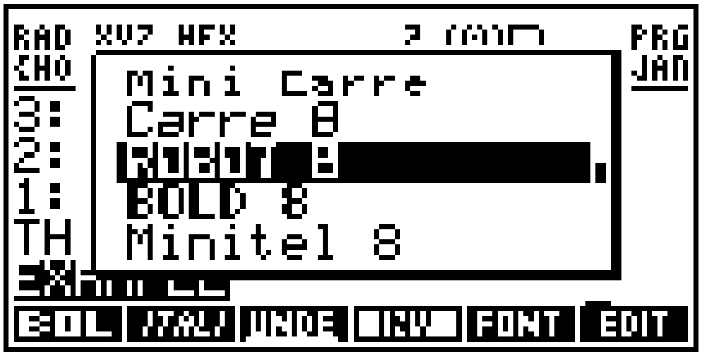
Maubert Development Group

META KERNEL

MDG Meta Kernel



Manual

ROM Version 2.30 – July. 1998

[Dec. 1998 - Cut-down version]

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Thanks to

Jake Schwartz (without whom this English manual wouldn't exist!)

Paul Courbis (the 'Voyage' is our bible)

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Hewlett Packard (for the HP48 and the RPLMAN doc)

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Using the Meta Kernel

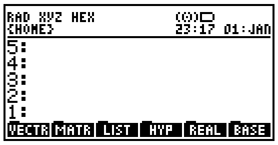
1 Installation

Switch off your calculator by pressing ↱ ON OFF .

Put the ROM card into the slot 1 of the HP48 (it must be the port 1)

Turn the HP48 on.

After a short time, the **Meta Kernel** is installed:



```
RAD XYZ HEX           ((•))▭
{HOME}                23:17 01:JAN
5:
4:
3:
2:
1:
VECTR MATR LIST HYP REAL BASE
```

2 General presentation

The **Meta Kernel** is an application card that changes the standard environment. A good knowledge of the standard environment is required, as the **MK** uses it, and adds several functions. Please read the HP48 GX User's Guide about it.

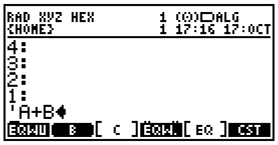
With the new stack display and command line, new utilities are provided:

- Equation editor (EQW) ....Page 17
- Matrix editor (MATR) ....Page 23
- Grob editor (PICTURE2) ....Page 24
- File utility (FILER)...Page 27
- Symbolic assembler (MASD)......................................Page 32
- Library maker ....Page 35
- System RPL Development Kit ....Pages 16, 36

3 Stack display

3.1 Display

The display is divided in three parts: (the command line belongs to the stack)



```
RAD XYZ HEX         1 ((•))▭ALG
{HOME}              1 17:16 17:OCT
4:
3:
2:
1:
'A+B◆
EQWU  B  [ C ] EQW. [ EQ ] CST
```

← Status area

← Stack

Command line →

← Menu

The stack and status area can be resized in height, see below.

3.1.1 Status area

The status area shows the current HP48 GX state.

Error messages, current path, calculator modes are displayed in this area.

Here are the new state flags:

DEG	: Degrees
RAD	: Radians
GRD	: Grads
XYZ	: Rectangular coordinates
R∡Z	: Polar coordinates
R∡∡	: Spherical coordinates
ALG	: Algebraic entry mode
PRG	: Program entry mode
((•))	: Beeper
HLT	: A program has been halted
USR	: User keyboard
1US	: User keyboard for the next keystroke
HEX	: Hexadecimal base
DEC	: Decimal base
OCT	: Octal base
BIN	: Binary base
▭	: ROM or write-protected RAM in port 2
■	: Read-write RAM card in port 2

The status area occupies two text lines by default. Its height can be changed to one or zero lines with the **MK** command →HEADER, consult Page 45.

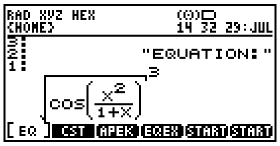
3.1.2 Stack

With the **MK**, up to nine lines can be viewed on the stack, as you can change the font height (6,7 or 8 pixels) and the status area height.

The maximum number of lines displayed by objects can be changed with →NDISP, consult Page 46.

More configuration capabilities are provided by the **Meta Kernel** system flags (**MK**SF), consult Page 11.

Algebraics and grobs may be displayed directly in the stack, use the **MK**SF to configure how and when they are displayed.

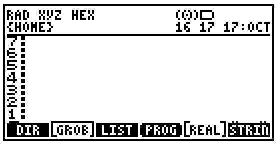


```
RAD XYZ HEX          (⊙)□
{HOME}           14 32 29:JUL
3:
2:              "EQUATION:"
1:
```

$$\sqrt{\cos\left(\frac{x^2}{1+x}\right)}^{3}$$

3.1.3 Menu labels

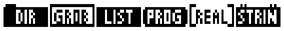
Menu-label style depends on the type of the stored object:



```
RAD XYZ HEX          (⊙)□
{HOME}           16 17 17:OCT
7:
6:
5:
4:
3:
2:
1:
```

DIR Directory	PROG Program, code
GROB Grob	[REAL] Real, complex, algebraic expression, matrix
LIST List, variable, binary integer	STRIN Character string

By default, labels are written using the **MK** mini font. If the **MK** system flag -20 is set (with `-20 SF2`), standard menu font is used instead:



3.2 Display configuration

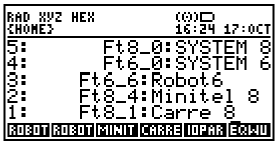
New display fonts can be created and used. The number of lines displayed on the stack differs with the font height.

With a font8 (8 pixels height), 5 to 7 lines may be viewed; with a font7, 6 to 8 lines ; with a font6, 7 to 9 lines.

3.2.1 Changing the display font

To use a different font, put it on the stack, and execute `→FONT`, consult Page 46.

Fonts are displayed on the stack like this:

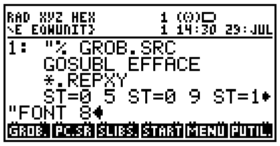


```
RAD XYZ HEX          (⊙)□
{HOME}           16:24 17:OCT
5:       Ft8_0:SYSTEM 8
4:       Ft6_0:SYSTEM 6
3:     Ft6_6:Robot6
2:     Ft8_4:Minitel 8
1:     Ft8_1:Carre 8
```

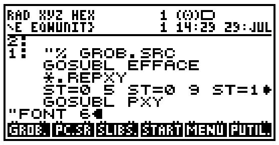
Example: `Ft8_0:SYSTEM 8`, this is the standard display font for the **MK**.

The first number (`8`) is the font height in pixels, the second number (`0`) is the id of the font, then the name (`SYSTEM 8`).

Two examples with a font8 and a font6:

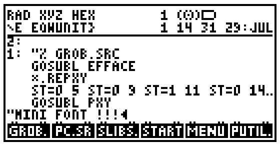


```
RAD XYZ HEX        1 (⊙)□
\E EQWUNIT}       1 14:30 29:JUL
1:  "% GROB.SRC
    GOSUBL EFFACE
    *.REPXY
    ST=0 5 ST=0 9 ST=1◆
"FONT 8◆
```



```
RAD XYZ HEX        1 (⊙)□
\E EQWUNIT}       1 14:29 29:JUL
2:
1:  "% GROB.SRC
    GOSUBL EFFACE
    *.REPXY
    ST=0 5 ST=0 9 ST=1◆
    GOSUBL PXY
"FONT 6◆
```

If the current font is a font6 (6 pixel-high), the **MK** system flags -8 and -9 force respectively the stack display and the command line to use the mini font:



```
RAD XYZ HEX        1 (⊙)□
\E EQWUNIT}       1 14 31 29:JUL
2:
1:  "% GROB.SRC
    GOSUBL EFFACE
    *.REPXY
    ST=0 5 ST=0 9 ST=1 11 ST=0 14..
    GOSUBL PXY
"MINI FONT !!!◀
```

3.2.2 Modifying the current font

The current display font may be modified with the CHARS menu (↱ CHARS PRG). Consult Page 31.

On the floppy disk, there are two programs, named GRB2FNT.PRG and FNT2GRB.PRG, which convert **MK** fonts to or from common 8x2048 grobs. Consult Page 46.

3.2.3 Changing the mini font

It is possible to change the **MK** mini font, used in the status area and the menu labels.

Use the commands `MINIFONT→` and `→MINIFONT`. A mini font is a `Library Data` object. This format is very popular in the HP48's world, particularly with programs which use UFL (Universal Font Library). In order to know how to use the UFL with the **Meta Kernel** check the column Tricks and Tips.

4 Configuration

4.1 MK variables

Some programs can be executed on some events, in place of the default programs. They must be stored in the HOME directory.

STARTUP	Executed at each reboot (ON - □c...).
STARTED	Executed just before entering in command line for editing an object. The object to be edited can be found on stack level 1. **This program must leave the object to be edited on the stack level 1.**
EXITED	Executed when the user stops the command line editing. Level 2 contains the object and level 1 TRUE if the user has pressed ENTER, or only FALSE for ON. For example, these two programs can be used to change the display while editing (try STARTED: « 0 →HEADER » and EXITED: « 2 →HEADER »).
STARTOFF	Executed when the automatic OFF is called, after a certain amount of idle time (You can make a screen saver! But remember, the HP48 GX works on batteries...).
TOFF	Defines the amount of idle time before an automatic OFF (or STARTOFF). It must be a binary integer, in Ticks (1 s = 8192 Ticks).
STARTEXT	Contains a string that is the path (using the MASD syntax) to the entries points list. Example: "4/DIR1/TABLE.EXT @" will refer to the table TABLE.EXT in Port 4, in the backup DIR1 For more details, please read page 36.
STARTSEND	Used by the filer for file transfer. By default, Kermit is used. If STARTSEND exists, it is called with the object on level 2 and the name on level 1. Consult page 27.
STARTERR	Used for the error messages display. The error is found in two character strings on levels 2 and 1.
STARTEQW	Called by EQW (equation editor) when CST is pressed.
FILER.CUSTOM	Called by the Filer when CST is pressed.

4.2 MK user and system flags (MKUF, MKSF)

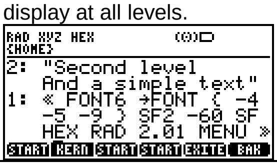
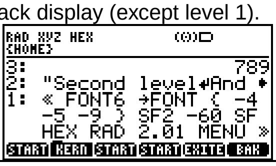
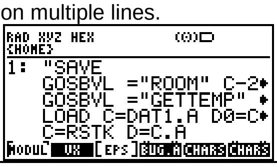
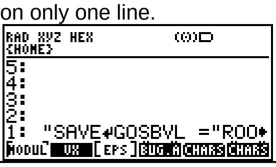
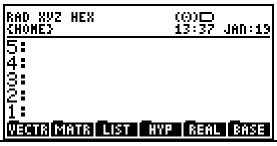
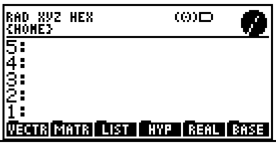
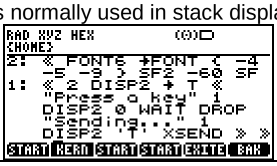
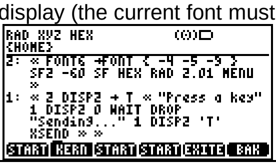
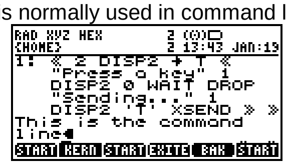
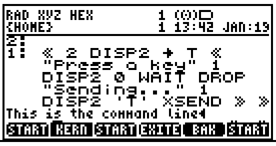
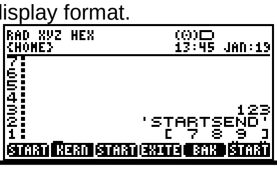
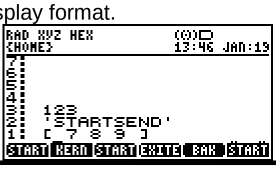
The **Meta Kernel** adds a new series of flags.

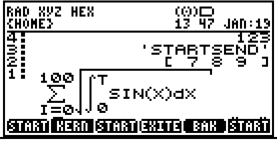
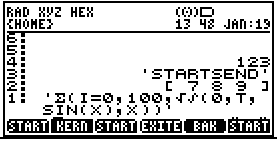
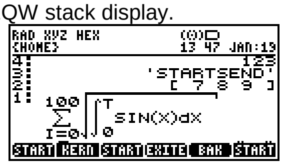
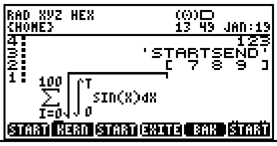
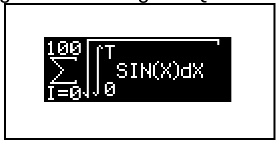
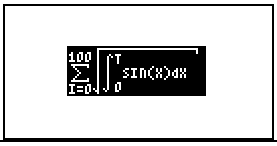
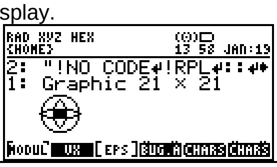
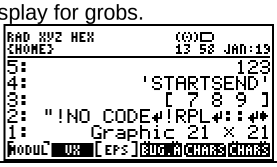
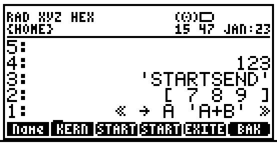
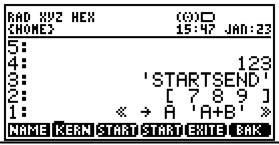
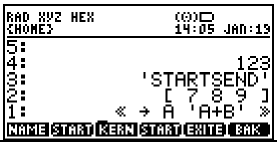
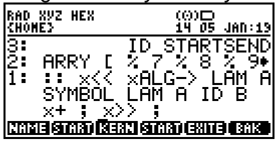
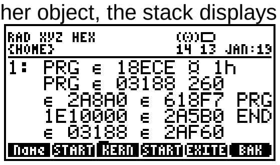
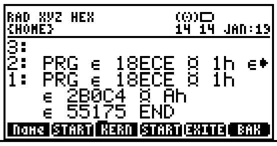
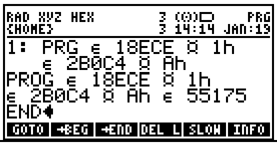
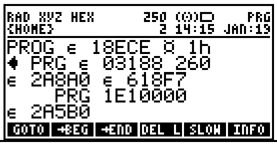
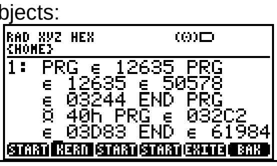
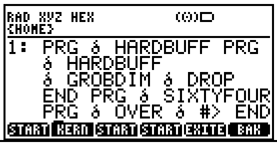
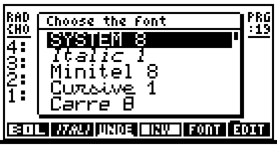
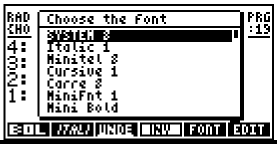
Use CF2, SF2, FC?2, FS?2, FC?C2, FS?C2 like the functions CF, SF...

By default, all flags are cleared.

MK System flags -1 to -64 are used by the **MK** to change parameters.

MK User flags 1 to 64 can be used by any program that runs under the **MK**.

Flag	Cleared (CF2)	Set (SF2)
-1	Multiline for stack display at all levels.  RAD XYZ HEX {HOME} 2: "Second level And a simple text" 1: « FONT6 →FONT { -4 -5 -9 } SF2 -60 SF HEX RAD 2.01 MENU » 	No multiline for stack display (except level 1).  RAD XYZ HEX {HOME} 3: 789 2: "Second level◂And ▸ 1: « FONT6 →FONT { -4 -5 -9 } SF2 -60 SF HEX RAD 2.01 MENU »
-2	Strings displayed on multiple lines.  RAD XYZ HEX {HOME} 1: "SAVE GOSBVL ="ROOM" C-2▸ GOSBVL ="GETTEMP" ▸ LOAD C=DAT1.A D0=C▸ C=RSTK D=C.A 	Strings displayed on only one line.  RAD XYZ HEX {HOME} 5: 4: 3: 2: 1: "SAVE◂GOSBVL ="ROO▸
-3	Digital clock in status area.  RAD XYZ HEX {HOME} 13:37 JAN:19 5: 4: 3: 2: 1: 	Analog clock in status area.  RAD XYZ HEX {HOME} 5: 4: 3: 2: 1:
-4	No auto-indentation in command line editing.	Auto-indentation in command line editing.
-5	Cursor can not go out of the text.	Full page editing.
-6	Strings take only one line for →GROB2.	Multi-line strings for →GROB2.
-7	ASM→ with addresses.	ASM→ without the addresses (makes labels).
-8	The current font is normally used in stack display.  RAD XYZ HEX {HOME} 2: « FONT6 →FONT { -4 -5 -9 } SF2 -60 SF 1: « 2 DISP2 → T « "Press a key" 1 DISP2 0 WAIT DROP "Sending..." 1 DISP2 'T' XSEND » » 	Mini-font in stack display (the current font must be a font6).  RAD XYZ HEX {HOME} 2: « FONT6 →FONT { -4 -5 -9 } SF2 -60 SF HEX RAD 2.01 MENU » 1: « 2 DISP2 → T « "Press a key" 1 DISP2 0 WAIT DROP "Sending..." 1 DISP2 'T' XSEND » »
-9	The current font is normally used in command line editing.  RAD XYZ HEX 2 {HOME} 2 13:43 JAN:19 1: « 2 DISP2 → T « "Press a key" 1 DISP2 0 WAIT DROP "Sending..." 1 DISP2 'T' XSEND » » This is the command line◂ 	Mini-font in command line editing (the current font must be a font6).  RAD XYZ HEX 1 {HOME} 1 13:42 JAN:19 2: 1: « 2 DISP2 → T « "Press a key" 1 DISP2 0 WAIT DROP "Sending..." 1 DISP2 'T' XSEND » » This is the command line◂
-10	Rightmost stack display format.  RAD XYZ HEX {HOME} 13:45 JAN:19 7: 6: 5: 4: 3: 123 2: 'STARTSEND' 1: [7 8 9] 	Leftmost stack display format.  RAD XYZ HEX {HOME} 13:46 JAN:19 7: 6: 5: 4: 3: 123 2: 'STARTSEND' 1: [7 8 9]

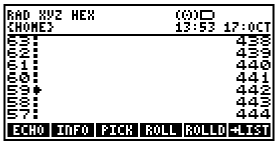
-11	Silent keystrokes.	Keystrokes click.
-12	No purge confirmation in the Filer.	Purge confirmation in the Filer.
-13	(Reserved for internal use).	
-14	(Reserved for internal use).	
-15	On-stack algebraics display.  RAD XYZ HEX {HOME} 13 47 JAN:19 4: 123 3: 'STARTSEND' 2: [7 8 9] 1: $\sum_{I=0}^{100}\sqrt{\int_0^T SIN(X)dX}$ START KERN START EXITE BAK START	Standard stack display for algebraics.  RAD XYZ HEX {HOME} 13 48 JAN:19 6: 5: 4: 123 3: 'STARTSEND' 2: [7 8 9] 1: 'Σ(I=0,100,√∫(0,T, SIN(X),X))' START KERN START EXITE BAK START
-16	Current font for EQW stack display.  RAD XYZ HEX {HOME} 13 47 JAN:19 4: 123 3: 'STARTSEND' 2: [7 8 9] 1: $\sum_{I=0}^{100}\sqrt{\int_0^T SIN(X)dX}$ START KERN START EXITE BAK START	Mini-font for EQW stack display.  RAD XYZ HEX {HOME} 13 49 JAN:19 4: 123 3: 'STARTSEND' 2: [7 8 9] 1: $\sum_{I=0}^{100}\sqrt{\int_0^T SIN(X)dX}$ START KERN START EXITE BAK START
-17	Current font for algebraic →GROB2.	Mini-font for algebraic →GROB2.
-18	Current font for algebraics editing in EQW.  $\sum_{I=0}^{100}\sqrt{\int_0^T SIN(X)dX}$	Mini-font for algebraics editing in EQW.  $\sum_{I=0}^{100}\sqrt{\int_0^T SIN(X)dX}$
-19	On-stack grobs display.  RAD XYZ HEX {HOME} 13 58 JAN:19 2: "!NO CODE↵!RPL↵::↵… 1: Graphic 21 × 21 MODUL VX [EPS] BUG.A CHARS CHARS	Standard stack display for grobs.  RAD XYZ HEX {HOME} 13 58 JAN:19 5: 123 4: 'STARTSEND' 3: [7 8 9] 2: "!NO CODE↵!RPL↵::↵… 1: Graphic 21 × 21 MODUL VX [EPS] BUG.A CHARS CHARS
-20	**MK** Mini-font menu labels.  RAD XYZ HEX {HOME} 15 47 JAN:23 5: 4: 123 3: 'STARTSEND' 2: [7 8 9] 1: « → A 'A+B' » Name KERN START START EXITE BAK	Standard menu labels.  RAD XYZ HEX {HOME} 15:47 JAN:23 5: 4: 123 3: 'STARTSEND' 2: [7 8 9] 1: « → A 'A+B' » NAME KERN START START EXITE BAK
-21	Normal stack display  RAD XYZ HEX {HOME} 14:05 JAN:19 5: 4: 123 3: 'STARTSEND' 2: [7 8 9] 1: « → A 'A+B' » NAME START KERN START EXITE BAK	Display the stack using the HP SysRPL syntax  RAD XYZ HEX {HOME} 14 05 JAN:19 3: ID STARTSEND 2: ARRY [% 7 % 8 % 9… 1: :: x<< xALG-> LAM A SYMBOL LAM A ID B x+ ; x>> ; NAME START KERN START EXITE BAK
-22	→S2 adds "!NO CODE<CR>!RPL<CR>" at the beginning of the source, and "@" at the end. Therefor it can be use directly by MASD	→S2 just convert an object into System RPL without adding any header.
-23	The stack display is recursive. When an object contains a reference to an other object, the stack displays it.  RAD XYZ HEX {HOME} 14 13 JAN:19 1: PRG ∊ 18ECE ¤ 1h PRG ∊ 03188 260 ∊ 2A8A0 ∊ 618F7 PRG 1E10000 ∊ 2A5B0 END ∊ 03188 ∊ 2AF60 Name START KERN START EXITE BAK	The stack display is not recursive.  RAD XYZ HEX {HOME} 14 14 JAN:19 3: 2: PRG ∊ 18ECE ¤ 1h ∊… 1: PRG ∊ 18ECE ¤ 1h ∊ 2B0C4 ¤ Ah ∊ 55175 END Name START KERN START EXITE BAK
-24	Object display in the command line is not recursive.  RAD XYZ HEX 3 PRG {HOME} 3 14:14 JAN:19 1: PRG ∊ 18ECE ¤ 1h ∊ 2B0C4 ¤ Ah PROG ∊ 18ECE ¤ 1h ∊ 2B0C4 ¤ Ah ∊ 55175 END… GOTO →BEG →END DEL L SLOW INFO	Object display in the command line is recursive (See flag –23)  RAD XYZ HEX 250 PRG {HOME} 2 14:15 JAN:19 PROG ∊ 18ECE ¤ 1h … PRG ∊ 03188 260 ∊ 2A8A0 ∊ 618F7 PRG 1E10000 ∊ 2A5B0 GOTO →BEG →END DEL L SLOW INFO
-25	In the normal stack display (-21 CF2), displays the addresses of all the unknown objects:  RAD XYZ HEX {HOME} 1: PRG ∊ 12635 PRG ∊ 12635 ∊ 50578 ∊ 03244 END PRG ¤ 40h PRG ∊ 032C2 ∊ 03D83 END ∊ 61984 START KERN START START EXITE BAK	If the address is in the entry point table, then use the mnemonic:  RAD XYZ HEX {HOME} 1: PRG ô HARDBUFF PRG ô HARDBUFF ô GROBDIM ô DROP END PRG ô SIXTYFOUR PRG ô OVER ô #> END START KERN START START EXITE BAK
-26	The CHOOSE2 boxes use the current font  Choose the Font SYSTEM 8 Italic 1 Minitel 8 Cursive 1 Carre 8 EOL ITAL UNDE INV FONT EDIT	The CHOOSE2 boxes use the mini-font.  Choose the Font SYSTEM 8 Italic 1 Minitel 8 Cursive 1 Carre 8 MiniFnt 1 Mini Bold EOL ITAL UNDE INV FONT EDIT

-27	The symbolic matrix writer will give an ARRAY only for the array of real and complex	Matrix Writer gives an array of ? for any object, each time the matrix contains objects of the same type. But beware of memory lost if you try to use a RPL command on it.
-28	MASD in assembly mode by default	MASD in SystemRPL mode by default
-29	Normal Header	Erable Header (shows the current mode of Erable : complex/real; symbolic/approximate; content of the VX variable)
-30	When exiting an environment (Equation Writer, Matrix Writer, EDG …), the result is put in LASTCMD	When exiting an environment (Equation Writer, Matrix Writer, EDG …), the result is not put in LASTCMD
-31 à –64	Not used, reserved for future versions.	

5 Interactive stack

The interactive stack works the same way as the standard one, but at a greater speed, and it is possible to edit many objects simultaneously: in the command line editor, it is possible to go temporarily to the interactive stack, and to edit another object recursively. It is also possible to `HALT` the editing environment.

Current stack level →



```
RAD XYZ HEX          (⊙)□
{HOME}          13:53 17:OCT
63:                      438
62:                      439
61:                      440
60:                      441
59:                      442
58:                      443
57:                      444
ECHO INFO PICK ROLL ROLLD →LIST
```

Interactive Stack Operations: (*n* indicates the current level)

ECHO	Copies the current level object on the command line, at the cursor position.
INFO	Shows information about the current level object (size, CRC...).
↰ INFO	Edits the current level object with the best environment (`EDITB`).
↱ INFO	Edits the object whose name is on the current level, with the best environment (`VISITB`).
PICK	Equivalent to *n* `PICK`.
ROLL	Equivalent to *n* `ROLL`.
ROLLD	Equivalent to *n* `ROLLD`.
→LIST	Equivalent to *n* `→LIST`.
DUPN	Equivalent to *n* `DUPN`.
DRPN	Equivalent to *n* `DROPN`.
LEVEL	Puts the number of the current level on level 1.
GOTO	Goes directly to a given level.
KEEP	Clears all the levels upper than the current level (Therefore it KEEPs the first stack levels up to the current one).
SLOW / FAST	Selects the cursor speed.

6 Command line

6.1 Generalities

The **Meta Kernel** improves editing with new functions: COPY/PASTE, FIND/REPLACE, text style (Bold, italic, underline, inverse). Styles can only be used inside strings (they will be ignored and lost in any other object).

You can edit an object by pressing ↰ EDIT +/- when the object is on stack level 1. There are other ways to edit an object (explained after).

6.2 Editing menu

There are four pages in the menu, plus the Style menu.

6.2.1 Major options

GOTO	Goes to a given line number.
↰ GOTO	Goes to a given position (in number of characters from the beginning).
↱ GOTO	Displays the menu of the text, which is composed of every line that begins with the character `*`, useful in assembly language.
→BEG	Goes to the beginning of the selection.
→END	Goes to the end of the selection.
DEL L	Clears the current line.
SLOW / FAST	Selects the cursor speed.
INFO	Displays information about the current text.
↰ INFO	Edits the selection with the best environment (`EDITB`).

6.2.2 Operations on the selection

⚠ Note: the selection marks are lost when the text is modified.

BEGIN	Sets the beginning of the selection.
END	Sets the end of the selection.
CUT	Copies the selection on the stack level 1, and clears it in the text.
COPY	Copies the selection on the stack level 1.
PASTE	Puts the object on the stack level 1 into the text at the cursor position.
↰ PASTE	Puts the object on the stack level 1 into the text at the cursor position, and deletes it from the stack.
DEL	Clears the selection.

6.2.3 Search operations

FIND	Displays a screen where you can type the search string. When you press enter, this string is put on stack level 1. The character ? stands for any character. Then the selection is placed on the first occurrence of this string after the cursor position.
REPL	Displays a screen where you can type the search string and the replace string. The search string is put on stack level 1, and the replace string on level 2. Then the selection is placed on the first occurrence of the search string. The change is not done yet!
NEXT	Selects the next occurrence of the search string (the string on stack level 1).
R	Replaces the selection by the replace string (the string on stack level 2).
R/N	Equivalent to R, then NEXT. So it makes one change, and goes to the next occurrence of the search string.
ALL	Equivalent to R and NEXT, repeated until the end of the text. So every occurrence of the search string is replaced by the replace string, from the cursor position to the end of the text, without confirmation.

6.2.4 Miscellaneous

←SKIP	Goes to the beginning of the previous word.
SKIP→	Goes to the beginning of the next word.
←DEL	Clears the text between the cursor and the beginning of the previous word.
DEL→	Clears the text between the cursor and the beginning of the next word.
Style	Displays the style menu.
↑STK	Goes to the interactive stack. Consult Page 13.
↰ ↑STK	EVALuates the selection and replaces it with the result. E.g. if 20 SIN is selected, it will be replaced by .342020143326.
↱ ↑STK	Equivalent to HALT. The current editing is suspended, you can do what you want (except a reboot) and get back to the text with ↰ CONT ON.

6.3 Styles

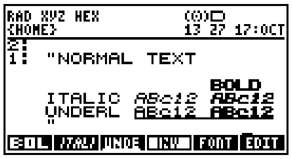
6.3.1 Generalities

Styles can be used inside text strings. There are four styles: Bold, italic, underline, inverse.

Several styles can be used on the same portion of text.

More than one font can also be used in the same text (but they must have the same height).

6.3.2 Style menu



```
RAD XYZ HEX          (⊙)▭
{HOME}               13 27 17:OCT
2:
1:  "NORMAL TEXT
                         BOLD
    ITALIC ABc12 ABc12
    UNDERL ABc12 ABc12
    "
```

BOL	Sets/clears the **bold** style.
ITAL	Sets/clears the *italic* style.
UNDE	Sets/clears the underlined style.
INV	Sets/clears the inversed style.
FONT	Displays the font list.
EDIT	Gets back to the Edit menu.

6.3.3 Using styles

You can modify the style of the current selected text by pressing a style menu key. If there is no selection, the text you will then type will be of the chosen style (If you move the cursor, the style will be the one under the cursor).

6.3.4 Using fonts

If you press the FONT menu key, a choose box shows all the fonts which have the same height as the current editing font.

If there is a selection, the font will be applied on this selection, otherwise it will be used for the text you will then type (If you move the cursor, the font will be the one under the cursor).

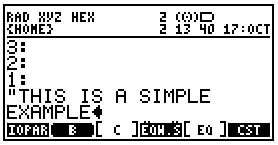
The **Meta Kernel** can use up to 247 fonts inside one text.

For a font to be recognized by the **MK** (so that it will appear in the FONT choose box), it just has to be saved in the HOME directory, or in a port (0, 2 to 31)

If several fonts use the same ID, the **MK** only takes the first one, in the order of the search (HOME, then 0, 2 ... 31). ID 0 is reserved for the system font. ID > 247 will be ignored.

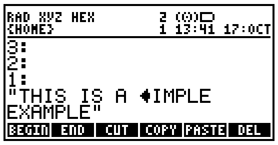
Example:

Type the text: `THIS IS A SIMPLE EXAMPLE`



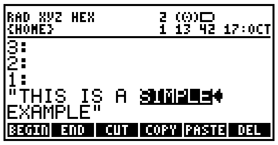
```
RAD XYZ HEX          2 (◎)□
{HOME}               2 13 40 17:OCT
3:
2:
1:
"THIS IS A SIMPLE
EXAMPLE◆
```

Put the cursor on the 11th character (`S` in `SIMPLE`). Press the menu key BEGIN



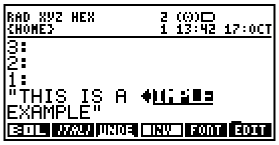
```
RAD XYZ HEX          2 (◎)□
{HOME}               1 13:41 17:OCT
3:
2:
1:
"THIS IS A ◆IMPLE
EXAMPLE"
```

Press ▶ six times. Press END



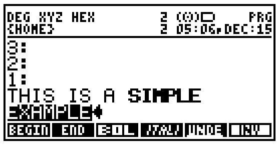
```
RAD XYZ HEX          2 (◎)□
{HOME}               1 13 42 17:OCT
3:
2:
1:
"THIS IS A SIMPLE◆
EXAMPLE"
```

Go to the Style menu and press BOL



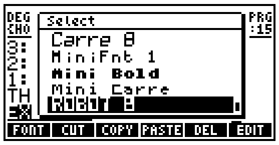
```
RAD XYZ HEX          2 (◎)□
{HOME}               1 13:42 17:OCT
3:
2:
1:
"THIS IS A ◆SIMPLE
EXAMPLE"
```

Now, select the word `EXAMPLE`



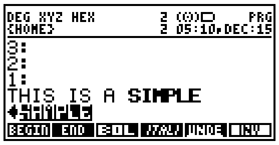
```
DEG XYZ HEX          2 (◎)□      PRG
{HOME}               2 05:06,DEC:15
3:
2:
1:
THIS IS A SIMPLE
EXAMPLE◆
```

Go to the Style menu and press FONT (There may be other fonts than shown below)



```
Select
Carre 8
MiniFnt 1
Mini Bold
Mini Carre
ROBOT 8
```

Choose the font you want (here ROBOT 8) with the up and down arrows and press ENTER.



```
DEG XYZ HEX          2 (◎)□      PRG
{HOME}               2 05:10,DEC:15
3:
2:
1:
THIS IS A SIMPLE
◆EXAMPLE
```

6.4 Miscellaneous command line options

6.4.1 Full screen mode

By default, if you press the ▶ key at the end of a line, the cursor will be placed on the first character of the next line. With the **MK**, it is possible to go ‘out’ of the lines, with the **MK** system flag -5.

Type `-5 SF2` to enable the full screen mode (if you like this mode, a good idea is to place a `-5 SF2` in the program `STARTUP`).

If you go beyond the end of a line and press a character key, spaces will automatically be inserted before the character you type.

6.4.2 Auto-indent mode

By default, when you press ↱ ↵ to insert a carriage return, the cursor is then always placed on the first column of the display. The **MK** implements the auto-indent mode, so that when you type a carriage return, the cursor will be placed under the first character of the upper line (Useful when programming).

Type `-4 SF2` to enable auto-indent mode.

6.4.3 Special keystrokes for System RPL

In the command line, some keystrokes help to type characters that are specific to System RPL, and also to easily find System RPL commands only by typing the first letters of the command.

These keystrokes are detailed on page 37.

6.4.4 Big strings editing

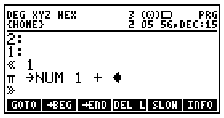
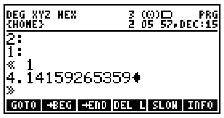
As specified in the HP48 GX User's Manual, you can not type character strings that are bigger than the half of the free memory.

The **MK** uses a new memory handler, so that when you edit strings (and only strings), you can have more characters than the half of the free memory, and still press ENTER, because the **MK** does not evaluate the string, but places it directly on the stack. You will never get an Insufficient Memory when validating a character string.

For other objects types, the **MK** built-in →STR will usually works if there is more or less as much free memory as the object size, so the object may be viewed. But when ENTER is pressed, the STR→ may have Insufficient Memory.

6.5 Shortcuts

The Shortcuts are available by pressing simultaneously a SHIFT key and another one.

α mode ↰ VAR J	Insert the character \
↱ MEMORY VAR	Suspend the current environment
↰ ▲	Page Up
↰ →NUM EVAL	Evaluate the current line and replace it with the result. Example:  DEG XYZ HEX 3 (ω)□ PRG {HOME} 2 05 56,DEC:15 2: 1: « 1 π →NUM 1 + ◆ » GOTO →BEG →END DEL L SLOW INFO ↰ →NUM EVAL  DEG XYZ HEX 3 (ω)□ PRG {HOME} 2 05 57,DEC:15 2: 1: « 1 4.14159265359◆ » GOTO →BEG →END DEL L SLOW INFO
↰ PICTURE ◀	Page Left
↰ VIEW ▼	Page Down
↰ SWAP ▶	Page Right
↱ TIME 4	BEGIN
↱ STAT 5	END
↱ UNITS 6	Select the current line
↱ I/O 1	Extend/Reduce the selection to the left
↱ EQ LIB 3	Extend/Reduce the selection to the right
α ↰ << >> −	Insert and indent a SystemRPL program bloc (see the MASD chapter for more information)
α ↱ ∡ SPC	Auto-Completion (see the MASD chapter for more information)

7 Command library

A command library is a special library which extends the STR→ function. The **MK** command library adds new keywords (they can be typed on the command line and used in programs):

TRUE	External Boolean true.
FALSE	External Boolean false.
$ *binary*	External of the given address. E.g. $ 3188h (external DUP). To type $, press α ↰ 4.
∈ *Hexa*	External of the given address. ∈ 3188 is equivalent to $ 3188h. To type ∈, press α ↱ E.
⊡ *binary*	System binary of the given number. To type , press α ↰ 6.
K$ *number*	Character of the given ASCII code.
XLIB *LibNumber* *PrgNumber*	Program #*PrgNumber* of the library #*LibNumber*.
INCLUDE *VarName*	Includes a given variable content in the line.
PRG	External program beginning ($ 02D9Dh), a END must close the program.
~	NoEval ($ 06E97h), which causes the next object not to be evaluated. To type ~, press α ↱ √x V.
PROG	~ PRG (To edit an external program, begin it with PROG, so it won't be evaluated when ENTER is pressed).

`CODE` *Hexa*	Creates a CODE object with the following binary data. Length is calculated.
`OBJ` *Hexa*	Creates an object with the following binary data.
`GREY` *X Y Hexa*	Creates a four-grayscale grob XxY.
`ȧ` *Name*	Puts the address of the corresponding name, if it exists in the entry points table. Consult page 36. To type ȧ, press α ↱ D.

8 Equation editor

The program EQW can easily create, edit and manipulate algebraic objets, in their hand-written style.

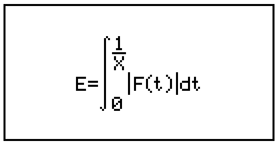
For example, here is a mathematical equation:

$$E = \int_0^{\frac{1}{X}} \left|F(t)\right| dt$$

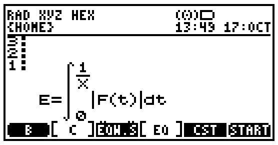
Here is how it usually appears on the stack:

`E=∫(0,1/X,ABS(F(t)),t)`

And now, here is the same equation typed with EQW:



This EQW display is also used in the stack display:



8.1 First view of EQW

In this document, 'equation' stands for all algebraic objects.

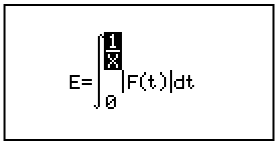
8.1.1 Introduction

EQW is a special environment in which the keyboard is redefined and limited to specific operations.

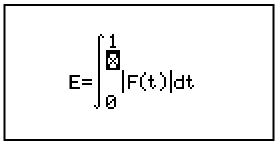
8.1.2 Modes

EQW provides three modes of operation:

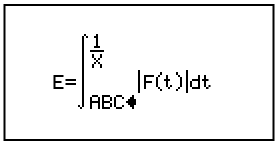
- Selection mode



or

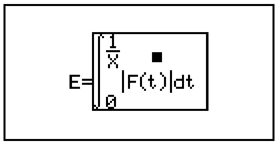


- Editing mode



In most cases, selection and edit modes are used to enter equations.

- Cursor mode, used to navigate rapidly through the equation.



8.1.3 Editing

During editing, keys behave in different ways, depending on the current mode.

In selection mode, a part of the equation is inverted or boxed. If a function key is pushed, the function is applied on the selection.

In edit mode, a flashing cursor is ready to insert new characters.

The next sections explain how to enter and edit an equation.

8.2 Creating equations

8.2.1 Running EQW

Type ↰ EQUATION ENTER to run EQW with a new equation.

8.2.2 Exiting EQW

To validate the current equation on the stack, press ENTER.

To get out of EQW, and lose all changes made on the equation, press ON.

There may be some times when EQW can't draw the equation as fast as you type, but all keystrokes are processed, none are lost. In this case, EQW draws the equation only when there is enough time to do so.

8.2.3 Numbers and names

Type real numbers and names the same way as in the command line.

In edit mode (with the flashing cursor), the character X is directly available by pressing DEL.

⚠ Note: in EQW, the α key locks the alpha mode by pressing it once (corresponding to -60 SF). Therefore, to type a name, either hold α and press the character keys, or press α once, then press the character keys and press α to unlock the alpha mode.

8.2.4 Addition, subtraction, and multiplication

To enter +, − and ·, press +, − and ×.

The operation is applied on the edited number or name, or the current selection.

To enter implicit multiply, do not press ×. An implicit multiply is automatically inserted in the following cases:

- A number followed by an alpha character or a prefix function (a function whose name is before arguments, for example 7 SIN).
- An alpha character followed by a prefix function.

8.2.5 Complex numbers and expressions

To enter a complex number or expression, type in the real part, then ↰ , • and then the imaginary part.

A complex expression is considered as a two-argument function (equivalent to +).

A complex number is stored directly in the final equation, whereas a complex expression like (A,B) is converted to A+B*i.

8.2.6 Moving in the equation

Before going further, here are the movement keys. In fact, entering an equation with EQW is not far from the RPN way: no parenthesis are needed. For example, to type (X+5)·2, press α - 1/x x + 5, then select X+5 by typing ▲, and then type × 2. See the examples at the end of this chapter to handle more cases.

Arrow keys move the selection. They behave different ways, depending on the type of selection.

Here are the movement keys when the selection is inverted:

- ▼ selects the first argument of the current function, or if the selection is already a number or a name, then selection becomes a box.
- ▲ selects the upper function of the selection.
- ◄ and ► select the previous or next argument of the upper function.

Here are the movement keys when the selection is in a box:

- ▲ goes back into inverted selection mode.
- ◄ and ► select the previous or next number or name, in hierarchical order. This keys are useful to rapidly move around the whole equation.

To rapidly select a part of the equation, even far from the selection, use the cursor mode (see the Cursor Mode section).

8.2.7 Divisions

Press ÷ to insert a division.

Division is applied on the edited object or the current selection.

To 'go out' of the division, use ▲ or ► until the whole division is selected.

8.2.8 Exponents

y^x begins the exponent on the edited object or the selection.

Use ▲ or ► to go out of the exponent.

8.2.9 Square root

- In selection mode, √x applies a square root on the selection.
- In edit mode, √x inserts a square root, eventually with an implied multiply.

8.2.10 Nth square root

- In selection mode, ↱ ˣ√y √x places the selection under the root. Press ◀ and type the outside term. To exchange the two arguments, read the Modifications section.
- In edit mode, ↱ ˣ√y √x inserts a root. Type the outside term. Press ▶ and then type the inside expression.

8.2.11 Parenthesized-argument functions

- In selection mode, press the function key to apply it on the selection. If the function needs more than one argument, the selection is used as the first one. press ▶ to go and type the next arguments.
- In edit mode, press the function key or type its name followed by ↰ ( ) ÷, and then the arguments.

8.2.12 User functions

These functions are created by the user and are not handled directly by the HP 48GX.

Type the function name, press ↰ ( ) ÷ and type the first argument.

To add an argument, press SPC.

8.2.13 Parenthesized terms

EQW draws equations with the fewest possible parentheses. To add explicit parentheses around the selection, press ↰ ( ) ÷.

8.2.14 Differentiation

- In selection mode, press ↱ ∂ SIN to insert a differentiate sign, the selection is the function to be differentiated. Press ◀ and type the variable of differentiation.
- In edit mode, press ↱ ∂ SIN to insert a differentiate sign, type the variable of differentiation, press ▶ and type the equation to be differentiated.

See the Evaluations section to discover how to differentiate a function without exiting from EQW.

8.2.15 Integration

- In selection mode, press ↱ ∫ COS to add an integral sign. The current selection is the equation to be integrated. Press ◀ and ▶ to move around the integral arguments and type them.
- In edit mode, press ↱ ∫ COS to insert an integral sign. Type the arguments, press ▶ to move to the next one.

8.2.16 Summations

- In selection mode, press ↱ Σ TAN to add a summation sign. The selection is the function to be summed. Press ◀ and ▶ to move around the arguments and type them.
- In edit mode, press ↱ Σ TAN to insert a summation sign. Type the arguments, press ▶ to move to the next one.

8.2.17 Where function |

- In selection mode, press α ↱ VAR to add a where function. The current selection is the base expression. Press ▶ to move to the next argument (the variable and its value).
- In edit mode, press α ↱ VAR to insert a where sign. Type the arguments, press ▶ to move to the next one.

8.3 Manipulating equations

8.3.1 Modifying equations with EQW

To edit an equation with EQW, press ▼ when the equation is on level 1 of the stack.

8.3.2 Modifications

To edit a variable name or a bigger expression with the command line editor, select it and press ↰ EDIT +/-.

It can also be edited with HP's EQUATION WRITER by typing ↰ EQUATION ENTER.

8.3.3 Temporary exit to the stack

It is possible to go temporarily to the stack by pressing ↰ CONT ON. Press ↰ CONT ON again to get back to EQW, in the same state as before halting.

8.3.4 Copy paste functions

Copy and paste functions are available. SUB copies the selected expression on the stack. REPL pastes the expression on level 1 either onto the selection, or where the edit cursor is. These commands are accessible in the menu or on keyboard:

Sub : ↱ RCL STO,

Repl : ↰ DEF STO.

8.3.5 Deletions

There are different ways to delete a part of an equation.

- In selection mode, typing numbers or characters suppresses the current selection. To enter a new expression that does not begin with a number or a name, pressing ↰ DROP ← deletes the selection and goes into edit mode.
- To delete a one-argument function, just select this function and press DEL.
- To delete one argument of a two-argument function, select it and press ↰ CLEAR DEL.
- Press ↱ CLEAR DEL to delete all arguments but the one selected.

8.3.6 Evaluations

Selected expressions can be processed by RPL commands `EVAL`, `COLCT` and `EXPAN`. The result replaces the old selection. These commands are accessible through menus or on keyboard:

Eval : EVAL,

Colct : ↰ ▼,

Expan : ↰ ▲.

8.3.7 Custom program evaluation

An external program may be applied on the current selection. By pressing CST, the program `STARTEQW` situated in the HOMEDIR is called, with the current selection on the stack level 1. This program must return the new expression on the stack level 1.

For example, the following program transforms all the INV functions by 1/ :

```
« { 'INV(&X)' '1/&X' } ↑MATCH DROP »
```

8.4 Cursor mode

8.4.1 Switching to cursor mode

To get into cursor mode, press '.

8.4.2 Movement

Arrow keys direct the cursor movement. The movement is faster when ↰ is held. To go directly to a border, hold ↱ and press one arrow key.

When the cursor stops, a box is drawn around the underlying expression.

8.4.3 Exiting cursor mode

There are two ways to return to selection mode.

' returns to the same state prior to entering in cursor mode, whereas ENTER makes the expression under the cursor (which appears in a box) the new selection. This is a fast way to select a particular part of an equation.

8.5 Miscellaneous functions

8.5.1 Menu use

To show the menu, press a menu key, or NXT. The menu may be hidden by pressing ↱ MENU NXT . When switching to cursor mode, the menu is automatically hidden.

8.5.2 Zoom

EQW can draw the equation using the system mini-font, by pressing PRG or Zoom. This key can be used in any mode. A second keystroke returns to the stack font.

8.5.3 -→Grob

The current selection may be pushed onto the stack as a graphic object by pressing STO or →Grob. This function is the same as the RPL command `0 →GROB2`.

8.6 Error messages

An error message remains displayed as long as a key is pressed, to keep from destroying the expression.

`Incomplete Expression`	One cannot exit from EQW, or perform certain functions when the equation is not complete.
`Global Expected`	For some functions (e.g. differentiate, integrate), one of the arguments must be a variable name.
`First Argument Missing`	Two-argument functions must be typed after the first argument.
`Two Arguments Expected`	↰ CLEAR DEL (One argument delete) must be applied on a two-arguments or user function.
`Edit Mode`	RPL commands (EVAL, COLCT...) require selection mode.
`1 Arg Function Needed`	DEL must be used on a one-argument function like SIN.

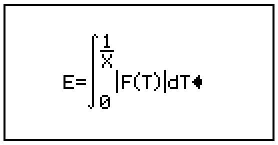
Select An Argument	↱ CLEAR DEL can not be used on the whole equation.
Algebraic Expected	To paste an expression, the first level of the stack must contain an algebraic object.
Too Few Arguments	The stack is empty.
Command Forbidden	RPL commands like SWAP, DUP... are forbidden in equations.

8.7 Examples

$$E = \int_0^{\frac{1}{X}} |F(t)| dt$$

Press:

E=∫(	α - ▭E ↰ = 0 ↱ ∫ COS
0,1/X	0 ▶ 1 ÷ DEL ▶
ABS(	α - ▭A ▭B SIN S ↰ ( ) ÷
F(T	α ▭F ↰ ( ) ÷ α - COS T ▶
dT	α COS T



$$E=\int_0^{\frac{1}{X}} |F(T)|dT$$

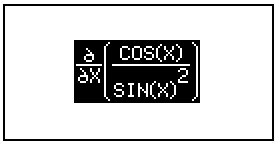
ENTER

```
1: E=∫(0,1/X,ABS(F(T)),T)
```

$$\partial x(\frac{\cos x}{\sin^2 x})$$

Type the expression:

COS(X)	COS DEL ▶
/SIN(X)	÷ SIN DEL
^2	▶ y^x 2
∂	↱ ▲ ↱ ∂ SIN DEL ▲ ▲



$$\frac{\partial}{\partial X}\left(\frac{COS(X)}{SIN(X)^2}\right)$$

Save it on the stack:

MTH NXT Sub

Differentiate it:

EVAL EVAL EVAL EVAL

Simplify it:

Expan Expan Colct

Rebuild the expression:

↰ = 0 Repl ↰ ◀

Change INV into 1/:

', move on the last INV, ENTER DEL ÷ 1 ▲ ↰ ▶

8.8 Key reference for EQW

8.8.1 Selection mode

	Inverted selection	Boxed selection
◀	Previous argument.	Previous variable or number.

▶	Next argument (if on last argument, go to upper function).	Next variable or number (if on last argument, go to upper function).
▲	Upper function.	Inverted selection.
▼	First argument of the selected function.	
↱ ◀	First argument.	
↱ ▶	Last argument.	
↰ ◀	Argument left roll.	
↰ ▶	Argument right roll.	
↱ ▲	Whole equation selection.	
↱ ▼	First name or number of the selection, boxed selection.	
↱ RCL STO	SUB, copies the selection to the stack.	
↰ ▲	EXPANDs the selection.	
↰ ▼	COLCTs the selection.	
EVAL	EVALuates the selection.	
STO	→GROB on the selection.	
↰ EDIT +/-	Line command editing.	
↰ EQUATION ENTER	HP's Equation Writer editing.	
↰ ( ) ÷	Adds/removes parentheses.	
DEL	One-argument function deletion.	
↰ CLEAR DEL	Argument deletion in a two-argument function or in a user function.	
↱ CLEAR DEL	Deletes all but the selection.	
⬅	Variable or name edition.	
↰ DROP ⬅	Clears selection, goes into edit mode.	
SIN, COS, TAN, √x...	Inserts a one-argument function.	
↱ ∂ SIN, ↱ ∫ COS, ↱ x√y √x...	Inserts a function, the selection becomes the first argument (except for ∫ and Σ where the selection becomes the main argument).	
SPC	Next argument, or create another argument in a user function.	
↰ , •	Creates a complex number, selection is the real part.	
Digit, character	Deletes the selection, starts editing.	

8.8.2 Edit mode

Digit, character	Adds a character; a number followed by an alpha inserts an implicit multiply.
DEL	Fast access to the character X (α not needed).
↰ ( ) ÷	Creates user function.
SPC	Next argument, or creates another argument in a user function.

8.8.3 Selection and edit mode - common keys

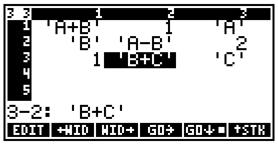
ENTER	Saves changes and exits.
ON	Discards changes and exits.
↰ CONT ON	HALT, temporary exit, a second ↰ CONT ON returns to EQW, at the same place.
↱ OFF ON	OFF.
PRG	Switches between stack font and little font.
MTH	Display the first page of the menu.
NXT	Menu, next page.
↰ PREV NXT	Menu, previous page.
↱ MENU NXT	Turn off the menu.
↰ DEF STO	REPLaces the expression from the stack in the equation.

8.8.4 Cursor mode

Arrows ◀, ▶, ▲, and ▼	Movement.
Arrows with ↰	Fast movement.
Arrows with ↱	Border movement.
'	Back in selection mode, no changes to the selection.
ENTER	Back in selection mode, the new selection is the part of the equation that is pointed to by the cursor.
ON	Discards changes and exits.

9 Matrix editor

The Matrix Editor is a matrix-oriented environment.



```
3 3        1          2          3
1   'A+B'         1        'A'
2     'B'   'A-B'            2
3       1   'B+C'          'C'
4
5
3-2:  'B+C'
EDIT ←WID WID→ GO→ GO↓■ ↑STK
```

9.1 Presentation

The **MK** Matrix Editor can be used like the standard Matrix Writer, but it adds new features. Not only real and complex matrixes can be edited, but also symbolic, character strings, program, etc., arrays.

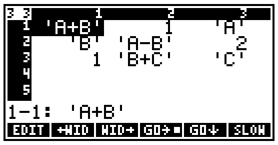
For example, here is how the following symbolic matrix:

$$\begin{vmatrix} \text{'A+B'} & 1 & \text{'A'} \\ \text{'B'} & \text{'A-B'} & 2 \\ 1 & \text{'B+C'} & \text{'C'} \end{vmatrix}$$

is represented on the stack as a list of lists:

```
{{ 'A+B' 1 'A' }
 { 'B' 'A-B' 2 }
 { 1 'B+C' 'C' }}
```

To view and edit it under the Matrix Editor, press the down arrow ▼, or execute the command `EDITB`.



```
3 3        1          2          3
1   'A+B'         1        'A'
2     'B'   'A-B'            2
3       1   'B+C'          'C'
4
5
1-1:  'A+B'
EDIT ←WID WID→ GO→■ GO↓ SLOW
```

The symbolic Matrix Writer is powerful enough to manage any knid of datas. For example you can edit you contacts list.

With some external tools you can also transform the Symbolic Matrix Writer into a spreadsheet.

9.2 Usage

Two modes are available, one to create a new matrix, the other to edit an existing matrix.

To create a new matrix, press ↱ MATRIX ENTER. An empty matrix is displayed, where any object can be entered. When ENTER is pressed, if all the elements in the matrix are of the same type, an `Array of type` is pushed on the stack (the content is displayed for real and complex numbers and strings), otherwise a list of list is created (this is a multi-typed array).

In the second mode, when an existing array is edited, if a new element is entered outside the matrix, the other empty cells will be filled with "null" elements corresponding to the matrix type (0 for reals, `""` for strings, `NOVAL` for multi-typed arrays, etc.).

*PS: For some security reasons, only arrays of real and complex are created. If you want to create an array of an other type, set the **MK** flag –27.*

9.3 Reference

9.3.1 Keys

Arrows ◀, ▶, ▲, and ▼	Movement.
Arrows with ↰	Page by page movement.
Arrows with ↱	Border movement.
DEL	Clears the current cell (fills it with the "null" element).

9.3.2 Menu keys

EDIT	Edits the current cell in the command line editor.
↰ EDIT	Edits the current cell in the best environment (`EDITB`).
←WID	Makes the cells narrower and displays one additional column.
WID→	Makes the cells wider and displays one less column.
GO→■ / GO→	If the box is visible, makes the cursor move to the next column after entry (on by default).
GO↓ / GO↓■	If the box is visible, makes the cursor move to the next row after entry.
FAST / SLOW	Selects the cursor speed.
+ROW	Inserts a row of "null" elements.
-ROW	Deletes the current row.
+COL	Inserts a column of "null" elements.

-COL	Deletes the current column.
→STK	Copies the current cell to stack level 1.
↰ →STK	Copies the object on stack level 1, to the current cell.
↑STK	Activates the interactive stack.
BEGIN	Set the selection's upper left corner
END	Set the selection's lower right corner
COPY	Copies the selection on the stack level 1 as a symbolic matrix
PASTE	Copies the matrix on the stack level 1 to the current position
DEL	Erase the selection

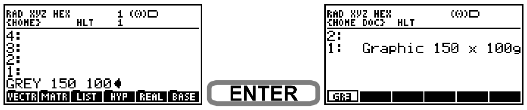
10 Grob editor (Picture2)

PICTURE2 creates and modifies graphic objects, similar to PICTURE, but is more powerful for bitmap creation. Grobs can be in two or four-level grayscale, and every drawing is made in real-time, with or without zoom.

10.1 Usage

In this part, basis functions will be used to create a sample grob. See the reference part for a complete list of functions.

First create a four-level grayscale grob. Type `GREY 131 64` ENTER

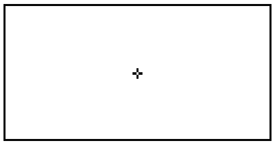


```
RAD XYZ HEX        1 (X)D
{HOME}      HLT    1
4:
3:
2:
1:
GREY 150 100◆
VECTR MATR LIST HYP REAL BASE
```

```
RAD XYZ HEX          (X)D
{HOME DOC}  HLT
2:
1:   Graphic 150 x 100g
GREY
```

The blank grob is displayed on the stack.

Then edit it. Press ▼



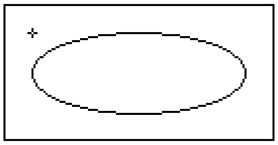
There are two ways to use PICTURE2 functions.

- Using the menu. To display the menu, press −. NXT and ↰ PREV NXT cycle through the menu pages.
- With Shortcut keys. Hold α and press the first letter of a function to launch it. When you don't know the letter corresponding to a function, search the function in the menu, the shortcut letter is displayed bold.

Now draw an ellipse, using the menu. Press − to display the menu if necessary. The ellipse is called by the menu key ELLIPS. Press − to hide the menu.

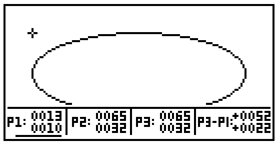
To call an ellipse with the shortcut keys, hold α and press E (E for Ellipse, remember the bold E on the menu key).

The ellipse can be shaped, using the arrow keys.



Press EEX Z anytime to Zoom. Press EEX Z a second time to get back to the normal view.

Press + to display the cursors coordinates.



```
P1: 0013  P2: 0065  P3: 0065  P3-P1:+0052
    0010      0032      0032        +0022
```

There are three coordinates shown: P1, P2 and P3. P1 is the current cursor position (it is underlined). To put the cursor on one coordinate, press 1, 2 or 3. In the case of the ellipse, P3 is the center of the ellipse, and P1 is a corner of the enclosing box. P2 is not used.

When the ellipse is correctly positioned (with P1 and P3), it is necessary to fix it on the grob. With no menu displayed, press:

A to fix it in white,

B to fix it in light gray (white for a two-level grayscale),

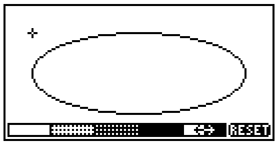
C to fix it in dark gray (black for a two-level grayscale),

D to fix it in black,

▭E to fix it in XOR mode (every pixel of the ellipse will be the opposite of the underlying pixel).

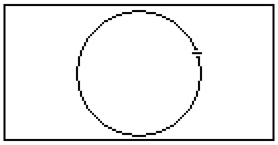
Or press ← or ▭F to cancel the ellipse.

These color keys are displayed in the third page of the menu:

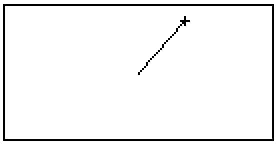


The other simple shapes are: (with the α shortcut keys):

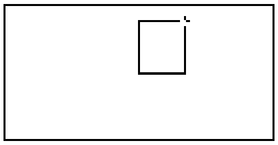
▭C Circle. P3 is the center and P1 is a point of the circle.



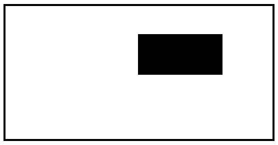
NXT L Line. P1 and P3 are the two ends.



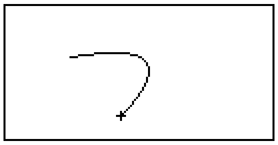
▭B Box. P1 and P3 are two opposite corners.



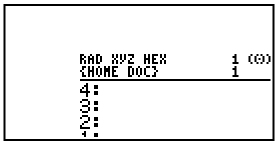
◀P Plan (filled box). P1 and P3 are two opposite corners.



SIN S Spline curve. P1 and P3 are the ends, P2 is the tangential point.



MTH G GXOR. Merges another grob, see the reference part (here with a LCD→ grob).



A surface can be filled with a given color: Place the cursor on the surface to be filled, press α - ▭F (Fill), and then, in case of a four-level grayscale grob, the corresponding color key ▭A, ▭B, ▭C or ▭D. A pattern can be used to fill a surface, see the reference part.

To leave a trail behind the cursor (like DOT+), press a color key ▭A, ▭B, ▭C, ▭D or ▭E. To stop the trail, press ←.

To change only one pixel, press MTH G, PRG H, CST I or VAR J, corresponding to the color keys ▭A, ▭B, ▭C, ▭D.

To exit, press ON, the modified grob will be put on the stack.

10.2 Reference

10.2.1 Commands

These commands can be typed in the command line, or called from RPL programs.

PICTURE2	The graphic editor which works with the PICT.
EDITB	The graphic editor which works with the grob on stack level 1.
→PICT	Stores the grob on stack level 1 in the PICT (like PICT STO, but it also works the four-level grayscale grobs).
PICT→	Puts the current PICT grob on the stack.
?GREY	If the grob on stack level one is in four-level grayscale, returns 1, else 0.
GBLANK	Equivalent to BLANK, but creates a four-level grayscale grob.
→GREY	Takes two B&W grobs on the stack and creates one four-level grayscale grob with them. The grob on level 2 defines the low-weighted bits (a pixel in this grob becomes a light gray pixel in the gray-grob, a pixel in the grob on level 1 becomes a dark gray

	pixel in the gray-grob; if both or set, they become a black pixel). To convert a two-level grayscale grob into a four-level one, type `DUP →GREY`.
`GREY→`	Contrary of `→GREY`, takes a four-level grayscale grob and returns two B&W grobs.

10.2.2 Keys

ON	Exits PICTURE2.
↱ ON (OFF)	Switches off the calculator.
+	Switches on or off the coordinates display.
−	Switches on or off the menu display.
1	Position the cursor at P1, and set P1 as the current cursor.
↰ 1	Stores the current cursor position in P1.
↱ 1	Position the cursor at P1.
2	Position the cursor at P2, and set P2 as the current cursor.
↰ 2	Stores the current cursor position in P2.
↱ 2	Position the cursor at P2.
3	Position the cursor at P3, and set P3 as the current cursor.
↰ 3	Stores the current cursor position in P3.
↱ 3	Position the cursor at P3.
•	Inverts the color of the pixel under the cursor.
×	Copies P1 coordinates in P3.
÷	Switches between P1 and P3 as cursor (No effects if P2 is the current cursor).
ENTER	Puts the cursor coordinates on the stack, as a complex number.
↰ ENTER	Puts the cursor coordinates on the stack, as a list of two binary numbers.
↱ ENTER	Does a SUB. The grob boxed between P1 and P3 is put on the stack, as a grob.
⬅	Cancels the current shape (line, circle...) and returns to normal cursor mode.
↰ DEL (CLEAR)	Clears the whole grob.
EEX Z	Switches between the zoomed and the normal view.
STO	Puts the current grob on the stack.
Arrows ◀, ▶, ▲ and ▼	Cursor movement.
↰ +Arrows	Page by page cursor movement.
↱ +Arrows	Position the cursor on a border.
NXT −	Menu keys.
▭ A	In cursor mode, DOT+ in white. In shape mode, fixes the shape in white.
▭ B	In cursor mode, DOT+ in light gray (white in B&W). In shape mode, fixes the shape in light gray.
▭ C	In cursor mode, DOT+ in dark gray (black in B&W). In shape mode, fixes the shape in dark gray.
▭ D	In cursor mode, DOT+ in black. In shape mode, fixes the shape in black.
▭ E	In cursor mode, DOT+ in XOR mode. In shape mode, fixes the shape in XOR mode.
↰ ▭ E	like ▭ E, but only inverses the high-weighted bit plan (try it!).
▭ F	Cancels the current shape and returns to normal cursor mode.
MTH G	Puts a white pixel.
PRG H	Puts a light gray pixel (white in B&W).
CST I	Puts a dark gray pixel (black in B&W).
VAR J	Puts a black pixel.

10.2.3 ALPHA keys

To use these keys, hold α down.

1	Suspends the current editing, and edits the grob found on stack level 1 (Useful to edit a pattern for a pattern fill). Press ON to return to the other grob editing.
▭ B	Box. P1 and P3 are two opposite corners.
▭ C	Circle. P3 is the center, P1 is a point on the circle.
▭ D	Executes the program stored in `DOPICT`.
▭ E	Ellipse. P3 is the center, P1 is a corner of the enclosing box.
▭ F	Surface Fill. In B&W, inverses the surface color. In grayscale, the wanted color must be then defined with ▭ A, ▭ B, ▭ C, or ▭ D. Press ▭ F or ⬅ to cancel.
▲ K	Goes to the interactive stack. Press ON to return to PICTURE2.
NXT L	Line. P1 and P3 are the ends.
' M	Pattern fill (*Motif*). The pattern must be a 8x8 grob found on the stack level 1, in B&W or in grayscale.

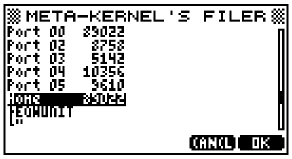
◀ P	Filled box (Plan). P1 and P3 are two opposite corners.
▶ R	REPL. Takes the grob on stack level 1. It may be positioned with the arrow keys. It is validated by pressing: ▭ C does a REPL and drops the grob. ▭ D does a GOR and drops the grob. ▭ E does a GXOR and drops the grob. ▭ F or ⇐ cancels.
SIN S	Spline curve. P1 and P3 are the ends, P2 defines the tangent lines.

11 Filer

The Filer is a file utility that eases directory and port access.

Press ↱ MEMORY VAR to execute it. The first screen lets you choose the directory.

11.1 Ports and directories screen



```
▒ META-KERNEL'S FILER ▒
Port 00   89022
Port 02    8758
Port 03    5142
Port 04   10356
Port 05    9610
HOME      89022
 EQUNIT
 L..
                CANCL   OK
```

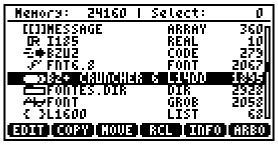
The tree screen shows a list of ports and directories.

Press ▲, ▼ to go throughout the list.

Press ▶, ENTER or OK to go in the selected location.

Press ON or CANCL to exit to Filer.

11.2 File selection screen



```
 Memory:  24160 | Select:      0
   [[]]MESSAGE          ARRAY   360
    IR I185             REAL     10
   ⇒BZU2                CODE    279
    FNT6.8              FONT   2067
   82+ CRUNCHER 6 L1400         1895
   FONTES.DIR           DIR    2928
   FONT                 GROB   2058
   { }L1600             LIST     68
EDIT COPY MOVE RCL INFO ARBO
```

On this screen are shown: the free memory, the total size of the selected files, a list of files and the menu.

Press ▲ and ▼ to move in the file list.

In each line, there are five fields: the selection number (if the object is selected), an icon depending on the file type, the name, the type and the size of the file.

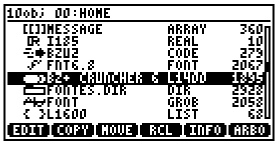
Press ENTER to select or deselect a file.

Press ▶ on a directory or a library to go into it.

Press ◀ to go out of the current directory of library.

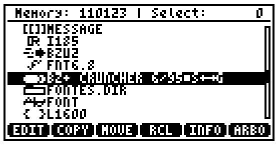
For all the commands that require a list of files, if there is no selection, the current line will be taken as the selection.

You can change the header in order to display the number of objects available and the working path (here port 0 home): ↱ MENU NXT



```
10obj  00:HOME
   [[]]MESSAGE          ARRAY   360
    IR I185             REAL     10
   ⇒BZU2                CODE    279
    FNT6.8              FONT   2067
   82+ CRUNCHER 6 L1400         1895
   FONTES.DIR           DIR    2928
   FONT                 GROB   2058
   { }L1600             LIST     68
EDIT COPY MOVE RCL INFO ARBO
```

To hide the type and the size of every objects press VAR



```
 Memory: 110123 | Select:      0
   [[]]MESSAGE
    IR I185
   ⇒BZU2
    FNT6.8
   82+ CRUNCHER 6/95■S←→G
   FONTES.DIR
   FONT
   { }L1600
EDIT COPY MOVE RCL INFO ARBO
```

11.3 Menu

Some commands work only in a special mode, for example only in the HOME directory. When you try to run these commands in an incorrect mode, a beep is produced.

EDIT ↰ EDIT +/-	Edits the current object.
COPY	Copies the selected objects. You define the destination with the tree screen: select the destination (a port or a directory)

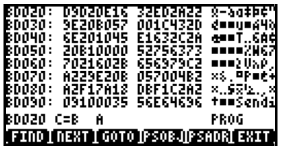
	and press ENTER or OK.
MOVE	Moves the selected objects to the destination you selects in the tree screen.
RCL ↱ RCL STO	Puts the selected objects on the stack.
INFO α CST I	Gives information about the current object: Name, type, size, address, CRC.
ARBO ↱ ◄	To go to the tree screen.
PURG ↰ PURG EEX	Clears the selected objects. If the **MK** flag –12 is clear (default) you will be prompt for a confirmation
RENAM	Renames the current object. This command is available only in the VAR
ORDER α EVAL O	Orders the selected files in the order of the selection. The other files follow.
EVAL EVAL	Evaluates the current object (Some programs that normally do not work in port 2, can work using this command).
SEND	Sends the selected files with KERMIT, with the current I/O settings. If the variable `STARTSEND` exists in the HOME directory, it is used to send the files (level 2: the object, level 1: the name).
HALT α ◄ P	Suspend the Filer and return to the RPL stack
HEXA	Goes to the hexadecimal editor, at the beginning of the current object.
VIEW α √x V	Views the current file if it is a string.
EDITB ↱ CMD +/-	Edits the current object with the best environment.
CUSTO CST	Starts the custom mode if the FILER.CUSTOM is defined
HEAD ↱ MENU NXT	By default, the Filer displays the memory available and the selected objet's number. It can display the number of objects and the working path

11.4 HEXA Editor

The screen shows 64 nibbles and their ASCII value. Each line represents 16 nibbles (separated by 8).

On the bottom of the screen are written the assembly instruction, and the RPL object at the current address.

Press ◄ and ► to go one nibble backward or forward. Press ▲ and ▼ to move by 16 nibbles.



```
BD020:  09D20E16 32ED2A22
BD030:  9E20B057 001C432D
BD040:  6E201045 E1632C2A
BD050:  20B10000 52756373
BD060:  7021602B 656979C2
BD070:  A229E20B 057004B2
BD080:  A2F17A18 DBF1C2A2
BD090:  09100035 56E64696
BD020 C=B  A        PROG
```

11.4.1 Menu

FIND	Searches an hexadecimal string
NEXT	Searches the next occurrence.
GOTO	Goes to a given address.
PSOBJ	Pushes the current object on the RPL stack. This command is very useful to recover data from a corrupted card ((`Invalid Card Data`)
PSADR	Pushes the current address on the RPL stack as a binary integer
EXIT	Exits the Hexa Editor.

11.4.2 Keys

NXT	Jumps to the next assembly instruction.
VAR	Jumps to the next RPL object.
↰ EDIT +/-	Goes in edit mode.

11.4.3 Edit mode

Very dangerous, use at your own risk !

Use the arrow keys to move, press a hexadecimal key from 0 to F to put the digit at the cursor position. Press ↰ EDIT +/- again to exit the Edit Mode.

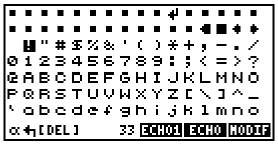
Utilities

1 Font Editor (EDF)

EDF is a font editor. It is accessed through the CHARS menu, where the current font can be edited. Any font can be edited by pushing it on the stack and pressing ▼.

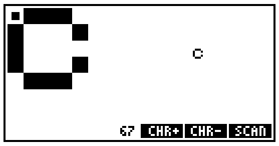
1.1 Font editing

When EDF is launched, scan mode is active, the font is displayed on the screen and the cursor is moved by the arrow keys. The current character number is displayed on the bottom of the screen (here 67: C).



```
■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ↵ ■ ■ ■ ■ ■
■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ◀ ■ ◆ ◆
  █ " # $ % & ' ( ) * + , - . /
0 1 2 3 4 5 6 7 8 9 : ; < = > ?
@ A B C D E F G H I J K L M N O
P Q R S T U V W X Y Z [ \ ] ^ _
` a b c d e f g h i j k l m n o
α↰[DEL]       33 ECHO1 ECHO MODIF
```

MODIF Switches to edit mode. On the left of the screen, the character is displayed eight times bigger, on the right in its normal size.



SCAN gets back to the CHARS mode.

The cursor is in the big character view, on the left. It is moved with the arrow keys, and • inverts the pixel under it.

1.2 CHARS mode

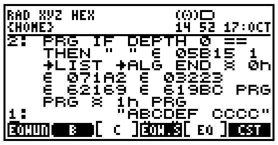
The chars mode is the default mode when EDF is launched. The cursor is moved by the arrow keys.

ECHO pushes the current character on the command line. Press ON to exit.

ECHO1 pushes the current character on the command line and exits to the command line.

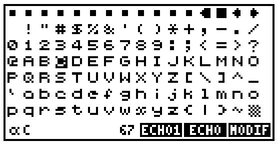
1.3 A session with CHARS

We will add a point inside the character C.



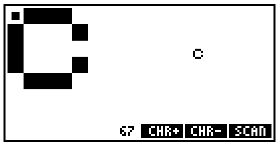
```
RAD XYZ HEX             (⊙)□
{HOME}            14 52 17:OCT
2: PRG IF DEPTH 0 ==
   THEN " " ∈ 05B15 1
   →LIST →ALG END ¤ 0h
   ∈ 071A2 ∈ 03223
   ∈ 62169 ∈ 619BC PRG
   PRG ¤ 1h PRG
1:            "ABCDEF CCCC"
EQHUN  B  [ C ] EQH.S [ EQ ]  CST
```

Press ↱ CHARS PRG to enter in CHARS. Use the arrows to move to the C character:

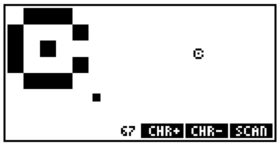


```
■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ◀ ■ ◆ ◆
  ! " # $ % & ' ( ) * + , - . /
0 1 2 3 4 5 6 7 8 9 : ; < = > ?
@ A B █ D E F G H I J K L M N O
P Q R S T U V W X Y Z [ \ ] ^ _
` a b c d e f g h i j k l m n o
p q r s t u v w x y z { | } ~ ▒
αC            67 ECHO1 ECHO MODIF
```

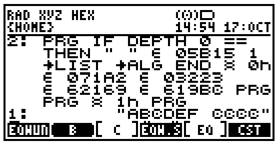
Press MODIF to edit it:



Use the arrows to move to the center of the character, press • to put a point:



Press ON to return to the stack display. See how the C characters have changed.



```
RAD XYZ HEX           ((•))▭
{HOME}            14:54 17:OCT
2: PRG IF DEPTH 0 ==
   THEN " " ∈ 05B15 1
   →LIST →ALG END ¤ 0h
   ∈ 071A2 ∈ 03223
   ∈ 62169 ∈ 619BC PRG
   PRG ¤ 1h PRG
1:         "ABCDEF ©©©©"
```

▲ Note that this only affects the current font. The next →FONT will destroy the changes. To make them permanent, do a FONT→ and store the changed font.

2 Machine Language Compiler (Masd)

2.1 Generalities on ML (Machine Language)

As the Saturn processor directly executes ML, the operating system can not control what a ML program is doing.

On the HP 48 calculator, user data are stored in the same area as temporary data. When there is a bug in a ML program, you have best chance to lost your data's. So be very careful when programming in ML.

ML is a processor dependent language, so what you will learn on the HP 48 will not be useful on other processor. On the other hand, the programming techniques you will acquire are not dependent of the hardware and then will be reusable.

2.2 Launching Masd

To compile a program, put the string on the top of the stack and type ASM or use the ASM menu of the MDGK library.

2.3 Generalities on Masd Syntax

Masd expects a character string (called source) on the top of the stack.

A source is a set of instructions, comments, and separation characters and ends with a carriage return and an @ sign.

Masd is case sensitive, so be careful, as « boucle » and « BOUCLE » are two different labels.

Separation characters are those with an ASCII number below 32. They include spaces, tabs, line feed and carriage return.

Some instructions need a parameter, called field. Separation characters between an instruction and the field, are spaces, tabs, and points. Therefore A+B.A can be used instead of A+B A.

Comments can be placed everywhere between two instructions. They begin with % or ; and finish at the end of the current line.

Directives change the way Masd interprets your source. Theses instructions begin with a ! and will be explained later.

While Masd is working, it displays messages on the screen to explain what is processed.

Linking FileName	Compiles the FileName file. The main file is called Main.
Uplink	Ends the compilation of a file.
Compil. Glab	Compiles global jumps.
Compil. Exp	Calculates expressions.
Garbage	Reconfigures the memory.
Ghost LabelName	Detects an unused label.

If Masd detects one or more syntax error, it will push a list describing all errors on the stack. This list is used by ER to find the location of errors, and let the user correct them.

Errors may be notified at the wrong place. For example if a label is not correctly defined, the errors will be located on the calling instructions.

2.4 Links

Links are source files that can be linked during compile time (equivalent to the {$I} directive in PASCAL and #include in C).

When a link call is encountered, Masd stops compiling the current link, compiles the new one and then continues compiling the first one.

Syntax:

'FileName   links the file called FileName.

Note 1: A link can call other links.

Note 2: You can not use more than 256 links in your project.

Note 3: To know how Masd looks for files, see the File search section.

Note 4: Links are useful to cut projects in independent parts to allow fast and easy access to source code.

2.5 Using labels

A label is a marker in the program. The principal use of labels is to determine jump destinations.

A label is a set of less than 128 characters different from space, '+', '−', '*' and '/'. A label begins with a star '*' and ends with a separation character.

*BigLoop   is the BigLoop label declaration.

Be careful about upper and lower cases!

Three types of labels can be used:

- Global labels

  A global label is a label that can be used everywhere in the project, like global variables in Pascal or C.
- Local labels

  A Local lab is a label that is only accessible in a local section like local variables in Pascal or C.

  A local section starts at the beginning of a source, after a global label, after a link (see link section) or after a `!LOCAL` directive.

  A local section finishes at the end of a source, before a link, before a global label or before a `!LOCAL` directive.

  A local label is identified by a ‘`.` ’ as the first character.
- Link labels

  A link label is a label that exists only in the link where it is declared, like a private clause in Object Pascal.

  A link label is identified by a ‘`_`’ as the first character.

  Note 1: In projects, using less global labels is better because a global label is longer to compile and because it gives a better program structure. A good habit is to use global labels to cut the program in subroutines, and to use local labels inside these subroutines.

  Note 2: The **Meta Kernel** command line is able to find labels in a source. Press blue shift `GOTO`.

2.6 Using constants

It is possible to define constants. It is useful to identify a memory address by a name, rather by the address itself.

For example, instead of typing `D1=80100` every time it is needed, it is better to declare `DC Result 80100` at the beginning of the project and then to type `D1=(5)Result` when needed.

Constant declaration:

`DCE` *`CstName Expression`* or

`EQUE` *`CstName Expression`* or

`DEFINE` *`CstName Expression`*

`DC` *`CstName CstValue`* or `EQU` *`CstName CstValue`*

CstValue is a hexadecimal number. A decimal number can be typed with a leading `#` character.

`DC Foo 10` is same as `DC Foo #16`

Note 1: A constant cannot be given the same name as a declared label.

Note 2: The name of a constant follows the same rules as the name of a label.

Note 3: A constant value is always stored on 5 nibbles.

Masd introduces a ‘programming register’ called CP (Constant Pointer) which helps to define constants. CP is defined by:

`CP=`*`Cst`* or `CPE=`*`Expression`*

CP is defined on 5 nibbles, its initial value is 80100.

`DCCP` *`Increment ConstantName`*

declares a constant with the current CP value and then increase CP by Increment.

Note: Increment is a hexadecimal value, to use a decimal value, put a leading `#`.

For example, if CP equals to $10

`DCCP 5 Foo`

defines a Foo constant with a value of $10 and then change the value of CP to $15.

Several constants can be defined, starting from CP.

`:` *`Inc CstName0 CstName1`* ... *`CstNameN-1`* `:`

defines *N* constants CstName*x* with a value of CP+*x***Inc* and then changes the CP value to CP+*N***Inc*.

By default, *Inc* is a decimal number. It can be typed in hexadecimal, with a leading `$`.

2.7 Expressions

An expression is a mathematical operation that is calculated while compiling.

Terms of this operation are hexadecimal or decimal values, constants or labels.

An expression stops on a separation character.

```
DCCP 5 @Data
...
D1=(5)@Data+$10/#2 D0=(5)$5+DUP LC(5)"DUP"+#5
```

are correct expressions.

Notes:

- A hexadecimal value must begin with a `$` and a decimal value must begin with a `#`.
- The `&` character equals to the address of the current instruction in absolute mode, or to the offset of the current instruction in standard mode (This value has no meaning in itself, but may be used to calculate the distance between a label and the current instruction).
- The value of a label is the address of the label in absolute mode, or the offset of the label in the program in normal mode (This value has no meaning in itself, but may be used to calculate the distance between a label and the current instruction).

- Entries from the STARTEXT table may be used. In an ambiguous case (DUP+#5 may either be an addition DUP + 5, or an entry ‘DUP+#5‘), add "" around the word: "DUP"+#5.
- There is no priority (precedence) in operations. $1+$2*$3=$9 instead of $7. Use parentheses to set priorities.
- You can’t use more than three level of parenthesis.
- Calculations are done on 64 bits.
- X divide by 0 = $FFFFFFFFFFFFFFFF.
- By default, expressions are calculated at the end of the compilation of the project.
- Masd can be forced to compile expressions using the !COMPEXP directive. But be careful, if an expression uses a label that is not already declared, this will cause an error on the expression and not on the !COMPEXP directive.
- Masd can be forced to compile the last expression using the !COMPEX directive with the same remarks than for !COMPEXP. This can be useful when local labs are used in an expression.

2.8 Skips

Skips are a first step from ML to a third generation language, even if they are only another way to write SATURN instructions.

The basement of Skips is the Block structure.

A block is enclosed in { and }, and can be inside another block.

The following instructions deal with blocks.

SKIPS instructions	Equivalents
SKIP { ... }	GOTO .S ... *.S
SKIPL { ... }	GOTOL .S ... *.S
SKIPC { ... }	GOC .S ... *.S
SKC { ... }	GOC .S ... *.S
SKIPNC { ... }	GONC .S ... *.S
SKNC { ... }	GONC .S ... *.S
Test SKIPYES { ... }	Test GOYES .S ... *.S
Test { ... }	Test GOYES .S ... *.S
Test → { ... }	/Test GOYES .S ... *.S
SKUB { ... }	GOSUB .S ... *.S
SKUBL { ... }	GOSUBL .S ... *.S
{ ... }	Defines a block (generates no code)
STRING { ... }	$/02A2C GOIN5 *.S ... *.S (to create a character string)
CODE { ... }	$/02DCC GOIN5 *.S ... *.S (to create a code object)
STROBJ *PROLOG* { ... }	$/*PROLOG* GOIN5 .S ... *.S (to create a ‘prolog – length’ object)

/Test is the opposite of Test. For example if Test is ?A<C.A, /Test is ?A>=C.A. The test instructions dealing with the hardware register (?HST=0, ?MP=0, ?SR=0, ?XM=0 and ?SB=0) cannot be inverted.

Once blocks are defined, special instructions can be used in them. These instructions called EXIT and UP allow to jump to the end or to the beginning of a block.

These instructions	are equivalent to
{	*.Beginning
EXIT	GOTO.End
EXITC	GOC.End
EXITNC	GONC.End
?A=0.A EXIT	?A=0.A →.End
UP	GOTO.Beginning
UPC	GOC.Beginning
UPNC	GONC.Beginning
?A=0.A UP	?A=0.A →.Beginning
}	*.End

Note: do not make confusion between EXIT and UP instructions, which are GOTOs, and EXIT and UP after a test, which are GOYES’s.

EXIT and UP can jump to the beginning or to the end of an upper-level block by specifying the number of blocks to exit, after the UP or EXIT instructions.

These instructions	Are equivalent to
{	*.Beg3
{	*.Beg2
{	*.Beg1
UP2	GOTO.Beg2
UP3	GOTO.Beg3
EXIT1	GOTO.End1
EXIT3	GOTO.End3
}	*.End1
}	*.End2
}	*.End3

Note: EXIT1 is equivalent to EXIT, and UP1 is equivalent to UP.

Using SKIPELSE, SKEC or SKENC instructions, two blocks create an IFNOT-THEN-ELSE structure.

These instructions	Are equivalent to	Or in high-level language
?A=0.A SKIPYES	?A=0.A GOYES.Beg2	IF NOT A=0 THEN

{	*.Beg1	BEGIN
EXIT	GOTO.End2 % and not End1	...
UP	GOTO.Beg1	...
}	*.End1	END
SKELSE	GOTO.End2	ELSE
{	*.Beg2	BEGIN
A+1.A	A+1.A	...
EXIT	GOTO.End2	...
UP	GOTO.Beg2	...
}	*.End2	END

2.9 Macros

If data are to be included in a project, they can be entered in a source file, using $.

But a simpler way is to include data from an external file, which is a macro. The macro file must be a character string, a graphic, a code object or a list.

In case of a string or a code, Masd includes only the data part (after the length)

In case of a graphic, only the graphic data will be included (no length, no dimensions).

In case of a list, only the first object of the list will be included following the previous rules.

The syntax is:

```
/FileName
```

Note: To know how Masd looks for the FileName file, see the following section.

2.10 Filename conventions

Masd sometimes needs to find a file in the HP 48 memory.

The file can be found either by specifying the complete file name and location, or only the file name to be search in the search path list.

The initial search path list contains the current directory, the upper directory and so on to the HOME directory.

Note: You can add a directory in the search path list using `!PATH+ RepName` where RepName identifies a directory name using the full pathname rules, explained below.

To specify a full path, use

`H/` to specify HOMEDIR as the root.

x/, where *x* is a port number, to specify a port as root.

This root is followed by a list of directories, ending with the name of the file.

`4/TOTO/TITI/TUTU` specifies the TUTU file in the TITI directory, stored in the TOTO backup of the fourth port.

`H/ME/YOU` specifies the YOU file in the ME directory, in the HOMEDIR.

2.11 Units

A unit is a part of a project, which can be compiled separately and stored in a file. The generated unit code can then be included in the project final code, without recompiling it.

A unit can use labels and constants defined in the calling program, and the calling program can use labels and constants defined in the unit.

Any source can be changed into a unit by placing a `!UNIT` directive in the source.

In the calling source file, type `USES FileName` to include a unit.

Note 1: A unit is smaller in memory than the source file it comes from.

Note 2: Using a unit is a very fast operation, faster than compiling the source.

Note 3: Tools libraries can be created and distributed without sharing the source code.

2.12 Library creation

Libraries can be created with Masd using the following instructions:

LIB, MESSAGE, VISIBLE, HIDDEN and LCONFIG.

Here is a source producing a library:

```
!NO CODE           % no code prolog $02DCC
LIB                % beginning of lib
{ "library name"   % library title
  1234             % library romid in decimal
  MESSAGE          % message table
  { "Message 1"
    "Message 2"
  }
  VISIBLE          % $visible list
  { VisibleName1   % Name of File Names containing
    VisibleName2   % visible objects
  }
  HIDDEN           % $hidden list
  { HiddenName1    % Name of File Names containing
    HiddenName2    % hidden objects
  }
```

```
    LCONFIG ConfigName      % Name of the file containing
                            % the Config Object
  }                         % end of lib
  @
```

2.13 SysRPL mode

Masd can switch to SysRPL mode (also called System RPL or External) using the !RPL directive. In RPL mode, lots of things are changing.

Separation characters don't change (Characters of ASCII number below 32).

Comments begin with * and end at the end of the line, or begin with '(' and end with ')'.

2.13.1 Instructions

In RPL mode, Masd interprets instructions in the following order.

a) Constants

If a constant exists with the same name, the constant value is used on 5 nibbles.

Example:

```
EQU TOTO 4E2CF
...
TOTO
```

will produce

```
FC2E4
```

b) External (in entry points table)

If an entry in the external table exists with the same name, the value associated with this entry is used.

```
BZUExt
```

will produce

```
DB10C
```

Note 1: Use the TableCreator program on your PC to create the table.

Note 2: This table can be stored anywhere in the HP 48 memory. Create a STARTEXT text file in the HOMEDIR with the file name of the External table on the first line and a @ on the second line.

Example of a STARTEXT file for a table stored in the Table backup to the fourth port:

```
"4/Table
@"
```

Note 3: Using an external table is much faster than using constants. On the other hand, constants are project dependant, which is not the case of an external table.

c) Tokens

::	Program prolog $02D9D
;	List, Program or Algebraic end $0312B
{	List prolog $02A74
}	List end $0312B
SYMBOLIC	Algebraic prolog $02AB8
UNIT	Unit prolog $02ADA
# *cst*	System Binary of *cst* value, given in hexadecimal.
# #*cst*	System Binary of *cst* value, given in decimal.
#*cst*	System Binary (hexadecimal value). If the SB exists in ROM, its address is used.
##*cst*	System Binary (decimal value). If the SB exists in ROM, its address is used.
PTR *cst*	Address. PTR 4E2CF generates FC2E4.
ACPTR *cst1 cst2*	Extended pointer.
ROMPTR *LibN ObjN*	XLIB.
% *real*	Real number.
%% *real*	Long real number.
C% *real1 real2*	Complex number.
C%% *real1 real2*	Long complex number.
"..."	Character string. Special characters can be included by typing \ and the ASCII value on two hexadecimal characters.
ID *name*	Global name.
LAM *name*	Local name.
TAG *chrs*	Tagged object.
xxlibName	XLIB identified by its name. If it is a standard HP48 command (like xDUP), the address is used instead of an XLIB object.
HXS *Size Data*	Binary integer ($02A4E), Size is in hexadecimal and Data is a set of hexadecimal characters. Example: HXS 5 FFA21
GROB *Size Data*	GROB ($02B1E).
LIBDAT *Size Data*	Library data ($02B88).
BAK *Size Data*	Backup ($02B62).
LIB *Size Data*	Library ($02B40).
EXT1 *Size Data*	Extended1 ($02BAA).
EXT2 *Size Data*	Extended2 ($02BCC).
EXT3 *Size Data*	Extended3 ($02BEE).
EXT4 *Size Data*	Extended4 ($02C01).
ARRAY *Size Data*	Array ($029E8).

LNKARRAY *Size Data*	Linked Array ($02A0A).
CODE *Size Data*	Code object ($02DCC).
NIBB *Size Data* or NIBHEX *Data* or CON(*Size*) *Expr*	Includes directly hexadecimal data (no prolog).
CHR x	Character object.
INCLOB *FileName*	Includes the content of the file *FileName*.
INCLUDE *FileName*	Includes the source of the file *FileName* to be compiled (Like ' in ASM mode).
LABEL *label*	Defines a label (like * in ASM mode).
EQU *CstName Cst* or EQUE *CstName Exp* or DEFINE *CstNam Exp*	Defines a constant (Like DC in ASM mode).
EQUCP *Interleave CstName*	Defines a constant (Like DCCP in ASM mode).

Note: A constant can be defined in ASM or RPL mode, and may be used in both modes.

d) Decimal value (System Binary)

If the instruction is not yet recognized, and if it is a decimal value, Masd generates a system binary.

e) Unnamed local variables

Then, Masd tries to match the instruction with declared local variables.

A local environment is set using:

`{{ var1 var2 ... varN }}` with *N*<23

These variables have names during compile time, but they are implemented as unnamed local variables, which are faster to access than named local variables.

A local variable is recalled by typing its name

Data can be stored in a local variable by typing its name, with a leading ! or =.

Note 1: Local variable are available until the next local definition.

Note 2: The local environment is not closed automatically, use ABND or other provided words.

Example:

`{{ label1 label2 .. labelN }}` will become :

`' NULLLAM <#N> NDUPN DOBIND` (or `1LAMBIND` if there is only one variable)

And:

```
label1 → 1GETLAM
=label1 → 1PUTLAM
!label1 → 1PUTLAM
```

Program example

::
        {{ A B }}
        B A!
        ABND
;
	::
	' NULLLAM TWO NDUPN DOBIND
	2GETLAM 1PUTLAM
	ABND
	;

Notes on RPL mode.

Masd switches back to ASM mode using the !ASM directive.

2.13.2 Special keystrokes in the command line

In the command line editor, some keystrokes help to enter characters that are specific to System RPL, and also to easily find a command (auto-completion).

↰ followed by • displays a comma , .

↰ **maintained** and • displays a semicolon ; .

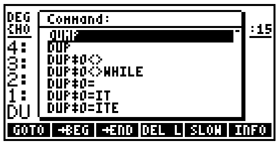
In alpha mode, ↱ followed by VAR displays a vertical bar | .

In alpha mode, ↱ **maintained** and VAR displays an anti-slash \.

Auto-completion works as follow:

Type the first characters of the command, for example DU.

Press ↱ and maintain it. Press SPC once. The screen will now display all the commands that begin with DU: DUMP.



```
DEG
<HO                        :15
      Command:
      DUMP
4:    DUP
3:    DUP#0<>
2:    DUP#0<>WHILE
      DUP#0=
1:    DUP#0=IT
DU    DUP#0=ITE
```

Use ▲ and ▼ to travel in the list.

Press ENTER to insert the command in the text.

To cancel the search without inserting a command, press ON.

Inserting a bloc program:

α then ↰ **maintained** and << >> − will:

If no Command Line exists: create one with:

ASSEMBLY MODE:

```
"!NO CODE
!RPL
::
 _
;
@"
```

SystemRPL MODE:

```
"::
 _
;
@"
```

`_` is the position of the cursor.

If a Command Line exits insert and indent a SystemRPL program bloc :

```
::
 _
;
```

2.13.3 Program example

To find or understand the syntax of a particular object, use `→S2` to produces an Masd syntax-source

As in ASM mode, a RPL source must end with a `@`.

```
"!NO CODE
!RPL
::
ONE (My first program)
!ASM
% Turn into ASM mode
CODE { SAVE LOADRPL }
!RPL (Turn into SysRPL mode)
TWO
;
@"
```

2.14 SATURN instructions syntax

In this section:

x is an integer number between 1 and 16.

h is a hexadecimal digit.

a is a 1 to 16 or a 0 to 15 number depending of the current mode (0-15 or 1-16)

f is a field A, B, X, XS, P, WP, M or S.

Reg is a working register A, B, C or D.

SReg is a save register R0, R1, R2, R3 or R4.

Exp is an expression.

Cst is a constant. The value is given in hexadecimal or decimal using a leading `$` or `#` respectively.

DReg is a pointer register D0 or D1.

Data is memory data pointed by D0 or D1. It means `DAT0` or `DAT1`.

Note: For instructions that use two working registers, only the pairs A-B, B-C, C-D and A-C are available.

For instructions like *Reg1*=*Reg1*… you can write only *Reg1*… Example: `A=A+C.A` is the same as `A+C.A`.

2.14.1 Assigning 0 to a register

Syntax: *Reg*=0.*f*

Example: `A=0.M`

2.14.2 Loading a value in A or C

LC and LA instructions allow to load a constant value into A or C register.

`LC` *hhh...hh* loads x nibbles into C.

`LA` *hhh...hh* loads x nibbles into A.

Example: `LC 80100`

Note: LC #12 allow to load 12 decimal into the 3 first nibbles of C. The number of nibbles used is the number of characters necessary to write the value (including the `#`). So #12 will take three nibbles.

`LCASC(x) Characters` loads the hexadecimal value of *x* characters into C. *x* must be between 1 and 8. `LAASC(x)` if the counterpart for A.

Example: `LCASC(7) HP_MASD`

`LC(x) Exp` or `LA(x) Exp` load the result of an expression into C or A, using x nibbles.

Example: `LC(5)@Buffer+DataOffset`

2.14.3 Loading a register value into another register

Syntax: *Reg1=Reg2.f*

Example: `A=B.X`

2.14.4 Exchange between two registers

Syntax: *Reg1Reg2*EX.*f*

Example: `CDEX.W`

2.14.5 Addition

Syntax: *Reg1=Reg1+Reg2.f* or *Reg1+Reg2.f*

Example: `C=C+A.A` or `C+A.A`

Note if *Reg1* and *Reg2* are same, this cause to multiply the register by two.

2.14.6 Subtraction

Syntax: *Reg1*=Reg1-Reg2.*f*or *Reg1-Reg2.f*

Example: `C=C-B.A` or `C-B.A`

Note: The following instructions are also available:

`A=B-A.f` `B=C-B.f` `C=A-C.f` `D=C-D.f`

2.14.7 Increment and decrement

Syntax: *Reg=Reg+Cst.f* or *Reg+Cst.f Reg=Reg-Cst.f* or *Reg-Cst.f*

Example: `A=A+10.A` or `A+10.A` `A=A-10.A` or `A-10.A`

Note 1: The Saturn processor is not able to add a constant greater than 16 to a register but if *cst* is greater than 16, Masd will generate as many instructions as needed.

Note 2: Even if adding constants to a register is very useful, big constants should be avoided because this will slow down execution, and generate a big program.

Note 3: Adding a constant greater than 1 to a P, WP, XS or S field is a bugged SATURN instruction (problem with carry propagation). Use these instructions with care.

Note 4: After adding a constant greater than 16 to a register, the carry should not be tested.

2.14.8 Right nibbles shifting (divide by 16)

Syntax: *Reg*SR.*f*

Example: `ASR.W`

2.14.9 Left nibbles shifting (multiply by 16)

Syntax: *Reg*SL.*f*

Example: `ASL.W`

2.14.10 Right bit shifting (divide by 2)

Syntax: *Reg*SRB.*f*

Example: `ASRB.W`

2.14.11 Right circular nibble shifting

Syntax: *Reg*SRC.*f*

Example: `ASRC.W`

2.14.12 Left circular nibble shifting

Syntax: *Reg*SLC.*f*

Example: `ASLC.W`

2.14.13 Logical AND

Syntax: *Reg1=Reg1&Reg2.f* or *Reg1&Reg2.f*

Example: `C=C&B.A` or `C&B.A`

2.14.14 Logical OR

Syntax: *Reg1=Reg1!Reg2.f* or *Reg1!Reg2.f*

Example: `C=C!B.A` or `C!B.A`

2.14.15 Logical NOT

Syntax: *Reg1=-Reg1*-1.*f*

Example: `C=-C-1.A`

2.14.16 Mathematical NOT

Syntax: *Reg1=-Reg1.f*

Example: `C=-C.A`

2.14.17 Loading value into a R Register

Syntax: *RReg=Reg*.f

Example: `R0=A.W`

Note: *Reg* can only be A or C.

2.14.18 Loading value into A or C from a R register

Syntax: *Reg=RReg*.f

Example: `A=R1.X`

Note: *Reg* can only be A or C.

2.14.19 Exchange between A or C and a R register

Syntax: *RegRRegEX*.f

Example: `AR1EX.X`

Note: *Reg* can only be A or C.

2.14.20 Memory write (POKE)

Theses instructions write the value of A or C at the address pointed to by D0 or D1.

Syntax: *Data=Reg.f* or *Data=Reg.x*

Example: `DAT1=C.A` or `DAT0=A.10`

Note: *Reg* can only be A or C.

2.14.21 Memory read (PEEK)

Theses instructions load into A or C the data pointed to by D0 or D1.

Syntax: *Reg=Data.f* or *Reg=Data*.x

Example: `C=DAT1.A` or `A=DAT0.10`

Note: *Reg* can only be A or C.

2.14.22 D0 and D1 modifications

a) Loading D0 and D1

Syntax: *DReg=hh*or *DReg=hhhh* or *DReg=hhhhh* or
DReg=(2)E*xp* or *DReg*=(4)*Exp* or *DReg*=(5)*Exp*

Example: `D0=FF` `D0=12345` `D1=(5)toto+$5`

b) Exchanges between A or C and D0 or D1

- Loading A or C, field A, into D0 or D1

Syntax: *DReg=Reg*

Example: `D0=A`

Note: *Reg* can only be A or C.

- Loading the four low nibbles of A or C into D0 or D1

Syntax: *DReg=Reg*S

Example: `D0=AS`

Note: *Reg* can only be A or C.

- Exchanging A or C, field A, and D0 or D1.

Syntax: *RegDRegEX*

Example: `AD1EX`

Note: *Reg* can only be A or C.

- Exchanging the 4 first nibbles of A or C and D0 or D1

Syntax: *RegDRegXS*

Example: `AD1XS`

Note: *Reg* can only be A or C.

c) Increment and decrement of D0 and D1

Syntax: *DReg=DReg+Cst* or *DReg+Cst*

Syntax: *DReg=DReg-Cst* or *DReg-Cst*

Example: `D0=D0+12` `D1-50`

Note 1: The Saturn processor is not able to add a constant greater than 16 to a register but if *cst* is greater than 16, Masd will generate as many instructions as needed.

Note 2: Even if adding constants to a register is very useful, big constants should be avoided because this will slow down execution, and generate a big program.

Note 3: After adding a constant greater than 16, the carry should not be tested.

2.14.23 Working registers tests

Notes:

- A test is always followed by RTNYES, GOYES, SKIPYES, EXIT, UP, GOTO, GOTOL, GOVLNG, GOSUB, GOSUBL or GOSBVL.
- RTY is the same as RTNYES.
- An arrow (→) may be followed by a label name, then replacing GOYES, or may be followed by a skip block, which is equivalent to the inverse of the test followed by SKIPYES, to reproduce a IF-THEN structure. Example: ?A=C.A → { } is the same as ?A#C.A { }.
- SKIPYES may be omitted if followed by a skip block ({}).
- If the test if followed by a GOTO, GOTOL, GOVLNG, GOSUB, GOSUBL or GOSBVL, Masd compiles the inverse of the test, to reproduce a GOYES with a larger range. Example: ?A=C.A GOTO B is the same as ?A#C.A { GOTO B }.
- GOTO, GOTOL, GOVLNG, GOSUB, GOSUBL, GOSBVL or → { cannot be used after a HST test.
- A label name must follow a GOYES, GOTO, GOTOL, GOVLNG, GOSUB, GOSUBL or GOSBVL.

a) Equality and inequality tests

Syntax: ?*Reg1=Reg2.f*   ?*Reg1#Reg2.f*

Example: ?A=C.B   ?C#D.A

Note: The HP inequality character may be used.

b) Lower and greater tests

Syntax: ?*Reg1<Reg2.f*   ?*Reg1<=Reg2.f*

Example: ?A<C.B   ?C>=D.A

Note: The HP lower or equal and greater or equal characters may be used.

c) Nullity tests

Syntax: ?*Reg=0.f*   ?*Reg*#0.*f*

Example: ?A=0.B   ?C#0.XS

Note: The HP inequality character may be used.

2.14.24 Working with some bits of A or C register

*Reg*BIT=*v.a*   *?Reg*BIT=*v.a* where Reg is A or C, *v* is 0 or 1 (reset or set), and a is the bit number.

Examples: ABIT=0.5, ?CBIT=1.3 GOYES TOTO

2.14.25 Operations on PC

A=PC C=PC PC=A PC=C APCEX CPCEX PC=(A) PC=(C)

2.14.26 Working with the Hardware Status Register

SB=0 XM=0 SR=0 MP=0 HST=*a*
?SB=0 ?XM=0 ?SR=0 ?MP=0 ?HST=*a*

2.14.27 Working with P

P=*a*
P=P+1 P+1 P=P-1 P-1
?P=*a* ?P#*a*
P=C.*a* C=P.*a* CPEX.*a*
C=C+P+1 C+P+1

2.14.28 Jump instructions

GOTO *label*

GOTOL *label* or GOLONG *label*

GOVLNG *Cst*   *Cst* is an hexadecimal number.

GOVLNG =*label*   *label* is a constant, or a label in absolute mode

GOVLNG ="*COMMAND*"   *Command* is an entry in the STARTEXT table.

GOSUB *label*

GOSUBL *label*

GOSBVL *Cst*   *Cst* is a hexadecimal number.

GOSBVL =*label*   *label* is a constant, or a label in absolute mode.

GOSBVL ="*COMMAND*"   *COMMAND* is an entry in the STARTEXT table.

GOC *label*

GONC *label*

GOTOC *label* same as SKIPNC { GOTO label }

GOTONC *label*same as SKIPC { GOTO label }

RTN RTNSXM RTNCC RTNSC RTI

RTNC RTNNC

RTNYES or RTY after a test.

2.14.29 Exchanges between C and RSTK

C=RSTK and RSTK=C instructions allow to push to or pop data from the Saturn return stack.

2.14.30 Input / output instructions

OUT=CS, OUT=C, A=IN and C=IN

Note 1: A=IN and C=IN instructions are bugged (they only work on even addresses). So use A=IN2 and C=IN2, which are ROM calls to A=IN and C=IN instructions.

Note 2: if the beginning of ROM is not usable (because it is recovered by RAM), use A=IN3 and C=IN3, which are calls to A=IN and C=IN instructions in the **Meta Kernel** Card.

Note 3: OUT=C=IN is a ROM call that does OUT=C C=IN.

Note 4: OUT=C=IN3 is the same, but in the **Meta Kernel** card (works even if lower ROM is recovered).

2.14.31 Processor control instructions

Working mode modification

SETDEC SETHEX

other instructions

UNCNGF CONFIG RESET C=ID

SHUTDN INTON INTOFF RSI

SREQ?

BUSCB BUSCC BUSCD

2.14.32 New instructions of Masd

GOINC *label*	Equivalent to LC(5)label-&. (& is the address of the instruction)
GOINA *label*	Equivalent to LA(5)label-&. (& is the address of the instruction)
« and »	Program prolog 02D9D and epilog 0312B.
~	Noeval
A*label*	In absolute mode, places the address of the label.
B*label*	In absolute mode, places the address of the label+5.
$*hhhh...hhh* or *NIBHEX hhhh...hhh*	Includes hexadecimal data. Example: $12ACD545680B.
$/*hhhh...hhh*	Includes hexadecimal data in reverse order. Example: $/123ABC is equivalent to $CBA321.
$(*x*)*Exp* or CON(*x*)*Exp* or EXP(*x*)*Exp*	Places the value of *Exp* in the code, on *x* nibbles.
¢*Ascii*	Includes ASCII data. The end of the string is the next ¢ or carriage return. Example: ¢Hello¢. To output a ¢ character, put it twice.
INCLUDE *FileName*	Includes directly the specified file as data.
∈*Cst*	Includes the value of Cst on 5 nibbles. ∈123 is equivalent to $/00123.
¤cst	Includes a system binary of value *Cst.*
¤ cst	Includes a system binary of value *Cst.* If this number already exists in ROM, its address is used instead.
GOIN5 *lab* G5 *lab* GOIN4 *lab* G4 *lab* GOIN3 *lab* G3 *lab* GOIN2 *lab* G2 *lab*	Same as $(*x*)*label*-& with *x*=5, 4, 3 or 2. Useful to create a jump table.
SAVE	Equivalent to GOSBVL 0679B
LOAD	Equivalent to GOSBVL 067D2
RPL	Equivalent to A=DAT0.A D0+5 PC=(A)
LOADRPL	Equivalent to GOVLNG 138B9
INTOFF2	Equivalent to GOSBVL 01115
INTON2	Equivalent to GOSBVL 010E5
ERROR_C	Equivalent to GOSBVL 10F80
RES.STR	Equivalent to GOSBVL 05B7D
RES.ROOM	Equivalent to GOSBVL 039BE
[...] *Size*	Makes the code inside the brackets fit the given size, by adding zeros if necessary. Only three levels of brackets can be used.

2.15 Masd directives

!PATH+ *DirName*	Add the specified directory in the search path list.
!LINK *chr*	Change the char identifying link labs to *chr.*
!OFF	Shut down the screen. This speeds up the HP48 by 13%.
!LOCAL *chr*	Change the char identifying local labs to chr.
!DISP message	Display the message on the screen.
!UNIT	The output file will be a unit.
!WAROFF	Masd will not display ghost labels.
!NO CODE	Masd will not generate a $02DCC prolog but will directly output the data.
!1-16	Switch to 1-16 mode.
!1-15	Switch to 0-15 mode.
!RPL	Switch to RPL mode.
!ASM	Switch to ASM mode.
!FL=0.*a*	Clear the *a* compilation flag.

!FL=1.*a*	Set the *a* compilation flag.
!?FL=0.*a*	Compile the end of the line if flag *a* is set.
!?FL=1.*a*	Compile the end of the line if flag *a* is clear.
!ABSOLUT *Addr*	Switch to absolute mode. The program begins at the address *Addr*. Note: Masd always consider the prolog $02DCC and code length to be the beginning of the program even if !NO CODE is set.
!ABSADR *Addr*	If in absolute mode, add whites nibbles to continue at the specified address. If not possible, errors.
!EVEN	In absolute mode, cause an error if the directive is not on an even address.
!ADR	Masd will generate a source defining all constants and labels used in the program instead of the program.
!COMPEXP	Cause Masd to calculate all previous expressions.
!COMPEX	Cause Masd to calculate last expression.

2.16 Error messages

Invalid File	The file is not a source or a macro. (must end with a @)
Too many links	Only 256 links are supported. May be due to a recursion.
Unknown Instr.	Unknown instruction.
Bad Field	Incorrect field.
0-15 Expected	An integer between 0 and 15 is expected.
1-16 Expected	An integer between 1 and 16 is expected.
Error Stack Size	You use more than three brackets.
Size Too Small	Program between brackets is too big.
Close Size	There are more] than [.
Label Expected	A label name is expected.
Const Expected	A hexadecimal number is expected.
Can't Find	Can't find the label or the file.
Lab. Already Dec.	A label or a constant is already declared with the same name.
Need {	An opening { was expected.
Need }	A closing } was expected.
Forbidden	Operation not allowed.
Bad Expression	Error in expression.
Jump too Long	No comments.

3 Disassembler

The disassembler converts binary code into a source string. There are two ways to use it: with a Code on the stack level 1 or with two addresses (in binary) that point to the beginning and the end of the code to be disassembled.

The syntax used is Masd syntax, in mode 0-15.

Each line contains an address and an instruction.

If the **MK** system flag -7 is set (with -7 SF2), addresses are not shown, except for the destinations of jumps. In this case, the resulting source may be then reassembled if needed.

Example:

-7 CF2 (default)	-7 SF2
AE734 GOSBVL 0679B AE73B LC 01000 AE742 C-A A AE744 GONC AE742 AE747 GOVLNG 138B9	GOSBVL 0679B LC 01000 *AE742 C-A A GONC AE742 GOVLNG 138B9

4 Miscellaneous Utilities

These utilities are found in the MDGKER library.

Some of the following commands are marked **Dangerous!**, which means that incorrect use of them can corrupt memory. Use them at your own risk!

4.1 -→H →H

Returns a character string containing the hexadecimal numbers that form the object on stack level 1 in memory.

Example: 'A' →H returns "84E201014"

4.2 H→ H→

Inverse of →H, it converts a hexadecimal character string to the objects coded in it. **Dangerous!**

Example: "47A209C2A2B2130" H→ returns { 1 }

4.3 S→H S→H

Converts a character string into its hexadecimal form (every character is converted to two characters).

Example: "HI" S→H returns "8494"

4.4 H→S H→S

Inverse of S→H. Every couple of hexadecimal characters gives an ASCII character.

Example: `"8405" H→S` returns `"HP"`

4.5 CD→ CD→

Does a →H on the content of a Code object.

4.6 -→CD →CD

Inverse of CD→. A hexadecimal string is placed inside a Code object.

4.7 -→A →A

Returns the memory address of the object on stack level 1.

Example: `1 →A` returns `#2A2C9h` (address of the real number 1)

4.8 A→ A→

Puts the object pointed to by the given address on stack. `Dangerous!`

Example: `#1B4Ach A→` returns `SIN`

4.9 PEEK PEEK

Reads memory. Level 2 contains the starting address (a binary number), level 1 gives the number of nibbles to be read (a binary number). A hexadecimal string is returned on the stack.

Example: `#0 #10d PEEK` returns `"2369B108DA"`

4.10 POKE POKE

Writes memory. Level 1 contains the hexadecimal string, level 1 the start address. `Dangerous!`

Example: `#101h "C" POKE` changes the contrast.

4.11 SREV SREV

Reverses the order of the characters in a string.

Example: `"HP 48" SREV` returns `"84 PH"`

4.12 PRG~LST PRG~L

Transforms a program to a list and vice-versa.

Example: `{ SWAP DROP } PRG~LST` returns `PRG SWAP DROP END`.

4.13 -→RAM →RAM

Creates a new copy of the object in memory, equivalent to `NEWOB`, but it also works with ROM objects.

Example: ~ `DUP →RAM` returns `PRG ∈ 18AA5 ∈ 03188 END` (the `DUP` program in ROM).

4.14 APEEK APEEK

Reads the address at a given address (binary number on stack level 1).

Example: `#3188h APEEK` returns `#318Dh`

4.15 R~SB R~SB

Transforms a real number to a system binary and vice-versa.

Example: `32 R~SB` returns `¤ 20h`

4.16 -→GROB2 →GROB

Transforms an object to its graphical representation.

The object is on stack level 2. A real number at level 1 gives the desired height:

- 1: Mini-font
- 2: Stack font
- 3: Big font

- 0: Big font, but if the object is an algebraic, the **MK** equation editor is used to draw it.

If the system flag2 -6 is set, the carriage returns in a string are used to draw multiple lines, otherwise if this flag -6 is cleared, the string will only be drawn on one line.

Example: 'SIN(X)' 0 →GROB2 returns Graphic 31 × 9

4.17 -→HEADER →HEAD

Defines the number of lines of the status area, 0, 1 or 2.

4.18 HEADER→ HEADE

Returns the current status area height.

4.19 INPUT2 INPUT

Works like INPUT, but uses the **Meta Kernel** environment.

4.20 DISP2 DISP2

Works like DISP, but uses the current system font (defined with →FONT), so that up to 9 lines can be written.

4.21 HALT2 HALT2

Works like HALT, but returns to the **Meta Kernel** stack (HALT returns to the standard HP stack).

⚠ Note: DEBUG, SST and NEXT in the PRG-RUN menu have been rewritten to work under the **Meta Kernel**.

4.22 -→S2 →S2

Converts an object into a character string in Masd format, in RPL mode.

4.23 -→S4 →S4

Converts an object into a character string, like the standard →STR. EDIT uses it.

4.24 CHOOSE2 CHOOS

Works like CHOOSE, but uses the current system font.

4.25 EDIT EDIT

Starts editing the object on stack level 1, with the command line editor.

4.26 VISIT VISIT

Starts editing the object stored in the given variable name, with the command line editor.

4.27 EDITB EDITB

Equivalent to EDIT, but uses the best adapted environment (command line, equation editor, graphic editor...), depending on the object type.

4.28 VISITB VISIT

Equivalent to VISIT, but uses the best adapted environment (command line, equation editor, graphic editor...), depending on the object type.

4.29 EQW EQW

Launches the equation editor with the expression given on stack level 1.

4.30 FILER FILER

Launches the filer.

4.31 ASM ASM

Launches the assembler with the source string on stack.

4.32 ER ER

Edits the error after assembling. There must be a string at level 2 and the errors list at level 1.

4.33 ASM→ ASM→

Starts the disassembler. Consult Page 43.

4.34 -→NDISP →NDIS

Defines the maximum number of lines taken by an object displayed on stack (including grobs and algebraics).

4.35 -→FONT →FONT

Sets the font object on stack level 1 as the system font.

4.36 FONT→ FONT→

Returns the current system font on the stack.

4.37 FONT8, FONT6 FONT8 FONT6

Returns the standard **Meta Kernel** fonts 6 and 8.

⚠ Note: there is a FONT7 in the MDG menu, but it is empty (Not enough space left !).

4.38 KERNEL? KERNE

Returns nothing. It is used to test if the **Meta Kernel** is present, if a program needs it.

4.39 SF2, CF2, FS?2, FC?2, FS?C2, FC?C2, STOF2, RCLF2 SF2 CF2 FS?2 FC?2 FS?C2 FC?C2 STOF2 RCLF2

Equivalent to `SF`, `CF`, `FS?`, `FC?`, `FS?C`, `FC?C`, `RCLF` and `STOF`, with the new **Meta Kernel** flags. Consult Page 11.

4.40 SREPL SREPL

Does a find/replace in a character string. The main string is at level 3, the find string at level 2 and the replace string at level 1. Every occurrence of the find string in the main string will be replaced by the replace string. The find and replace strings may have different lengths.

4.41 AR~LST AR~LS

Converts an array into a list of lists and vice-versa.

E.g. `[[ 1 2 ] [ 3 4 ]]` ←`AR~LST`→`{{ 1 2 } { 3 4 }}`.

⚠ Note: All the objects must be of the same type.

4.42 DIMS DIMS

Puts the size of the array contained in a list of lists on stack level 2 and 1 on stack level one. If it is **not** an array, returns 0.

```
{ 1 { 2 3 } } DIMS →0
{{ 1 'A' "ABC" }
 { 2 NOVAL 3 }} DIMS →{ 2 3 } 1
```

4.43 -→MINIFONT →MINI

Sets the mini-font object on stack level 1 as the system mini-font.

4.44 MINIFONT→ MINIF

Returns the current system mini-font on the stack.

4.45 FNT2GRB.PRG

Converts an **MK** font to a grob font (common 6,7 or 8 x 2048 grob).

This program is on the floppy disk.

4.46 GRB2FNT.PRG

Converts a grob font to an **MK** font. The grob in at level 3, the name is a character string at level 2 and the identifier a real number at level 1.

This program is on the floppy disk.

Appendixes

1 Introduction to assembly language

[in complete documentation]

2 Introduction to System RPL

[in complete documentation]

3 Tips and tricks

3.1 Meta Kernel and UFL

UFL (Universal Font Library) is an attempt to normalize the use of fonts in HP48 programs. The idea is to allow all programs to share the same fonts, instead of having as many fonts as software. UFL is a standard library. It provides two different fonts, the normal font or the mini-font. The **Meta Kernel** is able to work only with the last one, since the **MK** provides many more powerful features in font management, such as more than 240 different fonts at the same time, while UFL can manage only one. Also, you can change the system font, without restarting your HP48 with an ON-C.

You will find more information about the UFL at this URL:

http://www.engr.uvic.ca/~aschoorl/ufl/

The **Meta Kernel** uses its own mini-font, but may use the UFL mini-font. Just execute these few lines, or add them in the STARTUP file:

```
      1 FNT →MINIFONT
```

3.2 STARTED and EXITED examples

3.2.1 Remove the header display

When you edit files, it may be useful to have the whole screen available. Using the STARTED and EXITED capabilities, it is very easy to remove the header while editing, and restore it after.

```
STARTED:
«
      0  →HEADER
»

EXITED:
«
      2  →HEADER
»
```

3.2.2 Edit compressed files

When you are short in memory, it may be useful to compress some files. BZ was written by Mika Heiskanen (http://www.hut.fi/~mheiskan/) it is a very efficient and very fast compressor.

You will find the BZPlus package on http://www.hpcalc.org/utils/compress/.

The problem with the compressor, is that if you want to edit the file, you must uncompress the file manually, edit it, compress it again, then store it.

With STARTED and EXITED, you won't have to do that anymore. The idea is to check if a file is a compressed file with STARTED, if yes uncompress it, and when leaving the command line, compress it with EXITED.

The main difficulty is that the **Meta Kernel** can edit more than one text at the same time. Then you must save the history of the edited files, in order to know if the file was compressed or not. The history will be saved in the HOME directory with the name CHECK.BZ

STARTED is called by the **Meta Kernel** just before editing an object, and finds the object on the first stack level. Sometimes the **MK** calls STARTED without any valid object, in this case, you find the object NULL$ on the stack.

EXITED is called by the **Meta Kernel** just after exiting the command line by pressing ENTER or ON. When the user press ENTER, the **MK** pushes two objects on the stacks as follow:

2: Object

1: TRUE

If the user has pressed ON, only FALSE is pushed on the first stack level.

The following STARTED and EXITED use both System RPL and User RPL, they may be enhanced very easily by using only System RPL. Anyway, it is a good example of how to use the MASD in RPL mode.

```
"!NO CODE
!RPL
::
      xDUP NULL$ EQ                 (Check if it's the NULL$ object)
      ?SKIP                         (If yes do nothing)
```

```
    ::
        xPATH xHOME xSWAP          (Save the working directory)
        xIF xBZ?                   (Is it a compressed file?)
        xTHEN
        :: xBZU %1 ;               (If yes, uncompress it)
        xELSE %0
        xIFEND
        xIFERR                     (Check if the history file exists)
        :: ' ID CHECK.BZ xRCL ;
        xERRTHEN
        ::                         (If not, create it with a null list)
            xDROP {}
            ' ID CHECK.BZ xSTO
            %1
        ;
        xIFEND
        xDROP                      (Save the history entry)
        ' ID CHECK.BZ xSTO+
        xSWAP xEVAL                (Go to the previous directory)
    ;
;
@"

EXITED:
"!NO CODE
!RPL
::
    xPATH xSWAP xHOME              (Save the working directory)
    ITE                            (If the user pressed ENTER)
    ::
        xSWAP                      (Get the entry in the history file)
        ID CHECK.BZ
        xIF xHEAD
        xTHEN                      (If it was a compressed file)
        ::                         (Compress it again)
            xIFERR xBZC xERRTHEN xIFEND
        ;
        xIFEND
        xSWAP TRUE
    ;
    FALSE
    ID CHECK.BZ                    (Remove the entry in the history)
    xTAIL
    ' ID CHECK.BZ xSTO
    xSWAP xEVAL                    (Go to the previous directory)
;
@"
```

3.3 Meta Kernel and Erable

Erable is a very powerful Algebra system for the HP48GX. Combined with the **Meta Kernel**, you will get one of the best handheld computer algebra system (far better than the TI-92). Here is an example of an STARTEQW file, which allow to use all Erable's functions from the Equation Writer, by pressing CST.

This STARTEQW was written by Erable's author: Bernard Parisse

You will find more information about Erable at:

http://www-fourier.ujf-grenoble.fr/pp/parisse/english.html

```
STARTEQW:
« "ERABLE"
{ "1.SIMP" "2.TRIG" "3.INTDER" "4.EXEC"
  "5.PLOT" "6.CFG" "7.ARIT" }
1 CHOOSE2
IF THEN
  DUP
  {
  { EXPA COLC EXPLIN SINCOS TEXPA LNCOLC TSIMP
    { "0.BACK" STARTEQW } }
  { TRIGLIN TRIGCOS TRIGSIN TAN2SC TAN2SC2 HALFTAN
  { "0.BACK" STARTEQW }
  }
  { der1 RISCH PF LAP ILAP { "0.BACK" STARTEQW }}
  {
  { "1.NEW VX" « DUP 'VX' STO » }
  { 2 "REPLACE" « "REPLACE" { "'X='" 4 ALG V }
    INPUT2 STR→ EXEC » }
  { "3.COMMAND" « "COMMAND" { "" 4 ALG V }
    INPUT2 STR→ EVAL » }
  { "4.ISOL VX" « VX EXEC » }
  { "0.BACK" STARTEQW }
  }
  {
  { "1.ERASE AND PLOT" « ERASE DUP STEQ
    # B4045h LIBEVAL » }
  { "2.ADD TO PLOT" « EQ DUP TYPE 5 ==
    IF THEN OVER + ELSE OVER 2 →LIST END
    STEQ # B4045h LIBEVAL » }
  { "3.PLOT MENU" « # B4045h LIBEVAL » }
  { "0.BACK" STARTEQW }
  }
  {
  { "1.COMPLEX MODE" « 13 SF » }
  { "2.REAL MODE" « 13 CF » }
  { "3.INTEGER ARIT" « 10 SF » }
  { "4.POLYN. ARIT" « 10 CF » }
  { "0.BACK" STARTEQW }
  }
  { CHS re im conj { "BACK" STARTEQW } }
  }
  SWAP
  1 1 SUB STR→ GET 1 CHOOSE2
    IF THEN EVAL END
END
»
```

3.3.1 STARTOFF and TOFF example

Here is a completely useless program. But like all completely useless programs, it is completely essential.

This is a screen saver program, it will displays points in the screen until you press a key.

If you want the **Meta Kernel** to run this program after two minutes of idle time, put `#983040d` in the 'TOFF' file.

```
STARTOFF:
«
PICT→ LCD→ →PICT { #0 #0 } PVIEW
DO
RAND 131 * R→B
RAND 64 * R→B
2 →LIST PIXON
UNTIL KEY END DROP
TEXT →PICT
»
```

4 The MK for Programmers

4.1 Customizing the Filer

4.1.1 Overview

The filer is completely customizable. You can run your own programs from inside the filer. These programs can utilize all of the functionality of the filer, which the internal functions use. You can also access all internal functions. This customization is accomplished using a custom menu that displays labels for each of your custom programs. In the filer, if you press CST or CUSTOM in the built-in menu, the filer will try to find the file 'FILER.CUSTOM'. This file is used to create your custom menu.

4.1.2 FILER.CUSTOM Format

FILER.CUSTOM is a list with the following arguments :

```
{
GROB 131*n              This is the GROB that will be displayed in the menu area when you press CST. You can also
                        use a program that gives a GROB as a result.
System Binary 1         Number of pages for the menu
{
      System binary 2   Execution Type
      System binary 3   Exit type
      [Program]         Program which will be run by the filer
      [System binary 4] Shortcut-key for the program
}
{
      ....An entry just as above for each custom program
}
}
```

4.1.3 Explanation of each component

a) System Binary 1 and GROB

This is an integer that tells the FILER how many pages the menu will use. For example, if you want two pages (12 labels) then *GROB 131*n* would be a 131*16 GROB and SB1 would be 2.

b) System binary 2

This integer allows you to control when the program will be started.

There are 5 possibilities:

SB	Program Control
0	You can run the program everywhere (VAR,PORT,BACKUP,LIB)
1	Only when you are in VAR
2	Won't run if you are in a library
3	Won't run if you are in a backup
4	Will run only in port (home of the port)

c) System binary 3

This integer tells the filer how the associated program will be run. This also allows you to access all the filer's internal subroutines. There are two categories of custom programs: internal calls, and custom calls.

NOTE: You can use a Binary integer instead of System Binary (it is easier to manage with the User-RPL compiler).

d) Internal calls

The internal calls are included so that you can access the built-in functionalities of the filer from inside your custom menu. For these calls, you don’t need to put a program in the file unless you want to allow a shortkey (Ex Left-Shift 2). If you use a shortkey then add any program you want because it won’t be run at all. You should use the smallest possible program (ex: TakeOver $40788) internal empty program).

SB	Operation
0	Bip
1	Info
2	Hexa
3	View
4	Arbo
5	Up
6	MaxUp
7	Down
8	Maxdown
9	Select (same as ENTER)
A	Updir
B	Downdir
C	Previous menu
D	Next menu
E	EVAL
F	Swap header
18	Display or remove file’s details (Type& size)
19	EDIT
1A	COPY
1B	MOVE
1C	RCL
1D	PURGE
1E	RENAME
1F	CRDIR
20	ORDER
21	SEND
22	HALT2
23	EDITB

e) Custom program

If you are going to run a custom program there are 7 ways to call the program. Every time, the filer will place the working path on the stack.

Examples:

`{}`	for HOME
`:nb:{}`	for a port
`:02: { FOO.DIR }`	if you are working in port 2 in the backup FOO.DIR

If you launch the program in the VAR, then your program will start in the current directory. The possible calls are: (1: ect is the resulting stack that will appear just before your program is run)

SB	Type of call
10	Recalls only the path: 1: Path
11	Recalls the name and the object for the currently selected object: 3: Path 2: Object 1: Name
12	Multiple objects selected n: Path ... 5: Object 2 4: Name 2 3: Object 1 2: Name 1 1: Number of objects (System Binary)
13	The FILER will call your program after each object. The FILER will place the following on the stack each time and call your program for each object selected. 3: Path 2: Object 1 1: Name 1
14	Recalls the name of the current object only 2: Path 1: Name
15	Recalls all the names selected n: path ... 3: Name2 2: Name1 1: Number of names selected (System Binary)
16	Recalls the current object only in a string of addresses 2: Path 1: String

17	Recalls the selected objects in a string of addresses 2: Path 1: String

f) Explanation for the string of addresses

This string recalled by the filer is a list of addresses. You can use it only in ML or with FILER_FRCL, FILER_FNAME and FILER_NXTADR, for SysRPL use:

FILER_FRCL (C030F): Takes a String of addresses, and recalls the first object. FILER_FNAME (C030A): Same thing but recalls the first name object, FILER_NXTADR (C0314): Takes a string of addresses, and removes the first addresses. And FALSE if there are some addresses left. TRUE if not.

The string format is:

Prolog (02A2C) Size AdrName1 AdrObject1 AdrName2 AdrObject2 ...

Each address is on 5 nibbles.

g) Explanations about the name

For all calls except 14 and 15, the name is the real filename. If you call the program from a library, then the name will be the name of the library itself (Like 'Strwrt: v4.31 (c)'). However, for 14 and 15, if you have selected a library, the name will be a real number that is the library number. For 13, if the object is a library, then the name will be a 'L' plus the Id number.

Example: For Library 1303, the name will be: 'L1303'

NOTE: You can browse every library, but can only run your programs from an attached library.

h) Warning and very important points

In order to save room, we used list of addresses. So, if you modify the directory structural in your programs (using STO, PURGE, etc.), then NEVER USE CALL 13. And if you are a very experienced programmer, you can use calls 16 and 17.

4.2 Machine Language entry points list

Here is a list of entry points inside the **Meta Kernel**. They can be used by experienced programmers for programs to take advantage of the **MK**. Of course, if these entry points are used, the program won't run without the **MK**.

Call a routine with `GOSBVL C0`*xxx*.

Rf means the R register with the field f. Example: Ca describes the register C, field A.

Input and output registers are described in the 'In' and 'out' sections.

4.2.1 MINI_DISP

Address `C0040`
Description Displays a Mini-font character string
In
Ca = number of characters
D1 = string address
D0 = display starting address (in a 131*x grob)
ST11 = inversion (white on black)

4.2.2 MINI_FONT_ADDRESS

Address `C0047`
Description Mini-font address in the card
E.g. `D0=C0047 A=DAT0.A`

4.2.3 DISPLAY_SBR

Address `C004C`
Description Main display routine
Call INIT_DISPLAY_LINE before using this routine.
In
R0b = font identifier
R1s = (font height) * 2 - 1
D0 = starting display address in a grob
D1 = string address
Da = number of characters
R2a = display grob width in nibbles
Ba = left margin in characters
Ca = right margin in characters
ST4 = display left shift
ST5 = display right shift
ST0,1,2,3 = text attributes (bold, italic, underline, inverse)
ST8 = display carriage returns as characters if set
ST9 = mini-font display
Out
D0 = next line address in the grob
Aa = last written character address
Da = number of remaining characters
ST8 = set if a CR has been read
D1 = end of displayed text in the grob

4.2.4 EDIT_SBR

Address `C0053`
Description Mini-edit (used by FIND in the command line)
Call INIT_DISPLAY_LINE before using this routine.

In

R4a = screen address
Ca = maximum number of characters
D1 = buffer address
ST9 = mini-font display

Out

Carry = set if ENTER has been pressed, clear exit by ON

4.2.5 FILER.ADR

Address C0319
Description Address of the main FILER program

4.2.6 SCAN_FONT

Address C009A
Description Rebuild the font table

This function forces the **MK** to search through all ports to build the font table.

4.2.7 RECONFIG

Address C00A1
Description Reconfigures the second card

After a DECONFIG, this routine reconfigures the second port card at C0000 (hidden by the **MK** card), and the bank switcher at 7F000.

4.2.8 DECONFIG

Address C00A8
Description Deconfigures the second card

This routine is used to gain direct access to the second card, without deconfiguring the **MK**.

The second port card is moved from C0000 (where it is hidden by the **MK** card) to 40000. The bank switcher is moved from 7F000 to 3F000.

4.2.9 CMD_SIZE

Address C00BE
Description Computes the command line size

Out

Aa = number of characters.

4.2.10 GET_PATH

Address C00C5
Description Finds the relative path of a directory

In

D1 = buffer address
Ca = maximum length
If ST2 = 0, the path is taken from the HOME directory to the current directory
if ST2 = 1, D0 = starting directory address, Da = ending directory address

4.2.11 DECONFIG_RAM

Address C00CC
Description Moves the RAM from 80000 to 00000

Useful if you plan to make your own interrupt handler. If your RAM based program call this entry point, the return address (RTN) will be recalculated

4.2.12 RECONFIG_RAM

Address C00D3
Description Moves the RAM from 00000 back to 80000

4.2.13 GET_FONT

Address C00DA
Description Returns the address of a given font

Call SCAN_FONT once before using this routine.

In

Ab = font id

Out

R0a = font address

4.2.14 INIT_DISPLAY_LINE

Address C00E1
Description Initializes the display routines

This routine initializes the registers necessary for the **MK** display routines.

In

Ca = screen width in nibbles

4.2.15 CHANGE_FLAG

Address C00E8
Description Updates the ST flags 0 to 3 and R0 for the display routine

Computes some parameters for the display routines, when special characters are encountered (font control characters...)

4.2.16 GET_ASCII_KEY

Address C00F6
Description Keyboard handler
Gets an ASCII character or a key number if not in ALPHA mode. This routine handles the shifts and alpha displays.
Out
ST0 = 0 if ASCII
ST0 = 1 if key number.

4.2.17 GET_KEY

Address C00FD
Description Keyboard handler
Out
Carry = set if no character in the keyboard buffer.
Aa = key code (if carry cleared)

4.2.18 RUN_KEY

Address C0104
Description Key assignment
This routine associates an assembly code with a key.
Syntax:

```
GOSBVL =RUN_KEY
GOIN4 NO_KEY_ROUTINE
$/01 GOIN4 KEY_A % 01 is the A key code
$/xx GOIN4 KEY_x % xx key code (same as in External)
...
$00 GOIN4 NOT_HANDLED_KEY % a bip routine for example
```

4.2.19 MINI_DISP_VAL

Address C010B
Description Displays a hexa value in mini-font
In
D0 = screen address
Bw = number to be displayed
Ca = number of digits to be displayed
ST11 = inverse (white on black)
ST10 = 1 to display leading zeros

4.2.20 MINI_DISP_AWP

Address C0112
Description Displays a hexadecimal value in mini-font
In
D0 = screen address
Awp = number to be displayed
P = (number of digits) - 1
ST11 = inverse (white on black)
ST10 = 1 to display leading zeros

4.2.21 TRUP

Address C0119
Description Copy up
Equivalent to 066B9, but works even after a DECONFIG_RAM (when RAM is at 00000)

4.2.22 TRDN

Address C0120
Description Copy down
Equivalent to 0670C, but works even after a DECONFIG_RAM (when RAM is at 00000)

4.2.23 ZEROM

Address C0127
Description Resets a memory zone to 0
In
D1 = zone starting address
Ca = number of nibbles to blank

4.2.24 SCAN_KEY

Address C012E
Description Keyboard handler
Does a keyboard scan, updates the keyboard buffer and the keystate. Use it when interrupts are disabled.

4.2.25 NEW_ADR

Address C0135
Description Moves an object at the end of the temporary zone
Moves an object in the temporary RAM at the end of this zone, so that 16671 (object resize) and RESIZE_PLUS can be used on it.

4.2.26 RESIZE_PLUS

Address C013C
Description Resize up a character string

Resize up the last character string in the temporary RAM.

In

R0a = string address
D0 = new end of the character string

4.2.27 C=IN3

Address C02F2
Description Equivalent to C=IN2, but in the **MK** card

4.2.28 A=IN3

Address C02FA
Description Equivalent to A=IN2, but in the **MK** card

4.2.29 OUT=C=IN3

Address C02EF
Description Equivalent to OUT=C=IN, but in the **MK** card

4.2.30 OUT=CA=IN3

Address C02F7
Description Equivalent OUT=C A=IN, but in the **MK** card

4.2.31 DISP_DEC

Address C0143
Description Displays a decimal number
In

D0 = screen address
Ca = number to be displayed
ST11 = inverse (white on black)
ST10 = 1 to display leading zeros

4.2.32 MULT_BAC

Address C014A
Description Ba = Ca * Aa

4.2.33 GREY?

Address C0151
Description Tests if a grob is in grayscale
In

D1 = grob address

Out

Carry = set if grob is in grayscale

4.2.34 BEEP

Address C0158
Description Do a beep if the system flag –56 is clear

4.2.35 KEY_REPEAT

Address C015C
Description Keyboard handler routine
Repeats a routine associated with a key.
Syntax:

```
GOSBVL =KEY_REPEAT
$/keymask % in/out mask, e.g. $/02040 for Q (OUT=040, IN=02)
GOTO KEY_REPEAT_ROUTINE
GOTO END_KEY_REPEAT
```

4.2.36 KEY_NO

Address C0160
Description Waits for all keys to be released

4.2.37 HEX_DEC

Address C0164
Description Hexa to decimal conversion
In

Ca = hexa to be converted

Out

Aa = decimal result

4.2.38 A_DIV_C

Address C0168
Description Ba = Aa / Ca

4.2.39 SET_BIT

Address C016C
Description Sets a bit in a bit field
In

D1 = bit field address
Aa = bit number (to be set to 1)

4.2.40 CLEAR_BIT

Address FEC3F
Description Clears a bit in a bit field
In
D1 = bit field address
Aa = bit number (to be clear)

4.2.41 BIT?

Address C0173
Description Tests a bit in a bit field
In
D1 = bit field address
Aa = bit number (to be tested)
Out
Carry = set to the value of the tested bit

4.2.42 BZU.SBR

Address C017A
Description BZU (BZ Uncompression)
Uncompress data using Mika Heiskanen algorithm in his program BZ.
In
D0 = Address of the object to decompress (strings without the B prolog BZ).
D1 = Address where you want to uncompress.

4.2.43 INV.ZONE

Address C0186
Description Invert a memory zone
In
D0 = Address zone.
Ca = Size in nibbles to inverse

4.2.44 OFF.SBR

Address C0192
Description Turns off the machine (real Off)
OFF in ML, doesn’t reboot if libraries have changed.

4.2.45 InitTable

Address FECA0
Description Initializes memory zones for SysRPL-table routines
Initializes pointers used by the following routines, which deal with the System RPL entry point table.
There are examples on the floppy disk, in the file EXAMPLES2.DIR.
Warning: Port 2 must be at address 40000. Use the DECONFIG and RECONFIG routines.
Out
Carry set if no table has been found.
Uses RSTK(5) Aw Cw Ba D0 D1 Da, plus the following memory zones:
(b=bytes, n=nibbles)

```
DC @ResZone      BE4A5    % on 256b, table name
DC NbExternals   BE422    % on 5n, number of entries
DC @TableText    BE427    % on 5n, address of the first entry
DC @TableHash    BE42C    % on 5n, address of the hash table
DC @Table→@      BE431    % on 5n, address of the pointers table, sorted by addresses
DC TablePort     BE436    % on 2n, port number of the table
DC RclPort       BE3AF    % on 2n, port number of the table
```

4.2.46 GetAdr

Address FECAC
Description Returns the address associated with a name
Warning: Port 2 must be at address 40000. Use the DECONFIG and RECONFIG routines.
In
DO = Address of the text to find, followed by a separation character
Out
Carry = Set if name not found
Ca = Address
Uses Aw, Cw, Ba, Da, D0, D1, RSTK(5).

```
DC @ResZone BE4A5    % on 256b, name saved
```

4.2.47 GetText

Address FECA6
Description Returns a pointer to the name associated to an address
Warning: Port 2 must be at address 40000. Use the DECONFIG and RECONFIG routines.
In
Ca = Address
Out
Carry = Set if address not found
D1 = Address of the text (2n for the length, followed by the characters)
Uses Aa, Ba, Ca, Da, D0, D1, RSTK(2).

4.2.48 GetFirst

Address FECB2
Description Finds the first name beginning with the given text
Warning: Port 2 must be at address 40000. Use the DECONFIG and RECONFIG routines.
In
DO = Address of the text to find, followed by a separation character
Out
Carry = Set if no name found
D1 = Address of the text (2n for the length, followed by the characters)
Uses Aw, Ba, Cw, RSTK(4), D0, D1, Da
DC @ResZone BE4A5 % saving of the name to find (on 256 bytes)

4.2.49 GetNext

Address FECB8
Description Finds the next name beginning with the given text
Use GetFirst first, values of Bb, Da and D1 must be preserved.
Warning: Port 2 must be at address 40000. Use the DECONFIG and RECONFIG routines.
In
DO = Address of the text to find, followed by a separation character
Out
Carry = Set if no name found
D1 = Address of the text (2n for the length, followed by the characters)
Uses Aw, Ba, Cw, RSTK4, D0, D1, Da
DC @ResZone BE4A5 % saving of the name to find (on 256 bytes)

4.2.50 GetFirstAdr

Address FECBE
Description Returns a pointer to the first table entry
Warning: Port 2 must be at address 40000. Use the DECONFIG and RECONFIG routines.
Out
D0 = Address of an entry structure:
Address (5n), name length (2n), name.
Uses D0, D1, Aa, Da, Ca, RSTK(2).

4.2.51 GetNextAdr

Address FECC4
Description Returns a pointer to the next table entry
Use GetFirstAdr first, values of Da and D1 must be preserved.
The table is sorted by addresses.
Warning: Port 2 must be at address 40000. Use the DECONFIG and RECONFIG routines.
Out
Carry = Set if no more entries
D0 = Address of an entry structure (see GetFirstAdr)
Uses D0, D1, Aa, Da, Ca, RSTK(2).

4.2.52 RclPath

Address FEC39
Description Finds the address of a file
Warning: Port 2 must be at address 40000. Use the DECONFIG and RECONFIG routines.
In
DC @ResZone BE4A5 % on 256b, filename (Masd syntax, ends with an ASCII 0)
Out
Carry = Set if no file found
D1 = Address of the file
Uses Aw, Ba, Cw, RSTK4, D0, D1

4.3 SysRPL entry points

Here is a list of entry points inside the **Meta Kernel**. They can be used by programmers for programs to take advantage of the **MK**. Of course, if these entry points are used, the program won't run without the **MK**.

Call a routine with PTR xxxxx in MASD, or with ∈ xxxxx

4.3.1 GET.INDEX

Address FEC96
Description Create an index for a fast access
In
1 : Matrix (List of list)
Out
2 : Matrix (list of list)
1 : Index (Strings)

4.3.2 GET .Y.I

Address C006A
Description Recall a row from a matrix
In
3 : Matrix (List of list)
2 : Index (String)

1 : Row nb (System Binary)
Out
3 : Matrix (List of list)
2 : Index (String)
1 : List

4.3.3 GET .X.Y.I

Address `C0305`
Description Recall a cell
In
4 : Matrix (List of list)
3 : Index (String)
2 : X (System Binary)
1 : Y (System Binary)
Out
3 : Matrix (List of list)
2 : Index (String)
1 : Object

4.3.4 PUT.X.Y

Address `FEC64`
Description Put an object into a cell
The matrix has to be split using INNERCOMP ($ 54AF) ex :
{ { 1 2 3 } { 4 5 6 } } INNERCOMP :
3 : { 1 2 3 }
2 : { 4 5 6 }
1 : <2>

In
N : First row
...
5 : Row n
4 : Number of rows (System Binary)
3 : X (System Binary)
2 : Y (System Binary)
1 : Object
Out
N : First row
...
2 : Row n
1 : Number of rows (System Binary)

4.3.5 DIMS

Address `FEC9B`
Description Give the dimensions of a matrix
In
1 : Matrix (list of lists)
Out
If it’s a matrix
4 : Matrix
3 : X (System Binary)
2 : Y (System Binary)
1 : TRUE
or
1 : FALSE

4.3.6 FILER_FNAME

Address `C030A`
Description See page 52

4.3.7 FILER_FRCL

Address `C030F`
Description See page 52

4.3.8 FILER_NEXTADR

Address `C0314`
Description See page 52

4.3.9 SURPRISE

Address `C031E`
Description Just try!

4.3.10 INPUT

Address `C0080`
Description SysRPL INPUT, works like `InputLine (42F44)`
This INPUT command takes 10 arguments. [more in complete documentation].

4.3.11 CTRL_LOOP

Address C0085

Description Parameterized outer loop, like ParOuterLoop (38985)

Takes 9 arguments. [more in complete documentation].

4.3.12 INIT_CMD

Address C008A

Description Initializes the command line

4.3.13 CMP_PLUS

Address C0090

Description Adds a character to the command line string

4.3.14 DISP_CALL

Address C0095

Description Text display

In

2: Character string

1: TRUE if carriage returns are to be interpreted

4.3.15 BZU

Address C018D

Description Uncompress with BZU

Uncompress the compressed strings using Mika Heiskanen's algorithm from his BZ program.

In

1 : Strings (without its BZ prolog).

Out

1 : Object

4.3.16 KER_PARAM

Address C0181

Description OuterLoop

Internal version of the ParOuterLoop. This program doesn't create a local environment to save the menus, therefore you can use unnamed local variables.

4.3.17 MINI_EDITOR

Address C0199

Description Mini editor on one screen line

In

3: String (if boolean on level 2 is TRUE)

2: Boolean

1: Line number, where the command line has to be put.

Out

2: String

1: Boolean (TRUE if line validated by ENTER, else FALSE)

If the boolean is TRUE, the editor is initialised with the character string on level 2.

4.3.18 KEY_PARAM

Address FEC82

Description Recall a program associated to a key

Assigns a program to key. Recalls the corresponding program.

In

3: Key code

2: Shift code

1: program list (string)

The list is as follow in MASD format :

STRING {

$/*axx* ∈ xxxxx

% *a* is 1 if in alpha mode, else 0. *xx* is the code of the key, plus the ML shift code: %RightShift=C0 ; LeftShift=40. For example for the LeftShift+ENTER, run the %internal command DUP :

$/059 EXP(5)DUP

$00 %at the end

}

Out

If the key is in the list :

2: program

1: TRUE

Otherwise

1: FALSE

4.3.19 UPSTACK.ADR

Address FEC69

Description Internal programs list

Recalls the programs list used by the Interactive Stack. See KEY_PARAM.

Out

1: String

4.3.20 WAITKEY.ADR

Address FEC6E

Description Internal programs list
Recalls the programs list used by the Kernel. See KEY_PARAM.
Out
1 : String

4.3.21 COMMANDLINE.ADR

Address FEC73
Description Internal programs list
Recalls the programs list used by the command line editor. See KEY_PARAM.
Out
1 : String

4.3.22 MATRIX.ADR

Address FEC87
Description Internal programs list
Recalls the programs list used by the Matrix Writer. See KEY_PARAM.
Out
1 : String

4.3.23 SAVE.ARG

Address FEC78
Description Save the LASTARG
This program is very useful, while you want to run a User RPL command, and you don't want this program to save the last arg. See LOAD.ARG too
Ex :

```
"!NO CODE
!RPL
EQU   SAVE.ARG FEC78
EQU   LOAD.ARG FEC7D
::
      SAVE.ARG
      xDUP
      LOAD.ARG
;
@"
```

In case of errors, the program will restore the good stack.

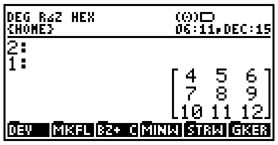
4.3.24 LOAD.ARG

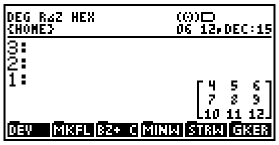
Address FEC7D
Description Restore the LASTARG saved by SAVE.ARG
See above

5 MetaKernel 3.0 : Preview

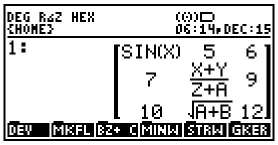
Here are some screens shot. Juste pour le plaisir des yeux

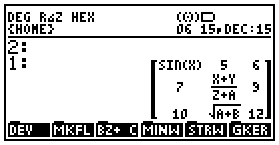
Pretty Print on numerical matrices



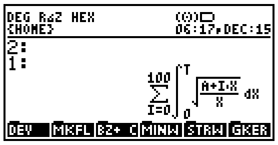


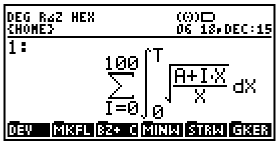
Symbolic matrices



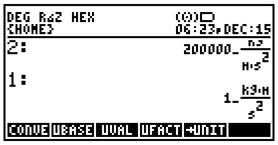


Symbolic Expressions

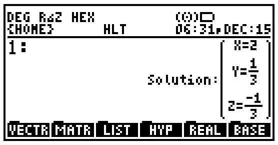




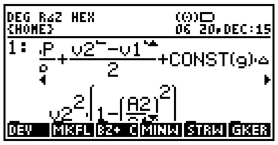
Units in pretty print



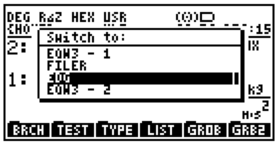
Erable results in pretty print



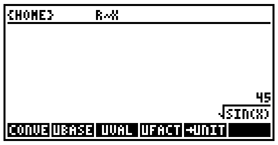
View big objects directly on the stack



Multi-Tasking: Switch between applications on the fly



Algebraic Mode



And…

Equation Writer 3: Edit symbolic matrices, unit objects

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And MUCH MORE ….

Coming Soon…