Direct and Alternating Voltages, the Oscilloscope

Required Equipment

1. A Philips PM3335 Analog/Digital Oscilloscope
2. Function Generator
3. DC Power Supply
4. Potentiometer
5. Various resistors

Introduction

The lab is equipped with 60 MHz oscilloscopes that have both analog and digital functions. We will investigate both in turn.

Analog Oscilloscope

1. Begin by connecting the function generator to both *y* inputs (A and B) of the scope. Get traces on the screen for both *y* inputs. You will find the *auto set* helpful. Learn to control the signal form the function generator.
2. Understand the functions of the controls *y pos, y var, xpos, xvar* and *gnd*. Also the functions *add, invert, invert and add.*
3. Use the top three rocker switches. What is the maximum voltage scale? What is the maximum voltage that the scope can read? What is the minimum voltage scale? What are maximum and minimum time base scales? How does the fastest time scale correlate with the label on the scope that marks it as a 60 MHz scope?
4. Use the scope to measure the peak-to-peak voltage of the largest sine signal that the function generator can make. What is the importance of the “cal” position on the *y var* control to your measurement?
5. Set the function generator to make a sine wave with frequency of 1000 Hz and measure the period on the scope. What is the importance of the “cal” position on the *x var* control?
6. Set the function generator to make a high-frequency (1.5 MHz) square wave and use the scope to measure the rise time. This is the time it takes the wave to go from 10% to 90% of its maximum amplitude. Measure also the corresponding fall time.
7. What is the use of the *alternate* and *chop* options? To find out, put the same low-frequency (~10 Hz) signal on both *y* inputs and set the time base so that a few cycles appear on the screen. Observe the two channels in both *alternate* and *chop* modes. Which do you prefer? Hint: the true nature of the chop mode can only be seen at high sweep rates.

8. *Triggering:* To see the importance of triggering, put a sine signal on the scope and remove triggering by using the *Trig* or *X source* button to select "external trigger". Because there is nothing connected to the "ext" inputs there is no trigger. Observe that the pattern on the scope screen is not stationary but rolls. Next restore proper triggering and observe the effect of *trigger level* adjustment.

The Digital Scope

Select the digital memory with the white button and make it display a sine waveform.

1. What is the function of *lock*? Try removing the input signals with *lock* on and off.
2. Use the cursors to find the peak-to-peak voltage, the period of the sine wave and the phase difference between two consecutive peaks of the sine wave.

AC-DC Signals

1. *Scope Coupling*: The scope *y* inputs can be ac or dc coupled. The ac coupling blocks the constant part of the signal. Add some dc offset to the function generator output and switch between ac and dc coupling. Observe the effects on the scope. Figure 1

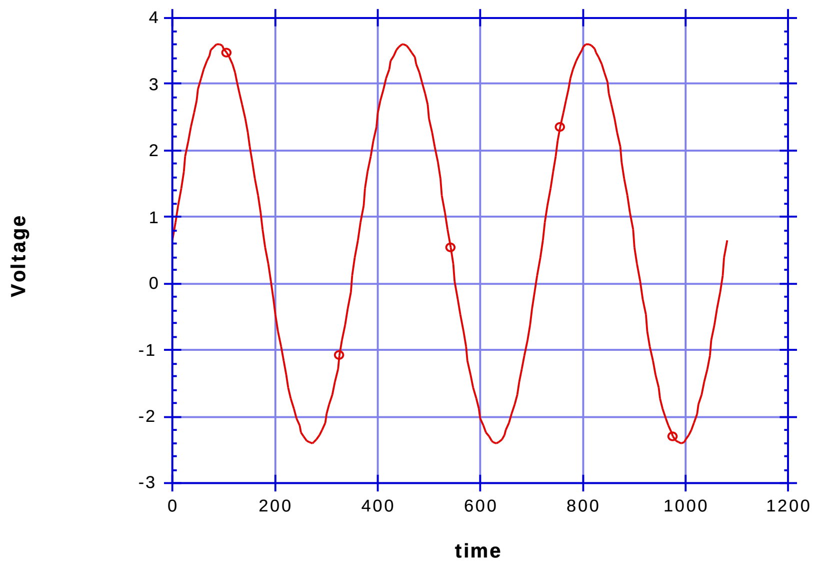

Figure 1: A 3 V sine wave with 0.6 V offset

shows a sine wave with an offset.

2. Explain how to use ac-coupling to measure the small ripple in the output of a power supply. Typical ripple might be a 120 Hz sine wave, 10 mV peak-to-peak, added to a constant 5-Volt output from the power supply. Try to find a ripple in one of the lab power supplies.

3. *AC level control*: Use a potentiometer to attenuate an ac signal as shown below. This is the essence of an audio volume control.

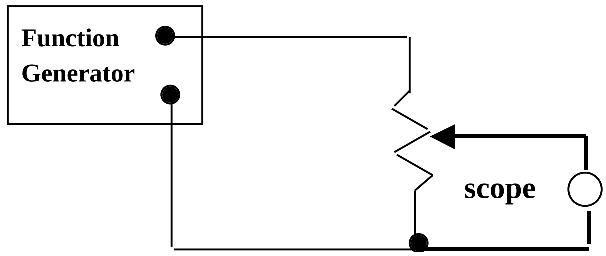

Figure 2: AC level control.

4. *Passive Summer*:
The summer adds the dc voltage from the power supply to offset the ac voltage from the function generator. Suppose that the function generator is an ideal

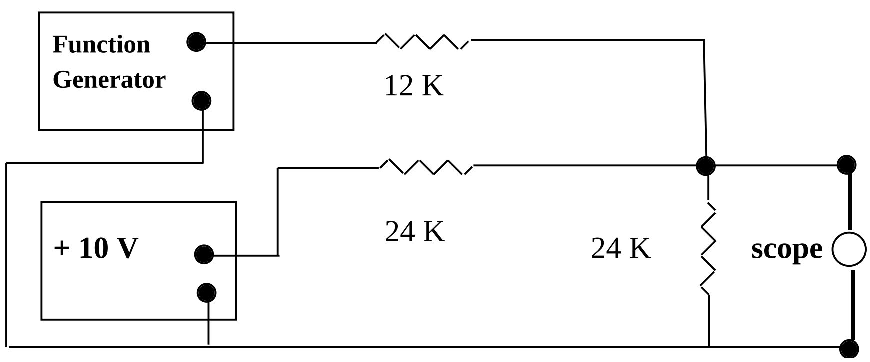

Figure 3: Passive summer.

voltage source (no internal resistance) creating a sine voltage $V_{AC} = 5 \sin(2\pi ft)$, where f is the frequency and the amplitude is 5 volts. Suppose that the 10-volt supply is an ideal voltage source. Show that the output is always positive and looks like the figure below.

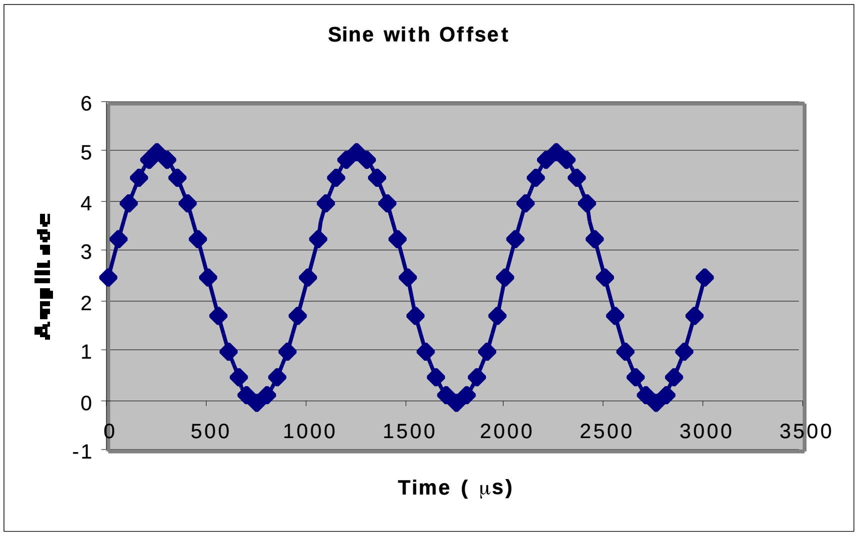

Figure 4: Sine wave with positive offset.