BUILD THIS POCSAG SIGNAL GENERATOR

Generate pager signals with this simple interface and computer program.

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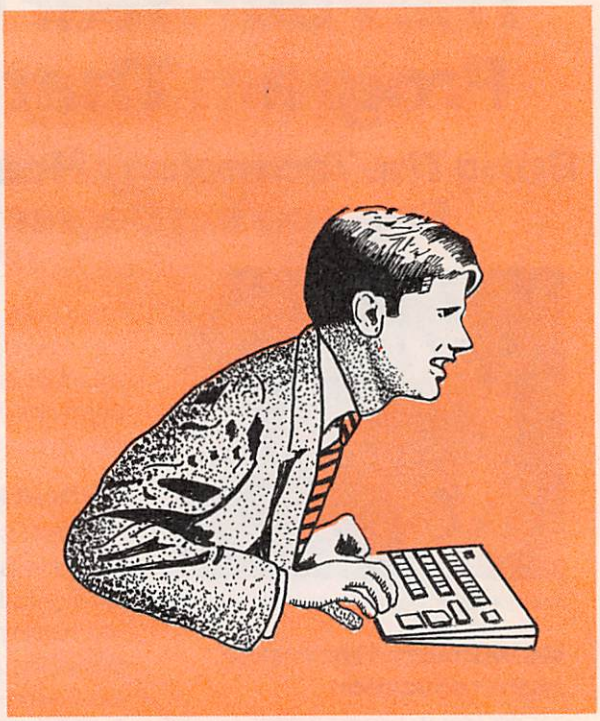


Not too many years ago, personal pagers were mainly used only by people in the business world. Now pagers have become a popular means for almost everyone to keep in touch with one another. These days, even school children have pagers on their belts or in their backpacks so that they can keep in touch with their parents and friends.

The strange-sounding digital signals that activate pagers and encode their messages are not difficult to generate. We'll show you how to build a simple POCSAG pager-signal generator and encoding system using a small interface circuit to connect an IBM-compatible personal computer and an FSK (frequency-shift keyed) FM-radio transmitter or signal generator.

The software for the pager encoder is readily available over the Internet, and it is free. The interface itself can be built for about $10.00 on a small piece of perfboard.

What is POCSAG? POCSAG is an abbreviation for Post Office Code Standard Advisory Group. It refers to the standard protocol used to send messages to common pocket pagers that many people carry around on their belts or in their purses. As opposed to the radio signals used for voice transmission, POCSAG is based on digital signals. Depending upon the type of pager used, different digital signals can be sent. Some *tone-only* pagers activate when they receive a special tone. With tone-only pagers, you generally have to call the pager service in order to find out what the message is. *Numeric* pagers can receive numeric information such as a telephone number to call to talk directly to the person trying to contact them. *Alphanumeric* pagers have the capability of viewing actual text messages; long messages will usually scroll across a viewing screen. Some people even have the capability of directing their Internet e-mail to their alphanumeric pager so that they can read their e-mail directly from it.

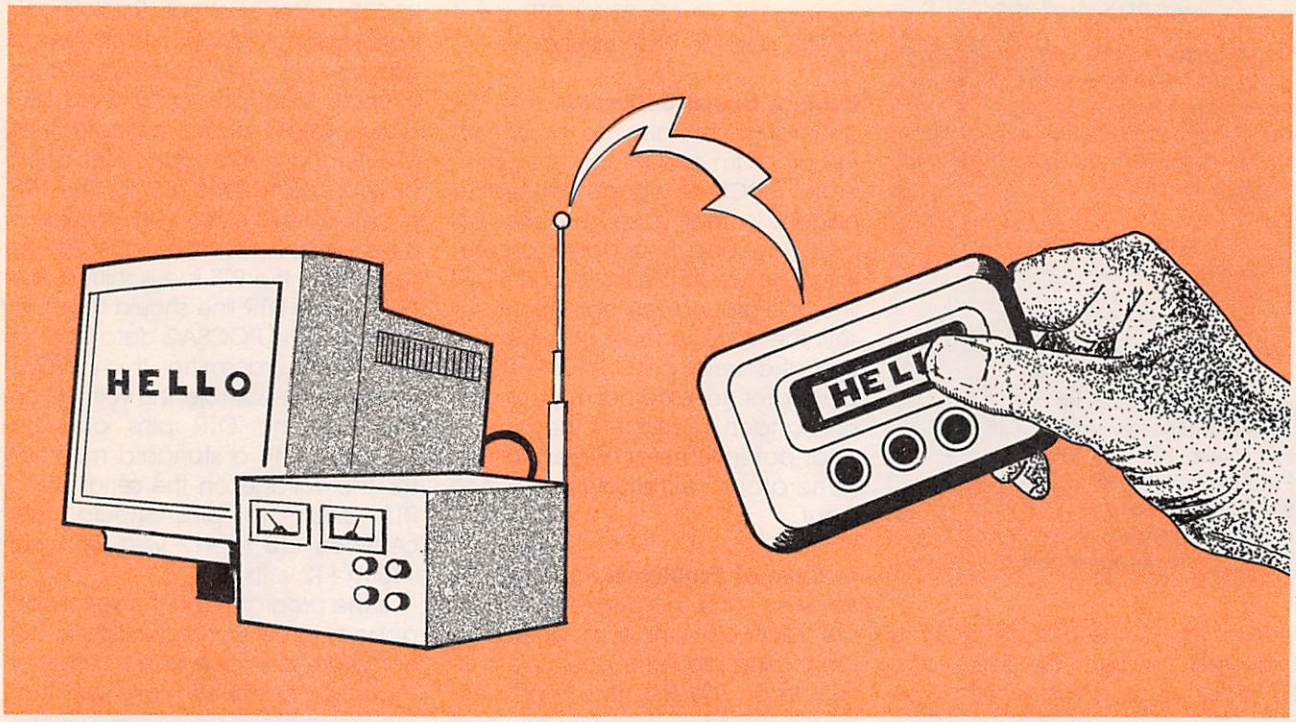
The most common baud rates used by pagers are 512 baud, 1200 baud, and 2400 baud. With just a little experience, a person can distinguish different pager baud rates just by listening to the digital signal over a scanner or radio receiver.

What is FSK? POCSAG signals are sent using a method called *Frequency-Shift Keying*, or FSK for short. With that method, the carrier wave is shifted by 4.5 KHz up or down from the center frequency. Those shifts represent the actual data being sent. For example, a signal sent on 158.100 MHz will shift back and forth between 158.0955 MHz and 158.1045 MHz.

One of the easiest ways to create an FSK signal is to directly control the modulation stage of an FM transmitter. A varactor (a voltage-variable capacitor) is usually used to couple the digital data into the transmitter. The changing voltage fed to the varactor changes its capacitance. That will change the tuning of the transmitter's modulation stage, causing the transmitter to shift its output frequency in direct response to the digital data.

Ham operators who have 9600-baud packet-capable radios can use those radios to generate POCSAG signals. Many other crystal-controlled FM radios can also be used for FSK work when properly modified. Some older radio equipment that uses phase-locked loop circuits might have problems trying to generate FSK signals. A list of known FSK-capable radios is shown in Table 1.

The Software. An excellent program that can be used to generate POCSAG signals and control a radio transmitter has been written by two British ham-radio enthusiasts, Clive Cooper (G8UKN) and Pete Baston (GW0PJA). The pro-



gram, PE.EXE, can be found at several Internet locations, including http://www.seelect.demon.co.uk/pocsag.html and ftp://ftp.demon.co.uk/pub/ham/scanners/pe-204.zip.

At only 68 kilobytes, PE.EXE is a fairly small DOS-based program that needs only an 80386-based personal computer or better. Text to be sent is typed into the program, which then assembles the data into the POCSAG format and sends that information to an RS-232 port for controlling the radio transmitter. The radio is keyed by shifting the voltage state on the serial port RTS (Request to Send) pin. The POCSAG data is then sent to the transmitter's modulation stage by shifting the voltage state on the DTR (Data Terminal Ready) pin.

When first started, the program asks for the "capcode" of the pager. A capcode is a unique seven-digit identification number that is assigned to each pager. After the capcode is entered, the program asks for the data that will be sent. Once the data is typed in, the program will ask if the data should be sent in the alphanumeric or numeric format. If the data is all numbers, the program will default to numeric format.

The baud rate and serial port can be shifted though the various choices by simply pressing the various control keys. Each press of a certain control key will cycle that individual setting to the next choice. Pages can be sent in normal or inverted mode by keyboard control as well. Different transmitters might invert the digital signal, so try the inverted signal format if the normal mode does not work.

One particularly useful way to use the program is by entering all of the information directly through the DOS command line. That method, which can be used in a "batch" command, is set up as follows:

PE (CAPCODE) (TYPE) ("MESSAGE") (N/I) (COMPORT#) (BAUD)

The first entry, of course, is the program itself. The pagers seven-digit capcode is entered next. The "type" choices are A, N, 1, or 2, which refers to alphabetic, numeric, signal and tone only function 1, or tone only function 2. The message to be sent must be enclosed in quotation marks. One important limitation of the unregistered version of the software is that the message is limited to a maximum of eight characters and spaces. The registered version of the software allows longer text strings. If the signal must be inverted as described above, type an "I" next. Typing an "N" will not invert the signal. Finally, the serial port and baud rate are specified.

A typical command line might look something like:

PE 1281491 N "800 555 1212" I 4 512

In that example, the numeric-only message "800 555 1212" will be sent to pager number 1281491. The inverted signal will be sent to serial port 4 at a rate of 512 baud.

TABLE 1—RADIOS THAT ARE KNOWN TO BE FSK CAPABLE

Alinco DR-1200 Data Radio
GE Mastr Executive II, VHF and UHF
GE Custom MVP, VHF and UHF
Icom IC series: 25, 38, 228, 271, 290, 471
Kenwood TM series: 211, 212, 221, 231, 431, TS series 700 and 770
Motorola Mitrek
MFJ Model 8621 VHF Data Radio
Standard C58, C140
Yaesu FT series: 212, 221, 230

The Interface. Any number of different interface designs between the computer serial port and radio transmitter could be used. A suggested circuit is shown in Fig. 1. That circuit uses a small relay powered directly by the voltage from the serial port's RTS line. The relay provides a reliable switch to turn on and off the radio transmitter. The voltage

PAGER SOURCES

The following businesses have agreed to supply refurbished numeric and alphanumeric pagers without signing a commercial pager contract. For a reasonable charge, the pagers can be re-crystaled for a specific frequency.

McManus Communications
400 North Fifth Street
Blytheville, AR 72315
501-763-6250 (voice)
501-763-6533 (fax)

PageCo International, Inc.
2400 E. Commercial Blvd., Suite 630
Ft. Lauderdale, FL 33308-4033
954-491-9501 (voice)
954-491-8834 (fax)
e-mail: info@pageco.com
Web: http://www.pageco.com

level of the POCSAG data, which is delivered through the serial port DTR pin, can be adjusted with R2. A 2.2-µf non-polarized capacitor (C1) provides DC isolation between the transmitter and the serial port while passing the modulation voltage. A bipolar LED (LED1) is included for a visual indicator of the outgoing modulation data. An additional LED (LED2) shows when the radio is keyed on. That LED also prevents the RTS voltage from closing the relay when the program is idle. Diode D1 is included to sink any possible voltage spikes caused by the collapsing magnetic field when the relay is switched off.

The circuit can easily be built on a small piece of perfboard. For a neater appearance, an etched single-sided PC board can also be used. A foil pattern has been included here for those who wish to use that method for building the interface. A source where you can obtain etched PC boards is given in the Parts List.

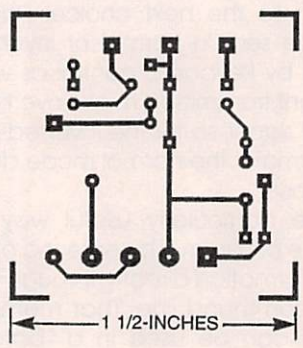
If an etched board is used, the parts-placement diagram in Fig. 2 should be followed. Note the polarities of the diodes when assembling the board. The three connections to the computer serial port should be wired to the proper terminals of a suitable connector. The particular pins to be used depend upon the type of connector that will be used. If a 9-pin connector will be used, connect DTR to pin 4, RTS to pin 7, and the ground to pin 5. For a 25-pin connector, use pin 20 for DTR, pin 4 for RTS, and pin 7 for ground.

Using a Signal Generator. A signal generator can also be used with the program and interface to generate POCSAG signals for testing pagers. In that case, the only circuitry needed is a potentiometer wired between the serial port's DTR line and ground. The potentiometer sets the voltage level of the signal from the serial port. Set the signal generator to external modulation and attach interface's the ground and potentiometer wiper to the generator's external-modulation input.

In Case of Problems. Although the software and hardware interface are relatively simple in operation, diagnosing problems could be a little difficult. The first step in problem solving would be to make sure that the program is operating properly. The best diagnostic tool for that is an RS-232 tester such as RadioShack catalog No. 276-1401. That device has red and green LEDs that light up to show serial port activity. No LED activity at all probably indicates that the wrong serial port has been picked. The tester's LED for the RTS pin should shift color when the radio is keyed up to send a page. At the same time the RTS line is shifted, the LED on the DTR line should flicker to show that the POCSAG data is being sent to the transmitter. If an RS-232 tester is not available, the voltage on the RTS and DTR pins can be checked with a standard multimeter. The voltage on the serial port's RTS and DTR pins should shift between -10 to -12 volts DC and +10 to +12 volts DC.

If the program and the serial port appear to be working properly, the hardware interface and transmitter should be checked. Make sure that the transmitter is being keyed when pages are being sent. The program will indicate "Transmitting" on the status line at the bottom of the screen, and the RTS pin on the serial line will shift from +12 volts to -12 volts.

Most transmitters are turned on and off by a control line that is switched on and off to ground. The output of the hardware interface should change the resistance from a high resistance state to near ground potential state that should activate the transmitter's push-to-talk (PTT) switch. In case the keying of the radio is reversed, change the polarity of the LED2. If the relay does not work at all, try reversing the



The POCSAG interface is simple enough to be laid out on a single-sided PC board.

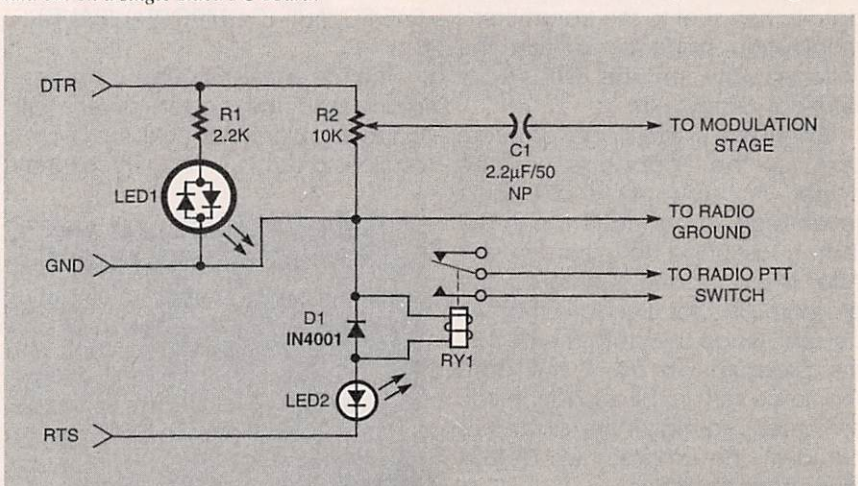


Fig. 1. The interface circuit for the POCSAG encoder is very simple. Light-emitting diodes give a visual indication of activity during transmission.

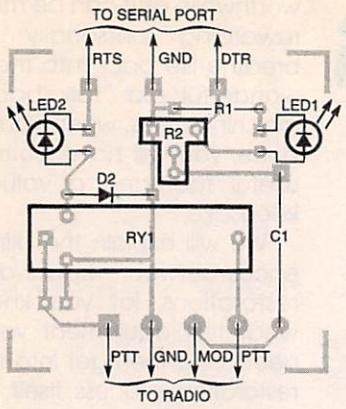


Fig. 2. Use this parts-placement diagram if you build the interface circuit on an etched PC board.

polarity of D1.

If the radio keys up properly, monitor the transmitted signal with a scanner or another radio. POCSAG signals are very distinctive. The easiest way to check your transmitter volume level (deviation) without expensive test equipment is simply by listening to a commercial pager transmission and setting your signal level to about the same level. If a commercial signal is not available for comparison, just set your output level to a sound level comparable with normal voice transmissions. Signals that are cut short or sound especially distorted or garbled are probably at too high a level. Reduce the level of voltage output though R2. Also, some transmitters might work better if you remove capacitor C1.

If you still have problems, your radio might not be FSK capable or you might not be injecting the signal to the proper modulation stage on your radio. Remember, you are sending data by direct frequency shifting. Using the regular transmitter microphone input for this application simply will not work.

What You Can Do With a POCSAG Encoder. This project lends itself to quite a number of useful applications. First, it is quite educational. You can learn about POCSAG signals and how pagers function. The project can be used to demonstrate POCSAG operation to others. Using a second PC with a POCSAG decoder, such as the unit described in the May 1997 issue of **Electronics Now**, allows a complete POCSAG transmission and reception system to be demonstrated.

Commercial paging companies and technicians will enjoy using the POCSAG encoder program to test and diagnose pagers without the need to use expensive page-generating equipment. Amateur operators could use the program to set up their own personal- or club-paging system on the ham bands. Using the paging capabilities from the DOS command prompt, pages could even be sent remotely using remote-computer-control programs such as pcAnywhere from Symantec Corporation.

POCSAG encoding is really fairly simple. The software and hardware interface described here can be used to generate POCSAG digital signals for a wide variety of diagnostic, demonstration, and actual applications. Ω

PARTS LIST FOR THE POCSAG ENCODER

LED1—Light-emitting diode, bi-polar
LED2—Light-emitting diode, green
D1—1N4001, silicon diode
R1—2200-ohm ¼-watt, 5% resistor
R2—10,000-ohm potentiometer
C1—2.2-µF, 50 WVDC, electrolytic capacitor, non-polarized
RY1—12-volt DC relay, single-pole, single-throw (RadioShack 275-233 or similar)
Wire, PC board, 9- or 25-pin connector, hardware, etc.

The POCSAG encoding program can be found at http://www.seelect.demon.co.uk/pocsag.html and ftp://ftp.demon.co.uk/pub/ham/scanners/pe-204.zip. United States purchasers can obtain registered copies of PE, the POCSAG encoding program, from Robert B. Whitaker, Trustee, P.O. Box 1266, Victoria, TX 77902-1266. The registered, full-function software costs $39.95, postage paid. Unregistered software, for those without Internet access, can also be purchased for $12.50, postage paid.

A high-quality printed circuit board with silkscreen artwork for parts placement is available from FAR Circuits, 18N640 Field Ct., Dundee, IL, 60118-9269 for $3.75. A fully assembled and tested interface kit is available for $29.95, plus $5.05 for shipping and handling, from Robert B. Whitaker, P.O. Box 1266, Victoria, TX, 77902-1266.