## 7.1 OP experiments

The slew rate (SR) is defined as the maximum rate of change of the output of an op amp circuit. The SR in general describes the degradation effect on the high frequency response of the active amplifier (one with an op amp) near or at the rated maximum output voltage swing. This effect is generally due to the compensating capacitor and not to the transistor circuits internal to the op amp. In short, the SR effect is due to the maximum supplied current available for charging up the compensating capacitor.

The circuit in Figure 1 can be used to measure the slew rate of the operational amplifier uA741installed in the switching matrix on the stage.

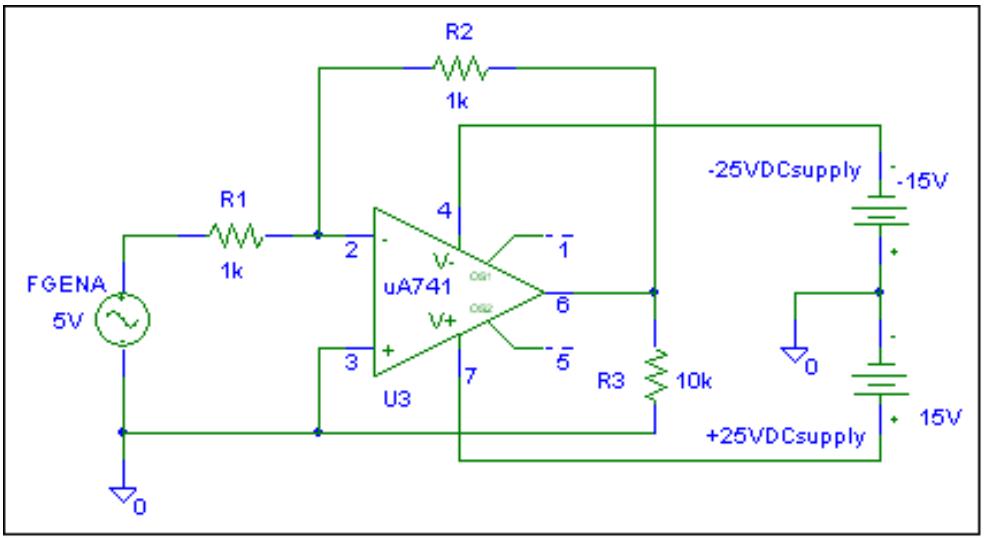


**Figure 1. Inverting op amp**

If you are unfamiliar with the solderless breadboard press the help button bottom left. Then wire the circuit as is shown in Figure 2. Students are encouraged to download the instrument manuals from the manufacturer's home page but in this session we have no internet connection. Short hints are given in the Figures.

1. Set the power supply to +15 V and –15 V.
2. The default frequency of the function generator is 1000 Hz. Do not change the frequency but set the generator to square wave and to 5 Vpp. Please note that the voltage displayed is the voltage the generator would feed into a 50 ohm load. The load is here 10k and the output will approximately 10 V.
3. Set the oscilloscope and press the *Perform Experiment* button to send your circuit and your instrument settings to the server.

Slew rate …….. V/us

Typical slew rate for a uA741 amplifier is 0.5 V/us

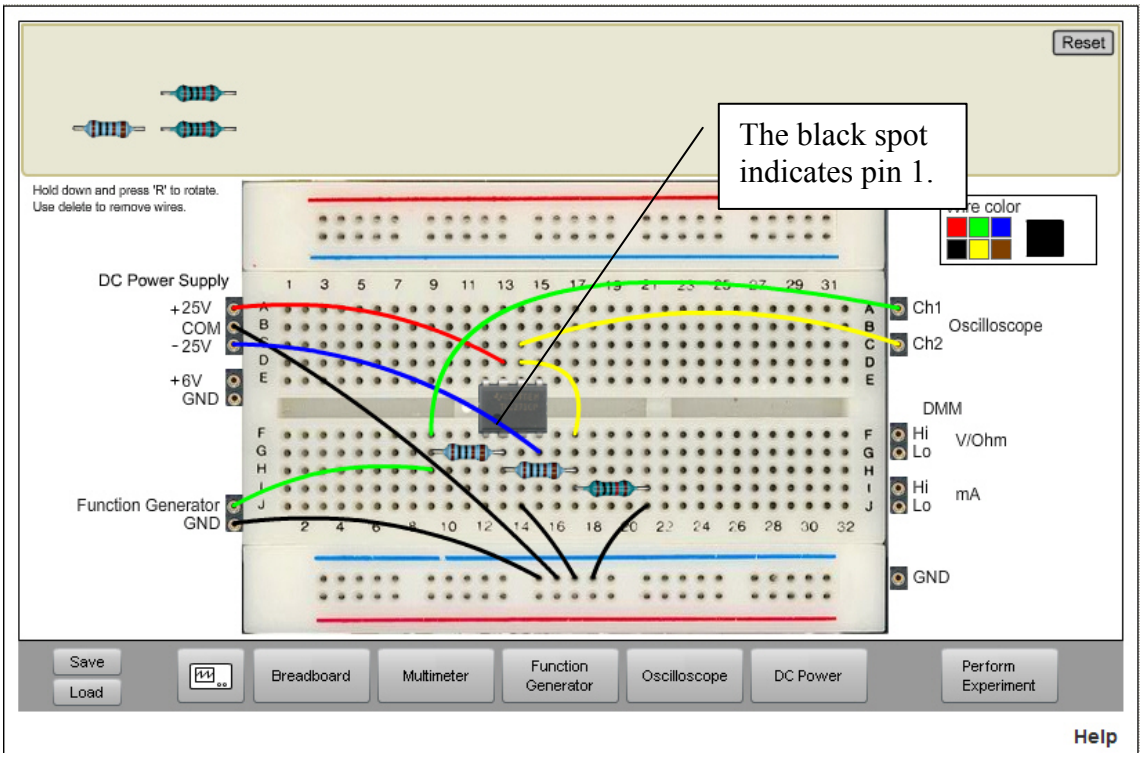


**Figure 2 The inverting op amp circuit wired on the solderless breadboard**

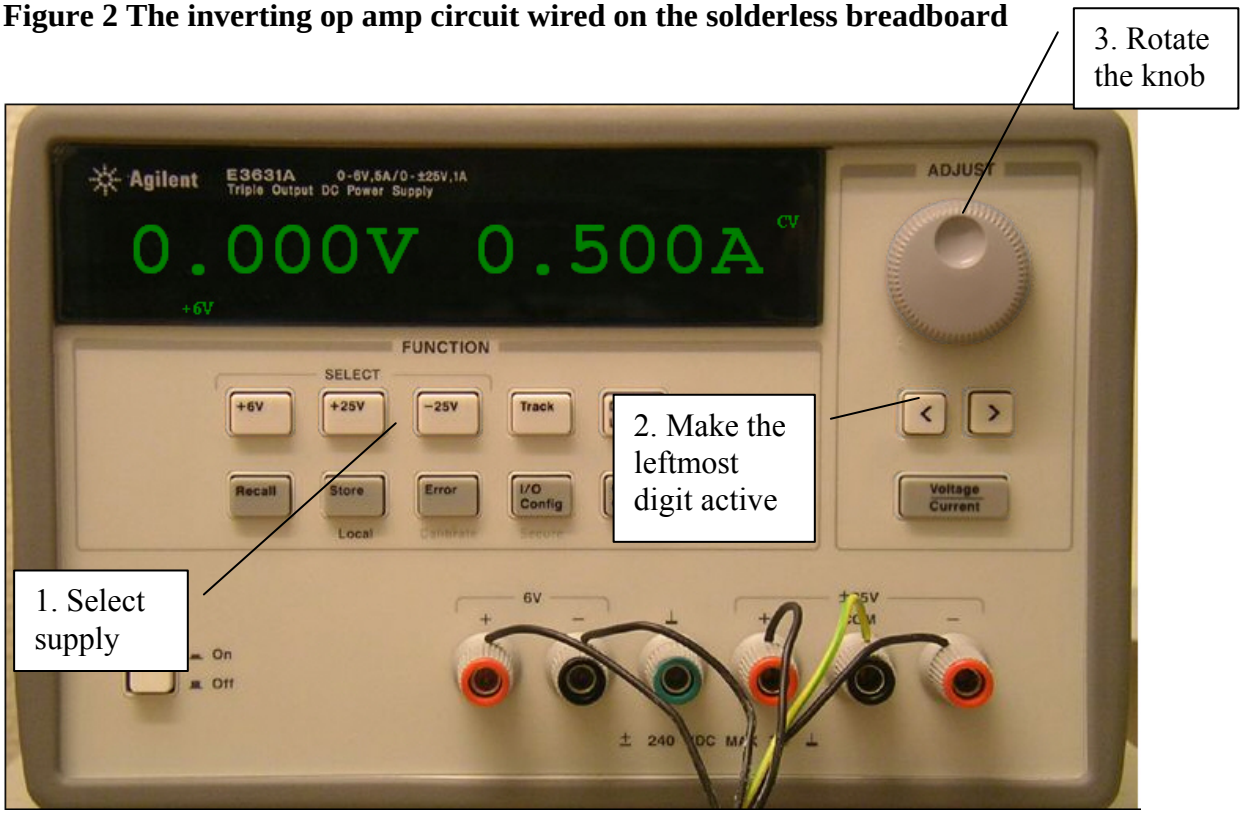


**Figure 3. Setup of +15 V and – 15 V**

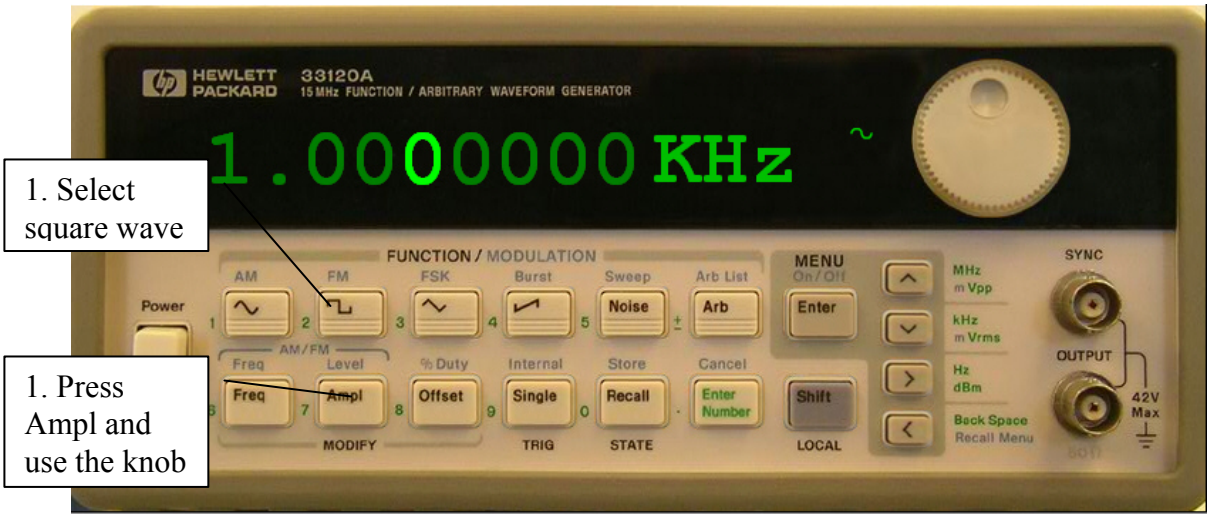


**Figure 4. Function Generator**

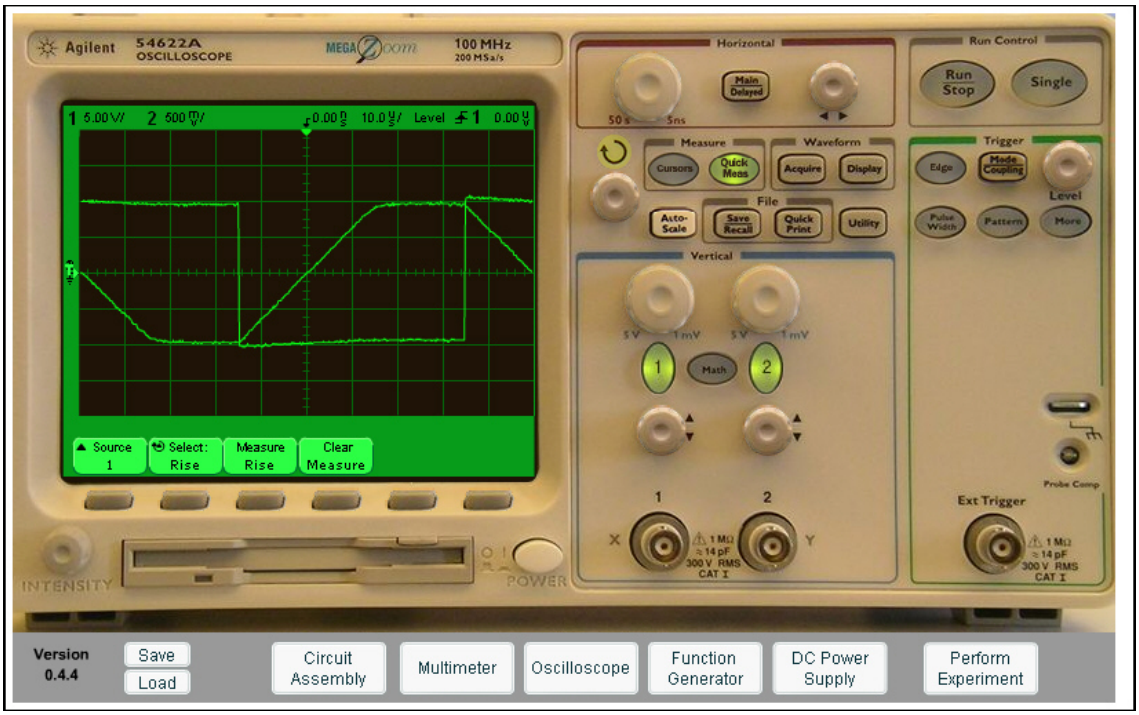


**Figure 5. Oscilloscope**

## 7.2 The virtual instructor allows more experiments

The teacher sets the limits for the experimentation to avoid damaged or destroyed components and instruments. In the laboratory there is a virtual instructor checking every circuit before the sources are switched on. The teacher creates the rules for the virtual instructor. If there are no such rules no experiments will be permitted. The teacher defines all loops permitted and the maximum voltages of the sources.

Figure 6 shows all the loops permitted to be created in the switching matrix in this session. The circuit in Figure 6 would be created if the relays connecting the sources and the components provided in this session were energized. These closed relay switches are omitted in the diagram. In the circuit there are seven nodes denoted A – D and F and G. In the Figure there are other special relay switches, conditional jumpers

(JUMPER_LEAD), used to connect nodes to each other. For example, the +25 V DC power supply is connected to the hardware auxiliary node X2 but can also be connected to the hardware node F by a jumper. For example, if a wire from the + 25 V DC supply to pin 7 of the op amp is wired on the breadboard the jumper connecting node F to aux node X2 would be installed. The configuration In Figure 6 supports both inverting circuits and non-inverting ones.

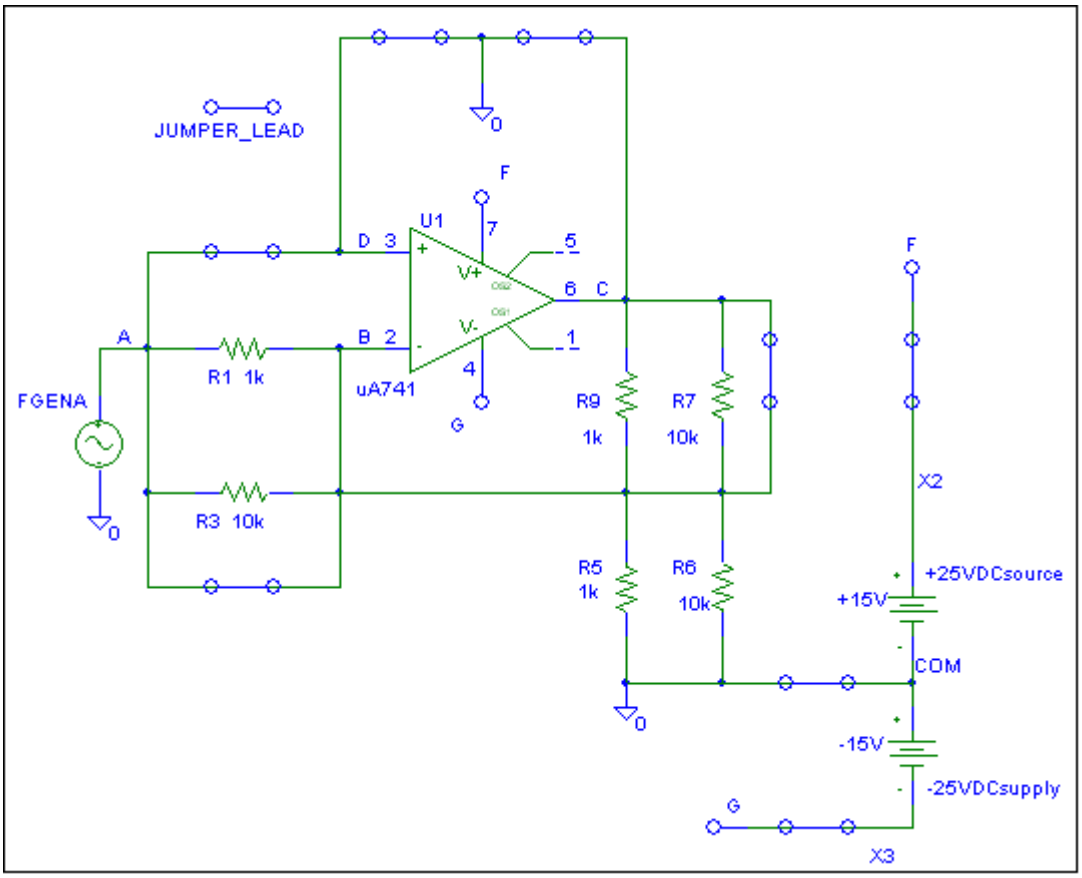


**Figure 6. Permitted loops**

## 7.3 Bill of materials

| | | |
|---|---|---|
| 1. | Operational amplifier | uA741 |
| 2. | R1, R5, R9 | 1 kΩ |
| 3. | R3, R6, R7 | 10 kΩ |
| 4. | Triple power supply | |
| 5. | Function generator | |
| 6. | Oscilloscope | |