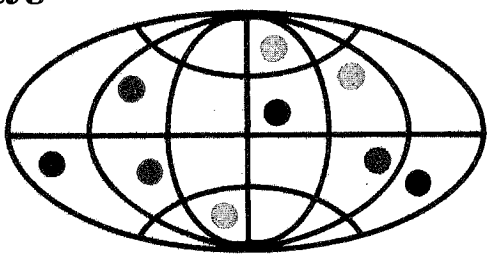
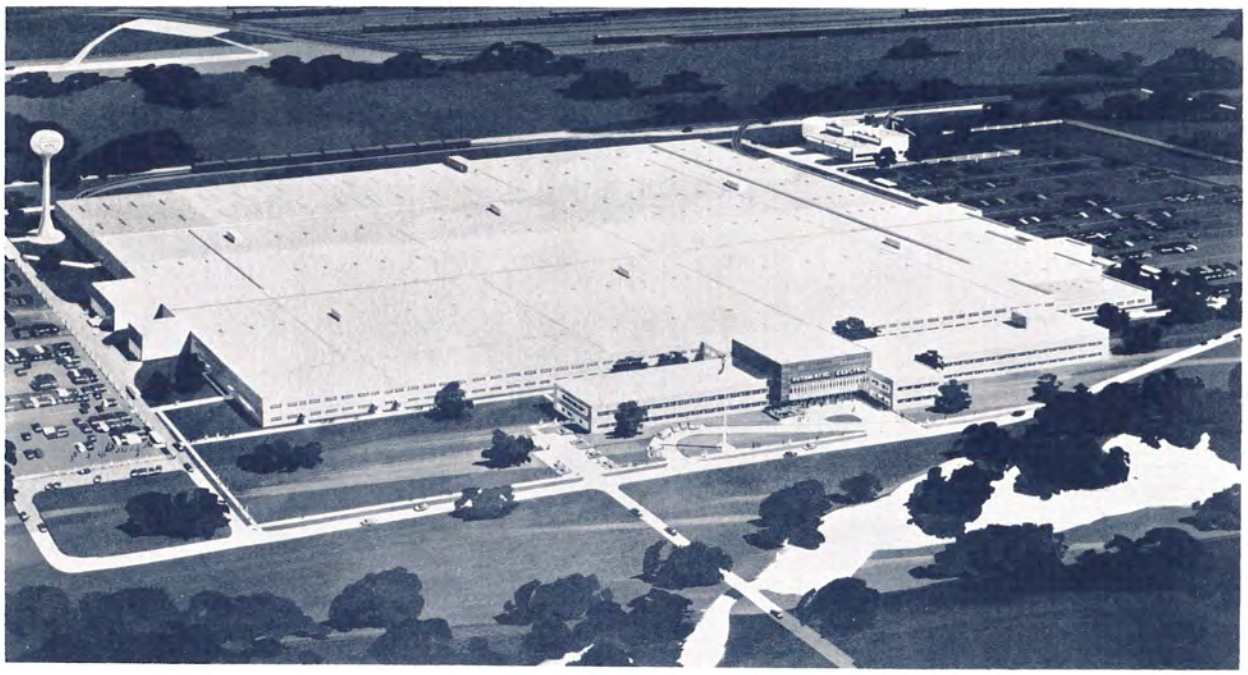
Overseas



AUTOVON

AUTOMATIC ELECTRIC
SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

Technical Bulletin 950-330



Automatic Electric Company General Offices, Laboratories and principal manufacturing facilities are located in this new 37 acre plant in Northlake, Illinois, a suburb of Chicago. Branch factories are located in Genoa, Illinois and Waukesha, Wisconsin.

These modern facilities are devoted exclusively to the manufacture of a complete line of automatic telephone equipment, electrical control components and systems.

AUTOVON Switching System

1. INTRODUCTION

The Overseas AUTOVON (Automatic Voice Network) Switching System was designed to upgrade the communications facilities used by military and government personnel. Its installation will complete the overseas portion of a worldwide, general purpose direct dialing defense communications system whose goal is to connect two prearranged points anywhere in the world in about two seconds and to complete regular connections at pushbutton speed.

The Overseas AUTOVON Switching System is made up of a number of installations (21 at present) comparable in function to commercial telephone exchanges. An installation is referred to hereinafter as a Switch.

To provide the bandwidth capability required (up to 108 kc), the Switching System will be basically directional four wire and will employ correed crosspoints with electronic controls. The crosspoints will be similar to those already used in two systems previously designed and built by Automatic Electric, the Broadband Switching System and E-A-X (Electronic Automatic Exchange).

Since the Overseas AUTOVON Switching System is primarily a tandem-switching network, each Switch will serve a large number of trunks to and from other Switches. It will also serve P-B-X's within its area on a four-wire basis. The Switch will serve local lines, connecting directly to each on a four-wire basis. The intra-matrix trunking is nonblocking which means there is no internal link blockage in the Switch and that every call attempted through a Switch will be completed, provided the desired line or trunk is idle. On the inter-switch trunks, only multifrequency pulsing will be used; pulsing to and from P-B-X's will be primarily by conventional dial pusling.

Local lines served directly from the Switch will be equipped with Touch Calling telephones, with four pushbuttons for establishing precedence of service. This service is one of the many unusual features of the Switch. In addition to the usual "class of service" identification there are five levels of precedence with four above "routine," (FO, F, I, P, and R). A maximum level will be assigned to and recorded for each station. To exercise this precedence on any call, the calling party simply depresses one of the allowed precedence pushbuttons. The Switch will then, if necessary, pre-empt for him an interoffice trunk being used by a call of lower precedence, in order to complete the desired connection without delay. If the called line is busy on a call of lower precedence, the Switch will release the existing connection and complete the higher precedence call. In either case the "pre-empted" parties will receive a distinctive tone signal to tell them what has happened.

Each Switch also provides a number of conference facilities. Certain arrangements of these facilities make possible three types of conference calls: preset, broadcast, and random.

In a preset conference call, some of these facilities will be made available directly to the calling station, thus permitting the user to key-in an assigned number thereby establishing a conference involving a preselected group of stations. The preset conference allows full duplex transmission. Broadcast arrangements are the same as those of the preset conference in all respects except for transmission. The preset conference allows full duplex transmission whereby each conferee can talk to all others. Broadcast, on the other hand, allows three modes of transmission at the option of the broadcast conference originator. These modes are identified as: no talk back to console; talk back to console only; and full duplex between conferees.

The establishment of a random conference is controlled by the dial service assistance operator upon the request of an authorized caller. Two random conference methods are provided: "meet-me" and "progressive." In the former, the conferees call in to the conference equipment whereas in the latter, the operator handles the call completely. Pre-emption of a conference access will be denied regardless of precedence. Any conferee may, however, be disconnected by seizure of his own line or by seizure of an interoffice trunk to which he is connected by a call of higher precedence.

The DSA console provides all the usual facilities for originating, answering, and completing calls. In addition, the DSA console renders interception, information, and similar services.

Because of the tremendous importance of the AUTOVON Switching System, all practical means are employed to assure uninterrupted service. For reliability, the DSA marker and parts of the common control group are provided as redundant systems. In addition, the switch marker is provided in duplicate.

Automatic monitoring equipment will constantly supervise the operation of each Switch. Automatic trunk testing facilities will check the transmission quality available on each communication channel and record pertinent information. The system will also provide complete facilities for recording the volume of traffic handled.

In a vital network such as this, it is most important to prevent failures that would affect service and to keep the entire system in operation as close as possible to 100% of the time. Each Switch is designed to maintain an operational reliability of 800 hours MTBF (mean time between failures). In case of failure, the standby equipment will take over and within 30 minutes MDT (mean down time) the original piece of malfunctioning equipment will be restored to service. The equipment is designed to these values of inherent reliability.

1.1 Features and Services

The features of and the services performed by each Switch are as follows:

a. Normal service.

Each Switch provides its users with the capability of dialing other users on a worldwide basis. Two types of service are available for non-pre-emptive traffic. The first enables callers at two-wire subsets of local P-A-B-X's to dial desired numbers and accomplish direct connection. Second, in many cases, dialing through a P-A-B-X may not be practical; therefore, calls will be handled through an operator.

b. Four-wire service.

Selected personnel are provided with special four-wire terminal equipment having direct access to the AUTOVON Switching System. Signaling from a four-wire subset will be on a Touch Calling Multi-Frequency basis. Four-wire subsets can be provided with up to five levels of precedence. Each level of precedence will pre-empt all lower levels. A caller using a four-wire subset may employ any level of precedence he desires up to and including the highest level he is authorized. Assignment of levels of precedence to subsets is electrically reprogramable at the servicing switching centers.

c. Hot-line service.

A hot-line transmission path is established between the end point users when one of the users goes off-hook to request service. If an off-hook circuit is interrupted during the course of a call, the connection is capable of being re-established by both parties going on-hook and then either party going off-hook to initiate another call.

d. Conferencing.

Conferencing can be provided by the Switch on either a preset, broadcast, or a random basis.

The preset conference is initiated from any authorized four-wire telephone by keying-in a seven digit preset conference number. This number is translated into a predetermined number of outgoing codes and establishes a call to each called party via local links, tandem bridges located in this or another Switch, or trunks to a party served by another Switch.

The broadcast conference has three modes of transmission at the option of the broadcast conference originator: no talk back to console; talk back to console only; and, full duplex between conferees. In the first two modes the conference bridge circuit is split, forming two separate paths: one outgoing and one incoming. The outgoing path extends from the originator's console to the various conferees and is used for voice or TCMF signaling. The incoming path extends from the conferee's subsets to the TCMF receiver at the originator's console and is normally used for answering roll call, or for requesting permission to speak to the conference originator. If the participant is granted permission to speak to the conference originator, the originator will connect the participant's receiver to the receiver pair and disconnect the tone receiver. The originator can enable the bridge to operate on full duplex transmission and then return it to the "no talk back" condition whenever necessary.

There are two modes of random conferences: the "meet-me" and the "progressive." If the "meet-me" conference method is used, the dial service assistance operator will call each participant and instruct him to dial a predetermined code that automatically brings him into the conference. With the "progressive" mode the dial service assistance operator calls each participant and notifies him to stand by for a conference.

e. Dedicated networks.

Several types of dedicated networks may be accommodated by each Switch. Privacy of service may be afforded to users of the

individual networks or users of the networks may be allowed access to the entire AUTOVON Switching System. Trunks employed in interconnection normally will be general purpose trunks. These dedicated networks generally fall into three categories:

(1) Category 1.

These networks allow callers to employ abbreviated dialing to certain other designated parties. Their instruments will provide normal four-wire service, but also can accommodate abbreviated dialing with authorized levels of pre-emption.

(2) Category 2.

These networks allow callers to dial one another through the AUTOVON Switching System general purpose facilities. Levels of pre-emption including flash can be provided to these users.

(3) Category 3.

In many areas of the world, existing P-A-B-X and other dial facilities must be integrated into the AUTOVON Switching System network. Such P-A-B-X and dial facilities will employ the same general purpose trunking facilities as does each Switch. These P-A-B-X and dial facilities will enjoy the same or better grade of service than they have enjoyed prior to installation of the AUTOVON Switching System.

f. Speed of service.

The normal connection through the AUTOVON Switching System will be effected in about 4-seconds. Difficult conditions or unusual routings may lengthen this time to a maximum of 10-seconds. Hot-line connections will normally be completed in less than 2-seconds.

g. Wide-band service.

When required, the Switches can be employed for switching wide-band facilities up to 108 kilocycles in bandwidth.

h. Dial Service Assistance Position.

This assistance is of the type normally provided by a telephone switchboard.

i. Automatic testing.

The Switch facility utilizes a trouble analyzer to continuously and automatically test critical electronic common control subsystems. Detection of a malfunction accesses a maintenance monitor whose associated printer provides the maintenance technician with the time, nature, and location of the malfunction. In addition, routiners enable the technician to automatically test the register-senders and trunk equipment. Finally, a toll testboard makes it possible to test all through trunks in the Switch facility.

2. BLOCK DIAGRAM ANALYSIS

Figure 1 shows the equipment groups comprising an AUTOVON Switching System. The groups mainly concerned with processing a call through the Switch are the Line and Trunk Group, the Switch Matrix and Marker Group, the Common Control Group, and if operator assistance is required, the DSA Position Group, and the DSA Matrix and Marker Group. The Power Group, as its name implies, provides power to the equipment. The Test Group contains the equipment used to check the Switch circuits for proper functioning. The Ancillary Group consists of SF signaling equipment, station apparatus, recording equipment, and distributing frames.

To gain a better understanding of the equipment groups mainly concerned with processing a call and their associated circuits comprising the Switch, we will process two different types of calls.

2.1 Locally Initiated Call

This call is initiated from a local line and extended via the Switch Matrix and Marker Group to an outgoing trunk circuit, Figure 2. This outgoing trunk circuit, chosen by the Common Control Group, terminates at the desired distant Switch.

The calling party initiates a call by lifting the telephone handset off-hook which causes seizure of the four-wire line circuit associated with the calling party. The line circuit extends the call for service to the Switch Matrix and Marker Group. The marker, continuously scanning the matrix control leads, recognizes this call for service and determines the location of the calling party. The location of the calling party is the inlet to the switch matrix (A or C stage) to which the calling party's four-wire line circuit is connected. This is a permanent relationship and when the marker has determined the line number identification it is gated onto the data bus and sent to the Common Control.

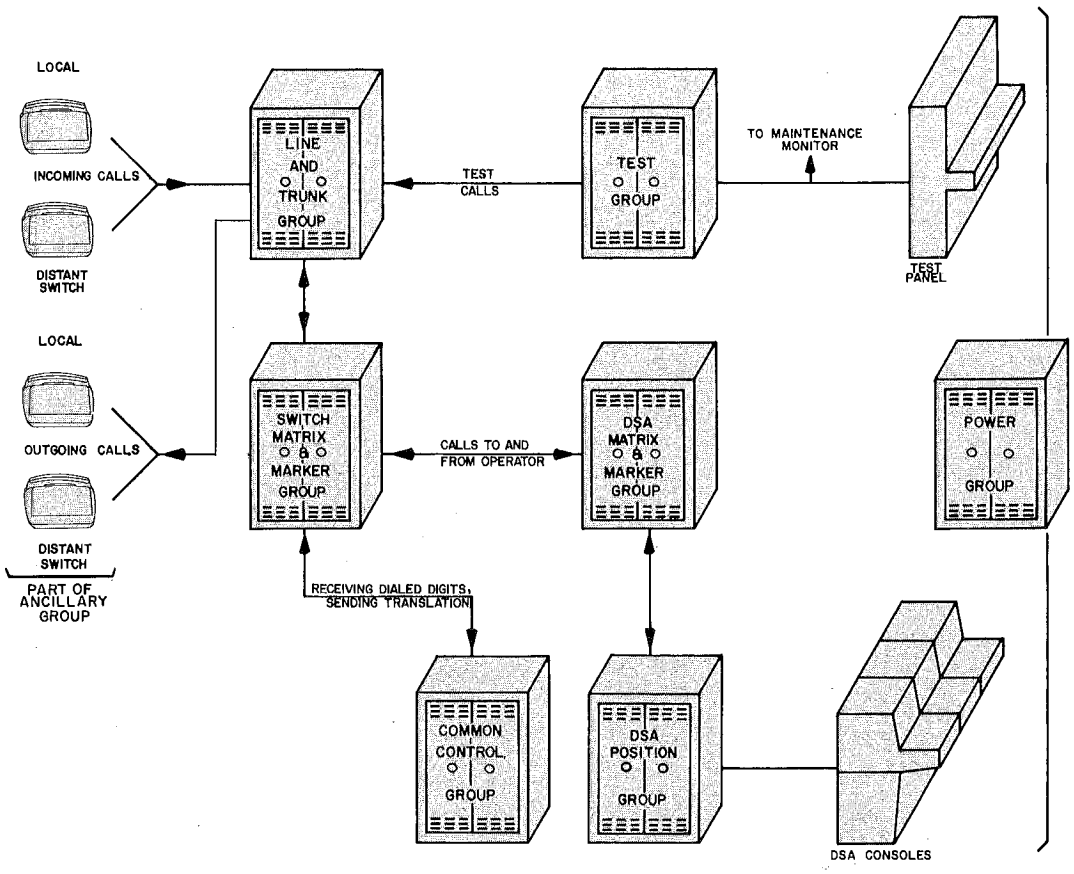


Figure 1. AUTOVON Switching Equipment Groups.

The Common Control scans the memory, and when it finds an idle register-sender, loads its equipment number location onto the data bus to be sent to the marker.

The marker now hunts for an idle path through the matrices from the line circuit at the A stage to the idle register-sender and the C stage. The line circuit, however, appears at the A and C stage. This double appearance gives the marker two possible paths (though more than two paths are generally available) to interconnect the line circuit to the register-sender, which also appears at the A and C stage. If the marker is unable to find an idle path from the A stage to the C stage, the marker will proceed to hunt for a connection from the same calling party, but now from the C stage appearance of the line circuit to the same idle register-sender at its A stage appearance. This configuration assures a path will be found through the matrices as long as an idle register-sender is available.

When an idle path is found, one and only one path through the matrices is pulled by the marker to connect the calling party to the register-sender. The marker checks the connection for continuity and ability to hold. The register performs a service treatment translation to determine mode of receiving. The marker then releases. For this example, we will assume the mode of dialing is TCMF (Touch Calling Multi-Frequency). The register-sender calls in a TCMF receiver to assist in processing the call. Dial tone is now returned to the calling party, and the calling party begins to key-in (dial) the number of the desired party. Upon receipt of the necessary digits, the register-sender passes this information to the translator to determine the translation necessary for this call.

The register-sender calls the marker in a second time and indicates the outgoing trunk needed for this call. The marker now establishes a new connection between the sender and the outgoing trunk in the same manner it connected the calling party to the register. The original directory number is spilled forward to the next office, while the level of precedence and class of call are stored in the memory. Once the register-sender has completed its functions, the marker is called a third time and instructed to drop the connection from the calling party to the register-sender and from the register-sender to the outgoing trunk. The originating line and terminating trunk are held by the marker

until the transmission path from the calling party to the outgoing trunk is established.

If this were a call to a party served by the same Switch, the outgoing trunk would be replaced by a four-wire line circuit. The general mode of handling the call would be the same; however, the sender would not be connected.

2.2 Call for Dial Service Assistance (DSA)

In a Switch equipped with a DSA position (Figure 2), a local station dials the digit "0" to reach the operator.

The call in its early stages is processed as presented in paragraph 2.1. The calling party initiates the call by lifting the handset off-hook, is then identified by the marker of the Switch Matrix and Marker Group and receives dial tone from the register-sender. The calling party dials the digit "0." After receiving the digit "0" the Common Control instructs the marker of the Switch Matrix and Marker Group to drop the connection from the calling party to the register-sender and establish a connection from the calling party to a DSA trunk.

A three-stage, full availability DSA matrix is provided for connecting a DSA trunk to a DSA position. The matrix is under control of the DSA marker. The marker is continuously monitoring the control leads of the matrix for a call for service.

A call for service is extended to the matrix by a DSA trunk accessed via the matrix of the Switch Matrix and Marker Group. The DSA marker recognizes the call for service from a DSA trunk, and proceeds to process the call in much the same manner as the marker of the Switch Matrix and Marker Group. The DSA marker identifies the trunk calling for service and selects an idle position, and an idle link on the position to serve the call.

The operator can extend the connection for the calling party via a separate appearance of the DSA trunk on the matrix of the Switch Matrix and Marker Group. The operator extends the call by operating a key which, via the other appearance of the DSA trunk, will request a

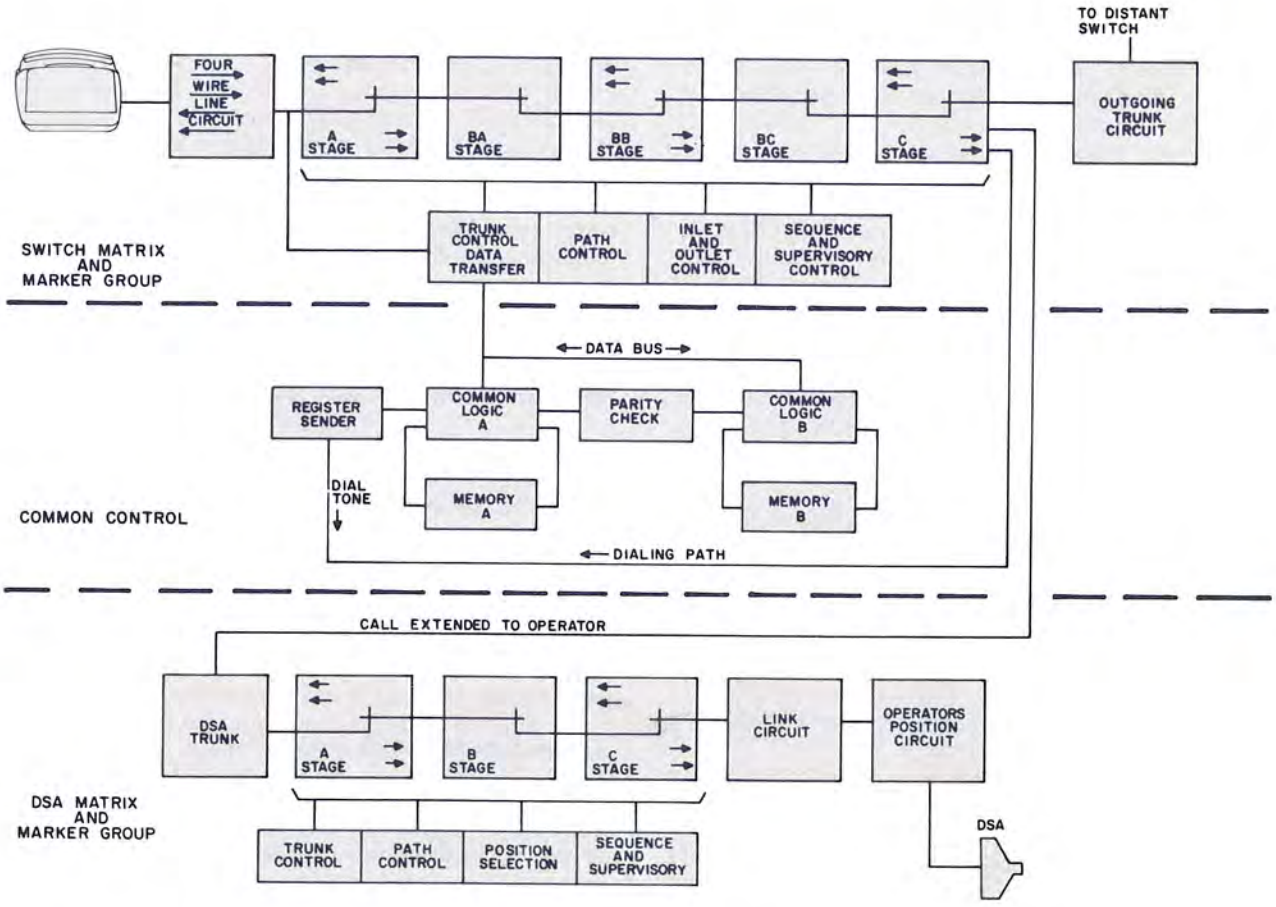


Figure 2. Call Processing.

register-sender through the matrix of the Switch Matrix and Marker Group. The call is then processed as previously described.

3. EQUIPMENT GROUPS OF THE AUTOVON SWITCH

The equipment groups of the Switch use fully electronic controls for their speed and tremendous capacity. These controls are designed to be more than adequate for any future needs. Inter- and intra- AUTOVON Switching System paths are completed by using relays and correed assemblies in the trunk and line circuits and matrix card assemblies in the matrices.

The correed assembly is essentially a cluster of reedcapsules surrounded by coil windings. Each reedcapsule contains two magnetic reeds. When the coil is energized, the reeds are magnetized and attract each other. The magnetic reeds have contact ends of diffused gold and, since they operate in a sealed capsule, their life is measured in billions of operations. A typical correed assembly has two windings, an operate winding and a hold winding. Hermetic sealing of the reed contacts (metal-to-metal contacts) makes them immune to corrosion which might introduce noise.

The following paragraphs present in more detail the circuits of the various equipment groups.

3.1 Line and Trunk Group

The four-wire line circuits, incoming P-B-X trunks, and intertoll trunks are part of the circuitry comprising the Line and Trunk Group. These are electromechanical circuits consisting mostly of correeds and relays. As shown in Figure 3, these circuits terminate at the Switch Matrix and Marker Group. The remaining circuits of the Line and Trunk Group make up the conferencing equipment used when making preset and broadcast conference calls.

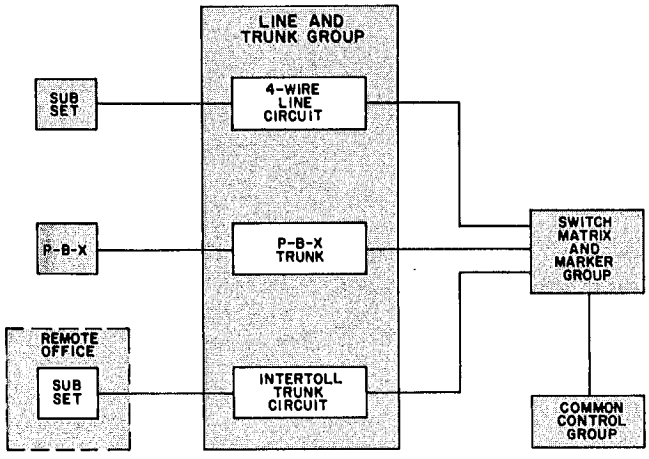


Figure 3. Line and Trunk Group. (Conference Equipment Not Shown).

3.1.1 Four-wire TCMF line circuit

The four-wire line circuit provides the connecting termination between the subset and the switching equipment.

The line circuit is arranged for E and M signaling. When the calling party lifts the handset off-hook the line circuit is informed of a request for service and extends the call for service to the matrix of the Switch Matrix and Marker Group. On a call to a station the line circuit will cause the called station to be signaled.

Each line circuit uses two main paths to connect to the equipment in the Switch. One path is via the matrix of the Switch Matrix and Marker Group to the register-sender of the Common Control, other lines, trunks, etc. This is a six-wire circuit which includes the four-wire directional transmission path and two control leads. The other path is via a data bus which provides for exchange of information between the line circuit and the Common Control via the switch marker.

3.1.2 P-B-X trunks

The P-B-X trunks are arranged for four-wire directional transmission and E and M signaling from the P-B-X to the Switch. Two types of P-B-X service can be provided. The first type provides two-way service to a distant P-B-X attendant. The second type will provide two-way automatic-to-automatic service between the Switch and the attendant or stations of a distant P-B-X. Trunks to a P-B-X may be pre-emptable, non-pre-emptable or a mixture of both in any desired ratio.

3.1.3 Intertoll trunks

Intertoll trunks provide through and terminating service for calls originating in the distant switching centers. Locally terminating lines and trunks are given access to distant switching centers through these trunks. All intertoll trunks are arranged for two-way operation with E and M signaling facilities. Transmission is on a four-wire basis.

3.1.4 Conference equipment

The conferencing equipment enabling the establishment of preset conference calls consists of the following: a register, translator, sender, one-way incoming trunk, one-way outgoing trunk, four-wire six way conference bridge with amplifier, broadcast bridge splitting circuit, and a voice operated loss control and

suppression circuit. A broadcast console enables the conference originator to initiate broadcast conference calls. The originator keys a seven digit conference number plus precedence and thereby establishes conferencing circuits containing the following conference equipment previously mentioned.

a. A conference bridge with a leg for each associated four-wire station and a trunk allowing full duplex transmission.

b. Means for signaling associated four-wire stations and switching them into the conference bridge.

c. A register for storing the precedence and conference combination as received from the switch register.

d. Translating facilities consisting of a wired program selected by the register in accordance with the access code.

e. A TCMF sender for sequentially presenting calls to the Switch via associated trunks using abbreviated codes.

Outpulsing is controlled by the translator to establish connection to conference circuits in other centers after which trunks are switched into the bridge. The calls to other conference circuits result in connections to four-wire stations in other centers.

The voice operated loss control and suppression circuit is used to overcome the degradation of transmission levels when two or more conference bridges are interconnected.

The conference bridge is a resistive network that allows up to six conferees to be connected at one time with full duplex transmission between all conferees.

As in paragraph 1.1-d the broadcast conference is capable of three modes of transmission at the option of the conference console operator.

3.2 Switch Matrix and Marker Group

The Switch Matrix and Marker Group consists of a three- or five-stage matrix, depending on matrix size required by the Switch, and an electronic marker provided in duplicate. The actual switching of calls through an AUTOVON Switching System is accomplished via the matrix, under control of the marker.

The metallic path for talking and dialing is established through contacts of the switch matrix. The path to be switched (completed) through the matrix, selection of an outlet corresponding to a line or trunk circuit, and inter-group communication (Switch Matrix and Marker Group to Common Control, etc.) are accomplished by the marker.

3.2.1 Matrix

The matrix of the Switch Matrix and Marker Group is nonblocking. This nonblocking feature assures that there is no internal link blockage in the Switch; once an inlet to the matrices is identified and the desired outlet is found idle, a path will be found through the matrices to interconnect the two. It therefore does away with any possibility of link congestion. This matrix can be expanded from 100 to 2,000 lines. The matrix is built on a modular basis with A, BA, BC, C, stage growth in 50-inlet groups. The basic building block is a fifty-crosspoint correed matrix card assembly capable of interconnecting any one of five circuits to any one of ten circuits. The correed matrix card assembly is capable of switching frequencies of 108 kc. The physical size of the matrix will vary from Switch to Switch. A five-stage system is shown in Figure 4. Since the matrix is nonblocking, every line and trunk, either one-way or two-way, will have an appearance on the input of the primary A stage and an appearance on the output of the final C stage.

Seven leads are extended through the matrices. Six leads are switched, the four transmission leads, and the hold and supervisory leads. The seventh lead, the pull lead, is not switched.

As shown in Figure 4, the inlets to the matrix are in groups of 50, five per card. An inlet can have connected to it one of the following: four-wire line circuit, P-B-X trunk circuit, intertoll trunk circuit, a register-sender, or DSA trunk, conference trunks, test terminations, etc.

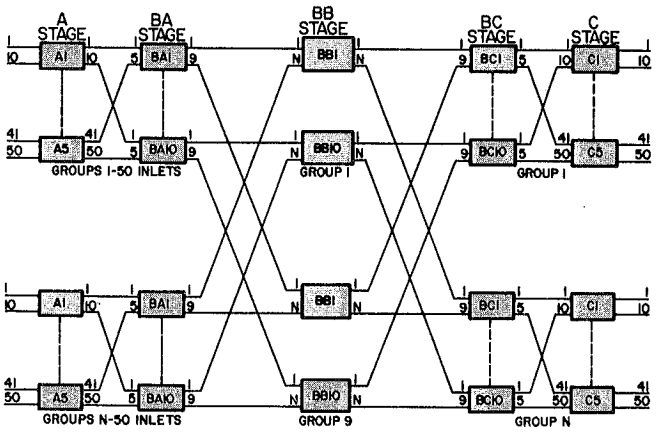


Figure 4. Matrix, Switch Matrix and Marker Group.

3.2.2 Marker

The basic function of the marker of the Switch Matrix and Marker Group is to provide the controls necessary to interconnect switching unit inlets and outlets via an available idle path through the matrices. This includes the following operations: identification of inlet, path selection, completion of connection and communication with the Common Control.

The tasks performed by the marker in processing a call are controlled by the sequence and supervisory circuit, Figure 5. This control can be compared to a programmed computer in that the marker follows a fixed plan of operation. Information signals from equipment. When an incoming call or an inlet requests service, it signals the identifier of the inlet-outlet control circuit by means of a connection on a trunk circuit relay. The identifier functions to provide the inlet trunk location identity of this calling inlet, locking out all other inlets that may be requesting service at that time. The marker transfers the inlet trunk identity to the Common Control via the data transfer circuit and the data bus and requests the location of an idle register-sender. The register-sender location is received by the marker and gated into that portion of the identifier for access to the register-sender. The marker now has sufficient information to mark the end points of the inlet-to-register connection.

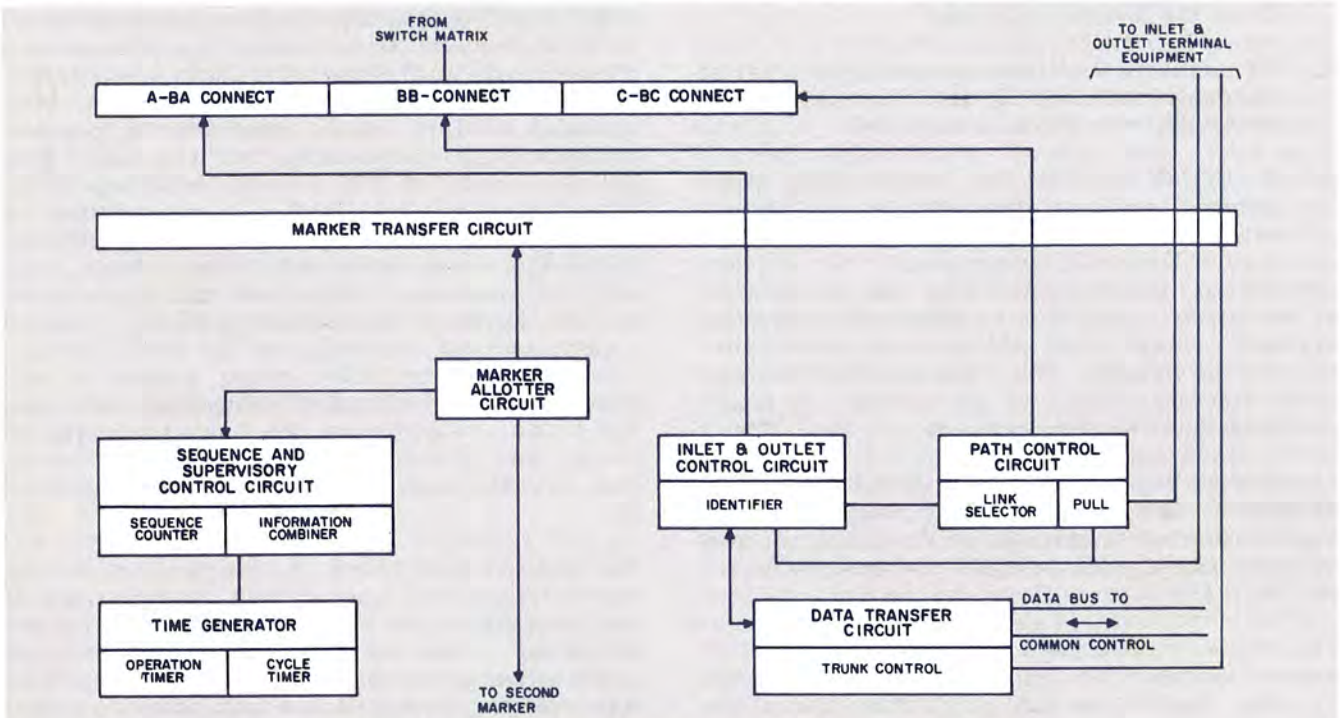


Figure 5. Marker, Switch Matrix and Marker Group.

all circuits of the marker, indicating the progress of the operation, are combined by the common logic of the information combiner to generate the commands needed to perform the next operation. The supervisory control function includes the sequence counter, which advances the sequence state, a clock circuit to provide pulses to synchronize operations within the marker, and a timing circuit that provides the proper timing outputs to sequence electronic operations.

Calls are handled by the marker on a one-at-a-time basis, thus reducing the possibility of double connections within the matrix. The marker is continually scanning for service requests from inlets and the Common Control

Matrix connect correeds of the A-BA-BB-BC-C stage connect circuit are operated to connect the group of "C" leads which will be scanned by the path control circuit to determine an idle path.

The fact that the marker handles calls on a one-at-a-time basis does not rule out the possibility that more than one line or trunk circuit could almost simultaneously generate calls for service to the matrix. The call serviced first will be the call seen first by the identifier, in the marker, used to identify the calling line or trunk. When the marker completes its cycle of operation, it will service the next call seen by the identifier.

When an inlet is identified, its trunk connect correed is operated, which places negative battery on the associated pull lead of the A stage matrix. Under the control of the marker, the C leads for the outlets of the A-BA group where the identified inlet appears are connected via a common highway to the link selector of the path control circuit. Similarly the C leads for the outlets of the B-BC group where the register-sender appears are connected via the common highway to the link selector. The C leads are now scanned for the coincident idle condition of links which defines a unique idle path.

On finding an idle path, the path control circuit places ground on the selected idle link pull lead. With the pull leads of the inlet and register-sender marked, and the BB to BC link pull-lead grounded, one crosspoint correed in each of the A, BA, BB, BC and C matrices is operated to complete the connection from the identified inlet to the assigned register-sender. At this time a conventional cut-off relay in the inlet circuit operates to signal busy and inform the marker that the connection is complete. The marker tests the tip and ring conductors while applying a "wetting current" through the transmission loops of the operated connection. The marker can now inform the Common Control the connection is complete, clear the marker circuits, and return to the idle state to scan for additional requests for service.

After the Common Control processes an incoming call, the marker is re-called by the Common Control to connect the sender associated with the active register to an idle trunk. When recognition is received, the Common Control transmits, via the data bus and marker data transceiver, the trunk location identity of both the sender and idle trunk. With this information the marker positions the identifier in the inlet and outlet control to access the two end points of the connection. As before, matrix connect correeds are operated to close "C" leads into the path control for selection of an idle path. The marker completes the connection by selecting an idle path and pulling the connection. At this point, the Common Control is signaled of the successful completion of the operation.

3.3 Common Control Group

The main function of the Common Control equipment is to provide the Switch with registering, sending and translating capabilities. In addition it provides permanent and temporary storage facilities for each trunk and line in the office. It will constantly monitor these trunks and lines, select a proper path through the office, the proper outgoing route, and direct the marker of the Switch Matrix and Marker Group to switch the path, when required.

The Common Control circuits, with the exception of the register-sender, receivers (which are supplied according to traffic requirements) connect matrix and parity test circuit, are provided in duplicate, Figure 6. The units are synchronized, simultaneously processing the same information. A comparison is made between these two units. All outgoing information is simultaneously presented from both units. Only one unit is in control, but both are processing the calls. Any time a discrepancy is found between the information preselected by the two units, the one in control is temporarily removed from service. The unit not at fault is then connected to the busses and any information that had been interrupted is re-sent. All calls in process may be successfully completed even though one of the Common Control units is temporarily in trouble.

The Common Control is subdivided into several functional sections, each having its own independent logical control. All functional groups utilize the memory system although each is assigned an independent group of cores large enough to satisfy the memory requirements of the particular section.

3.3.1 Register-sender

The register-sender constitutes a functional section and is a time shared unit with the ability to register and process as many simultaneous calls as are required by a particular Switch.

The register-sender serves as the inlet and outlet device to the Common Control Group needed to perform registration and sending. A register-sender is accessed from the switch matrix, A or C stage. This circuit provides the real time supervision of lines and trunks for space-division switching of outside facilities. As such, the register-sender employs correeds for all switching functions of the Common Control which require direct connection to the calling line or trunk. These functions include dial pulse repeating, dial tone control, battery feed to the calling line and outpulsing. Sending (outpulsing) can be either dial pulsing or 2/6 MF; the latter is used on all interoffice trunking.

3.3.2 Receiver pool

The registers have available to them both TCMF and 2/6 MF receivers organized in a pool and assigned as required by the receiver assigner.

a. *Touch Calling Multi-Frequency receiver.*

This circuit provides the system with the capability of receiving information

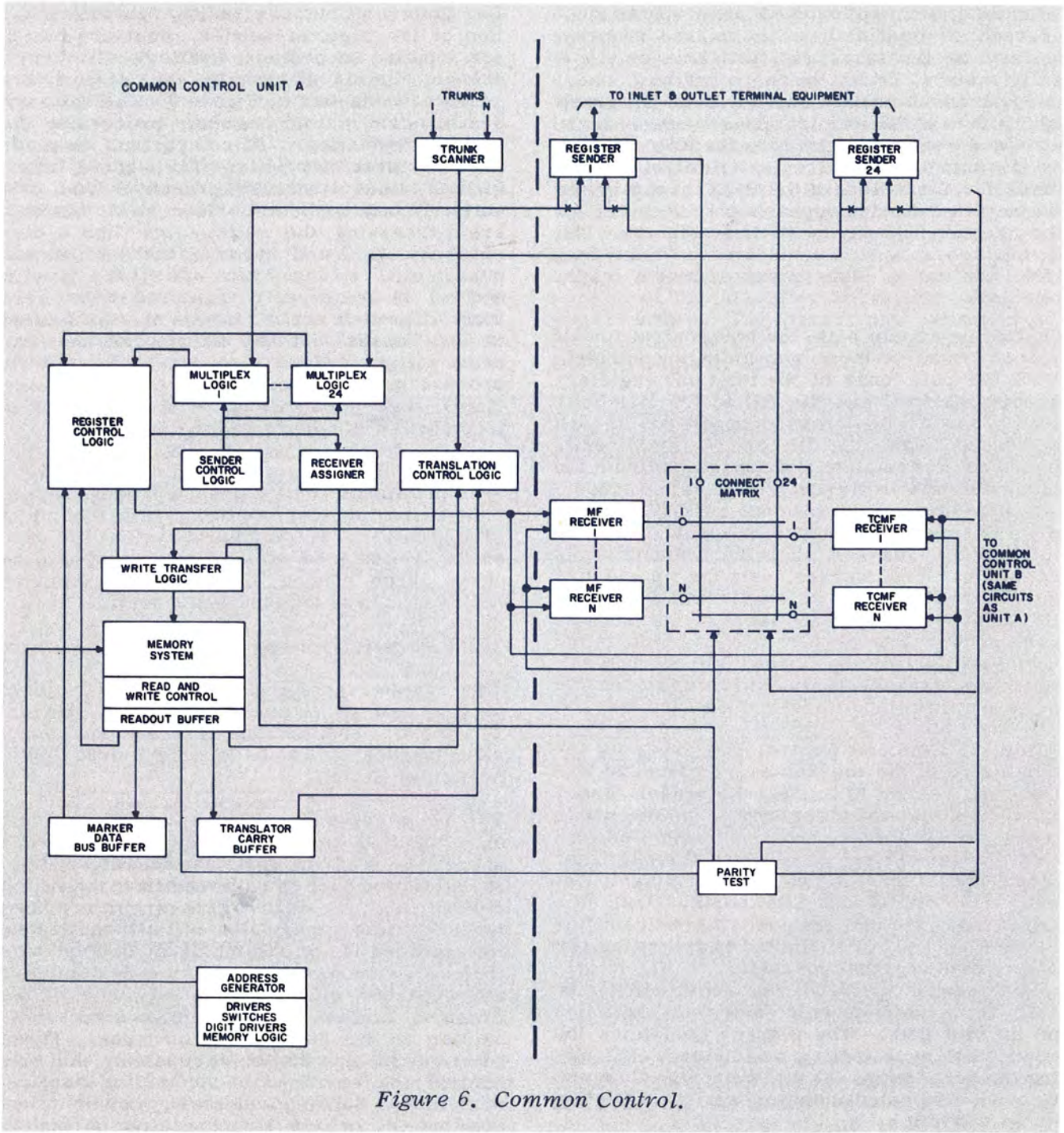


Figure 6. Common Control.

through Touch Calling Multi-Frequency signals. It receives alternating-current signals in two-out-of-eight code and converts these into DC logic level signals and presents them for storage in the memory.

b. Multifrequency receiver.

This circuit provides the system with the capability of receiving information through 2/6 multifrequency signals. It receives the alternating current audio-frequency signals in a two-out-of-six code and converts them into DC logic level signals and presents them to the Common Control for storage.

3.3.3 Common logic circuits

a. Multiplex logic circuit.

This circuit provides a means for a two-way transfer of information between the

all correed space divided register-sender and the electronic time divided Common Control components. One lead multiplex circuit is provided per register-sender. This circuit is used to transfer information to the fast acting electronic equipment from the more slowly operated correed controlled register-sender, or vice versa.

b. Receiver assigner.

The receiver assigner provides the selection control to establish a connection from a register-sender to an idle multifrequency or TCMF receiver. It couples any of the register-senders to any of the multifrequency receivers or Touch Calling Multi-Frequency receivers in the receiver pool.

c. Marker data buffer.

This circuit provides for communication between the marker and the Common Control equipment. It provides a means to transfer the originating equipment number from the marker to the Common Control for storage in the early stage of a call and later it is used to send the originating number, terminating equipment number, level of precedence of call in process, alternate route, special trunk termination indication, and incomplete dialing indication from the Common Control memory to the marker.

d. Register controller.

This circuit provides timing logic, information transfer logic, decision control logic and carry control logic. This circuit arranges, in association with the memory system, the dialed digits to be written into the memory. As many as 14 dialed digits can be arranged for presentation to the memory.

e. Translator controller.

This circuit is used to control the system translation function. The functions performed can be divided into three categories: decision networks, timing networks, and arrangement networks. The decision and timing functions provide the necessary system control while the arrangement networks assure that information is in the correct location in the memory.

f. Translator carry buffer.

This circuit provides a two-way parallel data-communication link between the translator portion and the register-sender portion of the Common Control. Information is presented to the translator carry buffer from the read-out buffer of the memory system. This information is then used to locate, in the translation storage area, the information needed. The resulting translation is then entered into storage in the register-sender area that requested service.

g. Sender controller.

The sender controller provides the gating control needed for proper transfer of the dialed digits to the sender. It also controls the sending mode used to outpulse these digits.

3.3.4 Memory system

An AUTOVON Switching System has a memory capable of expanding to 6,000-words in multiples of nominally 1,000-words. The size of the memory at each Switch depends upon the terminations at that Switch. Thus, a Switch of 200 terminations or less requires a 1,000-word memory; one of 200-350 terminations require a 2,000-word memory; and, Switches with more than 350 terminations require 3,000-word memories. In addition mounting and wiring is provided in each Switch for at least 1,000-words above these requirements. The memory is a modular unit and can grow in 1,000-word increments, each word consisting of 44 cores. Basically, the circuits that comprise the memory system are the memory read and write control circuit, the ferrite core memory and read out buffer.

The read and write control circuitry provides current pulses needed in transferring information to and from the cores of the ferrite core array.

The ferrite core memory can be broken down into two major categories in terms of usage. The first category is the register-sender group, for which the memory has a fixed number of cores (aligned in rows) per register-sender. Hence, the amount of memory is a function of the number of register-senders required per Switch. The ferrite core memory array provides temporary storage for the register-sender control logic. Each register-sender is assigned a time slot. Each row is accessed by sub-time slots. The second major function of the memory is translation of the routing information. The size of the memory in this case is dependent on the number of unique codes to be translated and the number of routes to be generated. This area of memory includes hot-lines, area and office code translation, trunk group and trunk number

indexes, class of service, routing digit translation, route transfer and sequence, abbreviated dialing, and zone network. In addition to the foregoing, features such as special use of NNX codes, amount of abbreviated dialing, and number of hot-line subsets will affect the size of the memory required by each Switch.

The buffer and read out register provides storage for memory read out. This circuit is also utilized to shift information during a particular sub-time slot from one position to another.

The memory system is sequentially accessed or randomly accessed. Sequential access occurs during the register-sender scan whereas random access occurs during translation. The unit is capable of providing any required memory to any function. Additional rows are provided for storage for maintenance programming.

Multiple sense amplifiers and read out buffers with gating between buffers helps to make a 6,000-word memory possible. In addition, "read-in" of the memory is facilitated by the use of drivers, switches, digit drivers, and memory logic (not to be confused with common logic). The memory logic is initially provided to accommodate 6,000-words. However, the drivers, switches, and digit drivers are equipped and wired in accordance with the size of the Switch.

3.3.5 Write transfer circuit

This circuit allows information from either the register-sender control logic, the translator control logic, or the common control parity test logic to be transferred to the write control of the memory system.

3.3.6 Address generator

This circuit provides memory access pulses and control pulses so that the memory can be scanned either sequentially or in a random access mode.

3.3.7 Parity test logic

This circuit compares the memory system output of Common Control unit A with that of unit B. During normal operation the outputs of both units should be identical. If they do not match, an alarm condition exists.

3.4 DSA Position Group

The function of the operator at the Dial Service Assistance position is to provide services such as directory information, intercept service (when use of a recorder announcer is not applicable), conference assistance, and signaling assistance. A Dial Service Assistance console is shown in Figure 7.

The number of positions provided depends on traffic requirements. Each position is equipped with eight links which are accessed by the DSA matrix under control of the DSA marker. Local DSA trunks have two appearances on the main Switch matrix, one for extending the call to the DSA matrix and the operator, and one to allow the operator to extend the call via the Switch matrix. (This duplicates the front and rear operations of a manual board.)

Figure 7. DSA Position.

The call distribution portion of the marker contains a position scanner, operated on a sequential basis in order that calls may be evenly distributed to operators.

3.4.1 Conference equipment

The interconnection or conferencing of three or more parties where each party must be able to talk to every other party requires special treatment. This is especially true in the case of four-wire transmission. Two four-wire stations are connected over two transmission pairs, one pair for each direction of transmission. To add a third party to the connection, a network must be provided that not only allows transmission both ways between each of the parties, but does not introduce losses or feedback that would tend to degrade transmission.

A six-way, four-wire conference bridge is used to allow up to six conferees at a time

to hold conference. It is also possible to interconnect two or more conference bridges to allow additional conferees to be included in a single conference.

3.4.2 Random conference

This arrangement is controlled by the operator at a Dial Service Assistance position. On instruction to establish a conference of up to six parties the operator will select an idle

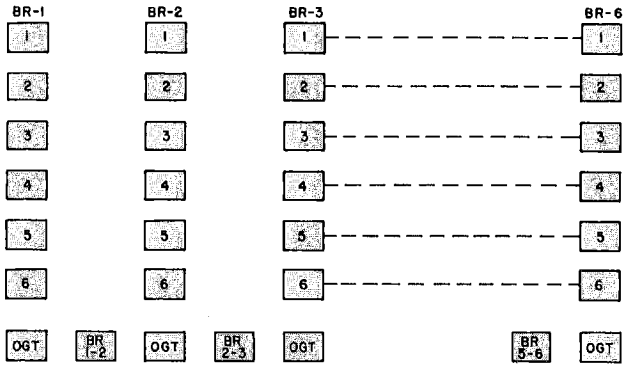


Figure 8. Random Conference Key Panel.

bridge. Depressing the associated keys (1 through 6) for the number of participants opens the required number of paths to the bridge, Figure 8. The lamp associated with each depressed key will flash. Each participant will dial an abbreviated code that automatically brings him into one access of the bridge, Figure 9. As this occurs the lamp associated with this access glows steadily. As each participant retires from the conference, the associated lamp goes dark.

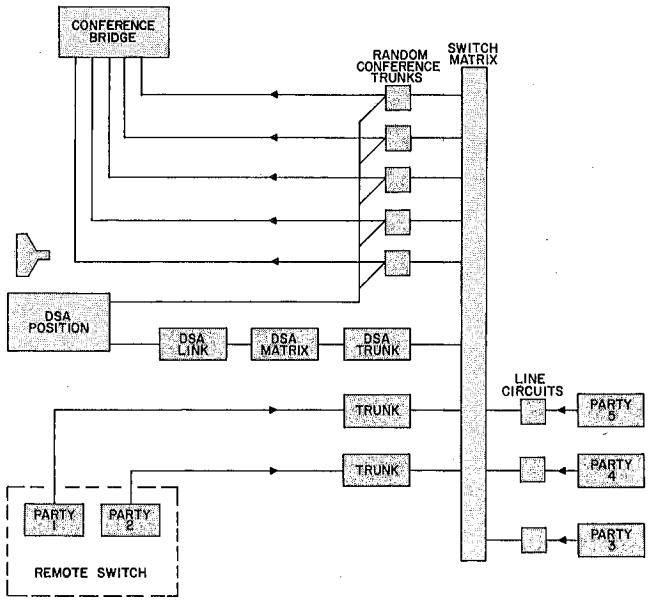


Figure 9. Random Conference Arrangement.

To set up a conference for more than six parties but not more than 10 (again using the BR-1 keys Figure 8), the operator would operate the BR 1-2 key and the BR-2 keys in an amount depending on the number of additional parties. If more than 10 parties were to be added, key BR 1-2 and key BR 2-3 would be operated.

The above example illustrates using a bridge or bridges in the same office. A conference arrangement employing connected bridging configuration in separate offices is also possible.

3.5 DSA Matrix and Marker Group

3.5.1 DSA matrix

Calls destined for an operator are routed to a DSA trunk, Figure 10. The trunk signals for an operator through the DSA matrix. This signal is received by the DSA marker which allots the next available position to the call if the type of service check indicates this position can handle it. The call is now switched through the three-stage matrix.

The matrix is arranged to handle both incoming calls to an operator and outgoing calls by an operator. The same DSA trunks are used in both cases.

3.5.2 DSA marker

The function of the DSA marker is to provide the control necessary to interconnect operator's trunks to and from the operator link circuits via an available idle path through the matrix, Figure 10. The DSA marker is similar in design to the marker of the Switch Matrix and Marker Group. The basic functions of the marker are identification, call distribution by type, path selection, and completion of connection.

3.6 Test Group

3.6.1 Maintenance monitor

The maintenance monitor, Figure 11, provides the self checking function of the Common Control equipment. Continuous automatic testing of critical Common Control subsystems, such as the memory, common logic, trunk scanner, etc., is mandatory because of the serious consequences of undetected malfunctions. The trouble analyzer is basically a third skeleton Common Control, which provides a "standard" for comparing the outputs of the Common Control subsystems when the output of the two is not in agreement. If a malfunction is discovered, the maintenance monitor is informed via the access circuit.

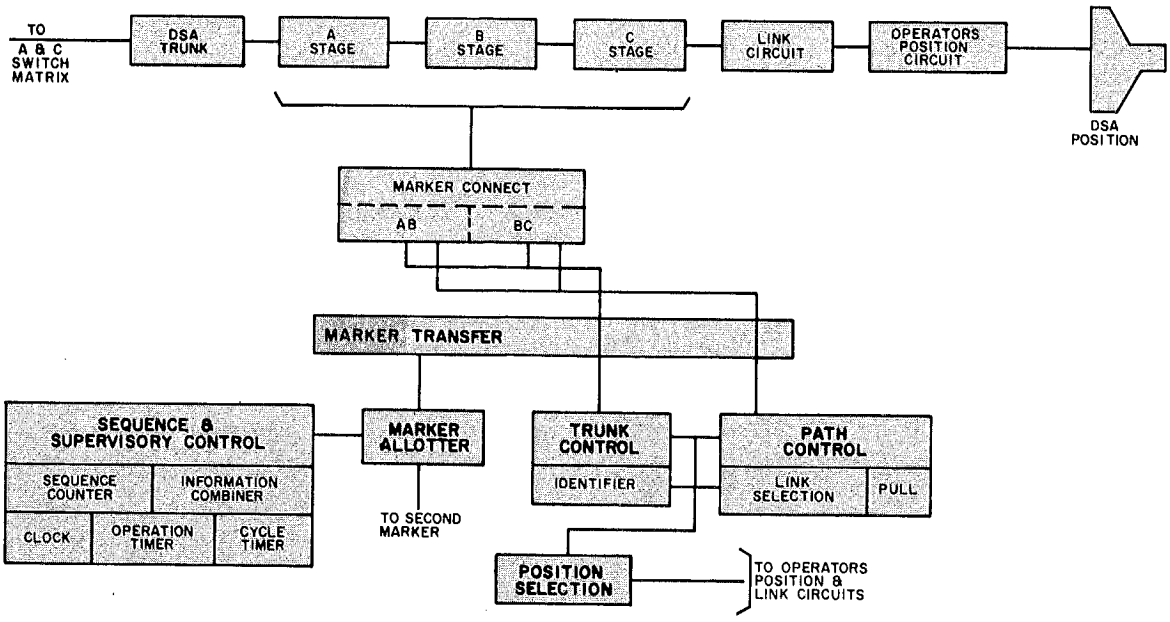


Figure 10. DSA Matrix and Marker Group.

The access circuit provides the circuitry necessary to connect the equipment to be monitored for malfunction to the maintenance monitor.

The printer for the maintenance monitor furnishes a trouble record in code form, which can be easily interpreted by consulting the trouble dictionary.

The heading storage provides the printer with the name of the particular piece of malfunctioning equipment.

The storage register connects the leads from the equipment to the maintenance monitor over which the information available from the equipment is passed.

3.6.2 Register-sender routiner

The register-sender routiner provides for testing of the register-senders. The testing can either be automatic, under the control of the automatic control, or manual, by the maintenance man using the control panel. The automatic test routine consists of tests performed sequentially on each register.

The control panel permits the maintenance man to select the test conditions and register he wishes to check. The automatic test of a register-sender will check each register for tone reception, storage of bits in register portion of memory, proper registration of pulsing, proper sender out pulsing, class-of-service recognition, pre-emption functions, and proper disposition of non-standard situations. The control panel provides for a manual access of a preselected register, manual choice of test termination, manual selection of input pulsing, repeated test of any register, stop upon test failure, count number of test failures, count number of units tested, and four-wire audio termination.

3.6.3 Automatic trunk routiner

The automatic trunk routiner provides for the automatic routining of intertoll and P-B-X trunks to insure early discovery of malfunctions in the trunk equipment.

Associated with the routiner is a rack mounted commercial teletypewriter set, which records the number of the trunk failing a test and the nature of the failure. Peg count meters are provided to count the number of trunks tested, the number of circuits passed busy, the number of test failures, and the number of repeat tests completed. Trunks found faulty by the routiner are automatically busied out.

The automatic trunk routiner is placed in operation by operating keys at the control panel. A "preset" selection circuit is provided, which permits the tester to test a specific trunk, or to start a routine with a specific trunk.

While trunks are under test, they will be marked busy to normal traffic. The test call made by the routiner will not score the normal traffic peg count meter associated with the trunk.

All trunks in the facility are routined sequentially. When the last trunk has been tested, a signal is given indicating that testing is complete. A repeat control key is provided which, when operated, inhibits the stepping mechanism and causes a selected trunk to be routined continuously. A "single" repeat testing feature is also provided for recycling a test on a particular trunk.

Lamps provided on the control panel identify the trunk being tested and indicate the progress of routining.

3.6.4 Toll testboard

The toll testboard will be located with the switching equipment at all Switch sites and will enable the maintenance technician to: make busy tests and establish an out-of-service condition on circuits being tested; talk, monitor, and originate outgoing or incoming calls to test lines (terminations) in the same or distant Switch or to access lines; make testboard-to-testboard (Switch-to-Switch) tests on all circuits terminating at the Switch; and make tests through the Switch to ensure proper functioning of the switching equipment. Access to the line and drop sides of all trunks and lines terminating on the Switch will be provided by cable testboards, VF patch bays and circuit patch bays.

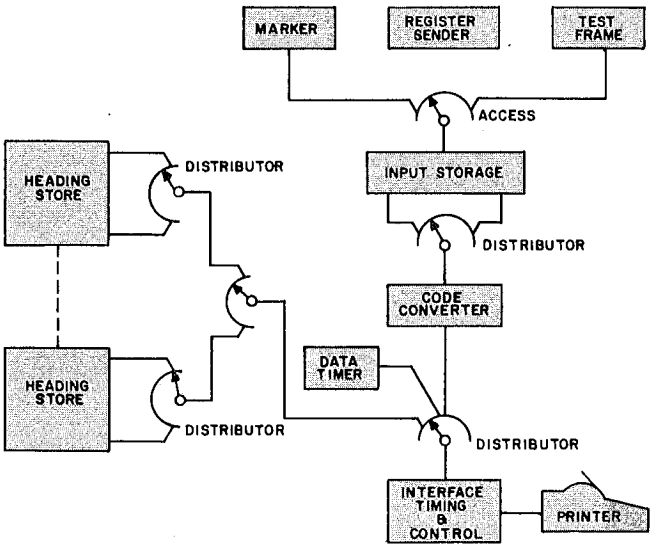


Figure 11. Maintenance Monitor.

3.7 Ancillary Group

The ancillary equipment consists of station apparatus, SF signaling equipment, recording equipment and distributing frames.

3.7.1 Station apparatus

The station apparatus for the AUTOVON Switching System is the Type AE-023 Four-wire Subset, as shown in Figure 12. The subset contains an electronic ringer mounted on a replaceable modular printed wiring card. The subset is equipped with an addressing keyset instead of a dial, and a four-button precedence keyset.

In all but routine calls, the correct precedence key is depressed immediately prior to keying with the addressing keyset.

An extra push key is mounted with the addressing keyset, in the lower right hand corner. This key must be depressed after using the keyset to enable abbreviated dialing.

Extension capabilities will permit the installation of up to six four-wire extension telephones in addition to the main station.

The hot-line subset is similar to the normal station apparatus just described. As discussed earlier (paragraph 1.1-c) a hot-line connection is established between the end point users when one of the users goes off-hook to request service.

3.7.2 SF signaling equipment

The in-band signaling equipment converts E- and M- lead signaling to 2,600 cps tone signaling for presentation to carrier transmission facilities. Likewise, the in-band signaling equipment converts 2,600 cps tone from the carrier receiving facility to E- and M- lead signaling.

Plug-in card assemblies are used with electronic circuitry. When equipped with the signaling supply shelf, two signaling oscillators (one on "main" and one on standby) are used. Transfer and alarm equipment automatically switches from the main to the standby oscillator in the event of a malfunction.

A four-wire line adapter circuit is provided as an interface between the telephone instrument and the signaling equipment.

3.7.3 Recording equipment

Various recording equipments are provided with the AUTOVON Switching System. These are as follows:

a. Trunk routiner printer.

This commercial teletypewriter set is a page printer, receives only, and is rack mounted. The unit types out information presented to it by the automatic trunk routiner on a malfunction encountered

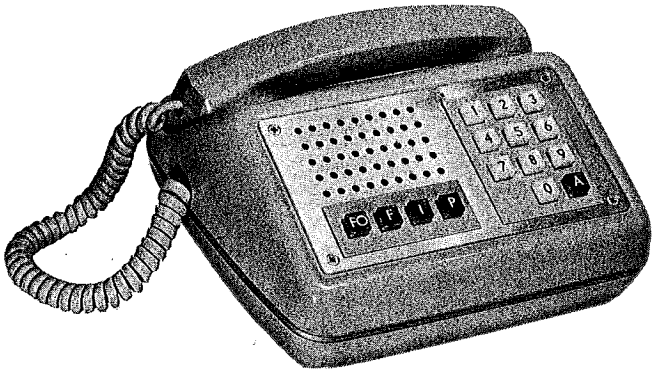


Figure 12. Type AE-023 Four-Wire Subset.

in the testing of the trunk circuits. The printer records the number of the trunk failing a test and the nature of the failure.

b. *Maintenance monitor printer.*

The equipment having a trouble condition to report gains access to the printer through the maintenance monitor access circuit. The printer will furnish a trouble record in code form, which can be easily interpreted by consulting the trouble dictionary.

c. *Traffic recorder.*

The traffic recorder is a rack mounted self-contained electromechanical traffic recording device containing a constant speed motor, relays, peg count meters, and related electronic components and wiring. The front or display panel contains the peg count meters, control switches, fuse holders, and supervisory lamps.

d. *MCF Automatic Recorder - Announcer.*

The MCF Automatic Recorder-Announcer (multi-channel, fixed message length) is designed to intercept calls to unassigned levels. The MCF is capable of delivering five different messages simultaneously to five different callers. The message cycle lasts 6-1/2 seconds; however, with some adjustment, a 12-second message can be provided. New messages may be recorded from a standard telephone. The unit is rack mounted, multi-channeled and consists of a mechanical drum mechanism and electronic control circuitry. The circuitry is contained on standard printed wiring cards mounted in a card file frame.

e. *Answering time recorder.*

The Answering Time Recorder (ATR) is an electromechanical device used for measuring operator speed of answer. The equipment is arranged to allow connection to a number of groups of lines and allows selection of one group of lines on which measurements are to be taken. The Answering Time Recorder samples calls occuring on the selected group, counts them, times them against a preset standard interval, and counts separately all calls which were answered within the standard interval. The standard interval, against which calls are timed, may be set at various intervals by operation of the selector switch. The Answering Time Recorder consists of a control panel and an equipment assembly. The control panel contains all of the controls and indicators associated with the ATR. The rack mounted equipment assembly contains all of the relays and stepping switches associated with the ATR.

3.8 Power Group

The Switch power plant is a 50-volt DC system. A power control board regulates voltage and distributes power through fuses to the various equipment frames. The power plant includes duplicate source supplies for dial tone, busy tone, ringback tone, ringing current and accessory pulses required by the switching equipment.

All power for electronic equipment is derived from the office battery using DC-to-DC converters. Battery and ground are distributed to each frame of electronic equipment. Generally one or more static converter modules and the required number of voltage-regulator modules are provided per frame of electronic switching equipment.

To aid in fault isolation, alarm-type fuses are provided on a "per regulated voltage basis" for each file of electronic circuit cards. Electronic ground is common to the outputs of all regulator modules in a given frame of equipment.

The positive side of the 50-volt DC supply is grounded in accordance with conventional telephone practice, to minimize the hazard to personnel and equipment caused by an accidental cross with high-voltage lines. A conductor is provided for this purpose. All conductor shields are connected to a grounding conductor at one end only, and are insulated from all equipment supporting frames.

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