Experiment 1
Using the Digital Storage Oscilloscope

Introduction

The purpose of this experiment is to become familiar with the HP 54600 digital storage oscilloscope (DSO) and some useful procedures for documenting DSO waveforms in a report. A sample report is provided, which the student must complete and turn in for this lab. The sample report will then serve as a model for the remaining reports in this class.

Equipment Needed

- HP 54600 digital storage oscilloscope (DSO)
- HP 33120A function generator
- PC with IEEE-488 interface to DSO
- HP 34401A digital multimeter
- BenchLink (windows program)
- Windows "Write" word processor
- Sample Report (sample.wri)

Procedure

Turn on the PC and open both Windows "Write" and "BenchLink." Load the sample report found in "sample.wri" into "Write." Turn on the DSO and function generator. The first step in using a scope is to verify the probe compensation.

1. Connect both probes to the front-panel calibrator output. Use "Autoscale" to get square wave traces on both channels 1 and 2.

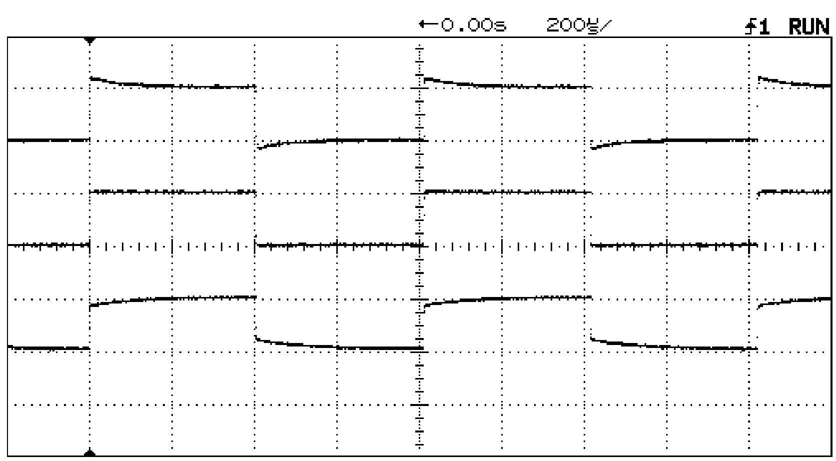

Fig. 1. Upper: Overcompensated probe. Center: Properly compensated probe. Lower: Undercompensated probe.

2. Compare your displayed waveform with Fig. 1, which shows the effects of misadjustment of the probe. Verify the probe compensation by checking that the square waves have no visible overshoot, and no visible tilt. If necessary, ask the lab instructor for an adjusting tool and set the probe compensation. This checking procedure should be done at the beginning of every lab, although the probe compensation is expected to be OK if they have not been mishandled.

Practice setting the function generator (FG) by using its front panel controls, and verifying the result with the DSO.

1. Set the following parameters on the FG: triangle wave, no modulation, 10 kHz, 2.5 Vp-p, +2 V offset.

2. Connect channel 1 of the DSO to the FG output. Display the waveform using a vertical sensitivity of 1 V/div, horizontal sweep rate of 50 μs/div, and the baseline in the center of the screen. The result should appear exactly like Fig. 1 in the sample report. (Hint: If the amplitude is off by a factor of 2, re-read the section of this manual describing the procedure for setting the FG output termination.)

3. Activate the scope's measurement readouts. Turn on readouts for the average, peak-to-peak and rms voltage on channel 1. These should appear at the bottom of the screen. Do they agree with the FG settings to within 2 significant figures?

4. Switch the active window on the PC to "BenchLink." Copy the DSO screen as an image using BenchLink. It should now appear on the monitor.

5. Import this image into "Write," using it to replace the existing Fig. 1. The Windows clipboard is the easiest way to do this, although you could also save the image as a .PCX file as an intermediate step. (In future lab experiments, you will want to save DSO waveforms as .PCX or .TIF image files on your floppy disk for later use with your favorite word processor.) These images can be easily annotated (but do it sparingly) by Windows "Paintbrush."

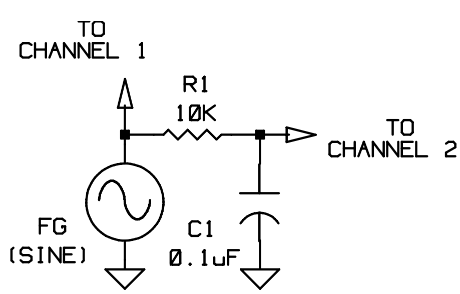

Fig. 2. Test circuit (a low-pass filter).

6. Use the digital multimeter (DMM) to measure the dc and ac components of the FG output. The measured dc component should agree with the average value reading on the scope to two significant figures or better. The measured ac value will *not* agree with the rms value readout on the scope. (Why?)

Next, set up the circuit shown in Fig. 2 below. Note that the ground symbol in the schematic implies a point of common reference. The ground clips on both scope probes and the shield connection on the FG output cable are connected here.

1. Set the FG for 159 Hz, sine wave, 2 Vp-p, zero offset.

2. Display channels 1 and 2, using vertical sensitivities of 500 mV/div for both with a horizontal sweep rate of 1 ms/div. Place the baselines for both channels in the center of the screen.

3. Turn on readouts to measure the frequency of channel 1, and the phase difference between channels 1 and 2. (Hint: Search the menus under "Measure," "Time," "Next Menu".) It may be necessary to adjust the triggering conditions such as trigger level and slope, or turn on the trigger filters, to obtain a stable display with a full period of the waveform showing. The phase and frequency routines will fail if the DSO cannot identify a full period of each waveform.

4. Import this screen image into the word processor as report Fig. 2.

5. Without changing any vertical settings on the DSO, switch to its X-Y mode. (This is found under "Horizontal," "Main/Delayed," "XY".) This puts channel 1 on the X axis, and channel 2 on the Y axis. Time no longer appears as an explicit variable.

6. Import this screen image into the word processor as report Fig. 3.

7. Please <u>do not</u> save this file as sample.wri (do not over-write the original file). Instead, save your version of sample.wri containing your lab results to a floppy disk, or transfer it to your computer account, or print it using the printer in the computer lab across the hall.

<u>Report</u>

The report should review the definitions of the following terms: average, dc, offset, peak-to-peak, and rms. Using the waveform plotted in the experimental image of the triangle wave, directly calculate these quantities and verify that the DSO measurement facility has produced a plausible result. Determine what the DMM has measured in its "dc" and "ac" measurements. Why doesn't its ac measurement agree with the scope's rms readout? Given the input to Fig. 2 of a 2 Vp-p sine wave, calculate the theoretical voltage that should appear on channel 2, and compare it with the measured result. What is the name given to the experimental image shown in report Fig. 3?