This project arose from a two-fold need connected with learning CW: First, it goes beyond the traditional oscillator-only method by providing you with a display with which you can verify the correctness of your keying—send and see. Secondly, you can connect the decoder to your receiver to help you copy code either as practice or during a QSO. Having an alphanumeric readout can be an especially big assist to newcomers who tend to be a bit nervous and have difficulty copying during their initial CW QSOs. The readout helps you cope with band conditions and variable sending speeds, too. A decoder such as this one can’t substitute for the ear/brain combination, but it can speed up the process of learning CW and enjoying it! The received signal must be clear and strong: don’t expect the decoder to perform well with a weak and fading signal in QRM. For such a situation, your ear/brain combination will do a much better job. With a decent incoming signal level, this decoder performs well, automatically adapting itself to the incoming CW at speeds between 5 and 30 WPM.

Decoder Software
I developed the software using the PIC16F84 assembly language to run in a PIC16F84 microprocessor (see the sidebar, "Development Tools"). The program measures the received signal on and off times, obtains some statistical mean values, then calculates three parameters that are then used for decoding: the mean lengths of the dit and dah cycles, the intercharacter pause and the interword pause. A flow chart of the program (macro level) is shown in Figure 1.

An interword automatic spacing function is provided, based on a regular timing of the pauses in the code received. If the decoder is used for training purposes, or while receiving improperly sent CW, the interword spacing can be turned off. With the interword spacing turned off, received

The asterisks appearing at the interword spaces are generated by sending a bogus Morse character. This display was generated using the straight key and as shown here, interword spacing is turned off.

An inside view of the decoder. The LCD’s 10-pin connector at the bottom-left in the photo attaches to the PC-board-mounted connector at the left near the PIC (U1) and pot (RV1).
The decoder’s initial setting is approximately 15 WPM and is refreshed every 15 dits or dahs received. The character set includes all letters, numbers 0 through 9, the period, comma, hyphen, double dash and question mark. Unrecognized characters are displayed as asterisks (*). The prosign SK is displayed as an octothorpe (#).

**Circuit Description**

The circuit (see Figure 2) is simple and employs only four ICs. The main characters in the decoder are a programmed PIC16F84 microprocessor 1, 2 and a 16-character, 1-line LCD. Ground the unused pins of the LCD (B0-B3) and the R/W-pin. For some component IDs, we deviate from QST style to accommodate existing author-supplied IDs. Equivalent parts can be substituted; n.c. indicates no connection. Parts can be obtained from several sources (see Note 2) including Digi-Key Corp, 701 Brooks Ave S, Thief River Falls, MN 56701-0677; tel 800-344-4539, 218-681-6674, fax 218-681-3380; http://www.digikey.com, Mouser Electronics, 958 N Main St, Mansfield, TX 76063-4827; tel 800-346-6873, 817-483-4422, fax 817-483-0931; sales@mouser.com; http://www.mouser.com; and B.G. Micro, PO Box 280298, Dallas Texas 75228; tel 800-276-2206, 972-271-5546, local Dallas orders call 972-271-5546, fax 972-271-2482 and others.

**Notes**

1Notes appear on page 40.

- **LCD.** Ground the unused pins (B0-B3) of the LCD and its R/W pin. You can increase the LCD’s line length to 24 or 40 characters by performing a simple software modification (You’ll need to be able to program your own PIC to do this.—Ed.) If a two-line LCD is easier (and/or cheaper) to obtain, use it. If a two-line LCD is easier (and/or cheaper) to obtain, use it.

- **Power.** Power is applied to the unit via J1 through S1. A 9-V source is easily obtainable and avoids input-voltage marginality. Although a 9-V battery can supply power for short-term portable or other intermittent operation, use an ac-operated supply for prolonged operation. U3, a 78L05 regulator, delivers +5 V dc to the circuit. The entire circuit draws about 15 mA.

- **Received audio.** Received audio is applied to J3, the AUDIO jack. The minimum acceptable audio-input level is 100 mV P-P with a time duration of at least 20 ms. An on-board germanium-diode clipper (D1, D2) handles large input-signal levels. A KEY input is provided for sending practice, and both inputs (AUDIO and KEY) activate the display and audio monitor. So whatever you’re receiving or keying appears on the LCD.

- **U4.** An NE567 tone decoder, takes charge of processing the audio-input signal. While receiving CW, LED DS1 (LOCK), connected to the pin 8 of U4, indi-
Except as indicated, decimal values of capacitance are in microfarads (\(\mu F\)); others are in picofarads (\(pF\)); resistances are in ohms; 
\(k=1,000\).

T = Tantalum

* See text and caption
n.c. = No connection
Here's how the display appears with no interword spacing.

**Development Tools**

If you’ve built (or read) any of the PIC projects described earlier in *QST*, you’ll know PIC development tools abound. You may find several commercial development tools for the PIC16F84 microprocessor (see, for example, the Microchip Starter Kits), but if you are interested in a low-cost approach, at the Microchip Web site (http://www.microchip2.com/index.html), you can download the assembler software (MPASM) and the simulator (MPSIM), together with the technical documentation, from http://www.microchip.com/10/Tools/pTools/MPASM/index.htm and http://www.microchip.com/10/Tools/Archive/index.htm, respectively. To program the PIC, I used a circuit described by David Tait (see Note 1, too—Ed.). It’s available free from the Internet site http://www.man.ac.uk/~mbhstdj/files/. For schematic capture and PC-board layout software, I use Circad. You can download a shareware version from the Holophase Internet site http://www.holophase.com/.
—Francesco Morgantini, IK3OIL

*Notes*

2. PC boards and *programmed* PICs for this project are available from FAR Circuits, 18N640 Field Ct, Dundee, IL 60118-9260; tel 847-836-9148 (voice and fax);Prices: *Programmed* PIC, $20; PIC board, $5 plus $1.50 shipping for up to four boards and ICs. Visa and MasterCard accepted with a $3 service charge. See the caption of Figure 2 for component-distributor information.

*First licensed in 1990, Francesco Morgantini, IK3OIL, holds an electronic engineering degree from Padova University. His Amateur Radio interests include “homebrewing” and experimenting with HF RF circuits and QRP. Francesco’s SSB/CW solid-state multiband station is entirely homemade! For QRP, Francesco has built several little rigs for various amateur bands. Other interests include experimenting with microprocessors, particularly for use in DDS and DSP for Amateur Radio purposes. Francesco has had several articles published in the Italian Amateur Radio Society journal. See the July/August 1998 issue of *QEX* for Francesco’s description of a homemade PLL VFO project.* You can contact Francesco at Via Leoncavallo, 21, 35010 Vigonza (PD), Italy; ik3oil@iol.it.


**NEW PRODUCTS**

**NEW IC-706 AMPLIFIER RELAY FROM W1WEF**

W1WEF has added another accessory to his line of contest interfaces. The new device facilitates connection of any version of the ICOM IC-706 transceiver to nearly any HF or 6-meter amplifier. A 13-pin DIN connector on a short pigtail plugs into the accessory connector on the rear of the ‘706, and an RCA (phono) jack is provided to connect a cable to the amplifier’s relay control point. When the IC-706 is keyed in CW, or the PTT/VOX is tripped on SSB, the relay contacts are rated for 1 A at 250 V dc.

The price is $29 plus $3 shipping and handling. For more information or to place an order, contact Jack Schuster, W1WEF, 408 Thompson St, Glastonbury, CT 06033; w1wef@snet.net.

**POCKETPRO SUB-MINI H-T POUCH**

With a design similar to the pocket protectors used to hold pens and pencils, Cutting Edge Enterprises’ *PocketPRO* lets you carry the new sub-mini H-Ts—like the Yaesu VX-1R, the Alinco S and C series and the ICOM IC-Q7A—upright and secure in your shirt pocket.

The PocketPRO is constructed of glove leather and features a clip that passes over the front of your shirt pocket to keep the protector in place. Three compartments, a wide center section for the radio, and two narrow sections on each side for holding pens, pencils or spare antennas, are provided.

Price: $19.95. For further information, contact Cutting Edge Enterprises, 1803 Mission Street, Suite 546, Santa Cruz, CA 95060; tel 800-206-0115; fax 831-426-0115; cee@cruzio.com.

Next New Product