IBM-POUGHKEEPSIE
December 31, 1964

Diagnostic Engineering Publications
1410/7010

Subject: Diagnostic Program M003E Program Addressable Clock Test

Sequence Number 259
Replaces / M003D

M003E replaces and obsoletes M003D. Card number 001 is a System Control Card.

The following correction was made to M003D to create M003E:

FROM:
pglin
1331 ERROR 5 MLCWA START+7, ERREXT+6 03021 D02007 03487X

TO:
pglin
1331 ERROR 5 E MLCWA START+6, ERREXT+6 03021 D02006 03487X

Enclosures: 27 Pages
Card Deck for CARD ONLY SYSTEMS (as punched by UP51)
8 Cards - Card Loader (1-7) and 1 Core Clear
58 Cards No. 001-058 Data Cards
1 Card Execute Card

Distribution:
X 1410 with Program Addressable Clock Feature 5737/5738
X 7010 with RPQ F97414
Other

M003E

1410/7010

PROGRAM ADDRESSABLE CLOCK TEST

12/31/64

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8.01.00.0 TEST DESCRIPTION

00.1 MODIFICATIONS

The modifications to M003C are minor in so far as test operation is concerned.

The System Control Card now provides information as to system type.

Timing constants are included to test the clocks operation on a 7010 System.

The Loop on G(C)T instruction routine is now set up to take advantage of RESET & RESTART mode on solid machine failures.

00.2 DESCRIPTION

Proper operation of M003 does not depend on having any other programs run prior to it. It does assume that all CPU instructions are working properly and the G(C)T instruction is at least understood by the CPU circuitry.

The objective of this program is to provide a test of the clock's operation that covers the following areas:

a. The transfer of time to a specified location in storage, including the transfer of the busy signal indication.

b. The presence of the proper busy signal indication (99999) and the length of time the busy signal is active.

c. The advance of the clock from one hundreths position to the next, and the length of time it takes to complete this advance.

8.01.00.2 DESCRIPTION (continued)

The method by which this is accomplished is as follows:

A preliminary test is run to establish whether the clock can be further tested and timed. The only acceptable Identifier Digits I.D.) are 0 and 9. The only acceptable time data are 0xxxx and 99999, the clock time and busy signal indication respectively. Any other time data stored are rejected as errors and are dis played followed by a typed message. In this phase two successive times are stored within given intervals. If the first time stored was 0xxxx, the second must be 99999 in order for the test to proceed to the "Main Body." A time limit of approximately 70 seconds is placed on this advance in case the clock is stopped or the busy switch is not connected.

If the first time data stored was 99999, the second time stored is delayed one second. It must be 0xxxx in order for the test to proceed to the "Main Body." Any failure to meet these conditions is typed out.

The "Main Body" of the test is in two sections. The first section stores the time data needed and times the sequential advances. The second analyzes the data compiled. More specifically, the first section begins by storing time data to use as a starting point. Once a valid starting point has been established, [1]a busy signal indication is stored, compared to (99999) and the duration it is active is timed. The interval between the termination of the busy signal indication just timed and the next busy signal indication is computed to complete the timing of an advance of one hundreths position digit. Finally, the next clock time available is stored and typed out for a visual comparisbn with the clock itself.

Programmed comparisons are made of the time the busy signal indication is active, 345 $\pm$ 115 milliseconds, and a total time to advance one hundreths position, 60 $\pm$ 1 seconds. The time data stored are checked to see if the clock advanced properly to the next hundreths position. If any of these conditions are not met, an error message preceded by an asterisk (*) is typed to this effect.

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1 See Operating Hints and Comments, Section 8.01.03.4.

8.01.00.2 DESCRIPTION (continued)

Three passes are made (6 minutes) covering all hundreths position digits in order and one advance to the next higher tenths position. [1] Only the time stored after every second advance will be typed unless all test data is requested in a summary typeout.

00.3 EQUIPMENT

M003 tests the Program Addressable Clock Feature (Feature No. 5737/5738 on the 1410 System, RPQ F97414 on the 7010 System).
System type, CPU speed, memory size and I/O devices attached are irrelevant.

00.4 CARD DECK

A complete card deck of M003 contains:

7 Cards	Load Program
1 Card	Core Clear
Data cards[1]	M003 Program Deck
1 Card	Execute (Branch to 2000)

00.5 EC LEVEL OF SYSTEM

1410:
Minimum EC level EC 251784 (Program Addressable Clock Logic Change). EC 252311 should be applied as soon as possible. It is not essential to the program's operation but does increase clock reliability.
7010:
None

8.01.01.0 LOADING PROCEDURE

Use Standard 1410/7010 Diagnostic Loading procedure. Refer to "1410/7010 Introduction," Volume 1.00 for further information.

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[1] Refer to Release Sheet for exact number of cards.

8.01.02.0 OPERATING PROCEDURE

No manual intervention is required to run this test. Program operation can be altered at any time using the "Program Alter Routine." TADS are loaded as blanks and TAD locations are only tested for 1.

NOTE: During the period when the busy time and advance time are being computed, no Inquiry Request is acknowledged. Consequently a delay of up to two minutes may be encountered between the time the request is made and entry through the keyboard is possible.

STANDARD TADS

TAD	ADDRESS	NOT 1	1
TAD 0	01000	Do Not	Bypass Typeouts
TAD 1	01001	Do Not	Loop on Routine
TAD 2	01002	Do Not	Halt on Error
TAD 3	01003	Do Not	Repeat Program

SPECIAL TAD

TAD 4	01004	Do Not	Typeout Summary

8.01.03.0 OPERATING HINTS AND COMMENTS

1. Some additional notes on TADs

Standard TADs

TAD 0 — Not interrogated. It is not possible to bypass either the clock time typeout given upon the completion of a pass or any of the error typeouts. To loop on the G(C)T instruction with no typeouts see note following TAD 1.

TAD 1 = 1 — Provides entry to a three instruction loop containing the G(C)T instruction. Entry is possible from the body of the program or after an error message. To leave this loop, set TAD 1 to not 1.

NOTE: On entering the Loop on G(C)T instruction routine the branch instruction at location 00001 is changed to provide for an automatic branch back to the aforementioned routine on a system check. Setting TAD 1 to 1 and the CHECK CONTROL switch to RESET & RESTART will keep the test in this loop on any SYSTEM CHECK.

8.01.03.0 OPERATING HINTS AND COMMENTS (continued)

TAD 2	Not interrogated (see Error Halts)
TAD 3 = 1	The test will normally run three passes (6 minutes). If TAD 3 is set to a 1, passes are made repeatedly disregarding the count. Should TAD 3 be returned to 1, the test will terminate when the pass count reaches three.

Special TAD

TAD 4 = 1	Provides summary typeout of all time data stored as well as the length of time the busy signal was active and the length of time to advance one position.

2. The total time to advance one hundreths position digit is compared to 59 seconds as a lower limit and 61 as an upper. Though specifications do not clearly define these limits, maximum permissable power line frequency variation tolerances and the testing done during the evolution of this program indicate these limits are reasonable.

3. Three passes of this program require a little over six minutes operating time. This is a minimum test. Time permitting nine passes (18 minutes) would be better since three passes cover only one third of the hundreths position digits on the hundredths position wheel.

4. Due to the fact that the busy switch contacts bounce considerably when transferring from a busy to a ready status, a one-second delay is included to cover this interval in order to accomplish timing of sequential events. This one-second delay should be more than enough to cover the worst case. Should random indications over a longrun imply that the busy time and/or the time to advance was extraordinarily small or that the clock went through a ready-busy-ready sequence without advancing, a badly bouncing busy switch could be the cause.

8.01.04.0 PROGRAM STOPS AND RESTARTS

Only one normal halt is used in this program and it is in the Preliminary Test portion only. The stop occurs after the message

* FAILURE TO ADVANCE INDICATED

Pressing START will cause the Preliminary Test to be repeated.

8.01.05.0 TYPEOUTS

05.1 NORMAL TYPEOUTS

The only normal typeout (not under TAD control) is the clock time. It is typed on the completion of each pass (two minutes) for visual comparison with the clock itself.

CLOCK TIME 0xxxx

Should a summary typeout be requested be setting TAD 4 to 1, the following data are typed:

TIME A 0xxxx	
TIME B 9xxxx	
TIME C 0xxxx	
TIME D 9xxxx	
TIME E 0xxxx	
BUSY TIME xxx MS	Total time busy signal active.
TIME TO ADVANCExxxxxMS	Total time to advance one hundreths position digit.

Times A through E are the time data stored during sequential advances. Times A, C, E should be clock times. Times B and D should be 99999.

EOJ

Typed on conclusion of the test.

8.01.05.0 TYPEOUTS (continued)

05.1 NORMAL TYPEOUTS

NO SYS CARD

This message is typed only if the test is being run without a System Control Card. You may continue from this point by entering the correct system type in location 01256. Enter:

O For 1410 Standard
I For 1410 With the Accelerator Feature
X For 7010

and press START.

05.2 ERROR TYPEOUTS

All error typeouts are preceded by asterisks (*).

During the running of the Preliminary Test, eight combinations of the following error typeouts are possible:

* TIME 1 xxxxx

The first time data stored.

* TIME 2 xxxxx

The second time data stored.

* INVALID ID

Typed if the ID of the first time data stored is invalid.

* ADVANCED TO INVALID ID

The ID of the first time data stored is acceptable, the second is not.

* FAILURE TO ADVANCE INDICATED

The ID of the first time data is 0. The ID of the second time stored did not become 9 after more than a 70-second waiting period.

* READ OUT FAILURE

The ID of the time data stored was a 9 but the remaining four digits were not 9999, i.e., not a busy signal.

* STUCK ON BUSY OR
* READ OUT FAILURE

The first time data stored is 99999. The second time data stored more than one second later is 99999. This is either a continuous busy signal indication or a continuous failure to read out the hundreths position.

During the main body of the program the following error messages may occur:

* TIME X WAS xxxxx EXPECTED 99999

X is filled in with either a B or a D.
xxxxx is filled in with the actual time data in question.
The message is typed if during the timing of sequential advances. The ID changes from 0 to 9 but the following four digits are not 9999, i.e., not a busy signal indication but a read out failure.

* BUSY TIME WAS xxx MS - NOT IN SPECS

The busy signal indication should be active for not less than 230 milliseconds and not more than 460 milliseconds. The message is typed if it is not within tolerance.

* TIME TO ADVANCE xxxxx MS - CHECK

The hundreths position digit should advance once per minute. If the time to advance is less than 59 seconds or more than 61 seconds, the above message is typed.
It is advisable to check this area further. [1]

* TIME WAS xxxxx ADVANCED TO xxxxx

The time data stored following each advance are compared to their previous values with the hundreths position digit increased to the next position. Should the comparison indicate that the clock did not advance properly, the above message is typed.

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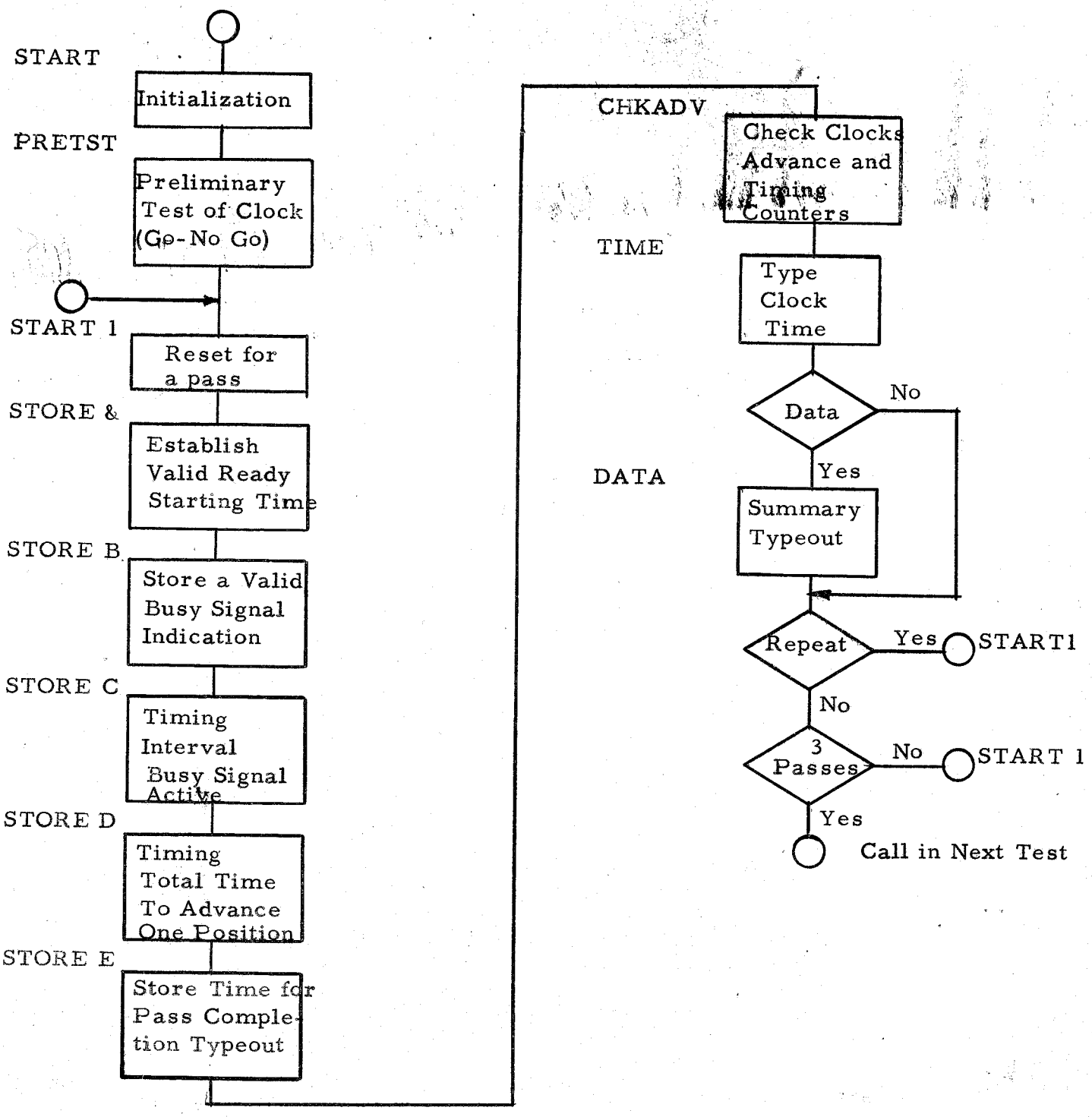
1 See Operating Hints and Comments, Section 8.01.03.0.2


START
Initialization
PRETST
Preliminary Test of Clock (Go-No Go)
START 1
Reset for a pass
STORE A
Establish Valid Ready Starting Time
STORE B
Store a Valid Busy Signal Indication
STORE C
Timing Interval Busy Signal Active
STORE D
Timing Total Time To Advance One Position
STORE E
Store Time for Pass Completion Typeout
CHKADV
Check Clocks Advance and Timing Counters
TIME
Type Clock Time
Data
No
Yes
DATA
Summary Typeout
Repeat
Yes
START1
No
3 Passes
No
START 1
Yes
Call in Next Test

```
PGLIN     LABEL      OPCOD  OPERAND                                  CT  ADDRS  INSTRUCTION

1002      LOADER     EQU    400              ADDRESS OF LOAD PROGRAM
1003
1004
1005      *                        SUMMARY OF TEST OBJECTIVES AND OPERATION
1006      *  OBJECT             TEST CLOCK OPERATION COVERING FOLLOWING AREAS
1007      *                     1 TRANSFER OF TIME TO A SPECIFIED AREA IN STORAGE
1008      *                       INCLUDING TRANSFER OF BUSY SIGNAL INDICATION
1009      *                     2 PROPER BUSY SIGNAL INDICATION, 99999
1010      *                       LENGTH OF TIME IT IS ACTIVE
1011      *                     3 ADVANCE TO THE NEXT POSITION
1012      *                       LENGTH OF TIME TO COMPLETE ADVANCE
1013      *                                  *****
1014      *  METHOD             PRE TEST    CAN CLOCK BE TESTED AND TIMED
1015      *                                  IS THE I.D. A 0 OR 9
1016      *                                  DOES THE I.D. CHANGE AT ALL
1017      *                                  IS I.D. OF 9 FOLLOWED BY 9999
1018      *                     MAIN BODY   STORE DIGITS, TIME SEQUENTIAL EVENTS
1019      *                                  A  GET A GOOD STARTING POINT
1020      *                                  B  WAIT TILL BUSY, REALLY BUSY
1021      *                                  C  TIME LENGTH OF BUSY SIGNAL
1022      *                                  D  TIME INTERVAL TILL BUSY AGAIN
1023      *                                  E  STORE TIME FOR TYPEOUT
1024      *                     CHECK DATA  CHECK ADVANCE AND TIMING
1025      *                                  BUSY TIME IN TOLERANCE  230-460 MS
1026      *                                  TIME TO ADVANCE WITHIN  59-61 SECS
1027      *                                  ADVANCE TO NEXT DIGIT CORRECTLY
1028      *                     TIME        COMPLETE PASS BY TYPING CLOCK TIME
1029      *                                 FOR VISUAL COMPARISON
1030      *                          NOTE   CLOCK TIME WILL BE TYPED AT 2 MINUTE
1031      *                                 INTERVALS IF NO ERRORS OCCUR
1032      *                     DATA        SET UP ALL TEST DATA FOR SUMMARY
1033      *                                 TYPEOUT IF REQUESTED
1034      *                                       *****
1035      *  NOTE   ** TO LOOP ON THE G C T INSTRUCTION , SET TAD 1 TO 1
```

```
PGLIN   LABEL    OPCOD  OPERAND                                    CT  ADDRS  INSTRUCTION
1037    *                *****   STANDARD TADS     *****
1038             ORG    1000                                           01000
1039    *                        NOT 1             1
1040    TAD0     DC     @ @      DO NOT    BYPASS TYPE OUTS         1  01000
1041    TAD1            @ @      DO NOT    LOOP ON ROUTINE          1  01001
1042    TAD2            @ @      DO NOT    HALT ON ERRORS           1  01002
1043    TAD3            @ @      DO NOT    REPEAT PROGRAM           1  01003
1044
1045    *                *****   SPECIAL  TADS     *****
1046
1047    TAD4     DC     @ @      DO NOT    TYPEOUT SUMMARY          1  01004
1048
1049                    *TEST SET UP IN THE NOT 1 CONDITION*
1050                     AND WILL ONLY CHECK FOR A 1
1051
1052    GMWM     DCW    @M@                                         1  01005
1053
1054    *                                 *PROGRAM ALTER ROUTINE
1055
1056    ALTER    SBR    ALTRXT&5          STORE RETURN ADDR         7  01006  G 01073 B
1057    ENTER    RCP    ADDRES&4          ENTER LOCATION TO BE ALTERED 10 01013  M %TO 01048 R
1058             BNT1   ALTRXT            INQ NOT FROM CONSOLE      7  01023  R 01068 B
1059             BEX1   ENTER,M           TRY AGAIN IF 1/2/4/8      7  01030  R 01013 M
1060             BA1    ADDRES                                      7  01037  R 01044 M
1061    ADDRES   RCPW   00000             ENTER DATA INTO ADDRES SPECIFIED 10 01044  L %TO 00000 R
1062             BEX1   ADDRES,M                                    7  01054  R 01044 M
1063             BA1    *&1                                         7  01061  R 01068 M
1065    ALTRXT   B      00000             RETURN TO PROGRAM         7  01068  J 00000
```

```
PGLIN     LABEL      OPCOD  OPERAND                                  CT  ADDRS  INSTRUCTION
1067                 CRG    1230          CONTROL INFORMATION            01230
1068                 DC     @             @  NOT USED                12  01241
1069                 CCW    @12@          USE BBE TO CHECK FOR A 1 BIT    2  01243
1070                        @0@            IN SYSTEM CARD,LOCATION - SYS620  1  01244
1071                        @259CT@       SEQ# 259  4K  SYS CRD ONLY      5  01249
1072
1073      TESTID     CCW    @MOD3@        TEST IDENTIFICATION             4  01253
1074      LEVEL  E   DC     @E@           SUFFIX LEVEL                    1  01254
1075
1076                 CRG    1256          *SYSTEM CONTROL CARD               01256
1077      SYS1       DC     @ @           SYSTEM TYPE                     1  01256
1078                                      C 1410 STD
1079                                      I 1410 ACC
1080                                      X 7010
1081                 DC     @             @  NOT INTERROGATED            15  01271
1082                        @   @                                         4  01275
1083               620 DC    @ @           A 1 FOR PROGRAM ADDRESSABLE CLOCK  1  01276
1084                 DC     @             *@  NOT INTERROGATED           12  01288
1085
1086                 CRG    ALTRXT67                                          01075
```

```
PGLIN   LABEL    OPCOD  OPERAND                        COMMENTS                                CT  ADDRS  INSTRUCTION
1088    SETUP    MRCW   START,1                        MOVE RESET RESTART INTO POSITION        12  01075  D 02000 00001 M
1089             MRCW                                                                           1  01087  D
1090             B      TYPEIT                         TO COMMON TYPING ROUTINE                7  01088  J 03539
1091             CCW    @MC03D@,G                                                              5  01099
1092             ZA     TENCPU,DT4                     TIMING CONSTANTS FOR 1410 STD          11  01101  C 01304 03615
1093             ZA                                                                            1  01112  C
1094             ZA                                                                            1  01113  C
1095             ZA                                                                            1  01114  C
1096             BCE    PRETST,SYS1,0                  SYSTEM IS 1410 STD                     12  01115  B 01337 01256 0
1097             ZA     EYECPU,DT4                     SET UP TIMING CONSTANTS FOR 1410I      11  01127  C 01320 03615
1098             ZA                                                                            1  01138  C
1099             ZA                                                                            1  01139  C
1100             ZA                                                                            1  01140  C
1101             BCE    PRETST,SYS1,I                  SYSTEM IS 1410 ACC                     12  01141  B 01337 01256 I
1102             ZA     XXXCPU,DT4                     SET TIMING CONSTANTS FOR 7010          11  01153  C 01336 03615
1103             ZA                                                                            1  01164  C
1104             ZA                                                                            1  01165  C
1105             ZA                                                                            1  01166  C
1106             BCE    PRETST,SYS1,X                  SYSTEM IS 7010                         12  01167  B 01337 01256 X
1107             B      TYPEIT                                                                 7  01179  J 03539
1108             CCW    @NC SYS CRD@,G                 NO SYSTEM CARD                        10  01195
1109             H      SETUP                          PUT SYSTEM TYPE IN LOCATION 01256      6  01197  . 01075
1110             H                                                                             1  01203  .
1111             ORG    1289                                                                      01289
1112             CCW    0394                           LOOP TIME IN USECS  -DT0 1410 STD      4  01292
1113                    0232                                               -DT1               4  01296
1114                    0252                                               -DT3               4  01300
1115    TENCPU          0265                                               -DT4               4  01304
1116                    0335                           LOOP TIME IN USECS  -DT0 1410 ACC      4  01308
1117                    0150                                               -DT1               4  01312
1118                    0212                                               -DT3               4  01316
1119    EYECPU          0220                                               -DT4               4  01320
1120                    0114                           LOOP TIME IN USECS  -DT0 7010          4  01324
1121                    0066                                               -DT1               4  01328
1122                    0072                                               -DT3               4  01332
1123    XXXCPU          0076                                               -DT4               4  01336
```

```
PGLIN   LABEL    OPCOD  OPERAND                                  CT  ADDRS  INSTRUCTION
1125    *                                  *PRELIMINARY TEST OF THE CLOCK
1126
1127    *                                *  STORE TIME - WAIT FOR A CHANGE
1128
1129    PRETST   BNQ    ALTER              TEST ALTERATION ROUTINE   7  01337  J 01006 Q
1130             BCE    REQLUP,TAD1,1      LOOP ON STORE TIME INSTRUCTION 12  01344  B 03422 01001 1
1131    STORE1   STC    TIME1              STORE TIME                7  01356  G 01714 T
1132             B      DELAY1             TO DELAY ROUTINE,DELAY 1 SECOND 7  01363  J 03495
1133             BCE    DELAY0,TIME1-4,0   READY AT TIME 1          12  01370  B 01552 01710 0
1134             BCE    BZYCK1,TIME1-4,9     OR BUSY                12  01382  B 01408 01710 9
1135             B      ERROR1             . TIME 1                  7  01394  J 01687
1136             B      MESGE0             . HAD INVALID I.D.        7  01401  J 01759
1137
1138    *                                *  I.D. A 9 AT TIME 1
1139
1140    BZYCK1   C      TIME1,@99999@      CHECK FOR BUSY SIGNAL INDICATION 11  01408  C 01714 03687
1141             BE     RDYCHK             O K CONTINUE CHECKING     7  01419  J 01440 S
1142             B      ERROR1             . TIME 1 WAS 9XXXX        7  01426  J 01687
1143             B      MESGE3             . READOUT FAILURE         7  01433  J 01873
1144    RDYCHK   STC    TIME2              SAMPLE AGAIN-WAIT FOR AN ADVANCE 7  01440  G 01750 T
1145             BCE    START1,TIME2-4,0   CHANGED,OK CONTINUE ON TO TEST 12  01447  B 02007 01746 0
1146             BCE    BZYCK2,TIME2-4,9   CHECK FURTHER             12  01459  B 01492 01746 9
1147             B      ERROR1             . TIME 1 WAS 99999  OK    7  01471  J 01687
1148             B      ERROR2             . ADVANCED TO TIME 2      7  01478  J 01723
1149             B      MESGE1             . INVALID I.D.            7  01485  J 01788
1150    BZYCK2   C      TIME2,@99999@      CHECK FOR BUSY SIGNAL INDICATION 11  01492  C 01750 03687
1151             BE     STUCK&             COULD BE STUCK ON BUSY    7  01503  J 01531 S
1152             B      ERROR1             . TIME 1 WAS 99999  OK    7  01510  J 01687
1153             B      ERROR2             . TIME 2 WAS 9XXXX        7  01517  J 01723
1154             B      MESGE3             . READOUT FAILURE         7  01524  J 01873
1155    STUCK&   B      ERROR1             . TIME 1 WAS 99999  OK    7  01531  J 01687
1156             B      ERROR2             . TIME 2 WAS 99999        7  01538  J 01723
1157             B      MESGE4             . PROBABLY STUCK ON BUSY OR 7  01545  J 01906
1158                                       . A READOUT FAILURE
```

```
PGLIN  LABEL    OPCOD  OPERAND          CT  ADDRS  INSTRUCTION
1160   *                        *  I.D. A 0 AT TIME 1
1161
1162   DELAY0   STC    TIME2            READ CLOCK AGAIN                    7  01552  G 01750 T
1163            A      DT0,DLAYCT       ADD LOOP TIME TO DELAY COUNTER     11  01559  A 03603 03637
1164            BCE    BZYCK3,TIME2-4,9 CHECK FURTHER                      12  01570  B 01627 01746 9
1165            BCE    STOPED,DLAYCT-7,7 FAILED TO ADV IN APPROX 70 SECS   12  01582  B 01666 03630 7
1166            BCE    DELAY0,TIME2-4,0 WAIT TILL READY                    12  01594  B 01552 01746 0
1167            B      ERROR1           . TIME 1 WAS 0XXXX  OK              7  01606  J 01687
1168            B      ERROR2           . ADVANCED TO TIME ?                7  01613  J 01723
1169            B      MESGE1           . INVALID I.D.                      7  01620  J 01788
1170   BZYCK3   C      TIME2,@99999@    CHECK FOR BUSY SIGNAL INDICATION   11  01627  C 01750 03687
1171            BE     START1           ADVANCED OK ON TO TEST              7  01638  J 02007 S
1172            B      ERROR1           . TIME 1 WAS 0XXXX  OK              7  01645  J 01687
1173            B      ERROR2           . TIME 2 WAS 9XXXX                  7  01652  J 01723
1174            B      MESGE3           . READOUT FAILURE                   7  01659  J 01873
1175   STOPED   B      ERROR1           . TIME 1 WAS 0XXXX  OK              7  01666  J 01687
1176            B      ERROR2           . TIME 2 WAS 0XXXX                  7  01673  J 01723
1177            B      MESGE2           . DID NOT GO THRU BUSY IN 70 SECS   7  01680  J 01829
1178   *                                . FAILURE TO ADVANCE INDICATED
```

```
PGLIN   LABEL    OPCOD  OPERAND                                  CT  ADDRS  INSTRUCTION
1180    *                        *  ERROR INDICATIONS AND MESSAGES
1181
1182    ERROR1   SBR    EREXT1&5          SAVE ADDRESS FOR RETURN  7  01687  G 01721 B
1183             B      TYPEIT                                     7  01694  J 03539
1184    TIME1    DCW    @* TIME 1      @,G                        14  01714
1185    EREXT1   B      00000             RETURN TO ROUTINE        7  01716  J 00000
1186
1187    ERROR2   SBR    EREXT2&5          SAVE ADDRESS FOR RETURN  7  01723  G 01757 B
1188             B      TYPEIT                                     7  01730  J 03539
1189    TIME2    DCW    @* TIME 2      @,G                        14  01750
1190    EREXT2   B      00000             RETURN TO ROUTINE        7  01752  J 00000
1191
1192    MESGE0   B      TYPEIT                                     7  01759  J 03539
1193             DCW    @* INVALID I.D.@,G                        14  01779
1194             B      PRETST            TRY AGAIN                7  01781  J 01337
1195
1196    MESGE1   B      TYPEIT                                     7  01788  J 03539
1197             DCW    @* ADVANCED TO INVALID I.D.@,G            26  01820
1198             B      PRETST            TRY AGAIN                7  01822  J 01337
1199
1200    MESGE2   B      TYPEIT                                     7  01829  J 03539
1201             DCW    @* FAILURE TO ADVANCE INDICATED@,G        30  01865
1202             H      STORE1            TRY AGAIN                6  01867  . 01356
1203
1204    MESGE3   B      TYPEIT                                     7  01873  J 03539
1205             DCW    @* READ OUT FAILURE@,G                    18  01897
1206             B      PRETST            TRY AGAIN                7  01899  J 01337
1207
1208    MESGE4   B      TYPEIT                                     7  01906  J 03539
1209             DCW    @* STUCK ON BUSY OR@,G                    18  01930
1210             B      MESGE3            ADD MESSAGE 3            7  01932  J 01873
1211
1212    *                                *****
```

```
PGLIN     LABEL     OPCOD  OPERAND                    CT  ADDRS  INSTRUCTION
1214                ORG    2000          PROGRAM BEGINS HERE      02000
1215      *                          *    MAIN BODY OF TEST
1216
1217      *                              *READ CLOCK
1218
1219      START     B      SETUP         INITIALIZATION-DONE 1ST PASS ONLY  7  02000  J 01075
1220      START1    S      TOTAL         ZERO TIME TO ADVANCE COUNTER       6  02007  S 03629
1221                S      PASSNO        ZERO PASS COUNT                    6  02013  S 03538
1222                S      BZTIME        ZERO COUNT OF BUSY TIME            6  02019  S 03621
1223                BNQ    ALTER         WANT TO DO ANYTHING SPECIAL        7  02025  J 01006 Q
1224                BCE    REQLUP,TAD1,1 REQUEST STC LOOP                  12  02032  B 03422 01001 1
1225      STORE&    STC    TIME&         SAMPLE TIME                        7  02044  G 03642 T
1226                B      DELAY1        BRANCH TO DELAY ROUTINE            7  02051  J 03495
1227      STOREA    STC    TIMEA         TIME A SHOULD BE CLOCK TIME        7  02058  G 03647 T
1228                C      TIME&,TIMEA   . COMPARE TIMES STORED TO PREVENT  11  02065  C 03642 03647
1229                BU     STORE&        . ADVANCE ON BOUNCE INDICATION     7  02076  J 02044 /
1230                BCE    STORE&,TIMEA-4,9 TRY AGAIN IF BUSY - I.D. A 9   12  02083  B 02044 03643 9
1231      STOREB    STC    TIMEB         TIME B SHOULD BE 99999,CLOCK BUSY  7  02095  G 03657 T
1232                BCE    STOREB,TIMEB-4,0 TRY AGAIN IF NOT BUSY          12  02102  B 02095 03653 0
1233                C      TIMEB,@99999@ TIME B SHOULD BE 99999,BUSY       11  02114  C 03657 03687
1234                BU     ERROR5B       PROBABLY A READ OUT FAILURE        7  02125  J 02966 /
1235      STOREC    STC    TIMEC         TIME C SHOULD BE TIME A & 1 MIN.   7  02132  G 03662 T
1236                A      DT3,BZTIME    . ADD LOOP TIME CONST TO           11  02139  A 03611 03621
1237                BCE    STOREC,TIMEC-4,9 . BUSY TIME COUNT              12  02150  B 02132 03658 9
1238                B      DELAY1                                           7  02162  J 03495
1239                A      DLAYCT,TOTAL  ADD TO TOTAL                      11  02169  A 03637 03629
1240                A      BZTIME,TOTAL  INCLUDE BUSY TIME IN TOTAL        11  02180  A 03621 03629
1241      STORED    STC    TIMED         TOTAL ADVANCE TIME CHECK           7  02191  G 03672 T
1242                A      DT4,TOTAL     .ADD LOOP TIME CONST TO TOTAL      11  02198  A 03615 03629
1243                BCE    STORED,TIMED-4,0 .TILL CLOCK GOES BUSY AGAIN    12  02209  B 02191 03668 0
1244                C      TIMED,@99999@ EXPECT BUSY SIGNAL INDICATION     11  02221  C 03672 03687
1245                BU     ERROR5D       PROBABLY A READ OUT FAILURE        7  02232  J 02997 /
1246      STOREE    STC    TIMEE         TIME FOR TYPE OUT                  7  02239  G 03677 T
1247                BCE    STCREE,TIMEE-4,9 MUST BE CLOCK TIME             12  02246  B 02239 03673 9
1248                BNQ    ALTER                                            7  02258  J 01006 Q
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PGLIN     LABEL     OPCOD  OPERAND                                                CT  ADDRS  INSTRUCTION
1250      *                                    *CHECK RESULTS OF AN ADVANCE
1251
1252      CHKADV    C      BZTIME-3,@460@      460 MS MAX. BUSY TIME                11  02265  C 03618 03690
1253                BL     ERROR6              BUSY TOO LONG , ERROR ROUTINE         7  02276  J 03075 T
1254                C      BZTIME-3,@230@      LOWER LIMIT                          11  02283  C 03618 03693
1255                BH     ERROR6              BUSY TOO SHORT                        7  02294  J 03075 U
1256                C      TOTAL-6,@61@        CHECK UPPER LIMIT                    11  02301  C 03623 03695
1257                BL     ERROR7              TOO LONG                              7  02312  J 03136 T
1258                C      TOTAL-6,@59@        CHECK LOWER LIMIT                    11  02319  C 03623 03697
1259                BH     ERROR7              TOO SHORT                             7  02330  J 03136 U
1260                CW     ERCR8A&1            SET SWITCHES FOR                      6  02337  ¤ 03230
1261                SW     EROR8B&1            ERROR TYPE OUTS                       6  02343  , 03262
1262                MLNA   TIMEA,TIMEA1        SAVE TIME A ADD TO TIME A1           12  02349  D 03647 03652 /
1263                BCE    ADDONE,TIMEA1,2     .CLOCK ADVANCES FROM 2 TO 3          12  02361  B 02396 03652 2
1264                BCE    ADDONE,TIMEA1,7     .OR FROM 7 TO 8                      12  02373  B 02396 03652 7
1265                A      &1,TIMEA1           . CLOCK ADVANCES FROM 0 TO 2         11  02385  A 03698 03652
1266      ADDONE    A      &1,TIMEA1           . 3 TO 5 , 5 TO 7, 9 TO 0            11  02396  A 03698 03652
1267                C      TIMEA1,TIMEC        COMPARE TIME A ADJUSTED TO TIME C    11  02407  C 03652 03662
1268                BE     SWITCH              O K CONTINUE                          7  02418  J 02461 S
1269                C      TIMEA1,@02400@      RESETTING ON NEXT PASS               11  02425  C 03652 03703
1270                BU     ERROR8                                                    7  02436  J 03197 /
1271                C      TIMEC,@00000@       RESET TO 00000                       11  02443  C 03662 03708
1272                BU     EROR8C              SHOULD BE EQUAL                       7  02454  J 03222 /
1273      SWITCH    SW     ERCR8A&1            SET SWITCHES FOR                      6  02461  , 03230
1274                CW     EROR8B&1            ERROR TYPE OUTS                       6  02467  ¤ 03262
1275                MLNA   TIMEC,TIMEC1        SAVE TIME C ADD TO TIME C1           12  02473  D 03662 03667 /
1276                BCE    ADDUNO,TIMEC1,2     REPEAT AS DONE FOR A & C ABOVE       12  02485  B 02520 03667 2
1277                BCE    ADDUNO,TIMEC1,7                                          12  02497  B 02520 03667 7
1278                A      &1,TIMEC1                                                11  02509  A 03698 03667
1279      ADDUNO    A      &1,TIMEC1                                                11  02520  A 03698 03667
1280                C      TIMEC1,TIMEE        COMPARE TIME C ADJUSTED TO TIME E    11  02531  C 03667 03677
1281                BE     SETIME                                                    7  02542  J 02585 S
1282                C      TIMEC1,@02400@      RESETTING ON NEXT PASS               11  02549  C 03667 03703
1283                BU     ERROR8                                                    7  02560  J 03197 /
1284                C      TIMEE,@00000@       RESET TO 00000                       11  02567  C 03677 03708
1285                BU     ERCR8C              SHOULD BE EQUAL                       7  02578  J 03222 /
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PGLIN     LABEL     OPCOD  OPERAND                                  CT  ADDRS  INSTRUCTION
1287      SETIME    MLNA   TIMEE,TIME          SET CLOCK TIME IN MESSAGE   12  02585  D 03677 02619 /
1288                B      TYPEIT              TYPE CLOCK TIME FOR VISUAL CHECK  7  02597  J 03539
1289      TIME      DCW    @CLOCK TIME 00000@,G                            16  02619
1290                BNQ    ALTER               ANYMORE INFORMATION WANTED   7  02621  J 01006 Q
1291                BCE    DATA,TAD4,1         TAD 4 TO 1 FOR ALL DATA     12  02628  B 02647 01004 1
1292                B      INQREQ              CONTINUE  NO DATA            7  02640  J 02887
1293      DATA      MLNA   TIMEA,MESGEA        SET DATA IN DATA MESSAGES   12  02647  D 03647 02749 /
1294                MLNA   TIMEB,MESGEB                                    12  02659  D 03657 02769 /
1295                MLNA   TIMEC,MESGEC                                    12  02671  D 03662 02789 /
1296                MLNA   TIMED,MESGED                                    12  02683  D 03672 02809 /
1297                MLNA   TIMEE,MESGEE                                    12  02695  D 03677 02829 /
1298                MLNA   BZTIME-3,RESULT-3                               12  02707  D 03618 02850 /
1299                MLNA   TOTAL-3,MINUTE-3                                12  02719  D 03626 02882 /
1300                B      TYPEIT                                          7  02731  J 03539
1301      MESGEA    DCW    @TIME A       @,G                               12  02749
1302                B      TYPEIT                                          7  02751  J 03539
1303      MESGEB    DCW    @TIME B       @,G                               12  02769
1304                B      TYPEIT                                          7  02771  J 03539
1305      MESGEC    DCW    @TIME C       @,G                               12  02789
1306                B      TYPEIT                                          7  02791  J 03539
1307      MESGED    DCW    @TIME D       @,G                               12  02809
1308                B      TYPEIT                                          7  02811  J 03539
1309      MESGEE    DCW    @TIME E       @,G                               12  02829
1310                B      TYPEIT                                          7  02831  J 03539
1311      RESULT    DCW    @BUSY TIME 000 MS@,G                            16  02853
1312                B      TYPEIT                                          7  02855  J 03539
1313      MINUTE    DCW    @TIME TO ADVANCE 00000 MS@,G                    24  02885
1314      INQREQ    BNQ    ALTER               WHERE TO FROM HERE           7  02887  J 01006 Q
1315                BCE    REQLUP,TAD1,1       REQUEST STC LOOP            12  02894  B 03422 01001 1
1316                BCE    START1,TAD3,1       REPEATING TEST              12  02906  B 02007 01003 1
1317                A      &1,PASSNO           COUNT PASSES THRU PROGRAM    11  02918  A 03698 03538
1318                BCE    *&8,PASSNO,3        . 3 PASSES COMPLETE 1/3 REV. 12  02929  B 02948 03538 3
1319                B      START1              . MINIMUM TEST NECESSARY     7  02941  J 02007
1320                B      TYPEIT                                          7  02948  J 03539
1321                DCW    @ECJ@,G                                         3  02957
1322                B      LOADER              CALL IN NEXT TEST           7  02959  J 00400
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PGLIN     LABEL     OPCOD  OPERAND                                    CT  ADDRS  INSTRUCTION
1324      *                              *SET UP ERROR MESSAGES
1325
1326      ERCR5B    MLCS   @B@,MESGE5-26       SET UP MESSAGE         12  02966  D 03709 03047 3
1327                MLNA   TIMEB,MESGE5-16     SET TIME B IN MESSAGE 5  12  02978  D 03657 03057 /
1328                B      ERROR5                                      7  02990  J 03021
1329      ERCR5C    MLCS   @D@,MESGE5-26       SET UP MESSAGE         12  02997  D 03710 03047 3
1330                MLNA   TIMED,MESGE5-16     SET TIME D IN MESSAGE 5  12  03009  D 03672 03057 /
1331      ERROR5 E  MLCWA  START&&,ERREXT&&    START AGAIN ON THIS ERROR  12  03021  D 02006 03487 X
1332                B      TOERRT                                      7  03033  J 03335
1333      MESGE5    DCW    @* TIME X WAS CCCOC  EXPECTED $9999@,G       34  03073
1334      *         **NOT A BUSY SIGNAL INDICATION BUT A READOUT FAILURE
1335
1336      ERROR6    SBR    ERREXT&5            STORE ADDRESS FOR RETURN   7  03075  G 03486 B
1337                MLNA   BZTIME-3,MESGE6-19 SET ACTUAL BUSY TIME IN MESGE6  12  03082  D 03618 03115 /
1338                B      TOERRT                                      7  03094  J 03335
1339      MESGE6    DCW    @* BUSY TIME CCO MS - NOT IN SPECS @,G      34  03134
1340
1341      ERROR7    SBR    ERREXT&5            STORE ADDRESS FOR RETURN   7  03136  G 03486 B
1342                MLNA   TOTAL-3,MESGE7-11  SET TOTAL ADVANCE TIME IN MESGE7  12  03143  D 03626 03184 /
1343                B      TOERRT                                      7  03155  J 03335
1344      MESGE7    DCW    @* TIME TO ADVANCE CCCCC MS - CHECK@,G      34  03195
1345
1346      ERROR8 '  SBR    ERREXT&5            STORE ADDRESS FOR RETURN   7  03197  G 03486 B
1347                A      &18,ERREXT&5      ADJUST ERROR EXIT ADDRESS    11  03204  A 03712 03486
1348                B      ERCR8A                                      7  03215  J 03229
1349      ERCR8C    SBR    ERREXT&5            STORE ADDRESS FOR RETURN   7  03222  G 03486 B
1350      ERCR8A    NOPWM                                              1  03229  N
1351                B      ERCR8B              SKIP A-C, DO C-E           7  03230  J 03261
1352                MLNA   TIMEA,MESGE8-18     .SET CLOCK TIMES IN ERROR MESSAGE  12  03237  D 03647 03315 /
1353                MLNA   TIMEC,MESGE8        .TIME A SHOULD EQUAL TIME C  12  03249  D 03662 03333 /
1354      ERCR8B    NOPWM                                              1  03261  N
1355                B      READY                                       7  03262  J 03293
1356                MLNA   TIMEC,MESGE8-18     .SET CLOCK TIMES IN ERROR MESSAGE  12  03269  D 03662 03315 /
1357                MLNA   TIMEE,MESGE8        .TIME C SHOULD EQUAL TIME E  12  03281  D 03677 03333 /
1358      READY     B      TOERRT                                      7  03293  J 03335
1359      MESGE8    DCW    @* TIME WAS OCCOO ADVANCED TO COOCC@,G      34  03333
```

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PGLIN     LABEL     OPCOD  OPERAND                    *  SET UP ERROR ROUTINE                    CT  ADDRS  INSTRUCTION
1361      *                                           *
1362
1363      TCERRT    SBR    MOVE65                        STORE ADDR OF MESGE                     7  03335  G 03347 B
1364      MOVE      MRCHG  00000,BUFFER-33               MOVE ADDR OF MESGE TO BUFFER           12  03342  D 00000 03368 D
1365                B      ERROUT                        TO ERROR ROUTINE                        7  03354  J 03361      L
1366
1367      *                                           *  ERROR ROUTINE  AND G O O T LOOP
1368
1369      ERROUT    B      TYPEIT                        TYPE ERROR MESSAGE                      7  03361  J 03539
1370      BUFFER    DCW    @                                                  @,G                34  03401
1371                BCE    SET4RR,TAD1,1                 LOOP ON A 1 - STORING CLOCK TIME       12  03403  B 03429 01001 1
1372                B      EREXT                         BYPASS SCOPE LOOP                       7  03415  J 03481
1373
1374      RECLUP    SBR    EREXT65                       STORE ADDRESS FOR RETURN                7  03422  G 03486 B
1375      SET4RR    MRCW   AUTORR,1                      SET UP AUTO RESET RESTART BRANCH       12  03429  D 03488 00001 T
1376                MRCW                                                                         1  03441  D                M
1377      LOOP      BNG    ALTER                         TO ALTER ROUTINE TO LEAVE LOOP          7  03442  J 01006 G
1378                STC    TIMEX                         LOOP ON STC                             7  03449  G 03682 T
1379                BCE    LOOP,TAD1,1                   STAY IN LOOP IF TAD1 IS SET            12  03456  B 03442 01001 1
1380                MRCW   START,1                       REPLACE CLC RESET RESTART ADDRESS      12  03468  D 02000 00001 M
1381                MRCW                                                                         1  03480  D                I
1382
1383      EREXT     B      00000                                                                   7  03481  J 00000
1384
1385      AUTORR    B      LOOP                          AUTOMATIC RETURN TO LOOP                7  03488  J 03442
```

```
PGLIN  LABEL   OPCOD  OPERAND                 CT  ADDRS  INSTRUCTION
1387   *                        *  DELAY 1 SEC ROUTINE
1388   *               * APPROX 1 SEC DELAY IS ADDED TO ALLOW FOR
1389   *               * CONTACT BOUNCE TO SUBSIDE PREVENTING THE
1390   *               * ADVANCE OF THE PROGRAM ON PREMATURE INDICATIONS
1391   *
1392   DELAY1  SBR    DLAEXT&5                7  03495  G 03524 B
1393           S      DLAYCT                  6  03502  S 03637
1394   ADITUP  A      DT1,DLAYCT              11 03508  A 03607 03637
1395   DLAEXT  BCE    00000,DLAYCT-6,1        12 03519  B 00000 03631 1
1396           B      ADITUP                  7  03531  J 03508
1397
1398   PASSNO  DCW    @ @                     1  03538
1399
1400   *               TYPING ROUTINE
1401
1402   TYPEIT  SBR    TYPE&8                  7  03539  G 03554 B
1403   TYPE    WCP    00000                   10 03546  M %TO 00000 W
1404           SBR    TYPEXT&5                7  03556  G 03582 B
1405           BCB1   TYPE                    7  03563  R 03546 2
                                                         G
1406           BA1    *&1                     7  03570  R 03577 M
1407   TYPEXT  B      00000                   7  03577  J 00000
1408           H                              1  03584  .
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```
PGLIN     LABEL     OPCOD  OPERAND                                    CT  ADDRS  INSTRUCTION
1410                ORG    *&X00                                          03600
1411      DT0       DCW    &0000      CONSTANT FOR DELAY LOOP          4  03603
1412      DT1                &0000      DELAY1 TIME CONST                4  03607
1413      DT3                &0000      CONSTANT FOR BUSY TIME LOOP      4  03611
1414      DT4                &0000      CONSTANT FOR ADVANCE TIME LOOP   4  03615
1415      BZTIME             &000000    BUSY TIME COUNT                  6  03621
1416      TOTAL              &00000000  TIME TO ADVANCE COUNT            8  03629
1417      DLAYCT             &00000000  DELAY COUNT                      8  03637
1418
1419      TIME&              00000      FIRST SAMPLE TIME MAIN BODY      5  03642
1420      TIMEA              00000      TIME A                           5  03647
1421      TIMEA1             00000      TIME A PLUS 1 OR 2               5  03652
1422      TIMEB              00000      TIME B                           5  03657
1423      TIMEC              00000      TIME C                           5  03662
1424      TIMEC1             00000      TIME C & 1 OR 2                  5  03667
1425      TIMED              00000      TIME D                           5  03672
1426      TIMEE              00000      TIME E                           5  03677
1427      TIMEX              00000      TIME STORED IN STC LOOP          5  03682
1428                LTORG                                                 03683
1428                       @99999@                                     5  03687
1428                       @460@                                       3  03690
1428                       @230@                                       3  03693
1428                       @61@                                        2  03695
1428                       @59@                                        2  03697
1428                       &1                                          1  03698
1428                       @02400@                                     5  03703
1428                       @00000@                                     5  03708
1428                       @B@                                         1  03709
1428                       @D@                                         1  03710
1428                       &18                                         2  03712
1429                END    START                                             J02000
```

END OF ASSEMBLY