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## COMMON SYSTEMS "TOUCH-TONE®" CALLING RECEIVING CIRCUIT TYPE A3

CHANGES

B. Changes in Apparatus (Components)

| B.1 Superseded | Superseded By |
|---|---|
| All KS-13490,L1 Resistors | KS-20810,L1A Resistors |
| Resistor R9 CPS1, Sheet J1 KS-13491,L1, 2000 ohms | Resistor R9 CPS1, Sheet J1 KS-20289,L6C, 2000 ohms |
| Resistor R8 CPS2, Sheet J2 KS-13492,L1, 2700 ohms | Resistor R8 CPS2, Sheet J2 KS-20289,L6C, 2740 ohms |
| Resistor R17 CPS5, Sheet J5 KS-13492,L1, 820 ohms | Resistor R17 CPS5, Sheet J5 KS-20289,L6C, 825 ohms |
| Resistor R14 CPS5, Sheet J5 KS-20810,L1A, 10,400 ohms Option ZO | Resistor R14 CPS5, Sheet J5 KS-20810,L1A, 10,500 ohms Option ZO |
| Capacitor C4 CPS1, Sheet J1 KS-13814,L8, .005 UF | Capacitor C4 CPS1, Sheet J1 KS-13814,L8, .005 or 570 AB, .00511 UF |
| Capacitor C6 CPS2, Sheet J2 KS-13814,L8, .05 UF | Capacitor C6 CPS2, Sheet J2 KS-13814,L8, .05 or 570 GN, .0511 UF |
| Capacitors C1, C3 CPS3A, B, C, D, Sheet J3 KS-13814,L8, .005 UF | Capacitors C1, C3 CPS3A, B, C, D, Sheet J3 KS-13814,L8, .005 or 570 AB, .00511 UF |
| Capacitor C1 CPS4, Sheet J4 KS-13814,L8, .005 UF | Capacitor C1 CPS4, Sheet J4 KS-13814,L8, .005 or 570 GN, .00511 UF |

D. Description of Changes

D.1 The code of all KS-13490,L1, KS-13491, L1 and KS-13492,L1 resistors is changed for cost reduction purposes.

D.2 The value of R14, CPS5, is changed for cost reduction purposes.

D.3 The code of all KS-13814,L8 capacitors is changed for cost reduction purposes.

D.4 The above changes required some minor component value changes.

F. Changes in CD Section III

F.1 Add the following to 4. CONNECTING CIRCUITS:

4.05 Traffic Management Systems

(a) Signal Converter/Allotter Circuit - SD-3B024-01.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 4131-MS-EGS

# COMMON SYSTEMS "TOUCH-TONE® CALLING RECEIVING CIRCUIT TYPE A3

## CHANGES

### B. Changes in Apparatus (Components)

| B.1 Superseded | Superseded By |
|---|---|
| Diode CR1,2,3<br>Sheet J1, 446C<br>Option R | Diode CR1,2,3<br>Sheet J1, 808E<br>Option R |
| Diode CR5<br>Sheet J5, 446T<br>Option R | Diode CR5<br>Sheet J5, 808E<br>Option R |
| Diode CR2,3<br>Sheet J6, 446B<br>Option R | Diode CR2,3<br>Sheet J6, 808B<br>Option R |
| Diode CR5<br>Sheet J6, 446M<br>Option R | Diode CR5<br>Sheet J6, 808AB<br>Option R |
| Diode CR6<br>Sheet J6, 446T<br>Option R | Diode CR6<br>Sheet J6, 808E<br>Option R |
| Capacitor C2<br>Sheet J2,<br>KS-20300 L5,0.0022<br>or 594G,0.00215<br>Option ZA | Capacitor C2<br>Sheet J2,<br>KS-20300 L5,0.0022<br>or 594G,0.00215 or<br>KS-20977 L5,0.0022<br>Option ZA |

B.2 Added

Diode CR2
Sheet B1, 533J
Option ZY

### D. Description of Changes

D.1 The code of all 446-type diodes is changed on a cost reduction basis.

D.2 A diode is added in series with the -48 volt supply to prevent positive voltage spikes from entering and damaging the receiver in the 701 PBX application only.

D.3 Circuit Note 111 is added.

D.4 Diode CR2, Sheet B1, is specified as a 446K diode, but is changed to a 533J diode on a line-out basis for cost reduction purposes.

### F. Changes in CD Section III

F.1 2.01 is deleted. Test Points are deleted on issue 16D.

BELL TELEPHONE LABORATORIES, INCORPORATED

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# COMMON SYSTEMS "TOUCH-TONE ®" CALLING RECEIVING CIRCUIT TYPE A3

CHANGES

## B. Changes in Apparatus (Components)

B.1 Superseded

| Superseded | Superseded By |
|---|---|
| All 221A and 237A Resistors | KS-20810,L1A Resistors |
| Capacitor C3, Sheet J1, 542A, Option ZR | Capacitor C3, Sheet J1, 575E, Option ZS |
| Capacitors C1 and C5, Sheet J6, 542N, Option ZR | Capacitors C1 and C5, Sheet J6, 575F, Option ZS |
| Circuit Pack B9, Sheet J6, Output Timer, Option ZV | Circuit Pack B26, Sheet J6, Output Timer, Option ZW |

B.2 Added

Resistor R29,
Sheet J5, KS-20810,L1A,
10,000 Ohms,
Option ZT

B.3 Removed

Resistors: R13, Sheet J1;
R12, R13, Sheet J2;
R17, R18, R19, Sheet J3;
R17, R19, Sheet J4;
R26, R27, Sheet J5;
R19, R20, Sheet J6;
KS-13490,L2, 1000 Ohms,
Option ZU

## D. Description of Changes

D.1 The code of all 221A and all 237A resistors is changed on a cost reduction basis.

D.2 The code of three capacitors is changed on a cost reduction basis.

D.3 Resistor R29, sheet J5, has been added to lower the high input impedance of Q1, thereby reducing the effect of battery noise on signal timer operation.

D.4 All test points and associated protective resistors are removed on a cost reduction basis.

D.5 A -30 volt lead has been brought out to pin 7 of the B19 circuit pack connector to facilitate manufacturing testing.

D.6 The use of the B9 circuit pack in this receiving circuit has been discontinued. A modified B9 circuit pack, coded B26, has been substituted.

D.7 Circuit Note 111 has been added.

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# COMMON SYSTEMS "TOUCH-TONE® " CALLING RECEIVING CIRCUIT TYPE A3

TABLE OF CONTENTS



## 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 received frequencies to dc signals which are passed to the associated register, sender, or converter circuit for translation and storage.

1.02 The receiving circuit must offer a high degree of protection against false operation by voice-frequency components contained in speech or noise picked up by the telephone transmitter.

### 2. ENVIRONMENT

2.01 The receiving circuit is used in combination with a register, sender, or converter to provide for reception of either conventional dial pulses or TOUCH-TONE signals. The input to the receiving circuit is bridged across the input to the dial pulse receiving equipment. In order not to interfere with dial pulsing the receiving circuit input impedance is high at all frequencies.

2.02 The output leads of the channel circuits are normally connected to dry reed relays such as the 295A in the connecting circuit. If, however, there are output leads, including the STR, which are equipped in the receiver and not used in the connecting circuit, they must be terminated in a 2400-ohm ±5 percent 2-watt resistor in the connecting circuit. This requirement is covered by Circuit Note 107 on the drawing.

### 3. SIGNALING CODE

3.01 The signaling code used for TOUCH-TONE dialing is known as the 4 by 3 code. It consists of two groups of frequencies: a low group of four frequencies ranging from 697 to 941 Hz and a high group of three frequencies ranging from 1209 to 1477 Hz. Provision is made for the future addition of a fourth frequency, 1633 Hz, in the high group. A digital signal consists of one frequency in the low group and one frequency in the high group. Thus, the 4 by 3 code provides 12 frequency combinations and expansion to a 4 by 4 code will provide 16 combinations.

## SECTION II - DETAILED DESCRIPTION

### 1. INPUT CIRCUITRY

1.01 The two signaling frequencies pass through an input amplifier circuit which provides a high input bridging impedance, a low output impedance, and high pass filtering to attenuate longitudinally induced power frequencies. The filter also attenuates a new noninterfering dial tone. The principal components of this dial tone are at 350 and 440 Hz.

### 2. FREQUENCY SEPARATION

2.01 The two signaling frequencies are then separated by a network containing two band elimination filters. The filter which 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. As will be seen later, the reason for using this type of frequency separation is to provide protection against simulation of digits by speech or noise.

## 3. LIMITING

3.01 After separation by the band elimination filters, each signaling frequency passes through a limiter circuit. The output of each limiter is a square wave of fixed amplitude, whose transitions occur at the zero voltage crossings of the incoming ac signal. Thus, 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. FREQUENCY RECOGNITION AND DETECTION

4.01 The limiter outputs each go to a group of series-tuned circuits used for recognition of the signaling frequencies. Each tuned circuit output connects to a detector circuit which operates when the tuned circuit is exposed to a frequency at or near its resonant frequency.

## 5. CHANNEL BANDWIDTH

5.01 Because the limiter has a standardized output amplitude, the tuned circuit frequency response will be a curve of fixed amplitude with its peak near the resonant frequency. The operating threshold levels of the detectors are set about 2 dB below the peak of the tuned circuit response curves. The intersections of the detector threshold level with a tuned circuit response curve mark the bounds of detector operating bandwidth.

## 6. VALIDITY CHECK AND SIGNAL TIMING

6.01 The detector circuits in each group connect to a checking circuit used to verify the operation of one and only one detector in each group. To provide added protection against digit simulation, the receiver does not deliver output signals as soon as this check is satisfied, but instead requires the validity check to persist uninterrupted for an interval of approximately 21 ms. This check and timing function is performed by the signal timer circuit. If the validity check fails, the signal timer is recycled and must start its timing cycle over again. If a valid signal persists for the required period of time, the signal timer runs out and turns on a transistor which (a) delivers a signal on the STR lead for control of the steering circuit in the register, sender, or converter, and (b) triggers the output timer circuit.

6.02 Should the valid input signal persist after the conclusion of the output timing interval, the steering output is locked up, and will not release until about 20 ms after the conclusion of the input tones. This lockup is provided to prevent short breakups of the input from recycling the receiver outputs. This slow release lockup action does not become effective until about 10 ms after the end of the output timer interval in order to prevent it from operating on short input signals and possibly affecting the overall receiver cycle time.

## 7. OUTPUT TIMER

7.01 The output timer circuit remains operated for about 45 ms and while operated (a) enables the channel output transistors, and (b) activates a lockout circuit which prevents operation of detectors other than the two already operated.

## 8. OUTPUT STAGES

8.01 When the channel output transistors are enabled, the two output transistors corresponding to the operated detectors are turned on by the detectors and energize the corresponding channel relays in the register, sender, or converter circuit. As long as the channel output stages are enabled by the output timer, the operated stages remain locked in by means of a positive feedback circuit from the collector of each output stage to the base of the corresponding detector.

8.02 At the end of the output timing interval, the channel output stages are disabled and turned off, releasing the corresponding relays in the register, sender, or converter. If an input signal is still present, the operated detectors remain operated for the duration of the signal and hold the steering circuit energized through the signal timing circuit.

## 9. PROTECTION AGAINST DIGIT SIMULATION BY LIMITER GUARD ACTION

9.01 The following describes what happens when the receiver is exposed to speech. Assume the speech contains two frequencies capable of simulating a TOUCH-TONE digit. It will also contain other frequency components. Since the band elimination filters reject a relatively small portion of the voiceband, each limiter will be exposed to a signaling frequency component plus other components in the voiceband. The nature of limiters is such that if there is an interfering frequency at the input whose amplitude is comparable to a signaling frequency component, the amplitude of the signaling component at the limiter output is decreased below its normal value. Since the detector threshold level is set high on the tuned circuit response curve, the amplitude reducing effect produced by interfering frequencies either reduces 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 provides an effective means of

protecting against digit simulation. This principle is known as limiter guard action.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

RECEIVER OUTPUT

1.01 The load connected to receiver output leads LG1, LG2, LG3, LG4, HG1, HG2, HG3, HG4, and STR shall have a minimum of 472 ohms and a maximum of 2880 ohms resistance to -48 volts.

2. FUNCTIONAL DESIGNATIONS

2.01 Test Posts:

| Designation | Meaning |
|---|---|
| CKH | Check high group detectors |
| CKL | Check low group detectors |
| D | Detector control |
| GND | Ground |
| HO | Output of high group limiter |
| H1, H2, H3, H4 | High group detector outputs 1, 2, 3, and 4, respectively |
| LO | Output of low group limiter |
| L1, L2, L3, L4 | Low group detector outputs 1, 2, 3, and 4, respectively |
| OUT | Output of input amplifier |
| R | Ring input |
| STR | Steering output |
| T | Tip input |
| -22 | Derived -22 volt supply for operating output relays |
| -24 | Derived -24 volt supply for input amplifier and limiters |
| -30 | Derived -30 volts for signal timer |
| -48 | -48 volt supply |

2.02 Networks:

| Designation | Meaning |
|---|---|
| BEF | Band elimination filters |

3. FUNCTIONS

3.01 To receive multifrequency signals from a customer TOUCH-TONE telephone set and to convert the received tone signals into dc outputs suitable for translation and registration by an originating register, sender, or converter circuit.

3.02 To offer a sufficiently high input impedance to permit bridging the receiver across the tip and ring conductors of dial pulse receiving equipment without adversely affecting the transmission or reception of rotary dial pulses or other signals.

3.03 To respond to valid TOUCH-TONE signals whose duration is greater than 40 ms, whose cyclic time is no less than 83 ms, and whose interpulse interval is at least 40 ms.

3.04 To deliver dc output signals on digital leads (one lead for each of the signaling frequencies) whose duration is held close to 45 ms, regardless of input signal duration, by providing output memory and timing.

3.05 To deliver a steering output signal which remains on as long as either digital outputs are present or an incoming signal is present.

3.06 To provide ample power on the digital and steering outputs to operate 295A dry reed relays or the equivalent.

3.07 To tolerate a variation in the received signaling frequencies of ±1.5 percent about their nominal value.

3.08 To respond to valid TOUCH-TONE signals whose individual signaling frequency amplitude is less than 2.0 volts rms but greater than 0.12 volt rms at the receiver input. The ratio of the amplitude of the two signaling frequencies shall not be greater than 1.6 to 1.0.

3.09 To be able to differentiate between valid TOUCH-TONE signals and speech or noise without resorting to special out-of-band signals.

3.10 To provide protection against false operation on speech or noise by the following means:

(a) Limiter guard action.

(b) Fast acting detectors.

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

(d) A fast recycling timer which forces a valid looking signal to persist uninterrupted for a required time interval before output signals are delivered.

(e) Close control of channel bandwidth.

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

(g) Signal timer lockup to prevent short breakups in the input signals due to

noise from recycling the receiver outputs.

3.11 By means of band elimination filters which separate the two frequencies into their respective groups, and high gain limiters, to provide 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.

3.12 To be able to receive signals in the presence of dial tone.

3.13 To tolerate and be unresponsive to high amplitude voltage transients resulting from dial pulses, line surges, etc.

3.14 To operate satisfactorily over an ambient temperature range of 32 to 120°F.

4. CONNECTING CIRCUITS

4.01 Crossbar System No. 1.

(a) Pushbutton Calling Signal to Dial Pulse Converter Circuit - SD-26184-01.

4.02 Crossbar System No. 5

(a) Originating Register Circuit, Dial Pulsing, and Pushbutton Calling - SD-26040-01.

4.03 Panel System

(a) Pushbutton Calling Signal to Dial Pulse Converter Circuit - SD-21976-01.

4.04 Step-by-Step System

(a) Pushbutton Calling Signal to Dial Pulse Converter Circuit - SD-32328-01.

(b) Step-by-Step Common Control System Originating Register Outpulsing Control Circuit for Step-by-Step Common Control Circuit - SD-32351-01.

(c) TOUCH-TONE Converter Circuit - SD-32352-01.

(d) Crossbar Systems No. 5 Reverting Call Trunk Circuit - SD-26069-01.

(e) Crossbar Systems No. 5 Conference Trunk Circuits - SD-27635-01.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 The manufacturing testing requirements are covered in X-77090.

6. TAKING EQUIPMENT OUT OF SERVICE

6.01 See TEOS information for connecting circuit.

SECTION IV - REASONS FOR REISSUE

D. Description of Changes

D.1 The -48 volt control office battery (option ZP) has been changed to -48 volt talk battery (option ZQ) for central office applications.

D.2 Circuit Note 101 has been modified.

D.3 Circuit Notes 109 and 110 have been added.

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