SYSTEM CENTURY®
CENTRALIZED AND LOCAL
AUTOMATIC MESSAGE ACCOUNTING
SUBSYSTEMS

GENERAL DESCRIPTION

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1. INTRODUCTION

1.01 This section provides a general description of the Centralized and Local Automatic Message Accounting (CAMA/LAMA) subsystems that are used with the SYSTEM CENTURY Digital Central Office (DCO). This section includes the purpose and use of the subsystems, physical and technical characteristics of the CAMA/LAMA hardware, and a functional description of the CAMA/LAMA logic circuits and equipment.

1.02 This section is reissued to add the following:

a. Information about the usage-sensitive recording (USR), measured in-WATS, and measured out-WATS features provided by DCO software release 9.

b. Information about the 1600-character-per-inch (CPI) tape drives that are available as a CAMA/LAMA option.

c. References to the control and maintenance frame (CMF) and the power, ringing, and test access frame (PRT). The CMF takes the place of the common control frame (CCF) and the maintenance and administration frame (MAF) in some DCO systems. The PRT takes the place of the power frame in some systems.

1.03 In addition, Part III, Functional Description, has been completely rewritten to describe the operation of the CAMA/LAMA subsystem during normal call data recording and error reporting.

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, P.O. Box 1698, Sanford, Florida 32771.

2.02 Related Sections.

The following sections are recommended for use with this document. To determine the actual section numbers of sections marked with an asterisk (*), refer to the *DCO Index of Related Sections* provided with your set of Stromberg-Carlson Practices (SCPs).

*23-YYY-99	Message Dictionary
28-005-00	CAMA/LAMA Subsystem, Index of Related Sections and Subject Keysheet
28-005-20	CAMA/LAMA Subsystem, Installation
28-005-50	CAMA/LAMA Subsystem, Maintenance

PART I. EQUIPMENT DESCRIPTION

3. PURPOSE AND USE

3.01 The CAMA/LAMA subsystem is used primarily to record ticket information for 1+ direct distance dial (DDD) noncoin toll calls. Under control of the DCO system, the CAMA/LAMA subsystem can ticket calls with a system configuration of one- to four-party automatic line identification or circle digit identification. In a case of operator-identified multiparty lines or automatic number identification failures, the call can be optionally routed to an ONI operator, busy tone, or recorded announcement.

3.02 The CAMA/LAMA subsystem can provide a CAMA function, a LAMA function, or a combined CAMA/LAMA function, as follows:

a. In a class-4P office, the subsystem functions as a CAMA recording system. As shown in figure 1, such a CAMA system records toll ticket information collected from a number of tributary class-5 offices that do not have local ticket capability.

b. In a class-5 office, the subsystem functions as a LAMA recording system. Each LAMA recording system, as shown in figure 2, records the toll ticket information for DDD calls originated through the class-5 office in which the respective LAMA system is installed.

c. In a class-4/5 office, as shown in figure 3, the CAMA/LAMA subsystem provides combined CAMA and LAMA functions. Toll ticket information for DDD calls originating in tributary class-5 offices is collected by the class-4 portion of the 4/5 office and recorded as a CAMA function by the CAMA/LAMA subsystem. In addition, toll ticket information for DDD calls originating through the class-5 portion of the 4/5 office is recorded as a LAMA function by the CAMA/LAMA subsystem.

3.03 In addition to recording toll ticketing information for 1+ DDD calls, the CAMA/LAMA subsystem also records information for the optional measured in-WATS, measured out-WATS, and usage-sensitive

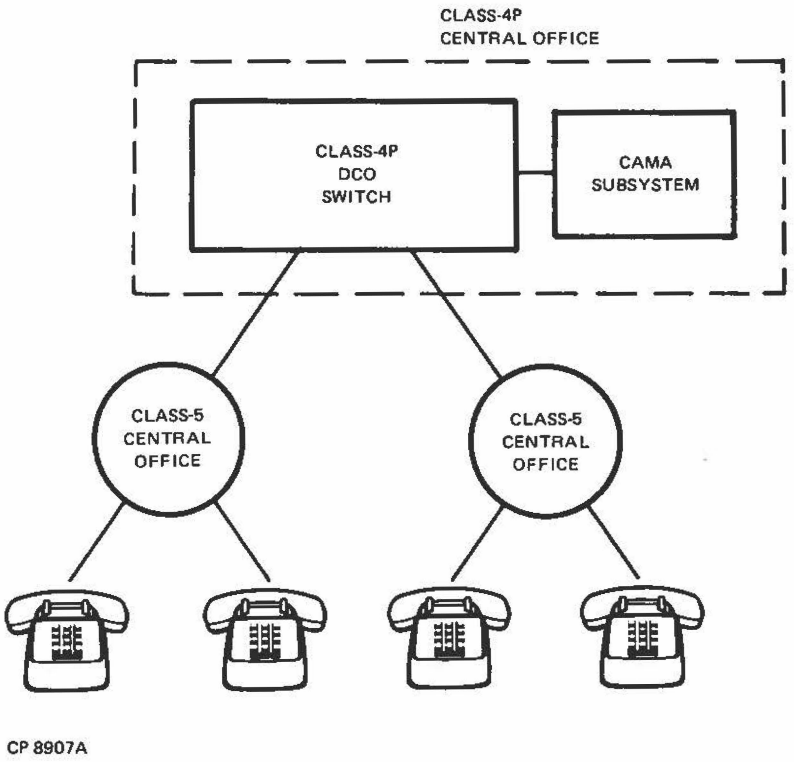

Figure 1. CAMA/DCO-Switch Relationship

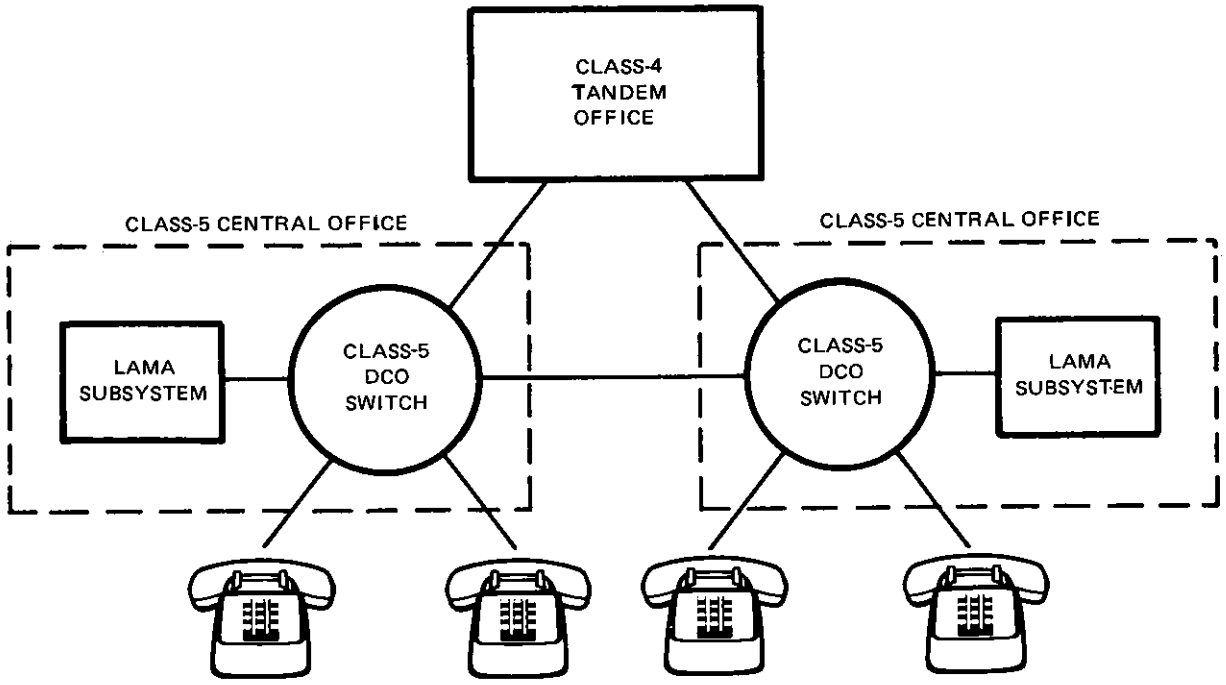

Figure 2. LAMA/DCO-Switch Relationship

recording (USR) features. For the measured in-WATS feature, the CAMA/LAMA subsystem records the normal call ticketing information, plus the type of call, to mark the ticket as an originating or terminating in-WATS ticket. For the measured out-WATS feature, the subsystem similarly records the normal call ticketing information, plus the out-WATS call type and the band (service area) identification. For USR, the subsystem records call data for single-party-originating calls terminating locally, for extended-area-service (EAS) calls, or for selective EAS calls. This call data includes usage records for the speed calling, three-way calling, call forwarding, and off-hook service features, as well as records of incomplete calls.

4. FEATURES

4.01 General.

The following paragraphs describe important features of the CAMA/LAMA subsystem.

4.02 Tape Drives and Recording Densities.

The standard CAMA/LAMA tape drive units record call information at 800 characters per inch (CPI) on nine-track reel-to-reel magnetic tape. Optional tape drive units that record at 1600 CPI are available.

NOTE. The eight bits of each character are recorded in parallel across the eight channels of the recording tape. (A parity bit for each character is recorded in the ninth channel.) Therefore, the recording densities of 800 and 1600 CPI also can be stated as 800 and 1600 (parallel) bits per inch (BPI).

4.03 Tape Recording Formats.

With the standard tape drive units installed, the CAMA/LAMA subsystem records call data at 800 CPI in nonreturn-to-zero inverse (NRZI) format. If the optional larger-capacity tape drive units are installed, the subsystem records call data at 1600 CPI in phase encoded (PE) format.

4.04 Read-After-Write Error Checking.

Read-after-write error checking ensures that data is verified in the same pass of the tape in which the data was recorded. This feature is provided automatically by the tape drive as the recording tape passes first over the write gap of the write/read head and then over the read gap of the write/read head. This allows each block of data to be read from the tape and checked immediately after it is written without backspacing the tape.

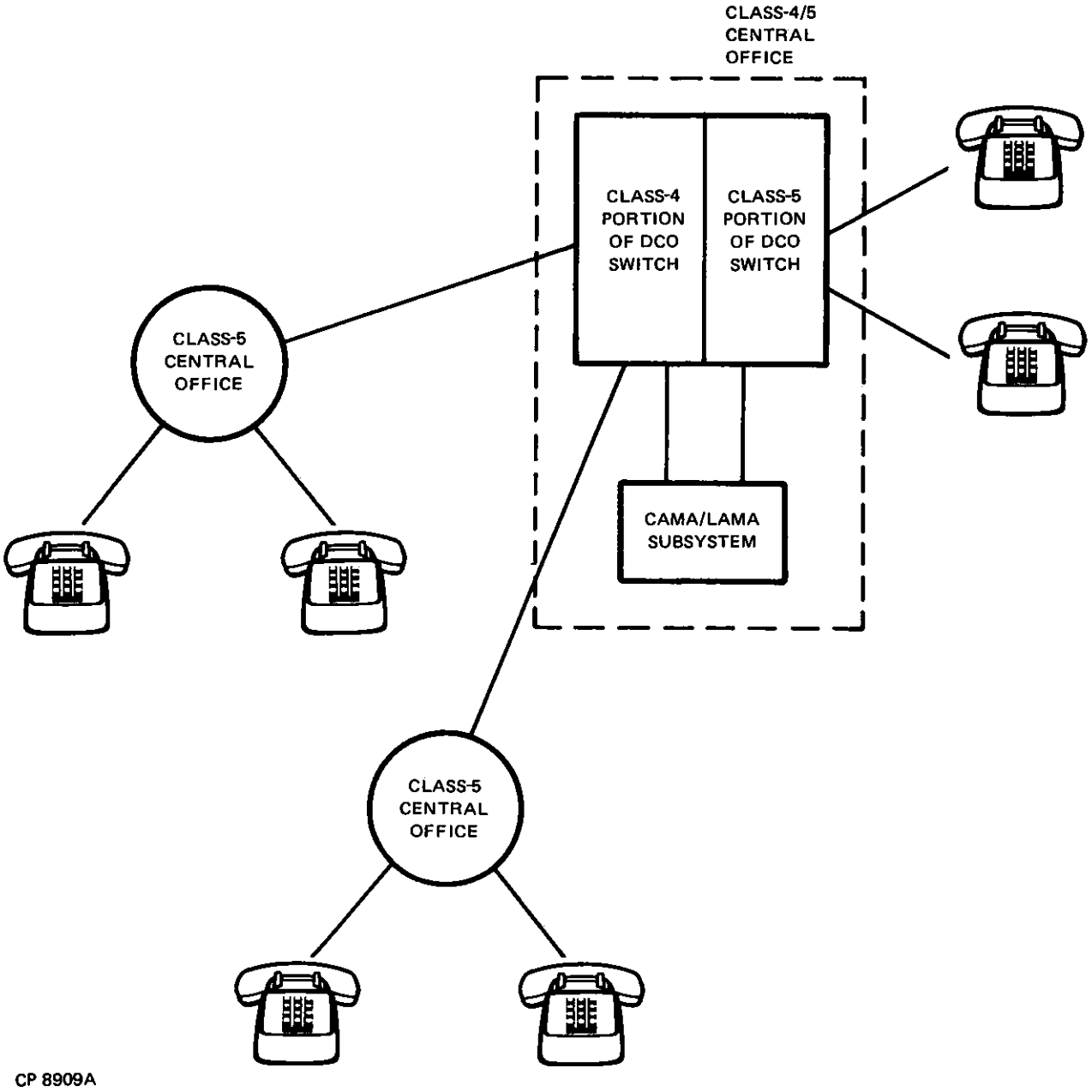

Figure 3. CAMA/LAMA/DCO-Switch Relationship

4.05 Header/Trailer Label Flexibility.

The magnetic tape header/trailer label content can be controlled by software to conform to individual site recording requirements. Header/trailer labels are provided according to the specification of the operating company. Header label information normally includes date of recording, data block size, recording office identification, and tape transport identification. The trailer label may include data block and message counts.

4.06 CAMA/LAMA Subsystem Redundancy.

The CAMA/LAMA tape drive units and all the PWBAs involved in recording call data on tape are duplicated. This ensures that recording continues while a tape is being changed or if a side of the subsystem is off line.

4.07 System I/O Console Interface.

The DCO system I/O console allows maintenance and administration personnel to communicate

with and control the CAMA/LAMA subsystem operation. A series of commands can be entered that do a number of subsystem checks or select the tape drive unit that is being used to record call information. The I/O console also provides fault and command printout information.

4.08 CAMA/LAMA Diagnostics.

Second-level diagnostic software is used to locate and identify hardware faults in the CAMA/LAMA subsystem, including the CP line calendar clock. The diagnostic programs can be called manually by using the DCO system I/O console, or they can be initiated automatically by the MP. The section titled *CAMA/LAMA Subsystem, Maintenance*, referenced in paragraph 2.02, explains how the CAMA/LAMA diagnostic software is used to isolate and diagnose faults in the CAMA/LAMA subsystem.

5. HARDWARE

5.01 General.

The CAMA/LAMA hardware comprises the automatic message accounting frame (AMAF) and its contents and five PWBAs that are mounted in the maintenance and administration frame (MAF) or, in some systems, the control and maintenance frame (CMF). The AMAF contains the tape control cell, in which are mounted six logic PWBAs and two power PWBAs. The AMAF also contains two tape drive units and a status/control panel. These items of CAMA/LAMA hardware are described individually in the following paragraphs.

5.02 Automatic Message Accounting Frame.

The AMAF is a standard DCO equipment frame containing, from top to bottom, respectively, the tape control cell and the two tape drive units (fig. 4). At the right-hand side of the frame, as viewed from the front, is a cable compartment that accommodates the data and control cables linking the AMAF with the DCO. Mounted at the front of this compartment, midway between the top and the bottom of the frame, is the AMAF status/control panel. On the right-hand rear frame upright, as viewed from the rear, is a power/ground bus strip. External power cables are attached to the bus strip, and internal power wiring is distributed from the bus strip to the tape control cell and the two tape drive units. To ensure that the AMAF can be leveled, it rests on four wrench-adjustable feet. Instructions for installing the AMAF and maintaining the equipment in it are contained in the sections titled *CAMA/LAMA Subsystem, Installation* and *CAMA/LAMA Subsystem, Maintenance*, respectively, which are referenced in paragraph 2.02.

5.03 Tape Control Cell.

Mounted in the top of the AMAF is the tape control cell. This cell contains two identical sets of four PWBAs (three logic PWBAs and one power PWBA), each plugged into connectors on two identical backplanes. Viewed from the front of the AMAF, the left-most set of PWBAs is associated with tape drive unit X; the right-most set of PWBAs is associated with tape drive unit Y. Data and control cables for the X-side circuits enter the tape control cell through an opening between the two backplanes on the rear of the cell. However, data and control cables for the Y-side circuits enter the cell directly through the side of the cell common with the cable compartment.

5.04 Printed Wiring Board Assemblies.

a. Some of the PWBAs associated with the CAMA/LAMA subsystem are mounted in the MAF (or, in some systems, the CMF) and some in the AMAF. The PWBAs that are in the MAF (or CMF) are as follows:

1. Call processor (CP) line calendar clock, 814551-526 (duplicated, A and B; CP line calendar clock A is in CPU tone and pulse cell A, whereas CP line calendar clock B is in CPU tone and pulse cell B).

2. Tape bus interface, 814289-526/536 (duplicated, A and B; tape bus interface A is in CPU tone and pulse cell A, whereas tape bus interface B is in CPU tone and pulse cell B).

3. Tape diagnostic, 814288-526 (not duplicated; the tape diagnostic PWBA is in the maintenance and administration cell).

b. The PWBAs that are mounted in the tape control cell of the AMAF are as follows:

1. Logic power supply, 814463-026 (duplicated, X and Y; power supply X occupies PWBA position 6, whereas power supply Y occupies PWBA position 65).

2. Tape interface buffer, 814290-526 (duplicated, X and Y; tape interface buffer X is installed in PWBA position 13,

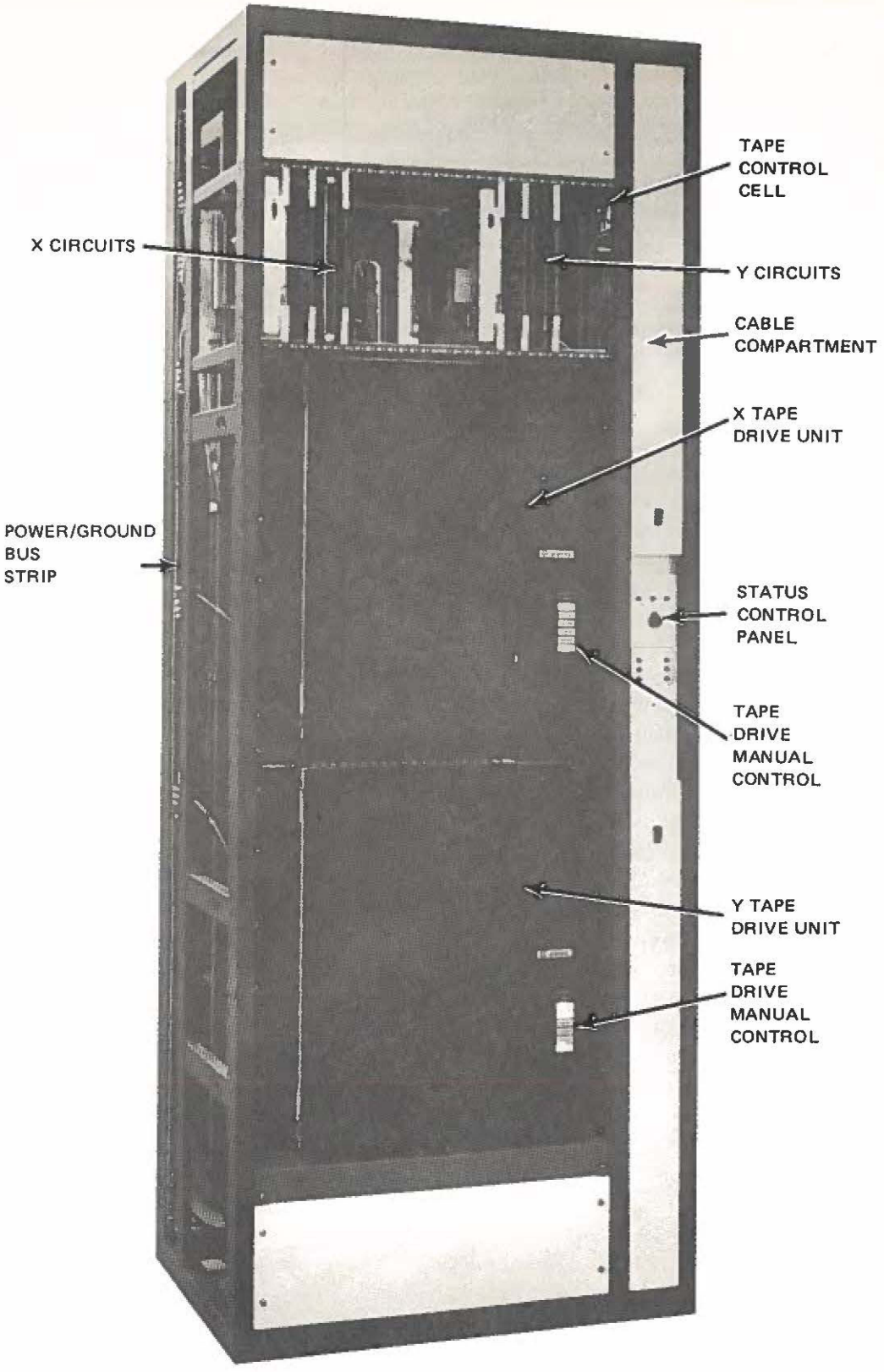

Figure 4. CAMA/LAMA Subsystem AMA Frame Layout

whereas tape interface buffer Y is installed in PWBA position 72).

3. Tape motion control, 814291-526 (duplicated, X and Y; tape motion control X occupies PWBA position 19, whereas tape motion control Y occupies PWBA position 78).

4. Tape buffer, 814298-526 (duplicated, X and Y; tape buffer X is installed in PWBA position 22, whereas tape buffer Y is installed in PWBA position 81).

5.05 Tape Drive Units.

The CAMA/LAMA subsystem uses redundant X-side and Y-side tape drive units to record call information on magnetic tape. The two tape drive units are mounted, one above the other, in the AMAF. The upper unit is the X-side tape drive; the lower unit is the Y-side tape drive. The front panel of each tape drive unit contains switches/indicators for applying tape drive unit power, advancing tape to the load point, selecting the on-line unit, rewinding the tape, advancing the tape, reversing the tape, and indicating that the file ring is installed on the tape reel to enable write operations. The standard tape drive units provided with the CAMA/LAMA subsystem record information at 800 CPI. However, as an option, the subsystem can be supplied with tape drive units that record at 1600 CPI.

5.06 AMAF Status/Control Panel.

The AMAF status/control panel (fig. 5) contains POWER, ACTIVE, and ALARM status indicator lamps for sides X and Y of the CAMA/LAMA subsystem, as well as a MANUAL SELECT switch. The MANUAL SELECT switch allows maintenance and administration personnel to leave the selection of the on-line side under control of the maintenance processor (AUTO position) or to select the on-line side manually (X SIDE or Y SIDE position). A LAMP TEST switch at the bottom of the panel lights all the status indicator lamps on the panel to ensure that they are operative.

6. CABLE RACEWAYS AND TROUGHS

6.01 Raceways can be used for running cables under the floor to the AMAF. Overhead cable troughs or grid cable racks can also be provided for routing cables. Instructions for installing the cables that connect the AMAF to the MAF (in some systems, the CMF) are contained in the section titled *CAMA/LAMA Subsystem, Installation*, referenced in paragraph 2.02.

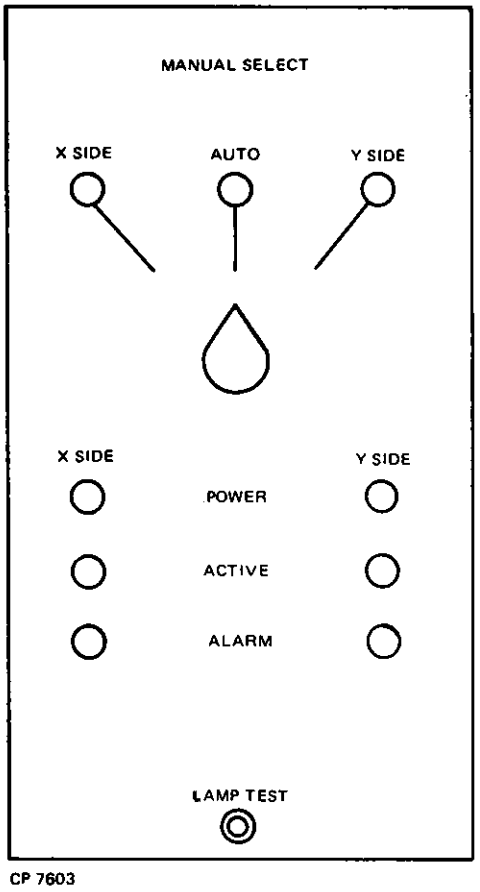

Figure 5. AMAF Status/Control Panel

7. POWER

7.01 The DCO office battery supplies the AMAF with -44 to -54 Vdc. The X and Y logic power PWBAs convert this voltage to ±5 Vdc The ±5 Vdc from the logic power PWBAs is used in the respective X- or Y-side circuits. A green LED on each logic power PWBA indicates the status of the PWBA. An alarm is indicated when the LED is dark. The DCO also supplies -44 to -54 Vdc to the tape drive units.

PART II. TECHNICAL CHARACTERISTICS

8. SUBSYSTEM CHARACTERISTICS

8.01 General.

Table 1 lists the physical, electrical, and environmental characteristics and specifications for the CAMA/LAMA subsystem.

8.02 Main Battery.

Power for the CAMA/LAMA subsystem (−44 to −54 Vdc) is supplied to the AMAF from the regular and standby power supplies in the DCO via circuit breakers on the DCO battery distribution frame (BDF).

8.03 Logic Voltage Converters.

Redundant voltage converters are located on logic power supply PWBAs in the AMAF. They convert the main battery voltage (−44 to −54 Vdc) to ±5 Vdc for use in the AMAF logic.

8.04 Tape Drive Power.

The tape drive unit receives −44 to −54 Vdc from the DCO battery distribution system.

9. ENVIRONMENTAL REQUIREMENTS

9.01 Operating.

The operating ambient environment should be between 32 °F (0 °C) and 85 °F (29.4 °C) and between 20 and 65 percent relative humidity. The operating environment can increase up to 120 °F (49 °C) and 90 percent humidity for 8 continuous hours provided it does not occur more than three times in 12 months.

9.02 Nonoperating.

The equipment is not adversely affected by nonoperating or storage temperature limits of 40 °F (−40 °C) to 160 °F (71.1 °C) at 100 percent (noncondensing) humidity.

Table 1. Subsystem Characteristics

CHARACTERISTIC	*SPECIFICATION*
Tape Drive Unit	
Power Input	−44 to −54 Vdc
Power Consumption	Min. 110 watts, max. 280 watts
Reel Size	10.5 in. (26.7 cm)
Reel Capacity	2400 ft (731.5 m) of 0.5 in. (1.27 cm) computer tape
Height	24.5 in. (62.2 cm)
Width	19.0 in. (48.3 cm)
Depth	15.6 in. (39.6 cm)
Weight	90 lb (40.8 kg)
Tape Format	Fixed - variable length
Operating Temperature Range	32 °F to 85 °F (0 °C to 30 °C)
Humidity	20% to 65% (noncondensing)
CAMA/LAMA Frame	
Power Input	−44 to −54 Vdc
Power Consumption	Max. 600 watts
Height	86 in. (218 cm)
Width	32 in. (81.3 cm)
Depth	22 in. (55.9 cm)
Weight	500 lb (227 kg)

PART III. FUNCTIONAL DESCRIPTION

10. FUNCTIONAL SEPARATION AND REDUNDANCY

10.01 The equipment that constitutes the CAMA/LAMA subsystem is duplicated to provide redundancy in the subsystem similar to the redundancy in the host DCO switch. However, to minimize interruptions in the recording of call data that might occur during switchovers between redundant sides (of either the DCO or the subsystem), the redundancy in the CAMA/LAMA subsystem is independent of the redundancy in the DCO switch. The on-line operation of the DCO can switch between side A and side B without affecting the recording of call data, and the active recording of data can be switched between side X and Y of the subsystem without requiring a DCO switchover. This dual redundancy is provided through a functional separation between the DCO switch and the CAMA/LAMA subsystem.

10.02 This functional separation, shown in figure 6, actually occurs within the CAMA/LAMA subsystem itself. The tape bus interface PWBAs, although functionally part of the subsystem, are mounted in the MAF (or, in some cases, the CMF) and are A/B redundant like the DCO switch. On the other hand, the tape interface buffer, tape buffer, tape motion control, and tape logic power supply PWBAs and the tape drive units are mounted in the AMAF and are X/Y redundant. This separation between the A/B-redundant and X/Y-redundant portions of the subsystem is bridged by the tape bus, which carries data, timing, and control signals between the tape bus interface and the tape interface buffer.

10.03 To provide the dual redundancy necessary to ensure reliable recording of call data, both A/B-redundant tape bus interface PWBAs are connected to both X/Y-redundant tape interface buffers. These cross connections, via interframe cabling between the MAF (or, in some cases, the CMF) and the AMAF, allow whichever side of the DCO switch is on line (A or B) to transmit call data to both sides (X and Y) of the subsystem simultaneously. Then, if call processing should switch over to the side of the DCO switch that previously was off line, uninterrupted call data still is transmitted simultaneously to both redundant sides of the subsystem. In the subsystem, the call data is processed by both redundant sides, but only the side that is in the active mode actually records the data on tape.

11. SUBSYSTEM OPERATION

11.01 General.

The circuits and equipment that constitute one side of the CAMA/LAMA subsystem are shown in figure FO-1. The paragraphs that follow describe how these circuits operate during normal call data recording and error reporting.

11.02 Normal Call Data Recording.

a. Call data to be recorded by the CAMA/LAMA subsystem can be for toll ticketing, optional measured in-WATS (WX) or measured out-WATS (WO) recording, or optional usage-sensitive recording (USR). The data to be recorded is collected by the CP during the various stages of a call and accumulated in a software buffer.

b. The data collected for toll ticketing includes the following:

1. Connect time.
2. Disconnect time.
3. Calling party's directory number.
4. Special call features (call forwarding, call waiting, etc.).
5. Called party's directory number.
6. Call record information (incomplete, cancelled, etc.).
7. Connect date.
8. Traffic study indicator.
9. Calling party's equipment number.
10. Called party's equipment number.
11. MF tone receiver equipment number.
12. MF tone sender equipment number.
13. Elapsed time.

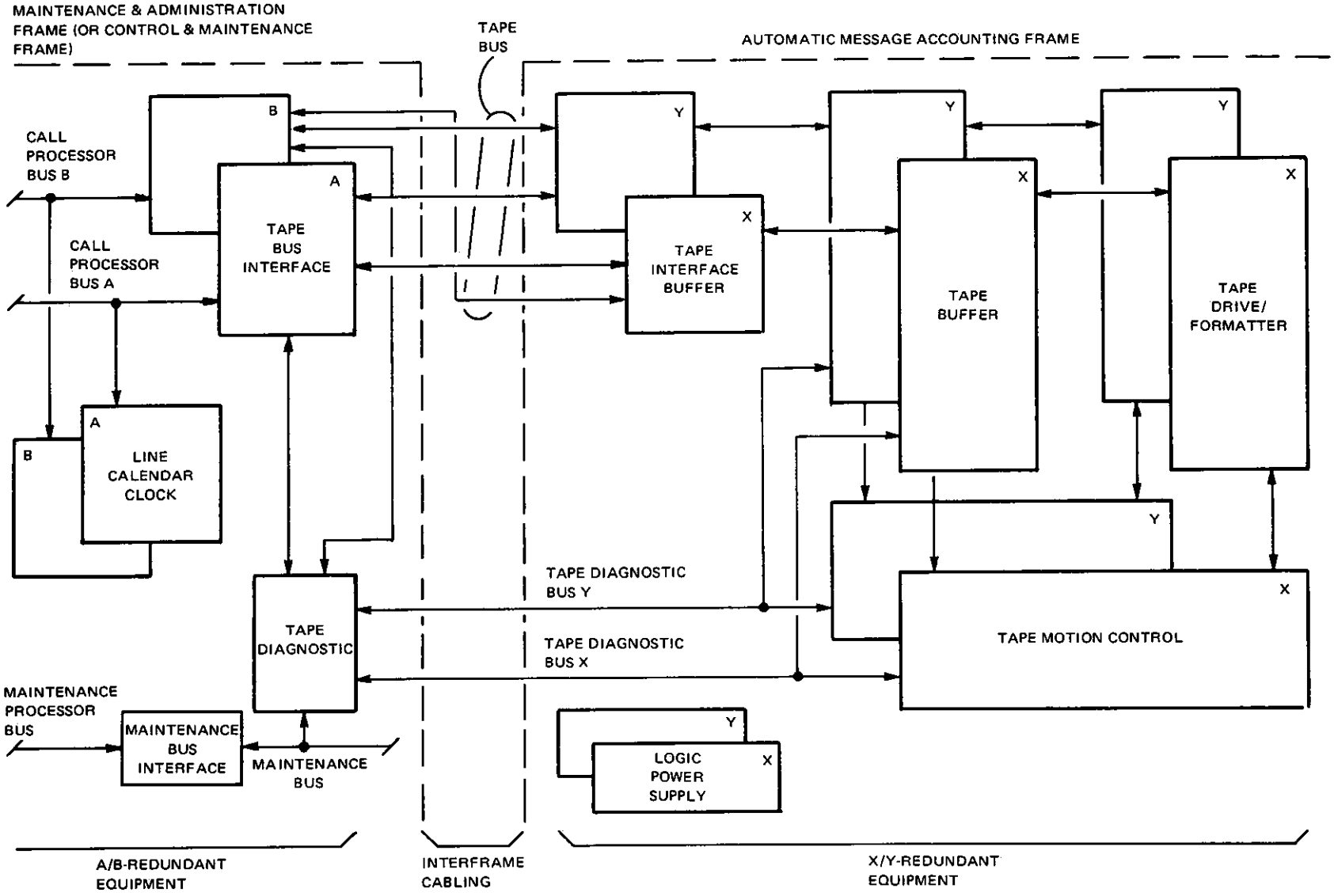

Figure 6. CAMA/LAMA Subsystem, Functional Separation and Redundancy of Equipment

14. Type of call (SSSP, WATS, etc.).

15. Information digit (ANI, ONI, or (ANIF).

16. Number of time changes.

17. Midnights passed.

18. Operator position for ONI.

c. The time information included in the collected data (connect time, disconnect time, connect date, etc.) is read from the CP line calendar clock (fig. 7). This clock contains dividing circuits that count in years, months, days, hours, minutes, seconds, tenths of a second, and 250ths of a second. The outputs of these dividing circuits are stored in registers, which are read by the CP to determine the date, time, and exact duration of a call.

d. For the optional measured in-WATS feature, the CP software collects the same call information as for toll ticketing. In addition, however, the CP also collects information specifying the type of each in-WATS call. Data recorded by the subsystem for an in-WATS call that originates in the DCO includes the call type, originating WX (in-WATS). The record for an in-WATS call that terminates in the DCO includes the call type, terminating WX, plus a dummy calling directory number.

e. The optional measured out-WATS feature requires that the CP software collect the same data as for toll ticketing, plus the call type (WO) and the band (service area) identification.

f. If the DCO has the optional USR feature, the CP software determines from a calling subscriber's class of service whether that subscriber's bill should be based on use of the telephone service rather than on a flat rate. If so, the CP collects the information necessary to produce a subscriber ticket for each call originated by that subscriber. Such usage-sensitive call records can be made for single- or two-party originations and can accommodate speed calling (abbreviated dialing), three-way calling, call forwarding, and off-hook service (fixed call address).

g. After all the data required for a call record is accumulated, the CP arranges it into the format specified by a software format table. The call then is transferred via the CP bus to the tape bus interface PWBA, where it is loaded into the 256-by-9-bit local buffer. The call record is transferred over the CP bus one 16-bit word at a time and received in the tape bus interface by a bank of bus transceivers (fig. 8).

h. From the bus transceivers, the 16-bit word is strobed into the data/command register (address, 167002*). A data clock signal derived from the DOUT control signal that accompanies the output data word on the CP bus strobes the data word into the register. After the data word is latched in the data/command register, the high/low byte select multiplexer selects the lower byte (bits 0-7) and then the upper byte (bits 8-15) of the register outputs for loading into the 256-by-9-bit local buffer.

i. Timing and control logic on the tape bus interface PWBA provides enabling signals, RAM addresses, and write pulses to load first the lower and then the upper byte of call record data into the local buffer. These signals, addresses, and pulses are repeated in the same sequence for each 16-bit data word transferred from the CP to the tape bus interface. When the final word of the completed call record has been transferred, the CP issues to the tape bus interface a command to send the call record to the 4K RAM (also referred to as the remote buffer) on the tape interface buffer PWBA.

j. The command to send the call record to the 4K RAM sets bit 0 in the CP command/status register (address, 167000) on the tape bus interface PWBA. This bit causes the timing and control logic to cycle through a series of state control signals that read 1 byte from the 256-by-9-bit local buffer and load it into the universal asynchronous receiver/transmitter (UART).

*The CP, with CP memory management enabled, accesses registers on the tape bus interface PWBA by issuing addresses in the 167XXX format. The MP, using the data link, addresses these same registers by issuing addresses in the 147XXX format.

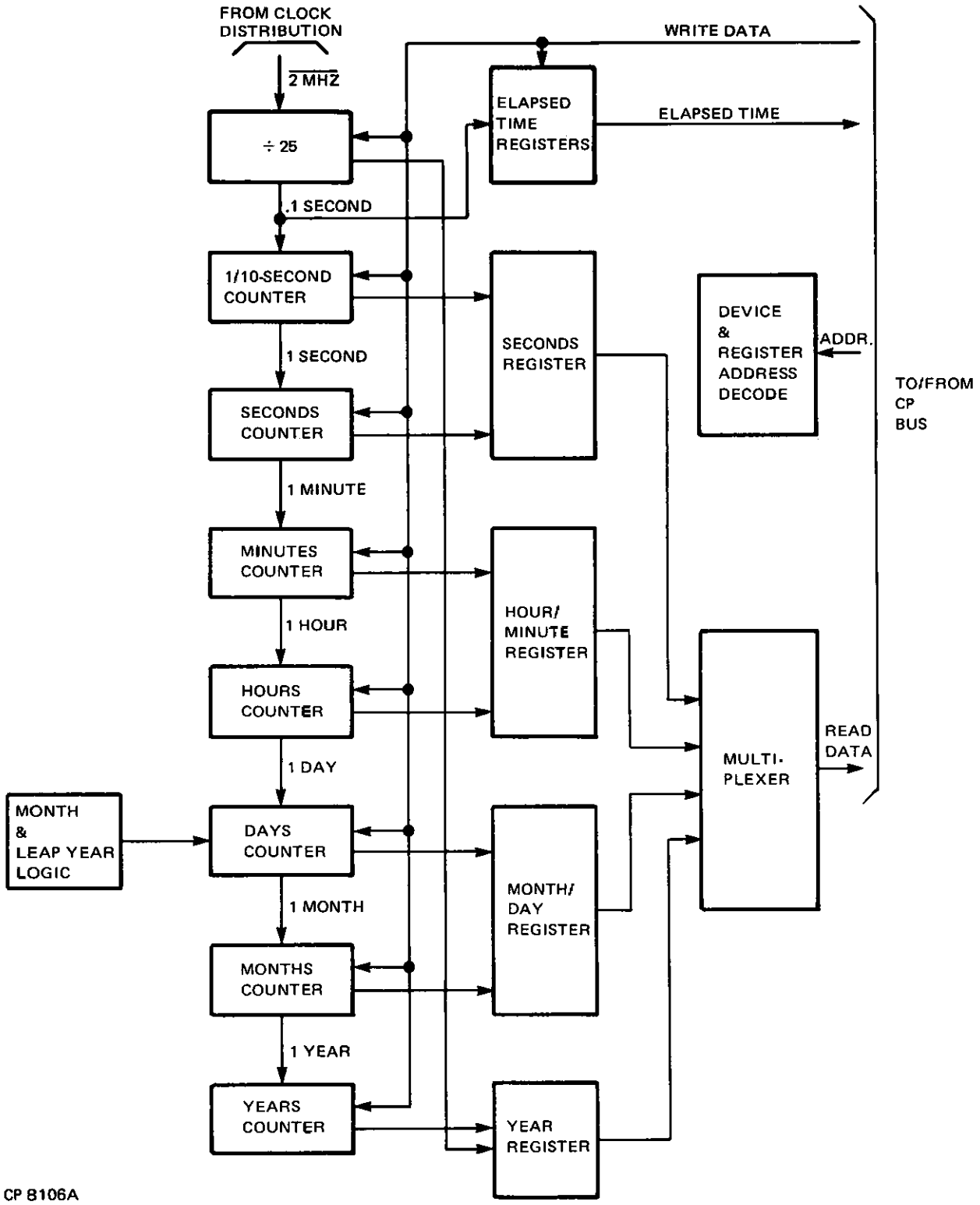

Figure 7. CP Line Calendar Clock, Functional Block Diagram

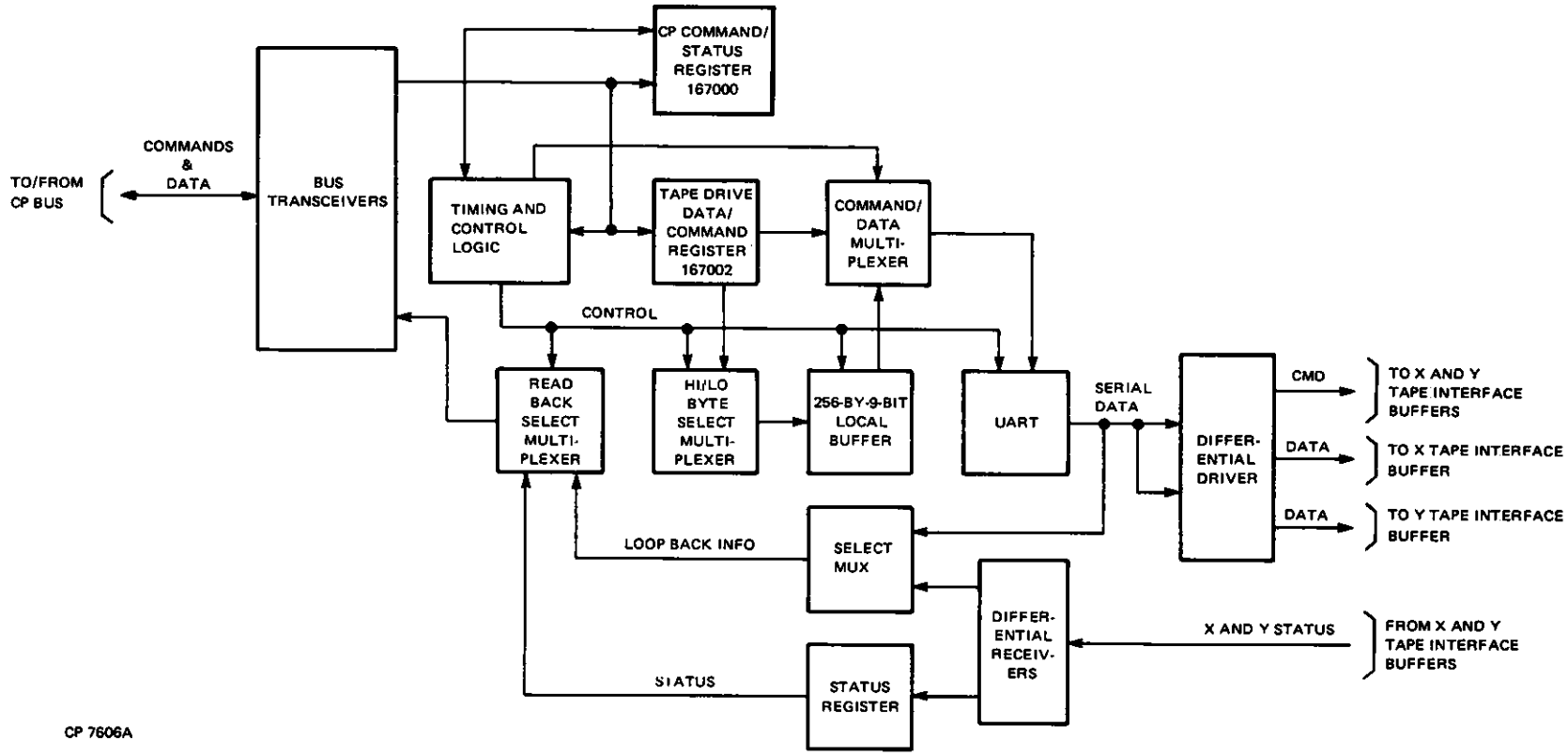

Figure 8. Tape Bus Interface, Functional Block Diagram

k. The data byte is read from the local buffer and loaded into the transmit register of the UART in parallel form. A start bit, an odd parity bit, and two stop bits are added to the eight data bits. Then the data byte is transmitted in serial form over the tape bus to the receive section of the UART on the tape interface buffer PWBA. When the transmit register of the UART on the tape bus interface PWBA is empty, another byte of call record data is moved into the UART from the local buffer. Then, this byte is transmitted to the UART in the tape interface buffer. This procedure is repeated until the entire call record is emptied from the local buffer and transmitted to the tape interface buffer.

l. Each serial byte of call data received by the tape interface buffer is shifted into the receive section of the UART by the UART control logic on the tape interface buffer PWBA (fig. 9). The UART checks the parity of the serial data received and then arranges the data into 8-bit parallel form for transfer to the tape buffer PWBA.

m. Command/data timing and control logic on the tape interface buffer PWBA generates a data register clock that latches the parallel data outputs from the UART into the CP data register (address, 164124) on the tape buffer PWBA (fig. 10). From this register, the byte of call record data is gated by the RAM input multiplexer back to the 4K RAM (remote buffer) on the tape interface buffer PWBA. Under control of the 12-bit RAM address counter on the tape interface buffer PWBA, the data byte is loaded into the 4K RAM.

n. This sequence of transferring records of calls from the CP through the local buffer, the UARTs, and the CP data register and into the 4K RAM continues until the CP determines that a complete block of call records has been transferred. Then the CP issues a command to write the block of call records onto the tape in the tape drive.

o. To initiate the writing of the block of call records onto tape, the CP sends a command word with bit 1 set to the CP command/status

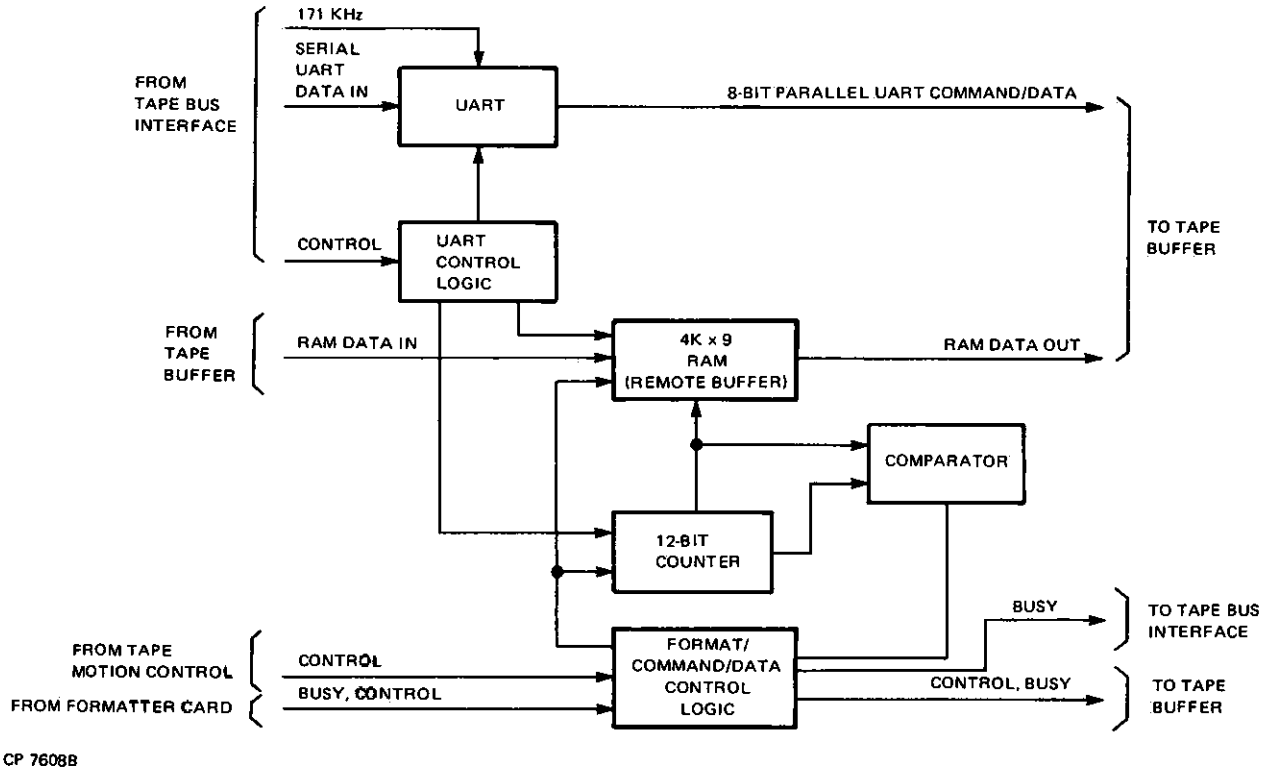

Figure 9. Tape Interface Buffer, Functional Block Diagram

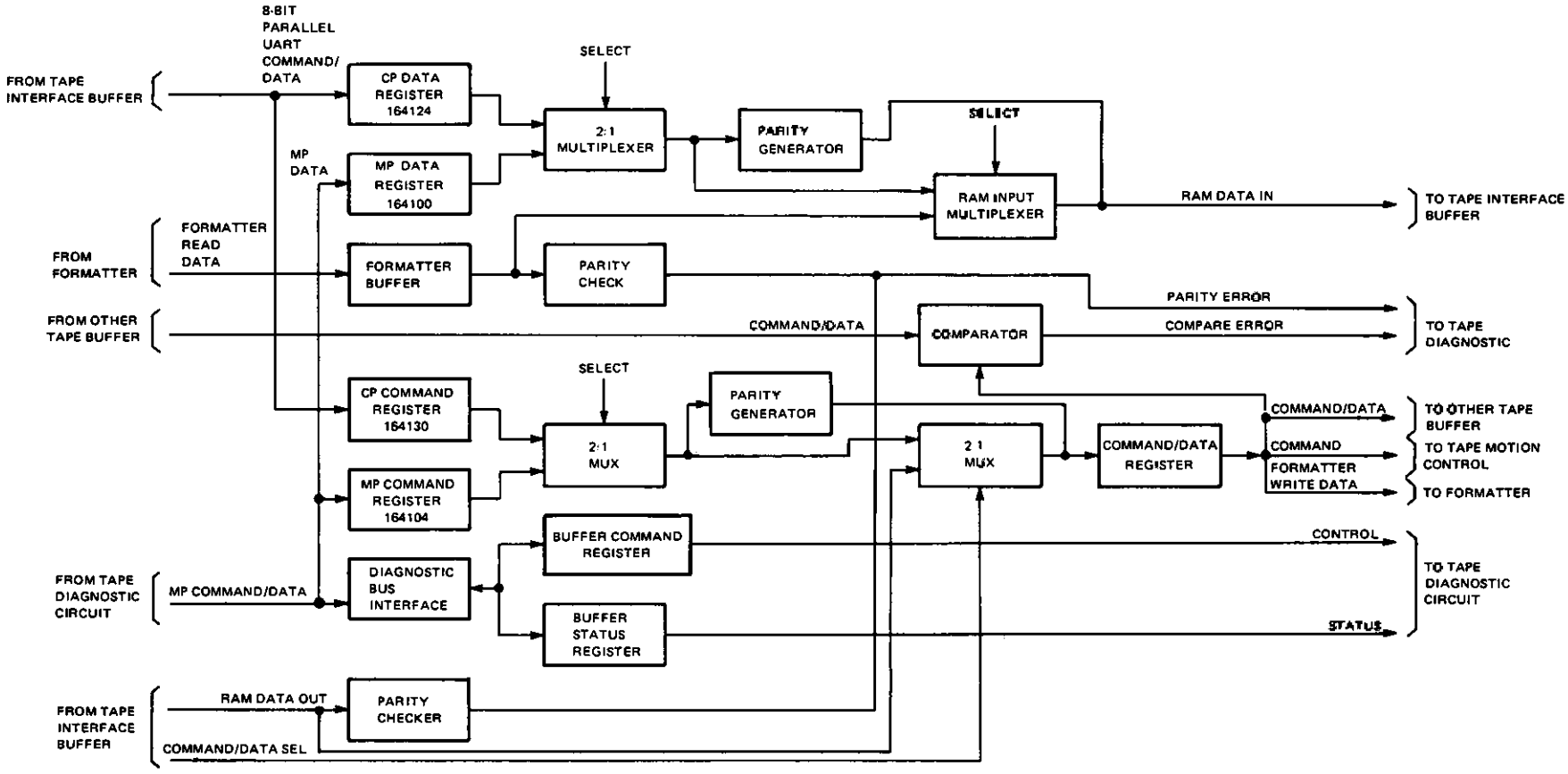

Figure 10. Tape Buffer, Functional Block Diagram

register (address, 167000) on the tape bus interface PWBA. This signifies that the 8 bits that subsequently are sent to the tape drive data/command register (address, 167002) constitute a command to the tape motion control PWBA. This 8-bit command, after being loaded into the tape drive data/command register, bypasses the 256-by-9-bit local buffer and is sent, via the UARTs, the tape bus, and the tape interface buffer PWBA, to the CP command register (address, 164130) on the tape buffer PWBA. After being stored in the CP command register, the command passes through command and data multiplexers and a parity generator before being stored in a command/data register for subsequent transfer to the tape motion control PWBA.

p. The command to write the block of data onto tape is received by the tape motion control PWBA (fig. 11) as the address of a microprogram stored in the microcontrol PROM. This address accesses a series of microwords in the PROM that control specific sequential operations in the tape motion control, tape interface buffer, tape buffer, and tape formatter circuits.

q. The microprogram accessed by the write command first verifies that the tape drive is ready to receive data (i.e., the tape drive power is on, the tension of the tape in the drive unit is correct, the tape is at the load point, and the tape drive unit is on line). Then the microprogram ensures that the tape drive/formatter is not busy (i.e., in motion or executing a previously issued command). When these initial conditions are met, the microprogram generates a signal to latch in a register the address of the last byte of call record data that was stored in the 4K RAM on the tape interface buffer PWBA and to reset the RAM-addressing circuitry to zero. (This resetting of the RAM-addressing circuitry is referred to as topping the pointer.)

r. With the RAM address at zero, the first byte of stored call record data is read from the RAM. This byte of data is transferred to the tape buffer PWBA, where it is latched into the command/data register. At approximately the same time that the signal to top the RAM pointer is generated, the microprogram also generates a write command signal to the tape drive formatter. In response, the formatter generates a write strobe to transfer the byte of data in the command/data register on the tape buffer PWBA to the formatter. The byte is then written onto the tape in the tape drive. Following this, the RAM address is incremented, and the next byte of call record data is transferred to the command/data register on the tape buffer PWBA, to be written onto tape when the next write strobe is generated by the formatter.

s. Each time the RAM address is incremented, it is compared with the final address that was stored when the RAM pointer was topped.

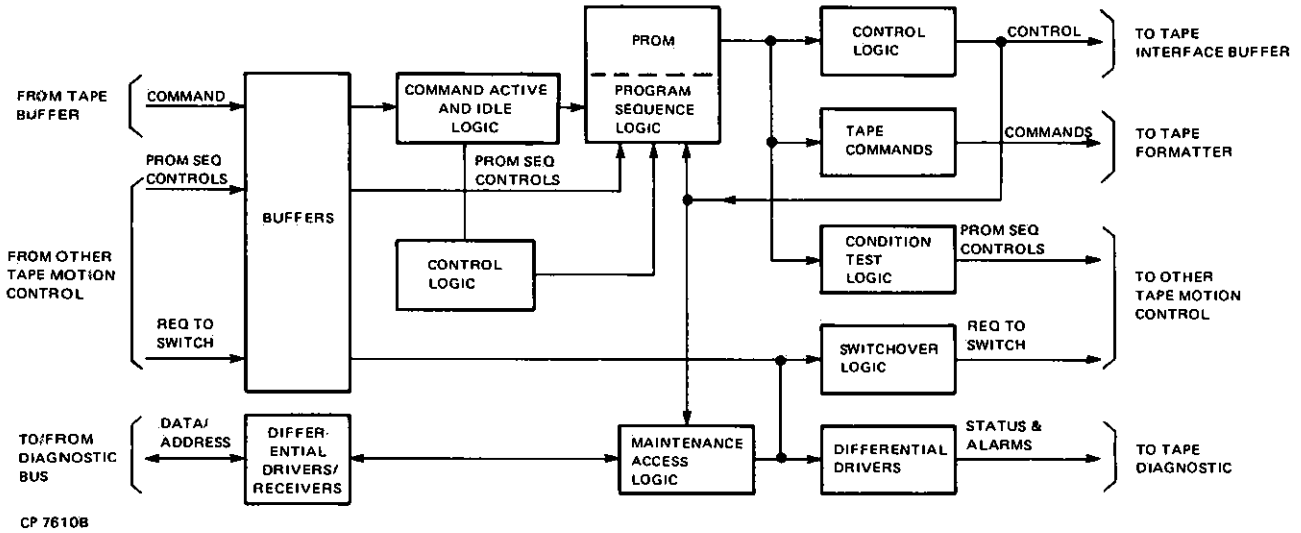

Figure 11. Tape Motion Control, Functional Block Diagram

When the incremented address equals this stored final address, the tape drive formatter generates one more write strobe to read the final byte from the 4K RAM and write it onto the tape. Then the microprogram reads the status of the tape drive/formatter to ensure that the block of call records was written without errors.

t. If an error is reported, the entire write operation is attempted up to three more times before a hardware switchover to the other side of the subsystem is requested. However, if no error is reported by the tape drive/formatter, the microprogram increments the block counter on the tape motion control PWBA, clears the RAM address pointer to prepare the 4K RAM to receive another block of call records, and switches the tape motion control circuitry from the active state to the idle state. At this point, the 4K RAM is ready again to begin receiving bytes of call record data from the 256-by-9-bit local buffer.

u. Figure 12 shows how the blocks of call records are arranged on the tape in relation to the volume/serial label, headers, tapemarks, and end-of-file labels on a typical CAMA/LAMA tape.

11.03 Error Reporting.

a. Errors in the operation of the CAMA/LAMA subsystem are detected in either of two ways: by software in the CP or by error-reporting circuits on the subsystem PWBAs. In the first instance, if software in the CP detects that the software buffers that accumulate call records are about to overflow, the CP initiates an error-processing operation by the MP. In the second instance, error reports generated by circuitry on one or more of the following subsystem PWBAs result in error-processing operations by the MP:

1. Tape bus interface (A or B).

2. Tape buffer (X or Y).

3. Tape motion control (X or Y).

b. The following paragraphs describe the types of hardware errors detected by these PWBAs, how the errors are reported, and how the error reports are converted into interrupts to the MP. Included is a description of how the MP subsequently analyzes the fault information stored by the subsystem PWBAs to determine the appropriate system response.

c. Mounted in the MAF (or, in some systems, the CMF), the A/B-redundant tape bus interface reports errors in the operation of the 256-by-9-bit local buffer (RAM) and the UART mounted on the tape bus interface PWBA (fig. 13). In addition, the tape bus interface reports loose connections in, or the absence of, the cable that carries data between the UARTs in the tape bus interface and the tape interface buffer. The failure of this UART link to transfer data after four successive attempts also is reported through the tape bus interface.

d. The signals representing these errors are logically ORed to generate the AERR (tape bus interface A) or BERR (tape bus interface B) signal to the tape diagnostic PWBA. The bits representing these conditions can be read by the MP, via the data link, by addressing the CP command/status register (address, 147000) and the MP command/status register (address, 147004). The bit formats for these registers are shown in figures 14 and 15, respectively.

e. The tape drive data/command register normally is used to transfer data and commands to the tape drive, but it also can be used to read back diagnostic data and UART status bits. When bit 7 (maintenance loop-back mode) is set in either the CP command/status register or the MP command/status register, a diagnostic data pattern sent to the UART is looped back and stored in bits 0 through 7 of the tape drive data/command register. Bits 12 through 15 of this register are used during the maintenance loop-back mode to store the status of the UART operation. The loop-back data and the UART status bits are read when address 147002 is issued. Figure 16 shows the bit assignments in the tape drive data/command register for both the normal and the loop-back modes of operation.

f. Various errors detected on the tape buffer PWBA and the tape interface buffer PWBA are reported by the tape buffer as shown in figure

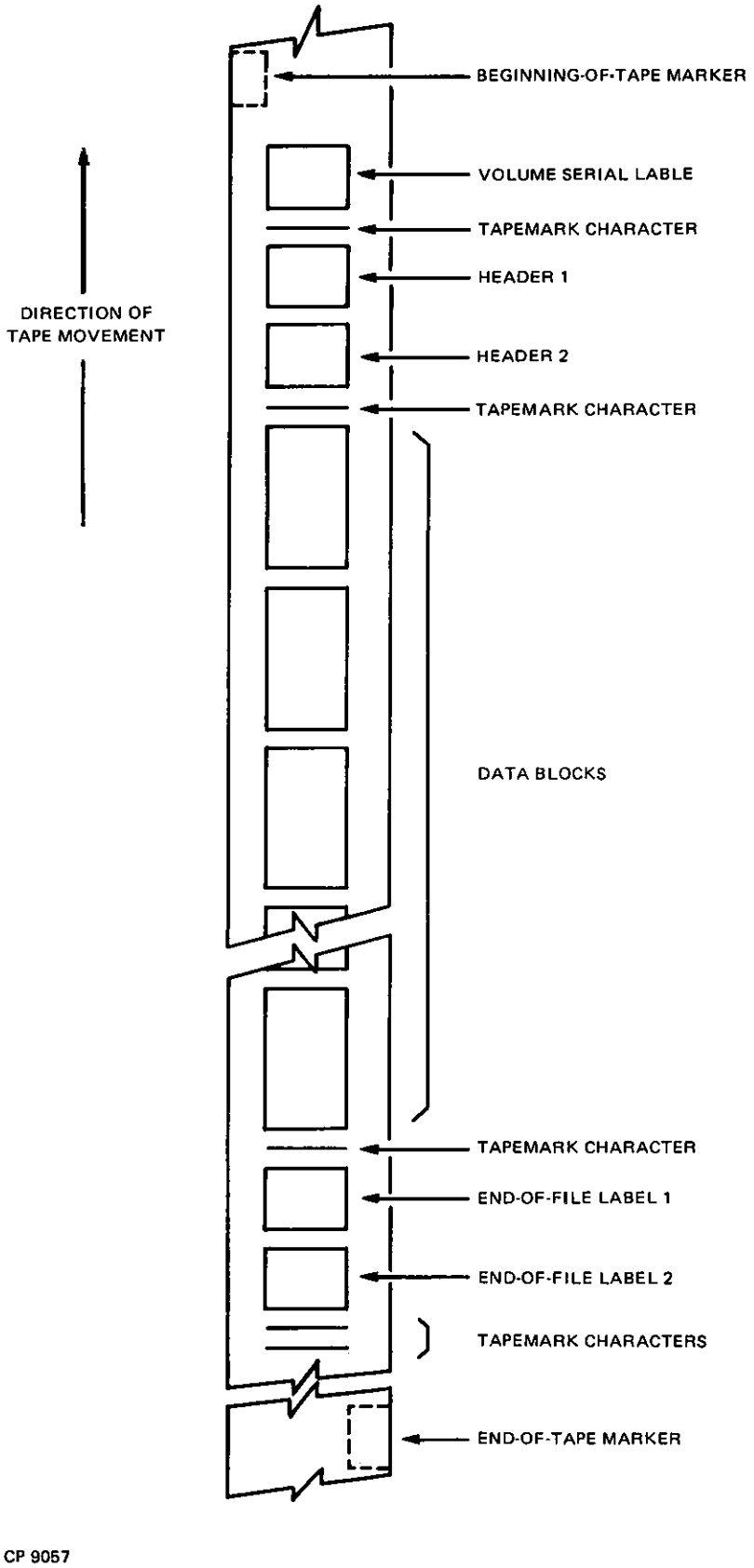

Figure 12. Typical CAMA/LAMA Tape Data Format

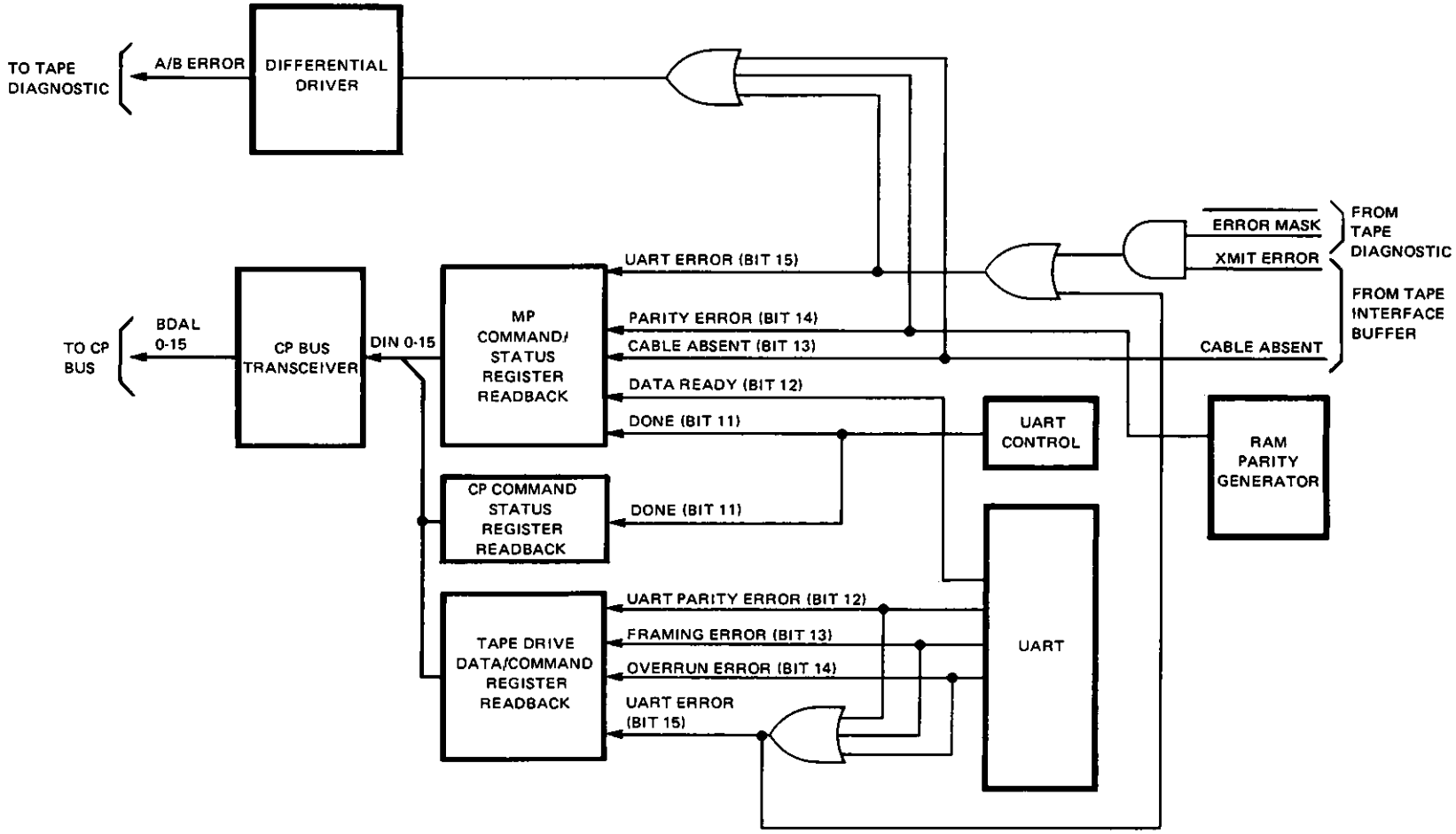

Figure 13. Tape Bus Interface Error/Status Reporting

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8
				DONE			

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
MAINT LOOP BACK MODE	SIDE SELECT		<-- C O M M A N D S -->			MOTION CONTROL COMMAND OR 0=DATA	LOCAL BUFFER TRANS-FER
	0 0 = NO ACTION 0 1 = A->X,B->Y 1 0 = A->Y,B->X 1 1 = NO ACTION		00 0 = NO ACTION 00 1 = RESET 01 0 = WRITE TO BUFFER 01 1 = SIMULATE ERROR 10 0 = RESET ERR LATCH 10 1 = LONG LOOP XMIT				

CP 9059

Figure 14. Bit Format of Tape Bus Interface CP Command/Status Register (147000)

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8
UART ERROR	RAM PARITY ERROR	CABLE ABSENT ERROR	DATA READY	DONE			

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
MAINT LOOP BACK MODE	SIDE SELECT		<-- C O M M A N D S - ->			MOTION CONTROL COMMAND OR 0 = DATA	LOCAL BUFFER TRANS-FER
	0 0 = NO ACTION 0 1 = A->X,B->Y 1 0 = A->Y,B->X 1 1 = NO ACTION		00 0 = NO ACTION 00 1 = RESET 01 0 = WRITE TO BUFFER 01 1 = SIMULATE ERROR 10 0 = RESET ERR LATCH 10 1 = LONG LOOP XMIT				

CP 9061

Figure 15. Bit Format of Tape Bus Interface MP Command/Status Register (147004)

17. These errors include parity errors in data read from the 4K RAM and from the tape drive formatter. These errors also include faults in the operation of the receive UART on the tape interface buffer PWBA and CRC errors from the tape drive formatter.

g. Logical ORing of these error signals generates the XERR (tape buffer X) or YERR (tape buffer Y) signal to the tape diagnostic PWBA. In addition, if the same command or data words to both the X and the Y sides are found not to be identical, the compare error is generated to the tape diagnostic PWBA as the TB MISMATCH X (tape buffer X) or TB MISMATCH Y (tape buffer Y) signal. Bits representing these various errors are stored on the tape buffer PWBA in register 4 and can be read by the MP by issuing the address 164120 for tape buffer X or 164122 for tape buffer Y. Figure 18 shows the bit format of the data stored in the register.

h. Status receivers and registers on the tape motion control PWBA report errors and status from the tape drive formatter, the tape interface buffer PWBA, and the tape motion control PWBA itself. The error signals and status conditions that require a switchover to the opposite side of the

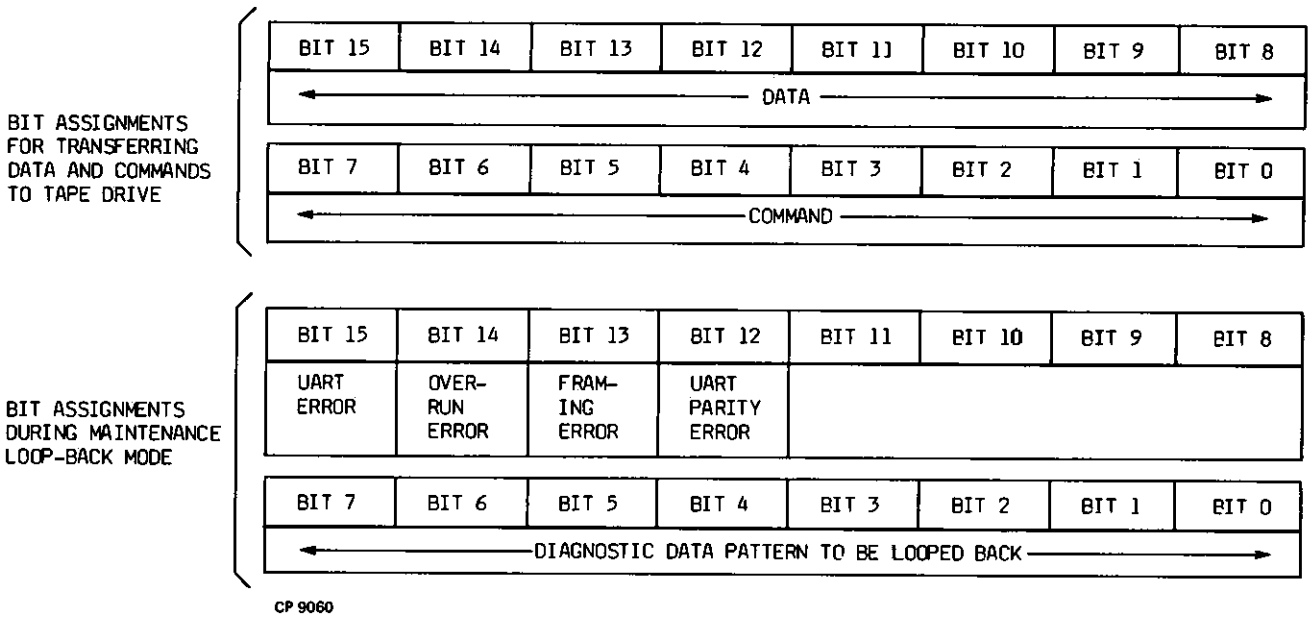

Figure 16. Bit Format of Tape Bus Interface Tape Drive Data/Command Register (147002)

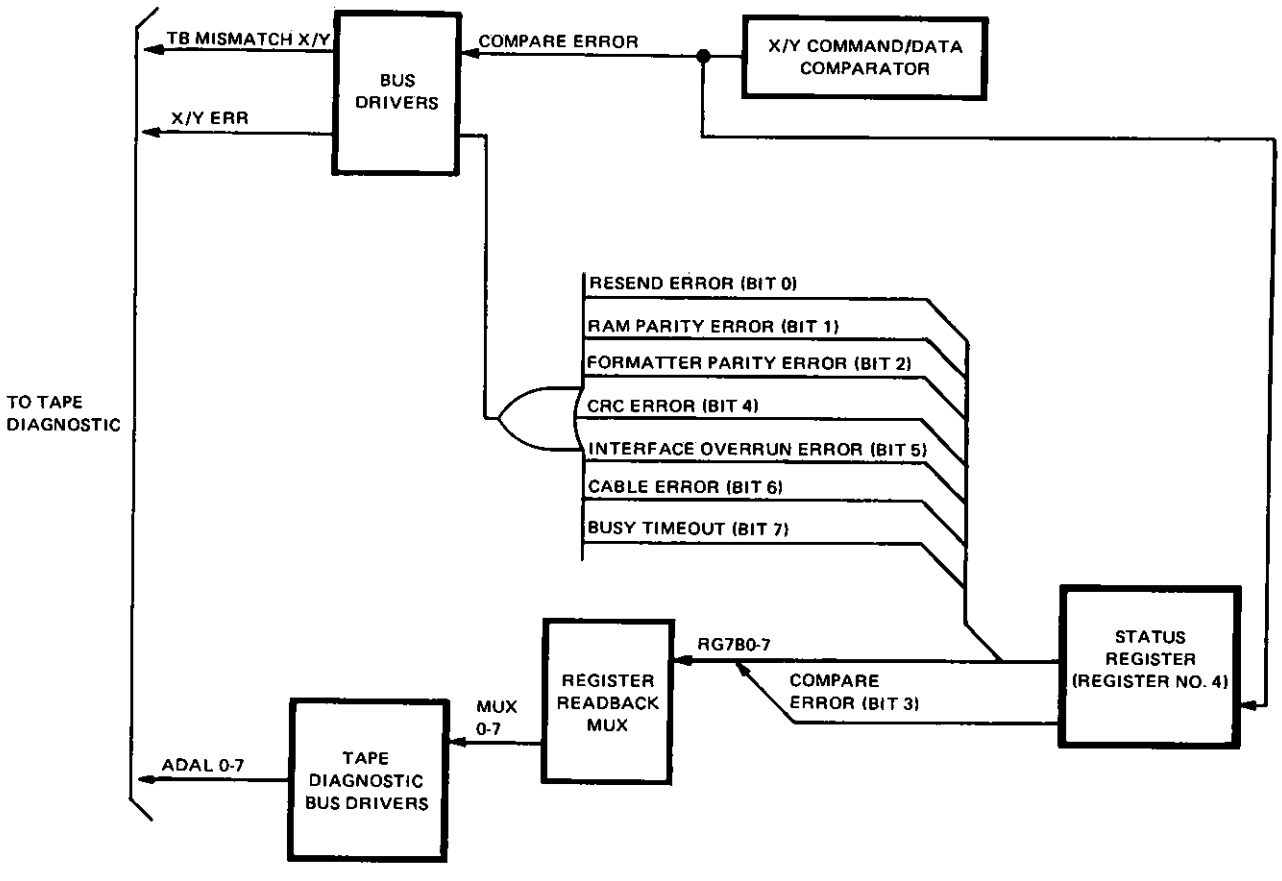

Figure 17. Tape Buffer Error/Status Reporting

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
BUSY TIMEOUT ERROR	CABLE ERROR	INTFC OVERRUN ERROR	CRC ERROR	COMPARE ERROR	FMTR PARITY ERROR	RAM PARITY ERROR	RESEND ERROR

CP 9063

Figure 18. Bit Format of Tape Buffer Status Register (X = 164120, Y = 164122)

subsystem are logically ORed (fig. 19) to generate the MC FLAG X (tape motion control X) or MC FLAG Y (tape motion control Y) signal to the tape diagnostic PWBA.

i All the error and status conditions reported through the tape motion control PWBA can be read by the MP by issuing the addresses 164014, 164020, and 164030 (tape motion control X) or 164016, 164022, 164032 (tape motion control Y). Figures 20 through 22 show the bit formats of the status words accessed by these addresses.

j. Error signals from the tape bus interface PWBAs (A and B), the tape buffer PWBAs (X and Y), the tape motion control PWBAs (X and Y), and the AMAF power supplies (X and Y) are transferred over the tape diagnostic bus from the AMAF to the MAF (or, in some systems, the CMF) and applied to error-masking circuits on the tape diagnostic PWBA (fig. FO-1). These error signals then are applied to two maintenance status registers on the tape diagnostic PWBA (fig. 23).

k. Status register 1 stores the A-side and X-side errors; status register 2 stores the B-side and Y-side errors. These registers can be read by the MP by issuing the addresses 164054 and 164056, respectively. Figures 24 and 25 show the bit formats of these status registers. The signals stored in the status registers also are logically ORed to generate the tape diagnostic error flag (MERR) to the MBI.

l. When a CAMA/LAMA error causes the tape diagnostic PWBA to generate the error flag, the flag is stored as bit 10 of the status register in the MBI. The MBI then interrupts the MP. After acknowledging the interrupt, the MP determines, by reading the MBI status register, that the tape diagnostic PWBA is the interrupting device. Based on this information, the MP sends a pattern of masking bits to the mask register in the MBI.

m. As a result, bit 10 of the MBI status register is masked, cancelling the interrupt request and allowing the MP to read maintenance status registers 1 and 2 on the tape diagnostic PWBA. The MP also reads the status registers on the tape buffer PWBAs (X and Y) and the tape motion control PWBAs (X and Y). Then the CAMA/LAMA error-handling software in the MP begins analyzing the contents of these registers in an attempt to isolate the error.

n. First, the MP software builds an A/B error code based on the contents of the status registers of the tape diagnostic and tape motion control PWBAs. This error code then is compared against an A/B error table to determine if an A- or B-side equipment error caused the tape diagnostic flag to be sent to the MBI. If an A- or B-side error is the cause, an error handler subroutine causes a message to that effect to be printed.

o. If the faulted side still is on line, the subroutine requests an A/B switchover and then masks the A/B error logic in the tape diagnostic. If the CAMA/LAMA error flag persists in the MBI status register, the MP software proceeds to test for X- or Y-side equipment errors.

p. However, if masking the A/B error cancels the CAMA/LAMA error, the MP software sets the office alert alarm, requests the CP to resume call data recording, and prints a fault card list. For more information about the fault card (repair) list, refer to the section titled *Message Dictionary*, referenced in paragraph 2.02.

q. If the MP finds no A- or B-side equipment errors, or if masking the A/B error does not clear the CAMA/LAMA error flag in the MBI status register, the MP software begins checking for X- or Y-side equipment errors. The MP software builds an X/Y error code based on the contents of the status registers on the tape diagnostic,

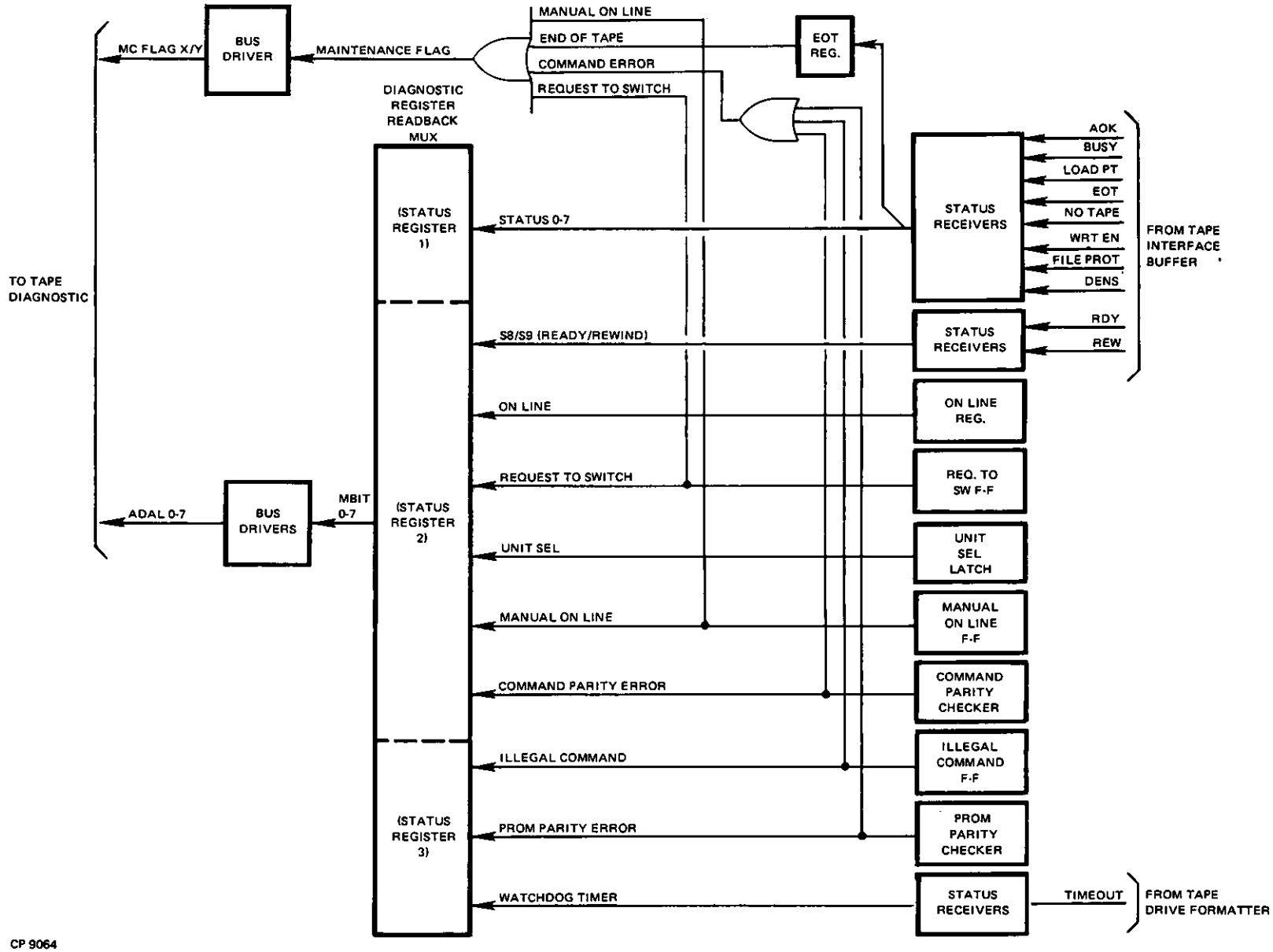

Figure 19. Tape Motion Control Error/Status Reporting

tape buffer, and tape motion control PWBAs. Then the software compares this error code with an X/Y error table.

r. If this comparison reveals that an X- or Y-side equipment error caused the CAMA/LAMA error flag, an appropriate error handler subroutine causes a message pertinent to the error to be printed and initiates the required system response to the error. However, if no X- or Y-side error can be identified, the MP causes the UNCLASSIFIED ERROR message to be printed and then retests the AMA error bit (bit 10) in the MBI status register to determine if the error still exists. If the AMA error is found no longer to exist, the MP unmasks the AMA error bit in the MBI and exits the error-handling routine. On the other hand, if the AMA error is found still to exist, the MP causes the CAN'T UNMASK MBI message to be printed and triggers the "Office Alert" alarm.

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
DENSITY	FILE PROTECT	WRITE ENABLE	NO TAPE	END-OF-TAPE	LOAD POINT	BUSY	AOK

CP 9065

Figure 20. Bit Format of Tape Motion Control Status Register 1 (X = 164014, Y = 164016)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
	COMMAND PARITY ERROR	MANUAL ON-LINE SELECT	UNIT SELECT	REQUEST TO SWITCH	ON-LINE	REWIND	READY

CP 9066

Figure 21. Bit Format of Tape Motion Control Status Register 2 (X = 164020, Y = 164022)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
					WATCH-DOG TIMEOUT	PROM PARITY ERROR	ILLEGAL COMMAND

CP 9067

Figure 22. Bit Format of Tape Motion Control Status Register 3 (X = 164030, Y = 164032)

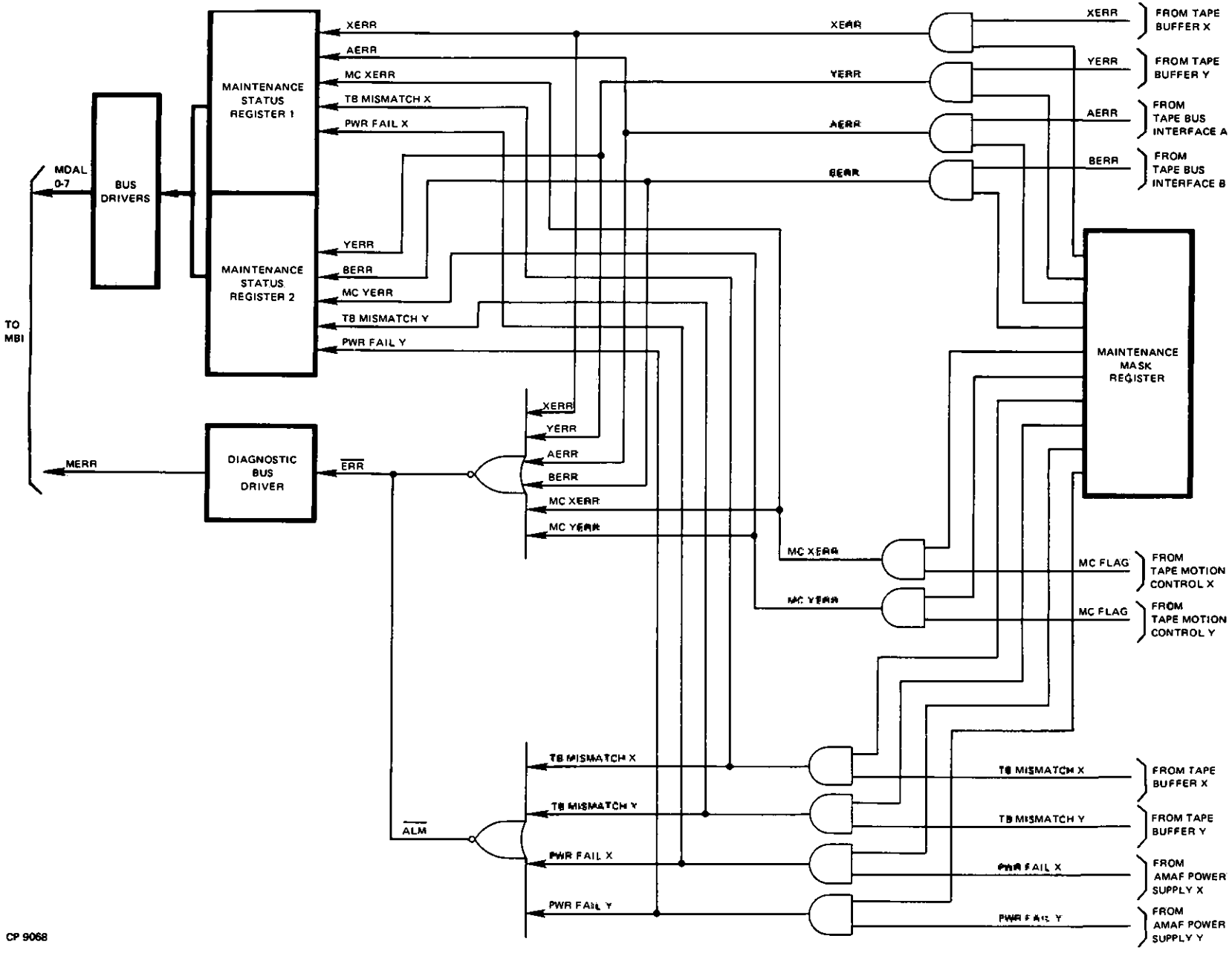

Figure 23. Tape Diagnostic Error/Status Reporting

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
X-SIDE ON-LINE	B-SIDE C.P. SELECT		TAPE BUS INTER-FACE A-SIDE ERROR	POWER FAIL X-SIDE ERROR	TAPE BUFFER MIS-MATCH ERROR	TAPE BUFFER X-SIDE ERROR	MOTION CONTROL X-SIDE ERROR

CP 9069

Figure 24. Bit Format of Tape Diagnostic Maintenance Status Register 1 (164054)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Y-SIDE ON-LINE	B-SIDE C.P. SELECT		TAPE BUS INTER-FACE B-SIDE ERROR	POWER FAIL Y-SIDE ERROR	TAPE BUFFER MIS-MATCH ERROR	TAPE BUFFER Y-SIDE ERROR	MOTION CONTROL Y-SIDE ERROR

CP 9070

Figure 25. Bit Format of Tape Diagnostic Maintenance Status Register 2 (164056)

(GRN) Yel-DATA
(RED) GRN - commands

Yel DATA
GRN COMMANDS

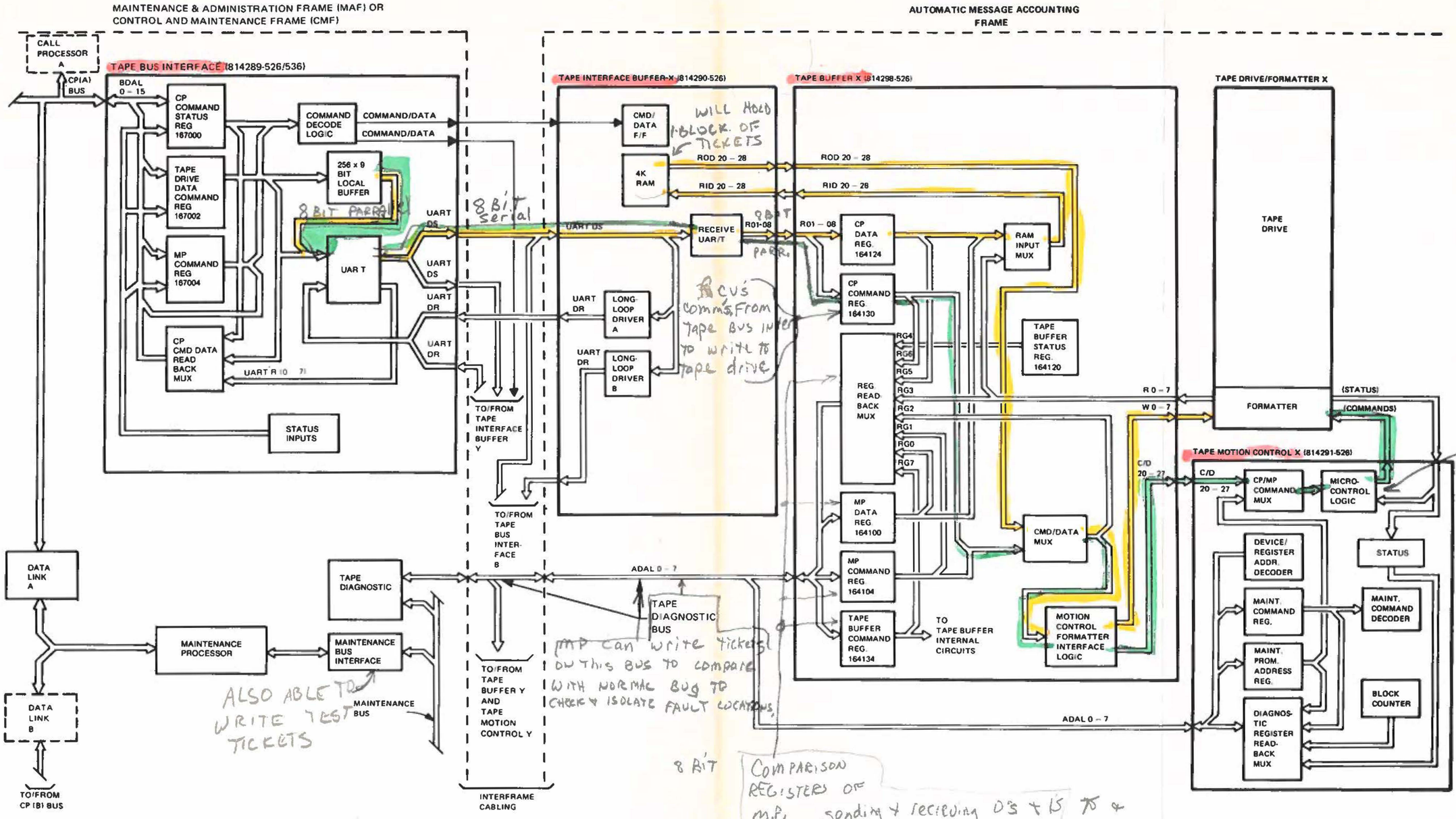

Figure FO-1. CAMA/LAMA Subsystem, Functional Block Diagram

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