

Figure 1

## The 6A Key System:

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environments where signaling range and simulation protection may be reduced for economy. The least expensive type D, offering standards slightly lower than type C, was designed for the least exacting job: the key system intercom. Before examining this particular piece of technology in detail, here's a summary of how DTMF signaling works.

Figure 1 illustrates how the eight voice-band frequencies used for DTMF are combined, in a matrix fashion, to represent particular digits or control signals. The frequencies fall into two distinct bands: the high group of column tones and low group of row tones. Frequencies were chosen to have a non-harmonic relationship with one another to reduce the likelihood of false signaling from music pickup. Boxes shown

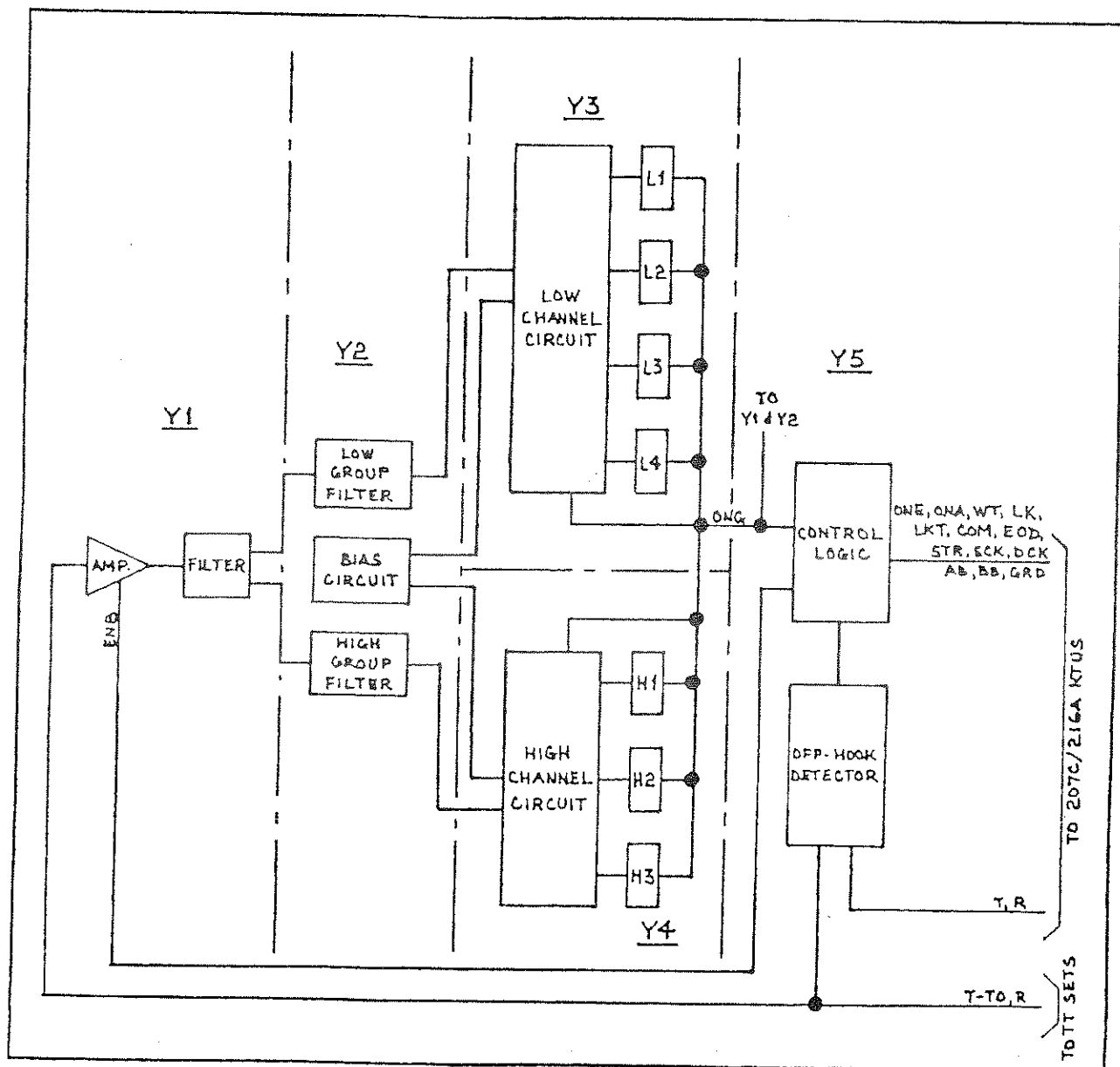


Figure 2

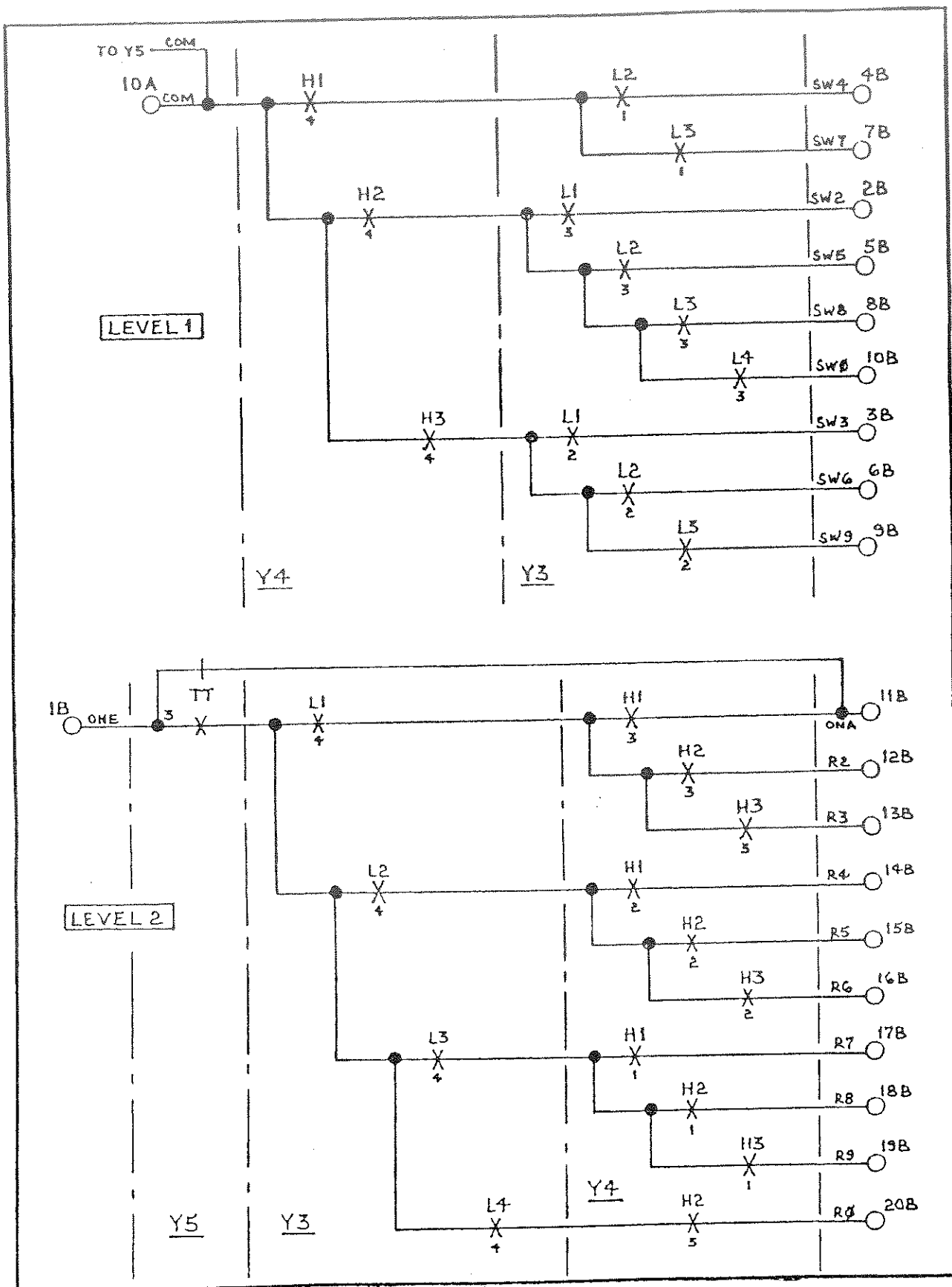


Figure 3

by broken lines represent signals not supported by the type D receiver.

## 2. The 247B KTU

Following testing of a D1 receiver D the 247A Key Telephone Unit, Bell Labs settled on a D2, known as the 247B. The unit, configured as a panel-type KTU, is a 7" high x 7" wide cage designed to accept five printed circuit cards. On the unit's backplate, two strips of twenty screw terminals each provide for external connections in the standard way.

Figure 2 shows, in block form, the functions of the five printed circuit cards comprising the 247B KTU. While cards "Y1" through "Y4" are essential to any application of the 247B, it is noteworthy that circuit board "Y5" was designed specifically for interfacing with the 207C KTU. Other cards in the fifth slot allow the 247B KTU to be used with different intercom systems, typically of the 1A2 Key System generation.

When the unit is engaged, control circuitry grounds lead ONG to all cards, and grounds the ENB lead to the input amplifier on "Y1". A valid DTMF signal is split into its low and high frequencies and filtered by card "Y2" to eliminate extraneous audio. Card "Y3" identifies which low tone is present, while "Y4" identifies which high tone. The result is operation of one "L" and one "H" relay, producing a digit output via the "one of ten" contact trees shown in figure 3, the two trees corresponding to levels one and two of the 207C selector. By reversing the series order of contacts between one tree and the other, designers were able to evenly distribute the number of contacts required among the seven MB13 relays.

## 3. Operation With 207C KTU

Figure 4 shows the full schematic of circuit board "Y5", along with relevant portions of the 207C KTU to which it is connected. When a Touch-Tone station goes off-hook, loop current through the station, resistor R1 in the "Y5" board and the windings of relay "A" in the 207C KTU causes "A" to operate. This causes relay "B" to operate, as described in Part I of this series, lighting station lamps and preparing the selector for operation. The voltage drop across resistor R1 causes transistor Q1 to conduct, turning on transistor Q2. Operation of relay "B" in the 207C applies ground to lead COM which is passed via Q2 to relay "TT", causing it to operate. "TT" locks operated under control of the COM lead.

Operated relay "TT" applies battery to the other three relays on the "Y5" card and applies off-normal ground ONG, via contacts on non-operated relay "CK", to cards "Y1" through "Y4" of the 247B KTU, preparing the unit to receive DTMF information.

### Dialing Single-Digit Code

Pressing a dial pad button on the originating telephone operates a particular combination of "H-" and "L-" relays in

the 247B KTU, extending ground from lead COM to the selected SW lead, via the upper contact tree shown in figure 3. All SW leads representing single-digit codes are strapped together (lead SDG) to terminals 14A-18A of the 247B KTU. Where the SW lead for a single-digit code is used to operate code-specific apparatus such as an off-premise station circuit, its SW lead is strapped to 14A-18A with a diode (lead PRC).

Ground via lead SDG or PRC operates "Y5" relay "DG2", which locks up to ONG under control of operated "TT" and non-operated "CK". Operation of "DG2" grounds lead EOD, operating 207C KTU relay "C" and energizing the selector, which steps to position one. Ground from 207C relay "C" via lead LK, contacts of "TT", lead STR, selector position 1 and off-normal contacts, lead SCK and non-operated contacts on relay "DGI" energize relay "CK". "CK" locks up on ground via operated "TT" and non-operated "DGI", transferring the source of ONG from relay "TT" to lead "LK".

Operation of "CK" de-energizes the 207C KTU selector magnet and relay "C", which is slow to release. When "C" releases, audible signal supply to the selector is enabled, signaling the called station for about 1.5 seconds. When 207C relay "T" releases, the selector is restored and ground removed from lead STR. This releases relay "DG2" of the "Y5" board, opening ONG ground to all circuit boards in the 247B KTU. The operated "H-" and "L-" relays release. For the remainder of the call, relays "A" and "B" in the 207C KTU and relays "TT" and "CK" on the "Y5" board remain operated.

### Dialing Two-Digit Code

When a dial button is depressed for the first digit, one "H-" and one "L-" relay operate in the 247B KTU. Relay "DGI" on the "Y5" board is energized through non-operated "DG2" contacts, via ground on pin 5 directly from board "Y3". "DGI" operates, holding on off-normal ground ONG. Relay "RL" in the selected transfer circuit operates from ground on lead "SW-" through the contact tree previously described, locking up to COM ground and CE battery. Release of the dial button operates relay "CK" through operated "DGI" contacts and a chain of contacts on the non-operated "H-" relays providing ground on pin 16 directly from board "Y4".

"CK" locks up on ground via non-operated "DG2" and operated "TT", energizing relay "TR" in the selected 216A via lead LKT. Relay "TR" locks up to COM ground via operated "RL".

When a dial button is pressed for the second digit, "H-" and "L-" relays operate, applying ONG to pin 5 of the "Y5" board, energizing relay "DG2" via operated contacts on "CK". "DG2" locks operated on ONG, now being furnished over lead STR. Operation of "DG2" releases "CK", which grounds lead EOD to the 207C. Relay "C" of the 207C operates, releasing relay "DGI" and stepping the selector to position one. Relay "CK" re-operates and the called station is now signalled as described in the single-digit case.

