

Names \_\_\_\_\_

### Objectives:

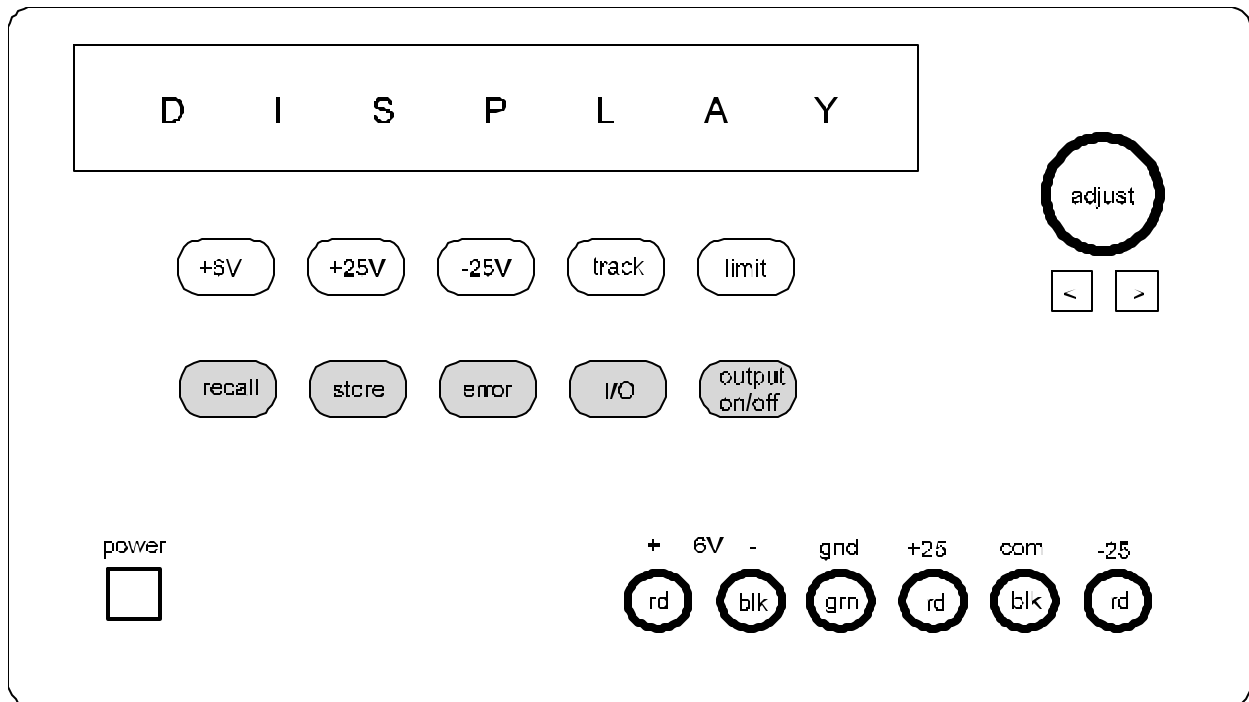
- 1) Orientation to laboratory power supply and function generator
- 2) Construct op-amp amplifier
- 3) Validate op-amp amplifier operation through measurement

### Deliverables

- 1) Input-output measurements on an inverting op-amp amplifier for i) 5kHz, 200 mV peak-to-peak sinusoidal input, ii) 1kHz, 100 mV peak-to-peak square-wave input, and iii) 2kHz, 150 mV peak-to-peak triangle-wave input.
- 2) Demonstration to instructor of these input-output characteristics.

### Procedure

- 1) Agilent E3631 triple power supply orientation



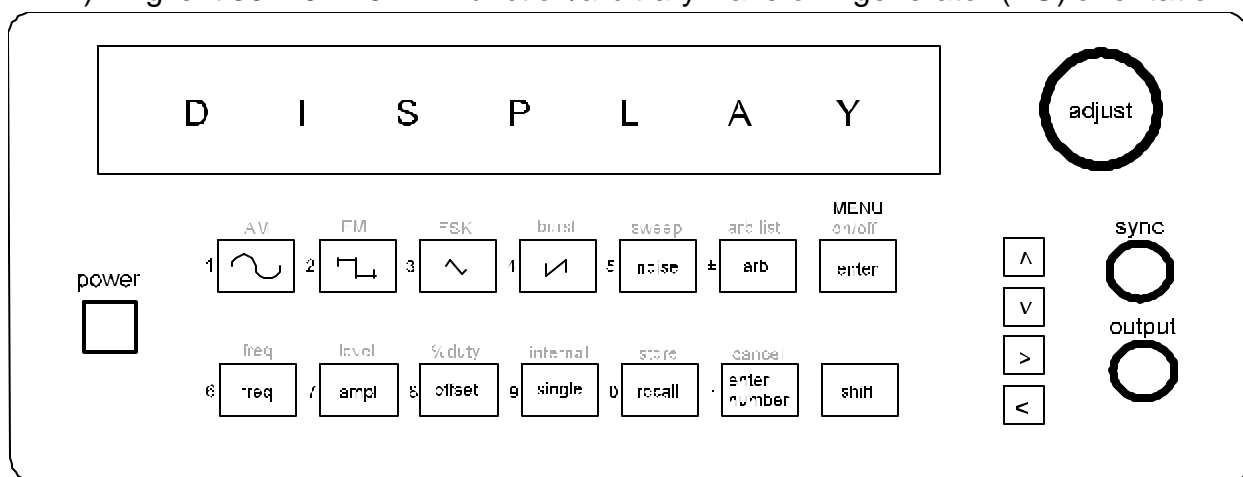
*Agilent E3631 triple power supply*

This supply has an adjustable 0 to +6V supply and a  $\pm$ dual supply adjustable from 0 to +25V and 0 to -25V (both referenced to the black common terminal).

Use the procedure below to obtain a dual  $\pm$ 15V supply to power the TL072 op-amp chip.

- 1) (cont.)
  - i) Press **Power**
  - ii) Select **+25V** (selects the 0 to +25V adjustable supply)
  - iii) Press **Output On/Off** (turns +25V supply on)
  - iv) Press **Track** until you here a beep. Track causes the 0 to -25V supply to be adjusted as the 0 to +25V supply is adjusted—that is, the -25V supply tracks the +25V supply. This is just what is needed with op-amp circuits.
  - v) Use adjust knob to 15V.
  - vi) Press **-25V** to confirm presence of -15V
  - vii) Turn power supply off

2) Agilent 33120A 15MHz function/arbitrary waveform generator (FG) orientation



*Agilent 33120A function/arbitrary function generator*

- i) There are two BNC (Bayonet Neill-Concelmann) connectors, the **sync** and the **output**. **Sync** always provides a square wave the same frequency as the **output**. **Output** can be adjusted in amplitude, shape, and frequency using the front panel push buttons.

The **output** will provide the input to our op-amp amplifier. Attach the BNC-to-microclip cable (red is +, black -) to this terminal.

- ii) Turn on FG by pressing **Power**. The output default is a 100mV peak-to-peak sinusoid at 1kHz.  
Press **Shift** then **MENU on/off**.  
Press **Ⓜ** three times to come to D: SYS MENU.  
Press **←** twice to come to PARAMETER: 50 OHM  
Press **Ⓜ** once to configure FG for HIGH Z termination.  
Press **Enter**.

iii) Press **Ampl**

Press  $\leftarrow$  and  $\textcircled{R}$  as required to highlight the “2” digit.

Adjust knob for amplitude of 2V peak-to-peak.

iii) Connect an oscilloscope probe to channel 1 of the oscilloscope and display the function generator **output** on channel 1 of the oscilloscope.

iv) OSCILLOSCOPE: Press **edge** (in trigger section) and choose channel 1. Press **mode/coupling** and choose normal. Adjust time (horizontal) and amplitude (vertical) scales. Adjust the reference position (ground). Adjust horizontal position of signal (adjust where time is zero).

Adjust trigger level and observe effect on oscilloscope display. Place level above the trace, and note the flashing **trig'd** on the screen. This means the display is no longer being updated and that the display is an old one.

v) Press FG green **Enter Number**.

Press **1** then  $-$  (green  $V_{pp}$ ) for 1V peak-to-peak.

Press green **Enter Number**.

Press **2** then for  $-$  (green rms) for  $2V_{rms}$  sinusoid (adjust OS amplitude scale)

iv) Press FG **Freq**.

Press  $\leftarrow$  and  $\textcircled{R}$  as required to highlight the “1” digit.

Adjust knob for frequency of 5 kHz. (observe OS display)

Press green **Enter Number**.

Press **100** then  $\textcircled{R}$  (Hz in green) for 100 Hz. (adjust OS time scale)

Press green **Enter Number** again.

Press **10** then  $-$  (green KHz) to adjust frequency to 10 KHz. (adjust scale)

Press  $\leftarrow$  and  $\textcircled{R}$  as required to highlight the “1” digit.

Adjust FG knob for frequency of 100 kHz. (adjust OS time scale)

iv) Press FG button with square wave on it for 1V peak-to-peak square wave.

Press **Ampl**.

Press green **Enter Number**.

Press **5** then  $-$  (green  $V_{pp}$ ) for 5 V peak-to-peak square wave

Press **Freq**

Press **Enter Number**

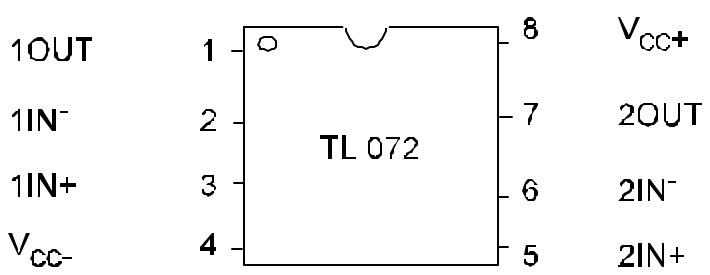
Press **1250** and  $\textcircled{R}$  (Hz in green) for 1.25 kHz, 5  $V_{pp}$  square wave.

v) Press FG button with triangle wave on it (next to square wave).  
Adjust amplitude and frequency for 4V peak-to-peak and 12 kHz.

vi) Turn function generator off.

3) Op-amp circuit.

i) The TL072 dual op-amp (that is, the chip has two op-amps—we use op-amp #1) comes in an eight-pin dual-inline package (DIP). It has eight pins as shown below.

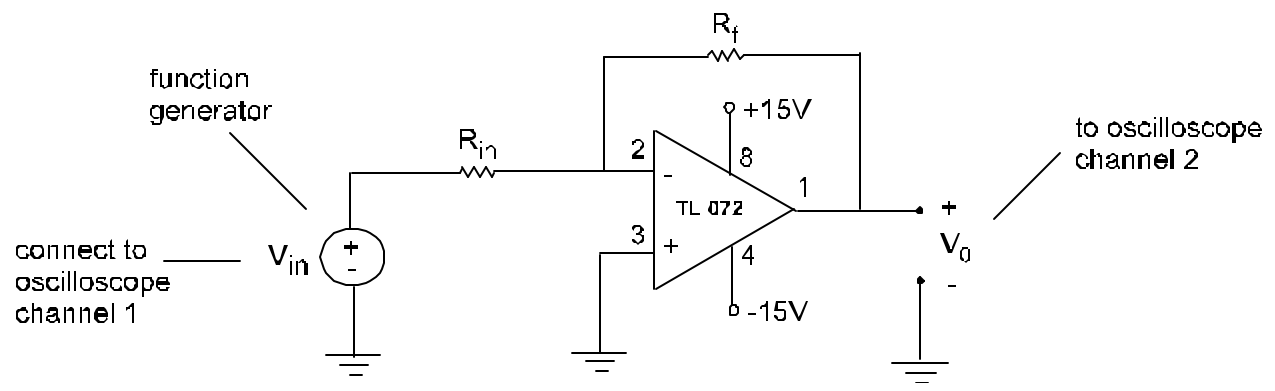


Top View  
Pin-Out for the TL072 Op-Amp

**Turn power supply and function generator off as you connect the op-amp circuit.**

ii) Connect +15 V at pin 8 and -15V to pin 4 to power the op-amp.

The 15V common is connected to function generator common at some point on the breadboard. **This point will be the common for the circuit.** For the inverting configuration the +input is connected to common.

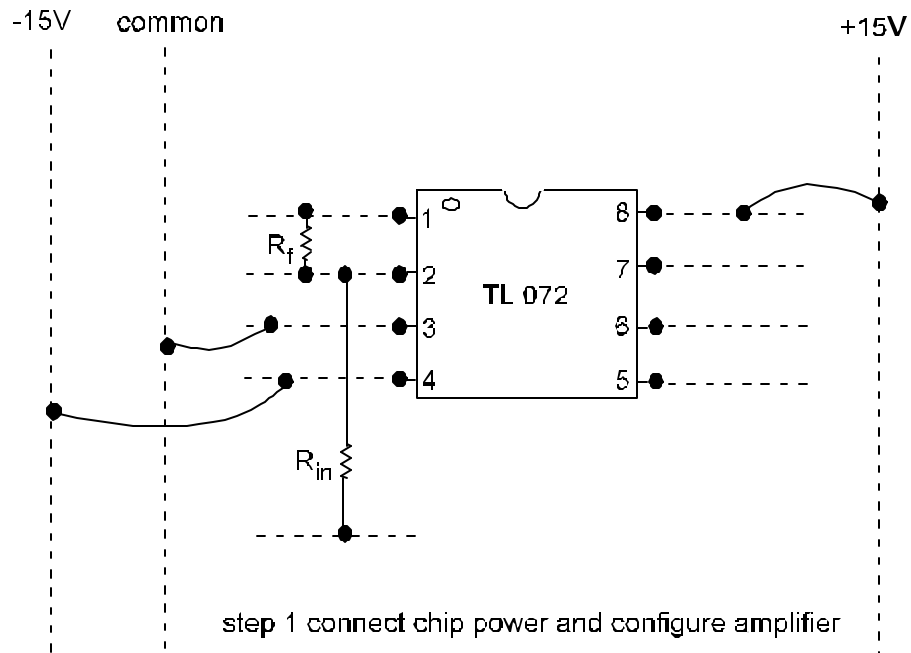


Choose  $R_{in} = 1 \text{ k}\Omega$  and  $R_f = 10 \text{ k}\Omega$  for  $\frac{V_o}{V_{in}} \cong -10$ .

Measure  $R_f$  and  $R_{in}$  with DMM.

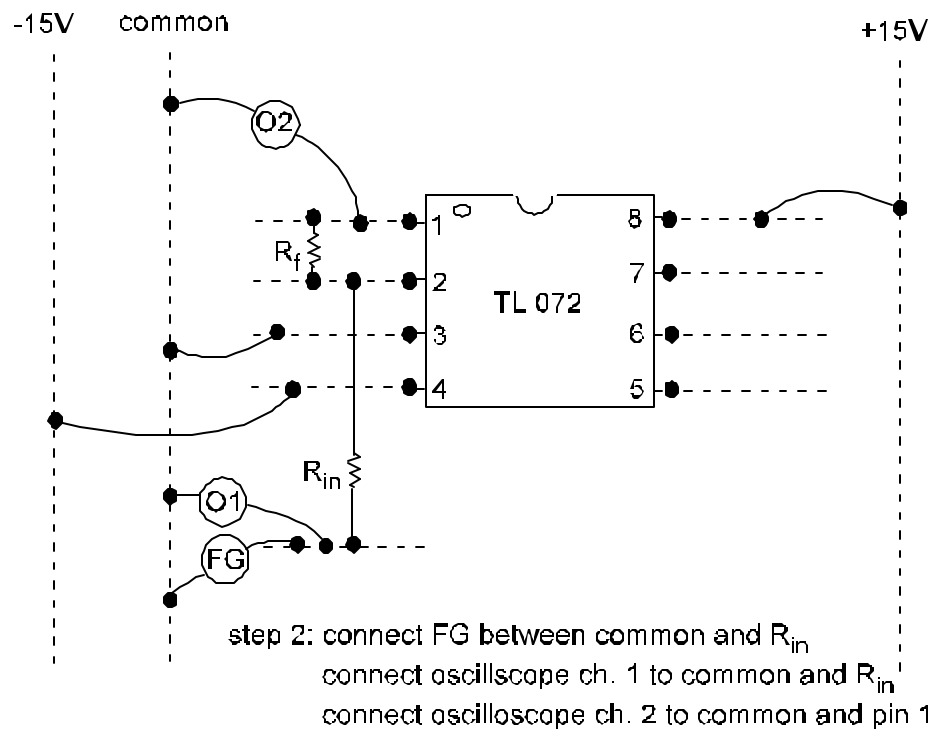
$R_{in} =$  \_\_\_\_\_       $R_f =$  \_\_\_\_\_

## iii) Circuit construction 1



DO NOT HAVE POWER SUPPLY ON  
WHEN CONNECTING THE CIRCUIT

## iv) Circuit construction 2



DO NOT HAVE EQUIPMENT ON  
WHEN CONNECTING THE CIRCUIT

- v) Turn on power supply. Configure  $\pm 15\text{V}$  supply as described in part 1)
- vi) Turn on FG and configure for HIGH Z input as describe in part 2)
- vii) Observe input-output relationship for the amplifier for three inputs i)5kHz, 400 mV peak-to-peak sinusoidal input, ii)1kHz, 600 mV peak-to-peak square-wave input, and iii)2kHz, 750 mV peak-to-peak triangle-wave input.
- viii) Demonstrate to the instructor that the circuit 1)is properly and neatly wired and 2)that the circuit functions properly.

**Instructor Signature** \_\_\_\_\_