UNIVERSAL TRUNK CIRCUITS AND FRAME DESCRIPTION/THEORY 2-WIRE NO. 1 AND 1A ELECTRONIC SWITCHING SYSTEM

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1. GENERAL

1.01 This section provides the physical description, functional description, and theory of operation of the No. 1 and No. 1A Electronic Switching System (ESS) universal trunk frames.

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

1.03 The universal trunk frame (UTF) establishes telephone connections between trunk circuits or to customer lines through the switching network. The main function of the UTF is for transmission and supervision. All other functions of trunk circuits, such as pulsing, charging, timing, etc, are delegated either directly to program control or to the service circuits which, in turn, are under program control.

1.04 Listed below are the abbreviations used in this section:

CC—central control

CPD—central pulse distributor

ESS—electronic switching system

HMP—home mounting plate

IDF—intermediate trunk frame

SD—signal distributor

TDF—trunk distributing frame

UTF—universal trunk frame.

2. PHYSICAL DESCRIPTION

2.01 There are two types of UTFs; home and mate (Fig. 1, 2, and 3). Bay 1 of the home frame contains 512 ferrod sensors to sense transmission battery and the control equipment necessary for interrogating 1024 ferrods and converting their outputs to signals that can be used by other parts of the system (Fig. 4). Bay 1 of the mate frame contains only 512 ferrods; the control equipment for them being located on bay 1 of the home frame. A formed cable interconnects the home and mate frames to the two halves of the matrix. The frames are 6 feet 6 inches wide by 7 feet high.

2.02 On the home frame, the top section of the scanner control unit contains the apparatus associated with the peripheral communication bus. For the mate frame, a separate communication bus unit is furnished to serve the signal distributor.

2.03 Each UTF consists of three bays. The 0 and the 2 bays are arranged to mount 64 individual trunk units, or a total of 128 units for the frame (Fig. 5). The units are plugged into trunk chassis mountings. Four mountings are arranged horizontally on a 4- by 25-inch mounting plate and each bay mounts 16 of these mounting plates. The number of circuits per plug-in unit is either one or two. The frame will accommodate 256 circuits if all the units are of the 2 circuit type.

2.04 The center bay designated 1 mounts, in addition to the scanner and the signal distributor, the power control panel, the fuse panels, and the power filters for the scanner and signal distributor units. The 512 scanner matrix points and 768 of the 1024 signal distributor matrix points are wired in a fixed pattern to the connectors on the trunk chassis mountings. The remaining 256 points are used for remote circuits. Four scan and six signal distributor points are reserved for each trunk chassis mounting connector. The left-half of the matrix is wired to the connectors in bay 0 and the right-half, to those in bay 2. The control panel contains the keys which turn off the power to the circuits having circuit packs and associated connectors. Power must be removed from the connector before the circuit pack is removed to prevent electrical sparking and resultant damage to the contacts of the connector.

2.05 Bays 0 and 2 are equipped with terminal strips at the top, or highest mounting plate position. The terminal strips provide incoming and outgoing connections to the trunks on the bay for T and R leads. For those trunks requiring E&M signaling leads, only one circuit per unit is provided and the E&M leads are assigned to what would have been the T and R leads of the second circuit. All leads from the terminal strips are cabled to the distributing frames. The leads going out of the office are cabled to the intermediate distributing frame (IDF) and those to the switching system, to the trunk distributing frame (TDF). The trunks or service circuits require control leads from the scanner and signal distributor units located in bay 1. These leads plus the battery leads for

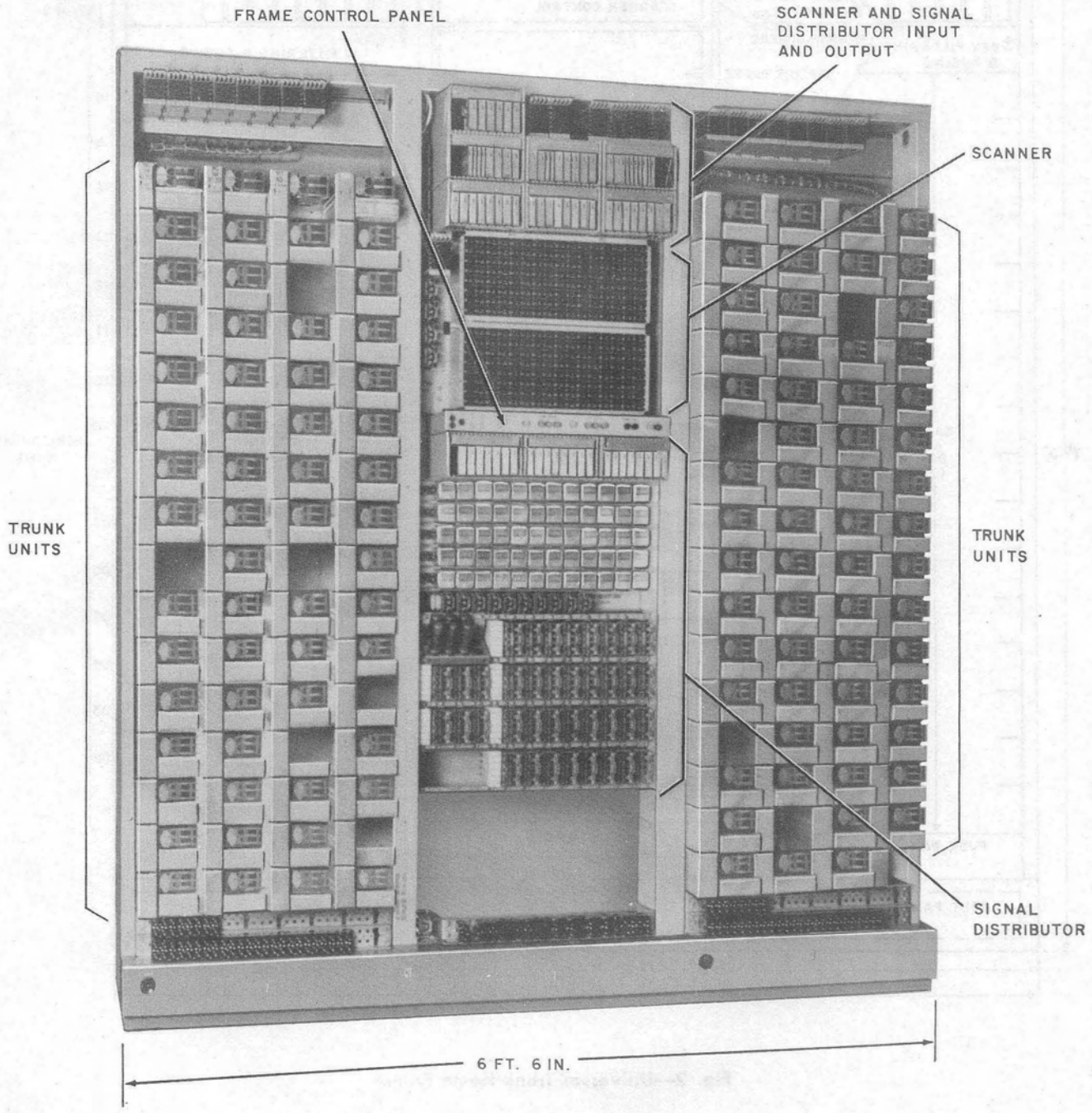


Fig. 1—Universal Trunk Frame

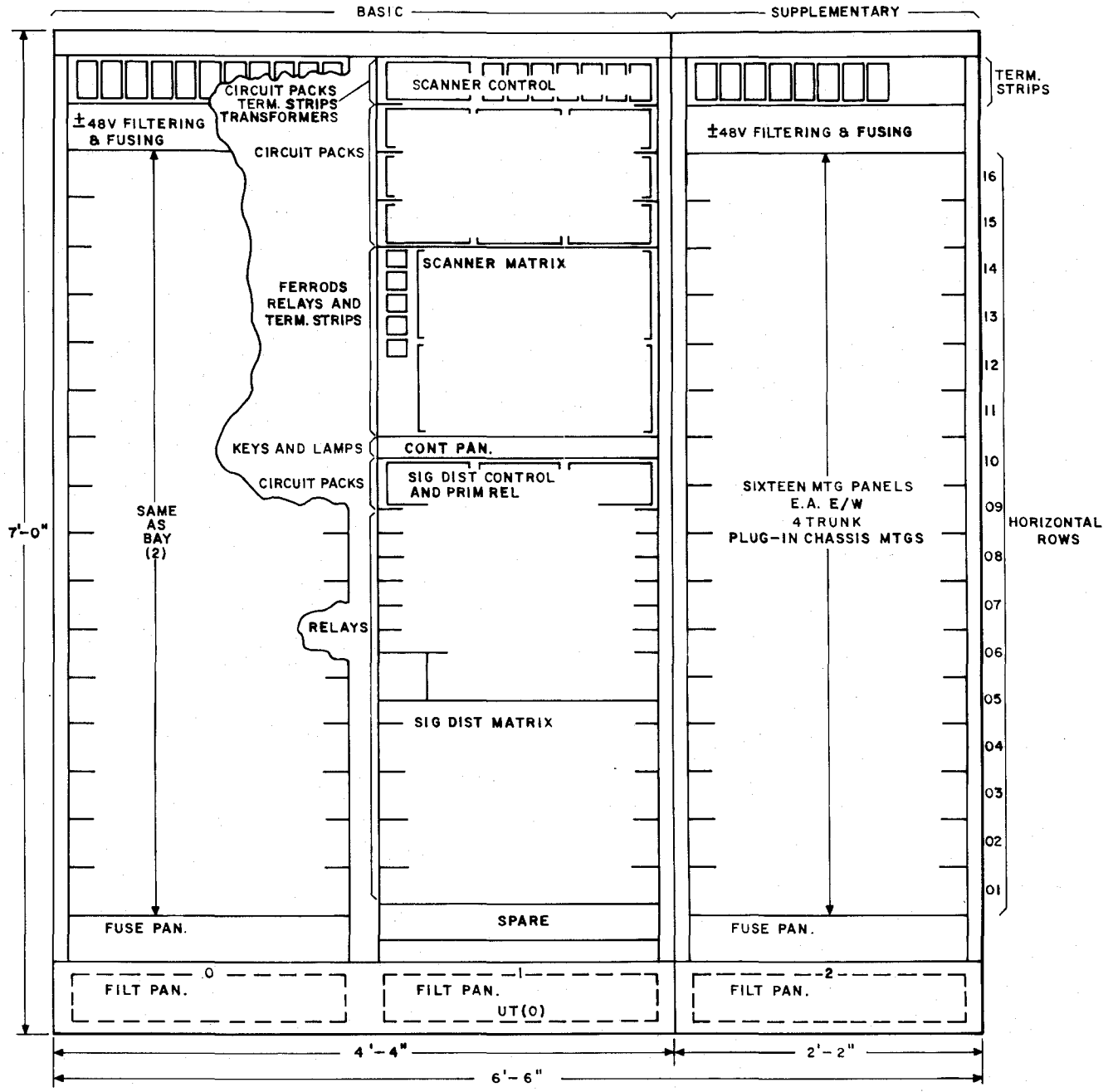


Fig. 2—Universal Trunk Home Frame

bay 1 are formed into three frame local cables for the frame. These three cables are kept separated for electrical interference reasons but are applied to the frame as one. A similar construction is used for bay 2 of the frame. Here the scanner and signal distributor connections to bays 0 and 1 from bay 2 are in a frame cable shipped attached to bay 2 and installer-connected in the telephone office if these bays are shipped separately.

2.06 At the top of bay 0 are three terminal strips on which appear 256 signal distributor points and associated ground shield leads. These are for use by the trunks and service circuits mounted on the miscellaneous trunk frames.

2.07 Power is supplied to the frames from the power distributing frames. The even-numbered trunk frames secure their 48-volt power from one

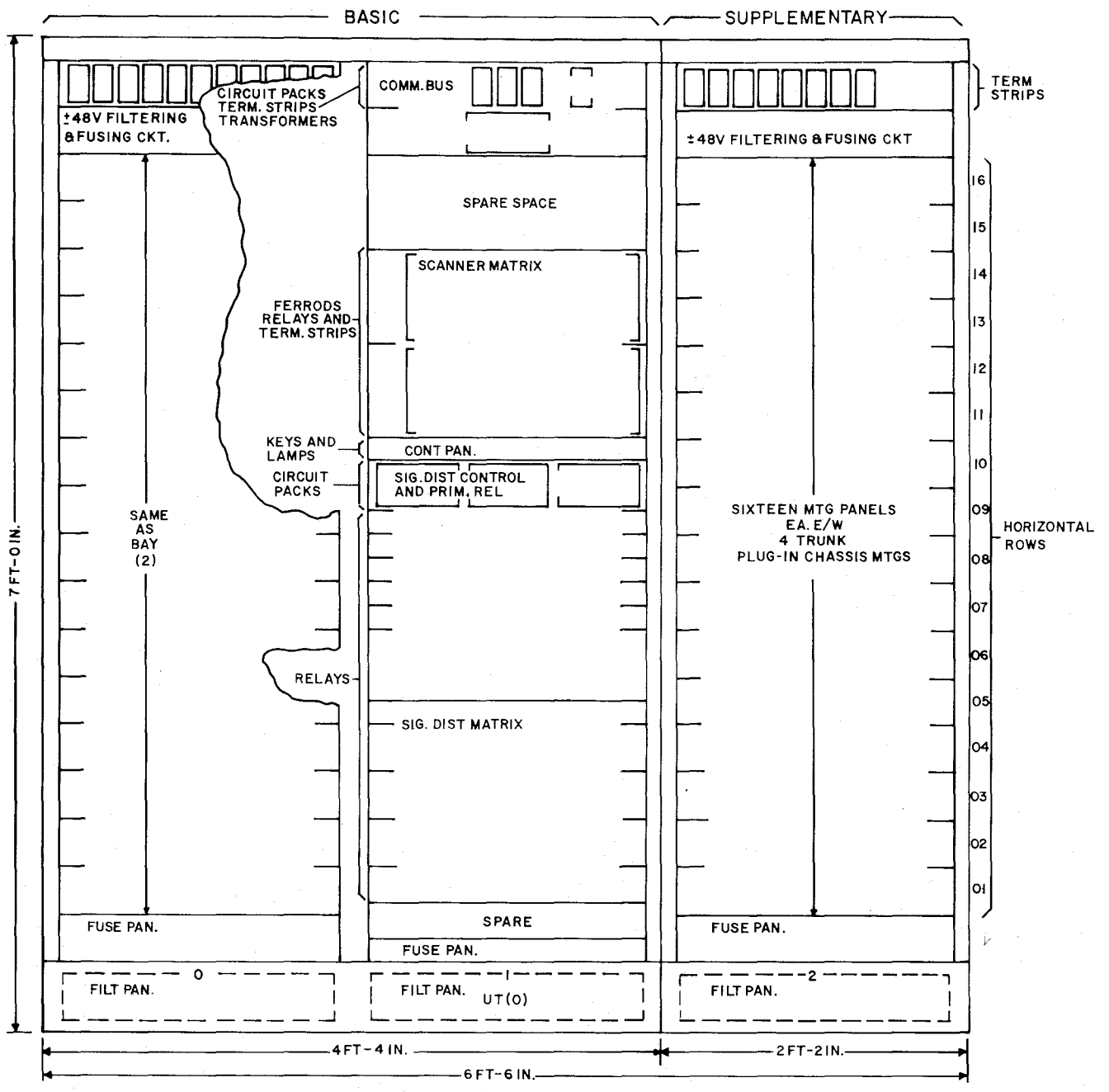


Fig. 3—Universal Trunk Mate Frame

power distributing frame and the odd-numbered trunk frames, from another power distributing frame. However, for the 24-volt needs of the scanner and signal distributor, two supplies are required; one from each power distributing frame of a pair. The power feeders required are as follows: (1) a 6-gauge pair of 48-volt battery and ground to bay 0; (2) a 12-gauge triple of one 48-volt lead for the signal distributor, a 24-volt lead for the first-half of the scanner and signal distributor, and a lead for ground, run to the center section of bay 0-1; (3) a 12-gauge pair of a 24-volt lead and ground lead for the second-half of the scanner and signal distributor, run to bay 1; and (4) a 6-gauge pair of 48-volt battery and ground for talking use, run to bay 2 (Fig. 6).

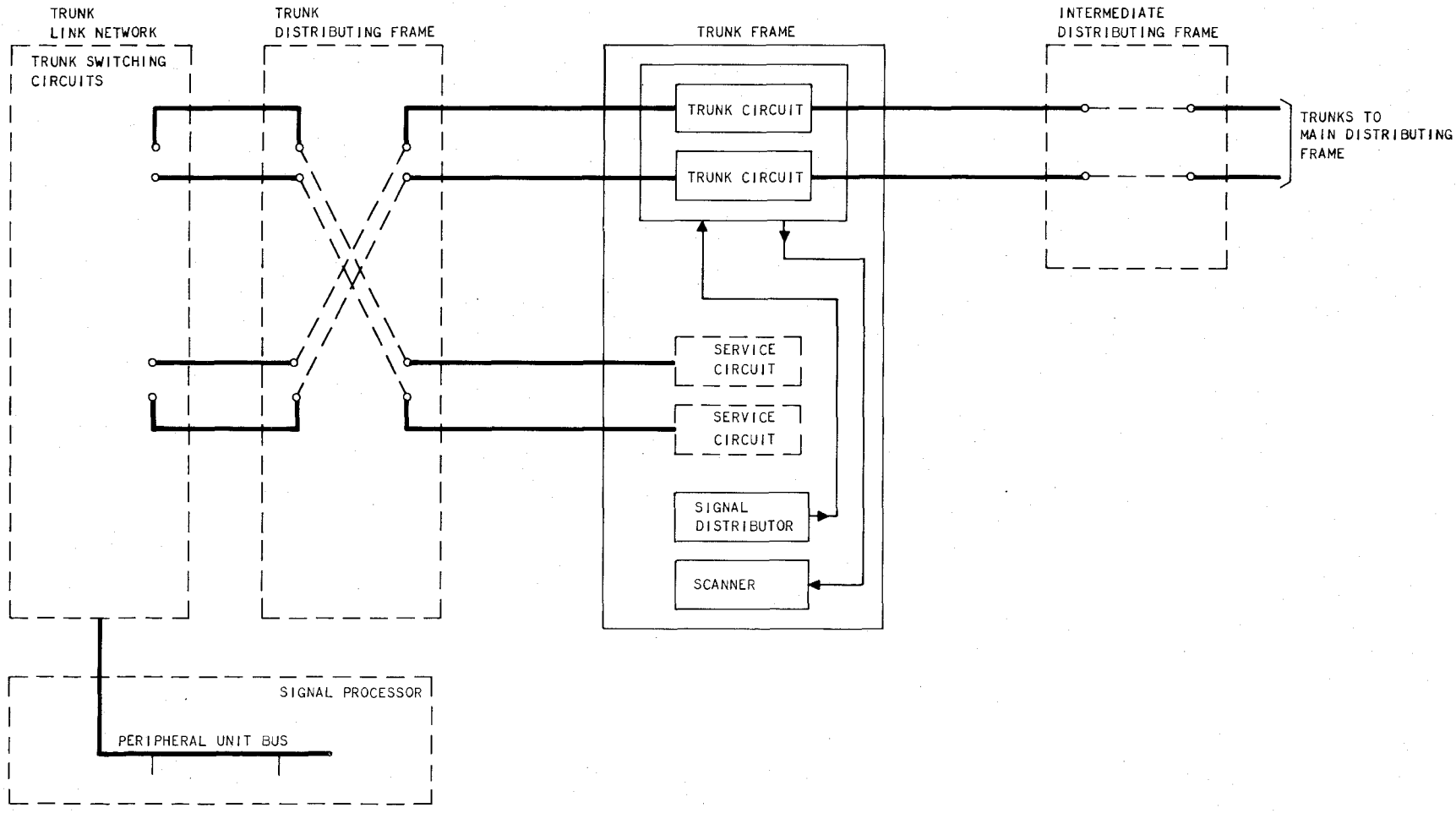


Fig. 4—Block Diagram Showing Relationship of Universal Trunk Frame and Interfacing Units of No. 1 and No. 1A ESS

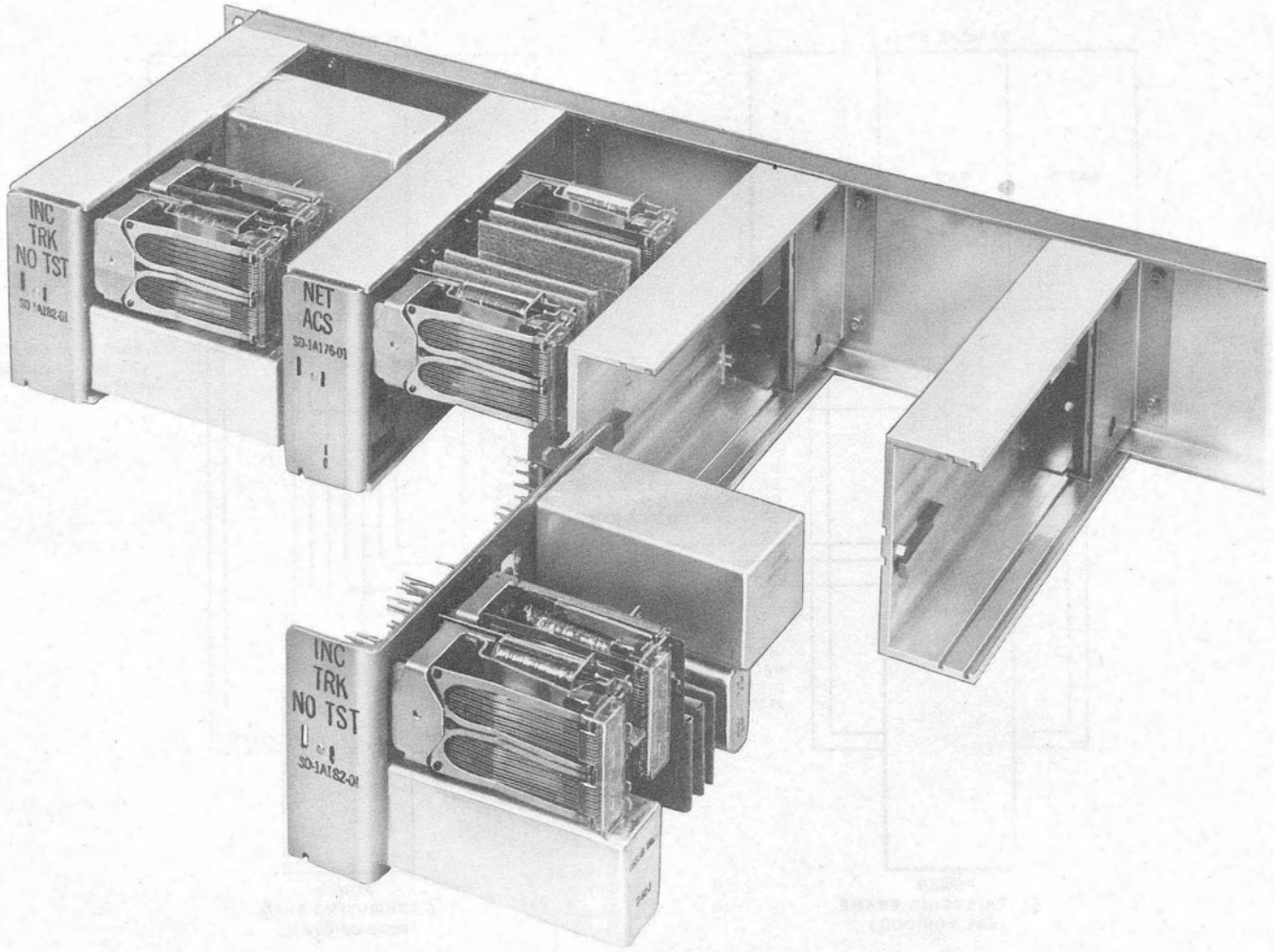


Fig. 5—Typical Trunk Unit

2.08 The power feeders are terminated at the top of the frame by special connectors which mate them to cables that run from the top of the frame, through the hollow section of the frame uprights, and down to the filters located in the base of the frame. The filter outputs connect to fuse panels located in the lowest mounting plate positions of the frame. The fuse panels for bays 0 and 2 provide 64, 48-volt fuses for talking battery. The fuse panel in bay 1 provides 48-volt fuses for the signal distributor and 24-volt fuses for the signal distributor, scanner, and bus circuits.

3. FUNCTIONAL DESCRIPTION

A. General

3.01 The UTF is used to complete and supervise paths established through the switching network (Fig. 7). Relays within the trunk circuits operate under the direction of central control (CC) via the central pulse distributor (CPD) and signal distributor (SD). The SDs give CC access to relays in the trunk circuits. They are the buffers between the high-speed CC and the low-speed relays. Scanners in the UTF supervise interoffice calls and miscellaneous trunk and service circuits. The frames are arranged for mate operation in the scanner section. The home frame has the control unit for a 1024-point scanner. The associated matrix is split in half with 512 points on the home frame and 512 points on the mate frame. The scanner detects and sends to CC any change in trunk or loop conditions that results from relay operations or from actions by a customer or distant office.

3.02 Universal trunk ferrods are scanned at either 50-ms or 100-ms rates. A home UTF and

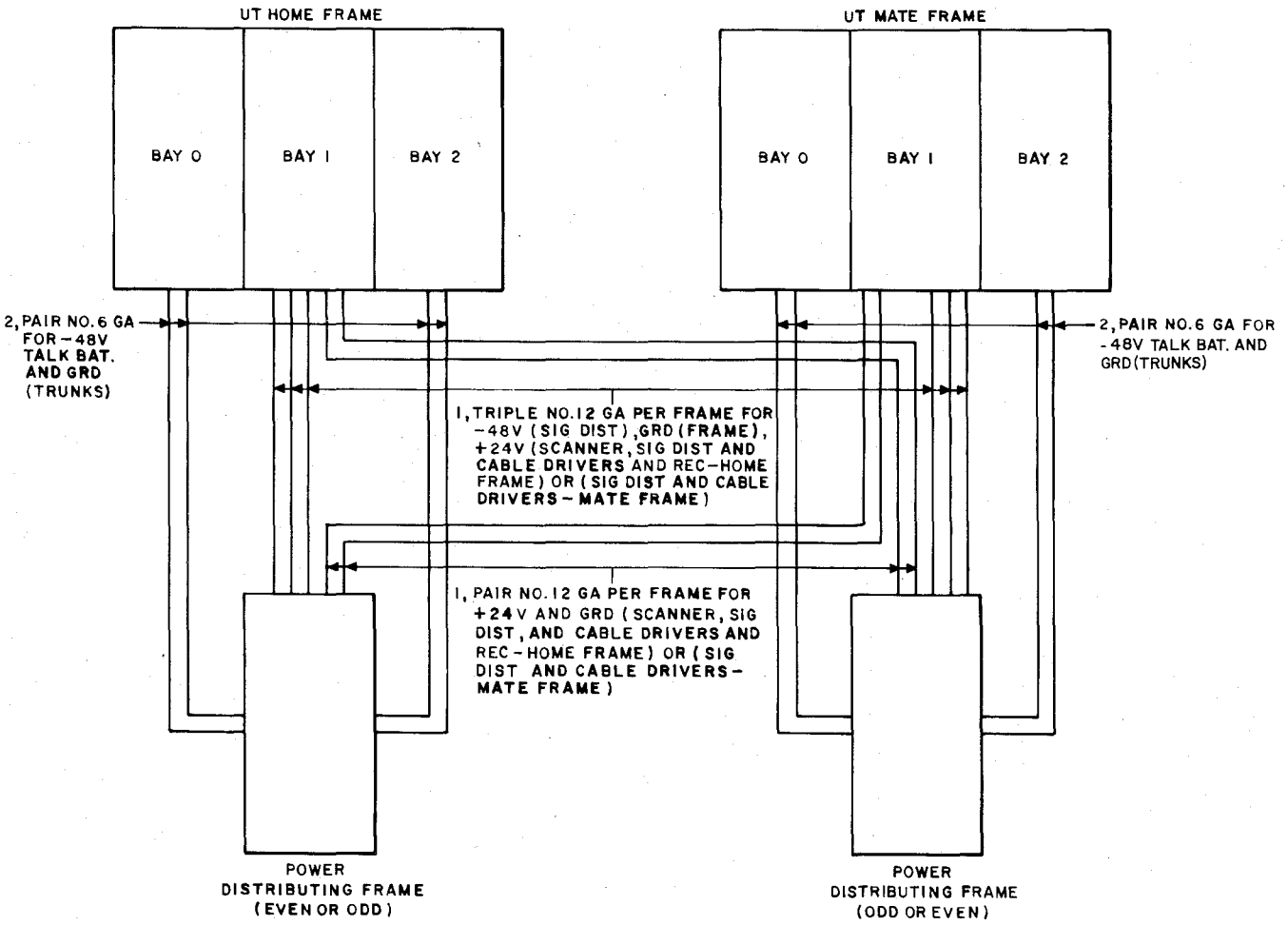


Fig. 6—Power Feeders

its mate frame are scanned by one scanner controller located in the home UTF. The horizontal mounting plates (HMPs) on the home UTF are scanned by the even-numbered rows in the scanner, and the HMPs on the mate UTF are scanned by the odd-numbered rows. The objective of the assignment restriction is to minimize the number of rows that must be scanned at the 50-ms rate in order to scan all of the wink trunks, while still spreading the wink trunks over at least two frames for reliability. Wink trunks are the trunks actually used for switchboard traffic having rering, ringback, or controlled ringing with or without coin control. Trunks capable of wink (50-ms) operation may also be arranged for nonwink (100-ms) operation.

3.03 Trunks are classified as outgoing, incoming, or 2-way, depending on whether the local office, the distant office, or both, can originate a call. Trunks may be further classified by the type of supervision used, by special features provided, etc. Table A lists some of the typical trunk circuits used in the No. 1 and No. 1A ESS.

3.04 All connections between the trunk circuits and the service circuits are made through trunk link networks. At times a trunk circuit is reduced to a simple pair of wires to allow the associated service circuit to accept certain pulsing and supervisory signals. This is called the bypass state. In the bypass state all transmission elements and supervisory bridges are switched out to provide a clear metallic path through the network.

B. Scanner

3.05 There are two main sections in each scanner: the current sensing ferrods, which are wired

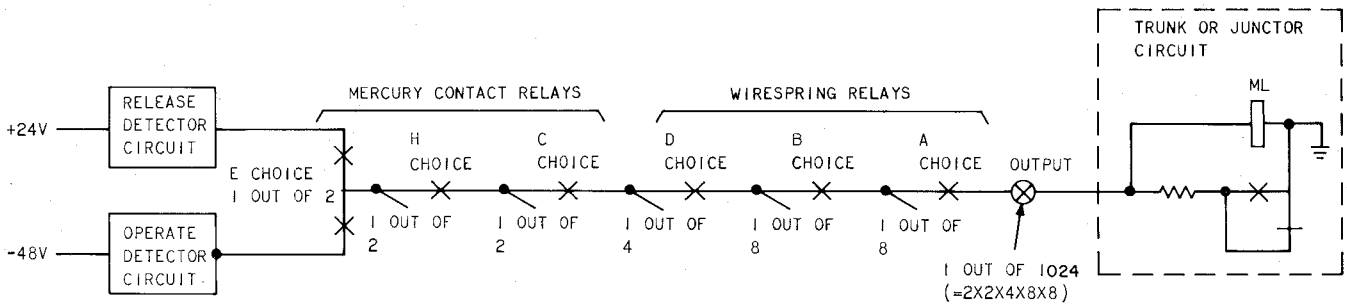


Fig. 7—Complete Selection Path to Operate or Release a Magnetically Latching Relay

to the points to be supervised; and a controller. The controller is used by CC to gain access to the interrogate windings of the ferrods and to detect the readout from a selected group of 16 ferrods.

3.06 All scanners on the same bus system are addressed simultaneously, but only one scanner receives an enable signal. The size of the address varies with the size of the scanner. In a 512-point scanner, the address consists of 12 bits in a 1-out-of-4 (1/4) and a 1-out-of-8 (1/8) code. The address for a 1024-point scanner has 16 bits (1/8 and 1/8 code).

C. Signal Distributor

3.07 The basic signal distributor is composed of a controller and a relay contact tree. Information from the CC, called the address, is accepted and stored by the controller. Through the relay contact tree, the controller closes a unique metallic path to the specified relay winding and applies to it an appropriate signal to operate or release. The controller senses the operation or release of the selected relay and returns to normal along with the relay contact tree. The controller is unavailable or busy to CC during the 25-ms interval between the storing of the address and the return to normal.

4. THEORY

A. General

4.01 The UTF circuits have little, if any, autonomy. With few exceptions, relays within these circuits operate only under the direction of CC via the CPD and the SD. CC detects via a scanner any change in the trunk or loop conditions that results from relay operation or from actions by a customer or a distant office.

B. Trunk Circuits—Description of Operation

4.02 The UTF is part of the communication channel between two switching systems (Fig. 8). The communication channel starts at the outgoing terminals of the originating office and ends at the incoming terminals of the switching network of the terminating office. As shown in Fig. 8, a trunk includes the transmission facility terminated in two trunk circuits, one at each end.

TABLE A

TYPICAL NO. 1 AND 1A ESS TRUNK CIRCUITS

CLASS	TITLE	SC	SD	TYPE
Interoffice	Outgoing (local and tandem) — reverse battery supervision	2	3	P
	Incoming (local and tandem) — reverse battery supervision	2	3	P
	2-way, E&M lead supervision — mf pulsing	2	4	P
Operator	2-way switchboard No. 3CL in distant building — reverse battery supervision, inband coin, and rering signals	2	3	P
	Outgoing to switchboard No. 3CL in distant building — high-low supervision, reverse battery ringback, coin control on tip and ring	4	5	W
	Outgoing — coin zone dialing to switchboard No. 3CL in distant building, polar double-duplex supervision	6	10	W
	Outgoing — local coin overtime and stuck coin trunk to switchboard No. 3CL in distant building	6	10	W
	Incoming — no-test Simplex controlled ringing and reverse battery supervision	3	3	P
	Incoming from switchboard No. 3CL in distant building — third wire coin control, simplexed rering signal	4	4	P
Miscellaneous	Outgoing — verification request and intercept — reverse battery high-low supervision	2	6	W
	Outgoing — to local test desk No. 14, sleeve lead supervision	3	2	P
	Outgoing — to repair service desk No. 2 high-low supervision	3	4	P
	Incoming — from local test desk No. 14 or from local test cabinet No. 3, sleeve lead supervision	6	4	W
	Intraoffice trunk circuit	2	2	P

Note:

P plug-in
W wired-in

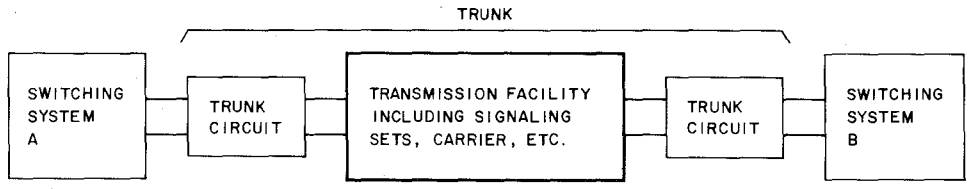


Fig. 8—Relationship of Trunk Circuits to Trunk

4.03 The simplified illustration of Fig. 9 shows the relationship of outgoing and incoming trunks to the switching network.

4.04 The incoming trunk circuit (Fig. 10) consists of three relays A, B, and C, to control its operation and transmission components. The two ferrod sensors designated 0 and 1 are used to pass call status signals to the central processor (supervision). The ferrod sensors, although associated with the trunk circuit, are not physically located in this circuit. Ferrod sensors for trunk circuits are located in the ferrod matrix of the UTF scanner circuit, while the ferrods used in the supervision of service circuits are located in the master scanner matrix. The A, B, and C relays are operated by a control circuit under program control and are used to provide the necessary circuit states for each function of the circuit. Circuit state tables (Table B) are used to identify each circuit state and to help in analyzing circuit trouble conditions. Each state can be defined by the operation of particular relays in the circuit. Crossing a vertical and/or horizontal line in the circuit state table is equivalent to the operation or release of relays by the control circuit. For example, if relay A were operated, the circuit would be put in the bypass state (01). If relays B and C are operated, the circuit is put in the tandem free state (06). The A and B relays being operated would define the talk local charge state (03).

4.05 Circuit states for each circuit, regardless of complexity, are defined by circuit state tables in the same manner as those described in 4.04 for the incoming trunk.

4.06 Incoming trunk circuits terminate incoming transmission facilities from other central offices and provide the necessary transmission, supervision, and control elements needed to process incoming calls. Such calls may terminate locally or be switched tandem through the ESS office. The various incoming trunk circuit states are shown

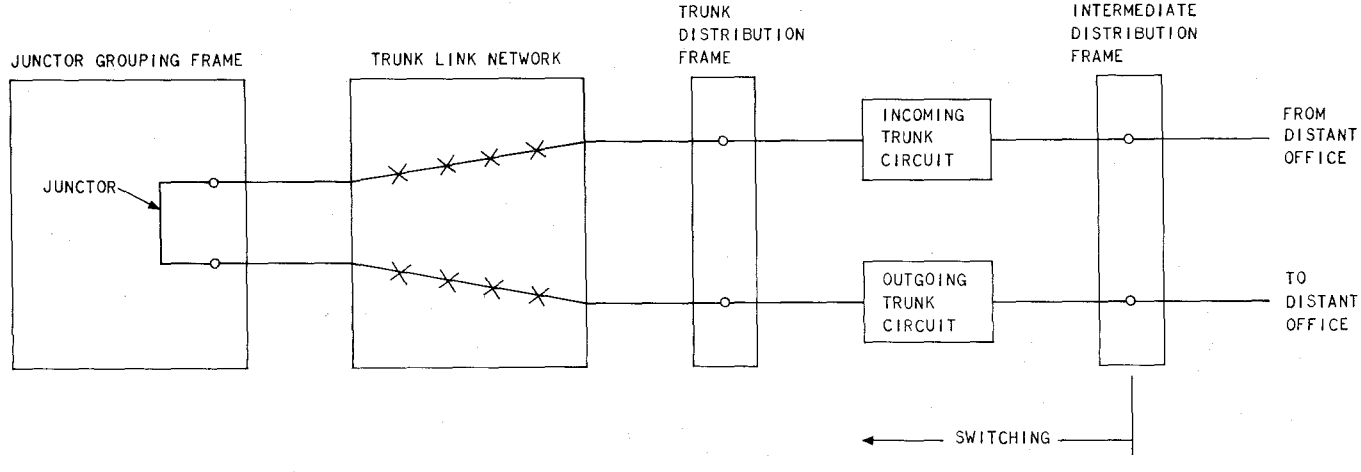
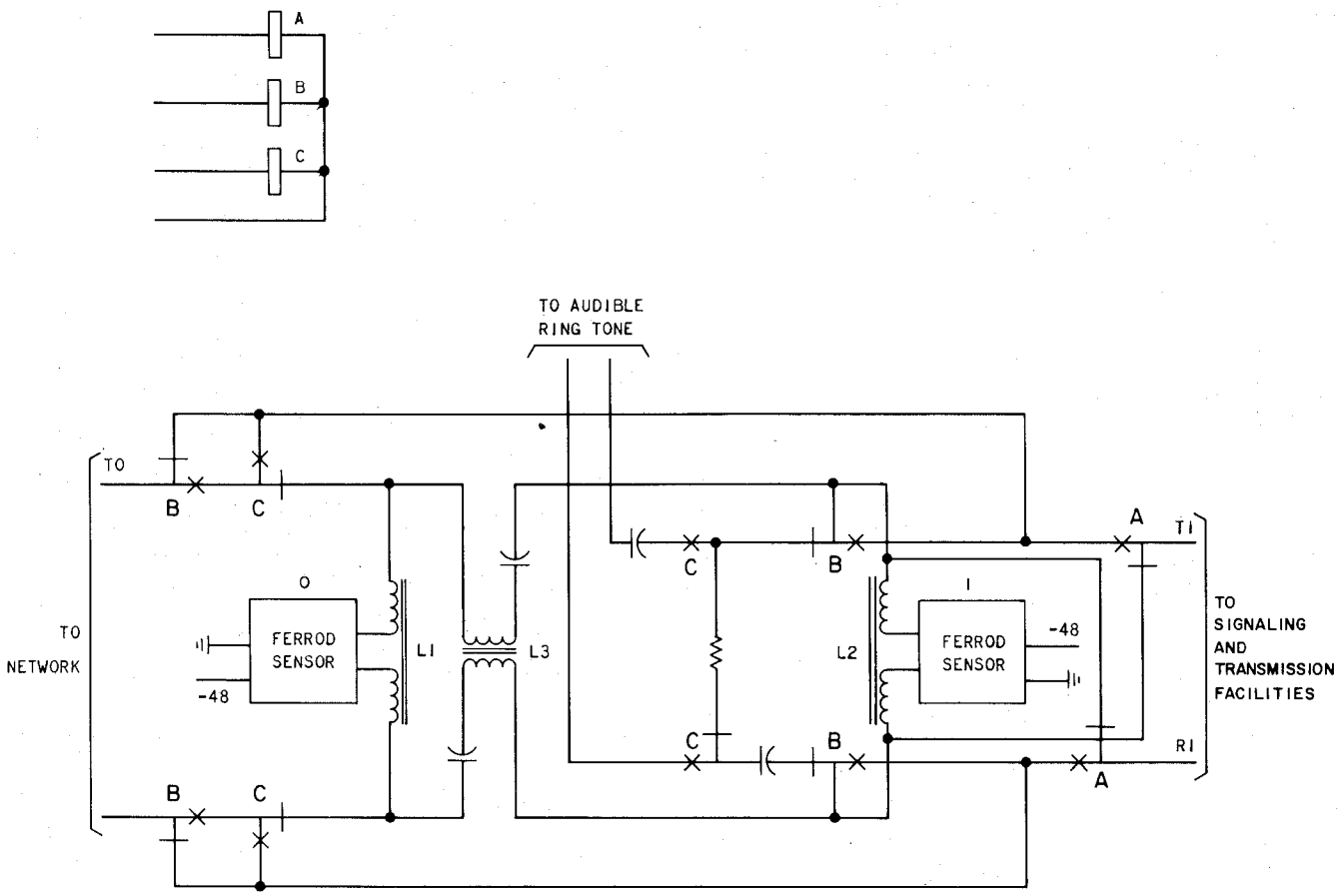


Fig. 9—Outgoing and Incoming Trunk Arrangement



A OPERATED

IDLE (00)	BYPASS (01)	TALK LOCAL CHARGE (03)	TALK LOCAL FREE (02)
AUDIBLE RING (04)	NOT USED	TANDEM CHARGE (07)	TANDEM FREE (06)

C OPERATED

B OPERATED

Fig. 10—Incoming Trunk Circuit and Circuit State Table

in Fig. 11A. Figure 11B and 11C show the sequence of actions respectively for an incoming and an outgoing call.

4.07 The incoming trunk circuit (Fig. 11 and 12) is normally in an idle state (00) with all relays released. When the communication channel is seized at the distant office, ferrod sensor 1 of this circuit is saturated. The scanning program detects this and directs the processor to cause a digit receiver to be connected to this circuit via the switching network. The central processor places the incoming trunk circuit in the bypass state (01) by operating relay A, thereby associating the digit receiver directly with the transmission facility. After digit reception, the receiver is

TABLE B

CIRCUIT STATES AND RELAY CONDITIONS

IDLE	NO RELAYS OPERATED	(00)
BYPASS	A RELAY OPERATED	(01)
TALK LOCAL CHARGE	A AND B RELAYS OPERATED	(03)
TALK LOCAL FREE	B RELAY OPERATED	(02)
TALK TANDEM FREE	B AND C RELAYS OPERATED	(06)
TALK TANDEM CHARGE	A, B, AND C RELAYS OPERATED	(07)
AUDIBLE RING	C RELAY OPERATED	(04)

	"A" RELAY OPER RLS		"B" RELAY OPER RLS		"C" RELAY OPER RLS	
IDLE		X		X		X
BYPASS	(X)			X		X
TALK LOCAL CHARGE	(X)		(X)			X
TALK LOCAL FREE		X	(X)			X
TANDEM FREE		X	(X)		(X)	
TANDEM CHARGE	(X)		(X)		(X)	
AUDIBLE RING		X		X	(X)	

released and supervision of the distant office is transferred to ferrod 1 of the incoming trunk circuit by returning to the idle state.

4.08 If the call is to terminate locally and the called line is idle (Fig. 11 and 13), the control circuit operates relay C (state 04 AUD RING) via instructions from the central processor and returns audible ring tone to the calling customer. At the same time, the called line is alerted by a ringing circuit connected to the line via a separate network path.

4.09 When the called party answers, the trunk circuit is connected to the called party line via a previously reserved switching network path (Fig. 11 and 14). Relay B is operated and relay C is released, thereby placing the circuit in state 02 (talk local free). In this state, ferrod sensor 0 provides supervision of the calling line. When either one or both parties disconnect, the incoming trunk circuit is returned to the idle state.

4.10 The ESS No. 1 and No. 1A UTF scanner circuit functional block diagram is shown in Fig. 15. The ESS No. 1 and No. 1A UTF signal

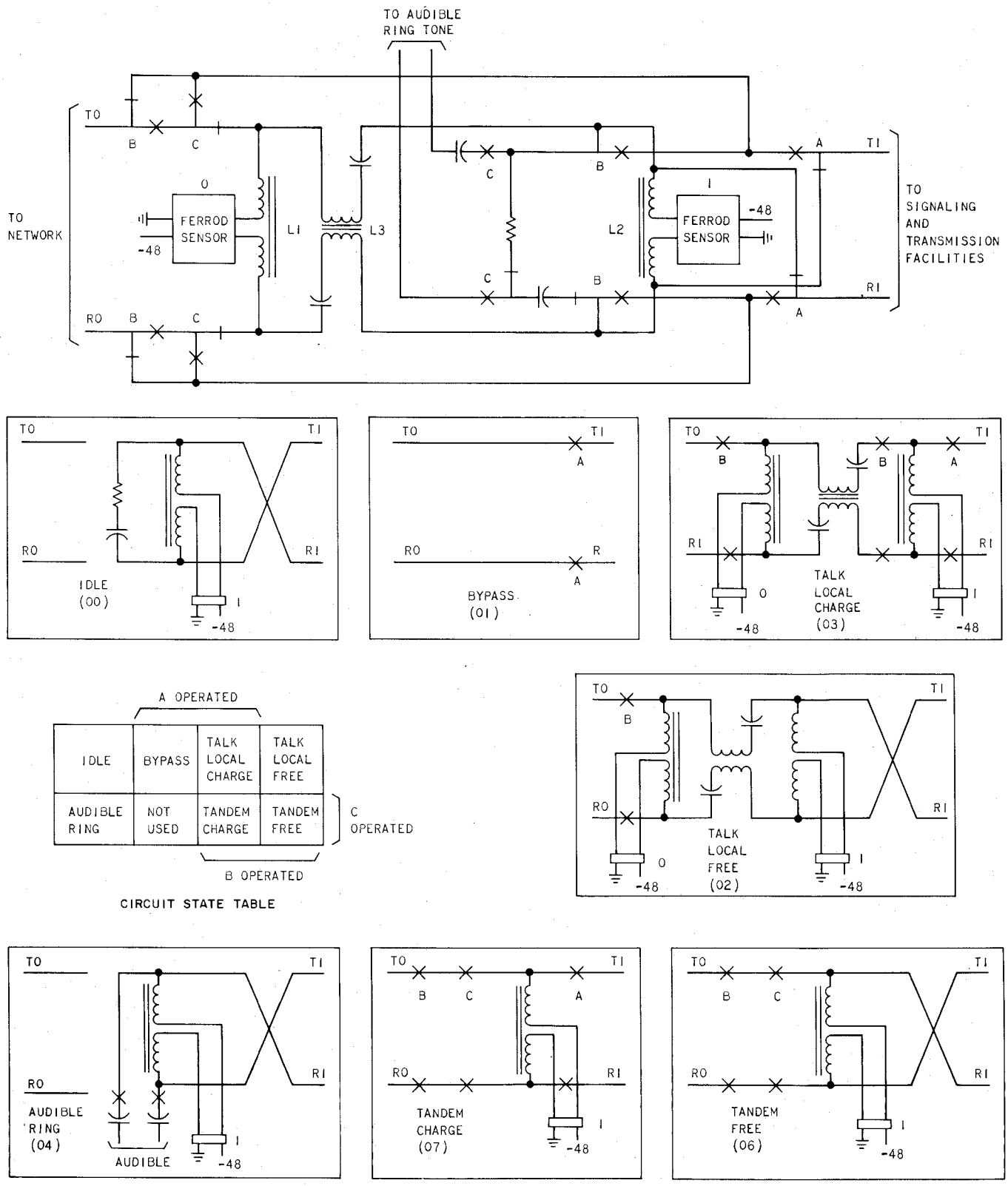


Fig. 11A—Incoming Trunk Circuit States

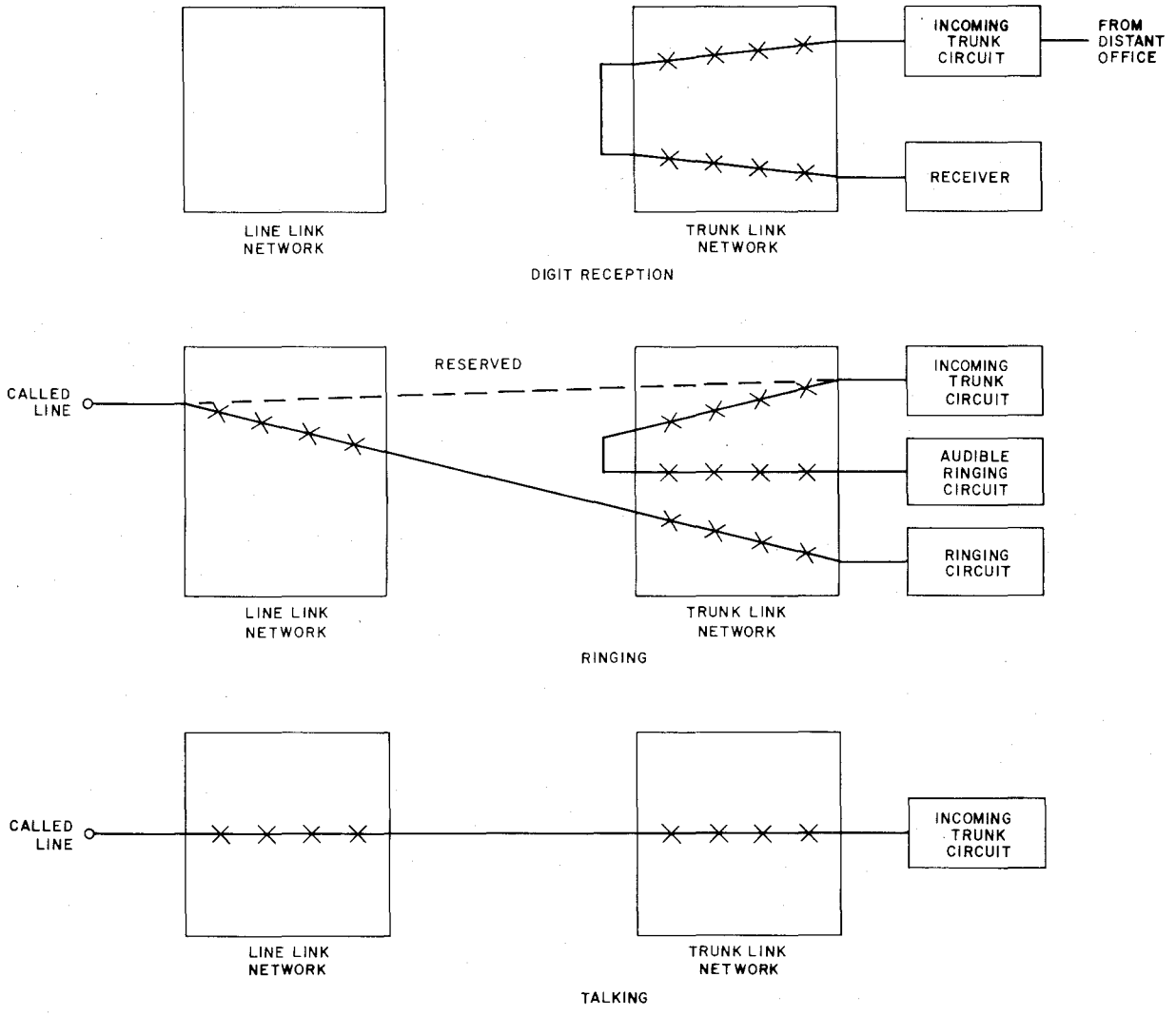


Fig. 11B—Sequence of Actions on an Incoming Call

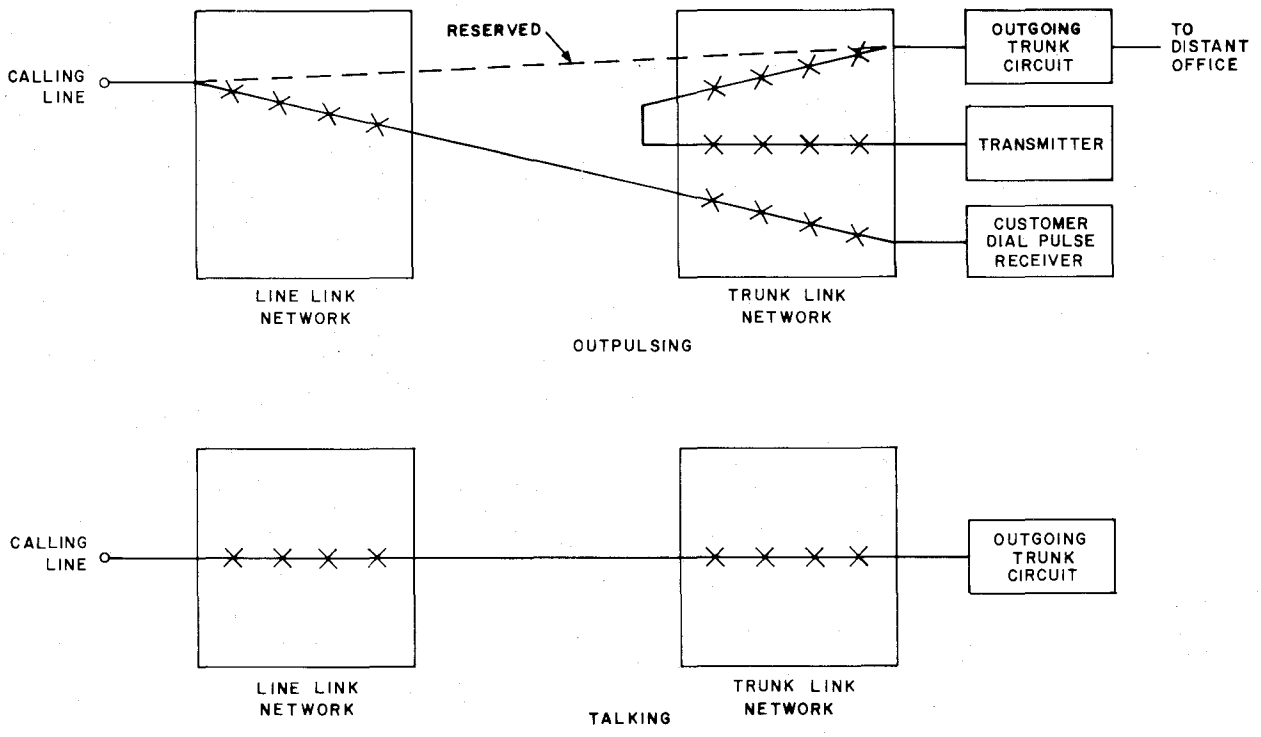


Fig. 11C—Sequence of Actions on an Outgoing Call

distributor circuit functional block diagram is shown in Fig. 16.

5. MAINTENANCE

5.01 Maintenance provisions for the No. 1 and No. 1A ESS UTF circuits consist of the following:

- maintenance circuits and programs for detection and diagnosis of failures automatically or by manual requests.
- a master control center for communicating, controlling, testing, and recording requirements of the system.
- An office alarm system for both system-detected and locally-detected failures.

6. REFERENCES

6.01 The following list provides the number and title of related documents:

SECTION	TITLE
966-120-100	2-Wire No. 1A Electronic Switching System - General Description
231-007-101	Signal Distributor - Description
231-010-101	Scanners - Description
231-130-101	Trunk Test Capabilities - Description
231-008-101	Central Pulse Distributor - Description
231-009-101	Duplication and Bus System - Description

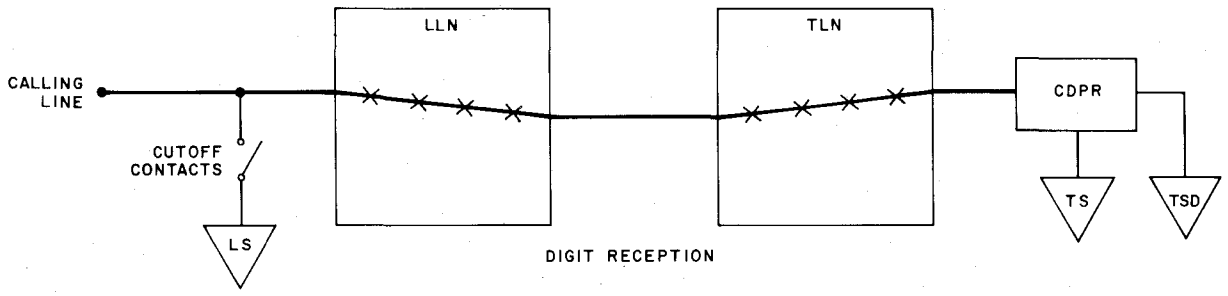


Fig. 12—Incoming Trunk and Digit Receiver Connection

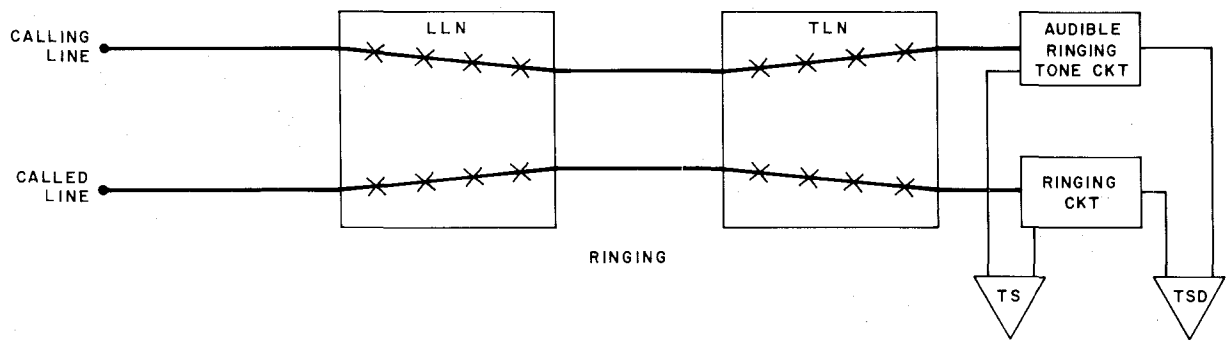


Fig. 13—Incoming Trunk Audible Ring Tone Connection

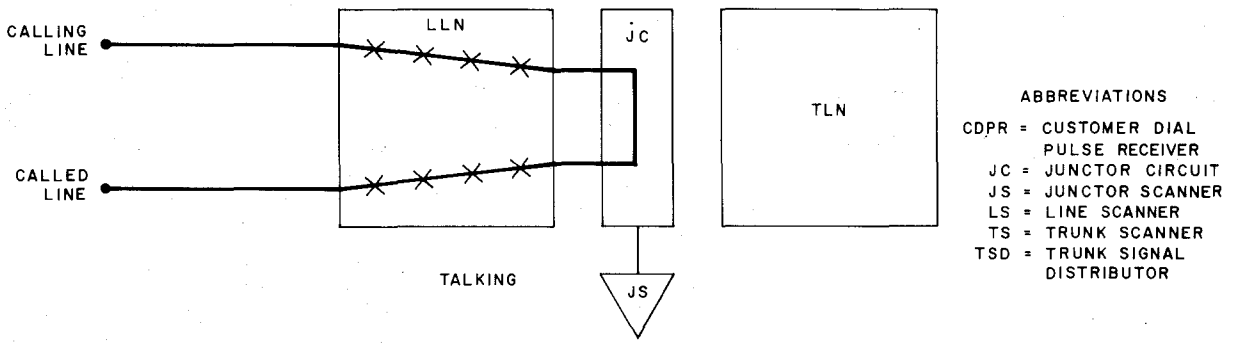
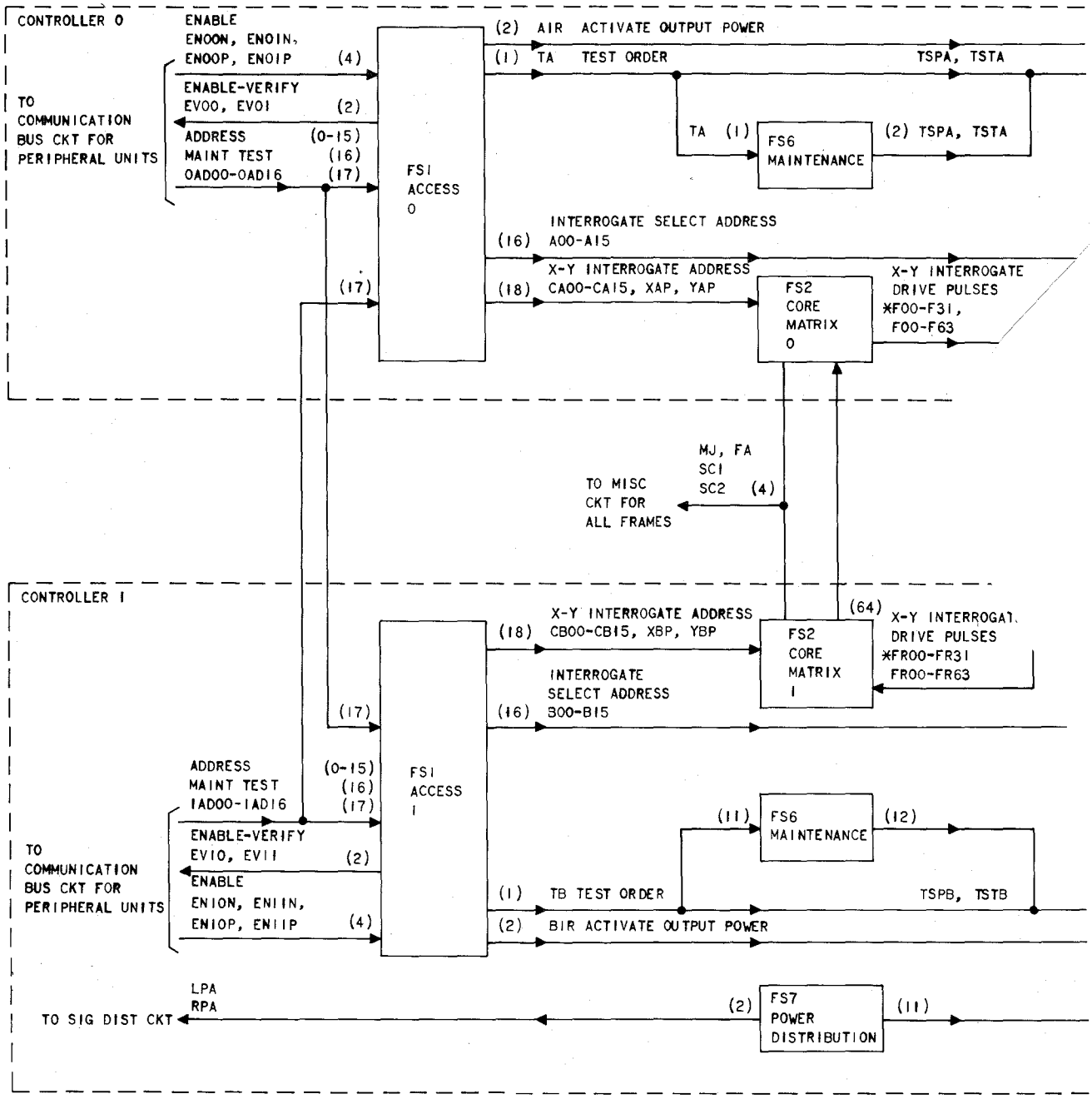


Fig. 14—Talk Local Free Connection


CONTROLLER 0
ENABLE
ENOON, ENOIN,
ENOOP, ENOIP (4)
ENABLE-VERIFY
EVOO, EVOI (2)
ADDRESS (0-15)
MAINT TEST (16)
OADOO-OADI6 (17)
TO COMMUNICATION BUS CKT FOR PERIPHERAL UNITS
FSI ACCESS 0
(2) AIR ACTIVATE OUTPUT POWER
(1) TA TEST ORDER
TSPA, TSTA
TA (1)
FS6 MAINTENANCE
(2) TSPA, TSTA
INTERROGATE SELECT ADDRESS
(16) A00-A15
X-Y INTERROGATE ADDRESS
(18) CA00-CA15, XAP, YAP
(17)
FS2 CORE MATRIX 0
X-Y INTERROGATE DRIVE PULSES
*F00-F31,
F00-F63
MJ, FA
SC1
SC2 (4)
TO MISC CKT FOR ALL FRAMES
CONTROLLER 1
X-Y INTERROGATE ADDRESS
(18) CB00-CB15, XBP, YBP
(64)
FS2 CORE MATRIX 1
X-Y INTERROGAT. DRIVE PULSES
*FR00-FR31
FR00-FR63
INTERROGATE SELECT ADDRESS
(16) B00-B15
(17)
ADDRESS (0-15)
MAINT TEST (16)
IADOO-IADI6 (17)
ENABLE-VERIFY
EVIO, EVII (2)
ENABLE
ENION, ENIIN,
ENIOP, ENIIP (4)
TO COMMUNICATION BUS CKT FOR PERIPHERAL UNITS
FSI ACCESS 1
(11)
FS6 MAINTENANCE
(12)
(1) TB TEST ORDER
TSPB, TSTB
(2) BIR ACTIVATE OUTPUT POWER
LPA
RPA
TO SIG DIST CKT
(2)
FS7 POWER DISTRIBUTION
(11)

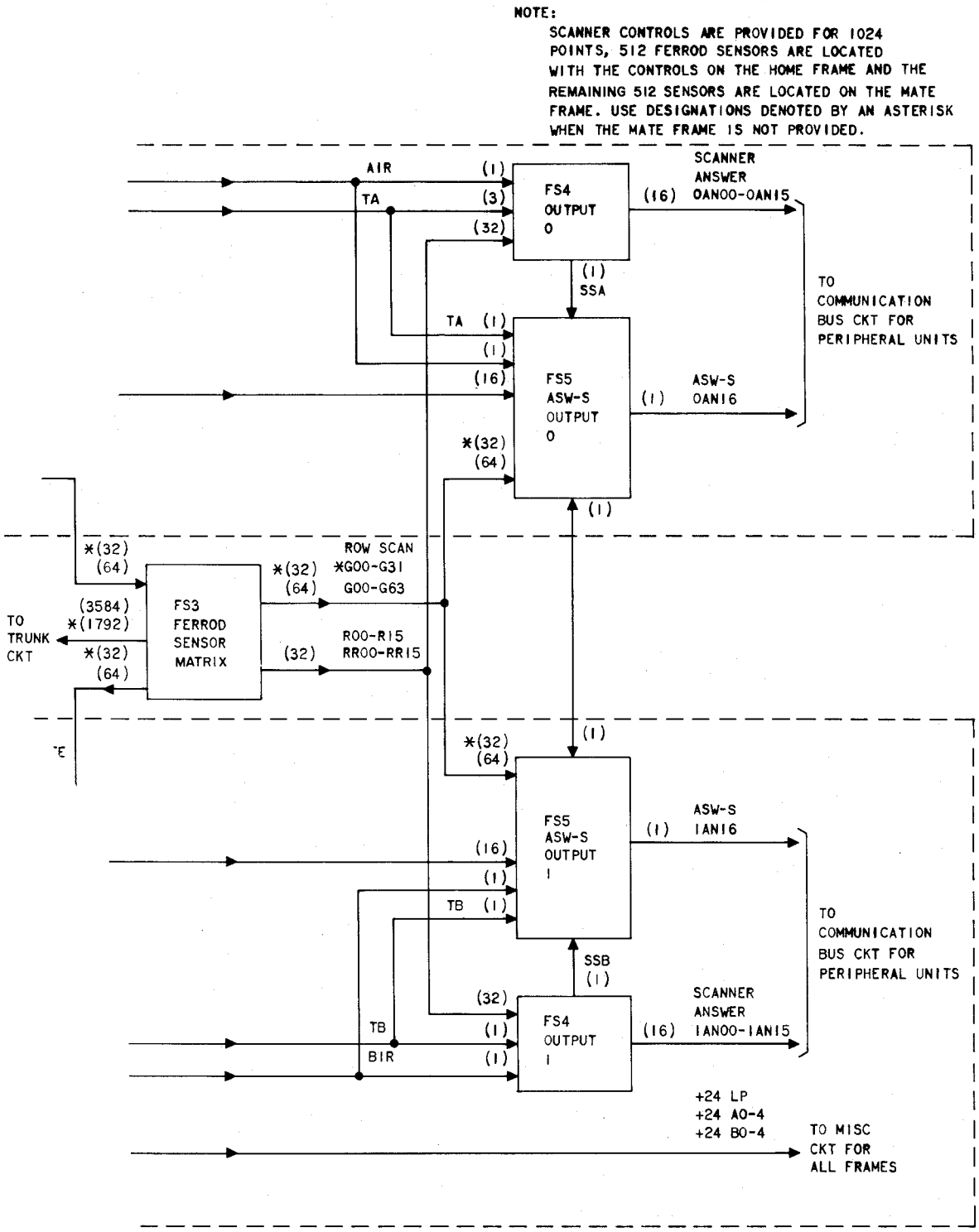
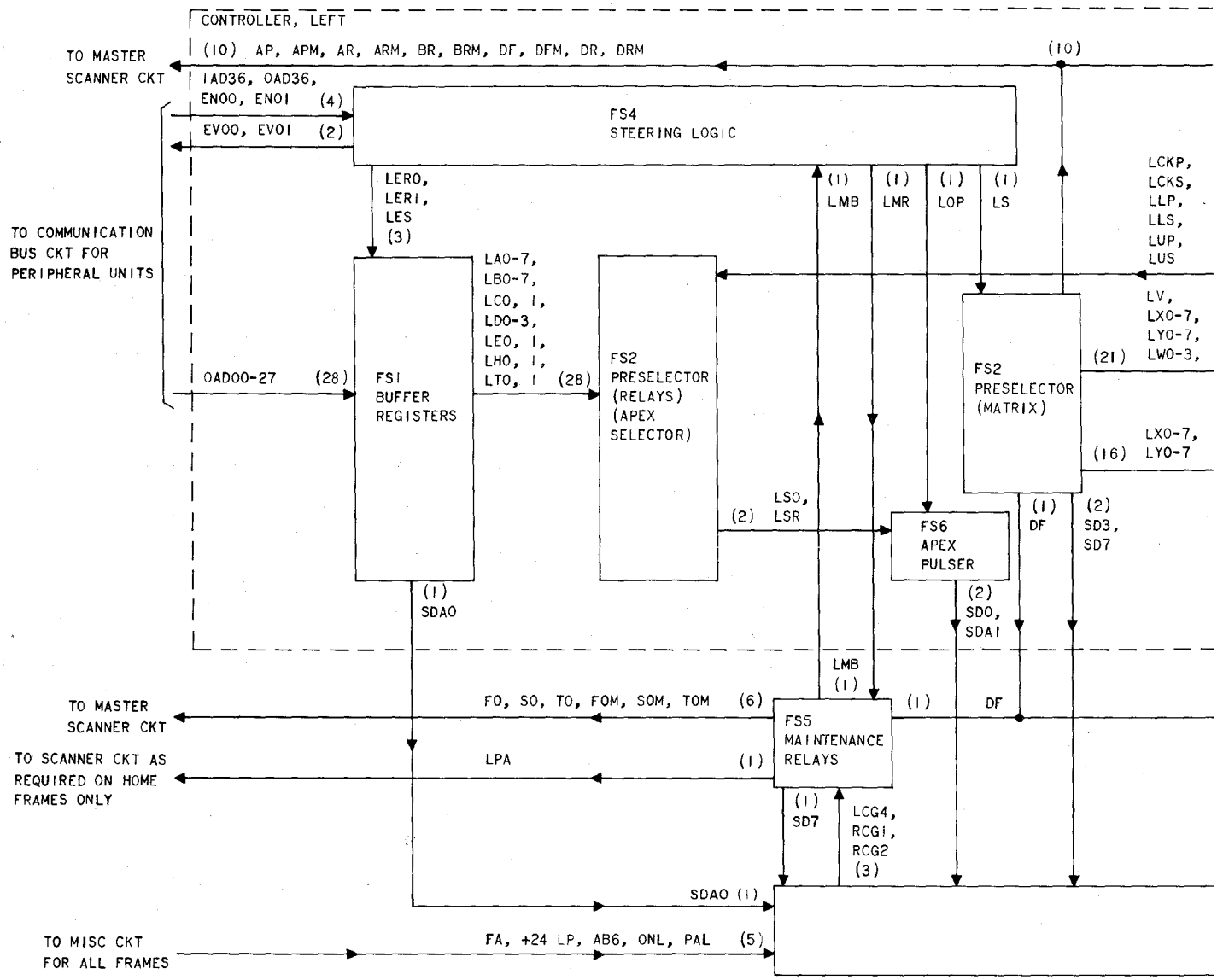


Fig. 15—ESS No. 1 and No. 1A UTF Scanner Circuit Functional Block Diagram


CONTROLLER, LEFT
(10) AP, APM, AR, ARM, BR, BRM, DF, DFM, DR, DRM
(10)
TO MASTER SCANNER CKT
IAD36, OAD36, EN00, EN01 (4)
EV00, EV01 (2)
FS4 STEERING LOGIC
LERO, LERI, LES (3)
(1) LMB
(1) LMR
(1) LOP
(1) LS
LCKP, LCKS, LLP, LLS, LUP, LUS
TO COMMUNICATION BUS CKT FOR PERIPHERAL UNITS
LA0-7, LB0-7, LC0, 1, LD0-3, LE0, 1, LH0, 1, LT0, 1 (28)
OAD00-27 (28)
FS1 BUFFER REGISTERS
FS2 PRESELECTOR (RELAYS) (APEX SELECTOR)
FS2 PRESELECTOR (MATRIX)
LV, LX0-7, LY0-7, LW0-3, (21)
LX0-7, LY0-7 (16)
(2) LS0, LSR
FS6 APEX PULSER
(1) DF
(2) SD3, SD7
(1) SDA0
(2) SD0, SDA1
LMB (1)
TO MASTER SCANNER CKT
F0, S0, T0, F0M, S0M, T0M (6)
(1)
DF
FS5 MAINTENANCE RELAYS
TO SCANNER CKT AS REQUIRED ON HOME FRAMES ONLY
LPA (1)
(1) SD7
LCG4, RCG1, RCG2 (3)
SDA0 (1)
TO MISC CKT FOR ALL FRAMES
FA, +24 LP, AB6, ONL, PAL (5)

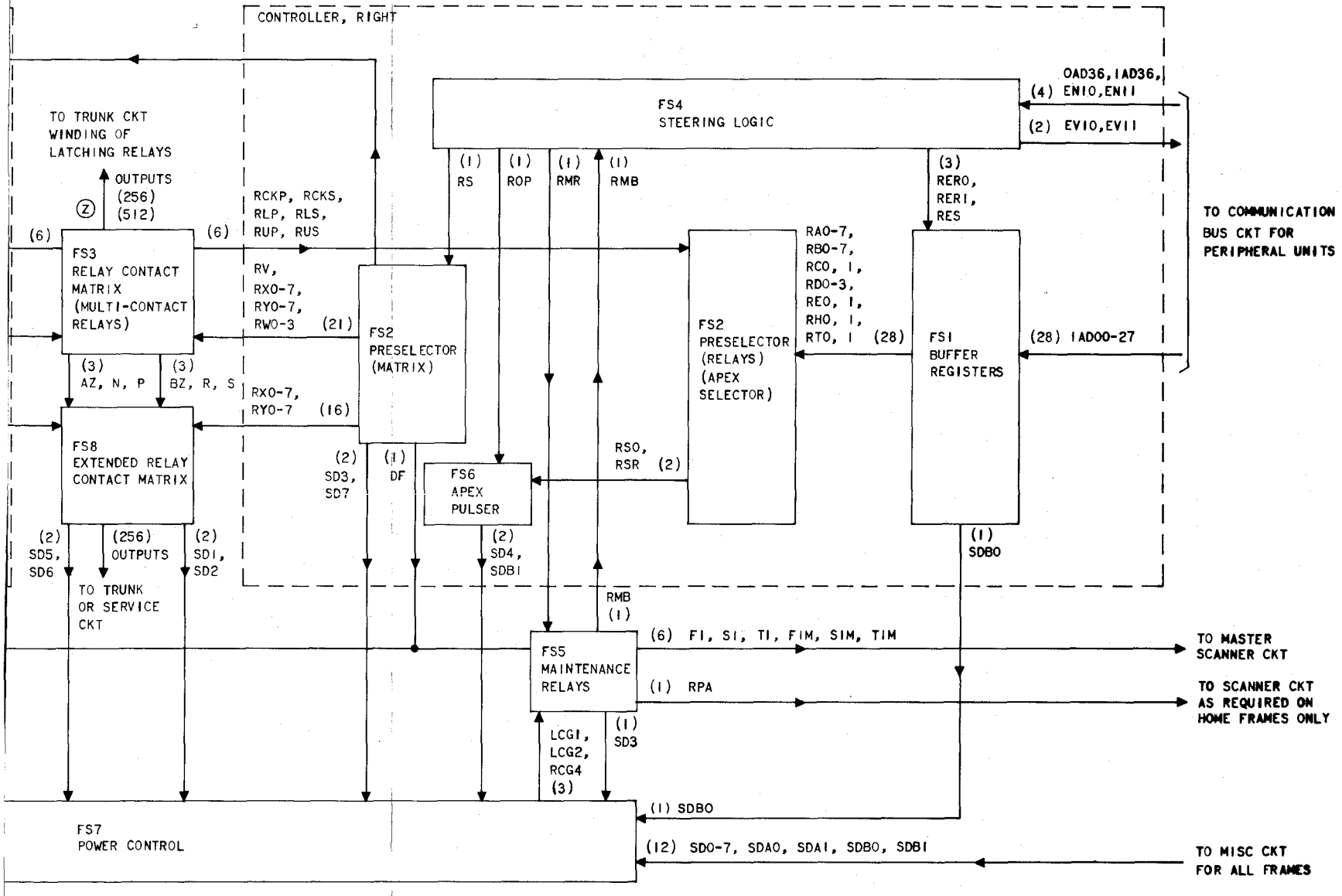


Fig. 16—ESS No. 1 and No. 1A UTF Signal Distributor Circuit Functional Block Diagram