Build A Versatile DTMF TONE PAD

It's an affordable way to add a DTMF keypad to your current transceiver.

BY BRIAN PLILER

One of the greatest benefits to being an electronics hobbyist is that you can build equipment you need rather than spending a lot of money to buy it. A great example of such a money-saving, do-it-yourself project is the *Versatile DTMF Tone Pad* described in this article; it can be built for about $20 (that's a fraction of the cost of commercial units). The Tone Pad can generate all 16 standard DTMF tone pairs (0–9, *, #, A, B, C, and D), will automatically key a connected transceiver whenever any key is pressed, and contains a built-in monitor amplifier and speaker that allows the actual tone pairs to be heard as they are transmitted.

Circuit Description. The schematic diagram for the DTMF Tone Pad is shown in Fig. 1. An input 12-volts DC (which can most likely be provided by a transceiver) is regulated by transistor Q1, resistor R1, and Zener-diode D2 to provide the circuit with a 5-volt supply.

A telephone-type keypad, KPD1, is used to enter a desired DTMF tone. When a button is pressed, a column and a row of the keypad are both connected to ground. Then, a TP5089N DTMF dialer (IC1), in conjunction with a 3.58-MHz color-burst crystal (XTAL1), generates the corresponding tone.

Switch S1 makes it possible to select all 16 DTMF tone pairs with the 12-button keypad, KPD1. When S1 is in the NORM (normal) position, column 3 on the keypad operates normally. But when S1 is placed in the EXP (expanded) position, DTMF tone pairs representing "digits" A, B, C, and D are generated in place of digits 3, 6, 9, and #, respectively.

When any key is pressed, pin 10 on IC1 goes low. That low is applied to the base of transistor Q2 through resistor R3, and causes 5 volts to appear at Q2's collector. Then, LED1 lights and, at the same time, transistor Q3 turns on via diode D3, which then keys the transceiver.

Resistor R5 and capacitor C3 create a short time delay that keeps the transceiver keyed between dialed digits. That keying circuit is compatible with the majority of modern transceivers using electronic switching. If the Tone Pad is used with a transceiver that uses relay switching, a spike-suppression diode (D5) should be added as shown in Fig. 1. That will prevent damage from occurring to transistor Q3.

The DTMF tone output from IC1 is coupled to trimmer-potentiometer R7, which controls the amplitude of the transmitted DTMF tones. Transistor Q4 operates as a buffer amplifier with an output impedance of approximately 500 ohms (that allows for direct connection to the microphone input on most transceivers). If the transceiver used with the Tone Pad has an input impedance that is greater than 500–600 ohms, the value of R10 must be changed accordingly.

Note that resistor R10 is not connected directly to ground, but to the anode of diode D4 and to capacitor C6 instead. That allows the buffer amplifier to be disabled when it is not needed. Recall that pin 10 on IC1 goes low when any key is pressed. That low pulls R10 low via diode D4 and discharges capacitor C6, thereby allowing the buffer amplifier to operate. As soon as the key is released, pin 10 on IC1 goes high, C6 charges, and the buffer amplifier is disabled once again.

The DTMF tone output from IC1 is also coupled to trimmer-potentiometer R6, which controls the unit's monitor volume. An LM386 audio amplifier, IC2, changes the low-level DTMF output from IC1 into a signal suitable for driving speaker SPKR1. Switching-jack J1 is wired so that when a plug is inserted, SPKR1 is disconnected and audio comes from the jack. Jack J2 provides speaker-level audio without silencing SPKR1.

Construction. The author's prototype was assembled on a small section of perforated board using point-to-point wiring. However, if you'd like to build the project on a printed-circuit board, you can use the foil pattern shown in Fig. 2 to etch and drill one. For those building the project on a printed-circuit board, a parts-placement diagram is provided in Fig. 3.

To make assembly of the tight circuit board easier, it is recommended that you mount low-profile parts first. Begin with sockets for IC1 and IC2. Next, install the jumper wires and resistors (mount R2, R4, R9, and R10 vertically), followed by the two trimmer potentiometers. Continue by adding the diodes, being sure to check their polarity (as mentioned earlier, whether or not D5 is installed depends on the type of transceiver you plan on using with the Tone Pad).

Go on to solder the capacitors next,

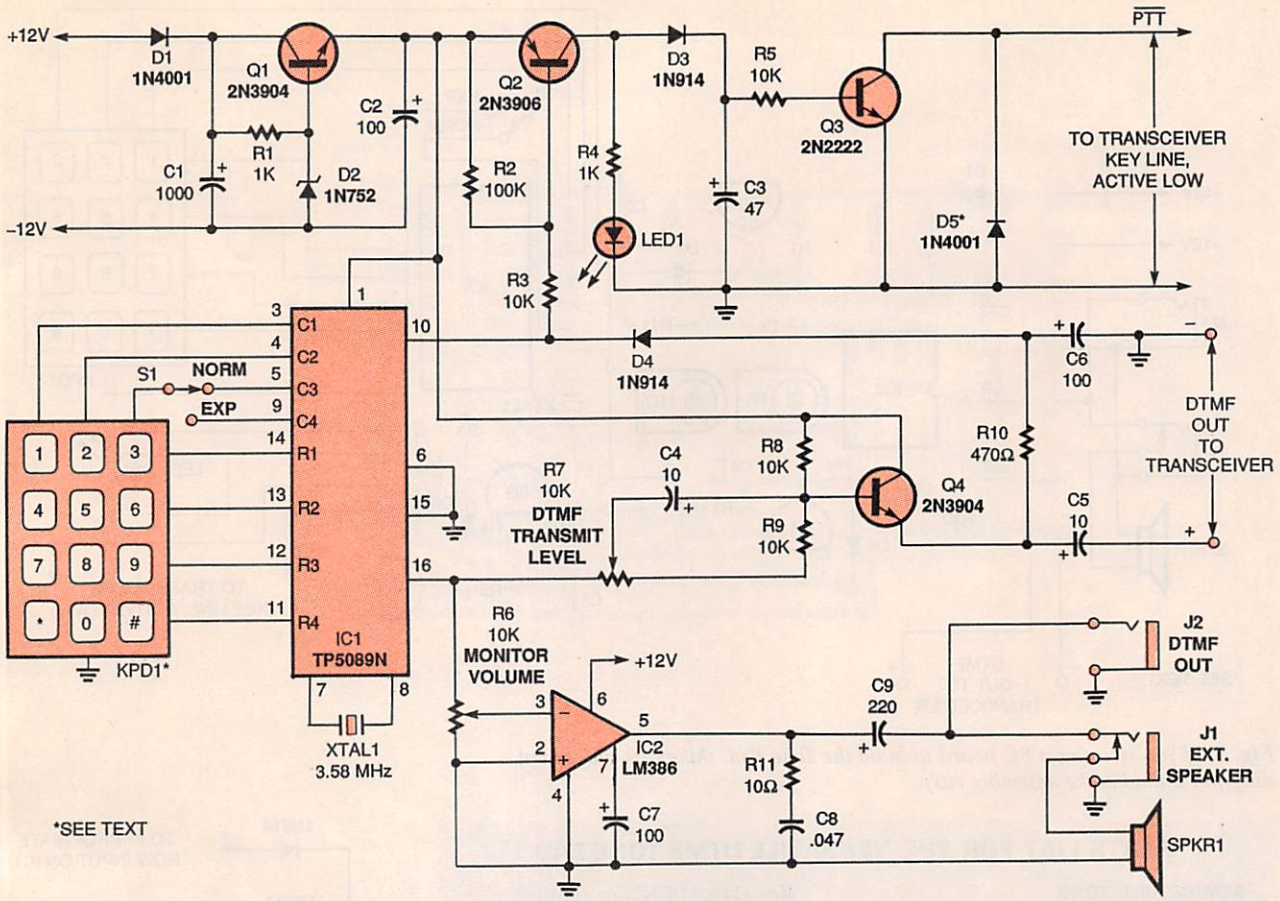

Fig. 1. This is the schematic for the DTMF Tone Pad. Switch S1 makes it possible to get 16 DTMF tones from a 12-digit keypad, KPD1. Just set S1 to EXP and digits 3, 6, 9, and # will produce tones A, B, C, and D, respectively.

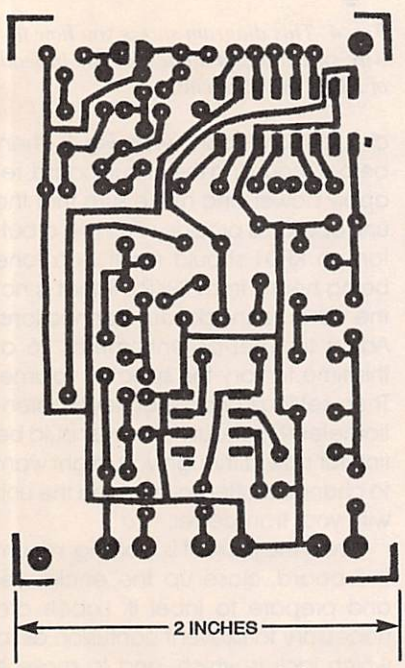

Fig. 2. Here's the full-size foil pattern for the Tone Pad PC board.

noting the polarity of the electrolytic units. Then install the transistors, being sure to orient them as shown in the parts-placement diagram. Before continuing with assembly, double check all connections and perform the following two tests:

Apply power to the board to confirm that the 5-volt regulator circuitry is operating correctly. Capacitor C2 should be supplying +5 volts. If that voltage is missing, ensure that diodes D1 and D2 are installed correctly. After you confirm that the regulator circuitry is working properly, temporarily connect LED1 to its pads on the board, and use an insulated jumper wire to temporarily ground the junction of resistor R3 and diode D4. As long as that jumper is held in place, LED1 should stay lit.

Disconnect the power source you just used from the board before continuing with assembly. Solder wires to the circuit board to facilitate the off-board connections to the keypad, jacks, switch, speaker, and LED. Also, solder long wires to the points on the board that will go to power and transceiver connections. Then insert IC1 and IC2 into their respective sockets to complete the on-board assembly.

Mount the 12-digit keypad to the enclosure you will use. If you have a difficult time buying a suitable keypad locally, you can do one of the following: First, try salvaging a keypad from an existing piece of telephone equipment (the keypad in the author's prototype came from a non-working cordless telephone). If that fails, try ordering one from Alltronics Corp. (2300 Zanker Road, San Jose, CA 95131), Electronic Goldmine (P.O. Box 5408, Scottsdale, AZ 85261), Electronix Express (365 Blair Road, Avenel, NJ 07001), or MECI (340 East First Street, Dayton, OH 45402). Write and ask for a catalog from one or all of those sources.

Another option is to make your own keypad, although the amount of parts and effort required might make finding a pre-existing keypad seem more desirable. To make a keypad of your own, wire normally open, SPST

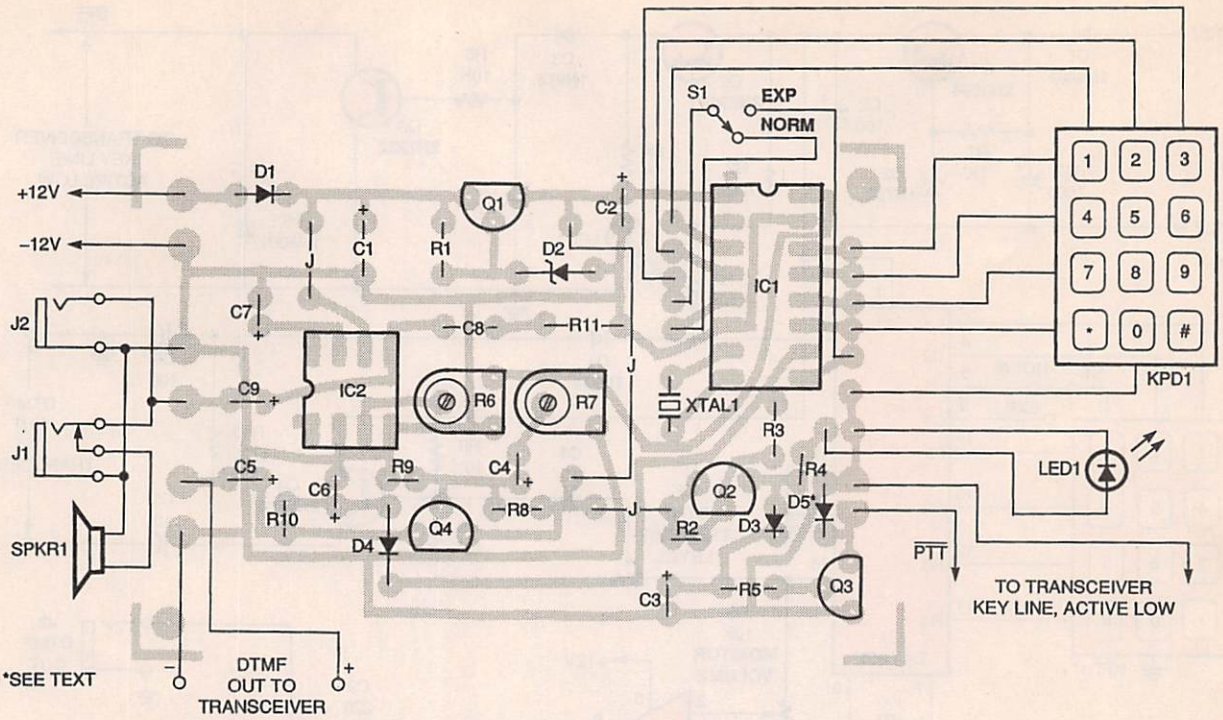

Fig. 3. If you're using a PC board to build the Tone Pad, this parts-placement diagram should make assembly easy.

PARTS LIST FOR THE VERSATILE DTMF TONE PAD

SEMICONDUCTORS

IC1—TP5089N, TCM5089N, LR4089, or ECG1690 DTMF dialer, integrated circuit (Digi-Key TP5089N-ND or equivalent)
IC2—LM386 low-power audio amplifier, integrated circuit
Q1, Q4—2N3904 general-purpose NPN transistor
Q2—2N3906 general-purpose PNP transistor
Q3—2N2222 general-purpose NPN transistor
D1—1N4001 silicon rectifier diode
D2—1N752 Zener diode
D3, D4—1N914 general-purpose silicon diode
D5—1N4001 silicon rectifier diode (optional, see text)
LED1—Light-emitting diode, red

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R4—1000-ohm
R2—100,000-ohm
R3, R5, R8, R9—10,000-ohm
R6, R7—10,000-ohm trimmer potentiometer, PC-mount (Digi-Key D4AA14-ND or similar)
R10—470-ohm
R11—10-ohm

CAPACITORS

C1—1000-µF, 16-WVDC, electrolytic
C2, C6, C7—100-µF, 16-WVDC, electrolytic
C3—47-µF, 16-WVDC, electrolytic
C4, C5—10-µF, 16-WVDC, electrolytic
C8—0.047-µF, Mylar
C9—220-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

XTAL1—3.58-MHz color-burst crystal
J1—3.5-mm switching panel-mount jack, normally closed
J2—3.5-mm panel-mount jack
KPD1—12-button telephone keypad (3 × 4 matrix with common)
SPKR1—8-ohm, 0.2-watt, 2-inch diameter speaker
S1—SPDT miniature toggle switch
Printed-circuit materials, project enclosure, IC sockets, rub-on labels, clear lacquer, wire, solder, hardware, etc.

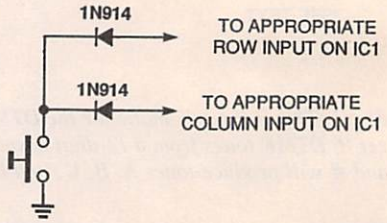

Fig. 4. This diagram shows you how to wire switches and diodes for use instead of KPD1 in the circuit.

pushbutton switches as shown in Fig. 4. Note that each "digit" will require one switch and two 1N914 diodes.

Once you have mounted the keypad, go on to mount the jacks, switch, speaker, and LED to the enclosure. Make the connections between all those off-board components and the circuit board as shown in Fig. 3. Then, before mounting the circuit board, reapply power and make sure that the unit operates properly. Pushing a button on KPD1 should result in a tone being heard from SPKR1. If that is not the case, recheck your connections. Adjust trimmer-potentiometer R6 at this time to vary the speaker volume. Then, set the transmission-level potentiometer, R7; about halfway should be fine for now, although you might want to change it after you've used the unit with your transceiver.

When the project is working, mount the board, close up the enclosure, and prepare to label it. Labels are necessary to prevent confusion as to which jack is which, and to make it easier to remember which setting of S1 will yield the expanded tones. The author used rub-on labels and

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coated them with a layer of clear lacquer to protect them from damage in everyday use. You can do the same or use another type of labeling technique.

To use the Tone Pad with a transceiver you have to first decide how you would like to connect the two. While the unit could be hard-wired to the transceiver, using matching plug-and-socket connectors would be a better idea. Some transceivers have +12-volt, ground, transmit audio, and PTT keyline connections already available at an accessory socket on the rear panel. If that is the case, simply use matching plugs on the unit's connection wires.

And that's all there is to it! Once it's connected to your transceiver, the DTMF Tone Pad can be used for countless tasks, making it a constant reminder of the money-saving benefits you can enjoy by being an electronics hobbyist. ■