ATC Electronics' DTMF Plus

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Decoding DTMF (touch-tone) signals continues to be an area of interest for many people. There have been several articles published over the last couple of years describing various ways of accomplishing this task. The DTNE-Plus unit described in this article takes the best features of various units and combines them into one universal device.

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 still continues to be in items related to the public telephone network. Whatever the source of the signal, DTMF-Plus will be able to decode it.

Each time DTMF-Plus receives a valid signal it converts it to an RS-232 data stream and sends it to your PC where it is displayed on the screen. There are four different data rates available which should make the unit compatible with any type of PC. The unit also decodes all 16 of the digit combinations.

The heart of the DTMF-Plus unit is a Microchip PIC 16C54 microprocessor. It receives the DTMF information from a SSI-204 decoder chip and processes it for display purposes. You can purchase a preprogrammed 16C54 from the source shown in the parts list. If you want to program your own part, the source code is available on the Electronics Now Website for downloading. The RS-232 data is displayed on your PC using any communications program that you happen to have. You may also purchase an optional data logging program to permanently store the information that you decode.

As you can see by looking at Fig. 1, there are two possible sources for input signal. Switch S1 selects the source as either a standard telephone line or as the self-contained microphone. The 1458 dual op-amp handles the necessary gain and impedance conversions that the SSI-204 needs to detect the DTMF signals. When the microphone is used as the signal source, you will have to experiment to obtain the optimum speaker volume level that the unit needs to decode the signals. However, the gain of the microphone amplifier is preset so that normal listening level are sufficient for the unit to function properly.

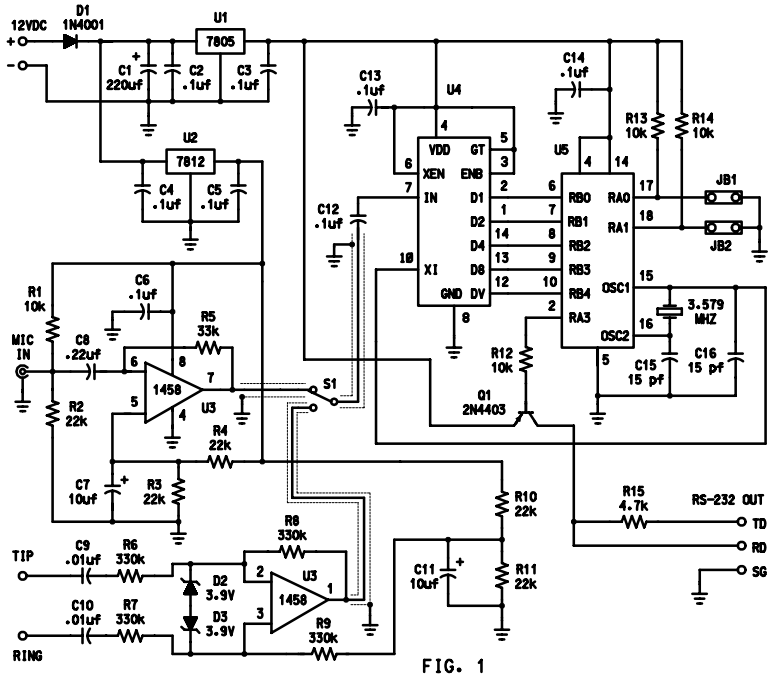


FIG. 1

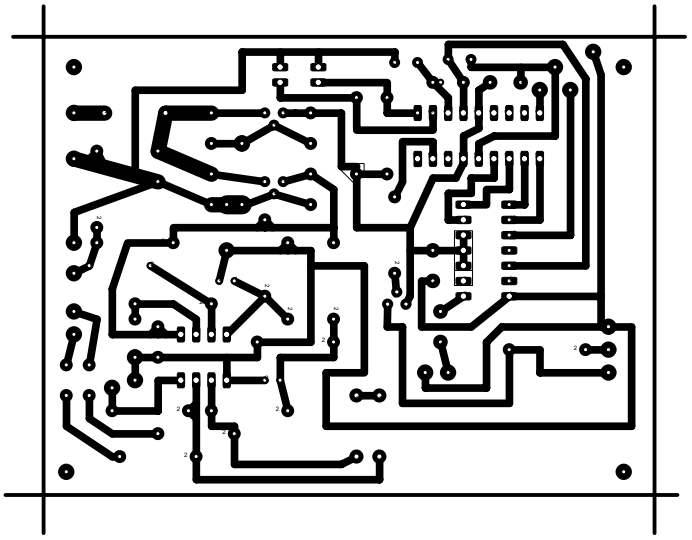
The 16C54 drives Ql which converts the data signal to a RS-232 level signal. This conversion takes place by using the voltage that is available at the TD terminal of the PC. Therefore a separate negative voltage power supply is not required. Looking further at Fig. 1, you will notice 2 jumpers labeled J1 and J2. These jumpers determine the speed of the RS-232 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, 1 stop bit, and no parity bit.

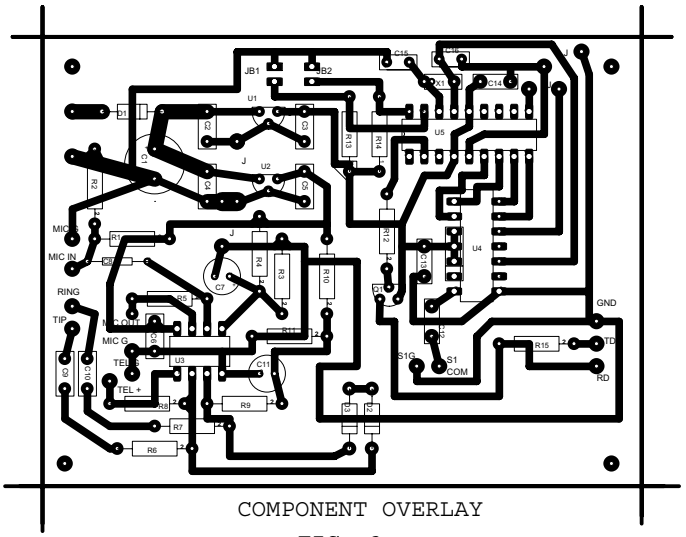
Each time a DTMF digit is received, a 3 second timer is started. If 3 seconds elapse between digits, the unit moves the cursor over 5 spaces on the screen. If 10 seconds elapse between digits, the unit sends out a carriage return and a line feed. These timers make for a more readable digit format on the screen. For example, if someone dials a pager number, they wait for the pager service to answer and then they enter the callback number. 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, you have to make the assumption that there will be no more dialing for this particular call. Therefore, if additional digits are received at a later time, they should be displayed on a separate line. This type of screen formatting should handle most situations.

As was previously mentioned, you can purchase the data logging program to keep a permanent record of the signals you decode. This program allows you to store the calls as they come in and view them at a more convenient time. Just leave the unit connected to your phone line and PC. Each time a number is dialed it will be stored to the database for later viewing. Every time the unit sends a CR/LF combination, the row of digits is stored as a call record. Records can be deleted from the database on an individual basis or all records can be deleted at once. The DOS based program runs on any IBM compatible machine. At this time there is no Windows version available. You could also write a program of your own using the language of your choice. Use the CR/LF sequence as you key to write the new record.

You can construct the DTMF-Plus using perfboard or you can purchase a PC board from the source shown. You can also make your own PC board using the board layouts shown in Figs. 2 and 3. Wiring is non-critical and either method will yield good results. If you use the perfboard method, keep the wiring associated with the 1458 as short as possible. Also, make sure that you use shielded wire for the connections to S1 and to the microphone. Do not connect the shields together at S1. When installing the unit in a case it would be best to drill a hole in the case and mount the microphone inside the case over the hole. This will protect the microphone from damage if the unit is accidentally dropped. Silicone glue can be used to mount the microphone to the case.





COMPONENT OVERLAY

FIG. 3

Power for the unit comes from a 12 vdc wallwart type of power adapter. The cheapest and smallest one you can find will be sufficient since current requirements are next to nothing. An onboard 5-volt and 12 volt regulator insures that the voltages are correct for the unit. Additional filtering is provided as most of the wallwart supplies have fairly high AC voltage ripple.

Construct the unit according to the schematic shown in Fig. 1. I suggest using IC sockets for the 16C54 and SSI-204. If you are using perfboard construction, it is best to use sockets for all ICs in the event one of them has to be changed later. The only connection to your PC will be the TD line, the RD line and the SIG GND line. If your serial port has a 25 pin connector, connect TD to pin 2, RD to pin 3 and SIG GND to pin 7. If you have 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 machine, you will need to determine where your transmit data, receive data and signal ground lines are and make the appropriate connections.

When construction is completed, install the jumpers to set the speed at which you will be communicating with your PC. Connect the unit to your PC and start you communications program in the dumb terminal mode. Make sure you have it set up for the proper COM port that you will be using. The easiest way to test the unit is to connect it to your home telephone line. Remove the cover from the wall jack that your telephone is plugged into. Depending on how old the wiring in the house 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, there should be a white wire with a blue

tracer and a blue wire with a white tracer. Connect the unit to these wires. If you by chance have 2 lines in the house, line 2 should be on the white with orange tracer and orange with white tracer wires. In the case of older wiring, line 2 should be on the black and yellow wires. Polarity of the connections is unimportant.

Now, apply power to the unit. You should see a sign on message that says "Touch-tone decoder is now active". If you get garbage on the screen check your communications program parameters to make sure they are set properly. If you do not get anything at all, check the wiring between the unit and your PC. Also, check the construction of 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 your telephone handset and dial 3 or 4 digits. Then pause for 4 seconds. Now dial a couple of more digits. You should see the numbers appear in two separate columns. Ten seconds after you dial the last digit, you should see the cursor drop down to the beginning of the next row.

The final test is to use the microphone to receive the touch-tone signals. Turn on a radio where you know you will be hearing DTMF signals sent out over the air. Turn the radio volume level up to a comfortable level and place the unit about 6 inches from the radio speaker. Put S1 in the microphone position. When you hear DTMF signals on the radio you should see them displayed on the screen. If you have a speakerphone, you may also be able use it to test the microphone. Place the unit in front of the speakerphone and turn the speakerphone on. Go to another telephone and pick it up and dial several digits. They will come out over the speakerphone and the unit should decode them and send them to the PC. Some speakerphones limit and clip high level signals. This results in distortion of the tones and the unit will not decode them. If you cannot decode tones from your speakerphone, you will have to wait until you hear them on your radio to determine the correct distance to place the unit from the speaker.

If all of the above tests check out, the unit is ready to be closed up and put into 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 will not have any adverse affect on the unit.

PARTS LIST

R1, R12, R13, R14 - 10,000 ohm
R2, R3, R4, R10, R11 - 22,000 ohm
R5 - 33,000 ohm
R6, R7, R8, R9 - 330,000 ohm
R15 - 4700 ohm

C1 - 220 uF, 25 WVDC, aluminum electrolytic
C2-C6, C12-C14 -- .1 uF, ceramic disc
C7, C11 - 10 uF, 16 WVDC, aluminum electrolytic
C8 -- .22 uF, mylar or ceramic disc
C9, C10 -- .01 uF, 50 WVDC, ceramic disc
C15, C16 - 15 pF, ceramic disc

D1 - 1N4002 diode
D2, D3 - 3.9V ½ watt zener diode
Q1 - 2N4403 PNP transistor
IC1 - 78L05 voltage regulator
IC2 - 78L12 voltage regulator
IC3 - LM1458 dual op-amp
IC4 - SSI-204 or CD22204 DTMF decoder
IC5 - PIC16C54A-04 microprocessor

Additional Parts

J1 - Wall adapter compatible power jack
J2 - 2 position terminal strip
J3 - DB-9 or DB-25 female RS-232 connector
JP1, JP2 - 2-position header pin
MIC1 - Electret-condenser microphone
S1 - Single-pole, double-throw toggle switch
XTAL1 - 3.579 Mhz crystal

The following parts are available from:

ATC Electronics
P.O. Box 43033
Phoenix, AZ 85080-3033
623-516-2926

Pregrogrammed PIC16C54 microcontroller	$10.00
SSI-204 DTMF decoder IC	$ 2.50
Printed circuit board	$ 6.50
Data logging program	$ 7.50
Complete kit of parts. Includes everything needed to build DTMF Plus except for case and RS-232 connector	$32.50

Add $2.00 for shipping and handling on individual parts orders
Add $4.00 for shipping and handling on complete kit order
AZ residents include 7.2% sales tax.

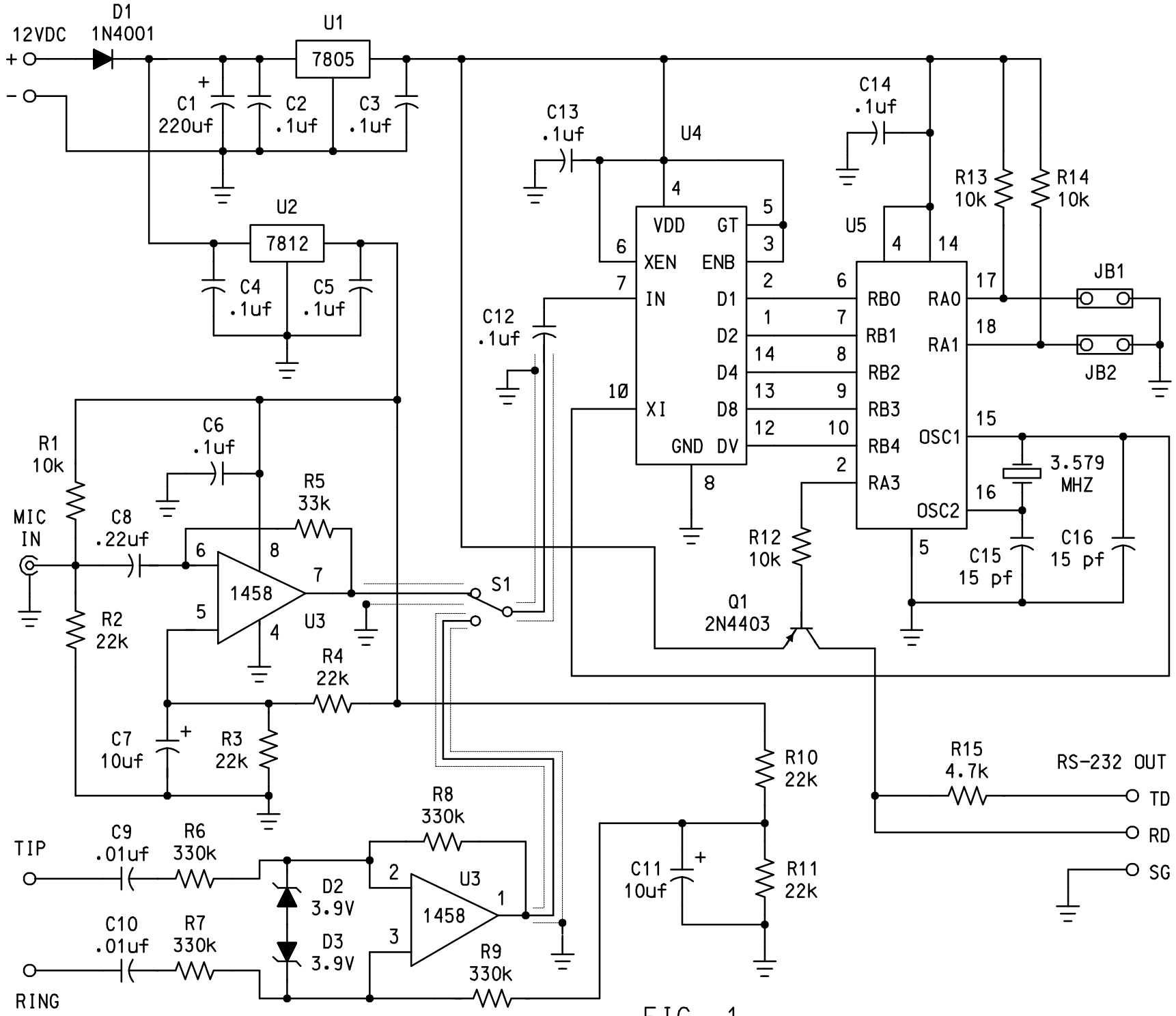

12VDC
D1
1N4001
U1
7805
C1
220uf
C2
.1uf
C3
.1uf
U2
7812
C4
.1uf
C5
.1uf
C13
.1uf
U4
VDD
GT
XEN
ENB
IN
D1
D2
D4
D8
XI
GND
DV
C14
.1uf
U5
RB0
RB1
RB2
RB3
RB4
RA3
RA0
RA1
OSC1
OSC2
R13
10k
R14
10k
JB1
JB2
3.579
MHZ
C15
15 pf
C16
15 pf
C12
.1uf
R12
10k
Q1
2N4403
R1
10k
C6
.1uf
R5
33k
MIC
IN
C8
.22uf
1458
U3
S1
R2
22k
R4
22k
C7
10uf
R3
22k
R10
22k
R15
4.7k
RS-232 OUT
TD
RD
SG
R8
330k
TIP
C9
.01uf
R6
330k
D2
3.9V
D3
3.9V
C10
.01uf
R7
330k
RING
R9
330k
C11
10uf
R11
22k

FIG. 1

This graphic is the correct size for making a PCB