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ELECTRONICS ENGINEERING GROUP (1842ND) SCOTT AFB IL  
LINE ACCESS TEST SYSTEM (LATS).(U)

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JUL 79 M VERSTEGEN, J MCCORMACK  
1842 EEG/EETE/TR-79-12

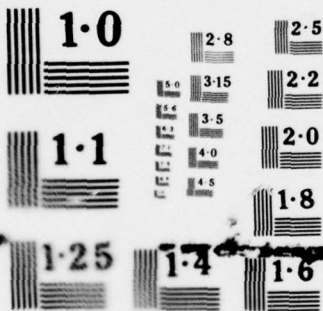
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**LEVEL II**

1842 EEG/EETE TR 79-12

AFCS TECHNICAL REPORT

LINE ACCESS TEST SYSTEMS (LATS)

AFCS SYSTEMS APPLICATION FACILITY  
1842 ELECTRONICS ENGINEERING GROUP (AFCS)  
SCOTT AIR FORCE BASE, ILLINOIS 62225

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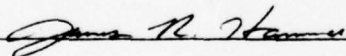
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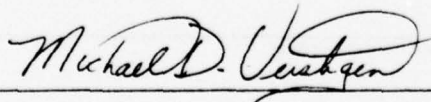
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#### ABSTRACT

This technical report discusses the Line Access Test System (LATS) which can perform matrix switching operations on four wire circuits. Each circuit accessed may be tested for D.C. voltage, resistance, A.C. voltage and capacitance. A microprocessor control implementation is also included with the necessary programs for operation.

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## 1.0 BACKGROUND.

1.1 The Line Access Test System (LATS) was a joint Air Force Academy/1842 EEG project accomplished under the cadet summer research program in 1978. Cadet First Class John McCormack undertook the LATS project and completed all of the requirements in the six week span of the program.

1.2 To date, the LATS interface is complete in both hardware and software and has been put into service for specific test applications.

## 2.0 TECHNICAL DISCUSSION.

### 2.1 LATS Description.

2.1.1 The Line Access Test System (LATS) is an array of relays and supporting circuitry that allows a user to access individual four wire circuits (common in telephone networks) for testing. LATS is composed of a control panel and up to 60 matrix units or bays. Each bay can address up to 80 four-wire circuits through opening contacts on the relays. The address is supplied by the control panel. Each circuit is passed through two relays, a km and a kb relay (Figure 1). Using these relays, a circuit may be either monitored or broken. When a circuit is monitored, the input is shunted through the km relay onto the Z (west) data bus without interrupting the information flow. When a circuit is broken, both the km and kb relays are opened, putting both the east and west wires onto the bus, east on the A bus and west on the Z bus. The information flow is interrupted and the user may observe the flow in either direction.

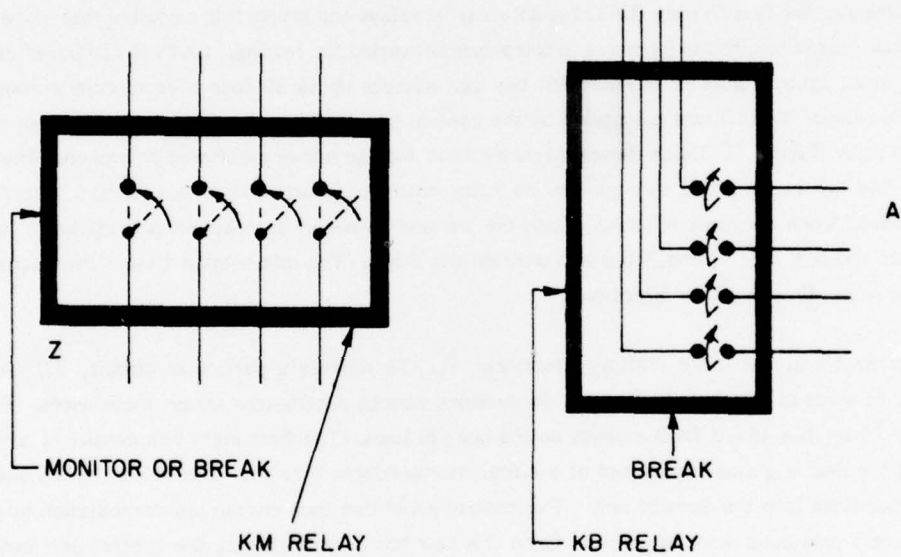
2.1.2 The control unit has three primary functions: (1) To address a particular circuit, (2) To access a particular pair of wires in that circuit, and (3) To measure various parameters across those wires. To access a circuit, the LATS sends a 16-bit BCD address on the control lines. The first eight bits consist of a matrix unit address, while the next eight are composed of a circuit number from 0 to 79. The circuit, when monitored or broken, ties four lines into the control unit. The control panel can then choose any combination of these as a pair, or compare a particular wire to ground. Once this pair has been accessed, the control unit can test four parameters: D.C. voltage, resistance, A.C. voltage, and capacitance. The scales of these measurements are fixed, rather than floating, so that an off-scale or overflow reading causes the display to show "OF".

2.1.3 LATS is equipped with external jacks for attaching reliable measuring equipment to the accessed circuit. Eight lines (R, T, R1, T1, Rz, Tz, R1z, T1z) are brought out so that the pair selected is available for measurements by external equipment.

2.1.4 The control panel is equipped with a self test capability. In addition, there are two indicator lights. One indicates that the circuit was not accessed; this is the Fault (FLT) signal, which usually means that the selected bay was not present. The other indicator is the MIC (micro in control) which indicates that the LATS is being controlled by a computer. The interface consists of three 50-pin connectors on the back panel of the control unit connected to five 16-pin DIP ports on the Edumicro.

Z BUS TO CONTROL PANEL

A BUS TO CONTROL PANEL



NOTE: When a break command is given, both relays switch their information to the two data buses. When a monitor is given, only the KM relay is switched causing Z to go onto the data bus; therefore, the circuit is not interrupted.

Figure 1. Relays in One Circuit in Matrix Unit

## 2.2 LATS Interface.

2.2.1 Edumicro is an Intel 8080A Based Micro Processor system developed by USAFA/DFEE. The basic Edumicro has onboard 2k of RAM (Random Access Memory), 8 input and 8 output ports, 1k of ROM (Read Only Memory) monitor and room for 1k of user ROM. The user ROM is filled by the LATS monitor when the Edmuicro is used to control the LATS.

2.2.2 The connections between the LATS and Edumicro are a straightforward process. Using the LATS interface specification, the control bits are grouped into eight-bit bytes which can be processed by the INTEL 8080A. The MIC is controlled by a toggle switch.

## 2.3 LATS SOFTWARE.

2.3.1 The approach to the software was to determine exactly what the LATS was capable of doing and to supply the necessary control sequence to accomplish it. For example, to call up a four wire circuit, the previous circuit must first be cleared by outputting the CCSD (clear circuit select data) bit. Next, the circuit must be addressed. The address is sixteen BCD bits, an eight-bit bay (or Matrix unit) address, and an eight-bit circuit address. The format for transferring this information is in a sequence of four 4-bit words (CKB) strobed by a fifth line (CKST) for a specified time interval.

2.3.2 The next step in accessing a circuit is making sure that the circuit that was supposed to be called was the one actually called. This is done by inputting BTCK (bay tens check), BUCK (bay units check), OTCK (circuit tens check), and OUCK (circuit units check), and comparing the input to what was put out. The circuit must then be broken or monitored by outputting the appropriate bit, delaying, and inputting the check bit. Under micro control, the break and monitor set bits do not clear automatically; so once set, these bits need not be reset or regenerated for every circuit. The user must input and check the FLT bit (corresponding to the indicator light) for an unaccessed circuit.

2.3.3 Now that a circuit has been accessed, it may be checked for various conditions by the LATS; but first, the user needs to select a pair of wires by outputting the MTC (meter configuration) bits and inputting the MTCK (meter configuration check) bits for a check. Once on a pair of wires, the user may select a particular function to check, such as D. C. potential, by putting the proper code on the RFB lines and strobing the range/function information with RFS (range-function strobe). Next, RFN must be inputted and checked to insure that the information put out was the information received.

2.3.4 To read the meter, the meter must first be turned on (MTON) and checked for being on (MTRK). Then the user must start the reading (MST) and wait for the EOC (end of conversion) input to signal that the reading is complete. The user must check the OVR bit (comparable to the "OF", overflow, display) to insure that the reading was within the range selected. If it was not within range, the range must be changed.

2.3.5 The computer is capable of checking all of the circuits for all parameters without the operator having to key it; so the software counts. It counts through all of the circuit functions in all of the bays. It also performs a zero test for proper meter operation and a grounding test for proper relay operation; this process is explained in Appendix A.

2.3.6 Perhaps the user may not have sixty bays present, or he may only want to test ten circuits instead of eighty. The software then compensates. The program expects several user-keyed inputs: the lower limit and upper limit of numbered bays to be tested; and, if only one bay is being tested, the lower and upper limits of circuits within that bay. The user also determines whether to break or monitor all circuits and whether or not he wishes to run a grounding test to check relay operation.

2.3.7 Because of the length of the LATS words (four-bits and the abundance of single-bit instructions) the Edumicro output information was combined into usable eight-bit status words and saved in memory. Status words allow the program to change a bit of output and remember the change every time the output port is used. In addition to status words, there is also a series of flag words; one to remember whether to break or monitor and another to signal when all testing has been done. If the user wants to count circuits after ground testing, the done flag (DNFLG) must be reset.

2.3.8 The program contains an error message routine which displays a particular one byte message which will indicate either FLT, overflow, transfer error, or an unacceptable reading of a grounded input. After a key is depressed, the display will tell the user where the error occurred. The user is then given the option of keying in an address and resuming calculations at that location.

2.3.9 The monitor is flexible enough for a user to access one circuit without counting to the next circuit, to access a single function or a single pair without scanning, or to use the counting routines and check every possible combination.

APPENDIX A

AFCS 8080 ASSEMBLER

LATS CONTROLLER

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PAGE 1

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LINE  LOC  B1 B2 B3      SOURCE LINE
1          NAM LATS CONTROLLER
2          ****
3          *
4          *
5          * THIS PROGRAM IS DESIGNED TO CONTROL THE LATS USING
6          * THE EDUMICRO COMPUTER.  IT INITIALIZES THE SYSTEM
7          * BY STORING THE VALUES OF THE DESIRED BAYS AND
8          * CIRCUITS TO BE TESTED, AS WELL AS ZERO TESTING THE
9          * UNIT.  IT IS FLEXIBLE FOR ANY FURTHER TESTING,
10         * CONTAINING SUBROUTINES FOR CONFIGURING AND READING
11         * THE LATS
12         *
13         *          VARIABLE LIST:
14         *          NAME          CONTENTS          ASSIGNMENT
15         *          STPNTR       INITIAL VALUE STACK POINTER  0CDF
16         *          BAY          METER OUTPUT          0CE0
17         *          TPBAY        METER OUTPUT          0CE1
18         *          CKT          METER OUTPUT          0CE2
19         *          TPCKT        METER OUTPUT          0CE3
20         *          MOT          METER OUTPUT          0CE4
21         *          PNTR        POINTER TO FUNCTION TABLE  0CE5
22         *          -           (2 BYTE)              0CE6
23         *          EC          ERROR COUNT            0CE7
24         *          STS4A       MTC.CKB              0CE8
25         *          STS4        CKST,MON,CCDS,EXM,RFB    0CE9
26         *          STS5        AZ,MTRK,MTON,BRK,RFS,MST,MTZ 0CEA
27         *          BRKI        BREAK,MONITOR FLAG      0CEB
28         *          VAC         RANGE/FUNCTION TABLE   0CEC
29         *          VDC         0CED
30         *          RES         0CEE
31         *          CAPA        0CEF
32         *          DNFLG       DONE FLAG              0CF0
33         *          DSPLA       KEYBOARD DISPLAY LSB    0CF1
34         *          DSPMS       KEYBOARD DISPLAY MSB    0CF2
35         *          INPUT PORT ASSIGNMENTS:
36         *          0           KEYBOARD KEYS 7-0
37         *          01          KEYBOARD KEYS F-0
38         *          03          MRVK,MTRK,BRKK,EOC,AZK,
39         *          02          MSD,OVR,POL,MONK,FLT,
40         *          05          MTOT,MTOU
41         *          04          RGFN,MTCK
42         *          07          BTCK,BUCK
43         *          06          OTCK,DUCK
44         *          OUTPUT PORT ASSIGNMENTS:
45         *          00          DISPLAY VALUES
46         *          01          DISPLAY POSITIONS
47         *          05          AZ,.MTRV,MTON,BRK,RFS,MST,MTZ
48         *          07          MTZ,CKB
49         *          06          CKST,MON,CCSD,EXM,RFB
50         *          STACK SPACE NEEDED: 16 BYTES
          *          MEMORY USED: 0CD0-0CF2

```

| LINE | LOC  | B1 | B2 | B3 | SOURCE LINE  |
|------|------|----|----|----|--|
| 51   |      |    |    |    | * ALGORITHM SOURCE: C1C JOHN B. MCCORMACK          |
| 52   |      |    |    |    | * USAFA, CO 80840                                  |
| 53   |      |    |    |    | * PERM ADDRESS: 116 MILBURN LN                     |
| 54   |      |    |    |    | * E.HILLS, NY 11577                                |
| 55   |      |    |    |    | * (516) 621-1327                                   |
| 56   |      |    |    |    | * SOME OF THE SOFTWARE WAS BORROWED FROM           |
| 57   |      |    |    |    | * THE EDMICRO MONITOR WRITTEN FOR USAFA/DFEE       |
| 58   |      |    |    |    | * (7 APRIL 78) BY ALAN J. LARSON.                  |
| 59   |      |    |    |    | * WRITTEN: JULY, 1978                              |
| 60   |      |    |    |    | *****  |
| 61   |      |    |    |    | ORG '0400  |
| 62   |      |    |    |    | STPTR EQU '0CDF                                    |
| 63   |      |    |    |    | BAY EQU '0CE0                                      |
| 64   |      |    |    |    | TPBAY EQU '0CE1                                    |
| 65   |      |    |    |    | CKT EQU '0CE2                                      |
| 66   |      |    |    |    | TPCKT EQU '0CE3                                    |
| 67   |      |    |    |    | MOT EQU '0CE4                                      |
| 68   |      |    |    |    | PNTR EQU '0CE5                                     |
| 69   |      |    |    |    | EC EQU '0CE7                                       |
| 70   |      |    |    |    | STS4A EQU '0CE8                                    |
| 71   |      |    |    |    | STS4 EQU '0CE9                                     |
| 72   |      |    |    |    | STS5 EQU '0CEA                                     |
| 73   |      |    |    |    | BRKI EQU '0CEB                                     |
| 74   |      |    |    |    | VAC EQU '0CEC                                      |
| 75   |      |    |    |    | VDC EQU '0CED                                      |
| 76   |      |    |    |    | RES EQU '0CEE                                      |
| 77   |      |    |    |    | CAPA EQU '0CEF                                     |
| 78   |      |    |    |    | DNFLG EQU '0CF0                                    |
| 79   |      |    |    |    | DSPLA EQU '0CF1                                    |
| 80   |      |    |    |    | DSPMS EQU '0CF2                                    |
| 81   |      |    |    |    | DN EQU 'F0   |
| 82   |      |    |    |    | * TELLS PNTR WHERE END OF TABLE                    |
| 83   |      |    |    |    | IS   |
| 84   |      |    |    |    | *****  |
| 85   |      |    |    |    | * INIT   |
| 86   |      |    |    |    | * PRESETS ALL STATUS REGISTERS, READS IN BAYS AND  |
| 87   |      |    |    |    | * CIRCUITS TO BE TESTED FROM KEYBOARD, DECISION TO |
| 88   |      |    |    |    | * MONITOR, OR BREAK, AND ZERO TESTS THE LATS UNIT. |
| 89   |      |    |    |    | *****  |
| 90   | 0400 | 31 | DF | 0C | INIT LXI SP, STPTR                                 |
| 91   | 0403 | 21 | EC | 0C | LXI H, VAC   |
| 92   | 0406 | 22 | E5 | 0C | SHLD PNTR  |
| 93   | 0409 | 21 | E7 | 0C | LXI H, EC  |
| 94   | 040C | 36 | 00 |    | MVI M, '00   |
| 95   | 040E | 23 |    |    | INX H  |
| 96   |      |    |    |    | * ADVANCE MEMORY TO SET                            |
| 97   | 040F | 36 | 00 |    | OTHER STATUS WORDS                                 |
| 98   | 0411 | 23 |    |    | STS4A, MTC AND CKB                                 |
| 99   | 0412 | 36 | 8D |    | STS4, CKST(1), MON(0)                              |
| 100  | 0414 | 23 |    |    | CCSD(1), EXM(1), AND RFB(D)                        |
|      |      |    |    |    | STS5, AZ(1), MTRY(0), MTON(0)                      |

| LINE | LOC  | B1 | B2 | B3 | SOURCE           | LINE                           |
|------|------|----|----|----|------------------|--------------------------------|
| 101  | 0415 | 36 | 0F |    | MVI M, '0F       | BRK(0),RFS(1),MST(1),MTZ(1)    |
| 102  | 0417 | 23 |    |    | INX H            | SKIP A PLACE IN MEMORY FOR B   |
| 103  | 0418 | 23 |    |    | INX H            | NEXT 4 LOCATIONS,VAC,VDC       |
| 104  | 0419 | 36 | FD |    | MVI M, 'FD       | RES AND CAPA ARE A TABLE       |
| 105  | 041B | 23 |    |    | INX H            | OF RANGE FUNCTIONS THAT        |
| 106  | 041C | 36 | FB |    | MVI M, 'FB       | BE POINTED TO BY THE           |
| 107  | 041E | 23 |    |    | INX H            | POINTER, AND SCANNED IN        |
| 108  | 041F | 36 | F6 |    | MVI M, 'F6       | THE FNCSN SUBROUTINE           |
| 109  | 0421 | 23 |    |    | INX H            |                                |
| 110  | 0422 | 36 | F2 |    | MVI M, 'F2       |                                |
| 111  | 0424 | 23 |    |    | INX H            | SET DNFLG TO NOT ZERO          |
| 112  | 0425 | 36 | FF |    | MVI M, 'FF       |                                |
| 113  | 0427 | CD | 34 | 04 | CALL INBAY       | USER DETERMINES THE SCOPE      |
| 114  | 042A | CD | C3 | 07 | CALL RD2A        | KEYIN 0 FOR BREAK,             |
| 115  | 042D | 32 | E8 | 0C | STA BRKI         | BREAK FLAG STATUS WORD         |
| 116  | 0430 | CD | 60 | 04 | CALL ZTEST       | CHECK METER OPERATION          |
| 117  | 0433 | C9 |    |    | RET              |                                |
| 118  |      |    |    |    |                  |                                |
| 119  |      |    |    |    |                  |                                |
| 120  |      |    |    |    |                  |                                |
| 121  |      |    |    |    |                  |                                |
| 122  |      |    |    |    |                  |                                |
| 123  |      |    |    |    |                  |                                |
| 124  |      |    |    |    |                  |                                |
| 125  |      |    |    |    |                  |                                |
| 126  |      |    |    |    |                  |                                |
| 127  | 0434 | CD | C3 | 07 | INBAY CALL RD2A  | READ IN LOWER BOUND OF BAYS    |
| 128  | 0437 | 32 | E0 | 0C | STA BAY          | SAVE IN STATUS WORD BAY        |
| 129  | 043A | CD | C3 | 07 | CALL RD2A        | UPPER BOUND READ IN            |
| 130  | 043D | 32 | E1 | 0C | STA TPBAY        | SAVE IN STATUS WORD TPBAY      |
| 131  | 0440 | 47 |    |    | MOV B,A          |                                |
| 132  | 0441 | 3A | E0 | 0C | LDA BAY          | FETCH BAY                      |
| 133  | 0444 | 88 |    |    | CMP B            |                                |
| 134  | 0445 | CA | 53 | 04 | JZ INCKT         | IF TESTING WITH A SINGLE       |
| 135  |      |    |    |    | *                | BAY, DECIDE WHICH CIRCUITS     |
| 136  | 0448 | 3E | 00 |    | MVI A, '00       | IF MORE THAN 1 BAY, USE THE    |
| 137  | 044A | 32 | E2 | 0C | STA CKT          | DEFAULT VALUES,00-79           |
| 138  | 044D | 3E | 79 |    | DFCKT MVI A, '79 | DEFAULT FOR TPCKT OF 79        |
| 139  | 044F | 32 | E3 | 0C | STA TPCKT        |                                |
| 140  | 0452 | C9 |    |    | RET              | RETURN TO INIT                 |
| 141  | 0453 | CD | C3 | 07 | INCKT CALL RD2A  | READ IN LOWER BOUND OF CIRCUIT |
| 142  | 0456 | 32 | E2 | 0C | STA CKT          | SAVE IN STATUS WORD CKT        |
| 143  | 0459 | CD | C3 | 07 | CALL RD2A        | READ IN UPPER BOUND            |
| 144  | 045C | 32 | E3 | 0C | STA TPCKT        | SAVE IN TPCKT                  |
| 145  | 045F | C9 |    |    | RET              | RETURN TO INIT                 |
| 146  |      |    |    |    |                  |                                |
| 147  |      |    |    |    |                  |                                |
| 148  |      |    |    |    |                  |                                |
| 149  |      |    |    |    |                  |                                |
| 150  |      |    |    |    |                  |                                |

| LINE | LOC  | B1 | B2 | B3 | SOURCE LINE  |
|------|------|----|----|----|--|
| 151  |      |    |    |    | *****  |
| 152  | 0460 | CD | E7 | 04 | ZTEST CALL CKRT SELECT 1ST CIRCUIT                   |
| 153  | 0463 | CD | CF | 05 | CALL BRKMN EITHER BREAK OR MONITOR                   |
| 154  | 0466 | 3A | EA | 0C | LDA STS5 GET STS5 FOR MTZ BIT                        |
| 155  | 0469 | E6 | FD |    | ANI 'FD CHANGE MTZ TO 0                              |
| 156  | 046B | D3 | 05 |    | OUT '05 MTZ TO LATS                                  |
| 157  | 046D | 06 | 32 |    | MVI B,'32 DELAY 50 MS TO GET VALID                   |
| 158  |      |    |    |    | SIGNAL   |
| 159  | 046F | 32 | EA | 0C | * STA STS5 SAVE UPDATED STS5                         |
| 160  | 0472 | 3A | E9 | 0C | LDA STS4 GET STS4 FOR RFB                            |
| 161  | 0475 | F6 | 0F |    | ORI '0F MAKE RFB 1111 (199 VAC)                      |
| 162  | 0477 | 32 | E9 | 0C | STA STS4 UPDATE STS4                                 |
| 163  | 047A | CD | 83 | 06 | CALL ZFNCT TEST METER CALIBRATION                    |
| 164  | 047D | 3A | EA | 0C | LDA STS5 GET STS5 FOR MTZ                            |
| 165  | 0480 | F6 | 02 |    | ORI '02 RESET MTZ BIT TO 1                           |
| 166  | 0482 | D3 | 05 |    | OUT '05 CLEAR LATS                                   |
| 167  | 0484 | 06 | 32 |    | MVI B,'32 DELAY 50 MS                                |
| 168  | 0486 | CD | DF | 07 | CALL DBMS  |
| 169  | 0489 | 32 | EA | 0C | STA STS5 UPDATE STS5                                 |
| 170  | 048C | C9 |    |    | RET RETURN TO INIT                                   |
| 171  |      |    |    |    | *****  |
| 172  |      |    |    |    | * RGFN EXPECTS THE PROPER STATUS WORD IN THE A REG.  |
| 173  |      |    |    |    | * IT SAVES STS4, OUTPUTS THE RANGE AND FUNCTION TO   |
| 174  |      |    |    |    | * THE LATS, AND INSURES THE INFORMATION WAS RECEIVED |
| 175  |      |    |    |    | *****  |
| 176  | 048D | 32 | E9 | 0C | RGFN STA STS4 SAVE STS4                              |
| 177  | 0490 | D3 | 06 |    | OUT '06 PUT RFB ON LINES                             |
| 178  |      |    |    |    | * (MUST STILL STROBE RFS)                            |
| 179  | 0492 | 5F |    |    | MOV E,A SAVE STS4 IN E                               |
| 180  | 0493 | 3E | 00 |    | MVI A,'00 INITIALIZE EC                              |
| 181  | 0495 | 32 | E7 | 0C | STA EC   |
| 182  | 0498 | 3A | EA | 0C | LDA STS5 GET STS5 FOR RFS                            |
| 183  | 049B | E6 | F7 |    | ANI 'F7 BRING RFS LOW                                |
| 184  | 049D | D3 | 05 |    | OUT '05 STROBE RFS TO ENTER RFB                      |
| 185  | 049F | 06 | 64 |    | MVI B,'64 DELAY 100 MS                               |
| 186  | 04A1 | CD | DF | 07 | CALL DBMS  |
| 187  | 04A4 | F6 | 08 |    | ORI '08 TAKE RFS BACK UP TO 1                        |
| 188  | 04A6 | D3 | 05 |    | OUT '05  |
| 189  | 04A8 | 7B |    |    | MOV A,E CHECK RFB FOR CAP OR AC                      |
| 190  | 04A9 | E6 | 0F |    | ANI '0F MASK RFB FROM STS4                           |
| 191  | 04AB | 57 |    |    | MOV D,A SAVE RFB IN D REGISTER                       |
| 192  | 04AC | FE | 02 |    | CPI '02  |
| 193  | 04AE | CA | DA | 04 | JZ LONG CAPA AND VAC NEED MORE DELAY                 |
| 194  | 04B1 | FE | 03 |    | CPI '03  |
| 195  | 04B3 | CA | DA | 04 | JZ LONG  |
| 196  | 04B6 | FE | 0F |    | CPI '0F  |
| 197  | 04B8 | CA | DA | 04 | JZ LONG  |
| 198  | 04BB | FE | 0E |    | CPI '0E  |
| 199  | 04BD | CA | DA | 04 | JZ LONG  |
| 200  | 04C0 | FE | 0D |    | CPI '0D  |

| LINE | LOC  | B1 | B2 | B3 | SOURCE LINE     |                               |
|------|------|----|----|----|-----------------|-------------------------------|
| 201  | 04C2 | CA | DA | 04 | JZ LONG         |                               |
| 202  | 04C5 | 06 | 0A |    | MVI B, '0A      | DELAY VDC AND RES 10 MS       |
| 203  | 04C7 | CD | DF | 07 | CALL DBMS       |                               |
| 204  | 04CA | DB | 04 |    | CHK IN '04      | INPUT FOR RFN                 |
| 205  | 04CC | E6 | F0 |    | ANI 'F0         | MASK FOR RFN                  |
| 206  | 04CE | 0F |    |    | RRC             | PUT IN POSITION TO CHECK      |
| 207  | 04CF | 0F |    |    | RRC             |                               |
| 208  | 04D0 | 0F |    |    | RRC             |                               |
| 209  | 04D1 | 0F |    |    | RRC             |                               |
| 210  | 04D2 | BA |    |    | CMP D           | RFB=RFN?                      |
| 211  | 04D3 | C8 |    |    | RZ              | RETURN IF RFB=RFN             |
| 212  | 04D4 | CD | 74 | 05 | CALL ECHO       | ERROR ROUTINE IF RFB NEQ RFN  |
| 213  | 04D7 | C3 | 8D | 04 | JMP RGFN        | IF NOT MANY ERRORS, TRY AGAIN |
| 214  | 04DA | 06 | FA |    | LONG MVI B, 'FA | DELAY 500 MS IF CAP OR VAC    |
| 215  | 04DC | CD | DF | 07 | CALL DBMS       |                               |
| 216  | 04DF | 06 | FA |    | MVI B, 'FA      |                               |
| 217  | 04E1 | CD | DF | 07 | CALL DBMS       |                               |
| 218  | 04E4 | C3 | CA | 04 | JMP CHK         |                               |
| 219  |      |    |    |    |                 |                               |
| 220  |      |    |    |    |                 |                               |
| 221  |      |    |    |    |                 |                               |
| 222  |      |    |    |    |                 |                               |
| 223  | 04E7 | 3E | 00 |    | CKRT MVI A, 00  | RESET EC                      |
| 224  | 04E9 | 32 | E7 | 0C | STA EC          |                               |
| 225  | 04EC | 3A | EA | 0C | CRT1 LDA STS5   | GET STS5 FOR BRK              |
| 226  | 04EF | E6 | EF |    | ANI 'EF         | RESET BRK TO 0                |
| 227  | 04F1 | D3 | 05 |    | OUT '05         |                               |
| 228  | 04F3 | 32 | EA | 0C | STA STS5        | UPDATE STS5                   |
| 229  | 04F6 | 3A | E9 | 0C | LDA STS4        | GET STS4 FOR MON              |
| 230  | 04F9 | E6 | 0F |    | ANI '0F         | RESET CCSD AND MON TO 0       |
| 231  | 04FB | D3 | 06 |    | OUT '06         |                               |
| 232  | 04FD | 06 | C9 |    | MVI B, 'C9      | 200 MS DELAY FOR MON AND BRK  |
| 233  | 04FF | CD | DF | 07 | CALL DBMS       |                               |
| 234  | 0502 | 32 | E9 | 0C | STA STS4        | SAVE STS4                     |
| 235  | 0505 | DB | 02 |    | IN '02          | CHECK THAT BOTH MONK AND BRK  |
| 236  | 0507 | E6 | 40 |    | ANI '40         | ARE 0, IE, THAT THE CIRCUIT   |
| 237  | 0509 | C2 | 1A | 05 | JNZ ER          | IS NOT MONITORED OR BROKEN    |
| 238  | 050C | DB | 03 |    | IN '03          |                               |
| 239  | 050E | E6 | 20 |    | ANI '20         |                               |
| 240  | 0510 | C2 | 1A | 05 | JNZ ER          |                               |
| 241  | 0513 | CD | 59 | 05 | CALL STROB      |                               |
| 242  | 0516 | CD | AC | 05 | CALL CHECK      | OUTPUT CIRCUIT TO EDMICRO     |
| 243  | 0519 | C9 |    |    | RET             |                               |
| 244  | 051A | CD | 74 | 05 | ER CALL ECHO    | USE ERROR ROUTINE             |
| 245  | 051D | C3 | EC | 04 | JMP CRT1        | TRY AGAIN                     |
| 246  |      |    |    |    |                 |                               |
| 247  |      |    |    |    |                 |                               |
| 248  |      |    |    |    |                 |                               |
| 249  |      |    |    |    |                 |                               |
| 250  |      |    |    |    |                 |                               |

\* CKRT OUTPUTS THE DESIRED CIRCUIT TO LATS, AND  
 \* CHECKS TO INSURE THE INFORMATION WAS RECEIVED.  
 \* CKCNT COUNTS THROUGH THE CIRCUITS, AND IS CALLED  
 \* WHEN ALL PAIRS HAVE BEEN TESTED IN THE PREVIOUS  
 \* CIRCUIT. IT CALLS BYCNT WHEN ALL THE CIRCUITS  
 \* IN A BAY HAVE BEEN TESTED.

| LINE | LOC  | B1 | B2 | B3 | SOURCE LINE   |
|------|------|----|----|----|---|
| 251  |      |    |    |    | *****   |
| 252  | 0520 | 3A | F0 | 0C | CKCNT LDA DNFLG CHECK FLAG FOR ALL DONE             |
| 253  | 0523 | FE | 00 |    | CPI '00 IF DONE, JUMP OUT OF ROUTINE                |
| 254  | 0525 | CA | EA | 07 | JZ DONE   |
| 255  | 0528 | CD | E7 | 04 | CALL CKRT ACCESS DESIRED CIRCUIT                    |
| 256  | 052B | 3A | E3 | 0C | LDA TPCKT GET TPCKT                                 |
| 257  | 052E | 47 |    |    | MOV B,A   |
| 258  | 052F | 3A | E2 | 0C | LDA CKT GET CKT                                     |
| 259  | 0532 | B8 |    |    | CMP B ALL CIRCUITS TESTED?                          |
| 260  | 0533 | CC | 3E | 05 | CZ BYCNT YES? NEXT BAY                              |
| 261  | 0536 | 3C |    |    | INR A INCREASE CIRCUIT COUNT                        |
| 262  | 0537 | 37 |    |    | STC IN BCD. CARRY BIT                               |
| 263  | 0538 | 3F |    |    | CMC MUST BE ZERO FOR DAA TO                         |
| 264  | 0539 | 27 |    |    | DAA WORK.   |
| 265  | 053A | 32 | E2 | 0C | STA CKT RETURN TO CKT                               |
| 266  | 053D | C9 |    |    | RET   |
| 267  |      |    |    |    | *****   |
| 268  |      |    |    |    | * BYCNT IS VERY SIMILAR TO CKCNT, BUT INSTEAD OF    |
| 269  |      |    |    |    | * CIRCUITS. IT COUNTS BAYS. IT HALTS WHEN ALL BAYS  |
| 270  |      |    |    |    | * HAVE BEEN TESTED.                                 |
| 271  |      |    |    |    | *****   |
| 272  | 053E | 3A | E1 | 0C | BYCNT LDA TPBAY GET TPBAY                           |
| 273  | 0541 | 47 |    |    | MOV B,A   |
| 274  | 0542 | 3A | E0 | 0C | LDA BAY GET BAY                                     |
| 275  | 0545 | B8 |    |    | CMP B BAY = TPBAY?                                  |
| 276  | 0546 | C2 | 4F | 05 | JNZ BINC  |
| 277  | 0549 | 3E | 00 |    | MVI A, '00 YES? ALL TESTING DONE                    |
| 278  | 054B | 32 | F0 | 0C | STA DNFLG SO SET DNFLG TO ZERO                      |
| 279  | 054E | C9 |    |    | RET   |
| 280  | 054F | 3C |    |    | BINC INR A  |
| 281  | 0550 | 37 |    |    | STC   |
| 282  | 0551 | 3F |    |    | CMC   |
| 283  | 0552 | 27 |    |    | DAA   |
| 284  | 0553 | 32 | E0 | 0C | STA BAY UPDATE BAY                                  |
| 285  | 0556 | 3E | 99 |    | MVI A, '99 RESET CKT BEFORE RET TO CKCNT            |
| 286  | 0558 | C9 |    |    | RET   |
| 287  |      |    |    |    | *****   |
| 288  |      |    |    |    | * STROBE SEES THAT THE BAYS AND CIRCUITS ARE TRANS- |
| 289  |      |    |    |    | * MITTED TO LATS PROPERLY. OUTPT IS THE SUBROUTINE  |
| 290  |      |    |    |    | * THAT DOES THE BULK OF THE WORK.                   |
| 291  |      |    |    |    | *****   |
| 292  | 0559 | 3A | E9 | 0C | STROB LDA STS4 GET CCSD                             |
| 293  | 055C | E6 | DF |    | ANI 'DF TAKE LOW TO CLEAR LATS                      |
| 294  | 055E | D3 | 06 |    | OUT '06   |
| 295  | 0560 | CD | 4C | 07 | CALL HUNUS  |
| 296  | 0563 | F6 | 20 |    | ORI '20 TAKE BACK HIGH AFTER STROBE                 |
| 297  | 0565 | D3 | 06 |    | OUT '06   |
| 298  | 0567 | 3A | E0 | 0C | LDA BAY FETCH BAY BAY=INF                           |
| 299  | 056A | CD | 83 | 05 | CALL OUTPT  |
| 300  | 056D | 3A | E2 | 0C | LDA CKT FETCH CKT CKT=INF                           |

| LINE | LOC  | B1 | B2 | B3 | SOURCE   | LINE   |
|------|------|----|----|----|--|--|
| 301  | 0570 | CD | 83 | 05 | CALL   | OUTPT  |
| 302  | 0573 | C9 |    |    | RET  |  |
| 303  |      |    |    |    | *****  |  |
| 304  |      |    |    |    | * ECHO IS A ROUTINE CALLED WHENEVER THERE HAS BEEN   |  |
| 305  |      |    |    |    | * AN ECHO ERROR, IE, DIFFERENT INFORMATION BACK FROM |  |
| 306  |      |    |    |    | * LATS THAT WAS GIVEN TO IT. ECHO PROVIDES A LITTLE  |  |
| 307  |      |    |    |    | * PADDING BY REPEATING THE TRANSFER A FEW TIMES      |  |
| 308  |      |    |    |    | * BEFORE PRINTING THE ERROR MESSAGE.                 |  |
| 309  |      |    |    |    | *****  |  |
| 310  | 0574 | 3A | E7 | 0C | ECHO   | LDA EC            FETCH EC                   |
| 311  | 0577 | 3C |    |    |  | INR A            INCREASE IT                 |
| 312  | 0578 | FE | 10 |    |  | CPI '10        HOW MANY READ ERRORS?         |
| 313  | 057A | 32 | E7 | 0C |  | STA EC        UPDATE EC                      |
| 314  | 057D | C0 |    |    |  | RNZ            FEW ERRORS, RETURN AND        |
| 315  |      |    |    |    | *  | TRY AGAIN                                    |
| 316  | 057E | 1E | 01 |    |  | MVI E, '01    MANY ERRORS, GIVE ERROR        |
| 317  | 0580 | C3 | 53 | 07 |  | JMP ERMS     MESSAGE 01                      |
| 318  |      |    |    |    | *****  |  |
| 319  |      |    |    |    | * LATS EXPECTS BAY AND CIRCUIT INFORMATION IN A      |  |
| 320  |      |    |    |    | * STRING OF 4 BIT WORDS STROBED BY CKST. EDUMICRO    |  |
| 321  |      |    |    |    | * USES 8 BIT WORDS WHICH MUST BE SHIFTED AND MASKED  |  |
| 322  |      |    |    |    | * BEFORE TRANSMISSION. OUTPT DOES THIS. WHILE STROB  |  |
| 323  |      |    |    |    | * KEEPS TRACK OF WORDS.                              |  |
| 324  |      |    |    |    | *****  |  |
| 325  | 0583 | 1E | 00 |    | OUTPT  | MVI E, '00        INITIALIZE N               |
| 326  | 0585 | 57 |    |    |  | MOV D, A                                     |
| 327  | 0586 | 7B |    |    | BACK   | MOV A, E                                     |
| 328  | 0587 | FE | 02 |    |  | CPI '02        N ITERATIONS?                 |
| 329  | 0589 | C8 |    |    |  | RZ   |
| 330  | 058A | 7A |    |    |  | MOV A, D        INF                          |
| 331  | 058B | 0F |    |    |  | RRC            MOVE TENS DIGIT TO RIGHT      |
| 332  | 058C | 0F |    |    |  | RRC            FIRST TIME THRU, AND UNITS    |
| 333  | 058D | 0F |    |    |  | RRC            TO RIGHT SECOND TIME THRU     |
| 334  | 058E | 0F |    |    |  | RRC  |
| 335  | 058F | 57 |    |    |  | MOV D, A                                     |
| 336  | 0590 | 3A | E8 | 0C |  | LDA STS4A     GET STS4A FOR CKB              |
| 337  | 0593 | 47 |    |    |  | MOV B, A                                     |
| 338  | 0594 | 7A |    |    |  | MOV A, D                                     |
| 339  | 0595 | E6 | 0F |    |  | ANI '0F        MASK OFF EITHER TENS OR UNITS |
| 340  | 0597 | B0 |    |    |  | ORA B  |
| 341  | 0598 | D3 | 07 |    |  | OUT '07        OUTPUT STS4A                  |
| 342  | 059A | 3A | E9 | 0C |  | LDA STS4     GET STS4 FOR CKST               |
| 343  | 059D | E6 | 7F |    |  | ANI '7F        BRING CKST LOW                |
| 344  | 059F | D3 | 06 |    |  | OUT '06                                      |
| 345  | 05A1 | CD | 4C | 07 |  | CALL HUNUS    HOLD LOW FOR 100US             |
| 346  | 05A4 | F6 | 00 |    |  | ORI '00                                      |
| 347  | 05A6 | D3 | 06 |    |  | OUT '06                                      |
| 348  | 05A8 | 1C |    |    |  | INR E        INCREASE N                      |
| 349  | 05A9 | C3 | 86 | 05 |  | JMP BACK     SECOND HALF OF WORD             |
| 350  |      |    |    |    | *****  |  |

| LINE | LOC  | B1 | B2 | B3 | SOURCE LINE  |
|------|------|----|----|----|--|
| 351  |      |    |    |    | * CHECK MAKES SURE THAT THE CORRECT CIRCUIT AND BAY              |
| 352  |      |    |    |    | * WAS RECEIVED BY LATS.  |
| 353  |      |    |    |    | *****  |
| 354  | 05AC | 06 | 32 |    | CHECK MVI B, '32                    DELAY 50 MS FOR BCK AND OCK  |
| 355  | 05AE | CD | DF | 07 | CALL DBMS                            TO SETTLE                   |
| 356  | 05B1 | DB | 07 |    | IN '07                                GET BCK                    |
| 357  | 05B3 | 47 |    |    | MOV B,A  |
| 358  | 05B4 | 3A | E0 | 0C | LDA BAY                                FETCH BAY                 |
| 359  | 05B7 | B8 |    |    | CMP B                                 BAY=BYCK?                  |
| 360  | 05B8 | CA | C4 | 05 | JZ CKCK  |
| 361  | 05BB | CD | 74 | 05 | ERR CALL ECHO                        BAY NEQ BYCK,OCK NEQ CKT,   |
| 362  | 05BE | CD | 59 | 05 | CALL STROB                          REPEAT INPUT                 |
| 363  | 05C1 | C3 | AC | 05 | JMP CHECK  |
| 364  | 05C4 | DB | 06 |    | CKCK IN '06                         GET OCK                      |
| 365  | 05C6 | 47 |    |    | MOV B,A  |
| 366  | 05C7 | 3A | E2 | 0C | LDA CKT                                FETCH CKT                 |
| 367  | 05CA | B8 |    |    | CMP B                                 OCK=CKT?                   |
| 368  | 05CB | C2 | BB | 05 | JNZ ERR  |
| 369  | 05CE | C9 |    |    | RET  |
| 370  |      |    |    |    | *****  |
| 371  |      |    |    |    | * BREAKS OR MONITORS CIRCUIT BASED ON STATUS WORD                |
| 372  |      |    |    |    | * BRKI,0 FOR BREAK, ALL OTHER FOR MONITOR                        |
| 373  |      |    |    |    | *****  |
| 374  | 05CF | 3E | 00 |    | BRKMN MVI A,00   |
| 375  | 05D1 | 32 | E7 | 0C | STA EC                                INITIALIZE EC              |
| 376  | 05D4 | 3A | EB | 0C | AA LDA BRKI                          GET BRKI                    |
| 377  | 05D7 | F6 | 00 |    | ORI '00                                SET FLAGS                 |
| 378  | 05D9 | CA | F9 | 05 | JZ BKST                                IF BRKI=0,BREAK CIRCUIT   |
| 379  | 05DC | 3A | E9 | 0C | LDA STS4                               GET STS4 FOR MON          |
| 380  | 05DF | F6 | 40 |    | ORI '40                                SET MON=1                 |
| 381  | 05E1 | D3 | 06 |    | OUT '06  |
| 382  | 05E3 | 06 | C9 |    | MVI B,'C9  |
| 383  | 05E5 | CD | DF | 07 | CALL DBMS                            DELAY 200 MS FOR VALID MON  |
| 384  | 05E8 | 32 | E9 | 0C | STA STS4                               RETURN STS4               |
| 385  | 05EB | CD | 54 | 06 | CALL FLT                                CHECK FOR FLT            |
| 386  | 05EE | DB | 02 |    | IN '02                                CHECK MONK                 |
| 387  | 05F0 | E6 | 40 |    | ANI '40  |
| 388  | 05F2 | C0 |    |    | RNZ                                    MONK RECEIVED, RETURN     |
| 389  | 05F3 | CD | 74 | 05 | CALL ECHO                            NOT RECEIVED? ERROR ROUTINE |
| 390  | 05F6 | C3 | D4 | 05 | JMP AA   |
| 391  | 05F9 | 3A | EA | 0C | BKST LDA STS5                         GET STS5 FOR BRK           |
| 392  | 05FC | F6 | 10 |    | ORI '10                                SET BRK HIGH TO BREAK     |
| 393  | 05FE | D3 | 05 |    | OUT '05  |
| 394  | 0600 | 06 | C9 |    | MVI B,'C9                            DELAY 200 MS FOR VALID BRK  |
| 395  | 0602 | CD | DF | 07 | CALL DBMS  |
| 396  | 0605 | 32 | EA | 0C | STA STS5                                SAVE STS5                |
| 397  | 0608 | CD | 54 | 06 | CALL FLT                                CHECK FOR FLT            |
| 398  | 060B | DB | 03 |    | IN '03                                BRKK                       |
| 399  | 060D | E6 | 20 |    | ANI '20  |
| 400  | 060F | C0 |    |    | RNZ                                    BRKK RECEIVED, RETURN     |

| LINE | LOC  | B1 | B2 | B3 | SOURCE LINE   |
|------|------|----|----|----|---|
| 401  | 0610 | CD | 74 | 05 | CALL ECHO   |
| 402  | 0613 | C3 | D4 | 05 | JMP AA  |
| 403  |      |    |    |    | *****   |
| 404  |      |    |    |    | * COUNTS THROUGH MATRIX OF PAIRS OF WIRES, AND      |
| 405  |      |    |    |    | * GROUNDS, ONCE ALL PAIRS TESTED, IT CALLS CKCNT    |
| 406  |      |    |    |    | *****   |
| 407  | 0616 | 3A | E8 | 0C | PRCNT LDA STS4A GET STS4A FOR MTC                   |
| 408  | 0619 | FE | A0 |    | CPI 'A0 ALL PAIRS TESTED                            |
| 409  | 061B | CA | 27 | 06 | JZ CIR YES? GO TO NEXT CIRCUIT                      |
| 410  | 061E | CD | 35 | 06 | PRCL CALL PR  |
| 411  | 0621 | C6 | 10 |    | ADI '10 INCREASE MTC                                |
| 412  | 0623 | 32 | E8 | 0C | STA STS4A RESTORE STS4A                             |
| 413  | 0626 | C9 |    |    | RET   |
| 414  | 0627 | CD | 20 | 05 | CIR CALL CKCNT SET UP NEXT CIRCUIT                  |
| 415  | 062A | CD | CF | 05 | CALL BRKMN AND MONITOR OR BREAK IT                  |
| 416  | 062D | 3E | 00 |    | MVI A, '00 INITIALIZE MTC                           |
| 417  | 062F | 32 | E8 | 0C | STA STS4A UPDATE STS4A                              |
| 418  | 0632 | C3 | 1E | 06 | JMP PRCL AND EXAMINE THE FIRST PAIR                 |
| 419  |      |    |    |    | *****   |
| 420  |      |    |    |    | * EXPECTS PAIR TO BE CALLED IN STS4A, THIS ROUTINE  |
| 421  |      |    |    |    | * OUTPUTS THE MATRIX TO LATS AND CHECKS FOR INFO    |
| 422  |      |    |    |    | * RECEIVED.   |
| 423  |      |    |    |    | *****   |
| 424  | 0635 | 57 |    |    | PR MOV D,A DO NOT DESTROY STS4A                     |
| 425  | 0636 | 3E | 00 |    | MVI A,00 INITIALIZE EC                              |
| 426  | 0638 | 32 | E7 | 0C | STA EC  |
| 427  | 063B | 7A |    |    | PR1 MOV A,D GET STS4A                               |
| 428  | 063C | D3 | 07 |    | OUT '07 OUT TO LATS                                 |
| 429  | 063E | 06 | 0A |    | MVI B, '0A  |
| 430  | 0640 | CD | DF | 07 | CALL DBMS DELAY 10 MS FOR VALID SIGNAL              |
| 431  | 0643 | 47 |    |    | MOV B,A   |
| 432  | 0644 | DB | 04 |    | IN '04 MTC INPUT                                    |
| 433  | 0646 | E6 | 0F |    | ANI '0F MASK OFF MTCK                               |
| 434  | 0648 | 0F |    |    | RRC ROTATE TO MTC POSITION                          |
| 435  | 0649 | 0F |    |    | RRC   |
| 436  | 064A | 0F |    |    | RRC   |
| 437  | 064B | 0F |    |    | RRC   |
| 438  | 064C | B8 |    |    | CMP B MTCK = MTC?                                   |
| 439  | 064D | C8 |    |    | RZ  |
| 440  | 064E | CD | 74 | 05 | CALL ECHO   |
| 441  | 0651 | C3 | 38 | 06 | JMP PR1 NOT EQUAL , REPEAT                          |
| 442  |      |    |    |    | *****   |
| 443  |      |    |    |    | * CHECKS FOR FLT BIT AFTER BRK OR MON, IF FLT, GOES |
| 444  |      |    |    |    | * TO ERROR MESSAGE.                                 |
| 445  |      |    |    |    | *****   |
| 446  | 0654 | DB | 02 |    | FLT IN '02 INPUT AND MASK FLT BIT                   |
| 447  | 0655 | E6 | 00 |    | ANI '00 (ACTIVE LOW)                                |
| 448  | 0658 | C0 |    |    | RNZ   |
| 449  | 0659 | 1E | 02 |    | MVI E, '02 ERROR MESSAGE 02, FLT SIGNAL             |
| 450  | 065B | C3 | 53 | 07 | JMP ERMS DISPLAY ERROR MESSAGE                      |

| LINE | LOC  | B1 | B2 | B3 | SOURCE   | LINE                         |
|------|------|----|----|----|--|------------------------------|
| 451  |      |    |    |    |  |                              |
| 452  |      |    |    |    | * READ TAKES THE READING OFF THE METER AND STORES IT |                              |
| 453  |      |    |    |    | * IN MOT STATUS WORD. OVR BIT SAYS METER OFF SCALE,  |                              |
| 454  |      |    |    |    | * READ CHECKS AND CHANGES SCALE. IF TOP SCALE, ERROR |                              |
| 455  |      |    |    |    | * MESSAGE IS GENERATED.                              |                              |
| 456  |      |    |    |    |  |                              |
| 457  | 065E | 3E | 00 |    | READ MVI A,00  | INITIALIZE EC                |
| 458  | 0660 | 32 | E7 | 0C | STA EC   |                              |
| 459  | 0663 | DB | 03 |    | RD1 IN '03   | CHECK MTON (ACTIVE HIGH)     |
| 460  | 0665 | E6 | 40 |    | ANI '40  |                              |
| 461  | 0667 | CA | 6E | 06 | JZ ONMT  | IF NOT, TURN METER ON        |
| 462  | 066A | CD | A1 | 06 | CALL DREAD   | IF ON, READ METER            |
| 463  | 066D | C9 |    |    | RET  |                              |
| 464  | 066E | 3A | EA | 0C | ONMT LDA STS5  | NOT ON, GET STS5 FOR MTON    |
| 465  | 0671 | F6 | 20 |    | ORI '20  | MTON HIGH, TURN METER ON     |
| 466  | 0673 | 32 | EA | 0C | STA STS5   | SAVE STS5                    |
| 467  | 0676 | D3 | 05 |    | OUT '05  |                              |
| 468  | 0678 | 06 | 32 |    | MVI B, '32   | DELAY 50 MS FOR VALID SIGNAL |
| 469  | 067A | CD | DF | 07 | CALL DBMS  |                              |
| 470  | 067D | CD | 74 | 05 | CALL ECHO  |                              |
| 471  | 0680 | C3 | 63 | 06 | JMP RD1  |                              |
| 472  |      |    |    |    |  |                              |
| 473  |      |    |    |    | * COUNTS THROUGH FUNCTIONS AND RANGES FOR ZERO TEST  |                              |
| 474  |      |    |    |    |  |                              |
| 475  | 0683 | CD | 8D | 04 | ZFNCT CALL RGFN                                      | OUTPUT RFB TO LATS           |
| 476  | 0686 | CD | 8B | 06 | CALL ZREAD   | CHECK VALUES FROM METER      |
| 477  | 0689 | 3A | E9 | 0C | BB LDA STS4  | GET STS4 FOR RFB             |
| 478  | 068C | 3D |    |    | DCR A  | MOVE TO NEXT FUNCTION (IN    |
| 479  |      |    |    |    | *  | TEST, MUST CHECK ALL RANGES  |
| 480  |      |    |    |    | *  | AND FUNCTIONS                |
| 481  | 068D | 4F |    |    | MOV C,A  | SAVE NEW STS4                |
| 482  | 068E | E6 | 0F |    | ANI '0F  | MASK RFB                     |
| 483  | 0690 | FE | 05 |    | CPI '05  | THIS RANGE NOT POSSIBLE      |
| 484  | 0692 | CA | 89 | 06 | JZ BB  | SO DECREASE AGAIN            |
| 485  | 0695 | FE | 04 |    | CPI '04  | SAME WITH RANGE 04           |
| 486  | 0697 | CA | 89 | 06 | JZ BB  |                              |
| 487  | 069A | FE | 01 |    | CPI '01  | CHECK ALL DONE               |
| 488  | 069C | 79 |    |    | MOV A,C  | STS4 MUST BE IN A FOR RGFN   |
| 489  | 069D | CB |    |    | RZ   |                              |
| 490  | 069E | C3 | 83 | 06 | JMP ZFNCT  | REPEAT LOOP UNTIL ALL DONE   |
| 491  |      |    |    |    |  |                              |
| 492  |      |    |    |    | * DREAD STROBES METER, WAITS FOR IT TO SETTLE, AND   |                              |
| 493  |      |    |    |    | * CHECKS OVR BIT, CALLED FROM ZREAD OR MREAD.        |                              |
| 494  |      |    |    |    |  |                              |
| 495  | 06A1 | 3A | EA | 0C | DREAD LDA STS5                                       | GET STS5 FOR MST             |
| 496  | 06A4 | E6 | FB |    | ANI 'FB  | BRING MST LOW                |
| 497  | 06A6 | D3 | 05 |    | OUT '05  |                              |
| 498  | 06A8 | CD | 4C | 07 | CALL HUNUS   | STROBE MST LOW FOR 100 US    |
| 499  | 06AB | F6 | 04 |    | ORI '04  | TAKE MST HIGH                |
| 500  | 06AD | D3 | 05 |    | OUT '05  | END OF PULSE                 |

| LINE | LOC  | B1 | B2 | B3 | SOURCE | LINE       |                              |
|------|------|----|----|----|--------|------------|------------------------------|
| 501  | 06AF | DB | 03 |    | WAIT   | IN '03     | LOOK FOR EOC (END OF         |
| 502  |      |    |    |    | *      |            | CONVERSION)                  |
| 503  | 06B1 | E6 | 10 |    | ANI    | '10        | MASK EOC AND WAIT FOR LOW    |
| 504  | 06B3 | C2 | AF | 06 | JNZ    | WAIT       |                              |
| 505  | 06B6 | DB | 02 |    | IN     | '02        | LOOK FOR OVR                 |
| 506  | 06B8 | E6 | 10 |    | ANI    | '10        | AND MASK                     |
| 507  | 06BA | C9 |    |    | RET    |            |                              |
| 508  |      |    |    |    |        |            |                              |
| 509  |      |    |    |    |        |            |                              |
| 510  |      |    |    |    |        |            |                              |
| 511  |      |    |    |    |        |            |                              |
| 512  |      |    |    |    |        |            |                              |
| 513  | 06BB | CD | 5E | 06 | ZREAD  | CALL READ  | WAIT FOR READING, CHECK OVR  |
| 514  | 06BE | CA | D2 | 06 | JZ     | CAP        | EXPECT OVR IF CAP            |
| 515  | 06C1 | CD | E0 | 06 | CALL   | CKRFN      | CHECK RFB FOR CAP            |
| 516  | 06C4 | F6 | 00 |    | ORI    | '00        | SET FLAGS                    |
| 517  | 06C6 | C4 | DB | 06 | CNZ    | ERZ        | IF CAP, AND NOT OVR.         |
| 518  |      |    |    |    | *      |            | ZERO TEST FAILS              |
| 519  | 06C9 | DB | 05 |    | IN     | '05        | READ IN MTO                  |
| 520  | 06CB | 47 |    |    | MOV    | B,A        |                              |
| 521  | 06CC | DE | 05 |    | SBI    | '05        |                              |
| 522  | 06CE | F4 | DB | 06 | CP     | ERZ        | IF MTO >5, ZERO TEST FAILED  |
| 523  | 06D1 | C9 |    |    | RET    |            |                              |
| 524  | 06D2 | CD | E0 | 06 | CAP    | CALL CKRFN | CHECK RFB FOR OTHER THAN CAP |
| 525  | 06D5 | F6 | 00 |    | ORI    | '00        | ONLY CAP SHOULD OVERFLOW     |
| 526  | 06D7 | CC | DB | 06 | CZ     | ERZ        |                              |
| 527  | 06DA | C9 |    |    | RET    |            |                              |
| 528  | 06DB | 1E | 03 |    | ERZ    | MVI E,03   | ERROR MESSAGE 03, ZERO TEST  |
| 529  |      |    |    |    | *      |            | FAILURE                      |
| 530  | 06DD | C3 | 53 | 07 | JMP    | ERMS       | DISPLAY MESSAGE              |
| 531  | 06E0 | 3A | E9 | 0C | CKRFN  | LDA STS4   | STS4 FOR RFB                 |
| 532  | 06E3 | E6 | 0F |    | ANI    | '0F        | MASK RFB                     |
| 533  | 06E5 | FE | 02 |    | CPI    | '02        | CHECK FOR CAP                |
| 534  | 06E7 | CA | F2 | 06 | JZ     | NG         | IF CAP, SET CAPFLG TO A 1    |
| 535  | 06EA | FE | 03 |    | CPI    | '03        | (OTHER RFB FOR CAP)          |
| 536  | 06EC | CA | F2 | 06 | JZ     | NG         |                              |
| 537  | 06EF | 3E | 00 |    | MVI    | A,00       | SET CAPFLG TO A 0            |
| 538  | 06F1 | C9 |    |    | RET    |            |                              |
| 539  | 06F2 | 3E | 01 |    | NG     | MVI A,01   |                              |
| 540  | 06F4 | C9 |    |    | RET    |            |                              |
| 541  |      |    |    |    |        |            |                              |
| 542  |      |    |    |    |        |            |                              |
| 543  |      |    |    |    |        |            |                              |
| 544  |      |    |    |    |        |            |                              |
| 545  | 06F5 | CD | 5E | 06 | MREAD  | CALL READ  | METER READ                   |
| 546  | 06F8 | CA | 01 | 07 | JZ     | CRNG       | CHANGE RANGE IF OVR          |
| 547  | 06FB | DB | 05 |    | IN     | '05        | INPUT MOT                    |
| 548  | 06FD | 32 | E4 | 0C | STA    | MOT        | SAVE MOT                     |
| 549  | 0700 | C9 |    |    | RET    |            | MOT IS IN RAM FOR OPERATOR   |
| 550  |      |    |    |    |        |            |                              |

| LINE | LOC  | B1 | B2 | B3 | SOURCE LINE   |
|------|------|----|----|----|---|
| 551  |      |    |    |    | * CHANGES RANGE IF OVR AND NOT ON TOP SCALE, IF TOP   |
| 552  |      |    |    |    | * SCALE, GIVES ERROR MESSAGE.                         |
| 553  |      |    |    |    | *****   |
| 554  | 0701 | 3A | E9 | 0C | CRNG LDA STS4 GET STS4 FOR RFB                        |
| 555  | 0704 | 47 |    |    | MOV B,A   |
| 556  | 0705 | E6 | 0F |    | ANI '0F MASK RFB                                      |
| 557  | 0707 | FE | 0F |    | CPI '0F MAKE SURE METER IS NOT AT TOP                 |
| 558  | 0709 | CC | 28 | 07 | CZ ERM RANGE FOR VAC,VDC,RES OR CAP                   |
| 559  | 070C | FE | 0C |    | CPI '0C   |
| 560  | 070E | CC | 28 | 07 | CZ ERM  |
| 561  | 0711 | FE | 0A |    | CPI '0A   |
| 562  | 0713 | CC | 28 | 07 | CZ ERM  |
| 563  | 0716 | FE | 03 |    | CPI '03   |
| 564  | 0718 | CC | 28 | 07 | CZ ERM  |
| 565  | 0718 | 3C |    |    | INR A GO TO NEXT RANGE                                |
| 566  | 071C | 4F |    |    | MOV C,A   |
| 567  | 071D | 78 |    |    | MOV A,B RETRIEVE OLD STS4                             |
| 568  | 071E | E6 | F0 |    | ANI 'F0 TO GET EXM,CCDS,MON,CKST                      |
| 569  | 0720 | B1 |    |    | ORA C   |
| 570  | 0721 | CD | 8D | 04 | CALL RGFN NEW STS4 TO LATS                            |
| 571  | 0724 | CD | 5E | 06 | CALL READ TRY INPUT METER UNDER NEW                   |
| 572  |      |    |    |    | * RANGE (MUST CALL TO KEEP                            |
| 573  |      |    |    |    | * STACK STRAIGHT).                                    |
| 574  | 0727 | C9 |    |    | RET   |
| 575  | 0728 | 1E | 04 |    | ERM MVI E,'04 ERROR MESSAGE 04, OVER RANGE            |
| 576  | 072A | C3 | 53 | 07 | JMP ERMS DISPLAY ERROR MESSAGE                        |
| 577  |      |    |    |    | *****   |
| 578  |      |    |    |    | * FNCSN USES THE POINTER IN RAM TO SCAN THE FOUR      |
| 579  |      |    |    |    | * FUNCTIONS LATS CAN MEASURE, RESETS THE POINTER, AND |
| 580  |      |    |    |    | * GOES TO THE NEXT PAIR WHEN ALL FUNCTIONS TESTED.    |
| 581  |      |    |    |    | *****   |
| 582  | 072D | 2A | E5 | 0C | FNCSN LHLD PNTR GET PNTR                              |
| 583  | 0730 | 7D |    |    | MOV A,L   |
| 584  | 0731 | FE | F0 |    | CPI DN ALL FUNCTIONS DONE?                            |
| 585  | 0733 | CC | 45 | 07 | CZ PAIR IF ALL DONE, GO TO NEXT PAIR                  |
| 586  | 0735 | 46 |    |    | MOV B,M PUT RFB IN B                                  |
| 587  | 0737 | 3A | E9 | 0C | LDA STS4 GET STS4 FOR OLD RFB                         |
| 588  | 073A | F6 | 0F |    | ORI '0F MASK STS4 OF OLD RFB                          |
| 589  | 073C | A0 |    |    | ANA B UPDATE STS4                                     |
| 590  | 073D | CD | 8D | 04 | CALL RGFN SAVE STS4 AND OUTPUT RANGE                  |
| 591  | 0740 | 23 |    |    | INX H   |
| 592  | 0741 | 22 | E5 | 0C | SHLD PNTR ADVANCE AND SAVE POINTER                    |
| 593  | 0744 | C9 |    |    | RET   |
| 594  | 0745 | CD | 15 | 06 | PAIR CALL PRCNT GO TO NEXT PAIR                       |
| 595  | 0748 | 21 | EC | 0C | LXI H,VAC INITIALIZE POINTER                          |
| 596  | 074B | C9 |    |    | RET   |
| 597  |      |    |    |    | *****100 U SECOND DELAY*****                          |
| 598  | 074C | 06 | 04 |    | HUNUS MVI B,04 DELAY OF 100 US FOR STROBING           |
| 599  | 074E | 05 |    |    | ONE DCR B   |
| 600  | 074F | C2 | 4E | 07 | JNZ ONE   |

| LINE | LOC  | B1 | B2 | B3 | SOURCE LINE  |
|------|------|----|----|----|--|
| 501  | 0752 | C9 |    |    | RET  |
| 502  |      |    |    |    | *****  |
| 503  |      |    |    |    | * PRINT ERROR MESSAGE * 01 TRANSFER ERROR            |
| 504  |      |    |    |    | * 02 FLT SIGNAL                                      |
| 505  |      |    |    |    | * 03 ZERO TEST FAILURE                               |
| 506  |      |    |    |    | * 04 OVERFLOW  |
| 507  |      |    |    |    | * WAIT FOR KEYIN BEFORE DISPLAYING RETURN ADDRESS    |
| 508  |      |    |    |    | * AND JUMP TO ADDRESS KEYED IN                       |
| 509  |      |    |    |    | *****  |
| 510  | 0753 | CD | 75 | 07 | ERMS CALL DS1BY DISPLAY EM                           |
| 511  | 0756 | CD | 93 | 07 | CALL KEYIN WAIT FOR KEY BEFORE DISPLAY               |
| 512  | 0759 | D1 |    |    | POP D GET RET ADDRESS OFF STACK                      |
| 513  | 075A | CD | 65 | 07 | CALL DSDE DISPLAY RETURN ADDRESS                     |
| 514  | 075D | CD | D5 | 07 | CALL RD2HL INPUT 2 BYTES INTO H-L                    |
| 515  | 0760 | E9 |    |    | PCHL JUMP TO INPUTTED ADDRESS                        |
| 516  |      |    |    |    | *****  |
| 517  |      |    |    |    | * ROUTINE DISPLAYS VARIOUS THINGS DEPENDING ON ENTRY |
| 518  |      |    |    |    | * POINT. DS2BY: CONTENTS OF 2 MEMORY LOCATIONS       |
| 519  |      |    |    |    | * DSDE : CONTENTS OF D,E REGISTERS                   |
| 520  |      |    |    |    | * DS1BY: CONTENTS OF E REGISTER                      |
| 521  |      |    |    |    | * REGISTERS: ALL                                     |
| 522  |      |    |    |    | * MEMORY: DISPLA,DSPMS                               |
| 523  |      |    |    |    | * STACK SPACE: 2 BYTES                               |
| 524  |      |    |    |    | * OUTPORTS: 0,1                                      |
| 525  |      |    |    |    | * PROGRAMMER: AL LARSON                              |
| 526  |      |    |    |    | *****  |
| 527  | 0761 | 2A | F1 | 0C | DS2BY LHLD DSPLA GET LOCATIONS OF DATA               |
| 528  | 0764 | EB |    |    | XCHG PUT IN D,E                                      |
| 529  | 0765 | 7A |    |    | DSDE MOV A,D DISPLAY DIGIT 2                         |
| 530  | 0766 | 06 | 04 |    | MVI B,'04 LOCATION TO DISPLAY                        |
| 531  | 0768 | CD | 82 | 07 | CALL DISPL   |
| 532  | 076B | 7A |    |    | MOV A,D DISPLAY DIGIT 3                              |
| 533  | 076C | 0F |    |    | RRC  |
| 534  | 076D | 0F |    |    | RRC  |
| 535  | 076E | 0F |    |    | RRC  |
| 536  | 076F | 0F |    |    | RRC  |
| 537  | 0770 | 06 | 08 |    | MVI B,'08  |
| 538  | 0772 | CD | 82 | 07 | CALL DISPL   |
| 539  | 0775 | 7B |    |    | DS1BY MOV A,E DISPLAY DIGIT 0                        |
| 540  | 0776 | 06 | 01 |    | MVI B,'01  |
| 541  | 0778 | CD | 82 | 07 | CALL DISPL   |
| 542  | 077B | 7B |    |    | MOV A,E DISPLAY DIGIT 1                              |
| 543  | 077C | 0F |    |    | RRC  |
| 544  | 077D | 0F |    |    | RRC  |
| 545  | 077E | 0F |    |    | RRC  |
| 546  | 077F | 0F |    |    | RRC  |
| 547  | 0780 | 06 | 02 |    | MVI B,'02 PLCE DIGIT IN DISPLAY 1                    |
| 548  |      |    |    |    | *****  |
| 549  |      |    |    |    | *DISPL DISPLAYS A(3:0) IN KEYBOARD DISPLAY LOCATIONS |
| 550  |      |    |    |    | *DESIGNATED BY REGISTER B. THE LSB OF B CORRESPONDS  |

LINE LOC B1 B2 B3

SOURCE LINE

```

551                                     *TO THE LSB OF THE DISPLAY LIGHTS ETC.A LOGIC 1 IN A
552                                     *BIT POSITION CAUSES A(3:0) TO BE DISPLAYED IN THE
553                                     *CORRESPONDING DISPLAY POSITION.A (3:0) MAY BE
554                                     *DISPLAYED IN UP TO 5 POSITIONS SIMULTANEOUSLY. 0 IN
555                                     *B CAUSES CORRESPONDING DISPLAY POSITION TO REMAIN
556                                     * REGISTERS: A,C
557                                     * OUTPORTS: 0,1
558                                     * PROGRAMMER: AL LARSON, MODIFIED BY M.VERSTEGEN
559                                     ****
660 0782 E6 0F          DISPL ANI '0F          RESET UPPER TO UNBLANK
661 0784 D3 01          OUT '01          SEND TO DISPLAY
662 0786 3E FF          MVI A,'FF          SEND LOAD COMMAND TO PORT 0
663 0788 D3 00          OUT '00
664 078A 78            MOV A,B          GET LOAD WORD
665 078B 2F            CMA            COMPLEMENT
666 078C D3 00          OUT '00          AND SEND
667 078E 3E FF          MVI A,'FF          RESEND ZERO VALUE
668 0790 D3 00          OUT '00
669 0792 C9            RET
670                                     ****
671                                     *KEYIN SENSES 1 KEY DOWN, DEBOUNCES, DECODES, AND PUTS
672                                     *HEX VALUE IN A REGISTER
673                                     * REGISTERS: A,B,C,D,E
674                                     * INPORTS: 0,1
675                                     * PROGRAMMER: AL LARSON
676                                     ****
677 0793 DB 00          KEYIN IN '00          READ KEYS 7-0
678 0795 2F            CMA            INVERT
679 0796 4F            MOV C,A          SAVE A COPY
680 0797 DB 01          IN '01          READ KEYS F-8
681 0799 2F            CMA
682 079A 47            MOV B,A
683 079B B1            ORA C            CHECK FOR ANY KEY PRESSED
684 079C CA 93 07          JZ KEYIN          NONE DOWN, WAIT IN THIS LOOP
685 079F 1E 00          KEYCD MVI E,00          INITIALIZE HEXCODE
686 07A1 79            MOV A,C          GET 7-0
687 07A2 16 00          LOOP MVI D,'00          SET UP 8 BIT COUNTER
688 07A4 0F            ROTAT RRC          PUT NEXT LS BIT IN CARRY
689 07A5 DA B1 07          JC KEYUP          DONE IF THIS WAS KEYDOWN
690 07A6 1C            INR E            ADVANCE HEXCODE
691 07A7 15            DCR D            SEE IF WORD IS DONE
692 07AA C2 A4 07          JNZ ROTAT          NO? KEEP SHIFTING FOR KEY
693 07AD 78            MOV A,B          PUT KEYS F-8 IN A
694 07AE C3 A2 07          JMP LOOP          LOOK FOR KEYDOWN IN SECOND
695 07B1 16 00          KEYUP MVI D,'00          SET DELAY COUNT
696 07B3 DE 00          READU IN '00          READ KEYS 0-7
697 07B5 47            MOV B,A          SAVE IN B
698 07B6 DB 01          IN '01          READ KEYS 8-F
699 07B8 A0            ANA B            CHECK ALL UP
700 07B9 FE FF          CPI 'FF
    
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| LINE | LOC  | B1 | B2 | B3 | SOURCE   | LINE                         |
|------|------|----|----|----|--|------------------------------|
| 701  | 078B | C2 | B1 | 07 | JNZ KEYUP  | KEY STILL DOWN, WAIT         |
| 702  | 078E | 15 |    |    | DCR D  | ALL UP, DELAY TO DEBOUNCE    |
| 703  | 078F | C2 | B3 | 07 | JNZ READU  | LOOP UNTIL DELAY DONE        |
| 704  | 07C2 | C9 |    |    | RET  |                              |
| 705  |      |    |    |    |  |                              |
| 706  |      |    |    |    | *****  |                              |
| 707  |      |    |    |    | *RD2A AND RD2HL WERE ROUTINES WRITTEN FOR EDUMICRO O/S |                              |
| 708  |      |    |    |    | *MODIFIED FOR THIS PROGRAM                             |                              |
| 709  |      |    |    |    | * REGISTERS: ALL                                       |                              |
| 710  |      |    |    |    | * MEMORY: DSPLA,DSPMS                                  |                              |
| 711  |      |    |    |    | * STACK: 5 BYTES                                       |                              |
| 712  |      |    |    |    | * INPORTS: 0,1   |                              |
| 713  |      |    |    |    | * OUTPORTS:0,1   |                              |
| 714  | 07C3 | CD | 93 | 07 | RD2A CALL KEYIN  | READ KEY CHARACTER TO A      |
| 715  | 07C6 | 0F |    |    | RRC  | SHIFT TO MS POSITION         |
| 716  | 07C7 | 0F |    |    | RRC  |                              |
| 717  | 07C8 | 0F |    |    | RRC  |                              |
| 718  | 07C9 | 0F |    |    | RRC  |                              |
| 719  | 07CA | 6F |    |    | MOV L,A  | SAVE KEYED CHARACTER         |
| 720  | 07CB | CD | 93 | 07 | CALL KEYIN   | READ LS KEYED CHARACTER      |
| 721  | 07CE | B5 |    |    | ORA L  |                              |
| 722  | 07CF | 5D |    |    | MOV E,L  |                              |
| 723  | 07D0 | CD | 75 | 07 | CALL DS18Y   |                              |
| 724  | 07D3 | 7B |    |    | MOV A,E  | EXPECT VALUE IN A            |
| 725  | 07D4 | C9 |    |    | RET  |                              |
| 726  | 07D5 | CD | C3 | 07 | RD2HL CALL RD2A  |                              |
| 727  | 07D8 | E5 |    |    | PUSH H   | SAVE FIRST SET OF CHARACTERS |
| 728  | 07D9 | CD | C3 | 07 | CALL RD2A  | AND GET SECOND SET           |
| 729  | 07DC | E1 |    |    | POP H  | AS WELL AS FIRST             |
| 730  | 07DD | 67 |    |    | MOV H,A  | SET SECOND IN H              |
| 731  | 07DE | C9 |    |    | RET  |                              |
| 732  |      |    |    |    | *****  |                              |
| 733  |      |    |    |    | * DELAYS B MILLISECONDS WHERE B IS THE VALUE IN B      |                              |
| 734  |      |    |    |    | * REGISTERS: B,C                                       |                              |
| 735  |      |    |    |    | * PROGRAMMER: AL LARSON                                |                              |
| 736  |      |    |    |    | *****  |                              |
| 737  | 07DF | 0E | 3D |    | DBMS MVI C,^3D   |                              |
| 738  | 07E1 | 0D |    |    | DIMS DCR C   |                              |
| 739  | 07E2 | C2 | E1 | 07 | JNZ DIMS   |                              |
| 740  | 07E5 | 05 |    |    | DCR B  |                              |
| 741  | 07E6 | C2 | DF | 07 | JNZ DBMS   |                              |
| 742  | 07E9 | C9 |    |    | RET  |                              |
| 743  | 07EA | 76 |    |    | DONE HLT   |                              |
| 744  |      |    |    |    | END  |                              |

AFCS 0000 ASSEMBLER

SYMBOL TABLE

| SYMBOL | VALUE | SYMBOL | VALUE | SYMBOL | VALUE | SYMBOL | VALUE |
|--------|-------|--------|-------|--------|-------|--------|-------|
| STPTR  | 0C DF | BAY    | 0C E0 | TPBAY  | 0C E1 | CKT    | 0C E2 |
| TPCKT  | 0C E3 | MOT    | 0C E4 | PNTR   | 0C E5 | EC     | 0C E7 |
| STS4A  | 0C E8 | STS4   | 0C E9 | STSS   | 0C EA | BRKI   | 0C EB |
| VAC    | 0C EC | VDC    | 0C ED | RES    | 0C EE | CAPA   | 0C EF |
| DNFLG  | 0C F0 | DSPLA  | 0C F1 | DSPMS  | 0C F2 | DN     | 00 F0 |
| INIT   | 04 00 | INBAY  | 04 34 | DFCKT  | 04 4D | INCKT  | 04 53 |
| ZTEST  | 04 60 | RGFN   | 04 8D | CHK    | 04 CA | LONG   | 04 DA |
| CKRT   | 04 E7 | CRT1   | 04 EC | ER     | 05 1A | CKCNT  | 05 20 |
| BYCNT  | 05 3E | BINC   | 05 4F | STROB  | 05 59 | ECHO   | 05 74 |
| OUTPT  | 05 83 | BACK   | 05 86 | CHECK  | 05 AC | ERR    | 05 8B |
| CKCK   | 05 C4 | BRKMN  | 05 CF | AA     | 05 D4 | BKST   | 05 F9 |
| PRCNT  | 06 16 | PRCL   | 06 1E | CIR    | 06 27 | PR     | 06 35 |
| PR1    | 06 3B | FLT    | 06 54 | READ   | 06 5E | RD1    | 06 63 |
| ONMT   | 06 6E | ZFNCT  | 06 83 | BB     | 06 89 | DREAD  | 06 A1 |
| WAIT   | 06 AF | ZREAD  | 06 8B | CAP    | 06 D2 | ERZ    | 06 DB |
| CKRFN  | 06 E0 | NG     | 06 F2 | MREAD  | 06 F5 | CRNG   | 07 01 |
| ERM    | 07 28 | FNSCN  | 07 2D | PAIR   | 07 45 | HUNUS  | 07 4C |
| ONE    | 07 4E | ERMS   | 07 53 | DS2BY  | 07 61 | DSDE   | 07 65 |
| DS1CY  | 07 75 | DISPL  | 07 82 | KEYIN  | 07 93 | KEYCD  | 07 9F |
| LOOP   | 07 A2 | ROTAT  | 07 A4 | KEYUP  | 07 B1 | READU  | 07 B3 |
| RD2A   | 07 C3 | RD2HL  | 07 D5 | DBMS   | 07 DF | DIMS   | 07 E1 |
| DONE   | 07 EA |        |       |        |       |        |       |

\*\* ASSEMBLY COMPLETE, NO ERRORS 1003 BYTES ASSEMBLED \*\*