BURR - BROWN® APPLICATION BULLETIN
Mailing Address: PO Box 11400 • Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd. • Tucson, AZ 85706
Tel: (602) 746-1111 • Twx: 910-952-111 • Telex: 066-6491 • FAX (602) 889-1510 • Immediate Product Info: (800) 548-6132

BUILD A THREE PHASE SINE WAVE GENERATOR WITH THE UAF42

By Johnnie Molina (602) 746-7592

Figure 1 shows how a three phase sine wave oscillator can be built using one UAF42 state variable filter along with some resistors and diodes. Three output nodes are available; highpass out, bandpass out and lowpass out. The signal at the bandpass and lowpass out nodes are 90° and 180° out of phase, respectively, with the highpass out node. An on-chip auxiliary op amp is available for use as a buffer or gain stage.

SETTING THE FREQUENCY OF OSCILLATION

The frequency of oscillation is set with resistors R_{F1} and R_{F2} using Equation 1.

$$f_{OSC} = \frac{1}{2\pi RC} \tag{1}$$

Where,

$R = R_{F1} = R_{F2}$

$C = C_1 = C_2 = 1000pF$

The max f_{OSC} obtainable using the UAF42 state variable filter is 100kHz. Distortion becomes a factor though for frequencies above 10kHz. For low frequencies of oscillation (f_{OSC} < 100Hz), the use of external capacitors is recommended. They should be placed in parallel with the internally supplied C_1 and C_2 capacitors. This will reduce the

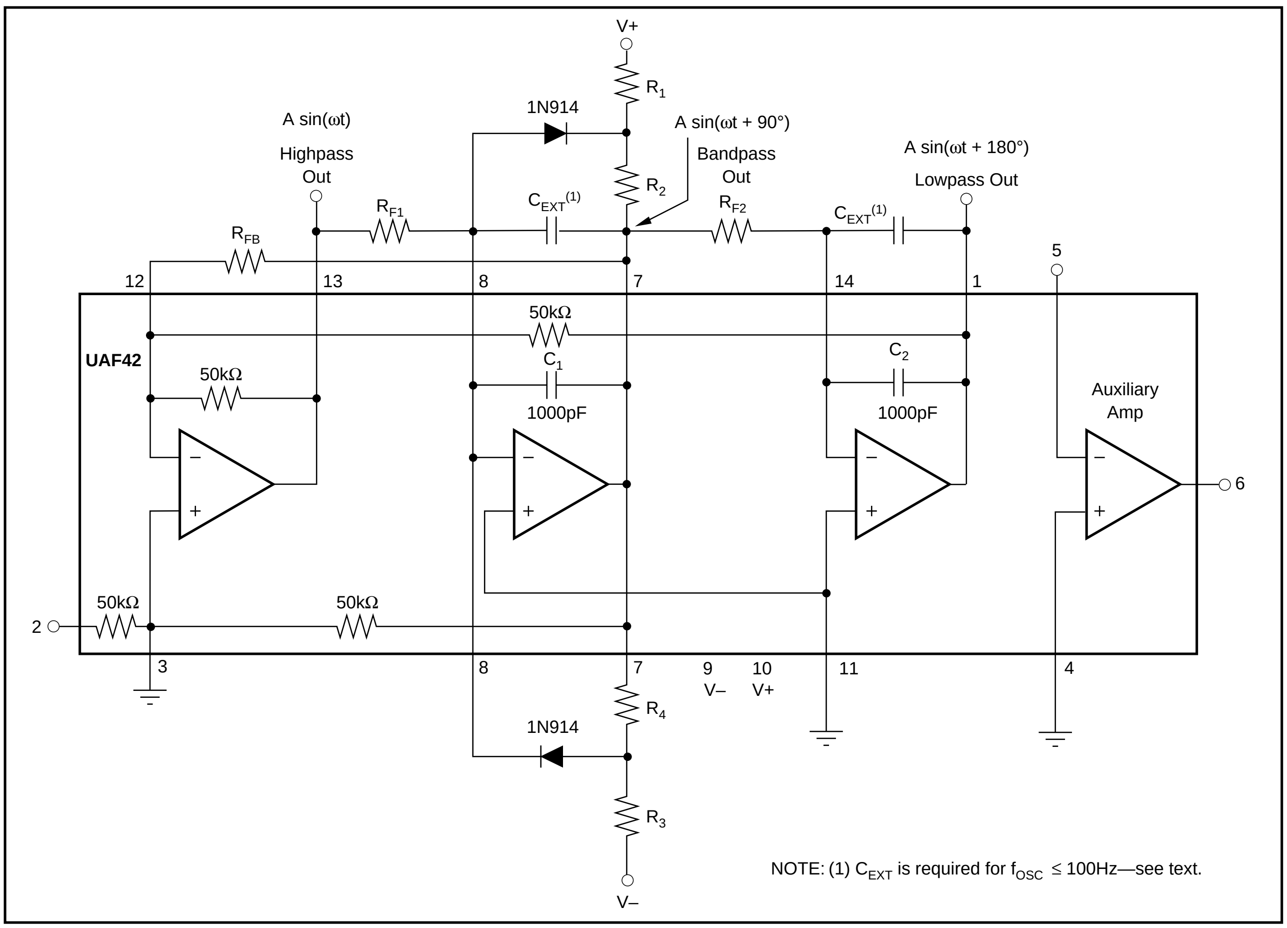

FIGURE 1. Three Phase Quadrature Oscillator.

value of frequency setting resistors R_{F1} and R_{F2} which can exceed tens of megaohms for low frequency oscillator designs. An NPO ceramic or mica capacitor is recommended. The value used for C in Equation 1 should be the sum of both the external and on-chip 0.5% 1000pF capacitor.

SETTING THE SIGNAL MAGNITUDE

Resistors R_1, R_2, R_3 and R_4 should be selected using Equation 2 to set the desired signal amplitude.

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} = \frac{V_O + V_{SUPPLY}}{V_O - 0.15} - 1 \qquad (2)$$

Actual signal amplitude may vary somewhat from the designed for value. This is due to the non-ideal characteristics of the diodes and op amps. Some gain adjustment on the R_1/R_2 and R_3/R_4 ratios, or the auxiliary op amp gain stage (if used), may be required.

START UP

Resistor R_{FB} provides a positive feedback path from the bandpass out node to the summing amplifier input. This provides the necessary "start up" required to begin oscillation. Suggested values are shown in Table I below.

f_{OSC}	R_{FB}
≥ 1kHz	10MΩ
10Hz to 1kHz	5MΩ
< 10Hz	750kΩ

TABLE I.

Note that resistor R_{FB} influences the signal magnitude since it introduces positive feedback in the first integrator/summing amplifier loop. Using smaller values than those suggested above may increase the signal amplitude and introduce distortion. The time required to begin oscillation is proportional to the frequency of oscillation. Low frequency designs can be started quickly by switching in a 1kΩ resistor in parallel with R_{FB} at turn on and then switching it out.

Example:

To design a 1kHz, 1.4V peak oscillator, use Equation 1 to calculate the value of frequency setting resistors R_{F1} and R_{F2}.

$$R_{F1} = R_{F2} = \frac{1}{2\pi \, 1\text{kHz} \left(10^{-9}\right)} = 159.2\,\text{k}\Omega$$

Use Equation 2 to determine values for signal magnitude setting resistors R_1, R_2 and R_3, R_4.

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} = \frac{V_O + V_{CC}}{V_O - 0.15} - 1$$

Assuming V_{SUPPLY} = 15V,

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} = 12.1$$

Setting R_1 and R_3 equal to 12.1kΩ and R_2 and R_4 equal to 1kΩ provides the proper resistor ratios. Note that these resistors act as loads to the internal op amp. The maximum load current for the UAF42 is 10mA. Table I indicates that R_{FB} should be a 10MΩ resistor.