INTRODUCTORY GUIDE TO DIGITISING WITH THE LASER-SCAN LASERTRAK

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1 *OBJECTIVE OF THIS GUIDE*

This introductory guide is designed to train new operators the method of digitising map data with the Laser-Scan Lasertrak semi-automatic digitiser. It assumes the user to be a novice operator with some cartographic skills and explains basic system operation in step-by-step procedures. Most descriptions are limited to those essential for basic system operation. A full description of Lasertrak features and commands can be found in the "Laseraid Reference Manual".

2 *INTRODUCTION*

The Laser-Scan Lasertrak is a semi-automated line-following digitiser for the mass conversion of line drawings into digital form. It performs the conversion under the guidance of an operator who directs the system to each line for digitising and who intervenes with appropriate feature coding and assistance when required. Actual line digitising is performed automatically and is achieved with minimum operator intervention in most cases.

The Lasertrak system is based on the same hardware configuration as is being used in Laser-Scan's High Resolution Display device (HRD-1). Readers are referred to the HRD technical manuals for details of the hardware configuration and software interface.

The source documents for digitising on Lasertrak are film negatives which are photographic reductions of the original source drawings. The film negative is of standard A6 microfiche size (148mm x 105mm). This source image is inserted into the optics unit of the Lasertrak on the film negative holder and thence the image for digitising is back-projected on to the large format display screen for interpretation by the operator. Though all scanning is carried out on the fiche-size negatives, the operator can observe all digitising and software decisions on the enlarged projection of the display screen.

The digital data generated by the Lasertrak are placed directly into a linear (vector) form as though they had originated from a manual digitising table. All digital lines (including curves) are represented as straight line segments between two digitised coordinates. Clearly, lines of extreme curvature have considerably more coordinates than straight lines: two end-points are used to demarcate and fix the latter case.

The system of coordinates that is generated by the Lasertrak is selected by the operator during the machine set-up stage. The target coordinates of four known control points are provided to the system which then ensures that all subsequent digitising is performed in relation to the same coordinate space.

The representation of line features is also defined by the operator who is able to direct the laser cursor along appropriate routes during digitising and determine the feature start and end locations, its attribute code and so on.

The name given to the controlling software which drives the Lasertrak during digitising is LASERAID. This is the program which runs on the Digital VAX and MicroVax series of computers and which converse with the Lasertrak hardware to produce the automatic line-following capabilities of the system. This manual describes the nature of the Laseraid program and the basic facilities it provides for the operator during digitising. There are three main

methods of line following that can be used with Laseraid and these include normal line-following (both solid, continuous lines or dashed lines), extended line-following with junction recognition capability and finally edge-following mode to digitise, for example, the outer periphery of colour mask sources.

3 *COMPONENTS OF THE LASERTRAK SYSTEM*

The five diagrams which follow show the components of the Lasertrak system. Diagram A shows the whole of Lasertrak with pointers to the locations of key control panels which operators should be aware of. These panels are referenced by the letters B-E, which corresponds to the titles used for the four close-up diagrams which follow diagram A.

A summary of the five component diagrams is given below.

A - The Lasertrak system components and control panels
B - Main control panel
C - Engineer's panel
D - Operator's panel
E - Optics unit and film carrier

A convention has been used in this document so that each control switch on each panel is labelled uniquely. This reference system is used throughout in the text descriptions which follow. Thus, the reference (**C**23) used within the text refers to diagram C, control switch number 23 - in this case, it is the photo-chromic clamp switch.

A

A

A

A

A

4 *PHOTOGRAPHY CONSIDERATIONS FOR FILM NEGATIVE PRODUCTION*

4.1 *Choice Of Documents*

To digitise a map accurately the source document must be on a stable based transparent or translucent film. Source documents on paper are equally able to be digitised but operators should be aware of accuracy limitations.

Before photographing, it must be decided to what reduction factor the film negative will be made for the map; this depends on the size of the map, the widths of the line-work, the strength in density of the lines and the complexity of the detail on the map. The Lasertrak projects the source negative at a 10X enlargement on the photochromic screen, so if photographed at less than 10X reduction factor the map will be larger on screen than the original. This is recommended to aid the Lasertrak operator and also as a starting point on deciding the reduction factor necessary.

4.2 *Considerations Of Line Quality*

The ideal line for Lasertrak is one which is crisp and black with a clear background. However, within certain limitations, the Lasertrak can also handle lower quality source data and operators will quickly appreciate by experience its capabilities.

The diagram below may help: it gives some example enlargements of a line showing various possible densities

4.3 *Linewidth Specifications*

The minimum linewidth required for digitising is 0.03mm (0.0012 in.) on the reduced negative, the maximum is 0.3mm (0.012 in), and the optimum is about 0.04mm on the source negative.

4.4 *Film Negative Size And Its Relationship With Source Documents*

The film negative should be 105mm wide, 148mm long. The digitising area is

placed centrally as shown in the diagram below.

The exposure should have an optical density of approximately 0D1. Laser-Scan recommends Kodak ON4 film.

The digitising region on the map must be reduced to fit the area on the negatives as shown above. Some examples follow which show the size of the map and the reduction factor necessary.

Reduction Factor	*Original size (Max)*
x 2	10.6 x 13.6
x 3	29.4 x 20.4
x 4	39.2 x 27.2
x 5	49.0 x 34.0
x 6	58.8 x 40.8
x 7	68.6 x 47.6
x 8	78.4 x 54.4
x 9	88.2 x 61.2
x10	98.0 x 68.0
x11	107.8 x 74.8

If the map is too big to be reduced within x10 reduction factor or if it can not meet the linewidth requirement, then it needs to be photographed in sections so that more than one film negative is produced for each map. This also applies if the map is too complex and needs a low reduction factor to define the lines clearly on the negative. If there is a gap between two lines to be digitised of at least 0.4mm on the screen then it will be possible for the machine to follow all lines. Some examples below show some typical Laser-Scan experiences.

4.5 *Pre-Photography Enhancement And Map Definition*

4.5.1 *Control Points* -

Each full map (or each sub-division if it is necessary to digitise a map in portions) must have four clear control points. These must have at least the same line qualities as the lines which comprise the map data. It is sometimes an advantage to draw the control points outside the edge of the data to help the Lasertrak to locate them but is not crucial.

There follows some examples which, show the required location of control points for maps which are to be digitised in portions.

4.5.2 *Photography Reference Marks* -

It is an advantage to always mark on the map an upward pointing arrow prior to photography. Clearly this should not obscure data to be digitised and aids operators in ensuring correct film orientation when it is placed into the Lasertrak. In general, the arrow should always be made to point so that it is aligned along the shortest map axis to enable the effective use of the maximum reduction factor possible.

Also marked on the map should be a reference name and a small opaque block (approx. one inch square) which will be used within Lasertraks check made for machine tuning - see section 9.4.

Examples of these additions are shown below.

4.6 *Calibration Grids For Each Batch Of Photography*

Always, when photographing a new batch of negatives, a square grid is also photographed to enable Lasertrak calibration for this batch. The grid should have a pitch of 2cm or 4cm squares (1 or 2 inches). The grid should also have an arrow and an opaque block as previously explained in pre-photography enhancements (section 4.5.2). Use of this calibration grid negative is essential and details of machine calibration are given in section 9.5. It is also essential that the calibration grid is photographed in exactly the same position and orientation as the map data photography. It is futile to take map data photography in one orientation and take a photograph of the calibration grid in a totally different orientation; this results in total loss of registration when measuring the distortions inherent in the camera lens.

4.7 *Photographic Stage*

4.7.1 *Positioning On Photographic Table For Film Maps -*

First of all position the map on the photographic bed so that the North arrow is pointing upwards and the map text is forward reading. Flip the map over so that the text becomes reverse reading and then rotate it through 90 degrees so that the upward arrow in now pointing to the right. Notice that in both the start position and the final position the lower left control remains as the same negative control point.

The quickest way to achieve correct orientation is to move the bottom right hand corner of the map to the top left. This procedure is copied for the grids. N.B. It is recommended to position the digitising area of the map as centrally as possible.

4.7.2 *Film Negative Exposure* -

We have now reached the stage where we have marked up the maps and positioned them onto the photographic bed. The camera should then itself be moved to the required settings to give the reduction factor which has been decided. It is *CRUCIAL* that the camera is *NOT* moved again until the photographic session (or batch) is complete. The photographic exposures of each map in the batch and the standard grid can now be made.

Laser-Scan always takes at least three different exposures of each map and grid thereby giving the Lasertrak operator a choice of exposures from which the best can be selected. Before doing a large batch it is a good idea to take several test exposures first to try to determine the best setting for the Lasertrak. Once the best exposure has been decided the full batch can be made.

Use side and back lighting on the camera for the best results.

4.7.3 *Paper Maps: Some Minor Differences* -

We do not recommend using paper maps for accuracy reasons, though in some cases it can not be avoided. The only difference in using paper is in the positioning on the photographic bed: all other procedures should be following exactly as before.

When positioning paper on the photographic bed rotate the map through 90 degrees without turning it over e.g.

The grid should be positioned exactly the same as was used for the paper described above. Only use side lights on the camera for paper maps.

4.8 *Preparation Of Film Negatives For Entry Into The Lasertrak*

Once the photography has been completed and developed successfully, each negative should be cut so that it fits neatly into the Lasertrak film carrier. Section 4.4 describes the details of film size.

The following sections (5-11) describe the operations necessary to use the Lasertrak for digitising. Details are given on setting-up the hardware from cold and also the various stages and modes of software operation.

5 *SYSTEM HARDWARE START-UP PROCEDURES*

The instructions which follow explain the procedures necessary to start-up the Lasertrak hardware; they assume that the system is currently switched off with no power being supplied to either the projection system or the lasers. Confirmation that the system is in this off state is provided by the following symptoms:

Main control panel(**A**5):

(a) Master power-lock key in off, vertical position (**B**9)

(b) Green confirmation on/off light extinguished (**B**10)

(c) Orange photochromic display (**A**2) extinguished: note other machine states can produce similar symptoms - see details on diazo plotting and main shutter switch under section 5.1.

(d) Water cooling unit and water supply should also be switched off.

The procedure to power-up Lasertrak from cold involves following a series of steps in sequence as are described below.

(a) Switch on water supply for the laser cooling system

(b) Turn clockwise to horizontal the master power-lock key on Lasertrak main panel (**B**9)

(c) Depress green master on/off button to power-up machine: confirmation is given by green illumination of this button (**B**10).

(d) Confirm that machine status is on-line by adjusting the 'M/C STATUS' switch to its on-line position (**B**11).

The Lasertrak is now in a powered-up state confirmed by the illumination of the green power-on light (**B**10). Under normal circumstances, further confirmation of this switched-on state will be the appearance of the orange colour to the photochromic display screen; this will start to appear after about thirty seconds and will reach full brightness within five minutes.

5.1 *Potential Problems*:

Symptom	Cause	Correction
Green power light fails to illuminate (*B10)	- Lack of power supply	
Orange display screen fails to illuminate, when green power light is on	- Main shutter switch in closed position (*C28)	Switch main shutter to open
	- Machine in diazo plotting mode	Run SETHRD Initialising routine See 7.2

6 *LOADING OF SOURCE NEGATIVES FOR DIGITISING*

Lasertrak digitises its line work from 105mm source negatives as produced at the photography stage (see section 4). These documents should be placed with correct orientation into the negative carrier (**E**32) for insertion to the optics unit of the Lasertrak. The negative loading procedure is described in detail below.

(a) Check that the correct negative is available and select that with the best contrast of dark and light if several negatives are available.

(b) Set the photo-chromic clamp switch on Lasertrak's engineers panel to open (PC clamp switch to upward position) (**C**23).

(c) Open the door of the optics unit by rotating the key anti-clockwise (clockwise on Fastraks) and pulling open the door (**A**3).

(d) Unclamp the negative carrier by moving the zone plate clamp to the left (E34).

(e) Withdraw the negative carrier from the optics unit by sliding it out through the door. ENSURE THAT THE CARRIER DOES NOT FOUL THE PHOTOCHROMIC FILM DURING THIS OPERATION. Careful withdrawal can obviate this problem.

(f) Remove existing negative from the holder if present.

(g) Check that the film holder is clean and free from dust and greasy finger prints.

(h) Hold the new source negative so that it is the correct way up (with text reading correctly). Rotate it so that the negative is still the correct way up but with the text reversed. Laser-Scan suggest that user's include an arrow pointing upwards on all Lasertrak photography to provide easy reference of negative orientation (see Section 4.5.2).

(i) Place the negative on to the negative carrier and slip it under the spring loaded edges. Take care not to mark the glass with dirty fingers.

(j) Replace the negative carrier complete with negative in the optics unit, ensuring that the glass side of the carrier is pointing towards the rear of the Lasertrak (i.e. towards the orange projection bulb) and the negative side is positioned adjacent to the photochromic film.

(k) Re-engage the zone plate clamp by sliding the lever to the right to fasten the negative carrier in place. (**E**32).

(l) Close the door of the optics unit and lock it by pushing firmly and rotating the key clockwise (anti-clockwise on Fastraks) (**A**3).

(m) Re-position the photochromic clamp switch on the engineers panel to closed (PC clamp switch to downward position) (**C**23).

The negative is now in position and operators can begin to invoke software procedures necessary to digitise linework from it. Note that the negative should be projected clearly on to the Lasertrak display screen with all control points and drawing extremes visible. If the image is not completely visible then readjust the position of the negative in the carrier until the complete image can be seen on the display screen.

7 *COMMENCING A COMPUTER SESSION FOR DIGITISING*:

7.1 *The Login Procedure*

The Lasertrak system connects to a standard Digital Equipment VAX and MicroVax series of computers running a version of the standard VMS (or MicroVMS) operating system. Before any digitising session can commence, the operator must first log on to the VMS system at the Lasertrak close-up terminal. Readers are referred to the collection of manuals on VMS produced by Digital Equipment for the detailed command structure and facilities.

Basic login is achieved by prompting the attention of the computer and supplying a valid user's code and password. Prompting the attention of the computer is achieved by hitting the <return> key slowly several times. Successful connection is confirmed by the command.

USERNAME:

The operator replies with a valid user code (hitting return to signify completion of typing). On the command

PASSWORD:

the operator types in the valid security code (which is not displayed on the screen) and successful completion will be confirmed with a report of the version of VMS currently installed and the VMS prompt symbol:

$

The dollar symbol '$' is the standard VMS prompt and signifies to the user that the computer is at DCL command level (This can be considered the stage when the operating system can accept commands in the Digital Control Language known as 'DCL'). At this stage, any legal DCL command or appropriate Laser-Scan command can be entered as required.

7.2 *The SI And SD Commands*

7.2.1 *Basic Use* -

A basic digitising session on Lasertrak first involves the operator directing VMS to the appropriate file directory into which will be placed the digitised vector coordinates. All files of digitising have by default the file extension '.IFF' to their names. IFF stands for Internal Feature File and is Laser-Scan file structure generated by the Lasertrak and other Laser-Scan mapping systems. Specifying the appropriate target directory in which to place the IFF file is achieved with the Laser-Scan command SI ('set IFF directory'). This command is given in response to the VMS ($) prompt and may take the form

SI file directory
e.g. SI DRA2:[BUREAU.COASTLINE]

The command is not mandatory but is advisable for effective file handling on VMS. Failure to include the 'SI' command prior to digitising will result in the IFF files being generated in a default directory with logical name LSL$IF:.

Users should also note a complementary Laser-Scan command 'SD' which directs VMS to the user's default directory on which can be run standard VMS commands. Typical use of the command may take the form

SD file directory
e.g. SD DRA2:[BUREAU.COASTLINE].

7.2.2 *The SI And SD Commands - Advanced Use -*

There are a number of extensions to the SI and SD commands in which abbreviations can reduce considerably the amount of typing required. The list below with 'SD' and 'SI' compares the command syntax necessary with standard VMS equivalents.

SD
Set/Show the default directory

Examples:	Equivalent to:
SD	SHOW DEFAULT (also SD @ and SD ?)
SD FRED	SET DEF [FRED]
SD .FRED.BILL	SET DEF [.FRED.BILL]
SD DRA2:JOHN.FRED	SET DEF DRA2:[JOHN.FRED]
SD "	SET DEF [-] (move up to parent directory)
SD .JOHN	SET DEF [---.JOHN]
SD	select your main directory
SD .FRED.BILL	select one of your sub-directories
SD :FRED	select login disc and directory [FRED]
SD.	re-select the previous current directory
	- can be repeated ad nauseam (also SD <)
SD DRA1:	select same current directory name on device DRA1:
SD logical name	select directory defined by given logical name
SD [FRED]	same as SD FRED

Users are referred to Digital Equipment VMS manual volume 2A for details of the SET DEFAULT command.

7.3 *Initialisation Of The Lasertrak Display And Digitising Laser*

Before users can invoke the Lasertrak digitising software, it is first necessary to initialise the scanning hardware. This is achieved by issuing two Laser-Scan commands in reponse to the VMS prompt. The first command takes the form:

SETHRD (which can be abbreviated to SETH)

This initialises the large screen display and re-sets various parameters in the system. Note that this command will also return the device to photochromic mode if it is currently in diazo mode. Confirmation of the successful completion of this operation is achieved with the appearance of the orange display screen and all function buttons extinguished. Operators should not confuse or mistype SETHRD (abbreviated to SETH) as 'SET H' since this is a standard VMS/DCL command 'SET HOST' which performs rather different functions not discussed here. Note also that the SETHRD command (even in its correct form) is unable to complete successfully if the Lasertrak is off-line to the computer. In such an event, the following warning message will persist until the device is switched on-line.

'FASTRAK OFF-LINE - PLEASE SWITCH ON-LINE'

The Lasertrak is switched on-line by raising (or rotating) the 'M/C STATUS' switch (**B**11) on the main control panel to the on-line position from the downward off-line position.

The second initialising command for Lasertrak digitising takes the form:

COL RED

This invokes the red laser for refresh mode in Lasertrak. Failure to use 'COL RED' may result in an inappropriate initialisation of the Lasertrak for digitising. The default option (i.e. no use of 'COL RED') is to use the blue refresh laser rather than red. Generally it is advisable to use the red refresh laser while digitising. Both the SETHRD and COL RED commands are mandatory at least once during a digitising session, although often a standard command file is provided to do this when the user logs in.

8 *INVOKING LASERAID FOR DIGITISING*

8.1 *Introduction*

Laseraid is the name of the controlling software used by the Lasertrak hardware for digitising. Its operation requires the following information to be available before the session commences:

(a) Is the session starting a new map or is it adding to a file that has already started on a previous session?

(b) What is the name of the file into which the digitised line work is going to be placed?

(c) What is the name of the Lasertrak parameter file for this job and has it been calibrated?

8.2 *Overview Of The Laseraid Run Command*

The command string necessary to invoke Laseraid is given in response to the VMS prompt. It consists of the Laseraid startup command and two parameters; all of which are mandatory with options to include additional keywords for other facilities. The command and two parameters (plus optional keywords) are typed on a single line and terminated by carriage return: they are separated by one or more spaces. It is recommended that the order in which the parameters are specified is adhered to for routine production work.

Command:

LAJ this acronym stands for Lines, Area-features and Junctions.

Parameter 1:

typically takes one of two keywords (though there are others - see Reference Manual) which defines the current status of digitising for the current file in question, these two keywords are:

IFF

- Specifies that this digitising session is opening a new file of output for the first time.

OLD

- Specifies that digitising has already been started in a previous session and the current session will be adding to the work created previously.

Parameter 2:

is the file name into which the digitised output from Lasertrak is

to be placed. It must follow parameter 2 above. The file name is given either with or without a three character VMS file extension. File names given without an extension are assumed to have the suffix '.IFF'. File names given with an extension preserve this extension in the output file name.

e.g.	FRED	producing FRED.IFF
	BERT.IFF	producing BERT.IFF
	TONY.DIG	producing TONY.DIG

If the keyword 'OLD' was supplied for parameter 1, it is essential that the file name given in parameter 2 already exists in the current IFF target directory.

NON MANDATORY COMMANDS:

Parameter filename specifier

By default, Laseraid will call up LNK.LAJ as the parameter file which Laseraid will use to control its performance in digitising for the current map. The parameter file (sometimes called the 'patch' file) will often change according to the nature of the digitising production to be undertaken. Therefore a different 'patch' file may need to be assigned. Basic operators need not be totally conversant with the parameter file and merely need to know its name and status of calibration for the current batch of source photography.

The names of parameter files follow normal VMS conventions . File extension comprises of up to three characters and is by default .LAJ . It is recommended that the default naming convention is adhered to for easy reference, although it is possible to specify alternative naming conventions.

Note that all parameter files for Laseraid are expected by the software to be found in the directory with the logical name:

LSL$LK:

In order to specify a 'patch' file in the command line, the following keyword must be entered before the patch filename.

WITH 'patch filename'

Photochromic frame selection

NP

The photochromic film will be wound on one frame automatically when Laseraid is invoked

Contour elevation specifier

HTD HTI

The commands 'HTD' or 'HTI' (optionally followed by a numeric argument) may be specified to instruct Laseraid of the desired method of coding for heighting (or elevation) data in contour digitising. The mnemonic 'HTI' forces coding to be restricted to integer coding only and the codes placed in IFF as a type 2 Ancillary Code (for integer contours). Typical examples of integer coding includes 3003, -36, 27, 295.

The mnemonic 'HTD' forces coding to use the decimal option for the coding of elevations; these will be placed in IFF as a type 3 Ancillary Code (for real contours). Users are referred to the descriptions of the IFF structure which is given in the IFF user's guide. Particular reference should be made to IFF ACs (ancillary coding).

The optional numeric value which follows 'HTI' or 'HTD' initialises the elevation datum to that value. Increment or decrement of this elevation datum is achieved by functions buttons whilst digitising (see section 10.3.1 para k).

The default method of coding elevations without the use of 'HTD' or 'HTI' is to use the feature serial number entry in the IFF file (the NF number - see IFF reference manual). More detail of using Laseraid in either normal 'feature' mode or special 'height' mode is given in sections 10.2.1 and 10.2.2

There now follows several examples of the command strings necessary to invoke Laseraid.

(i) **LAJ IFF FRED**

invokes Laseraid for a new file to be called FRED.IFF in the current IFF target directory using the default laseraid parameter file LSL$LK:LNK.LAJ

(ii) **LAJ OLD ROCKVILLE**

invokes Laseraid to continue digitising into the file ROCKVILLE.IFF using the default parameter file LSL$LK:LNK.LAJ

(iii) **LAJ IFF N22631NW WITH 056141**

invokes Laseraid to start new file called N22631NW.IFF using parameter file LSL$LK:056141.LAJ

(iv) **LAJ OLD TEMP.123 WITH TEST.ABC**

invokes Laseraid to continue digitising into file TEMP.123 with parameter file LSL$LK:TEST.ABC.

(v) **LAJ IFF EVEREST WITH LNK122 HTD 300.5**

invokes Laseraid to digitise into a new file 'EVEREST.IFF' using parameter file LSL$LK:LNK122.LAJ. Decimal heights are to be coded with the start (initial base) being 300.5 units.

9 *PREPARATION OF LASERAID FOR DIGITISING*

9.1 *Overview*

Laseraid divides naturally into three stages.

STAGE 1

The first stage is where various necessary machine parameters and system calibrations are set-up. It includes the measurement of a standard grid and the control points, and input of operator identification details, feature coding schemes to be used and so on. See section 9

STAGE 2

This is the stage in which the feature (an edge,line or symbol) to be digitised is selected and any extra details such as its code and hierarchical level (layer) is supplied. See section 10

STAGE 3

This is the actual scanning process: here, measurements which are determined by Lasertrak produce digitised coordinates to represent linear features in a numeric, vector form. See Section 10.3 and 10.4

The results generated during stage three can be either accepted, or rejected if errors have been made. In any event, the program will return to stage two for the selection and coding of the next feature. A typical digitising session will then comprise alternating between stages two and three until the work is complete when the 'end-of-session' command 'EOS' is given to terminate the Laseraid program and return the operator to VMS main mode.

9.2 *Laseraid Introductory Messages And Start-Up*

Once Laseraid has been invoked successfully (as described in Section 8) there are four confirmation messages. The first gives the version of laseraid which is implemented, the second confirms the designated parameter (or 'patch') file, the third confirms the destination IFF file, and the fourth confirms successful initialisation. For example, the following command string

LAJ IFF FRED WITH PATCH.116

might produce

```
Laseraid [LAJ] of 11:28:36   01-Jun-1986
LSL$LK:PATCH.116;0
LSL$IF:FRED.IFF
Initialisation completed
```

line 1 gives the current version of Laseraid being run
lines 2 and 3 confirm the parameter file and target output file being used and the statement 'Initialisation completed' is the final response to confirm that Laseraid has started correctly and is awaiting a command from the operator.

9.3 *Laseraid Command Structure And User Interface*

Commands are supplied by the operator to the program via the function buttons (FBs) and the close-up screen keyboard. In general, the most common commands at any time are available on the function buttons, whilst less common commands (and those requiring numbers or text as arguments) are given via the close-up screen keyboard. All commands available on the function buttons at any time are equally available via the keyboard and are given as their three character mnemonic names. Typing the command "?" at the keyboard at any time when a command is expected will print out all the commands available (both on the function buttons and the close-up keyboard). Typing "??" will provide a summary of all the Laseraid commands available in the current mode, whilst "? command" will give an explanation of that command.

Laseraid does not give operators any prompt character (as does VMS, for example, with its dollar sign). However, the function buttons have the ability to light-up and extinguish to show both program status and the availability of options at any one time.

9.3.1 *Function Button Commands* -

A function button numbering system (**D**30) is used throughout Laser-Scan documentation and this is explained below

```
 ----- ----- ----- -----
I     I     I     I     I
I FB1 I FB2 I FB3 I FB4 I
I     I     I     I     I
 ----- ----- ----- -----
I     I     I     I     I
I FB5 I FB6 I FB7 I FB8 I
I     I     I     I     I
 ----- ----- ----- -----
I     I     I     I     I
I FB9 I FB10I FB11I FB12I
I     I     I     I     I
 ----- ----- ----- -----
I     I     I     I     I
I FB13I FB14I FB15I FB16I
I     I     I     I     I
 ----- ----- ----- -----
```

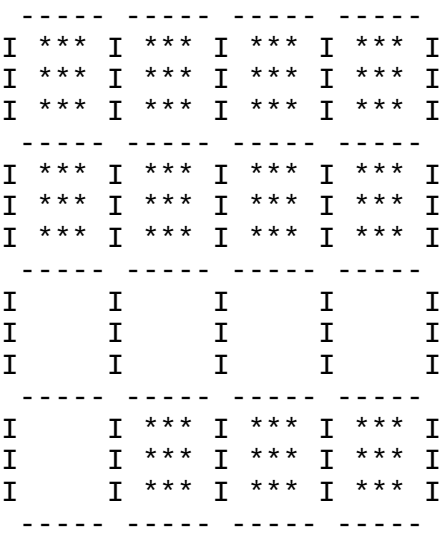
In general, only those function buttons which have relevance in a particular stage of the Laseraid program are illuminated. The meaning of some buttons do change in different modes of the program, though some preserve the same meaning throughout; FB16 is an example of this latter case as it always means ABAndon, which is the failure exit, returning the operator to the previous level and undoing as much as possible as it goes. FB4 is usually ACCept, which is the successful completion. Other buttons are used for commands specific to that program level. The extra commands are positioned so that the pattern of function button lights is easily recognisable for each level, and this will become relevant in subsequent sections of this manual.

9.3.2 *Keyboard Commands* -

Commands at the keyboard are recognised by their first three letters, hence ABA is sufficient for the ABANDON command. Those commands requiring either a numeric or a text argument should have the complete details typed on the same line. A full summary of Laseraid commands is given in the Laseraid Reference Manual: they are listed also in Appendix A of this manual.

9.4 *Initialisation Stage*

Once Laseraid has been invoked successfully (and the statement 'Initialisation completed' is given on the close-up screen), the program enters the main mode level. This is the basic level of Laseraid from which all subsequent modes are entered to perform specific tasks. More details on Main Mode level are given in section 10.3; confirmation of Main Mode Level is given by the pattern of function button lights as shown below:

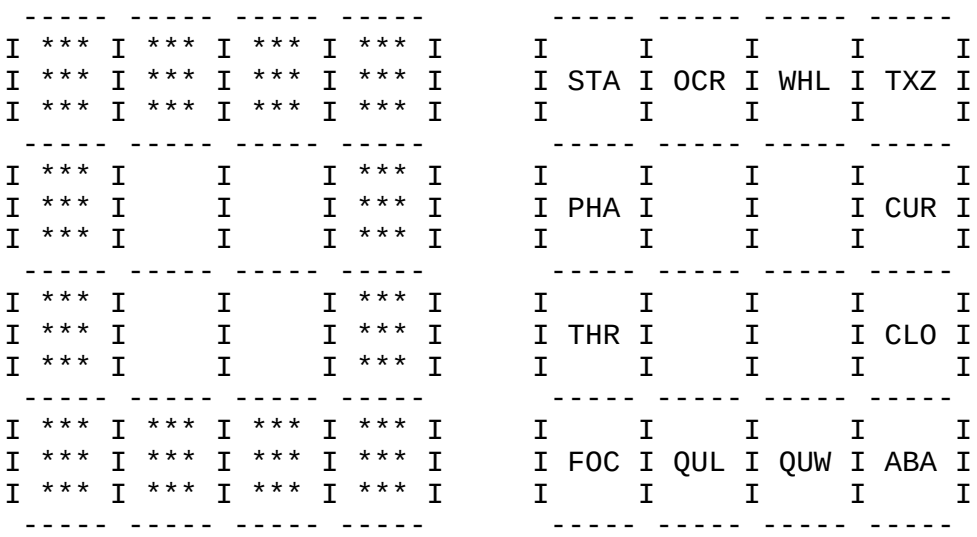


The first procedure advisable once Laseraid has been started is to determine and confirm that the scanning hardware is reading the source map correctly. To perform this tuning, the operator should enter 'check mode' which is achieved by typing the three character mnemonic

CHK <return>

on the close-up screen keyboard whilst in main mode.

The result is to place control into Laseraid check mode which is confirmed by the function button pattern of lights:



The equivalent keyboard commands are shown alongside,

where:

STA	=	STArt vector
OCR	=	Offset and Counts Ratios
WHL	=	draw WHite Line
TXZ	=	clear close-up screen
PHA	=	set the PHAse correction
CUR	=	CURsor positioning from the close-up screen
THR	=	set the THResholds
CLO	=	draw a CLOse-up around the laser cursor position
FOC	=	set the red beam FOCus
QUL	=	confirm QUality of Line positioning over the scan
QUW	=	confirm QUality of line Width over the scan
ABA	=	ABAndon check mode and return to main mode

The major other commands available in check mode from the close-up keyboard are detailed in the Lasertrak Reference Manual. Under normal circumstances, there are only a few additional commands with which basic operators should be familiar; these are listed below:

TYP n	select a particular line type
PSP	print scanner parameters

Other commands may be manipulated to tune the Lasertrak on each occasion that a new series of maps is to be digitised. This detailed tuning need only be carried out once for a map series and it is advisable that this be performed by a competent system manager.

Details on Lasertrak tuning are given in the Lasertrak Reference Manual.

9.4.1 *Procedures In CHK Mode* -

In most cases, the abridged summary of commands shown above (in section 9.4) are all that basic operators need to be aware of when they wish to start a digitising session. A detailed description of the procedures necessary for machine tuning follows with a brief, repeat summary of all the actions necessary at the end.

(a) The operator should scan the document to be digitised visually as it is being displayed on the photochromic display and select one or a series of line portions which are considered to be representative of the whole map. He should then show to Laseraid his choice of line; this portion of line need be no longer than about 0.25 - 0.4 inches in length. The STArt command (FB1) is used to show laseraid where his choice of line (or vector) begins. The operator should steer the laser cursor cross with the trackerball to the start of the line portion and depress FB1 to issue a STArt command to Laseraid. The effect that this will have is to anchor a start point on the test line.

(b) The operator then shows Laseraid where his test line portion should end - remember to keep its length to about 0.3 inches. To do this, he moves the laser cursor gently along the test line to a new position 0.25 - 0.4 inches away from the anchor point defined in (a) above.

(c) Stages (a) and (b) above have now defined the start and end position of a short vector to be used to tune certain parameters which Lasertrak needs to be able to follow lines automatically. Now this test portion has been defined it need not be re-defined unless the operator wishes to repeat the exercise on other test portions. There are three basic parameters which should be tuned with this test portion of line; these are the Phase (PHA), the threshold (THR) and the focus (FOC). These procedures are explained in stages (d) to (f) below.

(d) The focus is the first parameter that should be tuned under normal circumstances, *but this can only be achieved successfully by first providing an arbitrarily high threshold setting*.

To set a high threshold, the operator depresses FB9 to issue a THReshold command to Laseraid. This command causes the Lasertrak to scan across the test line and produce a graph and cross-hairs on the close-up screen. Typical examples could be as shown below

Examples

The graphs serve to show the operator a visual representation of what the Lasertrak has seen as it scans *across* the test line from one edge to the other. Thus, diagram (i) is a good scan - the plateau peak represents a clear white line with well defined edges. Diagram (ii) is equally acceptable since a plateau is evident; the uncharacteristic peak to the left is probably due to some noise also detected by the scanner or fluctuations in the black areas of the negative. Diagram (iii) is rather more alarming; there is no clear plateau which suggests that the line being scanned has a poor contrast quality or is on the limits of minimum line-width for line-following. Operators are advised that line-following performance may be degraded with such lines and that care should be taken. Other remedies could be to try a negative of better image contrast or to use a smaller reduction factor in the photography and to perform the digitising in halves (see section 4).

A high threshold setting as required by the Focus calibration is assigned by positioning the close-up screen cursor with the keyboard cursor control keys to the far right edge of the threshold graphs and hitting the space-bar.

Examples: high threshold settings

(e) The setting of the Focus is now possible and is achieved by depressing FB13 to issue 'FOC' to Laseraid. This causes Lasertrak to re-scan the test line portion and generate a Focus graph on the close-up screen. If the operator has not pressed FB4 (to issue a 'TXZ' - clear close-up screen command) before starting this stage then the Focus graph will be superimposed on the threshold graph from stage d above. The Focus graph always has a much lower peak than does the threshold graph and a correct Focus setting is achieved by steering the close-up screen cursors to the Focus peak and hitting the space-bar. To distinguish between threshold and focus in the example below, the focus graph is shown as a dashed line. It is advisable to perform focus tests as described above in two directions of test line. Horizontal and vertical test lines should be used to reduce the chances of a badly astigmatic spot.

Example: Focus

(f) The threshold parameter should now be set correctly and this is achieved by repeating stage (d) above, though positioning the close-up screen cursor to about the centre of the threshold plateau peak. It is also advisable to clear the close-up screen first by depressing FB4.

Example
Correct threshold

NOTE: threshold determines how much detail the Lasertrak will see. Setting the close-up screen cursor more to the left of the plateau makes it see more (good for faint lines). Settings nearer to the right makes it see less and hence is useful in very cluttered areas. This threshold can always be modified slightly as digitising is taking place to ensure good machine set-up and best digitising quality.

(g) It is at this stage where operators can experiment with different portions of representative test lines to obtain a good average threshold reading. It is possible to repeat stages (a), (b) and (f) on different line portions. It is generally not necessary to repeat the focus procedures as defined in stages (d) and (e).

(h) Setting the PHAse corrections in both axes (horizontal and vertical) follows next. Operators should repeat the procedure detailed below on two test lines - one that is vertical and one that is horizontal (or as near as possible). The test lines should be clear, straight and continuous (i.e. not broken). First choose the test line and define its start and end with FB1 (see stage (a) and (b) above). Second, clear the close-up screen with FB4. Third, press the PHAse function button, FB5. Since Lasertrak can scan lines both horizontally and vertically, it is important that these scans are produced in phase;

this phase is different for different frequencies and different widths. Phase measurement is performed by Lasertrak automatically in most cases and is confirmed on the close-up screen as a near-straight line graph crossing a horizontal line. There will be a series of these near straight-line graphs for each of the line types that Lasertrak knows to expect from details held in its parameter file. The correct phase setting is achieved where the line-graphs cross the horizontal line. In most cases, Laseraid can determine this for itself.

Example
Phase Correction

This procedure is repeated for both vertical and horizontal test lines

(i) The final parameters which can be set easily in this cycle of events are the Red/Blue offsets and counts ratios; this procedure involves the use of commands WHL (FB3) and OCR (FB2). These measurements do not involve the scanning of white lines on the source negative but of artificial white lines of known characteristics which are drawn by the Lasertrak on a light area of the photochromic film. It was for this reason that a black opaque area was suggested to be included on the film master at the photography stage (see section 4.5.2). First, it is important to select a different line type for white line drawing and this is achieved by typing at the close-up screen keyboard the command

TYP 1 <carriage return>

Next, show the Lasertrak where you wish the artificial white line to be drawn. Use the STArt command (FB1) and mark a line vector of half an inch length (as explained in stage (a) above) on a clear area of the photochromic display. The test line being constructed must be either horizontal or vertical - you will repeat the exercise for both in any case.

Next depress FB3 (the WHL (white line) command) and notice that a white line with dark background is constructed on the photochromic display. Repeated use of the WHL command is suggested to ensure a very clear white line with dark background. If for any reason the white line is not seen to be drawn, it means that Lasertrak's blue laser is not operative; seek further help in such situations.

The actual measurements of offsets and counts ratios can now be performed by depressing FB2 to invoke the OCR command. The Lasertrak is seen to scan repeatedly the white line and display on the close-up screen a graphic representation of the offsets and counts ratios that it sees. The graphs produced - commonly known as the 'goal-posts' are shown below:

Example:
Offset and Counts Ratios

A good measurement is confirmed by a near-straight diagonal line. Repeated measurement by depressing OCR (FB2) again can improve the result. Usual reasons for failure - i.e. diagonals which are not straight - are caused by poor quality white-lines (repeat WHL) or poor threshold settings (repeat threshold measurement). It is recommended that OCR is performed at least twice.

Repeat WHL and OCR for both horizontal and vertical white lines.

(j) This concludes the routine set-up procedures which are carried out in check mode, though there are many other procedures involved in Lasertrak tuning which are detailed in the User's Guide. Basic operators should not concern themselves with these.

(k) The four remaining function buttons in check mode which have not been discussed provide either confidence checks or aids to the machine tuning operations. They are summarised below:

(i) QUL (FB14) and QUW (FB15) give quantitative measurements of the quality of digitising. QUL measures the quality of the observed line position with respect to time and QUW measures width variations with respect to positions across the scan. They are used on any orientation of straight lines.

(ii) CLO (FB12) provides close-up images on the close-up screen of the source data seen by a single scan of the Lasertrak in any selected location which is defined by the laser cursor. This is by far the most useful tool which the operator has to confirm successful tuning. It should always be used after set-up to check for good scans and clean line connections at junctions.

(iii) CUR (FB8) provides an interactive procedure to aligning the position of the laser cursor by means of the magnified images and cursor displayed on the close-up screen. Its use is described

below:

(a) With trackerball point laser cursor in the vicinity of the desired location

(b) Depress CUR (FB8) command

(c) Using close-up cursor position precisely the desired location and hit the space-bar

(d) Laser cursor is seen to move to the exact, required location

(e) Depressing FB16 (the ABAndon command) at any time when in check mode returns the operator to Laseraid main mode which is confirmed by the main modes pattern of function button lights.

9.4.2 *Summary Of Basic Operations In Check Mode* -

1. Enter check mode from main mode with command 'CHK' on close-up screen keyboard

2. Define appropriate test line with STA (FB1) and trackerball using a clear , representative line on source negative

3. Set high threshold value with THR (FB9) and close-up screen

4. Set Focus level with FOC (FB13) and close-up screen

5. Set correct threshold level with THR (FB9) and close-up screen

6. Define appropriate horizontal test line on source negative using STA (FB1) and trackerball. Using two test lines in horizontal and vertical orientation is recommended to test for likely hardware problems.

7. Set horizontal phase level with PHA (FB5) and close-up screen

8. Define appropriate vertical test line on source negative using STA (FB1) and trackerball

9. Set vertical phase level with PHA (FB5) and close-up screen

10. Select line type 1 with command 'TYP 1' on close-up screen keyboard; define and draw a horizontal white line on a clear portion of the photochromic display with trackerball, STA (FB1) and repeated use of WHL (FB3)

11. Measure horizontal offsets and counts ratios (CRX) with OCR (FB2) and close-up screen

12. Define and draw a vertical white line on a clear portion of the photochromic display with trackerball, STA (FB1) and repeated use of WHL (FB3)

13. Measure vertical offsets and counts ratios (CRY) with OCR (FB2) and close -up screen

14. Confirm good tuning with CLO (FB12), QUL (FB14) and QUW (FB15)

15. Leave check mode and return to main mode with ABA (FB16).

9.5 *Calibration Of The Lasertrak For Batches Of Photography*

9.5.1 *Overview* -

The coordinate system used internally by the Lasertrak (which in most cases is transparent to its users) is somewhat different to the coordinate systems used in mapping. Moreover, there are distortions in the Lasertrak's measurement system - due in part to non-linearities in the machine's optics and in part to photographic distortions introduced into the source fiche negatives by the various enlargement and reduction processes which have been carried out beforehand. For all of these reasons it is ESSENTIAL that the Lasertrak is calibrated each time a new *batch* of source photography is to be digitised or after major hardware repair.

In essence, system calibration involves the generation of a set of cubic coefficients which are held in the relevant Laseraid parameter files to compensate for all of the distortions cited above. It follows, therefore, that there will be different parameter files for each batch of photography *AND* also for each different Lasertrak machine. Further, re-calibrations of all parameter files which are pertinent to a particular machine should be carried out after any maintenance work has been performed on the machine's optics system.

The actual calibration procedure (i.e. the generation of the set of cubic coefficients) is achieved by instructing Laseraid to measure the positions of the intersecting lines of a *standard grid*. Source negatives of this grid will have been made at the same time that the relevant batch of map photography was being carried out (see section 4.6). A more reliable set of coefficients will be generated if many grid intersections are measured. The minimum number allowed is sixteen, though Laser-Scan suggests at least twenty five for production work. Indeed, the calibration sections of the software will not allow too few (or inappropriate) points to be measured, reporting "BAD POINT DISTRIBUTION" if attempts are made. The following sub-section describes in detail the procedures that should be performed for machine calibration.

9.5.2 *Lasertrak Calibration Procedure* -

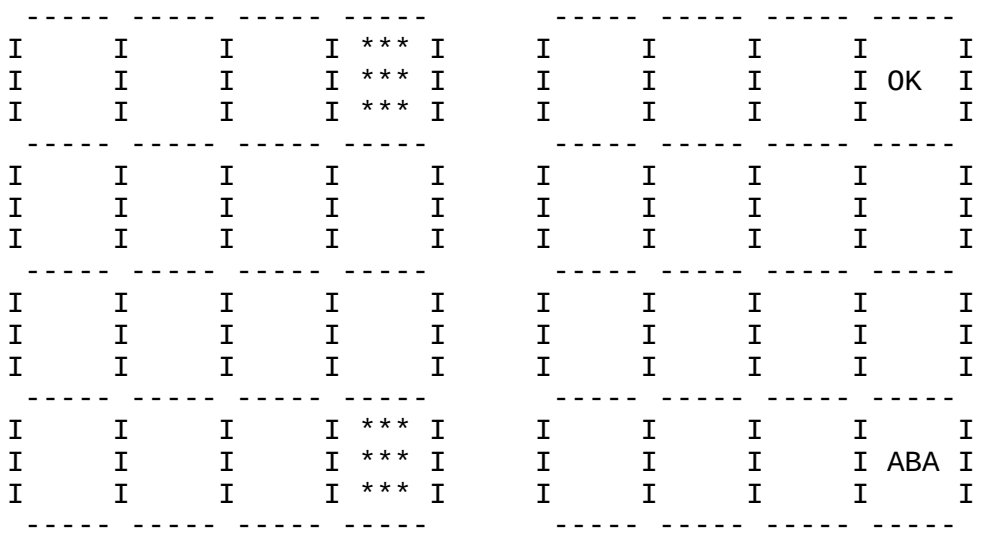
(a) A good contrast source negative of the standard grid relevant to the current batch of photography is inserted into the Lasertrak system (see section 6).

(b) After Lasertrak has been tuned in check mode (see section 9.4) and whilst Laseraid is in main mode, the calibration procedure is invoked with the three-letter mnemonic

CAL

This is the abbreviation for CALibrate and is entered from the close-up screen keyboard followed by carriage return.

(c) Confirmation that Laseraid is in CALibrate mode is given by the function button lights as shown below



Also appearing in the top right-hand corner of the photochromic display screen is a red cursor cross with the adjacent message "upper-right". At this stage, Laseraid is requesting the extremes and pitch of the grid to be measured. Note that at least sixteen intersections should be measured and their locations should cover the extremes of digitising area on the photochromic display screen in order to give a reliable set of cubic-coefficients. There are two commands (both available on the function buttons) at this stage in the calibration procedure. The usual command ABAndon is available on FB16 and this abandons calibrate mode and returns command to main mode. The second command is OK or 'accept' which is available on FB4.

The UPPER-RIGHT extreme of the calibration grid is defined by directing the laser cursor cross with the trackerball to the required grid intersection. This position is confirmed by then depressing FB4 to enter it and proceed to the next stage.

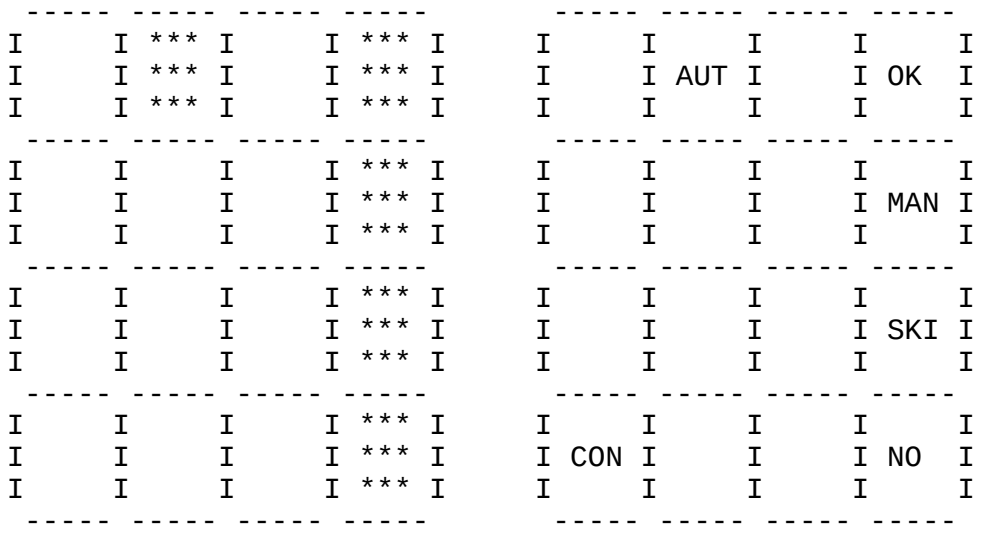
(d) Calibrate mode then seeks to determine the lower-left extreme of the calibration grid. The red laser cursor-cross is seen to move to the lower-left area of the photochromic display and the prompt "lower-left" appears adjacent to it. The location of this lower-left extreme is then selected with the trackerball and confirmed with FB4 "OK".

(e) It is then necessary to show the calibrate mode the x and y grid pitch or 'steps' to be used. The laser cursor should be directed via the trackerball to the required x increment (x direction is considered to be along a horizontal line, y is along a vertical line). Confirmation is given with FB4 "OK".

(f) The y-pitch or step is supplied in a similar way to x in step (e) above.

(g) Once the details of the calibration grid have been supplied as per steps (c) - (f) above, it is then possible to perform the intersection measures. In fact, the Lasertrak will have already attempted to measure the first lower-left intersection and confirmation of success will have been given with a bleep from the close-up terminal and entry

into the second phase of the calibration procedure. This second phase involves the measurement of each grid intersection and a report of each success or failure. Confirmation of entry into phase two of calibrate mode is given by a new pattern of lights on the function buttons as shown below: each of the commands available have importance.



The following commands are available on the function buttons

FB2	-	AUT	- automatic re-scan
FB4	-	OK	- accept measure
FB8	-	MAN	- request manual measure
FB12	-	SKI	- skip or ignore a poor measure
FB13	-	CON	- request automatic, continuous calibration
FB16	-	NO	- quit the calibration and return to main mode

Note above that FB13 has importance here, since although it has no illumination, it is accommodating a command "CON". It has no illumination as yet, because it is a flip-flop command; it is an option that can be either requested or ignored - the default in this case is for it to be ignored. See step (l) below for details of its use.

(h) The procedure now is to measure each of the assigned grid intersections in turn - the Lasertrak knows where each of these are by virtue of the grid details supplied to it in steps (c) - (f) above. The measurement procedure is performed automatically; it is the job of the operator to confirm success of a measure with the "OK" command (FB4). This acceptance enables the Lasertrak to proceed to the next intersection for measurement. As each measurement is carried out, its acceptance is confirmed by a small cross shown on the close-up screen which overlays exactly the measured point. Each grid intersection is measured in this way until the complete grid (as defined initially by the operator) has been examined. There are a number of other provisions and facilities in the calibration measurement procedure of which operators should be aware - these are described in steps (i) - (l) below.

(i) *The AUT command (FB2) - automatic - or re-scan request*. The descriptions of calibration given thus far have assumed that the Lasertrak is able to detect and measure each grid intersection with total success. However, there are occasions when some intersections cannot be detected correctly - possibly because of a low contrast or a poor source negative or conflict with linework. On such occasions, the Lasertrak will report its failure by issuing on the close-up screen the command

"Manual measure please"

At this point, there are a number of options open to the operator. On pressing FB2 to issue a "AUT" command, the Lasertrak is instructed to attempt a re-scan on the suspect point. This can be repeated several times, though continued failure may mean performing a manual measure (see j below) or skipping it altogether (see k below).

(j) *The MAN command (FB8) - request the manual measurement of an intersection*. If repeated attempts to scan and measure a grid intersection have failed as outlined in step (i) above, it is necessary to request operator intervention to measure a point manually. This request is made with FB8 at which time the command 'MAN' is issued. Manual measure involves the Lasertrak scanning the grid intersection and displaying at very enlarged scale on the close-up screen the lines as seen by the scan. The cross hair cursors are also displayed and these can be pointed to the intersection centre by means of the cursor control keys and sent to Laseraid by hitting the space-bar. In this way the grid intersection is measured and Lasertrak will pass on to the next intersection as normal.

(k) *The SKI command (FB12) - skip and ignore a poor measure*. In the event that neither an automatic measure by Lasertrak nor a manual measure by the operator has produced reliable results (perhaps because of a poor source image) it is possible to skip and ignore the offending intersection. This is achieved by depressing FB12 to SKIp rather than depressing FB4 to accept or FB8 to request manual measure. Operators are advised not to ignore too many intersections (especially locally) and certainly to be aware of the minimum acceptable number of measures for calculating the cubic-coefficients (see section 9.5.1).

(l) *The CON command option (FB13) - request CONtinuous, automatic measurement with minimum operator intervention*. Under normal circumstances, this option is very useful and can speed the calibration exercise considerably. The default option is for CON not to run; operators may select it by depressing FB13 (which will be confirmed by the illumination of FB13). Continuous measurement enables the Lasertrak to proceed automatically from grid point-to-grid point with no pause, providing that each intersection is seen clearly without confusion or error. This means that operators no longer have to confirm acceptance of a measurement between points. In the event that a bad measure is encountered, the Lasertrak will halt the continuous option and request "Manual Measure please". At this point the operator can either attempt a re-scan (AUT), manual measure (MAN) or ignore (SKI) as desired. Re-activation of the CONtinuous option is then achieved by further depressing FB13.

(m) *The NO command (FB16) - abort calibrate mode*. Depressing FB16 returns operation to Laseraid main-mode.

(n) *Acceptance or correction of the calibration*. As soon as the last point of the calibration grid has been measured and accepted, the system automatically reports the quality of calibration exercise. The following details are displayed on the close-up screen: confirmation of the number of points which have been measured and accepted and a statement of the residuals obtained between measured and corrected point locations. The summary of the residuals are given in a form as shown in the example below.

```
                    3    4    3    2    4
                    8    5    3    1    3

                   -3   23         4    3
                    6   13         3    3

                   -8   13    8    5    3
                    5   10    3    1    5

                    4   -1   -9   -8   -7
                    6   -7   -2   -4   -4

RMS      8.7    7.9     MAX   23    13   FOR   19 POINTS
```

The above diagram reports the quality of the measurements performed (in units known to Laser-Scan as HRD counts). Users need not be too familiar with those units, though it should be realised that residuals of greater than 15 HRD counts are too large and should be re-measured. In fact, 1 HRD-count represents approximately 1 micron on the negative. The matrix of numbers on the close-up screen represents (by measured intersection location) the residuals in the x direction (upper) and y direction (lower). Thus in the example cited above the reading of x=23, y=13 in row 2, column 2 ought to be re-measured. This is attempted by either auto re-scan (FB2) or manual measure (FB8). Note that row 3 column 2 is a grid intersection without any readings, as that intersection was skipped.

The acceptance or rejection of a set of readings is achieved by either depressing FB4 ("OK" command) or FB16 ("NO" command). Acceptance enables Laseraid to generate the new cubic coefficients and return the user to main mode. Rejection enables users to re-scan, manual measure or skip intersections as described before.

9.5.3 *Summary Of Procedures In A Typical CALibration Run* -

1. Ensure that standard calibration grid negatives for current batch of photography is in Lasertrak and that appropriate machine set-up 'CHK' mode has been performed.

2. Enter CALibrate mode from main mode with command CAL.

3. Using trackerball and laser cursor fix the extreme NE grid intersection with FB4 "OK".

4. Using trackerball and laser cursor fix the extreme SW grid intersection with FB4 "OK".

5. Using trackerball and laser cursor define the x-step increment by positioning the laser cursor on the next required grid intersection to the East of the SW corner. Confirm its position with FB4 "OK".

6. Using trackerball and laser cursor define the y-step increment by positioning the laser cursor on the next required grid intersection to the north of the SW corner. Confirm its position with FB4 "OK".

7. Depress the CONtinuous command flip/flop button (FB13) and accept the measure of the SW corner intersection.

8. Observe the automatic continuous measures of each nominated grid intersection. Intervene with help (AUTo rescans (FB2), MANual measures (FB8) or SKIp points (FB12)) as necessary, when requested.

9. Observe quality of total measures and refine any which are outside tolerance (greater than 15 units) with AUTo re-scans (FB2) and MANual measures (FB8).

10. Accept total measures with ACCept (FB4).

9.6 *Control-Point Measurement To Assign A Coordinate Reference System*

9.6.1 *Introduction* -

In order to digitise with an appropriate scaling and coordinate system, it is necessary for operators to measure the positions of the control points on the Lasertrak and supply details of their known Cartesian coordinates. The positions of the control points need not be square in relation to each other, but they should be located as near to the edges of the map extremes as possible - certainly no more than 10 per cent of the sheets total length away from the edge. The control points should also be clear with a high line-contrast; it may have been necessary to enhance the clarity of the map control points prior to the photography stage (see section 4.5.1).

9.6.2 *Measure Procedure - Control Points (CP)* -

Once the map negative is mounted correctly on its film holder in the Lasertrak, it is possible to measure the control points and assign the coordinate system. The individual steps below describe the sequence of CP measurement.

(a) Control point measurement is performed by issuing the command

CP <carriage return>

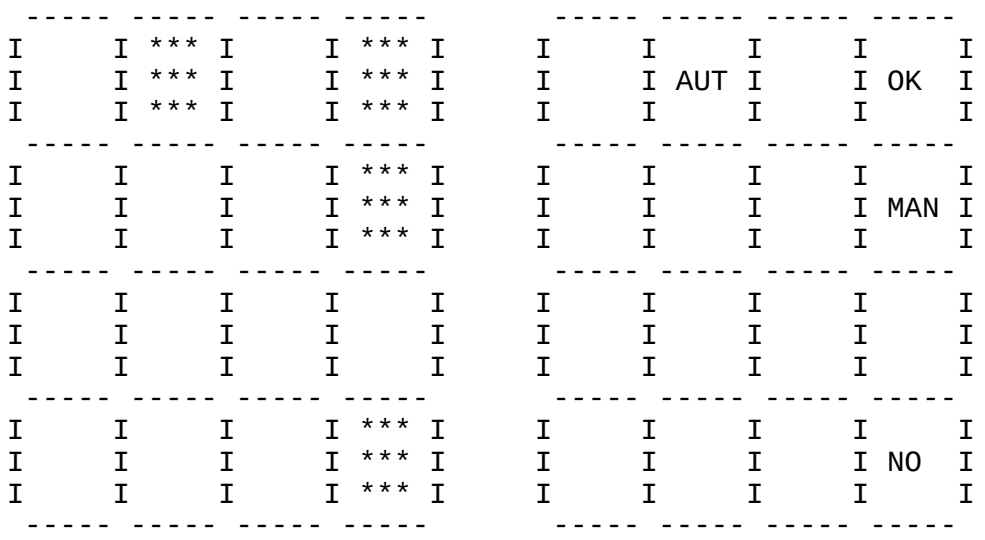
on the close-up screen's keyboard whilst in main mode.

(b) The action of step (a) places Laseraid in control point measuring mode and the laser cursor will move automatically to the vicinity of the first control point to be measured. By convention, all Laser-Scan systems and software adopt the following sequence (or ordering) of control points: NW,SW,SE,NE. Thus, the laser cursor in Measure mode will first attempt to scan and measure the NW control point. If it is successful it will display the default coordinates to be used on the close-up screen and seek confirmation of acceptance. If it unsuccessful in finding the control point, the message

"Can't find fiducial"

is displayed with an audible "bleep".

(c) In failure situations when attempting to scan control point locations, operators should reposition the laser cursor on the appropriate control point and attempt either an AUTo re-scan (FB2) or a MANual measure (FB8). The function button options available this time are described below



FB2	-	AUT	- automatic re-scan control point
FB4	-	OK	- accept measurement
FB8	-	MAN	- perform manual measure
FB16	-	NO	- reject point and abandon Measure mode

(d) Once a successful control measurement has been achieved (confirmed by accurate superimposition of the red laser cross on the source negative cross) it is then necessary to accept it.

This is achieved with (FB4) "OK". As an alternative, rejection would be to perform a re-scan with AUT (FB2) or a manual measure (FB8). Pressing "NO" (FB16) does not reject a single point; it quit Measure mode completely and returns command to main mode. Note all four control points must have been measured and accepted before it is possible to digitise line work.

(e) At this same time, it is possible (and may be necessary) to issue new control point coordinates. These are assigned by typing-in on the close-up screen keyboard the new values for x and y (separated by a space) immediately prior to control point acceptance with (FB4) "OK". The default values which are assumed by the system if no others are supplied, are those which were used during the last run of the current Lasertrak parameter (or patch) file.

(f) There are some important considerations of control point assignments and these are discussed in section 9.6.4).

(g) The remaining control points (SW,SE,NE) are measured in exactly the same way. On each occasion, the laser cursor will look in the vicinity of the relevant control point in an attempt to find and measure each one.

(h) Once all four control points have been measured and accepted, the close-up screen displays their details (including new coordinate values, if supplied) and operators have a final chance to accept "OK" (FB4) or reject "NO" (FB16) them. Acceptance passes on to the final

fiducial error stage (see step i) and rejection quits Measure mode and returns directly to main mode.

(i) *Fiducial Optics Check*. The final stage of the control point procedure is the assignment of an appropriate threshold value for an optics check which gives confidence of accurate digitising. This is an automatic fiducial check performed at intervals automatically by the system to test for such unlikely events as optics drift. The check is performed by re-measuring the position of a nominated control point after a specified number of features have been digitised. If the measured displacement is greater than the nominated tolerance, it will report the fact to the operator who will have to re-measure the control points again as described in this section (9.6.2). The initial set -up of this fiducial check is made at this stage in the procedure. Laseraid requests responses to be given via the close-up terminal to the following three questions:

"WHICH CORNER AS FIDUCIAL (1-4)?"

- operators should choose a clear, distinct control for the fiducial check; the number supplied represents the standard Laser-Scan ordering

-1	=	Select an additional control point
1	=	NW
2	=	SW
3	=	SE
4	=	NE
0	=	do not run fiducial check at all.

Note : If -1 is selected on subsequent remeasuring of the control points, then the values entered for the fiducial checks from the previous measurements will be reassigned. In order to redefine the additional control point for the fiducial check it is necessary to issue the following command whilst in main mode:

CHF 0 0

- The operator will then be able to select a different control point for the fiducial check.

"EVERY HOW MANY FEATURES?"

- Laseraid expects a nominated number of features to dictate the frequency of the fiducial check - Laser-scan suggests every 5 features. Thus the fiducial check would be performed automatically each time five features have been digitised.

"MAX PERMITTED ERROR?"

- this is the allowable distance error of measured position in microns (1/ 1000th of mm) - Laser-Scan suggests every 15 microns

Appropriate responses to each of these questions will give the confirmation message, for example

"FID 3 EVERY 5 FEATURES WITH ERROR LIMIT OF 15 MICRONS"

on the close-up screen and control then passes automatically to main-mode. In the event that the fiducial error limit is reported to have been exceeded whilst digitising, it is necessary for the operator to quit digitising temporarily and re-enter Measure mode for control point remeasurement. If continuous drift is reported by the system during a digitising session, it is advisable to seek advise from the Laser-Scan Service Department.

9.6.3 *Summary Of Procedures In Measure (CP) Mode* -

1. Ensure that the film negative is loaded and that check mode CHK procedure has been run successfully.

2. Enter control point mode from main mode with command CP.

3. Measure NW control location by either AUTo scan or manual measure.

4. Give new coordinate values (if appropriate) and confirm acceptance with " OK" (FB4).

5. Repeat steps 3-4 in order for control SW,SE,NE.

6. Check very carefully new control details supplied and confirm acceptance with "OK" (FB4).

7. Nominate fiducial control, frequency of fiducial check and error limit in microns.

9.6.4 *Some Important Considerations On Values Assigned To Control Points* -

1. The Lasertrak assumes that all source documents are to be digitised in a rectangular Cartesian coordinate grid system. All distances, therefore, are linear and a square map space is assumed. All control point entries are placed in Layer 0.

2. All data files generated by Laseraid digitising software are unprocessed initially. This means that although details of control coordinates have been supplied at machine set-up time, all generated digitising is held in a special Lasertrak "calibration space" until such time as the file is run through a post-processing stage (after digitising is completed) - see section 11. Therefore, it is possible to alter the values of the control points before the file is processed into the specified map coordinates. The post-processing program is called LAPROCESS. (see section 11)

3. Operators should be aware of the limits of coordinate precision in Laser-Scan's IFF data files. Sufficient storage is reserved in IFF to enable a single ordinate to be held with full precision by up to six figures. This means that coordinates of a greater length will lose accuracy. For these reasons, it is recommended that operators digitise into a coordinate system which falls within these precision limits. A good solution is to digitise locally into a millimetre or inches system relative to a maps South West corner. Full eight or nine figure grid references are not acceptable and in such cases operators are advised to relate grid values to some local offset datum which reduces the values of the coordinates over the map being digitised.

In general, Laseraid will report problems with control point distributions, although care should be taken in the assignment of control point values. The message

"Bad corner points or cubic coefficients"

for example, suggests that the combination of measured control locations and supplied coordinates do not give a valid, square digitising space and operators are advised to re-check the control locations, their measured position, the supplied coordinates and in extreme cases also the previously run CALibration procedure.

9.7 *Operator Identification*

There are facilities within the IFF structure to hold single line descriptions of text which can be used by operators to identify files of data uniquely. These single lines of text are held within the NS entry of IFF files (see the IFF user's guide for details). The maximum number of characters comprising the line of text is restricted to seventy-two.

By default, the NS entry is stored with details of the date, time, username and Lasertrak machine number. It is recommended that these default entries are used for everyday operation. However the operator may override the default entry by issuing the following command

OP or **IDE**

Either command is entered via the close-up screen keyboard whilst in Laseraid main mode followed by the rest of the line giving the required text details.

10 *LINE DIGITISING WITH LASERAID*

10.1 *Introduction*

At this point, the initialisation for the Lasertrak digitising process will have been completed. Therefore, stage one (as described in section 9.1) will have been completed.

To reiterate:

1. Stage one is the initialisation or set-up stage as described and performed in section 9. Stages two and three concern the actual line-following (or edge-following) digitising procedures.

2. Stage two is considered to be the feature selection stage in which the operator chooses those lines which require to be digitised. This could mean working sequentially across a map sheet - selecting every line on the source document until each has been completed - or it could involve just choosing a smaller, sub-set of lines defined by the job's specification.

3. Stage three is considered to be the actual automatic line following process, including any assistance and intervention as deemed to be necessary by the operator or when requested by the software. Map digitising is achieved by alternating between stages two and three repeatedly until the job is completed.

Operators need to be aware of two modes of operation which Laseraid adopts during line digitising:

1. *MAIN MODE* is the base software level always adopted by Laseraid initially

2. *HELP MODE* is used when operator assistance is being given. There are a number of other sub-modes which have a lesser usage, and these are described as necessary in the following descriptions.

Laseraid is capable of following three main varieties of linear feature:

1. LINES. This is the principal type of line following and is the chief concern of this introductory document.Lines may include many styles such as pecks, curves, thickness variations and so on.

   Laseraid is designed specifically to follow transparent linework on a black negative background. However, it is possible to work with inverse polarity in order to track along the darkened centre of parallel white lines. The adjustment of the necessary parameters to achieve inverse polarity is described in detail in the Laseraid Reference Manual.

2. AREAS. In this mode, Laseraid is capable of following the edges of solid fills. This is done by detecting the difference between white and black on the negative, rather than detecting the white line on the black background which is performed for normal line following.

3. JUNCTIONS. The philosophy of digitising with junctions is to follow lines and, if desired, to recognise, display and accept automatically the location of each junction before continuing scanning along the line. Once a junction has been recognised and registered, its coordinate position is held within a rapid access list by the VAX computer; this is known as the 'junction list'. In this way, it is easy for operators to return to any junction, that has had one or more arms digitised, merely by depressing a function button. Further lines to be digitised which are entrant to that junction can then be followed. The result is unique junction creation and quicker throughput for polygon and urban map digitising. Junctions remain in this special junction list throughout the time that there are still entrant lines to be digitised. Once all lines entering a junction have been digitised, its entry is removed from the junction list.

   JUNCTION SCANS. i.e. the procedures which the Lasertrak performs when it thinks it has found a junction - are generated automatically. By default, the system will know whether or not to expect junctions along a line by virtue of the line-type and scan parameters held in the system parameter file. However, junction recognition expectancy can be overruled and turned on or off interactively by means of a function button. Furthermore, in the event that the Lasertrak is unable to recognise a junction automatically, there are facilities by which junction locations can be defined interactively (i.e. manually) either by means of the laser cursor position or the close-up screen facility. Typical evidence that a junction has not been spotted successfully could include the inability to display junction arms before continuing automatically or when the laser does stop at a junction with tram-lines being displayed for guidance. Unless the paint-out facility has been suppressed, it will paint-out all lines entrant to a junction at the time when the digitised feature is accepted. There are extensions to paint-out so that short segments of line always remain at junctions. This provides a tool to confirm to operators the position of junctions.

   It is also possible to set up the parameter file to recognise junctions and wait for the operator to accept the junction before continuation of line following. Details of this use of 'JNC' for the adjustment of the scan parameters to alter the nature of junction recognition, can be found in the Laseraid Reference Manual.

10.2 *Selection Of Feature Layers And The Base Feature Serial Number*

Before the Lasertrak can begin to digitise any lines at the start of a digitising session, it is first necessary to select a layer within the IFF structure is to be used to place the data. Details of the hierarchical (or layer) structure of IFF are given in the IFF Reference Manual. Confirmation that the layer has yet to be selected (when Laseraid has just been started) is shown by the question mark (?) which appears on the photochromic screen adjacent to the laser cursor-cross. Layer assignment is achieved via the close-up screen keyboard with the command LAY which is followed by a numeric argument to define the layer number to be used. The current maximum number of layers possible is 64, though the naming convention can be any number between 1 and 32767.

Typical layer assignment might be achieved by the example below

LAY 5 <carriage return>

This will report the confirmation message

"Layer 5 created and selected"

The above message confirms that layer 5 did not exist before and that it has therefore been created and selected. If it already exists (perhaps from a previous digitising session) the message would be restricted to:

"Layer 5 selected"

Further confirmation of successful layer selection is given on the photochromic screen display: the previous question mark (?) appearing adjacent to the laser cursor cross will have changed to a number. This number corresponds to the current feature serial number of the next feature to be digitised (unless the options 'HTD' or 'HTI' were specified on the Laseraid command line to show contour elevations instead of serial numbers): this is using Laseraid in height mode - see section 10.2.2

10.2.1 *Laseraid In Normal Feature Mode* -

In the simplest case, the number being shown adjacent to the laser cursor will be 1, showing that the file being created is new with no other features included at present. Operators are able to change the value of this serial number at will, by entering the new value required via the close-up keyboard. No Laseraid command needs to prefix this number (though the command 'NF' is optional, if desired). As an example, on typing in the value '226' on the close-up keyboard (followed by carriage return) it will be seen that value '226' appears adjacent to the laser cursor on the photochromic screen. The next feature to be digitised will have serial number 226 and this will be held in the IFF entry 'NF' - new feature - see IFF User's Guide.

By default, Laseraid will increment the base serial number by one automatically on each occasion that a feature has been digitised and accepted. There are two commands possible to change this incrementing operation. Both are entered from the close-up keyboard and both need to be given with a numeric argument.

The two commands are:

ANF n (set automatic increment of feature number to n)

MNF n (set manual increment of feature number to n)

Use of the commands is easy and logical: the command

ANF 10

makes each serial number be increment automatically by ten each time the previous feature is digitised and accepted. The use of MNF is slightly different - it is used in conjunction with two other commands which are provided on two function buttons in Laseraid main-mode. These two commands are 'INC'

(increment - FB15) and 'DEC' (decrement - FB14). This combination of commands enables operators to have total flexibility in assigning feature serial numbers manually. Its operation is described below. MNF performs in a similar way to ANF except that the increment/decrement value (which is defined by the argument to the command) is applied manually when operators depress FB14 (DEC) and FB15 (INC). It is *essential* that operators de-activate the ANF facility if they wish to use the MNF option; this is achieved with the command

ANF 0

10.2.2 *Laseraid In Special Height Mode* -

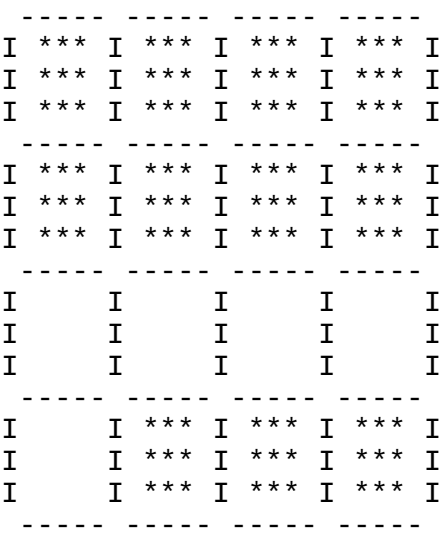
In the case when Laseraid is to be used in height mode (i.e. the parameters 'HTD' or 'HTI' are included in the Laseraid invoking command line - see section 8.2), it is necessary to include different commands to establish elevation (or height) increments and decrements.

The commands AHT and MHT are analogous to ANF and MNF respectively (see 10.2.1). By setting MHT, it means that DECrement and INCrement on FB14 and FB15 operate on the coding of elevation data. ANF still has relevance and provides mechanisms to increment feature serial numbers automatically. MNF has no real effect when using Laseraid in height mode when, no doubt, MHT will have been set.

10.3 *MAIN MODE*

This is the software level from which most other modes are selected and entered. It is also the mode from which Laseraid can be terminated with the command EOS (end-of-session). The selection of features for digitising is carried out in main mode.

Successful entry into Laseraid main mode is confirmed with the following pattern of function button lights.

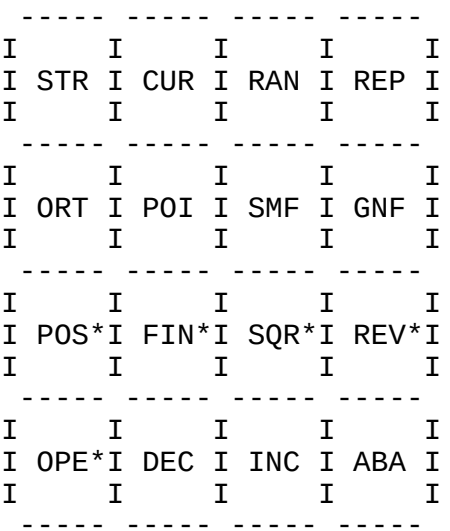


There are many commands available in Laseraid main mode with which basic operators need not be concerned. Reference to the complete list of commands should be made in the Lasertrak Reference Manual. To serve as an introduction, only a small sub-set of the most important commands (with which users should be aware) are described in this manual. As usual, there are commands available both via the function buttons and from the close-up keyboard; commands most widely used are held on the function buttons.

10.3.1 *Function Button Commands In Main Mode: -*

The first eight function buttons are used to initiate actions such as feature select or re-paint. The next five buttons are used as flip-flops to set options such as reverse next feature, and the last three buttons provide control functions.

The function buttons generally have the following meanings, although each of the six feature start buttons (FB1,2,3,5,6,7) can be programmed to refer to any line type along with its associated line following mode and its feature (or attribute) code



Those commands asterisked are flip-flop options with defaults assumed 'off' (i.e. not selected).

FB1	STR	-	start digitising a STRaight line string feature
FB2	CUR	-	start digitising a gently CURving feature
FB3	RAN	-	start digitising a RANdomly curved feature
FB4	REP	-	Paint-out once again all features digitised thus far (ABA-FB16 stops it)
FB5	ORT	-	start digitising an ORThogonal line string feature
FB6	POI	-	start digitising a point symbol, cross feature or 'O' symbol
FB7	SMF	-	start digitising a small feature in a single pass - i.e. no line following
FB8	GNF	-	Obtain next junction from the junction list. Or get next feature from guidance file. The latter case is only relevant if a pre-guidance file has been set-up with keyboard command GUI. Considered to be advanced usage and not discussed in detail here.
FB9	POS	-	Paint-Out Suppress - turns off paint out
FB10	FIN	-	turns on automatic Feature FINd and start
FB11	SQR	-	flag feature for squaring by post-process
FB12	REV	-	flag feature to be reversed by post-process
FB13	OPE	-	turns off loop closure detection
FB14	DEC	-	(causes the feature serial number to be
FB15	INC	-	(decremented/incremented by the value
			(set by keyboard command MNF
		-	(see sections 10.2.1 & 10.3.2 para k
FB16	ABA	-	ABAndon. Re-initialise certain parameters

and position laser cursor to the screen centre.

The meaning and usage of each of the above main mode commands are explained in detail below.

(a) *STR, CUR, RAN, ORT - register line-type*

The meaning of each of the above four commands is to register a Line's type and descriptive code prior to digitising for each of the following lines: Straight, Curved, Random Curved and Orthogonal respectively.

The purpose of line-type registration is, in fact, to aid the feature selection stage of digitising (stage 2 in Laser-Scan's philosophy to digitising mentioned in sections 9.1, 10.1 above). This selection operation involves directing the laser cursor with the trackerball to a position near to the start of the line to be digitised. Once the operator is happy with the cursor's position, he can register it with any of the commands STR (FB1), CUR (FB2), RAN (FB3) or ORT (FB5). By this action, he has done a number of things. Firstly he has instructed Laseraid that it can prepare for line-following (at which time it will move into HELP MODE immediately to seek assistance - see section 10.4). Secondly, he has supplied an attribute code for the line which is next in line to be digitised. Thirdly, he has warned Laseraid what sort of line characteristic to expect so that it can gain an idea of the best line-following methods to use from look-up tables in its current parameter file. This may include line following, line following with junction recognition and area or edge following.

In practice, these commands need not be restricted to straights, curves, randomly curves and orthogonals. They really refer to the lists of line-following parameters which best suit the line to be digitised. For example, Laseraid can be tuned so that it will follow the black centre line of a double cased road - thereby running in inverse mode. These parameters are held in the parameter file and operators are advised to seek advice locally to best understand which function buttons to use for each line-type on their own Lasertrak installation.

(b) *REP (FB4) - re-paint out*

The Lasertrak is able to paint-out each line from the photochromic display screen, once the line has been digitised and accepted. For a number of reasons, the operator may wish to paint-out these lines again. A typical reason might be paint-out fade which re-occurs about every thirty minutes as the photochromic film image begins to disappear. Other reasons could be re-paint-out after the selection of a clean frame of photochromic film or before continuation of a digitising session which was first started on a previous occasion. The command 'REP' on FB4 in main mode forces Laseraid to paint-out once again all lines digitised in the IFF file to-date.

Use of REP for repaint has its limitations because it can be a fairly lengthy process when a large digitised file is being processed. Operators can always abandon a re-paint easily with 'ABA' on FB16.

'REP' performs the re-paint in reverse order, thus the latest lines digitised are painted out first. This reverse paint out further slows its operation. The advantage of 'REP' is that it can be invoked by a function button. An alternative option is forward paint-out (the FOR keyboard command), which is performed more quickly - particularly when operators use it in conjunction with the WIN keyboard command to define a window within which re-paint out is to be performed (see item (m) below).

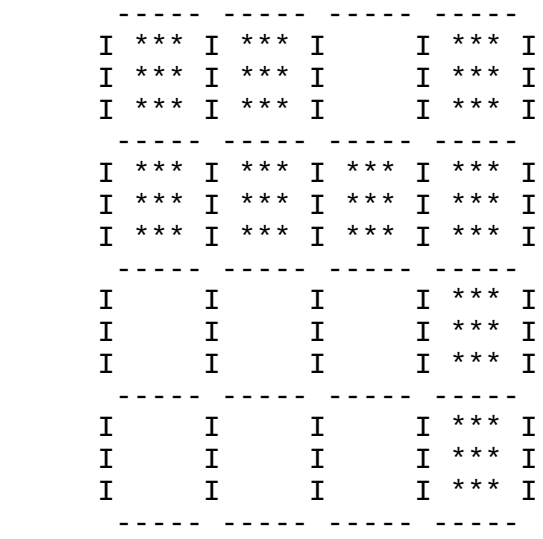
(c) *POI (FB6) digitise a Point Feature*

The digitising of point features is different in concept to line-following. Such features are fixed with the command 'POI' on FB6. Operators direct the laser cursor-cross to the vicinity of the point to be digitised and register its type with FB6 to issue a POInt digitise command. There are two types of point feature capture:

1. Restricted to cross symbols:'X' and '+' and 'O's

2. Square features - one or more square features such as buildings are captured in a single scan and output to the IFF file as one or a number of oriented symbols.

Use of FB6 moves Laseraid into a special sub-mode for point features which is confirmed with a new pattern of function button lights as shown below



FB1	-	DPO	-	perform a cross symbol POint mode scan and draw its results on the close-up screen
FB2	-	POI	-	perform a cross symbol POInt mode scan
FB4	-	OK	-	accept measurement and paint-out
FB5	-	DSQ	-	perform a SQuare feature point mode scan and draw its results on the close-up screen

FB6	-	SQP	-	perform a SQuare feature Point mode scan
FB7	-	DRF	-	DRaw selected square Features
FB8	-	NXT	-	select the NeXT square feature
FB12	-	CLO	-	draw a CLOse up of the scan on terminal screen
FB16	-	ABA	-	ABAndon and return to main mode

Ancillary Codes may be added to point features by issuing the command:

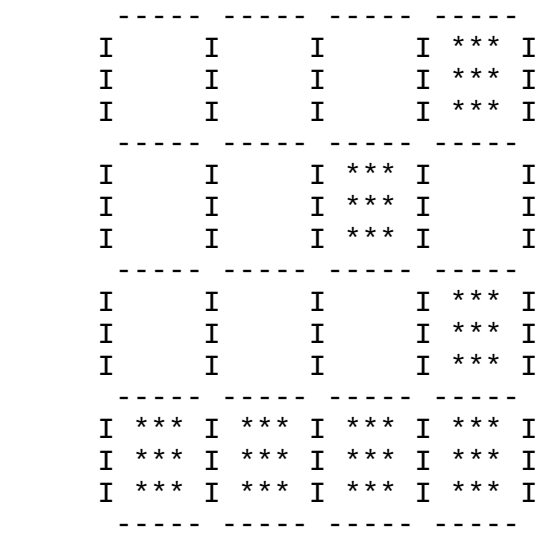
AC type value [text]

once a feature is found, but before it is accepted.

(d) *SMF (FB7) - Small Feature Digitising*

Though the Lasertrak is a line-following scanner, it is equally able to scan small features and register their positions automatically without line-following, providing that they are sufficiently small, closed, isolated features. A general guide to feature size possible is all objects of approx maximum size of 1 cm (0.4 inches) square on the photochromic display screen.

Small feature digitising is performed in the following manner. First the operator directs the laser cursor with trackerball to a close vicinity of the small feature to be digitised. Its type is registered by depressing FB7 to issue a 'SMF' command. At this point, Laseraid moves into small feature mode and the following pattern of lights will illuminate on the function buttons:



The main Function Buttons for small feature capture in line mode are:

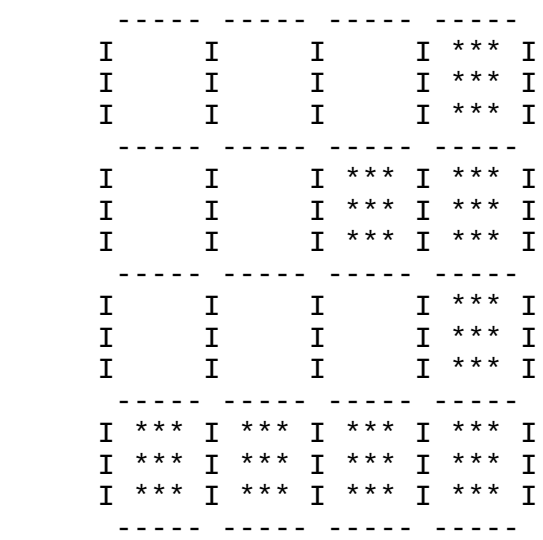
FB4	-	STA	-	leave small feature mode and STArt line following using the

feature code assigned to FB 7
FB7 - SMF - repeat SMall Feature scan
FB12 - END - accept highlighted small feature scan
FB16 - ABA - ABAndon and return to main mode

Laseraid attempts to scan the small, closed feature automatically. If the scan and digitising is successful the close-up screen "bleeps" and the object is seen to glow in red refresh on the photochromic screen. The operator is then free to use the above commands to accept or reject the digitising.

In the event that the small feature scan is unsuccessful, no audible "bleep" is heard and the extreme dimensions of the small-feature scan are shown as a red-refresh box on the photochromic screen. Operators can attempt a re-scan repeatedly by further depressing FB7 to issue another SMF command. At the same time, the trackerball can be used to re-position the scan box more appropriately over the small feature on the photochromic display screen. As an aid, it is suggested that small features be positioned as close to the lower-left extremes of the scan box as possible to ensure a successful measure. If repeated scans are unsuccessful, then the feature can be digitised with normal line following using FB4

If the line type of the small feature to be captured has been set-up in the parameter file to use edge following then the pattern of function button lights will be as follows:



The main Function Buttons for small feature capture in edge mode are:

FB4 - STA - leave small feature mode and STArt line following
using the feature code assigned to FB 7
FB7 - ESF - perform another scan if unsuccessful
FB8 - NXE - select the next feature in the scan (if more than

one found)
FB12 - END - accept highlighted small feature scan

FB16 - ABA - ABAndon and return to main mode

(e) *GNF (FB8) Get Next Feature*

The operation of this facility is dependent on the line type to be used for digitising. If simple line following is to be performed then GNF will refer to a preset guidance file. Preguidance is considered to be advanced usage of Laseraid and is not discussed in this introductory document.

The principal use of the 'GNF' facility is when junction recognition is enabled. It only becomes relevant to digitising after one or a series of junctions have already been recognised and their positions are fixed. Repeated use of the 'GNF' command (Get Next Feature) on FB8 in main mode aids and speeds the feature selection stage for digitising. Each time a junction is recognised, its location and other details such as the number of entrant links and their direction are entered into a special junction list in the computer memory. This entry remains throughout the time that there are still links to be digitised which are entrant to that junction. The action of repeated use of 'GNF' (FB8) is to count continually and cyclically through the current junction list and position the laser cursor exactly over each junction in turn. In most cases, subsequent single scans by selecting the desired line-type are able to present to the operator a reasonable guess of the likely line from which to leave the junction position with line-following.

Readers are also referred to the keyboard main mode command 'ZIJ' which clears the junction list, thereby resetting it to have zero items.

(f) *POS (FB9) Flip-Flop (default off) Paint Out Suppress*

Lasertrak is able to paint-out from the photochromic display all features that have been digitised, once they have been accepted by the operator when in help mode. The default option is for this paint-out facility to be switched on. Selection of the Paint-Out Suppress 'POS' facility on FB9 at any time whilst in main mode enables the paint-out facility to be suppressed. The result is that all subsequent lines to be digitised are no longer painted-out for the entire time that the POS option is active. Confirmation that 'POS' is operative is given by the illumination of FB9; it is normally extinguished. Once 'POS' is deactivated (turned-off), perhaps at a later stage, all lines which formerly had their paint-out suppressed are then all painted out as soon as the next feature to be digitised is accepted.

A typical reason for using paint-out suppress is to speed digitising rates or to make complex areas easier to see and interpret.

(g) *FINd (FB10) Flip-Flop (default off) automatic Feature find and start*

The FINd option is a very useful facility to speed digitising - particularly on sparse-to-medium density data or easy linework such as contours. The default option is for 'FIN' to be turned-off and it is activated whilst in Laseraid main mode by depressing FB10.

Confirmation that 'FIN' has been selected is given by the illumination of FB10; it is normally extinguished.

Under normal circumstances (when 'FIN' is not selected) digitising would involve the registering of the type of line to be digitised (see paragraphs a,c,d above), followed automatically with immediate entry into help mode (see section 10.4) for operators to give Laseraid further assistance such as the direction to start scanning.

Use of the 'FIN' option provides facilities to remove much of this basic operator assistance - particularly if the direction to follow the lines is not too important. Once 'FIN' has been selected with FB10 the operator need merely direct the laser to the vicinity of the line to be followed and register its type. Once this is done, Lasertrak tries automatically to find the line and begin to line-follow automatically in a direction that it chooses; there is a tendency by default for it to digitise upwards on the photochromic screen by default. Once line-following has commenced, it will continue until such time as the end of line is reached or operator intervention or help is required. In both cases, Laseraid will enter HELP mode for an operator decision to be made (see section 10.4).

There is a particularly useful facility when 'FIN' is selected which eases considerably some line digitising such as contours. This facility involves the automatic connection of lines that have been digitised in two halves in opposite directions. To use this facility, operators should not commence digitising the line feature by first directing the laser cursor to the features start. Instead, they should choose some point in the centre of the feature's course. In this way, once the line type has been registered Laseraid will begin to line-follow one half of the line feature in a direction that it chooses. Once this half is completed, accepted and painted-out, the cursor will automatically find the other half of the line and digitise it too in the opposite direction again after its line type has been established again with either STR (FB1), CUR (FB2), RAN (FB3). Once both halves of the feature have been digitised in opposite directions, the system automatically reverses the digitising of one of the halves and connects it to the other half to produce a simple, connected digitised line as though it had been digitised in one direction from start to finish in the first place. The overriding benefit of using this technique for digitising is that the line-following is assured of scanning right to the end of lines; which is not necessarily the case when relying on the operator to position the cursor manually at line ends.

De-selection of 'FIN' is achieved by depressing again FB10 whilst in main mode and confirmation is given by the extinguishing of the function button light.

(h) *SQR (FB11) - Flag next feature for squaring*

The action of depressing FB11 is to issue the 'SQR' command which will 'flag' or mark every feature that is digitised subsequently in the IFF file for squaring by post-hoc processing software (see LAPROCESS User's Guide). Features are not squared immediately by Laseraid, they are merely flagged to be squared later. The selection of 'SQR' on FB11 is confirmed by the illumination of FB11. It is de-selected by

depressing FB11 again whilst in main mode, at which time the button's illumination is seen to extinguish. All features which are digitised throughout the time that 'SQR' is operative will be flagged for squaring.

(i) *REV (FB12) Flip-Flop (default off) force the next feature as digitised to be reversed*

The 'REV' option is selected via FB12 whilst in main mode and is confirmed by the illumination of FB12. Its action is to force the next feature only which is to be digitised to be reversed if necessary to ensure that its coordinates run clockwise. It is only operable on closed loop features and then only if they are digitised anticlockwise. Its action is to ensure that all closed loop features are digitised in the same direction. 'REV' is only operable for the feature which is digitised immediately after the option has been selected. As soon as this feature has been captured and accepted the option is de-selected automatically. 'REV' can be selected repeatedly by re-pressing FB12 before each feature is digitised if there are a number of lines which require to be reversed. Once selected, the 'REV' option can be cancelled with 'ABA' (FB16) prior to the feature being digitised.

(j) *OPEn (FB13) Flip-Flop (default off) turn off closure detection*

Under normal circumstances, the Lasertrak is continuously searching for closed features. As soon as it reaches a location along a line being digitised which equals the start position of that line, Lasertrak will halt and report in help mode that the end of a closed loop feature has been reached. This facility can be turned-off with the 'OPE' command (FB13) in main mode. Confirmation is given by the illumination of FB13 and the option remains active until it is de-selected by again depressing FB13.

Care is necessary in its use. Attempts to digitise a loop feature with 'OPE' selected as operative will mean that the Lasertrak will no longer know the location of the features end-point and it will, in fact, cycle repeatedly until such a time as the operator halts line-following manually.

(k) *DEC/INC (FB14/FB15) Decrement and Increment manually*

The 'INC' and 'DEC' commands are used in conjunction with the keyboard commands 'MNF' and 'MHT' and their function depends on whether Laseraid is running in feature mode (see 10.2.1) or elevation - or height - mode (see 10.2.2).

On depressing either 'DEC' (FB14) or 'INC' (FB15) (repeatedly if desired) whilst in main mode the action is to decrement or increment the coding (feature serial number or feature elevation code) by the interval defined by the keyboard commands MNF or MHT. In Laseraid's normal (or feature) mode, 'MNF' is used and DEC/INC operate on the feature serial numbers (NF entries in IFF). In Laseraid elevation mode (which is established by the keywords 'HTD' or 'HTI' on the invoking command line - see section 8.2), 'MHT' is used and DEC/INC operate on the feature elevation coding (AC entries in IFF).

(l) *ABA (FB16) Abandon*

As usual, 'ABA' is the panic, error exit command available at all times on FB16. Its effect is to cancel any previous operations: repeated use also centres the laser cursor on the photochromic display screen.

This completes the commands available from function buttons in main-mode. The items below detail some of the other important commands available on the close-up screen keyboard.

10.3.2 *Keyboard Commands In Main Mode: -*

A selection of the important keyboard commands which are of use to basic operators is given below

?	-	display current function button meanings
?command	-	gives help on a specified command
ADJ	-	enter system ADJust mode to modify line-following parameters in the parameter (patch) file
AHT n	-	set automatic elevation coding increment to n (used in Laseraid height mode only - see 10.2.2)
ANF n	-	set automatic feature serial increment to n (see section 10.2.1)
CAL	-	enter CALibrate mode (see section 9.5)
CAN	-	CANcel (delete) the last feature digitised
CHF n1,n2,r	-	re-set fiducial check to point n1, every n2 features, with error limit r - (see section 9.6.2.)
CHK	-	enter tuning and CHEck mode (see section 9.4)
CP	-	enter Control Points measuring mode (see 9.6)
EOS	-	End-Of-Session (program exit)
FCF n m	-	set user-defined Feature Codes to Function buttons FB1,FB2,FB3,FB5,FB6,FB7
FOR n1,n2	-	re-paint out FORwards through layers n1,n2 (arguments optional - default = all)
IDE/OP	-	input operator IDEntification (see section 9.7)
LOC	-	LOCate nearest captured feature to the cursor for subsequent edit operation
MHT n	-	set manual elevation coding increment/decrement to n (used in Laseraid height mode only - see 10.2.2)
MNF n	-	set manual feature serial increment/decrement to n (used in Laseraid feature mode only - see 10.2.1)
n or NF n	-	change current feature serial number

		(see 10.2) note: the value of n should be 1-32767 inclusive
LAY n	-	select LAYer n for output of data (see 10.2)
PAP	-	Print All Parameters
PCF r	-	move PhotoChromic Film by r frames (default 1)
PFB	-	print the feature codes and line types associated with FB1,FB2,FB3,FB5,FB6,FB7
PON	-	Print Overlay (Layer) Numbers
PMF	-	Print Maximum Feature number to-date
PPP	-	Print Primary Parameters (for viewing system parameters)
TIM	-	print out system TIMings to-date
TYF n m	-	set use-defined line TYpes for Function buttons FB1,FB2,FB3,FB5,FB6,FB7
WHA	-	print out job details
WIN	-	define a WINdow for paint-out
ZIJ	-	Zero In-core Junction list
ZTI	-	Zero system TImings

Important commands follow in more detail:

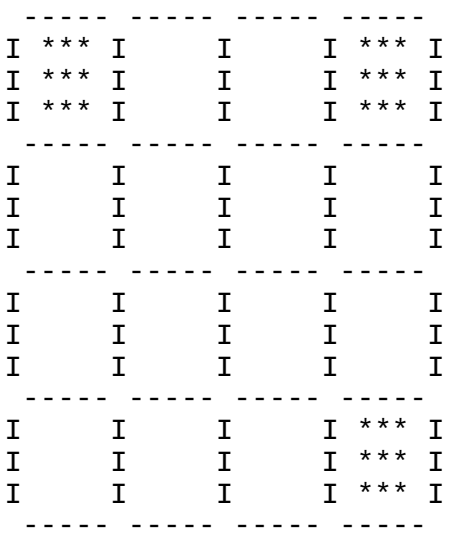
1. *WIN - define a WINDOW for local paint-out*

Paragraph (b) in section (10.3) describes the nature of re-paint-out in Lasertrak. By its nature, total paint-out of a large map image can be a lengthy process and hence in many instances it is appropriate to re-paint-out only those lines which fall with a localised rectangular space. This is possible with the main mode keyboard command 'WIN'.

The use of 'WIN' is achieved by typing it as a prefix to the 'FOR' (forward paint-out) or 'REP' (re-paint-out) command (see item b, above). The commands are typed on the same line and separated by at least one space. Up to seven layers may be selected at any one time for paint out. By issuing the following command:

WIN FOR n1 - n6 <carriage return>

Laseraid will enter 'window paint-out' mode which is confirmed by the function button pattern of lights as detailed below.



FB1	-	'RED'	- re-define window limits (command CANNOT be typed at keyboard)
FB4	-	'OK'	- accept window
FB16	-	'ABA'	- abandon window re-paintout mode

The operator should then define the limit of the re-paint window; this is done with the laser cursor and the trackerball. First the lower left limits (South West corner) of the required window is visited with the laser cursor. Then, careful movement towards the upper-right of window (North East corner) is performed with the window being displayed with the red laser in refresh on the photochromic screen. Successful confirmation and acceptance of the window definition is achieved with FB4 to issue the 'OK' command. The Lasertrak will then re-paint out all lines which have been digitised within the defined window. The two alternatives to the use of 'OK' (FB4) could have been (FB1) to redefine the window's location again and cancelling the previous definition or 'ABA' (FB16) to abandon window repaint altogether and return to main mode.

2. *LOC - locate nearest captured feature for simple edit operation*

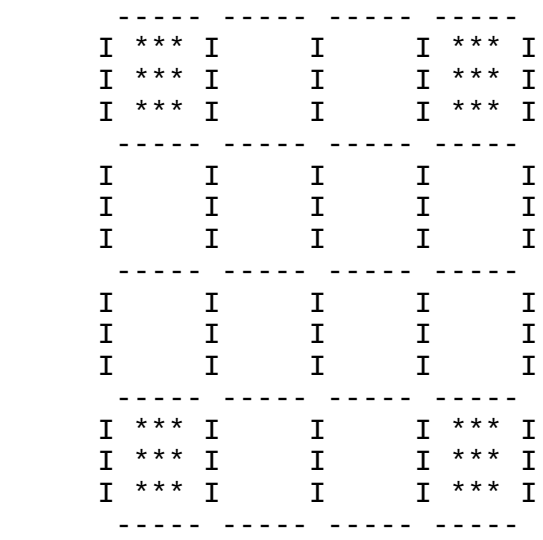
It is suggested that most edit operations on digitised files are best performed on bona-fide editing work stations such as the Laser-Scan LITES system. However, some simple operations can be performed on existing digitised lines within Laseraid, though these operations can be slow and are restricted either to total deletion or to re-paint-out. These two functions are defined by appropriate function buttons as described below.

Entry into Laseraid's simple editing mode is achieved from the close-up screen keyboard with the command

LOC <carriage return>

Before depressing <carriage return> the operator will have pointed the laser cursor to the vicinity of the desired feature for edit. If Laseraid is unable to find the requested feature (and the search could

take some time), it will remain in main mode. If, however, line detection is successful, the feature found will be refreshed in red on the photochromic display and LOCATE mode will be entered - confirmed by the function button pattern of lights as shown below:



FB1 - NXT - find next feature
FB4 - REP - re-paint out feature
FB13 - DEL - delete feature
FB16 - ABA - abandon locate mode

The options open to the operator in 'locate mode' are as follows:

NXT (FB1) select any other feature in the cursor's vicinity in comparison to the current one found in hand: this is useful where many features lie close to each other

REP (FB4) the feature in hand is re-painted out and control returns to main mode

DEL (FB13) the feature in hand is deleted completely from the IFF file and control returns to main mode

ABA (FB16) locate mode is abandoned with no further action taken. Control returns to main mode.

3. *PON - Print overlay (layer) numbers to-date*

The action is to detail on the close-up screen a summary list of all layer numbers currently created in the output IFF file.

4. *PMF - Print maximum feature number to-date*

The action is to detail on the close-up screen the value of maximum feature serial number currently held in the output IFF file.

5. *TIM/ZTI - Print system timings to-date/zero these timings*

The action of the keyboard command 'TIM' is to detail on the close-up screen a summary of the system timings to-date. The following break-down is used when summarising system times:

- INITIALISING	-	time spent invoking Laseraid and reading in the system parameter (or patch) files
- MAIN MODE	-	time spent obeying main mode commands
- HELP MODE	-	time spent obeying help mode commands
- FOLLOWING	-	time spent in automatic line-following
- POINT MODE	-	time spent digitising point features
- PAINTING OUT	-	time spent on paint-out
- CALIBRATION	-	time spent on CP and CHK mode
- IDLE TIME	-	time spent idle awaiting operator decision
- GRAND TOTAL	-	sum total of all above

Using the command 'ZTI' will artificially reset all timers to zero and the clock will commence counting from this point on. All items of timing are zeroed by ZTI except the TOTAL item which remains unchanged. Initially, ZTI is run automatically on each occasion that Laseraid is invoked.

6. *ZIJ - clear the junction list*

The action of the keyboard command 'ZIJ' is to clear all entries in the current junction list. This will cause 'GNF' (FB8) to have no effect and this situation will continue throughout the time that the junction list is empty. The junction list will begin to re-fill as more junctions are recognised from subsequent digitising. All junction entries which are removed from the list by 'ZIJ' cannot be recreated during the current digitising session. It is possible to reconstruct a list by terminating Laseraid with 'EOS' and re-starting it again; this action provides a junction list in the form that it appeared prior to the original 'ZIJ' being issued.

7. *PCF r. Move photochromic film by r frames*

The action of this command is to move the photochromic film on to a new frame, thereby removing the effects of any previous paint-outs. The command is entered from the close-up keyboard and can take two forms, viz

PCF <carriage return>

PCF r <carriage return>

The first option is to scroll by the default number of frames (which is one frame only). The second option is to scroll by a defined number of frames supplied in the argument r. It should be pointed out that once the photochromic film has been moved to a new frame (either by PCF or by the Main control panel switch) it is necessary to remeasure the control points in Measure mode to re-register the paint out data with the digitised map data.

8. *CAN - Cancel (i.e. delete) the last feature digitised*

Whilst digitising both in line following or edge following modes, features can be abandoned before they have been accepted in the help mode by the command 'ABA' (FB16). Once accepted, though, each feature is stored in the IFF file and can only be cancelled either by *post-hoc* editing, by the LOCate option (see item n above) or by the command 'CAN'. The 'CAN' command is issued in Laseraid main mode and deletes the immediate previous line to be digitised and accepted. It is only operable if no attempt has been made to commence digitising the next feature.

9. *WHA - print out job details 'WHAT'*

The action is to detail on the close-up screen a summary of various descriptions of the current job in progress. Examples include the operator's identification, the IFF output file, the parameter (patch) file, etc.

10. *ADJ - adjust system parameters*

This activates the facility to view and edit the parameter file which govern line following characteristics. Details of the use and adjustment of parameter files can be found in the Laseraid Reference Manual.

11. *EOS - end of session*

This is the Laseraid program exit. It terminates the Lasertrak controlling software (though it does not power-down the hardware - see section 11.0). All output IFF files are closed and the system parameter file is up-dated with the new parameters obtained from this session.

12. *PFB - print the feature codes and line types currently associated with FB1, FB2, FB3, FB5, FB6, FB7*

Para (a) in this section has described the association between line-type and feature coding and six function buttons in main mode. These feature codes and line types are set appropriately by the operator and this information is stored in the system's current parameter file for use in future digitising sessions. Paragraphs (w) and (x) below explain how the feature codes and line types associated with the function buttons can be modified.

The keyboard command 'PFB' enables the operator to determine what the current settings for line types and feature codes are with respect to the six line type buttons: FB1, FB2, FB3, FB5, FB6, FB7. On issuing the command 'PFB' from the close-up keyboard a summary report of the current settings is displayed on the close-up screen. A typical example is shown below:

```
FC:      1    2    3    -
         5    6   30    -

TYPE:    5    3    4    -
         2    2    1    -
```

This report can be interpreted in the following way. 'FC' is Laser-Scan's IFF entry for interpolation or feature code. Thus, currently FB1 has feature code 1, FB7 has feature code 30 etc. Similarly, line type 5 (in Laseraid's current parameter file - see the Lasertrak Reference Manual) is associated with FB1, and line type 2 is associated with FB5, FB6. Confirmation of changes is equally possible with 'PFB'.

13. *FCF n m - Modify feature codes associated with function buttons*

Readers are referred initially to para (v) above. The FCF command enables operators to modify the feature codes associated with the line type function buttons FB1, FB2, FB3, FB5, FB6, FB7. The command is typed whilst in main mode from the close-up keyboard and takes two numeric arguments (separated by spaces). The first argument, n, refers to the function button number to be changed; it can only take either of the values 1,2,3,5,6,7. The second argument, m, refers to the FC (feature code) to be set and should be an integer in the range 0 to 32767.

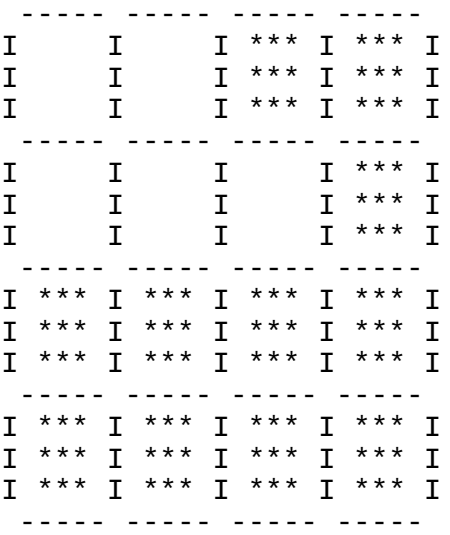
14. *TYF n m - Modify line-types associated with function buttons*

Readers are referred initially to the previous paragraphs. The TYF command enables operators to modify the line types associated with line type function buttons. Line types are defined within the current Laseraid parameter (or patch) files and exist as a collection of special scan parameter settings within a table of values. Each column in the table (known as the "type-tables ") refers to a type of line and these are limited to seven columns and hence seven line types. The Lasertrak Reference Manual gives more details on line types and scan parameter tuning. TYF if typed whilst in main mode from the close-up screen keyboard and takes two numeric arguments (separated by spaces). The first argument, n, refers to the function button number to be changed; it can only take either of the values 1,2,3,5,6,7. The second argument, m, refers to the line type corresponding to the relevant column in the type tables; it takes the value 1-6 inclusive. Confirmation of the change is possible with 'PFB' - see above.

10.4 *HELP MODE*

This section describes the nature of help mode. This is the software level which is always available for operator assistance and intervention whilst automatic line-following is taking place. It is also the level which Laseraid will enter when it stops itself to request the help of the operator. Thus, help mode provides stage 3 of the Lasertrak digitising cycle (as was described in section 10.1); it is here where lines are digitised, verified and accepted.

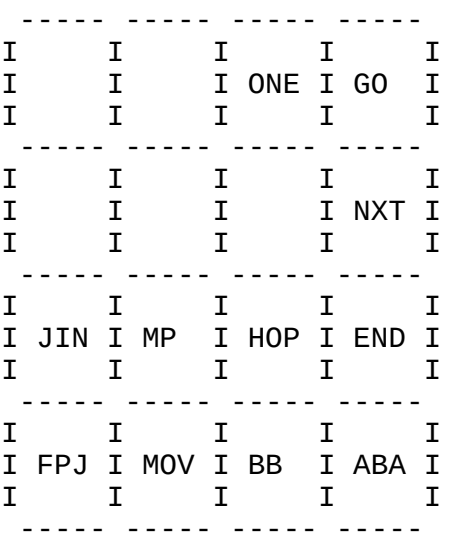
Confirmation that Laseraid has entered help mode is given with the following pattern of function button lights.



Help mode is entered initially before auto-line following begins but after line-type selection has been made for each line to be digitised (see 10.3.1a). Once the operator has selected his desired line to be digitised and registered its type from main mode, the system enters help mode immediately to seek further assistance for the automatic line following. This situation assumes that the main mode command option 'FIN' is not operative at the time (see section 10.3.1 para (g)). Help mode is also entered after a line following pause due either to operator or software intervention.

The commands available in help mode, as usual are given by both function buttons and the close-up keyboard: the most widely used being available on function buttons with the remainder available from the close-up keyboard. Help mode commands are described below.

10.4.1 Function Button Commands In Help Mode -



FB3	ONE	-	proceed by ONE single scan and re-enter help mode after each scan.
FB4	GO	-	proceed normally with automatic line-following
FB8	NXT	-	display cyclically the possible paths available
FB9	JIN	-	explore the region for possible junctions
FB10	MP	-	insert a master point at the cursor position
FB11	HOP	-	hop or jump over portions of poor quality lines or inappropriate data
FB12	END	-	accept the feature and return to main mode
FB13	FPJ	-	enable/disable junction recognition
FB14	MOV	-	change cursor mode between "change angle" and "change position"
FB15	BB	-	pause line-following
FB16	ABA	-	abandon line capture for current feature, halt help mode and return to main mode.

The meaning and usage of each of the above help mode commands are explained in detail below.

(a) *ONE (FB3) - proceed with a single scan*

This facility is used in association with the laser cursor "tram-lines"; these are the parallel lines whose direction and length is controlled by the trackerball. The orientation of the "tram-lines" should be adjusted so that the Lasertrak is informed of the direction in which scanning ought to begin. Depressing FB3 to issue the command 'ONE' then instructs the Lasertrak to produce a single scan in the

direction determined by the tramlines. If the tramlines are not present on the screen, then ONE command will produce them on the screen. Once a single scan has been performed, line-following pauses once again in help mode and displays in red refresh on the photochromic screen the portion of the line detected.

The use of the ONE command on all occasions is very useful in confirming to the operator that line-following would perform correctly if it were allowed to proceed automatically. It provides the operator with 'peace-of-mind'.

(b) *GO (FB4) - proceed normally with automatic line-following*

Depressing FB4 in help mode issues the 'GO' command; this is the Laseraid instruction to commence automatic line-following and attempt to digitise the current feature easily and efficiently. Automatic line following is seen on the photochromic screen as a sequential series of single scans (with no pause in between each). The scans should be seen to track along the current line being digitised with little or no delay in progression along the line.

Whilst automatic line-following is taking place, operators are advised to monitor its progress visually and intervene on the following occasion.

(i) when the software pauses line-following automatically because it is confused: typical actions might be

- 'GO' (FB4) try line-following again
- 'ONE' (FB3) try single-scan to "generate" tram-lines and hence gives direction assistance
- 'NXT' (FB8) show and select alternate routes available
- 'HOP' (FB11) jump over confused area

(ii) when the software pauses because the end of feature has been reached

- 'END' (FB12) accept feature and return to main mode

(iii) when line-following is seen to make a mistake

- 'BB' (FB15) pause line-following. A second press of FB15 enters Laseraid into a rolling mode where the tracker ball can be used to 'wind back' to the problem area in order to re-scan. A full explanation of 'rolling mode' is in para h

(c) *NXT (FB8) display possible alternative paths available*

The NeXT command on FB8 is useful in particularly complex areas of maps to be digitised where there are several alternate paths or lines to follow in close proximity. The action of 'NXT' is to display to the operator (as short portions of line in red refresh on the photochromic screen) all path options available for line-following at the laser cursor's current position. Repeated pressing of 'NXT' (FB8) cycles repeatedly through the path options. Once the desired path is selected operators can attempt further line-following with either 'ONE' (FB3) or 'GO' (FB4).

When junction recognition is operative the command 'NXT' (FB8) has an enhanced use since it is able to select and display to operators (with red refresh on the photochromic screen) all directions detected which enter and exit the current junction position. This provides a fast and flexible method to direct the line-following through a network of lines; in most cases, it obviates the use of the trackerball and tramlines and is particularly useful when used in conjunction with 'GNF' (FB8) in main mode. The proviso for the use of 'NXT' in this way is that junctions must first have been scanned and recognised before 'NXT' becomes operative. Further, it is of no use when a junction has been fixed manually with 'MAJ' . In such situations, there is no information in the junction list of the directions of entrant lines - NXT needs this information and it can only be achieved when a junction has been scanned and recognised automatically.

If the operator wishes to stop the automatic scanning at the next junction in order to change the direction of the scan using 'NXT', then FB15 is depressed once the junction has been accepted. The default wait between junction acceptance and continuation is set at 0.2 seconds.

Continuous depressing of 'NXT' in help mode at junction positions cycles repeatedly through all the entrant/exit lines which have been detected. Once the appropriate exit has been chosen, the 'GO' command on FB4 will restart auto line-following.

(d) *MP (FB10) - insert a Master Point at the cursor's current position*

The 'MP' command on FB10 provides the operator with a means to force a digitised point to be fixed at specific, defined locations. It is useful, for example, to include digitised points manually across connections over large gaps in a digitised source line. Operators need merely position the laser cursor over the desired point location and depress FB10 to issue the 'MP' command. Points may be registered by subsequent pressing of FB10. Master points are equally able to be created manually on the close-up screen with the keyboard command 'CLO'. The operator should direct the laser cursor to vicinity of the desired point location and type on the keyboard:

CLO <carriage return>

The action is for the close-up screen to show a greatly enlarged impression of the source document from which an accurate fix can be made with the close-up screen's cursor. Readers are referred to para (k) in this section for details of CLOse-up digitising of points. Once

the laser cursor is positioned accurately, use of FB10 will create the Master Point in that location.

Several Master Points may be created using the close-up screen by typing at the keyboard the command:

MAN <carriage return>

This action again produces a close-up view on the close-up screen, but this time each press of the space bar creates a Master Point, from the close-up keyboard as the cursor's location on the close-up screen. The command

E

ends the sequence.

(e) *HOP (FB11) - jump over inappropriate data or portions of poor source linework*

The HOP command on FB11 is used on occasions where it is required to ignore certain areas of the source document. Typical regions to be ignored could be unrequired symbols (such as markers along a line's course or elevation details on contours) or they could comprise poor portions of line work which the scanner is unable to detect successfully by automatic line-following. In either event line-following will have been paused (perhaps by operator intervention FB15 or by software request for help) and the system will be in help mode.

The 'HOP' command is invoked by depressing FB11 and the tram lines are seen on the photochromic display. The trackerball is used to re-position the laser cursor (in this case the tramlines) to the desired new location from which automatic line-following can recommence and this can be re-started with either 'ONE' (FB3) or 'GO' (FB4). The former option is desirable initially to confirm that the Lasertrak has re-detected the correct line before automatic line-following is released with 'GO' (FB4).

(f) *END (FB12) Accept the feature and return to main mode*

Once the end of a feature has been reached - it could be because there is no more line to follow, or because a loop feature has closed or due to an operator pause instruction - it is necessary to accept the feature before it is stored in the output IFF file and the next feature can be started.

At this stage, the operator can either accept or reject the feature: he will have monitored line-following progress and will be able to see the current buffer of digitised coordinates in red refresh on the photochromic display. The feature is rejected with 'ABA' (FB16) - see (i) below. The feature is accepted with 'END' (FB12). As soon as the 'END' command is issued the feature is stored in the output IFF file and it is painted out from the photochromic display (if the Paint Out Suppress 'POS' option is not operative from main mode (FB9)). Control immediately returns to Laseraid main mode and the feature serial numbers (and elevation ancillary codes, if relevant) are updated

if the ANF (and AHT) commands are set appropriately (see section 10.2.1 and 10.2.2).

Once a feature has been accepted with 'END', it can no longer be rejected easily and such operations are best left to *post-hoc* editing processes. Users are referred to the main-mode command 'CAN' (via keyboard only) in which the latest feature accepted can be deleted immediately - though this is only possible if no attempt has been made to start digitising the next feature (see section 10.3.2).

(g) *MOV (FB14) - change cursor mode between "change angle" and "change position"*

During operator intervention phases of Lasertrak digitising, the cursor takes on two states of appearance or "movements" from trackerball. One state is the movement of the cursor's physical position; this is possible when it is a 'cross' and can also be possible (for example with the 'HOP' command - see item (e) above) when it is the 'tram-lines' symbol. The second state is only possible with the tram-lines cursor and this is the facility where the trackerball can be used to rotate the cursor's angle with its base position anchored in a fixed screen location.

The 'MOV' command available on FB14 in help mode instructs the laser cursor to flip cyclically between each state of operation - angle and position. The facility is useful when operators wish to pass over poor line work or chain on to other lines. It is very similar in concept to the 'HOP' command but does not fix master points on either side of the gaps being jumped. If the 'MOVE' command was to be used in a similar way to 'HOP' it would be necessary to include master points where appropriate with the command 'MP' on FB10.

(h) *BB (FB15) pause line-following and back track manually along line captured*

FB15 has two important functions during the digitising process. Firstly, it provides the operator with an option to pause automatic line-following which will have been started originally with the command 'GO' on FB4. This line-following interrupt stops auto-digitising and the red laser displays in refresh on the photochromic display the current 'buffer' of digitised coordinates. The operator can then re-start auto-digitising again with 'GO' (FB4) or he can intervene with other options such as 'HOP' (FB11), 'ONE' (FB3), 'END' (FB12), 'ABA' (FB16). Secondly, he can backtrack along the line digitised thus far to possible sources of error.

The rolling mode can be obtained by pressing BB (FB15) for a second time. This will enable the tracker ball and redefine FB15 to become BAC which will enable the operator to delete master points individually with each consequent press of FB15. The tracker ball can also be used to back track along the digitised line - deleting master points on the way.

Simultaneously, when rolling mode is entered (by pressing FB15 twice) function button 8 (FB8) is also redefined as LJN - Locate previous JunctioN. This is only relevant if the operator is digitising using a line type which has enabled junction recognition. Once rolling

mode has been entered, the operator is able to roll back the trackerball to the previous junction. Depressing 'LJN' (FB8) within the tolerance of the search scan redefines FB8 to become 'NXT' thus enabling the operator to chose a different arm to scan along. FB4 will restart the line following.

(i) *ABA (FB16) Abandon help mode*

The 'ABA' command on FB16 is the usual panic option in help mode. It is only operable when auto-line following is paused and its effect is to cancel all digitised achieved to-date on the current feature and return to main mode. Thus it provides a reject option for a digitised line (as opposed to accept with 'END' (FB12)). Rejection of a line feature or abandoning help mode for some other reason in this way does not increment feature serial numbers (or elevation codes if relevant) and tram-line cursors are returned to the 'cross' symbol in main mode. 'ABA' will not work whilst line-following is active; it must first be paused with 'BB' on FB15.

10.4.2 Important Keyboard Commands/macros In Help Mode -

B	-	display on close-up screen the current buffer of vector data for line being digitised
CLO	-	re-position the laser cursor by means of accurate positioning from the close-up screen
MAN	-	multiple entry of Master Points from close-up screen
E		and keyboard
MAJ	-	input of manual junction points from the close-up screen and keyboard

1. *B - display on close-up screen a digitised back-log*

This facility is included in this introductory guide under help mode commands for convenience, though strictly speaking it is a *macro* rather than a *command*. The concept of Laseraid macros is not discussed in detail in this document. Briefly a macro is a user-defined sequence of Laseraid basic commands held under an assumed macro name. On supplying an instruction to invoke the macro - which is achieved by supplying its assumed name - the sequence of commands are run in turn automatically.

The macro 'B' is an example of such a sequence of commands; to a novice operator, there need be no distinctions made between commands and macros. The function of the macro 'B' for all versions of Laseraid help mode is to display on the close-up screen the vector representation of the previous buffer of digitised line-work. The position of fixed master points is also shown on the display as crosses. The facility is useful for operator's to confirm successful digitising before a feature is accepted with 'END' (FB12). 'B' is only available from the close-up keyboard and line-following must have been paused by

either operator or software intervention.

2. *CLO - reposition laser cursor accurately via close-up screen*

This facility is particularly useful when wishing to register the cursors location very accurately - perhaps to digitise Master Points (MP-FB10). Under normal circumstances, the positioning of the laser cursor is only as good as can be determined by the operator's visual inspection of the photochromic screen and his movement of the trackerball. The keyboard command 'CLO' provides a means of more accurate cursor positioning. Operator's first direct the laser with trackerball to the vicinity of the required position. The command 'CLO' is then issued from the close-up keyboard which instructs the Lasertrak to scan the vicinity of cursor position and show a facsimile of what has been seen on the close-up screen. Accurate cursor positioning is then possible by means of adjusting the close-up cursor to the required location and pressing the space-bar. This action moves the laser cursor to the correct position on the photochromic screen.

3. *MAN and E - multiple entry of Master Points from close-up screen and keyboard*

Several Master Points may be created using the close-up terminal by typing the command 'MAN' at the keyboard. Laseraid must be in help mode and line-following should be paused. The action of the command MANual draws a close-up facsimile on the close-up screen. The close-up cursor can then assign accurately the required Master Point locations and each time the space bar is depressed, a Master Point is created. The command 'E' from the keyboard ends the sequence. The combination of inserting manual master points and manual junctions is described in the following section.

4. *MAJ n - Define a junction position manually*

There may be instances when operators require to force a junction feature in locations where laseraid cannot define one for itself automatically. Usual reasons are from the effects of poor-quality line-work, short gaps or dirt at the junction position or inappropriate Lasertrak tuning.

Manual definition of a junction can be performed in two ways at present and though both involve the use of several commands, it is the command

MAJ n

which is fundamental to the junction creation process. MAJ takes one argument which is numeric and this represents the number of lines (or arms) which are entrant to the junction being created. A 'T' junction, for example, has three entrant lines and hence it is created with the command

MAJ 3

'MAJ' can only be entered from the close-up keyboard and line-following must have been paused with the system in help mode.

There are two ways in which manual junctions can be created - one involves the use of the laser cursor on the photochromic screen and the second is for very accurate positioning involving the close-up screen. Both procedures are described in steps below.

1. *Manual junctions from the position of the laser-cursor*

(i) Position the laser cursor over the required location for the junction point position as accurately as possible with the trackerball,

(ii) enter master point mode by pressing FB10. Create a master point at that location by issuing a 'MP' command on FB10.

(iii) convert the master point from (ii) above into a junction point of known number of entrant lines by typing at the close-up keyboard

MAJ n

where n is the determined number of entrant lines.

(iv) a junction point at the cursor's location will have been created and an entry made in the junction list.

2. *Manual junctions with the use of the close-up terminal*

(i) If an automatic scan is unsuccessful, then it may be necessary to generate a manual junction.

(ii) ask for a close-up facsimile of the vicinity of the laser cursor to be drawn on the close-up screen. This is achieved by typing at the close-up keyboard

MAN <carriage return>

The result is a close-up facsimile and the appearance of the close-up screen cursor.

(iii) using the 'joy stick' on the close-up terminal, position the close-up cursor over the exact position where the manual junction is required.

(iv) using the keyboard space bar, the junction can be placed and then the letter 'E' to end the junction point. Since only one point is to be fixed, it can be typed immediately. The alternative could have been to create several points - these would be done by a combination of the close-up cursor and the keyboard space bar. The sequence of points created, though, should always be terminated with 'E'.

(v) convert the Master Point that has been created into a junction with the keyboard command

MAJ n

where n represents a numeric argument to define the determined number of entrant lines

(vi) the junction has now been created and it will have an entry in the junction list.

In both methods for manual junction creation, there are a number of conditions and disadvantages, viz:

- 'NXT' (FB8) has no effect because manual junctions have no details on the direction of entrant lines.

- once all lines entrant to the manual junction have been digitised, it will not be deleted from the junction list. It remains there forever, or until the total list is cleared with 'ZIJ'.

- digitising of lines which exit the manual junction is achieved by 'ONE' (FB3) to determine direction with the tram-lines and 'GO' (FB4) to commence auto-line-following.

- when a manual junction is encountered by Laseraid, the message 'Manual junction' appears on the close-up screen and tramlines will be produced. The direction of line following can be chosen with the tracker ball and line following resumed with FB4

11 *LAPROCESS - POST-PROCESSOR FOR IFF FILES*

The LAPROCESS post-processing program is a utility supplied by Laser-Scan which must be applied to all data digitised using Laseraid before that data can be edited, plotted or otherwise manipulated. It is invoked by the command:

LAPROCESS input-filename output-filename

in response to the VMS prompt. The program has several powerful functions :

1. Transformation of the coordinate data into the target 'map' space specified in the control point setup stage. (Section 9.6)

2. Unification of two part features created using the FIND option set in main mode (Section 10.3)

3. Ordering of closed features if they were tagged with the reverse option (Section 10.3)

To run this utility, operators must first ensure that the target IFF file directory has been established by the command 'SI' (see section 7.2).

The full specification of LAPROCESS can be found in the LAPROCESS User Guide.

12 *SYSTEM HARDWARE POWER-DOWN PROCEDURES*

The instructions which follow explain the procedures necessary to power-down the Lasertrak hardware; they assume that the system is currently switched on with power being supplied to the projection system, the lasers and the water cooling unit. It is recommended that at most the Lasertrak only be switched on and off once per day. It is not necessary (indeed not recommended) to power-down the hardware each time it is not required for use. Lasertrak should only be powered-down at the end of a day's session.

The procedure to power-down Lasertrak involves following a series of steps in sequence as are described below.

(a) Switch the Lasertrak to disable off-line by positioning the machine STATUS switch on the main control panel (**B**11) to the disable position.

(b) Depress green master on/off button to power-down the machine: confirmation is given by the extinguishing of this power light (**B**10).

(c) Turn anti-clockwise to vertical the master power-lock key on the Lasertrak main panel (**B**9).

(d) Switch off water supply for the laser cooling system.

The Lasertrak is now powered-down confirmed by the extinguishing of all lights and the darkness of the photochromic screen (**A**2). The Lasertrak can now be left in this state with confidence until it is required again, at which time the hardware should be powered-up in the normal way (see section 5).

APPENDIX A

Summary of the more important Laseraid commands discussed in this document

Command	Mode Available	Function Button	Description
?	ALL	K	Display current setup of function buttons
?command	ALL	K	Gives help on a specified command
STR	M	1	STRaight line - line-type associated with FB 1
CUR	M	2	CURved line - line-type associated with FB 2
RAN	M	3	RANdom line - line-type associated with FB 3
REP	M,LOC	4	Re-paint-out
ORT	M	5	ORThogonal line - line-type associated with FB 5
PNT	M	K	Point digitising for small buildings
POI	M,POI	6	POInt digitising mode
SMF	M	7	SMall Feature digitising by single scan
GNF	M	8	Get Next Feature for digitising
POS	M	9	Paint Out Suppress option: default off
FIN	M	10	FINd option: default off
SQR	M	11	Flag feature for SQuaRing: default off
REV	M	12	REVerse next feature's point order: default off
OPE	M	13	Suppress CLOsed feature detection: default off
DEC	M	14	DECrement coding (serial number of AC heighting)
INC	M	15	INCrement coding (serial number of AC heighting)
ABA	ALL	16	ABAndon process and return to parent mode
WIN	M	K	WINdow paint-out
FOR	M	K	FORwards paint-out
LOC	M	K	LOCate feature for simple edit operations
CP	M	K	Measure control points and establish coordinate system to be used: i.e. enter Measure Mode
CAL	M	K	CALibrate system parameter file with grid measurement: i.e. enter Calibrate Mode.
IDE	M	K	Include operator IDEntification
LAY	M	K	Select LAYer for data output
NF	M	K	Assign new feature serial number
PON	M	K	Print Overlay (layer) Numbers used to-date
PMF	M	K	Print Maximum Feature serial no. to-date
FCF	M	K	Set feature code for feature-start buttons
TYF	M	K	Set line-type code for feature-start buttons
PFB	M	K	Print current settings of feature-start function buttons
CHK	M	K	Enter system CHecK mode for Lasertrak tuning and thresholding
MNF	M	K	Set Manual feature serial increment
ANF	M	K	Set Automatic feature serial increment
HTD	M	K	Display elevation coding as decimals
HTI	M	K	Display elevation coding as integers
MHT	M	K	Set manual elevation code increment
AHT	M	K	Set automatic elevation code increment
TIM	M	K	Print all system TIMings
ZTI	M	K	Zero (initialising) all system timings
PCF	M	K	Move photo-chromic film to a new frame

CAN	M	K	CANcel last feature digitised
WHA	M	K	Print job details
ZIJ,ZJC	M	K	Clear In-Core Junction list
ADJ	M	K	ADJust system parameters: use of this command gives privileged entry to help mode to alter the type tables
EOS	M	K	End-Of-Session: exit Laseraid
OK,YES	MEA,CAL POI,CON	4	Confirm acceptance to proceed
GO	H	4	Commence auto-line following
STA	CHK	1	Define STArt of test vector
OCR	CHK	2	Measure Offset and Counts Ratios
WHL	CHK	3	Draw a WHite Line on photo-chromic film
TXZ	CHK	4	Clear close-up screen
PHA	CHK	5	Measure PHAse correction
CUR	CHK	8	Accurate cursor positioning with close-up screen
THR	CHK	9	Measure THReshold
CLO	CHK	12	Draw close-up of laser cursor's vicinity
FOC	CHK	13	Set red beam FOCus
QUL	CHK	14	Confirm Line position QUality
QUW	CHK	15	Confirm Line width QUality
TYP	CHK	K	Select a different line type
PSP	CHK	K	Print scanner parameters
AUT	CAL,MEA,POI	2	AUTo-re-scan
MAN	CAL,MEA,POI/H	8/K	Request MANual measure
SKI	CAL,MEA,POI	12	SKIp or ignore a measure
CON	CAL	13	Request automatic, CONtinuous calibration
CLO	POI	1	Show close-up around cursor's vicinity
DEL	LOC	13	Delete located feature in-hand
ONE	H	3	ONE scan/tramline request
NXT	H	8	Offer alternative track to follow
MP	H	10	Create a Master Point
HOP	H	11	HOP or jump over defined area
END	H	12	Accept digitised feature and return to main mode
MOV	H	14	Change cursor's status and appearance
BB	H	15	Pause line-following; enter 'rolling' mode
BAC	H	15	BACktrack, deleting data points
LJN	H	8	Locate previous junction
CLO	H	K	Accurate cursor positioning by CLOse-up
B	H	K	Macro to display digitised vector buffer on the close-up screen
DR	H	K	Display buffer on close-up screen
DR B n	H	K	Display n masterpoints on close-up screen
JAN	H	9	Search for junction position
FPJ	H	13	Turn on/off junction recognition
MAJ	H	K	Create Manual junction

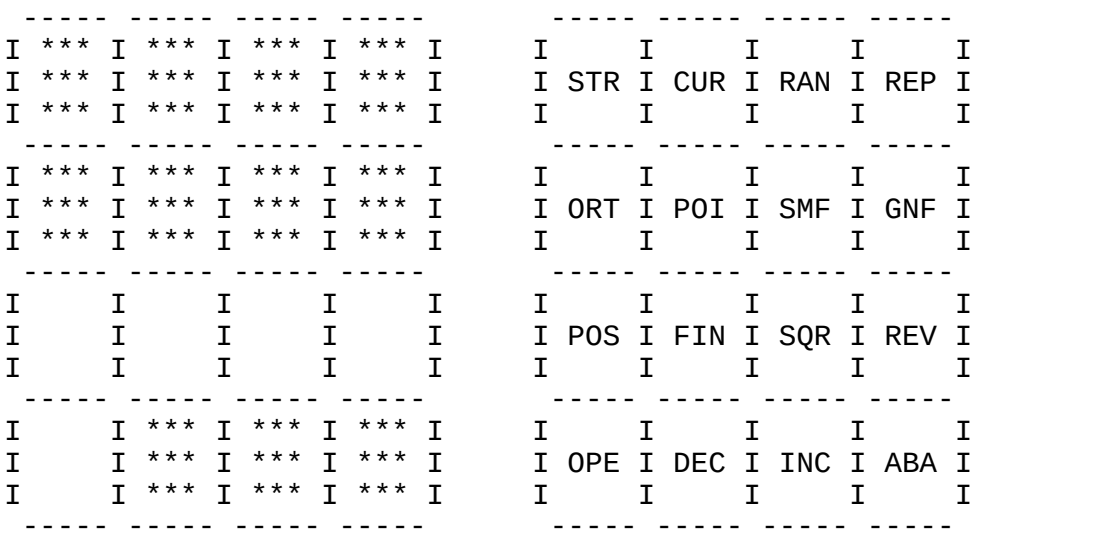
Definition of codes used in this table:

M = Main Mode
H = Help Mode
LOC = Locate Mode
POI = Point digitise mode
CAL = Calibrate Mode
MEA = Measure mode
CON = Confirm mode (e.g. for windowing)
K = From close-up keyboard
1-16 = Function button reference

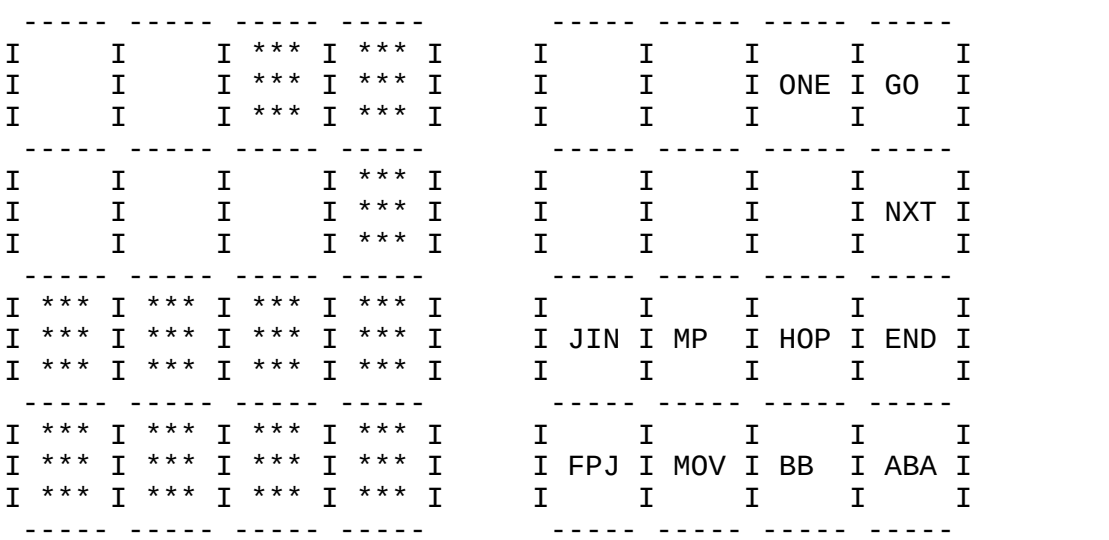
APPENDIX B

Summary of function button commands and light pattern for all modes of Laseraid discussed in this document

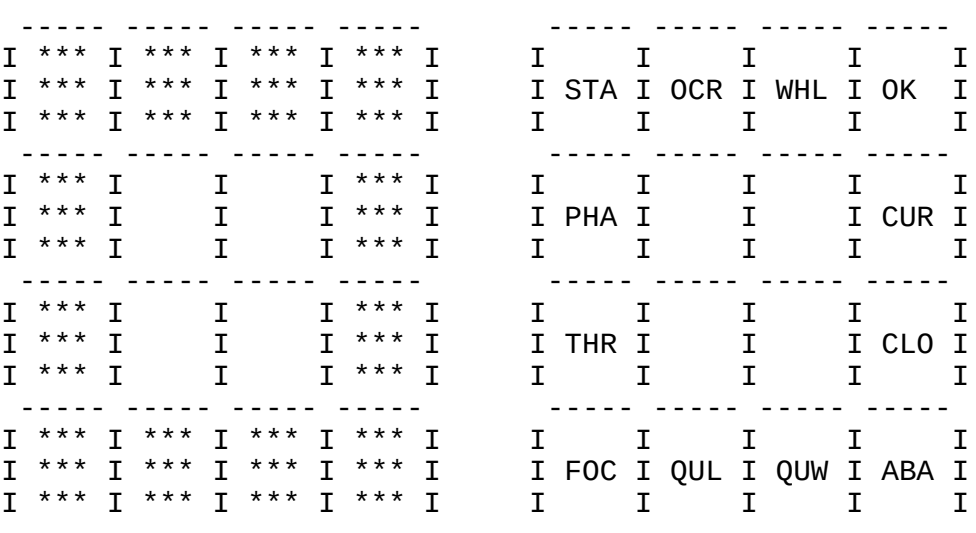
MAIN MODE:



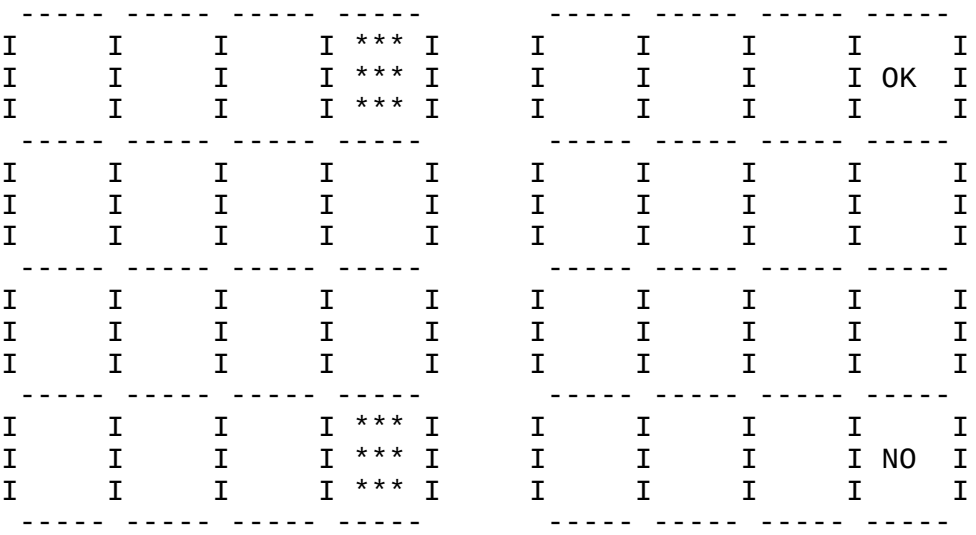
HELP MODE:



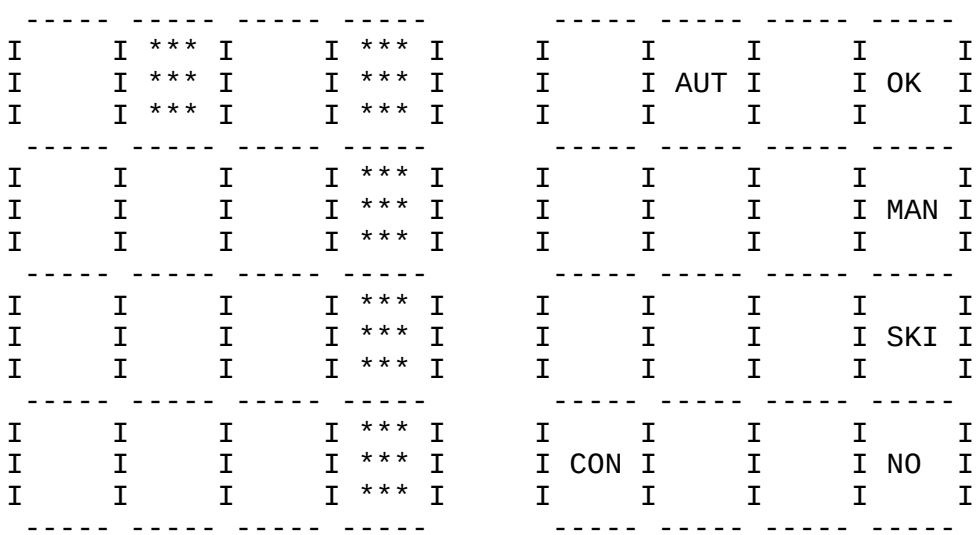
CHECK MODE:



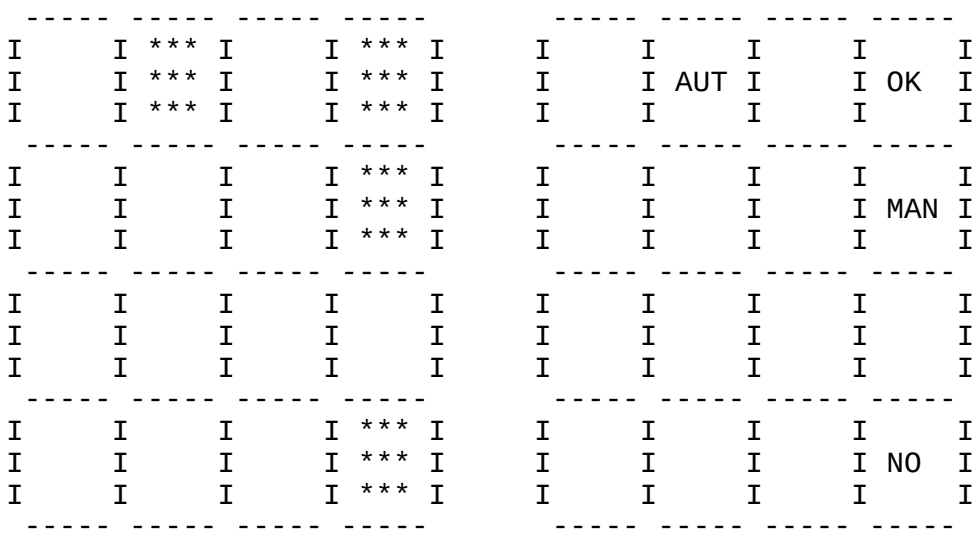
CALIBRATION PART 1 (CONFIRM MODE):



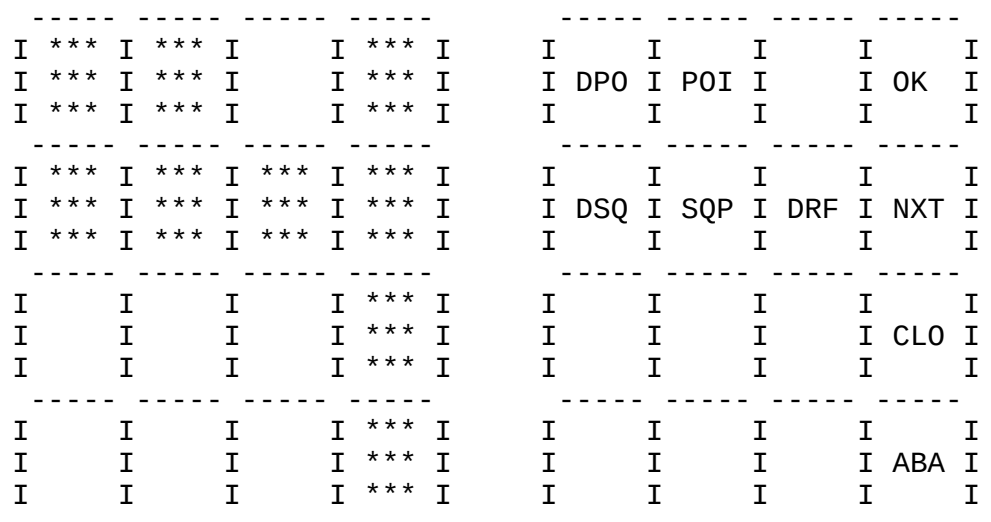
CALIBRATION PART 2 (CALIBRATE MODE):



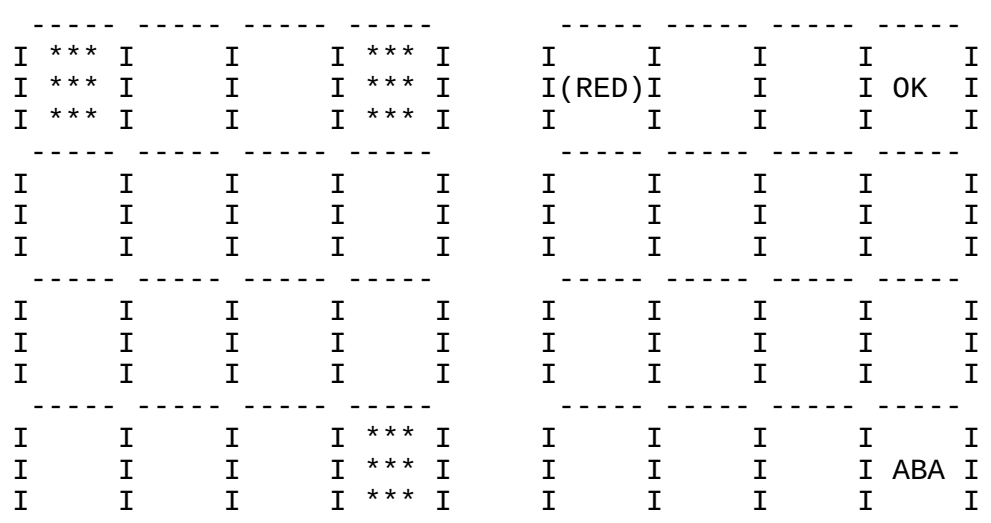
CONTROL POINTS (MEASURE MODE):



POINT DIGITISING MODE:



WINDOWING (CONFIRM MODE):



LOCATE MODE: