HP 41 C / HP 41 CV / HP 41 CX

PANAME ROM

USER MANUAL

FOREWORD

When the HP-41 was realeased, in 1979, it represented a great improvement in its field ; it was able to receive, process, and display alphabetical strings. A real dialogue was now possible between the user and the calculator, this new flexibility was even improved by some sound possibilities.

In fact these advantages were only the most visible improvements. The alphanumeric keyboard induces other new and powerful capacities.

The first possibility is very useful in program mode. Instructions are not in code, but in plain language. Now "specialised machine language" is not adequated for the HP-41, "specialised assembly language" is better. In fact, for this calculator, HEWLETT-PACKARD has developed an advanced language, Forth-like, which places the HP-41 in a class of its own.

The comprehension of this potentialities induces the way one will use the HP-41.

THIS LANGUAGE IS AN INTERPRETED ONE.

The instructions inserted in the calculator memory are not directly intelligible to the microprocessor. Prior to execution they must be translated into a succession of micro-instructions, which are understandable by the HP-41 chip. This deciphering operation is called interpretation.

A SYMBOLIC LANGUAGE FOR THE HP-41.

A computer spends most of its time searching its memory to transfer informations from one place to an other. This information can be transformed in the process, but it is not always necessary. To execute these transfers the microprocessor must know the data origin and destination, both are absolute addresses.

There are two types of informations :

- data : numeric values or characters strings.

- instructions : whose sequence represents a program.

At the machine language level all these informations are numbers. But the common users are very different from a microprocessor, they find it easier to remember words than numbers or instructions sequences : programmers prefer symbols to numbers. So the microprocessor must link, one way or another, the symbol and the address to get a given information. It can use catalogs which can be compared to a directory, where a telephone number is found using a surname. A language is characterized by its degree of symbolism.

THE HP-41 IS MODULAR.

In the world of micro-computers the HP-41 is one of the few machines which can contain an undetermined number of programs. They can be created, edited, erased, and (if you own a mass storage device) saved or loaded independently.

At this physical independence, is opposed a logical dependence. Any program can call a group of instructions belonging to another program. This sequence has only to begin by an alphabetical label : LBL "X..." and end by RTN or END.

Therefore it is possible to divide a complicated program, in a sequence of easier ones (and so on) according to the valuable principles of top-down programming. The problems of data handling are left to lower levels subroutines, while the logical sequence of the program is clearly visible at the higher levels. This programming technique has numerous advantages :

- It becomes very difficult to make mistakes while conceiving the different stages of a program. If it happens, it is easy to correct it because the mistake is quickly located within a small number of instructions.

- It is also very easy to test each subroutine to see if the output is consistent with a given input.

- Finally, some subroutines happen to be so useful that one wish to have an assembly language version of them. This module is a good illustration of it : most functions included in the PANAME ROM, where first created as subroutines in user language. The conception of the array handling techniques and of most functions were done in 1982.

PROGRAMMING THE HP-41.

The HP-41 has three programming levels.

- Programs are, in fact, a sequence of routines with tests in between. Always designed for a specific purpose, the program illustrates the stategical importance of the programmer's ability. A program must be understandable when reading it, and it must include its documentation.

- Routines, represent the tactical side of programming. A routine should be short, fast, memory saving, and modify as few variables as possible. It performs a specific task.

They are general enough to be used several times in a program, even in different programs. So, they should always be in memory. A standardisation of programming technics saves time and efforts. If a routine meets all these requirements it can be considered as a new function for the HP-41 language : an illustration of the last quality of this language : its capacity of evolution.

- Assembly language functions. They are the elements of the language itself. A function should be general, even more than a routine. The two authors of this module provide us with a coherent group of more than 120 new functions.

FIRST CONCEPT : PERIPHERALS HANDLING.

Using the functions in this module is realizing what simplifications they offer when dealing with peripheral. Either using video or printer functions, a lot of time is saved when running a program or creating it. Plain language instructions instead of escape sequences, represents the same enhancement than reading "SIN" instead of "31 04". "CLEAR" is better than "27 ACCHR 69 ACCHR" : it is more intelligible, and it works in trace mode. From this point of view the "PANAME" ROM is a great enhancement and it solves problems which had virtually no solution before.

ANOTHER CONCEPT : ARRAYS HANDLING.

How many times did we hear that the HP-41 was not designed for array handling. Now, every one will see how the use of the stack, that we have recommended, prepared us to these new functions. The rise of to FORTH language will give another evidence of this conception. Those lucky enough to use RPN logic will be prepared for FORTH, which perhaps, will replace BASIC.

We hope that all HP-41 programmers will appreciate the power of the "PANAME" ROM.

PHILIPPE DESCAMPS

WARNING

The PANAME ROM includes new functions for the HP-41, and they induce lots of different applications. But, as for other functions of the HP-41, either original ones or new ones, Users with their wide range of applications, are the only ones, who can show the interest of these functions.

This module would have been impossible without our PPC club, because it facilitates the exchange of solutions : it is very useful to share with other people knowledge and programming skills.

For the moment the PANAME ROM has a user manual, which has been made as clear and precise as possible. But we are aware of our limits. Therefore, we have decided to write, with evereybody's help, a document following the spirit which was at the origin of the PPC Module.

If you are interested in a Solution Book for the PANAME ROM, you can put your name down with J.J. DHENIN, BCMW 2 bis rue N. HOUEL 75005 PARIS. When the solution book is ready you will be notified.

How do we intend to write this collective book ?

Everyone will find unclear points in the original manual. We hope you will send us written questions. It will be better if a new redaction of these points is also proposed. As a matter of fact, we are so accustomed to these new functions that we are unable to evaluate the difficulties faced by a new user. So you are the only ones who can help us to enhance this manual.

Finaly, examples are the best explanation, especially when the manual is not written in author native language. So we hope you will send us your own applications, short if possible.

According to your suggestions and to your work, we will be able to send you a new and better document in the future.

Happy programming.

- Find device according to its Accessory ID - **FINDAID**

FINDAID (**FIND** by Accessory **ID**) allows the HP-41 to find the location on the loop, of a device specified by its accessory ID. This function is the complement of the function FINDID in the HP82160A HPIL ROM, which allows searching for a device according to its device ID.

For greater ease-of-use, the FINDAID function can also locate a device of a specific class. A device class representing devices whose AID is in a specific range. For instance, the "Mass Storage" device class regroups all devices with an AID between 16 and 31. For the different class definitions refer to Appendix C.

INSTRUCTIONS FOR FINDAID

FINDAID allows the HP-41 to search a device of a given class or type which you specify with a number in the X-register. To specify a class, put in the X-register a negative number, which absolute value corresponds to the device class. Refer to Appendix C to set the number corresponding to each device class.

The **FINDAID** function starts its search at the primary device.

-If the specified device is found, its HP-IL address is returned to the X-register.

-If the search is unsuccessful 0 is returned to the X-register.

The old value of the X-register is always saved in LASTX.

EXAMPLE

1) To find the first printer on the loop, put -32 (Class number for "printer") in the X-register, and execute FINDAID.

2) Application program for FINDAID : 'FNDAIDN'

FNDAIDN searches the loop for the Nth device of a given class or AID.

To use FNDAIDN :
- Put N in the Y-register.
- Put the device class number or AID in the X-register. (As with FINDAID.)
- The result is left in the X-register; all other stack registers, including LASTX, are destroyed.

FNDAIDN listing :

```
LBL "FNDAIDN"  RCLSEL  STO 00  ST/ X
LBL 01  SELECT  RCLSEL  X#Y?  GTO 02  R^  R^  FINDAID  X=0?
GTO 03  X<> L  ISG L  NOP  LASTX  DSE Z  GTO 01  DSE X  GTO 03
LBL 02  CLX  LBL 03  RCL 00  SELECT  RDN  END
```

Related functions :

- HP-IL ROM: FINDID, SELECT, AUTOIO, MANIO.
- PANAME ROM: AID, ID, RCLSEL.

- Accessory Identity - AID

AID returns the Accessory **ID** of the primary device. The Accessory ID is an integer in the range 0 to 255 which identifies the device type.

For instance, the Accessory ID of the HP82162A thermal printer is 32. If the primary device is a HP82162A printer, the AID function returns 32 to the X register.

AID INSTRUCTIONS

The AID function returns to the X register an integer representing the Acessory Identity of the primary device. To compute the AID number of a device, refer to the description of the HPIL message "Sent Accessory Identity" in the device owner's manual.

If the primary device has no Accessory Identity, the error message NO RESPONSE is displayed.

Related functions

EXTENDED I/O MODULE : FINDAID, ID
HPIL ROM : FINDID, SELECT, AUTOIO, MANIO
PANAME ROM : RCLSEL

Appendix C

For every type of accessory, this list gives the name, identity range and number related to a device type.

To find a device of a given type, store the type identifier into the X register and execute FINDAID.

Type	AID	Type identifier
controller	0 to 15	- 1
mass storage	16 to 31	- 16
printer	32 to 47	- 32
display	48 to 63	- 48
interface	64 to 79	- 64
	80 to 95	- 80
graphic device	96 to 111	- 96
	112 to 127	-112
	128 to 143	-128
	144 to 159	-144
	160 to 175	-160
	176 to 191	-176
	192 to 207	-192
	208 to 239	-224
	240 to 255	-240

ID (**D**evice **ID**) returns the Device ID of the SELECTed device. The Device ID is an alphanumeric string which identifies the device. Generally the ID string indicates the device manufacturer and reference.

For instance, the Device ID of the HPIL-RS232 interface is "HP82164A". If the SELECTed device is the HPIL-RS232 interface, the ID function returns "HP82164A" to the ALPHA register.

INSTRUCTIONS FOR ID

The ID function returns the Device ID of the SELECTed device to the ALPHA register. To get the ID string of a device, refer to the description of the HPIL message "Sent Device Identity" in the device owner's manual.

If the SELECTed device has no device identity, the error message
NO RESPONSE is returned.

RELATED FUNCTIONS :

HPIL ROM : FINDID, SELECT, AUTOIO, MANIO
PANAME ROM : AID, FINDAID, RCLSEL

- Input prefix for OUT functions - OUT

Easy keyboard input of functions beginning with **OUT** is possible thanks to the [OUT] function. This function is very useful when it is assigned to a key. For instance assign OUT to the [LN] key.

Keystrokes : [ASN][ALPHA][O][U][T][ALPHA][LN]
Put the calculator in USER mode, then execute or program a function whose name begins with OUT, for instance OUTAX.

Keystrokes : [OUT]([LN] key)[ALPHA][A][X][ALPHA]

Without the OUT function the keystrokes would have been [XEQ][ALPHA][O][U][T][A][X][ALPHA], so you save 3 keystrokes every time you type a function beginning with OUT.

OUT INSTRUCTIONS

1) Assign OUT to a key and set the calculator to USER mode.

2) To execute or program a function beginning with OUT, strike :

[OUT] (It is assigned to a key)

[ALPHA]

...characters of the function name without the first three one.

...(for instance YBX for the OUTYBX function).

[ALPHA]

- OUTA with repetition according to X - OUTAX

OUTAX performs one or several OUTAs functions, it sends the ALPHA register contents to the SELECTed device. The absolute value of the X register indicates the number of OUTAs to be performed.

If flag 17 is cleared, an End Line sequence is added to the ALPHA string each time. (End Line : characters CR and LF, decimal code 13 and 10).

If Flag 17 is set, the ALPHA string is sent several time without any separation character.

INSTRUCTIONS FOR OUTAX

The string to be sent several times must be put in the ALPHA register, the number of repetitions in the X register, and Flag 17 must be set or cleared according to the required effect (as mentioned above) then execute OUTAX.

EXAMPLE :

To draw a line of 40 "_*" on a HP82905B printer, use the following sequence. (The printer must be the SELECTed device)

```
"_*"  SF 17  40  OUTAX  ADV
```

RELATED FUNCTIONS :

Any function beginning with OUT.

HPIL ROM : MANIO, SELECT are used to select the device.

- OUTput Carriage Return - OUTCR

OUTCR sent a CR character to the SELECTed device. (Carriage Return : decimal code 13).

- OUTput Line Feed - OUTLF

OUTLF sends a LF character to the SELECTed device. (Line Feed : decimal code 10).

- OUTput Line Feeds by X - OUTLFX

OUTLFX Sends one or several LF characters to the SELECTed device. (Line Feed : decimal code 10). The number of characters is specified by the absolute value of the X register.
(0<= X <= 999).

INSTRUCTIONS FOR OUTLFX.

Put the number of LF characters to be sent in the X register and execute OUTLFX.

- Output space characters - OUTSPX

OUTSPX (**OUT**put **SP**aces by **X**) sends the number of space characters (decimal code 32) specified by the absolute value of the X-register, (0<=X<=999),to the primary device.

INSTRUCTIONS FOR OUTSPX

Put in the X-register the number of space characters to be sent to the primary device, and execute OUTSPX.

EXAMPLE

Numerous printers have no tabulation functions. The OUTSPX function replaces it quite well. For instance, the program OUTAT sends to the printer an alphabetical string of a given length L, representing the string in the ALPHA register followed, if necessary, by several space characters. If the string in the ALPHA register is longer than L, it is shortened to the first L characters (1).

The string length is limited to 24 characters because of the size of the ALPHA register.

OUTAT use :

- Put the string length (L) in the X-register.

- Type the string in the ALPHA register.

- Execute **OUTAT**.

The OUTAT program destroys registers X, T, LASTX and sets flag 17.

Note : L must be a positive integer number.

Listing of **OUTAT** :

```
LBL "OUTAT"   ALENG   X>Y?   GTO 01
-   LBL 02   SF 17   OUTA   OUTSPX   RTN
LBL 01   DSE Y   NOP   CLX   1 E2   /   SUB$
CLX   GTO 02   END
```

N.B. : The text is left-justified. To print a text right-justified just swap OUTA and OUTSPX in OUTAT.

(1) : In this case, the ALPHA register is modified by OUTAT.

OUTXB

- Sent a character by its decimal code -

OUTXB sends to the primary device, the character, whose decimal code is specified by the absolute value of the X-register. This value must be in the range 0-255.

INSTRUCTIONS FOR OUTXB

Put the decimal code of the character in the X-register, and execute OUTXB.

EXAMPLE

To sent to the printer the character "\" (Decimal code 92), use the sequence : 92 OUTXB.

OUTYBX

- Send a character, several time, by its decimal code -

OUTYBX sends to the primary device, one or several times, a character whose decimal code is specified by the absolute value of the Y-register. The absolute value of the X-register specifies the number of characters to sent.

Restrictions : 0<=ABS(X)<=999 and 0<=ABS(Y)<=255.

INSTRUCTIONS FOR OUTYBX

Put in the Y-register the decimal code of the character and the character count in the X-register, then execute OUTYBX.

EXAMPLES

1) To send 20 "'" characters to the printer (Decimal code 39), use the sequence :

39 ENTER^ 20 OUTYBX.

2) 'PRNBLZ' (PRint Number with Leading Zeroes)

This program prints numbers with leading zeroes. The entry conditions are :

- The X-register holds the number to be printed.

- The Y-register holds the length of the printing field (maximum number of digits) .

- Select the display format.

- Execute PRNBLZ.

If the printing field cannot hold the formatted number, it is field with "*" characters.

After execution, registers X, Y, LASTX and ALPHA are lost.

Listing of PRNBLZ :

```
LBL "PRNBLZ"   CLA   ARCL X   X<0?   XEQ 00
CLX   ALENG   X>Y?   GTO 01   -   48   X<>Y   OUTYBX   OUTA   RTN
LBL 00   CLX   ATOXL   OUTXB   RTN
LBL 01  CLX   42   X<>Y   OUTYBX   END
```

OUTA with 7th bit set - **OUTa**

OUTa works like OUTA except that the 7th bit of every character sent is set. Therefore 128 is added when the character code is smaller than 128 with two important exceptions : LF and CR characters which are automatically sent after an ALPHA string when flag 17 is clear. (CR : carriage return, decimal code 13. LF : line feed decimal code 10).

INSTRUCTIONS FOR OUTA

Put in the ALPHA register the string to be sent, set or clear flag 17 (see above), execute OUTa.

EXAMPLES

1) To display a string in "reverse video" mode on the HP82163 video interface, you have to add 128 to each character code before sending the string to the interface.The OUTa function does it automatically. So to display a string in reverse video, select the interface as the primary device, put the string in the ALPHA register and execute OUTa. Flag 17 enables or disables the sending of an "End-of-line" sequence.

2) Some printers can automatically underline if you add 128 to the code of the character code to be underline. The OUTa function makes this operation easier with such printers.

3) There are two ways to use special characters on the HP82905B :

- Using the secondary character set mode, which give new meanings to the codes 32 to 127.

- Using characters with codes higher than 127.

The second method is very easy using the OUTa function.

- OUTa with repetion by X - **OUTaX**

OUTaX executes several times the OUTa function (refer to it). The absolute value of the X-register specifies the number of OUTas.to be performed.
If flag 17 is clear, an "End-of-line indicator (CR and LF, decimal codes 13 and 10) is sent after each string.
If flag 17 is set the string is sent several times without any other character.

INSTRUCTIONS FOR OUTAX

Put the string in the ALPHA register, the number of OUTAs to be performed in the X-register, set or clear flag 17 (see above), then execute OUTaX.

EXAMPLE

To display a line of 16 "-*" strings in "reverse video" on the HP82163 video interface (which has to be the primary device), use the following sequence :
"-*" SF 17 16 OUTaX

- Recall primary device address - **RCLSEL**

RCLSEL (**ReCaLl SEL**ected address) returns in the X-register, after stack lift if it is enabled, the HP-IL address of the primary device. This address is an integer number. The RCLSEL function also checks the loop integrity (for device in standby mode it has the same effect as the PWRUP function, refer to the HP82160A HPIL ROM manual). There is a difference between the "EXTENDED I/O ROM" RCLSEL function and the "PANAME ROM" one : The "PANAME ROM" RCLSEL function can return a value, different from the last address specified by the SELECT function. This happens when the SELECT function has been executed with an address greater than the number of devices on the loop ; in this case the address returned by RCLSEL is 1. This characteristic is useful in programs with a routine executed once for every device on the loop. A test between the SELECT address and the address returned by RCLSEL will check if all devices have been tested. Refer to the programs LOOP in the Example section of AID and ID, and FNDAIDN in the example section of FINDAID, to see how this method is used.

INSTRUCTIONS FOR RCLSEL

Execute RCLSEL ; an integer number, which represents the address of the primary device is returnrd to the X-register as specified above.

EXAMPLE

RCLSEL can be used to save the primary device selection at the beginning of a program, which might modify it, and to restore it upon program termination. Use RCLSEL STO nn at the beginning and RCL nn SELECT at the end.

82163 FUNCTIONS GROUP

This group of functions will make the HP 826163 video easier to use. A full control of the video interface is possible without escape sequences or control characters. For instance to clear the screen or to move the cursor down, CLEAR and CRSDN (CuRSor DowN) are used.

For all these functions the primary device must be the video interface. For the different ways to select a device refer to the functions FINDAID (in this manual) and FINDID (in the HPIL ROM HP82160A owners manual).

In AUTOIO mode, if the primary device has a device identity other than 48 (standard video interface) an AID ERR error message is displayed.

However in MANIO mode, this error checking is not performed. So it is possible to use these functions with video interfaces, such as the Mountain Computer MC00701A (AID 50), PAC-TEXT, or KRISTAL(*) MINITEL interface.

For further informations on escape sequences, refer to Appendix V.

* KRISTAL, Chemin des Clos Zirst 38240 MEYLAN (FRANCE), is an HP ICC.

- Clear the display - **CLEAR**

CLEAR clears the display, sets the cursor to position (0,0) and selects the replacement cursor.(*)

INSTRUCTIONS FOR CLEAR

Execute CLEAR.

EXAMPLE

ESC E, which is sent by the function CLEAR, is the reset sequence of the HP82905B printer. So CLEAR can be used to reinitialize this printer, but it must be performed in MANIO mode because the Accessory ID of the HP 82905B is 33.

- Clear the display from the cursor - **CLEARO**

CLEARO clears the display, starting from the cursor and down to the end of the display. Cursor type and position are unchanged.

INSTRUCTIONS FOR CLEARO

Execute CLEARO.

(*) This is not true for all non-HP video interface.

- Move cursor down - **CSRDN**

CSRDN (**C**ur**S**o**R** **D**ow**N**) moves the cursor one position down. If the cursor is on the bottom line of the display, the cursor is not moved.

- Move cursor Horizontally by X - **CSRHX**

CSRHX (move **C**ur**S**o**R** **H**orizontaly by **X**) moves the cursor horizontally. The absolute value of X specifies the number of characters of the move and its sign the direction:
- For X<0, CSRHX performs (-X) CSRLs (moves the cursor left by (-X) characters).
- For X>=0, CSRHX performs X CSRRs (moves the cursor right by X characters).

For instance -1 CSRHX is equivalent to CSRL and 1 CSRHX is equivalent to CSRR.

INSTRUCTIONS FOR CSRHX

Put in X the number corresponding to the desired move, then execute CSRHX.

- Move the cursor to the left - **CSRL**

CSRL (**C**ur**S**o**R** **L**eft) moves the cursor one position to the left. If the cursor is at position (0,0), it is not moved.

- Suppress the cursor - **CSROFF**

CSROFF (**C**ur**S**o**R** **OFF**) suppresses the cursor. The cursor is not visible until the next execution of CLEAR or CSRON or the next interface initialization (Power on or HPIL message -DCL- or -SDC-).

- Display the cursor - **CSRON**

CSRON (**C**ur**S**o**R** **ON**) switches the cursor on. It can be swiched off using CSROFF.

- Move the cursor to the right - **CSRR**

CSRR (**C**ur**S**o**R** **R**ight) moves the cursor one position to the right. If the cursor is at the end of a line, the cursor is sent to the beginning of the next line, except if it is at the end of the last line, in which case it is not moved.

- Move the cursor down according to X - **CSRVX**

CSRVX (move **C**ur**S**o**R** **V**ertically by **X**) moves the cursor vertically. The absolute value of X specifies the number of lines of the move and its sign the direction :
- For X<0, CSRVX performs (-X) CSRUPs (moves the cursor up by (- X) lines).
- For X>=0, CSRVX performs X CSRDNs (Moves the cursor down by X lines).

INSTRUCTIONS FOR CSRVX

Put in X, the number corresponding to the desired move, then execute CSRVX.

- Move the cursor up - **CSRUP**

CSRUP (**CurSoR UP**) moves the cursor one position up. If the cursor is on the top line of the display, it is not moved.

- Select the type of cursor - **CTYPE**

CTYPE (Cursor **TYPE**) selects the type of cursor acording to the value of X :

- For X=0, selects the "insertion" cursor (blinking arrow) ;

- For X=1 or -1, selects the "replacement" cursor (blinking block).

INSTRUCTIONS FOR CTYPE

Put in X the value specifing the desired type of cursor and execute CTYPE. Beware that when using the Video interface Mountain Computer MC00701A, the selection of the insertion cursor (Blinking underline) selects neither "character insertion" mode nor "line insertion" mode.

- Put the cursor at the upper left position of the display - **HOME**

HOME moves the cursor to position (0,0).

- Scroll the display down - **SCRLDN**

SCRLDN (SCRolL DownN) scroll the display on line down. (So the bottom line disappears and a new line appears at the display top.)

- Scroll the display one line up - **SCRLUP**

SCRLUP (**SCRolL UP**) scroll up the display by one line. (So the top line of the display disappears and a new line appears at the bottom of the screen.)

- Scroll the display according to X - SCRLX

SCRLX (**SCR**ol**L** as specified by **X**) the display is scroll according to X. The absolute value of X specifies the number of lines of the scroll, and its sign the direction.

- For X<0 SCRLX performs (-X) SCRLUPs. (Scrolls the display up by (-X) lines.)

- For X>=0, SCRLX performs X SCRLDNs. (Scrolls the display down by X lines.)

INSTRUCTIONS FOR SCRLX

Put in X, the number corresponding to the desired scrolling, and execute SCRLX.

- Move the cursor to position (X,Y) - XYTAB

XYTAB (**(X,Y) TAB**ulate) moves the cursor to position (x,y), The column number is specified by the absolute value of X and the line number by that of Y.

INSTRUCTIONS FOR XYTAB

Put in X the column number, in Y the line number and execute XYTAB.

Appendice V

Sequences sent to the primary device by the HP82163 FCNS group.

"ESC" represents the escape character, decimal code 27.

Function(s)	Sequence	Characters codes
CLEAR	ESC E	27 69
CLEARO	ESC J	27 74
CSRDN, CSRVX for X>=0	ESC B	27 66
CSRL, CSRHX for X<0	BS	08
CSROFF	ESC <	27 60
CSRON	ESC >	27 62
CSRR, CSRHX for X>=0	ESC C	27 67
CSRUP, CSRVX for X<0	ESC A	27 65
CTYPE for X=0	ESC Q	27 81
CTYPE for X=1 or -1	ESC R	27 82
HOME	ESC H	27 72
SCRLDN, SCRLX for X>=0	ESC T	27 84
SCRLUP, SCRLX for X<0	ESC S	27 83
XYTAB	ESC % {c} {l}	27 37 col ln

82162 FUNCTIONS GROUP

This group of functions makes easier the operation of the HP82162A Thermal Printer. You will be able to use every features of this printer, even those not described in the manual.

These features are :

- Two different character sets ;

- A "parse" mode ;

- A absolute dot-level tabulation function, independent from any data already in the printer buffer ;

- The possibility to obtain status information from the printer.

These functions work on the first HP82162A printer on the loop starting from the primary device. If no HP82162A printer is found on the loop, the error message "NO 82162" is displayed. The STATUS function of the "PANAME ROM" is the only exception to this rule; refer to this function for further details.

- Select "8 bit mode" - **8BIT**

8BIT selects "8 bit mode", which validates the HP41 character set. This mode is automatically selected when a specific printer function is used. (One of the -PRINTER 2E functions of the HP-IL ROM.) This function is useful only if the HP82162A printer is used with non-specific printer functions, such as OUTA or OUTYBX.

- Select "Escape" mode - **ESCAPE**

ESCAPE selects the "escape" mode, which activates the ASCII (non HP-41) character set . In this mode, you cannot use specific printing functions to send characters to the printer because they automatically select the "8 bit mode". However some applications may require the use of the ASCII character set. The ESCAPE function enables the use of this set, but printing must be done with the OUTA function, or related functions, which only send characters to the primary device. Beware that in this case, the primary device must be the printer, even though this is not necessary with specific printer functions such as PRA.

-Select "Line feed on space" mode - **PARSE**

PARSE selects parse mode, which enables automatic word-wrap at end of lines. A line feed is performed by the printer on the space, when the next word cannot be printed completely on the current line.

- Clear the buffer - **CLBUF**

CLBUF returns the printer to power on status :

- The printer head is at the right ;

- The printer buffer is empty ;

- selected modes are : "escape", single width, uppercase letters, left justification, line-feed on the 24th character.

This function is mainly used to clear the printer buffer of any data, it is the only way to do it.

- select the "line-feed on the 24th character mode" - UNPARSE

UNPARSE disables the special mode selected by UNPARSE.

- Column tabulation - TABCOL

TABCOL enables an absolute tabulation on the dot level as opposed to SKIPCOL, which permits a relative tabulation.

Using TABCOL, it is easy to print a output with several columns (Only two columns with FMT !).

INSTRUCTION FOR TABCOL

Put the column number (0 to 167) in X and execute TABCOL.

EXAMPLE

To print the following chart :

```
A=   123.00 FF
B=    23.95 FS
C=  1115.70 FB
```

You can use the following sequence :

```
FIX 2  CLBUF  "A="  ACA  28  TABCOL  123  ACX  91  TABCOL  "FF"  ACA  PRBUF
              "B="  ACA  28  TABCOL  23.95  ACX  91  TABCOL  "FS"  ACA  PRBUF
              "C="  ACA  28  TABCOL  1115.7  ACX  91  TABCOL  "FB"  ACA  PRBUF
```

82905 Functions Group

This group of functions will make the HP82905B 80-column printer much easier to use. Thanks to them you can completely control the printer without knowing escape sequences or control characters normally needed to perform a specific task. These functions permits an easier writing or reading of programs using the various modes of the HP82905B.

For all these functions the printer must be the primary device. Refer to FINDAID (in this manual) or to FINDID (in the HP82160A HPIL ROM manual) to find how to select a given device.

In AUTOIO mode, if the primary device does not have an AID of 33, the error message AID ERR is displayed.

However, this check is not performed in MANIO mode. So they can be used with other printers using the same escape sequences or control characters.

For more informations on sequences sent by these functions, refer to Appendix P.

- Beep signal - BELL

BELL rings the "bell" of the printer for one second. This function can be used to call the attention of the user.

- Character set selection - CHARSET

CHARSET selects the primary character set if X=0, and the secondary one if X=1. Refer to the HP82905B printer User's Manual for informations on both character sets.

- Form feed - FFEED

FFEED sends to the printer a "form feed" command, which sets the printer to the top of the next page. Beware that you must position the paper correctly and set the number of lines per page (using FORMLEN) prior to using FFEED.

- Page length - FORMLEN

FORMLEN defines the number of lines per page (It is related to the paper's physical form length and line spacing selected with VSPAC).

The absolute value of X indicates the number of lines, which must be in the range 1-128. At power on or after reinitialization with the CLEAR function (refer to this function for futher information) the default line count is 66.

- Graphic output - GRAPHX

GRAPHX indicates to the printer that the next X bytes received are binary data, not characters, each value representing a dot column. Refer to the printer User's Manual to find the relations between data sent and printer output (Graphic mode section).

The absolute value of X represents the number of bytes to be considered as graphic data.

- Printing mode - MODE

MODE selects the printing mode according to the absolute value of X :

X value :	Mode :	Nb char./line :
0	Normal	80
1	Expanded	40
2	Compressed	132
3	Compressed-Expanded	66
9	Bold	80

You can combine modes "0" and "1" or "2" and "3" ; other combinations give impredictable results.

If X has other values than "0", "1", "2", "3", or "9", the error message DATA ERROR is displayed.

- Disables perforations skip - SKIPOFF

SKIPOFF cancels the SKIPON function.

- Enables perforation skip- SKIPON

SKIPON enables perforations skip mode on the printer. When this mode is on, the printing of the last text line of a page generates a form feed : the paper is set to the beginning of thhe next page. (the number of text line per page is selected with the TEXTLEN function), So nothing will ever be printed accross two pages.

Perforations skip mode is off, at power on or upon excution of the CLEAR function. (Refer to this function for further information).

- Text length - TEXTLEN

TEXTLEN sets the number of number of lines in the "text area" equal to the absolute value of X. This number must be in the range 1 to the number of line per page (selected with FORMLEN). At power on or after executing the CLEAR function, the default is 60 text (useable) lines per page.

- Vertical spacing - **VSPAC**

VSPAC selects the vertical spacing in lines per inch according to the absolute value of X.

This number must be 6,8,9,12,18,24,36 or 72. Any other value will cause a DATA ERROR.

Appendix P

Sequences sent to the primary device by the 82905 FNCS functions.

- ESC represents the escape character, decimal code 27.
- {#} symbolises the ASCII representation of a number and {parm} the related character codes .

Function(s)	Sequence	Codes	Thinkjet
BELL	BEL	07	
CHARSET for X=0	SI	15	Normal
CHARSET for X=1 or -1	SO	14	Bold
FFEED	FF	12	FF
FORMLEN	ESC &l {#} P	27 38 108 {parm} 80	FL
GRAPHX	ESC *b {#} G	27 42 98 {parm} 71	
MODE	ESC &k {#} S	27 38 107 {parm} 83	
			0 Normal (80 c/l)
			1 expanded (40 c/l)
			2 compressed (142 c/l)
			3 expanded-compressed (71 c/l)
SKIPOFF	ESC &l0L	27 38 108 48 76	skipoff
SKIPON	ESC &l1L	27 38 108 49 76	skipon
TEXTLEN	ESC &l {#} F	27 38 108 {parm} 70	textlen
VSPAC	ESC &l {#} D	27 38 108 {parm} 68	vspac

Roman-8 Characters (ASCII)

CHAR.		DEC.	HEX.
CTL@	$^{N}_{U}$	0	00
CTLA	$^{S}_{H}$	1	01
CTLB	$^{S}_{X}$	2	02
CTLC	$^{E}_{X}$	3	03
CTLD	$^{E}_{T}$	4	04
CTLE	$^{E}_{Q}$	5	05
CTLF	$^{A}_{K}$	6	06
CTLG	🔔	7	07
CTLH	$^{B}_{S}$	8	08
CTLI	$^{H}_{T}$	9	09
CTLJ	$^{L}_{F}$	10	0A
CTLK	$^{V}_{T}$	11	0B
CTLL	$^{F}_{F}$	12	0C
CTLM	$^{C}_{R}$	13	0D
CTLN	$^{S}_{O}$	14	0E
CTLO	$^{S}_{I}$	15	0F
CTLP	$^{D}_{L}$	16	10
CTLQ	$^{D}_{1}$	17	11
CTLR	$^{D}_{2}$	18	12
CTLS	$^{D}_{3}$	19	13
CTLT	$^{D}_{4}$	20	14
CTLU	$^{N}_{K}$	21	15
CTLV	$^{S}_{Y}$	22	16
CTLW	$^{E}_{B}$	23	17
CTLX	$^{C}_{N}$	24	18
CTLY	$^{E}_{M}$	25	19
CTLZ	$^{S}_{B}$	26	1A
CTL[	$^{E}_{C}$	27	1B
CTL\	$^{F}_{S}$	28	1C
CTL]	$^{G}_{S}$	29	1D
CTL^	$^{R}_{S}$	30	1E
CTL_	$^{U}_{S}$	31	1F

CHAR.	DEC.	HEX.
	32	20
!	33	21
"	34	22
#	35	23
$	36	24
%	37	25
&	38	26
'	39	27
(	40	28
)	41	29
*	42	2A
+	43	2B
,	44	2C
–	45	2D
.	46	2E
/	47	2F
0	48	30
1	49	31
2	50	32
3	51	33
4	52	34
5	53	35
6	54	36
7	55	37
8	56	38
9	57	39
:	58	3A
;	59	3B
<	60	3C
=	61	3D
>	62	3E
?	63	3F

CHAR.	DEC.	HEX.
@	64	40
A	65	41
B	66	42
C	67	43
D	68	44
E	69	45
F	70	46
G	71	47
H	72	48
I	73	49
J	74	4A
K	75	4B
L	76	4C
M	77	4D
N	78	4E
O	79	4F
P	80	50
Q	81	51
R	82	52
S	83	53
T	84	54
U	85	55
V	86	56
W	87	57
X	88	58
Y	89	59
Z	90	5A
[	91	5B
\	92	5C
]	93	5D
^	94	5E
_	95	5F

CHAR.	DEC.	HEX.
`	96	60
a	97	61
b	98	62
c	99	63
d	100	64
e	101	65
f	102	66
g	103	67
h	104	68
i	105	69
j	106	6A
k	107	6B
l	108	6C
m	109	6D
n	110	6E
o	111	6F
p	112	70
q	113	71
r	114	72
s	115	73
t	116	74
u	117	75
v	118	76
w	119	77
x	120	78
y	121	79
z	122	7A
{	123	7B
|	124	7C
}	125	7D
~	126	7E
■	127	7F

MINIPLOTTER

Several Miniplotters can be used with the HP-41. TANDY, CANON ... have the same mechanism and the same command set. Of course, the miniplotter should be interfaced with the HP-IL loop with the HP82166A converter.

Several companies produce HP-IL interfaced miniplotters, or a converter and parallel interface, which can be used with such miniplotters.

The main features of those miniplotters are :

- 4 colors . The printhead is in fact a cylinder of 4 mini ball pens. The color can be changed, either by program or by a switch, during plotting.

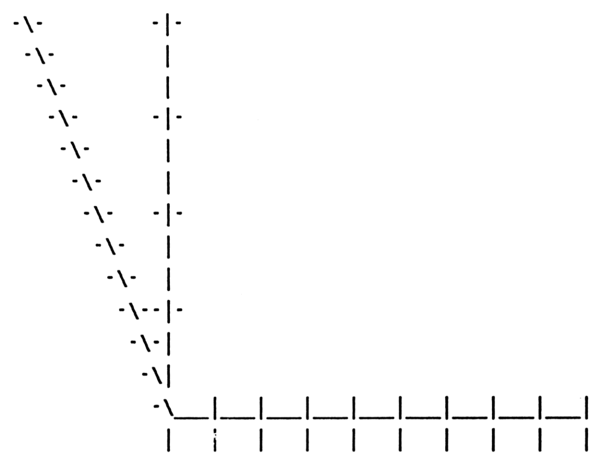
- 11.4 cm in roll paper. It is possible to draw, or plot on the length of the paper, so one can print large charts.

- Horizontally you can print 80 c/l.

- Of course, these miniplotters can be used with other HP-IL controllers such as the HP-75, HP-85, HP-71. So these devices will not be obsolete soon.

AXIS

AXIS draws several kind of axis on the mini-plotter.



INSTRUCTIONS FOR AXIS

AXIS uses four parameters, which must be on the stack before executing the function:
T: half-length of a tick
Z: vertical distance between two ticks
Y: horizontal distance between two ticks
X: number of ticks

The axis is drawn from the current pen position, and the direction depends on the values in the Y and Z registers.
However, ticks are always either vertical or horizontal according to the axis inclination from the horizontal (X direction) : under 45 degrees, ticks are vertical, over they are horizontal.

The parameter in T makes the drawing of charts easier. For instance with arrays.

Example : The following program draws a chart with 2 lines and C columns. Each column has a width of W and each line an height of H. To use it, only type XEQ'CHART' and answer the questions. (Input the value and R/S).

01 LBL "CHART"	
02 "HP82166"	GP-IO Converter identification.
03 FINDID	Search the address of the mini-plotter.
04 SELECT	Select the miniplotter.
05 RESET	Reinitialization.
06 "Nb. COL. ?"	
07 PROMPT	Input the number of columns (C).
08 STO 00	R00= Number of columns.
09 "COL. WIDTH ?"	
10 PROMPT	Input the columns width.

11 STO 01	R01= Columns width.
12 *	First chart dimension.
13 "HT. LINE ?"	
14 PROMPT	Input the line height.
15 STO 02	R02= Height of each line.
16 ST+ X	There are 2 lines, the 2nd dimension is 2*X.
17 CHS	The displacement will be down !
18 X<>Y	
19 0	
20 ENTER^	
21 BOX	BOX uses the 4 parameters T, Z, Y and X.
22 RCL 02	
23 CHS	
24 0	
25 *MOVE	Starting position.
26 RCL 02	
27 0	
28 RCL 01	
29 RCL 00	
30 AXIS	Drawing of inside lines.
31 END	

XEQ "CHART"
Nb. COL. ? — Will print:
4.0000 RUN
COL. WIDTH ?
100.0000 RUN
HT. LINE ?
50.0000 RUN

- Writing direction in graphic mode - *LDIR

***LDIR** specifies the writing direction for *LABEL. There are four possibilities :

0 to the right, 1 down, 2 to the left, 3 up.

- Line Type - *LTYPE

***LTYPE** (Line **TYPE**) specifies one of the 16th possible line types of the miniplotter.

The value of the X-register is considered modulo 16. The line type will be used with the DRAW and RDRAW functions.

- Move pen up - *MOVE

***MOVE** moves the pen, without plotting, to the (X,Y) coordinates.

- Broken line plotting - *PLREGX

***PLREGX** (**PL**ot **REG**isters by **X**) joins the points, whose coordinates are specified by successive registers.

The X-register contains a bbb,eee pointer; the integer part (bbb) specifies the register storing the first coordinate of the first point, the fractional part (eee) specifies the register storing the second coordinate of the last point. If in the succession of data the calculator finds one or several ALPHA strings the pen skip to the next cordinate (numeric data) without plotting (*MOVE), then it resumes plotting (DRAW).

- Relative Drawing - RDRAW

RDRAW (Relative **DRAW**ing) draws a line up to the position (x,y) relative to the current position of the pen.

- Reinitialization - RESET

RESET moves the pen to the left margin and selects Text mode.

- Reverse line feed - REVLF

REVLF (**REV**erse **L**ine **F**eed) moves the pen one line upward.

- Reverse line feed by X - REVLFX

REVLFX (**REV**erse **L**ine **F**eed by **X**) moves the pen upward of the number of lines specified by the absolute value of the X-register.

- Relative MOVEment - RMOVE

RMOVE (Reltive **MOVE**ment) moves to the (x,y) position relative to the current pen position.

- Set origin - SETORG

SETORG (**SET ORiG**in) sets the current pen position has the origin (0,0).

- BACKSPACE - BACKSP

BACKSP moves the pen one character backward

- BACKSPACE BY X - BACKSPX

BACKSPX moves the pen backward by the number of characters specified by the absolute value of the integer part of the X-register.

- Box drawing - BOX

BOX draws a rectangle, whose 2 opposite angles have the coordinates :

(x1,y1) and (x2,y2), with T=y2, Z=x2, Y=y1, X=x1.

- Color selection - *COLOR

***COLOR** selects one of the four colors according to the value of the X-register.

- Character size - *CSIZE

***CSIZE** (Character **SIZE**) selects the character size. The value of the X-register must be in the range 0-63.

- Draw a segment - *DRAW

***DRAW** draws a line segment from the current pen position to the (X,Y) coordinates.

- Sent pen to origin - *HOME

***HOME** move pen to (0,0) coordinates.

- Print the ALPHA register - *LABEL

***LABEL** prints the ALPHA register. This function is useful because the drawing can be done in four directions in text mode : these four directions are specified by the *LDIR function.

- Recall printer status - STATUS

STATUS returns to the Y-register an integer, which is the printer first status byte, and in the X-register an integer, which is the printer second status byte. The effect of STATUS on the stack depends on whether stack lift is enabled or not when the function is executed :

- If stack lift is enabled :

```
Before          After

T: t            T: y
Z: z            Z: x
Y: y            Y: 1st status byte
X: x            X: 2nd status byte
```

- If stack lift is disabled :

```
Before          After

T:t             T: z
Z: z            Z: y
Y: y            Y: 1st status byte
X: x            X: 2nd status byte
```

However, the LASTX-register is not modified.

The STATUS function has a specific feature : in MANIO mode, it returns to the X and Y registers two numbers, which specify the primary device status.

- If the primary device has no status bytes, STATUS returns 97 to the X and Y registers;

- If the primary device has only one status byte, STATUS returns the decimal representation of this byte to Y register, and returns 64 to the X-register;

- If the primary device has, at least, two status bytes, STATUS works with the primary device, as with the HP82162A printer in AUTOIO mode.
Status bytes after the second one are ignored.

To compute the number, and definition of the status bytes of a device, refer to the description of the HP-IL message "SENT STATUS" in the device manual.

The appendix S1 gives the detailed definition of the two status bytes of the HP82162A printer.

APPENDICE T2

Minimum function set needed to use a 4 color mini-plotter with the PLOT FCNS functions group.

Refer to JPC n15 june 1984 for a description of the mini-plotter.

Representation convention :

- # represents a numeric character string, with an optional minus sign and no more than 4 digits (For instance : -230; 0024);

The syntax column specifies the signification of each parameters;

Control characters (Decimal values) :

```
17:  Select TEXT mode
18:  Select GRAPHICS mode
11:  Reverse line feed (Text mode only)
08:  Backspace (Text mode only)
```

GRAPHICS mode instructions

Syntaxe	Format	Action
A	A	Initialization
H	H	Home (Position (0,0))
Mx,y	M#,#	Move to position (x,y)
Dx,y	D#,#	Drawing to position (x,y)
Rx,y	R#,#	Relative move of (x,y)
Jx,y	J#,#	Relative drawing of (x,y)
Pstring	Pstring	Printing of the characters string "string"
Lx	L#	Select line type x
Cx	C#	Select pen x (Change color)
Sx	S#	Select character size x
Qx	Q#	Select printing direction x (For P instruction only).

GRAPHICS mode functions

The mini-plotter instructions, which correspond to these functions, require the Graphics mode. So these functions set Graphic mode before executing the operation, and leave the mini-plotter in this mode after execution.

Functions that are not mode specific

These mini-plotter instructions must be executed in Graphic mode. So these functions set Graphic mode before executing the instruction. However these functions are oftenly used in Text mode. The user can control in which mode the mini-plotter is left after execution.

UTILITIES

This function group has a wide range of applications :

- Character string manipulation ;

- Manipulation of numeric and alphanumeric arrays (one or two dimensions) ;

- Numeric or alphanumeric sorting ;

- Extended memory management (HP82180A XFUNCTIONS and HP82181A XMEMORY) ;

- Wide range of other applications...!

- Euclidian division - /MOD

/MOD (Divide MOD) computes the remainder and the quotient of an Euclidian division (i.e. with integers). It is an extension of the built-in [MOD] function.

EXAMPLE

- Calculation of the modulus and quotient of the division of 13 by 3.

Input	Display	
13	13_	Dividend input.
[ENTER^] 3	3_	Divisor input.
[XEQ] "/MOD"	1,0000	Remainder.
[X<>Y]	4,0000	Division quotient.
[LASTX]	3,0000	The divisor is saved in the L-register.

INSTRUCTIONS FOR /MOD

1) To compute the modulus and quotient of the division of Y by X.

2) [XEQ] "/MOD". The quotient and modulus of the division are returned respectively to the Y and X registers. The divisor is saved in the L-register, the dividend is lost. T and Z registers are left unchanged.

3) If the X-register contains 0, the calculator displays DATA ERROR.

STACK

Input:	Output:
T: t	T: t
Z: z	Z: z
Y: Dividend	Y: quotient
X: Divisor	X: Remainder
L:l	L: Divisor

APPLICATION PROGRAMS FOR /MOD

1) A fairly quick way to compute the decimals of the division of A by B when A<B and the last digit of B is 9 :

```
LBL "DIV9" 10 / INT 1 + STO 01 RDN SF 21 LBL 01 RCL 01 /MOD VIEW Y
10 * + GTO 01 END
```

So to divide 153 by 209

153/209=0,732057...

2) [/MOD] can be used in a short subprogram as a small base conversion ! This short program, "YBX", gives the digits of the new number; but in reverse order. X and Y must be integers.

For instance 1103 [ENTER^] 8 [XEQ] "YBX" returns 7 [R/S] 1 [R/S] 1 [R/S] 2 [R/S] 0.

That means : 1103 (DEC) = 2117 (OCT). This results can be check with the DEC and OCT functions.

N.B : If it is possible to get the divisor back with X<>Y LASTX * + for a quotient >0 and with X<>Y X<0? DSE X NOP * LASTX * + for a quotient <0, it is impossible for a quotient equal to 0.

- ADDRESS TO LINE AND COLUMN - AD-LC

AD-LC returns the coordinates (line,column) of an array element from its address (Rnn) and the array pointer.

Example : Compute the coordinates of register 36 in the array A (Below), which array pointer 25,04405 is in R00. R25= first array element, R44= last aray element.

ARRAY A

column	no1	no2	no3	no4	no5
line no1	R25	R26	R27	R28	R29
line no2	R30	R31	R32	R33	R34
line no3	R35	R36	R37	R38	R39
line no4	R40	R41	R42	R43	R44

Input :	Display :	
36 [ENTER^]	36,0000	Input register no .
[RCL] 00	25,04405	Recall the array pointer.
[XEQ] "AD-LC"	2,00000	Column no2.
[RDN]	3,00000	Line no3.
[LAST X]	25,04405	The pointer is saved in L.

- INSTRUCTIONS FOR AD-LC

To get the line,column coordinates of an array element when you know the array pointer and the register address of this element : Input the register number, [ENTER^], array pointer, [XEQ] "AD-LC". The column number is returned in the X-register and the line number in the Y-register. The array pointer is saved in L, registers Z and T are unchanged.

STACK

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	z
Y:	Register no	Y:	line no
X:	Array pointer	X:	Column no
L:	L	L:	Array pointer

NOTA : This function does not check if the register is part of the array.
If registers X or Y contains an Alpha string, ALPHA DATA is displayed.

- Alpha LENGth - ALENG

[ALENG] returns to the X-register the length of the current string in the ALPHA register.

Example 1: In a program, the HP-41 stops and waits for an ALPHA input.
The string length is needed to store the string in several registers. An other solution is the RGAX function which is described in this manual.

INSTRUCTION FOR ALENG

Place in ALPHA the string, [ALENG] returns in the X-register the string length and the stack is lifted (if it is enable).

THE STACK

```
Input:                 Output:

T:  t                  T:   z
Z:  z                  Z:   y
Y:  y                  Y:   x
X:  x                  X:   String length.

L:  l                  L:   l
```

Application program for ALENG.

Example 2 : The following routine upercases in the ALPHA register. It uses [ALENG] to provide a loop counter initially equal to the number of characters in the string (which must not contain null characters).

```
01  LBL "CAP"
02  ALENG     counts characters in ALPHA register.
03  LBL 00
04  ATOXL    Places code of leading characters into X.
05  97  The lowercase letters are in the range 97 to 122.
06  X>Y?
07  GTO  01
08  CLX
09  122
10  X<Y?
11  GTO 01     If not lower case character, go to [LBL] 01
12  CLX    The character codes for uppercase letters
13  32    are determined by substracting 32 from their
14  -      lowercase counterparts.
15  R^
16  LBL 01
17  RDN
18  XTOAR    restores capitalized letter to ALPHA.
19  RDN
20  DSE X
21  GTO 00    branches if their is any character left.
22  AON
23  .END.
```

- **Search number in ALPHA** - **ANUM**

[ANUM] (Alpha to NUMber) searches the ALPHA register, from left to right, for a number (in ASCII form). The first number found is returned to the X-register.

Example : The ALPHA register contains the string : "PRICE: 1.234,50" read from an extended memory ASCII file. To extract the numeric value for further use: [XEQ] "ANUM" and the number is returned to the X-register.

INSTRUCTIONS FOR ANUM

1) The ANUM function searches for a numeric value in the ALPHA register string. If a number is found, it is returned to the X-register and flag 22 is set. If a number is not found, the X-register and flag 22 are left unchanged.

2) Numbers in the ALPHA register are processed according to the status of flags 28 and 29. If a number in the ALPHA register has a "-" sign, a negative number is returned to the X-register when the function is executed. Suppose that the ALPHA register contains the string of example 1 :

Flag 28	Flag 29	Display
set	set	1,234.5000
set	clear	1,0000
clear	set	1,2345
clear	clear	1,2340

STACK

Input :	Output :
T: t	T: z
Z: z	Z: y
Y: y	Y: x
X: x	X: number found in ALPHA.
L: l	L: l

-Search ALPHA number and delete -

ANUMDEL

ANUMDEL searches the current string in the ALPHA register, from left to right, for a number (in ASCII form) and returns to the X-register the value of the number. It also deletes all characters in the string from the start of the string to the last numerical character used.

Example 1 : Suppose that the ALPHA register contains the string "PRICE: $1,234.5XYZ", to extract the numeric value for futher use, [XEQ] "ANUMDEL" stores this number in the X-register; The ALPHA string is deleted up to "5" included.

INSTRUCTIONS FOR ANUMDEL

1) ANUMDEL searches the string in the ALPHA register for a numeric value . If a number is found, it is stored in the X-register and the string is deleted up to the last numerical character used to build the number.

2) If the ALPHA string contains more than one number separated by non-numeric characters, ANUMDEL uses only the first number. ANUMDEL is identical in operation to the ANUM function, except that the ANUM function does not alter the string. The HP-41 considers execution of ANUMDEL as a numeric entry, and sets flag 22, if a number is returned to the X-register. If the ALPHA string contains no numeric characters, ANUMDEL clears the ALPHA register but has no effect on the stack.

3) The characters "+", "-", ".", ",", "E" (for exponent) are interpreted by ANUMDEL as numeric or non-numeric characters according to their context in the ALPHA string. An isolated "+", is not treated as a numeric character. A "+" or "-" symbol immediately preceding, embedded in, or following a sequence of number digits will be interpreted exactly as if the symbols and numbers had been keyed into the X-register (with [CHS] representing "-" and [CHS][CHS] representing "+".) For instance, ANUMDEL returns the value -3425 if executed when the ALPHA register contains the string "34-2+5"..

The status of the numeric display control flags (flags 28 and 29) determines how the Alpha string is interpreted by ANUMDEL. For example, if flags 28 and 29 are both set, commas are treated as digit separators. But commas are considered as non-numeric if flag 28 is set and flag 29 is clear. Suppose that the Alpha register contains the string of example 1 : "PRICE: $1,234.5XYZ". Set FIX 4 and execute ANUMDEL; the following table shows the result according to the setting of flags 28 and 29.

Flag 28	Flag 29	X-Register	Modified Alpha String
set	set	1,234.5000	XYZ
set	clear	1,0000	,234.5XYZ
clear	set	1,2345	XYZ
clear	clear	1,2340	.5XYZ

STACK

Input :	Output :
T: t	T: z
Z: z	Z: y
Y: y	Y: x
X: x	X: First numeric value found in ALPHA.
L: l	L: l

APPLICATION PROGRAM FOR ANUMDEL

Example 2 : The HP 7470A Graphics Plotter can send on HP-IL an ASCII character string that describes the current pen position. The string contains three integer numbers separated by commas : X,Y,P. X is the pen's x-coordinate; Y is the pen's y-coordinate; P has a value of 1 if the pen is down, or 0 if the pen is up.
Suppose that the plotter has sent the string "123,456,1" to the HP-41's ALPHA register. You could use the following keystrokes to decipher the string :

Keystrokes	Display	
[SF 28]		Ensures that a comma is not interpreted as a radix.
[ANUMDEL]	123.0000	X-coordinate.
[ANUMDEL]	456.0000	Y-coordinate.
[ANUMDEL]	1.0000	Pen is down.

Example 3 : ALPHA has the string "34/-2/5"

[CF 28]	
[ANUMDEL]	34.0000
[ALPHA]	/-2/5
[ALPHA] [ANUMDEL]	-2.0000
[ALPHA]	/5
[ALPHA] [ANUMDEL]	5.0000

This example shows that "/" and "*" are not considered as "+", "-", or ".".

- Append the integer part of X to ALPHA - APPX

APPX (APPend X) appends the integer part of the X-register to the right of the ALPHA register string.

Example : The result of an area computation is in the X-register: 1,225.7 , and the message "AREA: " is in the ALPHA register, the APPX function appends the X-register value after the message, without rounding: ALPHA = "AREA: 1,225"

INSTRUCTIONS FOR APPX

1) [APPX] appends the integer part of the X-register to the left of the ALPHA register. [APPX] results depends on flags 28 and 29. The number is written as in FIX 0 mode, except that the decimal separator is not appended, and the number is not rounded. As for [ASTO] [APPX] does not beep, when its execution overflows the ALPHA register capacity.

2) If at the execution of [APPX], the X-register contains an alpha string, ALPHA DATA is displayed.

- ALPHA Rotation - AROT

AROT (Alpha **ROT**ate) rotates the ALPHA register string of the number of characters specified by the X-register.

Example : The ALPHA register contains the string "AROT". To display "TARO" then "ROTAX".

Input :	Display :
[ALPHA] AROT	AROT_
[ALPHA] 1 [CHS]	-1_
[XEQ] "AROT" [ALPHA]	TARO
[ALPHA] 2	2_
[XEQ] "AROT" [ALPHA]	ROTA

INSTRUCTIONS FOR AROT

[AROT] rotates the ALPHA register string of the number of characters specified by the value, modulo 24, of the X-register. The rotation is done to the left, if the X-register contains a positive number, and to the right if it is negative. (Refer to the appendix for futher information on the effect of [AROT] on null characters).
The execution of [AROT] does not modify the stack.

APPLICATION PROGRAMS FOR AROT

1) The [AROT] function can be used with the [ANUM] and [POSA] functions to get the number of repetition of a given string, or character, in the ALPHA register without destruction.

2) An operation on a device returns to the ALPHA register the following string "68.2 69.88" (a number, a space, a number). To extract separately two numbers to use them in a program, the following sequence can be used :

Input :	Display :	
[CF] 28		
[XEQ] "ANUM"	68.2000	Return the first number to the X-register.
[STO] 20	68.2000	Store for future use.
32	32_	Space code.
[XEQ] "XTOAR"	32.0000	Add a space to the right of the ALPHA string.
[XEQ] "POSA"	4.0000	Search the first space in the ALPHA register.
[XEQ] "AROT"	4.0000	Rotate the string; ALPHA contains 69.88 68.2; Without a space ALPHA would contain 69.8868.2.
[XEQ] "ANUM"	69.8800	Return 69.88 to the X-register.

- Character transfer between ALPHA and X

- Transfer leftmost character of ALPHA to X - **ATOXL**

[ATOXL] (Alpha-**TO-X** Left) deletes the first character of ALPHA and returns its decimal code to the X-register.

- Transfer rightmost character of ALPHA to X - **ATOXR**

[ATOXR] (Alpha-**TO-X** Right) deletes the last character of ALPHA and returns its decimal code to the X-register.

- Transfer specified character of ALPHA to X - **ATOXX**

[ATOXX] (Alpha-**TO-X** by X) returns to the X-register the character of ALPHA specified by the value of the X-register. The ALPHA register is left unchanged.

INSTRUCTIONS FOR ATOXL, ATOXR, ATOXX

1) [ATOXL] deletes the leftmost character of the ALPHA register string and returns its decimal code to the X-register. If the first character is followed by one, or several null characters, the string is moved, to the left, up to the first non null character. If the ALPHA register is empty, [ATOXL] returns -1 to the X-register.

2) [ATOXR] deletes the rightmost character of the ALPHA register string, and returns its decimal code to the X-register. If the ALPHA register is empty, -1 is returned to the X-register.

3) [ATOXX] returns to the X-register the decimal code of the character, whose position in the string, is specified in the X-register. The ALPHA register is left unchanged.

A positive value in the X-register specifies a position in the ALPHA register string, starting form the first non null character. This first character is in position 0. This convention is the one used for the POSA function in the XFUNCTION module.

On the contrary, a negative number specifies an absolute position in the ALPHA register, it is independent from the string. Positions are considered from right to left, -1 for the rightmost position and -24 for the left most position. The following chart illustrates the [ATOXX] interpretation of the character positions.

Character position	character
n > 23 ou r >= string length	DATA ERROR
0 <= n < string length	Nth character after the leftmost
n = 0	Fist character starting from the left
-24 <= n < 0	Nth character starting from the right and up to the register end
n < -24	DATA ERROR

If the X-register contains an Alpha string ,ALPHA DATA is displayed.

Example :

In this example, the ALPHA register is completely represented, null characters at the left of the register are represented with horizontal marks, but they cannot be displayed by the calculator.

Input :	Display		
[ALPHA] DECAMETRE [ALPHA]		DECAMETRE	
0 [XEQ] "ATOXX"	68.0000		Code of "D"
4 [XEQ] "ATOXX"	77.0000		Code of "M"
6 [CHS] [XEQ] "ATOXX"	65.0000		Code of "A"
10 [CHS] [XEQ] "ATOXX"	0.0000		Null character

- Build a pointer - BLDPT

[BLDPT] (BuiLD PoinTer) builds a pointer bbb.eeeii if X>0 or an array pointer if X<0.

Example 1 : A program has left in the Z-register the number of the first register of a set of data, in the Y-register the number of the last register of the set, and in the X-register the number of registers between two data. Z=25 Y=40 X=5

To compute the pointer: [XEQ] "BLDPT", [FIX] 5. X= 25.04005 will give the address of R25, R30, R35, R40.

Example 2 : A previous program has left, in the Z-register the first register number of an array, in the Y-register the number of lines, in the X-register the number of columns : Z=25 Y=4 X=5.
To get the array pointer, [CHS] [XEQ] "BLDPT", X=25.04405

column	no1	no2	no3	no4	no5
line no1	R25	R26	R27	R28	R29
line no2	R30	R31	R32	R33	R34
line no3	R35	R36	R37	R38	R39
line no4	R40	R41	R42	R43	R44

ARRAY A

INSTRUCTIONS FOR BLDPT

1) To build a bbb.eeeii pointer :

- Put bbb in the Z-register;
- Put eee in the Y-register;
- Put ii in the X-register;
- Execute [BLDPT].

2) To build a bbb.eeecc array pointer; where bbb specifies the address of the first register used by the array, eee specifies the last register used by the array and cc the number of columns :

- Put bbb in the Z-register;
- Put the number of lines lll of the array in the Y-register;
- Put the number of columns cc of the array in the X-register, with a negative sign;
- Execute [BLDPT].

NOTA : If either the X, Y, Z register contains an Alpha string, ALPHA DATA is displayed.
The pointer is built with the absolute values of bbb and eee.

STACK :

for X>0		For X<0	
Input :	Output :	Input :	Output :
T: t	T: t	T: t	T: t
Z: bbb	Z: t	Z: bbb	Z: t
Y: eee	Y: t	Y: lll	Y: t
X: ii	X: bbb.eeeii	X: cc	X: bbb.eeecc
L: l	L : eee	L: l	L: lll

- Break pointer - **BRKPT**

[BRKPT] (BReaK PoinTer) splits into its three components a bbb.eeeii pointer if X>0, or an array pointer if X<0.

EXAMPLES :

1) A program needs the elements of a bbb.eeeii pointer, where bbb is the first register of a set of data, eee is the last one and ii the number of values between two data in the set. X= 25.04005 specifies registers R25, R30, R35, R40 [XEQ] "BRKPT" returns Z=25, Y=40, X=5.

2) The array pointer is 25.04405, it specifies that the array begins at R25, ends at R44, and has 5 columns. The array number of lines is returned by : [CHS] [XEQ] "BRKPT". So Z=25 (1st register), Y=4 (number of lines), X=-5(number of columns).

```
          column     no1   no2   no3   no4   no5
                    _____ _____ _____ _____ _____
                   | R25 | R26 | R27 | R28 | R29 |
        line no1   |_____|_____|_____|_____|_____|
                   | R30 | R31 | R32 | R33 | R34 |
        line no2   |_____|_____|_____|_____|_____|
                   | R35 | R36 | R37 | R38 | R39 | ARRAY
        line no3   |_____|_____|_____|_____|_____|
                   | R40 | R41 | R42 | R43 | R44 |
        line no4   |_____|_____|_____|_____|_____|
```

INSTRUCTIONS FOR BRKPT

1) To split up a bbb.eeeii pointer where bbb, in the range 0-999, is the first element of a loop or a vector; where eee, in the same range, is the last element; and where ii is the increment. One must check that the number in the X-register is positive, for instance with [XEQ] "ABS"; then [XEQ] "BRKPT" will return the integer part of the X-register to the Z-register, the first 3 digits of the decimal part to the Y-register, and the 4th and 5th digits of the decimal part to the Z-register.
The pointer is saved in LASTX.

2) To break a bbb.eeecc array pointer, where bbb is the register of the first element of the array, eee is its last register, and cc is the number of columns. One must insure that the number in the X-register is negative, for instance with [ABS] [CHS]; then [XEQ] "BRKPT" returns the first register (bbb) to the Z-register, the number of lines lll=(eee+1-bbb)/cc to the Y-register, and the number of columns (cc) to the X-register.
The array pointer is saved in LASTX.

Nota : If there is an Alpha string in the X-register, ALPHA DATA is displayed.

STACK :

for X>0		For X<0	
Input :	Output :	Input :	Output :
T: t	T: x	T t	T: x
Z: z	Z: bbb	Z: z	Z: bbb
Y: y	Y: eee	Y: y	Y: ll
X: bbb.eeeii	X: ii	X: bbb.eeecc	X: cc
L: l	L: bbb.eeeii	L: l	L: bbb.eeecc where $eee=(ll*\lvert cc\rvert)-1+bbb$

- **Load flag set** -

CHFLAG

[CHFLAG] (**CH**ange **FLAG**s) restores the flag set that was current when the CHFLAG function was written in the program.

Example : At the beginning of a program, you want to be in DEGree mode, 3 digits ENG and with the 5 first flags (0-4) set.

While in RUN mode (PRGM indicator off) initialize the calculator as needed, then in PRGM mode [XEQ] "CHFLAG". It writes two lines in the program : the first line is CHFLAG, the second one is a 7 character string. When the program is executed the calculator is initialized to the needed state.

INSTRUCTIONS FOR CHFLAG

1) In RUN mode, initialize the calculator to the state needed by the program.

2) In PRGM mode, [XEQ] "CHFLAG" writes two lines, the first one is CHFLAG, the second one contains a seven character string, which represents the current flag set. This string begins with a configuration indicator. If this string is destroyed or replaced by a wrong one, CHFLAG execution will halt program execution and CHFLAG ERR will be displayed.

STACK :

[CHFLAG] execution does not affect the stack.

N.B : The ALPHA register is not modified by [CHFLAG]. The character string represents a set of flags, it is not for the ALPHA register.

One must not put a test instruction before CHFLAG as ISG or X=Y?.

```
E.g. : FS? 01      If the flag is set

CHFLAG            Reinitializes the calculator.

'-----'           Initialization string.
```

If the test is negative (Flag 01 clear) the ALPHA register is destroyed by the configuration string.

[CHFLAG] only saves flags 00 to 43.

F00 to F10 : user's flags.

F11 : Automatic execution of current program, at power on; or after reading one from mass memory.

F12 to F20 : External device commands.

F12		Double width.
F13		Lower case letters.
F15	F16	Printing mode of HP-IL printer.
0	0	Manual
0	1	Normal
1	0	Trace
1	1	Trace and stack printing.

F16
F17 CR-LF ignored
F18
F19
F20
F21 Print enabled
F22 set by a numeric input.
F23 set by an alphanumeric input
F24 Out of range ignored.
F25 Error ignored
F26 Beep on
F27 User mode
F28 Decimal separator type.
F29 Three digit groups separator.
F31 DMY mode of TIME module.
F32 MANIO mode on HP-IL module.
F34 ADROFF mode on EXTENDED I/O.
F35 Auto start enable (AUTOSTART/DUPLICATION ROM).
F36 to F39 Number of digits for FIX, SCI, ENG.
F40 and F41 Display mode.
F42 and F43 Angular mode.

- Clear Increment - CLINC

[CLINC] (CLear INCrement) truncates the number in the X-register from the 4th digit of the decimal part.

Example : You want to compute the first and last registers of an array.
The array pointer is saved in R00. Use the following sequence :

Keystrokes :	Display	
[RCL] 00	25.04405	Recall the array pointer
[XEQ] "CLINC"	25.04400	
[XEQ] "INT"	25.00000	1st register
[LASTx]	25.04400	
[XEQ] "FRC"	0.04400	
[EEX] 3 [*]	44.00000	Last register

INSTRUCTIONS FOR CLINC

[CLINC] replaces, in the X-register, any decimal digits after the 3rd one by 0. The old value is saved in LASTX.

STACK

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	z
Y:	y	Y:	y
X:	bbb.eeeii	X:	bbb.eee
L:	l	L:	bbb.eeeii

NOTA : If the X-register contains an Alpha string, ALPHA DATA is displayed.

Create column pointer - COLPT

[COLPT] (COLumn PoinTer) returns a column pointer to the X-register, from the column number in the Y-register, and the array pointer in the X-register.

Example : to gets the second column pointer of the array A, which pointer is in register 00.

Keystrokes :	Display :	
2	2_	Column number.
[RCL] 00	25.04405	Recall pointer.
[XEQ] "COLPT"	26.04105	2nd column pointer.

column	no1	no2	no3	no4	no5	
line no1	R25	R26	R27	R28	R29	
line no2	R30	R31	R32	R33	R34	
line no3	R35	R36	R37	R38	R39	ARRAY A
line no4	R40	R41	R42	R43	R44	

INSTRUCTIONS FOR COLPT

1) Input the column number.

2) Put the array pointer in the X-register.

3) [XEQ] "COLPT" returns the column pointer to the X-register, and saves the array pointer in LASTX.

STACK :

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	t
Y:	Column NO	Y:	z
X:	bbb.eeeii	X:	bbb.eeeii
L:	l	L:	bbb.eeeii

N.B. : i'i'=ii

[GETRGX] (**GET** Re**G**isters by **X**) copies in the registers specified by the X-register, the data of the current Extended Memory file (file where the pointer is), starting from pointer position, and according to the increment in the X-register.

Example : The pointer in the curent file is on 10, 25.0440510 [XEQ] "GETRGX" copies register 10, 20, 30,... from the X-Memory file, to registers 25, 30, 35,... in main memory.

INSTRUCTIONS FOR GETRGX

1) Set the current file pointer to the right position with [SEEKPT] or [SEEKPTA].

2) The number in the X register is a bbb.eeeiijj pointer, where bbb is the first main memory register, eee the last main memory register where you want to copy the X-Memory data set, ii is the increment for the main memory registers, and jj the increment for the X-Memory registers.

3) [XEQ] "GETRGX" copies the registers from the X-Memory current file to the main memory registers as specified by the pointer in the X-register.

STACK :

The stack is unchanged by [GETRGX].

EXAMPLE

The drawings below represents two arrays, the left one is in main memory, the right one is in X-Memory. In each square is indicated the register number, and its value (a letter).

Set the X-Memory pointer to the first register to copy, with 12 [SEEKPT].

To copy the second column of the array B, in X-Memory to the 3rd column of array A in main memory, put in the X-register the pointer of the 3rd column of array A (27,04205), and add the increment for the X-Memory registers (03) as 6th and 7th decimal digits :

X= 27.0420503 .

27 = bbb 1st register in main memory.
42 = eee last register in main memory.
05 = ii increment for main memory registers.
03 = jj increment for X-Memory registers.

[XEQ] "GETRGX" copies the registers as specified by the pointer in the X-register; the result is represented on the second drawing.

BEFORE [GETRGX]

Array A main memory

col	no1	no2	no3	no4	no5
ln 1	R25 A	R26 B	R27 C	R28 D	R29 E
ln 2	R30 F	R31 G	R32 H	R33 I	R34 J
ln 3	R35 K	R36 L	R37 M	R38 N	R39 O
ln 4	R40 Q	R41 R	R42 S	R43 T	R44 U

Array B X-Memory

col	no1	no2	no3
ln no1	R11 a	R12 b	R13 c
ln no2	R14 d	R15 e	R16 f
ln no3	R17 g	R18 h	R19 i
ln no4	R20 j	R21 k	R22 l

AFTER [GETRGX]

Array A main memory

col	no1	no2	no3	no4	no5
ln 1	R25 A	R26 B	R27 b	R28 D	R29 E
ln 2	R30 F	R31 G	R32 e	R33 I	R34 J
ln 3	R35 K	R36 L	R37 h	R38 N	R39 O
ln 4	R40 Q	R41 R	R42 k	R43 T	R44 U

Array B X-Memory

col	no1	no2	no3
ln no1	R11 a	R12 b	R13 c
ln no2	R14 d	R15 e	R16 f
ln no3	R17 g	R18 h	R19 i
ln no4	R20 j	R21 k	R22 l

- Line-column to address - LC-AD

[LC-AD] (Line-Column-ADDress) returns the register number of an array element from its line number, column number, and array pointer.

Example : Register number of the element on line 2 and column 3 of array A, which array pointer (25.04405) is saved in R00.$

column	no1	no2	no3	no4	no5	
line no1	R25	R26	R27	R28	R29	
line no2	R30	R31	R32	R33	R34	
line no3	R35	R36	R37	R38	R39	ARRAY A
line no4	R40	R41	R42	R43	R44	

Keystrokes :	Display :	
[2] [ENTER^]	2.0000	Input line number.
[3]	3_	Input column number.
[RCL] 00	25.04405	Recall array pointer.
[XEQ] "LC-AD"	32.00000	Register NO.

INSTRUCTIONS FOR LC-AD

To compute the register number of an array element, when you know its line number, column number, and array pointer : Input line number, [ENTER^], Column number, [ENTER^], array pointer. [XEQ] "LC-AD" returns the register number to the X-register, and saves the pointer in LASTX.

STACK :

Input :	Output :
T: T	T: T
Z: line no	Z: T
Y: column no	Y: T
X: Array Pointer	X: register no
L: L	L: Array pointer

- Create line pointer - LINPT

[LINPT] (**LIN**e **P**oin**T**er) returns a line pointer to the X-register, given the line number in the Y-register and the array pointer in the X-register.

Example : To compute the registers used by the 2nd line of array A, whose array pointer is assumed to be found in register R00 :

Keystrokes :	Display :	
[2]	2_	Line number.
[RCL] [0] [0]	25.04405	Recall array pointer.
[XEQ] "LINPT"	30.03400	2nd line pointer.

column	no1	no2	no3	no4	no5
line no1	R25	R26	R27	R28	R29
line no2	R30	R31	R32	R33	R34
line no3	R35	R36	R37	R38	R39
line no4	R40	R41	R42	R43	R44

ARRAY A

INSTRUCTIONS FOR LINPT

1) Input the line number, whose pointer is needed.

2) Put the array pointer in the X-register.

3) [XEQ] "LINPT" returns the line pointer to the X-register and saves the array pointer in LASTX.

STACK :

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	t
Y:	line NO	Y:	z
X:	bbb.eeeii	X:	bbb.eeeii
L:	l	L:	bbb.eeeii

- No Operation - NOP

[**NOP**] (No **OP**eration) is used after a test, when the conditional goto is not used.

Example : To increment the X and Y registers in a loop.

The following sequence will do it :

```
ISG Y    Increment the Y-register.
NOP      No OPeration.
ISG X    Increment the X-register,
GTO 03   and looped if higher.
```

- Position of an string in ALPHA - POSA

[**POSA**] (**POS**ition in Alpha) searches the ALPHA register, from left to right, for the character or string specified in the X-register.

Example 1 : The string "ABCDEFGHIJ" is in the ALPHA register, what is the position of the 1st "D" character ?

Keystrokes :	Display :	
68	68_	"D" character code.
[XEQ] "POSA"	3.0000	1st "D" character position.

Example 2 : [ALPHA] [CLA] DEF [ASTO] . X ABCDEFGHIJ [ALPHA] [XEQ] "POSA" X=3.00

INSTRUCTIONS FOR POSA

1) [POSA] searches the ALPHA register, from left to right, for the character or string specified in the X-register. The string can be specified either by giving a character code, or by storing the string or character in the X-register with [ASTO] [.] [X]. If the calculator finds the string in the ALPHA register, it returns the 1st character position to the X-register.

2) Positions are considered from left to right and start with position 0. If the string or character appears several time in the ALPHA register, the calculator returns only the first position. If the string or the character does not exist in the ALPHA register, -1 is returned.

3) The string or character code is saved in LASTX.

STACK :

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	z
Y:	y	Y:	y
X:	code or string	X:	position in ALPHA
L:	l	L:	code or string

- MEMORY ALLOCATION FUNCTIONS -

- Programmable SIZE - PSIZE

[PSIZE] (Programmable SIZE) allocates the number of data registers specified by the X-register.

- Number of data registers - SIZE

[SIZE?] returns to the X-register the number of data registers.

[SIZE?] and [PSIZE] can be used in the same program to change the number of data registers without loosing any data.

EXAMPLE :

```
01 ....
02 ....
....            Your program
....
07 SIZE?        Return to the X-register the number of data registers.
08 125          The new program needs 125 data registers.
                The current number of data registers is in the Y-register.
09 X>Y?         Does the program needs more data registers ?
10 PSIZE        Change if necessary.
```

-Read all extended memory from mass memory - READEM

[READEM] (**READ** Extended Memory) copies from a mass memory file (HP82161A tape drive) the whole contents of X-Memory, which was previously saved in the file with the WRTEM function.

Example : To load the file "MAT3" from the tape.

```
    Keystrokes :            Display :

[XEQ] "EMDIR"             DIR EMPTY     Checks that the X-Memory is empty.
                                        If two XMEMORY modules are plugged
                                        in, there are 600 registers available.
[ALPHA] "MAT 3" [ALPHA]   600.0000      File name in ALPHA.
[XEQ] "READEM"
                          600.0000      the files are loaded into X-Memory.
[XEQ] "EMDIR"           MATRP   P012
                        A       D100    All these files have been read
                        TEXTE   A040    by READEM.
                        ....
```

INSTRUCTIONS FOR READEM

1) After storing the file name into the ALPHA register, [XEQ] "READEM" copies this file from the mass memory medium to X-Memory.

2)If there is no HP-IL module, NO HPIL is displayed.

3) If the file is not on the medium, FL NOT FOUND is displayed.

4) If there is not enough space in X-Memory, NO ROOM is displayed. In this case add one or two X-MEMORY modules

5)If the HP-IL module is plugged in, but there is no mass memory device on the loop, "NO DRIVE" is displayed.

6)If the file specified was not created by [WRTEM], "FLTYPE ERR" is displayed.

NOTA : Before loading a set of files, [READEM] purges the X-Memory.

STACK :

The stack is unaffected by [READEM].

INVERSE FUNCTION : WRTEM.

[RG] is a function which makes easier the entry of functions beginnings with "RG". This function should be assigned to a key. For instance, assigne [RG] to the [LN] key.

ASN "RG" 15

Keystrokes : [ ] [ASN] [ALPHA] [R] [G] [ALPHA] [LN]. Put the calculator in USER mode. Now to execute or program a function beginning with "RG", for instance "RGVIEW", stroke the following keys :

[RG] (LN key) [ALPHA] [V] [I] [E] [W] [ALPHA]

This sequence is equivalent to :

[XEQ] [ALPHA] [R] [G] [V] [I] [E] [W] [ALPHA]

So you save 2 keystrokes, every time you use a function beginning with "RG".

INSTRUCTIONS FOR RG

1) Assign [RG] to a key and set USER mode.

2) To execute or input a function beginning with "RG" :

[RG] (Assigned previously)

[ALPHA]

...function name without the 1st two letters.

...(e.g. SUM for RGSUM).

[ALPHA]

- OPERATIONS BETWEEN REGISTERS -

- Addition or substraction of two vectors - **RG+-**

[RG+-] (ReGisters + or -) adds or substracts, element by element, two vectors whose pointers are in registers X and Y. The sign of the X register specifies the type of operation.

- Multiplication of two vectors, element by element - **RG***

[RG*] (ReGisters *) multiplies the two vectors, element by element, whose pointers are in registers X and Y.

- Divide two vectors, element by element - **RG/**

[RG/] (ReGisters /) divides, element by element, the two vectors, whose pointers are in the X and Y registers.

Example : in the Array below :

- replace the 1st column by the addition, element by element, of the 3rd and 1st column ;

- then compute the square of the elements of 4th column;

- finaly, divide each of those squares by the 4 first elements of the first line.

The array pointer is saved in register R00.

Array before execution :

N.B. In each box are shown the register number and its initial value.

column	no1	no2	no3	no4	no5
line no 1	R25 142	R26 20	R27 857	R28 40	R29 1
line no 2	R30 285	R31 12	R32 714	R33 14	R34 2
line no 3	R35 428	R36 22	R37 571	R38 24	R39 3
line no 4	R40 714	R41 32	R42 285	R43 34	R44 4

ARRAY B

Keystrokes :	Display :	
[CF] 28 [FIX] 5		
[1] [RCL] 00	25.04405	
[COLPT]	25.04005	First column pointer.
[3] [RCL] 00	25.04405	
[COLPT]	27.04205	3rd column pointer.
[XEQ] "RG+-"	25.04005	Pointer of the output vector.

Now, you can check that registers R25, R30, R35, and R40, which make up the first column, are equal to 999.

[4] [RCL] 00	25.04405	
[COLPT] [ENTER]	28.04305	X and Y contains the 4th column pointer.
[RG] "*"	28.04305	

Now, the elements of the 4th column are :

R28= 1600 R33= 196 R38= 576 R43= 1.156

[1] [RCL] 00	25.04405	
[LINPT]	25.02900	First line pointer.
[XEQ] "RG/"	28.04305	

At end, the 4th column contains the result of the division, and the array is the following.

column	no1	no2	no3	no4	no5
	R25	R26	R27	R28	R29
line no1	999	20	857	1.60	1
	R30	R31	R32	R33	R34
line no2	999	12	714	9.80	2
	R35	R36	R37	R38	R39
line no3	999	22	571	0.67	3
	R40	R41	R42	R43	R44
line no4	999	32	285	722	4

ARRAY C

INSTRUCTIONS FOR RG+- RG* RG

1) Functions [RG+-], [RG*] and [RG/] require two pointers. The operand pointer must be in the Y-register and the operator pointer in the X-register.

2) The results are stored into the block pointed by the Y-register.

3) After execution, the X-register contains the resulting vector pointer.

STACK :

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	t
Y:	pointer no1	Y:	z
X:	pointer no2	X:	pointer no1
L:	l	L:	pointer no2

- SCALAR TO REGISTERS OPERATIONS -

- Add constant to registers - **RG+Y**

[RG+Y] (ReGisters + Y) adds the Y-register value to the registers specified by the X-register.

- Multiply registers by constant - **RG*Y**

[RG*Y] (ReGisters * Y) multiplies the registers specified by the X-register, by the Y-register value.

- Divide registers by constant - **RG/Y**

[RG/Y] (ReGisters / by Y) divides the registers specified by the X-register, by the Y-register value.

Example : In the Array B :

- Substract 5 to the first column ;
- multiply by 2 the 3rd line;
- divide by 6 the 5th column.

The array pointer is saved in register R00.

column	no1	no2	no3	no4	no5
	R25	R26	R27	R28	R29
line no1	1	2	3	4	5
	R30	R31	R32	R33	R34
line no2	6	7	8	9	10
	R35	R36	R37	R38	R39
line no3	11	12	13	14	15
	R40	R41	R42	R43	R44
line no4	16	17	18	19	20

ARRAY B

Keystrokes :	Display :	
5 [CHS] [ENTER^]	-5.00000	Input the constant.
1 [RCL] 00	25.04405	
[COLPT]	25.04005	First column pointer.
[RG] "+Y"	25.04405	Pointer of result vector.

You can check that R25, R30, R35, R40 contains respectively 4, 1, 6, and 11 ; it is the first column of the array.

```
2 [ENTER^]          2.00000         Input the constant.
3 [RCL] 00          25.04405
[LINPT]             35.03900        3rd column pointer.
[RG] "*Y"           35.03900
```

Now the 3rd line values have been multiplied by 2. R35= 12, R36= 24, R37= 26, R38= 28, R39= 30.

```
6 [ENTER^]          6.00000         Input constant.
5 [RCL] 00          25.04405
[COLPT]             29.04405        5th column pointer.
[RG] "/Y"           29.04405
```

After all these transformations, array B is :

column	no1	no2	no3	no4	no5
	R25	R26	R27	R28	R29
line no1	-4	2	3	4	0.83
	R30	R31	R32	R33	R34
line no2	1	7	8	9	1.66
	R35	R36	R37	R38	R39
line no3	12	24	26	28	5
	R40	R41	R42	R43	R44
line no4	11	17	18	19	3.33

ARRAY B

INSTRUCTIONS FOR RG+Y RG*Y RG/Y

1) [RG+Y], [RG*Y], [RG/Y], need a constant in the Y-register, and a pointer in the X-register.

2) Operations are directly performed on the register value, so results replace initial values.

STACK :

Input :	Output :
T: t	T: t
Z: z	Z: z
Y: scalar	Y: scalar
X: pointer	X: pointer
L: l	L: l

The stack is unchanged by [RG+Y], [RG*Y], [RG/Y].

- Registers to ALPHA or ALPHA to registers - RGAX

[RGAX] (ReGisters-Alpha by X) performs two functions :

1)If X<0, it copies the ALPHA register to the registers specified by the register pointer in the X-register;

2) If X>=0, it appends to the ALPHA register the contents of the registers specified by the register pointer in the X-register.

Example : The string "ABCDEFGHIJKLMNOPQRSTUVWX" is in the ALPHA register. To save it in even registers, starting from R10, use the following sequence :

Keystrokes :	Display :	
10.00002 [CHS]	-10.00002_	Pointer. The negative value indicates that it stores ALPHA to registers.
[RG] "AX"	-17.00002	The pointer specified the register following the last one used by [RGAX].
[RCL] 10	ABCDEF	first 6 characters.
[RCL] 12	GHIJKL	next 6 characters.
[RCL] 14	MNOPQR	next 6 characters.
[RCL] 16	STUVWX	last 6 characters.

Now, if you want to retrieve registers R12 and R16 to the ALPHA register :

12.00004	12.00004	Register pointer to recall the string.
[XEQ] "CLA"	12.00004	clear the ALPHA register.
[RG] "AX"	17.00004	Indicate next register.
[ALPHA]	GHIJKLSTUVWX	Recall ends, when the last character of the string is found.

INSTRUCTIONS FOR RGAX

1) The [RGAX] function can be used, to save all the ALPHA register to the registers specified by the register pointer in the X-register. In this case the pointer must be negative. When the calculator saves a string, it adds an 'End-of-String' indicator to the last register used. This indicator is used when the string is recalled ; it is invisible, but a modification of the last register destroys the indicator.

2) The [RGAX] function can also be used to recall a string that was previously saved in a set of registers. In this case, the pointer should be positive. The string is appended to the ALPHA register string. If the new string is more than 24 characters long, only the last 24 ones remains in the ALPHA register. The leftmost characters are lost. Loading stops when an 'End-of-String' indicator is recalled, or if there is no indicator, when a numeric value is found. In this case, the numeric value is appended, in the current format, to the ALPHA register, as it would be with [ARCL].

3) In both cases, [RGAX] saves the initial pointer in LASTX, and leaves a ± bbb,eeeii pointer in the X-register. bbb is the last register used +1, eeeii is the eeeii part of the initial pointer. The first three decimal digits of the initial pointer can be anything, because [RGAX] does not use them.

STACK :

Input :	Output :
T: t	T: t
Z: z	Z: z
Y: y	Y: y
X: Initial pointer	X: New pointer
L:l	L: Initial pointer

- Copy or exchange registers -

RGCOPY

[**RGCOPY**] (**R**e**G**isters **COPY**) performs two types of operations :

If X>=0, [RGCOPY] copies the registers specified by the X-register pointer, to the registers specified by the Y-register pointer.

If X<0, [RGCOPY] swaps the registers specified in the X-register, with the ones specified in the Y-register.

Example : In the array B, copy the first column to the 3rd one, then swap the 1st and 2nd columns.

ARRAY B

column	no1	no2	no3	no4	no5
line no1	R25 1	R26 2	R27 3	R28 4	R29 5
line no2	R30 6	R31 7	R32 8	R33 9	R34 10
line no3	R35 11	R36 12	R37 13	R38 14	R39 15
line no4	R40 16	R41 17	R42 18	R43 19	R44 20

Suppose that the array pointer is in register R00.

Keystrokes :	Display :	
3 [RCL] 00 [COLPT]	27.04205	Destination pointer.
1 [LAST X] [COLPT]	25.04005	Origin pointer.
[XEQ] "RGCOPY"	27.04205	Destination pointer.
[RGVIEW]		list the 3rd column R27= 1,..., R42= 16.
1 [RCL] 00 [LINPT]	25.02900	1st Pointer.
2 [LAST X] [COLPT] [CHS]	-26.04105	2nd pointer.
[RG] "COPY"	25.02900	The stack moved down.

The final array is :

column	no1	no2	no3	no4	no5
line no1	R25 2	R26 7	R27 12	R28 17	R29 5
line no2	R30 6	R31 1	R32 6	R33 9	R34 10
line no3	R35 11	R36 1	R37 11	R38 14	R39 15
line no4	R40 16	R41 4	R42 16	R43 19	R44 20

ARRAY B

INSTRUCTIONS FOR RGCOPY

1) The sign of the pointer in the X-register specifies if the registers have to be copied (X>=0) or swapped (X<0).

2) Copy is performed from the registers specified by the pointer in the X-register to the registers specified by the pointer in the Y-register.
At the end the stack moves down.

3) Swap is done between the registers specified in the X and Y registers.
If there is no overlapping, swap begins with the lower register number.
If there is overlapping, the calculator begins, one way or another (i.e. upwards or downwards), so that no information is lost.

STACK :

Input :	Output :
T: t	T: t
Z: z	Z: t
Y: Destination pointer	Y: z
X: Origin pointer	X: Destination pointer
L: l	L: Origin pointer

Initialization of registers by X - **RGINIT**

[RGINIT] (ReGisters INITialize) performs two kinds of initializations :

If X>=0 [RGINIT] stores zero in all the registers specified by the pointer in the Xregister.

If X<0 [RGINIT] stores integers, from 1 to N, into the registers specified by the pointer in the X-register, N being the numbers of registers specified.

Example : In the array B, which pointer is saved in register R00, columns 3 and 5 will be zeroed, then the columns will be numbered from 1 to 5, throught the first line.

column	no1	no2	no3	no4	no5	
	R25	R26	R27	R28	R29	
line no1	a	b	c	d	e	
	R30	R31	R32	R33	R34	
line no2	f	g	h	i	j	
	R35	R36	R37	R38	R39	ARRAY B
line no3	k	l	m	n	o	
	R40	R41	R42	R43	R44	
line no4	p	q	r	s	t	

Keystrokes :	Display :	
3 [RCL] 00 [COLPT]	27.04205	3rd column pointer.
[XEQ] "RGINIT"	27.04205	Initialize 3rd column to zero.
5 [LASTx] [COLPT]	29.04405	5th column pointer.
[XEQ] "RGINIT"	29.04405	Initialize 5th column to zero.
1 [LASTx] [LINPT] [CHS]	-25.02900	Negative sign to indicate an
[XEQ] "RGINIT"	-25.02900	Initialization with integers 1 to N.

column	no1	no2	no3	no4	no5	
	R25	R26	R27	R28	R29	
line no1	1	2	3	4	5	
	R30	R31	R32	R33	R34	
line no2	f	g	Ø	i	Ø	
	R35	R36	R37	R38	R39	ARRAY B
line no3	k	l	Ø	n	Ø	
	R40	R41	R42	R43	R44	
line no4	p	q	Ø	s	Ø	

INSTRUCTIONS FOR RGINIT

1) When the register pointer, in the X-register, is positive, the specified registers are initialized to zero.

2) When the register pointer in the X-register is negative, the specified registers are initialized with integers, starting with 1 and incrementing it by 1 for each register, up to the last one.

STACK :

The stack is unchanged by the execution of [RGINIT].

- Number of registers specified by a pointer - RGNb

[RGNb] (**ReG**isters, **NumB**er of) returns the number of registers specified by the pointer in the X-register.

Example : Compute the number of elements of an array, whose pointer is saved in register R00 ; then compute the number of registers per line.

Keystrokes :	Display :	
[RCL] 00 [CLINC]	25.04400	Registers pointer.
[XEQ] "RGNb"	20.00000	The array contains 20 registers.
1 [RCL] 00 [LINPT]	25.02900	Line pointer.
[XEQ] "RGNb"	5.00000	There are 5 registers per line.

INSTRUCTIONS FOR RGNb

[RGNb] returns to the X-register, the number of registers specified by a bbb.eeeii pointer to the X-register. The pointer is saved in LASTX.

STACK

Input :	Output :
T: t	T: t
Z: z	Z: z
Y: y	Y: y
X: Pointer	X: Number of elements
L: l	L: Pointer

- Sum of registers - RGSUM

[RGSUM] (ReGisters, SUM of) returns to the X-register the sum of the registers specified by the pointer in the X-register.
If the pointer is negative, [RGSUM] performs the sum of the absolute values of the specified registers.

Example : In the array F, whose pointer is saved in register R00, one wants the total of the 1st column, and the sum of the 4th column, but considering the absolute value of the elements.

column	no1	no2	no3	no4	no5
	R25	R26	R27	R28	R29
line no1	-14	15	21	2	8
	R30	R31	R32	R33	R34
line no2	7	13	19	-20	1
	R35	R36	R37	R38	R39
line no3	0	6	12	18	24
	R40	R41	R42	R43	R44
line no4	23	4	5	11	17
	R45	R46	R47	R48	R49
line no5	16	22	3	9	10

ARRAY F

Keystrokes :	Display :	
1 [RCL] 00 [COLPT]	25.04505	1st column pointer.
[RG] "SUM"	32.00000	Sum of elements.
4 [RCL] 00 [COLPT]	28.04805	4th column pointer.
[CHS]	-28.04805	Negative. It specifies a sum of absolute values.
[XEQ] "RGSUM"	60.00000	Sum of absolute values.

INSTRUCTIONS FOR RGSUM

[RGSUM] returns to the X-register, the sum of the registers specified in the X-register. If the pointer in the X-register is negative, [RGSUM] performs the sum of the absolute values of the registers.

STACK :

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	z
Y:	y	Y:	y
X:	Pointer	X:	Sum
L:	l	L:	Pointer

APPLICATION PROGRAMS FOR RGSUM

1) In the array F, we want to put in the 3rd column, the percentage of the values of the 4th column, related to their sum.

Keystrokes ::	Display :	
3 [RCL] 00 [COLPT]	27.04705	Destination pointer.
2 [LAST X] [COLPT]	26.04605	Origin pointer.
[RGCOPY]	27.04705	Copy the 2nd column to the 3rd one.
[XEQ] "RGSUM"	60.00000	Sum of elements.
[LAST X] [X<>Y]	60.00000	Save the pointer.
100 [/]	0.60000	To compute the percentage.
[X<>Y] [RG/Y]	27.04705	End.

Now array F is :

column	no1	no2	no3	no4	no5
	R25	R26	R27	R28	R29
line no1	-14	15	25	2	8
	R30	R31	R32	R33	R34
line no2	7	13	21.6	-20	1
	R35	R36	R37	R38	R39
line no3	0	6	10	18	24
	R40	R41	R42	R43	R44
line no4	23	4	6.6	11	17
	R45	R46	R47	R48	R49
line no5	16	22	36.6	9	10

ARRAY F

The 3rd column now holds the percentages !

- Registers input or catalog - RGVIEW

[RGVIEW] (ReGisters VIEW) is a multi-mode function to view, and/or edit registers.

Example : the following sequence performs several viewing of the array I. In some cases, registers are modified.

```
      column    no1   no2   no3   no4   no5
               _____ _____ _____ _____ _____
              | R25 | R26 | R27 | R28 | R29 |
    line no1  |   1 |   2 |   3 |   4 |   5 |
              |_____|_____|_____|_____|_____|
              | R30 | R31 | R32 | R33 | R34 |
    line no2  |   6 |   7 |   8 |   9 |  10 |
              |_____|_____|_____|_____|_____|
              | R35 | R36 | R37 | R38 | R39 |
    line no3  |  11 |  12 |  13 |  14 |  15 |   ARRAY I
              |_____|_____|_____|_____|_____|
              | R40 | R41 | R42 | R43 | R44 |
    line no4  |  16 |  17 |  18 |  19 |  20 |
              |_____|_____|_____|_____|_____|
```

Keystrokes :	Display :	
[CF] 28 [FIX] 6 [<-]	0.000000	
[RCL] 00 [RGVIEW]	25= 1.000000	
	30= 6.000000	View the first column.
[R/S]	35= 11.00000	Halt the catalog.
[SST]	40= 16.00000	Single stepping is
[BST]	35= 11.00000	Possible in both direction.
[<-]	25.044050	Exit the catalog .
[CLINC]	25.044000	Register pointer.
[RGVIEW]	25= 1.000000	
	26= 2.000000	Automatic stepping in the
	27= 3.000000	registers and visualization
	28= 4.000000	of them.
[ON]		Turn the calculator off, then back on.
[ON] [CHS]	-25.044000	Pointer to stop at the first value.
[RGVIEW]	25= 1.000000	
15	25= 15_	Input directly
[CHS]	25= -15_	Into the register,
[EEX]	25= -15 _	exactly as normal keyboard
2 [CHS]	25= -15 -2_	input.
[R/S]	26= 2.000000	Validate data.
[BST]	25= -0.15000	Verification.
[SST] [ALPHA]	26= 2.000000	Set ALPHA mode.
ABCDEF	26= ABCDEF_	Up to 6 characters

G	26= BCDEFG_	are allowed.
[<-]	26= BCDEF_	Corrections can be made.
[R/S] [BST]	26= BCDEF	Validation and verification.
[SST] A	27= A_	The ALPHA mode is still on.
[ALPHA]	27= 3.000000	Numeric mode.
[EEX] 2	27= 1 2_	
[SST] [BST]	27= 3.000000	Unchanged : no validation with [R/S].
[<-]	-25.044000	Exit.
2 [EEX] 6 [CHS]	2 -6	
[RCL] 00 [+]	25.044052	Array pointer.
[ALPHA] NOTHING G	NOTHING G_	Array name.
[ALPHA] [RGVIEW]	G1,1= -0.150000	Only the last character is used as the array name.
	G1,2= BCDEF	stepping in the array,
	G1,3= 3.000000	is automatic.
[R/S]	G1,4= 4.000000	[R/S] halts it.
[SST] [SST]	G2,1= 6.000000	The element coordinates
[BST]	G1,5= 5.000000	are displayed on the left.
19.5	G1,5= 19.5_	Quick and clear array
[R/S] .	G2,1= ._	input is possible.
[R/S]	G2,2= 7.000000	
[BST]	G2,1= 0.000000	
[<--] 6 [EEX] 6 [CHS]	6 -6_	
[RCL] 00 [CHS]	-25.044056	Vector pointer.
[RGVIEW]	G1= -0.1500000	1st element of the 1st column.
[SST]	G2= 0.000000	2nd element (R30).
[<--] 3 [RCL] 00 [COLPT]	27.042050	3rd column pointer.
6 [EEX] 6 [CHS] [+]	27.042056	
[CHS] [RGVIEW]	G1= 3.000000	1st element (R27).
[ALPHA] MONDAY	G1= MONDAY_	
[R/S] TUESD.	G2= TUESD._	Input the column,
[R/S] WEDN.	G3= WEDN._	element per element.
[R/S] THUR. [R/S] [ALPHA]	-27.042056	End input and clear ALPHA mode
4 [EEX] 6 [CHS] [ENTER]	0.000004	Creation of a new
3 [RCL] 00 [COLPT] [+]	27.042054	pointer.
[CHS] [RGVIEW]	MONDAY=	In this mode, [RGVIEW]
29	MONDAY= 29_	allows inputs while the former
[R/S] 12	TUESD.= 12_	value or string
[R/S] [BST]	12.000000=	is still displayed.
[<--] 1 [EEX] 6 [CHS]	1 -6	
[RCL] 00 [+] [RGVIEW]	25= -0.150000	In this catalog mode,
	35= 11.000000	zeroes are ignored.
	40= 16.000000	
	25.044051	

INSTRUCTIONS FOR RGVIEW

1) [RGVIEW] is a general purpose display, input, and print function, for main memory registers.

2) The X-register pointer specifies registers and [RGVIEW] mode. It is a bbb.eeeiij pointer.

If **X>0** : View in sequence the registers specified , up to the end of the specified block, or up to an interruption with the [R/S] key.

If **X<0** : View and stop on the 1st register specified. Use [SST] to skip to the next register. The [R/S] key resumes the listing.

When j is an odd number, registers equal to 0 are ignored (skipped).

If **j= 0** or **1**, it is a standard catalog : the register number and its value are displayed.

If **j= 2** or **3**, [RGVIEW] displays the array elements to the contents of the array name and elements coordinates to the left.

If **j= 4** or **5** [RGVIEW] displays the register value, followed by "=". Input is performed with the old value still in the display.

Example : Display LUNDI=
Input LUNDI= 10_

If **j=6** or **7** [RGVIEW] displays the vector name (1 dimension), the element coordinate (index), and its value.

In ALPHA mode, only the last six characters input are retained for entry.

A printer in NORMal or TRACE mode prints the register catalog output by [RGVIEW].

3) [RGVIEW] works like a CATalog ([SST] and [BST] are allowed).

STACK :

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	z
Y:	y	Y:	y
X:	pointer	X:	pointer
L:	l	L:	previous pointer

- Sort numeric and/or alphanumeric data - SORT

[SORT] sorts the registers specified in the X-register.

Example : In the array A below :

1) Sort in increasing order the values in the 2nd col.

2) Sort in decreasing order the values in the 3rd col.

ARRAY A

column	no1	no2	no3	no4	no5
	R25	R26	R27	R28	R29
line no1	14	B	21	2	8
	R30	R31	R32	R33	R34
line no2	7	13	19	20	1
	R35	R36	R37	R38	R39
line no3	0	A	-12	18	24
	R40	R41	R42	R43	R44
line no4	23	99	50	11	17

Keystrokes :	Display :	
2 [RCL] 00 [COLPT]	26.04105	Build 2nd column pointer.
[XEQ] "SORT"	SORTING	Sorting in progress ...
	26.04105	Done.
3 [LASTx] [COLPT] [CHS]	-27.04205	3rd column pointer; the negative pointer indicates a decreasing order.
[XEQ] "SORT"	SORTING	Sorting in progress ...
	-27.04205	Done.

ARRAY A

column	no1	no2	no3	no4	no5
	R25	R26	R27	R28	R29
line no1	14	13	50	2	8
	R30	R31	R32	R33	R34
line no2	7	99	21	20	1
	R35	R36	R37	R38	R39
line no3	0	A	19	18	24
	R40	R41	R42	R43	R44
line no4	23	B	-12	11	17

INSTRUCTIONS FOR SORT

1) [SORT] sorts either numeric values, or alpha strings. Strings are sorted according to their ASCII code and they are considered as being greather numeric values.

2) The pointer in the X-register specifies the registers to sort.

3) If X>=0, registers are sorted in increasing order.

4) If X<0, registers are sorted in decreasing order.

5) While sorting is in progress, if there is no message yet in the display, "SORTING" is displayed.

STACK :

[SORT] leaves the stack unchanged.

- Store by L-register - STO>L

[STO>L] (**STO**re by **L**) stores the X-register value, into the register specified by the integer part of the L-register pointer. It also increments this pointer ; stack lift is disabled.

Example : To input all the elements of the 1st line, of a 4 lines, 5 columns array, beginning with register R25.

Keystrokes :	Display :	
1	1_	
[RCL] 00	25.04405	Recall the pointer.
[LINPT]	25.02900	Compute 1st line pointer.
[STO] [.] [L]	25.02900	Store it in the L-register.
50	50_	1st line, 1st element.
[XEQ] "STO>L"	50.00000	Store it in R25.
[VIEW] [.] [L]	26.02900	Pointer has been incremented.
60	60_	2nd element.
[XEQ] "STO>L"	60.0000	Store 2nd element.
70	70_	
[XEQ] "STO>L"	70.0000	
80	80_	
[XEQ] "STO>L"	80.0000	
90	90_	
[XEQ] "STO>L"	90.0000	
[LASTx]	30.0290	

INSTRUCTIONS FOR STO>L

[STO>L] uses the L-register, as an address pointer to store the X-register value.

[STOL>L] transfers the X-register value, to the register specified by the L-register. Stack lift is not done, so several values can be input, without altering registers Y, Z, T. Furthermore, the pointer in the L-register is automatically incremented, resulting in significant code savings within a program.

STACK :

Input :		Output :	
T:	t	T:	t
Z:	z	Z:	z
Y:	y	Y:	y
X:	value to store	X:	value stored
L:	bbb	L:	bbb+1

Note : The decimal part of the L-register is ignored.

NOTA : If there is an alpha string in the L-register, ALPHA DATA is displayed.

APPLICATION PROGRAM FOR STO>L

1) [STO>L] was designed, to input register values programmatically. In order to input, the 1st colonne of the array B, whose pointer is in register R00, use the following sequence :

```
1  RCL 00   COLPT   STO L   50   STO>L   60   STO>L    70   STO>L  80  STO>L
```

column	no1	no2	no3	no4	no5
line no 1	R25 50	R26	R27	R28	R29
line no 2	R30 60	R31	R32	R33	R34
line no 3	R35 70	R36	R37	R38	R39
line no 4	R40 80	R41	R42	R43	R44

ARRAY A

- Extraction or justification of a substring - SUB$

[SUB$] (**SUB** string) extracts a substring from the ALPHA register, or performs a right or left justification of a string, adding spaces to it.

Example : To extract 7 characters, starting with "C", from the string 'ABCDEFGHIJKLMNOPQRSTUVW', which is in the ALPHA register :

Keystrokes :	Display :	
2.08	2.08	2 is the position of "C".
		8 is the position of the 7th character to extract.
[XEQ] "SUB$"	2.0800	Extract the string.
[ALPHA]	CDEFGHI	Substring.

To right-justify in a 10 character field :

[ALPHA]		
10	10_	Justification field length.
[CHS]	-10_	Specifies right justification.
[XEQ] "SUB$"	-10.0000	
[ALPHA]	CDEFGHI	Three spaces have been added to the left.
		The string in ALPHA register is 10 characters long.

To put 5 spaces at the right of the string :

[ALPHA]	-10.0000	
15	15_	New justification field length.
[XEQ] "SUB$"	15.0000	Left justification because the X-register is positive.
[ALPHA]	CDEFGHI	
[APPEND]	DEFGHI _	The ALPHA register scrolls to the left and the
		cursor is displayed after the 5 spaces.

INSTRUCTIONS FOR SUB$

[SUB$] modifies the ALPHA register as specified by the X-register.

- If the X-register number is an integer, the calculator extracts the |X| left most characters of the initial string. If the initial string has less than |X| characters, spaces are added to get a |X| character string; spaces are added to the left if X<0, to the right if X>0.

- If the number in the X-register has a decimal part (bb,ee), the calculator extracts the substring comprising of the characters from the position bb to the position ee.
(The first character is at position 0). If ee is higher than the position of the last character of the string, the substring is the initial string, with spaces added to get a ee-bb+1 character string. Spaces are added to the left if X<0, to the right if X>0. Beware that the sign of the X-register is ignored if ee is not higher than the position of the last character in the ALPHA register.

If bb is higher than the position of the last character of the initial string, [SUB$] puts a string of ee-bb+1 space characters in the ALPHA register.

STACK :

The stack is not changed by [SUB$].

NOTA : if the ALPHA register string is 24 character long, the calculator puts in the front of the string, characters with code 0, which are displayed as small dushes before the string.

- Toggle printer flag - TF55

[TF55] (Toggle Flag 55) toggles flag 55, which indicates that a printer is connected to the HP41. This flag cannot be modified by the user without the PANAME ROM. The TF55 function :

1) Sets flag 55 when there is no printer attached to the HP41; this eases the use of some programs (for instance in Application Pacs), which must be executed with flag 21 set (Printing enabled). So you can use them as subprograms, because when flag 55 is cleared, those programs halts at every VIEW or AVIEW instructions. With [TF55] there is no more interruption.

2) Clears flag 55, when a printer is attached to the HP-41 : this speed up programs when the printer is not used. Another [TF55] puts the printer back to use.

INSTRUCTIONS FOR TF55

1) To set flag 55, when it is cleared, execute [TF55].

2) To clear flag 55, when it is set, execute [TF55].

- View key assignations - **VKEYS**

[**VKEYS**] (View **KEYS**) lists the key assignments to he HP 41 built in display. For instance, if the PROMPT function is assigned to the "ENG" key (shifted [3], key code -74), the calculator will display :

-74 PROMPT

Key listing can be :

- Suspended by pressing and holding down any key but [R/S] or [ON] ;

- Terminated with the [ON] or [R/S] key. [ON] also turns off the calculator off.

Nota : [VKEYS] is not programmable.

- Write Extended Memory file - WRTEM

[WRTEM] (WRiTe Extended Memory) copies all the extended memory to a mass medium (HP82161A Tape drive or HP9114 Disk Drive).

Example :

```
Keystrokes :        Display :
[XEQ] "EMDIR"       MATRP  P012
                    A      D100       Samples contents of
                    TEXTE  A040       Extended Memory.

[ALPHA] "MAT 3" [ALPHA]  600.00   Put the file name in ALPHA
[XEQ] "WRTEM"          600.00   All the X-Memory files have been written to the mass medium.
```

INSTRUCTION FOR WRTEM

1) Put in the ALPHA register the file name in which all the X-Memory should be saved; then [XEQ] "WRTEM" copie all the X-Memory to this file.

2) If there is no HP-IL ROM, NO HPIL is displayed.

3) If a file exists with the same name on the mass medium, it is replaced by the new one.

STACK :

The stack is unchanged by [WRTEM].

INVERSE FUNCTION : READEM.

- Swap the X-register with flags 0-7 - X<>F

The X<>F function swaps the X-register and a imaginary register F, which represents the status of flags 0-7. This representation is an integer, in the range 0-255, which is the sum of the values related to the flags set :

Flag	Value
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128

For instance, if flags 0, 1, and 3 are set, and flags 2, 4, 5, 6, and 7 are cleared, the "F" register value is :

```
1 (value of flag 0)
+2 (value of flag 1)
+8 (value of flag 3)
=11
```

INSTRUCTIONS FOR X<>F

To swap the current status of flags 0-7, with a new one :

1) Compute (see above), the number related to the new status of flags 0-7 and put it in the X-register;

2) Execute X<>F.
Now, the X-register number contains the old status of flags 0-7, and flags 0-7 are set to the new status.

APPLICATION PROGRAM FOR X<>F

The XFLAGS program gives you up to 80 new flags. Usage of these extended-flags (0-79) is as follows :

- Set the Nth X-flag : Put N in the X-register and XSF.

- Clear the Nth X-flag : Put N in the X-register and execute XCF.

- Test the Nth X-flag : Put N in the X-register and execute XFS?.
After XFS?, flag 08 reflects the status of the X-flag being tested.

XSF . XCF and XFS? programs uses the stack and registers R00 to R09. XFS? also uses flag 08.

XFLAGS program listing :

```
LBL "XFLAGS"  .009  RGINIT  RDN  RTN
LBL "XSF"  XEQ 00  SF IND Y  GTO 01
LBL "XCF"  XEQ 00  CF IND Y  GTO 01
LBL "XFS?"  XEQ 00  CF 08  FS? IND Y  SF 08
LBL 01  X<>F  STO IND Z  R^  RTN
LBL 00  STO Y  8  /MOD  RCL IND Y  X<>F  .END.
```

Note : XEQ "XFLAGS" clears all X-flags 00 thru 79.

- Compare X and a register - X...NN?

Functions X#NN?, X<=NN?, X<NN?. X<=NN?, X>=NN? et X>NN? work as the built-in test functions (X=Y?) of the HP-41, but they compare the X-register contents with the contents of any register specified in the Y-register.

Furthermore these functions also compare alphanumeric strings.

INSTRUCTIONS FOR X...NN?

To compare the contents of the X-register with that of data register r :

If the r register is :	Put in Y :
- a data register Rnnn	- the number nnn
- the Z-register	- the string 'Z' ('Z' ASTO.Y)
- the T-register	- the string 'T'
- the L-register	- the string 'L'

In RUN mode, the calculator displays YES or NO according to the result of the test.

In a program, X...NN? behaves like any built-in test function. The line following the test is executed if the test is true, or it is skipped if the test is false.

These functions compare numeric and alphanumeric functions, according to the following asoumptions :

1) A number is always less than a string.

2) Strings are compared according to their character codes.
(e.g. : 'AB0' < 'ABA' because the code of '0' is 48 and that of 'A' is 65.

3) A short string identical to the beginning of a larger one is considered as being less than the larger one (e.g. "ABC" < "ABCD").

- Question Yes/No - Y/N

[Y/N] is useful in programs, which ask for an answer Yes or No.

Example : The following sequence displays the question :

EXIT   Y/N?

If the user answers Yes (Y key), the program resumes execution at label 00, if the user answer NO (N key) the program resumes execution at label 01:

```
"EXIT"          1,000
Y/N
GTO 00
GTO 01
```

INSTRUCTIONS FOR Y/N

The Y/N function can only be used in a program.

1a) To ask a question in the form :

```
message Y/N?
```

Put the message (max. 7 characters) in the ALPHA register and execute Y/N;

1b) To ask another type of question put the message in the ALPHA register, execute AVIEW then Y/N (one that does not contain Y/N ? explicity).

2) In both cases, when the Y/N function is executed, the calculator suspends program execution and waits for a keystroke :

- If the key pressed is ON, the calculator is turned off:

- If the key pressed is R/S, program execution is stopped and the program pointer is set to the line following Y/N ;

- If the key pressed is Y (Yes) or O (Oui), program execution resumes at the line following immediately Y/N ;

- If the key pressed is N (No), the line following Y/N is skipped, and the program resumes execution at the second line after Y/N (As for a false test; see the description of the X=Y? function in the HP41 manual).

- Any other key is ignored.

Appendix ON

With the PANAME ROM plugged in, MEMORY LOST is not the only ON/Key combination that is meaningful to the HP 41 : 6 new functions are possible when you switch on the HP-41.

Notation : ON/+ represents the function performed when you turn the calculator on with [ON], while the + key is held down. Also you must release [ON] before +.
For instance, with ON/[←] you get a MEMORY LOST.

ON/.

Change the mumeric display format : from the "American" one (1,234.25), to the "European" one (1.234,25). This function is built in the HP-1x calculators.
In fact ON/. toggles flag 28.

ON/K

Clear all user key assignations.

ON/A

Set the "A key assignment set", to the top rows. If one key was already assigned to som function or program, its key assignment is not modified.

ATOXL	ALENG	ATOXX	ANUMDEL	ATOXR	Shifted 1st row
XTOAL	AROT	YTOAX	ANUM	XTOAR	Unshifted 1st row

ON/M

Like ON/A, but with the following "H key assignment set".

STO>L	BRKPT	COLPT	AD-LC	RGVIEW	Shifted 1st row
RG	BLDPT	LINPT	LC-AD	CLINC	Unshifted 1st row

ON/T

Like ON/A, but with the following "T key assignment set".

AXIS	BOX	SETORG	RMOVE	*CSIZE	Shifted 1st row
*HOME	RESET	*LABEL	*MOVE	*LDIR	Unshifted 1st row
*PLREGX	REVLFX	BACKSPX	RDRAW	*LTYPE	Shifted 2nd row
		OUT	*DRAW	COLOR	Unshifted 2nd row

ON/V

Like ON/A, but with the following "V key assignment set".

	SCRLUP	CLEAR	XYTAB	CTYPE	Shifted 1st row
HOME	SCRLDN	CLEARO	CSRL	CSRR	Unshifted 1st row
	SCRLX	CSRVX	CSRUP	CSROFF	Shifted 2nd row
		CSRHX	CSRDN	CSRON	Unshifted 2nd row

The HP-41 uses the "Reverse Polish Notation" (RPN), to solve complex problems, without requiring parentheses and with a minimum of keystrokes. This system was created by a famous polish mathematician, Lukasiewicz, and not by the Hewlett-Packard company.

- A TIME SAVING SYSTEM : the access to memory registers is quicker in the stack with any memory partition, than on any other type of calculator ;

- A SPACE SAVING SYSTEM : an intermediat result, which does not use a register, let it free for something else ;

- Furthermore the STACK avoid a COMPLEX MEMORY MANAGEMENT : one can use a subprogram without modifying it, because of the memory implantation of the variables in the calling program.

So, subprograms parameters are passed through the stack, calculations are done in the stack, and results are returned to the stack : a subprogram is general, and easy to use.

In general any arithmetic processing, with up to 4 values, can be performed in the stack.

Example 1 : roots of a ax^2 + bx + c = 0 equation.

To use the program given below :

c ENTER^ b ENTER^ a XEQ "ROOTS" .
LBL "ROOTS" ST/ Z CHS ST+ X / ENTER^ X^2
RCL Z - SQRT RCL Y SIGN * + ST/ Y .END.

For instance to solve the following equation set :

x^2 + x -6 = 0 and
3x^2 + 2x -1 =0 -6
ENTER^ 1 ENTER^ XEQ "ROOTS" .
x'= -3 and RDN x"= 2

For the second one -1 ENTER^ 2 ENTER^ 3 XEQ "ROOTS"
x'= -1 and RDN x"= 0,3333

This example illustrates the easiness given by the arithmetic done directly in the stack.

Example 2 : GCD (Greatest Common Divisor) of 2 numbers.

01 LBL "GCD" LBL 02 MOD LASTX X<>Y X#0? GTO 02 + .END.
91 ENTER^ 65 XEQ "GCD" . X = 13,00

In this example, you must put the two numbers in the X and Y registers, and the result is returned to the X-register.

Example 3 : reduced fraction.

Generally you compute the GCD to get the reducted form of a fraction. Also with the GCD of a fraction it is easy to get the LCM (Least Common Multiple).,

01 LBL "RF" STO Z X<>Y STO T XEQ "GCD" ST/ Z ST/ Y RDN ST* Z .END.

Application : 91 ENTER^ 65 XEQ "RF" returns X= 5 and Y=7 so 91/65 = 7 / 5 ; the GCD and the LCM of 91 and 65 are Z = 455 and T = 13

Example 4 : calculation with two fractions.

LBL "F/" X<>Y LBL "F*" ST* Z RDN ST* Z RDN GTO "RF" 09 LBL "F-" CHS LBL "F+" ST* T X<> Z ST* Z * RCL Z + X<>Y GTO "RF" .END.

Application : what resistance should be put in parallel with a 100 ohms one to get a result of 80 ohms ?

1 ENTER^ 80 ENTER^ 1 ENTER^ 100 XEQ "F-" 1/X . So it is a 400 ohms one.

These examples illustrate, quite well, the powerful capabilities of the stack.