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ELECTRONIC SWITCHING SYSTEMS NO. 1 "TOUCH-TONE" DETECTOR TEST CIRCUIT

CHANGES

D. Description of Changes

D.1 Overload test state level has been changed from +3 db per tone to 0 db per tone.

D.2 Frequency requirements have been added to circuit requirements.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 2422-EB-AF

ELECTRONIC SWITCHING SYSTEMS
NO. 1
"TOUCH-TONE" DETECTOR TEST CIRCUIT

CHANGES

D. Description of Changes

D.1 Option S is added to allow connection of this circuit to the Supplementary Signal Distributor Circuit.

D.2 FS1, option index, Circuit Note 104, and CAD 3 have been amended to include this change.

D.3 Due to excessive parasitic capacity in tank circuits of TOUCH-TONE oscillators, causing difficulty in tuning, and because the method of inhibiting TOUCH-TONE oscillators was not optimum, this circuit will be completely redesigned. This circuit is now rated Mfr Disc. and is being replaced by SD-1A263-01.

F. Changes in CD Sections

F.1 In SECTION III, under 4. CONNECTING CIRCUITS, add:

(f) Supplementary Signal Distributor Circuit - SD-1A247-01.

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NO. 1
"TOUCH-TONE" DETECTOR
TEST CIRCUIT

CHANGES

C. Changes in Circuit Requirements Other Than Those Caused by Changes in Apparatus

C.1 All current flow requirements and test notes pertaining to the magnetic latching relays have been deleted. Requirements are now covered in a BSP.

D. Description of Changes

D.1 The ferrod sensors may not saturate with a large resistance in the connecting wires from this circuit to the associated scanner circuit. Therefore, a Critical Lead Resistance table has been added as Equipment Note 206.

D.2 The signal distributor lead lengths have been limited to 75 feet; this is stipulated in Equipment Note 207.

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ELECTRONIC SWITCHING SYSTEMS
NO. 1
"TOUCH-TONE" DETECTOR TEST CIRCUIT

TABLE OF CONTENTS

SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 This circuit generates a group of test signals which can be applied to any TOUCH-TONE receiver via the trunk link networks. By applying these signals and observing the output (or lack thereof) at the TOUCH-TONE detector, the system control is provided with assurance of successful operation or else with detection and location of troubles.

1.02 In addition, the opening and closing of the tip-ring path can be done in this circuit to keep the trunk link networks from having to make and break current. Check of the continuity of the path through the Trunk Switching Circuit to the TOUCH-TONE receiver can be made in this test circuit or the customer dial pulse receiver portion of the TOUCH-TONE receiver.

2. GENERAL DESCRIPTION OF OPERATION

2.01 This circuit contains two oscillators for generating TOUCH-TONE frequencies and a third oscillator to generate a non-TOUCH-TONE frequency. The TOUCH-TONE oscillator tank circuits can be altered by signal distributor operation to provide signals at the upper and lower band edges, outside the lower band edge, and at the nominal TOUCH-TONE frequencies. Signal distributor operations also select high, intermediate, and low signal levels. The duration of TOUCH-TONE signal pulses is under program control. Single frequencies, as opposed to the TOUCH-TONE frequency pairs, can be generated, and a non-TOUCH-TONE frequency can also be produced.

2.02 The circuit is intended to be stepped through all tests, in order, under program control since only a combination of responses from the TOUCH-TONE detector under test will reveal satisfactory operation or diagnose the type of failure. The actual pulsing of test signals is arranged in such a way that a large portion of the program for the mf transmitter circuit can be used. This explains the presence of certain scan points required in the associated scanner circuit and the arrangement of the central pulse distributor inputs.

SECTION II - DETAILED DESCRIPTION

1. STATES OF THE CIRCUIT

1.01 This circuit has three magnetic latch relays designated A, B, and C. These relays, when operated and released by the signal distributor circuit, can put this circuit into eight different states. Each state can be defined by the particular magnetic latch relays operated and identified by the sum of the weighting numbers associated with each operated relay. Weighting numbers are assigned as follows: A = 1, B = 2, C = 4.

1.02 Only one relay at a time can be operated or released by the signal distributor circuit. Thus any state number can change by only 1, 2, or 4.

1.03 Information Note 302 on the schematic diagram displays the circuit states pictorially. Crossing a vertical or horizontal line in the diagram is equivalent to the operation or release of one relay by the signal distributor circuit.

1.04 In general, the circuit is placed in a given state by the signal distributor circuit under control of the program. The scanner, again under program control, reports circuit conditions in both this circuit and the TOUCH-TONE detector circuit under test so that proper appraisal of the TOUCH-TONE detector circuit performance can be made.

2. PURPOSE OF CIRCUIT COMPONENTS (FS1)

2.01 Relay ON is an off-normal relay which connects tip and ring to the Trunk Switching Circuit (and thus to the receiver under test). It is operated when one or more of the three signal distributor relays A, B, or C are operated and is released when A, B, and C are all released. Associated scan point 1 checks operation and release of the A, B, and C relays. It is unsaturated when two relays or none are operated and is saturated for one or three.

2.02 The transmission circuit, consisting of L1, L2, T, C1, C2, C3, C4, R1, R3, and R4, couples the unbalanced TOUCH-TONE signal generated in the oscillator and mixer circuit packs to a balanced loop. Inductor L1 acts as the collector load impedance for the mixer transistor. C1 and C2 block dc from the adjustable signal-level pad on the A158 circuit pack and thus prevent transients. C3 and C4 block dc from the windings of transformer T. R1 limits the current flowing in the path to the receiver under test and the associated scan point 0 which monitors loop continuity. R3 and R4 are external parts of the signal-level pad.

2.03 Relays S1, S2, S3, and S4 (coils shown on FS2) select the particular taps on the oscillator coils in the signal source and start oscillations. They are controlled via logic by the program acting through the Central Pulse Distributor Circuit.

2.04 Circuit packs A157 and A158 generate test frequencies and mix them linearly to produce the required composite test signals. Inductors LB, HB, and 3F are oscillator tank inductors and are mounted externally to the circuit packs to permit adjustment when required. Contacts on relays A, B, and C select padder capacitors on circuit pack A157 to give the proper fine-tuning to the oscillator tanks for the particular test in progress. Additional contacts on these relays permit either or both of the two TOUCH-TONE oscillators to be connected to the mixer and activate, when required, a third-frequency oscillator which produces a non-TOUCH-TONE frequency.

2.05 All three oscillators would oscillate at a very high frequency with no S- relay operated unless steps were taken to inhibit such signals. The SO1 gate on FS1 and the SO2, SO3, SO4, SO5, and SO6 gates on FS2 provide suitable damping when the circuit is idle or when no digits are being sent. The gates on FS2 inhibit the oscillators on circuit pack A157 via the BL and BH leads. Additional inhibition on the 3F coil is provided by contacts on relays A, B, and C.

2.06 The output levels of the oscillators on A157 and A158 may require adjustment from time to time and adjustment should always be made when a new circuit pack is inserted. By use of a card-extender board, access to level-adjusting potentiometers is possible. Both level and frequency measuring equipment can connect to terminals 32 and 33 on the terminal block to make output measurements.

2.07 Capacitors C6 and C7 are used as part of the HB oscillator tank circuit for controlling band-edge frequencies. Capacitors C8 and C9 are trimmer capacitors added to the tank circuit to make oscillators meet frequency band-edge requirements.

3. PURPOSE OF CIRCUIT COMPONENTS (FS2)

3.01 The bipolar flip-flops (BPFF) are operated and released by the Central Pulse Distributor Circuit to key the test signals. A valid digit consists of two flip-flops set. The BPFFs connect to the TL gates which translate the two-out-of-four signal to one-out-of-four of the S- relays operated. Diodes on the contact protection circuit pack CP1 limit inductive surges from the select relays S1-S4 and the off-normal relay ON. Removal of CP1 provides a convenient way to disconnect the relays from their operating circuitry for testing.

3.02 Operation and release of the S- relays are checked by the associated scan points 2 and 3 driven by gate CK. When all relays are released (and the circuit is in use), both scan points are saturated. If one or more S- relay is operated, the scan points are not saturated. Thus a 1 output means a digit is being sent and a 0 output means all relays are released. Two scan points are provided, in series, to match similar numbered scan points associated with the mf transmitter. This, along with two BPFFs to set single S- relays, permits use of a large portion of the mf transmitter circuit program.

3.03 To prevent current from flowing in scan points 2 and 3 when the circuit is idle, break contacts on relays A, B, and C operate gate CK when all relays are released. The SO- gates, as discussed in connection with FS1, prevent parasitic oscillations when the S- relays are released. The SO- gates are operated by both the CK gate and the break contacts on relays A, B, and C to provide the inhibition when required.

3.04 Load resistors on circuit pack LR1 provide the dummy loads required by the BPFFs, the logic gates, and also resistors through which scan-point current can be drawn. Two resistors are used in connection with scan points; the first limits current flow when the scan point is saturated and the second limits the inductive surge when scan-point current is terminated.

3.05 Capacitor C5 gives an approximate 1-msec delay for the operation of the S03, S04, S05, and S06 gates for the purpose of damping oscillations. Diodes CR1 and CR2 limit the voltage across C5 to approximately 4 volts. Resistor R2 limits the discharge current of C5 into the S02 gate.

4. CIRCUIT STATES

4.01 Information about circuit states is summarized in Table A. Additional information will be found in the reference paragraphs below.

KEYING PROCEDURES FOR ALL STATES

4.02 Portions of the program for the mf transmitter circuit, SD-1A175-01, are used to key digits in this circuit. Since mf uses a completely different code, the TOUCH-TONE test keying procedure requires explanation. To properly test every channel detector in a TOUCH-TONE detector circuit, every frequency in the low TOUCH-TONE band (697, 770, 852, and 941 cps) and every frequency in the high TOUCH-TONE band (1209, 1336, 1477, and 1633 cps) must be received at least once. Since each TOUCH-TONE signal consists of one tone from the low and one from the high band, the digits 1, 5, and 9 plus the special combination of 941 and 1633 cps make a satisfactory set of digits for testing. The select relays S1, S2, S3, and S4 each, when operated alone, key one of the four signals above. Because two central pulse distributor outputs are pulsed to transmit each mf digit, translation is required between the bipolar flip-flops and the S- relays. Considering this translation, the mf program transmits the digits 1, 3, 6, and 4 in terms of its own code. Note that none of these requires the fifth or sixth mf signaling frequencies. This information is summarized in Information Note 303 on SD-1A151-01. The up-check and down-check scan points (3 and 2, respectively) match the similarly numbered up- and down-check scan points in the mf transmitter. In both circuits, scan point 2 saturated means a successful down-check while 3 unsaturated following an observation of 2 saturated guarantees a valid digit is being transmitted. Note that all timing of digit and interdigit intervals is under program control.

LEVELS IN ALL STATES

4.03 Circuit pack A158, the TOUCH-TONE oscillator mixer (TTOM), contains a pad associated with terminals 2, 3, and 10 to set the level for various test states. These levels are called high, medium, and low in Table A and they are selected by various combinations of the relays A, B, and C. High level is 0 dbm per tone of 0.948 volt rms across 900 ohms. Medium level is -10 dbm per tone or 0.3 volt rms across 900 ohms. Low level is -22 dbm or 0.076 volt rms across 900 ohms. All measurements can be made between test points TP1 and TP2 on the terminal block. If measurements are made at the master control center, 0.25 db should be subtracted from the above values to allow for the average loss through the trunk link networks. Each of the three oscillators can be adjusted to satisfy the above values; each oscillator is best adjusted in one particular circuit state. State 5 puts out a tone from the low-group oscillator only. State 4 serves for the high group. In each case, the central pulse distributor can gate the tone by sending the digit 3 in mf code which corresponds to 5 in TOUCH-TONE. The third-frequency oscillator on the TOUCH-TONE oscillator mixer (TTOM), circuit pack A158, can be adjusted in state 7 with none of the S-relays operated. Medium level is transmitted in all instances. Card-extender boards are necessary to gain access to the level adjusting potentiometers on the printed wire boards.

STATE 0, IDLE

4.04 All relays operated by the signal distributor (A, B, and C), the central pulse distributor (S1, S2, S3, and S4), and otherwise (ON) are released. All scan points are unsaturated and should read 1.

STATE 1, HIGH BAND EDGE

4.05 All frequencies are 1.5 percent above their normal values since no padder capacitors on circuit pack A157 (TTO) are switched in. Each digit should be on for an accurately determined interval to test TOUCH-TONE detector response and signal-present timing. Interdigital time should be 40 msec or greater and need not be timed with great accuracy. Scan point 1 should be saturated to give a state check.

STATE 3, LOW BAND EDGE

4.06 All frequencies are 1.5 percent below their nominal values since the appropriate capcitors on circuit pack A157 are switched in. Pulse timing requirements are as in state 1 above. Scan point 1 should be unsaturated to give the state check.

TABLE A

RELAY STATES

State		Relays Operated	Tests, Components, and Features Associated with Tip and Ring		Connected Scan Points	Tip-Ring Connected to Trunk Link Net.	See
No.	Name		Function	Designation			
0	Idle	None	None		None	No	4.04
1	High Band Edge	A	Tone Source Transmission Circuit Low-Level Tones High Band Edge Tones Fast Keying	Circuit Packs TTO, TTOM With Associated Inductors LB, HB and 3F L1, L2, T, C1, C2, C3, C4, R1, R3, and R4	0,1,2,3 2 and 3 Follow S-Relays	Yes	4.02 4.03 4.05
3	Low Band Edge	AB	Tone Source Transmission Circuit Low-Level Tones Low Band Edge Tones Fast Keying	See State 1 Above See State 1 Above	0,2,3 2 and 3 Follow S-Relays	Yes	4.02 4.03 4.06
2	Overload	B	Tone Source Transmission Circuit High-Level Tones Low Band Edge Tones Fast Keying	See State 1 Above See State 1 Above	0,1,2,3 2 and 3 Follow S-Relays	Yes	4.02 4.03 4.07
6	Out of Band	BC	Tone Source Transmission Circuit High-Level Tones Out-of-Band Tones Nominal Keying Speed	See State 1 Above See State 1 Above	0,2,3 2 and 3 Follow S-Relays	Yes	4.02 4.03 4.08
7	3rd Freq	ABC	Tone Source Transmission Circuit Medium-Level Tones Nominal Frequency Tones Nominal Speed Keying 3rd Frequency Present (not TT)	See State 1 Above See State 1 Above	0,1,2,3 2 and 3 Follow S-Relays	Yes	4.02 4.03 4.09

TABLE A (Cont)

RELAY STATES

State		Relays Operated	Tests, Components, and Features Associated with Tip and Ring		Connected Scan Points	Tip-Ring Connected to Trunk Link Net.	See
No.	Name		Function	Designation			
5	Low Group Only	AC	Tone Source Transmission Circuit Medium Level Tone Nominal Frequency Tone Nominal Speed Keying TT Frequency from Low Group Only	See State 1 Above See State 1 Above	0,2,3 2 and 3 Follow S- Relays	Yes	4.02 4.03 4.10
4	High Group Only	C	Tone Source Transmission Circuit Medium Level Tone Nominal Frequency Tone Nominal Speed Keying TT Frequency from High Group Only	See State 1 Above See State 1 Above	0,1,2,3 2 and 3 Follow S- Relays	Yes	4.02 4.03 4.11

STATE 2, OVERLOAD

4.07 All frequencies are 1.5 percent below their nominal values. Pulse timing requirements are as in state 1 above. Scan point 1 should be saturated to give the state check.

STATE 6, OUT OF BAND

4.08 All frequencies are 3.5 percent below their nominal values. Nominal pulsing speed (70 msec on, 70 msec off with accuracy as in the mf transmitter) is used. The TOUCH-TONE detector under test should NOT respond to these off-frequency signals. Scan point 1 should be unsaturated to give the state check.

STATE 7, THIRD FREQUENCY

4.09 As soon as this state is entered, the third frequency comes on. This 2000-cycle signal should prevent response of the TOUCH-TONE detector under test when the nominal TOUCH-TONE signals at medium tone level are keyed at the 70 msec on, 70 msec off rate. The 2000-cps signal is removed when the next state is entered. Scan point 1 should be saturated to give the state check.

STATE 5, LOW GROUP ONLY

4.10 In this state, the high-group oscillator is disconnected from the mixer and only the low-group signal is emitted. A single tone input should be insufficient to produce a signal-present indication at the TOUCH-TONE detector under test. Scan point 1 should be unsaturated to give the state check.

STATE 4, HIGH GROUP ONLY

4.11 In this state, the low-group oscillator is disconnected from the mixer and only the high-group signal is emitted. Again a single tone input should be insufficient to produce a signal-present indication at the TOUCH-TONE detector under test. Scan point 1 should be saturated to give the state check.

5. SEQUENCES

5.01 Normally this circuit will use only one sequence: 0-1-3-2-6-7-5-4-0.

5.02 In all test states, the four signals 1, 5, 9, and special (in TOUCH-TONE code) can be sent via operations of the central pulse distributor. However, in states 4 and 5, only the TOUCH-TONE digit 5 need be sent to carry out the test properly. Additional variations are possible.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 When testing a TOUCH-TONE detector circuit with this circuit, the maximum external conductor loss between this circuit and the TOUCH-TONE detector should be 0.5 db or less at 1000 cps. This corresponds to a total of 65 ohms of 26 gauge cable or 45 ohms of 24 gauge cable.

2. FUNCTIONAL DESIGNATIONS

2.01 Circuit States

Designation	Meaning
High Band Edge	High Band Edge TOUCH-TONE Frequencies Transmitted
Low Band Edge	Low Band Edge TOUCH-TONE Frequencies Transmitted
Overload	High-Level Signals Transmitted
High Group Only	High TOUCH-TONE Frequency Transmitted
Low Group Only	Low TOUCH-TONE Frequency Transmitted
3rd Frequency	2000-Cycle Frequency Transmitted
Out-Of-Band	TOUCH-TONE Frequencies Out of Limits

2.02 Relays

Designation	Meaning
ON	Off-Normal
S1,S2,S3,S4	Select 1,2,3,4
A,B,C	These relays are alphabetically designated for program reference. For circuit functions associated with the operation of these relays, see Information Note 3.02 and 2.01 above.

2.03 Transformers

Designation	Meaning
3F	Third Frequency
HB	High Band
LB	Low Band
T	Transmission

2.04 Circuit Packs and Gates

Designation	Meaning
TTO	TOUCH-TONE Oscillators
TTOM	TOUCH-TONE Oscillator-Mixer
BPFF	Bipolar Flip-Flop
TL1,TL2,TL3,TL4	Translate 1,2,3,4
CK	Check
CP1	Contact Protection 1
LR1	Load Resistors 1
SO1,SO2,SO3, SO4,SO5,SO6	Stop Oscillations 1,2,3,4,5,6

2.05 Associated Scanner Ferrod Sensors

Designation	Meaning
0,1,2,3	Ferrod sensors associated with this circuit are numerically designated for program reference.

3. FUNCTIONS

3.01 Most of the functions which this circuit can perform are determined by program control which operates the circuit in the required sequence of states as described in Section II. In particular, action of the central pulse distributor should produce TOUCH-TONE and off-channel signals of the proper amplitude and frequency and the signal distributor should produce a third frequency as described in Section II, 4.02 and 4.03.

4. CONNECTING CIRCUITS

(a) Miscellaneous Trunk Frame Scanner Circuit - SD-1A117-01, Master Scanner Circuit - SD-1A118-01, Master Scanner Circuit - SD-1A209-01, as required.

(b) Miscellaneous Trunk Frame Signal Distributor Circuit - SD-1A128-01 or Signal Distributor Circuit - SD-1A216-01, as required.

(c) Central Pulse Distributor Circuit - SD-1A109-01.

(d) Miscellaneous Circuit for All Frames - SD-1A129-01.

(e) Trunk Switching Circuit - SD-1A107-01.

(f) Supplementary Signal Distributor - SD-1A247-01.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 All wiring in this circuit should be checked for continuity and all magnetic latch relays checked for operation and release.

5.02 Connect +24 volt battery and ground as shown in SD-1A151-01.

5.03 Frequency adjustments and trimmer capacitor selection should be made in accordance with frequency requirements of SD-1A151-01. If frequency requirements of SD-1A151-01 are not met, a trimmer capacitor must be selected to make the frequencies of each oscillator track. The lowest frequency of each oscillator is first tuned and the highest frequency of each oscillator is measured. After noting frequency, see Table B for proper selection of trimmer capacitor. The procedure to determine the size of trimmer capacitors C8 and C9 is as follows. Operate B relay and ground terminal 7 of transformer not being tuned. Remove BPFF A45 position 11. Ground TL1, terminal 10 position 8, and tune transformer LB to 686.5 ±0.1 cps or HB to 1190 ±0.1 cps. Remove ground from TL1 and ground TL4, terminal 0 position 8. Note frequency and select trimmer capacitor according to Table B. After trimmer capacitor is added, adjust frequency of transformers as per frequency requirements of SD-1A151-01.

TABLE B

LB Frequency	Choose Cap. Size	HB Frequency	Choose Cap. Size
926.8 to 927.5	0	1608.5 to 1609.5	0
927.5 to 928.0	51	1609.5 to 1610.0	51
928.0 to 928.5	150	1610.0 to 1610.5	100
928.5 to 929.0	240	1610.5 to 1611.0	100
929.0 to 929.5	360	1611.0 to 1611.5	150
929.5 to 930.0	430	1611.5 to 1612.0	150
930.0 to 930.5	430	1612.0 to 1612.5	200
930.5 to 931.0	510	1612.5 to 1613.0	200
931.0 to 931.5	510	1613.0 to 1613.5	240
		1613.5 to 1614.0	240
		1614.0 to 1614.5	300
		1614.5 to 1615.0	300
		1615.0 to 1615.5	360
		1615.5 to 1616.0	360
		1616.0 to 1616.5	360
		1616.5 to 1617.0	430
		1617.0 to 1617.5	430
		1617.5 to 1618.0	430
		1618.0 to 1620.0	510

5.04 Level measurements should be made on the TOUCH-TONE signals from each oscillator individually. With 900 ohms connected from TP1 to TP2, the signal voltage measured across the 900 ohms with a high-impedance ac meter balanced to ground should be as shown in Table C. Voltmeter should be Hewlett Packard 400H or equivalent. To start oscillations connect terminal 47 of TS(B) on unit to ground.

TABLE C

Relays Operated	Voltage Level	Ground Terminal 7 Transformer
B	0.924 to 0.976	HB
B	0.924 to 0.976	LB
C	0.291 to 0.309	-
A,C	0.291 to 0.309	-
A	0.0738 to 0.0782	HB
A	0.0738 to 0.0782	LB
A,B,C	0.291 to 0.309	HB and LB

6. ALARM INFORMATION

6.01 This circuit is fused individually with one fuse to the +24 volt supply on the bay fuse panel. If this fuse blows, it will cause the FA relay in the frame miscellaneous circuit to operate an alarm.

7. TAKING EQUIPMENT OUT OF SERVICE

7.01 This circuit is taken out of service by following the directions given in SD-1A132-01. Before working on the circuit or removing circuit packs, the POWER-OFF key on this unit (or the associated POWER-OFF key on the frame control panel) must be operated to disconnect all voltages.

SECTION IV - REASONS FOR REISSUE

D. Description of Changes

D.1 Method of inhibiting parasitic oscillations caused dc transients which altered the TOUCH-TONE test signals. The method of inhibiting oscillations was changed on this issue.

D.2 Because of slow scanning rates of the TOUCH-TONE detector circuit, the output pulse of this circuit had to be increased by approximately 1 msec by delaying the inhibit action by 1 msec.

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