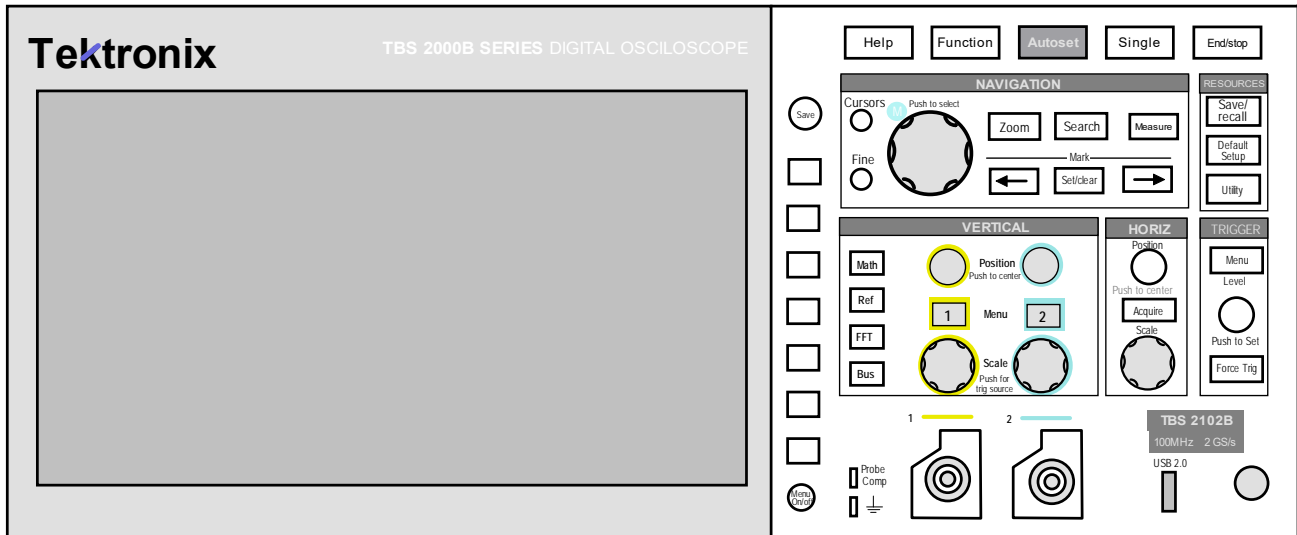


Electric Circuits Laboratory

ENGR 250L - LAB EXERCISES

LAB 5 - SCOPE, FG II (2 h)



Let's continue to use the scope and FG to learn more about how to properly use them.

Note, that you are often instructed to NOT use AUTOSET as it will often not display the traces as desired. However, once in awhile you may have to press AUTOSET, and then adjust position and scale to get the desired trace. This happens when you simply cannot get the traces to display right using manual techniques. We suspect that some miscellaneous setting is preventing the proper display, and AUTOSET clears this setting.

5.1 EQUIPMENT NEEDED

1. Oscilloscope ("scope") (Tektronix TBS 2000B (60 MHz, 1 GSa/s) (scope probes, screwdriver)
2. Function generator ("FG") (BK Precision 4011A) (+FG breakout cable)
3. Trainer
4. DMM
5. Resistors: $R = 100 \text{ k}\Omega$ (x2) (brown-black-yellow)
6. USB Flash Drive (formatted as FAT32) (STUDENTS TO BRING)
7. (***) Measure & record component values with DMM

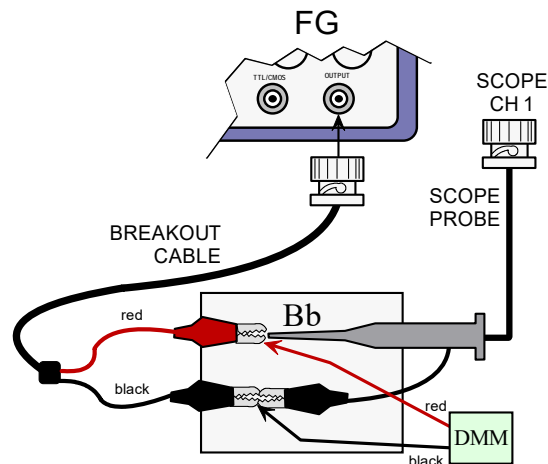
5.2 DMM AMPLITUDE

The DMM will display a numerical value for a measured AC voltage. For sinusoids there are different possible amplitudes such as: peak, peak-to-peak, average, max, and RMS. Here we will use the scope to

determine which of these is being displayed on the DMM. Note that RMS value for sine waves is 0.707 of the sine wave amplitude.

STEPS

1. Set the FG to produce a SINE WAVE, 2 Vpp, 0V offset, 1 kHz (i.e., Vmax = 1V)
(note on the Tektronix scopes Vmax = amplitude of sine wave)
2. Complete the set up shown.
3. Display the FG signal on the scope and adjust the FG to obtain the proper values.
4. (***) Measure & record the voltage using the DMM (ACV setting).
5. Use the MEASURE function on the scope, trying different amplitude values (Vpp, Vmax, Vrms, etc.).
6. (***) Which measurement parameter matches the DMM? (e.g., is it Vpp, Vmax, Vrms, etc.?)



5.3 DCV ON SCOPE

The scope can also measure DC voltage. Pass a 5V DC signal to the scope. Use the trainer power supply. Use a scope probe (verify the probe attenuation is set properly). Try different scope measurements (Vpp, Vmax, Vrms, Vavg, etc.). (Measure > xxx >) **UPDATE**

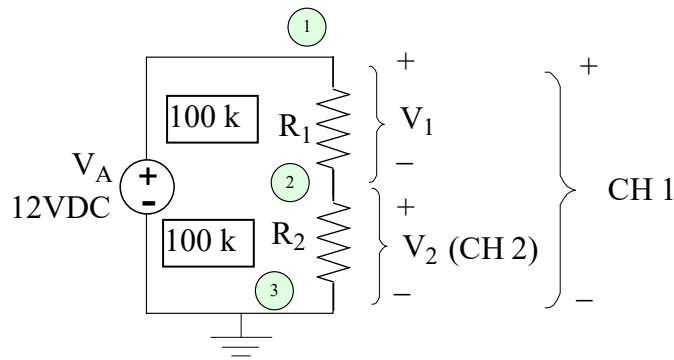
(***) Which scope measurement parameter is best for DC voltages?

5.4 OTHER WAVEFORMS

Set the function generator to output SQUARE and TRIANGLE wave forms. Adjust the scope to display these traces nicely.

(***) Capture these traces.

5.5 NON-GROUND REFERENCE VOLTAGE ON SCOPE



Scopes cannot generally measure voltages NOT referenced to ground. For instance, the scope cannot properly measure V_1 above. And we cannot simply place the probe tips on the top side of R_1 and the ground clip on the other side of R_1 . The scope (on a single channel) can only measure voltage relative to Earth ground! In other words, think of the black clip on the scope as a grounding clip. If you hook it up anywhere on the circuit, it grounds that portion of the circuit (that would be BAD). So how do we measure V_1 ? We must use 2 channels on the scope and subtract. This is possible using the scope's MATH functions. Note – DMMs (and other battery-powered devices) CAN measure non-ground reference voltages since they are powered by a battery whose voltage "floats" relative to earth ground. You can display the MATH result by adding a measurement from "MATH" instead of CH 1 or CH 2.

STEPS

1. Build the circuit shown.
2. Measure the voltage values using the DMM.
3. Now measure the voltages using the scope (use "Vavg or Vmean"). Place the probe tips and the grounding clip across each resistor accordingly. To measure V_1 directly, place scope probe at node 1 and scope ground clip at node 2. To measure V_2 directly, place the scope probe at node 2 and the scope ground clip at node 3. DC signals on the scope appear as a horizontal line.
4. (Does V_1 measure properly on the scope?)
5. (***) Record data.

5.6 MULTIPLE SIGNALS & AUTOSET

Often we will display 2 traces on the oscilloscope. We may want those traces OVERLAID (one right on top of the other), and other times we want them OFFSET (displaced from each other). Here we will find out what AUTOSET will do to 2 AC signals. Refer to the **CT GUIDE** on how to use the trainer FG.

STEPS

1. Pass 2 AC signals to the scope (1 from BK FG & 1 from trainer FG).
2. Set the frequencies to be identical as best you can (e.g., $f = 1$ kHz).
3. Display both traces on the scope.
4. Press AUTOSET
5. (***) Are the 2 traces overlaid or offset?
6. Set the trigger to work on CH 1
7. (***) With trigger on CH 1, which trace stands still (is "static")?
8. (***) Now switch trigger to CH 2. Which trace is static now?
9. (***) In either case, what is the non-trigger channel trace doing?
10. (***) Can you get both traces to be static at the same time?

LAB 5 - ANSWER SHEET

SCOPE FG II

Team Number: _____

Name 1: _____

Name 2: _____

5.1 Measure components

_____. _____.

Resistor (100 k nominal)

5.2 DMM Amplitude

_____.

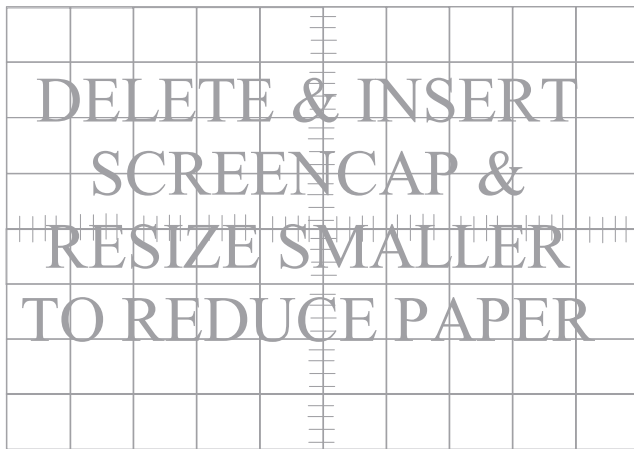
The DMM displays what voltage amplitude parameter for a sine wave?

5.3 DCV on Scope

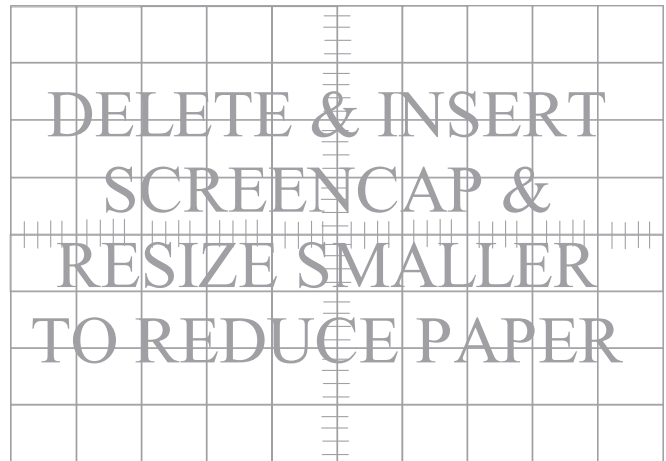
_____.

Which measurement parameter best reflects DC voltage value on the scope?

5.4 Other Waveforms



SQUARE WAVE



TRIANGLE WAVE

5.5 Non-Ground Reference Voltage on Scope

_____. V_1 directly

_____. V_2 directly

_____. V_1 using subtraction

5.6 Multiple Signals and Autoset

_____. Does Autoset OVERLAY or OFFSET 2 scope signals?

_____. With trigger on CH 1, which trace is static?

_____. Now switch trigger to CH 2. Which trace is static now?

_____. In either case, what is the non-trigger channel trace doing?

_____. Can you get both traces to be static at the same time?