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MINICOMPUTER SOFTWARE FOR TIDAL MODELS.

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ABSTRACT

Physical models of estuaries and tidal waters are commonly used as a tool to investigate and design civil engineering projects, such as reclamation schemes, navigation channels, and port works. Such models use a variety of instruments to record water levels, velocities and salinity. In recent years, developments in electronics and computing have enabled a much more efficient and detailed logging and analytical presentation of model data.

This report contains details of two suites of programs developed for use on tidal models. It is divided into two main sections for each suite; the program details to be used by programmers wishing to update/amend the programs for different applications, and running instructions used by the person operating the model who need have no previous computing experience.

All the programs are intended to be easily adaptable to run on any PDP11 system whatever the operating system. However, major changes to the plotting subroutines will be required if a different graphics terminal is used.

CONTENTS

1 INTRODUCTION

Tidal model software on the PDP11 minicomputer consists of two suites of programs. The first is for data acquisition and analysis with simple graphical output. The second is for producing EPROMs which can be used for generating tides and triggering devices (eg. cameras, clocks etc.) during a tide.

1.1 Use of the minicomputer on tidal models

Analog data from models is provided by various types of instruments eg. Water level transmitters, salinometers etc., and fed through a rack of HR built interfaces which scale the signals to fit the range -2.5 to +2.5 volts (or 0 to 5 volts depending on type). These analog inputs are converted to binary numbers (0 to 1023) by the analog to digital converter board (AR11) in the PDP minicomputer. The digital output can then be translated into prototype measurements by use of suitable calibration factors and offsets.

Analysis of the data from physical models can be done in several ways. Data can be stored on magnetic tape (reels or cassettes), sent down a network line to a central minicomputer or stored in the computer's memory for immediate analysis. The first two methods allow several types of analysis to be carried out at any time on a remote computer, but the last allows only the single analysis as data is lost when the computer is switched off.

The new tidal programs provide a fourth method of analysis. Data is stored in the memory for simple analysis and graphical display. The user can then store the data on a floppy disc for future use on the model or for transfer to another computer system for more detailed analysis. Prototype data is also stored on the disc to give graphical comparisons.

1.2 Purpose of the report

The purpose of the report is to introduce the user to the two suites of programs and then to describe in greater detail their usage and structure. The report is divided into two main sections for each suite; the program details and running instructions. The user need only concern himself with the latter since this contains all the information necessary to use the programs without going into the technical and structural detail covered by the former.

1.3 Data Acquisition

At present the programs run on a PDP11/34 running RSX11M v3.2, but for use on a model, the programs will be transferred to a PDP11/04 running RT-11 v2.1.

There are four types of data collection and plotting programs:

(i) Water-level program.
(ii) Salinities program.
(iii) Non-directional velocities program.
(iv) Directional velocities program.

All programs are run using a menu-driven system so that the user can sample, plot or tabulate as many times as are required during data collection sessions. Data can also be stored in named files on floppy discs for re-analysis at a later date.

There are also initialisation and editing programs for setting up and amending data files for use by any of the above. These are also run using the menu system enabling the user to select the level at which editing is carried out (file, record or single data value).

1.4 Producing EPROMs

The programs for producing EPROMs for use on tidal models can be run either on the PDP11/04 used for data acquisition or on the main PDP11 /34 in the Computer Unit.

There are four programs available:

(i) Tide curve program

The user inputs data for producing a tide and can then check the curve when it is plotted to the screen. If not satisfactory, the data can be edited within the program or by using the PDP editor. Output data in hexadecimal format can then be sent to the PROM programmer using program (iii) below.

(ii) Device triggering program

The user inputs data for triggering up to eight devices at specified points or time intervals during the tide. Blocks of data can be repeated for any number of channels.

(iii) Reading/writing EPROMs program

Data produced by (i) and (ii) above is sent to the PROM programmer. The program can also be used for listing old EPROMs in order to find out what they contain.

(iv) Plotting EPROM data program

Files containing EPROM data can be plotted to the screen.

2 HARDWARE

The main minicomputer system comprises:

PDP11/34 with 128K memory running RSX11M v 3.2.
RK07 disc-drives.
VT55 terminal (with graphics facility.)
Decwriter (LA120) for hard copy listing.
Data I/O Model 20A MOS memory programmer.
(Plus other peripherals not used in this project.)

When used on a model the hardware required will be:

PDP11/04 with 16K memory running RT-11 v 2.1.
RX01 floppy disc-drives.
VT55 terminal (with graphics facility.)
Decwriter (LA120) (optional for hard copy listings)
Data I/O Model 20A MOS memory programmer.
Rack of interfaces connected to the computer through an AR11.
Intervalometer (external clock) for triggering sampling.

Reference should be made to the following manuals where more details are required.

RT-11
Vol 2 System User's Guide
Teco User's Guide
Vol 3 Macro-11 Reference
Vol 4 Fortran User's Guide
Fortran Language Reference

RSX-11M
Vol 2 MCR operations
Vol 5A Guide to writing I/O drivers

Fortran IV
Language Reference Manual

Plotting routines
VT55 Programming manual
Fortran / RT-11 extensions manual

3 DATA ACQUISITION SOFTWARE

3.1 Water levels

Program WLPROG is used to measure water levels at various positions on the model and to display the resulting tide curves along with the expected tide curves. The results can also be tabulated and stored

on disc for future use. The program can handle up to twelve water level transmitters which are scanned as near to simultaneously as possible.

The program consists of three stages.

(i) Input of WLT offsets

The program reads the WLT offsets from the file OFFSET.DAT which is created using program STILL (qv). The program then asks whether sampling is required. If not, it reads the data from the existing file named and proceeds to the output stage.

(ii) Sampling the WLTs

The program scans the WLTs at intervals when triggered by the external clock. The water levels are scaled and stored in arrays for plotting. The raw data is stored in the file DIAGS.DAT for channel checking. If required, the program checks the data for three consecutive levels being the same, and if so, prints a warning message to the terminal. (NB. Only the first occurrence on a channel is treated this way.)

(iii) Display of results

The model results can be tabulated, displayed graphically or stored in a file by selecting the appropriate options from those given (see running instructions below for details).

When tabulating the results, the maximum and minimum water levels are calculated and displayed.

The graphical displays are of two types:

(a) Model results together with field values. (Range = 0.0 - 12.0)
(b) Differences between the two. (-1.0 - +1.0)

The field data is read from the file WPROTS.BIN which can be created or edited using program INIT (qv).

More data can be sampled if required by repeating stage (ii).

3.2 Salinities program

Program SALIN is used to measure salinities at various positions on the model and to display the resulting salinity curves along with the prototype curve. The results can also be tabulated and stored on disc for future use. The program can handle up to twelve salinometers which are scanned as near to simultaneously as possible.

The program consists of three stages:

(i) Initialisation

The program asks whether sampling is required. If not, it reads the data from the existing file named and proceeds to the output stage.

(ii) Sample data

The salinities are sampled, scaled and stored in arrays for plotting. Raw data is written to the file DIAGS.DAT for later checking. After 55 scans the program proceeds to the output stage.

(iii) Display of results

The model results are tabulated, displayed graphically or stored in a file by selecting the appropriate options from those given (see running instructions below for details).

When tabulating the results, the maximum and minimum values are calculated and displayed.

The graphical displays show model results together with the selected prototype curve. Prototype salinities are stored in a file SPROTS.BIN which is created or edited by a run of program INIT (qv).

More data can be sampled if required by repeating stage (ii).

3.3 Non-directional velocities

Program VELOS is used to measure velocities at various positions on the model and to display the resulting curves along with the prototype values. The results are also tabulated and stored on disc for future use. The program can handle up to twelve current meters.

The program consists of three main stages

(i) Read parameters

The program reads the channel data and the current meter parameters from files CHANDT.DAT and CMPARS.DAT respectively. The files can be created or edited by a run of program INIT (qv). The program asks whether sampling is required. If not, it reads the data from the existing file named and proceeds to the output stage.

(ii) Sampling data

The current meters are scanned at selected intervals and the data values scaled using the current meter parameters already read in. If required, the program checks the data for three consecutive values being the same, and if so, prints a warning message to the terminal. (NB. Only the first occurrence on a channel is treated this way.) Raw data is stored in the file DIAGS.DAT for checking. After 55 scans of the meters the program proceeds to the output stage.

(iii) Display of results

The model results are tabulated, displayed graphically or stored in a file by selecting the appropriate options from those given (see running instructions below for details).

When tabulating the results, the maximum and minimum values are calculated and displayed.

The graphical displays show model results together with the selected prototype curve. Prototype velocities are stored in a file VPROTS.BIN which is created or edited by a run of program INIT (qv). Since the velocities are non-directional there is a facility for inverting the data to give a better picture of the model curve. (See operating instructions for more details.)

More data can be sampled if required by repeating stage (ii).

3.4 Directional velocities

The program is similar to the non-directional velocities program above except that the directions of the velocities are also read during sampling. Two additional files are used during the first stage. These are DIROFF.DAT and POINTS.DAT containing the direction meter position offsets and pointers respectively. Both files are created or edited by a run of program INIT (qv). These values are used in scaling the collected data. Because the directions are known no data inversion is required when plotting.

3.5 Initialisation programs

3.5.1 Program INIT

Program INIT is used to set up all the parameter and prototype data files used. The prototype files created are in binary format with record lengths as shown below and the parameter files are in card-

image data format. It can also be used to edit selected files (see running instructions for details).

The program gives the option of selecting a single set of files or all four by selecting 'W','S','V','D' or 'A' as appropriate. It then uses the appropriate subroutine to input prototype values and parameters.

In all cases the whole file can be listed and then selected records can be amended. The prototype data can also be changed at element level (to avoid retyping 55 values each time). See the editing instructions given later for further details.

3.5.2 Program STILL

Program STILL is used to set up the WLT offset file used by WLPROG. Each WLT has an offset constant which has to be evaluated when the water level is still and may vary from day to day. Therefore WLTs are read once a day (with still water) and the offsets are evaluated by typing in a reading which specifies the actual water level.

The program asks for a point gauge reading and takes a single reading from each water level transmitter. Data is output to the screen and if the values are acceptable they are written to the file OFFSET.DAT.

4 RUNNING INSTRUCTIONS

4.1 Data collection programs

The following instructions apply to all data collection programs. Where differences occur (eg. extra questions) these will be shown by [*?] where ? will be one of 'W','S','V' or 'D' indicating the program name concerned.

When replying to the questions type the character or data value(s) required followed by < CR > (Carriage return).

Type RUN program name < CR>

Dialogue follows:

Stage 1:
Initialisation

Program reads in any required data from the appropriate files.

Do you wish to proceed to the results stage ?
Type Y to sample new data, N to use an old file.

If N:
Type filename :
    Type filename of data file to be used.
Proceed to output stage.

Stage 2:
Sampling

[*W,V] Consecutive value checking required ?
    Type Y or N as required.

The program now samples the data.

[*W,V] Error messages indicating three consecutive equal values for a channel are displayed and the alarm bell rung if any errors are detected.

At the end of 55 scans:

Stage 3: Output

Type R-erun, S-top, L-ist, W-rite to disc, G-raphs

    Type in letter to select option.

Option R: Rerun - Sample again.

Program re-samples data. Select next option.

Option S: Stop - End the run.

Exits the program.

Option L: List - List to terminal in tabular form.

The model results are tabulated on the terminal in blocks.

Press < CR> to continue
    Press < CR> to continue with next block,
    < CTRL Z> to list maxima and minima.
Select next option.

Option W: Write to disc - Store data in a file.

Type filename [6 chars]
    Type required filename.

Option G: (Nearly all different here.)

[*W] Type D-ifference : P-lots : E-nd
    Type D for difference plots,
    P for model against field plots,
    E to select next option.
If plotting :

Channel ?
Select channel to be plotted.

Last two questions repeated for all channels required.

[*S,D] Channel ?
    Select channel to be plotted.
Prototype curve no ?
    Select prototype curve to be used.

Last two questions repeated for all required plots.

[*V] Type I-nvert : P-lots : E-nd
    Type I to invert the current plot,
    P to plot prototype and model curves,
    E to select next option.
If P:
Channel ?
    Select channel to be plotted.
Prototype curve no ?
    Select prototype curve to be used.

If I:
Timesteps ?
    Type in the inversion specification as follows:

Type two integers representing the first and last values of the range to be inverted. For single point inversion input a single value. If the values specified are not in the range 1-55 or if the last value is less than the first, the question is repeated. Terminate with zero.

Last three questions repeated for all required plots.

4.2 Initialisation programs

4.2.1 Program STILL

Type RUN STILL < CR >
Point gauge reading ?
    Type reading.
Data values are displayed on the terminal.
Calibration OK ?
    Type Y to write to file, N to repeat.

4.2.2 Program INIT.

Type RUN INIT < CR >
Creating new or amending old files [N/O]
    Type O to edit existing files.
If N:
Previous data will be lost
Continue ?
    Type Y to create new files.

```
Indicate which files are to be set up:
S[alinities]   :
D[irection]    :
V[elocities]   :
W[ater levels] :
A[ll four]     :
     Type in letter to select option.

Option S: Salinities.
Edit prototype data file ?
     Y to use subroutine PROEDT (qv).

Option D: Directional velocities.
Edit directional data file ?
     Y to use subroutine DIREDT (qv).

Option V: Velocities.
Edit prototype data file ?
     Y to use subroutine PROEDT (qv).
Edit channel parameter file ?
     Y to use subroutine CHNEDT (qv).
Edit current meter parameter file ?
     Y to use subroutine CMPEDT (qv).

Option W: Water levels.
Edit field data file ?
     Y to use subroutine PROEDT (qv).
```

4.2.3 Data file editing instructions:

Subroutine PROEDT.

```
Prototype data editing operates on three levels;
file, record and element.  The commands available
are:

(i) File level

A-lter - Change to record level.
E-nd - Finish the run.
L-ist - List present contents of file.

(ii) Record level

Select curve to be changed in reply to:
Curve number ?

C-hange - Change to element level.
F-inish - Return to file level.
L-ist - List the specified record.
N-ew - Insert a new record by typing in the required
values after the prompt:
Point n : (where n = 1,55.)
```

(iii) Element level.

F-inish - Return to record level.
P-rint - Print element of the selected curve to be listed in reply to: Element number ?
R-eplace - Insert single element by typing in the required values to:
Type element number, new value :

Subroutines DIREDT, CHNEDT, CMPEDT.

Parameter file editing commands are:

L-ist - List present contents of file.
E-nd - Re-write the file and finish the run.
C-hange - Change a record for a particular meter depending on file type as shown below.

CMPEDT
Meter number ?
    Type integer meter number.
The present record is displayed.
Type new record for meter n :
Input six real numbers.

DIREDT
Type meter number, position, offset :
    Input two integers and one real.

CHNEDT
Type channel, meter no and position :
    Input three integer numbers.
Type depth code for channel : I
    Input one of:
    B - Bed
    M - Middle
    S - Surface.

4.3 Program names and associated files.

The files are:			Rec length
*W	Water levels program:		
	WPROTS.BIN	Water level of field data.	48
	OFFSET.DAT	WLT offsets.	
*S	Salinities program:		
	SPROTS.BIN	Salinities prototypes.	48
*V,D	Both velocities programs:		
	VPROTS.BIN	Velocity prototypes.	48
	CHANDT.DAT	Channel data.	
	CMPARS.DAT	Current meter parameters.	
*D	Directional velocities only:		
	DIROFF.DAT	Directional offsets.	
	POINTS.DAT	Pointers.	
	All files:		
	RUNNO.DAT	Latest run number.	

Notes: The default for all Y/N questions is 'N' obtained by pressing < CR >. For all other questions where a choice is given, the reply must be one of the characters specified. If not, the question is repeated.

Plotting: The programs check that the channel and prototype curve numbers selected are within the correct ranges for that particular program. If not, the questions are repeated.

5 THE MOS MEMORY PROGRAMMER PROGRAMS

5.1 HEXPLT

To produce digitised values of tidal waveforms in hexadecimal format suitable for input to an EPROM. The values are plotted and changes can be made as necessary.

Options:

Data:
Data can be typed in at the terminal and stored for future use or read from a file.

Any units can be used for X and Y values - the program will set up scaling factors such that $0 < X < 2047$ and $-127 < Y < 127$.

Editing:
If the curve plotted is unsatisfactory the input data may be edited within the program and the new curve drawn. The program reads the input and asks if the value(s) need changing. X,Y limits can be changed and data values can be amended, deleted or inserted at selected values of X.

Plotting:
Labelled vertical grid lines optional.

Markers showing points at which values were input are available if required.

After editing the new curve can be superimposed over the old one - shown shaded.

Checks made:
Maximum values must be greater than minimum values.

Data values must lie within specified limits.

X values must be strictly increasing.

5.2 CHTRIG and CHTRIN

To produce hexadecimal values in the required format to program an EPROM which will be used to trigger up to eight devices (eg. camera, clock etc) at specified points or intervals during a tide.

The output values represent eight-bit numbers, each bit of which corresponds to one device or channel. The bit is set to '0' if the device is to be triggered, to '1' if not. The least significant bit corresponds to channel 0 and the most significant to channel 7.

Options:

Data:
Data can be typed in at the terminal and stored for future use or read from a file.

Any units can be used for X values - the program will set up scaling factors such that $0 < X < 2047$.

Up to eight channels may be selected - ranging between 0 and 7.

Start and end values are required for triggering over an interval. To obtain an instantaneous trigger set the end value to 0.

(CHTRIN only) Blocks of data can be repeated for subsequent channels.

Checks made:
Channel numbers selected must lie in the range 0 - 7.

If end value = 0, end = start (ie single point).

The channel number triggered must be one of those specified.

X values must lie within range given.

If end value not 0, start value must be less than end value.

5.3 PROMPROG

To enable EPROMs to be programmed and read using the MOS memory programmer connected via a DZ11 terminal line to a PDP11/34 running RSX11M.

The program connects to terminal line TT13: and communicates to the MOS memory programmer by use of interactive commands. (See running instructions for details.)

If a connexion cannot be made the program outputs a message and exits.

5.4 PRPLOT

Read a hexadecimal formatted data file and plot the resultant curve.

Options:

File:
Choice of three input formats:
1. INTELLEC 8/MDS
2. 'HH ' (old format - not used now)
3. As produced by '#'

Program:
Can be repeated as many times as required.

Checks made:

Checks that the format is one of the three specified above.

Checks that all characters are hexadecimal.

6 OPERATING INSTRUCTIONS

If running on the main minicomputer programs can be run using the menu driven command file PROM. Log in to the PDP11, type PROM and select the appropriate option. All programs are automatically run under [30,41] so files produced will be found there.

```
;
; Prom programming
;
* Job number or username [S]:
     As given on form.
;
; Answer with appropriate number for:
;
; Tide curves (HEXPLT) ( Ans 1)
; Triggering devices (real) (CHTRIG) (Ans 2)
; Triggering devices (integer) (CHTRIN) (Ans 3)
; Read/write EPROM (PROMPROG) (Ans 4)
* Plot EPROM data (PRPLOT) (Ans 5) [0]:
```

Select required program. See individual running instructions below.

On completion of HEXPLT, CHTRIG or CHTRIN asks:
* Ready to write EPROM ?

If Y:
; Set up programming unit for Remote Control but do not press START/
; STOP until program PROMPROG is running.
;
* Press < CR> when unit is ready ? [Y/N]:

If N:
* Edit data file ? [Y/N]:
     N for output stage.
* Filename [6 chars] ? [S]:
     Filename used.
* Edit OK ? [Y/N]:
     N to repeat edit.
     Y returns to menu.
On completion of HEXPLT, CHTRIG or CHTRIN asks:
* Do you want O/P listed ? [Y/N]:
If Y:
* Name of file [6 chars] [S]:
     Filename used above.
Prints .DAT and .HEX files with given name.
* Another program ? [Y/N]:
     Y to return to menu.

If running on a model simply type RUN program name.

6.1 HEXPLT

(Use only the Digital Decgraphic scope terminals)

New input data:

Type filename to be used [6 chars]
     Type in the six characters of the required filename. [.DAT]
New or old data ? [N/O]
     Type N (for new).

Min & Max values : [4]
     Type in four real values for X-min, X-max, Y-min, Y-max.
First data values : [2]
     Type in first X and Y values.
Next values : [2]
     Type in subsequent data.

At the end of the input the screen is cleared.

Type heading
     Type in a suitable heading for the plot (max. 20 characters).
Vertical grid lines ? [Y/N]
     Type Y for grid lines dividing the plot into eight sections.
Markers required ? [Y/N]
     Type Y for markers indicating points for which data has been input.

Curve is now plotted. Press COPY button for hard copy.

Is plot OK ? [Y/N]
If Y,
Clear screen ? [Y/N]
Last filename used - ABCDE1
End of program.
If N,
Program proceeds to the editing stage during which it is possible to change some or all of the data values. This is done by a series of questions and all replies are checked for validity.

Old input data:

In this case a file of data has been created during a previous run or by using the computer's editor.

Type filename to be used [6 chars]
     Type filename.
New or old data ? [N/O]
     Type O (for old)
**** INTERPOLATING ****
Program reads the data and interpolates the curve.

Plot is produced as for new data.

6.2 CHTRIG

New input data:

Type filename to be used [6 chars]
     Type in the six characters of the required filename. [.DAT]
New or old data ? [N/O]
     Type N (for new).

Type X-MIN and X-MAX [2]
    Type in two real values for limits X-min and X-max.
Type channels [0 - 7]
    Type in channel numbers of all devices to be triggered.
Data:
    Type in channel number, start and end positions for each interval/point required.
At the end of the data type
< CTRL Z >
**** END OF RUN ****

Old input data:

In this case data has been created during a previous run and/or using the computer's editor.

Type filename to be used [6 chars]
    Type filename.
New or old data ? [N/O]
    Type O (for old)
**** WORKING ****
**** END OF RUN ****

6.3 CHTRIN

Run as for CHTRIG except for :
Data for channel I :
    Type in start point, end point for specified channel ending with < CTRL Z >. (Strictly increasing values for start.)
Repeat block of data [Y/N] ?
    Type Y for repeat of data for the next channel specified.

6.4 PROMPROG

Set up the programming unit for remote control (see later.) Check that the unit is attached to line 13 on the PDP11. Place a blank EPROM into the COPY socket.

> RUN PROMPROG/PRI=100.

PROMPROG version xx

Writing:
?
Type:
    I < CR > To instruct unit to accept input in INTELLEC 8/MDS format.
    INPUT = filename .HEX file to be used (6 chars).
Ok
Program reads the file and writes to the programming unit's memory.

> If successful.

Type:
P < CR > - To program contents of memory into the device in the COPY socket.
> If successful.

Type:
V < CR > - Verifies the copy.

> If successful.

Repeat for required number of input files.

Reading:

?
Type:
L < CR > - Loads contents of EPROM into memory.

> If successful.

Type:
OUTPUT = filename .LST file to be used.
Ok
Program sets up file.

Type:
< CR > - Lists contents of memory to the file.

> If successful.

Ending:

Type:
Z < CR > - To exit from remote control.
EXIT - To exit from the program.

NB. To check for blank device type B < CR >. The reply > indicates blank device, E indicates badly installed device and F non-blank.

6.5 PRPLOT

(Use only the Digital Decgraphic scope terminals)

Type filename [6 chars]
Type the filename to be read.
Checks format of file - if not one of the three allowed:
STOP - Error in file
Reads the file and checks for non-hexadecimal chars.
If found:
STOP - Non-hex character (Pos 1/2)

Type heading
Curve is plotted with specified heading. Press COPY to get hard copy of plot.

Any more to be plotted ? [Y/N]
If Y: Repeat from beginning.
If N: End program.

6.6 Selecting filenames for PROM programs

Only six characters are available for filenames.
Input files of X,Y data are filename.DAT.
Files of hexadecimal values are filename.HEX.

HEXPLT:

The suggested format of a filename when running HEXPLT is :-

Characters 1,2 - User's initials.
" 3-5 - First 3 letters of project name.
" 6 - Number to indicate version.
Eg. SMTES1

When the input file is edited, the last character of the filename is updated to indicate different versions of the file. The last filename used which gave a satisfactory plot is output to the screen.
Eg. Last filename used - SMTES3

CHTRIG/CHTRIN:

The suggested format of a filename when running CHTRIG or CHTRIN is:-

Characters 1,2 - User's initials.
" 3-6 - First 4 letters of project name.
Eg. SMTEST.

6.7 INTELLEC 8/MDS format

Intel data records begin with a nine-character prefix and end with a two-character suffix containing the checksum of the record. Each record starts with a colon followed by a two-character byte count. The four digits following give the address of the first data byte. The next two are the record type. Data bytes are represented by two hexadecimal digits.

eg. :10004000112233445566778899AABBCCDDEEFF80

The data is terminated by:
:00000001FF

7 SUMMARY OF COMMANDS USED IN REMOTE CONTROL

7.1 Setting up the programming unit:

Switch on the programming unit. Display shows '2708'.
Install device to be used in the 'COPY' socket.
(NB. Do not turn power on or off when a device is in the socket.)
Select correct PROM code by pressing NEXT or LAST. (Usually 2516)
Press START/STOP button. Display shows 'SEL'.
Press LAST button until 'rC' is displayed.
Start up program PROMPROG.
Press START/STOP button.
The buttons then remain inoperative until remote control is exited.

7.2 Control commands:

RETURN executes each command (except in Edit mode).
In Edit mode RETURN exits.

ESCAPE or BREAK commands cause the programmer to halt any operation in progress.

7.3 Utility commands used:

- L - Loads data into memory from the device in the socket.
- P - Programs contents of memory into the device.
- V - Compares data in memory with data of device.
- I - Accepts data in INTELLEC 8/MDS format and stores in memory.
- #,O - Outputs contents of memory to the host system.
- B - Check device for any programmed bits.
- X - Outputs any error codes accumulated.
- Z - Exits remote control.

7.4 Response characters:

- - On entering remote control. After successful completion of an operation.
- F - After failure of an operation.
- ? - After invalid command.
- E - When EPROM is incorrectly installed.