



Schematic of the Heathkit® Touch-Tone® Decoder Model HD-1530

NOTES:

1. All resistors are 1/4-watt, 5% tolerance unless otherwise noted. (K = 1000, M = 1,000,000)
2. Capacitors less than 1 are in μF (microfarads); 1 or greater are in pF, unless otherwise noted.
3.  indicates a wire connection on the circuit board.
4.  indicates chassis ground.
5.  indicates circuit board ground.
6.  indicates a DC voltage taken with a high-impedance voltmeter from the point indicated to circuit board ground.

To find the physical location of parts, refer to the "Circuit Board X-Ray View" on Manual Page 41.

CIRCUIT DESCRIPTION

Before describing the internal circuits of your Touch-Tone Decoder, we recommend that you read the following information on DTMF (dual-tone multi-frequency) signals. Although not a part of the working components of your unit, it provides an interesting description of the reasons for and usages of this type of communications signaling.

TOUCH-TONE (DTMF) CODING

More than 25 years ago, the need for an improved method of telephone dialing was recognized. The pulse dialing used during this earlier period was not only slow, but suffered from severe distortion over long wire loops — the distance between your telephone and its switching exchange. This distortion was even more severe on the cross-country distances between the company exchanges. This method used a DC voltage path through all of the involved telephone and exchange circuits, from the caller to the called party.

A new signaling method was developed which used a pair of intermixed (AC) audio signals within the human audible range, and proved to be a very reliable alternative to the older pulse dialing system. This new signaling method was called “dual-tone multi-frequency” (DTMF) and was registered under the name Touch-Tone® dialing. As the name implies, a valid DTMF signal is the sum of two tones of different and specific frequencies. This tone-pair is comprised of tones taken from two groups; the low group consisting of four different tones from 697 to 941 Hz and the high group consisting of four different tones from 1209 to 1633 Hz. The matrix scheme for combining these eight different tones allows 16 different combinations. Ten of these codes are the numerals, while the other six are the symbols “*” and “#” and the letters A, B, C, and D. These last six are used for special functions in most applications. Note also that some telephone “keypads” incorporate only 12 of these symbols, leaving out the alphabetic keys.

The new tone signal system was not only a breakthrough for the telephone, but for other types of communication as well. The signals are fast and accurate even over great distances, but more importantly, they lend themselves nicely to remote control in all types of communication work. Each communications keypad, like the one on your telephone, is set up in a matrix pattern in rows and columns as shown in Figure 4. Note that the alphabetic column is omitted in the 12-key configuration. Each key, therefore, selects a single tone from the low group row and one from the high group column.

For example, when you dial the number 1, the resultant DTMF tones will consist of one from the low group (697 Hz) and one from the high group (1209 Hz). Similarly, all subsequent numbers that you dial will consist of a unique pair of tones.

		<u>HIGH GROUP</u>			
		1209 Hz	1336 Hz	1447 Hz	1633 Hz
<u>LOW GROUP</u>	697 Hz	1	2	3	A
	770 Hz	4	5	6	B
	852 Hz	7	8	9	C
	941 Hz	*	0	#	D

Figure 4

This DTMF coding system ensures that only one tone from each low and high group is represented in the audio signal. All that remains is for a decoding process at the terminal or receiving end. Note also that a great advantage in this process is that the audio signals, just as voice signals, can be impressed on an RF carrier to be transmitted over indefinite distances without any need for directly-connected wire linkages.

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Your Touch-Tone Decoder is a device to convert a pair of DTMF signals into a logic format, then to an analog function which will then control many other devices too numerous to list.

GENERAL CIRCUIT DESCRIPTION

Refer to the Schematic Diagram in the Illustration Booklet as you read the following descriptive information.

The following text will describe the use of your Touch-Tone Decoder as a muting device for your receiver's output. Its use in other applications, which should require only relatively minor circuit changes, should then also be obvious.

When audio signals are output from your receiver, an interrupted speaker line that is connected to the Audio In terminal on the Decoder rear panel routes the signal to point E on the circuit board. When your Decoder is in the On (listening) mode, audio from the receiver is connected through the contacts of switch SW101 to series resistor R103. At the same time, the 11-ohm impedance is approximately maintained on your receiver through relay K101 by paralleled resistors R116 and R117. When a DTMF signal is received, the two-tone audio signal is coupled by C107 to DTMF receiver IC U103 pin 2 through an input control circuit consisting of R106 and R131.

Capacitor C108 provides high-frequency bypass, while resistor R104 and control R105 make up an adjustable sensitivity circuit for the IC input. DTMF receiver U103 is the heart of the decoding process. This receiver takes the two input audio tones, filters them into their respective low- and high-tone groups through an internal bandsplit filter, and then couples them to a digital counter which verifies the frequency and duration of the received tones before passing the corresponding codes to an output buss. Crystal Y101 is a 3.58 MHz device which makes up the internal clock oscillator circuit. It is this standard that maintains the precise measurement needed in decoding the DTMF signals. Resistor R108 and capacitor C109 make up the guard time adjustment for better noise immunity and allows the receiver to accept only the valid DTMF tones.

The output of the DTMF receiver at pins 11, 12, 13, and 14 (Q1 through Q4) are in binary coded decimal (BCD) form which is decoded by the 4- to 16-line hex decoder, IC U104. The output of this decoder represents all sixteen combinations of the code system 1 through 9, 0, *, #, A, B, C, and D.

The strobe line of U103 pin 15 will go high each time a valid tone is received. This clocks decoder U104 to decode this information and send it to its proper outputs as previously stated. At the same time, this strobe line from U103 pin 15 drives the base (B) of transistor Q101 high to turn the transistor on.

The collector (C) of Q101 is tied to +8.3 volts. The emitter (E) of Q101, is tied to the base of mute switch transistor Q102. When Q101 conducts, it turns Q102 on, effectively connecting a ground path to the MUTE output on the rear panel of the Decoder. The same voltage that turns on Q102 also is biased by resistor R109 and applied to Tone Valid LED D107, turning it on. Resistors R111 through R115 provide the proper biasing for all three of these devices.

After any one of the 16 outputs of U104 goes high, the associated diode turns on (diodes D108-D125). These diodes are employed as DC blocking devices when a nonvalid code number is detected, and maintain the proper output control from U104 to the lock-control circuit of IC U105.

Dip switches SW102 and SW103 select the digits not to be used in the coding of the unit, and if any invalid digit is detected, will then switch on to reset lock control U105. Suppose, for example, the combination 4-5-3-2 is chosen for the correct code. The switches for this combination are turned off, and all the others are turned on. Any entered digit other than the 4, 5, 3, and 2 (after the correct digit) will reset U105.

Lock Control U105

The proper 3- or 4-digit code, in the prescribed order, is programmed to U105 pins 11, 12, 13, and 14 by four program wires connected to circuit board plugs P103 and P104. These input pins make up the

sequential logic for the correct digital information from U104 and the program control of switches SW102 and SW103. As stated in the "Operation and Special Functions" section, any number that is invalid or out of sequence will reset U105.

At the first entry digit, transistor Q105 will start the entry time clock preset of the RC time constant consisting of resistors R131 and R132 and capacitor C114. Control R132 determines the duration of the entry time. After all the criteria have been met, U105 pin 9 lock control momentarily goes high, causing capacitor C113 to charge up. At the same time, pin 1 is high, which causes pin 4 to go high. The combination of the control setting on R125 and the discharge time of C113 will set the time-on for pin 4. After capacitor C113 discharges to the preset level determined by resistor R124 at pins 1 and 2, the lock control circuit of U105 will be reset. Resistor R127 makes sure that a charge time will occur, even when control R125 is set at its minimum.

Two-Digit Reset

When lock control U105 is on, a two-digit reset programmed in an exact sequence on P102 can reset U105 to turn it off. This calls for a function that will discharge time-out capacitor C113. When the proper two-digit reset code is entered, the first selected digit is connected to IC U106A at the same time charging up the RC combination of resistor R135 and capacitor C115. Since the two input pins of AND gate U106A are high, its pin 3 will also become a logic high.

When the second digit is entered, pins 4 and 5 of U106B will go high, causing its output pin to also go high. Since U106A is held high by R135 and C115, both pins 9 and 10 of U106C will go high for the short duration of the time constant of R135/C115. In turn, this momentary voltage at output pin 8 of U106C is applied to the base of transistor Q105, turning it on. Q105's emitter is connected to ground, and this potential is also felt at the collector during the time the transistor is on. This action, through resistor R128, discharges C113, which causes the reset of lock control U105.

Lock Control and Relay Circuit

To better understand this function, you should review the material in the "Operation and Special Features" section of this Manual, noting the differences for the optional Timed and Toggle modes of operation.

When lock control IC U105 is activated, pin 4 will be at a logic high for the duration of the preset time. At the same time, pin 8 will go high until the 3- or 4-digit code is re-entered. Either of the toggled or timed outputs at pins 4 and 8 will be routed through its corresponding jumper to the base of either transistor Q103 or Q104, turning it on. Since the collectors of both of these transistors are connected to the 8.3-volt supply, relay K101 will be energized by the voltage now at the emitter of either transistor.

When either the Toggle or Timed option occurs, LED D129 will conduct through resistor R123 to provide a visual indication that the Decoder has been activated. When the contacts of relay K101 close, this connects the Audio In at circuit board connection E through the relay to Audio Out connection F on the circuit board and causes the "8-ohm" load (actually 11 ohms, paralleled R116 and R117) to be removed from the receiver line. Circuit board points K and L are routed as either N.O. (normally open) or N.C. (normally closed) connections to the rear panel or to a telephone line terminal strip for external device switching.

Power Supply

The HD-1530 Touch-Tone Decoder was designed to operate from a wide range of voltages (see "Specifications"). Power to the Decoder is connected through rear panel Power socket S101 to bridge rectifier D101-D104. An AC voltage is supplied to the bridge rectifier, which is polarity-protected for DC voltages. The rectified voltage is connected to 5-volt regulator IC U102 and to 8.3-volt regulator IC U101 after being filtered by capacitor C106. Diode D105 permits U102 to operate 0.3 volts above its normal 8-volt regulation point. When power is applied to the regulators, it is also routed to Power LED D106 for a visual indication. Capacitors C103, C104, and C105 also provide additional filtering and bypass capacitance to the main circuits.

SEMICONDUCTOR IDENTIFICATION

<u>HEATH COMPONENT NUMBER</u>	<u>PART NUMBER</u>	<u>MAY BE REPLACED WITH</u>	<u>KEY NUMBER</u>
DIODES			
D101 thru D105	57-65	1N4002	A1
D106 thru D128	56-56	1N4149A	A1
TRANSISTORS			
Q101	417-801	MPSA20	B1
Q102	417-218	TZ1150	B2
Q103	417-218	TZ1150	B2
Q104	417-218	TZ1150	B2
Q105	417-801	MPSA20	B1

INTEGRATED CIRCUITS

U101	442-691	78M08	C1
U102	442-627	78L05	C2
U103	442-785	MT8870	C3
U104	443-871	MC14514	C4
U105	443-1290	LS7225	C5
U106	443-780	74LS08	C6

