Single Supply Op Amps

When working with a unipolar (0-Vcc, as opposed to bipolar +/-Vcc) supply, certain design considerations must be made. For instance, the 411 is no longer a viable choice for an op-amp. Recall that the ouptut of the 411 only gets within about 1.5 volts of the power supply (and this can be as much as 3 volts). If we were to power this chip by 0 and 5 volts this would only allow us to have outputs from about 1.5 to 3.5 volts (and it might not even work if we got a chip that only got within 3 volts of the supply voltage).

We also have to worry about the fact that we cannot generate negative outputs.

There are several techniques for dealing with this.

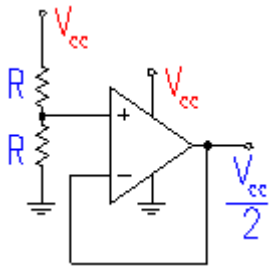
RAIL-TO-RAIL OP AMPS

When doing single supply design it is common to use what are called rail to rail op amps. These amplifiers can output voltage very near the power supply voltages (or rails). You have already seen an example of one such amplifier, the LM324, whose output can go almost to the negative rail (ground), but still can't get close to the positive rail (Vcc). If you do you design carefully, you could use a 324 in this lab. It has the advantage of being quite cheap.

Another option is to use an op amp that goes near both supply rails. These tend to be much more expensive, but easier to work with. In the lab you will find two rail to rail op amps from Texas Instruments. the TLCV2772, and the TLC2774. The op amps on the chips are identical - the 2772 is an 8 pin DIP with 2 amplifiers, the 2774 is a 14 pin DIP with 4 amplifiers.

VIRTUAL GROUND

To cope with the problem of not being able to generate negative voltages, a virtual ground is used. The virtual ground is simply a voltage reference that is typically half way between Vcc and ground. One way of generating a virtual ground is shown below. The two resistors form a voltage divider so that Vcc/2 appears at the non-inverting input of the op amp. Since it is set up as a follower, Vcc/2 also appears at the output, as shown.

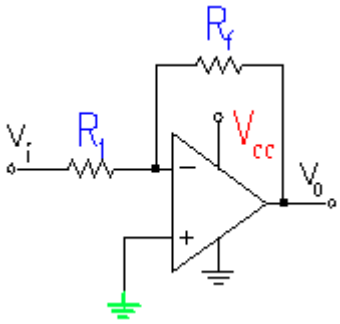
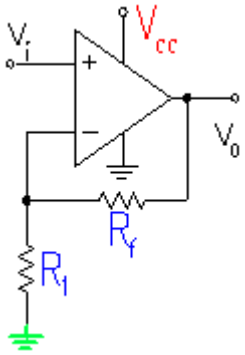


An easier way to do this is to use a virtual ground circuit, such as the TLE2426 virtual ground (the "Rail Splitter") from Texas Instruments. It generates an output precisely midway between the two supply rails, has noise reducing circuitry and can source and sink about 20 mA. You can also find these in the lab.

Considerations when using a virtual ground.

The virtual ground can now be used just like a normal ground in your circuit, but you have to remember that the virtual ground has limited output current. For this reason it is usually advisable to use the op-amp in its inverting configuration (which requires no ground current), rather than the non-inverting configuration (which requires ground current). However, as long as you are careful not to exceed the manufacturer's specifications on maximum current from the virtual ground, you can use either.

In the diagrams below, virtual ground is depicted by a green symbol with thick lines, ground by a black symbol.

Inverting Amplifier (Virtual ground current = 0)	**Non-inverting Amplifier** (Virtual ground current != 0)
	
Virtual Ground  Physical Ground 	

MORE INFORMATION

If you want more information you can read various application notes:

- Using Single Supply Operational Amplifiers - from Microchip.
- Designing Single Supply, Low-Power Systems - from Analog Devices.
- Designing Circuits for Single Supply Operation - from Linear Technology.
- Single Supply Design - from TI
- Design Trade-Offs for Single-Supply Op Amps - from the Maxim website..
