

## SWOP AMPS SIMPLIFY RF SIGNAL PROCESSING

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When designing high performance systems for RF and video applications requiring amplifiers, multiplexers, or programmable gain amplifiers, finding the right components to do the job is not simple. A pair of SWOP amps from Burr-Brown, the OPA675 and OPA676, open the door to high speed without the headaches. These devices are true operational amplifiers with a built-in switchable front end, hence the name SWOP amp, for switchable input OP amp. The resulting integrated circuit functions as a fast settling wideband op amp with a DPDT switch on the two input pins. Using a SWOP amp makes it easy to switch from one channel to another in nanoseconds.

Figure 1 shows the OPA676 multiplexing two input signals into a single output. The gain for each channel is set by external feedback resistors according to standard op amp design techniques. The inverting input pins for both input stages are connected to the same feedback network, guaranteeing that the gains will be identical for both channels without requiring precision matched resistors.

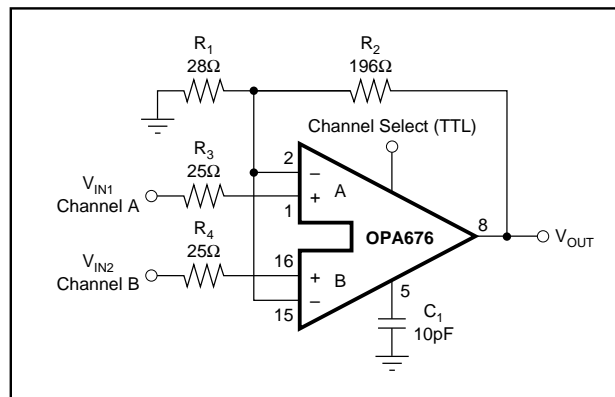


FIGURE 1. Two-Input Multiplexer with a Gain of +8V/V for Each Channel. Gain is identical for each channel without precision resistors. Bandwidth is greater than 100MHz.

Either channel may be configured as inverting or noninverting. If different gains are desired for the two channels, separate feedback networks may be used as shown in Figure 2. Note that the compensation node is common to both channels. The capacitor must be large enough to make the channel with the lowest gain stable. For this reason, channel B in Figure 2 has  $R_7$  added across the inputs to make

the noise gain equal to +10V/V, although the signal gain is +2V/V. This allows the SWOP amp to be compensated with 6.5pF for a gain of +10V/V, instead of the 35pF that would be required for a gain of +2V/V. The noise gain calculation is:

$$\text{Noise Gain}_{\text{CHANNEL B}} = 1 + R_6 / (R_5 \parallel R_7)$$

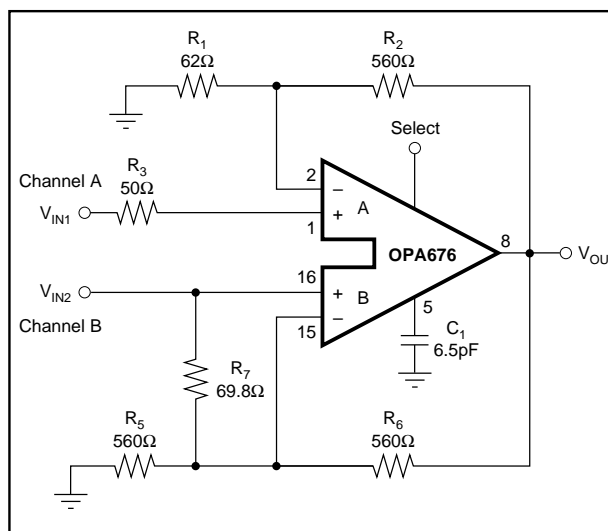


FIGURE 2. SWOP amp with a Gain of +10V/V for Channel A. Gain of +2V/V for channel B. Connecting both inputs together yields a programmable gain amplifier.

By selecting different gains for each channel and connecting the inputs together, a programmable gain amplifier is realized. The selectable input amplifier can also function as a gated amplifier, for noise blanking with RF signals, or a return to zero deglitcher for digital-to-analog converters. Filtering may be added to any of the circuits shown here, using standard op amp filter designs.

Figure 3 shows a four channel MUX made with three SWOP amps. The circuit for each amplifier is shown in Figure 1 with SWOP amps  $A_1$  and  $A_2$  used to MUX the four channels into two.

$A_3$  performs the final multiplexing down to one output channel. The circuit uses two bits for channel select, as shown in the table in Figure 3. The second bit selects

channel A or B on amplifier  $A_1$  and channel C or D on amplifier  $A_2$ . The first bit selects side A or B on amplifier  $A_3$ , which selects the output of amplifier  $A_1$  or amplifier  $A_2$ , respectively.

Using regular operational amplifier design techniques, any of the four channels may be configured for any inverting or noninverting gain. Note that the SWOP amp is optimized for gains greater than 2. Filtering can also be added to one or more channels. When selecting the compensation capacitor for the three amplifiers, several things should be considered for optimum performance. Split up the gain for each channel evenly between the first bank of SWOP amps

( $A_1$  and  $A_2$ ) and  $A_3$ . This allows all the amplifiers to be compensated for maximum bandwidth. For a wide range of gains, try to group high gains on  $A_1$  and low gains on  $A_2$ . This allows  $A_1$  to be compensated lightly for the high gains, maximizing bandwidth.

Another technique for optimizing the bandwidth for different gains is to make a low-gain channel by placing the first SWOP amp in a gain of 8 to 12 and preceding it with an attenuator. This will degrade SNR, since the input signal is attenuated before it is added to the first SWOP amp's noise. This is usually not a problem because the SWOP amp exhibits only  $2.3\text{nV}/\sqrt{\text{Hz}}$  input noise.

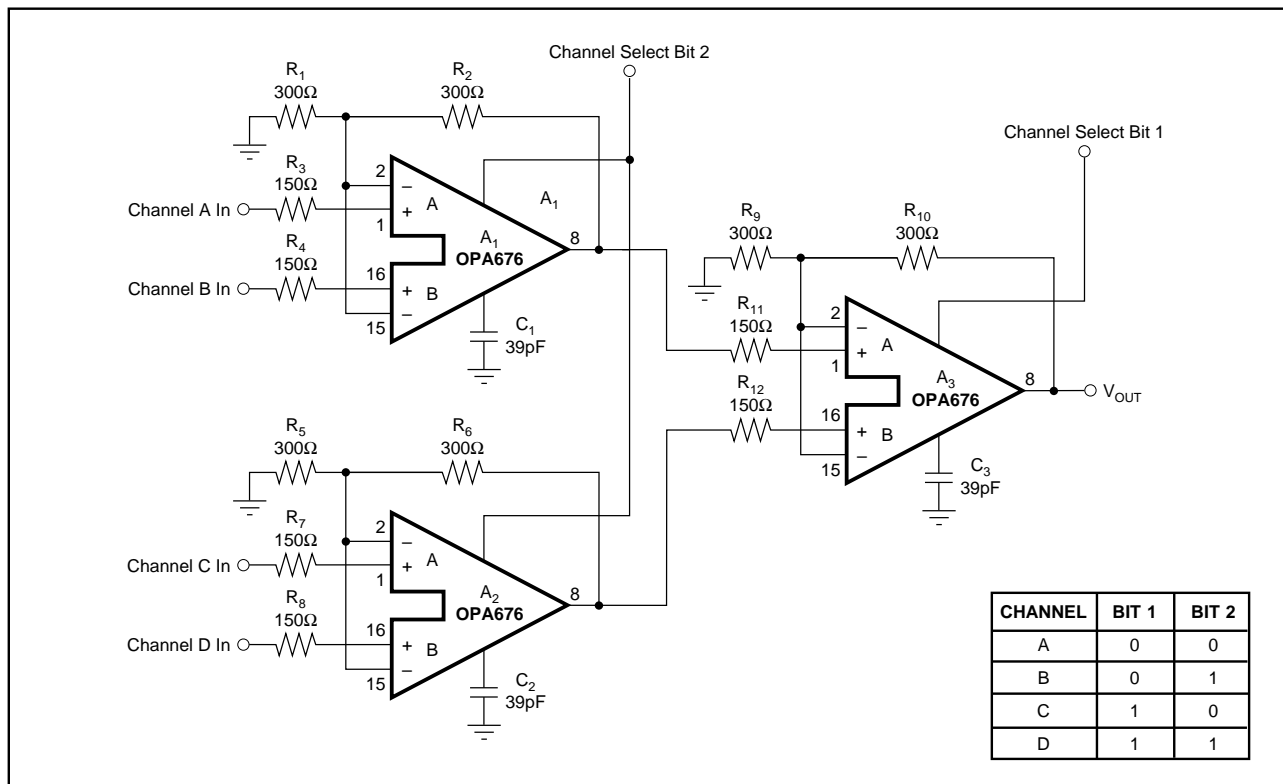


FIGURE 3. A Fast, Four-input Multiplexer Using Three SWOP amps.  $V_{OUT} = 4 \cdot V_{IN}$  for the selected channel. Bandwidth is 70MHz.

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