

## AUTOMATIC INTERCEPT SYSTEM EXTENDED RANGE TRANSMISSION CONSIDERATIONS

CONTENTS	PAGE	CONTENTS	PAGE
1. INTRODUCTION . . . . .	1	5. WIRING RESTRICTIONS . . . . .	20
2. SYSTEM DESCRIPTION . . . . .	2	6. CONCENTRATORS . . . . .	21
A. General . . . . .	2	A. No. 1 Trunk Concentrator . . . . .	21
B. Single AIC System . . . . .	2	B. No. 23 Trunk Concentrator . . . . .	22
C. Multi-AIC System . . . . .	4	7. AIS POSITION TRUNKS AND OPERATOR HEADSETS . . . . .	23
D. AIS Subsystems . . . . .	4	8. BALANCE CONSIDERATIONS . . . . .	25
3. AIS EXTENDED RANGE-TRANSMISSION PLANNING CONSIDERATIONS . . . . .	5	A. General . . . . .	25
A. General . . . . .	5	B. AIS Time Division Switch . . . . .	25
B. Loss-Noise Grade of Service Objectives . . . . .	6	9. AIS NETWORK—CIRCUIT ORDER AND MAINTENANCE TESTS . . . . .	25
C. Talker Echo Satisfaction . . . . .	6	10. REFERENCES . . . . .	26
D. Operator Sidetone . . . . .	13		
4. TRANSMISSION PLAN FOR EXTENDED RANGE AIS . . . . .	13	1. INTRODUCTION	
A. Introduction . . . . .	13	1.01 A new transmission plan for the Automatic Intercept System (AIS) extends the range of this system up to 1000 route miles between the intercepting class 5 office and the Centralized Intercept Bureau (CIB). This is accomplished by using the 4251B network in the position telephone circuits and adding compandors to long toll type trunks. In addition to range extension, the following items are incorporated in the new transmission plan:	
B. Extended AIS Trunk Loss Plan . . . . .	13	(a) The 4251B network is to be included in the operator and supervisory consoles at the CIB to provide echo suppression for the operator,	
C. Compandors . . . . .	16		
D. Trunk Inserted Connection Loss, Return Loss and Noise Requirements . . . . .	18		
E. Announcement Levels . . . . .	18		
F. AIC Time Division Switch Network-Transmission Requirements . . . . .	19		

**NOTICE**

Not for use or disclosure outside the  
Bell System except under written agreement

## SECTION 852-405-101

independent sidetone control, and automatic receive gain control.

(b) The AIS transmission plan has been revised in order to use standard carrier terminal capability, to allow a concentrator stage ahead of a remote Automatic Intercept Center (AIC) and to permit extended range systems. Four-wire trunks are required except for some intra-building trunks between class 5 offices and trunk concentrators, or between class 5 offices and the AIC where trunk concentrators are not used. Compandors are required on toll-type analog trunks over 100 miles in length to reduce circuit noise.

(c) The 4-wire No. 1 trunk concentrator is recommended for new installations over the 2-wire No. 23 trunk concentrator.

(d) Transmission considerations for operator number identification (ONI) positions.

**1.02** Whenever this section is reissued, the reasons for reissue will be given in this paragraph.

**1.03** The initial version of the AIS (Section 852-405-100) was developed to serve intercepted calls in metropolitan areas. The transmission considerations for the initial systems were based on the use of metallic or carrier facilities with a limited range of 150 route miles. Existing systems that are to be extended to the new 1000-mile range should be designed to conform to the transmission plan presented in this section.

**1.04** Standard trunk designs to be used with the extended range AIS are presented in the Standard Message Trunk Design System (SMETDS).

## 2. SYSTEM DESCRIPTION

### A. General

**2.01** Intercept traffic consists of those calls made to exchange line numbers that are vacant, disconnected, changed, or experiencing trouble. This traffic is generally handled at a centralized point to which calls from several offices are routed.

**2.02** The AIS consists of the intercept office, an AIC and CIB (Fig. 1). Operator number identification (ONI) positions are provided for those offices where automatic number identification (ANI)

for the called number is not available. Two configurations are available—one for a single AIC and one for multi-AIC operation.

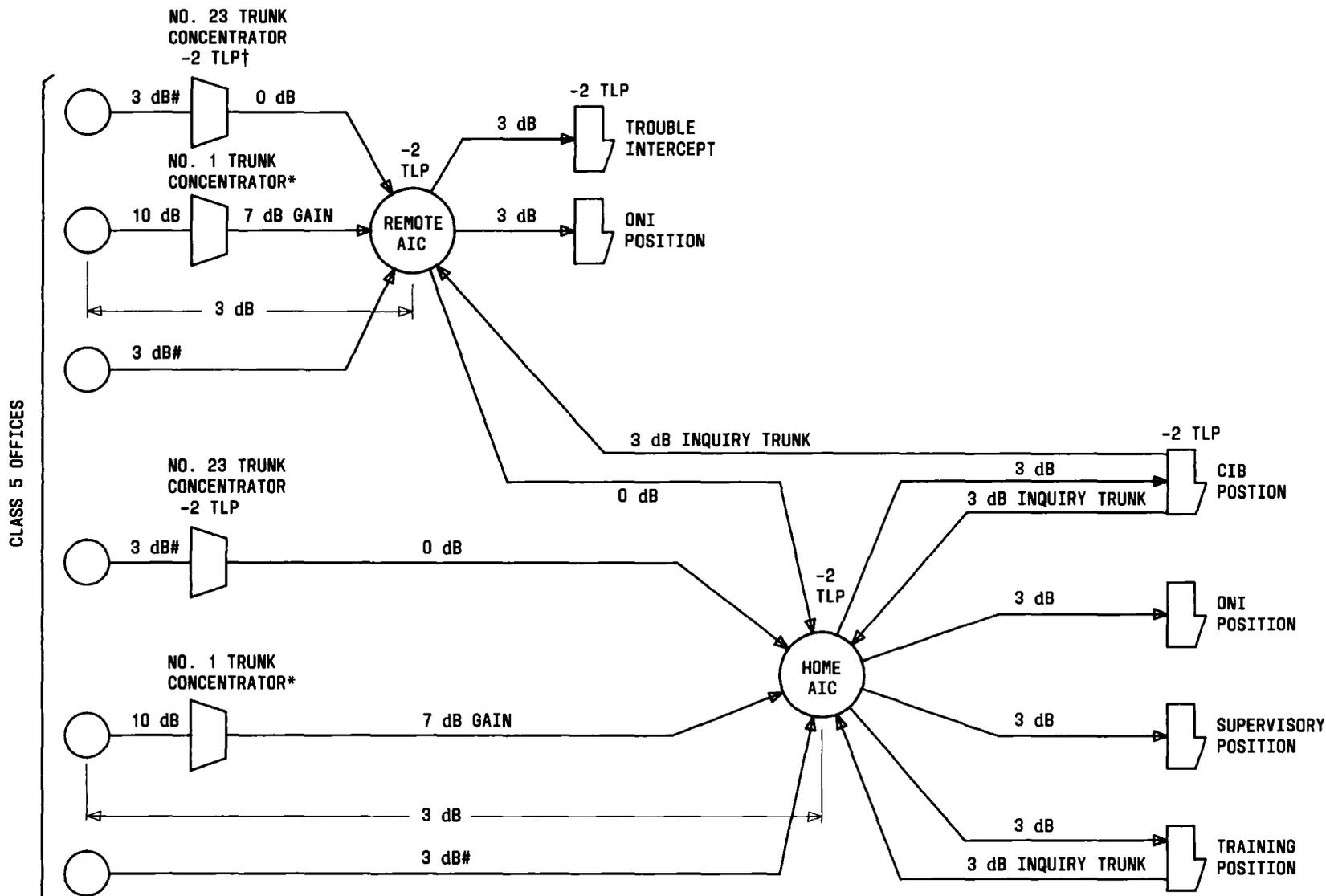
**2.03** The incoming intercepted calls are routed to either a recorded announcement or to an operator by means of a time-division switch. Customer access to the CIB operator is available for calls that require additional assistance. The announcement informs the customer of the number he has reached, the reason the number is not in service and, if available, a new number for the called party. After the message is repeated, if the customer waits on the connection, he is connected to the CIB operator. Where intercept ANI is not available, the call first goes to an ONI operator who requests the identity of the called number. The ONI operator then enters the number into the AIC and the call is handled in the same manner as described above.

**2.04** Calls to lines which are experiencing trouble should be routed to nearby trouble-operator board for completion when feasible. If call completion is not required, the call may be routed to a CIB. Where concentrators between class 5 intercept offices and the AIC are used, the trouble calls should be directed to trouble-operator boards located at the concentrator. Trouble calls from remote areas should not be routed to a cord switchboard from the home AIC in extended systems because the switchboards are not designed with the necessary features to control customer and operator echo.

### B. Single-AIC System

**2.05** A single AIC system has one AIC and an associated CIB. ONI consoles may be provided if called number identification and associated outpulsing equipment is not available in the intercepting class 5 office. The AIC is capable of handling intercept traffic originating from up to 16 number plan areas (NPAs) depending upon the traffic concentration in the area served. A single AIC can serve about 50 to 100 offices per network depending upon the intercept rates of the individual class 5 offices.

**2.06** The CIB operator, upon receiving a call from a customer, has the ability to interrogate the AIC disc file for status information by using an inquiry trunk to the AIC. This status information is presented either visually or by voice recording depending on the digit prefixed by the operator.



\* REFER TO SECTION 852-408-101 FOR ENGINEERING CONSIDERATIONS FOR THE NO. 1 TRUNK CONCENTRATOR.  
 # 3 dB ICL ON REPEATED TRUNKS  
 2 dB TO 4 dB ICL ON NONREPEATED TRUNKS

Fig. 1—AIS Trunk Loss Plan

However, the voice recording takes more time than the visual presentation and is mainly used by maintenance personnel. If additional assistance is required, the operator can transfer the call to a supervisory position and connect the customer directly to the supervisor. The operator also has the ability to confer with the supervisor before transferring the call. The operator can then release the connection and become available for additional calls. The CIB also has trunks to repair bureaus and lines to a local central office for use by the operator.

**Single AIC With Trunk Concentrators**

**2.07** The AIC switch may have as many as four networks for switching. These networks are each capable of terminating about 300 incoming trunks. As the intercept traffic generated in a class 5 office is generally small, usually 5 trunks are adequate between the class 5 office and the AIC. Therefore, trunk concentrators may be necessary to combine intercept traffic from many class 5 offices. Concentrators may be the 4-wire No. 1 trunk concentrator or the 2-wire No. 23 trunk concentrator. Only one stage of concentration is permitted.

**C. Multi-AIC System**

**2.08** When the amount of traffic requires more than one AIC, additional AICs (up to a total of four remote AICs and a home AIC) may be connected together to form a multi-AIC system. The AIC associated with the CIB is designated as the home AIC and the four remote AICs access the CIB through the home AIC. The home AIC and each remote AIC has associated disc files for intercept records, announcement machines, a processor and, where applicable, a team of ONI operators or trouble operators. All calls to the CIB operator are routed through the home AIC. The CIB operator has inquiry trunks to each AIC. Only a single stage of concentration is permitted. A multi-AIC system is shown in Fig. 1.

**D. AIS Subsystems**

**Home AIC**

**2.09** The home AIC handles the intercept traffic by giving an assembled recorded announcement regarding the status of the intercepted number reached. Customers requiring assistance in addition

to the announcement may wait on the line and after a timed interval (18 seconds), will be transferred to the CIB operator for additional assistance. The CIB operator also handles special kinds of intercept calls, such as a telephone number which has been changed to two other numbers because of a dissolution of a partnership, or calls in which a failure in the ANI equipment causes the called number not to be properly identified. The CIB operator may also handle light load or transferred directory assistance (DA) calls and ONI calls where ANI equipment is not provided.

**2.10** AICs with four switching networks have a capacity of 1660 terminations (trunks, service circuits such as data outpulsers, and MF receivers), 256 simultaneous connections, and 96 announcement trunks. About 1200 incoming trunks can be served by the four networks.

**Remote AIC**

**2.11** The remote AICs are similar to the home AIC, except CIB operators are not directly associated with remote AIC's. However, ONI and trouble intercept may be associated with each remote AIC. The remote AIC is also program controlled and contains announcement machines and disc files. When the remote AIC has multiple networks, separate trunk groups are required from each network to the home AIC.

**AIC Trunk Circuits**

**2.12** There are two types of trunk circuits in the AIS: trunk circuits which do not supply gain and trunk circuits with built-in gain units. The SD-1B185 is a non-gain unit and the SD-1B186 is a gain unit. Both are plug-in units. Use of non-gain and gain units are as follows:

- (a) **2-dB Loss Connection Through the AIC**—This consists of a non-gain trunk circuit connected to a non-gain trunk circuit. In general, the losses in this connection are due to the contact resistance of the bilateral switch and the resistance of the inductors used for resonant transfer. As shown in Fig. 2, there is a 2-dB loss between terminals of two similar non-gain trunk circuits. This loss is distributed as a theoretical 1 dB loss from the input of each trunk circuit to the intergroup bus which is considered to be the center reference point of the switch. (This is a theoretical loss since

transmission between the trunks occurs via pulse amplitude modulation). This connection is used for testing purposes where the incoming trunk is routed to a test line.

(b) **0.5-dB Loss Connection**—If a non-gain trunk circuit is connected to a gain trunk circuit, the losses are as shown in Fig. 3. The loss to the intergroup bus and center reference point of the non-gain trunk circuit is 1 dB. The loss from the intergroup bus to the input of the amplifier in the gain trunk circuit is 1 dB. The amplifier gain is set at 1.5-dB gain so that the overall connection through the AIC is a loss of 0.5 dB. This connection is typical of a connection between an incoming trunk circuit (SD-1B185) and the position circuit (SD-1B186).

On the basis of these losses, a non-gain trunk circuit has a theoretical loss of 1 dB while a gain trunk circuit has a theoretical gain of 0.5 dB. This information is used in establishing a TLP of -2 dB for the AIC at the intergroup bus and for the design and alignment of the facilities.

### Trunk Concentrators

2.13 There are two types of trunk concentrators that may be used in the AIS:

(a) The No. 1 trunk concentrator is a 4-wire concentrator which provides a concentration ratio of 40 to 12 or 40 to 24. Adding more crossbar switches will increase its capacity to 200 to 30 or 200 to 60 depending on the equipment and wiring arrangement. The No. 1 trunk

concentrator is the preferred concentrator for use in new AIS installations (see paragraph 6.01).

(b) The No. 23 trunk concentrator is a 2-wire trunk concentrator and has a concentration ratio of 20 to 1, where 20 trunk circuits are furnished at the incoming end of the switch and one junctor is furnished at the outgoing end of the switch for one outgoing trunk. Up to 20 juncctors can be installed before another crossbar switch and equipment arrangement must be provided (see paragraphs 6.02 and 6.03).

## 3 AIS-EXTENDED RANGE—TRANSMISSION PLANNING CONSIDERATIONS

### A. General

3.01 An allocation of transmission impairments such as loss, noise, gain-slope, and return loss to the several trunk segments to meet grade of service objectives for the overall system must be incorporated in trunk transmission planning considerations. Transmission planning includes the following tasks:

- (a) Assigning 1000 Hz connection losses with standard aligned facilities, if possible, to the various segments of the system to provide for adequate volume and for some control of echo impairment.
- (b) By selecting transmission facilities with low noise for short haul type trunks and by using companders on long toll-type trunks.

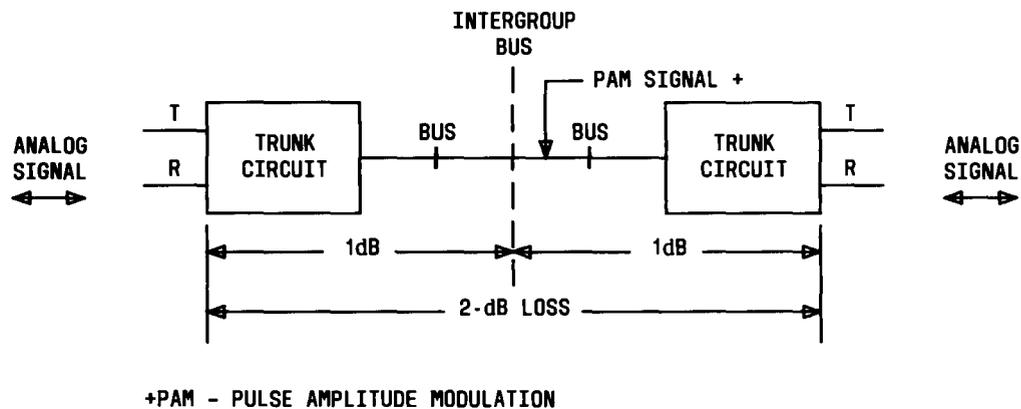


Fig. 2—Loss Between Two No-Gain Trunk Circuits Within the AIC

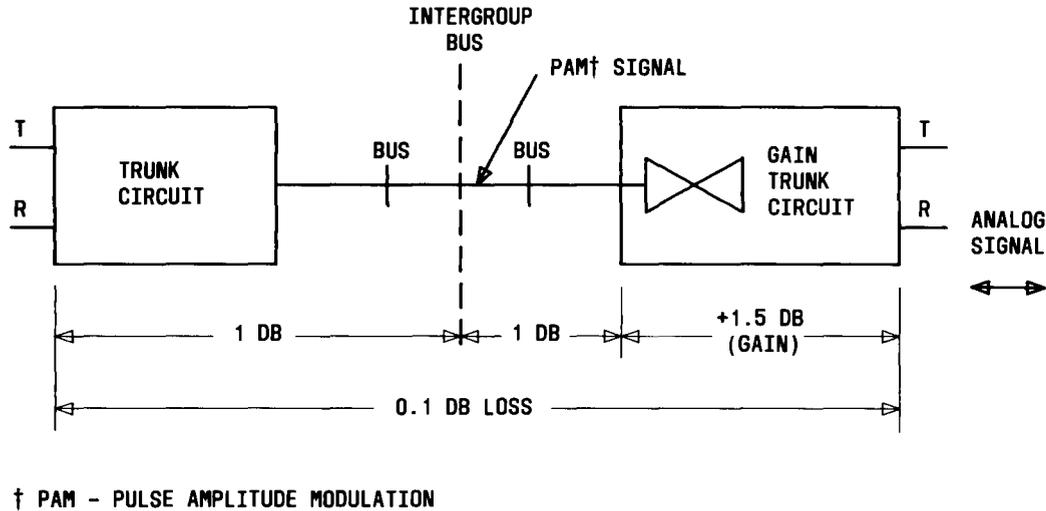


Fig. 3—Loss From a No-Gain Trunk Circuit to a Gain Trunk Circuit Within the AIC

(c) Controlling talker echo and loss in the echo path. The return loss requirements are similar to those used in the message telecommunications service (MTS) network. Table A provides the return loss requirements for the extended range AIS.

(d) Providing for proper sidetone level and for the electroacoustic efficiencies of the operator's telephone apparatus.

## B. Loss-Noise Grade of Service Objectives

**3.02** Loss-noise grade of service objectives in terms of percent good or better ratings for customer and operators have been set for two intercept conditions. These are:

(a) "Local intercept" where the central office originating the call is in the same metropolitan area as the intercepting office.

(b) "Toll intercept" where the central office originating the calls is in a remote numbering plan area.

**3.03** For the local intercept objective, the grade of service should be about the same as for customer-to-customer calls over a short (100 mile) toll connection. For the toll intercept objective, the grade of service should be about the same as for a non-intercepted MTS call.

**3.04** Calculations have been made to determine the grade of service for:

- (a) Intercepted connections using various facilities in the AIS network
- (b) Connections in the MTS network of similar length.

The results of the calculations were then used to determine the facility mileage limits for the various trunks in the AIS network. Some sample results of these calculations are discussed in paragraph 4.07. The AIS noise requirements are contained in Table B. When trunks are routed over multiple facility types, select the requirement with the highest dBrnC value applicable.

## C. Talker Echo Satisfaction

**3.05** The talker echo objective for both the customer and the operators is based upon estimates of talker echo satisfaction received by present MTS toll customers.

**3.06** The AIS talker echo objective for local and toll intercept is an 85% good or better grade of service. This is somewhat poorer than for an equivalent length of MTS connection but is considered adequate since it is expected that only a small percentage of connections will be extended to the full 1000 route mile limit.

TABLE A  
AIS BALANCE REQUIREMENTS

TEST NO.	TEST SITE	BALANCE TEST CONFIGURATIONS	REQUIREMENTS					
			ERL (dB)			SRL/SRL-HI (dB)		
			MEDIAN	MIN.	TURN DOWN	MEDIAN	MIN.	TURN DOWN
1	BALANCE VERIFICATION OF CODE 101 TEST LINE		27	21	18	20	14	11
2	BALANCE VERIFICATION OF OUTGOING TRUNKS FROM REMOTE AIC TO HOME AIC		27	21	18	20	14	11
3	BALANCE VERIFICATION OF OUTGOING TRUNKS FROM AIC TO ONI, CIB, AND SUPERVISOR POSITIONS		22	16	10	15	11	4

\* VERIFY BALANCE OF 101 TEST LINE WHILE CONNECTED TO:  
a. THE LONGEST INCOMING REFERENCE TRUNK,  
b. THE LONGEST OUTGOING REFERENCE TRUNK.  
† TDS - TIME DIVISION SWITCH

TABLE A (Contd)  
AIS BALANCE REQUIREMENTS

TEST NO.	TEST SITE	BALANCE TEST CONFIGURATIONS	REQUIREMENTS					
			ERL (dB)			SRL/SRL-HI (dB)		
			MEDIAN	MIN.	TURN DOWN	MEDIAN	MIN.	TURN DOWN
4	BALANCE VERIFICATION OF INCOMING 4-WIRE TRUNKS FROM REMOTE AIC, NO. 1 TRUNK CONCENTRATOR, NO. 23 TRUNK CONCENTRATOR, OR SWITCHBOARD		27	21	18	20	14	11
5	BALANCE VERIFICATION OF INCOMING 4-WIRE TRUNKS FROM CLASS 5 OFFICES, CIB INQUIRY, AND OPERATOR TRAINING POSITIONS		22	16	10	15	11	4
6	BALANCE VERIFICATION OF 2-WIRE TRUNKS FROM THE AIC TO CLASS 5 OFFICES		18	13	10	10	6	4

† TDS - TIME DIVISION SWITCH

TABLE A (Contd)  
AIS BALANCE REQUIREMENTS

TEST NO.	TEST SITE	BALANCE TEST CONFIGURATIONS	REQUIREMENTS					
			ERL (dB)			SRL/SRL-HI (dB)		
			MEDIAN	MIN.	TURN DOWN	MEDIAN	MIN.	TURN DOWN
7	BALANCE VERIFICATION OF INCOMING 2-WIRE TRUNKS FROM AIC TO 3C, 3CL, OR NO. 1 SWITCHBOARDS		27	21	18	20	14	11

† TDS - TIME DIVISION SWITCH

TABLE B

**NOISE LIMITS (DBRNC) FOR AIS TRUNKS**  
**A/B A = CIRCUIT ORDER AND MAINTENANCE LIMIT**  
**B = IMMEDIATE ACTION LIMIT**

TRUNK LOSS	FACILITY	FACILITY ROUTE MILES				
		0-50	51-100	101-200	201-400	401-1000
ICL = 0 ± 0.5 dB EML = 4 ± 0.5 dB (Note 5 for other EMLs)	Analog non-compandored	27/36	29/36	31/36	33/38	—
	Analog compandored (Note 2)	22/30	24/30	26/30	28/32	—
	LMX w/N3 Compandor Applique	17/22	18/23	18/23	19/24	20/25
	Digital	24/30	24/30	24/30	24/30(T2)	—
	VF Metallic	25/36 (0-15 miles)		—	—	—
Position Trunk Operator RCV Direction (Note 3) ICL = 4 dB EML = 7.5 dB	Analog non-compandored	24/33	26/33	28/33	30/35	—
	Analog compandored (Note 2)	19/27	21/27	23/27	25/29	—
	LMX w/N3 Compandor Applique	14/19	15/20	15/20	16/21	17/22
	Digital	21/27	21/27	21/27	21/27(T2)	—
	VF Metallic	22/33 (0-15 miles)		—	—	—
Position Trunk Operator TRMT Direction (Note 4) ICL = 2 dB EML = 5.5 dB	Analog non-compandored	26/35	28/35	30/35	32/37	—
	Analog compandored (Note 2)	21/29	23/29	25/29	27/31	—
	LMX w/N3 Compandor Applique	16/21	17/22	17/22	18/23	19/24
	Digital	23/29	23/29	23/29	23/29(T2)	—
	VF Metallic	24/35 (0-15 miles)		—	—	—

Notes:

- Noise measured with test pads.
- For carrier facilities with built-in syllabic compandors such as N-type carrier.
- Measured with 132A Test Set connected at position head set jacks, terminated at MTF of AIS. Limits include loss of the 132A Set.
- Measured at MTF of AIS (TP2), terminated at position via 132A Test Set. Limits include loss of the TP2 test pad.
- If EML is less than shown add the difference of EML values to the noise limits, if EML is greater subtract the difference. If noise is measured without the test pad but loss is measured with the test pad on the same trunk, subtract the value of the test pad from the noise limits.

**D. Operator Sidetone**

**3.07** The proposed nominal sidetone for customers is taken as a standard for operators as well. This objective is a mean acoustic-to-acoustic sidetone path loss of 12 dB. Sidetone losses between 8 and 16 dB are acceptable (see paragraphs 7.07 and 7.08).

**4. TRANSMISSION PLAN FOR EXTENDED RANGE AIS****A. Introduction**

**4.01** In the transmission plan described in Section 852-405-100 for the 150-mile range AIS, 2 dB and 4dB trunks were required. Standard trunk designs were not available for that system. Each AIS installation had to be custom designed. In addition, the remote AIC was not permitted to have concentrated traffic from a trunk concentrator located at a remote point. In some cases, this restriction made it difficult to properly load the AIC for best traffic efficiency.

**4.02** The extended range AIS loss plan permits the use of standard trunk designs. These designs are covered in the Standard Message Trunk Design System (SMETDS). The AIC switches and the No. 23 concentrators have been assigned a transmission level of -2 dB.

**4.03** In order to meet the AIS operator transmission objectives, it is necessary for the following to be observed.

- (a) Trunks are to meet the loss requirements shown on Fig. 1.
- (b) Trunks are to meet the noise requirements of Table B.
- (c) Compandors are used to reduce noise on long intertoll-type trunks (longer than 100 miles) between trunk concentrators and AICs.
- (d) The 4251B network is used in all new and existing CIB and ONI operator and supervisory positions on AIS extended range designs. (The 4251B network is described in Section 332-121-110.)
- (e) Wiring restrictions are followed for proper return loss.

(f) Remote AICs are to be through balanced.

(g) It is recommended that SMETDS trunk designs be used.

**B. Extended AIS Trunk Loss Plan**

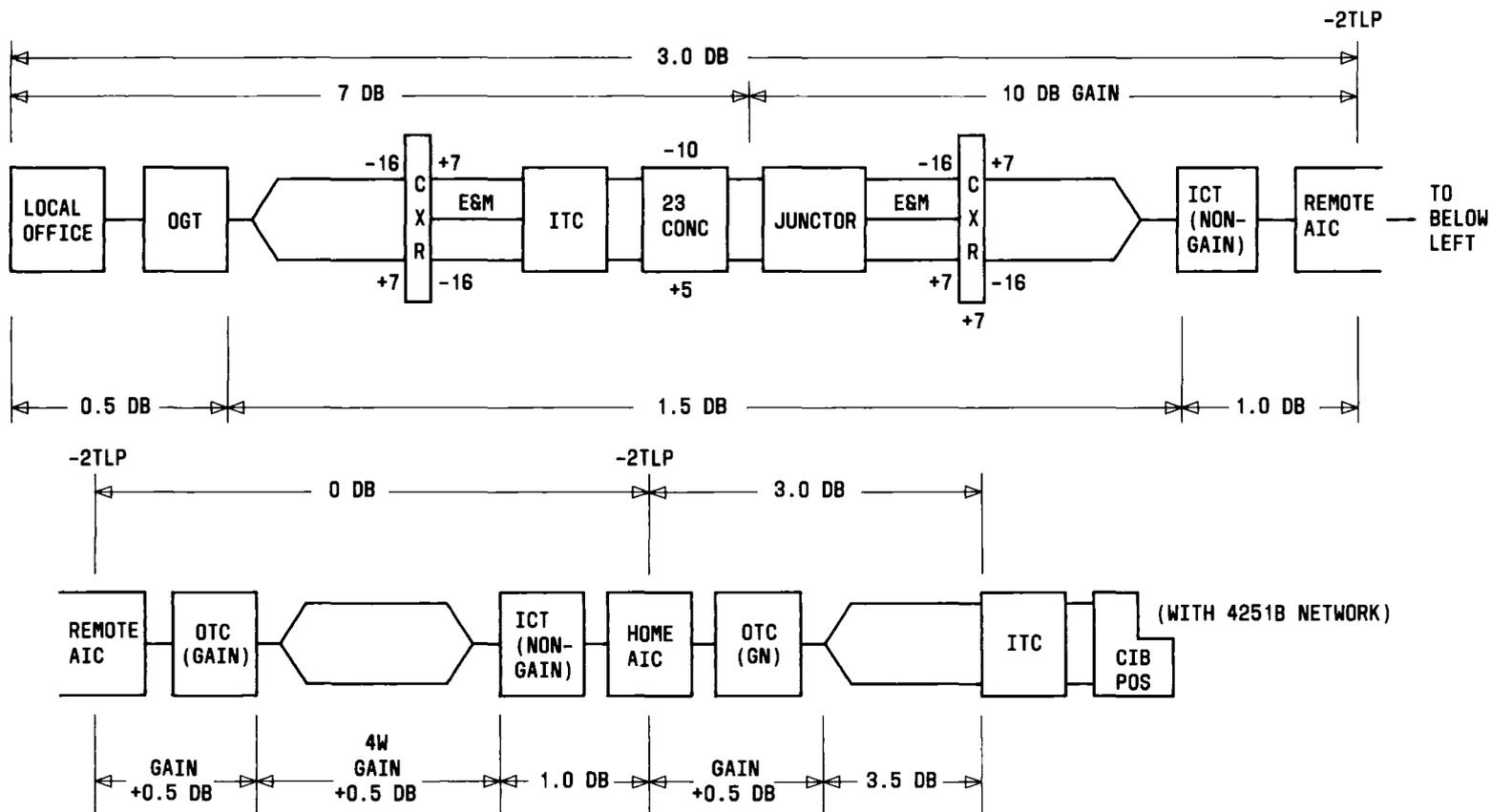
**4.04** The extended AIS trunk loss plan consists of trunks with design ICLs of 3 dB and 0 dB. When a No. 1 trunk concentrator is used, the incoming and outgoing trunks are considered as one trunk with an overall ICL of 3 dB. The AIS loss plan devised for extended range AIS's and all new AIS's is shown in Fig. 1, 4, and 5. A maximum of four trunks in tandem are allowed. These are:

- (a) Class 5 office to concentrator
- (b) Concentrator to remote AIC
- (c) Remote AIC to home AIC
- (d) Home AIC to CIB.

All of the trunks in the AIS network are to be 4-wire, with the exception of trunks from the class 5 office to the trunk concentrator (or from the class 5 office to the AIC when a concentrator is not used) and a few service trunks. Trunks from the class 5 office to the concentrator or AIC may be either 2-wire or 4-wire. Operator position trunks must be 4-wire facilities.

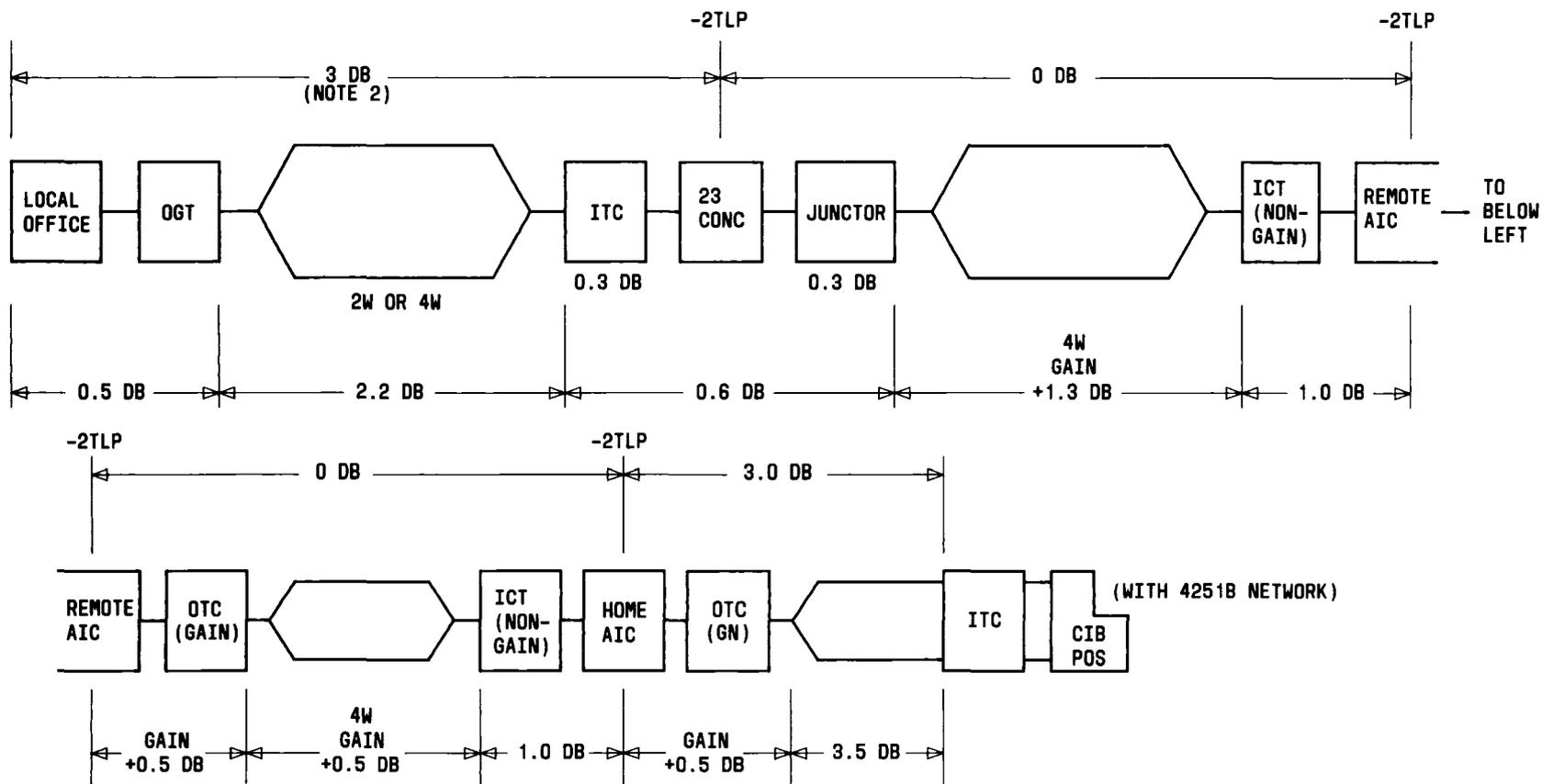
**4.05** The No. 23 concentrator and the AICs are given the -2 TLP assignment to provide proper carrier loading and return loss. Manual testing arrangements at the No. 23 concentrator and the 101- and 102-type test lines provided by the AIC must be changed accordingly. A 2 dB loss is provided in the test circuit, one dB in the trunk circuit and one dB in the test line. This change will place a -2 TLP at the time division bus of the AIC.

**4.06** Four-wire transmission facilities must be used for 0 dB loss links. Care must be taken in links having 2-wire switching (No. 23 trunk concentrator and AIC) to provide the proper return losses and through balance for acceptable singing and echo performance. Precision networks (4066C) are available for the No. 23 trunk concentrator to provide improved balance. Idle circuit terminations to prevent singing in the idle condition are provided



NOTE: SEE SECTION 852-408-101 FOR OTHER TRANSMISSION FACILITIES TO NO. 1 TRUNK CONCENTRATOR

Fig. 4—Transmission Loss Plan for Trunks to the AIC Through a No. 23 Trunk Concentrator



NOTES:

1. REFER TO SECTION 852-408-100 FOR ENGINEERING CONSIDERATIONS FOR THE NO. 23 TRUNK CONCENTRATOR.
2. 3 dB ICL ON REPEATERED TRUNKS, 2 dB TO 4 dB ON NONREPEATERED TRUNKS.

Fig. 5—Transmission Loss Plan for Trunks to the AIC Through a No. 23 Trunk Concentrator

## SECTION 852-405-101

in both the incoming and outgoing trunks in the No. 23 trunk concentrator and in both the incoming and outgoing trunks of the AIC. A proper idle circuit termination is necessary at both ends to assure stability. Proper termination must be retained during testing or troubleshooting. Idle circuit terminations are not required for the No. 1 concentrator due to its 4-wire design.

### **Typical Allowable Trunk Lengths for Various Facilities**

**4.07** Table C shows some typical overall lengths for the AIS system when using various types of exchange carrier facilities from the class 5 office to the trunk concentrator. All cases are assumed to have either up to 30 miles of cable or up to 100 miles of T-carrier from the AIC to CIB. All digital trunks are assumed to be a single link of digital facility.

(a) **Case 1**—When the trunk between the class 5 office and the concentrator is made up of:

- 20 miles of N2, ON, or O carrier, or
- 80 miles of N3 carrier, or
- 50 to 100 miles of T-carrier, or
- 30 miles of cable.

A maximum of 130 miles of noncompandored LMX facilities or 800 miles of compandored LMX facilities may be placed between the concentrator and the home AIC. The length of the noncompandored AIS network will consequently be limited to between 180 and 330 route miles. The compandored AIS network will have a limit of 1000 route miles.

(b) **Case 2**—When the trunk between the class 5 office and the concentrator is made up of:

- 90 miles of N2, ON, or O carrier, or
- 200 miles of N3 carrier, or
- 30 miles of cable

A maximum of 120 miles of noncompandored LMX facilities, or 700 miles of compandored LMX facilities, may be placed between the concentrator and the home AIC. The range of

the AIS equipped with noncompandored facilities will be from 180 to 420 route miles. The AIS range limit when equipped with compandored facilities will be 1000 route miles.

(c) **Case 3**—When the trunk between the class 5 office and the concentrator is made up of:

- 30 miles of N1 carrier, or
- 200 miles of N2, N3, ON, or O carrier.

A maximum of 100 miles of noncompandored LMX facilities, or 700 miles of compandored LMX facilities, can be placed between the concentrator and the home AIC. The maximum AIS range with noncompandored facilities that will meet the grade of service limit is 160 to 400 route miles. Using compandored facilities, the range may be increased to 1000 route miles.

(d) **Case 4**—When the trunk between the class 5 office and the concentrator is:

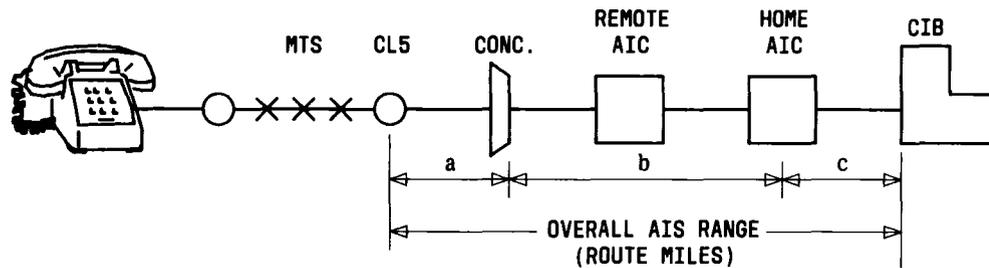
- 70 miles of N1 carrier, or
- 200 miles of N2, N3, ON, or O carrier.

A maximum of 90 miles of noncompandored LMX facilities, or 700 miles of compandored LMX facilities, may be used between the concentrator and the home AIC. The range of the AIS when nonextended is limited to between 190 and 390 route miles. When compandors are used to extend the facility length, the AIS range may be increased to 1000 route miles.

### **C. Compandors**

**4.08** Extending the range of the AIS to 1000 route miles is based on improving the noise performance of the individual trunks in the intercept system. The improved noise performance will allow the system length to be increased while maintaining an appropriate grade of service. This noise improvement is accomplished by use of compandors on LMX facilities. At present, there are two methods of providing compandors for use with L-Carrier:

- (a) The single channel N3 compandor applique
- (b) The Type B N3-L junction which compands groups of 12 or 24 channels.



CASE	"a" (CL5 TO CONC.)	"b" (CONC. TO HOME AIC)	"c" (HOME AIC TO OPERATOR POSITIONS)	NONCOMPANDORED OVERALL AIS RANGE	COMANPANDORED OVERALL AIS RANGE
1	N2, ON = 20 MI N3 = 80 MI T-CARRIER = 50 TO 100 MI CABLE = 30 MI	NONCOMPANDORED L-CARRIER = 130 MI COMPANDORED L-CARRIER = 1000 MI-(a+c)	CABLE = 30 MI T-CARRIER = 50 TO 100 MI	180 TO 330 MI	1000 MI
2	N2, ON = 90 MI N3 = 200 MI CABLE = 30 MI	NONCOMPANDORED L-CARRIER = 120 MI COMPANDORED L-CARRIER = 1000 MI-(a+c)	CABLE = 30 MI T-CARRIER = 50 TO 100 MI	180 TO 420 MI	1000 MI
3	N1 = 30 MI N2, N3, ON, O = 200 MI	NONCOMPANDORED L-CARRIER = 100 MI COMPANDORED L-CARRIER = 1000 MI-(a+c)	CABLE = 30 MI T-CARRIER = 50 TO 100 MI	160 TO 400 MI	1000 MI
4	N1 = 70 MI N2, N3, ON, O = 200 MI	NONCOMPANDORED L-CARRIER = 90 MI COMPANDORED L-CARRIER = 1000 MI-(a+c)	CABLE = 30 MI T-CARRIER = 50 TO 100 MI	190 TO 390 MI	1000 MI

1. ALL DISTANCES SHOWN ARE IN ROUTE MILES.
2. LINK " b" CONSISTS OF TWO TRUNKS WHEN A REMOTE AIC IS INCLUDED;  
TO REALIZE 1000 MILE RANGE BOTH TRUNKS MUST BE COMPANDORED.

Table C—Typical AIS Trunk Lengths Using Various Combination of Facilities

4.09 The N3 compandor applique (J99338E) is the preferred means for companding LMX trunks. The compandor applique provides compandors on a single channel basis and does not require use of a carrier frequency generator. The compandor applique consists of two plug-in units: the J99300AA N3 compandor, and the ED-2C448-30 compandor applique circuit. The N3 compandor applique is described in Sections 332-421-100 and 332-421-500.

4.10 To avoid false operation of single frequency (SF) signaling units due to enhancement of spurious tones by the compandor applique, the recommended arrangement of the compandor applique in a transmission circuit is to place the applique between the carrier terminal and the SF signaling unit at both ends of the circuit as in Fig. 6. To realize the noise improvement required for extended range service, it is necessary to avoid the presence of SF tones on the circuit while the trunk is in the talking state. This means that answer supervision (SF tone removed from completed circuit) must be provided on all compandored facilities.

4.11 The second compandor arrangement is to provide Type B N3-L junctions at both ends of the LMX facilities. The Type B N3-L junction provides groups of 12 or 24 channels of compandored facilities to LMX terminals. When the junction is used, intermediate connection of links at voice frequencies is not allowed. Interconnection should be by use of L-L connectors if necessary.

4.12 A description of the N3 compandor may be found in Section 362-911-100. A description of the Type B N3-L junction may be found in Section 362-920-100.

**D. Trunk Inserted Connection Loss, Return Loss and Noise Requirements**

4.13 Inserted Connection Loss (ICL) requirements are shown in Fig. 1. The ICLs are based

on using the correct impedance terminations at both ends of the trunk. Return loss requirements for the trunks in the AIS are found in Table A. Return losses are based on present MTS requirements for 2-wire switching with 4-wire and 2-wire facilities. These requirements and the use of the 4251B network in the CIB, ONI and supervisory consoles will provide adequate echo performance for both customer and operator. The noise requirements of Table B are based on the requirements for message trunks in the MTS network.

**Trouble Intercept Considerations**

4.14 The return loss requirements of Table A were based on connections made to CIB positions equipped with 4251B networks for echo control. Existing trouble intercept operator positions, usually at 3CL switchboards, do not have the 4251B network and will have a major operator echo problem if trouble calls are routed through the extended range AIS network to these positions. Such trouble intercept calls should be routed out at the class 5 office or at the trunk concentrator to a trouble intercept position for call completion. If call completion is not required, the call may be routed to the CIB.

**E. Announcement Levels**

4.15 The output of the AIC announcement machine should be adjusted to provide the proper levels into trunks to class 5 offices. This level is -20VU at the input to the incoming trunk circuit of the AIC. This will provide -22VU at the class 5 office. Figure 7 shows levels leaving the AICs and arriving at the class 5 offices and at the operators positions.

4.16 The announcement machine output level is adjusted as described in Section 250-410-501. However, the levels shown above should be used.

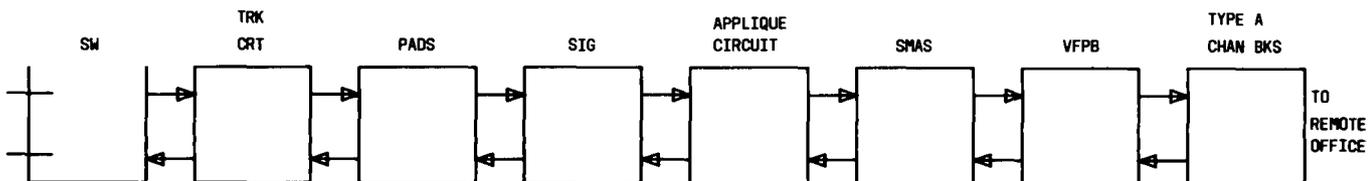
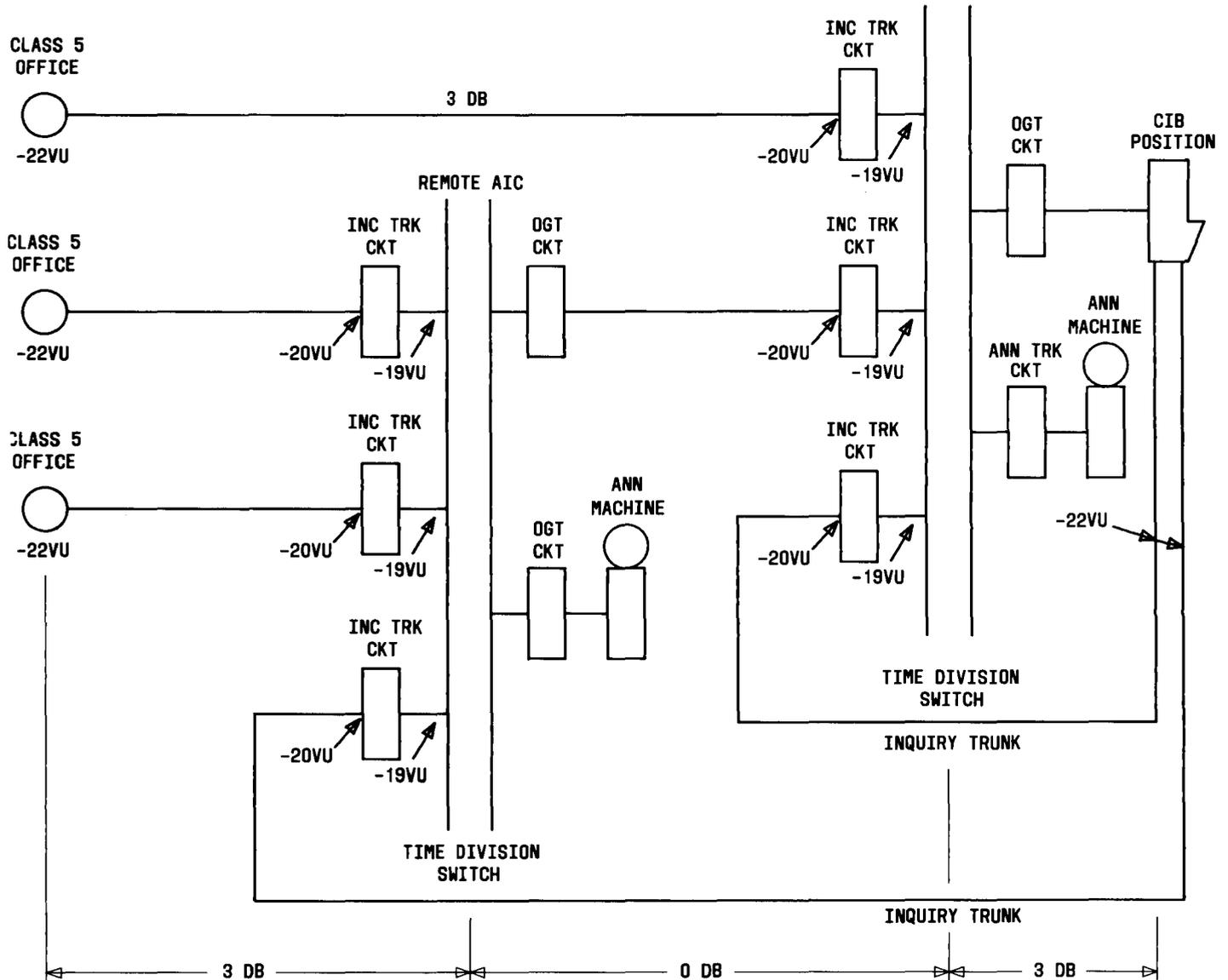


Fig. 6—Application of the N3 Compandor Applique Circuit



\* REFER TO SECTION 852-408-101 FOR ANNOUNCEMENT MACHINE LEVELS AT NO. 1 TRUNK CONCENTRATOR

Fig. 7—AIC Announcement Machine Levels

4.17 When the No. 1 concentrator is connected to a 6A announcement machine for non-working numbers, the levels at the concentrator incoming trunk circuit are:

4-wire access: -33 VU.

2-wire access: -19VU.

4.18 For the No. 23 concentrator, the level from the 6A announcement machine at the incoming trunk circuit should be -19VU.

F. AIC Time Division Switch Network—Transmission Requirements

4.19 The following requirements apply to trunk-to-trunk connections through the time division switch network of an AIC. Measurements are made from an incoming trunk through the time division switch to an outgoing trunk connected to the 101-type test line. The procedure for making the measurements are covered in Section 250-402-501.

## SECTION 852-405-101

### (a) Insertion Loss:

- (1) Non-gain trunk circuit to gain trunk circuit  
0.5  $\pm$ 0.2 dB
- (2) Non-gain trunk circuit to non-gain trunk  
circuit 2.0  $\pm$ 0.2 dB.

### (b) Return Loss:

Requirements are covered in Table A. (It may be necessary to adjust the negative impedance converter on AIS switch time division bus for optimum return loss.)

### (c) Noise:

- (1) Message circuit noise: 18 dBmC average and 24 dBmC maximum from all sources.
- (2) Impulse Noise: No more than 40 counts above 48 dBmC in 30 minutes on a 6( ) type impulse noise measuring set.

### (d) Gain Frequency Response:

The loss relative to 1 kHz loss should be no more than +1 to -0.5 dB in the band from 300 to 3000 Hz.

### (e) Envelope Delay Distortion:

The maximum deviation from the lowest reading in the bands is to be less than shown below for data trunks (operator's inquiry trunks):

1000 to 2600 Hz = 10 msec

500 to 3000 Hz = 100 msec.

## 5. WIRING RESTRICTIONS

**5.01** Unless the guidelines for all office wiring lengths are followed, the through balance requirements for the AIS trunks will not be realized. It has been found that those offices which exceed the wiring restriction fail to meet through balance requirements.

**5.02** The restrictions on the length of office wiring of the T, R, T1 and R1 leads are shown in Fig. 8 for the AIC, CIB, ONI and supervisory positions. The restrictions for the No.

1 trunk concentrator are shown in Fig. 9 and for the No. 23 trunk concentrator in Fig. 10. The lengths are based on the use of 26-gauge switchboard cable. Allowable lengths for other gauges can be determined by their relative resistances as listed in Table D.

**5.03** Due to a lack of space in the supervisory console, the 4251B network must be mounted at the equipment location (this network is mounted in the desks, or consoles, of the CIB and ONI positions). There are two configurations for the 4251B network serving the supervisory position. If the length of 26-gauge cable between the 4251B network and the supervisory console is within 70 feet, the network can be wired directly to the console headset jacks. If the wiring length from the 4251B network to the supervisory console is between 70 and 350 feet, component assembly ED-94950-31 must be installed with the 4251B network. The maximum allowable distance from the network to the headset jacks at the supervisor's console is 350 feet of 26-gauge cable. These restrictions are necessary to ensure sufficient current to operate the microphone of the supervisors headset.

**5.04** The wiring restrictions shown in Fig. 9 for the No. 1 trunk concentrator are based on a proposed standard allowing a cross-office loss slope for 4-wire switching of 0.3 dB (loss at 1 kHz relative to loss at 400 Hz or at 2.8 kHz). Assuming that wiring accounts for this slope, a total length of about 1400 feet of 26-gauge cable can be allowed in cross-office paths. On this basis, a length of about 600 feet each can be allowed for connections from the carrier terminals to the trunk circuits. The transmitting and receiving leads are to be in separate sheaths separated by a minimum of 3 inches to avoid crosstalk problems. A maximum of 200 feet can be allowed from the incoming trunk circuit to switch frames where a common sheath is used. The latter connection is at -10 and +5 dB levels, and is limited by crosstalk considerations unless separate cable sheaths are used.

**5.05** Signaling restrictions may further limit the wiring lengths depending upon the signaling equipment utilized. Signaling ranges (dc resistance) should be determined from the schematic drawings and circuit descriptions associated with the particular signaling equipment.

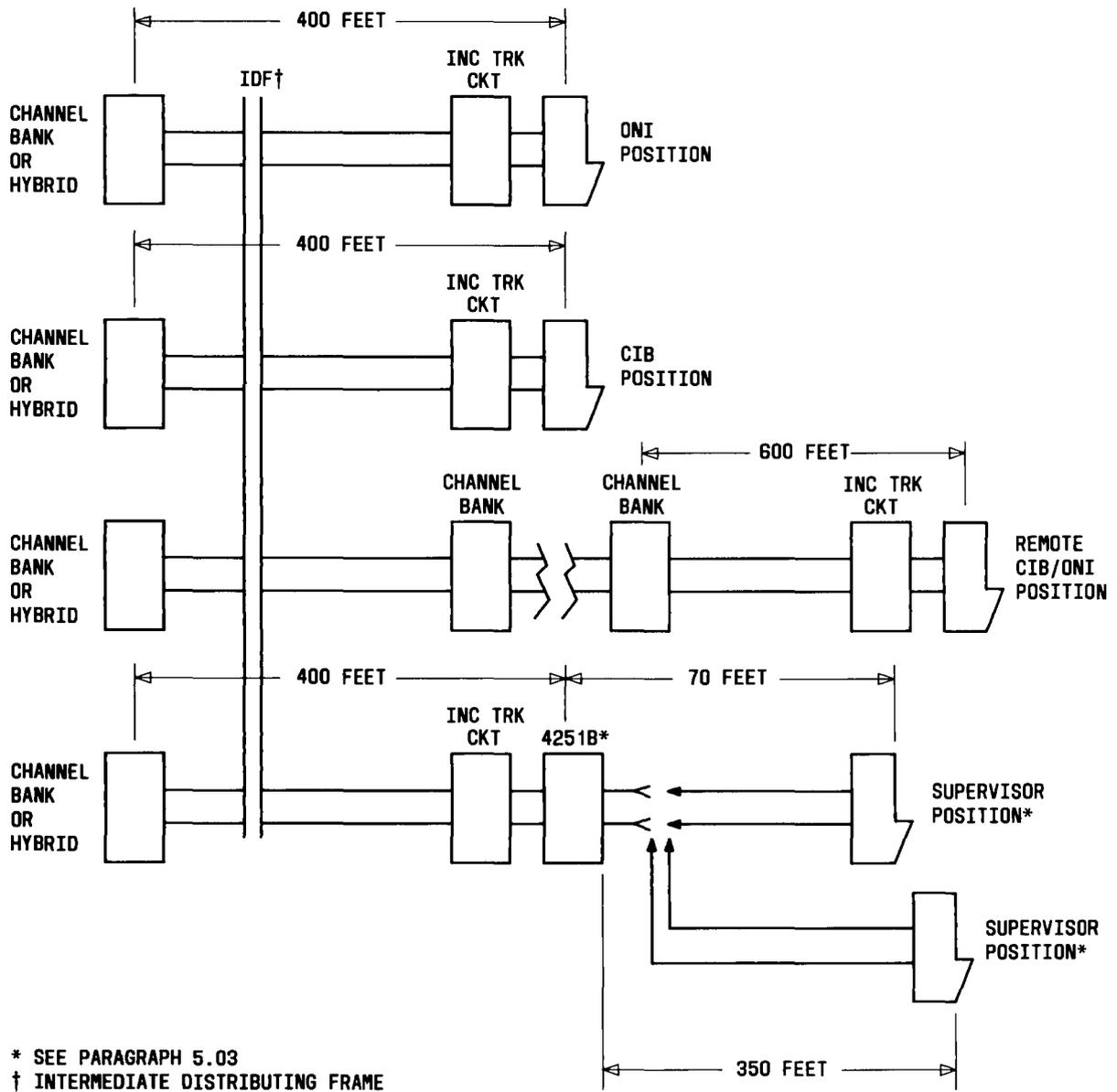


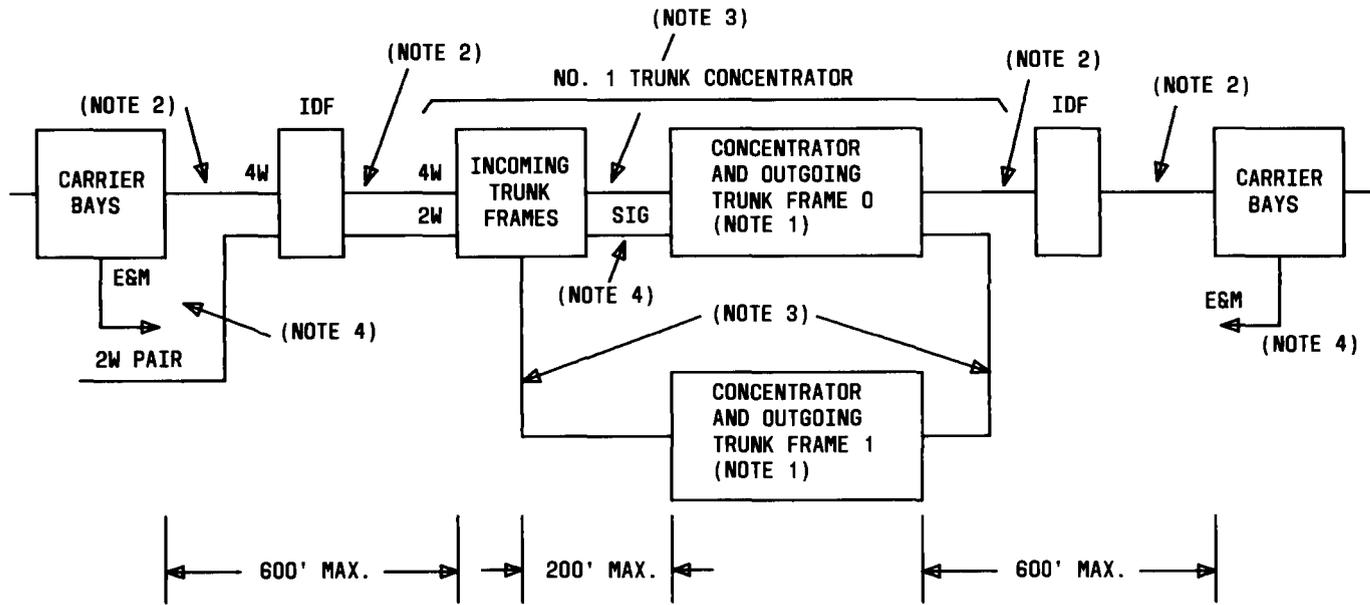
Fig. 8—AIS Office Wiring Restrictions -26 Gauge Cable

**6. CONCENTRATORS**

**A. No. 1 Trunk Concentrator**

**6.01** The No. 1 trunk concentrator is a 4-wire concentrator which has been designed for +5 dB and -10 dB TLPs at the switch. The No. 1 trunk concentrator has been designed to allow the use of gain from carrier facilities on one side

of the concentrator to offset some of the loss of facilities on the other side of the concentrator, thereby possibly reducing the need for repeaters in the circuit. (Refer to Section 851-408-101 for No. 1 trunk concentrator transmission engineering considerations.) The J94747A trunk test set has been designed for use with the No. 1 trunk concentrator and will be required for line-up and maintenance testing.



NOTES:

1. CONCENTRATOR AND OUTGOING TRUNK FRAMES 0 AND 1 WILL MOUNT ADJACENT TO EACH OTHER.
2. SEPARATE SHEATHS.
3. COMMON SHEATH
4. SEE SIGNALING EQUIPMENT FOR LIMITS.

Fig. 9—No.1 Trunk Concentrator Office Wiring Restrictions -26 Gauge Cable.

NO. 23 TRUNK CONCENTRATOR

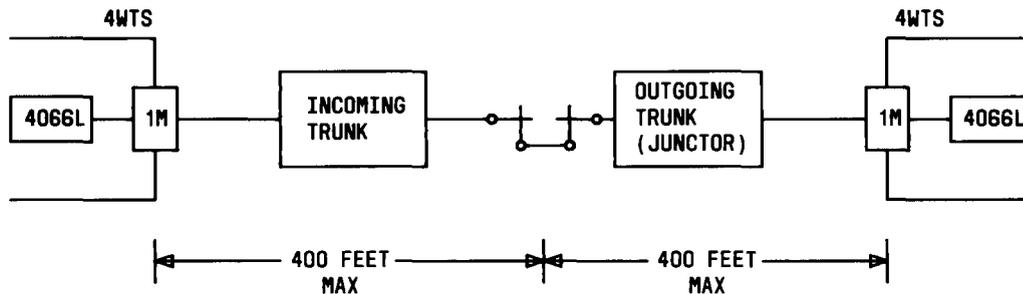


Fig. 10—No. 23 Trunk Concentrator Office Wiring Restrictions -26 Gauge Cable

B. No. 23 Trunk Concentrator

6.02 Section 851-406-102 covers the transmission considerations for the No. 23 trunk concentrator. The 1 kHz loss of this concentrator is taken into account by the transmission plan, thus avoiding deterioration of the grade of service. Where

presently placed in existing systems, the No. 23 trunk concentrator should be retained but as new systems are designed, it is recommended that the No. 1 trunk concentrator be used.

6.03 The No. 23 concentrator has been assigned a TLP of -2 dB and, accordingly, the manually

**TABLE D**  
**WIRING RESTRICTIONS FOR VARIOUS**  
**GAUGES OF CABLE**

CABLE GAUGE *	LENGTH FEET	RESISTANCE OHMS **	CAPACITANCE $\mu$ F
22	1020	32.6	.024
24	600	31.2	.013
26	400	32.8	.008

\* For mixed gauge, the resistance must be measured.

\*\* The resistance requirement of 33 ohms for the AIS must not be exceeded.

applied test tone used for line-up and maintenance purposes should be adjusted to -2 dBm at the outgoing switch.

## 7. AIS POSITION TRUNKS AND OPERATOR HEADSETS

**7.01** The transmission plan for the AIS network is based, in part, on the electrical characteristics of the 4251B network and electroacoustical characteristics of operator headsets. Alignment levels for position trunks equipped with the 4251B network are shown in Fig. 11. The 4251B network is to be used in the CIB, ONI and supervisory positions.

**7.02** The lineup procedures for the 4251B network are covered in Section 250-402-503. These procedures will require the 132A test set and a new test connector, the 252A adapter, will be used to provide test access to the various ports for adjustment purposes.

**7.03** In the past, several different operator headsets having varying electroacoustic efficiencies and impedances have been used and were sometimes mixed indiscriminately within operator teams. A mixture of headsets is not recommended for AIS as the positions will be aligned for the standard headsets listed in paragraph 7.04.

### *Operator Headsets*

**7.04** The standard headsets recommended for AIS operators and supervisors include the WE 60A and 61A, KS-20778 List 16B and KS-21118

headsets or their equivalents. Headsets other than those listed above, should not be used. The KS-20778, List 16B, has ear pieces which are color coded according to the diameter of the hole in the ear piece. The beige ear piece should be used to provide performance near to that of the 60A and 61A headsets.

**7.05** Under normal conditions the use of an external headset amplifier is not recommended for use in the AIS in either the operator position or in the supervisor position. The only intended application of headset amplifiers is for use with a head telephone set by operators with impaired hearing. It is important that these amplifiers be used only where a real need exists, such as in cases where their use would permit the continued effective employment of operators whose hearing losses would interfere with their normal job performance. Headset amplifiers should not be used in conjunction with any jack equipped head telephone sets having built-in amplifiers.

**7.06** Headset amplifiers should not be used for correcting any inadequate transmission due to excessive trunk or loop loss. Persons with normal hearing using the amplifier in such cases will hear excessive sidetone which will result in a reduction of speech volume and thereby increase an already unsatisfactory transmission condition. (For additional information on headset amplifiers, refer to Sections 024-108-100 and 024-108-105.)

### *Operator Sidetone and Room Noise*

**7.07** Excessively high room noise levels may cause a substantial number of customer and operator complaints. To avoid this problem, it is recommended that operating room noise be held low by soundproofing and proper location of the consoles, as necessary, to the following room noise objectives at the consoles:

55 dB (A) average

62 dB (A) maximum.

**7.08** Any standard sound level meter which meets the requirements in the American National Standards Institute S1.4, Issue 1971, may be used to make this measurement. A procedure for measuring acoustical room noise is contained in Section 870-190-102.

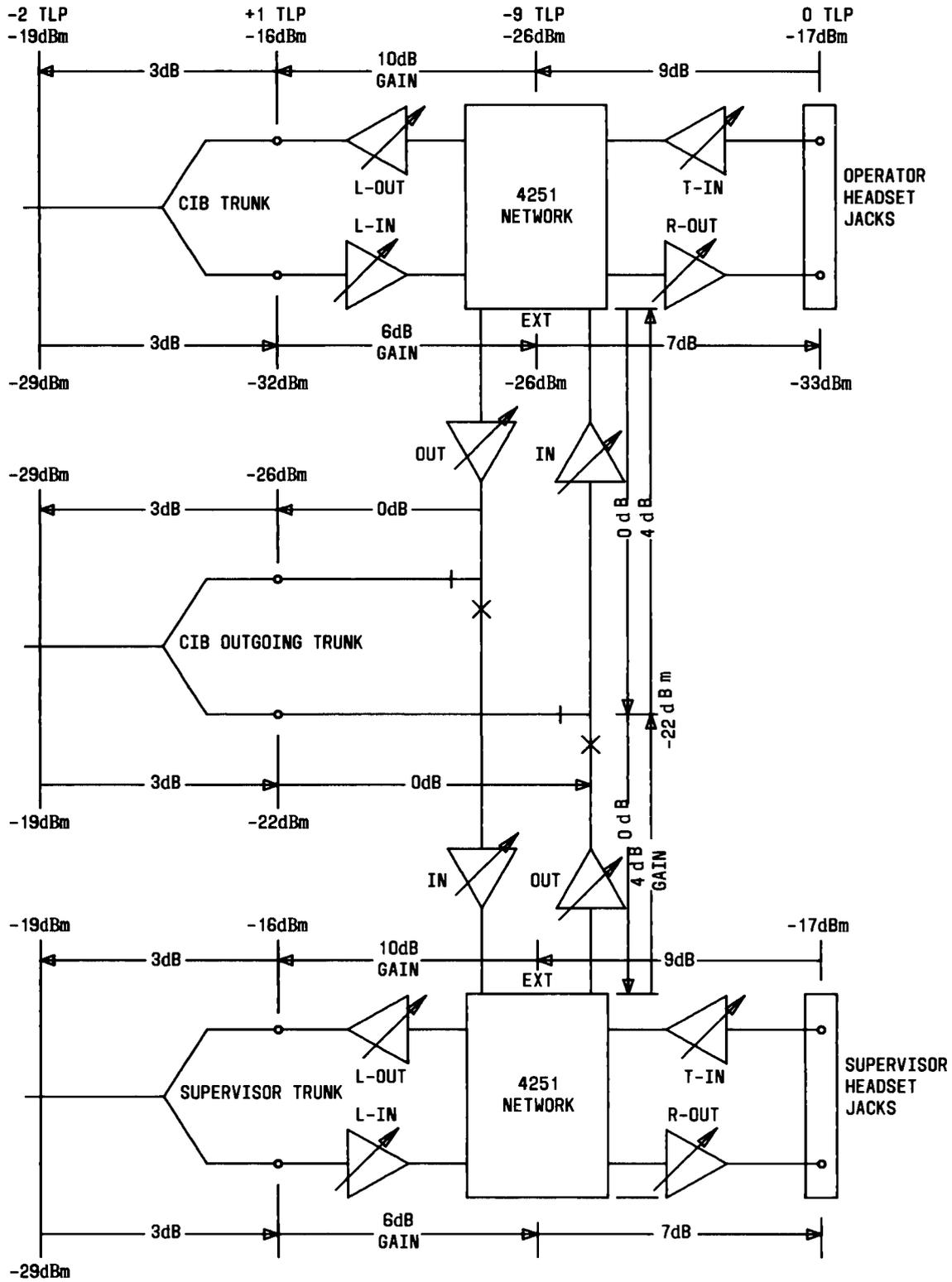


Fig. 11—Alignment of Position Trunks and 4251 Network

## 8. BALANCE CONSIDERATIONS

### A. General

**8.01** The certification of an AIS as balanced is the responsibility of the transmission engineer (or other person with equal authority). The requirements for certification are given in Section 853-500-110. The following is a summary of these requirements:

- (a) Trunks that do not meet design objectives as specified in this section are classified as not meeting minimum balance requirements.
- (b) Intertoll-type trunks are to be assigned as 4-wire facilities. Those that are not must be classified as not meeting minimum balance requirements.
- (c) Trunks for which recorded measurements are not available are classified as below minimum requirements for ERL and SRL.
- (d) At least 50 percent of all measurements for each class of trunk must be equal to or greater than the median requirement. Similarly, not more than two percent of the measurements for each class of trunk may be below minimum requirements.
- (e) All trunks with measurements below the turndown limit must be removed from service.
- (f) Balance records must be complete as specified in the 660-479-101 section.

**8.02** In Section 660-479-301, craft personnel are given the median requirement as the objective. All trunks are to be measured and the values recorded for ERL, SRL and SRL—HI. This data is given to the transmission engineer. Those trunks meeting the median objective are turned up for service. The trunks not meeting the stated objective will be turned up for service on instruction of the transmission engineer using the guidelines of (d) above. Investigation should be made of those trunks not meeting the stated requirement in Section 660-479-301. Some common cause may be the problem if the trunks are generally poor in balance. Trouble locating procedures are found in Section 660-479-301.

**8.03** General balancing information is found in Section 660-479-100. Section 660-479-101 describes the AIS trunking layout and forms used in recording balance measurements.

*Note:* The growth factor mentioned in the above sections is not used in the AIS.

### B. AIS Time Division Switch

**8.04** The circuitry of the time division switch of the AIS includes a negative impedance converter on the time division bus. The converter changes the impedance of the trunk, or termination, connected through the switch and affects the return loss. Return loss can be optimized by adjustment of the converter.

## 9. AIS NETWORK—CIRCUIT ORDER AND MAINTENANCE TESTS

**9.01** The circuit order and maintenance tests for AIS trunks are the same as the tests to be made on regular message trunks as outlined in Sections 660-450-300 and 660-450-301. The requirements which apply to the AIS network are contained in this section. The message circuit noise requirements for the AIS access trunks are in Table B. Circuit noise test classifications and recommended test intervals are covered in Section 660-403-300. Balance procedures for the AIS may be found in the 660-479-ZZZ layer of practices. A form for recording the results of the tests is available in Section 660-450-010. For maintenance purposes, frequency of loss testing and permissible loss deviation is given in Section 660-402-300.

**9.02** A description of the AIC trunk test circuit is provided in Section 250-403-101. Procedures for line-up tests on the operator positions and position trunks for the 3A and 3B auxiliary service positions in an extended range AIS (with 4251B network) are in Section 250-402-503. Position tests and position trunk tests for 4A auxiliary service positions for an extended range AIS (with 4251B network) are in Section 250-418-502.

**9.03** The return loss measuring set best suited to make return loss measurements on the AIS is the Wiltron 9031 or 9041 Test Set. The test methods using the Wiltron test set are presented in the 660-479-ZZZ sections.

**SECTION 852-405-101**

**9.04** The test circuits provided in the AIS are the codes 100, 101 and 102 test circuits. These have the same function as test circuits in other offices. Due to the code 100 and 102 being inaccessible for balancing, only the code 101 may be built out to match incoming or outgoing trunk circuits. It is suggested that two test hybrids be installed with connections to the code 101 test circuit; one to match the longest incoming trunk and one to match the longest outgoing trunk.

**10. REFERENCES**

**10.01** The following BSP sections and publications are listed to assist with the transmission engineering considerations presented in this section.

<b>SECTION</b>	<b>TITLE</b>	<b>SECTION</b>	<b>TITLE</b>
			Position 4A Operator Number Identification Arranged With Unified Telephone Circuit (4251B Network)
		332-121-110	4251-Type Networks—Description
		332-421-100	N3 Compander Applique Circuit—General Description
		332-421-500	N3 Compander Applique Circuit—Tests and Adjustments
		332-852-10Z	4066-Type Networks—Description
		362-900-506	N3 Carrier—Channel Noise Measurement
		362-920-100	N3-L Junction—Description
		660-402-300	Transmission Maintenance—Overall 1004 Hz Loss Measurements on Message Trunks
		660-403-500	Message Circuit Noise Measurements—Requirements
179-100-304	E-Type Signaling Systems—Compatibility	660-450-010	Forms for Recording Trunk or Circuit Order Test Results on Message Trunks — Test Center Operation
179-100-307	T-Carrier Systems—D2 Channel Bank—Signaling Compatibility	660-450-300	Trunk Order or Circuit Order Tests for All Types of Message Trunks — General Information
250-402-501	Trunk Transmission Tests—AIC No. 1A	660-450-301	Trunk Order or Circuit Order Tests for All Types of Message Trunks
250-402-502	Trunk and Position Transmission Tests — Auxiliary Service Positions 3A, 3B Centralized Intercept Bureau (Without 4251B Network)	660-479-100	AIS—General Balancing Information
250-402-503	Trunk and Position Transmission Tests — Auxiliary Service Positions 3A, 3B Centralized Intercept Bureau Arranged With Unified Telephone Circuit (4251B Network)	660-479-101	AIS—Extended Range—General Balancing Information Administration and Records
250-410-501	KS-19725 Announcement System Electrical Transmission Tests and Adjustments	660-479-200	AIS-Extended Range—NBO and DBO Capacitor Selection and Application
250-418-501	Trunk and Position Transmission Tests — Auxiliary Service Position 4A Without Unified Telephone Circuit (4251B Network) Operator Number Identification		
250-418-502	Trunk and Position Transmission Tests — Auxiliary Service		

SECTION	TITLE	SECTION	TITLE
660-479-301	AIS—Extended Range Balance Requirements and Verification Tests	852-408-101	No. 1 Trunk Concentrator-Engineering Considerations
800-100-100	Notes on Distance Dialing	853-500-100	Through and Terminal Balance-General Engineering Considerations
801-206--53	J94747A Test Set	853-500-110	Through and Terminal Balance Certification Requirements
801-505-153	D3 Channel Bank Equipment—Specifications	855-335-108	N3-L Junction—General
852-405-100	AIS-150 Mile Range—Transmission Considerations	984-120-100	AIS—General Description
852-408-100	No. 23 Concentrator- Engineering Considerations	Other:	
			American National Standard Institute S1.4 Issue 1971