N6705A DC Power Analyzer – Comprehensive Demo Guide

*Important Note: There is built-in protection for each of the input cables of the Demo Kit. If at any time during the demo any of the outputs of the N6705A go into "CC" mode, this means the protection circuit has been engaged. Please press the "Emergency Stop" key, check all of the circuit breakers, and make sure you have the correct voltage and current set for each output.

Equipment Required:

- (1) Agilent N6705A DC Power Analyzer mainframe with the following modules installed:
  - **Output 1**: N6762A
  - **Output 2**: N6762A
  - **Output 3**: N6752A
  - **Output 4**: N6773A

This is the standard configuration that is setup in each demo hub worldwide. See Figure 1.

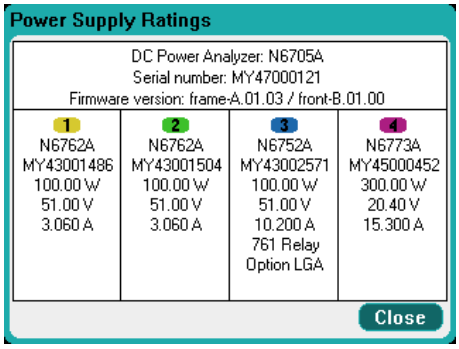


Figure 1 – Power Supply Ratings

- (1) N6705A Demo Kit (NPN-125890)

GENERAL SETUP

1. Plug the power cable into the N6705A and turn it on.
2. Plug the demo kit cables into their respective outputs on the N6705A mainframe. Cable "1" to **Output 1**, cable "2" to **Output 2**, etc.
   a. Observe polarity – red to red (+) and black to black (–)
   b. The cable labeled "S" should be connected to the "Sense" terminals of **Output 4**, red to +S and black to –S.

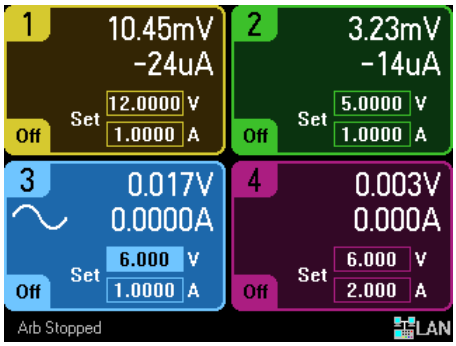


Figure 2 – Multiple Output View

There are three measurement modes on the N6705A: The "Meter View," the "Scope View," and the "Data Logger."

THE METER VIEW (page 51 of User's Guide)

The N6705A will power up into the Multiple Output View seen in Figure 2 above. This display mode shows all four outputs at once. The state of the output, a measurement of the actual voltage and current that is being output, the set voltage and current points, and whether or not an arbitrary waveform is programmed are shown for each output.

- Press the "Meter View" key once to bring up the Single Output View. This view shows more detail about the selected output, in this case **Output 3** (see Figure 3). Output On and Off delays, Slew Rate, Max V & I, and OVP and OCP levels are added to the display. You can still monitor the other three output's V, I, & state (CV, CC, Off, etc.) at the bottom of the screen.

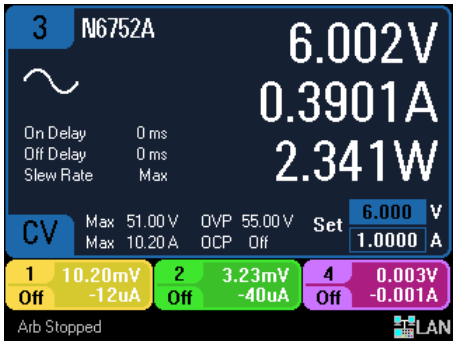


Figure 3 – Single Output View (3)

DEMO 1: CHARACTERIZE A DC FAN'S CURRENT WITH AMMETER MODE (METER VIEW)

Average DC Measurement

You work for a DC fan manufacturer and your boss has asked you to measure the average current of the new 12 V DC fan your company produces. The fan is located in the demo kit and is connected in series to a 5 V relay (see Attachment 1 for a schematic of the Demo Kit). Using **Output 1** & **Output 2** on the N6705A apply power to the fan and relay.

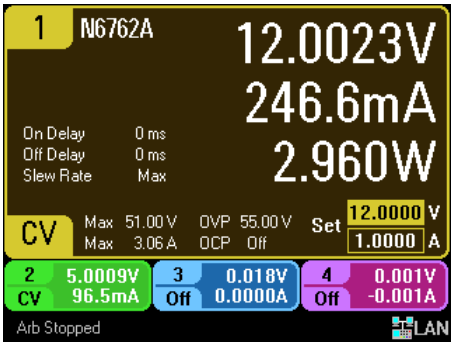


Figure 4 – Single Output View (1)

1. Make sure that Switch 1 on the Demo Kit is in the "Fan/Relay" position.
2. Use the arrow keys to highlight the appropriate "Set" box (V or A), then use the keypad to enter the following "Set" values. Hit "Enter" after each value:
   i. **Output 1**: 12 V, 1 A
   ii. **Output 2**: 5 V, 1 A
3. Turn on **Output 1** & **Output 2** by using their colored "On" keys. The fan will begin spinning.
4. The current displayed in the yellow section of the Meter View (**Output 1**) is the average current for the fan. Observe that it is ~250 mA.
5. Make sure **Output 1** is selected by pressing the "1" under "Select Output" on the front panel.
6. Press the "Meter View" key with **Output 1** selected to see more information as described above in THE METER VIEW section. You will see something similar to Figure 4.
7. Press the "Meter View" key again if you'd like to return to the previous screen.
8. Report the results to your boss.

Demo 1 shows:

- Ease of test setup
  - Color coding of the outputs to reduce errors
  - Large, easy to read, color display shows set values and measured values
- Easy to make accurate current measurements thanks to the integrated DMM (ammeter) functions in "Meter View"
  - No current shunt (aka sense resistor) or current probe needed
  - Fully specified measurement compared to difficult to determine specs when using separate pieces (Voltmeter + Shunt or Scope + Current probe)
- The N6705A has 21 different modules to choose from so you can pick the right voltage, current, power and accuracy needed for your particular test configuration(s).

THE SCOPE VIEW (page 52 of User's Guide)

Each power module for the N6705A has at least one built-in 50 kHz digitizer (20.48 µs / sample) that is always running. The digitizers can measure either voltage or current (the N676xA modules have two digitizers and can measure V & I simultaneously in scope mode). These measurements are shown in a scope-like display in the "Scope View" (see Figure 5). Pressing the "Scope View" key a second time brings up the markers.

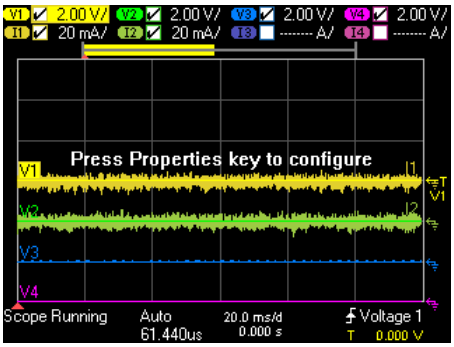


Figure 5 – The Scope View

DEMO 2: CHARACTERIZE THE CURRENT WAVEFORM OF A DC FAN USING SCOPE MODE (SCOPE VIEW)

You bring your results from Demo 1 to your boss and s/he is very pleased. However, s/he is now interested in knowing whether or not the required current is straight DC or if it is a fluctuating waveform. S/he asks you to investigate. Using the "Scope View" of the N6705A, you will capture the waveform for current versus time (I vs. t).

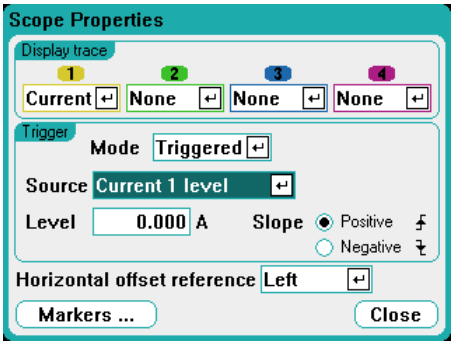


Figure 6 – Scope Properties

1. Use the same V & I settings as in DEMO 1 above.
2. Change to Scope View by pressing the "Scope View" key.
3. Press the "Properties" key to bring up the "Scope Properties" screen (see Figure 6).
    a. Set Display trace for (1) to "Current" by using the arrow keys to highlight the drop down box, press "Enter", choose "Current" then press "Enter" again.
    b. Set Display trace for all the rest to "None"

    NOTE: You can also perform steps a. and b. while still in the "Scope View" by highlighting the appropriate signal you'd like to see (V1, I1, V2, I2,…) using the arrow keys, then press the "Enter" key to check or uncheck the box. See Figures 5, 7, & 8 below. In Figure 5, V1, I2, V2, I2, V3, and V4 are all checked. In Figures 7 and 8, only I1 is checked.

    c. Set trigger mode to "Triggered"
    d. Set trigger source to "Current 1 level"
4. Press "Scope View" key again to bring back the scope screen
5. Highlight I1 as in Figure 7, then turn the "Volts / Div" knob until I1 is set to 100 mA/
6. Turn the "Vertical Offset" knob to center the waveform vertically.
7. Turn the "Time / Div" knob until "5.0 ms/d" is displayed at the bottom-center of the screen
8. Turn the "Trigger Level" knob until a stable trigger is achieved (HINT: see Figure 7 above).

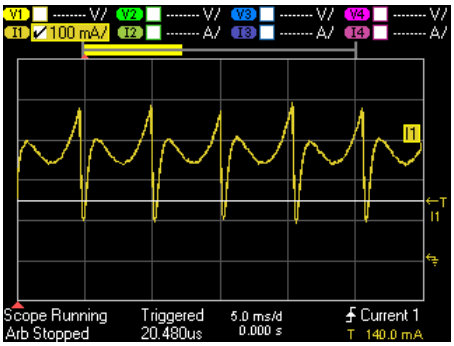


Figure 7 – DC Fan Current Waveform (Scope View)

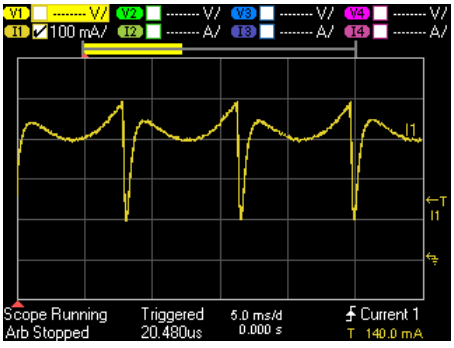


Figure 8 – DC Fan Current Waveform with Resistance Applied (Scope View)

9. Use your finger to apply resistance to the fan as it spins to see the changes in the waveform. Compare Figure 8 to Figure 7.

Demo 2 shows:

- How fast and easy was it is to make accurate current measurements vs. time measurements thanks to the integrated scope function?
    - Just press ONE key to see the trace – no additional hardware or wiring
    - No current shunt (aka sense resistor) or current probe needed
    - Fully specified measurement compared to difficult to determine specs when using separate pieces (Voltmeter + Shunt or Scope + Current probe)
- The scope mode operates just like an Agilent Oscilloscope, so that no relearning of new instruments is needed (leverages knowledge)
- How easy is it to save the data?
    - You can save a screen capture (.GIF file) to USB memory to integrate into a report
    - You can save the scope data to recall later
    - You can export the scope data to a CSV file for analysis on a PC (Excel, etc.)

THE DATA LOGGER (page 58 of User's Guide)

As described above in The Scope View section, each power supply module has a built-in digitizer to digitize the voltage and/or current being provided by the module. The Data Logger provides the ability to view this information over longer periods of time, from seconds to days. In the data logger mode, modules that only have one digitizer can be set to take both V & I measurements. The V & I measurements are interleaved based on the sample period.

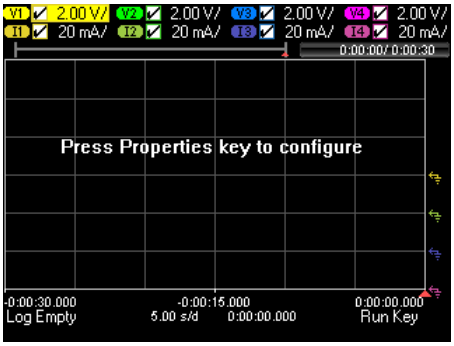


Figure 9 – The Data Logger

DEMO 3: CHARACTERIZATION OF A COMPUTER CD DRIVE'S CURRENT WITH DATA LOGGER MODE (DATA LOGGER)

You work for a computer CD drive manufacturer. Your boss has asked you to capture the current draw from the CD drive in order to establish the power consumption of the drive and to verify if it is functioning properly. The CD drive takes two inputs, 12 V and 5 V. The 12 V powers the CD drive's motor. The motor opens and closes the drive door as well as spins the CD. The 5 V powers the logic inside the drive. You must apply power to the CD drive and measure the current versus time (I vs. t) of both **Output 1** (12 V) and **Output 2** (5 V) for 30 seconds using the data logger.

1. Press the **All Outputs "Off"** key to turn off all of the power supply outputs
2. Switch 1 on the demo kit should be changed to the "CD Drive" position before applying power again. Failing to do so may result in the Demo Kit's built-in protection circuit engaging as described in the Important Note on the first page of this guide.
3. Turn both **Output 1** and **Output 2** on again by pressing their colored "On" keys.
    a. Output 1 should still be set to 12V, 1A as in DEMO 1
    b. Output 2 should still be set to 5V, 1A as in DEMO 1
4. Once power is properly applied, the green light on the drive should begin to blink. Confirm that the proper voltages have been applied by opening and closing the drive door.
5. Press the **All Outputs "Off"** key
6. Press the "Data Logger" key to switch to data logger mode
7. Press the "Properties" key to set up the data logger (see Figure 10).
   NOTE: For steps a. and b. you can also use the same procedure as described in the NOTE in DEMO 2, Step 3.
    a. Set Display trace for (1) and (2) to "Current"
    b. Set Display trace for all the rest to "None"
    c. Set Logging-Duration to 30 seconds
    d. Set Logging-Sample Period to 50 ms
8. Press the "Data Logger" key to return to the data logger screen
9. Use the arrow keys to highlight I1, then use the "Volts / div" knob to set 200 mA/
10. Use the arrow keys to highlight I2, then use the "Volts / div" knob to set 200 mA/ and use the vertical offset knob to set the I2 offset to ~600 mA
11. Start capturing data by pressing the "Run/Stop" key
12. While 30 seconds of data is being captured, do the following:

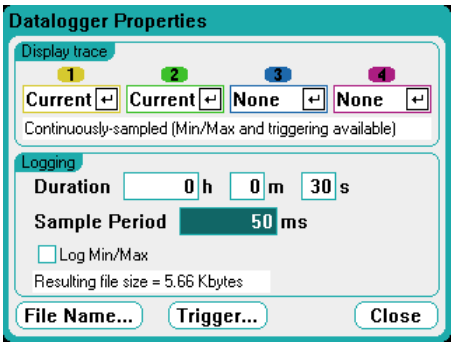


Figure 10 – Datalogger Properties

a. Turn both **Output 1** and **Output 2** on again by pressing their colored "On" keys.
b. Wait 5 seconds
c. Open the drive door, then close the drive door
d. Open the drive door again and insert a CD, if available
e. Provide resistance to the door when it opens or closes

13. Once data is captured, you can use the "Vertical-Offset" and "Time / Div" knobs to zoom in on the waveform and inspect particular areas for more details (see Figure 11 below).

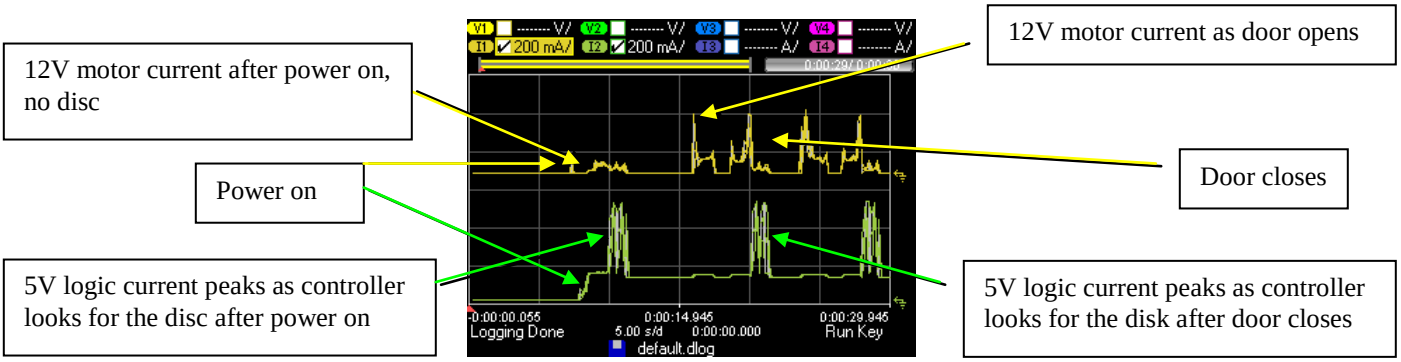


Figure 11 – Logged CD Drive Current Data

Demo 3 shows:

- How easy is it to make accurate current measurements vs. time measurements thanks to the integrated data logger function?
  - Just press ONE key to see the trace – no additional hardware or wiring
  - No current shunt (aka sense resistor) or current probe needed
  - Fully specified measurement compared to difficult to determine specs when using separate pieces (Voltmeter + Shunt or Scope + Current probe)
- Seeing multiple traces on the same screen shows relationships between data, such as door closing causes 5V logic to activate (drive searching for a disc)
- Data logging typically requires a PC and software
  - With the N6705A everything is integrated – one box solution, no mess of wires, everything is debugged and specified already
  - Fast setup gets results quickly - no programming required.
- It is extremely easy to save the data to the internal non-volatile memory
  - 64 MB of internal memory, more coming soon
    - That's enough for 16Million readings or 30 minutes of data at the max data rate of 1 ms per reading on all outputs simultaneously
- It is extremely easy to save the data externally
  - Max data log size is 2 GB, or 500 Million readings
  - You can save a screen capture (.GIF file) to USB memory to integrate into a report
  - You can save the data logger data to recall later
  - You can export the logged data to a CSV file for analysis on a PC (Excel, etc.)

DEMO 4: OUTPUT SEQUENCING (page 41 of User's Guide)

Some devices under test, such as PC motherboards, require multiple voltages in a specific sequence. If the voltages are applied in an improper sequence, the DUT would be damaged. Thus, if the voltages are not precisely controlled and sequenced, a very expensive prototype DUT could be transformed into junk.

Use the N6705A's output sequencing feature to turn the following output voltages on at the specified times:

- **Output 1**: 10 ms
- **Output 2**: 0 ms
- **Output 3**: 20 ms
- **Output 4**: 13 ms

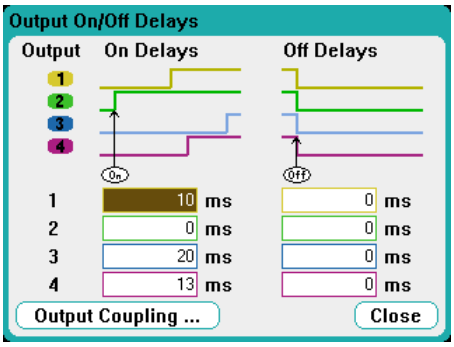


Figure 12 – Output On/Off Delays Configuration Page

1. Press the **All Outputs "Off"** key to turn off all of the power supply outputs
2. Press the "Settings" key twice to bring up the Output On/Off Delays screen (see Figure 12).
3. Set the output delay values listed in the description above.

   NOTE: As you enter values in for Outputs **1**, **2**, **3**, and **4**, the display will show a preview of the output sequence (see Figure 12 above). Later, you should compare this preview screen to the actual scope traces (see Figure 13 below).
4. In "Meter View" set Outputs **1**, **2**, **3**, and **4** each to 5 V and 1 A.
5. Press the "Scope View" key.
6. Select all four output voltages by checking boxes V1, V2, V3, and V4. As you check each box, set V1 – V4 each to "5 V / div"
7. Uncheck I1 – I4
8. Press the "Properties" key then set the following trigger properties
   a. Mode: Single
   b. Source: Voltage 2 level
   c. Level: 1 V
   d. Slope: Positive
   e. Horizontal offset reference: Center

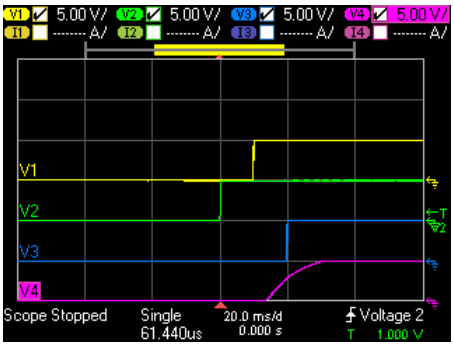


Figure 13 – Output On Delay in Scope View

9. Close the Properties screen (either select "Close" or press the "Scope View" key)
10. Using the "Time / Div" knob, set the time base to 20 ms / div
11. If the "Run/Stop" key is already illuminated, which indicates it is ready and waiting for a trigger, skip this step and proceed to Step 13. If not, then press the "Run/Stop" key. The key should illuminate as well as clear the screen.
12. Press the "All Outputs On" key to start the sequence
    a. You should see a screen approximately the same as the one shown in Figure 13 above.

    NOTE: V4 begins at the correct time, however, it does not ramp to 5 V as fast as V1, V2, and V3. This is because Output 4 is an N6773A, which is a Basic module. Outputs 1 & 2 are Precision modules and Output 3 is a High-

Performance module. Press “Settings” then “Properties” to see the configuration of the N6705A mainframe.

Demo 4 shows:

- How would you have done this task with conventional test equipment?
    - Multiple power supplies, messy wiring, PC, programming, FET control (extra design work)?
- How long would it have taken you to build, debug, and validate your sequencing system? Days? Weeks?
    - You just did it in less than 5 minutes – no additional hardware or wiring, no software, no PC, no debugging, everything just works
- You can synchronize across multiple N6705A mainframes if sequencing of more than 4 outputs is necessary.

THE ARBITRARY WAVEFORM GENERATOR (ARB) (page 44 of User's Guide)
Sometimes it is necessary to stimulate a DUT with a waveform. Ordinary function generators are capable of doing this, however, they do not have the power necessary to drive all DUTs. The N6705A's built in Arb makes powerful waveform generation as easy as pressing a few buttons. Figure 14 shows the different preprogrammed waveforms available. User defined waveforms are also possible.

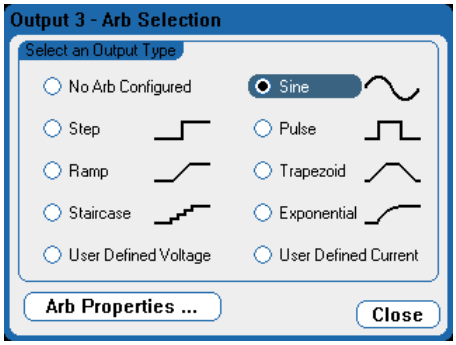


Figure 14 – Arb Selection Screen

DEMO 5A: ARB – SINE WAVE
Using the ARB on **Output 3**, source a sine wave with the following parameters through a speaker:

- V_{P-P} = 6 V (V_0 = 3 V)
- V_{OFFSET} = 4 V (V_1 = 4 V)
- f = 500 Hz

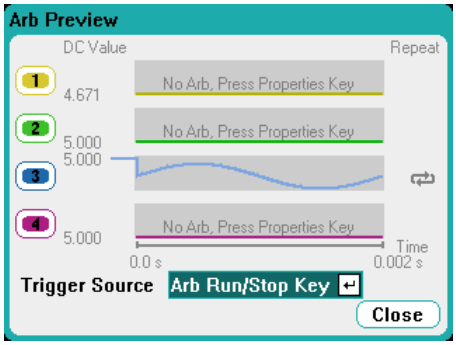


Figure 15 – Arb Preview Screen

1. Press the **All Outputs "Off"** key to turn off all of the power supply outputs
2. Select **Output 3** by pressing the blue "3" key under "Select Output" on the front panel
3. Bring up the Arb Selection screen by pressing the "Arb" key twice. This key is located under "Source" on the front panel
4. Using the arrow keys select the Sine wave then press "Enter"
5. Bring up the Sine wave properties page by pressing the "Properties" key.
6. Set V_0 = 3 V. This sets the peak-to-peak voltage to 6 volts.
   NOTE: An Advisory screen will appear indicating the system has automatically changed V_1 to 3 V. Press "Enter" to clear this screen.
7. Set V_1 = 4 V. This is the DC offset voltage.
8. Set f = 500 Hz. This sets the frequency to 500 Hz.
9. Check "Continuous" at the bottom left of the screen. This sets the Repeat Count to infinity.
10. In order for the output to power the speaker the current limit needs to be set above 0 A. In the "Meter View" set the current of **Output 3** to 2 A.
11. Turn **Output 3** on by pressing the blue "On" key
12. Start the sine wave by pressing the "Arb Run/Stop" key. The key will be lit when the Arb is engaged.
13. Turn the speaker on by flipping the speaker switch on the demo kit to "Speaker". You should hear a 500 Hz tone.
    HINT: If the tone becomes annoying, turn the switch to the "Off" position.
14. Press the "Scope View" key to see the sine wave on the scope screen
15. Turn all the other output displays off by using the arrow keys to uncheck their respective boxes. Leave the **Output 3** voltage "V3" checked.
16. Highlight "V3" then use the "Volts / div" knob to set "V3" to "2.00 V/"
17. Press the "Properties" and set the following:

a. Mode: Triggered
b. Source: Voltage 3 level
c. Level: 0 V
d. Slope: Positive
e. Horizontal offset reference: Center

18. Press "Scope View" to return to the scope screen
19. If the "Run/Stop" key is not lit, press it
20. Use the "Trigger Level" knob to adjust the trigger until you see the sine wave
21. Use the "Time / Div" knob to change the time base to 1 ms/d
22. Press "Arb" twice then "Properties" to go back to the Arb Properties screen.
23. Change the frequency to 1000 Hz.
24. Cycle the ARB by pressing "Arb Run/Stop" twice. What happens to the tone?
25. Press the "Scope View" key to return to the scope screen to see the 1 kHz signal.
26. Press the "Scope View" key again to engage the markers. Use the "marker 1" and "marker 2" knobs to look at one period of the waveform.
    NOTE: The markers may be off screen.

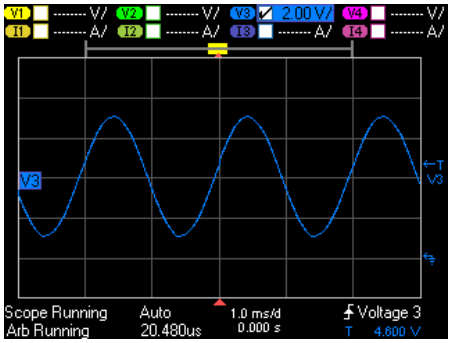


Figure 16 – 500 Hz Sine Wave in Scope View

Demo 5A shows:

- How would you have done this task with conventional test equipment?
  - Function generator doesn't have enough power, power supply with an analog input, PC, programming, custom design (extra design work)?
- How long would it have taken you to build, debug, and validate your Arb?
  - You just did it in less than 5 minutes – no additional hardware or wiring, no software, no PC, no debugging, everything just works
- You can create user defined waveforms for both voltage and current within minutes.
- You can import data points from a PC via USB memory or over the web interface to create waveforms of up to 512 points.

DEMO 5B: ARB – STAIRCASE

Using the ARB on **Output 3**, you will create a stepped ramp into the capacitor and light. This is a form of margin testing where the voltage is stepped up and the resulting current is measured dynamically. When the voltage steps above 12 V, a protection circuit within the Demo Kit will be triggered, the circuit breaker will pop, and the Fault light will illuminate. When this occurs, **press the "Emergency Stop" key**. The Data Logger continues to capture data the entire time, even after the "Emergency Stop" key is pressed. This enables the user to have crucial data on hand even after a fault occurs. This is especially useful if the fault destroyed a valuable prototype. The values recorded at the time of the fault may lead to the prevention of future losses.

1. Press the **All Outputs "Off"** key to turn off all of the power supply outputs
2. If the "Arb Run/Stop" key is lit, press it so that it is no longer lit
3. In "Meter View" set Output 3 to 5 V and 10 A
4. On the Demo Kit, switch the "Capacitor" and the "Light" on and the "Speaker" off
5. Turn on **Output 3** by pressing the blue "On" key, the light will illuminate slightly

6. Select **Output 3** by pressing the "3" key under "Select Output"
7. Press the "Arb" key twice
8. Select "Staircase" and press "Enter"
9. Press the "Properties" key
10. Set the following:
    a. $V_0 = 0$ V
    b. $V_1 = 16$ V
    c. $t_0 = 2$ s
    d. $t_1 = 8$ s
    e. $t_2 = 2$ s
    f. # of Steps = 8
    g. Return to DC Value – selected
    h. Continuous – unchecked
    i. Repeat Count = 1

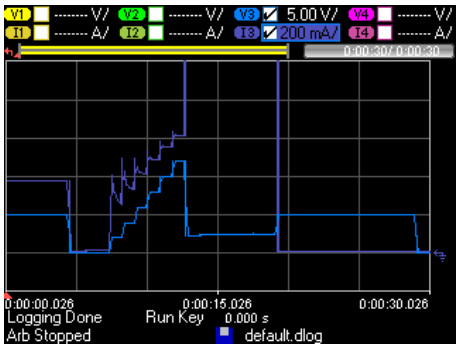


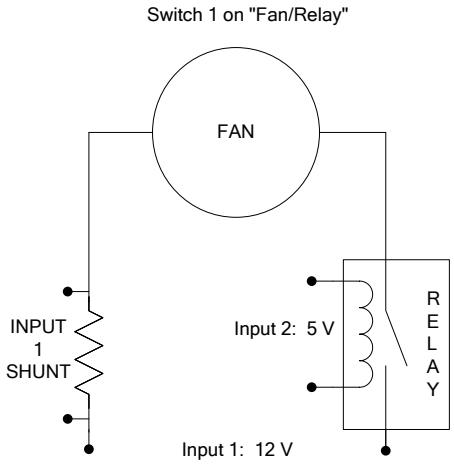
Figure 17 – Stepped Voltage Ramp into a Cap in Data Logger

11. Press the "Data Logger" key
12. Use the arrow keys to uncheck all the Output voltages and currents (V1, I1, V2, I2 …) EXCEPT for V3 and I3. Leave V3 and I3 checked.
    NOTE: You may see an Advisory screen indicating that the settings require a longer sample period. Press "Enter" to clear this message.
13. Use the "Volts / Div" knob to set V3 to "5 V/" and I3 to "200 mA/"
14. Press the "Properties" key
15. Set the duration to 0 h 0 m 30 s
16. Set the Sample period to 75 ms
17. Press the "Data Logger" key
18. Press the "Run/Stop" key to begin data logging, within a few seconds of beginning the data log, press the "Arb Run/Stop" key to start the staircase function. **Immediately proceed to Step 19.**
19. This should create a fault condition and will illuminate the Fault light on the Demo Kit after approximately 20 seconds. When the Fault light illuminates, press the "**Emergency Stop**" key.
20. Figure 17 shows what the data log should look like. Even though you hit the Emergency Stop key, the data logger continues to capture valuable data.
21. Reset the popped circuit breaker on the Demo Kit by pressing it down.

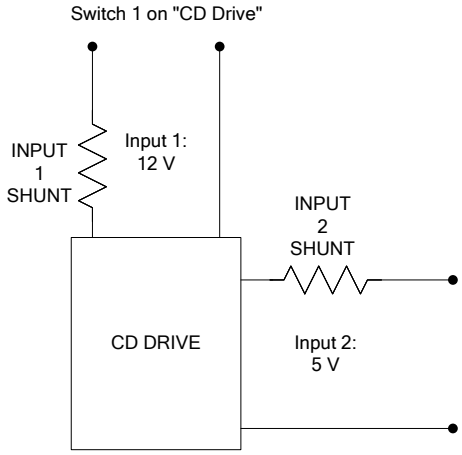
Demo 5B shows:

- How would you have done this task with conventional test equipment?
  - PC, programming, custom design (extra design work)?
- How long would it have taken you to build, debug, and validate your system?
  - You just did it in less than 5 minutes – no additional hardware or wiring, no software, no PC, no debugging, everything just works
- You can create user defined waveforms for both voltage and current within minutes.
- You can import data points from a PC via USB memory or over the web interface to create waveforms of up to 512 points.
- How would you have handled the fault with a conventional power supply?
  - The Emergency Stop key shuts down all the outputs, but the data logger continues to run saving valuable data.

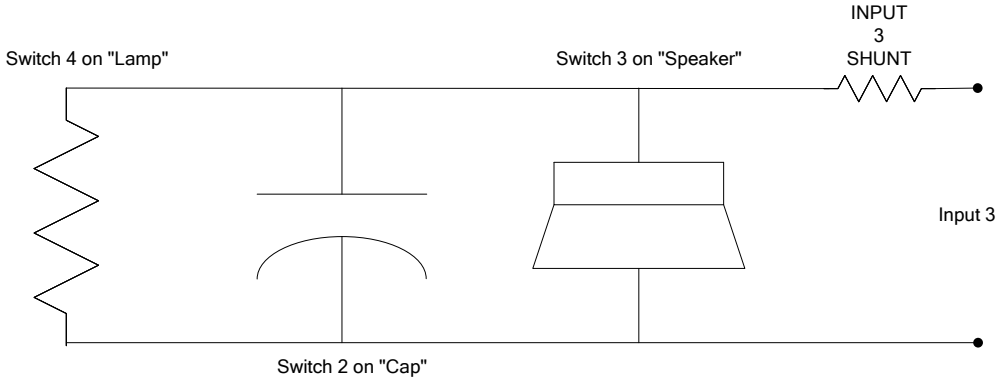
Attachment 1: Demo Kit Schematic



Fan/Relay: Inputs 1 & 2



CD Drive: Inputs 1 & 2



Capacitor, Speaker, & Light: Input 3