SUBSCRIBER LINES AND OUTGOING TRUNKS

VOLTMETER TESTS USING OGT TEST FRAME SD-25177-01

NO. 1 CROSSBAR OFFICES

1. GENERAL

1.01 This section describes methods of testing subscriber lines, and voltmeter and resistance tests of outgoing trunks in No. 1 crossbar offices using outgoing trunk test frame trunk and line test circuit SD-25177-01.

1.02 This section is reissued to revise Test G to include procedures for trunks with E and M supervision. This reissue does not affect the Equipment Test List.

1.03 The tests covered are:

1.04 A particular subscribers line is accessed from the outgoing trunk test frame by means of a special no-hunt incoming trunk associated with an office unit or pair of office unit jacks. By setting the test frame numerical keys for the line number desired, the control circuits switch this special test trunk to the desired subscriber line through the incoming and line link frames.

1.05 Voltmeter and ammeter tests on outgoing trunks are made on a manual basis under the control of key operations as required. The test circuit is associated with an outgoing trunk by means of a 3-conductor patching cord. ▶Tests or trunks to recording-completing (E & M), or TSP/TSPS ANI (E & M) require two patching cords.◀

1.06 In areas where the insulation breakdown feature is made inoperative or where local instuctions state that breakdown tests are not to be applied from the outgoing test frame, Tests B, C, and D shall be disregarded.

1.07 Test D combines Tests A and B or A and C. When Test D is made, it is not necessary to make Tests A, B, or C.

1.08 Customer lines served by a No. 1A line concentrator are tested the same as nonconcentrated lines. An exception to the regular concentrator lines are the test terminations. Usually, one test termination is provided for each concentrator trunk group. If a line test is made to the test termination, the normal test indication will be a 33K-ohm shunt at the remote unit. Also, when making a test in this section and it is necessary to test an individual concentrator trunk, the concentrator control circuit must be blocked according to the method described in Section 067-105-502, Line Concentrator No. 1A—System Tests. Whenever this is done, a test call originated in the outgoing trunk test frame will connect the line called through the concentrator trunk desired.

Caution: Do not block No. 1A line concentrator trunks busy any longer then necessary when making tests on individual trunks.

1.09 ***Lettered Steps:*** A letter a, b, c, etc, added to a step number in Part 3 or 4 of this section, indicates an action which may or may not be required depending on local conditions. The condition under which a letter step or a series of lettered steps should be made is given in the ACTION column, and all steps governed by the same condition are designated by the same letter within a test. Where a condition does not apply, all steps designated by that letter should be omitted.

2. APPARATUS

All Tests

2.01 Outgoing trunk test frame SD-25177-01.

2.02 332A make-busy plugs, as required.

Test G

2.03 Two P3F cords 4 feet long equipped with one 309 plug and one 310 plug (3P12A cord).

3. PREPARATION

STEP	ACTION	VERIFICATION
Tests A through F		
1a	If incoming test trunk cut-in circuits are provided— Insert a make-busy plug into proper unit jack to select a trunk in office unit or pair of office units in which line to be tested is located.	
2b	If line to be tested is located in second unit of a pair and incoming test trunk is common to both units— Operate HF key.	
3c	If line to be tested is in extra number series— Operate XN key.	

STEP	ACTION	VERIFICATION
	Note: When setting up number to be tested on numerical keys, number group is set up on TH and H keys, coded number on T and U keys.	
Test G		
4d	If any OB_, OG_, TAN H_, TAN T_, TAN U_, STA_ keys remain operated from previous test— Momentarily operate KR key.	All keys normal.
5	Using 3P12B patching cord, connect T1 or T2 jack to jack of trunk to be tested. (See 1.05.) ***Note:*** In following steps, assume T1 jack is used. When testing trunks to recording-completing (E & M) or TSP/TSPS ANI (E & M), proceed as shown in Step 9g.	If trunk is busy— BY and ON1 lamps lighted. If trunk becomes idle— BY lamp extinguished.
6e	If trunk is service busy— Remove plug from test jack of trunk.	
7e	Momentarily operate DISC 1 key.	All lamps extinguished.
8f	If trunk has previously been made busy— Operate NT key.	
9g	▶If trunk to recording-completing (E & M) or TSP/TSPS ANI (E & M) is being tested— Connect T1 jacks to TO jack of trunk.	
10g	Connect T2 jack to E & M LINE jack of trunk.◀	

4. METHOD

STEP	ACTION	VERIFICATION
A. Subscriber Lines—Automatic Voltmeter Test		
4	Set up number of line to be tested on numerical keys. See Note, Step 3c.	
5	Operate 900Ω trunk compensating, DM, and AV keys.	
6	Momentarily operate LT ST key and observe verification sequence. ***Note:*** See Table A for significance of lamps. During period when R or T lamp is lighted, disregard a ballistic throw of voltmeter needle or any steady deflection within locally prescribed limits.	If line is busy all paths are busy— LT lamp flashes. If line is idle— CT lamp (when provided) lighted. If line is idle and CT lamp not provided— RP, TP, or HG lamp lighted. VM and R lamps lighted.

STEP	ACTION	VERIFICATION
		Voltmeter indicates ring to ground insulation resistance. R lamp extinguished. T lamp lighted. Voltmeter indicates tip to ground insulation resistance. T and VM lamps extinguished. ET lamp lighted.
7h	If desired to observe voltmeter for long interval— Operate SOR and RP keys.	ET lamp extinguished. R and VM lamps lighted. Voltmeter indicates ring to ground insulation resistance. ***Note:*** If voltmeter reading is outside prescribed limits, perform Step 11i at this time.
8h	Operate SOT key.	
9h	Restore SOR key.	R lamp extinguished. T lamp lighted. Voltmeter indicates tip to ground insulation resistance. See Step 7h note.
10h	Restore SOT key.	T and VM lamps extinguished. ET lamp lighted.
11i	If voltmeter reading in Steps 7h or 9h are outside prescribed limits— Operate RG key.	If needle restores to zero— Short circuit indicated. If deflection does not change— Ground on ring indicated on ring test or ground on tip indicated on tip test.
12i	Restore RG key.	
13j	If another line is to be tested— Change setting of numerical keys.	
14j	Operate and hold LT ST key until ET and CT, TP, RP, or HG lamps are extinguished. ***Note:*** If ET lamps is not lighted, operate and hold LT DIS key until CT, TP, RP, or HG lamp is extinguished and then momentarily operate LT ST key.	ET and CT, TP RP, or HG lamps extinguished. See verification, Step 6.
15k	If repeat test on same line is required— Operate and hold RP key until ET lamp is extinguished.	Same as Step 6.
16	Restore AV key to normal.	

STEP	ACTION	VERIFICATION
17	Operate and hold LT DIS key until ET and CT, TP, RP, or HG lamps are extinguished.	ET and CT, TP, RP, or HG lamps extinguished.
B.	**Subscriber Lines—Automatic Breakdown Test, Both Sides of Line**	
4	Set up number of line to be tested on numerical keys. See Note, Step 3c.	
5	Operate 900Ω trunk compensating, IBD, and DM keys.	
6	Momentarily operate LT ST key. ***Note:*** During period when IBD, T, and R lamps are lighted, milliammeter reading should be within locally prescribed limits.	If lines is busy or all paths are busy— LT lamp flashes. If line is idle— CT lamp (when provided) lighted. If line is idle and CT lamp not provided— RP, TP, or HG lamp lighted. IBD, T, and R lamps lighted. ET lamp lighted. IBD, T, and R lamps extinguished.
7h	If another line is to be tested— Change setting of numerical keys.	
8h	Operate and hold LT ST key until ET and CT, RP, TP, or HG lamps are extinguished. ***Note:*** If ET lamp is not lighted, operate and hold LT DIS key until CT, RP, TP, or HG lamp is extinguished and then momentarily operate LT ST key.	
9i	If repeat test on same line is desired— Operate and hold RP key until ET lamp is extinguished.	Same as Step 6.
10	Restore IBD key to normal.	
11	Operate and hold LT DIS key until ET and CT, RP, TP, or HG lamps are extinguished.	ET and CT, RP, TP, or HG lamps extinguished.
C.	**Subscriber Lines—Automatic Breakdown Test, Each Side of Line**	
4	Set up number of line to be tested on numerical keys. See Note, Step 3c.	
5	Operate 900Ω trunk compensating, DM, and IBD 1 keys.	

STEP	ACTION	VERIFICATION
6	Momentarily operate LT ST key. ***Note:*** During period when R or T lamp is lighted, observe that milliammeter reading is within locally prescribed limits.	If line is busy or all paths are busy— LT lamp flashes. If line is idle— CT lamp (when provided) lighted. If line is idle and CT lamp not provided— RP, TP, or HG lamps lighted. IBD and R lamps lighted. R lamp extinguished. T lamp lighted. IBD and T lamps extinguished. ET lamp lighted.
7h	If another line is to be tested— Change setting of numerical keys.	
8h	Operate and hold LT ST key until ET and CT, RP, TP, or HG lamps are extinguished. ***Note:*** If ET lamp is not lighted, operate and hold LT DIS key until CT, RP, TP, or HG lamp is extinguished and then momentarily operate LT ST key.	ET and CT, RP, TP, or HG lamps extinguished. See verification, Step 6.
9i	If repeat test on same line is required— Operate and hold RP key until ET lamp is extinguished.	Same as Step 6.
10	Restore IBD 1 key to normal.	
11	Operate and hold LT DIS key until ET and CT, RP, TP, or HG lamps are extinguished.	ET and CT, RP, TP, or HG lamps extinguished.
D.	**Subscriber Lines—Automatic Breakdown Voltmeter and Breakdown Test**	
4	Set up number of line to be tested on numerical keys. See note, Step 3c.	
5	Operate 900Ω trunk compensating, DM, and AV keys.	
6h	If breakdown test on both sides of line simultaneously is desired— Operate IBD key.	
7i	If breakdown test on each side of line sequencially is desired— Operate IBD 1 key.	
8	Momentarily operate LT ST key and observe verification sequence.	If line is busy or all paths are busy— LT lamp flashes—

STEP	ACTION	VERIFICATION
	Note: See Table A for significance of lamps. During period when VM and R or T lamps are lighted, disregard a ballistic throw of voltmeter needle or any steady deflection within locally prescribed limits. During period when IBD and R or T lamps are lighted, milliammeter reading should be within locally prescribed limits.	If line is idle— CT lamp (if furnished) lighted. If line is idle and CT lamp not provided— RP, TP, or HG lamp lighted. VM and R lamps lighted. Voltmeter indicates ring to ground insulation resistance. R lamp extinguished. T lamp lighted. Voltmeter indicates tip to ground insulation resistance. T and VM lamps extinguished. If IBD key is operated— IBD, T, and R lamps lighted. ET lamp lighted. IBD, T, and R lamps extinguished. If IDB1 key is operated— IBD and R lamps lighted. R lamp extinguished. T lamp lighted. ET lamp lighted. IBD and T lamps extinguished.
9j	If another line is to be tested— Change setting of numerical keys.	
10j	Operate and hold LT ST key until ET and CR, RP, TP, or HG lamps are extinguished. ***Note:*** If ET lamp is not lighted, operate and hold LT DIS key until CT, RP, TP, or HG lamp is extinguished and then momentarily operate LT ST key.	ET and CT, RP, TP, or HG lamps extinguished. See verification, Step 8.
11k	If repeat test on same line is desired— Operate and hold RP key until ET lamp is extinguished.	same as Step 8.
12	Restore AV and IBD or IBD1 key to normal.	
13	Operate and hold LT DIS key until ET and CT, RP, TP, or HG lamps are extinguished.	ET and CT, RP, TP, or HG lamps extinguished.
E.	**Subscriber Lines—Continuity Test of Lines Equipped with Cold Cathode Tube Type Subscriber Set**	
4	Set up number of line to be tested on numerical keys. See Note, Step 3c.	
5	Operate 900Ω trunk compensating, DM, and MV keys.	

STEP	ACTION	VERIFICATION
6	Momentarily operate LT ST key. ***Note:*** See Table A for significance of lamps.	If line is busy or all paths are busy— LT lamp flashes. If line is idle— CT lamp (when provided) lighted. If line is idle and CT lamp not provided— RP, TP, or HG lamp lighted.
7	Momentarily operate – STA key.	If line is equipped with negative station on ring— Voltmeter deflection greater than deflection on a line with no negative station on the ring.
8	Momentarily operate + STA key.	If line is equipped with positive station on ring— Voltmeter deflection greater then deflection on a line with no positive station on the ring.
9	Operate REV key.	
10	Momentarily operate – STA key.	If line is equipped with negative station on tip— Voltmeter deflection greater than deflection on a line with no negative station on tip.
11	Momentarily operate + STA key.	If line is equipped with positive station on tip— Voltmeter deflection greater than deflection on a line with no positive station on tip.
12	Restore REV and MV keys to normal.	
13	Operate and hold LT DIS key until CT, RP, TP, or HG lamp is extinguished.	CT, RP, TP, or HG lamp extinguished.

F. Subscriber Lines—Manual Voltmeter Tests

4	Set up number of line to be tested on numerical keys. See Note, Step 3c.	
5	Operate 900Ω trunk compensating, DM, and MV keys.	
6	Momentarily operate LT ST key. ***Note:*** Do not proceed to next step until voltmeter needle comes to rest.	If line is busy or all paths are busy— LT lamp flashes. If line is idle— CT lamp (when provided) lighted. If line is idle and CT lamp not provided— RP, TP, or HG lamp lighted.
7	Operate G key.	Steady deflection approximately zero. Ballistic deflection as shown in Table B.

STEP	ACTION	VERIFICATION
	Note: Disregard any ballistic deflection of needle or steady deflection within prescribed limits. Proceed to Step 11h if steady deflection is beyond prescribed limits.	
8	Operate REV key. *Note:* Proceed to Step 11h is steady deflection is beyond prescribed limits.	Ballistic deflection and steady deflection indicate insulation resistance, tip side of line. *Note:* Insulation resistance should be within locally prescribed limits. See Tables B, D, E, F, and H.
9	Restore REV key to normal.	Ballistic deflection and steady deflection indicate insulation resistance, ring side of line. See Notes, Step 8.
10	Restore G key to normal.	
Foreign Ground		
11h	If during Steps 7 through 9 the steady deflection is beyond prescribed limits — Restore G and REV keys to normal.	If a steady deflection is observed— Ring ground is indicated. *Note:* Voltmeter reading in excess of test battery voltage indicates a cross with central office battery, foreign potential, or earth potential. See Step 14i.
12h	Operate REV key.	If a steady deflection is observed— Tip ground is indicated. See note, Step 11h.
13h	Operate G key.	If a steady deflection is observed— Tip and ring cross is indicated. See note, Step 11h.
Foreign Potential		
14i	If voltmeter reading in Steps 11h through 13h is in excess of test battery voltage— Operate keys as shown in Table C to determine voltage and location of foreign potential.	
Resistance Measurement		
15j	If ground is indicated in any of Steps 11h through 13h and resistance measurement is required— With scale change key normal, note reading of voltmeter.	
16j	Successively operate and restore 20000Ω and 1000Ω keys, noting reading obtained.	

STEP	ACTION	VERIFICATION
17j	Using setting of 20000Ω and 1000Ω key which gives nearest to one half full scale deflection.	Actual resistance in ohms determined from meter reading by consulting Table D, E, or F.
18k	If there is any foreign potential on conductors— Note first reading as E1.	
19k	Operate FEMF key.	Voltmeter reads foreign potential. Reading noted as −E2. ***Note:*** E1 ±E2 equals value of voltmeter reading to be used for determining resistance from Table D, E, or F. All readings to be on same scale.
20l	If Step 19k results in voltmeter needle moving off scale to the left— Operate VM REV key.	Voltmeter reads foreign potential. Reading noted as +E2. See note, Step 19k

Intercept Lines—AIS Not Provided

Note: Line circuits for AIS (with or without LLP) are covered under separate sections.

21	Repeat Steps 4 and 5.	
22	Momentarily operate LT ST key.	HG lamp lighted. High ballistic deflection observed on voltmeter.
23	Operate VM TLK key.	
24	Momentarily operate ±key.	Ringing induction heard in telephone set until operator answers.
25	When operator answers, verify that line being tested is recorded on intercept record.	
26	Restore all keys to normal.	
27	Operate and hold LT DIS key until CT, TP, RP, or HG lamp is extinguished.	

G. Trunks

Continuity and Polarity Tests

11	Operate VM1, REV, and FEMF keys.	ON1 lamp lighted. Proper voltage indicated on voltmeter.
12h	If trunk under test such as permanent signal trunk is normally reversed— Restore REV key.	Same as Step 11.

STEP	ACTION	VERIFICATION
13	Restore all keys except VM1.	
Tests for Trouble Conditions		
14	With trunk opened at distant end, observe voltmeter.	Steady deflection of less than 100 volts may by crossed with positive potential but usually indicates ground ring side. Deflection of more than 100 volts indicates negative potential on ring side.
15	Operate REV key.	Steady deflection of less than 100 volts may be crossed with positive potential but usually indicates ground tip side. Deflection of more than 100 volts indicates negative potential on tip side.
16	Restore REV key.	
17	Operate G key.	Voltmeter reading of approximate test battery voltage indicates short between tip and ring.
18	Operate FEMF key.	Voltmeter deflection to right indicates negative potential ring side.
19i	If voltmeter needle tends to move to left— Operate VM REV key.	Voltmeter deflection to right indicates positive potential ring side.
20i	Restore VM REV key.	
21	Operate REV key.	Voltmeter deflection to right indicates negative potential tip side.
22i	Repeat Step 19i.	Voltmeter deflection to right indicates positive potential tip side.
23	Restore all keys except VM1.	
24g	◗If trunk to recording-completing (E & M) or TSP/TSPS (E & M) is being tested— Operate keys as specified in Table I.	Voltmeter indicates condition of E and M leads, ***facilities*** side.
25g	Move plug of patching cord from E & M LINE jack to E & M DROP jack.	
26g	Operate keys as specified in Table I.	Voltmeter indicates condition of E & M leads, ***drop*** side.
27g	Restore all keys.	
28g	Remove testing cord from E & M DROP jack.	
29g	Remove testing cord from TO jack.◖	

STEP	ACTION	VERIFICATION
Resistance Measurements		
30j	If readings obtained in Steps 14, 15, or 17 are not approximately half the full scale deflection— Operate and restore successively 20000Ω, 1000Ω, and AM keys, noting deflection in each case.	
31	Using reading which is nearest half of full scale deflection, determine value of resistance in ohms by consulting Tables D, E, or F.	
Capacity Balance Test		
32	When trunk is free of battery, ground, or short circuit, operate G key.	
33	Operate and restore REV serveral times, waiting each time for needle to come to rest.	Deflection due to capacity same for each movement of key. See Table H for deflection values.
34	Restore G and REV.	
Metallic Ammeter Tests		
35	Operate FEMF and AM. (Tip of metallic trunk connected to negative terminal of meter and ring to positive terminal.) ***Note:*** Ammeter tests will advance trunk off normal. Check that trunk is normal as covered in Steps 38 and 39 before disconnecting trunk.	Current indicated on milliammeter scale. See Table G.
36	To reverse connection to trunk, operate REV key.	Same as Step 35.
37	Restore all keys.	
38	Operate REV and FEMF keys.	
39	While observing voltmeter, operation VM1 key.	Readings and timing of deflections indicate that trunk is normal. ***Note:*** If MO lamp flashes, disregard it.
40	Restore REV and FEMF keys.	
Talking and Supervision		
41	Operate VM TLK key.	SV lamp lighted. If trunk supplies battery on ring and ground on tip, SV lamp extinguished.

STEP	ACTION	VERIFICATION
42	If trunk does not supply battery and ground—Operate BAT key.	SV lamp lighted. If there is a ring ground or short circuit on trunk, SV lamp extinguished.
43	To apply ac ringing to ring side of trunk and ground to tip side, operate ±key.	
44	To reverse connection to trunk, operate REV before ±key.	
45	Restore VM TLK, BAT, ±, and REV keys.	
Disconnect		
46	Repeat Steps 35 and 39 to check that trunk is normal.	
47	Restore all keys..	
48	Momentarily operate DISC 1 key.	
49	Disconnect patching cord from trunk test jack.	

TABLE A

LAMP INDICATIONS

LAMP	INDICATION
LT	Flashes to indicate called line busy.
CT*	Cut-through position to called line.
RP*	Cut-through position to ring party line.
TP*	Cut-through position to tip party line.
HG*	Cut-through position to first or intermediate line of PBX hunting group.
VM	Connection to voltmeter circuit.
R	Test battery through voltmeter connected to ring conductor.
T	Test battery through voltmeter connected to tip conductor.
ET	End of test.

*If CT is not furnished, RP, TP, HG lamps will be furnished.

TABLE B

BALLISTIC DEFLECTION INDICATIONS

TYPE OF CIRCUIT	TEST STEP	KEY OPERATION OR RESTORAL	BALLISTIC DEFLECTION
Capacitor tip to ring	7	Operate G	Noted
	8	Operate REV	See Note
	9	Restore REV	See Note
Capacitor ring to ground	7	Operate G	None
	8	Operate REV	None
	9	Restore REV	Noted
Capacitor tip to ground	7	Operate G	None
	8	Operate REV	Noted
	9	Restore REV	None

Note: Deflection twice as great as noted when G key was operated.

TABLE C

FOREIGN POTENTIAL INDICATIONS

KEYS OPERATED	VOLTMETER NEEDLE MOVEMENT	INDICATION
FEMF	RIGHT	NEGATIVE FOREIGN POTENTIAL RING SIDE POSITIVE FOREIGN POTENTIAL TIP SIDE
	LEFT*	POSITIVE FOREIGN POTENTIAL RING SIDE NEGATIVE FOREIGN POTENTIAL TIP SIDE
G FEMF	RIGHT	NEGATIVE FOREIGN POTENTIAL RING SIDE
	LEFT*	POSITIVE FOREIGN POTENTIAL RING SIDE
G FEMF REV	RIGHT	NEGATIVE FOREIGN POTENTIAL TIP SIDE
	LEFT*	POSITIVE FOREIGN POTENTIAL TIP SIDE

* Operate VM REV key to obtain a reading to the right of zero.

TABLE D

**100,000 OHM WINDING—
120 OR 150 VOLT SCALE**

VOLT-METER READING (VOLTS)	RESISTANCE		
	TEST BATTERY VOLTAGE		
	99	100	101
100		0	1,000
98	1,020	2,040	3,061
96	3,125	4,166	5,208
94	5,319	6,382	7,446
92	7,608	8,695	9,782
90	10,000	11,110	12,220
88	12,500	13,640	14,770
86	15,120	16,280	17,440
84	17,860	19,050	20,240
82	20,730	21,950	23,170
80	23,750	25,000	26,250
78	26,920	28,200	29,490
76	30,260	31,580	32,890
74	33,780	35,130	36,490
72	37,500	38,890	40,280
70	41,430	42,860	44,280
68	45,590	47,060	48,530
66	50,000	51,510	53,030
64	54,690	56,250	57,810
62	59,680	61,290	62,900
60	65,000	66,670	68,330
58	70,690	72,410	74,140
56	76,780	78,570	80,360
54	83,330	85,180	87,040
52	90,380	92,310	94,230
50	98,000	100,000	102,000
48	106,200	108,300	110,400
46	115,200	117,400	119,600
44	125,000	127,300	129,500
42	135,700	138,100	140,500
40	147,500	150,000	152,500
38	160,500	163,200	165,800
36	175,000	177,800	180,600
34	191,200	194,100	197,100
32	209,400	212,500	215,600
30	230,000	233,300	236,700
28	253,600	257,100	260,700
26	280,800	284,600	288,500
24	312,500	316,700	320,800
22	350,000	354,500	359,100
20	395,000	400,000	405,000
18	450,000	455,600	461,100
16	518,700	525,000	531,300
14	607,100	614,300	621,400
12	725,000	733,300	741,700
10	890,000	900,000	910,000
8	1,137,000	1,150,000	1,162,000
6	1,550,000	1,367,000	1,583,000
4	2,375,000	2,400,000	2,425,000
2	4,850,000	4,900,000	4,950,000

TABLE E

**20,000 OHM WINDING—
24 OR 30 VOLT SCALE**

VOLT-METER READING (VOLTS)	RESISTANCE		
	TEST BATTERY VOLTAGE		
	19.4	20	20.6
20		0	600
19.6		408	1,020
19.2	208	833	1,458
18.8	638	1,276	1,914
18.4	1,086	1,739	2,392
18.0	1,556	2,222	2,888
17.6	2,046	2,727	3,410
17.2	2,558	3,255	3,954
16.8	3,096	3,809	4,524
16.4	3,658	4,390	5,122
16.0	4,250	5,000	5,750
15.6	4,872	5,641	6,410
15.2	5,526	6,315	7,106
14.8	6,236	7,027	7,838
14.4	6,944	7,777	8,612
14.0	7,714	8,571	9,428
13.6	8,530	9,411	10,290
13.2	9,394	10,300	11,210
12.8	10,310	11,250	12,260
12.4	11,290	12,260	13,230
12.0	12,330	13,330	14,330
11.6	13,450	14,480	15,520
11.2	14,640	15,710	16,790
10.8	15,930	17,040	18,150
10.4	17,310	18,460	19,620
10.0	18,800	20,000	21,200
9.6	20,420	21,670	22,920
9.2	22,170	23,480	24,780
8.8	24,090	25,450	26,820
8.4	26,190	27,620	29,050
8.0	28,500	30,000	31,500
7.6	31,050	32,630	34,210
7.2	33,890	35,360	37,220
6.8	37,060	38,820	40,590
6.4	40,620	42,500	44,380
6.0	44,670	46,670	48,670
5.6	49,290	51,430	53,570
5.2	54,620	56,920	59,230
4.8	60,830	63,330	65,830
4.4	68,180	70,910	73,640
4.0	77,000	80,000	83,000
3.6	87,780	91,110	94,450
3.2	101,200	105,000	108,800
2.8	118,600	122,900	127,100
2.4	141,700	146,700	151,700
2.0	174,000	180,000	186,000
1.6	222,500	230,000	237,500
1.2	303,300	313,300	323,300
.8	465,000	480,000	495,000
.4	950,000	980,000	1,010,000

TABLE F

1,000 OHM WINDING-
30 VOLT SCALE

VOLT-METER READING (VOLTS)	RESISTANCE		
	TEST BATTERY VOLTAGE		
	19.4	20	20.6
20.0		0	30
19.6		20	51
19.2	10	42	73
18.8	32	63	96
18.4	54	87	120
18.0	78	111	144
17.6	102	136	171
17.2	128	163	198
16.8	155	190	226
16.4	183	220	256
16.0	213	250	288
15.6	244	282	321
15.2	276	316	355
14.8	312	351	392
14.4	347	389	431
14.0	386	428	471
13.6	427	471	515
13.2	470	515	561
12.8	516	563	613
12.4	565	613	661
12.0	617	667	717
11.6	672	724	776
11.2	732	786	839
10.8	796	852	907
10.4	865	925	981
10.0	940	1,000	1,060
9.6	1,021	1,083	1,146
9.2	1,109	1,174	1,239
8.8	1,205	1,273	1,341
8.4	1,310	1,381	1,452
8.0	1,425	1,500	1,575
7.6	1,553	1,632	1,711
7.2	1,694	1,778	1,861
6.8	1,853	1,941	2,029
6.4	2,031	2,125	2,219
6.0	2,233	2,333	2,433
5.6	2,464	2,571	2,679
5.2	2,731	2,846	2,962
4.8	3,042	3,167	3,292
4.4	3,409	3,545	3,682
4.0	3,850	4,000	4,150
3.6	4,389	4,556	4,722
3.2	5,062	5,250	5,438
2.8	5,929	6,143	6,357
2.4	7,083	7,333	7,583
2.0	8,700	9,000	9,300
1.6	11,130	11,500	11,880
1.2	15,170	15,670	16,170
.8	23,250	24,000	24,750
.4	47,500	49,000	50,500

TABLE G

MILLIAMMETER SCALE
48 VOLT OFFICE BATTERY
200 Ohms Circuit Resistance

AMMETER READING (Milliamperes)	RESISTANCE		
	CENTRAL OFFICE BATTERY VOLTAGE		
	47	48.5	50
250			0
245			4.1
240		2.1	8.3
235	0	6.4	12.8
230	4.3	10.9	17.4
225	8.9	15.6	22.2
220	13.6	20.5	27.3
215	18.6	25.6	32.6
210	23.8	31.0	38.1
205	29.3	36.6	43.9
200	35.0	42.5	50.0
195	41.0	48.7	56.4
190	47.4	55.1	63.2
185	54.1	62.2	70.3
180	61.1	69.4	77.8
175	68.6	77.1	85.7
170	76.5	84.5	94.1
165	84.9	93.9	103.0
160	93.8	103.1	112.5
155	103.2	112.9	122.6
150	113.3	123.3	133.3
145	124.1	134.5	144.8
140	135.7	146.4	157.1
135	148.2	159.3	170.4
130	161.5	173.1	184.6
125	176.0	188.0	200.0
120	191.7	204.2	216.7
115	208.7	221.7	234.8
110	227.3	240.9	254.6
105	247.6	261.8	276.2
100	270.0	285.0	300.0
95	294.7	310.5	326.3
90	322.2	338.9	355.6
85	352.9	370.6	388.2
80	387.5	406.2	425.0
75	426.7	446.7	466.7
70	471.4	492.9	514.3
65	523.1	546.2	569.2
60	588.3	608.3	633.3
55	654.6	681.8	709.1
50	740.0	770.0	800.0
45	844.	878.	911.
40	975.	1013.	1050.
35	1143.	1186.	1229.
30	1367.	1417.	1467.
25	1680.	1740.	1800.
20	2150.	2225.	2300.
15	2933.	3033.	3133.
10	4500.	4650.	4800.
5	9200.	9500.	9800.
0			

TABLE H

BALLISTIC DEFLECTIONS
USING THE 100,000 OHM VOLTMETER

Values are approximate and are based on zero subscriber loop

TYPE OF LINE	EQUIPMENT ON LINE		BALLISTIC DEFLECTION OF POINTER — INSULATION RESISTANCE OF LINE				
			INFINITE OHMS	500,000 OHMS	200,000 OHMS	100,000 OHMS	50,000 OHMS
Individual line	68A (1400 ohms) ringer with 1-mf. Capacitor bridged across line.		50	53	57	63	72
Individual line	8AA (1000 ohms) ringer with 2-mf. Capacitor bridged across line.			74	73	74	78
2-Party Message Rate or 2-Party Flat Rate	68AA (1000 ohms) or 68A (1400 ohms) ringer in series with 1-mf. Capacitor from one side of line to ground.		25	35	45	57	70
2-Party	8AA (1000 ohms) ringer in series with 2-mf. Capacitor from one side of line to ground.		39	46	53	62	72
4-Party Semi-Selective	68A (1400 ohms) ringer in series with 1-mf. Capacitor two stations from one side of line to ground.		40	46	53	62	72
4-Party Semi-Selective	8AA (1000 ohms) ringer in series with 2-mf. Capacitor two stations from one side of line to ground.		55	59	63	69	76
4-Party Full-Selective	85 type relay in series with .5-mf. Capacitor bridged across line.	1 station	30	38	47	57	70
		2 stations	51	54	58	65	73
		3 stations	67	66	67	70	76
		4 stations	79	76	74	75	79
4-Party Full-Selective	85 type relay in series with .5-mf. Capacitor bridged across line.	1 station	50	53	57	63	72
		2 stations	78	75	73	74	78
		3 stations	97	90	85	83	83
		4 stations	110	101	94	89	86
19 and 22-Gauge Cable, Open Loop		5 miles	22	32	42	55	68
		10 miles	38	44	51	60	71
		15 miles	49	53	58	64	73
		20 miles	57	59	63	68	75
		25 miles	64	65	67	72	77
		30 miles	69	70	71	74	78
24-Gauge Cable, Open Loop		5 miles	21	31	42	55	68
		10 miles	35	42	50	59	71
		15 miles	45	50	56	63	73
		20 miles	53	56	60	67	75
		25 miles	59	61	65	71	76
		30 miles	64	66	68	72	77

TABLE I

VOLTMETER TESTING OF E AND M LEADS

KEYS OPERATED	VOLTMETER INDICATION
VM2	Ground on M lead
VM2, REV	Ground on E lead
VM2, FEMF, G	−48 volts on M lead
VM2, FEMF, G, REV	−48 volts on E lead