6 ELECTRONIC SWITCHING SYSTEMS

NO. 3 "TOUCH-TONE" CALLING DETECTOR CIRCUIT

CHANGES

D. Description of Changes

D.1 Changed unit wiring to separate leads TM0 and TM1 which connect the TT test timer circuit pack and the TT interface circuit pack. When run together, these leads capacitively couple which causes the signal present scan point to oscillate at around 100 mHz. The oscillations do not affect the normal circuit operations but cause excessive RFI around the office.

D.2 Corrected drafting errors.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5333-DJS-GH

Printed in U.S.A.

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NO. 3

"TOUCH-TONE" CALLING DETECTOR CIRCUIT

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 This circuit is used to receive voice-frequency TOUCH-TONE* signals from a customer telephone set, recognize what frequencies are present, and convert the signaling frequencies into dc signals suitable for operating associated scan ferrods.

1.02 In addition to receiving TOUCH-TONE signaling information, this circuit offers a high degree of protection against false operation by voice-frequency components contained in speech or noise picked up by the telephone transmitter.

2. GENERAL DESCRIPTION OF OPERATION

2.01 TOUCH-TONE signaling uses two groups of frequencies in the speech band. Each group is made up of four frequencies, and the code is known as the 4-by-4 code. A valid signal consists of exactly one frequency from the low band and exactly one frequency from the high band. There are 16 valid combinations.

2.02 The TOUCH-TONE calling detector circuit is normally bridged across the tip and ring associated with a customer dial pulse receiver circuit. It has a high input impedance from direct current on up to prevent interference with dial pulsing. A filter in the TOUCH-TONE detector prevents dial tone supplied to the calling customer from interfering with detector operation.

2.03 The TOUCH-TONE detector first separates the high- and low-band frequencies present in a valid signal combination. The signal from each band is amplified and limited separately. It appears at the output of each limiter as a square wave of constant amplitude, with a period corresponding to that of the input signal. The square waves are applied to four tuned detector circuits. One of the four detector circuits in each band will

* Registered U.S. Patent Office.

respond to the fundamental component of the square wave. The ac signal will be rectified and converted to a dc signal suitable for operating scan ferrods. Each of the eight detectors has its own scan ferrod in the master scanner.

2.04 To prevent momentary noise and speech signals from simulating digits, a signal must be present for a certain minimum period of time before it is recognized. A timer is started when both the high and low bands have active detector outputs. If the signal remains for the timer interval, a ninth scan point (located in the master scanner) is activated. Only when this signal-present indication has been observed will the detector outputs be scanned to obtain the digit.

2.05 Certain types of noise can momentarily block a valid signal after it has been recognized. To prevent double registration of the same digit in such an instance, the timer does not release until after the signal has been gone for another timed interval.

2.06 Additional techniques are used in the design of the TOUCH-TONE detector circuit to prevent noise from interfering with or simulating valid signals.

SECTION II - DETAILED DESCRIPTION

1. SIGNALING CODE

1.01 The TOUCH-TONE signaling code is shown in Table A. The frequencies in each group are spaced geometrically (each is approximately 11 percent higher than the next lower one) and the two groups are arranged in such a way that almost no harmonic relationships exist between low- and high-group frequencies. Since speech signals are rich in harmonics, this discrimination against harmonics tends to prevent digit simulation.

TABLE A

RELATION OF TOUCH-TONE SIGNALS AND FREQUENCIES

LOW BAND	HIGH BAND			
HZ	1209 HZ	1336 HZ	1477 HZ	1633 HZ
697	1	2	3	Spare
770	4	5	6	Spare
852	7	8	9	Spare
941	*	0	#	Spare

2. PURPOSE OF CIRCUIT COMPONENTS

2.01 A TOUCH-TONE detector circuit is made up of eight printed-wire boards and three filters. The purpose of each device will be described in the order in which a signal passes through the circuit.

2.02 The input filter, part of the 638B filter assembly, is a high-pass filter, which blocks dial tone and longitudinally induced power frequencies out of the TOUCH-TONE detector and passes as much as possible of the remainder of the voice-frequency band. In addition to reactive components, the input filter contains a 19,600-ohm resistor in series with the T and R leads to the customer dial pulse receiver. This high impedance prevents interference with dial pulses on calls where an ordinary subset is used.

2.03 The input amplifier, CPS A118 amplifies the portion of the voice-frequency band passed by the input filter and applies it to the band-elimination filters from independent outputs. The amplifier also matches the input filter to the band-elimination filter and compensates for input filter loss.

2.04 The two signaling frequencies are then separated by the two band-elimination filters in the 638B filter assembly. The filter that serves the low-group-frequency detectors rejects only the high-group frequencies and passes the remainder of the voice-frequency band. Similarly the filter serving the high-group detectors rejects only the low-group frequencies. This procedure of frequency separation is to provide protection against simulation of digits by speech or noise.

2.05 When high- and low-frequency band separation has occurred, each signaling frequency passes through a limiter. Both high- and low-group limiters are on CP A120. The output of each limiter is a square wave of fixed amplitude, whose transitions occur at the 0.0-volt crossings of the incoming ac signal. With a pure signaling frequency at a limiter input, the limiter output will contain the fundamental plus the odd harmonics of the signaling frequency at a carefully controlled amplitude (4 volts peak-to-peak).

2.06 The low-group limiter output goes to detectors on CPs A121 and A122, and the high-group limiter output goes to detectors on CPs A123 and A124. Included in the detectors is a series tuned circuit that accepts only a single frequency. Each tuned circuit is followed by a transistor circuit that operates when the tuned circuit is exposed to a frequency at or near the resonant frequency. These operated detectors apply a suitable dc output signal to the associated scan point via drivers on CP A1025.

2.07 Because each limiter has a standardized output amplitude, the frequency response of the tuned circuit will be a curve of fixed amplitude with the

peak near the resonant frequency. The operating threshold levels of the detectors are set about 2 db below the peak of the response curve of the tuned circuit. The intersections of the threshold level of the detector with the response curve of the tuned circuit mark the bounds of the operating band-width of the detector.

2.08 One output from each detector is fed to a TOUCH-TONE test timer CP A946. This circuit is used to verify the operation of one detector in each group. To provide added protection against digit simulation, CP A946 does not deliver a signal-present indication as soon as this check is satisfied. The TOUCH-TONE test timer requires the signal to be present for a minimum time interval of 11 ms for the signal to be valid. A second timing restriction of 22 ms is imposed on the input signal. If either input signal discontinues prior to 22 ms, the output of the detector is maintained to prevent double registration of one digit interrupted by channel noise. If a valid signal persists for the required period, the signal timer delivers a signal-present indication to the master scanner via the driver on A1025.

2.09 The signal timer remains operated as long as a valid signal is present at the input. At the conclusion of the input signal, the channel detectors release and the validity check is no longer satisfied. The signal-present output is not released immediately. It is held until the validity check has been off for a period of about 22 ms. This provides protection against short break-ups in valid signals as a result of noise at the receiver input, and prevents double registration of the same signal.

3. PROTECTION AGAINST DIGIT SIMULATION BY LIMITER-GUARD ACTION

3.01 Speech can provide the necessary two frequencies to simulate a TOUCH-TONE digit. The band-elimination filters reject a relatively small portion of the voice band, therefore each limiter will be exposed to a signaling-frequency component plus other components in the voice band. A feature of the limiter is that if there is an interfering frequency at its input whose amplitude is comparable to a signaling-frequency component, the amplitude of the signaling component at the limiter output is decreased below the normal value. Since the threshold level of the detector is set high on the response curve of the tuned circuit, the amplitude-reducing effect produced by interfering frequencies either reduces the detector bandwidth or, if the interfering frequencies are strong enough, prevents detector response to a signaling component. In this manner the combination of band-elimination filters, limiters, tuned circuits, and high-threshold detectors provide an effective means of protecting against digit simulation. This principle is known as limiter-guard action.

3.02 Limiter operation and high detector threshold as described also prevent more than one detector in each group from responding at one time when a valid signal is received in the presence of somewhat smaller noise signals of TOUCH-TONE frequencies.

4. METHOD OF OPERATION

4.01 When a customer TOUCH-TONE subset comes off-hook, it is detected by the system. The class information stored in memory determines that a customer dial pulse receiver (CDPR) and TOUCH-TONE detector is required. A path is set up through the network to the TOUCH-TONE detector circuit chosen. Tests on the network are done and the line attending element is disconnected. At this time a combination of CDPR and TOUCH-TONE detector is connected to the subscriber line.

4.02 Dial tone is returned to the subset via the CDPR. When dial tone is returned, the CDPR is ready to receive either dial pulsing or TOUCH-TONE signals. Either may be received since a customer may have a TOUCH-TONE subset in one room and an extension with a rotary dial in another room.

4.03 The signal-present output from the TOUCH-TONE test timer (CP A946) is scanned every 10 ms. When the subscriber sends a valid TOUCH-TONE signal by depressing a pushbutton on the set, the signal is handled by the TOUCH-TONE detector as previously described. One scan point in the low band and one on the high band are activated and the signal present scan point in the master scanner changes from active to inactive. Under these conditions, the system control directs a scan of eight scan points corresponding to the frequency outputs. The digit thus detected is stored in memory and no further scans are made of the frequency outputs until the signal-present scan point in the master scanner changes from the inactive state to active, and then back to inactive again.

4.04 As soon as possible after the detection of the first TOUCH-TONE digit, the system control advances the CDPR to a state where digits can be received but dial tone is removed as previously described and, when all the expected digits are received, the CDPR is advanced to an idle state and the calling customer is connected to a junctor.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 None.

2. FUNCTIONAL DESIGNATIONS

2.01 None.

3. FUNCTIONS

3.01 The functions of the TOUCH-TONE calling detector circuit are as follows:

(a) Provide means to receive TOUCH-TONE signals from a customer TOUCH-TONE telephone set and to convert the received signals into dc outputs suitable for detection by the No. 3 ESS scanner.

(b) Provides a sufficiently high input impedarce to permit bridging across the tip and ring conductors of a customer dial pulse receiver circuit without adversely affecting the transmission or reception of rotary dial pulses or other signals.

(c) Provides response to valid TOUCH-TONE signals whose duration is greater than 40 ms, whose cycle time is no less than 80 ms, and whose interpulse interval is at least 40 ms.

(d) Provides response to TOUCH-TONE signals whcse amplitude is less than 1.5-volt rms but greater than 0.09-volt rms per tone at the input of the TOUCH-TONE calling detector. The ratio of the amplitude of the two signaling frequencies shall not be greater than 1.6 to 1.

(e) Provides means to deliver dc output signals whose duration is at least 11 ms, regardless of input-signal duration, for a valid signal for each of the signaling frequencies.

(f) Provides means to deliver a signal-present output signal that starts about 16 ms after both digit outputs are present and remains operated until about 22 ms after the input signal is terminated.

(g) Provides ample power from the frequency and signal-present outputs to operate scan points.

(h) Provides means to tolerate a variation in the receive signaling frequencies of ±1.5 percent about their nominal value.

(i) Provides means to be able to differentiate between valid TOUCH-TONE signals and speech or noise without resorting to special out-of-band signals.

(j) Provides protection against false operation on speech or noise by the following means:

(1) Limiter-Guard Action

(2) Fast-acting detectors

(3) A signal-validity check requiring operation of one and only one detector in each of the two signaling groups

(4) A fast-recycling timer which forces a valid-looking signal to persist uninterrupted for a required time interval before the signal-present output is delivered

(5) Close control of channel bandwidth

(6) Negative feedback in limiters to provide control of limiter sensitivity and equalization

(7) Signal timer holding to prevent recycling when noise causes short break-ups in the input signals.

(k) Provides for the reception of input signals whose amplitudes may vary over a wide range, and whose two frequencies may differ considerably from each other in relative amplitude, by means of band-elimination filters (which separate the two frequencies into their respective groups) and high-gain limiters.

(l) Provides means to tolerate and be unresponsive to high-amplitude-voltage transients resulting from dial pulses, line surges, etc.

(m) Provides operation satisfactorily over an ambient temperature range of 32°F to 140°F.

(n) Provides operation solely from standard +24 volt central office supplies.

4. CONNECTING CIRCUITS

4.01 When this circuit is listed on a keysheet, the following connecting information thereon is to be followed.

(a) Master Scanner Circuit - SD-3H140-01.

(b) Customer Dial Pulse Receiver and Regular Ringing Circuit - SD-3H410-01.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 The manufacturing testing requirements are specified in the X-79179 specification.

6. TAKING EQUIPMENT OUT OF SERVICE

6.01 See Input Message (IM) and Output Message (OM) Manuals to remove from software.

6.02 Depress POWER OFF key to remove power.

SECTION IV - REASONS FOR REISSUE

D. Description of Changes

D.1 Provided complete CD information.

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DEPT 5341-RGS-LEG