Stromberg-Carlson
A PLESSEY TELECOMMUNICATIONS COMPANY

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SYSTEM CENTURY®
DIGITAL CENTRAL OFFICE
SYSTEM DESCRIPTION

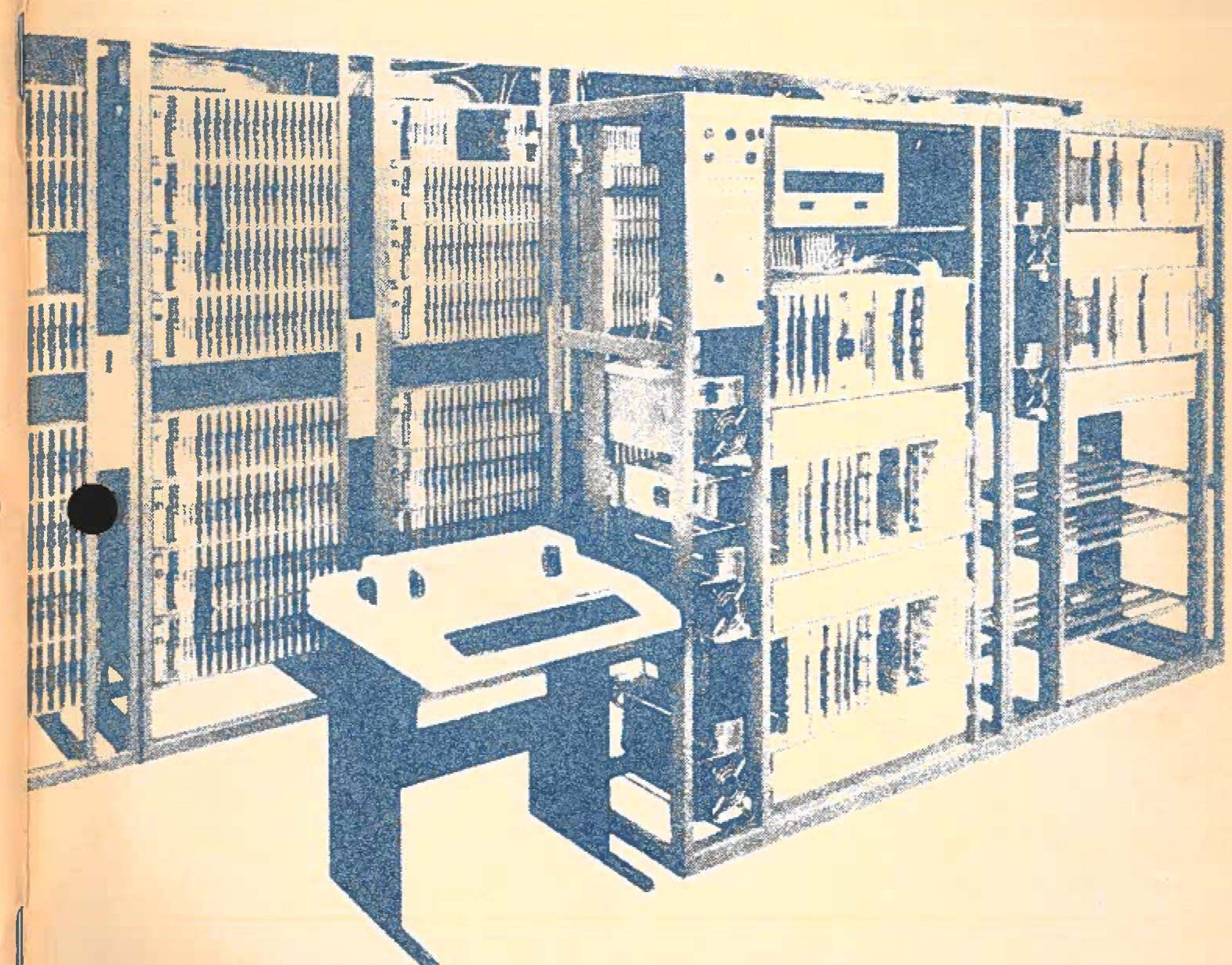

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

LIST OF ILLUSTRATIONS

TABLES

CHAPTER 1

SYSTEM CENTURY TECHNOLOGY

The SYSTEM CENTURY Digital Central Office is a fully-featured exchange designed for Class 5, Class 4/5, and Class 4 Service. The DCO® system can be provided with Local Automatic Message Accounting (LAMA) for Class 5 service and with Centralized Automatic Message Accounting (CAMA) for Class 4/5 service. The DCO system can be expanded to completely automated Class 4C service with the SYSTEM CENTURY Operator Position System (SCOPS).

SECTION 1
INTRODUCTION

1.1 SYSTEM CAPACITY

The SYSTEM CENTURY DCO system has a network capacity of 216,576 Average Busy Season Busy Hour (ABSBH) CCS. The network can serve up to 32,400 lines and 4,000 trunks and the central processing unit has a throughput capacity of over 114,000 BHCA. The system is completely modular and will serve requirements throughout Local and Local-Toll Switch applications. This modular growth plan permits cost savings in smaller applications while allowing additional capacity for larger exchanges.

1.2 OUTLINE

The following sections of this chapter will provide details on:

Section 2 – Basic System Architecture
Section 3 – Common Control Equipment
Section 4 – Local Line Switch
Section 5 – Remote Line Switch
Section 6 – DCO Technical Characteristics
Section 7 – SYSTEM CENTURY Traffic Engineering
Section 8 – SYSTEM CENTURY Power Engineering
Section 9 – TSPS – SYSTEM CENTURY Operator Position System (SCOPS)
Section 10 – Centralized Maintenance and Administration Center

1.3 NETWORK ADVANTAGES

The DCO product line provides substantial advantages as a total network product. Table 1-1.1 summarizes these features and advantages.

TABLE 1-1.1
DCO NETWORK ARCHITECTURE ADVANTAGES

FEATURE	ARCHITECTURE	ADVANTAGES
System Growth	Up to 32,400 lines and 4,000 trunks on a modular system of hardware and software common equipment.	Increases network flexibility Increases value of in-service systems Reduces training and inventory
Digital Communications/ Modular Construction	Used in local/remote switching, pair gain systems, and integral subscriber carrier.	Increases network flexibility
Intelligent Remote	Optional intelligence may be added to a Remote Line Switch. Provides standalone capability for the switch in case of PCM cable failure.	Increases customer satisfaction by making more local-to-local dialing time available Serves community of interest Provides emergency service Field upgradable Deloads traffic in host DCO system
Large Line Switch Groups	Line Switch houses up to 1,080 lines and requires 8.25 square feet of floor space.	Reduces floor space Simplifies wiring and installation Increases traffic efficiency due to increased size of groups
Expanded Traffic Capability	Line Switch can provide variable line capacity (3 to 6.2 CCS/line) without depopulation. Accomplished by varying number of links to host DCO system in order to meet traffic requirements.	Reduces demand and first cost of traffic-sensitive facilities
Remote Pair Gain Systems	Pad-mounted, weather-proof cabinet can be used to house Remote Line Switch.	Eliminates building costs Allows right-of-way mounting Reduces first cost by deferring cable investment
Intra-Nodal Remote Switching	Optional addition to Remote Line Switch allows intra-nodal processing of intra-local calls.	Reduces number of T1 lines required

TABLE 1-1.1
DCO NETWORK ARCHITECTURE ADVANTAGES (Cont)

FEATURE	ARCHITECTURE	ADVANTAGES
Intra-Nodal Remote Switching (Cont)		Increases toll usage of T1 lines Increases per-line CCS capacity
Remote Line Group Pair Gain System	Line Groups of up to 90 lines each may be remoted via a T-1 span line from local or remote line switches. This provides an additional dimension of cost-effective pair gain systems. Pad/pole mounting.	Reduces first cost Reduces spares cost Increases network flexibility Expands use of existing plant
Virtual Spare	Line Switch contains an option for automatic or manual replacement of a failed line circuit.	Reduces maintenance time and cost Increases customer satisfaction
Reduced Power Requirements	DCO system requires less common equipment using Line Switch architecture.	Reduces first cost Reduces floor space and air conditioning load Reduces life cycle operational cost
Full Central Office Features	All future DCO systems will have full features, including custom calling and Line Switch architecture.	Increases system value and revenues Increases customer satisfaction
Microprocessor Control	Line Group and Line Switch Controllers control all line switching functions.	State-of-art distributed processing Increases reliability
Segregated Lines and Trunks	DCO lines and trunks are housed in separate frames.	Lines and trunks do not compete for same resources Simplifies testing and administration
Distributed Network	Delivers enhanced service and features to expanded remote areas.	Reduces first cost Increases network flexibility Expands use of existing plant

SECTION 2
BASIC SYSTEM ARCHITECTURE

2.1 DEFINITION

The DCO system consists of major hardware sections and software to support the functions of call processing, maintenance, and office administration. These include the call processing system, maintenance and administration processor, local and remote line switches, remote line groups, trunk frames for analog or service circuits, digital trunk frame for directly connected digital trunks, call processing stored programs, automatic multilevel diagnostic software, and peripheral elements (magnetic tape recorders, keyboards, line printers, and video displays, etc.).

2.1.1 SYSTEM ELEMENTS. The system elements used in the DCO system are: the local and remote line switching units, analog and digital trunk frames, and the common equipment group.

Analog and digital trunk frames terminate on a fully duplicated, virtually non-blocking, switching matrix to provide a very reliable and highly efficient grade of service to telephone users. The DCO common equipment uses duplicated, synchronized call processing systems. Both systems are on line processing originating call attempts. Both systems perform exactly the same function (per unit of time, call, and instruction) recognizing line or trunk request for service, returning dial tone, receiving and reading dialed digits, translating the digits, and setting up a terminating call path. The only difference in the operating sequence of the duplicated call processing systems is that only one of the two call paths actually terminates on the called line or trunk, with the other path being held for instantaneous use, if required.

The use of these modular, duplicated switching elements is unique in that each type of element may be connected in parallel to satisfy the needs of an almost continuous series of network or exchange applications. For example, when the line and trunk capacity of a single common equipment group is exceeded, another group may be added to increase the line and trunk capacity of the exchange or network served.

All administration functions for all lines or trunks connected to common equipment groups, may be accomplished from a single teleprinter or CRT. Traffic and maintenance reports are printed on a total exchange basis with individual common equipment group, or subgroup reports selected by customer option.

2.1.2 ARCHITECTURAL ADVANTAGES. Advantages of the Stromberg-Carlson modular architecture are:

- Continued use of field proven, mature system elements
- Precludes obsolesence of system elements and spares
- Increases the value of systems in-service
- Improved system reliability and customer satisfaction
- Allows exchange growth by adding known elements
- Provides a modular but totally integrated exchange over a wide range of line and trunk requirements
- Single point control of administration and maintenance
- Increased system reliability

This architecture was carefully chosen by Stromberg-Carlson to accommodate the following advantages over other systems.

- Eliminates the use of non-digital space-division elements to increase connectivity
- Reduces design and product risks
- Precludes additional training, spares, and test equipment expense as new elements are added
- Reduces service disruptions during system growth (expansion)

The DCO architecture is shown in figure 1-2.1 Local/remote line switches are connected to the common equipment group. The common equipment group is redundant and capable of handling over 114,000 BHCA. Network analog and digital trunks are also connected to the common equipment group.

2.1.3 MAINTENANCE AND ADMINISTRATION. Maintenance and administration of the common equipment group are connected to a maintenance and administration processor. This processor is responsible for all maintenance and administrative functions of the exchange. These responsibilities include:

- Administration Functions
  - Line Administration
  - Trunk Administration
  - Network Administration
  - Traffic Reports
- Maintenance Functions
  - System Maintenance
  - Line Circuit Routine/Manual Testing
  - Line Testing Manual/Automatic
- Operational Functions
  - General Program Load
  - Office Data Base Load
  - Program Audit/Edit

The Stromberg-Carlson modular architecture is a totally integrated, highly reliable, duplicated, all digital switching exchange that is economical over the full product life.

2.2 COMMON CONTROL EQUIPMENT

The DCO common control equipment is made up of the duplicated synchronous call processing systems and the maintenance and administration processor with its peripheral ele-

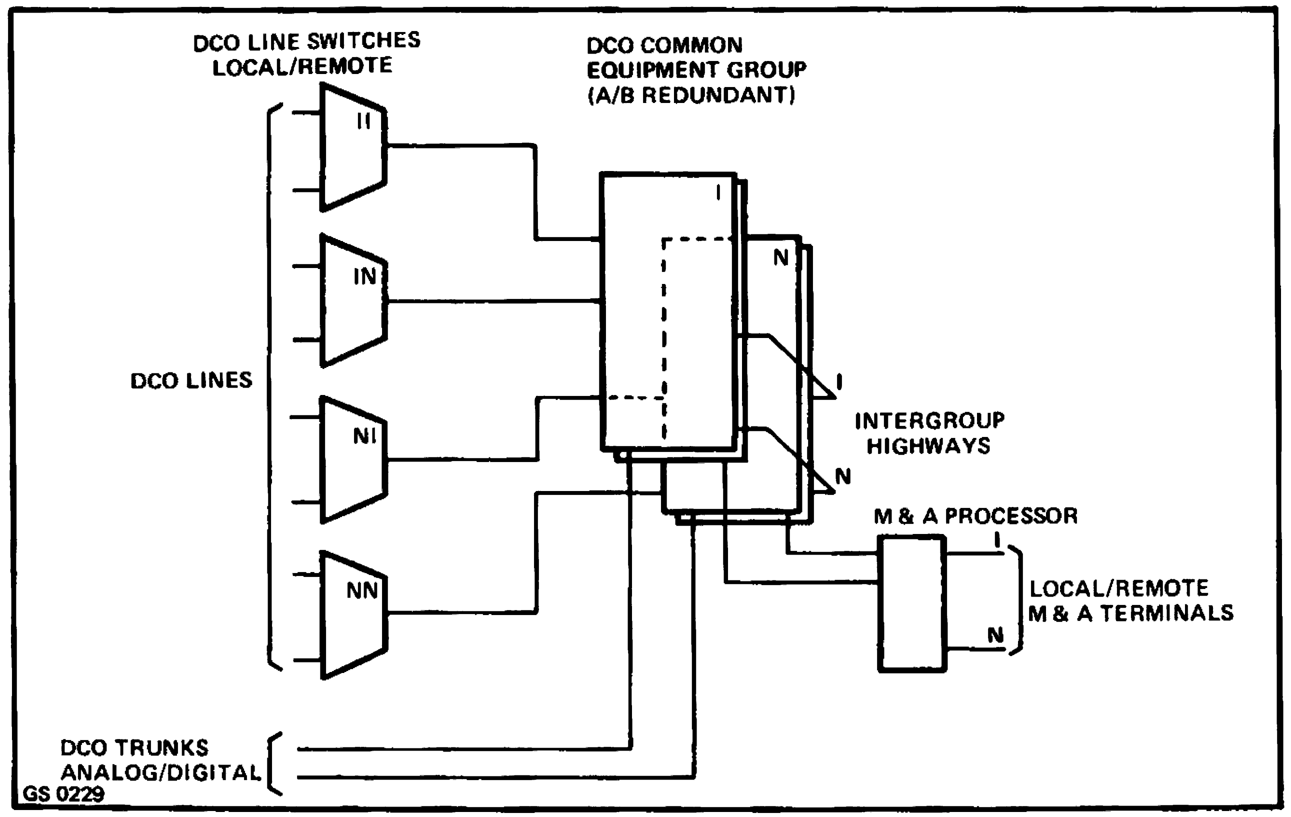


Figure 1-2.1. Multicommon Equipment Group DCO Exchange Architecture

ments. In the call processing system there is a timeslot interchange, telephony preprocessor, call processor, memory, and communications buffer controller.

Supervisory information, such as on-hook/off-hook status, is passed between the line switch and the telephony preprocessor via the timeslot interchange and the communications buffer control. Under control of the call processor, the telephony preprocessor performs all real-time-dependent functions of the ports. The call processor sends commands to the telephony preprocessor via its controller to specify the function required for each line. Examples are "look for seizure" and "ring the line." When the function has been accomplished, the preprocessor informs the call processor of this fact via its controller. This controller also is the communications path between the timeslot interchange and the call processor for establishing and releasing voice paths between ports.

One common control sector can serve up to eight timeslot interchanges for a total of 1920 common equipment ports. Duplicated common controls and timeslot interchanges always are equipped with these ports. Up to four common control sectors can be provided in the DCO common equipment for a total of 7680 ports. A diagram of the common control equipment is given in Figure 1-2.2.

Timeslot interchanges use time-division multiplexing to provide the connection or path for routing digital voice information from a calling line circuit to the correct called line or trunk. Each timeslot interchange serves up to eight sets of port group highways, or 240 voice ports in the DCO common equipment. Dual cross-office highways expand the capacity to 28.2 CCS per port using 256 timeslots for 6,768 CCS ABSBH capacity per timeslot interchange.

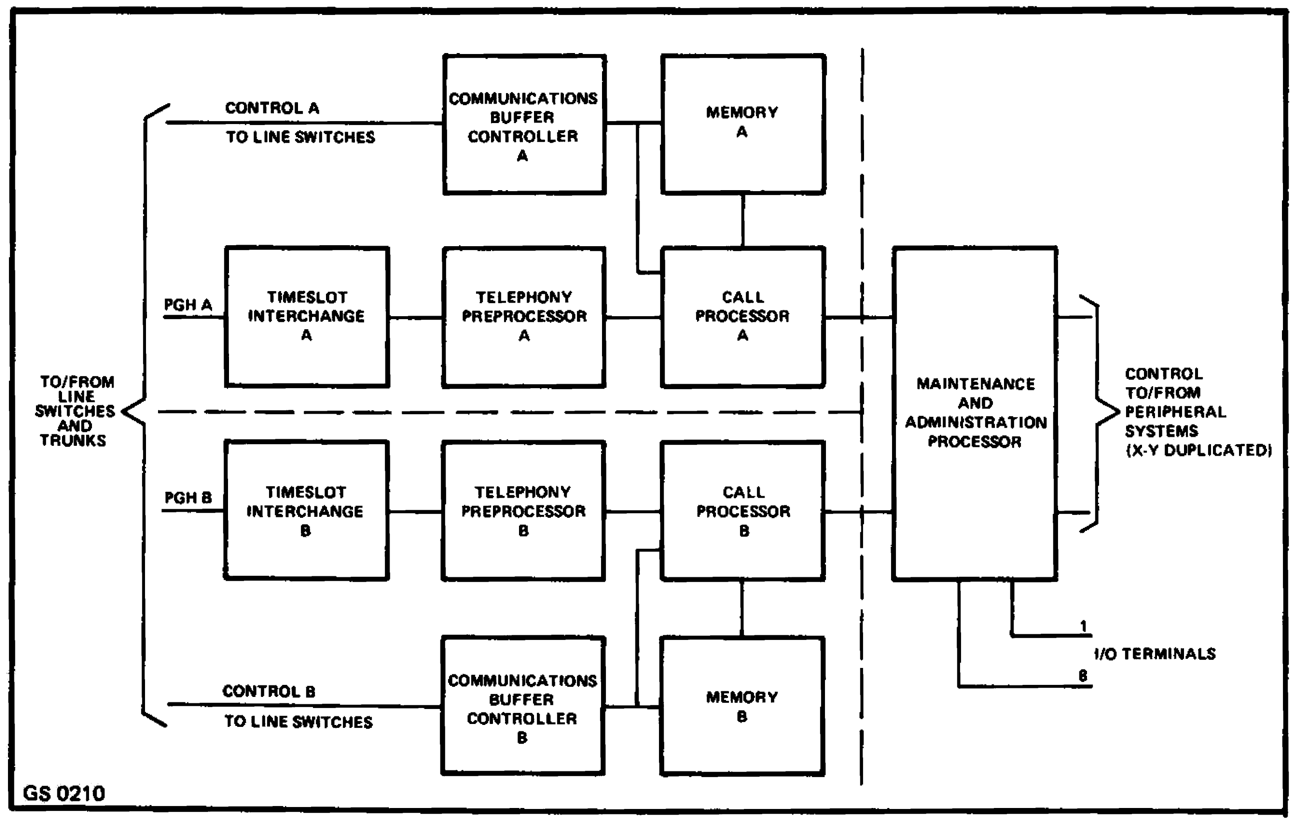


Figure 1-2.2. DCO Common Control Equipment Block Diagram

A typical timeslot interchange is shown in Figure 1-2.3.

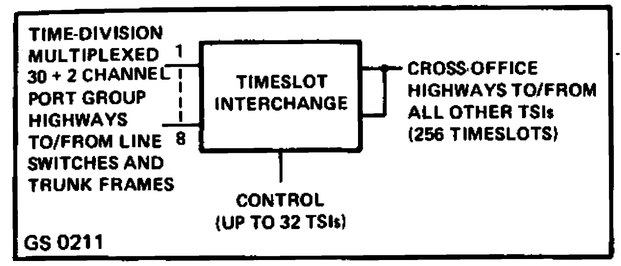


Figure 1-2.3. Timeslot Interchange Block Diagram

The maintenance and administration processor, in conjunction with input/output terminals such as keyboard/printers, CRTs and high-speed line printers is used for all administrative functions and for most maintenance functions. This processor is similar to those used in the call processing systems. The use of a maintenance and administration processor separate from the call processor is advantageous to operating companies by conserving the real time capacity of the call processor during traffic peaks and reducing delays during maintenance and administration actions. Administrative software programs control and document changes to the office configuration data base. Most changes in system operation can be accomplished by software modifications, entered via keyboard into the call processor memory, under control of the maintenance and administration processor. A malfunction in either of the dual call processing systems automatically alerts the maintenance and administration processor. Three levels of diagnostics are used, which are explained in detail in Section 3 of this chapter.

2.3 LOCAL LINE SWITCH

Lines are connected to the DCO common equipment via local or remote line switch frames capable of handling up to 1,080 lines. The line switch design recognizes the inherent high CCS capacity of the DCO common equipment ports providing increased line connectivity. Installation may be local with or remote from the DCO common equipment. The port group highways to the timeslot interchanges are 30 channels each and operate at 2.048 million bits per second (Mb/s). Two-to-eight port group highways may be provided for each local line switch dependent upon traffic requirements of the individual switch. This allows a line switch to connect via 60 to 240 channels to the common equipment.

The line switch is a solid-state, PCM subsystem with the capability of providing variable ABSBH line traffic up to 6.2 CCS per line without depopulation. As part of the distributed processing concept in the DCO system, twelve microprocessor-controlled line groups of 90 lines each are contained in each line switch. Redundant line switch controllers provide switching control as well as communicate with the DCO common equipment via CBCs. The local line switch functional block diagram is given in Figure 1-2.4.

2.4 REMOTE LINE SWITCH

The remote line switch (Figure 1-2.5) is similar to the local line switch; all line PWBAs, power supply, line group common equipment, and line switch controllers are identical. DS-1 compatible (1.544 Mb/s) 24 channels link the remote line switch to the DCO. A local ringing equipment control is provided at the remote site. Two of the initial 48 channels are dedicated as control data channels between the remote line switch controller and the host DCO call processor. Optional automatic line insulation testing (ALIT), virtual spare line, Intra-Nodal Switching (INS), and Emergency Switching Service (ESS) may be added to the remote line switch. These capabilities are explained in Section 4 of this chapter.

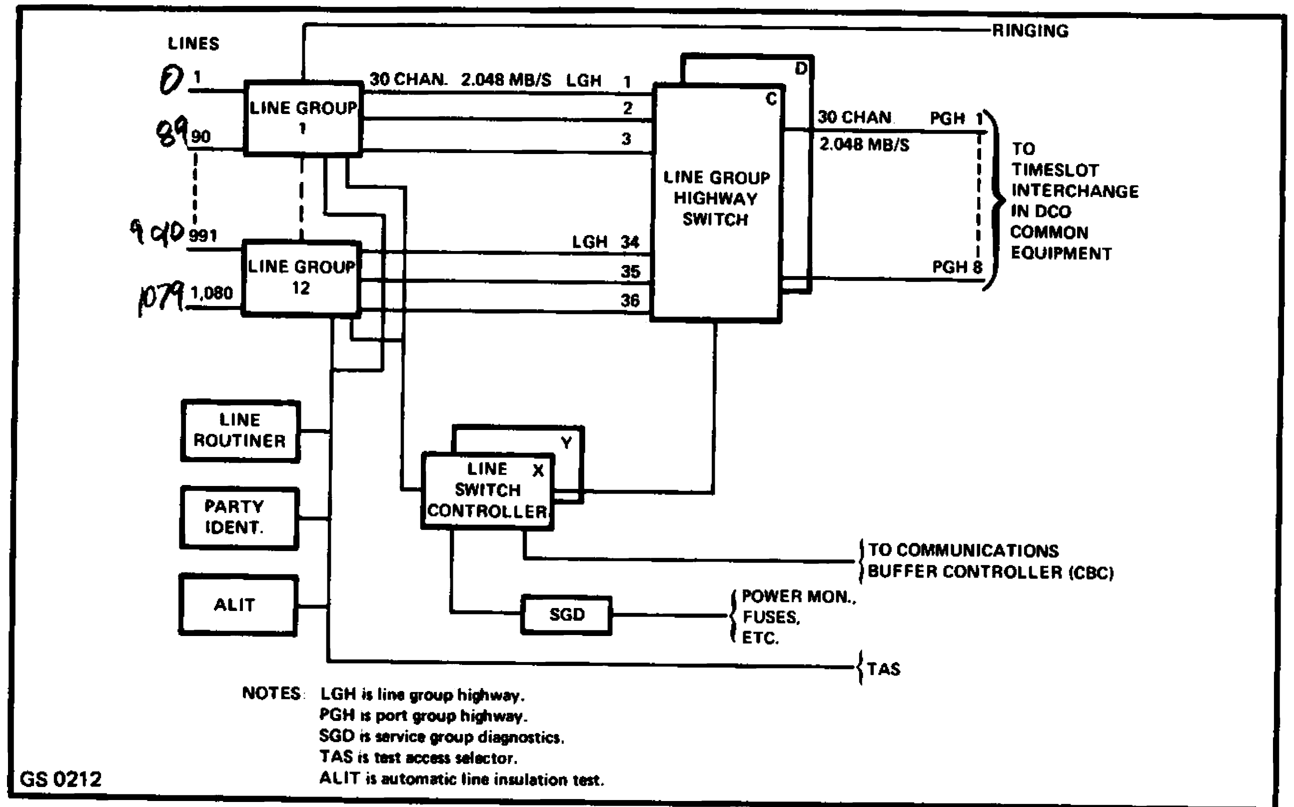


Figure 1-2.4. Local Line Switch Block Diagram

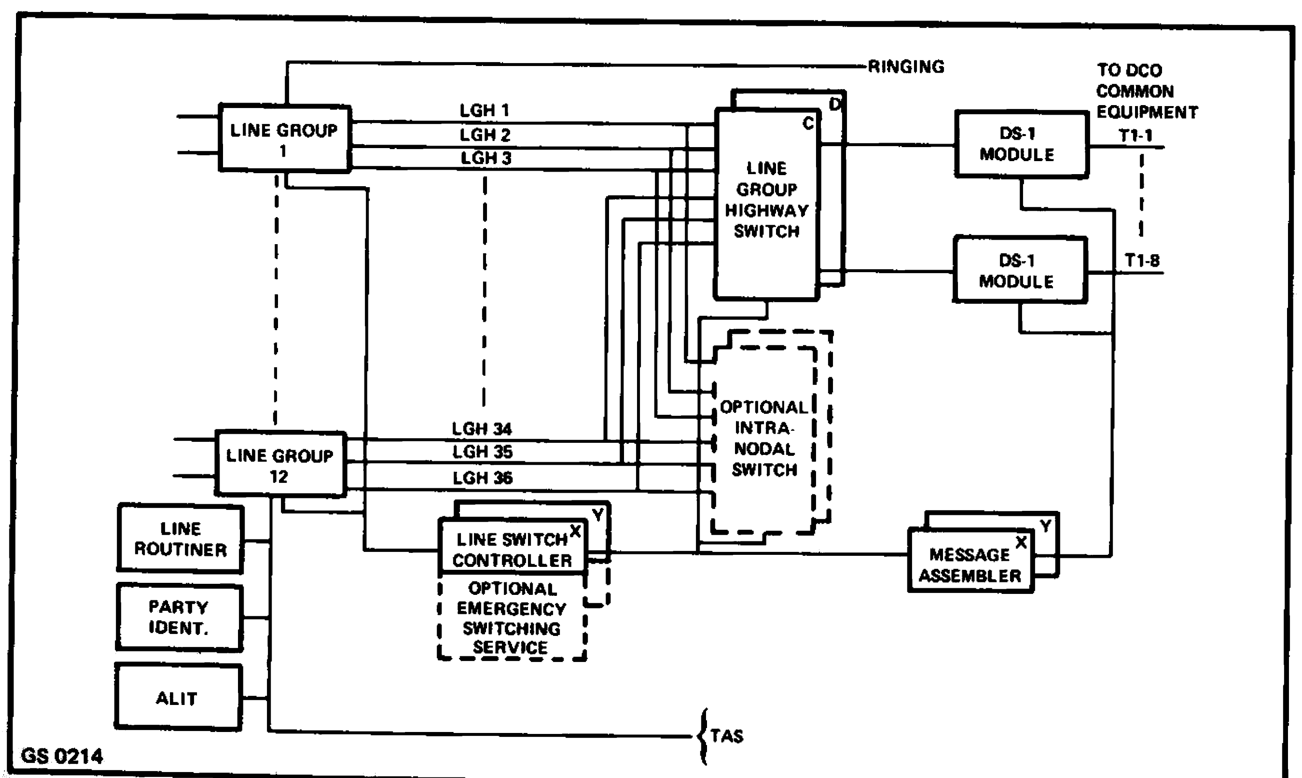


Figure 1-2.5. Remote Line Switch Block Diagram

SECTION 3
COMMON CONTROL EQUIPMENT

The Stromberg-Carlson DCO common control equipment contains three basic systems: call processing, maintenance and administration and peripheral. These three systems are described in the following paragraphs.

3.1 CALL PROCESSING SYSTEMS

The call processing systems contain fully duplicated call processors and timeslot interchanges. The duplicated call processing systems are designated as "A" and "B", thus the term "A-B mode" is used to describe the physical relationship between the two call processing systems. The designations of A and B for the call processing systems are a matter of choice. Both call processing systems are entirely equal in design and function. The designations A and B are only used for identification and for the purpose of clarification in the following text and art.

The call processing systems of the Digital Central Office operate in a unique fashion compared to most other switching systems on the market. They operate in a completely synchronous mode performing exactly the same functions on a bit-per-bit basis. One unit is designated as the on-line unit and the other as the off-line unit with the only operating difference being the suppression of signals to the outgoing port from the off-line unit. Those signals are held in the A-B select circuit for instantaneous use if required. Table 1-3.1 compares the functions of the on-line and off-line call processor systems. The roles of the two call processing systems may be instantaneously reversed either automatically or manually without loss of calls at any stage of processing. The maintenance and adminstration processor continually monitors and compares the outputs of the two units. When a mismatch occurs, both are automatically tested to determine faulty unit and cause transfer and fault printout as required.

The significance of the dual processing technique (A-B mode) is that the active reserve call processor (B) is continuously functioning and requires no warm-up orientation or preparatory time (call dropping) prior to replacing the on-line call processor (A) in the event of a fault in call processor (A). The automatic switchover is virtually instantaneous and no calls are lost. Figure 1-3.1 shows the duplicated call processor systems.

3.2 MAINTENANCE AND ADMINISTRATION SYSTEM

The maintenance and administration system performs control, supervisory, and maintenance functions for the call processor systems and for the peripheral system. Because the maintenance and administration system communicates with on-line and off-line elements, it has memory data tables for on-line functions and off-line functions. The major functions of the maintenance and administration system are described in the following paragraphs.

3.2.1 MONITORING OF CALL PROCESSOR SYSTEMS. The maintenance and administration system continuously monitors the call processor systems on a bit-by-bit basis. When a fault is found in the on-line call processor sys-

TABLE 1-3.1
SUMMARY OF CALL PROCESSING SYSTEM DIFFERENCES: ON-LINE VERSUS OFF-LINE

	CPS FUNCTIONS							
CPS	OPERATES IN BIT-BY-BIT SYNCHRONISM WITH OTHER CPS	READS INCOMING DIGITS	TRANSLATES INCOMING DIGITS	SETS UP CALL PATHS	VERIFIES CALL PATH IS SET UP	SWITCHES CALL	TRANSMITS CALL DATA TO LINE OR TRUNK	MONITORS CALL PATH DURING CONVERSATIONS
On-Line A or B	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Off Line A or B	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

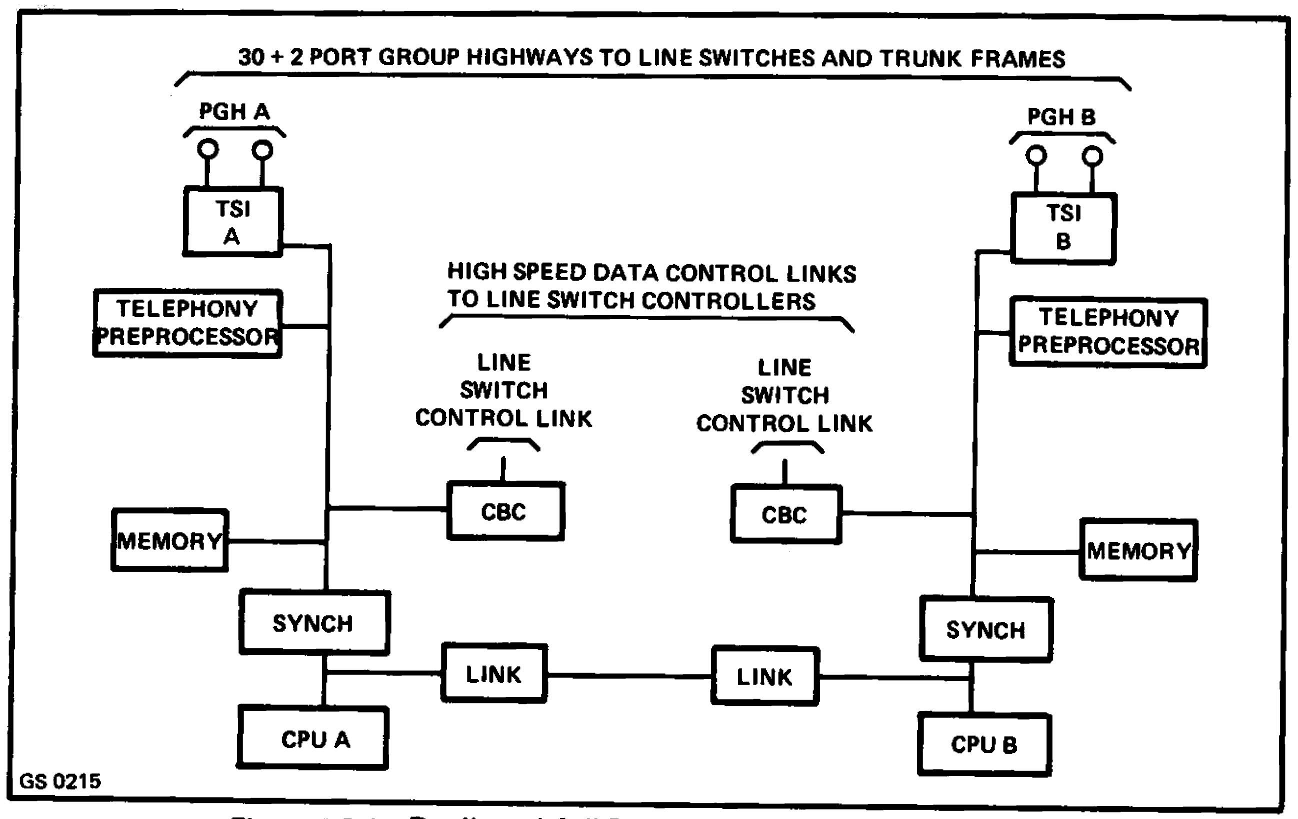


Figure 1-3.1. Duplicated Call Processing Systems Block Diagram

tem, the call processor system is removed from service and replaced with the other call processor system that has been operating in active reserve status. This replacement process is virtually instantaneous without dropping calls. Then the maintenance and administration system continues through automatic levels of maintenance to isolate or automatically correct the faulty call processor systems. In addition, the maintenance and administration system identifies the type and location of the fault which are then printed on a hard copy. The maintenance and administration system, with its relationship to the call processor system is shown in Figure 1-3.2.

3.2.2 MONITORING OF PERIPHERAL SYSTEM. The peripheral system is continuously monitored by the maintenance and administration system. When a fault in the peripheral system is identified, the faulty peripheral function, such as ringing, is instantly replaced by a ringing function in the duplicated peripheral system. Then the maintenance and administration system continues through levels of maintenance to isolate or automatically correct the faulty function. In addition, the maintenance and administration system identifies the type and location of the fault which are then printed on a hard copy. The maintenance and administration system, with its relationship to the peripheral system is shown in Figure 1-3.2.

3.2.3 MONITORING OF ON-LINE DCO SYSTEMS. To assist the maintenance and administration system with its monitoring functions and to ensure complete identification of faults, the call processor systems and the peripheral system have built-in, on-line, bit-by-bit monitors to detect faults and irregularities. When a fault or irregularity is detected by an on-line monitor, it automatically notifies the maintenance and administration system. Then the maintenance and administration system instantly removes the faulty system or function, switches to a duplicated system, and initiates automatic levels of maintenance to isolate or correct the faulty system.

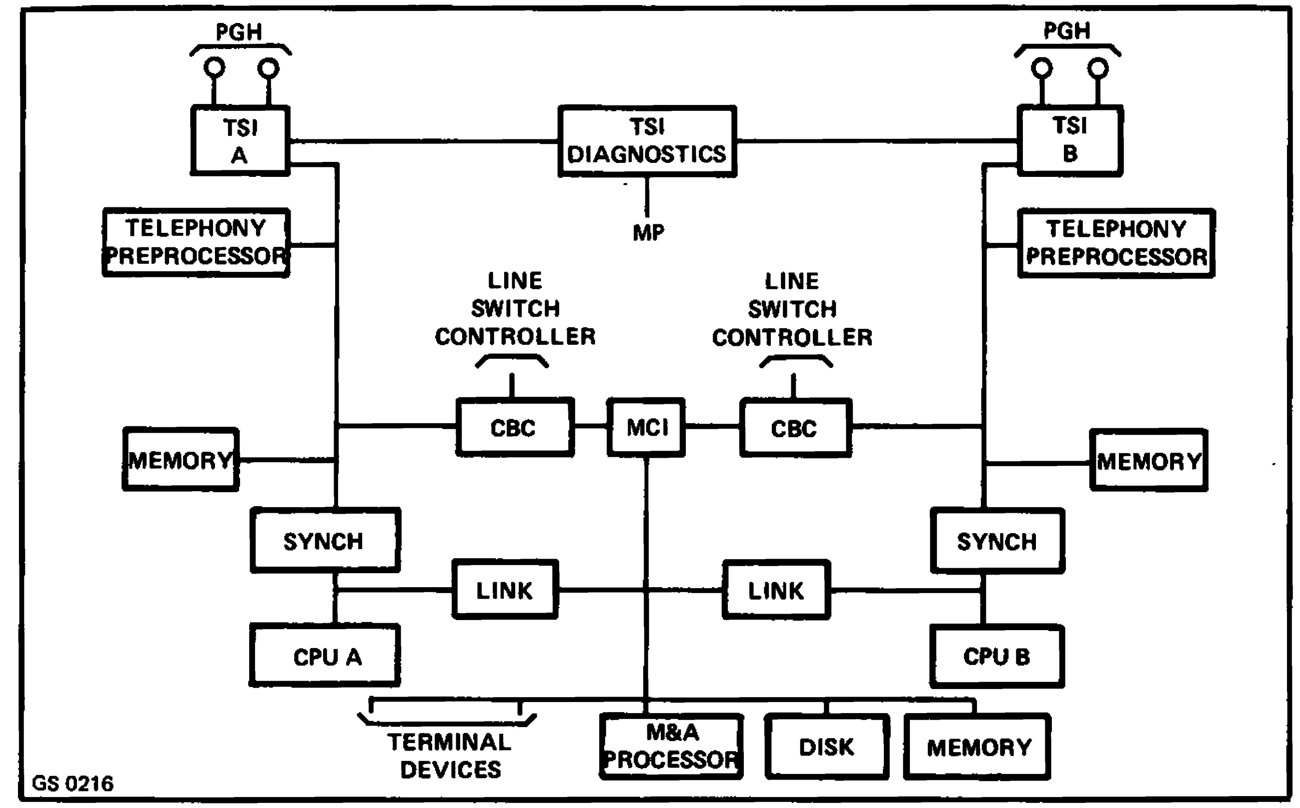


Figure 1-3.2. Maintenance and Administration System Block Diagram

3.2.4 MONITORING OF DCO CIRCUITS AND LINE SWITCHES. In addition to the major tasks of monitoring the call processor systems and the peripheral system, the maintenance and administration system constantly and automatically monitors all circuits and functions in the DCO system on a 24-hour-per-day basis. This level of monitoring includes all line groups, timeslot interchanges, ports, line switch controllers, lines and trunks, analog portion of line circuits, transmission, signaling, ringing, and supervisory functions. If a fault occurs in the call processor system or peripheral system while the maintenance and administration system is performing a routine line and trunk test, the maintenance and administration system automatically switches to the duplicated system and performs three-level maintenance to isolate and correct the fault. The maintenance and administration system has a fault priority routine that automatically switches to the most critical fault if more than one fault occurs simultaneously. When the fault has been corrected or isolated, the maintenance and administration system automatically switches back to the test routine for the lines and trunks.

3.2.5 MAINTENANCE AND ADMINISTRATION SYSTEM LEVELS OF MAINTENANCE. When a fault is detected by the maintenance and administration system, it initiates a series of maintenance procedures or levels, as follows.

a. Level 1 locates the fault and automatically removes the faulty system or function from service.

b. Level 2 automatically performs elaborate diagnostic routines on the faulty system or function and provides a printout that identifies the most probable faulty component(s) which is usually a replaceable printed wiring board assembly.

c. Level 3 is used as a manual "trouble trap" method for those faults that may require technician involvement.

These Stromberg-Carlson DCO system maintenance procedures provide state-of-the-art fault isolation and correction to provide operating companies with cost and time savings in switch maintenance, improved subscriber service, and better service index reports.

3.3 PERIPHERAL SYSTEMS

The DCO peripheral systems are duplicated in similar fashion to the duplicated call processor systems except for the synchronous operation of the call processor systems. The duplicated peripheral system remains in a hot-standby mode. Stromberg-Carlson uses the "X" and "Y" designations to identify the duplicated peripheral systems thus describing the physical relationship between each peripheral system.

Note that the designations of X and Y for the two peripheral systems are a matter of choice. Both peripheral systems are entirely equal in design and function. The designations X and Y are only used for identification and for clarification in the following text and art.

Each peripheral system consists of equipment with specialized functions used in call processing, such as ringing. The Stromberg-Carlson peripheral system contains a number of peripherals, both basic and optional. The following peripherals are included for the purpose of explanation (There are other available DCO peripherals).

- System Clocks – basic
- Synchronized Network Clocks – optional
- Ringing System – basic
- Magnetic Tape Recorders – optional
- Line Switch Controllers – basic
- Coin Voltage Supply – optional

Figure 1-3.3 shows the duplicated peripheral systems. It also shows the relationship between the call processor systems, the maintenance and administration system, and the peripheral systems. It is significant to note that the peripheral systems operate independently of the call processor systems and that the X and Y systems are independent of each other. Neither the X nor Y peripheral system is slaved to either the A or B call processor system. Therefore, a number of operational configurations are possible. This provides extreme flexibility in the DCO redundant systems to meet virtually any emergency. This type of flexibility is important to operating companies because it allows full service even though simultaneous failures of dissimilar functions occur on opposite peripheral sides (X and Y).

Most important is the selective method of switching X for Y or Y for X. Should a fault occur, such as ringing in the on-line system X, only the ringing function from the off-line system Y is substituted. The entire Y system is not substituted for the on-line X system which has faulty ringing. This selective substitution for a specific fault greatly simplifies the automatic and instantaneous maintenance process that is controlled and supervised by the maintenance and administration system. Figure 1-3.4 illustrates the substitution of the ringing function: X is on-line and Y is off-line in this example. Other functions may be substituted similarly.

Although it is very unlikely that the need would ever arise, it is possible to instantaneously substitute or switch Y for X or X for Y. This would substitute all of the functions in Y for all of the functions in X, or vice versa.

It should be noted that all competitive digital switches operate in a modified A-B mode, but no other ones offer the extreme maintenance flexibility or reliability that are built into the Stromberg-Carlson DCO system. Therefore, the result of a double fault in some digital switches is a non-operational central office. The Stromberg-Carlson maintenance and administration system can easily tolerate a fault in either (A-B and X-Y) systems. The DCO system with its unique maintenance and administration surpass all other systems available on the market today.

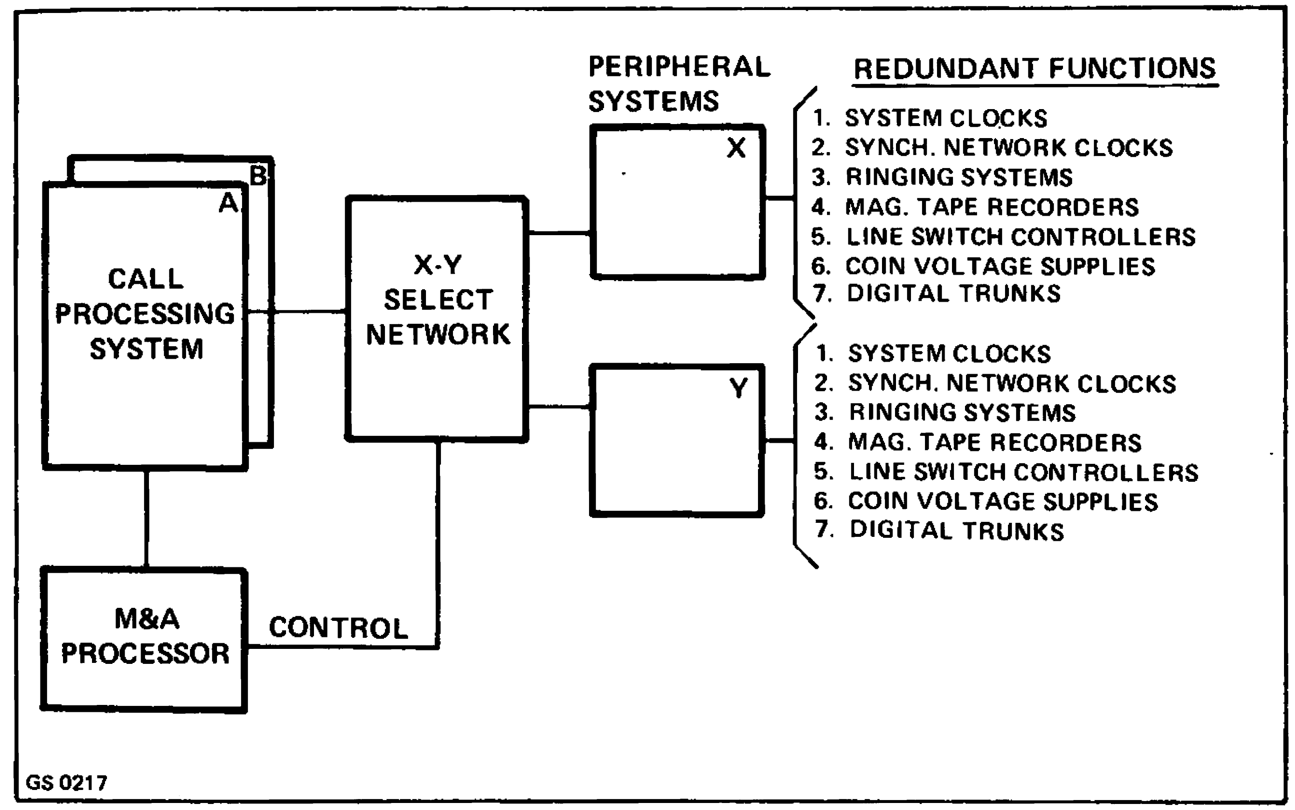


Figure 1-3.3. Duplicated Peripheral Systems Block Diagram

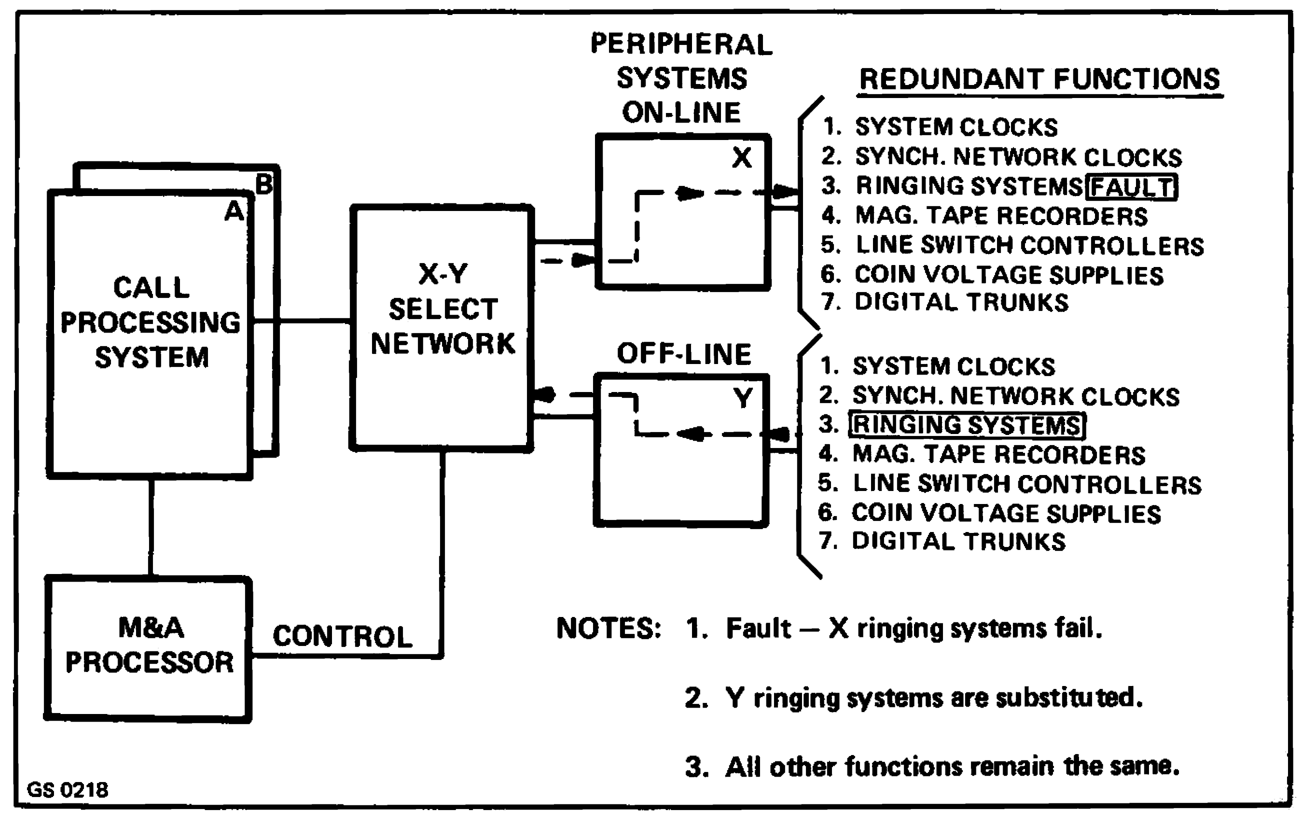


Figure 1-3.4. Peripheral System Substitution of Ringing Function Block Diagram

3.4 COMMON CONTROL AND MAINTENANCE EQUIPMENT FRAME

Figure 1-3.5 depicts the mounting of the dual call processors, telephony preprocessors, timeslot interchanges, and maintenance and administration processor in the control and maintenance frame. This frame is 87" high by 51" wide by 22" deep. Also shown is an expansion frame to accommodate system growth.

3.5 SOFTWARE ORGANIZATION

The DCO software system (Figure 1-3.6) is organized into three main groups: call processing, maintenance, and administration. The DCO software is structured on a cluster/module concept where clusters correspond with major task assignments and modules are subtasks of clusters. The number of modules within a cluster group is dependent on the complexity of the task. Each of the call processing and the maintenance groups has an executive cluster that determines the sequence of tasks to be done.

3.5.1 CALL PROCESSING SOFTWARE. The call processing software controls the processing of a call and has the traditional translator/marker tasks assigned to it, such as directory number translations and selection of route information by accessing the call processor data base. The call processor software interacts with the telephony preprocessor that is functionally part of the DCO common control equipment. The call processor executive cluster runs in an interrogation (search) loop, constantly polling the telephony preprocessor priority queues for sub-

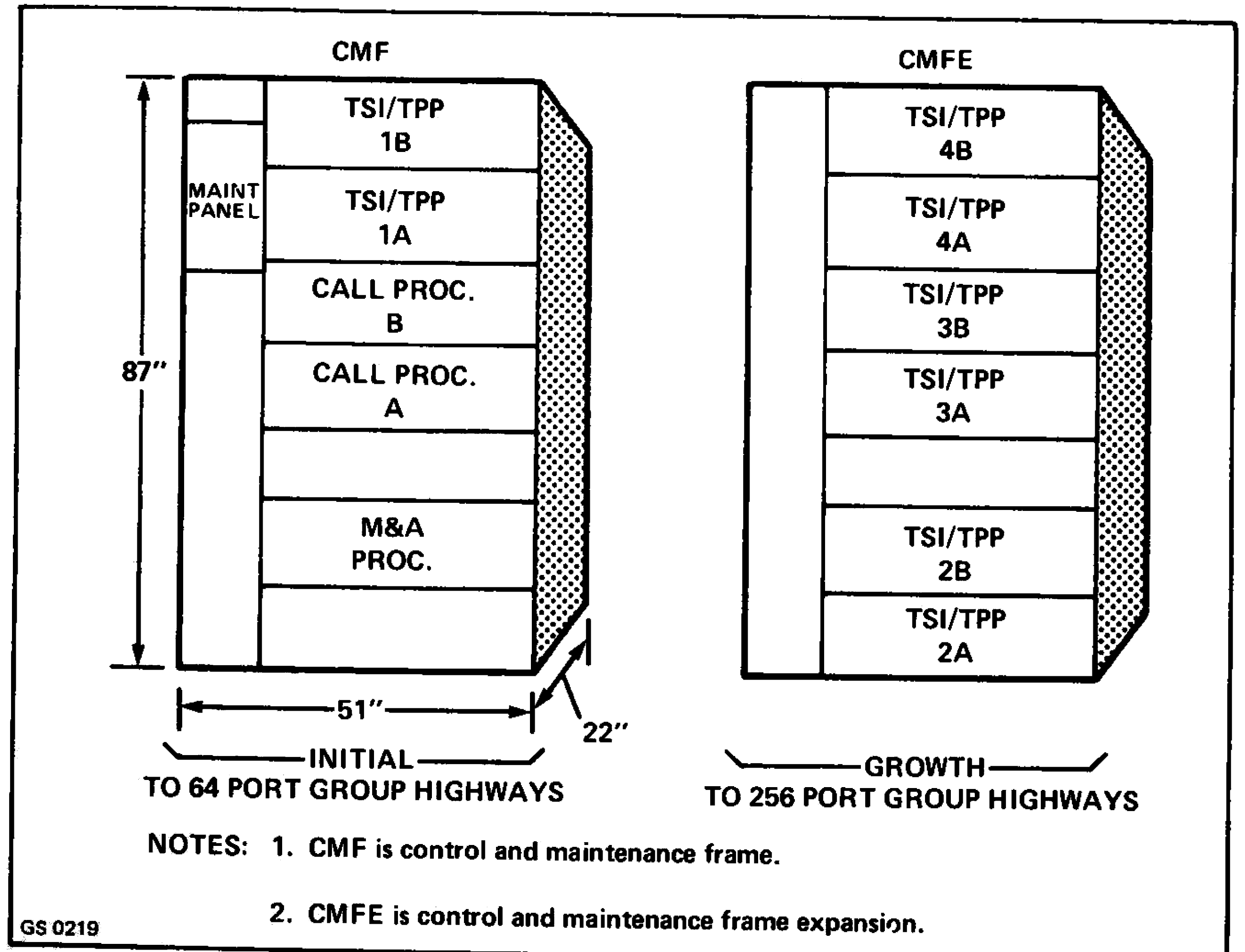


Figure 1-3.5. Common Control Equipment Frames

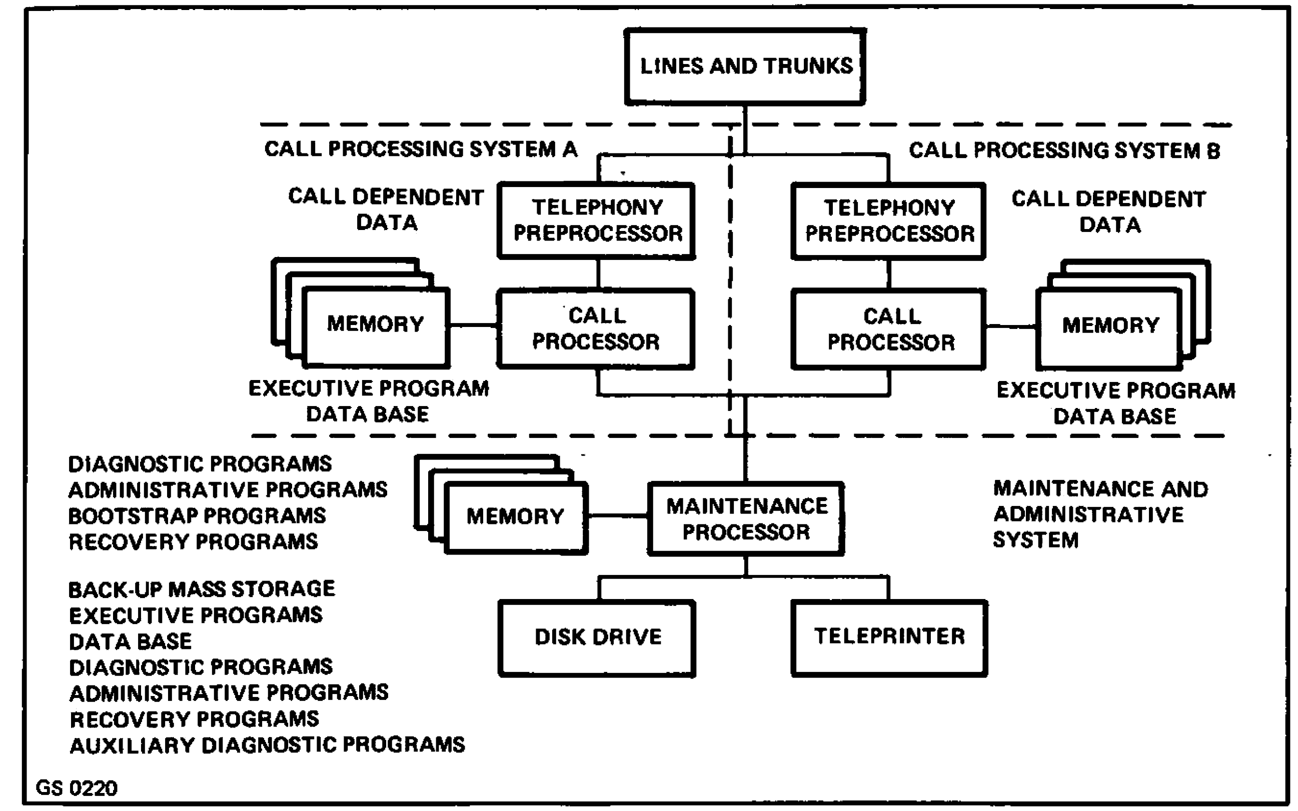


Figure 1-3.6. DCO Software System

scriber origination and release events. When the executive cluster detects an event from the telephony preprocessor, it notifies the appropriate call processor state transition routine that advances the call to the next state. Call states of a typical line-to-line call are idle, line off-hook, dial tone, first-digit translation, etc.

Call state, port identification and event code data stored in the telephony preprocessor for each port are needed by the call processor to determine the correct transition routine to invoke. Call state data (for example: idle state, equipment busy tone, ringing, etc.) are stored as an eight-bit binary code in a port store area field in the telephony preprocessor. Port identification data are stored during a specific call state in a four-bit port store area field that identifies which port generated an event. Event code data are stored in a separate four-bit port store area field.

During normal operation, an identical copy of the call processor software resides in each call processor memory. Switchover control circuitry selects one of the redundant call processing systems for on-line operation and gates only its associated outputs to the external bus. A copy of the call processor software is stored on a disk drive to initialize (start up) the call processor system when necessary.

3.5.2 DATA BASE. Each DCO system requires a unique data base that is engineered to the customer's requirements. The call processor data base characteristically contains various code-translator and number-translator tables [for example: directory number (DN), equipment number (EN), route treatment, code point, etc.] and other data and address tables (for example: line/trunk class-of-service data, TRK/PBX group data, hunt group address, etc.) that include telephony-related information. The code translation tables interpret a string of incoming digits into route treatment information that determines how a connection is made by the system. These tables use indexing, addressing, vectoring, and expansion methods that considerably enhance the code translating capabilities of the system. The number translation table (EN/DN translation, DN hundreds group director, etc.) use the same methods mentioned above and are assigned the task of translating a given directory number into equipment number and ring code information through the directory number translator. The reverse of the above operation is done through the equipment number translator. The call processor software accesses data base tables by invoking one of its clusters titled call processor data base utilities.

The size of the data base is dependent on a number of variables. Examples of these variables are number blocks, mix of single-party and multi-party lines, trunks, position of the office within the national DDD network and the local EAS environment.

Data base information and call processor programs are stored together in call processor memory. Copies are stored peripherally on a disk drive.

3.5.3 ADMINISTRATION SOFTWARE. The administration software of the DCO system has three primary tasks: control and document changes to the on-line, office-configuration data base (data base administration program tasks); capability to make a backup copy of the call processor data base (copy data base task); and monitor traffic/service (traffic measurement program task) related information. The off-line data base can also be controlled and existing tables can be altered. The data base administration task allows updating of PBX group, trunk group, translation tables, line class of service, and route treatment information. The copy data base task replaces (copies over) the current copy of the call processor data base that is stored on the disk with the memory resident copy from either the on-line or off-line side. The traffic measurement task collects and reports (on demand or at preselected times) measurements of the system's activities during specified time intervals. Several traffic measurement parameters are administrable (for example, the length of the interval during which measurements are collected). The administration software is stored on a disk and is loaded into maintenance and administration memory when requested from the system control keyboard.

3.5.4 MAINTENANCE SOFTWARE. The maintenance software consists of two main programs: resident tasks and second-level diagnostics. The resident tasks program includes: the routine testing function that exercises many areas of the DCO system to detect possible faults before they affect subscriber service; and the first-level diagnostics function that attempts to isolate side-dependent faults. The maintenance software also controls all input/output data to/from the mass-storage device. This disk contains copies of the latest system tables, maintenance programs (for example: diagnostics, startup and recovery, etc.), administration programs, and call processor programs.

The routine testing function of the resident tasks program operates in a background mode and may run concurrently with administrative tasks. Routine testing is suspended when diagnostics are performed. The various functions of routine testing are:

a. To automatically generate test calls through the system using the line routiner, test access network, and individual test access relays in each line circuit. This function simulates the action of subscriber lines. Proper system responses are checked at various call states and established transmission paths are tested. If the proper response is not received within the allotted time for each step of the call, the call is marked as having failed and diagnostic routines are invoked. Trunks are similarly tested by a test call generator.

b. To initiate call processor sanity tests located in call processor memory. Sanity tests exercise processor instructions by sequencing the program. If the test is successful, a sanity timer is reset before it is allowed to time out. If the test fails, the timer expires and a sanity-failure interrupt is generated.

The first-level diagnostics function of the resident tasks program is automatically done

in response to a system fault. First level diagnostics isolates faults to one side or the other in the A-B redundant portion of the system. First-level diagnostics is usually involved whenever an A-B mismatch error occurs. The mismatch error may be accompanied, preceded, or followed by other error signals that are side-specific. Certain error signals may determine the faulty side and others provide only a degree of probability. In the latter case, further diagnostic routines are used to verify side operation.

The second-level diagnostic program of the maintenance software is controlled by the second-level diagnostic controller. The second-level diagnostics program can be manually executed at an input/output console in four modes: fault isolation, repair verification, restore verification, and selective diagnostics. Second-level diagnostics can test the following areas for the DCO system: common control sectors, line switches and trunk frames, and maintenance and administration system.

3.5.5 HUMAN INTERFACE SOFTWARE. The human interface software for LLS and RLS is menu driven. That is, lists of tests, controls, etc. are automatically provided by the MP and a simple yes (Y), no (N) or number (1, 2, 3 etc.) response is all that is required from a craftsperson. All the tests or functions that a craftsperson can perform on the line switches are located in the line switch manual command (LSMC) software. This software can be activated by simply entering "$LSMC". The MP will then respond by asking if a menu is required. At this point, a "Y" or "N" is all that is needed for an input. The MP will now drive the menu asking only for decimal numbers to be entered that correspond to listed tests or functions. All tests or functions are listed by decimal numbers and are in everyday English.

The line switch manual command software is designed so that even the nontechnical craftsperson can test, troubleshoot or control the system with full confidence and good understanding of the functions that he/she is performing.

The five main routine selections are:

a. Manual test

b. Configuration changes

c. Mask control

d. Status request

e. Debug

Each one of these routines has a variety of test/functions that can be performed and are listed by the MP when one of these routines are selected. Any routine or test can be easily terminated by entering a "T". In addition, the user can ask for help by entering an "H". This will further list test or functions that can be performed in a specific or all routines.

SECTION 4
LOCAL LINE SWITCH

4.1 LOCAL LINE SWITCH DEFINITION

The local line switch is a solid-state, PCM, line-switching frame. It has the capability of connecting up to 1,080 lines, via a time-switching stage, to two-to-eight 30-channel port group highways in the DCO common equipment. This variable port group highway capability allows up to 6.2 ABSBH CCS per line without depopulation. Redundant controllers in the local line switch are responsible for all line-switching functions. The local line switch functional block diagram is given in Figure 1-4.1. All analog-to-digital conversions are completed via line printed wiring board assemblies (PWBAs) (Figure 1-4.2).

The local line switch is an integral component of the latest DCO systems. It is important to understand that the local line switch was introduced in 1981 but is compatible with the DCO systems sold in 1977 and 1978. Adding this capability to existing in service DCO systems exemplifies two important points. First, the DCO system has a flexible architecture which allows DCO owners to add new features and capabilities as they are conceived. Secondly, this retrofitable nature of subsequent hardware and software is indicative of Stromberg-Carlson's commitment to its customers and products. It is also available as a separate, add-on unit for in-service DCO systems. Line switch applications provide growth opportunities using existing equipment rather than additional line/trunk frames. This enables economical growth.

4.2 LOCAL LINE SWITCH FRAME

The local line switch is mounted in a welded, unitized frame that will service up to 1,080 lines. The frame also contains the controllers and other common equipment, such as switching PWBAs and 12 line groups (90 lines each), for a total of 1,080 lines. The frame is 87" high by 54"wide by 22" deep. Figure 1-4.3 depicts the local line switch frame.

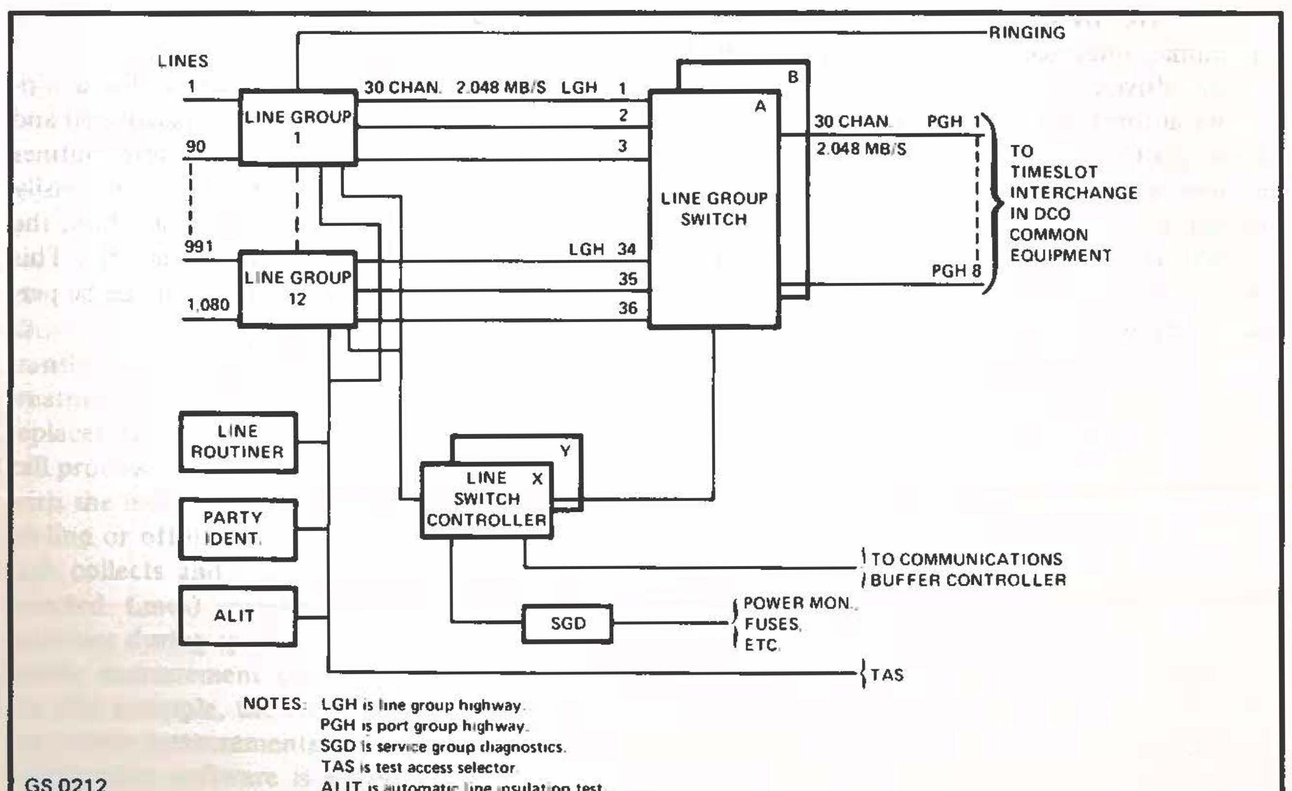


Figure 1-4.1. Local Line Switch Block Diagram

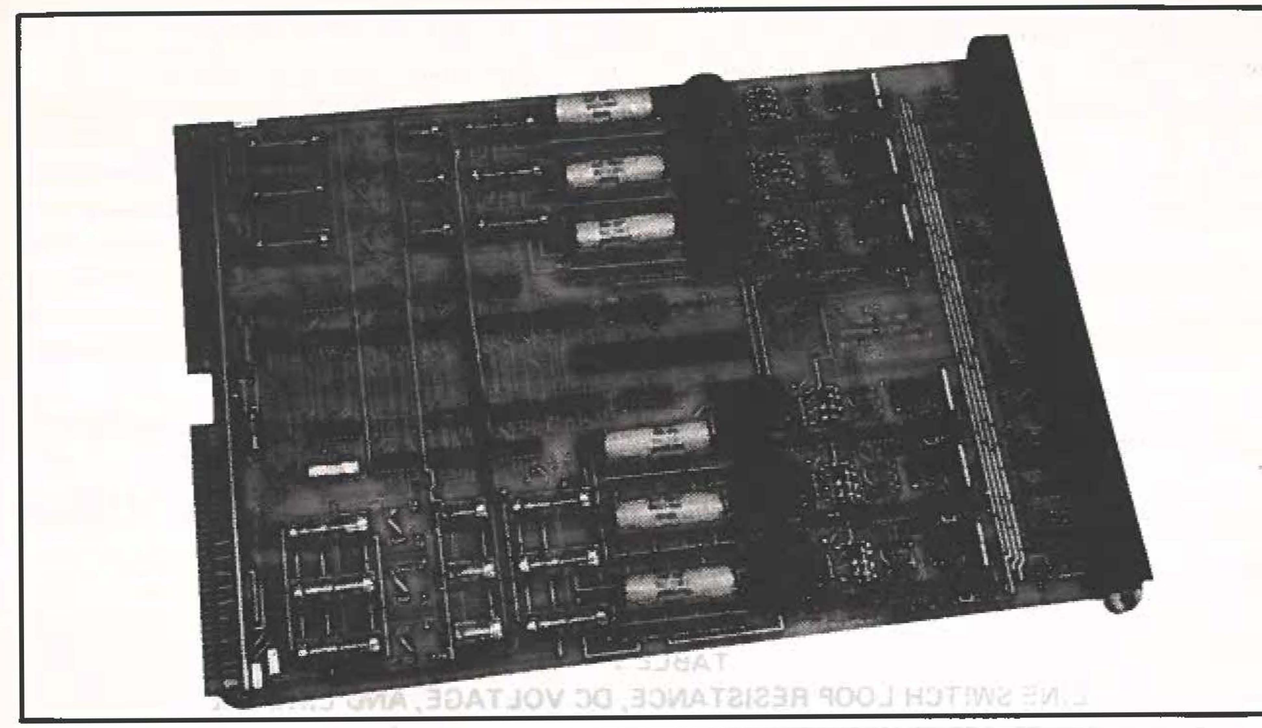


Figure 1-4.2. Typical Line Switch Printed Wiring Board Assembly

4.3 LINE SWITCH TRAFFIC CAPABILITY

The local line switch has the capability to combine line traffic from 1,080 lines and switch this traffic to the DCO common equipment via line group switch links. The line switch uses up to 6.2 ABSBH CCS per line capacity to take advantage of the inherent high traffic provisions of the DCO common equipment design.

Twelve microprocessor-controlled line groups (90 lines each) are contained in each line switch. Redundant controllers are used to provide switching functions within the line switch and also to communicate with the DCO common equipment call processors. Two-to-eight 30-channel links (port group highways) may be connected from a line switch to the DCO common equipment. These links operate at 2.048 Mb/s. This allows a line switch to connect 60-to-240 voice channels to the DCO common equipment. Based on erlang B tables at a blocking probability of .003, the DCO system provides the capacities shown in Table 1-4.1.

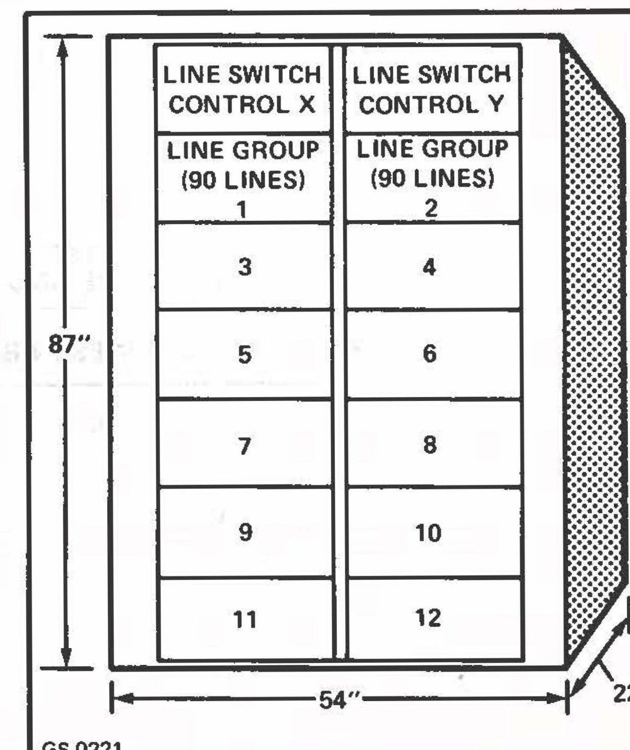


Figure 1-4.3. Local Line Switch Frame

Loop resistance, dc voltage, and line use for the line switch are shown in Table 1-4.2.

4.4 SERVICE SELECTION USING PWBAs

Flexibility of the line switch permits service additions in accordance with PWBA selection. Table 1-4.3 shows the various line PWBA types that may be selected and plugged into each line group.

TABLE 1-4.1
DCO CAPACITIES

NO. OF CHANNELS	AVAILABLE CCS	NO. OF LINES	CCS/LINE: ORIGINATING/TERMINATING
60	1,692	1,080	1.3
240	6,768	1,080	6.2

TABLE 1-4.2
LINE SWITCH LOOP RESISTANCE, DC VOLTAGE, AND LINE USE

LOOP RESISTANCE (ohms)	DC VOLTAGE (V dc)	LINE USE
0 to 1,500	44 to 54	Non-Coin
0 to 1,900	51.6 to 54	Non-Coin
0 to 1,200	44 to 54	Prepay Coin
0 to 1,000	44 to 54	Semi-Post Pay Coin

TABLE 1-4.3
LINE PWBA TYPE AND SERVICE PROVIDED

LINE PWBA TYPE	NO. LINES/PWBA	SERVICE PROVIDED
540	6	Single Party, Bridged Ringing
541	6	Bridged Ringing, ANI, Single or multiparty
541	6	Bridged/Divided Ringing, ANI, Reverse Battery, Single or multiparty
543	3	Ground or Loop Start, Sleeve Lead (two-way)
544	4	Superimposed Bridged/Divided Ringing, Single or multiparty
545	3	Prepay Coin

4.5 COMMUNICATIONS BUFFER CONTROLLERS

Line switch controllers communicate with the DCO common equipment call processors via a communications buffer controller. Up to four redundant communications buffer controllers can be connected to the DCO common equipment. Each communications buffer controller can accommodate eight line switches for a maximum of 32 line switches, as shown in Figure 1-4.4.

4.6 LINE SWITCH TESTING

The optional fully featured Automatic Line Insulation Test (ALIT) system may be provided in line switches to test subscriber loops. Another option, the virtual spare line, also may be used to protect individual lines automatically in case of failure.

A built-in line routiner will test all line circuits, including those installed in a line switch but not assigned in the DCO data base. The ALIT and line routiner can be set to test automatically or manually on demand.

The line switch/DCO maintenance package includes routines for complete equipment self-test. These routines, in addition to other unique provisions, enable the most thorough and comprehensive testing and maintenance available in the telecommunications field.

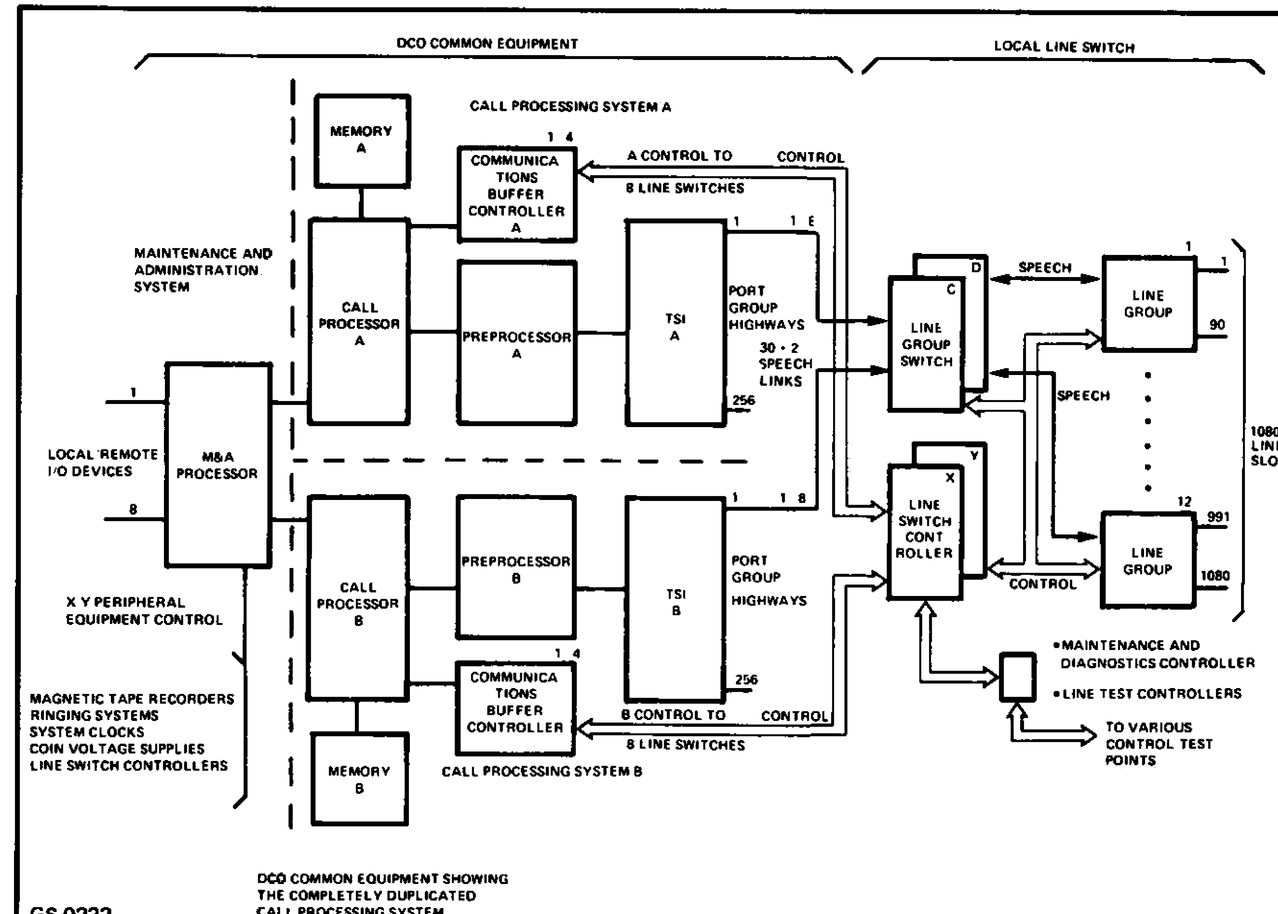


Figure 1-4.4. Local Line Switch Connection Block Diagram

SECTION 5
REMOTE LINE SWITCH

5.1 REMOTE LINE SWITCH DEFINITION

The remote line switch (RLS) functions as an extension of the DCO system. It deploys subscriber lines via conventional T-1 lines or other DS-1 compatible facilities. The remote line switch functional block diagram is given in Figure 1-5.1.

The RLS is available in two basic configurations. The first configuration is capable of handling up to 1,080 lines and is packaged in two frames (RLS-1 and RLS-2). The initially equipped frame, RLS-1, provides a maximum capacity of 720 lines plus the required control circuitry which includes the T-1 interface circuits. The second frame, RLS-2, is utilized for the additional 360 lines that provide the total line capacity of 1,080 lines.

The second configuration available is the 360-line, pad-mounted RLS. This 360 RLS is primarily designed for mounting in dual cabinets that are environmentally controlled. However, the equipment can be removed from the cabinets and located in a "hut" type of building. One cabinet is equipped with the 360 lines plus the associated control equipment (identical to the 1,080 RLS). The second cabinet contains such items as batteries, chargers, protection blocks, and span terminating equipment.

Both configurations, 1,080 RLS and 360 RLS, have identical feature and option contents. All printed wiring boards are totally interchangeable which allow for reduced quantities of spares. Typical remote line switch applications are as follows:

- Central Dial Office Replacement
- Central Dial Office Expansion
- Pair Gain
- Remote Line Group Pair Gain
- Temporary or Emergency Service

The remote line switch is similar to the local line switch; line PWBAs, line group common equipment, and controllers are identical. Differences between the two switches include remote line switch-to-DCO links that are DS-1 compatible (24 channels/1.544 Mb/s) and two options that are not available with the local line switch:

- An Intra-Nodal Switch (INS) can also be provided in the remote line switch to permit intra-local, line-to-line switching.
- An Emergency Switching Service (ESS) can be provided in the remote line switch to permit the continuation of local traffic (POTS) during a total DS-1 facility failure.

Local ringing equipment is included at the remote line switch site. Maintenance and administration of the remote line switches is performed from the host DCO console, or remotely using the multitasking feature of the DCO maintenance and administration system.

The remote line switch provides for the same line test (ALIT), line circuit routine, virtual spare line and self-test routines as the local line switch with the addition of faulty span line detection.

The remote line group (RLG) is a 90-line concentrated subscriber carrier subsystem which has a direct digital interface to either an RLS (1,080 or 360) or LLS. The RLG is basically a 90-line CUA that is remoted from an RLS or LLS with a DS-1 interface used as the transmission medium for both voice and data between the RLG and the host line switch. The RLG is housed in an environmentally controlled enclosure. The concentration can be 90 lines into one T-1 line or two T-1 lines. Each span configuration can support an additional span utilized for protection/transfer.

The application of the ALIT and line routiner options provide a diagnostic package that minimizes troubleshooting time by auto-

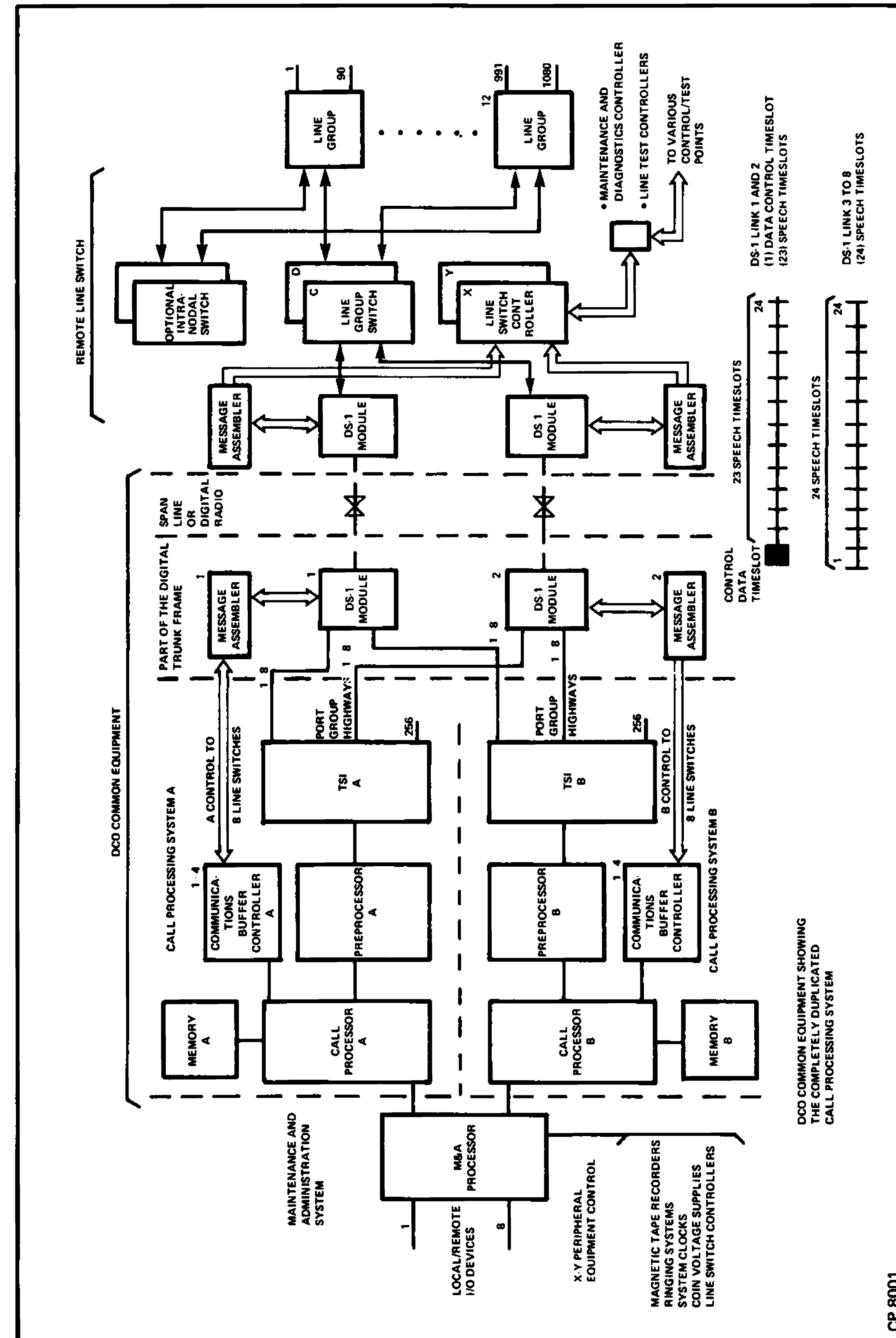


Figure 1-5.1. Remote Line Switch Connections

matically isolating a fault. Combined with the multitasking feature of the DCO system, the RLG can be maintained or diagnosed by one craftsperson either centrally or remotely located. Access for a portable printer/terminal is provided to allow for on-site (at the RLG) troubleshooting or maintenance alleviating the need for a second craftsperson at a host or central location.

5.2 REMOTE LINE SWITCH FRAME

The remote line switch may be mounted in welded, unitized frames similar to the frames used for the local line switch or in a pad-mounted weatherproof cabinet. Two frames are required to service 1,080 lines for the remote line switch configuration. Frames can be mounted in rooms or containers with standard 8 feet high ceilings. The first frame (87" high by 54" wide by 22" deep) contains the remote line switch controllers, optional INS and ESS PWBAs, and eight line groups of 90 lines each for a total of 720 lines. The second frame (87" high by 27" wide by 22" deep) contains the remaining four line groups of 360 lines. Figure 1-5.2 shows the indoor remote line switch frames. Power, ringing, and span terminating equipment is separately mounted. Figures 1-5.3 and 1-5.4 show the pad-mounted frames for line groups/controllers and power/ringing/span terminating equipment, respectively.

5.3 MESSAGE ASSEMBLERS

A significant way in which the remote line switch differs from the local line switch is as follows. In the local line switch, the communications buffer control communicates directly with the line switch controllers over a digital data link. In the remote line switch, the communications buffer control interfaces with the controllers via message assemblers which connect to the first channel of each of the first two T-spans to the remote line switch. These two channels are dedicated for control messages between the host DCO system and the remote line switch. The host message assemblers are slave devices on the communications buffer control digital data link; also, they are X-Y redundant with each able to communicate over either channel to a remote line switch. Each host message assembler can connect to eight message channels. Since each remote line switch has two message channels, the host message assemblers can connect to four remote line switches.

At the remote line switch, there are two remote message assemblers. The on-line unit (link master) can communicate over either channel to the host. Using this architecture, a span failure does not cause a switchover in any redundant equipment in the host or the remote line switch. Furthermore, a coincident failure of a redundant element and a span line does not result in any service loss or degradation. Since the remote message assemblers switch independently of the line switch controllers, a failure in a remote assembler does not cause a controller switchover.

5.4 INTRA-NODAL SWITCH

The optional intra-nodal switch is available for a remote line switch to provide 120 switching paths on intra-local, line-to-line calls (240 lines); this is in addition to the remote line switch-host DCO links. When an intra-nodal switch is provided in a remote line switch, originating calls are set up through the host DCO common equipment. The host DCO common equipment searches its memory files to determine if an intra-nodal switching path may be used. Upon determination of a local-to-local remote line switch call, the stations are connected via an intra-nodal switch link. The remote line switch-host DCO link is then released for use by other traffic. Thus, the number of DS-1 links required to support remote line switch traffic may be greatly reduced. Certain hook-switch-controlled line features, such as call waiting or malicious call handling, may preclude the use of drop-link operation on lines using these features.

5.5 REMOTE LINE SWITCH TRANSMISSION SYSTEMS

Various transmission system options are available for the remote line switch which has a maximum of eight DS-1 ports for the host-

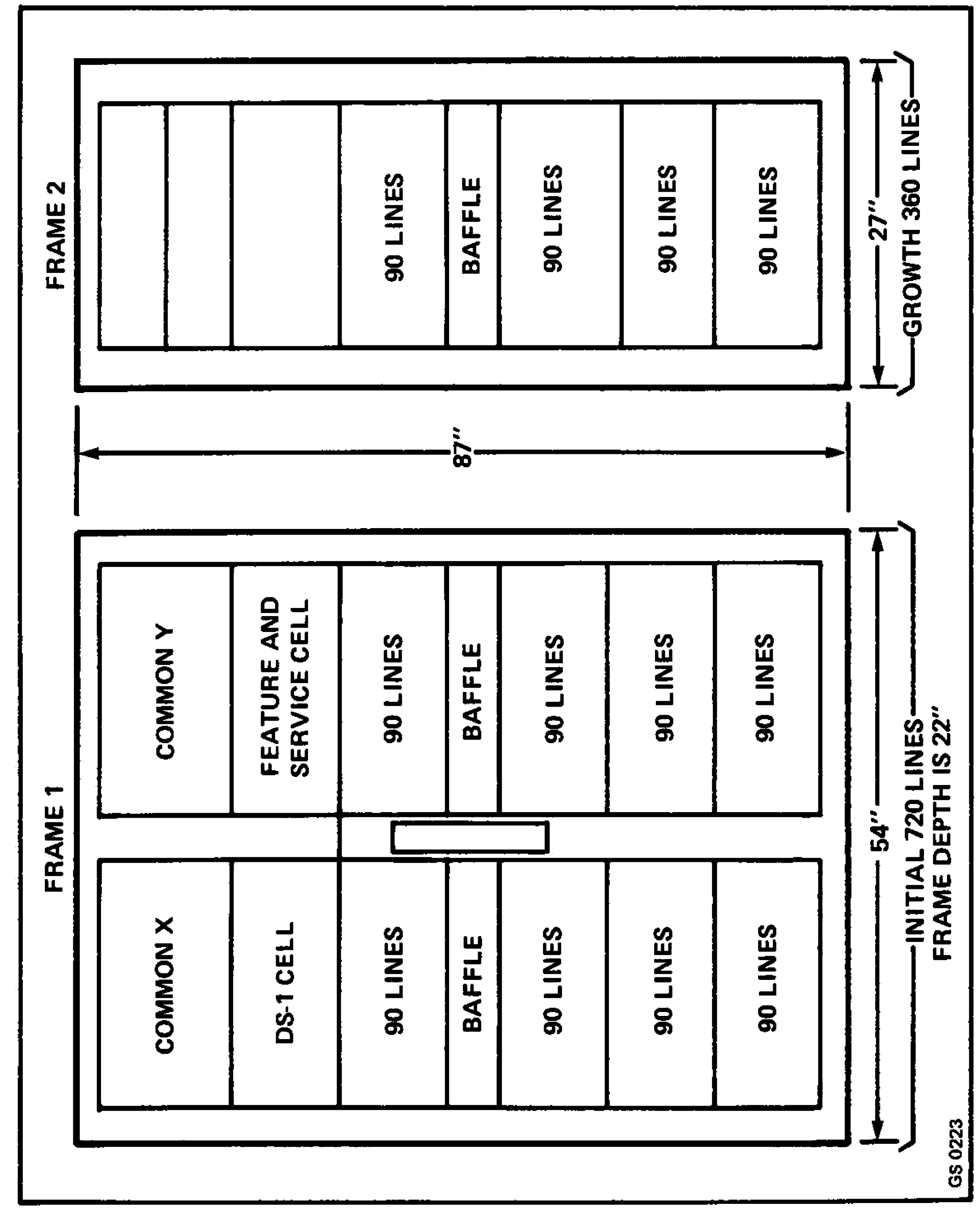


Figure 1-5.2. Remote Line Switch Indoor Frames

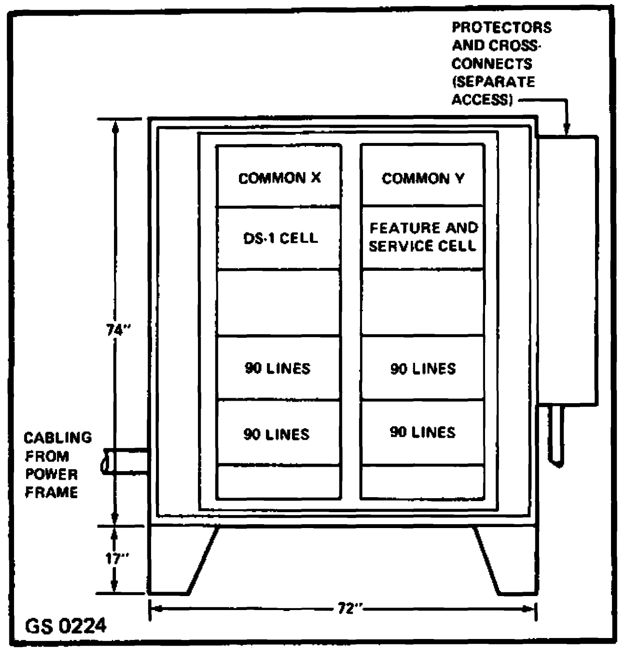


Figure 1-5.3. Remote Line Switch Pad-Mounted Equipment Frame

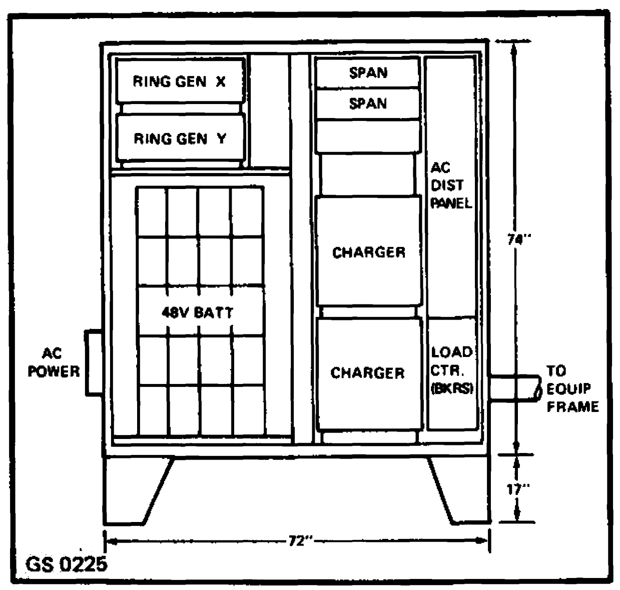


Figure 1-5.4. Remote Line Switch Pad-Mounted Power Frame

to-remote connections. A DS-1 port consists of 24 channels. The first channel of each of the first two ports are always required to provide the high-speed data paths by which remote line switch controllers and message assemblers communicate with the DCO common equipment. Because the remote line switch and DCO are DS-1 compatible, a variety of equipment can be used, including the following transmission systems:

- T 1 24-channel span line
- T 1C 48-channel span line
- Duo-binary span line
- 96-channel digital radio

One or all of the above options may be used simultaneously, as no special restrictions are placed on the design of these facilities. Alternate route diversity and spare span line switching may also be used to provide protection against loss of DS-1 facilities.

5.6 REMOTE LINE SWITCH APPLICATIONS

As stated in paragraph 5.1, the remote line switch has a series of applications that can provide economical solutions to a wide spectrum of digital network requirements. These solutions are accomplished with a single unit of hardware (the remote line switch) customized by software as needed. Major remote line switch applications include the following:

- Central dial office replacement
- Addition to existing electromechanical office
- Creation of pair gain systems
- Temporary service
- Emergency service.

5.6.1 CENTRAL DIAL OFFICE (CDO) REPLACEMENT. The remote line switch can be used as an unattended replacement for small-to-medium Class 5 CDOs, analog or digital. Operating companies can realize the economies of consolidating small, remote CDOs into one integrated digital network with centralized administration and maintenance. Multiple remote line switches can be co-located to serve exchanges larger than 1,080 lines using T 1 span route diversity. The basic benefits from such a con-

solidation are as follows:

- Capital investment for new host DCO common equipment is eliminated or postponed until line and trunk requirements dictate new capacities.
- Service to customers is expanded to include the full features of the host DCO common equipment.
- The expanded service offerings produce new telephone company revenues.
- Administration and maintenance costs are reduced because these functions are centralized in the host DCO common equipment.
- Directly connected pair gain systems provide cost-efficient relief to outside plant costs, CDO floor space and MDF space.

5.6.2 ADDITION TO EXISTING ELECTROMECHANICAL OFFICE. The remote line switch also can be co-located with existing analog CDOs in lieu of making line additions to the existing system. A minimum of floor space is required for the remote line switch addition. The remote line switch subscribers can then be offered the full complement of features available on the DCO system at lower cost than the analog system can provide. The added remote line switch expands the capacity of existing CDOs and provides the following cost benefits:

- Capital investment for new host DCO common equipment is deferred.
- Depreciation on existing equipment is extended because it is retained.
- System transmission and signaling quality is improved due to the elimination of multiple analog-to-digital conversions.
- Analog equipment is frozen at present investment by network-compatible digital equipment.
- Floor space and power cost are reduced due to the small size and low power drain of the remote line switch unit.
- Directly-connected pair gain systems provide cost-effective relief to outside plant cost.

5.6.3 CREATION OF PAIR GAIN SYSTEMS. The DCO architecture is a series of modular system elements that affords two distinct pair gain systems for network applications. These are classified as a remote line switch and a remote line group.

A remote line switch is equal to the local line switch in functions and features, but may be remoted from the DCO common equipment over DS-1 facilities.

The remote line group is a group of 90 lines remoted from a local or remote line switch over a DS-1 facility. These pair gain systems allow digital planners an additional dimension in network flexibility and deployment of DCO systems.

The remote line switch is well suited to an economical pair gain system that permits the deferment of cable investment. Use of the remote line switch as a pair gain system provides additional cable capacity because T 1 lines are used to replace individual cable pairs. Cable pairs then become available for additional line expansion. Lines are added at the remote end of the feeder cables as opposed to line additions at the central office. This eliminates building and cable construction costs for the following reasons:

- Cable plant investment is deferred when T 1 lines replace individual cable pairs.
- Loop treatment equipment is eliminated because line equipment may be located within the resistance range of the cable plant.
- Buildings and associated costs are eliminated when the remote line switch pad cabinet is used.

- Back-hauling subscriber lines over regained pairs provides distribution plant relief.
- Full DCO features are offered to remote subscribers.
- A second level pair gain system may also be added.

5.6.4 **TEMPORARY SERVICE.** The remote line switch may be used to provide temporary telephone service in a number of network situations. The remote line switch is capable of meeting the demand for temporary service because it is easily transportable to the temporary service area. Thus, it can respond immediately to service requirements, such as the following:

- Office complexes while plant cable is being constructed
- Trailer parks during the busy season
- Conventions and fairs
- Resort locations during the busy season
- Temporary construction or work areas

Cable or a digital microwave radio may be used to connect the remote line switch to a host DCO.

5.6.5 **EMERGENCY SWITCHING SERVICE.** The ESS option provides for completion of local-to-local remote line switch calls and calls to special operator or emergency numbers when DS-1 links to the host DCO common equipment are inoperable for any reason. The intra-nodal switch option is a prerequisite for this feature. Arrangements should be made to provide facilities to operator and emergency numbers separate from normal remote line switch-to-host links for use during ESS operational mode.

5.7 REMOTE LINE SWITCH CAPABILITIES

The numerous remote line switch capabilities are listed below and include basic, optional, and normal operation. Capabilities are defined as the basic or optional features provided by the remote line switch in various network applications.

a. Basic Capabilities.

- Extended subscriber serving area
- Additions to existing electromechanical switches
- 135-to-1 pair gain system at 3 CCS per line
- Local dual processor control and memory (X and Y)
- PWBAs and spares common to local line switch
- Connection to DCO common equipment via DS-1 digital facilities
- Flexible deployment
- 100% digital matrix (no analog or relay switching)
- Operates with separate or same NXX as base switch location
- 1,900-ohm subscriber loop operation
- Ringing (divided, bridged or multifrequency)

b. Optional Capabilities.

- Installation without requiring new building
- Shares NXX codes with existing electromechanical switches
- Full central office features
- Integral pair gain
- Emergency switching service

5.8 REMOTE LINE GROUP

The remote line group can connect up to 90 lines to a local or remote line switch. This cost-effective pair gain system is typically specified for small systems. All features and services available in the local or remote line switch are available in the remote line group. DCO line

cards are interchangeable in all three units. Optional pole or pad mounting of the outside equipment cabinet is available.

The RLG can be arranged with 3 basic span configurations (Figure 1-5.5). This allows for span protection and higher traffic capability. The traffic capability with a one active span configuration is 4.8 CCS (90 lines into one T-1 line) and 10.2 CCS with two active spans (90 lines into T-1 lines).

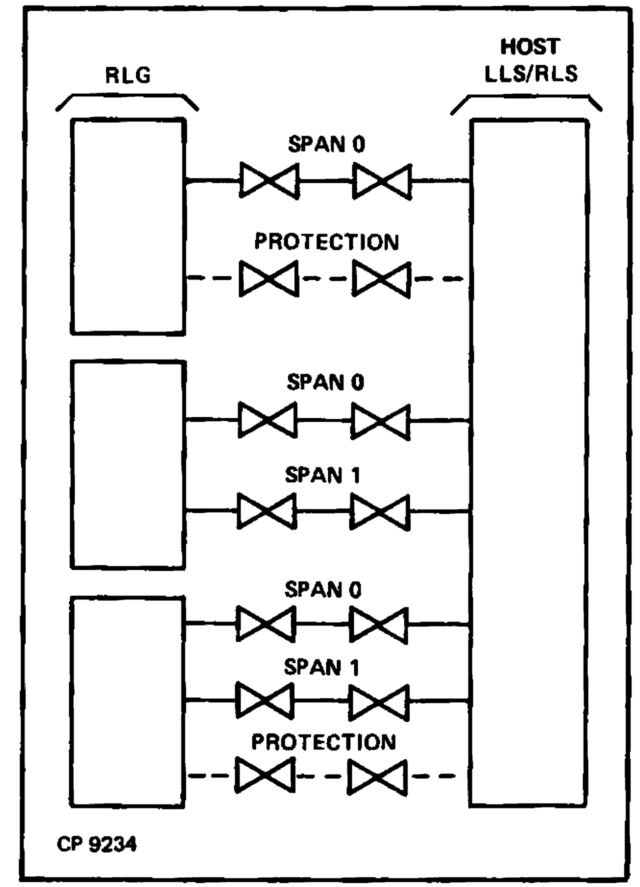


Figure 1-5.5 Remote Line Group Span Configurations

The functional block diagram of the RLG is depicted in Figure 1-5.6. The basic building block of the RLG is the 90-line group which is common to the LLS and RLS. The DS-1 interfaces are functionally similar to the DS-7 in the RLS. These PWBs are utilized at both the RLG and the host line switch. The remote group controller is the heart of the RLG and is an 8-bit microprocessor. This PWB is also equipped at both the RLG and the host line switch. The optional PWBs (ALIT, Line Test Controller, Line/Party Test, and Coin Voltage) are the identical PWBs that are utilized in the LLS and RLS.

The enclosure (Figure 1-5.7) is designed for either pole or pad mounting. Its compact size and color variety allows for application and installation without detracting or disturbing its surrounding environment. The RLG features are summarized as follows:

- 1 Party Service
- 2/4 Party Identification (ANI)
- 1500 Ohm Subscriber Loop
- Zero db Line Circuit
- Prepay Coin Service (Inband or Multi-Wink)
- Ground Start Line Circuit
- Sleeve Lead Line Circuit
- Software Controlled Line Balance
- Virtual Spare
- Multifrequency Ringing (Bridged/Divided)
- 1 & 2 Code Ringing
- Superimposed Ringing (Future)
- Second Span Operation
- Manual Testing (Host or Remote Initiated)
- Auto Line Routining
- ALIT
- Central Alarm Panel
- Remote Terminal Access

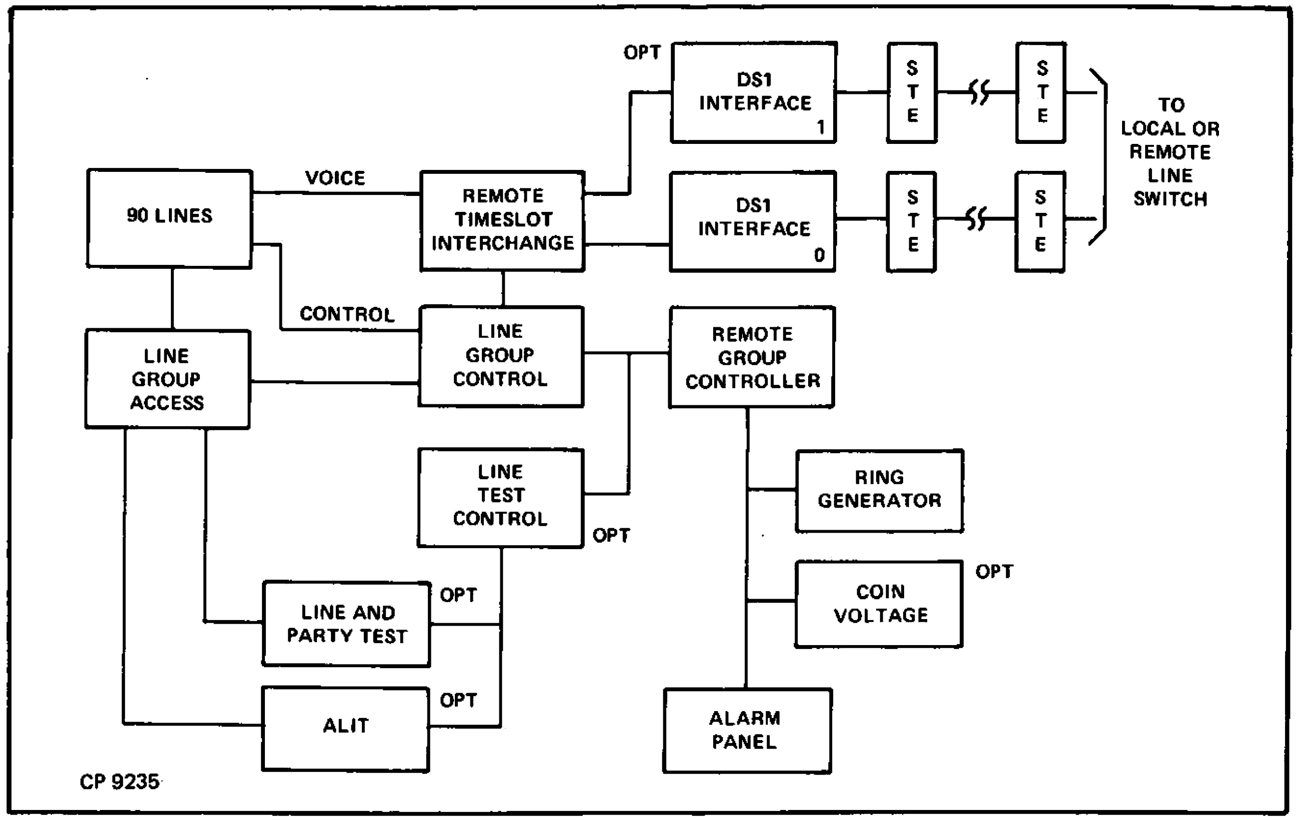


Figure 1-5.6 Remote Line Group Block Diagram

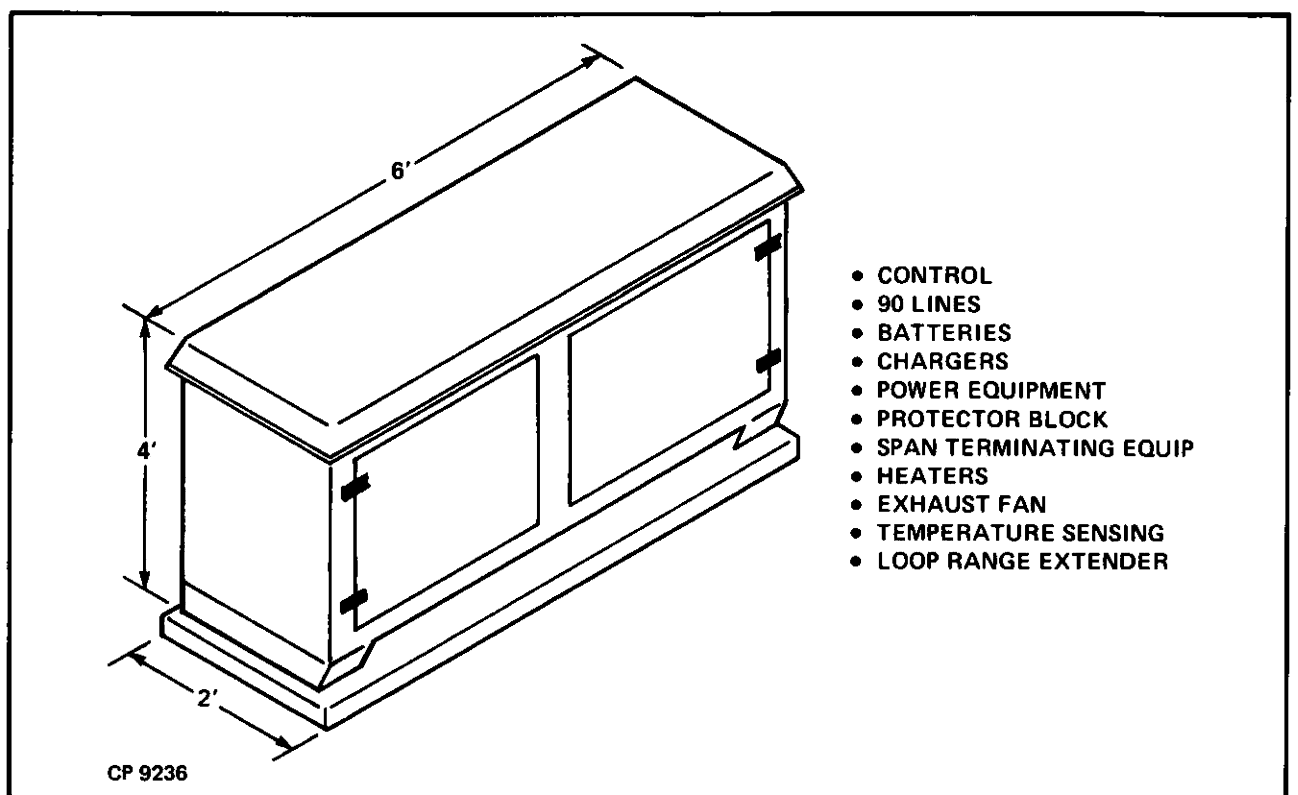


Figure 1-5.7 Remote Line Group Housing

SECTION 6
DCO TECHNICAL CHARACTERISTICS

The technical characteristics of the DCO system are extremely important to telecommunications network planners, especially during the development of plans for new products, services, and growth. The Stromberg-Carlson DCO system meets or exceeds all current specifications and provides a broad range of operating characteristics. It has outstanding flexibility and connectivity which permit easy configuration to meet a specific application. Modular design enables an operating company to configure the exact switching and transmission specifications that are required. This same flexibility permits easy adaptation of future improvements. The Stromberg-Carlson DCO system is designed to meet the demanding needs of *today* and *tomorrow*. The technical characteristics of the DCO system are divided into the following four major groups and presented in the following paragraphs:

- Electrical
- Environmental
- Transmission
- Operating Limits

6.1 ELECTRICAL CHARACTERISTICS

6.1.1 GENERAL. The DCO nominal operating voltage is −48 volts dc. This is supplied by 24 lead-acid storage cells and associated battery chargers. Low-voltage power for operating the electronic portion of the system is developed by dc-to-dc converters located in various equipment shelves.

6.1.2 POWER SOURCE. The primary source of power for the DCO system is the converted commercial ac power supplied by the local utility company. This ac power is converted to proper regulated and filtered voltage levels before being connected to the system. The conversion, regulation, and filtering are done by rectifier/charger units. Output voltages are set to the float level of the office battery (−52 to −54 volts dc). The office battery is a source of emergency power during a commercial ac power failure and also serves as a noise filter in the power system. An auxiliary engine-driven generator may be used as a standby source of ac power.

6.1.3 DC POWER SUPPLIES. Dc power supplies are normally furnished on a per-equipment cell basis. These power supplies provide all the power requirements for the associated cell. The power supplies operate from the −48-volt office battery supply and provide the following current-limited outputs:

a. −48-volt relay drive

b. −48-volt filtered talking battery

c. ±5-volt regulated logic supply

d. ±8-volt and −15-volt analog supply

e. +12-volt memory supply.

6.1.4 GROUNDING. The DCO system uses separate frame logic, analog circuit, and −48-volt signal grounds. The DCO equipment is connected to the steel superstructure of the building and the ac power ground by a special single-point ground system. The single-point ground connection is provided at a centrally located copper bus bar. All frame logic and signal grounds from each enclosure are wired only to this single-point ground location. This grounding method is similar to other available grounding systems and meets or exceeds standard industrial practices. Most important, the DCO grounding system provides excellent protection for equipment and personnel.

6.2 ENVIRONMENTAL CHARACTERISTICS

Environmental operating ranges of the DCO are given in Table 1-6.1. "Short term" is defined as up to 8 continuous hours occurring less than 4 times in any 12-month period.

TABLE 1-6.1
ENVIRONMENTAL OPERATING RANGES

FUNCTION	RECOMMENDED TEMPERATURE °F (°C) LOW	RECOMMENDED TEMPERATURE °F (°C) HIGH	RECOMMENDED HUMIDITY % RH LOW	RECOMMENDED HUMIDITY % RH HIGH	SHORT TERM TEMPERATURE °F (°C) LOW	SHORT TERM TEMPERATURE °F (°C) HIGH	SHORT TERM HUMIDITY % RH LOW	SHORT TERM HUMIDITY % RH HIGH
Remote Switching	32 (0)	100 (38)	20	65	32 (0)	120 (49)	20	90
DCO Common Equipment	50 (10)	85 (30)	20	65	32 (0)	120 (49)	20	90

6.3 TRANSMISSION CHARACTERISTICS

6.3.1 **INSERTION LOSS.** The insertion loss for trunk-to-trunk (two-wire to two-wire), line-to-line, and line-to-trunk is 0.0 dB ±0.3 dB.

6.3.2 **FREQUENCY RESPONSE.** The frequency response for line-to-line and trunk-to-trunk (two-wire) is listed in Table 1-6.2.

TABLE 1-6.2
FREQUENCY RESPONSE

FREQUENCY (Hz)	LOSS AT 0 dBm0 INPUT (dB)
60	20 (minimum)
300 to 3,000	−0.5 to 1
3,200	0.5 to 1.5

6.3.3 **GAIN TRACKING.** Gain tracking (linearity) is 1,004 Hz, reference at 0 dBm0. Input signal level and gain deviation are shown in Table 1-6.3.

6.3.4 **RETURN LOSS.** When measured at a two-wire trunk against 900 ohms in series with 2.16 μF, the return loss is as follows:

a. Echo Return Loss (ERL): 24 dB minimum.

b. Singing Return Loss (SRL): 17 dB minimum.

TABLE 1-6.3
GAIN TRACKING

INPUT SIGNAL LEVEL (dBm0)	GAIN DEVIATION (dB)
+3 to −37	±0.3
−37 to −50	±1

6.3.5 **LONGITUDINAL BALANCE.** For frequencies of 180, 300, 540, 1,000, and 2,000 Hz, the minimum longitudinal balance is 60 dB; at 3,400 Hz the minimum longitudinal balance is 50 dB.

6.3.6 **STEADY NOISE.** When measured on a terminated call, the steady noise is as follows:

a. Maximum: 23 dBrnc0

b. Average: 18 dBrnc0 or less

c. 3,000 Hz Flat: The objective is less than 35 dBrn0.

6.3.7 **CROSSTALK COUPLING LOSS.** The crosstalk coupling loss between any two line circuits is 75 dB minimum for all frequencies in the range of 200 to 3,400 Hz.

6.3.8 **QUANTIZING DISTORTION.** Quantizing distortion is shown in Table 1-6.4.

TABLE 1-6.4
QUANTIZING DISTORTION

INPUT LEVEL AT 1,004 OR 1,020 Hz (dBm0)	MINIMUM SIGNAL-TO-DISTORTION WITH C-MESSAGE WEIGHTING (dB)
0 to −30	33
−30 to −40	27
−40 to −45	22

6.3.9 **ENVELOPE DELAY DISTORTION.** On any properly established connection, the envelope delay distortion will not exceed the limits shown in Table 1-6.5.

TABLE 1-6.5
ENVELOPE DELAY DISTORTION LIMITS

BAND WIDTH (Hz)	MICROSECONDS
1,000 to 2,600	190
800 to 2,800	350
600 to 3,000	500
400 to 3,200	700

6.4 OPERATING LIMITS

6.4.1 **SUBSCRIBER LINES.** The minimum dc insulation resistance and ringer load are defined by various loop resistance ranges that include telephone instruments, as listed in Table 1-6.6. The dc insulation resistance refers to the minimum resistance between line conductors or between either or both conductors and ground without any line attachments. The ringer load assumes high-impedance ringers. It provides adequate audibility of all signals at maximum loop resistance without premature ring trip at minimum loop resistance.

6.4.2 **PULSING LIMITS.** The pulsing limits of the DCO are listed below.

a. Rotary Dial Operation. The equipment operates with instruments having an operational speed of between eight and 12 pulses per second and a break period of 55-to-67 percent of the total pulse period.

b. Dual-Tone Multi-Frequency (DTMF) Operation. The frequency pairs used for DTMF signaling are given in Table 1-6.7. Variations in frequency of ±1.5

TABLE 1-6.6
SUBSCRIBER LINE LOOP RESISTANCE RANGES

LOOP RESISTANCE (ohms)	DC VOLTAGE (volts)	MINIMUM INSULATION RESISTANCE (ohms)	RINGER LOAD
0 to 1,500	44 to 54	15,000	17 ringers or one three-line common audible
0 to 1,900	51.6 to 54	25,000	10 ringers or one three-line common audible
1,900 to 4,500	51.6 to 54 with loop range extenders	100,00	Six ringers or one three-line common audible

percent are allowable. Valid tone pulses are present for at least 40 milliseconds and the levels of the two tones do not differ by more than 5 dB. Interdigital time intervals are not less than 50 milliseconds.

TABLE 1-6.7
DTMF SIGNALING, FREQUENCY PAIRS

LOW FREQUENCY (Hz)	HIGH FREQUENCY (Hz) 1,209	1,336	1,477
697	1	2	3
770	4	5	6
852	7	8	9
941	*	0	#

6.4.3 **TRUNK SIGNALING.** Trunk dc signaling is not affected by subscriber loops because trunks do not connect directly to subscriber loops.

6.4.4 **OFF-HOOK, ON-HOOK RECOGNITION LIMITS.** Recognition limits of the DCO are listed below.

a. Under normal operation, the minimum off-hook, connect-signal recognition time is 60 milliseconds.

b. An on-hook, disconnect signal of 150 milliseconds or less is not recognized. The standard duration is 180 milliseconds when a hookswitch flash detector is not provided, and 2.2 seconds when provided.

c. The hookswitch flash recognition signal is 200 milliseconds minimum, and 2 seconds maximum.

6.4.5 **OFFICE IMPEDANCE.** The working impedance of the internal switching paths of the office is 900 ohms at 1,000 Hz. Impedance of the multi-frequency senders, test circuits, and trunk circuits is 900 ohms. Analog trunks are strappable for 600- or 900-ohm operation.

6.4.6 **PARTY IDENTIFICATION.** A party test for two- and four-party automatic number identification can be made through a total path resistance of up to 4,100 ohms in the presence of a 5-volt rms ground potential.

6.4.7 **INTEROFFICE TRUNKS.** Interoffice trunk characteristics of the DCO are listed below.

a. Trunk Loop Resistance. The trunk loop operates over a 2,000-ohm loop for loop pulsing and over a 3,000-ohm loop for battery and ground pulsing.

b. Trunk Line Insulation Resistance. The dc insulation resistance between conductors or between either or both conductors and ground is 50,000 ohms minimum.

c. Trunk Release Time. To guard against re-seizure before release, the trunk guard time is 700 milliseconds to 1,000 milliseconds and is software administrable.

The preceding technical characteristics of the DCO provide data which are useful in communications planning. Stromberg-Carlson sales representatives are experienced and are available to assist communications planners in system development.

SECTION 7
SYSTEM CENTURY TRAFFIC ENGINEERING

7.1 **LINE SWITCH ARCHITECTURE**
The local line switch is an integral component of the DCO system that offers built-in, cost savings opportunities. The dual cross-office highways in the TSI of the DCO common equipment supply 28.2 ABSBH CCS traffic capacity per voice port. Each 240-port TSI can then carry 28.2 x 240 = 6,768CCS. Each line switch can connect to the DCO common control equipment via two-to-eight 2.048 Mb/s links (30 channels each). Because line switches may operate when only partially equipped, full capacity investment is not required. Line or link capacity may be added in increments. The quantity of links required is based on the amount of traffic to be carried by the line switch rather than solely on the quantity of lines equipped. This provides initial savings in equipment cost.

7.2 **LOCAL LINE SWITCH TRAFFIC COMPUTATION**
The ABSBH CCS requirement may be easily computed for a specific office. The sample computation presented in Table 1-7.1 is based on the data of a ficticious office. However, the types of data and the method of computation are the same for any office.

The following steps are used for computing the CCS per line:

a. Complete Column 1 (local records).

b. Complete Column 2 (local records).

c. Multiply Column 1 by Column 2 for each type of service. This provides the figures for Column 3.

d. In Column 4, fill in the number of required lines (based on local historical records).

e. Add Columns 3 and 4 to determine column totals.

f. Divide the total of Column 3 (CCS) by the total of Column 4 (total lines required). This quotient equals the CCS per line. (For example, 18,171 ÷ 4,692 = 3.9CCS per line.)

TABLE 1-7.1
CCS COMPUTATION EXAMPLE

TYPE OF SERVICE	MAIN STATION (CCS)	NUMBER OF MAIN STATIONS	TOTAL CCS (COLUMN 1 X 2)	NUMBER OF LINES REQUIRED (HISTORICAL RECORD)
Industrial – Residential	3.0 x	3,000 =	9,000	3,000
Two-Party Residential	2.0 x	1,000 =	2,000	500
Industrial – Business	4.5 x	800 =	3,600	800
Two-Party Business	2.8 x	700 =	1,960	100
Four-Party	1.8 x	600 =	1,080	150
Special Lines	6.0 x	20 =	120	20
Pay Station	5.5 x	50 =	275	50
Telephone Co. Official	6.0 x	20 =	120	70
Wire Chief	8.1 x	2 =	16	2
TOTALS	----	----	18,171	4,692

The CCS per line is then used to calculate the number of 30-channel links required. Figure 1-7.1 shows the basis for this computation and can be used as a reference during the computation.

The following steps are used for determining the number of 30-channel links required:

Total Lines / Line Switch Capacity	= 4,692 / 1,080 =	4.3 Line Switches required; round-off 4.3 to 5= 5 Line Switches required.

In this example, it is assumed that four of the line switches are fully equipped with 1,080 lines (1,080 x 4 = 4,320) and the fifth line switch contains the remaining lines (4,692 - 4,320 = 372).

From Figure 1-7.1 it is determined that, at 3.9 CCS per line, each of the four fully equipped line switches requires five 30-channel port group highways and the partially equipped line switch with 372 lines requires two 30-channel port group highways. In this example, a total of 22 links is necessary for the system.

Note that the total number of lines will usually be the wired capacity as opposed to the equipped capacity. This allows additional lines to be plugged-in, as needed, without the requirement for increased traffic capacity.

The DCO line switch is three times as large as similar products on the market today which makes continued traffic engineering or load balancing at a minimum. Also, the CCS capacity for the line switch may be easily expanded, at any time, by incremental additions of 30-channel digital links.

7.3 REMOTE LINE SWITCH TRAFFIC CAPACITY

The RLS is DS-1 compatible and typically operates over T-1 lines, although T-1C or digital radio may be used to drive DS-1 ports. However, the RLS is limited to 24 channels as opposed to the 30-channel links used in the LLS. The RLS operates in two different traffic handling modes – gain and central office replacement. Pair gain systems are typically smaller in line size and are not equipped with the emergency switching service which provides protection for cable outages. This means that the traffic capacity is a function of the traffic capacity of the T-1 lines serving the RLS.

7.4 REMOTE LINE SWITCH WITHOUT INTRA-NODAL SWITCH

RLS traffic capacity is computed in exactly the same manner as the LLS. Without the Intra-Nodal Switch (INS), the RLS CCS capacity is the same as the CCS capacity of the remote-to-host DCO links. Using the same computation method that was used for the LLS, the RLS T-1 line requirement may be determined directly from the curves shown in Figure 1-7.2.

7.5 REMOTE LINE SWITCH WITH INTRA-NODAL SWITCH

The INS capability (optional) for the RLS provides 120 switching paths for intra-local, line-to-line calls. The RLS uses two remote-to-host DCO links to set up local-to-local calls. Upon detection of such calls, the RLS controller drops the links to the host DCO system and connects the links through the intra-nodal link. This is automatically accomplished without audible tones or signals. This capability can provide a significant increase in traffic carrying capacity since the line switch does not derive its total traffic capacity from the connecting T-1 lines.

Savings are achieved by using the INS option in the RLS. For example, a 720-line RLS with a 4 CCS/line calling rate requires 5 T-1 spans without INS (Figure 1-7.2). The same RLS with INS and only 15% intra-nodal traffic requires only 4 T-1 spans (Figure 1-7.4). The savings are even more dramatic at higher percentages of intra-nodal traffic as shown in Figure 1-7.9. The cost of the INS option can, in most cases, be offset where reduction of between one and two spans can be achieved.

Since 30 to 50 percent of the originating traffic in an RLS may terminate locally, additional traffic curves are required to provide the remote RLS ABSBH line capacity (CCS) at various intra-local calling rates. Figures 1-7.3 through 1-7.9 show the RLS per line CCS capacity at various intra-local calling rates. These curves can be used to determine the number of T-1 lines at 5 to 65 percent intra-local calling. RLS units with INS have a CCS per line capacity greater than the DS-1 facility capacity which varies with the percentage of intra-local calls.

7.6 REMOTE LINE SWITCH PROTECTION

The RLS can be equipped with protection in two ways. The first method, route diversity, is the practice of using different facilities over different routes to ensure that a single failure will not disconnect all remote-to-host links. The second method, the ESS mode, enables the RLS to continue local service and make connection to operator and emergency numbers over separate facilities when communication to the host DCO is lost.

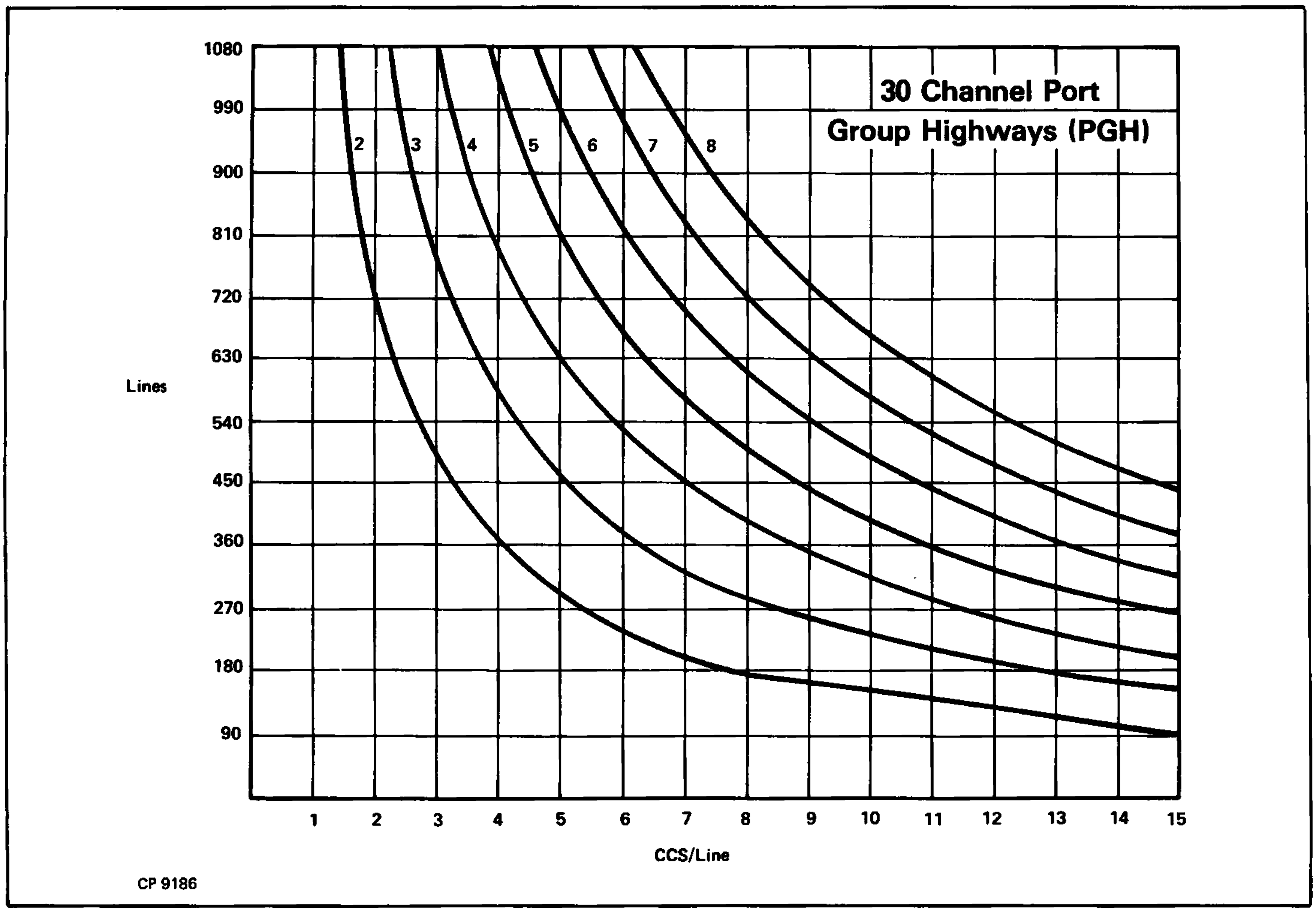


Figure 1-7.1 LLS Port Group Highway Traffic

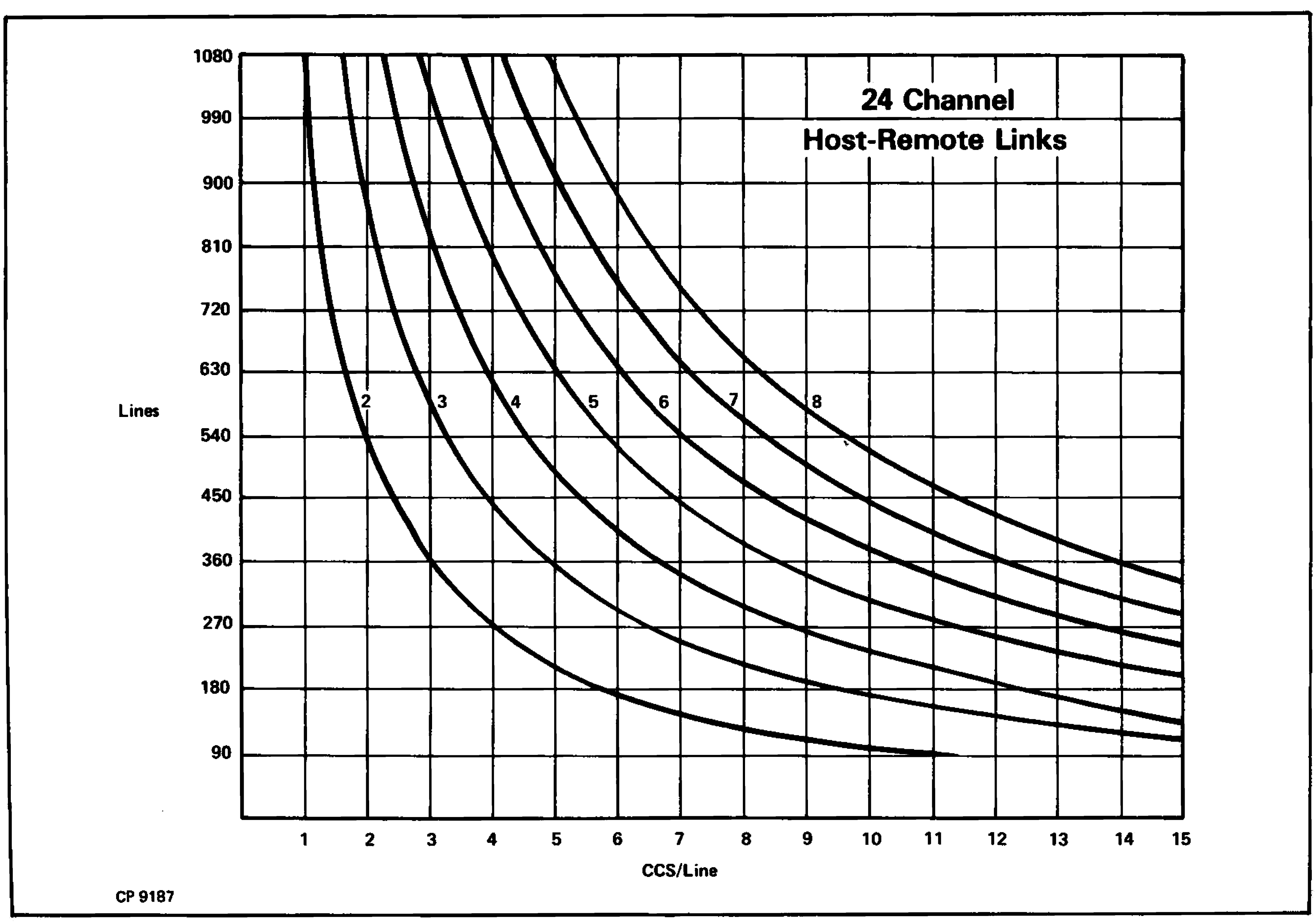


Figure 1-7.2 0% Intra-Nodal Traffic (RLS)

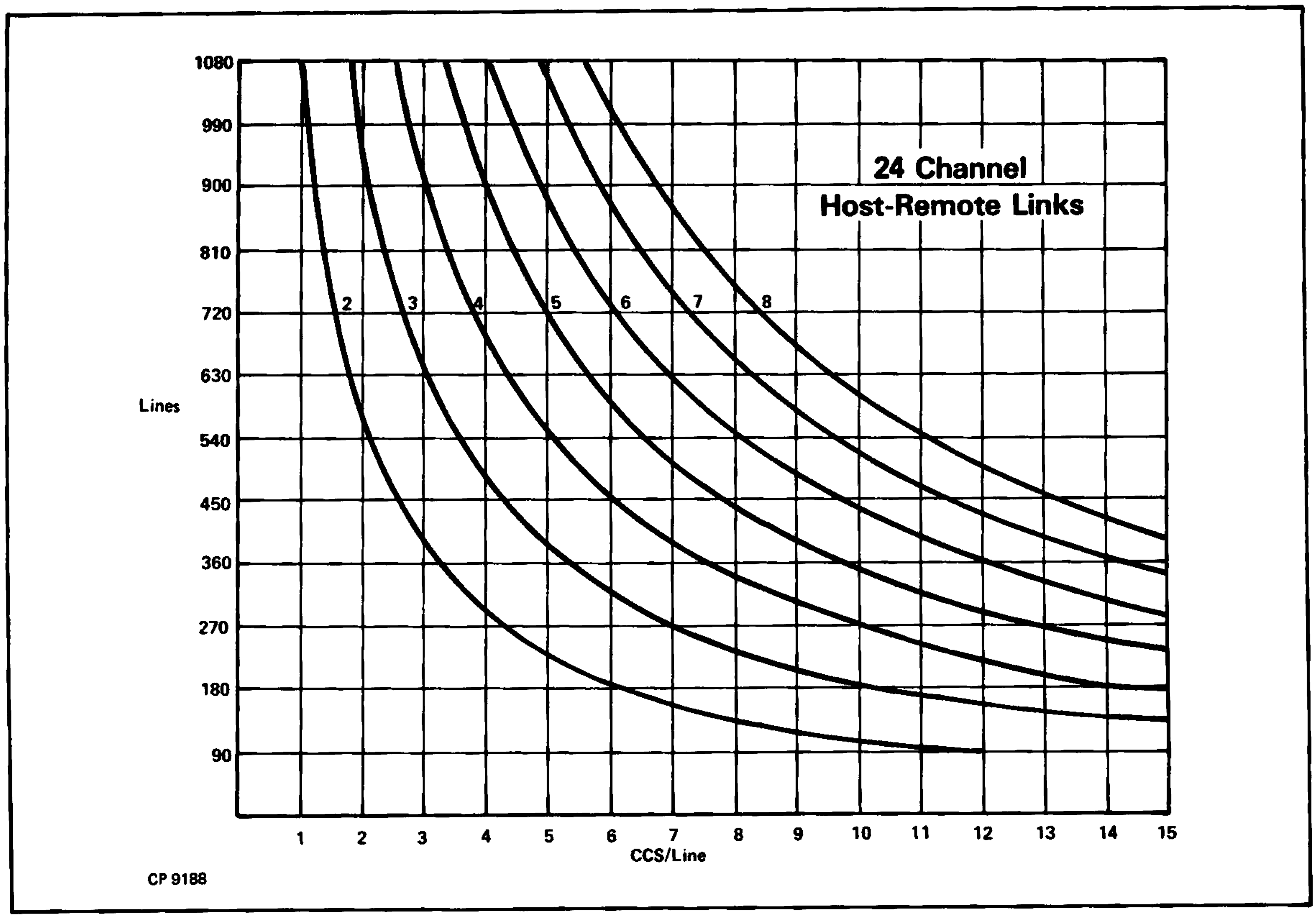


Figure 1-7.3 5% Intra-Nodal Traffic (RLS)

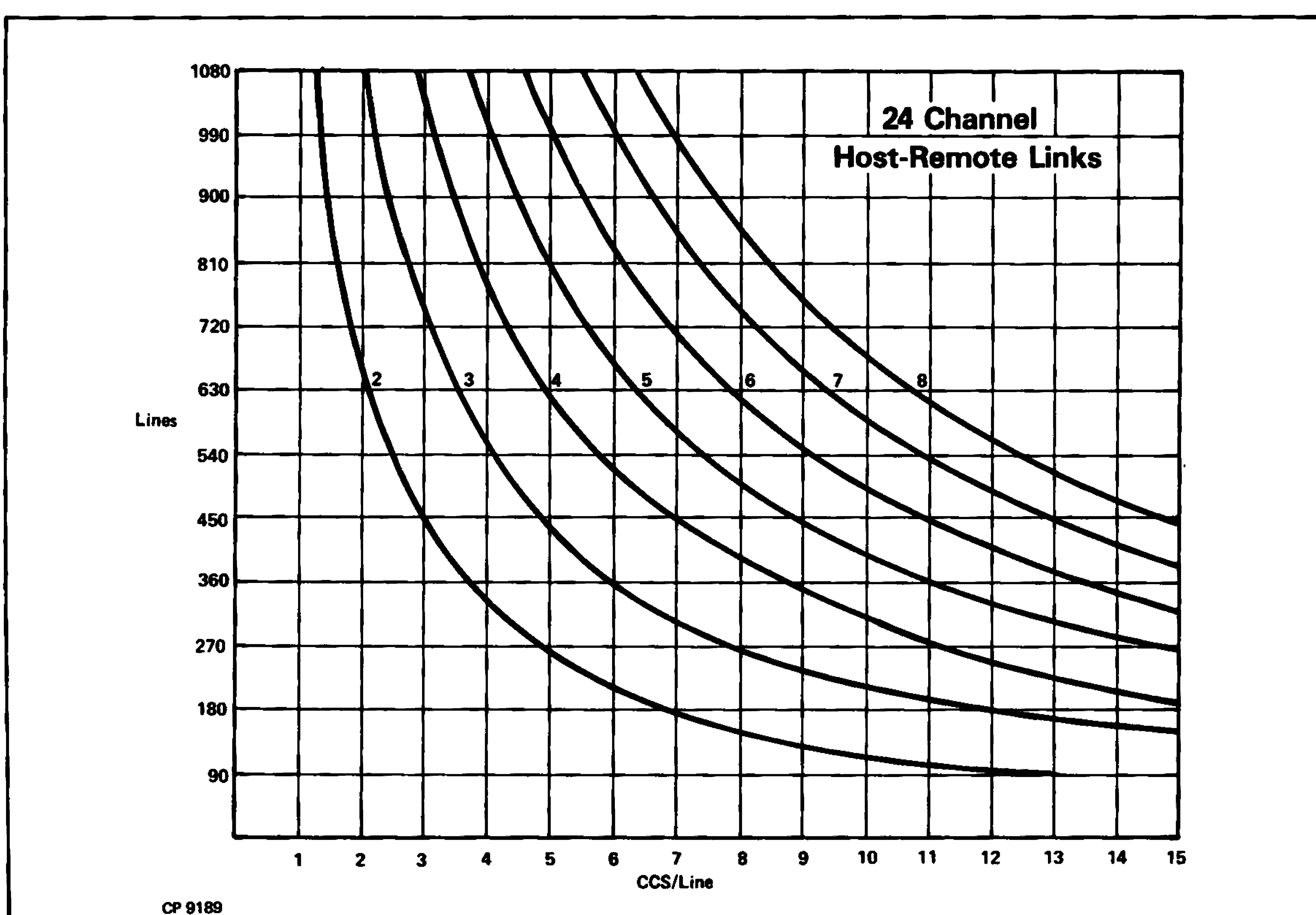


Figure 1-7.4 15% Intra-Nodal Traffic (RLS)

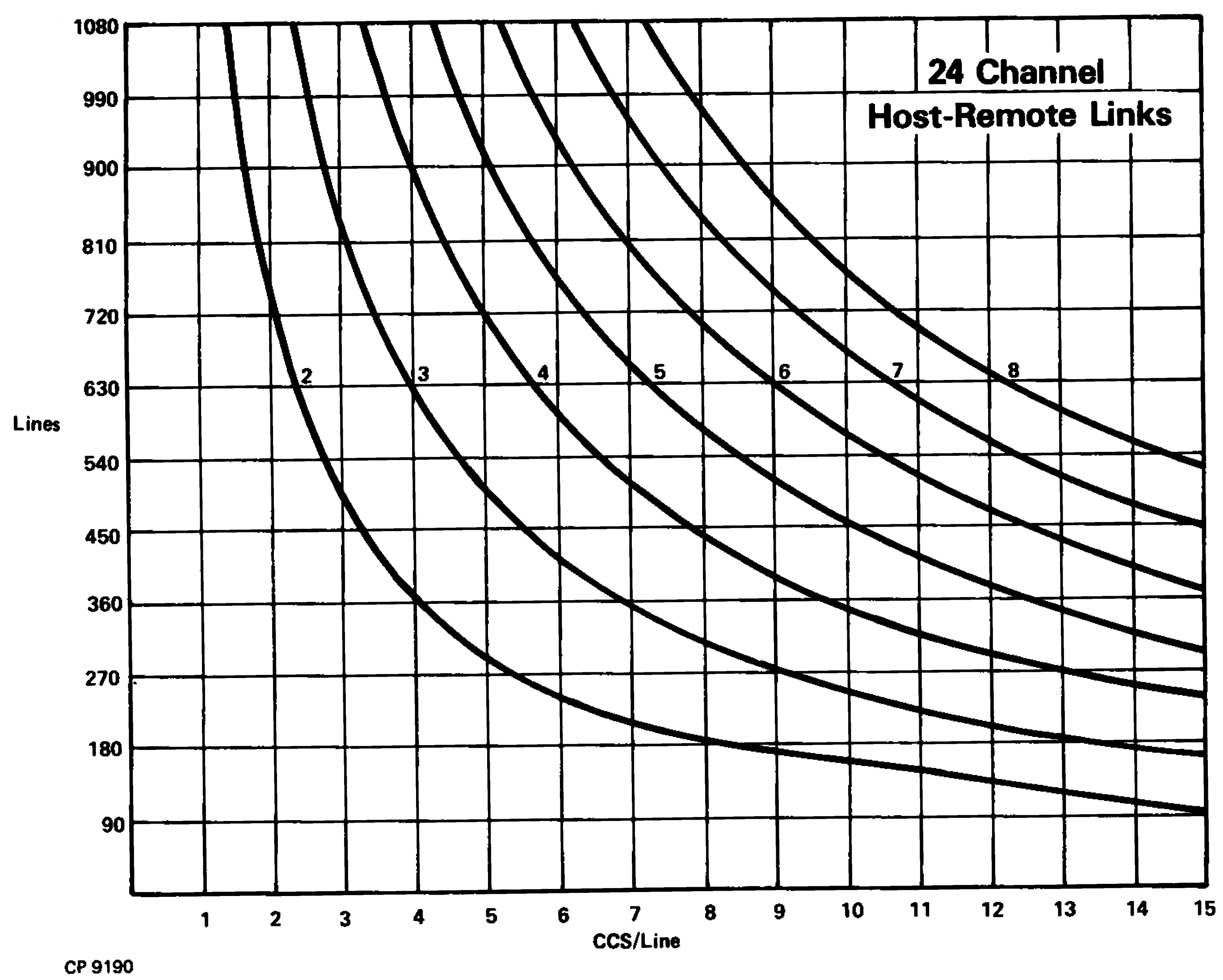


Figure 1-7.5 25% Intra-Nodal Traffic (RLS)

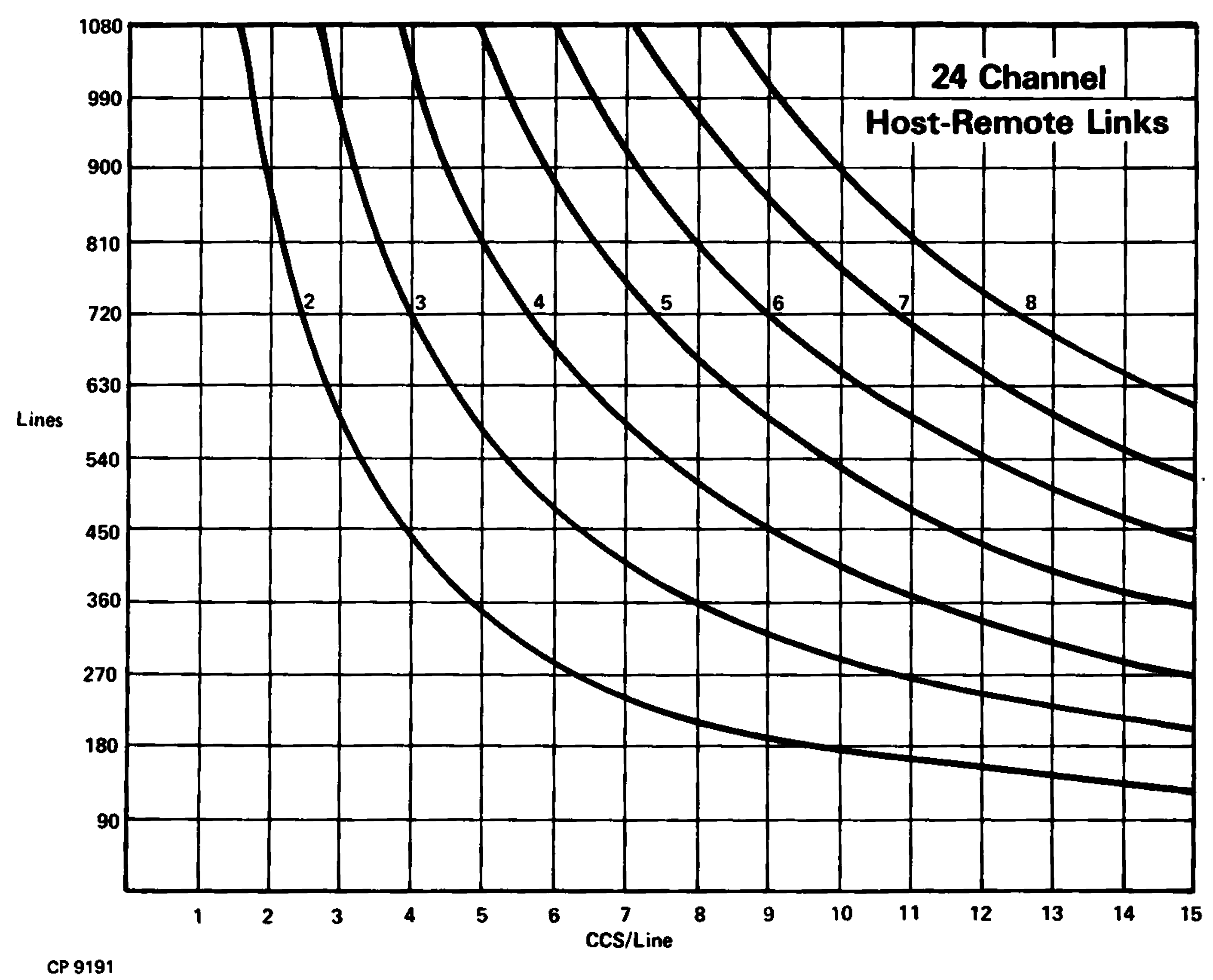


Figure 1-7.6 35% Intra-Nodal Traffic (RLS)

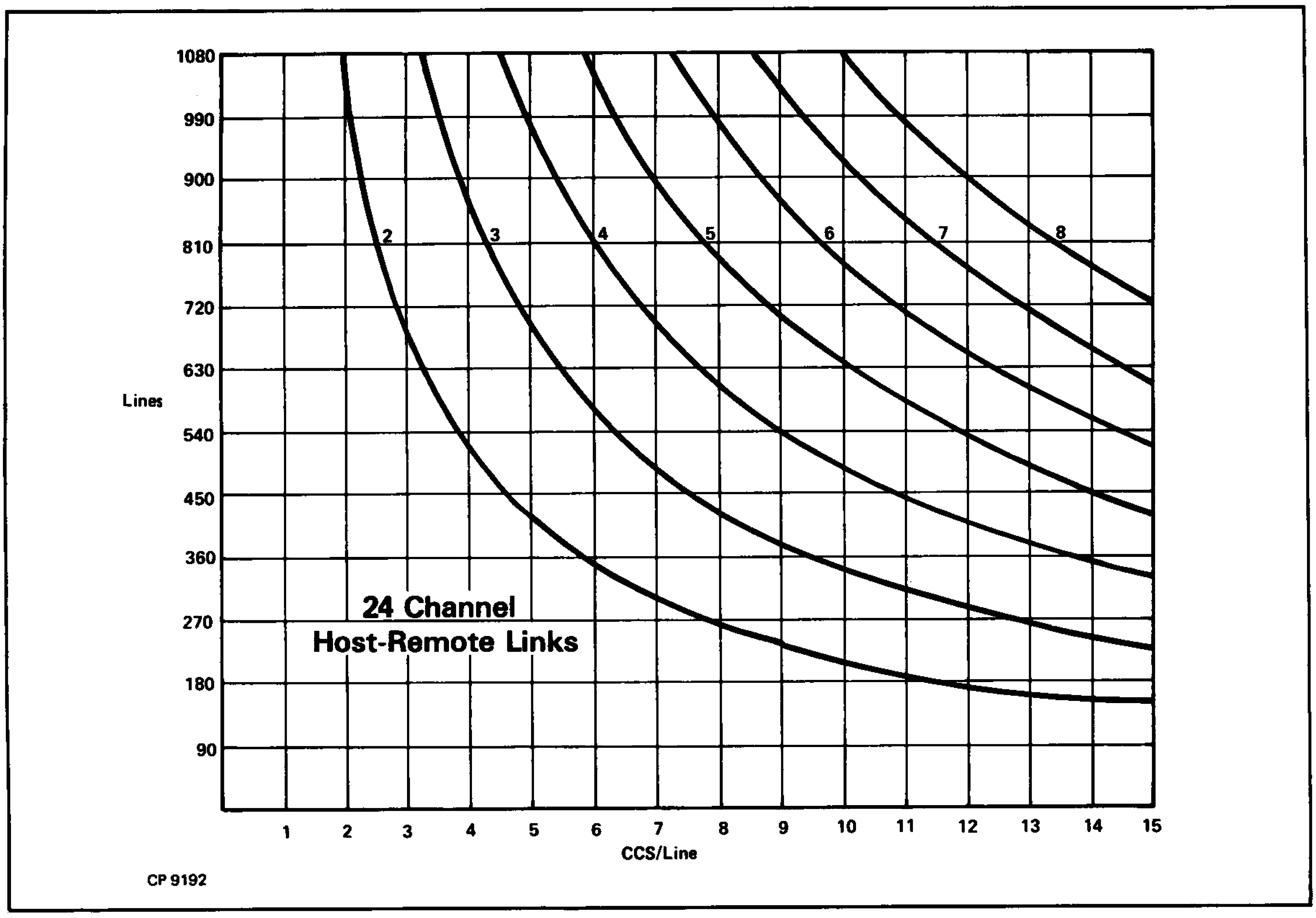


Figure 1-7.7 45% Intra-Nodal Traffic (RLS)

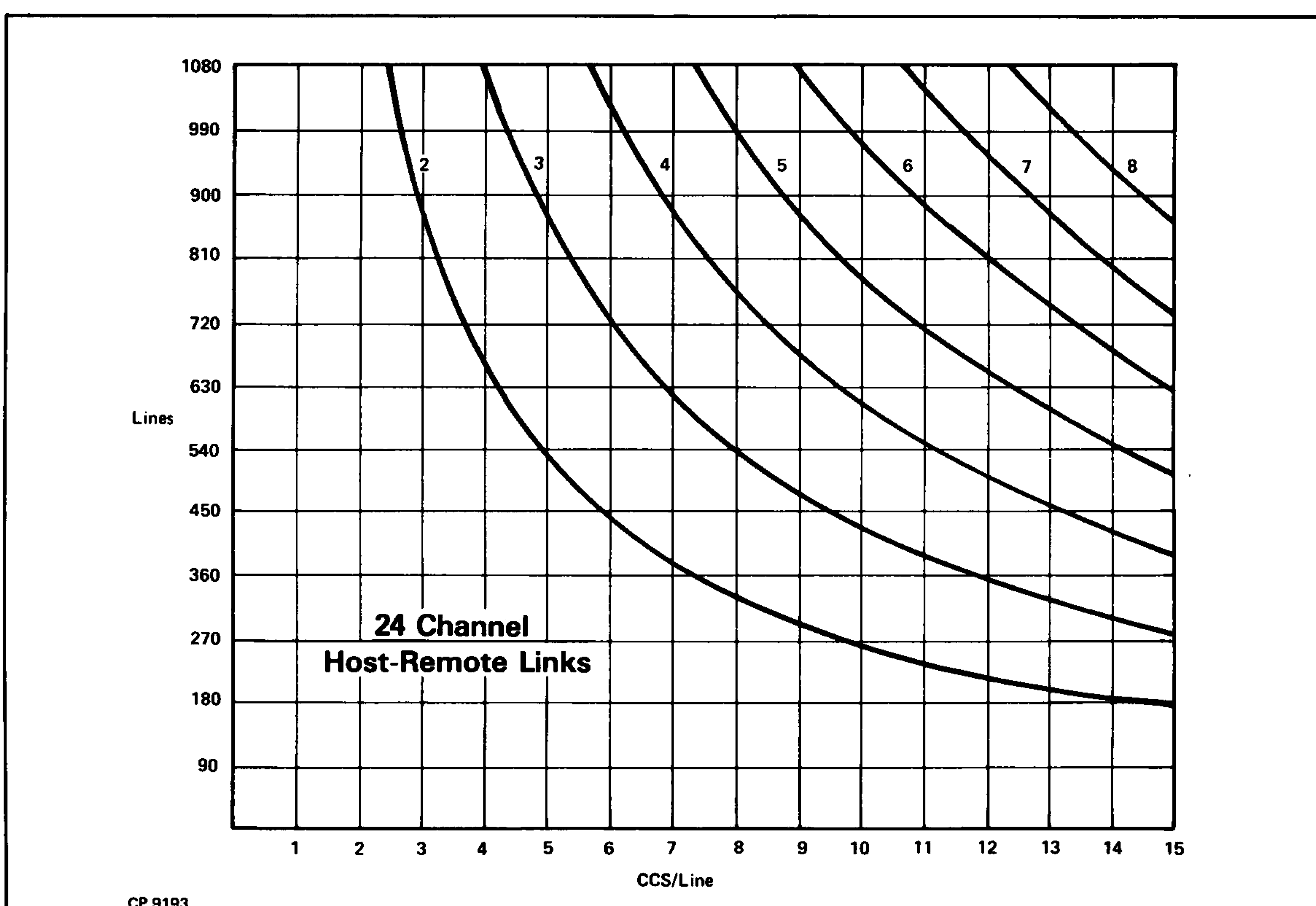


Figure 1-7.8 55% Intra-Nodal Traffic (RLS)

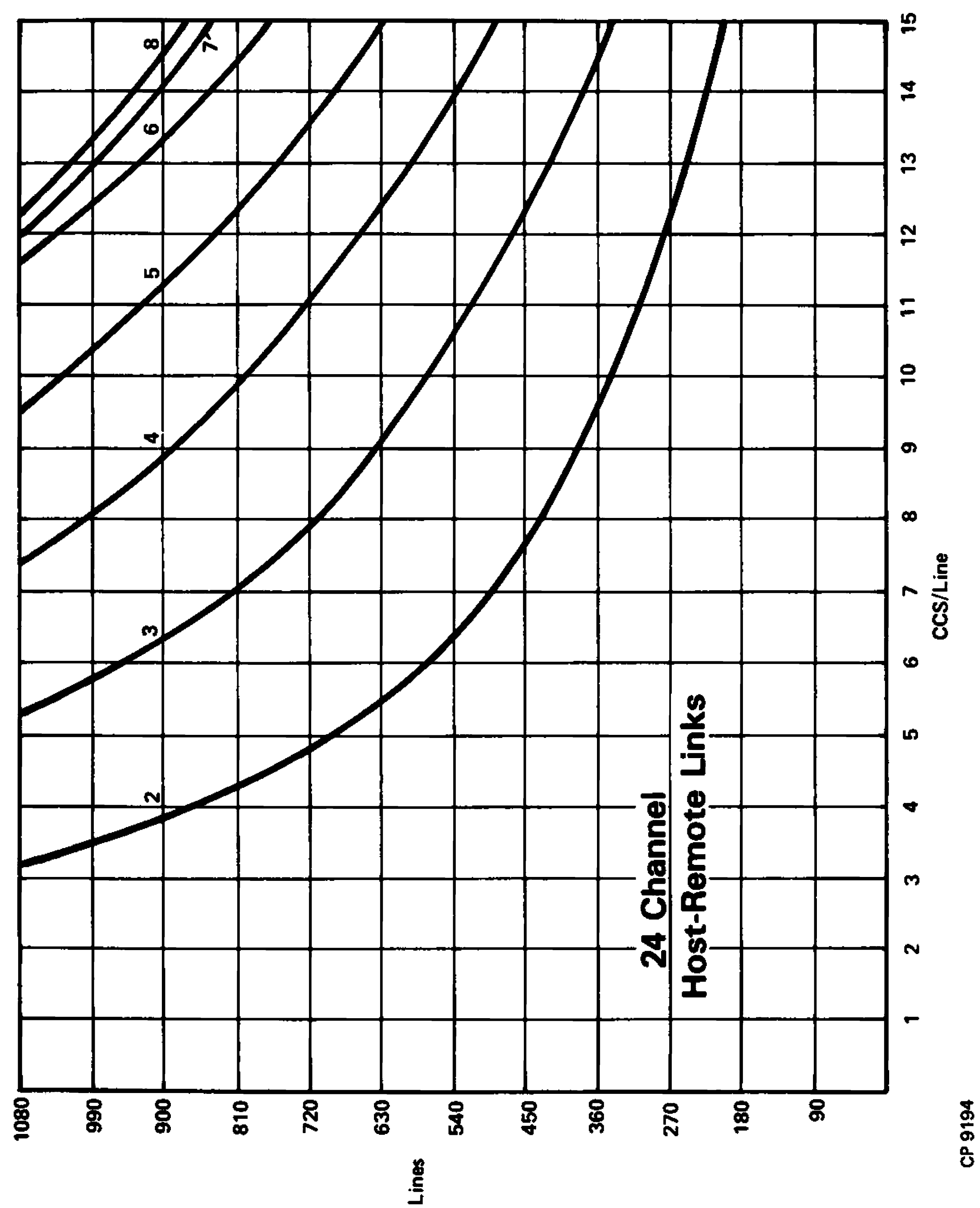


Figure 1-7.9 65% Intra-Nodal Traffic (RLS)

SECTION 8
SYSTEM CENTURY
POWER ENGINEERING

8.1 DCO POWER

DCO power engineering data is presented in Table 1-8.1, 1-8.2 and 1-8.3 for 3 CCS per line, 4 CCS per line, and 5 CCS per line, respectively; all at 12 percent trunking, with 1/2 analog and 1/2 digital trunks. Battery and charger sizing data are also listed.

8.2 RLS POWER

RLS power engineering is presented in Tables 1-8.4, 1-8.5, and 1-8.6 for 3 CCS per line, 4 CCS per line, and 5 CCS per line, respectively. The values in the tables do not include INS (2.7 amps and 503 BTU) or ESS (1.8 amps and 335 BTU). INS is a prerequisite for ESS.

8.3 BATTERY SIZING

The battery sizing calculation formula is:

Amp-Hour Capacity =
Busy Hour Drain x Busy Hour Reserve Factor

The busy hour reserve factors are:

3 Hours = 4.545
4 Hours = 5.464
5 Hours = 6.369
6 Hours = 7.299
7 Hours = 8.065
8 Hours = 8.850

The selected battery should be at least equal to or greater than the required Amp-Hour capacity. Battery life should be approximately 12 years.

8.4 CHARGER SIZING

For redundant calculations, the user should proportion busy hour drain among the most convenient and economical charger sizes, so that if any one charger fails, the remaining charger (s) will carry the busy hour load. A minimum of two chargers should be used. On REA contracts, a minimum of three chargers must be used.

The load-sharing, charger-sizing calculation formula is:

$$\text{Charger Capacity} = \frac{\text{Battery Amp-Hour Capacity} \times 1.15}{24} \times \text{Busy Hour Drain}$$

The user should proportion the required charger capacity among the most convenient and economical charger sizes. A minimum of two chargers should be used.

TABLE 1-8.1 DCO POWER: 3 CCS PER LINE, 12% TRUNKING

LINES	BUSY HOUR AMPS	BUSY HOUR BTU
500	62	12,071
1,000	74	14,285
1,500	91	17,721
2,000	104	20,211
2,500	122	23,647
3,000	134	25,861
3,500	152	29,296
4,000	164	31,788
4,500	182	35,222
5,000	194	37,437
7,500	269	51,885
10,000	362	69,860
12,500	437	84,308
20,000	677	130,521

TABLE 1-8.2 DCO POWER: 4 CCS PER LINE, 12% TRUNKING

LINES	BUSY HOUR AMPS	BUSY HOUR BTU
500	63	12,232
1,000	77	14,988
1,500	94	18,204
2,000	110	21,237
2,500	126	24,452
3,000	141	27,209
3,500	157	30,424
4,000	173	33,458
4,500	192	37,055
5,000	204	39,430
7,500	301	58,029
10,000	383	73,845
12,500	462	89,100
20,000	716	138,111

TABLE 1-8.3 DCO POWER: 5 CCS PER LINE, 12% TRUNKING

LINES	BUSY HOUR AMPS	BUSY HOUR BTU
500	64	12,394
1,000	79	15,311
1,500	96	18,687
2,000	113	21,882
2,500	133	25,640
3,000	146	28,176
3,500	165	31,934
4,000	182	35,129
4,500	199	38,504
5,000	214	41,423
7,500	315	60,828
10,000	403	77,831
12,500	504	97,237
20,000	775	149,428

TABLE 1-8.4 RLS POWER: 3 CCS PER LINE

LINES	BUSY HOUR AMPS	BUSY HOUR BTU
90	21.7	4,049
180	23.6	4,396
270	25.5	4,744
360	27.3	5,092
450	29.4	5,466
540	31.2	5,814
630	33.2	6,189
720	35.1	6,537
810	37.0	6,884
900	39.0	7,259
990	40.9	7,607
1,080	42.7	7,954

TABLE 1-8.5 RLS POWER: 4 CCS PER LINE

LINES	BUSY HOUR AMPS	BUSY HOUR BTU
90	21.9	4,069
180	23.8	4,431
270	25.8	4,805
360	27.9	5,199
450	29.9	5,567
540	32.0	5,962
630	34.0	6,330
720	36.1	6,724
810	38.1	7,092
900	40.2	7,487
990	42.2	7,854
1,080	44.2	8,222

TABLE 1-8.6 RLS POWER: 5 CCS PER LINE

LINES	BUSY HOUR AMPS	BUSY HOUR BTU
90	22.0	4,089
180	24.0	4,477
270	66.8	4,981
360	28.4	5,280
450	30.6	5,694
540	32.8	6,109
630	34.0	6,497
720	37.0	6,885
810	39.3	7,326
900	41.4	7,714
990	43.7	8,129
1,080	45.6	8,490

SECTION 9
SYSTEM CENTURY OPERATOR POSITION SYSTEM

9.1 INTRODUCTION

The SYSTEM CENTURY product line also includes the SYSTEM CENTURY Operator Position System (SCOPS) to provide Class 4C service in conjunction with the DCO system, any other digital switch or any common control analog switch. The associated Class 4 exchange performs incoming digit analysis and routes only calls requiring operator assistance to the SCOPS common equipment.

SCOPS is compact in size and low in cost. However, the system has all the flexibility and capability of larger operator position systems, increasing call handling efficiency and eliminating billing errors. With a simple, color-coded, single-stroke keyboard, operators can handle all call types.

- One Plus ONI
- Zero Minus
- Zero Plus
- Inward (1X1, 115X or equivalent)
- Busy Verification
- Assistance Service
- Hotel/Motel Service
- Time and Charges Reporting
- Notify Reports
- Coin Services
- International Gateway Service (CCITT #5)

SCOPS is fully compatible with all call billing types including:

- Send Paid
- Credit Card
- Third Number
- Collect
- Split Billing
- Special Billing Number
- Call Back
- DDD Rates

The SYSTEM CENTURY design is totally modular, giving complete flexibility in locating operator positions. System common equipment can be placed in the Class 4 office adjacent to the exchange or it can be installed at a remote site. Operator positions can be located with the common equipment or at different facilities. The SCOPS system provides up to 40 individual operator positions and two supervisory positions.

9.2 TOLL SYSTEM ARCHITECTURE

The complete toll system architecture includes several distinct equipment groups.

9.2.1 COMMON EQUIPMENT GROUP. This group houses the microprocessors, timing cards, dual disk drive with controller, power system interconnect panel for external devices, and a maintenance and alarm panel. Full control redundancy is a SCOPS system standard.

9.2.2 COMMUNICATIONS EQUIPMENT GROUP. This group provides a 24-channel (DS-1 compatible) interface from the SCOPS to a digital toll exchange. One to 40 DS-1 interfaces may be equipped. A D-3 compatible channel bank equipped with 4-wire E&M channels is required for each equipped Communications Equipment Group if the associated toll switch is analog.

9.2.3 COMMUNICATIONS SIGNALING EQUIPMENT GROUP. This group provides MF sending and receiving capability between the SCOPS and associated toll exchange.

9.2.4 OPERATOR'S POSITION. The operator's position consists of a video terminal with audio logic card and cable set.

9.2.5 SUPERVISOR'S POSITION. The supervisor's position has a video terminal with audio logic card and set of cables.

9.2.6 RATING SYSTEMS. The SCOPS can be equipped with one of two optional rating systems. These systems are an automatic system and a semi-automatic system.

9.2.6.1 Automatic Rating System. This system will automatically rate calls via a system based V&H coordinate table. Rates and charges will be displayed on the video positions, automatically computed, and entered into the billing system.

9.2.6.2 **Semi-Automatic Rating System.** This system allows the position operator to manually enter the initial and overtime rate. The system will automatically compute the charges for the call and enter those charges into the billing system.

9.2.7 **SYSTEM TELEPRINTER.** The teleprinter is used for system management and maintenance reports, and may also be used to print time and charge messages. One is standard, and 2 local and 16 remote printers can be provided for hotel/motel T&C message reports.

9.2.8 **SCOPS FURNITURE.** The furniture offers a desk especially designed for TSPS operation. Position chairs may also be included.

TABLE 1-9.1
SCOPS FEATURES

System Parameters:	– Fully digital with stored program control
	– Complete standalone system (meets section 4 of AT&T Notes on the Network 1980)
	– 40 operator and 2 supervisor positions
	– Automatic call distribution (ACD)
	– Connects to associated Class 4 exchange over 1 to 40 DS-1 ports
	– Traffic, maintenance, and management (FADS) report printout
	– Hotel/Motel services
	– Calls float in the system when not connected to a position
	– Overlapped capability for up to three additional calls
	– Coin control
	– Optional offerings:
	  – Manual rate look-up with automatic computation
	  – Rate computer for automatic billing
	  – Industry compatible magnetic tape billing records

Position Equipment:	– Highly efficient video terminals – Position and furniture design insures personal comfort and convenience – Human engineered single stroke keyboard – Inherent flexibility for present and future traffic patterns – RS-232 & voice frequency compatibility – Remote position deployment capability – Position training program
Network Compatibility:	– DS-1, D3/D4 compatible (or optional 30 + 2 CEPT) – Network clock synchronization – Fixed digital and VNL loss plans – Analog or digital associated Class 4 compatibility – R1, CCITT #5 signaling compatibility (CCITT #7 future), R2, CMF – Bell CAMA identification format – ABC/ACTS future compatibility

TABLE 1-9.1
SCOPS FEATURES (Cont)

Environmental:	–Temperature
	  Operating 10° to 40° C
	  Storage 0° to 85° C
	– Relative Humidity
	  (non-condensing) 10 to 95%

Mechanical:	– The common equipment for each eight operators mounts in a single cabinet 87" high, 32" wide and 22" deep (221cm x 81cm x 56cm). – Weight is 100 pounds per square foot (4.88 kgm/m^2). – SCOPS position video terminals are approximately 15" high, 18-1/2" wide, 23" deep (38cm x 47cm x 58cm) and weigh approximately 38 pounds (18 kgm).
Power:	– Fully loaded system both trunks and position: Voltage Supply / Power Required 120/220 VAC (50/60HZ) — 5 KW 48 VDC — 5 KW

SECTION 10
CENTRALIZED MAINTENANCE AND ADMINISTRATION CENTER

10.1 INTRODUCTION

Stromberg-Carlson recognized the need for automation and centralization of operating company procedures for performing maintenance and administrative functions. These functions are a source of continuing and ever-increasing costs. The Centralized Maintenance and Administration Center was developed to increase efficiency and reduce the effort in performing these functions, not only for digital systems and network but also for analog or mixed systems.

The CMAC® network is a management information system developed specifically to meet the needs of the telephone operating companies. As a computer-based, stand-alone information center, the CMAC network gives management more precise control of operations, reduces clerical, maintenance and administration costs and improves service to subscribers.

The CMAC system can be used with any analog or digital central office, or in a multi-office network environment. The system centralizes maintenance and alarm reports, administrative functions, repair bureau reports, and service orders. The CMAC system automatically routes critical information to wherever it is needed and maintains complete system records.

- Management control is enhanced because the system collects and analyzes all network data and produces concise status reports in real time.
- Clerical cost is cut because hand maintenance and routing of records are replaced by totally automatic processing of all service orders, trouble reports, and business documents.
- Preventive maintenance is made more effective because maintenance schedules are based on accurate line-test data.
- Repairs are speeded because trouble reports are instantly routed to the nearest service facility.
- Customer service is improved because service requests are delivered simultaneously to all offices and facilities involved.

Information processed by the CMAC network covers all critical telephone operating company activities.

10.2 MAINTENANCE

The CMAC system continuously monitors multiple digital switching and other stored program switching machines for maintenance message output. Messages can be immediately printed at the CMAC console or routed to a remote terminal at a maintenance center. Maintenance personnel have total accessibility to multiple switching units from a single I/O device. Maintenance information is stored by the system and periodic maintenance summaries are easily produced.

10.3 CENTRALIZED ALARM MONITORING

In addition to the centralized maintenance network, the CMAC system has the capability of monitoring the network for external alarms. In most digital switching machines, external alarms can be processed by the machine itself and forwarded to the CMAC system in the form of a maintenance message. In locations where this capability does not exist, alarm inputs are forwarded to the CMAC system.

10.4 TRAFFIC DATA COLLECTION AND REPORT GENERATION

The CMAC system automatically polls the data collection facilities in each switching center once each hour and stores the data for report generation. In the event the switching machine does not have a buffer area in which the traffic data can be stored, the CMAC system accepts the data as it is generated. The Centralized Maintenance and Administration Center tabulates the data and provides a call completion and disposition analysis to maintenance personnel on an hourly basis. It also provides traffic engineers with tabulated data on a 24-hour basis, including the peak hour and peak-hour usage or peg count for each category of traffic measurement.

10.5 DIAL LINE ADMINISTRATION

The CMAC network performs the data base administration function to multiple switching systems from a single I/O device at a remote location. Data base changes, additions, and deletions are accomplished as easily as if maintenance personnel were on-site.

10.6 AUTOMATED SERVICE ORDER BUREAU

The CMAC system incorporates a fully automated service order bureau within its design. Service orders are electronically transmitted to the plant or engineering department for equipment and cable assignment. The necessary data base additions or changes in the target switching machine are automatically done by the CMAC system. When the service order is completed, equipment records are automatically updated.

10.7 PAPERLESS REPAIR DESK OPERATION

The CMAC system utilizes an electronic mailbox approach to create a paperless repair desk facility. The clerk receiving the trouble call enters the NNX code and line number on a standard format CRT screen. The CMAC system utilizes the information stored in the line equipment record to fill in additional information such as name, address, equipment number, cable routing and end user apparatus. The entry clerk then electronically sends the repair ticket to the next area of responsibility. Once the trouble has been cleared, the ticket is electronically transmitted to the location that is charged with the responsibility for closing the ticket. The repair order system also supplies various administrative reports based on opened tickets and trouble classifications.

10.8 AUTOMATIC AND INDIVIDUAL OUTSIDE PLANT TESTING

The CMAC network is capable of providing a full outside plant test system that is operated on a remote basis. This system is capable of automatic routing by NNX line block or testing any line on an individual basis. In the automatic mode, the CMAC system commands the remote line test units regarding start time, step time, and lines to be tested. It receives reports on lines that exceed pre-established thresholds and provides these reports to a specific location. In the individual line test mode, an operator sitting at a specific location can direct the system to test any line within the network.

10.9 RECORD-KEEPING CAPABILITIES

10.9.1 HISTORIC EQUIPMENT RECORDS. The CMAC system can be equipped for automatic processing and storage of physical equipment records on a historic basis.

10.9.2 LINE EQUIPMENT RECORD STORAGE. The line equipment records stored in the CMAC system are fully administrable by operating company personnel and are maintained through the service order concept described earlier.

10.10 FILE MANAGEMENT

The operating company can utilize this program to implement many record keeping functions in the operations or engineering areas. The file management system is a multiple field record keeping system. It can sort, increment, decrement and do other data manipulations on a multifield basis.

Because it combines the full range of network operations in one efficient system, the CMAC network can improve subscriber service and slash maintenance and administration costs. It is the next logical step in Stromberg-Carlson's commitment to the digital telecommunications networks for the Information Century.

10.11 CMAC SYSTEM SPECIFICATIONS

Equipment Location	System may be located at any central office or maintenance complex
Temperature	59 °F to 90 °F (15 °C to 32 °C) ambient
Humidity	20% to 80% relative humidity

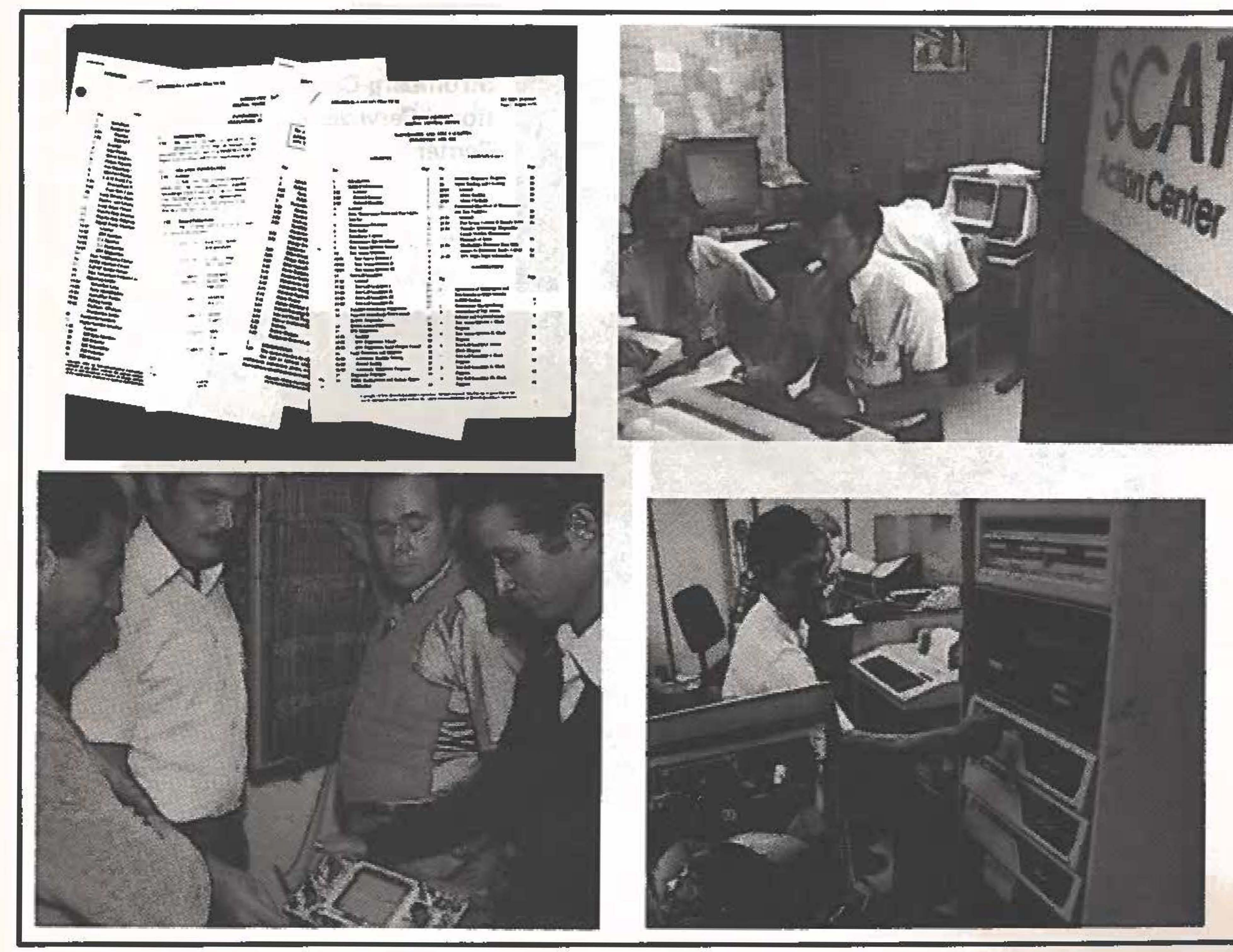
Heat Dissipation	5225 BTU/hour maximum
Power Consumption	1480 watts
Work Station	6 ft. desk containing mini-computer, disk, and tape storage systems
Power	48V power plant or 110Vac commercial
Memory	16K byte E prom (generic), 64K byte RAM (background area), 256K byte memory
Memory Mapping	Expandable to 4 megabyte
CPU	8 general purpose registers, 16-bit processor
Disk Unit	Winchester, 30 megabyte capacity
Line Interface	Serial 0-9600 baud, RS422, RS232C EIA standard or 20 mA loop, 7 or 8 data bits with parity-expandable to 32 remote sites
Terminals	Accommodates any RS232 or 20 mA standard terminal or CRT
Modems	0-2400 BPS 2W-4W leased line or dial-up. Bell 103/202/212 compatible.

CHAPTER 2

SYSTEM SUPPORT

With the SYSTEM CENTURY Digital Central Office product line, operating companies will receive the benefits of Stromberg-Carlson's support services capability. These comprehensive programs are designed to assist the operating companies in achieving the maximum benefit from the DCO product line. Some of these supporting services include:

- **Documentation**
- **Training**
- **Quality and Reliability**
- **Material Service Center**
- **Stromberg-Carlson Assistance Team**



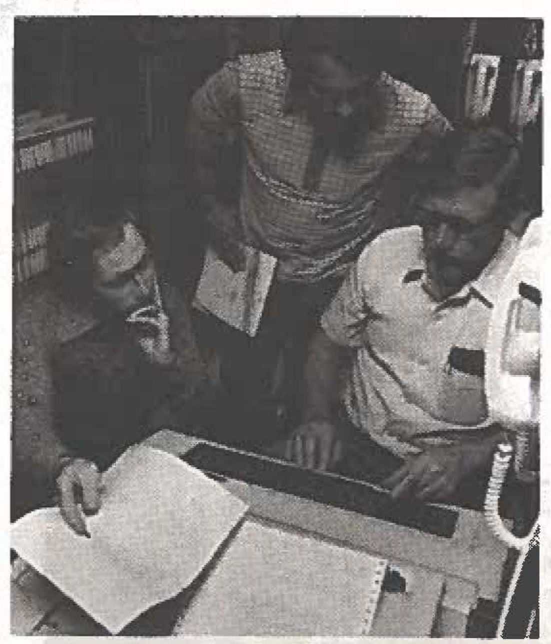
SECTION 1
TRAINING

Stromberg-Carlson maintains a modern Educational Services Training Center in Winter Park, Florida for the training of operating company personnel in the installation, operation, and maintenance of SYSTEM CENTURY DCO equipment. This complex contains comfortable, efficiently-equipped classrooms for instruction and hands-on training.

The instructors in the training center are well-qualified educators with a practical background in telecommunications and supporting disciplines. Extensive use is made of state-of-the art training aids to enhance the course material.

The courses offered in the training center cover all areas required by operating company personnel to understand the DCO system and to properly operate and maintain the system. Courses range from a 2-day Appreciation Seminar providing a technical introduction to the DCO family to a 20-day maintenance and administration course providing knowledge to the level required to perform administrative changes and efficient system maintenance. A captive system is maintained for hands-on experience in operating and troubleshooting techniques.

Stromberg-Carlson Educational Services Training Center



Hands-On Instruction at the Stromberg-Carlson Training Center

SECTION 2
DOCUMENTATION

Stromberg-Carlson is committed to provide a most comprehensive documentation support of its products. The documentation provided to support the DCO system is in the form of Stromberg-Carlson Practices (SCPs) and engineering documentation consisting of descriptive information and drawings.

The Stromberg-Carlson Practices are prepared in a style and format similar to that used in Bell System Practices. Great care is taken to assure both technical and operational accuracy. These documents are written by technically competent personnel and are edited for language clarity and ease of understanding. The Stromberg-Carlson Practices are then reviewed by Engineering, Marketing, and Customer Service areas for technical accuracy. Operating, testing, and maintenance actions are verified on operating equipment in the laboratory and are further tested through field usage before formal publication and issuance of each Stromberg-Carlson Practice.

The practices can be grouped into the following five general categories:

1. Descriptions and Engineering Considerations (Practices). This grouping provides a general description, theory of operation (at a detail block diagram level), equipment descriptions, feature descriptions, and engineering practices such as site requirements, grounding requirements, environmental requirements, etc.
2. Installation. This grouping provides the practices needed to properly install and test the system (precutover test plan, precutover test procedures, and acceptance test procedure).
3. Maintenance and Administration. This grouping provides preventive and corrective maintenance actions to be performed and provides operating procedures for maintenance equipment such as the maintenance panel, wire chief's test panel, etc. Office administration procedures are outlined for various administrative tasks such as on-line recent change facilities, traffic measuring, trouble and status reporting, etc. Suggested formats are also included for various administrative records.
4. Operators and Message Manuals. This grouping contains the operating instructions necessary to do data base administration (the input/output tasks) and a dictionary of all input commands and output messages. Corrective actions for error messages are included in this grouping.
5. Subsystems. This grouping provides detailed information on various subsystems available with the Digital Central Office (CAMA/LAMA, DNI, DSU, DTI).

A complete listing of SCPs provided with a DCO system is listed in Section 23-001-00, *Index of Related Sections and Subject Keysheet.*

The following engineering documentation is provided with the DCO system:

- Job Specifications
- Job Drawings such as floor plans, cable run drawings, etc.
- Assembly Drawings
- Schematic Diagrams (S-drawings)
- Circuit Descriptions (DS)
- Configuration Identification (CI)
- Net Lists (NL) – wire run lists
- Pin Identification (PI)

SECTION 3
QUALITY AND RELIABILITY

Stromberg-Carlson has always had a reputation for providing products and services of outstanding quality. The company's quality policy is directed to maintaining this reputation by stating:

- Product quality will consistently meet or exceed our customer's requirements.
- Product quality will continue to be a primary marketing attribute.
- The ultimate measure of quality is customer satisfaction.

To support the corporate policy, the following quality direction has been identified:

- Emphasis on prevention
- Quality cost management
- An integrated quality system
- Training/motivation for quality
- Automation

Stromberg-Carlson's philosophy is to provide "customer to customer" quality – *customer* quality requirements leading to *customer* satisfaction. To achieve this, a quality attitude is being built at all levels of the organization, from management to factory worker; and in all facets of operation, from manual to automated.

Some practices that are taking place at the organizational level include:

- Quality circles in the production and engineering areas
- Software/hardware review and verification programs
- Company training programs at initial and upgrading levels
- Company suggestion and award programs for performance and productivity

In the manufacturing area, some of the programs to ensure quality and reliability are:

- Preproduction engineering, manufacturing, and test activities
- Supplier surveys
- Purchase materials inspection
- Failure analysis testing
- Component burn-in
- Subsystem and integrated system testing
- Customer acceptance testing

The goals of Stromberg-Carlson's design and manufacturing practices are to provide customers with initial operability as well as long term reliability and maintainability. Efforts at all levels of the production cycle are therefore involved to guarantee system and network integrity.

SECTION 4
MATERIAL SERVICE CENTER

The primary function of the Material Service Center is to assure that Stromberg-Carlson's customers receive essential material services promptly, and thus minimize delays or equipment downtime. The Material Service Center provides support both during the installation/test phase and after the system has been cut into service.

Modern order service processing techniques are employed to assure prompt return of material to the customer site.

The Material Service Center (MSC) is an integral part of the Public Switching Center factory facility, and takes full advantages of the technology and technicians available to manufacturing operations. The MSC Computer Aided Test and Repair (CATR) is equal in scope to the CAD/CAM operation used in our factory and research and development centers. Verification and fault detection is accomplished quickly through computer-aided diagnostic and verification equipment. The Material Service Center operates under the same stringent quality and reliability standards as the entire Stromberg-Carlson facility.

The key to success of the Material Service Center has been the continued ability to improve performance and speed of response through automated customer records and computer assisted logistics systems.

Modern Order Service Processing Techniques at Material Service Center

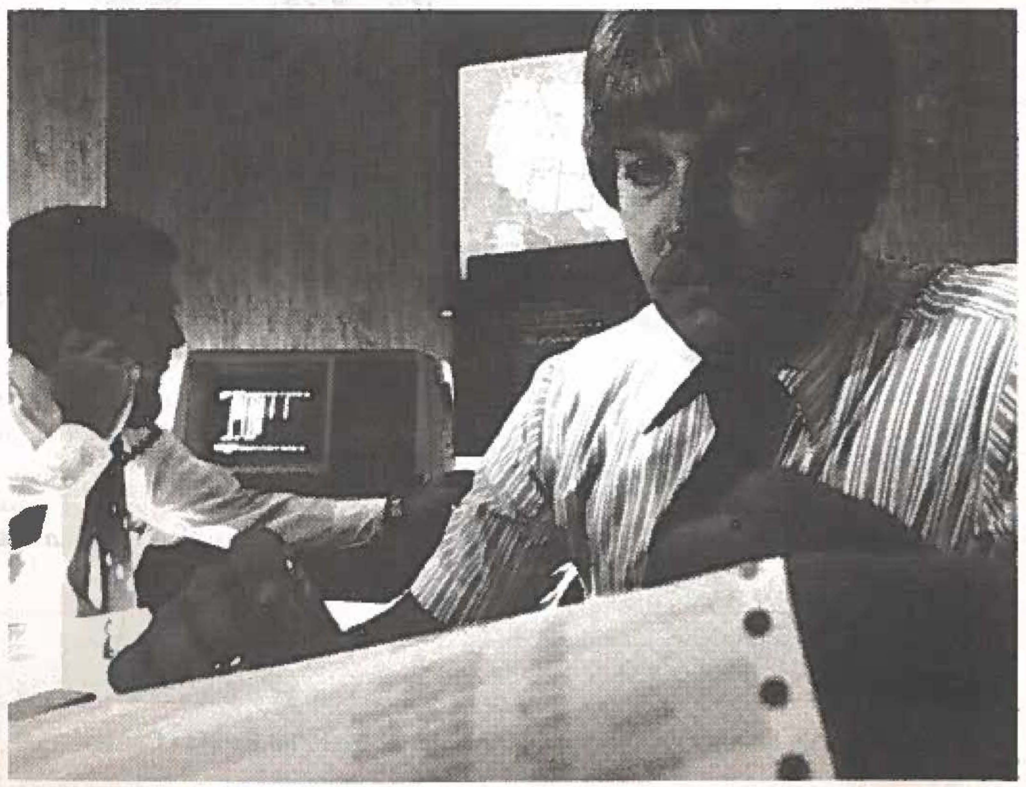
SECTION 5
STROMBERG-CARLSON ASSISTANCE TEAM

The Stromberg-Carlson Assistance Team is a customer service organization established to provide technical assistance to operating company job locations on a 24-hour, 365 days-per-year basis. The SCAT^{SM} service center utilizes a team of highly skilled service engineers with expertise in both the hardware and software disciplines of SYSTEM CENTURY products.

The SCAT service center uses state-of-the-art microprocessor technology to simulate customer problems. This coupled with personal experience allows SCAT personnel to efficiently solve routine customer requests. SCAT's ability to quickly reference previous situations and draw upon organizational expertise allows them to be more responsive to operating company emergency needs.

Over 75% of the SCAT organization has had actual operating company experience either as operating company technicians or as Stromberg-Carlson technicians and engineers. Their knowledge of the detailed operations of telephone operating company central offices is a major asset when working on-line to assist operating company personnel. In addition to formal training in microprocessor technology and state-of-the-art repair logic techniques, the SCAT engineers are provided updated information from our research and engineering organization. This close association with the design engineers gives the SCAT personnel additional insight into the system thereby increasing their effectiveness in meeting customer needs.

The SCAT service center is operational 24 hours per day, 7 days per week and is equipped to function with individual operating company locations or remote maintenance centers. The SCAT service center is currently serving Digital Central Offices throughout the world including Korea, American Samoa, Colombia, and Guam.



Stromberg-Carlson Assistance Team Service Center Features Direct Contact With DCO User