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Emergency Tone Alert System

During the last part of July, 1979, tropical storm Claudette hit the Galveston-Houston area, dropping from ten to forty-five (yes, forty-five) inches of rain in various parts of the region in a very short time. Although the area was well blanketed with repeaters carrying emergency information, the rapid rise of water at night caught many hams unaware; some did not know of the emergency until water started coming into their homes. At that time, there was no way of alerting the radio amateurs once they went to bed, since most of them turned off their two-meter rigs so that the routine chatter on the frequency would not keep them awake.

Claudette made it extremely clear that a method was needed to quickly and efficiently alert area amateurs that an emergency situation existed. Two additional emergencies in rapid sequence made it imperative that we act immediately.

Our need was for a simple, economical system that could be put into effect almost immediately. Discussion on the air and at the August meeting of the Tidelands Amateur Radio Society (TARS) and the University of Texas Medical Branch (Galveston)-Emergency Communications Group (UTMB-ECG) developed criteria for a device similar to the tone-alert system of the National Weather Service (NWS), a single-tone system.

A system for decoding dual tones has been used in Dallas for the past two years. Of the approximately 400 Radio Amateur Civil Emergency Service (RACES) members in Dallas, one hundred have the tone alert available. The usual response to any use of the emergency tone alert is at least 50% of the hams equipped to receive it. The local authorities are very impressed with the ability of the hams to respond to emergencies. The Dallas system is the "A-Tone Decoder" using the DTMF A tone. The tone alert is initiated by Civil Defense. Initially, the alert is on the 146.28/.88-MHz repeater, but it may go to other repeaters if the area of emergency is wider than can be covered by one repeater. The choice of the A tone for this metropolitan area was based upon the high possibility for abuse of other tones. The A tone generally is not available on the pads commonly used by hams. So far, Dallas has had no false alerts, even though some non-hams have gotten access to two-meter equipment and some hams have tried to jam the

Photo A. Completed tone alert.

transmissions.

Tarrant County (Fort Worth), near Dallas, is interested in implementing a similar system in the near future.

The decision of TARS and UTMB-ECG was to develop a tone-alert device based upon the success of Dallas, the ideas expressed by WA3ENK,[1] the WB5PRD design, and utilizing at least a four-second signal of the dual tones of the DTMF figure 9 (which most amateurs have available in a touch-tone™ or comparable pad) as the triggering signal. Use of a relay to silence the audio circuit to an external speaker until activated by the tone was considered the simplest alert device. The four-to-five-second duration of the tone in our tone alert causes a relay to close which then turns on an external speaker or alarm bell.

Twenty copies of the original WB5PRD board were ordered, and within three days the interest was so great that an additional 50 boards were ordered.

The original WB5PRD schematic was modified (but still using the original board) to fit our needs and to use the DTMF 9 tones. Local sources of parts in quantity were inadequate, so parts were ordered to provide 50 tone-alert kits. Parts were ordered from companies advertising in the several amateur radio journals. Upon checking the parts when they arrived, we found one company had shipped 30% of the parts in an inoperable condition, so these had to be replaced. By careful selection of sources, we were able to get the total cost (parts and board) down to $12.50 for each kit. (The prototype using parts bought in small quantities was built for about $18.00.) While awaiting receipt of parts, a construction and testing manual was written.

Photo B. Assembled PC board.

Word of what we were doing spread rapidly and inquiries came from other clubs and groups. Discussions concerning this system became quite active among several RACES and CD nets in Houston, Alvin, Clear Lake, and East Texas areas. Several groups asked if the device could be adapted to their special needs.

The concept of TARS and UTMB-ECG calls for the Emergency Operating Centers (EOCs) or a duly-authorized operator to initiate the 9 tone whenever the need arises to activate the net for emergencies. We also use the tone alert to call up our weekly repeater (147.75/.15 MHz) and simplex (145.53 MHz) nets.

As others have discovered, in the absence of phone-patch capability, hams must rely on tone alert.[2] It soon became apparent that two levels of alert would be needed: a low-level alert for personal emergencies such as car trouble, and a high-level alert for general emergencies such as hurricanes, floods, or explosions. A single-tone capability for low-level alerts can be added without additional circuitry, using a toggle switch to ground one decoder output. With the switch in the low position, the tone alert can be activated by a DTMF 7, 8, or 9. We recommend the use of the figure 7 for low-level alerts and reservation of the figure 9 for high-level alerts.

Generally, the amateurs leave the tone alert on low level when they are around the shack and switch to high level when they go to bed. Thus, their alert device would awaken them only for high-level general emergencies.

Several other groups are planning to use the 9 for their alerts. Thus, a number of hams are now using the tone alert with scanners monitoring these several repeaters. The scanners are being modified so that they will scan silently even if there is routine activity on the frequency, but if the 9 signal is given, the scanner will lock onto that frequency and activate the audio.

The Texas DX Society is considering using the tone alert on their repeater to alert members when rare DX is heard on the HF bands. They anticipate using a set of tones other than the 9 so that their signal will not activate scanners that are monitoring the repeaters for emergencies.

Another modification of the tone alert will be for use with weather radios to decode the 1050-Hz tone of the National Weather Service alerts and activate weather receivers not previously provided with tone alert. Since the NWS alert is only a single tone, such use will require only one decoder of the tone alert. The tone alert used for NWS cannot be used at the same time for the DTMF emergency tones.

Why were the 9 and 7 tones chosen? We thought that since 911 is used on the telephone to dial emergencies to fire and police, use of a 9 would be easy to remember as the alert sig-

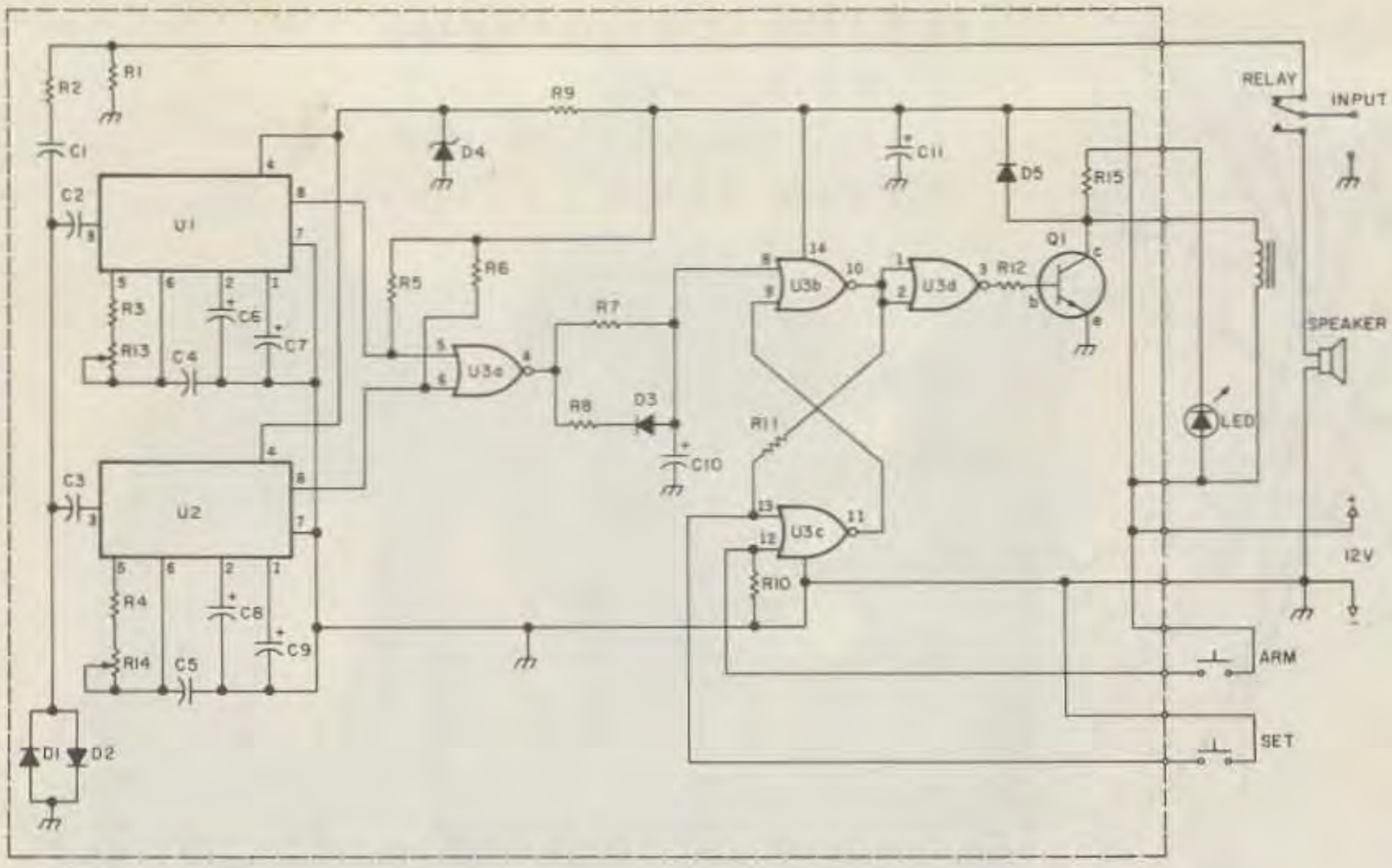

Fig. 1. Schematic diagram. (See Parts List.)

nal. The low-level alert is a good-neighbor service for individual or personal emergencies; therefore, it was considered appropriate to use the 7 or 73 for this alert tone.

Whether a large area such as the Galveston-Houston area is involved in emergencies or smaller local areas only, there is a way to alert only one or the other. If a general alert is involved, then the alerting operator goes from repeater to repeater giving the alert and announcing the emergency. If only a local area is involved, then only the repeater covering that area is alerted.

Because of the seriousness of emergencies that can occur in this region of the Gulf Coast and the potential for abuse, it was early decided to establish the following Galveston County general guidelines for use of the tone alert.

High-Level Alert

1. The tone alert will be activated only by duly-authorized operators acting on behalf of emergencies declared by Civil Defense or other official agencies, or on behalf of the repeater organization.

2. Alert will be sounded:
a) in the event of a civil emergency;
b) for a regularly scheduled test or drill;
c) to call attention to bulletins of general interest during an emergency.

3. Initially, the alert will be sounded on the repeater (147.75/.15 MHz) covering the area affected by the emergency and on 145.53 MHz simplex.

4. Alert will be sounded by transmitting the digit 9 for 15 seconds. The station transmitting the tone will:

a) identify;
b) transmit tone for 15 seconds;
c) call CQ or QST;
d) state the nature of the emergency or that a test or drill is in progress;
e) give instructions concerning action to be taken and/or frequencies to be monitored.

5. Individual testing and tune-up of the tone-alert circuit will be done on a simplex frequency other than 145.53 MHz and will not be done on repeaters. Use low power if possible when testing or tuning circuit.

6. High-level tone alert will not be used for routine personal emergencies such as flat tire, out of gas, etc.

Low-Level Alert

1. This alert may be sounded by any amateur having a personal or individual emergency for which he needs help. (It is recommended that a direct call on the repeater or simplex frequency be tried first before using the tone alert.)

2. Low-level alerts will be sounded only on the local area simplex or repeater frequency. Low-level alerts are not to be used for general alerts covering more than one repeater.

3. Alert will be sounded by transmitting the digit 7 for 15 seconds. The station transmitting the tone will:

a) identify;
b) transmit the 7 tone for 15 seconds;
c) call CQ or QST;
d) state the nature of the emergency and request the necessary assistance.

This plan has been operational since August, 1979, is gaining adherents, and the idea is spreading. Based upon our experience, we would recommend this or a similar system to other amateurs participating in emergency activities.

Circuit Description

The schematic is shown in Fig. 1. The components listed in the Parts List are standard items which are readily available. Advantages and disadvantages of the 567 PLL tone decoder have been discussed previously in the amateur literature.[1-4]

The circuit is powered from a 12-volt dc source. Zener diode D4 provides 6.2 volts dc for U1 and U2.

When the circuit is armed by bringing pin 12 of U3c to logic one briefly, audio is routed through the normally-closed contact of the relay to loading resistor R1 and to the input of the decoder circuits through R2. Germanium diodes D1 and D2 conduct at 300 mV to protect the circuit from audio overload. C2 and C3 pass the audio tones but block dc from entering U1 and U2 along with the audio signal.

U1 and U2 decode the high and low tones, respectively. R3, R13, and C4 set the center frequency of U1; R4, R14, and C5 set the center frequency of U2 (bandwidth is about 5% of the center frequency).

When a decoder locks on an incoming tone, pin 8 goes to logic zero. When both U1 and U2 are locked, pin 4 of NOR gate U3a goes to logic one. C10 then charges through R7 to provide a delay before pin 8 of U3b reaches logic one. U3d inverts the output of U3b. The sequence is now complete, the relay and LED are activated by Q1, and audio is now routed to the speaker until the circuit is again armed.

A total delay of three to four seconds is introduced between initial reception of the tone and activation of the relay to prevent false activation of the circuit.

D3 and R8 provide a discharge path for C10 when no tone is present. This prevents a buildup of charge over a period of time from intermittent false signals which might cause activation of the circuit. D5 protects Q1 from the transient voltage present when the relay is deactivated.

Momentarily closing the normally-open ARM (RESET) switch will deactivate the relay (open the audio circuit to the speaker) and will arm the decoders so that they can respond to an incoming tone signal.

Momentarily closing the normally-open SET switch will activate the relay so that audio goes to the speaker. This mode will continue until the ARM (RESET) switch is activated. (A momentary DPDT toggle switch with center off can be used in place of two separate momentary switches.)

Assembly

The circuit was assembled on a WB5PRD circuit board. (Drilled printed circuit boards are available from WB5PRD for an SASE and $4.00.) The foil side of the board is shown in Fig. 2, which is suitable for use in reproducing the board. An assembled PC board and a completed tone alert are shown in the photographs.

Parts layout is shown in Fig. 3. Assembly can be facilitated if one starts with those components at the center of the board and works outward toward the edge. Diodes, capacitors, trimpots, and quarter-Watt resistors are mounted vertically. The two one-Watt resistors are mounted horizontally. If proper care is taken as to which end of the vertically-mounted resistors is upmost, then that point of the resistor can be used as a test-point contact for testing other parts of the circuit. (See Table 1.)

The usual precautions should be observed when handling the 4001 CMOS integrated circuit. For temperature stability, C4 and C5 must be high-quality mylar™ or metallized film capacitors.

The switches and LED are installed on the front panel or speaker enclosure. The LED should be near the SET switch; the LED lights when the tone-alert unit is in the SET activation. The relay is installed off the circuit board with epoxy glue or silicone rubber. A multi-pole relay may be substituted if other devices, in addition to the speaker, are to be controlled. (Remember that when other devices such as bells or buzzers are on the relay, they will be activated when the SET switch is activated.)

The twelve-volt dc supply is connected between points marked + and − (ground). One side of the relay coil and the LED anode are connected to point K&L and the other side of the relay coil goes to K. The cathode of the LED goes to L. The ARM (RESET) switch is connected to the points marked A. The SET switch is connected to the two points marked S. Audio is connected between INPUT and ground. Points E, B, and C indicate the emitter, base, and collector of Q1.

Tune-Up

The tone alert may be adjusted for the DTMF tone 9 using either of two procedures—either a frequency counter or a voltmeter may be used. With the frequency counter method, the counter is connected to U1 at pin 5 (for a square wave) or pin 6 (for a triangle wave), and R13 is adjusted until the counter shows 1477 Hz. Take care not to load the circuit with the test equipment. Next, connect the counter to pin 5 or 6 of U2 and adjust R14 until the counter shows 852 Hz.

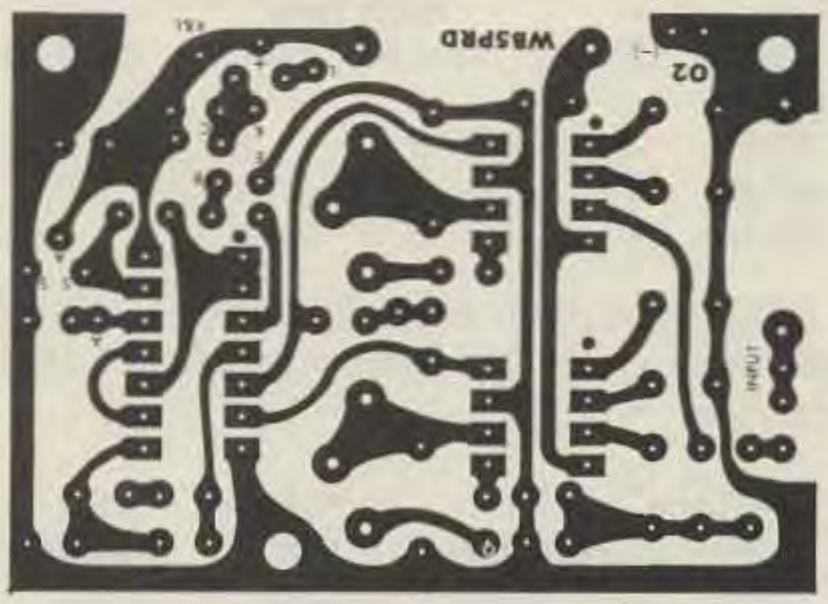

Fig. 2. PC board, foil side. This is suitable for reproducing the board for those who would like to do so.

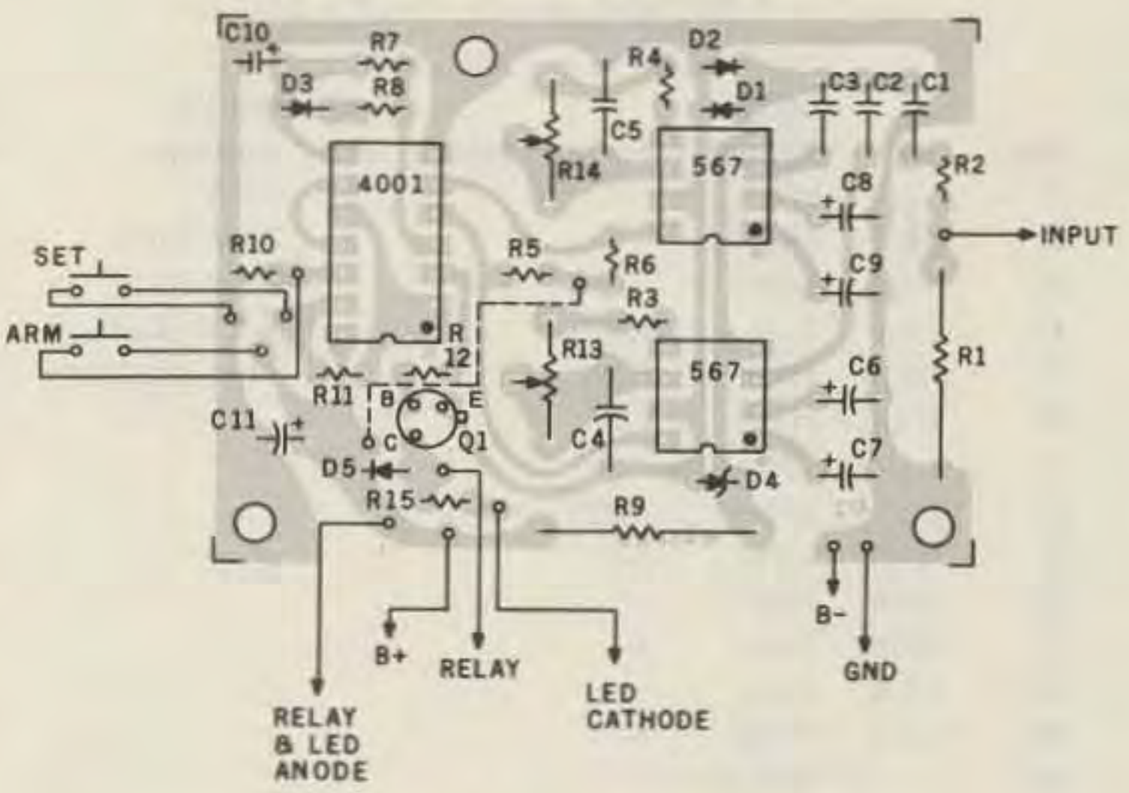

Fig. 3. Parts layout.

Alternatively, a voltmeter or logic probe may be used. Start with R13 and R14 fully counterclockwise. Apply an alert tone with the probe on pin 8 of U1 or pin 5 of U3 and slowly turn R13 clockwise. Note the position of R13 when the voltage drops and continue turning R13 clockwise until the voltage goes back up; note this point. Turn R13 counterclockwise to a point midway between the two voltage change settings. Do the same with the probe on pin 8 of U2 or pin 6 of U3 while adjusting R14.

Operation

Apply 12 volts dc to the unit. Momentarily close the SET switch; the relay should activate. Provide an audio input from the two-meter rig. The circuit will not function properly with a high noise signal or with too little audio drive. Turn the audio gain up to ensure proper drive level. The loading resistor is rated at one Watt. ARM the circuit and have another operator transmit an alert tone on a simplex frequency for fifteen seconds. The unit should activate in less than ten seconds.

Circuit Alternatives

The circuit can be tuned for tones other than the digit 9. The standard tone pairs are listed in Table 2.

Component	Connection
R3	Pin 5, U1
R4	Pin 5, U2
R5	Pin 5, U3a
R6	Pin 6, U3a
R7	Pin 8, U3b
R8	Pin 4, U3a
R11	Pin 2, U3d
R12	Pin 3, U3d

Table 1. The end of the component connected to the listed test point is placed in the up position.

Low Tone	High Tone 1209 Hz	1336 Hz	1477 Hz	1633 Hz
697 Hz	1	2	3	A
770 Hz	4	5	6	B
852 Hz	7	8	9	C
941 Hz	*	0	#	D

Table 2. DTMF tone pairs. Each digit or sign is composed of two tones. For example, 1 is composed of a 697-Hz tone and a 1209-Hz tone.

Low Tone (Hz)	R4 (kilohms)	High Tone (Hz)	R3 (kilohms)
697	11.0	1209	5.6
770	10.0	1336	5.6
852	8.2	1477	5.6
941	8.2	1633	3.9

Table 3. Alternate values for R3 and R4.

Pin	4001 Set	Armed	Tone Present	U1 and U2 Pin	Voltage
1	Low	High	—	4	6.2 V
2	Low	High	—	5	12.0 V (no alert tone)
3	High	Low	—		0.1 V (alert tone present)
4*	Low	Low	High		
5*	High	High	Low		
6*	High	High	Low		
7	--------Ground pin--------				
8*	Low	Low	High		
9	High	Low	—		
10	Low	High	—		
11	High	Low	—		
12**	Low	Low	—		
13	Low	High	—		
14	---------12 volt pin---------				

*These remain at the same state during SET and ARMed periods and change only during the presence of the alert tone. Do not replace the chip yet if any of these pins do not agree.
**This pin should go high while pressing the ARMed button.

Table 4. Logic and voltage chart.

The corresponding alternative values for R3 and R4 are shown in Table 3.

Most of the delay between the introduction of an alert tone and relay activation is introduced by R7 and C10. These may be adjusted to provide a longer or shorter delay.

If one wishes to have both a low level of alert and a high level of alert, this can be done by adding an SPST toggle switch so that pin 5 of U3a (or pin 8 of U1) can be grounded. With pin 5 or pin 8 grounded, only a single tone (852 Hz) will activate the unit. With the switch in the closed (grounded) position, the tone alert can be activated by the digit 7 for a low-level or personal emergency, and in the switch-open position, it will take both tones of the digit 9 to activate the unit.

Weather Watch (Alert) Modifications

Only minor changes are required on this circuit to decode the NWS 1050-Hz alert tone for weather radios that do not have this feature. U1, R3, R5, R13, C4, C6, and C7 are omitted. A jumper is placed between the foils originally intended for pins 7 and 8 of U1. R14 is adjusted for 1050 Hz at pin 5 or 6 of U2. Activation methods and time will remain the same.

Troubleshooting

Step One: Most problems with performance can be traced to bad solder joints, solder bridges, incorrect parts placement, or failure to observe polarity of diodes or capacitors. All construction steps should be retraced with this firmly in mind.

Step Two: Confirm that adequate noise-free audio is actually present at the input and that the relay will work out of the circuit. Close the SET switch to activate the relay.

Step Three: Use a VTVM or FET-VOM (at least a megohm resistance) and check the voltages listed in Table 4.

Step Four: Using a piece of hookup wire, connect one end to ground and carefully touch the other end to both pins 5 and 6 of U3 with the circuit ARMed. The relay should activate in about four seconds. If it takes as long as thirty seconds to activate the relay, check R7, R8, C10, and D3. If this fails, replace U3.

Step Five: Check U1 and U2 for proper tuning.

Step Six: Ground pin 8 of U1 and send a DTMF digit 7 signal over the audio input. If this activates the relay in 4-6 seconds, then U2 is tuned and functioning. If the relay does not activate, then replace U2 and try again.

Step Seven: Ground pin 8 of U2 and send a DTMF digit 3 signal over the audio input. If this activates the relay in 4-6 seconds, then U1 is tuned and functioning. If the relay does not activate, then replace U1 and try again. ■

Parts List

Resistors
R1—10 Ohms, 1 Watt
R2—1.5k Ohms, ¼ Watt
R3—5.6k Ohms, ¼ Watt
R4—8.2k Ohms, ¼ Watt
R5, 6, 11—27k Ohms, ¼ Watt
R7—560k Ohms, ¼ Watt
R8—1k Ohms, ¼ Watt
R9—220 Ohms, 1 Watt
R10—10k Ohms, ¼ Watt
R12—22k Ohms, ¼ Watt
R13, 14—5 kilohms, vertical trimpots
R15—1k Ohms, ¼ Watt
Capacitors
C1, 2, 3—0.1 μF ceramic disc, 25 V
C4, 5—0.1 μF mylar™, 16 V
C6, 8—1.0 μF electrolytic, 6 V
C7, 9—10.0 μF electrolytic, 6 V
C10—3.3 μF electrolytic, 16 V
C11—100 μF electrolytic, 16 V
Semiconductors
D1, 2—1N34A germanium (or equivalent)
D3—1N914 silicon (or equivalent)
D4—6.2 volt, 400 mW zener
D5—1N4001 (or equivalent)
Q1—2N2222 NPN transistor
U1, U2—567 dual inline, tone decoder
U3—4001 CMOS logic block
Keep CMOS wrapped in foil until ready to install.
LED—jumbo LED of choice

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3. J. H. Everhart WA3UXH, "Toward A More Perfect Touch-tone Decoder," *73 Magazine*, November, 1976.
4. Rick Swenton WA1LWV, "Tone Decoder Improvements," *73 Magazine*, February, 1979.