solid-state mobile touch-tone circuit

This all solid-state Touch-Tone circuit provides automatic, mobile fm operation

Roy C. Hejhall, K7QWR, Motorola Semiconductor Products, Inc.

Since joining the growing crowd of two-meter fm repeater enthusiasts over a year ago, I have observed a variety of telephone Touch-Tone pad interface circuits for connecting the pad to the transmitter. Most have had various features which I felt could be improved upon by an all solid-state version. Thus, I launched the design effort which resulted in the circuit described in this article.

background

One of the better circuits to come to my attention is the one described in an excellent article by WØLPQ.[1] This circuit has several advantages over other Touch-Tone interface circuits commonly in use: automatic keying of transmitter with delayed drop-out, automatic connect-disconnect of Touch-Tone audio output to transmitter audio system, and no transformer or battery required.

It was decided that the new design would incorporate the above features while replacing the relay with an all solid-state circuit. This approach has the advantage of all electronic circuitry (no

moving parts). Total cost of all four transistors is only $1.56.

I also decided to inject the audio signal someplace downstream in the transmitter speech amplifier, instead of at the super-sensitive, high-impedance microphone input. There is adequate signal level available to do this. Making connection to a higher signal level, lower impedance point in the speech amplifier minimizes hum worries and eliminates the level control R1, unity gain amplifier Q2, and on to the transmitter.

Transistor Q3 is a dc switch and Q4 is both a dc and signal path switch. Q1, a Darlington-connected transistor pair in a single package, performs the function of the transmitter push-to-talk switch.

All four transistors are normally *off.* When any button on the 35A3 Touch-Tone pad is depressed, Q1, Q3 and Q4 become essentially short circuits while

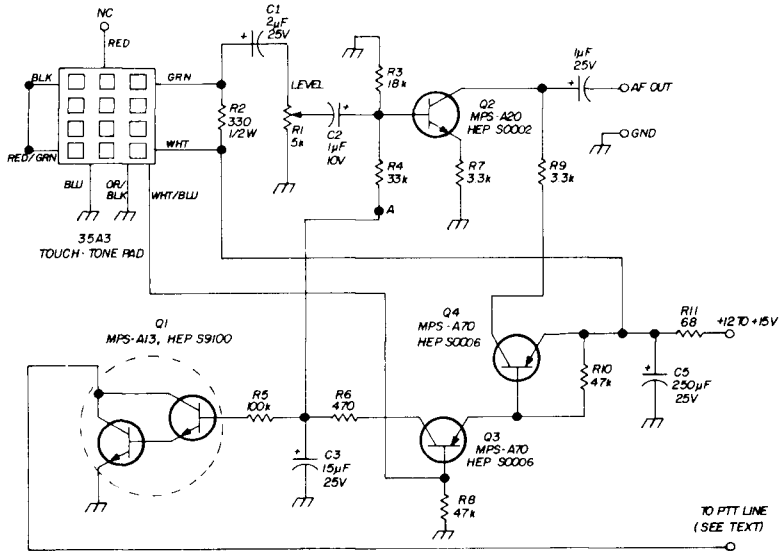


fig. 1. Schematic diagram of the mobile Touch-Tone circuit. The 5.1k resistor connected between the blue and white/blue leads inside the 35A3 must be removed.

need for shielded wire to carry the audio signal to the transmitter.

the circuit

Fig. 1 shows the schematic of the Touch-Tone interface. The Touch-Tone pad I used is a Western Electric Model 35A3. All wires on the 35A3 are color coded and the schematic indicates the connections by wire color.

One modification of the 35A3 is required. Remove the 5.1k resistor which is connected to the white and white-blue leads. This is easily located and snipped out.

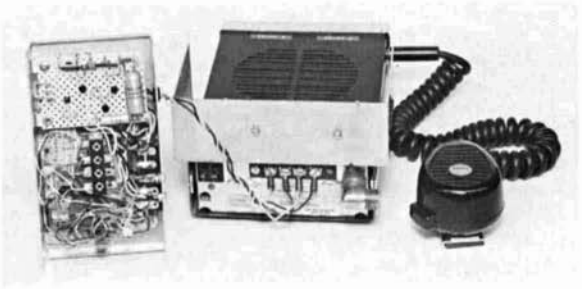
The green wire is the audio output lead of the 35A3. The signal goes through Q2 is biased *on* to perform its amplifier function.

The automatic audio disconnect is accomplished by turning transistors Q2 and Q4 off. Under these conditions, essentially an open circuit is presented to the point of signal connection inside the transmitter. Transistor Q3 performs the function of turning Q1 and Q2 on and off. The dc input filter R11-C5 was added to reduce spikes (or ac ripple when operating from an ac supply).

I liked WØ LPQ's automatic keying and delayed drop-out features, and incorporated similar functions in this circuit. This results in the transmitter being keyed automatically when any 35A3 button is

depressed. It remains keyed until after the last digit of the phone number is dialed, instead of switching back to receive between each digit. This delay is accomplished by the gradual discharge of C3 through R3, R4, Q2, R5 and Q1 after Q3 is switched off. Resistor R6 limits the turn-on charging current through Q3 to a safe value.

There is nothing critical at all about the circuit, and layout is left to the constructor. In fact, as one who works with rf most of the time, building a noncritical audio circuit is a refreshing change of pace. A printed-circuit is available to those who are interested.* Level control R1 should be a "set it and forget it" control, so it may be an internal screwdriver adjustment.



Bottom view of the Touch-Tone circuit. At top is the circuit, mounted on a 2 x 3" piece of Vector perf-board. Touch-Tone pad is below. The four terminals on the back of the HR-2A were modified to permit connection to the solid-state Touch-Tone circuit.

connection and checkout

The dc feedline is connected directly to the automobile electrical system with no voltage regulation or additional filtering beyond that shown in **fig. 1.** The circuit also functions very well when connected to an ac supply with 1.2 volts peak-to-peak ripple when the transmitter is keyed. If your car is noisy, the value of capacitor C5 may have to be increased.

The lion's share of total current drain is the 16 mA or so drawn by the 35A3 Touch-Tone pad. The remainder of the circuit draws less than 2 mA when on and less than 0.5 mA when off.

The automatic transmitter keying circuit is designed to be connected in parallel with the PTT mike switch in the Regency HR-2A. Before making connection to the PTT line of other rigs, the following must be determined:

1. The PTT circuit must be similar to that shown in **fig. 2.**

2. The PTT line current must be less than 300 mA with up to 16 Vdc input to the rig.

If your rig does not meet these requirements, the automatic keying portion of the interface circuit must be redesigned, not connected, or eliminated.

Not connecting this function simply means leaving the collector of Q1 open. To eliminate this portion of the circuit, delete Q1, R5, C3 and R6; connect the collector of Q3 to the lower end of R4 (point A). Neither of these options will have any effect on the operation of the remainder of the interface circuit.

Advantages of connecting the audio output someplace downstream in the transmitter speech amplifier were discussed earlier. However, for the builder who prefers making the connection to the microphone input, the circuit should function just as well that way with no modifications. In the HR-2A I connected the audio output of the circuit to the junction of C226 and R223 between the second and third stages of the speech amplifier.

Excessive rf from the transmitter can

*Printed-circuit boards are now available from Contact, Inc., 35 West Fairmont, Tempe, Arizona 85281, for $3.00 for the board only, or $11.50 fully wired and tested, plus 25 cents postage and handling. Please direct all correspondence regarding the board to this address and not to the author.

cause the interface circuit to malfunction. To prevent this I bypassed the PTT and dc supply lines inside the HR-2A. This was accomplished by connecting 0.001-μF disc ceramic capacitors between the lines and ground at the point where the lines leave the HR-2A cabinet to go to the Touch-Tone circuit.

The only adjustment is R1. If deviation measuring equipment is available, set it for the deviation specified for your local auto-patch system. Otherwise, set R1 for reliable operation of the patch.

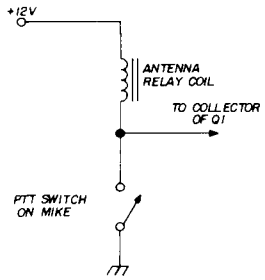


fig. 2. Push-to-talk circuit for the Regency HR-2A vhf fm transceiver.

circuit variations

The time that the transmitter remains keyed after release of the last button is determined by the capacitance value of C3. To shorten the time, decrease the capacitance; to lengthen it, increase the capacitance.

A temporary disabling mode for the automatic keying feature may be included by adding a switch from the base of Q1 to ground. Closing this switch will prevent automatic keying of the transmitter without affecting the operation of the remainder of the circuit.

acknowledgment

Special thanks are due to Dick Evans, W7BBW, who constructed and field tested the prototype unit.

reference

1. William P. Lambing, WØLPQ, "Mobile Operation with the Touch-Tone Pad," *ham radio*, August, 1972, page 58.

ham radio