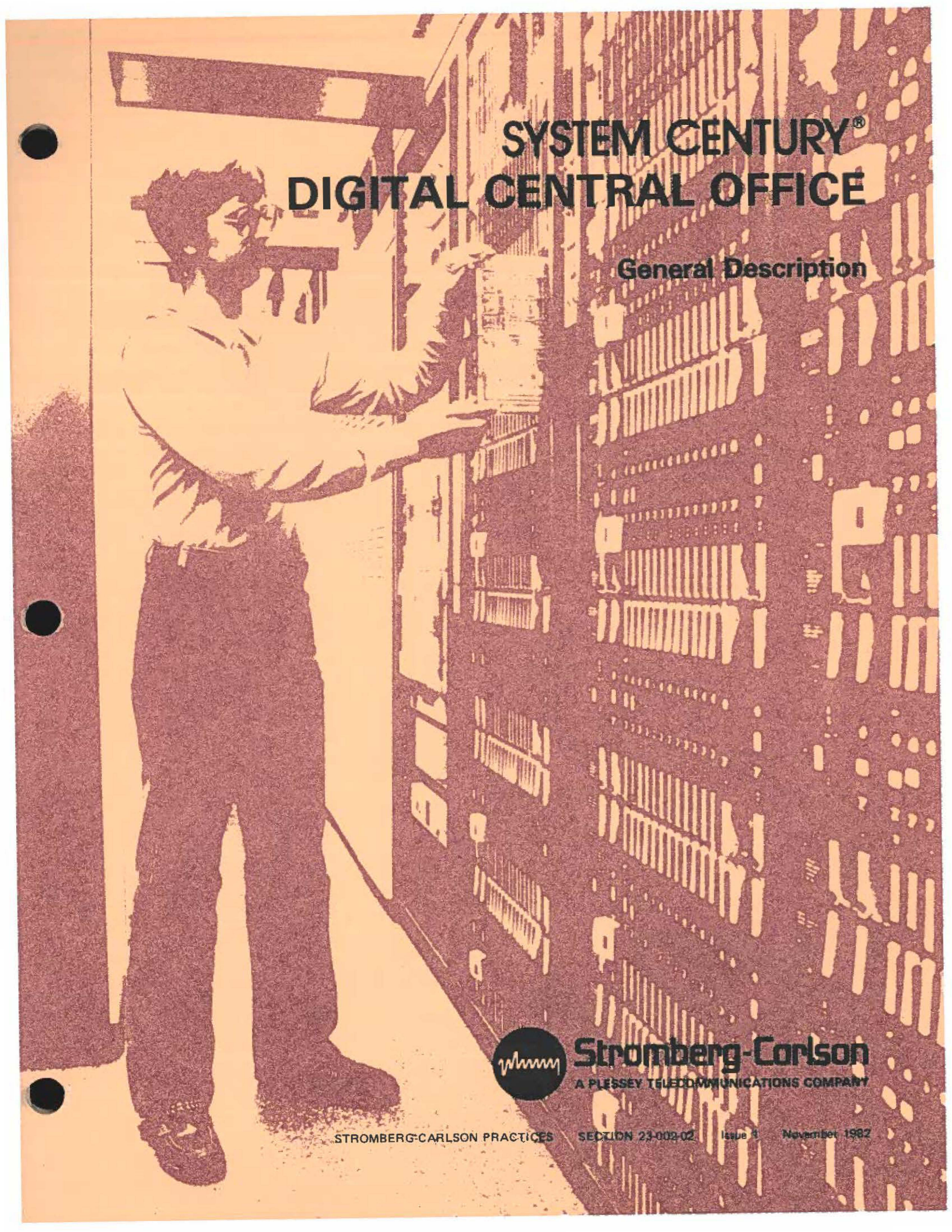




SYSTEM CENTURY® DIGITAL CENTRAL OFFICE

General Description



Stromberg-Carlson
A PLESSEY TELECOMMUNICATIONS COMPANY

STROMBERG-CARLSON PRACTICES

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SYSTEM CENTURY®
DIGITAL CENTRAL OFFICE

GENERAL DESCRIPTION

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1. INTRODUCTION

1.01 This section presents general information on SYSTEM CENTURY Digital Central Offices equipped with local line switches (LLS). Physical, technical, and functional block diagram descriptions are included. Related sections with detailed technical information are referenced in paragraph 2.02 and within the text where applicable.

2. RELATED INFORMATION

2.01 General.

A Sales and Instructional Literature Index of latest available publications can be obtained from your Stromberg-Carlson sales representative or from Publications Services, Stromberg-Carlson Corporation, 400 Rinehart Road, Lake Mary, Florida 32746.

2.02 Related Sections.

The following sections are recommended for use with this document:

01-012-03	Central Office Grounding, Engineering Considerations
01-014-03	Atmospheric Environmental Control for Digital Telephone Switching Systems

01-027-05	Glossary of Digital Central Office Features
23-002-64	On-Line Recent Change Facilities, Forms and Administrative Instructions
23-002-97	System Operators Manual
23-065-05	Power and Alarm System, Description
23-237-51	Equipment Location
24-005-02	Digital Satellite Unit, General Description
24-015-02	Digital Trunk Interface, General Description
28-005-02	Centralized and Local Automatic Message Accounting Subsystems, General Description

PART I. DESCRIPTION AND ORGANIZATION

3. GENERAL

3.01 The SYSTEM CENTURY Digital Central Office is intended for use as a class 5, class 5/4P, or class 4P telephone switching system; it can be equipped with 32,400 lines and 4,080 trunks and service circuits. For class 5 configurations, the system can be provided with Local Automatic Message Accounting (LAMA) ticketing equipment, and for class 5/4P or class 4P configurations, the system can be provided with Centralized Automatic Message Accounting (CAMA). Additionally, the system can be equipped with a Digital Trunk Interface (DTI) that permits direct digital connection to a T-1 carrier system. When the remote end of the T-1 carrier system is digitally connected to another digital office, a synchronous network clock (SNC) is added to the DCO[®] system to permit synchronous network operation. Conversely, when the remote end of the T-1 carrier system is digitally connected to D-channel bank equipment, SNC is not required by the DCO system. However, in the latter case, loop timing between the DCO system and D-channel bank equipment is required.

3.02 The DCO system is a digital switching device that uses pulse code modulation (PCM) for analog-to-digital and digital-to-analog conversion of voice signals. It also uses time division multiplexing (TDM) and a timeslot interchange (TSI) to enable simultaneous conversation processing.

3.03 Two commercially available computers running in synchronism are used as call processors and a similar but separate computer is used for maintenance and administrative functions. A specially designed telephony preprocessor, the timeslot interchange, and upward compatible software provide great flexibility in system design and enable modular growth.

3.04 The overall traffic capacity of the system is 216,576 average busy season busy hour (ABSBH) CCS (6016 erlangs).

3.05 The DCO system (fig. 1) 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 line switches,

trunk frames for analog trunks, call processing stored programs, automatic multilevel diagnostic software, and peripheral elements (magnetic tape recorders, keyboards, teleprinters, video displays, etc.)

3.06 One local line switch consists of 12 line groups with each group having 90 lines as its input and 3 line group highways (LGHs) as its output. The 36 LGHs enter the LGH switch and are multiplexed onto a maximum of 8 port group highways (PGH).

3.07 The port grouping circuits consist of port (trunk and service) circuits and the associated port group control circuits. The port circuits provide conversion of analog to digital information, as required. Up to 30 port circuits are associated with each port group control.

3.08 The timeslot interchanges (TSIs) use time division multiplexing and provide the switching of digital voice data within the system. The TSI provides the connection or path for routing digital voice information from a calling line to the correct called line. Each TSI serves up to 8 sets of port grouping circuits, or 240 ports. Each TSI has a traffic capacity of 6768 CCS (188 erlangs).

3.09 The common control is made up of the supervisory buffer, the telephony preprocessor (TPP), and controller circuits. Supervisory information (on-hook/off-hook status, apply ringing voltage, etc.) is passed between the port circuits and the TPP via the TSI and supervisory buffer as shown in figure 1. The TPP, under control of the call processor, performs all real time dependent functions for the ports. The call processor sends commands to the TPP via the controller, to inform the TPP of the function (look for seizure, ring the line, etc.) required for each port. When the function for a port has completed, the TPP informs the call processor, via the controller, that the event is complete. The controller also is the communication path between the TSI and call processor, for establishing and releasing voice paths between the ports. One common control can serve up to 8 timeslot interchanges. Redundant common controls are always provided. Up to four common controls can be provided in a fully equipped system.

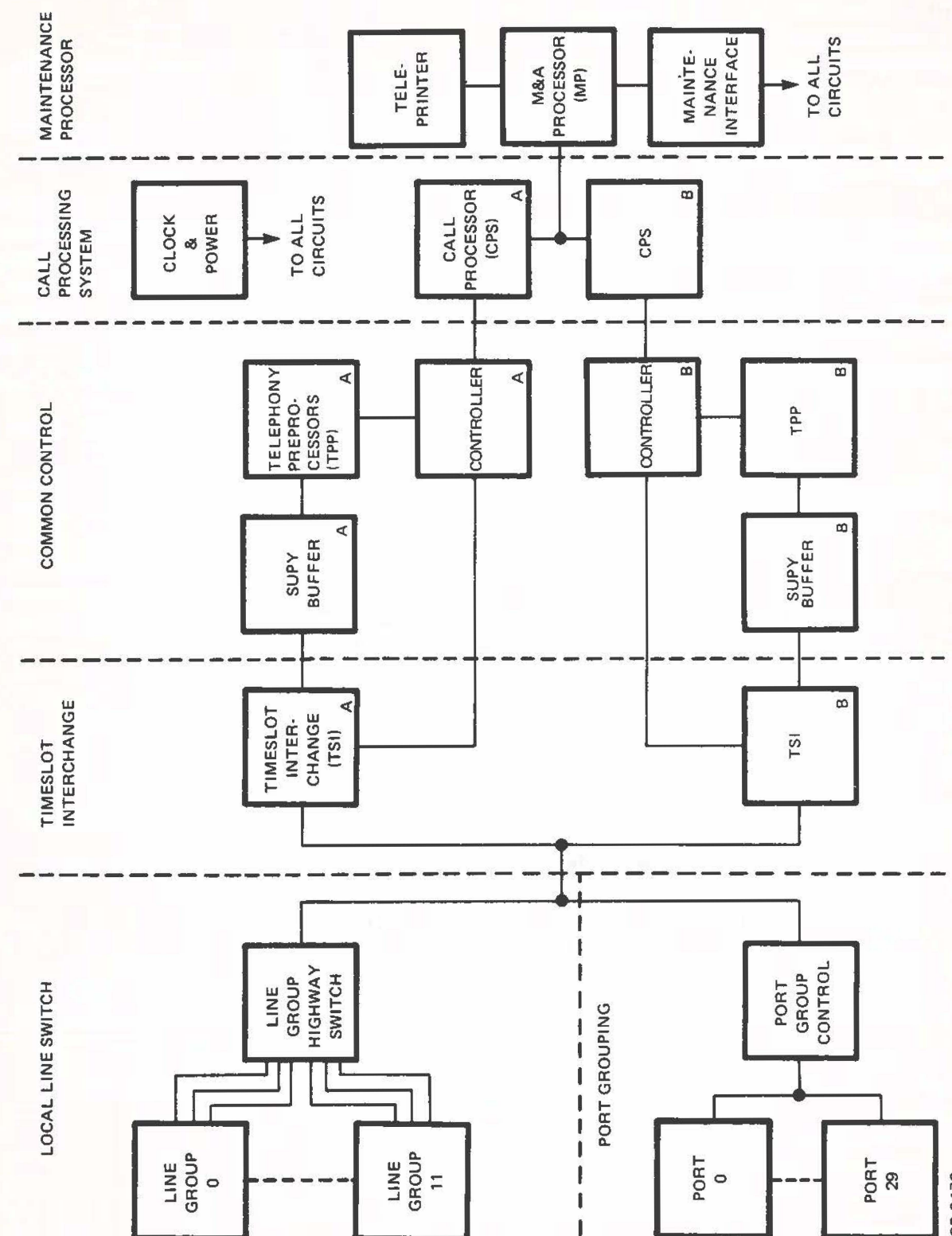


Figure 1. DCO System, Basic Functional Block Diagram

3.10 The call processing system (CPS) consists of synchronized redundant DEC LSI-11 or LSI-11/23* computers, synchronizers, and random-access-memory (RAM). The primary task of the CPS is the traditional translator/marker function. The telephony preprocessor in the common control conveys occurrences of selected events (off-hook, dialed digits, etc.) to the call processors. The CPS then does translations, selects terminations, and marks or unmarks TSI paths.

3.11 The maintenance and administration processor (MP), in conjunction with an input/output terminal such as a teleprinter, is used for all administrative functions and for most maintenance functions. This computer is similar to those used in the redundant CPSs. Administrative software programs control and document changes to the office configuration data base. Most changes in system operation can be done by software changes, entered by means of the teleprinter into the CP memory, under control of the MP. A malfunction in either of the redundant systems (CPS, common control, or TSI network) calls in the MP to diagnose the trouble. One of three levels of diagnostics are then used:

- a. Level one localizes the trouble to one of the two parallel systems and automatically removes the faulty system from service.
- b. Level two does elaborate diagnostic routines on the faulty system and, if possible, identifies, on the teleprinter, the faulty element — usually a replaceable printed wiring board assembly.
- c. Level three is the infrequently used manual trouble location method for those faults that may require manual intervention.

4. PHYSICAL DESCRIPTION

4.01 The DCO system is housed in interconnected equipment frames that contain the system printed wiring board assemblies (PWBAs), control/indicator panels, and power equipment. Frames generally contain PWBAs that do specific functions. For example, the PWBAs for the maintenance and administration processor and related maintenance and diagnostic circuits are contained in the maintenance and administration

frame (MAF). The unitized steel frames are divided into compartments or cells as shown in figure 2. The various PWBAs are plugged into these cells.

4.02 Figure 3 is a floor plan of a typical DCO system that can support up to 2160 lines and 960 trunks and service ports. This plan requires approximately 476 square feet (44.2 square meters) of floor space.

4.03 Figure 4 shows the physical layout of a typical system. Due to interframe cabling requirements, the common control frame (CCF) is located next to the MAF. Figure 5 is a front view of a line/trunk frame with PWBAs installed and figure 6 is the rear view of an LTF. Details on equipment organization are in Part V of this section.

5. SYSTEM FEATURES

5.01 General.

System features are listed in the following paragraphs. The first list gives the standard features provided with a DCO system. The second list presents available optional system features. These features are listed by name only. Feature descriptions are given in the section titled *Glossary of Digital Central Office Features*, referenced in paragraph 2.02.

5.02 Standard Features.

Alarm and Fault Printout

Alarm Sending and Checking (7 and 10 Digits)

Alternate Routing (Up to Three Routes)

ANI (One- and Two-Party)

Announcers

Class of Service (COS) by Software Assignment

Coin Service (Semipostpay Coin)

Data Security

Denied Originating

Denied Terminating

Directory Assistance Routes to CAMA Office

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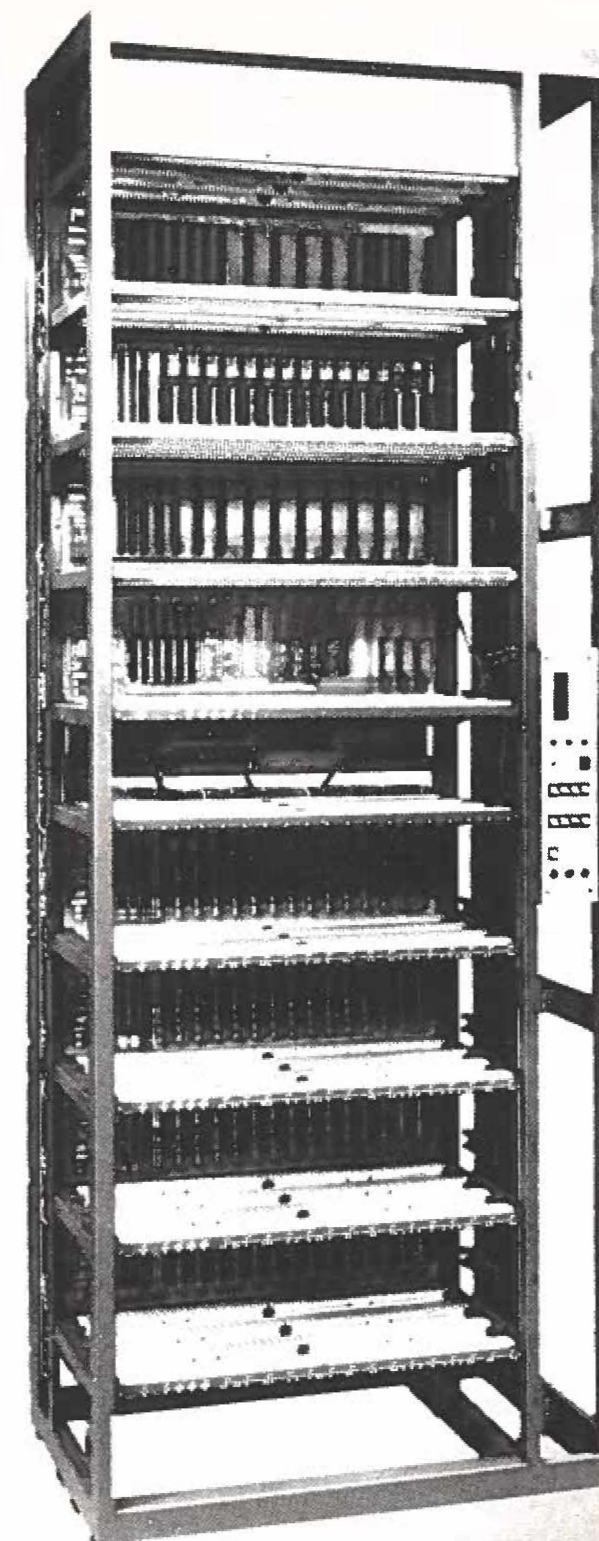
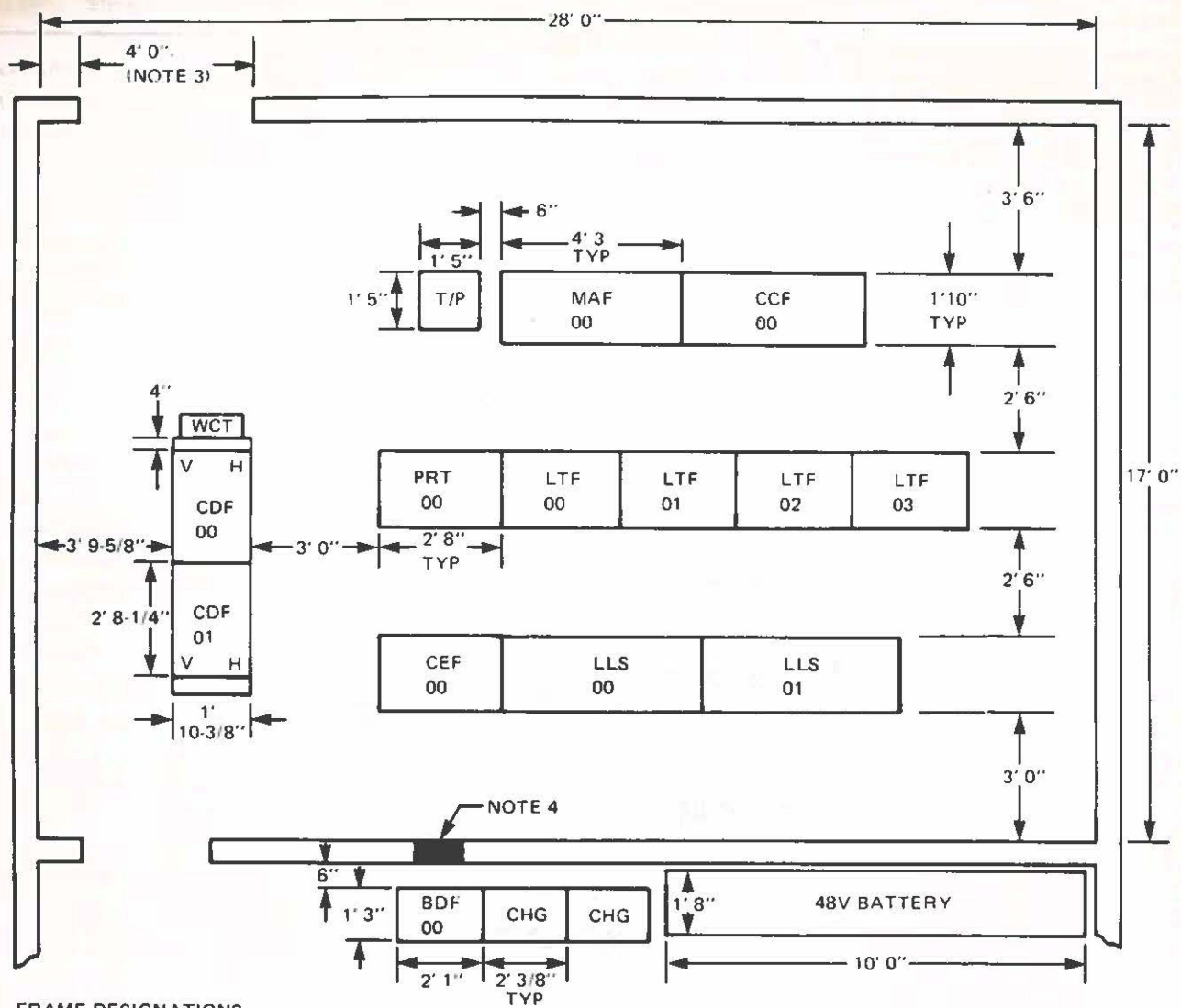


Figure 2. Empty Equipment Frame

HT 10281



FRAME DESIGNATIONS

- BDF Battery Discharge Frame
- CCF Common Control Frame
- CDF Combined Distributing Frame
- CEF Common Equipment Frame
- CHG Charger
- LLS Local Line Switch
- LTF Line Trunk Frame
- MAF Maintenance & Administration Frame
- PRT Power, Frame Ringing and Test Access Selector Frame
- T/P Teleprinter
- WCT Wire Chief Test Panel

NOTES

- 1. Height of Ceiling = 10' 0" In Clear.
- 2. Weight of Equipment = 150 lbs P.S.F. (732 Kg/cm²).
- 3. Loading Door = 4' x 9'
- 4. 1' 1" Wide by 1' 0" High Cable Hole, 7' 4-1/2" From Floor

CP 9177A

Figure 3. Typical Floor Plan for 2160 Lines and 960 Trunks and Service Ports

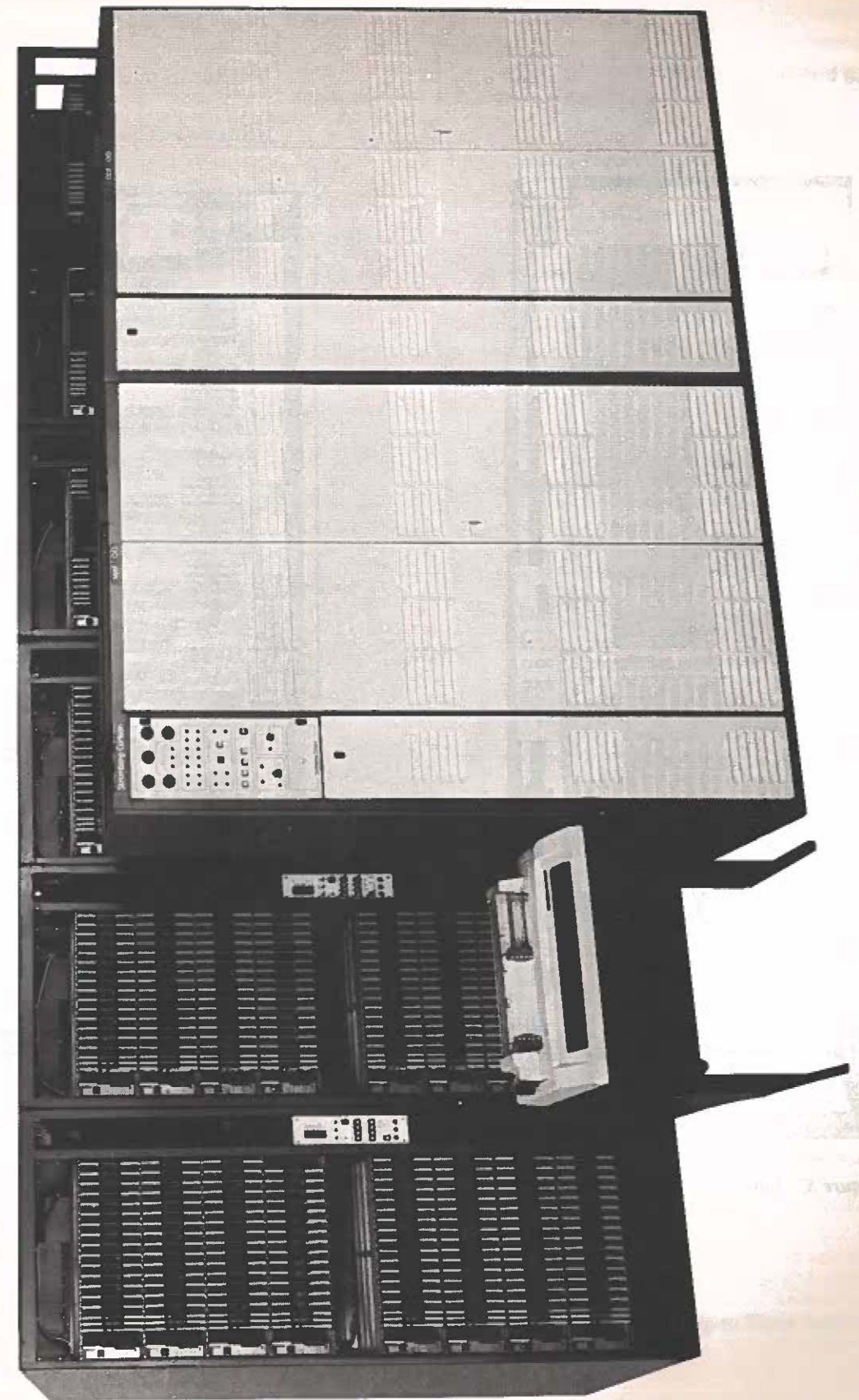
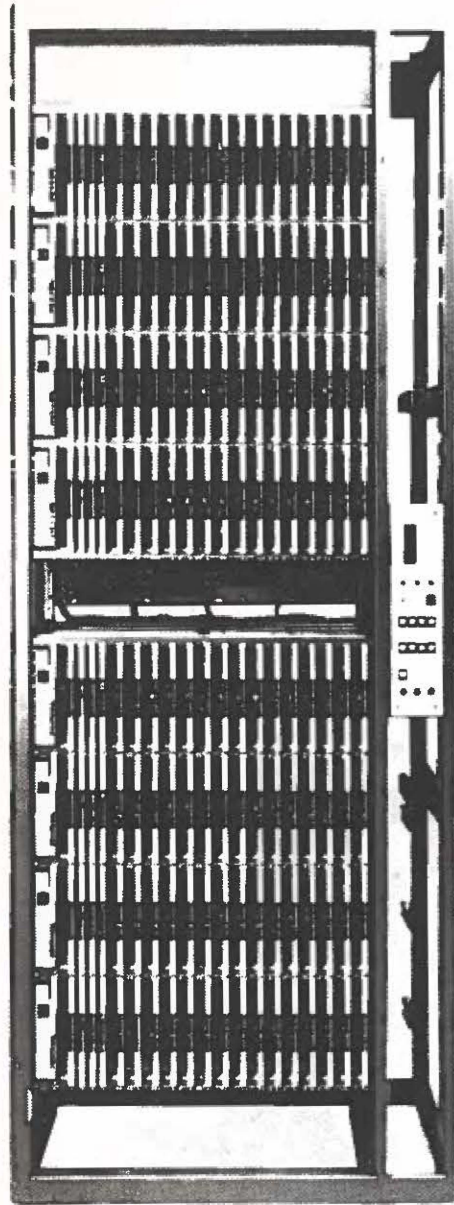
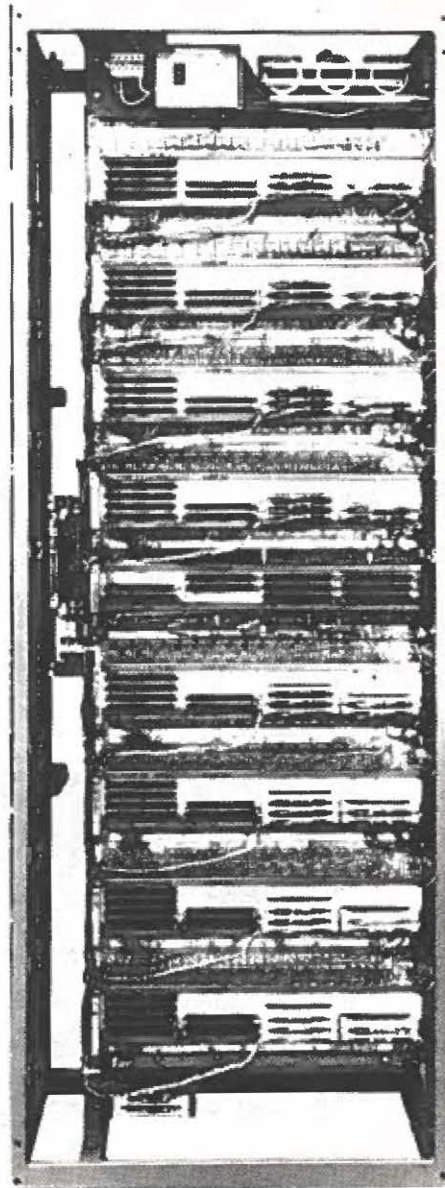


Figure 4. Typical DCO System

HT 10229



HT 10282
Figure 5. Line/Trunk Frame, Front View



HT 10280
Figure 6. Line/Trunk Frame, Rear View

- E&M Trunk Lead Signaling and Supervision
- Environmental Alarm Provisions
- Fixed Call Address (To Operator)
- Four-Wire EAS and Toll Trunks
- Free Terminating
- Glare Guard on Two-Way Trunks
- Ground Start Line Circuits
- Hotel/Motel Reverse Battery Supervision
- Hundreds Digits Routing
- Integrity and/or Polarity Check
- Intercept (Interface to Announcing Machine and/or to Operator)
- Interchangeable Office and Area Codes
- International DDD Routing to TSPS
- Line Lockout
- Man/Machine Interface (Single-Teleprinter)
- MDF Test Shoe Capability
- MF Send/Receive
- Multiline Hunt
- Multiple Local Office Codes (Up to Six)
- Operator Busy Verification (One in Basic System)
- Outpulsing Delay Controls
- PBX DID/DOD
- Receiver-Off-Hook (ROH) Treatment
- Reverse Battery Supervision

- Revertive Call
- Send ANI/ONI/ANI FAIL (Standard Bell CAMA Format)
- Service to Key Telephone System
- Six Digit Translation (Up to Three FNPAs)
- Sleeve Lead Line Circuit
- Test Access Relays
- Test Call Generator
- Thousands Digits Routing
- Three-Digit Code Translation for EAS
- Toll Restriction
- Traffic Measurement and Recording System (Basic)
- Trunk Control of Call Path (CLR Holding)
- Visual Alarm Indicator
- Wire Chiefs Test Panel
- X11 and 10X Service Codes
- 0± With and Without Timeouts to Operator
- 0+ and 1+ Address Digits (DDD)
- 911 Emergency Routing
- 1900-Ohm Loop, 4100-Ohm Identification
- 4800-Baud Analog Data Transmission
- 5.03 Optional Features.**
 - Abbreviated Dialing
 - Alternate Routing (Up to Three Additional Routes)
 - ANI (Four-Party)

Automatic Intercept System Interface

Automatic Line Insulation Testing

Call Forwarding (Variable; Fixed by Code;
Fixed by Ring Count)

Call Waiting

CAMA

CAMA Loop-Around Test

Circle-Digit Identification

Coin Service (Prepay With In-Band)

Coin Service (Prepay With Multiwink)

Coin Service (Local Prepay/Toll Postpay)

Dc-to-Ac Inverter (For Peripheral Equipment)

Digital Satellite Interface (DSI)

Digital Trunk Interface (DTI)

EAS Selected Service

Fixed Call Address (7-Digit Number in Local
Office and 7- or 10-Digit Number in Remote
Office)

Foreign Exchange (FX) Lines

Full Measured WATS (WATS and in-WATS)

Hotel/Motel Point of Origin Announcement

Improved Mobile Telephone System Interface

International DDD Routing (Two-Stage
Outpulsing)

LAMA

Line Load Control

Live Service Observation

Loop Range Extension

Malicious Call Handling

MDF Protectors (High Density)

Mechanized Calling Card Service

Modems for Remote Teleprinter

Multiple Independent Teleprinter Operation
With Assignable Functions (Multitasking)

Network Management - Controlled Office

ONI Links

Pad Control

Remote Test Facility Capability

Revertive Calling by Class of Service

SCATSM Service PackageSend ANI/ONI/ANI FAIL (NT-400 or
-500 Format)

Send ANI/ONI/ANI FAIL (Pentaconta Format)

Send ANI/ONI/ANI FAIL [Canadian
Automatic Ticketing (CAT) Format]

Send ANI/ONI/ANI FAIL (SATT 62 Format)

Six-Digit Translation (Fourth Through Tenth
FNPA)

Spare Parts Packages

Step-by-Step Collocation Interface Trunks

Subscriber Line Transfer

Synchronous Network Clock

Test Codes and Trunking

Three-Way Calling

DTMF Operation

Traffic Measurement and Recording System
(Enhanced)

Transmission Tests

Usage Sensitive Recording (USR)

Volunteer Firefighters Reporting System

6. ASSOCIATED SYSTEM CENTURY SUBSYSTEMS

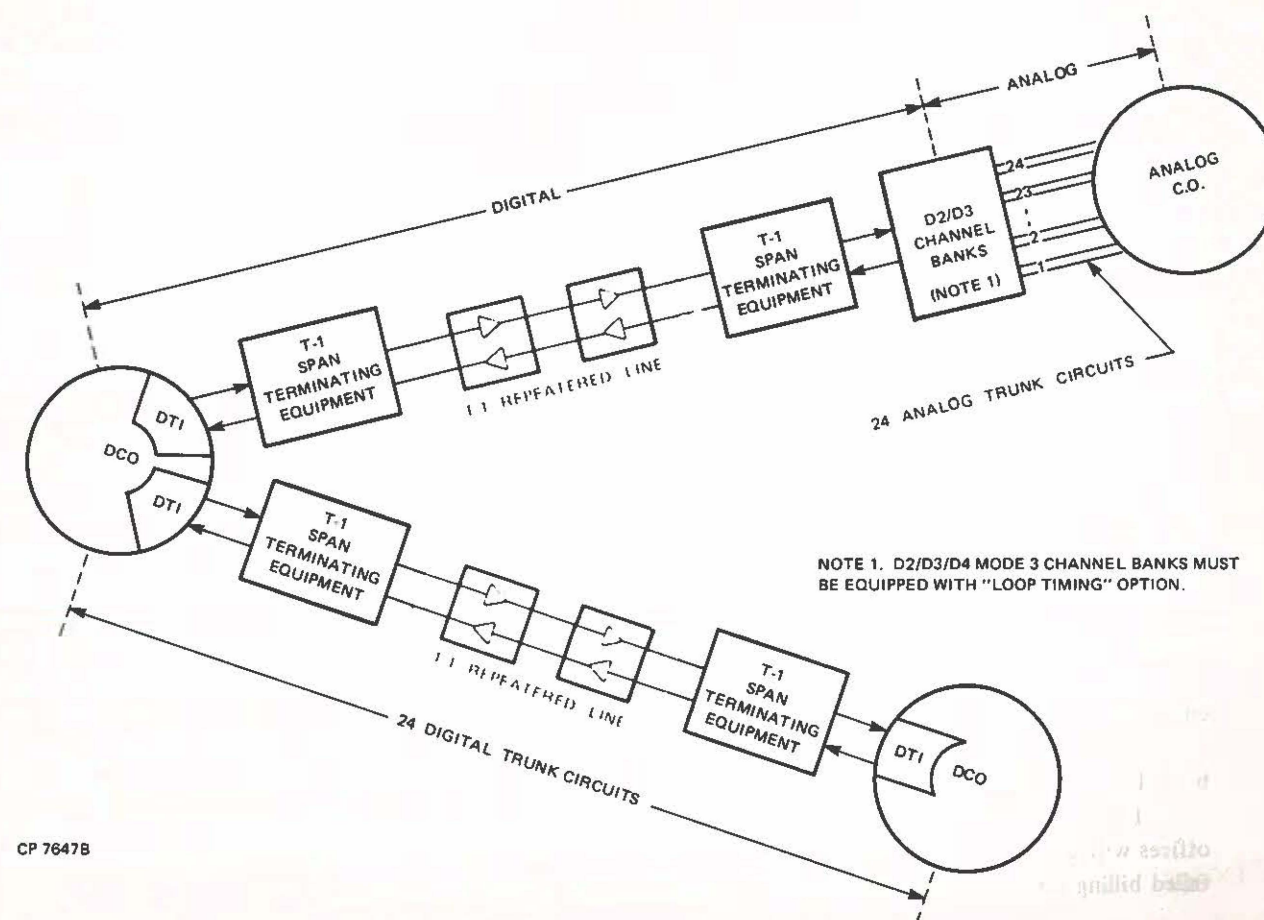
6.01 Digital Trunk Interface.

The Digital Trunk Interface (DTI) provides an efficient and economical means of direct digital interfacing with a T-1 carrier system. DTI accommodates a distant digital central office that has direct D2/D3 compatible T-1 interface capabilities as shown in figure 7, or a distant analog central office that is equipped with D2/D3 channel bank equipment. In either case, the di-

rect DTI interface method eliminates a need for PCM carrier channel bank equipment and corresponding analog trunk circuits.

a. The DTI is capable of receiving and transmitting between central offices voice and signaling information from 24 local or toll-type trunks through a single pulse-code modulated, 24-channel T-1 carrier. To accomplish transfer through the DCO system, the 1.544 Mb/s transmission bit rate of the T-1 carrier is converted to 2.048 Mb/s by the DTI. Subsequently, it is reconverted to 1.544 Mb/s by the DTI for retransmission over the same or another T-1 carrier system.

b. The DTI also includes alarm and test functions that are integrated into the DCO system, as well as a capability for alarm sending to the distant office. Diagnostic testing of the DTI can be controlled manually through the input/output (I/O) console.



CP 7647B

Figure 7. Typical DTI Applications

c. When an optional Synchronous Network Clock (SNC) is used, reference timing for the SNC is derived from a remote master clock through the T-1 carrier system.

d. For further details on the DTI characteristics, refer to the section titled *Digital Trunk Interface, General Description*, referenced in paragraph 2.02.

6.02 Digital Satellite Interface.

A Digital Satellite Interface (DSI) provides a means of direct digital interfacing between a DCO system and the span terminating equipment of a Digital Satellite Unit (DSU) (see fig. 8). In this manner, the DSI which forms a subsystem of the DSU, enables the DSU to extend central office service and features to remotely located subscriber groups. To accomplish this, the DSI is integrated with the DCO system. For further details on DSI and DSU, refer to the section titled *Digital Satellite Unit, General Description*, referenced in paragraph 2.02.

6.03 Centralized and Local Automatic Message Accounting.

a. General.

The centralized and local automatic message accounting (CAMA/LAMA) subsystem allows class 5 and class 5/4P offices to record and ticket calls from one-, two-, or four-party lines on an ANI (automatic number identification) basis or from multiparty (four or more parties) lines on an ONI (operator number identification) basis. Typical call information recorded by the subsystem includes the called and calling station numbers, date, time of call answer, elapsed or disconnect time, the ANI information digit, and trunk identity numbers. Figure 9 shows the CAMA/LAMA and DCO system relationship. For further details on CAMA/LAMA characteristics, refer to the section titled *Centralized and Local Automatic Message Accounting Subsystem, General Description*, referenced in paragraph 2.02.

b. LAMA.

The LAMA subsystem alone provides class 5 offices with a capability to record and read out detailed billing information on ticketed calls. During

a call requiring ticketing, the call information described in paragraph a (above) is accumulated in call processor memory. On final disconnect, the accumulated call information is transferred from memory with a single data entry format to a magnetic tape for permanent storage. The LAMA subsystem accommodates ASCII (American Standard Code for Information Interchange) or EBCDIC (Expanded Binary Coded Decimal Interchange Code) codes.

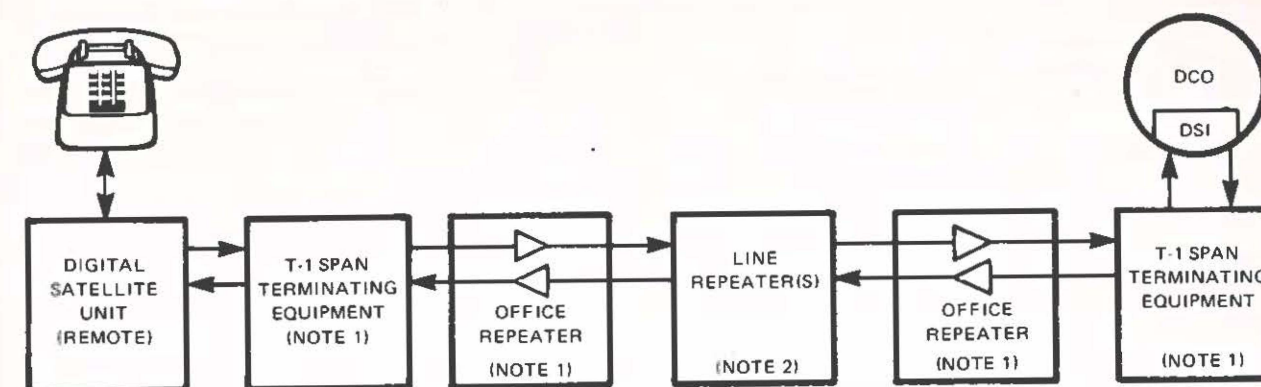
c. CAMA.

The CAMA subsystem provides a class 5/4P office with a capability to record, in call processor memory, detailed billing information (for the same types of calls described in paragraph a above) from tributary central offices. After the last digit of a called number has been received over a CAMA trunk, the calling subscriber identity is determined and the call is processed. On call disconnect, the accumulated call information is transferred from memory to magnetic tape.

6.04 SYSTEM CENTURY Operator Position System.

a. The SYSTEM CENTURY Operator Position System (SCOPS) is a stand-alone, stored-program-controlled digital system that provides manual toll processing for any common control digital or analog class 4 office. The associated class 4 office analyzes the incoming digits and routes only calls requiring operator assistance to the SCOPS.

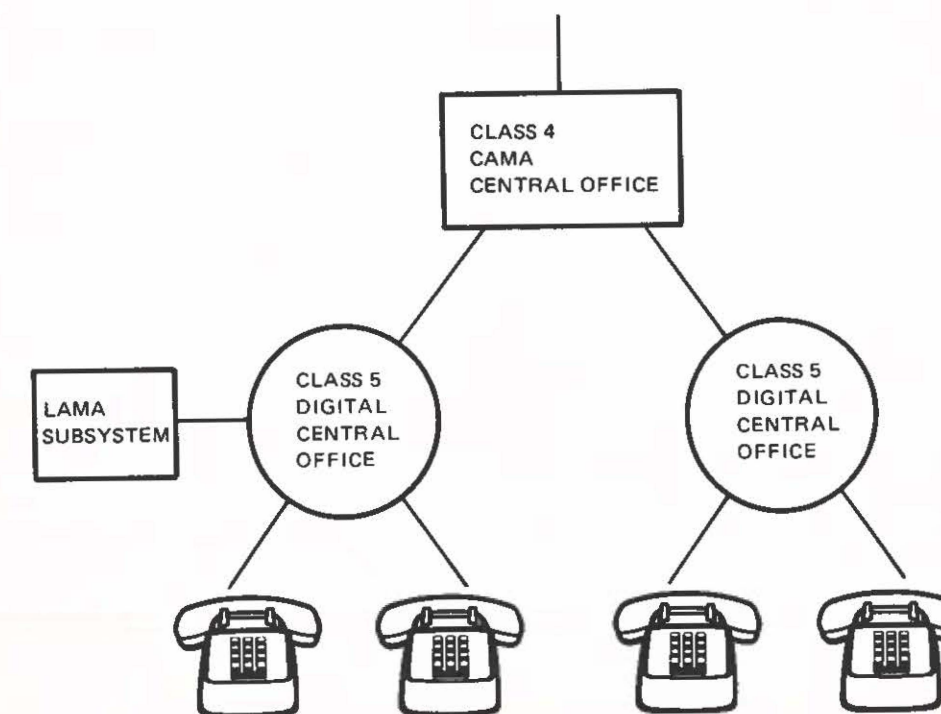
b. The SCOPS provides automated operator processing and assistance on certain type toll originating (0-/0+, coin/noncoin, and 1+ ANIF/ONI) and terminating calls. However, it is also capable of providing additional operator services for handling other types of traffic such as information, intercept, repair, etc. Coin paid and time and charge calls processed through the SCOPS may be rated manually by an operator or automatically by the SCOPS with automatic charge computation. Automatic bill recording is done with a link to the rating and billing computer (RBC) subsystem.



NOTES.
1. PART OF SPAN LINE EQUIPMENT.
2. QUANTITY OF LINE REPEATERS NEEDED DEPENDANT ON DISTANCE BETWEEN DSU AND DCO.

CP 8136A

Figure 8. Typical DSU/DSI/DCO Interface Scheme



CP 7602A

Figure 9. CAMA/LAMA/DCO Relationship

c. The RBC subsystem is a rate computer that provides automatic rate computations on a per-call basis using stored rates through an automatic type rating sequence. (In the event a location cannot be rated automatically, there is an alternate method of entering the rates manually.) The subsystem, which is housed in a separate cabinet, also includes an automatic message accounting type dual magnetic tape system.

d. The SCOPS design is totally modular, giving complete flexibility in locating operator positions. The SCOPS common equipment frame can be placed adjacent to the class 4 office equipment or it can be installed at a remote site. Operator positions can be located with the common equipment or at different facilities. SCOPS provides for up to 40 operator positions and 2 supervisors positions.

6.05 Centralized Maintenance and Administration Center.

The Centralized Maintenance and Administration Center is a centralized computer-based maintenance and administration system that is compatible with all digital and analog central offices or private branch exchanges. Available in a variety of configurations, the CMAC[®] system allows the operating company to concentrate maintenance, administration, traffic, testing, and inventory functions into one central location. There, information required for these functions can be collected by the CMAC system via direct or dialed-up lines and modems. Depending on the function, the CMAC system (automatically, in some cases, or under control of operating personnel) can print reports, store records, conduct tests, make administrative changes, or transmit information to appropriate operating company personnel.

7. ELECTRICAL CHARACTERISTICS

7.01 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 operation of the electronic portion of the system is developed by dc-to-dc converters. For detailed information, refer to the section titled *Power and Alarm System, Description*, referenced in paragraph 2.02.

7.02 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 is 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. Auxiliary engine-driven generators are recommended for use as a standby source of ac power.

7.03 Dc-to-Ac Inverter.

The optional dc-to-ac inverter serves as a primary source of 110-volt ac power for peripheral equipment such as the floppy disk, terminals, magnetic tape recorder, etc. Power for the inverter is obtained from the -48-volt dc office battery. If the inverter is not used, peripheral equipment is operated with commercial ac power.

7.04 Dc Power Supplies.

Dc power supplies required by the system are normally furnished per office requirements. Typical voltages supplied are:

- a. -48-volt (nominal) relay drive
- b. -48-volt (nominal) filtered talking battery
- c. ± 5 -volt regulated logic supply
- d. ± 8 -volt and -15-volt analog supply

PART II. TECHNICAL CHARACTERISTICS

- e. +12-volt memory supply
- f. +48-volt supply (coin service)
- g. +130-volt supply (coin service)
- h. -130-volt supply (coin service)

7.05 Grounding.

The system uses separate frame, logic, analog, and -48-volt signal grounds. The equipment is connected to the building steel, superstructure, etc. by a special single-point ground system. Physically, 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. Refer to the section titled *Central Office Grounding, Engineering Considerations*, referenced in paragraph 2.02.

8. ENVIRONMENTAL CHARACTERISTICS

8.01 Temperature and Humidity.

Operational temperature and humidity characteristics of the DCO system are given in table 1. The temperature restriction at the low end is due to the maintenance processor access to the floppy disk which is part of the maintenance and administration system. Short term is defined as not more than four excursions per year, each of which is no more than 8 continuous hours. Details related to the control of atmospheric conditions are provided in the section titled *Atmospheric Environmental Control for Digital Telephone Switching Systems*, referenced in paragraph 2.02.

8.02 Air Filtration.

Except for extremes of temperature and humidity, the greatest potential problem to satisfactory equipment operation is contamination from dust and chemical fumes. The contaminants present establish the type of air filtration required in the office.

9. TRANSMISSION CHARACTERISTICS

9.01 Insertion Loss.

Trunk-to-Trunk (two-wire to two-wire), Line-to-Line and Line-to-Trunk: 0 dB ± 0.3 dB.

Table 1. Environmental Operating Ranges and Limits

FUNCTION	RECOMMENDED				SHORT TERM			
	TEMPERATURE °F(°C)		HUMIDITY %RH		TEMPERATURE °F(°C)		HUMIDITY %RH	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
CALL PROCESSING	32 (0)	85 (30)	20	65	32 (0)	120 (49)	20	90
M & A	50 (10)	85 (30)	20	65	50 (10)	85 (30)	20	65
SYSTEM	50 (10)	85 (30)	20	65				

9.02 Frequency Response.

- a. Two-Wire Line or Trunk to Two-Wire Line or Trunk.

FREQUENCY (Hz)	LOSS AT 0-dBm0 LEVEL POINT
60	20 dB minimum
200	0 to 5 dB
300 – 3000	–0.5 to +1 dB
3200	–0.5 to +1.5 dB
3400	0 to 3 dB

- b. Two-Wire Line or Trunk to Digital Trunk Interface.

FREQUENCY (Hz)	LOSS AT 0-dBm0 LEVEL POINT
60	20 dB minimum
200	0 to 2.5 dB
300 – 3000	–0.25 to +0.5 dB
3200	–0.25 to +0.75 dB
3400	0 to 1.5 dB

- c. Two-Wire Line or Trunk to Four-Wire Trunk.

FREQUENCY (Hz)	LOSS AT 0-dBm0 LEVEL POINT
60	20 dB minimum (2W to 4W) 16 dB minimum (4W to 2W)
200	0 to 4 dB
300 – 3000	–0.4 to +0.65 dB
3200	–0.4 to +1.5 dB
3400	0 to 3 dB

- d. Four-Wire Trunk to Four-Wire Trunk.

FREQUENCY (Hz)	LOSS AT 0-dBm0 LEVEL POINT
60	16 dB minimum
200	0 to 3 dB
300 – 3000	–0.3 to +0.3 dB
3200	–0.3 to +1.5 dB
3400	0 to 3 dB

- e. Four-Wire Trunk to Digital Trunk Interface.

FREQUENCY (Hz)	LOSS AT 0-dBm0 LEVEL POINT
60	16 dB minimum
200	0 to 1.5 dB
300 – 3000	–0.15 to +0.15 dB
3200	–0.15 to +1.75 dB
3400	0 to 1.5 dB

9.03 Gain Tracking (Linearity).
100-Hz reference at 0 dBm0.

- a. Two-Wire Line, Two-Wire Trunk, or Four-Wire Trunk to Digital Trunk Interface.

INPUT SIGNAL LEVEL	GAIN DEVIATION
+3 to –37 dBm0 –37 to –50 dBm0	±0.25 dB ±0.5 dB

- b. All other Connections (Except Digital Trunk Interface to Digital Trunk Interface).

INPUT SIGNAL LEVEL	GAIN DEVIATION
+3 to –37 dBm0 –37 to –50 dBm0	±0.5 dB ±1.0 dB

9.04 Return Loss.

- a. Class 5 office: two-wire or four-wire trunk to two-wire or four-wire trunk, local line, or remote line.

Echo Return Loss (ERL): 24 dB minimum.
Singing Return Loss (SRL): 17 dB minimum.

- b. Class 4/5 office: two-wire or four-wire trunk to local or remote line.

ERL: 24 dB minimum.
SRL: 17 dB minimum.

- c. Class 4 or class 4/5 office: two-wire or four-wire trunk to two-wire or four-wire trunk.

ERL: 27 dB minimum.
SRL: 20 dB minimum.

- d. All offices: line or remote line to line, remote line, or trunk.

ERL: 18 dB minimum.
SRL: 12 dB minimum.

9.05 Longitudinal Balance.

For frequencies of 180, 300, 540, 1000, and 2000 Hz, the minimum balance is 60 dB; at 3400 Hz the minimum is 50 dB.

9.06 Steady Noise.
Measured on terminated call.

CONNECTION TYPE	MAXIMUM	AVERAGE	3 KHz FLAT
A/A	23 dBrnC0	18 dBrnC0	35 dBrn0 max.
A/D	22 dBrnC0	17 dBrnC0	35 dBrn0 max.
D/A	16 dBrnC0	11 dBrnC0	35 dBrn0 max.

9.07 Crosstalk Coupling Loss.
75-dB minimum for all frequencies in the range 200-3400 Hz.

9.08 Quantizing Distortion.

INPUT LEVEL (dBm0) 1004 OR 1020 Hz	MINIMUM SIGNAL TO DISTORTION WITH C-MESSAGE WEIGHTING
0 to –30	33 dB
–30 to –40	27 dB
–40 to –45	22 dB

9.09 Envelope Delay Distortion.
On any properly established connection, the envelope delay distortion does not exceed the following limits:

BAND WIDTH (Hz)	MICROSECONDS
1000 to 2600	190
800 to 2800	350
600 to 3000	500
400 to 3200	700

10. OPERATING LIMITS

10.01 Subscriber Lines.

The minimum dc insulation resistance and ring-er load is defined by various loop resistance ranges that include the telephone instruments. See table 2. The dc insulation resistance refers to the minimum resistance between line conductors or between either or both conductors and ground without any line attachments. It provides adequate volume of all signals at maximum loop resistance.

10.02 Pulsing Limits.

- a. Rotary-Dial Operation.

The equipment operates with instuments having a speed of operation between 7.5 and 12 pulses per second (pps) and a break period of 42 to 76 percent of the total pulse period.

Table 2. Subscriber Line Loop Resistance Ranges

LOOP RESISTANCE	DC VOLTAGE	MINIMUM INSULATION RESISTANCE	RINGER LOAD
0 to 1500 ohms	44 to 54 volts	15,000 ohms	17 ringers or one 3-line common audible
0 to 1900 ohms	51.6 to 54 volts	25,000 ohms	10 ringers or one 3-line common audible
1900 to 4500 ohms	51.6 to 54 volts with loop range extenders	100,000 ohms	6 ringers or one 3-line common audible

- b. Dual Tone Multifrequency Operation.
- The frequency pairs used for DTMF signaling are shown in table 3. Variations in frequency of ± 1.5 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 3. DTMF Signaling, Frequency Pairs

LOW FREQUENCY (Hz)	HIGH FREQUENCY (Hz)		
	1209	1336	1477
697	1	2	3
770	4	5	6
853	7	8	9
941	*	0	#

- 10.03 Trunk Signaling.
- Trunk dc signaling is not affected by subscriber loops because trunks do not connect directly to subscriber loops.

10.04 Off-Hook, On-Hook Recognition Limits.

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

- b. An on-hook (disconnect) signal of 150 ms or less is not recognized. The standard duration is 180 ms when a hookswitch flash detector is not provided and 2.2 seconds when provided.
- c. The hookswitch flash recognition signal is 200 ms minimum and 2.0 seconds maximum.

10.05 Party Identification.

A party test, for two- and four-party ANI, can be made through a total path resistance of up to 4100 ohms in the presence of a 5-volt rms ground potential.

10.06 Interoffice Trunks.

- a. Trunk Loop Resistance.
- The loop trunk operates over a 2000-ohm loop pulsing and over a 3000-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 reseizure before release, the trunk guard time is 700 ms to 1000 ms.

PART III. SOFTWARE

11. SOFTWARE ORGANIZATION

11.01 The DCO software system is organized into three main groups: call processing, administration, and maintenance. 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. The call processing and the maintenance groups each have an executive cluster that determines the sequence of tasks to be done.

12. CALL PROCESSING SOFTWARE

12.01 The call processing (CP) software controls the processing of a call and has the traditional translator/marker tasks assigned to it, such as doing directory number translations and selecting route information by accessing the CP data base (paragraph 13). The CP software interacts with the telephony preprocessor (TPP) that is functionally part of the DCO common control. The CP executive cluster runs in an interrogation (search) loop, constantly polling the TPP priority queues for subscriber origination and release events. When the executive cluster detects an event from the TPP, it notifies the appropriate call processor state transition routine that advances the call to the next state. Call states in a typical line-to-line call are idle, line off-hook, dial tone, first-digit translation, etc.

12.02 Call state, port identification (ID), and event code data stored in the TPP for each port is needed by the CP software to determine the correct transition routine to invoke. Call state data (for example: idle state, equipment busy tone, ringing, etc.) is stored as an 8-bit binary code in a port store area (PSA) field in the TPP. Port ID data is stored during a specific call state in a 4-bit PSA field that identifies which port generated an event. Event code data is stored in a separate 4-bit PSA field. Details of how a DCO system handles a typical call are described in paragraph 18.

12.03 During normal operation, an identical copy of the CP software reside in each CP memory. Switchover control circuitry selects one of the redundant call processing systems (CPS) for on-line operations and gates only its associated outputs to the external bus. A copy of the CP software is stored on a floppy disk to initialize (startup) the CPS when necessary.

13. CALL PROCESSING DATA BASE

13.01 Each DCO system requires a unique data base that is engineered to the customer's requirements. The call processing data base typically 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 telephone-related information. The code translation tables interpret a string of incoming digits into route treatment information that determines how a connection is made. These tables use methods that considerably enhance the code translating capabilities of the system. The number translation tables (EN/DN translation, DN hundreds group directory, etc.) use the same methods and are assigned the task of translating a given DN into EN and ring code information through the DN translator. The reverse is done through the EN translator. The CP software accesses data base tables by invoking one of its clusters titled CP data base utilities.

13.02 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 and trunks, position of the office within the national DDD network and within its local EAS environment (this affects size of route treatment table), etc.

13.03 Data base information and CP programs are stored together in CP memory. Copies are stored peripherally on a floppy disk. For detailed instructions describing the establishment and maintenance of daily records relating to data base transactions, refer to the section titled *On-line Recent Change Facilities, Forms and Administrative Instructions*, referenced in paragraph 2.02.

14. ADMINISTRATION SOFTWARE

14.01 The administration software of the DCO system has three primary tasks: control and documentation changes to the on-line, office-configuration data base (data base administration program tasks); provide the capability to make a backup copy of the CP 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, TRK group, translation tables, line COS, trunk COS, and route treatment information. The copy data base task replaces (copies over) the current copy of the CP 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 recording system (TMRS) task collects and reports (on demand or at preselected times) measurements of the system's activities during specified time intervals. Several TMRS parameters are administrable (for example, the day, time, and length of the interval during which measurements are collected). Details of specific instructions for implementing administration tasks are described in the section titled *System Operator Manual*, referenced in paragraph 2.02. The administration software is stored on a floppy disk and is loaded into MP memory when requested from the teleprinter.

15. MAINTENANCE SOFTWARE

15.01 The maintenance software consists of four main programs: resident tasks, second-level diagnostics, utility tasks, and maintenance tasks. The resident tasks program includes: the routine testing function that exercises many areas of the system to detect possible faults before they affect subscriber service, and the first-level diagnostics function that attempts to isolate the side-dependent faults. The maintenance software also controls all input/output data to/from the mass-storage device (floppy disk). The floppy disk contains copies of the latest data base, maintenance/debug programs (for example: diagnostics, startup and recovery, etc.), administration programs, CP programs, and utility programs (for example: disk backup, AMA tape read, etc.).

15.02 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 test call generator, test access network, and individual test access relays in each trunk circuit. This function simulates the action of trunks. 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.
- b. To initiate CP sanity tests located in CP 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.

15.03 The first-level diagnostics (FLD) function of the resident tasks program is automatically done in response to a system fault. FLD isolates faults to one side or the other in the A/B redundant portion of the system. FLD 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.

15.04 The second-level diagnostic (SLD) program of the maintenance software is invoked automatically or manually to isolate faulty hardware in the off-line side. The SLD program can be manually executed at an input/output console in four modes: fault isolation, repair verification, restore verification, and selective diagnostics. SLD can test the following areas of the system: call processing, common control sectors, LLS and trunk frames, LAMA subsystem, DTI subsystem, and the maintenance and administration system. Further details of SLD procedures and capabilities are described in the section titled *System Operators Manual*, referenced in paragraph 2.02.

PART IV. FUNCTIONAL DESCRIPTION

16. SYSTEM BLOCK DIAGRAM

16.01 General.

Figure 10 is a simplified block diagram of a basic DCO system that shows the functional flow of data and control within the system. No redundant circuits are shown. Figure FO-1 is an expanded block diagram that shows redundant circuits and greater details of maintenance and diagnostic functions. Refer to these figures during the following discussion.

16.02 Port Grouping.

The port grouping circuits include port circuits for trunks, adapter interface circuits, service ports associated with various service circuits, and port group control circuits. A port group consists of 30 ports and 1 port group control. Eight port group control circuits can service 240 ports and may be connected by 8 separate port group highways (PGHs) to 1 timeslot interchange.

a. Port Circuits.

The input to each port circuit is the transmission and signaling leads of a trunk. The port circuits have transmit and receive filters, the coder-decoder (CODEC) that converts the analog signals into 8-bit pulse code modulated (PCM) words, two- to four-wire hybrid, and all associated relays.

b. Port Group Control.

The port group control (PGC) circuits have two sets of logic; port group control 1 and port group control 2. The parallel data output of the 30 CODECs passes through a multiplexer-demultiplexer (mux/demux) circuit (not shown in diagram) before entering the port group control logic. This mux/demux converts the parallel 8-bit words of all 30 ports to form a frame of serial words. Port group control 1 logic adds two supervisory sense bits to these words for control. The serialized bits of the words are transmitted over a PGH as shown in the block diagram. Port group control 2 logic contains the relay circuits for establishing test access paths to the port circuits.

c. Port Group Highway.

Each PGH (fig. 11) carries digital data and control bits for 30 associated timeslots. Words are carried on the PGH in sets of 256-bit master frames that are 125 microseconds in length. Each

master frame is made up of eight 32-bit subframes that contain one data bit for each of the 30 timeslots plus 2 bits that are used for control and supervisory purposes. Each subframe is 15.625 microseconds and made up of 32 equal timeslots of 488 nanoseconds each.

16.03 Local Line Switch.

a. One LLS consists of 12 line groups with each group having 90 lines as its input and 3 line group highways (LGHs) as its output. The 36 LGHs enter the LGH switch and are multiplexed onto a maximum of 8 PGHs. The PGHs carry the voice and signaling data to the timeslot interchange (TSI).

b. If all 12 line groups are fully equipped (1080 lines) and all 8 PGHs are provided, the LLS has a capacity of 6.2 CCS (0.174 erlang) per line without depopulation. The LGH switch provides full availability from any line to any PGH timeslot. The LGH data format is the same as that for the PGH (par. 16.02c).

c. Each 90-line group connects to a line group mux/demux PWBA containing 3 identical circuits, each serving 30 lines. The voice and supervisory data for each 30 lines is multiplexed onto 1 LGH and demultiplexed in the opposite direction by the line group mux/demux. The line group is microprocessor controlled by the line group controller, which monitors the activity of the lines and the mux/demux then reports to the line switch controller. The line group access, under control of the line group controller, allows the line router to access the tip and ring for automatic line insulation testing (ALIT) and for routine line testing.

d. The entire LLS is microprocessor controlled by the line switch controller, which monitors the line groups, assigns lines to PGH timeslots, controls the maintenance and administration for the LLS, and interfaces the LLS to the call processors and maintenance processor. The line switch controller also controls the line test controller and the maintenance and diagnostic controller.

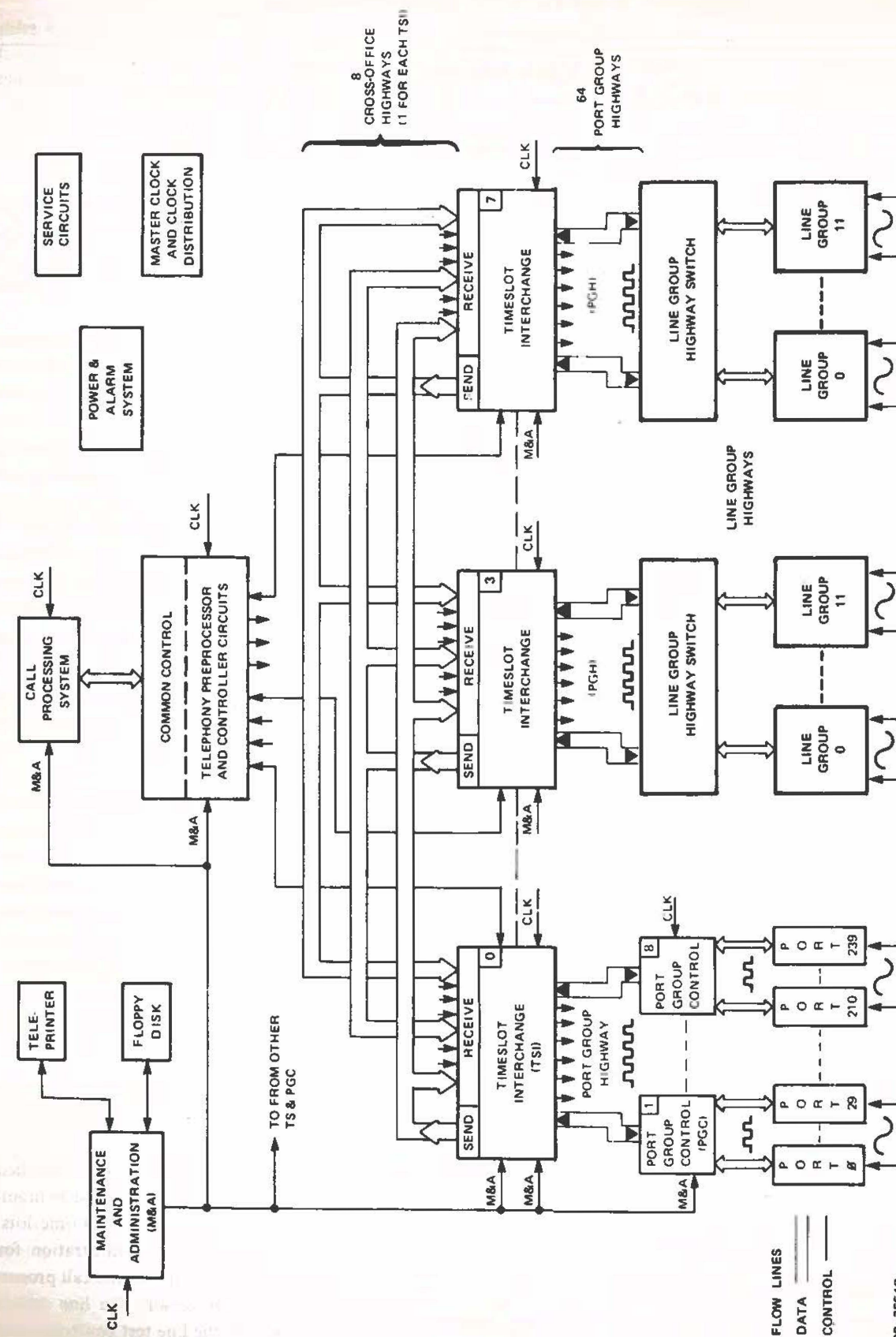


Figure 10. Basic DCO System, Simplified Block Diagram

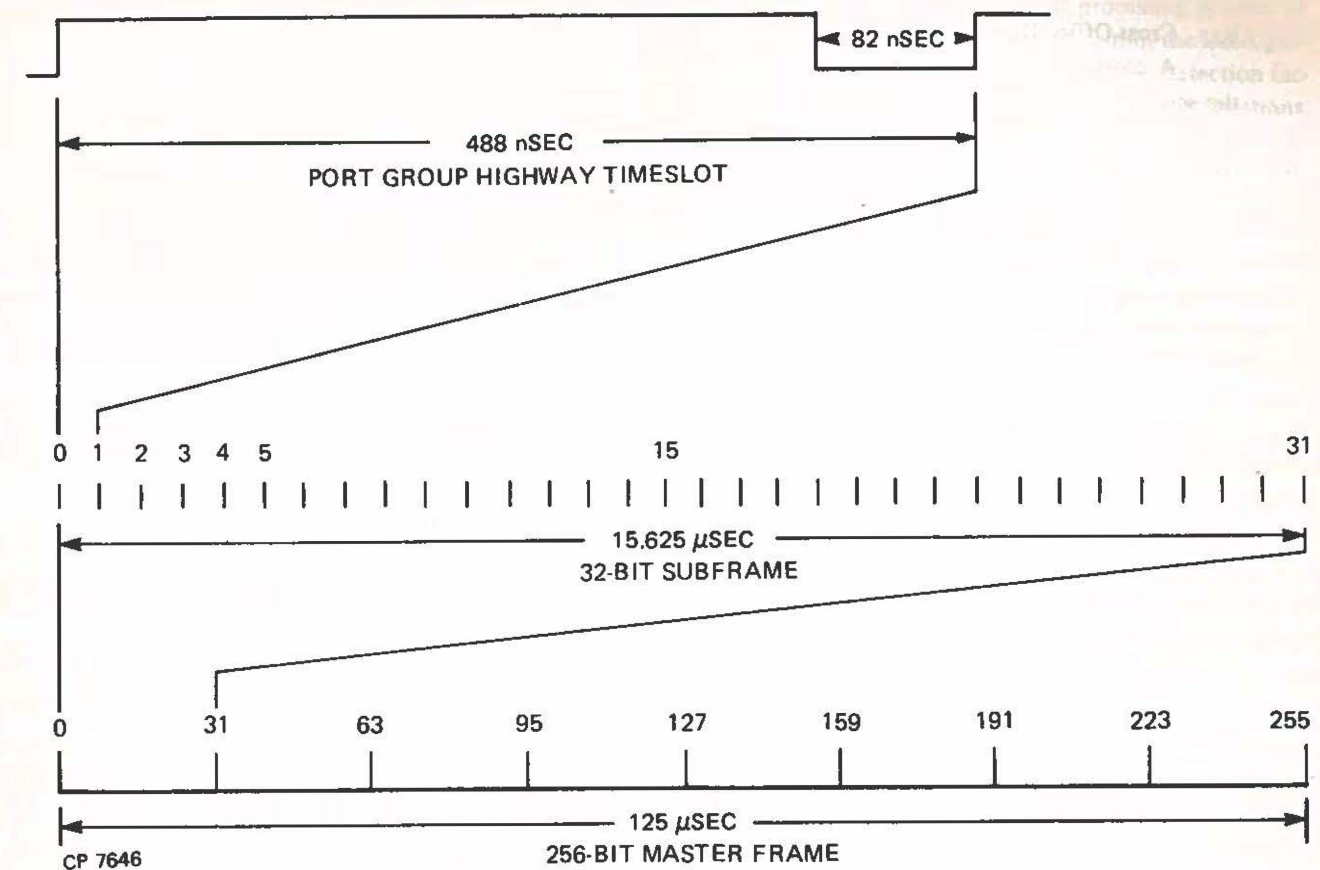


Figure 11. Port Group Highway Timing Diagram

1. The line test controller does line routing and party testing and makes measurements for ALIT. All test results are reported to the line switch controller.
2. The maintenance and diagnostic controller is the gathering point for alarms and status changes in the LLS and reports to the line switch controller.

16.04 Timeslot Interchange.

The TSI is controlled by a group of common control circuits; it does the digital switching functions within the system. It provides the digital path between the calling and called lines or trunks. One common control can service up to eight TSIs (each of which can service eight PGHs). A TSI is connected to every other TSI by way of cross-office highways (XOH); one, or optionally two, for each TSI. Cross-office highways provide the digital switch connections for every call in the system. The timeslot interchange consists of two major sections that operate independently of each other — the send section and the receive section.

a. Send Logic.

The send logic receives framed data bits from the PGH. It processes this information and generates multiplexed data that is transmitted over a single-line XOH to the receive section of every TSI connected to the common control. The PGH handles eight 32-bit frames (256 bits) for its associated 30 timeslots. Each timeslot is assigned a RAM location in the TSI and is identified by TSI number. The RAM sequentially receives each bit of the word until all 8 bits have been received (125 microseconds). The send logic multiplexes and stores the bits from all 8 groups (240 timeslots) that it serves. In the sequence specified by the call processor, the send logic assigns the bits from each PGH timeslot to one of 128 recurring timeslots on the XOH. The 8 sets of timeslot supervisory sense bits are stripped from each frame, multiplexed into a 16-bit stream, and sent to the supervisory buffers.

b. Cross-Office Highway.

A cross-office highway (XOH) originates at the send section of each TSI. Each XOH connects to the receive section of every TSI in the common control sector, including the TSI which originated it. The serial data format on the XOH consists of recurring 15.625-microsecond time frames. Each frame is divided into 128 bit locations or timeslots. Each of the 128 XOH timeslots contain a bit from a different PGH timeslot. Each frame contains the same PGH timeslot positions; therefore, each 128th XOH timeslot contains a bit from the same PGH timeslot. The XOH can accommodate only 128 of the possible 240 PGH timeslots at any one time.

c. Receive Logic.

The receive logic accepts input signals from the 128 timeslots of the XOH, under control of the common control. It processes the data that is directed to its PGHs and generates multiplexed data for the PGH. Data, directed to the receive logic from the XOH, is read into the RAM buffer designated for that PGH timeslot. The RAM buffer receives each bit sequentially from recurring XOH timeslot positions (every 128th timeslot position) until all bits have been received. The receive logic multiplexes and transmits the bits from the RAM buffer to the specific called line or trunk by way of the 256-bit, 8-frame PGH, as set up by the call processor (CP).

d. Port-to-Port Connection.

In the sequence specified by the CP, the send logic of the TSI assigns the bits from each line or trunk to one of the 128 recurring timeslots on the XOH. The receive logic of a TSI is directed by the CP to select an XOH input and store the bit present on that XOH during that timeslot. The receive section then assigns the stored bits to the PGH and specific line or trunk as specified by the CP. The connection path for a call is established by assigning the same XOH timeslot to the calling line or trunk in a send section as to the called line or trunk in the selected receive section.

16.05 Common Control.

One common control sector serves up to 8 TSIs which, in turn, serve 1920 PGH timeslots. The common control consists of two major circuit groups, the tele-

phony preprocessor and the controller circuits. Redundant common controls are provided within the system as shown in figure FO-1. Additional redundant common control sectors are added as system size is increased.

a. Telephony Preprocessor.

1. Trunk Functions.

The telephony preprocessor does all real-time dependent functions for the trunks associated with it. It communicates with the call-processing system (CPS) by way of the controller circuits with status information, port control store memory access, and queue information, and with the trunk by means of supervisory sense and control bits developed in the telephony preprocessor. The telephony preprocessor also contains a dedicated storage area (port control store) for each trunk. This storage area is used to store all current information required to service a trunk. This information includes type of port, call state (off-hook, ringing, etc.), dialed digits, etc.

2. Line Functions.

The main line functions are receipt of dialed digits and sending of supervisory information. All other functions are handled by the line switch controller. Another difference for lines is that each port control store serves one port group highway timeslot and is assigned a common port type for all LLS/port group highway timeslots.

b. Controller Circuits.

1. The timeslot interchange controller, port store controller, and crosswrite circuits provide the interface required for the call processors to communicate with the port control store and the TSI. They enable the CPS to read out of, write into, and search the TSI stores. The TSI number and CPS commands are decoded by the controller and required control signals are then sent to the TSI to do the appropriate functions, such as writing and reading of call data and searching for receive equipment numbers.

2. For lines, redundant communications buffer controller (CBC) circuits provide an interface between the call processors and the LLS line switch controller. Each CBC pair also interfaces with the maintenance processor through a maintenance communications interface (MCI).

16.06 Call Processing System.

The call processing system (CPS) is the computer-based stored program controller of the system. It has the system operating program and the user's data base. The CPS does such functions as translation, path selection, path setup, and trunk selection. Of the many circuits making up the CPS, the computer and synchronizer are of primary interest.

a. Computer.

The computer in the DCO system is one of the following: LSI-11 microcomputer, LSI-11/23 microcomputer, or PDP-11/34 minicomputer. The LSI-11 is used in small systems, and either the LSI-11/23 or the PDP-11/34 is used in large systems.

b. Synchronizer.

The computers in the redundant call processor systems (fig. FO-1) operate independently of each other. Therefore, synchronization of the memory and input/output operations of these computers is required. Each CPS has its own synchronizer circuit, interconnected with the associated computers and their data buses.

16.07 Service Group Circuits.

The service group circuits consist of multifrequency signal detectors, ringing generators, receiver-off-hook generators, precise tone generators, and associated buffer, monitor, distribution and supervisory circuits. The service group circuits also include the master clock and clock distribution circuits; these circuits develop and distribute timing signals throughout the system.

16.08 Maintenance and Administration Circuits.

The maintenance and administration circuits consist of a separate computer (similar to the ones used in the CPS), data link circuits, and various diagnostic circuits. As shown in figure FO-1, the maintenance and administrative (M&A) processor is connected to the redundant call processing systems by way of individual data links. This allows the M&A computer to continually

monitor the activities of the call processing systems as traffic is being processed. Software within the M&A processor has performance checking and fault detection facilities to provide surveillance of vital system functions. Automatic test call generators and test access select circuits are connected to the maintenance bus. Diagnostic circuits associated with most of the major circuits are also connected to this maintenance bus. The maintenance bus provides access to the switchover control circuit that, in turn, automatically switches to the redundant side when a fault occurs in one side.

17. INPUT/OUTPUT DEVICES

17.01 The interface between maintenance and administrative personnel and the DCO system is accomplished by way of terminal devices such as teleprinters. The system is basically arranged for single-terminal operation, with this terminal located in the central office and having direct access to the maintenance bus. It is recommended that a teleprinter always be provided. This terminal serves as the system console and is arranged to do all input/output functions such as administration, trouble diagnostics, etc.; it provides a hard copy that can be used for analysis and record keeping.

17.02 Additional terminals (teleprinters, video displays, etc.) can be provided at the central office and/or at remote locations. These terminals can be arranged for direct access or for dial-up access, for simultaneous operation or for operation one at a time. For remote operation, data modems are used at the DCO site and at the remote terminal.

17.03 A multiple terminal interface PWBA, which can be provided in the maintenance and administration cell, provides access for up to four input/output devices. The card is equipped with a four-position switch, each position allowing input access to the system from one terminal. The card, however, is arranged so that terminals can monitor messages outputted by the system or inputted by the connected terminal. In addition to the basic hard-copy printer, additional terminals can be located in the business office, traffic office or as required.

17.04 An optional feature, called multitasking, provides the capability of configuring the DCO with seven auxiliary terminals, connected either directly or by way of data modems. Each of the eight terminals (basic plus seven auxiliaries) can reschedule and execute maintenance and administrative tasks within a predeter-

mined job classification: maintenance, administration, traffic measurement, or status display.

17.05 With multitasking, data modems can provide dial-up access from any of the eight terminals. If separate terminals are assigned to do specific tasks, each can do its task concurrently with the other terminals. With this feature, each job classification is protected by security passwords, so that tasks in a particular classification can be done only by authorized personnel. However, any terminal can do any task if the correct password is entered. This allows temporary system reconfiguration in the event of a terminal or data line failure, and also provides for maintenance actions from an outside source, if necessary. The system console functions can be temporarily taken over at any other terminal, provided the master password is entered. This permits all functions to be diverted to an attended location when the system is unattended. System passwords are redefinable by the telephone company, when required, to provide the proper level of security.

17.06 Dual floppy disk drives are considered as input devices. Floppy disks provide mass storage for all data base and software programs that are not permanently resident in processor memory. The data provided on these disks are tailored to each installation; it is determined by the system size, features provided, and office data. Floppy disk directories, provided with each system, define what data is provided and its location on the disks.

18. TYPICAL CALL SEQUENCE

18.01 General.

The following paragraphs describe how a typical call is handled by the system. Block diagrams are used to show the sequence of connections without detailed reference to circuit operation.

18.02 Dial-Tone Connection.

a. **Off-Hook Detection.**

1. A request for dial tone begins when a station user lifts the telephone handset (fig. 12). This closes a loop across the tip and ring of the line to signal the line circuit assigned to the station (connection 1).

2. The line circuit sends an off-hook supervisory sense bit to the line group controller (connection 2), which continuously monitors the 90 line circuits under its control.
3. The line group controller sends an off-hook message to the line switch controller (connection 3) and the line group multiplexer/demultiplexer (connection 4).
4. The line switch controller marks the line busy and searches for an idle timeslot on the line group highway and port group highway. When a timeslot is found, the line switch controller sends a line group multiplexer/demultiplexer assignment command to the line group controller (connection 5) to identify the line circuit that is to be switched to the selected timeslot. The port group highway and timeslot (same as line group highway timeslot) are also identified.
5. The line switch controller also marks the timeslot busy and checks the line circuit type to determine if a party test is required. If a test is required, the line switch controller commands the line group controller to make the test; the results are returned to the line switch controller.
6. The line switch controller now sends an origination message to the communications buffer controller (connection 6) and commands the line group multiplexer/demultiplexer to send the off-hook supervisory bit to the TSI, by way of the line group highway switch (connection 7).
7. Each CPS continuously scans the status registers of the associated communications buffer controller. When the CPS detects the origination message, it uses a cross-reference table to determine the port store area (PSA) in the port control store associated with the port group highway timeslot being used.

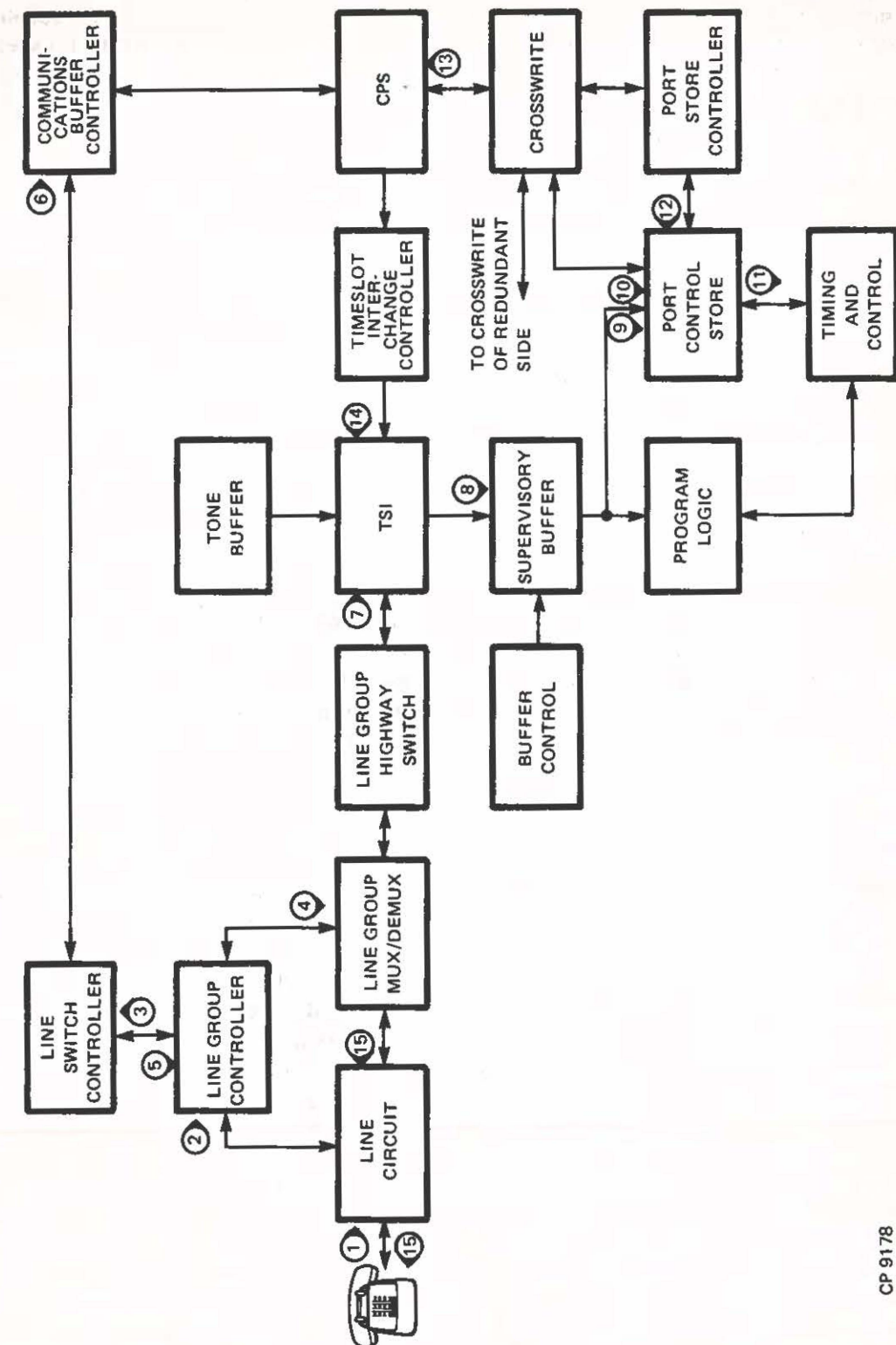


Figure 12. Dial-Tone Connection

8. The off-hook supervisory bit, previously sent to the TSI, is detected by the supervisory buffer (connection 8) and transferred to the PSA being used for the call (connection 9).

9. Once every 4 milliseconds, each PSA is strobed and the information is read out to the program logic (PL). When off-hook is detected, a seizure event code is stored in the PSA (connection 10).

10. The timing and control stores the address of the PSA in the appropriate queue (connection 11).

11. On the next periodic scan of queue states, the CPS recognizes that a queue has an entry in it. The CPS accesses the queue to determine which PSA has an event code.

12. The CPS then reads the PSA (by way of the crosswrite and port store controller circuits) for the line (connection 12) and detects the seizure event code (connection 13). The CPS also stores, in the PSA, the next call state and command (receive-digits) and resets the various counter storage areas (pulse counter, digit counter, etc.) for the line.

b. Dial-Tone Application.

The CPS sends a dial-tone command to the TSI, by way of the TSI controller, to connect dial tone (broadcast tone) to the line (connection 14). The pulse-code modulated dial tone is then converted to an analog signal by a decoder in the line circuit (connection 15) and heard by the calling party.

18.03 Dialing.

When the receive-digits PL (fig. 13) receives the receive-digits command stored in the PSA by the CPS, it enables the receive-digits start circuitry in the receive-digits and receive-digits/send-digits (RD/SD) PL (connection 1). When the calling party starts to dial, the line circuit forwards the dial pulses to the TSI (connection 2). The dial-pulse bits are detected by the supervisory buffer (connection 3) and forwarded to the PSA (connection 4). The bits are then read out to the RD/SD PL (connec-

tion 5) where they increment the pulse counter 1 register. When interdigital timing circuits in the receive-digits PL detect the end of a digit, the 4-bit output of the pulse counter/register in the RD/SD PL is transferred to the digit storage area of the PSA (connection 6). At the completion of dialing, the interoffice equipment number is translated, and the CPS instructs the TSI (connection 7) to set up a calling-to-called-line transmission path. The path is set up by assigning a cross-office highway timeslot (from calling-to-called TSI) for the calling line.

18.04 Ringing/Ringback Tone.

a. The CPS (fig. 14) sends a termination command to the LLS (connection 1). The line switch controller checks the status of the called line; if it is free, the line switch controller does a line group highway/port group highway path search. If an idle path is found, the line switch controller marks it busy, sets up the line group highway switch, and sends a line group multiplexer/demultiplexer assignment command to the line group controller (connection 2). The line group controller responds with a mux path assigned message when the timeslot data has been written into the line group multiplexer/demultiplexer. The line switch controller now sends a connect message to the CPS (via the communications buffer controller) to identify the port group highway and timeslot to be used (connection 3).

b. The CPS responds by selecting a tone buffer associated with the same TSI as the called line. To ensure that a conversation path is available when the called party answers, the ringback tone source and called port are assigned the same cross-office highway timeslot in the called TSI (connection 4). (All transmission between TSIs is over cross-office highways on a first-come/first-serve basis.)

c. The CPS causes ringback tone to be sent to the calling line (connection 5), gets the ring-code information for the called LLS line, and sends a ring-line command to the line switch controller (via the communications buffer controller) (connection 6). The line switch controller converts the ring-line command to a line-group-controller-ring command, causing the line group controller to operate the ring relay on the called line circuit (connection 7).

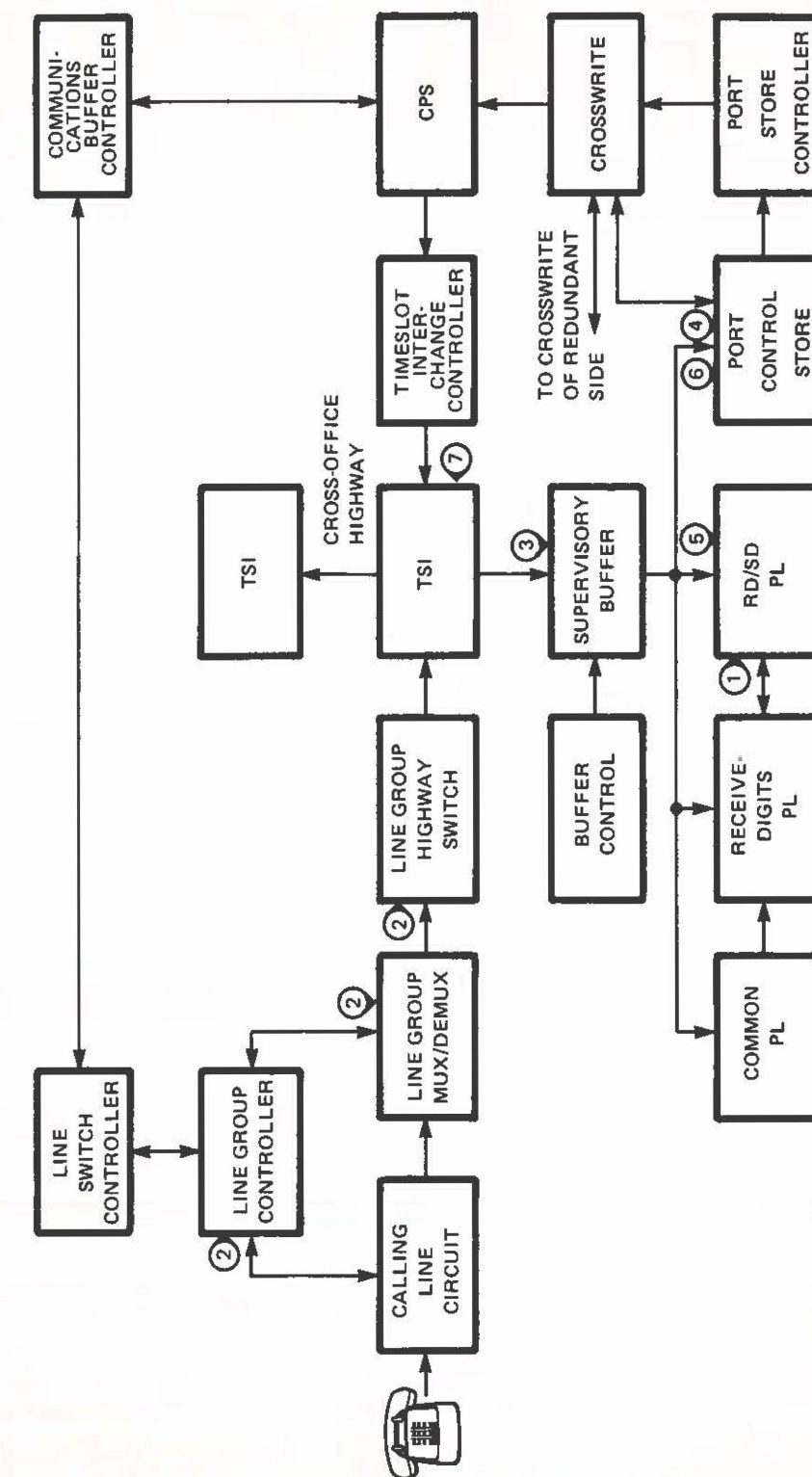


Figure 13. Dialing

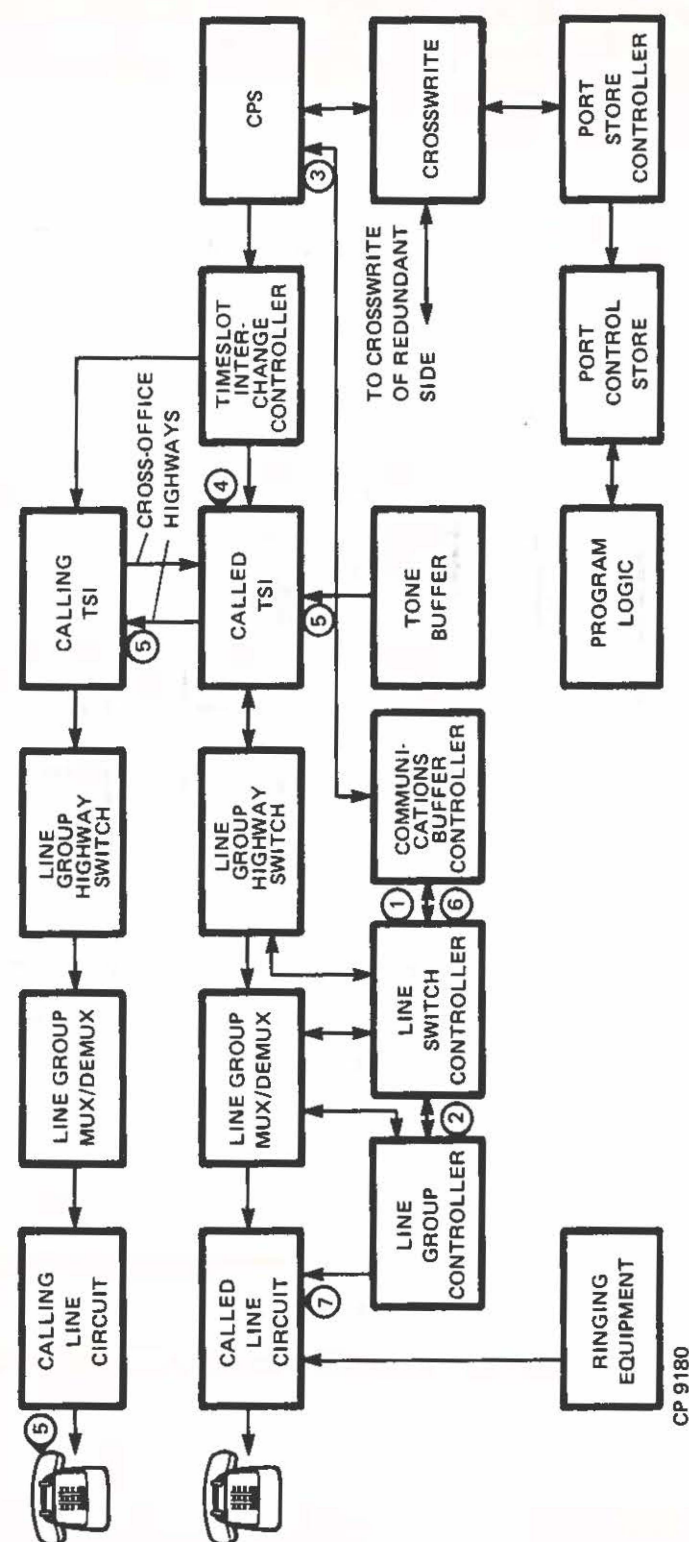


Figure 14. Ringing and Ringback Tone Application

18.05 Answer.

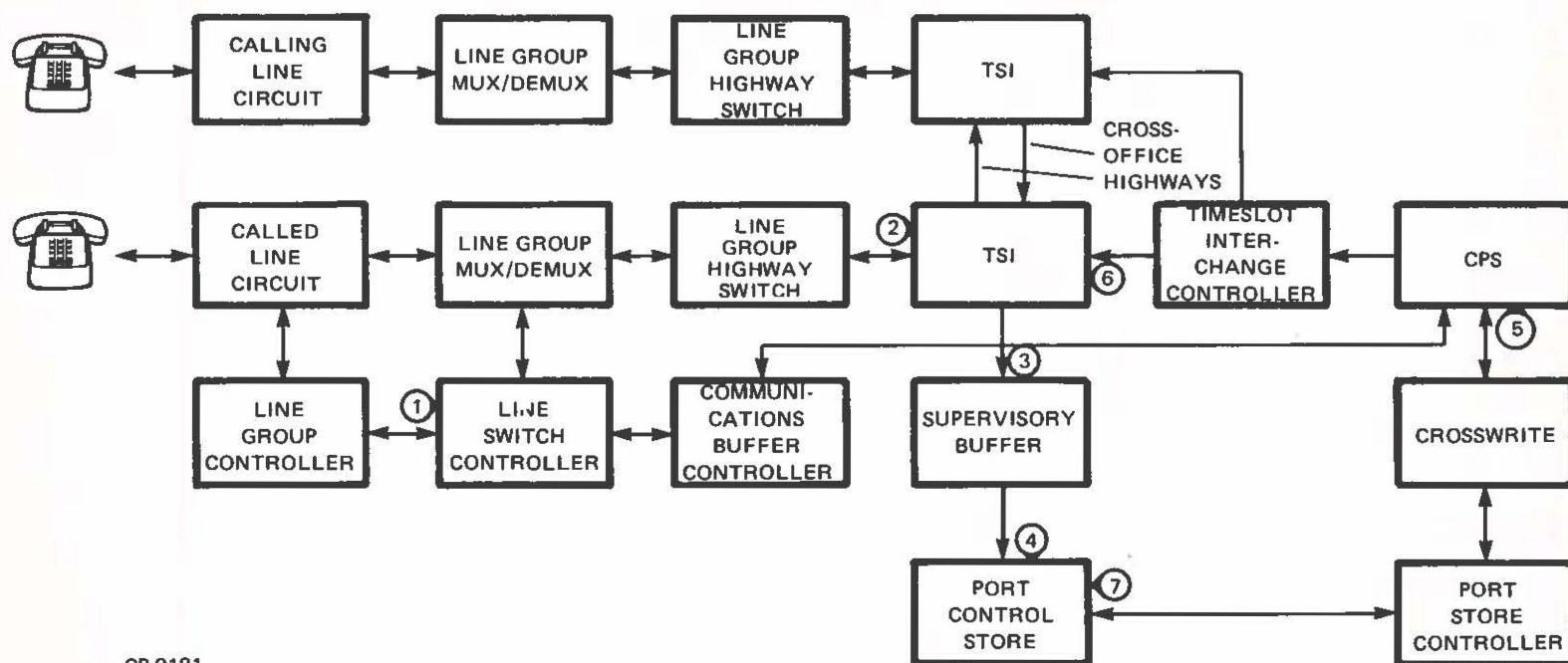
Ring trip (fig. 15) is detected by the line group controller, which sends a ring-trip message to the line switch controller (connection 1). The line switch controller commands the line group multiplexer/demultiplexer to send the ring-trip sense bit to the TSI, by way of the line group highway switch (connection 2). The supervisory buffer detects the ring-trip sense bit (connection 3) and stores a ring-trip event code in the PSA (connection 4). When the CPS reads the PSA, it detects and verifies the ring-trip event code (connection 5). The cross-office highway timeslot used for ringback tone to the calling line is assigned to the called line by the CPS (connection 6) to permit called-to-calling-line conversation. The CPS changes the call state of the calling and called lines to "talking line-to-line" in the associated PSAs (connection 7).

18.06 Release.

- a. Referring to figure 16, assume the calling party goes on-hook (connection 1). An on-hook supervisory bit is sent to the PSA (connection 2) and an on-hook message is sent to the CPS (connection 3), as described in paragraph 18.02.

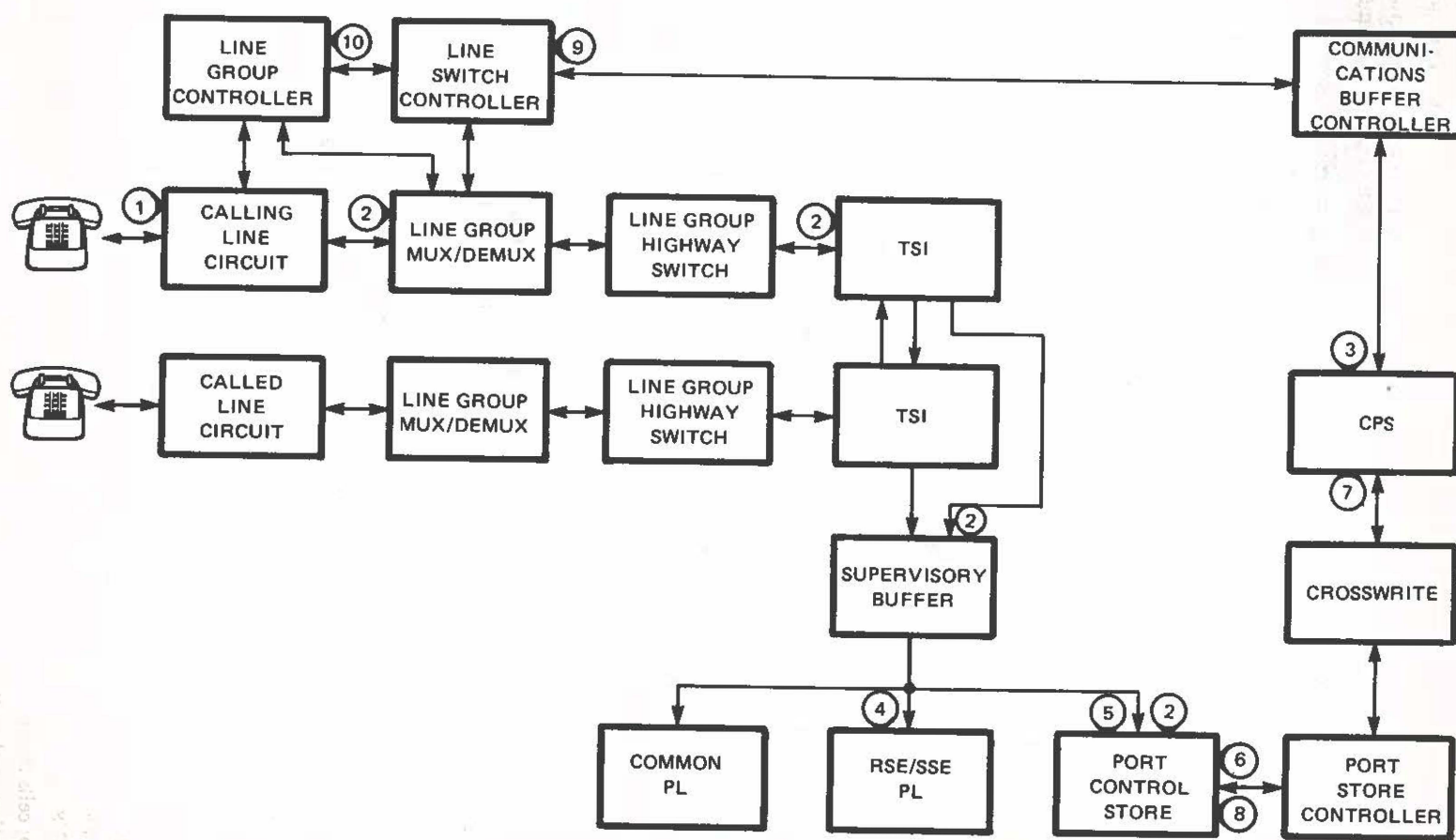
The RSE/SSE PL detects the on-hook bit (connection 4) and sends a release event code back to the PSA (connection 5). When the CPS reads the PSA for the on-hook line (connection 6), it detects and verifies the release event code (connection 7). The CPS sets the call state for the on-hook line to "idle" and the call state for the other line to "release timeout" in the respective PSAs (connection 8). The CPS then sends a disconnect command to the line switch controller (connection 9). The line switch controller releases the line group highway switch path and sends a line group multiplexer/demultiplexer release command to the line group controller (connection 10) to identify the timeslot that is to be released. The line switch controller also sets the line call state to idle.

- b. If the called party goes on-hook before timeout occurs, the release sequence is the same as that just described. If timeout occurs (16.3 seconds), the common PL generates the release event code and sends it to the PSA. The CPS then detects the release event code and release continues as described in paragraph a above.



CP 9181

Figure 15. Answer



CP 9182

Figure 16. Release

PART V. EQUIPMENT ORGANIZATION

19. BUILDING BLOCKS

19.01 General.

The central office equipment in a DCO system, excluding the power and peripheral devices, is assembled in rows of equipment frames. Information detailing the location of equipment within the frames is provided in the section titled *Equipment Location*, referenced in paragraph 2.02. The various types of frames used contain one or more of the following:

- a. Permanently mounted cells (for housing plug-in printed wiring board assemblies).
- b. Permanently mounted air circulators (fans or blowers).
- c. Semipermanently mounted low-voltage dc power supplies.
- d. Prewired cabling to fixed cable connectors (for quick attachment of interframe cables).

19.02 Printed Wiring Board Assemblies.

The integrated circuits, transistors, relays, inductors, resistors, and capacitors that make up individual circuits are mounted on plug-in PWBA's. The PWBA's contain printed wiring on both sides and often are multi-layered; component parts are mounted on one side only. Two sizes of Stromberg-Carlson PWBA's are used in the DCO system in addition to those contained in vendor subassemblies. See figure 17. The single-connector level PWBA measures 7-1/8 inches (18.5 cm) high, and a double-connector level PWBA measures 10-5/8 inches (27.5 cm) high. Both sizes of PWBA's measure 15 inches (38.1 cm) wide. The rear edge of the PWBA contains the connecting surface of the PWBA.

19.03 Cells.

The equipment compartments in which PWBA's are installed are identified as cells. Four sizes of cells are used: cells for port circuits (trunks, etc.) are 24 inches (61 cm) wide, 8-3/4 inches (22.2 cm) high, and 16 inches (40.6 cm) deep; cells in the LLS frames are 22-1/2 inches (57 cm) wide, 11-3/8 inches (28.7 cm) high, and 22 inches (56 cm) deep; cells for common control, maintenance and administration, and in the call processing unit frame are 33 inches (83.8 cm) wide, 12-1/4 inches (31 cm) high, and 16 inches (40.6 cm) deep; cells in the

power, ringing, and test access (PRT) frames are 24 inches (61 cm) wide, 12-1/4 inches (31 cm) high, and 16 inches (40.6 cm) deep. The card connector arrangement at the back of the cell determines the number of PWBA's that can be installed in the cell. The backplane of a cell is prewired by an automatic wire-wrap machine. (Before installation in the appropriate equipment frame, the cell is wired to a cable connector field for connection with intra- and intercabinet cables.)

19.04 Frames.

Several types of frames are used in the DCO system; they are the equipment housings for cells and low-voltage power supplies. The five size frames presently in use are: line/trunk (LTF), common equipment (CEF), automatic message accounting (AMAF), PRT, and SCOPS frames are 87 inches (221 cm) high, 32 inches (81 cm) wide, and 22 inches (56 cm) deep; LLS frames are 87 inches (221 cm) high, 54 inches (137 cm) wide, and 22 inches (56 cm) deep; the common control (CCF) and maintenance and administration (MAF) frames are 76 inches (193 cm) high, 51 inches (130 cm) wide, and 22 inches (56 cm) deep; the battery discharge frame (BDF) is 72 inches (183 cm), 84 inches (213 cm), or 96 inches (244 cm) high, 25 inches (63.5 cm) wide, and 14-1/2 inches (36.8 cm) deep; and the CMAC frame is 72 inches (182 cm) high, 22 inches (56 cm) wide, and 39 inches (76 cm) deep.

19.05 Distributing Frames.

The main or combined distributing frame is expandable in 32.25 inch (83-cm) segments. Each section accommodates 3 verticals and 1800 protectors. See figure 18.

20. EQUIPMENT LOCATION

20.01 General.

This paragraph briefly describes the location of hardware associated with the equipment described in paragraph 3. To aid in this description, typical frame layouts are provided in figures 19 through 29. Specific locations of individual circuits are provided in the section titled *Equipment Location*, referenced in paragraph 2.02.

20.02 Service Group.

Circuits that make up the service group are located in either the PRT frames or in the MAF. The PRT frame contains a ringing monitor and maintenance cell,

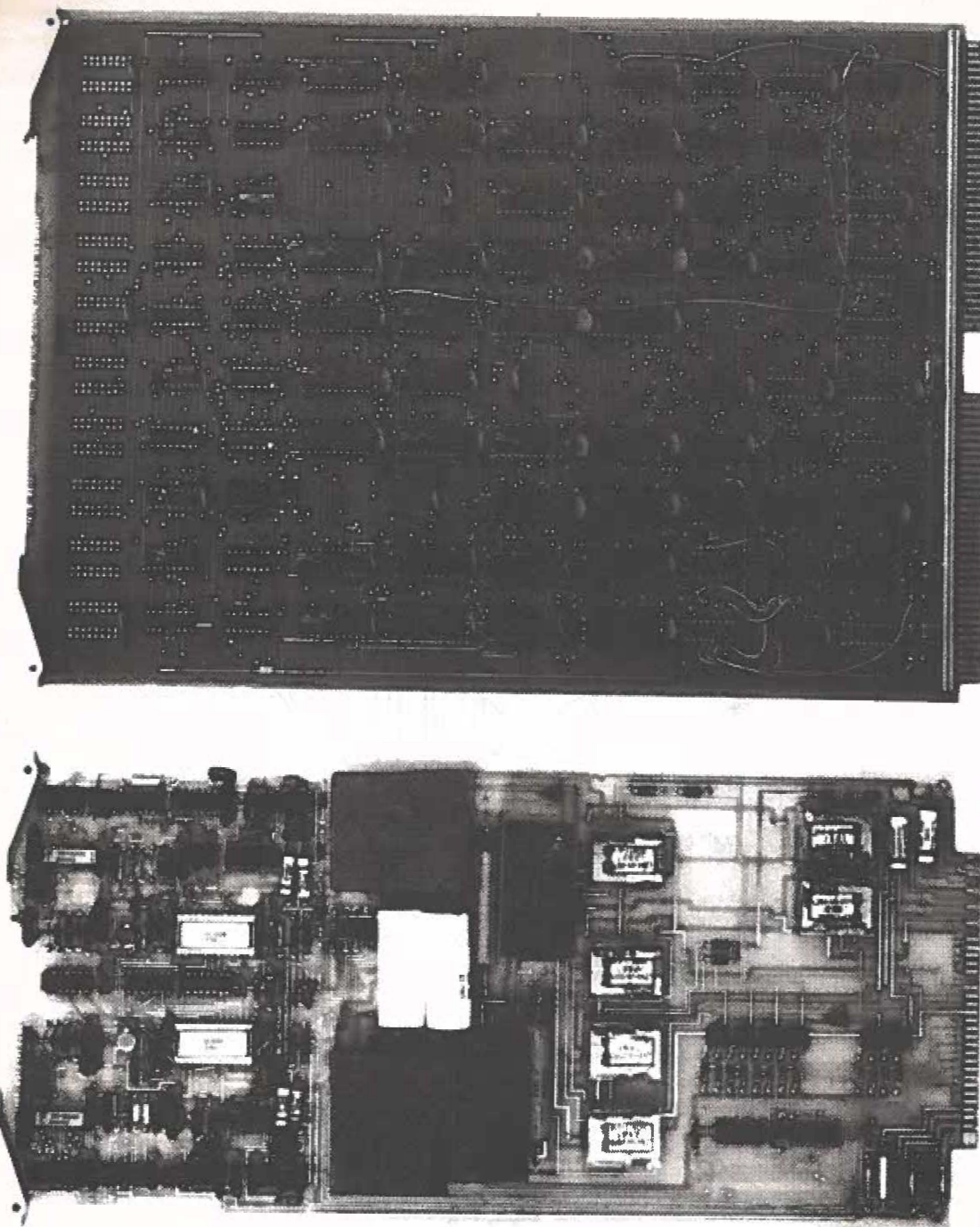
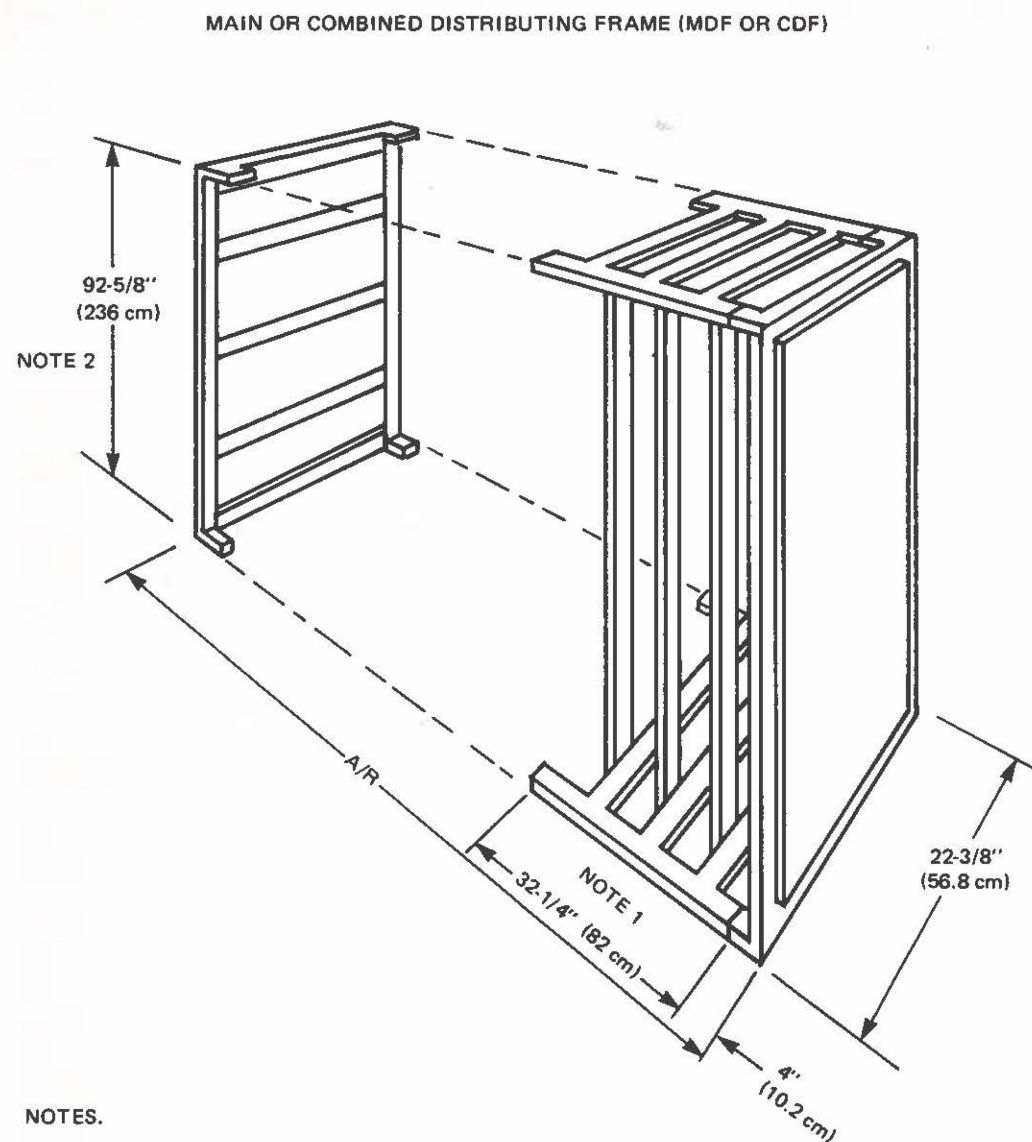


Figure 17. Printed Wiring Board Assemblies



NOTES.

1. Each 32-1/4" (82 cm) modular section will accommodate 3 verticals & 1800 Cook No. 310 or Reliable 730 protectors.
2. Levelers will increase 92-5/8" (236 cm) dimension to 93-13/32" (237 cm) to 94-3/16" (240 cm).

CP 5536B

Figure 18. Main or Combined Distributing Frame, Typical Layout

the ringing monitor cell, power, battery, and ground distribution, and associated frequency meters and panels. The MAF contains the maintenance and administration cell; the maintenance and test access control cell; CP tone and pulse cells; the basic maintenance panel; and associated power supplies and blowers.

20.03 Port Group.

Port group circuits are located in line/trunk frames (LTF). These include any combination of eight trunk group, trunk/service group, DTI group or DSI group cells.

20.04 Local Line Switch.

The line circuits and associated circuits that make up the LLS are located in LLS frames.

20.05 Timeslot Interchange.

The circuits for each of the redundant timeslot interchanges are contained in TSI/port control system (TSI/PCS) cells in the CCF.

20.06 Common Control.

The circuits for each of the redundant common controls are contained in a TSI/PCS cell in the CCF.

20.07 Call Processing System.

The microcomputer, synchronizer, and other circuits included in the call processing systems are contained in the CPU tone and pulse cell which is mounted in the MAF.

20.08 Maintenance and Diagnostics.

- a. Most circuits that are considered to be associated with maintenance, administration, and diagnostics are contained in the MAF. The PRT 1 frame contains the test access selector circuits, some of the test-call generator circuits, and the ringing monitor and serializer circuits. Ringing equipment, alarm checking and sending circuits, and major and minor alarm buzzers are also contained in the PRT frame. The maintenance processor, interface circuits, basic maintenance panel, and maintenance and diagnostic circuits are mounted in the MAF.

- b. The centralized maintenance and administration system (CMAC) is housed in the CMAC frame and at the work station in the operations center. Remote switch sites can also be provided.

20.09 Message Accounting.

- a. Automatic message accounting equipment (CAMA/LAMA) used for ticketing purposes in class 5/4P and class 4P configurations is installed on the AMAF. This equipment typically includes two tape drive units, a tape control cell with redundant PWBAs, and a control panel.
- b. The SYSTEM CENTURY Operator Position System (SCOPS) is contained in the SCOPS common equipment frame and at the operators and supervisors positions.

20.10 Ancillary Equipment.

Ancillary equipment such as a reference tone generator, a multichannel drum announcer, toll MF detector cells, tone dial detector cells, dc-to-dc converters, loop extension/voice (frequency) repeater (LE/VR) equipment, line test equipment, and/or remote test equipment, etc. are installed on common equipment frames. However, it should be noted that some of the above mentioned units may also be mounted on PRT 2 and PRT 3 frames.

20.11 Power.

The battery rack, chargers, and battery discharge frame (BDF) are normally located in a separate power room. The BDF provides the facility for mounting the battery discharge panels with the associated meters. The 48-volt supply is distributed to the various equipment cabinets by way of PRT frames in the equipment room. Dc-to-dc converters which convert 48 volts to ± 5 volts, ± 8 volts, +12 volts, and/or -15 volts, and the associated fusing, are provided on a per-cell basis in a power compartment on the left-hand side of each frame requiring such conversion.

20.12 Cabling.

- a. Cable compartments are provided on the right-hand side of most frames for intraframe cabling between the various cells and the cable connector fields at the rear of the frames. These cable compartments are also used for intercabinet cables that must go out of the cabinet from either the top or bottom.
- b. PGH grading panels on the common control frame(s) are used to distribute PGHs to line/trunk frames (LTF) and LLS frames as re-

quired for load balancing. PGHs are assigned to LTFs based on the number of cells equipped in the LTF (one PGH per cell). PGHs are assigned to LLS frames based on the traffic requirements of each frame.

20.13 Raceways.

Raceways for running cables under the floor can be used or overhead cable troughs or grid cable racks can be provided.

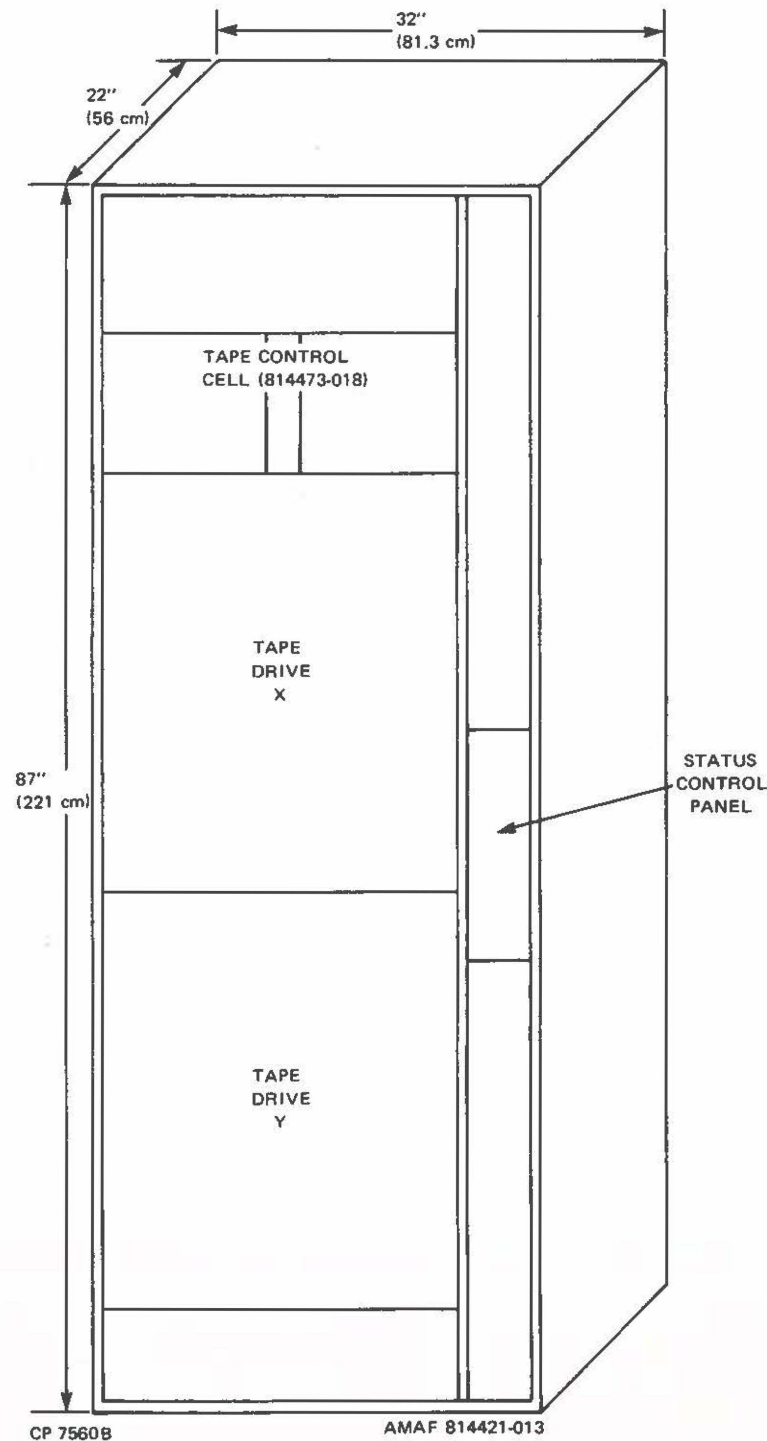


Figure 19. Automatic Message Accounting Frame (AMAF)

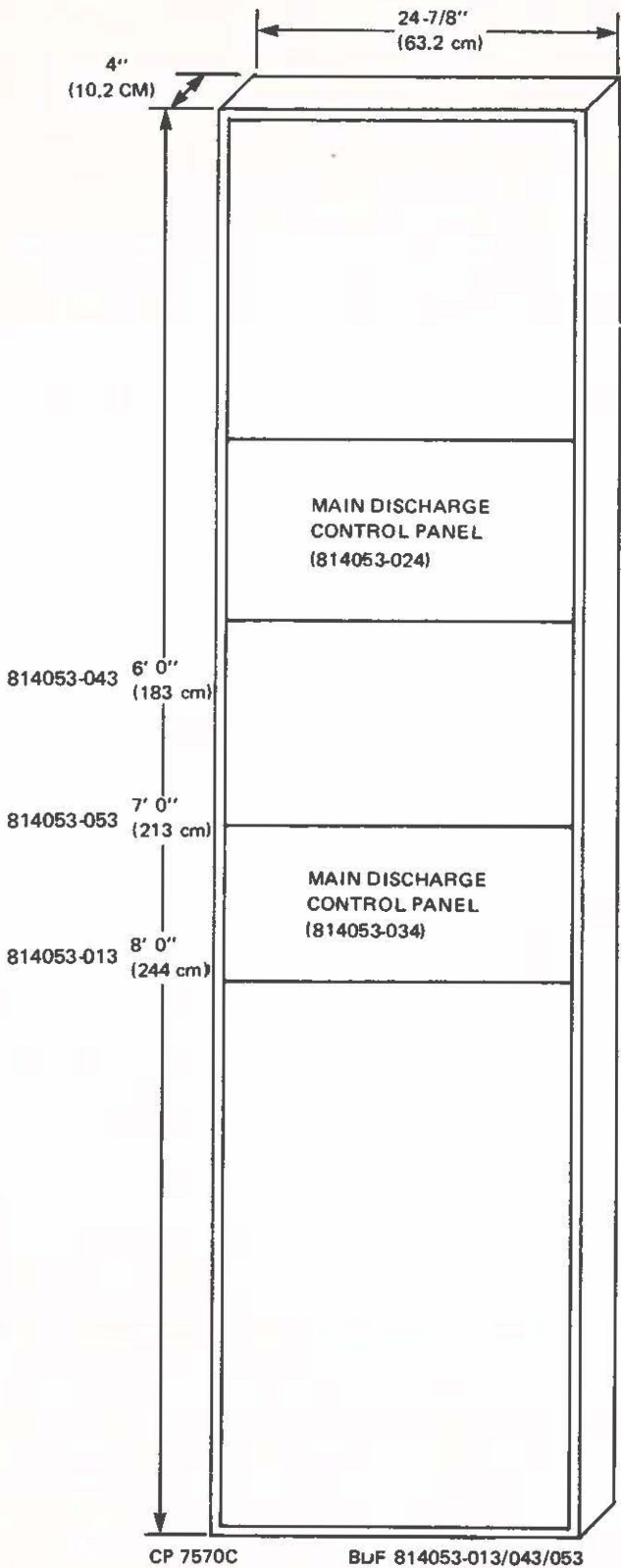


Figure 20. Battery Discharge Frame

PHOTOGRAPH NOT AVAILABLE AT THIS TIME

Figure 21. Centralized Maintenance and Administration System Frame

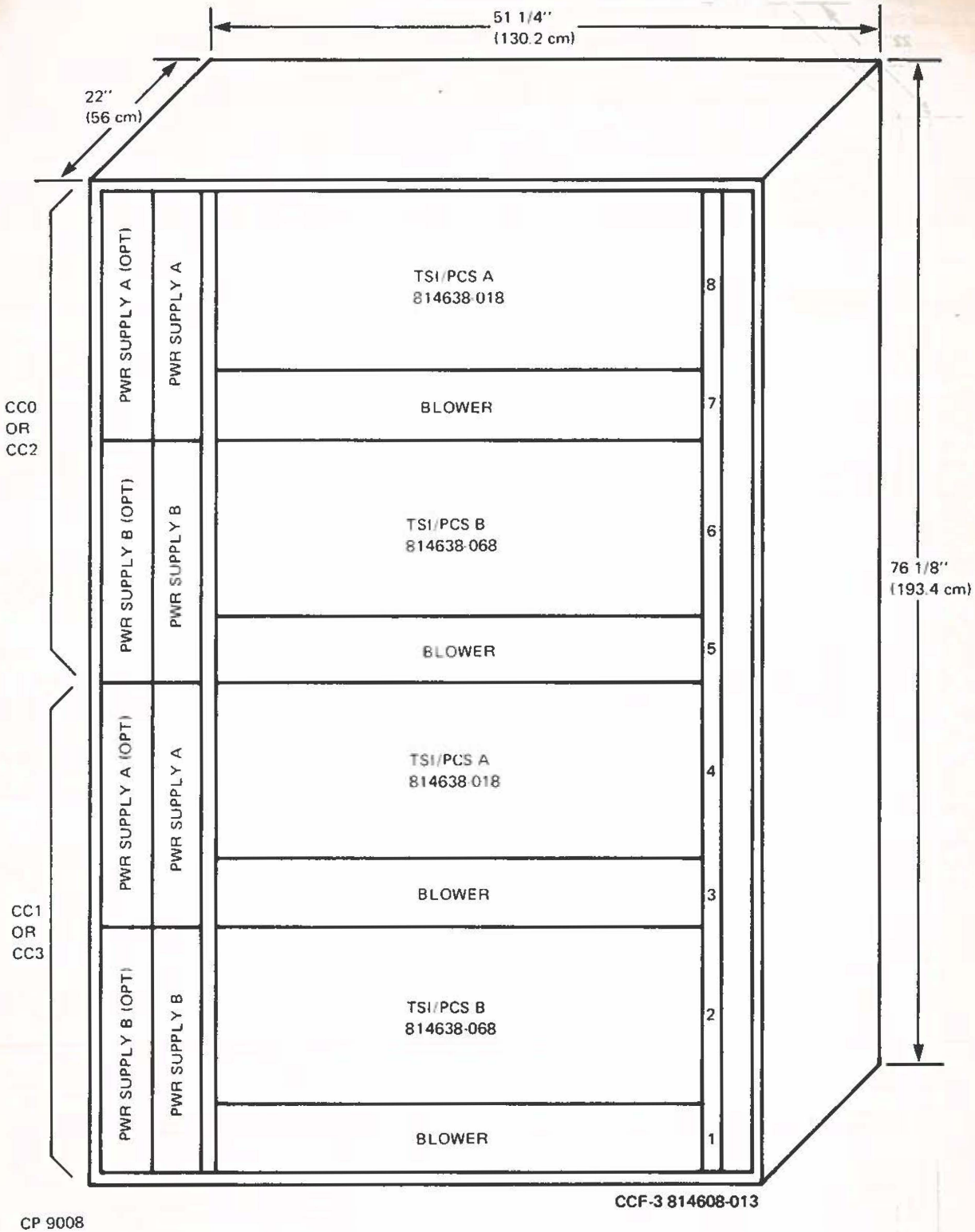
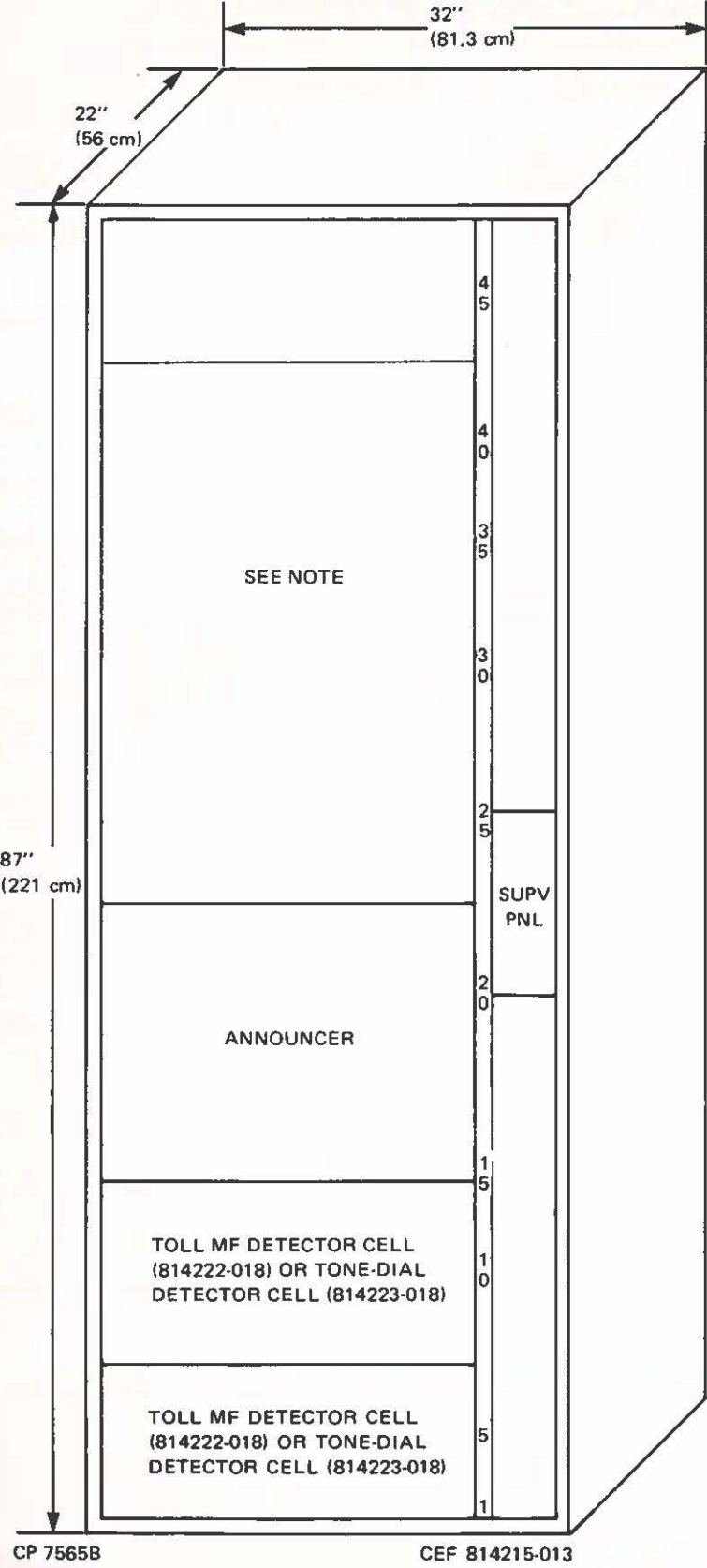


Figure 22. Common Control Frame (CCF)



NOTE. THIS SPACE USED FOR MOUNTING CUSTOMER SPECIFIED EQUIPMENT SUCH AS:

- LOOP EXTENDERS
- TAPE OR DRUM ANNOUNCERS
- VOLUNTEER FIREFIGHTER COMMUNICATIONS

Figure 23. Typical Common Equipment Frame (CEF)

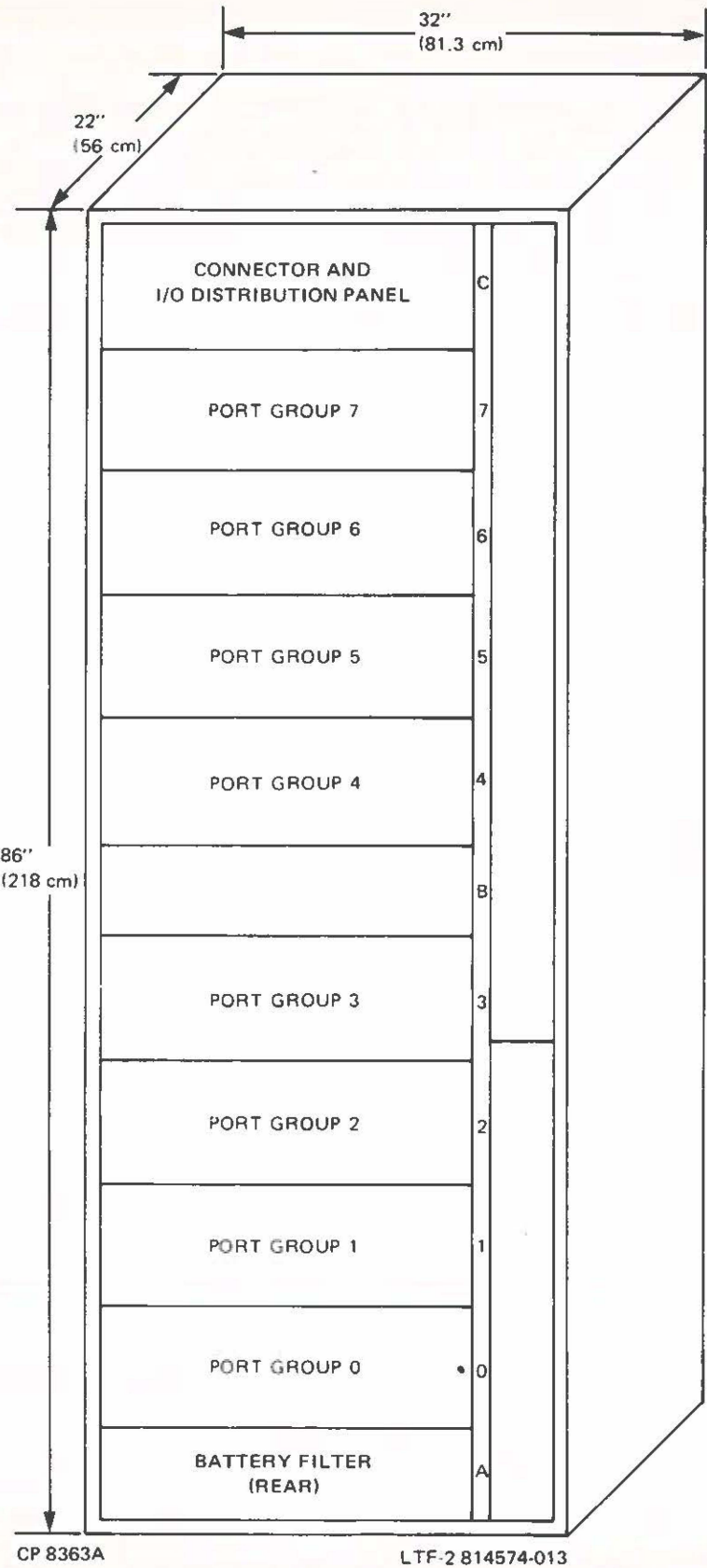


Figure 24. Line/Trunk Frame (LTF)

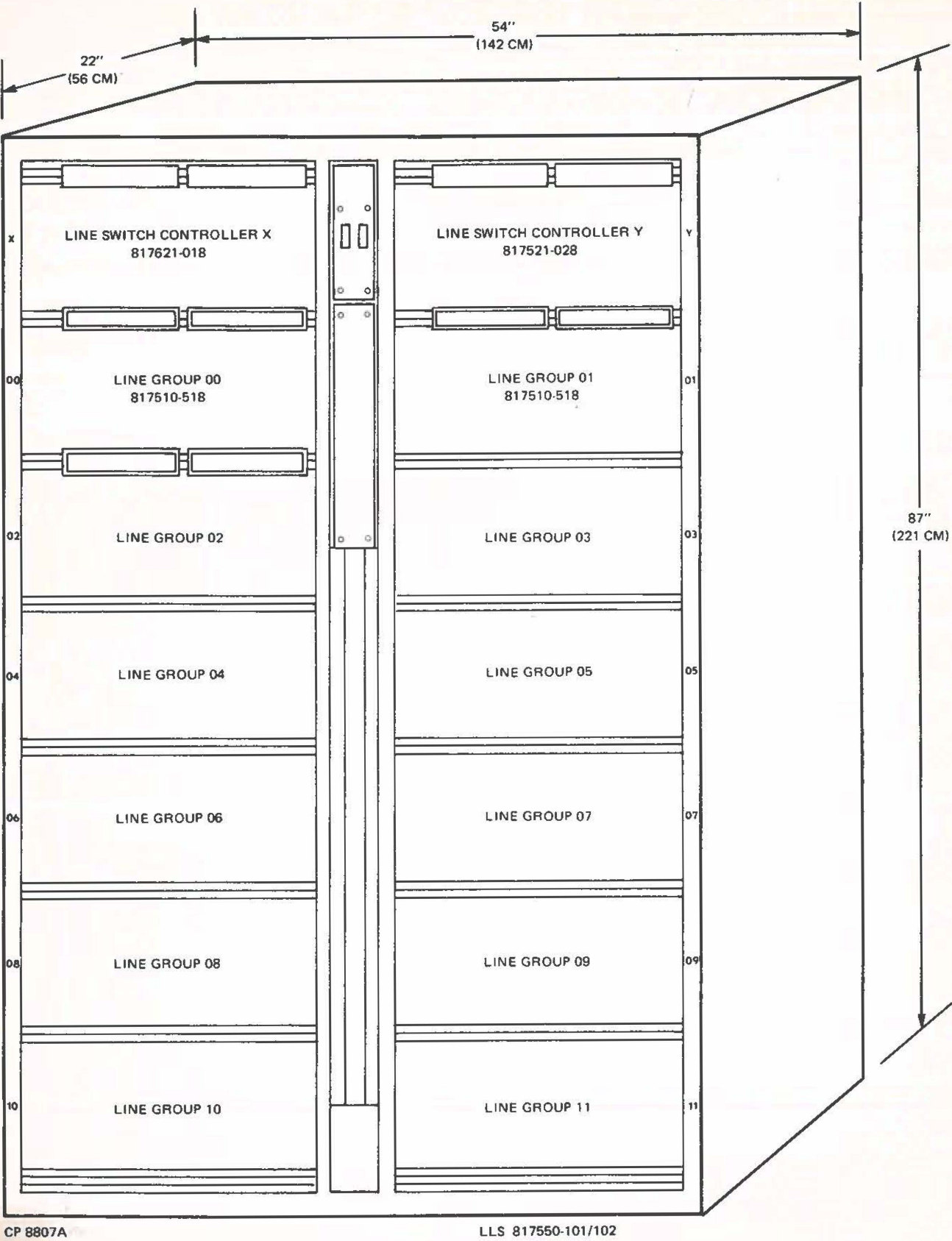


Figure 25. Local Line Switch (LLS) Frame

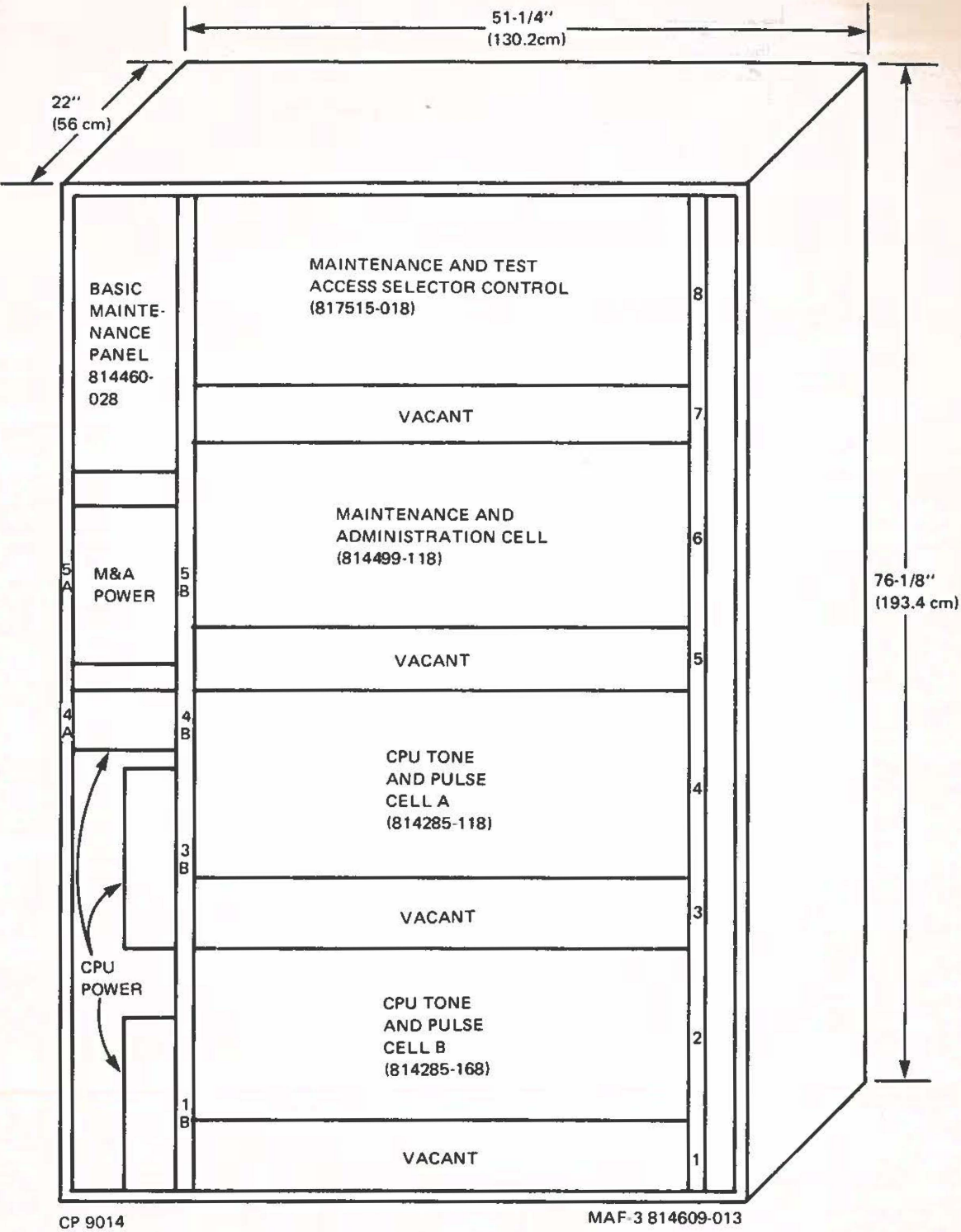


Figure 26. Maintenance and Administration Frame (MAF)

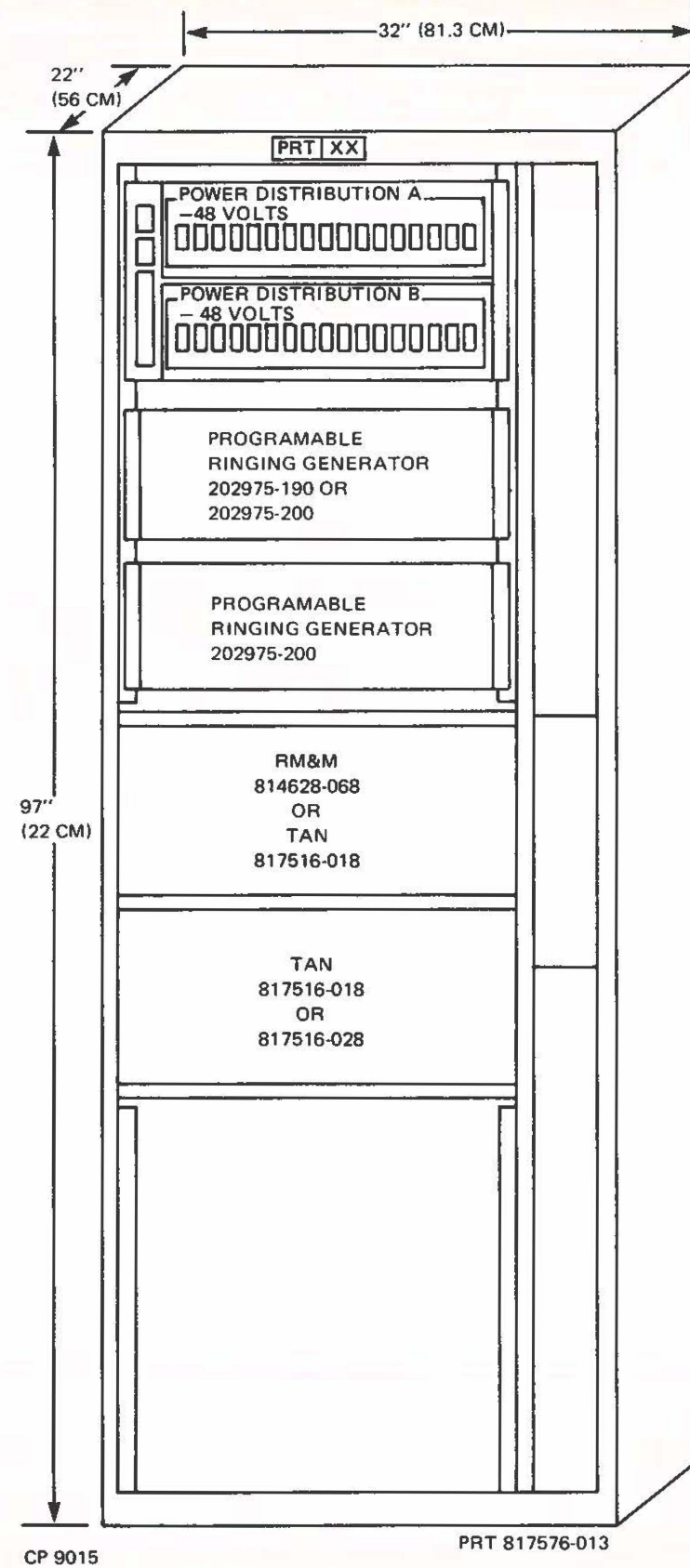


Figure 27. Power, Ringing, and Test Access Selector (PRT) 1 Frame

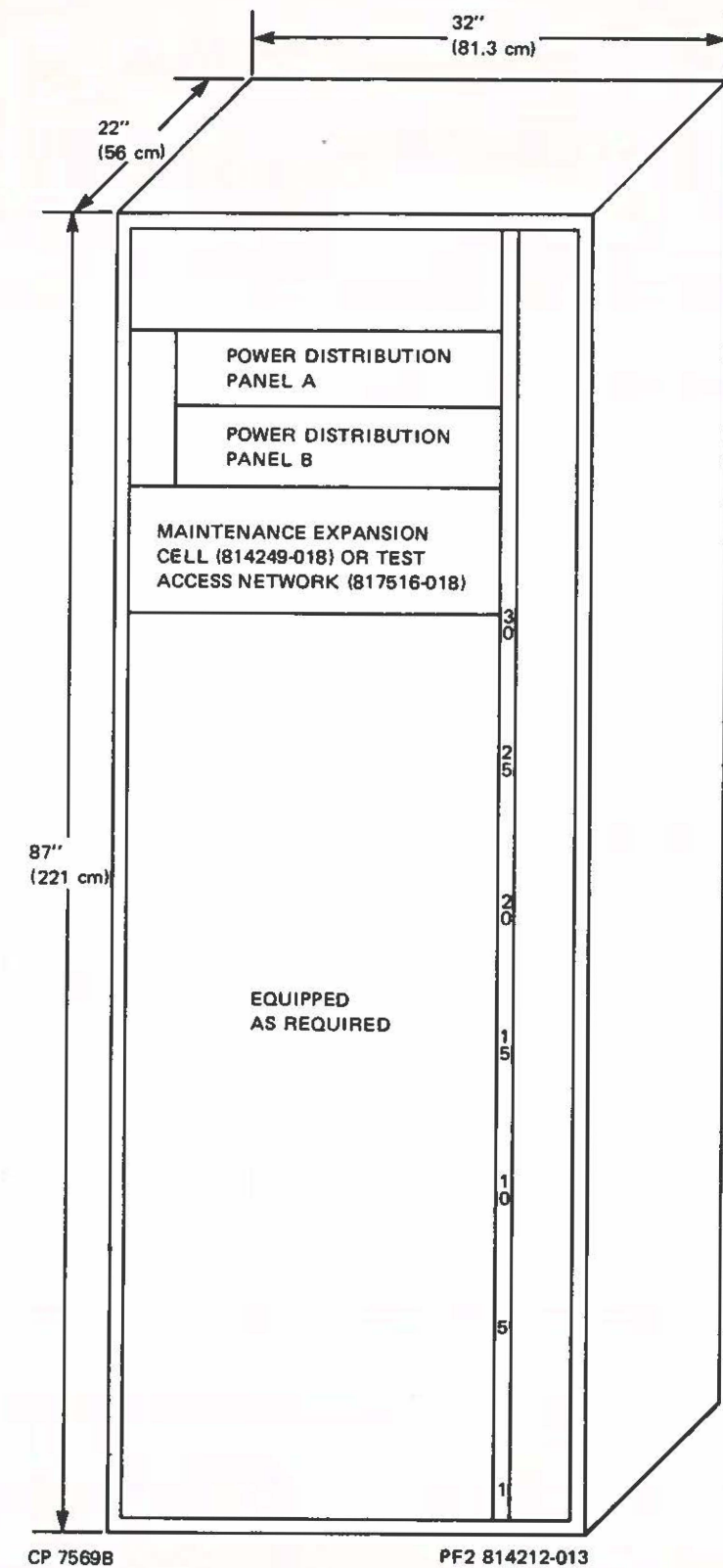


Figure 28. PRT 2 Frame

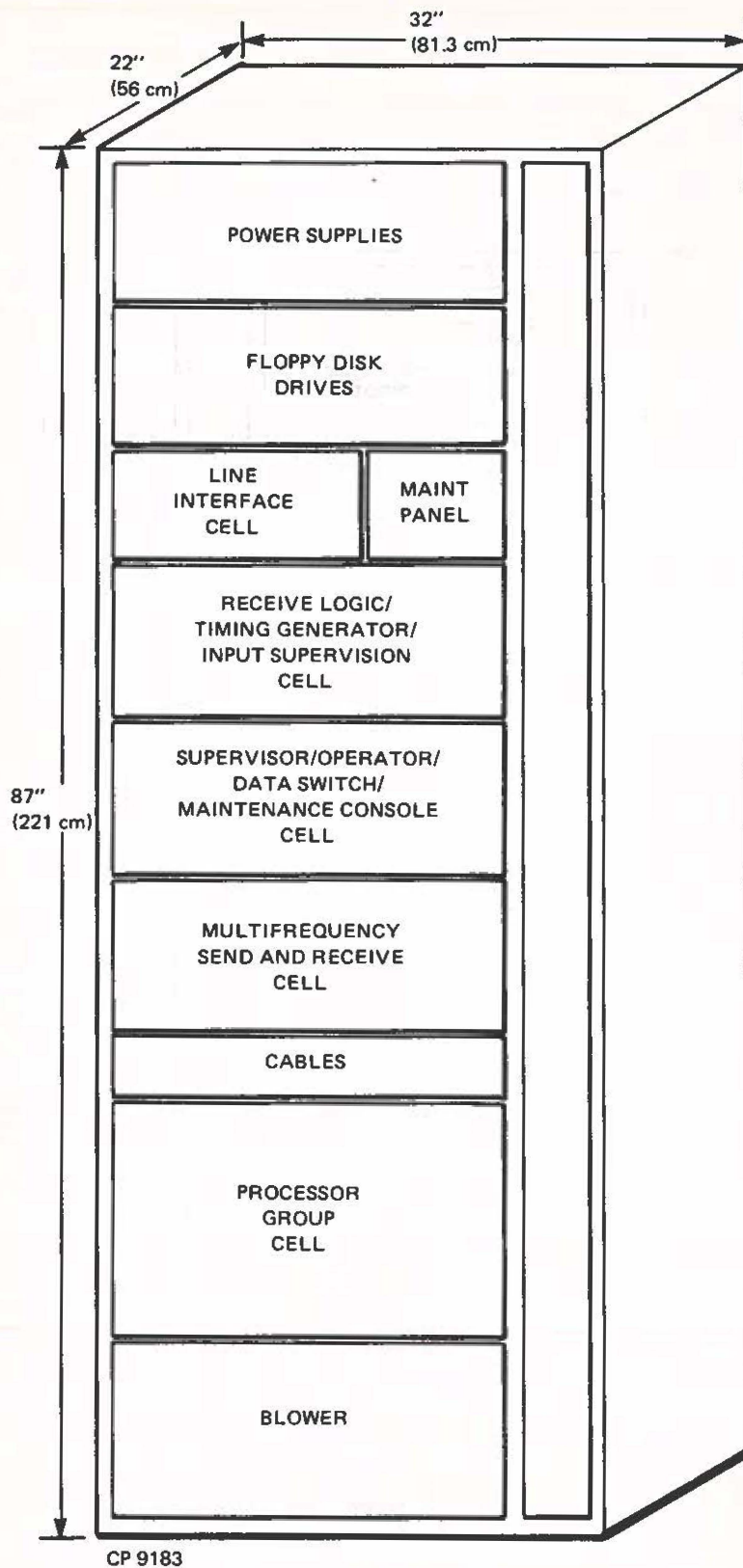
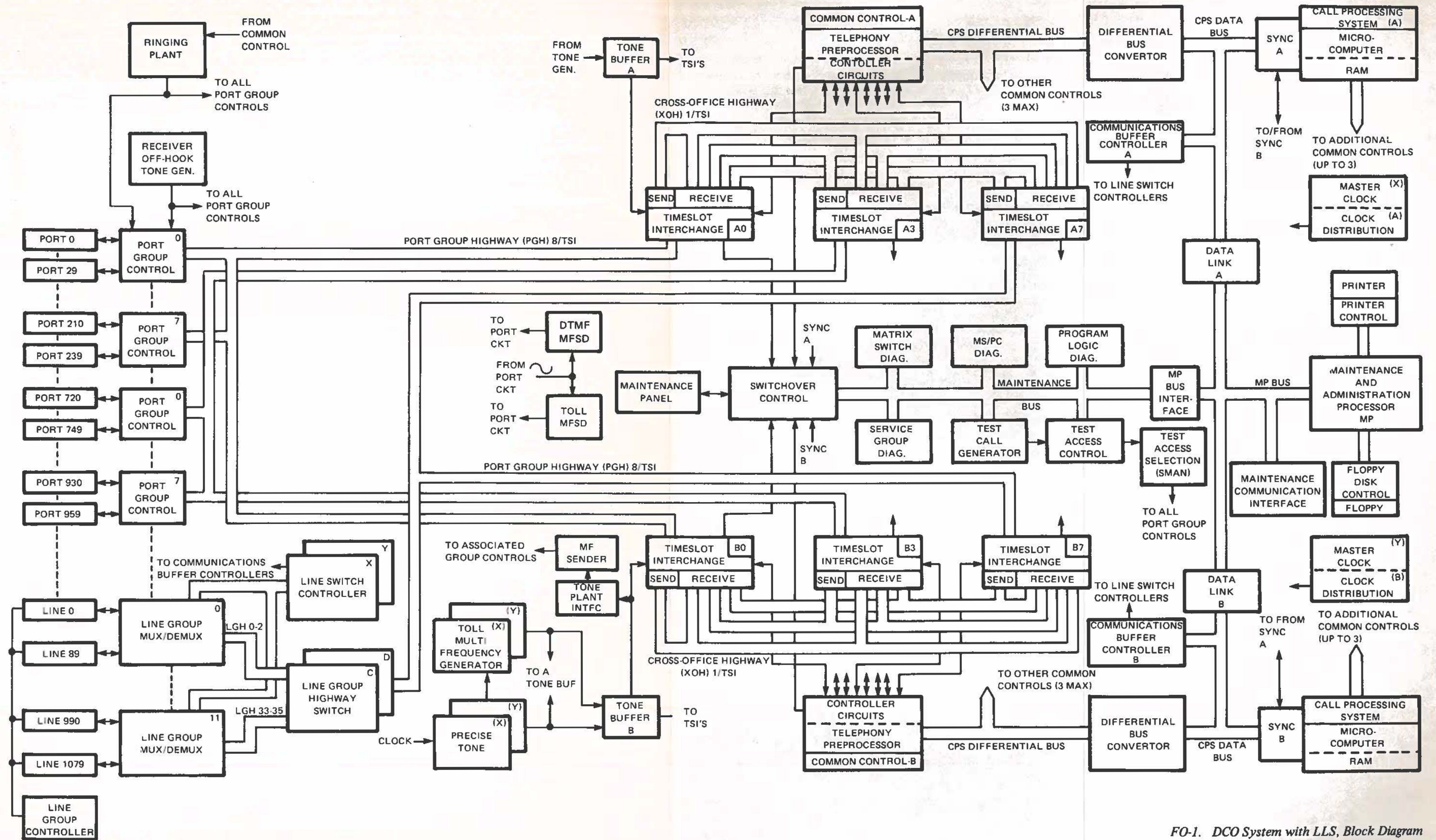


Figure 29. SYSTEM CENTURY Operator Position System (SCOPS) Frame



CP 9184

FO-1. DCO System with LLS, Block Diagram