

AUTOMATIC IDENTIFIED OUTWARD DIALING MAINTENANCE PROCEDURES USING MAINTENANCE TELETYPEWRITER NO. 2 AND NO. 2B ELECTRONIC SWITCHING SYSTEMS

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1. GENERAL

1.01 This section describes some of the techniques for analysis of call processing troubles on the automatic identified outward dialing (AIOD) equipment. It is an attempt to cite some of the problems that may arise and solutions that could be used. This section explains how to use the input and output messages in the maintenance procedures. It also explains how to analyze some of the messages for problem isolation.

1.02 This is the initial issue of this section.

1.03 A variety of messages are available for controlling and determining the status of the automatic number identification (ANI) equipment's data link, and the AIOD interface circuit. This control is exercised through the use of the maintenance teletypewriter (TTY).

1.04 The term ANI is used to identify the hardware located on the customer's premises that identifies the station making the call and the trunk it is using.

1.05 The AIOD interface circuit is all the hardware in the central office associated with AIOD operation (Fig. 1, 2, and 3). It is basically a data link terminating set. The AIOD interface circuit is composed of two independent data receivers with associated 41-bit shift registers and check circuitry. The duplicated halves of the AIOD interface circuit can function independently. Diagnostic circuitry and two test transmitters are shared between the halves and are not used in routine call processing. The data receivers are connected to a given data link by means of relays located on the ANI connecting unit (Fig. 1). These relays are controlled by dedicated trunk peripheral decoder applique circuits. The function of the AIOD interface circuit

is to receive from the ANI a 41-bit serial message in 2-out-of-5 code. It then checks each digit for proper parity by means of a resistive network and presents the message in parallel form, via a master scanner, to the AIOD program. Refer to Fig. 4 for a block diagram of the AIOD interface circuit.

1.06 The data link runs from the ANI to the AIOD interface circuit at the central office. A coded representation of the station number and trunk number is transmitted over this data link.

1.07 Program CTXIOD (PR-2H306) provides the following AIOD features:

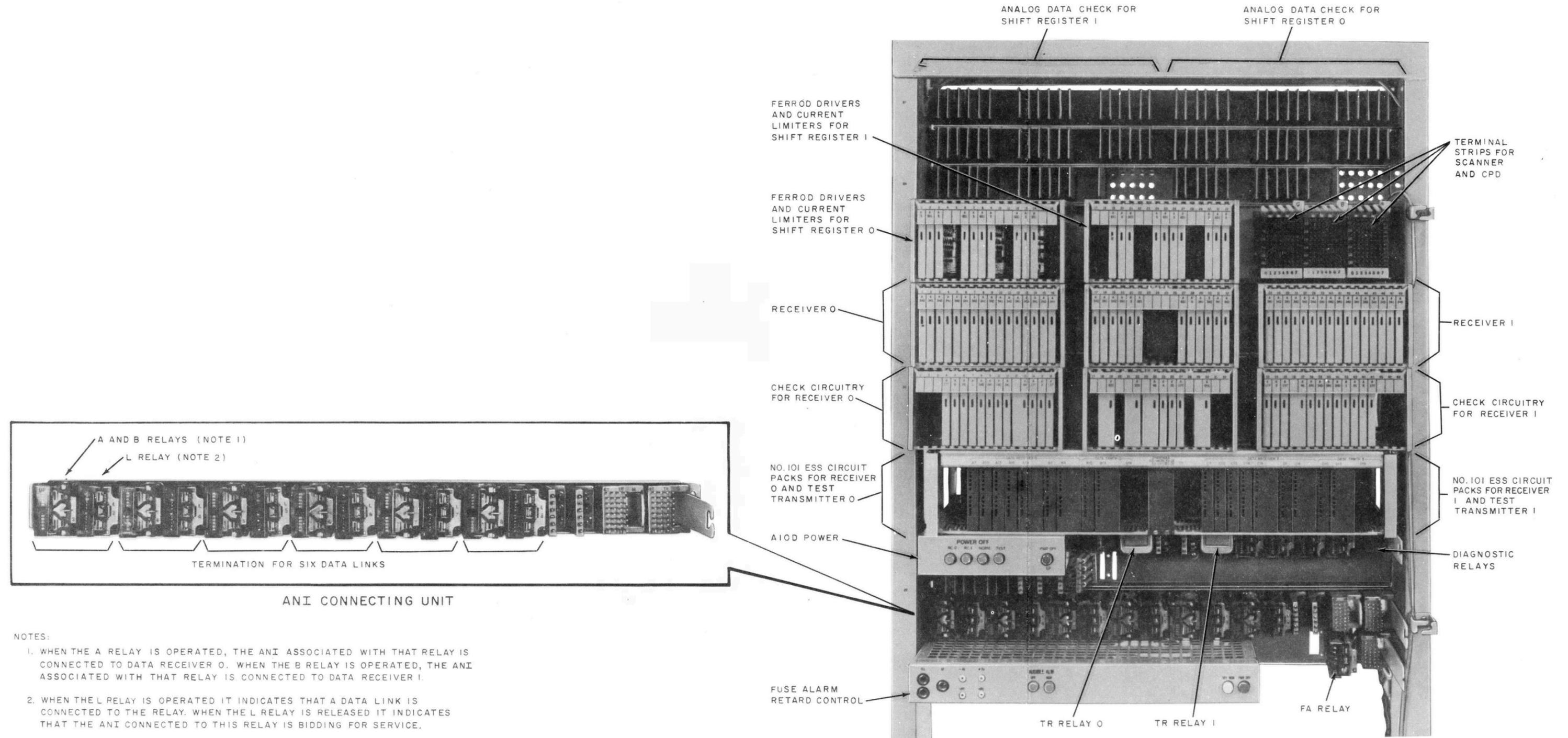
- **Automatic Identified Outward Dialing Call Processing**
- **Automatic Identified Outward Dialing Fault Recognition**
- **Automatic Identified Outward Dialing Diagnostics**

1.08 For a detailed description of the AIOD feature and the AIOD interface circuit, refer to Section 232-203-101 and CD-1A301.

1.09 The AIOD feature provides a means for the identification of calling stations in a customer-located centrex system (Centrex-CU) making outward calls requiring local automatic message accounting (LAMA) billing. When the AIOD equipment malfunctions on a charged call, the system bills the listed directory number (LDN) associated with the Centrex-CU group from which the call has come. The primary purpose of AIOD maintenance and fault recognition is to aid in determining why the system is producing failures and to remove any faulty unit from service. Maintenance personnel are notified of system activity by output messages printed on the maintenance TTY. These output messages and the available input messages are explained in detail later in this section.

1.10 The program activity for AIOD call processing can be divided into two sections:

- Store cycle—sequence of events from customer dialing central office access code to storing the station number in the CALL STORE BUFFER TABLE (Fig. 5).



NOTES:

1. WHEN THE A RELAY IS OPERATED, THE ANI ASSOCIATED WITH THAT RELAY IS CONNECTED TO DATA RECEIVER 0. WHEN THE B RELAY IS OPERATED, THE ANI ASSOCIATED WITH THAT RELAY IS CONNECTED TO DATA RECEIVER 1.
2. WHEN THE L RELAY IS OPERATED IT INDICATES THAT A DATA LINK IS CONNECTED TO THE RELAY. WHEN THE L RELAY IS RELEASED IT INDICATES THAT THE ANI CONNECTED TO THIS RELAY IS BIDDING FOR SERVICE.

Fig. 1—Automatic Identified Outward Dialing Interface Circuit

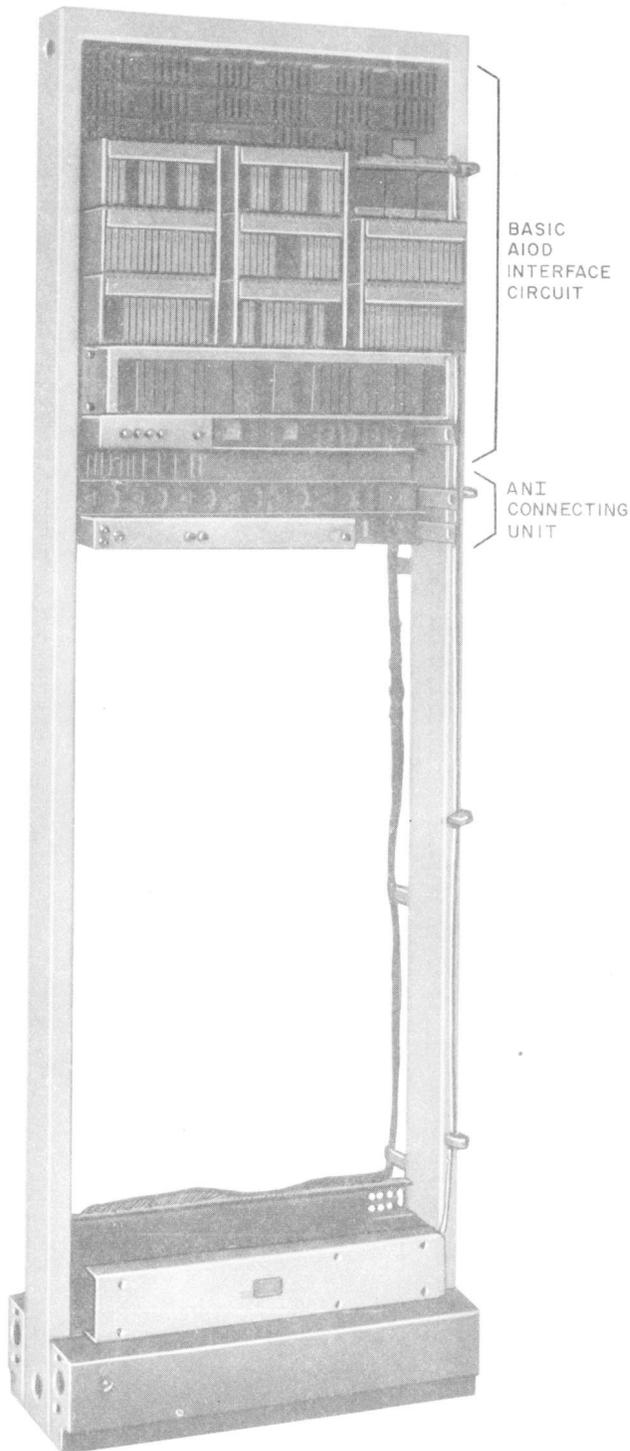


Fig. 2—Basic (Minimum Configuration) AIOD Frame

- Fetch cycle—sequence of events that remove the station digits from the CALL STORE BUFFER TABLE. The normalized office code obtained from the LDN is used to create a billing number (Fig. 5).

Note: With non-AMA calls the fetch cycle is not performed, but the buffer table is cleared on disconnect.

2. AIOD PEG AND ERROR COUNTERS

2.01 The AIOD feature uses a self-checking system for fault detection and isolation. Fault detection and isolation for the AIOD interface circuit is performed by the analysis of error counters associated with each AIOD receiver. Faults can exist in the AIOD frame at the central office, the data link, or the ANI frame at the customer's location.

2.02 There are three basic types of counters used by the CTXIOD program.

- general peg counter (one) for entire AIOD system)
- receiver error counters (two; one for each AIOD receiver)
- data link error counters (seven for each equipped data link)

A. General Peg Counter

2.03 The general peg counter is incremented each time an idle AIOD receiver is connected to a bidding data link. The peg count is printed and zeroed each time the office totals (OFT) selection of the H or C traffic schedule is automatically printed. (When requested manually the peg counter is printed but not zeroed.)

B. Receiver Error Counters

2.04 The system has an error counter associated with each AIOD receiver. Each time an error occurs and the program logic pinpoints that error to a particular receiver, the receiver error counter increments. The receiver error counter increments for receiver initialization failures, ANI parity errors and shift register errors. These errors do not necessarily imply a failure in the

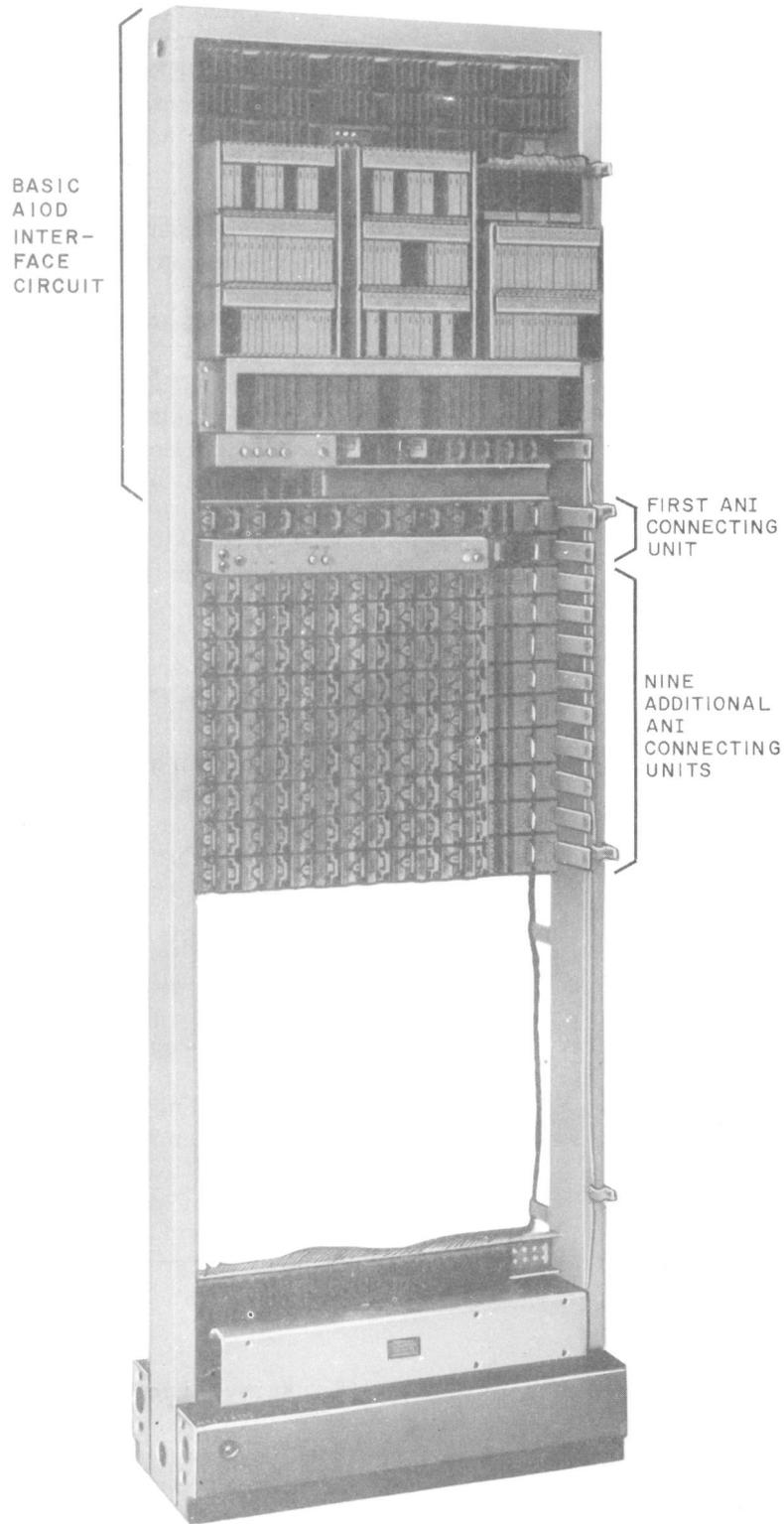


Fig. 3—Fully Equipped AIOD Frame

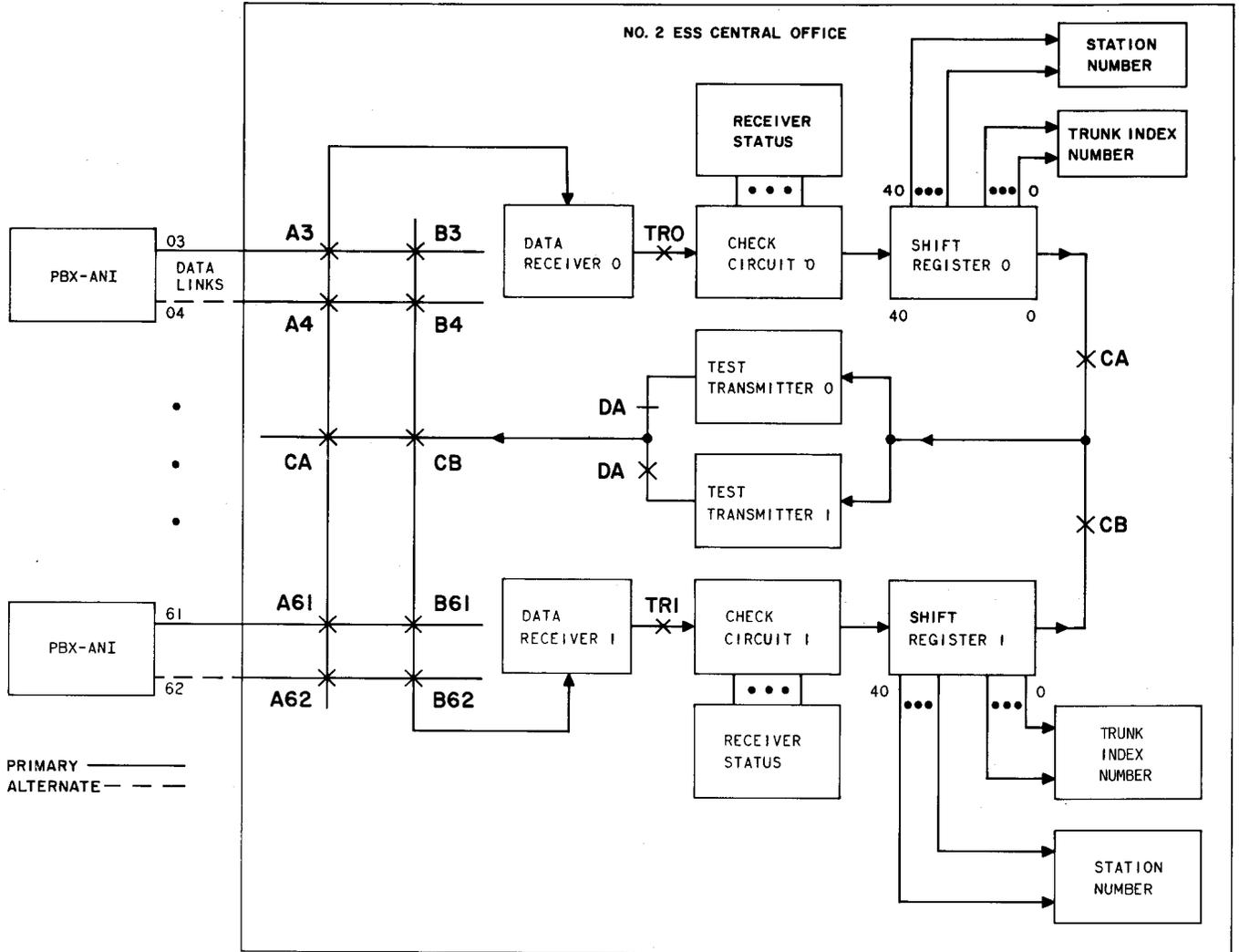


Fig. 4—Automatic Identified Outward Dialing (AIOD) Interface Circuit Block Diagram

AIOD interface circuit. The errors could be caused by a fault at the ANI.

- A receiver initialization error occurs when the ferroids in the receiver status row are not in the expected state 100 ms after the bidding data link is connected to the idle receiver. See Table A for the correct state

of the ferroids during the initialization scan. Refer to Table B to determine the conditions that could cause a receiver initialization error.

- An ANI parity error occurs when five binary ones are present in cells 40 through 36 of the shift register.

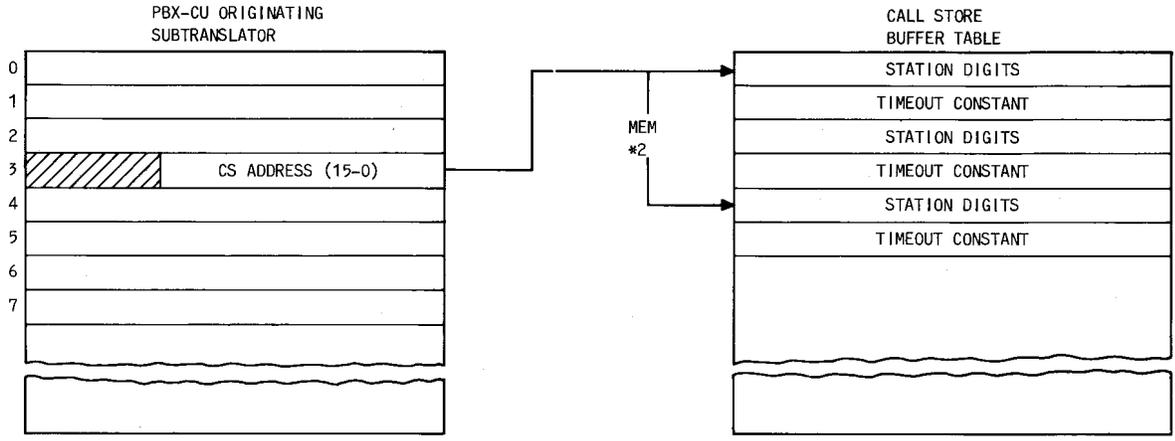


Fig. 5—Call Store Buffer Table

- A shift register error occurs when the AIOD receiver discovers that an invalid 2-out-of-5 code exists in the shift register.

TABLE A

CORRECT STATE OF FERRODS DURING RECEIVER INITIALIZATION SCAN

FERROD	AB OP	TRT	SPM	APE	CM	TRR	FIB	PMB	SRE 7	SRE 6	SRE 5	SRE 4	SRE 3	SRE 2	SRE 1	SRE 0
STATE	DC	0	DC	DC	1	0	0	0	DC	0						

DC = don't care
 0 = saturated
 1 = unsaturated

TABLE B

**CONDITIONS THAT WOULD CAUSE AN
INITIALIZATION FAILURE**

FERROD	STATE	EXPLANATION
SRE0	1	Shift register did not clear
CM	0	Counting circuit failed to reset
PMB	1	Shift register did not clear
TRT	1	Not connected to an ANI (no continuity)
TRR	1	Not connected to an ANI (no continuity)
FIB	1	Shift register did not clear

2.05 When one of the two receiver error counters reaches a built-in threshold of 8, a check is made to determine if the value of the other receiver error counter is less than 4.

- If the value is 4 or less, and both receivers are in service, an automatic diagnostic is requested. If the diagnostic fails, the receiver is removed from service. A message is printed on the maintenance TTY and the MISC trouble lamp is lighted on the System Status section of the Maintenance Center Panel.
- If the value is greater than 4, both receiver error counters are cleared.
- If the value is 4 or less, and the other receiver is out of service, a transient error message is printed on the maintenance TTY.

2.06 If one receiver is getting an unusually large number of errors, an attempt is made to locate the fault in the AIOD interface circuit. If both receivers are getting an unusually large number of errors, the fault can be pinpointed to a specific ANI or data link. The data link error counters are used to determine a specific ANI or data link.

C. Data Link Error Counters

2.07 Each data link has seven data link error counters. The data link error counters increment at each error occurrence in the system that can be pinpointed to a specific data link or ANI. The values of the counters are printed and the counters are zeroed according to the plant schedule. The value of a specific counter is automatically printed for the first error occurrence as well as for the 255th occurrence of the error. The value of a specific counter is also printed on each occurrence of the error if the following message has been typed on the maintenance TTY:

M PO:CTL:05 1!

The printing of the data link error counters can be disabled by the message:

M PO:CTL:05 0!

The meaning of each data link error counter printout is analyzed in Part 5, of this section.

2.08 The data link error counters allow the maintenance personnel to determine on which data link the errors are occurring. It is recommended that if the plant schedule indicates that errors are occurring in the AIOD system, the printing of the data error counter should be enabled. If at any time a data link error counter reaches the value of 255, then serious problems exist and should be investigated as soon as possible.

3. AIOD RECEIVER, TEST TRANSMITTER, AND DATA LINK SERVICE MESSAGES

A. Removal of an AIOD Unit from Service

3.01 To remove an AIOD unit from service, the following message must be typed on the maintenance TTY:

Ma AD:RMV:fg -!

(For an explanation of the variable fields, refer to input message manual IM-2H200)

Note: Removing a data link from service should be done with extreme care since billing

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to individual station numbers will not be done. Billing will be to the listed directory number.

3.02 If the AIOD system removes a unit from service, the following message will be printed on the maintenance TTY:

MR AD RMV fg i

(For an explanation of the variable fields, refer to output message manual OM-2H200).

B. Restoration of an AIOD Unit to Service

3.03 To restore a unit to service, enter the following message on the maintenance TTY:

Ma AD:RST:fg -!

(For an explanation of the variable fields, refer to input message manual IM-2H200).

3.04 If the AIOD system restores a unit to service, the following message will be printed on the maintenance TTY:

MR AD RST fg i

3.05 When a receiver is to be restored to service the test transmitters must be in service. The message

MH AD RST 02 -!

can be used to restore the test transmitter to service when one of the receivers is out of service, without harmfully affecting the processing of messages from ANIs.

4. REQUEST THE STATUS OF THE RECEIVERS, TEST TRANSMITTER AND DATA LINKS

4.01 To request status of the AIOD unit as well as any other peripheral unit, enter the following message on the maintenance TTY:

M PU:SI!

The system will respond by printing several messages. If the following message is among those printed on the maintenance TTY then at least one

of the units associated with the AIOD *is out of service*:

MR AD SI jk l bbbbbb cccccc dddddd eeeeee

(For an explanation of the variable fields, refer to output message manual OM-2H200).

5. ANALYSIS OF THE MI AD AER MESSAGE

5.01 The following message is printed each time an error that can be associated with a specific data link occurs.

MI AD AER a bb ccc dddddd eeeeee ffffff

(For an explanation of the variable fields, refer to output message manual OM-2H200).

The message is automatically printed for the first and the 255th occurrence of the error.

5.02 To determine how to cause the occurrences of data link errors to be printed on the maintenance TTY, refer to 2.07.

A. Data Link Associated Errors (Type 0)

5.03 The error type 0 of the output message MI AD AER is an error that can usually be attributed to either the tip-ring pair between the remote location and the central office or the circuitry associated with the data link in the AIOD interface circuit. The error is indicated for three basic reasons:

- ANI failure to respond to a bid for service
- ANI failure to restore battery & ground
- Failure to operate A/B relay

(a) Once the ANI bids for service by removing the battery and ground from the data link, the AIOD responds by operating the A or B relay. This connects the data link to a data receiver. The data receiver supplies the battery and ground to the data link. This action is a signal to the ANI to start transmitting. If, after 200 ms, the ANI does not send the message the error counter is incremented. For example; an open data link could cause this error.

(b) The second reason for incrementing the error counter occurs if the ANI fails to restore the battery and ground after the AIOD Interface Circuit has removed the battery and ground from the data link. The ANI is given 100 ms to restore the battery and ground after the AIOD Interface Circuit has removed it. Each of the two previously mentioned failures [(a) and (b)] implies problems in the ANI circuit at the remote location, the tip-ring pair from the remote location to the central office, or the circuitry associated with the data link on the AIOD interface circuit. It should be noted that the diagnostic program is not capable of testing this circuitry.

(c) Finally, the third reason for incrementing the data link counter is the failure to operate either the A or B relay on the circuitry associated with the data link. This failure is caused by a failure in the circuitry associated with the data link in the AIOD interface circuit.

B. Listed Directory Number Calls Error Counter (Type 1)

5.04 This counter indicates an ultimate failure in the AIOD operation. This error counter keeps a record of times the AIOD system is unable to bill the individual station making a charged call.

The call is completed but the system must bill the call to the LDN. Failure can be located at the ANI, the data link from the remote location to the central office or the AIOD interface circuit. The variable field dddddd will contain the Terminal Equipment Number (TEN) of the Multiline Hunt Group (MLH) member associated with the error.

5.05 It is important to realize that an LDN billed call could be the result of any type of data link error.

C. Shift Register Error (SRE) Counter (Type 2)

5.06 The data link error counter indicating shift register errors is incremented if any one of the ferrods SRE 0 through SRE 7 indicates that its respective digit contains an invalid 2-out-of-5 code. When the supervisory ferrods in the receiver status row are scanned at the time the message is completed, the expected results should appear as indicated in Table C. When a valid 2-out-of-5 code resides in each group of 5 bits, the corresponding SRE ferrod reads unsaturated (1). Refer to Table D for an explanation of the 2-out-of-5 encoding. Failures in this area usually indicate that noise is affecting the transmission of information over the data link, a defective ANI or a defective data receiver at the central office.

TABLE C

EXPECTED RESULTS OF DIRECTED SCAN FOR COMPLETE MESSAGE (CM)

FERROD	AB OP	TRT	SPM	APE	CM	TRR	FIB	PMB	SRE 7	SRE 6	SRE 5	SRE 4	SRE 3	SRE 2	SRE 1	SRE 0
STATE	DC	1	1	0	0	1	DC	1	1	1	1	1	1	1	1	1

DC = don't care
 0 = saturated
 1 = unsaturated

The scan for complete message is done after all of the bits have shifted to their respective final cells.

TABLE D
TWO-OUT-OF-FIVE ENCODING

DIGITS	2/5 ENCODING (See Note)						TRUNCATED 2/5 ENCODING			
	7	4	2	1	0		7	4	2	1
1	0	0	0	1	1		0	0	0	1
2	0	0	1	0	1		0	0	1	0
3	0	0	1	1	0		0	0	1	1
4	0	1	0	0	1		0	1	0	0
5	0	1	0	1	0		0	1	0	1
6	0	1	1	0	0		0	1	1	0
7	1	0	0	0	1		1	0	0	0
8	1	0	0	1	0		1	0	0	1
9	1	0	1	0	0		1	0	1	0
0	1	1	0	0	0		1	1	0	0

Note: Two-out-of-five encoding is a way of representing ten digits by using all the possible combinations of two ones and three zeros. The 0-weighted bit is used only for error checking.

TABLE E

RELATIONSHIP BETWEEN SREs AND RESPECTIVE DIGITS IN THE SHIFT REGISTER

← STATION NUMBER →					← TRUNK MEMBER NUMBER →				
	U	T	H	T	U	T	H	T	
	N	E	U	H	N	E	U	H	
	I	N	N	O	I	N	N	O	
	T	S	D	U	T	S	D	U	
	S			S	S			S	
FIB	PMB	SRE 7	SRE 6	SRE 5	SRE 4	SRE 3	SRE 2	SRE 1	SRE 0

The Premessage Bit (PMB) ferrod is always a (1) when the message has been completed. The First Information Bit (FIB) ferrod indicates either a (0) or (1) depending upon the message received.

Note: Refer to Table E for an insight into the relationship between SRE and the digits of the trunk and station numbers as they appear in the shift register.

5.07 The occurrence of an SRE causes the receiver error count to be incremented. When the SRE causes the receiver error counter to reach a threshold level of 8, the system diagnoses the receiver. This is premised on the second data receiver being in service and its error counter being less than 4. The results of the diagnostic test are provided in the following TTY output message:

Ma AD DGN fg nnnn oooooo pppppp qqqqqq

Using the trouble number from this message and TLM-2H301, the faulty circuit packs may be located.

Note: A possible cause of the SRE could be a noisy data link. The level of the ANI data signal measured at the central office end should be:

-22 dBm MINIMUM

0 dBm MAXIMUM

D. ANI Parity Error Counter (Type 3)

5.08 The data link error counter, indicating ANI parity errors, is incremented when five

binary ones appear in cells 40 through 36 of the shift register. (Refer to Fig. 6.) An ANI parity error occurs whenever the ANI fails to identify the station making the call or whenever the ANI detects an invalid 2-out-of-5 code in any digit. When an invalid 2-out-of-5 code is detected the ANI sends all binary ones for the remainder of its message.

5.09 The ANI parity error indicates failures from the equipment on the customer's premises, or failure in the ANI parity error check circuitry located in the AIOD interface circuit. The occurrence of an ANI parity error causes the receiver error count to be incremented also.

5.10 When the ANI parity error causes the receiver error counter to reach a predetermined level of 8, the system diagnoses the receiver. Again this action is based on the second data receiver being in service, and the other receiver error count being less than 4. The output message with the trouble number along with Trouble Locating Manual (TLM-2H301) enables the location of the faulty circuit packs.

E. ANI Time-Out Counter (Type 4)

5.11 When the ANI bids for service, the data link scanning portion of program CTXIOD detects the bid. The data link associated with the ANI is connected to an idle receiver. The

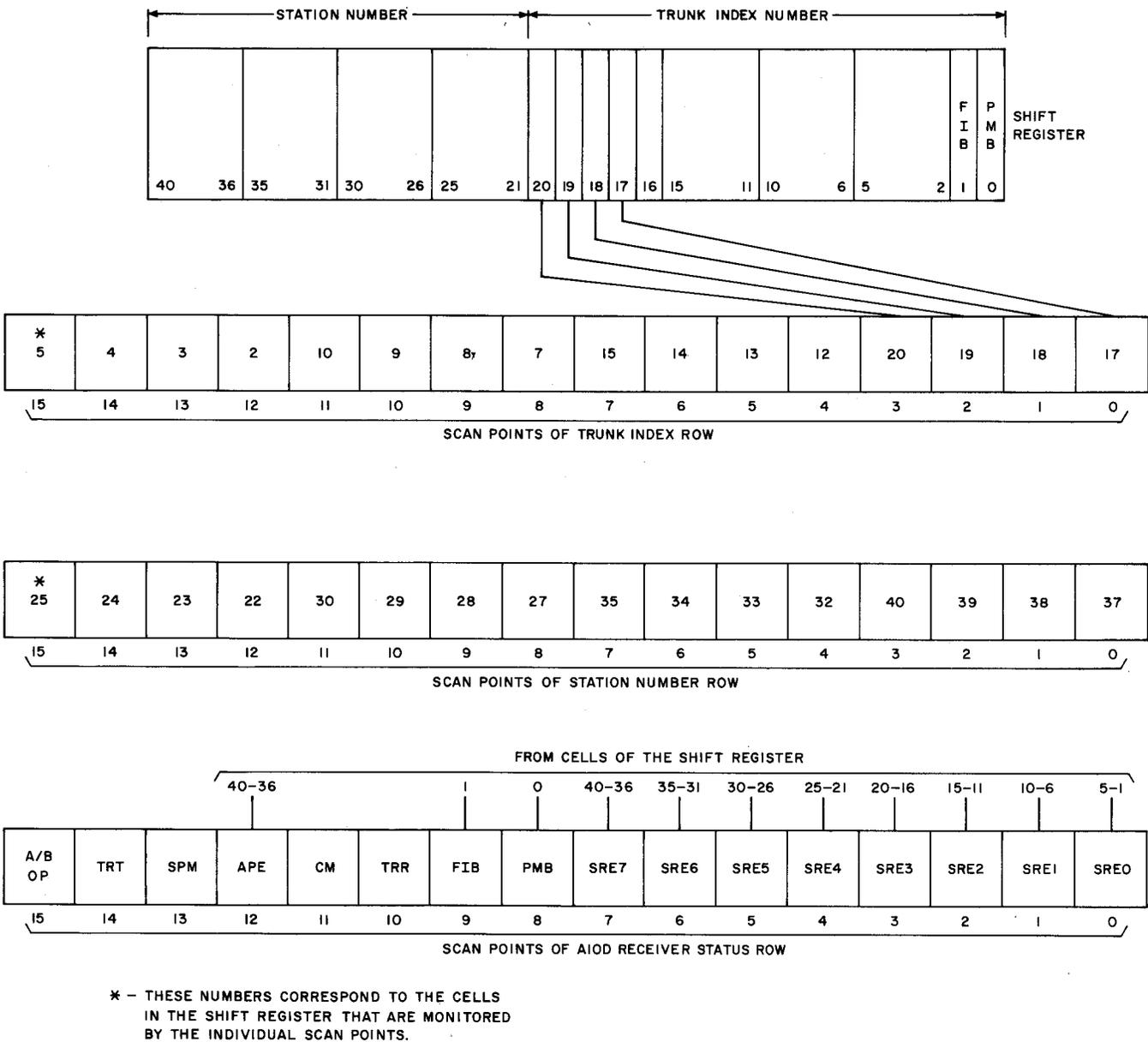


Fig. 6—Scan Points Associated with Shift Register

receiver supplies battery and ground to the data link. This action is a signal to the ANI to start transmitting. The data links are scanned for bids only when an idle receiver is available. If no receivers are available, the bid would not have been detected and signal to transmit would not have been sent. If the ANI does not receive a signal to transmit within a fixed period of time, the ANI times out. The ANI can also time out

under overload conditions or if both AIOD receivers are out-of-service.

5.12 An ANI time-out error is detected by scanning the TRR and the TRT ferroids. The TRR and the TRT ferroids indicate current in the ring and the tip of the data link, respectively. If either one of these ferroids is unsaturated indicating that current is not present, and if the receiver had

properly initialized previously, then the ANI time-out error counter is incremented.

F. Translation Error Counter (Type 5)

5.13 The error counter that indicates translation errors is incremented for two basic reasons:

- Invalid messages received from the ANI.
- Translations at the central office are incorrect

Possible errors could be that the ANI did not transmit the correct member number or the central office translations are incorrect.

5.14 If the translation error appears to be caused by a noisy data link, ensure that the level of the ANI data signal at the central office is between the following ranges:

-22 dBm MINIMUM

0 dBm MAXIMUM

G. Storing But Not Idling Error Counter (Type 6)

5.15 This error occurs when new data being shifted from the ANI to the call store buffer table tries to overwrite old data that has not yet been cleared. (See Section 232-203-101 for an explanation of the buffer table.) The output message variable fields ddddd, eeeee, and fffff print the contents of the scan rows on which the error occurred.

6. ANALYSIS OF THE MA AD RMV MESSAGE

6.01 The following message indicates that one of the AIOD receivers, test transmitters or data links has been removed from service automatically. In addition to this message the miscellaneous trouble lamp lights.

MA AD RMV fg i h ee

(For an explanation of the variable fields, refer to output message manual OM-2H200).

Error Mode Analysis

6.02 The following paragraphs give a description of the error mode given in the h field of the MA AD RMV message.

6.03 Error Mode 1—Each time that the data links are scanned to determine if any bids are present, the ferrods associated with the power on the AIOD interface circuit are also scanned. If any of the AIOD power ferrods indicate that power is not present on either of the AIOD receivers, then the receiver is removed from service. A removal message is then printed with error mode 1.

6.04 Error Mode 2—If the scanner containing the receiver's status row, the station number row, or the trunk member number row, is inaccessible, the appropriate receiver is removed from service and the message is printed with error mode 2.

6.05 Error Mode 3—If the AIOD system attempts to release either A or B relay and the program discovers that the release was not successful due to either the CPD having failed, or that the ABOP ferrods indicate that an A or B relay is operated, the receiver will be removed from service and the removal message with error mode 3 will be printed. If receiver 0 is indicated then relay A is presently inoperative, if receiver 1 is printed, then relay B is presently inoperative. The field ee in output message MA AD RMV fg i h ee, specifies the relay that is inoperative.

6.06 Error Mode 4—If a central pulse distributor failure occurs while trying to operate either A or B relay, the receiver is removed from service. The removal message with error mode 4 is printed.

7. AIOD DIAGNOSTIC SEQUENCE

7.01 The purpose of the diagnostic program is to test receiver 0 or receiver 1 and to discover if any faults exist in the AIOD interface circuit. If any faults are present, in the TTY output message, a 4-digit trouble number is printed. The trouble number can be cross-referenced in the Trouble Locating Manual (TLM-2H301) to find the faulty circuit pack.

7.02 If the diagnostic sequence is requested manually, the receiver is reset to its original service status. If the diagnostic is requested automatically under program control and the diagnostic fails then the defective receiver is removed from service.

7.03 The following input message is used to request diagnostics of the AIOD frame.

Ma AD:DGN:fg -!

(For an explanation of the variable fields, refer to input message manual IM-2H200).

7.04 The output message M AD DGN is printed as a result of an AIOD diagnostic that has terminated. Any of the following output messages may be given and are specified as follows:

Ma AD DGN fg - nnnn oooooo pppppp qqqqqq
Ma AD DGN fg-ATP
Ma AD DGN fg-ABT n
Ma AD DGN fg-REJ n

(For an explanation of the variable fields, refer to output message manual OM-2H200 and TLM-2H301).

8. GLOSSARY

8.01 The following glossary defines some of the commonly used abbreviations associated with this section.

ABOP—A relay or B relay operated ferrod

AIOD—Automatic Identified Outward Dialing

AMA—Automatic Message Accounting

ANI—Automatic Number Identification

APE—ANI Parity Error

CENTREX-CU—A PBX switching unit with DID and AIOD

CM—Complete Message

CPD—Central Pulse Distributor

CTXIOD—Program Identification for AIOD program in No. 2 ESS EF-1 generic

DID—Direct Inward Dialing

FIB—First Information Bit

LDN—Listed Directory Number

PMB—Premessage Bit

SBNI—Storing But Not Idling Error

SPM—Signal Present in Message

SRE—Shift Register Error

TRR—Current in ring lead of data link

TRT—Current in tip lead of data link