Synchronous oscillator converts audio, video to FM

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The synchronous oscillator (SO) and the coherent phase-locked synchronous oscillator (CPSO) are universal multifunctional networks that track, synchronize, and amplify as much as 80 dB; improve SNR by as much as 70 dB; and modulate AM, FM, and FSK signals. You can also use these networks as ADCs, sampling networks, and dividers that divide by rational integer numbers, such as 3/4, 5/7, and 7/8. Suitable applications include wideband spread-spectrum communications and binary-phase-shift-keying (BPSK) and quadrature-phase-shift-keying (QPSK) generation. A CPSO retains all the properties of the SO and provides zero phase error.

One SO application area is the conversion of audio and video to FM in a single process. Figure 1a shows a simple, one-stage SO oscillating at 94 MHz. This frequency is a good choice for testing the audio-to-FM conversion on an FM broadcast receiver. The audio or video input to this SO should not exceed –5 dBm; any signal above this level may induce amplitude modulation. C₄'s decoupling capacitor passes the audio or video to the SO and eliminates dc bias at the input. R₁ biases the SO.

Because the oscillator's load is a combination of resistance, inductance, and capacitance, the load line is a combination of a straight line and an ellipse (Figure 1b). The linear load line indicates the dc bias, and you must locate the load line away from the nonlinear characteristics of the transistor.

C₃ and the connection between points A and B each provide positive feedback. High positive feedback is essential to the optimum operation of the SO. The value of C₃ should range from 2000 to 5000 pF. Rₚ in parallel with C₅ has numerous functions. The presence of this network allows positive feedback within the SO, but looking from the input, Rₚ and C₅ also provide negative feedback. This negative feedback adds frequency stability. Finally, Rₚ and C₅ divert the input audio or video to the oscillator, not to ground. Rₚ and C₅ are approximately 15W and 20 pF, respectively, and these values depend on the of the transistor. L₂ is an RF choke that diverts the collector feedback to the base of the transistor. You should tune the tank circuit, which comprises L₁, C₁, and C₂, to approximately 95 MHz to be within the FM broadcast band. A 2N5031 for Q₁ works well for this application because it has high gain and low noise; any other transistor with the same characteristics is suitable. A 2- or 3-in. long wire attaches to the output and acts as an antenna.

The conversion from audio or video to FM takes place in the internal base-emitter junction capacitor by its parametric action, and the changes of the junction capacitor due to audio-to-video variations modulates the oscillations to provide an audio- or video-to-FM conversion.

The SO also has high input-signal sensitivity and high noise rejection. It can detect signals as low as –100 dBm and signals with SNRs as low as –40 dB. For a PLL, these performance numbers are –25
dBm and 3 dB, respectively. The SO is frequency-stable and has low phase jitter because the tank circuit has a high Q that can reach $3 \times 10^6$. The SO has three independent internal filters. With a 200-Hz noise-rejection filter, the SO exhibits a data bandwidth or tracking range of several megahertz. For input signals with high noise, a two-transistor cascoded SO is preferable.

The output buffer, $Q_2$, provides protection between the oscillator and the output world. However, if you want to simplify the circuit, you can remove $Q_2$ and its 1.2-kW pullup resistor and connect the 100-pF capacitor at the output directly to Point C. (DI #2379)