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MEMORANDUM

NASA TM X-73976

An Interface Between a Datametrics 1085A Manometer

and a Hewlett-Packard 2100S Computer
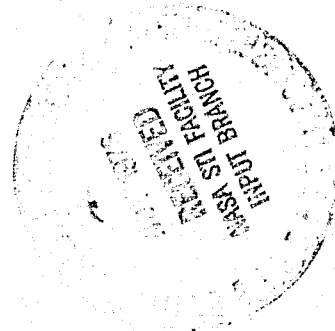
By Mervin E. Hillard, Jr. and James I. Clemmons

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16. Abstract

A hardware/software interface designed to mate a Datametrics model 1085A electronic manometer to a Hewlett-Packard (HP) model 2100S computer is described. The software driver operates in the Basic Control System (BCS) and requires 173 words of memory; the hardware interface uses an HP data source interface (DSI) card which requires one computer input-output (I/O) channel.

Results obtained by incorporating this interface into a data acquisition system indicate that the interface operates successfully.

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AN INTERFACE BETWEEN A DATAMETRICS 1085A

MANOMETER AND A HEWLETT-PACKARD 2100S COMPUTER

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SUMMARY

A hardware/software interface designed to mate a Datametrics model 1085A electronic manometer[1] to a Hewlett-Packard (HP) model 2100S computer is described. The software driver operates in the Basic Control System[2] (BCS) and requires 173 words of memory; the hardware interface uses an HP data source interface (DSI) card which requires one computer input-output (I/O) channel.

Results obtained by incorporating this interface into a data acquisition system indicate that the interface operates successfully.

INTRODUCTION

This work was undertaken as part of the development of a Raman scattering gas density measurement system. Routine use of the Raman technique requires careful calibration and repeated spot checks for precision density measurements. To facilitate the use of this measurement process in wind tunnels, methods for automatically performing the necessary calibration procedure have been developed. Part of the calibration procedure utilizes a Datametric manometer for static pressure measurements.

No interface was found for operating the Datametrics manometer with the HP computer, so a hardware/software interface was designed and tested to provide the pressure measurements needed for the Raman system calibration. The manometer has a six-digit readout in torr with a resolution of 0.01 torr. It provides for remote measurement initiation and for detection of

measurement completion. A Basic Control System software driver was written to input the digital pressure data to the Raman calibration system and to make the manometer and computer electrically compatible.

PROGRAM PROCEDURE

The software driver operates in the interrupt mode through the non-buffered I/O control subroutine (.IOC.) of the Basic Control System. It does not use direct memory access. The driver consists of two sections: the initiator section in which the manometer, hardware interface, and driver are made ready for data transfer and the continuation section where the data transfers are completed. A flow chart of these two sections is provided in Appendix A and a complete assembly listing of the driver is given in Appendix B.

The data input process is controlled by the standard BCS assembly language calling sequences for READ, STATUS, and CLEAR operations.

Data Buffer Format

The basic and minimum buffer length required to input one data point is 5 words. If multiple data transfers are desired from a single READ request, 5 consecutive storage locations must be allocated for each data point. No check is made to insure that the request contains the correct buffer length. The number of data points that will be transferred by a READ request equals the buffer length ÷ 5. Each word in the data buffer is described below; this data format will repeat for each data point if multiple data readings are requested.

Data word 1. – This word contains an error indicator for data words 2-5.

2

0_8, no error

Word = $\qquad$ 1_8, manometer overload

2_8, negative pressure value

Data words 2-5. - These words contain the actual measured pressure value (in torr) in ASCII code. They contain the sign, six significant digits, and the decimal location. For example, the pressure value $\pm$ ABCD.EF (torr) is output as follows:

Word 2	PLUS or MINUS	A

Word 3	B	C

Word 4	D	PERIOD

Word 5	E	F

Each byte of words 2-5 contains the ASCII code for the measured value as labelled above.

System Generation

To include this manometer driver in a Basic Control System, the I/O channel where the hardware interface is placed and the entry points for the software driver must be specified when the BCS system is generated. The position of the hardware interface within the computer defines the priority of the manometer within the total BCS system. For the Raman system in which this hardware/software interface is operational the manometer is a low priority device and therefore is assigned a high select code. The entry point for the initiator section of the driver is labelled "D.55"; this label

3

must be used to generate the equipment table. The continuator entry point is labelled "I.55"; this must be specified for the interrupt linkage.

The memory requirement for this driver is 173 words.

HARDWARE PROCEDURE

This interface requires one computer I/O channel. It provides compatibility between the electronic manometer and the computer by using an HP data source interface (DSI) card (model HP 12604B).[3]

Interconnecting Cable

On the rear panel of the model 1085A manometer is a connector labelled "J2"; the interconnecting cable links this connector to the DSI card. All the pin connections for this cable are shown in figure 1 with a description of the signal which each pin represents.

Interface Jumper Selection

The DSI card jumper selections required for compatibility with the manometer are shown in figure 2. A brief description of the function of each jumper is also given.

Electrical Modifications

The Datametrics manometer and the DSI card are not directly compatible. Figure 3 shows the changes required for compatibility. The remote sample input (pin D) on the manometer requires TTL logic levels. The encode line (pin 12) on the DSI card is a negative true signal of +13.5 V to ground. The 1N914 diode shown in figure 3 provides compatibility. Next the positive logic signal level of the manometer is tied to pin N to provide a reference

voltage for the DSI card. Finally, the record command from the manometer is input to a monostable multivibrator (74121) to produce a negative-true 30 microsecond pulse. This is input to a nand buffer which inverts the signal, drives the interconnecting cable, and provides the positive true pulse required by the DSI card. All other data lines are compatible.

CONCLUSION

A hardware/software interface between a Datametric manometer and HP computer has been developed. Hardware interfacing was achieved by modifying a standard HP data source interface circuit. A Basic Control System software driver has been developed. The driver operates in the interrupt mode through a nonbuffered I/O control subroutine. It consist of an initiation section and data transfer section and does not use direct memory access. Memory requirement for the driver is 173 words.

REFERENCES

1. Hewlett-Packard Co., "A Pocket Guide to Interfacing the HP 2100 Computer," Part No. HP 5951-4498, March 1973.

2. Hewlett-Packard Co., "Data Source Interface Computer Interface Kit, Operating and Service Manual," Part No. HP 12604-90002, Sept. 1970.

3. Datametrics, "Instruction Manual, Model 1085 Electronic Manometer," Oct. 1974.

Cable Diagram for Datametrics Electronic Manometer

HP2100S/2155A -
12604B Data Source
Interface Card

Model 1085
Inv. No. 173534
Serial No. 124

Computer		Instrument (J2 - Input/Output)	
Signal Name	Pin	Pin	Signal Name
1 $\rangle 10^0$	4	B	Overload Out
2	B	A	Neg. Out
4	J	14	Remote Sample Gnd
8	L	14	Remote Sample Gnd
1 $\rangle 10^1$	T	14	
2	V	14	Remote Sample
4	6	14	Gnd
8	8	14	
1 $\rangle 10^2$	2	3	1
2	D	5	2
4	F	6	4
8	N	4	8
1 $\rangle 10^3$	R	U	10
2	X	V	20
4	Z	18	40
8	10	17	80
1 $\rangle 10^4$	5	ç	100K (overrange)
2	C	14	Remote Sample
4	K	14	Gnd
8	M	14	
1 $\rangle 10^5$	U	Y	100
2	W	Z	200
4	7	22	400
8	9	21	800
1 $\rangle 10^6$	3	c	1K
2	E	d	2K
4	H	26	4K
8	P	25	8K
1 $\rangle 10^7$	S	h	10K
2	Y	j	20K
4	AA	30	40K
8	11	29	80K
-Encode	12	D	Remote Sample
+Record Command	16	L	+Record
+Reference	14	N	+Reference
+Hold	13	E	Transfer Delay
Ground	24, BB	14	Remote Sample Gnd
IOI Output	A $\rangle$		Tied together
IOI Return	1		

Figure 1

DSI CARD JUMPER SELECTION CHART

Jumper	Position	Description
W1	Installed	not important
W2	B	allows the +Record command to remove the Encode signals
W3	Installed	not important
W4	Installed	enables the -Encode signal
W5	Installed	not important
W6	Installed	enables automatic removal of Encode signals after 60-80 microseconds
W7	Installed	gives 1 millisecond settling time

Note: There are two slide switches on this card for the Encode and Hold lines. The Encode switch must be "on," the Hold switch may be "off."

Figure 2.
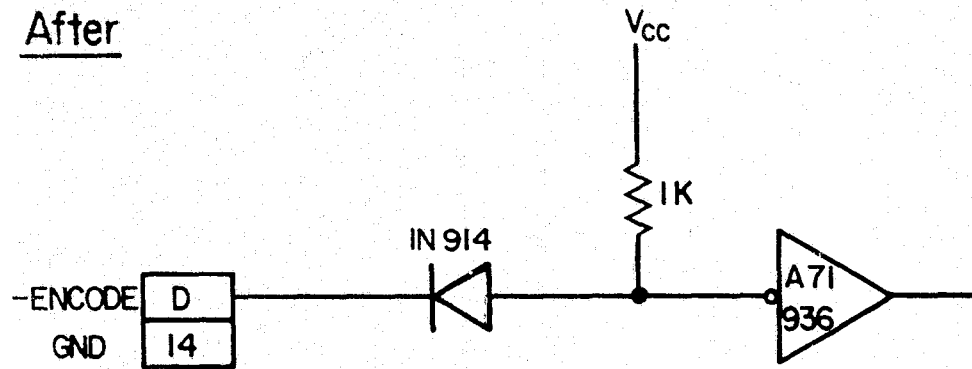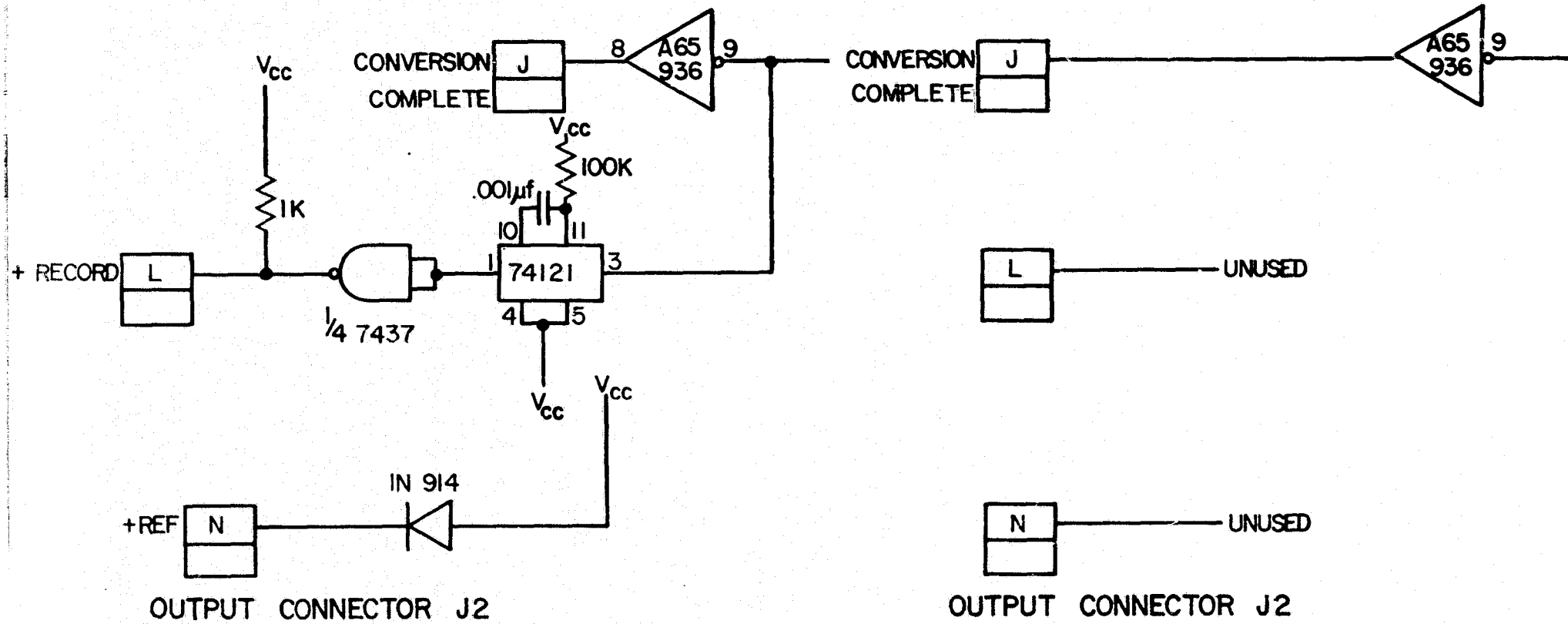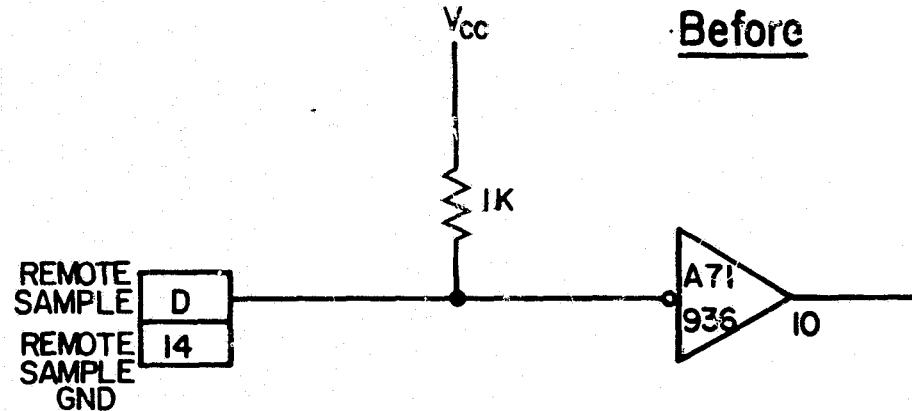
Figure 3. Circuit Modification

APPENDIX A

FLOW CHART

Initiation Section

ENTER

Save EQT and
Request Code Addresses

Clear
Request? — Yes → Set Word Count and
Transmission Log = 0 → C

Driver
Busy? → Set
$B = 100000_8$

No

Device
Busy? — Yes

No

Set
$A = 1_8$ → EXIT

Request
Legal? — No → B → Set
$B = 0_8$

Yes

A

```
                           ( A )
                            │
           ┌────────────────┴────────────────┐
           │             Save                │
           │         Buffer Address          │
           └────────────────┬────────────────┘
                            │
                       ╱────┴────╲
                      ╱  Buffer   ╲
                     ╱  Length < 0? ╲──── Yes ───────▶ ( B )
                      ╲            ╱
                       ╲────┬────╱
                            │ No
           ┌────────────────┴────────────────┐
           │          Save Buffer            │
           │            Length               │
           └────────────────┬────────────────┘
           ┌────────────────┴────────────────┐
           │          Configure I/O          │
           └────────────────┬────────────────┘
           ┌────────────────┴────────────────┐
           │         Set Driver and          │
           │          Device Busy            │
           └────────────────┬────────────────┘
           ┌────────────────┴────────────────┐
           │        Reset Character          │
           │   Count and Transmission        │
           │             Log                 │
           └────────────────┬────────────────┘
                   ╱─────────┴─────────╲
                  ╱       Start         ╱
                 ╱        Device       ╱
                ╱────────────┬────────╱
                        ╭────┴────╮
                        │  EXIT   │
                        ╰─────────╯
```

Continuation Section

```
                            ┌─────────┐
                            │  ENTER  │
                            └────┬────┘
                        ┌────────┴────────┐
                        │    Save All     │
                        │    Registers    │
                        └────────┬────────┘
                        ╱────────┴────────╱
                       ╱     Input       ╱
                      ╱      Data       ╱
                     ╱─────────┬───────╱
                        ┌──────┴──────────┐
                        │   Convert To    │
                        │ ASCII and Store │
                        └────────┬────────┘
                               ╱─┴─╲
                             ╱       ╲
                           ╱   Last    ╲    No
                          ╱   Point?    ╲──────────►
                           ╲           ╱
                             ╲       ╱
                               ╲─┬─╱
                                 │ Yes
                        ┌────────┴────────────┐
                        │ Finalize Word Count │
                        │ and Transmission Log│
                        └────────┬────────────┘
                               ( C )
                        ┌────────┴────────┐
                        │ Clear Device and│
                        │ Driver Busy Flags│
                        └────────┬────────┘
                        ┌────────┴────────┐
                        │  Disable Data   │
                        │   Transfers     │
                        └────────┬────────┘
                            ┌────┴────┐
                            │  EXIT   │
                            └─────────┘
```

Update Word Count and Transmission Log → Restore Registers

Start Measurement
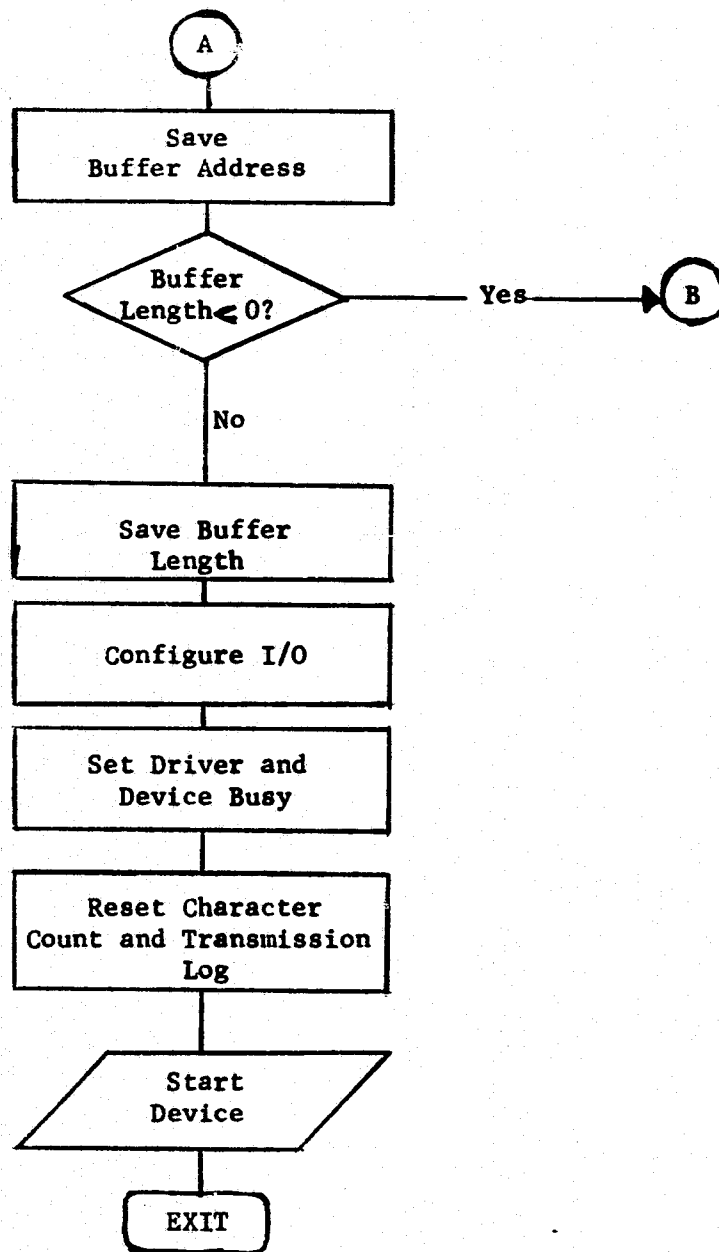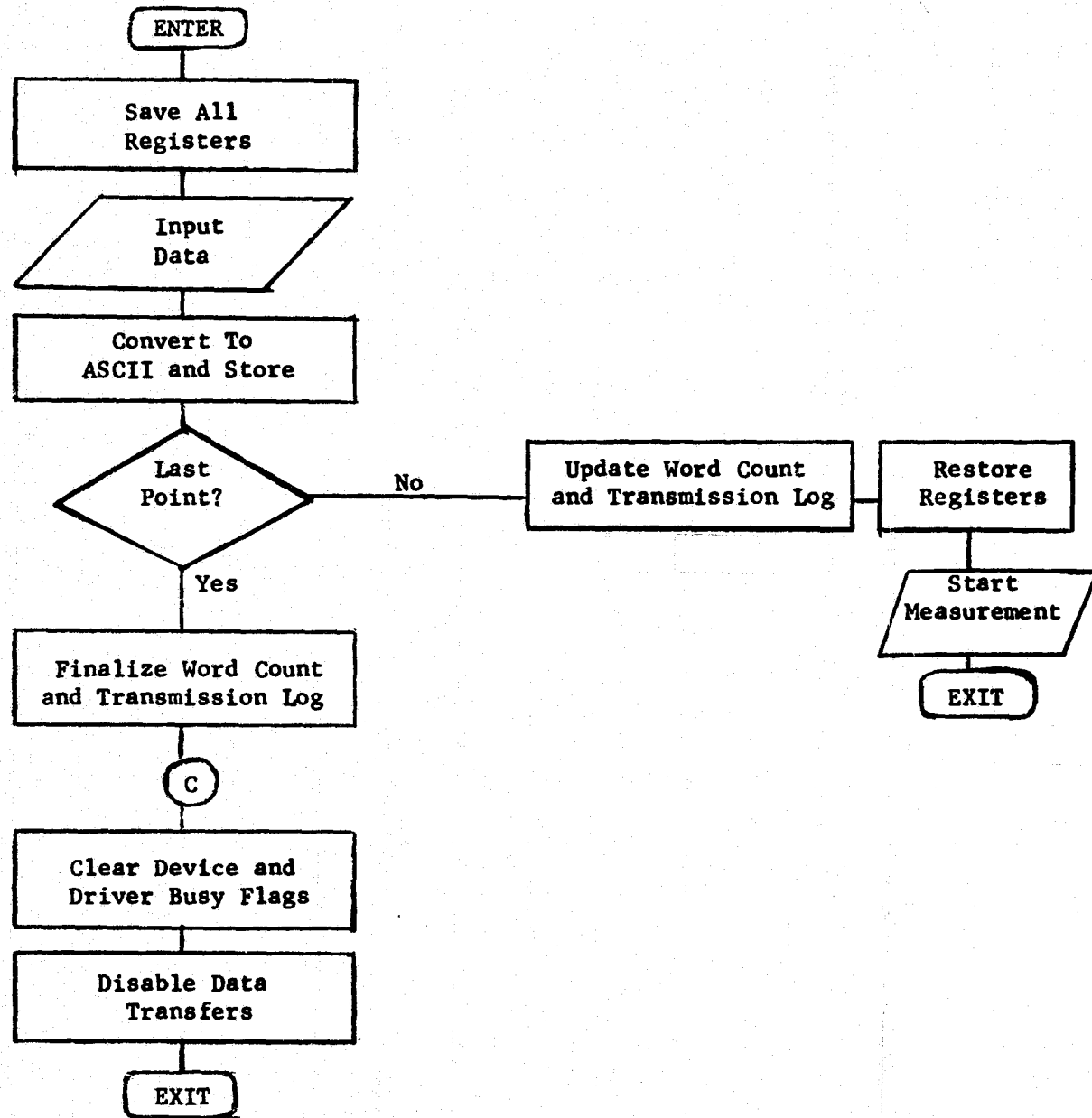
EXIT

APPENDIX B

SYMBOL TABLE, ASSEMBLY LISTING,

AND CROSS-REFERENCE TABLE

```
0001                         ASMB,R,L,T
D.55   R  000000
I.55   R  000105
I.1    R  000010
I.4    R  000012
D55.1  R  000017
I.2    R  000064
I.3    R  000077
RCER   R  000101
REJB   R  000102
R.0    R  000114
R.1    R  000116
EXIT   R  000153
STAT1  R  000154
X.6    R  000167
I.5    R  000175
UNPAK  R  000177
STORE  R  000212
A         000000
B         000001
EQTA   R  000221
EQT3   R  000222
A2     R  000223
RCA    R  000224
M17    R  000225
SAVAX  R  000226
DFLG   R  000227
M77    R  000230
SFSI   R  000231
M15    R  000232
BUF    R  000233
LENG   R  000234
CHC    R  000235
SAVBX  R  000236
SAVEX  R  000237
LOW    R  000240
HIGH   R  000241
M360   R  000242
C7400  R  000243
PLUS   R  000244
MINUS  R  000245
DECPT  R  000246
MST    R  000247
LIAM   R  000250
LIBM   R  000251
STC    R  000252
CLC    R  000253
ASCII  R  000254
SIZE   R  000255
**   NO  ERRORS PASS#1 **RTE ASMB 750420**
```

```
0001                     ASMB,R,L,T
0002*
0003*
0004* THIS DRIVER INPUTS BCD DATA FROM THE MODEL 1085A
0005* ELECTRONIC MANOMETER AND STORES THIS DATA IN THE
0006* USER'S BUFFER IN ASCII FORM. AN ERROR FLAG
0007* IS PROVIDED IF AN OVERRANGE OR NEGATIVE PRESSURE CONDITION IS
0008* DETECTED DURING THE MEASUREMENT. THE FIRST WORD OF
0009* THE DATA BUFFER CONTAINS THE ERROR FLAG:
0010*          0 - NO ERROR
0011*          1 - OVERRANGE
0012*          2 - NEGATIVE PRESSURE
0013*
0014* MEMORY REQUIREMENT: 173 WORDS
0015*
0016*
0018*
0019*
0020  00000                 NAM D.55
0021*
0022*
0023                        ENT D.55,I.55
0024*
0025*
0026* A DETAILED DESCRIPTION OF THIS DRIVER IS GIVEN
0027* IN THE PROGRAM PROCEDURE.
0028*
0029*
0030*     ********************************************
0031*     *                                          *
0032*     * D.55 BCS DRIVER FOR DATAMETRICS MODEL 1085A *
0033*     *                                          *
0034*     ********************************************
0035*
0036*
0037*
0038*** *** INITIATOR SECTION *** ***
0039*
0040*
0041  00000 000000  D.55   NOP              SAVE EQT
0042  00001 072221R         STA EQTA        ADDRESS. SAVE REQUEST
0043  00002 076224R         STB RCA         CODE ADDRESS.
0044*
0045  00003 160001          LDA B,I         FETCH REQUEST
0046  00004 001700          ALF             CODE AND
0047  00005 012225R         AND M17         ISOLATE REQUEST.
0048  00006 002002          SZA             IS IT A CLEAR REQUEST?
0049  00007 026017R         JMP D55.1       NO, CONTINUE.
0050*
0051*
0052*** *** TERMINATE OPERATION FOR CODE = 0
0053*
0054*
0055  00010 126000R  I.1    JMP D.55,I      YES, DISABLE
0056  00011 072226R         STA SAVAX       INTERFACE.
0057  00012 102100  I.4     STF 0           SET FLAG.
```

```
0058   00013 062000R        LDA D.55        GO TERMINATE
0059   00014 072105R        STA I.55        OPERATION, RESET
0060   00015 002400         CLA             BUSY FLAGS, AND
0061   00016 026154R        JMP STAT1       TRANSMISSION LOG.
0062*
0063*
0064   00017 066227R D55.1  LDB DFLG        TEST DRIVER FLAG.
0065   00020 006002         SZB             IS DRIVER BUSY?
0066   00021 026102R        JMP REJB        YES, REJECT.
0067*
0068   00022 000065         CLE,ERA         IS THIS A
0069   00023 002002         SZA             LEGAL REQUEST?
0070   00024 026101R        JMP RCER        NO, REJECT.
0071*
0072   00025 036224R        ISZ RCA         FETCH BUFFER
0073   00026 036224R        ISZ RCA         ADDRESS.
0074   00027 062224R        LDA RCA         OMIT ALL
0075   00030 160000         LDA A,I         INDIRECTS
0076   00031 001275         RAL,CLE,SLA,ERA AND
0077   00032 026030R        JMP *-2         STORE FINAL
0078   00033 072233R        STA BUF         ADDRESS.
0079*
0080   00034 036224R        ISZ RCA         FETCH BUFFER
0081   00035 162224R        LDA RCA,I       LENGTH.
0082   00036 002020         SSA             IS IT < 0?
0083   00037 026101R        JMP RCER        YES, REJECT.
0084   00040 003004         CMA,INA         NO, NEGATE
0085   00041 072234R        STA LENG        AND SAVE.
0086*
0087   00042 162221R        LDA EQTA,I      FETCH SELECT
0088   00043 012230R        AND M77         CODE FOR DEVICE.
0089*
0090   00044 032231R        IOR SFSI        COMBINE WITH SFS
0091   00045 072064R        STA I.2         INSTRUCTION.
0092   00046 022251R        XOR LIBM        COMBINE WITH LIB
0093   00047 072114R        STA R.0         INSTRUCTION.
0094   00050 022250R        XOR LIAM        COMBINE WITH LIA
0095   00051 072116R        STA R.1         INSTRUCTION.
0096   00052 022252R        XOR STC         COMBINE WITH STC,C
0097   00053 072077R        STA I.3         INSTRUCTION.
0098   00054 072175R        STA I.5
0099   00055 022253R        XOR CLC         COMBINE WITH CLC
0100   00056 072010R        STA I.1         INSTRUCTION.
0101   00057 022251R        XOR LIBM        COMBINE WITH
0102   00060 072012R        STA I.4         STF INSTRUCTION.
0103*
0104   00061 062221R        LDA EQTA        SAVE ADDRESS
0105   00062 042223R        ADA A2          OF TRANSMISSION
0106   00063 072222R        STA EQT3        LOG.
0107*
0108   00064 102300  I.2    SFS 0           IS DEVICE BUSY?
0109   00065 026102R        JMP REJB        YES,REJECT.
0110*
0111   00066 036221R        ISZ EQTA        NO, LOCATE
0112   00067 162221R        LDA EQTA,I      EQT WORD 2
0113   00070 032232R        IOR M15         AND SET
```

```
0114   00071 172221R          STA EQTA,I      DRIVER
0115   00072 072227R          STA DFLG        BUSY.
0116*
0117   00073 002400           CLA             RESET CHARACTER
0118   00074 072235R          STA CHC         COUNT AND
0119   00075 036221R          ISZ EQTA        TRANSMISSION
0120   00076 172221R          STA EQTA,I      LOG.
0121*
0122   00077 103700   I.3     STC 0,C         START MEASUREMENT
0123   00100 126000R          JMP D.55,I      AND RETURN.
0124*
0125*
0126*** *** REJECT SECTION *** ***
0127*
0128*
0129   00101 006401   RCER    CLB,RSS         SET B=0.
0130   00102 066232R  REJB    LDB M15         SET B=100000.
0131   00103 002404           CLA,INA         SET ERROR FLAG.
0132   00104 126000R          JMP D.55,I      TAKE ERROR EXIT.
0133*
0134*
0135*** *** CONTINUATOR SECTION *** ***
0136*
0137*
0138   00105 000000   I.55    NOP             SAVE
0139   00106 072226R          STA SAVAX       ALL
0140   00107 076236R          STB SAVBX       REGISTERS
0141   00110 001520           ERA,ALS         A,
0142   00111 102201           SOC             B,
0143   00112 002004           INA             O,
0144   00113 072237R          STA SAVEX        E.
0145*
0146   00114 106500   R.0     LIB 0           INPUT
0147   00115 076240R          STB LOW         PRESSURE DATA
0148   00116 102500   R.1     LIA 0           AND
0149   00117 072241R          STA HIGH        SAVE.
0150*
0151   00120 062223R          LDA A2           LOCATE STATUS
0152   00121 002004           INA             AND STORE
0153   00122 010001           AND B           IN
0154   00123 064000           LDB A           USER'S
0155   00124 016212R          JSB STORE       BUFFER.
0156*
0157   00125 005100           BRS             IS THE
0158   00126 062244R          LDA PLUS        MEASURED VALUE
0159   00127 004010           SLB             <0?
0160   00130 062245R          LDA MINUS       YES, SET NEGATIVE.
0161*
0162   00131 066241R          LDB HIGH        NO, IS EXTENDED
0163   00132 004010           SLB             RANGE SET?
0164   00133 002004           INA             YES, SET FLAG.
0165   00134 016212R          JSB STORE       NO, STORE DATA.
0166*
0167   00135 062241R          LDA HIGH        FETCH NEXT TWO
0168   00136 001727           ALF,ALF         BCD DIGITS AND
0169   00137 016177R          JSB UNPAK       STORE IN USER'S BUFFER.
```

```
0170*
0171   00140 062241R       LDA HIGH        FETCH NEXT
0172   00141 012242R       AND M360        DIGIT, INSERT
0173   00142 001700        ALF             DECIMAL POINT
0174   00143 032246R       IOR DECPT       AND STORE IN
0175   00144 016212R       JSB STORE       USER'S BUFFER.
0176*
0177   00145 062240R       LDA LOW         FETCH LAST TWO
0178   00146 001727        ALF,ALF         BCD DIGITS AND
0179   00147 016177R       JSB UNPAK       STORE.
0180*
0181   00150 062235R       LDA CHC         IF NOT LAST DATA
0182   00151 172222R       STA EQT3,I      POINT, UPDATE TRANSMISSION
0183   00152 026167R       JMP X.6         LOG AND RESTART.
0184*
0185   00153 062235R EXIT  LDA CHC         MAKE FINAL CHARACTER
0186   00154 172222R STAT1 STA EQT3,I      COUNT AND TRANSMISSION-
0187   00155 003400        CCA             LOG UPDATE.
0188   00156 042222R       ADA EQT3        FETCH EQT
0189   00157 070001        STA B           WORD 2.
0190   00160 160001        LDA B,I         RESET
0191   00161 012247R       AND MST         BUSY
0192   00162 170001        STA B,I         FLAG.
0193*
0194   00163 002400        CLA             RESET DRIVER-
0195   00164 072227R       STA DFLG        BUSY FLAG.
0196   00165 062010R       LDA I.1         SET CLC,H AS
0197   00166 072175R       STA I.5         LAST INSTRUCTION.
0198*
0199   00167 062237R X.6   LDA SAVEX       RESTORE ALL
0200   00170 103101        CLO             REGISTERS:
0201   00171 000036        SLA,ELA         E,
0202   00172 102101        STF 1           O,
0203   00173 062226R       LDA SAVAX       A,
0204   00174 066236R       LDB SAVBX       B.
0205   00175 103700 I.5    STC 0,C         EITHER RESTART OR
0206   00176 126105R       JMP I.55,I      TERMINATE MEASUREMENT.
0207*
0208   00177 000000 UNPAK  NOP             THIS ROUTINE
0209   00200 072224R       STA RCA         CONVERTS TWO
0210   00201 001700        ALF             BCD DIGITS
0211   00202 012243R       AND C7400       TO TWO
0212   00203 070001        STA B           ASCII
0213   00204 062224R       LDA RCA         CHARACTERS
0214   00205 012225R       AND M17         AND
0215   00206 032254R       IOR ASCII       STORES THE
0216   00207 030001        IOR B           ASCII DATA
0217   00210 016212R       JSB STORE       IN THE USER'S
0218   00211 126177R       JMP UNPAK,I     BUFFER.
0219*
0220   00212 000000 STORE  NOP             THIS ROUTINE
0221   00213 172233R       STA BUF,I       STORES DATA
0222   00214 036233R       ISZ BUF         POINTS IN USER'S
0223   00215 036235R       ISZ CHC         BUFFER, UPDATES
0224   00216 036234R       ISZ LENG        WORD COUNT AND CHECKS
0225   00217 126212R       JMP STORE,I     FOR BUFFER FULL.
```

```
0226    00220 026153R        JMP EXIT
0227*
0228*
0229*** *** CONSTANTS *** ***
0230*
0231*
0232    00000              A     EQU 0
0233    00001              B     EQU 1
0234    00221 000000       EQTA  NOP
0235    00222 000000       EQT3  NOP
0236    00223 000002       A2    OCT 2
0237    00224 000000       RCA   NOP
0238    00225 000017       M17   OCT 17
0239    00226 000000       SAVAX NOP
0240    00227 000000       DFLG  OCT 0
0241    00230 000077       M77   OCT 77
0242    00231 102300       SFSI  SFS 0
0243    00232 100000       M15   OCT 100000
0244    00233 000000       BUF   NOP
0245    00234 000000       LENG  NOP
0246    00235 000000       CHC   NOP
0247    00236 000000       SAVBX NOP
0248    00237 000000       SAVEX NOP
0249    00240 000000       LOW   NOP
0250    00241 000000       HIGH  NOP
0251    00242 000360       M360  OCT 360
0252    00243 007400       C7400 OCT 7400
0253    00244 025460       PLUS  ASC 1,+0
0254    00245 026460       MINUS ASC 1,-0
0255    00246 030056       DECPT ASC 1,0.
0256    00247 037400       MST   OCT 37400
0257    00250 004000       LIAM  OCT 4000
0258    00251 004600       LIBM  OCT 4600
0259    00252 001200       STC   OCT 1200
0260    00253 005000       CLC   OCT 5000
0261    00254 030060       ASCII ASC 1,00
0262    00255              SIZE  EQU *
0263*
0264*
0265                             END
** NO ERRORS *TOTAL **RTE ASMB 750420**
```

D.55

CROSS-REFERENCE SYMBOL TABLE

A	00232	00075	00154			
A2	00236	00105	00151			
ASCII	00261	00215				
B	00233 00216	00045	00153	00189	00190	00192	00212
BUF	00244	00078	00221	00222		
C7400	00252	00211				
CHC	00246	00118	00181	00185	00223	
CLC	00260	00099				
D.55	00041	00023	00055	00058	00123	00132
D55.1	00064	00049				
DECPT	00255	00174				
DFLG	00240	00064	00115	00195		
EQT3	00235	00106	00182	00186	00188	
EQTA	00234 00119	00042 00120	00087	00104	00111	00112	00114
EXIT	00185	00226				
HIGH	00250	00149	00162	00167	00171	
I.1	00055	00100	00196			
I.2	00108	00091				
I.3	00122	00097				
I.4	00057	00102				
I.5	00205	00098	00197			
I.55	00138	00023	00059	00206		
LENG	00245	00085	00224			
LIAM	00257	00094				
LIBM	00258	00092	00101			
LOW	00249	00147	00177			

CROSS-REFERENCE SYMBOL TABLE

M15	00243	00113	00130			
M17	00238	00047	00214			
M360	00251	00172				
M77	00241	00088				
MINUS	00254	00160				
MST	00256	00191				
PLUS	00253	00158				
R.0	00146	00093				
R.1	00148	00095				
RCA	00237	00043	00072	00073	00074	00080	00081
	00209	00213				
RCER	00129	00070	00083			
REJB	00130	00066	00109			
SAVAX	00239	00056	00139	00203		
SAVBX	00247	00140	00204			
SAVEX	00248	00144	00199			
SFSI	00242	00090				
@SIZE	00262					
STAT1	00186	00061				
STC	00259	00096				
STORE	00220	00155	00165	00175	00217	00225
UNPAK	00208	00169	00179	00218		
X.6	00199	00183				