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DECUS NO.	BASIC8-56
TITLE	LABORATORY AND DISPLAY INSTRUCTIONS FOR OS/8 BASIC
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COMPANY	Ohio State University Columbus, Ohio
DATE	July 11, 1974
SOURCE LANGUAGE	PAL-8

GENERAL INFORMATION

Object Computer(s) LAB-8/E Source Computer (if different) _____

File Name OVER.BN Version No. _____

Title Laboratory and Displ y Instructions for OS/8 BASIC

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Submitter (if other than author) _____

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Monitor/Operating System OS/8 V II DEC No. _____

Core Storage Required 8K Starting Address _____

Peripherals Required LAB/8E

Other Software Required OS/8 BASIC DEC or DECUS No. 8E-LBASA-A-D

Source Language PAL-8 Category Computer Science & Programming

Restrictions, Deficiencies, Problems Must overlay LAB/8E functions for OS/8 BASIC, DEC-8E-ALOSA-A-LA

Date of Planned or Possible Future Revis ons _____

TAPES AVAILABLE

Paper Tapes Object Binary ☐ Object ASCII ☐ Source ☐ Other _____

DECtape ☒ LINCtape ☐ Format OS/8 Magtape: 7 Track ☐ 9 Track ☐ BPI _____

Object Files ☒ Source Files ☒ Documentation Files ☒ Other Listing File

ABSTRACT

This program is a set of user-def ned functions for OS/8 BASIC It is combined with the LAB/8E functions (DEC-8E-ALOSA-A- .A) to build the file BASIC.UF; a run-time overlay for OS/8 BASIC. These functions cont ol DEC analog and Digital input and output devices and the VC8E display-control. They p rmit real-time data sampling, with background display, and control of both the X and Y co rdinates for CRT plotting.

LABORATORY AND DISPLAY INSTRUCTIONS FOR OS/8 BASIC

DECUS Program Library Write-up

DECUS NO. BASIC8-56

THIS PROGRAM IS A SET OF USER-DEFINED FUNCTIONS FOR OS/8 BASIC. IT IS COMBINED WITH THE LAB/8E FUNCTIONS (DEC-8E-ALOSA-A-LA) TO BUILD THE FILE BASIC.UF; A RUN-TIME OVERLAY FOR OS/8 BASIC. THESE FUNCTIONS CONTROL DEC ANALOG AND DIGITAL INPUT AND OUTPUT DEVICES AND THE VC8E DISPLAY-CONTROL. THEY PERMIT REAL-TIME DATA SAMPLING, WITH BACKGROUND DISPLAY, AND CONTROL OF BOTH THE X AND Y COORDINATES FOR CRT PLOTTING.

WRITE-UP

THIS PROGRAM CONSISTS OF A SET OF USER-DEFINED-FUNCTIONS WHICH HAVE BEEN WRITTEN TO ENABLE OS/8 BASIC TO CONTROL LABORATORY PERIPHERALS. IT SHARES MANY OF ITS FEATURES WITH THE LAB/8E FUNCTIONS FOR OS/8 BASIC AND IS A LARGE OVERLAY TO THAT PROGRAM (DEC-8E-ALOSA-A-LA).

THE SPECIFIC MOTIVATION FOR WRITING THIS PROGRAM WAS TO REMOVE THE TIME-BASE DEPENDENCY FOR SAMPLING AND DISPLAY WHICH IS CHARACTERISTIC OF LAB/8E BASIC. THESE NEW INSTRUCTIONS PERMIT EXPLICIT SPECIFICATION OF BOTH THE X AND THE Y COORDINATES OF THE VC8E DISPLAY CONTROL. ALSO ROUTINES TO INITIATE ADC SAMPLING TRIGGERED FROM EXTERNAL EVENTS (RATHER THAN THE CLOCK) HAVE BEEN IMPLEMENTED. THESE SAMPLING ROUTINES PERMIT THE RELATIONSHIP BETWEEN PAIRS OF ANALOG SIGNALS TO BE OBTAINED WHILE DISPLAYING THE DATA IN BACKGROUND.

THE OTHER MAJOR FEATURES OF THIS PROGRAM WHICH DIFFER FROM THOSE OF LAB/8E BASIC ARE AS FOLLOWS:

(1). FLOATING POINT NUMBERS AND DIMENSIONED ARRAYS OF FLOATING POINT NUMBERS MAY BE DISPLAYED DIRECTLY. THE PROGRAMMER NEED NOT BE CONCERNED WITH DATA CONVERSION TO 10 BIT DISPLAYABLE FORMAT SINCE THE UDEF'S ARE COMPATABLE WITH BASIC'S ARRAYS.

(2). PROGRAMMING HOUSEKEEPING HAS BEEN MINIMIZED. ARRAYS DO NOT REQUIRE INIALIZATION, ONLY BASIC'S "USE" STATEMENT IS NEEDED PRIOR TO A FUNCTION WHICH REQUIRES USE OF A DIMENSIONED ARRAY. THE "INI" FUNCTION IS REQUIRED ONLY IN CONJUNCTION WITH "PLY" OR TO DELIBERATELY MODIFY THE ACTION OF A PARTICULAR FUNCTION. ELIMINATION OF THE NECESSITY FOR CALLS TO "INI" SIMPLIFIES PROGRAMMING BUT THE ABILITY TO ADD NEW DATA TO A PREVIOUSLY "CLOSED" ARRAY IS LOST (EXCEPT WITH PLY).

IN ADDITION, THE CALLING SEQUENCE FOR INTERRUPT DRIVEN SAMPLING OF THE ADC'S, WITH BACKGROUND DISPLAY OF DATA, HAS BEEN SIMPLIFIED.

(3). A UDEF FOR LOADING UP TO SIX DIGITAL-TO-ANALOG CONVERTER OUTMODS (AA50-AP) HAS BEEN ADDED.

(4) DRO AND DRI FUNCTIONS HAVE BEEN LIMITED TO CONTROL OF A SINGLE BOARD (CODE 50). DRO HAS BEEN MODIFIED SO THAT OUTPUT IS PROGRAM SELECTABLE AS EITHER POSITIVE OR NEGATIVE LOGIC. THIS FEATURE PERMITS UPDATE OF EITHER LOW-LEVEL OR HI-LEVEL OUTPUT SIGNALS AND OUTPUTS TO BE CLEARED TO EITHER THE ALL-HI OR ALL-LOW STATE.

THE GENERAL RESTRICTIONS ON ARGUMENTS PASSED BY THE USER FUNCTIONS ARE (EXCEPT AS OTHERWISE NOTED):

0<=ARG<=4095

A FATAL (IA) ERROR WILL OCCUR IF THE ARGUMENT IS OUTSIDE THIS RANGE.

PREPARING BASIC FOR THE FUNCTIONS

(1). MODIFICATIONS TO BRTS.SV

LOCATION	VALUE	
0001/	5402	
0002/	4456	
1560/	3600	PLT
1561/	4310	REF
1562/	3531	ADC
1563/	4100	CLK
1564/	3551	CLW
1565/	3400	DRO
1566/	4302	DRI
1567/	4000	SAM
1570/	3453	DAC
1571/	4400	GET
1572/	4431	PUT
1573/	3425	INI
1574/	3515	PLY

(2). UDEF STATEMENTS MUST BE IN THE SAME ORDER AS THE STARTING ADDRESSES IN BRTS.SV.

```
10 UDEF PLT(N,X,Y), REF(N,X,Y), ADC(N), CLK(R,O,S), CLW(N)
15 UDEF DRO(T,M), DRI(N), SAM(C,N,P,T), DAC(M,N), GET(M,L)
20 UDEF PUT(M,L), INI(N), PLY(Y)
```

(3). BUILDING BASIC.UF

THIS PROGRAM IS AN OVERLAY FOR LAB/8E BASIC (BASIC.UF) VERSION 26, DEC-8E-ALOSA-A-LA. FOLLOW THIS PROCEDURE TO CREATE THE NEW 'BASIC.UF' FILE.

```
.R ABSLDR
DEV:BASIC.UF/I
DEV:OVER.BN$

.SAVE SYS:BASIC.UF
```

FUNCTION DESCRIPTION:

PLT(N,X,Y)

THIS FUNCTION IS USED TO DISPLAY FLOATING POINT NUMBERS ON THE CRT (VC8-E CONTROL) AND FOR DRIVING A X/Y ANALOG RECORDER IN PARALLEL TO THE CRT.

IF N=0, THE ARGS X AND Y ARE TREATED AS COORDINATES OF A SINGLE POINT TO BE DISPLAYED. THIS POINT IS PLOTTED FOLLOWED BY AN IMMEDIATE RETURN TO BASIC. THE RANGE OF ACCEPTABLE VALUES FOR THE ARGS IS: 0<=X,Y< 1.0. VALUES OUTSIDE OF THIS RANGE CAUSE A FATAL ERROR (IA= ILLEGAL ARGUMENT).

IF N >< 0, X,Y ARE DUMMY ARGS AND THE FUNCTION BECOMES A CALL TO PLOT A 2-DIMENSIONAL ARRAY OF "N" FLOATING-POINT PAIRS OF NUMBERS. THE NUMBERS IN THE ARRAY MUST BE 0<=X,Y< 1.0 AND THE ORDER OF NUMBERS IN THE ARRAY MUST BE:

```
X0,Y0
X1,Y1
X2,Y2
.
.
.
X(N-1),Y(N-1)
```

THE DIMENSIONS OF THE ARRAY ARE (1,N).

THE ARRAY FOR PLOTTING IS SPECIFIED BY BASIC'S "USE" STATEMENT WHICH SHOULD PRECEDE THE CALL TO PLT (OTHERWISE THE FIRST DIMENSIONED ARRAY OF THE PROGRAM IS USED).

PLT FIRST CONVERTS THE FL. PT. VALUES IN THE ARRAY TO 10 BIT DISPLAYABLE NUMBERS THEN DISPLAYS "N" PAIRS OF POINTS UNTIL A CLOCK OR KEYBOARD INTERRUPT OCCURS. THE ROUTINE RETURNS A NUMBER TO BASIC ACCORDING TO THE TYPE OF INTERRUPT. THE CLOCK INTERRUPT CODES ARE THE SAME AS "CLW", A KEYBOARD INTERRUPT (ANY CHARACTER) RETURNS THE NUMBER 8 TO BASIC.

EXAMPLE

THE PROGRAM FIRST CREATES AN ARRAY OF 50 X,Y DATA POINTS THEN DISPLAYS THE ARRAY FOR 20 SEC. THE PRINT STATEMENT WILL RETURN THE NUMBER 0 SIGNIFYING AN OVERFLOW RETURN TO BASIC.

```
100 DIM A(1,49)
105 FOR I=0 TO 49
110 A(0,I)= X EXPRESSION
115 A(1,I)= Y EXPRESSION
120 NEXT I
125 U=CLK(2,2000,0)
130 USE A
135 W=PLT(50,0,0)
140 PRINT W
```

THE ARRAY DIMENSIONS MUST BE SPECIFIED IN THE FORM 'A(1,N)' PLT CHECKS TO SEE IF THE NUMBER OF POINTS TO BE PLOTTED WILL EXCEDE THE SIZE OF THE ARRAY, ANY ATTEMPT TO EXCEDE THESE DIMENSIONS CAUSES A FATAL ERROR. THIS PROTECTION PREVENTS LOSS OF DATA IN ADJACENT ARRAYS DURING THE CONVERSION OF THE DATA TO 10 BIT. ONCE THIS CONVERSION TAKES PLACE THE DATA REMAINS IN 10 BIT FORMAT.

IN DIMENSIONING ARRAYS THE USER SHOULD KEEP IN MIND THAT 0 IS ALWAYS THE FIRST SUBSCRIPT OF A DIMENSIONED ARRAY.

REF(N,X,Y)

THE REFRESH FUNCTION IS SIMILAR TO PLT BUT IS USED ONLY TO DISPLAY AN ARRAY OF 10 BIT (DISPLAYABLE) NUMBERS. THE ORDER OF DATA IN THE ARRAY SHOULD BE: X0,Y0,X1,Y1..ETC. SINCE "PLT" CONVERTS A FL. PT. ARRAY TO 10 BIT VALUES, REFRESH SHOULD BE USED TO RE-DISPLAY AN ARRAY SUBSEQUENT TO INTERRUPTION*. REFRESH IS ALSO EMPLOYED TO DISPLAY DATA-ARRAYS OBTAINED FROM ADC SAMPLING(10 BIT).

THE X,Y ARGS ARE TREATED AS VECTORS. IF OTHER THAN ZERO THE DISPLAY WILL BE DISPLACED HORIZONTALLY (X) OR VERTICALLY (Y). THE AMOUNT OF THE DISPLACEMENT MAY BE APPRECIATED BY CONSIDERING THE CRT TO BE A GRID OF THE DIMENSIONS 1024 BY 1024. A UNIT OF DISPLACEMENT IS PRODUCED FOR EACH INTERGER VALUE OF X AND Y. WHERE -1024<=X,Y<=1024.

THE DISPLAY IS TERMINATED BY A CLOCK OR KEYBOARD INTERRUPT AND A NUMBER IS RETURNED TO BASIC AS WITH PLT(N,X,Y).

EXAMPLE:

```
100 B=CLK(3,10,1)
105 USE A
110 W=REF(100,X,Y)
115 X=ADC(0)
120 Y=ADC(1)
125 IF W >< 1 THEN 110
130 END
```

THIS PROGRAM WILL DISPLAY AN ARRAY OF 100 X,Y PAIRS OF 10 BIT NUMBERS WHEN STARTED BY ANY SCHMITT TRIGGER. ANALOG KNOBS 0 AND 1 ARE USED TO MOVE THE DISPLAY ABOUT THE CRT SCREEN. DISPLAY IS TERMINATED WHEN A SIGNAL IS RECEIVED BY SCHMITT TRIGGER NUMBER 1.

---

*

PLT(N,X,Y) CAN BE USED TO RE-DISPLAY 10 BIT ARRAYS PROVIDED CERTAIN CONDITIONS ARE MET. PLT RETAINS A RECORD OF THE LAST ARRAY NUMBER USED. THIS RECORD IS COMPARED TO THE NUMBER OF THE NEXT ARRAY CALLED BY THE ROUTINE. IF THEY ARE THE SAME, THE ARRAY IS TREATED AS 10 BIT AND DISPLAYED WITHOUT CONVERSION, OTHERWISE THE ARRAY IS TREATED AS FLOATING POINT AND CONVERSION IS INITIATED. THIS FEATURE IS USEFUL BECAUSE IT PERMITS PLT TO BE USED WITHIN LOOPS.

THE MEMORY OF THE LAST ARRAY USED IS LOST WHEN BASIC.UF IS REPLACED IN CORE BY ONE OF THE OTHER OVERLAYS. THE NEXT ARRAY WILL THEREFORE BE TREATED AS FLOATING POINT NUMBERS. PLT'S MEMORY CAN BE PRESET TO ANY DESIRED NUMBER BY USE OF "INI". E.G.

```
100 USE A
105 A=INI(0)
110 C=PLT(N,X,Y)
```

PLT WILL TREAT 'A' AS A 10 BIT ARRAY. THUS WHEN PLT IS USED WITHIN A LOOP WHERE THE FUNCTIONS ARE OVERLAYED INI SHOULD BE USED PRIOR TO THE SECOND AND ALL SUBSEQUENT CALLS TO PLT.

ADC(N)

THIS FUNCTION IS IDENTICAL TO LAB/8E BASIC.

CLK(R,O,S)

THIS FUNCTION IS SIMILAR TO LAB/8E BASIC EXCEPT IN ITS INTERACTIONS WITH SAM(C,N,P,T). THESE DIFFERENCES ARE DESCRIBED BELOW.

CLW(N)

THIS FUNCTION IS IDENTICAL TO LAB/8E BASIC.

DRO(T,M)

THIS FUNCTION IS USED TO LOAD THE OUTPUT REGISTER OF THE DIGITAL OUTPUT REGISTER (CODE 50). THE REGISTER BITS ARE SET BY THE VALUE M. IF M=0 THE OUTPUT REGISTER IS CLEARED OTHERWISE THE BITS REMAIN SET SO THAT ADDITIONAL BITS OF THE REGISTER CAN BE SET WHILE MAINTAINING THOSE SET EARLIER.

IF T=1, THE SET BITS ARE LOW, CLEARED BITS ARE HI.
IF T=0, THE SET BITS ARE HI, CLEARED BITS ARE LOW.

DRI(N)

THIS FUNCTION IS USED TO SAMPLE THE DIGITAL INPUT REGISTER (CODE 50) AND RETURN THE FLOATING POINT RESULT TO BASIC.

SAM(C,N,P,T)

THIS FUNCTION IS USED ONLY IN CONJUNCTION WITH CLK(R,O,S) TO SET UP PARAMETERS FOR SAMPLING ADC'S OR THE DIGITAL I/O'S.

T : IF T=0, SAMPLE ADC'S.
IF T><0 SAMPLE THE DIGITAL I/O'S.

C = FIRST CHANNEL TO BE SAMPLED.

N = NUMBER OF CONSECUTIVE CHANNELS TO BE SAMPLED. FOR ADC SAMPLING THIS MUST BE AN EVEN NUMBER OTHERWISE A FATAL ERROR WILL OCCUR.

P = NUMBER OF TIMES EACH CHANNEL IS BE BE SAMPLED.

THE PROCEDURES FOR SAMPLING THE DIGITAL I/O BOARDS ARE IDENTICAL TO THOSE OF LAB/8E BASIC EXCEPT THAT "INI" NEED NOT BE CALLED PRIOR TO THE CALL TO "SAM".

WHEN ADC SAMPLING IS SPECIFIED (T=0) THE CHARACTERISTICS OF THIS SAMPLING DEPENDS UPON THE VALUE OF "S" IN CLK(R,O,S) WHICH ALWAYS FOLLOWS THE SAM INSTRUCTION.

1. S >< 0

"N" ADC CHANNELS (NUMBER MUST BE EVEN) ARE SAMPLED AT EACH SCHMITT TRIGGER FIRING AND THE DATA IS PLACED SEQUENTIALLY IN THE USER ARRAY. THE SAMPLING IS INTERRUPT DRIVEN AND SUCCESSIVE CHANNELS ARE USED AS POINT COORDINATES FOR CRT DISPLAY IN BACKGROUND.

EACH CHANNEL IS SAMPLED "P" TIMES OR UNTIL THE CLOCK HAS OVERFLOWED "S" TIMES (THE CLOCK IS STARTED BY FIRST SAMPLE). SINCE 1<=S<4095 THE INTERNAL CLOCK TIMING RANGE IS ALMOST 2 DAYS. THE CLK FUNCTION RETURNS A NUMBER TO BASIC EQUAL TO THE NUMBER OF SAMPLES PER CHANNEL TAKEN DURING THE SPECIFIED TIME PERIOD. RETURN TO BASIC NORMALLY OCCURS AFTER "P" SAMPLES HAVE BEEN TAKEN

THE DATA IS PLACED IN THE USER ARRAY IN THE ORDER: X1, Y1 X2, Y2, ETC AND MAY BE RE-DISPLAYED DIRECTLY BY REFRESH.

EXAMPLE

SAMPLE ADC CHANNELS 0 AND 1 100 TIMES OR FOR 1 MINUTE, STORE IN USER ARRAY AND DISPLAY CHAN 1 VERSUS CHAN 0 ON THE FLY.

```
100 USE A
105 A=SAM(0,2,100,0)
110 B=CLK(2,100,60)
```

TO DISPLAY THE DATA AFTER THE END OF THE SAMPLING PERIOD:

```
200 USE A
205 W=REF(B,0,0)
```

2. S=0

ADC SAMPLING IS INITIATED BY CLOCK OVERFLOW AND CONTINUES UNTIL "P" SAMPLES PER CHANNEL HAVE BEEN TAKEN AND DEPOSITED IN THE USER ARRAY. DURING THE SAMPLING PERIOD SUCCESSIVE CHANNELS ARE DISPLAYED ON THE FLY:

CHAN 1 AGAINST CHAN 0
CHAN 3 AGAINST CHAN 2
ETC.

RESULTS SIMILAR TO LAB/8E BASIC ARE OBTAINED IN THIS MODE OF SAMPLING IF ONE OF THE ANALOG CHANNELS OF EACH PAIR RECEIVES A TIME-VARYING SIGNAL. THIS MODE CAN ALSO BE USED TO COMPARE THE TEMPORAL CHARACTERISTICS OF SIGNALS.

DAC(N,M)

DAC IS USED TO LOAD DIGITAL-TO-ANALOG CONVERTER NUMBER "N" WHERE 0<=N<=5, WITH A FLOATING POINT NUMBER M, WHERE 0<=M<=4095. THE DAC REMAINS SET UNTIL RELOADED.

GET(M,L)

IDENTICAL TO LAB/8E BASIC FUNCTION EXCEPT "INI" IS NOT REQUIRED.

EXAMPLE:

THE SECOND WORD IN THE USER ARRAY IS RETRIEVED, FLOATED, AND ASSIGNED TO VARIABLE W.

```
100 USE A
105 W=GET(0,2)
```

PUT(M,L)

IDENTICAL TO LAB/8E BASIC FUNCTION EXCEPT "INI" IS NOT REQUIRED.

INI(N)

USED TO INITIALIZE THE POINTERS OF THE ARRAY SPECIFIED BY "USE". THIS IS CALLED AUTOMATICALLY BY ALL FUNCTIONS WHICH USE ARRAYS EXCEPT FOR "PLY". FUNCTION HAS THE SAME ACTION AS IN LAB/8E BASIC WITH THE ADDITIONAL FEATURE THAT IT SETS "PLT" MEMORY TO THE ARRAY SPECIFIED BY "USE".

PLY(N)

IDENTICAL TO LAB/8E BASIC FUNCTION.