重庆大学-辛辛那提大学联合学院

学生实验报告

CQU-UC Joint Co-op Institute (JCI)
Student Experiment Report

实验课程名称 Experiment Course Name College Physics Experiment II

开课实验室（学院）Laboratory (School) CQU-UC

学院 School JCI 年级专业班 Student Group 2018 ME01

学生姓名 Student Name 易弘睿 学号 Student Number 20186103

学年 Academic Year 2019——2020 学期 Semester Spring

成绩 Grade	
教师签名 Signature of Instructor	

批改说明 Marking instructions:

指导老师请用红色水笔批改，在扣分处标明所扣分数并给出相应理由，在封面的平时成绩处注明成绩。

Supervisors should mark the report with a **red ink pen**. Please write down **the points deducted** for each section when errors arise and specify the corresponding reasons. Please write down **the total grade** in the table on the cover page.

重庆大学-辛辛那提大学联合学院 实验报告

JCI Experiment Report

学院 School Chongqing University 年级专业班 Student Group 2018ME01
姓名 Name 易弘睿 学号 Student Number 20186103
开课学院、实验室 Academic School/ Laboratory CQU-UC
实验时间 Date of Experiment 2020 年 Year 4 月 Month 30 日 Day
报告时间 Date of Report 2020 年 Year 5 月 Month 3 日 Day

课程名称 Course Name	College Physics Experiment II	实验项目名称 Experiment Project	Operation of Oscilloscope	实验项目类型 Type of experiment project				
				验 证 Verification	演 示 Presentation	综 合 Comprehensive	设 计 Design	其 他 Others
指导老师 Supervisor	边立功	成绩 Grade				√		

实验目的 Description/Instruction:

1. To understand the oscilloscope's structure and working principle.
2. To learn how to use the oscilloscope.
3. To learn Function Signal Generator Usage.
4. To observe the AC signal waveform, measure the amplitude and period of the signal.
5. To observe the Lissajous figure, measure the signal frequency.

原理和设计 Principle and Design:

The oscilloscope consists of four parts: oscilloscope tube, scanning and step device, X-axis and Y-axis amplifier and power supply. The circuit composition of the single-track single-sweep oscilloscope is shown in Fig. 1, as long as two sets of the same Y-axis are used in front of the oscilloscope. In addition, an electronic switch can be used to observe two signals (electronic double tracer) simultaneously, with a single tracer oscilloscope.

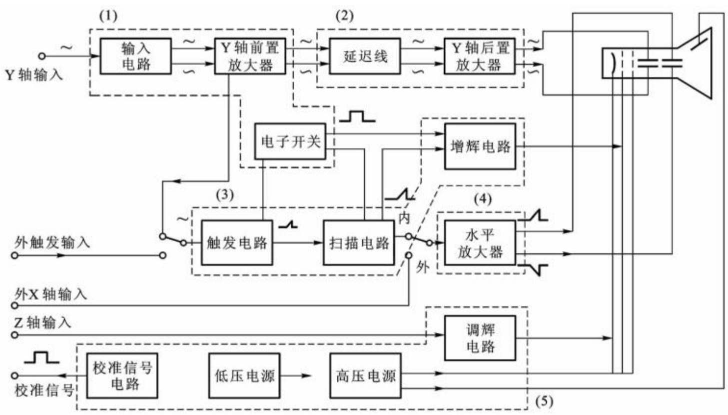

Figure 1 The Circuit Composition of the Single-track Single-sweep Oscilloscope

First, the basic structure of an oscilloscope tube is introduced:

The oscilloscope tube is a glass vacuum tube in the shape of a horn, as shown in Fig. 2. It is equipped with an electron gun and two. For vertical deflection plates, fluorescent substances are coated on the bell-shaped curved surface wall to form a fluorescent display screen. When high-speed electrons hit the screen, the electrons make the fluorescent material glow, and a light can be seen on the screen Points. Changes in the movement of electrons over time can be displayed on a fluorescent screen.

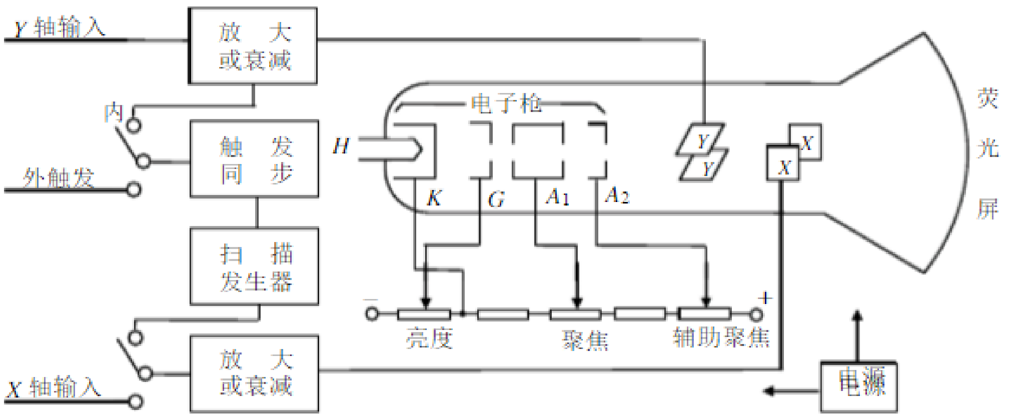

Figure 2 The Basic Structure of an Oscilloscope Tube

Second, the focus adjustment is introduced:

The side view of the oscilloscope tube is shown in Fig. 3. The electron gun consists of filament F, cathode K, control pole M, and section 1. The first anode A1 and the second anode A2 are composed of cathode K, pole M, A1 and A2. When the filament is electrified, the cathode is formed. Electrons emitted because of heating. Because the anode potential is higher than the cathode, electrons are accelerated by the anode. Changing the anode voltage, which is called focusing, enables electrons in different emission directions to converge at exactly one point on the screen. The focusing button on the panel is used to change the anode potential to achieve focusing.

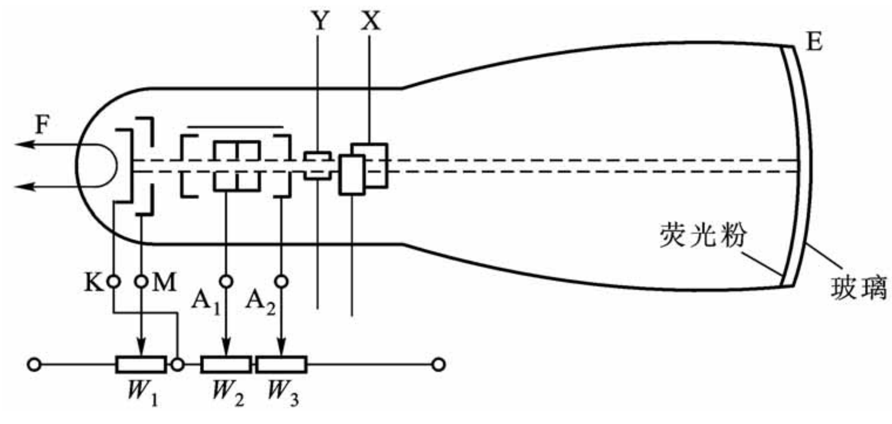

Figure 3 The Side View of the Oscilloscope Tube

Third, the brightness adjustment is presented:

The potential of the control electrode M is lower than that of the cathode K, which can inhibit the emission of electrons from the cathode. Changing the voltage of the control pole can control the number of electrons emitted by the electron gun, or even make the electrons pass completely. The brightness button on the oscilloscope is used to adjust the voltage of the control pole to control the brightness and darkness of the bright spots on the fluorescent screen Degree, which is called luminosity regulation.

Forth, the displacement adjustment of X and Y is intrigued:

The oscilloscope has a pair of X deflection plates (two electrodes placed vertically) and a pair of Y deflection plates (placed horizontally). When there is no potential difference between the two deflection plates, the electron beam emitted from the gun will remain unchanged. When there is a potential difference on the deflection plate, under the action of the electric field between the plates, the electric field is applied to the screen. The beam is deflected to one side, causing the spot on the screen to move to the other side. Therefore, only the DC current on the deflection plate is adjusted. The position of the spot can be changed by pressing. The "Y-axis shift" and "X-axis shift" knobs on the panel are used to adjust the upper, lower, left and right positions of the light trace, respectively.

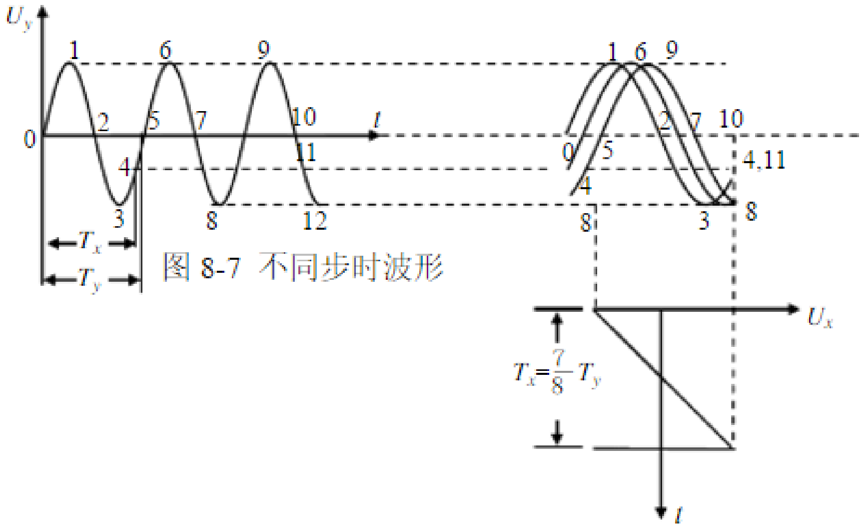

Figure 4 The Principle of Scanning and Stepping

Last, the principles of scanning and stepping are explained:

If the sine wave and saw tooth voltage cycle slightly different, the screen appears to be a moving instability graphics. This situation can be illustrated in Figure 4. The period Tx of the saw tooth voltage is set to be slightly smaller than the sine wave voltage period Ty, say, Tx / Ty = 7/8. During the first scan cycle, the curve segment between 0 and 4 points of the sinusoidal signal is displayed on the screen. During the second cycle, the curve segment between 4 and 8 points is displayed with the starting point at 4; in the third cycle, 8~11 points between the curve segment, starting at 8. In this way, the on-screen display of the waveform does not overlap each time, as if the waveform is moving to the right. Similarly, if Tx is slightly larger than Ty, it will move to the left. The situation described above often occurs during oscilloscope use. The reason is that the period of the scanning voltage is not equal to or not an integral multiple of the period of the signal under test, so that the starting point of the waveform curve is different at the beginning of each scanning. In order to stabilize the graphics on the screen, it is necessary to make Tx / Ty = n (n = 1,2,3...), where n is the number of complete waveforms displayed on the screen. To obtain a certain number of waveforms, adjust the scan time (or scan range) button and fine adjustment button, the period Tx (or frequency fx) of the saw tooth voltage is adjusted to have an appropriate relationship with the period Ty (or frequency fy) of the signal under test , So as to get the required number of complete measured waveforms on the oscilloscope screen. The measured signal input to the Y axis is independent of the saw tooth voltage inside the oscilloscope. Due to the environmental or other factors, their cycle (or frequency At this moment, although the cycle can be adjusted to an integral multiple by adjusting the scan button, it changes a moment later and the waveform moves again, which is especially noticeable when the high-frequency signal is observed. This oscilloscope equipped with scanning synchronization device, so that the starting point of the saw tooth voltage scanning automatically follow the measured signal change, which is called the entire step (or synchronization) .On the oscilloscope, you need to scan voltage and A synchronization signal portion, so with the Trigger Select key, select external trigger operating state, with the appropriate external trigger signal input.

实验器材 List of instruments and materials:

6502 oscilloscope, rectifier circuit teaching box, hysteresis loop display box, low frequency signal generator.

实验步骤 Implementation:

1. Get familiar with the use of 6502 oscilloscope, and observe the waveform of output signal of signal generator:

(1) Understand the model of the oscilloscope, clarify the role of the knobs and switches on the panel, and then start the experiment.

(2) Turn on the power supply of the oscilloscope, and don't press the other buttons. CH1 coupling mode switch "29" to hit the middle "GND" block, trigger mode switch "16" to hit the automatic scanning "AUTO", familiarize yourself with the functions of the knobs of "brightness", "focus", "X-axis displacement" and "Y-axis displacement", so as to make the brightness moderate. If there is a horizontal line on the screen, it is because the switch "29" hit the "GND", input short circuit, no signal input, so the horizontal line is generated by the scanning signal, the distance in the horizontal direction is proportional to the time, so it is a time baseline, which can represent the time axis.

(3) Refer to the instructions of signal generator, after clarifying the functions of knobs and terminals on the panel of signal generator, the voltage of signal generator "changing with time according to sinusoidal law" is input to the "CH1 input" end of 6502 oscilloscope with "probe", and the switch "29" is hit to the AC block above. X-axis signal is used in oscilloscope book. The scanning voltage of the body is triggered by "automatic trigger" (the switch "16" hits the top), the trigger source chooses "internal trigger" (the switch "18" hits the top), the appropriate scanning time base (time DIV) is selected according to the frequency of the observed signal, and the appropriate voltage sensitivity (VDIV) is selected according to the amplitude of the signal, and then the voltage sensitivity (VDIV) is adjusted. The trigger level is within the range of the signal amplitude, so that the signal waveform can be displayed stably and the waveform can be scanned from the appropriate position. The vertical sensitivity fine-tuning knob "32" and the time-base adjusting knob "12" are twisted clockwise to the end, so that they are in the calibration position "CAL". The frequency of the output signal of the signal generator is adjusted to make the fluorescent screen. A complete waveform is displayed on the screen. The amplitude and period of the signal are measured. The frequency of the signal is kept unchanged, the scanning time base selection switch "15" and the time base adjustment knob "12" are adjusted, and the scanning voltage period is changed. The waveform when the scanning voltage period is 2 and 3 times of the signal period is adjusted respectively, and quantified on the square paper. Describe observed waves.

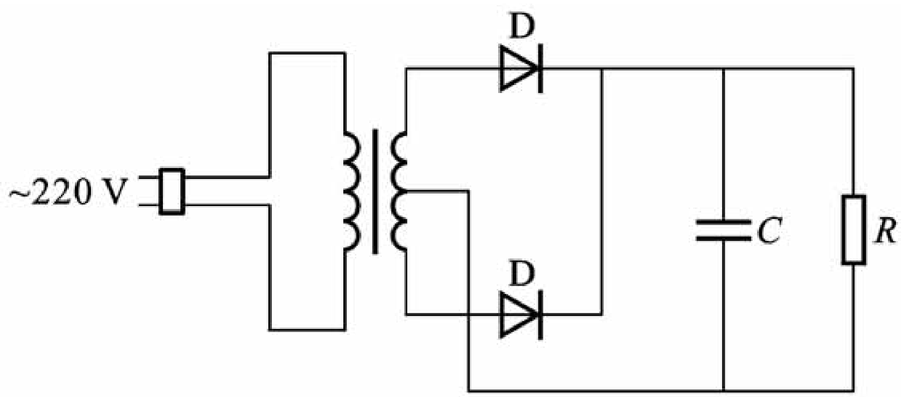

Figure 5 The Transistor Rectifier Filter Circuit

2. Observe and Measure Voltage Graphics of Rectifier and Filter Circuits:

The transistor rectifier filter circuit is shown in Fig. 5. The circuit is installed in the rectifier filter experimental box. When the rectifier filter experimental box is connected with a power supply, the output signal of the rectifier filter experimental box is input to the CH2 input terminal with a probe, and the corresponding buttons on the experimental box are pressed one by one. At this time, the output terminals are connected with the corresponding contacts in the circuit respectively. The AC, half-wave rectifier, full-wave rectifier, filter and other electrical signals can be sent to the oscilloscope for observation. When observing the rectifier and filter waveforms, the DC coupling mode is selected because of the overlap of AC and DC. Because these signals are synchronized with AC power supply, the trigger source is selected to trigger LINE observation. The amplitude and period of the four waveforms are measured, and the four waveforms observed are plotted quantitatively.

实验结果和数据处理 Results and Data processing:

1. Measure the time parameter of the signal by the time base of the X-axis

(1) Measure the period of the output signal of self-provided square wave of oscilloscope

Table 2 The period of the output signal of self-provided square wave of oscilloscope

Number	1	2	3
T.B.(ms)	0.1	0.2	0.5
Square Signal	1098.9	1087	1090.9

(2) Choose signal generator of the symmetric square wave input Y (range and the Y range option), the signal frequency is 200-2 KHZ (every 200 hz measurement "), choose the oscilloscope suitable time base, measuring the number of centimeters, cycle and frequency of the corresponding frequency (indicate the time base of the shaft). The frequency of the signal generator for x, the frequency of the oscilloscope measurement for the Y axis, x-y curves.

Table 2 Oscilloscope's frequency-Annunciator's frequency

Number	1	2	3	4	5	6	7	8	9	10
T.B.(ms)	1	0.5	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Number of cm	4.6	4.6	7.6	5.8	4.6	4.8	7.5	5.8	5	4.6
Period	4.6	2.3	1.52	1.16	0.92	0.96	0.75	0.58	0.5	0.46
Ocsilliscope's frequency	217.3913	434.7826	657.8947	862.069	1086.957	1041.667	1333.333	1724.138	2000	2173.913
Annunciator's frequency	200	400	600	800	1000	1200	1400	1600	1800	2000

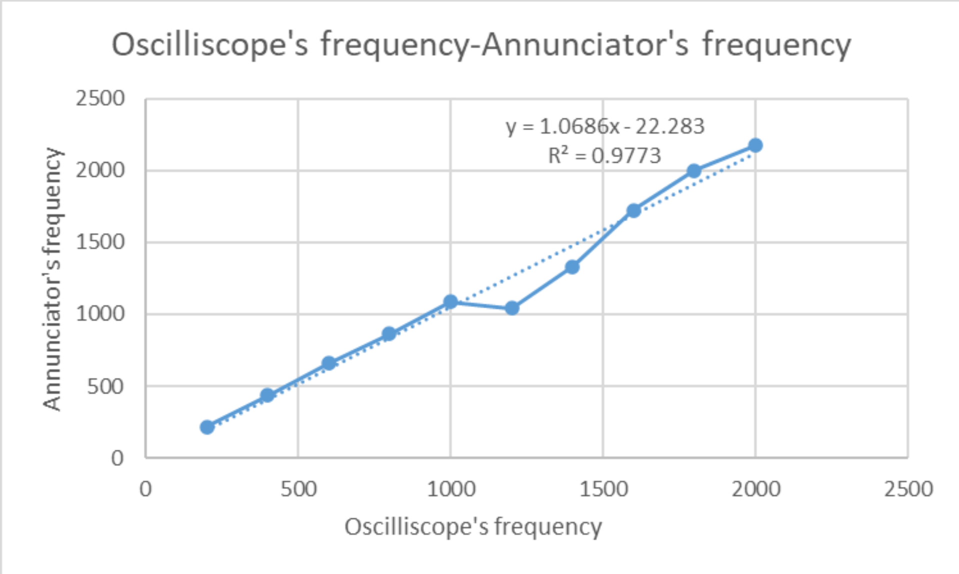

Figure 6 Oscilloscope's frequency-Annunciator's frequency

(3) Choose the asymmetrical square-wave signal generator to meet Y input (amplitude and Y range option), frequency, respectively 200, 500, 1 k, 2 k, 10 k, 20 k (Hz), measurement of each frequency cycle and the width of the positive wave.

Table 3 Period and positive wave width of each frequency

Known frequency(Hz)	200	500	1000	2000	10000	20000
T.B.(ms)	0.5	0.5	0.2	0.1	0.1	0.05
Signal cycle	4.6	1.8	0.92	0.46	0.18	0.23
Positive wave width	9.2	3.6	4.6	4.6	1.8	4.6

(4) Choose the signal generator output triangular wave, frequency is 500, 1 K, 1.5 K (Hz), measuring the rise time, fall time and frequency

Table 4 The rise time, fall time and frequency

Number	500	1000	1500	2000
T.B.	1	0.5	0.2	0.05
Number of cm(Rise)	1.2	1.2	2	4.6
Number of cm(Fall)	1.2	1.2	2	4.6
Time(Rise)	1.2	0.6	0.4	0.23
Time(Fall)	1.2	0.6	0.4	0.23
Time	2.4	1.2	0.8	0.46

2. With two signal generator (one for the group, one is under test), will be unknown CH2 sine signal input, input signal generator CH1, fx/fy - 1.2, 1/2, draw the relevant graphics and seek for the signal generator frequency.

Table 5 the signal generator frequency.

Number	1	2	3
fx/fy	1	2	0.5
Signal frequency to be measured(Hz)	980.9	920.45	930.8

Figure 7 The graph when fx/fy=1

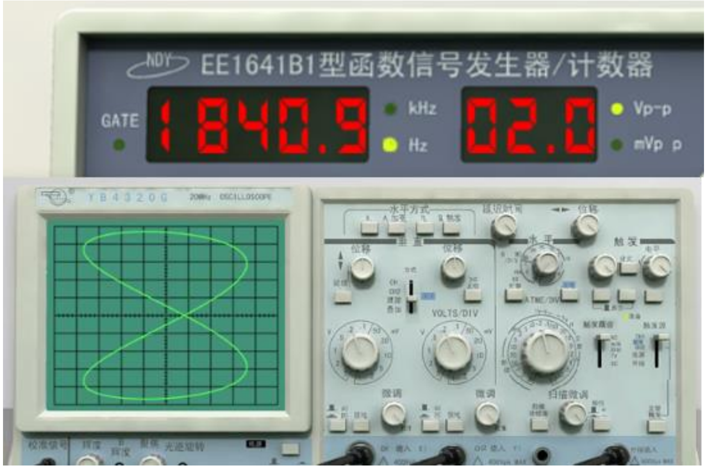

Figure 8 The graph when fx/fy=2

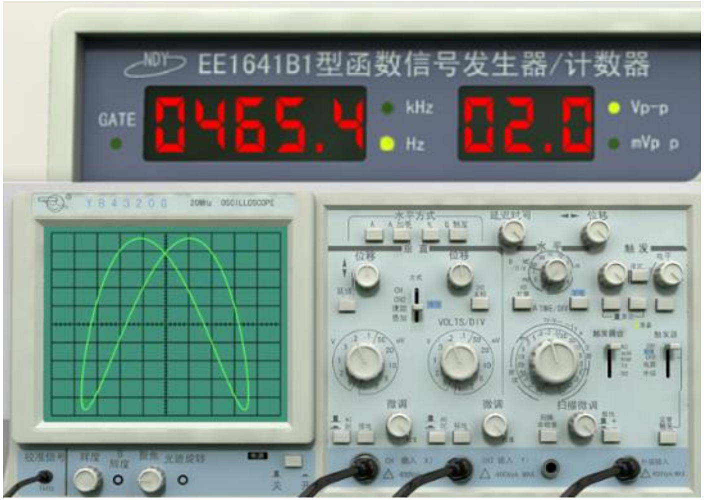

Figure 9 The graph when fx/fy=0.5

<u>实验讨论 Discussions:</u>

1. Error

(1) No light spots or waveforms

Bai is not connected to the power supply; The luminescence du knob is not properly adjusted; X, Y axis shift button position adjustment; Y axis potentiometer adjustment improper, causing dc amplifier circuit serious imbalance.

(2) The horizontal direction is not open

If the trigger source selector switch is placed in the outer gear and there is no external trigger signal input, then no sawtooth wave is generated. Improper level knob adjustment; the stability potentiometer is not adjusted to make the scanning circuit in the critical state to be triggered; The X-axis selection is mistakenly placed in the external X position, and there is no signal input in the external socket.

If the two-trace oscilloscope only USES channel A (channel B has no input signal), and the internal trigger switch is placed in the pull YB position, no sawtooth wave will be generated.

(3) No display in the vertical direction

The input coupling mode DC-earthing AC switch is mistakenly placed in the earthing position; The high and low potential ends of the input end are opposite to the high and low potential ends of the circuit under test. The input signal is small and V/ DIV is mistakenly placed in a low sensitivity range.

2. Discussion

(1) Horizontal direction cannot be extended

If the trigger source selection switch is placed in the outer gear and there is no input of the external trigger signal, there will be no sawtooth wave. Besides, there exists improper adjustment of level buttons.

Moreover, the stability potentiometer is not adjusted to make the scanning circuit in the critical state to be triggered, and the X-axis selection is misplaced in the external position of X, and there is no signal input on the external socket. If the two tracer oscilloscopes only use channel A (channel B has no input signal), and the internal trigger switch is placed at the pull YB position, no sawtooth wave will be generated.

(2) No light spot or waveform

There are few possible reasons:

Power is not connected, the gloss knob is not adjusted properly, position adjustment of X, Y axis shift knob or improper adjustment of Y-axis balancing potentiometer results in serious imbalance of DC amplifier circuit.

物理实验 原始实验数据记录

Experiment Data

姓名 Name______易弘睿______学号 Student Number________20186103________实验时间_2020.4.30_

实验名称 Name of experiment: Operation of Oscilloscope

仪器名称	量程	最小量	估读误差	仪器误差	零位误差
Analog oscilloscope x axis(div)	0~10	0.2	0.1	0.1	
Analog oscilloscope y axis(div)	0~8	0.2	0.1	0.1	
Conductor					
Waveform generator					

实验数据 Experiment Data （表格自拟）

测量示波器自备方波输出信号的周期（时基分别为0.1，0.2，0.5ms/cm）,哪种时基测出的数据更准确？为什么？

方波信号(单位HZ)

序号:	1	2	3
选择时基(ms)	0.1	0.2	0.5
方波信号(单位HZ)	1098.9	1087.0	1090.9

选择信号发生器的对称方波接Y输入（幅度和Y轴量程任选），信号频率为200--2KHz（每隔200Hz测量一次），选择示波器合适的时基，测量对应频率的厘米数、周期和频率（注明X轴的时基）。信号发生器的频率为X，示波器测量的频率为Y轴，作X-Y曲线，求斜率并讨论。

对应频率的厘米数

1	2	3	4	5	6	7	8	9	10
1	0.5	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
4.6	4.6	7.6	5.8	4.6	4.8	7.5	5.8	5	4.6
4.6	2.3	1.52	1.16	0.92	0.96	0.75	0.58	0.5	0.46
200	400	600	800	1000	1200	1400	1600	1800	2000

选择信号发生器的非对称方波接Y输入（幅度和Y轴量程任选），频率分别为200，500，1K，2K,10K,20K (Hz)，测量各个频率时的周期和正波的宽度。

信号周期

序号:	1	2	3	4	5	6
已知频率(Hz)	200	500	1000	2000	10000	20000
信号周期(ms)	3.8	3.6	0.2	0.1	0.1	0.01
正波宽度	3.8	3.6	4.6	4.6	1.8	4.6

选择信号发生器的输出三角波，频率为500，1K，1.5K（Hz），测量各个频率时的上升时间、下降时间及周期。

三角信号(单位HZ)

序号:	1	2	3	4
已知频率(Hz)	500	1000	1500	2000
三角信号上升时间(ms)	0.92	0.44	0.3	0.022
三角信号下降时间(ms)	0.92	0.44	0.3	0.022
三角信号周期(ms)	1.84	0.88	0.6	0.044

实验室提供的示波器，信号发生器、待测未知信号源。请按照要求完成下列实验，并将测量实验数据填入表格内。

用两台信号发生器(一台为本组，一台为待测),将未知正弦信号输入CH2,信号发生器输入CH1,取fx/fy=1、2、1/2时,画出有关图形及求待测信号发生器的频率。

李萨如图形

序号:	1	2	3
fx/fy	1	2	0.5
待测信号频率(单位HZ)	980.9	920.45	930.8

关闭

指导教师：边立功