

CENTREX SERVICE FX TRUNKS AND REMOTE WATS TRUNKS TRANSMISSION DESIGN OBJECTIVES SWITCHED SPECIAL SERVICES SYSTEMS ENGINEERING

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F. Foreign Exchange Trunk Levels and Losses	6	1.01 This section presents standard transmission and signaling designs for Centrex CO foreign exchange trunks (FT) and remote wide area telecom- munication service (WATS) trunks. These designs are divided into the following groups:	
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(c) Those applications where FT circuits are switched by the Centrex CO to tie trunks (on a through basis, pad out on both trunks) and require through and terminal balance at the Centrex CO.

1.02 This section is reissued to include changes in recommended inserted connection loss (ICL) and test level point values in Fig. 2 and to modify the information relevant to this figure. Revision arrows have been used to emphasize the more significant changes.

B. Foreign Exchange Trunks (FT)

1.03 The FTs are provided to interconnect the Centrex group with the distant Message Telecommunications Systems (MTS) switcher other than the switcher serving the Centrex. Foreign exchange trunks for Centrex CO customers may be terminated at the Centrex location on a 2-wire No. 1/1A ESS, 2-wire No. 2/2B ESS, or 2-wire No. 5 Crossbar system or may be extended to a customer premises and terminated on a switchboard.

1.04 A Centrex station or tie trunk may gain access to a foreign exchange trunk by dialing a code (typically 1XX) to obtain dial tone from the distant office. Additional digits are then dialed to reach MTS telephone numbers. Toll charges will only be incurred for the calls extended over the MTS network. This type of service requires ground-start operation. Toll restriction may be provided to deny access to the toll network on No. 5 Crossbar Centrex services. The No. 1/1A ESS and No. 2/2B ESS FTs do not provide toll restriction.

1.05 Incoming calls to a No. 5 crossbar Centrex must terminate on an attendant trunk terminated in a switchboard or attendant console position. They are then extended to Centrex stations through the PBX cord circuit or by the attendant trunk circuits. Extending the trunk through switchboard cord circuits will involve multiple loops. Multiple loops increase circuit loss and provide poor transmission on incoming calls. When released-loop attendant trunk circuits are used, they are released upon completion of the transfer. The station and FTs are then connected without the attendant trunk.

1.06 Incoming calls to an ESS Centrex will automatically signal the designated attendant console via the attendant loop circuit. The call may then be answered and transferred to station line, tie trunks, etc. The attendant will release from the connection when the transfer is complete. This arrangement provides the same grade of transmission as if the incoming party had dialed the station directly.

C. Wide Area Telecommunication Service (WATS) (WI,WS,WY)

1.07 The WATS trunks enable the Centrex customer to make calls over extensive geographic areas at a flat monthly or measured rate. The WATS trunks can be directly dialed by the user or with assistance of the attendant.

1.08 Incoming WATS (INWATS WI) calls are routed to the attendant and transferred to the desired party, like FT service. On switchboard calls manually extended by the attendant, INWATS has the same transmission problem of multiple loops in No. 5 crossbar as FT circuits.

1.09 On outgoing calls, OUTWATS (WS) dial access is provided using a dialing code basis (typically 1XX) for each group of WATS trunks. The WATS trunks are always ground-start operation. Two-way WATS trunks (WY) provide incoming and outgoing WATS service.

1.10 Design considerations for INWATS and OUTWATS trunks terminating in a distant class 5 office customer line are the same. When WATS trunks are interconnected with class 4 or higher toll offices, they are designed like message toll connecting trunks and are not considered in this section.

2. DESIGN CONSIDERATION

A. Inserted Connection Loss Objectives

2.01 The ICL objectives for FT and WATS trunks are as follows.

TYPE OF TRUNK	ICL
Trunks without gain	4.0 dB minimum
Short-haul trunk with gain	3.5 dB
Long-haul trunk to No. 5 crossbar or ESS Centrex	(VNL + 4.0) dB
Long-haul trunk to ESS Centrex CO that switches to VNL designed tie trunks* (without ES) (with ES)	(VNL + 2.0 + 2S) dB (2.0 + 2S) dB

*Provided with trunk circuits SD-1A240-01, SD-1A360-01, and SD-1A415-05 for 1 ESS and SD-2H180-01 for 2 ESS.

B. Foreign Exchange Trunk Circuit Features

2.02 Table A contains the various foreign exchange trunk circuits that may be used to provide Centrex FT and WATS trunks. These trunks may be used for INWATS, OUTWATS, and foreign exchange trunks.

2.03 The trunk circuits listed in Table A terminate in the trunk link of the Centrex switching system and are extended by carrier or cable to a line appearance of a distant class 5 office.

2.04 Trunks SD-1A241-01, SD-1A416-05, SD-2H174-01, and ES-26289-01 are used on short-haul FT and WATS circuits. These circuits interface 2-wire with the Centrex switching system and with transmission facilities.

2.05 Trunks SD-1A240-01, SD-1A360-01, SD-1A415-05, and SD-2H180 are long-haul foreign exchange circuits. These circuits are equipped with a hybrid to provide a 900-ohm 2-wire interface with the Centrex switching system and a 600-ohm 4-wire interface with the transmission facilities. The signaling interface is provided on external A and B leads. A 2-dB switchable pad is also provided. Trunk SD-1A360-01 has the option for providing the city of origin announcement on the receive side of the term set. This trunk is used mainly for automatic call distributor (ACD) service.

2.06 Long-haul trunks may also be used in short-haul applications involving carrier systems. If the FT is a short-haul design, then the 2-dB switchable pad should be programmed to remain *in* the transmission path.

2.07 Trunks SD-1A240-01, SD-1A360-01, and SD-2H180-01 have a hybrid circuit with transmitting and receiving 89-type pad sockets to adjust transmission levels. When external loss adjustments are used, 0-dB 89-type pads should be plugged in these sockets. Some offices may prefer to always use zero pads in the trunks and to provide loss adjustment with the transmission facility. It is desirable to use a minimum of 4-dB loss adjustment to ensure a good impedance to the hybrid.

2.08 The 4-wire terminating set used with SD-1A240-01, SD-1A360-01, SD-1A415-05, and SD-2H180-01 has a compromise network and network build-out capacitors (NBOC) for office balancing. These should be adjusted as required to meet through and terminal balance requirements as discussed in Subpart 2I.

Idle Circuit Terminations

2.09 All the short-haul foreign exchange trunk circuits are equipped with an idle circuit termination. When trunks using short-haul trunks SD-1A241-01, SD-1A360-01, and SD-2H174-01 with option Z are in the idle state, the transmission facility is terminated in 1000 ohms and 2 μ F. Option Z must be removed when using E2S/E2SA and FSA ground-start signaling units. This provides an open tip and ring and prevents a signaling problem called pumping. In this case, these signaling units cut and terminate the 4-wire voice path and eliminate the need for an idle circuit termination.

2.10 The FTs and WATS trunks using SD-1A416-05 are not susceptible to the pumping problem because the capacitor in the idle circuit termination has been reduced to 0.511 μ F.

Switchable 2-dB Pads

2.11 Improved transmission can be obtained on through connections that use long-haul 4-wire Centrex foreign exchange trunks terminated in ESS switching systems by use of a switchable 2-dB pad. The 2-dB pad is controlled by the No. 1/1A and 2/2B ESS programs which switch the pad IN or OUT of the

transmission path depending on specific connections. The 2 dB is always IN the transmission path during terminating connections. Thus, the 2-dB pad will be included in the transmission path when the foreign exchange trunk is switched to a local Centrex station line, a long-haul station line, or an attendant trunk. The pad is OUT on foreign exchange trunk to tie trunks and certain other connections (Table B).

2.12 The program uses specific, locally generated translation information to determine whether the 2-dB pad of a 4-wire ESS trunk circuit should be switched *in* or *out* of the transmission path.

2.13 The 2-dB switchable pads can only be provided using trunks SD-1A240-01, SD-1A360-01, SD-1A415-05, and SD-2H280-01. The switchable pads are not available on No. 5 crossbar systems and for ESS circuits using 2-wire short-haul foreign exchange trunk circuits.

C. Facilities

2.14 The use of 4-wire metallic or carrier facilities is required for FT applications when the 2-dB switchable pad is used. This design is recommended for all long-haul FTs connecting to via net loss (VNL) designed trunks at an ESS Centrex. In this case, through balance requirements apply.

2.15 Two-wire metallic facilities or carrier facilities with 2-wire interfaces may be used in short-haul applications for FT and WATS. Where the short-haul trunk will be connected in tandem with tie trunks at the Centrex, terminal balance requirements apply. The 2-dB switchable pad in the tie trunk should be OUT on connections to FTs and WATS trunks.

2.16 Metallic facilities for 2-wire and 4-wire trunk layouts use H88 or 25H88 MAT® loaded trunk cables between the Centrex, intermediate, and foreign central offices. Nonloaded cable will normally not be encountered in trunk cables and is not considered in these designs.

2.17 All long-haul FT designs are 4-wire facilities between CO(A) and CO(Z). However, the portion of the circuit from CO(A) to the 2-wire switch may be a short length of 2-wire facilities provided they meet all the following requirements:

- (a) The hybrid must be located within 1.0-dB loss of the CO switch (approximately 2 kft of 24- or 26-gauge cable).

- (b) The use of gain transfer to reduce higher losses to 1.0 dB is not allowed.

- (c) The 2-wire section includes the office and any interoffice cabling used.

- (d) The cable may not have load coils or bridged taps.

If all the above requirements cannot be met, the 4-wire portion must be extended to CO(A) and the hybrid placed nearer the switch.

D. Metallic Facilities Transmission Levels

2.18 Transmission levels for metallic facilities are established to minimize crosstalk between cable pairs. The transmission level point (TLP) values shown in Table C are the 1004-Hz maximum transmitting and minimum receiving TLPs for crosstalk limited cable losses. The TLP values in Table C are the gain (+) or loss (−) relative to 0 TLP. ♦The milliwatt 0 dBm, 1004-Hz supply shown in the layouts is *not* considered to be at 0 TLP in general. This 1004-Hz test-tone power dropped across the office loss or test access loss is shown as X dB in the layouts. The 0 TLP points for signals transmitted into the channel in each direction are at the two end points of the channel between which the ICL is indicated in the layouts. The receive TLPs at these end points are each (−ICL). Therefore, in the A to Z direction shown, a 0 dBm test source would read (−X) dBm at 0 TLP at the “A” end of the channel. The test power read at any other TLP would be X dB lower than the TLP value itself, assuming proper impedance matching of the test equipment to the point of access. A −16 dBm test signal would read (−16−X) dBm at the 0 TLP point, and the reading at any other TLP would be (16 + X) dB lower than the TLP value itself. A typical value for X to a dialed-up milliwatt is 0.5 dB, but X may vary by central office and by use of Switched Maintenance Access System (SMAS) access, no test trunks, portable test equipment, etc. Hence the value for X at each appropriate end of the channel must be chosen locally for expected measured loss (EML) calculations.♦

Four-Wire Designs

2.19 When the cable loss between repeaters is less than the maximum 15-dB values indicated in Table C, it is recommended that the maximum and minimum TLPs shown in Table C be adjusted symmetrically about the actual cable loss used for lineup.

This procedure minimizes crosstalk by lowering transmitting levels. Symmetrical averaging of the maximum transmitting and minimum receiving TLPs based on the actual cable pair transducer loss is provided as follows:

$$TLP_{TA} = [TLP_T(\text{Max}) + TLP_R(\text{Min}) + \text{Loss}] \div 2$$

$$TLP_{RA} = [TLP_T(\text{Max}) + TLP_R(\text{Min}) - \text{Loss}] \div 2$$

Where:

$TLP_T(\text{Max})$ = Maximum cable pair transmitting TLP at CO location from Table C

$TLP_R(\text{Min})$ = Minimum cable pair receiving TLP at CO location from Table C

TLP_{TA} = Adjusted transmitting TLP

TLP_{RA} = Adjusted receiving TLP

Loss = Cable transducer loss with proper terminations.

2.20 Table D is a summary of formulas for 4-wire applications using the maximum and minimum TLP values from Table C. Only the actual cable transducer loss to be used needs to be substituted to obtain adjusted TLP values.

Two-Wire Designs

2.21 Repeater net gains for 2-wire layouts are computed to produce the assigned ICL for end-to-end layouts. Figure 1 gives the equations for computing metallic facility terminal (MFT) repeater gains for the range of acceptable transducer loss limits for the various repeater locations for 2-wire designs. Allocation of repeater gains for the cable loss limits shown minimizes level differences for the best crosstalk performance. The gain equations are valid for losses of less than 10 dB between repeaters and approximate from 10 dB to the 15 dB maximum. The TLP values along a 2-wire layout are computed by assigning 0 TLP to the switch at CO(A) or the Centrex at CO(Z) and assigning other TLP values along the layout using the cable loss and computed repeater gains. Repeater gains for E6 overall designs are computed to produce the required ICL for overall designs using repeater locations indicated in the coded layouts.

E. Digital Carrier Transmission Levels

2.22 Figure 2 provides possible lineup TLPs on various combinations of D1, D3, and D4 channel units. Where possible, office levels and carrier channel standard test levels are maintained. In some cases carrier channel gains are lowered to obtain an overall ICL of 3.5. Slight adjustments in TLPs may be necessary due to office wiring losses. Specific discussion of D1 and D3 follows to illustrate level problems. The D4 channel units are not expected to be a problem in TLP adjustments. For newer vintage D3 and D4 banks, lineup and maintenance practices and certain test equipment require that standard carrier TLPs will be adhered to. In addition, standard carrier TLPs are desirable for VF interconnection of carrier systems via tandem units. In recognition of this, an alternative carrier 2-wire end link design has been added to standard designs. This alternate design features standard TLPs for 2-wire foreign exchange channel units of the D3 and D4 banks. The new designs have been added to Fig. 2.

D1 Channel Units

2.23 The D1 channel units have XMT and REC jacks which are used to measure the transmit and receive levels from the D1 channel bank. The recommended initial lineup TLP at the XMT jack is -9.25 dBm and +2.75 dB at the RCV jack. When a D1 channel unit is used in a D1D channel bank, +2.5 dB is used.

2.24 All D1 channel units are equipped with a GAIN potentiometer in the receive path to adjust the +2.75 (+2.5) receive level. In addition, screw switch options V and X provide 0.5-dB loss in the receive and transmit path of the FXO unit and 1.0-dB loss in the receive and transmit path of the FXS unit.

2.25 An ICL of 3.5 on short-haul Centrex FTs cannot be obtained when standard TLPs are maintained on D1 carrier systems. This is due to insufficient adjustable loss in the FXO (0.5 dB) and FXS (1.0 dB) channel units. Figure 2 provides a recommended lineup of TLPs on various combinations of D1, D3, and D4 channel units.

D3 Channel Units

2.26 The older D3 2-wire FXO and FXS channel units have 0.0- to 3.0-dB receive and transmit

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pads, depending on the list number and options. The pads are adjustable in 1.0-dB steps. In addition, older channel units J98718BD, List 1 and J98718BE, List 1 have ganged receive and transmit potentiometers with 0.1- to 1.5-dB loss. When the ganged pads are adjusted, the same loss is inserted in the receive and transmit path. This makes maintenance of standard levels difficult with certain combinations of carrier terminals.

2.27 New D3 FXO and FXS units J98718BD, List 2 and J98718BE, List 2 have independent receive and transmit pads. When these units are used between D3 and D4, standard office levels can be maintained. The D1 and D3 units should be adjusted as shown in Fig. 2.

F. Foreign Exchange Trunk Levels and Losses

2.28 The following average trunk losses (TL) should be used to calculate TLPs from the Centrex outgoing switch to the term set, repeaters, or signaling units. These are the losses that will be incurred when the trunk is in the talk-tandem state (trunk-to-trunk connection) and are included in the circuit ICL. In the talk-tandem state, the ICL and EML losses are equal when the trunk test panel is adjusted to 0 dBm at the outgoing switch appearance. The overall lineups should be made in the talk-tandem state.

TRUNK	TRUNK LOSS (TL)
SD-1A240-01	6.5*
SD-1A360-01	6.5*
SD-1A415-05	6.5*
SD-1A241-01	0.5
SD-1A416-05	0.4
SD-2H174-01	0.5
SD-2H180-01	6.5*
ES-26289-01	0.9

*Includes term set and 2-dB switch pad in the 4-wire trunk.

In ESS Centrex, additional losses are incurred when the trunk is in talk-local state at the supplementary

trunk test panel (STTP) as follows: 0.3 dB in trunk, 0.1-dB interswitch loss, and 0.1 dB at terminal A. This 0.5 loss (X) is not included in the circuit's ICL, but will be included in the circuit EML. The EML then becomes ICL +0.5. This 0.5 loss (X) is also used for No. 5 Crossbar Centrex.

2.29 If the loss encountered is greater than 0.5, the X should be raised accordingly (up to a maximum of 1.0 dB) and included in the EML. The transmitting level from the Centrex manual trunk test panel (MTTP) or STTP is TP0 (0 TLP) or TP2 (-2 TLP). The No. 1/1A ESS Centrex with expanded test features (Centrex 7 or later) provides TP2 (-2 dBm) testing to 4-wire trunks with 2.0-dB switch pads.

G. Terminating Impedances

2.30 The FTs and WATS trunks to a class 5 office operate with predetermined conventions of 900-ohm Centrex CO impedance and 900-ohm impedance at COs. Transmission measurements are made with test equipment adjusted to match the designated 900-ohm resistive impedance. Measurement correction is not required when the circuit resistive impedance and test equipment impedances are equal. Measurements are made at the MTTP or STTP at 900 ohms with a TP0 or TP2.

H. Application of Echo Suppressors

2.31 Echo suppressors are required for long-haul FTs when the circuit length exceeds 1850 miles. The latest application rules for echo suppressors are given in Sections 851-300-100 and 853-104-100. For those layouts using SF signaling, the most desirable location for a full echo suppressor is at CO(Z) or CO(A). The CO(Z) is preferred because this location is nearer the center of the circuit than CO(A) on a through switched connection that may involve tandem echo suppressors. It is easier to install and maintain an echo suppressor at these locations as discussed below.

Intermediate Echo Suppressors

2.32 When split echo suppressors are not available at CO(A) and CO(Z) and SF signaling is used for end-to-end layouts, the direct insertion of an echo suppressor at an intermediate CO between end office SF units will block the SF signaling tones. Therefore, two additional 4-wire SF units must be installed at

an intermediate CO which separates the signaling and transmission paths. The 4A echo suppressor can then be placed in the transmission path between the back-to-back SF units. Examples of the application of intermediate echo suppressors can be found in Section 851-316-122.

2.33 Back-to-back signaling units will increase the overall circuit disconnect timing and may result in false seizures and glare problems. Trunk guard timing should be increased or full echo suppressors should be provided at the CO(A) or (Z) locations. Echo suppressors may be used at the +7 and -16 TLPs of carrier channels or associated with F-type SF units shown by dashed boxes at intermediate COs. The following notes and specifications are applicable to the 3A and 4A echo suppressors:

TYPE	UNIT	NOTE	
4A (Full)	Tone disabler	J68914AA	1
	Bridging amplifier	J68914AB	—
	Logic	J68914AC	2
3A (Split)	Tone disabler	J68881AA	3
	Bridging amplifier	J68881AB	—
	Logic	J68881AC	—
	Speech compressor	J68881AD	4

Notes:

1. See Section 804-003-155 for list numbers and options.
2. Switch position all the way right (full, without pad).
3. See Section 804-003-152 for list numbers, options, and J-specifications for power, fuse, and units.
4. An SP COMPR plug (dummy) unit or a switched pad unit (J68881AH) may be substituted. See Section 332-412-101.

2.34 Other arrangements which use a combination of E- and F-type units are also workable. These combinations are as follows: FUA-FRA with E1P, FUA-FPA with E1R, and E1R with E1P.

2.35 When E- or F-type combinations are used, external 1C pads will be required to produce the 23-dB loss objective between carrier terminals. The location of these pads in the circuit is important to maintain the +7 and -16 interface TLPs required by the echo suppressor. This loss may be divided between the FUA and the 1C pads or may all be incorporated in the external pads. The FUA converter slide-switch attenuators provide a maximum of 16.5-dB loss in each direction.

2.36 Four-wire SF units with E and M leads cannot be used since the 20-Hz modulated SF tones (indicating a ring toward the station) will not pass with E and M operation.

I. Meeting Office Balance Requirements in a No. 1/1A or 2/2B ESS Office

2.37 Through or terminal balance requirements (Section 851-330-100) must be met at a switching office on tandem connections between various trunks to provide echo protection. Through office balance requirements must be met at the switching office when two 4-wire trunks, each operating on a VNL basis, are connected in tandem. Terminal office balance requirements must be met at a switching office when a 4-wire VNL trunk is connected in tandem with either a 2-wire or a 4-wire non-VNL trunk. Since the two trunks which may be connected in tandem by a switching office can be arbitrary, limits must be placed on the minimum and maximum length of intraoffice wiring between the midpoint of the switching network and the point of good impedance of the trunk (half-path length) for all trunks in the switching office having balance requirements and on the distribution of these half-path lengths. When 4-wire trunk facilities are used, the point of good impedance of the trunk is provided by the 4-wire hybrid circuit. When 2-wire trunk facilities are used, the point of good impedance of the trunk is provided by an impedance compensator or the equivalent.

2.38 In 1/1A or 2/2B ESS offices, if 1/1A or 2/2B ESS foreign exchange 4-wire and tie trunk circuits are used, a 4-wire hybrid circuit is included as part of this ESS trunk circuit which is located within the switching office boundaries. If ESS or No. 5

Crossbar 2-wire trunk circuits are used, the point of good impedance of the trunk will be provided external to the switching office boundaries by an impedance compensator, a 4-wire terminating set, or a carrier terminal channel unit. The ESS 4-wire trunk circuits must be used for 4-wire VNL trunks. Either ESS 4-wire trunk circuits or 2-wire trunk circuits in conjunction with externally provided 4-wire hybrid circuits could be used for 4-wire non-VNL trunks.

2.39 The variable series resistance and variable shunt capacitance portions of the hybrid balancing network associated with each ESS 4-wire trunk circuit are provided to permit the effect of intraoffice cabling in a connection to be balanced. The variable series resistance and shunt capacitance of the hybrid balancing network of each ESS 4-wire trunk circuit used on a VNL trunk will be adjusted to provide maximum balance when the trunk is connected to a test circuit. The test circuit will consist of a properly terminated ESS 4-wire trunk circuit, or the equivalent impedance, plus a length of 26-gauge switchboard cable approximately equal to the average half-path length for all 4-wire trunks using ESS 4-wire trunk circuits in that office.

2.40 Where 26-gauge switchboard cabling for all intraoffice wiring and ESS 4-wire trunk circuits has been used, through office balance requirements will be met if:

- (a) Fifty percent of the 4-wire VNL trunks have half-path lengths within plus or minus 600 feet with respect to the half-path length of the test circuit
- (b) All of the 4-wire VNL trunks have half-path lengths within plus or minus 1000 feet with respect to the half-path length of the test circuit.

2.41 Where 26-gauge switchboard cabling for all intraoffice wiring, including wiring outside the nominal office boundaries, has been used, terminal balance requirements will be met if the 2- and 4-wire non-VNL trunks have half-path lengths which do not exceed 800 feet plus the half-path length of the test circuit. This length restriction ensures that intraoffice cabling will not significantly degrade an echo return loss of 18 dB versus a compromise network of 900 ohms + 2.16 μ F provided at the point of good impedance of the 2- or 4-wire non-VNL trunk. This point of good impedance could be located outside of the nominal office boundary intermediate distributing frame (IDF) or equivalent for trunks.

J. Open Switch Interval Protection (OSIP)

2.42 The No. 1 ESS and some No. 5 crossbar switching systems create momentary interruptions in the flow of line current during switching network transitions. This is done in order to protect the ferrous and crosspoints of the switching system. These open intervals are relayed by the ESS Centrex foreign exchange trunk to the ESS Centrex CO switching system. These opens can cause call cutoffs due to premature on-hook indications to line connected equipment which are sensitive to momentary interruptions in the flow of line currents (eg, ACDs, key telephone systems, and PBXs).

2.43 Open intervals up to 300 milliseconds can be eliminated when SF signaling units or MFT loop signaling repeater (LSR) units J99343AC and AF are used. The MFT loop signaling extender (LSE) units do not provide OSIP. For intervals longer than 300 ms, use the J99343AE loop-start/ground-start converter with sleeve lead control at the class 5 dial-tone office. The No. 5 crossbar trunk ES-26289-01 provides between 175 to 395 ms OSIP.

2.44 If foreign exchange trunks are encountering open switch interval problems, a special line applique circuit SD-1A297-01 may be bridged on the 1 ESS line circuit to connect holding battery in the line, thus preventing interruptions in current flow. Prior to switching network transitions, a relay will be operated in circuit SD-1A297-01 to apply the holding battery to the lines. After the switching has been completed, the relay will be released and circuit SD-1A297-01 will be open circuited. During operation, 1940 ohms of resistance will be placed in series with -48V battery. Circuit SD-1A297-01 has an external circuit loop resistance range of 1500 ohms and is compatible with all Centrex foreign exchange trunks listed in Table A.

2.45 During talking, the applique acts like a bridge tap to the circuit and will not affect the transmission loss unless an office cross-connection wire from the main distributing frame line location to the applique location is excessive. Normally, the loss is small and ignored for ICL calculations.

K. SMAS Access Points

2.46 The SMAS allows a tester to obtain circuit access from a centralized location. On com-

mand, an access point is switched through a concentration stage to a centralized test location.

2.47 An access point location plan, in Section 667-000-001, gives *guidelines* for a *minimum* set of access points to *sectionalize* troubles with the Switched Access Remote Test System (SARTS). The plan objective is to provide a minimum of *one access point per building*, ensuring *at least one access point per facility*.

2.48 Interfaces to be considered for access point assignment are:

- Metallic customer loop interfaces
- Carrier facility interfaces
- Metallic trunk facility to metallic trunk facility interfaces
- Metallic trunk facility to central office equipment interfaces
- Switch interfaces
- Interfaces with non-SMAS environments.

2.49 The possible access point circuit locations shown on the figures are indicated by code AP only. Additional information is available in Sections 667-302-102 and 667-302-200.

3. DESIGN LAYOUTS

3.01 This part outlines the standard design procedures for Centrex FTs and WATS trunks to class 5 offices using MFT, E6, and V4 repeatered metallic facilities. Analog and digital carrier systems arrangements with or without metallic extensions are also available. Information on MFT combined function units (CFUs) can be found in Sections 332-910-100 (Description) and 332-910-180 (Applications).

3.02 Figure 3 shows the general layout plan for the FTs and WATS trunk designs. Figure 4 provides 2- and 4-wire repeatered layouts with reference to figures and sheets that show the overall design.

A. MFT 2-Wire Designs

3.03 Two-wire designs are presented for FTs and WATS trunks to the class 5 offices. The ICL

objectives for the various applications are shown on the design layouts. All MFT layouts are overall designs.

3.04 Two-wire MFT layouts use either one or two repeater designs. Figure 1 shows the basic repeater locations and maximum cable facility transducer loss limits and gives equations for computing repeater gains. The losses shown include the cable transducer loss (900:900, 900:600) and any equipment items.

3.05 Figure 5 shows detailed layouts with equipment types and repeater locations referred to in Fig. 1. Diagrams are shown for each basic design which indicate the type of repeater (J99343PA, etc) to be used. Also, the A-B side and B-A side orientation of the repeater with the connections properly terminated on the office (A) side and the facility (B) side are shown. The 2-repeater types shown (eg, PA/PG) indicate the older and newer repeater types (left to right). The right (PG) repeater is similar to PA with the additional feature included for use with 25H88 MAT cables. Similar designations are used with other repeater types. Possible locations for MFT signaling units (SU) are shown as dashed boxes. Design procedures for selection of signaling unit locations are described in paragraph 4.39.

3.06 Double-module MFT arrangements are shown; however, the battery-boost LSE unit may be used without the passive 2-wire transmission unit in the transmission unit (TU) slot for single-module arrangements. Equipment types with application notes are shown in Fig. 5.

3.07 Figure 5 also includes switch settings for the various types of 2-wire repeaters (and 2-wire transmission unit) with and without signaling units for A-B and B-A circuit orientations.

3.08 Refer to Section 851-300-130 for details on MFT equalization and to Section 332-912-212 for settings. Section 332-912-212 contains settings for terminal and intermediate repeater locations. No prescription equalizer settings are given for H88 loaded repeaters equipped with 309C amplifiers as they furnish a small amount of fixed gain shaping for H88 loaded cables. Repeaters using the 309D amplifiers provide adjustable slope equalizers for nonloaded cables. Single-gauge and mixed 2-gauge tables are supplied. A small roll-off at 400 Hz and 2800 Hz, referenced to 1000 Hz, is desirable for 2-wire circuit stability for the range of far-end terminations that may

be used. It is necessary to stop short of a completely flat frequency response due to stability considerations.

3.09 Figure 6 for ESS Centrex and Fig. 7 for No. 5 crossbar Centrex show the recommended locations for one or a maximum of two range extender signaling units for trunk applications. The signaling design procedure is presented in Part 4. The signaling unit is selected to provide ground-start (GS) operation. The range tables referenced in Fig. 6 and 7 are included in Section 851-300-170, and these range limits will result in satisfactory signaling designs for trunks. These range tables list the conductor loop resistance (CLR) values which must also include the loop resistance of any equipment items in the signaling path. The range tables referenced in Section 851-300-170 are based on 48-volt and 72-volt operation.

3.10 Figure 8 shows 2-wire layouts using E6 repeaters in place of MFT repeaters.

B. 4-Wire Designs with MFT and Carrier

3.11 The MFT 4-wire designs include overall metallic layouts. In addition, designs using analog and digital carrier channels with 4-wire metallic extensions are presented. Four-wire MFT designs for metallic layouts are shown in Fig. 9 and 10. Four-wire designs must meet terminal balance requirements at CO(A) and CO(Z).

3.12 Figure 9 also shows, by simplified repeater diagrams, the signaling leads for the various repeaters with and without signaling units for A-B and B-A circuit orientation of the repeaters. Sheet notes list application data for the various designs. Simplified diagrams also show the signaling lead arrangements for the J99343FC and J99343FD E and M converter units.

3.13 Figure 11 shows 4-wire designs with equipment types and design notes for 4-wire metallic and carrier layouts. All repeater types shown are of the MFT J99343 series. Refer to Section 851-300-130 for details on the various repeater types. The two repeater types shown (eg, RD/RH) indicate the older and newer repeater types (left to right.) The RH repeater is similar to RD with the additional feature allowing use with 25H88 MAT cable. Similar designations are used with other repeater types. All facility losses shown are transducer loss values between

equipment terminations as follows: 4-wire H88 loaded, 1200:1200; 4-wire nonloaded, 600:600; 2-wire H88 loaded or nonloaded extensions, 900:600. Transducer loss tables at 68°F are given in Section 304-305-100, with prescription settings given in Sections 332-912-222 and 332-912-232. Possible locations for signaling units and intermediate repeaters are indicated by dashed boxes. In general, 4-wire metallic designs are limited to one intermediate repeater between CO(A) and CO(Z). Long metallic designs should be checked to ensure that they do not exceed the 6-ms round-trip delay requirement for short-haul designs.

3.14 Figure 11 also shows detailed carrier channel layouts equipped with MFT transmission and signaling units. Layouts using digital or analog carrier channels and single-frequency signaling are shown. Dashed boxes indicate possible locations when required. The ICL limits shown are for the various trunk applications. The layouts are designed for end-to-end lineup. Equalization techniques for metallic sections are indicated with post equalization used primarily with settings obtained from prescription tables. In those cases where a repeater amplifier provides both pre- and post-equalization, the manual measurement procedures outlined in Section 332-912-231 will be required.

3.15 Figure 12 shows VNL designed long-haul 4-wire layouts with switchable 2-dB pads at the Centrex CO. These designs are analog carrier facilities and use in-band signaling. Dashed boxes indicate optional locations for echo suppressors. The ICL for these trunks is $VNL + 2.0 + 2S$.

3.16 Figure 10 shows more detailed equalization techniques. Equalization for 4-wire sections is shown. When the J99343BD 4-wire extension network is used with carrier channels, pre- and post-equalization for the metallic extension must be provided by the repeater located at CO(I) or CO(Z). In this case, pre- and post-equalizer prescription settings are the same.

C. Combined V4 and MFT Equipment Designs

3.17 The V4 and MFT repeaters will operate satisfactorily within the same repeater section for all types of H88 loaded cables when the proper equalization techniques are used. A 24V4 or 44V4 repeater can be substituted for the terminal or intermediate MFT repeater shown in the standard design layouts in Fig. 9. Figure 10 shows examples of combined repeaters used in 4-wire layouts.

3.18 The first 4-wire layout in Fig. 10 uses the MFT J99343SB intermediate repeater with 24V4 terminal repeaters. The SB repeater provides post- and pre-equalization for the layout with the 359-type V4 equalizers providing either 600- or 1200-ohm cable terminations without equalization. A second arrangement of the same 4-wire layout uses an intermediate 44V4 repeater equipped with 359-type network equalizers. Post-equalization is provided jointly by the intermediate 44V4 repeater and the terminal J99343RA repeaters. The reduced facility loss limits are controlled by the 359-type equalizers.

Equipment and Cable Losses

3.19 Losses for terminating sets and equalizers are listed in the V4 sections referenced in Section 851-300-101. Nonloaded cable losses should be the transmission loss measurement (not attenuation) of the cable with the test termination impedance equal to the impedance of the equalizer facing the cable (150 ohms for 359B equalizers, 600 ohms for 359F equalizers). A list of 359-type equalizers for nonloaded cables by gauge and length is shown in Table E. Cable plus equalizer losses are given in chart form in Section 852-307-102 for solid gauges. Cable transducer losses for single and mixed gauges with and without bridged taps may be found in Section 304-305-100. Losses for loaded cable may be the attenuation loss or the 1200-ohm transducer losses. The differences between loaded cable transducer and attenuation losses are very small.

V4 Amplifier Gain and Pad Loss

3.20 The procedures given in the V4 sections referenced in Section 851-300-101 should generally be followed to determine the 227-amplifier gain or pad loss when amplifiers are not required. The method of computing cable facility transmission levels for minimum crosstalk given in Part 2D should be used. The maximum transmitting and minimum receiving levels for cable facilities should not be exceeded. Transmitting amplifier gains are set to establish the computed cable input level. Receiving amplifier gains at CO(A) and the Centrex CO are set to an output level that will produce the layout EML. When the 1M terminating sets are used, they should include at least 5.0-dB pads to improve the 2-wire return loss. The 1M terminating set has fixed NO AMPL impedance correction shunts. The use of less than 5.0-dB pads between the amplifier and the 1M terminating set will result in degraded 2-wire return loss. The re-

ceive pad also helps reduce the impedance variation caused by different receive amplifier gain settings. Amplifier gains are increased beyond other circuit losses to compensate for the loss of these pads. Where carrier channels or SF signaling units are used, amplifier gains or pad losses are set to meet the +7 and -16 TLPs shown on the layouts.

Terminating Set Switch Options

3.21 On all 4-wire metallic layouts, one reversal of the simplex signaling leads is required to preserve the continuity between end units. The proper SX REV—NOR switch positions are shown on the standard design layouts. The terminating set SX inductors are shorted when either a DLL or MFT signaling unit is used at CO(Z) facing the Centrex CO. The SX inductors are used when dial long lines (DLL) or MFT signaling units are not required. The appropriate NBOC screws should be down when terminal balance is required. The COMP NET screws are turned down at CO(A) and Centrex CO locations.

4. SIGNALING ON CENTREX FOREIGN EXCHANGE CIRCUITS

4.01 Centrex foreign exchange and WATS trunk circuits use ground-start foreign exchange type signaling circuits. The features of these trunks are listed in Table A.

4.02 Outgoing address signals to the MTS network can either be TOUCH-TONE® dialing or dial pulse. Incoming central office ringing signals are 2-seconds on, 4-seconds off.

4.03 On outgoing calls, immediate off-hook supervision is returned to the station or tie trunk when the ground-start trunk is accessed at an ESS Centrex switching system. On a No. 5 crossbar Centrex, off-hook signals are not returned over tie trunks because the tie trunks cannot dial pulse against an off-hook signal. Off-hook signals are returned to stations.

4.04 On incoming Centrex calls, answering supervision is transmitted to the MTS network when the attendant or station answers the call. Audible ringing is transmitted by the MTS class 5 office back to the calling party. Any call progress tones generated at the Centrex (eg, busy, ringing) are not heard by the calling party.

A. Incoming Ringing Detectors

4.05 Circuits SD-1A240-01, SD-1A241-01, SD-1A360-01, and ES26289-01 are equipped with a ringing detector circuit to recognize 2-seconds on, 4-seconds off central office ringing. When the subscriber line at the distant office is seized and the seizure signal (ground on the tip from the CO or E1R followed within 4 seconds by the ac ringing) is received, the central processor connects the FT or WATS trunk circuit to an attendant trunk circuit.

4.06 Newer circuits SD-1A415-05, SD-1A416-05, SD-2H174, and SD-2H180 do not have ringing detectors. When the subscriber line at the distant office is seized and the tip from the CO or the A lead from the E1R (FRA) is grounded, the central processor makes two 600-millisecond checks for a grounded tip. If tip is still grounded, the processor connects the FT or WATS trunk circuit to an attendant trunk circuit.

4.07 Incoming FTs or WATS trunks using circuits SD-1A415-05, SD-1A416-05, SD-2H174-01, and SD-2H180-01 are subject to false seizures due to line signaling tone interruptions or false grounds on the tip conductions. These circuits should be provided with carrier group alarm (CGA), when available, to minimize false incoming signal problems. Outgoing-only FTs should be routed to service trunks on false incoming seizures. Care should also be exercised during testing to avoid transmitting false ringing signals.

B. Signaling Equipment Selection

4.08 The ESS Centrex performs guard timing when a foreign exchange trunk is idled before making the trunk available for further calls. The trunk is then restored to service without verifying that the distant terminal has returned on-hook. Tandem signaling units will increase the disconnect time and may result in false seizures or glare when the disconnect time is excessive.

4.09 To reduce signaling delays end-to-end, SF, carrier, LSR, or DLL signaling is preferred. (Link-by-link signaling is recommended; it aids sectionalization and is more cost effective in most cases.) Conversion of signals at intermediate locations degrades pulsing and increases delay in establishing calls or idling trunks.

SF Signaling Units

4.10 End-to-end inband SF signaling is preferred when using mixed analog, digital, or voice frequency facilities. The E-, F-, and G-type SF units listed in Table F are recommended for use with the various trunks at the Centrex CO. The limits of the E-type units are given in Section 179-100-304, and the approved combinations of E and F units are given in Section 859-215-102.

4.11 The units listed in Table G can be used at the class 5 office (Term A).

4.12 Where end-to-end SF signaling is chosen, any out-of-band signaling (OBS) capabilities of carrier-type channels must be disabled as follows:

T1 CARRIER—Transmission only, E and M, and pulse link repeater channel units can be used, but if E and M channels are used with a D1 channel bank, the M lead must be connected to -48 volts (by Y option screw on units manufactured after 1962; by strap at the distributing frame on older units).

N1 CARRIER—If message-channel unit (J98703FA) is specified, connect the M lead to -38.5 volts. If the channel unit without signaling is specified (J98703AF), it may be used without change.

O AND ON CARRIER—Specify the E and M channel unit with the M lead connected to -48 volts by strap at the distributing frame. If channel units without signaling circuits are specified, they may be used without change.

Out-of-Band Signaling

4.13 For some carrier systems using out-of-band signaling, the E and M type DLLs may be used to convert ground-start signals to E and M operation. The new DLLs suitable for this application are MFT dial tone units J99343FC and J99343FD. The FC faces the dial tone CO and the FD faces the Centrex CO. Terminal companion MFT 4-2 repeaters J99343RA and RE may be used to provide 2-wire 900-ohm impedances at both COs.

4.14 The DLLs suitable for E and M operation are the SD-1C353-01 facing the CO and SD-1C354-01 facing the Centrex CO. These layouts use

1M terminating sets with 1- μ F capacitor across the A and B leads.

T1 Signaling

4.15 Where foreign exchange channel units are used with T-carrier systems D1, D3, and D4 channel units, external signaling equipment is generally not required. The ground-start signals are converted by the digital FXS or FXO channels to digital signals and transmitted over the digital system. The following units are compatible with trunks SD-1A241-01, SD-1A416-05, SD-2H174-01, and ES-26289-01.

AT CO	AT CO(Z)
D1 FXO J98711AF (T1CX430D)	FXS J98711AE (T1CX310B)
D3 FXO J98718BE (D3CX643F)	FXS J98718BD (D3CX551E)
D4 FXO J98726BE (D4CX200K)	FXS J98726BD (D4CX100J)
D4 FXO/GT J98726SK (D4CX400F)	FXS/GT J98726SG (D4CX300E)

Four-Wire FXS units cannot be used with foreign exchange trunks SD-1A240-01, SD-1A360-01, SD-1A415-05, and SD-2H180-01, unless external coils or networks are used to simplex the A and B leads of the trunk circuit to the transmission path of the 4-wire FXS.

4.16 When tandem T1-carrier systems are used for ground-start or loop-start service, 4-wire 600-ohm tandem units must be applied at the intermediate terminations. These units pass the 3-state signals used in ground-start foreign exchange signaling in either direction without introducing objectional signal delays. Loop-start circuits require the use of tandem units (unless the terminal at the office end is a D4 bank) to transmit the ringing signal toward the station end. The intermediate tandem units are as follows.

D1	4W TDM	J98711SD	T1CE603F
D3	4W TDM	J98718SF	D3C3600F
D4	4W TDM	J98726SF	D4CE500E

Extending SF Signaling on 4-Wire Cable Facilities

4.17 When SF signaling units are not available at the switching CO or Centrex CO to provide end-to-end SF signaling, carrier facilities can be extended using 4-wire cable facilities. The signaling from the A and B leads of the E1P, FPA, E1R, or FRA unit can be simplexed on the 4-wire cable facilities. When using T-carrier 4-wire FXS units for long metallic extensions, signaling is also simplexed onto the voice cable pairs.

4.18 The LSRs are not required unless the external conductor loop resistance from the signaling unit to the Centrex CO trunk exceeds the maximum signaling range of the signaling unit or the Centrex is a No. 5 crossbar. In this case MFT (LSRs) may be used, but consideration should be given to providing end-to-end signaling.

Metallic Facilities

4.19 Range extension is required when the total conductor loop resistance from the dial tone CO to the Centrex CO exceeds the signaling ranges shown in Section 851-300-170.

4.20 The LSR unit (J99343AC or AF) of the MFT group provides ground-start operation and is the preferred type of range-extending equipment. Both units provide pulse correction when used in either the 2-wire path with the 2-wire transmission unit or in the A and B leads (2-wire to 4-wire operation). This feature permits any number of LSRs to be used in tandem.

4.21 When two units are required, the preferred arrangement is the use of MFT DX to ground-start converters J99343FC (at CO) and J99343FD (at Centrex CO end). This arrangement can be used with up to 5000 ohms SX resistance between the MFT units and approximately 1300 ohms between the terminals and the CO. These units are always used in pairs on metallic facilities. These units may also be used in the CO when using carriers with out-of-band signaling.

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4.22 Newer foreign exchange trunk circuits SD-1A416-05, SD-2H174-01, and SD-2H180-01 do not have incoming ringing detectors and do not require 20-Hz ringing signaling incoming. When only battery boost range extension is required to activate sensing devices, LSE units J99343CA, CB, CC, and CD are more economical.

4.23 The RE designation used in the 4-wire layouts implies the application of either DLL or MFT units; however, the MFT units are preferred. Descriptive information on the LSR is given in Section 332-911-101. The LSR is used with a 2- or 4-wire passive transmission unit or with a repeater in double-module mountings. Switch settings shown on design figures must be included on the circuit layout record card. A switch on either side of the 2-wire transmission unit selects the 600- or 900-ohm impedance for that side. The switching BOR switch in the LSR may be switched in or out.

4.24 The LSR does not open the transmission path while pulsing, and E6 repeater disablers are not required since disabling is provided by the LSR.

4.25 Where an LSR is used adjacent to an E6 repeater on a circuit using a DLL at a different location, the LSR disabling control should be used for all applications. The passive 4-wire transmission unit (BB) is used with the LSR for 24V4 2- to 4-wire operation. The switching BOR switch and REV reversing switches are provided.

4.26 If the LSR is not available, DLL circuits SD-66474 or SD-66192 for ground-start and SD-96371 for loop-start or ground-start converter at the switching CO may be used. It is desirable to specify 120T repeating coils for these types. The 120T coils not only provide better transmission than other 120-type coils, but also provide a choice of 600- or 900-ohm impedance on one side. Although DLLs with 120T repeating coils are the best of the older DLLs, not more than two in tandem should be used. If more than two are needed, an LSR should be placed at an intermediate location to provide pulse correction.

4.27 Where DLLs (not LSRs) are used at intermediate points in a layout, each E6 repeater is usually supplied with a repeater disabler (Section 851-300-114) to keep the circuit stable in the idle condition. A disabler may be omitted if the loss of a repeated section between DLLs or a DLL and either end is 2 dB or more. The resistance-capacitance (RC)

network across the DLL pulsing contact provides some loss. If the circuit is low-frequency critical, the RC network is not effective.

C. Signaling Range Design Considerations

ESS Foreign Exchange Trunk Signaling Ranges

4.28 The ESS foreign exchange trunk circuits have independent battery feeds for the Centrex station line and trunk facilities. Therefore, the dc loop resistance toward the customer loop does not affect the range of the ESS Centrex foreign exchange trunks. The ESS trunk circuits have sufficient range to serve customer loops designed for 1300 ohms or less loop resistance or have signaling range extension equipment.

4.29 Signal ranges from the ESS trunk circuit to the foreign class 5 office line circuit must be considered when the trunks are interconnected with metallic facilities. Section 851-300-170 provides the conductor loop resistance ranges between class 5 office switching systems and the ESS Centrex foreign exchange trunk circuits.

4.30 Section 851-300-170 provides conductor loop resistance ranges between range extenders and Centrex foreign exchange trunks. Figure 6 provides the possible equipment locations and limits for various combinations of range extenders with ESS Centrex foreign exchange trunks.

No. 5 Crossbar Foreign Exchange Trunk Signaling Ranges

4.31 The No. 5 crossbar foreign exchange auxiliary trunk circuit ES-26289-01 cuts through to the station line. Battery feed is supplied by the central office station line circuit at the foreign office by range extension equipment or by carrier terminal equipment.

4.32 Therefore, when designing FTs and WATS trunks, the total resistance of the longest Centrex station, the Centrex trunk circuit, and the trunk loop would have to be determined. This must not exceed the switching system to station set ranges given in Section 851-300-170. Because this design technique is very difficult to administer in the practical field environment, the alternative below is recommended.

4.33 It is recommended that a signaling repeating range extender (SRRE) or carrier facility ter-

minal signaling unit be collocated with the trunk circuit ES-26289-01. This design technique assures that trunk designs and loop designs can be treated independently.

4.34 Section 851-300-170 provides the conductor loop resistance ranges between the class 5 office switching systems and the signaling repeating range extender. Figure 7 provides the possible equipment locations and limits for various combinations of range extenders with No. 5 crossbar FTs and WATS trunks when using metallic facilities.

Range Extender Location Considerations With Carrier Terminal Signaling Units

4.35 Range extension equipment is not required when SF or D-bank foreign exchange ground-start signaling units are used at CO(A) (dial-tone CO) and the Centrex CO. When SF units are located at intermediate central offices, the range limits of the signaling units must be considered to determine if intermediate range extension equipment is required. The following procedures established for all metallic facilities should be used to calculate the metallic ranges between the intermediate central office and CO(A) or the Centrex CO.

Metallic Facilities

4.36 The CLR of metallic 2-wire, 4-wire, and 4-wire links with 2-wire extensions from CO(A) (dial-tone CO) to the Centrex CO must be determined to ensure adequate signaling to class 5 office line circuits. For 2-wire facilities, the CLR includes the cable loop resistance and any equipment in the signaling path. In 4-wire facilities, the CLR includes the cable simplex resistance (1/2 the loop resistance) and any equipment in the signaling path.

4.37 The procedures given in this part are based on information and range tables listed in Section 851-300-170. This section should be consulted before beginning signaling designs.

4.38 Figure 6 shows range table references and signaling unit locations as configurations 1 through 5 for ESS Centrex trunks. Figure 7 shows the same information for No. 5 crossbar trunks. Figure 7 always shows a range extender at the No. 5 crossbar Centrex location because the trunk operates cut-through as discussed in paragraph 4.31.

Design Procedures

4.39 The following procedure should be used for signaling design of Centrex FTs and WATS trunks:

- (a) Select the layout from Fig. 4 and do the initial transmission design. This locates transmission equipment in the signaling path.
- (b) If Centrex is ESS, use Fig. 13 flowchart.
- (c) If Centrex is No. 5 crossbar, use Fig. 14 flowchart.
- (d) Select options for type of signaling unit to be used (Section 851-300-170). Impedance options should be 900 ohms.

5. REFERENCES

5.01 The following sections provide additional information.

SECTION	TITLE
197-100-3ZZ	Signaling Compatibility
332-910-100	MFT Description
332-910-180	MFT Applications
660-472-ZZZ	5 Crossbar Offices—Through and Terminal Balance Requirements
660-476-ZZZ	No. 1 ESS Offices—Through and Terminal Balance Requirements
851-300-100	Transmission Design Considerations and Objectives—Switched Special Services and PBX Services
851-300-170	Standard Design of Switched Special Services Circuits Signaling Range Information
851-330-100	Centrex Service Transmission Engineering Considerations
851-311-122	Transmission and Signaling Design of Foreign Exchange and Remote WATS Trunks
958-120-100	No. 5 Crossbar Centrex Service General Descriptive Information

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SECTION	TITLE	SECTION	TITLE
966-102-100	2-Wire No. 1 and No. 1A Electronic Switching System Business Customer Service (Centrex and PBX CO)—General Description	966-202-100	Centrex Central Office Service—General Description-No. 2 Electronic Systems

TABLE A
CENTREX FX TRUNK CIRCUITS

SWITCHING SYSTEM		1/1A ESS				2/2B ESS		NO. 5 CROSSBAR	
USE		LONG-HAUL FT			SHORT-HAUL FT		LONG-HAUL FT	SHORT-HAUL FT	FX TRUNK
TRUNK SD		SD-1A240-01	SD-1A360-01	SD-1A415-01	SD-1A241-01	SD-1A416-01	SD-2H180-01	SD-2H174-01	ES-26289-01
Cut-Through Service		Yes	Yes	Yes	No	No	Yes	No	No
2-dB Switchable Pad		Yes	Yes	Yes	No	No	Yes	No	No
Hybrid		Yes	Yes	Yes	No	No	Yes	No	No
Pads in Hybrid		Yes	Yes	No	NA	NA	Yes	NA	No
City of Origin Applique		No	Yes	No	Yes	Yes	No	No	No
Supervisory Leads		A&B	A&B	A&B	T&R	T&R	A&B	T&R	T&R
Pulse Repeater Circuit		Yes	Yes	Yes	No	No	Yes	No	No
Incoming Ringing Detector		Yes	Yes	No	Yes	No	No	No	Yes
Range and Resistance Toward Trunk Facilities	CKT DC (R _{FT}) Resistance	420	420	246	470	650	420	420	*
	Supervisory Range	NA A&B Leads	6000	NA	3000	3000	NA	OPT X 3000 OPT Y 200	Cut-Through†
	Ring-Up Range	NA A&B Leads	3000	NA	3000	3000	NA	NA	
	Rering Range	NA A&B Leads	2000	NA	2000	2000	NA	NA	
Range and Resistance Toward Local Customer	CKT DC Resistance W/O LCN	470	470	470	406	350	470	406	*
	CKT DC Resistance W/LCN	474	474	474	410	350	NA	NA	
	Sensor Sensitivity	1900	1900	1900	1900	1900	1900	1900	Cut-Through†
	23 mA to Station Set	1350	1350	1350	1470	1470	1350	1350	

*Without toll diversion: 23 ohms
 With toll diversion: 46 ohms
 Add 132 ohms if attendant console provided
 †See paragraph 4.31.

TABLE B
CENTREX FOREIGN EXCHANGE TRUNK (FT)
SWITCH PAD OPERATION

	ESS VNL LONG-HAUL FOREIGN EXCHANGE TRUNK	ESS NON VNL SHORT-HAUL TRUNK	NO. 5 CROSSBAR FOREIGN EXCHANGE TRUNK
ESS VNL Long-Haul FT	Out / Out	— / Out	NA / NA
ESS Non-VNL Short-Haul FT	— / Out	— / —	NA / NA
Tandem Tie Trunk	Out / Out	Out / —	Out / —
Intertandem Tie Trunk	Out / Out	Out / —	Out / —
MTS Trunk	— / Out	— / —	— / —
Attendant Trunk	— / *In	— / —	NA / —
Centrex Station Line Local Area	— / In	— / —	— / —
Centrex Station Line Long Haul	— / In	— / —	— / —

Legend:

- OUT = 2-dB pad is switched out of connection.
- IN = 2-dB pad is left in the connection.
- = Circuit does not have 2-dB pad.
- NA = Not applicable because connection not possible.

* Switch pads will operate when attendant releases from circuit if new connection calls for switch pad operation.

TABLE C
METALLIC FACILITIES
MAXIMUM PERMISSIBLE TRANSMITTING TRANSMISSION LEVEL POINT (TLP)
AND
MINIMUM PERMISSIBLE RECEIVING TRANSMISSION LEVEL POINT (TLP)
(CROSSTALK LIMITING)

	H88 LOADED CABLE		NONLOADED CABLE	
	MAXIMUM OUTPUT TO CABLE (DB)	MINIMUM INPUT FROM CABLE (DB)	MAXIMUM OUTPUT TO CABLE (DB)	MINIMUM INPUT FROM CABLE (DB)
At CO	+6	-9	+6	-9 (-15)*

*The -15 dB TLP applies only when a nonloaded cable is provided with 150-ohm terminations at both ends.

TABLE D

FOUR-WIRE METALLIC FACILITIES
TRANSMITTING TRANSMISSION LEVEL POINT (TLP)
AND
RECEIVING TRANSMISSION LEVEL POINT (TLP)
ADJUSTMENT FORMULAS

CO-CO (H88)
At CO $TLP_T (Max) = +6 \text{ dB}$ $TLP_R (Min) = -9 \text{ dB}$ $TLP_{TA} = -15 + \frac{Loss}{2}$ $TLP_{RA} = -1.5 - \frac{Loss}{2}$

TABLE F

FX TRUNKS AND COMPATIBLE SF SIGNALING UNITS

TRUNK	E TYPE	F TYPE	G TYPE
SD-1A240-01	E1R	FUA + FRA	GRA
SD-1A241-01 Remove Opt Z	E2S/E2SA E1R+1M Term Set	FUA + FSA	GSA
SD-1A415-01	E1R + C Pads	FUA + FRA	GRA
SD-1A416-01	E2S/E2SA E1R+1M Term Set	FUA + FSA	GSA
SD-2H174-01 Remove Opt Z	E2S/E2SA E1R+1M Term Set	FUA + FSA	GSA
SD-2H180-01	E1R	FUA + FRA	GRA
ES-26289-01	E2S/E2SA E1R+1M Term Set	FUA + FSA	GSA

TABLE E

NONLOADED CABLE
359-TYPE EQUALIZERS
FOR
V4 REPEATER APPLICATIONS

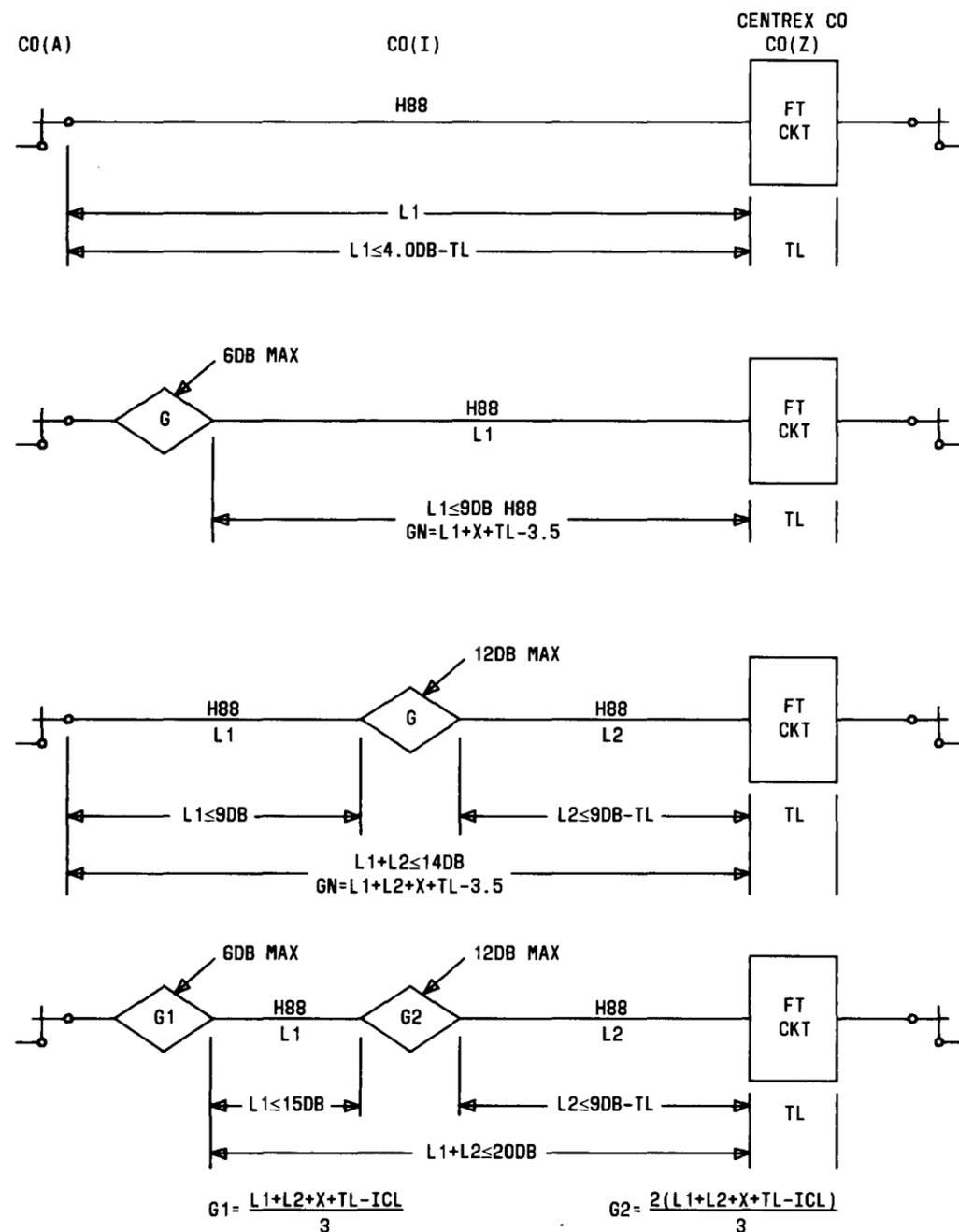
CABLE GAUGE	CABLE LENGTH IN KFT		
	359F — 359F (NOTE)	359F — 359B (NOTE)	359B — 359B (NOTE)
19	0 to 9	9.1 to 16	16.1 and above
22	0 to 8	8.1 to 14	14.1 and above
24	0 to 7.5	7.6 to 12	12.1 and above
25	0 to 9	9.1 to 13	13.1 and above
26	0 to 7 (Short)	7.1 to 10 (Medium)	10.1 and above (Long)

Note: Equalizer Impedance: 359F = 600, 359B = 150

TABLE G

CLASS 5 OFFICE LINE COMPATIBLE SF SIGNALING UNITS

TRUNK	E TYPE	F TYPE	G TYPE
Class 5	E2L/E2LA E1P+1M Term Set	FUA + FLA	GLA



LEGEND:
 G = GAIN
 L = LOSS
 X = EQUIPMENT LOSS
 TL = FT LOSS
 ICL = 3.5DB

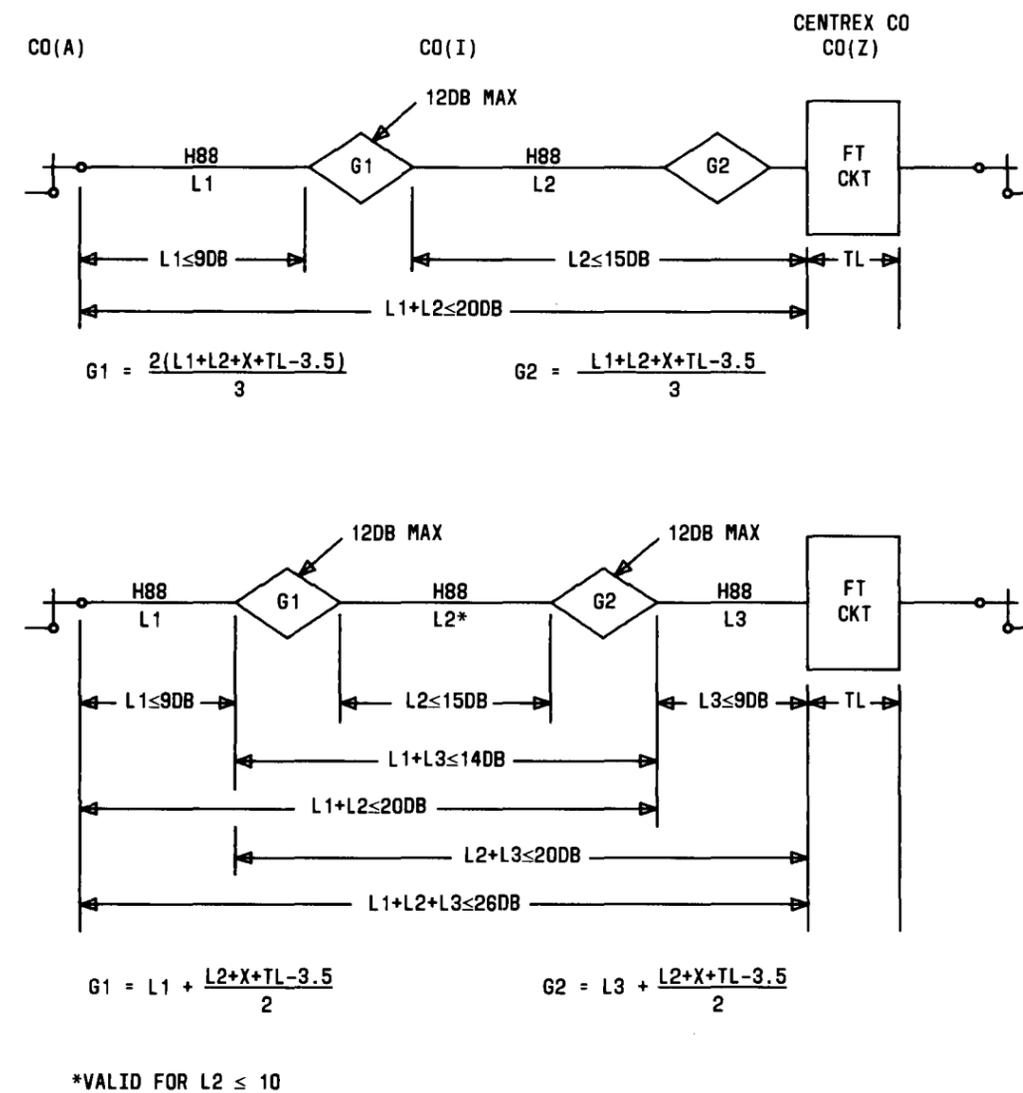


Fig. 1—Two-Wire MFT Repeated Loss Limits and Gain Computation for Centrex FX Trunks

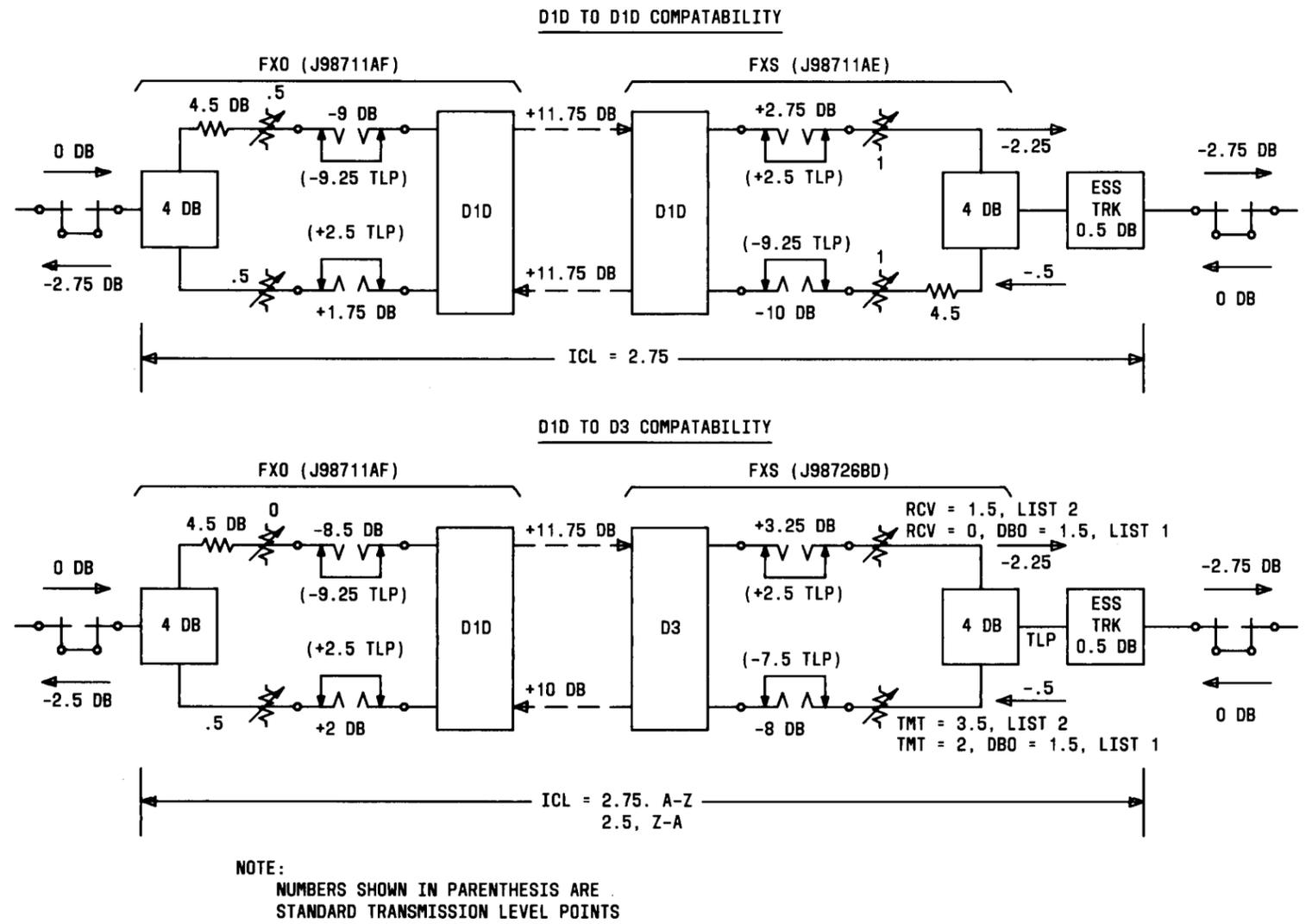


Fig. 2—Recommended Lineup of TLPs on FX Trunks to ESS Centrex (Sheet 1 of 5)

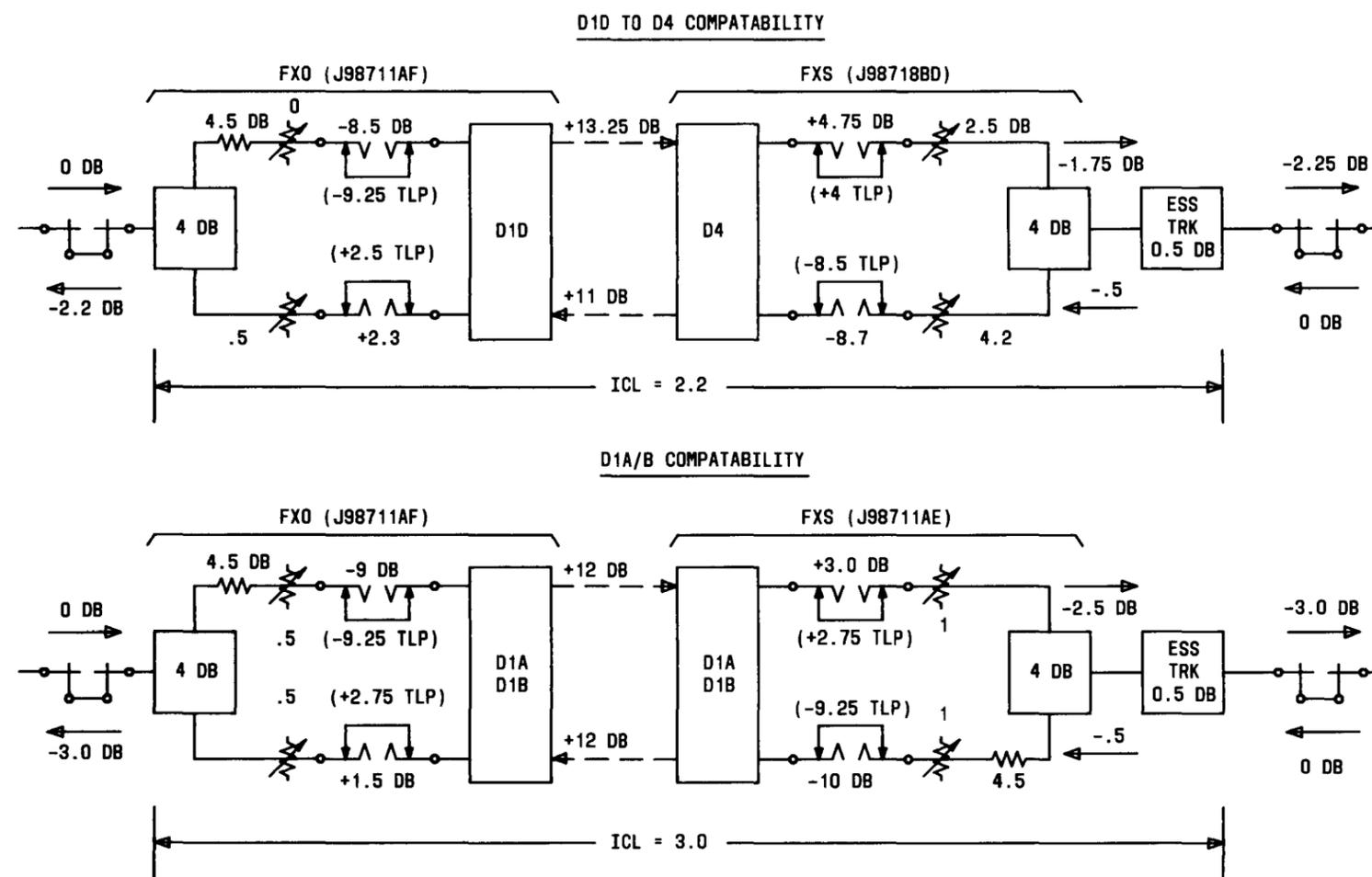


Fig. 2—Recommended Lineup of TLPs on FX Trunks to ESS Centrex (Sheet 2 of 5)

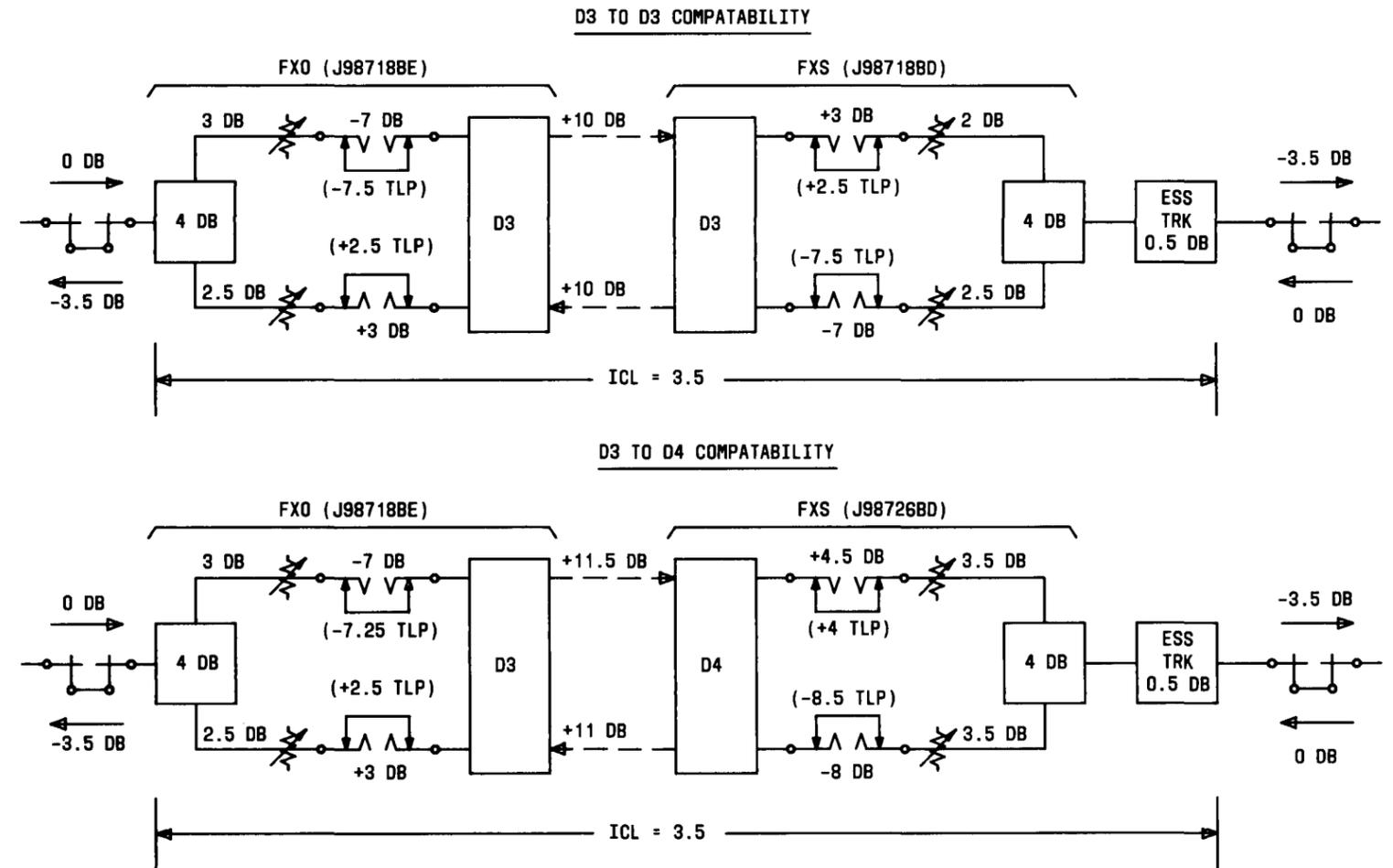


Fig. 2—Recommended Lineup of TLPs on FX Trunks to ESS Centrex (Sheet 3 of 5)

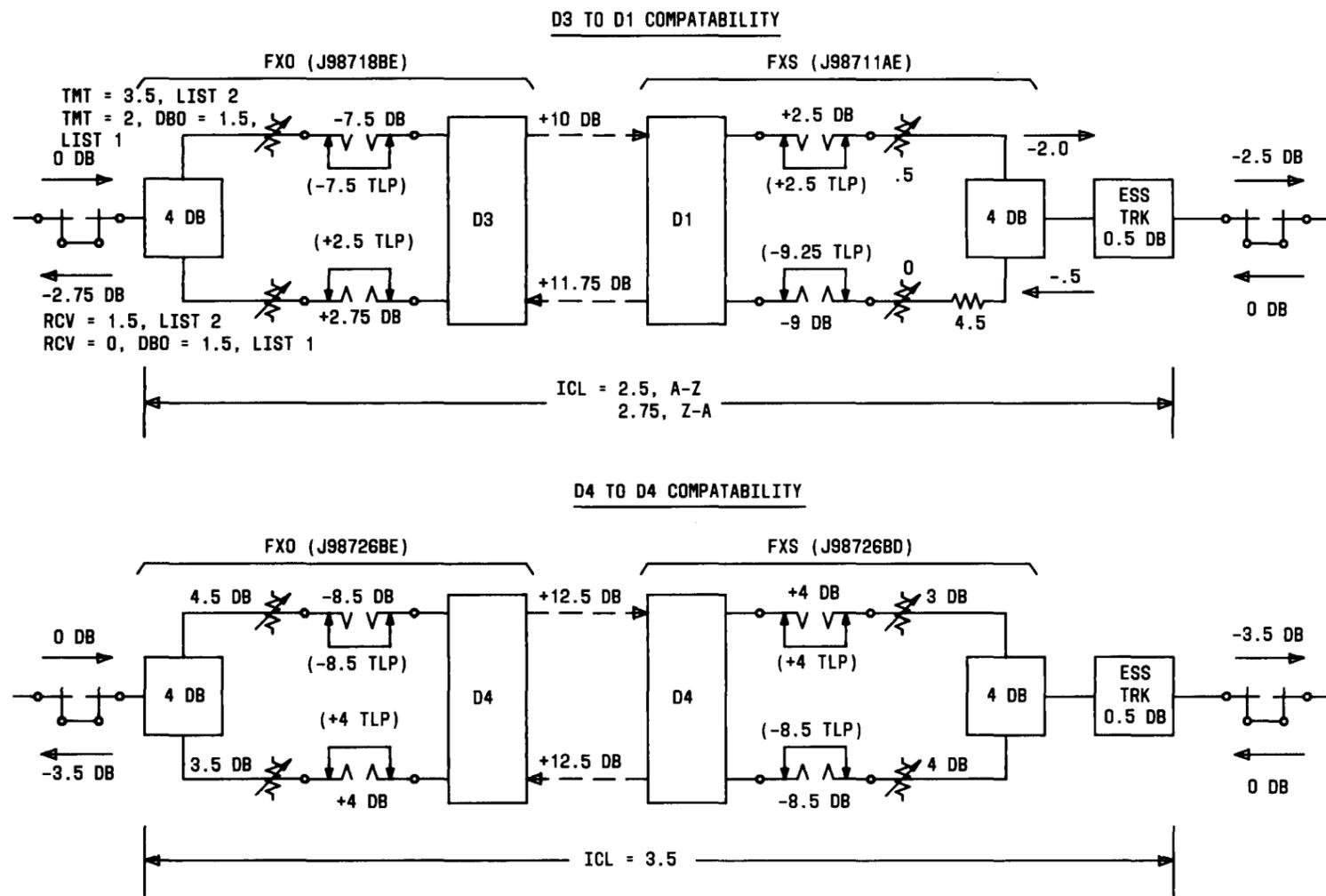


Fig. 2—Recommended Lineup of TLPs on FX Trunks to ESS Centrex (Sheet 4 of 5)

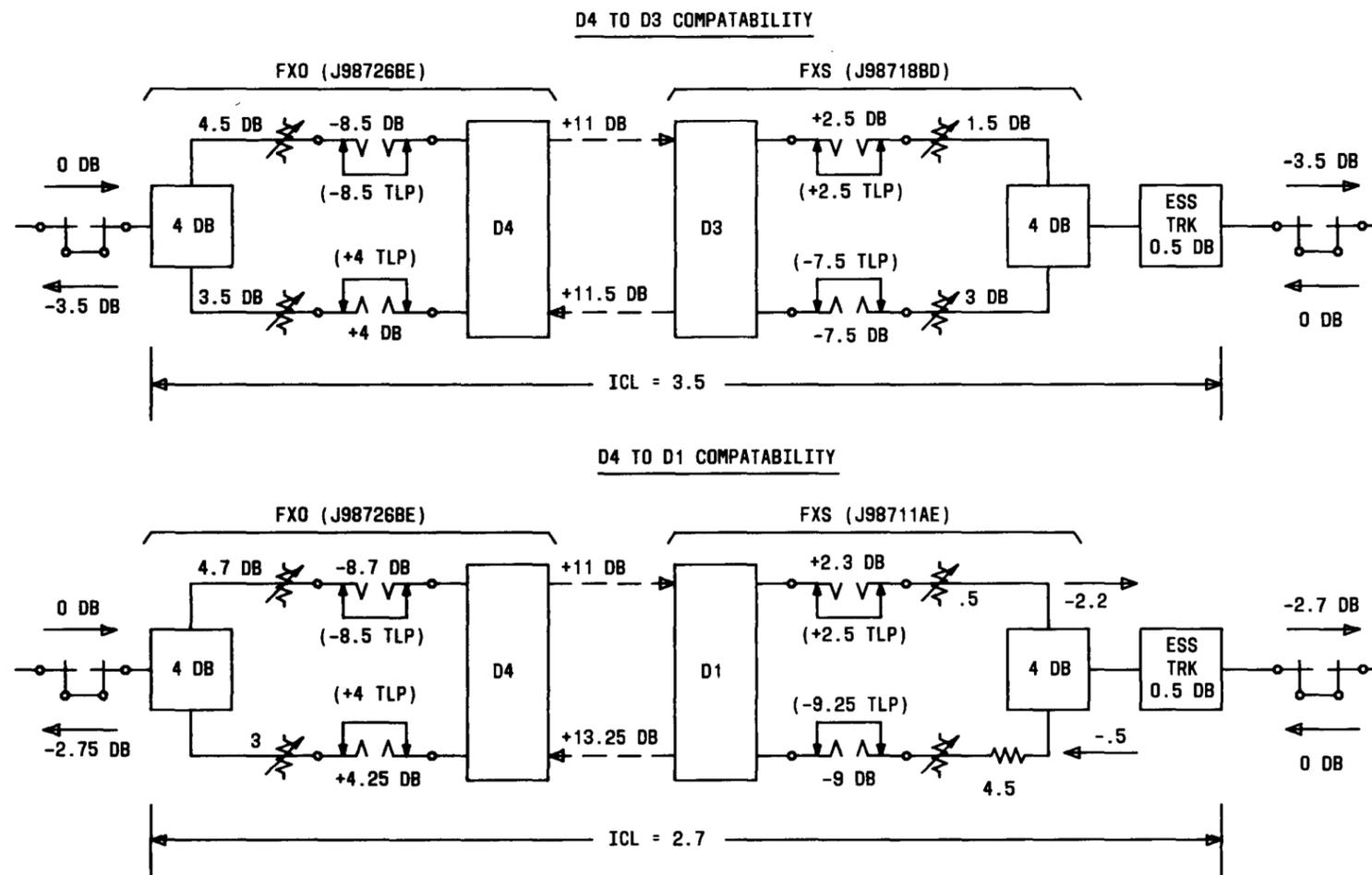


Fig. 2—Recommended Lineup of TLPs on FX Trunks to ESS Centrex (Sheet 5 of 5)

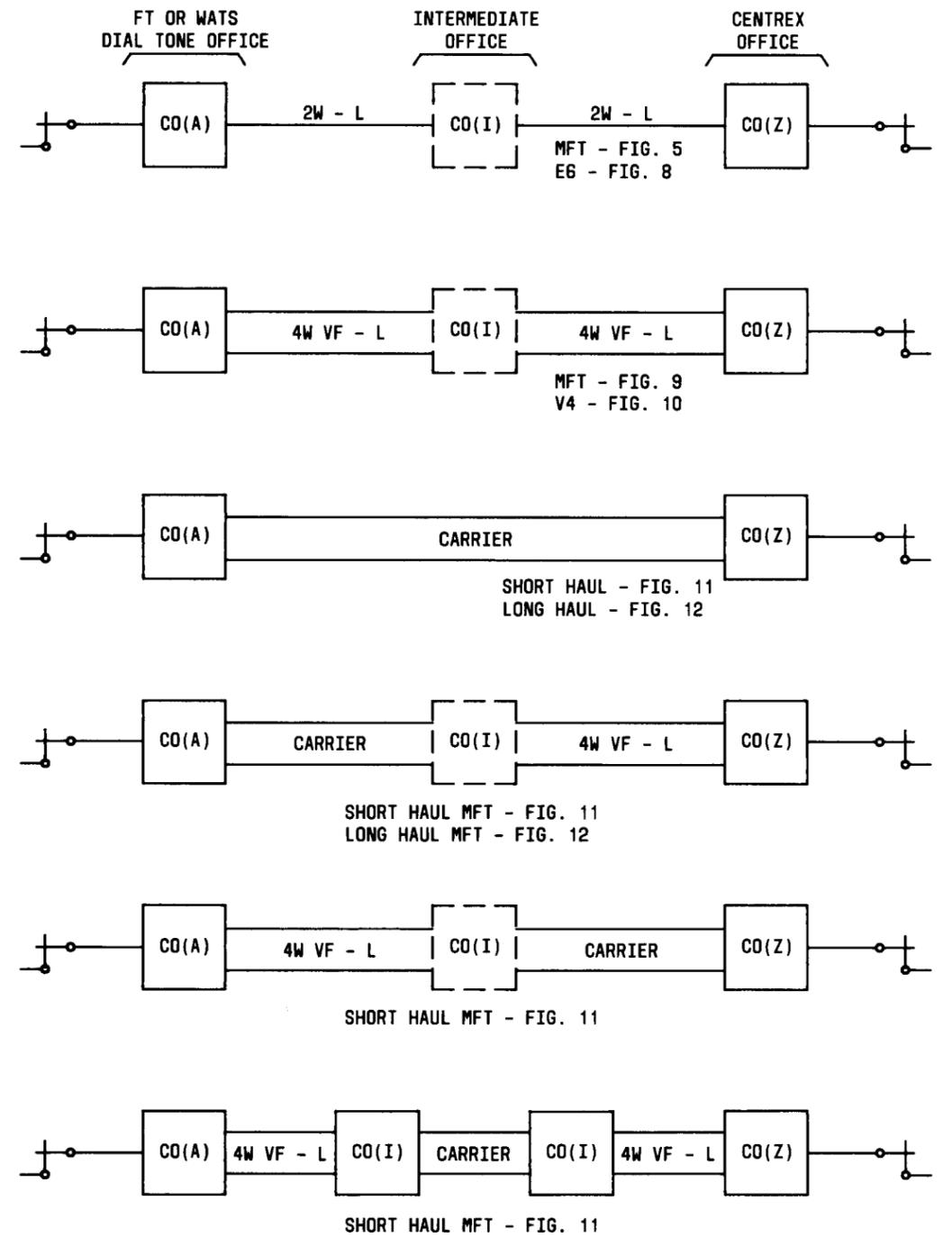
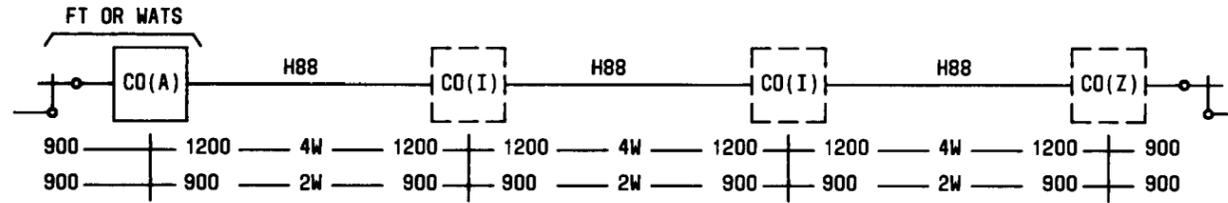


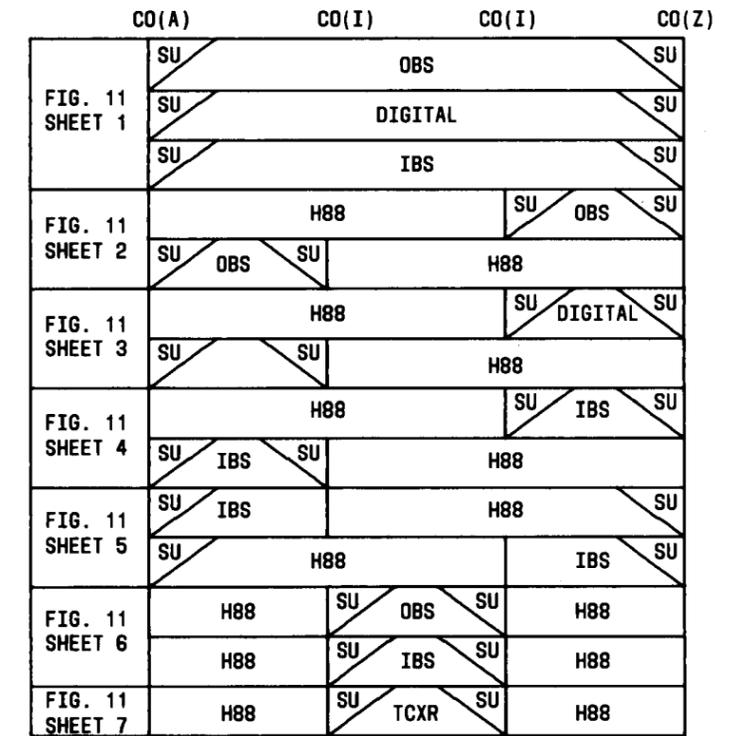
Fig. 3—General Layout Plan for FX or WATS Trunks



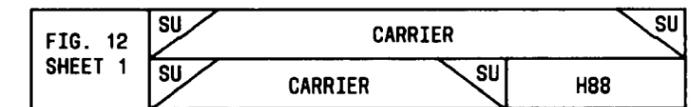
FACILITY TRANSDUCER LOSS (DB)				
CO (A) - CO (Z)	CO (A) - CO (I) OR CO (Z)	CO (I) - CO (I)	CO (I) - CO (Z)	TOTAL LOSS CO (A) - CO (Z)
2-WIRE (MFT REPEATED LAYOUTS)				
NO RPTR AT CO (A)	H88	H88	H88	UP TO 3.5 DB
5-1 RPTR AT CO (A)	H88	H88	H88	UP TO 9.0 DB
5-2 RPTR AT CO (Z)	H88	H88	H88	UP TO 9.0 DB
5-3 RPTRS AT CO (A) CO (I)	UP TO 15.0 DB	UP TO 9.0 DB		UP TO 20.0 DB
5-4 RPTRS AT CO (A) CO (Z)	UP TO 15.0 DB	H88		UP TO 15.0 DB
5-5 RPTRS AT CO (I) CO (I)	UP TO 9.0 DB	UP TO 15.0 DB	UP TO 9.0 DB	UP TO 26.0 DB
5-6 RPTRS AT CO (I) CO (Z)	UP TO 9.0 DB	UP TO 15.0 DB		UP TO 20.0 DB
5-7 RPTR AT CO (I)	UP TO 9.0 DB	UP TO 9.0 DB		UP TO 14.0 DB
4-WIRE (MFT REPEATED LAYOUTS)				
9-1 RPTRS AT CO (A) CO (Z)	UP TO 15.0 DB	H88	H88	UP TO 15.0 DB
9-1 RPTRS CO (A) CO (I) CO (Z)	UP TO 15.0 DB	H88	UP TO 15.0 DB	UP TO 30.0 DB

CODING NOTES:
 1. CIRCLED NUMBERS DENOTE FIGURE NUMBERS & SHEET
 2. THE DB FACILITY LIMITS ARE TRANSDUCER LOSS VALUES (SEE SECTION 304-305-100)

SHORT HAUL 4 WIRE LAYOUTS WITHOUT SWITCH PAD

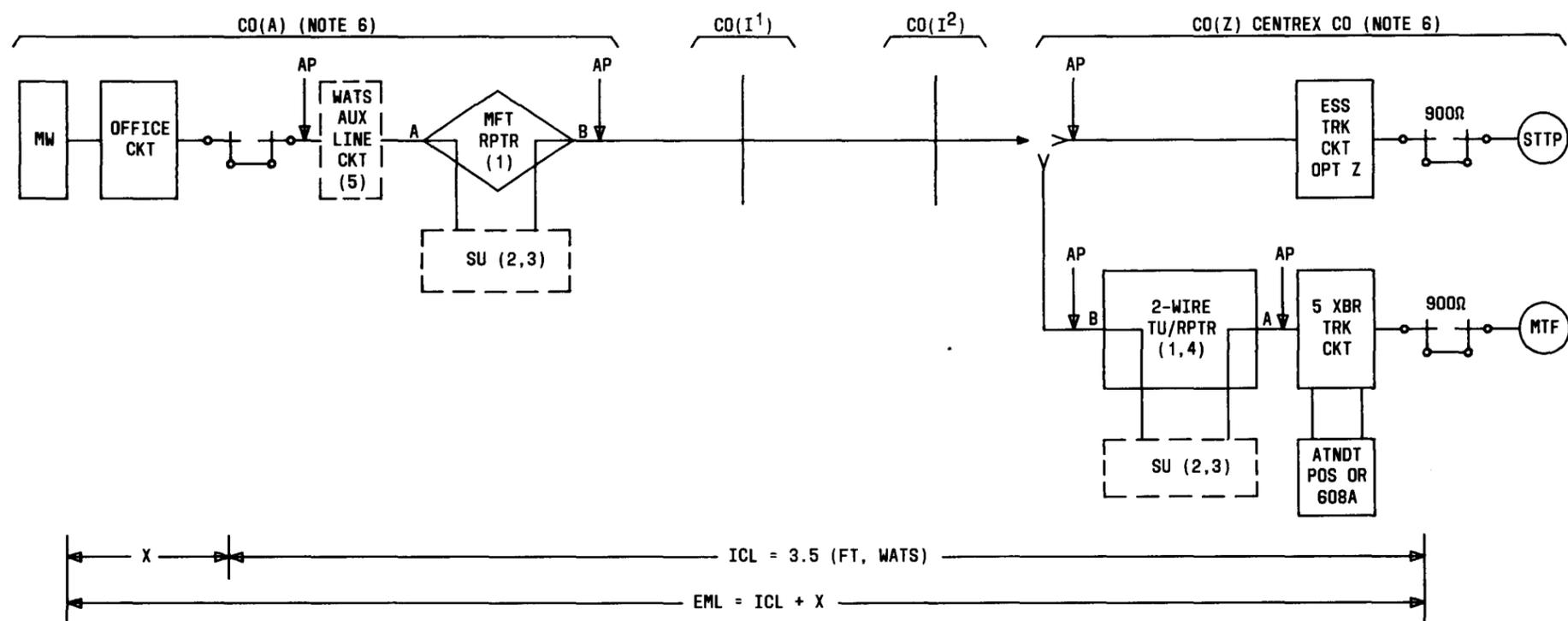


LONG HAUL 4 WIRE LAYOUTS WITH SWITCH PAD



LEGEND:
 ISB = INBAND SIGNALING SYSTEM SUCH AS N2, N3, L, R, ETC
 OBS = OUTBAND SIGNALING SYSTEM SUCH AS ON, N1
 SU = LOCATION OF SF, FXO, FXS OR DLL SIGNALING UNIT DESIGN

Fig. 4— MFT Repeated Layouts, 2- and 4-Wire Layouts, and Signaling Unit Locations



- NOTES:**
- J99343PA/PG TERMINAL REPEATERS SWITCH SETTINGS:**

WITHOUT SU	WITH SU
NOR-RV=NOR	NOR-RV=NOR
NOR-RV/T=RV/T	NOR-RV/T=NOR
NOR-SX SH=NOR	NOR-SX SH=NOR
	=SX/SH (WITH LSE)
 - WITH TRUNKS SD-1A241-01, ES-26289-01 SIGNALING UNITS**

LSR-J99343AC, AF OR MODIFIED AA:

LS-GS=GS (GROUND START)

BOR: SEE SECTION 851-300-130

WITH TRUNKS SD-1A416-05, SD-2H174-01

LSE-J99343CC, CA, CB, OR CD.

(S1) NOR-REV=NOR (A-B), REV (B-A)

LS-GS CONVERTER-J99343AE (USE AT CO A)

S1-S12: SEE SECTION 332-911-101
 - CONDUCTOR LOOP RESISTANCE CO (A) TO CO (Z) ≤5000Ω WITH DX UNITS**

DX TO GROUND START CONVERTERS J99343FC AT CO (A)

DX/EM = DX
ML1 = DOWN
ML2 = DOWN
C BAL = 6 μF
MPC = DOWN

BOR: SEE SECTION 851-300-130

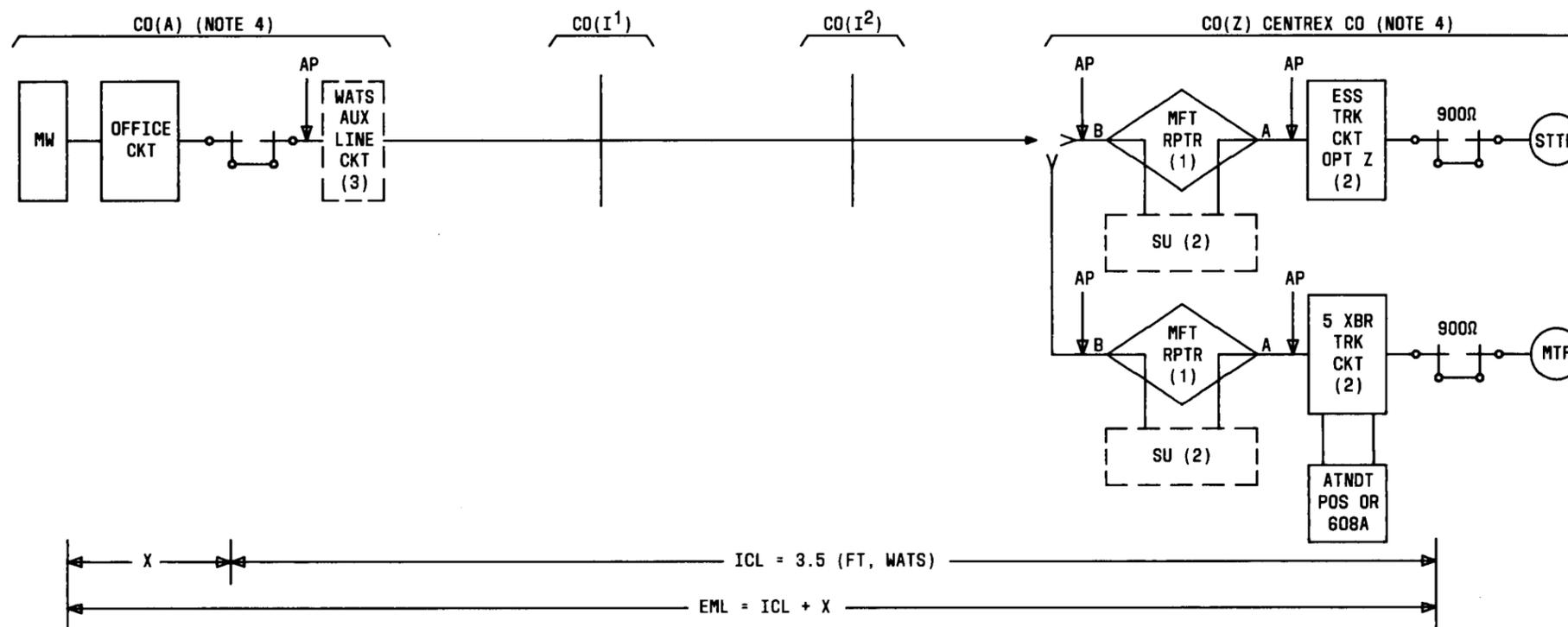
J99343FD AT CO (I¹), (I²) OR (Z)

DX/EM = DX
ML1 = DOWN
ML2 = DOWN
C BAL = 6 μF
MPC = DOWN
 - 2-WIRE TU J99343BC**

A SIDE Z=900
B SIDE Z=900
NOR-RV=NOR(A-B)
=RV(B-A)
NOR-L1 SH=NOR
NOR-L2 SH=NOR, L2 SH (WITH LSE)
SB1=IN (BEST RETURN LOSS)
=OUT (REDUCES 1KHZ LOSS FROM 0.8DB TO 0.4DB)
 - AUXILIARY LINE CIRCUIT SD-99439-01 USED WITH MEASURED RATE INCOMING WATS SERVICE**
 - PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K**

Fig. 5—Basic Design Layouts Using MFT (Sheet 1 of 7)

TPA-644071-1 BSP 851-330-122 FIG. 5 60W X 45H

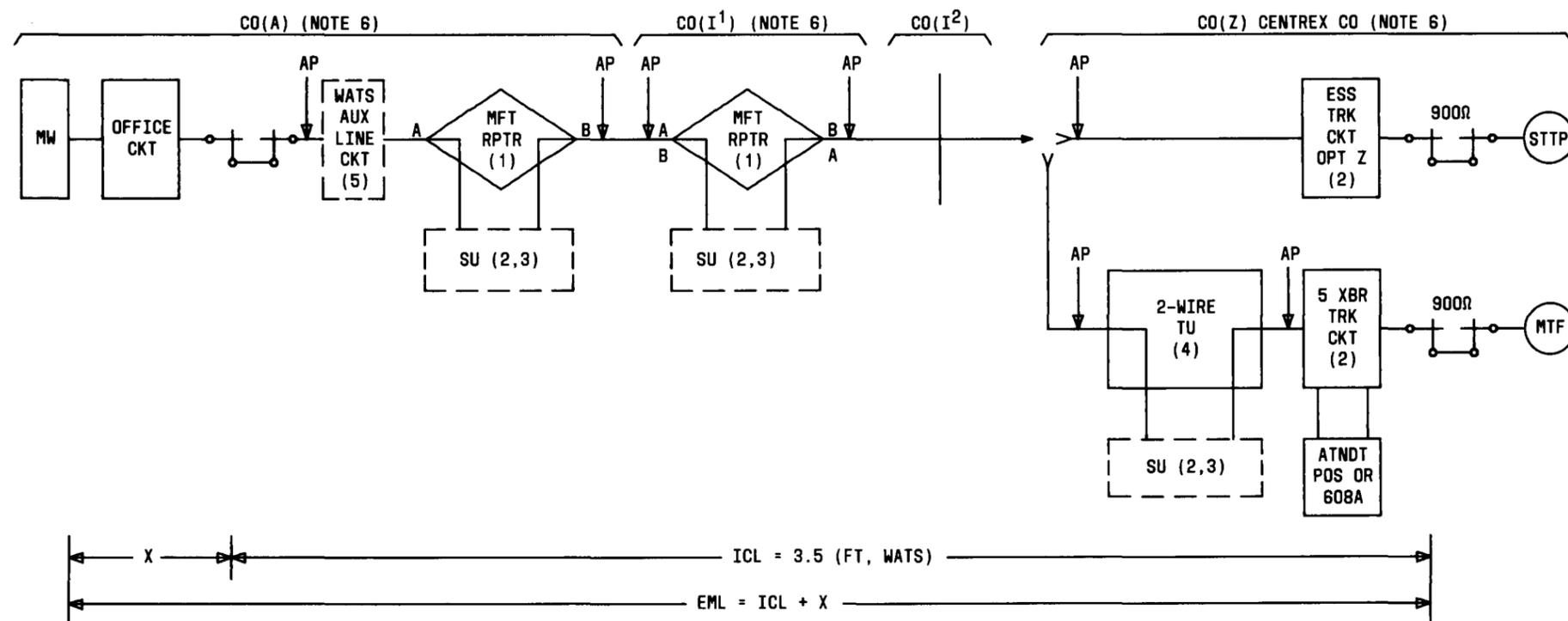


NOTES:

1. J99343PA/PG REPEATERS AT CO(Z) SWITCH SETTINGS:

<u>WITHOUT SU</u>	<u>WITH SU</u>
NOR-RV=NOR	NOR-RV=NOR(A-B), RV(B-A)
NOR-RV/T=RV/T	NOR-RV/T=NOR(A-B), RV(B-A)
NOR-SX SH=NOR	NOR-SX SH=NOR, SX SH (WITH LSE OR CONVERTERS)
2. WITH TRUNKS SD-1A241-01, ES-26289-01
SIGNALING UNITS
LSR-J99343AC, AF OR MODIFIED AA
LS-GS=GS (GROUND START)
BOR: SEE SECTION 851-300-130
WITH TRUNKS SD-1A416-05, SD-2H174-01
LSE-J99343CC, CA, CB, OR CD.
S1 NOR-REV=NOR(A-B), REV(B-A)
3. AUXILIARY LINE CIRCUIT SD-99439-01
USED WITH MEASURED RATE INCOMING
WATS SERVICE
4. PROVIDE ACCESS POINTS (AP) AS SHOWN ON
THE FIGURE AND SEE PART 2-K

Fig. 5—Basic Design Layouts Using MFT (Sheet 2 of 7)



NOTES:

1. J99343 PA/PG AT CO (A)
 J99242 PC/PH AT CO (I¹) OR (I²)
 SWITCH SETTINGS

WITHOUT SU	WITH SU
NOR-RV=NOR	NOR-RV=NOR(A-B), RV(B-A)
NOR-RV/T=RV/T	NOR-RV/T=NOR(A-B), RV/T(B-A)
NOR-SX SH=NOR	NOR-SX SH=NOR, SX SH(WITH LSE OR CONVERTERS)

2. CONDUCTOR RESISTANCE CO (A) TO CO (I¹) OR (I²) ≤ 2375Ω

WITH TRUNKS SD-1A241-01, ES-26289-01
 SIGNALING UNITS
 LSR-J99343AC, AF, OR MODIFIED AA

LS-GS=GS(GROUND START)

BOR: SEE SECTION 851-300-130

WITH TRUNKS SD-1A416-05, SD-2H174-01
 LSE-J99343CC, CA, CB OR CD.

(S1)NOR-REV=NOR(A-B), REV(B-A)

3. CONDUCTOR LOOP RESISTANCE CO (A) TO CO (I¹) OR (I²) ≤ 5000Ω WITH DX UNITS.

DX TO GROUND START CONVERTERS
 J99343FC AT CO (A)

DX/EM	=DX
ML1	=DOWN
ML2	=DOWN
C BAL	=6 μF
MPC	=DOWN

BOR: SEE SECTION 851-300-130

J99343FD AT CO (I¹), (I²) OR (Z)

DX/EM	=DX
ML1	=DOWN
ML2	=DOWN
C BAL	=6 μF
MPC	=DOWN

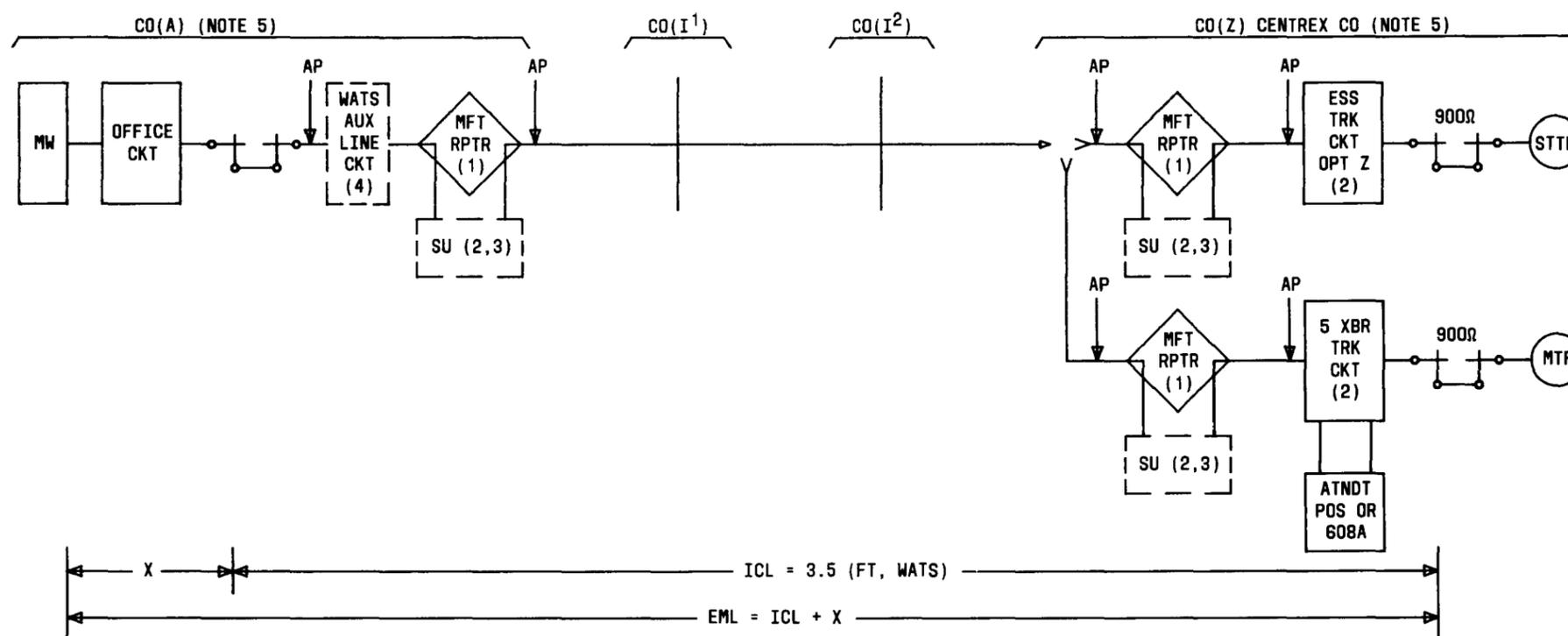
4. 2-WIRE TU J99343BC

A SIDE Z=900
 B SIDE Z=900
 NOR-REV=NOR(A-B), REV(B-A)
 NOR-L1 SH=NOR
 NOR-L2 SH=NOR L2 SH(WITH LSE)
 SB1=IN(BEST RETURN LOSS)
 =OUT(REDUCES 1-KHZ LOSS FROM 0.8DB TO 0.4DB)

5. AUXILIARY LINE CIRCUIT SD-99439-01
 USED WITH MEASURED RATE INCOMING
 WATS SERVICE

6. PROVIDE ACCESS POINTS (AP) AS SHOWN
 ON THE FIGURE AND SEE PART 2-K

Fig. 5—Basic Design Layouts Using MFT (Sheet 3 of 7)



NOTES:

1. J99343PA/PG AT CO(A) OR CO(Z)

SWITCH SETTINGS

WITHOUT SU

NOR-RV=NOR
 NOR-RV/T=RV/T
 NOR-SX SH=NOR

WITH SU

NOR-RV=NOR(A-B), RV(B-A)
 NOR-RV/T=NOR(A-B), RV/T(B-A)
 NOR-SX SH=NOR, SX SH (WITH LSE OR CONVERTERS)

2. CONDUCTOR RESISTANCE CO(A) TO CO(Z) $\leq 2375\Omega$

WITH TRUNKS SD-1A241-01, ES-26289-01
 SIGNALING UNITS

LSR-J99343AC, AF, OR MODIFIED AA

LS-GS=GS (GROUND START)

BOR: SEE SECTION 851-300-130

WITH TRUNKS SD-1A416-05, SD-2H174-01
 LSE-J99343CC, CA, CB, OR CD.

(S1) NOR-REV=NOR(A-B), REV(B-A)

3. CONDUCTOR LOOP RESISTANCE CO(A) TO CO(Z) $\leq 5000\Omega$ WITH DX UNITS

DX TO GROUND START CONVERTERS

J99343FC AT CO(A)

DX/EM = DX
 ML1 = DOWN
 ML2 = DOWN
 C BAL = $6\mu F$
 MPC = DOWN

BOR: SEE SECTION 851-300-130

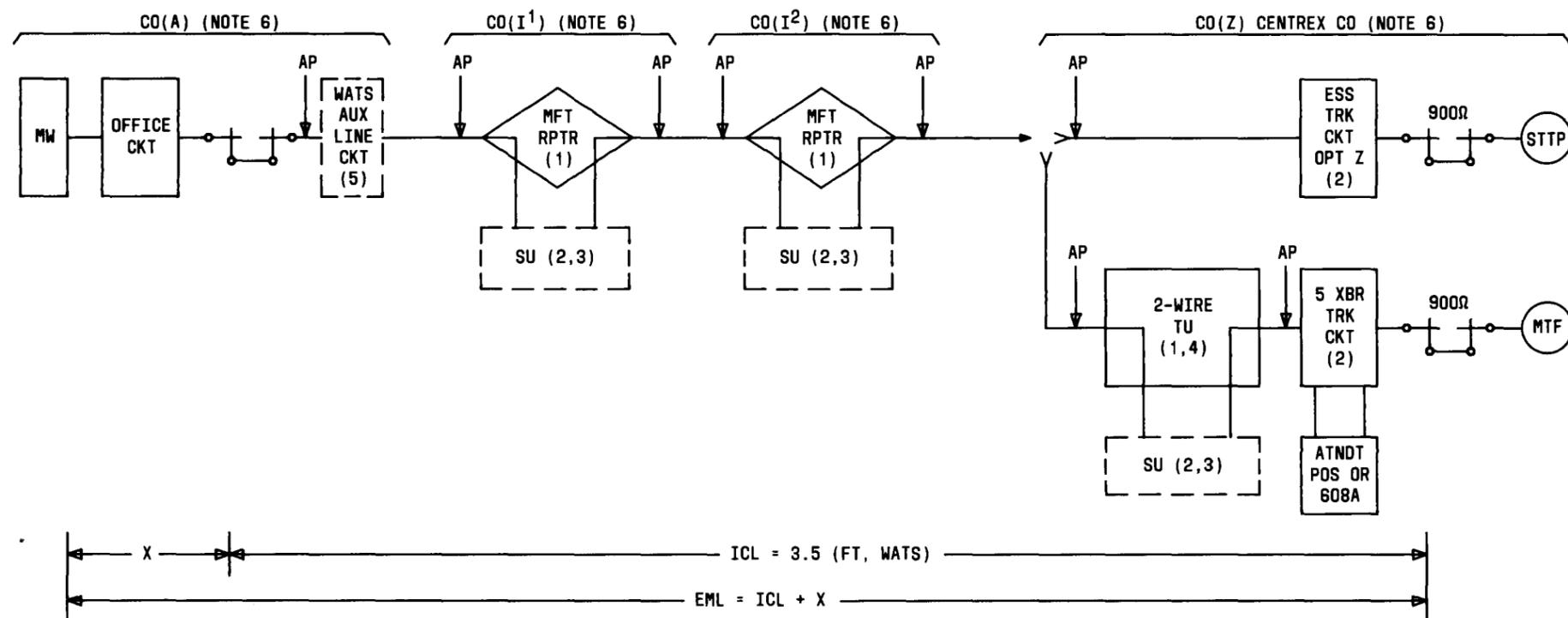
J99343FD AT CO(Z)

DX/EM = DX
 ML1 = DOWN
 ML2 = DOWN
 C BAL = $6\mu F$
 MPC = DOWN

4. AUXILIARY LINE CIRCUIT SD-99439-01 USED WITH MEASURED RATE INCOMING WATS SERVICE

5. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K

Fig. 5—Basic Design Layouts Using MFT (Sheet 4 of 7)



NOTES:

1. J99343 PA/PG AT CO(Z)
 J99343 PC/PH AT CO(I¹) OR (I²)
 SWITCH SETTINGS

WITHOUT SU	WITH SU
NOR-RV=NOR	NOR-RV=NOR(A-B), RV(B-A)
NOR-RV/T=RV/T	NOR-RV/T=NOR(A-B), RV/T(B-A)
NOR-SX SH=NOR	NOR-SX SH=NOR =SX SH(WITH LSE OR CONVERTERS)

2. CONDUCTOR RESISTANCE CO (I¹) OR (I²) ≤ 2375Ω

WITH TRUNKS SD-1A241-01, ES-26289-01
 SIGNALING UNITS

LSR-J99343AC, AF, OR MODIFIED AA

LS-GS=GS(GROUND START)

BOR: SEE SECTION 851-300-130

WITH TRUNKS SD-1A416-05, SD-2H174-01
 LSE-J99343CC, CA, CB OR CD.

(S1)NOR-REV=NOR(A-B), REV(B-A)

3. CONDUCTOR LOOP RESISTANCE CO(I¹) TO
 CO(I²) OR CO (Z) ≤ 5000Ω WITH DX UNITS.

DX TO GROUND START CONVERTERS
 J99343FC AT CO (I¹)

DX/EM	=DX
ML1	=DOWN
ML2	=DOWN
C BAL	=6 μF
MPC	=DOWN

BOR: SEE SECTION 851-300-130

J99343FD AT CO(I²), OR (Z)

DX/EM	=DX
ML1	=DOWN
ML2	=DOWN
C BAL	=6 μF
MPC	=DOWN

4. 2-WIRE TU J99343BC

A SIDE Z=900

B SIDE Z=900

NOR-REV=NOR(A-B), REV(B-A)

NOR-L1 SH=NOR

NOR-L2 SH=NOR L2 SH(WITH LSE)

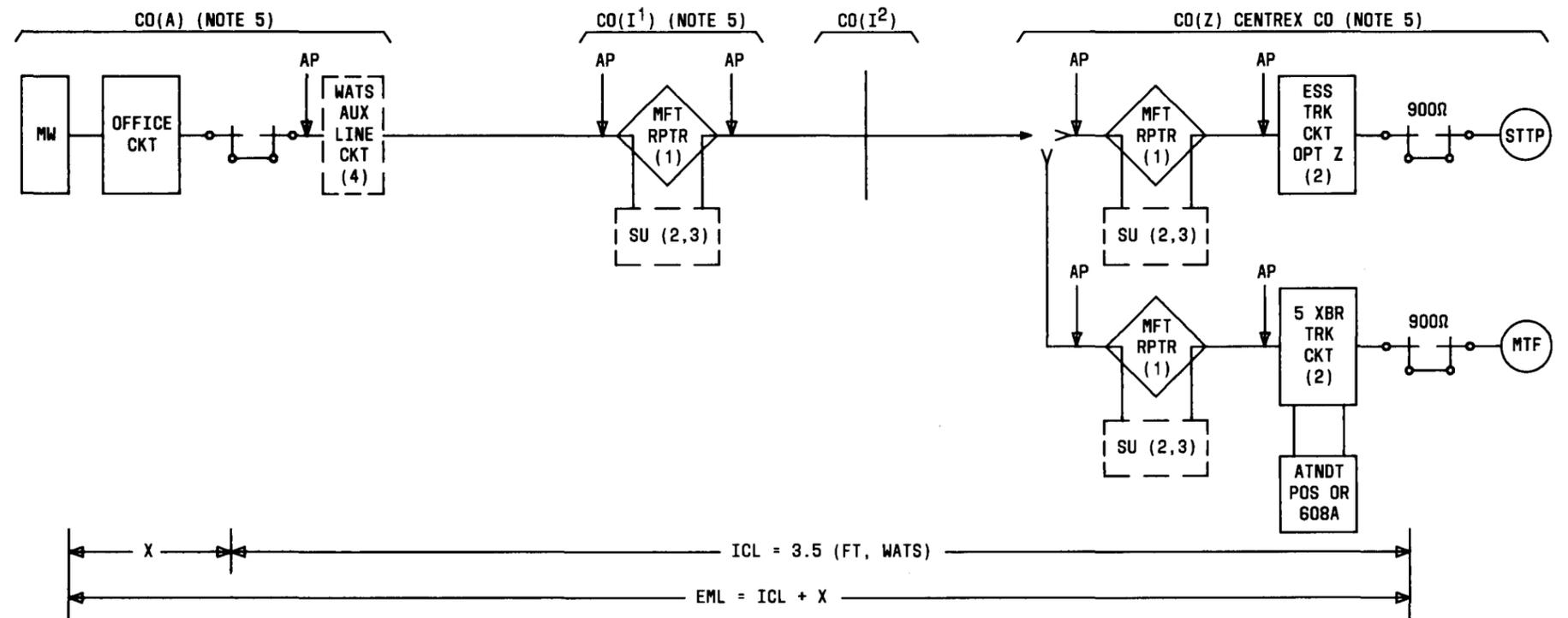
SB1=IN(BEST RETURN LOSS)

=OUT(REDUCES 1-KHZ LOSS FROM
 0.8DB TO 0.4DB)

5. AUXILIARY LINE CIRCUIT SD-99439-01
 USED WITH MEASURED RATE INCOMING
 WATS SERVICE

6. PROVIDE ACCESS POINTS (AP) AS SHOWN
 ON THE FIGURE AND SEE PART 2-K

Fig. 5—Basic Design Layouts Using MFT (Sheet 5 of 7)



NOTES:

1. J99343 PA/PG AT CO(Z)
 J99343 PC/PH AT CO(I¹) OR (I²)
 SWITCH SETTINGS

WITHOUT SU	WITH SU
NOR-RV=NOR	NOR-RV=NOR(A-B), RV(B-A)
NOR-RV/T=RV/T	NOR-RV/T=NOR(A-B), RV/T(B-A)
NOR-SX SH=NOR	NOR-SX SH=NOR =SX SH(WITH LSE OR CONVERTERS)

2. CONDUCTOR RESISTANCE CO(I) TO CO(Z) ≤ 2375Ω

WITH TRUNKS SD-1A241-01, ES-26289-01
 SIGNALING UNITS
 LSR-J99343AC, AF, OR MODIFIED AA
 LS-GS=GS (GROUND START)
 BOR: SEE SECTION 851-300-130

WITH TRUNKS SD-1A416-05, SD-2H174-01
 LSE-J99343CC, CA, CB, OR CD.
 (S1)NOR-REV=NOR(A-B), REV(B-A)

3. CONDUCTOR LOOP RESISTANCE CO(I¹) TO CO(Z) ≤ 5000Ω WITH DX UNITS.

DX TO GROUND START CONVERTERS
 J99343FC AT CO(I¹) OR (I²)

DX/EM = DX
 ML1 = DOWN
 ML2 = DOWN
 C BAL = 6 μF
 MPC = DOWN

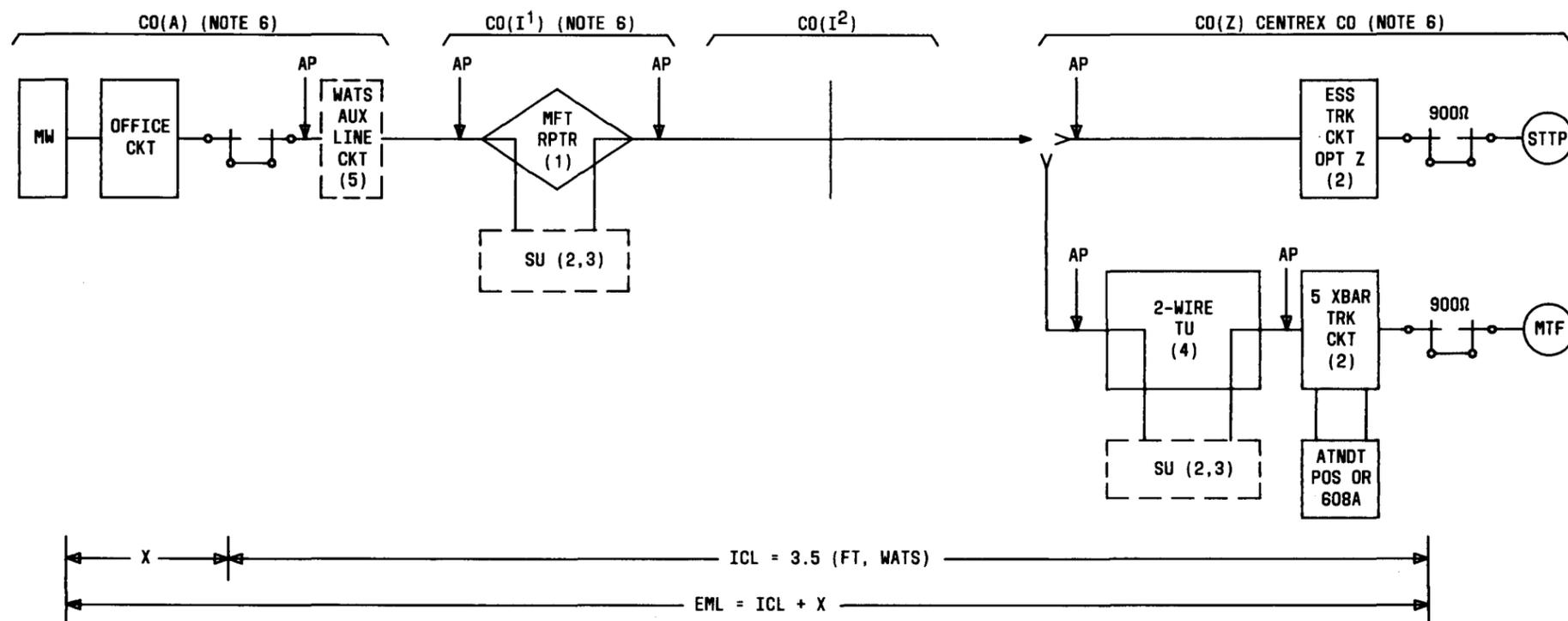
BOR: SEE SECTION 851-300-130

J99343FD AT CO(Z)

DX/EM = DX
 ML1 = DOWN
 ML2 = DOWN
 C BAL = 6 μF
 MPC = DOWN

4. AUXILIARY LINE CIRCUIT SD-99439-01 USED
 WITH MEASURED RATE INCOMING WATS SERVICE
5. PROVIDE ACCESS POINTS (AP) AS SHOWN ON
 THE FIGURE AND SEE PART 2-K

Fig. 5—Basic Design Layouts Using MFT (Sheet 6 of 7)



NOTES:

1. J99343 PC/PH AT CO(I¹) SWITCH SETTINGS

WITHOUT SU	WITH SU
NOR-RV=NOR	NOR-RV=NOR(A-B), RV(B-A)
NOR-RV/T=RV/T	NOR-RV/T=NOR(A-B), RV/T(B-A)
NOR-SX SH=NOR	NOR-SX SH=NOR, =SX SH(WITH LSE)

2. WITH TRUNKS SD-1A241-01, ES-26289-01 SIGNALING UNITS

LSR-J99343AC, AF, OR MODIFIED AA

LS-GS=GS(GROUND START)

BOR: SEE SECTION 851-300-130

WITH TRUNKS SD-1A416-05, SD-2H174-01 LSE-J99343CC, CA, CB OR CD.

(S1)NOR-REV=NOR(A-B), REV(B-A)

3. CONDUCTOR LOOP RESISTANCE CO (I¹) TO CO (Z) ≤ 5000Ω WITH CX UNITS

DX TO GROUND START CONVERTERS J99343FC AT CO(A)

DX/EM = DX
ML1 = DOWN
ML2 = DOWN
C BAL = 6 μF
MPC = DOWN

BOR: SEE SECTION 851-300-130

J99343FD AT CO (I¹), (I²) OR (Z)

DX/EM = DX
ML1 = DOWN
ML2 = DOWN
C BAL = 6 μF
MPC = DOWN

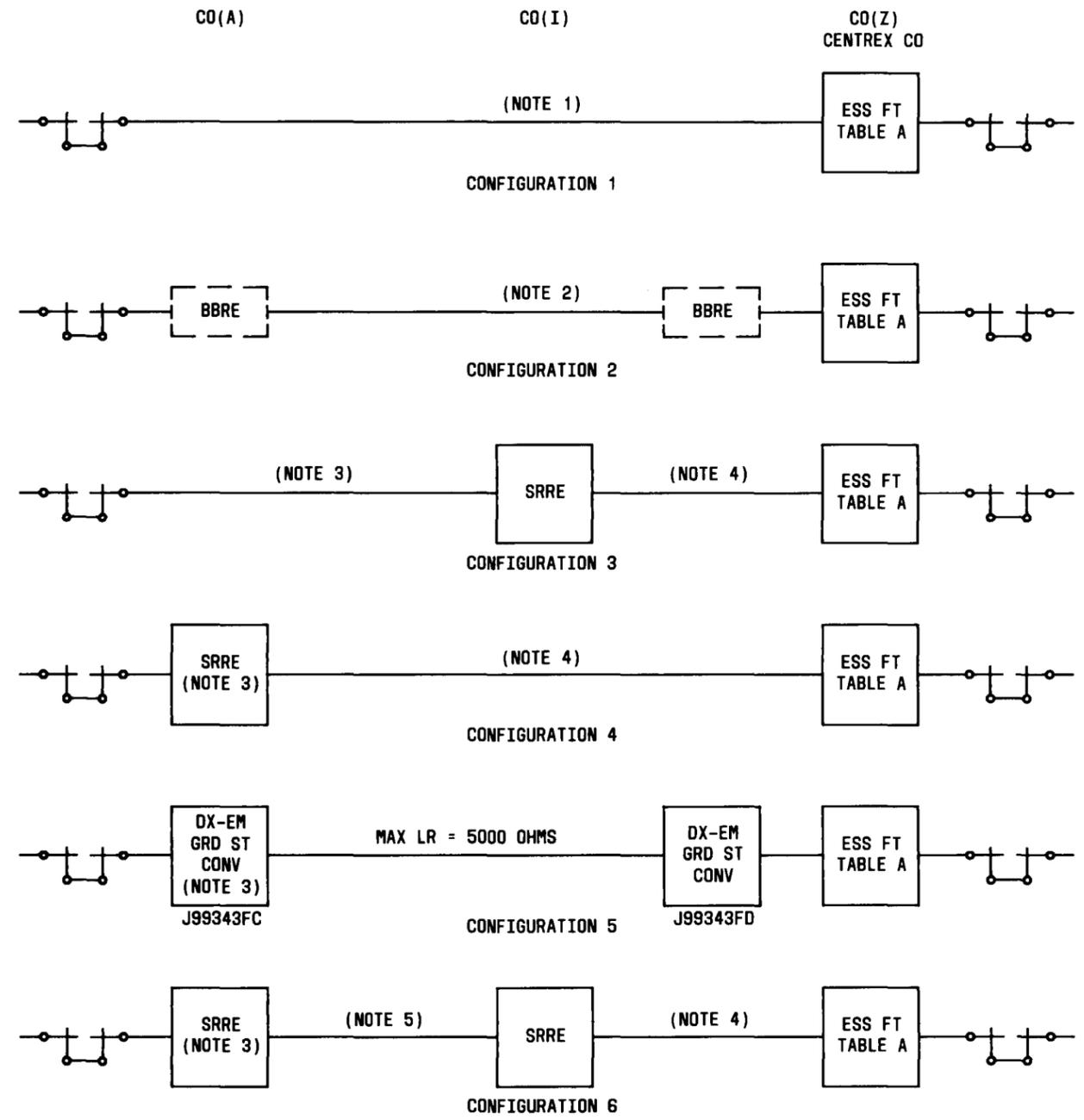
4. 2-WIRE TU J99343BC

A SIDE Z=900
B SIDE Z=900
NOR-REV=NOR(A-B), REV(B-A)
NOR-L1 SH=NOR
NOR-L2 SH=NOR L2 SH(WITH LSE)
SB1=IN(BEST RETURN LOSS)
=OUT(REDUCES 1-KHZ LOSS FROM 0.8DB TO 0.4DB)

5. AUXILIARY LINE CIRCUIT SD-99439-01 USED WITH MEASURED RATE INCOMING WATS SERVICE

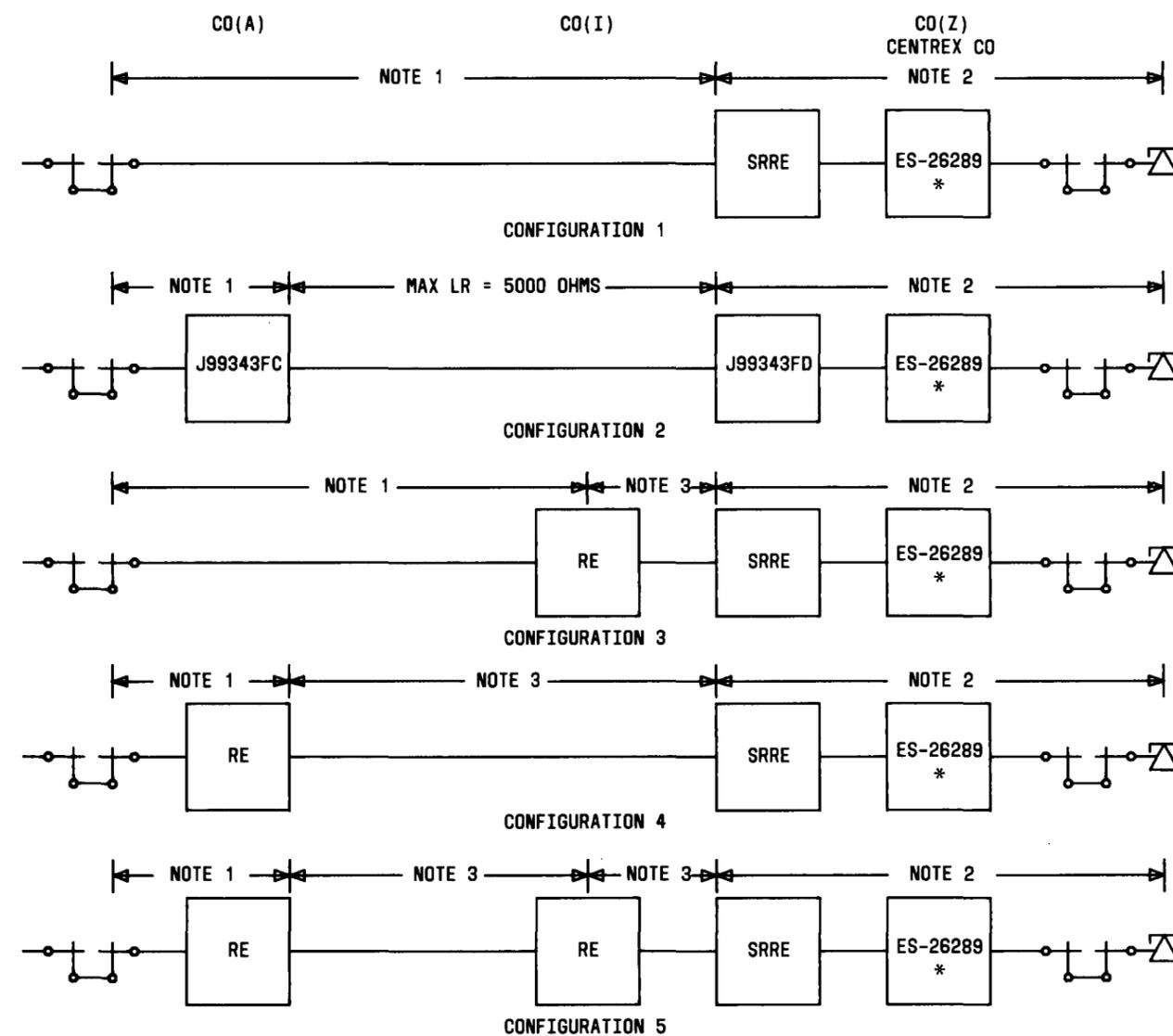
6. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K

Fig. 5—Basic Design Layouts Using MFT (Sheet 7 of 7)



- NOTES: SEE SECTION 851-300-170 FOR THE FOLLOWING TABLES
1. SWITCHING SYSTEM TO CENTREX TRUNK RANGES (48V)
 2. SWITCHING SYSTEM TO CENTREX TRUNK RANGES (72V)
 3. SWITCHING SYSTEM TO SRRE RANGES
 4. RANGE EXTENDER TO CENTREX TRUNK RANGES
 5. RANGE EXTENDER TO RANGE EXTENDER RANGES

Fig. 6—Range Extension Equipment Location and Limits for ESS Centrex FX Trunks

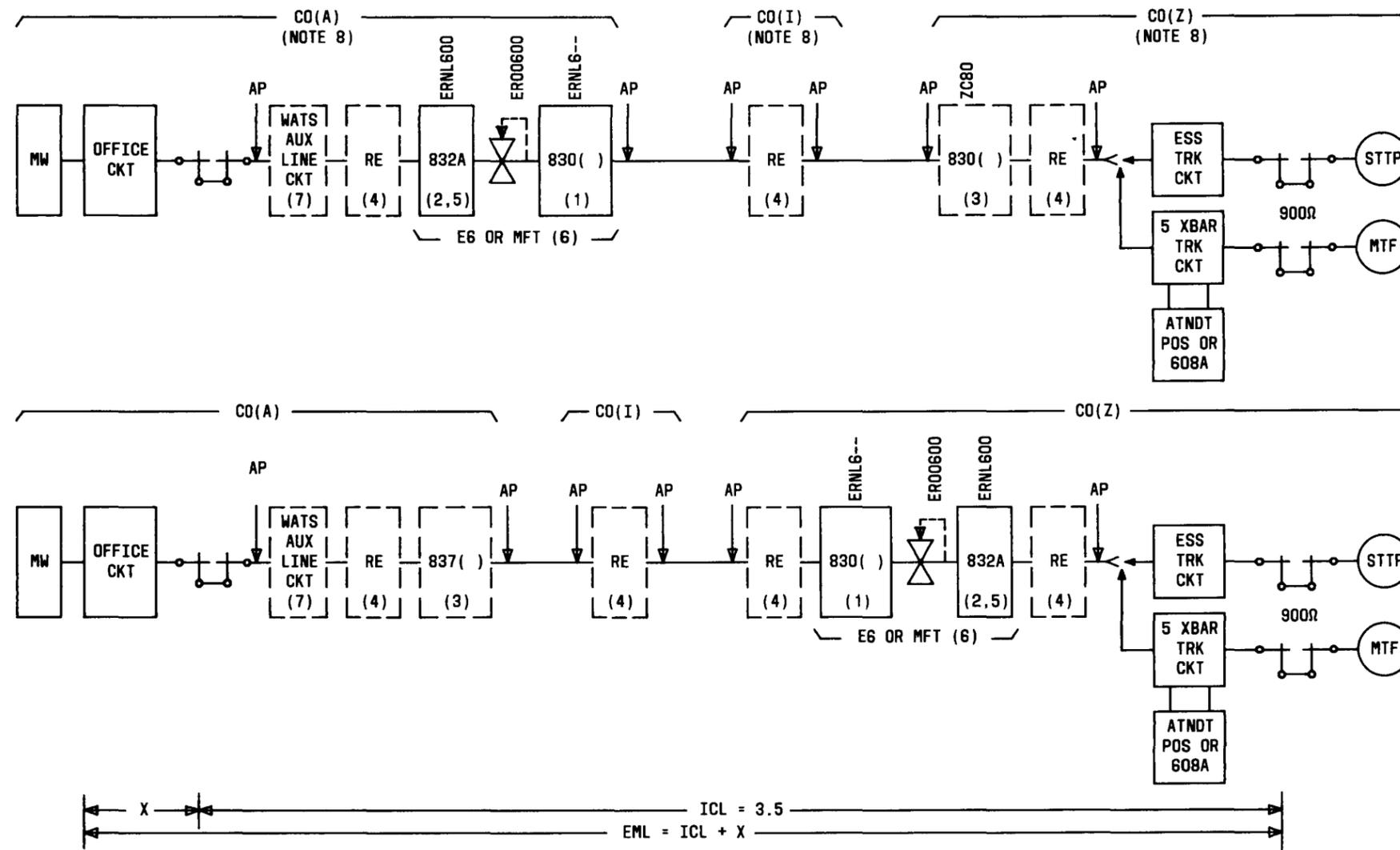


NOTES: SEE SECTION 851-300-170 FOR THE FOLLOWING TABLES

1. SWITCHING SYSTEM TO SRRE RANGES
2. SRRE TO CUSTOMER TERMINATION RANGES
3. RANGE EXTENDER TO RANGE EXTENDER RANGES

* RESISTANCE 23 OHMS WITH TOLL DIVERSION 46 OHMS PLUS 132 OHMS WITH ATTENDANT

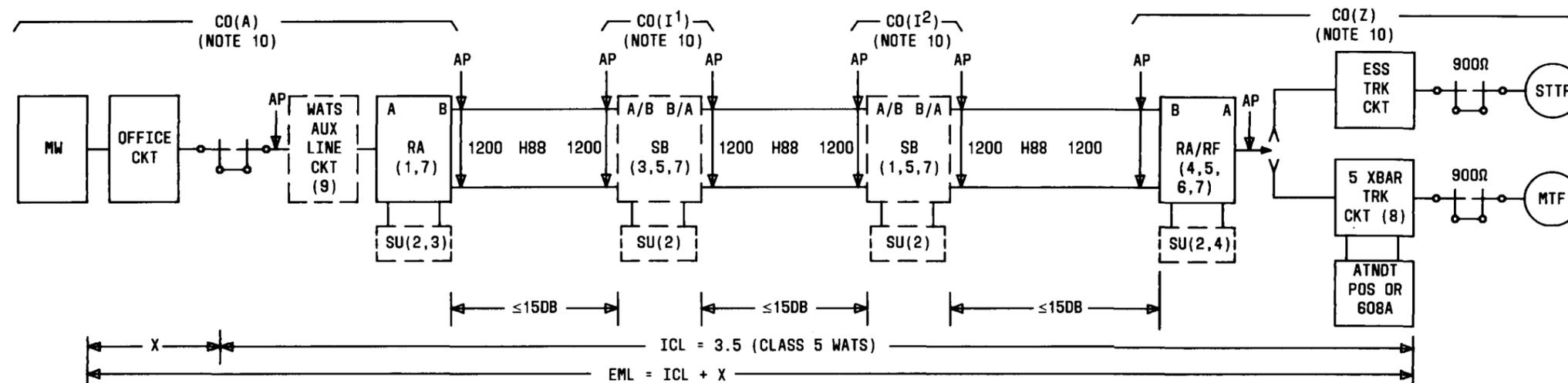
Fig. 7— Range Extension and Equipment Location for No. 5 Crossbar Centrex CO



NOTES:

1. FOR LOADED CABLES USE
 830A FOR 19-, 22-, OR 24H88 HIGH-CAPACITANCE (HC) CABLE
 830B FOR 19-, OR 24H88 LOW-CAPACITANCE (LC) CABLE
 830G FOR 26H88 CABLE
 830J FOR 25H88 CABLE
 FOR UNLOADED CABLES USE
 830C FOR LINKS WITH 837-TYPE NETWORK AT FAR END
 830E FOR LINKS WITHOUT 837-TYPE NETWORKS
2. WHERE DELAY EQUALIZATION IS REQUIRED, SPECIFY AN 830F NETWORK IN PLACE OF THE 832A NETWORK
3. WITH 837-TYPE NETWORKS, END SECTIONS PLUS BRIDGED TAP SHOULD NOT EXCEED 5KFT FOR H LOADING. WHERE NO 837-TYPE NETWORK IS USED, THE END SECTION PLUS BRIDGED TAP MAY BE INCREASED TO 6KFT. USE 837A FOR 19-, 22-, AND 24H88 OR -D88 CABLE. USE 837J FOR 25H88 AND 837G FOR 26H88. THE 837-TYPE NETWORK SHOWN IN DASHED LINES AT CO(A) AND CO(Z) IS SPECIFIED WHEN TERMINAL BALANCE IS REQUIRED AT THE CO
4. THE FOLLOWING TYPES OF DLL'S MAY BE USED:
 SD-66192-01 OR SD-66474-01
 THE 120T REPEATING COIL IS PREFERRED WITH IMPEDANCE RATIO OF 1:1. SD-96371-01 MAY BE USED AT CO(A). RANGE EXTENDER IS REQUIRED IF CENTREX IS NO. 5 CROSSBAR
5. THE E6RE(MD) OR THE NEWER E6B BATTERY-BOOST RANGE EXTENDERS MAY BE USED WHERE THE 832A (DUMMY) NETWORK IS SHOWN. RANGES UP TO 2400 OHMS (23 MA) ARE PROVIDED WITH A MAXIMUM LOOP CURRENT OF 40 MA. REPEATER DISABLING IS PROVIDED. DO NOT OPERATE IN TANDEM WITH OTHER SIGNALING UNITS OPERATING AT -72 VOLTS. TANDEM OPERATION WITH -48 VOLT SIGNALING UNITS IS SATISFACTORY. INTRODUCES 0.2-DB LOSS AT 1KHZ. REFER TO SECTIONS 332-206-129 (E6RE) AND 332-206-130 (E6B)
6. MFT J99343 PA/PG REPEATERS MAY BE SUBSTITUTED
7. AUXILIARY LINE CIRCUIT SD-99439-01 USED WITH MEASURED RATE INCOMING WATS SERVICE
8. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K

Fig. 8—E6 Design for 2-Wire FX Centrex Trunks



NOTES:

1. RA REPEATER AT CO(A)

HYB 1, 2 = 900
 S1, S4 = IN (1.06μF)
 NOR-SX SH = NOR
 NOR-SX RV = NOR, SX RV (SU AT CO I OR CO Z)
 NOR-RV = NOR
 OUT = 1200
 NOR-RV/T = NOR (WITH SU), RV/T (WITHOUT SU)

2. CONDUCTOR LOOP RESISTANCE ≤2375 OHMS

A. WITH TRUNKS SD-1A241-01, ES-26289-01

SIGNALING UNIT TYPES:
 LSR - J99343AC, AF OR MODIFIED AA

LS-GS = GS (GROUND START)
 BOR = SEE SECTION 851-300-130

B. WITH TRUNKS SD-1A416-01, SD-2H174-01

LSE - J99343CA, CC, (CB, CD TOLL DIVERSION)
 (S1) NOR-REV = NOR (A,B), REV (B-A)

LS-GS CONVERTER - J99343AE (AT CO A)
 S1 THROUGH S12 = SEE SECTION 332-911-201
 REFER TO FIG.

3. CONDUCTOR LOOP RESISTANCE ≤5000 OHMS
 CO(A) TO CO(Z)

DX-GS CONVERTER J99343FC AT CO(A)
 DX/EM = DX
 ML1 = DOWN
 ML2 = DOWN
 C BAL = 5 μF
 MPC = DOWN

4. CONDUCTOR LOOP RESISTANCE ≤5000 OHMS
 CO(A) TO CO(Z)

DX-GS CONVERTER J99343FD AT CO(Z)
 DX/EM = DX
 ML1 = DOWN
 ML2 = DOWN
 C BAL = 5 μF
 MPC = DOWN

5. SB REPEATER AT CO(I¹) OR CO(I²)

SWITCH	A-B	B-A
IN	1200	1200
OUT	1200	1200
NOR-RV (NO SU)	RV	NOR
NOR-RV (WITH SU)	NOR	*
NOR-RV/T (NO SU)	NOR	RV/T
NOR-RV/T (WITH SU)	NOR	*

REFER TO FIGS. 6 & 7 FOR SIGNALING UNIT LOCATIONS
 * INCOMPATIBLE WITH SU AT CO(Z)

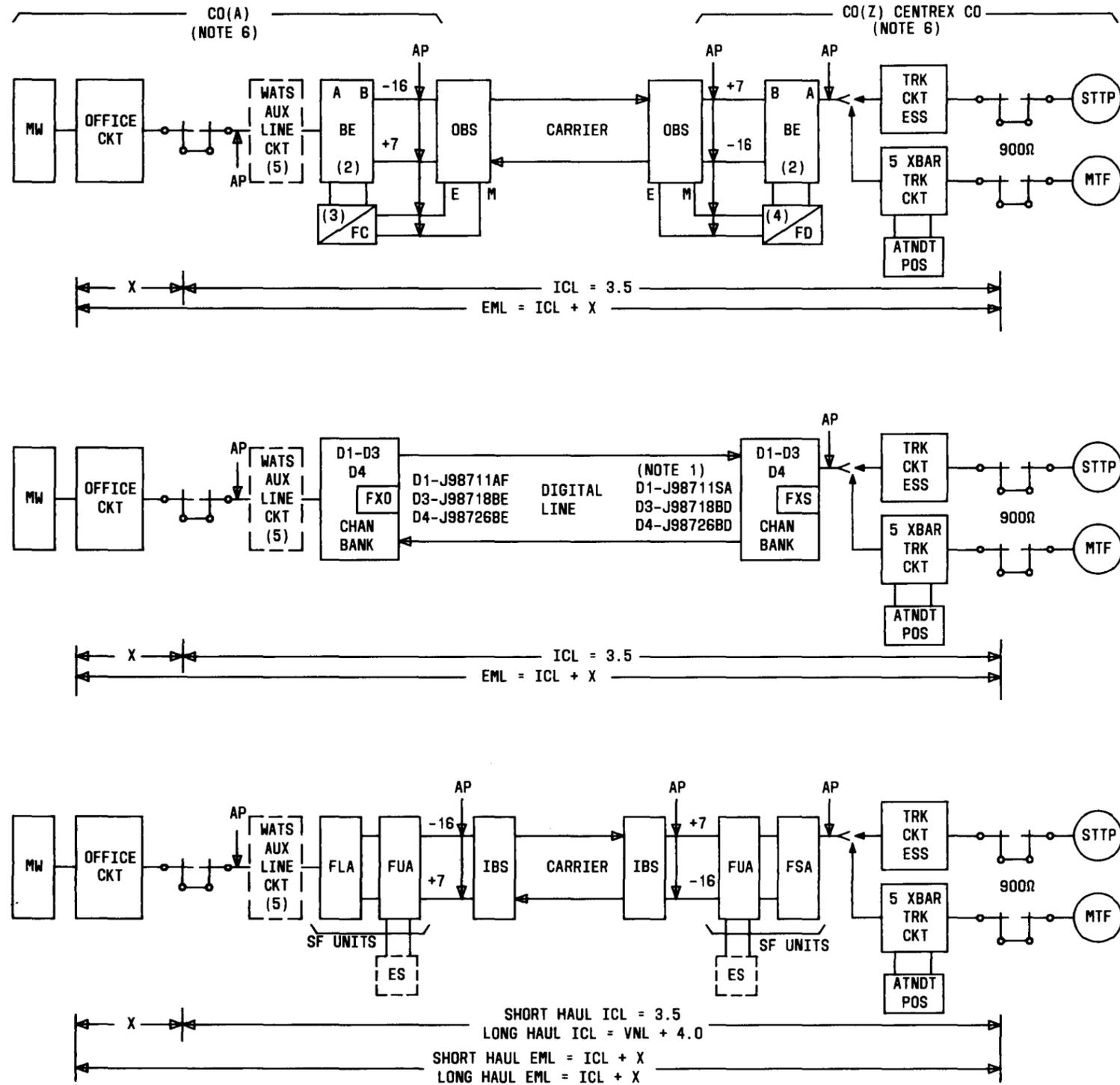
6. RA/RF REPEATER AT CO(Z)

HYB 1, 2 = 900
 S1, S4 = IN (1.06 μF)
 NOR-SX SH = NOR
 NOR-SX RV = NOR (SU AT CO I OR CO Z)
 SX RV (OTHERWISE)
 NOR-RV = RV (WITH SU), NOR (NO SU)
 NOR-RV/T = RV/T
 OUT = 1200 (H88)

7. V4 SUBSTITUTIONS: A 44V4 MAY BE SUBSTITUTED FOR A 4-4MFT AT CO(I) WITH A LOADED CO(I¹) TO CO(I²) LINK. USE 359A EQUALIZERS PER V4 DESIGN RULES. WITH A NONLOADED CO(I²) TO CO(Z) LINK, USE 359F OR B ON THE NONLOADED SIDE AND AN RF TYPE REPEATER AT CO(Z). A 24V4 MAY BE SUBSTITUTED AT EITHER END IF 359A (LOADED) OR 359F OR B (NONLOADED) EQUALIZERS ARE USED. THE REPEATER AT CO(Z) MUST PRE-EQUALIZE FOR NONLOADED CABLE IN THIS CASE

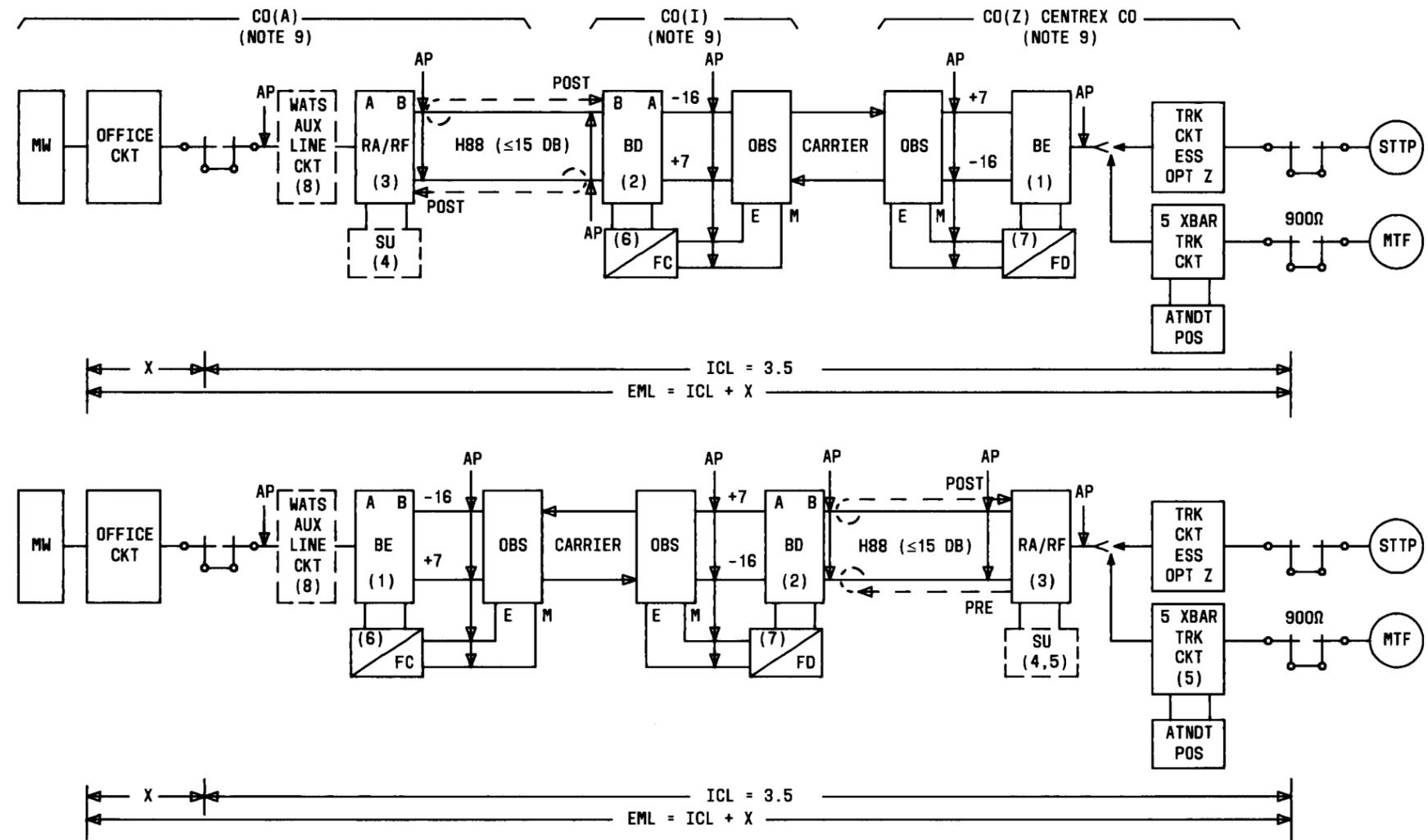
8. SU REQUIRED WHEN CENTREX IS NO. 5 CROSSBAR AND TRUNK CIRCUIT ES-26289-01 IS USED
9. AUXILIARY LINE CIRCUIT SD-99439-01 USED WHEN MEASURED RATE INCOMING WATS SERVICE
10. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K

Fig. 9—MFT Design for 4-Wire FX Trunks Using Metallic Layouts



- NOTES:
1. WHEN D1 FXD AND FXS CHANNEL UNITS ARE USED, A 2-DB PAD (SD-95756-01) MUST BE USED AT THE CENTREX CO TO LINE UP CIRCUIT TO AN ICL OF 3.5
 2. MFT J99343BE TERM SET
 CO A (A-B) CO Z (B-A)
 S1 = IN IN
 S2,S3 = OUT OUT
 SXSH = NOR NOR
 SXRV = NOR NOR
 RV = NOR RV
 RV/T = NOR RV/T
 3. EM/DX TO GS CONVERTER J99343FC AT CO (A)
 DX/EM = EM
 ML1/ML2 = DOWN
 C BAL S6 = DOWN
 S7 = UP
 S8 = DOWN
 MPC = DOWN
 BOR (SEE SECTION 851-300-130)
 4. EM/DX TO GS CONVERTER J99343FD AT CO (Z)
 DX/EM = EM
 ML1/ML2 = DOWN
 C BAL S6 = DOWN
 S7 = UP
 S8 = DOWN
 MPC = DOWN
 5. AUXILIARY LINE CIRCUIT SD-99439-01 USED WITH MESSAGE RATE INCOMING WATS SERVICE
 6. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K

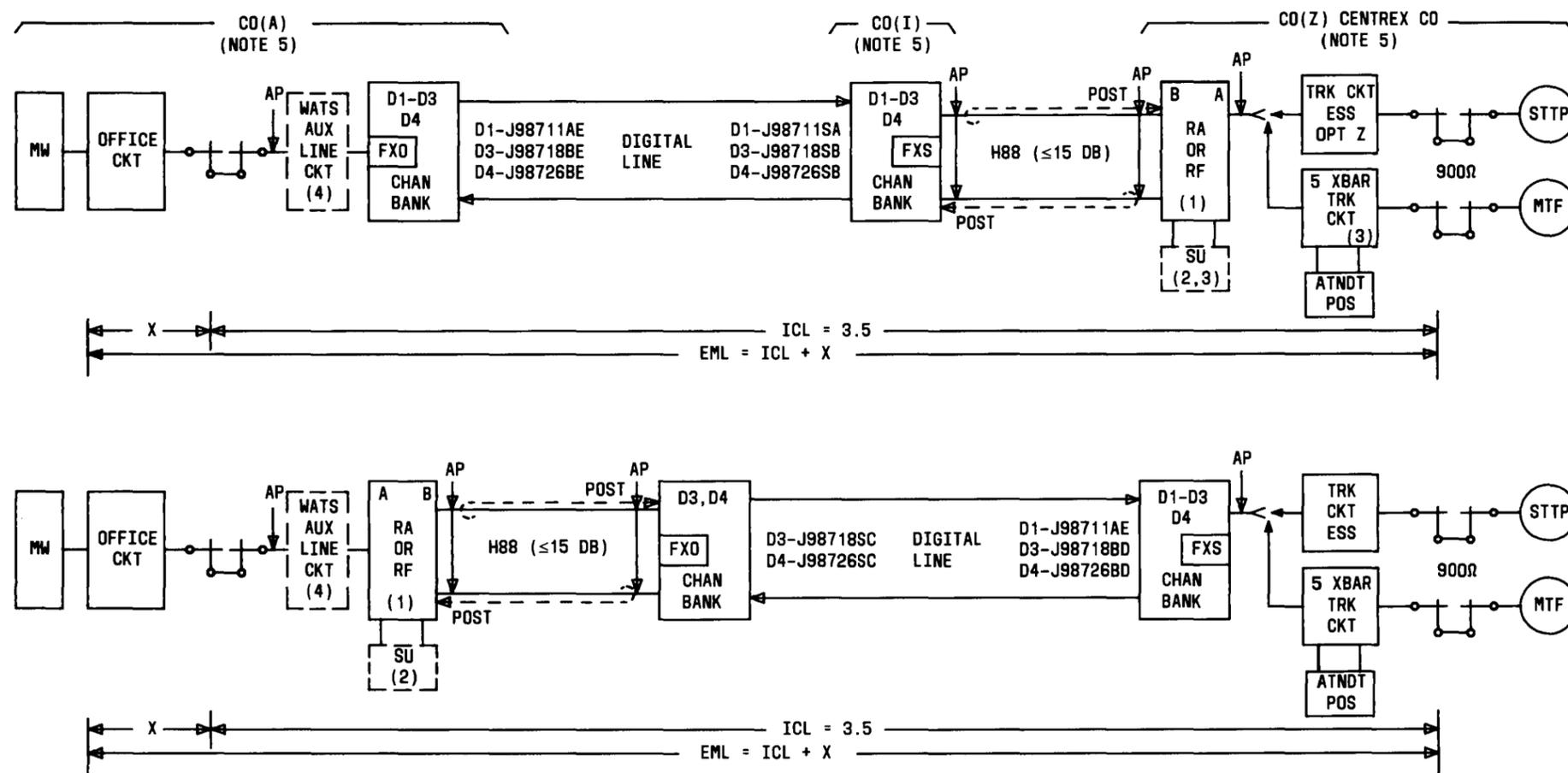
Fig. 11—MFT Design Using 4-Wire Metallic and Carrier Facilities for MFT Trunks (Sheet 1 of 7)



NOTES:

- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|----------------------------|------------|---------|----|-------------|-----|------------|-----|------------|-----|----------|----|------------|------|--------------|--------------|------------|---|------------|------------|------------|----|-------------|-----|--------------------|----------|------------|-----|------------|----------------------------|----------|--------------------------|-----------------------|----------------|--|--------------------------|------------------------------------|---------------------------|----------------------------|--------------------------|------------------------------------|--|--|------------|----------------|-----------------|---------|-----------|------------|---|------------|----------------|-----------------|---------|-----------|------------|
| <p>1. MFT J99343BE TERM SET</p> <table border="0"> <tr> <td>CO A (A-B)</td> <td>CO Z (B-A)</td> </tr> <tr> <td>S1 = IN</td> <td>IN</td> </tr> <tr> <td>S2,S3 = OUT</td> <td>OUT</td> </tr> <tr> <td>SXSH = NOR</td> <td>NOR</td> </tr> <tr> <td>SXRV = NOR</td> <td>NOR</td> </tr> <tr> <td>RV = NOR</td> <td>RV</td> </tr> <tr> <td>RV/T = NOR</td> <td>RV/T</td> </tr> </table> <p>2. MFT J99343BD 4-WIRE TU</p> <table border="0"> <tr> <td>EXT SX = NOR</td> </tr> <tr> <td>SX REV = NOR</td> </tr> <tr> <td>OUT = 1200</td> </tr> </table> | CO A (A-B) | CO Z (B-A) | S1 = IN | IN | S2,S3 = OUT | OUT | SXSH = NOR | NOR | SXRV = NOR | NOR | RV = NOR | RV | RV/T = NOR | RV/T | EXT SX = NOR | SX REV = NOR | OUT = 1200 | <p>3. MFT J99343RA/RF REPEATER SETTINGS</p> <table border="0"> <tr> <td>CO A (A-B)</td> <td>CO Z (B-A)</td> </tr> <tr> <td>S1,S4 = IN</td> <td>IN</td> </tr> <tr> <td>S2,S3 = OUT</td> <td>OUT</td> </tr> <tr> <td>HYB 1,2 = 900 OHMS</td> <td>900 OHMS</td> </tr> <tr> <td>SXSH = NOR</td> <td>NOR</td> </tr> <tr> <td>SXRV = NOR</td> <td>RV (WITH SU) OTHERWISE NOR</td> </tr> <tr> <td>RV = NOR</td> <td>RV (WITH SU) NOR (NO SU)</td> </tr> <tr> <td>RV/RT = NOR (WITH SU)</td> <td>RV/T (WITH SU)</td> </tr> <tr> <td></td> <td>RV/T (NO SU) NOR (NO SU)</td> </tr> </table> <p>4. SIGNALING UNITS TYPES</p> <table border="0"> <tr> <td>LSR = J99343AC, AF, OR MODIFIED AA</td> </tr> <tr> <td>LS/GS = GS (GROUND START)</td> </tr> <tr> <td>LSE = J99343CA, CC, CB, CD</td> </tr> <tr> <td>(S1) NOR-(A-B) REV (B-A)</td> </tr> <tr> <td>LS-GS CONVERTER J99343AE (AT CO A)</td> </tr> <tr> <td>S1 THROUGH S12 SEE SECTION 332-911-101</td> </tr> </table> | CO A (A-B) | CO Z (B-A) | S1,S4 = IN | IN | S2,S3 = OUT | OUT | HYB 1,2 = 900 OHMS | 900 OHMS | SXSH = NOR | NOR | SXRV = NOR | RV (WITH SU) OTHERWISE NOR | RV = NOR | RV (WITH SU) NOR (NO SU) | RV/RT = NOR (WITH SU) | RV/T (WITH SU) | | RV/T (NO SU) NOR (NO SU) | LSR = J99343AC, AF, OR MODIFIED AA | LS/GS = GS (GROUND START) | LSE = J99343CA, CC, CB, CD | (S1) NOR-(A-B) REV (B-A) | LS-GS CONVERTER J99343AE (AT CO A) | S1 THROUGH S12 SEE SECTION 332-911-101 | <p>5. LSR SU IS REQUIRED WHEN CENTREX IS A NO. 5 CROSSBAR WITH TRUNK ES-26289-01. USE J99343AF FOR TOLL RESTRICTION</p> <p>6. EM/DX TO GS CONVERTER J99343FC AT CO</p> <table border="0"> <tr> <td>DX/EM = EM</td> </tr> <tr> <td>ML1/ML2 = DOWN</td> </tr> <tr> <td>C BAL S6 = DOWN</td> </tr> <tr> <td>S7 = UP</td> </tr> <tr> <td>S8 = DOWN</td> </tr> <tr> <td>MPC = DOWN</td> </tr> </table> <p>BOR SEE SECTION 851-300-130</p> | DX/EM = EM | ML1/ML2 = DOWN | C BAL S6 = DOWN | S7 = UP | S8 = DOWN | MPC = DOWN | <p>7. EM/DX TO GS CONVERTER J99343FD AT CO</p> <table border="0"> <tr> <td>DX/EM = EM</td> </tr> <tr> <td>ML1/ML2 = DOWN</td> </tr> <tr> <td>C BAL S6 = DOWN</td> </tr> <tr> <td>S7 = UP</td> </tr> <tr> <td>S8 = DOWN</td> </tr> <tr> <td>MPC = DOWN</td> </tr> </table> <p>8. AUXILIARY LINE CIRCUIT SD-99439-01 USED WHEN MEASURED RATE INCOMING WATS SERVICE</p> <p>9. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K</p> | DX/EM = EM | ML1/ML2 = DOWN | C BAL S6 = DOWN | S7 = UP | S8 = DOWN | MPC = DOWN |
| CO A (A-B) | CO Z (B-A) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 = IN | IN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S2,S3 = OUT | OUT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SXSH = NOR | NOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SXRV = NOR | NOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| RV = NOR | RV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| RV/T = NOR | RV/T | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EXT SX = NOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SX REV = NOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OUT = 1200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO A (A-B) | CO Z (B-A) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1,S4 = IN | IN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S2,S3 = OUT | OUT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HYB 1,2 = 900 OHMS | 900 OHMS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SXSH = NOR | NOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SXRV = NOR | RV (WITH SU) OTHERWISE NOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| RV = NOR | RV (WITH SU) NOR (NO SU) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| RV/RT = NOR (WITH SU) | RV/T (WITH SU) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | RV/T (NO SU) NOR (NO SU) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LSR = J99343AC, AF, OR MODIFIED AA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LS/GS = GS (GROUND START) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LSE = J99343CA, CC, CB, CD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (S1) NOR-(A-B) REV (B-A) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LS-GS CONVERTER J99343AE (AT CO A) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 THROUGH S12 SEE SECTION 332-911-101 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DX/EM = EM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ML1/ML2 = DOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C BAL S6 = DOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S7 = UP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S8 = DOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MPC = DOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DX/EM = EM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ML1/ML2 = DOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C BAL S6 = DOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S7 = UP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S8 = DOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MPC = DOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Fig. 11—MFT Design Using 4-Wire Metallic and Carrier Facilities for MFT Trunks (Sheet 2 of 7)



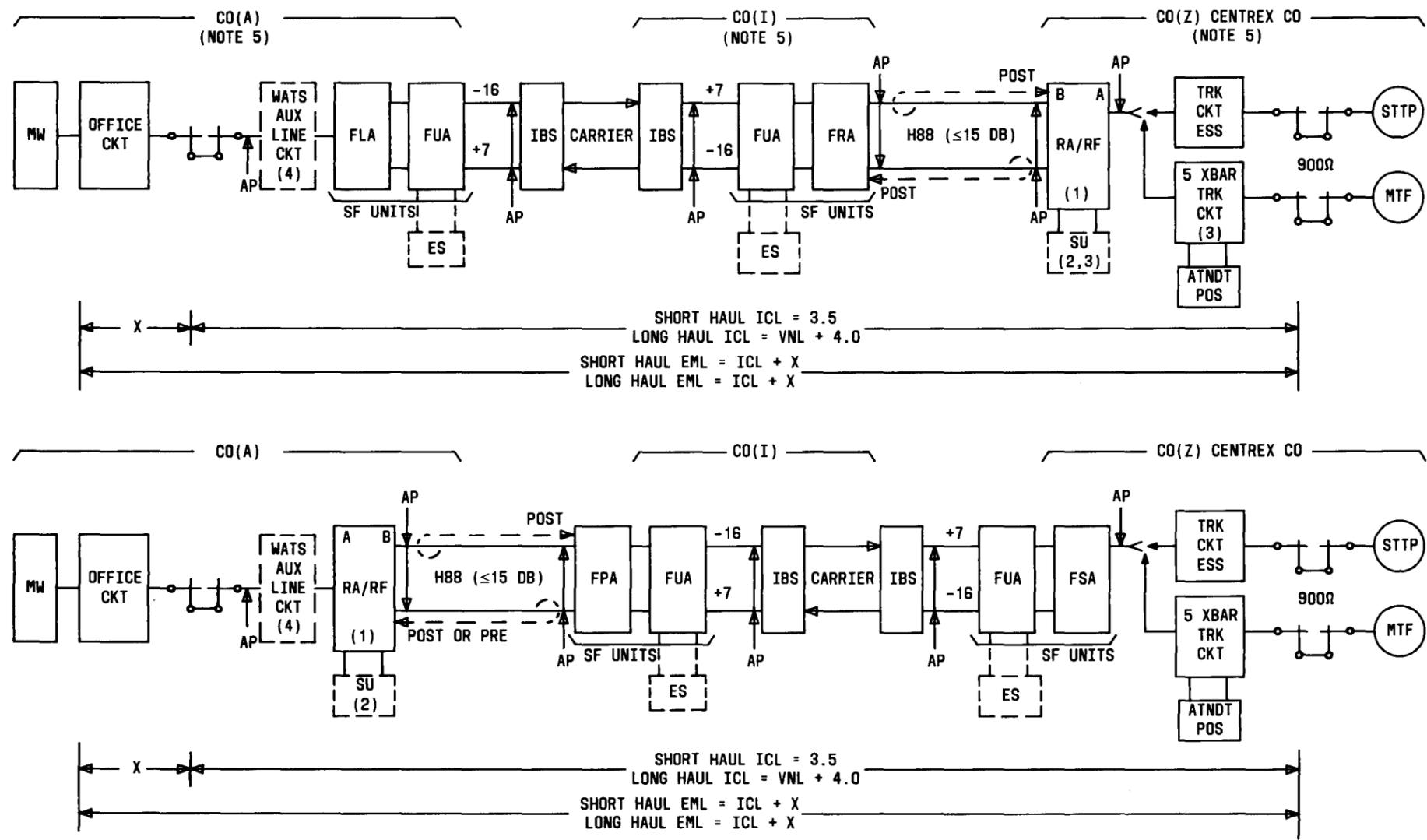
NOTES:

1. MFT J99343RA/RF REPEATER SETTINGS

CO A (A-B)	CO Z (B-A)
S1, S4 = IN	IN
S2, S3 = OUT	OUT
HYB 1, 2 = 900 OHMS	900 OHMS
SXSH = NOR	NOR
SXRV = NOR	NOR
RV = NOR	RV (WITH SU) NOR (NO SU)
RV/T = NOR (WITH SU)	RV/T (WITH SU)
RV/T (NO SU)	NOR (NO SU)
2. SIGNALING UNITS TYPES

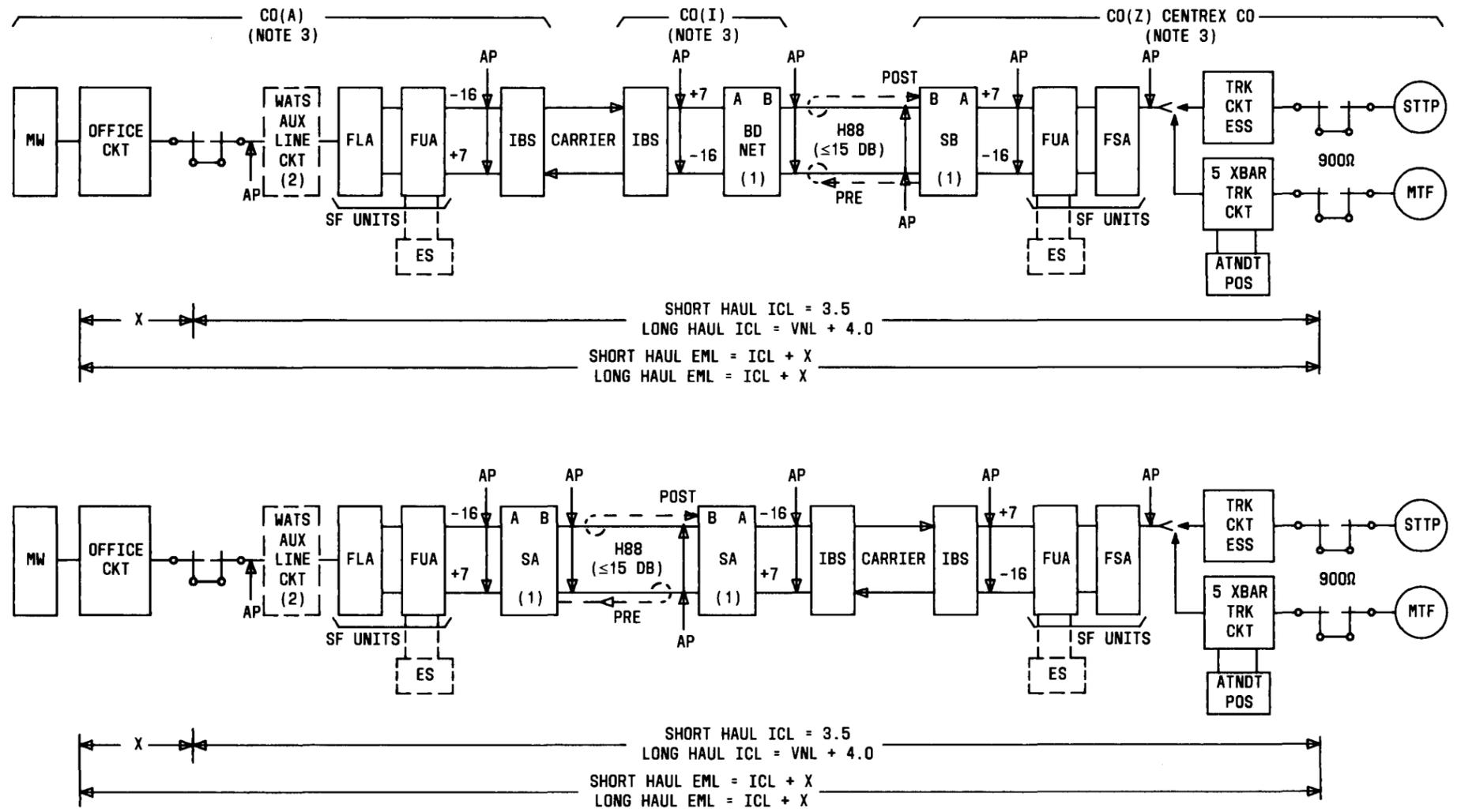
LSR = J99343AC, AF, OR MODIFIED AA
 LS/GS = GS (GROUND START)
 LSE = J99343CA, CC, CB, CD
 (S1) NOR-(A-B) REV (B-A)
 LS-GS CONVERTER J99343AE (AT CO A)
 S1 THROUGH S12 SEE SECTION 332-911-101
3. LSR SU IS REQUIRED WHEN CENTREX IS A NO. 5 CROSSBAR WITH TRUNK ES-26289-01. USE J99343AF FOR TOLL RESTRICTION
4. AUXILIARY LINE CIRCUIT SD-99439-01 USED WITH MESSAGE RATE INCOMING WATS SERVICE
5. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K

Fig. 11—MFT Design Using 4-Wire Metallic and Carrier Facilities for MFT Trunks (Sheet 3 of 7)



- NOTES:
- | | | | |
|--------------------------------------|--------------------------|--|---------------------------|
| 1. MFT J99343RA/RF REPEATER SETTINGS | | 2. SIGNALING UNITS TYPES | 4. AUXILIARY LINE CIRCUIT |
| CO A (A-B) | CO Z (B-A) | LSR = J99343AC, AF, OR MODIFIED AA | SD-99439-01 USED WITH |
| S1,S4 = IN | IN | LS/GS = GS (GROUND START) | MESSAGE RATE INCOMING |
| S2,S3 = OUT | OUT | LSE = J99343CA, CC, CB, CD | WATS SERVICE |
| HYB 1,2 = 900 OHMS | 900 OHMS | (S1) NOR-(A-B) REV (B-A) | 5. PROVIDE ACCESS POINTS |
| SXSH = NOR | NOR | LS-GS CONVERTER J99343AE (AT CO A) | (AP) AS SHOWN ON THE |
| SXRV = NOR | NOR | S1 THROUGH S12 SEE SECTION 332-911-101 | FIGURE AND SEE PART 2-K |
| RV = NOR | RV (WITH SU) NOR (NO SU) | 3. LSR SU IS REQUIRED WHEN CENTREX | |
| RV/T = NOR (WITH SU) | RV/T (WITH SU) | IS A NO. 5 CROSSBAR WITH TRUNK | |
| RV/T (NO SU) | RV/T (NO SU) | ES-26289-01. USE J99343AF FOR | |
| | | TOLL RESTRICTION | |

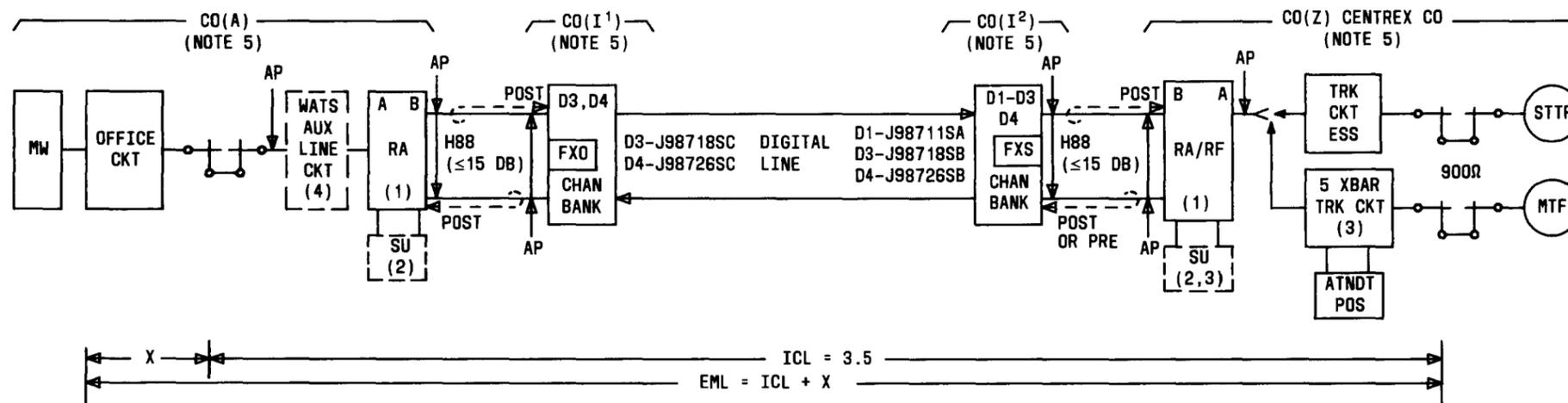
Fig. 11—MFT Design Using 4-Wire Metallic and Carrier Facilities for MFT Trunks (Sheet 4 of 7)



NOTES:

1. V4 SUBSTITUTIONS:
 A 44V4 MAY BE SUBSTITUTED AT CO (A),
 CO (I) OR CO (Z) WITH 359A EQUALIZERS
 SET ACCORDING TO V4 DESIGN RULES
2. AUXILIARY LINE CIRCUIT SD-99439-01 USED WHEN
 MEASURED RATE INCOMING WATS SERVICE
3. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE
 FIGURE AND SEE PART 2-K

Fig. 11—MFT Design Using 4-Wire Metallic and Carrier Facilities for MFT Trunks (Sheet 5 of 7)



NOTES:

1. MFT J99343RA/RF REPEATER SETTINGS

CO A (A-B)	CO Z (B-A)
S1, S4 = IN	IN
S2, S3 = OUT	OUT
HYB 1, 2 = 900 OHMS	900 OHMS
SXSH = NOR	NOR
SXRV = NOR	NOR
RV = NOR	RV (WITH SU) NOR (NO SU)
RV/T = NOR (WITH SU)	RV/T (WITH SU)
RV/T (NO SU)	NOR (NO SU)

2. SIGNALING UNITS TYPES

LSR = J99343AC, AF, OR MODIFIED AA
 LS/GS = GS (GROUND START)
 LSE = J99343CA, CC, CB, CD
 (S1) NOR-(A-B) REV (B-A)
 LS-GS CONVERTER J99343AE (AT CO A)
 S1 THROUGH S12 SEE SECTION 332-911-101

3. LSR SU IS REQUIRED WHEN CENTREX

IS A NO. 5 CROSSBAR WITH TRUNK
 ES-26289-01. USE J99343AF FOR
 TOLL RESTRICTION

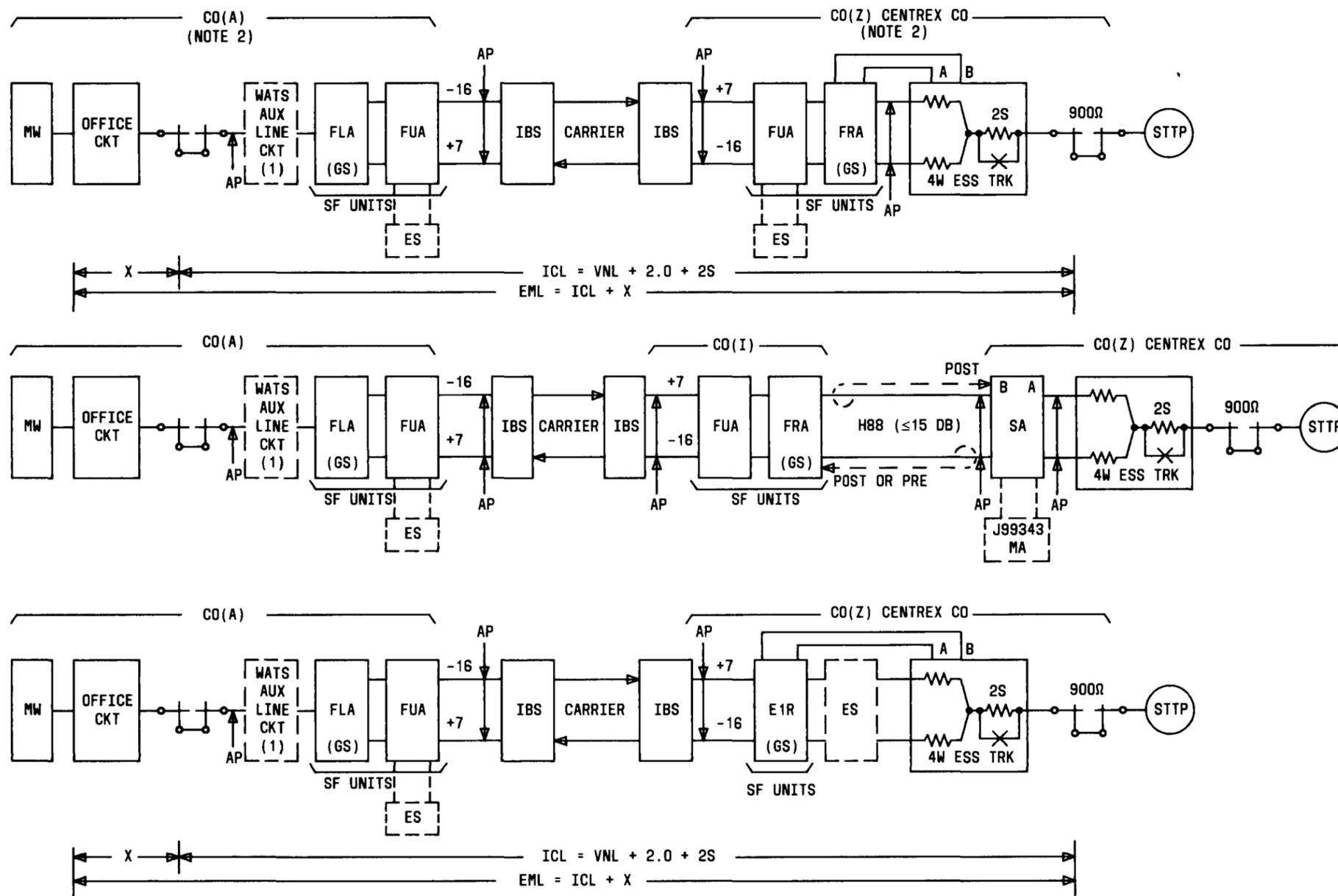
4. AUXILIARY LINE CIRCUIT

SD-99439-01 USED WITH
 MESSAGE RATE INCOMING
 WATS SERVICE

5. PROVIDE ACCESS POINTS

(AP) AS SHOWN ON THE
 FIGURE AND SEE PART 2-K

Fig. 11—MFT Design Using 4-Wire Metallic and Carrier Facilities for MFT Trunks (Sheet 7 of 7)



NOTES:

1. AUXILIARY LINE CIRCUIT SD-99439-01 USED WITH MEASURED RATE INCOMING WATS SERVICE
2. PROVIDE ACCESS POINTS (AP) AS SHOWN ON THE FIGURE AND SEE PART 2-K

Fig. 12—VNL Design Long-Haul FX Trunks With Switchable 2-dB Pads (Sheet 1 of 2)

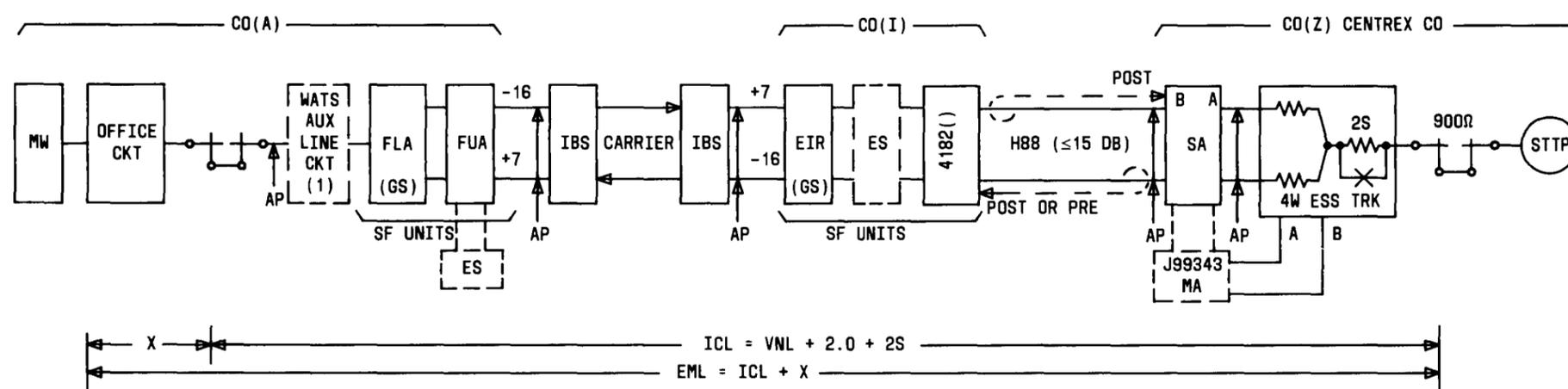
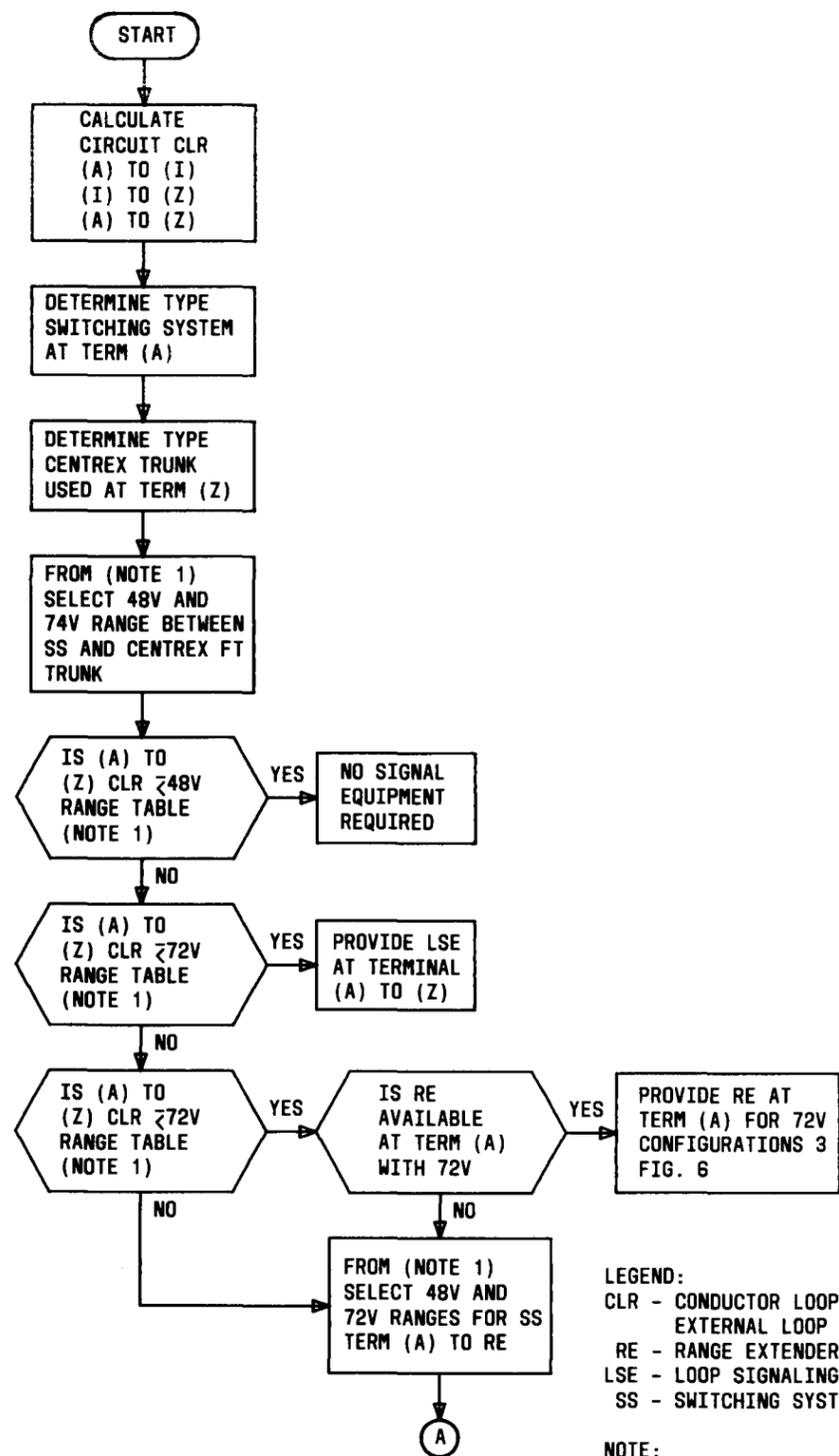


Fig. 12—VNL Design Long-Haul FX Trunks With Switchable 2-dB Pads (Sheet 2 of 2)



LEGEND:
 CLR - CONDUCTOR LOOP RESISTANCE OF
 EXTERNAL LOOP AND EQUIPMENT
 RE - RANGE EXTENDER
 LSE - LOOP SIGNALING EXTENDER
 SS - SWITCHING SYSTEM

NOTE:
 1. SEE SECTION 851-300-170

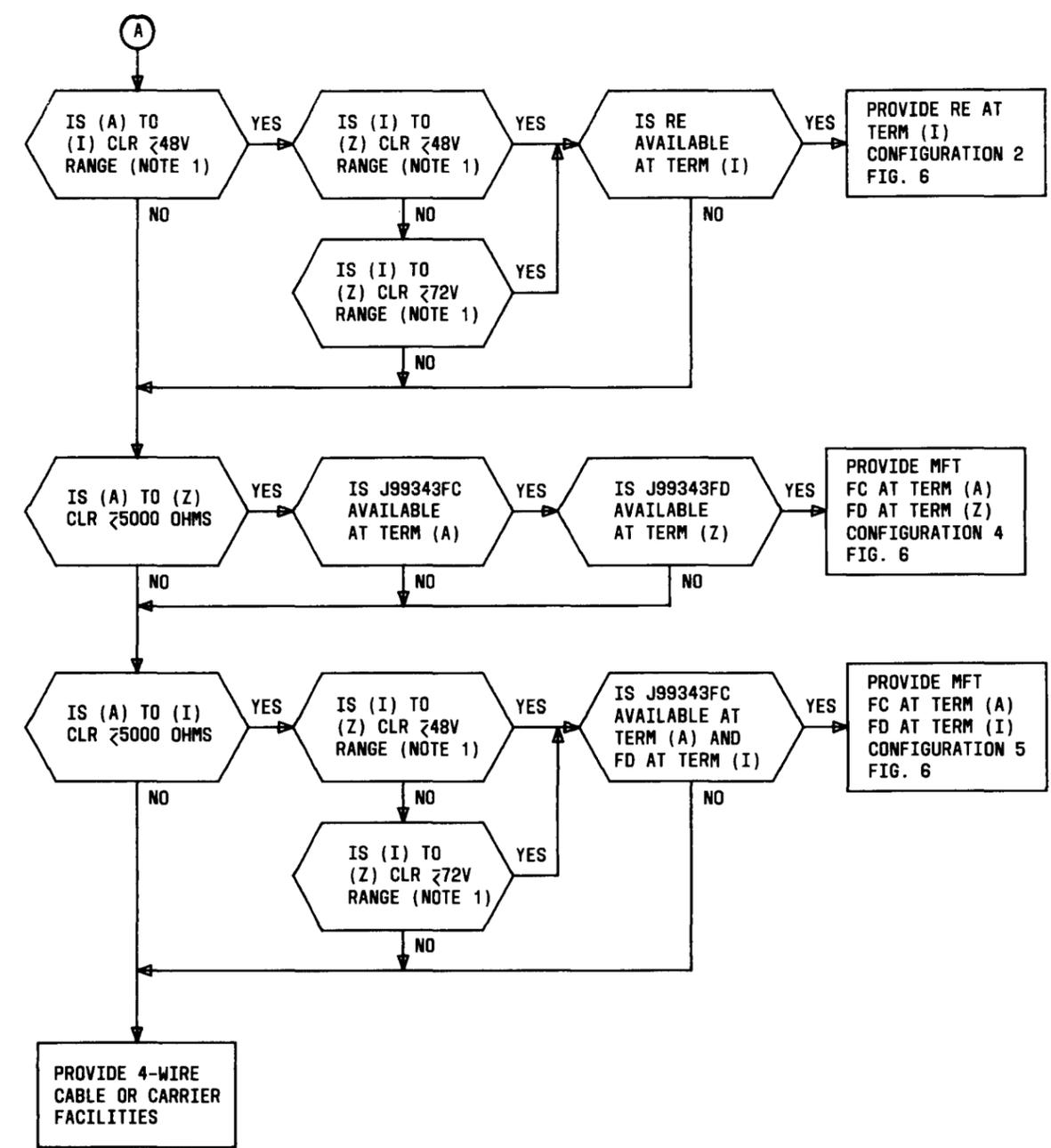
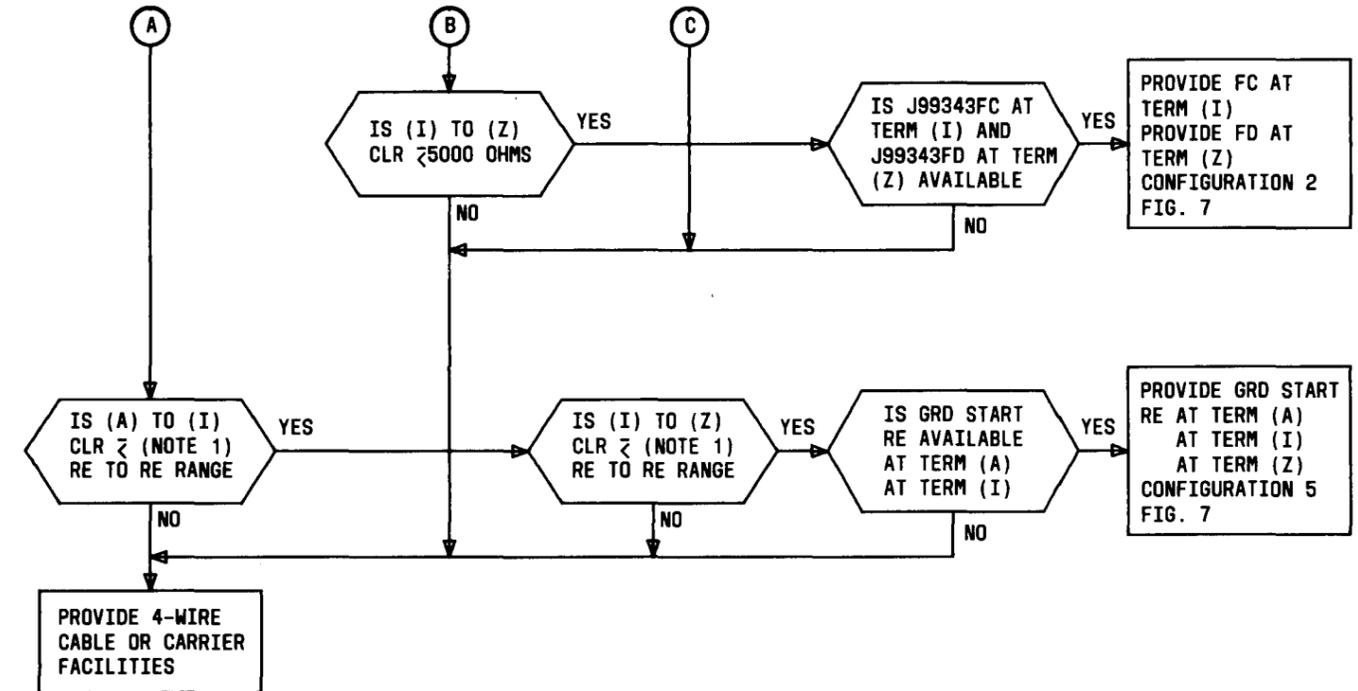
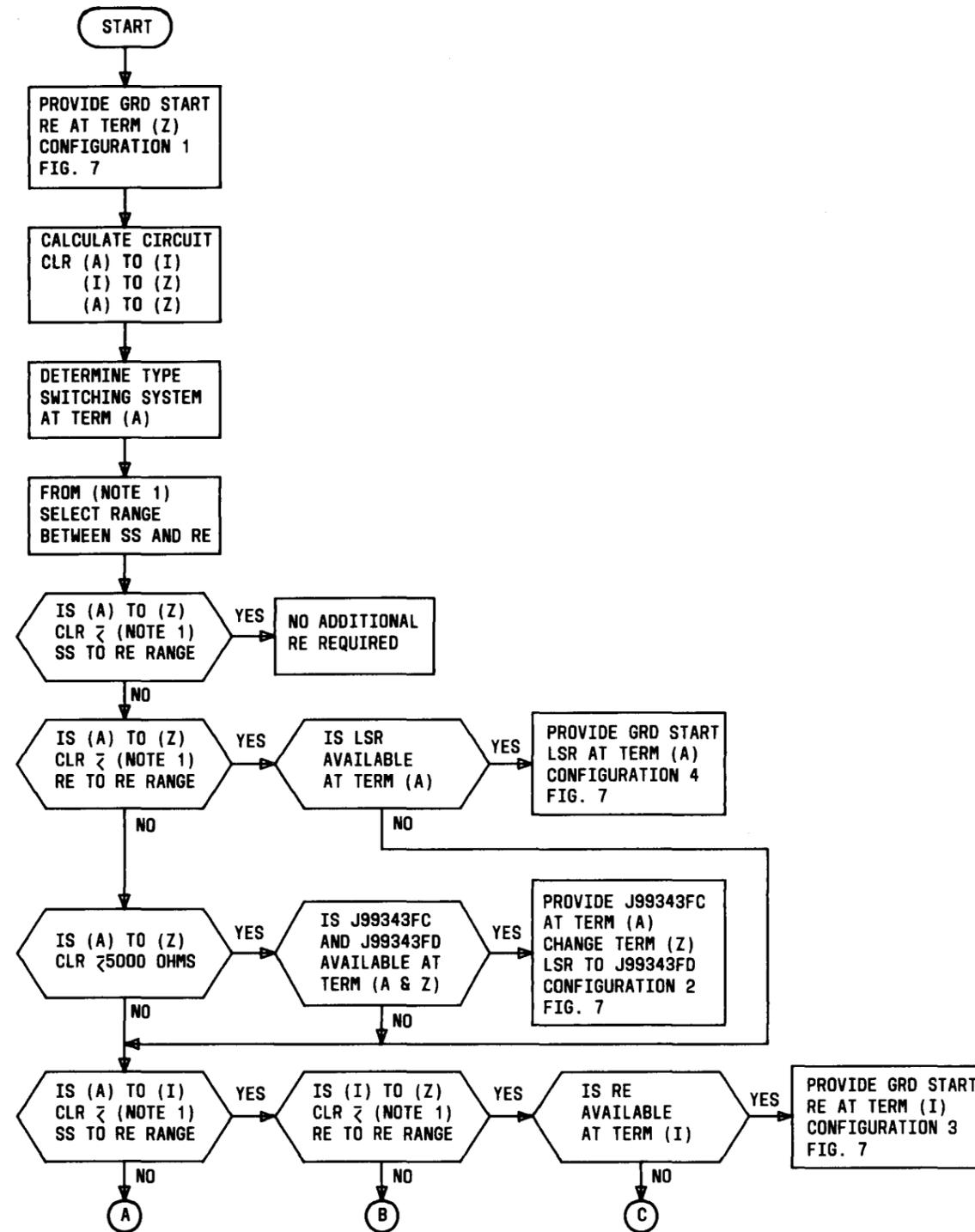


Fig. 13—Signaling Design Flowchart for ESS Centrex FX and WATS Trunks



LEGEND:
 LSR - LOOP START ONLY OR LOOP START/GRD START
 SS - SWITCHING SYSTEM
 RE - RANGE EXTENDER
 CLR - CONDUCTOR LOOP RESISTANCE OF EXTERNAL LOOP AND EQUIPMENT

NOTE:
 1. SEE SECTION 851-300-170

Fig. 14—Signaling Design Flowchart for No. 5 Crossbar Centrex FX and WATS Trunks