

**GENERAL DESCRIPTION  
CALL DATA TRANSMITTER  
NO. 5 CROSSBAR OFFICES**

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**1. GENERAL**

**1.01** This section describes in general terms the call data transmitter (CDT) operation in No. 5 Crossbar Telephone Switching System. Section 958-110-100 describes the basic No. 5 crossbar switching features.

**1.02** The reasons for reissuing this section are listed below. Revision arrows are used to emphasize the more significant changes. This issue does not affect Equipment Test Lists.

- (a) To incorporate software changes for data processing and system status
- (b) To revise Fig. 4 and 5 for the addition of a third ROM circuit board
- (c) To revise Table A for the increase of scanned trunks per office for a single controller
- (d) To make minor revisions, as required.

**1.03** The CDT is a low first cost billing system for No. 5 Crossbar Switching System. The CDT collects data for billing by scanning completing markers and trunks. ♦Billing numbers are obtained from existing translators (AMA, AIOD).♦ The CDT sends its information to a 1A Automatic Message Accounting Recording Center (AMARC) to provide the recording of billable calls on magnetic tape.

**1.04** The various configurations available in the CDT system allow recording originating AMA features, including local, toll, wide area telephone service (WATS), directory assistance call recording, automatic identified outward dialing (AIOD), and hotel-motel guest register operation.

Automatic number identification (ANI) for operation with the Traffic Service Position System (TSPS) will be provided by existing No. 5 crossbar equipment.

**1.05** Incoming AMA features such as CAMA, INWATS, and tandem AMA are not provided with CDT, however existing LAMA-A equipment may continue to provide these features without interference from a collocated CDT.

**1.06** Call record data is sent from the CDT to a No. 1A AMARC in multiple entry formats (initial entry, then supervisory timing entries). The No. 1A AMARC will assemble the call data into a single entry format to be recorded on magnetic tape.

**SYSTEM CONFIGURATIONS**

**1.07** There are several system configurations for the CDT, depending upon the requirements and needs of the particular office. Figure 1 is a block diagram of a single controller CDT with an optional or shared translator access circuit and single scanning for trunks. Figure 2 is a block diagram of a dual controller CDT with an optional or shared translator access circuit and single and dual scanning for trunks.

**1.08 Single Controller.** Where measured service is to be recorded and all other billable calls are to be handled by existing LAMA-A or LAMA-B equipment, one controller only may be required. A second translator access circuit may be required for traffic reasons or it may be provided for added reliability.

**1.09 Shared Dual Controllers.** With this configuration, measured service trunks may be split between the two controllers (single scanning of trunks) and toll traffic handled by either controller (trunk scanning by both controllers). Greater reliability on toll calls is afforded by dual scanning of toll traffic. Existing LAMA-A equipment would still handle ANI, incoming and tandem AMA, and CAMA.

**1.10 Translator Access Circuits.** Each controller is provided with a dedicated translator access (TA) circuit, however, the traffic demand or reliability may require that an additional translator access circuit be provided which is shared between the two controllers.

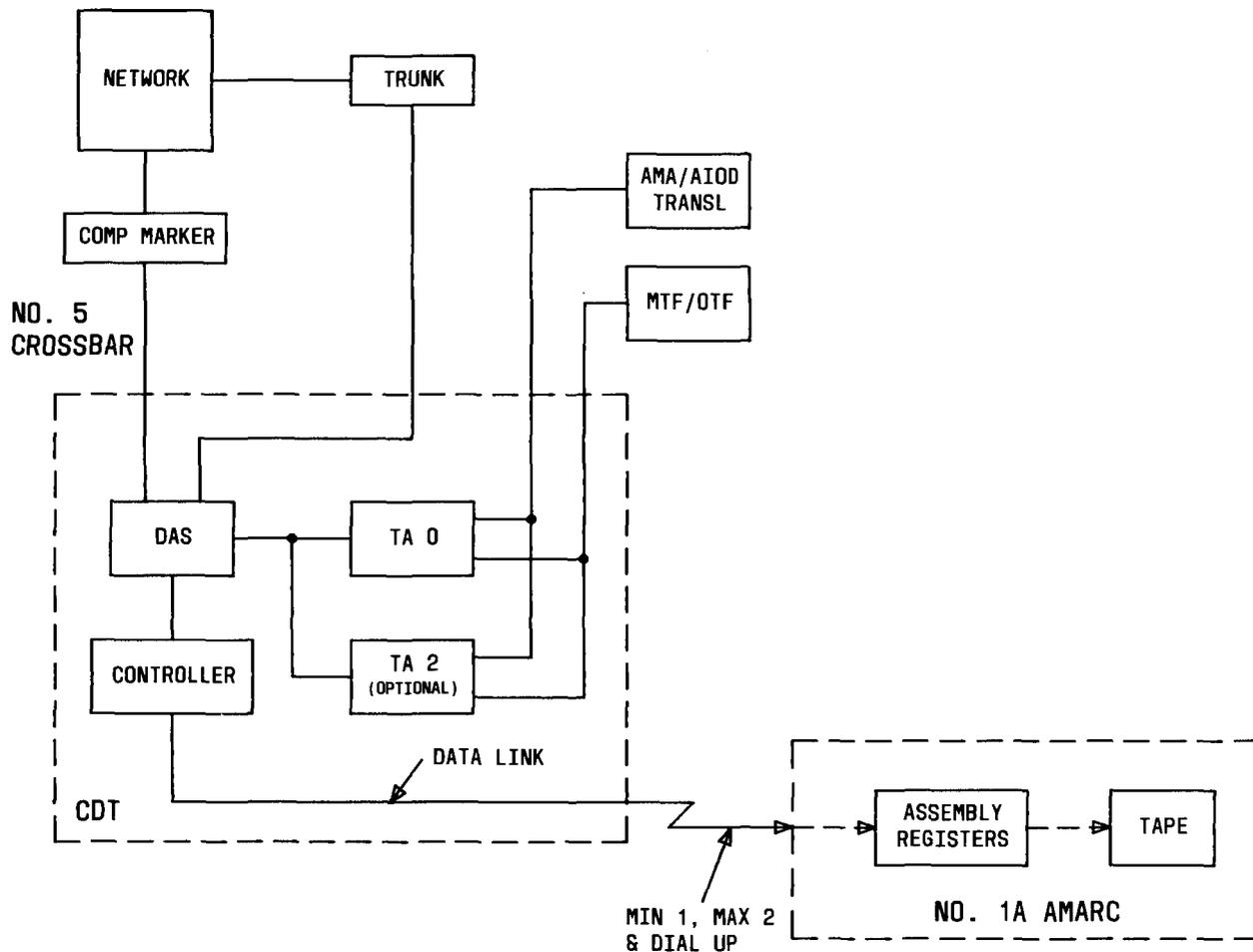


Fig. 1—Single Controller Call Data Transmitter

**SYSTEM CAPACITY**

1.11 Table A lists the maximum system capacities for the CDT with a single controller or a dual controller.

◆TABLE A◆  
SYSTEM CAPACITIES

UNITS	SINGLE CONTROLLER	DUAL CONTROLLER
Marker Groups	1	1
Completing Markers	10	10
TAs	2	3
Dedicated AMARC Channels	2	4
Dial-Up AMARC Channels	1	2
Scanned Trunks per TLF	96	96
Scanned Trunks per Office	2880	2880
Recordable* Attempts per Dedicated AMARC Channel	12,000	12,000
Recordable* Attempts per TA	15,000	15,000

\* A recordable attempt is a call attempt on which initial, timing (if answered) and disconnect entries are sent to AMARC. All attempts over scanned trunks are recordable unless a "do not record" signal is received from the marker during call setup.

## OVERVIEW OF CALL DATA PROCESSING

1.12 The following is a brief description of the call data processing through a single controller CDT and a dual controller CDT. A more in-depth presentation on the theory of call data processing is provided in Part 4 of this section.

1.13 **Single Controller CDT.** The CDT is alerted to the state of a call when trunk seizure is detected during a periodic scan of the trunk scan units. Each trunk scan point is dedicated to a specific trunk link frame, hence the controller knows which trunk link frame is used on a given call. The CDT then scans the completing markers to determine which marker is setting up a call to the trunk link frame of interest (only one marker may be using a trunk link frame at one time). Once the marker serving the call is identified, additional data such as the calling line equipment number (LEN), class of service, called number,

and miscellaneous data is obtained from the marker scan points.

1.14 After marker release, the LEN is distributed to the TA circuit which seizes an existing translator to obtain the billing telephone number. The billing number is combined with the data previously obtained from the marker to form an initial entry. This entry is placed in a buffer and subsequently transmitted to AMARC. When the data reaches the AMARC it is placed in a call record register which is dedicated to the trunk over which the call is carried. AMARC also examines the originating party class of service and called number data to determine the type of call and message billing index to be used if and when the call is recorded on the tape.

1.15 Meanwhile, the CDT continues to monitor the trunk for subsequent supervision scan point changes. All changes in called party supervision, coupled with the trunk number and the time, result

in timing entries which are placed in a buffer to be transmitted to AMARC where the data is used to update the call record register. If the billing translation indicates that the call is to be recorded and if the call was answered, the information is compiled into a single entry format and recorded on magnetic tape.

**1.16 Dual Controller CDT.** In this configuration (Fig. 2), each controller has one dedicated translator access circuit. When additional translator access capacity is required, a third translator access circuit is shared between both controllers. Each controller has its own set of scan points for markers and trunks. Trunk scan points may be equipped for both controllers or equipped for only one of the controllers, in which case the trunk is scanned by only that controller (single scan). These scan points are multiplied in the distribute and scan (DAS) unit backplane so that only a single cable is required for each dual or single scan point.

**1.17** The operation of each of the dual controllers is identical to the single controller operation. For dual scanned trunks, a decision is made during the marker scan processing as to which controller will process the call. For the controller selected, the subsequent operation is identical to that for a single scan trunk. For the controller not selected, the operation is that no initial, timing, or disconnect entries are sent to AMARC for the call from that controller. The controller selection signal is provided on a per marker basis and alternates selection between the two controllers for successive calls. In the case of a controller failure, the circuitry is arranged to steer all calls to the working controller. For reliability, all toll trunks should be dual scanned.

## SYSTEM FEATURES

**1.18** The call data transmitter system features and capabilities include the following:

- Provides all originating LAMA features, such as local, toll, WATS, DTWX, directory assistance charging, AIOD, hotel-motel (via junctors)
- May be colocated with LAMA-A (paper or billing data transmitter), CAMA (paper or billing data transmitter), or LAMA-B (magnetic tape)

- Provides improved precision answer and disconnect timing
- Dedicated positions for association of trunk scan points with trunks per trunk link frame
- Uses existing AMA and AIOD translators
- No internal data base required for the CDT (Billing translation data base in AMARC)
- No recent change support required at the local office
- CDT alarms are tied into local office alarms
- Traffic and plant registers are provided for CDT counts
- Self-diagnosing by means of diagnostics and error-checking circuits.

## 2. EQUIPMENT ELEMENTS

### GENERAL

**2.01** This part is divided into two sections. The first section covers the CDT elements - controllers, distribute and scan (DAS) units, marker interface, translator access units, translator access cross-connections, diagnostic test panel (DTP), and the DTP controller. The second section covers the existing No. 5 crossbar equipment elements that are modified for use by the CDT system.

### CALL DATA TRANSMITTER EQUIPMENT ELEMENTS

**2.02** The CDT is provided on one No. 5 crossbar double bay frame, 11 feet 6 inches high by 5 feet 7 inches wide. This frame is arranged for dual controllers (but may be equipped with a single controller), all distribute and scan (DAS) equipment, the first translator access circuit and cross-connect unit, marker interfaces, and associated power supplies (Fig. 3).

**2.03** When more than one translator access circuit is required, a translator access frame (11 feet 6 inches high by 2 feet 9 inches wide) is provided. This frame may house two translator access circuits.

**2.04 CDT Controller.** The controller unit contains 12 printed circuit boards and the

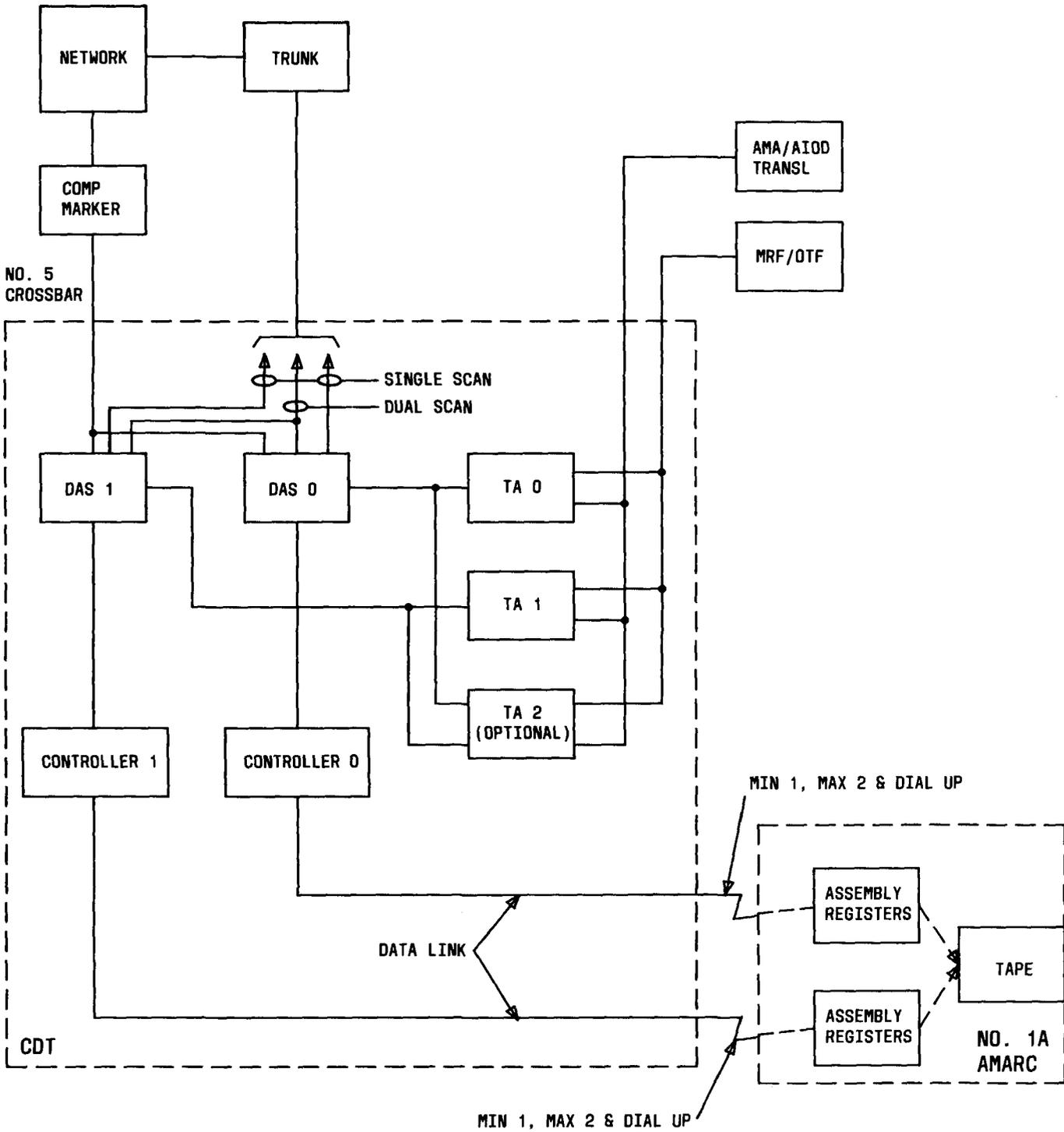
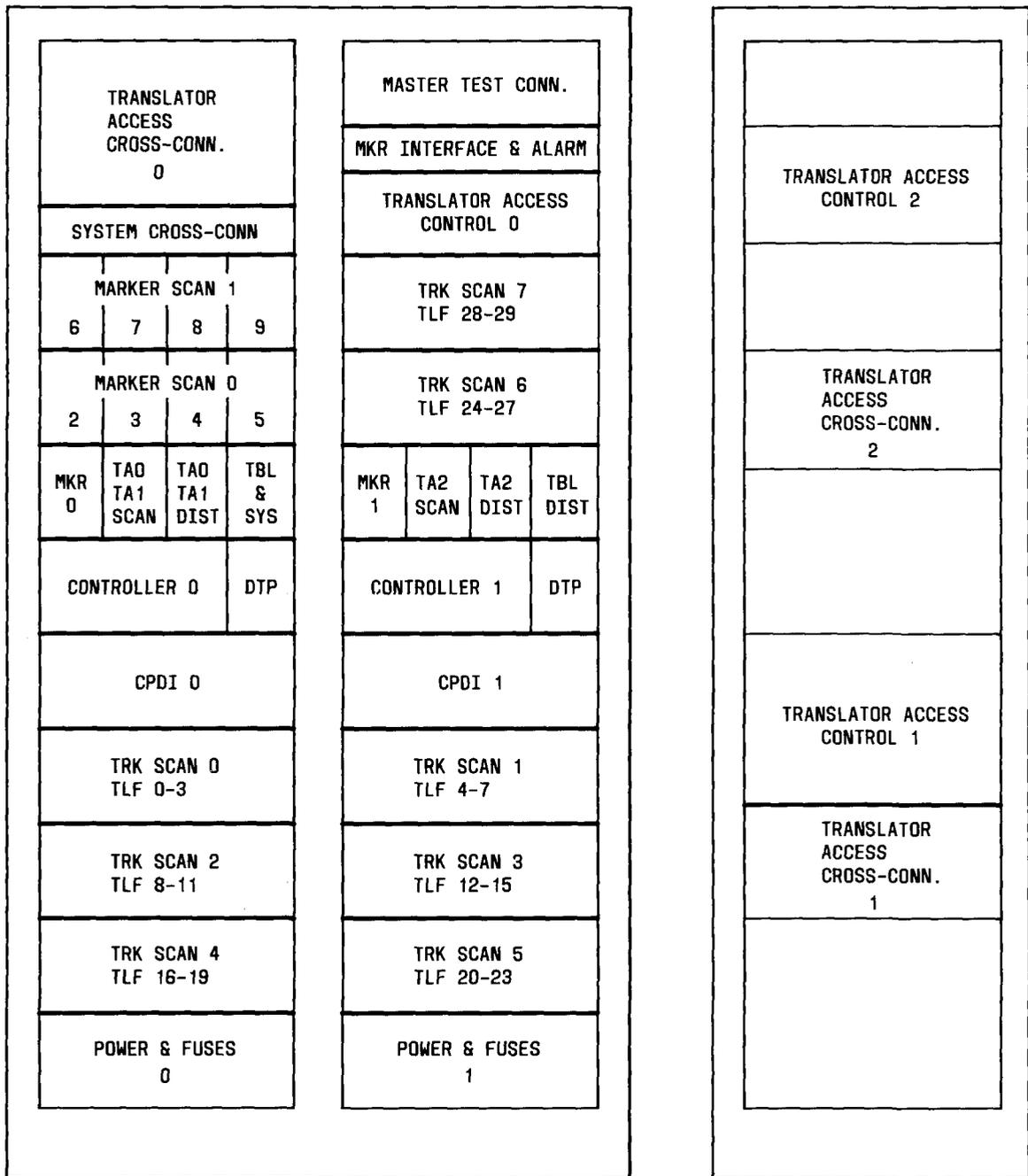


Fig. 2—Dual Controller Call Data Transmitter



CALL DATA TRANSMITTER FRAME - J22482A  
(11'6" X 5'7 1/8" X 12")

TRANSLATOR ACCESS - J22482B  
11'6" X 2'9 9/16" X 10 1/2"

Fig. 3—CDT Frame Layout

diagnostic test panel. The boards and their uses are defined as follows. (See Fig. 4.)

- **Central Processing Unit (CPU).** The CPU board contains an INTEL 8086 micro

processor and will execute all instructions specified by the programs stored in the read only memory (ROM). The address range of the CPU is approximately one megabyte with an 18-bit data bus (16 bits for data

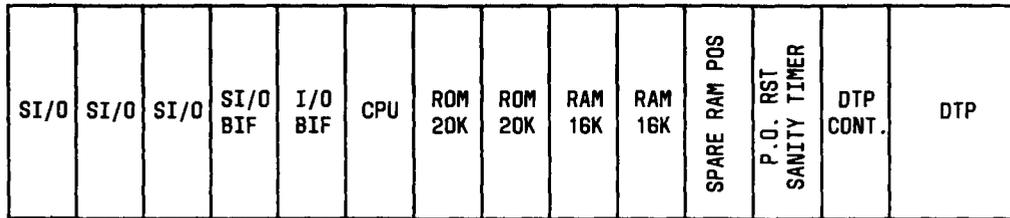


Fig. 4—CDT Controller Unit

and 2 parity bits.) The CPU board also contains 3 programmable timers, error control circuits, and 15 priority levels of interrupts.

- **Read Only Memory (ROM).** The ROM boards contain the system programs and fixed data. Two ROM boards can contain up to 20 kilobytes of memory. A third ROM board contains four kilobytes of memory. Three boards are required per system.
- **Random Access Memory (RAM).** The RAM boards provide the variable data storage for the system. Each RAM board will consist of 16 kilobytes of read-write memory. Two RAM boards are required per controller.
- **Input/Output Bus Interface I/O BIE).** The I/O BIF board separates the DAS I/O bus from the CPU bus since the two buses operate at different speeds. Also, this board isolates the CPU and DAS I/O buses for diagnostics and to minimize loading problems.
- **Serial Input/Output Bus Interface (SI/O BIF).** The SI/O BIF board separates the SI/O bus from the CPU bus. It allows the two buses to operate at different speeds. Also, this board isolates the SI/O and CPU buses to aid the diagnostics.
- **Serial Input/Output (SI/O).** Each SI/O board is a serial data link driver and receiver that allows the CDT to communicate with

AMARC. The interface between the SI/O board and the 202T or 212A data set is the EIA standard RS-232C.

- **Diagnostic Test Panel (DTP).** The DTP, one per controller, is mounted with the controller. The DTP will be the interface between the craft and the CDT electronic hardware. The DTP will initiate diagnostics or phases of diagnostics that include discrete tests such as directed scan, distribute operations, and memory operations. It contains all status and alarm indicators, alarm controls, inhibit automatic restart switch, controller restart key, DTP restart switch, input control and maintenance displays, and input controls and keypad. The panel is divided into three sections - input, output, and alarm control, status, and restart. The panel will be discussed in more detail in Part 5, Maintenance Arrangements.

- **DTP Controller.** The DTP controller board scans the keyboard, displays information on the alphanumeric display, and handles the interface with the CPU serial data link.

- **Reset and Sanity Timer Circuit.** The reset and sanity timer circuit board provides the power-on reset function and the sanity timer function for the CDT system.

- **Data Buses.** Buses are used to move data between units. In CDT, there are four parallel input/output buses - unit, I/O, CPU, and SI/O. Each bus is interfaced with

buffers for isolation. Figure 5 is an overview of the CDT with respect to the branching or different buses.

**2.05 Distribute and Scan (DAS).** The interface between the No. 5 crossbar switching system and the CDT controller is the distribute and scan equipment. Scan points are the data inputs to the controller and convert noisy battery-ground signals from the electro-mechanical circuits into the low-level, noise-free signals required by the

controller. Scan point inputs consist of a single high impedance lead which is bridged onto the existing electro-mechanical circuits (Fig. 6). There are 64 scan points on each scan board.

**2.06 Distribute points** (Fig. 7) are the output control devices for the controller which provide clean contact closures for the -48 volt electro-mechanical circuits. Each distribute point contains a latching device which drives a circuit pack mounted mercury-contact relay. The contact

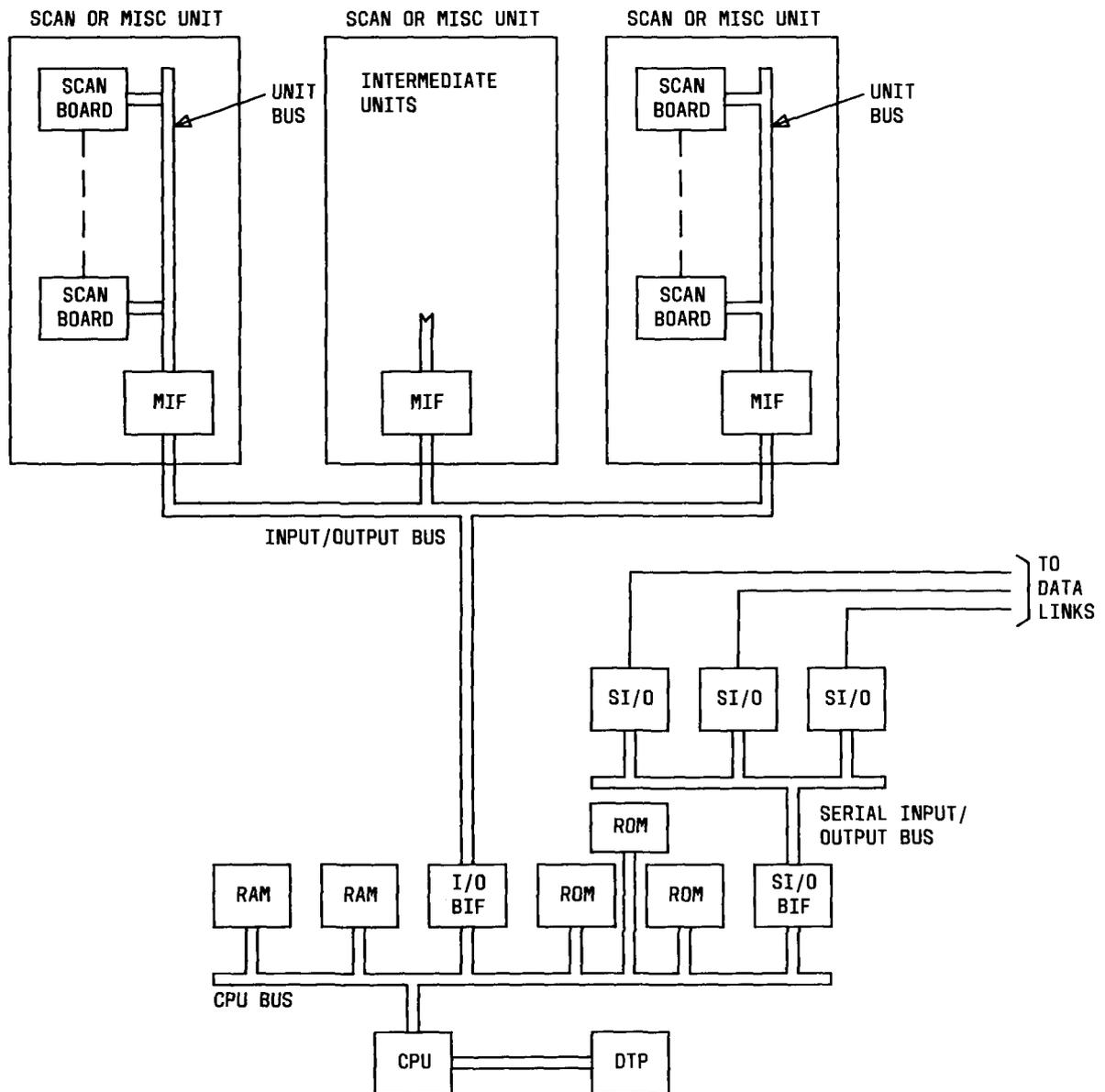


Fig. 5—Branching Buses

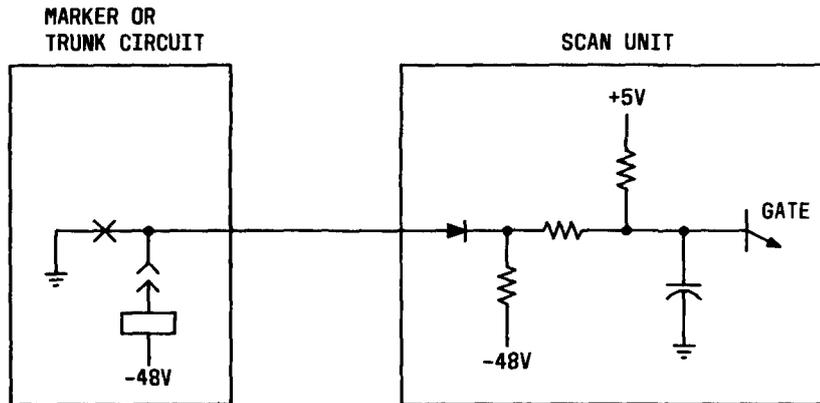


Fig. 6—Typical Scan Point Configurations

of this relay is the distribute output. In most cases, distribute points are used to operate relays in the electro-mechanical environment. There are 32 distribute points on each distribute board.

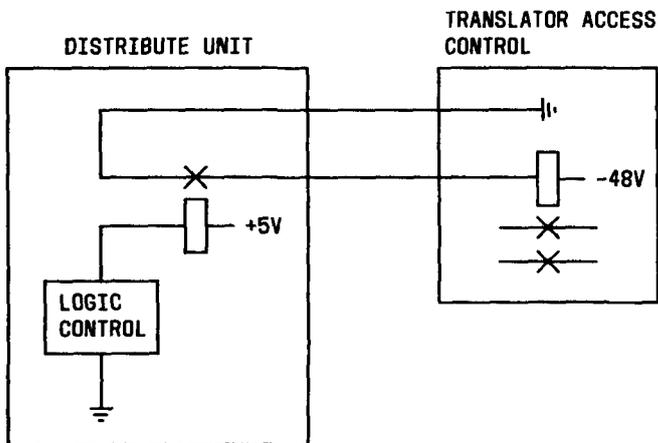


Fig. 7—Typical Distribute Point Configuration

**2.07 Matrix Interface (MIF).** The MIF separates the input/output bus from the unit bus to minimize loading problems, to aid the diagnostics, and to perform some of the address decoding.

**2.08** There are three codes of DAS units. DAS A units are used for the marker scan units and the trunk scan units. Only scan boards are used in DAS A units. DAS B and DAS C units

are used in the combination of scan and distribute points and backplane strapping.

**2.09 A trunk scan unit (TKS)** contains a matrix interface control (MIF) position and 12 scan positions. Each position may hold 2 boards, one for each controller. The MIF position is used to isolate the bus from the I/O bus. Each scan board contains 64 scan points. Eight trunks (two scan points per trunk) on each of 4 trunk link frames may be assigned to one scan board, or 96 trunks per trunk link frame for a maximum of 384 trunks per trunk scan unit. As shown in Fig. 8, each position may accommodate a scan board for each controller. In the backplane of the unit, the same scan point for both controllers in the same position are strapped. When a scan board is inserted into a position, no additional wiring is required for dual scanning by the controllers.

**2.10 A marker scan unit (MKS)** contains a matrix interface control (MIF) position and 12 scan board positions. Each position may hold 2 boards, one for each controller. The MIF board is used to isolate the unit bus from the I/O bus. Each scan board contains 64 scan points. Four markers are assigned 3 scan positions each, or, 192 scan points per marker. As shown in Fig. 9, each position may accommodate a scan board for each controller. In the backplane of the unit, the same scan point for both controllers in the same position are strapped. In Fig. 3, the two scan units for markers 2 through 9 are in the left bay of the CDT frame. Note that marker 0 and 1 are included in the miscellaneous scan and distribute units.

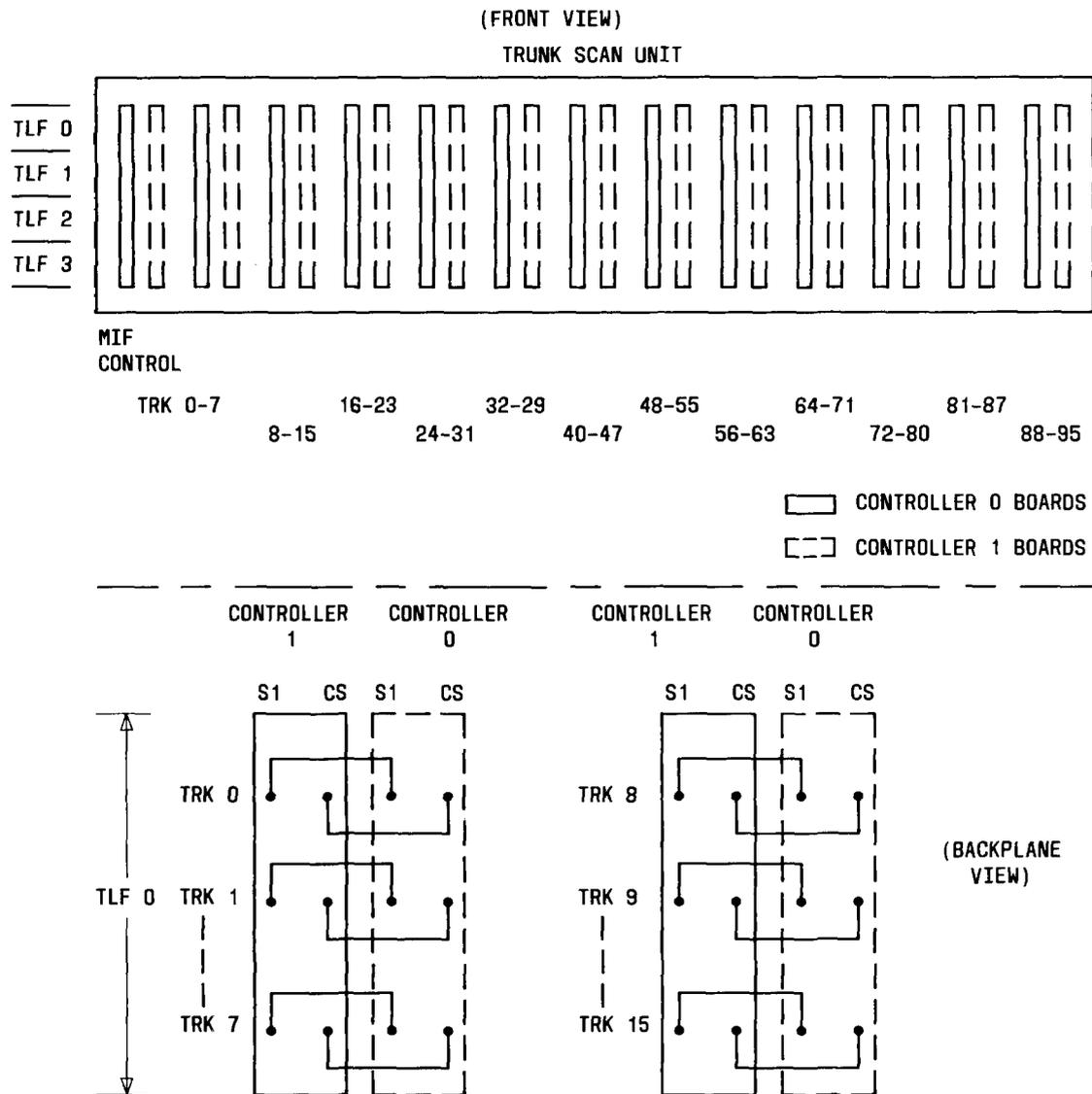


Fig. 8—Trunk Scan Unit Layout

2.11 A *miscellaneous distribute and scan unit* (MISC) contains a matrix interface control (MIF) position, scan positions, and distribute positions. Each position may hold two boards, one for each controller. The MIF board is used to isolate the unit bus from the I/O bus.

2.12 Two miscellaneous distribute and scan units (MISC 0 and MISC 1) are used in CDT. Figure 10 provides the circuit board positions for these two units. MISC 0 contains a MIF position, 3 scan positions for marker 0 (with same position scan points strapped in the backplane), dedicated translator access scan and distribute positions for translator access circuits 0 and 1, system scan and

distribute positions, and trouble record distribute positions. MISC 1 contains a MIF position, 3 scan positions for marker 1 (with same position scan points strapped in the backplane), shared translator access circuit, 2 scan and distribute positions, and trouble record distribute positions.

2.13 *Power and Data Interface (CPDI)*. A CPDI is dedicated to a controller. It contains a 132T power converter to provide +5, -15 and +15 volts (which is regulated down to -12 or +12 volts for data set control), one or two 202T data sets, one 212A dial-up data set, RS-232C regular standard interface, and power fuses and switches for the controller.

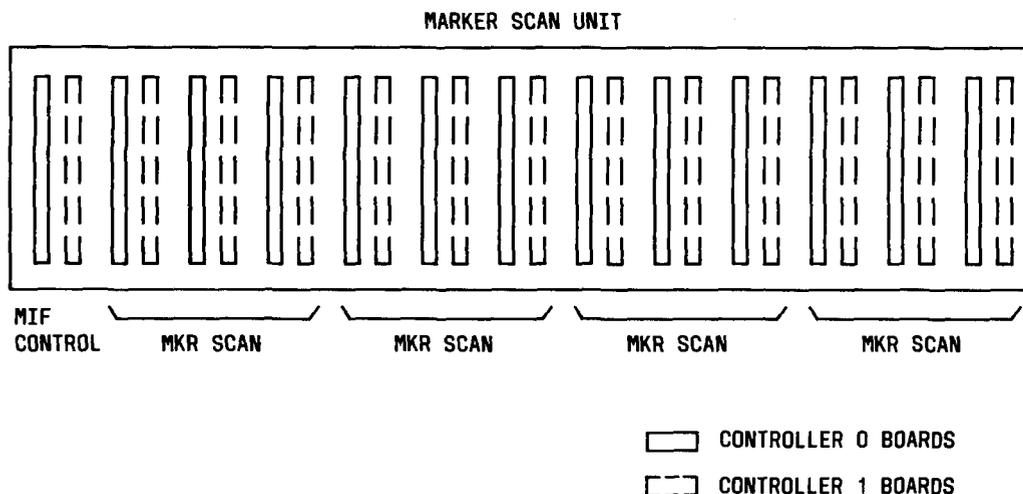


Fig. 9—Marker Scan Layout

**2.14 Translator Access Circuit (TA).** The translator access circuit is an electro-mechanical interface between the controllers and the AMA translators. One TA circuit is dedicated to each controller. In a single controller office, a second TA circuit may be required. In a dual controller office, a third TA circuit may be shared between the two controllers.

**2.15** The controller will operate distribute points in the MISC 0 or 1 distribute and scan unit which in turn will cause relays in the TA circuit to be operated, corresponding to the line location of the calling subscriber. The line location will be passed to the translator which will return to the TA circuit, the billing telephone number, by operating corresponding relays in the TA circuit. The operated relays will cause corresponding scan points in the MISC 0 or 1 distribute and scan unit to be operated.

**2.16** When a trouble condition is encountered by the controller or the TA circuit, a trouble record will be made by the TA circuit. Software timers for the TA circuit are used to insure that the billing translation is made within a given period of time.

**2.17 Data Sets.** The interface between CDT and the AMARC is via data sets. The communication with AMARC is via 1200 baud, full duplex data links operated in half duplex mode, using 202T data sets as the primary. Each controller may work through one or two 202T data sets and a 212A dialup data set. The data sets are mounted

in the CPDI unit on the CDT frame or may be provided externally.

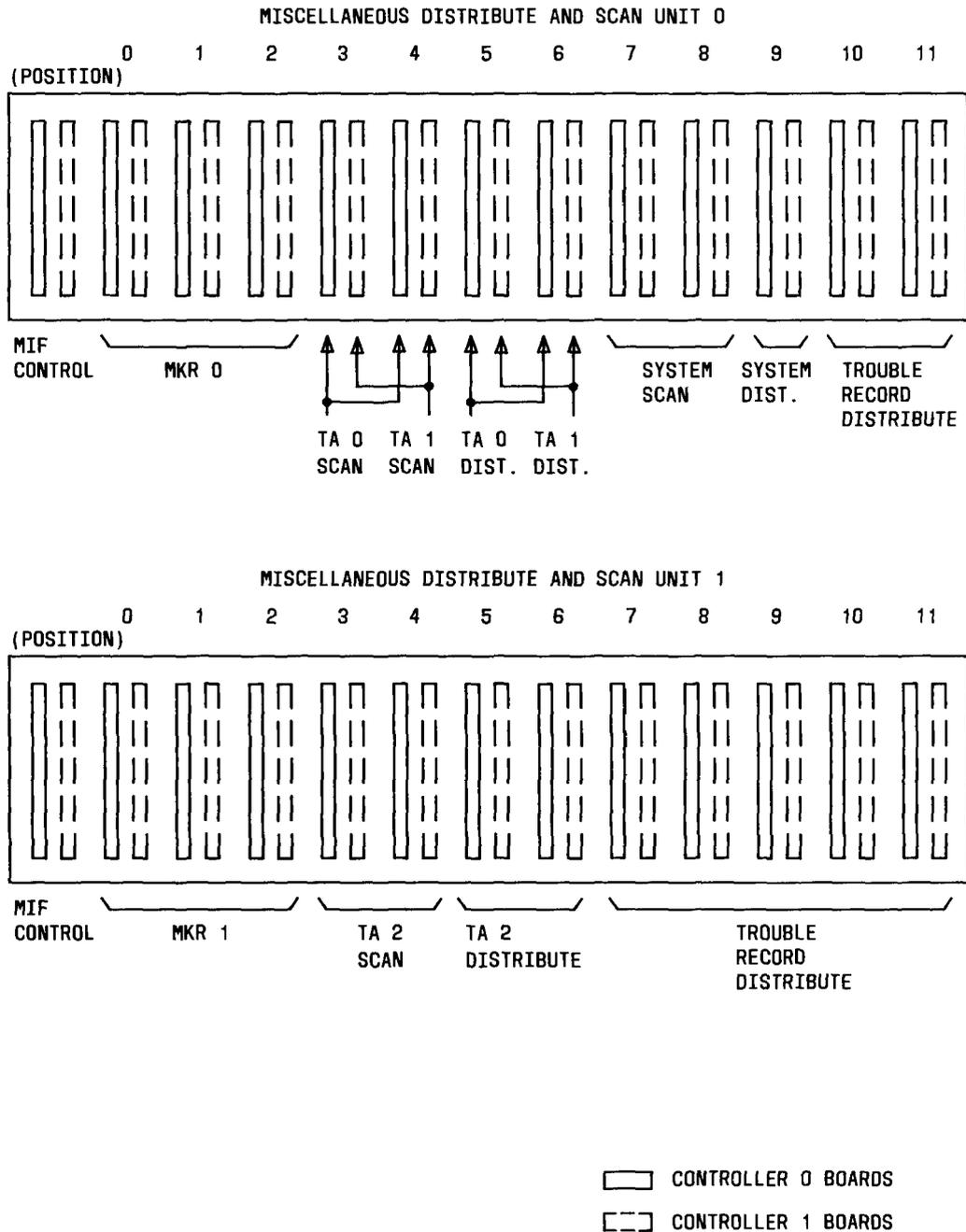
**2.18 Peripheral Power Unit.** The PPU contains two 132T converters to provide +5 volts for DAS units as well as +15 and -15 volts for frame mounted data sets. When only one controller is provided, PPU 1 unit is provided and wired, but the converters are not required in the unit.

**2.19 Marker Interface and Alarm Unit.** Two functions are provided for within this unit. When dual controllers are provided, the marker interface determines which controller will be used with the completing marker (controls controller preference). The alarm function of the unit is used to interface the CDT alarms with the office alarms and TASC.

**2.20 System Cross-Connections.** Cross-connection fields are provided to inform the CDT of the office parameters, such as number of trunk link frames, number of completing markers, class of service coding, etc. The cross-connections cause scan points to be operated which in turn provide the CDT with the office parameters.

#### EXISTING ELECTRO-MECHANICAL EQUIPMENT MODIFIED

**2.21 Completing Markers.** Data relative to a call is passed from the completing marker to the CDT via scan points. Leads are connected to certain progress marks and call data from the



**Fig. 10—Miscellaneous Distribute and Scan Unit Layouts**

completing marker to individual scan points in the DAS. The operated or released states of the scan points will be stored in marker buffers in memory by the controller, then used for matching of trunk link frame numbers or for building an initial entry to be translated.

**2.22** The connection of the scan leads to the markers during installation will have little effect on completing marker operation. However, there are three features that require minor changes to the markers: service observing, flat rate route series screening, and point to point traffic sampling.

**2.23** Completing markers arranged for ANI without LAMA are not equipped with the necessary apparatus to provide service observing for AMA recording. A unit is available for providing service observing for CDT.

**2.24** To minimize unnecessary AMARC and data link load for flat rate calls, the RCD (record) and NRCD (non-record) route series screening relays may be provided on a per-marker basis. Also, class of service screening fields may be needed to separate flat rate and message service into two groups.

**2.25** Two types of traffic sampling are provided—CCSA sampling for distribution of revenue (on a class of service or trunk group basis), and point-to-point sampling for traffic engineering on trunk groups. Fifteen counters are maintained in software which may be divided between the types of sampling. (When sampling requires more than fifteen counters, existing electro-mechanical counters and paper tape perforators must be maintained.) The electro-mechanical counters in the markers will be disabled when counters in software are used.

**2.26 Trunk Circuits.** All trunks that handle calls to be billed via CDT are wired with supervisory scan points. Originating supervision is detected by an S1 scan point and answer supervision is detected by the CS scan point. The scan points are dedicated to a particular trunk link frame which enables the controller to determine which trunk link frame and trunk is being used on a particular call. Figure 8 provides the pattern for dedication of trunks, via trunk link frame numbers, to associated scan points.

**2.27 Trouble Recorder Cards.** Existing trouble record cards are modified to provide CDT error codes as well as information used for the CDT data processing and translator access translation.

**2.28 Transverters.** When the office is not arranged for ANI to TSPS, one transverter must be left in the office even when all billable data is forwarded to AMARC. One transverter is required for testing the translator cross-connections. Also, it is required when line insulation testing directory number printout is provided in the office. Transverters associated with ANI must remain in the office.

**2.29 Transverter Connectors.** The connectors are modified to permit access to the AMA or AIOD translators by the translator access circuit.

**2.30 Master Test Control Circuit.** Keys have been added to the MTCC to allow an indication that the test call is for the CDT, to select a particular controller, to select a particular translator access circuit, to perform timing tests, and to have a trouble record taken by the translator access circuit on a test call. Testing arrangements will be covered in greater detail in Part 7 of this section.

**2.31 Master Test Frame Connector.** Means are provided to connect leads from the CDT master test connector unit to the MTFC for causing trouble record cards to be taken by the CDT or translator access circuit.

**2.32 Office Test Frame.** Keys have been added to the OTF to allow an indication that the test call is for the CDT, to select a particular controller, to select a particular translator access circuit, to perform timing tests, and to have a trouble indication taken by the translator access circuit on a test call. The trouble indicator has been modified with additional lamps for CDT trouble indications.

### 3. CALL DATA TRANSMITTER APPLICATION PROGRAMS

**3.01** The application programs for CDT may be divided into four general categories - initialization, data processing, system status, and diagnostics. The CD prefix in the mnemonic name of the program indicates the program is for CDT. The programs and their basic tasks are described in the following paragraphs.

#### SYSTEM INITIALIZATION

**3.02 CDINIT.** The initialization program is used to initialize the CDT firmware routines by initiating direct initialization or by calling the necessary initialization routines associated with the process. Following a power-down or trouble condition, all buffers must be initialized to their normal configuration, distribute points released/operated to normal state, and data links reactivated. Diagnostics are also run to determine that all required circuit packs are present and working, non-working circuit packs are removed from service and then if the required level of equipment is

working, the system will be started with all programs enabled.⚡

#### DATA PROCESSING

**3.03 CDDLPRO.** The data link protocol program is used to perform the following tasks.

- Verify that the data links are active
- Provide a cyclic redundancy check (CRC) on messages to AMARC
- ⚡Notify CDFORM program when data has been received from AMARC or when data has been sent to AMARC.⚡
- Determine what data from the next control block is to be sent.
- Control the reading and writing of the serial input/output links.

**3.04 CDFORM.** The format program is used to perform the following tasks.

- Control the preparing and formatting of data to be transmitted to AMARC via CDDLPRO program.
- Format messages (other than call data) for transmission to AMARC
- Process data link messages received from the CDDLPRO program
- Collect data for tracer statistical report to AMARC
- Take completed entries from the pipeline buffer, then place the formatted entries in even or odd data link buffers, discard the unneeded entries, or add additional data into the entries before placing them in the data link buffers.

**3.05 CDMKRD.** The marker data processing program is responsible for the following tasks.

- Maintain a marker buffer for each equipped completing marker

- Read marker scan points to determine marker progress.

- Load data from marker scan points according to the dictates of marker progress

- Determine a match between a trunk and a marker on an originating call and set the track flag, when appropriate, in the CDTRKS program to indicate that the controller is to track the call.

- Check for flat rate screening, free number, or test calls

- Keep counters updated for traffic sampling

- Load all initial entry data into the pipeline buffer and clear the marker buffer used on the call.

- Maintain peg and traffic counts for marker-related data.

**3.06 CDTADP.** The translator access data processing program performs the following tasks.

- Load the initial entry into the TA buffer
- Check the validity of marker data in the initial entry
- Operate distribute points to pass the LEN to a TA circuit (shared or dedicated)
- Read scan points for billing telephone number and load into the TA buffer
- Load the formatted initial entry from the TA buffer into the pipeline buffer
- Gain access to trouble recorder or trouble indicator to record translation failures or controller detected failures

**3.07 CDTRKS.** The trunk scan program performs the following tasks.

- Read the S1 scan points for all trunks at 20 millisecond intervals and the CS scan points at 200 millisecond intervals.

- When an S1 scan point operation is detected, pass the trunk link frame number (0-29) and trunk number (0-95) to the CDMKRDP program.
- Perform a directed scan on a particular CS scan point upon request from the CDMKRDP program and pass back the condition of the scan point
- Maintain a record if the trunk is to be tracked by the controller
- When tracking a call, detect changes of state of the S1 and CS scan points and place required timing entries in the pipeline buffer

#### SYSTEM STATUS

**3.08 CDSTAT.** The system status program is responsible for the followings tasks.

- Maintain a physical and/or logical status map for markers, translator access circuits, trouble recorder or indicator, and the system.
- Peg certain plant and traffic registers every 20 milliseconds.
- Used to determine if distribute or scan units are to be removed from service. Provide for a retry of DAS accesses whenever an error is detected. After two failing retries, remove the physical or logical function from service.

#### DIAGNOSTICS

**3.09 CDDIAG.** The diagnostic program is used to schedule and perform the diagnostics for initialization, on-line (or background), and those performed on demand. The diagnostic capabilities will be covered in greater detail in Part 5 of this section.

#### 4. DESCRIPTION OF CALL DATA PROCESSING

**4.01** Part 1 of this section provided an overview of call data processing. This part provides the theory and description of call data processing which will include an overview of the software-hardware interaction. When a software program is referred, its mnemonic name will be used, such as CDTRKS

for CDT trunk scanning program. Part 3 of this section defines the software programs. Figure 11 provides an overview of the theory of call data processing.

**4.02** One of the unique features of No. 5 Crossbar Switching System is that only one completing marker may be working in a trunk link frame at one time. This feature along with specific DAS positions assigned for each TLF is used by CDT to associate a particular completing marker with a particular trunk on a given trunk link frame.

**4.03** Two programs, CDTRKS and CDMKRDP, are continuously scanning the trunks and completing markers, respectively, at 20 millisecond intervals to detect associated scan point changes of state. The progress marks for each marker are stored in its respective buffer by CDMKRDP. The following progress marks are scanned. CKG - marker seized; TBK - marker working in a trunk link frame on an originating call; RK3 - register check on call back portion of a call; and HMS1 - hold magnets being operated and the linkage is being set between the line link frame and the trunk link frame.

**4.04** When the completing marker is seized and a trunk link frame selected, the CKG and TBK scan points associated with that marker will be operated. The selected trunk link frame number will be read from the marker scan points and will be stored in the respective buffer by CDMKRDP. When the linkage is set to the trunk by the marker, the S1 scan point will be grounded by the trunk.

**4.05** The CDTRKS program will detect the operation of the S1 scan point, identify the trunk link frame and trunk number from the operated scan point. This information will then be passed to the CDMKRDP program. A search is made by CDMKRDP of all marker buffers to determine which marker is operating in the specified trunk link frame. When a match of trunk link frame numbers is found, the trunk number is then entered into the marker buffer.

**4.06** After the linkage has been established, the S1 scan point operated in the trunk, and the HMS1 and RK3 scan points operated in the completing marker, the CDMKRDP program will then read all the scan points operated by the completing marker - class of service, call number, line equipment number, and other data associated

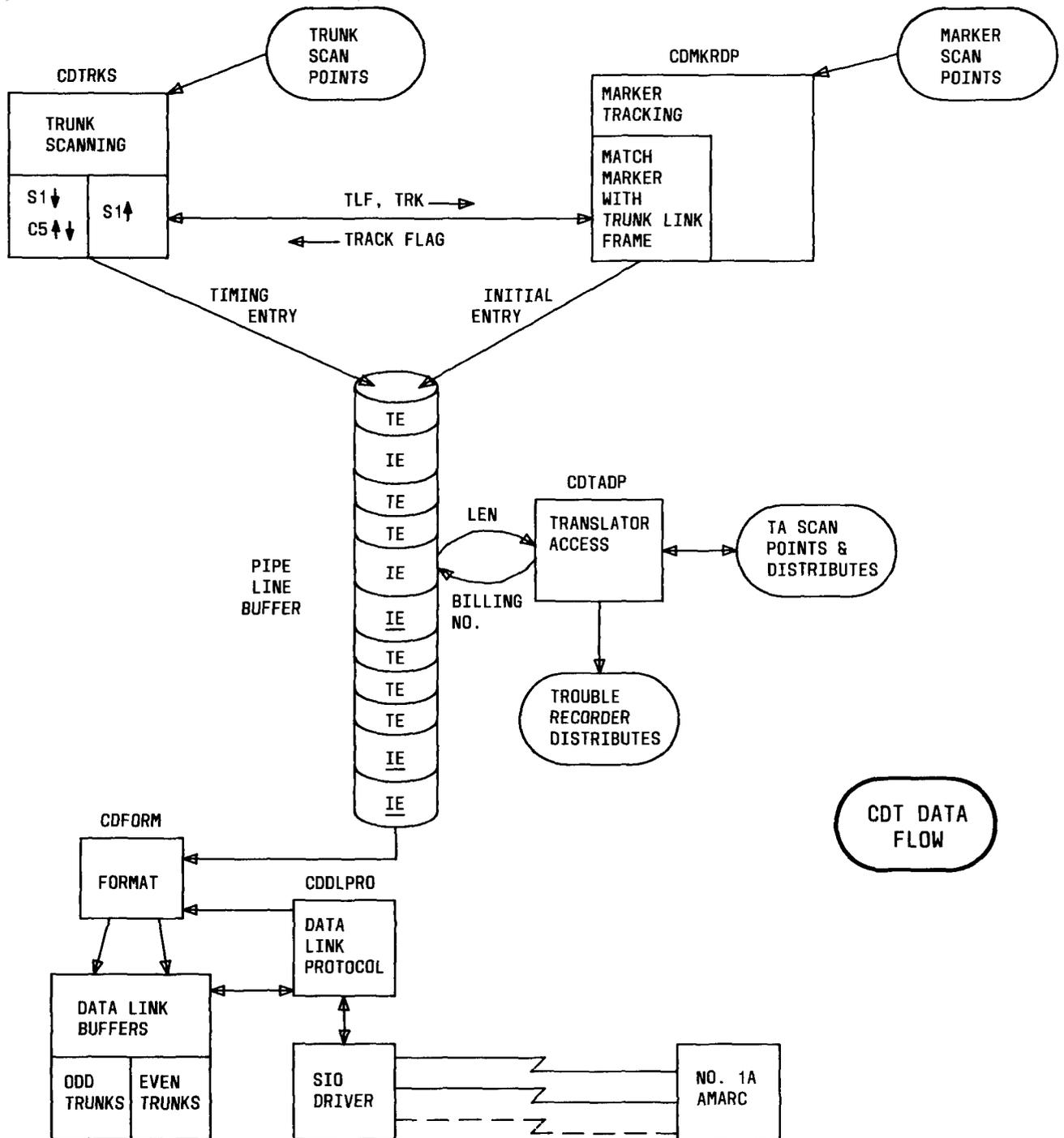


Fig. 11—Overview of Data Processing

with the call. All information is then stored in the marker buffer.

4.07 After linkage is established, the completing marker will release and its associated scan

points will also be released. At this time, the call data is loaded from the marker buffer as an initial entry into the pipeline buffer. That data in the pipeline buffer is treated on a first in, first out basis.

**4.08** When the office is arranged with dual controllers and the trunk is being scanned by both controllers, an indication is received from the marker interface circuit as to which controller is to continue tracking or following the call. A track flag will then be set in the CDTRKS trunk map by the controller that is to handle the data processing for the call. Once the track flag is set by a particular controller, the controller will continue to process call data until the call is terminated.

**4.09** The CDTADP program is responsible for performing the LEN-to-billing telephone number translation on the initial entries in the sequence in which they are entered in the pipeline buffer.

**4.10** One translator access (TA) circuit is dedicated to each controller, however, a third TA circuit, shared by both controllers, may be required. When a shared TA circuit is provided, a preference circuit will indicate which controller may use the shared TA circuit for translation. The CDTADP program will store all initial entry data in the TA buffer and will pass to the selected TA circuit the LEN via operated distribute points, which in turn operates corresponding relays in the TA circuit. A validity check is then made by the TA circuit on the data distributed. A translator will then be seized and a ground passed via the operated relays in the TA circuit to the translator where the LEN will be converted into a billing telephone number.

**4.11** When the billing telephone number is passed from the translator to the TA circuit, corresponding relays will be operated in the TA circuit. A validity check of the data received from the translator will be performed by the TA circuit. The operated billing telephone number relays will in turn operate associated scan points. The CDTADP program will read the scan points and store the data in the TA buffer. The program will then convert the data in the TA buffer into binary or binary coded decimal and load this formatted data into the initial entry slot of the pipeline buffer being served by the TA.

**4.12** Software timers associated with the TA circuit check that the billing telephone number is received and verified within 200 milliseconds and that the translation did not exceed the overall time allowed for the translation. When a time-out does occur, the initial entry in the pipeline buffer will carry with it a translation failure indication.

The LEN will be in the initial entry for possible later use at the billing center.

**4.13** When a call is answered, a CS scan point will be grounded by the trunk. The CDTRKS program will detect the operated scan point, and if the track flag for that trunk has been set, will determine the trunk link frame and trunk number, and cause a timing entry to be made in the pipeline buffer. The time inserted into the timing entry will be a CDT time count which AMARC will later convert into actual time. All CS transitions while the S1 scan point is operated and the track flag is set, are sent to AMARC. The CS scan points are read every 200 milliseconds. A scan point is not read as being operated until two scan cycles have occurred, however only one scan cycle is required to determine that the CS scan point has been released.

**4.14** When the call is terminated, as detected by the release of the S1 scan point by the trunk, the CDTRKS program detects the release, and if the track flag for that trunk is set, causes another timing entry to be made and loaded into the pipeline buffer. The timing entry will contain the trunk link frame number, and the CDT time count.

**4.15** The CDFORM program is continuously processing the entries found in the pipeline buffer on a first in, first out basis. This insures that a timing entry for a given call can never be received by AMARC ahead of the initial entry.

**4.16** The formatted initial entry and timing entries are stored in data link buffers. ♦Multiple♦ data link buffers (odd and even) are used. Odd buffers are loaded with the formatted entries from odd numbered trunks and the even buffers with entries from even numbered trunks. When only one data link (plus a dial backup data link) is provided, the odd and even buffers are sent out alternately over the one data link. The formatted entries in the data link buffers are grouped into blocks for transmission to AMARC.

**4.17** The CDDLPRO program acts as an interface between data links and the CDFORM program. CDDLPRO also controls which data link blocks from the data link buffers will be transmitted. When a request is received via the data link to transmit a block of call data, a block of data will be taken from the data link buffers by the CDFORM and

passed through a serial input-output driver and sent to AMARC. Should a retransmit request be received from AMARC, the same block of data would again be transmitted. All statistical data relative to transmit, retransmit, block counts, etc. is maintained by the CDFORM and CDDLPRO programs and transmitted to AMARC via tracer records, which are requested by a command for AMARC.

**4.18** At AMARC, each trunk is assigned a call record register in software where the initial entry and all timing entries, as received, are stored. When the call has been terminated, AMARC will use the contents of the call record register to create a single entry call record. The call record contains all information relative to billing the subscriber for the call (or statistical studies such as subscriber line usage or traffic sampling). The call record is recorded on magnetic tape for later processing at the billing center.

**4.19 AMARC Data Processing.** In the initial entry sent to AMARC via the data link from the CDT, the following data is included: called number, billing telephone number, class of service, trunk link frame and trunk number, marker number, and certain flags or marks to indicate special conditions associated with the call. The special conditions are sampling, service/complaint observed, subscriber line usage study, 1+ dialing pattern, and a mark to indicate if the billing telephone number or the line equipment number (in case of translation failure) is in the data.

**4.20** The initial entry and timing entry data from the CDT is stored in a call record register on a per trunk basis as they are received from the CDT. When the AMARC software determines that the call is finished, all data in the call record register is transferred, with some transformation, to a tape output register to await billing translation. The call record register for the trunk is now ready for recording the next call handled by the trunk.

**4.21** The billing translation is now performed on the data in the tape output register. Figure 12 provides an overview for the method used to determine the type of AMA record structure code and call type to be used for formatting the call.

**4.22** The class of service is translated into a message billing class (MBC). Depending upon the MBC, the type of AMA record structure

code and call type may be directly determined from the billing class or additional rate translation may be required.

**4.23** The rate tables are indexed by the called number code (NXX or NPA+NXX) and the results of the translation in determining the format of the record are non-local, flat rate, or message rate. Also, complaint/service observing is considered after the rate translation.

**4.24** After the type of AMA record structure code and call type has been determined, a single entry billing record will be formatted from the data in the tape output register and stored in a tape output buffer until the entry can be recorded on disk or magnetic tape.

## 5. MAINTENANCE ARRANGEMENTS

### GENERAL

**5.01** Means are provided in CDT for maintenance of the controller, distribute and scan, and translator access circuits by use of diagnostic tests, diagnostic test panel, test calls from the MTF or OTF, and trouble record cards or trouble indicator displays. A brief description of each follows.

### DIAGNOSTICS

**5.02** A series of programs labeled diagnostics are used to isolate controller problems. The objective of the program is usually accomplished by exercising the device in question as thoroughly as possible in a logical sequence tailored to that particular device.

**5.03** The diagnostics may be divided into the following categories: stand-alone, initialization, on-line, and on-demand. **Stand-alone** diagnostics are those which reside in the CPU ROM and the main ROM and are used to verify CPU, RAM, and ROM basic operations. **Initialization** diagnostics are used to verify that all buffers, registers, distributes, etc. are normalized and certain devices are operable prior to allowing the CDT to process data. **On-line** diagnostics are being continuously performed in the background to detect any errors or system malfunctions that might occur. **On-demand** diagnostics are initiated from the DTP by the craft as an aid in trouble isolation. The two most-used on-demand diagnostics are the directed scan and the directed distribute. The condition of a particular

scan point may be verified by using the directed scan, and likewise, a particular distribute point operation is verified by using the directed distribute.

#### DIAGNOSTIC TEST PANEL (DTP)

**5.04** The DTP (located on the controller unit) is used as an interface between the craft and CDT and is provided in lieu of a terminal or a teletypewriter. From the DTP, certain diagnostic tests may be initiated and the results observed on an alphanumeric display. Also, certain error conditions encountered by the controller may be displayed and an alarm sounded to alert the craft that an error display is present on the DTP. Figure 13 provides an overview of the DTP and the three sections of the panel. A brief discussion of each section follows.

**5.05 *Input Section.*** The input section consists of a key pad, input control keys, input command, and data displays. This section is used by the craft to enter commands and data which instructs the controller to execute a diagnostic on a particular circuit or to display certain data stored in the controller.

**5.06 *Output Section.*** The output section consists of the maintenance message display (alphanumeric), and is used by the controller to display the results of diagnostics as well as to display system status messages.

**5.07 *Alarm Control, Status, and Restart Section.*** This section consists of the CDT system status LEDs, CDT initialization control keys, and the alarm control keys. The LEDs are used to convey the status of various portions of the system as well as alarm conditions when they exist. The alarm keys are used to cut off audible alarms and to release alarms. The initialization control keys are used to reset their respective hardware. The auto restart control is used when diagnostics are going to be run that take more than 3 seconds to execute, in order to prevent a system timeout. Three seconds is the length of time before automatic system re-initialization occurs, therefore a long diagnostic would cause the system to re-initialize which would terminate the diagnostic. The sanity timer must be ticked at least every .5 seconds or a time-out alarm will be generated, therefore when a long diagnostic is performed, a time-out alarm will occur. Alarms generated are tied into the

office alarm system. When TASC is provided, these alarms will also be tied into the TASC system.

#### MASTER TEST FRAME/OFFICE TEST FRAME

**5.08** New keys and lamps have been added to the MTF and OTF to allow test calls to be made to verify phases of CDT data processing. Selection of a particular controller, translator access circuit, or a request for a trouble indication from the translator access circuit may be made.

**5.09** Completing marker tests will be used to verify the operation of all scan points associated with the completing marker. Trunk tests will be used to verify S1 and CS scan points for trunk supervision. Test calls will also be made from the MTF or OTF to verify scan and distribute points associated with the translator access circuits.

**5.10** Trouble indications may be sent from the translator access circuit to the MTF trouble recorder or the OTF trouble indicator display for any of the following reasons:

- Certain controller detected errors
- A translator access circuit detected error
- A request for a trouble indication from the translator access circuit by key operation at the MTF or OTF.

**5.11** The trouble card for the MTF and the trouble indicator display for the OTF have been modified for CDT. Provision has been made for error codes to be given on the trouble card or the trouble indicator display. Error codes are generated in software to indicate a particular error condition. The error code, plus additional perforations on the trouble record card or lamps lighted on the trouble indicator display, will be used in conjunction with the error code to further isolate error conditions.

#### TRUNK AUDITS AND ERROR DETECTION

**5.12 *AMARC Trunk Audits.*** Each trunk capable of handling recordable calls is assigned a call record register at AMARC. By examining the call record registers at given intervals, it is possible to determine whether a trunk has been in use for 24 hours, has been idle for 48 hours, never answered, or always answered.

ORIG.  
LINE  
CLASS

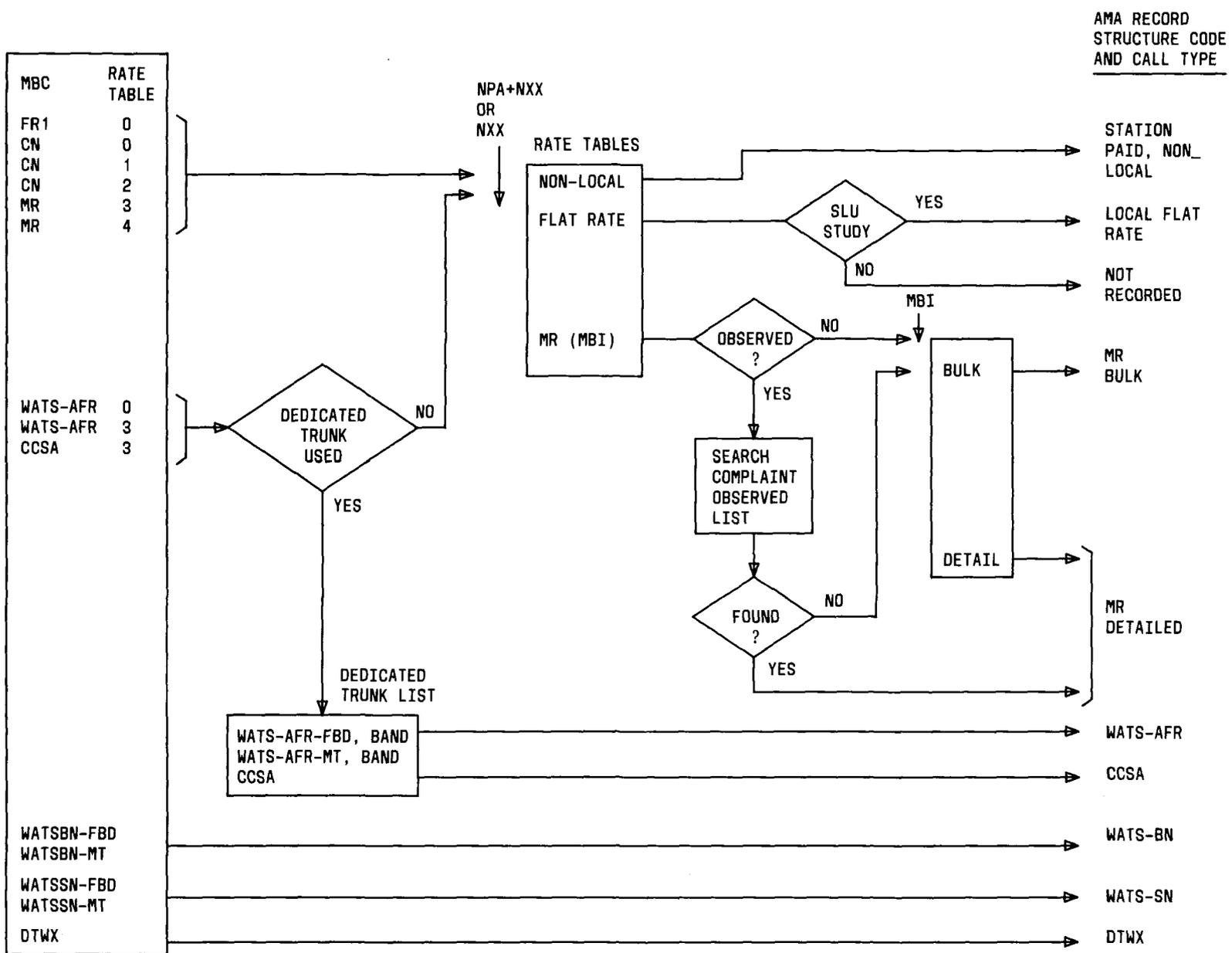


Fig. 12—AMARC Billing Translation for CDT

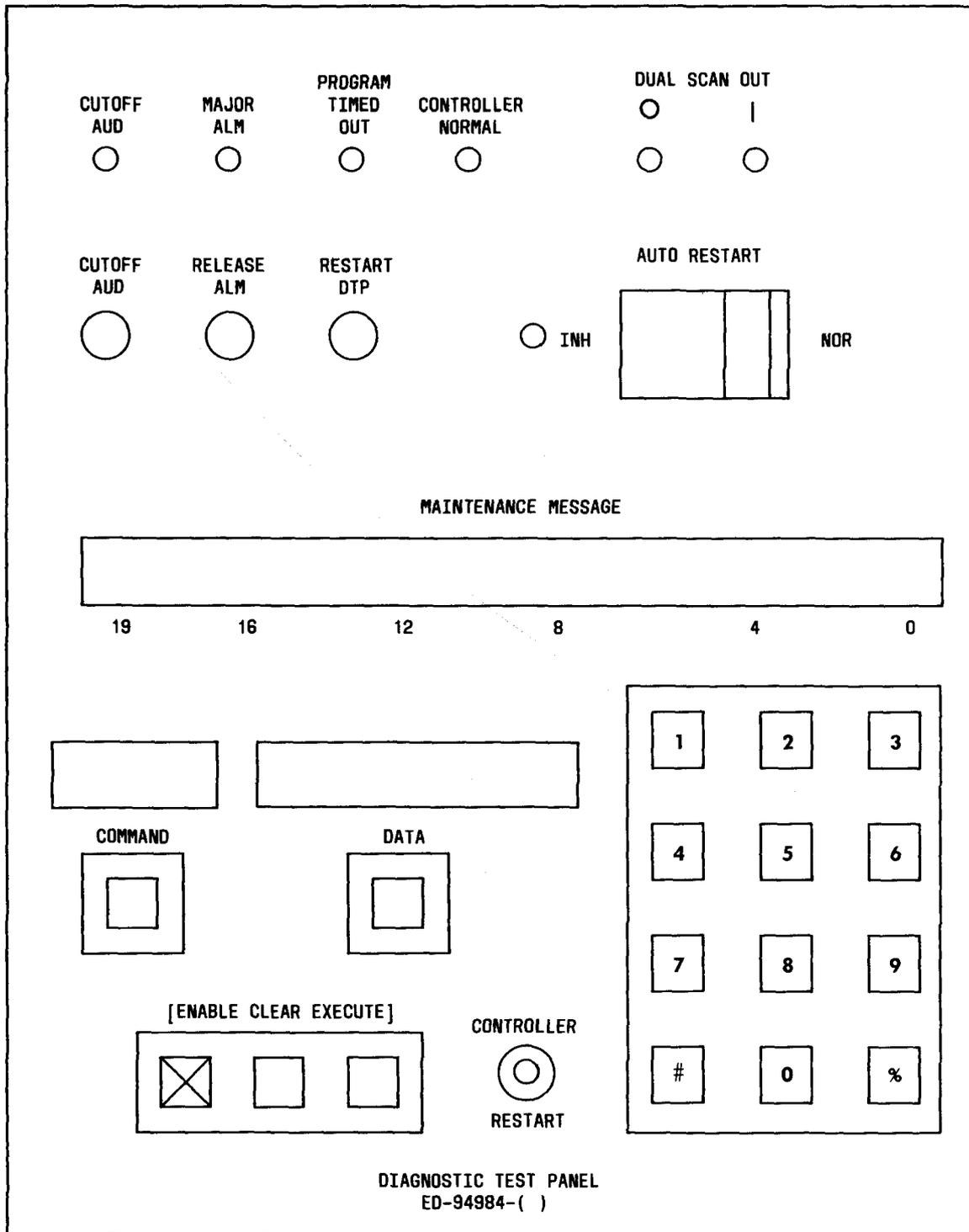


Fig. 13—Diagnostic Test Panel

**5.13 CDT Trunk Error Detection.** The CDT software detects irregular CS scan point operations and cases where two scan points operate together (crosses) or a scan point operates but no marker is processing a call using that trunk. These errors are reported via trouble record cards or trouble indicator display for the MTF and OTF respectively.

#### FAULT DETECTION

**5.14** The object of fault detection is to detect any type of trouble that could result in billing errors. Whenever a fault is detected which cannot result in overbilling yet has a minimum revenue loss, the controller will continue data processing (with appropriate alarms and error reports). However, when a fault is detected which may jeopardize the never-overbill criteria, a system initialization will be initiated, thereby resulting in a charge guard on all calls in progress.

**5.15** With dual scanning, when a controller detects system degradation in its ability to handle dual scan calls, it will shift those calls to the other controller.

**5.16 DAS Data Fault Detection.** Faults are detected in DAS data by the use of coded N/M fields, sequence checks, and long term trunk audits.

**5.17 Translator Access Fault Detection.** Cross detection, N/M field checks, sequence checks, and the work timer are the fault detectors used in the translator access circuits.

**5.18 Controller Fault Detection.** The following means are used for fault detection in the controllers: decoding and sequence checks, parity on address and data, background diagnostics and audits, and the sanity timer.

**5.19 AMARC Data Channel Fault Detection.** The following means are provided for fault detection in the data links to AMARC: cyclic redundancy checks (CRC) on transmitted data, sequence numbers on data blocks, periodic tests of the dial backup channel from AMARC, and the time clock audits.

#### FAULT ISOLATION

**5.20** When a fault has been detected, the cause of the fault must be isolated by the use of the maintenance tools covered previously in this part.

**5.21 Electromechanical and DAS.** When the fault is in the electromechanical circuits or the DAS, completing marker or trunk tests originated from the MTF or the OTF will be used to check marker or translator access circuit scan and distribute points, trunk supervision, selection of combinations of markers, controllers, and translator access circuits, and use of trouble record cards/trouble indicator displays.

**5.22 Electronics.** Fault isolation in the electronics portion of the CDT is via diagnostics scheduled or requested from the DTP to check out the CPU, buses, ROM, RAM, SIO, and certain portions of the DAS.

**5.23 Data Links.** Fault isolation for the data links is accomplished by loop-back tests from AMARC, requested diagnostics at the DTP, and by standard data facilities test access.

#### 6. ADMINISTRATION CONSIDERATIONS

##### ADMINISTRATIVE CONSIDERATIONS BETWEEN CDT AND AMARC

**6.01** Prior to the addition of CDT to the No. 5 crossbar office, all billing translation changes were confined to the local office. However, with CDT, it becomes necessary to coordinate changes that affect billing translations with the AMARC.

**6.02** Listed below are the major items that must be coordinated between the local office and AMARC.

- Physical changes relative to trunk circuits, such as removals or additions.
- Usage changes of trunk circuits, such as WATS bands, that affect billing translation
- Reassignment of class of service that affects CCSA, POTS, flat rate, message rate, etc
- Local or foreign area code activation or deactivation

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- Changes in tariff codes

**6.03** When coordinated changes, additions, or removals have been made, service-type test calls should be made. Test calls from the MTF or OTF are not recorded at AMARC, therefore a service-type test line with the appropriate class of service assigned must be used for the test call. The AMARC trap (MON LIN) for the test line should be set. Verification of the change should then appear in the trap message and the recorded entry on magnetic tape.

**TRAFFIC AND PLANT COUNTS**

**6.04** Traffic and plant counts are maintained for the translator access circuits, data links, and the controllers.

**6.05** The traffic counts maintained are as follows:

- Translator Access Circuit
  - Translation attempts
  - Usage
  - Made-busy usage
- Controller AMA data processed (scale factor of 10)
  - Single-scan initial entries (per controller)
  - Dual-scan initial entries (per controller)

Single-scan timing entries (per controller)

Dual-scan timing entries (per controller)

- Controller initial entry attempts lost due to buffer overflow (per controller)

**6.06** The plant counts maintained are as follows:

- Translator Access Circuit Translator Usage (per TA)

Translation failures (per TA)

First trial failures (per TA)

Second trial failures (one/system)

- Controller (Counts are on a per controller basis)

Trunk seizures (scale factor of 10)

Trunk seizure failures (scale factor of 10)

Initial Entry attempts (scale factor of 10)

Initial entry attempts lost due to buffer overflow

Mutilated initial entries

Trunk scan charge guards