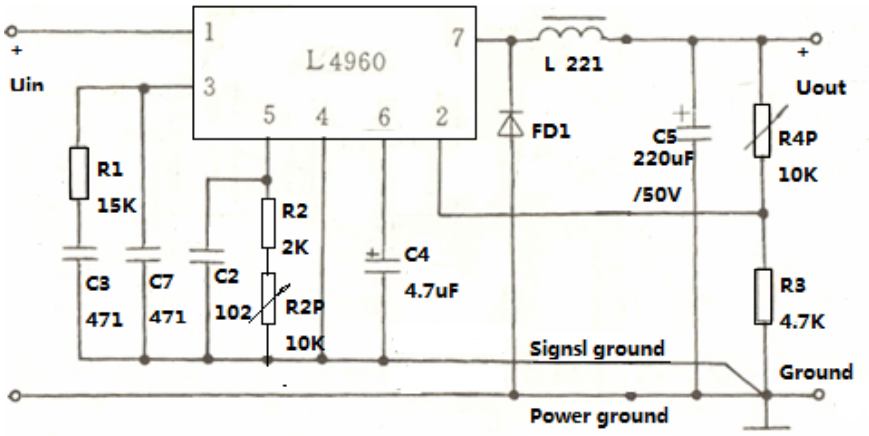


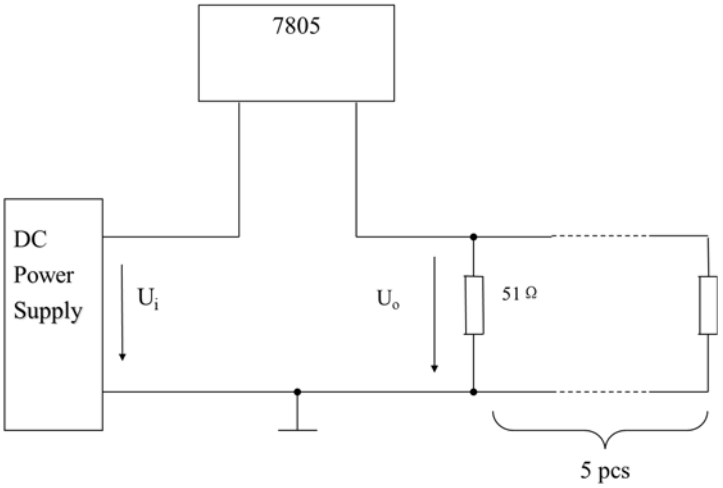
Figure 2. Series regulated power supply



(a)L4960 pin out (b) L4962 pin out



Switched mode regulated power supply



3-Terminal voltage regulator

Tasks

1.Rectification and smoothing at line frequency

In figure1, C=47μF, or 220μF, or 2200μF, RL= ∞, 2KΩ, or 255Ω (5 pcs of 51Ω in series), measure u2, Ūd, u~ , calculate the ripple factor 's'. Fill them in table 1. Observe their waves, and plot them.

2. Linear DC regulated power supply

Connect the output from the rectification and smoothing circuit under C=2200μF and RL= ∞, to the input Uin of the series regulated power supply (terminal C of Tip122) .

1. Turn Rp, and test the range of output Uout.
2. With no load, turn Rp to make Uout =10V. Test the output characteristics. RL=120Ω--20Ω.
3. Connect the output Uout of the series regulator to the input Ui of 3-terminal voltage regulator 7805. Test the Coefficient of voltage stabilization 'Sr' and Internal resistance 'r'. Fill them in table 2.

（1）Test Coefficient of voltage stabilization: keep RL=51Ω, turn Rp to get Ui =7V, 8V, 9V, 10V, 11V, and measure Uo respectively.

（2）Test Internal resistance: turn Rp to make Ui=8V, RL=51Ω, 2pcs of 51Ω in parallel, 3pcs of 51Ω in parallel, 4pcs of 51Ω in parallel, 5pcs of 51Ω in parallel, and measure Uo respectively.

3. Switched mode power supply

Connect the output from the rectification and smoothing circuit under C=2200μF and RL= ∞, to the input Uin of the switched mode regulated power supply (pin1 of L4960).

1. Turn R2p, test the frequency range f of oscillation from pin5.
2. When f =150KHz, turn R4p to test the range of output Uout.
3. When f =150KHz, RL=120Ω, turn R4p to make Uout=12V, then observe on oscilloscope and plot waveforms from pin5, pin7, and the output and noise from Uout.
4. With f =150KHz and no load, turn R4p to make Uout=12V, test the output characteristics,

RL=120Ω--20Ω.

5. Connect the output Uout of the switched mode power supply to the input Ui of 3-terminal voltage regulator 7805. Test the Coefficient of voltage stabilization ‘Sr’ and Internal resistance ‘r’.

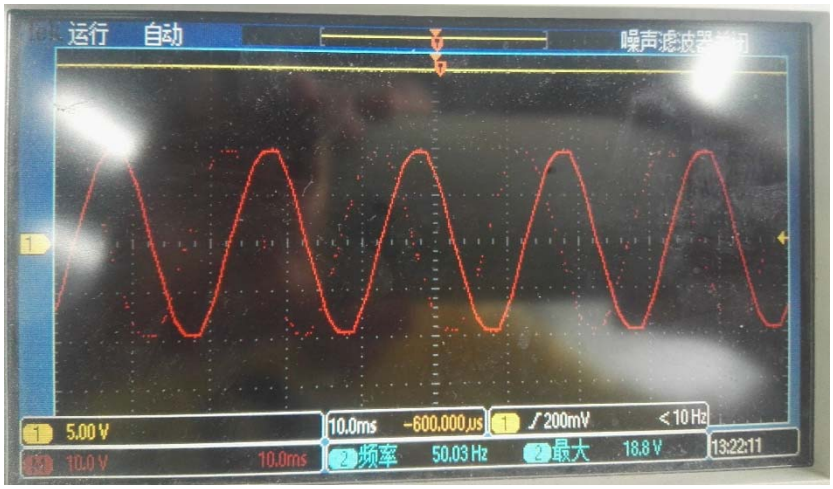
（1）Test Coefficient of voltage stabilization: keep RL=51Ω, turn Rp to get Ui =7V, 8V, 9V, 10V, 11V, and measure Uo respectively.

（2）Test Internal resistance: turn Rp to make Ui=8V, RL=51Ω, 2pcs of 51Ω in parallel, 3pcs of 51Ω in parallel, 4pcs of 51Ω in parallel, 5pcs of 51Ω in parallel, and measure Uo respectively.

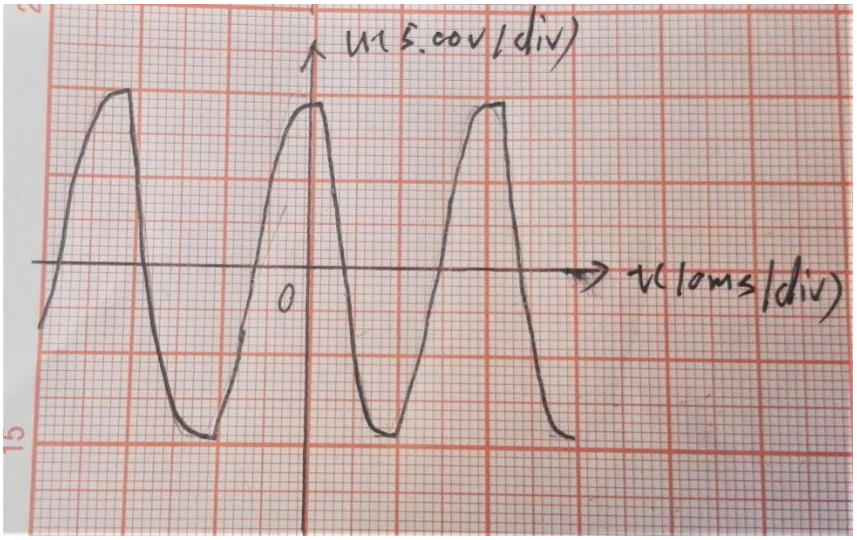
Data collation and analysis

Task1：

Wave of U_2



Waveform of U2 on oscilloscope



Waveform of U2

	R_L	u_2	$\bar{U}_d$	$\tilde{u}$	Wave of $\bar{U}_L$	Wave of $\tilde{u}_L$	$S=\tilde{u}/\bar{U}_d$
C=47μF	∞	13.7V	18.29V	0.48mV			≈0
	2KΩ	13.7V	17.18V	0.457V			0.027
	255Ω	13.6V	14.59V	2.385V			0.163
C=220μF	∞	13.7V	18.16V	0.487mV			≈0
	2KΩ	13.7V	17.55V	99.44mV			0.006
	255Ω	13.6V	16.62V	0.744V			0.045
C=2200μF	∞	13.7V	18.12V	0.488mV			≈0
	2KΩ	13.7V	17.56V	11.35mV			0.0006
	255Ω	13.7V	16.98V	83.29mV			0.005

Capacitance can act as a filter, so the bigger capacitance is, the better output characteristic(less Sr).

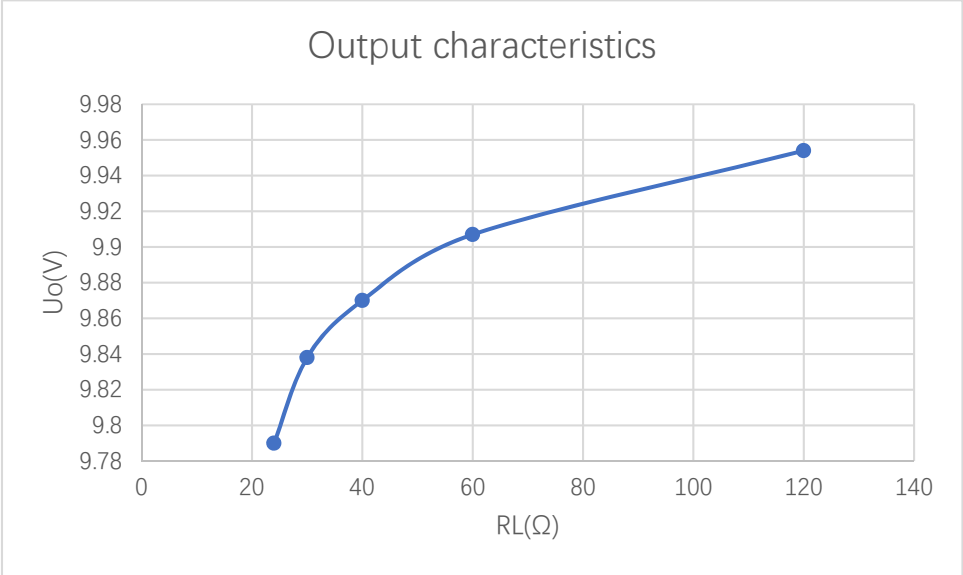
Task2：

2.1

The range of output is 5.93V~11.84V.

2.2

$R_L(\Omega)$	∞	120	60	40	30	24	20
Uo(V)	10.023	9.954	9.907	9.870	9.838	9.790	9.728



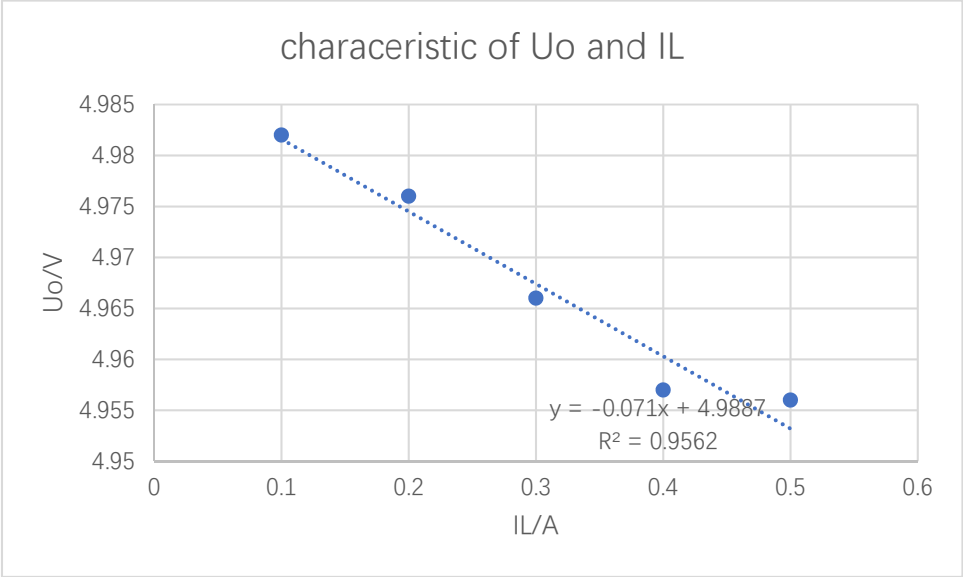
2.3

Coefficient of voltage stabilization

U_i (V)	7.01	8.07	9.09	10.0	11.03
U_o (V)	4.986	4.978	4.940	4.922	4.908
$S_r = \frac{\Delta U_O / U_O}{\Delta U_i / U_i}$	-0.01	-0.06	-0.04	-0.03	-0.03

Internal resistance

I_L (A)	0.1	0.2	0.3	0.4	0.5
Uo (V)	4.982	4.976	4.966	4.957	4.956



b=-0.071 ,so Ro=0.071Ω.

Task 3

3.1

The frequency range f is 68.25kHz~347.7kHz.

3.2

When frequency is 151.2kHz, the range of output Uout is 5.071V~15.183V.

3.3

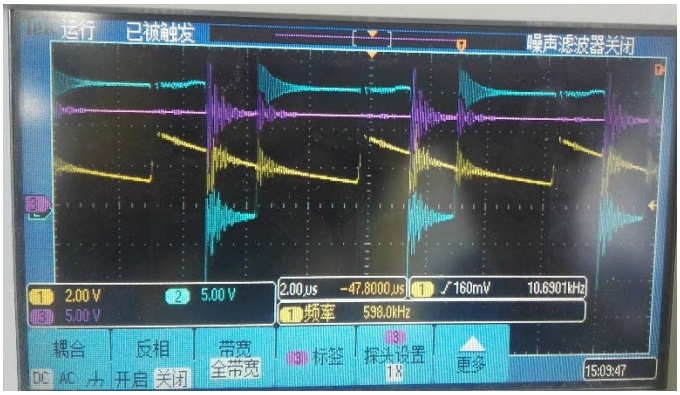
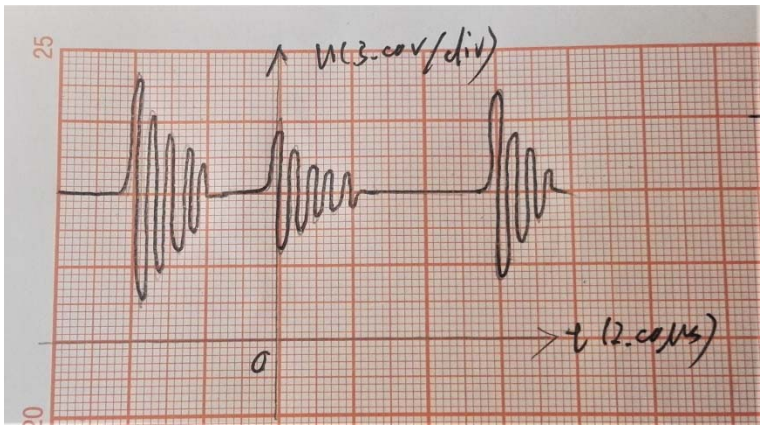
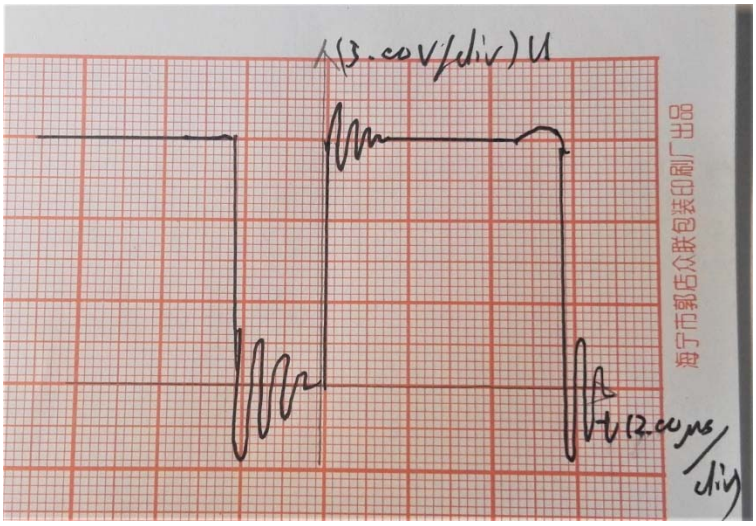


Figure of Oscilloscope



Waveform of output



Waveform of pin 7

3.4

$R_L(\Omega)$	∞	120	60	40	30	24

Uo(V)	11.993	11.967	11.954	11.935	11.907	11.861

3.5

Coefficient of voltage stabilization

U_i (V)	7.01	8.00	9.01	10.02	11.00
U_o (V)	4.997	4.996	4.996	4.995	4.994
$S_r = \frac{\Delta U_O / U_O}{\Delta U_i / U_i}$	-1.41*10^-3	0	-1.79*10^-3	-2.05*10^-3	-2.25*10^-3

Internal resistance

I_L (A)	0.1	0.2	0.3	0.4	0.5
Uo (V)	4.995	4.995	4.996	×	×

r= △Uo/△I_L=$\frac{4.996-4.995}{0.3-0.2}$=0.01Ω

Summary

The series transistor regulator power supply has simple circuit, but transistor itself will consume more power, causes less efficiency, and will have much bigger volume.

Switched mode power supply has more efficiency, but has larger output noise.