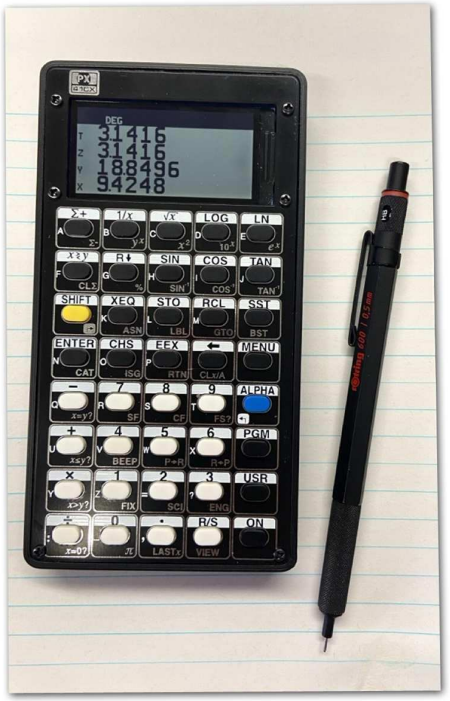
PROGRAMMABLE CALCULATOR

PX-41CX



User Manual

Foreword

The first programmable calculators appeared in the mid-1970s with models from the ***Hewlett-Packard*** company and also models from the ***Texas Instruments*** company.

These two American companies subsequently produced many different models but some of these calculators which appeared at the end of the 70s or the beginning of the 80s became legendary machines still adored today by unconditional fans.

At Hewlett-Packard the Voyager models (**HP-10C**, **11C**, **12C**, **15C**, **16C**) with in particular the **HP-15C** are still sought after but the most adored of all the models was the **HP-41** available in three models : **C**, **CV** and **CX**.

Then many years later, the following century, craftsmen, not to say artists, decided to bring such machines back to life. Whether in the Czech Republic, Mexico, Switzerland or elsewhere, little ones were born using the functionalities of these legendary calculators.
These clones either took over just the possibilities of the old calculators, or greatly improved the possibilities of the ancestors, or resulted in new machines combining the potentials of several old machines with important additions.

No matter the level of evolution of each new machine, no matter the artisanal or industrial manufacturing method, the main thing remains the inventiveness, the creativity carried by these projects.
... then these beautiful objects make it possible to perpetuate techniques that seem obsolete and yet remain unrivaled.

The **HP-41CX** introduced in 1983 was discontinued in 1990.
Many people dreamed of such a machine, not necessarily accessible to everyone due to its high price, but worthy of its capabilities.

Today the **PX-41CX** is the worthy successor to the legendary **HP-41CX** with the possibility of loading the ROM modules of your choice into memory (Maths, Stats, Finance, Games, etc.) and exchanging your programs and data with a PC.

The **PX-41CX** programmable calculator is a calculator that incorporates the functionalities and language of the HP-41CX calculator thanks to an emulation running on an AVR128DA microcontroller.

This manual is not intended to document the use of these features nor to present the programming language of the 41CX which are documented in manuals in PDF format on

http://literature.hpcalc.org/#model:41CX

and in particular:

- HP-41CX Owner's Manual Volume 1: Basic Operation (http://literature.hpcalc.org/items/909)
- HP-41CX Owner's Manual Volume 2: Operation in Detail (http://literature.hpcalc.org/items/913)

This manual therefore presents the particular functionalities of the **PX-41CX**:

- calculator menu and settings,
- **PX-41CX** firmware update,
- exchange of programs and data between **PX-41CX** and PC

Version 0.900 Build 2024.08.03

Table of Contents

1 - Physical characteristics

- **Hardware**

Microcontroller AVR128DA28
8 bits
Speed : 8-32 Mhz
128KB flash
16K RAM
Real Time Clock with 32,768 Khz crystal
Communication with standard RS232 (Upload/Download and Flash)

Display

Ultra Low Power (less than 35µA))
250x122 pixels
High Contrast Reflective Display (No Backlight)

Power

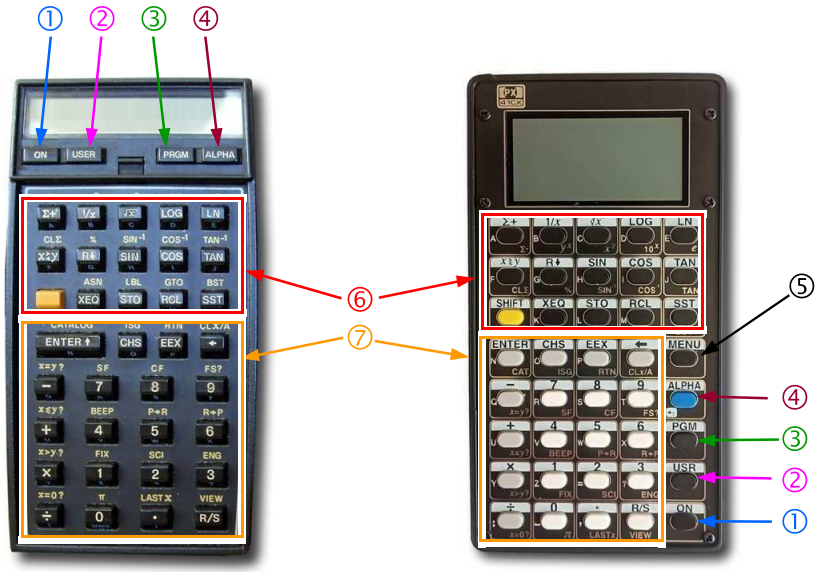
Standard CR2032 Coin Battery
Power consumption :
Standby 8µA (RTC running, Display OFF)
Idle: <35 µA (Dispplay on)
Running: 2~5mA (depending on selected running speed)

Buttons

Tactile Switches with 70gf
Color Keycaps

• The keyboard

The keyboard of the **PX-41CX** calculator (40 keys) differs little from that of the HP-41CX (39 keys) since apart from the arrangement of the ON①, USER②, PRGM③, ALPHA④ keys and the addition of the MENU⑤ key, the other keys ⑥⑦ remain identical in title and positioning.



• The top

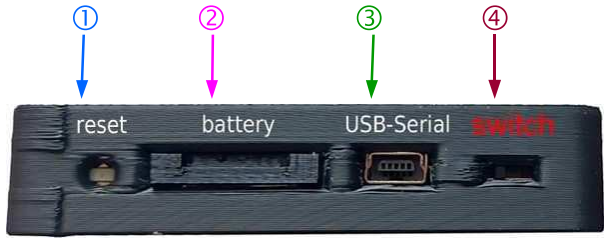
The top of the **PX-41CX** calculator has 4 distinct elements :

① a “RESET” button which allows a total reset of the calculator and erases ALL memory (***Attention*** ! This is **not** a simple soft reset!)

② a “drawer” for the CR2032 battery

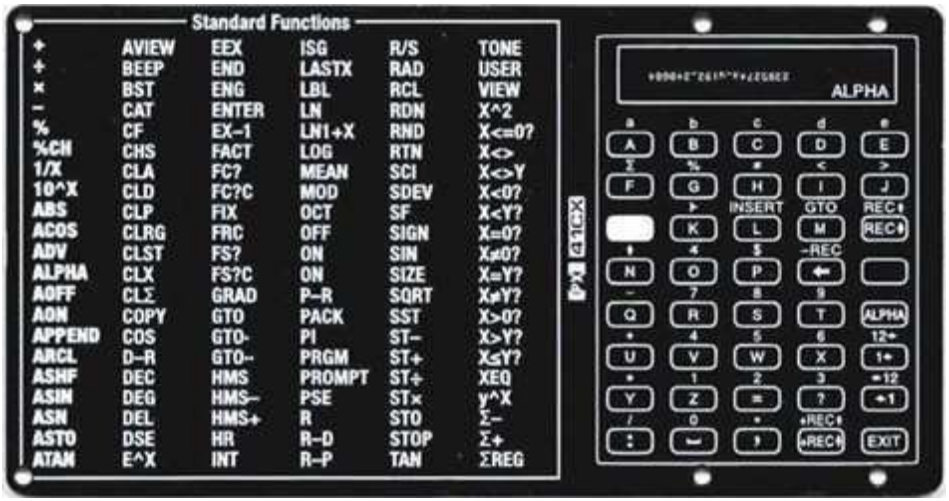
③ a USB connector to connect the USB-Serial interface to a PC

④ a switch for normal mode (towards the left) or for firmware flash (towards the right)



- **The back**

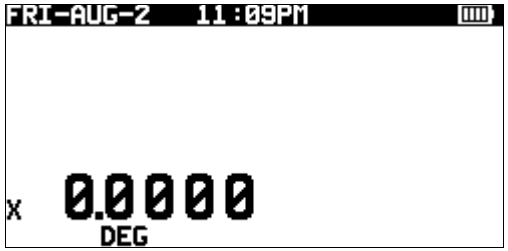
The back of the **PX-41CX** calculator consists of a plate printed on each of its sides.
It is therefore possible to unscrew it, to turn it around, and screw it back in, thus choosing the presentation of your choice.



2 - Menu

The MENU key of the **PX-41CX** calculator provides access either to calculator setting options or to information on its internal contents.

By pressing this key the ordinary calculator screen



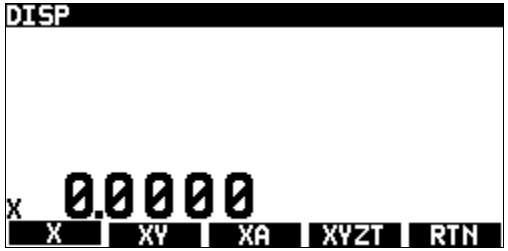
is replaced by a screen called “MENU” offering 5 choices:

- **DISP** allows you to choose the display mode on 1, 2 or 4 lines,
- **VIEW** to display either all registers or all flags,
- **COM** to exchange memory contents with a PC in the form of dump,
- **MORE** to access an additional MENU screen,
- **EXIT** to exit MENU mode.

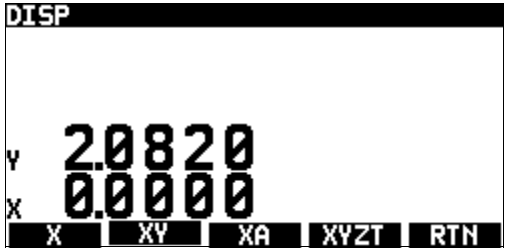
In all screens of MENU mode, pressing the ON key or the MENU key returns to the standard calculator screen.

➡ **DISP** offers 4 display modes :

X to display only the X register on one line of the screen,

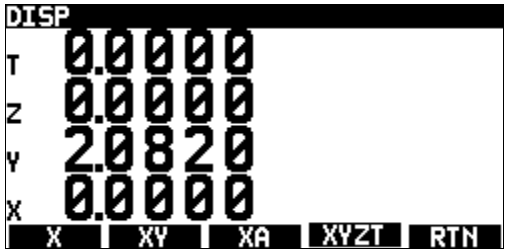


XY to display the X and Y registers on two lines of the screen,



XA to display the X register and the ALPHA register on two lines of the screen,

XYZT to display the stack (X, Y, Z and T registers) on four lines of the screen.



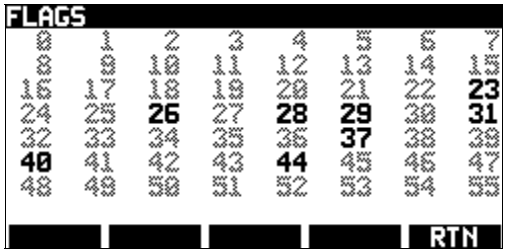
RTN returns to the MENU screen

➡ **VIEW** offers 2 choices :

- **REGS** to view registers on one or more pages (depending on the SIZE option).
- **FLAGS** to view the flags

REGS displays 16 registers per page with PREV and NEXT choices if necessary,

FLAGS displays the flags. (black characters if “up”)



RTN returns to the higher level screen

➡ **COM** offers 2 choices :

- **DUMP** to send a memory dump from the **PX-41CX** to PC
- **LOAD** to receive a memory dump from a PC.

(see “Program and data exchange” page 24)

RTN returns to the higher level screen

➡ **MORE** gives you acces to... more options...

- **CONF** to to choose configuration options,
- **MODS** allows you to consult the list of modules present internally.
- **INFO** to access information regarding the **PX-41CX**,
- **RTN** to return to the first MENU.

➡ **CONF** allows you to change the settings of various parameters :

- **BEEP** to choose whether a sound should be assigned to the keys or not,
- **SLEEP** to choose the delay before automatic shutdown of the **PX-41CX**,
- **SPEED** to choose the processor speed (cadence in MHZ),
- **S.IMG** to choose whether a splash screen should be displayed or not when the **PX-41CX** is turned off,
- **RTN** to return to the first MENU.

➡ **BEEP** offers 2 choices :

- **OFF** = no sound when pressing a key,
- **ON** = sound emitted when pressing a key

➡ **SLEEP** offers 4 options for automatic shutdown :

- **1MIN**,
- **2MIN**,
- **4MIN**,
- or **NEVER** (no automatic shutdown)

➡ **SPEED** offers 4 frequencies for speed of **PX-41CX** :

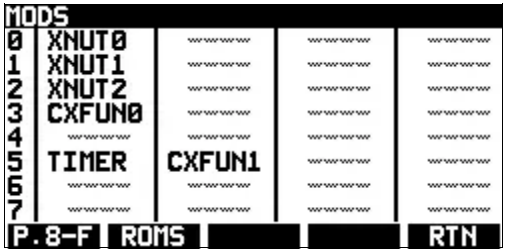
- **8MHZ**,
- **16MHZ**,
- **24MHZ**,
- **32MHZ**

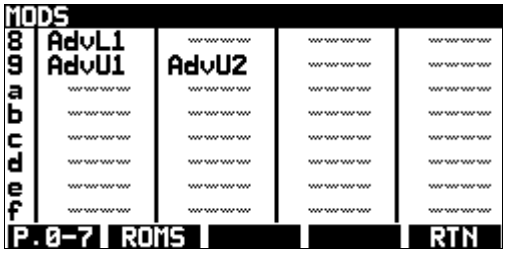
➡ **S.IMG** offers 2 choices :

- **OFF** = no splash screen when **PX-41CX** is turned off,
- **ON** = a splash screen is displayed when **PX-41CX** is turned off

RTN returns to the higher level screen

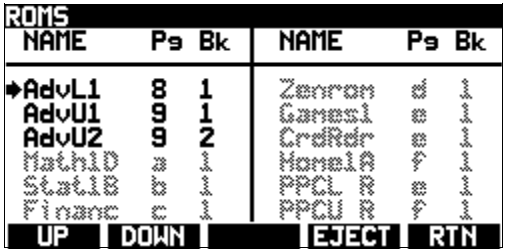
➡ **MODS** allows you to see the allocated ROMs in their respective pages.

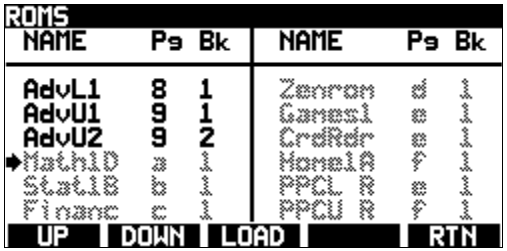




➡ **ROMS** allows you to load and eject modules.

The **PX-41CX** has space to store twelve 4K ROMs, the number of modules will depend on the number of 4K ROMs that each of them contains.
For the changes to take effect, you must restart the **PX-41CX** (turn it off and then back on again).





UP *go to the upper line*

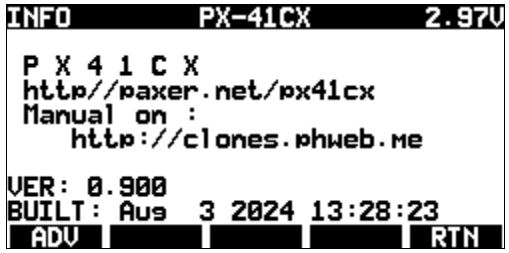
DOWN *go to the lower line*

LOAD *load a module*

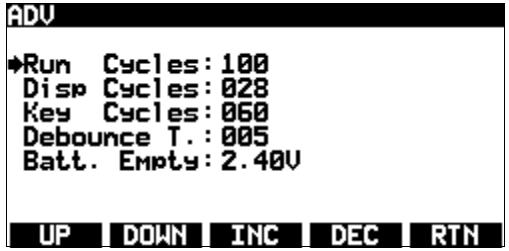
EJECT *eject a module*

RTN returns to the higher level screen

➡ **INFO** displays battery status and firmware version and date, and also 4 lines of customizable text. (see "Additional tools")



➡ **ADV** allows you to modify advanced configuration parameters :



- **Run Cycles** : Number of cycles to execute at a time before housekeeping (Updating display)
- **Disp Cycles** : Number of cycles to add before redrawing display. This is to minimize display glitches.
- **Key Cycles** : Number of cycles to wait before a key press is recognized.
- **Debounce T.** : Increasing this value will help with the debounce of buttons.
- **Batt. Empty** : Value at which the battery is considered empty.

UP *go to the upper line*

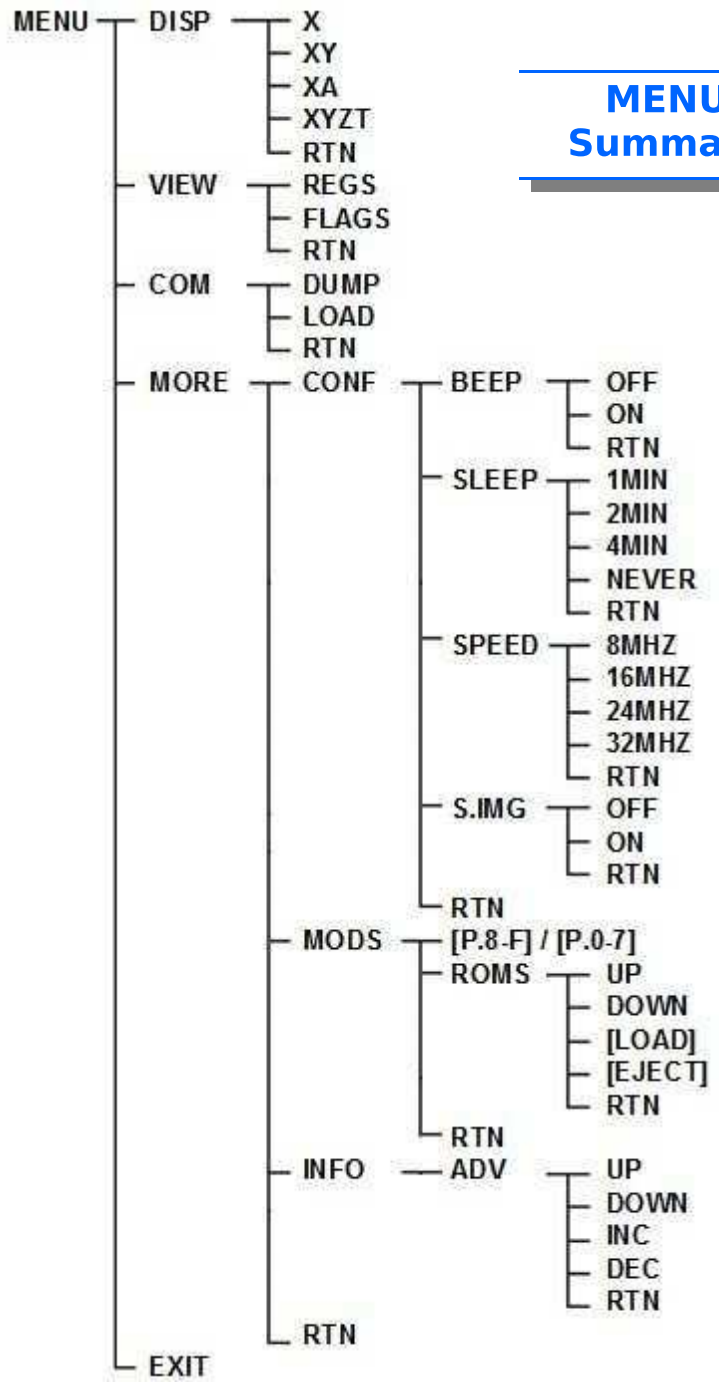
DOWN *go to the lower line*

INC *increment value*

DEC *decrement value*

RTN returns to the higher level screen

MENU Summary



3 - Firmware update

To update the firmware of the **PX-41CX** several elements are essential :

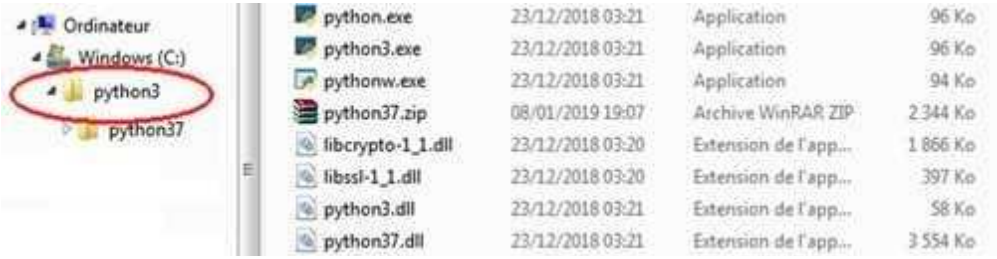
- a USB Serial cable: USB A socket on the PC side, mini USB on the calculator side
  For Windows you will need to install the corresponding driver (Prolific USB-to-Serial Comm Port)

- **python 3**
  python3-3.7.2.post1-embed-win32v2a.zip

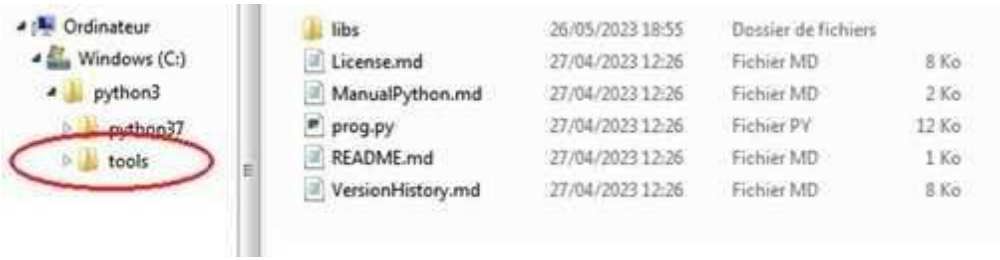
- python tools for the **SerialUPDI** interface (prog.py et libs)
  https://github.com/SpenceKonde/DxCore/tree/master/megaavr/tools
  (.../DxCore/blob/master/megaavr/tools/ManualPython.md)

For Windows :

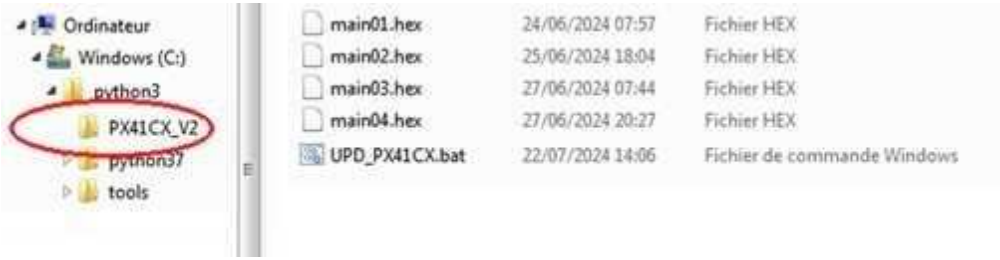
1) Install Python in c:\python3



2) Install the interface tools (prog.py and libs) in c:\python3\tools



3) Create a directory to receive updates for **PX-41CX**
for example : c:\python3\PX41CX_V2

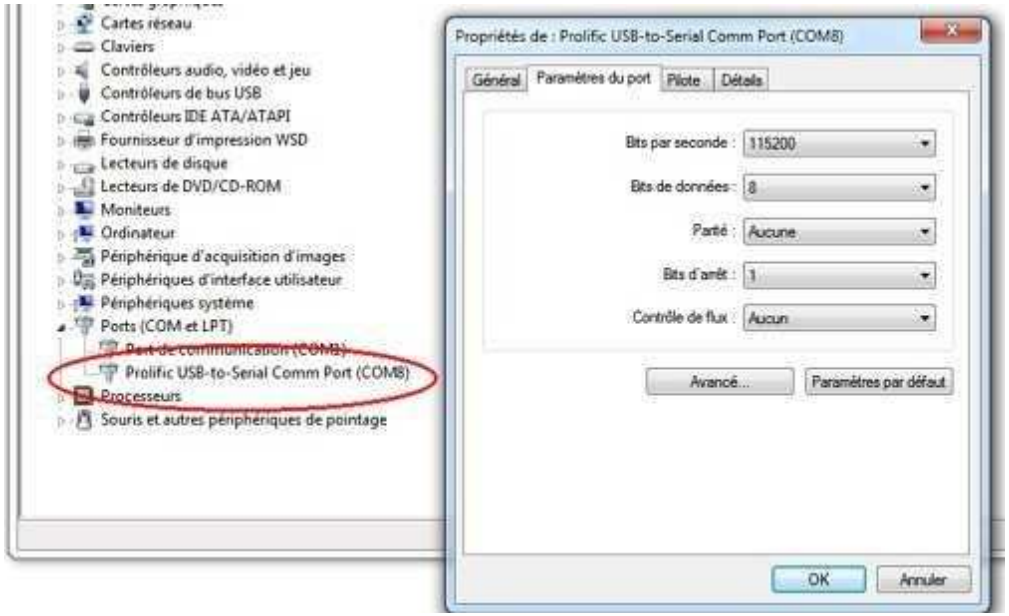


in this last directory you can keep the different firmware versions by numbering them.
To make updates easier, create a command file such as :

```
@echo off
CD..
cls
@echo +=====================================================+
@echo !   P X 4 1 C X  :   F I R M W A R E   U P D A T E   !
@echo +=====================================================+
SET numv=
SET /P numv=Version (01, 02, 03,...) ?
python -u tools/prog.py -t uart -u COM8 -b 115200 -d avr128da28 --fuses
5:0b11001001 6:0x04 7:0x00 8:0x00 -f PX41CX_V2/main%numv%.hex -a write -v
pause
```

and save it as UPD_PX41CX.bat

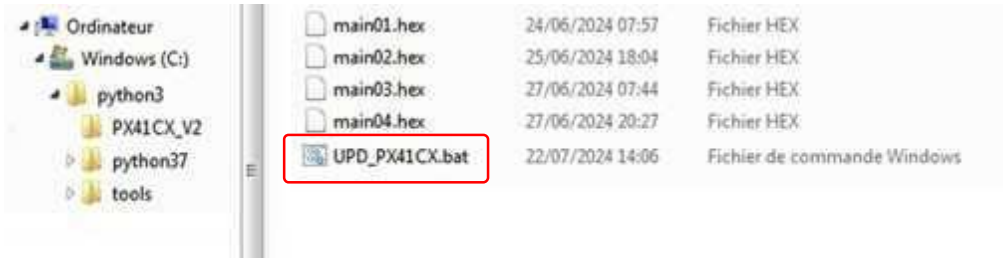
it will be necessary to adapt this command file to the parameters of the COM port used.



then before launching an update it is imperative to move the switch of the **PX-41CX** to the right :

“firmware update” position

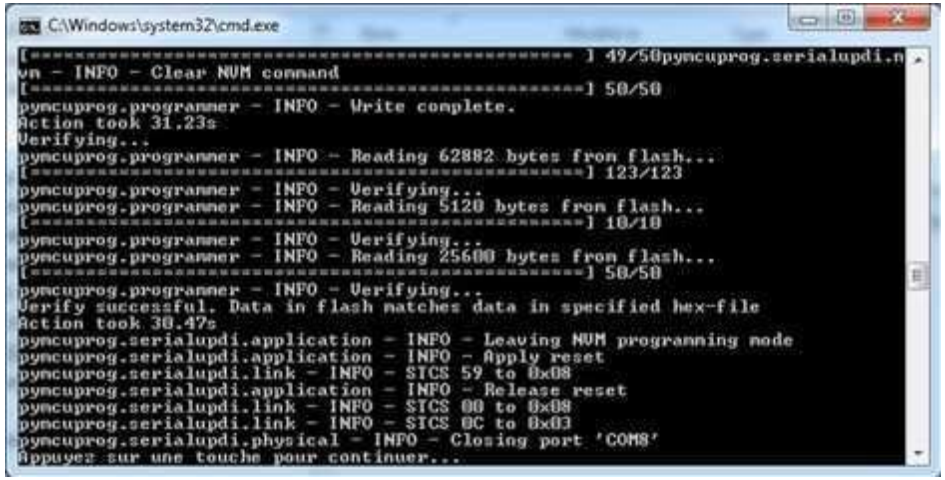
Start the update by double clicking on UPD_PX41CX.bat



then choose the file number to load

and the update runs...

until loading is complete...



it will then absolutely be necessary to re-position the **PX-41CX** switch to the left :

"calculator mode" position

Attention !
Each time the calculator firmware is updated, all data and programs are lost!

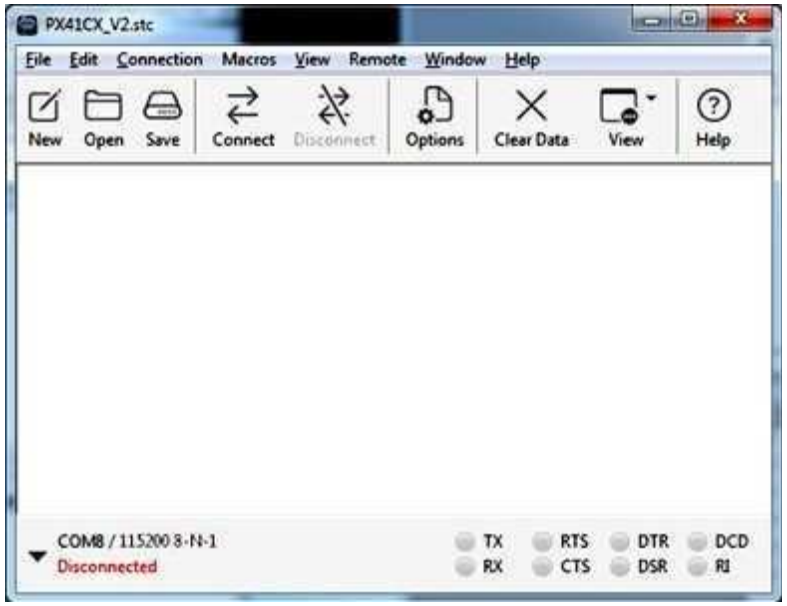
Update is a complete reset.

4 - Program and data exchange

For the exchange between the **PX-41CX** and a PC the cable is the same as that used for updating the firmware.

But for the "software" part you need :

- "Terminal" transfer software : **CoolTerm** from Roger Meier is most suitable (http://freeware.the-meiers.org/)



- DUMP decoding software (in case of DUMP from **PX-41CX**)
- HP-41 program coding software (in case of sending DUMP to **PX-41CX**)

DUMP

To extract a DUMP from the **PX-41CX** and send it to the PC, you must :
1) on the calculator press:

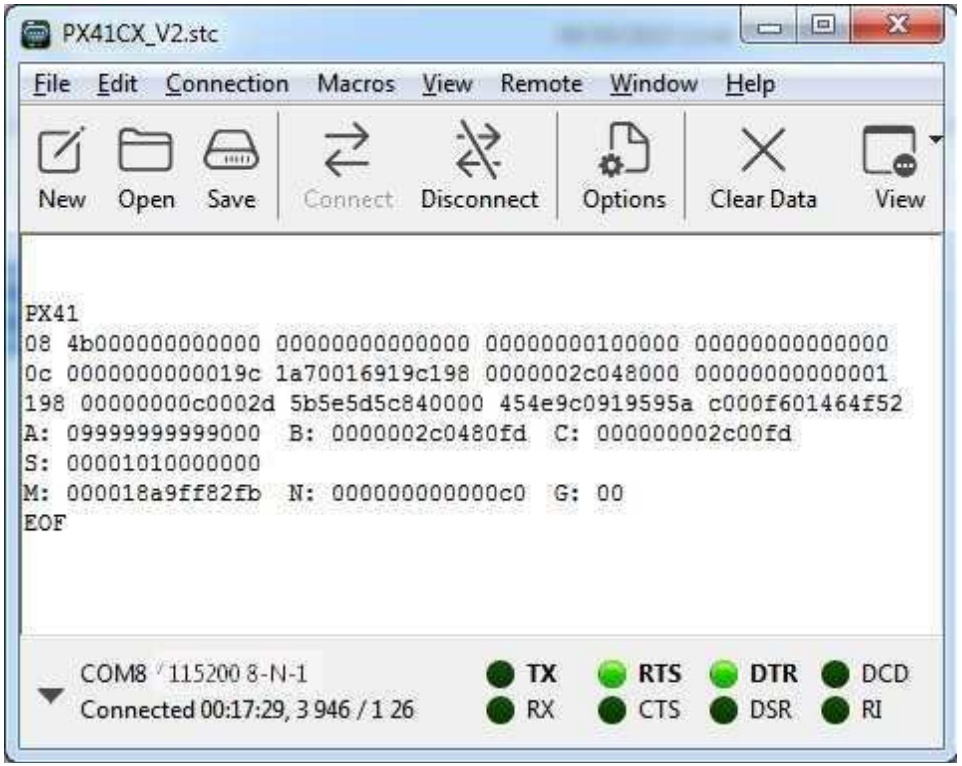
to display the MENU screen

to display the COM screen

2) connect the SerialUSB cable between the calculator and the PC,
3) then on PC launch the CoolTerm program and connect to the COM port corresponding to your SerialUSB
4) on the calculator press

corresponding to the DUMP choice to start the transfer

the transfer result is displayed in CoolTerm :



this DUMP can be selected and copied to then be pasted either into a TXT file for backup or into a decoding tool.

LOAD

To load a DUMP into the **PX-41CX**, you must :
1) on the calculator press :

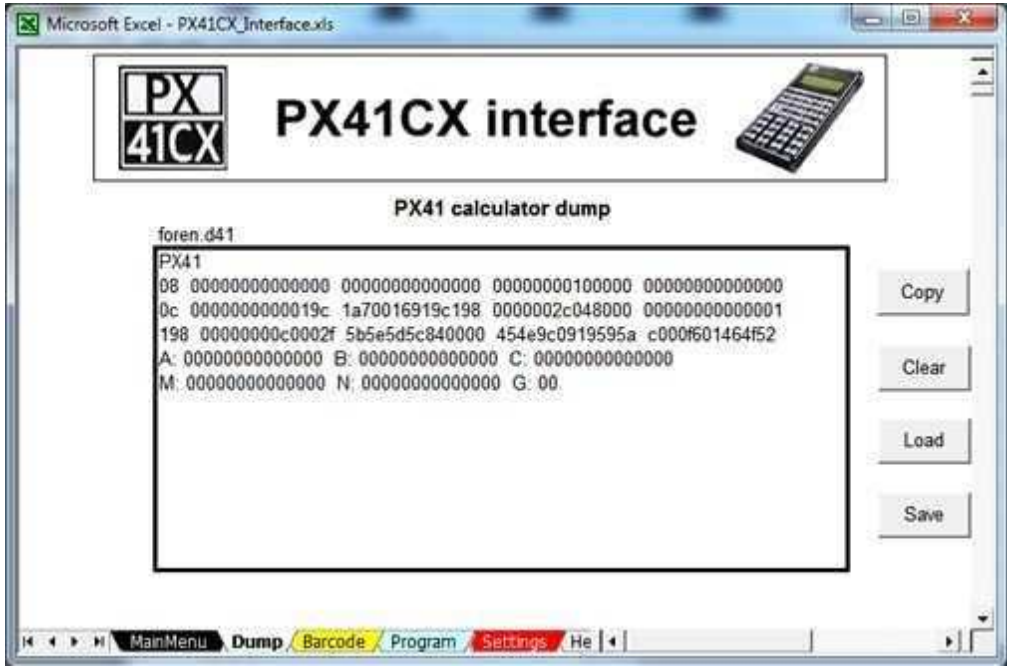
to display the MENU screen

to display the COM screen

2) connect the SerialUSB cable between the calculator and the PC,
3) then on PC launch the CoolTerm program and connect to the COM port corresponding to your SerialUSB

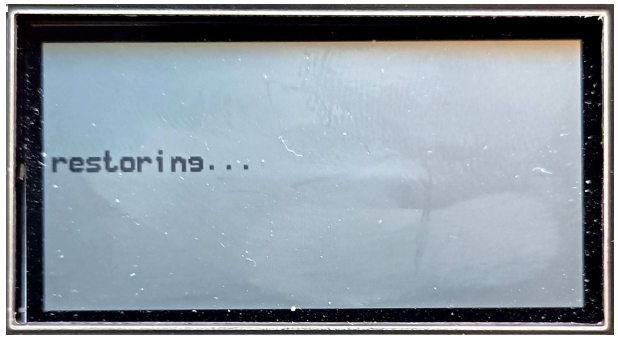
Attention !
LOAD allows you to load the equivalent of a complete DUMP of RAM : this means that the entire contents of the calculator RAM are erased to be replaced.

4) either from a text editor (Notepad type) or from HP-41 program coding software, copy the DUMP (CTRL + C)

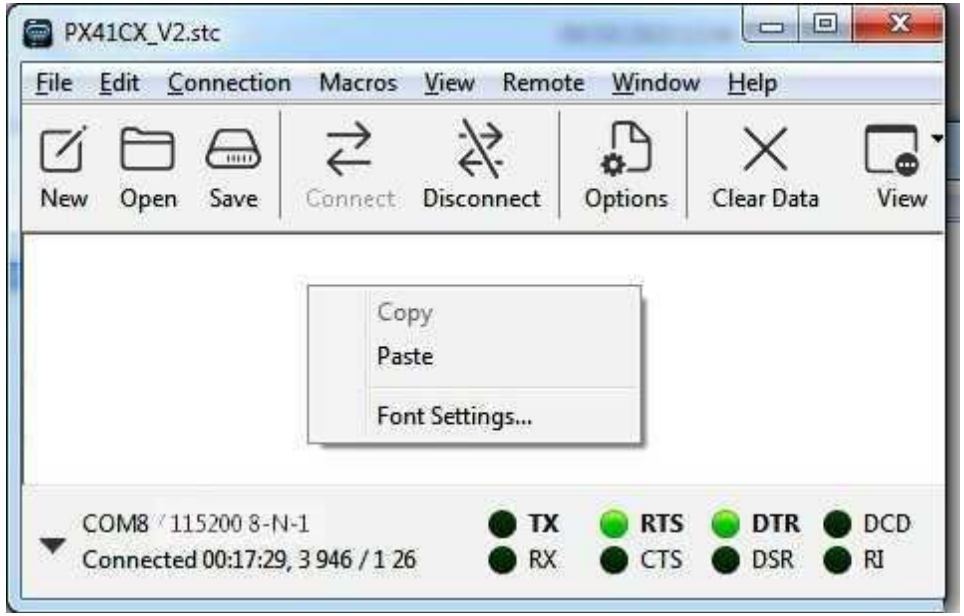


5) on the **PX-41CX**, press

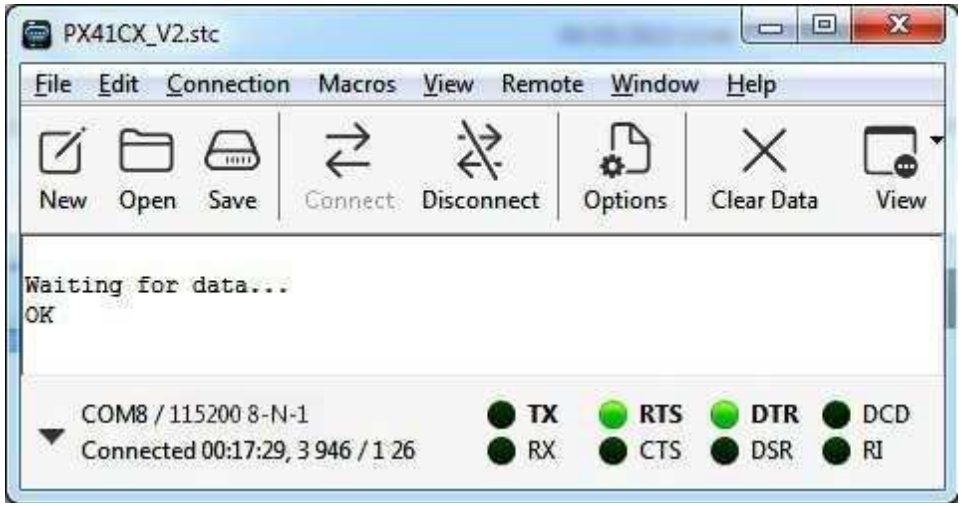
corresponding to the LOAD choic
to wait for the transfer...



6) in CoolTerm, right-click to get the context menu to paste the DUMP to send to the **PX-41CX**

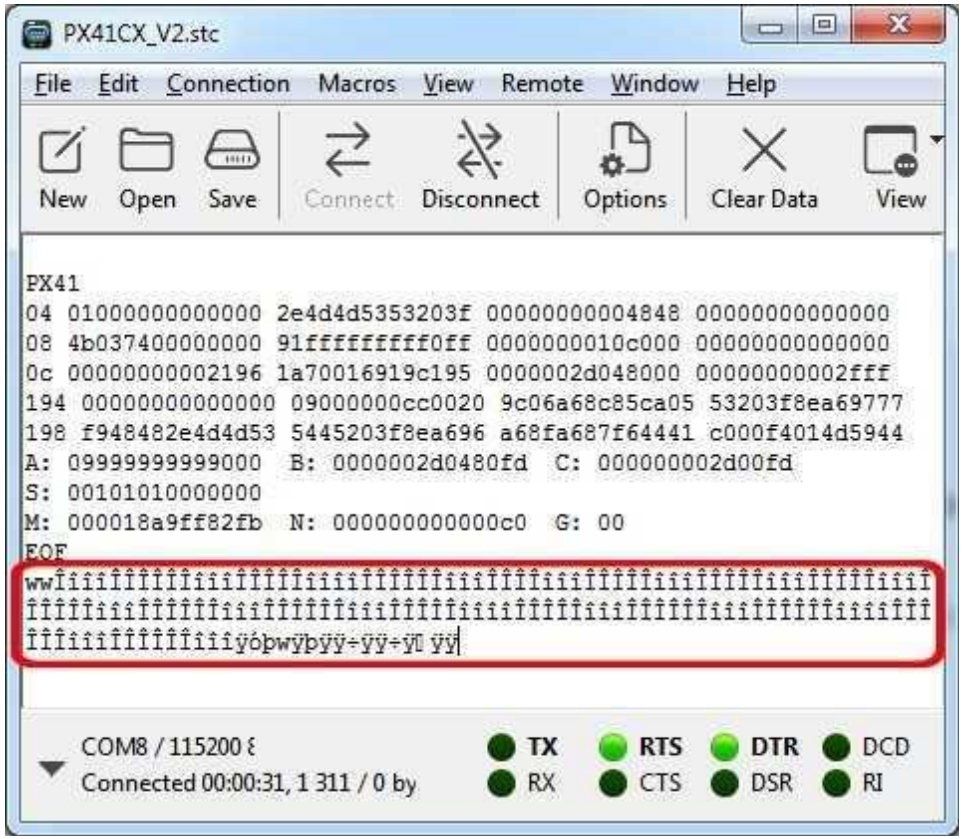


7) Click on “Paste”, the DUMP is sent
(sometimes the message “Waiting for data...” is not displayed, click on “Paste” anyway!)



Notice :

Sometimes in CoolTerm some "noise" may appear due to minor problems on the COM port.
Ignore these small incongruous characters and do not copy them to the destination file.



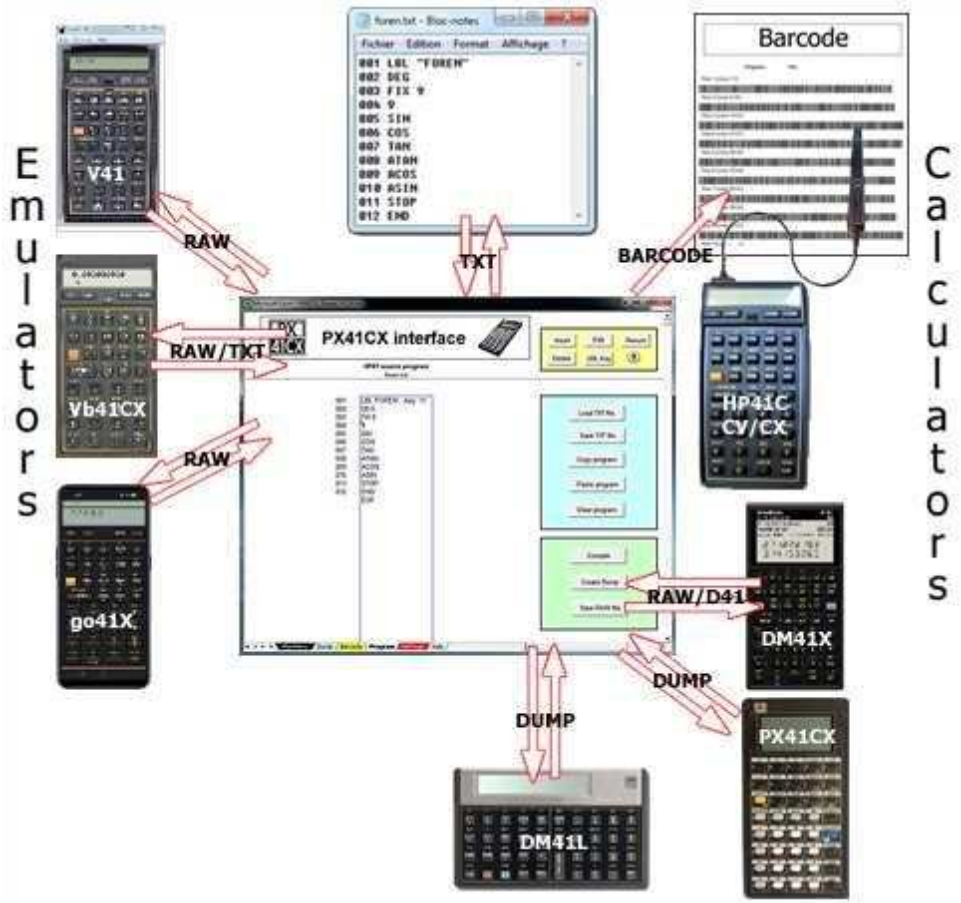
Decoding **PX-41CX** dumps :

currently the only tool allowing decoding of dumps is
DM41 programming tool from Swiss Micros.
(https://dm41.swissmicros.com/)

Coding in **PX-41CX** dumps :

The **PX-41CX** interface allows HP-41 programs to be coded into dumps

PX-41CX interface



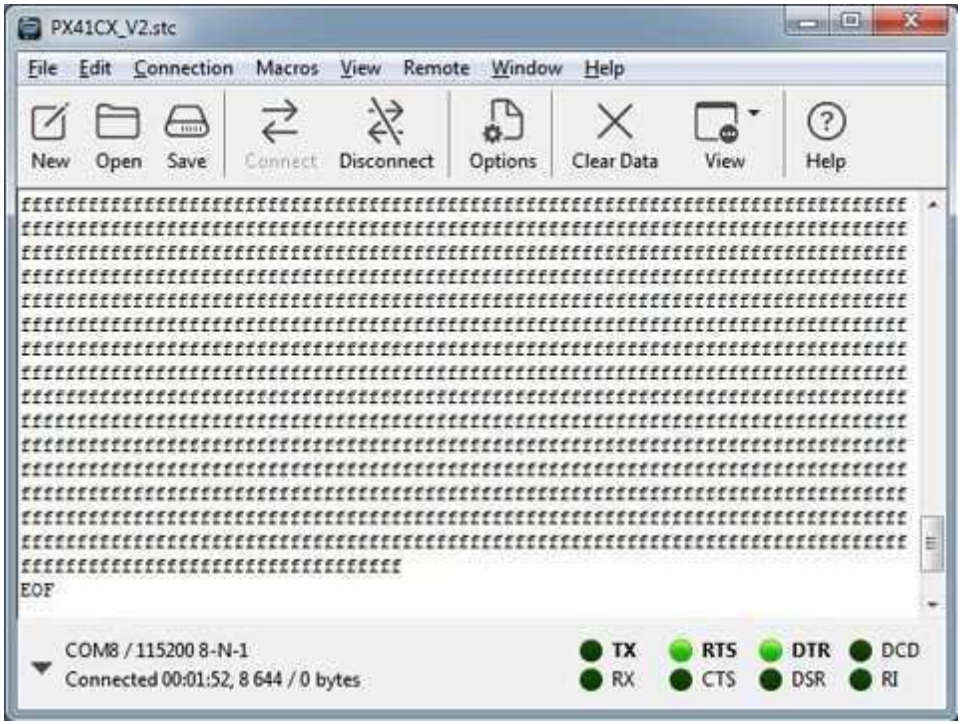
5 - Screenshots

It is possible to take screenshots on the **PX-41CX**.

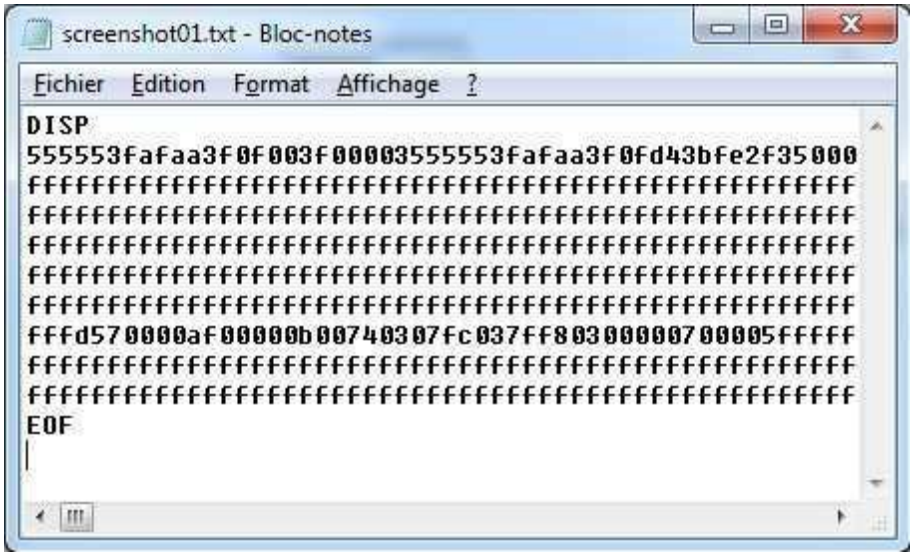
Like for the program exchange, Coolterm must be used.

- Connect the calculator to the PC.
- Launch Coolterm and connect...
- Then on the calculator screen of your choice, while holding down the **MENU** key, press **SHIFT** and release both keys together.

- On the Coolterm screen a series of hexadecimal characters appears...

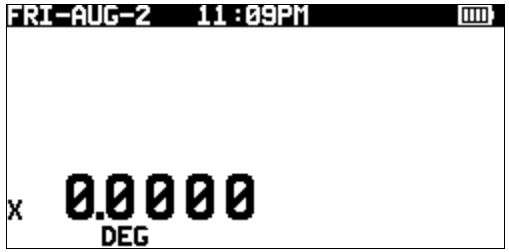


- Select this entire character sequence from DISP to EOF inclusive and copy (CTRL C) then, in a simple Text Editor, paste and adding a newline behind the EOF.
- Save in txt format.



- This txt file can then be transformed into BMP with
  - ⇒ either Alex's ***decode_screenshot.exe*** program,
  - ⇒ either Darren's ***px41cx-hex2bmp.py*** tool

(See “Additional tools”)



6 - Implemented modules

Time (CX)	
TIME 2C	CX TIME
ADATE	CLALMA
ALMCAT	CLALMX
ALMNOW	CLRALMS
ATIME	RCLALM
ATIME24	SWPT
CLK12	
CLK24	
CLKT	
CLKTD	
CLOCK	
CORRECT	
DATE	
DATE+	
DDAYS	
DMY	
DOW	
MDY	
RCLAF	
RCLSW	
RUNSW	
SETAF	
SETDATE	
SETIME	
SETSW	
STOPSW	
SW	
T+X	
TIME	
XYZALM	

X Functions (CX)		
EXT FNC 2D		CX EXT FCN
ALENG	INSREC	ASROOM
ANUM	PASN	CLRGX
APPCHR	PCLPS	ED
APPREC	POSA	EMDIRX
ARCLREC	POSFL	EMROOM
AROT	PSIZE	GETKEYX
ATOX	PURFL	RESZFL
CLFL	RCLFLAG	?REG?
CLKEYS	RCLPT	X=NN?
CRFLAS	RCLPTA	X?NN?
CRFLD	REGMOVE	X<NN?
DELCHR	REGSWAP	X<=NN?
DELREC	SAVEAS	X>NN?
EMDIR	SAVEP	X>=NN?
FLSIZE	SAVER	
GETAS	SAVERX	
GETKEY	SAVEX	
GETP	SEEKPT	
GETR	SEEKPTA	
GETREC	SIZE?	
GETRX	STOFLAG	
GETSUB	X<>F	
GETX	XTOA	
INSCHR		

ADVANTAGE				
ADV CONV B	ADV MTRX		ADV MATH	
BININ	*C<>C*	*MRIJ*	SOLVE	D?
BINVIEW	*CMAXAB*	*MRIJA*	INTEG	BFIT
OCTIN	*CNRM*	*MRR+*	SILOOP	FIT
OCTVIEW	*CSUM*	*MRR-*	SIRTN	Y?X
HEXIN	DIM?	*MS*	Z?N	SZ?
HEXVIEW	*FNRM*	*MSC+*	MAGZ	VC
NOT	*I+*	*MSIJ*	e?Z	CROSS
AND	*I-*	*MSIJA*	LNZ	VS
OR	*J+*	*MSR+*	Z?1/N	VR
XOR	*J-*	*MSWAP*	SINZ	DOT
ROTXY	*M“M*	*MSYS*	COSZ	VE
BIT?	*MAT**	*PIV*	TANZ	V-
	MAT+	*R<>R*	a?Z	V+
	MAT-	*R>R?*	LOGZ	VXY
ADV TVM	*MAT/*	*RMAXAB*	Z?1/W	UV
TVM	MATDIM	*RNRM*	Z?W	V?
N	*MAX*	*RSUM*	C+	VD
PV	*MAXAB*	*SUM*	C-	V*
PMT	*MDET*	*SUMAB*	CINV	TR
FV	*MIN*	*TRNPS*	C*	CT
*I	*MINV*	*YC+C*	C/	AIP
	MMOVE	MEDIT	PLY	
	MNAME?	*CMEDIT*	RTS	
	MR	*MP*	DIFEQ	
	MRC+	MATRX	CFIT	
	MRC-	*MTR*	A?	

STAT 1B
?BSTAT
?BSTG
*BE
?MMTUG
?MMTGD
*MT
*MD
?AOVONE
?AOVTWO
?ANOCOV
?LIN
?EXP
?LOG
?POW
?POLYP
?POLYC
?MLRXY
?MLRXYZ
?PTST
?TSTAT
?XSQEV
?EEFXSQ
?CTKK
?CTKKK
?SPEAR
?NORMD
?CHISQD
*a
*b

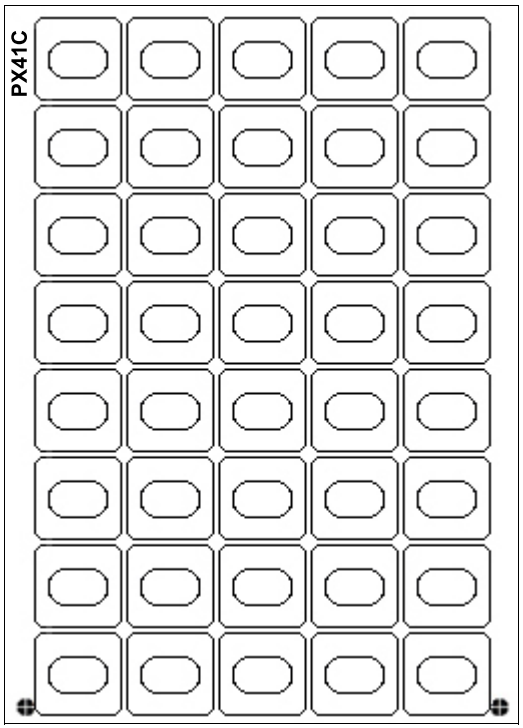
MATH 1D	
MATRIX	a^Z
SIMEQ	LOGZ
VCOL	Z^1/W
VMAT	Z^W
PVT	C+
DET	C-
INV	CINV
EDIT	C*
SOLVE	C/
SOL	SINH
POLY	COSH
ROOTS	TANH
INTG	ASINH
DIFEQ	ACOSH
FOUR	ATANH
Z?N	SSS
MAGZ	SAA
e?Z	ASA
LNZ	SAS
Z?1/N	SSA
SINZ	TRANS
COSZ	*FN
TANZ	

FINANCE 1D
MONEY
IRR
MIRR
NPV
AMORT
SL
DB
SOYD
BOND
DAYS
*N
*I
*PV
*PMT
*FV
*IRR
*MIRR
*NPV
*AMORT
*SL
*DB
*SOYD
*PRC
*YLD
*DAYS
*BGN
*SIZE
*DATA
*DATA1
*OUT
*TGL
*TGL1
*Y/N
$ENG

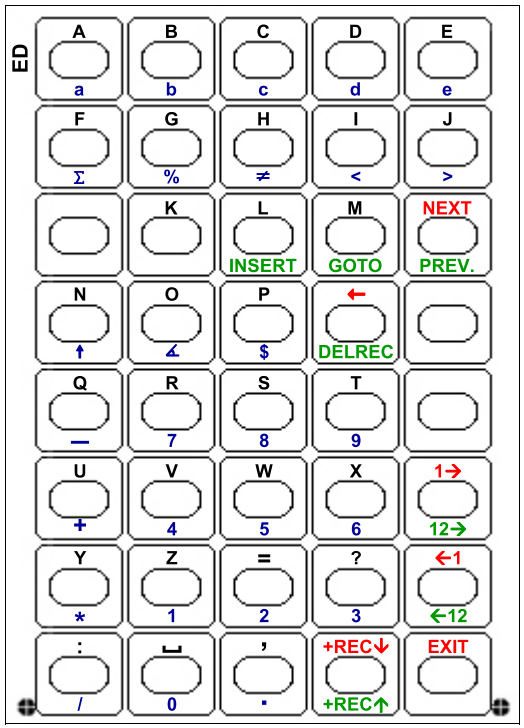
For other modules, you can find them on the Web with also the tools to extract the ROMs.
Attention :
HEPAX, Printing, HPIL are not supported.

7 - Keyboard overlays

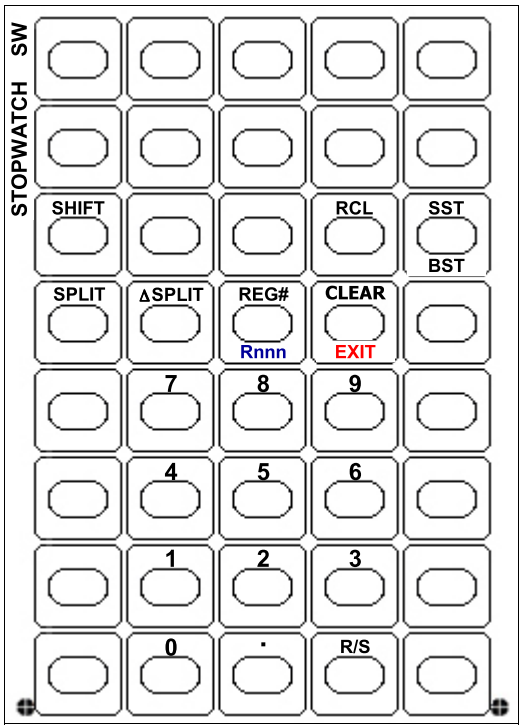
Some module programs can be made easier to use using overlays. You can make your own overlays on Bristol, and cut them with a precision cutter (x-acto knife)



Blank overlay for **PX-41CX**



Overlay for ED (CX EXT FCN)



Overlay for SW (TIME 2C)

8 - Additional tools

Darren's tools

1) **px41cx-utility**

It is possible to modify a “hex” file (**PX-41CX** firmware) before updating the calculator (see “Firmware update” page 19) using a Python procedure available on github.

http://github.com/diemheych/px41cx-utility

This tool allows:

- to personalize the 4 lines of text on the INFO screen,
- modify the list of ROMS loadable in the **PX-41CX**,
- to load the image which will be displayed when the calculator is turned off.
-

2) **px41cx-hex2bmp**

It is possible to transform multiple “hex” screenshots stored in a txt file to a BMP file using a Python procedure available on github.

http://github.com/diemheych/px41cx-hex2bmp

Useful sources of information

- Pages of ***Alex***'s site dedicated to the **PX-41CX** :
  https://paxer.net/px41cx/

- ***Darren***'s **PX-41CX** Firmware Utility for changing ROMs and options :
  https://github.com/diemheych/px41cx-utility

- ***Darren***'s **PX-41CX** screenshot decoder :
  https://github.com/diemheych/px41cx-hex2bmp

- ***Swiss Micros*** **DM41X** state file decoder/encoder :
  https://dm41.swissmicros.com/

- ***Roger Meier***'s excelent **CoolTerm** software :
  https://freeware.the-meiers.org/

- Youtube review by ***Calculator Clique*** :
  https://www.youtube.com/watch?v=BzJK0F3aNTQ

- Where to buy : Tindie
  https://www.tindie.com/products/35362/

- this manual in English and also in French
- Interface between **PX-41CX**, HP-41CV/CX, DM41X, DM41L, go41X, Vb41CX, V41...
- and other resources (programs, splashscreen...)

https://px41cx.phweb.me/