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MANUAL FOR THE WAVETANK DATA ACQUISITION SYSTEM

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MANUAL FOR THE WAVETANK DATA ACQUISITION SYSTEM

IOS INTERNAL DOCUMENT NO. 71

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WAVETANK DATA LOGGING SYSTEM

Operating Manual with Program Description

Contents

Wavetank Data Logging System

This manual should be read in conjunction with the following:

		Abbreviations
1.	HP2647A Reference Manual	HPRM
2.	HP2647A User Manual	HPUM
3.	Data Processing Document ~~DP/D/~~ COS/FB/1	
4.	HP2647A Quick Reference Guide	HPQRG
5.	Caty Manual DP/D/14 June 1979	
6.	System Loading on PDP11/Camac Systems DP/D/15 January 1979	

1.1 Scope

This manual covers (1) BASIC programs written for the HP2647A to enable data acquisition, archival and processing. It does not cover the use of the terminal, and assumes a fair familiarity with simple terminal operations. The program suite is on two tape cartridges, System Tape #1 and Program Tape #2, Sections 2, 3 and 4. (2) Programs in CATY for data acquisition and archival, Section 5.

1.2 General Features of the HP2647A Operation

1.2.1 Softkeys

The first file on each tape holds the SOFTKEY assignments for that tape and a text page with brief instructions. (For softkey explanation see HPUM 3-11; 12-1). Each tape also has a copy of the BASIC interpreter which can be accessed by a SOFTKEY (! basic).

1.2.2 Loading from a SYSTEM tape

It is vital that the tape is inserted into the left tape slot. When the green light stops blinking, the tape is ready for reading. Pressing the READ key (HPUM 3-12, 10-3) will read the first (softkey) file into memory. If this operation is unsuccessful press RESET twice within 0.5 seconds (HPUM 3-9, 14-1) and try again. When completed, the SOFTKEY assignments will be displayed at the bottom of the screen. Loading a program is achieved through pressing the appropriate softkey.

1.2.3 BASIC

If BASIC is loaded, the memory partition between the workspace and the display will need to be changed (HPQRG 12) using the command SET SIZE. The programs require a workspace of up to 12000 bytes and thus the command is:

SET SIZE = 12000 C/R

A SET SIZE command clears the memory, and the SOFTKEY assignments are lost, and must be reloaded from the SYSTEM tape.

2.0 SYSTEM Tape #1 Description

This is the system tape for data acquisition and archival of up to 4 channels, with 200 scans each; a limit imposed by HP2647A memory size. The tape contains the following files, with their SOFTKEY names.

File	Name	Function
1	-	Softkey assignments and run instructions.
2	f6: EXPLAIN	Description of setting up analogue data acquisition.
3	f1: AQUIRE	Archival of raw data.
4	f4: PROCESS	Regression and plotting of archived data.
5	f5: !basic	Copy of BASIC interpreter.
6	f3: timeplot	Plot of selected channel against sample number.
7	f2: dataplot	Plots of 2, 3 or 4 channels against sample number or selected channels.

The other two SOFTKEYS, f7 and f8 are assigned escape sequences to initialise and halt the HP2647A data logging function.

2.1 Terminal Operation Softkeys

2.1.1 Softkey f7: LOGSETUP

This carries out the following functions by means of escape code sequences (HPUM 3-2, HPQRG A-1 to A-37):

(a) Assigns destination to left tape

(b) Assigns source to display

(c) Clears display

(d) Enables edit mode

(e) Beeps the terminal

When EDIT is enabled, the state of the REMOTE/LOCAL key is locked, so it is important to have the terminal in REMOTE before the SOFTKEY is pressed. If successful, the red 'edit' lamp above f8 flashes. A steady lamp shows the terminal to be in local, whilst no light shows the tape cartridge to be write protected.

2.1.2 Softkey f8: stop

This key is used to transfer the data remaining on the screen after the transmission from the PDP11/Camac has ended. The functions are:

(a) Disables edit mode

(b) Assigns source to left tape

(c) Assigns destination to right tape

(d) Homes cursor

(e) Copies all from display to left tape

(f) Marks a file header on left tape

(g) Beeps the terminal

2.2 Programs in BASIC

2.2.1 AQUIRE

This program is accessed through f1: AQUIRE, and erases any previous program in memory.

Purpose:

To read data logged on tape cartridges as a 'data file' (see Appendix A), and collect pertinent information to form a header. Then to calculate the mean and standard deviation of the data. The header and averaged data files are then written to an archive tape.

Brief description:

The first section of the program sets up header data by question and answer, together with the values set up on the Camac BSD panel (see ~~DP/D/**~~ CDS/FB/1). Date and time are initially entered through the Command channel (HPUM 10-11) and are subsequently automatic (excepting reloading BASIC, a SET SIZE command or a double reset).

Data is then read in to memory, and checked for sync. errors. A warning of such errors is given on the display, and a recovery routine is provided. The results of the processing are displayed on the screen, and also recorded on the archive tape.

Note that for each raw data file the program must be restarted.

2.2.2 PROCESS

Purpose:

To read an archive tape, to calculate a linear regression on any two channels (including standard deviations) and to plot the regression, residuals from the regression or the slope of the data (sensitivity).

Brief description:

The main program is an initialisation, the processing is carried out by three subroutines:

(a) RDPRI reads the archived data files, skipping the header files, and prints onto the display.

(b) FIT performs the linear regression, prints slope, intercept and correlation coefficient.

(c) PILOT sets up a plot through question and answer, and plots the requested data.

2.2.3 Timeplot and dataplot

Purpose:

To display raw data in graphical form.

Brief description:

These programs require the raw data tape to be in the left slot. Timeplot is self-explanatory with a simple question and answer set-up. Data plot must be set up for the same number of channels as on the tape, and multiple plots can be done without re-reading the data.

3.1 Program Tape #2 Description

This is an applications program tape, and contains useful 'quick look' programs. It is important to realize the limitations of the analysis programs, e.g. no averaging provided on the FFT; limited to 20 coefficients for digital filter.

The tape contains the following files, with their SOFTKEY names.

File	Name	
1	-	SOFTKEY assignment and run instructions.
2	f1: SPECTRUM	FFT spectrum analysis, graphical output.
3	f2: FILTER	Digital low-pass filter set at 1Hz cut-off.
4	f3: Dataplot	Plots of 2, 3 or 4 channels against sample number or selected channel.
5	f4: !basic	Copy of BASIC interpreter.
6	f5: FILTDES	Digital low pass filter design program.
7	f6: EDITOR	Archive tape file editor program.

Softkeys f7 to f8 are not assigned.

3.1.1 SPECTRUM

This program is a translation of the NIO Fortran Library FFT and RTRAN subroutines, limited to transform lengths of 32, 128 and 512 input data points.*

It is a single channel transform, and accepts input from a raw data tape in the left tape slot. The raw data is plotted on the bottom left of the screen, and when the transform is completed, the spectrum is plotted on the upper right of the screen. An option to use log coordinates for the y axis is available.

There are three error traps in the FFT subroutine, triggered on illegal use of the routine. These errors cause the program to halt.

A separate printout is made of the d.c. level of the input from a simple mean on the data, and this is removed from the data before it is transformed. The d.c. value is not plotted on the display.

3.1.2 FILTER

This program is a digital low pass filter with an impulse response length of 20 samples (Fig. 1). The filter coefficients are found from the program FILTDES based on a Lanczos window with the window parameter set to 2 (Cappellini et al. (1978)). If the coefficients need to be altered, they are contained within the array E( ), and only the first 10 coefficients need be defined (the array being symmetrical).

Raw data is read from the left tape slot, and filtered data written onto the right tape. A plot of both filtered and raw data is given on the display.

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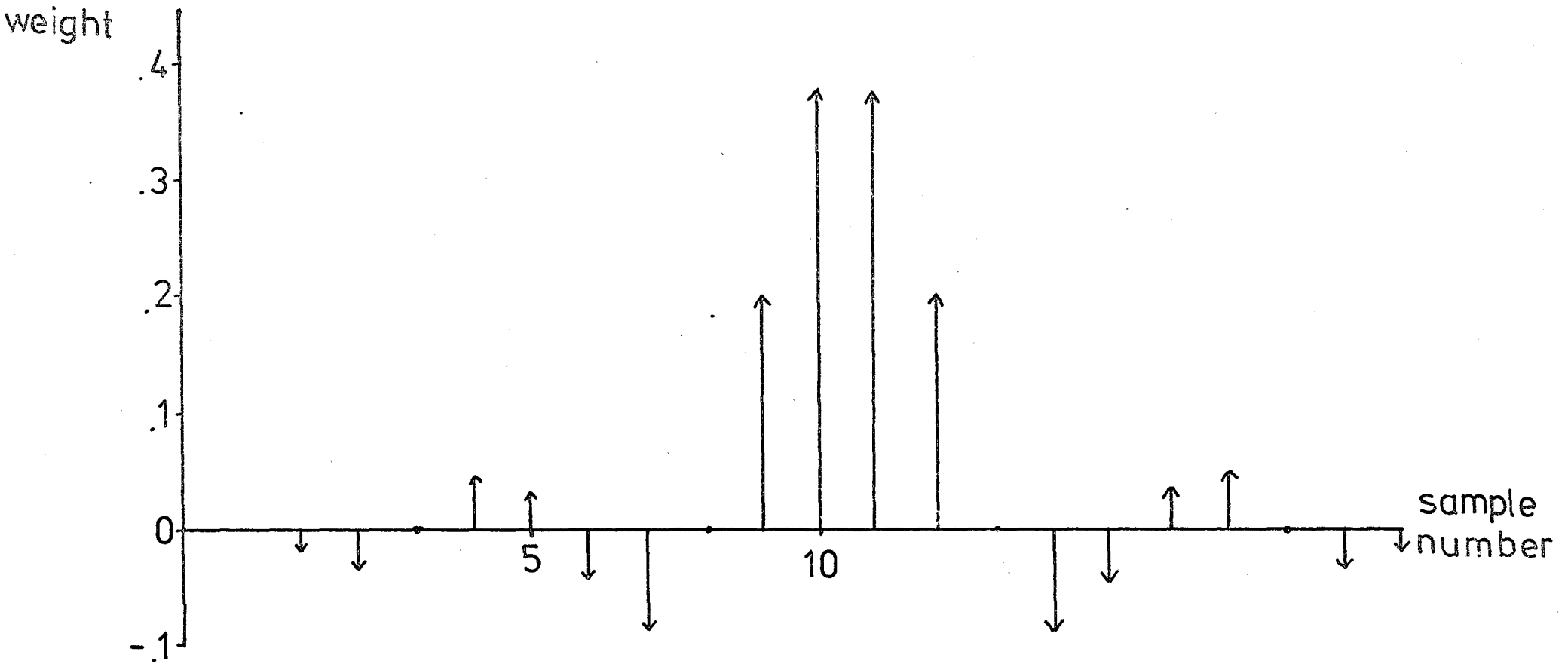
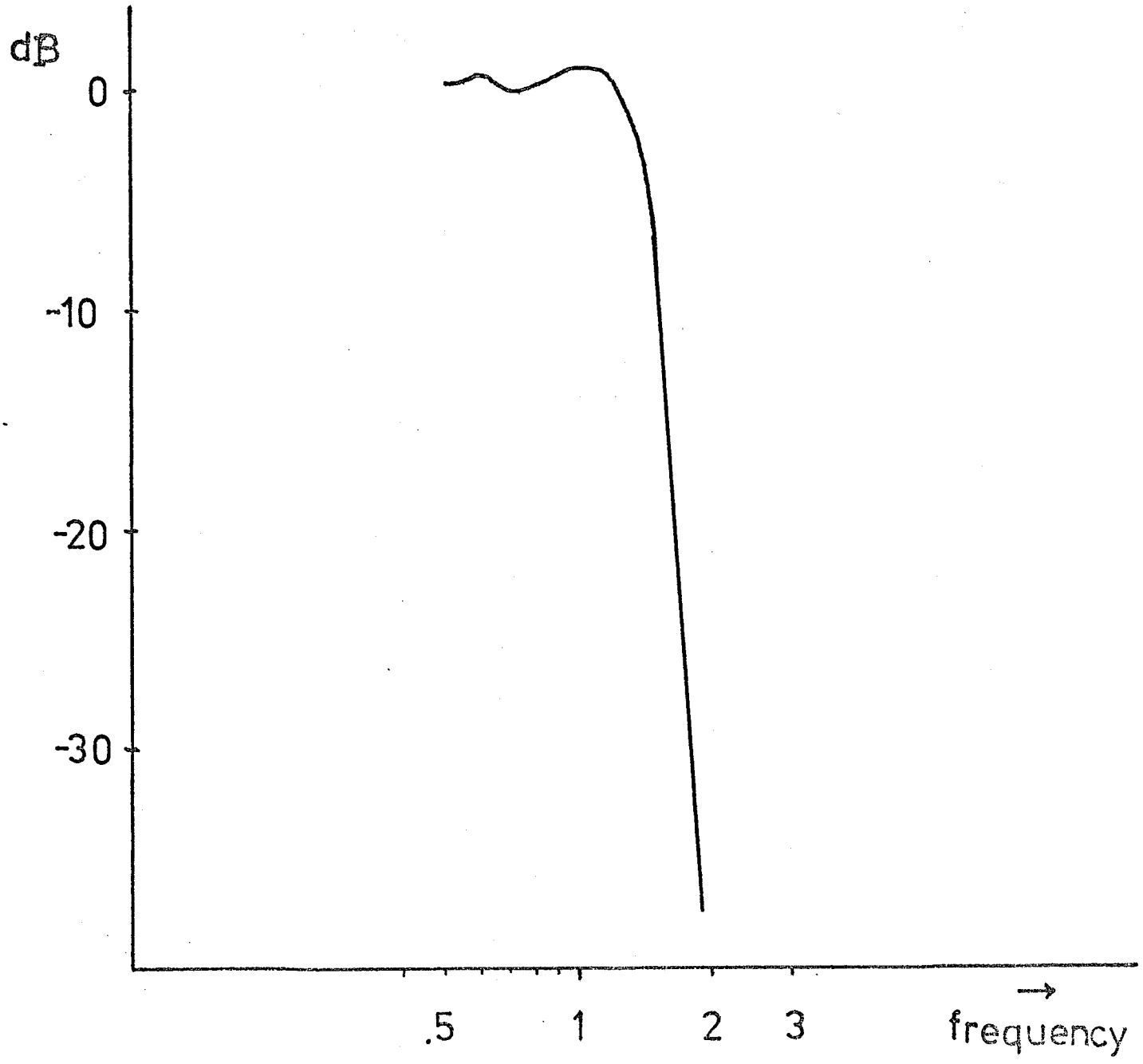
*With the present memory size it is not possible to incorporate averaging of adjacent spectral estimates except by deletion of the 512 point facility.

DIGITAL FILTER IMPULSE RESPONSE



DIGITAL FILTER AMPLITUDE RESPONSE



Note that the filtered data will be short of 20 points over the input data set - this is important if the data is to be used for a SPECTRUM input. Also note that this is a single channel program, and to maintain compatibility with the data file format, it is assigned Channel #1, and not its initial designator.

With the program in its present state, it is not advisable to use it to create filtered data for input to the AQUIRE program.

3.1.3 Dataplot - see 2.2.3

3.1.4 !basic - see 1.2.3

3.1.5 FILTDES

This is a translation and simplification of the program in Appendix 3 of Cappellini et al. (1978). It allows the design of a Lanczos window finite impulse response low pass filter with up to 128 coefficients. Access to the program is by the softkey f5: FILTDES.

3.1.6 EDITOR

Program specification:

To enable file editing of archive and other tapes.

Program operation:

This is through a command language; the following options are available, in answer to a ? at the left of the screen:

1. COPY
2. REWIND
3. STATUS
4. EOF
5. EDIT
6. SKIP
7. PRINT
8. EXIT

Commands are executed such that data is transferred from left to right. Thus the 'old' tape must be in the left slot, and the 'new' tape in the right slot.

Command description:

1. COPY: editor then asks: # of files? - a numeric answer is required, and this must lie between $0 < N < 256$. This number of files is then copied from LEFT to RIGHT tape.

2. REWIND: editor then asks: LEFT, RIGHT, or BOTH? the specified tapes are rewound, and an end of data marked if the preceding file was the last on the tape.

3. STATUS: shows position on tapes; next file number and inches of tape remaining (full tape = 1700 in.).

4. EOF: writes an end of file mark on the right tape.

5. EDIT: copies next file from left tape to display and then allows the user to edit the file. All cursor movements and C/R are available. When editing is complete, the BREAK key is pressed. This copies the file from the screen to the right tape. An end of file mark is automatically generated.

6. SKIP: (a) editor then asks L or R? specify tape drive, (b) editor asks # of files? specify number of files. A negative sign indicates a skip back, no sign gives skip forward.

7. PRINT: editor asks L or R? specify tape drive, then the next file is printed on the screen.

8. EXIT: returns to BASIC.

To run program: enter BASIC - put system tape in left drive - press editor softkey.

4. Operation of WTS with System Tape #1

4.1 Data transfer from CAMAC/PDP11 to HP2647A

This section must be read in conjunction with document DP/D/** and HPUM 11-4. DP/D/** describes the operation of the CAMAC/PDP11 system to enable a data transfer to be made, familiarity with this procedure is assumed in this description. The use of the SOFTKEYS LOGSETUP (2.1.1) and stop (2.1.2) greatly simplify the operator intervention, and hence references to the operation of the HP2647A in DP/D/** do not apply when these SOFTKEY functions are used.

It is assumed that the PDP11 memory contains the data from a run, and that a data transfer is required. Follow the procedure:

1. Insert a write enabled tape cartridge labeled RAW DATA TAPE into the left slot of the terminal.

2. If BASIC is active (a > at the left side of the display) type EXIT to enter 'terminal mode'.

3. Ensure REMOTE key is down.

4. If the softkey assignments are not displayed press SOFTKEYS.

5. Press f7: LOGSETUP to enable data logging mode. (Note, this will clear the screen of all previous data).

6. Start transmission by lifting BSD switch 4 and pressing the interrupt button (CDS/FB/1 ~~DP/D/**~~).

7. When the transmission has ended - press f8: stop to transfer the data from the screen to the tape.

8. Set remote key to local.

9. Use command channel to rewind the left tape, and then to enter BASIC.

The tape is now ready to be read by the program AQUIRE. This procedure is to be used when it is certain that the left tape will contain less than 1300 lines - if more data is expected in a single transfer then the procedure in HPUM 11-4 must be followed. (Note, AQUIRE is not able to accept more than 800 lines of data).

4.2 Operation of program AQUIRE

AQUIRE can be used with single or multiple raw data files, but it must be restarted for each run. Loading AQUIRE is covered in 2.2.1. Place raw data tape in left slot, archive tape in right slot. After the RUN command, the program requests information on the carriage speed calibration - a default calibration is built in, and the option to change it is given.

For the first run of the day, it is necessary to update the time/date through the command channel by e.g.

Command next, next, next, SET TIME 09:00:00 AM

next, next, next, SET DATE "3 SEPTEMBER 1979"

Note that the date string is limited to 20 characters.

The question/answers are self explanatory with the following exceptions:

1. APPEND - this option is not available at present.

2. EDIT - this option is not available, use RAW.

Other command errors will be trapped and the program will prompt a repeat.

It is advised that the number of scans to be averaged be set at 95% or less of the scans on the tape. This is because of the possibility of sync. errors, which could result in insufficient data on the tape to satisfy the number of scans requested.

The program asks for the channel numbers scanned, these must be entered singly, followed by a carriage return, in the same order as they are scanned by CAMAC. As this forms the basis of sync. error detection it is important to enter the correct channel numbers.

The results are printed on the screen, and stored on the archive tape (Appendix A section 2). Note that the carriage speed channel will be given in units corresponding to those selected on the carriage speed box, i.e. in mm/s or × 10 mm/s.

4.2.1 Operation of AQUIRE.D

AQUIRE.D, on Program tape #-3 is a version of AQUIRE accepting data input from the floppy discs in conjunction with FLOPS1 running in the PDP11. Refer to section 4.2 for a description of AQUIRE.

After the answer RAW, the program appears with "?"; with FLOPS1 running, a switch register interrupt transfers the header data. Similarly, after the channel numbers have been typed, and a "?" appears, a second interrupt transfers the data scans. See also section 5.3.1.

4.3 Operation of Process

The loading is covered in section 2.2.2, ensure the archive tape is in the right hand slot. Type RUN to start the program, which will then request a confirmation that the correct tape is in the right hand slot. The number of runs to be processed and the number of data channels are entered.

First, the program allows linear regression of any two user selected channels. Note that the standard deviation of any particular channel is available as Ch## +16 e.g. s.d. of channel 3 is on channel 19, and these too can be used in a regression. The option to plot is given at the end of the regression, for this the user sets up some of the plot parameters. The plot memonics are:

X_0 - minimum x value

X_1 - maximum x value

Y_0 - minimum y value

Y_1 - maximum y value

The labels and title are then entered, up to 20 characters each. In addition to the data points, the residuals from the regression line can be plotted using the reply RESIDUALS, similarly SENSITIVITY allows $(y_a - z)/x_a$ to be plotted, z is the x = zero intercept on the y-axis. Multiple plots are possible as the program loops for further analysis or plotting. Note that before residuals can be plotted for a pair of channels, the linear regression for that pair must be performed.

4.4 Operating of Timeplot

This program reads a selected channel from the raw data tape in the left slot and plots it against sample number. Selection of y axis values is possible, but x axis values are set by the program. The program ends with a repeat request, but requires the tape to be rewound before proceeding if another channel is to be plotted.

4.5 Operation of Dataplot

This gives 2, 3 or 4 plots of logged raw data, but the number must equal the number of channels on the data tape. The request is made for the x-axis variable to be either sample number (reply S) or a logged data channel (L). As the data is read in to the memory before being plotted, no tape rewinding is necessary.

The user sets up the plots using the following memonics:

X_{mi} - minimum x value

X_{ma} - maximum x value

Y_{mi} - minimum y value

Y_{ma} - maximum y value

then:

X_i - x axis tick interval = ½ grid interval

Y_i - y " " " " "

X_o -)

Y_o -) origin of graph

After plotting the first graph, the program goes to the next automatically. At the end, the option to erase the screen and repeat with a different x axis is given.

5.0 PDP11/CATY Programs

These programs are written in IOS release 2.0 of CATY2, and use functions which may not be supported under future releases (see CATY manual DP/D/14 June 1979). The programs are resident on disk; systems programs on disk SYS005 on drive 0, and all applications programs on disk drive 1. Refer to the CATY manual, and DP/D/15 for a full description of CATY and operating the PDP11.

A description of the analogue data acquisition program WAVE is given in DP/D/**, however, updates to this program are given in section 5.1.

5.1.1 Wavetank Program Documentation UPDATE 1

Program Name: WAVE 2

Location: Disk ~~CMC001~~ WAV002

Date: 12/9/79

Origin: F. Bilimoria/G. Griffiths

Strings used: adds REGIST to original list 1,1,12

Purpose of update:

To allow carriage speed to be logged from a 4 decade BCD input.

Operation:

Ensure connector on carriage speed box is in, and that the range switch is set to the high speed range. Note that the carriage speed will be updated once a second, and is thus NOT co-incident with data sampling at other rates. It is a restriction (at 12/9/79) that sampling rates are <1 second; and it is advisable to sample at a rate giving integer multiples into 1 second (e.g. 100 mS, 200 mS, not 300 mS). This is to avoid loss of synchronization.*

*Efforts will be made to lift these restrictions.

Carriage speed will be allocated the next free channel number after the analogue channels, and as there is a present restriction of 4 (due to HP2647A memory size), no more than 3 analogue channels can be used.* The data is entered directly in mm/s.

Program Description:

The data array A is split into A and E, A is now dimensioned 3000, and is used for analogue samples. E is dimensioned 1000 and is used solely for carriage speed.

The 16 bit input register is enabled for interrupts by the carriage speed box by F17 Regist,0,'3 when the analogue sampling is started, and ENB REGIST,0. Upon interrupt from the carriage speed box (1 per second), the command F0 REGIST,0,E(D) reads in the data value into the array and clears the LAM. The BCD value E(D) is then converted into decimal by the BCD to decimal GOSUB. An extra decade is used in the subroutine, a flag is set when the GOSUB is called by INTR REGIST to enable 4 decade conversion. The decimal data is then stored in E(D).

Synchronization of the analogue and carriage speed data is done on print-out, and this puts carriage speed as channel N+1 where N is the number of analogue data channels. As the analogue sampling may be at a higher rate than 1 Hz, the factor Q = 100/A(2) (A(2) is the analogue sampling rate in 10s of ms) is used as a loop constant. The carriage speed is printed for Q scans of the analogue data, then the carriage speed array pointer is incremented to update the printed data. Note that this procedure precludes certain sampling rates due to non-integer Q. The REGIST is disabled after the ADC disable command, within INTR ADC. The array E is cleared on program start, and all variables are initialized.

5.1.2 Wavetank Program Documentation UPDATE 2

Program Name: WAVE 1

Location: Disk ~~EXG004~~ WAV002

Date: 8/10/79

Origin: F. Bilimoria/G. Griffiths

Strings used: as UPDATE 1

Purpose of update:

To output the data onto the floppy disc as stream 1 instead of onto the screen - resulting in a factor of 20 improvement in transfer time.

Operation:

As update 2 but with the following additions:

1. Assign data file as !AS1:1,RUN 6.

---

*Continuous mode F17 Regist,0,'1 may be used for faster sampling - if incremental values are OK{more computations required}

2. Be sure to return switch 4 to 0 after the transmission request interrupt.

3. When lights 24, 4, 1 flash, the program can be halted by CNTRL X.

4. To replay a data file use program FLOPS, or FLOPS 1.

5.2 Carriage Speed Program

Program Name: SPEED Language: CATY 2.0

Location: Disk ~~CXG001~~ WAV002

Date: 12/9/79

Origin: G. Griffiths

Strings used: REGIST 1,1,12

SWREG 1,1,13

Program Specification:

To read a parallel 4 decade BCD word from the carriage speed box and to output this on the console. At the end of a user selected period, the mean speed is to be displayed.

Program Operation:

Read in program by typing !RD1 SPEED, then run by !RUZ. After a short pause, the program is ready. Speed logging can begin by pressing the switch register LAM button. Carriage speed is updated every second. On a second switch register LAM, the logging is stopped and the average speed displayed. The procedure can then be repeated, or a CNTRL X typed to exit the program.

Program Description:

The four decade BCD input is via a 16 bit register, which is updated once a second by the Latch signal from the carriage speed box. This generates a LAM in the module, which is handled by the interrupt service routine. To enable this mode, an F17 REGIST,0,'3 is used. The data is read in and then converted to decimal.

Control is via a SWREG interrupt and two flags. Interrupts from the data register are disabled when not required.

5.3 Data File Readback, FLOPS

Program Name: FLOPS Language: CATY 2.0

Location: Disk ~~CXG004~~ WAV002

Date: 8/10/79

Origin: G. Griffiths

Strings used: None

Program Specification:

To read data from a floppy disc data file in the format of WAVE 1, and to print the data on the screen. The program output is to be compatible with the HP2647A input requirements under program AQUIRE.

Program Operation:

Assign the data file to be printed as !AS1:1, RUN1.DAT. It is necessary to use the .DAT file qualifier. To run type !RUZ. Note that if this program is used in conjunction with the Basic program AQUIRE, the terminal will be placed off-line by the Basic program.

Notes:

Spurious output may result if the input data contains characters other than the digits 0 → 9, ^{C}R or - (negative sign). An ASCII to decimal conversion is performed after the parity bit has been dropped. Specific tests are made for a ^{C}R and '55, the negative sign, this causes a flag to be set and the data to be shifted to the positive format.

5.3.1 Update to FLOPS: FLOPS1

Program name: FLOPS1 Language: CATY 2.0

Location: Disk ~~CXC005~~ WAV002

Date: 15/10/79

Origin: G. Griffiths

Strings used: SWREG 1,1,13

Program Specification:

As FLOPS (section 5.3), with the addition of switch register interrupt control for inputing data in the format required by AQUIRE.

Program Operation:

Assign data file and run as in FLOPS. The program will not print data onto the screen until the switch register LAM button is pressed. On the first press, three lines of header information will be printed. On the second press, the data scans will be printed.

This program can be run with AQUIRE.D, the disk version of Aquire. In this case, immediately after typing !RUZ, the terminal can be put in Local, and Basic entered. When AQUIRE.D appears with a ? indicating a request for header data, the SWREG LAM can be pressed. There is no need to put the terminal in Remote. Similarly when AQUIRE.D request data scans, the SWREG LAM is pressed.

Note:

It is important that you EXIT Basic before putting the terminal into remote if data is still being transmitted by FLOPS or FLOPS1. Otherwise the Basic program may be corrupted.

5.4 Floppy disc utility programs

These comprise three programs to enable data to be read from a cartridge tape on the HP2647A and transferred to the CAMAC floppy disc. A readback program is also provided.

1. CARTRD

This is a Basic program, resident on Program Tape 3, which reads lines of data from the RIGHT tape, and places it a character at a time onto the datacomm lines. The program uses the character string functions LEN and PUTDCM (HPQRG) and forms a single character substring which is used as the output to the CATY program. An option to transfer one or more files is given. This program can be used to transfer archive tape data to disk.

2. KEYDSK

This program is written in CATY2, and must co-run with the CARTRD program. The subroutine KEYINS must be loaded, and accepts input into the array A. This is then transferred character by character to the floppy disc in binary format. A carriage return is used as a record separator. The file to accept the data must be assigned to stream 1, and must be empty.

3. GETDSK

This CATY program reads binary data from the disc, and displays it on the terminal. A pause in transmission can be made by pressing the switch register LAM button. On a second press, transmission continues.

Operation:

A) DATA TRANSFER

1. Declare console as 10 CONSOL = 1,1,8.
2. Read in KEYINS !SR KEYINS.
3. Read in main program !RD1 KEYDSK.
4. Assign data file !AS1:1,DATA1.
5. Run !RUZ.
6. Program should then print a ?

Take the terminal out of remote and into Basic. Load CARTRD program and follow instructions given.

7. Press remote key down.

The data transfer will then start - to end transfer type CNTRL X, then quickly put the terminal in local and type CNTRL A.

B) DATA READBACK

1. EXIT BASIC.
2. Erase program in CATY by !NE.
3. Read in playback program by !RD1 GETDSK.
4. Assign data file !AS1:1,DATA1.BIN.
5. Run !RUZ.
6. To pause press SWREG interrupt, press again to resume.

5.5 Timing and frequency measurement programs

The Camac crate has a toggling scaler module, which together with an external interface allows the system to log various timing/frequency inputs.

5.5.1 Use of the external timing interface

Card 2 in the 19" rack contains the timing interface, which enables the system to log time or frequency. The panel controls are:

(1) Timebase - 1μs, 10μs, 100μs or 1000μs.

(2) Function - timer (t), frequency (f), test, and external (ext).

(3) Event - 1 (2 mm sockets I/P) or 2 (BNC socket I/P), (TTL levels).

(a) Timer mode

The time between event pulses is logged in units set by the timebase switch. The maximum intervals for each of the ranges are as table 1. This mode is used in the Bergen current meter calibration program (6.0) and in the optical carriage speed measurement (5.5.3).

(b) Frequency mode

The input is connected to the 'freq' input of the interface. A level greater than 0.6V and less than 5V is required. It is advisable to set the Timebase selector to 1000μs to avoid spurious glitches on the frequency input line.

(c) Test mode

In this mode, the frequency of the internal timebase is measured, this should be as table 1. Any deviation suggests a fault in the interfaces.

(d) External mode

The frequency and event pulses are routed from the front panel connectors.

Event inputs

The 2 mm sockets are specially wired to accept a Hall-effect probe for Bergen current meter calibration. Other devices to use this input must be able to sink 6mA at TTL levels. The input to the BNC socket is at TTL level, with a 3KΩ pull-up resistor.

The optical carriage speed is coupled to event input 2 internally, but this input can be used as a wired-OR.

TABLE 1

Timebase position	Max. interval	Test mode frequency
1μs	16.77s	1 MHz
10μs	167.7 s	100 kHz
100μs	27.9 min	10 kHz
1000μs	279 min (4 hrs 40 min)	1 kHz

5.5.2 Frequency measurement program

Program name: FREQ 1 Language: CATY 2.0

Location: Disk WAV002

Date: 17/12/79

Origin: G. Griffiths

Strings used: CONSOL 1,1,8

SWREG 1,1,13

SCALER 1,1,18

Program specification

To measure a frequency input in the range 2 Hz to 400 kHz via the external interface and to print it on the console. The ability to compute an average frequency is also required.

Program operation (see 5.5 for selection of mode)

Read in program by typing !RD1 FREQ 1, then run by typing !RUZ. After a short pause the program asks: Do you require mean frequency?

Answer 0 for yes, 1 for no. Logging starts when the switch register interrupt button is pressed, a second press stops the logging. Every second, values of the frequency in Hz are printed on the screen.

Note: when in average mode, the maximum sum is $\sim 16.7 \times 10^6$, and when the sum is likely to exceed this figure, an average frequency is automatically printed.

5.5.3 Optical speed measurement

Program name: SPEED 2 Language: CATY 2.0

Location: Disk WAV002

Date: 17/12/79

Origin: G. Griffiths

Strings used: CONSOL 1,1,8

SWREG 1,1,13
REGIST 1,1,12
SCALER 1,1,18

Program specification

To measure the speed of the carriage to an accuracy of <0.2%±3 mm/sec in conjunction with the timer interface, and 1 metre (±3 mm) spaced reflectors.

Program operation (see 5.5 for selection of mode)

Read in program by typing !RD1 SPEED 2, then run by typing !RUZ. Starting and stopping are accomplished by pressing the switch register interrupt button. The mean speed in mm/sec is printed. Note that the first two and last events are neglected to avoid errors.

Interface settings

Timebase: 1000μsec, Event: 2; switch on optical interface (card 3).

6.0 BERGEN CURRENT METER CALIBRATION

The Wavetank Data Logging System is now able to calibrate Bergen current meters.

The following items are required:

1. Counter/Timer Interface (in the 19" rack).
2. Hall effect probe.
3. Disk WAVØØ2 and tape 'BERGEN'.

It is assumed that the computer system is ready to use: i.e. that BASIC is running in the terminal, and CATY in the PDP11. (See Wavetank Data Logging System Operating Manual).

USER INSTRUCTIONS

1. Place Disk WAVØØ2 in disk drive 1.
2. Switch on disk drive, and carriage speed readout.
3. Place tape 'BERGEN' in the left slot of the terminal.
4. Press 'Read' key.

   The tape light will flash and a message will appear.

   Wait 2 minutes for the programs to be read from the tape and the disk.

   When the second message appears, the system is ready.
5. Press SWREG LAM ('L' button on switch panel above terminal).

   This will start the data logging, the first two revolutions will not be logged to avoid start-up errors.
6. To stop the sampling press the SWREG LAM again.
7. If the data is good, and you want it to be plotted, press the 'ENTER' key on the terminal.
8. To reject data - press 'ESC' on the keyboard.
9. To log additional runs, repeat from step 5.
10. To finish logging and plot the data, press the 'Break' key as indicated by the program. This will give a listing in logged order of all the accepted data. The program then computes limits for each axis of the

graph as:

(a) max. carriage speed in cm/sec,

(b) maximum rotation frequency in Hz, for the given pulses per revolution.

A graph of the results is then plotted. Numeric results, including the best fit line slope, intercept on the rotation frequency axis, and the best fit threshold speed are available after pressing SHIFT STOP together, twice.

11. For another set of runs, repeat from step 4.
(Note: the tape will automatically rewind on completion of step 10).

12. At any time after step 4, pressing the CLEAR DISPLAY key will stop the programs and return the user to the start of step 4. Note that all logged data will be lost - and no plot will be displayed.

6.1.1 BERGEN - Update 1 (15/1/80)

Purpose of update:

To allow logging of a miniature propeller type current meter which produces a higher pulse repetition frequency.

Operation:

The operation is identical to the original, with the addition of specifying the current meter type when prompted. Note that if the pulse repetition frequency becomes greater than 10 Hz, the printout will stop, and every tenth sample will be flashed onto the switch register. This program can cope with up to 400 pulses per second.

6.2 PROPEL - pulse time data acquisition onto disc with graphics

Program name	: PROPEL	Language : BASIC
Location	: Tape PROPEL-DISC	
in conjunction with		
Program name	: BERG 2	Language : CATY 2.0
Location	: Disk WAV002	
Date	: 15/1/80	
Origin	: G. Griffiths	
Strings used	: SWREG 1,1,13	
	SCALER 1,1,18	
	REGIST 1,1,12	
	CONSOL 1,1,8	

Program Specification

As BERGEN with update 1, but to include the following facilities:

(1) The ability to store raw data onto a disk file during a run, and to access the data at the end of a run.

(2) To plot the raw data as a time series, calculate statistics and check errors.

Program Operation

This is similar to BERGEN, except the program in BASIC is loaded from tape PROPEL. The program requires an unique file name under which the data will be stored.

To store raw data onto disc, press SHIFT TEXT when prompted, this will put a file section onto disk. Then the ESC or ENTER keys can be used as in BERGEN.

At the end of a session, either before or after pressing BREAK, pressing SHIFT G-DSP will enter the readback program. Note that the record program cannot then be re-entered - hence if SHIFT G-DSP is pressed before BREAK, the regression data and plot are lost.

To read data from a file, a file section letter designator is required, this is explained in Appendix C. The program then reads the data from disc, calculates mean and standard deviation and then plots the data as a time series. The option is given to display another data file section or to end the session. Note that data file sections can only be read in the order that they were written, though file section skipping is permitted.

Appendix A File formats for Raw and Archived Data on Tape Cartridges

1. Raw Data Files

A feature of the HP2647A BASIC is that to read 2 or more variables on the same line, they must be separated by a delimiter, i.e. a comma. The format used is of free length files terminated in a single end-of-file mark. Each line has the format

a_1 , a_2

where a_1 is the data value and a_2 is the channel number.

The first three lines of the raw data file contain run information passed from the Camac switch display and consist of

b_1 , c c = s + 3

b_2 , c s = number of scans*channels

b_3 , c

where b_1 = Run number, b_2 = Sampling rate in units of 10 ms, b_3 = number of channels scanned and c is the total number of lines transferred*.

In order for other data acquisition programs to use the utility programs, they must conform to the above file format.

2. Archive Data Files

Each raw data file processed by the program AQUIRE has two archive files associated with it. These are a header information file and a data file.

2.1 Header Information File

The following details are contained within the file:

Date

Time

Run # Sampling Rate (ms) Channels

# of samples Scans

Number of scans averaged

Nominal carriage speed

Line of comments

The time and date are obtained from the command channel and need to be reset daily. The nominal carriage speed and the line of comments (80 characters) are from the question/answer of AQUIRE. All the other information

*Note: The ADC appears to end its final scan with value of -10V for channel 1, this is not trapped by the WAVE program and it is advisable to enter a number $>(c - 4)/b_3$ for the number of scans when using AQUIRE.

is copied from the values set up on the Camac BSD. The file is marked with a single end-of-file.

2.2 Data File

The data file is organised as follows:

<<<	START DATA	>>>
<<<	MEAN	STANDARD DEVIATION >>>
	$\bar{x}_1$	δ_1
	x_2	δ_2
	.	.
	x_{16}	δ_{16}
***	END OF FILE	***

The first two lines and the last line are for information, and are ignored by the PROCESS program. A single end-of-file marks the end of the data file.

Appendix B Data Format on Floppy Disc

The data format on floppy disc as used by the program WAVE 1 is as follows:

1. Single variable per line, negative sign optional - generated by PUTBIN1:'55, where '55 is ASCII negative sign as the data file is assigned to stream 1.

Otherwise the data is transferred using the PRINT@1: command.

FORMAT

Three pairs of header lines

Run #

# of samples

Sampling rate

# of samples

# of channels

# of samples

This is followed by data and channel number lines.

data $^{C}_{R}$

ch.# $^{C}_{R}$

data $^{C}_{R}$

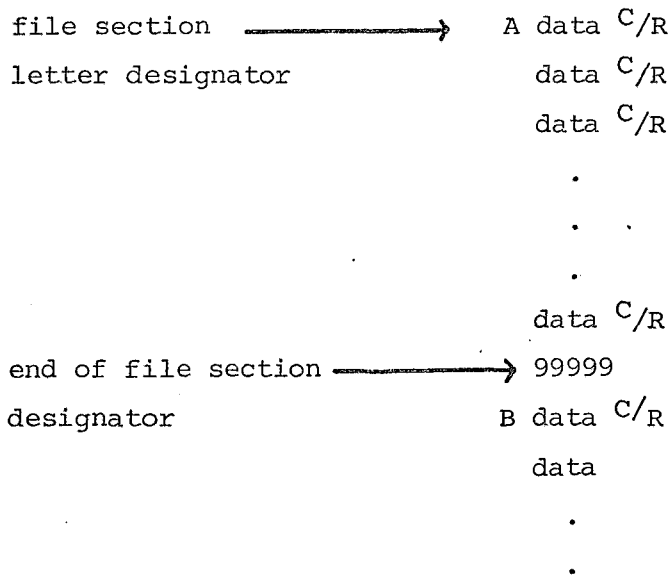
ch.# $^{C}_{R}$

Data can be unsigned or signed.
Negative, and up to 9999 in magnitude.
N.B. Channel number must always be positive.

where $^{C}_{R}$: carriage return '15 in ASCII. This is used as a terminator, and is used in the readback program.

Appendix C Data Format on Floppy Disc for Program BERG 2

All the data logged by PROPEL/BERG 2 is kept in one file, if several runs are logged then the file has several file sections. The file section boundaries are marked as follows:



The file section letter designators start at A (octal 101) and continue in sequence; up to 63 file sections can be used.

List of file section designators

file #	designator
1 to 26	A to Z
27	[
28	\
29	]
30	^
31	_
32	`
33 to 58	a to z
59	{
60	¦
61	}
62	~
63	DEL