Mark/space modulator drives acoustic coupler

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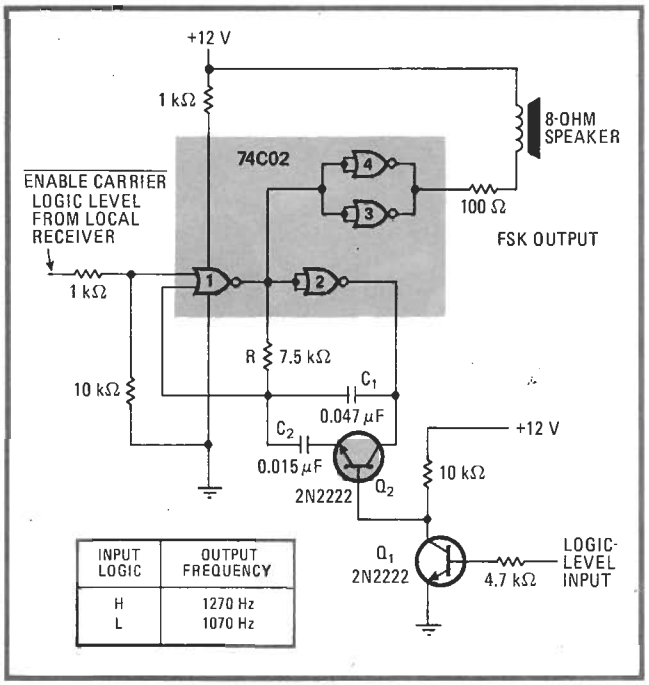
When data must be transmitted over a voice channel, the circuitry used to translate the logic lows and highs into audio-frequency signals usually includes frequency-trimming potentiometers. But precise enough mark and space audio signals can be obtained from a circuit that uses only standard resistor and capacitor values, provided the supply voltage is well-regulated.

The circuit shown translates serial logic-level data into audio-frequency analog frequency-shift-keyed signals for transmission by telephone, radio, or other voice channels. The modulation function, including provision for a logic-level data input and an active-low enable-carrier input, is implemented with a single complementary-MOS 74C02 quad NOR gate. The output buffer, which consists of gates 3 and 4 of the integrated circuit, has four n-channel transistors paralleled to ground for driving an 8-ohm speaker. The speaker provides acoustic coupling to a telephone handset.

Logic low at the data input turns off transistor Q_1 and turns on transistor Q_2. With Q_2 on, C_2 is switched into the circuit. The frequency of the audio oscillator, made from gates 1 and 2 of the integrated circuit, is proportional to $1/RC$ where $C = C_1 + C_2$. Switching C_2 into the circuit causes the output frequency to shift from K/RC_1 to $K/R(C_1+C_2)$ where K is a constant. With the component values shown, $K/RC_1 = 1{,}269$ hertz, and $K/R(C_1+C_2) = 1{,}052$ Hz. These frequencies have been found to be sufficiently close to the specified 1,270-Hz mark frequency and 1,070-Hz space frequency for reliable transmission at a data rate of 110 bits per second to a Bell 103 dataset.

The circuit draws about 30 milliamperes from a regulated 12-volt supply. With appropriate changes in the values of components R, C_1, and C_2, supply voltages from 6 to 15 V can be used.

The enable-carrier input to the modulator is driven from a companion receiver circuit to complete the "handshake" sequence at the beginning of a data call; that is, the local receiver asserts the active-low enable



FSK modulator. C-MOS quad NOR gate is audio-signal generator and output driver/buffer for transmitting data over voice channel by frequency-shift-keyed audio signals. The logic-level enable-carrier input must be taken low for the modulator to operate; this input is driven by the local receiver and is used to properly sequence the initial exchange of signals called "handshaking." The enable carrier should be taken low about half a second after the dataset at the other end of the line answers the call with its 2,225-Hz marking tone.

carrier shortly after it first hears the 2,225-Hz marking tone coming from the dataset at the other end of the phone line.

Bell 103 line protocol calls for frequency-division-multiplexed simultaneous two-way transmission. The modem originating the call sends 1,270-Hz mark and 1,070-Hz space frequencies and receives 2,225-Hz mark and 2,025-Hz space frequencies from the answering dataset. At the beginning of the call, the answering dataset immediately places its 2,225-Hz mark signal on the line. On a long-distance call, this tone should be allowed to reside alone on the line for at least 400 milliseconds to disable any one-way-at-a-time devices (echo suppressors) on the telephone trunk lines. □