DTMF COMPUTER INTERFACE

BRIAN PLILER

Decode DTMF signals picked up by your scanner and display that information on your computer screen or save it to memory with this simple scanner-to-computer interface circuit.

If you have been looking for an inexpensive method of decoding DTMF digits and you already own a PC or compatible computer, then the *DTMF Computer Interface* described in this article might just be the monitoring accessory that you have been looking for.

The interface decodes DTMF tones that are received on any scanner, communications receiver, or other source (such as a tape recorder, *etc.*) and displays the resulting digits on the computer's monitor complete with the approximate time at which the digits were decoded. (The information is also stored automatically in a disk file for logging purposes.) The interface simply connects to the scanner or other receiver through the external speaker jack and to the PC through an ordinary parallel-printer port, such as LPT1.

Circuit Description. A schematic diagram of the DTMF Computer Interface is shown in Fig. 1. Note that relatively few parts are required for the interface. Scanner audio is fed to IC1 (an SSI-75202 DTMF receiver) through ceramic-disc capacitor C1. (Capacitor C1 must be a ceramic-disc unit, or digit decoding performance will be degraded—**Do not** substitute Mylar types for C1.) The DTMF receiver (IC1), with the aid of a single resistor (R1) and an inexpensive 3.58-MHz colorburst crystal (XTAL1), decodes the DTMF tones and outputs a 4-bit binary code, identifying each DTMF digit as it is decoded.

The DTMF digits along with their equivalent binary code as output from IC1 are given in Table 1. When IC1 decodes a DTMF digit, its Data Valid (DV) output at pin 14 goes high. The DV line goes high only while IC1 is decoding a DTMF Digit, signifying that binary-digit data is available from IC1. The binary-digit data that's output at pin 14 of IC1 is considered to be valid for the current digit only while the DV signal is present.

The 4-bit output (plus the DV signal) of IC1 is fed to IC2 (a 74LS04 low-power Schottky, hex inverting buffer). Note that only five of IC2's inverters are used as signal buffers. The data originally output by IC1 is coupled through a short length of cable to your PC.

Operating power for the circuit is provided by a 9-volt battery, whose terminal voltage is regulated to +5 volts by IC3 (an LM78L05 low-power, fixed, 5-volt regulator). Capacitors C2 and C3 filter against power transients, while switch S1 serves as the project's power switch.

Interfacing to the Computer. You are probably wondering how the interface can be connected to the computer's parallel printer port, since it is normally used to output data to a printer. The truth is that while the parallel port is usually considered strictly as an output port, it also has five TTL level input pins that are normally used to monitor status signals from the printer,
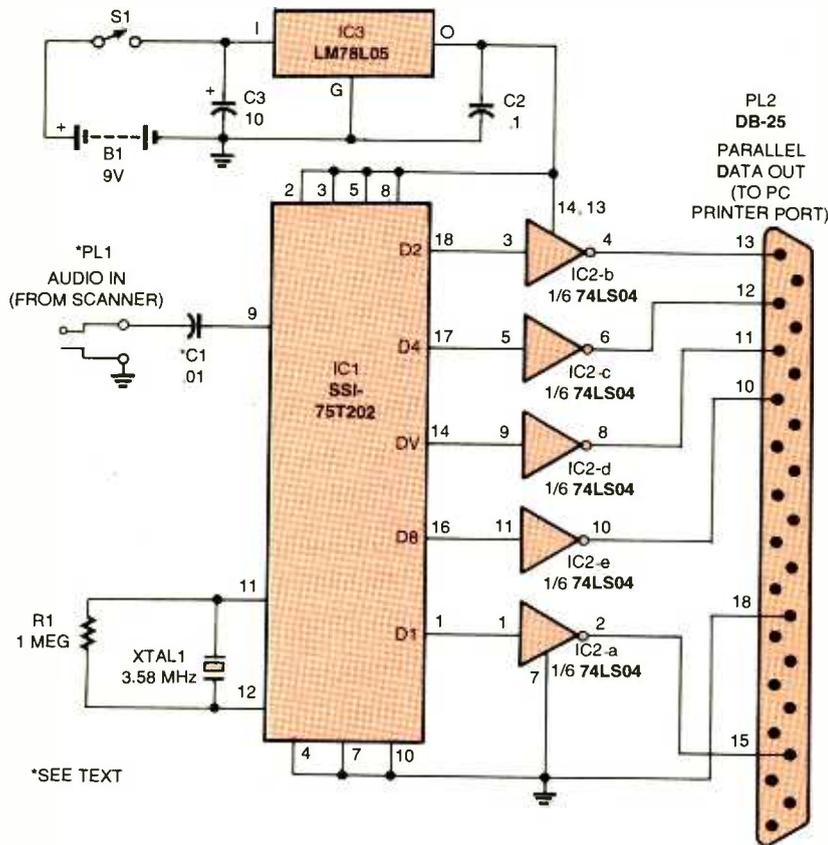
Fig. 1. This schematic diagram of the DTMF Computer Interface reveals that the circuit is comprised of relatively few components. At the heart of the circuit is an SSI-75T202 DTMF receiver, which with the aid of a single resistor (R1) and an inexpensive 3.58-MHz colorburst crystal (XTAL1) decodes the DTMF digits and outputs a 4-bit binary code, identifying each DTMF digit as it is decoded.

TABLE 1—DTMF OUTPUT DATA

KEY	OUTPUT
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
0	1010
*	1011
#	1100
A	1101
B	1110
C	1111
D	0000

such as: error, paper out, etc. It is those five input pins that allow the DTMF interface to communicate with the PC.

A PC can actually have up to three parallel printer ports, normally referred to as LPT1, LPT2, and LPT3. If there is only one parallel printer port (most home systems), it is referred to as LPT1.

Construction. Construction is not critical, as the project can be assembled on a small section of perfboard or a printed-circuit board. For those readers who prefer to go the printed-circuit route, a template of the author's board layout is shown in Fig. 2. After etching your printed-circuit board, examine it carefully for shorted connections, etc., and correct any defects before proceeding.

Using the parts-placement diagram shown in Fig. 3 as a guide, begin installing the parts onto the printed-circuit board. The use of sockets for IC1 and IC2 is strongly encouraged. After all of the appro-

priate parts have been soldered onto the circuit board, check the board for solder bridges and poor connections. (**Do not** insert IC1 and IC2 into their sockets at this time.)

Now temporarily apply power to the board, and check for the presence of +5 volts at the output of IC3 (the regulator). If that checks out, set the completed printed-circuit board aside for the time being.

Prepare the enclosure that's been chosen to house the project by simply drilling holes for the power switch, audio input wires, and the computer data cable. Note that almost any type of cable can be used to connect the interface to the computer as long as it contains six conductors (five signal lines and a ground), and its length doesn't exceed 3 to 4 feet.

Before you solder the audio input and computer data wires to the board, it is suggested that several inches of each be pulled into the enclosure. Then, strip and solder each wire to its respective pad (as

shown in Fig. 3). After all of the wires have been attached to the printed-circuit board, mount the board into the enclosure, and carefully extract (pull out) any excess slack in the wires, being sure to fasten them securely into the enclosure so that they can't be pulled out again.

With that done, connect an audio plug (selected to mate with the external speaker or earphone jack on your scanner or other receiver) to the appropriate points on the printed-circuit board through audio-speaker cable. After that, connect a male DB-25 connector to the 6-conductor cable to the printed-circuit board as indicated in Fig. 3. IC1 and IC2 can now be installed into their respective sockets.
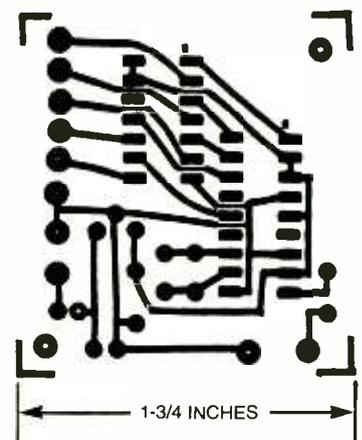

Fig. 2. The project can be assembled on a small section of perfboard or a printed-circuit board. For those who prefer to go the printed-circuit route, a full-size template of the author's board layout is shown here.

1-3/4 INCHES

The Software. The DTMF-digit decoding program (DTMF.BAS), which is written in QBASIC, is given in Listing 1.

Note that machines running Windows 95 and greater will not have QBASIC installed, you'll need to go to the "other" folder of your Win95 CD-ROM, click on "oldmsdos" and copy "QBASIC.EXE" and QBASIC.HLP to your hard drive. There are a few things about the program that should be pointed out. The first is that the program expects the interface to be connected to parallel port LPT1 at address &H379. If the interface is to be connected to LPT2 at address &H279 or LPT3 at address &H3BD, then the "INP (&H379)" statements appearing in lines 11 and 14 must be changed accordingly. For example, if LPT2 is to be used, change line 11 to read: "11 IF INP (&H279) <> 127 THEN 11", and change line 14 to read: "14 P = INP (&H279) : IF INKEY$ = CHR$(27) THEN 50."

Note: The program was originally written for a 386SX operating at 20 MHz, so the CT value in line 13 (currently 5000) may have to be changed, depending on the computer speed and user preferences.

The CT value is what determines how much time must pass after the last digit was decoded before the system time and date information is displayed. A 5- to 10-second time delay is usually desired by most users. Suitable CT values for various computer speeds are given in Table 2. Note that all of the data that is displayed on the monitor is also saved in a comma-delimited disk file named "DTMFDATA.TXT," which is placed in the current directory. That data can then be imported into a spreadsheet program for later analysis if desired.

The term "comma delimited" simply means that the different information fields are each separated by a comma. For instance, suppose that the telephone number 555-1234 was decoded at 7:25:00 p.m. on March 13th, 1998. That information would be saved in file "DTMFDATA.TXT" as: 5551234, 07:25:00.p, 03-13-1998 followed by a carriage return (CHR$(13)), which causes any new decoded information to be placed on a new and separate line.

To use the decoded data in a spreadsheet program, such as the one included with MSWORKS, first start Windows and start MSWORKS. Choose "Open File" and select file "DTMFDATA.TXT." A dialog box will appear stating that MSWORKS cannot open conversion files; click OK. In the next dialog box that appears, choose "open as spreadsheet." The spreadsheet program then appears with the data from file DTMFDATA.TXT placed in the first three data fields. Decoded DTMF-digit data appears in the "A" field, the time information appears in the "B" field, and the date information appears in the "C" field.

The data can now be sorted or printed as desired. Other spreadsheet programs should have similar features—refer to their instruction manuals. To enter the program DTMF.BAS, boot the PC into DOS or DOS mode. At the DOS prompt (C:>), start QBASIC by typing the word "QBASIC" and pressing <ENTER>. (QBASIC is included with DOS versions 5.0 and above. If you installed it yourself as described earlier, make sure you try to run it from the directory or folder you put it in.) Press the <ESC> key to clear
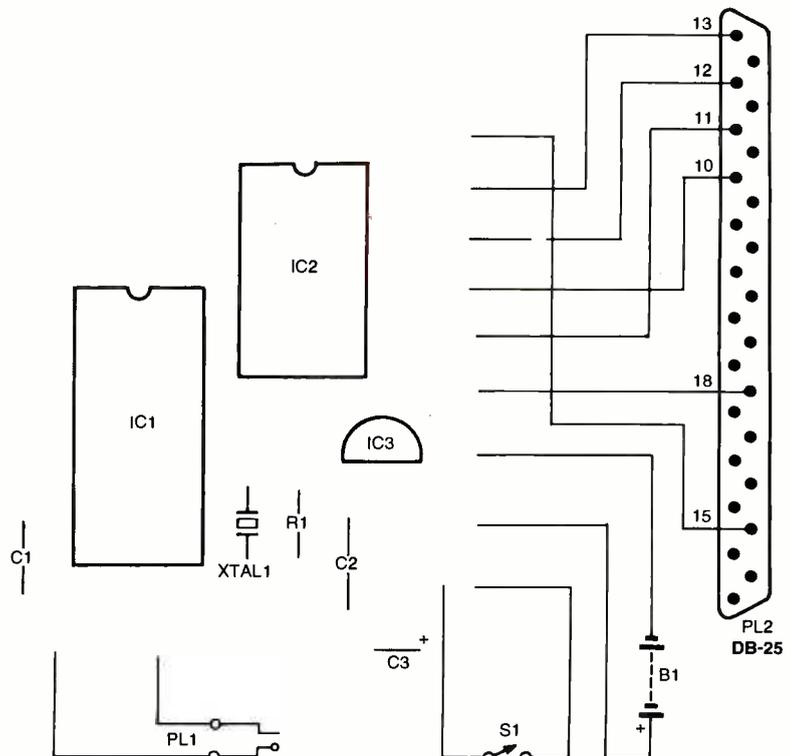

Fig. 3. Assemble the project guided by this parts-placement diagram. **Note:** *The use of sockets for IC1 and IC2 is strongly encouraged.*

LISTING 1—DTMF BAS

```
1 REM DTMF Digit Decoder Program for PC/Compatibles
2 REM by Brian Pliler 8-96  DTMF.BAS
3 REM with Time/Date Stamp & Disk Logging
4 REM Interface Connects to Parallel Port
5 REM LPT1=&H379 LPT2=&H279 LPT3=&H3BD
6 REM Uses System Clock for Time/Date info.
7 CLS : LOCATE 1, 15: PRINT " DTMF Digit Decode Screen Press 'ESC' to End "
8 OPEN "DTMFDATA.TXT" FOR APPEND AS #1
9 CT = 1000000: GOTO 14
10 PRINT #1, CHR$(DIG); : PRINT CHR$(DIG);
11 IF INP(&H379) <> 127 THEN 11
12 CT = 0
13 CT = CT + 1: IF CT = 5000 THEN 45
14 P = INP(&H379): IF INKEY$ = CHR$(27) THEN 50
15 IF P = 127 THEN 13
16 IF P = 255 THEN DIG = 68: GOTO 10
17 IF P = 247 THEN DIG = 49: GOTO 10
18 IF P = 239 THEN DIG = 50: GOTO 10
19 IF P = 231 THEN DIG = 51: GOTO 10
20 IF P = 223 THEN DIG = 52: GOTO 10
21 IF P = 215 THEN DIG = 53: GOTO 10
22 IF P = 207 THEN DIG = 54: GOTO 10
23 IF P = 199 THEN DIG = 55: GOTO 10
24 IF P = 191 THEN DIG = 56: GOTO 10
25 IF P = 183 THEN DIG = 57: GOTO 10
26 IF P = 175 THEN DIG = 48: GOTO 10
27 IF P = 167 THEN DIG = 42: GOTO 10
28 IF P = 159 THEN DIG = 35: GOTO 10
29 IF P = 151 THEN DIG = 65: GOTO 10
30 IF P = 143 THEN DIG = 66: GOTO 10
31 IF P = 135 THEN DIG = 67: GOTO 10
45 PRINT CHR$(44); : PRINT #1, CHR$(44); : PRINT TIME$; : PRINT #1,
TIME$;
46 PRINT CHR$(44); : PRINT #1, CHR$(44); : PRINT DATE$; : PRINT #1,
DATE$;
47 PRINT CHR$(10); : PRINT #1, CHR$(13)
48 GOTO 14
50 CLOSE #1: CLS : END
```

the opening dialog box. Press <ALT>, then choose "F" for file, then "N" for new, and press <ENTER>. Now type in the program as it appears in Listing 1, making any needed changes to lines 11, 13, and 14.

After the program has been entered, press <ALT>, then press "F" for file, select "S" for save, and press <ENTER>. Type in the name DTMF.BAS and press <ENTER>.

To run the program (DTMF.BAS) that you just entered and saved, press <ALT>, then press "R" for run, then "S" for start, and press <ENTER>.

The screen will clear, the program will start, and the words "DTMF Digit Decode Screen Press 'ESC' to End" will appear at the top of the monitor screen. Any DTMF digits decoded by the interface will appear on the monitor.

Approximately five seconds after the last digit is decoded, the system time and date information appears to the right of the previously decoded DTMF digits. The next DTMF digit decoded appears on a new line immediately below the first. Once the screen becomes full, the oldest line of information is scrolled upwards one line at a time, as a new line of information is displayed. But don't worry, because all displayed information is saved in disk file "DTMFDATA.TXT," located in the same directory as DTMF.BAS.

To stop the program—whether to make changes or to exit—simply press the <ESC> key. The words "Press any key to continue" will appear at the bottom of the screen. Pressing any keyboard button will return you to the QBASIC main screen. To exit the program and QBASIC, press <ALT>, then press "F" for file, and select Exit from the menu. You'll be returned to the DOS prompt.

Use. With your computer and the DTMF interface both turned off, carefully connect the interface to the appropriate parallel port on your computer and turn on your computer. Make sure that the computer is up and running before applying power to the interface. After the DTMF decode program is running, connect the audio cable on the interface to a scanner tuned to an active frequency with DTMF tones present, or other appropriate source of DTMF tones. (Perhaps a friendly ham-radio operator can help you with this.)

DTMF DECODER IC SOURCES

B.G. Micro, Inc.
PO Box 280298
Dallas, TX 75228
Tel. 800-276-2206

Debco Electronics
4025 Edwards Road
Cincinatti, OH 45209
Tel. 800-423-4499

JDR Microdevices
1850 South 10th Street
San Jose, CA 95112-4108
Tel. 800-538-5000

If you are unable to find a suitable source of DTMF tones to test the interface, an alternative would be to create a test tape using your answering machine. Simply ask a friend to call your answering machine, and instead of leaving a normal voice message on the machine, have the friend dial digits

TABLE 2—DELAY TIMES

PC Type/Speed	CT Value (5-Sec. Delay)	CT Value (10-Sec. Delay)
386SX/20	CT = 5000	CT = 10,000
386DX/33	CT = 10,000	CT = 20,000
486DX/2-66	CT = 20,000	CT = 40,000
586 DX4-133	CT = 35,000	CT = 70,000

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0-9, *, # several times, and then hang up the phone.

Once the answering machine resets, simply remove the tape and play it back using a cassette recorder with an earphone jack. After cueing up the tape to the portion containing the DTMF tones, connect the interface to the recorder's earphone jack, and play back your test tape. DTMF digits should now begin appearing on your monitor. If no digits appear, try raising or lowering the tape recorder's (or scanner's) volume-control setting and try again. However, normal volume should suffice.

If incorrect digits appear on the monitor (for example, the digit received was known to be a DTMF "1," but a "4" was displayed), then re-check the wiring of the DB-25 connector and try again. After everything is working properly, install the cover onto the enclosure, and show your friends that useful monitoring accessories don't have to be expensive. ∎

HIGH-VOLTAGE CIRCUIT

condition, R1 would take the full 117-volt line, dissipating approximately 7.2 watts. At the maximum line-voltage tolerance of 117 volts AC + 10%, or about 129 volts AC, the resistor would have to dissipate about 8.3 watts. If a 10- or 20-watt resistor were used, you'll probably never have a problem. But if you are concerned, the optional thermal cut-out protector mentioned earlier can be attached to R1 to provide added protection for the circuit in the event of a catastrophic failure.

Construction. The author's prototype unit was assembled on a small section of perforated construction board measuring approximately 6 by 2⁷/₁₆ inches (which is about the width the transformer's base). Assemble the circuit, using Fig. 4 (the circuit's schematic diagram) as a guide. Start by temporarily

mounting the components to the perfboard section. When mounting power resistor R1, be sure that it is mounted away from anything flammable and that sufficient space is provided between the power resistor and any other components to allow good air flow around the resistor. **Note:** Although the author specifies a 10-watt power resistor in the Parts List, the unit used in the prototype is a 50-watt, metal-enclosed unit. Using a resistor of sufficient power-handling capacity helps to guard against possible mishap.
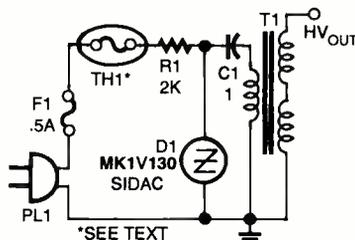

Fig. 4. This circuit featuring a SIDAC (which can be defined as a silicon, bilateral, voltage-triggered switch) reduces the cost and complexity of assembling high-voltage circuits, while retaining the capacity to efficiently switch several amps of power.

Depending on the line voltage in your area and the SIDAC you use, it may be necessary to adjust the value of R1 in order to get the circuit to switch at or before 90 degrees. Doing so reduces the amount of power R1 is required to dissipate, while allowing sufficient margin to enable the SIDAC to fire slightly after 90 degrees in the event that the line voltage goes low.

A two-position barrier block was tied to the transformer output and used to connect the circuit's high-voltage source to an 18-inch long, small-diameter neon tube.

Use. With its 2400-volt output, the circuit can be used to fire neon tubes. The author used the circuit to repair an ancient "weed-burner" fence charger by replacing the burned-out mechanical vibrator with this SIDAC-based circuit. With high-voltage rectification, the circuit can be used as a plasma neon laser supply or an air ionizer. Use your imagination—the possibilities are limitless! ∎

SCANNER SCENE

between them. Split your 16 oz. can of Pepsi with a pal and what's left for you? Just enough to fill an 8 oz. glass! Split the antenna's received energy, and it's divided in half to each scanner. Not to worry. Although each set will notice a minimal 3-dB signal loss, in most instances this should be imperceptible to you. weak signals can be rejuvenated with a SuperAmplifier.

MONITORING THE FEDS

Barry, of Charleston, SC, reports monitoring unidentified communications on 140.075 MHz, and he asks for more information. We looked it up, and it's the Channel 1 repeater of the U.S. Naval Investigative Service! This agency uses the same eight channels, nationwide.

Interest in monitoring federal agencies continues to tantalize scanner owners. An excellent guide for Barry and everyone else who's interested is the huge 308-page *Federal Government Frequency Assignments, 6th Edition.* Here's the all-in-one resource for the latest known VHF/UHF frequencies used by the U.S. military services; the Secret Service, ATF, CIA, DEA, FBI, Border Patrol, and Immigration; IRS, Customs Service, and Postal Inspectors; EPA, FAA, FCC, NASA, and NSA; and by the National Park Service, Dept. of Agriculture, and so on. CTCSS tone information is provided.

Plenty of additional information reveals military satellite communications channels, White House code names, USAF aircraft IDs, *etc.* Frequencies are listed by agencies, and they are also cross-indexed. Special lists show all (1500+) assignable federal frequencies from 29–420 MHz.

This great reference is $24.95, plus $5 shipping/handling ($7 to Canada) from CRB Research Books, Inc., P.O. Box 56, Commack, NY 11725; Tel. 516-543-9169; Web (fully secure site): *www.crbbooks.com.* Residents of NY state, please include $2.47 tax. MC/VISA are OK.

We invite your questions, comments, and frequencies. Our direct e-mail address is Sigintt@juno.com. Send snail mail to *Scanner Scene,* **Popular Electronics,** 500 Bi-County Blvd., Farmingdale, NY 11735. ∎