ANALYZING AND LOCATING TROUBLE IN SIGNAL DISTRIBUTORS
2-WIRE AND 4-WIRE NO. 1 ELECTRONIC SWITCHING SYSTEM

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1.01 This section provides an approach to locating and analyzing many of the malfunctions that

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can occur in the controllers and the relay contact tree of the Signal Distributor (SD).

1.02 This section is reissued to include the DR02 message for CTX-7 Issue 9 and 1E4 generic programs and to make minor corrections.

Note: Effective with what would have been CTX-8 Issue 4 of No. 1 ESS, the equivalent generic program designation is 1E4.

2. GENERAL DESCRIPTION

2.01 The signal distributor starts an operational cycle when the Central Pulse Distributor (CPD), as instructed by Central Control (CC), transmits an enable signal over a private bus. This causes a particular signal distributor to gate the selection data from the peripheral unit address bus into its buffer register (Fig. 1). The buffer register stores this data until the selected magnetic latching relay has operated or released. When the signal distributor senses the completion of the magnetic latching relay action, it releases the established path through the relay contact tree and becomes available for a new order.

2.02 The function of the network controller in the Signal Distributor is to:

(a) Receive address information
(b) Check address information for errors
(c) Block further action if errors are found and notify CC
(d) Operate preselector relays
(e) Receive verification that the selected magnetic latching relay worked as intended.

If all circuit conditions are satisfied, the controller resets for the next cycle of operation.
Fig. 1—Basic Signal Distributor
2.03 The relay contact tree consists of an organized system of wire-spring relays which provide a unique electrical connection called a selection path from the apex pulser to the addressed output. A typical selection path to operate or release a magnetic latching relay within a basic unit is shown in Fig. 2.

![Diagram of relay contact tree]

**Fig. 2—Selection Path to Operate or Release a Magnetic Latching Relay**

### 3. REFERENCE DOCUMENTS

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<td>TRUNK AND LINE TEST PANEL AND SUPPLEMENTARY TRUNK TEST PANEL—METHOD OF OPERATION</td>
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### 4. TOOLS, MATERIALS, AND TEST APPARATUS

**CODE OR SPEC. NO.**

**DESCRIPTION**

**TOOLS**
5. NETWORK CONTROLLER DIAGNOSTIC FAILURES

5.01 Circuit failures can be detected by TTY printouts or TBL lamps at the MCC. If detected by TBL lamps, use NETSD-TBL message to determine the failing unit. Refer to IM-1A001 Input Message Manual for complete message. The system will respond with an MA06 NTSD TBL message. Refer to OM-1A001 Output Message Manual for complete message. The controller enable word is shown in Fig. 3.

![Fig. 3—Layout of Network and SD Enable Word](image)

**Note 1:** Bit 1 = 1—controller is in trouble and out of service.

Bit 2 = 1—controller is bus or CPD sensitive.

Bit 3 = 1—fault recognition is in progress on controller.

Bit 4 = 1—both controllers are faulty.

**Note 2:** Bits 5 and 6 indicate maintenance responses to CC:

Bit 5 = 1—look for ASW, always 0.

Bit 6 = 1—look for enable verify, normally 1.

**Note 3:** Member number = 00. Octal digits 05603502 represent controller 0 and octal digits 05603500 represent controller 1. Bit 1 of controller 0 word equals 1; therefore controller 0 is out of service.

5.02 Using the information obtained in 5.01, request a diagnostic using NET DGN message as per IM-1A001 Input Message Manual. The system will respond with a DR01 TBL message. Refer to OM-1A001 Output Message Manual for complete output message.

5.03 Repeat 5.02 to insure that trouble is not random. Numerous circuit failures can be the cause of network frame controllers failing a diagnostic. Refer to TLM 1A216 for UTSDs and JSDs and to TLM 1A247 for SSDs and MSDs, and if an exact match is found, replace the designated circuit packs one at a time. Repeat diagnostic each time a pack is replaced. If the same universal trouble number occurs, replace the old pack and proceed to the next pack listed. If this fails to fix the trouble, or if the original trouble did not yield an exact match, the next step will be to request a raw data printout.
5.04 Analysis of the raw data printout will be made easier if the fundamental operation of the Signal Distributor (SD) is understood.

5.05 SD diagnostic tests are predicated on sending a series of orders to the suspected controller and monitoring the internal relay operations from private master scanner points. The following paragraphs show the basic operations for the SD internal circuitry.

Steering Logic—FS4

5.06 Each controller can be enabled by either of two CPD signals. For a given controller, each enable originates from a different CPD and allows the controller to receive orders from either PU address bus (Fig. 4).

5.07 Once a controller has been properly enabled, an enable verify pulse will be sent back to the CPD, and the timing sequence to receive and carry out the order is started. Successful completion of the order results in resetting the controller via an output from the apex pulser. If the controller is not reset by completion of the order, it may be reset by a CC pulse (lead 36) sent to all controllers at the end of each cycle.

Maintenance Relays—FS5

5.08 The F, S, and T points are connected over private pairs to a master scanner. These points reflect the state of the controller, and also the source of the controller reset (Fig. 4).

5.09 In addition to the F, S, and T points, FS5 contains the maintenance relays used for changing states of a controller. This circuitry is controlled by a CC order to the mate controller, and is designed to prevent mate units from being placed in conflicting states.

Relay Contact Matrix—FS3

5.10 The peripheral order received in FS1 should have operated one X and one Y relay in FS2. In FS3 this “one and only one” concept is tested. If more than one relay is operated in either group, the R/LCKP or R/LCKS lead will be grounded and will prevent the controller from affecting an external relay.

Apex Pulser—FS6

5.11 When the relay path has been established to the output point, the apex pulser will attempt to operate or release the external relay. If the external relay functions properly, a step current will be detected, resulting in an R/LOP pulse to reset the controller.

5.12 At the MCC-TTY request raw data diagnostic as described in 5.02.

5.13 The following examples represent typical raw data failures on a UTSD. In each case, analysis of the printout will narrow the trouble possibilities to a relatively small area.

5.14 Controller diagnostic programs perform a logical sequence of tests to isolate internal circuitry problems. When analyzing raw data results, it is usually advantageous to examine the data from all preceding and succeeding tests which may have passed.

5.15 Example #1—UTSD CONTROLLER 0. Phases 2 and 3 fail identical tests using PK 1A028 and the raw data printout. The information derived is as follows:

DR02 RAW DGN RES UTSD 0 CONTR 0

<table>
<thead>
<tr>
<th>PH 1 ATP</th>
<th>PH 2 STF</th>
<th>PH 3 STF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>00000000</td>
<td>00000000</td>
</tr>
<tr>
<td></td>
<td>02104000</td>
<td>02104000</td>
</tr>
<tr>
<td></td>
<td>00210420</td>
<td>00210420</td>
</tr>
<tr>
<td></td>
<td>00000000</td>
<td>00000000</td>
</tr>
<tr>
<td></td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td></td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>

5.16 All failing bits refer to Note 88 in PK-1A028, which in turn refers to Note 87. Note 87 explains why the AP point on the diagnostic bus will read zero (saturated). This occurs when the LSO or LSR (the failure is in controller 0) relays operate. These relays operate when either the operate or release current flows.
5.17 A check of each failing bit shows the problem always to be \( AP = 0 \). For each of these test orders, a Y relay is supposed to operate without any X or W relays operating. If the controller functions properly, the operate or release potential should not be closed through. Therefore, the AP point would be unsaturated.

5.18 There are 8 LY relays (0 through 7), but only 7 bits failed in the raw data test. Checking the remaining test orders shows that bit 0 of word 3 passes. In this instance, the LY3 relay is being operated.

5.19 FS3 of SD-1A216 contains the relay matrix. If more than one relay in any group operates, a shunting ground is placed in the path of the operate or release potential.

5.20 Since the LY3 is the only relay that passes the test, it can be assumed that this relay is operating falsely on the other seven test orders, resulting in a "more than one" failure.

5.21 It would appear that the L03 relay, make contacts 3 to 10, are stuck closed. Using an ohmmeter, check contacts, change the circuit packs associated with the LY3, and inspect the wiring or use NET-ONE order (6.29) to locate the trouble.

5.22 Example #2 - UTSD CONTROLLER 0. In this case, only one failing bit is indicated in the printout:

<table>
<thead>
<tr>
<th>PH 1 ATP</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 2 STF 00000000</td>
</tr>
<tr>
<td>PH 3 STF 00000200</td>
</tr>
<tr>
<td>00000000</td>
</tr>
<tr>
<td>00000000</td>
</tr>
</tbody>
</table>

5.23 The fact that only one bit is shown as failing does not mean that all other tests passed. In this case the remainder of the tests were bypassed once a failure was encountered. The indication that the diagnostic phase has ended can be obtained from the PK sheets as shown by the notation "terminate points". In this case, phase 2 or 3 will be terminated after bit 7 if any failure occurs between bits 4 through 7.

5.24 Bit 4 indicates a DC check failure on point AR. These points can be located by using the lead index in the SD. This point tests the normal state of relays L08 through L15 through a contact of the LTA relay.

5.25 For offices with CTX-7 Issue 9, IE4 or later generic programs, the DR02 message is basically the same. The differences are as follows:

- A 12-digit phase trouble number is printed
- A 12-digit universal trouble number is printed
- The word number in decimal of the failing raw data is printed
- All raw data words which contain only zeros are not printed

6. RELAY TROUBLE LOCATING PROCEDURES

6.01 Using Fig. 5 flowchart with numbered Procedures listed in 6.02 through 6.29, this section can be used as a guide to locating most problems encountered in the relay section of Signal Distribution Frames.

PROCEDURE 1—ANALYZING NN10 MESSAGE FOR SD POINTS

6.02 At MCC-TTY type in:

```
NM-SNAP-ALL0001111.
```

System response:

```
OK-followed by
```

```
NN10 message when a failing order is detected.
```
LOG FAILURE BY MIDDLE LINE OF NNI10 MESSAGES FOR PATTERN ANALYSIS

CONVERT FAILURE DATA TO UT OR MT APPEARANCE

DOES A TRUNK PATTERN EXIST

YES

OBTAIN TNN OR TRUNK

PROCEDURE-2

NO

END

DOES A FRAME PATTERN EXIST

NO

END

YES

ARE FAILURES EXCESSIVE AND RANDOM

NO

ONE

YES

OBTAINTNN'S OF MOST PREDOMINANT FAILING TRUNKS

PROCEDURE-2

SUSPECT WEAK AND/OR MISADJUSTMENT OF 286N RELAYS (X+Y)

PROCEDURE-8

TROUBLE CLEARED

NO

XY

YES

END

TROUBLE CLEARED

NO

XY

YES

END

FSCAN OR ERR

FSCAN

ERR

ALWAYS RELEASE ORDER

NO

XY

YES

CHECK CONTACT ALIGNMENT OF FAILING MULTICONTACT RELAYS

TROUBLE CLEARED

NO

XY

YES

END
PROCEDURE-3

X Y

DOES A PATTERN EXIST IN X OR Y RELAY SELECTION

YES

TST REL ADJUSTMENT, OPERATION, WIRING AND CONTACT PROT TO LOCATE TROUBLE

TROUBLE CLEARED

NO

MAKE BOTH THE FAILING AND NONFAILING CONTROLLER WORK IN THE COMBINED MODE

PROCEDURE-4

DO THE FAILURES ALWAYS OCCUR IN ONE CONTROLLER

YES

NO

USE SDIAZ16 SH B17 TO B21 TO DETERMINE IF THE FAILURES APPEAR ON THE SAME LEAD DESIGNATION A-M SHEET (B17)

X Y

HAS A PATTERN

NO

NEXT

UT OR MT

UT

HAS PLUG IN UNIT BEEN REPLACED

YES

XY

NO

MT

HAS RELAY BEEN TESTED WITH MLR TEST SET

YES

ADJUST RELAY WITH TEST SET

NO

MAKE RELAY TESTING SET TO A PARTICULAR RELAY BUSY. IF ANY GROUP STOPS THE TROUBLE LOOK FOR A WIRING OR BAND STRING CROSS

NO

NO

TROUBLE CLEARED

YES

END

YES

END

REPLACE UNIT ON TRIAL-DIAG BOTH TRUNKS AND RESTORE IF ATP

TROUBLE CLEARED

NO

TEST RELAY IN FAULTY UNIT WITH MLR, TEST SET, REPAIR OR REPLACE UNIT

END

MT

NO

REPLACE UNIT ON TRIAL-DIAG BOTH TRUNKS AND RESTORE IF ATP

TROUBLE CLEARED

NO

MAKE ALL TNN ASSOC WITH A PARTICULAR RELAY BUSY. IF ANY GROUP STOPS THE TROUBLE LOOK FOR A WIRING OR BAND STRING CROSS

END

NO

TROUBLE CLEARED

NO

YES

END

NO

YES

END

NO

YES

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YES

END

NO

YES

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END
Fig. 5—Relay Trouble Location Flowchart
6.03 Analyze NN10 message as follows:

NN10 aaaa
bbb ccc
ddd eee ff & ggg s hhh i j k l m n o
ppppppp
cccc cccc cccc cccc cccc cccc cccc gggg gggg gggg gggg gggg

Variable field:

bbb = Frame type
ccc = Network or Frame no.
ppppppp = Network order in octal
gggg ---- = order as it appears on the PU bus.

6.04 Analyze ppppppp as follows: for 2-wire No. 1 ESS

Note: If bit position 0 and 1 = 11, then it is an EXTERNAL SD point (MT) (see example b).

Bit position =

<table>
<thead>
<tr>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>b</td>
<td>h</td>
<td>m</td>
<td>a</td>
<td>e</td>
<td>k</td>
<td>c</td>
<td>r</td>
<td>0 0</td>
<td>= A relay</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>y</td>
<td>r</td>
<td>t</td>
<td>a</td>
<td>1 0</td>
<td>= C relay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 = operate</td>
<td>1 = release</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) EXAMPLE: Internal SD point

ppppppp = 0000271

00 0:0:0:1 0 1:1:0:1 B relay
ckt = 0
VF = 3
HMP = 6 (5+1)
Bay = 0
Relay failed to operate

(b) EXTERNAL SD point

bit position

<table>
<thead>
<tr>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>b</td>
<td>e</td>
<td>x</td>
<td>a</td>
<td>1 0</td>
<td>= EXTERNAL SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>y</td>
<td>e</td>
<td>x</td>
<td>t</td>
<td>11</td>
<td>Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 = operate</td>
<td>1 = release</td>
<td></td>
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</tbody>
</table>

0 = bay 0
1 = bay 2

To determine SD point: convert binary bits 2 thru 8 to octal, convert octal to decimal for SD point for bay "0", if bay is 1, add 128 to decimal number for SD point. SD points 000 through 127 appear on bay 0 and SD points 128 through 255 appear on bay 2.

Use the 1201 form (MT Frame Assignments) to locate the TNN. Use office base T drawing to locate signal distributor points.
(c) EXAMPLE:
EXTERNAL SD point
ppppppp = 0001657

<table>
<thead>
<tr>
<th>0</th>
<th>0</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>1</th>
<th>1</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.153</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>107</td>
<td>10</td>
</tr>
<tr>
<td>bay 2</td>
<td>SD point = 107</td>
<td>If bay was 1 the SD point would have been 235</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

relay did not operate

6.05 Analyze ppppppp as follows: for 4-wire

bit position = 11 10 9 8 7 6 5 4 3 2 1 0

\[
\begin{align*}
0 &= \text{operate} \\
1 &= \text{release}
\end{align*}
\]

b = HMP-1
c = ckt
r = 00 = CT relay
e = 01 = M relay
l = 10 = SL relay
a = y

6.06 Analyze ppppppp for SUPPLEMENTARY SIGNAL DISTRIBUTOR POINTS

bit position = 11 10 9 8 7 6 5 4 3 2 1 0

\[
\begin{align*}
0 &= \text{operate} \\
1 &= \text{release}
\end{align*}
\]

a = QUAD
h = ROW
f = FIELD

EXAMPLE: ppppppp = 0002023

<table>
<thead>
<tr>
<th>0</th>
<th>0</th>
<th>1</th>
<th>0</th>
<th>0</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>FIELD = 3</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ROW = 4</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>QUAD = 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>HALF = 0</td>
<td></td>
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</tr>
</tbody>
</table>
Point did not release

Using TABLE A, this SD point is No. 388. Refer to office base T drawings to find assignments.

PROCEDURE 2 CONVERTING UT APPEARANCE TO TNN

6.07 At MCC-TTY type in:

```
VFY-UTCN-12bb c ddd.
```

bb = UT Frame no. from NN10 message
c = bay (0=bay 0, 1=bay 2) from NN10 message
ddd = CKT no. (from Fig. 6)

System response:
TR11 a b c d e f g h i j

a b c = trunk circuit no. specified in input message.
  d = 0 = not a trunk circuit
  = 1 = valid trunk circuit
  e f g h i j = TNN of trunk

PROCEDURE 3—ANALYZING pppppppp OF NN10 MESSAGE FOR X AND Y PATTERN

6.08 As in Table B, the second and third least significant digit is the NN10 message which can be translated into the X and Y relay selection. Bit 2 of the order designates which digit represents each relay.

Example:
(a) pppppppp = 0002044

(a) Bit 2 = 1 (bits 3-5 = X relay, bits 6-8 = Y relay)

(a) Bit 9 = 0 = left half

(a) Bits 3-5 = 4 = LX4 relay operated

(a) Bits 6-8 = 0 = LX0 relay operated

(b) ppppppp = 0002040

(b) Bit 2 = 0 (bits 3-5 = Y relay, bits 6-8 = X relay)

(b) Bit 9 = 0 = left half

(b) Bits 3-5 = 4 = LY4 relay operated

(b) Bits 6-8 = 0 = LX0 relay operated
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<thead>
<tr>
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<th>QUADRANT</th>
<th>ROW</th>
</tr>
</thead>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
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<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
### Table A
**Supplementary Signal Distributor Points**

<p>| HALF FIELD | QUADRANT | ROW  | 0   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  |
|------------|----------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0          | 512      | 513  | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 | 541 | 542 | 543 |     |     |     |     |     |     |     |     |     |     |
| 1          | 544      | 545  | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 |     |     |     |     |     |     |     |     |     |     |
| 2          | 576      | 577  | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 |     |     |     |     |     |     |     |     |     |     |
| 3          | 608      | 609  | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 |     |     |     |     |     |     |     |     |     |     |</p>
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<th>122</th>
<th>123</th>
<th>124</th>
<th>125</th>
<th>126</th>
<th>127</th>
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<td>117</td>
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<td>006</td>
<td>007</td>
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</tr>
</tbody>
</table>

Fig. 6—Circuit Location for UTs
TABLE B
PPPPPPP OF NN10 MESSAGE

<table>
<thead>
<tr>
<th>BIT</th>
<th>PURPOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>Selects L/RWO through L/RW3 relays. L/RW3 is used for external points.</td>
</tr>
<tr>
<td>2</td>
<td>Selects circuit within PLUG-IN-UNIT.</td>
</tr>
</tbody>
</table>
| 3-5 | X or Y relay selection  
   Bit 2 = 0 = Y relay selection  
   Bit 2 = 1 = X relay selection |
| 6-8 | X or Y relay selection  
   Bit 2 = 0 = X relay selection  
   Bit 2 = 1 = Y relay selection |
| 9   | Left or right half  
   Bit 9 = 0 = bay 0  
   Bit 9 = 1 = bay 2 |
| 10  | Operate or release  
   Bit 10 = 0 = operate  
   Bit 10 = 1 = release |

PROCEDURE 4—RUNNING CONTROLLER IN COMBINED MODE

6.09 Run each controller in the combined mode. This procedure will determine whether the failure is associated with a relay path or the internal controller circuitry.

Example: If controller 1 fails only to points in bay 2 when running in either the normal or combined mode, the trouble would most likely be with the right half relay tree (R relays), since the controller can crossfire without trouble to the left relay tree (L relays). To further isolate trouble, run controller 0 in the combined mode. If failures occur in the right half while controller 0 is running combined, the trouble will be proven into the right relay tree. If the failure does not occur with controller 0 combined, the RX and RY relays (the relay tree) can be eliminated, since these relays operate properly from one controller. In this case, the trouble area to suspect would be the R00 through R25 relays.

PROCEDURE 5—STRAPPING AROUND SUSPECTED RELAY CONTACTS

6.10 If failing orders always show the L19 relay, rather than the L18 relay, the trouble might be caused by the L18 relay failing to restore properly after completing an order. If the next order requires the operation of the L19 relay, the pulse path would be open and thus fail.

6.11 Figure 7 shows where strap would be applied, for test purposes.

WARNING: Before applying any external strap, be sure to study SD 1A216-01 and CD 1A216 carefully for possible side effects.

6.12 276A AND 276AA RELAYS

(a) These relays are used to reset the controller (L/R 29 etc), and if they occasionally stick, will cause random failures.

PROCEDURE 6—TESTING TIMING OF L29 OR R29 RELAY

6.13 At the UT Frame, connect trace lead of oscilloscope to pin 1 of the LCO or RCO relay (depending on the relay to be timed). Normally this relay should never operate. If it does, connect the oscilloscope to pin 8 break of the L29 or R29 relay.
(a) Connect sync lead of the oscilloscope to the active enable.

(b) Set timing on the oscilloscope at 5 ms.

(c) The waveform shown in Fig. 8 should be observed.

(d) The pulse observed should occur between 17-18 msec. If the timing is 19 msec or more, the relay should be replaced.

(e) Check the timing on the new relay after it is installed.

**Note:** Several new relays have been found to be troublesome.

---

**Fig. 7—Apex Selector**

---

**Fig. 8—Timing Pulse**
PROCEDURE 7—ANALYZING NN10 MESSAGE BUS

6.14 Analyze NN10 message as follows:

NN10 aaaa

Using Table C determine L or R relays that are operating.

6.15 Fault could be relay that never appears in failure message. By keeping a stroke record of the L or R relays (313A) appearing in NN10 messages, sticky relays can be elected. If one relay never appears in the NN10 message, it could be this relay is sticking.

Example: If random failures are being received which never involve the R08 relay, this relay should be suspected. If this relay is occasionally sticking, it would cause a "more than one" failure on any subsequent order. However, if the next order involves the R08 relay, it will pass because this relay's contacts are already closed.

PROCEDURE 8—LOCATING X AND Y RELAY TROUBLE

CAUTION: This procedure should be used only during periods of light traffic.

6.16 At the TLTP make most predominant TNN TWIN BUSY.

System response:

TN06 TNN
TN06 TNN

6.17 At UT frame—Remove the trunk pack in question. Reinsert trunk pack using the 169A trunk pack adapter.

6.18 At the MCC-TTY type in:

NET-ONE-aaa bbc de ffffffff gggggggg hhhhhhh.

Variable e in NET-ONE message = 0

Variable gggggggg is the same as variable pppppppp in NN10 message or word 4 of MN01 message (6.30).

6.19 At the UT frame determine which 286N relays are pulsing by observation.

WARNING: These relays CANNOT be removed from service. DO NOT interfere with their normal operation.

6.20 Using Table D, determine where the sync lead of the oscilloscope should be attached for the 286N relays determined in 6.19. Attach sync lead to the designated pin of the circuit pack. Only one lead is needed. If there are excessive extraneous pulses, use other relay circuit packs for sync pulse.

6.21 Attach oscilloscope trace lead on the battery side of relay winding of the relay determined from ppppppp in the NN10 message.

6.22 Adjust oscilloscope so entire pulse can be seen clearly. The operate pulse (−48V) and the release pulse (+24V) will be seen superimposed. The pulses should appear to be uniform and clean on the oscilloscope (no nipples, spikes, variation in length, etc).

6.23 If pulses appear distorted, look for the following conditions on 286N relays in the path set up by the NET-ONE message:

(a) Foreign elements in contacts

(b) Excessive spacing between fixed and moving contacts (compare with other relays in the tree)

(c) Vertical alignment of contacts not uniform from top to bottom (compare with other relays in the tree).

Clean contacts with bond paper saturated with trichloroethane. DO NOT BURNISH THESE CONTACTS.

6.24 Test and adjust 286N relays as per Section 040-272-701. Special attention should be given to the problem of sticking armatures on 286N relays, a condition which frequently causes relay chatter well beyond the 4 ms allowed tolerance.
6.25 Remove all oscilloscope leads. At the MCC, abort the NET-ONE message by depressing PROGRAM CONTROL KEY 20.

6.26 At the UT frame, remove the 169A Adapter. Reinsert the trunk pack.

6.27 At the TLTP make both TNN's idle. Call through on both TNNs.

6.28 Start with 6.16 on next trouble. It is possible that some of the existing NN10 messages may now be clear due to adjustments already accomplished.

PROCEDURE 9—CONSTRUCTING A NET-ONE MESSAGE

6.29 This message will allow a single order to be repeatedly sent to the signal distributor frame. Refer to IM-1A001 for the complete message structure.

6.30 This example of a NET-ONE message is constructed in long binary as taken from raw data failure (Fig. 9). This failure is on a UTSD controller 0 and bit 0 failed:

\[ \text{ffffff of NET-ONE message} = 00000400 \text{ for long binary} \]

\[ \text{gggggg of NET-ONE message are bits} \ 0 \text{through} \ 22 \text{of the order as it goes out on the bus (Fig. 9) = 01200400} \]

\[ \text{hhhhhhh of NET-ONE message are bits} \ 23 \text{through} \ 35 \text{of the order as it goes out on the bus (Fig. 9) = 0000012} \]

The message would be as follows:

NET-ONE USD00000 00000200 00500200 0000012.

### TABLE C

ORDER ON PU BUS

<table>
<thead>
<tr>
<th>BIT</th>
<th>RELAY OPERATED</th>
<th>RELAY OPERATED</th>
</tr>
</thead>
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<td>1ST</td>
<td>2ND</td>
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<tr>
<td>0</td>
<td>L/R 0</td>
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<tr>
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<td>L/R 1</td>
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<td>L/R Y6</td>
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<tr>
<td>7</td>
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<td>L/R X6</td>
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### TABLE D

SYNC LEADS FOR UTSD TREE RELAYS

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<th>RELAY</th>
<th>CKT-PKT</th>
<th>PIN</th>
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<td>120-44</td>
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<td>RW2</td>
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**Fig. 9—Raw Data Failure**