BUILD A THREE PHASE SINE WAVE GENERATOR
WITH THE UAF42

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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.

\[
f_{OSC} = \frac{1}{2\pi RC}
\]

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

![Diagram of Three Phase Quadrature Oscillator](image-url)
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.

\[
\frac{R_1}{R_2} = \frac{R_3}{R_4} = \frac{V_O + V_{SUPPLY}}{V_O - 0.15} - 1
\]

(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.

<table>
<thead>
<tr>
<th>( f_{osc} )</th>
<th>( R_{FB} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \geq 1kHz )</td>
<td>10MΩ</td>
</tr>
<tr>
<td>10Hz to 1kHz</td>
<td>5MΩ</td>
</tr>
<tr>
<td>&lt; 10Hz</td>
<td>750kΩ</td>
</tr>
</tbody>
</table>

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 \( R_{F2} \).

\[
R_{F1} = R_{F2} = \frac{1}{2 \pi f_{osc} \left(10^{-3}\right)} = 159.2kΩ
\]

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

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

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.
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