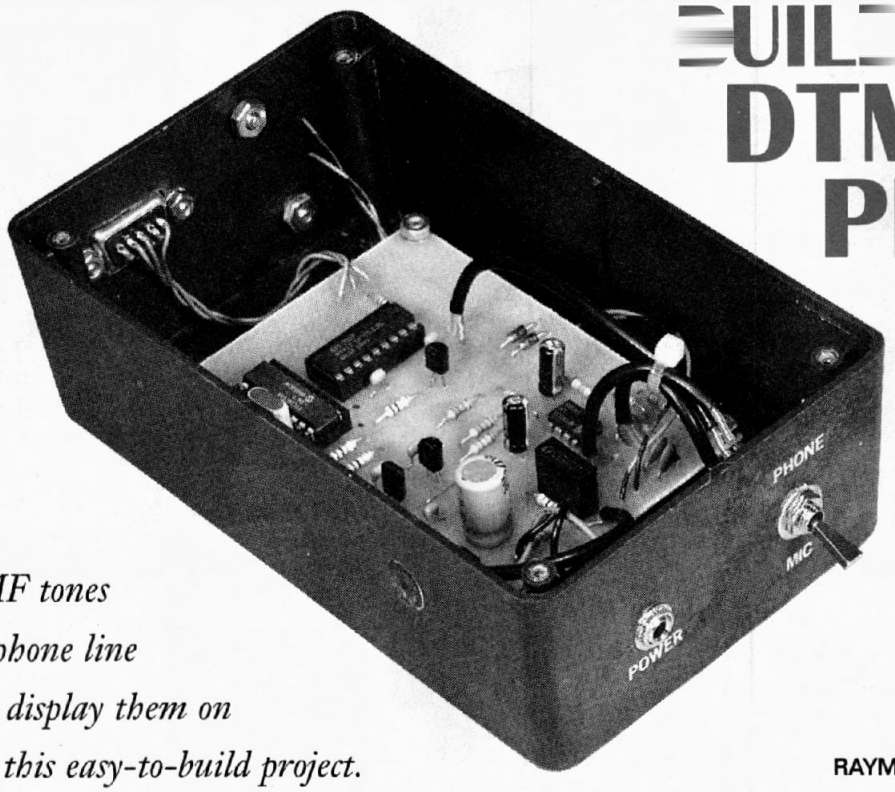
BUILD THE DTMF-PLUS



Decode DTMF tones from the telephone line or radio, and display them on any PC with this easy-to-build project.

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Decoding dual-tone modulated-frequency (DTMF) signals continues to be an area of interest for many people. DTMF signals can come from a variety of sources. They are used to control everything from home-automation equipment to amateur-radio repeaters. However, their largest use continues to be in items related to the public-telephone network.

There have been several articles published in the past that have described various ways of accomplishing the task of decoding DTMF signals. The DTMF-Plus universal decoder presented here combines the best features of those previous devices. It will be able to decode any DTMF signal from any source.

How it Works. The heart of the DTMF-Plus decoder is an SSI-202 DTMF-decoder chip. That chip determines which of the 16 possible DTMF tone-pair combinations is being received. The result is sent as an appropriate binary number to a Microchip 16C54 microprocessor. That microprocessor sends the binary information through an RS-232 port to a PC. With appropriate software, the decoded data can be displayed on the PC's screen. There are four different data rates available that should make the unit compatible with any type of PC.

If there is a delay of more than 3 seconds between digits, the cursor on the PC is moved five spaces. If more than 10 seconds elapse between digits, a carriage return and a line feed are sent to the PC. That formatting arrangement makes the screen display more readable. For example, if someone dials a pager number, there is first a wait for the pager service to answer, after which the callback number is entered. The pager access number and the callback number will be displayed in separate columns on the screen. If more than 10 seconds elapse without dialing, the assumption is that there will be no more dialing for that particular call. If additional digits are received later, they will be displayed on a separate line. That should handle most situations.

Circuit Description. There are two possible sources of DTMF tones for the circuit in Fig. 1: MIC1, an audio microphone, or J2, which connects to a standard telephone line. The inputs are individually amplified by IC3, an LM1458 dual op-amp. That chip handles the necessary gain and impedance conversions needed by IC4, an SSI-202 DTMF detector. When the microphone is used as the signal source, some experimentation might be necessary to find the best location for placing MIC1 near a radio speaker. The gain of IC3-a is preset so that normal listening levels are sufficient for the unit to function properly.

The source of DTMF tones is routed by S1 to IC4, where conversion takes place. The binary number appearing on the output pins of IC4 is read by IC5, a 16C54 microprocessor.

The serial output of IC5 drives Q1. In order to make a stream of serial data into a true RS-232 signal, both positive and negative voltages are needed. When Q1 is off, the negative voltage at the TD terminal on the computer's serial port is connected to the RD terminal. Turning on Q1 applies positive voltage to the RD terminal. The circuitry that drives the TD terminal is protected from destruction by R15. That way, a negative-voltage is not needed.

The two jumpers labeled JP1 and JP2 set the speed of the RS-232

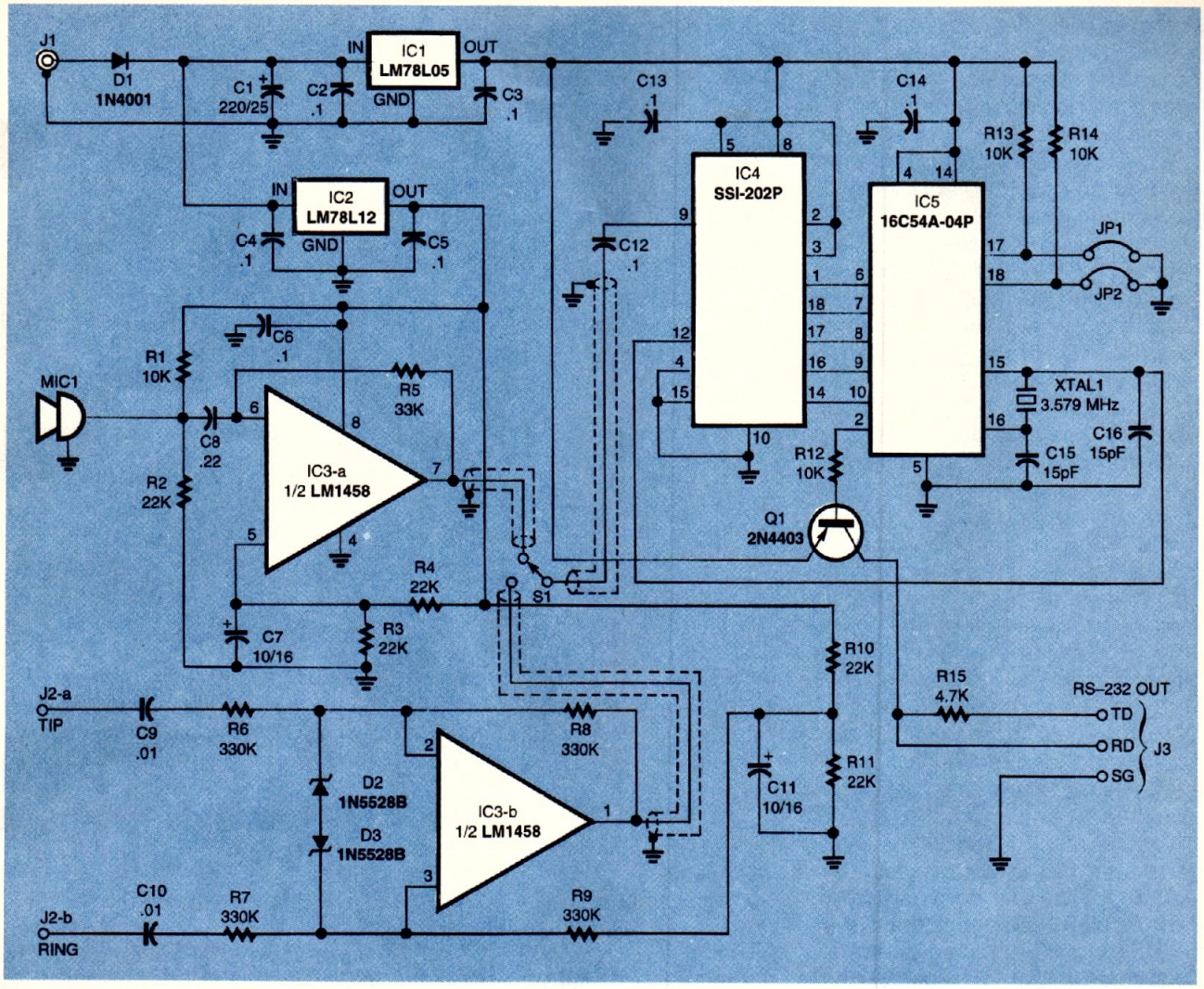


Fig. 1. Thanks to the use of a PIC microcontroller chip, the DTMF-Plus can use a very simple circuit to accomplish some very complicated tasks. The jumper blocks set the data rate to any of four different speeds.

data stream. With no jumpers installed, the speed is 9600 baud. If J1 is installed, the speed is 2400 baud. If J2 is installed, the speed is 1200 baud. If both J1 and J2 are installed, the speed is 300 baud. In all cases, the data stream consists of a start bit, 8 data bits without an additional parity bit, and 1 stop bit.

Power for the unit comes from a 12-volt DC wall-type adapter. The cheapest and smallest one will be fine since current requirements are very low. On-board 5-volt and 12-volt regulators IC1 and IC2 insure that the voltages needed by the individual chips are correct. As most wall-mount supplies do not have very good regulation, additional filtering for both low- and high-frequency ripple is also provided by C1 through C5.

Construction. The DTMF-Plus decoder is simple enough to be built on perfboard. If you wish, you can etch and drill a PC board from the foil pattern supplied. An etched and drilled board is also available from the source given in the Parts List. If you use the provided foil pattern or purchase a board, follow the parts-placement diagram in Fig. 2 for proper component placement. The circuit does not have any critical layout requirements, so either construction method will yield good results.

If you decide to use perfboard, keep the wiring associated with IC3 as short as possible. With either method of construction, the connections to S1 and to the microphone should use shielded audio cable. That shielding will prevent any stray hum from interfering with the DTMF tones. It is important to connect only one end of the wire shields to ground, not both. If that does happen, a ground loop will be created. Instead of minimizing noise pickup, that situation will cause the shields to act like an antenna, resulting in more noise than if unshielded wire were used.

Using sockets for IC4 and IC5 is a good idea in case one of those components has to be changed in the future. You might also use a socket for IC3, especially if you are using perfboard construction.

It is necessary for a special program to be burned into IC5 before installing it into the PC board. A preprogrammed chip is available from the source shown in the Parts List. If you want to program your own

component, the source code needed is available for downloading at the **Electronics Now** FTP site (ftp://ftp. gernsback.com/pub/EN/dtmfplus.exe).

The only connections to the serial port on a computer are the TD line, the RD line, and the SIG GND line. If the serial port has a 25-pin connector, connect TD to pin 2, RD to pin 3, and SIG GND to pin 7. If the serial port has a 9-pin connector, connect TD to pin 3, RD to pin 2, and SIG GND to pin 5. If you are not using an IBM-compatible computer, you will have to determine what pins to connect to by consulting your computer's manuals.

When installing the decoder in a case, it would be best to drill a hole in the case slightly smaller than the diameter of the microphone. Mounting the microphone inside the case over the hole will protect the microphone from damage if the unit is accidentally dropped. Silicone glue can be used to mount the microphone to the case.

Testing. When construction is completed, install JP1 and JP2 as needed to set the speed at which the DTMF-Plus will be communicating with your PC. Connect the DTMF-Plus to your PC and start a terminal communications program. Set up the program for the serial port to which the DTMF-Plus is connected.

The easiest way to test the unit is to connect it to a telephone line. Remove the cover from a telephone wall jack. Depending on how old the wiring is, there will be two different color code schemes in use. In the case of older wiring, the colors are green and red. With newer wiring, the colors are white wire with a blue stripe, and blue wire with a white stripe. Connect the DTMF-Plus to those wires. If you have two telephone lines in the house, line 2 might be on the white with orange stripe and orange with white stripe wires. In the case of older wiring, line 2 should be on the black and yellow wires. Polarity of the connections does not matter.

When the unit is turned on, the computer screen should display: "Touch-tone decoder is now active." If garbage characters appear on the screen, check the communication program settings to make sure they are set properly. If there is no characters at all, check the wiring between the unit and the PC. Also, check the unit to make sure there are no wiring errors. If you see the sign-on message, check to make sure that S1 is in the telephone position. Pick up a telephone and dial three or four digits. Pause for 4 seconds and dial a few more digits. The two groups of numbers should appear in two separate columns. Ten seconds after the last digit is dialed, the cursor should drop down to the beginning of the next line.

Once the telephone connection is working properly, the microphone is tested next. Turn on a shortwave or amateur receiver and tune to a signal where DTMF signals can be heard. Turn the receiver volume level up to a comfortable level and place the DTMF-Plus about 6 inches from the speaker. Set S1 to the microphone position. As DTMF signals are heard on the receiver, the corresponding numbers should be displayed on the PC screen. If a suitable receiver is not available, you could also use a speakerphone to test the microphone. Place the unit in front of the speakerphone and turn the speakerphone on. Go to another telephone, pick it up, and dial several digits. The digits should be heard over the speakerphone. The DTMF-Plus should decode them and send them to the PC. Note, however, that some speakerphones limit and clip loud signals, which could result in distortion of the tones. If that happens, the unit will not decode them, and this technique will not work.

If everything is working well, the unit is ready to be put to use. You may leave it connected permanently to the telephone line if you wish. It will not interfere with normal telephone operation and the incoming ring voltage from the

PARTS LIST FOR THE DTMF-PLUS

SEMICONDUCTORS

IC1—78L05 voltage regulator, integrated circuit
IC2—78L12 voltage regulator, integrated circuit
IC3—LM1458 dual op-amp, integrated circuit
IC4—SSI-202P DTMF decoder, integrated circuit (Silicon Systems SSI75T204-IP or similar)
IC5—PIC16C54A-04P microprocessor, integrated circuit
Q1—2N4403 PNP transistor
D1—1N4001 silicon diode
D2, D3—1N5528B Zener diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1, R12, R13, R14—10,000 ohm
R2–R4, R10, R11—22,000-ohm
R5—33,000-ohm
R6–R9—330,000-ohm
R15—4,700-ohm

CAPACITORS

C1—220-µF, 25WVDC, aluminum electrolytic
C2–C6, C12–C14—0.1-µF, ceramic disc
C7, C11—10-µF, 16WVDC, aluminum electrolytic
C8—0.22-µF, ceramic disc
C9, C10—0.01-µF, ceramic disc
C15, C16—15-pF, ceramic disc

ADDITIONAL PARTS AND MATERIALS

J1—Wall-adapter compatible power-input jack
J2—Modular telephone jack
J3—DB-9 or DB-25 RS-232 connector
JP1, JP2—2-position header pin
MIC1—Electret-condenser microphone cartridge
S1—Single-pole, double-throw toggle switch
XTAL1—3.579-Mhz crystal jumper blocks, 12-volt DC wall adapter, case, hardware, etc.

Note: The following items are available from ATC Electronics, PO Box 14091, Scottsdale, AZ 85260-4091: Preprogrammed PIC16C54 microcontroller, $10.00; Printed circuit board, $6.50; IC4 (SSI-202P), $2.25; Complete kit of all parts, less case and RS-232 connector, $32.50; Data-logging program, $7.50. Please add $4.00 for shipping and handling on all component orders—data-logging program price includes shipping. AZ residents must add appropriate sales tax. IC4 is also available from B. G. Micro, Inc., PO Box 280298, Dallas, TX 75228, Tel: (800) 276-2206.

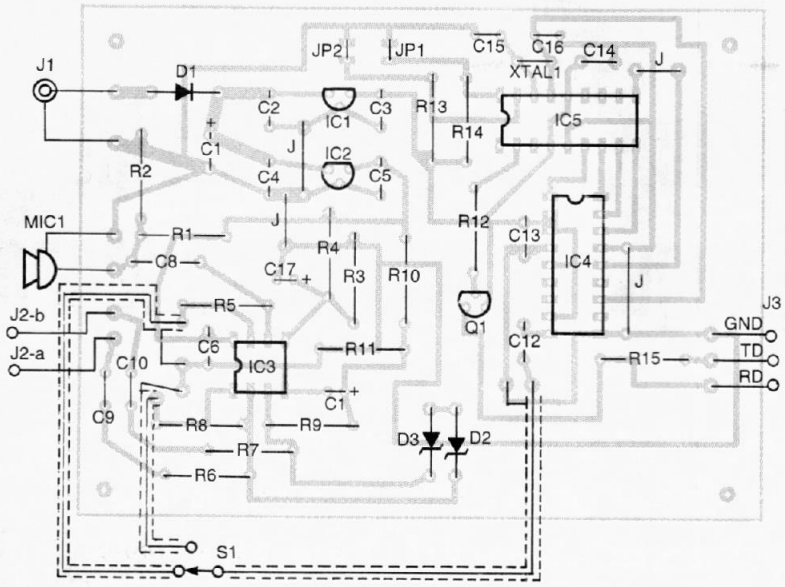
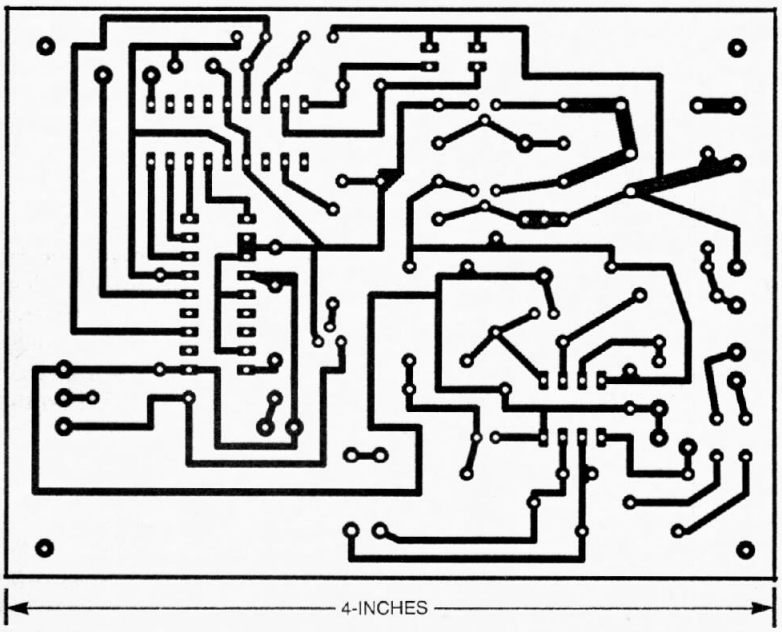


Fig. 2. Use this parts-placement diagram to locate the parts of the DTMF-Plus if you use the foil pattern. Shielded cable should be used to connect S1. The shield should be connected to the ground holes in the PC board only—do not connect them together at the switch.

telephone system will not have any adverse affect on the unit.

Using the DTMF-Plus. Data from the DTMF-Plus can be displayed on a PC using any available communications program. An optional data-logging program is also available from the source given in the Parts List to permanently store any information that is decoded. That program lets you store any data that is decoded for viewing at a more convenient time. For example, you can leave the DTMF-Plus connected to a telephone line and a PC. Each time a number is dialed, it will be stored in the computer for later viewing. Each time the DTMF-Plus sends a carriage return/line feed combination, the line of digits is stored as a call record in a database. Records can be deleted from the database on an individual basis or all records can be deleted at once. That DOS-based program runs on any IBM-compatible computer.

As you explore the abilities of the DTMF-Plus, you'll find new ways to use the unit. One use is as a tester for telephones, modems, and communication programs. The only limit is your imagination. Ω



Here's the foil pattern for the DTMF-Plus. A simple circuit and a few jumper wires easily fit the entire project onto a single-sided board.

SMARTBOX

(continued from page 32)

just comes on. Then accelerate slightly and note that LED2 goes out. Allow the vehicle to coast, and note that LED2 comes on again.

You will probably wish to drive several miles at various speeds and through upgrades and downgrades to learn how the setting of R14 suits your vehicle and driving habits. It may be readjusted in accordance with individual taste. Remember, when LED2 is on, the compressor is enabled when the air-conditioning system calls for cooling.

Once the calibration is completed to your satisfaction, install the Smartbox in the vehicle where the driver can operate S1 and view the LEDs.

When the vehicle is parked in full sun on a hot day, you may wish to use the override switch to obtain maximum cooling power until the interior is cool. That allows the system to operate normally without the fuel-saving feature. Once the interior of the vehicle is comfortable, switch back to automatic control for improved fuel economy and vehicle performance. Ω