LASERAID

THE LASER-SCAN LASERTRAK DIGITISING PROGRAM REFERENCE MANUAL

RELEASE 1.0

Science Park, Milton Road, Cambridge, England CB4 4FY tel: (0223) 420414
Document "LASERAID Reference Manual" Category "REFERENCE"
Document Issue 1.0 Dave Meader 16-Sep-1986

CONTENTS

1 *LASERAID - THE LASER-SCAN DIGITISER*

1.1 *Introduction*

LASERAID is the control program for the Laser-Scan line-following digitiser, LASERTRAK. It is the first of a sequence of programs which combine to produce high quality digital data from a source document. Assisted by the operator, LASERAID will capture features on a reduced negative and output the results as a stream of coordinates to a file on disk.

The resulting file structure is Laser-Scan's own IFF (Internal Feature Format), which offers the combined benefits of compactness and efficiency. It contains various kinds of data in addition to the coordinates, such as line thicknesses, coding information and, optionally, a 'link-and-node' structure for holding networks.

This document describes the LASERAID user interface in terms of the commands available to the operator; it assumes a certain familiarity with the concepts of digitising using LASERTRAK. See the 'Introductory Guide to Digitising with the Laser-Scan LASERTRAK' for a more detailed description of the digitising process.

1.2 *Overview*

When LASERAID is invoked it reads a 'patch' file containing values for all the various digitising 'parameters' and 'command macros' (see sections 8 and 9). There is a pause, after which the message 'Initialisation completed' is displayed.

The subsequent use of LASERAID divides naturally into three stages. The first stage involves the automated calibration of the LASERTRAK and definition of the target coordinate system for the resulting data. This includes the measurement of a standard calibration grid and/or a set of four 'control points'. Additional information such as 'wash coding' may also be entered at this stage.

When the setup procedure is complete, stage two is entered in which a feature is selected to be digitised and any extra information is added. Stage three is the actual feature capture process, during which operator guidance may be requested. When the feature has been accepted, or feature capture has been abandoned, the program returns to stage two ready for the next feature.

Stages two and three alternate until the digitising session is complete. The End Of Session (EOS) command is then given in stage two to exit from the program. The patch file is completely remade at the end of each digitising session using the parameter settings current at that time. This means that the operator's initialisation work (parameter tuning, LASERTRAK setup etc.) is greatly reduced if the next session is on the same (or a related) map. The current calibration coefficients and control point values are also stored in the patch file.

Each of the above stages involves one or more program levels (or 'modes'), each with its own set of commands and characteristic use of the LASERTRAK function buttons.

2 *HARDWARE DESCRIPTION*

A standard Laser-Scan HRD-1 (High Resolution Display) contains a blue laser which is deflected under program control to write on photochromic film. This film is normally clear, and is darkened when exposed to the blue laser light. This image of black lines on white is continuously back-projected onto a large screen by orange light to which the film is insensitive. The resultant image is black lines on orange.

LASERTRAK has an additional red laser of low power which follows the same path as the blue. A film negative to be digitised is placed in contact with the photochromic film, producing a superimposed image of the map on the screen with clear lines on a black background. A photomultiplier positioned behind the photochromic film detects lines on the film by measuring the intensity of the red beam after passing through the two films in contact. LASERAID uses this information to follow a line on the film, after which the blue laser is used to paint over the clear-on-black image with a black line on the photochromic film. This effectively removes that line from the image on the screen, so that the operator can see which lines have already been digitised. They are also rendered invisible to the photomultiplier. If the painted out line does not overlay the digitised line, possible causes are the negative or photochromic film being inserted back to front (the emulsions of both films must be next to each other), or CRX/Y not set up correctly (see section 4.1.2).

To insert the film unlock and open the door on the right hand side of the optics unit, and slide out the film holder, which is on the far right (black handle with catch at bottom), taking care it does not catch on the photochromic film. The negative slides under the clamps on the holder. The emulsion should always be 'up' (next to the photochromic film). Normally, the original will have been photographed 'upside down', and the negative will also have been inserted 'upside down', so that the image is right reading on the screen.

2.1 *Controls*

The LASERTRAK controls are positioned so that the operator can reach the tracker ball, function buttons and keyboard while seated in front of the main screen. Onto the main screen are projected the images of the film negative and the main cursor (a red cross which can be moved by rolling the tracker ball).

The close-up screen is used for keyboard command reflection, any error messages, and for displaying graphs during the setup procedure. It can also show an enlargement of the area around the main cursor, optionally with a close-up cursor for fine positioning. This cursor is a pair of cross-hairs which can be moved using controls on the Tektronix keyboard. When the cursor is correctly positioned, typing any character transmits the position to the program.

3 *COMMANDS*

LASERAID is normally invoked at the LASERTRAK terminal by giving the command 'LAJ' followed by one or more qualifiers as described in the next section (the acronym LAJ may be taken to stand for '*L*ines, *A*rea-features and *J*unctions', a description of the digitising capabilities of the program). When the message 'Initialisation completed' is displayed, LASERAID is ready to be used.

Commands are given to the program via the function buttons (FBs) and the keyboard. In general the most common commands at any time are available on the function buttons, while less common commands (and those requiring numbers or text as arguments) are given via the keyboard. Each function button command is also available via the keyboard by typing its name (note that only the first three letters of any command are significant). Typing '?' at the keyboard (at any time when a command is expected) will display the current function button meanings and all the commands available in the current LASERAID mode. Typing '??' will produce a list of all the topics for which on-line help is available in that mode, and '? topic' will display the on-line help for that topic.

3.1 *Command-line Qualifiers*

The following may be specified on the command line:

1. The IFF Filename

   LASERAID can either create a new IFF file or add data to the end of an existing one. The default file specification is LSL$IF:IFF.IFF, and this will be used to substitute any part of the filename not given by the user. Note that if the filename is numeric (e.g. 999), the resulting file specification will be LSL$IF:IFF.999.

   The commands are:

   ```
   IFF <file>      to create a new file
   NEW <file>
   TO <file>
   <file>          (if first command on line)

   or

   OLD <file>      to add to an existing file
   APP <file>
   UPD <file>
   ```

2. The 'Patch' File

   The PATCH file (sometimes also known as the LINK file) is used to keep the values of the digitising parameters from one session to another. Its name defaults to LSL$LK:LNK.LAJ, however normally the user specifies the required file by means of the 'WITh' command (e.g. WIT URBAN). The name of the file is often used to indicate the type of operation for which the patch file is tuned, and if several LASERTRAKs are in use at a site, it is usual to append the machine number to the end of the filename (e.g. URBAN114.LAJ). It is recommended that the file type is not changed.

3. Use of the LASERTRAK

   The command 'NOD' (NO Display) will suppress the use of the LASERTRAK. Note, however, that very few operations can be performed under these circumstances.

4. Photochromic Film Advance

   The photochromic film may be wound on one frame by giving the command 'NP'.

5. Height Coding Specifier

   The commands HTD or HTI (optionally followed by a value) may be specified on the command line and cause LASERAID to use the corresponding method for coding height information (see section 5.4). By default it is assumed that the IFF feature numbers will be used to hold height values.

Typical command lines are:

```
LAJ <file> [WITH <patchfile>] [HTD <value>]

or LAJ OLD <file> [WITH <patchfile>] [NP]
```

3.1.1 *Reading-in OLD Files* -

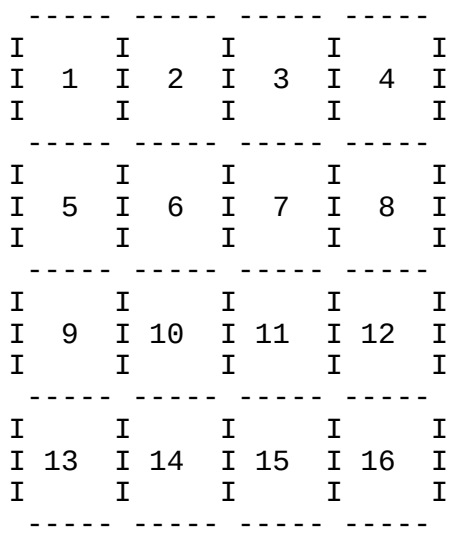
The OLD command-line option enables data to be added to an existing IFF file. LASERAID recognises two varieties of such files, which are termed 'old' and 'very old'.

An 'old' IFF file contains data digitised using converged LASERAID. It should be unprocessed (i.e. not passed through LAPROCESS). The file is read straight into LASERAID, any incomplete junctions are put into the 'in-core junction list' and digitising may continue. This is the normal use of the OLD command.

A 'very old' file is one digitised using a pre-convergence version of LASERAID (old LAJ, FLF or ELA). Note that in this case the file should already have been processed using LAPROCESS. The data are not actually read into LASERAID until the control point (CP) measurement has been performed, (see section 4.3) at which time they are overlaid onto the output coordinate system. If an unprocessed 'very old' file is read into LASERAID the results will be unpredictable (but wrong).

3.2 *Function Button Commands*

The function buttons are numbered as follows :



In general, only those buttons which are valid or active are illuminated. In the overall plan of function button commands, FB 16 is usually ABAndon, which is the failure exit, returning to a higher program mode and undoing as much as possible as it goes. FB 4 is usually OK or GO, which is the success exit. Other buttons are used for commands specific to the current mode. These commands are positioned so that the pattern of function button lights is easily recognisable for each mode.

3.3 *Keyboard Commands*

Commands at the keyboard are recognised by their first three letters, hence ABA is sufficient for the ABAndon command. If a command requires any arguments, these must be typed on the same line.

4 *INITIALISATION*

When the message 'Initialisation completed' is displayed, LASERAID has read the patch file (and dealt with any OLD file specified on the command line), and is ready for interaction. At this stage the program is in MAIN mode, which is described in more detail in section 5.

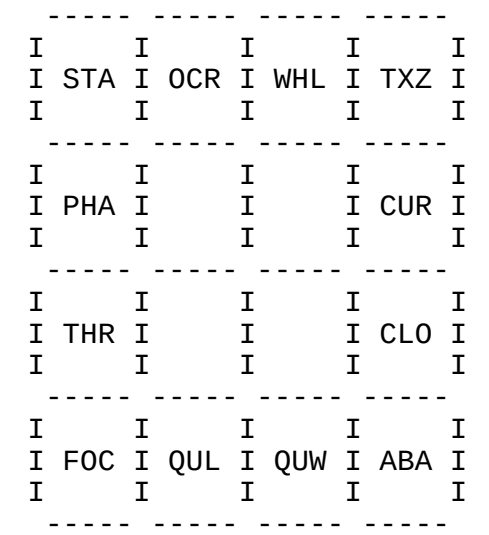
The first action of the operator is to set up the LASERTRAK so that it can 'see' the linework on the negative. This is achieved by means of CHECK mode (see below). After this a standard grid may be digitised for calibration purposes, and the four control points are measured. Digitising may then commence.

4.1 *CHECK Mode*

CHECK mode is entered from MAIN mode by means of the commands CHK or CHEck. It enables the LASERTRAK to be set up optimally.

4.1.1 *Commands* -

The function button layout in CHECK mode is as follows :



Where:

STArt	sets the start point of the line to be scanned
OCR	sets the red/blue Offsets and Counts Ratio
WHL	draws a WHite Line on the photochromic for OCR to use
TXZ	clears the Tektronix screen
PHAse	sets the phase correction
CURsor	draws a close-up view around the cursor position, puts up the close-up cursor and waits for a character to be typed. It then positions the main cursor to the close-up cursor position (used for fine positioning). Also see CLO below
THReshold	sets the digitising threshold
CLOse-up	draws a close-up view around the cursor position
FOCus	sets the digitising laser focus
QUL	draws a graph of the quality of line positioning over the width of the scan
QUW	draws a graph of the quality of line width over the width of a scan
ABAndon	returns to MAIN mode

Other useful commands available are:

ERR	repeatedly scans a line and checks the results (FB 16 to abandon)
PSP	Print Scanner Parameters
TYP n	selects one of the line types (see section 8.5)
PTY	prints out the current line types
MOD n	0/1 -> edge/line mode for scanner
FRQ n	sets the scan frequency (must then reset PHAse)
WID n	sets the scan width
PIT n	sets the scan pitch
TLO n	sets the threshold for scan encounters
TSW n	0/1 selects automatic/manual threshold

For information on the other commands available in CHECK mode, refer to the on-line help. Note that most of these are only of interest to Laser-Scan engineers.

4.1.2 *Setting Up The Digitiser* -

The digitiser threshold should be set up first, after which the phase correction can be performed. There are, in fact, two phase corrections (one for each axis) so this must be done on both a horizontal and a vertical track. The process is repeated automatically for each of the different scan widths in the 'type table' (see section 8.5). If the negative to be digitised has very fine lines it is also worth adjusting the focus of the red digitising spot. If any maintenance work has been performed on either the blue or red beam optics, it may be necessary to recalculate the red/blue offsets and counts ratios. The procedure for performing these corrections is described in the following sections.

The general state of the machine may be checked by drawing a few close-ups of different areas of the negative using the CLO command, and by using the QUL and QUW commands. If the LASERTRAK has just been turned on it is advisable to perform some long 'dummy' scans in order to allow the thresholding circuitry to stabilise. A stable threshold will produce crisp close-ups.

4.1.2.1 *Hardware Corrections* -

These are the parameters which are concerned with the behaviour of the digitiser hardware. They include the digitiser discrimination threshold (TLO) and the phase corrections for the two axes (PHX and PHY). They can all be set in CHECK mode.

The digitiser can work with two types of thresholding: manual or automatic. The mode is controlled by the Threshold Switch TSW. If this is set to 1 then manual threshold is selected, and 0 selects automatic threshold. One caveat associated with automatic threshold is that the threshold tends to drift towards zero if no scans are being done, and it takes about half a scan to correct itself. Hence the first scan after a pause in digitising may not see everything.

The correct parameter values are established by repeatedly measuring a piece of track while varying the appropriate parameter. The encounters measured are then analysed to provide the best value for the parameter. The procedure is as follows:

1. Place the cursor on a clear, straight track and press the button STArt.

2. Move the cursor to indicate the portion of the line to be measured. (this should be at most one centimetre long on the screen) and press THR or PHA.

3. A graph will be drawn on the close-up screen showing the results of the digitisation against the parameter being measured. The parameter is set by choosing the value that gives the best result, and indicating this value using the close-up cursor.

4.1.2.2 *Threshold (TLO)* -

With TSW 1 set this should produce a graph similar to the one in Figure 1. The optimum threshold is the mid point of the flat part of the threshold.

The X axis of the graph is increasing TLO, and the vertical axis is the number of black/white and white/black transitions seen in the scan. If TLO is set at the extreme left hand side of the graph, everything is seen as white. The spike (especially pronounced if the line has 'stipple' on one or both sides) is where small amounts of black are beginning to appear in the white. The horizontal line is the region where the line is seen in its entirety, although its apparent thickness decreases with increasing TLO, and conversely the apparent gap between adjacent lines increases. At the right hand side, the line is breaking up, with gaps starting to appear.

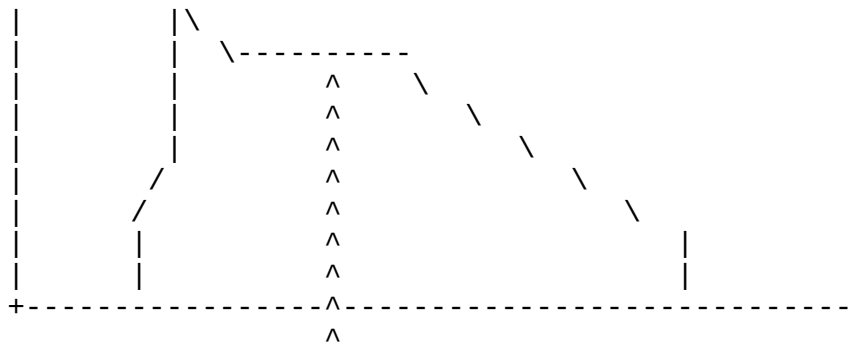


Figure 1

4.1.2.3 *Phase* -

A typical graph is shown in Figure 2. The correct phase is where the graph crosses the horizontal line. If this is clear the program will choose for itself.

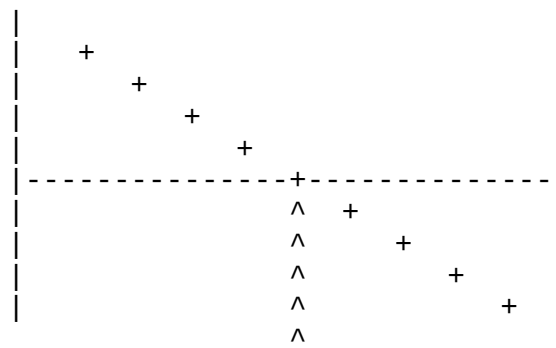


Figure 2.

The phase value compensates for the fact that the minimirrors usually scan the lines in alternating directions. The phase is different for different frequencies and different widths. If the phase is wrong, a close-up may look appear as in Figure 3.

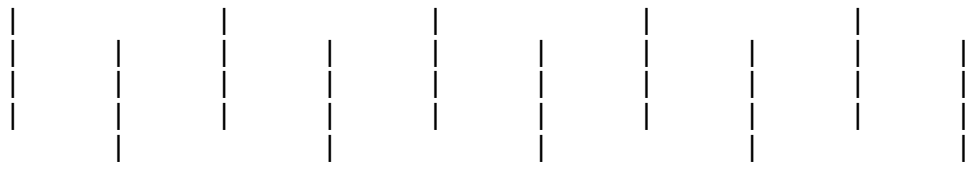


Figure 3.

If the scanner is running at a high frequency and large pitch, the minimirrors may already have reversed their direction before the 'along the axis move' has completed, in which case the scan is delayed until the minimirrors have again changed direction. This can give the appearance of perfect phase correction.

4.1.2.4 *Focus* -

To set the focus of the red beam, first set up a scan vector in one axis, draw a threshold graph and select a point halfway down the falling side of the curve. Then press FOC (FB 13) to draw the focus graph. This should be of similar shape to a threshold graph, and the maximum height should be selected. The procedure should then be repeated for the other axis to check that the digitising spot is not astigmatic. If the graphs from the two axis do not overlay exactly (typically they will not) then a mean position should be selected. After setting the focus it is necessary to remeasure the threshold to reset it to the normal value.

4.1.2.5 *Red/Blue Offsets And Counts Ratios* -

These parameters are set using a clear part of the negative. First select a wide line type by entering TYP 1 at the keyboard, then draw a 'white' line on the photochromic film by pressing STArt and moving the cursor in the usual manner. On pressing WHL (FB 3), a line will be drawn. Then press OCR (FB 2) which will draw a graph and set the parameters automatically. The graphs produced should (after two or three OCR scans) lie along the 45 degree line on the 'goal-post', without any large deviations or systematic effects. This setup should be performed twice with the white line approximately horizontal and vertical.

4.1.2.6 *Confidence Checks* -

Two commands are available to give qualitative and quantitative measurements of the quality of digitising. These are QUL (FB 14) and QUW (FB 15). QUL measures the quality of observed line position across the width of a scan, and QUW measures the quality of observed line width similarly. These are used on any orientation of straight line, and should produce approximately horizontal traces on the close-up screen (the vertical position of these traces is not significant).

4.2 *Standard Grid (CALIBRATE Mode)*

Calibration provides a set of cubic coefficients which relate the coordinate systems of the digitiser and the source map, correcting for any distortions introduced by the photographic processes involved in producing the digitising negative, and for any non-linearities in the LASERTRAK optics. A calibration should be done for each BATCH of negatives (the coefficients are preserved in the patch file so it is not necessary to calibrate each individual negative), and after any work has been done on the optics of the digitiser. To perform a calibration the following procedure should be followed:

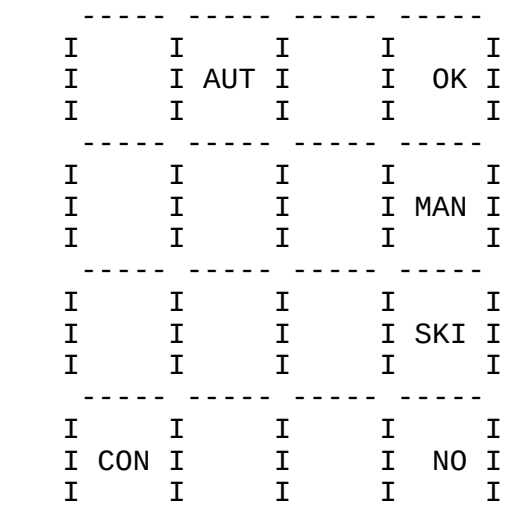
Give the command CALibrate with an argument which is the size of the grid squares. This size is only used to normalise the residual values, and should be given either in microns on the reduced negative or millimetres on the map. You will then be asked to outline a grid using the LASERTRAK cursor and the function buttons (the extent of the grid and the X/Y increments must be specified).

When the description of the grid is complete, it will be measured. The program attempts to measure each intersection automatically. However, if this fails, the operator is asked to measure it manually using the commands described in the next section. When the grid has been measured, press OK (FB 4) to perform the fit; the calibration coefficients are calculated and the residuals are displayed. If the residuals are very uneven, or if the RMS residuals are large, then reject the calibration by pressing NO (FB 16). Otherwise accept them with OK (FB 4). If accepted, the coefficients will be applied to subsequent coordinate data prior to output to the IFF file and will be saved in the patch file at end of session. If the fit is rejected then you can try again with better threshold and/or phase, or a better grid.

If the switch FCT is set to 1 in HELP mode (see section 7), then the calibration is incorporated in the control point (CP) set up described in section 4.3.

4.2.1 *Commands* -

The function button layout in CALIBRATE mode is as follows:



Where:

AUTomatic	is retry automatic point digitising
OK	is accept the cursor position
MANual	is draw close-up area and invoke cross-hair cursor
SKIp	is skip this point
CONtinue	is set/unset automatic continuation after each point
NO	is return to MAIN mode

4.2.2 *Recovery From A Bad Calibration* -

If a digitised dataset is found to be distorted and the problem is traced to a bad CALibration (e.g. the wrong grid negative was used), a mechanism is available by which a new calibration can be substituted, hopefully correcting the problem. It should be noted that the *same LASERTRAK* must be used both to digitise and correct the data. The LASERTRAK device name and machine number are included in the operator identification text (in the IFF NS entries), assuming that the OPerator command was not given (see section 4.4).

A *COPY* of the *UNPROCESSED* distorted file should be read into converged LASERAID using the 'OLD' command option. A CALibration and Control Point measurement should be made as usual, and then the RECover command can be given. When the command finishes, LASERAID can be terminated as usual and the calibration will have been replaced.

It should be noted that it is NOT possible to correct 'very old' files (digitised using pre-convergence versions of LASERAID) in this way.

4.3 *Control Points (MEASURE Mode)*

The Control Points are measured by giving the command CP in MAIN mode. The LASERTRAK cursor will automatically move to the vicinity of the first control point and the appropriate prompt will be displayed on the terminal screen (NW for the first point). The coordinates of this control point in map (target) space may then be entered to replace the current values, and the cursor should be positioned over the point using the tracker ball. AUT (FB 2) will then attempt to digitise the control point automatically. If this fails the close-up screen and cross-hair cursor may be used. The available commands are listed in the next section.

When the command OK (FB 4) is given, the position is stored and the cursor moves to the next control point for the process to be repeated. Note however that it is not sufficient simply to move the cursor to the required position and press FB 4. A scan must be performed for the position to be registered. After all four control points have been processed in this way, the whole set may be either accepted or rejected.

After the four control points have been measured the user is asked to specify a check fiducial. This intersection will be remeasured at regular intervals to check for LASERTRAK slip, etc. If the specified tolerance is exceeded then a message is printed and the last feature may be deleted by typing CANcel. The control points should then be redigitised before continuing.

If the user specifies a number in the range 1 to 4, this will select the corresponding control point as the fiducial. A fiducial number of zero disables fiducial checking completely.

If the user specifies fiducial '-1', the tracker ball may be used to select a fiducial which is unrelated to the control points (it need only be an intersection of suitable quality). The user rolls the tracker ball to the required intersection and presses FB 4. The intersection is then scanned and, if found successfully, it may be accepted using FB 4 (otherwise it may be re-scanned in the usual manner).

When the fiducial has been accepted, LASERAID will ask how often the fiducial check should be performed ('After how many features ?'), and for a measurement tolerance in microns on the negative. Typical values for these might be every 5 features with an error limit of 15 microns. The command CHF (q.v.) may be used to alter these values.

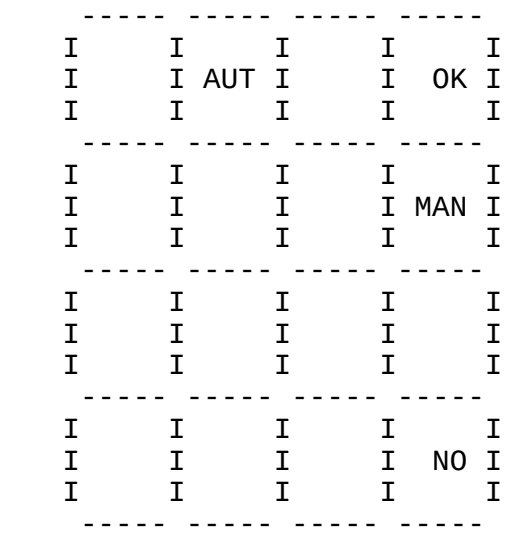
It should be noted that once a check fiducial has been selected (by whatever means), if -1 is entered on SUBSEQUENT occasions it will cause the SAME fiducial and set of parameters to be used again. The user does not have to roll the tracker ball or answer any further questions (-1 is taken to mean 'same again').

If the user subsequently wishes to select a new fiducial by means of the tracker ball, the existing settings must first be cleared by specifying CHF 0 0.

If the switch FCT is set to 1, calibration and control point measurement are merged into one operation. The combined procedure is to type CP, which now causes a calibration to be performed. At the end, any grid intersection may be selected as a check fiducial by positioning the cursor in its vicinity and pressing FB 4, after which the usual questions are asked.

4.3.1 *Commands* -

The function button layout in MEASURE mode is as follows:



Where:

AUTomatic	is retry automatic point digitising
OK	is accept the cursor position
MANual	is draw close-up area and invoke cross-hair cursor
NO	is return to MAIN mode

4.4 *Operator Identification*

The command OP (or IDE) allows the user to specify the 'operator identification' (e.g. operator name, map number, date etc.) which is entered in the NS entries of the IFF file. A default entry (containing the date, time, username and LASERTRAK machine number) is created if the command is not given.

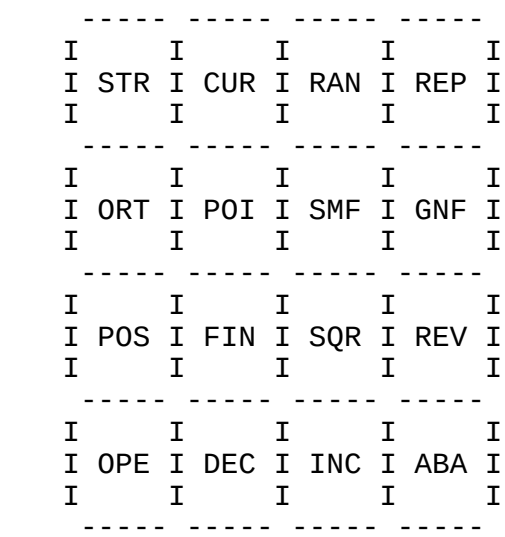
5 *FEATURE SELECTION (MAIN MODE)*

As the name suggests, MAIN mode is the outermost level of LASERAID. It contains the commands described in previous sections for entering CHECK mode (CHK), CALIBRATE mode (CAL) and MEASURE mode (CP), as well as LOCATE mode (LOC) which is described later (section 5.5). The EOS command for terminating a session is also given in MAIN mode. As will be seen, several other commands are available for controlling coding, pre-guidance and paintout.

The primary function of MAIN mode is, however, feature selection (corresponding to 'stage two' as described in section 1.2). A feature is selected by placing the LASERTRAK cursor over it and pressing the appropriate 'feature start' button (i.e. FB 1, 2, 3, 5, 6 or 7).

5.1 *Commands*

The function button layout in MAIN mode is as follows:



Where:

STRaight	is start feature (nominally STRaight)
CURved	is start feature (nominally CURved)
RANdom	is start feature (nominally RANdom)
REPaint	REPaints captured features (FB 16 to abandon)
ORThogonal	is start feature (nominally ORThogonal)
POInt	is start single POInt feature
SMF	is start SMall Feature
GNF	is Get Next Feature from guidance file, or next junction
POS	disables paint-out (Paint-Out Suppress)
FINd	enables automatic feature FINd-and-start (fumble)
SQR	sets squaring flag in second word of FS entry
REVerse	causes closed features to be clockwise rather than anticlockwise
OPEn	disables closure detection

DECrement	causes the NF number to be DECremented by MNF (but see section 5.4)
INCrement	causes the NF number to be INCremented by MNF (but see section 5.4)
ABAndon	resets REVerse and PO to initial states (repeated presses position the cursor to the centre of the screen)

The following keyboard-only commands are also available (these are shown in the order given by typing '?' in MAIN mode):

PO	sets Paint-out Only for this feature (do not keep the data)
GUI file	take GUIdance information from an IFF file (section 10)
VFG n	sets Very Fast Guidance on/off if n=1/0
SKIp n	skips to feature n in the guidance file
WIN	define a window for paintout
FOR n1,n2...	paint out FORwards through layers n1,n2 of the file (cf. REPaint for reverse)
LOCate	LOCate nearest captured feature to the cursor (section 5.5)
MCF	Measure Check Fid (repeats at interval set by CFT)
CP	measure Control Points
CFT r	sets Check Fid Time (see MCF)
CHF n1,n2,r	sets Check Fid to n1, every n2 features, with error r
CAL r	CALibrates the machine with grid of spacing r
CCP r	CALibrates with control points, as CP with FCT=1
REC	RECover from a bad CALibration
OP <text> or IDE <text>	input OPerator IDEntification (section 4.4)
TC <text>	input Transmitted Comment
TEX <text> or CH <text>	rest of line is taken as literal text and entered into the file
OV n or LAY n	select IFF OVerlay n to hold the data
SS n	Symbol Select
PT n	Plotter Type
NF n	change current NF number to n (1<=n<=32767)
ACB n	set Ancillary Code Base to n (see section 5.3)
SAC n1 n2 text	set or show Standing Ancillary Code (see section 5.3)
PON or PLN	Print Overlay Numbers
PMF	Print Maximum Feature numbers for each overlay
FCF n1 n2	set Feature Code for Function button n1 to n2
TYF n1 n2	set TYpe for Function button n1 to n2
PFB	Print Function Button meanings
GFC n1 n2	Guidance Feature Code allocations (section 10)
CHK or CHEck	enter CHECK mode
MNF n	set manual increment of NF number to n (see INC)
ANF n	set auto increment of feature number to n
HTD [r]	capture height as real number (see section 5.4)
HTI [n]	capture height as integer (see section 5.4)
MHT n	manual height increment (see section 5.4)
AHT n	automatic height increment (see section 5.4)

NFI	cancel HTD/HTI (see section 5.4)
PNT [n]	set or show the current point feature mode (see section 7.2)
TIMe	print out TIMings so far
ZTI	zero timings
PMI	initialise performance monitor (FOR LSL USE ONLY)
PME	end performance monitoring (FOR LSL USE ONLY)
PCF [r]	move Photochromic Film on [r frames (default 1.0)]
TYPe n	set line type to n
CANcel	CANcel (delete) last feature digitised
WHA	prints out WHAt ID, patch file, IFF file are
ZJC or ZIJ	Zero (forget) in-core junctions
WIZ	Debugging aid (FOR LSL USE ONLY)
ADJ	enters 'adjust mode' (privileged HELP mode)
EOS	End Of Session (program exit)
NXG	NeXt Guidance command (section 10)

The on-line help contains additional information on many of these commands.

5.2 *Starting A Feature*

Each of the 'feature start' function buttons (FBs 1, 2, 3, 5, 6 and 7) may have associated with it:

1. a feature code, selectable using the FCF command

2. an implicit 'feature type': linear feature for buttons 1, 2, 3 and 5, point feature (section 7.2) for button 6, and small feature (section 7.3) for button 7

3. an explicit 'line type', defining a set of LASERAID parameters to be used when following features started using this button. These parameter values are held in the 'type table' (section 8.5), and selected via the TYF command. Seven line types are available, and any of these can be assigned to any of the 'start' function buttons. It is NOT the case that FB 1 must use type 1 etc.

It should be noted that the names of FBs 1, 2, 3 and 5 (i.e. STRaight, CURved, RANdom and ORThogonal) do not have any enforced significance. FB 1 can be set up to follow a tortuous contour as easily as FB 3. However, the meanings of FB 6 and FB 7 *are* 'hard-wired'; for example it is not possible to follow a contour using FB 6, or to measure a point feature using FB 1. However, by assigning different line types to FB 7 it is possible to determine the MODe (i.e. edge or line) used when capturing small features (see section 7.3).

5.3 *Ancillary Coding*

IFF features may contain any number of Ancillary Code (AC) entries which can be used to hold user-specific coding information. AC entries are characterised by their TYPE; some AC types have fixed definitions (see the next section) but many are available for user-specific applications. In practice, AC types 0 - 99 should be considered to be reserved by Laser-Scan for current or future

applications. Each user will normally be allocated a set of 20 contiguous AC types for their own use; additional groups will be issued on request. Users should restrict themselves to using their own ACs, otherwise confusion may arise when the data are processed using general Laser-Scan utilities.

As each users group of private ACs will contain a constant offset (e.g. he may be allocated the range 200 to 219), it would be inconvenient to have to enter the whole AC type each time. Hence the ACB (AC Base) command is provided. This specifies a number (200 in our example) which will be added to the type of all ACs explicitly created using SAC or AC, before the entry is inserted in the IFF file. The AC base is held in the patch file and will normally be transparent to the user once the system is installed. Hence each user can consider himself to have his own group of ACs in the range 0 to 19. The command is provided in case of exceptional circumstances where the user may wish to access a different range of ACs.

AC entries may be created in several ways. LASERAID may automatically create height ACs (see below), the user may specify that a particular AC should appear in all features until further notice (this is termed the Standing AC and is created using the SAC command), or explicit AC entries may be added to each feature using the AC command.

The Standing AC (SAC) command may only be given in MAIN mode (before a feature is begun). The format of the command is:

```
SAC type value [text]
```

This AC is inserted in all subsequent features until altered by another SAC command or explicitly disabled by SAC 0. It is also preserved in the patch file between sessions. Note that SAC 0 0 is a valid setting and produces:

```
AC 'AC base' 0
```

In the AC and SAC commands, the AC 'value' is examined for a decimal point and is stored as a real number if one is found.

For example, the commands:

```
ACB 1000

SAC 1 50

<start new feature>

AC 5 123.6 POINT ELEVATION
```

Would cause the following ACs to be inserted in the IFF file:

```
AC 1001 50

AC 1005 123.6 POINT ELEVATION
```

It should be noted that the AC command MAY only be given after a feature has been started (using function buttons 1, 2, 3, 5, 6 or 7) and SHOULD only be given before any actual line following has begun for that feature. AC entries specified after line following has begun may or may not be accepted (LASERAID

will reject any attempt to create an AC once the first ST in the feature has been output to the IFF file).

The current Standing AC and AC base may be examined by just typing SAC and ACB, respectively.

5.4 *Height Coding*

The traditional technique for holding height information within IFF has been to use the feature (NF) number, manipulated in LASERAID via the ANF and MNF increment commands. This approach has many limitations (large, negative or non-integer values are difficult to represent) and so a mechanism has been introduced whereby heights may be held in special AC entries. The user may choose to code height information either as real numbers (stored in AC type 3 entries) or as integers (stored in AC type 2 entries). The current height may be displayed beside the cursor (in place of the feature number) and may be incremented automatically and/or manually.

The commands HTD, HTI, MHT, AHT and NFI control the height coding mechanism. These determine both what is displayed beside the cursor and what is output to the IFF file. The default is to display the NF number (an implicit NFI command); HTD displays the height as a real (decimal) number (AC 3), while HTI displays the height as an integer (AC 2). If HTD or HTI is given an argument, the appropriate mode will be entered and the height will be initialised to that value, e.g.

```
HTD 23.5

HTI 120
```

Note that HTD 100 is allowed, but HTI 53.5 is not.

Once LASERAID is in 'height' mode, any numbers typed on their own at the keyboard (in MAIN mode) are interpreted as heights rather than feature numbers (the default). The NF number output to the IFF file is, however, still incremented by the value specified using ANF (default 1) as usual, although it is not displayed. The NF command may still be used to assign specific NF values.

MHT and AHT control the manual and automatic height increments (both zero by default); these are directly analogous to the ANF and MNF commands.

NFI returns to displaying the current NF number. It should be noted that in this mode NO HEIGHT AC ENTRIES ARE PRODUCED.

All of these commands may be given in MAIN mode (i.e. before starting a feature using function buttons 1, 2, 3, 5, 6 or 7), however HTD and HTI may also be specified on the command line so that LASERAID comes up in the appropriate mode. For example:

```
LAJ FRED WIT LNK122 HTD 300.5
```

will put LASERAID into 'real height' mode and initialise the height to 300.5.

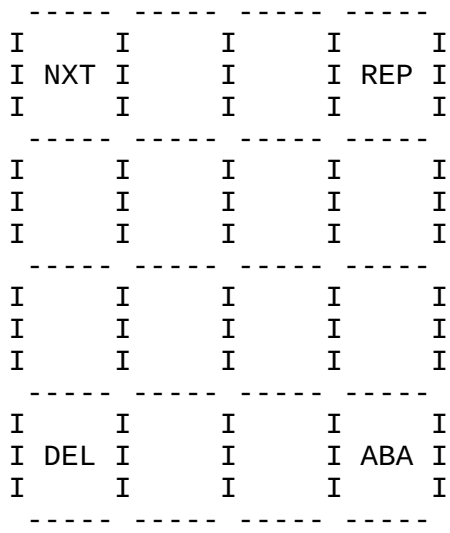
5.5 *LOCATE Mode*

The LOCate command enables the user to find up to four previously digitised features in the immediate vicinity of the LASERTRAK cursor and selectively repaint or delete them. The features must lie within a screen area of about 3 cm square centred on the cursor in order to be found. If any features are found, LASERAID enters LOCATE mode to allow interaction with them.

It should be noted that LOCate has to scan the whole IFF file and may be very slow if a lot of data has been captured. The search can be be abandoned by pressing FB 16.

5.5.1 *Commands* -

The function button layout in LOCATE mode is as follows:



Where:

NXT	is get next feature in the 'found' list
REPaint	is repaint the refreshed feature
DELete	is delete the refreshed feature (irretrievably)
ABAndon	is return to MAIN mode

6 *HELP MODE*

When a line-feature 'start' button is pressed in MAIN mode (see section 5) then, assuming that FINd (FB 10) is not enabled, the program pauses with the scan vector (or 'tramlines') displayed for guidance. LASERAID is then in HELP mode.

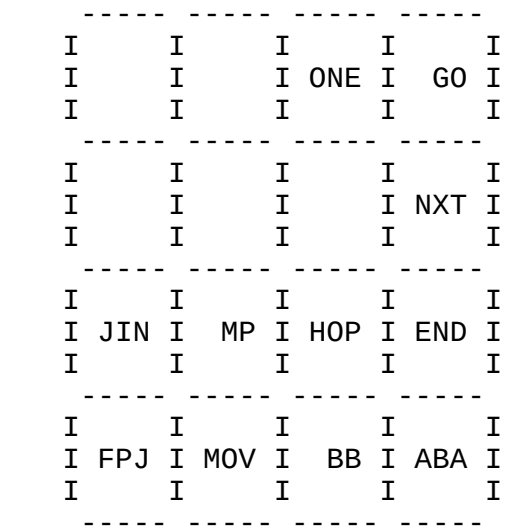
HELP mode is the main interaction level, in which all the line-following parameters are available to the operator as well as commands for controlling the digitising process. The most important parameters are discussed in section 8 (with additional information in Appendix A and the on-line help), and the most common commands are described below. Some of these commands are discussed further in section 7.

HELP mode may be temporarily entered from MAIN mode for the purposes of examining or modifying parameter values by means of the ADJust command (section 5.1).

6.1 *Commands*

HELP mode is different from the other program states described in this document, as the function button layout is context-dependent. The current function button meanings can be displayed at any time when a command is expected by typing '?'

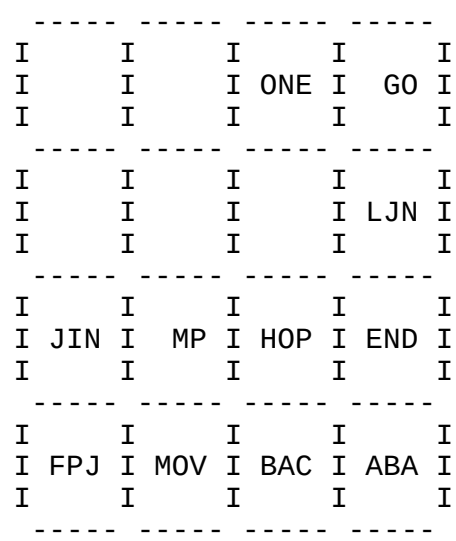
The initial function button layout in HELP mode is as follows:



Where:

ONE	is to control the direction of one scan vector before proceeding
GO	is to proceed normally
NXT	displays the possible paths available cyclically
JIN	explores the region for possible junctions
MP	inserts a manual Master Point at the cursor position
HOP	is used to jump over bad bits of line
END	accepts the feature and returns to MAIN mode.
FPJ	FliPs Junction recognition (disable/re-enable - see section 8.6)
MOVe	changes the cursor mode between 'change angle' and 'change position'
BB	enables 'rolling' mode for backing up along the digitised line
ABAndon	abandons capture and returns to MAIN mode.

After 'BB' has been pressed (to enter 'rolling' mode) the function button layout is as follows:



Where:

LJN	is Locate JunctioN near cursor (if any)
BAC	is delete the last master point (irretrievably)

Other HELP mode function button patterns are described under 'Small Feature capture' (section 7.3).

Some useful keyboard-only commands in HELP mode are:

PPP	print primary (user) parameters (see section 8.1)
PAP	print all parameters (see section 8.1)
PTY	print type table (see section 8.5)
PMA	print macro commands (see section 9)
PLW	print limits and weights (see section 8.4)
TYPe n	set current line type to n

6.2 *Operator Guidance*

Apart from at the start of a feature, there are two other cases where the program will automatically pause for operator guidance. The first is where it has found a piece of line which it believes to be the correct one, but requires verification because either there are several equally good possibilities, or the only one is of poor quality (see section 8.7 for a discussion of chain quality). In either case the best line is shown in refresh and alternatives may be selected using NXT (FB 8). If it has totally the wrong line then BB (FB 15) may be used to enable backtracking, and ONE (FB 3) may be used to display a scan vector with which to guide the program in the correct direction.

The other occasion is when the digitiser cannot see any continuation of the current line. In this case it shows a scan vector to request a new direction in which to look. The commands MP (manual Master Point) and HOP are useful in this case to get across difficult sections of line.

6.3 *Manual Intervention*

The user may interrupt the line following process by pressing FB 15. This button, which is always available when following and corresponds to the command macro INT (see section 9), causes LASERAID to pause in HELP mode. All of the interaction facilities associated with HELP mode are then available.

6.4 *Manual Digitising*

In the event that the line work is too complex, or of such poor quality that the digitiser cannot follow it automatically, three methods of manual digitising are available

1. Pressing MP (FB 10) once will enter MANUAL mode, and repeated presses will create a Master Point at the LASERTRAK cursor position, controlled by the tracker ball.

2. The master points may be positioned more accurately in MANUAL mode by typing CLOse-up at the keyboard. A view of the area around the LASERTRAK cursor is drawn on the Tektronix. The cross-hair cursor may then be positioned over the point to be created, and any key pressed to accept it. This positions the LASERTRAK cursor, after which FB 10 may be pressed to create a master point.

3. Several master points may be created using the Tektronix screen by typing the command MANual at the keyboard. This again draws a close-up on the screen and invokes the cross-hair cursor, but this time each press of the space bar creates a master point. The letter 'E' ends the sequence (without creating a master point).

When a manual point has been created using the first two methods, it can be turned into a junction by means of the MAJ command (see section 7.1.1). The same is true of the final master point created using the third method.

7 *FEATURE CAPTURE*

7.1 *Line Features*

As mentioned in section 6, when a line-feature 'start' button is pressed in MAIN mode the scan vector is usually displayed (but see the discussion of FINd below), and LASERAID is in HELP mode. On pressing GO (FB 4) the program will search for the first section of track and will pause with anything it has found displayed in refresh. If the wrong section of line has been located, NXT (FB 8) may be used to cycle through the known 'chain elements'. If none of these is acceptable, or nothing was seen at all, ONE (FB 3) may be pressed after which the correct scan position and orientation can be indicated via the scan vector and tracker ball. MOV (FB 14) switches between 'change scan orientation' and 'change scan position'. When the scan vector is repositioned, GO (FB 4) may be pressed again.

Once an acceptable starting track segment is displayed, automatic feature capture (line following) may be initiated by pressing GO (FB 4) again, and following will continue until:

1. the end of the feature is reached, or
2. the program requires assistance (see section 6.2), or
3. the operator intervenes manually (see section 6.3).

Note that if automatic FINd (FB 10) has been enabled in MAIN mode (this is often referred to as 'fumbling'), then line following will begin immediately the 'feature start' button is pressed. In this case the operator has no control over the starting direction. Typically a feature digitised using FINd will be started in the middle. When one half of the line has been captured it may be accepted using END (FB 12), and LASERAID will then return to the start point with the scan oriented so as to digitise the second half. Line following may be initiated by pressing GO (FB 4). Line types which may have FINd enabled should contain the parameter INI set to 15 in the type table (see also section 8.5.3). Note that FINd should not be used with features which contain junctions, as current post-processing software is unable to re-order such features to give a common direction.

LASERAID can follow linear features in either 'edge mode' (for the boundary of solid areas) or 'line mode' (for contours, rivers etc.). The required mode is selected by the value of the parameter MOD given to the line type assigned to the starting function button (see section 8.5). MOD 1 selects line mode and MOD 0 selects edge mode.

7.1.1 *Junctions* -

LASERAID is able to capture 'link-and-node' data by recognising junctions in continuous linework. The junction 'arms' (or links) are 'snapped' to a common point to ensure the geometrical integrity of the data, even if the actual IFF cross-pointers are subsequently removed.

In order to recognise junctions, at least one line type must be set up in the type table to have appropriate parameter values. The most important of these parameters are JNC, INI, CRS and SPD, which are discussed in section 8. If junction spotting is enabled LASERAID will, while line following, be sensitive to conditions symptomatic of junctions and will attempt to locate a junction if these conditions are met. The first time a particular junction is encountered, a scan is made in both axes (using line type 7), and an attempt is made to decipher the junction to determine its position and number of arms. If this is successful, the number of arms is displayed in refresh for verification purposes.

If 'auto-accept-and-go' is enabled (see section 8.6), LASERAID will automatically accept the junction after a brief pause for verification, and will continue line following along an arm selected on the basis of parameter CRS (q.v.). Otherwise the program will wait at each junction with the appropriate exit arm indicated in refresh. If GO (FB 4) is pressed this arm will be appended and digitising will continue. NXT (FB 8) will cycle through the arms (and possibly other junctions if more that one has been found in a scan), and JIN (FB 9) will perform another junction search and analysis.

Once a junction has been found it is stored in the so-called 'in-core junction list' until all of its arms have been digitised. By default this list is used to recognise existing junctions during line following, causing LASERAID to 'snap' to these automatically without performing another complete area-scan each time they are visited.

In order that junctions can be 'spotted' on subsequent visits, it is necessary to leave a portion of each arm unpainted when the junction is accepted. This is controlled by the parameter SPD which is discussed in section 8.6.

The command FPJ (FB 13) in HELP mode enables junction recognition to be disabled and re-enabled after line following has begun. This can sometimes be useful when following poor quality linework where the true junctions are widely separated and the data quality causes LASERAID to do unnecessary work rejecting spurious encounters. The user pauses line following using FB 15 and then presses FB 13. Line following can be resumed using FB 4. The current state of junction recognition (i.e. enabled or disabled) is indicated by FB 13 (lit => enabled).

The in-core list mentioned above can also be used for pre-guidance, assuming no external guidance file is already open (see section 10). After a junction has been accepted, pressing FB 8 (GNF) will cause the program to position the cursor over the next incomplete junction in the list. Repeated use of FB 8 will cycle through this list. After FB 8, the normal feature-start button can be used to locate the junction, and it should be seen that the arm offered is one of the currently unsatisfied ones. If the digitiser captures a junction which has no remaining unsatisfied arms (i.e. there is no exit route), the message 'End of feature ?' is displayed. This is to indicate to the user that he should not expect to be able to line-follow out of the junction - the question is rhetorical!

If the digitiser misses a junction or, for example, auto-accept-and-go is enabled and the program's idea of the best arm to follow does not accord with the operator's, line following can be stopped using FB 15 and HELP mode will be entered. Pressing FB 15 (BB) again will enable rolling mode (and BACk), so that the digitised line can be rolled back to the junction position, and junction recognition can be invoked manually using JIN (FB 9). Alternatively, if the

junction was recognised correctly the user can roll back (or BACk up with FB 15) until he is ON the junction (the tolerance is JPT), and press FB 8 (LJN - Locate JunctioN). If he is close enough to the junction it is found, taken 'in hand' and the previously followed arm is offered. FB 8 has then been redefined to be NXT, which can be used to cycle through the arms. It should be noted that the refresh arm indicated at this stage is a direction only, it will typically not lie exactly along the source linework. When the required arm is indicated, FB 4 will restart line following.

If LASERAID is unable to capture a particular junction (e.g. because the line quality is too poor), a 'manual' junction can be created by using the command 'MAJ n' in association with MANUAL mode digitising (see section 6.4). The mandatory argument 'n' is the number of junction arms. When a manual junction is subsequently encountered while line following, or located using LJN, the message 'Manual junction' is output on the close-up screen and the program will pause with the scan vector ('tramlines') displayed for the user to choose a direction to resume line following (or accept the feature). The tramlines can be rotated using the tracker ball as usual, and FB 4 will resume line following in the chosen direction. Note that FB 3 (ONE) should not normally be pressed in this situation as this may cause LASERAID simply to find the manual junction again.

Note that there are some restrictions on the use of manual junctions. Firstly, although LASERAID knows how many arms the manual junction has (this is the mandatory argument to the MAJ command), the angles are unknown. This means that the IFF junction structure cannot be completely set up. Secondly, no attempt is made at present to spot the fact that all the arms of a manual junction have been measured. This has the side effect that manual junctions are never automatically deleted from the in-core junction list and may be repeatedly offered. If all other junctions are complete then the WHOLE in-core list can be deleted by using the ZJC command.

7.1.2 *Inverse Polarity Linework* -

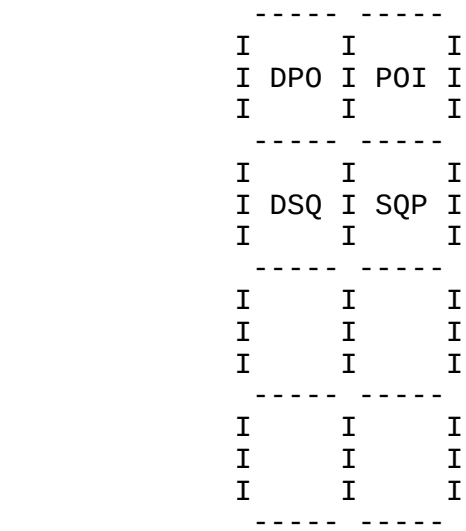
By default, LASERAID line-follows negatives with 'white' (transparent) lines on a 'black' (opaque) background. The command INV causes the polarity of all encounters returned by the LASERTRAK to be inverted, enabling black lines to be followed. Specifying INV 1 (either in HELP mode or in the type tables) enables this facility; INV 0 disables it. The current main use of this mechanism is in the following of double-line rivers or roads where only a single centre line is required. Paint out is achieved by drawing a pair of parallel lines either side of the measured centre line. The separation of these lines is set using the current THK/PTH mechanism (see section 8), but some care should be exercised when setting this value as the painted lines are rather thin. A good rule of thumb is to determine the typical line width using the Z and C macros (see the on-line help), and then set the thickness to be about 1.5 times this value. It should be noted that the LASERTRAK *hardware* still considers black to be background, and hence is not able to clean up the signal as efficiently as normal. It may be found, therefore, that the line following process is more susceptible to variations in negative quality when inverse-polarity mode is used. In particular, it will be found that when following double lines with junctions enabled, any break in either line will be seen as a possible three-arm junction. It is recommended, therefore, that FB 13 (FPJ) be used to temporarily disable junction spotting when following long stretches of double-linework which do not contain any real junctions.

7.2 *Point Features*

A point feature scan is invoked by pressing FB 6 in MAIN mode. In the default POINT mode the program attempts to digitise a symbol automatically by scanning and looking for a cross (x or +) or a very small ring. If this succeeds the cursor is positioned over the symbol and a dot is displayed in refresh. If it fails then a message is printed and the cursor remains as it was. The commands are shown below. OK (FB 4) reads the current cursor position and writes it out as a single point feature.

LASERAID contains a second POINT mode facility, 'square buildings'. This enables one or more building features (represented by filled squares) to be captured in a single scan, and output to the IFF file as *oriented symbols*. This facility is selected by command PNT, which can be given interactively or placed in the type tables. PNT 0 specifies the traditional point feature mode, and PNT 1 specifies square building mode. PNT only determines the *default* scan type on entry to point feature mode (i.e. on pressing function button 6 in MAIN mode); once in this mode either type of scan can be selected by using the function buttons (see below). PNT is preserved in the patch file at end of session, and old patch files (which do not have an explicit PNT entry at read-in time) default to PNT 0.

The function button layout for point mode is given below:



Where:

DPO	is perform (and draw) a traditional point-mode scan
POI	is perform a traditional point-mode scan
OK	is accept the point feature(s)
DSQ	is perform (and draw) a square building point scan
SQP	is perform a square building point scan
DRF	is draw selected square building(s)
NXT	is select the next square building
CLO	is draw a close-up of the scan area on the Tektronix
ABAndon	is return to MAIN mode

Traditional point scans are performed using the line type specified for button 6, but square building scans use type 1. It is recommended that the pitch for type 1 be set to 10 (there is no benefit in setting it any lower).

When a square building scan is performed, buildings within the scan region are recognised and highlighted in refresh (the scan box is also shown; this may be moved using the trackerball and another scan performed if required). The number of features found in the scan is displayed in refresh beside the highlighted objects. Pressing FB 4 (OK) will cause *ALL* these features to be accepted in one go (they will be placed into separate IFF features, with feature numbers incremented by ANF as usual). If, however, the user does not want all the indicated features, pressing FB 8 (NXT) will cause LASERAID to cycle through the found objects in turn. When a desired object is highlighted, pressing FB 4 will cause it to be accepted and the next object (if any) will be refreshed. ABA may be used to drop any remaining unwanted objects, returning to MAIN mode. DRF will draw any highlighted objects on the Tektronix, displaying a cross to indicate the position and orientation of the point feature.

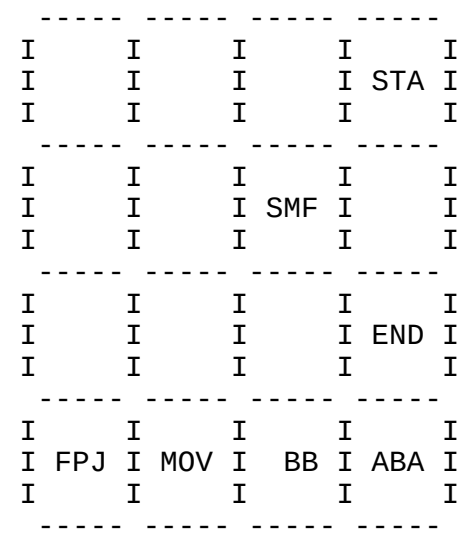
Ancillary codes (ACs) may be manually added to the feature prior to acceptance by means of the AC command (see section 5.3). Note, however that if multiple point features are accepted in one go (i.e. in 'square building' mode) then only the *FIRST* of those features will contain the specified AC(s). All of the features will contain any Standing AC, however.

7.3 *Small Features*

When FB 7 is pressed in MAIN mode, LASERAID performs a 'small feature' scan looking for closed objects which are smaller than the size of the scan (approximately 1 cm square on the LASERTRAK screen). In fact, two different types of small feature scan are available, line-mode and edge-mode; which one is selected is determined by the MODe value (1 or 0) of the line type assigned to FB 7 (see section 8.5).

7.3.1 *Line-Mode Small Features* -

A line-mode small feature scan searches for a closed loop. If one is found it is displayed in refresh, the operator is informed and LASERAID enters HELP mode with the following function button layout:



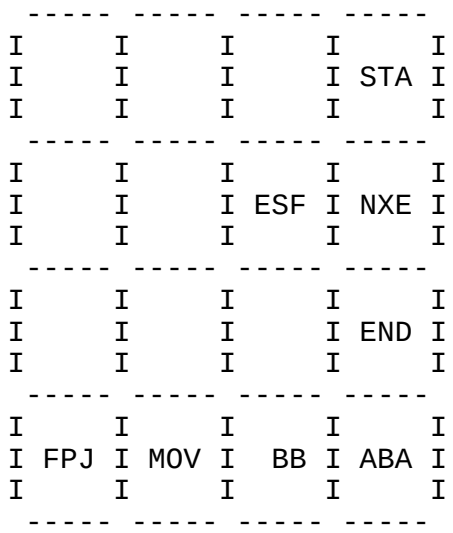
Where the significant buttons are:

STA	drop into ordinary line following, using the line type assigned to FB 7
SMF	repeat small feature scan
END	accept highlighted small feature
ABA	return to MAIN mode

7.3.2 *Edge-Mode Small Features* -

An edge-mode small feature scan searches for small solid areas. If the area contains a 'hole', two scans are necessary to capture the inside (ordered clockwise by default) and the outside (ordered anticlockwise by default). These default directions may be over-ridden by means of the MAIN mode command REV (FB 12).

When an edge-mode small feature scan is performed, any closed areas detected are highlighted in refresh with the number found indicated beside the scan box. LASERAID enters HELP mode with the following function button layout:



If the scan position was not ideal, the refresh box may be moved by means of the tracker ball and another scan performed using ESF (FB 7). It should be noted that at present only one small feature may be accepted in a single scan, despite the fact that several may be found. The required feature may be chosen by means of NXE (FB 8) which cycles through the found objects, and accepted using END (FB 12).

8 *PARAMETERS*

LASERAID has many 'parameters' which are used to control the line following process and are stored in the patch file between sessions. Most of these are of no interest to the ordinary user but the more important ones which may have to be 'tuned' (usually by the system or flow-line manager) in order to capture a new sort of map are listed below (see Appendix A and the on-line help for a more complete description of these and numerous other parameters).

8.1 *The PAP (Print All Parameters) Command*

The PAP command in HELP mode displays all the parameters available to the system or flow-line manager for controlling the line-following process. A typical list produced by this command might be as follows:

```
Switches:  +ELF  +JNC  -INV  +VEX  +SMO  +EDG  +BCH  -ECH  -TCH  +BRF
Line type:  TYP     6   ID    300   WID    25   PIT     8   INI    25
Filtering:  ETA   3.0   H      8.   S      0.   E     25.
            CRC 0.985   CRD   40.
Following:  GAP  100.   SHA -0.90
Junctions:  CRS     0   JPT   40.   JAT   40.   JWT  0.30
Trackjump:  NEA  3.00   BET  0.20   PRL  0.50
Backtrack:  MPN  50.0   MPB    12
Chaining:   CLU  2.00   CLV  2.00   CLW  2.50   CLX  3.00
            EPS  15.0   HOL    45   RIP    80
Matching:   ANG 0.000   LEN 0.010   DST 5.000   WTH 0.000
            DIF  0.90   SMA  1.00   STI    1.   BIA  0.00
Scanning:   MOD     0   FRQ     6   WID    25   PIT     8
            TLO    67   TSW     1   FLE     8   TMS     0
            CRX  0.26   CRY  0.25
            OFX  -27.   OFY  -32.
            PHX  74.3   PHY  73.1
Priority:   FPR     4   PPR     4   WPR     5
Point Mode: PNT     1
Paintout:   THK  80.0   PTH   0.0   STH 200.0   HCH     3   SPD -300.
            SEP 0.016   SPO 0.010
Fiducials:  OFF  8.00   QUA  0.30   SCT    30   REP     1   AVE     5
            GRI  50.0   TIK  500.   CHF     0   FCT     0
Masterpts:  MPL    80   MPF    20   MPX  2900
Squaring:   SQT   30.
```

As may be seen, the parameters are grouped by function as far as possible (although there are some grey areas - you will notice that WID and PIT occur twice, for example). Some of the more important parameters are described in later sections; for more information see Appendix A and the on-line help.

Another command, PPP (alias PUP), displays a subset of this list. This subset contains the 'primary' parameters which may be of interest to the ordinary user, allowing simple tuning operations to be performed (e.g. selection of edge-mode rather than line-mode line following).

8.2 *Description Of Primary Parameters*

ELF	n	0/1 -> edge/line mode line-following
JNC	n	0:7 -> junction analysis
INV	n	0/1 -> data polarity normal/inverted
VEX	n	0/1 -> vertex extraction off/on
SMO	n	0/1 -> data smoothing off/on
EDG	n	0/1 -> ignore/use edge information in line mode
BCH	n	0/1 -> backtrack check off/on
ECH	n	0/1 -> command echoing off/on
TCH	n	0/1 -> temporary checks off/on
BRF	n	0/1 -> brief messages off/on
ID	r	scan vector length (microns)
ETA	r	sideways tolerance for initial compaction (microns)
H	r	sideways tolerance for bunching of points (microns)
S	r	maximum distance before forced master point (microns)
E	r	minimum distance between master points (microns)
GAP	r	maximum acceptable gap to jump over (microns)
SHA	r	cosine of sharpest angle to follow round (0 => 90 deg, -1 => 180 deg)
CRS	n	-1/0/+1 -> go left/straight on/right at junctions
JPT	r	junction position tolerance (microns)
NEA	r	nearness of adjacent tracks for track jumping (in units of PIT)
PNT	n	0/1 -> set default point mode (section 7.2)
THK	r	thickness of line features
PTH	r	paintout thickness (microns) - if <=0.0 use THK
STH	r	single point paintout thickness (microns)
HCH	n	0:3 -> hatching style for area paintout
SPD	r	suppress paintout distance around junctions (microns)

Also available are the commands for changing the scan parameters (WID, PIT etc) which are described under CHECK mode (section 4.1), and the priority changing parameters (section 8.8).

8.3 *Advanced Parameters*

The following parameters are intended for system and flow-line managers. They are effectively constants, and will only require changing to follow unusual or poor quality data.

BET	r	cosine of limiting angle to prevent track jumping
CLV	r	chain growing tolerance across the scan (units of PIT)
CLX	r	chain growing tolerance for new chains (units of PIT)
ANG	r	weight for angle of segment in chain matching
LEN	r	weight for length of segment in chain matching
DST	r	weight for distance of segment in chain matching
WTH	r	weight for width of segment in chain matching
SMA	r	smallness (minimum attachable segment) - units of PIT
DIF	r	line is WIDE if (width-trackwidth)/trackwidth >= DIF

ANG, LEN, DST and WTH are discussed further in section 8.7.

8.4 *LIMits And Weights*

The LIMits and Weights are a set of miscellaneous values required by the line-following algorithms. Optimum values have been ascertained by Laser-Scan and users should not attempt to modify them unless so instructed by a Laser-Scan engineer. The current values can be displayed by means of the PLW command.

8.5 *Line Types*

LASERAID supports seven line types which may be assigned to the six MAIN mode 'start feature' buttons (see section 5.2). Each type may have independent values for the line following parameters, and these are stored in the 'type table'. The current type table may be examined by means of the PTY command (in CHECK or HELP mode).

The following should be noted:

1. Function buttons can be set up to use different line types by means of the TYF command in HELP mode. It is NOT the case that FB 1 must use type 1, etc. (in fact this would not be sensible given the scan WIDth of type 1).

2. Some line types are (at least partially) reserved, in that they must have particular attributes. These are:

   Type 1 - This must be a large scan (WID 63, ID about 1200, PIT about 10) using line mode (MOD 1) without inverse polarity (INV 0). Type 1 is used everywhere that a large scan is required (e.g. POINT mode, small feature scans, FINd/FUMble). In some cases attributes are taken from another type, with type 1 merely used to set the scan size. The prime example of this is small feature capture, where the MODe of the type assigned to FB7 determines whether edge-mode or line-mode small feature is used (see section 7.3).

   Type 2 - This must be capable of following a normal line, as it is used for measuring the control points etc. (MOD 1, INV 0, sensible WID).

   Type 7 - The WIDth and PITch of this type are used to set the size of junction scans. If INV is in the type table, that will be used as well. Other than that type 7 may be used at will.

Types 3 to 6 are completely user-definable.

8.5.1 *Modifying The Type Table* -

The following commands allow the user to examine and modify the type table:

TYP n	set line type to n (1 to 7)
PTY	print line types
PAR n xxx	make xxx a type dependent parameter occupying slot n.
SET n r1 ..r7	set the values of slot n to r1 ... r7 (if too few values are given the remaining entries are zeroed)
VAR n1 n2 r	set the value of slot n1 for type n2 to r

In order to avoid accidental modification of the type table, the command ADJust must be given before SET, VAR and PAR.

8.5.2 *Selecting Edge Or Line Mode Following* -

Whether LASERAID follows edges or lines (and performs the appropriate paintout) is, by default, determined solely by the MODe value of the line type assigned to the starting function button used. MOD 1 indicates line mode and MOD 0 indicates edge mode. The current following mode may be examined by typing PPP (Print Primary Parameters); +ELF indicating edge following and -ELF indicating line following.

In fact, the command ELF may be placed in the type tables (after MOD) to force the following strategy, but this mechanism is only likely to be of interest to Laser-Scan engineers.

8.5.3 *Setting Up A Line Type For Junction Spotting* -

Junction line types should specify appropriate values for JNC (e.g. 3) and SPD (e.g. -300). INI should also be set to 25 (rather than 15).

8.6 *Junction Parameters*

The following parameters are available for controlling junction recognition:

1. JNC n - junction recognition

   This is a switch to enable or disable junction recognition. It is bitwise decoded as follows:

   Assuming a starting value of zero,
   Add 1 if junction recognition is required at all, then
   Add 2 if the program should accept the junction automatically, then
   Add 4 if the program should NOT automatically snap to existing junctions, but should perform a complete junction scan each time.

   The most usual settings are:
   JNC 0 - junctions disabled
   JNC 3 - junctions enabled, 'auto-accept-and-go' enabled

Another useful setting is JNC 2. In this state, FPJ (FB 13) in HELP mode will turn junction recognition on or off, enabling 'auto-accept-and-go' at the same time.

2. CRS - Behaviour at 'Crossings'

   Specifying CRS -1/0/+1 causes LASERAID to try to go left/straight on/right when a junction is found. This can be used, for example, when capturing polygon data to cause each polygon to be followed in turn. If 'auto-accept-and-go' is enabled (see above), the selected arm will be accepted automatically and digitising will continue.

3. JPT - Junction Position Tolerance

   This may be thought of as the 'radius of influence' of each junction. If two junctions are found which are closer together than JPT then they are pulled together to form one junction. Also, when locating an existing junction, if the LASERTRAK cursor is within JPT of the junction then it is found.

   The value of JPT should be approximately (say within a factor of two of) the mean linewidth in HRD counts. If JPT is too small LASERAID will have problems 'snapping' and locating junctions; if it is too large then the wrong junction may be found and close junctions may be erroneously merged.

4. JAT - Junction arm Angle Tolerance

   This is used to decide which of the junction arms matches the current track.

   JAT is usually 40 degrees.

5. JWT - Junction arm-Width Tolerance

   A junction is not spotted if the line width falls below JWT times the current track width. This reduces 'flapping' (searching for spurious junctions) in poor quality data where the linework may contain holes.

   A typical value for JWT is 0.3; setting it to 0.0 disables this check completely. Note that the junction spotting success rate will be severely reduced if JWT is larger than about 0.8.

6. SPD - Suppress Paintout Distance

   In order to 'spot' a previously measured junction when line following, a small amount of each captured arm must be left unpainted. The amount which must be left depends on whether junction 'snapping' is enabled. If a full junction scan must be performed every time (JNC greater than 4) a fairly large region must be left (SPD 300 might be typical). If 'snapping' is enabled (JNC less than 4), LASERAID is able to choose an appropriate paintout gap automatically. This mechanism is invoked by setting SPD negative (usually the existing value is simply negated, e.g. SPD -300). The units are HRD counts (microns).

8.7 *Chain Quality*

One of the most complicated areas of LASERAID tuning relates to the concept of chain quality. During the line-following process the LASERTRAK encounters are 'grown' into chain elements, and these are then appended together to produce a continuous track. In fact, for unbroken lines this is now a well-defined process for data within a individual scan. The uncertainty arises when appending data from different scans, or when the original line is fragmented (e.g. a pecked line). In such cases, each chain element is assigned a 'quality', and the one with the highest quality is appended.

Consider a chain element which has a length 'len', width 'wid', is a distance 'dis' from the current end of the track and makes an angle 'ang' with the track. The quality of the element is then related to:

```
LEN*('len'/(SMA*PIT))**2  +  ANG*(cos('ang'))  -
DST*('dis'/GAP)**2        -  WTH*(('wid'-trackwidth)/trackwidth)
```

The quantities LEN, ANG etc. were introduced earlier. As may be seen, this is a rather complex function, but the important thing to remember is that a BALANCE should be maintained. If you want to favour the nearest chain element then DST can be increased, but you should also consider altering one of the other values to prevent the overall quality from being reduced too much (if the quality becomes too small LASERAID will refuse to append anything).

The 'Z' command macro performs a scan and lists the chain elements and qualities (refer to the on-line help for more information). This can be a useful tool when tuning LASERAID to follow awkward or poor quality data. Command macros are discussed in section 9.

8.8 *VAX Priority Settings*

The priority at which various LASERAID functions are performed may be set by the user (assuming he has the necessary quotas) by means of the commands FPR, PPR and WPR. These determine the priorities for Following, Paint-out and Waiting (rolling the tracker ball, etc). If these are not set in the patch file, or if they are outside the range 1 to 10, they are set to the processes current base priority. It is suggested that FPR and PPR should be set to 4 (the VAX default), and WPR to 5 (to give good interactive response). For faster line following (at the expense of other users) FPR may be increased to 5. It is not recommended that PPR be increased.

9 *COMMAND MACROS*

Many LASERAID commands in HELP mode are, in fact, macros (groups of 'fundamental' commands). Some of these are invoked directly by the user (via function buttons or keyboard commands); the rest are called by other macros or by the program itself. The fundamental commands (or 'macro components') perform individual operations such as predicting the next scan direction, performing the scan, analysing the machine encounters and so on.

The operation of the macros is usually of no concern to the user, hence these commands are only described in this document if they appear on function buttons (e.g. the macro 'BB' which enables the LASERTRAK cursor to be rolled along the current feature). Additional information on specific macros is available in the on-line help.

At present 35 macro 'slots' are available in LASERAID; all of these are reserved for Laser-Scan. Macros which are currently unused are given names such as 'AAA', 'BBB' etc. These commands appear in the list obtained by typing '?' in HELP mode but are not shown by the PMA (Print MAcros) command. It should be noted that user-definition of macros is not supported, and no attempt should be made to modify the standard macros provided by Laser-Scan.

10 *PRE-GUIDANCE*

Pre-guidance is a means whereby increased throughput may be obtained from a LASERTRAK by having most of the operator-dependent actions (selection of feature, setting of NF and feature code, typing of TCs etc.) done offline and stored in an IFF file to be used to 'guide' the automatic digitisation of a map.

10.1 *The Guidance File*

This is an IFF file and is identical to a normal IFF file used for map data, except that there is usually only one data point for each feature (if more than one data point is present then the mean position is used, hence an ordinary data file can be used as a test guidance file). Guidance files will normally be produced using a digitising table.

Each feature should contain the following:

1. NF Number - this is treated as you would expect. It sets the NF number of the feature.

2. Feature code (first word of FS entry) - this is not copied by LASERAID but is used to select both a line following 'type' and a real feature code from a table. The feature type is necessary because LASERTRAK needs to know what sort of feature it is to digitise (smooth curve, small feature, point feature and so on). The LASERTRAK operator can allocate meanings to the feature codes in the guidance file by means of the GFC command .

3. One or more data points (ST entry) - this indicates, to the LASERTRAK operator, which feature to measure next. If more than one point is given, they are averaged to produce a mean position. The point should therefore be chosen to avoid any ambiguity and should also (if possible) be chosen to be a suitable place on the feature for LASERTRAK to start digitising it automatically. The data points in the guidance file should be expressed in the same units, and with the same control points, as the map in the LASERTRAK.

4. Any necessary TCs, which are entered in the usual way.

Various entries in the guidance file correspond to commands given by the operator to the LASERTRAK:

Entry	*Equivalent Command*
RA,HI,MH,MD,CC	ignored
CP	used to transform to output space
NS	OP or IDE
SS	SS
SL	PT
NO	OV or LAY
TC	TC
CH	TEXt or CH
NF	NF
FS	special - sets up feature code and line type via table
AC	ignored
TH	ignored
ST	used to position the LASERTRAK cursor
EF	special - returns control to the operator
EJ	causes the guidance file to be closed

10.2 *How To Use Guidance Files*

A file of pre-digitised guidance commands is a standard IFF file and is opened by the GUI command. The control points must have been measured before the GUI command can be given. When a guidance file is open, pressing FB 8 in MAIN mode (or giving the equivalent command - GNF) will cause the guidance file to be accessed, rather than the 'in-core junction list' (see section 7.1.1). Commands will be read from the file until an EF entry is encountered. At this point:

1. the NF number will be set

2. the cursor will be on the feature

3. one of the six function buttons (1, 2, 3, 5, 6 or 7) used to start digitising a feature will be lit to indicate to the operator what sort of feature it is. It should be noted that this is purely advisory; the operator can press ANY of the six buttons to digitise the feature.

When a feature has been digitised, it can be accepted or abandoned in the usual way. Pressing FB 8 will get the next feature to be measured. Pressing FB 8 repeatedly will fetch successive pre-digitisings from the file, though alternatively the SKIp command will skip through the guidance file until a particular NF is reached.

The speed of operation using pre-guidance can be increased by use of the VFG option. This is enabled by the command VFG 1 and disabled by VFG 0. When enabled it has the effect that when a feature has been accepted, commands continue to be taken from the guidance file (as if FB 8 had been pressed). On the other hand, if a feature is abandoned or the check fiducial measurement fails then commands are taken from the operator in the normal way to allow the feature to be remeasured, cancelled etc.

10.3 *Pre-guidance Commands*

GUIde <file> close any currently open guidance file and, if <file> is given, open file LSL$GU:file.IFF.

GNF (FB 8) (Get Next Feature) Commands are read from the guidance file until an EF entry is found, at which point all necessary information (NF, feature code, position etc.) will be present to allow the operator to start measuring the feature.

VFG [n [r]] controls the Very Fast Guidance option. The option is enabled if the integer argument n is non-zero, and disabled if is zero or absent. The very fast guidance option has two effects:

1. when a feature is accepted, the next feature is automatically fetched from the guidance file.

2. when a feature has been fetched from the guidance file, one of the six 'feature select' buttons will be lit. If 'automatic starting' has been enabled, the command corresponding to this button will be given automatically after a short time. Typing another command, pressing a function button or moving the tracker ball will stop this command being given. The time delay for this command is defined by the second (real) argument for VFG. If this number is positive it enables 'automatic starting' and sets the time delay (expressed in seconds). If the number is negative then the option is disabled. If no second argument is given the time delay is left as it was, regardless of what the first argument is. Thus:

```
VFG 1 0.5 - enable option and set delay to half
            a second
VFG 0     - disable option
VFG 1     - re-enable with same delay as before
```

NXG Gets the NeXt Guidance command from the file and obeys it. This is only for testing the system, and for examining the effect of each entry in the guidance file.

SKI [n] skip all items in guidance file, up to NF n, or the next feature. The correct layer number will be set. If no such NF entry is found, the guidance file is left positioned where it was and an error message is output.

GFC [n [m]] arrange for feature code n in the guidance file to mean that FB m should be used to start measuring the feature. The line type and feature code assigned to the feature will depend on which button is actually used. If m is absent then feature code n is removed from the table. If both n and m are absent then the table is typed.

APPENDIX A

LASERAID PARAMETERS

LASERAID PARAMETERS

This is a list of the parameters which are used to control the digitising process in LASERAID, and which are stored in the patch file.

The following information is provided:

* The name by which the parameter is known to the user
* The range of values it typically takes, or the recommended value
* The common block in which it lives, and its internal name
* The units in which it is measured
* The modules of LASERAID which reference it (A=B meaning A calls B with the variable as an argument)
* Some documentation of its function

```
******************************

Parameters from the PAP command

******************************

ELF   0:1       ! /LKPARM/ELF
                ! switch
                ! ASSESS FLFBLK FLMAIN FLSUB FUMBLE IFWSYS INOUT LINK MATCH
                ! NXTSEG SURE
                        ! ELF 0/1 => edge/line mode following
                        ! usually set automatically based on MOD (q.v.)
```

```
JNC   0:7       ! /LKPARM/JNCING
                ! switch (bitwise decoded)
                ! ANALYZ APPSEG ASSESS AUTX FUMBLE IFWSYS INOUT JMATCH LINK
                ! LOCJUN MATCH  NEWVEC SURE TSTCON
                        ! JNC 0 => junction recognition disabled
                        ! JNC 1 => junction recognition enabled,
                        !          program waits at every junction
                        ! JNC 2 => junction recognition disabled,
                        !          (FB13 => enable it with auto-accept-and-go)
                        ! JNC 3 => junction recognition enabled,
                        !          auto-accept-and-go enabled
                        ! JNC 5,7 => as JNC 1,3 but DON'T attempt to locate
                        !          existing junction before scanning (i.e
                        !          perform a complete junction scan every time)
                        ! (similarly for JNC 4,6)

INV   0:1       ! /LKPARM/INVPOL
                ! switch
                ! ANALYZ FLMAIN IFWSYS INOUT JSIFTC XYPRC XYSCA
                        ! INV 0/1 => do not/do invert encounter polarities

VEX   0:1       ! /LKPARM/VEXING
                ! switch
                ! APPSEG BUNCH IFWSYS INOUT LINK PNTFTR
                        ! VEX 0/1 => do not/do perform vertex extraction

SMO   0:1       ! /LKPARM/SMOING
                ! switch
                ! IFWSYS INOUT LINK
                        ! SMO 0/1 => do not/do smooth chains

EDG   0:1       ! /LKPARM/EDGING
                ! switch
                ! GROW IFWSYS INOUT MATCH SURE
                        ! EDG 0/1 => do not/do use edge info in line mode

BCH   0:1       ! /LKPARM/BAKCHK
                ! switch
                ! IFWSYS INOUT MATCH
                        ! BCH 0/1 => do not/do test for backtracking

ECH   0:1       ! /LKPARM/ECHO
                ! switch
                ! GETMAC IFWSYS INOUT LINK
                        ! ECH 0/1 => do not/do echo commands
                        ! is first entry in patch file so that patch file
                        ! can be verified as it is read in
```

```
TCH   0:1       ! /LKPARM/TMPCHK
                ! switch
                ! ADDJUN ANALYZ AREPRC ELEMNT EXPLOR IFWSYS INOUT  JCENTR JCHECK
                ! JFINTP JMAIN  JREMCH JSIFTC LINK=WADDLE   PNTFTR POINT  SURE
                ! WADDLE XYSET
                       ! TCH 0/1 => disable/enable temporary checks
                       ! (draw junctions as unravelled and output additional
                       ! information if various errors occur)

BRF   0:1       ! /LKPARM/BRIEF
                ! switch
                ! CHKFID FLFBLK FLMAIN IFWSYS INOUT JASSES JMAIN LINK
                       ! BRF 0/1 => full/brief informational messages
                       ! enables messages such as 'closed', 'abandoned' etc.
                       ! to be disabled for demonstration purposes

TYP   1:7       ! /DIGC/LTYPE
                ! integer
                ! AUTGRD CHKFID CORCAL FLMAIN FLSUB FUMBLE IFWSYS INOUT LINK
                ! POINT  SCHECK
                       ! current line type for parameter selection
                       ! (argument to PARIO)

ID  100:2000    ! /LKPARM/IDSIZE
                ! HRD counts
                ! IFWSYS INOUT JMATCH LINK LOCJUN NEWVEC
                       ! length of scan vector

WID  10:63      ! /SCPARM/IWID
                ! units are 64 digitiser counts
                ! ADDNBR ARESCA AUTX   CENTRE CHKFID=FAX    CHKINF CORCAL=FAX
                ! DRWELF DRWJNC DRWMP  DRWPTS DRWSCN EDGARE EDGDMP FAX    FAXARE
                ! FIDFND FIDMES=FAX    FLFBLK FUMBLE IFWSYS INOUT  JDRAW  LINK
                ! LNKDRW PAINT  PEER   POINT  SCHECK SIMPLE TSTCON XYSCA
                       ! width of scan
                       ! width in HRD counts = IWID*64*CRX or IWID*64*CRY

PIT  10:50      ! /SCPARM/IPIT
                ! HRD counts
                ! ADDNBR ANALYZ ARECHN AREPRC ARESCA ASSESS CENTRE CHKFID=FAX
                ! CHKINF CHNPIX CLOJOI CORCAL=FAX    DRWCHN DRWPTS DRWTRK FAX
                ! FAXARE FIDFND FIDMES=FAX    FLFBLK FUMBLE GROW   GRWARE IFWSYS
                ! INOUT  JMATCH JOIN   LINK   LNKTEK LOCJUN MATCH  NEWVEC PEER
                ! PNTFTR POINT  SCHECK SIMPLE SURE   XYPRC  XYSCA
                       ! pitch of scan

INI  15,25      ! /LKPARM/INICOM
                ! macro number
                ! IFWSYS INOUT LINK
                       ! macro number to use on feature start
                       ! set to 25 to start on a junction
                       !     or 15 for FINd/FUMble
```

```
ETA   0.5:6.0   ! /LKPARM/ETA
                ! HRD counts
                ! ARECHN CHNPIX CMPCT IFWSYS INOUT LINK
                       ! sideways bunching tolerance for COMPACTing or
                       ! CRUSHing chains (see also S below)

H   5.0:20.0    ! /MPEP/H(1)
                ! HRD counts
                ! BUNCH FILTER IFWSYS INOUT PNTFTR
                       ! sideways tolerance in master point bunching

S   500.:32000. ! /MPEP/S(1)
                ! HRD counts
                ! BUNCH FILTER IFWSYS INOUT PNTFTR
                       ! max separation of master points
                       ! also, max no. of points to suppress when CMPCTing
                       ! is S*0.7071/IPIT (see also ETA)
                       ! setting S=0 disables S altogether

E     20.:100.  ! /MPEP/E(1)
                ! HRD counts
                ! FILTER FLUSH IFWSYS INOUT PNTFTR
                       ! min separation of master points
                       ! (special measures for points closer than this
                       ! if vertex extraction enabled or junction found)

CRC   0.985     ! /LKPARM/CRUCOS
                ! cosine
                ! ARECHN CHNPIX IFWSYS INOUT LINK=CRUSH
                       ! max cosine for use in CRUSHing

CRD  40.0       ! /LKPARM/CRUDIS
                ! HRD counts
                ! ARECHN CHNPIX IFWSYS INOUT JCENTR JCHECK JFINTP JMAIN LINK
                       ! max distance for use in CRUSHing

GAP 100.0:350.0 ! /LKPARM/GAPSIZ
                ! HRD counts
                ! ADDASS IFWSYS INOUT MATCH
                       ! largest gap to be jumped
                       ! also used in calculating quality

SHA  -1.0:+1.0  ! /LKPARM/SHRPNS
                ! cosine
                ! IFWSYS INOUT MATCH
                       ! cosine of sharpest corner to go round
                       ! 0.0 => up to 90, -0.7 => 135, -1.0 => can go backwards
```

```
CRS   -1:+1     ! /LKPARM/CRSSNG
                ! switch
                ! (ASSESS=USEFRK) IFWSYS INOUT JASSES
                        ! In junction arm assessment:
                        ! CRS -1/0/1 => go left/straight over/right at junction
                        !
                        ! (USEFRK mechanism is currently unused)

JPT     40.0    ! /JNCLST/JPOSTL
                ! HRD counts
                ! ADDJUN APPSEG FLFBLK IFWSYS INOUT JSSRTS LOCJUN
                        ! position tolerance for junction searching/matching

JAT     40.0    ! /JNCLST/JANGTL
                ! angle in degrees
                ! ADDJUN FLFBLK IFWSYS INOUT JASSES JSSRTS
                        ! arm angle tolerance for junction searching/matching

JWT     0.3     ! /JNCLST/JWIDTL
                ! fraction of track width
                ! ADDNBR FLFBLK IFWSYS INOUT
                        ! don't allow a junction if line width falls below
                        ! JWT*(current track width)
                        ! prevents 'flapping' in poor quality data where the
                        ! line may contain holes. Will seriously reduce the
                        ! junction spotting success rate if too large !
                        ! check can be disabled by setting JWT to 0.0

NEA   3.0:6.0   ! /LKPARM/NEARNS
                ! units of IPIT
                ! IFWSYS INOUT MATCH
                        ! if the line segment is nearer than this, don't do
                        ! the track jump test.
                        ! smaller => less likely to jump track
                        ! larger  => easier to go round corners
                        !            in thick tortuous lines

BET   0.1       ! /LKPARM/BETA
                ! cosine
                ! IFWSYS INOUT MATCH
                        ! if the line segment or the track make an angle
                        ! with the gap greater than this, we've track-jumped
                        ! larger => less likely to jump track

PRL   0.0       ! /LKPARM/PRLLNS
                ! cosine
                ! IFWSYS INOUT MATCH
                        ! if the line segment is less parallel than this,
                        ! don't do the track jump test
                        ! (0.0 => 90 degrees => rarely forbid track jump test !)
```

```
MPN  50.0       ! /LKPARM/MPNEAR
                ! HRD counts
                ! IFWSYS INOUT MATCH
                       ! tolerance for back-track checking
                       ! small => easy to back-track, large => no hairpins

MPB  12         ! /LKPARM/NMPBAK
                ! number of master points
                ! IFWSYS INOUT MATCH
                       ! number of master points back to use in back-track
                       ! checking

CLU   2.0       ! /LKPARM/CHLIM(1)
                ! units of pitch
                ! GROW IFWSYS INOUT
                       ! used to determine if a point belongs on
                       ! the end of a growing chain
                       ! CLU is max distance DU along scan axis
                       ! only used for edge-mode small feature capture

CLV   2.0       ! /LKPARM/CHLIM(2)
                ! units of pitch
                ! ANALYZ GROW IFWSYS INOUT
                       ! used to determine if a point belongs on
                       ! the end of a growing chain
                       ! CLV is max difference across scan between <posn of
                       !     this point> and <extrapolated posn of the chain>

CLW   2.5       ! /LKPARM/CHLIM(3)
                ! units of pitch
                ! GROW IFWSYS INOUT
                       ! used to determine if a point belongs on
                       ! the end of a growing chain
                       ! CLW is max difference between <width of this point>
                       !     and <width extrapolated for this chain>
                       ! in practice, CLW is no longer used

CLX   3.0       ! /LKPARM/CHLIM(4)
                ! units of pitch
                ! ANALYZ GROW IFWSYS INOUT JOIN
                       ! used to determine if a point belongs on
                       ! the end of a growing chain
                       ! CLX is max distance between the edges of the previous
                       !     point and the the edges of this point when
                       !     adding the 2nd and 3rd points to a new chain

EPS  15         ! /ELFPAR/EPSLON
                ! HRD counts
                ! IFWSYS INOUT LINK=EDGFTR
                       ! tolerance for merging two chains together
```

```
HOLE 45          ! /LKPARM/HOLE
                 ! HRD counts
                 ! CUTARE CUTLER IFWSYS INOUT LINK
                        ! maximum hole (gap in line) to chain across in FORKing

RIP  80          ! /LKPARM/RIPPLE
                 ! HRD counts
                 ! CUTARE CUTLER IFWSYS INOUT LINK
                        ! max lateral ripple along line to chain in FORKing

ANG   0.00       ! /LKPARM/ANGWGT
LEN   0.01       ! /LKPARM/LENWGT
DST   5.00       ! /LKPARM/DSTWGT
WTH   0.00       ! /LKPARM/WTHWGT
                 ! weight
                 ! IFWSYS INOUT MATCH
                        ! evaluate the quality of the connection by multiplying
                        ! each of the following factors by its weight:
                        !
                        !  (cosine of angle)    )
                        !  (length/SMA)**2      ) factors in assessing
                        ! -(distance/GAP)**2    ) goodness of chain match
                        ! -(frac width change)  )
                        !
                        ! N.B. the values listed above are examples only

DIF   0.8        ! /LKPARM/WIDDIF
                 ! ratio of chain widths
                 ! IFWSYS INOUT MATCH SURE
                        ! if chain width is .GE. (1.0 + DIF) times the
                        ! current trackwidth then the chain is WIDE
                        ! (see also W3 for APEX implications)

SMA   1.0:2.0    ! /LKPARM/SMLLNS
                 ! units of IPIT
                 ! IFWSYS INOUT MATCH
                        ! smallest line element connected in MATCH
                        ! also used in determining chain quality

STI   1.0        ! /LKPARM/STFFNS
                 ! HRD counts
                 ! ASSESS=GTLST2 IFWSYS INOUT MANDIG=GTLST2 MATCH
                        ! stiffness, minimum length of line used to estimate
                        ! position and direction of track for matching, etc.
                        ! large for smooth corners
                        ! since Jan 1983, STIffness may be set down to 1 for
                        ! almost all continuous line-work (see LIM 8 also)
```

```
BIA   0.0       ! /LKPARM/BIAS
                ! same units as quality
                ! IFWSYS INOUT MATCH
                       ! added to assessed quality to tend to
                       ! right/straight/left if negative/zero/positive
                       ! effectively obsolete now

MOD   0:7       ! /SCPARM/IMOD
                ! switch (bitwise decoded)
                ! ANALYZ ARESCA ASSESS CHKINF FAX    FAXARE FLFBLK FLMAIN FLSUB
                ! FUMBLE IFWSYS INOUT  LINK   MATCH  PEER   SCHECK TSTCON XYSCA
                       ! bit 0=0/1 => edge/line mode
                       ! bit 1=0/1 => don't/do return empty scans (see bit 2)
                       ! bit 2=0/1 => return all-inline only/ALL empty scans
                       ! instructs the scan library to return encounters as
                       ! points in edge mode, or construct line centres and
                       ! widths where possible in line mode.
                       ! empty scan (all-line or all-background) information
                       ! is also required for some operations.
                       !
                       ! in LASERAID, the user only specifies MOD 0 or 1

FRQ   3:6       ! /SCPARM/IFRQ
                ! arbitrary units in range 0:6
                ! CHKINF FLFBLK IFWSYS INOUT SCHECK
                       ! frequency of scan, corresponds to 13:1200 Hz by
                       ! factors of 2. If changed will require
                       ! re-calibration of PHX/Y

TLO  10:150     ! /SCPARM/ITLO
                ! arbitrary units in range 1:255
                ! FLFBLK IFWSYS INOUT PEER SCHECK
                       ! threshold for black/white

TSW   0:1       ! /SCPARM/ITSW
                ! switch
                ! FLFBLK IFWSYS INOUT SCHECK
                       ! TSW 0/1 => auto/manual threshold

FLE   0:15      ! /MASTER/REDFOC
                ! integer
                ! IFWSYS INOUT PAINT PEER SCHECK
                       ! red beam focus level

TMS   0:5       ! /SCPARM/ITMS
                ! units are 1/50th seconds in UK
                ! IFWSYS INOUT SCHECK
                       ! (not implemented on VAX)
                       ! time share period, relinquishes this time
                       ! to other processes whenever there is no raw data.
                       ! 0 => none, high => slow LASERAID
```

```
CRX 0.25:0.33   ! /SCCORR/CRX
CRY             ! /SCCORR/CRY
                ! ratio
                ! ADDNBR ANALYZ ARESCA AUTX   CENTRE CHKINF DRWELF DRWJNC DRWMP
                ! DRWPTS DRWSCN EDGARE EDGDMP FAX    FAXARE FIDFND FUMBLE IFWSYS
                ! INOUT  JDRAW  LINK   LNKDRW MANDIG PAINT  PEER   POINT  SCHECK
                ! SIMPLE TSTCON XYSCA
                       ! equivalent in HRD counts of one digitiser count
                       ! for each axis

OFX -500:+500   ! /SCCORR/OFX
OFY             ! /SCCORR/OFY
                ! HRD counts
                ! IFWSYS INOUT PEER SCHECK
                       ! offset between red digitising beam and blue
                       ! writing beam for each axis

PHX 30.0        ! /SCCORR/PHX
PHY             ! /SCCORR/PHY
                ! time delay (phase correction)
                ! IFWSYS INOUT PEER SCHECK
                       ! time lag of scanner position behind theoretical
                       ! position.
                       ! related to frequency

FPR   4:5       ! /MASTER/FPRIO
                ! VAX priority
                ! FLMAIN FPAINT IFWSYS INOUT RDCOMM
                       ! priority while line-following

PPR   4:5       ! /MASTER/PPRIO
                ! VAX priority
                ! FPAINT IFWSYS INOUT
                       ! priority while painting out

WPR   4:5       ! /MASTER/WPRIO
                ! VAX priority
                ! FLMAIN IFWSYS INOUT RDCOMM
                       ! priority while waiting to begin following
                       ! (e.g. waiting for keyboard input)

PNT   0:1       ! /DIGC/PNTINI
                ! switch
                ! FLSUB IFWSYS INIT INOUT POINT
                       ! 0/1 => normal/'square building' default point mode

THK  20.0:200.0 ! /LKPARM/THKNSS
                ! HRD counts
                ! APPSEG=OUTMP1 IFWSYS INOUT LINK=OUTMP1 POINT
                       ! thickness of line feature, set by operator
```

```
PTH 30.0:100.0  ! /LKPARM/THKPNT
                ! HRD counts
                ! FLMAIN=PAINT FPAINT=PAINT IFWSYS INOUT LOCATE=PAINT PAINT
                       ! thickness of line for paintout, if <=0.0 use THK

STH 200.0:400.0 ! /LKPARM/SNGLTH
                ! HRD counts
                ! FLFBLK IFWSYS INOUT PAINT
                       ! thickness of single-point feature paintout (draws a
                       ! filled square of this size)

HCH   3         ! /LKPARM/NHATCH
                ! switch
                ! ARFILL FLMAIN=PAINT FPAINT=PAINT IFWSYS INOUT LOCATE=PAINT
                       ! affects paintout speed for areas
                       ! HCH 0 => total infill with lines of thickness THKPNT
                       ! HCH 1/2/3 => paintout horizontally/vertically/both
                       ! with normal lines separated by THKPNT

SPD   0.0:300.0 ! /LKPARM/SPDIS
                ! HRD counts
                ! IFWSYS INOUT PAINT
                       ! suppress paintout around junctions
                       ! if NEGATED, LASERAID will choose value for itself

SEP     0.016   ! /THKPAR/SEP   (N.B. /THKPAR/ is declared explicitly)
                ! mm on photochromic film
                ! IFWSYS INOUT PAINT
                       ! separation of lines for paintout

SPOT    0.010   ! /THKPAR/SPOT
                ! mm on photochromic film
                ! IFWSYS INOUT
                       ! size of beam on film for paintout

OFF     8.0     ! /GRPARM/OFFNSS
                ! HRD counts
                ! FIDFND IFWSYS INOUT
                       ! expected scatter for fiducial measurement

QUA     0.3     ! /GRPARM/FQUAL
                ! quality
                ! FIDFND IFWSYS INOUT
                       ! minimum quality for 'fiducial found'

SCT    30       ! /GRPARM/ISCAT
                ! HRD counts
                ! FIDFND IFWSYS INOUT
                       ! abandon fiducial search if more than 1/2 the points
                       ! exceed this scatter
```

```
REP     1       ! /GRPARM/IGREP
                ! number of scans
                ! FIDFND IFWSYS INOUT
                        ! number of fiducial scans to allow digitiser to settle

AVE     5       ! /GRPARM/IGRAVE
                ! number of scans
                ! FIDFND IFWSYS INOUT
                        ! number of scans to measure fiducial

GRI    50.0     ! /GRID/GRIDSQ
                ! distance, e.g. microns on film, metres on ground
                ! AUTGRD CORCAL IFWSYS INOUT
                        ! size of calibration grid square

TIK 500.0       ! /LKPARM/TIKSIZ
                ! HRD counts
                ! FLSUB IFWSYS INOUT NEWSEC
                        ! length of arms of control-point ticks
                        ! <=0.0 => no control-point ticks output

CHF   0         ! /LKPARM/CPCHEK
                ! -------
                ! IFWSYS INOUT
                        ! *** currently unused

FCT     0       ! /MASTER/CORCCP
                ! boolean
                ! FLSUB IFWSYS INOUT
                        ! type of control point set up when CP typed
                        !  0 => standard CP
                        !  0 => combined grid calibrate and control point

MPL    80       ! /MPEP/MPLIM
                ! number
                ! APPSEG GETFTR IFWSYS INOUT SMLFTR
                        ! output master points at this total, and ...

MPF    20       ! /MPEP/MPLEFT
                ! number
                ! APPSEG=OUTMP1 IFWSYS INOUT
                        ! leave this many behind

MPX  2900       ! /MPEP/MPTOTE
                ! number
                ! APPSEG IFWSYS INOUT
                        ! max number of master points in a feature
                        ! (limit 32767)
```

```
SQT  30.0       ! /LKPARM/SQUTOL
                ! angle (degrees)
                ! IFWSYS INOUT LINK SQUARE
                       ! squaring tolerance for SQU keyboard command


************

Limits (PLW)

************

LIM1     5.0    ! /LKPARM/LIMIT(1)
                ! units of IPIT
                ! CENTRE IFWSYS INOUT NEWVEC SIMPLE
                       ! scan again if within LIM1 of end of scan

LIM2 -3000.0    ! /LKPARM/LIMIT(2)
                ! units of IPIT
                ! CENTRE IFWSYS INOUT SIMPLE
                       ! scan again if within LIM2 of edge of scan
                       ! N.B. currently always NEGATIVE to disable check !

LIM3     0.0    ! /LKPARM/LIMIT(3)
                ! -------
                ! IFWSYS INOUT SIMPLE
                       ! *** currently unused

LIM4     0.3    ! /LKPARM/LIMIT(4)
                ! cosine
                ! AUTX IFWSYS INOUT
                       ! cosine of limiting parallel angle in point symbols

LIM5     3.0    ! /LKPARM/LIMIT(5)
                ! units of IPIT
                ! ASSESS FUMBLE IFWSYS INOUT LINK=MERSCN
                       ! minimum starting chain length

LIM6     0.2    ! /LKPARM/LIMIT(6)
                ! quality
                ! ASSESS IFWSYS INOUT JMATCH LOCJUN
                       ! become CONFUSED if best two qualities differ by
                       ! less than this

LIM7    15.0    ! /LKPARM/LIMIT(7)
                ! quality
                ! ADDASS ASSESS IFWSYS INOUT JMATCH LOCJUN SURE
                       ! become CONFUSED if best quality is less than this
                       ! (also see W4)
```

```
LIM8     1.0    ! /LKPARM/LIMIT(8)
                ! HRD counts
                ! IFWSYS INOUT JMATCH=GTLST2 NEWVEC=GTLST2
                       ! minimum length of line for prediction
                       ! (akin to STIffness)
                       ! larger => less likely to predict away from correct
                       ! direction owing to glitches at end of backlog buffer
                       ! (this may be 1 for continuous line-work)

LIM9     4.0&5  ! /LKPARM/LIMIT(9)
                ! HRD counts
                ! AUTX IFWSYS INOUT
                       ! max perpendicular distance between parallel chains

LIM10    1.0&5  ! /LKPARM/LIMIT(10)
                ! HRD counts
                ! ASSESS IFWSYS INOUT JMATCH=GTLST2
                       ! GTLST2 must produce guide points within this
                       ! distance of start of scan.

LIM11    0.0    ! /LKPARM/LIMIT(11)
                ! units of pitch
                ! ANALYZ GROW IFWSYS INOUT PEER
                       ! ignore any encounters within this many pitches
                       ! from start of scan
                       ! high scan frequency (5,6) may cause displaced data
                       ! in early scan-lines
                       ! should be 0.0 for optimum junction spotting

LIM12    0.3    ! /LKPARM/LIMIT(12)
                ! -------
                ! IFWSYS INOUT
                       ! *** currently unused

LIM13 1600.0    ! /LKPARM/LIMIT(13)
                ! HRD counts**2
                ! APPSEG IFWSYS INOUT
                       ! feature is CLOSED if first and last points
                       ! less than this apart (**2)

LIM14    1.0    ! /LKPARM/LIMIT(14)
                ! number of chain points
                ! IFWSYS INOUT LINK
                       ! minimum gap between master points when CMPCTing

LIM15    3.0    ! /LKPARM/LIMIT(15)
                ! weight
                ! AUTX IFWSYS INOUT
                       ! AUTX ignore encounters with           -
                       ! width > LIM15 * <average width>       -
                       ! to ignore thick lines              -------
                       ! in centre of cross                    -
                                                               -
```

```
LIM16    0.6    ! /LKPARM/LIMIT(16)
                ! ratio (usual range 0.0:1.0)
                ! IFWSYS INOUT NEWVEC
                       ! 'twitch' scan vector about 45 degree line if
                       ! ABS(ABS(DX) - ABS(DY)) <= LIM16

LIM17    0.0    ! /LKPARM/LIMIT(17)
                ! -------
                ! IFWSYS INOUT
                       ! *** currently unused

LIM18    0.0    ! /LKPARM/LIMIT(18)
                ! -------
                ! IFWSYS INOUT
                       ! *** currently unused

LIM19     0.5   ! /LKPARM/LIMIT(19)
                ! sine
                ! IFWSYS INOUT JCENTR ONSIDE TSTCON
                       ! if sine of angle between two vectors is .LE.
                       ! this value, the vectors are judged to be parallel

LIM20     8.0   ! /LKPARM/LIMIT(20)
                ! number of points
                ! ARECHN CHNPIX IFWSYS INOUT
                       ! reject contoured chain if shorter than this


*************

Weights (PLW)

*************

W1   0.05       ! /LKPARM/WGHT(1)
                ! weight
                ! ASSESS FUMBLE IFWSYS INOUT
                       ! converts starting chain length to quality

W2   0.5        ! /LKPARM/WGHT(2)
                ! fraction of track width
                ! IFWSYS INOUT NXTSEG
                       ! don't add points to segment if less than
                       ! W2*trackwidth from end of (e.g.) wide line
                       ! helps with point positioning for sideways steps

W3   0.3        ! /LKPARM/WGHT(3)
                ! ratio of widths
                ! IFWSYS INOUT MATCH SURE
                       ! ratio of widths for apex; set APEX if chain
                       ! is WIDE, and <far width> is less than W3*<near width>
                       ! (also see DIF)
```

```
W4  20.0        ! /LKPARM/WGHT(4)
                ! units of quality
                ! IFWSYS INOUT MATCH
                       ! quality offset (makes it positive usually)

W5   3.0        ! /LKPARM/WGHT(5)
                ! line widths
                ! IFWSYS INOUT JCENTR
                       ! no. of line widths back to predict junction centre

W6   1.5        ! /LKPARM/WGHT(6)
                ! ratio
                ! IFWSYS INOUT JNCTRK=TSTATT
                       ! give up if track width increases by more than
                       ! this ratio over the running mean (i.e. sides of
                       ! junction arm are diverging)
```

INDEX