

# ***EAGLE***

***EASILY APPLICABLE GRAPHICAL LAYOUT EDITOR***

## ***User Language***

***Version 5.7***



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## User Language

The EAGLE User Language can be used to access the EAGLE data structures and to create a wide variety of output files.

To use this feature you have to write a User Language Program (ULP), and then execute it.

The following sections describe the EAGLE User Language in detail:

<u>Syntax</u>	lists the rules a ULP file has to follow
<u>Data Types</u>	defines the basic data types
<u>Object Types</u>	defines the EAGLE objects
<u>Definitions</u>	shows how to write a definition
<u>Operators</u>	lists the valid operators
<u>Expressions</u>	shows how to write expressions
<u>Statements</u>	defines the valid statements
<u>Builtins</u>	lists the builtin constants, functions etc.
<u>Dialogs</u>	shows how to implement a graphical frontend to a ULP

## Writing a ULP

A User Language Program is a plain text file which is written in a C-like syntax. User Language Programs use the extension `.ulp`. You can create a ULP file with any text editor (provided it does not insert any additional control characters into the file) or you can use the builtin text editor.

A User Language Program consists of two major items, definitions and statements.

Definitions are used to define constants, variables and functions to be used by statements.

A simple ULP could look like this:

```
#usage "Add the characters in the word 'Hello'\n"
      "Usage: RUN sample.ulp"
// Definitions:
string hello = "Hello";
int count(string s)
{
    int c = 0;
    for (int i = 0; s[i]; ++i)
        c += s[i];
    return c;
}
// Statements:
output("sample") {
    printf("Count is: %d\n", count(hello));
}
```

If the `#usage` directive is present, its value will be used in the Control Panel to display a description of the program.

If the result of the ULP shall be a specific command that shall be executed in the editor window, the `exit()` function can be used to send that command to the editor window.

## Executing a ULP

User Language Programs are executed by the RUN command from an editor window's command line.

A ULP can return information on whether it has run successfully or not. You can use the exit() function to terminate the program and set the return value.

A return value of 0 means the ULP has ended "normally" (i.e. successfully), while any other value is considered as an abnormal program termination.

The default return value of any ULP is 0.

When the RUN command is executed as part of a script file, the script is terminated if the ULP has exited with a return value other than 0.

A special variant of the exit() function can be used to send a command to the editor window as a result of the ULP.

## Syntax

The basic building blocks of a User Language Program are

- Whitespace
- Comments
- Directives
- Keywords
- Identifiers
- Constants
- Punctuators

All of these have to follow certain syntactical rules, which are described in their respective sections.

## Whitespace

Before a User Language Program can be executed, it has to be read in from a file. During this read in process, the file contents is *parsed* into tokens and *whitespace*.

Any spaces (blanks), tabs, newline characters and comments are considered *whitespace* and are discarded.

The only place where ASCII characters representing *whitespace* are not discarded is within literal strings, like in

```
string s = "Hello World";
```

where the blank character between 'o' and 'W' remains part of the string.

If the final newline character of a line is preceded by a backslash (\), the backslash and newline character are both discarded, and the two lines are treated as one line:

```
"Hello \  
World"
```

is parsed as "Hello World"

## Comments

When writing a User Language Program it is good practice to add some descriptive text, giving the reader an idea about what this particular ULP does. You might also want to add your name (and, if available, your email address) to the ULP file, so that other people who use your program could contact you in case they have a problem or would like to suggest an improvement.

There are two ways to define a comment. The first one uses the syntax

```
/* some comment text */
```

which marks any characters between (and including) the opening `/*` and the closing `*/` as comment. Such comments may expand over more than one lines, as in

```
/* This is a  
   multi line comment  
*/
```

but they do not nest. The first `*/` that follows any `/*` will end the comment.

The second way to define a comment uses the syntax

```
int i; // some comment text
```

which marks any characters after (and including) the `//` and up to (but not including) the newline character at the end of the line as comment.

## Directives

The following *directives* are available:

```
#include  
#require  
#usage
```

### #include

A User Language Program can reuse code in other ULP files through the `#include` directive. The syntax is

```
#include "filename"
```

The file `filename` is first looked for in the same directory as the current source file (that is the file that contains the `#include` directive). If it is not found there, it is searched for in the directories contained in the ULP directory path.

The maximum include depth is 10.

Each `#include` directive is processed only **once**. This makes sure that there are no multiple definitions of the same variables or functions, which would cause errors.

## Portability note



If *filename* contains a directory path, it is best to always use the **forward slash** as directory separator (even under Windows!). Windows drive letters should be avoided. This way a User Language Program will run on all platforms.

## #require

Over time it may happen that newer versions of EAGLE implement new or modified User Language features, which can cause error messages when such a ULP is run from an older version of EAGLE. In order to give the user a dedicated message that this ULP requires at least a certain version of EAGLE, a ULP can contain the `#require` directive. The syntax is `#require version`

The *version* must be given as a real constant of the form

```
V.RRrr
```

where V is the version number, RR is the release number and rr is the (optional) revision number (both padded with leading zeroes if they are less than 10). For example, if a ULP requires at least EAGLE version 4.11r06 (which is the beta version that first implemented the `#require` directive), it could use

```
#require 4.1106
```

The proper directive for version 5.1.2 would be

```
#require 5.0102
```

## #usage

Every User Language Program should contain information about its function, how to use it and maybe who wrote it.

The directive

```
#usage text [, text...]
```

implements a standard way to make this information available.

If the `#usage` directive is present, its *text* (which has to be a string constant) will be used in the Control Panel to display a description of the program.

In case the ULP needs to use this information in, for example, a `dlgMessageBox()`, the *text* is available to the program through the builtin constant `usage`.

Only the `#usage` directive of the main program file (that is the one started with the RUN command) will take effect. Therefore pure include files can (and should!) also have `#usage` directives of their own.

It is best to have the `#usage` directive at the beginning of the file, so that the Control Panel doesn't have to parse all the rest of the text when looking for the information to display.



If the usage information shall be made available in several languages, the texts of the individual languages have to be separated by commas. Each of these texts has to start with the two letter code of the respective language (as delivered by the `language()` function), followed by a colon and any number of blanks. If no suitable text is found for the language used on the actual system, the first given text will be used (this one should generally be English in order to make the program accessible to the largest number of users).

## Example

```
#usage "en: A sample ULP\n"
      "Implements an example that shows how to use the EAGLE User
Language\n"
      "Usage: RUN sample.ulp\n"
      "Author: john@home.org",
"de: Beispiel eines ULPs\n"
      "Implementiert ein Beispiel das zeigt, wie man die EAGLE User
Language benutzt\n"
      "Aufruf: RUN sample.ulp\n"
      "Author: john@home.org"
```

## Keywords

The following *keywords* are reserved for special purposes and must not be used as normal identifier names:

break  
case  
char  
continue  
default  
do  
else  
enum  
for  
if  
int  
numeric  
real  
return  
string  
switch  
void  
while

In addition, the names of builtins and object types are also reserved and must not be used as identifier names.

## Identifiers

An *identifier* is a name that is used to introduce a user defined constant, variable or function.

Identifiers consist of a sequence of letters (a b c..., A B C...), digits (1 2 3...) and underscores (\_). The first character of an identifier **must** be a letter or an underscore.

Identifiers are case-sensitive, which means that

```
int Number, number;
```

would define two **different** integer variables.

The maximum length of an identifier is 100 characters, and all of these are significant.

## Constants

Constants are literal data items written into a User Language Program. According to the different data types, there are also different types of constants.

- Character constants
- Integer constants
- Real constants
- String constants

### Character Constants

A *character constant* consists of a single character or an escape sequence enclosed in single quotes, like

```
'a'  
'='  
'\n'
```

The type of a character constant is char.

### Integer Constants

Depending on the first (and possibly the second) character, an *integer constant* is assumed to be expressed in different base values:

first	second	constant interpreted as
0	1-7	octal (base 8)
0	x, X	hexadecimal (base 16)
1-9		decimal (base 10)

The type of an integer constant is int.

### Examples

```
16      decimal  
020     octal  
0x10    hexadecimal
```

### Real Constants

A *real constant* follows the general pattern

```
[ - ] int . frac [ e | E [ ± ] exp ]
```

which stands for

- optional sign
- decimal integer
- decimal point
- decimal fraction
- e or E and a signed integer exponent

You can omit either the decimal integer or the decimal fraction (but not both). You can omit either the decimal point or the letter e or E and the signed integer exponent (but not both).

The type of a real constant is real.

## Examples

Constant	Value
23.45e6	$23.45 \times 10^6$
.0	0.0
0.	0.0
1.	1.0
-1.23	-1.23
2e-5	$2.0 \times 10^{-5}$
3E+10	$3.0 \times 10^{10}$
.09E34	$0.09 \times 10^{34}$

## String Constants

A *string constant* consists of a sequence of characters or escape sequences enclosed in double quotes, like

```
"Hello world\n"
```

The type of a string constant is string.

String constants can be of any length (provided there is enough free memory available).

String constants can be concatenated by simply writing them next to each other to form larger strings:

```
string s = "Hello" " world\n";
```

It is also possible to extend a string constant over more than one line by escaping the newline character with a backslash (\):

```
string s = "Hello \n\nworld\n";
```

## Escape Sequences

An *escape sequence* consists of a backslash (\), followed by one or more special characters:

Sequence	Value
----------	-------

<code>\a</code>	audible bell
<code>\b</code>	backspace
<code>\f</code>	form feed
<code>\n</code>	new line
<code>\r</code>	carriage return
<code>\t</code>	horizontal tab
<code>\v</code>	vertical tab
<code>\\</code>	backslash
<code>\'</code>	single quote
<code>\"</code>	double quote
<code>\0</code>	0 = up to 3 octal digits
<code>\xH</code>	H = up to 2 hex digits

Any character following the initial backslash that is not mentioned in this list will be treated as that character (without the backslash).

Escape sequences can be used in character constants and string constants.

## Examples

```
'\n'  
"A tab\tinside a text\n"  
"Ring the bell\a\n"
```

## Punctuators

The *punctuators* used in a User Language Program are

```
[ ] Brackets  
( ) Parentheses  
{ } Braces  
, Comma  
; Semicolon  
: Colon  
= Equal sign
```

Other special characters are used as operators in a ULP.

## Brackets

*Brackets* are used in array definitions

```
int ai[];
```

in array subscripts

```
n = ai[2];
```

and in string subscripts to access the individual characters of a string

```
string s = "Hello world";
```

```
char c = s[2];
```

## Parentheses

*Parentheses* group expressions (possibly altering normal operator precedence), isolate conditional expressions, and indicate function calls and function parameters:

```
d = c * (a + b);
if (d == z) ++x;
func();
void func2(int n) { ... }
```

## Braces

*Braces* indicate the start and end of a compound statement:

```
if (d == z) {
    ++x;
    func();
}
```

and are also used to group the values of an array initializer:

```
int ai[] = { 1, 2, 3 };
```

## Comma

The *comma* separates the elements of a function argument list or the parameters of a function call:

```
int func(int n, real r, string s) { ... }
int i = func(1, 3.14, "abc");
```

It also delimits the values of an array initializer:

```
int ai[] = { 1, 2, 3 };
```

and it separates the elements of a variable definition:

```
int i, j, k;
```

## Semicolon

The *semicolon* terminates a statement, as in

```
i = a + b;
```

and it also delimits the init, test and increment expressions of a for statement:

```
for (int n = 0; n < 3; ++n) {
    func(n);
}
```

## Colon

The *colon* indicates the end of a label in a switch statement:

```
switch (c) {
  case 'a': printf("It was an 'a'\n"); break;
  case 'b': printf("It was a 'b'\n"); break;
  default: printf("none of them\n");
}
```

## Equal Sign

The *equal sign* separates variable definitions from initialization lists:

```
int i = 10;
char c[] = { 'a', 'b', 'c' };
```

It is also used as an assignment operator.

## Data Types

A User Language Program can define variables of different types, representing the different kinds of information available in the EAGLE data structures.

The four basic data types are

<u>char</u>	for single characters
<u>int</u>	for integral values
<u>real</u>	for floating point values
<u>string</u>	for textual information

Besides these basic data types there are also high level Object Types, which represent the data structures stored in the EAGLE data files.

The special data type `void` is used only as a return type of a function, indicating that this function does **not** return any value.

### char

The data type `char` is used to store single characters, like the letters of the alphabet, or small unsigned numbers.

A variable of type `char` has a size of 8 bit (one byte), and can store any value in the range 0 . . 255.

See also Operators, Character Constants

### int

The data type `int` is used to store signed integral values, like the coordinates of an object.

A variable of type `int` has a size of 32 bit (four byte), and can store any value in the range -2147483648 . . 2147483647.

See also [Integer Constants](#)

## real

The data type `real` is used to store signed floating point values, like the grid distance.

A variable of type `real` has a size of 64 bit (eight byte), and can store any value in the range  $\pm 2.2e-308$  . .  $\pm 1.7e+308$  with a precision of 15 digits.

See also [Real Constants](#)

## string

The data type `string` is used to store textual information, like the name of a part or net.

A variable of type `string` is not limited in its size (provided there is enough memory available).

Variables of type `string` are defined without an explicit *size*. They grow automatically as necessary during program execution.

The elements of a `string` variable are of type `char` and can be accessed individually by using `[index]`. The first character of a `string` has the index 0:

```
string s = "Layout";
printf("Third char is: %c\n", s[2]);
```

This would print the character 'y'. Note that `s[2]` returns the **third** character of `s`!

See also [Operators](#), [Builtin Functions](#), [String Constants](#)

## Implementation details

The data type `string` is actually implemented like native C-type zero terminated strings (i.e. `char[]`). Looking at the following variable definition

```
string s = "abcde";
```

`s[4]` is the character 'e', and `s[5]` is the character '\0', or the integer value `0x00`. This fact may be used to determine the end of a string without using the `strlen()` function, as in

```
for (int i = 0; s[i]; ++i) {
    // do something with s[i]
}
```

It is also perfectly ok to "cut off" part of a string by "punching" a zero character into it:

```
string s = "abcde";
s[3] = 0;
```

This will result in `s` having the value "abc". Note that everything following the zero character will actually be gone, and it won't come back by restoring the original character. The same applies to any other operation that sets a character to 0, for instance `--s[3]`.

## Type Conversions

The result type of an arithmetic expression, such as  $a + b$ , where  $a$  and  $b$  are different arithmetic types, is equal to the "larger" of the two operand types.

Arithmetic types are char, int and real (in that order). So if, e.g.  $a$  is of type int and  $b$  is of type real, the result of the expression  $a + b$  would be real.

See also Typecast

## Typecast

The result type of an arithmetic expression can be explicitly converted to a different arithmetic type by applying a *typecast* to it.

The general syntax of a typecast is

```
type(expression)
```

where *type* is one of char, int or real, and *expression* is any arithmetic expression.

When typecasting a real expression to int, the fractional part of the value is truncated!

See also Type Conversions

## Object Types

The EAGLE data structures are stored in three binary file types:

- Library (\*.lbr)
- Schematic (\*.sch)
- Board (\*.brd)

These data files contain a hierarchy of objects. In a User Language Program you can access these hierarchies through their respective builtin access statements:

```
library(L) { ... }  
schematic(S) { ... }  
board(B) { ... }
```

These access statements set up a context within which you can access all of the objects contained in the library, schematic or board.

The properties of these objects can be accessed through *members*.

There are two kinds of members:

- Data members
- Loop members

**Data members** immediately return the requested data from an object. For example, in

```
board(B) {  
    printf("%s\n", B.name);  
}
```



the data member *name* of the board object *B* returns the board's name. Data members can also return other objects, as in

```
board(B) {
  printf("%f\n", B.grid.size);
}
```

where the board's *grid* data member returns a grid object, of which the *size* data member then returns the grid's size.

**Loop members** are used to access multiple objects of the same kind, which are contained in a higher level object:

```
board(B) {
  B.elements(E) {
    printf("%-8s %-8s\n", E.name, E.value);
  }
}
```

This example uses the board's *elements()* loop member function to set up a loop through all of the board's elements. The block following the *B.elements(E)* statement is executed in turn for each element, and the current element can be referenced inside the block through the name *E*.

Loop members process objects in alpha-numerical order, provided they have a name.

A loop member function creates a variable of the type necessary to hold the requested objects. You are free to use any valid name for such a variable, so the above example might also be written as

```
board(MyBoard) {
  MyBoard.elements(TheCurrentElement) {
    printf("%-8s %-8s\n", TheCurrentElement.name, TheCurrentElement.value);
  }
}
```

and would do the exact same thing. The scope of the variable created by a loop member function is limited to the statement (or block) immediately following the loop function call.

Object hierarchy of a Library:

```
LIBRARY
  GRID
  LAYER
  DEVICESET
    DEVICE
    GATE
  PACKAGE
    CONTACT
      PAD
      SMD
    CIRCLE
    HOLE
    RECTANGLE
    FRAME
    TEXT
    WIRE
```

POLYGON  
WIRE  
SYMBOL  
PIN  
CIRCLE  
RECTANGLE  
FRAME  
TEXT  
WIRE  
POLYGON  
WIRE

## Object hierarchy of a Schematic:

SCHEMATIC  
GRID  
LAYER  
LIBRARY  
SHEET  
CIRCLE  
RECTANGLE  
FRAME  
TEXT  
WIRE  
POLYGON  
WIRE  
PART  
INSTANCE  
ATTRIBUTE  
BUS  
SEGMENT  
LABEL  
TEXT  
WIRE  
WIRE  
NET  
SEGMENT  
JUNCTION  
PINREF  
TEXT  
WIRE

## Object hierarchy of a Board:

BOARD  
GRID  
LAYER  
LIBRARY  
CIRCLE  
HOLE  
RECTANGLE  
FRAME  
TEXT  
WIRE  
POLYGON  
WIRE  
ELEMENT  
ATTRIBUTE  
SIGNAL

CONTACTREF  
POLYGON  
WIRE  
VIA  
WIRE

## UL\_ARC

### Data members

angle1 real (start angle, 0.0...359.9)  
angle2 real (end angle, 0.0...719.9)  
cap int (CAP\_...)  
layer int  
radius int  
width int  
x1, y1 int (starting point)  
x2, y2 int (end point)  
xc, yc int (center point)

See also UL\_WIRE

### Constants

CAP\_FLAT flat arc ends  
CAP\_ROUND round arc ends

### Note

Start and end angles are defined mathematically positive (i.e. counterclockwise), with  $\text{angle1} < \text{angle2}$ . In order to assure this condition, the start and end point of an UL\_ARC may be exchanged with respect to the UL\_WIRE the arc has been derived from.

### Example

```
board(B) {
  B.wires(W) {
    if (W.arc)
      printf("Arc: (%d %d), (%d %d), (%d %d)\n",
             W.arc.x1, W.arc.y1, W.arc.x2, W.arc.y2, W.arc.xc, W.arc.yc);
  }
}
```

## UL\_AREA

### Data members

x1, y1 int (lower left corner)  
x2, y2 int (upper right corner)

See also UL\_BOARD, UL\_DEVICE, UL\_PACKAGE, UL\_SHEET, UL\_SYMBOL

A `UL_AREA` is an abstract object which gives information about the area covered by an object. For a `UL_DEVICE`, `UL_PACKAGE` and `UL_SYMBOL` the area is defined as the surrounding rectangle of the object definition in the library, so even if e.g. a `UL_PACKAGE` is derived from a `UL_ELEMENT`, the package's area will not reflect the elements offset within the board.

### Example

```
board(B) {
    printf("Area: (%d %d), (%d %d)\n",
          B.area.x1, B.area.y1, B.area.x2, B.area.y2);
}
```

## UL\_ATTRIBUTE

### Data members

constant	<u>int</u> (0=variable, i.e. allows overwriting, 1=constant - see note)
defaultvalue	<u>string</u> (see note)
display	<u>int</u> ( <code>ATTRIBUTE_DISPLAY_FLAG_...</code> )
name	<u>string</u>
text	<u>UL_TEXT</u> (see note)
value	<u>string</u>

See also UL\_DEVICE, UL\_PART, UL\_INSTANCE, UL\_ELEMENT

### Constants

<code>ATTRIBUTE_DISPLAY_FLAG_OFF</code>	nothing is displayed
<code>ATTRIBUTE_DISPLAY_FLAG_VALUE</code>	value is displayed
<code>ATTRIBUTE_DISPLAY_FLAG_NAME</code>	name is displayed

A `UL_ATTRIBUTE` can be used to access the *attributes* that have been defined in the library for a device, or assigned to a part in the schematic or board.

### Note

`display` contains a bitwise or'ed value consisting of `ATTRIBUTE_DISPLAY_FLAG_...` and defines which parts of the attribute are actually drawn. This value is only valid if `display` is used in a `UL_INSTANCE` or `UL_ELEMENT` context.

In a `UL_ELEMENT` context `constant` only returns an actual value if f/b annotation is active, otherwise it returns 0.

The `defaultvalue` member returns the value as defined in the library (if different from the actual value, otherwise the same as `value`). In a `UL_ELEMENT` context `defaultvalue` only returns an actual value if f/b annotation is active, otherwise an empty string is returned.

The `text` member is only available in a `UL_INSTANCE` or `UL_ELEMENT` context and

returns a `UL_TEXT` object that contains all the text parameters. The value of this text object is the string as it will be displayed according to the `UL_ATTRIBUTE`'s 'display' parameter. If called from a different context, the data of the returned `UL_TEXT` object is undefined.

For global attributes only `name` and `value` are defined.

### Example

```
schematic(SCH) {
  SCH.parts(P) {
    P.attributes(A) {
      printf("%s = %s\n", A.name, A.value);
    }
  }
}
schematic(SCH) {
  SCH.attributes(A) { // global attributes
    printf("%s = %s\n", A.name, A.value);
  }
}
```

## UL\_BOARD

### Data members

`area`    [UL\\_AREA](#)  
`grid`    [UL\\_GRID](#)  
`name`    [string](#) (see note)

### Loop members

`attributes()`    [UL\\_ATTRIBUTE](#) (see note)  
`circles()`        [UL\\_CIRCLE](#)  
`classes()`        [UL\\_CLASS](#)  
`elements()`       [UL\\_ELEMENT](#)  
`frames()`         [UL\\_FRAME](#)  
`holes()`          [UL\\_HOLE](#)  
`layers()`         [UL\\_LAYER](#)  
`libraries()`      [UL\\_LIBRARY](#)  
`polygons()`      [UL\\_POLYGON](#)  
`rectangles()`    [UL\\_RECTANGLE](#)  
`signals()`        [UL\\_SIGNAL](#)  
`texts()`          [UL\\_TEXT](#)  
`wires()`          [UL\\_WIRE](#)

See also [UL\\_LIBRARY](#), [UL\\_SCHEMATIC](#)

### Note

The `name` member returns the full file name, including the directory.

The `attributes()` loop member loops through the *global* attributes.

**Example**

```
board(B) {
  B.elements(E) printf("Element: %s\n", E.name);
  B.signals(S) printf("Signal: %s\n", S.name);
}
```

**UL\_BUS****Data members**

name string (BUS\_NAME\_LENGTH)

**Loop members**

segments() UL\_SEGMENT

See also UL\_SHEET

**Constants**

BUS\_NAME\_LENGTH max. length of a bus name (obsolete - as from version 4 bus names  
TH can have any length)

**Example**

```
schematic(SCH) {
  SCH.sheets(SH) {
    SH.busses(B) printf("Bus: %s\n", B.name);
  }
}
```

**UL\_CIRCLE****Data members**

layer int  
radius int  
width int  
x, y int (center point)

See also UL\_BOARD, UL\_PACKAGE, UL\_SHEET, UL\_SYMBOL

**Example**

```
board(B) {
  B.circles(C) {
    printf("Circle: (%d %d), r=%d, w=%d\n",
          C.x, C.y, C.radius, C.width);
  }
}
```

**UL\_CLASS****Data members**

clearance[number] int (see note)

drill	<u>int</u>
name	<u>string</u> (see note)
number	<u>int</u>
width	<u>int</u>

See also [Design Rules](#), [UL\\_NET](#), [UL\\_SIGNAL](#), [UL\\_SCHEMATIC](#), [UL\\_BOARD](#)

## Note

The `clearance` member returns the clearance value between this net class and the net class with the given number. If the number (and the square brackets) is omitted, the net class's own clearance value is returned. If a number is given, it must be between 0 and the number of this net class.

If the `name` member returns an empty string, the net class is not defined and therefore not in use by any signal or net.

## Example

```
board(B) {
  B.signals(S) {
    printf("%-10s %d %s\n", S.name, S.class.number, S.class.name);
  }
}
```

## UL\_CONTACT

### Data members

name	<u>string</u> (CONTACT_NAME_LENGTH)
pad	<u>UL_PAD</u>
signal	<u>string</u>
smd	<u>UL_SMD</u>
x, y	<u>int</u> (center point, see note)

See also [UL\\_PACKAGE](#), [UL\\_PAD](#), [UL\\_SMD](#), [UL\\_CONTACTREF](#), [UL\\_PINREF](#)

### Constants

CONTACT_NAME_LENGTH	max. recommended length of a contact name (used in formatted output only)
---------------------	---------------------------------------------------------------------------

## Note

The `signal` data member returns the signal this contact is connected to (only available in a board context).

The coordinates (`x`, `y`) of the contact depend on the context in which it is called:

- if the contact is derived from a `UL_LIBRARY` context, the coordinates of the contact will be the same as defined in the package drawing
- in all other cases, they will have the actual values from the board

**Example**

```
library(L) {
  L.packages(PAC) {
    PAC.contacts(C) {
      printf("Contact: '%s', (%d %d)\n",
            C.name, C.x, C.y);
    }
  }
}
```

**UL\_CONTACTREF****Data members**

contact     UL\_CONTACT  
 element    UL\_ELEMENT

See also UL\_SIGNAL, UL\_PINREF

**Example**

```
board(B) {
  B.signals(S) {
    printf("Signal '%s'\n", S.name);
    S.contactrefs(C) {
      printf("\t%s, %s\n", C.element.name, C.contact.name);
    }
  }
}
```

**UL\_DEVICE****Data members**

area                 UL\_AREA  
 description        string  
 headline            string  
 library             string  
 name                string (DEVICE\_NAME\_LENGTH)  
 package             UL\_PACKAGE (see note)  
 prefix              string (DEVICE\_PREFIX\_LENGTH)  
 technologies        string (see note)  
 value               string ("On" or "Off")

**Loop members**

attributes()        UL\_ATTRIBUTE (see note)  
 gates()             UL\_GATE

See also UL\_DEVICESET, UL\_LIBRARY, UL\_PART

**Constants**

DEVICE\_NAME\_LENGTH   max. recommended length of a device name (used in formatted output only)



**DEVICE\_PREFIX\_LENGTH** max. recommended length of a device prefix (used in formatted output only)

All members of `UL_DEVICE`, except for `name` and `technologies`, return the same values as the respective members of the `UL_DEVICESET` in which the `UL_DEVICE` has been defined. The `name` member returns the name of the package variant this device has been created for using the `PACKAGE` command. When using the `description` text keep in mind that it may contain newline characters (`'\n'`).

## Note

The `package` data member returns the `package` that has been assigned to the device through a `PACKAGE` command. It can be used as a boolean function to check whether a package has been assigned to a device (see example below).

The value returned by the `technologies` member depends on the context in which it is called:

- if the device is derived from a `UL_DEVICESET`, `technologies` will return a string containing all of the device's technologies, separated by blanks
- if the device is derived from a `UL_PART`, only the actual technology used by the part will be returned.

The `attributes()` loop member takes an additional parameter that specifies for which technology the attributes shall be delivered (see the second example below).

## Examples

```
library(L) {
  L.devicesets(S) {
    S.devices(D) {
      if (D.package)
        printf("Device: %s, Package: %s\n", D.name, D.package.name);
      D.gates(G) {
        printf("\t%s\n", G.name);
      }
    }
  }
}
```

```
library(L) {
  L.devicesets(DS) {
    DS.devices(D) {
      string t[];
      int n = strsplit(t, D.technologies, ' ');
      for (int i = 0; i < n; i++) {
        D.attributes(A, t[i]) {
          printf("%s = %s\n", A.name, A.value);
        }
      }
    }
  }
}
```

## UL\_DEVICESET

### Data members

area	<u>UL_AREA</u>
description	<u>string</u>
headline	<u>string</u> (see note)
library	<u>string</u>
name	<u>string</u> (DEVICE_NAME_LENGTH)
prefix	<u>string</u> (DEVICE_PREFIX_LENGTH)
value	<u>string</u> ("On" or "Off")

### Loop members

devices()	<u>UL_DEVICE</u>
gates()	<u>UL_GATE</u>

See also UL\_DEVICE, UL\_LIBRARY, UL\_PART

### Constants

DEVICE_NAME_LENGTH	max. recommended length of a device name (used in formatted output only)
DEVICE_PREFIX_LENGTH	max. recommended length of a device prefix (used in formatted output only)

### Note

The `description` member returns the complete descriptive text as defined with the DESCRIPTION command, while the `headline` member returns only the first line of the description, without any HTML tags. When using the `description` text keep in mind that it may contain newline characters ('`\n`').

### Example

```
library(L) {
  L.devicesets(D) {
    printf("Device set: %s, Description: %s\n", D.name, D.description);
    D.gates(G) {
      printf("\t%s\n", G.name);
    }
  }
}
```

## UL\_ELEMENT

### Data members

angle	<u>real</u> (0.0...359.9)
attribute[]	<u>string</u> (see note)
column	<u>string</u> (see note)
locked	<u>int</u>
mirror	<u>int</u>

name	<u>string</u> (ELEMENT_NAME_LENGTH)
package	<u>UL_PACKAGE</u>
row	<u>string</u> (see note)
smashed	<u>int</u> (see note)
spin	<u>int</u>
value	<u>string</u> (ELEMENT_VALUE_LENGTH)
x, y	<u>int</u> (origin point)

**Loop members**

attributes()	<u>UL_ATTRIBUTE</u>
texts()	<u>UL_TEXT</u> (see note)

See also UL\_BOARD, UL\_CONTACTREF

**Constants**

ELEMENT_NAME_LENGTH	max. recommended length of an element name (used in formatted output only)
ELEMENT_VALUE_LENGTH	max. recommended length of an element value (used in formatted output only)

**Note**

The `attribute[]` member can be used to query a `UL_ELEMENT` for the value of a given attribute (see the second example below). The returned string is empty if there is no attribute by the given name, or if this attribute is explicitly empty.

The `texts()` member only loops through those texts of the element that have been detached using **SMASH**, and through the visible texts of any attributes assigned to this element. To process all texts of an element (e.g. when drawing it), you have to loop through the element's own `texts()` member as well as the `texts()` member of the element's package.

`angle` defines how many degrees the element is rotated counterclockwise around its origin.

The `column()` and `row()` members return the column and row location within the frame in the board drawing. If there is no frame in the drawing, or the element is placed outside the frame, a '?' (question mark) is returned.

The `smashed` member tells whether the element is smashed. This function can also be used to find out whether there is a detached text parameter by giving the name of that parameter in square brackets, as in `smashed["VALUE"]`. This is useful in case you want to select such a text with the MOVE command by doing `MOVE R5>VALUE`. Valid parameter names are "NAME" and "VALUE", as well as the names of any user defined attributes. They are treated case insensitive, and they may be preceded by a '>' character.

**Examples**

```
board(B) {
  B.elements(E) {
    printf("Element: %s, (%d %d), Package=%s\n",
```

```

        E.name, E.x, E.y, E.package.name);
    }
}

board(B) {
    B.elements(E) {
        if (E.attribute["REMARK"])
            printf("%s: %s\n", E.name, E.attribute("REMARK"));
    }
}

```

## UL\_FRAME

### Data members

columns    int (-127...127)  
 rows        int (-26...26)  
 border      int (FRAME\_BORDER\_...)  
 layer       int  
 x1, y1      int (lower left corner)  
 x2, y2      int (upper right corner)

### Loop members

texts()     UL\_TEXT  
 wires()     UL\_WIRE

See also UL\_BOARD, UL\_PACKAGE, UL\_SHEET, UL\_SYMBOL

### Constants

FRAME_BORDER_BOTTOM	bottom border is drawn
FRAME_BORDER_RIGHT	right border is drawn
FRAME_BORDER_TOP	top border is drawn
FRAME_BORDER_LEFT	left border is drawn

### Note

border contains a bitwise or'ed value consisting of FRAME\_BORDER\_... and defines which of the four borders are actually drawn.

The texts() and wires() loop members loop through all the texts and wires the frame consists of.

### Example

```

board(B) {
    B.frames(F) {
        printf("Frame: (%d %d), (%d %d)\n",
            F.x1, F.y1, F.x2, F.y2);
    }
}

```

## UL\_GATE

### Data members

addlevel     int (GATE\_ADDLEVEL\_...)  
 name         string (GATE\_NAME\_LENGTH)  
 swaplevel    int  
 symbol       UL\_SYMBOL  
 x, y         int (origin point, see note)

See also [UL\\_DEVICE](#)

### Constants

GATE\_ADDLEVEL\_MUST     must  
 GATE\_ADDLEVEL\_CAN     can  
 GATE\_ADDLEVEL\_NEXT    next  
 GATE\_ADDLEVEL\_REQUEST request  
 GATE\_ADDLEVEL\_ALWAYS  always  
 GATE\_NAME\_LENGTH     max. recommended length of a gate name (used in formatted  
 H                     output only)

### Note

The coordinates of the origin point (x, y) are always those of the gate's position within the device, even if the UL\_GATE has been derived from a [UL\\_INSTANCE](#).

### Example

```

library(L) {
  L.devices(D) {
    printf("Device: %s, Package: %s\n", D.name, D.package.name);
    D.gates(G) {
      printf("\t%s, swaplevel=%d, symbol=%s\n",
            G.name, G.swaplevel, G.symbol.name);
    }
  }
}

```

## UL\_GRID

### Data members

distance     real  
 dots         int (0=lines, 1=dots)  
 multiple     int  
 on            int (0=off, 1=on)  
 unit         int (GRID\_UNIT...)  
 unitdist     int (GRID\_UNIT...)

See also [UL\\_BOARD](#), [UL\\_LIBRARY](#), [UL\\_SCHEMATIC](#), [Unit Conversions](#)

**Constants**

GRID_UNIT_MIC	microns
GRID_UNIT_MM	millimeter
GRID_UNIT_MIL	mil
GRID_UNIT_INCH	inch

**Note**

`unitdist` returns the grid unit that was set to define the actual grid size (returned by `distance`), while `unit` returns the grid unit that is used to display values or interpret user input.

**Example**

```
board(B) {
    printf("Gridsize=%f\n", B.grid.distance);
}
```

**UL\_HOLE****Data members**

<code>diameter[layer]</code>	<u>int</u> (see note)
<code>drill</code>	<u>int</u>
<code>drillsymbol</code>	<u>int</u>
<code>x, y</code>	<u>int</u> (center point)

See also [UL\\_BOARD](#), [UL\\_PACKAGE](#)

**Note**

`diameter[]` is only defined for layers `LAYER_TSTOP` and `LAYER_BSTOP` and returns the diameter of the solder stop mask in the given layer.

`drillsymbol` returns the number of the drill symbol that has been assigned to this drill diameter (see the manual for a list of defined drill symbols). A value of 0 means that no symbol has been assigned to this drill diameter.

**Example**

```
board(B) {
    B.holes(H) {
        printf("Hole: (%d %d), drill=%d\n",
            H.x, H.y, H.drill);
    }
}
```

**UL\_INSTANCE****Data members**

<code>angle</code>	<u>real</u> (0, 90, 180 and 270)
--------------------	----------------------------------

column	<u>string</u> (see note)
gate	<u>UL_GATE</u>
mirror	<u>int</u>
name	<u>string</u> (INSTANCE_NAME_LENGTH)
row	<u>string</u> (see note)
sheet	<u>int</u> (0=unused, >0=sheet number)
smashed	<u>int</u> (see note)
value	<u>string</u> (PART_VALUE_LENGTH)
x, y	<u>int</u> (origin point)

**Loop members**

attributes()	<u>UL_ATTRIBUTE</u> (see note)
texts()	<u>UL_TEXT</u> (see note)
xrefs()	<u>UL_GATE</u> (see note)

See also UL\_PART, UL\_PINREF

**Constants**

INSTANCE_NAME_LEN	max. recommended length of an instance name (used in
GTH	formatted output only)
PART_VALUE_LENGTH	max. recommended length of a part value (instances do not have
	a value of their own!)

**Note**

The `attributes()` member only loops through those attributes that have been explicitly assigned to this instance (including *smashed* attributes).

The `texts()` member only loops through those texts of the instance that have been detached using **SMASH**, and through the visible texts of any attributes assigned to this instance. To process all texts of an instance, you have to loop through the instance's own `texts()` member as well as the `texts()` member of the instance's gate's symbol. If attributes have been assigned to an instance, `texts()` delivers their texts in the form as they are currently visible.

The `column()` and `row()` members return the column and row location within the frame on the sheet on which this instance is invoked. If there is no frame on that sheet, or the instance is placed outside the frame, a '?' (question mark) is returned. These members can only be used in a sheet context.

The `smashed` member tells whether the instance is smashed. This function can also be used to find out whether there is a detached text parameter by giving the name of that parameter in square brackets, as in `smashed["VALUE"]`. This is useful in case you want to select such a text with the MOVE command by doing `MOVE R5>VALUE`. Valid parameter names are "NAME", "VALUE", "PART" and "GATE", as well as the names of any user defined attributes. They are treated case insensitive, and they may be preceded by a '>' character.

The `xrefs()` member loops through the contact cross-reference gates of this instance. These are only of importance if the ULP is going to create a drawing of some sort (for instance a DXF file).

**Example**

```
schematic(S) {
  S.parts(P) {
    printf("Part: %s\n", P.name);
    P.instances(I) {
      if (I.sheet != 0)
        printf("\t%s used on sheet %d\n", I.name, I.sheet);
    }
  }
}
```

**UL\_JUNCTION****Data members**

diameter    int  
 x, y        int (center point)

See also UL\_SEGMENT

**Example**

```
schematic(SCH) {
  SCH.sheets(SH) {
    SH.nets(N) {
      N.segments(SEG) {
        SEG.junctions(J) {
          printf("Junction: (%d %d)\n", J.x, J.y);
        }
      }
    }
  }
}
```

**UL\_LABEL****Data members**

angle        real (0.0...359.9)  
 layer        int  
 mirror       int  
 spin         int  
 text         UL\_TEXT  
 x, y         int (origin point)  
 xref         int (0=plain, 1=cross-  
               reference)

**Loop members**

wires()      UL\_WIRE (see note)

See also UL\_SEGMENT

**Note**

If xref returns a non-zero value, the wires() loop member loops through the wires that



form the flag of a cross-reference label. Otherwise it is an empty loop.

The `angle`, `layer`, `mirror` and `spin` members always return the same values as those of the `UL_TEXT` object returned by the `text` member. The `x` and `y` members of the text return slightly offset values for cross-reference labels (non-zero `xref`), otherwise they also return the same values as the `UL_LABEL`.

`xref` is only meaningful for net labels. For bus labels it always returns 0.

### Example

```
sheet(SH) {
  SH.nets(N) {
    N.segments(S) {
      S.labels(L) {
        printf("Label: %d %d '%s'\n", L.x, L.y, L.text.value);
      }
    }
  }
}
```

## UL\_LAYER

### Data members

<code>color</code>	<code>int</code>
<code>fill</code>	<code>int</code>
<code>name</code>	<code>string</code> (LAYER_NAME_LENGTH)
<code>number</code>	<code>int</code>
<code>used</code>	<code>int</code> (0=unused, 1=used)
<code>visible</code>	<code>int</code> (0=off, 1=on)

See also [UL\\_BOARD](#), [UL\\_LIBRARY](#), [UL\\_SCHEMATIC](#)

### Constants

<code>LAYER_NAME_LEN</code>	max. recommended length of a layer name (used in formatted
<code>H</code>	output only)
<code>LAYER_TOP</code>	layer numbers
<code>LAYER_BOTTOM</code>	
<code>LAYER_PADS</code>	
<code>LAYER_VIAS</code>	
<code>LAYER_UNROUTED</code>	
<code>LAYER_DIMENSION</code>	
<code>LAYER_TPLACE</code>	
<code>LAYER_BPLACE</code>	
<code>LAYER_TORIGINS</code>	
<code>LAYER_BORIGINS</code>	
<code>LAYER_TNAMES</code>	
<code>LAYER_BNAMES</code>	
<code>LAYER_TVALUES</code>	

LAYER\_BVALUES  
LAYER\_TSTOP  
LAYER\_BSTOP  
LAYER\_TCREAM  
LAYER\_BCREAM  
LAYER\_TFINISH  
LAYER\_BFINISH  
LAYER\_TGLUE  
LAYER\_BGLUE  
LAYER\_TTEST  
LAYER\_BTEST  
LAYER\_TKEEPOUT  
LAYER\_BKEEPOUT  
LAYER\_TRESTRICT  
LAYER\_BRESTRICT  
LAYER\_VRESTRICT  
LAYER\_DRILLS  
LAYER\_HOLES  
LAYER\_MILLING  
LAYER\_MEASURES  
LAYER\_DOCUMENT  
LAYER\_REFERENCE  
LAYER\_TDOCU  
LAYER\_BDOCU  
LAYER\_NETS  
LAYER\_BUSSES  
LAYER\_PINS  
LAYER\_SYMBOLS  
LAYER\_NAMES  
LAYER\_VALUES  
LAYER\_INFO  
LAYER\_GUIDE  
LAYER\_USER                   lowest number for user defined layers (100)

### Example

```
board(B) {  
  B.layers(L) printf("Layer %3d %s\n", L.number, L.name);  
}
```

## UL\_LIBRARY

### Data members

description	<u>string</u> (see note)
grid	<u>UL_GRID</u>

headline        string  
 name            string (LIBRARY\_NAME\_LENGTH, see note)

**Loop members**

devices()        UL\_DEVICE  
 devicesets()    UL\_DEVICESET  
 layers()        UL\_LAYER  
 packages()      UL\_PACKAGE  
 symbols()       UL\_SYMBOL

See also UL\_BOARD, UL\_SCHEMATIC

**Constants**

LIBRARY\_NAME\_LEN    max. recommended length of a library name (used in formatted  
 TH                    output only)

The `devices()` member loops through all the package variants and technologies of all `UL_DEVICESETs` in the library, thus resulting in all the actual device variations available. The `devicesets()` member only loops through the `UL_DEVICESETs`, which in turn can be queried for their `UL_DEVICE` members.

**Note**

The `description` member returns the complete descriptive text as defined with the `DESCRIPTION` command, while the `headline` member returns only the first line of the description, without any `HTML` tags. When using the `description` text keep in mind that it may contain newline characters ('`\n`'). The `description` and `headline` information is only available within a library drawing, not if the library is derived from a `UL_BOARD` or `UL_SCHEMATIC` context.

If the library is derived from a `UL_BOARD` or `UL_SCHEMATIC` context, `name` returns the pure library name (without path or extension). Otherwise it returns the full library file name.

**Example**

```
library(L) {
  L.devices(D)        printf("Dev: %s\n", D.name);
  L.devicesets(D)    printf("Dev: %s\n", D.name);
  L.packages(P)      printf("Pac: %s\n", P.name);
  L.symbols(S)       printf("Sym: %s\n", S.name);
}
schematic(S) {
  S.libraries(L)     printf("Library: %s\n", L.name);
}
```

**UL\_NET****Data members**

class            UL\_CLASS  
 column          string (see note)

name        string (NET\_NAME\_LENGTH)  
 row        string (see note)

**Loop members**

pinrefs()    UL\_PINREF (see note)  
 segments()  UL\_SEGMENT (see note)

See also UL\_SHEET, UL\_SCHEMATIC

**Constants**

NET\_NAME\_LENGTH    max. recommended length of a net name (used in formatted output only)

**Note**

The pinrefs() loop member can only be used if the net is in a schematic context.  
 The segments() loop member can only be used if the net is in a sheet context.

The column() and row() members return the column and row locations within the frame on the sheet on which this net is drawn. Since a net can extend over a certain area, each of these functions returns two values, separated by a blank. In case of column() these are the left- and rightmost columns touched by the net, and in case of row() it's the top- and bottommost row. If there is no frame on that sheet, "? ?" (two question marks) is returned. If any part of the net is placed outside the frame, either of the values may be '?' (question mark). These members can only be used in a sheet context.

**Example**

```
schematic(S) {
  S.nets(N) {
    printf("Net: %s\n", N.name);
    // N.segments(SEG) will NOT work here!
  }
}
schematic(S) {
  S.sheets(SH) {
    SH.nets(N) {
      printf("Net: %s\n", N.name);
      N.segments(SEG) {
        SEG.wires(W) {
          printf("\tWire: (%d %d) (%d %d)\n",
                W.x1, W.y1, W.x2, W.y2);
        }
      }
    }
  }
}
```

**UL\_PACKAGE****Data members**

area                    UL\_AREA

```

description  string
headline     string
library      string
name         string (PACKAGE_NAME_LENGTH)

```

**Loop members**

```

circles()    UL_CIRCLE
contacts()   UL_CONTACT
frames()     UL_FRAME
holes()      UL_HOLE
polygons()   UL_POLYGON
rectangles() UL_RECTANGLE
texts()      UL_TEXT (see note)
wires()      UL_WIRE

```

See also UL\_DEVICE, UL\_ELEMENT, UL\_LIBRARY

**Constants**

```

PACKAGE_NAME_LENGTH  max. recommended length of a package name (used in formatted
TH                   output only)

```

**Note**

The `description` member returns the complete descriptive text as defined with the DESCRIPTION command, while the `headline` member returns only the first line of the description, without any HTML tags. When using the `description` text keep in mind that it may contain newline characters (`'\n'`).

If the `UL_PACKAGE` is derived from a `UL_ELEMENT`, the `texts()` member only loops through the non-detached texts of that element.

**Example**

```

library(L) {
  L.packages(PAC) {
    printf("Package: %s\n", PAC.name);
    PAC.contacts(C) {
      if (C.pad)
        printf("\tPad: %s, (%d %d)\n",
              C.name, C.pad.x, C.pad.y);
      else if (C.smd)
        printf("\tSmd: %s, (%d %d)\n",
              C.name, C.smd.x, C.smd.y);
    }
  }
}
board(B) {
  B.elements(E) {
    printf("Element: %s, Package: %s\n", E.name, E.package.name);
  }
}

```

## UL\_PAD

### Data members

angle	<u>real</u> (0.0...359.9)
diameter[layer]	<u>int</u>
drill	<u>int</u>
drillsymbol	<u>int</u>
elongation	<u>int</u>
flags	<u>int</u> (PAD_FLAG_...)
name	<u>string</u> (PAD_NAME_LENGTH)
shape[layer]	<u>int</u> (PAD_SHAPE_...)
signal	<u>string</u>
x, y	<u>int</u> (center point, see note)

See also UL\_PACKAGE, UL\_CONTACT, UL\_SMD

### Constants

PAD_FLAG_STOP	generate stop mask
PAD_FLAG_THERMALS	generate thermals
PAD_FLAG_FIRST	use special "first pad"
PAD_SHAPE_SQUARE	shape square
PAD_SHAPE_ROUND	shape round
PAD_SHAPE_OCTAGON	shape octagon
PAD_SHAPE_LONG	shape long
PAD_SHAPE_OFFSET	shape offset
PAD_SHAPE_ANNULUS	annulus (only if supply layers are used)
PAD_SHAPE_THERMAL	thermal (only if supply layers are used)
PAD_NAME_LENGTH	max. recommended length of a pad name (same as
H	CONTACT_NAME_LENGTH)

### Note

The parameters of the pad depend on the context in which it is accessed:

- if the pad is derived from a UL\_LIBRARY context, the coordinates (x, y) and angle will be the same as defined in the package drawing
- in all other cases, they will have the actual values from the board

The diameter and shape of the pad depend on the layer for which they shall be retrieved, because they may be different in each layer depending on the Design Rules. If one of the layers LAYER\_TOP..LAYER\_BOTTOM, LAYER\_TSTOP or LAYER\_BSTOP is given as the index to the diameter or shape data member, the resulting value will be calculated according to the Design Rules. If LAYER\_PADS is given, the raw value as defined in the library will be returned.

`drillsymbol` returns the number of the drill symbol that has been assigned to this drill diameter (see the manual for a list of defined drill symbols). A value of 0 means that no symbol has been assigned to this drill diameter.

`angle` defines how many degrees the pad is rotated counterclockwise around its center.

`elongation` is only valid for shapes `PAD_SHAPE_LONG` and `PAD_SHAPE_OFFSET` and defines how many percent the long side of such a pad is longer than its small side. This member returns 0 for any other pad shapes.

The value returned by `flags` must be masked with the `PAD_FLAG_...` constants to determine the individual flag settings, as in

```
if (pad.flags & PAD_FLAG_STOP) {
    ...
}
```

Note that if your ULP just wants to draw the objects, you don't need to check these flags explicitly. The `diameter[]` and `shape[]` members will return the proper data; for instance, if `PAD_FLAG_STOP` is set, `diameter[LAYER_TSTOP]` will return 0, which should result in nothing being drawn in that layer. The `flags` member is mainly for ULPs that want to create script files that create library objects.

## Example

```
library(L) {
  L.packages(PAC) {
    PAC.contacts(C) {
      if (C.pad)
        printf("Pad: '%s', (%d %d), d=%d\n",
              C.name, C.pad.x, C.pad.y, C.pad.diameter[LAYER_BOTTOM]);
    }
  }
}
```

## UL\_PART

### Data members

<code>attribute[]</code>	<code>string</code> (see note)
<code>device</code>	<code>UL_DEVICE</code>
<code>deviceset</code>	<code>UL_DEVICESET</code>
<code>name</code>	<code>string</code> ( <code>PART_NAME_LENGTH</code> )
<code>value</code>	<code>string</code> ( <code>PART_VALUE_LENGTH</code> )

### Loop members

<code>attributes()</code>	<code>UL_ATTRIBUTE</code> (see note)
<code>instances()</code>	<code>UL_INSTANCE</code> (see note)

See also [UL\\_SCHEMATIC](#), [UL\\_SHEET](#)

### Constants

<code>PART_NAME_LENGTH</code>	max. recommended length of a part name (used in formatted
-------------------------------	-----------------------------------------------------------

	output only)
PART_VALUE_LENGTH	max. recommended length of a part value (used in formatted output only)

## Note

The `attribute[]` member can be used to query a `UL_PART` for the value of a given attribute (see the second example below). The returned string is empty if there is no attribute by the given name, or if this attribute is explicitly empty.

When looping through the `attributes()` of a `UL_PART`, only the `name`, `value`, `defaultvalue` and `constant` members of the resulting `UL_ATTRIBUTE` objects are valid.

If the part is in a sheet context, the `instances()` loop member loops only through those instances that are actually used on that sheet. If the part is in a schematic context, all instances are looped through.

## Example

```
schematic(S) {
  S.parts(P) printf("Part: %s\n", P.name);
}

schematic(SCH) {
  SCH.parts(P) {
    if (P.attribute["REMARK"])
      printf("%s: %s\n", P.name, P.attribute["REMARK"]);
  }
}
```

## UL\_PIN

### Data members

<code>angle</code>	<u>real</u> (0, 90, 180 and 270)
<code>contact</code>	<u>UL_CONTACT</u> (see note)
<code>direction</code>	<u>int</u> (PIN_DIRECTION_...)
<code>function</code>	<u>int</u> (PIN_FUNCTION_FLAG_...)
<code>length</code>	<u>int</u> (PIN_LENGTH_...)
<code>name</code>	<u>string</u> (PIN_NAME_LENGTH)
<code>net</code>	<u>string</u> (see note)
<code>swaplevel</code>	<u>int</u>
<code>visible</code>	<u>int</u> (PIN_VISIBLE_FLAG_...)
<code>x, y</code>	<u>int</u> (connection point)

### Loop members

<code>circles()</code>	<u>UL_CIRCLE</u>
<code>texts()</code>	<u>UL_TEXT</u>
<code>wires()</code>	<u>UL_WIRE</u>

See also UL\_SYMBOL, UL\_PINREF, UL\_CONTACTREF



## Constants

PIN_DIRECTION_NC	not connected
PIN_DIRECTION_IN	input
PIN_DIRECTION_OUT	output (totem-pole)
PIN_DIRECTION_IO	in/output (bidirectional)
PIN_DIRECTION_OC	open collector
PIN_DIRECTION_PWR	power input pin
PIN_DIRECTION_PAS	passive
PIN_DIRECTION_HIZ	high impedance output
PIN_DIRECTION_SUP	supply pin
PIN_FUNCTION_FLAG_NONE	no symbol
PIN_FUNCTION_FLAG_DOT	inverter symbol
PIN_FUNCTION_FLAG_CLK	clock symbol
PIN_LENGTH_POINT	no wire
PIN_LENGTH_SHORT	0.1 inch wire
PIN_LENGTH_MIDDLE	0.2 inch wire
PIN_LENGTH_LONG	0.3 inch wire
PIN_NAME_LENGTH	max. recommended length of a pin name (used in formatted output only)
PIN_VISIBLE_FLAG_OFF	no name drawn
PIN_VISIBLE_FLAG_PAD	pad name drawn
PIN_VISIBLE_FLAG_PIN	pin name drawn

## Note

The `contact` data member returns the contact that has been assigned to the pin through a CONNECT command. It can be used as a boolean function to check whether a contact has been assigned to a pin (see example below).

The coordinates (and layer, in case of an SMD) of the contact returned by the `contact` data member depend on the context in which it is called:

- if the pin is derived from a `UL_PART` that is used on a sheet, and if there is a corresponding element on the board, the resulting contact will have the coordinates as used on the board
- in all other cases, the coordinates of the contact will be the same as defined in the package drawing

The `name` data member always returns the name of the pin as it was defined in the library, with any '@' character for pins with the same name left intact (see the PIN command for details).

The `texts` loop member, on the other hand, returns the pin name (if it is visible) in the same way as it is displayed in the current drawing type.

The `net` data member returns the name of the net to which this pin is connected (only available in a schematic context).

**Example**

```

library(L) {
  L.symbols(S) {
    printf("Symbol: %s\n", S.name);
    S.pins(P) {
      printf("\tPin: %s, (%d %d)", P.name, P.x, P.y);
      if (P.direction == PIN_DIRECTION_IN)
        printf(" input");
      if ((P.function & PIN_FUNCTION_FLAG_DOT) != 0)
        printf(" inverted");
      printf("\n");
    }
  }
  L.devices(D) {
    D.gates(G) {
      G.symbol.pins(P) {
        if (!P.contact)
          printf("Unconnected pin: %s/%s/%s\n", D.name, G.name, P.name);
      }
    }
  }
}

```

**UL\_PINREF****Data members**

instance    [UL\\_INSTANCE](#)  
part        [UL\\_PART](#)  
pin         [UL\\_PIN](#)

See also [UL\\_SEGMENT](#), [UL\\_CONTACTREF](#)

**Example**

```

schematic(SCH) {
  SCH.sheets(SH) {
    printf("Sheet: %d\n", SH.number);
    SH.nets(N) {
      printf("\tNet: %s\n", N.name);
      N.segments(SEG) {
        SEG.pinrefs(P) {
          printf("connected to: %s, %s, %s\n",
                P.part.name, P.instance.name, P.pin.name);
        }
      }
    }
  }
}

```

**UL\_POLYGON****Data members**

isolate    [int](#)  
layer      [int](#)

orphans     int (0=off, 1=on)  
 pour         int (POLYGON\_POUR\_...)  
 rank         int  
 spacing     int  
 thermals    int (0=off, 1=on)  
 width        int

**Loop members**

contours()    UL\_WIRE (see note)  
 fillings()    UL\_WIRE  
 wires()       UL\_WIRE

See also UL\_BOARD, UL\_PACKAGE, UL\_SHEET, UL\_SIGNAL, UL\_SYMBOL

**Constants**

POLYGON\_POUR\_SOLID    solid  
 POLYGON\_POUR\_HATCH   hatch

**Note**

The contours() and fillings() loop members loop through the wires that are used to draw the calculated polygon if it is part of a signal and the polygon has been calculated by the RATSNEST command. The wires() loop member always loops through the polygon wires as they were drawn by the user. For an uncalculated signal polygon contours() does the same as wires(), and fillings() does nothing.

If the contours() loop member is called without a second parameter, it loops through all of the contour wires, regardless whether they belong to a positive or a negative polygon. If you are interested in getting the positive and negative contour wires separately, you can call contours() with an additional integer parameter (see the second example below). The sign of that parameter determines whether a positive or a negative polygon will be handled, and the value indicates the index of that polygon. If there is no polygon with the given index, the statement will not be executed. Another advantage of this method is that you don't need to determine the beginning and end of a particular polygon yourself (by comparing coordinates). For any given index, the statement will be executed for all the wires of that polygon. With the second parameter 0 the behavior is the same as without a second parameter.

**Polygon width**

When using the fillings() loop member to get the fill wires of a solid polygon, make sure the *width* of the polygon is not zero (actually it should be quite a bit larger than zero, for example at least the hardware resolution of the output device you are going to draw on). **Filling a polygon with zero width may result in enormous amounts of data, since it will be calculated with the smallest editor resolution of 1/10000mm!**

**Partial polygons**

A calculated signal polygon may consist of several distinct parts (called *positive* polygons),

each of which can contain extrusions (*negative* polygons) resulting from other objects being subtracted from the polygon. Negative polygons can again contain other positive polygons and so on.

The wires looped through by `contours()` always start with a positive polygon. To find out where one partial polygon ends and the next one begins, simply store the  $(x_1, y_1)$  coordinates of the first wire and check them against  $(x_2, y_2)$  of every following wire. As soon as these are equal, the last wire of a partial polygon has been found. It is also guaranteed that the second point  $(x_2, y_2)$  of one wire is identical to the first point  $(x_1, y_1)$  of the next wire in that partial polygon.

To find out where the "inside" and the "outside" of the polygon lays, take any contour wire and imagine looking from its point  $(x_1, y_1)$  to  $(x_2, y_2)$ . The "inside" of the polygon is always on the right side of the wire. Note that if you simply want to draw the polygon you won't need all these details.

## Example

```
board(B) {
  B.signals(S) {
    S.polygons(P) {
      int x0, y0, first = 1;
      P.contours(W) {
        if (first) {
          // a new partial polygon is starting
          x0 = W.x1;
          y0 = W.y1;
        }
        // ...
        // do something with the wire
        // ...
        if (first)
          first = 0;
        else if (W.x2 == x0 && W.y2 == y0) {
          // this was the last wire of the partial polygon,
          // so the next wire (if any) will be the first wire
          // of the next partial polygon
          first = 1;
        }
      }
    }
  }
}
```

```
board(B) {
  B.signals(S) {
    S.polygons(P) {
      // handle only the "positive" polygons:
      int i = 1;
      int active;
      do {
        active = 0;
        P.contours(W, i) {
          active = 1;
          // do something with the wire
        }
      }
    }
  }
}
```

```

    }
    i++;
  } while (active);
}
}
}

```

## UL\_RECTANGLE

### Data members

angle     real (0.0...359.9)  
 layer     int  
 x1, y1    int (lower left corner)  
 x2, y2    int (upper right  
           corner)

See also [UL\\_BOARD](#), [UL\\_PACKAGE](#), [UL\\_SHEET](#), [UL\\_SYMBOL](#)

angle defines how many degrees the rectangle is rotated counterclockwise around its center. The center coordinates are given by  $(x1+x2)/2$  and  $(y1+y2)/2$ .

### Example

```

board(B) {
  B.rectangles(R) {
    printf("Rectangle: (%d %d), (%d %d)\n",
          R.x1, R.y1, R.x2, R.y2);
  }
}

```

## UL\_SCHEMATIC

### Data members

grid            UL\_GRID  
 name            string (see note)  
 xreflabel       string

### Loop members

attributes()    UL\_ATTRIBUTE (see note)  
 classes()       UL\_CLASS  
 layers()        UL\_LAYER  
 libraries()     UL\_LIBRARY  
 nets()           UL\_NET  
 parts()          UL\_PART  
 sheets()         UL\_SHEET

See also [UL\\_BOARD](#), [UL\\_LIBRARY](#)

### Note

The name member returns the full file name, including the directory.

The `xreflabel` member returns the format string used to display cross-reference labels.  
 The `attributes()` loop member loops through the *global* attributes.

### Example

```
schematic(S) {
  S.parts(P) printf("Part: %s\n", P.name);
}
```

## UL\_SEGMENT

### Loop members

<code>junctions()</code>	<code>UL_JUNCTION</code> (see note)
<code>labels()</code>	<code>UL_LABEL</code>
<code>pinrefs()</code>	<code>UL_PINREF</code> (see note)
<code>texts()</code>	<code>UL_TEXT</code> (deprecated, see note)
<code>wires()</code>	<code>UL_WIRE</code>

See also `UL_BUS`, `UL_NET`

### Note

The `junctions()` and `pinrefs()` loop members are only available for net segments.

The `texts()` loop member was used in older EAGLE versions to loop through the labels of a segment, and is only present for compatibility. It will not deliver the text of cross-reference labels at the correct position. Use the `labels()` loop member to access a segment's labels.

### Example

```
schematic(SCH) {
  SCH.sheets(SH) {
    printf("Sheet: %d\n", SH.number);
    SH.nets(N) {
      printf("\tNet: %s\n", N.name);
      N.segments(SEG) {
        SEG.pinrefs(P) {
          printf("connected to: %s, %s, %s\n",
                P.part.name, P.instance.name, P.pin.name);
        }
      }
    }
  }
}
```

## UL\_SHEET

### Data members

<code>area</code>	<code>UL_AREA</code>
<code>number</code>	<code>int</code>

**Loop members**

busses()	<a href="#"><u>UL_BUS</u></a>
circles()	<a href="#"><u>UL_CIRCLE</u></a>
frames()	<a href="#"><u>UL_FRAME</u></a>
nets()	<a href="#"><u>UL_NET</u></a>
parts()	<a href="#"><u>UL_PART</u></a>
polygons()	<a href="#"><u>UL_POLYGON</u></a>
rectangles()	<a href="#"><u>UL_RECTANGLE</u></a>
texts()	<a href="#"><u>UL_TEXT</u></a>
wires()	<a href="#"><u>UL_WIRE</u></a>

See also [UL\\_SCHEMATIC](#)

**Example**

```
schematic(SCH) {
  SCH.sheets(S) {
    printf("Sheet: %d\n", S.number);
  }
}
```

**UL\_SIGNAL****Data members**

airwireshidden	<a href="#"><u>int</u></a>
class	<a href="#"><u>UL_CLASS</u></a>
name	<a href="#"><u>string</u></a> (SIGNAL_NAME_LENGTH)

**Loop members**

contactrefs()	<a href="#"><u>UL_CONTACTREF</u></a>
polygons()	<a href="#"><u>UL_POLYGON</u></a>
vias()	<a href="#"><u>UL_VIA</u></a>
wires()	<a href="#"><u>UL_WIRE</u></a>

See also [UL\\_BOARD](#)

**Constants**

SIGNAL_NAME_LENGTH	max. recommended length of a signal name (used in formatted output only)
--------------------	--------------------------------------------------------------------------

**Example**

```
board(B) {
  B.signals(S) printf("Signal: %s\n", S.name);
}
```

**UL\_SMD****Data members**

angle	<a href="#"><u>real</u></a> (0.0...359.9)
-------	-------------------------------------------

<code>dx[layer], dy[layer]</code>	<code>int</code> (size)
<code>flags</code>	<code>int</code> (SMD_FLAG_...)
<code>layer</code>	<code>int</code> (see note)
<code>name</code>	<code>string</code> (SMD_NAME_LENGTH)
<code>roundness</code>	<code>int</code> (see note)
<code>signal</code>	<code>string</code>
<code>x, y</code>	<code>int</code> (center point, see note)

See also [UL\\_PACKAGE](#), [UL\\_CONTACT](#), [UL\\_PAD](#)

## Constants

<code>SMD_FLAG_STOP</code>	generate stop mask
<code>SMD_FLAG_THERMALS</code>	generate thermals
<code>SMD_FLAG_CREAM</code>	generate cream mask
<code>SMD_NAME_LEN</code>	max. recommended length of an smd name (same as
<code>H</code>	<code>CONTACT_NAME_LENGTH</code> )

## Note

The parameters of the `smd` depend on the context in which it is accessed:

- if the `smd` is derived from a `UL_LIBRARY` context, the coordinates (`x`, `y`), `angle`, `layer` and `roundness` of the `smd` will be the same as defined in the package drawing
- in all other cases, they will have the actual values from the board

If the `dx` and `dy` data members are called with an optional layer index, the data for that layer is returned according to the [Design Rules](#). Valid [layers](#) are `LAYER_TOP`, `LAYER_TSTOP` and `LAYER_TCREAM` for a via in the Top layer, and `LAYER_BOTTOM`, `LAYER_BSTOP` and `LAYER_BCREAM` for a via in the Bottom layer, respectively.

`angle` defines how many degrees the `smd` is rotated counterclockwise around its center.

The value returned by `flags` must be masked with the `SMD_FLAG_...` constants to determine the individual flag settings, as in

```
if (smd.flags & SMD_FLAG_STOP) {
    ...
}
```

Note that if your ULP just wants to draw the objects, you don't need to check these flags explicitly. The `dx[]` and `dy[]` members will return the proper data; for instance, if `SMD_FLAG_STOP` is set, `dx[LAYER_TSTOP]` will return 0, which should result in nothing being drawn in that layer. The `flags` member is mainly for ULPs that want to create script files that create library objects.

## Example

```
library(L) {
    L.packages(PAC) {
```



```

PAC.contacts(C) {
  if (C.smd)
    printf("Smd: '%s', (%d %d), dx=%d, dy=%d\n",
           C.name, C.smd.x, C.smd.y, C.smd.dx, C.smd.dy);
}
}
}

```

## UL\_SYMBOL

### Data members

area        UL\_AREA  
 library     string  
 name        string (SYMBOL\_NAME\_LENGTH)

### Loop members

circles()    UL\_CIRCLE  
 frames()     UL\_FRAME  
 rectangles() UL\_RECTANGLE  
 pins()       UL\_PIN  
 polygons()   UL\_POLYGON  
 texts()      UL\_TEXT (see note)  
 wires()      UL\_WIRE

See also UL\_GATE, UL\_LIBRARY

### Constants

SYMBOL\_NAME\_LENGTH    max. recommended length of a symbol name (used in formatted output only)

### Note

If the UL\_SYMBOL is derived from a UL\_INSTANCE, the texts() member only loops through the non-detached texts of that instance.

### Example

```

library(L) {
  L.symbols(S) printf("Sym: %s\n", S.name);
}

```

## UL\_TEXT

### Data members

angle        real (0.0...359.9)  
 font         int (FONT\_...)  
 layer        int  
 mirror       int  
 ratio        int  
 size         int

spin        int  
 value      string  
 x, y       int (origin point)

**Loop members**

wires()    UL\_WIRE (see note)

See also UL\_BOARD, UL\_PACKAGE, UL\_SHEET, UL\_SYMBOL

**Constants**

FONT\_VECTOR        vector font  
 FONT\_PROPORTIONAL    proportional font  
 FONT\_FIXED         fixed font

**Note**

The wires() loop member always accesses the individual wires the text is composed of when using the vector font, even if the actual font is not FONT\_VECTOR.

If the UL\_TEXT is derived from a UL\_ELEMENT or UL\_INSTANCE context, the member values will be those of the actual text as located in the board or sheet drawing.

**Example**

```
board(B) {
  B.texts(T) {
    printf("Text: %s\n", T.value);
  }
}
```

**UL\_VIA****Data members**

diameter[layer]    int  
 drill                int  
 drillsymbol        int  
 end                  int  
 flags                int (VIA\_FLAG\_...)  
 shape[layer]       int (VIA\_SHAPE\_...)  
 start                int  
 x, y                 int (center point)

See also UL\_SIGNAL

**Constants**

VIA\_FLAG\_STOP      always generate stop  
                       mask  
 VIA\_SHAPE\_SQUARE    square  
 VIA\_SHAPE\_ROUND     round  
 VIA\_SHAPE\_OCTAGON   octagon

VIA\_SHAPE\_ANNULUS   annulus  
 VIA\_SHAPE\_THERMAL   thermal

## Note

The diameter and shape of the via depend on the layer for which they shall be retrieved, because they may be different in each layer depending on the [Design Rules](#). If one of the [layers](#) LAYER\_TOP..LAYER\_BOTTOM, LAYER\_TSTOP or LAYER\_BSTOP is given as the index to the diameter or shape data member, the resulting value will be calculated according to the Design Rules. If LAYER\_VIAS is given, the raw value as defined in the via will be returned.

Note that diameter and shape will always return the diameter or shape that a via would have in the given layer, even if that particular via doesn't cover that layer (or if that layer isn't used in the layer setup at all).

start and end return the layer numbers in which that via starts and ends. The value of start will always be less than that of end.

drillsymbol returns the number of the drill symbol that has been assigned to this drill diameter (see the manual for a list of defined drill symbols). A value of 0 means that no symbol has been assigned to this drill diameter.

## Example

```
board(B) {
  B.signals(S) {
    S.vias(V) {
      printf("Via: (%d %d)\n", V.x, V.y);
    }
  }
}
```

## UL\_WIRE

### Data members

arc            [UL\\_ARC](#)  
 cap           [int](#) (CAP\_...)  
 curve         [real](#)  
 layer         [int](#)  
 style         [int](#) (WIRE\_STYLE...)  
 width         [int](#)  
 x1, y1       [int](#) (starting point)  
 x2, y2       [int](#) (end point)

### Loop members

pieces()       [UL\\_WIRE](#) (see note)

See also [UL\\_BOARD](#), [UL\\_PACKAGE](#), [UL\\_SEGMENT](#), [UL\\_SHEET](#), [UL\\_SIGNAL](#), [UL\\_SYMBOL](#), [UL\\_ARC](#)

## Constants

CAP_FLAT	flat arc ends
CAP_ROUND	round arc ends
WIRE_STYLE_CONTINUOUS	continuous
WIRE_STYLE_LONGDASH	long dash
WIRE_STYLE_SHORTDASH	short dash
WIRE_STYLE_DASHDOT	dash dot

## Wire Style

A `UL_WIRE` that has a *style* other than `WIRE_STYLE_CONTINUOUS` can use the `pieces()` loop member to access the individual segments that constitute for example a dashed wire. If `pieces()` is called for a `UL_WIRE` with `WIRE_STYLE_CONTINUOUS`, a single segment will be accessible which is just the same as the original `UL_WIRE`. The `pieces()` loop member can't be called from a `UL_WIRE` that itself has been returned by a call to `pieces()` (this would cause an infinite recursion).

## Arcs at Wire level

Arcs are basically wires, with a few additional properties. At the first level arcs are treated exactly the same as wires, meaning they have a start and an end point, a width, layer and wire style. In addition to these an arc, at the wire level, has a *cap* and a *curve* parameter. *cap* defines whether the arc endings are round or flat, and *curve* defines the "curvature" of the arc. The valid range for *curve* is  $-360..+360$ , and its value means what part of a full circle the arc consists of. A value of  $90$ , for instance, would result in a  $90^\circ$  arc, while  $180$  would give you a semicircle. The maximum value of  $360$  can only be reached theoretically, since this would mean that the arc consists of a full circle, which, because the start and end points have to lie on the circle, would have to have an infinitely large diameter. Positive values for *curve* mean that the arc is drawn in a mathematically positive sense (i.e. counterclockwise). If *curve* is  $0$ , the arc is a straight line ("no curvature"), which is actually a wire.

The *cap* parameter only has a meaning for actual arcs, and will always return `CAP_ROUND` for a straight wire.

Whether or not an `UL_WIRE` is an arc can be determined by checking the boolean return value of the `arc` data member. If it returns  $0$ , we have a straight wire, otherwise an arc. If `arc` returns a non-zero value it may be further dereferenced to access the `UL_ARC` specific parameters start and end angle, radius and center point. Note that you may only need these additional parameters if you are going to draw the arc or process it in other ways where the actual shape is important.

## Example

```
board(B) {
  B.wires(W) {
    printf("Wire: (%d %d) (%d %d)\n",
```

```
        w.x1, w.y1, w.x2, w.y2);  
    }  
}
```

## Definitions

The data items to be used in a User Language Program must be defined before they can be used.

There are three kinds of definitions:

- Constant Definitions
- Variable Definitions
- Function Definitions

The scope of a *constant* or *variable* definition goes from the line in which it has been defined to the end of the current block, or to the end of the User Language Program, if the definition appeared outside any block.

The scope of a *function* definition goes from the closing brace (}) of the function body to the end of the User Language Program.

## Constant Definitions

*Constants* are defined using the keyword `enum`, as in

```
enum { a, b, c };
```

which would define the three constants `a`, `b` and `c`, giving them the values `0`, `1` and `2`, respectively.

Constants may also be initialized to specific values, like

```
enum { a, b = 5, c };
```

where `a` would be `0`, `b` would be `5` and `c` would be `6`.

## Variable Definitions

The general syntax of a *variable definition* is

```
[numeric] type identifier [= initializer][, ...];
```

where `type` is one of the data or object types, `identifier` is the name of the variable, and `initializer` is an optional initial value.

Multiple variable definitions of the same type are separated by commas (,).

If `identifier` is followed by a pair of brackets ([ ]), this defines an array of variables of the given type. The size of an array is automatically adjusted at runtime.

The optional keyword `numeric` can be used with string arrays to have them sorted alphanumerically by the sort() function.

By default (if no `initializer` is present), data variables are set to 0 (or "", in case of a string), and object variables are "invalid".

## Examples

```
int i;           defines an int variable named i
string s = "Hello"; defines a string variable named s and initializes it to
                  "Hello"
real a, b = 1.0, c; defines three real variables named a, b and c, initializing b to
                  the value 1.0
int n[] = { 1, 2, 3 }; defines an array of int, initializing the first three elements to
                  1, 2 and 3
numeric string names[]; defines a string array that can be sorted alphanumerically
UL_WIRE w;       defines a UL_WIRE object named w
The members of array elements of object types can't be accessed directly:
UL_SIGNAL signals[];
...
UL_SIGNAL s = signals[0];
printf("%s", s.name);
```

## Function Definitions

You can write your own User Language functions and call them just like the Builtin Functions.

The general syntax of a *function definition* is

```
type identifier(parameters)
{
    statements
}
```

where `type` is one of the data or object types, `identifier` is the name of the function, `parameters` is a list of comma separated parameter definitions, and `statements` is a sequence of statements.

Functions that do not return a value have the type `void`.

A function must be defined **before** it can be called, and function calls can not be recursive (a function cannot call itself).

The statements in the function body may modify the values of the parameters, but this will not have any effect on the arguments of the function call.

Execution of a function can be terminated by the return statement. Without any return statement the function body is executed until it's closing brace (`}`).

A call to the exit() function will terminate the entire User Language Program.

## The special function `main()`

If your User Language Program contains a function called `main()`, that function will be explicitly called as the main function, and its return value will be the return value of the program.

Command line arguments are available to the program through the global Builtin Variables `argc` and `argv`.

## Example

```
int CountDots(string s)
{
    int dots = 0;
    for (int i = 0; s[i]; ++i)
        if (s[i] == '.')
            ++dots;
    return dots;
}
string dotted = "This.has.dots...";
output("test") {
    printf("Number of dots: %d\n",
          CountDots(dotted));
}
```

## Operators

The following table lists all of the User Language operators, in order of their precedence (*Unary* having the highest precedence, *Comma* the lowest):

Unary	<u>! ~ + - ++ --</u>
Multiplicative	<u>* / %</u>
Additive	<u>+ -</u>
Shift	<u>&lt;&lt; &gt;&gt;</u>
Relational	<u>&lt; &lt;= &gt; &gt;=</u>
Equality	<u>== !=</u>
Bitwise AND	<u>&amp;</u>
Bitwise XOR	<u>^</u>
Bitwise OR	<u> </u>
Logical AND	<u>&amp;&amp;</u>
Logical OR	<u>  </u>
Conditional	<u>?:</u>
Assignment	<u>= *= /= %= += -= &amp;= ^=  = &lt;&lt;= &gt;&gt;=</u>
Comma	<u>,</u>

Associativity is **left to right** for all operators, except for *Unary*, *Conditional* and *Assignment*, which are **right to left** associative.

The normal operator precedence can be altered by the use of parentheses.

## Bitwise Operators

Bitwise operators work only with data types char and int.

### Unary

~ Bitwise (1's) complement

### Binary

<< Shift left

>> Shift right

& Bitwise AND

^ Bitwise XOR

| Bitwise OR

### Assignment

&= Assign bitwise AND

^= Assign bitwise XOR

|= Assign bitwise OR

<<= Assign left shift

>>= Assign right shift

## Logical Operators

Logical operators work with expressions of any data type.

### Unary

! Logical NOT

### Binary

&& Logical AND

|| Logical OR

Using a string expression with a logical operator checks whether the string is empty.

Using an Object Type with a logical operator checks whether that object contains valid data.

## Comparison Operators

Comparison operators work with expressions of any data type, except Object Types.

< Less than

<= Less than or equal to

> Greater than

>= Greater than or equal

to

== Equal to

!= Not equal to

## Evaluation Operators

Evaluation operators are used to evaluate expressions based on a condition, or to group a sequence of expressions and have them evaluated as one expression.

?: Conditional



### , Comma

The *Conditional* operator is used to make a decision within an expression, as in

```
int a;
// ...code that calculates 'a'
string s = a ? "True" : "False";
```

which is basically the same as

```
int a;
string s;
// ...code that calculates 'a'
if (a)
    s = "True";
else
    s = "False";
```

but the advantage of the conditional operator is that it can be used in an expression.

The *Comma* operator is used to evaluate a sequence of expressions from left to right, using the type and value of the right operand as the result.

Note that arguments in a function call as well as multiple variable declarations also use commas as delimiters, but in that case this is **not** a comma operator!

## Arithmetic Operators

Arithmetic operators work with data types char, int and real (except for ++, --, % and %=).

### Unary

+	Unary plus
-	Unary minus
++	Pre- or postincrement
--	Pre- or postdecrement

### Binary

*	Multiply
/	Divide
%	Remainder (modulus)
+	Binary plus
-	Binary minus

### Assignment

=	Simple assignment
*=	Assign product
/=	Assign quotient
%=	Assign remainder (modulus)
+=	Assign sum
-=	Assign difference

See also String Operators

## String Operators

String operators work with data types `char`, `int` and `string`. The left operand must always be of type `string`.

### Binary

+ Concatenation

### Assignment

= Simple assignment

+= Append to string

The + operator concatenates two strings, or adds a character to the end of a string and returns the resulting string.

The += operator appends a string or a character to the end of a given string.

See also [Arithmetic Operators](#)

## Expressions

An *expression* can be one of the following:

- [Arithmetic Expression](#)
- [Assignment Expression](#)
- [String Expression](#)
- [Comma Expression](#)
- [Conditional Expression](#)
- [Function Call](#)

Expressions can be grouped using [parentheses](#), and may be recursive, meaning that an expression can consist of subexpressions.

## Arithmetic Expression

An *arithmetic expression* is any combination of numeric operands and an [arithmetic operator](#) or a [bitwise operator](#).

### Examples

```
a + b
c++
m << 1
```

## Assignment Expression

An *assignment expression* consists of a variable on the left side of an [assignment operator](#), and an expression on the right side.

### Examples

```
a = x + 42
b += c
```

```
s = "Hello"
```

## String Expression

A *string expression* is any combination of string and char operands and a string operator.

### Examples

```
s + ".brd"  
t + 'x'
```

## Comma Expression

A *comma expression* is a sequence of expressions, delimited by the comma operator

Comma expressions are evaluated left to right, and the result of a comma expression is the type and value of the rightmost expression.

### Example

```
i++, j++, k++
```

## Conditional Expression

A *conditional expression* uses the conditional operator to make a decision within an expression.

### Example

```
int a;  
// ...code that calculates 'a'  
string s = a ? "True" : "False";
```

## Function Call

A *function call* transfers the program flow to a user defined function or a builtin function. The formal parameters defined in the function definition are replaced with the values of the expressions used as the actual arguments of the function call.

### Example

```
int p = strchr(s, 'b');
```

## Statements

A *statement* can be one of the following:

- Compound Statement
- Control Statement

- Expression Statement
- Builtin Statement
- Constant Definition
- Variable Definition

Statements specify the flow of control as a User Language Program executes. In absence of specific control statements, statements are executed sequentially in the order of appearance in the ULP file.

## Compound Statement

A *compound statement* (also known as *block*) is a list (possibly empty) of statements enclosed in matching braces (`{}`). Syntactically, a block can be considered to be a single statement, but it also controls the scoping of identifiers. An identifier declared within a block has a scope starting at the point of declaration and ending at the closing brace.

Compound statements can be nested to any depth.

## Expression Statement

An *expression statement* is any expression followed by a semicolon.

An expression statement is executed by evaluating the expression. All side effects of this evaluation are completed before the next statement is executed. Most expression statements are assignments or function calls.

A special case is the *empty statement*, consisting of only a semicolon. An empty statement does nothing, but it may be useful in situations where the ULP syntax expects a statement but your program does not need one.

## Control Statements

*Control statements* are used to control the program flow.

Iteration statements are

do...while  
for  
while

Selection statements are

if...else  
switch

Jump statements are

break  
continue  
return

## break

The *break* statement has the general syntax

```
break;
```

and immediately terminates the **nearest** enclosing do...while, for, switch or while statement. This also applies to *loop members* of object types.

Since all of these statements can be intermixed and nested to any depth, take care to ensure that your *break* exits from the correct statement.

## continue

The *continue* statement has the general syntax

```
continue;
```

and immediately transfers control to the test condition of the **nearest** enclosing do...while, while, or for statement, or to the increment expression of the **nearest** enclosing for statement.

Since all of these statements can be intermixed and nested to any depth, take care to ensure that your *continue* affects the correct statement.

## do...while

The *do...while* statement has the general syntax

```
do statement while (condition);
```

and executes the statement until the condition expression becomes zero.

The condition is tested **after** the first execution of statement, which means that the statement is always executed at least one time.

If there is no break or return inside the statement, the statement must affect the value of the condition, or condition itself must change during evaluation in order to avoid an endless loop.

## Example

```
string s = "Trust no one!";  
int i = -1;  
do {  
    ++i;  
} while (s[i]);
```

## for

The *for* statement has the general syntax

```
for ([init]; [test]; [inc]) statement
```

and performs the following steps:

1. If an initializing expression `init` is present, it is executed.
2. If a `test` expression is present, it is executed. If the result is nonzero (or if there is no `test` expression at all), the `statement` is executed.
3. If an `inc` expression is present, it is executed.
4. Finally control returns to step 2.

If there is no `break` or `return` inside the `statement`, the `inc` expression (or the `statement`) must affect the value of the `test` expression, or `test` itself must change during evaluation in order to avoid an endless loop.

The initializing expression `init` normally initializes one or more loop counters. It may also define a new variable as a loop counter. The scope of such a variable is valid until the end of the active block.

### Example

```
string s = "Trust no one!";
int sum = 0;
for (int i = 0; s[i]; ++i)
    sum += s[i]; // sums up the characters in s
```

### if...else

The *if...else* statement has the general syntax

```
if (expression)
    t_statement
[else
    f_statement]
```

The conditional `expression` is evaluated, and if its value is nonzero the `t_statement` is executed. Otherwise the `f_statement` is executed in case there is an `else` clause.

An `else` clause is always matched to the last encountered `if` without an `else`. If this is not what you want, you need to use braces to group the statements, as in

```
if (a == 1) {
    if (b == 1)
        printf("a == 1 and b == 1\n");
}
else
    printf("a != 1\n");
```

### return

A function with a return type other than `void` must contain at least one *return* statement with the syntax

```
return expression;
```

where `expression` must evaluate to a type that is compatible with the function's return

type. The value of `expression` is the value returned by the function.

If the function is of type `void`, a `return` statement without an `expression` can be used to return from the function call.

## switch

The `switch` statement has the general syntax

```
switch (sw_exp) {
  case case_exp: case_statement
  ...
  [default: def_statement]
}
```

and allows for the transfer of control to one of several case-labeled statements, depending on the value of `sw_exp` (which must be of integral type).

Any `case_statement` can be labeled by one or more case labels. The `case_exp` of each case label must evaluate to a constant integer which is unique within it's enclosing `switch` statement.

There can also be at most one `default` label.

After evaluating `sw_exp`, the `case_exp` are checked for a match. If a match is found, control passes to the `case_statement` with the matching case label.

If no match is found and there is a `default` label, control passes to `def_statement`. Otherwise none of the statements in the `switch` is executed.

Program execution is not affected when `case` and `default` labels are encountered. Control simply passes through the labels to the following statement.

To stop execution at the end of a group of statements for a particular case, use the `break` statement.

## Example

```
string s = "Hello World";
int vowels = 0, others = 0;
for (int i = 0; s[i]; ++i)
  switch (toupper(s[i])) {
    case 'A':
    case 'E':
    case 'I':
    case 'O':
    case 'U': ++vowels;
              break;
    default: ++others;
  }
printf("There are %d vowels in '%s'\n", vowels, s);
```

## while

The *while* statement has the general syntax

```
while (condition) statement
```

and executes the statement as long as the `condition` expression is not zero.

The `condition` is tested **before** the first possible execution of `statement`, which means that the statement may never be executed if `condition` is initially zero.

If there is no `break` or `return` inside the statement, the statement must affect the value of the `condition`, or `condition` itself must change during evaluation in order to avoid an endless loop.

### Example

```
string s = "Trust no one!";
int i = 0;
while (s[i])
    ++i;
```

## Builtins

Builtins are *Constants*, *Variables*, *Functions* and *Statements* that provide additional information and allow for data manipulations.

- [Builtin Constants](#)
- [Builtin Variables](#)
- [Builtin Functions](#)
- [Builtin Statements](#)

## Builtin Constants

*Builtin constants* are used to provide information about object parameters, such as maximum recommended name length, flags etc.

Many of the [object types](#) have their own **Constants** section which lists the builtin constants for that particular object (see e.g. [UL\\_PIN](#)).

The following builtin constants are defined in addition to the ones listed for the various object types:

EAGLE_VERSION	EAGLE program version number ( <a href="#">int</a> )
EAGLE_RELEASE	EAGLE program release number ( <a href="#">int</a> )
EAGLE_SIGNATURE	a <a href="#">string</a> containing EAGLE program name, version and copyright information
REAL_EPSILON	the minimum positive <a href="#">real</a> number such that $1.0 + \text{REAL\_EPSILON} \neq 1.0$
REAL_MAX	the largest possible <a href="#">real</a> value
REAL_MIN	the smallest possible (positive!) <a href="#">real</a> value



	the smallest representable number is <code>-REAL_MAX</code>
<code>INT_MAX</code>	the largest possible <u>int</u> value
<code>INT_MIN</code>	the smallest possible <u>int</u> value
<code>PI</code>	the value of "pi" (3.14..., <u>real</u> )
<code>usage</code>	a <u>string</u> containing the text from the <code>#usage</code> directive

These builtin constants contain the directory paths defined in the directories dialog, with any of the special variables (`$HOME` and `$EAGLEDIR`) replaced by their actual values. Since each path can consist of several directories, these constants are string arrays with an individual directory in each member. The first empty member marks the end of the path:

<code>path_lbr[]</code>	Libraries
<code>path_dru[]</code>	Design Rules
<code>path_ulp[]</code>	User Language Programs
<code>path_scr[]</code>	Scripts
<code>path_cam[]</code>	CAM Jobs
<code>path_epf[]</code>	Projects

When using these constants to build a full file name, you need to use a directory separator, as in

```
string s = path_lbr[0] + '/' + "mylib.lbr";
```

The libraries that are currently in use through the USE command:

```
used_libraries[]
```

## Builtin Variables

*Builtin variables* are used to provide information at runtime.

<code>int argc</code>	number of arguments given to the <u>RUN</u> command
<code>string argv[]</code>	arguments given to the RUN command ( <code>argv[0]</code> is the full ULP file name)

## Builtin Functions

*Builtin functions* are used to perform specific tasks, like printing formatted strings, sorting data arrays or the like.

You may also write your own functions and use them to structure your User Language Program.

The builtin functions are grouped into the following categories:

- Character Functions
- File Handling Functions
- Mathematical Functions
- Miscellaneous Functions
- Printing Functions
- String Functions
- Time Functions

- Object Functions

Alphabetical reference of all builtin functions:

- abs()
- acos()
- asin()
- atan()
- ceil()
- clrgroup()
- cos()
- exit()
- exp()
- filedir()
- fileerror()
- fileext()
- fileglob()
- filename()
- fileread()
- filesetext()
- filesize()
- filetime()
- floor()
- frac()
- ingroup()
- isalnum()
- isalpha()
- iscntrl()
- isdigit()
- isgraph()
- islower()
- isprint()
- ispunct()
- isspace()
- isupper()
- isxdigit()
- language()
- log()
- log10()
- lookup()
- max()
- min()
- palette()
- pow()
- printf()
- round()
- setgroup()

- [sin\(\)](#)
- [sort\(\)](#)
- [sprintf\(\)](#)
- [sqrt\(\)](#)
- [status\(\)](#)
- [strchr\(\)](#)
- [strjoin\(\)](#)
- [strlen\(\)](#)
- [strlwr\(\)](#)
- [strrchr\(\)](#)
- [strrstr\(\)](#)
- [strsplit\(\)](#)
- [strstr\(\)](#)
- [strsub\(\)](#)
- [strtod\(\)](#)
- [strtol\(\)](#)
- [strupr\(\)](#)
- [strxstr\(\)](#)
- [system\(\)](#)
- [t2day\(\)](#)
- [t2dayofweek\(\)](#)
- [t2hour\(\)](#)
- [t2minute\(\)](#)
- [t2month\(\)](#)
- [t2second\(\)](#)
- [t2string\(\)](#)
- [t2year\(\)](#)
- [tan\(\)](#)
- [time\(\)](#)
- [tolower\(\)](#)
- [toupper\(\)](#)
- [trunc\(\)](#)
- [u2inch\(\)](#)
- [u2mic\(\)](#)
- [u2mil\(\)](#)
- [u2mm\(\)](#)

## Character Functions

*Character functions* are used to manipulate single characters.

The following character functions are available:

- [isalnum\(\)](#)
- [isalpha\(\)](#)
- [iscntrl\(\)](#)
- [isdigit\(\)](#)
- [isgraph\(\)](#)

- [islower\(\)](#)
- [isprint\(\)](#)
- [ispunct\(\)](#)
- [isspace\(\)](#)
- [isupper\(\)](#)
- [isxdigit\(\)](#)
- [tolower\(\)](#)
- [toupper\(\)](#)

## is...()

### Function

Check whether a character falls into a given category.

### Syntax

```
int isalnum(char c);
int isalpha(char c);
int iscntrl(char c);
int isdigit(char c);
int isgraph(char c);
int islower(char c);
int isprint(char c);
int ispunct(char c);
int isspace(char c);
int isupper(char c);
int isxdigit(char c);
```

### Returns

The `is...` functions return nonzero if the given character falls into the category, zero otherwise.

## Character categories

<code>isalnum</code>	letters (A to Z or a to z) or digits (0 to 9)
<code>isalpha</code>	letters (A to Z or a to z)
<code>iscntrl</code>	delete characters or ordinary control characters (0x7F or 0x00 to 0x1F)
<code>isdigit</code>	digits (0 to 9)
<code>isgraph</code>	printing characters (except space)
<code>islower</code>	lowercase letters (a to z)
<code>isprint</code>	printing characters (0x20 to 0x7E)
<code>ispunct</code>	punctuation characters ( <code>iscntrl</code> or <code>isspace</code> )
<code>isspace</code>	space, tab, carriage return, new line, vertical tab, or formfeed (0x09 to 0x0D, 0x20)
<code>isupper</code>	uppercase letters (A to Z)
<code>isxdigit</code>	hex digits (0 to 9, A to F, a to f)

### Example

```
char c = 'A';
```

```
if (isxdigit(c))
    printf("%c is hex\n", c);
else
    printf("%c is not hex\n", c);
```

## to...()

### Function

Convert a character to upper- or lowercase.

### Syntax

```
char tolower(char c);
char toupper(char c);
```

### Returns

The `tolower` function returns the converted character if `c` is uppercase. All other characters are returned unchanged.

The `toupper` function returns the converted character if `c` is lowercase. All other characters are returned unchanged.

See also [strupr](#), [strlwr](#)

## File Handling Functions

*Filename handling functions* are used to work with file names, sizes and timestamps.

The following file handling functions are available:

- [fileerror\(\)](#)
- [fileglob\(\)](#)
- [filedir\(\)](#)
- [fileext\(\)](#)
- [filename\(\)](#)
- [fileread\(\)](#)
- [filesetext\(\)](#)
- [filesize\(\)](#)
- [filetime\(\)](#)

See [output\(\)](#) for information about how to write into a file.

## fileerror()

### Function

Returns the status of I/O operations.

### Syntax

```
int fileerror();
```

### Returns

The `fileerror` function returns 0 if everything is ok.

See also [output](#), [printf](#), [fileread](#)

`fileerror` checks the status of any I/O operations that have been performed since the last call to this function and returns 0 if everything was ok. If any of the I/O operations has caused an error, a value other than 0 will be returned.

You should call `fileerror` before any I/O operations to reset any previous error state, and call it again after the I/O operations to see if they were successful.

When `fileerror` returns a value other than 0 (thus indicating an error) a proper error message has already been given to the user.

### Example

```
fileerror();
output("file.txt", "wt") {
    printf("Test\n");
}
if (fileerror())
    exit(1);
```

## fileglob()

### Function

Perform a directory search.

### Syntax

```
int fileglob(string &array[], string pattern);
```

### Returns

The `fileglob` function returns the number of entries copied into `array`.

See also [dlgFileOpen\(\)](#), [dlgFileSave\(\)](#)

`fileglob` performs a directory search using `pattern`.

`pattern` may contain '\*' and '?' as wildcard characters. If `pattern` ends with a '/', the contents of the given directory will be returned.

Names in the resulting `array` that end with a '/' are directory names.

The `array` is sorted alphabetically, with the directories coming first.

The special entries '.' and '..' (for the current and parent directories) are never returned in the `array`.

If `pattern` doesn't match, or if you don't have permission to search the given directory, the resulting `array` will be empty.

### Note for Windows users



The directory delimiter in the `array` is always a **forward slash**. This makes sure User Language Programs will work platform independently. In the `pattern` the **backslash** ('\\') is also treated as a directory delimiter.

Sorting filenames under Windows is done case insensitively.

## Example

```
string a[];  
int n = fileglob(a, "*.brd");
```

## Filename Functions

### Function

Split a filename into its separate parts.

### Syntax

```
string filedir(string file);  
string fileext(string file);  
string filename(string file);  
string filesetext(string file, string newext);
```

### Returns

`filedir` returns the directory of file (including the drive letter under Windows).

`fileext` returns the extension of file.

`filename` returns the file name of file (including the extension).

`filesetext` returns file with the extension set to `newext`.

See also [Filedata Functions](#)

## Example

```
if (board) board(B) {  
    output(filesetext(B.name, ".out")) {  
        ...  
    }  
}
```

## Filedata Functions

### Function

Gets the timestamp and size of a file.

### Syntax

```
int filesize(string filename);  
int filetime(string filename);
```

### Returns

`filesize` returns the size (in byte) of the given file.

`filetime` returns the timestamp of the given file in a format to be used with the [time functions](#).

See also [time](#), [Filename Functions](#)

## Example

```
board(B)  
    printf("Board: %s\nSize: %d\nTime: %s\n",  
        B.name, filesize(B.name),
```

```
t2string(filetime(B.name)));
```

## File Input Functions

*File input functions* are used to read data from files.

The following file input is available:

- [fileread\(\)](#)

See [output\(\)](#) for information about how to write into a file.

### fileread()

#### Function

Reads data from a file.

#### Syntax

```
int fileread(dest, string file);
```

#### Returns

`fileread` returns the number of objects read from the file.

The actual meaning of the return value depends on the type of `dest`.

See also [lookup](#), [strsplit](#), [fileerror](#)

If `dest` is a character array, the file will be read as raw binary data and the return value reflects the number of bytes read into the character array (which is equal to the file size).

If `dest` is a string array, the file will be read as a text file (one line per array member) and the return value will be the number of lines read into the string array. Newline characters will be stripped.

If `dest` is a string, the entire file will be read into that string and the return value will be the length of that string (which is not necessarily equal to the file size, if the operating system stores text files with "cr/lf" instead of a "newline" character).

#### Example

```
char b[];
int nBytes = fileread(b, "data.bin");
string lines[];
int nLines = fileread(lines, "data.txt");
string text;
int nChars = fileread(text, "data.txt");
```

## Mathematical Functions

*Mathematical functions* are used to perform mathematical operations.

The following mathematical functions are available:

- [abs\(\)](#)
- [acos\(\)](#)



- asin()
- atan()
- ceil()
- cos()
- exp()
- floor()
- frac()
- log()
- log10()
- max()
- min()
- pow()
- round()
- sin()
- sqrt()
- trunc()
- tan()

## Error Messages

If the arguments of a mathematical function call lead to an error, the error message will show the actual values of the arguments. Thus the statements

```
real x = -1.0;  
real r = sqrt(2 * x);
```

will lead to the error message

```
Invalid argument in call to 'sqrt(-2)'
```

## Absolute, Maximum and Minimum Functions

### Function

Absolute, maximum and minimum functions.

### Syntax

```
type abs(type x);  
type max(type x, type y);  
type min(type x, type y);
```

### Returns

`abs` returns the absolute value of `x`.  
`max` returns the maximum of `x` and `y`.  
`min` returns the minimum of `x` and `y`.

The return type of these functions is the same as the (larger) type of the arguments. type must be one of char, int or real.

**Example**

```
real x = 2.567, y = 3.14;
printf("The maximum is %f\n", max(x, y));
```

**Rounding Functions****Function**

Rounding functions.

**Syntax**

```
real ceil(real x);
real floor(real x);
real frac(real x);
real round(real x);
real trunc(real x);
```

**Returns**

`ceil` returns the smallest integer not less than `x`.  
`floor` returns the largest integer not greater than `x`.  
`frac` returns the fractional part of `x`.  
`round` returns `x` rounded to the nearest integer.  
`trunc` returns the integer part of `x`.

**Example**

```
real x = 2.567;
printf("The rounded value of %f is %f\n", x, round(x));
```

**Trigonometric Functions****Function**

Trigonometric functions.

**Syntax**

```
real acos(real x);
real asin(real x);
real atan(real x);
real cos(real x);
real sin(real x);
real tan(real x);
```

**Returns**

`acos` returns the arc cosine of `x`.  
`asin` returns the arc sine of `x`.  
`atan` returns the arc tangent of `x`.  
`cos` returns the cosine of `x`.  
`sin` returns the sine of `x`.  
`tan` returns the tangent of `x`.

## Constants

**PI** the value of "pi"  
(3.14...)

## Example

```
real x = PI / 2;  
printf("The sine of %f is %f\n", x, sin(x));
```

## Exponential Functions

### Function

Exponential Functions.

### Syntax

```
real exp(real x);  
real log(real x);  
real log10(real x);  
real pow(real x, real y);  
real sqrt(real x);
```

### Returns

`exp` returns the exponential  $e$  to the power of  $x$ .  
`log` returns the natural logarithm of  $x$ .  
`log10` returns the base 10 logarithm of  $x$ .  
`pow` returns the value of  $x$  to the power of  $y$ .  
`sqrt` returns the square root of  $x$ .

## Note

The "n-th" root can be calculated using the `pow` function with a negative exponent.

## Example

```
real x = 2.1;  
printf("The square root of %f is %f\n", x, sqrt(x));
```

## Miscellaneous Functions

*Miscellaneous functions* are used to perform various tasks.

The following miscellaneous functions are available:

- [exit\(\)](#)
- [language\(\)](#)
- [lookup\(\)](#)
- [palette\(\)](#)
- [sort\(\)](#)
- [status\(\)](#)
- [system\(\)](#)

- Unit Conversions

## exit()

### Function

Exits from a User Language Program.

### Syntax

```
void exit(int result);  
void exit(string command);
```

### See also RUN

The `exit` function terminates execution of a User Language Program.

If an integer `result` is given it will be used as the return value of the program.

If a string `command` is given, that command will be executed as if it were entered into the command line immediately after the `RUN` command. In that case the return value of the ULP is set to `EXIT_SUCCESS`.

## Constants

<code>EXIT_SUCCESS</code>	return value for successful program execution (value 0)
<code>EXIT_FAILURE</code>	return value for failed program execution (value -1)

## language()

### Function

Returns the language code of the system in use.

### Syntax

```
string language();
```

### Returns

`language` returns a string consisting of two lowercase characters that identifies the language used on the current system. If no such language setting can be determined, an empty string will be returned.

The `language` function can be used to make a ULP use different message string, depending on which language the current system is using.

In the example below all the strings used in the ULP are listed in the string array `I18N[]`, preceded by a string containing the various language codes supported by this ULP. Note the `vtab` characters used to separate the individual parts of each string (they are important for the `lookup` function) and the use of the commas to separate the strings. The actual work is done in the function `tr()`, which returns the translated version of the given string. If the original string can't be found in the `I18N` array, or there is no translation for the current language, the original string will be used untranslated.

The first language defined in the `I18N` array must be the one in which the strings used throughout the ULP are written, and should generally be English in order to make the program accessible to the largest number of users.

**Example**

```

string I18N[] = {
    "en\v"
    "de\v"
    "it\v"

    /
    "I18N Demo\v"
    "Beispiel für Internationalisierung\v"
    "Esempio per internazionalizzazione\v"

    /
    "Hello world!\v"
    "Hallo Welt!\v"
    "Ciao mondo!\v"

    /
    "+Ok\v"
    "+Ok\v"
    "+Approvazione\v"

    /
    "-Cancel\v"
    "-Abbrechen\v"
    "-Annullamento\v"
};
int Language = strstr(I18N[0], language()) / 3;
string tr(string s)
{
    string t = lookup(I18N, s, Language, '\v');
    return t ? t : s;
}
dlgDialog(tr("I18N Demo")) {
    dlgHBoxLayout dlgSpacing(350);
    dlgLabel(tr("Hello world!"));
    dlgHBoxLayout {
        dlgPushButton(tr("+Ok")) dlgAccept();
        dlgPushButton(tr("-Cancel")) dlgReject();
    }
};

```

**lookup()****Function**

Looks up data in a string array.

**Syntax**

```

string lookup(string array[], string key, int field_index[,
char separator]);
string lookup(string array[], string key, string field_name[,
char separator]);

```

**Returns**

lookup returns the value of the field identified by `field_index` or `field_name`. If the field doesn't exist, or no string matching key is found, an empty string is returned.

See also [fileread](#), [strsplit](#)

An array that can be used with `lookup()` consists of strings of text, each string representing one data record.

Each data record contains an arbitrary number of fields, which are separated by the character separator (default is `'\t'`, the tabulator). The first field in a record is used as the key and is numbered 0.

All records must have unique key fields and none of the key fields may be empty - otherwise it is undefined which record will be found.

If the first string in the array contains a "Header" record (i.e. a record where each field describes its contents), using `lookup` with a `field_name` string automatically determines the index of that field. This allows using the `lookup` function without exactly knowing which field index contains the desired data.

It is up to the user to make sure that the first record actually contains header information.

If the key parameter in the call to `lookup()` is an empty string, the first string of the array will be used. This allows a program to determine whether there is a header record with the required field names.

If a field contains the separator character, that field must be enclosed in double quotes (as in `"abc;def"`, assuming the semicolon (`' ; '`) is used as separator). The same applies if the field contains double quotes (`"`), in which case the double quotes inside the field have to be doubled (as in `"abc;""def"";ghi"`, which would be `abc;"def";ghi`).

**It is best to use the default "tab" separator, which doesn't have these problems (no field can contain a tabulator).**

Here's an example data file (`' ; '` has been used as separator for better readability):

```
Name;Manufacturer;Code;Price
7400;Intel;I-01-234-97;$0.10
68HC12;Motorola;M68HC1201234;$3.50
```

## Example

```
string OrderCodes[];
if (fileread(OrderCodes, "ordercodes") > 0) {
    if (lookup(OrderCodes, "", "Code", ';')) {
        schematic(SCH) {
            SCH.parts(P) {
                string OrderCode;
                // both following statements do exactly the same:
                OrderCode = lookup(OrderCodes, P.device.name, "Code", ';');
                OrderCode = lookup(OrderCodes, P.device.name, 2, ';');
            }
        }
    }
    else
        dlgMessageBox("Missing 'Code' field in file 'ordercodes'");
}
```

## palette()

### Function

Returns color palette information.

### Syntax

```
int palette(int index[, int type]);
```

### Returns

The `palette` function returns an integer ARGB value in the form `0xaarrggbb`, or the type of the currently used palette (depending on the value of `index`).

The `palette` function returns the ARGB value of the color with the given `index` (which may be in the range `0..PALETTE_ENTRIES-1`). If `type` is not given (or is `-1`) the palette assigned to the current editor window will be used. Otherwise `type` specifies which color palette to use (`PALETTE_BLACK`, `PALETTE_WHITE` or `PALETTE_COLORED`).

The special value `-1` for `index` makes the function return the type of the palette that is currently in use by the editor window.

If either `index` or `type` is out of range, an error message will be given and the ULP will be terminated.

### Constants

<code>PALETTE_TYPES</code>	the number of palette types (3)
<code>PALETTE_BLACK</code>	the black background palette (0)
<code>PALETTE_WHITE</code>	the white background palette (1)
<code>PALETTE_COLORED</code>	the colored background palette (2)
<code>PALETTE_ENTRIES</code>	the number of colors per palette (64)

## sort()

### Function

Sorts an array or a set of arrays.

### Syntax

```
void sort(int number, array1[, array2, ...]);
```

The `sort` function either directly sorts a given `array1`, or it sorts a set of arrays (starting with `array2`), in which case `array1` is supposed to be an array of `int`, which will be used as a pointer array.

In any case, the `number` argument defines the number of items in the array(s).

### Sorting a single array

If the `sort` function is called with one single array, that array will be sorted directly, as in the following example:

```
string A[];  
int n = 0;
```

```
A[n++] = "World";
A[n++] = "Hello";
A[n++] = "The truth is out there...";
sort(n, A);
for (int i = 0; i < n; ++i)
    printf(A[i]);
```

## Sorting a set of arrays

If the `sort` function is called with more than one array, the first array must be an array of `int`, while all of the other arrays may be of any array type and hold the data to be sorted. The following example illustrates how the first array will be used as a pointer:

```
numeric string Nets[], Parts[], Instances[], Pins[];
int n = 0;
int index[];
schematic(S) {
    S.nets(N) N.pinrefs(P) {
        Nets[n] = N.name;
        Parts[n] = P.part.name;
        Instances[n] = P.instance.name;
        Pins[n] = P.pin.name;
        ++n;
    }
    sort(n, index, Nets, Parts, Instances, Pins);
    for (int i = 0; i < n; ++i)
        printf("%-8s %-8s %-8s %-8s\n",
            Nets[index[i]], Parts[index[i]],
            Instances[index[i]], Pins[index[i]]);
}
```

The idea behind this is that one net can have several pins connected to it, and in a netlist you might want to have the net names sorted, and within one net you also want the part names sorted and so on.

Note the use of the keyword `numeric` in the string arrays. This causes the strings to be sorted in a way that takes into account a numeric part at the end of the strings, which leads to IC1, IC2,... IC9, IC10 instead of the alphabetical order IC1, IC10, IC2,...IC9.

When sorting a set of arrays, the first (`index`) array must be of type `int` and need not be initialized. Any contents the index array might have before calling the `sort` function will be overwritten by the resulting index values.

## status()

### Function

Displays a status message in the status bar.

### Syntax

```
void status(string message);
```

See also [dlgMessageBox\(\)](#)

The status function displays the given message in the status bar of the editor window in



which the ULP is running.

## system()

### Function

Executes an external program.

### Syntax

```
int system(string command);
```

### Returns

The `system` function returns the exit status of the command. This is typically 0 if everything was ok, and non-zero in case of an error.

The `system` function executes the external program given by the command string, and waits until the program ends.

As a security precaution, you will be prompted with the command string before the command is executed, in order to make sure there is no "evil" ULP that executes unwanted external commands. If this dialog is canceled, the `system()` call will return -1. If the dialog is confirmed, any future `system()` calls in the current EAGLE session with exactly the same command string will be executed without any further confirmation dialog.

## Input/Output redirection

If the external program shall read its standard input from (or write its standard output to) a particular file, input/output needs to be redirected.



On **Linux** and **Mac OS X** this is done by simply adding a '`<`' or '`>`' to the command line, followed by the desired file name, as in



```
system("program < infile > outfile");
```

which runs `program` and makes it read from `infile` and write to `outfile`.



On **Windows** you have to explicitly run a command processor to do this, as in

```
system("cmd.exe /c program < infile > outfile");
```

(on DOS based Windows systems use `command.com` instead of `cmd.exe`).

## Background execution

The `system` function waits until the given program has ended. This is useful for programs that only run for a few seconds, or completely take over the user's attention.



If an external program runs for a longer time, and you want the system call to return immediately, without waiting for the program to end, you can simply add an '`&`' to the command string under **Linux** and **Mac OS X**, as in



```
system("program &");
```



Under Windows you need to explicitly run a command processor to do this, as in

```
system("cmd.exe /c start program");
```

(on DOS based Windows systems use `command.com` instead of `cmd.exe`).

### Example

```
int result = system("simulate -f filename");
```

This would call a simulation program, giving it a file which the ULP has just created. Note that `simulate` here is just an example, it is not part of the EAGLE package!

## Unit Conversions

### Function

Converts internal units.

### Syntax

```
real u2inch(int n);
real u2mic(int n);
real u2mil(int n);
real u2mm(int n);
```

### Returns

`u2inch` returns the value of `n` in *inch*.

`u2mic` returns the value of `n` in *microns* (1/1000mm).

`u2mil` returns the value of `n` in *mil* (1/1000inch).

`u2mm` returns the value of `n` in *millimeters*.

See also [UL\\_GRID](#)

EAGLE stores all coordinate and size values as int values with a resolution of 1/10000mm (0.1 $\mu$ ). The above unit conversion functions can be used to convert these internal units to the desired measurement units.

### Example

```
board(B) {
  B.elements(E) {
    printf("%s at (%f, %f)\n", E.name,
          u2mm(E.x), u2mm(E.y));
  }
}
```

## Printing Functions

*Printing functions* are used to print formatted strings.

The following printing functions are available:

- [printf\(\)](#)

- [sprintf\(\)](#)

## printf()

### Function

Writes formatted output to a file.

### Syntax

```
int printf(string format[, argument, ...]);
```

### Returns

The `printf` function returns the number of characters written to the file that has been opened by the most recent [output](#) statement.

In case of an error, `printf` returns `-1`.

See also [sprintf](#), [output](#), [fileerror](#)

## Format string

The format string controls how the arguments will be converted, formatted and printed. There must be exactly as many arguments as necessary for the format. The number and type of arguments will be checked against the format, and any mismatch will lead to an error message.

The format string contains two types of objects - *plain characters* and *format specifiers*:

- Plain characters are simply copied verbatim to the output
- Format specifiers fetch arguments from the argument list and apply formatting to them

## Format specifiers

A format specifier has the following form:

```
% [flags] [width] [.prec] type
```

Each format specification begins with the percent character (%). After the % comes the following, in this order:

- an optional sequence of flag characters, [flags]
- an optional width specifier, [width]
- an optional precision specifier, [.prec]
- the conversion type character, type

## Conversion type characters

d    **signed decimal int**  
o    **unsigned octal int**  
u    **unsigned decimal int**  
x    **unsigned hexadecimal int** (with a, b,...)  
X    **unsigned hexadecimal int** (with A, B,...)

f	<b>signed real</b> value of the form [ - ] dddd . dddd
e	<b>signed real</b> value of the form [ - ] d . dddd e [ ± ] ddd
E	same as e, but with E for exponent
g	<b>signed real</b> value in either e or f form, based on given value and precision
G	same as g, but with E for exponent if e format used
C	single character
S	character string
%	the % character is printed

## Flag characters

The following flag characters can appear in any order and combination.

" -	the formatted item is left-justified within the field; normally, items are right-justified
" +	a signed, positive item will always start with a plus character (+); normally, only negative items begin with a sign
" "	a signed, positive item will always start with a space character; if both "+" and " " are specified, "+" overrides " "

## Width specifiers

The width specifier sets the minimum field width for an output value.

Width is specified either directly, through a decimal digit string, or indirectly, through an asterisk (\*). If you use an asterisk for the width specifier, the next argument in the call (which must be an `int`) specifies the minimum output field width.

In no case does a nonexistent or small field width cause truncation of a field. If the result of a conversion is wider than the field width, the field is simply expanded to contain the conversion result.

<i>n</i>	At least <i>n</i> characters are printed. If the output value has less than <i>n</i> characters, the output is padded with blanks (right-padded if " -" flag given, left-padded otherwise).
<i>0n</i>	At least <i>n</i> characters are printed. If the output value has less than <i>n</i> characters, it is filled on the left with zeroes.
*	The argument list supplies the width specifier, which must precede the actual argument being formatted.

## Precision specifiers

A precision specifier always begins with a period (.) to separate it from any preceding width specifier. Then, like width, precision is specified either directly through a decimal digit string, or indirectly, through an asterisk (\*). If you use an asterisk for the precision specifier, the next argument in the call (which must be an `int`) specifies the precision.

none	Precision set to default.
.0	For <code>int</code> types, precision is set to default; for <code>real</code> types, no decimal point is printed.
. <i>n</i>	<i>n</i> characters or <i>n</i> decimal places are printed. If the output value has more than <i>n</i> characters the output might be truncated or rounded (depending on the type)

character).

- \* The argument list supplies the precision specifier, which must precede the actual argument being formatted.

### Default precision values

douxX	1
eEf	6
gG	all significant digits
c	no effect
s	print entire string

### How precision specification ( . n ) affects conversion

douxX	.n specifies that at least <i>n</i> characters are printed. If the input argument has less than <i>n</i> digits, the output value is left-padded with zeros. If the input argument has more than <i>n</i> digits, the output value is <b>not</b> truncated.
eEf	.n specifies that <i>n</i> characters are printed after the decimal point, and the last digit printed is rounded.
gG	.n specifies that at most <i>n</i> significant digits are printed.
c	.n has no effect on the output.
s	.n specifies that no more than <i>n</i> characters are printed.

### Binary zero characters

Unlike `printf`, the `printf` function can print binary zero characters (0x00).

```
char c = 0x00;
printf("%c", c);
```

### Example

```
int i = 42;
real r = 3.14;
char c = 'A';
string s = "Hello";
printf("Integer: %8d\n", i);
printf("Hex:      %8X\n", i);
printf("Real:     %8f\n", r);
printf("Char:    %-8c\n", c);
printf("String:  %-8s\n", s);
```

## sprintf()

### Function

Writes formatted output into a string.

### Syntax

```
int sprintf(string result, string format[, argument, ...]);
```

### Returns

The `printf` function returns the number of characters written into the `result`

string.

In case of an error, `sprintf` returns -1.

See also [printf](#)

## Format string

See [printf](#).

## Binary zero characters

Note that `sprintf` can not return strings with embedded binary zero characters (0x00). If the resulting string contains a binary zero character, any characters following that zero character will be dropped. Use [printf](#) if you need to output binary data.

## Example

```
string result;
int number = 42;
sprintf(result, "The number is %d", number);
```

## String Functions

*String functions* are used to manipulate character strings.

The following string functions are available:

- [strchr\(\)](#)
- [strjoin\(\)](#)
- [strlen\(\)](#)
- [strlwr\(\)](#)
- [strrchr\(\)](#)
- [strrstr\(\)](#)
- [strsplit\(\)](#)
- [strstr\(\)](#)
- [strsub\(\)](#)
- [strtod\(\)](#)
- [strtol\(\)](#)
- [strupr\(\)](#)
- [strxstr\(\)](#)

## strchr()

### Function

Scans a string for the first occurrence of a given character.

### Syntax

```
int strchr(string s, char c[, int index]);
```

### Returns

The `strchr` function returns the integer offset of the character in the string, or -1 if the character does not occur in the string.

See also [strrchr](#), [strstr](#)

If `index` is given, the search starts at that position. Negative values are counted from the end of the string.

### Example

```
string s = "This is a string";
char c = 'a';
int pos = strchr(s, c);
if (pos >= 0)
    printf("The character %c is at position %d\n", c, pos);
else
    printf("The character was not found\n");
```

## strjoin()

### Function

Joins a string array to form a single string.

### Syntax

```
string strjoin(string array[], char separator);
```

### Returns

The `strjoin` function returns the combined entries of array.

See also [strsplit](#), [lookup](#), [fileread](#)

`strjoin` joins all entries in array, delimited by the given separator and returns the resulting string.

If separator is the newline character ("`\n`") the resulting string will be terminated with a newline character. This is done to have a text file that consists of N lines (each of which is terminated with a newline) and is read in with the [fileread\(\)](#) function and [split](#) into an array of N strings to be joined to the original string as read from the file.

### Example

```
string a[] = { "Field 1", "Field 2", "Field 3" };
string s = strjoin(a, ':');
```

## strlen()

### Function

Calculates the length of a string.

### Syntax

```
int strlen(string s);
```

### Returns

The `strlen` function returns the number of characters in the string.

**Example**

```
string s = "This is a string";
int l = strlen(s);
printf("The string is %d characters long\n", l);
```

**strlwr()****Function**

Converts uppercase letters in a string to lowercase.

**Syntax**

```
string strlwr(string s);
```

**Returns**

The `strlwr` function returns the modified string. The original string (given as parameter) is not changed.

See also [strupr](#), [tolower](#)

**Example**

```
string s = "This Is A String";
string r = strlwr(s);
printf("Prior to strlwr: %s - after strlwr: %s\n", s, r);
```

**strrchr()****Function**

Scans a string for the last occurrence of a given character.

**Syntax**

```
int strrchr(string s, char c[, int index]);
```

**Returns**

The `strrchr` function returns the integer offset of the character in the string, or `-1` if the character does not occur in the string.

See also [strchr](#), [strrstr](#)

If `index` is given, the search starts at that position. Negative values are counted from the end of the string.

**Example**

```
string s = "This is a string";
char c = 'a';
int pos = strrchr(s, c);
if (pos >= 0)
    printf("The character %c is at position %d\n", c, pos);
else
    printf("The character was not found\n");
```



## strstr()

### Function

Scans a string for the last occurrence of a given substring.

### Syntax

```
int strstr(string s1, string s2[, int index]);
```

### Returns

The `strstr` function returns the integer offset of the first character of `s2` in `s1`, or `-1` if the substring does not occur in the string.

See also [strstr](#), [strchr](#)

If `index` is given, the search starts at that position. Negative values are counted from the end of the string.

### Example

```
string s1 = "This is a string", s2 = "is a";
int pos = strstr(s1, s2);
if (pos >= 0)
    printf("The substring starts at %d\n", pos);
else
    printf("The substring was not found\n");
```

## strsplit()

### Function

Splits a string into separate fields.

### Syntax

```
int strsplit(string &array[], string s, char separator);
```

### Returns

The `strsplit` function returns the number of entries copied into `array`.

See also [strjoin](#), [lookup](#), [fileread](#)

`strsplit` splits the string `s` at the given `separator` and stores the resulting fields in the `array`.

If `separator` is the newline character ("`\n`") the last field will be silently dropped if it is empty. This is done to have a text file that consists of `N` lines (each of which is terminated with a newline) and is read in with the [fileread\(\)](#) function to be split into an array of `N` strings. With any other `separator` an empty field at the end of the string will count, so "`a:b:c:`" will result in 4 fields, the last of which is empty.

### Example

```
string a[];
int n = strsplit(a, "Field 1:Field 2:Field 3", ':');
```

## strstr()

### Function

Scans a string for the first occurrence of a given substring.

### Syntax

```
int strstr(string s1, string s2[, int index]);
```

### Returns

The `strstr` function returns the integer offset of the first character of `s2` in `s1`, or `-1` if the substring does not occur in the string.

See also [strrstr](#), [strchr](#), [strxstr](#)

If `index` is given, the search starts at that position. Negative values are counted from the end of the string.

### Example

```
string s1 = "This is a string", s2 = "is a";
int pos = strstr(s1, s2);
if (pos >= 0)
    printf("The substring starts at %d\n", pos);
else
    printf("The substring was not found\n");
```

## strsub()

### Function

Extracts a substring from a string.

### Syntax

```
string strsub(string s, int start[, int length]);
```

### Returns

The `strsub` function returns the substring indicated by the `start` and `length` value.

The value for `length` must be positive, otherwise an empty string will be returned. If `length` is omitted, the rest of the string (beginning at `start`) is returned.

If `start` points to a position outside the string, an empty string is returned.

### Example

```
string s = "This is a string";
string t = strsub(s, 4, 7);
printf("The extracted substring is: %s\n", t);
```

## strtod()

### Function

Converts a string to a real value.

**Syntax**

```
real strtod(string s);
```

**Returns**

The `strtod` function returns the numerical representation of the given string as a real value. Conversion ends at the first character that does not fit into the format of a real constant. If an error occurs during conversion of the string `0.0` will be returned.

See also [strtol](#)

**Example**

```
string s = "3.1415";  
real r = strtod(s);  
printf("The value is %f\n", r);
```

**strtol()****Function**

Converts a string to an integer value.

**Syntax**

```
int strtol(string s);
```

**Returns**

The `strtol` function returns the numerical representation of the given string as an `int` value. Conversion ends at the first character that does not fit into the format of an integer constant. If an error occurs during conversion of the string `0` will be returned.

See also [strtod](#)

**Example**

```
string s = "1234";  
int i = strtol(s);  
printf("The value is %d\n", i);
```

**strupr()****Function**

Converts lowercase letters in a string to uppercase.

**Syntax**

```
string strupr(string s);
```

**Returns**

The `strupr` function returns the modified string. The original string (given as parameter) is not changed.

See also [strlwr](#), [toupper](#)

### Example

```
string s = "This Is A String";
string r = strupr(s);
printf("Prior to strupr: %s - after strupr: %s\n", s, r);
```

## strxstr()

### Function

Scans a string for the first occurrence of a given regular expression.

### Syntax

```
int strxstr(string s1, string s2[, int index[, int &length]]);
```

### Returns

The `strxstr` function returns the integer offset of the substring in `s1` that matches the regular expression in `s2`, or `-1` if the regular expression does not match in the string.

See also [strstr](#), [strchr](#), [strrstr](#)

If `index` is given, the search starts at that position. Negative values are counted from the end of the string.

If `length` is given, the actual length of the matching substring is returned in that variable.

*Regular expressions* allow you to find a pattern within a text string. For instance, the regular expression `"i.*a"` would find a sequence of characters that starts with an `'i'`, followed by any character (`'.'`) any number of times (`'*'`), and ends with an `'a'`. It would match on `"is a"` as well as `"is this a"` or `"ia"`.

Details on regular expressions can be found, for instance, in the book *Mastering Regular Expressions* by Jeffrey E. F. Friedl.

### Example

```
string s1 = "This is a string", s2 = "i.*a";
int len = 0;
int pos = strxstr(s1, s2, 0, len);
if (pos >= 0)
    printf("The substring starts at %d and is %d charcaters long\n", pos, len);
else
    printf("The substring was not found\n");
```

## Time Functions

*Time functions* are used to get and process time and date information.

The following time functions are available:

- [t2day\(\)](#)
- [t2dayofweek\(\)](#)

- [t2hour\(\)](#)
- [t2minute\(\)](#)
- [t2month\(\)](#)
- [t2second\(\)](#)
- [t2string\(\)](#)
- [t2year\(\)](#)
- [time\(\)](#)
- [timems\(\)](#)

## **time()**

### **Function**

Gets the current system time.

### **Syntax**

```
int time(void);
```

### **Returns**

The `time` function returns the current system time as the number of seconds elapsed since a system dependent reference date.

See also [Time Conversions](#), [filetime](#), [timems\(\)](#)

### **Example**

```
int CurrentTime = time();
```

## **timems()**

### **Function**

Gets the number of milliseconds since the start of the ULP.

### **Syntax**

```
int timems(void);
```

### **Returns**

The `timems` function returns the number of milliseconds since the start of the ULP.

After 86400000 milliseconds (i.e. every 24 hours), the value starts at 0 again.

See also [time](#)

### **Example**

```
int elapsed = timems();
```

## **Time Conversions**

### **Function**

Convert a time value to day, month, year etc.

### **Syntax**

```
int t2day(int t);
int t2dayofweek(int t);
int t2hour(int t);
int t2minute(int t);
int t2month(int t);
int t2second(int t);
int t2year(int t);
```

```
string t2string(int t);
```

**Returns**

t2day returns the day of the month (1..31)  
t2dayofweek returns the day of the week (0=sunday..6)  
t2hour returns the hour (0..23)  
t2minute returns the minute (0..59)  
t2month returns the month (0..11)  
t2second returns the second (0..59)  
t2year returns the year (including century!)  
t2string returns a formatted string containing date and time

See also [time](#)

**Example**

```
int t = time();
printf("It is now %02d:%02d:%02d\n",
      t2hour(t), t2minute(t), t2second(t));
```

## Object Functions

*Object functions* are used to access common information about objects.

The following object functions are available:

- [clrgroup\(\)](#)
- [ingroup\(\)](#)
- [setgroup\(\)](#)

### clrgroup()

**Function**

Clears the group flags of an object.

**Syntax**

```
void clrgroup(object);
```

See also [ingroup\(\)](#), [setgroup\(\)](#), [GROUP command](#)

The `clrgroup()` function clears the group flags of the given object, so that it is no longer part of the previously defined group.

When applied to an object that contains other objects (like a UL\_BOARD or UL\_NET) the group flags of all contained objects are cleared recursively.

### Example

```
board(B) {
  B.elements(E)
  clrgroup(E);
}
```

## ingroup()

### Function

Checks whether an object is in the group.

### Syntax

```
int ingroup(object);
```

### Returns

The `ingroup` function returns a non-zero value if the given object is in the group.

**See also** [clrgroup\(\)](#), [setgroup\(\)](#), [GROUP command](#)

If a group has been defined in the editor, the `ingroup()` function can be used to check whether a particular object is part of the group.

Objects with a single coordinate that are individually selectable in the current drawing (like UL\_TEXT, UL\_VIA, UL\_CIRCLE etc.) return a non-zero value in a call to `ingroup()` if that coordinate is within the defined group.

A UL\_WIRE returns 0, 1, 2 or 3, depending on whether none, the first, the second or both of its end points are in the group.

A UL\_RECTANGLE and UL\_FRAME returns a non-zero value if one or more of its corners are in the group. The value has bit 0 set for the upper right corner, bit 1 for the upper left, bit 2 for the bottom left, and bit 3 for the bottom right corner.

Objects that have no coordinates (like UL\_NET, UL\_SEGMENT, UL\_SIGNAL etc.) return a non-zero value if one or more of the objects within them are in the group.

UL\_CONTACTREF and UL\_PINREF, though not having coordinates of their own, return a non-zero value if the referenced UL\_CONTACT or UL\_PIN, respectively, is within the group.

### Example

```
output("group.txt") {
  board(B) {
    B.elements(E) {
      if (ingroup(E))
        printf("Element %s is in the group\n", E.name);
    }
  }
}
```

## setgroup()

### Function

Sets the group flags of an object.

### Syntax

```
void setgroup(object[, int flags]);
```

**See also** [clrgroup\(\)](#), [ingroup\(\)](#), [GROUP command](#)

The `setgroup()` function sets the group flags of the given object, so that it becomes part of the group.

If no `flags` are given, the object is added to the group as a whole (i.e. all of its selection points, in case it has more than one).

If `flags` has a non-zero value, only the group flags of the given points of the object are set. For a `UL_WIRE` this means that '1' sets the group flag of the first point, '2' that of the second point, and '3' sets both. Any previously set group flags remain unchanged by a call to `setgroup()`.

When applied to an object that contains other objects (like a `UL_BOARD` or `UL_NET`) the group flags of all contained objects are set recursively.

### Example

```
board(B) {
    B.elements(E)
        setgroup(E);
}
```

## Builtin Statements

*Builtin statements* are generally used to open a certain context in which data structures of files can be accessed.

The general syntax of a builtin statement is

```
name(parameters) statement
```

where `name` is the name of the builtin statement, `parameters` stands for one or more parameters, and `statement` is the code that will be executed inside the context opened by the builtin statement.

Note that `statement` can be a compound statement, as in

```
board(B) {
    B.elements(E) printf("Element: %s\n", E.name);
    B.Signals(S)  printf("Signal: %s\n", S.name);
}
```

The following builtin statements are available:

- [board\(\)](#)



- [deviceset\(\)](#)
- [library\(\)](#)
- [output\(\)](#)
- [package\(\)](#)
- [schematic\(\)](#)
- [sheet\(\)](#)
- [symbol\(\)](#)

## board()

### Function

Opens a board context.

### Syntax

```
board(identifier) statement
```

**See also** [schematic](#), [library](#)

The `board` statement opens a board context if the current editor window contains a board drawing. A variable of type `UL_BOARD` is created and is given the name indicated by `identifier`.

Once the board context is successfully opened and a board variable has been created, the statement is executed. Within the scope of the statement the board variable can be accessed to retrieve further data from the board.

If the current editor window does not contain a board drawing, an error message is given and the ULP is terminated.

### Check if there is a board

By using the `board` statement without an argument you can check if the current editor window contains a board drawing. In that case, `board` behaves like an integer constant, returning 1 if there is a board drawing in the current editor window, and 0 otherwise.

### Accessing board from a schematic

If the current editor window contains a schematic drawing, you can still access that schematic's board by preceding the `board` statement with the prefix `project`, as in `project.board(B) { ... }`

This will open a board context regardless whether the current editor window contains a board or a schematic drawing. However, there must be an editor window containing that board somewhere on the desktop!

### Example

```
if (board)
  board(B) {
    B.elements(E)
    printf("Element: %s\n", E.name);
```

```
}
```

## deviceset()

### Function

Opens a device set context.

### Syntax

```
deviceset(identifier) statement
```

See also [package](#), [symbol](#), [library](#)

The `deviceset` statement opens a device set context if the current editor window contains a device drawing. A variable of type `UL_DEVICESET` is created and is given the name indicated by `identifier`.

Once the device set context is successfully opened and a device set variable has been created, the statement is executed. Within the scope of the statement the device set variable can be accessed to retrieve further data from the device set.

If the current editor window does not contain a device drawing, an error message is given and the ULP is terminated.

### Check if there is a device set

By using the `deviceset` statement without an argument you can check if the current editor window contains a device drawing. In that case, `deviceset` behaves like an integer constant, returning 1 if there is a device drawing in the current editor window, and 0 otherwise.

### Example

```
if (deviceset)
  deviceset(D) {
    D.gates(G)
    printf("Gate: %s\n", G.name);
  }
```

## library()

### Function

Opens a library context.

### Syntax

```
library(identifier) statement
```

See also [board](#), [schematic](#), [deviceset](#), [package](#), [symbol](#)

The `library` statement opens a library context if the current editor window contains a library drawing. A variable of type `UL_LIBRARY` is created and is given the name indicated by `identifier`.

Once the library context is successfully opened and a library variable has been created, the statement is executed. Within the scope of the statement the library variable can be accessed to retrieve further data from the library.

If the current editor window does not contain a library drawing, an error message is given and the ULP is terminated.

### Check if there is a library

By using the `library` statement without an argument you can check if the current editor window contains a library drawing. In that case, `library` behaves like an integer constant, returning 1 if there is a library drawing in the current editor window, and 0 otherwise.

### Example

```
if (library)
  library(L) {
    L.devices(D)
    printf("Device: %s\n", D.name);
  }
```

## output()

### Function

Opens an output file for subsequent `printf()` calls.

### Syntax

```
output(string filename[, string mode]) statement
```

See also [printf](#), [fileerror](#)

The output statement opens a file with the given `filename` and `mode` for output through subsequent `printf()` calls. If the file has been successfully opened, the statement is executed, and after that the file is closed.

If the file cannot be opened, an error message is given and execution of the ULP is terminated.

By default the output file is written into the **Project** directory.

### File Modes

The `mode` parameter defines how the output file is to be opened. If no `mode` parameter is given, the default is "wt".

- a append to an existing file, or create a new file if it does not exist
- w create a new file (overwriting an existing file)
- t open file in text mode
- b open file in binary mode
- D delete this file when ending the EAGLE session (only works together with w)

F force using this file name (normally \*.brd, \*.sch and \*.lbr are rejected)  
Mode characters may appear in any order and combination. However, only the last one of a and w or t and b, respectively, is significant. For example a mode of "abtw" would open a file for textual write, which would be the same as "wt".

## Nested Output statements

output statements can be nested, as long as there are enough file handles available, and provided that no two active output statements access the **same** file.

### Example

```
void PrintText(string s)
{
    printf("This also goes into the file: %s\n", s);
}
output("file.txt", "wt") {
    printf("Directly printed\n");
    PrintText("via function call");
}
```

## package()

### Function

Opens a package context.

### Syntax

```
package(identifier) statement
```

See also [library](#), [deviceset](#), [symbol](#)

The `package` statement opens a package context if the current editor window contains a package drawing. A variable of type `UL_PACKAGE` is created and is given the name indicated by `identifier`.

Once the package context is successfully opened and a package variable has been created, the statement is executed. Within the scope of the statement the package variable can be accessed to retrieve further data from the package.

If the current editor window does not contain a package drawing, an error message is given and the ULP is terminated.

## Check if there is a package

By using the `package` statement without an argument you can check if the current editor window contains a package drawing. In that case, `package` behaves like an integer constant, returning 1 if there is a package drawing in the current editor window, and 0 otherwise.

### Example

```
if (package)
```

```
package(P) {
  P.contacts(C)
  printf("Contact: %s\n", C.name);
}
```

## schematic()

### Function

Opens a schematic context.

### Syntax

```
schematic(identifier) statement
```

**See also** [board](#), [library](#), [sheet](#)

The `schematic` statement opens a schematic context if the current editor window contains a schematic drawing. A variable of type `UL_SCHEMATIC` is created and is given the name indicated by `identifier`.

Once the schematic context is successfully opened and a schematic variable has been created, the `statement` is executed. Within the scope of the `statement` the schematic variable can be accessed to retrieve further data from the schematic.

If the current editor window does not contain a schematic drawing, an error message is given and the ULP is terminated.

### Check if there is a schematic

By using the `schematic` statement without an argument you can check if the current editor window contains a schematic drawing. In that case, `schematic` behaves like an integer constant, returning `1` if there is a schematic drawing in the current editor window, and `0` otherwise.

### Accessing schematic from a board

If the current editor window contains a board drawing, you can still access that board's schematic by preceding the `schematic` statement with the prefix `project`, as in

```
project.schematic(S) { ... }
```

This will open a schematic context regardless whether the current editor window contains a schematic or a board drawing. However, there must be an editor window containing that schematic somewhere on the desktop!

### Access the current Sheet

Use the [sheet](#) statement to directly access the currently loaded sheet.

### Example

```
if (schematic)
  schematic(S) {
```

```
S.parts(P)
  printf("Part: %s\n", P.name);
}
```

## sheet()

### Function

Opens a sheet context.

### Syntax

```
sheet(identifier) statement
```

### See also [schematic](#)

The `sheet` statement opens a sheet context if the current editor window contains a sheet drawing. A variable of type `UL_SHEET` is created and is given the name indicated by `identifier`.

Once the sheet context is successfully opened and a sheet variable has been created, the statement is executed. Within the scope of the statement the sheet variable can be accessed to retrieve further data from the sheet.

If the current editor window does not contain a sheet drawing, an error message is given and the ULP is terminated.

### Check if there is a sheet

By using the `sheet` statement without an argument you can check if the current editor window contains a sheet drawing. In that case, `sheet` behaves like an integer constant, returning 1 if there is a sheet drawing in the current editor window, and 0 otherwise.

### Example

```
if (sheet)
  sheet(S) {
    S.parts(P)
    printf("Part: %s\n", P.name);
  }
```

## symbol()

### Function

Opens a symbol context.

### Syntax

```
symbol(identifier) statement
```

### See also [library](#), [deviceset](#), [package](#)

The `symbol` statement opens a symbol context if the current editor window contains a symbol drawing. A variable of type `UL_SYMBOL` is created and is given the name indicated by `identifier`.

Once the symbol context is successfully opened and a symbol variable has been created, the statement is executed. Within the scope of the statement the symbol variable can be accessed to retrieve further data from the symbol.

If the current editor window does not contain a symbol drawing, an error message is given and the ULP is terminated.

## Check if there is a symbol

By using the `symbol` statement without an argument you can check if the current editor window contains a symbol drawing. In that case, `symbol` behaves like an integer constant, returning 1 if there is a symbol drawing in the current editor window, and 0 otherwise.

## Example

```
if (symbol)
  symbol(S) {
    S.pins(P)
    printf("Pin: %s\n", P.name);
  }
```

## Dialogs

User Language Dialogs allow you to define your own frontend to a User Language Program.

The following sections describe User Language Dialogs in detail:

<a href="#">Predefined Dialogs</a>	describes the ready to use standard dialogs
<a href="#">Dialog Objects</a>	defines the objects that can be used in a dialog
<a href="#">Layout Information</a>	explains how to define the location of objects within a dialog
<a href="#">Dialog Functions</a>	describes special functions for use with dialogs
<a href="#">A Complete Example</a>	shows a complete ULP with a data entry dialog

## Predefined Dialogs

*Predefined Dialogs* implement the typical standard dialogs that are frequently used for selecting file names or issuing error messages.

The following predefined dialogs are available:

- [dlgDirectory\(\)](#)
- [dlgFileOpen\(\)](#)
- [dlgFileSave\(\)](#)
- [dlgMessageBox\(\)](#)

See [Dialog Objects](#) for information on how to define your own complex user dialogs.

## dlgDirectory()

### Function

Displays a directory dialog.

**Syntax**

```
string dlgDirectory(string Title[, string Start])
```

**Returns**

The `dlgDirectory` function returns the full pathname of the selected directory. If the user has canceled the dialog, the result will be an empty string.

**See also** [dlgFileOpen](#)

The `dlgDirectory` function displays a directory dialog from which the user can select a directory.

`Title` will be used as the dialog's title.

If `Start` is not empty, it will be used as the starting point for the `dlgDirectory`.

**Example**

```
string dirName;  
dirName = dlgDirectory("Select a directory", "");
```

## **dlgFileOpen(), dlgFileSave()**

**Function**

Displays a file dialog.

**Syntax**

```
string dlgFileOpen(string Title[, string Start[, string  
Filter]])  
string dlgFileSave(string Title[, string Start[, string  
Filter]])
```

**Returns**

The `dlgFileOpen` and `dlgFileSave` functions return the full pathname of the selected file.

If the user has canceled the dialog, the result will be an empty string.

**See also** [dlgDirectory](#)

The `dlgFileOpen` and `dlgFileSave` functions display a file dialog from which the user can select a file.

`Title` will be used as the dialog's title.

If `Start` is not empty, it will be used as the starting point for the file dialog. Otherwise the current directory will be used.

Only files matching `Filter` will be displayed. If `Filter` is empty, all files will be displayed.

`Filter` can be either a simple wildcard (as in `*.brd`), a list of wildcards (as in `*.bmp *.jpg`) or may even contain descriptive text, as in `Bitmap files (*.bmp)`. If the "File type" combo box of the file dialog shall contain several entries, they have to be separated by double semicolons, as in



```
"Bitmap files (*.bmp);;Other images (*.jpg *.png)".
```

## Example

```
string fileName;  
fileName = dlgFileOpen("Select a file", "", "*.brd");
```

## dlgMessageBox()

### Function

Displays a message box.

### Syntax

```
int dlgMessageBox(string Message[, button_list])
```

### Returns

The `dlgMessageBox` function returns the index of the button the user has selected. The first button in `button_list` has index 0.

### See also [status\(\)](#)

The `dlgMessageBox` function displays the given `Message` in a modal dialog and waits until the user selects one of the buttons defined in `button_list`.

If `Message` contains any HTML tags, the characters '<', '>' and '&' must be given as "&lt;", "&gt;" and "&amp;", respectively, if they shall be displayed as such.

`button_list` is an optional list of comma separated strings, which defines the set of buttons that will be displayed at the bottom of the message box.

A maximum of three buttons can be defined. If no `button_list` is given, it defaults to "OK".

The first button in `button_list` will become the default button (which will be selected if the user hits ENTER), and the last button in the list will become the "cancel button", which is selected if the user hits ESCape or closes the message box. You can make a different button the default button by starting its name with a '+', and you can make a different button the cancel button by starting its name with a '-'. To start a button text with an actual '+' or '-' it has to be escaped.

If a button text contains an '&', the character following the ampersand will become a hotkey, and when the user hits the corresponding key, that button will be selected. To have an actual '&' character in the text it has to be escaped.

The message box can be given an icon by setting the first character of `Message` to

';' - for an *Information*

!' - for a *Warning*

':' - for an *Error*

If, however, the `Message` shall begin with one of these characters, it has to be escaped.



On **Mac OS X** only the character ':' will actually result in showing an icon. All others are ignored.

**Example**

```
if (dlgMessageBox("!Are you sure?", "&Yes", "&No") == 0) {
    // let's do it!
}
```

**Dialog Objects**

A User Language Dialog is built from the following *Dialog Objects*:

<u>dlgCell</u>	a grid cell context
<u>dlgCheckBox</u>	a checkbox
<u>dlgComboBox</u>	a combo box selection field
<u>dlgDialog</u>	the basic container of any dialog
<u>dlgGridLayout</u>	a grid based layout context
<u>dlgGroup</u>	a group field
<u>dlgHBoxLayout</u>	a horizontal box layout context
<u>dlgIntEdit</u>	an integer entry field
<u>dlgLabel</u>	a text label
<u>dlgListBox</u>	a list box
<u>dlgListView</u>	a list view
<u>dlgPushButton</u>	a push button
<u>dlgRadioButton</u>	a radio button
<u>dlgRealEdit</u>	a real entry field
<u>dlgSpacing</u>	a layout spacing object
<u>dlgSpinBox</u>	a spin box selection field
<u>dlgStretch</u>	a layout stretch object
<u>dlgStringEdit</u>	a string entry field
<u>dlgTabPage</u>	a tab page
<u>dlgTabWidget</u>	a tab page container
<u>dlgTextEdit</u>	a text entry field
<u>dlgTextView</u>	a text viewer field
<u>dlgVBoxLayout</u>	a vertical box layout context

**dlgCell****Function**

Defines a cell location within a grid layout context.

**Syntax**

```
dlgCell(int row, int column[, int row2, int column2])
statement
```

**See also** [dlgGridLayout](#), [dlgHBoxLayout](#), [dlgVBoxLayout](#), [Layout Information](#), [A Complete Example](#)

The `dlgCell` statement defines the location of a cell within a [grid layout context](#).

The row and column indexes start at 0, so the upper left cell has the index (0, 0).

With two parameters the dialog object defined by `statement` will be placed in the single cell addresses by `row` and `column`. With four parameters the dialog object will span over all cells from `row/column` to `row2/column2`.

By default a `dlgCell` contains a [dlgHBoxLayout](#), so if the cell contains more than one dialog object, they will be placed next to each other horizontally.

### Example

```
string Text;
dlgGridLayout {
    dlgCell(0, 0) dlgLabel("Cell 0,0");
    dlgCell(1, 2, 4, 7) dlgTextEdit(Text);
}
```

## dlgCheckBox

### Function

Defines a checkbox.

### Syntax

```
dlgCheckBox(string Text, int &Checked) [ statement ]
```

See also [dlgRadioButton](#), [dlgGroup](#), [Layout Information](#), [A Complete Example](#)

The `dlgCheckBox` statement defines a check box with the given `Text`.

If `Text` contains an '&', the character following the ampersand will become a hotkey, and when the user hits `Alt+hotkey`, the checkbox will be toggled. To have an actual '&' character in the text it has to be escaped.

`dlgCheckBox` is mainly used within a [dlgGroup](#), but can also be used otherwise. All check boxes within the same dialog must have **different** `Checked` variables!

If the user checks a `dlgCheckBox`, the associated `Checked` variable is set to 1, otherwise it is set to 0. The initial value of `Checked` defines whether a checkbox is initially checked. If `Checked` is not equal to 0, the checkbox is initially checked.

The optional `statement` is executed every time the `dlgCheckBox` is toggled.

### Example

```
int mirror = 0;
int rotate = 1;
int flip = 0;
dlgGroup("Orientation") {
    dlgCheckBox("&Mirror", mirror);
    dlgCheckBox("&Rotate", rotate);
    dlgCheckBox("&Flip", flip);
}
```

## dlgComboBox

### Function

Defines a combo box selection field.

### Syntax

```
dlgComboBox(string array[], int &Selected) [ statement ]
```

**See also** [dlgListBox](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgComboBox` statement defines a combo box selection field with the contents of the given array.

`Selected` reflects the index of the selected combo box entry. The first entry has index 0.

Each element of `array` defines the contents of one entry in the combo box. None of the strings in `array` may be empty (if there is an empty string, all strings after and including that one will be dropped).

The optional `statement` is executed whenever the selection in the `dlgComboBox` changes.

Before the `statement` is executed, all variables that have been used with dialog objects are updated to their current values, and any changes made to these variables inside the `statement` will be reflected in the dialog when the `statement` returns.

If the initial value of `Selected` is outside the range of the `array` indexes, it is set to 0.

### Example

```
string Colors[] = { "red", "green", "blue", "yellow" };
int Selected = 2; // initially selects "blue"
dlgComboBox(Colors, Selected) dlgMessageBox("You have selected " +
Colors[Selected]);
```

## dlgDialog

### Function

Executes a User Language Dialog.

### Syntax

```
int dlgDialog(string Title) block ;
```

### Returns

The `dlgDialog` function returns an integer value that can be given a user defined meaning through a call to the [dlgAccept\(\)](#) function.

If the dialog is simply closed, the return value will be 0.

**See also** [dlgGridLayout](#), [dlgHBoxLayout](#), [dlgVBoxLayout](#), [dlgAccept](#), [dlgReset](#), [dlgReject](#), [A Complete Example](#)

The `dlgDialog` function executes the dialog defined by `block`. This is the only dialog object that actually is a User Language builtin function. Therefore it can be used anywhere where a function call is allowed.

The `block` normally contains only other [dialog objects](#), but it is also possible to use other User Language statements, for example to conditionally add objects to the dialog (see the second example below).

By default a `dlgDialog` contains a [dlgVBoxLayout](#), so a simple dialog doesn't have to worry about the layout.

A `dlgDialog` should at some point contain a call to the [dlgAccept\(\)](#) function in order to allow the user to close the dialog and accept its contents.

If all you need is a simple message box or file dialog you might want to use one of the [Predefined Dialogs](#) instead.

## Examples

```
int Result = dlgDialog("Hello") {
    dlgLabel("Hello world");
    dlgPushButton("+OK") dlgAccept();
};
int haveButton = 1;
dlgDialog("Test") {
    dlgLabel("Start");
    if (haveButton)
        dlgPushButton("Here") dlgAccept();
};
```

## dlgGridLayout

### Function

Opens a grid layout context.

### Syntax

`dlgGridLayout` *statement*

**See also** [dlgCell](#), [dlgHBoxLayout](#), [dlgVBoxLayout](#), [Layout Information](#), [A Complete Example](#)

The `dlgGridLayout` statement opens a grid layout context.

The only dialog object that can be used directly in statement is [dlgCell](#), which defines the location of a particular dialog object within the grid layout.

The row and column indexes start at 0, so the upper left cell has the index (0, 0).

The number of rows and columns is automatically extended according to the location of dialog objects that are defined within the grid layout context, so you don't have to explicitly define the number of rows and columns.

### Example

```
dlgGridLayout {
    dlgCell(0, 0) dlgLabel("Row 0/Col 0");
    dlgCell(1, 0) dlgLabel("Row 1/Col 0");
    dlgCell(0, 1) dlgLabel("Row 0/Col 1");
    dlgCell(1, 1) dlgLabel("Row 1/Col 1");
};
```

```
}
```

## dlgGroup

### Function

Defines a group field.

### Syntax

```
dlgGroup(string Title) statement
```

See also [dlgCheckBox](#), [dlgRadioButton](#), [Layout Information](#), [A Complete Example](#)

The `dlgGroup` statement defines a group with the given `Title`.

By default a `dlgGroup` contains a [dlgVBoxLayout](#), so a simple group doesn't have to worry about the layout.

`dlgGroup` is mainly used to contain a set of [radio buttons](#) or [check boxes](#), but may as well contain any other objects in its statement.

Radio buttons within a `dlgGroup` are numbered starting with 0.

### Example

```
int align = 1;
dlgGroup("Alignment") {
    dlgRadioButton("&Top", align);
    dlgRadioButton("&Center", align);
    dlgRadioButton("&Bottom", align);
}
```

## dlgHBoxLayout

### Function

Opens a horizontal box layout context.

### Syntax

```
dlgHBoxLayout statement
```

See also [dlgGridLayout](#), [dlgVBoxLayout](#), [Layout Information](#), [A Complete Example](#)

The `dlgHBoxLayout` statement opens a horizontal box layout context for the given statement.

### Example

```
dlgHBoxLayout {
    dlgLabel("Box 1");
    dlgLabel("Box 2");
    dlgLabel("Box 3");
}
```

## dlgIntEdit

### Function

Defines an integer entry field.

### Syntax

```
dlgIntEdit(int &Value, int Min, int Max)
```

See also [dlgRealEdit](#), [dlgStringEdit](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgIntEdit` statement defines an integer entry field with the given `Value`.

If `Value` is initially outside the range defined by `Min` and `Max` it will be limited to these values.

### Example

```
int Value = 42;
dlgHBoxLayout {
    dlgLabel("Enter a &Number between 0 and 99");
    dlgIntEdit(Value, 0, 99);
}
```

## dlgLabel

### Function

Defines a text label.

### Syntax

```
dlgLabel(string Text [, int Update])
```

See also [Layout Information](#), [A Complete Example](#), [dlgRedisplay\(\)](#)

The `dlgLabel` statement defines a label with the given `Text`.

`Text` can be either a string literal, as in "Hello", or a string variable.

If `Text` contains any HTML tags, the characters '<', '>' and '&' must be given as "&lt;", "&gt;" and "&amp;", respectively, if they shall be displayed as such.

If the `Update` parameter is not 0 and `Text` is a string variable, its contents can be modified in the statement of, e.g., a [dlgPushButton](#), and the label will be automatically updated. This, of course, is only useful if `Text` is a dedicated string variable (not, e.g., the loop variable of a `for` statement).

If `Text` contains an '&', and the object following the label can have the keyboard focus, the character following the ampersand will become a hotkey, and when the user hits `Alt+hotkey`, the focus will go to the object that was defined immediately following the `dlgLabel`. To have an actual '&' character in the text it has to be escaped.

### Example

```
string OS = "Windows";
dlgHBoxLayout {
```

```
dlgLabel(OS, 1);
dlgPushButton("&Change OS") { OS = "Linux"; }
}
```

## dlgListBox

### Function

Defines a list box selection field.

### Syntax

```
dlgListBox(string array[], int &Selected) [ statement ]
```

**See also** [dlgComboBox](#), [dlgListView](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgListBox` statement defines a list box selection field with the contents of the given array.

`Selected` reflects the index of the selected list box entry. The first entry has index 0.

Each element of array defines the contents of one line in the list box. None of the strings in array may be empty (if there is an empty string, all strings after and including that one will be dropped).

The optional `statement` is executed whenever the user double clicks on an entry of the `dlgListBox`.

Before the `statement` is executed, all variables that have been used with dialog objects are updated to their current values, and any changes made to these variables inside the `statement` will be reflected in the dialog when the `statement` returns.

If the initial value of `Selected` is outside the range of the array indexes, no entry will be selected.

### Example

```
string Colors[] = { "red", "green", "blue", "yellow" };
int Selected = 2; // initially selects "blue"
dlgListBox(Colors, Selected) dlgMessageBox("You have selected " +
Colors[Selected]);
```

## dlgListView

### Function

Defines a multi column list view selection field.

### Syntax

```
dlgListView(string Headers, string array[], int &Selected[,
int &Sort]) [ statement ]
```

**See also** [dlgListBox](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgListView` statement defines a multi column list view selection field with the contents of the given array.



`Headers` is the tab separated list of column headers.

`Selected` reflects the index of the selected list view entry in the `array` (the sequence in which the entries are actually displayed may be different, because the contents of a `dlgListView` can be sorted by the various columns). The first entry has index `0`. If no particular entry shall be initially selected, `Selected` should be initialized to `-1`.

`Sort` defines which column should be used to sort the list view. The leftmost column is numbered `1`. The sign of this parameter defines the direction in which to sort (positive values sort in ascending order). If `Sort` is `0` or outside the valid number of columns, no sorting will be done. The returned value of `Sort` reflects the column and sort mode selected by the user by clicking on the list column headers. By default `dlgListView` sorts by the first column, in ascending order.

Each element of `array` defines the contents of one line in the list view, and must contain tab separated values. If there are fewer values in an element of `array` than there are entries in the `Headers` string the remaining fields will be empty. If there are more values in an element of `array` than there are entries in the `Headers` string the superfluous elements will be silently dropped. None of the strings in `array` may be empty (if there is an empty string, all strings after and including that one will be dropped).

A list entry that contains line feeds (`'\n'`) will be displayed in several lines accordingly.

The optional `statement` is executed whenever the user double clicks on an entry of the `dlgListView`.

Before the `statement` is executed, all variables that have been used with dialog objects are updated to their current values, and any changes made to these variables inside the `statement` will be reflected in the dialog when the `statement` returns.

If the initial value of `Selected` is outside the range of the `array` indexes, no entry will be selected.

If `Headers` is an empty string, the first element of the `array` is used as the header string. Consequently the index of the first entry is then `1`.

The contents of a `dlgListView` can be sorted by any column by clicking on that column's header. Columns can also be swapped by "click&dragging" a column header. Note that none of these changes will have any effect on the contents of the `array`. If the contents shall be sorted alphanumerically a `numeric string[]` array can be used.

## Example

```
string Colors[] = { "red\tThe color RED", "green\tThe color GREEN", "blue\tThe color BLUE" };
int Selected = 0; // initially selects "red"
dlgListView("Name\tDescription", Colors, Selected) dlgMessageBox("You have selected " + Colors[Selected]);
```

## dlgPushButton

### Function

Defines a push button.

**Syntax**

```
dlgPushButton(string Text) statement
```

**See also** [Layout Information](#), [Dialog Functions](#), [A Complete Example](#)

The `dlgPushButton` statement defines a push button with the given `Text`.

If `Text` contains an '&', the character following the ampersand will become a hotkey, and when the user hits `Alt+hotkey`, the button will be selected. To have an actual '&' character in the text it has to be [escaped](#).

If `Text` starts with a '+' character, this button will become the default button, which will be selected if the user hits ENTER.

If `Text` starts with a '-' character, this button will become the cancel button, which will be selected if the user closes the dialog.

**CAUTION: Make sure that the statement of such a marked cancel button contains a call to `dlgReject()`! Otherwise the user may be unable to close the dialog at all!**

To have an actual '+' or '-' character as the first character of the text it has to be [escaped](#).

If the user selects a `dlgPushButton`, the given statement is executed.

Before the statement is executed, all variables that have been used with dialog objects are updated to their current values, and any changes made to these variables inside the statement will be reflected in the dialog when the statement returns.

**Example**

```
int defaultWidth = 10;
int defaultHeight = 20;
int width = 5;
int height = 7;
dlgPushButton("&Reset defaults") {
    width = defaultWidth;
    height = defaultHeight;
}
dlgPushButton("+&Accept") dlgAccept();
dlgPushButton("-Cancel") { if (dlgMessageBox("Are you sure?", "Yes", "No") == 0)
    dlgReject(); }
```

**dlgRadioButton****Function**

Defines a radio button.

**Syntax**

```
dlgRadioButton(string Text, int &Selected) [ statement ]
```

**See also** [dlgCheckBox](#), [dlgGroup](#), [Layout Information](#), [A Complete Example](#)

The `dlgRadioButton` statement defines a radio button with the given `Text`.

If Text contains an '&', the character following the ampersand will become a hotkey, and when the user hits Alt+hotkey, the button will be selected. To have an actual '&' character in the text it has to be escaped.

`dlgRadioButton` can only be used within a `dlgGroup`.

All radio buttons within the same group must use the **same** Selected variable!

If the user selects a `dlgRadioButton`, the index of that button within the `dlgGroup` is stored in the Selected variable.

The initial value of Selected defines which radio button is initially selected. If Selected is outside the valid range for this group, no radio button will be selected. In order to get the correct radio button selection, Selected must be set **before** the first `dlgRadioButton` is defined, and must not be modified between adding subsequent radio buttons. Otherwise it is undefined which (if any) radio button will be selected.

The optional statement is executed every time the `dlgRadioButton` is selected.

### Example

```
int align = 1;
dlgGroup("Alignment") {
    dlgRadioButton("&Top", align);
    dlgRadioButton("&Center", align);
    dlgRadioButton("&Bottom", align);
}
```

## dlgRealEdit

### Function

Defines a real entry field.

### Syntax

```
dlgRealEdit(real &Value, real Min, real Max)
```

See also [dlgIntEdit](#), [dlgStringEdit](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgRealEdit` statement defines a real entry field with the given Value.

If Value is initially outside the range defined by Min and Max it will be limited to these values.

### Example

```
real Value = 1.4142;
dlgHBoxLayout {
    dlgLabel("Enter a &Number between 0 and 99");
    dlgRealEdit(Value, 0.0, 99.0);
}
```

## dlgSpacing

### Function

Defines additional space in a box layout context.

**Syntax**

```
dlgSpacing(int Size)
```

**See also** [dlgHBoxLayout](#), [dlgVBoxLayout](#), [dlgStretch](#), [Layout Information](#), [A Complete Example](#)

The `dlgSpacing` statement defines additional space in a vertical or horizontal box layout context.

Size defines the number of pixels of the additional space.

**Example**

```
dlgVBoxLayout {
  dlgLabel("Label 1");
  dlgSpacing(40);
  dlgLabel("Label 2");
}
```

## dlgSpinBox

**Function**

Defines a spin box selection field.

**Syntax**

```
dlgSpinBox(int &Value, int Min, int Max)
```

**See also** [dlgIntEdit](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgSpinBox` statement defines a spin box entry field with the given Value.

If Value is initially outside the range defined by Min and Max it will be limited to these values.

**Example**

```
int Value = 42;
dlgHBoxLayout {
  dlgLabel("&Select value");
  dlgSpinBox(Value, 0, 99);
}
```

## dlgStretch

**Function**

Defines an empty stretchable space in a box layout context.

**Syntax**

```
dlgStretch(int Factor)
```

**See also** [dlgHBoxLayout](#), [dlgVBoxLayout](#), [dlgSpacing](#), [Layout Information](#), [A Complete Example](#)

The `dlgStretch` statement defines an empty stretchable space in a vertical or horizontal box layout context.

`Factor` defines the stretch factor of the space.

### Example

```
dlgHBoxLayout {
  dlgStretch(1);
  dlgPushButton("+OK") { dlgAccept(); };
  dlgPushButton("Cancel") { dlgReject(); };
}
```

## dlgStringEdit

### Function

Defines a string entry field.

### Syntax

```
dlgStringEdit(string &Text)
```

**See also** [dlgRealEdit](#), [dlgIntEdit](#), [dlgTextEdit](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgStringEdit` statement defines a text entry field with the given `Text`.

### Example

```
string Name = "Linus";
dlgHBoxLayout {
  dlgLabel("Enter &Name");
  dlgStringEdit(Name);
}
```

## dlgTabPage

### Function

Defines a tab page.

### Syntax

```
dlgTabPage(string Title) statement
```

**See also** [dlgTabWidget](#), [Layout Information](#), [A Complete Example](#)

The `dlgTabPage` statement defines a tab page with the given `Title` containing the given `statement`.

If `Title` contains an `'&'`, the character following the ampersand will become a hotkey, and when the user hits `Alt+hotkey`, this tab page will be opened. To have an actual `'&'` character in the text it has to be escaped.

Tab pages can only be used within a [dlgTabWidget](#).

By default a `dlgTabPage` contains a [dlgVBoxLayout](#), so a simple tab page doesn't have to

worry about the layout.

### Example

```
dlgTabWidget {
  dlgTabPage("Tab &1") {
    dlgLabel("This is page 1");
  }
  dlgTabPage("Tab &2") {
    dlgLabel("This is page 2");
  }
}
```

## dlgTabWidget

### Function

Defines a container for tab pages.

### Syntax

`dlgTabWidget` *statement*

**See also** [dlgTabPage](#), [Layout Information](#), [A Complete Example](#)

The `dlgTabWidget` statement defines a container for a set of tab pages.

`statement` must be a sequence of one or more [dlgTabPage](#) objects. There must be no other dialog objects in this sequence.

### Example

```
dlgTabWidget {
  dlgTabPage("Tab &1") {
    dlgLabel("This is page 1");
  }
  dlgTabPage("Tab &2") {
    dlgLabel("This is page 2");
  }
}
```

## dlgTextEdit

### Function

Defines a multiline text entry field.

### Syntax

`dlgTextEdit`(string &Text)

**See also** [dlgStringEdit](#), [dlgTextView](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgTextEdit` statement defines a multiline text entry field with the given `Text`.

The lines in the `Text` have to be delimited by a newline character ('`\n`'). Any whitespace characters at the end of the lines contained in `Text` will be removed, and upon return there will be no whitespace characters at the end of the lines. Empty lines at the end of the text

will be removed entirely.

### Example

```
string Text = "This is some text.\nLine 2\nLine 3";
dlgVBoxLayout {
  dlgLabel("&Edit the text");
  dlgTextEdit(Text);
}
```

## dlgTextView

### Function

Defines a multiline text viewer field.

### Syntax

```
dlgTextView(string Text)
dlgTextView(string Text, string &Link) statement
```

See also [dlgTextEdit](#), [dlgLabel](#), [Layout Information](#), [A Complete Example](#)

The `dlgTextView` statement defines a multiline text viewer field with the given `Text`.

The `Text` may contain [HTML](#) tags.

If `Link` is given and the `Text` contains hyperlinks, `statement` will be executed every time the user clicks on a hyperlink, with the value of `Link` set to whatever the `<a href=...>` tag defines as the value of `href`. If, after the execution of `statement`, the `Link` variable is not empty, the default handling of hyperlinks will take place. This is also the case if `Link` contains some text before `dlgTextView` is opened, which allows for an initial scrolling to a given position.

### Example

```
string Text = "This is some text.\nLine 2\nLine 3";
dlgVBoxLayout {
  dlgLabel("&View the text");
  dlgTextView(Text);
}
```

## dlgVBoxLayout

### Function

Opens a vertical box layout context.

### Syntax

```
dlgVBoxLayout statement
```

See also [dlgGridLayout](#), [dlgHBoxLayout](#), [Layout Information](#), [A Complete Example](#)

The `dlgVBoxLayout` statement opens a vertical box layout context for the given `statement`.

By default a `dlgDialog` contains a `dlgVBoxLayout`, so a simple dialog doesn't have to worry about the layout.

### Example

```
dlgVBoxLayout {
  dlgLabel("Box 1");
  dlgLabel("Box 2");
  dlgLabel("Box 3");
}
```

## Layout Information

All objects within a User Language Dialog are placed inside a *layout context*.

Layout contexts can be either `grid`, `horizontal` or `vertical`.

### Grid Layout Context

Objects in a grid layout context must specify the grid coordinates of the cell or cells into which they shall be placed. To place a text label at row 5, column 2, you would write

```
dlgGridLayout {
  dlgCell(5, 2) dlgLabel("Text");
}
```

If the object shall span over more than one cell you need to specify the coordinates of the starting cell and the ending cell. To place a group that extends from row 1, column 2 up to row 3, column 5, you would write

```
dlgGridLayout {
  dlgCell(1, 2, 3, 5) dlgGroup("Title") {
    //...
  }
}
```

### Horizontal Layout Context

Objects in a horizontal layout context are placed left to right.

The special objects `dlgStretch` and `dlgSpacing` can be used to further refine the distribution of the available space.

To define two buttons that are pushed all the way to the right edge of the dialog, you would write

```
dlgHBoxLayout {
  dlgStretch(1);
  dlgPushButton("+OK")   dlgAccept();
  dlgPushButton("Cancel") dlgReject();
}
```



## Vertical Layout Context

Objects in a vertical layout context follow the same rules as those in a horizontal layout context, except that they are placed top to bottom.

## Mixing Layout Contexts

Vertical, horizontal and grid layout contexts can be mixed to create the desired layout structure of a dialog. See the [Complete Example](#) for a demonstration of this.

## Dialog Functions

The following functions can be used with User Language Dialogs:

<code>dlgAccept()</code>	closes the dialog and accepts its contents
<code>dlgRedisplay()</code>	immediately redisplay the dialog after changes to any values
<code>dlgReset()</code>	resets all dialog objects to their initial values
<code>dlgReject()</code>	closes the dialog and rejects its contents

### dlgAccept()

#### Function

Closes the dialog and accepts its contents.

#### Syntax

```
void dlgAccept([ int Result ]);
```

See also [dlgReject](#), [dlgDialog](#), [A Complete Example](#)

The `dlgAccept` function causes the [dlgDialog](#) to be closed and return after the current statement sequence has been completed.

Any changes the user has made to the dialog values will be accepted and are copied into the variables that have been given when the [dialog objects](#) were defined.

The optional `Result` is the value that will be returned by the dialog. Typically this should be a positive integer value. If no value is given, it defaults to 1.

Note that `dlgAccept()` does return to the normal program execution, so in a sequence like

```
dlgPushButton("OK") {  
    dlgAccept();  
    dlgMessageBox("Accepting!");  
}
```

the statement after `dlgAccept()` will still be executed!

### Example

```
int Result = dlgDialog("Test") {  
    dlgPushButton("+OK")    dlgAccept(42);  
    dlgPushButton("Cancel") dlgReject();  
}
```

```
};
```

## dlgRedisplay()

### Function

Redisplays the dialog after changing values.

### Syntax

```
void dlgRedisplay(void);
```

See also [dlgReset](#), [dlgDialog](#), [A Complete Example](#)

The `dlgRedisplay` function can be called to immediately refresh the `dlgDialog` after changes have been made to the variables used when defining the [dialog objects](#).

You only need to call `dlgRedisplay()` if you want the dialog to be refreshed while still executing program code. In the example below the status is changed to "Running..." and `dlgRedisplay()` has to be called to make this change take effect before the "program action" is performed. After the final status change to "Finished." there is no need to call `dlgRedisplay()`, since all dialog objects are automatically updated after leaving the statement.

### Example

```
string Status = "Idle";
int Result = dlgDialog("Test") {
    dlgLabel(Status, 1); // note the '1' to tell the label to be
updated!
    dlgPushButton("+OK")    dlgAccept(42);
    dlgPushButton("Cancel") dlgReject();
    dlgPushButton("Run") {
        Status = "Running...";
        dlgRedisplay();
        // some program action here...
        Status = "Finished.";
    }
};
```

## dlgReset()

### Function

Resets all dialog objects to their initial values.

### Syntax

```
void dlgReset(void);
```

See also [dlgReject](#), [dlgDialog](#), [A Complete Example](#)

The `dlgReset` function copies the initial values back into all [dialog objects](#) of the current `dlgDialog`.

Any changes the user has made to the dialog values will be discarded.

Calling `dlgReject()` implies a call to `dlgReset()`.

## Example

```
int Number = 1;
int Result = dlgDialog("Test") {
    dlgIntEdit(Number);
    dlgPushButton("+OK")    dlgAccept(42);
    dlgPushButton("Cancel") dlgReject();
    dlgPushButton("Reset")  dlgReset();
};
```

## dlgReject()

### Function

Closes the dialog and rejects its contents.

### Syntax

```
void dlgReject([ int Result ]);
```

See also [dlgAccept](#), [dlgReset](#), [dlgDialog](#), [A Complete Example](#)

The `dlgReject` function causes the [dlgDialog](#) to be closed and return after the current statement sequence has been completed.

Any changes the user has made to the dialog values will be discarded. The variables that have been given when the [dialog objects](#) were defined will be reset to their original values when the dialog returns.

The optional `Result` is the value that will be returned by the dialog. Typically this should be 0 or a negative integer value. If no value is given, it defaults to 0.

Note that `dlgReject()` does return to the normal program execution, so in a sequence like

```
dlgPushButton("Cancel") {
    dlgReject();
    dlgMessageBox("Rejecting!");
}
```

the statement after `dlgReject()` will still be executed!

Calling `dlgReject()` implies a call to [dlgReset\(\)](#).

## Example

```
int Result = dlgDialog("Test") {
    dlgPushButton("+OK")    dlgAccept(42);
    dlgPushButton("Cancel") dlgReject();
};
```

## Escape Character

Some characters have special meanings in button or label texts, so they need to be *escaped* if they shall appear literally.

To do this you need to prepend the character with a *backslash*, as in  
`dlgLabel("Miller \\& Co.");`

This will result in "Miller & Co." displayed in the dialog.

Note that there are actually **two** backslash characters here, since this line will first go through the User Language parser, which will strip the first backslash.

## A Complete Example

Here's a complete example of a User Language Dialog.

```
int hor = 1;
int ver = 1;
string fileName;
int Result = dlgDialog("Enter Parameters") {
    dlgHBoxLayout {
        dlgStretch(1);
        dlgLabel("This is a simple dialog");
        dlgStretch(1);
    }
    dlgHBoxLayout {
        dlgGroup("Horizontal") {
            dlgRadioButton("&Top", hor);
            dlgRadioButton("&Center", hor);
            dlgRadioButton("&Bottom", hor);
        }
        dlgGroup("Vertical") {
            dlgRadioButton("&Left", ver);
            dlgRadioButton("C&enter", ver);
            dlgRadioButton("&Right", ver);
        }
    }
    dlgHBoxLayout {
        dlgLabel("File &name:");
        dlgStringEdit(fileName);
        dlgPushButton("Bro&wse") {
            fileName = dlgFileOpen("Select a file", fileName);
        }
    }
    dlgGridLayout {
        dlgCell(0, 0) dlgLabel("Row 0/Col 0");
        dlgCell(1, 0) dlgLabel("Row 1/Col 0");
        dlgCell(0, 1) dlgLabel("Row 0/Col 1");
        dlgCell(1, 1) dlgLabel("Row 1/Col 1");
    }
    dlgSpacing(10);
    dlgHBoxLayout {
        dlgStretch(1);
        dlgPushButton("+OK")    dlgAccept();
        dlgPushButton("Cancel") dlgReject();
    }
};
```

## Supported HTML tags

EAGLE supports a subset of the tags used to format HTML pages. This can be used to format the text of several User Language Dialog objects, in the `#usage` directive or in the description of library objects.

Text is considered to be HTML if the first line contains a tag. If this is not the case, and you want the text to be formatted, you need to enclose the entire text in the `<html>...</html>` tag.

The following table lists all supported HTML tags and their available attributes:

Tag	Description
<code>&lt;html&gt;...&lt;/html&gt;</code>	An HTML document. It understands the following attributes <ul style="list-style-type: none"> <li><code>bgcolor</code> - The background color, for example <code>bgcolor="yellow"</code> or <code>bgcolor="#0000FF"</code>.</li> <li><code>background</code> - The background pixmap, for example <code>background="granit.xpm"</code>.</li> <li><code>text</code> - The default text color, for example <code>text="red"</code>.</li> <li><code>link</code> - The link color, for example <code>link="green"</code>.</li> </ul>
<code>&lt;h1&gt;...&lt;/h1&gt;</code>	A top-level heading.
<code>&lt;h2&gt;...&lt;/h2&gt;</code>	A sub-level heading.
<code>&lt;h3&gt;...&lt;/h3&gt;</code>	A sub-sub-level heading.
<code>&lt;p&gt;...&lt;/p&gt;</code>	A left-aligned paragraph. Adjust the alignment with the <code>align</code> attribute. Possible values are <code>left</code> , <code>right</code> and <code>center</code> .
<code>&lt;center&gt;...&lt;/center&gt;</code>	A centered paragraph.
<code>&lt;blockquote&gt;...&lt;/blockquote&gt;</code>	An indented paragraph, useful for quotes.
<code>&lt;ul&gt;...&lt;/ul&gt;</code>	An un-ordered list. You can also pass a type argument to define the bullet style. The default is <code>type=disc</code> , other types are <code>circle</code> and <code>square</code> .
<code>&lt;ol&gt;...&lt;/ol&gt;</code>	An ordered list. You can also pass a type argument to define the enumeration label style. The default is <code>type="1"</code> , other types are <code>"a"</code> and <code>"A"</code> .
<code>&lt;li&gt;...&lt;/li&gt;</code>	A list item. This tag can only be used within the context of <code>ol</code> or <code>ul</code> .
<code>&lt;pre&gt;...&lt;/pre&gt;</code>	For larger chunks of code. Whitespaces in the contents are preserved. For small bits of code, use the inline-style <code>code</code> .
<code>&lt;a&gt;...&lt;/a&gt;</code>	An anchor or link. It understands the following attributes: <ul style="list-style-type: none"> <li><code>href</code> - The reference target as in <code>&lt;a href="#123"&gt;...&lt;/a&gt;</code>.</li> <li><code>name</code> - The anchor name, as in <code>&lt;a name="123"&gt;...&lt;/a&gt;</code>.</li> </ul>

<code>&lt;em&gt;...&lt;/em&gt;</code>	Emphasized (same as <code>&lt;i&gt;...&lt;/i&gt;</code> ).
<code>&lt;strong&gt;...&lt;/strong&gt;</code>	Strong (same as <code>&lt;b&gt;...&lt;/b&gt;</code> ).
<code>&lt;i&gt;...&lt;/i&gt;</code>	Italic font style.
<code>&lt;b&gt;...&lt;/b&gt;</code>	Bold font style.
<code>&lt;u&gt;...&lt;/u&gt;</code>	Underlined font style.
<code>&lt;big&gt;...&lt;/big&gt;</code>	A larger font size.
<code>&lt;small&gt;...&lt;/small&gt;</code>	A smaller font size.
<code>&lt;code&gt;...&lt;/code&gt;</code>	Indicates Code. (same as <code>&lt;tt&gt;...&lt;/tt&gt;</code> . For larger chunks of code, use the block-tag <code>pre</code> .)
<code>&lt;tt&gt;...&lt;/tt&gt;</code>	Typewriter font style.
<code>&lt;font&gt;...&lt;/font&gt;</code>	Customizes the font size, family and text color. The tag understands the following attributes: <ul style="list-style-type: none"> <li><code>color</code> - The text color, for example <code>color="red"</code> or <code>color="#FF0000"</code>.</li> <li><code>size</code> - The logical size of the font. Logical sizes 1 to 7 are supported. The value may either be absolute, for example <code>size=3</code>, or relative like <code>size=-2</code>. In the latter case, the sizes are simply added.</li> <li><code>face</code> - The family of the font, for example <code>face=times</code>.</li> </ul>
<code>&lt;img...&gt;</code>	An image. This tag understands the following attributes: <ul style="list-style-type: none"> <li><code>src</code> - The image name, for example <code>&lt;img src="image.xpm"&gt;</code>. Supported image formats are: ".bmp" (Windows Bitmap Files) ".pbm" (Portable Bitmap Files) ".pgm" (Portable Grayscale Bitmap Files) ".png" (Portable Network Graphics Files) ".ppm" (Portable Pixelmap Files) ".xbm" (X Bitmap Files) ".xpm" (X Pixmap Files)</li> <li><code>width</code> - The width of the image. If the image does not fit to the specified size, it will be scaled automatically.</li> <li><code>height</code> - The height of the image.</li> <li><code>align</code> - Determines where the image is placed. Per default, an image is placed inline, just like a normal character. Specify <code>left</code> or <code>right</code> to place the image at the respective side.</li> </ul>
<code>&lt;hr&gt;</code>	A horizontal line.
<code>&lt;br&gt;</code>	A line break.
<code>&lt;nobr&gt;...&lt;/nobr&gt;</code>	No break. Prevents word wrap.

A table definition. The default table is frameless. Specify the boolean attribute `border` in order to get a frame. Other attributes are:

`<table>...</table>`

- `bgcolor` - The background color.
- `width` - The table width. This is either absolute in pixels or relative in percent of the column width, for example `width=80%`.
- `border` - The width of the table border. The default is 0 (= no border).
- `cellspacing` - Additional space around the table cells. The default is 2.
- `cellpadding` - Additional space around the contents of table cells. Default is 1.

A table row. Can only be used within `table`. Understands the attribute

`<tr>...</tr>`

- `bgcolor` - The background color.

A table data cell. Can only be used within `tr`. Understands the attributes

`<td>...</td>`

- `bgcolor` - The background color.
- `width` - The cell width. This is either absolute in pixels or relative in percent of the entire table width, for example `width=50%`.
- `colspan` - Defines how many columns this cell spans. The default is 1.
- `rowspan` - Defines how many rows this cell spans. The default is 1.
- `align` - Alignment, possible values are `left`, `right` and `center`. The default is left-aligned.

`<th>...</th>`

A table header cell. Like `td` but defaults to center-alignment and a bold font.

`<author>...</author>`

Marks the author of this text.

`<dl>...</dl>`

A definition list.

`<dt>...</dt>`

A definition tag. Can only be used within `dl`.

`<dd>...</dd>`

Definition data. Can only be used within `dl`.

Tag	Meaning
<code>&amp;lt;</code>	<code>&lt;</code>
<code>&amp;gt;</code>	<code>&gt;</code>
<code>&amp;amp;</code>	<code>&amp;</code>

---

&nbsp;	non-breaking space
&auml;	ä
&ouml;	ö
&uuml;	ü
&Auml;	Ä
&Ouml;	Ö
&Uuml;	Ü
&szlig;	ß
&copy;	©
&deg;	°
&micro;	μ
&plusmn;	±