Application Note

OPERATING A QUADRATURE MODULATOR AS AN FSK MODULATOR

A linear quadrature modulator is a generic modulator, with capabilities for many types of RF modulation. Obviously, QPSK is simplest to implement, simply by driving the I and Q ports with independent data signals, one can generate QPSK. GMSK is also obtainable by shaping the data signals prior to modulation. This note describes how to obtain FSK modulation using a quadrature modulator with very few external components.

Figure 1 shows a typical block diagram for deriving FSK modulation from the RF2402 quadrature modulator.

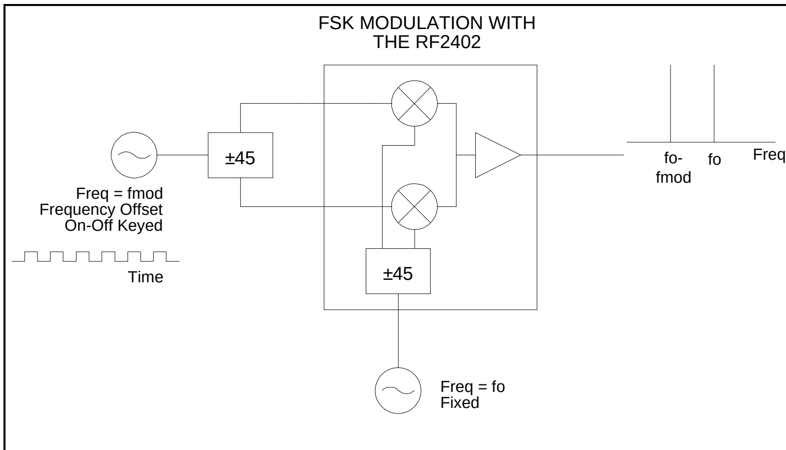

Figure 1

Use of RF2402 Quadrature Modulator for FSK Modulation using analog (OOK) input

The I/Q inputs are driven by a low-frequency oscillator, set at at the frequency offset f_{mod}, generally a few kHz to a few MHz. The output of the oscillator is split into quadrature components and applied to the modulator, thus generating a single-sideband output at the frequency f_o-f_{mod} (or f_o+f_{mod},depending on the phase relationship of I and Q inputs).

The LO is applied as a fixed-frequency oscillator at one of the desired output frequencies f_o (corresponding to data input “0”). Note that for this case, the I/Q signal inputs need a DC offset relative to the I/Q reference ports to achieve carrier feedthrough.

Now the low-frequency oscillator may be OOK (On-Off Keyed) to toggle between the fixed frequency f_o and the modulated frequency f_o-f_{mod}. This essentially toggles the modulator between SSB mode and carrier feedthrough mode.

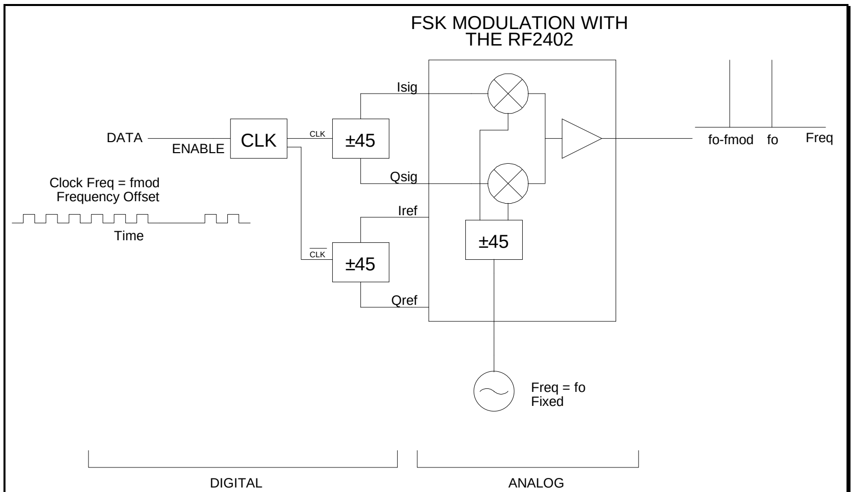

Figure 2

Use of RF2402 Quadrature Modulator for FSK Modulation using digital input

A second method, which uses all digital modulation and phase shifting, is shown in Fig. 2. This method may be more convenient if the digital section is flexible.

Using this technique, the I/Q signal ports again must be DC offset relative to the I/Q reference ports during the f_o modulation state. Otherwise, the carrier will be suppressed, in this case undesirably. The ±45° phase splitter can be implemented digitally as shown in Fig. 3.

A simpler way to shift the frequency using the digital technique shown in Fig. 2 is to alternate the I/Q-channel relationship: first let I lead Q, then vice-versa. This has the effect of alternating sidebands selected at the output. Thus, the carrier is always suppressed and the sideband merely shifts from one side to the other, as shown in Fig. 4. This can be done by inverting the phase to each of the T inputs shown in Fig. 3. Note that in this case the frequency f_{mod} referred to in Fig. 4 is ½ the frequency offset needed for FSK.

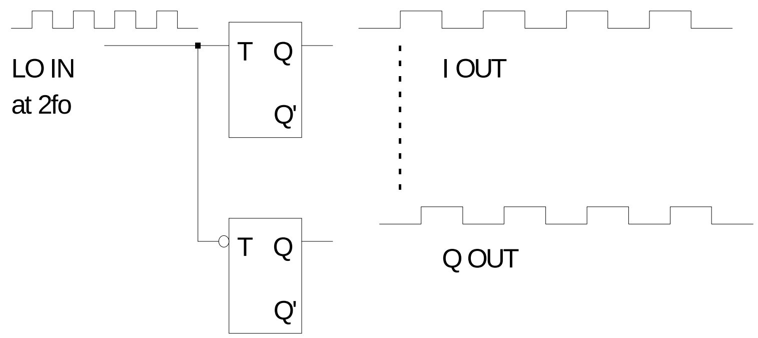

Figure 3

Digital phase shifter using T flip-flops

Summary

The quadrature modulator is an extremely versatile component, able to provide most any type of RF modulation. This note has illustrated several very simple techniques to use this modulator for FSK, both digital and analog. The RF2402, operating at 800-1000 MHz, is one of many modulators in RF Micro Devices' lineup; for modulation at higher frequencies, the RF2422 provides the same direct modulation from 0.9-2.5 GHz.

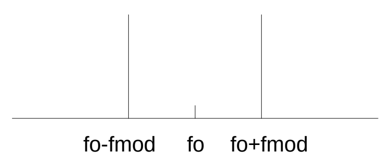

Figure 4

FSK output when alternating phase of I and Q inputs