Programming in System RPL

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First Edition

Preface

The programming features of the HP48 graphical calculator are very powerful. They allow you to do virtually anything. However, the documented programming functions, that are directly accessible to the user (the user language), is not everything the calculator can do.

There is another language: the System language. The User language is a subset of the System one, with just some commands and just a fraction of its power. However, the System language is not well documented. The existing documents on that subject are turned to someone who already knows it; they are just listings of the commands with some brief descriptions. Once you already know the language, even the brief descriptions can be left out, and those documents are really a very good source of information. But how does one *learn* System RPL?

The purpose of this book is exactly that: to be a way for someone who has already learned User RPL (if you haven't yet, learn it before, then come back to this), and wants to learn the *real* power of the calculator.

It is divided in three parts: the first (Basic RPL) teaches the basic aspects of the language, the ones the user must know in order to create some simple programs, which take and return values from and to the stack. The second part (Advanced RPL) deals about some more advanced concepts, such as other ways of getting input (directly from the keyboard, using input forms, etc.). Finally, the third and last part (Reference) is exactly what the name says. In the first two parts, only the most important commands about a subject are listed. In the reference, you will find many other commands. In the very end, there are two appendices: the first presents some tools for programming in System RPL and their basic features. The second explains how to create libraries.

I would greatly appreciate suggestions and corrections for further enhancements of this book.

July 12, 1998 Eduardo de Mattos Kalinowski

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And lastly, I would like to thank the Hewlett-Packard team for bringing us such wonderful tool the HP48 is.

Disclaimer

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Part I

Basic RPL

Chapter 1
Introduction

If you know how to create programs in User RPL (if you don't, learn before you continue reading this book), then you only know part of what the HP48 calculator can do. The System RPL programming language gives you power to do many thing which you could not even imagine, and *fast*. For example, in System RPL you can handle all 29 object types available. User RPL only gives access to some of them. Or you can do math with 15-digit accuracy, use arrays with non-numeric elements, and much more.

But before we start talking of System RPL, let us go back to User RPL to explain how it really works. I know you are anxious to start with the big thing right now, but the following information is important to a good understanding of System RPL.

The HP48 programs (User and System) are not stored internally using the names of the commands. Only the addresses of the objects are stored. Each of these addresses takes 2.5 bytes. When a program is run, the only thing that is actually done is a "gosub" to that address.

Some times, the address is another program with more jumps to another program with more jumps, and so on... A return stack keeps track of all the jumps, and this return stack does not have a fixed size, so you can have as many jumps as necessary, and you will always return to where you were before. Of course, the jumps must end somewhere, either in a program written in machine language or in an object that just puts itself in the stack (numbers, strings, etc).

But if the programs are just addresses, how can they be edited? The answer is that the HP has a table of the user commands'names and their corresponding addresses. So, when you put an User RPL program in the stack, the HP searches the table to get the name of the commands corresponding to the addresses stored in memory, and then displays the program in a readable form. You can then edit it, and after the editing is done, the table is searched for the addresses of the commands named, and only them are stored in memory. This is why it takes a long time to edit a long User RPL program.

That is OK, as long as all the commands have names. Guess what? There are over two thousand commands without names. This is the distinction between User and System RPL. User RPL, the language described in the manual (the « » language), can only access the named commands. (Actually, it can access the unnamed commands via the command SYSEVAL, as long as you know the address of the command. But this is not efficient, except for an occasional use). System RPL can access all commands.

Because of that, System RPL programs cannot be edited directly. Special tools are needed for that. On Appendix A you will find information about the available tools for writing System RPL programs.

Programming in System RPL is worth all the work you have. It is much more powerful and faster, because it does no error checking. In System RPL, the programmer must be sure that no error occurs, otherwise a crash might happen. For example, if a command requires two arguments in the stack and they are not there, or are not of the type the function requires, a warmstart or even a memory loss could happen. Fortunately, there are commands for checking if there are enough arguments, for their types, and for some other possible error conditions. The difference is that you probably just need to check if all arguments are present once, when the program starts. You do not need to repeat the check later. In User RPL, all commands have error checking, so tests are done unnecessarily, slowing the program.

One more question: if the commands do not have names, how can you program in System RPL? All commands have address, so you can call the address directly, using a PTR <address> command, and whatever is at that address will be executed. But there is an easier way.

The commands *have* names. The names simply are not stored in the HP48. But the HP48 design team has given them names, and they are stored somewhere (in the tools for creating System RPL programs). You write a program using those names, and then the System RPL compiler searches the names in the tables, and converts them to addresses. This is called compiling or assembling. Some tools can also do the opposite: convert the addresses into command names. This is called decompiling or disassembling.

Some of the commands are classified as "supported". They are guaranteed to stay at the same memory location in all ROM versions of the calculator, i.e., their address is not going to change, so programmers can use them safely. But there are commands that are classified as "unsupported". Programmers must use call them using their address (PTR xxx), because they are not listed in the command table of the compiler. But the address could be different in each ROM version, so the program may not work correctly in other ROM versions, and could even crash the machine. However, since version "R" has been released, in 1993, no more have been released, so you can use them because it is very unlikely that a new version is going to be released now.

1.1 Your first System RPL program

Let us create a very simple System RPL program, and explain it in detail. The program will calculate the area of a sphere, given the radius in the stack. See Appendix A for information on how to compile it. If you downloaded the examples file, you will find it with the name FIRST.

```
::
  CK1NOLASTWD      ( check if there is an argument )
  CK&DISPATCH1     ( check if it is a real number )
  real ::          ( if it is )
    %2 %^          ( square the radius )
    %PI            ( put PI in the stack )
    %*             ( and multiply )
  ;
;
```

Before we start analyzing it, on note: in System RPL, the case is relevant, so `pi` is different from `PI`, which is different from `pI`. Be careful when typing. Also, everything between ( )'s is considered a comment. (The HP Tools requires a whitespace after the leading open parenthesis). Lines that have a * in the first column are also considered comments.

The first line contains the start of secondary (program) marker, `::` (`DOCOL` is its name). The end marker is `;` (`SEMI`).

Following, there is the command `CK1NOLASTWD`. This command checks if there is one argument in the stack, and if there isn't generates a "Too Few Arguments" error. The next command, `CK&DISPATCH0`, checks the argument type and can do different things for different argument types. Our program only supports one argument type: real numbers. If any other argument type is entered, a "Bad Argument Type" error will be produced. Argument checking is described in detail on Chapter 4.

Following, there is the code to do if the argument is a real number. Note that the code is between `::` and `;`. This is because only one object is expected after the argument type. A secondary (sub-program) is only one object (with other objects inside it), so if we want to evaluate more than one object, they must be included in a secondary.

The rest of the program is very simple. The number two is put in the stack, and the radius (entered by the user) is raised to that power. There is a command which squares the real number in level 1, but it is unsupported, so I decided to make the program longer, but safer and more readable. You can replace `%2 %^` for `PTR 1B47B`, the address of that command. This would save 2.5 bytes.

To end, π is put in the stack, and the squared radius is multiplied by it. The stack now contains the area.

This program is 25 bytes long (using the unsupported command), opposed to the 20 of the User RPL program « `SQ π * ->NUM` ». However, the User RPL version took 0.0156 seconds to calculate (with radius 1). The System RPL took only 0.0019 seconds.

System RPL compilers (see Appendix A) support the following structure: `DEFINE <name> <text>` (everything must be in one line only). Whenever <name> is found in the code, it will be replaced by <text>. For example, the program

```
::
  DEFINE 3DUP DUPDUP DUP
  CK1
  3DUP
;
```

is equivalent to

```
::
  CK1
  DUPDUP
  DUP
;
```

This is not part of the language, it is just a “help” compilers give you. Using this may save a lot of typing, and can also make your code more readable, like in the example on Chapter 5.

Chapter 2
Object Types

As we have seen before, the basics of programming in User RPL and in System RPL are the same: you put objects in the stack, call a function that takes those objects as arguments, and the results are put back in the stack.

There are several types of objects that can be put in the stack. These go from the simplest ones, like numbers or strings, to some more complicated, like symbolics (algebraic expressions) and some even more complicated, like ROM pointers (indicators to the location of a library command).

Now we will see how to create and deal with the various objects supported.

2.1 Binary Numbers

Binary numbers are the objects you will see more often. They are not the user-level binary integers; those are actually hexadecimal strings. These system-level binary integers (or bints, for short) are objects which are not directly accessible to the user. If you happen to have one in the stack, they show like `<10h>`. Try this: enter the following number in the stack (triple check if it is right): `#408Fh`. Now, type `SYSEVAL` and press ENTER. You should get `<10h>` in the stack, or perhaps `<16d>`, if you are in decimal mode. Internally, they are always in hexadecimal mode.

Bints are the objects you will see more often because most commands that require a numeric argument need that argument to be in the form of a binary integer, as opposed to the real numbers needed by user functions. So, they should be easy to create. And, indeed, they are. You can put one in stack just by entering it on you program (in decimal form). But that is not recommended. First, because you can also put a real number in stack by just entering it in the same way (we will see later how to differ one from another). So, it is a good idea to use the following structure: `# <hex>`. This way, you can be sure you will get a binary number, and your code is clearer. Unfortunately, you must use the hexadecimal representation.

The second reason is that there are several "built-in" binary numbers. You can put one of these in the stack by just calling their address. Since almost all of them are supported, to get #6h in the stack, you just use the word `SIX`. The main advantage is that if you enter `# 6`, it takes five bytes. The word `SIX`, as all other commands, take only 2.5 bytes. Some words put two or even three bints in the stack, so the savings are even greater. The list of built-in bints is on Chapter 17.

The four basic operations with bints are `#+`, `#-`, `#*` and `#/`. There are also many others, which are listed on Chapter 17.

Here is an example of program that just put three real numbers in the stack, using the three methods:

```
::
  13         ( <13d> or <Dh> )
  # D        ( the same, using preferred method )
  THIRTEEN   ( in this case, this method is shorter )
;
```

2.2 Real numbers

Real numbers can be created in two ways. The first is by just entering them, without any prefix. But this method can also be used to create bints. So how does the compiler know when you want a real number and when you want a bint? If the number includes a radix and/or an exponent, then it is a real number; otherwise, it is a bint.

But again, the preferred method is to use the structure `% <dec>`. This way, you will surely get a real number, and the code is more readable.

As for bints, there are also many built-in real numbers. They are listed in Chapter 18.

The basic operations using real numbers are `%+`, `%-`, `%*`, `%/` and `%^`. There are many other, which are listed in Chapter 18.

There is also another kind of real number, which is not accessible to the user and to User RPL programs. They are the Extended (or Long) Real Numbers. They work like normal real numbers, with two differences: they have a 15-digit precision opposed to the 12-digit of the normal real numbers, and their exponents are in the range from -50000 to 50000.

Extended real numbers are created using `%% <dec>`. If you happen to get one in the stack, the only thing that you will see is `Long Real`. The basic operations are the same, except that they are prefixed with `%%` instead of `%`. Let me make one thing clear, if it is not already: in User RPL, `+` adds any kind of object, for example real numbers, user binary integers (hexadecimal strings as we will see later), adds elements to lists, etc. In System RPL, the word `%+` only works for two real numbers. To add two binary integers, you must use `#+`. To add extended reals, the word is `%%+`. If you call a function with the wrong arguments, there is a possibility that your system will crash.

To convert from a real number to an extended real number, the command is `%>%%`. Similarly, the opposite function is `%%>%`. To convert from a bint to a (normal) real number, the function is `UNCOERCE`, and the opposite function is `COERCE`.

2.3 Complex numbers

Complex numbers are created with the following structure: `C% <real> <imag>`. The real and imaginary parts are real numbers, in decimal form. If you have the real and imaginary parts in the stack, the word

%>C% will create a complex number from them. The command C%>% takes a complex number and returns the real and imaginary parts.

There are also the Extended Complex Numbers, which are not accessible to the user. They are complex number whose real and imaginary parts are extended reals. They are created using C%% <real> <imag>, where the real and imaginary parts are extended reals. They show in the stack as Long Complex.

In Chapter 19, there is a list of all the commands related to complex numbers, including mathematical operations.

2.4 Characters

The characters are another data type not available to the user. They are a string with only one character. You create them with CHR <char> or using on of the many built-in characters (listed on Chapter 20), but in the stack they show as Character. To convert a character to a bint, use CHR>#. The bint returned is the code for the character. The opposite function is #>CHR.

2.5 Strings

Strings are created with $ "<string>", or just "<string>". There are some built-in strings, listed in Chapter 20. Or you can convert a character into a string, with the command CHR>$.

Two useful and simple functions which deal with strings are LEN$ and &$. The first returns the length (in bytes) of a string as a bint, and the second concatenates two strings. To get a substring, i.e., part of a string, use the function SUB$. It expects three arguments: the original string, the start position (a bint) and the end position (also a bint). Everything between the start and end characters (inclusive) will be returned. And another function is POS$, which searches a string (in level three) for a character or string (in level two), starting from a specified position (a bint, in level one). The position of the first occurrence of the search string in the string is returned (as a bint) to level one. If it could not be found, #0 is returned. There are also many other functions, see Chapter 20 for a list.

2.6 Hexadecimal strings

Hexadecimal strings are the "base" numbers the user can access. They are created using the structure HXS <len> <hexbody>. len is the length of the string, in hexadecimal form, and hexbody is the actual contents of it. The tricky part about it is that because of the HP internal architecture, you must enter the contents in reverse order. To get, for example, the hex string #12AD7h, you must enter HXS 5 7DA21. To get #12345678h use HXS 8 87654321.

To convert an hex string to and from a bint, use the commands `HXS>#` and `#>HXS`. To convert an HXS to and from a real number, use `#>%` (or `HXS>%`) and `%>#`.

See Chapter 21 for more commands related to hex strings.

2.7 Identifiers

Identifiers are names of objects in memory. To the user, they appear in the stack between `''`. In System RPL, they are created with `ID <name>`. Another difference is that always that when you use the above structure, you do not get the identifier in the stack. It is always evaluated. So, if variable `anumber` contains 123.45 and you put somewhere in your program `ID anumber`, the stack will contain 123.45. To put an id to the stack, use `' ID <name>`. As you will see on Chapter 6, the command `'` puts the object after it in the stack.

You can convert a string to an id using `$>ID`, and the opposite transformation is archived with `ID>$`.

There is also another kind of identifiers: the temporary identifiers, or lams. These are used when creating local variables, and you will learn about them later in Chapter 5. They are created with `LAM <name>`, and work like normal ids.

2.8 Tagged objects

To create a tagged object, use the structure `TAG <tag> <object>`. Tag is a string, and object can be anything. To create `x: (2.3;3.5)`, for example, you would use `TAG x C% 2.3 3.5`. An object can have multiple tags, but there is not much use for that.

The word `>TAG` creates a tagged object, given the object (in level two) and a string representing the tag (in level one). `%>TAG` works the same way, but tags an object with a real number. `ID>TAG` tags an object with an identifier. To remove all tags from an object, call `STRIPTAGS`.

A few more commands related to tagged objects are listed on Chapter 22.

2.9 Lists

Lists are very easy to create: start the list with `{`, and end it with `}`. Inside, put as many objects as you wish, of any kind. One difference from User RPL is that if you put an id in a list, you will get its contents instead. So if you want the id itself, add `'` before. As in User RPL, you can have lists inside lists.

Lists are one kind of *composite object*. As the name says, they are composed of other objects. Other kinds are the secondaries (programs) and symbolics (algebraics). The commands described below for list also work for the other kinds of secondaries.

To concatenate two composites, put them in the stack and use &COMP. To add just one object to the head (beginning) or tail (end) of a composite, first put the composite in the stack, then the object, and call >HCOMP or >TCOMP respectively. To get the length of the composite (the number of objects, as a bint), just put in level one and use the word LENCOMP. To get one object of a composite, put the composite in level two, its number in level one (as a bint, naturally), and run NTHELCOMP. If the number were out of range, you would get a FALSE, otherwise the object and TRUE. NTHCOMPDROP is the above entry, followed by DROP. And to get part of a composite, use the function SUBCOMP. This function takes in level three the composite, in level two the start position (guess what? a bint) and in level one the end position (from now on, unless otherwise noted, all numeric arguments are bints). You will get a composite (of the same type, obviously) with the elements between the start and end positions, inclusive. This function checks if the numbers are not out of range (if they are, a null composite is returned. The same happens if the end position is greater than the start position).

Other commands can be found on Chapter 25.

2.10 Arrays

In user RPL, arrays can be only of real or complex numbers. In System RPL, you can have arrays of anything, even arrays of arrays.

If you use HP Tools or GNU Tools (see Appendix A), you can create an array using this structure: ARRY m n [objs]. This will create an m x n array. The objects are specified in order, from left to right and from top to bottom. All objects must be of the same type, and they must be actual objects, not pointers to objects. That means you cannot use built-in objects, you must use % 2 if you want to have the number two on the array, and not %2.

Here is an example of a 3 x 3 array of real numbers. Note that there is only one pair of delimiters.

```
::
  ARRY 3 3 [ % 11 % 12 % 13
             % 21 % 22 % 23
             % 31 % 32 % 33 ]
;
```

If you use JAZZ (see Appendix A), you cannot create arrays this way. This structure is not supported. A tip to create an array in JAZZ is to create the array in the stack if possible (i.e., it is an array of real or complex numbers) or using the HP Tools. Then, use the command DIS in JAZZ to decompile the array into a form recognized by JAZZ. Insert that code in your program.

You can also create an array of (normal, not extended) real or complex numbers by putting them in order in the stack, and entering a list representing the dimensions of the array (real numbers, not bints) in level one. Then run XEQ>ARRAY. This function does error checks to ensure there are enough arguments and if they are of the supported types.

The function ARSIZE returns the number of elements in an array. You can get the dimensions of the array with DIMLIMITS, which returns a list of bints representing the array dimensions. To get one element of an array, put the element number in level two, the array in level one, and run GETATELN. You will get the element and TRUE if it was found or only FALSE if the element does not exist. More array functions are listed on Chapter 23.

There is also another kind of array: the linked arrays. Linked arrays are like normal arrays, except that they have a table with pointers to all the objects in the array. This makes access to array elements faster, because when you need to access one object in the linked array, the only thing necessary is to read the pointer to that object in the table, and go directly there. With normal arrays, a sequential search is necessary.

2.11 Units

Units are another kind of composite objects. They are not really difficult to create, just laborious.

Units start with UNIT and end with ;. Inside, there are commands to define the unit. The best way to understand how a unit is created is by disassembling them. The unit object 3_kg*m^2/(A*s^3) was created using

```
::
  UNIT
    %3      ( 1:3 )
    CHR k   ( 2:3 1:k )
    $ "g"   ( 3:3 2:k 1:g )
    umP     ( 2:3 1:kg )
    $ "m"   ( 3:3 2:kg 1:m )
    %2      ( 4:3 3:kg 2:m 1:2 )
    um^     ( 3:3 2:kg 1:m^2 )
    um*     ( 2:3 1:kg*m^2 )
    $ "A"   ( 3:3 2:kg*m^2 1:A )
    $ "s"   ( 4:3 3:kg*m^2 2:A 1:s )
    %3      ( 5:3 4:kg*m^2 3:A 2:s 1:3 )
    um^     ( 4:3 3:kg*m^2 2:A 1:s^3 )
    um*     ( 3:3 2:kg*m^2 1:A*s^3 )
    um/     ( 2:3 1:kg*m^2/[A*s^3] )
    umEND   ( 1:3_kg*m^2/[A*s^3] )
  ;
;
```

As you are saw, creating units is done using the words um^, um*, um/ and umP. The meaning of the first three ones is easy to guess. The last is used to create prefix operators (kilo, mega, mili, etc.). First enter the prefix as a character or string, and then the unit name (all operations take unit names as characters or strings). Run umP and the prefixed unit is created. Then call the other functions as needed. To end a unit, use umEND, which joins the number (entered first) to the unit part. This code could be made shorter if built-in characters and strings (listed on Chapter 20) were used.

Several operations can be done with units. The complete list is on Chapter 24. The most important are UM+, UM-, UM*, UM/ and UFACT, whose meanings are obvious; UMCONV, which works like user word CONVERT; UMSI, equivalent to UBASE and U>nbr, which returns the numeric part of a unit.

2.12 Symbolics

Symbolics, algebraic expressions, are another type of composite objects. They are created in a similar manner to units. They are delimited by SYMBOL and ;. Let us see an example of disassembly of the algebraic expression $x = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$:

```
::
  SYMBOL
    ID x  ( 1:x )
    ID b  ( 2:x 1:b )
    xNEG  ( 2:x 1:-b )
    ID b  ( 3:x 2:-b 1:b )
    %2    ( 4:x 3:-b 2:b 1:2 )
    x^    ( 3:x 2:-b 1:b^2 )
    %4    ( 4:x 3:-b 2:b^2 1:4 )
    ID a  ( 5:x 4:-b 3:b^2 2:4 1:a )
    x*    ( 4:x 3:-b 2:b^2 1:4*a )
    ID c  ( 5:x 4:-b 3:b^2 2:4*a 1:c )
    x*    ( 4:x 3:-b 2:b^2 1:4*a*c )
    x-    ( 3:x 2:-b 1:b^2-4*a*c )
    xv    ( 3:x 2:-b 1:v[b^2-4*a*c] )
    x+    ( 2:x 1:-b+v[b^2-4*a*c] )
    %2    ( 3:x 2:-b+v[b^2-4*a*c] 1:2 )
    ID a  ( 4:x 3:-b+v[b^2-4*a*c] 2:2 1:a )
    x*    ( 3:x 2:-b+v[b^2-4*a*c] 1:2*a )
    x/    ( 2:x 1:-b+v[b^2-4*a*c]/[2*a] )
    x=    ( 1:x=-b+v[b^2-4*a*c]/[2*a] )
  ;
;
```

As you have seen, creating symbolics is very similar (and as laborious) to creating units. The variables are ids, and the functions are preceded by a lowercase x.

There are many functions that deal with symbolics (and most of them are not supported). The list is on Chapter 27.

Chapter 3
Stack operations

In System RPL, using the stack is almost the same as in User RPL. The basic operations are the same, except for little changes in the name: DUP, 2DUP (equivalent to User APL's DUP2), NDUP (DUPN), DROP, 2DROP (DROP2), NDROP (DROPN), OVER, PICK, SWAP, ROLL, UNROLL (ROLLD), ROT and DEPTH.

All commands that require or return a numeric argument (ROLL, UNROLL, PICK and DEPTH) use bints and not real numbers.

There is also new functions: UNROT, which is a ROT in the other way, i.e., 3 ROLLD; and reverse, which takes n objects and a bint representing this count, and reverses their order. For example the program

```
:: %1 %2 %3 %4 FOUR reversym ;
```

when run will reverse the order of the reals, leaving 4, 3, 2 and 1 in the stack.

There are also many commands that do two or even three operations in sequence. The complete list can be found on Chapter 29. Here is a list of the most used ones:

DUP	DROP	SWAP	OVER	ROT	UNROT
DUPDUP	DROPDUP	SWAPDUP	OVERDUP	ROTDUP	UNROTDUP
—	2DROP	SWAPDROP	—	ROTDROP	UNROTDROP
—	DROPSWAP	—	OVERSWAP	ROTSWAP	UNROTSWAP
—	DROPOVER	SWAPOVER	—	ROTOVER	UNROTOVER
DUPROT	DROPROT	SWAPROT	—	—	—
DUPUNROT	—	—	OVERUNROT	—	—
—	DROPSWAPDROP	—	—	—	UNROTSWAPDRO
—	—	SWAPDROPDUP	—	—	—
—	—	SWAPDROPSWAP	—	ROTDROPSWAP	—
—	—	—	—	ROT2DROP	UNROT2DROP
—	—	SWAP2DUP	—	ROT2DUP	—
DUP3PICK	—	SWAP3PICK	—	—	—
—	—	SWAP4PICK	—	—	—
—	—	—	OVER5PICK	—	—
—	—	SWAP4ROLL	—	—	—
DUP4UNROLL	—	—	—	—	—
—	—	—	—	ROTROT2DROP	—

Chapter 4
Checking arguments

In System RPL, it is very important to check if all arguments required by a command are present, and if they are of a valid type. In User RPL, you don't have to worry about this: it is done automatically. In System RPL, very few commands do that, so this is left for the programmer. This may seen at first a disadvantage, but it is in fact an advantage: you just need to check the arguments once, in the beginning of the program. This generates a fast code, differently from User RPL the arguments are checked in every command.

There are two kinds of checks: for number of arguments, and for argument type.

4.1 Number of arguments

To check for a specific number of arguments, use one of the following commands. They check if there are enough arguments in the stack, and produce a "Too Few Arguments" error if not.

Command	When to use
CK0, CK0NOLASTWD	No arguments required
CK1, CK1NOLASTWD	One argument required
CK2, CK2NOLASTWD	Two arguments required
CK3, CK3NOLASTWD	Three arguments required
CK4, CK4NOLASTWD	Four arguments required
CK5, CK5NOLASTWD	Five arguments required

Each word CK<n> "marks" the stack below the <n>th argument, and saves a copy of the arguments, if argument recovery is enabled. In case an error happens, the stack is cleared by the marked level, and if argument recovery is enabled, the saved arguments are restored.

The CK<n> words save the name of the command in which they are executed, and if an error happens, that name is displayed. These words must be the first object in a program. Also, they should only be used in libraries, because if they are not part of a library, and if there is an error, it will be shown as something like "XLIB 1364 36 Error:". To avoid this, use CK<n>NOLASTWD, which does not save the name of the command, thus is excellent for programs that are not part of a library. These words may be used in the middle of the program. Normally this should be done only after getting input from the user.

If your program uses a stack-defined number of arguments, use the words CKN or CKNNOLASTWD. These words first check for a real number in level one, and then for the specified number of objects in the stack. The stacked is marked at level two, but only the real number is saved in LAST ARG.

4.2 Argument typ e

The words CK&DISPATCH1 and CK&DISPATCH0 are used to do different actions based on different types of arguments. They are used like this:

```
...
CK&DISPATCH1
  #type1  action1
  #type2  action2
  #type3  action3
  ...
  #type<n>  action<n>
;
```

The type/action pairs are terminated by a SEMI (;).

This is how CK&DISPATCH0 works: it checks if the stack matches the definitions in #type1. If it does, action1 is executed, after which program execution resumes after SEMI. (Each action must be a single object, so if you want to do more than one action, they must be included in a secondary, i.e., between :: and ;). If the type definition does not match the stack, then type2 is checked, and so on. If no match was found, a "Bad Argument Type" error is generated.

The difference between CK&DISPATCH0 and CK&DISPATCH1 is that the latter, after completing the first pass, strips all the tags from the stack objects, and does a second pass. Only after the second pass without a match the "Bad Argument Type" error is generated.

Each type definition is a bint like this: #nnnnn. Each n is an hexadecimal number representing the object in one position of the stack, according to the table below. The first n represents the object in level five, the second in level four, and so on. This way, #00201 represents a complex number in level three, any object in level two and a real number in level one; #00096 represents a symbolic class in level two and an id in level one. There are also two-digit object type numbers, ending in F. Each time you use one of these, the number of arguments that can be checked is reduced. For example, #13F4F represents a real number in level three, an extended real in level 2 and an extended complex in level one.

Value	Argument	User type
0	Any object	
1	Real number	0
2	Complex number	1
3	Character string	2
4	Array	3, 4
5	List	5
6	Global name	6

Value	Argument	User type
7	Local name	7
8	Secondary	8
9	Symbolic	9
A	Symbolic class	6, 7, 9
B	Hexadecimal string	10
C	Graphics object	11
D	Tagged object	12
E	Unit object	13
0F	ROM Pointer	14
1F	Binary integer	20
2F	Directory	15
3F	Extended real	21
4F	Extended complex	22
5F	Linked array	23
6F	Character	24
7F	Code object	25
8F	Library	16
9F	Backup	17
AF	Library data	26
BF	Access pointer (GX only)	27
CF	External object 2	28
DF	External object 3	29
EF	External object 4	30

There are also the words CK<n>&Dispatch, where <n> is a number from one to five. These words combine CK<n> with CK&DISPATCH1.

4.3 Examples

By disassembling and studying built-in words, you can learn a lot. Not only about argument checking, but also about many other things. For example, here is the disassembly of the user command STO:

```
:: CK2&Dispatch
* 2:any 1:tagged
  THIRTEEN  XEQXSTO
* 2:any 1:id
  SIX       :: STRIPTAGS12 ?STO_HERE ;
* 2:any 1:lam
  SEVEN     :: STRIPTAGS12 STO ;
* 2:any 1:symb
  NINE      :: STRIPTAGS12 SYMSTO ;
* 2:grob 1:program [PICT]
  # 000C8   PICTSTO
* 2:backup 1:real number
  # 009F1   LBLSTO
* 2:library 1:real number
  # 008F1   LBSTO
;
```

The command STO starts by checking if there are two arguments present, stores the arguments and the command STO for error handling, and then dispatches to one of the actions listed. If the level one object is a tagged object, STO executes the word XEQXSTO. For a global name, :: STRIPTAGS12 ?STO_HERE ; is executed. And so forth, until the last one. If none of the types can be matched, then an "Bad Argument Type" error will be generated.

The TYPE command provides an example of dispatching at a point other than the start of a command. Its argument count and argument type checking parts are separated so that the latter part can be called by other system words that do not want to mark the stack. Here is its disassembly:

```
::
  CK1
  :: CK&DISPATCH0
      real       %0
      cmp        %1
      str        %2
      arry       XEQTYPEARRY
      list       %5
      id         %6
      lam        %7
      seco       TYPESEC ( 8, 18 or 19 )
      symb       %9
      hxs        %10
      grob       % 11
      TAGGED     % 12
      unitob     % 13
      rompointer % 14
      THIRTYONE  % 20 ( # )
      rrp        % 15
      # 3F       % 21 ( %% )
      # 4F       % 22 ( C%% )
      # 5F       % 23 ( LNKARRAY )
      # 6F       % 24 ( CHR )
      # 7F       % 25 ( CODE )
      library    % 16
      backup     % 17
      # AF       % 26 ( Library Data )
      any        % 27 ( external )
  ;
  SWAPDROP
;
```

In this case, CK&DISPATCH1 could have been used, because tagged objects are explicitly listed on the table. Since the last item on the list is any, so type 27 is returned for any other object not listed.

The object names are built-in bints. See Chapter 17 for a list of built-in bints.

Chapter 5
Local variables

System RPL local variables (also known as temporary or lambda variables) work in the same way as in User RPL. You assign values to them, and these values can be recalled or changed at any time. But there is one difference: in System RPL you can create unnamed local variables, which saves memory. But before learning how to create and use unnamed local variables, let us learn how to use normal, named ones.

5.1 Named local variables

Creating named local variables is very similar to creating temporary variables in User RPL. You have to create a list of local identifier (lams), and run the command BIND. To recall the contents of one of them, just enter its local identifier. To store a new value, put that value and the lam in the stack, and run STO. To remove the local variables from memory, use ABND ("abandon"). The code is not checked for matching BIND/ABND, so you may include them in different programs if you wish. But this also means you must be sure to have an ABND for each BIND.

Here is a little program that creates two local variables, recalls their contents and assigns new values for them (it is called LAM1):

```
::
  %2 %3
  {
   ' LAM firstVar
   ' LAM secVar
  }
  BIND          ( firstVar contains 2, and secVar 3 )
  LAM firstVar  ( recall contents from firstVar )
  LAM secVar    ( recall contents from secVar )
  DUP
  ' LAM firstVar
  STO           ( store new contents in firstVar )
  %+            ( results 5 )
  ' LAM secVar
  STO           ( store sum in secVar )
  ABND          ( delete variables from memory )
;
```

5.2 Unnamed local variables

If there is *no chance* that a new temporary environment will be created after the one you are about to create, you can use unnamed local variables (actually, they have a name: null name). The above program could be rewritten using null named temporary variables this way (now called LAM2):

```
::
  %2 %3
  { NULLLAM NULLLAM }
  BIND
  1GETLAM
  2GETLAM
  DUP
  1PUTLAM
  %+
  2PUTLAM
  ABND
;
```

The numbering is in the same order as the stack. There are functions to recall and store directly for up to 22 variables (1GETLAM to 22GETLAM). To access variables with numbers higher than 23, you GETLAM, which takes a bint representing the variable number and returns its contents; and PUTLAM, which takes an object and the variable number, and stores that object in the specified variable.

5.3 Suggestions

The RPL Manual (file RPLMAN.DOC of the HP Tools) suggests that you use DEFINE (see Chapter 1) to make the use of unnamed local variables more readable. For example, you could use

```
::
  DEFINE I%YR       1GETLAM
  DEFINE !I%YR      1PUTLAM
  DEFINE NPayments  2GETLAM
  DEFINE !NPayments 2PUTLAM
  ...
  { NULLLAM NULLLAM }
  BIND
  ...
  I%YR        ( Recalls contents from first var )
  ...
  NPayments   ( Recalls contents from second var )
  ...
  !I%YR       ( Stores something in first var )
  ...
  ABND
;
```

When you are binding a great number of local variables, instead of entering the following code (which takes 67.5 bytes)

```
...
{ NULLLAM NULLLAM NULLLAM NULLLAM NULLLAM NULLLAM
  NULLLAM NULLLAM NULLLAM NULLLAM NULLLAM NULLLAM
  NULLLAM NULLLAM NULLLAM NULLLAM NULLLAM NULLLAM
  NULLLAM NULLLAM NULLLAM NULLLAM NULLLAM NULLLAM }
BIND
...
```

use this, which takes only 12.5 bytes, saving 55 bytes:

```
... NULLLAM TWENTYFOUR NDUPN {}N BIND ...
```

You can even replace `{}N BIND` for `DOBIND`, which instead of a list of names, takes all names in the stack plus the count to bind the variables. This saves 2.5 bytes more.

Or you can also use `TWENTYFOUR ' NULLLAM CACHE`. However, if you use this, an extra variable is created to hold the count, so you must add one to the variable positions of the previous examples.

If you use JAZZ or GNU Tools (see Appendix A), you can use the following structure to create local variables:

```
::
  %2 %3
  {{ A B }}  ( no spaces between the brackets )
  A          ( recalls contents of A )
  B          ( recalls contents of B )
  DUP
  !A         ( stores new contents in A )
  %+
  !B         ( stores sum in B )
  ABND       ( destroy variables )
;
```

The code above binds 2 into variable `A` and 3 into variable `B`. To recall the contents of any variable, just enter its name. To store a new value, use `!<name>`, `<name>!` or `=<name>`.

The structure above is just a shortcut. The code is actually compiled as:

```
::
  %2 %3
  ' NULLLAM TWO NDUPN BIND
  1GETLAM 2GETLAM DUP 1PUTLAM
  %+ 2PUTLAM ABND
;
```

Chapter 6
Runstream control

In System RPL, the normal program flow is simple: all commands are executed in the order they are found in the program. However, there are some commands that change this flow. There are conditional and loops structures, which you will see in the following chapters, and there are words whose sole purpose is to interfere with the normal program flow. The complete list is on Chapter 34. Below, the most important are listed.

Word	**Stack and action**
`'`	(→ ob) This command assumes the next object after it is not `SEMI`. Then, if the next object in the runstream is an object, then that object is put into the data stack, and the interpreter pointer is moved to the next object. If the next object is a pointer, its pointee is put into the data stack, and the interpreter pointer is also moved to the next object. Basically, it means that as long as the object following `'` is not `SEMI`, it is put into the data stack, instead of being executed. Execution resumes at the object following that one. For example, the program `:: %3 %4 ' SWAP EVAL ;` is equivalent to `:: %3 %4 SWAP ;`.
`'R`	(→ ob) If the object pointed to by the top pointer on the return stack (i.e., the first element in the second body of the runstream) is an object, then that object is pushed into the data stack, and the pointer is advanced to the next object in the same composite. If the pointer points to an object pointer whose pointee is not `SEMI`, the pointee is pushed into the data stack, and the return stack pointer is also advanced. If the pointee is `SEMI`, then if the first element in the second body in the runstream is a pointer to `SEMI`, a null secondary is pushed into the data stack and the return stack pointer is not advanced. Rewriting this in a way a normal human can understand, this command does the following: the object after the next `SEMI` is put in the stack. Then, the execution continues after `'R`. If the object following `SEMI` was another `SEMI`, then a null composite is put in the stack. For example, assuming `n1` contains 1, `n2` contains 2, `n3` contains 3 and `n4` contains 4, the following code will put in the stack, in order `'n3'`, 1, 2 and 4: `:: :: 'R ID n1 ID n2 ; ID N3 ID N4 ;`

Word **Stack and action**

`ticR`

(→ ob TRUE)
(→ FALSE)

This works similarly to `'R`. The difference is that an object was found, it is returned along with `TRUE`. If it could not be found (i.e., the object after `SEMI` was another `SEMI`), `FALSE` is returned. The above code, if `ticR` were used instead, would return `'n3'`, `TRUE`, 1, 2 and 4. The following code

```
:: :: ticR ID n1 ID n2 ; ;
```

would return `FALSE`, 1 and 2.

`>R`

(:: →)

This command takes a composite as argument. The body of the composite is put into the runstream, just below the top one (i.e., a pointer to the body of the composite is pushed into the return stack). All that above can be simplified as: the objects following `>R` are executed, and in sequence the composite taken as argument. For example, the code below would put 3, 4, 1, 2 in the stack, in this order:

```
:: ' :: ID n1 ID n2 ; >R ID n3 ID n4 ;
```

`R>`

(→ ::)

Creates a program object from the composite body pointed to by the top return stack pointer, pushes it into the data stack, and pops the return stack. That means that a composite is created from the elements following the next `SEMI` (until the other `SEMI`) and put in the stack. Execution continues at the object following `R>`. For example, the code

```
:: :: R> ID n1 ID n2 ; ID n3 ID n4 ;
```

puts into the stack `:: ID n3 ID n4 ;`, 1 and 2. If it were changed to

```
:: :: R> EVAL ID n1 ID n2 ; ID n3 ID n4 ;
```

then the stack would contain 3, 4, 1, 2.

`R@`

(→ ::)

The same as `R>`, except that the return stack is not popped. That means that the code above, rewritten using `R@`, would produce 3, 4, 1, 2, 3, 4.

`IDUP`

(→)

Duplicates the top body in the runstream, i.e., the next objects until a `SEMI` are executed twice.

Word **Stack and action**

RDUP (→)
Duplicates top return stack level, i.e., the rest of the composite above the actual is executed twice. For example, the code below would return 1, 2, 3, 4, 3, 4 to the stack:

```
:: :: ID n1 RDUP ID n2 ; ID n3 ID n4 ;
```

RDROP (→)
Pops the return stack, i.e., the rest of the composite above the actual is skipped. For example, the code

```
:: :: ID n1 RDROP ID n2 ; ID n3 ID n4 ;
```

would put in the stack only 1 and 2.

?SEMI (flag →)
Exits the actual composite if the flag is TRUE.

COLA (→)
Executes the next object in the composite and skip all the rest. For example, the code below would put 1 in the stack.

```
:: COLA ID n1 ID n2 ID n3 ;
```

SKIP (→)
Skips the next object, and executes the rest. The code below would put 2 and 3 in the stack.

```
:: SKIP ID n1 ID n2 ID n3 ;
```

?SKIP (flag →)
If the flag is TRUE, skips the next object.

Chapter 7 Conditionals

In System RPL, conditionals are a bit different from User RPL. The first difference is that in User RPL, a false is a zero; any other value is a true. In System RPL, a false is FALSE, and a true is TRUE (amazing!). These words just put the corresponding objects in the stack. All commands that do a test return either one. Words like IF...THEN take one of these.

If you need, you can convert a TRUE or FALSE to a (real) 0 or 1 with COERCEFLAG. There is not a dedicated function to do the opposite transformation, like UNCOERCEFLAG, but %0<> does that.

There are many commands that put TRUE, FALSE, or some combination of them in the stack. See the list on Chapter 33.

The Boolean operators are present too: NOT, AND, OR and XOR. There are combinations: ORNOT and NOTAND. Finally, ROTAND does a ROT and then AND.

7.1 Tests

The test words are commands which take one or more arguments and return either TRUE or FALSE, after doing some kind of comparison to them. The tests for each kind of object type are listed on the chapter of the reference dedicated to the object type. General tests and tests for object type can be found on Chapter 33.

The most important of them are EQ and EQUAL. Both take two objects and return a flag. The first checks if the objects are the same, i.e., occupy the same address in memory. The second checks if the prolog and contents are the same.

If you put a string in level one, and press ENTER, EQ and EQUAL will return TRUE. However, if you enter a string, and then enter again the same string, only EQUAL will return TRUE. This happens because the contents of the strings are the same, but they are different objects in memory, occupying each a different address in memory. They just happen to have the same contents.

7.2 Object type tests

Use one of the following words to check if the object in level one is of a specific type. The words that start with DUP or D make a copy of the object first.

Object	No copy	With copy
Real number	TYPEREAL?	DUPTYPEREAL?, DTYPEREAL?
Complex number	TYPECMP?	DUPTYPECMP?
String	TYPECSTR?	DUPTYPECSTR?, DTYPECSTR?
Array	TYPEARRAY?	DUPTYPEARRY?, DTYPEARRY?
Real array	TYPERARRY?	Not available
Complex array	TYPECARRY?	Not available
List	TYPELIST?	DUPTYPELIST?, DTYPELIST?
Global identifier	TYPEIDNT?	DUPTYPEIDNT?
Local identifier	TYPELAM?	DUPTYPELAM?
Symbolic	TYPESYMB?	DUPTYPESYMB?
Hex string	TYPEHSTR?	DUPTYPEHSTR?
Grob	TYPEGROB?	DUPTYPEGROB?
Tagged	TYPETAG?	DUPTYPETAG?
Unit	TYPEEXT?	DUPTYPEEXT?
ROM Pointer	TYPEROMP?	DUPTYPEROMP?
Binary integer	TYPEBINT?	DUPTYPEBINT?
Directory	TYPEERRP?	DUPTYPEERRP?
Character	TYPECHAR?	DUPTYPECHAR?
Program	TYPECOL?	DUPTYPECOL?, DTYPECOL?

7.3 IF...THEN...ELSE

The conditionals of the type IF...THEN...ELSE can be created using the words RPIT and RPITE.

Word	Stack and action
RPIT	(flag ob1 → ?) If the flag is TRUE, ob1 is EVALuated. Otherwise, it is DROPped.
RPITE	(flag ob1 ob2 → ?) If the flag is TRUE, ob1 is EVALuated and ob2 is DROPped. If the flag is FALSE, ob2 is EVALuated and ob1 is DROPped.

However, there are also available prefix versions of those operations, which are more commonly used.

Word	Stack and action
IT	(flag →) If the flag is TRUE, the next object is executed, otherwise it is skipped.
ITE	(flag →) If the flag is TRUE, the next object is executed, and the second is skipped. If it is FALSE, the next object is skipped and the second is executed.

For example, the program

```
... ' ID MyProg %0= RPIT ...
```

will execute MyProg if there is a real number 0 in the stack. Its equivalent using postfix notation is

```
... %0= IT ID MyProg ...
```

The program below will output "Equal" if the two objects are equal, otherwise it outputs "Not equal":

```
... $ "Equal" $ "Not equal" EQUAL RPITE ...
```

Its equivalent using postfix notation is

```
... EQUAL ITE $ "Equal" $ "Not equal" ...
```

7.4 CASE

The CASE words (there are combinations of case with other tests and commands) are a combination of IT, SKIP and COLA. The basic word, case takes a flag in level one. If the flag is TRUE, the next object is executed, and the rest of the current stream is dropped, like COLA. If the flag is FALSE, then the next object is skipped and execution continues after it, like SKIP. For example, the following code outputs a string representing the bint in level one.

```
::
  DUP #0= case $ "Zero"
  DUP ONE #= case $ "One"
  DUP TWO #= case $ "Two"
  ...
;
```

There are many words that are a combination of case with tests or other actions. The complete list is on Chapter 35. One of them is OVER#=case. Its action is as the name says. First, OVER is executed. Then, #=. Finally, case. This way, the code above could be rewritten this way:

```
::
  ZERO OVER#=case $ "Zero"
  ONE OVER#=case $ "One"
  TWO OVER#=case $ "Two"
  ...
;
```

Chapter 8
Loops

As in User RPL, there are two types of loops in System RPL: the indefinite loops and the definite loops. Indefinite loops are loops in which you do not know beforehand how many times it will be executed: it will repeat until a specific condition is met. They are created in a very similar manner to User RPL indefinite loops. Definite loops, on the other hand, are executed a number of times specified before its start. They not created exactly like in User RPL, but their use is simple and more powerful. For example, you can change the number of times to run the loop while running it.

8.1 Indefinite loops

In System RPL, indefinite loops can be of three types (the third is useless). The first is the WHILE loop. It is created like this:

```
BEGIN
  <test clause>
WHILE
  <loop object>
REPEAT
```

This kind of loop executes `<test clause>`, and if the test is `TRUE`, `<loop object>` is executed, and the loop starts again. If the test returned `FALSE`, then execution resumes past `REPEAT`. If the first test returned `FALSE`, this loop would never be executed.

This loop requires `<loop object>` to be a single object. The HP Tools automatically inserts all the objects between `WHILE` and `REPEAT` in a composite. However, if there is only one object, this is not desired, so JAZZ does not do that.

The second type of indefinite loop is the UNTIL loop. It is created like this:

```
BEGIN
  <loop clause>
UNTIL
```

This loop is always executed at least once. The word `UNTIL` expects a flag. If it is `TRUE`, the `<loop clause>` is executed again. If it is `FALSE`, execution continues past `UNTIL`.

There is also a third type of indefinite loop:

```
BEGIN
  <loop object>
AGAIN
```

This loop has no test. To exit it, an error condition must happen, or a direct manipulation of the return stack.

8.2 Definite loops

Definite loops are created with DO. DO takes two bints from the stack, representing the stop and start values. The start value is stored as the current index, which can be recalled with INDEX@. The stop value can be recalled with ISTOP@. You can store a new value to one of them with INDEXSTO and ISTOPSTO, respectively.

DO's counterparts are LOOP and +LOOP. LOOP increments by one the index value, and checks if the new value is greater than or equal to the stop value, exiting the loop if it is. Otherwise, the loop is executed again. +LOOP works similarly, incrementing the index by the bint in level one.

The standard form of a DO loop is

```
stop start DO <loop clause> LOOP
```

which executes <loop clause> for each index value from start to stop-1.

There are several words provided to be used with DO loops, like ONE_DO, whose meaning is obvious. The list in on Chapter 36.

Here is an example of a simple loop which outputs the bints #1h, #2h, #3h and #4h to the stack:

```
::
  FIVE ONE
  DO
    INDEX@
  LOOP
;
```

It could be changed to:

```
::
  FIVE ONE_DO
    INDEX@
  LOOP
;
```

Chapter 9
System and memory operations

The words listed below deal with variables, directories and system functions, like changing the angle mode. Only the most important ones are listed below. For a complete list, turn to Chapter 37 and Chapter 39.

9.1 Variables and directories

The basic equivalents to the user functions STO and RCL are the words CREATE, STO and @:

Word	Stack and action
CREATE	(ob id →) Creates a variable with the name id and contents ob. An error occurs if the ob is or contains the current directory ("Directory Recursion"). Assumes that ob is not a primitive code object.
STO	(ob id →) (ob lam →) In the lam case, the temporary identifier is re-bound to ob. An error is returned if the lam is unbound. In the id case, STO attempts to replace the contents of the variable with ob. If a variable with that name was not found, a new variable is created. STO assumes that ob is not a primitive code object in the id case.
@	(id → ob TRUE) (id → FALSE) (lam → ob TRUE) (lam → FALSE) In the lam case, return the contents of the temporary variable along with TRUE or just FALSE if no temporary variable could be found with that name. In the id case does the same for global variables, starting from the current directory and working up through parent directories if necessary.

One problem with STO and @ is that if you give, for example, SIN as the (ob) argument, STO will copy the entire body of the program into a variable, and then @ would recall the undecompilable program. Because of this, it is preferred to use SAFESTO and SAFE@, which work like STO and @, but automatically convert ROM bodies into XLIB names.

Some other words related are:

Word	Stack and action
?STO_HERE	(ob id →) (ob lam →) This is the system version of user STO. Works like SAFESTO, but only stores in the current directory and does not overwrite directories.
SAFE@_HERE	(id → ob TRUE) (id → FALSE) (lam → ob TRUE) (lam → FALSE) Like SAFE@, but searches only in the current directory.
PURGE	(id →) Purges variable specified by id, does no type check on stored object.
?PURGE_HERE	(id →) Like PURGE, but works only in current directory.
XEQRCL	(id → ob) (id → error!) System version of user word RCL: same as SAFE@, but errors if variable does not exist.

REPLACE	(newob oldob → newob)
	Like STO, but instead of the name of the variable takes the previous contents as argument. For example:
	`$ "OLD" ' ID ABC STO ( creates var ABC )`
	`$ "NEW" ID ABC       ( 2:NEW, 1:OLD inside ABC )`
	`REPLACE`
	`ID ABC               ( returns NEW )`
	Be sure that the object in level one is inside a variable, otherwise you will probably get a memory clear. But using REPLACE is worth be risk, because it is much faster than STO. Instead of using "anobject ' ID avar STO" use "anobject ID avar REPLACE".

CREATEDIR	(id →) Creates an empty directory inside the actual. Does ?PURGE_HERE first to delete the original.
XEQPGDIR	(id →) Purges a directory, making all possible checks before.
XEQORDER	({ var1 var2 ... } →) Orders the variables in current directory. Does checks first.

Word	Stack and action
DOVARS	(→ { var1 var2 ... }) Returns list of variable names from current directory.
PATHDIR	(→ { HOME dir ... }) Returns current path.
UPDIR	(→) Goes to parent directory
HOMEDIR	(→) Sets HOME as current directory.

9.2 System commands

The commands below deal with user and system flags, and with other system functions like the angle mode.

Word	Stack and action
ClrUserFlag	(# →) Clears user flag.
SetUserFlag	(# →) Sets user flag.
TestUserFlag	(# → flag) Returns TRUE if user flag is set.
ClrSysFlag	(# →) Clears system flag.
SetSysFlag	(# →) Sets system flag.
TestSysFlag	(# → flag) Returns TRUE if system flag is set.
DOSTD	(→) Sets standard mode.
DOFIX	(# →) Sets fixed mode, with specified number of decimal places.
DOSCI	(# →) Sets scientific mode, with specified number of decimal places.

Word	Stack and action
DOENG	(# →) Sets engineering mode, with specified number of decimal places.
SETRAD	(→) Sets radians as the angle mode.
SETDEG	(→) Sets degrees as the angle mode.
SETGRAD	(→) Sets grads as the angle mode.
DOBEEP	(%freq %dur →) Beeps.
setbeep	(#MHz #msec →) Beeps.
MEM	(→ #) Returns amount of free memory (in nibbles). Does not force garbage collection, like the user word does.

Part II

Advanced RPL

Chapter 10
Error handling

When en error occurs in a System RPL program, what normally happens is that the program is aborted and the error message is shown at the top of the display. However, sometimes it is desired for the program to trap the error and if possible continue execution, or perhaps show that an error happened in a different way.

But sometimes, the programs need to *generate* an error. For example, if the user gave invalid input for the program, it should abort with a "Invalid Argument Type" error, instead of risking crashing the machine.

10.1 Trapping errors

You can intercept the execution of the error handling subsystem, i.e., trap an error generated by your program, using the following structure:

```
:: ... ERRSET <suspect object> ERRTRAP <if-error object> ... ;
```

It works like this: if the `<suspect object>` generates an error, the execution continues at `<if-error object>`. Otherwise, it continues past it.

The action of `<if-error object>` is completely flexible. Normally, it will handle the error and then continue or exit the program. The current error number can be recalled with `ERROR@`, and then your program can do different actions on different kinds of errors. The error messages and numbers can be found on Appendix B of the HP48G Series User Manual. Other functions related to error handling are on Chapter 32.

10.1.1 The protection word

Each temporary environment (see Chapter 5) and DO/LOOP environment (see Chapter 8) has a protection word. The purpose of this is to allow the error handling sub-system to distinguish which environments were created before the error trap, and which were created before. This way, all environments that were created after the error trap was set will be deleted. For example, consider the following code:

```
::
  ...
  1LAMBIND
  ...
  TEN ZERO_DO
    ERRSET ::
      ...
      1LAMBIND
      ...
      FIVE ONE_DO
        <suspect object is here>
      LOOP
      ABND
    ;
    ERRTRAP ::
      <error handling>
    ;
  LOOP
  ...
  ABND
;
```

If an error is generated, then the error will be trapped. The inner DO/LOOP and temporary environments will be deleted, thanks to the protection word.

The word ERRSET increments the protection word in the topmost temporary environment and topmost DO/LOOP environment. Thus, these environments now have a non-zero protection word. (The words DO and BIND had initialized the protection word to zero).

The words ERRTRAP and ERRJMP delete temporary and DO/LOOP environments (from the innermost to the outermost) until, in both cases, they find one with a non-zero protection word (which is then decremented). These environments were the ones that already existed before the setting of the error trap. This way, all environments created after the setting of the trap are deleted.

10.2 Generating errors

The error handling sub-system is invoked by the word ERRJMP. If an error trap was set, the error handler will be executed. If none was set, then the default one will be run (i.e., the error will be shown on the status line, together with a beep, etc.).

Normally, before calling ERRJMP, you must define which error you want to generate (most of the time when you generate errors, they are to be handled by the default error handler — such as displaying "Bad Argument Value" if the input is invalid, which is better than a crash). This can be done with the word ERRORSTO. It expects a bint as argument: the number of the error. The errors are listed on Appendix B of the HP48G Series User Manual.

There are some words that automate this process, automatically generating some common errors. They are listed on Chapter 32.

Chapter 11
Keyboard control

A System RPL program can get input from the user in five different ways:

- From the stack;
- Waiting keystrokes from the keyboard;
- Using the internal INPUT
- Using the internal INFORM;
- Setting up a Parameterized Outer Loop.

You have already seen how to get input directly from the stack. Using InputLine, ParOuterLoop and input forms will be seen on the following chapters. So, in this chapter you will learn how to read keystrokes from the keyboard.

11.1 Key locations

In User RPL, key representations have the form %rc.p. In System RPL, they are represented by two binary integers: #KeyCode, which goes from one to 49, and represents each key, in order, from left to right and top to bottom; and #Plane, which represents the modifier states, according to the table below:

#Plane	Modifiers	#Plane	Modifiers
ONE	None	FOUR	Alpha
TWO	Left-shift	FIVE	Alpha, left-shift
THREE	Right-shift	SIX	Alpha, right-shift

You can convert from one mode to another using:

Ck&DecKeyLoc (%rc.p → #KeyCode #Plane)

CodePl>%rc.p (#KeyCode #Plane → %rc.p)

11.2 Waiting for a key

The best function used to wait for a key is WaitForKey. This word puts the HP48 in a low-power state and waits until a key is pressed. It then returns the key code and plane. There are other words, which can be found on Chapter 40.

Chapter 12
Using `InputLine`

The word `InputLine` is the system equivalent to the user word `INPUT`. Its use is similar, and it does the same:

- Displays a prompt in the top of the screen;
- Starts the keyboard entry modes;
- Initializes the edit line;
- Accepts input until ENTER is pressed;
- Parses, evaluates, or just returns the user input;
- Returns `TRUE` if it was exited by ENTER or `FALSE` if aborted by ON/CANCEL.

The stack must contain the following parameters:

Name	**Description**
$Prompt	The prompt to be displayed during input.
$EditLine	The initial edit line.
CursorPos	The initial cursor position, specified as a binary integer character number or a two-element list of binary integer row and column. In both cases, `#0` represents the end of edit line, row or column.
#Ins/Rep	The initial insert/replace mode: • `#0` current mode • `#1` insert mode • `#2` replace mode
#Entry	The initial entry mode: • `#0` current entry plus program entry • `#1` program/immediate entry • `#2` program/algebraic entry
#Alphalock	The initial alpha mode: • `#0` current mode • `#1` alpha enabled • `#2` alpha disabled
ILMenu	The initial menu, in the format specified in section 14.5.
#ILMenu	The initial menu row number (normally `ONE`).
AttnAbort?	A flag: • `TRUE` CANCEL aborts the input • `FALSE` CANCEL just clears the edit line
#Parse	How to process the edit line: • `#0` return edit line as a string • `#1` return edit line as a string *and* a parsed object • `#2` parse and evaluate edit line

If AttnAbort? is TRUE, if the user presses CANCEL the edition is aborted. If it is FALSE, CANCEL just clears the edit line. If it was already empty, then it aborts the edit.

Depending on the value of #Parse, different values are returned, according to the table:

#Parse	Stack	Description
#0	$Editline TRUE	Edit line only
#1	$Editline obs TRUE	Edit line and parsed object(s)
#3	ob1 ... obn TRUE	Resulting object(s)
	FALSE	CANCEL pressed to abort

12.1 An example

Here is an example of InputLine, which prompts for your name, and if the edition was not aborted, displays it.

```
::
  $ "Your name:"   ( prompt )
  NULL$            ( initial edit line )
  #ZERO#ONE        ( cursor at end, insert mode )
  ONEONE           ( prog/immed mode, alpha enabled )
  NULL{}           ( no menu )
  ONE              ( menu row )
  FALSE            ( CANCEL clears )
  ZERO             ( returns string )
  InputLine
  NOT?SEMI         ( exit if FALSE )
  $ "Your name is "
  SWAP&$           ( concatenate string & name )
  CLEARLCD         ( clear display )
  DISPROW1         ( display string on 1st line )
  SetDAsTemp       ( freeze display )
;
```

Chapter 13
Creating input forms

In User RPL, creating input forms is not one of the easiest tasks to do. As expected, in System RPL it is even more difficult. But there are two advantages: in User RPL you can only have text fields, in System RPL you can have all four kinds of fields (see below). And in System RPL they have the extra advantage of being *fast*.

There are four kinds of fields: data fields (DF), the normal user type input fields; extended data fields (EDF), which allow you to enter text or select a variable; list fields (LF), which have a pre-determined set of values; and check fields (CF), which you can select yes or no, for example.

The command `DoInputForm` needs the following arguments:

Parameter	**Description**

`label1`
`...`
`labeln`
	Label definitions

`field1`
`...`
`field2`
	Field definitions

`#labels`	Number of labels
`#fields`	Number of fields
`MessageHandler`	Normally `'DROPFALSE`
`"Title String"`	Title string

13.1 Label definitions

Each label definitions is three arguments:

Parameter	**Description**
`"label"`	Label string
`#x_offset`	X coordinate
`#y_offset`	Y coordinate

The string will be displayed (with the small font) on the specified coordinates of the screen. The coordinates are two bints. The upper-left corner of the screen has the coordinates x=0 and y=0, and these values increase as the position goes down or right.

13.2 Field definitions

Each field definition is thirteen arguments:

Parameter	Notes
`MessageHandler`	Normally `'DROPFALSE`
`#x_offset`	X coordinate
`#y_offset`	Y coordinate (normally label Y coordinate + 2)
`#Length`	Length of field
`#Height`	Height of field (usually `NINE`)
`#FieldType`	Specified filed type
`#AllowedTypes`	List of user types for DF/EDF, or `MINUSONE` for LF/CF
`Decompile`	See below
`"HelpString"`	Help string
`ChooseData`	See below.
`ChooseDecompile`	See below.
`ResetValue`	Reset value: DF/EDF: any/`MINUSONE`; LF: { “label” foo }; CF: `TRUE`/`FALSE`
`RnitValue`	Initial value, same as above

The message handler is normally specified as `'DROPFALSE`, which means the programs does not hande what the user enters.

The x and y positions specify where the field will appear. They work similarly to the x and y positions of label definitions. Then length are also two binary integers, which specify the size of the field.

The field type is a bint which defines the field type:

Decimal value	Type
1	Text fields: DF or EDF
3	Algebraic fied: like DF, but automatically inserts ticks (').
12	List field
32	Check field

The allowed types is a list of system binary integers, where each represent a object type allowed for the field. The list of object types and numbers can be found on Chapter 4. If the field is a LF or CF, specify `MINUSONE` instead.

The decompile object can either be a secondary that takes an object and returns a string, or a bint. Here is an example of secondary that could be used for decompiling:

```
' ::
  DUP MINUSONE EQUAL casedrop NULL$
  DUPTYPECSTR? ?SEMI EDITDECOMP$
;
```

It first checks if the field is empty (i.e., its value is MINUSONE, in this case a null string is returned. Then, if the object is not already a string, the function EDITDECOMP$ is called for changing the object into a string.

You can also specify a binary integer, each bit represents something different:

Bit	Meaning if set
0	No decompile — only expects strings
1	Decompile object to have stack appearance (using current number settings)
2	Decompile object to have stack appearance (but using STD mode)
3	Gets first character of a string (expects only strings)
4	Get first object of composite and decompile it
5	Get second object of composite and decompile it

Normally, for data and extended data fields, it is desired to display the object, if it is a number, using STD mode, so you would set only bit two. This results in 2^2, or FOUR. When using list fields, most of the type this value will be set to SEVENTEEN, which is $2^0 + 2^4$. This means that each object in the choose box is a list. The first object is a string, which will be shown. The meaning of the others will be explained in the description of the ChooseData value. For check fiels, specify MINUSONE.

The help string is just a string that will be shown above the menu bar when the field is selected.

The choose data field is only used for extended data and list fields. Other types should specify MINUSONE as this parameter. For EDFs, it is a string that will display in the title of the choose box of the variables. The current directory name will be appended, so normally it is a string like "Reals in ", which will then show as something like "Reals in HOME".

For LFs, it is a list with all the possible choices. The format depends on the Decompile parameter. If it was specified as SEVENTEEN, then it is a list of the format

```
{ { “label1” <foo> } { “label2” <bar> } { ... } ... }
```

The first object in the sub-list will be shown, and the whole list will be pushed to the stack. However, if <foo> is something like DROP <bar>, then you just need to execute COMPEVAL with the list as argument to evalute the program <bar>.

The ChooseDecompile parameter follows the same rules as the Decompile one. Normally, specify SEVENTEEN for a LF, or MINUSONE for any other kind of field.

The reset and initial values specify the values which will show when the form is first displayed, or when it is reset. For DFs and EDFs, it is any object or MINUSONE if empy. For LFs, it is an object like in the ChooseData paramter (normally { “label” <foo> }). And for CFs, it is either TRUE or FALSE.

13.3 Label and field counts

These are two bints, representing the number of labels and fields defined. Note that since they are different values, you can have labels which just show some kind of information to the user, or fields without any label definition.

13.4 The message handler

The message handler is, again, a secondary (which is pushed in the stack, not evaluated) or simply `'DROPFALSE`, if your program does not test or change the input entered by the user.

13.5 The title string

This is a string that will be shown on the top of the display, with the small font. If it is longer than 131 characters (the width of the screen), it will be truncated and a "..." will be appended.

13.6 Results of the input form

The stack output, if the user exited the input form by ENTER is:

```
N+1: field1
  N: field2
     ...
  2: fieldN
  1: TRUE
```

If CANCEL was used to exit the form, then just `FALSE` is returned.

For each field type the output is:

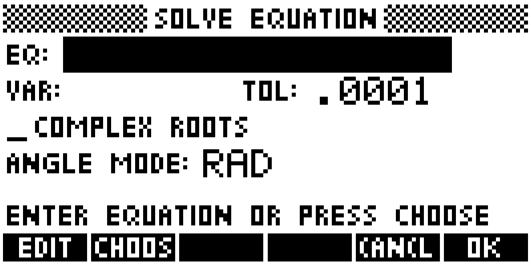
Field Type	Return value
DF/EDF	any (or `MINUSONE` if empty)
CF	`TRUE/FALSE`
LF	`{ "Label" foo }`

13.7 An example

Here is a program that displays an input form for an Equation Solver program. Then, if the screen was exited by ENTER, it puts some strings in the stack showing to the user selections. A *real* program would solve the equation, but this is only an example, so do not expect very much from it.

```
::
    CK0NOLASTWD        ( no args required )

* Label definitions
    $ "EQ:"           ONE   TEN
    $ "VAR:"          ONE   NINETEEN
    $ "TOL:"          SIXTY NINETEEN
    $ "COMPLEX ROOTS" EIGHT TWENTYEIGHT
    $ "ANGLE MODE:"   ONE   THIRTYSEVEN

* EQ field definition
    'DROPFALSE         ( no message handler )
    FIFTEEN            ( x position )
    EIGHT              ( y position )
    # 61               ( length )
    NINE               ( standard height - NINE )
    TWENTYTHREE        ( EDF )
    { NINE }           ( symbolics allowed )
    FOUR               ( decomp with STD mode )
    $ "Enter equation or press CHOOSE"  ( help string )
    $ "Equations in "  ( string to show in CHOOSE box )
    MINUSONE           ( choose decompile )
    DUPDUP             ( no reset/init value )

* VAR field definition
    'DROPFALSE         ( no message handler )
    EIGHTEEN           ( x position )
    SEVENTEEN          ( y position )
    THIRTYFIVE         ( length )
    NINE               ( height )
    ONE                ( DF )
    { SIX }            ( ID's allowed )
    FOUR               ( decomp with STD mode )
    $ "Enter variable" ( help string )
    MINUSONE           ( no choose data )
    DUP                ( no choose decompile )
    DUPDUP             ( no reset/init value )

* TOL field definition
    'DROPFALSE         ( no message handler )
    # 4D               ( x position )
    SEVENTEEN          ( y postion )
    THIRTYFIVE         ( length )
    NINE               ( height )
    ONE                ( DF )
    { ZERO }           ( reals allowed )
    FOUR               ( decomp with STD mode )
    $ "Enter tolerance" ( help string )
    MINUSONE           ( no choose data )
    DUP                ( no choose decomp )
    % .0001            ( reset value )
    DUP                ( init value )

* Checkmark field definition
    'DROPFALSE         ( no message handler )
    ONE                ( x position )
    TWENTYSIX          ( y position )
    SIX                ( checkmark length is SIX )
    NINE               ( height )
    THIRTYTWO          ( CF )
    MINUSONE           ( no types in CF )
    DUP                ( CF )
    $ "Use [+/-] to mark"  ( help string )
    MINUSONE           ( no choose data )
    DUP                ( nor choose decomp )
    FalseFalse         ( reset/init value: not checked )

* ANGLE MODE field definition
    'DROPFALSE         ( no message handler )
    FORTYNINE          ( x position )
    THIRTYFIVE         ( y position )
    THIRTY             ( length )
    NINE               ( height )
    TWELVE             ( LF )
    MINUSONE           ( no types in LF )
    SEVENTEEN          ( display first object in comp )
    $ "Use CHOOSE or [+/-] to select"  ( help string )
* Field contents. The first will be shown, the entire
* list will be pushed to the stack
    { { "RAD" DROP SETRAD }
      { "DEG" DROP SETDEG }
      { "GRAD" DROP SETGRAD } }
    SEVENTEEN          ( choose decomp )
    { "RAD" DROP SETRAD }  ( reset value )
    DUP                    ( init value )

* General info
    FIVE               ( five labels )
    DUP                ( same number of fields )
    'DROPFALSE         ( default message handler )
    $ "Solve Equation" ( title string )
    DoInputForm        ( do the form )
    NOT?SEMI           ( exit if CANCEL pressed )
    COMPEVAL           ( set angle mode )
* If this were a real program, solving would
* probably start here. But we will just show
* what the user selected
    FOUR reversym DROP
    SWAP $ "Solve for " SWAP
    ID>$ &$ $ " in" &$SWAP
    $ "Tol.: " 4ROLL
    DO>STR &$
    4ROLL
    ITE
    $ "Real&complex roots"
    $ "Real roots only"
;
```

The picture below shows how the screen will look like.



SOLVE EQUATION

EQ:

VAR: TOL: .0001

_COMPLEX ROOTS

ANGLE MODE: RAD

ENTER EQUATION OR PRESS CHOOSE

Chapter 14
The parameterized outer loop

The parameterized outer loop is a System RPL structure that allows you to create a complete application, which receives keystrokes and does different actions, based on the key that was pressed. This is repeated s many times as necessary, until an exit condition happens. Most of the times, there is a key that stops the loop, like CANCEL or DROP. Generally, it is used with programs that work with the display.

To set up a parameterized outer loop, nine parameters are necessary:

Parameter name	Description
AppDisplay	This object is evaluated before each key evaluation. "AppDisplay" should handle display updating not handled by the keys themselves, and should also perform special handling of errors.
AppKeys	The hard key assignments, in the format described below.
NonAppKeyOK?	A flag: if TRUE, then the hard keys not assigned perform their normal actions. Otherwise, they are canceled.
DoStdKeys?	A flag: if TRUE, then standard key definitions are used for non-application keys instead of default key processing.
AppMenu	The menu specification, in the format described below, or FALSE.
#AppMenuRow	The initial menu row. Normally ONE.
SuspendOK?	A flag: if TRUE, any user command that would create a suspended environment and restart the system outer loop will instead generate an error.
ExitCond	This object is evaluated before each display update and key evaluation. If the result is TRUE, the loop is exited.
AppError	The error-handling object to be evaluated in an error occurs during key evaluation.

After those arguments are in the stack, run ParOuterLoop. This word does not generate any results itself, but any of the key assignments can return results to the stack or any other form desired.

14.1 Parameterized outer loop words

The parameterized outer loop is formed by calls (with proper error handling) to calls to the following words. None of them return anything, and only POLSetUI takes arguments: the nine required by ParOuterLoop.

Word	Action
POLSaveUI	Saves the current user interface in a temporary environment.
POLSetUI	Sets the current user interface, according to the parameters given.
POLKeyUI	Displays, reads and evaluates keys. Handles errors, and exits according to the user interface specified by POLSetUI.
POLRestoreUI	Restores the user interface saved by POLSaveUI and abandons temporary environment.
POLResUI&Err	Restores the user interface and errors. This is used when there is an error not handled within the parameterized outer loop.

The word ParOuterLoop decompiles to:

```
::
  POLSaveUI        ( save the current user interface )
  ERRSET ::        ( start error trap )
    POLSetUI       ( set new user interface )
    POLKeyUI       ( handle keypresses )
  ;
  ERRTRAP
    POLResUI&Err   ( if an error happened, restore the saved )
                   ( interface and error )
  POLRestoreUI     ( restore saved user interface )
;
```

If you use the words above instead of ParOuterLoop, you *must* provide the same level of error protection as the code above.

One note: the parameterized outer loop creates a temporary environment when it saves its current user interface, and it abandons the interface when if restores a saved user interface. This means that you cannot use words that operate on the topmost temporary environment, like 1GETLAM within the loop, unless the variable was created *after* calling POLSaveUI, and it is abandoned *before* calling POLRestoreUI. For temporary environments created before POLSaveUI, *named* temporary variables should be used.

14.2 The display

In the parameterized outer loop, the user is responsible for setting up the display and updating it; there is no default display.

The display can be updated in two ways: with the parameter “AppDisplay” or with key assignments. For example, when the user presses a key to move the cursor, the key assignment can either pass information to “AppDisplay” (often implicitly), so that it handles the code, or the key assignment object can handle the display itself. Which method is more efficient depends on the situation. In our example below, AppKeys just sets the positions of the grob, which is draw by AppDisplay.

14.3 Error handling

If an error occurs during the key processing, AppError is executed. This parameter is responsible for processing any errors generated while the parameterized outer loop is running. AppError should determine the specific word and act accordingly. Or you can just specify `ERRJMP` as AppError, which means your application does not handle any errors.

14.4 Hard key assignments

In the parameterized outer loop, any key in any of the six planes (see section 11.1) can be assigned for a new function. The parameter AppKeys specifies which keys to assign and their new assignments.

If a key is not assigned by the application, and the NonAppKeyOK? parameter is `TRUE`, the standard key definition is executed if the DoStdKeys? parameter is `TRUE`, or, if available, the USER key assignment, if it is `FALSE`. If NonAppKeyOK? is `FALSE`, a warning beep is produced, and nothing else is done.

Most of the time, NonAppKeysOK? should be set to `FALSE`.

The AppKeys parameter is a secondary, which must take as argument the keycode and plane, and return either the desired key definition and `TRUE` or `FALSE` if the application does not handle it. Specifically, the stack diagram is as follows:

```
( #KeyCode #Plane → KeyDef TRUE )
( #KeyCode #Plane →  FALSE      )
```

The suggested form for the key assignments is:

```
ONE #=casedrop :: (process unshifted plane ) ;
TWO #=casedrop :: (process left-shifted plane ) ;
...
2DROP FALSE
```

Each plane handler normally has the form

```
SEVEN    ?CaseKeyDef :: TakeOver <process MTH key> ;
NINETEEN ?CaseKeyDef :: TakeOver <process TAN key> ;
...
DROP FALSE
```

The word ?CaseKeyDef replaces #=casedrop :: ' <keydef> TRUE ;. It should be used because it saves code and makes the definitions more legible. Specifically, ?CaseKeyDef is used in the form:

```
... #KeyCode #TestKeyCode ?CaseKeyDef <keydef> ...
```

If #TestKeyCode equals #KeyCode, ?CaseKeyDef drops both of them, pushes <KeyDef> and TRUE to the stack, and exits the secondary. Otherwise, it drops only #TestKeyCode, skips <KeyDef> and continues.

14.5 Menu key assignments

Any application can specify an initial menu via the AppMenu parameter to be displayed when the parameterized outer loop starts. All menu keys can have assignments to the unshifted, left-shifted and right-shifted planes. When the loop exits, the previous menu is restored intact.

You can specify FALSE as AppMenu. This indicates that the current menu is to be left intact. If you specify an empty list, then a menu of six null-menu keys is created.

Note: hard key assignments have priority over menu key assignments. So, if you are planning to include a menu key handler, you must put the following line in the hard key assignments parameter:

```
DUP#<7 casedrpfls
```

The parameter AppMenu is a list of the form:

```
{
  Menu Key 1 Definition
  Menu Key 2 Definition
  ...
  Menu Key n Definition
}
```

Each menu key definition is one the following:

1. NullMenuKey
2. { LabelObj :: TakeOver <action> ; }

3.
   ```
   { LabelObj {
               :: TakeOver <primary action> ;
               :: TakeOver <l-shift action> ;
              } }
   ```

```
4. { LabelObj {
              :: TakeOver <primary action> ;
              :: TakeOver <l-shift action> ;
              :: TakeOver <r-shift action> ;
             } }
```

A LabelObj may be any object, but it is normally a string or a 21x8 grob. The word NullMenuKey inserts a blank menu key that just beeps when pressed.

The word TakeOver indicates that the program will be executed even if the command line is active.

14.6 Preventing suspended environments

Your application may require the evaluation of arbitrary commands and user arguments, but do not want the current environment to be suspended by HALT or PROMPT commands. The parameter SuspendOK?, when FALSE, will cancel these and any other commands that would suspend the environment and generate a "HALT Not Allowed" error, which AppError can handle. If the parameter is TRUE, the application must be prepared to handle the consequences. "The dangers here are many and severe", as it is written on RPLMAN.DOC.

All foreseeable application should set FALSE as the SuspendOK? parameter.

14.7 The exit cond ition

The parameter ExitCond is an object that is evaluated before each key evaluation. If it evaluates to TRUE, the loop is exited, otherwise it continues. You could define, for example, ExitCond as `' LAM exit`. When the "quit" key is pressed, you just have to use `TRUE ' LAM exit STO` and the loop will be exited. Of course, you must create the lam and initialize it with FALSE before.

14.8 An example

The following program is an example of an application that uses a parameterized outer loop to create an environment where the user may move a little graphic over the screen. You can use the arrow keys to move, or the menu keys. In both cases, if you press left-shit before, the graphic moves ten steps instead of one. I added code so that the graphic does not go off the screen boundaries.

```
::
* Defines names for used keys. Makes things easier and
* more readable
  DEFINE kpNoShift    ONE
  DEFINE kpLeftShift  TWO
  DEFINE kcUpArrow    ELEVEN
  DEFINE kcLeftArrow  SIXTEEN
  DEFINE kcDownArrow  SEVENTEEN
  DEFINE kcRightArrow EIGHTEEN
  DEFINE kcLeftShift  THIRTYFIVE
  DEFINE kcOn         FORTYFIVE

* Prepare display
  RECLAIMDISP    ( clear and resize display )
  ClrDA1IsStat   ( temporarily disable clock )

* Smiling face grob. The below must be in one line only.
  GROB 7C 310003100008F000060300810C004000104000102000202401201000
4010004010004010004011044021042026032048F010400010810C0006030008F0
00
  FIFTYSIX      ( initial x coordinate for box )
  EIGHTEEN      ( initial y coordinate for box )
  FALSE         ( initial exit condition )
  {
   LAM MrSmile
   LAM x
   LAM y
   LAM exit?
  } BIND        ( binds local variables )
* The following composite is the display update object. It
* clears the screen and draws the smiling face grob to it.
' ::
    CLEARVISP        ( clear display )
    LAM MrSmile      ( recall smiling face grob )
    HARDBUFF         ( recall current display )
    LAM x LAM y      ( smile coordinates )
    GROB!            ( REPL )
    DispMenu.1       ( display menu )
  ;
* The following composite is the key action handler.
  ' ::
    kpNoShift #=casedrop ::
      DUP#<7 casedrpfls  ( enable softkeys )
      kcUpArrow ?CaseKeyDef
        :: TakeOver LAM y DUP ONE #<ITE :: DROP ERRBEEP ; :: #1- '
           LAM y STO ; ;
      kcDownArrow ?CaseKeyDef
        :: TakeOver LAM y DUP THIRTYSIX #>ITE :: DROP ERRBEEP ; ::
           #1+ ' LAM y STO ; ;
      kcLeftArrow ?CaseKeyDef
        :: TakeOver LAM x DUP ONE #<ITE :: DROP ERRBEEP ; :: #1- '
           LAM x STO ; ;
      kcRightArrow ?CaseKeyDef
        :: TakeOver LAM x DUP # 6F #>ITE :: DROP ERRBEEP ; :: #1+
           ' LAM x STO ; ;
      kcOn ?CaseKeyDef
        :: TakeOver TRUE ' LAM exit? STO ;
      kcLeftShift #=casedrpfls
      DROP 'DoBadKeyT
    ;
    kpLeftShift #=casedrop ::
      DUP#<7 casedrpfls  ( enable softkeys )
      kcUpArrow ?CaseKeyDef
        :: TakeOver LAM y DUP TEN #<ITE :: DROPZERO ERRBEEP ; ::
           TEN #- ; ' LAM y STO ;
      kcDownArrow ?CaseKeyDef
        :: TakeOver LAM y DUP TWENTYSEVEN #>ITE :: DROP
           THIRTYSEVEN ERRBEEP ; #10+ ' LAM y STO ;
      kcLeftArrow ?CaseKeyDef
        :: TakeOver LAM x DUP TEN #<ITE :: DROPZERO ERRBEEP ; ::
           TEN #- ; ' LAM x STO ;
      kcRightArrow ?CaseKeyDef
        :: TakeOver LAM x DUP # 66 #>ITE :: DROP # 70 ERRBEEP ;
           #10+ ' LAM x STO ;
      kcLeftShift #=casedrpfls
      DROP 'DoBadKeyT
    ;
    2DROP 'DoBadKeyT
  ;
  TrueTrue   ( key definitions )
* Menu specification
  { { "Up" {
             :: TakeOver LAM y DUP ONE #<ITE :: DROP ERRBEEP ; ::
                #1- ' LAM y STO ; ;
             :: TakeOver LAM y DUP TEN #<ITE :: DROPZERO ERRBEEP ;
                :: TEN #- ; ' LAM y STO ;
           }
    }
    { "Down" { :: TakeOver LAM y DUP THIRTYSIX #>ITE :: DROP
                  ERRBEEP ; :: #1+ ' LAM y STO ; ;
               :: TakeOver LAM y DUP TWENTYSEVEN #>ITE :: DROP
                  THIRTYSEVEN ERRBEEP ; #10+ ' LAM y STO ;
             }
    }
    { "Left" { :: TakeOver LAM x DUP ONE #<ITE :: DROP ERRBEEP ;
                  :: #1- ' LAM x STO ; ;
               :: TakeOver LAM x DUP TEN #<ITE :: DROPZERO ERRBEEP
                  ; :: TEN #- ; ' LAM x STO ;
             }
    }
    { "Right" { :: TakeOver LAM x DUP # 6F #>ITE :: DROP ERRBEEP ;
                   :: #1+ ' LAM x STO ; ;
                :: TakeOver LAM x DUP # 66 #>ITE :: DROP # 70
                   ERRBEEP ; #10+ ' LAM x STO ;
              }
    }
    NullMenuKey
    { "Quit" :: TakeOver TRUE ' LAM exit? STO ; }
  }
  ONEFALSE     ( first row, no suspended envs )
  ' LAM exit?  ( exit condition )
  'ERRJMP      ( error handler )
  ParOuterLoop ( run the par outer loop )
  RECLAIMDISP  ( resize and clear display )
  ClrDAsOK     ( redraw display )
;
```

Chapter 15
The display

There are two screens available to the programmer while programming in System-RPL: the graphics screen, which is visible, for example, in the Plot application, and the text screen, which is the graphic visible in the standard stack environment. Whenever possible, the latter should be used, leaving the graphics screen as a "owned" resource.

15.1 Display organ ization

The HP48 system RAM contains three dedicated graphic objects (subsequently called grobs) used for display purposes.

Pointer	Grob
HARDBUFF2	Menu labels
ABUFF	Text grob (stack)
GBUFF	Graphics grob (PICT)

The text and graphic grobs may be enlarged, and may be scrolled. The menu label grob has a fixed size of 131x8 pixels.

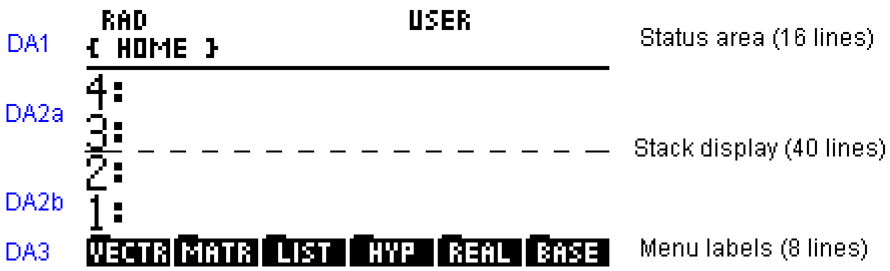
The word TOADISP makes the text grob visible; the word TOGDISP makes the graphic grob visible.

The following words return display grobs to the stack:

Word	Stack
ABUFF	(→ textgrob)
GBUFF	(→ graphgrob)
HARBUFF2	(→ menugrob)
HARDBUFF	(→ HBgrob) Returns whichever grob is visible (text or graph)
HBUFF_X_Y	(→ HBgrob #x1 #y1)

One thing to note is that the words above return just pointer to the grob, so if you alter the grob, the display will also be altered automatically. If you do not want that behavior, after using any of the words above, call TOTEMPOB to make a unique copy in temporary memory.

The text grob is divided in three regions. The display areas are numbered one, two and three. In many words you will find "DA", which means "Display Area".



Display area 2 is actually divided in two areas: 2a and 2b. The boundary between the two areas can move, but the overall size of all three areas is fixed.

15.2 Preparing the display

Two words establish control over the text display: `RECALIMDISP` and `ClrDA1IsStat`. The first does the following:

- Assures the current display is the text one;
- Clears the text display;
- If necessary, resizes the text display to the default size of 131x56 pixels.

This word works very similarly to the user word `CLLCD`, the difference is that `CLLCD` never resizes the text display.

The word `ClrDA1IsStat` is optional, but most of the time it should be used. It suspends the ticking clock display temporarily. When input is expected from the user from the keyboard, using `WaitForKey` or the parameterized outer loop, the ticking clock would botch the display. `ClrDA1IsStat` avoids this problem.

When the menu is not necessary, use the word `TURNMENUOFF` to hide the menu and enlarge the text grob to 131x64 pixels. It is turned on again with `TURNMENUON`.

The suggested framework for an application that uses the text display is:

```
::
  ClrDA1IsStat          ( suspend clock )
  RECLAIMDISP           ( set, clear and resize text display )
  TURNMENUOFF           ( turns off menu )

  <application>

  ClrDAsOK              ( redraw LCD )
    -or-
  SetDAsTEMP            ( freeze the whole display )
;
```

15.3 Controlling display refresh

In some programs, it is desired that, after the application ends, the screen is not redrawn, but continues frozen so that the user can see the results. In User RPL the word FREEZE is responsible for this. But sometimes, it is desired that the display is returned back to normal. In System RPL, several words serve those purposes. The most used ones are listed below; the whole list is on Chapter 41.

Word	Action
SetDA1Temp	Freezes display area 1.
SetDA2aTemp	Freezes display area 2a.
SetDA2bTemp	Freezes display area 2b.
SetDA2OKTemp	Freezes display areas 2a and 2b.
SetDA3Temp	Freezes display area 3.
SetDA12Temp	Freezes display areas 1 and 2.
SetDAsTemp	Freezes the whole display.
ClrDA1OK	Redraws display area 1.
ClrDA2aOK	Redraws display area 2a.
ClrDA2bOK	Redraws display area 2b.
ClrDA2OK	Redraws display areas 2a and 2b.
ClrDA3OK	Redraws display area 3.
ClrDAsOK	Redraws the whole display.

15.4 Clearing the display

The following words clear either the whole or part of HARDBUFF. Remember that HARDBUFF refers to the currently displayed grob, either the text or the graph display. Except from BLANKIT, no words take or return arguments.

Word	Action
BLANKIT	(#startrow #rows →) Clears #rows from HARDBUFF
CLEARVDISP	Clears entire HARDBUFF.
BlankDA1	Clears display area 1
BlankDA2	Clears display area 2
BlankDA12	Clears display areas 1 and 2
Clr16	Clears top 16 rows
Clr8	Clears top 8 rows
Clr8-15	Clears rows 8 to 15 (second status line)
CLCD10	Clears status and stack area
CLEARLCD	Clears entire display

15.5 Annunciator control

You can control the left-shift, right-shift and alpha annunciators directly, using the words listed below and on Chapter 41. However, be careful to return them to the state they were before after your application finishes.

Word	Action
ClrAlphaAnn	Clears the alpha annunciator.
SetAlphaAnn	Sets the alpha annunciator.
ClrLeftAnn	Clears the left-shift annunciator.
SetLeftAnn	Sets the left-shift annunciator.
ClrRightAnn	Clears the right-shift annunciator.
SetRightAnn	Sets the right-shift annunciator.

15.6 Display coordinates

The upper-left pixel of the display has the coordinates x=0 and y=0, and the bottom-right pixel has coordinates x=130 and y=63.

Subgrobs are taken from the upper left coordinate to the pixel below and to the right of the lower right corner coordinate. The terms #x1 and #y1 refer to the upper left coordinates, and #x2 and #y2 refer to the pixel below and to the right of the lower right corner.

15.6.1 Display subgrobs

The words described below return HARDBUFF and coordinates for the stack in a form suitable for a subsequent call to SUBGROB in order to get a portion of the current display. #x1 and #y1 refer to the upper left corner of the window on the currently displayed grob. If the grob has been scrolled (see section 15.6), these will *not* be #0 and #0.

When HARDBUFF has been scrolled, some of the words below may not be appropriate since they depend on the upper left corner being #0, #0. The LCD is then called window and the terms #x1 and #y1 refer to the upper left corner of the window. The word HBUFF_X_Y returns HARDBUFF and these coordinates. The word WINDOWCORNER returns just the coordinates.

Word	Stack
TOP8	(→ HBgrob #x1 #y1 #x1+131 #y1+8)
TOP16	(→ HBgrob #x1 #y1 #x1+131 #y1+16)
Rows8-15	(→ HBgrob #x1 #y1+8 #x1+131 #y1+16)

15.6.2 Scrolling the display

To scroll the display, use the words SCROLLUP, SCROLLDOWN, SCROLLLEFT and SCROLLRIGHT. These words scroll the display in the specified direction one pixel, and check if their corresponding arrow key is being held down. If it is, they repeat their action until the key is released or the edge of the display is reached.

To go directly to one edge of the display, use one of these words: JUMPTOP, JUMPBOT, JUMPLEFT or JUMPRIGHT.

15.7 Displaying text

The HP48 has three fonts available: the large font (5x9), the medium font (5x7) and the small font. The small font is variable width; the medium and large ones are fixed width.

In User RPL, the programmer can only use the medium font directly (with DISP). In System RPL, it is possible to display text directly with the large and medium fonts. If you want to use the small font or place the text exactly where you want, that must be done graphics, which will be described later.

15.7.1 Medium font

To display text with the medium font, use one of the words below. These words should only be used when the text grob is the current display and the screen has not been scrolled. Strings longer than 22 characters will be truncated to 21 characters and a trailing ellipsis (...) will be added. Shorter strings will be blank filled.

Word	**Stack and description**
DISPROW1	($ →) Displays string on first line.
DISPROW2	($ →) Displays string on second line.
DISPROW3	($ →) Displays string on third line.
DISPROW4	($ →) Displays string on fourth line.
DISPROW5	($ →) Displays string on fifth line.
DISPROW6	($ →) Displays string on sixth line.
DISPROW7	($ →) Displays string on seventh line.
DISPROW8	($ →) Displays string on eight line. Only works if menu is off.

Word	Stack and description
DISPN	($ #row →) Displays string on specified line.
DISP5x7	($ #start #max →) Display string starting at #start row, spanning up to #max rows. The string must have embedded carriage returns to show where to break to next line. If any line segment is longer than 22 characters, it is truncated and an ellipsis is added.

You can use the words DISPROW1* and DISPROW2* when the display has been scrolled. These words display in the first and second lines the given string, but the difference is that they display relative to the window corner. Unfortunately, there are no equivalents for the other five rows.

15.7.2 Large font

The words below can be used to display text in the large font. The same rules for long strings of the medium fonts are applied to the large font.

Word	Stack and description
BIGDISPROW1	($ →) Displays string on first line.
BIGDISPROW2	($ →) Displays string on second line.
BIGDISPROW3	($ →) Displays string on third line.
BIGDISPROW4	($ →) Displays string on fourth line.
BIGDISPN	($ #row →) Displays string on specified row.

15.7.3 Displaying warnings

The word FlashWarning is used to display a warning message. It displays the given string on the status area, beeps and pauses for approximately three seconds. To display a message in the status area, it uses the word DISPSTATUS2, which takes a string with a line break in it, and displays it using the two lines of the status area. After that, the display is returned to the state it was before.

A variation of FlashWarning is FlashMsg, which does not beep and pauses for a shorter time.

15.8 The menu lin e

The menu line consists of six grobs eight pixels high and 21 pixels wide. The starting columns for each menu key label in HARBDUFF2 is:

Column (Hex)	Softkey	Column (hex)	Softkey
0	First softkey (A)	42	Fourth softkey (D)
16	Second softkey (B)	58	Fifth softkey (E)
2C	Third softkey (C)	6E	Sixth softkey (F)

The word `DispMenu.1` redisplays the current menu; and `DispMenu` redisplays the current menu and calls `SetDA3Valid` to freeze the menu display area (display area 3).

The words below convert several kinds of objects to menu labels and display them at the specified column:

Word	Stack and action
`Str>Menu`	(#col $ →) Makes and displays a standard menu label.
`Id>Menu`	(#col id →) Recalls id and displays standard or directory label, depending on the contents.
`Grob>Menu`	(#col grob →) Displays a grob as a menu label.
`Seco>Menu`	(#col :: →) Evaluates secondary and uses results to create and display appropriate menu label.

The words below convert strings to the four different kinds of grobs available. All of them take a string and return a grob as arguments

Word	Action
`MakeStdLabel`	Makes a black label (standard).
`MakeBoxLabel`	Makes label with a box inside.
`MakeDirLabel`	Makes directory label (bar above)
`MakeInvLabel`	Makes white label (like in Solver).

15.9 Using graphic objects

Following, there are words for creating, manipulating and displaying graphic objects. The ones listed below are just the most used or important. You can find a complete list on Chapter 42

When dealing with graphics, keep two things in mind:

1. Some grob operations work directly on the grob without making a copy. So, all pointers to that object in the stack will be modified. You can use the word CKREF to ensure an object is unique. This kind of operation is denominated “bang-type”, and the commands normally have an exclamation point to indicate that, like GROB! or GROB!ZERO. These operations also have no error checking, so improper or out-of-range parameters may corrupt memory.
2. To place a grob in the display grob, it is better to use the word XYGROBDISP. This word checks if the grob to be placed in HARDBUFF would exceed its boundaries, and if so HARDBUFF is enlarged so that the grob fits.

15.9.1 Grob tools

The words below are used for creating or modifying graphic objects. The complete list is on Chapter 42

Word	Stack an description
GROB!	(grob1 grob2 #x #y →) Stores grob1 into grob2. Bang type.
GROB!ZERO	(grob #x1 #y1 #x2 #y2 → grob’) Blanks a rectangular region of the grob. Bang type.
GROB!ZERODRP	(grob #x1 #y1 #x2 #y2 →) Blanks a rectangular region of the grob. Assumes text or graph grob. Bang type.
SUBGROB	(grob #x1 #y1 #x2 #y2 → grob’) Returns specified portion of grob.
XYGROBDISP	(#row #col grob →) Stores grob in HARDBUFF, expanding if necessary.
GROB>GDISP	(grob →) Stores new graph grob.
MAKEGROB	(#height #width → grob) Creates a blank grob.
INVGROB	(grob → grob’) Inverts grob data bits. Bang type.
PIXON	(#x #y →) Sets pixel in text grob.

Word	Stack an description
PIXOFF	(#x #y →) Clears pixel in text grob.
PIXON?	(#x #y → flag) Is pixel in text grob on?
PIXON3	(#x #y →) Sets pixel in graph grob.
PIXOFF3	(#x #y →) Clears pixel in graph grob.
PIXON?3	(#x #y → flag) Is pixel in graph grob on?
ORDERXY#	(#x1 #y1 #x2 #y2 → #x1’#y1’#x2’#y2’) To draw lines, #x2 must be greater than #x1. This function orders the coordinates so that the above condition is met.
LINEON	(#x1 #y1 #x2 #y2 →) Draws a line in text grob.
LINEOFF	(#x1 #y1 #x2 #y2 →) Clears a line in text grob.
TOGLINE	(#x1 #y1 #x2 #y2 →) Toggles a line in text grob.
LINEON3	(#x1 #y1 #x2 #y2 →) Draws a line in graph grob.
LINEOFF3	(#x1 #y1 #x2 #y2 →) Clears a line in graph grob.
TOGLINE3	(#x1 #y1 #x2 #y2 →) Toggles a line in graph grob.
$>BIGGROB	($ → grob) Makes grob of the string using the large font (5x9).
$>GROB	($ → grob) Makes grob of the string using the medium font (5x7).
$>grob	($ → grob) Makes grob of the string using the small font.
Symb>HBuff	(symb →) Displays symbolic in HARDBUFF in Equation Writer form. Enlarges HARDBUFF if necessary, so use RECLAIMDISP after.

15.9.2 Grob dimensions

The words below return or verify size information of grobs.

Word	Stack and description
`GROBDIM`	(grob → #height #width) Returns dimensions of the grob.
`GROBDIMw`	(grob → #width) Returns width of the grob.
`DUPGROBDIM`	(grob → grob #height #width) Does `DUP`, then `GROBDIM`.
`GBUFFGROBDIM`	(→ #height #width) Returns dimensions of graphic grob.
`CKGROBFITS`	(grob1 grob2 #row #col → grob1 grob2 ’#row #col) Shrinks grob2 if it wouldn't fit in grob1, starting at specified row and column.

Part III

Reference

Chapter 16
Notes

In the following chapters, there is a list of (almost) all commands available in System RPL to the programmer. As observed earlier, there are two kinds of commands: supported and unsupported. Supported are the ones the HP design team guarantees to stay always at the same address in all ROM versions, so they can be used safely. Unsupported ones don't have that guarantee, so you must be careful when using them, or your program might not run in all ROM versions, and could even cause a crash. Unsupported commands have their names listed between ( )'s. They must be called by their addresses, using PTR <address>, because their names are not in the entry point list of the compilers.

However, it is better to assign names to those address (which will be valid only for that project). This way, you can call them by their names, and not by their addresses. This also makes your code more readable, and if the function is going to be called several times, you have one more reason to do that. Just include in your source file:

```
ASSEMBLE
=<name> EQU #<address>
...
RPL
```

You can include as many of these as needed. Just call the function using <name>.

In some chapters, there are conversion functions. The listed functions are the ones for converting to the data type described in the chapter only. So, to find a function to convert from a real number to a binary integer, look at the chapter about binary integers, and the opposite function will be found in the chapter about real numbers. The exceptions are the functions that convert complex numbers to reals representing the real and imaginary parts. Theses are listed in the chapter about complex numbers.

These are the object types and their representation in stack diagrams:

Type	Address	Prolog	Object Type	Stack
1	02933	DOREAL	Real number	%
2	02977	DOCMP	Complex number	C%
3	02A2C	DOCSTR	Character string	$
4	029E8	DOARRY	Array	[ ]
5	02A74	DOLIST	List	{ }
6	02E48	DOIDNT	Global identifier	id
7	02E6D	DOLAM	Local identifier	lam
8	02D9D	DOCOL	Secondary	::

Type	Address	Prolog	Object Type	Stack
9	02AB8	DOSYMB	Algebraic object	symb
B	02A4E	DOHSTR, DOHXS	Hexadecimal string	hxs
C	02B1E	DOGROB	Graphics object	grob
D	02AFC	DOTAG	Tagged object	tag
E	02ADA	DOEXT	Unit	unit
0F	02E92	DOROMP	ROM Pointer	romptr
1F	02911	DOBINT	Binary integer	#
2F	02A96	DORRP	Directory	rrp
3F	02955	DOEREL	Extended real number	%%
4F	0299D	DOECMP	Extended complex number	C%%
5F	02A0A	DOLNKARRY	Linked array	[L]
6F	029BF	DOCHAR	Character	chr
7F	02DCC	DOCODE	Code object	code
8F	02B40	DOLIB	Library	lib
9F	02B62	DOBAK	Backup	bak
AF	02B88	DOEXT0	Library data	libdat
BF	02BAA	DOACPTR	Access pointer (GX only)	acptr
CF	02BCC	DOEXT2	External type 2	ext2
DF	02BEE	DOEXT3	External type 3	ext3
EF	02C10	DOEXT4	External type 4	ext4

The stack representations below have special meanings:

Representation	Meaning
comp	Composite: either symb or :: or { }
sym	Symbolic class: either symb or id or lam
symf	Either symb or id or lam or % or C%
pco	Primitive code object
ROMPTR	ROMPTR object
romptr	Contents of ROMPTR (preceded by property fields)
romp	ROMPTR or romptr
meta or M	Meta object (see Chapter 26)
F%	Either % or C%
L%	Either %% or C%
B%	Either % or C% or %% or C%
ob	Any object
nob	Next object in the runstream

Chapter 17
Binary integers

17.1 Built-in binary integers

Dec	Hex	Address	Name(s)
0	0	03FEF	ZERO
1	1	03FF9	ONE, real, MEMERR
2	2	04003	TWO
3	3	0400D	THREE, str
4	4	04017	FOUR
5	5	04021	FIVE, list
6	6	0402B	SIX, id, idnt
7	7	04035	SEVEN
8	8	0403F	EIGHT, seco
9	9	04049	NINE, symb
10	A	04053	TEN, sym
11	B	0405D	ELEVEN
12	C	04067	TWELVE
13	D	04071	THIRTEEN
14	E	0407B	FOURTEEN, EXT
15	F	04085	FIFTEEN
16	10	0408F	SIXTEEN, REALOB
17	11	04099	SEVENTEEN, 2REAL, REALREAL
18	12	040A3	EIGHTEEN
19	13	040AD	NINETEEN
20	14	040B7	TWELVE
21	15	040C1	TWENTYONE
22	16	040CB	TWENTYTWO
23	17	040D5	TWENTYTHREE
24	18	040DF	TWENTYFOUR
25	19	040E9	TWENTYFIVE
26	1A	040F3	TWENTYSIX, REALSYM
27	1B	040FD	TWENTYSEVEN
28	1C	04107	TWENTYEIGHT
29	1D	04111	TWENTYNINE
30	1E	0411B	THIRTY, REALEXT
31	1F	04125	THIRTYONE
32	20	0412F	THIRTYTWO
33	21	04139	THIRTYTHREE
34	22	04143	THIRTYFOUR
35	23	0414D	THIRTYFIVE

Dec	Hex	Address	Name(s)
36	24	04157	THIRTYSIX
37	25	04161	THIRTYSEVEN
38	26	0416B	THIRTYEIGHT
39	27	04175	THIRTYNINE
40	28	0417F	FORTY, FOURTY
41	29	04189	FORTYONE
42	2A	04193	FORTYTWO
43	2B	0419D	FORTYTHREE
44	2C	64B12	FORTYFOUR
45	2D	64B1C	FORTYFIVE
46	2E	64B26	FORTYSIX
47	2F	64B30	FORTYSEVEN
48	30	64B3A	FORTYEIGHT
49	31	64B44	FORTYNINE
50	32	64B4E	FIFTY
51	33	64B58	FIFTYONE
52	34	64B62	FIFTYTWO
53	35	64B6C	FIFTYTHREE, STRLIST
54	36	64B76	FIFTYFOUR
55	37	64B80	FIFTYFIVE
56	38	64B8A	FIFTYSIX
57	39	64B94	FIFTYSEVEN
58	3A	64B9E	FIFTYEIGHT
59	3B	64BA8	FIFTYNINE
60	3C	64BB2	SIXTY
61	3D	64BBC	SIXTYONE
62	3E	64BC6	SIXTYTWO
63	3F	64BD0	SIXTYTHREE
64	40	64BDA	SIXTYFOUR, YHI, BINT_40h
65	41	64BE4	BINT_65d, ARRYREAL
66	42	64BEE	FOURTWO
67	43	64BF8	FOURTHREE
68	44	64C02	SIXTYEIGHT
69	45	64C0C	FOURFIVE
70	46	64C16	SEVENTY
74	4A	64C20	SEVENTYFOUR
79	4F	64C2A	SEVENTYNINE
80	50	64C34	EIGHTY
81	51	64C3E	EIGHTYONE, LISTREAL
82	52	64C48	LISTCMP
83	53	64C52	FIVETHREE
84	54	64C5C	FIVEFOUR
85	55	64C66	2LIST
86	56	64C70	FIVESIX
87	57	64C7A	LISTLAM
91	5B	64C84	BINT_91d
96	60	64C8E	BINT_96d
97	61	64C98	IDREAL
100	64	64CAC	ONEHUNDRED
111	6F	64CC0	char

Dec	Hex	Address	Name(s)
115	73	64CE8	BINT_115d
116	74	64CF2	BINT_116d
122	7A	64D06	BINT_122d
128	80	64D10	BINT80h
130	82	64D1A	BINT130d, XHI-1
131	83	64D24	BINT131d, XHI
145	91	64D38	SYMBREAL
158	9E	64D56	SYMBUNIT
160	A0	64D6A	SYMOB
161	A1	64D74	SYMREAL
166	A6	64D92	SYMID
167	A7	64D9C	SYMLAM
170	AA	64DB0	SYMSYM
174	AE	64DBA	SYMEXT
175	AF	1CD69	(BINT_AFh)
192	C0	64DD8	BINTC0h
204	CC	64DE2	2GROB
208	D0	64DEC	TAGGEDANY
225	E1	64DF6	EXTREAL
234	EA	64E00	EXTSYM
238	EE	64E0A	2EXT
240	F0	64E14	ROMPANY
253	FD	64E1E	BINT253
255	FF	64E28	BINT255d
256	100	64E32	REALOBOB
258	102	64E3C	#_102
273	111	64E64	3REAL
279	117	15D6F	(BINT_117h)
337	151	64F04	INTEGER337
2563	A03	34301	ATTN#
2563	A03	64FC2	ATTNERR
3082	C0A	6506C	Connecting
3584	E00	6508A	EXTOBOB
10547	2933	03F8B	TYPEREAL
10581	2955	03FDB	(TYPEEREL)
10568	2948	03FA9	TYPEIDNT
10615	2977	03F95	(TYPECMP)
10868	2A74	03F9F	(TYPELIST)
10902	2A96	03FC7	(TYPERRP)
10936	2AB8	03FBD	(TYPESYMB)
10970	2ADA	03FE5	(TYPEEXT)
11677	2D9D	03FB3	(TYPECOL)
11885	2E6D	03FD1	(TYPELAM)
458752	70000	65094	#EXITERR
1048575	FFFFF	6509E	MINUSONE

These words either put more than one bint in the stack or do some kind of stack manipulation:

Address	Name	Stack
641FC	ZEROZERO	(→ #0 #0)
64209	#ZERO#ONE	(→ #0 #1)
6427A	#ZERO#SEVEN	(→ #0 #7)
63AC4	ONEONE	(→ #1 #1)
		Also called ONEDUP.
6428A	#ONE#27	(→ #1 #27d)
6429D	#TWO#ONE	(→ #2 #1)
642AF	#TWO#TWO	(→ #2 #2)
642BF	#TWO#FOUR	(→ #2 #4)
642D1	#THREE#FOUR	(→ #3 #4)
642E3	#FIVE#FOUR	(→ #5 #4)
64309	ZEROZEROZERO	(→ #0 #0 #0)
6431D	ZEROZEROONE	(→ #0 #0 #1)
64331	ZEROZEROTWO	(→ #0 #0 #2)
62535	DROPZERO	(ob → #0)
64449	(3DROPZERO)	(ob1 ob2 ob3 → #0)
6254E	2DROP00	(ob1 ob2 → #0 #0)
62946	DROPONE	(ob → #1)
63A88	DUPZERO	(ob → ob #0)
63A9C	DUPONE	(ob → ob #1)
63AD8	DUPTWO	(ob → ob #2)
63AB0	SWAPONE	(ob1 ob2 → ob2 ob1 #1)
62E3A	ZEROSWAP	(ob → #0 ob)
63079	ZEROOVER	(ob → ob #0 ob)
6351F	ZEROFALSE	(→ #0 FALSE)
62E67	ONESWAP	(ob → #1 ob)
63533	ONEFALSE	(→ #1 FALSE)

17.2 Conversion words

Address	Word	Stack and notes
18CEA	COERCE	(% → #)
62CE1	COERCEDUP	(% → # #)
62E7B	COERCESWAP	(ob % → # ob)
194F7	COERCE2	(% % → # #)
18CD7	%ABSCOERCE	(% → #)
2EC11	%IP>#	(% → #)
		Does ABS too.
193DA	(COERCE{}2)	({ % } → { # })
		({ % % } → { # # })
05A03	HXS>#	(hxs → #)
4F3D1	(2HXS>#)	(hxs hxs → # #)

Address	Word	Stack and notes
05A51	CHR>#	(chr → #)
51532	2HXSLIST?	({ hxs1 hxs2 } → #1 #2) Converts list of two hxs to two bints. Generates “Bad Argument Value” for invalid input.

17.3 Arithmetic functions

In the following table, the object #1 and #2 represent two binary integers, and not the binary integers 1 and 2.

Address	Name	Stack and comments
03DBC	#+	(#1 #2 → #1+#2)
25B0B	(#+OVF)	(#1 #2 → #1+#2) 0 = result = FFFFF
03DEF	#1+	(# → #+1)
03E2D	#2+	(# → #+2)
6256A	#3+	(# → #+3)
6257A	#4+	(# → #+4)
6258A	#5+	(# → #+5)
6259A	#6+	(# → #+6)
625AA	#7+	(# → #+7)
625BA	#8+	(# → #+8)
625CA	#9+	(# → #+9)
625DA	#10+	(# → #+10)
625EA	#12+	(# → #+12)
03DE0	#-	(#1 #2 → #1-#2)
03E0E	#1-	(# → #-1)
03E4E	#2-	(# → #-2)
625FA	#3-	(# → #-3)
6260A	#4-	(# → #-4)
6261A	#5-	(# → #-5)
6262A	#6-	(# → #-6)
03EC2	#*	(#1 #2 → #1*#2)
191B9	#*OVF	(#1 #2 → #1*#2) 0 = result = FFFFF
03E6F	#2*	(# → #*2)
62691	#6*	(# → #*6)
62674	#8*	(# → #*8)
6264E	#10*	(# → #*10)
03EF7	#/	(#1 #2 → #rem #quo)
03E8E	#2/	(# → #/2) Rounded down
637CC	#-+1, #1--	(#1 #2 → (#1-#2)+1)
63808	#+-1, #1-+	(#1 #2 → (#1+#2)-1)
624FB	#-#2/	(#1 #2 → (#1-#2)/2)
627D5	#+DUP	(#1 #2 → #1+#2 #1+#2)

Address	Name	Stack and comments
62DFE	#+SWAP	(ob #1 #2 → #1+#2 ob)
63051	#+OVER	(ob #1 #2 → ob #1+#2 ob)
627F8	#-DUP	(#1 #2 → #1-#2 #1-#2)
62E12	#-SWAP	(ob #1 #2 → #1-#2 ob)
63065	#-OVER	(ob #1 #2 → ob #1-#2 ob)
62809	#1+DUP	(# → #+1 #+1)
62E26	#1+SWAP	(ob # → #+1 ob)
1DABB	#1+ROT	(ob1 ob2 # → ob2 #+1 ob1)
6281A	#1-DUP	(# → #-1 #-1)
5E4A9	#1-SWAP	(ob # → #-1 ob)
62FD9	#1-ROT	(ob1 ob2 # → ob2 #-1 ob1)
28558	#1-UNROT	(ob1 ob2 # → #-1 ob1 ob2)
62E4E	#1-1SWAP	(# → 1 #-1)
		Returns the bint ONE and the result
628EB	DUP#1+	(# → # #+1)
626F7	DUP#2+	(# → # #+2)
6292F	DUP#1-	(# → # #-1)
63704	2DUP#+	(#1 #2 → #1 #2 #1+#2)
		Also called DUP3PICK#+
637F4	DROP#1-	(# ob → #-1)
62794	SWAP#-	(#1 #2 → #2-#1)
62904	SWAP#1+	(# ob → ob #+1)
		Also called SWP1+
51843	SWAP#1+SWAP	(# ob → #+1 ob)
637E0	SWAP#1-	(# ob → ob #-1)
51857	SWAP#1-SWAP	(# ob → #-1 ob)
5EAF4	(SWAPDROP#1-)	(ob # → #-1)
637A4	SWAPOVER#-	(#1 #2 → #2 #1-#2)
6272C	OVER#+	(#1 #2 → #1 #2+#1)
6377C	OVER#-	(#1 #2 → #1 #2-#1)
63718	ROT#+	(#1 ob #2 → ob #2+#1)
63768	ROT#-	(#1 ob #2 → ob #2-#1)
637B8	ROT#1+	(# ob1 ob2 → ob1 ob2 #+1)
5FB76	ROT#1+UNROT	(# ob1 ob2 → #+1 ob1 ob2)
62DCC	ROT#+SWAP	(#1 ob #2 → #2+#1 ob)
		Also called ROT+SWAP
63740	3PICK#+	(#1 ob #2 → #1 ob #2+#1)
63754	4PICK#+	(#1 ob ob #2 → #1 ob ob #2+#1)
62DE5	4PICK#+SWAP	(#1 ob ob #2 → #1 ob #2+#1 ob)
		Also called 4PICK+SWAP
624BA	#MIN	(#1 #2 → #)
624C6	#MAX	(#1 #2 → #)
03EB1	#AND	(#1 #2 → #)
		Bitwise AND

17.4 Tests

The words below return TRUE or FALSE depending on the condition. Their names should be enough to understand the use. 2#=OR returns TRUE if either of the two arguments is ZERO. Note that ONE_EQ does an EQ check, not EQUAL check (see Chapter 33). Another name for #>1 is ONE#>.

Address	Name	Address	Name	Address	Name
03D19	#=	636C8	#2<>	6289B	2DUP#<
03CA6	#0=	03CE4	#<	63687	DUP#<7
622A7	#1=	63673	#<3	628D1	2DUP#>
6229A	#2=	03D83	#>	63385	ONE_EQ
62289	#3=	636F0	#>1	620EB	OVER#=
636B4	#5=	628B5	2DUP#=	6364B	OVER#0=
03D4E	#<>	62266	DUP#0=	6365F	OVER#<
03CC7	#0<>	622C5	DUP#1=	636DC	OVER#>
622B6	#1<>	622D4	DUP#0<>	6362D	2#0=OR

Chapter 18
Real numbers

18.1 Built-in real numbers

Number	Address	Real word	Address	Extended real word
-9.99E499	2A487	%-MAXREAL		— —
-9	2A42E	%-9		— —
-8	2A419	%-8		— —
-7	2A404	%-7		— —
-6	2A3EF	%-6		— —
-5	2A3DA	%-5		— —
-4	2A3C5	%-4		— —
-3	2A3B0	%-3		— —
-2	2A39B	%-2		— —
-1	2A386	%-1		— —
-1E-499	2A4B1	%-MINREAL		— —
0	2A2B4	%0	2A4C6	%%0
1E-499	2A49C	%MINREAL		— —
π/180 (0,0174...)		— —	2A62C	PI/180
.1	494B1	%.1	2A562	%%.1
.15	495AA	(%.15)		— —
.4		— —	2B3DD	%%.4
.5	650BD	%.5	2A57C	%%.5
.555...		— —	10E68	cfF
1	2A2C9	%1	2A4E0	%%1
			10E82	cfC (also %%1)
2	2A2DE	%2	2A4FA	%%2
e (2.7183...)	650A8	%e		— —
3	2A2F3	%3	2A514	%%3
π (3.1416...)	2A443	%PI	2A458	(%%PI)
4	2A308	%4	2A52E	%%4
5	2A31D	%5	2A548	%%5
6	2A332	%6		— —
2π (6.2832..)	514EB	(%2PI)	0F688	%%2PI
7	2A347	%7	2B1FF	%%7
8	2A35C	%8		— —
9	2A371	%9		— —
10	650E7	%10	2A596	%%10
11	1CC03	%11		— —
12	1CC1D	%12	2B2DC	%%12
13	1CC37	%13		— —

Number	Address	Real word	Address	Extended real word
14	1CC51	%14		— —
15	1CC85	%15		— —
16	1CD3A	%16		— —
17	1CD54	%17		— —
18	1CDF2	%18		— —
19	1CE07	%19		— —
20	1CC6B	%20		— —
21	1CCA4	%21		— —
22	1CCC3	%22		— —
23	1CCE2	%23		— —
24	1CD01	%24		— —
25	1CD20	%25		— —
26	1CD73	%26		— —
27	1CD8D	%27		— —
60		— —	2B300	%%60
80	320B1	%80		— —
100	415F1	%100		— —
180	650FC	%180		— —
273.15		— —	10E9C	(%%KZERO)
360	65126	%360		— —
459.67		— —	10EB6	(%%RZERO)
1200	22352	(%1200)		— —
2400	22367	(%2400)		— —
4800	2237C	(%4800)		— —
8192	0EFEE	(%TICKSsec)		— —
9600	22391	(%9600)		— —
491520	0F003	(%TICKSmin)		— —
29491200	0F018	(%TICKShour)		— —
707788800	0F02D	(%TICKSday)		— —
4954521600	0F042	(%TICKSweek)		— —
9.99E499	2A472	%MAXREAL		— —

These words combine stack manipulation with built-in real numbers:

Address	Word	Address	Word
5198F	(DROP%0)	1CA0D	(DROP%1)
54B1E	(DROP%0ABND)	54A9C	(DROP%1ABND)
1F047	(2DROP%0)		
56AFB	(4DROP%0)		
50A3B	(UNROT2DROP%0)		

18.2 Conversion words

Address	Word	Stack
245C1	%>%%	(% → %%)
62E8F	%>%%SWAP	(ob % → %% ob)
2A5B0	%%>%	(%% → %)
2B45C	2%>%%	(% % → %% %%)
2B470	2%%>%	(%% %% → % %)
5435D	HXS>%	(hxs → %)
18DBF	UNCOERCE	(# → %)
1950B	UNCOERCE2	(# # → % %)
63B96	UNCOERCE%%	(# → %%)
19529	(UNCOERCE{}2)	({ # } → { % })
		({ # # } → { % % })

18.3 Real functions

In the table below, all CK% functions work like the user versions. For example, CK%SQRT returns a complex number if its argument is negative. %SQRT error if its argument is negative. The same happen for the other CK% words.

Address	Real function	Address	Ex. Real function
2A974	%+	2A943	%%+
2A981	%-	2A94F	%%-
2A95B	%>%%-		— —
2A9BC	%*	2A99A	%%*
2A9FE	%/	2A9E8	%%/
	— —	63B82	%%/>%
2AA70	%^	2AA5F	%%^
2A900	%ABS	2A8F0	%%ABS
2A920	%CHS	2A910	%%CHS
2AAAF	%1/	2AA92	%1/
2AA9E	%>%%1/		— —
2AB09	%SQRT	2AAEA	%%SQRT
2AAF6	%>%%SQRT		— —
1B3F5	(CK%SQRT)		— —
1B47B	(%SQ)		— —
2AB2F	%EXP	2AB1C	%%EXP
2AB42	%EXPM1		— —
2AB6E	%LN	2AB5B	%LN
1B995	(CK%LN)		— —
2ABA7	%LNP1	2AB94	%%LNP1
2AB81	%LOG		— —
1BA0C	(CK%LOG)		— —
2ABBA	%ALOG		— —
2ABEF	%SIN	2AC06	%%SIN

Address	Real function	Address	Ex. Real function
	— —	2AC27	%%SINRAD
	— —	2AC17	%%SINDEG
2AC40	%COS	2AC57	%%COS
	— —	2AC78	%%COSRAD
	— —	2AC38	%%COSDEG
2AC91	%TAN		— —
	— —	2ACA8	%%TANRAD
2ACC1	%ASIN		— —
1B6EA	(CK%ASIN)		— —
	— —	2ACD8	%%ASINRAD
2ACF1	%ACOS		— —
1B775	(CK%ACOS)		— —
	— —	2AD08	%%ACOSRAD
2AD21	%ATAN		
2ADAE	%SINH	2AD95	%%SINH
2ADDA	%COSH	2ADC7	%%COSH
2ADED	%TANH		— —
2AE00	%ASINH		— —
2AE13	%ACOSH		— —
1B86C	(CK%ACOSH)		— —
2AE26	%ATANH		— —
1B8DE	(CK%ATANH)		— —
2A930	%MANTISSA		— —
2AE39	%EXPONENT		— —
2AF4D	%FP		— —
2AF60	%IP		— —
2AF86	%FLOOR	2AF99	%%FLOOR
2AF73	%CEIL		— —
2ABDC	%MOD		— —
2AFAC	(%INT)	2AF99	%%INT
1B30D	(%ARG)		— —
2AD38	%ANGLE	2AD4F	%%ANGLE
2AD3G	%>%%ANGLE		— —
	— —	2AD7C	%%ANGLERAD
	— —	2AD6C	%%ANGLEDEG
2B529	RNDXY		— —
	(%number %places → %number’)		
2B53D	TRCXY		— —
	(%number %places → %number’)		
2AE62	%COMB		— —
2AE75	%PERM		— —
2AE4C	%NFACT		— —
	Calculates factorial of number.		
2B0C4	%FACT		— —
	Calculates Γ(x+1)		
2AA81	%NROOT		— —
	Equivalent to user function XROOT		
2A70E	%MIN		— —
2A6F5	%MAX	2A6DC	%%MAX

Address	Real function	Address	Ex. Real function
62D81	%MAXorder (% % → %max %min)		— —
51AB7	(%MAXIMIZE) (% → %0, %MAXREAL or %-MAXREAL)		— —
2AFC2	%RAN Returns next random number.		— —
2B044	%RANDOMIZE System level RDZ.		— —
2B07B	DORANDOMIZE Stores given number as random number seed.		— —
2A9C9	%OF		— —
2AA0B	%T		— —
2AA30	%CH		— —
2A622	%D>R		— —
2A655	%R>D		— —
2B48E	%REC>%POL (x y → radius angle)	2B498	%%R>P
2B4BB	%POL>%REC (radius angle → x y)	2B4C5	%%P>R
2B4F2	%SPH>%REC (%r %th %ph → %x %y %z)		— —
	— — (%%1 %%2 → %%1^2+%%2^2)	51A94	(%%SQR)
51A71	(2%>%%SQR) Does 2%>%% and then %%SQR		— —
	— — (%%1 %%2 → %%1 %%2 %%(sqrt(%%1^2+%%2^2)))	520B2	(2DUP%%R)
50262	%1+		— —
50276	%1-		— —
62BF1	%10*		— —
51BE4	%+SWAP		— —
	— —	62EA3	%%*SWAP
	— —	62FED	%%*ROT
	— —	63C18	%%*UNROT
	— —	63BBE	SWAP%%/

18.4 Tests

Address	Word	Address	Word	Address	Word	Address	Word
2A8C1	%=	2A8B6	%<=	2A75A	%%0=	2A87F	%%>
2A76B	%0=	2A738	%0<	2A7BB	%%0<>	2A895	%%>=
63BAA	DUP%0=	2A88A	%>	2A81F	%%<	2A788	%%0>
2A8CC	%<>	2A8A0	%>=	2A8AB	%%<=	2A7E3	%%0>=
2A7CF	%0<>	2A799	%0>	2A727	%%0<		
2A871	%<	2A7F7	%0>=	2A80B	%%0<=		

Chapter 19
Complex numbers

19.1 Built-in complex numbers

Number	Address	Word	Number	Address	Word
(0,0)	524AF	C%0	(%%1,%%0)	5193B	C%%1
(1,0)	524F7	C%1	(0,1)	5267F	(C%i)
(-1,0)	5196A	C%-1	(0,-1)	526AE	(C%-i)

19.2 Conversion words

Address	Word	Stack
519F8	C%%>C%	(C%% → C%)
05C27	%>C%	(%re %im → C%)
632A9	SWAP%>C%	(%im %re → C%)
51A37	Re>C%	(%re → C%)
05D2C	C%>%	(C% → %re %im)
519A3	C>Re%	(C% → %re)
519B7	C>Im%	(C% → %im)
05C72	(%%>C%%)	(%%re %%im → C%%)
05DBC	C%%>%%	(C%% → %%re %%im)
51A07	%%>C%	(%%re %%im → C%)
519CB	C%>%%	(C% → %%re %%im)
519DF	C%>%%SWAP	(C% → %%im %%re)
51C6B	(SWAP2C%>%)	(C%2 C%1 → re1 im1 re2 im2)
51C84	(SWAP2C%%>%%)	(C%%2 C%%1 → re1 im2 re2 im2)

19.3 Complex Functions

Functions requiring two arguments:

Address	Word	Address	Word	Address	Word
51C16	(C%C+C)	51BD0	(C%C+R)	51BF8	(C%R+C)
51C3E	(C%%C+C)	51C9D	(C%%C+R)	51CB1	(C%%R+C)
51CFC	(C%C-C)	51CE8	(C%C-R)	51CD4	(C%R-C)

Address	Word	Address	Word	Address	Word
51D10	(C%%C-C)	51D38	(C%%C-R)	51D24	(C%%R-C)
51D88	(C%C*C)	51D4C	(C%C*R)	51D60	(C%R*C)
51DE2	(C%%C*C)	51DAB	(C%%C*R)	51DBF	(C%%R*C)
51EC8	(C%C/C)	51E64	(C%C/R)	51E19	(C%R/C)
51F13	(C%%C/C)	51F7C	(C%%C/R)	51F3B	(C%%R/C)
52374	C%C^C	52360	C%C^R	52342	C%R^C
51A4A	(C%*i)				
51A5F	(C/i)				

Functions that require just one argument:

Address	Complex Word	Address	Ex. Complex Word
52062	C%ABS	52080	(C%%ABS)
51B70	C%CHS	51B91	C%%CHS
51EFA	C%1/		– –
52107	C%SQRT		– –
1B48F	(C%SQ)		– –
520CB	C%SGN		– –
51BB2	C%CONJ	51BC1	C%%CONJ
52099	C%ARG		– –
52193	C%EXP		– –
521E3	C%LN		– –
522BF	C%LOG		– –
52305	C%ALOG		– –
52530	C%SIN		– –
52571	C%COS		– –
525B7	C%TAN		– –
52804	C%ASIN		– –
52863	C%ACOS		– –
52675	C%ATAN		– –
5262F	C%SINH		– –
52648	C%COSH		– –
5265C	C%TANH		– –
5281D	C%ASINH		– –
52836	C%ACOSH		– –
527EB	C%ATANH		– –

19.4 Tests

There are only two tests available for complex numbers:

Address	Word	Address	Word
51B43	C%0=	51B2A	C%%0=

19.5 Reals and complex numbers functions

Address	Name	Stack and description
35B47	(SWITCHFLOATS)	(B% → ?) Dispatches action based on type. The order is %, C%, %%, C%%. For example, to change the sign of any float: `:: SWITCHFLOATS %CHS C%CHS %%CHS C%%CHS ;`
35B88	(SWITCH2FLOATS)	(L% L% → ?) Works similarly to the above function. The order is %% %%, C%% %%, %% C%%, C%% C%%.
37D19	(F%>L%)	(% → %%) (C% C%%) Converts float to long float.
37BE9	(L%+)	(L% L% → L%) Adds long real or complex numbers.
37C0C	(L%-)	(L% L% → L%) Subtracts long real or complex numbers.
37C2F	(L%*)	(L% L% → L%) Multiplies long real or complex numbers.
37C52	(L%/)	(L% L% → L%) Divides long real or complex numbers.
37CD3	(B%NEG)	(B% → B%’) Changes sign of any number.
37C75	(B%ABS)	(B% → B%’) Absolute value of any number.
37DF6	(B%0=)	(B% → flag) Compares any number to zero.

Chapter 20
Character strings

20.1 Built-in characters

Address	Word
65464	CHR_0
6546B	CHR_1
65472	CHR_2
65479	CHR_3
65480	CHR_4
65487	CHR_5
6548E	CHR_6
65495	CHR_7
6549C	CHR_8
654A3	CHR_9
654CD	CHR_A
654D4	CHR_B
654DB	CHR_C
654E2	CHR_D
654E9	CHR_E
654F0	CHR_F
654F7	CHR_G
654FE	CHR_H
65505	CHR_I
6550C	CHR_J
65513	CHR_K
6551A	CHR_L
65521	CHR_M
65528	CHR_N
6552F	CHR_O
65536	CHR_P
6553D	CHR_Q
65544	CHR_R
6554B	CHR_S
65552	CHR_T
65559	CHR_U
65560	CHR_V
65567	CHR_W
6556E	CHR_X
65575	CHR_Y
6557C	CHR_Z
65583	CHR_a
6558A	CHR_b
65591	CHR_c
65598	CHR_d
6559F	CHR_e
655A6	CHR_f
655AD	CHR_g
655B4	CHR_h
655BB	CHR_i
655C2	CHR_j
655C9	CHR_k
655D0	CHR_l
655D7	CHR_m
655DE	CHR_n
655E5	CHR_o
655EC	CHR_p
655F3	CHR_q
655FA	CHR_r
65601	CHR_s
65608	CHR_t
6560F	CHR_u
65616	CHR_v
6561D	CHR_w
65624	CHR_x
6562B	CHR_y
65632	CHR_z
65456	CHR_.
65448	CHR_,
654AA	CHR_:
654B1	CHR_;
65441	CHR_+
6544F	CHR_-
6543A	CHR_*
6545D	CHR_/
654BF	CHR_=
656BE	CHR_<>
654B8	CHR_<
654C6	CHR_>
656B0	CHR_<=
656B7	CHR_>=
65694	CHR_[
6569B	CHR_]
656A2	CHR_{
656A9	CHR_}
65639	CHR_->
65640	CHR_<<
65647	CHR_>>
65433	CHR_#
65425	CHR_...
6541E	CHR_00
6564E	CHR_Angle
6542C	CHR_DblQuote
65655	CHR_Deriv
6565C	CHR_Integral
65663	CHR_LeftPar
6566A	CHR_Newline
65671	CHR_Pi
65678	CHR_Rightpar
6567F	CHR_Sigma
65686	CHR_Space
6568D	CHR_UndScore

20.2 Built-in character strings

Address	Word	Representation
055DF	NULL$	“”- Empty string
65254	SPACE$	“ ”- Also called tok_
65238	NEWLINE$	“\0a”- Newline
2E4F0	CRLF$	“\0d\0a”- Carriage return and line feed
65797	$_RAD	“RAD”
657A7	$_GRAD	“GRAD”
656E5	$_XYZ	“XYZ”
656D5	$_R<Z	“R\80Z”- “R<angle>Z”
656C5	$_R<<	“R\80\80”- “R<angle><angle>”
65769	$_EXIT	“EXIT”
65757	$_ECHO	“ECHO”
6577B	$_Undefined	“Undefined”
656F5	$_<<>>	“\AB\BB”- “« »”
65703	$_{}	“{}”
65711	$_[]	“[]”
6571F	$_''	“''”- Two single quotes
6572D	$_::	“::”
6573B	$_LRParens	“()”
65749	$_2DQ	“""""”- Two double quotes
414BD	($_:)	“: “
65290	tok,	“,”
65284	tok'	“'”- One single quote
652FC	tok-	“-”
6529C	tok.	“.”
0FA69	tok_g	“g”
0FA8E	tok_m	“m”
0FACE	tok_s	“s”
65176	tok{	“{”
651D6	tok<<	“<<”
65308	tok=	“=”
25446	tok->	“->”
6534C	tok0	“0”
65358	tok1	“1”
653AC	tok8	“8”
653B8	tok9	“9”
651BE	tokESC	“\1B”- Escape character
651E2	tokexponent	“E”
65278	tokquote	“""”- One double quote
6518E	toksharp	“#”
65212	(14spc$)	“ “- String of 14 spaces.

Combinations of NULL$ with other functions:

Address	Word	Action
62D59	NULL$SWAP	NULL$, then SWAP.
04D3E	DROPNULL$	DROP then NULL$.
04D57	(2DROPNULL$)	2DROP then NULL$.
1613F	NULL$TEMP	Creates null string in temporary memory (NULL$, then TOTEMPOB).

20.3 Conversion words

Address	Word	Stack and notes
6475C	CHR>$	(chr → $) Converts a character into a string.
167E4	#>$	(# → $) Creates string from the bint.
167D8	#:>$	(# → $) Creates string from the bint and appends a colon and a space. Ex: “1: ”
162B8	a%>$	(% → $) Converts real number into string using current display mode.
162AC	a%>$,	(% → $) Same as above, but does not use commas.
05BE9	ID>$	(id/lam → $) Converts identifier into string.
540BB	hxs>$	(hxs → $) Uses current display mode and wordsize.
54061	HXS>$	(hxs → $) Does hxs>$ and then appends base character.
140F1	DOCHR	(% → $) Creates string of the character with the number specified.
1410F	(DONUM)	($ → %) Returns number of first character of string.

Address	Word	Stack and notes
15B13	DECOMP$	(ob → $) Convert object into its string representation for stack display.
15A0E	EDITDECOMP$	(ob → $) Convert object into its string representation for edition.
14088	DO>STR	(ob → $) Internal version of ->STR.
14137	DOSTR>	($ → ?) Internal version of STR->.
238A4	palparse	($ → ob TRUE) ($ → $ # $'FALSE) Tries parsing a string into an object. If successful, returns object and TRUE, otherwise returns position of error and FALSE.
49079	PromptIdUtil	(id ob → $) Creates string of the form "id: ob".

20.4 Management words

Address	Word	Stack and action
05636	LEN$	($ → #) Returns length in bytes.
1CA26	(LEN$>%)	($ → %) LEN$ then UNCOERCE.
627BB	DUPLEN$	($ → $ #) DUP then LEN$.
05622	OVERLEN$	($ ob → $ ob #) OVER then LEN$.
1782E	(2LEN$#+)	($ $ → $ $ #) Returns sum of length of two strings.
127CA	(DROPDUPLEN$1+)	($ ob → $ #len+1) Does DROP, then DUP, then LEN$ and finally #1+.

Address	Word	Stack and action
050ED	CAR$	($ → chr) Returns first character of string, or NULL$ for null string.
0516C	CDR$	($ → $’) Returns string without first character, or NULL$ for null string.
05733	SUB$	($ #start #end → $’) Returns substring between specified positions.
62D6D	SUB$SWAP	(ob $ #start #end → $ ob) SUB$ then SWAP.
1C8BB	(XEQSUB$)	($ %start %end → $) Same as SUB$ but uses real numbers as arguments.
63245	#1-SUB$	($ #start #end → $’) Does #1- and then SUB$.
63259	1_#1-SUB$	($ #end → $’) Returns substring from the first character to the character before the specified position. Also called 1_#1-SUB
6326D	LAST$	($ #start → $’) Returns substring from the specified start position to the end (inclusive).
63281	#1+LAST$	($ #start → $’) Returns substring from the specified start position to the end (exclusive).
30805	SUB$1#	($ #pos → #char) Returns specified character as a bint.
05193	&$	($1 $2 → $1+$2) Concatenates two strings.
622EF	SWAP&$	($1 $2 → $2+$1) Concatenates two strings.
63F6A	&$SWAP	(ob $1 $2 → $1+$2 ob) &$ then SWAP.

Address	Word	Stack and action
62376	!append$	($1 $2 → $1+$2) Tries &$, if not enough memory does !!append$?.
622E5	!insert$	($1 $2 → $2+$1) Does SWAP then !append$.
62F2F	!append$SWAP	(ob $1 $2 → $1+$2 ob) !append$ then SWAP.
62312	!!append$?	($1 $2 → $1+$2) Attempts append “in place” if target is in tempob.
623A0	!!append$	($1 $2 → $1+$2) Tries appending “in place”.
62394	!!insert$	($1 $2 → $2+$1) Tries inserting “in place”.
0525B	>H$	($ chr → $’) Prepends character to string
052EE	>T$	($ chr → $’) Appends character to string.
62BB0	APPEND_SPACE	($ → $’) Appends space to string.
63191	NEWLINE$&$	($ → $’) Appends new line character to string. Also called NEWLINE&$.
2E4DC	APNDCRLF	($ → $’) Appends carriage return and line feed to string.
61C1C	EXPAND	($ #nibbles → $’) Appends null characters to the string. Since refers to the number of nibbles, you must use a number twice as large as the number of null characters you want appended.
645B1	POS$	($search $find #start → #pos) Search for $find in $start, start at position #start. Returns position of $find or 0 if not found.
645B1	POSCHR	($search chr #start → #pos) The same entry as above.

Address	Word	Stack and action
15EF6	(ONEPOS$)	($search $find/chr → #pos) POS$ with #start = 1.
1CAD7	(XEQPOS$)	($search $find/chr → %pos) POS$ with #start = 1 and followed by UNCOERCE.
645BD	POS$REV	($search $find #limit → #pos) Searches from end backwards until #limit.
645BD	POSCHRREV	($seach chr #limit → #pos) Same entry as above.
12770	COERCE$22	($ → $’) If the string is longer than 22 characters, truncates it to 21 characters and appends “...”.
127A7	SEP$NL	($ → $2 $1) Separates string at first newline character. First string is second line, second string is first line.
45676	Blank$	(# → $) Creates a string with the specified number of spaces.
188D2	(NOT$)	($ → $’) Logical NOT. Makes copy of the string first. These and the other words below work character by character of the string(s), doing the operation on the numerical representation of the character.
18961	(!NOT$)	($ → $’) Logical NOT “in place”.
18873	AND$	($1 $2 → $’) Logical AND. Errors if strings are not the same length.
188E6	(!AND$)	($1 $2 → $’) Logical AND. Does not check if strings are the same length.
18887	OR$	($1 $2 → $’) Logical OR. Errors if strings are not the same length.

Address	Word	Stack and action
188F5	(!OR$)	($1 $2 → $’) Logical OR, does not check if strings are the same length.
1889B	XOR$	($1 $2 → $’) Logical XOR. Errors if strings are not the same length.
18904	(!XOR$)	($1 $2 → $’) Logical XOR. Does not check if strings are the same length.

20.5 Tests

The string comparison test below (<, >, etc.) first check the length of the strings. If they are equal, then the character numbers are compared. Thus, “ABA” is smaller than “AAB”, which is smaller than “AAA”. However, “B” is smaller than “a”, because the uppercase characters have lower numbers. If you need to search ignoring case, you ll need to develop a routine to change everything to upper case or everything to lower case.

Address	Word	Stack
0556F	NULL$?	($ → flag)
63209	DUPNULL$?	($ → $ flag)
142A6	($<$?)	($1 $2 → %flag)
1420A	($>$?)	($1 $2 → %flag)
142E2	($<=$?)	($1 $2 → %flag)
142BA	($>=$?)	($1 $2 → %flag)
42C3D	CkChr00	($ → $ flag) Returns FALSE if string contains any null characters.

Chapter 21
Hexadecimal strings

21.1 Conversion words

Address	Word	Stack and notes
059CC	#>HXS	(# → hxs) Length will be five.
543F9	%>#	(% → hxs) Converts real number into hxs.

21.2 General functions

Address	Word	Stack and description
0EDE1	MAKEHXS	(#nibbles → hxs) Makes blank hxs of specified size.
3742D	(!MAKEHXS)	(#nibbles → hxs) Makes hxs filled with random data.
055D5	NULLHXS	(→ hxs) Puts a null hxs in the stack.
0518A	&HXS	(hxs1 hxs2 → hxs) Appends hxs2 to hxs1.
61C1C	EXPAND	(hxs #nibbles → hxs) Appends #nibbles zeros to the hxs.
05616	LENHXS	(hxs → #) Returns length in nibbles.
05815	SUBHXS	(hxs #start #end → hxs) Returns sub hxs string.

21.3 Arithmetic functions

All functions below assume a wordsize less than or equal to 64 bits. The resulting hxs length will be current wordsize.

Address	Word	Stack and description
53EA0	bit+	(hxs1 hxs2 → hxs) Adds two hxs.
54330	bit%#+	(% hxs → hxs) Adds real to hxs, returns hxs.
54349	bit#%+	(hxs % → hxs) Adds real to hxs, returns hxs.
53EB0	bit-	(hxs1 hxs2 → hxs) Subtracts hxs2 from hxs1.
542FE	bit%#-	(% hxs → hxs) Subtracts hxs from real, returns hxs.
5431C	bit#%-	(hxs % → hxs) Subtracts real from hxs, returns hxs.
53ED3	bit*	(hxs1 hxs2 → hxs) Multiplies two hxs.
542D1	bit%#*	(% hxs → hxs) Multiplies real by hxs, returns hxs.
542EA	bit#%*	(hxs % → hxs) Multiplies hxs by real, returns hxs.
53F05	bit/	(hxs1 hxs2 → hxs) Divides hxs1 by hxs2.
5429F	bit%#/	(% hxs → hxs') Divides real by hxs, returns hxs.
542BD	bit#%/	(hxs % → hxs) Divides hxs by real, returns hxs.
53EC3	(bitNEG)	(hxs → hxs) Changes sign of hxs.
53D4E	bitNOT	(hxs → hxs) Bitwise NOT.
53D04	bitAND	(hxs1 hxs2 → hxs) Bitwise AND.

Address	Word	Stack and description
53D15	bitOR	(hxs1 hxs2 → hxs) Bitwise OR.
53D26	bitXOR	(hxs1 hxs2 → hxs) Bitwise XOR.
53D5E	bitSL	(hxs → hxs) Shifts one bit to the left.
53D6E	bitSLB	(hxs → hxs) Shifts one byte to the left.
53D81	bitSR	(hxs → hxs') Shifts one bit to the right.
53D91	bitSRB	(hxs → hxs) Shifts one byte to the right.
53E0C	bitRL	(hxs → hxs) Shifts circularly one bit to the left.
53E3B	bitRLB	(hxs → hxs') Shifts circularly one byte to the left
53DA4	bitRR	(hxs → hxs) Shifts circularly one bit to the right.
53DE1	bitRRB	(hxs → hxs) Shifts circularly one byte to the right.
53E65	bitASR	(hxs → hxs') Arithmetic shift one bit to the right. The most significant bit (the sign) does not change.

21.4 Tests

For all words below, the stack diagram is (hxs1 hxs2 → flag), except for NULLHXS?, whose stack diagram is (hxs → flag).

Address	Test	Description
05566	(NULLHXS?)	Returns TRUE if the input is a null hxs.
544D9	HXS==HXS	== test
544EC	HXS#HXS	≠ test
54552	HXS<HXS	< test
54500	HXS>HXS	> test
5453F	HXS<=HXS	≤ test
5452C	HXS>=HXS	≥ test

Chapter 22
Tagged objects

Address	Word	Stack and notes
05E81	>TAG	(ob $ → tagged)
225F5	USER$>TAG	(ob $ → tagged)
		Maximum of 255 characters in string.
22618	%>TAG	(ob % → tagged)
05F2E	ID>TAG	(ob id/lam → tagged)
05E9F	({}>TAG)	({ id ob } → tagged)
647BB	TAGOBS	(ob $ → tagged)
		(ob1 ... obn { $1 ... $n } → tagged1 ... taggedn)
05EC9	(TAG>)	(tagged → ob $tag)
64775	STRIPTAGS	(tagged → ob)
647A2	STRIPTAGS12	(tagged ob’ → ob ob’)
		The two words above remove all tags from an object.

Chapter 23
Arrays

In the stack diagrams below, {dims} represents a list of two bints, representing the array dimensions or the position of a element of the array.

23.1 General operations

Address	Function	Stack and description
03562	ARSIZE	([ ] → #elements) Returns number of elements as a bint.
63141	OVERARSIZE	([ ] ob → [ ] ob #elements) Does OVER then ARSIZE.
035A9	DIMLIMITS	([ ] → {dims}) Returns list of array dimensions.
357A8	MDIMS	([ ] → #m FALSE) ([ ] → #m #n TRUE) If it is a vector, returns number of elements and FALSE. If it is an array (including arrays with only one line), returns dimensions and TRUE.
62F9D	MDIMSDROP	([ ] → #m) ([ ] → #m #n) MDIMS followed by DROP.
03442	MAKEARRY	({dims} ob → [ob]) Makes array with all elements initialized to ob.
19294	(>ARRY)	(F% ... F% #n [F%] → [F%]) Copies floats into array.
1D054	XEQ>ARRY	(F% ... F% {%dims} → [F%]) Makes array with specified dimensions and elements. Does checks first.
1D02C	(XEQ>VECTOR)	(F% ... F% %n → [F%]) Creates a vector.

Address	Function	Stack and description
1D0AB	(DOARRY>)	([ ] → F% ... F% {%dims}) Explodes array. Only works for arrays of (normal) real and complex numbers.
35D35	(MATIDN)	([F%] → [F%]’) Creates identity matrix. Errors if input is not a square matrix.
3745E	SWAPROWS	([ ] #m #n → [ ]’#m #n) Swaps two rows. Does not make copy in tempob.
37508	(SWAPCOLUMNS)	([ ] #m #n → [ ]’#m #n) Swaps two columns. Does not make copy in tempob.
0358F	(TYPEARRY@)	([ ] → #prolog) Returns address of the prolog of the array element type.
03685	(ARRYEL?)	({dims} [ ] → #element TRUE) ({dims} [ ] → FALSE) Returns TRUE if array element exists.
0371D	GETATELN	(# [ ] → ob TRUE) (# [ ] → FALSE) Get one element from array.
0C501	(GETEL)	(#index [ ] → ob TRUE) (#index [ ] → FALSE) (#index #addr_of_array → ob TRUE) (#index #addr_of_array → FALSE) Gets one element from array.
355B8	PULLREALEL	([%] #n → [%] %) Gets real element.
355C8	PULLCMPEL	([C%] #n →[C%] C%) Gets complex element.
3558E	(PULLEL)	([F%] #n → [F%] F%) Gets real or complex element.
35602	(PULLEREALEL)	([%] #n → [%] %%) Gets real element then converts to long real.
355D8	(PULLLONGEL)	([F%] #n → [F%] L%) Gets element then converts to long.

Address	Function	Stack and description
35628	PUTEL	([F%] B% #n → [F%]’) Puts element at specified position. Converts to “short” before.
3566F	PUTREALEL	([%] % #n → [%]’) Puts real element at specified position.
356F3	PUTCMPEL	[C%] C% #n → [C%]’) Puts complex element at specified position.

23.2 Calculations

Address	Word	Stack and description
36115	(MAT+)	([F%] [F%] → [F%]) Adds two arrays.
36278	(MAT-)	([F%] [F%] → [F%]) Subtracts two arrays.
3644E	(MAT*)	([F%] [F%] → [F%]) Multiplies two arrays.
36AC3	(MAT/)	([F%] [F%] → [F%]) Divides two arrays.
362DC	(MATFLOAT*)	([F%] F% → [F%]’) (F% [F%] → [F%]) Multiplies matrix by float.
363DB	(MATFLOAT/)	([F%] F% → [F%]’) Divides matrix by float.
36444	(MATSQ)	([F%] → [F%]’) Squares matrix.
35F30	(MATCONJ)	([F%] → [F%]) If a complex array, does the conjugate of all elements. If a real array, does nothing.
35DEB	(MATNEG)	([F%] → [F%]) Changes sign of all elements of array.
36A99	(MATINV)	([F%] → [F%]) Reciprocal of all elements of array.

Address	Word	Stack and description
3811F	MATTRN	([F%] → [F%]’) Transposes matrix.
37E0F	METREDIM	([F%] {dims} → [F%]) Redimensions matrix. Removes elements or adds zeros as necessary.
35CAE	MATCON	([F%] F% → [F%]) Replace all elements of [F%] by F%.
35FA3	(DUP%0CON)	([F%] → [F%] [0%]) DUP then creates a matrix of the same size filled with zeros.
36A48	(MATDET)	([F%] → F%) Calculates determinant of matrix. Generates “Invalid Dimension” error for non-square matrices.
369E9	(MATABS)	([F%] → F%) Returns the scalar magnitude of array.
36705	(MATDOT)	([F%] [F%] → [F%]) Returns the dot product of two vectors.
36791	(MATCROSS)	([F%] [F%] → [F%]) Returns the cross product of two vectors. Generates a “Invalid Dimension” error if inputs are not vectors.
365BB	(MATRSD)	([F%] [F%] [F%] → [F%]) Calculates residuals of solutions of a linear system.
368F4	(MATRNRM)	([F%] → F%) Row norm.
3690D	(MATCNRM)	([F%] → F%) Column norm.
36039	(MATR>C)	([%re] [%im] → [C%]) Creates complex matrix from real and imaginary parts.
360B6	(MATC>R)	([C%] → [%re] [%im]) Explodes complex matrix into real and imaginary parts.

Address	Word	Stack and description
35F8F	(MATRE)	([F%] → [F%]') Returns (real) matrix with real part of complex numbers. Does nothing if the input is a real matrix.
35FEE	(MATIM)	([F%] → [F%]) Returns (real) matrix with imaginary part of complex numbers. Returns an array of zeros if input is a real matrix.
35E2C	(MATRND)	([F%] % → [F%]) RND on all elements of matrix.
35EA9	(MATTRNC)	([F%] % → [F%]) TRNC on all elements of matrix.
35C2C	(DOARRYPRG1)	(seco [F%] → [F%]) Evaluates seco for each element in array, then builds array again. Argument for seco will be L%. See examples below.
35C63	(DOARRYPRG2)	(seco [m1] [m2] → [F%]') Same as above, but seco has two arguments: one from m1 and another from m2. Arrays must be F%. Arguments for seco will be L%. See examples below.

Examples of DOARRYPRG1 and DOARRYPRG2:

```
* MATCHS - Changes sign of all elements of array
::
  ' NEGF% SWAP DOARRYPRG1 ;


* MATADD - Adds two matrices
::
  ' L%+ UNROT DOARRYPRG2 ;
```

23.3 Statistics

All functions below operate on the variables ΣDAT and ΣPAR. They work like their user versions. The Column words take as arguments a bint and an array. They then calculate the function for the specified column of the array.

Address	Word	Address	Word
2C22F	STATCLST	2C706	(STATGETYCOL)
	Clears ΣDAT	2C8E6	(STATCOV)
2C270	(STATRCL)	2C940	(STATX)
2C1F3	(STATSTO)	2C959	(STATY)
2C2D9	STATSADD%	2C972	(STATXX)
	Σ+ with real	2C99A	(STATYY)
2C535	STATN	2C9C2	(STATXY)
2C58A	STATSMIN	2CA0D	(STATLR)
2C558	STATSMAX	2CB4D	(STATPREDX)
2C571	STATSMEAN	2CADA	(STATPREDY)
2C5A3	STATSTDEV	2CCD3	(ColumnMIN)
2C5BC	STATTOT	2CCBA	(ColumnMAX)
2C5D5	STATVAR	2CCEE	(ColumnMEAN)
2C675	(STATCOL)	2CD09	(ColumnTDEV)
2C6B6	(STATXCOL)	2CCDF	(ColumnTOT)
2C6CF	(STATYCOL)	2CCFD	(ColumnVAR)
2C6F2	(STATGETXCOL)	2C83C	(STATCORR)

Chapter 24
Unit objects

24.1 Creating units

Address	Word	Description
10B5E	um*	* marker
10B68	um/	/ marker
10B72	um^	^ marker
10B7C	umP	Character prefix operator
10B86	umEND	Unit end operator

24.2 General operations

Address	Word	Stack and descrption
0F371	UMCONV	(unit1 unit2 → unit1’) Change units of unit1 to units of unit2.
0F945	UMSI	(unit → unit’) Equivalent to user word UBASE.
197C8	(UMFACT)	(unit1 unit2 → unit) Equivalent to user word UFACT.
0F34E	UMU>	(unit → % unit’) Returns number and normalized part of unit.
10047	U>nbr	(unit → %) Returns number part of unit.
0F33A	UM>U	(% unit → unit’) Replaces number part of unit.
10065	Unbr>U	(unit % → unit’) Replaces number part of unit.
0F218	UNIT>$	(unit → $) Converts unit to string.

Address	Word	Stack and descrption
0FE44	U>NCQ	(unit → n%% cf%% [ ]) Returns the number, conversion factor to base units and a vector in the form: [kg m A s K cd mol r sr ?] where each element represents the exponent of that unit. For example, 1_N U>NCQ would return: %%1 %%1 [1 1 0 -2 0 0 0 0 0 0] since it is equivalent to 1_kg*m/s^2

24.3 Arithmetic functions

Binary arithmetic operations: (unit1 unit2 → unit)

Address	Word	Address	Word	Address	Word
0F6A2	UM+	0FB8D	UMMIN	0FCCD	UM%T
0F77A	UM-	0FB6F	UMMAX	0FC3C	UM%CH
0F792	UM*	0F8FA	UMXROOT	0FD0E	UM%
0F823	UM/				

Unary arithmetic operations: (unit → unit ')

Address	Word	Address	Word	Address	Word
0F5FC	UMABS	0FCE6	UMSIGN	0FD68	UMRND
0F615	UMCHS	0FCFA	UMIP	0FD8B	UMTRC
0F841	(UMINV)	0FD0E	UMFP	0F62E	UMSIN
0F913	UMSQ	0FD22	UMFLOOR	0F660	UMCOS
0F92C	UMSQRT	0FD36	UMCEIL	0F674	UMTAN
0FD4A	(UMOPER:)	Evaluates next object with numeric unit part, then builds unit again. For example: :: UMOPER: %1/ ;			

24.4 Tests

(unit1 unit2 → %flag)

Address	Word	Address	Word	Address	Word
0F584	UM=?	0F5AC	UM<?	0F5DA	UM<=?
0F598	UM#?	0F5C0	UM>?	0F5E8	UM>=?

Chapter 25 Composites

25.1 General operations

Address	Word	Stack and description
0521F	&COMP	(comp1 comp2 → comp1+comp2) Concatenates two composites.
052FA	>TCOMP	(comp ob → comp+ob) Adds ob to tail (end) of composite.
052C6	>HCOMP	(comp ob → ob+comp) Adds ob to head (beginning) of composite.
1AC93	(SWAP>HCOMP)	(ob comp → ob+comp) Does SWAP then >HCOMP.
05089	CARCOMP	(comp → ob) (nullcomp → nullcomp) Returns first object of the composite, or a null composite if the argument is a null composite.
6317D	?CARCOMP	(comp flag → comp) (comp flag → ob) If the flag is TRUE, does CARCOMP.
05153	CDRCOMP	(comp → comp ’) Returns the composite minus its first object, or a null composite if the argument is a null composite.
0567B	LENCOMP	(comp → #n) Returns length of composite (number of objects).
63231	DUPLENCOMP	(comp → comp #n) Does DUP then LENCOMP.
1CA3A	(LENCOMP>%)	(comp → %n) Returns length of composite as a real number.

Address	Word	Stack and description
05821	SUBCOMP	(comp #start #end → comp ’) Returns a sub-composite. Makes all possible index checks first.
056B6	NTHELCOMP	(comp #i → ob TRUE) (comp #i → FALSE) Returns specified element of composite and TRUE, or just FALSE if it could not be found.
62B9C	NTHCOMPDROP	(comp #i → ob) (comp #i →) Does NTHELCOMP then DROP.
62D1D	NTHCOMDDUP	(comp #i → ob ob) Does NTHCOMPDROP then DUP.
6480B	NEXTCOMPOB	(comp #offset → comp #next_offset ob TRUE) (comp #offset → FALSE) Returns object at specified nibble offset from start. If the object is SEMI (i.e., the end of the composite has been reached) returns FALSE. To get the first element, use FIVE as offset value (to skip the prolog).
055B7	NULLCOMP?	(comp → flag) If the composite is empty, returns TRUE.
6321D	DUPNULLCOMP?	(comp → comp flag) Does DUP then NULLCOMP?
643EF	matchob?	(ob comp → TRUE) (ob comp → ob FALSE) Returns TRUE if ob is EQUAL to any element of the composite.

64426	POSCOMP	(comp ob test → #i)
		(comp ob test → #0)
		Evaluates test for all elements of composite and ob, and returns index of first object which the test is TRUE, if no one returned TRUE, returns #0.
		For example, the program below returns #4:
		`:: { %1 %2 %3 %-4 %-5 %6 %7 } %0 ' %<`
		`POSCOMP ;`

644A3	EQUALPOSCOMP	(comp ob → #i) (comp ob → #0) POSCOMP with test = EQUAL.

Address	Word	Stack and description
644BC	NTHOF	(ob comp → #i) (ob comp → #0) Does SWAP then EQUALPOSCOMP.
6448A	#=POSCOMP	(comp # → #i) (comp # → #0) POSCOMP with test = #=.
644D0	Find1stTrue	(comp test → ob TRUE) (comp test → FALSE) Tests every element for test. The first one that returns TRUE if put into the stack along with TRUE. If no object returned TRUE, FALSE is put into the stack. For example, the program below returns -4 and TRUE: `:: { %1 %2 %2 %-4 %-5 %6 } ' %0< Find1stTrue ;`
6452F	Lookup	(ob test comp → nextob TRUE) (ob test comp → FALSE) Does matching in groups of two. If first matches, second is returned with TRUE; if there was no match, FALSE is returned. For example, the program below returns 6 and TRUE: `:: %0 { %1 %2 %3 %-4 %-5 %6 } ' %< Lookup ;`
64593	EQLookup	(ob comp → nextob TRUE) (ob comp → FALSE) Lookup with test = EQ.
64127	Embedded?	(ob1 ob2 → flag) Returns TRUE if ob2 is embedded in, or is the same as, ob1. Otherwise returns FALSE.

25.2 Building

Address	Word	Stack and notes
05331	(>COMP)	(meta #prolog → comp)
05459	{}N	(meta → { })
05445	::N	(meta → seco)
0546D	SYMBN	(meta → symb)

Address	Word	Stack
54CEF	(SYMBN:)	(meta → symb&nob) Creates symbolic from meta contents and next object in the runstream
5E661	(ONESYMBN)	(ob → symb)
05481	EXTN	(meta → unit)
5E0DA	P{}N	(meta → { })
5E111	(P::N)	(meta → seco)
5E0A3	(PSYMBN)	(meta → symb)

The P words first try the low level version, and if it errors (insufficient memory) the composite is built one element at a time. This allows garbage collection to happen while the composite is being built so that you can build larger composites. Use these words if you expect the composite to be very large.

25.3 Exploding

Address	Word	Stack
054AF	INNERCOMP	(comp → meta)
613E1	DUPINCOMP	(comp → comp meta)
631F5	SWAPINCOMP	(comp ob → ob meta)
62B88	INCOMPDROP	(comp → obn ... ob1)
62C41	INNERDUP	(comp → meta #n)
1C973	(INNERCOMP>%)	(comp → obn ... ob1 %n)
636A0	INNER#1=	(comp → obn ... ob1 flag)
5E585	(INNERtop&)	(meta comp → meta') Adds composite objects to meta object.

25.4 Lists

Address	Word	Stack and notes
055E9	NULL{}	(→ { }) Puts a null list to the stack.
63A6F	DUPNULL{}?	({ } → { } flag)
23EED	ONE{}N	(ob → { })
631B9	TWO{}N	(ob1 ob2 → { })
631CD	THREE{}N	(ob1 ob2 ob3 → { })
631A5	#1-{}N	(ob1 ... obn #n+1 → { })
1DC00	PUTLIST	({ } ob #n → { }) Replaces object at specified position. Assumes valid #i.
0E461	(INSERTN{})	({ } ob #n → { }) Insert ob at nth position. Assumes valid #n.

Address	Word	Stack and notes
0E4DE	(REMOVEN{})	({} #n → {}') Removes nth ob. Assumes valid #n.
49CD6	(ROLL{})	({} → {}) Rolls list elements.
35491	apndvarlst	({} ob → {}) Appends ob to list if not already there.

25.5 Secondaries

Address	Word	Stack and description
055FD	NULL::	(→ seco) Returns null secondary.
63FE7	Ob>Seco	(ob → seco) Does ONE then ::N.
63FCE	?Ob>Seco	(ob → seco) If the object is not a composite, does Ob>Seco.
63FFB	2Ob>Seco	(ob1 ob2 → seco) Does TWO then ::N.
632D1	::NEVAL	(meta → ?) Does ::N then EVAL.
5E8DE	(argum)	(seco → seco #args) Returns argument count for secondary. Checks first command, it it is different from CK0, CK1&Dispatch, etc. #5 is returned.
5E9A7	(infarg?)	(seco → seco flag) Is first command in secondary CKINFARGS?

Chapter 26
Meta objects

A meta object is actually a collection of n object and their count (a bint). The word INNERCOMP produces a meta object from a composite. A null meta is ZERO.

26.1 Stack functions

Address	Word	Stack and notes
5E35C	(dup)	(M → M M)
0326E	NDROP	(M →) Should be called drop.
63FA6	DROPNDROP	(M ob →) Should be called DROPdrop.
62F75	N+1DROP	(ob M →) Should be called dropDROP.
5EB1C	psh	(M1 M2 → M2 M1) Should be called swap.
5EB58	(rot)	(M1 M2 M3 → M2 M3 M1)
5EBDB	(unrot)	(M1 M2 M3 → M3 M1 M2)
5EBC6	(4roll)	(M1 M2 M3 M4 → M2 M3 M4 M1)
5EBEA	(4unroll)	(M1 M2 M3 M4 → M4 M1 M2 M3)
5ED45	(5roll)	(M1 M2 M3 M4 M5 → M2 M3 M4 M5 M1)
5ED5A	(5unroll)	(M1 M2 M3 M4 M5 → M5 M1 M2 M3 M4)
5EBFC	(N+1roll)	(M1 ... Mn+1 #n → M2 ... Mn+1 M1)
5ED6C	(N+1unroll)	(M1 ... Mn+1 #n → Mn+1 M1 ... Mn)
63911	SWAPUnNDROP	(M1 M2 → M2) Should be called swapdrop.
5E857	(rotswap)	(M1 M2 M3 → M2 M1 M3)
63F1A	metaROTDUP	(M1 M2 M3 → M2 M3 M1 M1) Should be called rotdup.
5E870	(4rollunrot)	(M1 M2 M3 M4 → M2 M1 M3 M4)

26.2 Combining functions

Address	Word	Stack and notes
5E415	top&	(M1 M2 → M1&M2)
5E4D1	pshtop&	(M1 M2 → M2&M1)

Address	Word	Stack and notes
63F2E	ROTUntop&	(M1 M2 M3 → M2 M3&M1)
63F42	roll2top&	(M1 M2 M3 → M3 M1&M2) Also called rolltwotop&.
5E3C0	(over&)	(M1 M2 M3 → M1&M2 M3)
5E3AC	psh&	(M1 M2 M3 → M1&M3 M2)
5E843	(overev&)	(M1 M2 M3 → M2&M1 M3)
5E490	(2top&)	(M1 M2 M3 → M1&M2&M3)
5B861	(top&pshtop&)	(M1 M2 M3 → M2&M3&M1)
5E585	(INNERtop&)	(M1 comp → M1&comp) Explodes composite and adds to meta: INNERCOMP top&

26.3 Meta and object operations

Address	Word	Stack and notes
5FC24	(pick1)	(ob M → ob M ob)
61305	get1	(ob M → M ob)
63105	OVER#2+UNROL	(M ob → ob M)
5E3E8	(pshm1)	(M ob → ob #1 M)
62904	SWAP#1+	(M ob → M&ob) Also called SWP1+
5E401	psh1top&	(M ob → ob&M)
5E4A9	pull	(M&ob → M ob)
5EAF4	(pulldrop)	(M&ob → M)
5E6BB	(pullpshm1)	(M&ob → ob #1 M)
5E4BD	pullrev	(ob&M → M ob)
6119E	DUP#1+PICK	(ob&M → ob&M ob)
5FA45	(pulldroppull)	(M&ob1&ob2 → M ob1)
5CC12	(2pulldrop)	(M&ob1&ob2 → M)
60F0E	ROTDROPSWAP	(M&ob1 ob2 → M&ob2)
5FA63	(revpulldrop)	(M&ob1 ob2 → M ob2)
548AA	(revpull&psh)	(M&ob1 ob2 → ob1&ob2 M)
5E706	psh1&	(M1 M2 ob → ob&M1 M2)
5E7A5	psh1&rev	(M1 M2 ob → ob&M1 M2)
57432	(addtpsh)	(M1 M2 ob → M1&ob M2)
10ADB	(rot1)	(ob M1 M2 → M1 M2 ob)
10AF9	(unrot1)	(M1 M2 ob → ob M1 M2)
5E4EA	pullpsh1&	(M1 M2&ob → ob&M1 M2)
5E503	(pullrev1&)	(M1 M2&ob → M1&ob M2)
5D6FA	(pshpullpsh1&)	(M1&ob M2 → ob&M2 M1)
5E67A	pshzer	(M → #0 M)
638FD	SWAPUnDROP	(ob M → M)
25322	(4psh)	(M1 ob1 ob2 ob3 ob4 → M2 M1) M2 = ob1&ob2&b3&ob4
554B3	(repl%1)	(M&ob → M&%1)

Address	Word	Stack and notes
55607	(repl%-1)	(M&ob → M&%-1)
5483C	(COLAkeep1st)	Returns and (M&ob → ob)
5FC38	(%1pshm1)	(M → %1 #1 M)

The words below take as argument the next object(s) in the runstream:

Address	Word	Stack
5E51C	(addt:)	(M → M&ob)
5E530	(addt2:)	(M → M&ob1&ob2)
5E59E	(repl:)	(M&ob → M&ob')
5E549	(psh1&rev:)	(M1 M2 → M1&ob M2)
5E562	(psh1&rev2:)	(M1 M2 → M1&ob1&ob2 M2)
5DD65	(2psh1&rev:)	(M1 M2 → M1&ob M2&ob)

The words below take as argument 1LAM and/or 3LAM:

Address	Word	Stack
55288	1GETLAMSWP1+	(M → M&LAM1)
55477	(replfunc)	(M&ob → M&LAM1)
560ED	xssgneral	(M1 M2 → M1&M2&LAM1)
56101	xnsgeneral	(M → LAM3&M&LAM1)
5611F	xsngeneral	(M → M&LAM3&LAM1)
562BE	(dropaddoper)	(M1 M2 M3 → M1&M2&LAM1)
56309	(MetaUnCalc)	(M ob → LAM3 #1)

26.4 Other operations

Address	Word	Stack and description
64345	SubMetaOb	(meta #start #end → meta') Gets a sub-meta. Does range checks.
643BD	SubMetaOb1	(ob1...obi...obn #n #i #n #i → ob1...obi #n #i) This function can be used to take the first i objects of a meta, if you follow it with SWAPDROP. Example: :: %1 %2 %3 %4 %5 FIVE THREE FIVE THREE SubMetaOb1 ; → Results: %1 %2 %3 #5 #3
5F996	(tailpsh)	(meta #n → meta1 meta2) Pushes n-1 last objects in meta to meta1.

Address	Word	Stack and description
28296	metatail	(ob1...obn-i...obn #i #n+1 → ob1...ob...obn-i #n-i obn-i+1...obn #i) #n is the count of the objects in meta. Takes the last #i elements of meta and creates a new one. Example: :: %1 %2 %3 %4 %5 TWO SIX metatail ; → Results: %1 %2 %3 #3 %4 %5 TWO
584B2	(MEQU?)	(M1 M2 → M1 M2 flag) If the metas are equal (i.e., same count and equal objects) returns TRUE.
5768A	(ObInMeta?)	(M ob → M ob FLAG) Returns TRUE if ob is equal to some ob in meta.
55314	(?addinver:)	(meta&Nob → meta) (meta → meta&1LAM) If next object in the runstream is equal to first object of meta, drops that object. Otherwise, adds 1LAM to meta.
5540E	(?addrever)	(meta&1LAM → meta&1LAM) (meta → meta&1LAM) Adds 1LAM to meta, if not already there.
5613D	(?addsimir)	(meta meta → meta) (meta1 meta2 → meta1&meta2&1LAM)
58715	(NoIdsInMeta?)	(M → M flag) If meta has any ids, lams or secondaries starting with CK0, returns FALSE.
5AD08	(dvars?)	(meta → meta flag) Returns TRUE if meta contains any LAM dvar.
5670F	(>dvars)	(meta1 meta2 → meta1&meta2’) All ids in meta2 matching lam 'dvar contents are changed to LAM_'dvar. (meta1 can be #0).
5AC86	(dvars>)	(meta → meta’) Lam 'dvars: are changed to 1LAM)

Dropping plus other actions:

Address	Word	Stack
169A5	NDROPFALSE	(M → FALSE)
50F60	(dropDROPf)	(ob M → FALSE)

Address	Word	Stack								
57419	(DROP2dropf)	(		M1	M2	ob	→	FALSE		)
57405	(2DROP2dropf)	(	M1	M2	ob1	ob2	→	FALSE		)
5551C	(Repl0)	(				M	→	%0	#1	)
55535	(Repl1)	(				M	→	%1	#1	)
5554E	(Repl-1)	(				M	→	%-1	#1	)
56183	(2Repl0)	(			M1	M2	→	%0	#1	)
561D8	(2Repl-1)	(			M1	M2	→	%-1	#1	)
5643A	(DropRepl0)	(			M	ob	→	%0	#1	)
5499F	(Repl0ABND)	(				M	→	%0		)

Chapter 27
Symbolics

27.1 General operations

Address	Word	Stack and description
055F3	(NULLSYMB)	(→ symb) Puts a null algebraic in the stack.
5E067	(SINNER)	(symb → meta) (ob → ob #1) If the argument is a symbolic, does INNERCOMP, otherwise ONE. Note that ob #1 is a meta object with only one object.
5E30C	(2SINNER)	(ob1 ob2 → meta1 meta2) SINNER for two objects.
5E2F8	(2SINNERtop&)	(ob1 ob2 → meta) Does 2SINNER then top&.
5E32A	(SINNERMETA)	(meta → meta') Explodes each object in meta with SINNER and merges the result with top&.
5F2A3	(EXPLODE)	(ob → meta) Uses recursive calls to SINNER to explode object.
5F2EE	(IMPLODE)	(meta → ob) Builds symbolic obeying VUNS properties (UNSYM element), checking fcnapply, etc. Does not build symbolic if result is a single object valid in symbolics.
5E652	symcomp	(ob → ob') If ob is symbolic, does nothing, otherwise ONESYMBN.
5E085	(CKSYMBN)	(meta → ob) If size is not one, does SYMBN, else DROPSYM.

Address	Word	Stack and description
5F384	(DROPSYM)	(ob1 ob2 → ob) Drops ob2, if ob1 if symf does nothing, else does ONESYMBN.
1CF2E	(EQ>)	(symb → arg1 arg2) Internal version of EQ->.
1CFD0	(EXPR>)	(symb → arg1 ... argn %n ob) Internal version of OBJ->.
1578D	CRUNCH	(ob → %) Internal version of ->NUM
22F68	(SYMCRUNCH1)	(ob → %) If id does XEQRCL, then does CRUNCH for all object types.
22F86	(SYMCRUNCH2)	(ob1 ob2 → % ob2) SYMCRUNCH1 for the object in level two.
353AB	(FINDVARS)	(symb → { }) Returns a list of the variables of the equation.
5A036	uncrunch	(→) Clears numeric results flag (system flag 3) for the next command only. Example: SYMCOLCT = :: uncrunch colct ;
545A0	cknumdsptch1	(sym → symf) Used by one argument functions to evaluate a symbolic or numeric routine according to numeric results flag. Usage: :: cknumdsptch1 <sym> <num> ; If numeric mode, the object in level one is CRUNCHed and <num> is COLAd. If symbolic mode, ckseval1: is called. Example: SYMRE = :: cknumdsptch1 MetaRE xRE ;
54DBC	(ckseval1:)	(symf’ → symf’) Binds next two objects in the runstream to LAMxSYMfcn and LAMxfnc. Explodes symf, then evaluates next on Meta, then builds ob with CKSYMBN. If symf is equation next is evaluated on both sides, then equation is rebuilt (ckevaleq1).

Address	Word	Stack and description
54E2A	(ckevaleq1)	(meta&= → symb) Evaluates 2LAM on both sides of equation, rebuilds symbolic and abandons temporary environment.
558DC	sscknum2	(sym sym → symf) Used by two argument functions to evaluate function according to current numeric mode. Usage: :: sscknum2 <sym> <num> ; In numeric mode both arguments are CRUNCHed and <num> is COLAd. Else, cksseval2: is called. Example: SYM+ = :: sncknum2 Meta+ x+ ;
558F5	sncknum2	(sym % → symf) Usage: :: sncknum2 <sym> <num> ; In symbolic mode uses cksneval2:. Example: SYM+O = :: sncknum2 Meta+Con x+ ;
5590E	nscknum2	(% sym → symf) Usage: :: nscknum2 <sym> <num> ; In symbolic mode uses cknseval2:. Example: O+SYM = :: nscknum2 Con+Meta x+ ;
55657	(cknum2:)	(symf symf → symf) Used by the three above functions to determine (and possibly to CRUNCH) the program to COLA.
557EC	(cksseval2:)	(sym sym → symf) Binds next two objects in the runstream to LAMxSYMfcn and LAMxfcn. Explodes the objects in the stack, and evaluates next object in the runstream. If either is an equation, ckevaleq2 is called. Rebuilds one symbolic.
5576F	(cksneval2:)	(sym % → symf) Binds % and next two objects in the runstream to LAMsc1, LAMxSYMfcn and LAMxfcn. Explodes sym, evaluates LAMxSYMfnc, rebuilds symbolic. If sym is equation, ckevaleq1 is called.
5575B	(cknseval:)	(% sym → symf) Does SWAP then cknseval2:.

Address	Word	Stack and description
58CE4	(parameval)	(sym param → ?) Ensures sym is symbolic (using symcomp), then executes param on each element of symbolic. param is bound to 1LAM during the loop. param should return a flag. If TRUE, or if the object in level 1 is not an operator the loop continues, else possible COLCT property is executed. (Better return TRUE always).
58CEE	(eval)	(sym → ?) Like parameval, but without binding of a new param. Use this for recursive evaluation with the same parameter. (See SHOWLS and showparam for examples).
5918A	(evalTRUE)	(sym → ? TRUE) Used for recursive parameval.

27.2 Mathematical operations

One argument meta functions assume function in 1LAM. Two argument meta functions for constants also assume Con in 3LAM.

Address	Symbolic funct.	Address	Meta funct.
55F2B	(SYM+O)	56543	(Meta+Con)
55F44	(O+SYM)	56331	(Con+Meta)
55F5D	(SYM+)	56160	(Meta+)
55F76	(SYM-O)	56566	(Meta-Con)
55F85	(O-SYM)	56359	(Con-Meta)
55F8F	(SYM-)	56174	(Meta-)
55FC1	(SYM*O)	56589	(Meta*Con)
55FDA	(O*SYM)	56390	(Con*Meta)
55FF3	(SYM*)	561BA	(Meta*)
5600C	(SYM/O)	565CF	(Meta/Con)
56025	(O/SYM)	563DB	(Con/Meta)
5603E	(SYM/)	56214	(Meta/)
55EE0	(SYM^O)	5645D	(Meta^Con)
55EF9	(O^SYM)	562FA	(Con^Meta)
55F12	(SYM^)		– –
56057	(SYM%MOD)	5660B	(MetamodCon)
56070	(%SYMMOD)	5642B	(ConmodMeta)
56089	(SYMMOD)	56250	(Metamod)
55E95	(SYM%MIN)		– –
55EAE	(%SYMMIN)		– –
55EC7	(SYMMIN)		– –
55E4A	(SYM%MAX)		– –

Address	Symbolic funct.	Address	Meta funct.
55E63	(%SYMMAX)		— —
55E7C	(SYMMAX)		— —
55C3D	(SYM%%OF)		— —
55C56	(%SYM%OF)		— —
55C6F	(SYM%OF)		— —
55C88	(SYM%%CH)		— —
55CA1	(%SYM%CH)		— —
55CBA	(SYM%CH)		— —
55CD3	(SYM%%T)		— —
55CEC	(%SYM%T)		— —
55D05	(SYM%T)		— —
55D1E	(SYM%COMB)		— —
55D37	(%SYMCOMB)		— —
55D50	(SYMCOMB)		— —
55D69	(SYM%PERM)		— —
55D82	(%SYMPERM)		— —
55D9B	(SYMPERM)		— —
55DB4	(SYM%RND)		— —
55DCD	(SYMRND)		— —
55DE6	(RNDSYM)		— —
55DFF	(SYM%TRNC)		— —
55E18	(TRCNYM)		— —
55E31	(SYMTRCN)		— —
560A2	(SYM%XROOT)		— —
560BB	(%SYMXROOT)		— —
560D4	(SYMXROOT)		— —
54EEB	(SYMNEG)	553D2	(MetaNEG)
54F04	(SYMABS)	555B2	(MetaABS)
54F68	(SYMSIGN)		— —
54F36	(SYMINV)	553EB	(MetaINV)
5518E	(SYMIP)		— —
551A7	(SYMFP)		— —
551C0	(SYMFLOOR)		— —
551D9	(SYMCEIL)		— —
551F2	(SYMEXPONENT)		— —
5520B	(SYMMANT)		— —
54AE0	(SYMRE)	5542C	(MetaRE)
54EB9	(SYMIM)	55495	(MetaIM)
54F1D	(SYMCONJ)	55567	(MetaCONJ)
54ED2	(SYMNOT)		— —
54F9A	(SYMSQ)	555E9	(MetaSQ)
54F81	(SYMSQRT)		— —
54FB3	(SYMSIN)	5533C	(MetaSIN)
54FCC	(SYMCOS)	55378	(MetaCOS)
54FE5	(SYMTAN)	553A5	(MetaTAN)
55049	(SYMASIN)		— —
55062	(SYMACOS)		— —
5507B	(SYMATAN)		— —

Address	Symbolic funct.	Address	Meta funct.
54FFE	(SYMSINH)	5529C	(MetaSINH)
55017	(SYMCOSH)	552B0	(MetaCOSH)
55030	(SYMTANH)	552C4	(MetaTANH)
55094	(SYMASINH)		— —
550AD	(SYMACOSH)		— —
550C6	(SYMATANH)		— —
550F8	(SYMLN)		— —
55143	(SYMLNP1)		— —
550DF	(SYMEXP)	552D8	(MetaEXP)
5515C	(SYMEXPM)	55300	(MetaEXPM)
55111	(SYMLOG)		— —
5512A	(SYMALOG)	552EC	(MetaALOG)
55175	(SYMFACT)		— —
55224	(SYMD>R)		— —
5523D	(SYMR>D)		— —
54F4F	(SYMARG)		— —
55256	(SYMUBASE)		— —
5226F	(SYMUVAL)		— —
5599A	(SYM%AND)		— —
559B3	(%SYMAND)		— —
559CC	(SYMAND)		— —
559E5	(SYM%OR)		— —
559FE	(%SYMOR)		— —
55A17	(SYMOR)		— —
55A30	(SYM%XOR)		— —
55A49	(%SYMXOR)		— —
55A62	(SYMXOR)		— —
55A7B	(SYMFLOAT==)		— —
55A94	(FLOATSYM==)		— —
55AAD	(SYM==)		— —
55AC6	(SYMFLOAT<>)		— —
55ADF	(FLOATSYM<>)		— —
55AF8	(SYM<>)		— —
55B11	(SYM%<)		— —
55B2A	(%SYM<)		— —
55B43	(SYM<)		— —
55B5C	(SYM%>)		— —
55B75	(%SYM>)		— —
55B8E	(SYM>)		— —
55BA7	(SYM%<=)		— —
55BC0	(%SYM<=)		— —
55BD9	(SYM<=)		— —
55BF2	(SYM%>=)		— —
55C0B	(%SYM>=)		— —
55C24	(SYM>=)		— —

27.2.1 Collection

Address	Word	Stack and description
57D90	SYMCOLCT	(symf → symf) `:: uncrunch colct ;`

57DA4	(colct)	(symf → symf)
		Basic collection function, does not check numeric results flag. Disassembly:
		`:: EXPLODE`
		`   pshzer colfac`
		`   pshzer colrev`
		`   ATTNFLG@ #0<> case`
		`     :: CKSYMBN CK0NOLASTWD ?ATTNQUIT ;`
		`   pshzer colunfac`
		`   SYMN COLA coleval`
		`;`

587AA	(colfac)	(meta1 meta2 → meta) Appends objects in meta2 tail to meta1 tail replacing all -, /, NEG, INV and SQ with +, *, ^, and -1 as a possible factor. Example rules: 'SQ(A)' → 'A^2' '-A' → '-1*A' 'A-B' → 'A+-1*b' 'A/B' → 'A*B^-1'
57E08	(colrev)	(meta1 meta2 → meta') Appends objects in meta2 to tail of meta1 collecting numeric factors, ordering terms according to a comparison function, collecting numeric terms to front. Only + and * factors are checked. Sub-routines used by this function: 58511 (MetaLess?) (M1 M2 → M1 M2 flag) 58525 (MetaMore?) (M1 M2 → M1 M2 flag) 585A7 (BodyMore?) (ob1 ob2 → flag)
58A20	(colunfac)	(meta1 meta2 → meta') Appends objects in meta2 to head of meta1 converting ^, + and * to / and - when suitable.
58CDA	(coleval)	(ob → ob') Passes FALSE as parameter to parameval. Thus eval uses ?COLCT to check special evaluation.

27.2.2 Expansion

Address	Word	Stack and description
57A0C	(SYMEXPAN)	(symf → symf) Expands symbolic or float
57A48	(expan)	(meta1 meta2 meta3 → meta) Expands meta3. Successful part is added to tail of meta2. Calls expan1 and larg until meta3 becomes empty.
57AA2	(expan1)	(meta → meta1 meta2) Expands meta. Meta1 is the unsuccessful part, meta2 the successful part (could be just and operator). Sub-expanders: 57B63 (?expan^) If ^ then expands (returns if successful.) 57AB6 (expansq) Expands SQ. 5BFD8 (MetaD->) 5C0B9 (Meta<-D) 5C2CE (MetaE^) 5C348 (MetaL*) 57B4C (?expanneginv) Prevents Meta->() from expanding [Expr INV NEG]. 5C137 (Meta->()) 57B01 (?expanapp) If xFCNAPPLY then tries calling ?EXPAN. 57C71 (expansum^) Expands (A+B)^2 or (A-B)^2 57CF8 (NXTPOT%) Returns next number when expanding ^. (% → flag %'TRUE) (% → % FALSE) The flag indicates wheter %0>. Do not use for %0.

27.2.3 Integration

Address	Word	Stack and notes
1F201	(XEQINTEGID)	(ob ob ob id/lam → symf)
1F27A	(XEQINTEG)	(ob ob ob QN → symf)
5AAC7	(SYMINTEG)	(symf symf symf QN → symf)

Address	Word	Stack and notes
5662E	(NUMINTEG)	(symf QN symf_lo symf_hi → %)
52C36	(CALCINTEG)	(seco %accuaracy %lo %hi → %integral %error) Low level numeric integration. If %low = %hi returns %0 %0. Checks that 1E-12 ≤ %accuracy ≤ 1. seco gets % as input and should return one value.
5ACC7	(intg)	(#0 #0 meta → meta_ok meta_fail) Integrates meta where variable of integration has been changed to LAMdvar. Meta objects should be merged by addition. Use colunfac to resume /, -, etc. from *, +.
5D0C2	(forceadd)	(meta → meta’) Forces top level operators to be +, NEG when possible by changing from -, +, NEG. Attempts to arrange rightmost term to be second argument for top +. Example: 'A+(B+C)' → 'A+B+-C'
5B659	(forcemul?aga)	(meta → meta’) Recursive Meta<-D, MetaD-> and forcemul calling. If any operation was successful AGAIN is executed.
5B717	(forcemul)	(meta → meta’) Forces top level operator to be + and NEG when possible by changing from / and INV. LAMdvar is ordered specially.
5AFAB	(intg1)	(M_ok M_fail M_temp meta → M_ok’M_fail’ M_temp) Integrates meta, ok part is adds to meta1 (meta3 is the next part to integrate in the top level loop.)
5B0FA	(intg1ok)	(M1 M2 M3 M4 → M1’M2 M3 TRUE) Adds M4 to M1. (Successful intg1).
5B09B	(intg1fail)	(M1 M2 M3 M4 → M1 M2’M4 TRUE) Adds M4 to M2. (Unsuccessful intg1).
5B0CD	(intgconst)	(M_ok M_fail M_temp meta → M_ok’M_fail’ M_temp) Integrates constant to meta. (dvars? gives FALSE).

Address	Word	Stack and notes
5B131	(intglinear)	(M1 M2 M3 M4 → M1'M2 M3) Integrates linear term (M4).
5B140	(intgaddlin)	(meta #loc → meta') Adds 2^/2 to LAMdvar in meta at stack level #loc.
5AD80	(linear?)	(meta #level → meta'TRUE) (meta #level → meta'#loc FALSE) Is meta linear in LAMdvar? #level is first location of LAMdvar obtained from dvars? `:: linear DUP IT SWAPDROP ;`
5AD9E	(linear)	(meta #level → meta #loc flag)
5AD6C	(linear!)	(meta #level → meta'flag) `:: linear SWAPDROP ;`

27.2.4 Other functions

Address	Word	Stack and notes
1F38B	(SYMWHERE)	(symf { } → symf)
1F439	(XEQSYMBWHERE)	(symf QN1 id1 ... QNn idn → symf)
1F43E	(CKWHEREARGS)	Checks pairs of quoted names/ids.
547B5	SYMBWHERE	(symf QN1 id1 ... QNn idn #2n+1 → symf)
547E2	(WHERE1)	(QN1 id1 ... QNn idn #n meta1 → symf) Used when meta size is 1.
54887	(WHEREN)	(QN1 id1 QNn idn #2 metan → symf)
58D75	SYMSHOW	(sym id/lam → symf)
20B00	XEQSHOWLS	(sym { } → symf)
5910B	(SHOWLS)	(sym {names} → symf) See this for a good example of recursive parameval.
1A4A3	(%IFTE)	(% ob1 ob2 → ?)
54564	(SYMIFTE)	(sym symf symf → symf) Uses cknumdsptch1 with: 54609 (MetaIFTE) 54653 (NumIFTE)
591AD	(SYMQUAD)	(sym id → symf) Avoids the obvious in solving a quadratic equation.
595DD	(SYMTAYLR)	(sym id % → symf) Calculates taylor polynomial.

Address	Word	Stack and notes
57293	(SYMISOL)	(sym id → symb) Isolate a variable.
1F113	(XEQSYMDERCON)	(QN %/C%/unit → symf)
1F0F5	(XEQSYMDERSTEP)	(QN sym → symf)
54977	(SYMDERSTEP)	(QN sym → symf) No CKSYMBTYPE check.
54954	(SYMDER)	(sym sym → symf)
56949	(SYMSUM)	(sym sym sym ob → symf)
56A06	(SYM%SUM)	(sym sym % ob → symf)
56A4C	(%SYMSUM)	(sym % sym ob → symf)
56AC9	(%%SUM)	(sym % % ob → symf)

27.3 Meta symbolics functions

27.3.1 Adding operators

Address	Word	Stack
5BC94	(addt+)	(meta → meta&+)
5BC67	(addt-)	(meta → meta&-)
5CD16	(addt*)	(meta → meta&*)
5CD2A	(addtNEG)	(meta → meta&NEG)
5CD3E	(addtINV)	(meta → meta&INV)
5BCC1	(repl/)	(meta&ob → meta&/)
5BCEE	(repl*)	(meta&ob → meta&*)

27.3.2 Changing operators

Address	Word	Stack
5ACD6	(M1st+?Drp)	(meta&+ → meta) (meta → meta)
5BC5D	(meta+)	(meta&NEG → meta&-) (meta → meta&+)
5BC8A	(meta-)	(meta&NEG → meta&+) (meta → meta&-)
5BCB7	(meta*)	(meta&INV → meta&/) (meta → meta&*)
5BCE4	(meta/)	(meta&INV → meta&*) (meta → meta&/)
5BD3E	(drpmeta+)	(meta&NEG&ob → meta&-) (meta&ob → meta&+)

Address	Word	Stack
5BD57	(drpmeta-)	(meta&NEG&ob → meta&+)
		(meta&ob → meta&-)
5BD70	(drpmeta*)	(meta&INV&ob → meta&/)
		(meta&ob → meta&*)
5BD89	(drpmeta/)	(meta&INV&ob → meta&*)
		(meta&ob → meta&/)
5BBE5	(metaneg)	(meta&NEG → meta)
		(meta → meta&NEG)
5BC3F	(metainv)	(meta&INV → meta)
		(meta → meta&INV)
5BC03	(metaneglft)	(meta → meta')
		metaneg on left sub-expression.
5BC21	(metainvlft)	(meta → meta')
		metainv on left sub-expression.

27.3.3 Splitting algebraic metas

Address	Word	Stack and description
5EA9F	pshzerpsharg	(meta → M_last M_rest) Pushes last sub-expression in meta. If meta is a valid expression M_rest will be empty.
63F92	pZpargSWAPUn	(meta → M_rest M_last) pshzerpsharg then psh.
63F56	plDRPpZparg	(meta&ob → M_last M_rest) Drops ob then calls pshzerpsharg.
5E68E	(pargop)	(meta → M_last&op M_rest) Pushes last sub-expression ignoring first object in meta. Thus op is +, -, etc. and M_last is their second argument.
5EAC2	(larg)	(meta → M_rest M_last) Splits last sub-expression from meta.
5E6F2	(parg&)	(meta1 meta2 → meta1&M_last M_rest)
5CCEE	(larg&)	(meta1 meta2 → meta1&M_rest M_last)
5CBF9	(drppargtop&)	(meta&ob → M_last&M_rest)
57F4B	(swappargunrot)	(meta1 meta2 → M_rest meta2 M_last)
1CF42	(drppargsym)	(meta&ob → 'M_Rest' 'MetaLast') Buids objects with PSYMBN. Will give invalid expressions if ob is not a two-argument function.

Address	Word	Stack and description
5F926	(splitup)	(meta #n #m → meta #level) Calculates stack level of last object to be included when splitting last m sub-expressions from meta starting from stack level n. (2 1 would give level of first object in the last sub-expression.)
5F96E	(splitdown)	(meta #n #m → meta #lowlevel #args+1) Seeks stack level n-1 downwards for extra operators for m expressions. #lowlevel is the stack level of the extra operator. #args indicates how many expressions the lowlevel operator is still missing.
558BE	(?spliteq)	(meta1&meta2&= → meta2 meta1) (meta → meta meta) If meta contains =, splits two sides, otherwise DUP.

27.3.4 Miscellaneous

Address	Word	Stack and description
58C02	(count+)	(meta → meta #0) (meta &+&+...&+ → meta #n)
58C0E	(count*)	Same as above for *.

27.3.5 Rules menu operations

Stack diagrams for functions below: (meta → meta ’)

For matching patterns the corresponding operation is COLAd, thus current stream is dropped in such cases.

Address	Word	Action
5BE56	(MetaMulInv)	Simplifiy combinations of INV and * (using /). Sub-functions: 58A61 (colinv1) [expr1 INV expr2 INV *] → [expr1 expr2 /] 58A93 (colinv2) [expr INV *] → [expr /] 58AAC (colinv3) [expr1 INV expr2 *] → [expr1 expr2 /]
5971D	(MetaDNEG)	Double negation.
5976B	(MetaDINV)	Double inversion.

Address	Word	Action
597B5	(Meta*1)	Multiply by one.
5983B	(Meta^1)	Raise to power of one.
59885	(Meta1/)	Divide by one.
5990F	(Meta+1-1)	Add one and subtract one.
596D3	(MetaRCOLCT)	Restricted collection.
5C6D9	(Meta<-T)	Move nearest right term to the left.
5C68D	(MetaT->)	Move nearest left term to the right.
5C623	(Meta(()))	Put parentheses over nearest term.
5C589	(Meta(<-)	Include left term.
5C5D6	(Meta->))	Include right term.
5BE81	(Meta<-->)	Commute terms.
5BECE	(Meta<-A)	Associate left term.
5BF53	(MetaA->)	Associate right term.
5C137	(Meta->())	Remove prefix.
5C0B9	(Meta<-D)	Delete left term (via expansion).
5C102	(Meta<-D!)	Delete left term (above – ^ expansion).
5BFD8	(MetaD->)	Delete right term (via expansion).
5C3C2	(Meta<-M)	Merge common factor on left side.
5C4CF	(MetaM->)	Merge common factor on right side.
5C261	(Meta-())	Double negate, then remove prefix.
5C204	(Meta1/())	Double inversion, then remove prefix.
5C348	(MetaL*)	Transform LN(A^B) to LN(A)*B.
5C375	(MetaL())	Transform LN(A)*B to LN(A^B).
5C2CE	(MetaE^)	Transform EXP(A*B) to EXP(A)^B.
5C31B	(MetaE())	Transform EXP(A)^B to EXP(A*B).
5C670	(Meta->TRG)	Change EXP to trigonometric functions.
5C53C	(MetaAF)	Add fractions.
5C845	(Meta->DEF)	Define function (SIN, SINH, ASIN...)
5C91D	(MetaTRG*)	Expand trigonometric function of a sum.
5C73D	(Meta->()C%)	Remove first RE, IM or CONJ.

Words for repeated evaluation:

Address	Word	Address	Word
5CDF2	(Meta<-Dall)	5CEF1	(MetaD->all)
5CE15	(Meta<-Aall)	5CE4C	(MetaA->all)
5CFF5	(Meta<-Mall)	5D009	(MetaM->all)
5CF5A	(Meta<-Tall)	5CF23	(MetaT->all)
5CEBA	(Meta(<-all)	5CE83	(Meta->)all)
5CF91	(Meta->()all)	5CFC3	(Meta->()C%all)

The repeater words:

Address	Word	Stack and description
5CD52	(evalcase:)	(meta → ?) Evaluates next object. If it drops current stream then continue, else SKIP next. Example: `:: evalcase: Meta<-D Meta<-Daga ;`

5CD7A	(revalcase:)	(meta → ?)
		Evaluates next object for sub-expressions until current stream is not dropped by ob. Example:
		`Meta<-Daga =`
		`:: revalcase: Meta<-D COLA RDROP ;`
		(COLA RDROP is there to makr successful oper.)

Chapter 28
Library and backup objects

28.1 Port operations

Address	Word	Stack and description
0AAB2	PORTSTATUS	(#port → present? writeable? merged? #size #addr?) Returns information for port.
0AB22	(PORTEND)	(#port → #addr) Gets end address of port.
0AB82	NEXTLIBBAK	(#addr → backup/library #nextaddr TRUE/FALSE) Gets next library or backup.
0B409	(MERGE)	(#port →) Merges specified port. Only works for port one. Checks if wrong port number was entered.

28.2 ROM pointers

Address	Word	Stack and description
07E50	#>ROMPTR	(#lib #cdm → ROMPTR) Creates ROM pointer.
08CCC	ROMPTR>#	(ROMPTR → #lib #cmd) Splits ROM pointer.
07EE9	ROMPTR@	(ROMPTR → ob TRUE) (ROMPTR → FALSE) Recall contents of ROM pointer.
62C19	DUPROMPTR@	(ROMPTR → ROMPTR ob TRUE) (ROMPTR → ROMPTR FALSE) Does DUP then ROMPTR@.

Address	Word	Stack and description
02FEF	(DoRomptr)	(ROMPTR → ?) Recalls contents of ROM pointer and EVAL. Generates "Undefined XLIB Error" if not found.
62A61	?>ROMPTR	(ob → ob') If ROM_WORD? and TYPECOL? then RPL@.
62A84	?ROMPTR>	(ob → ob') If TYPEROMP? and contents exit INHARDROM? then return contents.
62BD8	RESOROMP	(→ ob) Recalls contents of next object in the runstream (which must be a ROM pointer).
07E76	(PTR>ROMPTR)	(ob → ROMPTR TRUE) (ob → FALSE) If the object is a library command, returns its ROM pointer and TRUE, if not just FALSE.
081FB	(ROMPTRDECOMP)	(ROMPTR → id TRUE) (ROMPTR → FALSE) If the library command exists and has a name, returns that name and TRUE, otherwise FALSE.
081E3	(PTR>ID)	(ob → id TRUE) (ob → FALSE) If the object is a library command and has a name, returns its name and TRUE, if not returns just FALSE.
07C18	(ID>CMD)	(id → id TRUE) (id → ROMPTR TRUE) (id → FALSE) Searches id in current path, if found returns TRUE. Else searches attached libraries. If nothing was found, return FALSE.

28.3 Libraries

Address	Word	Stack and description
07709	TOSRRP	(# →) Attaches library to HOME directory.
076AE	OFFSRRP	(# →) Detaches library from HOME directory.

Address	Word	Stack and description
0778D	(ONSRRP?)	(# → flag) Returns TRUE if library is attached to HOME directory.
021DD	(ROMPOLL)	(→) Configures internal and external libraries.
0210F	(DOROMPOLL)	({ #libnum1 #libum2 ... } →) Configures specified libraries.
08199	(ROMPART>NAME)	(#libnum → id TRUE) (#libnum → FALSE) Returns title and TRUE of library. If library is not found, returns just FALSE.
081DE	(LIB>#)	(lib → #libnum TRUE) Returns number of library.
08081	(ROMPART>ADDR)	(#libnum → #addr TRUE) (#libnum → FALSE) Recalls library addres + 10 (prolog and length skipped).
080BF	(ROMPART>SIZE)	(#libnum → #nibbles-10 TRUE) (#libnum → FALSE) Returns size of library.
080DA	(NEXTROMPID)	(#libnum → #nexlibnum TRUE) (#libnum → FALSE) If specified library exists, #libnum is returned with TRUE.
08112	(GETHASH)	(#libnum → hxs_table TRUE) (#libnum → FALSE) Gets specified library’s hash table.
08130	(GETMSG)	(#libnum → [ ] TRUE) (#libnum → FALSE) Gets specified library’s message table.
0764E	(SETMSG)	([$] #libnum →) Sets message table of specified library.
0813C	(GETLINK)	(#libnum → hxs_table TRUE) (#libnum → FALSE) Gets specified library’s link table.

Address	Word	Stack and description
08157	(GETCONFIG)	(#libnum → ob TRUE) (#libnum → FALSE) Gets specified library's configuration routine.
07F86	(ROMPART)	(rrp → { #lib1 ... #libn } TRUE) (ROMPTR → #libnum) Gets library's number.

28.4 Backup objects

Address	Word	Stack and description
081D9	BAKNAME	(bak → id TRUE) Returns backup's name
0948E	BAK>OB	(bak → ob) Get's backup object.
21674	(>BAK)	(id ob → bak) Creates backup object with specified name and contents.

Chapter 29
Stack operations

Address	Word	Stack and notes
0314C	DEPTH	(1 ... n → 1 ... n #n)
5DE7D	reversym	(1 ... n #n → n ... 1)
03188	DUP	(1 → 1 1)
62CB9	DUPDUP	(1 → 1 1 1)
5E370	NDUPN	(ob #n → ob ... ob #n)
		(ob #0 → #0)
62FB1	DUPROT	(1 2 → 2 2 1)
630F1	DUPROLL	(1 ... n #n → 1 3 ... n #n 2)
61380	DUPUNROT	(1 2 → 2 1 2)
		Also called SWAPOVER.
61099	DUP4UNROLL	(1 2 3 → 3 1 2 3)
611F9	DUP3PICK	(1 2 → 1 2 2 1)
		Also called 2DUPSWAP.
630DD	DUPPICK	(n ... 1 #n → n ... 1 #n n-1)
6119E	DUP#1+PICK	(n ... 1 #n → n ... 1 #n n)
5FC24	(DUP#2+PICK)	(n ... 1 #n → n ... 1 #n n+1)
031AC	2DUP	(1 2 → 1 2 1 2)
611F9	2DUPSWAP	(1 2 → 1 2 2 1)
		Also called DUP3PICK.
63C40	2DUP5ROLL	(1 2 3 → 2 3 2 3 1)
031D9	NDUP	(1 ... n #n → 1 ... n 1 ... n)
03244	DROP	(1 →)
627A7	DROPDUP	(1 2 → 1 1)
63FA6	DROPNDROP	(1 ... n #n ob →)
6270C	DROPSWAP	(1 2 3 → 2 1)
62726	DROPSWAPDROP	(1 2 3 → 2)
		Also called ROT2DROP and XYX>Y.
62FC5	DROPROT	(1 2 3 4 → 2 3 1)
63029	DROPOVER	(1 2 3 → 1 2 1)
03258	2DROP	(1 2 →)
60F4B	3DROP	(1 2 3 →)
		Also called XYZ>.
60F7E	4DROP	(1 ... 4 →)
		Also called XYZW>.
60F72	5DROP	(1 ... 5 →)
60F66	6DROP	(1 ... 6 →)
60F54	7DROP	(1 ... 7 →)
0326E	NDROP	(1 ... n #n →)
62F75	N+1DROP	(ob 1 ... n #n →)
		Also called #1+NDROP.

Address	Word	Stack and notes
03223	SWAP	(1 2 → 2 1)
62747	SWAPDUP	(1 2 → 2 1 1)
6386C	SWAP2DUP	(1 2 → 2 1 2 1)
60F9B	SWAPDROP	(1 2 → 2) Also called XY>Y.
62830	SWAPDROPDUP	(1 2 → 2 2)
6284B	SWAPDROPSWAP	(1 2 3 → 3 1) Also called XYZ>ZX.
60F33	SWAPROT	(1 2 3 → 3 2 1) Also called UNROTSWAP and XYZ>ZYX.
63C2C	SWAP4ROLL	(1 2 3 4 → 2 4 3 1) Also called XYZW>YWZX.
61380	SWAPOVER	(1 2 → 2 1 2) Also called DUPUNROT.
63C54	SWAP3PICK	(1 2 3 → 1 3 2 1)
62001	2SWAP	(1 2 3 4 → 3 4 1 2)
03295	ROT	(1 2 3 → 2 3 1)
62775	ROTDUP	(1 2 3 → 2 3 1 1)
62C7D	ROT2DUP	(1 2 3 → 2 3 1 3 1)
60F21	ROTDROP	(1 2 3 → 2 3) Also called XYZ>YZ.
60F0E	ROTDROPSWAP	(1 2 3 → 3 2)
62726	ROT2DROP	(1 2 3 → 2) Also called DROPSWAPDROP and XYZ>Y.
60EE7	ROTSWAP	(1 2 3 → 2 1 3) Also called XYZ>YXZ.
6112A	ROTROT2DROP	(1 2 3 → 3) Also called UNROT2DROP and XYZ>Z.
62CA5	ROTOVER	(1 2 3 → 2 3 1 3)
60FBB	4ROLL	(1 2 3 4 → 2 3 4 1) Also called FOURROLL and XYZW>YZWX.
62864	4ROLLDROP	(1 2 3 4 → 2 3 4)
62ECB	4ROLLSWAP	(1 2 3 4 → 2 3 1 4)
63001	4ROLLROT	(1 2 3 4 → 2 4 1 3) Also called FOURROLLROT.
630A1	4ROLLOVER	(1 2 3 4 → 2 3 4 1 4)
60FD8	5ROLL	(1 2 3 4 5 → 2 3 4 5 1) Also called FIVEROLL.
62880	5ROLLDROP	(1 2 3 4 5 → 2 3 4 5)
61002	6ROLL	(1 ... 6 → 2 ... 6 1) Also called SIXROLL.
6106B	7ROLL	(1 ... 7 → 2 ... 7 1) Also called SEVENROLL.
6103C	8ROLL	(1 ... 8 → 2 ... 8 1) Also called EIGHTROLL.
03325	ROLL	(1 ... n #n → 2 ... n 1)
62F89	ROLLDROP	(1 ... n #n → 2 ... n)
62D45	ROLLSWAP	(1 ... n #n → 2 ... n-1 1 n)
612F3	#1+ROLL	(ob 1 ... n #n → 1 ... n ob)

Address	Word	Stack and notes
61318	#2+ROLL	(a b 1 ... n #n → b 1 ... n a)
612DE	#+ROLL	(1 ... n+m #n #m → 2 ... n+m 1)
612CC	#-ROLL	(1 ... n-m #n #m → 2 ... n-m 1)
60FAC	UNROT	(1 2 3 → 3 1 2)
		Also called 3UNROLL and XYZ>ZYX
62CF5	UNROTDUP	(1 2 3 → 3 1 2 1)
6284B	UNROTDROP	(1 2 3 → 3 1)
		Also called SWAPDROPSWAP and XYZ>ZX.
6112A	UNROT2DROP	(1 2 3 → 3)
		Also called ROTROT2DROP and XYZ>Z.
60F33	UNROTSWAP	(1 2 3 → 3 2 1)
		Also called SWAPROT and XYZ>ZXY.
60F0E	UNROTSWAPDRO	(1 2 3 → 3 2)
		Also called XYZ>ZY.
6308D	UNROTOVER	(1 2 3 → 3 1 2 1)
6109E	4UNROLL	(1 2 3 4 → 4 1 2 3)
		Also called FOURUNROLL and XYZW>WXYZ.
62D09	4UNROLLDUP	(1 2 3 4 → 4 1 2 3 3)
6113C	4UNROLL3DROP	(1 2 3 4 → 4)
		Also called XYZW>W.
63015	4UNROLLROT	(1 2 3 4 → 4 3 2 1)
610C4	5UNROLL	(1 2 3 4 5 → 5 1 2 3 4)
		Also called FIVEUNROLL.
610FA	6UNROLL	(1 ... 6 → 6 1 ... 5)
		Also called SIXUNROLL.
62BC4	7UNROLL	(1 ... 7 → 7 1 ... 6)
		Also called SEVENUNROLL.
63119	8UNROLL	(1 ... 8 → 8 1 ... 7)
6312D	10UNROLL	(1 ... 10 → 10 1 ... 9)
0339E	UNROLL	(1 ... n #n → n 1 ... n-1)
61353	#1+UNROLL	(ob 1 ... n #n → n ob 1 ... n-1)
61365	#2+UNROLL	(a b 1 ... n #n → n a b 1 ... n-1)
6133E	#+UNROLL	(1 ... n+m #n #m → n+m 1 ... n+m-1)
6132C	#-UNROLL	(1 ... n-m #n #m → n-m 1 ... n+m-1)
032C2	OVER	(1 2 → 1 2 1)
62CCD	OVERDUP	(1 2 → 1 2 1 1)
62D31	OVERSWAP	(1 2 → 1 1 2)
		Also called OVERUNROT.
63105	OVER#2+UNROLL	(1 ... n #n ob → ob 1 ... n #n)
63C90	OVER5PICK	(1 2 3 4 → 1 2 3 4 3 1)
63FBA	2OVER	(1 2 3 4 → 1 2 3 4 1 2)
611FE	3PICK	(1 2 3 → 1 2 3 1)
62EDF	3PICKSWAP	(1 2 3 → 1 2 1 3)
630B5	3PICKOVER	(1 2 3 → 1 2 3 1 3)
63C68	3PICK3PICK	(1 2 3 → 1 2 3 1 2)
6121C	4PICK	(1 2 3 4 → 1 2 3 4 1)
62EF3	4PICKSWAP	(1 2 3 4 → 1 2 3 1 4)
63069	4PICKOVER	(1 2 3 4 → 1 2 3 4 1 4)
6123A	5PICK	(1 2 3 4 5 → 1 2 3 4 5 1)

Address	Word	Stack and notes
6125E	6PICK	(1 ... 6 → 1 ... 6 1)
61282	7PICK	(1 ... 7 → 1 ... 7 1)
612A9	8PICK	(1 ... 8 → 1 ... 8 1)
032E2	PICK	(1 ... n #n → 1 ... n 1)
611A3	#1+PICK	(1 ... n #n-1 → 1 ... n 1)
611BE	#2+PICK	(1 ... n #n-2 → 1 ... n 1)
611D2	#3+PICK	(1 ... n #n-3 → 1 ... n 1)
611E1	#4+PICK	(1 ... n #n-4 → 1 ... n 1)
61184	#+PICK	(1 ... n+m #n #m → 1 ... n+m 1)
61172	#-PICK	(1 ... n-m #n #m → 1 ... n-m 1)

Chapter 30
Checking for arguments

Address	Word	Description
18AE1 18AA5 18A80 18A5B 18B92 18B6D	CK0 CK1 CK2 CK3 CK4 CK5	Saves current command to LASTCKCMD. Verify that there are at least <n> objects in the stack, if not generates a "Too Few Arguments" error. Saves stack mark to STACKMARK. If Last Arg is enabled then saves the arguments.
16C34	CKN	Checks for a real in level one. Then checks for that number of arguments.
18A15 18AB2 18A8D 18A68 18B9F 18B7A 18C4A	CK0NOLASTWD CK1NOLASTWD CK2NOLASTWD CK3NOLASTWD CK4NOLASTWD CK5NOLASTWD CKNNOLASTWD	Like the above, but does not save current command.
18F9D	CK&DISPATCH0	Dispatches on stack argument. See Chapter 4 for instructions on how to use.
18FB2	CK&DISPATCH1	Dispatches on stack arguments, stripping tags if necessary.
18ECE 18EDF 18EF0 18F01 18F12	CK1&Dispatch CK2&Dispatch CK3&Dispatch CK4&Dispatch CK5&Dispatch	Combines CK<n> with CK&DISPATCH1.
5EA09	CKINFARGS	Gets meta as argument and checks its length (using DEPTH), and errors if it is too short. Collects the arguments to a list, does CK1NOLASTWD, and explodes the meta again.
1884D	0LASTOWDOB!	Clears command save by last CK<n> command. Also called 0LastRowWord!.
40BC9	AtUserStack	:: CK0NOLASTWD 0LASTOWDOB! ;
1592D	CK1NoBlame	:: 0LASTOWDOB! CK1NOLASTWD ;

Address	Word	Description
62474	'RSAVEWORD	Stores first object in the composite above the actual to LASTCKCMD. Also called 'RSaveRomWrd.
18F23	EvalNoCK	(comp → ?) Evaluates composite without saving as current command. If first command is CK<n>&Dispatch it is replaced by CK&DISPATCH1. If first command is CK<n> it is skipped.
18F6A	(EvalNoCK:)	EvalNoCK with the next object in the runstream as argument.

30.1 Type checkin g

The words below check for a specified argument type, and call SETTTYPEERR if it is of the wrong type, i.e., a “Bad Argument Type” error is generated.

Address	Word	Stack and description
63B2D	CKREAL	(ob → ob) Checks for real.
193C1	(CKARRY)	(ob → ob) Checks for array.
194BB	(CKRARRY)	(ob → ob) Checks for real array.
194D9	(CKCARRY)	(ob → ob) Checks for complex array.
19443	(CKLIST)	(ob → ob) Checks for list.
20BE0	(CKNAMELIST)	(ob → ob) Checks for non-empty list of names.
1945C	(CKLISTTYPE)	(ob #prolog → ob) Checks for non-empty list of certain type.
1F05B	CKSYMBTYPE	(ob → ob) Checks for quoted name (name as symbolic).

Address	Word	Stack and description
54C63	nmetasyms	(meta → meta) Checks for meta containing %, C%, unit, id, lam or symb.

19207	(CKNFLOATS)	(ob1 ... obn any #n → ob1 ... obn any #n zero)
		Checks for #n floats (F%)
		zero = C%0 if at least one float was complex, otherwise it is %0.

Chapter 31
Temporary environments

31.1 Built-in ids and lams

Address	Word	Disassembly
15777	NULLID	Null identifier
34D30	NULLLAM	Null lam
211B4	(ID_CST)	ID CST
225A4	(ID_S)	ID S
3FACF	(ID_SKEY)	ID SKEY
3FAE8	(LAM_SKEY)	LAM SKEY
4AB1C	ID_X	ID X
4744F	'IDX	:: ' ID X ;
4AB59	ID_Y	ID Y
41A39	('idUserKeys)	:: ' ID UserKeys ;
41A43	(ID_UserKeys)	ID UserKeys
41A5F	('idUserKeys.)	:: ' UserKeys.CRC ;
41A69	(ID_UserKeys.)	ID UserKeys.CRC
1576C	(ID_EQ)	ID EQ
2C1FD	(ID_SIGMADAT)	ID \85DAT (ΣDAT)
549DB	(lam'dvar)	LAM 'dvar
5127E	('ID_PPAR)	:: ' ID PPAR ;

31.2 Conversion words

Address	Word	Stack
05B15	$>ID	($ → id)
63295	DUP$>ID	($ → $ id)
05AED	(ID>LAM)	(id → lam)
05B01	(LAM>ID)	(lam → id)

31.3 Temporary environments words

Address	Word	Stack and description
074D0	BIND	(obn ... ob1 { lamn ... lam1 } →) Binds n objects to n differently named lams.
074E4	DOBIND	(obn ... ob1 lamn ... lam1 #n →) Binds n objects to n differently named lams.
634CF	1LAMBIND	(ob →) Binds one object to a null named lam.
634CA	DUP1LAMBIND	(ob → ob) Does DUP then 1LAMBIND.
07497	ABND	(→) Abandons topmost temporary environment.
61CE9	CACHE	(obn ... ob1 #n lam →) Binds all objects under the same name. 1LAM has the count.
61EA7	DUMP	(NULLAM → ob1 ... obn #n) Inverse of CACHE. Always does garbage collection.
61D41	SAVESTACK	(→) Caches stack to SAVELAM.
61F8F	undo	(→) Dumps SAVELAM.
07943	@LAM	(lam → ob TRUE) (lam → FALSE) Tries recalling object from lam. If successful, returns object and TRUE, otherwise returns just FALSE.
07D1B	STOLAM	(ob lam →) Tries storing object in lam. Generates “Undefined Local Name” error if not found.
02FD6	(DoLam)	(lam → ob) (lam → !error!) Tries recalling object from lam, generates “Undefined Local Name” error if not found.

Address	Word	Stack and description
078E9	(@LAM1)	(lam → ob TRUE) (lam → FALSE) @LAM for first environment only.
078F5	(@LAMN)	(lam #n → ob TRUE) (lam #n → FALSE) @LAM for nth environment only.
61745	DUPTEMPEVN	(→) Duplicates topmost temporary environment (clears protection word).
075A5	GETLAM	(#n → ob) Gets contents of nth topmost lam.
613B6	1GETLAM	(→ ob) These words get the specified lam contents.
613E7	2GETLAM	
6140E	3GETLAM	
61438	4GETLAM	
6145C	5GETLAM	
6146C	6GETLAM	
6147C	7GETLAM	
6148C	8GETLAM	
6149C	9GETLAM	
614AC	10GETLAM	
614BC	11GETLAM	
614CC	12GETLAM	
614DC	13GETLAM	
614EC	14GETLAM	
614FC	15GETLAM	
6150C	16GETLAM	
6151C	17GETLAM	
6152C	18GETLAM	
6153C	19GETLAM	
6154C	20GETLAM	
6155C	21GETLAM	
615GC	22GETLAM	
075E9	PUTLAM	(ob #n →) Stores new contents to nth topmost lam.
615E0	1PUTLAM	(ob →) These words store a new contents to specified lam.
615F0	2PUTLAM	
61600	3PUTLAM	
61615	4PUTLAM	
61625	5PUTLAM	
61635	6PUTLAM	
61645	7PUTLAM	
61655	8PUTLAM	
61665	9PUTLAM	
61675	10PUTLAM	
61685	11PUTLAM	

Address	Word	Stack and description
61695	12PUTLAM	(ob →) These words store a new contents to specified lam.
616A5	13PUTLAM	
616B5	14PUTLAM	
616C5	15PUTLAM	
616D5	16PUTLAM	
616E5	17PUTLAM	
616F5	18PUTLAM	
61705	19PUTLAM	
61715	20PUTLAM	
61725	21PUTLAM	
61735	22PUTLAM	
61610	DUP4PUTLAM	(ob → ob) Does DUP then 4PUTLAM.
634B6	1GETABND	(→ 1lamob) Does 1GETLAM then ABND.
62DB3	1ABNDSWAP	(ob → 1lamob ob) Does 1GETABND then SWAP.
62F07	1GETSWAP	(ob → 1lamob ob) Does 1GETLAM then SWAP.
55288	1GETLAMSWP1+	(# → 1lamob #+1) Does 1GETLAM then SWAP#+.
632E5	2GETEVAL	(→ ?) Does 2GETLAM then EVAL.
617D8	GETLAMPAIR	(#n → #n ob lam FALSE) (#n → #n TRUE) Gets lam contents and name (10 = 1lam, 20 = 2lam, etc.)
34D30	NULLLAM	(→ NULLAM) Puts NULLLAM in the stack.
34D2B	1NULLLAM{}	(→ { }) Puts a list with one NULLLAM in the stack.
37DB9	(2NULLLAM{})	(→ { }) Puts a list with two NULLLAMs in the stack.
37B17	(3NULLLAM{})	(→ { }) Puts a list with three NULLLAMs in the stack.
52D26	4NULLLAM{}	(→ { }) Puts a list with four NULLLAMs in the stack.

Address	Word	Stack and description
3306C	(7NULLLAM{})	(→ { }) Puts a list with seven NULLLAMs in the stack.
10E36	(8NULLLAM{})	(→ { }) Puts a list with eight NULLLAMs in the stack.

Chapter 32
Error handling

32.1 General words

Address	Word	Stack and description
141E5	ERRBEEP	(→) Beeps.
04CE6	ERROR@	(→ #) Returns current error number.
04D06	ERRORSTO	(# →) Stores new error number.
6383A	ERROROUT	(# →) Stores new error number and does ERRJMP.
04D33	ERRORCLR	(→) Stores zero as new error number.
04ED1	ERRJMP	(→) Invokes error handling sub-system.
04E07	GETEXITMSG	(→ $) Gets EXITMSG (user defined error message).
04E37	EXITMSGSTO	($ →) Stores $ as EXITMSG.
1502F	DO#EXIT	(# →) Stores new error number, does AtUserStack and then ERRJMP.
15007	DO%EXIT	(% →) Same as above, but takes real number as argument.
1501B	(DOHXSEXIT)	(hxs →) Same as above functions, but input is hxs.

Address	Word	Stack and description
15048	DO$EXIT	($ →) Stores string as EXITMSG, #70000 as error number, does AtUserStack and then ERRJMP.
04EA4	ABORT	(→) Does ERRORCLR and ERRJMP.
04E5E	ERRSET	(→) Sets new error trap.
04EB8	ERRTRAP	(→) Error trap marker.
13FE5	(SAVEERRN)	(→) Saves error number to last error.
1400E	(ERR0)	(→) Clears last error.
14039	(ERRN)	(→ #) Returns last error number.
1404C	(ERRN>HXS)	(→ hxs) Returns last error number as hxs.
14065	(ERRM)	(→ $) Returns last error message.
04D87	JstGetTHEMESG	(# → $) Fetches message from message table. To get a message from a library, use the formula: libnum*#100+msgnum.
04D64	GETTHEMESG	(# → $) If #70000 then does GETEXITMSG, else does JstGETTHEMESG.
04DD7	(SPLITMSG#)	(#msg → #error #libnum) Splits message number into error and library numbers.

32.2 Error generating words

Number	Address	Word	Error message
001	04FB6	SETMEMERR	Insufficient memory
002	04FC2	(SETDIRRECUR)	Directory Recursion
003	04FCE	(SETUNDEFLAM)	Undefined Local Name
004	05016	SETROMPERR	Undefined XLIB Name
006	04FAA	(SETPOWERLOST)	Power Lost
008	04FDA	(SETINVCARD)	Invalid Card Data
009	04FE6	(SETOBINUSE)	Object In Use
00A	04FF2	SETPORTNOTAV	Port Not Available
00B	04FFE	(SETNOROOM)	No Room in Port
00C	0500A	(SETOBNOTIN)	Object Not In Port
102	10F54	(NULLCHARERR)	Can't Edit Null Char.
103	10F64	(INVFUNCERR)	Invalid User Function
104	10F74	(NOEQERR)	No Current Equation
106	10F86	SYNTAXERR	Invalid Syntax
124	10FE6	(LASTSTKERR)	LAST STACK Disabled
125	10FF6	(LASTCMDERR)	LAST CMD Disabled
126	10FC6	NOHALTERR	HALT Not Allowed
128	11006	(ARGNUMERR)	Wrong Argument Count
129	11016	SETCIRCERR	Circular Reference
12A	11026	(DIRARGERR)	Directory Not Allowed
12B	11036	(EMPTYDIRERR)	Non-Empty Directory
12C	11046	(INVDEFERR)	Invalid Definition
12D	11056	(MISLIBERR)	Missing Library
12E	10F96	(SETINVPPAR)	Invalid PPAR
12F	10FA6	(SETNONERAL)	Non-Real Result
130	10FB6	(SETISOLERR)	Unable to Isolate
13C	11066	(IDCONFERR)	Name Conflict
201	18CC2	SETSTACKERR	Too Few Arguments
202	18CB2	SETTYPEERR	Bad Argument Type
203	18CA2	SETSIZEERR	Bad Argument Value
204	18C92	SETNONEXTERR	Undefined Name
301	29DCC	(POSFLOWERR)	Positive Underflow
302	29DDC	(NEGFLOWERR)	Negative Underflow
303	29DEC	(OVERFLOWERR)	Overflow
304	29DFC	SETIVLERR	Undefined Result
305	29E0C	(INFRESERR)	Infinite Result
B01	10EEA	(INVUNITERR)	Invalid Unit
B02	10EFA	(CONSTUNITERR)	Inconsistent Units
C12	2EC34	SetIOPARerr	Invalid IOPAR
D04	0CBAE	(NOALARMERR)	Nonexistent alarm

Chapter 33
Flags and tests

33.1 Flags

Address	Word	Stack and notes
5380E	COERCEFLAG	(flag → %1/%0) Converts user flag to system flag, drops current stream.
2A7CF	%0<>	Can be used as the opposite function.
03A81	TRUE	(→ TRUE)
0BBED	TrueTrue	(→ TRUE TRUE)
634F7	TrueFalse	(→ TRUE FALSE) Also called TRUEFALSE.
03AC0	FALSE	(→ FALSE)
6350B	FalseTrue	(→ FALSE TRUE) Also called FALSETRUE.
2F934	FalseFalse	(→ FALSE FALSE)
0BC01	failed	(→ FALSE TRUE)
62103	DROPTRUE	(ob → TRUE)
2F542	(2DROPTRUE)	(ob1 ob2 → TRUE)
5F657	(3DROPTRUE)	(ob1 ob2 ob3 → TRUE)
10029	(4DROPTRUE)	(ob1 ob2 ob3 ob4 → TRUE)
6210C	DROPFALSE	(ob → FALSE)
62B0B	2DROPFALSE	(ob1 ob2 → FALSE)
5F5E4	(4DROPFALSE)	(ob1 ob2 ob3 ob4 → FALSE)
5F6B1	(5DROPFALSE)	(ob1 ... ob5 → FALSE)
169A5	NDROPFALSE	(ob1 ... obn #n → FALSE)
4F1D8	SWAPTRUE	(ob1 ob2 → ob2 ob1 TRUE)
21660	SWAPDROPTRUE	(ob1 ob2 → ob2 TRUE)
62EB7	XYZ>ZTRUE	(ob1 ob2 ob3 → ob3 TRUE)
5DE41	(COLATRUE)	(→ TRUE) Puts TRUE in the stack and drops rest of current stream.
5DE55	RDROPFALSE	(→ FALSE) Puts TRUE in the stack and drops rest of current stream.
03AF2	NOT	(flag → flag’) Returns FALSE if the input is TRUE, and vice-versa.
03B46	AND	(flag1 flag2 → flag) Returns TRUE if both flags are TRUE.

Address	Word	Stack and notes
03B75	OR	(flag1 flag2 → flag) Returns TRUE if either flag is TRUE.
03ADA	XOR	(flag1 flag2 → flag) Returns TRUE if flags are different.
63B50	ORNOT	(flag1 flag2 → flag) Returns FALSE if either flag is TRUE.
62C55	NOTAND	(flag1 flag2 → flag) Returns TRUE if flag1 is TRUE and flag2 is FALSE.
62C91	ROTAND	(flag1 ob flag2 → ob flag) Returns TRUE if either flag is TRUE.

33.2 General tests

Address	Word	Stack and description
03B2E	EQ	(ob1 ob2 → flag) Returns TRUE if both objects are the same, i.e., they occupy the same physical space in memory. Only the addresses of the objects are tested.
635D8	2DUPEQ	(ob1 ob2 → ob1 ob2 flag) Does 2DUP then EQ.
63605	EQOR	(flag ob1 ob2 → flag') Does EQ then OR.
6303D	EQOVER	(ob3 ob1 ob2 → ob3 flag ob3) Does EQ then OVER.
635F1	EQ:	(ob → flag) EQ with the next object in the current stream.
635EC	DUPEQ:	(ob → ob flag) Does DUP then EQ:.
03B97	EQUAL	(ob1 ob2 → flag) Returns TRUE if the objects are equal (but not necessarily the same), i.e., their prologs and contents are the same.
635C4	EQUALNOT	(ob1 ob2 → flag) Returns TRUE if the objects are different.
63619	EQUALOR	(flag ob1 ob2 → flag') Does EQ then OR.

33.3 Object type tests

General object type tests:

Address	Word	Stack and description
03C64	TYPE	(ob → #prolog) Returns address of prolog of object.
1CB90	XEQTYPE	(ob → ob %type) System version of user word TYPE.

Specific object type tests:

Object	Address	No copy	Address	With copy
Real number	6216E	TYPEREAL?	62169	DUPTYPEREAL?, DTYPEREAL?
Complex number	62183	TYPECMP?	6217E	DUPTYPECMP?
String	62159	TYPECSTR?	62154	DUPTYPECSTR?, DTYPECSTR?
Array	62198	TYPEARRAY?	62193	DUPTYPEARRY?, DTYPEARRY?
Real array	6223B	TYPERARRY?		Not available
Complex array	62256	TYPECARRY?		Not available
List	62216	TYPELIST?	62211	DUPTYPELIST?, DTYPELIST?
Global identifier	6203A	TYPEIDNT?	62035	DUPTYPEIDNT?
Local identifier	6221A	TYPELAM?	62115	DUPTYPELAM?
Symbolic	621D7	TYPESYMB?	621D2	DUPTYPESYMB?
Hex string	62144	TYPEHSTR?	6213F	DUPTYPEHSTR?
Grob	62201	TYPEGROB?	621FC	DUPTYPEGROB?
Tagged	6222B	TYPETAGGED?	62226	DUPTYPETAG?
Unit	6204F	TYPEEXT?	6204A	DUPTYPEEXT?
ROM Pointer	621AD	TYPEROMP?	621A8	DUPTYPEROMP?
Binary integer	6212F	TYPEBINT?	621DB	DUPTYPEBINT?
Directory	621C2	TYPERRP?	621D2	DUPTYPERRP?
Character	62025	TYPECHAR?	62020	DUPTYPECHAR?
Program	621EC	TYPECOL?	621E7	DUPTYPECOL?, DTYPECOL?

Chapter 34 Runstream control

Note: see Chapter 6 for more detailed explanations of some commands listed below.

Address	Word	Stack and description
06E86	NOP	(→) No operation.
06EEB	'R	(→ ob) Pushes next object in return stack (i.e., the first object in the composite above this one) to the stack (skipping it). If top return stack is empty (contains SEMI), a null secondary is pushed and the pointer is not advanced.
06F66	'REVAL	(→ ?) Does 'R then EVAL.
639DE	'R'R	(→ ob1 ob2) Does 'R twice.
61B89	ticR	(→ ob TRUE) (→ FALSE) Pushes next object in return stack to stack and TRUE, of just FALSE if the top return stack body is empty. In this case, it is dropped.
06F9F	>R	(:: →) Pushes :: to top of return stack (skips prolog, i.e., the composite will be executed automatically).
0701F	R>	(→ ::) Creates and pops a secondary from top return stack body to stack.
07012	R@	(→ ::) Like the above, but the return stack is not popped.

Address	Word	Stack and description
0716B	IDUP	(→) Pushes top body into return stack.
06F86	EVAL	(ob → ?) Evaluates object.
18EBA	COMPEVAL	(comp → ?) EVAL just pushes a list back, this one executes it.
61B45	2@REVAL	(→ ?) EVALs first object in the stream above the previous one.
61B55	3@REVAL	(→ ?) EVALs first object in the stream above the stream above the previous one.
619CB	GOTO	(→) Jumps to next address in stream. Address is a five-nibble address, not a system binary. Can only be used to jump to the middle of programs, cannot jump to a program prolog.
619E0	?GOTO	(flag →) If TRUE, jumps, else skips five nibbles.
619F3	NOT?GOTO	(flag →) If FALSE jumps, else skips five nibbles.
14EA5	RDUP	(→) Duplicates top return stack level.
06FB7	RDROP	(→) Pops the return stack.
6114E	2RDROP	(→) Pops two return stack levels.
61160	3RDROP	(→) Pops three return stack levels.
632F9	DROPRDROP	(ob →) Does DROP then RDROP.
62958	RDROPCOLA	(→) Does RDROP then COLA.

Address	Word	Stack and description
54C4F	(RDROPCOLATRUE)	(→ TRUE) Does RDROP then COLATRUE.
60EBD	RSWAP	(→) Swap in the return stack.
14F2A	(RROLL)	(#n →) Rolls nth return stack level to top of return stack.
63880	RSKIP	(→) Skips first object in the return stack (i.e., the first object in the composite above this one).

34.1 Quoting objects

Address	Word	Stack and description
06E97	'	(→ nob) Pushes next object in the stream to the stack (skipping it.)
63925	DUP'	(ob → ob nob) Does DUP then '.
6394D	DROP'	(ob → nob) Does DROP then '.
63939	SWAP'	(ob1 ob2 → ob2 ob1 nob) Does SWAP then '.
63961	OVER'	(ob1 ob2 → ob1 ob2 ob1 nob) Does OVER then '.
63975	STO'	(ob id/lam → nob) Does STO then '.
63989	TRUE'	(→ TRUE nob) Pushes TRUE and the next object to the stack.
639B6	FALSE'	(→ FALSE nob) Pushes FALSE and the next object to the stack.

Address	Word	Stack and description
6399D	ONEFALSE'	(→ #1 FALSE nob) Pushes ONE, FALSE and the next object to the stack.
639CA	#1+'	(# → #+1 nob) Does #1+ then '.
632BD	'NOP	(→ NOP) Pushes NOP to the stack.
63155	'ERRJMP	(→ ERRJMP) Pushes ERRJMP to the stack.
3A9B8	'DROPFALSE	(→ DROPFALSE) Pushes DROPFALSE to the stack.
3FDFE	'DoBadKey	(→ DoBadKey) Pushes DoBadKey to the stack.
3FE12	'DoBadKeyT	(→ DoBadKey TRUE) Pushes DoBadKey and TRUE to the stack.
63B5A	'x*	(→ x*) Pushes x* (user word *) to the stack.
63B6E	'xDER	(→ xDER) Pushes xDER (user word ?) to the stack.
5129C	'IDFUNCTION	(→ xFUNCTION) Pushes xFUNCTION (user word FUNCTION) to the stack.
512C4	'IDPOLAR	(→ xPOLAR) Pushes xPOLAR (user word POLAR) to the stack.
512B0	('xCONIC)	(→ xCONIC) Pushes xCONIC (user word CONIC) to the stack.
512D8	'IDPARAMETER	(→ xPARAMETRIC) Pushes xPARAMETRIC (user word PARAMETRIC) to the stack.
512EC	('xTRUTH)	(→ xTRUTH) Pushes xTRUTH (user word TRUTH) to the stack.
51300	('xSCATTER)	(→ xSCATTER) Pushes xSCATTER (user word SCATTER) to the stack.

Address	Word	Stack and description
51314	('xHISTOGRAM)	(→ xHISTOGRAM) Pushes xHISTOGRAM (user word HISTROGRAM) to the stack.
51328	('xBAR)	(→ xBAR) Pushes xBAR (user word BAR) to the stack.

34.2 Skipping objects

Address	Word	Description
06FD1	COLA	Evaluates next object and drops remainder of this stream.
63A15	ONECOLA	Does ONE then COLA.
63312	SWAPCOLA	Does SWAP then COLA.
63326	XYZ>ZCOLA	Does UNROT2DROP then COLA.
61A6D	COLA_EVAL	Returns and EVAL. (EVALs first object in previous stream).
6296D	COLACOLA	Drops the remainder of the current stream and does COLA in the above one.
0714D	SKIP	Skips next object in the runstream.
0715C	(2SKIP)	Skips next two objects in the runstream.
283D8	(3SKIP)	Skips next three objects in the runstream.
21C47	(MEMSKIP)	(ob → #nextaddress)
62CEE	skipcola	Does SKIP then COLA.
626E5	2skipcola	Does 2SKIP then COLA.
626DC	3skipcola	Does 3SKIP then COLA.
626AE	5skipcola	Skips five objects, then does COLA.
633B2	COLASKIP	Drops remainder of current stream and skips first object in the above stream.
283C4	(COLAskipcola)	Drops remainder of current stream, executes skipcola in the above one.

Chapter 35
Conditionals

How to read the diagrams below: what's on the left side of the arrow represents the stack. ob1 and ob2 are different objects. f1 and f2 are different flags, T represents TRUE and F, FALSE. #m and #n represent two binary integers, #m being smaller than #n. #set means the a flag is set, #clr means it is cleared. On the right of the arrow, the objects which will be executed are represented. The initial stream has the form:

```
:: <test> <ob1> ... <obn> ;
```

In the diagrams, <rest> represents everything after the object before.

For the case words, most of the times their names are enough to show their actions. Their names have up to three parts: the initial actions, written before case, which represent what is done before the test. Thus, NOTcase is equivalent to NOT then case. The final part can be of two types: the first type is written with lowercase letters, like casedrop. Those actions are done if the test is TRUE, along with the other object(s) specified by the user. So, the code below

```
:: ... casedrop <IfTrueAction> <IfFalseAction> ... ;
```

can be rewritten as

```
:: ... case :: DROP <IfTrueAction> ; <IfFalseAction> ... ;
```

The second type is written with uppercase letters. It means that the object(s) following are the conditions to be executed if the test is TRUE. For example, the code below

```
:: ... caseDROP <IfFalseAction> ... ;
```

is equivalent to

```
:: ... case DROP <IfFalseAction> ... ;
```

35.1 Flag tests

Address	Word	Action
61A3B	?SEMI	(T → :: ;) (F → :: <ob1> <rest> ;)
61A2C	NOT?SEMI	(T → :: <ob1> <rest> ;) (F → :: ;)
638E4	?SEMIDROP	(ob T → :: ob ;) (ob F → :: <ob1> <rest> ;)
61B72	NOT?DROP	(ob T → :: ob <ob1> <rest> ;) (ob F → :: <ob1> <rest> ;)
62F1B	?SWAP	(ob1 ob2 T → :: ob2 ob1 <ob1> <rest> ;) (ob1 ob2 F → :: ob1 ob2 <ob1> <rest> ;)
62D9F	?SKIPSWAP	(ob1 ob2 T → :: ob1 ob2 <ob1> <rest> ;) (ob1 ob2 F → :: ob2 ob1 <ob1> <rest> ;)
62F5C	?SWAPDROP	(ob1 ob2 T → :: ob1 <ob1> <rest> ;) (ob1 ob2 F → :: ob2 <ob1> <rest> ;)
62F43	NOT?SWAPDROP	(ob1 ob2 T → :: ob2 <ob1> <rest> ;) (ob1 ob2 F → :: ob1 <ob1> <rest> ;)
070FD	RPIT	(T ob → :: ob <ob1> <rest> ;) (F ob → :: <ob1> <rest> ;)
070C3	RPITE	(T ob1 ob2 → :: ob2 <ob1> <rest> ;) (F ob1 ob2 → :: ob1 <ob1> <rest> ;)
61A86	COLARPITE	(T ob1 ob2 → :: ob1 ;) (F ob1 ob2 → :: ob2 ;)
61AE9	2'RCOLARPITE	Returns to composite above and does ITE there.
619BC	IT	(T → :: <ob1> <rest> ;) (F → :: <ob2> <rest> ;)
0712A	?SKIP or NOT_IT	(T → :: <ob2> <rest> ;) (F → :: <ob1> <rest> ;)
61AD8	ITE	(T → :: <ob1> <ob3> <rest> ;) (F → :: <ob2> <rest> ;)

Address	Word	Action
6381C	COLAITE	(T → :: <ob1> ;) (F → :: <ob2> ;)
61A58	ITE_DROP	(ob T → :: <ob2> <rest> ;) (ob F → :: ob <ob1> <rest> ;)
63E61	ANDITE	(f1 f2 → :: <ob1> <ob3> <rest> ;) (f1 f2 → :: <ob2> <rest> ;)
61993	case	(T → :: <ob1> ;) (F → :: <ob2> <rest> ;)
619AD	NOTcase	(T → :: <ob2> <rest> ;) (F → :: <ob1> ;)
63CEA	ANDcase	(f1 f2 → :: <ob1> ;) (f1 f2 → :: <ob2> <rest> ;)
63DDF	ANDNOTcase	(f1 f2 → :: <ob1> ;) (f1 f2 → :: <ob2> <rest> ;)
629BC	ORcase	(f1 f2 → :: <ob1> ;) (f1 f2 → :: <ob2> <rest> ;)
618F7	casedrop	(ob T → :: <ob1> ;) (ob F → :: ob <ob2> <rest> ;)
618E8	NOTcasedrop	(ob T → :: ob <ob2> <rest> ;) (ob F → :: <ob1> ;)
6191F	case2drop	(ob1 ob2 T → :: <ob1> ;) (ob1 ob2 F → :: ob1 ob2 <ob2> <rest> ;)
61910	NOTcase2drop	(ob1 ob2 T → :: ob1 ob2 <ob2> <rest> ;) (ob1 ob2 F → :: <ob1> ;)
6194B	caseDROP	(ob T → :: ;) (ob F → :: ob <ob1> <rest> ;)
61960	NOTcaseDROP	(ob T → :: ob <ob1> <rest> ;) (ob F → :: ;)
638B2	casedrptru	(ob T → TRUE) (ob F → :: ob <ob1> <rest> ;) Note: should be caseDRPTRU.

Address	Word	Action
6356A	casedrpfls	(ob T → FALSE) (ob F → :: ob <ob1> <rest> ;) Note: should be caseDRPFLS.
63AEC	NOTcsdrpfls	(ob T → :: ob <ob1> <rest> ;) (ob F → FALSE) Note: should be NOTcaseDRPFLS.
61970	case2DROP	(ob1 ob2 T → :: ;) (ob1 ob2 F → :: ob1 ob2 <ob2> <rest> ;)
61984	NOTcase2DROP	(ob1 ob2 T → :: ob1 ob2 <ob1> <rest> ;) (ob1 ob2 F → :: ;)
63583	case2drpfls	(ob1 ob2 T → FALSE) (ob1 ob2 F → :: ob1 ob2 <ob1> <rest> ;) Note: should be case2DRPFLS.
634E3	caseTRUE	(T → TRUE) (F → :: <ob1> <rest> ;)
638CB	NOTcaseTRUE	(T → :: <ob1> <rest> ;) (F → TRUE)
6359C	caseFALSE	(T → FALSE) (F → :: <ob1> <rest> ;)
5FB49	NOTcaseFALSE	(T → :: <ob1> <rest> ;) (F → FALSE)

35.2 Binary number tests

Address	Word	Action
6336C	#=?SKIP	(#m #m → :: <ob2> <rest> ;) (#m #n → :: <ob1> <rest> ;)
63399	#>?SKIP	(#m #n → :: <ob1> <rest> ;) (#n #m → :: <ob2> <rest> ;)
62C2D	#=ITE	(#m #m → :: <ob1> <ob3> <rest> ;) (#m #n → :: <ob2> <rest> ;)

Address	Word	Action
63E9D	#<ITE	(#m #n → :: <ob1> <ob3> <rest> ;) (#n #m → :: <ob2> <rest> ;)
63EB1	#>ITE	(#m #n → :: <ob2> <rest> ;) (#n #m → :: <ob1> <ob3> <rest> ;)
6186C	#=case	(#m #m → :: <ob1> ;) (#m #n → :: <ob2> <rest> ;)
6187C	OVER#=case	(#m #m → :: #m <ob1> ;) (#m #n → :: #m <ob2> <rest> ;)
618D3	#=casedrop	(#m #m → :: <ob1> ;) (#m #n → :: #m <ob2> <rest> ;) Note: Should be OVER#=casedrop.
63547	#=casedrpfls	(#m #m → FALSE) (#m #n → :: #m <ob1> <rest> ;) Should be OVER#=caseDRPFLS.
63D3A	#<>case	(#m #m → :: <ob2> <rest> ;) (#m #n → :: <ob1> ;)
63D12	#<case	(#m #n → :: <ob1> ;) (#n #m → :: <ob2> <rest> ;)
63D67	#>case	(#m #n → :: <ob2> <rest> ;) (#n #m → :: <ob1> ;)
61A18	#0=?SEMI	(#0 → :: ;) (# → :: <ob1> <rest> ;)
6333A	#0=?SKIP	(#0 → :: <ob2> <rest> ;) (# → :: <ob1> <rest> ;)
63E89	#0=ITE	(#0 → :: <ob1> <ob3> <rest> ;) (# → :: <ob2> <rest>)
63E48	DUP#0=IT	(#0 → :: #0 <ob1> <rest> ;) (# → :: # <ob2> <rest> ;)
63EC5	DUP#0=ITE	(#0 → :: #0 <ob1> <ob3> <rest> ;) (# → :: # <ob2> <rest>)
61896	#0=case	(#0 → :: <ob1> ;) (# → :: <ob2> <rest> ;)

Address	Word	Action
61891	DUP#0=case	(#0 → :: #0 <ob1> ;)
		(# → :: # <ob2> <rest> ;)
618A8	DUP#0=csedrp	(#0 → :: <ob1> ;)
		(# → :: # <ob2> <rest> ;)
63CBD	DUP#0=csDROP	(#0 → :: ;)
		(# → :: # <ob1> <rest> ;)
63D26	#1=case	(#1 → :: <ob1> ;)
		(# → :: <ob2> <rest> ;)
63353	#1=?SKIP	(#1 → :: <ob2> <rest> ;)
		(# → :: <ob1> <rest> ;)
63D4E	#>2case	(#0/#1/#2 → :: <ob2> <rest> ;)
		(# → :: <ob1> ;)

35.3 Real and complex numbers tests

The function num0=case means either %0 or C%0. And so does the other ones. All the words except j%0=case make a copy of the object first.

Address	Word	Action
5F127	%0=case	(%0 → :: %0 <ob1> ;)
		(ob → :: ob <ob2> <rest> ;)
63D7B	j%0=case	(%0 → :: <ob1> ;)
		(ob → :: <ob2> <rest> ;)
5F13B	C%0=case	(C%0 → :: C%0 <ob1> ;)
		(ob → :: ob <ob2> <rest> ;)
5F0FA	num0=case	(0 → :: 0 <ob1> ;)
		(ob → :: ob <ob2> <rest> ;)
5F181	%1=case	(%1 → :: %1 <ob1> ;)
		(ob → :: ob <ob2> <rest> ;)
5F19F	C%1=case	(C%1 → :: C%1 <ob1> ;)
		(ob → :: ob <ob2> <rest> ;)
5F154	num1=case	(1 → :: 1 <ob1> ;)
		(ob → :: ob <ob2> <rest> ;)

Address	Word	Action
5F1EA	%2=case	(%2 → :: %2 <ob1> ;) (ob → :: ob <ob2> <rest> ;)
5F208	C%2=case	(C%2 → :: C%2 <ob1> ;) (ob → :: ob <ob2> <rest> ;)
5F1BD	num2=case	(2 → :: 2 <ob1> ;) (ob → :: ob <ob2> <rest> ;)
5F267	%-1=case	(%-1 → :: %-1 <ob1> ;) (ob → :: ob <ob2> <rest> ;)
5F285	C%-1=case	(C%-1 → :: C%-1 <ob1> ;) (ob → :: ob <ob2> <rest> ;)
5F23A	num-1=case	(-1 → :: -1 <ob1> ;) (ob → :: ob <ob2> <rest> ;)
5EEDB	(REALNEGcase)	(%<0 → :: % <ob1> ;) (ob → :: ob <ob2> <rest> ;)

35.4 Meta object tests

Address	Word	Action
5FBE6	(pick1#0=case)	(#0 M → COLA) (ob M → SKIP)
5EFD9	MEQ1stcase	Meta&ob1 ob2 → ob1=ob2 ? case
5EF15	AEQ1stcase	Meta&ob → ob=nob ? case
5EFF9	MEQopscase	Meta1&ob1 Meta2&ob2 ob3 →
5F048	AEQopscase	Meta1&ob1 Meta2&ob2 →
5F061	Mid1stcase	Meta&ob → ob is id or lam ? case
549EC	(MetaConcase)	(Meta → Meta) COLA if meta contains no ids, lams, symbs or romptrs. Else SKIP.
5EF2E	(M1st+case)	Meta&+ ? case
5EF41	(M1st-case)	Meta&- ? case
5EF54	(M1st*case)	Meta&* ? case
5EF67	(M1st/case)	Meta&/ ? case
5EFA0	(M1st^case)	Meta&^ ? case
58ADE	(M-1potcase)	Meta&-1&^ ? case
5EFB3	(M1stSQcase)	Meta&SQ ? case
5EF7A	(M1stNEGcase)	Meta&NEG ? case
5EF8D	(M1stINVcase)	Meta&INV ? case
5EFC6	(M1stFNCcase)	Meta&FCNAPPLY ? case
5EE10	M-1stcasechs	Meta&NEG → Meta COLA ; Meta → Meta SKIP Meta&(%<0) → Meta&ABS(%) COLA

35.5 General object tests

Address	Word	Action
63E2F	EQIT	(ob1 ob1 → :: <ob1> <rest> ;) (ob1 ob1 → :: <ob2> <rest> ;)
63E75	EQITE	(ob1 ob1 → :: <ob1> <ob3> <rest> ;) (ob1 ob2 → :: <ob2> <rest> ;)
63CD6	jEQcase	(ob1 ob1 → :: <ob1> ;) (ob1 ob2 → :: <ob2> <rest>)
61933	EQcase	(ob1 ob1 → :: ob1 <ob1> ;) (ob1 ob2 → :: ob1 <ob2> <rest> ;) Should be called OVEREQcase.
618BA	EQcasedrop	(ob1 ob2 → :: <ob1> ;) (ob1 ob2 → :: ob1 <ob2> <rest> ;)
63CFE	EQUALcase	(ob1 ob1 → :: <ob1> ;) (ob1 ob2 → :: <ob2> <rest> ;)
63DF3	EQUALNOTcase	(ob1 ob1 → :: <ob2> <rest> ;) (ob1 ob2 → :: <ob1> ;)
63CA4	EQUALcasedrp	(ob ob1 ob2 → :: <ob1> ;) (ob ob1 ob2 → :: ob <ob2> <rest> ;)
517FE	EQUALcasedro	(ob1 ob2 → :: <ob1> ;) (ob1 ob2 → :: ob1 <ob2> <rest> ;) Should be OVEREQUALcasedrp.
5E984	nonopcase	(seco → :: seco <ob2> <rest> ;) (ob → :: ob <ob1> ;)
5F0AA	idntcase	(id → :: id <ob1> ;) (ob → :: ob <ob2> <rest> ;)
63E07	dIDNTNcase	(id → :: id <ob2> <rest> ;) (ob → :: ob <ob1> ;)
5F0CD	idntlamcase	(id/lam → :: id <ob1> ;) (ob → :: ob <ob2> <rest> ;)
63D8F	REALcase	(% → :: <ob1> ;) (ob → :: <ob2> <rest> ;)

Address	Word	Action
63E1B	dREALNcase	(% → :: % <ob2> <rest> ;) (ob → :: ob <ob1> ;)
63DA3	dARRYcase	([ ] → :: [] <ob1> ;) (ob → :: ob <ob2> <rest> ;)
63DB7	dLISTcase	({ } → :: {} <ob1> ;) (ob → :: ob <ob2> <rest> ;)
27244	NOTLISTcase	({ } → :: {} <ob2> <rest> ;) (ob → :: ob <ob1> ;)
18E45	(DNOTSYMB?SEMI)	(symb → :: symb <ob1> <rest> ;) (ob → :: ob ;)
27254	NOTSECOcase	(seco → :: seco <ob2> <rest> ;) (ob → :: ob <ob1> ;)
27264	NOTROMPcase	(romp → :: romp <ob2> <rest> ;) (ob → :: ob <ob1> ;)
27224	(DNOTBAKcase)	(bak → :: bak <ob2> <rest> ;) (ob → :: ob <ob1> ;)
27234	(DNOTLIBcase)	(lib → :: lib <ob2> <rest> ;) (ob → :: ob <ob1> ;)
5EDFC	numb1stcase	If %, C%, [ ] or [L] then COLA, else SKIP.

35.6 Miscellaneous

Address	Word	Action
63ED9	UserITE	(#set → :: <ob1> <ob3> <rest> ;) (#clr → :: <ob2> <rest> ;)
63EED	SysITE	(#set → :: <ob1> <ob3> <rest> ;) (#clr → :: <ob2> <rest> ;)
63BEB	caseDoBadKey	(T → :: DoBadKey ;) (F → :: <ob1> <rest> ;) Also called caseDEADKEY.
63BD2	caseDrpBadKy	(ob T → :: DoBadKey ;) (ob F → :: ob <ob1> <rest> ;)
63169	caseERRJMP	(T → :: ERRJMP ;) (F → :: <ob1> <rest> ;)

Address	Word	Action
63B05	caseSIZEERR	(T → :: SIZEERR ;)
		(F → :: <ob1> <rest> ;)
63B19	NcaseSIZEERR	(T → :: <ob1> <rest> ;)
		(F → :: SIZEERR ;)
63B46	NcaseTYPEERR	(T → :: <ob1> <rest> ;)
		(F → :: TYPEERR ;)

Chapter 36
Loops

If you are using the HP Tools, you must take special care when you use the words marked with an asterisk below. The compiler does not recognize them, so if you simply use them, you'll get errors like "DO without LOOP". When you use one of them, insert DO or LOOP between ( )'s just after the word. This way, the compiler will not generate any errors. For example:

```
::
  ...
  ZERO_DO
  ...               *** WRONG ***
  DROPLOOP
  ...
;

::
  ...
  ZERO_DO (DO)
  ...               *** RIGHT ***
  DROPLOOP (LOOP)
  ...
;
```

If you use JAZZ, you do not need to worry about that. Note that there is no space after the parenthesis.

36.1 Indefinite loops

Address	Word	Stack and description
0716B	IDUP	(→) Pushes top body into return stack.
071A2	BEGIN	(→) Pushes top body into return stack.
071AB	AGAIN	(→) Copies return stack to top.
071E5	REPEAT	(→) Copies return stack to top.

Address	Word	Stack and description
071C8	UNTIL	(flag →) If FALSE then AGAIN, otherwise RDROP.
633C6	* NOT_UNTIL	(flag →) NOT then UNTIL.
62B6F	#0=UNTIL	(# → #) Actually, should be DUP#0=UNTIL.
071EE	WHILE	(flag →) If TRUE does nothing, otherwise RDROP then 2SKIP.
633DF	NOT_WHILE	(flag →) NOT then WHILE.
633F8	DUP#0<>WHILE	(# →) Try to guess what it does.

36.2 Definite loops

Address	Word	Stack and notes
073F7	DO	(#stop #start →)
073C3	* ZERO_DO	(#stop →)
6347F	* DUP#0_DO	(#stop → #stop)
073CE	* ONE_DO	(#stop →)
073DB	* #1+_ONE_DO	(#stop →)
63498	toLEN_DO	({ } → { })
		From ONE to #elements+1.
37BCB	(ONE_DO_ARRY)	([ ] → [ ])
		From ONE to #elements+1.
07334	LOOP	(→)
073A5	+LOOP	(# →)
		Increments index by specified number.
63466	* DROPLOOP	(ob →)
6344D	* SWAPLOOP	(ob1 ob2 → ob2 ob1)
54CB3	(SWAPDROPLOOP)	(ob1 ob2 → ob2)
07321	(STOPLOOP)	(→)
		Destroys topmost loop environment.
07221	INDEX@	(→ #)
		Recalls topmost loop counter value.
63411	DUPINDEX@	(ob → ob #)
63425	SWAPINDEX@	(ob1 ob2 → ob2 ob1 #)
63439	OVERINDEX@	(ob1 ob2 → ob1 ob2 ob1 #)

Address	Word	Stack and notes
63790	INDEX@-	(# → #’)
07270	INDEXSTO	(# →) Stores new topmost loop counter value.
07249	ISTOP@	(→ #) Recalls topmost loop stop value.
07295	ISTOPSTO	(# →) Stores new topmost loop stop value.
5182F	ISTOP-INDEX	(→ #)
07258	JINDEX@	(→ #) Recalls second topmost loop counter value.
072AD	JINDEXSTO	(# →) Stores new second topmost loop counter value.
07264	JSTOP@	(→ #) Recalls second topmost loop stop value.
072C2	JSTOPSTO	(# →) Stores new second topmost loop stop value.
6400F	ExitAtLoop	(→) Does not exit loop immediately. Just stores zero as the stop value, so all objects until the next LOOP will be evaluated. Also called ZEROISTOPSTO.
3F78C	(DUPExitAtLOOP)	(ob → ob ob)
3F7EB	(ExitAtLOOPDUP)	(ob → ob ob)
4334F	(DRPExitAtLOOP)	(ob →)

Chapter 37
Memory operations

37.1 Temporary memory

Address	Word	Stack and description
06657	TOTEMPOB	(ob → ob') Copies object to TEMPOB and returns pointer to the new copy.
62C69	TOTEMPSWAP	(ob1 ob2 → ob2 ob1) Does TOTEMPOB then SWAP.
37B44	CKREF	(ob → ob') If object is in TEMPOB, is not embedded in a composite and not referenced, does nothing. Else copies it to TEMPOB and returns the copy.
63F7E	SWAPCKREF	(ob1 ob2 → ob2 ob1) Does SWAP then CKREF.
06B4E	INTEMNOTREF?	(ob → ob flag) If the object is in TEMPOB area, is not embedded in a composite and is not referenced, returns the object and TRUE, otherwise returns the object and FALSE.
06B3E	(INTEMP?)	(ob → ob flag) Tests if object is in TEMPOB area and not in a composite.
065D9	(PTRREF?)	(ob → ob flag) Tests if object is referenced.
065E5	(REFERENCED?)	(ob → ob flag) Tests if object is referenced or in composite.
06BC2	(NOTREF?)	(ob → ob flag) Tests if object is not referenced or in composite. (:: REFERENCED? NOT ;)

Address	Word	Stack and description
06DDE	(>TOPTEMPOB)	(ob → ob') Moves object to top ob TEMPOB area. Does not garbage collection.
064BD	(UNREFOB)	(ob → ob ob') Makes a standalone copy by moving references to a new copy.
064D6	(UNREFTEMP)	(ob1 ob2 → ob1 ob') Moves references from ob2 to ob1 (ob1 in TEMPOB area).
064E2	(UNREFINTEMP)	(ob1 ob2 → ob1 ob') Moves references from ob2 to ob1 (ob1 in TEMPOB area). References to body of ob2 are moved too.

37.2 Recalling, storing and purging

Address	Word	Stack and description
0797B	@	(id/lam → ob TRUE) (id/lam → FALSE) Basic recalling function.
62C05	DUP@	(id/lam → id/lam ob TRUE) (id/lam → id/lam FALSE) Does DUP then @.
62A34	SAFE@	(id/lam → ob TRUE) (id/lam → FALSE) For lams does @. For ids does ?ROMPTR> to the ob found.
5E5EE	(SAFE@NOT)	(id → ob FALSE) (id → TRUE) Does SAFE@ then NOT.
62A2F	DUPSAFE@	(id/lam → id/lam ob TRUE) (id/lam → id/lam FALSE) Does DUP then SAFE@.
1853B	SAFE@_HERE	(id/lam → ob TRUE) (id/lam → FALSE) Same as SAFE@, but works only in the current directory.

Address	Word	Stack and description
20B81	XEQRCL	(id → ob) Same as SAFE@, but errors if variable is not found. Also works for lams, but you get the wrong error.
20B9A	LISTRCL	({ path id } → ob) Recalls from specified path.
5E602	(@LAMNOT)	(lam → ob FALSE) (lam → lam TRUE) Recalls lam contents if possible.
5E616	(ROMPTR@NOT)	(ROMPTR → ob FALSE) (ROMPTR → ROMPTR TRUE) Recalls contents of ROMPTR if possible.
5E5B7	(@OBNOT)	(ob → ob’ FALSE) (ob → ob TRUE) Recalls contents if input is id, lam or ROMPTR. For other types returns TRUE.
072D7	STO	(ob id/lam →) For ids: • Assumes ob is not pco; • If replacing some object that object is copied to TEMPOB and pointers are updated. For lams: • Errors if lam is unbound.
18513	XEQSTOID	(ob id/lam →) Same as SAFESTO, but will only store in the current directory and will not overwrite a directory. Also called ?STO_HERE.
085D3	REPLACE	(newob oldob → newob) Replaces oldob (in memory) with newob. See Chapter 9 for detailed description.
08C27	PURGE	(id →) Purges variable. Does no type check first.
1854F	?PURGE_HERE	(id →) Like PURGE, but only works in current directory.
08696	CREATE	(ob id →) Creates a variable in the current directory. Errors if id is or contains current directory. Assumes id is not a pco.

Address	Word	Stack and description
185C7	DoHere:	(→) Next object in the runstream is evaluated for the current directory only.

37.3 Directories

Address	Word	Stack and description
077E4	(CRDIR#)	(#libnum → rrp) Creates an empty directory.
08DF2	(!CREATEDIR)	(id →) Creates an empty directory. Does not check if the name is already used. (:: # 7FF CRDIR# SWAP CREATE ;)
184E1	CREATEDIR	(id →) Creates an empty directory. Calls ?PURGE_HERE first to delete the original.
08326	LASTRAM-WORD	(rrp → ob TRUE) (rrp → FALSE) Recalls first object in directory.
18621	LastNonNull	(rrp → ob TRUE) (rrp → FALSE) Recalls first object in directory (not null named).
08376	PREVRAM-WORD	(ob → ob' TRUE) (ob → FALSE) Recalls next object in directory.
1863A	PrevNonNull	(ob → ob' TRUE) (ob → FALSE) Recalls next object in directory (not null named).
18653	(CkNonNull)	(ob → ob TRUE) (ob → FALSE) Checks that the variable (ob) has a name.
082E3	RAM-WORDNAME	(ob → id) Recalls name of object in current directory.

Address	Word	Stack and description
18595	XEQPGDIR	(id →) Purges a directory. Checks references, etc. first.
20FF2	XEQORDER	({ id1 id2 ... } →) Orders directory.
18779	DOVARS	(→ { id1 id2 ... }) Returns list of variables from current directory.
1867F	(DODIRPRG)	(ob :: → { }) Executes seco (can be single object) on all directory variables. At execution: ob :: id_contents { } id To be returned: ob :: id_contents { } ob flag If flag is TRUE, ob is added with >TCOMP to list, else it is dropped.
1848C	PATHDIR	(→ { HOME dir1 dir2 ... }) Returns current path.
1A16F	UPDIR	(→) Goes to parent directory.
08309	(GETUPDIR)	(rrp → rrp’ TRUE) (rrp → FALSE) Gets parent directory.
08DD4	(HOMEDIR?)	(rrp → flag) Is the directory the HOME directory?
05D5A	CONTEXT@	(→ rrp) Recalls current directory.
08D08	CONTEXT!	(rrp →) Sets new current directory.
08D82	(LCONTEXT@)	(→ rrp) Recalls last directory.
08D4A	(LCONTEXT!)	(rrp →) Stores new last directory.
08D92	HOMEDIR	(→) Sets HOME as current directory. Also called SYSCONTEXT.

Address	Word	Stack and description
08DC4	(SYSLCONTEXT)	(→) Sets HOME as last directory.
640A0	SaveVarRes	(→) Binds current and last directories to two null-named lams.
640FA	RestVarRest	(→) First sets HOME as both the current and last directories (in case an error happens). Then, restores the current and last directories from 1LAM and 2LAM.

37.4 The hidden directory

Address	Word	Stack and description
640BE	SetHiddenRes	(→) Sets the hidden directory as the current and last directories.
64037	WithHidden	(→ ?) Executes next command in hidden directory.
64023	RclHiddenVar	(id → ob TRUE) (→ FALSE) Recalls variable in hidden directory. (:: WithHidden @ ;)
64078	StoHiddenVar	(ob id →) Stores variable in hidden directory. (:: WithHidden STO ;)
6408C	PuHiddenVar	(id →) Purges variable in hidden directory. (:: WithHidden PURGE ;)

Chapter 38
Time and alarms

The internal alarms list has the format: { { hxs action } { ... } ... }. The length of the hxs is 24 nibbles. The least significant 13 nibbles represent the tick value for the time and date, the next 10 nibbles the repeat interval (if any), and the most significant nibble represents the status of the alarm (pending, acknowledged, etc.).

Address	Word	Stack and description
40EE7	SLOW	(→) 15 millisecond delay.
40F02	VERYSLOW	(→) 300 millisecond delay.
40F12	VERYVERYSLOW	(→) 3 second delay.
1A7ED	(wait)	(hxs →) Wait specified number of ticks (there are 8192 ticks in a second).
1A7C9	dowait	(%secs →) Waits specified number of seconds.
1A7B5	(dowait/quit?)	(%secs →) Waits specified number of seconds, exits program if CANCEL is pressed.
2A673	%>HMS	(% → %hms) Converts from decimal to H.MMSS format.
2AF27	%%H>HMS	(%% → %%hms) Same function but for long reals.
2A68C	%HMS>	(%hms → %) Converts from H.MMSS format to decimal.
2A6A0	%HMS+	(%hms1 %hms1 → %hms) Adds time in hms format.
2A6C8	%HMS-	(%hms1 %hms2 → %hms) Subtracts time in hms format.

Address	Word	Stack and description
0CBFA	TOD	(→ %time) Returns current time.
0CD53	(>TIME)	(%time →) Sets time.
0CD3F	(CLKADJ)	(%time →) Also sets time.
0CC0E	DATE	(→ %date) Returns current date.
0CD2B	(>DATE)	(%date →) Sets date.
0CC5B	DATE+DAYS	(%date %days → %date’) Adds specified number of days to date.
0CC39	DDADYS	(%date1 %date2 → %days) Returns number of days between two dates.
0E235	ALARMS@	(→ { }) Returns internal alarms list.
0E6ED	STOALM	(%date %time action %repeat → %) Stores an alarm. %repeat is the number of ticks between every repetition. Since there are 8192 ticks in a second, 60 seconds in a minute, and 60 minutes in an hour, to make an alarm that repeats every hour, %repetition would be 8192*60*0 = 29491200. Returns real number representing the position of the alarm in the list.
0E54D	(STOALARMLS)	({ } → %) Stores an alarm. List contents: { %date %time action %repeats } You may omit %repeats and action. In this case, the alarm has no repetition and no message is displayed. Returns real number representing the position of the alarm in the list.
0E510	(STOALARM%)	(%time → %) Store an alarm at specified time today, with no message and no repetition. Returns real number representing the position of the alarm in the list.

Address	Word	Stack and description
0EF45	(>ALRMLS)	($ %date %time %rpt → { }) Generates list (of the internal type) representing the alarm.
0E1D8	(ALRMLS>)	({ } → { }') Converts list of internal format to list in the format of STOALARMLS.
0E402	(RCLALM)	(#n → { } TRUE) (#n → FALSE) Recalls nth alarm. List is in the internal format.
0E3DF	(RCLALARM%)	(%n → { }) Recalls nth alarm. List is in the format of STOALARMLS.
0EAD7	(FINDALARM%)	(%date → %) Returns position in the internal alarm list of the first alarm of that day (or in any following day).
0EB31	(FINDALARMLS)	({ } → %) Takes a list of the format: { %date %time } Returns real represent the position of the specified alarm in the alarm list, or 0 if not found.
0E724	(DELALARM)	(%n →) Deletes nth alarm.
422A1	ALARM?	(→ flag) Returns TRUE if an alarm is due.
0DDC1	(ACKALM)	(→ flag) Tries acknowledging first alarm due. Returns TRUE if no due alarm was found, or FALSE if a due alarm has been found and acknowledged.
0DDA8	(ACKALLALMS)	(→) Acknowledges all due alarms.
0EB81	CLKTICKS	(→ hxs) Returns tick count. Also called SysTime.

Address	Word	Stack and description
0D304	TIMESTR	(%date %time → $) Returns string representation of time, using current format. Example: "WED 06/24/98 10:00:45A"
0CFD9	Date>d$	(%date → $) Returns string representation of date, using current format.
0D2F0	(Date>wd$)	(%date → $weekday) Returns weekday: “SUN”, “MON”, etc.
0CF5B	(Ticks>wd$)	(hxs → $weekday) Same function but using clock ticks.
0D06A	TOD>t$	(%time → $) Returns string represent the time, using current format.
0EE50	Date>hxs13	(%date → hxs) Converts date to ticks.
0D156	(Ticks>Date)	(hxs → %date) Returns date from hxs of internal alarm list format.
0EE83	(TOD>Ticks)	(%time → hxs) Converts time to ticks.
0D143	(Ticks>TOD)	(hxs → %time) Returns time from hxs of internal alarm list format.
0D169	(Ticks>Rpt)	(hxs → %rpt) Converts hxs in internal alarm list format to repetition interval.
0EE26	(Date+Time)	(hxs_d hxs_t → hxs) Takes two hxs representing the date and the time, and joins them into only one hxs.

Chapter 39
System functions

39.1 User and system flags

Address	Word	Stack and notes
53731	SetSysFlag	(# →)
53761	ClrSysFlag	(# →)
53784	TestSysFlag	(# → flag) Returns TRUE if flag is set.
1C4EC	(TestSysClr)	(# → flag) Clears flag after testing.
3EDA2	(TogSysFlag)	(# →) Toggles system flag.
53725	SetUserFlag	(# →)
53755	ClrUserFlag	(# →)
53778	TestUserFlag	(# → flag) Returns TRUE if flag is set.
1C4CE	(TestUserClr)	(# → flag) Clears flag after testing.
1C637	RCLSYSF	(→ hxs) Recalls system flags.
1C731	(STOSYSF)	(hxs →) Stores system flags.
1C6E3	DOSTOSYSF	(hxs →) Stores system flags, checking for changes in LASTARG flag.
1C64E	RCLUSERF	(→ hxs) Recalls user flags.
1C6F7	(STOUSERF)	(hxs →) Stores user flags.
1C6CF	(STOALLF)	(hxs hxs →) Stores user and system flags. First is user flags, second is system flags.
1C6A2	DOSTOALLF	({ } →) Stores user and system flags. Expects a list of two hxs, first is user flags, second is system flags.
53CAA	dostws	(# →)
53C96	(XEQSTWS)	(% →)
54039	WORDSIZE	(→ #)
53CF0	(XEQRCWS)	(→ %)

Address	Word	Stack and notes
53C37	DOHEX	(→)
54C5B	DODEC	(→)
53C43	DOBIN	(→)
53C4F	DOOCT	(→)
54050	BASE	(→ #) Returns #10h, #10d, #10b or #10o. In decimal terms, 16 for hexadecimal base, 10 for decimal base, 8 for octal base or 2 for binary base.
5407A	(BASECHAR)	(→ char) Returns “h”, “d”, “b” or “o”.
16707	DOSTD	(→)
166E3	DOFIX	(# →)
166EF	DOSCI	(# →)
166FB	DOENG	(# →)
53B61	(NumbMode)	(→ #) Returns 0 for STD mode, 1 for FIX mode, 2 for SCI mode or 3 for ENG mode.
2A5F0	SETRAD	(→)
53BDD	RAD?	(→ flag)
2A5D2	SETDEG	(→)
53BC9	(DEG?)	(→ flag)
2A604	SETGRAD	(→)
167BF	DPRADIX?	(→ flag) Returns TRUE if current radix is “.”.
53C23	(PRSOL?)	(→ flag) Returns TRUE if general solutions flag (1) is set.
53C0A	(NOTCONST?)	(→ flag) Returns TRUE if symbolic constants flag (2) is cleared.
53B9C	(SETNUM)	(→) Sets numeric results flag (3).
53B88	(CLRNUM)	(→) Clears numeric results flag (3).
53BB0	(NOTNUM?)	(→ flag) Returns TRUE if numeric results flag (3) is cleared.

39.2 General functions

Address	Word	Stack and description
1415A	DOBEEP	(%freq %dur →) Beeps. Analog to user function BEEP.
141B2	setbeep	(#MHz #ms →) Also beeps.

Address	Word	Stack and description
041A7	TurnOff	(→) Internal OFF.
041DA	(!TurnOff)	(→) Internal OFF. Does not do alarm check, etc.
041ED	DEEPSLEEP	(→ flag) Returns TRUE if Invalid Card Data message.
0426A	ShowInvRomp	(→) Flashes Invalid Card Data message.
386D8	?FlashAlert	(→) Displays all possible system warnings.
04544	(GETWARN#)	(→ #) Gets last system warning: #0h = OK #4h = LowBat (P1) #1h = Alarm #8h = LowBat (P2) #2h = LowBat (S)
04575	(#>WARN$)	(# → $) Recalls system warning message.
0D2A3	(WSLOG)	(→ $4 $3 $2 $1) Recalls warm start log messages.
0D18A	(WSLOGN)	(#n → $) Recalls specified warm start log message.
21B4E	(WARMSSTART)	(→) Forces a warm start.
04912	(LiteSlp)	(→) Enters light sleep mode.
05F42	GARBAGE	(→) Forces garbage collection.
05F61	MEM	(→ #) Returns amount of free memory in nibbles. Does not garbage collection (the user word does).
05902	OSIZE	(ob → #) Returns object size in nibbles. Forces garbage collection.

Address	Word	Stack and description
05944	OCRC	(ob → # hxs) Returns size in nibbles and checksum as hxs.
1A1FC	OCRC%	(ob → hxs %) Returns checksum and size in bytes.
1A265	VARSIZE	(id → hxs %) Returns checksum and size in bytes of specified variable.
1A2DA	INHARDROM?	(ob → ob flag) Is object address < #70000h?
19350	(NOTINHARDROM?)	(ob → ob flag) Is object address ≥ #70000h?
05AB3	CHANGETYPE	(ob #prolog → ob’) Changes prolog of object, does TOTEMPOB.
05ACC	(!CHANGETYPE)	(ob #prolog → ob’) Changes prolog of object.
6595A	getnibs	(hxs hxs → hxs’) Peek. First hxs is data, second is address. The data is overwritten for its length (maximum 16) with nibbles starting from specified address.
6594E	putnibs	(hxs hxs →) Poke. First hxs is data, second is address. Works like above function.

Chapter 40
Keyboard control

40.1 User keys

If no keys are assigned, the internal key assignments list is an empty list. If there is one or more assignments, the list contains 49 sub-lists, each one representing one key. Each sub-list is either empty, if that key has no assignments; or contains six elements: each representing the assignment of one plane (in the order: unshifted, left-shifted, right-shifted, alpha, alpha and left-shift and finally alpha and right-shift). For planes with no assignment, an empty list is entered.

Address	Word	Stack and description
41F3F	GetUserKeys	(→ { }) Returns user keys list (internal format).
41C02	(XEQRclKeys)	(→ { }) Recalls all key assignments (in user format) plus status of non defined keys.
41B28	(XEQAsnKey)	(ob %rc.p →) Assigns an object to a key, specified in user format.
41E78	(AsnKey)	(ob #kc #p →) Assigns an object to a key, specified in system format.
41F2C	(UserKeys!)	({ } →) Stores user keys (list is in internal format).
41E32	(StoUserKeys)	({ } →) Like the above, but also recalculates CRC.
41AA1	(Ck&AsnUKeys)	({ } →) Stores user keys (list in user format), recalculates CRC.
41B8C	(DelKey)	(#kc #plane →) Deletes that key assignment, recalculates CRC.

Address	Word	Stack and description
41B3C	(XEQDelKeys)	({} →) Deletes specified keys (in user format).
41B69	(Ck&ClrUKey)	(0 →) (%rc.p →) System version of user word DELKEYS: if 0, deletes all keys, otherwise deletes specified key.
41F52	(PgUserKeys)	(→) Deletes all user keys.
41F13	(ClrUserKeys)	(→) Deletes all user keys and recalculates CRC.
3FF75	(NonUsrKeyOK?)	(→ flag) Returns TRUE if the keys not defined do their normal actions.
3FF86	(SetNUsrKeyOK)	(→) Keys not defined do their normal actions.
3FF97	(ClrNUsrKeyOK)	(→) Keys not defined just beep when pressed.

40.2 Waiting for keys

Address	Word	Stack and description
41CA2	Ck&DecKeyLoc	(%rc.p → #kc #p) Converts from user key representation format to system.
41D92	CodePl>%rc.p	(#kc #p → %rc.p) Inverse transformation.
00D71	FLUSHKEYS	(→) Flushes the key buffer. Also called FLUSH.
04708	CHECKKEY	(→ #kc TRUE) (→ FALSE) Returns next key in the key buffer, but does not pop it.

Address	Word	Stack and description
04714	GETTOUCH	(→ #kc TRUE) (→ FALSE) Pops next key from key buffer.
047C7	REPKEY?	(#kc → flag) Returns TRUE if the key is being pressed.
42402	KEYINBUFFER?	(→ flag) Returns TRUE if there is at least a key in the key buffer.
41F65	WaitForKey	(→ #kc #p) Returns next full key press.
1A738	Wait/GetKey	(% → ?) Internal WAIT command.
42262	ATTN?	(→ flag) Returns TRUE if CANCEL has been pressed.
4243E	?ATTN_QUIT	(→) If CANCEL has been pressed, ABORTs program.
4245C	NoAttn?Semi	(→) If CANCEL has been not pressed, drops the rest of the stream.
05040	ATTNFLG@	(→ #) Recalls CANCEL key counter.
05068	ATTNFLGCLR	(→) Clears CANCEL key counter. Does not affect the key buffer.

Chapter 41
The display

41.1 Display organization

Address	Word	Action
1314D	TOADISP	Sets the text display as the active.
13135	TOGDISP	Sets the graphic display as the active.
13167	(GDISPON?)	Returns a flag indicating whether the graphic display is active.
12655	ABUFF	Returns the text grob to the stack.
12665	GBUFF	Returns the graphic grob to the stack.
12635	HARDBUFF	Returns the current grob to the stack.
12645	HARDBUFF2	Returns the menu grob to the stack.
0E128	HBUF_X_Y	(→ HBgrob #x #y)
12B6C	HARDHEIGHT	(→ #height)
12B58	(HBUFFDIMw)	(→ #width)
5187F	GBUFFGROBDIM	(→ #height #width) Returns dimensions of graphic grob.

41.2 Preparing the display

Address	Word	Stack and description
130AC	RECLAIMDISP	(→) Activates the text grob, clears it and sets the default size.
39531	ClrDA1IsStat	(→) Suspends clock display.
4E2CF	TURNMENUOFF	(→) Turns off menu display, enlarges ABUFF to fill screen.
4E347	TURNMENUON	(→) Turns menu grob on.
4E360	MENUOFF?	(→ flag) Returns TRUE if the menu grob is off.

Address	Word	Stack and description
130CA	(RSZVDISP)	(→) Sets standard size for currently displayed grob.
1297D	(BROADENHBUFF)	(#cols →) Broadens currently displayed grob.
12964	(HEIGHTENHBUFF)	(#rows →) Heightens currently displayed grob.
12BB7	(BROADENGROB)	(grob #cols →) Broadens graph or text grob.
12DD1	HEIGHTENGROB	(gorb #rows →) Heightens graph or text grob.
13043	(KILLADISP)	(→) Clears text display.
13061	KILLGDISP	(→) Clears graph display.

41.3 Controlling display refresh

Address	Word	Notes
390CC	ClrDA1OK	(ClrDA1ValidF ClrDA1TempF ClrDA1NoCh)
38DAC	DA1OK?	
38F28	DA1OK?NOTIT	Does DA1OK?, NOT then IT.
390E5	ClrDA2aOK	(ClrDA2aValidF ClrDA2aTempF ClrDA2aNoCh)
38DFC	(DA2aOK?)	
38F41	DA2aOK?NOTIT	Does DA2aOK?, NOT then IT.
390FE	ClrDA2bOK	(ClrDA2bValidF ClrDA2bTempF ClrDA2bNoCh)
38E4C	(DA2bOK?)	
38F5A	DA2bOK?NOTIT	Does DA2bOK?, NOT then IT.
39117	ClrDA2OK	(ClrDA2aOK ClrDA2bOK)
38E9C	(DA2OK?)	
3912B	ClrDA3OK	(ClrDA3ValidF ClrDA3TempF ClrDA3NoCh)
38EB5	DA3OK?	
38F73	DA3OK?NOTIT	Does DA3OK?, NOT then IT.
39144	ClrDAsOK	(ClrDA1OK ClrDA2OK ClrDA3OK)
38F05	(DAsOK?)	
3902C	SetDA1Temp	(SetDA1TempF ClrDA1Bad ClrDA1IsStat)
39045	SetDA2aTemp	(SetDA2aTempF ClrDA2aBad)
39059	SetDA2bTemp	(SetDA2bTempF ClrDA2bBad ClrDA2bEdit)

Address	Word	Notes
39207	SetDA2OKTemp	(SetDA2aTemp SetDA2bTemp)
3921B	SetDA12Temp	(SetDA1Temp SetDA2OKTemp)
39072	SetDA3Temp	(SetDA3TempF ClrDA3Bad)
3922F	SetDAsTemp	(SetDA1Temp SetDA2OKTemp SetDA3Temp)
3932B	(SetDA1TempF)	
39339	(ClrDA1TempF)	
3931D	(DA1TempF)	
39355	(SetDA2aTempF)	
39363	(ClrDA2aTempF)	
39347	(DA2aTempF?)	
3937F	(SetDA2bTempF)	
3938D	(ClrDA2bTempF)	
39371	(DA2bTempF?)	
393A9	(SetDA3TempF)	
393B7	(ClrDA3TempF)	
3939B	(DA3TempF?)	
393D3	SetDA1NoCh	
393E1	(ClrDA1NoCh)	
393C5	(DA1NoCh?)	
393FD	SetDA2aNoCh	
3940B	(ClrDA2NoCh)	
393EF	(DA2aNoCh?)	
39427	SetDA2bNoCh	
39335	(ClrDA2bNoCh)	
39419	DA2bNoCh?	
3918A	SetDA2NoCh	
3919E	SetDA12NoCh	
39451	SetDA3NoCh	
3945F	(ClrDA3NoCh)	
39443	(DA3NoCh?)	
391C6	SetDA13NoCh	
391B2	SetDA23NoCh	
391DA	(SetDA12a3NoCh)	
391EE	SetDA123NoCh	
38FD2	SetDA1Valid	(SetDA1ValidF ClrDA1Bad ClrDA1IsStat)
38FEB	SetDA2aValid	(SetDA2aValidF ClrDA2aBad)
38FFF	SetDA2bValid	(SetDA2bValidF ClrDA2bBad ClrDA2bEdit)
3915D	SetDA2Valid	(SetDA2aValid SetDA2bValid)
39018	SetDA3Valid	(SetDA3ValidF ClrDA3Bad)
39171	(SetDAsValid)	(SetDA1Valid SetDA2Valid SetDA3Valid)
39283	(SetDA1ValidF)	
39291	(ClrDA1ValidF)	
39275	(DA1ValidF?)	
392AD	(SetDA2aValidF)	
392BB	(ClrDA2aValidF)	
3929F	(DA2aValidF?)	
392D7	(SetDA2bValidF)	
392E5	(ClrDA2bValidF)	

Address	Word	Notes
392C9	(DA2bValidF?)	
39301	SetDA3ValidF	
3930F	(ClrDA3ValidF)	
392F3	(DA3ValidF?)	
3947B	SetDA1Bad	
390A4	MENoP&FixDA1	(SetDA1Bad)
38DE8	(SetDA1BadT)	(SetDA1Bad TRUE)
39489	ClrDA1Bad	
3946D	(DA1Bad?)	
394A5	SetDA2aBad	
38E38	(SetDA2aBadT)	(SetDA2aBad TRUE)
394B3	ClrDA2aBad	
39497	DA2aBad?	
394CF	SetDA2bBad	
38E88	(SetDA2bBadT)	(SetDA2bBad TRUE)
394DD	ClrDA2bBad	
394C1	(DA2bBad?)	
390B3	MENP&FixDA12	(SetDA1Bad SetDA2aBad SetDA2bBad)
394F9	SetDA3Bad	
38EF1	(SetDA3BadT)	(SetDA3Bad TRUE)
39507	ClrDA3Bad	
394EB	(DA3Bad?)	
39248	(DAsBad?)	Is any DA "Bad"?
39523	SetDA1IsStat	
39531	ClrDA1IsStat	
39515	(DA1IsStat?)	
3954D	(SetDA2bEdit)	
3955B	(ClrDA2bEdit)	
3953F	(DA2bEdit?)	
3957A	SetNoRollDA2	
3958B	ClrNoRollDA2	
39569	(NoRollDA2?)	
39086	(?SetEditRoll)	(EditExst?NOT ITE SetDA2RollF SetDA2aNoCh)
38F8C	(InitDispModes)	(SetDAsBad ClrDA2RollF ClrDA1IsStat)
38FB9	DA2aLess1OK?	(DA2RollF? DA2aBad? NOTAND)

41.4 Clearing the display

Address	Word	Action
126DF	BLANKIT	(#startrow #rows →) Clears #rows from HARDBUFF, starting at #startrow.
134AE	CLEARVDISP	Clears HARDBUFF.
0E083	Clr8	Clears top eight rows (first status line).
0E097	Clr8-15	Clears second status line.

Address	Word	Action
0E06F	Clr16	Clears top 16 rows (both status lines).
3A546	BlankDA1	Clears status area from HARDBUFF.
3A591	BlankDA2a	Clears DA2a.
3A55F	BlankDA2	Clears DA2a and DA2b.
3A578	BlankDA12	Clears DA1 and DA2.
01F6D	CLCD10	Clears status and stack area.
01FA7	CLEARLCD	Clears entire display.
5046A	DOCLLCD	Like user word CLLCD.

41.5 Annunciator and modes control

Address	Word	Action
11361	SetLeftAnn	Sets left-shift annunciator.
1136E	ClrLeftAnn	Clears left-shift annunciator.
11347	SetRightAnn	Sets right-shift annunciator.
11354	ClrRightAnn	Clears right-shift annunciator.
1132D	SetAlphaAnn	Sets alpha annunciator.
1133A	ClrAlphaAnn	Clears alpha annunciator.
11543	(SetLock)	Sets alpha mode.
1156C	(ClrLock)	Clears alpha mode.
40D25	LockAlpha	Sets alpha mode, annunciators, etc.
40D39	UnLockAlpha	Clears alpha mode, annunciators, etc.
11501	(Lock?)	Is alpha mode set?
11320	(ClrPrgmAnn)	Clears program-entry annunciator.
11533	SetPrgmEntry	Sets program-entry mode.
1155C	(ClrPrgmEntry)	Clears program-entry mode.
11511	PrgmEntry?	Is program-entry mode set?
3EDF2	(Do1st/1st+:)	If in program mode, executes only the next object after it. If not, execution continues normally.
3EE1A	Do1st/2nd+:	If in program mode, executes the next object after it. If not in program mode, executes the rest of the stream starting at the second object after it.
53976	SetAlgEntry	Sets algebraic-entry mode.
53984	ClrAlgEntry	Clears algebraic-entry mode.
53968	AlgEntry?	Is algebraic-entry mode set?
408AA	ImmedEntry?	Returns TRUE if immediate-entry mode (program and algebraic-entry modes cleared).

41.6 Window coordinates

Address	Word	Stack and description
0E0D3	TOP8	(→ HBgrob #x1 #y #x1+131 #y1+8) Returns coordinates of first status line.
0E0FB	Rows8-15	(→ HBgrob #x1 #y1+8 #1+131 #y1+16) Returns coordinates of second status line.
0E0AB	TOP16	(→ HBgrob #x1 #y1 #x1+131 #y1+16) Returns coordinates of status area.
137B6	WINDOWCORNER	(→ #x #y) Gets coordinates of corner of window.
0E128	HBUFF_X_Y	(→ HBgrob #x #y) Returns current grob and window coordinates.
515FA	LEFTCOL	(→ #x) Gets x-coordinate of left column.
516E0	RIGHTCOL	(→ #x) Gets x-coordinate of right column.
515A0	TOPROW	(→ #y) Gets y-coordinate of top row.
515B4	BOTROW	(→ #y) Gets y-coordinate of bottom row.
13679	WINDOWXY	(#x #y →) Sets corner coordinates.
13695	(REDISPHBUFF)	(→) Sets #0 and #0 as window corner coordinates.

41.6.1 Scrolling the display

Address	Word	Action
131C8	WINDOWUP	Moves display one pixel up.
13220	WINDOWDOWN	Moves display one pixel down.
134E4	WINDOWLEFT	Moves display one pixel left.
1357F	WINDOWRIGHT	Moves display one pixel right.
4D132	SCROLLUP	Moves display one pixel up, checks for corresponding key being pressed.

Address	Word	Action
4D16E	SCROLLDOWN	Moves display one pixel down, checks for corresponding key being pressed.
4D150	SCROLLLEFT	Moves display one pixel left, checks for corresponding key being pressed.
4D18C	SCROLLRIGHT	Moves display one pixel right, checks for corresponding key being pressed.
51690	JUMPTOP	Jumps to top of display.
516AE	JUMPBOT	Jumps to bottom of display.
516E5	JUMPLEFT	Jumps to left of display.
51703	JUMPRIGHT	Jumps to right of display.
5162C	WINDOWTOP?	Is window at the top?
51645	WINDOWBOT?	Is window at the bottom?
5165E	WINDOWLEFT?	Is window at the left?
51677	WINDOWRIGHT?	Is window at the right?
12996	(ScreenUpN)	(#n →) Moves stack display up #n lines.
12A4A	(ScreenDnN)	(#n →) Moves stack display down #n lines.
12A0D	(ScreenUp)	Moves stack display up one line.
12AF6	(ScreenDn)	Moves stack display down one line.

41.7 Displaying text

41.7.1 Medium font

Address	Word	Stack and notes
1245B	DISPROW1 or DISP@01	($ →)
12725	DISPROW1*	($ →) Displays relative to window corner.
0E029	DISPROW1*!	($ →) Does Clr8 then DISPROW1*.
1246B	DISPROW2 or DISP@09	($ →)
12748	DISPROW2*	($ →) Displays relative to window corner.
1247B	DISPROW3 or DISP@17	($ →)
1248B	DISPROW4 or DISP@25	($ →)
1249B	DISPROW5	($ →)
124AB	DISPROW6	($ →)
124BB	DISPROW7	($ →)
124CB	DISPROW8	($ →) Only works if menu is off.
12429	DISPN	($ #row →)

Address	Word	Stack and notes
3A4CE	Disp5x7	($ #start #max →) Displays string on multiple lines, starting at #start and no using more than #max rows. New lines must be manually specified. Segments longer than 22 characters are truncated and appended with "...".

41.7.2 Large font

Address	Word	Stack
12415	BIGDISPROW1	($ →)
12405	BIGDISPROW2	($ →)
123F5	BIGDISPROW3	($ →)
123E5	BIGDISPROW4	($ →)
123C8	BIGDISPN	($ #max →)

41.7.3 Displaying warnings

Address	Word	Stack and description
0E047	(Save16)	(→ grob) Returns top 16 rows.
0E05B	(Restore16)	(grob →) Restores top 16 rows.
1270C	DISPSTATUS2	($ →) Displays message in status area using two lines.
12B85	FlashMsg	($ →) Displays message in status area, then restores it to normal.
38926	FlashWarning	($ →) Displays message in status area, beeps, then restores it to normal.
38908	DoWarning	($ →) Displays message, beeps and freezes status area.

Chapter 42
Graphics

42.1 Built-in grobs

Address	Word	Dims.	Grob
505B2	(NULLGROB)	0x0	Null grob
13D8C	CURSOR1	6x10	Insert cursor (arrow)
13DB4	CURSOR2	6x10	Replace cursor (solid box)
66EF1	SmallCursor	4x6	Cursor (box outline)
66ECD	MediumCursor	6x8	Cursor (box outline)
66EA5	BigCursor	6x10	Cursor (box outline)
5053C	CROSSGROB	5x5	Cross cursor (“+”)
5055A	MARKGROB	5x5	Mark symbol (“x”)
39B2D	(LineGrob)	131x2	Line (status area divider)
3A337	(StdLabelGrob)	21x8	Normal menu key
3A399	(BoxLabelGrob)	21x8	Menu key with box.
3A3FB	(DirLabelGrob)	21x8	Directory menu key.
3A45D	(InvLabelGrob)	21x8	Inverse menu key (solver)

42.2 Dimensions

Address	Word	Stack and notes
50578	GROBDIM	(grob → #height #width)
5179E	DUPGROBDIM	(grob → grob #heigth #width)
63C04	GROBDIMw	(grob → #width)
4F7E6	CKGROBFITS	(g1 g2 #n #m → g1 g2’#n #m) Shrinks g2 if it does not fit in grob1.

42.3 Grob handlin g

Address	Word	Stack an description
11679	GROB!	(grob1 grob2 #x #y →) Stores grob1 into grob2. Bang type.
11A6D	GROB!ZERO	(grob #x1 #y1 #x2 #y2 → grob’) Blanks a rectangular region of the grob. Bang type.
6389E	GROB!ZERODRP	(grob #x1 #y1 #x2 #y2 →) Blanks a rectangular region of the grob. Assumes text or graph grob. Bang type.
1192F	SUBGROB	(grob #x1 #y1 #x2 #y2 → grob’) Returns specified portion of grob.
128B0	XYGROBDISP	(#row #col grob →) Stores grob in HARDBUFF, expanding it if necessary.
12F94	GROB>GDISP	(grob →) Stores new graph grob.
1158F	MAKEGROB	(#height #width → grob) Creates a blank grob.
122FF	INVGROB	(grob → grob’) Inverts grob data bits. Bang type.
1384A	PIXON	(#x #y →) Sets pixel in text grob.
1383B	PIXOFF	(#x #y →) Clears pixel in text grob.
13992	PIXON?	(#x #y → flag) Is pixel in text grob on?
13825	PIXON3	(#x #y →) Sets pixel in graph grob.
1380F	PIXOFF3	(#x #y →) Clears pixel in graph grob.
13986	PIXON?3	(#x #y → flag) Is pixel in graph grob on?

Address	Word	Stack an description
51893	ORDERXY#	(#x1 #y1 #x2 #y2 → #x1’#y1’#x2’#y2’) To draw lines, #x2 must be greater than #x1. This function orders the coordinates so that the above condition is met.
518CA	ORDERXY%	(%x1 %y1 %x2 %y2 → %x1’%y1’%x2’%y2’) ORDERXY# with real numbers.
50B17	LINEON	(#x1 #y1 #x2 #y2 →) Draws a line in text grob.
50B08	LINEOFF	(#x1 #y1 #x2 #y2 →) Clears a line in text grob.
50AF9	TOGLINE	(#x1 #y1 #x2 #y2 →) Toggles a line in text grob.
50AEA	LINEON3	(#x1 #y1 #x2 #y2 →) Draws a line in graph grob.
50ACC	LINEOFF3	(#x1 #y1 #x2 #y2 →) Clears a line in graph grob.
50ADB	TOGLINE3	(#x1 #y1 #x2 #y2 →) Toggles a line in graph grob.
11CF3	$>BIGGROB	($ → grob) Makes grob of the string using the large font (5x9).
11D00	$>GROB	($ → grob) Makes grob of the string using the medium font (5x7).
11F80	$>grob	($ → grob) Makes grob of the string using the small font.
39632	Blank&GROB!	($ #x #x1 #x2 →) Clears HARDBUFF between (#x1, 0) and (#x2, 6). Converts string to grob with small characters and displays it at (#x, 0).
503D4	DOLCD>	(→ grob) Returns current display.
50438	DO>LCD	(grob →) Grob to display.

Address	Word	Stack an description
659DE	`Symb>HBuff`	(symb →) Displays symbolic in `HARDBUFF` in Equation Writer form. Enlarges `HARDBUFF` if necessary, so use `RECLAIMDISP` after.
1200C	`RIGHT$3x6`	($ #n → flag grob) Transforms string into grob, then take all characters starting after column #n. flag is `FALSE` if #n is greater than the width of the grob. In this case, the whole grob is returned.
1215E	`CENTER$3x5`	(grob #x #y $ #w → grob ’) Creates grob from string (3x5) and embeds it at specified position (#x, #y). #w represents the maximum width of the grob created. Bang-type.

42.4 Creating menu label grobs

Address	Word	Stack and description
3A328	`MakeStdLabel`	($ → grob) Makes standard menu label.
3A38A	`MakeBoxLabel`	($ → grob) Makes label with a box.
3A3EC	`MakeDirLabel`	($ → grob) Makes directory label.
3ED6B	`(DirLabel:)`	(→ grob) Makes directory label with next string in the stream. Usage: `:: DirLabel: $ ;`
3A44E	`MakeInvLabel`	($ → grob) Makes inverse label.
3EC99	`Box/StdLabel`	($ flag → grob) If `TRUE` makes box label, otherwise makes standard label.
3ECB2	`Box/StdLbl:`	(→ grob) Does `Box/StdLabel` with the next two objects from the stream. Usage: `:: Box/StdLbl: $ <test> ;`

Address	Word	Stack and description
3ECEE	(FBox/StdLbl:)	(→ grob) Takes a string and a bint from the runstream. Tests the system flag specified, does Box/StdLabel. Usage: :: FBox/StdLbl: $ #flag ;
3ED25	(BBox/StdLbl:)	(→ grob) Takes a string and a bint from the runstream. Does BASE then EQ, and finally Box/StdLabel. Usage: :: BBox/StdLabel: $ #base ;
3ED48	(MBox/StdLbl:)	(→ grob) Takes a string and a bint from the runstream. Does NumbMode and EQ, then Box/StdLabel. Usage: :: MBox/StdLbl: $ #mode ;
3ED0C	Std/BoxLabel	($ flag → grob) If TRUE makes standard label, otherwise makes box label.
3ECD0	(FStd/BoxLbl:)	(→ grob) Takes a string an a bint from the runstream. Tests the system flag specified, does Std/BoxLabel. Usage: :: FStd/BoxLbl: $ #flag ;
3A297	Grob>Menu	(#col grob →) Displays grob as menu label.
3A2B5	Str>Menu	(#col $ →) Displays string as menu label.
3A2DD	Id>Menu	(#col id →) Displays id as menu label.
3A2C9	Seco>Menu	(#col :: →) Does EVAL then DoLabel.
41904	DoLabel	(#col ob →) If ob is of one of the supported types, displays a menu label. If not, generates a “Bad Argument Type” error.
3A260	(>MENU)	(#col grob →) (#col $ →) (#col id →) (#col :: →) Works by dispatching the object type.

Chapter 43
User functions

Commands of library 2:

#	Address	Word
000	1957B	(xASR)
001	1959B	(xRL)
002	195BB	(xRLB)
003	195DB	(xRR)
004	195FB	(xRRB)
005	1961B	(xSL)
006	1963B	(xSLB)
007	1965B	(xSR)
008	1967B	(xSRB)
009	1969B	(xR>B)
00A	196BB	(xB>R)
00B	196DB	(xCONVERT)
00C	1971B	(xUVL)
00D	1974F	(x>UNIT)
00E	19771	(xUBASE)
00F	197A5	(xUFACT)
010	197F7	(xTIME)
011	19812	(xDATE)
012	1982D	(xTICKS)
013	19848	(xWSLOG)
014	19863	(xACKALL)
015	1987E	(xACK)
016	1989E	(xSETDATE)
017	198BE	(xSETTIME)
018	198DE	(xCLKADJ)
019	198FE	(xSTOALARM)
01A	19928	(xRCLALARM)
01B	19948	(xFINDLARM)
01C	19972	(xDELALARM)
01D	19992	(xTSTR)
01E	199B2	(xDDAYS)
01F	199D2	(xDATE+)
020	1A105	(xCRDIR)
021	1A125	(xPATH)
022	1A140	(xHOME)
023	1A15B	(xUPDIR)
024	1A194	(xVARS)
025	1A1AF	(xTVARS)
026	1A1D9	(xBYTES)
027	1A2BC	(xNEWOB)
028	1A303	(xKILL)
029	1A31E	(xOFF)
02A	1A339	(xDOERR)
02B	1A36D	(xERR0)
02C	1A388	(xERRN)
02D	1A3A3	(xERRM)
02E	1A3BE	(xEVAL)
02F	1A3FE	xIFTE
030	1A4CD	(xIFT)
031	1A52E	(xSYSEVAL)
032	1A584	(xDISP)
033	1A5A4	(xFREEZE)
034	1A5C4	(xBEEP)
035	1A5E4	(x>NUM)
036	1A604	(xLAST)
037	1A71F	(xWAIT)
038	1A858	(xCLLCD)
039	1A873	(xKEY)
03A	1A8BB	(xCONT)
03B	1A8D8	(x=)
03C	1A995	(xNEG)
03D	1AA1F	(xABS)
03E	1AA6E	(xCONJ)
03F	1AABD	(xPI)
040	1AADF	(xMAXR)
041	1AB01	(xMINR)
042	1AB23	(xCONSTANTe)
043	1AB45	(xi)
044	1AB67	x+
045	1ACDD	xNEGNEG
046	1AD09	x-
047	1ADEE	x*
048	1AF05	x/
049	1B02D	x^
04A	1B185	rpnXROOT
04B	1B1CA	xXROOT

#	Address	Word
04C	1B278	(xINV)
04D	1B2DB	(xARG)
04E	1B32A	(xSIGN)
04F	1B374	(xSQRT)
050	1B426	(xSQ)
051	1B4AC	(xSIN)
052	1B505	(xCOS)
053	1B55E	(xTAN)
054	1B5B7	(xSINH)
055	1B606	(xCOSH)
056	1B655	(xTANH)
057	1B6A4	(xASIN)
058	1B72F	(xACOS)
059	1B79C	(xATAN)
05A	1B7EB	(xASINH)
05B	1B830	(xACOSH)
05C	1B8A2	(xATANH)
05D	1B905	(xEXP)
05E	1B94F	(xLN)
05F	1B9C6	(xLOG)
060	1BA3D	(xALOG)
061	1BA8C	(xLNP1)
062	1BAC2	(xEXPM)
063	1BB02	xFACT
064	1BB41	preFACT
065	1BB6D	(xIP)
066	1BBA3	(xFP)
067	1BBD9	(xFLOOR)
068	1BC0F	(xCEIL)
069	1BC45	(xXPON)
06A	1BC71	(xMAX)
06B	1BCE3	(xMIN)
06C	1BD55	(xRND)
06D	1BDD1	(xTRNC)
06E	1BE4D	(xMOD)
06F	1BE9C	(xMANT)
070	1BEC8	(xD>R)
071	1BEF4	(xR>D)
072	1BF1E	(x>HXS)
073	1BF3E	(xHMS>)
074	1BF5E	(xHMS+)
075	1BF7E	(xHMS-)
076	1BF9E	(xRNRM)
077	1BFBE	(xCNRM)
078	1BFDE	(xDET)
079	1BFFE	(xDOT)
07A	1C01E	(xCROSS)
07B	1C03E	(xRSD)
07C	1C060	(x%)
07D	1C0D7	(x%T)
07E	1C149	(x%CH)
07F	1C1B9	(xRAND)
080	1C1D4	(xRDZ)
081	1C1F6	(xCOMB)
082	1C236	(xPERM)
083	1C274	(xSF)
084	1C2D5	(xCF)
085	1C313	(xFS?)
086	1C360	(xFC?)
087	1C399	(xDEG)
088	1C3B4	(xRAD)
089	1C3CF	(xGRAD)
08A	1C3EA	(xFIX)
08B	1C41E	(xSCI)
08C	1C452	(xENG)
08D	1C486	(xSTD)
08E	1C4A1	(xFS?C)
08F	1C520	(XFC?C)
090	1C559	(xBIN)
091	1C574	(xDEC)
092	1C58F	(xHEX)
093	1C5AA	(xOCT)
094	1C5C5	(xSTWD)
095	1C5FE	(xRCWS)
096	1C619	(xRCLF)
097	1C67F	xSTOF
098	1C783	(x>LIST)
099	1C79E	(xR>C)
09A	1C7CA	(xRE)
09B	1C819	(xIM)
09C	1C85C	(xSUB)
09D	1C8EA	(xREPL)
09E	1C95A	(xLIST>)
09F	1C98E	(xC>R)
0A0	1C9B8	xSIZE
0A1	1CAB4	(xPOS)
0A2	1CB0B	(x>STR)
0A3	1CB26	(xSTR>)
0A4	1CB46	(xNUM)
0A5	1CB66	(xCHR)
0A6	1CB86	(xTYPE)
0A7	1CE28	(xVTYPE)
0A8	1CE33	(xEQ>)
0A9	1CF7B	xOBJ>
0AA	1D009	(x>ARRY)
0AB	1D092	(xARRY>)

#	Address	Word
0AC	1D0DF	(xRDM)
0AD	1D186	(xCON)
0AE	1D2DC	(xIDN)
0AF	1D392	(xTRN)
0B0	1D407	(xPUT)
0B1	1D5DF	(xPUTI)
0B2	1D7C6	(xGET)
0B3	1D8C7	(xGETI)
0B4	1DD06	(xV>)
0B5	1DE66	(x>V2)
0B6	1DEC2	(x>V3)
0B7	1E04A	(xINDEP)
0B8	1E07E	(xPMIN)
0B9	1E09E	(xPMAX)
0BA	1E0BE	(xAXES)
0BB	1E0E8	(xCENTR)
0BC	1E126	(xRES)
0BD	1E150	(x*H)
0BE	1E170	(x*W)
0BF	1E190	(xDRAW)
0C0	1E1AB	(xAUTO)
0C1	1E1C6	(xDRAX)
0C2	1E1E1	(xSCALE)
0C3	1E201	(xPDIM)
0C4	1E22B	(xDEPND)
0C5	1E25F	(xERASE)
0C6	1E27A	(xPX>C)
0C7	1E29A	(xC>PX)
0C8	1E2BA	(xGRAPH)
0C9	1E2D5	(xLABEL)
0CA	1E2F0	(xPVIEW)
0CB	1E31A	(xPIXON)
0CC	1E344	(xPIXOFF)
0CD	1E36E	(xPIX?)
0CE	1E398	(xLINE)
0CF	1E3C2	(xTLINE)
0D0	1E3EC	(xBOX)
0D1	1E416	(xBLANK)
0D2	1E436	(xPICT)
0D3	1E456	(xGOR)
0D4	1E4E4	(xGXOR)
0D5	1E572	(xLCD>)
0D6	1E58D	(x>LCD)
0D7	1E5AD	(x>GROB)
0D8	1E5D2	(xARC)
0D9	1E606	(xTEST)
0DA	1E621	(xXRNG)
0DB	1E641	(xYRNG)
0DC	1E661	xFUNCTION
0DD	1E681	(xCONIC)
0DE	1E6a1	xPOLAR
0DF	1E6C1	xPARAMETRIC
0E0	1E6E1	(xTRUTH)
0E1	1E701	(xSCATTER)
0E2	1E721	(xHISTOGRAM)
0E3	1E741	(xBAR)
0E4	1E761	(xsME)
0E5	1E783	(xAND)
0E6	1E809	(xOR)
0E7	1E88F	(xNOT)
0E8	1E8F6	(xXOR)
0E9	1E972	(x==)
0EA	1EA9D	(x#?)
0EB	1EBBE	x<?
0EC	1EC5D	x>?
0ED	1ECFC	(x<=?)
0EE	1ED9B	(x>=?)
0EF	1EE38	(xOLDPTR)
0F0	1EE53	(xPR1)
0F1	1EE6E	(xPRSTC)
0F2	1EE89	(xPRST)
0F3	1EEA4	(xCR)
0F4	1EEBF	(xPRVAR)
0F5	1EF43	(xDELAY)
0F6	1EF63	(xPRLCD)
0F7	1EF7E	rpnDER
0F8	1EFD2	xDER
0F9	1F133	(xRCEQ)
0FA	1F14E	(xSTEQ)
0FB	1F16E	(xROOT)
0FC	1F1DA	rpnINTG
0FD	1D223	xINTEGRAL
0FE	1F2C9	(xSUM)
0FF	1F354	(rpnWHERE)
100	1F3F3	(xWHERE)
101	1F500	(xQUOTE)
102	1F55D	rpnAPPLY
103	1F5C5	xAPPLY
104	1F640	xFCNAPPLY
105	1F996	(COMPLEXDUMMY)
106	1F9AE	(POLARDUMMY)
107	1F9C4	(x->Q)
108	1F9E9	(x->QPI)
109	1FA59	(xMATCHUP)
10A	1FA8D	(xMATDHDN)
10B	1FAEB	xFORMUNIT

#	Address	Word
10C	1FB5D	(xPREDIV)
10D	1FB87	(xDUP)
10E	1FBA2	(xDUP2)
10F	1FBBD	(xSWAP)
110	1FBD8	(xDROP)
111	1FBF3	(xDROP2)
112	1FC0E	(xROT)
113	1FC29	(xOVER)
114	1FC44	(xDEPTH)
115	1FC64	(xDROPN)
116	1FC7F	(xDUPN)
117	1FC9A	(xPICK)
118	1FCB5	(xROLL)
119	1FCD0	(xROLLD)
11A	1FCEB	(xCLEAR)
11B	1FD0B	(xSTOSIGMA)
11C	1FD2B	(xCLSIGMA)
11D	1FD46	(xRCLSIGMA)
11E	1FD61	(xSIGMA+)
11F	1FD8B	(xSIGMA-)
120	1FDA6	(xNSIGMA)
121	1FDC1	(xCORR)
122	1FDDC	(xCOV)
123	1FDF7	(xSUMX)
124	1FE12	(xSYMY)
125	1FE2D	(xSYMX2)
126	1FE48	(xSUMY2)
127	1FE63	(xSUMXY)
128	1FE7E	(xMAXSIGMA)
129	1FE99	(xMEAN)
12A	1FEB4	(xMINSIGMA)
12B	1FECF	(xSDEV)
12C	1FEEA	(xTOT)
12D	1FF05	(xVAR)
12E	1FF20	(xLR)
12F	1FF7	(xPREDV)
130	1FF9A	(xPREDY)
131	1FFBA	(xPREDX)
132	1FFDA	(xXCOL)
133	1FFFA	(xYCOL)
134	2001A	(xUTPC)
135	2003A	(xUTPN)
136	2005A	(xUTPF)
137	2007A	(xUTPT)
138	2009A	(xSIGMACOL)
139	200C4	(xSCLSIGMA)
13A	200F3	(xSIGMALINE)
13B	2010E	(xBINHS)
13C	20133	(xBARPLOT)
13D	20167	(xHISTPLOT)
13E	2018C	(xSCATRPLOT)
13F	201B1	(xLINFIT)
140	201D6	(xLOGFIT)
141	201FB	(xEXPFIT)
142	20220	(xPWRFIT)
143	2025E	(xBESTFIT)
144	202CE	(xSINV)
145	2034D	(sSNEG)
146	203CC	(xSCONJ)
147	2044B	(xSTO+)
148	20538	(xSTO-)
149	2060C	(STO/)
14A	20753	(xSTO*)
14B	208F4	(xINCR)
14C	209AA	(xDECR)
14D	20A15	(xCOLCT)
14E	20A49	(xEXPAN)
14F	20A7D	(xRULES)
150	20A93	(xISOL)
151	20AB3	(xQUAD)
152	20AD3	(xSHOW)
153	20B20	(xTAYLR)
154	20B40	(xRCL)
155	20CC4	(xSTO)
156	20D65	(xDEFINE)
157	20EFE	(xPURGE)
158	20FAA	xMEM
159	20FD9	(xORDER)
15A	210FC	(xCLUSR)
15B	2115D	(xTMENU)
15C	21196	(xMENU)
15D	211E1	(xRCLMENU)
15E	211FC	(xPVARS)
15F	2123A	(xPGDIR)
160	2125A	(xARCHIVE)
161	2133C	(xRESTORE)
162	2137F	(xMERGE)
163	213D1	xFREE
164	214D2	(xLIBS)
165	21448	(xATTACH)
166	2147C	(xDETACH)
167	21E75	(xXMIT)
168	21E95	(xSRECV)
169	21EB5	(xOPENIO)
16A	21ED5	(xCLOSEIO)
16B	21EF0	(xSEND)

#	Address	Word
16C	21F24	(xKGET)
16D	21F62	(xRECN)
16E	21F96	(xRECV)
16F	21FB6	(xFINISH)
170	21FD1	(xSERVER)
171	21FEC	(xCKSM)
172	2200C	(xBAUD)
173	2202C	(xPARITY)
174	2204C	(xTRANSIO)
175	2206C	(xKERRM)
176	22087	(xBUFLEN)
177	220A2	(xSTIME)
178	220C2	(xSBRK)
179	220DD	(xPKT)
17A	22ACA	(xINPUT)
17B	224F4	(xASN)
17C	22514	(xSTOKEYS)
17D	22548	(xDELKEYS)
17E	22586	(xRCLKEYS)
17F	225BE	(x->TAG)
180	22633	(xDTAG)

Commands of library 1792:

#	Address	Word
00	22EC3	(xIF)
01	22EFA	(xTHEN)
02	22F5B	(xELSE)
03	22FD5	xIFEND
04	22FEB	xALG->
05	22033	(xWHILE)
06	2305D	(xREPEAT)
07	230C3	(xDO)
08	230ED	(xUNTIL)
09	23103	(xSTART)
0A	231A0	(xSTARVAR)
0B	2324C	(xNEXT)
0C	23380	(xSTEP)
0D	233DF	(xIFERR)
0E	23472	(xHALT)
0F	2349C	(xSILENT')
10	234C1	xRPN->
11	235FE	x>>ABND
12	2361E	x<<
13	23639	x>>
14	23654	(x')
15	23679	xENDTIC
16	23694	xWHILEEND
17	236B9	xENDDO
18	2371F	xERRTHEN
19	2378D	(xCASE)
1A	237A8	xTHENCASE
1B	23813	(xDIR)
1C	23824	(xPROMPT)

Chapter 44
Commands by name

The “see” column tells you which section to look for a reference of that command. If nothing is listed, then you are out of luck. Try disassembling the entry point with JAZZ. Sometimes it is enough to understand the action.

Addr.	Name	See
06E97	'	34.1
623A0	!!append$	20.4
62312	!!append$?	20.4
62394	!!insert$	20.4
50E59	!#1+IF<dim-1	
50EA5	!#1-IF>0	
0BCCF	!*triand	
0BC6F	!*trior	
62376	!append$	20.4
62F2F	!append$SWAP	20.4
1795A	!DcompWidth	
622E5	!insert$	20.4
03DE0	#-	17.3
624FB	#-#2/	17.3
03EC2	#*	17.3
191B9	#*OVF	17.3
03EF7	#/	17.3
167D8	#:>$	20.3
64E3C	#_102	17.1
03DBC	#+	17.3
637CC	#-+1	17.3
63808	#+-1	17.3
627D5	#+DUP	17.3
63051	#+OVER	17.3
61184	#+PICK	17.3
612DE	#+ROLL	17.3
62DFE	#+SWAP	17.3
6133E	#+UNROLL	17.3
03CE4	#<	17.4
03D4E	#<>	17.3
63D3A	#<>case	17.4
63673	#<3	17.3
63D12	#<case	35.2
63E9D	#<ITE	35.2
03D19	#=	17.4
6336C	#=?SKIP	35.2
6186C	#=case	35.2
618D3	#=casedrop	35.2
63547	#=casedrpfls	35.2
62C2D	#=ITE	35.2
6448A	#=POSCOMP	25.1
03D83	#>	17.4
167E4	#>$	20.3
5435D	#>%	19.2
63399	#>?SKIP	35.2
636F0	#>1	17.4
63D4E	#>2case	35.2
63D67	#>case	35.2
05A75	#>CHR	20.3
059CC	#>HXS	21.1
63EB1	#>ITE	35.2
07E50	#>ROMPTR	28.2
03CC7	#0<>	17.4
03CA6	#0=	17.4
61A18	#0=?SEMI	35.2
6333A	#0=?SKIP	35.2
61896	#0=case	35.2
63E89	#0=ITE	35.2
62B6F	#0=UNTIL	36.1
03E0E	#1-	17.3
637CC	#1--	17.3
631A5	#1-{}N	25.4
03DEF	#1+	17.3
63808	#1-+	17.3
639CA	#1+'	34.1
073DB	#1+_ONE_DO	36.2
62809	#1+DUP	17.3
63281	#1+LAST$	20.4
62F75	#1+NDROP	29
611A3	#1+PICK	29
612F3	#1+ROLL	29
1DABB	#1+ROT	17.3
62E26	#1+SWAP	17.3
61353	#1+UNROLL	17.3
622B6	#1<>	17.4
622A7	#1=	17.4
63353	#1=?SKIP	35.2
63D26	#1=case	35.2
6264E	#10*	17.3
625DA	#10+	17.3
62E4E	#1-1SWAP	17.3
625EA	#12+	17.3
6281A	#1-DUP	17.3
62FD9	#1-ROT	17.3
63245	#1-SUB$	20.4
5E4A9	#1-SWAP	17.3
28558	#1-UNROT	17.3
03E4E	#2-	17.3
03E6F	#2*	17.3
03E8E	#2/	17.3
03E2D	#2+	17.3
611BE	#2+PICK	29
61318	#2+ROLL	29
61365	#2+UNROLL	29
636C8	#2<>	17.4
6229A	#2=	17.4
625FA	#3-	17.3
6256A	#3+	17.3
611D2	#3+PICK	29
62289	#3=	17.4
6260A	#4-	17.3
6257A	#4+	17.3
611E1	#4+PICK	29
6261A	#5-	17.3
6258A	#5+	17.3
636B4	#5=	17.4
6262A	#6-	17.3
62691	#6*	17.3
6259A	#6+	17.3
625AA	#7+	17.3
62674	#8*	17.3
625BA	#8+	17.3
625CA	#9+	17.3
03EB1	#AND	17.3
627F8	#-DUP	17.3
65094	#EXITERR	17.1
642E3	#FIVE#FOUR	17.1
624C6	#MAX	17.3
624BA	#MIN	17.3
6428A	#ONE#27	17.1
63065	#-OVER	17.3
61172	#-PICK	29
03DC7	#PUSHA-	
612CC	#-ROLL	17.3
62E12	#-SWAP	17.3
642D1	#THREE#FOUR	17.1
642BF	#TWO#FOUR	17.1
6429D	#TWO#ONE	17.1
642AF	#TWO#TWO	17.1
6132C	#-UNROLL	29
64209	#ZERO#ONE	17.1
6427A	#ZERO#SEVEN	17.1
6571F	$_''	20.2
6572D	$_::	20.2
65711	$_[]	20.2
65703	$_{}	20.2
656F5	$_<<>>	20.2
65749	$_2DQ	20.2
65757	$_ECHO	20.2
65769	$_EXIT	20.2
657A7	$_GRAD	20.2
6573B	$_LRParens	20.2
656C5	$_R<<	20.2
656D5	$_R<Z	20.2
65797	$_RAD	20.2
6577B	$_Undefined	20.2
656E5	$_XYZ	20.2
11CF3	$>BIGGROB	42.3
11D00	$>GROB	42.3
11F80	$>grob	42.3
05B15	$>ID	31.2
11D8F	$5x7	41.7
2A981	%-	18.3
2A94F	%%-	18.3
2A99A	%%*	18.3
62FED	%%*ROT	18.3

Addr.	Name	See
3FF48	?CaseRomptr@	
40E3D	?ClrAlg	
40E5B	?ClrAlgSetPr	
3A1CA	?DispMenu	
39B85	?DispStack	
3959C	?DispStatus	
386D8	?FlashAlert	39.2
619E0	?GOTO	34
3FA7A	?Key>UKeyOb	
63FCE	?Ob>Seco	25.5
26A2D	?OKINALG	
1854F	?PURGE_HERE	37.2
39BF3	?RollUpDA2	
62A84	?ROMPTR>	28.2
61A3B	?SEMI	34
638E4	?SEMIDROP	34
0712A	?SKIP	35.1
62D9F	?SKIPSWAP	35.1
18513	?STO_HERE	37.2
62F1B	?SWAP	35.1
62F5C	?SWAPDROP	35.1
448C1	?TogU/LCase	
0797B	@	37.2
07943	@LAM	31.3
24EA6	{}>DIR	
05459	{}N	25.4
100E0	~BRbrowse	
450E0	~BRDispItems	
130E0	~BRdone	
530E0	~BRGetItem	
490E0	~BRinverse	
120E0	~BRoutput	
180E0	~BRRclC1	
170E0	~BRRclCurRow	
030E0	~BRStoC1	
520E0	~BRViewItem	
000B3	~Choose	
050B3	~ChooseMenu0	
060B3	~ChooseMenu1	
070B3	~ChooseMenu2	
2D0B3	~DoCKeyCance	
2B0B3	~DoCKeyChAll	
2A0B3	~DoCKeyCheck	
2E0B3	~DoCKeyOK	
2C0B3	~DoCKeyUnChA	
590B0	~DoKeyCancel	
5A0B0	~DoKeyOK	
090B1	~DoMKeyOK	
000B1	~DoMsgBox	
C80B0	~GetFieldVal	
C50B0	~gFldVal	
850B0	~grobAlertIc	
860B0	~grobCheckKe	
050B0	~IFMenuRow1	
060B0	~IFMenuRow2	
360B3	~LEDispItem	
350B3	~LEDispList	
300B3	~LEDispPromp	
120E4	~MESRclEqn	
020B1	~MsgBoxMenu	
630E3	~PCunpack	
580E7	~UTTYPEEXT0?	
110E7	~UTVUNS1Arg	
073A5	+LOOP	36.2
3E3E1	<DelKey	
3E2DD	<SkipKey	
3E4CA	>DelKey	
0525B	>H$	20.4
052C6	>HCOMP	25.1
648BD	>LASTRAM-WOR	
06F9F	>R	34
41422	>Review$	
3E35F	>SkipKey	
052EE	>T$	20.4
05E81	>TAG	22
052FA	>TCOMP	25.1
1884D	0LASTOWDOB!	30
1884D	0LastRomWrd!	30
2B789	1/X15	
63259	1_#1-SUB	20.4
63259	1_#1-SUB$	20.4
614AC	10GETLAM	31.3
61675	10PUTLAM	31.3
6312D	10UNROLL	29
614BC	11GETLAM	31.3
61685	11PUTLAM	31.3
614CC	12GETLAM	31.3
61695	12PUTLAM	31.3
614DC	13GETLAM	31.3
616A5	13PUTLAM	31.3
614EC	14GETLAM	31.3
616B5	14PUTLAM	31.3
614FC	15GETLAM	31.3
616C5	15PUTLAM	31.3
6150C	16GETLAM	31.3
616D5	16PUTLAM	31.3
6151C	17GETLAM	31.3
616E5	17PUTLAM	31.3
6152C	18GETLAM	31.3
616F5	18PUTLAM	31.3
6153C	19GETLAM	31.3
61705	19PUTLAM	31.3
3AA0A	1A/LockA	
62DB3	1ABNDSWAP	31.3
634B6	1GETABND	31.3
613B6	1GETLAM	31.3
55288	1GETLAMSWP1+	31.3
62F07	1GETSWAP	31.3
634CF	1LAMBIND	31.3
34D2B	1NULLLAM{}	31.3
615E0	1PUTLAM	31.3
514DC	1REV	
15978	1stkdecomp$w	
6362D	2#0=OR	17.4
2B470	2%%>%	18.2
2B45C	2%>%%	18.2
61B45	2@REVAL	34
6154C	20GETLAM	31.3
61715	20PUTLAM	31.3
6155C	21GETLAM	31.3
61725	21PUTLAM	31.3
6156C	22GETLAM	31.3
61735	22PUTLAM	31.3
03258	2DROP	29
6254E	2DROP00	17.1
3FDBD	2DropBadKey	
62B0B	2DROPFALSE	33.1
031AC	2DUP	29
63704	2DUP#+	17.3
6289B	2DUP#<	17.4
628B5	2DUP#=	17.4
628D1	2DUP#>	17.4
63C40	2DUP5ROLL	29
635D8	2DUPEQ	33.2
611F9	2DUPSWAP	29
64E0A	2EXT	17.1
632E5	2GETEVAL	31.3
613E7	2GETLAM	31.3
64DE2	2GROB	17.1
51532	2HXSLIST?	17.2
64C66	2LIST	17.1
63FFB	2Ob>Seco	25.5
63FBA	2OVER	29
615F0	2PUTLAM	31.3
61AE9	2'RCOLARPITE	35.1
6114E	2RDROP	34
04099	2REAL	17.1
626E5	2skipcola	34.2
62001	2SWAP	29
61B55	3@REVAL	34
60F4B	3DROP	29
6140E	3GETLAM	31.3
611FE	3PICK	29
63740	3PICK#+	17.3
63C68	3PICK3PICK	29
630B5	3PICKOVER	29
62EDF	3PICKSWAP	29
61600	3PUTLAM	31.3
61160	3RDROP	34
64E64	3REAL	17.1
626DC	3skipcola	34.2
60FAC	3UNROLL	29
60F7E	4DROP	29
60F83	4DropLoop	
61438	4GETLAM	31.3
52D26	4NULLLAM{}	31.3
6121C	4PICK	29
63754	4PICK#+	17.3
62DE5	4PICK#+SWAP	17.3
62DE5	4PICK+SWAP	17.3
630C9	4PICKOVER	29
62EF3	4PICKSWAP	29
61615	4PUTLAM	31.3
60FBB	4ROLL	29
62864	4ROLLDROP	29
630A1	4ROLLOVER	29
63001	4ROLLROT	29
62ECB	4ROLLSWAP	29
6109E	4UNROLL	29
6113C	4UNROLL3DROP	29
62D09	4UNROLLDUP	29
63015	4UNROLLROT	29
60F72	5DROP	29
6145C	5GETLAM	31.3
6123A	5PICK	29
61625	5PUTLAM	31.3
60FD8	5ROLL	29
62880	5ROLLDROP	29
626AE	5skipcola	34.2
610C4	5UNROLL	29
60F66	6DROP	29
6146C	6GETLAM	31.3
6125E	6PICK	29
61635	6PUTLAM	31.3
61002	6ROLL	29
610FA	6UNROLL	29
60F54	7DROP	29
6147C	7GETLAM	31.3
61282	7PICK	29
61645	7PUTLAM	31.3
6106B	7ROLL	29
62BC4	7UNROLL	29
6148C	8GETLAM	31.3
612A9	8PICK	29
61655	8PUTLAM	31.3
6103C	8ROLL	29
63119	8UNROLL	29

Addr.	Name	See
6149C	9GETLAM	31.3
61665	9PUTLAM	31.3
162B8	a%>$	20.3
162AC	a%>$,	20.3
39FB0	AbbrevStack?	
07497	ABND	31.3
04EA4	ABORT	32.1
12655	ABUFF	41.1
30914	ACK_INIT	
2B7DC	ADDF	
1265A	addrADISP	
4226A	addrATTNFLG	
0E7D3	addrClkOnNib	
00D48	addrKEYSTATE	
136AC	addrLINECNTg	
0188D	addrORghost	
04E66	addrTEMPENV	
179E8	addrTEMPTOP	
1263A	addrVDISP	
1264A	addrVDISP2	
1605F	addtics	
42EC7	AdjEdModes	
069F7	ADJMEM	
312DA	adr_uart_han	
047CF	adrDISABLE_K	
32CB6	adrGraphPrtH	
047DD	adrKEYBUFFER	
42284	adrTIMEOUTCL	
5EF15	AEQ1stcase	35.4
5F048	AEQopscase	35.4
071AB	AGAIN	36.1
2B770	aH>HMS	
0115A	AINRTN	
422A1	ALARM?	38
0E235	ALARMS@	
42113	ALARMxcp	
53968	AlgEntry?	41.5
3981B	AlgEntryStat	
1568F	ALGeq?	
001FF	allkeys	
010E5	AllowIntr	
324A6	AllowPrlcdCl	
2B67D	aMODF	
03B46	AND	33.1
18873	AND$	20.4
63CEA	ANDcase	35.1
63E61	ANDITE	35.1
63DDF	ANDNOTcase	35.1
39673	AngleStatus	
0010B	ANNCTRL	
2E4DC	APNDCRLF	20.4
35491	apndvarlst	25.4
38C08	AppDisplay!	
38C18	AppDisplay@	
62BB0	APPEND_SPACE	20.4
38C98	AppError!	
38CAB	AppError@	
38C68	AppExitCond!	
38C78	AppExitCond@	
38C38	AppKeys!	
38C58	AppKeys0	
38CFB	AppMode?	
47984	APPprompt1!	
479A7	APPprompt2	
00202	argtypeerr	
00203	argvalerr	
64BE4	ARRYREAL	17.1
03562	ARSIZE	23.1
0D5F6	ASLW5	
0D5E5	ASRW5	
34301	Attn#	17.1
42262	ATTN?	40.2
0CA60	ATTNchk	
64FC2	ATTNERR	17.1
05040	ATTNFLG@	40.2
05068	ATTNFLGCLR	40.2
420F5	ATTNxcp	
40BC9	AtUserStack	30
491D5	AUTOSCALE	
0948E	BAK>OB	28.4
081D9	BAKNAME	28.4
70601	BANKMTHDS	
54050	BASE	39.1
0010D	BAU	
071A2	BEGIN	36.1
66EA5	BigCursor	42.1
123C8	BIGDISPN	41.7
12415	BIGDISPROW1	41.7
12405	BIGDISPROW2	41.7
123F5	BIGDISPROW3	41.7
123E5	BIGDISPROW4	41.7
074D0	BIND	31.3
44F42	BindMatVars	
64CE8	BINT_115d	17.1
64CF2	BINT_116d	17.1
64D06	BINT_122d	17.1
64D1A	BINT_130d	17.1
64D24	BINT_131d	17.1
64BE4	BINT_65d	17.1
64C84	BINT_91d	17.1
64C8E	BINT_96d	17.1
64E1E	BINT253	17.1
64E28	BINT255d	17.1
64BDA	BINT40h	17.1
64D10	BINT80h	17.1
64DD8	BINTC0h	17.1
53EB0	bit-	21.3
5431C	bit#%-	21.3
542EA	bit#%*	21.3
542BD	bit#%/	21.3
54349	bit#%+	21.3
542FE	bit%#-	21.3
542D1	bit%#*	21.3
5429F	bit%#/	21.3
54330	bit%#+	21.3
53ED3	bit*	21.3
53F05	bit/	21.3
53EA0	bit+	21.3
53D04	bitAND	21.3
53E65	bitASR	21.3
008E6	BITMAP	
53D4E	bitNOT	21.3
00100	BITOFFSET	
53D15	bitOR	21.3
53E0C	bitRL	21.3
53E3B	bitRLB	21.3
53DA4	bitRR	21.3
53DE1	bitRRB	21.3
53D5E	bitSL	21.3
53D6E	bitSLB	21.3
53D81	bitSR	21.3
53D91	bitSRB	21.3
53D26	bitXOR	21.3
45676	Blank$	20.4
39632	Blank&GROB!	42.3
3A546	BlankDA1	41.4
3A578	BlankDA12	41.4
3A55F	BlankDA2	41.4
3A591	BlankDA2a	41.4
126DF	BLANKIT	41.4
515B4	BOTROW	41.6
3EC99	Box/StdLabel	42.4
3ECB2	Box/StdLbl:	42.4
2E108	BUILDKPACKET	
05DBC	C%%>%%	19.2
519F8	C%%>C%	19.2
51B2A	C%%0=	19.4
5193B	C%%1	19.1
51B91	C%%CHS	19.3
51BC1	C%%CONJ	19.3
4F408	C%>#	
05D2C	C%>%	19.2
519CB	C%>%%	19.2
519DF	C%>%%SWAP	19.2
524AF	C%0	19.1
51B43	C%0=	19.4
5F13B	C%0=case	35.3
524F7	C%1	19.1
5196A	C%-1	19.1
51EFA	C%1/	19.3
5F19F	C%1=case	35.3
5F285	C%-1=case	35.3
5F208	C%2=case	35.3
52062	C%ABS	19.3
52863	C%ACOS	19.3
52836	C%ACOSH	19.3
52305	C%ALOG	19.3
52099	C%ARG	19.3
52804	C%ASIN	19.3
5281D	C%ASINH	19.3
52675	C%ATAN	19.3
527EB	C%ATANH	19.3
52374	C%C^C	19.3
52360	C%C^R	19.3
51B70	C%CHS	19.3
51BB2	C%CONJ	19.3
52571	C%COS	19.3
52648	C%COSH	19.3
52193	C%EXP	19.3
521E3	C%LN	19.3
522BF	C%LOG	19.3
52342	C%R^C	19.3
520CB	C%SGN	19.3
52530	C%SIN	19.3
5262F	C%SINH	19.3
52107	C%SQRT	19.3
525B7	C%TAN	19.3
5265C	C%TANH	19.3
519B7	C>Im%	19.2
519A3	C>Re%	19.2
61CE9	CACHE	31.3
40CE9	CacheStack	
050ED	CAR$	20.4
05089	CARCOMP	25.1
0010E	CARDCTL	
0010F	CARDSTAT	
61993	case	35.1
6191F	case2drop	35.1
61970	case2DROP	35.1
63583	case2drpfls	35.1
63BEB	caseDEADKEY	35.6
63BEB	caseDoBadKey	35.6
618F7	casedrop	35.1
6194B	caseDROP	35.1
63BD2	caseDrpBadKy	35.6
6356A	casedrpfls	35.1
638B2	casedrptru	35.1

Addr.	Name	See
63169	caseERRJMP	35.6
6359C	caseFALSE	35.1
63B05	caseSIZEERR	35.6
634E3	caseTRUE	35.1
2BEE1	CCSB1	
0516C	CDR$	20.4
05153	CDRCOMP	25.1
1215E	CENTER$3x5	42.3
10E82	cfC	18.1
10E68	cfF	18.1
05AB3	CHANGETYPE	39.2
64CC0	char	17.1
444EE	Char>Edit	
42D82	CharEdit	
27D00	check_pdata	
511E3	CHECKHEIGHT	
04708	CHECKKEY	
4E266	CHECKMENU	
41111	CheckMenuRow	
51166	CHECKPICT	
4A9AF	CHECKPVARS	
32CAF	ChkGrHook	
325AA	ChkLowBat	
30B1D	CHOOSE_INIT	
65448	CHR_	20.1
6544F	CHR_-	20.1
65433	CHR_#	20.1
6543A	CHR_*	20.1
65456	CHR_.	20.1
65425	CHR_...	20.1
6545D	CHR_/	20.1
654AA	CHR_:	20.1
654B1	CHR_;	20.1
65694	CHR_[	20.1
6569B	CHR_]	20.1
656A2	CHR_{	20.1
656A9	CHR_}	20.1
65441	CHR_+	20.1
654B8	CHR_<	20.1
65640	CHR_<<	20.1
656B0	CHR_<=	20.1
656BE	CHR_<>	20.1
654BF	CHR_=	20.1
654C6	CHR_>	20.1
65639	CHR_->	20.1
656B7	CHR_>=	20.1
65647	CHR_>>	20.1
65464	CHR_0	20.1
6541E	CHR_00	20.1
6546B	CHR_1	20.1
65472	CHR_2	20.1
65479	CHR_3	20.1
65480	CHR_4	20.1
65487	CHR_5	20.1
6548E	CHR_6	20.1
65495	CHR_7	20.1
6549C	CHR_8	20.1
654A3	CHR_9	20.1
654CD	CHR_A	20.1
65583	CHR_a	20.1
6564E	CHR_Angle	20.1
654D4	CHR_B	20.1
6558A	CHR_b	20.1
654DB	CHR_C	20.1
65591	CHR_c	20.1
654E2	CHR_D	20.1
65598	CHR_d	20.1
6542C	CHR_DblQuote	20.1
65655	CHR_Deriv	20.1
654E9	CHR_E	20.1
6559F	CHR_e	20.1
654F0	CHR_F	20.1
655A6	CHR_f	20.1
654F7	CHR_G	20.1
655AD	CHR_g	20.1
654FE	CHR_H	20.1
655B4	CHR_h	20.1
65505	CHR_I	20.1
655BB	CHR_i	20.1
6565C	CHR_Integral	20.1
6550C	CHR_J	20.1
655C2	CHR_j	20.1
65513	CHR_K	20.1
655C9	CHR_k	20.1
6551A	CHR_L	20.1
655D0	CHR_l	20.1
65663	CHR_LeftPar	20.1
65521	CHR_M	20.1
655D7	CHR_m	20.1
65528	CHR_N	20.1
655DE	CHR_n	20.1
6566A	CHR_Newline	20.1
6552F	CHR_O	20.1
655E5	CHR_o	20.1
65536	CHR_P	20.1
655EC	CHR_p	20.1
65671	CHR_Pi	20.1
6553D	CHR_Q	20.1
655F3	CHR_q	20.1
65544	CHR_R	20.1
655FA	CHR_r	20.1
65678	CHR_RightPar	20.1
6554B	CHR_S	20.1
65601	CHR_s	20.1
6567F	CHR_Sigma	20.1
65686	CHR_Space	20.1
65552	CHR_T	20.1
65608	CHR_t	20.1
65559	CHR_U	20.1
6560F	CHR_u	20.1
6568D	CHR_UndScore	20.1
65560	CHR_V	20.1
65616	CHR_v	20.1
65567	CHR_W	20.1
6561D	CHR_w	20.1
6556E	CHR_X	20.1
65624	CHR_x	20.1
65575	CHR_Y	20.1
6562B	CHR_y	20.1
6557C	CHR_Z	20.1
65632	CHR_z	20.1
05A51	CHR>#	17.2
6475C	CHR>$	20.3
01160	CINRTN	
41CA2	Ck&DecKeyLoc	40.2
18F9D	CK&DISPATCH0	30
18FB2	CK&DISPATCH1	30
18FA9	CK&DISPATCH2	30
142FB	Ck&Freeze	
18A1E	CK0	30
23768	CK0ATTNABORT	
18A15	CK0NOLASTWD	30
18AA5	CK1	30
18ECE	CK1&Dispatch	30
1592D	CK1NoBlame	30
18AB2	CK1NOLASTWD	30
18A80	CK2	30
18EDF	CK2&Dispatch	30
18A8D	CK2NOLASTWD	30
18A5B	CK3	30
18EF0	CK3&Dispatch	30
18A68	CK3NOLASTWD	30
18B92	CK4	30
18F01	CK4&Dispatch	30
18B9F	CK4NOLASTWD	30
18B6D	CK5	30
18F12	CK5&Dispatch	30
18B7A	CK5NOLASTWD	30
42C3D	CkChr00	20.5
49C54	CkEQUtil	
4F7E6	CKGROBFITS	42.3
0A00E	CKLBCRC	
18C34	CKN	30
18C4A	CKNNOLASTWD	30
545A0	cknumdsptch1	27.1
51148	CKPICT	30.1
63B2D	CKREAL	30.1
37B44	CKREF	37.1
1F05B	CKSYMBTYPE	30.1
0D9C7	CKTIME	
01F6D	CLCD10	41.4
01FA7	CLEARLCD	41.4
51125	CLEARMENU	
134AE	CLEARVDISP	41.4
018E2	clkspd	
0EB81	CLKTICKS	38
0D7A1	CLKUTL1	
315C6	CLOSEUART	
315F9	CloseUart	
0E06F	Clr16	41.4
0E083	Clr8	41.4
0E097	Clr8-15	41.4
39FD2	ClrAbbrevStk	
53984	ClrAlgEntry	41.5
1133A	ClrAlphaAnn	41.5
38D17	ClrAppMode	
38D9B	ClrAppSuspOK	
39489	ClrDA1Bad	41.3
39531	ClrDA1IsStat	41.2
390CC	ClrDA1OK	41.3
394B3	ClrDA2aBad	41.3
390E5	ClrDA2aOK	41.3
394DD	ClrDA2bBad	41.3
39435	ClrDA2bNoCh	41.3
390FE	ClrDA2bOK	41.3
39117	ClrDA2OK	41.3
39507	ClrDA3Bad	41.3
3912B	ClrDA3OK	41.3
39144	ClrDAsOK	41.3
2BBE2	CLRFRC	
1136E	ClrLeftAnn	41.5
53A90	ClrNewEditL	
3958B	ClrNoRollDA2	41.3
11354	ClrRightAnn	41.5
2D9B2	ClrServMode	
53761	ClrSysFlag	39.1
423D3	clrtimeout	
53755	ClrUserFlag	39.1
40C94	CMDSTO	
0010A	CMODE	
41D92	CodePl>%rc.p	40.2
18CEA	COERCE	17.1
12770	COERCE$22	20.4
194F7	COERCE2	17.1
62CE1	COERCEDUP	17.1
5380E	COERCEFLAG	35.1
62E7B	COERCESWAP	17.1

Addr.	Name	See
06FD1	COLA	34.2
61A6D	COLA_EVAL	34.2
62986	COLAcase	
6296D	COLACOLA	34.2
6381C	COLAITE	
629A1	COLANOTcase	
61A8E	COLARPITE	35.1
633B2	COLASKIP	34.2
5573D	COLAthexFCN	
01FD3	Coldstart	
09B73	COMPCONFCRC	
18EBA	COMPEVAL	34
1F996	COMPLEXDUMMY	
396C8	ComVecStatus	
6506C	Connecting	17.1
00B02	constuniterr	
08D08	CONTEXT!	37.3
08D5A	CONTEXT@	37.3
00101	CONTRAST	
256E4	convertbase	
4651C	CopyColsLeft	
4677E	CopyColsRght	
46625	CopyRowsDown	
46409	CopyRowsUp	
7DF87	COPYVAR	
137DC	corner	
00104	CRC	
08696	CREATE	37.2
184E1	CREATEDIR	37.3
06AD8	CREATETEMP	
00113	CRER	
2E4F0	CRLF$	20.2
4DA0D	CROSS_HAIRS	
4DA76	CROSS_OFF	
5053C	CROSSGROB	42.1
4ECAD	CROSSMARKON	
1578D	CRUNCH	27.1
15941	CRUNCHNoBlam	
0D618	CSLW5	
0D607	CSRW5	
4248E	CtlAlarm!	
4E442	CURRENTMARK?	
427AF	Cursor&Disp	
444A5	CURSOR_END?	
13E85	CURSOR_OFF	
13D8C	CURSOR1	42.1
13DB4	CURSOR2	42.1
13D55	cursorblink-	
13D28	cursorblink+	
7DBF8	D/D-	
7DBE2	D/D*	
7DC03	D/D/	
7DDCF	D/D^	
7DDDA	D/D^X	
7DDE5	D/D^Y	
7DBED	D/D+	
7DC72	D/D=	
7DC7D	D/DABS	
7DCA1	D/DACOS	
7DCAC	D/DACOSH	
7DC72	D/Dalg=	
7DCB7	D/DALOG	
7DE1C	D/DAPPLY	
7DCC2	D/DARG	
7DCCD	D/DASIN	
7DCD8	D/DASINH	
7DCE3	D/DATAN	
7DCEE	D/DATANH	
7DCF9	D/DCHS	
7DD17	D/DCONJ	
7DD35	D/DCOS	
7DD40	D/DCOSH	
7DDF0	D/DDER	
7DD4B	D/DEXP	
7DD4B	D/DEXPM1	
7DD82	D/DIFTE	
7DE06	D/DINTEGRAL	
7DD56	D/DINV	
7DD61	D/DLN	
7DD6C	D/DLNP1	
7DD77	D/DLOG	
7DD8D	D/DSIN	
7DD98	D/DSINH	
7DDA3	D/DSQ	
7DDAE	D/DSQRT	
7DE11	D/DSUM	
7DDB9	D/DTAN	
7DDC4	D/DTANH	
7DDFB	D/DWHERE	
6384E	D0=DSKTOP	
01C31	D0->Row1	
01C58	D0->Sft1	
6385D	D1=DSKTOP	
3946D	DA1Bad?	41.3
38DAC	DA1OK?	41.3
38F28	DA1OK?NOTIT	41.3
39497	DA2aBad?	41.3
38FB9	DA2aLess1OK?	41.3
38F41	DA2aOK?NOTIT	41.3
39419	DA2bNoCh?	41.3
38F5A	DA2bOK?NOTIT	41.3
38EB5	DA3OK?	41.3
38F73	DA3OK?NOTIT	41.3
25223	DaDGNTc	
63DA3	dARRYcase	30.1
0CC0E	DATE	38
0CC5B	DATE+DAYS	38
0CFD9	Date>d$	38
0EE50	Date>hxs13	38
0D4AD	DAY#	
0D744	Day>Date	
0D62F	DCHXW	
17980	DcompWidth@	
424DA	DCursor	
0CC39	DDAYS	38
009A5	Debounce	
30D31	DECODE	
15B13	DECOMP$	
041ED	DEEPSLEEP	39.2
04292	DeepSleep	
2512D	delimcase	
0314C	DEPTH	29
7DC54	derprod1	
7DC0E	derquot	
63E07	dIDNTNcase	30.1
035A9	DIMLIMITS	23.1
01115	DisableIntr	
1245B	DISP@01	41.7
1246B	DISP@09	41.7
1247B	DISP@17	41.7
1248B	DISP@25	41.7
00120	DISP1CTL	
00130	DISP2CTL	
3A4CE	Disp5x7	41.7
13B51	DISPCHAR+PC	
4E6EF	DispCoord1	
4A055	DISPCOORD2	
398F4	DispDir?Tim1	
39958	DispDir?Tim2	
3988B	DispDir?Time	
3A00D	DispEditLine	
430CF	DispILPrompt	
3A1E8	DispMenu	
3A1FC	DispMenu.1	
12429	DISPN	
01BBD	DispOff	
01B8F	DispOn	
133AB	disprange	
1245B	DISPROW1	41.7
12725	DISPROW1*	41.7
1246B	DISPROW2	41.7
12748	DISPROW2*	41.7
1247B	DISPROW3	41.7
1248B	DISPROW4	41.7
1249B	DISPROW5	41.7
124AB	DISPROW6	41.7
124BB	DISPROW7	41.7
124CB	DISPROW8	41.7
395BA	DispStatus	
1270C	DISPSTATUS2	41.7
39B0A	DispStsBound	
39AF1	DispTimeReq?	
153FC	DispVarsUtil	
2BBB5	DIV2	
06A8E	DIV5	
2B977	DIVF	
63DB7	dLISTcase	30.1
073F7	DO	36.2
1502F	DO#EXIT	32.1
15048	DO$EXIT	32.1
15007	DO%EXIT	32.1
50438	DO>LCD	42.3
14088	DO>STR	20.3
3EE1A	Do1st/2nd+:	
02BAA	DOACPTR	16
029E8	DOARRY	16
3FDD1	DoBadKey	
3FDFE	'DoBadKey	34.1
3FE12	'DoBadKeyT	34.1
02B62	DOBAK	16
2EC84	DOBAUD	
1415A	DOBEEP	39.2
53C43	DOBIN	39.1
074E4	DOBIND	
02911	DOBINT	16
2EDE1	DOBUFLEN	
4F179	DOC>PX	
42475	DoCAlarmKey	
029BF	DOCHAR	16
140F1	DOCHR	20.3
5046A	DOCLLCD	41.4
02977	DOCMP	16
02DCC	DOCODE	16
02D9D	DOCOL	16
31854	docr	
31868	DOCR	
05981	DoCRC	
0597E	DoCRCc	
02A2C	DOCSTR	16
53C5B	DODEC	39.1
31FFD	DODELAY	
40DD4	DoDelim	
40DF7	DoDelims	
140AB	DODISP	
0299D	DOECMP	16
166FB	DOENG	39.1
4B60C	DOERASE	

Addr.	Name	See
02955	DOEREL	16
02ADA	DOEXT	16
02B88	DOEXT0	16
02BAA	DOEXT1	16
02BCC	DOEXT2	16
02BEE	DOEXT3	16
02C10	DOEXT4	16
620DC	DOFALSE	
2E876	DOFINISH	
3B211	DoFirstRow	
166E3	DOFIX	39.1
0554C	DOGARBAGE	
4CE6F	DOGRAPHIC	
02B1E	DOGROB	16
185C7	DoHere:	
53C37	DOHEX	39.1
02A4E	DOHSTR	16
02A4E	DOHXS	16
02E48	DOIDNT	16
199EB	DoInputForm	13
2EDA6	DOKERRM	
40454	DoKeyOb	
41904	DoLabel	42.4
02E6D	DOLAM	16
503D4	DOLCD>	42.3
02B40	DOLIB	16
02A74	DOLIST	16
02A0A	DOLNKARRY	16
40DC0	DoMenuKey	
41934	DoMenuKeyNS	
40350	DoNameKeyLRS	
40337	DoNameKeyRS	
44C31	DoNewMatrix	
3A71C	DoNextRow	
53C4F	DOOCT	39.1
44FE7	DoOldMatrix	
2EB37	DOOPENIO	
2ECCA	DOPARITY	
2E8D1	DOPKT	
3ADED	DoPlotMenu	
3A735	DoPrevRow	
31EE2	DOPRLCD	
4F0AC	DOPX>C	
2B07B	DORANDOMIZE	18.3
1572B	DORCLE	
02933	DOREAL	16
02E92	DOROMP	16
02A96	DORRP	16
2EE18	DOSBRK	
166EF	DOSCI	39.1
18CA7	DOSIZEERR	32.2
3BE54	DoSolvrMenu	
2EE97	DOSRECV	
16707	DOSTD	39.1
1C6A2	DOSTOALLF	39.1
15717	DOSTOE	
1C6E3	DOSTOSYSF	39.1
14137	DOSTR>	20.3
53CAA	dostws	39.1
02AB8	DOSYMB	16
02AFC	DOTAG	16
2ED10	DOTRANSIO	
620C3	DOTRUE	
186E8	DOTVARS%	
18779	DOVARS	37.3
1A7C9	dowait	38
38908	DoWarning	41.7
0DB51	dowutil	
167BF	DPRADIX?	39.1
4E582	DRAWBOX#	
50758	DRAWLINE#3	
4C639	drax	
63E1B	dREALNcase	35.5
03244	DROP	29
6394D	DROP'	34.1
637F4	DROP#1-	17.3
3FDC7	DropBadKey	
4D11E	DROPDEADTRUE	
627A7	DROPDUP	29
6210C	DROPFALSE	33.1
3A9B8	'DROPFALSE	34.1
03249	DropLoop	
63466	DROPLOOP	36.2
63FA6	DROPNDROP	29
04D3E	DROPNULL$	20.2
62946	DROPONE	17.1
63029	DROPOVER	29
632F9	DROPRDROP	34
62FC5	DROPROT	29
6270C	DROPSWAP	29
62726	DROPSWAPDROP	29
2DDC4	DropSysErr$	
18308	DropSysObs	
62103	DROPTRUE	33.1
62535	DROPZERO	17.1
00103	DSPCTL	
00102	DTEST	
62193	DTYPEARRY?	33.3
621E7	DTYPECOL?	33.3
62154	DTYPECSTR?	33.3
62211	DTYPELIST?	33.3
62169	DTYPEREAL?	33.3
61EA7	DUMP	31.3
03188	DUP	29
63925	DUP'	34.1
63687	DUP#<7	17.4
6347F	DUP#0_DO	36.2
622D4	DUP#0<>	17.4
633F8	DUP#0<>WHILE	36.1
62266	DUP#0=	17.4
61891	DUP#0=case	35.2
63CBD	DUP#0=csDROP	35.2
618A8	DUP#0=csedrp	35.2
63E48	DUP#0=IT	35.2
63EC5	DUP#0=ITE	35.2
6292F	DUP#1-	17.3
628EB	DUP#1+	17.3
6119E	DUP#1+PICK	29
622C5	DUP#1=	17.4
626F7	DUP#2+	17.3
63295	DUP$>ID	31.2
63BAA	DUP%0=	18.4
62C05	DUP@	37.2
634CA	DUP1LAMBIND	31.3
611F9	DUP3PICK	29
63704	DUP3PICK#+	17.3
61610	DUP4PUTLAM	31.3
61099	DUP4UNROLL	29
641CC	DupAndThen	
62CB9	DUPDUP	29
635EC	DUPEQ:	33.2
5179E	DUPGROBDIM	42.2
631E1	DUPINCOMP	25.3
63411	DUPINDEX@	36.2
627BB	DUPLEN$	20.4
63231	DUPLENCOMP	25.1
63209	DUPNULL$?	20.5
63A6F	DUPNULL{}?	25.4
6321D	DUPNULLCOMP?	25.1
63A9C	DUPONE	17.1
630DD	DUPPICK	29
630F1	DUPROLL	29
62C19	DUPROMPTR@	28.2
61FA9	DUPROM-WORD?	28.2
62FB1	DUPROT	29
62A2F	DUPSAFE@	37.2
61745	DUPTEMPENV	31.3
63AD8	DUPTWO	17.1
62193	DUPTYPEARRY?	33.3
6212A	DUPTYPEBINT?	33.3
62020	DUPTYPECHAR?	33.3
6217E	DUPTYPECMP?	33.3
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63A88	DUPZERO	17.1
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7DC88	easyabs	
42BD4	Echo$Key	
42BB6	Echo$NoChr00	
3EE47	Echo2Macros	
42AE4	EchoChrKey	
039EF	ECUSER	
15A40	ederr	
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63DCB	EditExstCase	
42D32	EditLevel1	
53A4A	EditLExists?	
44683	EDITLINE$	
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64C34	EIGHTY	17.1
64C3E	EIGHTYONE	17.1
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30BD7	ENCODE	
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635F1	EQ:	33.2
61933	EQcase	35.5
618BA	EQcasedrop	35.5
4E46A	EQCURSOR?	
63E2F	EQIT	35.5
63E75	EQITE	35.5
152FF	EqList?	
64593	EQLookup	25.1
63605	EQOR	33.2
6303D	EQOVER	33.2
03B97	EQUAL	33.2

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0402B	idnt	17.1
5F0AA	idntcase	35.5
5F0CD	idntlamcase	35.5
512D8	'IDPARAMETER	34.1
512C4	'IDPOLAR	34.1
64C98	IDREAL	17.1
0716B	IDUP	34
4744F	'IDX	31.1
408AA	ImmedEntry?	41.5
62B88	INCOMPDROP	25.3
2F383	IncrLAMPKNO	
510AD	INDEPVAR	
07221	INDEX@	36.2
63790	INDEX@#-	36.2
07270	INDEXSTO	36.2
00305	infreserr	
1A2DA	INHARDROM?	39.2
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4428B	InitEdLine	
44394	InitEdModes	
0970A	InitEnab	
2E6BE	InitIOEnv	
40F86	InitMenu	
41679	InitMenu%	
45023	InitOldMat	
385E8	InitSysUI	
41741	InitTrack:	
636A0	INNER#1=	25.3
054AF	INNERCOMP	25.3
62C41	INNERDUP	25.3
43200	InputLAttn	
43179	InputLEnter	
42F44	InputLine	
53A3C	INSERT?	
53A2E	INSERT_MODE	
03F24	IntDiv	
64F04	INTEGER337	17.1
06B4E	INTEMNOTREF?	37.1
00A03	intrptderr	
122FF	INVGROB	42.3
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2EC25	IOCheckReal	
0011F	IRAM@	
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3E5CD	IStackKey	
07249	ISTOP@	36.2
5182F	ISTOP-INDEX	36.2
07295	ISTOPSTO	36.2
619BC	IT	35.1
61AD8	ITE	35.1
61A58	ITE_DROP	35.1
63D7B	j%0=case	35.3
63CD6	jEQcase	35.5
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072AD	JINDEXSTO	36.2
04D87	JstGETTHEMSG	32.1
07264	JSTOP@	36.2
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516E5	JUMPLEFT	41.6
51703	JUMPRIGHT	41.6
51690	JUMPTOP	41.6
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3FB1A	Key>StdKeyOb	
3FA57	Key>U/SKeyOb	
04999	KeyInBuff?	
42402	KEYINBUFFER?	40.2
40A6F	KeyOb!	
40A82	KeyOb@	
40A95	KeyOb0	
13061	KILLGDISP	41.2
3016B	KINVISLF	
2FEDD	KVIS	
2FEC9	KVISLF	
418F4	LabelDef!	
2D45A	LAMKLIST	
2F211	LAMKML	
2D46D	LAMKMODE	
2D3EE	LAMKP	
2D441	'LamKPSto	
2D493	LAMKRM	
2D3FB	LAMLNAME	
63A3D	'LAMLNAMESTO	
2D40E	LAMOBJ	
2D41D	LAMOPOS	
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2D3A0	LAMPKNO	
2D3C6	LAMRETRY	
6326D	LAST$	20.4
426F1	LastERow?	
419E4	LastMenuDef!	
419F4	LastMenuDef@	
4186E	LastMenuRow!	
41881	LastMenuRow@	
18621	LastNonNull	
50D78	LASTPT?	
08326	LASTRAM-WORD	37.3
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515FA	LEFTCOL	41.6
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05616	LENHXS	21.1
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24C0D	List	
64C48	LISTCMP	17.1
64C7A	LISTLAM	17.1
20B9A	LISTRCL	37.2
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41175	LoadTouchTbl	
40D25	LockAlpha	41.5
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6452F	Lookup	25.1
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07334	LOOP	36.2
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62ABB	MACRODCMP	
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03442	MAKEARRY	23.1
017A6	makebeep	39.2
3A38A	MakeBoxLabel	42.4
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3A44E	MakeInvLabel	42.4
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4B323	MAKEPICT#	
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3A328	MakeStdLabel	42.4
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7DF45	MANMENUEQ	
7DF24	MANMENUEXP	
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7DF5B	MANMENUTRG	
5055A	MARKGROB	
643EF	matchob?	
643F9	matchob?Lp	
35CAE	MATCON	23.2
37E0F	MATREDIM	23.2
3811F	MATTRN	23.2
2D396	MAXRETRY	
357A8	MDIMS	23.1
62F9D	MDIMSDROP	23.1
66ECD	MediumCursor	42.1
05F61	MEM	39.2
03FF9	MEMERR	17.1
390A4	MENoP&FixDA1	41.3
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418A4	MenuDef@	
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41944	MenuKeyLS!	
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41924	MenuKeyNS@	
41964	MenuKeyRS!	
407FB	MenuMaker	
4E2AC	MENUOFF	
4E360	MENUOFF?	41.2
41848	MenuRow!	
4185B	MenuRow@	
418D4	MenuRowAct!	
5EFD9	MEQ1stcase	35.4
5EFF9	MEQopscase	35.4
63F1A	metaROTDUP	26.1
28296	metatail	26.4
5F061	Mid1stcase	35.4
6509E	MINUSONE	17.1
4085A	Modifier	
3FE7B	ModifierKey?	
0670C	MOVEDOWN	
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069C5	MOVEDSU	
06992	MOVERSD	
06A53	MOVERSU	
066B9	MOVEUP	
7DF7C	MOVEVAR	
0D8AE	mpop1%	
53EE4	MPY	
03991	MUL#	
2B91E	MULTF	
62F75	N+1DROP	29
63B19	NcaseSIZEERR	35.6

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64426	POSCOMP	25.1
00301	posunferr	
1BB41	preFACT	43
4E497	PREMARKON	
1863A	PrevNonNull	37.3
08376	PREVRAM-WORD	37.3
39853	PrgmEntrStat	
11511	PrgmEntry?	41.5
32161	PRINT	
32B74	PrintGrob	
32387	PRINTxNLF	
028FC	PRLG	
49709	PromptIdUtil	20.3
00C13	prtparerr	
5EB1C	psh	26.1
5E3AC	psh&	0
5E706	psh1&	26.3
5E7A5	psh1&rev	26.3
5E401	psh1top&	26.3
5E4D1	pshtop&	26.3
5E67A	pshzer	26.3
5EA9F	pshzerpsharg	27.3
323E9	PSubErr	
5133C	PtoR	
7DF71	PTYPE>PINFO	
6408C	PuHiddenVar	37.4
5E4A9	pull	26.3
355C8	PULLCMPEL	23.1
5E4EA	pullpsh1&	26.3
355B8	PULLREALEL	23.1
5E4BD	pullrev	26.3
0F3E4	puretemp?	
08C27	PURGE	37.2
06537	PUSH#	
0357C	PUSH#ALOOP	
2E31F	Push#FLoop	
0357F	PUSH#LOOP	
036F7	Push#TLoop	
2A188	PUSH%	
2A23D	PUSH%LOOP	
06529	PUSH2#	
627EB	Push2#aLoop	
03F14	Push2#Loop	
03A86	PUSHA	
620C0	PushF/TLoop	
620DC	PushFLoop	
5422C	PUSHhxs	
0596D	PUSHhxsLoop	
620D9	PushT/F	
620D9	PushT/FLoop	
620C3	PushTLoop	
2C04B	PUTAB0	
356F3	PUTCMPEL	23.1
35628	PUTEL	23.1
4AF77	PUTINDEP	
4AF8B	PUTINDEPLIST	
075E9	PUTLAM	31.3
1DC00	PUTLIST	25.4
6594E	putnibs	
4B076	PUTPTYPE	
3566F	PUTREALEL	23.1
4B012	PUTRES	
4AE3C	PUTSCALE	
31444	PUTSERIAL	
30E4E	PutSerialECk	
4B1AC	PUTXMAX	
4B166	PUTXMIN	
4B1CF	PUTYMAX	

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4B189	PUTYMIN	
4AB2A	PvarsC%0	
63F92	pZpargSWAPUn	27.3
06EEB	'R	34
07012	R@	34
0701F	R>	34
53BDD	RAD?	39.1
2B7B0	RADD1	
2B7CA	RADDF	
082E3	RAM-WORDNAME	37.3
2520A	'Rapndit	
00114	RBR	
2BEB5	RCAB0	
2BEC0	RCAB2	
2BECB	RCCD0	
2BED6	RCCD2	
01AD7	RCKBp	
42E86	Rcl&Do:	
64023	RclHiddenVar	37.4
1C637	RCLSYSF	39.1
1C64E	RCLUSERF	39.1
00111	RCS	
06FB7	RDROP	34
62958	RDROPCOLA	34
5DE55	RDROPFALSE	33.1
14EA5	RDUP	34
51A37	Re>C%	19.2
03FF9	real	17.1
63D8F	REALcase	35.3
0411B	REALEXT	17.1
0408F	REALOB	17.1
64E32	REALOBOB	17.1
265ED	realPAcode	
04099	REALREAL	17.1
040F3	REALSYM	17.1
130AC	RECLAIMDISP	41.2
510D5	RECORDX&YC%	
2F989	RecvNextPkt	
323F9	REMAP	
071E5	REPEAT	36.1
40E88	REPEATER	
51735	REPEATERCH	
047C7	REPKEY?	40.2
085D3	REPLACE	37.2
53A20	REPLACE_MODE	
629D0	REQcase	
629E9	REQcasedrop	
4B710	RESETDEPTH	
62BD8	RESOROMP	
0C147	restoreiram	
640FA	RestVarRes	
06F66	'REVAL	34
5DE7D	reversym	29
41984	ReviewKey!	
0C506	rGETATELN	
1200C	RIGHT$3x6	42.3
5160E	RIGHTCOL	41.6
2BEEC	RNDC[B]	
2B529	RNDXY	18.3
71C3B	rNTHELCOMP	
03325	ROLL	29
42E27	Roll&Do:	
63F42	roll2top&	0
62F89	ROLLDROP	29
62D45	ROLLSWAP	29
63F42	rolltwotop&	0
64E14	ROMPANY	
07E99	ROMPTR@	28.2
08CCC	ROMPTR>#	28.2

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61FB6	ROM-WORD?	28.2
61FCF	Rom-Word?	
06806	ROOM	
49BD2	RootUtil	
03295	ROT	29
63768	ROT#-	17.3
63718	ROT#+	17.3
62DCC	ROT#+SWAP	17.3
637B8	ROT#1+	17.3
5FB76	ROT#1+UNROT	17.3
62DCC	ROT+SWAP	17.3
62726	ROT2DROP	29
62C7D	ROT2DUP	29
62C91	ROTAND	33.1
60F21	ROTDROP	29
60F0E	ROTDROPSWAP	29
62775	ROTDUP	29
62CA5	ROTOVER	29
6112A	ROTROT2DROP	29
60EE7	ROTSWAP	29
63F2E	ROTUntop&	0
45C2F	RowElt#	
4489E	ROWNUM	
0E0FB	Rows8-15	41.6
070FD	RPIT	35.1
070C3	RPITE	35.1
234C1	RPN->	43
1F55D	rpnAPPLY	43
1EF7E	rpnDER	43
1F1D4	rpnINTG	43
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639FC	'RRDROP	34
62474	'RSaveRomWrd	
62474	'RSAVEWORD	
63880	RSKIP	34
15A60	rstfmt1	
2B7A7	RSUB1	
60EBD	RSWAP	
62A34	SAFE@	37.2
1853B	SAFE@_HERE	37.2
0A532	SAFESKIPOB	
62A02	SAFESTO	37.2
0000F	sALLOWINTR	
15A8B	savefmt1	
61D3A	SAVELAM	
40C76	SaveLastEdit	
4139B	SaveLastMenu	
61D41	SAVESTACK	31.3
640A0	SaveVarRes	
0679B	SAVPTR	
01307	SavPtrTime*	
00008	sBEG	
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4D150	SCROLLLEFT	41.6
4D18C	SCROLLRIGHT	41.6
4D132	SCROLLUP	41.6
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3A2C9	Seco>Menu	42.4
0312B	SEMI	
61A47	SEMILOOP	
2D5E1	SEND_PACKET	
2FEA1	SENDACK	
2D58C	SENDEOT	
2E0C7	SENDERROR	
2E6EB	SENDLIST	

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2E0A9	SENDNAK	
2FEB5	SENDNULLACK	
2E0F4	SENDPKT	
2EEC4	SendSetup	
127A7	SEP$NL	20.4
07661	SET	
39FC1	SetAbbrevStk	
53976	SetAlgEntry	41.5
1132D	SetAlphaAnn	41.5
38D09	SetAppMode	
38D8A	SetAppSuspOK	
141B2	setbeep	39.2
11016	SETCIRCERR	32.2
4325A	SetCursor	
391EE	SetDA123NoCh	41.3
3919E	SetDA12NoCh	41.3
3921B	SetDA12Temp	41.3
391C6	SetDA13NoCh	41.3
3947B	SetDA1Bad	41.3
39523	SetDA1IsStat	41.3
393D3	SetDA1NoCh	41.3
3902C	SetDA1Temp	41.3
38FD2	SetDA1Valid	41.3
391B2	SetDA23NoCh	41.3
394A5	SetDA2aBad	41.3
39086	SetDA2aEcho	41.3
393FD	SetDA2aNoCh	41.3
39045	SetDA2aTemp	41.3
38FEB	SetDA2aValid	41.3
394CF	SetDA2bBad	41.3
39427	SetDA2bNoCh	41.3
39059	SetDA2bTemp	41.3
38FFF	SetDA2bValid	41.3
3918A	SetDA2NoCh	41.3
39207	SetDA2OKTemp	41.3
3915D	SetDA2Valid	41.3
394F9	SetDA3Bad	41.3
39451	SetDA3NoCh	41.3
39072	SetDA3Temp	41.3
39018	SetDA3Valid	41.3
39301	SetDA3ValidF	41.3
3922F	SetDAsTemp	41.3
2A5D2	SETDEG	39.1
38D5D	SetDoStdKeys	
3252B	SetEcma94	
53B31	setflag	
2A604	SETGRAD	39.1
07638	SETHASH	0
640BE	SetHiddenRes	37.4
2EC34	SetIOPARErr	32.2
539F9	SetISysFlag	
29DFC	SETIVLERR	
3FCAF	SetKeysNS	
11361	SetLeftAnn	41.5
4CF41	SETLOOPENV	
04FB6	SETMEMERR	32.2
0764E	SETMESG	0
38D33	SetNAppKeyOK	
18C92	SETNONEXTERR	32.2
3957A	SetNoRollDA2	41.3
04FF2	SETPORTNOTAV	32.2
11533	SetPrgmEntry	41.5
2A5F0	SETRAD	39.1
417F3	SetRebuild	
11347	SetRightAnn	41.5
21CBA	SETROMPART	
05016	SETROMPERR	32.2
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18CA2	SETSIZEERR	32.2
3A9E7	SetSomeRow	
18CC2	SETSTACKERR	32.2
53731	SetSysFlag	39.1
410C6	SetThisRow	
423BB	settimeout	
18CB2	SETTYPEERR	32.2
53725	SetUserFlag	39.1
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6106B	SEVENROLL	29
04099	SEVENTEEN	17.1
64C16	SEVENTY	17.1
64C20	SEVENTYFOUR	17.1
64C2A	SEVENTYNINE	17.1
00001	Sfkey1	
00006	Sfkey6	
00002	sFLUSH	
0426A	ShowInvRomp	39.2
16671	Shrink$	
64190	Sig?ErrJmp	
0402B	SIX	17.1
61002	SIXROLL	29
0408F	SIXTEEN	17.1
64BB2	SIXTY	17.1
64C02	SIXTYEIGHT	17.1
64BDA	SIXTYFOUR	17.1
64BBC	SIXTYONE	17.1
64BD0	SIXTYTHREE	17.1
64BC6	SIXTYTWO	17.1
610FA	SIXUNROLL	29
0714D	SKIP	34.2
626EE	skipcola	34.2
03019	SKIPOB	
42131	SLEEPxcp	
40EE7	SLOW	38
66EF1	SmallCursor	42.1
558F5	sncknum2	27.1
00002	sNEGATE	
151A6	SolvMenuInit	
48FF9	SORTASLOW	
65254	SPACE$	20.2
2BC4A	SPLITA	
7DEF8	SPLITWHERE	
2BCA0	SPLTAC	
2BA0F	SQRF	
00118	SRQ1	
00119	SRQ2	
0131D	srvc_timer2	
007B5	SrvcKbdAB	
558DC	sscknum2	27.1
14C17	sstDISP	
2BE61	STAB0	
2BE6F	STAB2	
1686A	stackitw	
41008	StartMenu	
3858E	StartupProc	
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2C535	STATN	23.3
2C2D9	STATSADD%	23.3
2C558	STATSMAX	23.3
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3ED0C	Std/BoxLabel	42.4
2E99E	StdIOPAR	
401D4	StdMenuKeyLS	
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31F4A	StdPRTPAR	
159EB	stkdecomp$w	
07D27	STO	37.2
63975	STO'	34.1
0E6ED	STOALM	38
47467	STOAPPLDATA	
64078	StoHiddenVar	37.4
2E9CB	StoIOPAR	
07D1B	STOLAM	31.3
31F7D	StoPRTPAR	
0400D	str	17.1
3A2B5	Str>Menu	42.4
64775	STRIPTAGS	22
647A2	STRIPTAGSl2	22
64B6C	STRLIST	17.1
00001	sTRUNC	
05733	SUB$	20.4
30805	SUB$1#	20.4
62D6D	SUB$SWAP	20.4
05821	SUBCOMP	25.1
1192F	SUBGROB	42.3
05815	SUBHXS	21.2
64345	SubMetaOb	26.4
643BD	SubMetaOb1	26.4
29BC2	subpdcdptch	
1446F	SuspendOK?	
03223	SWAP	29
63939	SWAP'	34.1
62794	SWAP#-	
637E0	SWAP#1-	17.3
62904	SWAP#1+	17.3
51843	SWAP#1+SWAP	17.3
51857	SWAP#1-SWAP	17.3
63BBE	SWAP%%/	18.3
632A9	SWAP%>C%	19.2
622EF	SWAP&$	20.4
6386C	SWAP2DUP	29
63C54	SWAP3PICK	29
63C7C	SWAP4PICK	29
63C2C	SWAP4ROLL	29
63F7E	SWAPCKREF	37.1
63312	SWAPCOLA	34.2
5A01D	SWAPcompSWAP	
60F9B	SWAPDROP	29
62830	SWAPDROPDUP	29
6284B	SWAPDROPSWAP	29
21660	SWAPDROPTRUE	33.1
62747	SWAPDUP	29
631F5	SWAPINCOMP	25.3
63425	SWAPINDEX@	36.2
6344D	SWAPLOOP	36.2
63AB0	SWAPONE	17.1
61380	SWAPOVER	29
637A4	SWAPOVER#-	17.3
60F33	SWAPROT	29
3745E	SWAPROWS	23.1
4F1D8	SWAPTRUE	33.1
638FD	SWAPUnDROP	29
63911	SWAPUnNDROP	26.1
62904	SWP1+	17.3
04053	sym	17.1
04049	symb	17.1
659DE	Symb>HBuff	42.3
0546D	SYMBN	25.2
5A310	symbn	
32FF9	SYMBNUMSOLVE	
64D38	SYMBREAL	17.1
64D56	SYMBUNIT	17.1

Addr.	Name	See
547B5	SYMBWHERE	27.2
57D90	SYMCOLCT	27.2
5E652	symcomp	27.1
64DBA	SYMEXT	17.1
64D92	SYMID	17.1
64D9C	SYMLAM	17.1
64D6A	SYMOB	17.1
64D74	SYMREAL	17.1
58D75	SYMSHOW	27.2
64DB0	SYMSYM	17.1
10F86	SYNTAXERR	32.2
2EA6A	Sys@	
08D92	SYSCONTEXT	37.3
386A1	SysDisplay	
38728	SysErrorTrap	
63EED	SysITE	35.6
3866F	SysMenuCheck	
08D66	SysPtr@	
2E9E6	SysSTO	
40792	SystemLevel?	
0EB81	SysTime	38
64DEC	TAGGEDANY	17.1
647BB	TAGOBS	22
40788	TakeOver	14.5
00116	TBR	
00112	TCS	
0F41B	TempConv	
04053	TEN	17.1
53784	TestSysFlag	39.1
53778	TestUserFlag	39.1
04071	THIRTEEN	17.1
0411B	THIRTY	17.1
0416B	THIRTYEIGHT	17.1
0414D	THIRTYFIVE	17.1
04143	THIRTYFOUR	17.1
04175	THIRTYNINE	17.1
04125	THIRTYONE	17.1
04161	THIRTYSEVEN	17.1
04157	THIRTYSIX	17.1
04139	THIRTYTHREE	17.1
0412F	THIRTYTWO	17.1
0400D	THREE	17.1
631CD	THREE{}N	25.4
61B89	ticR	34
4227F	TIMEOUT?	
00137	TIMER1	
00138	TIMER2	
0012E	TIMERCTRL.1	
0012F	TIMERCTRL.2	
0D304	TIMESTR	38
1314D	TOADISP	41.1
0CBFA	TOD	38
0D06A	TOD>t$	38
13135	TOGDISP	41.1
5072B	TOGGLELINE#3	
3E586	TogInsertKey	
50AF9	TOGLINE	42.3
50ADB	TOGLINE3	42.3
65290	tok,	20.2
65284	tok'	20.2
652FC	tok-	20.2
6529C	tok.	20.2
65254	tok_	20.2
0FA69	tok_g	20.2
0FA8E	tok_m	20.2
0FACE	tok_s	20.2
65176	tok{	20.2
651D6	tok<<	20.2
65308	tok=	20.2
2856C	tok=casedrop	
25446	tok->	20.2
6534C	tok0	20.2
65358	tok1	20.2
653AC	tok8	20.2
0BD54	tok8cktrior	
0BD60	tok8trior	
653B8	tok9	
651BE	tokESC	20.2
651E2	tokexponent	20.2
65278	tokquote	20.2
6518E	toksharp	20.2
63498	toLEN_DO	36.2
5E415	top&	0
63F01	top&Cr	
0E0AB	TOP16	41.6
0E0D3	TOP8	41.6
4272D	TopERow?	
515A0	TOPROW	41.6
07709	TOSRRP	0
06657	TOTEMPOB	37.1
62C69	TOTEMPSWAP	37.1
2B53D	TRCXY	18.3
2EFD7	TRPACKETFAIL	
03A81	TRUE	33.1
63989	TRUE'	34.1
634F7	TRUEFALSE	33.1
634F7	TrueFalse	33.1
0BBED	TrueTrue	33.1
2BD76	TST15	
4E2CF	TURNMENUOFF	41.2
4E347	TURNMENUON	41.2
041A7	TurnOff	
3A9CE	TurnOffKey	
04067	TWELVE	17.1
040B7	TWENTY	17.1
04107	TWENTYEIGHT	17.1
040E9	TWENTYFIVE	17.1
040DF	TWENTYFOUR	17.1
04111	TWENTYNINE	17.1
040C1	TWENTYONE	17.1
040FD	TWENTYSEVEN	17.1
040F3	TWENTYSIX	17.1
040D5	TWENTYTHREE	17.1
040CB	TWENTYTWO	17.1
04003	TWO	17.1
631B9	TWO{}N	25.4
03C64	TYPE	33.3
62198	TYPEARRY?	33.3
6212F	TYPEBINT?	33.3
62256	TYPECARRY?	33.3
62025	TYPECHAR?	33.3
62183	TYPECMP?	33.3
621EC	TYPECOL?	33.3
62159	TYPECSTR?	33.3
6204F	TYPEEXT?	33.3
62201	TYPEGROB?	33.3
62144	TYPEHSTR?	33.3
03FA9	TYPEIDNT	17.1
6203A	TYPEIDNT?	33.3
6211A	TYPELAM?	33.3
62216	TYPELIST?	33.3
6223B	TYPERARRY?	33.3
03F8B	TYPEREAL	17.1
6216E	TYPEREAL?	33.3
621AD	TYPEROMP?	33.3
621C2	TYPERRP?	33.3
621D7	TYPESYMB?	33.3
6222B	TYPETAGGED?	33.3
10047	U>nbr	24.2
0FE44	U>NCQ	24.2
42249	UART?	
3133B	UARTBUFLEN	
42145	UARTxcp	
42660	UCursor	
0F774	UM-	24.3
0F598	UM#?	24.4
0FBAB	UM%	24.3
0FC3C	UM%CH	24.3
0FCCD	UM%T	24.3
0F792	UM*	24.3
10B5E	um*	24.1
0F823	UM/	24.3
10B68	um/	24.1
10B72	um^	24.1
0F6A2	UM+	24.3
0F5AC	UM<?	24.4
0F5D4	UM<=?	24.4
0F584	UM=?	24.4
0F5C0	UM>?	24.4
0F5E8	UM>=?	24.4
0F33A	UM>U	24.2
0F5FC	UMABS	24.3
0FD36	UMCEIL	24.3
0F615	UMCHS	24.3
0F371	UMCONV	24.3
0F660	UMCOS	24.3
10B86	umEND	24.1
0FD22	UMFLOOR	24.3
0FD0E	UMFP	24.3
0FCFA	UMIP	24.3
0FB6F	UMMAX	24.3
0FB8D	UMMIN	24.3
10B7C	umP	24.1
0FD68	UMRND	24.3
0F945	UMSI	24.2
0FCE6	UMSIGN	24.3
0F62E	UMSIN	24.3
0F913	UMSQ	24.3
0F92C	UMSQRT	24.3
0F674	UMTAN	24.3
0FD8B	UMTRC	24.3
0F34E	UMU>	24.2
0F8FA	UMXROOT	24.3
10065	Unbr>U	24.2
18DBF	UNCOERCE	18.2
63B96	UNCOERCE%%	18.2
1950B	UNCOERCE2	18.2
5A036	uncrunch	27.1
61F8F	undo	31.3
538DC	UNDO_OFF	
538CE	UNDO_ON	
538C0	UNDO_ON?	
0F218	UNIT>$	24.2
40D39	UnLockAlpha	41.5
0339E	UNROLL	29
60FAC	UNROT	29
6112A	UNROT2DROP	29
6284B	UNROTDROP	29
62CF5	UNROTDUP	29
6308D	UNROTOVER	29
60F33	UNROTSWAP	29
60F0E	UNROTSWAPDRO	29
071C8	UNTIL	36.1
1A16F	UPDIR	37.3
225F5	USER$>TAG	24.1
39748	UserFlagStat	
63ED9	UserITE	35.6

Addr.	Name	See
41A8D	UserKeys?	
397BB	UserKeysStat	
6416D	UStackDepth	
1A265	VARSIZE	39.2
0E66A	VerifyTOD	
30794	VERSTRING	
40F02	VERYSLOW	38
40F12	VERYVERYSLOW	38
42D46	ViewLevel1	
17B86	VLM	
4B553	VSCALE	
1165A	w->W	
1A738	Wait/GetKey	40.2
41F65	WaitForKey	40.2
01FBD	Warmstart	
071EE	WHILE	36.1
4F052	WINDOW#	
51645	WINDOWBOT?	41.6
137B6	WINDOWCORNER	
13220	WINDOWDOWN	41.6
134E4	WINDOWLEFT	41.6
5165E	WINDOWLEFT?	41.6
1357F	WINDOWRIGHT	41.6
51677	WINDOWRIGHT?	41.6
5162C	WINDOWTOP?	41.6
131C8	WINDOWUP	41.6
13679	WINDOWXY	
136AA	WindowXY	
64037	WithHidden	37.4
54039	WORDSIZE	39.1
1AD09	x-	43
1ADEE	x*	43
63B5A	'x*	34.1
1AF05	x/	43
0931B	X@	
1B02D	x^	43
1AB67	x+	43
1EBBE	x<?	43
2361E	x<<	43
1EC5D	x>?	43
23639	x>>	43
235FE	x>>ABND	43
22FEB	xALG->	43
1F5C5	xAPPLY	43
1D186	xCON	43
1EFD2	xDER	43
63B6E	'xDER	34.1
63A56	'xDEREQ	
236B9	xENDDO	43
23679	xENDTIC	43
1D054	XEQ>ARRAY	23.1
21B5A	XEQIOBACKUP	
20FF2	XEQORDER	37.3
18595	XEQPGDIR	37.3
20F8A	XEQPURGEPICT	
20B81	XEQRCL	37.2
21C6F	XEQSETLIB	
20B00	XEQSHOWLS	27.2
18513	XEQSTOID	37.2
40F22	XEQStoKey	
1CB90	XEQTYPE	30.1
2371F	xERRTHEN	43
1BB02	xFACT	43
1F640	xFCNAPPLY	43
1FAEB	xFORMUNIT	43
213D1	xFREE	43
1E661	xFUNCTION	43
64D24	XHI	17.1
64D1A	XHI-1	17.1
22FD5	xIFEND	43
1A3FE	xIFTE	43
1F223	xINTEGRAL	43
20FAA	xMEM	43
1ACDD	xNEGNEG	43
56101	xnsgeneral	27.1
1CF7B	xOBJ>	43
03ADA	XOR	33.1
1889B	XOR$	20.4
1E6C1	xPARAMETRIC	43
1E6A1	xPOLAR	43
1D5DF	xPUTI	43
1D0DF	xRDM	43
2349C	xSILENT'	43
1C9B8	xSIZE	43
5611F	xsngeneral	27.1
560ED	xssgeneral	27.1
231A0	xSTARTVAR	43
1C67F	xSTOF	43
237A8	xTHENCASE	43
1F3F3	xWHERE	43
23694	xWHILEEND	43
1B1CA	xXROOT	43
60F9B	XY>Y	29
2BE53	XYEX	
128B0	XYGROBDISP	42.3
60F4B	XYZ>	29
62726	XYZ>Y	29
60EE7	XYZ>YXZ	29
60F21	XYZ>YZ	29
6112A	XYZ>Z	29
63326	XYZ>ZCOLA	34.2
62EB7	XYZ>ZTRUE	33.1
6284B	XYZ>ZX	29
60FAC	XYZ>ZXY	29
60F0E	XYZ>ZY	29
60F33	XYZ>ZYX	29
60F7E	XYZW>	29
6113C	XYZW>W	29
6109E	XYZW>WXYZ	29
63C2C	XYZW>YWZX	29
60FBB	XYZW>YZWX	29
2BD32	Y<=X	
64BDA	YHI	17.1
0DB3A	YMD>Ticks	
4E776	Z-BOX	
03FEF	ZERO	17.1
073C3	ZERO_DO	36.2
6351F	ZEROFALSE	33.1
6400F	ZEROISTOPSTO	36.2
63079	ZEROOVER	17.1
62E3A	ZEROSWAP	17.1
641FC	ZEROZERO	17.1
6431D	ZEROZEROONE	17.1
64331	ZEROZEROTWO	17.1
64309	ZEROZEROZERO	17.1

Chapter 45
Commands by address

Addr.	Name	See
00001	Sfkey1	
00001	sTRUNC	
00002	sFLUSH	
00002	sNEGATE	
00003	DZP	
00004	sBPOFF	
00006	Sfkey6	
00008	sBEG	
0000A	portnotaverr	
0000F	sALLOWINTR	
00019	ENTERCODE	
000B1	~DoMsgBox	
000B3	~Choose	
00100	BITOFFSET	
00101	CONTRAST	
00102	DTEST	
00103	DSPCTL	
00104	CRC	
00108	LPD	
00109	LPE	
0010A	CMODE	
0010B	ANNCTRL	
0010D	BAU	
0010E	CARDCTL	
0010F	CARDSTAT	
00110	IOC	
00111	RCS	
00112	TCS	
00113	CRER	
00114	RBR	
00116	TBR	
00118	SRQ1	
00119	SRQ2	
0011A	IRC	
0011C	LCR	
0011D	LBR	
0011F	IRAM@	
00120	DISP1CTL	
00125	LINENIBS	
00128	LINECOUNT	
0012E	TIMERCTRL.1	
0012F	TIMERCTRL.2	
00130	DISP2CTL	
00137	TIMER1	
00138	TIMER2	
001FF	allkeys	
00202	argtypeerr	
00203	argvalerr	
00301	posunferr	
00302	negunferr	
00303	ofloerr	
00305	infreserr	
007B5	SrvcKbdAB	
008E6	BITMAP	
009A5	Debounce	
00A03	intrptderr	
00B02	constuniterr	
00C0D	kermsendmsg	
00C0E	kermrecvmsg	
00C10	kermpktmsg	
00C13	prtparerr	
00C74	OnKeyDown?	
00C80	OnKeyStable?	
00D48	addrKEYSTATE	
00D57	Flush	
00D71	FLUSH	40.2
00D71	FLUSHKEYS	40.2
00D8E	FlushAttn	
010E5	AllowIntr	
01115	DisableIntr	
0115A	AINRTN	
01160	CINRTN	
012EE	GetTimChk	
01307	SavPtrTime*	
0130E	GetTime++	
0131D	srvc_timer2	
017A6	makebeep	39.2
0188D	addrORghost	
018E2	clkspd	
01AD7	RCKBp	
01B8F	DispOn	
01BBD	DispOff	
01C31	D0->Row1	
01C58	D0->Sft1	
01F6D	CLCD10	41.4
01FA7	CLEARLCD	41.4
01FBD	norecPWLseq	
01FBD	Warmstart	
01FD3	Coldstart	
01FDA	norecCSseq	
020B1	~MsgBoxMenu	
028FC	PRLG	
02911	DOBINT	16
02933	DOREAL	16
02955	DOEREL	16
02977	DOCMP	16
0299D	DOECMP	16
029BF	DOCHAR	16
029E8	DOARRY	16
02A0A	DOLNKARRY	16
02A2C	DOCSTR	16
02A4E	DOHSTR	16
02A4E	DOHXS	16
02A74	DOLIST	16
02A96	DORRP	16
02AB8	DOSYMB	16
02ADA	DOEXT	16
02AFC	DOTAG	16
02B1E	DOGROB	16
02B40	DOLIB	16
02B62	DOBAK	16
02B88	DOEXT0	16
02BAA	DOACPTR	16
02BAA	DOEXT1	16
02BCC	DOEXT2	16
02BEE	DOEXT3	16
02C10	DOEXT4	16
02D9D	DOCOL	16
02DCC	DOCODE	16
02E48	DOIDNT	16
02E6D	DOLAM	16
02E92	DOROMP	16
03019	SKIPOB	
030E0	~BRStoC1	
0312B	SEMI	
0314C	DEPTH	29
03188	DUP	29
031AC	2DUP	29
031D9	NDUP	29
03223	SWAP	29
03244	DROP	29
03249	DropLoop	
03258	2DROP	29
0326E	NDROP	29
03295	ROT	29
032C2	OVER	29
032E2	PICK	29
03325	ROLL	29
0339E	UNROLL	29
03442	MAKEARRY	23.1
03562	ARSIZE	23.1
0357C	PUSH#ALOOP	
0357F	PUSH#LOOP	
035A9	DIMLIMITS	23.1
0366F	GPOverWrR0Lp	
03672	GPOverWrALp	
036F7	Push#TLoop	
0371D	GETATELN	
03991	MUL#	
039BE	GETTEMP	
039EF	ECUSER	
03A81	TRUE	33.1
03A86	PUSHA	
03AC0	FALSE	33.1
03ADA	XOR	33.1
03AF2	NOT	33.1
03B2E	EQ	33.2
03B46	AND	33.1
03B75	OR	33.1
03B97	EQUAL	33.2
03C64	TYPE	33.3
03CA6	#0=	17.4
03CC7	#0<>	17.4
03CE4	#<	17.4
03D19	#=	17.4
03D4E	#<>	17.3
03D83	#>	17.4
03DBC	#+	17.3
03DC7	#PUSHA-	
03DE0	#-	17.3
03DEF	#1+	17.3

Addr.	Name	See
03E0E	#1-	17.3
03E2D	#2+	17.3
03E4E	#2-	17.3
03E6F	#2*	17.3
03E8E	#2/	17.3
03EB1	#AND	17.3
03EC2	#*	17.3
03EF7	#/	17.3
03F14	Push2#Loop	
03F24	IntDiv	
03F5D	POP2#	
03F8B	TYPEREAL	17.1
03FA9	TYPEIDNT	17.1
03FEF	ZERO	17.1
03FF9	MEMERR	17.1
03FF9	ONE	17.1
03FF9	real	17.1
04003	TWO	17.1
0400D	str	17.1
0400D	THREE	17.1
04017	FOUR	17.1
04021	FIVE	17.1
04021	list	17.1
0402B	id	17.1
0402B	idnt	17.1
0402B	SIX	17.1
04035	SEVEN	17.1
0403F	EIGHT	17.1
0403F	seco	17.1
04049	NINE	17.1
04049	symb	17.1
04053	sym	17.1
04053	TEN	17.1
0405D	ELEVEN	17.1
04067	TWELVE	17.1
04071	THIRTEEN	17.1
0407B	EXT	17.1
0407B	FOURTEEN	17.1
04085	FIFTEEN	17.1
0408F	REALOB	17.1
0408F	SIXTEEN	17.1
04099	2REAL	17.1
04099	REALREAL	17.1
04099	SEVENTEEN	17.1
040A3	EIGHTEEN	17.1
040AD	NINETEEN	17.1
040B7	TWENTY	17.1
040C1	TWENTYONE	17.1
040CB	TWENTYTWO	17.1
040D5	TWENTYTHREE	17.1
040DF	TWENTYFOUR	17.1
040E9	TWENTYFIVE	17.1
040F3	REALSYM	17.1
040F3	TWENTYSIX	17.1
040FD	TWENTYSEVEN	17.1
04107	TWENTYEIGHT	17.1
04111	TWENTYNINE	17.1
0411B	REALEXT	17.1
0411B	THIRTY	17.1
04125	THIRTYONE	17.1
0412F	THIRTYTWO	17.1
04139	THIRTYTHREE	17.1
04143	THIRTYFOUR	17.1
0414D	THIRTYFIVE	17.1
04157	THIRTYSIX	17.1
04161	THIRTYSEVEN	17.1
0416B	THIRTYEIGHT	17.1
04175	THIRTYNINE	17.1
0417F	FORTY	17.1
0417F	FOURTY	17.1
04189	FORTYONE	17.1
04193	FORTYTWO	17.1
0419D	FORTYTHREE	17.1
041A7	TurnOff	
041ED	DEEPSLEEP	39.2
0426A	ShowInvRomp	39.2
04292	DeepSleep	
04708	CHECKKEY	
04714	GETTOUCH	
047C7	REPKEY?	40.2
047CF	adrDISABLE_K	
047DD	adrKEYBUFFER	
04840	POPKEY	40.2
04929	liteslp	
04999	KeyInBuff?	
04A0B	GETPROC	
04A41	GETDF	
04CE6	ERROR@	32.1
04D0E	ERRORSTO	32.1
04D33	ERRORCLR	32.1
04D3E	DROPNULL$	20.2
04D64	GETTHEMESG	32.1
04D87	JstGETTHEMSG	32.1
04E07	GETEXITMSG	32.1
04E37	EXITMSGSTO	32.1
04E5E	ERRSET	32.1
04E66	addrTEMPENV	
04EA4	ABORT	32.1
04EB8	ERRTRAP	32.1
04ED1	ERRJMP	32.1
04FB6	SETMEMERR	32.2
04FF2	SETPORTNOTAV	32.2
05016	SETROMPERR	32.2
05023	Errjmp	
05040	ATTNFLG@	40.2
05068	ATTNFLGCLR	40.2
05089	CARCOMP	25.1
050B0	~IFMenuRow1	
050B3	~ChooseMenu0	
050ED	CAR$	20.4
05143	GETPTRLOOP	
05153	CDRCOMP	25.1
0516C	CDR$	20.4
0518A	&HXS	21.2
05193	&$	20.4
0521F	&COMP	25.1
0525B	>H$	20.4
052C6	>HCOMP	25.1
052EE	>T$	20.4
052FA	>TCOMP	25.1
05445	::N	25.5
05459	{}N	25.4
0546D	SYMBN	25.2
05481	EXTN	25.2
054AF	INNERCOMP	25.3
0554C	DOGARBAGE	
0556F	NULL$?	20.5
055B7	NULLCOMP?	25.1
055D5	NULLHXS	21.2
055DF	NULL$	20.2
055E9	NULL{}	25.4
055FD	NULL::	25.5
05616	LENHXS	21.1
05622	OVERLEN$	20.4
05636	LEN$	20.4
0567B	LENCOMP	25.1
056B6	NTHELCOMP	25.1
05733	SUB$	20.4
05815	SUBHXS	21.2
05821	SUBCOMP	25.1
05902	OSIZE	39.2
05944	OCRC	39.2
0596D	PUSHhxsLoop	
0597E	DoCRCc	
05981	DoCRC	
059CC	#>HXS	21.1
05A03	HXS>#	17.2
05A51	CHR>#	17.2
05A75	#>CHR	20.3
05AB3	CHANGETYPE	39.2
05B15	$>ID	31.2
05B79	MAKE$	
05B7D	MAKE$N	
05BE9	ID>$	20.3
05C27	%>C%	19.2
05D2C	C%>%	19.2
05DBC	C%%>%%	19.2
05E81	>TAG	22
05F2E	ID>TAG	22
05F42	GARBAGE	37.1
05F61	MEM	39.2
060B0	~IFMenuRow2	
060B3	~ChooseMenu1	
0613E	GARBAGECOL	
06529	PUSH2#	
06537	PUSH#	
065AA	GPMEMERR	
06641	POP#	
06657	TOTEMPOB	37.1
066B9	MOVEUP	
0670C	MOVEDOWN	
0679B	SAVPTR	
067D2	GETPTR	
06806	ROOM	
06992	MOVERSD	
069C5	MOVEDSU	
069F7	ADJMEM	
06A1D	MOVEDSD	
06A53	MOVERSU	
06A8E	DIV5	
06AD8	CREATETEMP	
06B4E	INTEMNOTREF?	37.1
06E8E	NOP	34
06E97	'	34.1
06EEB	'R	34
06F66	'REVAL	34
06F8E	EVAL	34
06F9F	>R	34
06FB7	RDROP	34
06FD1	COLA	34.2
07012	R@	34
0701F	R>	34
070B3	~ChooseMenu2	
070C3	RPITE	35.1
070FD	RPIT	35.1
0712A	?SKIP	35.1
0712A	NOT_IT	35.1
0714D	SKIP	34.2
0716B	IDUP	34
071A2	BEGIN	36.1
071AB	AGAIN	36.1
071C8	UNTIL	36.1
071E5	REPEAT	36.1
071EE	WHILE	36.1
07221	INDEX@	36.2
07249	ISTOP@	36.2
07258	JINDEX@	36.2

Addr.	Name	See
07264	JSTOP@	36.2
07270	INDEXSTO	36.2
07295	ISTOPSTO	36.2
072AD	JINDEXSTO	36.2
072C2	JSTOPSTO	36.2
07334	LOOP	36.2
073A5	+LOOP	36.2
073C3	ZERO_DO	36.2
073CE	ONE_DO	36.2
073DB	#1+_ONE_DO	36.2
073F7	DO	36.2
07497	ABND	31.3
074D0	BIND	31.3
074E4	DOBIND	
075A5	GETLAM	31.3
075E9	PUTLAM	31.3
07638	SETHASH	0
0764E	SETMESG	0
07661	SET	
076AE	OFFSRRP	0
07709	TOSRRP	0
07943	@LAM	31.3
0797B	@	37.2
07D1B	STOLAM	31.3
07D27	STO	37.2
07E50	#>ROMPTR	28.2
07E99	ROMPTR@	28.2
081D9	BAKNAME	28.4
082E3	RAM-WORDNAME	37.3
08326	LASTRAM-WORD	37.3
08376	PREVRAM-WORD	37.3
085D3	REPLACE	37.2
08696	CREATE	37.2
08C27	PURGE	37.2
08CCC	ROMPTR>#	28.2
08D08	CONTEXT!	37.3
08D5A	CONTEXT@	37.3
08D66	SysPtr@	
08D92	HOMEDIR	37.3
08D92	SYSCONTEXT	37.3
090B1	~DoMKeyOK	
0931B	X@	
0948E	BAK>OB	28.4
0970A	InitEnab	
09B73	COMPCONFCRC	
0A00E	CKLBCRC	
0A532	SAFESKIPOB	
0AAB2	PORTSTATUS	28.1
0AB82	NEXTLIBBAK	28.1
0BBED	TrueTrue	33.1
0BC01	failed	33.1
0BC6F	!*trior	
0BCCF	!*triand	
0BD54	tok8cktrior	
0BD60	tok8trior	
0C147	restoreiram	
0C506	rGETATELN	
0CA60	ATTNchk	
0CBC4	ErrTime	
0CBFA	TOD	38
0CC0E	DATE	38
0CC39	DDAYS	38
0CC5B	DATE+DAYS	38
0CFD9	Date>d$	38
0D06A	TOD>t$	38
0D304	TIMESTR	38
0D4AD	DAY#	
0D5E5	ASRW5	
0D5F6	ASLW5	
0D607	CSRW5	
0D618	CSLW5	
0D62F	DCHXW	
0D6D8	FLOAT	
0D744	Day>Date	
0D7A1	CLKUTL1	
0D809	getBPOFF	
0D8AE	mpop1%	
0D92C	POPDATE%	
0D948	POPTIME%	
0D9C7	CKTIME	
0DB3A	YMD>Ticks	
0DB51	dowutil	
0DB91	HXDCW	
0E06F	Clr16	41.4
0E083	Clr8	41.4
0E097	Clr8-15	41.4
0E0AB	TOP16	41.6
0E0D3	TOP8	41.6
0E0FB	Rows8-15	41.6
0E128	HBUFF_X_Y	41.1
0E235	ALARMS@	
0E66A	VerifyTOD	
0E6ED	STOALM	38
0E7D3	addrClkOnNib	
0EB81	CLKTICKS	38
0EB81	SysTime	38
0EBD5	FindNext	
0EE50	Date>hxs13	38
0F218	UNIT>$	24.2
0F33A	UM>U	24.2
0F34E	UMU>	24.2
0F371	UMCONV	24.3
0F3E4	puretemp?	
0F41B	TempConv	
0F584	UM=?	24.4
0F598	UM#?	24.4
0F5AC	UM<?	24.4
0F5C0	UM>?	24.4
0F5D4	UM<=?	24.4
0F5E8	UM>=?	24.4
0F5FC	UMABS	24.3
0F615	UMCHS	24.3
0F62E	UMSIN	24.3
0F660	UMCOS	24.3
0F674	UMTAN	24.3
0F688	%%2PI	18.1
0F6A2	UM+	24.3
0F774	UM-	24.3
0F792	UM*	24.3
0F823	UM/	24.3
0F8FA	UMXROOT	24.3
0F913	UMSQ	24.3
0F92C	UMSQRT	24.3
0F945	UMSI	24.2
0FA69	tok_g	20.2
0FA8E	tok_m	20.2
0FACE	tok_s	20.2
0FB6F	UMMAX	24.3
0FB8D	UMMIN	24.3
0FBAB	UM%	24.3
0FC3C	UM%CH	24.3
0FCCD	UM%T	24.3
0FCE6	UMSIGN	24.3
0FCFA	UMIP	24.3
0FD0E	UMFP	24.3
0FD22	UMFLOOR	24.3
0FD36	UMCEIL	24.3
0FD68	UMRND	24.3
0FD8B	UMTRC	24.3
0FE44	U>NCQ	24.2
10047	U>nbr	24.2
10065	Unbr>U	24.2
100E0	~BRbrowse	
10B5E	um*	24.1
10B68	um/	24.1
10B72	um^	24.1
10B7C	umP	24.1
10B86	umEND	24.1
10E68	cfF	18.1
10E82	cfC	18.1
10F40	GPErrjmpC	
10F80	ErrjmpC	
10F86	SYNTAXERR	32.2
10FC6	NOHALTERR	32.2
11016	SETCIRCERR	32.2
110E7	~UTVUNS1Arg	
1132D	SetAlphaAnn	41.5
1133A	ClrAlphaAnn	41.5
11347	SetRightAnn	41.5
11354	ClrRightAnn	41.5
11361	SetLeftAnn	41.5
1136E	ClrLeftAnn	41.5
11511	PrgmEntry?	41.5
11533	SetPrgmEntry	41.5
1158F	MAKEGROB	42.3
115B3	makegrob	
1165A	w->W	
11679	GROB!	42.3
1192F	SUBGROB	42.3
11A6D	GROB!ZERO	42.3
11CF3	$>BIGGROB	42.3
11D00	$>GROB	42.3
11D8F	$5x7	41.7
11F80	$>grob	42.3
1200C	RIGHT$3x6	42.3
120E0	~BRoutput	
120E4	~MESRclEqn	
1215E	CENTER$3x5	42.3
122FF	INVGROB	42.3
123C8	BIGDISPN	41.7
123E5	BIGDISPROW4	41.7
123F5	BIGDISPROW3	41.7
12405	BIGDISPROW2	41.7
12415	BIGDISPROW1	41.7
12429	DISPN	
1245B	DISP@01	41.7
1245B	DISPROW1	41.7
1246B	DISP@09	41.7
1246B	DISPROW2	41.7
1247B	DISP@17	41.7
1247B	DISPROW3	41.7
1248B	DISP@25	41.7
1248B	DISPROW4	41.7
1249B	DISPROW5	41.7
124AB	DISPROW6	41.7
124BB	DISPROW7	41.7
124CB	DISPROW8	41.7
12635	HARDBUFF	41.1
1263A	addrVDISP	
12645	HARDBUFF2	41.1
1264A	addrVDISP2	
12655	ABUFF	41.1
1265A	addrADISP	
12665	GBUFF	41.1
126DF	BLANKIT	41.4
1270C	DISPSTATUS2	41.7
12725	DISPROW1*	41.7

Addr.	Name	See
12748	DISPROW2*	41.7
12770	COERCE$22	20.4
127A7	SEP$NL	20.4
128B0	XYGROBDISP	42.3
12B6C	HARDHEIGHT	41.1
12B85	FlashMsg	41.7
12DD1	HEIGHTENGROB	41.2
12F94	GROB>GDISP	42.3
13061	KILLGDISP	41.2
130AC	RECLAIMDISP	41.2
130E0	~BRdone	
13135	TOGDISP	41.1
1314D	TOADISP	41.1
131C8	WINDOWUP	41.6
13220	WINDOWDOWN	41.6
133AB	disprange	
134AE	CLEARVDISP	41.4
134E4	WINDOWLEFT	41.6
1357F	WINDOWRIGHT	41.6
13679	WINDOWXY	
136AA	WindowXY	
136AC	addrLINECNTg	
137B6	WINDOWCORNER	
137DC	corner	
1380F	PIXOFF3	42.3
13825	PIXON3	42.3
1383B	PIXOFF	42.3
1384A	PIXON	42.3
13986	PIXON?3	42.3
13992	PIXON?	42.3
13B51	DISPCHAR+PC	
13D28	cursorblink+	
13D55	cursorblink-	
13D8C	CURSOR1	42.1
13DB4	CURSOR2	42.1
13E85	CURSOR_OFF	
14088	DO>STR	20.3
140AB	DODISP	
140F1	DOCHR	20.3
14137	DOSTR>	20.3
1415A	DOBEEP	39.2
141B2	setbeep	39.2
141E5	ERRBEEP	32.1
142FB	Ck&Freeze	
1446F	SuspendOK?	
14483	nohalt	
14C17	sstDISP	
14EA5	RDUP	34
15007	DO%EXIT	32.1
1502F	DO#EXIT	32.1
15048	DO$EXIT	32.1
1518D	GsstFIN	
151A6	SolvMenuInit	
152FF	EqList?	
153FC	DispVarsUtil	
1553B	KeepUnit	
1568F	ALGeq?	
15717	DOSTOE	
1572B	DORCLE	
15744	EQUATION	
15777	NULLID	31.1
1578D	CRUNCH	27.1
1583C	EVALCRUNCH	
1592D	CK1NoBlame	30
15941	CRUNCHNoBlam	
15978	1stkdecomp$w	
159EB	stkdecomp$w	
15A0E	EDITDECOMP$	20.3
15A40	ederr	

Addr.	Name	See
15A60	rstfmt1	
15A8B	savefmt1	
15B13	DECOMP$	
15B31	editdecomp$w	
15E83	longhxs	
1605F	addtics	
1613F	NULL$TEMP	20.2
162AC	a%>$,	20.3
162B8	a%>$	20.3
16671	Shrink$	
166E3	DOFIX	39.1
166EF	DOSCI	39.1
166FB	DOENG	39.1
16707	DOSTD	39.1
167BF	DPRADIX?	39.1
167D8	#:>$	20.3
167E4	#>$	20.3
1686A	stackitw	
169A5	NDROPFALSE	33.1
170E0	~BRRclCurRow	
1795A	!DcompWidth	
17980	DcompWidth@	
179D0	NEXTRRPOB	
179E8	addrTEMPTOP	
17ADB	FixRRP	
17B86	VLM	
180E0	~BRRclC1	
18308	DropSysObs	
1848C	PATHDIR	37.3
184E1	CREATEDIR	37.3
18513	?STO_HERE	37.2
18513	XEQSTOID	37.2
1853B	SAFE@_HERE	37.2
1854F	?PURGE_HERE	37.2
18595	XEQPGDIR	37.3
185C7	DoHere:	
18621	LastNonNull	
1863A	PrevNonNull	37.3
186E8	DOTVARS%	
18779	DOVARS	37.3
1884D	0LASTOWDOB!	30
1884D	0LastRomWrd!	30
18873	AND$	20.4
18887	OR$	20.4
1889B	XOR$	20.4
18A15	CK0NOLASTWD	30
18A1E	CK0	30
18A5B	CK3	30
18A68	CK3NOLASTWD	30
18A80	CK2	30
18A8D	CK2NOLASTWD	30
18AA5	CK1	30
18AB2	CK1NOLASTWD	30
18B6D	CK5	30
18B7A	CK5NOLASTWD	30
18B92	CK4	30
18B9F	CK4NOLASTWD	30
18C34	CKN	30
18C4A	CKNNOLASTWD	30
18C92	SETNONEXTERR	32.2
18CA2	SETSIZEERR	32.2
18CA7	DOSIZEERR	32.2
18CB2	SETTYPEERR	32.2
18CC2	SETSTACKERR	32.2
18CD7	%ABSCOERCE	18.3
18CEA	COERCE	17.1
18DBF	UNCOERCE	18.2
18EBA	COMPEVAL	34
18ECE	CK1&Dispatch	30

Addr.	Name	See
18EDF	CK2&Dispatch	30
18EF0	CK3&Dispatch	30
18F01	CK4&Dispatch	30
18F12	CK5&Dispatch	30
18F23	EvalNoCK	30
18F9D	CK&DISPATCH0	30
18FA9	CK&DISPATCH2	30
18FB2	CK&DISPATCH1	30
191B9	#*OVF	17.3
194F7	COERCE2	17.1
1950B	UNCOERCE2	18.2
199EB	DoInputForm	13
1A16F	UPDIR	37.3
1A1FC	OCRC%	39.2
1A265	VARSIZE	39.2
1A2DA	INHARDROM?	39.2
1A3FE	xIFTE	43
1A738	Wait/GetKey	40.2
1A7C9	dowait	38
1AB67	x+	43
1ACDD	xNEGNEG	43
1AD09	x-	43
1ADEE	x*	43
1AF05	x/	43
1B02D	x^	43
1B185	rpnXROOT	43
1B1CA	xXROOT	43
1BB02	xFACT	43
1BB41	preFACT	43
1C637	RCLSYSF	39.1
1C64E	RCLUSERF	39.1
1C67F	xSTOF	43
1C6A2	DOSTOALLF	39.1
1C6E3	DOSTOSYSF	39.1
1C9B8	xSIZE	43
1CB90	XEQTYPE	30.1
1CC03	%11	18.1
1CC1D	%12	18.1
1CC37	%13	18.1
1CC51	%14	18.1
1CC6B	%20	18.1
1CC85	%15	18.1
1CCA4	%21	18.1
1CCC3	%22	18.1
1CCE2	%23	18.1
1CD01	%24	18.1
1CD20	%25	18.1
1CD3A	%16	18.1
1CD54	%17	18.1
1CD73	%26	18.1
1CD8D	%27	18.1
1CDF2	%18	18.1
1CE07	%19	18.1
1CF7B	xOBJ>	43
1D054	XEQ>ARRAY	23.1
1D0DF	xRDM	43
1D186	xCON	43
1D5DF	xPUTI	43
1DABB	#1+ROT	17.3
1DC00	PUTLIST	25.4
1E661	xFUNCTION	43
1E6A1	xPOLAR	43
1E6C1	xPARAMETRIC	43
1EBBE	x<?	43
1EC5D	x>?	43
1EF7E	rpnDER	43
1EFD2	xDER	43
1F05B	CKSYMBTYPE	30.1
1F1D4	rpnINTG	43

Addr.	Name	See
1F223	xINTEGRAL	43
1F354	rpnWHERE	43
1F3F3	xWHERE	43
1F55D	rpnAPPLY	43
1F5C5	xAPPLY	43
1F640	xFCNAPPLY	43
1F996	COMPLEXDUMMY	
1F9AE	POLARDUMMY	
1FAEB	xFORMUNIT	43
20B00	XEQSHOWLS	27.2
20B81	XEQRCL	37.2
20B9A	LISTRCL	37.2
20CAD	PICTRCL	
20F8A	XEQPURGEPICT	
20FAA	xMEM	43
20FF2	XEQORDER	37.3
213D1	xFREE	43
21660	SWAPDROPTRUE	33.1
216D8	OB>BAKcode	
21922	GetBVars	
21B5A	XEQIOBACKUP	
21C6F	XEQSETLIB	
21CBA	SETROMPART	
225F5	USER$>TAG	24.1
22618	%>TAG	22
22FD5	xIFEND	43
22FEB	xALG->	43
231A0	xSTARTVAR	43
2349C	xSILENT'	43
234C1	RPN->	43
235FE	x>>ABND	43
2361E	x<<	43
23639	x>>	43
23679	xENDTIC	43
23694	xWHILEEND	43
236B9	xENDDO	43
2371F	xERRTHEN	43
23768	CK0ATTNABORT	
237A8	xTHENCASE	43
238A4	palparse	20.3
23EED	ONE{}N	25.4
24C0D	List	
24EA6	{}>DIR	
2512D	delimcase	
2520A	'Rapndit	
25223	DaDGNTc	
2534A	nultrior	
25446	tok->	20.2
25452	getmatchtok	
255BD	ngsizecase	
255FB	need'case	
25632	newBASE	
256E4	convertbase	
25C41	Extobcode	
25CE1	GETPTRTRUE	
26162	GetNextToken	
265ED	realPAcode	
26A2D	?OKINALG	
26FAE	GETPTRFALSE	
27244	NOTLISTcase	35.5
27254	NOTSECOcase	35.5
27264	NOTROMPcase	35.5
27D00	check_pdata	
28296	metatail	26.4
28558	#1-UNROT	17.3
2856C	tok=casedrop	
29A8D	nextsym'R	
29BC2	subpdcdptch	
29DFC	SETIVLERR	
29E21	PACKSB	
29E46	PACK	
29FD0	POP1%SPLITA	
29FDA	POP1%	
2A002	POP2%	
2A0B3	~DoCKeyCheck	
2A188	PUSH%	
2A23D	PUSH%LOOP	
2A2B4	%0	18.1
2A2C9	%1	18.1
2A2DE	%2	18.1
2A2F3	%3	18.1
2A308	%4	18.1
2A31D	%5	18.1
2A332	%6	18.1
2A347	%7	18.1
2A35C	%8	18.1
2A371	%9	18.1
2A386	%-1	18.1
2A39B	%-2	18.1
2A3B0	%-3	18.1
2A3C5	%-4	18.1
2A3DA	%-5	18.1
2A3EF	%-6	18.1
2A404	%-7	18.1
2A419	%-8	18.1
2A42E	%-9	18.1
2A443	%PI	18.1
2A472	%MAXREAL	18.1
2A487	%-MAXREAL	18.1
2A49C	%MINREAL	18.1
2A4B1	%-MINREAL	18.1
2A4C6	%%0	18.1
2A4E0	%%1	18.1
2A4FA	%%2	18.1
2A514	%%3	18.1
2A52E	%%4	18.1
2A548	%%5	18.1
2A562	%%.1	18.1
2A57C	%%.5	18.1
2A596	%%10	18.1
2A5B0	%%>%	18.4
2A5C1	%>%%	18.2
2A5D2	SETDEG	39.1
2A5F0	SETRAD	39.1
2A604	SETGRAD	39.1
2A622	%D>R	18.3
2A62C	PI/180	18.1
2A655	%R>D	18.3
2A673	%>HMS	38
2A68C	%HMS>	38
2A6A0	%HMS+	38
2A6C8	%HMS-	38
2A6DC	%%MAX	18.3
2A6F5	%MAX	18.3
2A70E	%MIN	18.3
2A727	%%0<	18.4
2A738	%0<	18.4
2A75A	%%0=	18.4
2A76B	%0=	18.4
2A788	%%0>	18.4
2A799	%0>	18.4
2A7BB	%%0<>	18.4
2A7CF	%0<>	18.4
2A7E3	%%0>=	18.4
2A7F7	%0>=	18.4
2A80B	%%0<=	18.4
2A81F	%%<	18.4
2A871	%<	18.4
2A87F	%%>	18.4
2A88A	%>	18.4
2A895	%%>=	18.4
2A8A0	%>=	18.4
2A8AB	%%<=	18.4
2A8B6	%<=	18.4
2A8C1	%=	18.4
2A8CC	%<>	18.4
2A8D7	%SGN	18.3
2A8F0	%%ABS	18.3
2A900	%ABS	18.3
2A910	%%CHS	18.3
2A920	%CHS	18.3
2A930	%MANTISSA	18.3
2A943	%%+	18.3
2A94F	%%-	18.3
2A95B	%>%%-	18.3
2A974	%+	18.3
2A981	%-	18.3
2A99A	%%*	18.3
2A9BC	%*	18.3
2A9C9	%OF	18.3
2A9E8	%%/	18.3
2A9FE	%/	18.3
2AA0B	%T	18.3
2AA30	%CH	18.3
2AA5F	%%^	18.3
2AA70	%^	18.3
2AA81	%NROOT	18.3
2AA92	%%1/	18.3
2AA9E	%>%%1/	18.3
2AAAF	%1/	18.3
2AAEA	%%SQRT	18.3
2AAF6	%>%%SQRT	18.3
2AB09	%SQRT	18.3
2AB1C	%%EXP	18.3
2AB2F	%EXP	18.3
2AB42	%EXPM1	18.3
2AB5B	%%LN	18.3
2AB6E	%LN	18.3
2AB81	%LOG	18.3
2AB94	%%LNP1	18.3
2ABA7	%LNP1	18.3
2ABBA	%ALOG	18.3
2ABDC	%MOD	18.3
2ABEF	%SIN	18.3
2AC06	%%SIN	18.3
2AC17	%%SINDEG	18.3
2AC27	%%SINRAD	18.3
2AC40	%COS	18.3
2AC57	%%COS	18.3
2AC68	%%COSDEG	18.3
2AC78	%%COSRAD	18.3
2AC91	%TAN	18.3
2ACA8	%%TANRAD	18.3
2ACC1	%ASIN	18.3
2ACD8	%%ASINRAD	18.3
2ACF1	%ACOS	18.3
2AD08	%%ACOSRAD	18.3
2AD21	%ATAN	18.3
2AD38	%ANGLE	18.3
2AD4F	%%ANGLE	18.3
2AD5B	%>%%ANGLE	18.3
2AD6C	%%ANGLEDEG	18.3
2AD7C	%%ANGLERAD	18.3
2AD95	%%SINH	18.3
2ADAE	%SINH	18.3
2ADC7	%%COSH	18.3
2ADDA	%COSH	18.3

Addr.	Name	See
2ADED	%TANH	18.3
2AE00	%ASINH	18.3
2AE13	%ACOSH	18.3
2AE26	%ATANH	18.3
2AE39	%EXPONENT	18.3
2AE4C	%NFACT	18.3
2AE62	%COMB	18.3
2AE75	%PERM	18.3
2AF27	%%H>HMS	38
2AF4D	%FP	18.3
2AF60	%IP	18.3
2AF73	%CEIL	18.3
2AF86	%FLOOR	18.3
2AF99	%%FLOOR	18.3
2AF99	%%INT	18.3
2AFC2	%RAN	18.3
2B044	%RANDOMIZE	18.3
2B07B	DORANDOMIZE	18.3
2B0B3	~DoCKeyChAll	
2B0C4	%FACT	18.3
2B1FF	%%7	18.1
2B2DC	%%12	18.1
2B300	%%60	18.1
2B3DD	%%.4	18.1
2B45C	2%>%%	18.2
2B470	2%%>%	18.2
2B48E	%REC>%POL	18.3
2B498	%%R>P	18.3
2B4BB	%POL>%REC	18.3
2B4C5	%%P>R	18.3
2B4F2	%SPH>%REC	18.3
2B529	RNDXY	18.3
2B53D	TRCXY	18.3
2B67D	aMODF	
2B770	aH>HMS	
2B789	1/X15	
2B7A7	RSUB1	
2B7B0	RADD1	
2B7CA	RADDF	
2B7DC	ADDF	
2B91E	MULTF	
2B977	DIVF	
2BA0F	SQRF	
2BBB5	DIV2	
2BBE2	CLRFRC	
2BC4A	SPLITA	
2BCA0	SPLTAC	
2BD32	Y<=X	
2BD76	TST15	
2BE53	XYEX	
2BE61	STAB0	
2BE6F	STAB2	
2BE7D	STCD0	
2BE8B	STCD2	
2BE99	EXAB0	
2BEA7	EXAB2	
2BEB5	RCAB0	
2BEC0	RCAB2	
2BECB	RCCD0	
2BED6	RCCD2	
2BEE1	CCSB1	
2BEEC	RNDC[B]	
2BFE3	GETAB1	
2BFFD	GETAB0	
2C031	GETCD0	
2C04B	PUTAB0	
2C0B3	~DoCKeyUnChA	
2C22F	STATCLST	23.3
2C2D9	STATSADD%	23.3

Addr.	Name	See
2C535	STATN	23.3
2C558	STATSMAX	23.3
2C571	STATMEAN	23.3
2C58A	STATSMIN	23.3
2C5A3	STATSTDEV	23.3
2C5BC	STATTOT	23.3
2C5D5	STATVAR	23.3
2D0B3	~DoCKeyCance	
2D396	MAXRETRY	
2D3A0	LAMPKNO	
2D3B1	LAMPACKET	
2D3C6	LAMRETRY	
2D3EE	LAMKP	
2D3FB	LAMLNAME	
2D40E	LAMOBJ	
2D41D	LAMOPOS	
2D441	'LamKPSto	
2D45A	LAMKLIST	
2D46D	LAMKMODE	
2D493	LAMKRM	
2D517	EXCHINITPK	
2D564	Loop	
2D58C	SENDEOT	
2D5E1	SEND_PACKET	
2D730	KDispRow2	
2D74E	KDispStatus2	
2D9A1	SetServMode	
2D9B2	ClrServMode	
2DDC4	DropSysErr$	
2E0A9	SENDNAK	
2E0B3	~DoCKeyOK	
2E0C7	SENDERROR	
2E0F4	SENDPKT	
2E108	BUILDKPACKET	
2E31F	Push#FLoop	
2E4DC	APNDCRLF	20.4
2E4F0	CRLF$	20.2
2E6BE	InitIOEnv	
2E6EB	SENDLIST	
2E7EF	GETNAME	
2E876	DOFINISH	
2E8D1	DOPKT	
2E99E	StdIOPAR	
2E9CB	StoIOPAR	
2E9E6	SysSTO	
2EA4F	GetIOPAR	
2EA6A	Sys@	
2EAE2	KERMOPEN	
2EB37	DOOPENIO	
2EB62	OpenIO	
2EC11	%IP>#	17.2
2EC25	IOCheckReal	
2EC34	SetIOPARErr	32.2
2EC84	DOBAUD	
2ECCA	DOPARITY	
2ED10	DOTRANSIO	
2EDA6	DOKERRM	
2EDE1	DOBUFLEN	
2EE18	DOSBRK	
2EE97	DOSRECV	
2EEC4	SendSetup	
2EFD7	TRPACKETFAIL	
2F211	LAMKML	
2F383	IncrLAMPKNO	
2F39C	GetKermPkt#	
2F934	FalseFalse	33.1
2F989	RecvNextPkt	
2FEA1	SENDACK	
2FEB5	SENDNULLACK	

Addr.	Name	See
2FEC9	KVISLF	
2FEDD	KVIS	
2FFB4	GetStrLenStk	
2FFB7	GetStrLenC	
2FFBA	GetStrLen	
300B3	~LEDispPromp	
3016B	KINVISLF	
30794	VERSTRING	
307E2	GETKP	
30805	SUB$1#	20.4
30914	ACK_INIT	
30B1D	CHOOSE_INIT	
30BBE	ENCODE1PKT	
30BD7	ENCODE	
30D31	DECODE	
30E4E	PutSerialECk	
30ED2	OUTUART	
31289	POPUART	
312DA	adr_uart_han	
3133B	UARTBUFLEN	
3136C	FLUSHRSBUF	
31444	PUTSERIAL	
314E5	GETSERIAL	
315C6	CLOSEUART	
315F9	CloseUart	
3161E	OpenUartClr	
31854	docr	
31868	DOCR	
3187C	OpenIOPrt	
31EE2	DOPRLCD	
31F4A	StdPRTPAR	
31F7D	StoPRTPAR	
31FFD	DODELAY	
3205C	GetChkPRTPAR	
320B1	%80	18.1
32161	PRINT	
32387	PRINTxNLF	
323E9	PSubErr	
323F9	REMAP	
324A6	AllowPrlcdCl	
3251C	PopASavptr	
3251F	PopSavptr	
3252B	SetEcma94	
325AA	ChkLowBat	
32B08	ErrFixEIRU	
32B1A	FixEIRU	
32B74	PrintGrob	
32CAF	ChkGrHook	
32CB6	adrGraphPrtH	
32FF9	SYMBNUMSOLVE	
3303F	NUMSOLVE	
34301	Attn#	17.1
34D2B	1NULLLAM{}	31.3
34D30	NULLLAM	31.1
350B3	~LEDispList	
35491	apndvarlst	25.4
355B8	PULLREALEL	23.1
355C8	PULLCMPEL	23.1
35628	PUTEL	23.1
3566F	PUTREALEL	23.1
356F3	PUTCMPEL	23.1
357A8	MDIMS	23.1
35CAE	MATCON	23.2
360B3	~LEDispItem	
3745E	SWAPROWS	23.1
37B44	CKREF	37.1
37E0F	MATREDIM	23.2
3811F	MATTRN	23.2
3858E	StartupProc	

Addr.	Name	See
385E8	InitSysUI	
3866F	SysMenuCheck	
386A1	SysDisplay	
386D8	?FlashAlert	39.2
38728	SysErrorTrap	
38908	DoWarning	41.7
38926	FlashWarning	41.7
38985	ParOuterLoop	14
389BC	POLSaveUI	14.1
38A64	POLSetUI	14.1
38AEB	POLKeyUI	14.1
38B45	POLErrorTrap	
38B77	POLResUI&Err	14.1
38B90	POLRestoreUI	14.1
38C08	AppDisplay!	
38C18	AppDisplay@	
38C38	AppKeys!	
38C58	AppKeys0	
38C68	AppExitCond!	
38C78	AppExitCond@	
38C98	AppError!	
38CAB	AppError@	
38CFB	AppMode?	
38D09	SetAppMode	
38D17	ClrAppMode	
38D33	SetNAppKeyOK	
38D5D	SetDoStdKeys	
38D8A	SetAppSuspOK	
38D9B	ClrAppSuspOK	
38DAC	DA1OK?	41.3
38EB5	DA3OK?	41.3
38F28	DA1OK?NOTIT	41.3
38F41	DA2aOK?NOTIT	41.3
38F5A	DA2bOK?NOTIT	41.3
38F73	DA3OK?NOTIT	41.3
38FB9	DA2aLess1OK?	41.3
38FD2	SetDA1Valid	41.3
38FEB	SetDA2aValid	41.3
38FFF	SetDA2bValid	41.3
39018	SetDA3Valid	41.3
3902C	SetDA1Temp	41.3
39045	SetDA2aTemp	41.3
39059	SetDA2bTemp	41.3
39072	SetDA3Temp	41.3
39086	SetDA2aEcho	41.3
390A4	MENoP&FixDA1	41.3
390B3	MENP&FixDA12	41.3
390CC	ClrDA1OK	41.3
390E5	ClrDA2aOK	41.3
390FE	ClrDA2bOK	41.3
39117	ClrDA2OK	41.3
3912B	ClrDA3OK	41.3
39144	ClrDAsOK	41.3
3915D	SetDA2Valid	41.3
3918A	SetDA2NoCh	41.3
3919E	SetDA12NoCh	41.3
391B2	SetDA23NoCh	41.3
391C6	SetDA13NoCh	41.3
391EE	SetDA123NoCh	41.3
39207	SetDA2OKTemp	41.3
3921B	SetDA12Temp	41.3
3922F	SetDAsTemp	41.3
39301	SetDA3ValidF	41.3
393D3	SetDA1NoCh	41.3
393FD	SetDA2aNoCh	41.3
39419	DA2bNoCh?	41.3
39427	SetDA2bNoCh	41.3
39435	ClrDA2bNoCh	41.3
39451	SetDA3NoCh	41.3
3946D	DA1Bad?	41.3
3947B	SetDA1Bad	41.3
39489	ClrDA1Bad	41.3
39497	DA2aBad?	41.3
394A5	SetDA2aBad	41.3
394B3	ClrDA2aBad	41.3
394CF	SetDA2bBad	41.3
394DD	ClrDA2bBad	41.3
394F9	SetDA3Bad	41.3
39507	ClrDA3Bad	41.3
39523	SetDA1IsStat	41.3
39531	ClrDA1IsStat	41.2
3957A	SetNoRollDA2	41.3
3958B	ClrNoRollDA2	41.3
3959C	?DispStatus	
395BA	DispStatus	
39632	Blank&GROB!	42.3
39673	AngleStatus	
396C8	ComVecStatus	
39748	UserFlagStat	
397BB	UserKeysStat	
3981B	AlgEntryStat	
39853	PrgmEntrStat	
3988B	DispDir?Time	
398F4	DispDir?Tim1	
39958	DispDir?Tim2	
39971	PathStatus	
39AF1	DispTimeReq?	
39B0A	DispStsBound	
39B85	?DispStack	
39BF3	?RollUpDA2	
39F6F	LINESOFSTACK	
39FB0	AbbrevStack?	
39FC1	SetAbbrevStk	
39FD2	ClrAbbrevStk	
3A00D	DispEditLine	
3A1CA	?DispMenu	
3A1E8	DispMenu	
3A1FC	DispMenu.1	
3A297	Grob>Menu	42.4
3A2B5	Str>Menu	42.4
3A2C9	Seco>Menu	42.4
3A2DD	Id>Menu	42.4
3A328	MakeStdLabel	42.4
3A38A	MakeBoxLabel	42.4
3A3EC	MakeDirLabel	42.4
3A44E	MakeInvLabel	42.4
3A4AB	MakeLabel	42.4
3A4CE	Disp5x7	41.7
3A546	BlankDA1	41.4
3A55F	BlankDA2	41.4
3A578	BlankDA12	41.4
3A591	BlankDA2a	41.4
3A71C	DoNextRow	
3A735	DoPrevRow	
3A9B8	'DROPFALSE	34.1
3A9CE	TurnOffKey	
3A9E7	SetSomeRow	
3AA0A	1A/LockA	
3ADED	DoPlotMenu	
3B211	DoFirstRow	
3BDFA	EditMenu	
3BE54	DoSolvrMenu	
3E2DD	<SkipKey	
3E35F	>SkipKey	
3E3E1	<DelKey	
3E4CA	>DelKey	
3E586	TogInsertKey	
3E5CD	IStackKey	
3EC71	NullMenuKey	14.5
3EC85	NoExitAction	
3EC99	Box/StdLabel	42.4
3ECB2	Box/StdLbl:	42.4
3ED0C	Std/BoxLabel	42.4
3EE1A	Do1st/2nd+:	
3EE47	Echo2Macros	
3FA57	Key>U/SKeyOb	
3FA7A	?Key>UKeyOb	
3FB1A	Key>StdKeyOb	
3FCAF	SetKeysNS	
3FDBD	2DropBadKey	
3FDC7	DropBadKey	
3FDD1	DoBadKey	
3FDFE	'DoBadKey	34.1
3FE12	'DoBadKeyT	34.1
3FE26	H/WKey>KeyOb	
3FE44	H/W>KeyCode	
3FE7B	ModifierKey?	
3FF1B	?CaseKeyDef	14.4
3FF48	?CaseRomptr@	
4019D	StdMenuKeyNS	
401D4	StdMenuKeyLS	
40337	DoNameKeyRS	
40350	DoNameKeyLRS	
40454	DoKeyOb	
40788	TakeOver	14.5
40792	SystemLevel?	
407FB	MenuMaker	
40828	MenuKey	
4085A	Modifier	
408AA	ImmedEntry?	41.5
40A6F	KeyOb!	
40A82	KeyOb@	
40A95	KeyOb0	
40AD9	Parse.1	
40B2E	ParseFail	
40BC9	AtUserStack	30
40C76	SaveLastEdit	
40C94	CMDSTO	
40CE9	CacheStack	
40D25	LockAlpha	41.5
40D39	UnLockAlpha	41.5
40D93	NoEdit?case	
40DC0	DoMenuKey	
40DD4	DoDelim	
40DF7	DoDelims	
40E3D	?ClrAlg	
40E5B	?ClrAlgSetPr	
40E88	REPEATER	
40EE7	SLOW	38
40F02	VERYSLOW	38
40F12	VERYVERYSLOW	38
40F22	XEQStoKey	
40F86	InitMenu	
41008	StartMenu	
410C6	SetThisRow	
41111	CheckMenuRow	
41175	LoadTouchTbl	
4139B	SaveLastMenu	
41422	>Review$	
415C9	GetMenu%	
415F1	%100	18.1
41679	InitMenu%	
41741	InitTrack:	
417F3	SetRebuild	
41848	MenuRow!	
4185B	MenuRow@	
4186E	LastMenuRow!	

Addr.	Name	See
41881	LastMenuRow@	
418A4	MenuDef@	
418D4	MenuRowAct!	
418F4	LabelDef!	
41904	DoLabel	42.4
41914	MenuKeyNS!	
41924	MenuKeyNS@	
41934	DoMenuKeyNS	
41944	MenuKeyLS!	
41964	MenuKeyRS!	
41984	ReviewKey!	
419C4	ExitAction!	
419E4	LastMenuDef!	
419F4	LastMenuDef@	
41A8D	UserKeys?	
41CA2	Ck&DecKeyLoc	40.2
41D92	CodePl>%rc.p	40.2
41F3F	GetUserKeys	
41F65	WaitForKey	40.2
4203C	GetKeyOb	
42078	?BlinkCursor	
420A0	GETKEY*	
420F5	ATTNxcp	
42113	ALARMxcp	
42131	SLEEPxcp	
42145	UARTxcp	
42159	GETKEY	
42249	UART?	
42262	ATTN?	40.2
4226A	addrATTNFLG	
4227F	TIMEOUT?	
42284	adrTIMEOUTCL	
422A1	ALARM?	38
423BB	settimeout	
423D3	clrtimeout	
42402	KEYINBUFFER?	40.2
4243E	?ATTNQUIT	40.2
4245C	NoAttn?Semi	40.2
42475	DoCAlarmKey	
4248E	CtlAlarm!	
424DA	DCursor	
4256B	LCursor	
42660	UCursor	
426F1	LastERow?	
4272D	TopERow?	
427AF	Cursor&Disp	
42AE4	EchoChrKey	
42BB6	Echo$NoChr00	
42BD4	Echo$Key	
42C3D	CkChr00	20.5
42D32	EditLevel1	
42D46	ViewLevel1	
42D82	CharEdit	
42DC8	ObEdit	
42E27	Roll&Do:	
42E86	Rcl&Do:	
42EC7	AdjEdModes	
42F44	InputLine	
430CF	DispILPrompt	
43179	InputLEnter	
43200	InputLAttn	
4325A	SetCursor	
44277	InitEd&Modes	
4428B	InitEdLine	
44394	InitEdModes	
443CB	EditString	
444A5	CURSOR_END?	
444EE	Char>Edit	
44683	EDITLINE$	
44730	EDITPARTS	
4488A	NoEditLine?	
4489E	ROWNUM	
448C1	?TogU/LCase	
44C31	DoNewMatrix	
44F42	BindMatVars	
44FE7	DoOldMatrix	
45023	InitOldMat	
450E0	~BRDispItems	
45676	Blank$	20.4
45AE0	GetMat/Vec	
45C2F	RowElt#	
45D1F	GetElt	
46409	CopyRowsUp	
4651C	CopyColsLeft	
46625	CopyRowsDown	
4677E	CopyColsRght	
4744F	'IDX	31.1
47467	STOAPPLDATA	
47984	APPprompt1!	
479A7	APPprompt2	
48FF9	SORTASLOW	
490E0	~BRinverse	
491D5	AUTOSCALE	
494B4	%.1	18.1
49709	PromptIdUtil	20.3
49AD3	PointDerivUt	
49BA5	FcnUtilEnd	
49BD2	RootUtil	
49C54	CkEQUtil	
49F06	PointMoveCur	
4A055	DISPCOORD2	
4A0AA	GetEqN	
4A95A	ICMPDRPRTDRP	
4A9AF	CHECKPVARS	
4AAEA	MAKEPVARS	
4AB1C	ID_X	31.1
4AB2A	PvarsC%0	
4AB59	ID_Y	31.1
4ADB0	GETSCALE	
4AE3C	PUTSCALE	
4AF63	GETINDEP	
4AF77	PUTINDEP	
4AF8B	PUTINDEPLIST	
4AFDB	GETRES	
4B012	PUTRES	
4B062	GETPTYPE	
4B076	PUTPTYPE	
4B0DA	GETPMIN&MAX	
4B10C	GETXMIN	
4B120	GETYMIN	
4B139	GETXMAX	
4B14D	GETYMAX	
4B166	PUTXMIN	
4B189	PUTYMIN	
4B1AC	PUTXMAX	
4B1CF	PUTYMAX	
4B323	MAKEPICT#	
4B364	GETPARAM	
4B553	VSCALE	
4B5AD	HSCALE	
4B60C	DOERASE	
4B6D9	PLOTERR	
4B710	RESETDEPTH	
4B765	PLOTPREP	
4B7D8	GetRes	
4BFAE	NEXTSTEP	
4C09B	NEWINDEP	
4C639	drax	
4CE4C	EXITFCNsto	
4CE6F	DOGRAPHIC	
4CEE7	GraphicExit	
4CF05	GDISPCENTER	
4CF41	SETLOOPENV	
4CF68	ExitFcn	
4D11E	DROPDEADTRUE	
4D132	SCROLLUP	41.6
4D150	SCROLLLEFT	41.6
4D16E	SCROLLDOWN	41.6
4D18C	SCROLLRIGHT	41.6
4DA0D	CROSS_HAIRS	
4DA76	CROSS_OFF	
4E266	CHECKMENU	
4E2AC	MENUOFF	
4E2CF	TURNMENUOFF	41.2
4E347	TURNMENUON	41.2
4E360	MENUOFF?	41.2
4E37E	LINECHANGE	
4E442	CURRENTMARK?	
4E46A	EQCURSOR?	
4E497	PREMARKON	
4E4B0	NEWMARK	
4E582	DRAWBOX#	
4E6EF	DispCoord1	
4E776	Z-BOX	
4ECAD	CROSSMARKON	
4F052	WINDOW#	
4F0AC	DOPX>C	
4F179	DOC>PX	
4F1D8	SWAPTRUE	33.1
4F408	C%>#	
4F78C	GROB+#	
4F7E6	CKGROBFITS	42.3
50262	%1+	18.3
50276	%1-	18.3
503D4	DOLCD>	42.3
50438	DO>LCD	42.3
5046A	DOCLLCD	41.4
5053C	CROSSGROB	42.1
5055A	MARKGROB	
50578	GROBDIM	42.2
505C6	GETXPOS	
505E4	getxpos	
5068D	GETYPOS	
506AB	getypos	
5072B	TOGGLELINE#3	
50758	DRAWLINE#3	
50ACC	LINEOFF3	
50ADB	TOGLINE3	42.3
50AEA	LINEON3	
50AF9	TOGLINE	42.3
50B08	LINEOFF	42.3
50B17	LINEON	
50D78	LASTPT?	
50DA5	PlotOneMore?	
50E59	!#1+IF<dim-1	
50EA5	!#1-IF>0	
510AD	INDEPVAR	
510D5	RECORDX&YC%	
51125	CLEARMENU	
51148	CKPICT	30.1
51166	CHECKPICT	
511E3	CHECKHEIGHT	
5129C	'IDFUNCTION	34.1
512C4	'IDPOLAR	34.1
512D8	'IDPARAMETER	34.1
5133C	PtoR	
514AF	GETRHS	

Addr.	Name	See
514DC	1REV	
51532	2HXSLIST?	17.2
515A0	TOPROW	41.6
515B4	BOTROW	41.6
515FA	LEFTCOL	41.6
5160E	RIGHTCOL	41.6
5162C	WINDOWTOP?	41.6
51645	WINDOWBOT?	41.6
5165E	WINDOWLEFT?	41.6
51677	WINDOWRIGHT?	41.6
51690	JUMPTOP	41.6
516AE	JUMPBOT	41.6
516E5	JUMPLEFT	41.6
51703	JUMPRIGHT	41.6
51735	REPEATERCH	
5179E	DUPGROBDIM	42.2
517F3	EQUALcasedro	35.5
5182F	ISTOP-INDEX	36.2
51843	SWAP#1+SWAP	17.3
51857	SWAP#1-SWAP	17.3
5187F	GBUFFGROBDIM	41.1
51893	ORDERXY#	42.3
518CA	ORDERXY%	42.3
5193B	C%%1	19.1
5196A	C%-1	19.1
519A3	C>Re%	19.2
519B7	C>Im%	19.2
519CB	C%>%%	19.2
519DF	C%>%%SWAP	19.2
519F8	C%%>C%	19.2
51A07	%%>C%	19.2
51A37	Re>C%	19.2
51B2A	C%%0=	19.4
51B43	C%0=	19.4
51B70	C%CHS	19.3
51B91	C%%CHS	19.3
51BB2	C%CONJ	19.3
51BC1	C%%CONJ	19.3
51BE4	%+SWAP	18.3
51EFA	C%1/	19.3
52062	C%ABS	19.3
52099	C%ARG	19.3
520CB	C%SGN	19.3
520E0	~BRViewItem	
52107	C%SQRT	19.3
52193	C%EXP	19.3
521E3	C%LN	19.3
522BF	C%LOG	19.3
52305	C%ALOG	19.3
52342	C%R^C	19.3
52360	C%C^R	19.3
52374	C%C^C	19.3
524AF	C%0	19.1
524F7	C%1	19.1
52530	C%SIN	19.3
52571	C%COS	19.3
525B7	C%TAN	19.3
5262F	C%SINH	19.3
52648	C%COSH	19.3
5265C	C%TANH	19.3
52675	C%ATAN	19.3
527EB	C%ATANH	19.3
52804	C%ASIN	19.3
5281D	C%ASINH	19.3
52836	C%ACOSH	19.3
52863	C%ACOS	19.3
52D26	4NULLLAM{}	31.3
530E0	~BRGetItem	
53725	SetUserFlag	39.1
53731	SetSysFlag	39.1
53755	ClrUserFlag	39.1
53761	ClrSysFlag	39.1
53778	TestUserFlag	39.1
53784	TestSysFlag	39.1
5380E	COERCEFLAG	35.1
53860	HISTON?	
538C0	UNDO_ON?	
538CE	UNDO_ON	
538DC	UNDO_OFF	
538F8	NOBLINK	
53968	AlgEntry?	41.5
53976	SetAlgEntry	41.5
53984	ClrAlgEntry	41.5
539F9	SetISysFlag	
53A20	REPLACE_MODE	
53A2E	INSERT_MODE	
53A3C	INSERT?	
53A4A	EditLExists?	
53A90	ClrNewEditL	
53AE4	NoIgnoreAlm	
53B31	setflag	
53BDD	RAD?	39.1
53C37	DOHEX	39.1
53C43	DOBIN	39.1
53C4F	DOOCT	39.1
53C5B	DODEC	39.1
53CAA	dostws	39.1
53D04	bitAND	21.3
53D15	bitOR	21.3
53D26	bitXOR	21.3
53D4E	bitNOT	21.3
53D5E	bitSL	21.3
53D6E	bitSLB	21.3
53D81	bitSR	21.3
53D91	bitSRB	21.3
53DA4	bitRR	21.3
53DE1	bitRRB	21.3
53E0C	bitRL	21.3
53E3B	bitRLB	21.3
53E65	bitASR	21.3
53EA0	bit+	21.3
53EB0	bit-	21.3
53ED3	bit*	21.3
53EE4	MPY	
53F05	bit/	21.3
54039	WORDSIZE	39.1
54050	BASE	39.1
54061	HXS>$	20.3
540BB	hxs>$	20.3
5422C	PUSHhxs	
54266	GPPushA	
5429F	bit%#/	21.3
542BD	bit#%/	21.3
542D1	bit%#*	21.3
542EA	bit#%*	21.3
542FE	bit%#-	21.3
5431C	bit#%-	21.3
54330	bit%#+	21.3
54349	bit#%+	21.3
5435D	#>%	19.2
5435D	HXS>%	18.2
543F9	%>#	17.2
544D9	HXS==HXS	21.4
544EC	HXS#HXS	21.4
54500	HXS>HXS	21.4
5452C	HXS>=HXS	21.4
5453F	HXS<=HXS	21.4
54552	HXS<HXS	21.4
545A0	cknumdsptch1	27.1
547B5	SYMBWHERE	27.2
54C63	nmetasyms	30.1
55288	1GETLAMSWP1+	31.3
5573D	COLAthexFCN	
558DC	sscknum2	27.1
558F5	sncknum2	27.1
5590E	nscknum2	27.1
560ED	xssgeneral	27.1
56101	xnsgeneral	27.1
5611F	xsngeneral	27.1
57D90	SYMCOLCT	27.2
580E7	~UTTYPEEXT0?	
58D75	SYMSHOW	27.2
590B0	~DoKeyCancel	
5A01D	SWAPcompSWAP	
5A036	uncrunch	27.1
5A0B0	~DoKeyOK	
5A310	symbn	
5DE55	RDROPFALSE	33.1
5DE7D	reversym	29
5E0DA	P{}N	25.4
5E370	NDUPN	29
5E3AC	psh&	0
5E401	psh1top&	26.3
5E415	top&	0
5E4A9	#1-SWAP	17.3
5E4A9	pull	26.3
5E4BD	pullrev	26.3
5E4D1	pshtop&	26.3
5E4EA	pullpsh1&	26.3
5E652	symcomp	27.1
5E67A	pshzer	26.3
5E706	psh1&	26.3
5E7A5	psh1&rev	26.3
5E984	nonopcase	35.5
5EA9F	pshzerpsharg	27.3
5EB1C	psh	26.1
5EDFC	numb1stcase	
5EE10	M-1stcasechs	35.4
5EF15	AEQ1stcase	35.4
5EFD9	MEQ1stcase	35.4
5EFF9	MEQopscase	35.4
5F048	AEQopscase	35.4
5F061	Mid1stcase	35.4
5F0AA	idntcase	35.5
5F0CD	idntlamcase	35.5
5F0FA	num0=case	35.3
5F127	%0=case	35.3
5F13B	C%0=case	35.3
5F154	num1=case	35.3
5F181	%1=case	35.3
5F19F	C%1=case	35.3
5F1BD	num2=case	35.3
5F1EA	%2=case	35.3
5F208	C%2=case	35.3
5F23A	num-1=case	35.3
5F267	%-1=case	35.3
5F285	C%-1=case	35.3
5FB49	NOTcaseFALSE	35.1
5FB76	ROT#1+UNROT	17.3
60EBD	RSWAP	
60EE7	ROTSWAP	29
60EE7	XYZ>YXZ	29
60F0E	ROTDROPSWAP	29
60F0E	UNROTSWAPDRO	29
60F0E	XYZ>ZY	29
60F21	ROTDROP	29
60F21	XYZ>YZ	29

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60F33	SWAPROT	29
60F33	UNROTSWAP	29
60F33	XYZ>ZYX	29
60F4B	3DROP	29
60F4B	XYZ>	29
60F54	7DROP	29
60F66	6DROP	29
60F72	5DROP	29
60F7E	4DROP	29
60F7E	XYZW>	29
60F83	4DropLoop	
60F9B	SWAPDROP	29
60F9B	XY>Y	29
60FAC	3UNROLL	29
60FAC	UNROT	29
60FAC	XYZ>ZXY	29
60FBB	4ROLL	29
60FBB	FOURROLL	29
60FBB	XYZW>YZWX	29
60FD8	5ROLL	29
60FD8	FIVEROLL	29
61002	6ROLL	29
61002	SIXROLL	29
6103C	8ROLL	29
6103C	EIGHTROLL	17.1
6106B	7ROLL	29
6106B	SEVENROLL	29
61099	DUP4UNROLL	29
6109E	4UNROLL	29
6109E	FOURUNROLL	29
6109E	XYZW>WXYZ	29
610C4	5UNROLL	29
610C4	FIVEUNROLL	29
610FA	6UNROLL	29
610FA	SIXUNROLL	29
6112A	ROTROT2DROP	29
6112A	UNROT2DROP	29
6112A	XYZ>Z	29
6113C	4UNROLL3DROP	29
6113C	XYZW>W	29
6114E	2RDROP	34
61160	3RDROP	34
61172	#-PICK	29
61184	#+PICK	17.3
6119E	DUP#1+PICK	29
611A3	#1+PICK	29
611BE	#2+PICK	29
611D2	#3+PICK	29
611E1	#4+PICK	29
611F9	2DUPSWAP	29
611F9	DUP3PICK	29
611FE	3PICK	29
6121C	4PICK	29
6123A	5PICK	29
6125E	6PICK	29
61282	7PICK	29
612A9	8PICK	29
612CC	#-ROLL	17.3
612DE	#+ROLL	17.3
612F3	#1+ROLL	29
61305	get1	
61318	#2+ROLL	29
6132C	#-UNROLL	29
6133E	#+UNROLL	17.3
61353	#1+UNROLL	17.3
61365	#2+UNROLL	29
61380	DUPUNROT	29
61380	SWAPOVER	29
613B6	1GETLAM	31.3
613E7	2GETLAM	31.3
6140E	3GETLAM	31.3
61438	4GETLAM	31.3
6145C	5GETLAM	31.3
6146C	6GETLAM	31.3
6147C	7GETLAM	31.3
6148C	8GETLAM	31.3
6149C	9GETLAM	31.3
614AC	10GETLAM	31.3
614BC	11GETLAM	31.3
614CC	12GETLAM	31.3
614DC	13GETLAM	31.3
614EC	14GETLAM	31.3
614FC	15GETLAM	31.3
6150C	16GETLAM	31.3
6151C	17GETLAM	31.3
6152C	18GETLAM	31.3
6153C	19GETLAM	31.3
6154C	20GETLAM	31.3
6155C	21GETLAM	31.3
6156C	22GETLAM	31.3
615E0	1PUTLAM	31.3
615F0	2PUTLAM	31.3
61600	3PUTLAM	31.3
61610	DUP4PUTLAM	31.3
61615	4PUTLAM	31.3
61625	5PUTLAM	31.3
61635	6PUTLAM	31.3
61645	7PUTLAM	31.3
61655	8PUTLAM	31.3
61665	9PUTLAM	31.3
61675	10PUTLAM	31.3
61685	11PUTLAM	31.3
61695	12PUTLAM	31.3
616A5	13PUTLAM	31.3
616B5	14PUTLAM	31.3
616C5	15PUTLAM	31.3
616D5	16PUTLAM	31.3
616E5	17PUTLAM	31.3
616F5	18PUTLAM	31.3
61705	19PUTLAM	31.3
61715	20PUTLAM	31.3
61725	21PUTLAM	31.3
61735	22PUTLAM	31.3
61745	DUPTEMPENV	31.3
617D8	GETLAMPAIR	
6186C	#=case	35.2
6187C	OVER#=case	35.2
61891	DUP#0=case	35.2
61896	#0=case	35.2
618A8	DUP#0=csedrp	35.2
618BA	EQcasedrop	35.5
618D3	#=casedrop	35.2
618E8	NOTcasedrop	35.1
618F7	casedrop	35.1
61910	NOTcase2drop	35.1
6191F	case2drop	35.1
61933	EQcase	35.5
6194B	caseDROP	35.1
61960	NOTcaseDROP	35.1
61970	case2DROP	35.1
61984	NOTcase2DROP	35.1
61993	case	35.1
619AD	NOTcase	35.1
619BC	IT	35.1
619CB	GOTO	34
619E0	?GOTO	34
619F3	NOT?GOTO	34
61A02	popflag	
61A18	#0=?SEMI	35.2
61A2C	NOT?SEMI	35.1
61A3B	?SEMI	34
61A47	SEMILOOP	
61A58	ITE_DROP	35.1
61A6D	COLA_EVAL	34.2
61A8E	COLARPITE	35.1
61AD8	ITE	35.1
61AE9	2'RCOLARPITE	35.1
61B45	2@REVAL	34
61B55	3@REVAL	34
61B72	NOT?DROP	35.1
61B89	ticR	34
61C1C	EXPAND	21.2
61CE9	CACHE	31.3
61D3A	SAVELAM	
61D41	SAVESTACK	31.3
61EA7	DUMP	31.3
61F8F	undo	31.3
61FA9	DUPROM-WORD?	28.2
61FB6	ROM-WORD?	28.2
61FCF	Rom-Word?	
62001	2SWAP	29
62020	DUPTYPECHAR?	33.3
62025	TYPECHAR?	33.3
62035	DUPTYPEIDNT?	33.3
6203A	TYPEIDNT?	33.3
6204A	DUPTYPEEXT?	33.3
6204F	TYPEEXT?	33.3
62073	GPOverWrT/FL	
62076	GPOverWrTLp	
6207D	OverWrF/TLp	
62080	OverWrTLoop	
62096	GPOverWrFLp	
6209D	OverWrT/FLp	
620A0	OverWrFLoop	
620B6	GPPushT/FLp	
620B9	GPPushTLoop	
620C0	PushF/TLoop	
620C3	DOTRUE	
620C3	PushTLoop	
620D2	GPPushFLoop	
620D9	PushT/F	
620D9	PushT/FLoop	
620DC	DOFALSE	
620DC	PushFLoop	
620EB	OVER#=	17.4
62103	DROPTRUE	33.1
6210C	DROPFALSE	33.1
62115	DUPTYPELAM?	33.3
6211A	TYPELAM?	33.3
6212A	DUPTYPEBINT?	33.3
6212F	TYPEBINT?	33.3
6213F	DUPTYPEHSTR?	33.3
62144	TYPEHSTR?	33.3
62154	DTYPECSTR?	33.3
62154	DUPTYPECSTR?	33.3
62159	TYPECSTR?	33.3
62169	DTYPEREAL?	33.3
62169	DUPTYPEREAL?	33.3
6216E	TYPEREAL?	33.3
6217E	DUPTYPECMP?	33.3
62183	TYPECMP?	33.3
62193	DTYPEARRY?	33.3
62193	DUPTYPEARRY?	33.3
62198	TYPEARRY?	33.3
621A8	DUPTYPEROMP?	33.3
621AD	TYPEROMP?	33.3
621BD	DUPTYPERRP?	33.3

Addr.	Name	See
621C2	TYPERRP?	33.3
621D2	DUPTYPESYMB?	33.3
621D7	TYPESYMB?	33.3
621E7	DTYPECOL?	33.3
621E7	DUPTYPECOL?	33.3
621EC	TYPECOL?	33.3
621FC	DUPTYPEGROB?	33.3
62201	TYPEGROB?	33.3
62211	DTYPELIST?	33.3
62211	DUPTYPELIST?	33.3
62216	TYPELIST?	33.3
62226	DUPTYPETAG?	33.3
6222B	TYPETAGGED?	33.3
6223B	TYPERARRY?	33.3
62256	TYPECARRY?	33.3
62266	DUP#0=	17.4
62289	#3=	17.4
6229A	#2=	17.4
622A7	#1=	17.4
622B6	#1<>	17.4
622C5	DUP#1=	17.4
622D4	DUP#0<>	17.4
622E5	!insert$	20.4
622EF	SWAP&$	20.4
62312	!!append$?	20.4
62376	!append$	20.4
62394	!!insert$	20.4
623A0	!!append$	20.4
62474	'RSaveRomWrd	
62474	'RSAVEWORD	
624BA	#MIN	17.3
624C6	#MAX	17.3
624FB	#-#2/	17.3
62535	DROPZERO	17.1
6254E	2DROP00	17.1
6256A	#3+	17.3
6257A	#4+	17.3
6258A	#5+	17.3
6259A	#6+	17.3
625AA	#7+	17.3
625BA	#8+	17.3
625CA	#9+	17.3
625DA	#10+	17.3
625EA	#12+	17.3
625FA	#3-	17.3
6260A	#4-	17.3
6261A	#5-	17.3
6262A	#6-	17.3
6264E	#10*	17.3
62674	#8*	17.3
62691	#6*	17.3
626AE	5skipcola	34.2
626DC	3skipcola	34.2
626E5	2skipcola	34.2
626EE	skipcola	34.2
626F7	DUP#2+	17.3
6270C	DROPSWAP	29
62726	DROPSWAPDROP	29
62726	ROT2DROP	29
62726	XYZ>Y	29
62747	SWAPDUP	29
62775	ROTDUP	29
62794	SWAP#-	
627A7	DROPDUP	29
627BB	DUPLEN$	20.4
627D5	#+DUP	17.3
627EB	Push2#aLoop	
627F8	#-DUP	17.3
62809	#1+DUP	17.3
6281A	#1-DUP	17.3
62830	SWAPDROPDUP	29
6284B	SWAPDROPSWAP	29
6284B	UNROTDROP	29
6284B	XYZ>ZX	29
62864	4ROLLDROP	29
62880	5ROLLDROP	29
6289B	2DUP#<	17.4
628B5	2DUP#=	17.4
628D1	2DUP#>	17.4
628EB	DUP#1+	17.3
62904	SWAP#1+	17.3
62904	SWP1+	17.3
6292F	DUP#1-	17.3
62946	DROPONE	17.1
62958	RDROPCOLA	34
6296D	COLACOLA	34.2
62986	COLAcase	
629A1	COLANOTcase	
629BC	ORcase	35.1
629D0	REQcase	
629E9	REQcasedrop	
62A02	SAFESTO	37.2
62A2F	DUPSAFE@	37.2
62A34	SAFE@	37.2
62A61	?>ROMPTR	28.2
62A84	?ROMPTR>	28.2
62ABB	MACRODCMP	
62B0B	2DROPFALSE	33.1
62B1F	PALPTRDCMP	
62B5B	palrompdcmp	
62B6F	#0=UNTIL	36.1
62B88	INCOMPDROP	25.3
62B9C	NTHCOMPDROP	25.1
62BB0	APPEND_SPACE	20.4
62BC4	7UNROLL	29
62BD8	RESOROMP	
62BF1	%10*	18.3
62C05	DUP@	37.2
62C19	DUPROMPTR@	28.2
62C2D	#=ITE	35.2
62C41	INNERDUP	25.3
62C55	NOTAND	33.1
62C69	TOTEMPSWAP	37.1
62C7D	ROT2DUP	29
62C91	ROTAND	33.1
62CA5	ROTOVER	29
62CB9	DUPDUP	29
62CCD	OVERDUP	29
62CE1	COERCEDUP	17.1
62CF5	UNROTDUP	29
62D09	4UNROLLDUP	29
62D1D	NTHCOMDDUP	25.1
62D31	OVERSWAP	29
62D31	OVERUNROT	29
62D45	ROLLSWAP	29
62D59	NULL$SWAP	20.2
62D6D	SUB$SWAP	20.4
62D81	%MAXorder	18.3
62D9F	?SKIPSWAP	35.1
62DB3	1ABNDSWAP	31.3
62DCC	ROT#+SWAP	17.3
62DCC	ROT+SWAP	17.3
62DE5	4PICK#+SWAP	17.3
62DE5	4PICK+SWAP	17.3
62DFE	#+SWAP	17.3
62E12	#-SWAP	17.3
62E26	#1+SWAP	17.3
62E3A	ZEROSWAP	17.1
62E4E	#1-1SWAP	17.3
62E67	ONESWAP	17.1
62E7B	COERCESWAP	17.1
62E8F	%>%%SWAP	18.3
62EA3	%%*SWAP	18.3
62EB7	XYZ>ZTRUE	33.1
62ECB	4ROLLSWAP	29
62EDF	3PICKSWAP	29
62EF3	4PICKSWAP	29
62F07	1GETSWAP	31.3
62F1B	?SWAP	35.1
62F2F	!append$SWAP	20.4
62F43	NOT?SWAPDROP	35.1
62F5C	?SWAPDROP	35.1
62F75	#1+NDROP	29
62F75	N+1DROP	29
62F89	ROLLDROP	29
62F9D	MDIMSDROP	23.1
62FB1	DUPROT	29
62FC5	DROPROT	29
62FD9	#1-ROT	17.3
62FED	%%*ROT	18.3
63001	4ROLLROT	29
63001	FOURROLLROT	29
63015	4UNROLLROT	29
63029	DROPOVER	29
6303D	EQOVER	33.2
63051	#+OVER	17.3
63065	#-OVER	17.3
63079	ZEROOVER	17.1
6308D	UNROTOVER	29
630A1	4ROLLOVER	29
630B5	3PICKOVER	29
630C9	4PICKOVER	29
630DD	DUPPICK	29
630E3	~PCunpack	
630F1	DUPROLL	29
63105	OVER#2+UNROL	29
63119	8UNROLL	29
6312D	10UNROLL	29
63141	OVERARSIZE	23.1
63155	'ERRJMP	34.1
63169	caseERRJMP	35.6
6317D	?CARCOMP	25.1
63191	NEWLINE$&$	20.4
63191	NEWLINE&$	20.4
631A5	#1-{}N	25.4
631B9	TWO{}N	25.4
631CD	THREE{}N	25.4
631E1	DUPINCOMP	25.3
631F5	SWAPINCOMP	25.3
63209	DUPNULL$?	20.5
6321D	DUPNULLCOMP?	25.1
63231	DUPLENCOMP	25.1
63245	#1-SUB$	20.4
63259	1_#1-SUB	20.4
63259	1_#1-SUB$	20.4
6326D	LAST$	20.4
63281	#1+LAST$	20.4
63295	DUP$>ID	31.2
632A9	SWAP%>C%	19.2
632BD	'NOP	34.1
632D1	::NEVAL	25.5
632E5	2GETEVAL	31.3
632F9	DROPRDROP	34
63312	SWAPCOLA	34.2
63326	XYZ>ZCOLA	34.2
6333A	#0=?SKIP	35.2
63353	#1=?SKIP	35.2

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6336C	#=?SKIP	35.2
63385	ONE_EQ	
63399	#>?SKIP	35.2
633B2	COLASKIP	34.2
633C6	NOT_UNTIL	36.1
633DF	NOT_WHILE	36.1
633F8	DUP#0<>WHILE	36.1
63411	DUPINDEX@	36.2
63425	SWAPINDEX@	36.2
63439	OVERINDEX@	36.2
6344D	SWAPLOOP	36.2
63466	DROPLOOP	36.2
6347F	DUP#0_DO	36.2
63498	toLEN_DO	36.2
634B6	1GETABND	31.3
634CA	DUP1LAMBIND	31.3
634CF	1LAMBIND	31.3
634E3	caseTRUE	35.1
634F7	TRUEFALSE	33.1
634F7	TrueFalse	33.1
6350B	FALSETRUE	33.1
6350B	FalseTrue	33.1
6351F	ZEROFALSE	33.1
63533	ONEFALSE	33.1
63547	#=casedrpfls	35.2
6356A	casedrpfls	35.1
63583	case2drpfls	35.1
6359C	caseFALSE	35.1
635B0	ORNOT	33.1
635C4	EQUALNOT	33.2
635D8	2DUPEQ	33.2
635EC	DUPEQ:	33.2
635F1	EQ:	33.2
63605	EQOR	33.2
63619	EQUALOR	33.2
6362D	2#0=OR	17.4
6364B	OVER#0=	17.4
6365F	OVER#<	17.4
63673	#<3	17.3
63687	DUP#<7	17.4
636A0	INNER#1=	25.3
636B4	#5=	17.4
636C8	#2<>	17.4
636DC	OVER#>	17.4
636F0	#>1	17.4
636F0	ONE#>	17.4
63704	2DUP#+	17.3
63704	DUP3PICK#+	17.3
63718	ROT#+	17.3
6372C	OVER#+	17.3
63740	3PICK#+	17.3
63754	4PICK#+	17.3
63768	ROT#-	17.3
6377C	OVER#-	17.3
63790	INDEX@#-	36.2
637A4	SWAPOVER#-	17.3
637B8	ROT#1+	17.3
637CC	#-+1	17.3
637CC	#1--	17.3
637E0	SWAP#1-	17.3
637F4	DROP#1-	17.3
63808	#+-1	17.3
63808	#1-+	17.3
6381C	COLAITE	
6383A	ERROROUT	32.1
6384E	D0=DSKTOP	
6385D	D1=DSKTOP	
6386C	SWAP2DUP	29
63880	RSKIP	34
6389E	GROB!ZERODRP	42.3
638B2	casedrptru	35.1
638CB	NOTcaseTRUE	35.1
638E4	?SEMIDROP	34
638FD	SWAPUnDROP	29
63911	SWAPUnNDROP	26.1
63925	DUP'	34.1
63939	SWAP'	34.1
6394D	DROP'	34.1
63961	OVER'	34.1
63975	STO'	34.1
63989	TRUE'	34.1
6399D	ONEFALSE'	34.1
639B6	FALSE'	34.1
639CA	#1+'	34.1
639DE	'R'R	34
639FC	'RRDROP	34
63A15	ONECOLA	34.2
63A29	dvarlsBIND	
63A3D	'LAMLNAMESTO	
63A56	'xDEREQ	
63A6F	DUPNULL{}?	25.4
63A88	DUPZERO	17.1
63A9C	DUPONE	17.1
63AB0	SWAPONE	17.1
63AC4	ONEDUP	17.1
63AC4	ONEONE	17.1
63AD8	DUPTWO	17.1
63AEC	NOTcsdrpfls	35.1
63B05	caseSIZEERR	35.6
63B19	NcaseSIZEERR	35.6
63B2D	CKREAL	30.1
63B46	NcaseTYPEERR	35.6
63B5A	'x*	34.1
63B6E	'xDER	34.1
63B82	%%/>%	18.3
63B96	UNCOERCE%%	18.2
63BAA	DUP%0=	18.4
63BBE	SWAP%%/	18.3
63BD2	caseDrpBadKy	35.6
63BEB	caseDEADKEY	35.6
63BEB	caseDoBadKey	35.6
63C04	GROBDIMw	42.2
63C18	%%*UNROT	18.3
63C2C	SWAP4ROLL	29
63C2C	XYZW>YWZX	29
63C40	2DUP5ROLL	29
63C54	SWAP3PICK	29
63C68	3PICK3PICK	29
63C7C	SWAP4PICK	29
63C90	OVER5PICK	29
63CA4	EQUALcasedrp	35.5
63CBD	DUP#0=csDROP	35.2
63CD6	jEQcase	35.5
63CEA	ANDcase	35.1
63CFE	EQUALcase	35.5
63D12	#<case	35.2
63D26	#1=case	35.2
63D3A	#<>case	17.4
63D4E	#>2case	35.2
63D67	#>case	35.2
63D7B	j%0=case	35.3
63D8F	REALcase	35.3
63DA3	dARRYcase	30.1
63DB7	dLISTcase	30.1
63DCB	EditExstCase	
63DDF	ANDNOTcase	35.1
63DF3	EQUALNOTcase	35.5
63E07	dIDNTNcase	30.1
63E1B	dREALNcase	35.5
63E2F	EQIT	35.5
63E48	DUP#0=IT	35.2
63E61	ANDITE	35.1
63E75	EQITE	35.5
63E89	#0=ITE	35.2
63E9D	#<ITE	35.2
63EB1	#>ITE	35.2
63EC5	DUP#0=ITE	35.2
63ED9	UserITE	35.6
63EED	SysITE	35.6
63F01	top&Cr	
63F1A	metaROTDUP	26.1
63F2E	ROTUntop&	0
63F42	roll2top&	0
63F42	rolltwotop&	0
63F56	plDRPpZparg	27.3
63F6A	&$SWAP	20.4
63F7E	SWAPCKREF	37.1
63F92	pZpargSWAPUn	27.3
63FA6	DROPNDROP	29
63FBA	2OVER	29
63FCE	?Ob>Seco	25.5
63FE7	Ob>Seco	25.5
63FFB	2Ob>Seco	25.5
6400F	ExitAtLOOP	36.2
6400F	ZEROISTOPSTO	36.2
64023	RclHiddenVar	37.4
64037	WithHidden	37.4
64078	StoHiddenVar	37.4
6408C	PuHiddenVar	37.4
640A0	SaveVarRes	
640BE	SetHiddenRes	37.4
640FA	RestVarRes	
64127	Embedded?	
6416D	UStackDepth	
64190	Sig?ErrJmp	
641CC	DupAndThen	
641FC	ZEROZERO	17.1
64209	#ZERO#ONE	17.1
6427A	#ZERO#SEVEN	17.1
6428A	#ONE#27	17.1
6429D	#TWO#ONE	17.1
642AF	#TWO#TWO	17.1
642BF	#TWO#FOUR	17.1
642D1	#THREE#FOUR	17.1
642E3	#FIVE#FOUR	17.1
64309	ZEROZEROZERO	17.1
6431D	ZEROZEROONE	17.1
64331	ZEROZEROTWO	17.1
64345	SubMetaOb	26.4
643BD	SubMetaOb1	26.4
643EF	matchob?	
643F9	matchob?Lp	
64426	POSCOMP	25.1
6443A	nextpos	
6448A	#=POSCOMP	25.1
644A3	EQUALPOSCOMP	25.1
644BC	NTHOF	25.1
644D0	Find1stTrue	25.1
644EE	Find1stT.1	
6452F	Lookup	25.1
64548	Lookup.1	
64593	EQLookup	25.1
645B1	POS$	20.4
645B1	POSCHR	20.4
645BD	POS$REV	20.4
645BD	POSCHRREV	20.4
6475C	CHR>$	20.3

Addr.	Name	See
64775	STRIPTAGS	22
647A2	STRIPTAGSl2	22
647BB	TAGOBS	22
6480B	NEXTCOMPOB	25.1
648BD	>LASTRAM-WOR	
64B12	FORTYFOUR	17.1
64B1C	FORTYFIVE	17.1
64B26	FORTYSIX	17.1
64B30	FORTYSEVEN	17.1
64B3A	FORTYEIGHT	17.1
64B44	FORTYNINE	17.1
64B4E	FIFTY	17.1
64B58	FIFTYONE	17.1
64B62	FIFTYTWO	17.1
64B6C	FIFTYTHREE	17.1
64B6C	STRLIST	17.1
64B76	FIFTYFOUR	17.1
64B80	FIFTYFIVE	17.1
64B8A	FIFTYSIX	17.1
64B94	FIFTYSEVEN	17.1
64B9E	FIFTYEIGHT	17.1
64BA8	FIFTYNINE	17.1
64BB2	SIXTY	17.1
64BBC	SIXTYONE	17.1
64BC6	SIXTYTWO	17.1
64BD0	SIXTYTHREE	17.1
64BDA	BINT40h	17.1
64BDA	SIXTYFOUR	17.1
64BDA	YHI	17.1
64BE4	ARRYREAL	17.1
64BE4	BINT_65d	17.1
64BEE	FOURTWO	17.1
64BF8	FOURTHREE	17.1
64C02	SIXTYEIGHT	17.1
64C0C	FOURFIVE	17.1
64C16	SEVENTY	17.1
64C20	SEVENTYFOUR	17.1
64C2A	SEVENTYNINE	17.1
64C34	EIGHTY	17.1
64C3E	EIGHTYONE	17.1
64C3E	LISTREAL	17.1
64C48	LISTCMP	17.1
64C52	FIVETHREE	17.1
64C5C	FIVEFOUR	17.1
64C66	2LIST	17.1
64C70	FIVESIX	17.1
64C7A	LISTLAM	17.1
64C84	BINT_91d	17.1
64C8E	BINT_96d	17.1
64C98	IDREAL	17.1
64CAC	ONEHUNDRED	17.1
64CC0	char	17.1
64CE8	BINT_115d	17.1
64CF2	BINT_116d	17.1
64D06	BINT_122d	17.1
64D10	BINT80h	17.1
64D1A	BINT_130d	17.1
64D1A	XHI-1	17.1
64D24	BINT_131d	17.1
64D24	XHI	17.1
64D38	SYMBREAL	17.1
64D56	SYMBUNIT	17.1
64D6A	SYMOB	17.1
64D74	SYMREAL	17.1
64D92	SYMID	17.1
64D9C	SYMLAM	17.1
64DB0	SYMSYM	17.1
64DBA	SYMEXT	17.1
64DD8	BINTC0h	17.1
64DE2	2GROB	17.1
64DEC	TAGGEDANY	17.1
64DF6	EXTREAL	17.1
64E00	EXTSYM	17.1
64E0A	2EXT	17.1
64E14	ROMPANY	
64E1E	BINT253	17.1
64E28	BINT255d	17.1
64E32	REALOBOB	17.1
64E3C	#_102	17.1
64E64	3REAL	17.1
64F04	INTEGER337	17.1
64FC2	ATTNERR	17.1
6506C	Connecting	17.1
6508A	EXTOBOB	17.1
65094	#EXITERR	17.1
6509E	MINUSONE	17.1
650A8	%e	18.1
650BD	%.5	18.1
650E7	%10	18.1
650FC	%180	18.1
65126	%360	18.1
65176	tok{	20.2
6518E	toksharp	20.2
651BE	tokESC	20.2
651D6	tok<<	20.2
651E2	tokexponent	20.2
65238	NEWLINE$	20.2
65254	SPACE$	20.2
65254	tok_	20.2
65278	tokquote	20.2
65284	tok'	20.2
65290	tok,	20.2
6529C	tok.	20.2
652FC	tok-	20.2
65308	tok=	20.2
6534C	tok0	20.2
65358	tok1	20.2
653AC	tok8	20.2
653B8	tok9	
6541E	CHR_00	20.1
65425	CHR_...	20.1
6542C	CHR_DblQuote	20.1
65433	CHR_#	20.1
6543A	CHR_*	20.1
65441	CHR_+	20.1
65448	CHR_	20.1
6544F	CHR_-	20.1
65456	CHR_.	20.1
6545D	CHR_/	20.1
65464	CHR_0	20.1
6546B	CHR_1	20.1
65472	CHR_2	20.1
65479	CHR_3	20.1
65480	CHR_4	20.1
65487	CHR_5	20.1
6548E	CHR_6	20.1
65495	CHR_7	20.1
6549C	CHR_8	20.1
654A3	CHR_9	20.1
654AA	CHR_:	20.1
654B1	CHR_;	20.1
654B8	CHR_<	20.1
654BF	CHR_=	20.1
654C6	CHR_>	20.1
654CD	CHR_A	20.1
654D4	CHR_B	20.1
654DB	CHR_C	20.1
654E2	CHR_D	20.1
654E9	CHR_E	20.1
654F0	CHR_F	20.1
654F7	CHR_G	20.1
654FE	CHR_H	20.1
65505	CHR_I	20.1
6550C	CHR_J	20.1
65513	CHR_K	20.1
6551A	CHR_L	20.1
65521	CHR_M	20.1
65528	CHR_N	20.1
6552F	CHR_O	20.1
65536	CHR_P	20.1
6553D	CHR_Q	20.1
65544	CHR_R	20.1
6554B	CHR_S	20.1
65552	CHR_T	20.1
65559	CHR_U	20.1
65560	CHR_V	20.1
65567	CHR_W	20.1
6556E	CHR_X	20.1
65575	CHR_Y	20.1
6557C	CHR_Z	20.1
65583	CHR_a	20.1
6558A	CHR_b	20.1
65591	CHR_c	20.1
65598	CHR_d	20.1
6559F	CHR_e	20.1
655A6	CHR_f	20.1
655AD	CHR_g	20.1
655B4	CHR_h	20.1
655BB	CHR_i	20.1
655C2	CHR_j	20.1
655C9	CHR_k	20.1
655D0	CHR_l	20.1
655D7	CHR_m	20.1
655DE	CHR_n	20.1
655E5	CHR_o	20.1
655EC	CHR_p	20.1
655F3	CHR_q	20.1
655FA	CHR_r	20.1
65601	CHR_s	20.1
65608	CHR_t	20.1
6560F	CHR_u	20.1
65616	CHR_v	20.1
6561D	CHR_w	20.1
65624	CHR_x	20.1
6562B	CHR_y	20.1
65632	CHR_z	20.1
65639	CHR_->	20.1
65640	CHR_<<	20.1
65647	CHR_>>	20.1
6564E	CHR_Angle	20.1
65655	CHR_Deriv	20.1
6565C	CHR_Integral	20.1
65663	CHR_LeftPar	20.1
6566A	CHR_Newline	20.1
65671	CHR_Pi	20.1
65678	CHR_RightPar	20.1
6567F	CHR_Sigma	20.1
65686	CHR_Space	20.1
6568D	CHR_UndScore	20.1
65694	CHR_[	20.1
6569B	CHR_]	20.1
656A2	CHR_{	20.1
656A9	CHR_}	20.1
656B0	CHR_<=	20.1
656B7	CHR_>=	20.1
656BE	CHR_<>	20.1
656C5	$_R<<	20.2

Addr.	Name	See
656D5	$_R<Z	20.2
656E5	$_XYZ	20.2
656F5	$_<<>>	20.2
65703	$_{}	20.2
65711	$_[]	20.2
6571F	$_''	20.2
6572D	$_::	20.2
6573B	$_LRParens	20.2
65749	$_2DQ	20.2
65757	$_ECHO	20.2
65769	$_EXIT	20.2
6577B	$_Undefined	20.2
65797	$_RAD	20.2
657A7	$_GRAD	20.2
6594E	putnibs	
6595A	getnibs	39.2
659DE	Symb>HBuff	42.3
66EA5	BigCursor	42.1
66ECD	MediumCursor	42.1
66EF1	SmallCursor	42.1
70601	BANKMTHDS	
715B1	?ACCPTR>	
71C3B	rNTHELCOMP	
71DB2	RPTRACC	
7DBA0	nWHEREIFTE	
7DBAB	nWHEREDER	
7DBB6	nWHEREINTG	
7DBC1	nWHERESUM	
7DBCC	nWHEREWHERE	
7DBD7	nWHEREFCNAPP	
7DBE2	D/D*	
7DBED	D/D+	
7DBF8	D/D-	
7DC03	D/D/	
7DC0E	derquot	
7DC54	derprod1	
7DC72	D/D=	
7DC72	D/Dalg=	
7DC7D	D/DABS	
7DC88	easyabs	
7DCA1	D/DACOS	
7DCAC	D/DACOSH	
7DCB7	D/DALOG	
7DCC2	D/DARG	
7DCCD	D/DASIN	
7DCD8	D/DASINH	
7DCE3	D/DATAN	
7DCEE	D/DATANH	
7DCF9	D/DCHS	
7DD17	D/DCONJ	
7DD35	D/DCOS	
7DD40	D/DCOSH	
7DD4B	D/DEXP	
7DD4B	D/DEXPM1	
7DD56	D/DINV	
7DD61	D/DLN	
7DD6C	D/DLNP1	
7DD77	D/DLOG	
7DD82	D/DIFTE	
7DD8D	D/DSIN	
7DD98	D/DSINH	
7DDA3	D/DSQ	
7DDAE	D/DSQRT	
7DDB9	D/DTAN	
7DDC4	D/DTANH	
7DDCF	D/D^	
7DDDA	D/D^X	
7DDE5	D/D^Y	
7DDF0	D/DDER	
7DDFB	D/DWHERE	
7DE06	D/DINTEGRAL	
7DE11	D/DSUM	
7DE1C	D/DAPPLY	
7DE27	nINTGINV	
7DE32	nINTGSIGN	
7DE3D	nINTGSQRT	
7DE48	nINTGSQ	
7DE53	nINTGSIN	
7DE5E	nINTGCOS	
7DE69	nINTGTAN	
7DE74	nINTGSINH	
7DE7F	nINTGCOSH	
7DE8A	nINTGTANH	
7DE95	nINTGASIN	
7DEA0	nINTGACOS	
7DEAB	nINTGATAN	
7DEB6	nINTGLN	
7DEC1	nINTGLOG	
7DECC	nINTGALOG	
7DED7	nINTGEXPM	
7DEE2	nCustomMenu	
7DEED	nCOLCTQUOTE	
7DEF8	SPLITWHERE	
7DF03	MANMENU+-	
7DF0E	MANMENU*/	
7DF19	MANMENU^	
7DF24	MANMENUEXP	
7DF2F	MANMENULN	
7DF3A	MANMENUCSIV	
7DF45	MANMENUEQ	
7DF50	MANMENUCX	
7DF5B	MANMENUTRG	
7DF66	MANMENUATG	
7DF71	PTYPE>PINFO	
7DF7C	MOVEVAR	
7DF87	COPYVAR	
850B0	~grobAlertIc	
860B0	~grobCheckKe	
C50B0	~gFldVal	
C80B0	~GetFieldVal	

Appendices

Appendix A Tools for programming in System RPL

As said before, you cannot create System RPL programs only using your calculator. Until some years ago, it was necessary a PC to create System RPL programs. Now, you can create them using your just your calculator and special programs.

A.1 HP Tools

The HP Tools was the first package for creating System RPL programs. It was created by the HP staff, but it is not supported by them. They are a set of four utilities: a RPL compiler (RPLCOMP.EXE), a Saturn Assembler (SASM.EXE), a Saturn Linker (SLOAD.EXE) and a library creator (MAKEROM.EXE). There is also a program to conver a directory into a library (which will be explained in Appendix C), USRLIB.EXE.

If you want to use the HP Tools to compile the examples of this book or your programs, all source files must look like this:

```
ASSEMBLE
    NIBASC  /HPHP48-X/
RPL

::
* Your program here
;
```

This is because all HP files have the header HPHP48-X (actually X can be any letter of your choice). Since the program file was created in a computer, the header is not added. Without it, the file won't load correctly in the HP48. So, the instructions above add the header so that your program can be transfeered to the HP48 correctly.

Compiling a System RPL program with the HP48 requires several steps:

1. Create you source file (do not forget to add the above!), and save it with the extension .S. We will suppose that the your program is called MYPROG. So, the file with the source code would be called MYPROG.S.
2. Run RPLCOMP MYPROG.S MYPROG.A. This will generate the file MYPROG.A, which is the Saturn assemble source code.

3. Now, run SASM MYPROG.A. This wil create two files MYPROG.L and MYPROG.O.
4. Create a file called MYPROG.M that looks like this (see the file SLOAD.DOC for information on what the commands mean):

```
TITLE My First Program
REL MYPROG.O
OUTPUT MYPROG
LLIST MYPROG.LR
SEARCH ENTRIES.O
SUPRESS XREF
END
```

5. Now, run SLOAD -H MYPROG.M. This is create the files MYPROG.LR, the listing, and MYPROG, which is the program. Check the file MYPROG.LR. If there are no errors, your program is ready. If not, edit the source file, and restart from step 2.

The HP Tools can be found on ftp://hpcvbbs.external.hp.com/dist/ms-dos/tools.exe , or in Goodies Disk 4. The Goodies Disk are a compilation of several programs for your HP48. They can be found at Joe Horn's home page at http://user.kcyb.com/joehorn/ .

Also designed for programming in System RPL with a computer, there are the GNU Tools by Mario Mikocevic. They are like the HP Tools, with some of JAZZ enchancements. Their source code is available (in C), and they can be run on other plataforms. You can download the source code at Mario's home page at http:// www.zems.fer.hr/~mozgy/jwz/hp48.html . You can get them compiled for MS-DOS and Linux at Andre Schrool's home page at http://www.engr.uvic.ca/~aschrool/ .

A.2 JAZZ

Some years ago, Detlef Mueller and Raymond Hellstern developed the RPL48 package. This program allowed the user to create System RPL programs directly in the HP48. Later, Mika Heiskanen develop JAZZ. JAZZ is a library which allows you to create System RPL programs in your calculator, disassemble and debug them. It includes several enchancements, like the lambda variable generation described in section 5.3

The examples listed in this book are designed for JAZZ. Should you prefer using tools in your computer, you'll need to make some changes (see the above section). If you prefer using JAZZ, just type them (or upload the file, if provided), and run the ASS command. You'll get your program.

Other useful functions of JAZZ are the disassembler (commands DIS, DISXY and DOB), the debugger (SDB) and the entries catalog (EC). Consult the JAZZ documentation for more information.

You can get JAZZ at http://www.hut.fi/~mheiskan/ .

Appendix B
Creating libraries

The biggest advantage of libraries is that the user can only access the commands the creator of the library wants to be accessed. Sub-routines do not show in the menu, and cannot be directly accessed. This means that only the “main” programs need to have protection against bad input, for example. Since only they will call the sub-routines, you do not need to waste code putting this kind of check in the sub-routines, unless you are going to pass invalid parameters to them.

There are two ways to create libraries: converting a previously existent directory into one, or creating one directly. The first method is easier.

B.1 Converting a directory into a library

To create a library from a directory, the only thing you need is to create some special variables in it, and run a program to convert it. There are programs for PC’s (included in the HP and GNU Tools), or for the HP48 (which can be found on Mika Heiskanen’s Hack library, downloadable from http://www.hut.fi/~mheiskan/).

The special variables recognized by library converters are:

Variable	Description
`$ROMID`	**Required.** Contains a real or (user) binary representing the library number. The number should be in the range of 769-1792 (#301h-#6FFh).
`$TITLE`	Contains a string representing the tile of the library. The first five characters are used to create the softkey in the Library menu. The library does not need to have a title. But if it doesn’t, it will not show in the Library menu.
`$CONFIG`	Contains the program to be executed at configuration time. Normally, this is a program to attach the library, in the form « `1234 ATTACH` » or `:: 1234 TOSRRP ;`.
`$MESSAGE`	Specifies the message table. Its format varies from program to program, so check the documentation. In `USRLIB`, it is a list of variable names (which contain strings). Those strings will from the message table. In other tools, it is a list of strings.
`$VISIBLE`	Contains a list of the variables that will be converted to user-accessible commands. If not present, then all commands will be accessible.
`$HIDDEN`	Contains a list of the variables that will not be converted to user-accessible commands. If `$HIDDEN` and `$VISIBLE` are present, only `$HIDDEN` will be considered.

Variable	Description
$VARS	Contains a list of the variables which will not be converted to library commands, instead, they will remain in RAM. For example, if your program stores something in a variable, the name of this variable should be specified in this list.

Once you have created the directory with your application and the above variables, the only thing you need is to run the converter program.

B.2 Creating libraries directly

Creating libraries directly is a bit more complicated. Especially if you use the HP Tools or GNU Tools. The instructions here apply for JAZZ only. The process with HP Tools or GNU Tools is similar, but there are a few differences. See their documentation for instructions.

To create a library, before any code you must use the xROMID <numb> statement to tell the compiler you are creating a library and it's number. Following, if your library is to appear on the menu, you must put the statement to define the title: xTITLE <title>. The other commands, described below, can be anywhere in the file, but it is a good practice to put them all together in the beginning. The ideal form for the library is:

```
xROMID   <library number>
xTITLE   <library title>
xCONFIG  <configuration object name>
xMESSAGE <message table name>
EXTERNAL <command 1 name>
...
EXTERNAL <command N name>

* Main code
```

Then, each command that should be accessible is defined with the token xNAME <label>. Commands that should not be accessible are defined with NULLNAME <label>.

All visible commands must be preceded by a property field. This is a series of flags that indicate that the command has some special properties. A standard command with no special properties is defined with CON(1) 8.

Let's see an example of a library that calculates the greatest common factor and least common multiple. It has three commands: GCF, which calculates the greatest common factor; LCM, which calculates the least common multiple; and subGCF. The latter one is not accessible to the user. It is a subroutine used to calculate the gcf.

```
* Library number: 1566
xROMID  #61E
* Library title
xTITLE  MYLIB: My first library
```

```
* Name of configuration routine
xCONFIG TheConfig

* Command declarations.
EXTERNAL GCF
EXTERNAL LCM
EXTERNAL subGCF

* Configuration routine
LABEL TheConfig
::
  # 61E TOSRRP      ( Attach library )
;


* User-accessible command to calculate the GCF
ASSEMBLE
    CON(1)  8
RPL
xNAME GCF
::
  CK2&Dispatch      ( req. two arguments )
  2REAL subGCF      ( two reals? then calculate )
;


* User-accessible command to calculate the LCM
ASSEMBLE
    CON(1)  8
RPL
xNAME LCM
::
  CK2&Dispatch      ( req. two arguments )
  2REAL ::          ( two reals? )
    2DUP
    %*
    UNROT
    subGCF
    %/
  ;
;


* Sub-routine used to calculate the GCF
NULLNAME subGCF
::
  DUP%0=
  caseDROP
  DUPUNROT
  %MOD
  COLA
  subGCF
;
```