Texas Instruments

TI-74 Basicalc & TI-95 Procalc

Cartridges

8/16 x 32K FLASH Cartridge
&
8/16 x 32K RAM Cartridge
&
16 x 32K COMBO Cartridge

User Guide

Version 1.7

2 February 2025

References

1. Texas Instruments TI-74 Programming Reference Guide
2. Texas Instruments TI-74 Learn Pascal User's Reference Guide
3. Texas Instruments TI-74 Mathematics Library Guidebook
4. Texas Instruments TI-74 Statistics Library Guidebook
5. Texas Instruments TI-74 Finance Library Guidebook
6. Texas Instruments TI-74 Chemical Engineering Library Guidebook
7. Texas Instruments TI-95 Statistics Library Guidebook
8. Texas Instruments TI-95 Finance Library Guidebook
9. Texas Instruments TI-95 Chemical Engineering Library Guidebook
10. Texas Instruments TI-95 Programmers Guide
11. Texas Instruments 8K Constant Memory RAM Manual
12. Microchip FLASH SST39SF020A
    https://ww1.microchip.com/downloads/en/DeviceDoc/20005022C.pdf
13. Alliance RAM AS6C1008-55TIN
    https://www.alliancememory.com/wp-content/uploads/pdf/AS6C1008feb2007.pdf
14. TI 32kB x 8-bit static RAM expansion module for TI-74 BASICALC or TI-95 PROCALC (The relevant parts of the original text are reproduced in Annex A.)
    https://groups.google.com/g/comp.sys.handhelds/c/eQtqGIskUvM
15. MT DAR Video provides an example of programming the FLASH in a similar design.
    https://www.youtube.com/watch?v=CejyLsI0HIw
16. TIIF/TIIF2 for the CC-40/TI-74/95
    http://pengels.bplaced.net/index.php/tiif/

Have Vintage Apps at your Fingertips for your Favorite Devices!

Thank you for purchasing a TI RAM/FLASH cartridge for the TI-74/74S/95. For those with the FLASH Cartridge you now have easy access to many vintage, hard-to-find, programs such as Finance, Math and Learning Pascal. We'll add more as they are located, and you can program your own apps to the FLASH memory too! There is space for up to eight programs.

If you like having easy access to multiple apps for vintage computers, check out the other Dial-A-ROM products at https://www.soigeneris.com/dial-a-rom-for-vintage-computers

There are Dial-A-ROMs for the TRS-80 Model 100/102/200; NEC PC-8201A; EPSON PX-8; EPSON HX-20 and TI CC-40. Plus, you can purchase a Programming Adapter for your flash programmer to load your own applications to the Dial-A-ROM for easy access. One 'ROM', many programs – just dial them in! Vintage computing made user friendly.

Welcome to the Texas Instrument TI-74 & TI-95 Cartridge User Manual

Introduction

Both the TI-74 and TI-95 have cartridge ports that can accommodate either a plug-in cartridge with pre-loaded applications in a ROM (e.g., Finance, Statistics, etc.), or RAM cartridges that support 8K bytes or 32K bytes of constant battery memory. Unfortunately, neither the TI-74/95 were well supported by TI during their lifetimes thus making the pre-loaded application ROM cartridges hard to find; the RAM cartridges are slightly more available. This user guide describes three new memory cartridges that offer a unique approach to providing ROM and RAM based cartridge storage for both the TI-74 and TI-95.

The three new cartridges provide 32K banked FLASH and/or 32K banked RAM memory depending on the version installed. Both the FLASH and RAM cartridges have 8 x 32K (V1/V2) or 16 x 32K (V3) byte banks available. The COMBO cartridge has 16 x 32K RAM and FLASH; each bank can be selected/switched to by using onboard DIP switches. On the COMBO cartridge the RAM or FLASH can be selected by moving the slide switch on the cart PCB, it is obscured by the battery PCB. The RAM cartridge can function as either an 8K byte additional program memory or as a program storage area when used with the TI-74. The TI-95 will use only 16K bytes by default but can use the full 32K of memory with the method outlined in Ref [4] page and reproduced in Annex A. The TI-74 S (note the space between 4 and S) has access to the full 32K bytes of RAM. The TI-74S has same 8K limitation as TI-74.

The RAM cartridge uses a 512K* byte static RAM chip that has battery backup provided by a CR2032 button cell. The CR2032 should provide backup power to the RAM for a few months if the RAM cartridge is without power from the TI 74/95's AA batteries. The COMBO cartridge uses a CR1632 button cell due to space constraints. The backup battery is intended to protect the RAM contents while the main AA batteries are being swapped. It also allows the RAM cartridge to be moved to other machines while preserving the contents. Although, it is always good practice to backup any work in the RAM cartridge before replacing the AA batteries or removing the cartridge.

Further information about using a RAM cartridge in the TI-74 can be found in the *Texas Instruments TI-74 Programming Reference Guide* page 3.23. The manual covers how to operate the cartridge. The use of the RAM cartridge in the TI-95 is covered in several places in the *Texas Instruments TI-95 Programming Reference Guide,* but *Chapter 8: File operations* describes how to set up and access the cartridge memory.

NOTE: The TI-74 and TI-74S (note no space between 4 and S) can only access 8K bytes of the 32K RAM when used in RAM expansion or storage modes. The TI-95 and TI-74 S (note space between 4 and S) have access to the full 32K bytes of the bank, although the TI-95 will require modifying the RAM contents to access the full 32K bytes see Ref. [14] on page 2.

**A 512K RAM chip is used in the RAM cartridge, however only 256K of this memory is accessible on the V1/V2 cartridges. This is due to the availability of suitable RAM parts that can run at 5V. The V3 cartridges now access all 512K.*

#*The ">" is used to represent a hexadecimal number in line with TI nomenclature.*

NOTE: V1/V2 cartridges have a jumper wire to fix an issue with address lines A15 and A14. The lines are incorrectly labeled in the *TI Technical Reference Guide* for the TI-74 and need to be swapped. The functionality of the cartridge is not impacted.

Hardware Installation

Installation of the Memory Expansion Modules is very straightforward. It can be inserted into the slot on the right-hand side of the unit. Refer to the relevant user manuals for further details.

⚡WARNING⚡

The Memory Expansion Cartridge is static sensitive like any other piece of electronic equipment. Make sure to store any removed Memory Expansion Cartridge in a static-proof bag until needed. When handling the memory module do so by the edges and refrain from touching the edge connector or components when the cartridge is open.

Troubleshooting the Module installations

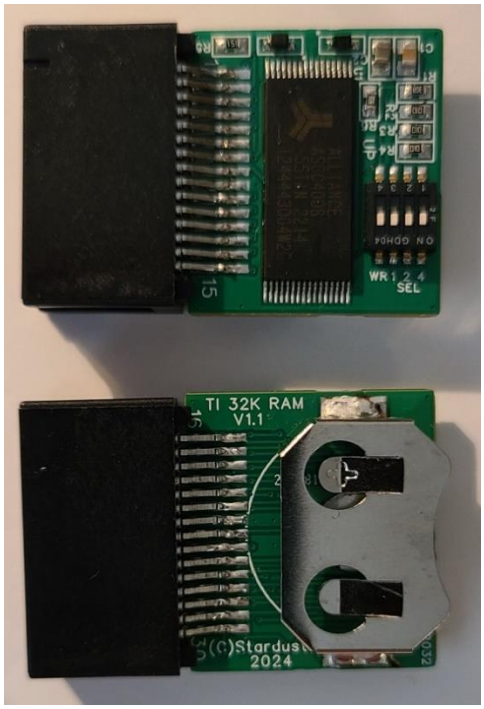
This section provides some ideas on troubleshooting installation issues.

- If a cartridge is not recognized when inserted, it is possible that corrosion has built up on main contacts of the motherboard preventing a good connection. This might be especially true if the cartridge port has never been used. In this case first, try using a contact cleaner (e.g. DeoxIT) to remove any oxidation. If this fails, try inserting/removing the cartridge a few times to clean off the contacts. If there seems to be excessive resistance to the insertion of the cartridge check the contacts again otherwise the connection pins on the cartridge might be damaged.

- If the cart is not responding or not showing up as extra memory/file storage, make sure the unit is fully inserted.

RAM Cartridge V3 installed

RAM Memory Cartridge

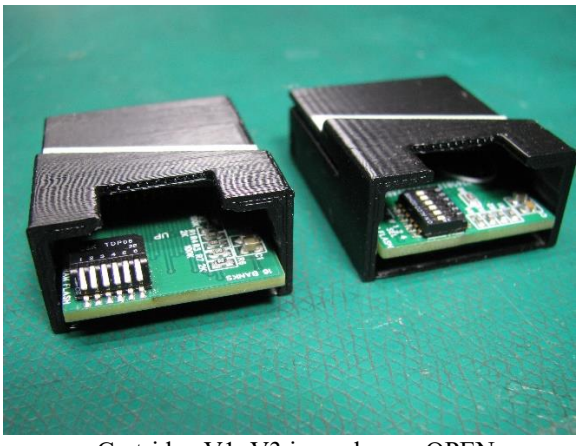


RAM Cartridge V1
(modules may vary in construction)

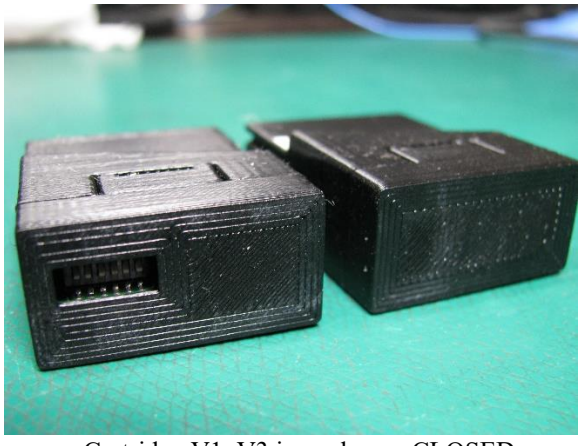
RAM Cartridge V3
(modules may vary in construction)

The RAM V1/V2 Cartridge provides a total capacity of 256K bytes, this is broken into 8 banks of 32K bytes. Each individual bank is selected or switched to using the onboard DIP switches – SEL/1 2 4 as shown in the picture. The DIP switch can be set ON or OFF the sequence determines the bank selected. For example, if switch 1 is ON, 2 is OFF and 4 is ON then bank 2 is selected.

The RAM V3 and COMBO V1 Cartridge provides a total capacity of 512K bytes, this is broken into 16 banks of 32K bytes. Each individual bank is selected or switched to using the onboard DIP switches – SEL/1 2 3 4 as shown in the picture. The DIP switch can be set ON (Down) or OFF (Up) the sequence determines the bank selected. For example, if switch 1 is ON, 2 is OFF and 4 is ON then bank 2 is selected.



Cartridge V1, V3 in enclosure OPEN



Cartridge V1, V3 in enclosure CLOSED

The selected 32K byte bank can be used in one of three ways:

1. The RAM Cartridge can be used to add extra memory to the BASIC program space by using `CALL ADDMEM` to initialize the memory on the TI-74/74S. On the TI-74/TI-74S this will provide ~15K bytes of BASIC program space. The TI-74 S (space between 4 and S) memory will increase to ~40K. The TI-95 file space will be expanded to 16K by default, however using the technique described in Annex A this can be increased to the full 32K. Switching away from the initialized memory bank by changing the DIP switches will cause any program stored to be lost as the TI-74/74 S will automatically re-initialize the memory. Once the bank has been initialized the DIP switches must be left unchanged until either the extra memory is no longer required, or the program has been saved to a backup medium. Refer to the relevant users guides for more information on the use of this command option.

   Depending on how the main memory and cartridge are partitioned on the TI-95 changing a bank may cause memory issues.

2. The RAM Cartridge can be used as a program storage area, again on the TI-74/74S only 8K bytes are available, on the 74 S only 16K bytes and 32K bytes on the TI-74 S (note the space) and 16K (default) on the TI-95. This option uses the `CALL GET` and `CALL PUT` commands. The TI-95 has quite sophisticated options for dealing with the constant memory cartridge, reference should be made the Chapter 8 of the TI-95 User Guide the discussion is beyond the scope of this introductory guide.

   On the TI-74/74S/74 S the `PUT` command can be used to save (`CALL PUT(1)`) the currently resident BASIC program to the RAM cartridge OR to swap (`CALL PUT(-1)`) the currently resident BASIC program with any BASIC program already stored on the RAM cartridge.

   On the TI-74/74S/74 S the `GET` command can be used to retrieve (`CALL GET(1)`) any BASIC program stored in the RAM cartridge and overwrite the currently resident BASIC program OR swap (`CALL GET(-1)`) any BASIC program currently stored on the RAM cartridge with the currently resident BASIC program.

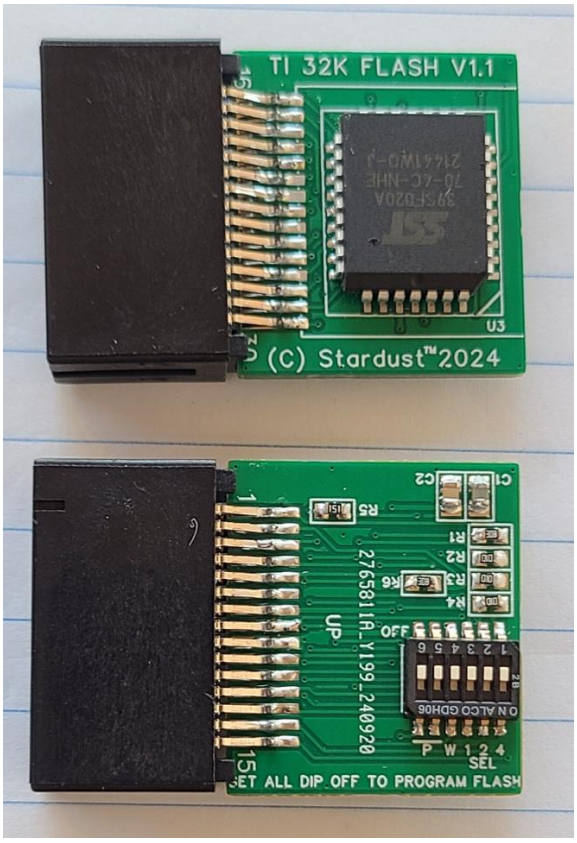
   The TI-95 uses a menu scheme to provide similar access to the cartridge. The TI-95 can have multiple programs stored on the cartridge unlike the TI-74/74S/74 S. In addition, the cartridge can be used to store/run programs and data. It is quite sophisticated in how the cartridge memory can be used. In effect the cartridge becomes a small drive for storing programs/data.

   When using this option, the bank can be changed without impacting the BASIC program stored on the RAM cartridge, therefore it is possible to store up to 8 (V1) or 16 (V3) different programs, switching to and loading each as required. Refer to the relevant users guides for more information on using these command options.

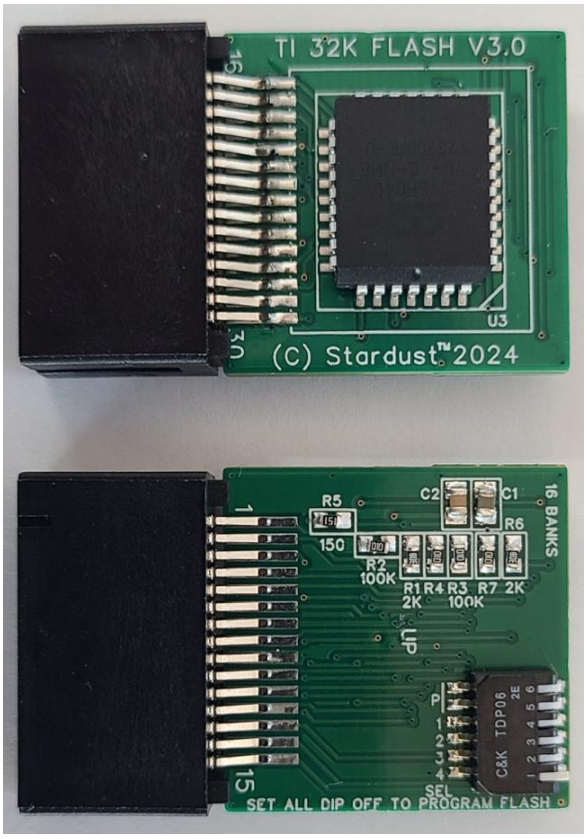
3. The RAM cartridge can be used to store ROM program images and accessed as a ROM program. Using the RAM cartridge to store a ROM program image requires both the ROM program image and personal computer software to transfer the ROM program image to the RAM, one such program is TIIF/TIIF2 see Ref [16] on page 2. Once the ROM program image is written to the RAM cartridge bank it can be used like the original ROM program. If desired the WRite switch on the DIP can be set OFF to protect any images from accidental deletion. Normally this switch would be left ON as the default condition. The RAM on the COMBO cartridge can be protected in a similar manner.

   NOTE: ROM program images for the TI-74 and TI-95 are not interchangeable, although TI-74 and TI-94 ROM program images can be stored on the same RAM cartridge in different banks.

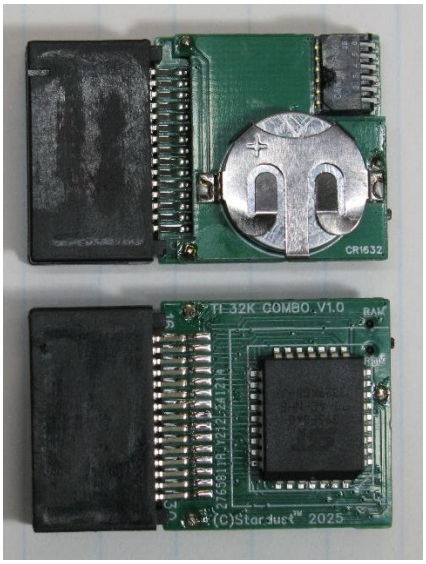
Flash Memory Cartridge

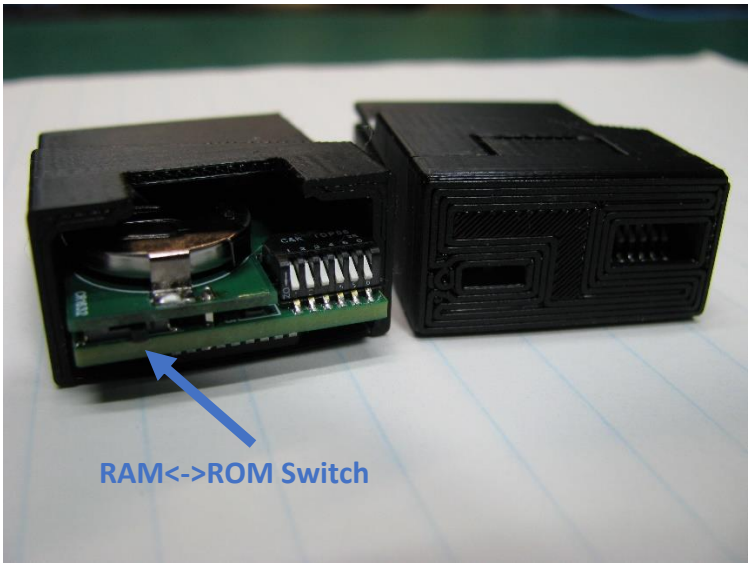


FLASH memory Cartridge
(modules may vary in construction)



FLASH memory Cartridge V3
(modules may vary in construction)





COMBO Cart V1 (modules may vary in construction)

The V1/V2 FLASH memory Cartridge provides a total capacity of 256K bytes, this is divided into 8 banks of 32K bytes. Each individual bank is selected or switched to using the onboard DIP switches – SEL/1 2 4 as shown in the picture. Each of the 32K byte banks can be used to store a ROM program image. Currently the ROM program images pre-stored on the FLASH Cartridge are listed in the table below. You can add other program images as required using the technique as outlined in Ref. [15] on page 2. ROM program images can be for either the TI-74 or TI-95, although they are different for each machine. The FLASH memory on the cartridge can be reprogramed many times.

The V3 FLASH and V1 COMBO memory Cartridge provides a total capacity of 512K bytes, this is broken into 16 banks of 32K bytes. Each individual bank is selected or switched to using the onboard DIP switches – SEL/1 2 3 4 as shown in the picture. Each of the 32K byte banks can be used to store a ROM program image. Currently the ROM program images pre-stored on the FLASH Cartridge are listed in the table below. You can add other program images as required using the technique as outlined in Ref. [15] on page 2. ROM program images can be for either the TI-74 or TI-95, although they are different for each machine. The FLASH memory on the cartridge can be reprogramed many times.

To program the FLASH chip on the cartridge using the 'reversed adapter' (Ref. [15] page 2) ALL the DIP switches must be set OFF. The DIP switches labeled with P and W are used to disconnect various pins on the FLASH chip to allow the FLASH chip programmer to function. The final setting of the W DIP is not important and can remain OFF.

NOTE: V1/V2 DIP switch numbering schema for program selection is reversed binary.
ORDER [PPW124] FLASH Cart, [W124] RAM Cart -- 1 = OFF, 0 = ON

Label	Switch	Use
FLASH		
PP	0 0 x x x	Normal RUN position. FLASH
PP	1 1 x x x	Programming position. FLASH (all switch up to program)
RAM		
W	x 0 x x x	RAM Accessible
W	x 1 x x x	Write protect. RAM Cart

FLASH Pre-stored program images

Slot	Switch x 1 2 4	ROM Program	To use the program
7	x 1 1 1	TI-95 Chemical	RUN "CHE"
6	x 0 1 1	TI-95 Statistics	RUN "STA"
5	x 1 0 1	TI-95 Math	RUN "MTH"
4	x 0 0 1	TI-74 Chemical	RUN "DIR"
3	x 1 1 0	TI-74 Statistics	RUN "DIR"
2	x 0 1 0	TI-74 Finance Cart	RUN "DIR"
1	x 1 0 0	TI-74 Math Cart	RUN "DIR"
0	x 0 0 0	TI-74 Learn Pascal	RUN "PASCAL"

V3 DIP Switch
ORDER [4321PP] FLASH Cart, [4321xW] RAM Cart -- 1 = OFF (UP), 0 = ON (DOWN)

Label	Switch	Use
FLASH		
PP	x x x x 0 0	Normal RUN position. FLASH
PP	x x x x 1 1	Programming position. FLASH (all sw. up to program)
RAM		
W	x x x x x 1	Write protect. RAM
W	x x x x x 0	RAM Accessible

COMBO DIP Switch
ORDER [P4321W] -- 1 = OFF (UP), 0 = ON (DOWN)

Label	Switch	Use
P	0 x x x x x	Normal RUN position. FLASH
P	1 x x x x x	Programming position. FLASH (all sw. up to program)
W	x x x x x 1	Write protect. RAM
W	x x x x x 0	RAM Accessible

V3 Combo FLASH Pre-stored program images

Slot	V3 Switch 4 3 2 1 x x	COMBO Switch x 4 3 2 1 x	ROM Program	To use the program
15	1 1 1 0 x x	x 1 1 1 0 x	BLANK	
14	1 1 1 0 x x	x 1 1 1 0 x	BLANK	
13	1 1 0 1 x x	x 1 1 0 1 x	BLANK	
12	1 1 0 0 x x	x 1 1 0 0 x	BLANK	
11	1 0 1 1 x x	x 1 0 1 1 x	BLANK	
10	1 0 1 0 x x	x 1 0 1 0 x	BLANK	
9	1 0 0 1 x x	x 1 0 0 1 x	TI-74 PIDWIZ*	AutoStart
8	1 0 0 0 x x	x 1 0 0 0 x	TI-95 Utility*	RUN …
7	0 1 1 1 x x	x 0 1 1 1 x	TI-95 Chemical	RUN "CHE"
6	0 1 1 0 x x	x 0 1 1 0 x	TI-95 Statistics	RUN "STA"
5	0 1 0 1 x x	x 0 1 0 1 x	TI-95 Math	RUN "MTH"
4	0 1 0 0 x x	x 0 1 0 0 x	TI-74 Chemical	RUN "DIR"
3	0 0 1 1 x x	x 0 0 1 1 x	TI-74 Statistics	RUN "DIR"
2	0 0 1 0 x x	x 0 0 1 0 x	TI-74 Finance Cart	RUN "DIR"
1	0 0 0 1 x x	x 0 0 0 1 x	TI-74 Math Cart	RUN "DIR"
0	0 0 0 0 x x	x 0 0 0 0 x	TI-74 Learn Pascal	RUN "PASCAL"

* #8 and #9 included as of 2/2/2025

Annex A: Ref [14] Text

The original text can be found at the link below. The relevant parts are reproduced here in case the link is removed; some clarifications have been [added] to the procedures to clarify the steps especially for those less experienced using some of the more obscure TI-95 features.

https://groups.google.com/g/comp.sys.handhelds/c/eQtqGIskUvM

32kB x 8 bit static RAM expansion module for TI-74 BASICALC or TI-95 PROCALC

Lorenz Born's profile photo
Lorenz Born
Mar 5, 2020, 10:53:43 AM
Dear all,

I had the unique opportunity to buy a pocket TI-95 PROCALC calculator together with a Math Statistics, a Chemical Engineering library module, a PC-324 printer and a PC interface for around $40 here in Switzerland.

Now I'm considering how the internal memory of only 8kByte could be expanded with a RAM memory module (RAM cartridge) with 32 kByte. In my opinion, this should work, since a ROM expansion (ROM cartridge) with a memory size of 32 kByte was also available for the TI-95 PROCALC calculator.

What do you think about that? Has anyone worked with such a RAM extension before? Probably built by yourself. Of course, I would have to develop it first. I imagine using a SAMSUNG KM62256CLG-7L (see https://app.ultralibrarian.com/details/Samsung/KM62256CLG-7L?uid=93ce5ab184e94c09) 32k x 8 bit low power CMOS static RAM (70ns).

Would anyone other than me be interested in such a 32 kByte RAM cartridge? Thanks in advance for any help or comments.

Best regards,
Lorenz
--
Mar 6, 2020, 6:30:33 AM
to
I had a rare TI 32K cartridge. It was directly usable on the TI-74 but to use all 32K on the 95, you needed to do some manipulation:

To allow full access:
(numbers are in Hex)

```
Store 20 in BFFC
Store 7F in BFF4

Key-by-key method:

1. Enter Hex Mode by pressing CONV, BAS (on function key), HEX (on function
key)
2. Enter System mode by pressing FUNC, SYS (on function key), YES (on
function key)
3.Type 2 then 0
4. Press STB (on function key)
```

```
5. Type 2nd, B (on HYP key), 2nd, F (on RCL key),a2nd, F (on RCL key), 2nd C
(on INCR key)
6. Type 7, 2nd F (on RCL key)
6a. Press STB (on function key) [ADDED]
7. Type 2nd B (on HYP key), 2nd F (on RCL key), 2nd F v (on RCL key), 4
```

Now when you do a CAT of the file space on the cartridge, it will show 32752 bytes free. You can remove the cartridge, insert other cartridges, even press reset or insert the 32K cart in another machine. The number of free bytes on that 32K cart will still be correct.

The number of free bytes is stored on the cartridge.

Lorenz Born

Tom, thank you for the very detailed explanation! This is new and very interesting for me. What else is saved in the last 16 bytes of the cartridge port memory map? Do you possibly know more about this? And why the two values #20 in BFFC and #7F in BFF4? Can these two hexadecimal values be explained? At the moment I don't see any connection with the memory size of 32768 bytes.
--

Mar 6, 2020, 1:38:09 PM

7F20 hex is decimal 32544. That's the memory size of the 32K cartridge after some bytes (224 decimal bytes) are taken for housekeeping. Since this is an 8-bit machine, you have to enter the hex value in two parts - 20 which is the LSB (least significant byte) and 7F which is the MSB (most significant byte)

I don't have any other information about data in the cartridge port. Sorry!

Mar 7, 2020, 2:03:35 AM

On 2020-03-06 22:38, Tom Lake wrote:
> On Friday, March 6, 2020 at 11:32:37 AM UTC-5, Lorenz Born wrote:
>> On 2020-03-06 15:30, Tom Lake wrote:
...
>> Tom, thank you for the very detailed explanation! This is new and very
>> interesting for me. What else is saved in the last 16 bytes of the
>> cartridge port memory map? Do you possibly know more about this? And why
>> the two values #20 in BFFC and #7F in BFF4? Can these two hexadecimal
>> values be explained? At the moment I don't see any connection with the
>> memory size of 32768 bytes.
>
> 7F20 hex is decimal 32544. That's the memory size of the 32K cartridge after
> some bytes (224 decimal bytes) are taken for housekeeping. Since this is an
> 8-bit machine, you have to enter the hex value in two parts - 20 which is
> the LSB (least significant byte) and 7F which is the MSB (most significant byte)
>
> I don't have any other information about data in the cartridge port. Sorry!
>
Tom, thanks again for your patience and answering my questions! In the meantime, my clarifications based on the TI-95 ROM listings (see http://www.rskey.org/CMS/index.php/the-library/13) have shown the following in the table below.

xx = value not (yet) known specific hexadecimal value applies to a 32kB module (RAM cartridge)

```
-------+-----+-----------------------------------------------------
address|value|function, description or assumption
-------+-----+-----------------------------------------------------
BFF0 | xx | unknown yet or no function
-------+-----+-----------------------------------------------------
BFF1 | xx | unknown yet or no function
-------+-----+-----------------------------------------------------
BFF2 | xx | probably MSB of used space (byte) in directory
-------+-----+-----------------------------------------------------
BFF3 | xx | LSB of used space (byte) in directory
-------+-----+-----------------------------------------------------
BFF4 | 7F | MSB of free bytes in cartridge (for 32kB)
-------+-----+-----------------------------------------------------
BFF5 | FF | LSB of free bytes in cartridge (for 32kB)
-------+-----+-----------------------------------------------------
BFF6 | xx | MSB of number of files (in cartridge)
-------+-----+-----------------------------------------------------
BFF7 | xx | LSB of number of files (in cartridge)
-------+-----+-----------------------------------------------------
BFF8 | 4E | character "N" \
-------+-----+------------------ |
BFF9 | 45 | character "E" > name of cartridge (?)
-------+-----+------------------ |
BFFA | 57 | character "W" /
-------+-----+-----------------------------------------------------
BFFB | xx | info byte of cartridge
-------+-----+-----------------------------------------------------
BFFC | 20 | cartridge memory size in kB (20h=32d)
-------+-----+-----------------------------------------------------
BFFD | xx | MSB of entry address of cartridge
-------+-----+-----------------------------------------------------
BFFE | xx | LSB of entry address of cartridge
-------+-----+-----------------------------------------------------
BFFF | 6A | signature byte of cartridge
-------+-----+-----------------------------------------------------
```

Knowledge gained by analyzing the files rom-cd1.asm and rom-cd3.asm. But not yet fully understood everything.

Perhaps this is also of interest to you. I am now trying to use the TI-95 statistical library module to find out which values are available at the addresses above -- if any. Maybe new insights may arise here.

Mar 7, 2020, 6:04:16 AM

On Saturday, March 7, 2020 at 5:03:35 AM UTC-5, Lorenz Born wrote:
It looks like you don't need to reserve those 224 bytes after all. You'd just need to change these three locations by entering the byte in the second column:

```
> BFF4 | 7F | MSB of free bytes in cartridge (for 32kB)
> -------+-----+-----------------------------------------------------
> BFF5 | FF | LSB of free bytes in cartridge (for 32kB)
-------+-----+-----------------------------------------------------
> BFFC | 20 | cartridge memory size in kB (20h=32d)
```