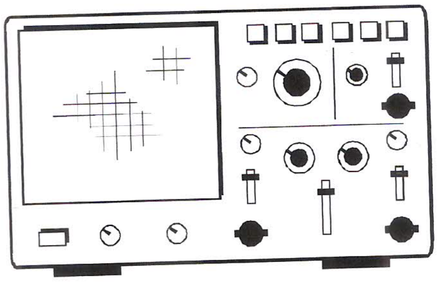
Experiment 1 - Setting up an oscilloscope

Preliminary discussion



The *cathode ray oscilloscope* (also known as just a "scope") is one of the most versatile pieces of test equipment in the electronics industry. The scope gives a visual display of a voltage so that its shape can be inspected. It also allows the user to measure a voltage's critical dimensions like its size (or *amplitude*) and cycle time (or *period*).

As you'll see, the scope is particularly useful when testing communications and telecommunications equipment and one is needed for most of the experiments in this manual. A basic 20MHz analog dual channel scope will do the job.

The experiment

Unfortunately, even the most basic scopes have quite a few controls and so they can be tricky to set up ready to view and measure signals if you're not using them all of the time. This experiment gives you a procedure that'll set up most scopes ready to show a stable 2kHz 4Vp-p signal on the scope's screen every time. Unless you have lots of experience in using scopes, it's recommended that you use this procedure as a starting point for the rest of the experiments.

As well as viewing AC signals, most experiments in this manual get you to measure their amplitude or period. This experiment gives you an opportunity to practise these skills in case you're a little rusty.

It should take you about 40 minutes to complete this experiment.

Equipment

- Dual channel 20MHz oscilloscope
- one oscilloscope lead
- Faceplate layout guide for the scope

Note: The faceplate layout of scopes varies widely from brand to brand and model to model so one is not provided in this manual.

Some things you need to know for the experiment

This box contains definitions for some electrical terms used in this experiment. Although you've probably seen them before, it's worth taking a minute to read them to check your understanding.

The **amplitude** of a signal is its physical size and is measured in *volts* (V). It is usually measured either from the middle of the waveform to the top (called the *peak* voltage) or from the bottom to the top (called the *peak-to-peak* voltage).

The **period** of a signal is the time taken to complete one cycle and is measured in *seconds* (s). When the period is small, the period is expressed in milli seconds (ms) and even micro seconds (μs).

The **frequency** of a signal is the number of cycles every second and is measured in *hertz* (Hz). When there are many cycles per second, the frequency is expressed in kilo hertz (kHz) and even mega hertz (MHz).

A **sinewave** is a repetitive signal with the shape shown in Figure 1.

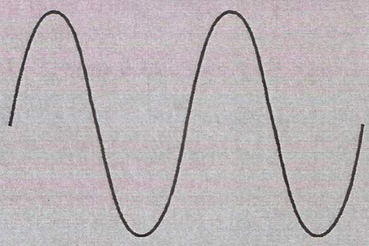


Figure 1

A **squarewave** is a repetitive signal with the shape shown in Figure 2.

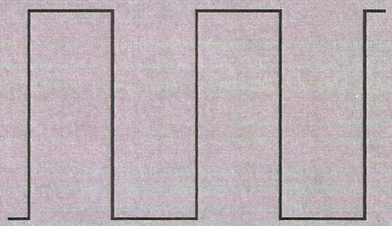


Figure 2

Procedure

1. General controls:

   i) Set the *Intensity* control to about three-quarters of its travel.

   ii) Set the *Mode* control to the *CH1* (or *CHA*) position.

2. Vertical controls:

   i) Set the *Input Coupling* control for both channels to the *AC* position.

   ii) Set the *Vertical Attenuation* control for both channels to the *1V/div* position.

   iii) Set the *Vertical Attenuation Calibration* control for both channels to the detent (locked) position.

   iv) Set the *Vertical Position* control for both channels to about the middle of their travel.

3. Horizontal controls:

   i) Set the *Horizontal Timebase* control to the *0.5ms/div* position.

   ii) Set the *Horizontal Timebase Calibration* control to the detent (locked) position.

   iii) Set the *Horizontal Position* control to about the middle of its travel.

4. Triggering controls:

   i) Set the *Sweep Mode* control to the *AUTO* position.

   ii) Set the *Trigger Level* control to the detent (locked) position. If it doesn't have a detent position, set it to about the middle of its travel.

   iii) Set the *Trigger Source* control to the *CH1* (or *INT*) position.

   iv) Set the *Trigger Source Coupling* control to the *AC* position.

   v) Set the *Slope* (or *Sync*) control to the "+" position.

5. Powering up:

i) Switch on the scope and let it warm up. After half a minute or so a trace should appear on the display.

If not, repeat steps 1 to 4 to check that you have set the controls correctly. If you still don't get a trace, call the instructor.

ii) Adjust the *Intensity* control so that the trace isn't too bright.

iii) Adjust the *Focus* control for a sharp trace.

6. Testing:

Use the oscilloscope lead to connect the Channel 1 input to the scope's *CAL* output.

Note: If the scope is working correctly, you should now see a stable squarewave on the display.

Ask the instructor to check
your work before continuing.

When measuring the amplitude of an *AC* waveform using a scope, it's common to measure its *peak-to-peak* voltage. That is, the waveform is measured from its lowest point to its highest point. This is shown in Figure 3.

Practise measuring the amplitude of an *AC* waveform by using the following procedure to measure the scope's *CAL* output.

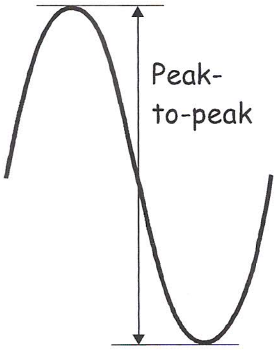


Figure 3

7. Use Channel 1's *Vertical Attenuation* control to make the waveform as big on the screen as possible without it going past the top and bottom lines.

8. Use the *Horizontal Position* control to align the top of the waveform with the centre vertical line on the screen.

9. Use Channel 1's *Vertical Position* control to move the bottom of the waveform so that it touches any one of the horizontal lines on the screen.

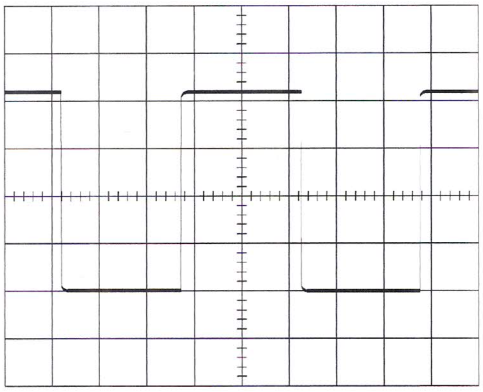


Figure 4

   Your display should now look something like Figure 4.

10. Count the number of divisions from the bottom of the waveform to the top.

    Tip: The subdivisions are worth 0.2.

11. Multiply this number by the *Vertical Attenuation* control's setting.

    For example: If you counted 6.6 divisions and the *Vertical Attenuation* control's setting is 0.5V/div, then multiply 6.6 by 0.5V. Using these values, the peak-to-peak voltage is 3.3V but your measurement will be different.

12. Record your measurement in Table 1 below.

Table 1

***CAL* output's peak-to-peak voltage**	

Ask the instructor to check your work before continuing.

The other dimension of an AC waveform that's important to know is its period. The period is the time it takes to complete one cycle and this is shown in Figure 5.

Although knowing the waveform's period is useful in its own right, it also allows us to calculate the signal's frequency.

Practise measuring the period of an AC waveform and calculating its frequency by using the following procedure.

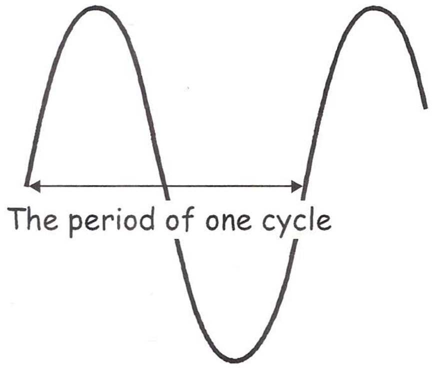


Figure 5

13. Use the *Horizontal Timebase* control to make the scope's *CAL* signal as wide on the screen as possible while still showing one complete cycle.

14. Set Channel 1's *Input Coupling* control to the *GND* position.

15. Use Channel 1's *Vertical Position* control to align the trace with the horizontal line across the middle of the screen.

16. Return Channel 1's *Input Coupling* control to the *AC* position.

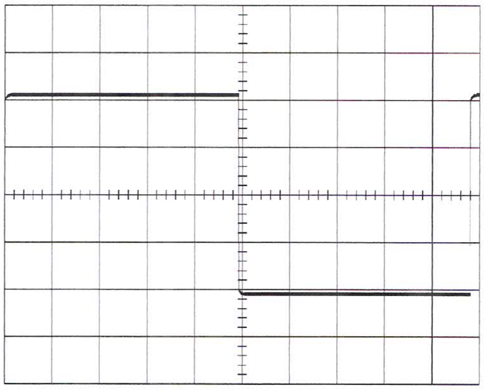


Figure 6

17. Use the *Horizontal Position* control to align the start of the waveform with the first vertical line on the screen.

    Your display should now look something like Figure 6.

18. Count the number of divisions for one complete cycle of the waveform.

    Tip: The subdivisions are worth 0.2.

19. Multiply this number by the *Horizontal Timebase* control's setting.

For example: If you counted 8.6 divisions and the *Horizontal Timebase* control's setting is 5ms/div, then multiply 8.6 by 5ms. Using these values, the period is 43ms but your measurement will be different.

20. Record your measurement in Table 2 below.

21. Use your measured value of period to calculate the waveform's frequency. If you're not sure how to calculate frequency, read the notes in the box below Table 2.

Table 2

***CAL* output's period**	
***CAL* output's frequency**	

Calculating frequency from period
Recall that the period of a waveform is the time it takes to complete one cycle. The standard unit of measurement for period is the second.

By definition, *frequency* is the number of a signal's cycles that occur in one second. So, to calculate a signal's frequency simply divide one second by its period.

As an equation, this looks like:

$$f = \frac{1s}{P}$$

Ask the instructor to check your work before finishing.