LIMITING CONDUCTOR LENGTHS BETWEEN FRAMES AND UNITS EQUIPMENT DESIGN REQUIREMENTS CROSSBAR TANDEM SYSTEM

1. GENERAL

Scope

1.01 This specification covers the maximum allowable lengths of conductors between frames and units in crossbar tandem offices, where such lengths are likely to approach the resistance or capacitance loading limits for satisfactory circuit operation.

1.02 This specification is reissued to provide limiting conductor length requirements not covered previously.

Description

1.03 In order to comply with operating margins and transmission requirements, it is necessary to impose resistance and capacitance loading limits on a number of leads connecting crossbar tandem office equipment These leads with their designations and limitations are listed in Tables A, B, and C of this specification. Any cable lengths or conductor resistances in excess of those specified may be reduced by various procedures outlined herein. Where sufficient reductions cannot be thus obtained and the arrangement of office equipment cannot be suitably changed, the problem should be referred to the Bell Telephone Laboratories, Incorporated, for recommendations.

1.04 Crossbar tandem offices employ common control type equipment which involve long multiples of common control leads. Floor plan layouts should be such as to avoid unnecessary looping of cables back and forth between floors and should permit taking full advantage of arrangements such as the local cable interframe multiple of the sender link frames. Consideration should also be given to the future expansion of equipment that would increase the overall length of existing multiples containing critical leads.

2. MAXIMUM CONDUCTOR LENGTHS

2.01 Critical leads and their maximum allowable resistances are listed in Tables A, B, and C of this specification. These resistances are applicable to switchboard cable lengths, including strippers. Unless otherwise specified, intraframe and unit wiring are not to be included as part of the conductor lengths restricted by these resistances.

2.02 Tables A, B, and C show the maximum length of No. 24 gauge cable permissible with the maximum resistance specified. The length shown assumes that the run is made entirely of No. 24 gauge cable. This is not always the case, particularly where the number of leads run is four or less and No. 22 gauge-type BH wire is provided, or where supplementary or special cabling is provided to care for excessive cable lengths. When a cable run is composed in part or entirely of other than No. 24 gauge cable, the maximum lengths are to be revised accordingly. However, in no case shall the specified maximum resistance be exceeded.

2.03 Graph A is provided at the end of this specification to facilitate revision of maximum conductor lengths where other than No. 24 gauge cable is provided. The graph is a plot of conductor length against resistance for the more commonly used gauges of wire. The following values were used to formulate the graph and shall be used in any further calculations of conductor resistances.

GAUGE OF WIRE	RESISTANCE (ohms) PER 100 FEET
24	2.86
22	1.78
20	1.13
19	0.90
16	0.45

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3. CRITICAL LEADS

TABLE A — FOR CROSSBAR TANDEM OFFICES

FROM	TO	REMARKS		LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
Incoming or 2-way Intertoll Trunk	Toll Switchboard (including jack multiple)	Via DF	2-way IT DP Trunk (SD-27003-01) to 3-type board	S	10.0	350		
			2-way IT MF Trunk (SD-27000-01) and Incoming Trunk (SD-27043-01) to 1- or 3-type Board	S-	30.0	1050		
	Service Observing Frame	Maximum lead length — 400 feet not including patch cord		T,R	–	400	3.01	
	Trunk Link or Trunk Link Extension Frame			S	4.3	150		
				SL	4.3	150	3.02	
				LC	4.7	165	3.03	2
	Sender	Via Sender Link including multiple		DC	8.6	300	3.03	2
	E and M Lead Signaling Unit	With signal lead extension circuit	Required	E	50.0	1750		
			Not required	E	100.0	3500		
Incoming or 2-way Intertoll	Transmission Test Line Ckt	Pair resistance between 1st and last frame, 1 mW 600-ohm jack (maximum length — 200 ft of 19-gauge wire specified		T plus R	3.2			
		Pair resistance between 1st and last frame, 1 mW 900-ohm jack (maximum length — 320 ft of 19-gauge wire specified		T plus R	5.2			
Outgoing or 2-way Intertoll Trunk	Office Link or Office Link Extension Frame	Via DF		S1	37.5	1310	3.04	

TABLE A (Cont)

FROM	TO	REMARKS	LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
Auxiliary Outgoing Trunk (for IT completion)	3-type Switchboard Ringdown IT Trunk	Direct or via DF	TS	40.0	1400		
			BS	45.0	1575		
Announcing Trunk (No. 5 Announcement System)	Announcement Connecting Trunk (including multiple)	Loop resistance	T1 plus R1	15.0	525		
	3-type Toll Switchboard (including jack multiple)	Via DF	S	40.0	1400		
		With 24 volts at manual ring jack	T1	28.0	980		
		With 48 volts at manual ring jack	T1	60.0	2100		
Announcement Trunk (time of day)	Announcement Supply		CT	17.0	595		
Signaling Converter	E and M Lead Signaling Unit		E	25.0	875		
4-wire Terminating Set (in)	4-wire Terminating Set (out)	Loop resistance of office transmission leads at CSP, including	T plus R,	65.0	2275	3.05	1
		cross-connection wiring at DF	T plus R, A plus B				
		With signaling converter outgoing intertoll trunk					
Trunk Link Frame	Trunk Link Extension Frame		S	5.7	200		
		Battery and ground feeder leads	All	5.7	200		
	Office Link Frame	Via Junctor Grouping frame	S	7.9	275		

TABLE A (Cont)

FROM	TO	REMARKS		LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
Office Link Frame	Office Link Extension Frame (including multiple)			S	2.8	100		
		Battery and ground feeder leads		All	2.8	100		
Marker	Trunk Link Frame (including multiple)			JC0-19	10.7	375		
				LS,S	11.4	400		
				SL	11.4	400	3.02	
				DK	11.4	400	3.03	2
	Office Link Frame (including multiple)			LS, S, S1	10.8	380		
	Sender	Via Marker Connector including multiple	Transmitting leads	2W, C1, CR-, IG5, MFA, OB-, OD, OG-, PF, RBS, SD, SDI, SK3, SO, SSA, SSB, TCI, TW, XB, ZDG	11.4	400		
				DC	5.7	200	3.03	2
				G0-4	5.7	200	3.06	
Sender Test Frame	Sender	Via Sender Test Connector		FT, FR, T, R	11.4	400		
		Including sender multiple	PCI Sender only	TM	3.5	120		
			RP Sender only	D	7.0	245		
	Sender Test Connector Frame	Battery and ground feeder leads		All	2.0	70		
	Signal Receiving Circuit (Multifrequency)			T, R T1, R1 J, L	15.0	525		
				—48, Grd	0.62	22		
				UL, Bat. 1	22.8	800		

TABLE A (Cont)

FROM	TO	REMARKS		LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
Incoming Trunk Test Frame	Office Link or Office Link Extension Frame	Via Incoming Trunk Test Connector Frame		S1 or S	17.2	600		3
				T, R	17.2	600	3.07	3
	Automatic Transmission Test and Control Frame			T, R	6.5	230		
Trouble Recorder Frame	Trouble Recorder Connector Frame			S0-8	40.0	1400		
Traffic Register Cabinet or Relay Rack	Equipment Operating Message Registers	Via TRDF	Ground lead from Traffic Usage Recorder for GCC Registers	CC-	13.8	485	3.08	
				P or 1	27.8	970		
			Via (1.05 ohms) series auxiliary relay	P or 1	26.8	935		
	Equipment Operating Magnetic Counters	Via pulse relay		MP or 1	27.8	970		
	Fuse Panel	Via battery supply relay for registers		S	4.8	170		
		Direct for counters		MS	7.8	270		
Traffic Usage Recorder	Traffiic Usage Recorder Control Panel			All	20.0	700		
	Fuse Panel	48-V battery and ground leads		All	1.0	35		
Traffic Usage Recorder Control Panel	Fuse Panel	48-V battery and ground leads		E	7.0	245		

TABLE A (Cont)

FROM	TO	REMARKS	LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
Emergency Filament Supply	MF Pulsing Receiver Frame	Loop resistance of supply leads including supply leads between receivers in same loop (maximum length — 280 feet for No. 12 gauge wire specified)	B plus G	0.5	–		
Senders MF DP PCI	Signal Receiving Circuit (Multifrequency)		T, R T1, R1 J, L	15.0	525		
			—48, Grd	0.62	22		
			UL, Bat. 1	22.8	800		

TABLE B — FOR CAMA OFFICES ONLY

FROM	TO	REMARKS	LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
Incoming Trunk	Recorder Frame	Via Call Identity Indexer	RC	17.0	595		
	Incoming Register and Link Frame		R	23.5	820		
	Service Observing Frame		OBS	50.0	1750		
	Step-by-Step Selector Multiple		S	13.0	455		
Calls-Waiting Signaling Unit	Outgoing Trunk to CAMA Position Unit	Loop resistance	G plus CW	7.0	245		
	DC Position Unit						
	MF Position Unit	Loop resistance	G plus CW	25.0	875		

TABLE B (Cont)

FROM	TO	REMARKS	LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
CAMA Position Link and Controller	Sender		S	20	700		
	Position & Telephone Circuit or AMA Position Circuit for Toll or D5A Switchboard or Outgoing Circuit to CAMA Position	Maximum Extension Circuit Resistor ZO and ZQ Option	GB	15	525		
	Traffic Regulator Circuit	ZS Option Maximum Extension Circuit Resistor	GB1A-G GBA-G	30	1050		
		ZR Option Maximum Extension Circuit Resistor	GBA-G	15	525		
		ZT Option Maximum Extension Circuit Resistor	CCGA CCGB	50	1750		
		ZU Option Maximum Extension Circuit Resistor		100	3500		
	CAMA Controller	Resistor to Ground	L	30	1050		
	Outgoing Trunk to CAMA Position Unit		P	22.0	770		
Sender Register Connector Frame	DP Sender Frame	Via Sender Link (including multiple), Incoming Trunk, and Incoming Register and Link Frame		54.5	1905		4
	Fuse Bay	Ground leads	A, B	10.8	375		

TABLE B (Cont)

FROM	TO	REMARKS	LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
Perforator Cabinet	Sender Frame	Perforator magnet leads via Recorder, Transverter, and Transverter Connector (including multiple)	A-, B-, C-, D-, E-, F-, G-, H-, J-, K-	25.7	900		
	Transveter Frame	Via Recorder (PAM lead from Perforator Cabinet to Recorder and PA lead from Recorder to Master Timing or Transverter)	PA or PAM	8.6	300		
	Master Timing Frame						
Master Timing Frame	Recorder Frame		RL, RNT	4.6	160		
	Fuse Panel on Outgoing Trunk Test Frame or on Miscellaneous Relay Rack	Battery leads	K, MO	1.0	35		
		Ground leads	A, AE, AF, B, H	1.0	35		
			E	3.0	105		
Call Identity Indexer Frame	Recorder Frame	Via Incoming Trunk (including multiple)	CH or DJ	16.0	560	3.09	
			BT	4.0	140	3.09	
	Fuse Panel on Recorder Frame or on Other Call Identity Indexer Frames	Battery leads	A	0.5	17		
		Ground leads	C	0.5	17		
			A	3.0	105		
Sender Test Frame	Transverter Frame (including multiple)		MA	40.0	1400		
	Incoming Register and Link Frame (including multiple)		R	23.5	820		

TABLE B (Cont)

FROM	TO	REMARKS	LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
CAMA 2-Way Signaling Circuit	Signal Receiving Circuit (Multifrequency)	Remote Switchboard MF Pulsing	T, R T1, R1 J, L	15.0	525		
			—48, Grd	0.62	22		
Outgoing Trunk Circuit To Remote CAMA Pos or to Remote or Collocate TSPS MF to DC Pulse Conversion			UL, Bat. 1	22.8	800		
Trunk Automatic Test and Connector Frame	Miscellaneous Circuit for Message Register Rack	16 AM Wire Maximum Length 2000 Ft	MG	9.0			
	AMA Trunk Circuit		MR	9.0	315		
	Office Link Frame		S	4.3	150		
CAMA Incoming Trunk	Messenger Register in Register Cabinet	Provide E Option if Lead Resistance Exceeds 5.2 Ohms or 180 Feet	MR	20.61	720	5	
	22-V 60~ Supply	Loop Resistance	± PLUS G				

TABLE C — 1+ CAMA OR 100A TSP OFFICES ONLY

FROM	TO	REMARKS	LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTE	SEE FIG.
Link Controller Frame	CAMA Controller or Other Link Controllers in PG-Chain	Resistance to Ground	L	30.0	1050		
Link and Connector Frame	Link Controller Frame		AL(0-3) A AL(0-3) B BL(0-3) 0 BL(0-3) 1 BL(0-3) 2 BL(0-3) 3	10.0	350		
	Position and Position Control FR or Position. Position Control FR Through Light Hour Transfer Frame		S(0-2)	10.0	350		
Position Position Control Frame	Position Consoles	Local Operation	All	50.0	1750		
Position Position Signaling Frame	Postion Consoles	Remote Operation	All	50.0	1750		
Trans-verter Connector Frame	Trans-verter Connector Trans-verter Auxiliary Frame	Fig. 9 to Fig. 7	TD(0-11)	25.0	875		
	Trans-verter Connector Position Auxiliary Frame	Fig. 10 to Fig. 6 and 8	SD(0-13)	25.0	875		
		Battery	E and D	25.0	875		

TABLE C (Cont)

FROM	TO	REMARKS	LEADS	MAX. RES (Ohms)	MAX. LENGTH 24 GAUGE CABLE (Feet)	SEE NOTES	SEE FIG.
Control Pulsing Ckt	Signal Receiving Ckt (Multifrequency)	Local and Remote Operation	T, R T1, R1 J, L	15.0	525		
Position Display Ckt			—48, Grd	0.62	22		
			UL Bat. 1	22.8	800		
Postion Test Ckt							
Control Pulsing Test Ckt							
Select and Monitoring Ckt							

3.01 The lead length requirement for the T and R leads between the service observing frame and trunk is based on allowable capacitance loading which is a function of cable length. Therefore, the maximum length specified can not be increased regardless of wire gauge.

3.02 The 4.3- and the 11.4-Ω limits of the SL lead between the trunk link and trunk and between the trunk link and marker, respectively, may be increased in one provided there is a corresponding decrease in the other, so that the sum of the two resistances does not exceed 15.7 ohms.

3.03 The following formula may be used to determine alternate limits for the leads shown in Fig. 2, R1, R2, and R3 representing runs 1, 2, and 3, respectively.

$$(0.39)R_1 + (0.33)R_2 + (0.26)R_3 \leq 11$$

3.04 The resistance of the S1 lead between the office link and the distributing frame shall be limited to a maximum of 14.3 ohms where outgoing trunks are used in common with another office or where the outgoing trunk test frame leads to the office link terminate at the distributing frame.

3.05 Where the 65-Ω loop resistance between 4-wire terminating sets can not be met, one or more of the following optional arrangements may be used to lower the loop resistance.

(a) Cable the line side of the intertoll trunks directly to the 4-wire terminating sets.

(b) Provide No. 22 gauge switchboard cable for loop cabling except for those cables terminating on the trunk link and office link frames.

(c) When loop is a combination of No. 22 and No. 24 gauge cable, locate frames to keep lengths of No. 24 gauge cable at a minimum.

3.06 The resistance limit for the G0-4 leads between markers and senders is required for the following senders only.

SD-25359-01 (RP)
SD-25478-01 (DP)
SD-25769-01 (MF)
SD-25866-01 (DP)
SD-25961-01 (PCI)
SD-25978-01 (MF-Non-FAT)

3.07 The following formula may be used to determine alternate limits for the T and R leads shown in Fig. 3; R_1 and R_2 representing the resistance of runs 1 and 2, respectively.

$$(1.5)R_1 + R_2 \leq 27.0$$

3.08 A pin jack arrangement is normally provided for access to traffic registers and magnetic counters. Resistance limits shown in Table A for these leads have been reduced 2.2 ohms below circuit requirements to take into account the resistance of the pin jacks and cords. Where the pin jack arrangement is not in use, the resistance limit may be increased by this value, increasing the maximum conductor length proportionately.

3.09 The 4-Ω limit of the BT lead between the call identity indexer and the recorder may be increased by an amount equal to a corresponding decrease in the 16-Ω limit of the resistance sum of the DJ lead between the call identity indexer and the trunk and the CH lead between the trunk and the recorder. The resistance of the DJ plus the CH lead shall in no case exceed the 16-Ω limit.

4. GENERAL NOTES

4.01 Where excessive conductor lengths result with normal office planning, the resistance of these conductors may be reduced by the following procedures. These procedures are objectionable from an overall standpoint and should be employed only where lead limitations can not be met by normal practices.

(a) Use larger gauge wire for single runs or to the first appearance of runs involving multipled circuits. Where this is done, it may be more economical to separate the critical leads from the cable and increase only their size, particularly where they represent only a small percentage of the total leads in the cable. In the case of wiring to apparatus with thin, flat terminals or terminals arranged for solderless wrapped connections, wire larger than No. 22 gauge should not generally be used, due to connecting difficulties. Even the use of No. 22 gauge wire should be avoided, if possible, for connections to the crosspoint terminals of crossbar switches where these terminals are arranged for wrapping and soldering the connections.

(b) Where No. 24 gauge wire is used for multiples between frames and where the use of larger gauge wire to the first appearance of the multiple is insufficient to reduce the overall resistance within specified limits, No. 22 gauge wire may be used for the multiples, space permitting.

4.02 This specification does not supersede any working limits covered on the circuit drawings. Floor plan layouts should be checked not only against the limits in this specification, but also against circuit requirements.

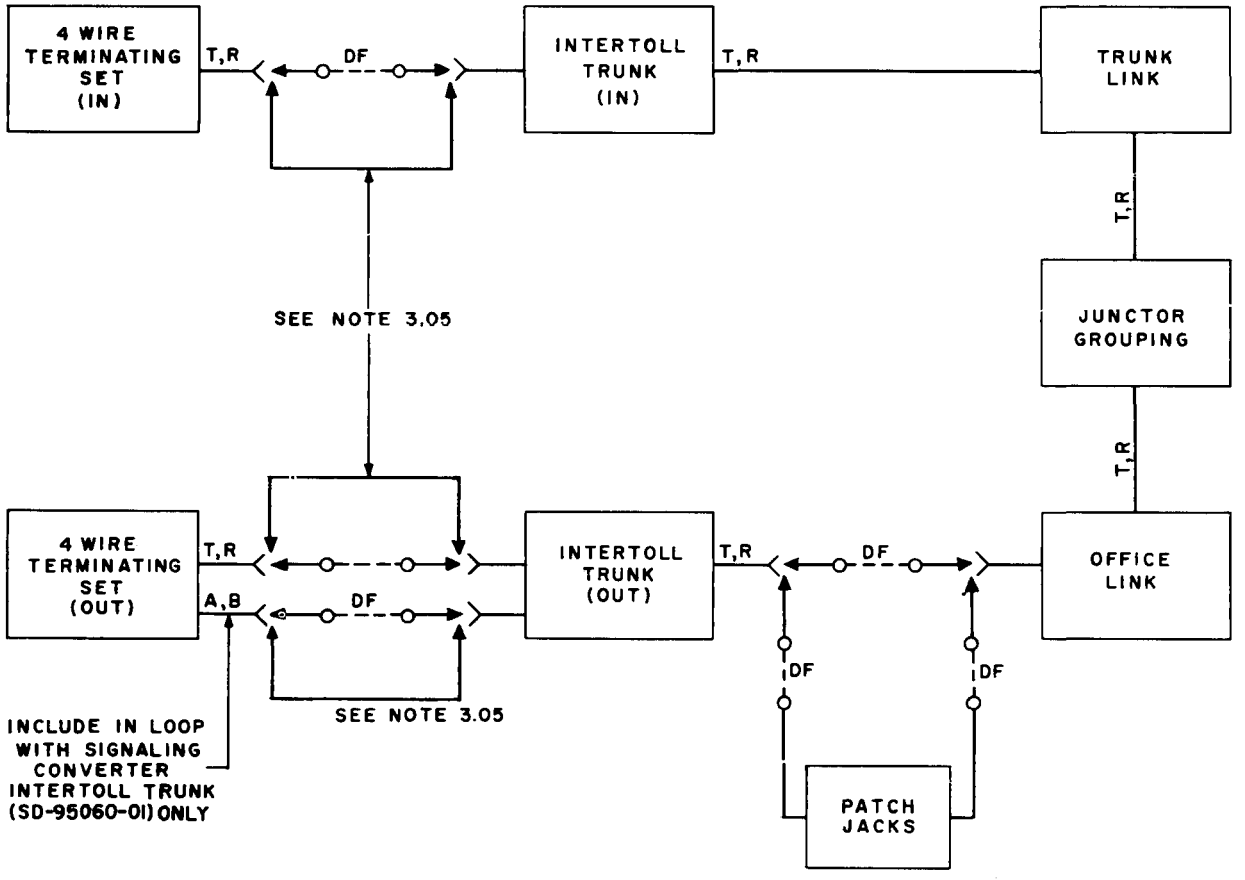


Fig. 1 — 2-Wire Loop at Control Switching Point Locations

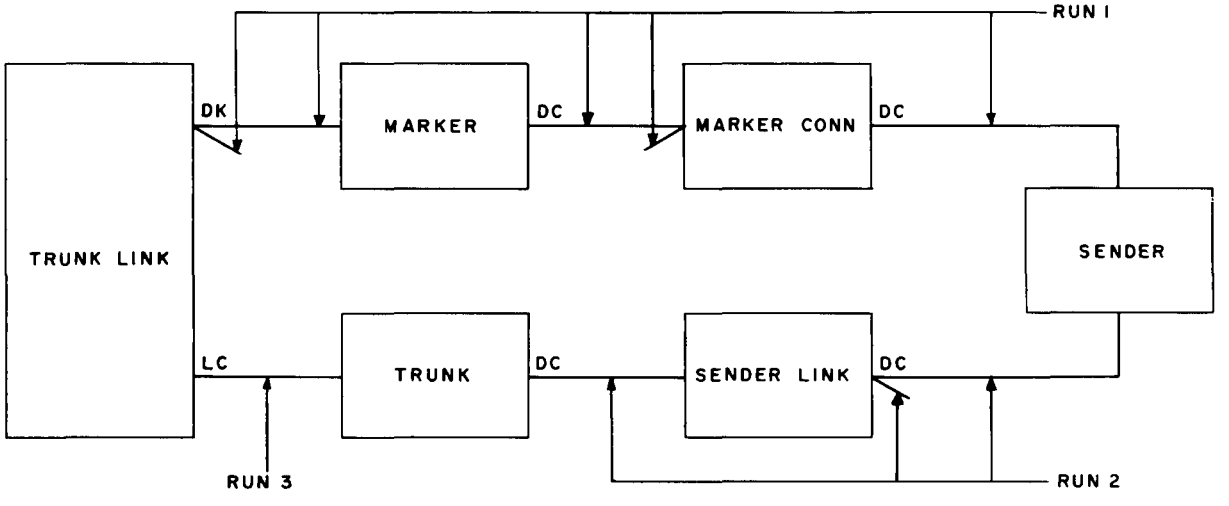


Fig. 2 — Operating Path of LC Relay in Trunk Link

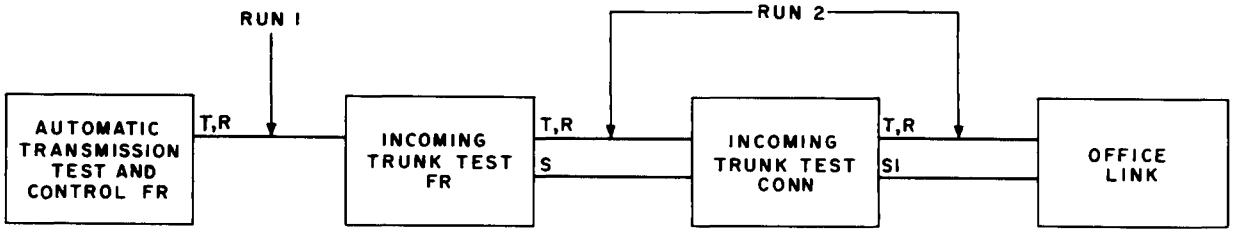


Fig. 3 — Test Leads

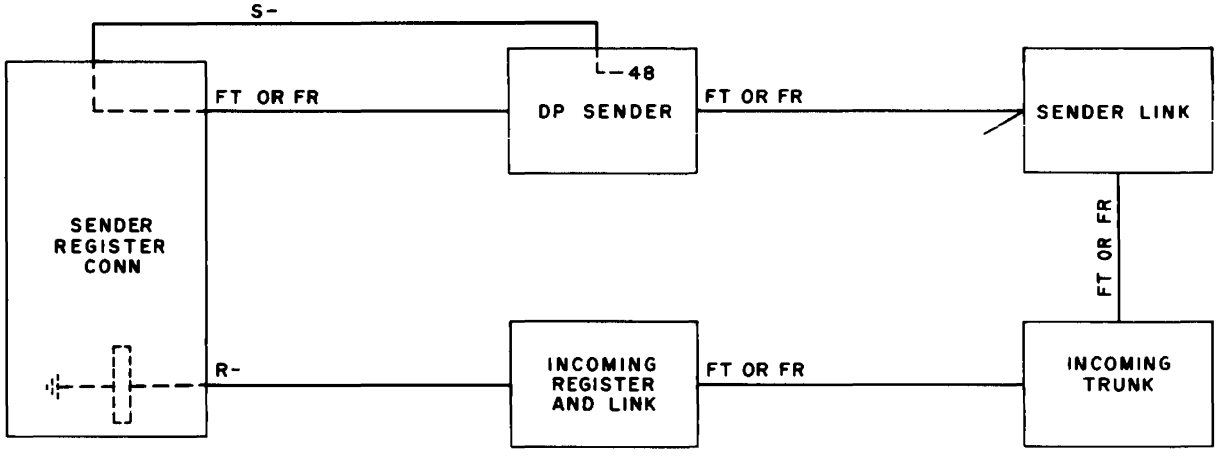
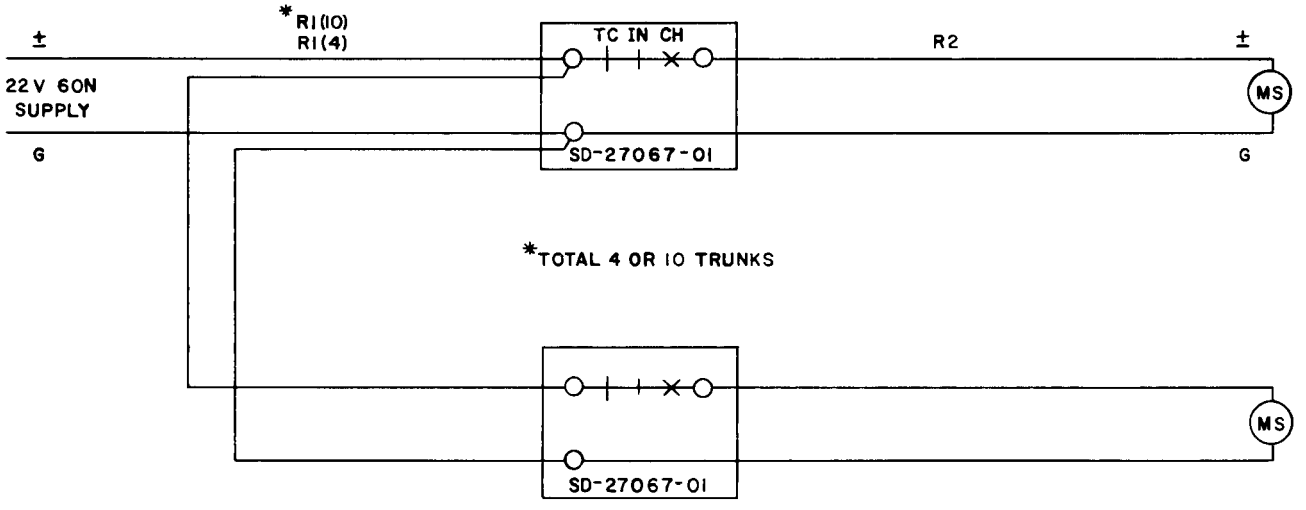
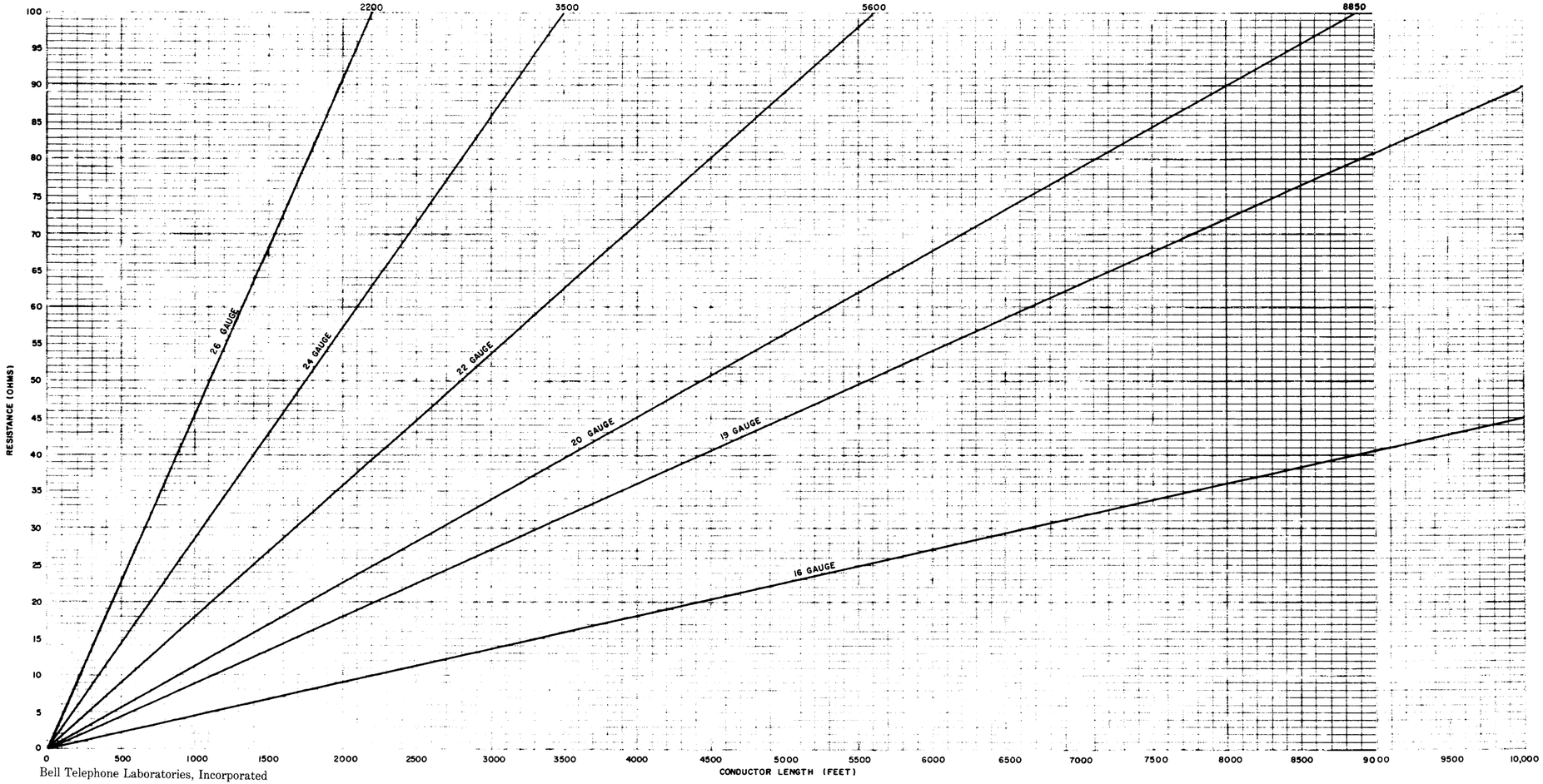


Fig. 4 — Operating Path of R-- Relay in Sender Register Connector



*RI(10) OR RI(4) LOOP RESISTANCE
R2 LOOP RESISTANCE
WHEN APP FIG 8 IS PROVIDED
RI(10)+R2 ≤ 50r
WHEN APP FIG 7 IS PROVIDED
RI(4)+R2 ≤ 13r

Fig. 5 — Wire Loop for MS Clock



Graph A — Resistance per Conductor Length (For resistance values of 10 ohms or less, let resistance scale read for 0 to 10 ohms and conductor length scale from 0 to 1000 feet)

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