29. TERMINALINPUT/OUTPUT

Most input/output operations in Interlisp can be simply modeled as reading or writing on a linear stream of bytes. However, the situation is much more complex when it comes to controlling the user's "terminal," which includes the keyboard, the mouse, and the display screen. For example, Interlisp coordinates the operation of these separate I/O devices so that the cursor on the screen moves as the mouse moves, and any characters typed by the user appear in the window currently containing a flashing cursor. Most of the time, this system works correctly without need for user modification.

The purpose of this chapter is to describe how to access the low-level controls for the terminal I/O devices. It documents the use of interrupt characters, the keyboard characters that generate interrupts. Then, it describes terminal tables, used to determine the meaning of the different editing characters (character delete, line delete, etc.). Then, the "dribble file" facility that allows terminal I/O to be saved onto a file is presented (see the Dribble Files section below). Finally, the low-level functions that control the mouse and cursor, the keyboard, and the screen are documented.

Interrupt Characters

Errors and breaks can be caused by errors within functions, or by explicitly breaking a function. The user can also indicate his desire to go into a break while a program is running by typing certain control characters known as "interrupt characters". The following interrupt characters are currently enabled in Interlisp-D:

Note: In Interlisp-D with multiple processes, it is not sufficient to say that "the computation" is broken, aborted, etc; it is necessary to specify which process is being acted upon. Usually, the user wants interrupts to occur in the TTY process, which is the one currently receiving keyboard input. However, sometimes the user wants to interrupt the mouse process, if it is currently busy executing a menu command or waiting for the user to specify a region on the screen. Most of the interrupt characters below take place in the mouse process if it is busy, otherwise the TTY process. Control-G can be used to break arbitrary processes. For more information, see Chapter 23.

Control-B Causes a break within the mouse process (if busy) or the TTY process. Use Control-G to break a particular process.

Control-D Aborts the mouse process (if busy) or the TTY process, and unwinds its stack to the top level. Calls RESET (see Chapter 14).

Control-E Aborts the mouse process (if busy) or the TTY process, and unwinds its stack to the last ERRORSET. Calls ERROR! (see Chapter 14).

Control-G Pops up a menu listing all of the currently-running processes. Selecting one of the processes will cause a break to take place in that process.

Control-P This interrupt is no longer supported in Medley.

Control-T Flashes the TTY process' window and prints status information for the TTY process. First it prints **"IO wait," "Waiting"**, or **"Running,"**

depending on whether the TTY process is currently in waiting for characters to be typed, waiting for some other reason, or running. Next, it prints the names of the top three frames on the stack, to show what is running. Then, it prints a line describing the percentage of time (since the last control-T) that has been spent running a program, swapping, garbage collecting, doing local disk I/O, etc. For example:

Running in TTWAITFORINPUT in TTBIN in TTYIN1

95% Util, 0% Swap, 4% GC

DELETE Clears typeahead in all processes.

The user can disable and/or redefine Interlisp interrupt characters, as well as define new interrupt characters. Interlisp-D is initialized with the following interrupt channels: RESET (**Control-D**), ERROR (**Control-E**), BREAK (**Control-B**), HELP (**Control-G**), PRINTLEVEL (**Control-P**), RUBOUT (**DELETE**), and RAID. Each of these channels independently can be disabled, or have a new interrupt character assigned to it via the function INTERRUPTCHAR described below. In addition, the user can enable new interrupt channels, and associate with each channel an interrupt character and an expression to be evaluated when that character is typed.

(**INTERRUPTCHAR** *CHAR TYP/FORM HARDFLG* —) [Function]

Defines *CHAR* as an interrupt character. If *CHAR* was previously defined as an interrupt character, that interpretation is disabled.

CHAR is either a character or a character code (see Chapter 2). Note that full sixteen-bit NS characters can be specified as interrupt characters (see Chapter 2). *CHAR* can also be a value returned from INTERRUPTCHAR, as described below.

If *TYP/FORM* = NIL, *CHAR* is disabled.

If *TYP/FORM* = T, the current state of *CHAR* is returned without changing or disabling it.

If *TYP/FORM* is one of the literal atoms RESET, ERROR, BREAK, HELP, PRINTLEVEL, RUBOUT, or RAID, then INTERRUPTCHAR assigns *CHAR* to the indicated Interlisp interrupt channel, (reenabling the channel if previously disabled).

If the argument *TYP/FORM* is a symbol designating a predefined system interrupt (RESET, ERROR, BREAK, etc), and HARDFLG is omitted or NIL, then the hardness defaults to the standard hardness of the system interrupt (e.g., MOUSE for the ERROR interrupt).

If *TYP/FORM* is any other literal atom, *CHAR* is enabled as an interrupt character that when typed causes the atom *TYP/FORM* to be immediately set to T.

If *TYP/FORM* is a list, *CHAR* is enabled as a user interrupt character, and *TYP/FORM* is the form that is evaluated when *CHAR* is typed. The interrupt will be hard if *HARDFLG* = T, otherwise soft.

(INTERRUPTCHAR T) restores all Interlisp channels to their original state, and disables

all user interrupts.

HARDFLG determines what process the interrupt should run in. If *HARDFLG* is NIL, the interrupt will run in the TTY process, which is the process currently receiving keyboard input. If *HARDFLG* is T, the interrupt will occur in whichever process happens to be running. If *HARDFLG* is MOUSE, the interrupt will happen in the mouse process, if the mouse is busy, otherwise in the TTY process.

INTERRUPTCHAR returns a value which, when given as the *CHAR* argument to INTERRUPTCHAR, will restore things as they were before the call to INTERRUPTCHAR. Therefore, INTERRUPTCHAR can be used in conjunction with RESETFORM or RESETLST (see Chapter 14).

INTERRUPTCHAR is undoable.

(**RESET.INTERRUPTS** *PERMITTEDINTERRUPTS SAVECURRENT?*) [Function]

PERMITTEDINTERRUPTS is a list of interrupt character settings to be performed, each of the form (CHAR TYP/FORM HARDFLG). The effect of RESET.INTERRUPTS is as if (INTERRUPTCHAR CHAR TYP/FORM HARDFLG) were performed for each item on PERMITTEDINTERRUPTS, and (INTERRUPTCHAR OTHERCHAR NIL) were performed on every other existing interrupt character.

If *SAVECURRENT?* is non-NIL, then RESET.INTERRUPTS returns the current state of the interrupts in a form that could be passed to RESET.INTERRUPTS, otherwise it returns NIL. This can be used with a RESET.INTERRUPTS that appears in a RESETFORM, so that the list is built at "entry", but not upon "exit".

(**LISPINTERRUPTS**) [Function]

Returns the initial default interrupt character settings for Interlisp-D, as a list that RESET.INTERRUPTS would accept.

(**INTERRUPTABLE** *FLAG*) [Function]

if *FLAG* = NIL, turns interrupts off. If *FLAG* = T, turns interrupts on. Value is previous setting. INTERRUPTABLE compiles open.

Any interrupt character typed while interrupts are off is treated the same as any other character, i.e., placed in the input buffer, and will not cause an interrupt when interrupts are turned back on.

Terminal Tables

A read table (see Chapter 25) contains input/output information that is media-independent. For example, the action of parentheses is the same regardless of the device from which the input is being performed. A terminal table is an object that contains information that pertains to terminal input/output operations only, such as the character to type to delete the last character or to delete the last line. In addition, terminal tables contain such information as how line-buffering is to be

performed, how control characters are to be echoed/printed, whether lowercase input is to be converted to upper case, etc.

Using the functions below, the user may change, reset, or copy terminal tables, or create a new terminal table and install it as the primary terminal table via SETTERMTABLE. However, unlike read tables, terminal tables cannot be passed as arguments to input/output functions.

(**GETTERMTABLE** *TTBL*) [Function]

If *TTBL* = NIL, returns the primary (i.e., current) terminal table. If *TTBL* is a terminal table, return *TTBL*. Otherwise, generates an **ILLEGAL TERMINAL TABLE** error.

(**COPYTERMTABLE** *TTBL*) [Function]

Returns a copy of *TTBL*. *TTBL* can be a real terminal table, NIL (copies the primary terminal table), or ORIG (returns a copy of the original system terminal table). Note that COPYTERMTABLE is the only function that creates a terminal table.

(**SETTERMTABLE** *TTBL*) [Function]

Sets the primary terminal table to be *TTBL*. Returns the previous primary terminal table. Generates an **ILLEGAL TERMINAL TABLE** error if *TTBL* is not a real terminal table.

(**RESETTERMTABLE** *TTBL FROM*) [Function]

Copies (smashes) *FROM* into *TTBL*. *FROM* and *TTBL* can be NIL or a real terminal table. In addition, *FROM* can be ORIG, meaning to use the system's original terminal table.

(**TERMTABLEP** *TTBL*) [Function]

Returns *TTBL*, if *TTBL* is a real terminal table, NIL otherwise.

Terminal Syntax Classes

A terminal table associates with each character a single "terminal syntax class", one of CHARDELETE, LINEDELETE, WORDDELETE, RETYPE, CTRLV, EOL, and NONE. Unlike read table classes, only one character in a particular terminal table can belong to each of the classes (except for the default class NONE). When a new character is assigned one of these syntax classes by SETSYNTAX (see Chapter 25), the previous character is disabled (i.e., reassigned the syntax class NONE), and the value of SETSYNTAX is the code for the previous character of that class, if any, otherwise NIL.

The terminal syntax classes are interpreted as follows:

CHARDELETE	(Initially BackSpace and Control-A in Interlisp-D) Typing this character deletes the previous character typed. Repeated use of this character deletes successive characters back to the beginning of the line.
LINEDELETE	(Initially Control-Q in Interlisp-D) Typing this character deletes the whole line; it cannot be used repeatedly.

WORDDELETE (Initially Control-W in Interlisp-D) Typing this character deletes the previous "word", i.e., sequence of non-separator characters.

RETYPE (Initially Control-R) Causes the line to be retyped as Interlisp sees it (useful when repeated deletions make it difficult to see what remains).

CTRLV
CNTRLV (Initially Control-V) When followed by A, B, ... Z, inputs the corresponding control character control-A, control-B, ... control-Z. This allows interrupt characters to be input without causing an interrupt.

EOL On input from a terminal, the EOL character signals to the line buffering routine to pass the input back to the calling function. It also is used to terminate inputs to READLINE (see Chapter 13). In general, whenever the phrase carriage-return linefeed is used, what is meant is the character with terminal syntax class EOL.

NONE The terminal syntax class of all other characters.

GETSYNTAX, SETSYNTAX, and SYNTAXP all work on terminal tables as well as read tables (see page X.XX). As with read tables, full sixteen-bit NS characters can be specified in terminal tables (see Chapter 2). When given NIL as a TABLE argument, GETSYNTAX and SYNTAXP use the primary read table or primary terminal table depending on which table contains the indicated CLASS argument. For example, (SETSYNTAX CH 'BREAK) refers to the primary read table, and (SETSYNTAX CH 'CHARDELETE) refers to the primary terminal table. In the absence of such information, all three functions default to the primary read table; e.g., (SETSYNTAX '{ '%[) refers to the primary read table. If given incompatible CLASS and table arguments, all three functions generate errors. For example, (SETSYNTAX CH 'BREAK TTBL), where TTBL is a terminal table, generates an **ILLEGAL READTABLE** error, and (GETSYNTAX 'CHARDELETE RDTBL) generates an **ILLEGAL TERMINAL TABLE** error.

Terminal Control Functions

(**ECHOCHAR** *CHARCODE MODE TTBL*) [Function]

ECHOCHAR sets the "echo mode" of the character *CHARCODE* to *MODE* in the terminal table *TTBL*. The "echo mode" determines how the character is to be echoed or printed. Note that although the name of this function suggests echoing only, it affects all output of the character, both echoing of input and printing of output.

CHARCODE should be a character code. *CHARCODE* can also be a list of characters, in which case ECHOCHAR is applied to each of them with arguments *MODE* and *TTBL*. Note that echo modes can be specified for full sixteen-bit NS characters (see Chapter 2).

MODE should be one of the litatoms IGNORE, REAL, SIMULATE, or INDICATE which

specify how the character should be echoed or printed:

IGNORE	*CHARCODE* is never printed.
REAL	*CHARCODE* itself is printed. Some terminals may respond to certain control and meta characters in interesting ways.
SIMULATE	Output of *CHARCODE* is simulated. For example, control-I (tab) may be simulated by printing spaces. The simulation is machine-specific and beyond the control of the user.
INDICATE	For control or meta characters, *CHARCODE* is printed as # and/or ^ followed by the corresponding alphabetic character. For example, Control-A would echo as ^A, and meta-Control-W would echo as #^W.

The value of ECHOCHAR is the previous echo mode for *CHARCODE*. If *MODE* = NIL, ECHOCHAR returns the current echo mode without changing it.

Warning: In some fonts, control and meta characters may be used for printable characters. If the echomode is set to INDICATE for these characters, they will not print out correctly.

(**ECHOCONTROL** *CHAR MODE TTBL*) [Function]

ECHOCONTROL is an old, limited version of ECHOCHAR, that can only specify the echo mode of control characters. *CHAR* is a character or character code. If *CHAR* is an alphabetic character (or code), it refers to the corresponding control character, e.g., (ECHOCONTROL 'Z 'INDICATE) if equivalent to (ECHOCHAR (CHARCODE ↑Z) 'INDICATE).

(**ECHOMODE** *FLG TTBL*) [Function]

If *FLG* = T, turns echoing for terminal table *TTBL* on. If *FLG* = NIL, turns echoing off. Returns the previous setting.

Note: Unlike ECHOCHAR, this only affects echoing of typed-in characters, not printing of characters.

(**GETECHOMODE** *TTBL*) [Function]

Returns the current echo mode for *TTBL*.

The following functions manipulate the "raise mode," which determines whether lower case characters are converted to upper case when input from the terminal. There is no "raise mode" for input from files.

(**RAISE** *FLG TTBL*) [Function]

Sets the RAISE mode for terminal table *TTBL*. If *FLG* = NIL, all characters are passed as typed. If *FLG* = T, input is echoed as typed, but lowercase letters are converted to upper case. If *FLG* = 0, input is converted to uppercase before it is echoed. Returns the previous setting.

(**GETRAISE** *TTBL*) [Function]

Returns the current RAISE mode for *TTBL*.

(**DELETECONTROL** *TYPE MESSAGE TTBL*) [Function]

Specifies the output protocol when a CHARDELETE or LINEDELETE is typed, by specifying character strings to print when characters are deleted.

Interlisp-10 (designed for use on hardcopy terminals) echos the characters being deleted, preceding the first by a \ and following the last by a \, so that it is easy to see exactly what was deleted. Interlisp-D is initially set up to physically erase the deleted characters from the display, so the DELETECONTROL strings are initialized to the null string.

The various values of *TYPE* specify different phases of the deletion, as follows:

1STCHDEL	*MESSAGE* is the message printed the first time CHARDELETE is typed. Initially "\" in Interlisp-10.
NTHCHDEL	*MESSAGE* is the message printed when the second and subsequent CHARDELETE characters are typed (without intervening characters). Initially "" in Interlisp-10.
POSTCHDEL	*MESSAGE* is the message printed when input is resumed following a sequence of one or more CHARDELETE characters. Initially "\" in Interlisp-10.
EMPTYCHDEL	*MESSAGE* is the message printed when a CHARDELETE is typed and there are no characters in the buffer. Initially "## cr" in Interlisp-10.
ECHO	If *TYPE* = ECHO, the characters deleted by CHARDELETE are echoed. *MESSAGE* is ignored.
NOECHO	If *TYPE* = NOECHO, the characters deleted by CHARDELETE are not echoed. *MESSAGE* is ignored.
LINEDELETE	*MESSAGE* is the message printed when the LINEDELETE character is typed. Initially "## cr".

Note: In Interlisp-10, the LINEDELETE, 1STCHDEL, NTHCHDEL, POSTCHDEL, and EMPTYCHDEL messages must be 4 characters or fewer in length.

DELETECONTROL returns the previous message as a string. If *MESSAGE* = NIL, the value returned is the previous message without changing it. For *TYPE* = ECHO and NOECHO, the value of DELETECONTROL is the previous echo mode, i.e., ECHO or NOECHO.

(**GETDELETECONTROL** *TYPE TTBL*) [Function]

Returns the current DELETECONTROL mode for *TYPE* in *TTBL*.

Line-Buffering

Characters typed at the terminal are stored in two buffers before they are passed to an input function. All characters typed in are put into the low-level "system buffer", which allows type-ahead. When an input function is entered, characters are transferred to the "line buffer" until a character with terminal syntax class EOL appears (or, for calls from READ, when the count of unbalanced open parentheses reaches 0). Note that PEEKC is an exception; it returns the character immediately when its second argument is NIL. Until this time, the user can delete characters one at a time from the line buffer by typing the current CHARDELETE character, or delete the entire line buffer back to the last carriage-return by typing the current LINEDELETE.

This line editing is not performed by READ or RATOM, but by Interlisp, i.e., it does not matter (nor is it necessarily known) which function will ultimately process the characters, only that they are still in the Interlisp line buffer. However, the function that is requesting input at the time the buffering starts does determine whether parentheses counting is observed. For example, if a program performs (PROGN (RATOM) (READ)) and the user types in "A (B C D)", the user must type in the carriage-return following the right parenthesis before any action is taken, because the line buffering is happening under RATOM. If the program had performed (PROGN (READ) (READ)), the line-buffering would be under READ, so that the right parenthesis would terminate line buffering, and no terminating carriage-return would be required.

Once a carriage-return has been typed, the entire line is "available" even if not all of it is processed by the function initiating the request for input. If any characters are "left over", they are returned immediately on the next request for input. For example, (LIST (RATOM) (READC) (RATOM)) when the input is "A Bcr" returns the three-element list (A % B) and leaves the carriage-return in the buffer.

If a carriage-return is typed when the input under READ is not "complete" (the parentheses are not balanced or a string is in progress), line buffering continues, but the lines completed so far are not available for editing with CHARDELETE or LINEDELETE.

The function CONTROL is available to defeat line-buffering:

(**CONTROL** *MODE TTBL*) [Function]

If *MODE* = T, eliminates Interlisp's normal line-buffering for the terminal table *TTBL*. If *MODE* = NIL, restores line-buffering (normal). When operating with a terminal table in which (CONTROL T) has been performed, characters are returned to the calling function without line-buffering as described below.

CONTROL returns its previous setting.

(**GETCONTROL** *TTBL*) [Function]

Returns the current control mode for *TTBL*.

The function that initiates the request for input determines how the line is treated when (CONTROL T) is in effect:

READ If the expression being typed is a list, the effect is the same as

though done with (CONTROL NIL), i.e., line-buffering continues until a carriage-return or matching parentheses. If the expression being typed is not a list, it is returned as soon as a break or separator character is encountered, e.g., (READ) when the input is "ABC<space>" immediately returns ABC. CHARDELETE and LINEDELETE are available on those characters still in the buffer. Thus, if a program is performing several reads under (CONTROL T), and the user types "NOW IS THE TIME" followed by Control-Q, only TIME is deleted, since the rest of the line has already been transmitted to READ and processed.

An exception to the above occurs when the break or separator character is an opening parenthesis, bracket or double-quote, since returning at this point would leave the line buffer in a "funny" state. Thus if the input to (READ) is "ABC(", the ABC is not read until a carriage-return or matching parentheses is encountered. In this case the user could LINEDELETE the entire line, since all of the characters are still in the buffer.

RATOM Characters are returned as soon as a break or separator character is encountered. Until then, LINEDELETE and CHARDELETE may be used as with READ. For example, (RATOM) followed by "ABC<control-A><space>" returns AB. (RATOM) followed by "(<control-A>" returns (and types ## indicating that control-A was attempted with nothing in the buffer, since the (is a break character and would therefore already have been read.

READC

PEEKC The character is returned immediately; no line editing is possible. In particular, (READC) is perfectly happy to return the CHARDELETE or LINEDELETE characters, or the ESCAPE character (%).

The system buffer and line buffer can be directly manipulated using the following functions.

(**CLEARBUF** *FILE FLG*) [Function]

Clears the input buffer for *FILE*. If *FILE* is T and *FLG* is T, the contents of Interlisp's system buffer and line buffer are saved (and can be obtained via SYSBUF and LINBUF described below).

When you type Control-D or Control-E, or any of the interrupt characters that require terminal interaction (Control-G, or Control-P), Interlisp automatically performs (CLEARBUF T T). For Control-P and, when the break is exited normally, control-H, Interlisp restores the buffer after the interaction.

The action of (CLEARBUF T), i.e., clearing of typeahead, is also available as the RUBOUT

interrupt character, initially assigned to the delete key in Interlisp-D. Note that this interrupt clears both buffers at the time it is typed, whereas the action of the CHARDELETE and LINEDELETE character occur at the time they are read.

(**SYSBUF** *FLG*) [Function]

If *FLG* = T, returns the contents of the system buffer (as a string) that was saved at the last (CLEARBUF T T). If *FLG* = NIL, clears this internal buffer.

(**LINBUF** *FLG*) [Function]

Same as SYSBUF for the line buffer.

If both the system buffer and Interlisp's line buffer are empty, the internal buffers associated with LINBUF and SYSBUF are not changed by a (CLEARBUF T T).

(**BKSYSBUF** *X FLG RDTBL*) [Function]

BKSYSBUF appends the PRIN1-name of *X* to the system buffer. The effect is the same as though the user typed *X*. Some implementations have a limit on the length of *X*, in which case characters in *X* beyond the limit are ignored. Returns *X*.

If *FLG* is T, then the PRIN2-name of *X* is used, computed with respect to the readtable *RDTBL*. If *RDTBL* is NIL or omitted, the current readtable of the TTY process (which is to receive the characters) is used. Use this for copy selection functions that want their output to be a readable expression in an Exec.

Note that if you are typing at the same time as the BKSYSBUF is being performed, the relative order of the typein and the characters of *X* is unpredictable.

(**BKLINBUF** *STR*) [Function]

STR is a string. BKLINBUF sets Interlisp's line buffer to *STR*. Some implementations have a limit on the length of *STR*, in which case characters in *STR* beyond the limit are ignored. Returns *STR*.

(**BKSYSCHARCODE** *CODE*) [Function]

This function appends the character code *CODE* to the system input buffer. The function BKSYSBUF is implemented by repeated calls to BKSYSCHARCODE.

BKLINBUF, BKSYSBUF, LINBUF, and SYSBUF provide a way of "undoing" a CLEARBUF. Thus to "peek" at various characters in the buffer, one could perform (CLEARBUF T T), examine the buffers via LINBUF and SYSBUF, and then put them back.

The more common use of these functions is in saving and restoring typeahead when a program requires some unanticipated (from the user's standpoint) input. The function RESETBUFS provides a convenient way of simply clearing the input buffer, performing an interaction with the user, and then restoring the input buffer.

(**RESETBUFS** *FORM$_1$, FORM$_2$, ... FORMN*) [NLambda NoSpread Function]

Clears any typeahead (ringing the terminal's bell if there was, indeed, typeahead), evaluates *FORM$_1$*, *FORM$_2$*, ... *FORM$_N$*, then restores the typeahead. Returns the value of *FORM$_N$*. Compiles open.

Dribble Files

A dribble file is a "transcript" of all of the input and output on a terminal. In Interlisp-D, DRIBBLE opens a dribble file for the current process, recording the terminal input and output for that process. Multiple processes can have separate dribble files open at the same time.

(**DRIBBLE** *FILE APPENDFLG THAWEDFLG*) [Function]

Opens *FILE* and begins recording the typescript. Returns the old dribble file if any, otherwise NIL. If *APPENDFLG* = T, the typescript will be appended to the end of *FILE*. If *THAWEDFLG* = T, the file will be opened in "thawed" mode, for those implementations that support it. (DRIBBLE) closes the dribble file for the current process. Only one dribble file can be active for each process at any one time, so (DRIBBLE FILE1) followed by (DRIBBLE FILE2) will cause FILE1 to be closed.

(**DRIBBLEFILE**) [Function]

Returns the name of the current dribble file for the current process, if any, otherwise NIL.

Terminal input is echoed to the dribble file a line buffer at a time. Thus, the typescript produced is somewhat neater than that appearing on the user's terminal, because it does not show characters that were erased via Control-A or Control-Q. Note that the typescript file is not included in the list of files returned by (OPENP), nor will it be closed by a call to CLOSEALL or CLOSEF. Only (DRIBBLE) closes the typescript file.

Cursor and Mouse

A mouse is a small box connected to the computer keyboard by a long wire. On the top of the mouse are two or three buttons. On the bottom is a rolling ball or a set of photoreceptors, to detect when the mouse is moved. As the mouse is moved on a surface, a small image on the screen, called the cursor, moves to follow the movement of the mouse. By moving the mouse, the user can cause the cursor to point to any part of the display screen.

The mouse and cursor are an important part of the Interlisp-D user interface. The Interlisp-D window system allows the user to create, move, and reshape windows, and to select items from displayed menus, all by moving the mouse and clicking the mouse buttons. This section describes the low-level functions used to control the mouse and cursor.

Changing the Cursor Image

Interlisp-D maintains the image of the cursor on the screen, moving it as the mouse is moved. The bitmap that becomes visible as the cursor can be accessed by the following function:

(**CURSORBITMAP**) [Function]

Returns the cursor bitmap.

CURSORWIDTH [Variable]
CURSORHEIGHT [Variable]

Value is the width and height of the cursor bitmap, respectively.

The cursor bitmap can be changed like any other bitmap by BITBLTing into it or pointing a display stream at it and printing or drawing curves. The CURSOR datatype has the following field names CUBITSPERPIXEL CUIMAGE, CUMASK, CUHOTSPOTX, CUHOTSPOTY, CUDATA

CURSOR objects can be saved on a file using the file package command CURSORS, or the UGLYVARS file package command.

(**CURSORCREATE** *BITMAP X Y*) [Function]

Returns a cursor object which has *BITMAP* as its image and the location (*X*, *Y*) as the hot spot. If *X* is a POSITION, it is used as the hot spot. If *BITMAP* has dimensions different from CURSORWIDTH by CURSORHEIGHT, the lesser of the widths and the lesser of the heights are used to determine the bits that actually get copied into the lower left corner of the cursor. If *X* is NIL, 0 is used. If *Y* is NIL, CURSORHEIGHT-1 is used. The default cursor is an uparrow with its tip in the upper left corner and its hot spot at (0,CURSORHEIGHT−1).

(**CURSOR** *NEWCURSOR* −) [Function]

Returns a CURSOR record instance that contains (a copy of) the current cursor specification. If *NEWCURSOR* is a CURSOR record instance, the cursor will be set to the values in *NEWCURSOR*. If *NEWCURSOR* is T, the cursor will be set to the default cursor DEFAULTCURSOR, an upward left pointing arrow: .

(**SETCURSOR** *NEWCURSOR* −) [Function]

If *NEWCURSOR* is a CURSOR record instance, the cursor will be set to the values in *NEWCURSOR*. This does not return the old cursor, and therefore, provides a way of changing the cursor without using storage.

(**FLIPCURSOR**) [Function]

Inverts the cursor.

The following list describes the cursors used by the Interlisp-D system. Most of them are stored as the values of various variables.

In variable DEFAULTCURSOR. This is the default cursor.

In variable WAITINGCURSOR. Represents an hourglass. Used during long computations.

In variable MOUSECONFIRMCURSOR. Indicates that the system is waiting for the user to confirm an action by pressing the left mouse button, or aborting the action by pressing any other button. Used by the function MOUSECONFIRM (see Chapter 28).

In variable SYSOUTCURSOR. Indicates that the system is saving the virtual memory in a sysout file. See SYSOUT, Chapter 12.

In variable SAVINGCURSOR. Indicates that SAVEVM has been called automatically to save the virtual memory state after the system is idle for long enough. See SAVEVMWAIT, Chapter 12.

In variable CROSSHAIRS. Used by GETPOSITION (see Chapter 28) to indicate a position.

In variable BOXCURSOR. Used by GETBOXPOSITION (see Chapter 28) to indicate where to place the corner of a box.

In variable FORCEPS. Used by GETREGION (see Chapter 28) when the user switches corners.

In variable EXPANDINGBOX. Used by GETREGION (see Chapter 28) when a box is first displayed.

In variable UpperRightCursor.

In variable LowerRightCursor.

In variable UpperLeftCursor.

In variable LowerLeftCursor.

The previous four cursors are used by GETREGION (see Chapter 28) to indicate the four corners of a region.

In variable VertThumbCursor. Used during scrolling to indicate thumbing in a vertical scroll bar.

In variable VertScrollCursor.

In variable ScrollUpCursor.

In variable `ScrollDownCursor`.

The previous four cursors are used by `SCROLL.HANDLER` (see Chapter 28) during vertical scrolling.

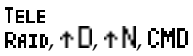
In variable `HorizThumbCursor`. Used during scrolling to indicate thumbing in a horizontal scroll bar.

In variable `HorizScrollCursor`.

In variable `ScrollLeftCursor`.

In variable `ScrollRightCursor`.

The previous four cursors are used by `SCROLL.HANDLER` (see Chapter 28) during horizontal scrolling.



These cursors are used by the Teleraid low-level debugger. These cursors are not accessable as standard Interlisp-D cursors.

Flashing Bars on the Cursor

The low-level Interlisp-D system uses the cursor to display certain system status information, such as garbage collection or swapping. This is done because changing the cursor image is very quick, and does not require interacting with the window system. Interlisp inverts horizontal bars on the cursor when the system is swapping pages, or doing certain stack operations. Normally, these bars are only inverted for a very short time, so they look like they are flashing. These cursor changes are interpreted as follows:

Inverted cursor: Whatever image is being displayed as the cursor, whenever Interlisp does a garbage collection, the whole cursor is inverted.

Top bar: Swap read. On when Interlisp is swapping in a page from the virtual memory file into the real memory. It is also on when Interlisp allocates a new virtual memory page, even though that doesn't involve a disk read. If this is flashing a lot, the system is doing a lot of swapping. This is an indication that the virtual memory working set is fragmented (see Chapter 22). Performance may be improved by reloading a clean Interlisp system.

Upper middle bar: Stack operations. If this is flashing a lot, it suggests that some process is neglecting to release stack pointers in a timely fashion (see Chapter 11).

Lowereler middle bar: Stack operations. On when Interlisp is moving frames on the stack. If

the system is slow, and this is flashing a lot, HARDRESET (see Chapter 23) sometimes helps.

Bottom bar: Swap write. On when Interlisp writes a dirty virtual memory page from the real memory back into the virtual memory file.

Cursor Position

The position at which the cursor bitmap is being displayed can be read or set using the following functions:

(**CURSORPOSITION** *NEWPOSITION DISPLAYSTREAM OLDPOSITION*) [Function]

Returns the location of the cursor in the coordinate system of *DISPLAYSTREAM* (or the current display stream, if *DISPLAYSTREAM* is NIL). If *NEWPOSITION* is non-NIL, it should be a position and the cursor will be positioned at *NEWPOSITION*. If *NEWPOSITION* is NIL, the current position is simple returned.

The current position of the cursor is the position of the "hot spot" of the cursor, not the position of the cursor bitmap.

If *OLDPOSITION* is a POSITION object, this object will be changed to point to the location of the cursor and returned, rather of allocating a new POSITION. This can improve performance if CURSORPOSITION is called repeatedly to track the cursor.

To get the location of the cursor in absolute screen coordinates, use the variables LASTMOUSEX and LASTMOUSEY.

(**ADJUSTCURSORPOSITION** *DELTAX DELTAY*) [Function]

Moves the cursor *DELTAX* points in the X direction and *DELTAY* points in the Y direction. *DELTAX* and *DELTAY* default to 0.

Mouse Button Testing

There are two or three keys on the mouse. These keys (also called buttons) are referred to by their location: LEFT, MIDDLE, or RIGHT. The following macros are provided to test the state of the mouse buttons:

(**MOUSESTATE** *BUTTONFORM*) [Macro]

Reads the state of the mouse buttons, and returns T if that state is described by *BUTTONFORM*. *BUTTONFORM* can be one of the key indicators LEFT, MIDDLE, or RIGHT; the atom UP (indicating all keys are up); the form (ONLY KEY); or a form of AND, OR, or NOT applied to any valid button form.

For example: (MOUSESTATE LEFT) will be true if the left mouse button is down. (MOUSESTATE (ONLY LEFT)) will be true if the left mouse button is the only one down. (MOUSESTATE (OR (NOT LEFT) MIDDLE)) will be true if either the left

mouse button is up or the middle mouse button is down.

(**LASTMOUSESTATE** *BUTTONFORM*) [Macro]

Similar to MOUSESTATE, but tests the value of LASTMOUSEBUTTONS (below) rather than getting the current state. This is useful for determining which keys caused MOUSESTATE to be true.

(**UNTILMOUSESTATE** *BUTTONFORM INTERVAL*) [Macro]

BUTTONFORM is as described in MOUSESTATE. Waits until *BUTTONFORM* is true or until *INTERVAL* milliseconds have elapsed. The value of UNTILMOUSESTATE is T if *BUTTONFORM* was satisfied before it timed out, otherwise NIL. If *INTERVAL* is NIL, it waits indefinitely. This compiles into an open loop that calls the TTY wait background function. This form should not be used inside the TTY wait background function. UNTILMOUSESTATE does not use any storage during its wait loop.

Low Level Mouse Functions

This section describes the functions and variables that provide low level access to the mouse and cursor.

(**LASTMOUSEX** *DISPLAYSTREAM*) [Function]

Returns the value of the cursor's X position in the coordinates of *DISPLAYSTREAM* (as of the last call to GETMOUSESTATE, below).

(**LASTMOUSEY** *DISPLAYSTREAM*) [Function]

Returns the value of the cursor's Y position in the coordinates of *DISPLAYSTREAM* (as of the last call to GETMOUSESTATE, below).

LASTMOUSEX [Variable]

Value is the X position of the cursor in absolute screen coordinates (as of the last call to GETMOUSESTATE, below).

LASTMOUSEY [Variable]

Value is the Y position of the cursor in absolute screen coordinates (as of the last call to GETMOUSESTATE, below).

LASTMOUSEBUTTONS [Variable]

Value is an integer that has bits on corresponding to the mouse buttons that are down (as of the last call to GETMOUSESTATE, below). Bit 4Q is the left mouse button, 2Q is the right button, 1Q is the middle button.

LASTKEYBOARD [Variable]

Value is an integer encoding the state of certain keys on the keyboard (as of the last call to GETMOUSESTATE, below). Bit 200Q = lock, 100Q = left shift, 40Q = ctrl, 10Q = right shift,

4Q = blank Bottom, 2Q = blank Middle, 1Q = blank Top. If the key is down, the corresponding bit is on.

(**GETMOUSESTATE**) [Function]

Reads the current state of the mouse and sets the variables LASTMOUSEX, LASTMOUSEY, and LASTMOUSEBUTTONS. In polling mode, the program must remember the previous state and look for changes, such as a key going up or down, or the cursor moving outside a region of interest.

(**DECODEBUTTONS** *BUTTONSTATE*) [Function]

Returns a list of the mouse buttons that are down in the state *BUTTONSTATE*. If *BUTTONSTATE* is not a small integer, the value of LASTMOUSEBUTTONS (above) is used. The button names that can be returned are: LEFT, MIDDLE, RIGHT (the three mouse keys).

Keyboard Interpretation

For each key on the keyboard and mouse there is a corresponding bit in memory that the hardware turns on and off as the key moves up and down. System-level routines decode the meaning of key transitions according to a table of "key actions", which may be to put particular character codes in the sysbuffer, cause interrupts, change the internal shift/control status, or create events to be placed in the mouse buffer.

(**KEYDOWNP** *KEYNAME*) [Function]

Used to read the instantaneous state of any key, independent of any buffering or pre-assigned key action. Returns T if the key named *KEYNAME* is down at the moment the function is executed.

Most keys are named by the characters on the key-top. Therefore, (KEYDOWNP 'a) or (KEYDOWNP 'A) returns T if the "A" key is down.

There are a number of keys that do not have standard names printed on them. These can be accessed by special names as follows:

Space	SPACE
Carriage return	CR
Line-feed	LF
Backspace	BS
Tab	TAB
Blank keys on 1132	The 1132 keyboard has three unmarked keys on the right of the normal keyboard. These can be accessed by BLANK-BOTTOM, BLANK-MIDDLE, and BLANK-TOP.
Escape	ESCAPE

Shift keys	LSHIFT for the left shift key, RSHIFT for the right shift key.
Shift lock key	LOCK
Control key	CTRL
Mouse buttons	The state of the mouse buttons can be accessed using LEFT, MIDDLE, and RIGHT.

If KEYNAME is a small integer, it is taken to be the internal key number. Otherwise, it is taken to be the name of the key. This means, for example, that the name of the "6" key is not the number 6. Instead, spelled-out names for all the digit keys have been assigned. The "6" key is named SIX. It happens that the key number of the "6" key is 2. Therefore, the following two forms are equivalent:

```
(KEYDOWNP 'SIX)

(KEYDOWNP 2)
```

(**SHIFTDOWNP** *SHIFT*) [Function]

Returns T if the internal "shift" flag specified by *SHIFT* is on; NIL otherwise.

If *SHIFT* = 1SHIFT, 2SHIFT, LOCK, META, or CTRL, SHIFTDOWNP returns the state of the left shift, right shift, shift lock, control, and meta flags, respectively.

If *SHIFT* = *SHIFT*, SHIFTDOWNP returns T if either the left or right shift flag is on.

If *SHIFT* = USERMODE1, USERMODE2, or USERMODE3, SHIFTDOWNP returns the state of one of three user-settable flags that have no other effect on key interpretation. These flags can be set or cleared on character transitions by using KEYACTION (below).

(**KEYACTION** *KEYNAME ACTIONS* —) [Function]

Changes the internal tables that define the action to be taken when a key transition is detected by the system keyboard handler. *KEYNAME* is specified as for KEYDOWNP. *ACTIONS* is a dotted pair of the form (DOWN-ACTION . UP-ACTION), where the acceptable transition actions and their interpretations are:

NIL

IGNORE Take no action on this transition (the default for up-transitions on all ordinary characters).

(CHAR SHIFTEDCHAR LOCKFLAG)

If a transition action is a three-element list, CHAR and SHIFTEDCHAR are either character codes or (non-numeric) single-character litatoms standing for their character codes. Note that CHAR and SHIFTEDCHAR can be full sixteen-bit NS characters (see page X.XX). When the transition occurs, CHAR or SHIFTEDCHAR is transmitted to

the system buffer, depending on whether either of the two shift keys are down.

LOCKFLAG is optional, and may be LOCKSHIFT or NOLOCKSHIFT. If LOCKFLAG is LOCKSHIFT, then SHIFTEDCHAR will also be transmitted when the LOCK shift is down (the alphabetic keys initially specify LOCKSHIFT, but the digit keys specify NOLOCKSHIFT). For example, (a A LOCKSHIFT) and (61Q ! NOLOCKSHIFT) are the initial settings for the down transitions of the "a" and "1" keys respectively.

1SHIFTUP, 1SHIFTDOWN

2SHIFTUP, 2SHIFTDOWN

CTRLUP, CTRLDOWN

METAUP, METADOWN — Change the status of the internal "shift" flags for the left shift, right shift, control, and meta keys, respectively. These shifts affect the interpretation of ordinary key actions. If either of the shifts is down, then SHIFTEDCHARs are transmitted. If the control flag is on, then the the seventh bit of the character code is cleared as characters are transmitted. If the meta flag is on, the the eighth bit of the character code is set (normally cleared) as characters are transmitted. For example, the initial keyactions for the left shift key is (1SHIFTDOWN . 1SHIFTUP).

LOCKUP, LOCKDOWN, LOCKTOGGLE

Change the status of the internal "shift" flags for the shift lock key. If the lock flag is down, then SHIFTEDCHARs are transmitted if the key action specified LOCKSHIFT. LOCKUP and LOCKDOWN clear and set the shift lock flag, respectively. LOCKTOGGLE complements the flag (turning it off if the flag is on; on if the flag is off).

USERMODE1UP, USERMODE1DOWN, USERMODE1TOGGLE

USERMODE2UP, USERMODE2DOWN, USERMODE2TOGGLE

USERMODE3UP, USERMODE3DOWN, USERMODE3TOGGLE

Change the status of the three user flags USERMODE1, USERMODE2, and USERMODE3, whose status can be determined by calling SHIFTDOWNP (above). These flags have no other effect on key interpretation.

EVENT — An encoding of the current state of the mouse and selected keys is placed in the mouse-event buffer when this transition is detected.

KEYACTION returns the previous setting for KEYNAME. If ACTIONS is NIL, returns the previous setting without changing the tables.

KEYACTIONS is a list of key actions to be set, each of the form (KEYNAME . ACTIONS). The effect of MODIFY.KEYACTIONS is as if (KEYACTION KEYNAME ACTIONS) were performed for each item on *KEYACTIONS*.

If *SAVECURRENT?* is non-NIL, then MODIFY.KEYACTIONS returns a list of all the results from *KEYACTION*, otherwise it returns NIL. This can be used with a MODIFY.KEYACTIONS that appears in a RESETFORM, so that the list is built at "entry", but not upon "exit".

(**METASHIFT** *FLG*) [NoSpread Function]

If *FLG* is T, changes the keyboard handler (via KEYACTION) so as to interpret the "stop" key on the 1108 as a metashift: if a key is struck while the meta is down, it is read with the 200Q bit set. For CHAT users this is a way of getting an "Edit" key on your simulated Datamedia.

If *FLG* is other than NIL or T, it is passed as the ACTIONS argument to KEYACTION. The reason for this is that if someone has set the "STOP" key to some random behavior, then (RESETFORM (METASHIFT T) --) will correctly restore that random behavior.

Display Screen

Medley supports a high-resolution bitmap display screen. All printing and drawing operations to the screen are actually performed on a bitmap in memory, which is read by the computer hardware to become visible as the screen. This section describes the functions used to control the appearance of the display screen.

(**SCREENBITMAP**) [Function]

Returns the screen bitmap.

SCREENWIDTH [Variable]
SCREENHEIGHT [Variable]

Value is the width and height of the screen bitmap, respectively.

WHOLEDISPLAY [Variable]

Value is a region that is the size of the screen bitmap.

The background shade of the display window can be changed using the following function:

(**CHANGEBACKGROUND** *SHADE* —) [Function]

Changes the background shade of the window system. *SHADE* determines the pattern of the background. If *SHADE* is a texture, then the background is simply painted with it. If *SHADE* is a BITMAP, the background is tesselated (tiled) with it to cover the screen. If *SHADE* is T, it changes to the original shade, the value of WINDOWBACKGROUNDSHADE.

It returns the previous value of the background.

WINDOWBACKGROUNDSHADE [Variable]

Value is the default background shade for the display.

(**VIDEOCOLOR** *BLACKFLG*) [NoSpread Function]

Sets the interpretation of the bits in the screen bitmap. If *BLACKFLG* is NIL, a 0 bit will be displayed as white, otherwise a 0 bit will be displayed as black. VIDEOCOLOR returns the previous setting. If *BLACKFLG* is not given, VIDEOCOLOR will return the current setting without changing anything.

Note: This function only works on the Xerox 1100 and Xerox 1108.

(**VIDEORATE** *TYPE*) [Function]

Sets the rate at which the screen is refreshed. *TYPE* is one of NORMAL or TAPE. If *TYPE* is TAPE, the screen will be refreshed at the same rate as TV (60 cycles per second). This makes the picture look better when video taping the screen. Note: Changing the rate may change the dimensions of the display on the picture tube.

Maintaining the video image on the screen uses cpu cycles, so turning off the display can improve the speed of compute-bound tasks. When the display is off, the screen will be white but any printing or displaying that the program does will be visible when the display is turned back on.

Note: Breaks and PAGEFULLFN waiting (see Chapter 28) turn the display on, but users should be aware that it is possible to have the system waiting for a response to a question printed or a menu displayed on a non-visible part of the screen. The functions below are provided to turn the display off.

Note: These functions have no effect on the Xerox 1108 display.

(**SETDISPLAYHEIGHT** *NSCANLINES*) [Function]

Sets the display to only show the top *NSCANLINES* of the screen. If *NSCANLINES* is T, resets the display to show the full screen. Returns the previous setting.

(**DISPLAYDOWN** *FORM NSCANLINES*) [Function]

Evaluates *FORM* (with the display set to only show the top *NSCANLINES* of the screen), and returns the value of *FORM*. It restores the screen to its previous setting. If *NSCANLINES* is not given, it defaults to 0.

Miscellaneous Terminal I/O

(**RINGBELLS** *N*) [Function]

Flashes (reverse-videos) the screen *N* times (default 1). On the Xerox 1108, this also beeps through the keyboard speaker.

(**PLAYTUNE** *Frequency/Duration.pairlist*) [Function]

On the Xerox 1108, PLAYTUNE plays a sequence of notes through the keyboard speaker. *Frequency/Duration.pairlist* should be a list of dotted pairs (*FREQUENCY . DURATION*). PLAYTUNE maps down its argument, beeping the 1108 keyboard buzzer at each frequency for the specified amount of time. Specifying NIL for a frequency means to turn the beeper off the specified amount of time. The units of time are TICKS (Chapter 12), which last about 28.78 microseconds on the Xerox 1108. PLAYTUNE makes no sound on a Xerox 1132. The default "simulate" entry for Control-G (ASCII BEL) on the 1108 uses PLAYTUNE to make a short beep.

PLAYTUNE is implemented using BEEPON and BEEPOFF:

(**BEEPON** *FREQ*) [Function]

On the Xerox 1108, turns on the keyboard speaker playing a note with frequency *FREQ*, measured in Hertz (see Chapter 12). The speaker will continue to play the note until BEEPOFF is called.

(**BEEPOFF**) [Function]

Turns off the keyboard speaker on the Xerox 1108.

(**SETMAINTPANEL** *N*) [Function]

On the Xerox 1108, this sets the four-digit "maintanance panel" display on the front of the computer to display the number *N*.