

**NO. 4A AND 4M CROSSBAR
 ELECTRONIC TRANSLATOR SYSTEM
 GENERAL DESCRIPTION**

TABLE OF CONTENTS

CONTENTS	PAGE	CONTENTS (Cont)	PAGE
1. INTRODUCTION	1	D. Distributor Register	5
2. DESCRIPTION OF ELECTRONIC TRANSLATOR SYSTEM	1	E. Central Pulse Distributor Applique	6
3. DESCRIPTION OF STORED PROGRAM CONTROL	2	F. Peripheral Scanner	5
4. FUNCTIONAL DESCRIPTION OF EQUIPMENT ASSOCIATED WITH SPC	2	G. Alarm and Display Frame	6
A. Processor	2	H. Decoder Channel Transitional Circuit	6
B. Store Frames	3	I. Power Distributing Circuit	6
C. Master Scanner	3	J. Group-Busy Relays	6
D. Signal Distributor	3	7. TRAFFIC NETWORK CONTROL CONSOLE	7
E. Central Pulse Distributor	3	8. ANNOUNCEMENT TRUNKS	8
F. Program Tape Unit	4	9. TRAFFIC MEASUREMENTS	8
G. Teletypewriters	4	10. PATH OF A CALL THROUGH AN ELECTRONIC TRANSLATOR OFFICE	8
H. Traffic Data Transmitter Circuit	4	11. PREPLANNING FOR GROWTH	9
5. ELECTRONIC TRANSLATOR SYSTEM — PERIPHERAL EQUIPMENT	4	12. STORED PROGRAM CONTROL REAL TIME USAGE DETERMINATION	10
6. FUNCTIONAL DESCRIPTION OF PERIPHERAL EQUIPMENT	5	13. MODIFICATION OF EXISTING 4A/4M CROSSBAR OFFICES FOR ELECTRONIC TRANSLATOR SYSTEM	11
A. Decoder Channel Circuit	5		
B. Communication Bus Circuit	5	FIGURES	
C. Peripheral Function Translator	5	1. Electronic Translator System Block Diagram	15
		2. Stored Program Control Equipment Design	16
		3. Peripheral Equipment Design	17

CONTENTS (Cont)	PAGE	CONTENTS (Cont)	PAGE
4. Block Diagram of Communication Bus	18	7. Stored Program Control—Real Time Usage	21
5. Network Control Console	19	8. 4A/4M Equipment Modified for Electronic Translator System	22
6. Block Diagram of Typical Call in an ETS Office	20	9. Marker Speedup	23

NO. 4A AND 4M CROSSBAR ELECTRONIC TRANSLATOR SYSTEM GENERAL DESCRIPTION

1. INTRODUCTION

1.01 This section provides a general description of the Electronic Translator System (ETS) used in the No. 4A/4M Crossbar Switching System (Fig. 1). The function of each component is described, as well as the interrelationship of these components with other elements of the switching system. Also covered are growth capabilities, conversion procedures, and the following:

- (a) Stored Program Control (SPC) No. 1A and its application to the telephone switching system, with a general description of the components which comprise the SPC
- (b) The components making up the peripheral equipment that are required to provide the interface between the SPC and the existing 4A/4M crossbar switching equipment
- (c) Description of new emergency announcement trunks associated with the network control console when ETS is provided
- (d) Types of traffic measurements, eg, peg count and overflow, that will be provided by the ETS
- (e) A description of the path of a call through an ETS office
- (f) Methods for preplanning of memory space in the various trunk tables for future additions, changes, and deletion of translation information
- (g) SPC real time usage determination

(h) Preliminary requirements and general procedures for modifying an existing 4A/4M crossbar office for ETS operation.

1.02 References in this section to methods, planning, data requirements, service levels, and equipment quantities are based on AT&T Company recommendations.

2. DESCRIPTION OF ELECTRONIC TRANSLATOR SYSTEM

2.01 The Electronic Translator System (ETS) translates the digits registered in the incoming sender, along with the incoming trunk class mark, into information for outgoing trunk group selection, alternate routing, code conversion, type of outpulsing, screening, and traffic data. This system may be used to increase capabilities of existing No. 4A/4M Crossbar Systems by replacement of decoders and card translators and is standard for all new installations. Provision of the ETS in an office will provide the following advantages:

- (a) Translation capacity and flexibility are greatly increased.
 - (1) The number of trunk classes is greatly increased.
 - (2) Translation instructions are easily altered by teletypewriter.
- (b) Floor space requirements decrease.
- (c) Power consumption is less.
- (d) Maintenance effort is reduced.
- (e) Heat and noise generated by the card translators are eliminated.

- (f) Office and network management controls are enhanced.
- (g) New developments are more easily accommodated.
- (h) Reduces cost of routing changes and trunk addition by use of electronic techniques, as compared to changes by electromechanical means.
- (i) Provides increased attempt handling capacity of No. 4A/4M Crossbar Systems.

2.02 The ETS consists of the following:

- (a) Stored Program Control (SPC) No. 1A
- (b) Peripheral equipment to interface with the existing No. 4A/4M Crossbar System.

3. DESCRIPTION OF STORED PROGRAM CONTROL

3.01 The Stored Program Control (SPC) No. 1A is an electronic control processing system employing modern electronic switching techniques. It provides existing electromechanical systems or new systems with access to a large capacity high speed memory and with access to stored program logic. The SPC consists of a processor, memory stores, central pulse distributor, signal distributor, master scanner, control and display, maintenance teletypewriter, and program tape unit. As used with the ETS, the memory stores contain the ETS logic, or generic program, and the specific office information relative to trunk assignments and routing. Each SPC memory store contains 16,384 40-bit full words (or 32,768 20-bit half words).

3.02 A noteworthy refinement is in the use of the piggyback twistor (PBT) memory module for both temporary (scratch pad) and semipermanent (program) store use. This new concept in store technology provides for rapid electronic alteration of the memory contents with nondestructive readout capability (a read process that does not erase the data in the source). Duplication and high reliability components are used to the utmost to maintain quality telephone facilities.

3.03 A summary of objectives and features of the Stored Program Control No. 1A are as follows:

- (a) The SPC is a stored program processing system of high reliability for general application in telephone switching.
- (b) It represents a flexible means to extend newly conceived telephone services to both electronic and electromechanical installations with a minimum of transition costs.
- (c) The system offers the advantages of a large, expandable, and electronically alterable high speed memory.

4. FUNCTIONAL DESCRIPTION OF EQUIPMENT ASSOCIATED WITH SPC

4.01 The equipment which comprises the SPC is illustrated in Fig. 2. The major units involved are the processor, store, central pulse distributor (CPD), signal distributor (SD), master scanner (MS), control and display (CD), maintenance teletypewriter (TTY) and the program tape unit (PTU).

A. Processor

4.02 The SPC operates under the control of a program of instructions, which is a set of words stored in the store memory. The processor obtains these instructions sequentially from the store and executes them one at a time. Internal registers are used to temporarily store information to be acted upon. The SPC registers can receive data from the input circuits or send data to the output circuits. The processor is a word-organized (basically half words) machine. It is also a macroprogrammed processor, which means that a simple instruction or symbol can be used to cause the processor to perform several different functions. It is the central control of the SPC and it directly or indirectly (according to instructions in the store) controls the operation of every circuit in the system. The processor monitors and controls peripheral equipment by performing operations on call data temporarily stored in its SPC registers under control of a sequence of programmed instructions. For example, an instruction or series of instructions may command the SPC to perform logical and/or arithmetic operations on data currently contained in store.

4.03 For service protection, two identical processors are provided for continuous parallel operation from duplicated stores. Both processors are simultaneously performing the same routines but only one is actively in control. High speed matching of information between the two processors provides the major means of trouble detection.

B. Store Frames

4.04 The store is a single memory circuit utilizing piggyback twistor (PBT) devices for storage of all the programs, translation memory, and data table needs of the SPC. The PBT provides nondestructive readout, and can be altered electrically for storage of temporary information and for changes in data and the stored program. The store frames provide the complete memory system for the SPC. Information stored in the memory consists of the generic, diagnostic, office data, and maintenance programs. The memory stores have been divided into two storage areas, protected and unprotected. The protected area is that area in which the actual SPC program and semipermanent data are stored. The protection consists of certain "locks" which must be opened before the master program can be altered. This provides a safety feature necessary in order to avoid accidental machine or man-made changes in the master program. The unprotected area of the store is that portion which is constantly being read and written into during the normal operation of the SPC.

4.05 Either five or six pairs of store frames are provided.

4.05 Store frames are always provided in pairs.

C. Master Scanner

4.06 A master scanner (MS) is the principal source of input to the system. Its main function is to sense the state of a row of points in the system where information may be obtained; that is, absence or presence of current flow in 1024 separate circuits. The many circuit points from which information is required are associated with ferroids (current sensing devices, used in scanners and other equipment having comparable functional capabilities for supervisory and other purposes) in

the scanner. The ferroids within a scanner are divided into 64 rows of 16 scan points each. Selection can be made from any row of 16 scan points for interrogation.

4.07 When the SPC desires to obtain information regarding the state of a specified circuit point, it addresses the scanner, which then scans the row containing the ferrod associated with the specified circuit point. The scanner answer transmitted to the SPC as the result of this interrogation represents the existing state of the specified circuit point, as well as all of the other circuit points associated with the remainder of the ferroids in the interrogated ferrod row.

4.08 One master scanner is provided with the SPC. Control of the MS in the SPC is duplicated, but the individual inputs are not.

D. Signal Distributor

4.09 The signal distributor (SD) provides the necessary access to operate electromechanical devices. In response to orders from the processor, the controller of the SD can, in about 19 milliseconds, operate or release one of a maximum 256 magnetic latching wire-spring-type relays. All of the SD outputs are used by the SPC for internal functions. Additional SDs can be added according to the requirements of the application. The SD controller section is duplicated, but the individual outputs are not.

E. Central Pulse Distributor

4.10 A central pulse distributor (CPD) provides the processor with rapid electronic access to numerous points throughout the installation. A major function of the CPD is to enable peripheral units such as the MS and SD to deliver information to another peripheral unit. The processor instructs the CPD to enable the desired unit to receive information over a separate address bus.

4.11 The CPD can select and pulse one of 768 outputs according to the address specified by the processor. Of the 768 outputs, 512 are unipolar; that is, pulses of only one polarity can be supplied. Unipolar outputs are used mainly to enable peripheral units in the installation served by the SPC. The remaining 256 outputs are bipolar, meaning that each can consist of a pulse of either positive or negative polarity. Bipolar

outputs are used mainly to control flip-flops (a circuit capable of assuming either of two stable states at a given time) and logic circuitry.

4.12 Two CDPs are provided with the stored program control to ensure continuity of service.

F. Program Tape Unit

4.13 The program tape unit (PTU) is used initially to load the memory stores with the program of the ETS. In addition, this equipment is used for insertion into the memory of major generic program changes, updating of the program, extensive changes in the translation data, and in general, all additions to the store which would be time consuming to be entered via the teletypewriter. The PTU can provide a large capacity magnetic tape output under direction of the processor which can be used for decompile-recompile of the ETS office data in preparation of a new office data tape or an office equipment addition.

4.14 The PTU also serves as a backup in the event of the total loss of duplicated information. Reserve generic and office data tapes can be loaded into the memory stores to restore the information.

4.15 The PTU uses a 1/2-inch, 9-channel magnetic tape. It has about 200 characters per inch, with a record length of 10 to 756 characters. The modes of operation include read, write, forward, reverse, rewind, and maintenance. The PTU is not duplicated.

G. Teletypewriters

4.16 There are four teletypewriter sets associated with each ETS. These sets are required to properly administer the traffic through the ETS and for maintenance purposes. Two are used for the 4A maintenance personnel and two for the traffic administrator organization. These sets are designated as channels 0 and 10 for maintenance and 2 and 3 for traffic administration.

4.17 Channel 0 is the SPC maintenance TTY set and is furnished with the control and display frame, program tape, and teletypewriter frame, which are part of the SPC equipment. The set is a keyboard send and receive (KSR) set.

4.18 Channel 10, the 4A maintenance set, is a free standing 35 automatic send and receive (ASR) type, and is located in the 4A maintenance area near the trouble recorder frame.

4.19 Channel 2, the traffic administration TTY, is a free standing 35 ASR type and is located in the network managers office preferably near the network control console.

4.20 Channel 3, the traffic data channel, is a free standing 35 receive-only with a typing reperforator (ROTR). The ROTR is not provided when a traffic data transmitter (TDT) is provided.

H. Traffic Data Transmitter Circuit

4.21 The traffic data transmitter (TDT) circuit provides a means of transmitting traffic data accumulated by the ETS to a remote traffic data recorder (TDR). This optional equipment arrangement is used in place of data output to local channel 3 teletypewriter. On receiving a ready signal from the TDR, the TDT will send the accumulated output data via a dedicated data channel to the TDR.

5. ELECTRONIC TRANSLATOR SYSTEM—PERIPHERAL EQUIPMENT

5.01 The peripheral circuits (Fig. 3) are required to provide an interface between the SPC and the No. 4A/4M crossbar machine.

5.02 These circuits are the decoder channel (DCH), peripheral function translator (PFT), distributor register (DREG), central pulse distributor applique (CPDA), and peripheral scanner (PSC).

5.03 The communication bus circuit, described in 6.05, provides the communication channels between the SPC and these peripheral units. In addition to these circuits required for the interface, three other circuits are required: the power distributing circuit, the alarm display circuit, and the decoder channel transitional circuit.

6. FUNCTIONAL DESCRIPTION OF PERIPHERAL EQUIPMENT

A. Decoder Channel Circuit

6.01 The decoder channel (DCH) circuit provides access from the decoder connectors to the SPC for translation of the dialed code digits, controls the selection of an IT or TC marker through the associated marker connector per instruction from the SPC, verifies the sender-marker connection through the decoder connector, and checks marker registration of routing information from the SPC.

6.02 The decoder channel circuit is capable of telling the SPC to provide additional trunk group information when the marker must select in trunk groups that have more than one subgroup and are not equipped with group-busy chain leads.

6.03 The DCH circuit has been equipped with cross-detecting relays and timing circuits to initiate trouble recordings. In order to eliminate trouble recording of nonreproducible failures, the decoder channel is designed to request a retrial for any failure which may have been caused by a SPC error or transient.

6.04 Five DCH circuits are mounted on an 11-foot, 6-inch frame. There are a minimum of three and a maximum of ten DCHs required in an office. The number of working DCHs in an office should not exceed total markers in any one train.

B. Communications Bus Circuit

6.05 The communications bus circuit (Fig. 4) transfers information between the SPC and peripheral units by pulsing over pairs of wires on a time-shared basis. The entire bus system is duplicated for system reliability. Except for the peripheral function translators, which are dedicated to one bus, all peripheral units are capable of using either of the duplicated buses.

6.06 The two main buses are the address bus and the answer bus. The address bus transmits binary information from the SPC to the PFT, translates information from the PFT to the peripheral scanners, and translates binary information from the PFT to the DREG. The answer bus

transmits binary information from the peripheral scanners to the SPC.

6.07 In addition, there is a "we really mean it" (WRMI) bus which provides a path for a gating pulse to peripheral units to guard against false signals. There are also some subsidiary dedicated buses for enable and "all seems well" (ASW) signals between the SPC and specific peripheral units.

6.08 This bus system must be isolated from power leads and signaling leads to relay-type circuits. It has other restrictions relating to length of leads and balance to ground.

C. Peripheral Function Translator

6.09 The peripheral function translator (PFT) receives binary information (20 bits + parity) from the processor, checks it for odd parity, registers it for timing purposes, and passes translated address information to the peripheral scanner and untranslated information to the DREG. It translates the binary information from the processor in order to interrogate a particular row of ferrods in the peripheral scanner. Information to the DREG is already coded and needs no translation. The PFT also has a means of generating invalid scanner addresses which are used in the diagnostic tests of the two peripheral scanners and the PFT.

6.10 The PFTs are dedicated to bus systems, and removing one from service removes one of the duplicated buses. Two PFT circuits are required per ETS installation.

D. Distributor Register

6.11 The DREG accepts high speed pulsed information from the SPC or PFT and amplifies and distributes this information at the speed required to operate relays in the electromechanical equipment. The desired register is selected by an enable signal generated by the CPD. The DREG circuit is capable of distributing as much as 120 bits of information (20 bits at a time) to other circuits such as the marker or trouble recorder. Even though the output information is coded and errors would be eventually detected, the DREG is designed to check the input by means of a parity check. This enables detection of errors when they occur so that a meaningful diagnosis can be made and remedial action taken, if necessary.

6.12 Three DREGs are mounted on each DREG frame with one CPDA on DREG frames 0 and 1. There is a DREG associated with each decoder channel, one for trouble recording and one for interface with an auxiliary recording control circuit.

E. Central Pulse Distributor Applique

6.13 The CPDA provides for fast single point distribution and acts as a buffer between the CPD and the link controller circuit. The CPDA unit is mounted on the DREG frame. It is also used to give out-of-service indications to the SPC.

6.14 Four CPDA units must be provided, each unit containing up to four CPDA circuits. Distributor register frames 0 and 1 are each equipped with a CPDA unit. The CPDA unit on DREG frame 0 serves up to 24 even link controllers; the CPDA unit on DREG frame 1 serves up to 24 odd link controllers. Up to eight CPDA circuits, units 2 and 3, are provided for miscellaneous distribution (out-of-service function of various peripheral units) with a distribution capability of 64 points. These CPDA circuits are mounted on the alarm and display (AD) frame.

6.15 The CPDA is seized by means of an enable signal generated by the CPD at the request of an address generated by the SPC. This signal sets the bipolar flip-flop to operate a dry reed relay, which signals the associated link controller. The controller informs the SPC via the scanner that the signal has been received. The flip-flop is then restored to normal.

F. Peripheral Scanner

6.16 The peripheral scanner (PSC) is the input buffer between the SPC and the electromechanical control equipment required for electronic translation. It converts the information stored in the relays of the electromechanical circuits into pulses that the SPC can use for translation. The principal circuits to be scanned are the sender, link controller, decoder channel, and group-busy relay chain.

6.17 The PSC is a 1280-point ferrod-type scanner with dual controller access. It is capable of providing a 20-bit readout, uses 1E ferros to provide for -48 volt operation, has readout loops containing 32 readout windings, and has improved

maintenance arrangements because the core circuit packs can be easily replaced. The 20-bit scanning was selected in lieu of 16-bit scanning because: (1) the SPC is capable of handling 20-bit words, (2) a great deal of 4A/4M intelligence such as sender input information to the decoder channel and link controller data is in a 2-out-of-5 code which fits 20-bit groups better, and (3) trunk subgroup sizes are generally arranged in multiples of 20.

6.18 A minimum of two and a maximum of four peripheral scanners are provided per office and each contains the duplicated controller. Only one of the two scanner controllers can be taken out of service at any time.

G. Alarm and Display Frame

6.19 The alarm and display (AD) circuit contains status indications for the DREG and peripheral scanner circuits and has provision for sounding the major and minor office alarms when a system-detected trouble occurs.

H. Decoder Channel Transitional Circuit

6.20 This is a small circuit, consisting of two relays and diodes, which is mounted on the incoming sender test or incoming sender and register test frames to allow testing of senders on an automatic basis. Testing occurs during the transition period when card translators and decoders are being replaced by the ETS.

I. Power Distributing Circuit

6.21 The power distributing (PD) circuit provides a central distributing point for +24 volt and -48 volt power feeding the electronic frames. Sufficient filtering is provided for noise isolation between feeders. The power supply is a 111A power plant which should be located on the same floor, or one floor above or below the ETS, and no farther than 200 cable feet from the power distribution frames.

J. Group-Busy Relays

6.22 A new group-busy (GB) relay circuit has been designed for use with the ETS. It provides a one-GB relay for use with small trunk groups not expected to exceed 40 trunks and 2-GB

and 4-GB relays for use with larger groups. The new circuit is to be used for all GB additions to an ETS equipped office. A modification for the existing GB circuit is available in SD-68420-01, Issue 11D to make present GB installations usable in ETS equipped offices.

6.23 It is recommended that group-busy relays be installed on all trunk groups, if practical, in order to minimize decoder channel and marker holding time. To equip all trunk groups with GB relays, the number of GB ferroids available for GB leads in the ETS has been increased to a maximum of 1720. Each GB relay requires the following number of ferroids:

TYPE	NO. OF FERROIDS
4 GB	5 (One GO lead + 4 GB leads)
2 GB	3 (One GO lead + 2 GB leads)
1 GB	2 (One GO lead + 1 GB lead)

Subgroups of the 4-GB and 2-GB relays can be assigned to different trains to assist in office balancing. GB relays cannot be assigned to announcement trunks.

7. TRAFFIC NETWORK CONTROL CONSOLE

7.01 The network control program (NETC) provides direct interface between the traffic administration personnel and the ETS. The associated control console (Fig. 5) can be desk- or console-mounted. It must be located in the traffic management area near the channel 2 teletypewriter. Also, provisions are provided for remoting the network console and teletypewriter by using telemetering circuits.

7.02 Controls in this console will activate scanner terminals in the ETS to accomplish changes in translation. In response, the ETS distributor register will provide control activation status information to the channel 2 teletypewriter and the console.

7.03 The console will allow the traffic administrator to execute the following controls:

- (a) Route cancellations can be placed on any outgoing trunk group. They will cancel

alternate route traffic, or direct and alternate route traffic, and will route this traffic to an announcement trunk (NCA or emergency ANN 1 or 2) as specified by the traffic administrator. A percentage (25, 50, 75, or 100) of the traffic may be controlled, as well as the type (alternate route or alternate route plus direct).

- (b) Skip alternate route or direct and alternate route traffic to the next in-chain alternate route by percentage (25, 50, 75, or 100).

(c) One hundred preprogrammed control selector positions are available for preplanned controls including cancels, skips, code blocks, and reroutes. The reroute control can be placed on any outgoing trunk group and will reroute overflow traffic to a preplanned out-of-chain route. A percentage (25, 50, 75, or 100) of traffic may be specified as well as the type. Traffic classified as nonreroutable codes will not be rerouted.

- (d) Code blocks can be placed on any 3- or 6-digit code. They will cancel by percentage (25, 50, 75, or 100) traffic destined for those codes and will route these calls to announcement (NCA or EA No. 1, 2).

7.04 Ten of the 100 preprogrammed control selector positions are available for activating multiple controls of ten each. Five of these preprogrammed controls can be activated remotely, usually via a dc control lead from the higher ranking office. Verification and status of each control, as it is implemented, are automatically printed on the channel 2 teletypewriter. A summary by type of all controls in effect is printed on demand.

7.05 Network controls are designated as manual, local-preprogrammed, or remote-preprogrammed. There are three restrictions on the number of local controls implemented simultaneously: 20 manual cancels and skips, 18 code blocks (both manual and local-preprogrammed), and 20 reroutes (local-preprogrammed and manual traffic overload reroute control).

7.06 At regional center switching systems, the traffic network control console is equipped to provide manual traffic overload reroute control (TORC). Direct and/or alternate route traffic overflowing from the regional finals (or preselected trunk groups) can be rerouted by percentage (25, 50, 75, or 100) to any other regional center, or to

one of the two predesignated intraregional primary or sectional centers. Twenty-four registers are available to measure peg count on traffic rerouted (TORC'd) from the regional final and the peg count on traffic rerouted to the via route.

8. ANNOUNCEMENT TRUNKS

8.01 The traffic control console permits routing of calls to either one of the two emergency announcement trunk groups (EA1, EA2), which should be established for this purpose. Calls can also be routed to the NCA trunks by key control.

8.02 Under this traffic control arrangement, the general provision of circuit-busy announcement (CBA) trunks will not be required for emergency or overload announcement.

8.03 The CBA circuits may be used on selected trunk groups, such as overseas trunks, where the performance history may indicate a repeated need for special announcements. This will reduce the need to utilize the emergency announcement trunks EA1 and EA2 for frequently recurring announcement requirements.

8.04 With the reduced requirement of CBA groups at new offices, a minimum of five jacks on each announcement channel may be provided at the traffic supervisory cabinet. At existing offices, the change in the jack quantity may not be warranted. Under ETS operation, calls will be directed mostly to a specific subgroup of announcement trunks by the ETS, instead of by the marker. The marker will continue to direct some calls to NCA or FRA and score these overflows on electromechanical registers.

9. TRAFFIC MEASUREMENTS

9.01 Trunk group peg count and overflow traffic counts will be stored in software registers and printed on a traffic data teletypewriter. Flexibility has been provided in that printing of data on selected items for network management can be scheduled on short intervals to meet the needs of the system. These registers can be assigned or reassigned quite readily by input requests from the network management teletypewriter.

9.02 The stored program included with the ETS provides traffic data in a readily usable format. The data have been divided into five blocks of information as follows:

- (a) Block A—machine engineering
- (b) Block B—trunk engineering and administration
- (c) Block C—network management
- (d) Block D—traffic administration
- (e) Block E—division of revenue.

9.03 The ETS will accumulate counts on the following major items and, for the most part, will replace counts now recorded on electromechanical registers:

- (a) Trunk group peg count and overflow—outgoing
- (b) Trunk group peg count—incoming
- (c) Announcement group peg count and overflow (EA, NCA, SOA, ROA, VCA, MCA, UCA)
- (d) Decoder channel peg count
- (e) Traffic separation peg counts
- (f) In, out, and through peg counts
- (g) INWATS terminating calls routed and not routed.

9.04 The decoder channel is the only ETS equipment whose usage is to be measured on the TUR.

10. PATH OF A CALL THROUGH AN ELECTRONIC TRANSLATOR OFFICE

10.01 The following covers the method of operation of that part of a 4A/4M office affected by the introduction of the ETS. Fig. 6 illustrates a typical call through an ETS office. When the distant end of an incoming call seizes a trunk, a start signal is sent to the sender link frame on which the trunk appears [(1) Fig. 6]. The sender

link frame bids for and attaches an idle link controller (2). Scanner ferrods associated with the bidding link controller contain the incoming trunk and idle sender identity. The SPC scans the link controller bid ferrods (3) in the peripheral scanner and recognizes a saturated (energized) bid ferrod as a request for service. The SPC, through the PFT, interrogates the scanner in which the link controller data appears (4), records trunk and sender identification in memory, and signals the controller (5) via the CPDA that identification has been successfully completed. The controller now completes the crosspoint closure, transfers control of the crosspoint connection to the sender, and the sender signals the originating distant office to begin outpulsing (6). The sender signals its decoder connector (7) to seize an idle decoder channel when sufficient digits have been received to proceed with translation. The code digits and sender identity are passed over decoder connector leads through the decoder channel input section to ferrods within the decoder channel scanner appearance (8). The decoder channel signals the SPC, requesting a route translation (9). The SPC identifies the sender being served by the decoder channel and the code requiring route translation by scanning the decoder channel ferrods. "It looks up" in memory the trunk being served by this sender (previously recorded from controller scan), obtains the trunk class information (10), and proceeds with translating the 3- or 6-digit code into an outgoing trunk route. Upon completion of route translation (11), the SPC distributes the following information (12) into the decoder channel output section via the PFT and DREG.

- (a) Marker (intertoll or toll completing train)
- (b) Outgoing trunk group location in the trunk block connector
- (c) Class, code conversion, and variable spill information to be transmitted from marker to sender
- (d) Action to be taken by marker if all trunks are busy.

The decoder channel then signals its marker connector to seize an idle marker (13). When a marker is connected, outgoing trunk group and associated information (14) is registered from the decoder channel distribution points. The decoder connector also closes a path from marker to sender. Upon registration of all decoder channel data, the marker

signals the decoder channel to release. The marker uses the trunk block and block relay numbers to connect to a block relay frame for outgoing trunk selection. Having tested for and seized a particular idle outgoing trunk, the marker identifies the outgoing link appearance (15). The marker now proceeds to establish connections on incoming and outgoing link frames between the selected outgoing trunk and the incoming trunk being served (16). The SPC routinely scans peripheral scanner ferrods dedicated to the marker to determine if a trunk has been selected on a call (17). After the trunk is selected, the SPC updates the peg count and overflow memory registers of the outgoing trunk group being used on the call. When crosspoints have been closed, the marker passes outpulsing information to the sender and releases (18). The sender outpulses the called digits over the transmission path (19) via the sender link, incoming link, outgoing link, and through the outgoing trunk to the distant office (20). The sender releases when it completes pulsing. The crosspoint linkage is left under control of the incoming trunk, which releases upon receipt of disconnect supervision.

11. PREPLANNING FOR GROWTH

11.01 When there is new Electronic Translator System installation, or an addition to an existing system, it will be necessary for the Dial Administrator to assist the Traffic Engineer as much as possible in preplanning to simplify future additions. Preplanning means providing certain office data in memory to be associated with foreseeable equipment additions and also providing for growth within key routing tables without necessitating the relocation of such tables. The preplanning should be done by using the spare memory available. If a new store frame is required on the next addition, consideration should be given to providing it and then preplanning memory with the additional store frame.

11.02 In a No. 4 crossbar office equipped with ETS, it is not practicable to generate a new master office data tape every time a change is made. Changes which will alter existing memory can be made very easily, but changes which require additional lines in memory tables can only be made by moving the existing table line by line to another location in memory, which is time consuming.

11.03 The following types of changes will require preplanned space in the ETS memory:

- (a) Additional trunk subgroups
- (b) New routing treatments
- (c) New trunk groups
- (d) New code conversion
- (e) New sender link frames.

11.04 The information for future changes can be obtained from the formal trunk estimates for intertoll and toll connecting trunks and from routing engineers for new codes, routing patterns, and code conversions.

11.05 The Traffic Engineer is responsible for determining the number of store frames required to provide memory capacity for actual and preplanned trunk groups and translation requirements. However, the actual preplanning of this memory capacity is done by the traffic assignment and routing personnel when the ETS questionnaire forms (E-8075) are completed. Refer to Division D, Section 7-d(2) for determination of store frame quantities.

12. STORED PROGRAM CONTROL REAL TIME USAGE DETERMINATION

12.01 The total real time usage (Fig. 7) is a summation of the overhead and call-dependent components. Overhead is a constant real time quantity, consisting primarily of executive control (ie, the scheduling of tasks and their associated administrations and the execution of periodically scheduled monitor programs), most of which is scanning for service requests.

12.02 The overhead, which is a fixed quantity of 15 percent, is expended whether or not any calls are being processed by the system. The call-dependent portion of the real time consists of trunk identification, code translation, and route selection functions executed on a per call basis. The call-dependent real time has been calculated to be 6.2 milliseconds per call; however, the selection of the first alternate route adds 1.6 milliseconds per call. The selection of alternate routes beyond the first alternate route will add an additional 1.2 milliseconds per call. The additional 0.4 millisecond

per call on the first alternate route is required to prime the traffic measurement program to score additional peg count and overflow registers.

12.03 Fig. 7 illustrates the system real time usage as a function of marker attempts per hour for three cases: all first choice routes, all first alternate routes, and all fourth alternate routes. For example, at 4A-type offices engineered for 120,000 marker attempts per busy hour, the total real time usage at 120,000 attempts is tabulated as follows:

All first choice routes—35.5%

All first alternate routes—40.6%

All fourth alternate routes—52.5%.

12.04 Inasmuch as route selection in a 4A machine normally falls between the first choice route and the all-first-alternate route situations, the real time usage for a 4A ETS System operating at 120,000 marker attempts would be less than 40 percent. 4A Systems operating at less than 120,000 marker attempts per busy hour will have a real time usage of less than 40 percent.

12.05 The following approach is recommended as the way to determine call processing real time usage in a working ETS office. Two pieces of data must be obtained to make meaningful real time calculations. First, the rate at which executive control is cycling E-to-E (a base level dispenser program which is divided into the following classes: A, B, C, D, and E to perform a required function on a regularly scheduled basis according to a priority pattern such as ABACABADABACABAEAB, etc, repeating endlessly with class A examined more frequently than class B) and the amount of artificial load added by the E-to-E time rate control program must be determined. This can best be done by observing the QEC00 output message. This message indicates the number of times executive control cycled class E to class E in the previous quarter-hour. This message is printed every quarter-hour. A typical printout is as follows:

```
QEC00 0072557 0006200
```

The second piece of data needed is the rate of decoder channel attempts during the time which the real time observation is to be made. This is easily done by requesting a plant measurements

counter dump at the beginning of the observation period and again at the end of the period. Decoder channel attempts can then be determined by noting the difference in the decoder channel attempts in the two plant measurement dumps. The decoder channel bid rate must be determined during the same time as the executive control program is being observed. The calculations shown here are for data gathered over a 15-minute period.

12.06 Under normal circumstances, the ETS is performing one of five functions: (1) call processing, (2) administering timetable driven work, (3) performing base level executive control overhead, (4) performing administration of the E-to-E rate control program, and (5) adjusting the E-to-E time. The sum of the time spent by each of these functions must equal the time over which the observation was made. Of these five, the only function whose time consumption cannot be easily determined is the call processing real time. Following is the procedure for calculating each of the functions, except the call processing real time. This will be determined by the difference between the time spent by the sum of the other four functions and the observation period. These calculations are for an observation period of 15 minutes. The data used are given in Table A.

13. MODIFICATION OF EXISTING 4A/4M CROSSBAR OFFICES FOR ELECTRONIC TRANSLATOR SYSTEM

13.01 The ETS has been designed to permit its introduction in an existing office on an in-service basis, with the minimum of down time in common control equipment. Fig. 8 shows the existing electromechanical equipment that is modified for ETS operation.

13.02 Modification of the E4390A trouble record card, removal of pretranslation in the senders, and decoder connector speedup are required prior to ETS operation. Consideration should be given to adding marker speedup (Fig. 9) and associated link frame modifications. The increased capacity features will reduce ETS holding time and will permit the new decoder connector frame to handle the maximum sender capacity of 36 senders per frame, with 9 senders per connector. The marker speedup alone will increase the decoder connector frame capacity in an ETS equipped office from 28 to 32 senders. Adding the link frame increased capacity permits the maximum of 36 senders per connector frame.

13.03 In 4A/4M switching offices which are planning to convert to ETS operation in the near future, implementation of the increased capacity features should be considered. By adding the increased capacity features prior to ETS operation, the decoder connector speedup (which is required for ETS) and marker speedup may forestall provision of additional decoders or markers. Additional frames are required (eg, supplementary decoder connector frames) when going beyond the tenth decoder or providing decoder subgrouping if the requirements exceed 18 decoders. The increased capacity features may be applied in different package combinations to meet the particular needs of the various 4A/4M offices.

13.04 When converting the existing No. 4A/4M office from card translation to ETS operation, there is considerable Western Electric activity; therefore, the job will require careful planning and the writing of methods of procedure to provide a smooth conversion. The MOP must have the approval of the Dial Administration. Refer to Div. H, Sec. 13d (7).

13.05 The modification of the existing equipment and the installation of the new equipment can be performed in five stages (13.06 through 13.17) for ease of installation.

13.06 Stage 1 consists of modifications made in advance and preparation for ETS features and options. The following modifications are required and must be provided in offices in which they are not already provided for ETS:

- (a) Remove pretranslation from senders
- (b) Add increased capacity features to decoder connectors
- (c) Modify trouble recorder (equip E-4390A card).

13.07 Stage 2 consists of modifications of existing equipment to add all or partial ETS features and options prior to cutting the ETS into service. Modifications to be made as part of stage 2 are as follows:

- (a) Decoder-marker test and trouble recorder frame
- (b) Marker
- (c) Sender link
- (d) Link controller and connector

TABLE A

Observation Period	15 Minutes = 900 Seconds
Number of Cycles E-to-E	30,063 (appears as 72557 ₈ in first data field of QEC00 output message) number of times executive control has cycled E-to-E in the past 15 minutes.
Figure of Artificial Load Added to System	3200 (appears as 6200 ₈ in second data field of QEC00 output message) number which is proportional to the amount of artificial load which has been added to the system in the past quarter-hour.
Decoder Channel Attempts	15,070

System Time Usage Calculations

- (1) Timetable driven tasks administration
(13.2% of system real time)* (.132) (900 sec) = 118.80
 - (2) Base level executive control administration
(8.54 ms/E-to-E cycle)* (8.54 x 10⁻³) (30,063) = 256.94
On a 15-minute basis, this is a fixed amount of time since ETS very accurately controls the E-to-E cycle rate. Also, in 15 minutes the 30,063 E-to-E cycles normally occur.
 - (3) Administration of E-to-E rate control program (.00136 sec/E-to-E cycle)* .00136 x 30,063 = 40.88
 - (4) Artificial load added to system
(.103 x # in second field of QEC output message)* .103 x 3200 = 329.60
- TOTAL 746.22 Sec

Call processing time = 900 sec — 746.22 sec = 153.78 sec

Call processing real time percentage = $\frac{153.78}{900} = 17.08\%$

Time/decoder channel attempt = $\frac{153.78}{15,070} = 10.2 \text{ ms}$

Projected real time usage at calling rate of 120,000 decoder channel attempts/hr = $\frac{(17.08) (120,000)}{(15,070) (4)} = 34.0\%$

* The figures as shown in items (1), (2), (3), and (4) are valid and can be used with Issues 7 and 8 of PG 68000 (the current ETS Generic).

- (e) Decoder connector
- (f) Incoming sender and register test frame
- (g) Incoming sender test frame
- (h) Incoming, outgoing, and intertoll trunk test set
- (i) Traffic register frame
- (j) Automatic incoming trunk test frame (AITT)
- (k) Floor alarm frame
- (l) Interrupter frame.

13.08 Stage 3 consists of installation of ETS frames. The installation of the new electronic ETS frames (Fig. 3 and 4) will require testing with the following frames:

- (a) New 111A power plant.
- (b) Decoder channel frames with the new marker connector frames.
- (c) New network control frame and console.
- (d) After the preceding preliminary tests have been made, the DREG and peripheral scanners should be connected to the electromechanical portion of the office.
- (e) Modification of the link controller and connector at this time will enable operational tests to be performed. These tests will verify controller scanner appearances on the CPDA circuits in order to allow the controller to be turned up for service and to permit calls to be presented to the SPC for memory storage. At this time, calls will still be completed via the decoder and card translator.
- (f) Overall operational tests of the decoder channels, marker connectors, markers, peripheral scanners, distributor registers, and the SPC translation data are made via the decoder-marker test and trouble recorder frame.
- (g) Verification tests of trunk class assignments in the SPC memory are now made via the teletypewriter.

13.09 One new marker connector frame, equipped with three connectors, is required for conversion and will be associated with the first three decoder channels cut into service. Though not recommended, the existing marker connectors could be reused for the remaining decoder channels. The advantages of all new marker connectors are as follows:

- (a) Channels and connectors can be pretested before conversion begins.
- (b) Increased capacity version will decrease decoder channel holding time. (Old version cannot be modified for increased capacity.)
- (c) Old flat spring version connectors will have a shortened life due to higher ETS usage.
- (d) Ease of conversion is provided.

13.10 Stage 4 consists of actual transition from decoder to decoder channel operation. There are five plans (A through E) covered in 13.11 through 13.15 for converting from decoder to decoder channel operation. Plans A and B will work in all offices equipped with four or more decoders. The other plans have certain advantages in particular offices and they should be reviewed to establish which plan is best for a particular office. Most serious consideration should be given to plan A, since overall it is the most practical plan from a service, economic, and ease of conversion standpoint in offices not having excess decoder capacity.

13.11 Plan A is used to establish a separate decoder channel group by adding additional decoder connectors. Plan A requires the addition of a sufficient number of new decoder connectors for reassigning existing office senders, in order to deload traffic from the existing decoders. Enough senders must be reassigned to permit removing three decoders from service, with the remaining decoders having sufficient capacity to handle the remaining traffic. Although this plan requires recabling of a number of senders and additional decoder connector frames, it represents the most practical plan in a decoder-limited office.

13.12 Plan B is used to establish a separate decoder channel group by adding additional decoder connectors. It also is used to establish a partial decoder channel group by rearranging the decoder connector multiple and chain leads for three

decoders. The actual sender conversion to ETS operation would be on a connector-by-connector basis. The main advantage to this plan is that it will work in all offices presently equipped with four or more decoders and will generally provide an economical transition while still leaving an adequate number of senders, decoders, and decoder channels in service at all times. The two basic requirements of this plan are (1) an adequate number of senders, decoders, and/or decoder channels must always be available to handle normal traffic conditions, and (2) any sender must have access to a minimum of two (preferably three) decoders or decoder channels. The plan does, however, require some decoder-to-decoder connector recabling and connector multiple rearrangements.

13.13 Plan C is used to establish a new decoder channel group by providing all new decoder connectors and reassigning existing senders to the new group. After a few of the senders are reassigned, the ETS would be made operational and work in parallel with the card translators. The card translator complex would be disabled and removed only after the last sender is reassigned. This plan offers a smooth transition period without affecting the traffic-handling capability of the office. Since the new connector frame can handle 36 senders and occupies less floor space than the older vintage decoder connectors, a review should be made (in offices that have limited floor space) to determine if the increased cost of the connectors and recabling

13.14 Plan D is the direct replacement of decoders with decoder channels, with the first two decoders replaced initially without deloading decoders. The actual sender conversion to ETS operation would be on a connector-by-connector basis. This plan offers minimum installer effort but affects the traffic-handling capability of the office. Since most offices converting to ETS will be decoder-limited, plan D will be difficult to use.

13.15 Plan E is used to add new decoder or decoder channel appearances on existing decoder connector frames. It requires the addition of two new decoder, or decoder channel, appearances

on existing decoder connector frames. The actual sender conversion to ETS operation would be on a connector-by-connector basis. The plan offers a smooth transition period without affecting the traffic-handling capacity of the office, but has the disadvantage of the cost of the extra connector relays. In addition, it would be necessary to reassign DR0 and 1 initially, or reassign the DCH assigned to the new appearances after transition to allow sequential growth of decoder channels. This plan cannot be used in offices with more than eight decoders, and should only be considered in smaller offices with large growth potential.

13.16 The steps involved under each plan and the plan applied to a 10- to 12-decoder office converting to five decoder channels are covered in more detail in BSP 818-007-153.

13.17 Stage 5 consists of the removal of unneeded equipment and conversion options after the office has been entirely converted to ETS operation. The following equipment items will require additions of new options for ETS operation and removal of options associated with card translator operation after the last decoder is removed from service:

- (a) Incoming sender and register test frame.
- (b) Incoming sender test frame.
- (c) Automatic incoming trunk test frame.
- (d) Trunk class translator frame.
- (e) Trouble receiver frame.
- (f) Traffic control frame. (Replace card translator option with ETS option.)
- (g) Marker (the removal of the announcement trunk routing and recording of stuck sender features).
- (h) The removal of the decoders, card translators, translator connectors, foreign area translators, and alternate route traffic control frame.

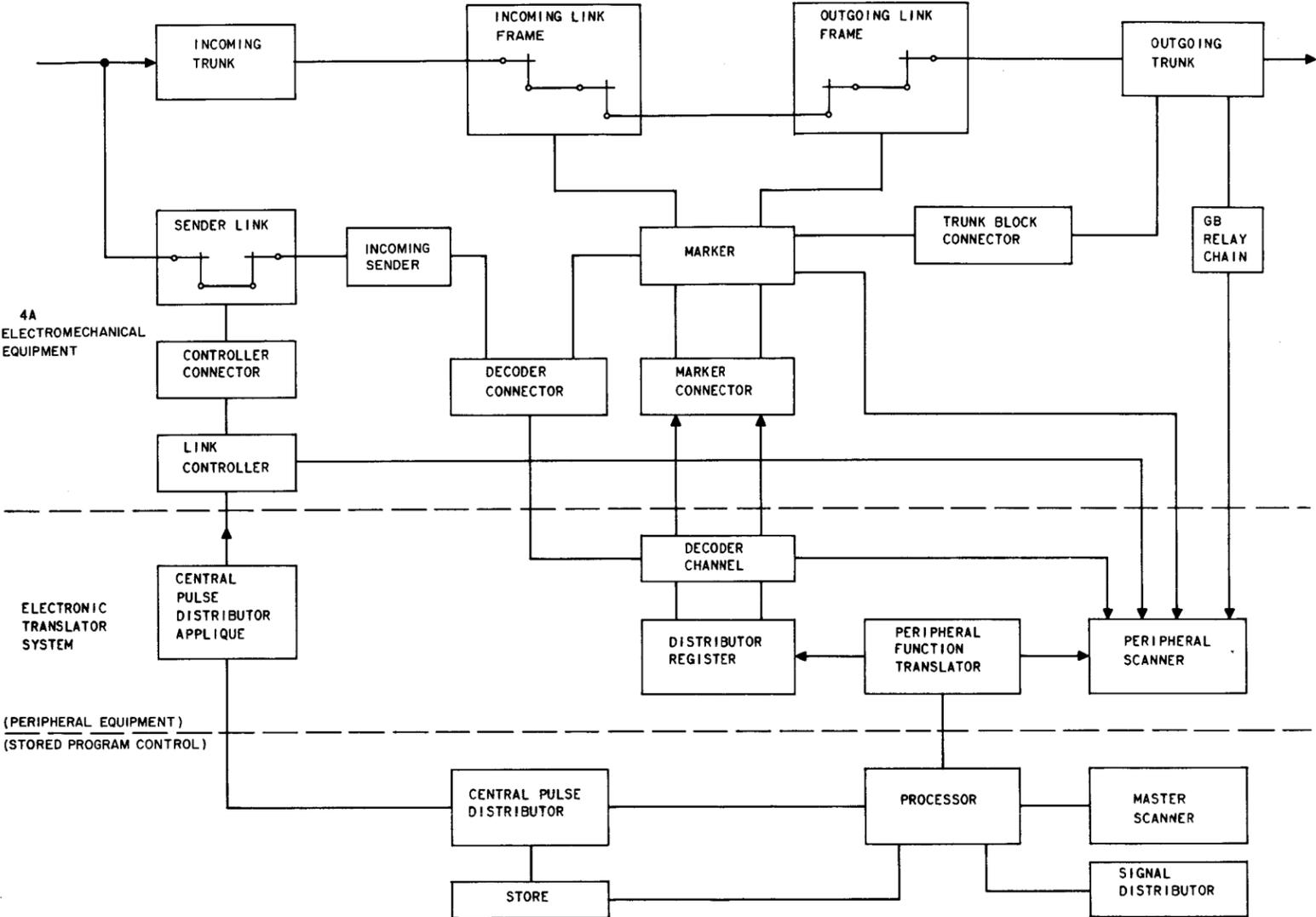


Fig. 1—Electronic Translator System Block Diagram (1.01)

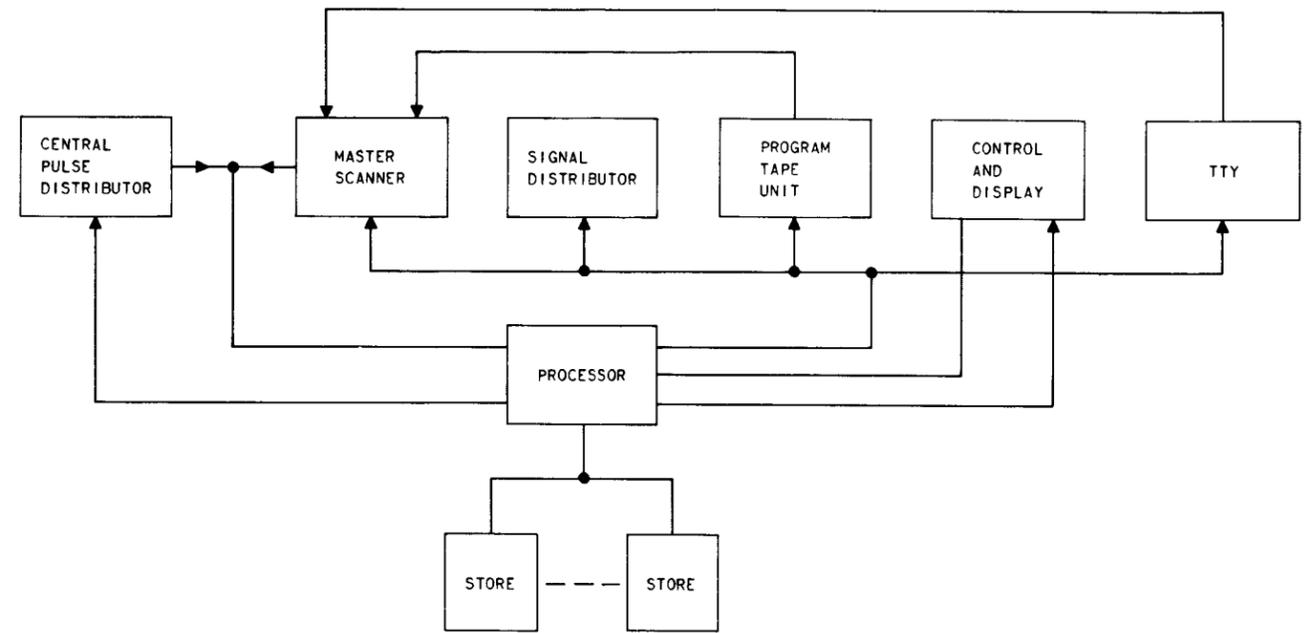


Fig. 2—Stored Program Control Equipment Design
(4.01)

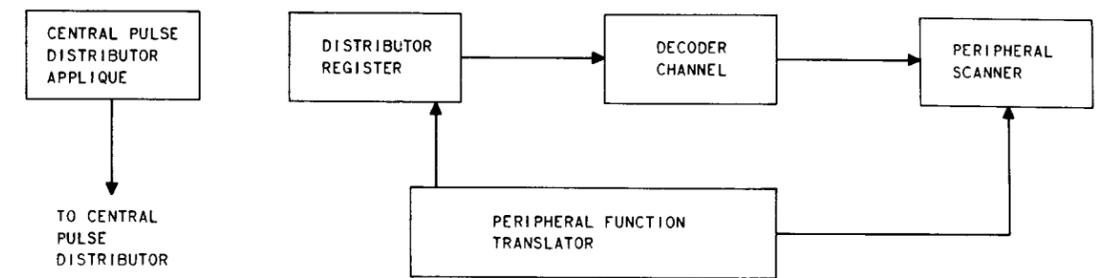
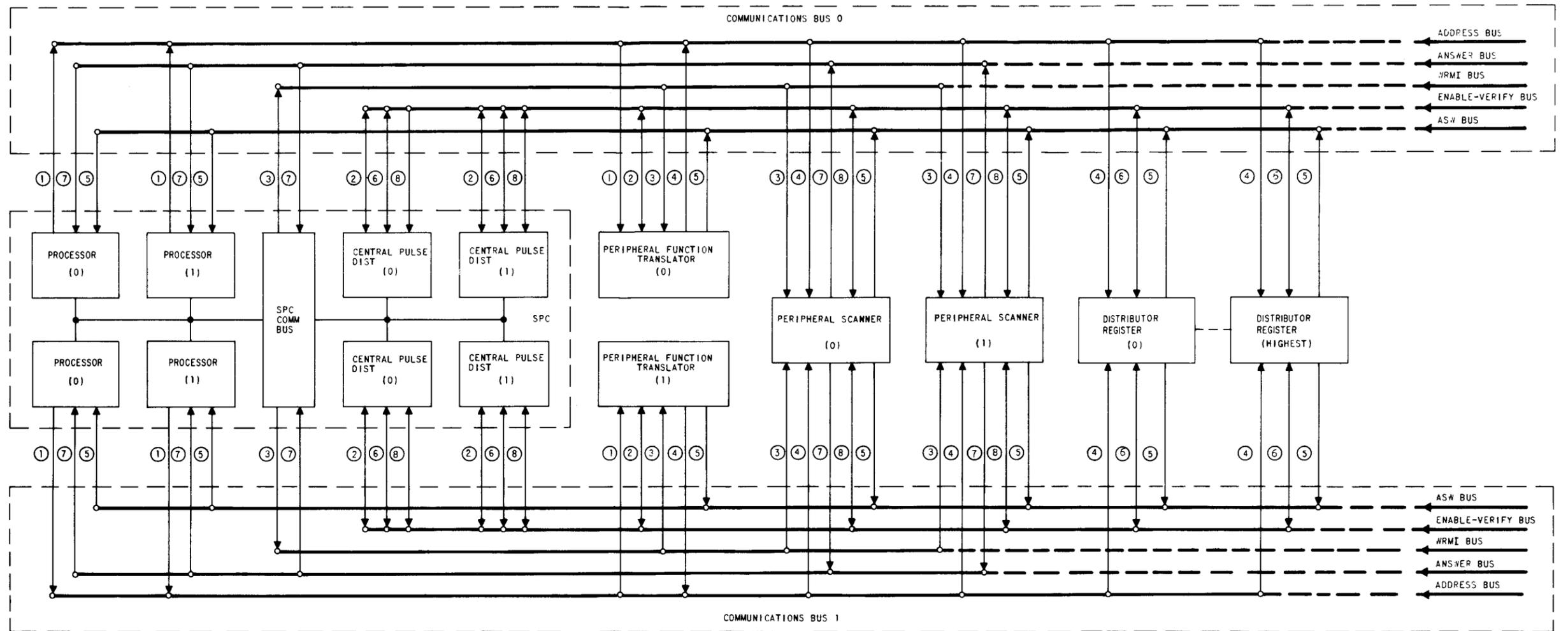


Fig. 3—Peripheral Equipment Design (5.01, 13.08)



NOTE:
MATCH CIRCLED NUMBERS TOGETHER TO COMPLETE CIRCUIT.
ARROWS GIVE DIRECTION OF PULSE TRANSMISSION.

LEGEND:
WRMI BUS - WE REALLY MEAN IT.
ASW BUS - ALL SEEMS WELL.

Fig. 4—Block Diagram of Communication Bus (6.05, 13.08)

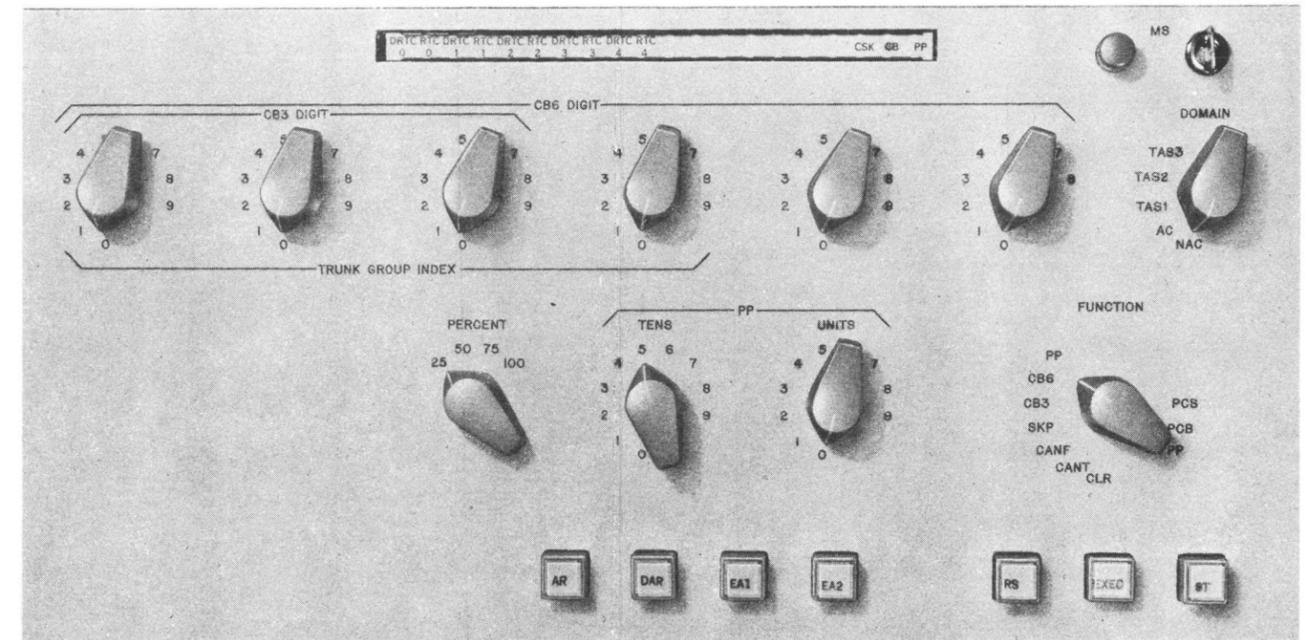


Fig. 5—Network Control Console (7.01)

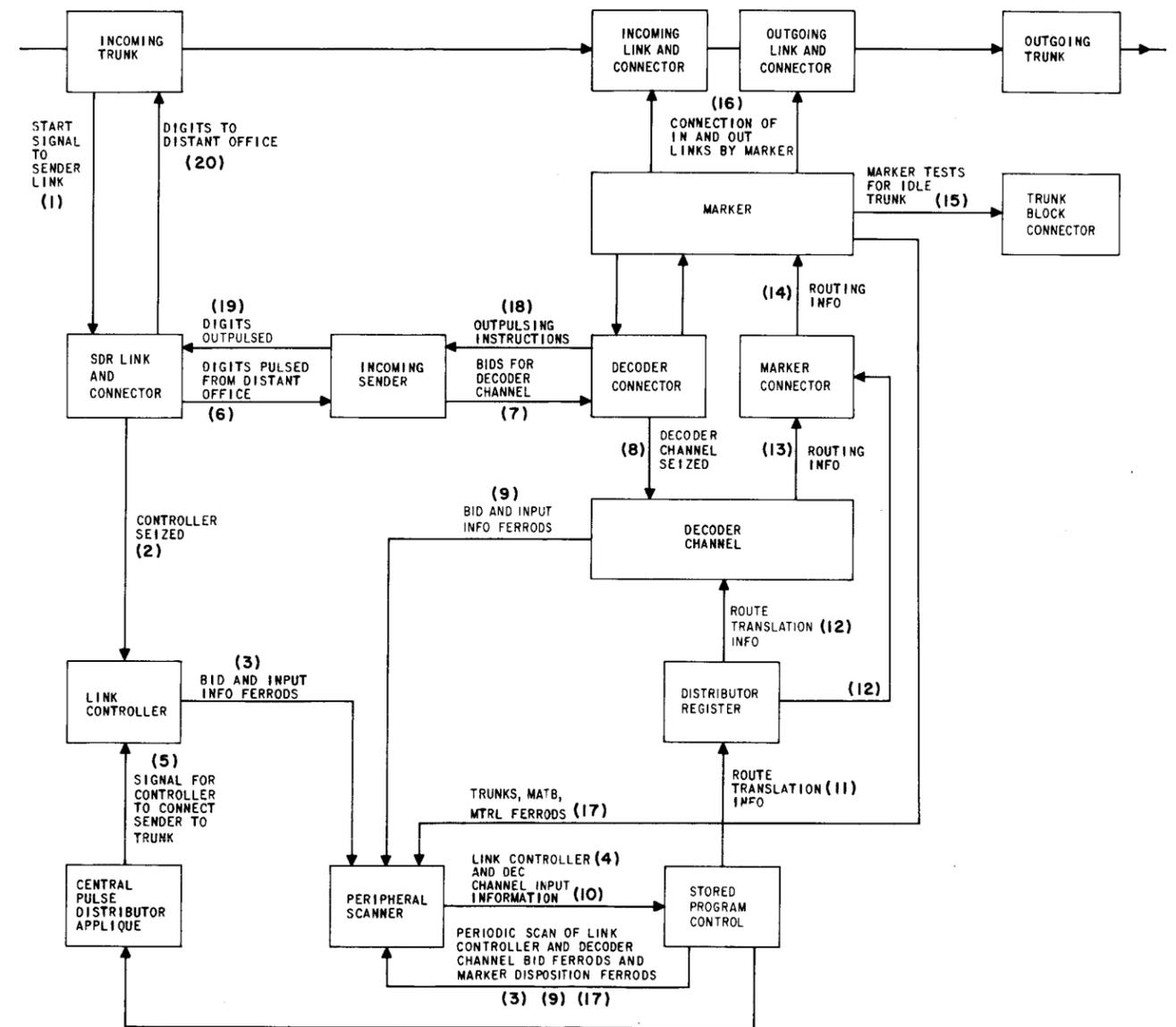


Fig. 6—Block Diagram of Typical Call in an ETS Office (10.01)

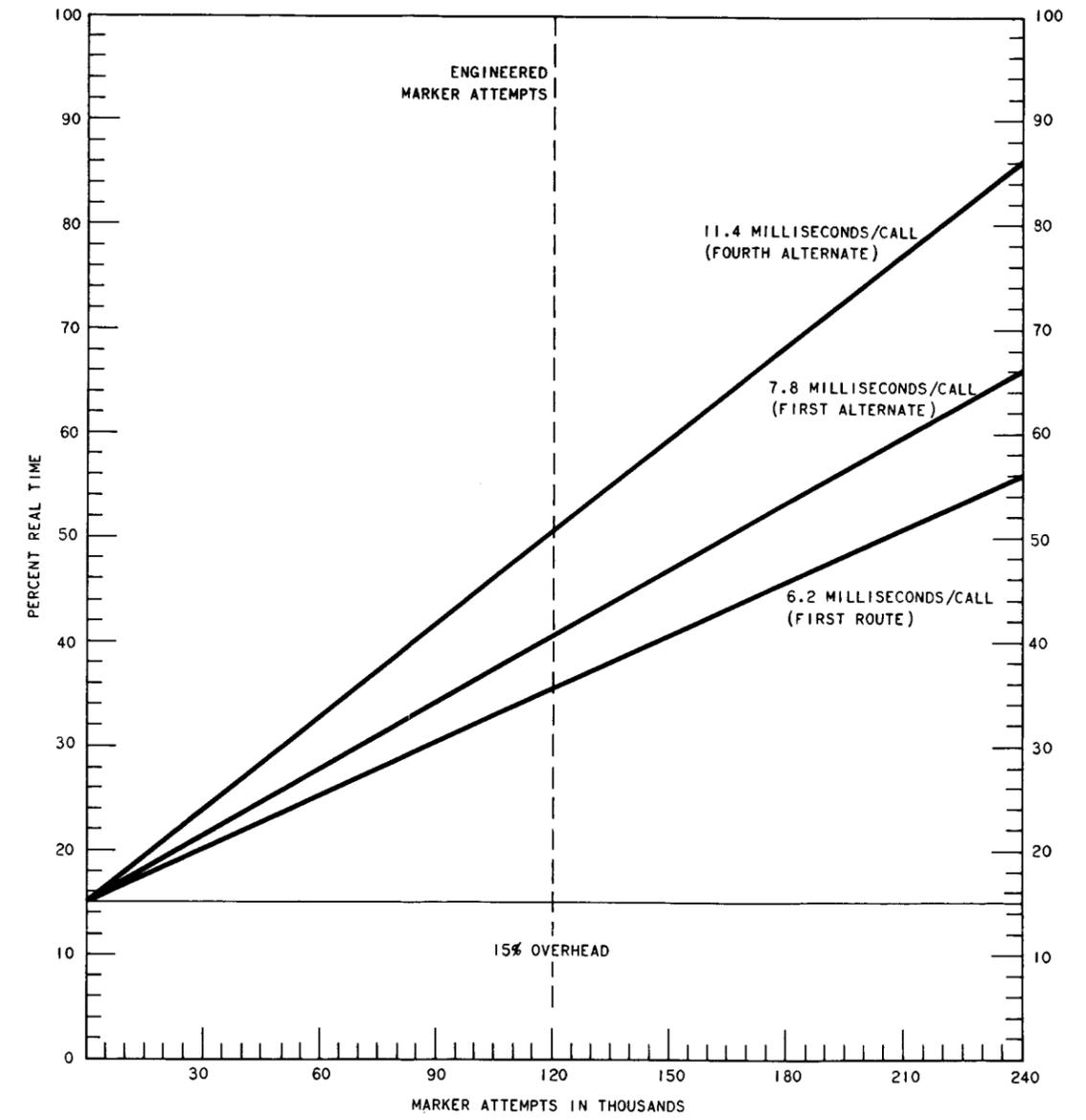


Fig. 7—Stored Program Control—Real Time Usage (12.03)

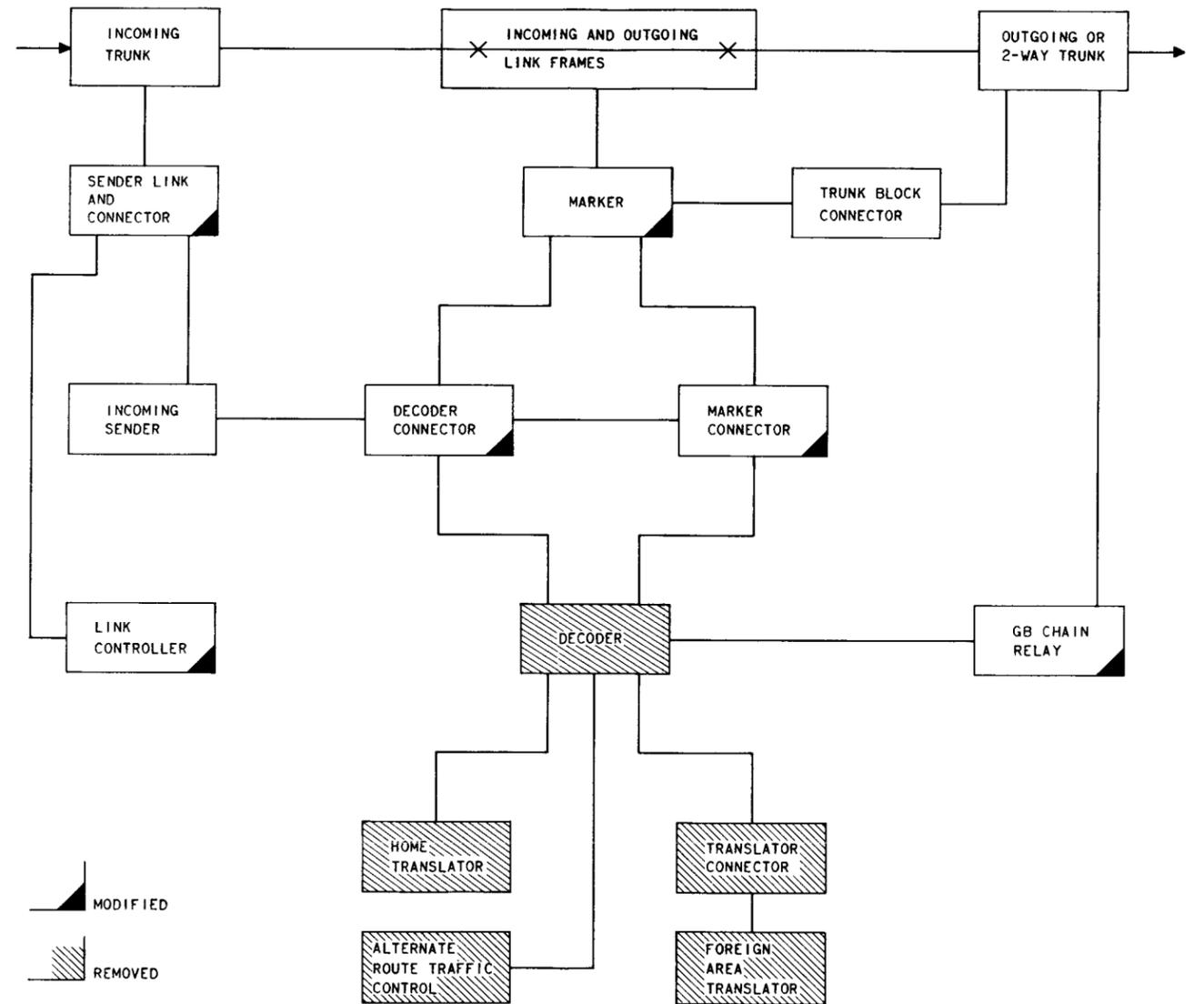


Fig. 8—4A/4M Equipment Modified for Electronic Translator System (13.01)

NEW FRAMES OR THOSE MODIFIED FOR INCREASED CAPACITY FEATURE	MARKER HOLDING TIME (MS) REDUCTION	FRAMES MODIFIED FOR MARKER PACKAGE NUMBER				
		1	2	3	4	
Marker	80	✓	✓	✓	✓	
Incoming Link	60	X	X	✓	✓	
Outgoing Link				✓	✓	
Decoder Connector and Marker Connector	15	X	X	✓	✓	
Block Relay	25			X	✓	
Overall Marker Holding Time in Milliseconds for Average Call		500	420	360	345	320

Note: Time shown for package 4 for calls using new block relay frames as additions.

Fig. 9—Marker Speedup (13.02)