The Gramulator

Models GR01—GR04

reference manual

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1.0: Introduction

The Gramulator is an advanced accessory device which plugs into the cartridge port of the Texas Instruments 99/4A Home Computer. The Gramulator contains circuitry that simulates GROMs 0–2 in the TI–99/4A console, GROMs 3–7 found in command modules and peripherals, and ROM or RAM at memory addresses >6000–>7FFF. Using the software built into the Gramulator, this allows you to load:

● Console GROMs, and/or

● Cartridge GROMs, and/or

● Cartridge ROMs

into the Gramulator's memory. This capability allows you to simulate every cartridge produced for the TI–99/4A. With the supplied Memory Editor, you can change the operating system built into the TI–99/4A console and customize cartridges for your needs.

The Gramulator is available in the following models:

Gramulator Models				
Model	Useable GRAM	Useable RAM	Total Gramulator RAM	Comment
GR01	64K	16K	96K	Standard Gramulator
GR02	64K	20K	96K	Includes: MBX option
GR03	104K	16K	136K	Includes: Alternate GRAM option
GRO4	104K	20K	136K	Includes: MBX option + Alternate GRAM option
Note: All of the Gramulator's memory is battery backed up.				

All options can be retro-fitted to a standard Gramulator GR01. You may elect to have options installed at the factory by returning your Gramulator for upgrade, or you may purchase option kits and install them yourself. Please call or write to CaDD Electronics for the cost of upgrades and/or kits.

There are three main benefits to using the Gramulator:

1. You can save a cartridge to disk, remove the cartridge, and then load the saved cartridge disk file(s) into the Gramulator. The Gramulator will then act as if you had the cartridge plugged in. By saving your cartridges to disk you will save considerable wear and tear on the console cartridge port.

2. Having your cartridges on disk gives you a backup in case of loss or damage to the cartridge.

3. You can customize cartridges saved to disk to fit your needs. An example would be the ability to change the Disk Manager 2 cartridge to access more than three drives.

Many man-hours have gone into giving you a complete product with full documentation and software that is as bug free as possible. However, CaDD Electronics apologizes for any errors which may be contained herein.

There are a few people who deserve much thanks for their support and help in creating the Gramulator:

● **Mike Wright** for helping with the documentation format, printed circuit board layout, advertising mailing and generally everything.

● **J. Peter Hoddie** for lending a hand on some difficult software problems and for support during the long development process. Peter also wrote the catalog routine contained in the Gramulator software.

● **Joyce Corker** for her help with the testing and debugging of software and for checking the documentation.

● Last, but definitely not least, my wife **Diane**. She has had to endure many long nights for these past months and I am grateful for her tolerance and support.

The Gramulator is designed to be easily used by the novice while still providing considerable flexibility for the expert.

– Mark Van Coppenolle, January 1990

2.0: System requirements

1. TI–99/4A console
2. 32K memory expansion
3. Disk controller and one or more disk drives

2.1: System notes

The Gramulator has been tested with:

1. Myarc 512K RAM disk card without XBII
2. Myarc 512K RAM disk card with XBII

   Note: You must leave the Gramulator Write Protect switch on to prevent XBII from overwriting a loaded cartridge.

3. Rave 99 MX01 RAM disk card.
4. Texas Instruments disk controller.
5. CorComp disk controller.
6. Myarc floppy disk controller.
7. Myarc hard/floppy disk controller.

All devices are accessed in the same fashion as the standard TI DSRLNK. Devices such as RAM disks and non-TI disk controllers should also work fine. If you encounter any trouble in accessing any device please contact:

CaDD Electronics
81 Prescott Road
Raymond, NH 03077
(603) 895-0119

3.0: Terminology

- **Press <fctn B>**
  means hold down the <fctn> key while you press the B key.

- **Press <ctrl C>**
  means hold down the <ctrl> key while you press the C key.

- **ROM**
  is an acronym for Read Only Memory.

- **RAM**
  is an acronym for Random Access Memory.

- **GROM**
  is an acronym for Graphics Read Only Memory. A GROM is a type of integrated circuit (chip) developed by Texas Instruments. When a GROM is addressed it will auto-increment its current address on successive memory fetches. A TI-99/4A can address up to 8 GROMs. GROMs 0-2 are in the console. GROMs 3-7 may be found in cartridges.

- **GRAM**
  is an acronym for Graphics Random Access Memory. There is no such thing as a GRAM integrated circuit. In the Gramulator, standard RAM chips and support circuitry are designed to emulate TI GROM chips.

- **Ascii**
  is an acronym for the American Standard Code for Information Interchange.

- **hex**
  is a commonly used abbreviation for referring to the hexadecimal numbering system (base 16).

- **>**
  is a symbol used to indicate that a hex value follows. For example: >7F is the decimal value 127.

- **TI Master Title Screen**
  is the TI "color bar" screen displayed when the computer is powered on.

- **TI Master Selection List**
  is the TI screen that is displayed when a key is pressed from the TI Master Title Screen.

- **Memory Editor**
  is a program supplied on disk as part of the Gramulator package. It allows you to examine or change the contents of RAM or GRAM.

- **MBX Expansion System**
  The MBX Expansion System was produced by Milton Bradley. It consists of a unit with a membrane touchpad, joystick(s), microphone, and cables to connect it to a TI-99/4A console. Milton Bradley produced 10 cartridges for the system.

- **MBX option**
  This is a Gramulator hardware option that makes use of 16K more RAM in the Gramulator. Some of the Milton Bradley cartridges contained extra RAM. The Gramulator requires this option to emulate these cartridges.

- **REVIEW MODULE LIBRARY**
  This is a software option built into the TI-99/4A console and displayed on the Master Selection List. It is invoked if the operating system detects more than one GROM header starting at base address >9800. Most TI users will never see this option.

- **Alternate GRAM option**
  This is a Gramulator hardware option that adds 40K of GRAM to the Gramulator. When a cartridge is stored in Alternate GRAM, the 99/4A console can access the cartridge using REVIEW MODULE LIBRARY.

- **Trademarks**
  Texas Instruments: 99/4-A, GROM, Extended BASIC
  Milton Bradley: MBX
  Myarc: Geneve 9640, XBII
  Triton: Super Extended BASIC
  Miller's Graphics (MG): Gram Kracker

4.0: Getting started

```
****************************************
**           ** WARNING **           **
**      NEVER INSERT THE GRAMULATOR  **
**        INTO THE CARTRIDGE PORT    **
**      WITH THE COMPUTER POWER ON.  **
****************************************
```

To begin using the Gramulator, first ensure that the computer console is turned off. Please follow these step-by-step instructions:

1. Insert the Gramulator into the computer cartridge port. Be sure that the battery holding clip clears the top of the computer cartridge part. If not, gently press down on top of the battery while inserting.

2. Set the positions of the Gramulator front panel switches as follows:

    ● Bank switching to on.

    ● RAM 1/RAM 0 to RAM 0.

    ● Loader to on.

    ● TI OS/GRAM 0 to TI OS.

    ● TI Basic/GRAMS 1-2 to TI Basic.

    ● Cartridge/Gramulator to Gramulator.

    ● Write protect to off.

Bank ON	RAM 1	Loader OFF	TI OS	TI Basic	Cartridge	Write ON
↑	↓	↓	↑	↑	↓	↓
OFF Switching	RAM 0	ON	GRAM 0	GRAMS 1-2	Gramulator	OFF Protect

3. *Models GR02 and GR04 only:**
    Set the MBX/Normal switch to Normal.

4. Turn the computer on. The TI master title screen is displayed.

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* See page 1 for model details.

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5. Press any key. The TI master selection list is displayed. A typical display is

    ```
    PRESS
    1. FOR TI BASIC
    2. FOR TOUCH TYPING TUTOR
    3. FOR GRAMULATOR Vm.n*
    ```

6. Select

    ```
    3. GRAMULATOR Vm.n*
    ```

    The value to select is usually 3, but will vary depending on your TI hardware configuration. The Gramulator main menu is displayed.

4.1: The Gramulator main menu

```
+---------------------------------+
|         THE GRAMULATOR          |
|           MAIN MENU             |
|                                 |
|   1. LOAD GRAMULATOR            |
|   2. SAVE A CARTRIDGE           |
|   3. SAVE RAM/GRAM              |
|   4. SAVE TI OS                 |
|   5. SAVE TI BASIC              |
|   6. TURN OFF TI OS             |
|   7. TURN OFF TI BASIC          |
|   8. TURN ON LOADER             |
|   9. SWAP RAM BANKS 0 AND 1     |
|   OTHER ACTIVE KEYS ^C ^M       |
+---------------------------------+
```

The following sections will cover each of the selections available from the Gramulator main menu.

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* The values for m and n depend on the version of the Gramulator's EPROM

5.0: Saving a cartridge

```
+-----------------------------------------------------+
|                    ** WARNING **                    |
|              NEVER INSERT A CARTRIDGE               |
|               INTO THE GRAMULATOR                   |
|            WITH THE COMPUTER POWER ON.              |
+-----------------------------------------------------+
```

To save a cartridge to disk:

1. Turn off the computer.

2. Insert the cartridge into the cartridge port on the Gramulator. The cartridge is inserted into the connector with the flat bottom towards you.

   Note: If you are saving Super Extended BASIC see *Appendix C* on page 45.

3. Follow the instructions on *Getting started* on page 6.

4. With the Gramulator main menu on the screen select

   `2. SAVE A CARTRIDGE`

5. The screen displays

   ```
   THE GRAMULATOR
   SAVE A CARTRIDGE

   Place CARTRIDGE/GRAMULATOR
   switch in the cartridge
   position NOW!

   Name of file to save cartridge
   as?
   ```

6. Place the Cartridge/Gramulator switch in the cartridge position.

7. Type in the filename you want to save the cartridge under. This name will be used later when you want to load the saved cartridge into the Gramulator. The format is `DEVICE.FILENAME`. For example, `DSK1.XB`. The filename portion should be nine characters or less. Most cartridges require more than one file. If this is the case, a 1 is added to the filename and then incremented for each succeeding file. Each filename is displayed during the save. For example:

   `DSK1.XB   DSK1.XB1   DSK1.XB2   DSK1.XB3   and so on`

8. When the save is complete the screen displays

   ```
   Return switch to Gramulator
   position NOW!
   PRESS ANY KEY
   ```

9. Set the Cartridge/Gramulator switch back to the Gramulator position. Press any key to return to the Gramulator main menu.

6.0: Loading the Gramulator

This function allows you to load any previously saved files into the Gramulator. These files are not limited to saved cartridges. They may also contain a saved or altered TI OS, TI Basic, or memory image (E/A5) program. If you are loading a saved auto-start cartridge (for example Plato), see *Appendix A* on page 39. To load the Gramulator:

1. Follow the instructions on *Getting started* on page 6.

2. With the Gramulator main menu on the screen select

   1. LOAD GRAMULATOR

3. The screen displays

   INIT MODULE SPACE? Y

   If you answer No to the prompt, proceed to step 10.

4. *Models GR01 and GR02 only:**
   If you answer Yes to the prompt, the screen displays

   INITIALIZE GRAMS 3-7

   INITIALIZE RAMS 0,1

   Now proceed to step 9.

5. *Models GR03 and GR04 only:**
   If you answer Yes to the prompt, the screen displays

   Alternate GRAM detected
   Init which bank? 1
   0= None
   1= Standard (>9800)
   2= Alternate (>9804)
   3= Both

6. *Models GR03 and GR04 only:**
   You may choose to initialize none of the GRAM, either GRAM bank, or all of the GRAM. If you choose to initialize any GRAM the following message is displayed

   INITIALIZE GRAMS 3-7 (>9800) or (>9804)

7. *Models GR03 and GR04 only:**
   You are now prompted by the menu

   Load which GRAM bank? 1
   1= Standard (>9800)
   2= Alternate (>9804)

   You can now choose which GRAM bank to load. Press <enter> for the default of standard.

8. *Models GR03 and GR04 only:**
   You are now asked if you wish to initialize RAMs 0 and 1 by the message

   Init RAMS 0 and 1? Y

   You should always initialize these RAMs unless a cartridge, which was previously loaded and not cleared, uses them. If you do choose to initialize them, this message is displayed

   INITIALIZE RAMS 0,1

9. If the message

   TURN OFF WRITE PROTECTION!

   is flashing then you have the Write Protect switch in the on position. You must turn this switch off to complete the initialization process or press any key to abort back to the INIT MODULE SPACE prompt.

10. When initialization is complete, or if you said No at the INIT MODULE SPACE prompt, the screen displays

    Name of file to load from?

    Type in the filename you used when you saved the cartridge. The format is DEVICE.FILENAME. For example: DSK1.XB. If <enter> is pressed without typing DEVICE.FILENAME, a default of DSK1.UTIL1 is used.

Note: If you do not choose to initialize the module area, the default GRAM Base Address will be >9800 (standard). This default is restored whenever the Gramulator main menu is displayed.

6.1: Switch settings when loading is complete

To run the cartridge you loaded into the Gramulator, turn the Write Protect switch on and press <fctn => (QUIT). You will be returned to the TI master title screen. Press any key to see the TI Master Selection List, which will show an entry for the "cartridge" you loaded into the Gramulator. If you loaded an MBX cartridge then leave the Write Protect switch off.

Warning

After the loading of a file the physical position of the switches on the front panel may not represent the internal state of the Gramulator. As part of the loading process the Gramulator software can change the electrical position of the switches. For example, if the file just loaded went into GRAM 0, then GROM 0, the GROM that contains the TI Operating System (TI OS), is no longer active even if the switch position is set to TI OS. To run the files just loaded after the computer is powered off, see *Running a loaded cartridge from power-up* on page 13.

7.0: Running a loaded cartridge from power-up

To run a cartridge from power-up you must have the front panel switches set correctly for the type of cartridge loaded. Most cartridges will need the front panel switches set as follows:

1. Bank switching to on.
2. RAM 0/RAM 1 to RAM 0.
3. Loader to off.
4. TI OS/GRAM 0 to TI OS.

   Note: If you wish to run your own operating system select GRAM 0.
5. TI BASIC/GRAMS 1-2 to TI BASIC.

   Note: If you have replaced TI BASIC with your own software then select GRAMS 1-2.
6. Cartridge/Gramulator to Gramulator.
7. Write Protect to on.

Bank ON	RAM 1	Loader OFF	TI OS	TI BASIC	Cartridge	Write ON
↑	↓	↑	↑	↑	↓	↑
OFF Switching	RAM 0	ON	GRAM 0	GRAMS 1-2	Gramulator	OFF Protect

8. *Models GR02 and GR04 only:*
   MBX/Normal to Normal. If you are running an MBX cartridge then set to MBX, turn off the Write Protect switch (step #7) and turn Bank Switching off (step #1). If you have XBII installed you <u>must</u> leave Write Protect on until the cartridge is selected.

9. Turn on the computer. Press any key to see the TI Master Selection List. Select your "cartridge" from the list.

7.1: Running a non-bank switched cartridge with XBII

If you have Myarc XBII installed and you wish to run a non-bank switched cartridge then follow the previous instructions except set Bank Switching to off.

A non-bank switched cartridge is a cartridge which only occupies either RAM 0 or RAM 1 but not both.

8.0: Saving the TI operating system (OS)

The TI operating system (OS) is stored in GROM 0 in the console. You can save the OS to disk and then load it into the Gramulator. You can make changes to the OS in the Gramulator using the Memory Editor and save the changes to disk so that you have a custom operating system. For example, you can change the TI master title screen, or the default character set.

To save the built-in operating system:

1. Follow the instructions on *Getting started* on page 6.

2. With the Gramulator main menu on the screen select

   4. SAVE TI OS

3. The screen displays

   THE GRAMULATOR
   SAVE TIOS
   Name to save !GROM! 0 as?

4. Type in the filename you want to save the OS under. This name will be used later when you want to load the OS into the Gramulator. The format is DEVICE.FILE-NAME. For example, DSK1.TIOS.

5. When the save is complete the screen displays

   PRESS ANY KEY

6. Press any key to return to the Gramulator main menu.

Note: Although saving the TI OS is separate from saving a cartridge, both are loaded using the

1. LOAD GRAMULATOR

option from the Main Menu.

9.0: Saving the built-in TI Basic

TI Basic is stored in GROMs 1 and 2 in the console. You can save TI Basic to disk and then load it into the Gramulator. You can make changes to the TI Basic in the Gramulator using the Memory Editor and save the changes to disk so that you have a custom version of Basic.

To save the built-in TI Basic:

1. Follow the instructions on *Getting started* on page 6.

2. With the Gramulator main menu on the screen select

   5. SAVE TI BASIC

3. The screen displays

   THE GRAMULATOR
   SAVE TI BASIC
   Name to save !GROMS! 1,2 as?

4. Type in the filename you want to save TI Basic under. This name will be used later when you want to load TI Basic into the Gramulator. The format is DEVICE.FILE-NAME. For example, DSK1.TIBASIC.

5. When the save is complete the screen displays

   PRESS ANY KEY

6. Press any key to return to the Gramulator main menu.

Note: Although saving TI Basic is separate from saving a cartridge, both are loaded using the

1. LOAD GRAMULATOR

option from the Main Menu.

10.0: Saving user-selected RAMs and GRAMs

This is one of the strongest features of the Gramulator. Once a cartridge has been loaded into the Gramulator it may be edited using the Memory Editor. You must know how the cartridge software works and at what address it stores information to make meaningful changes. Typical changes include changing default colors or allowing a wider range of parameters. For example: You can change the TE II cartridge to operate at 1200 baud, or the Disk Manager 2 cartridge to access DSK4. You can then save the changes to disk and use the "cartridge" in its altered form.

To save user-selected RAMs and GRAMs:

1. Follow the instructions on *Saving a cartridge* on page 8.

2. Follow the instructions on *Loading the Gramulator* on page 10. As the files are being loaded, write down the location that each file of the saved cartridge is loaded into. An example display is shown for the Extended Basic cartridge:

   FILES LOADED INTO
   RAM 1   RAM 0
   GRAM 6   GRAM 5
   GRAM 4   GRAM 3

   PRESS ANY KEY

   The locations are: RAM 1, RAM 0, GRAM 6, GRAM 5, GRAM 4 and GRAM 3.

3. Place the Gramulator software diskette in Drive 1. Press <ctrl M> to load the Memory Editor. The screen displays:

   Loading...
   DSK1.MEMEDITOR

   The Memory Editor screen is displayed.

4. To edit the cartridge, follow the instructions on *The Memory Editor* on page 25.

5. When editing is complete press <fctn Q> to leave the Memory Editor and return to the Gramulator main menu. Select:

   3. SAVE RAM/GRAM

6. The screen displays

   THE GRAMULATOR
   SAVE SELECTED RAMS/GRAMS
   Are you saving a loaded MBX
   cartridge? N

   Type <enter> to use the default of No if you are not saving an MBX cartridge.

7. *Models GR03 and GR04 only:*[*]
The following message will appear

```
Alternate GRAM detected
Save which GRAM bank? 1
1. Standard (>9800)
2. Alternate (>9804)
```

At this prompt you are asked to choose the GRAM bank you wish to save. If the saved cartridge was loaded and edited in the standard bank then select 1.

8. You must now enter the RAMs and GRAMs you want saved. You do this by typing a Y or y under the number of the desired RAM or GRAM. For the Extended Basic example above you would type:

```
RAMS        GRAMS
 0 1     0 1 2 3 4 5 6 7
----------------------
 Y Y         Y Y Y Y
```

Note: If you are saving an MBX cartridge you will not be prompted to select RAMs. All four MBX RAMs are saved automatically.

9. Press <enter> to move the cursor from RAMS to GRAMS. Press <enter> when you are done. The screen displays

```
Filename for RAMS/GRAMS?
```

10. Type in the filename you want to save the RAMS/GRAMS under. This name will be used later when you want to load the edited RAMS/GRAMS into the Gramulator. The format is DEVICE.FILENAME. For example, DSK1.MYXBASIC.

11. When the save is complete the screen displays

```
PRESS ANY KEY
```

12. Press any key to return to the Gramulator main menu.

When you use the SAVE CARTRIDGE option of the Gramulator only 6K of data is stored on disk for each GROM. Since GROMs only contain 6K of useful data, this is done to conserve disk space. However, GRAMs contain 8K of useful data and will therefore take up more disk space. A GROM uses 26 sectors while a GRAM uses 34 sectors on disk.

If you load the Gramulator with GROM disk files, you should ensure that you have sufficient disk space if you save these as altered GRAMs.

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[*] See page 1 for model details.

Note: When you return to the Gramulator main menu the GRAM base address will be restored to its default of >9800.

11.0: Miscellaneous main menu selections

These three main menu selections are useful when you become a little more advanced in using the Gramulator. These selections allow you to turn on or off the state of, say, the built-in TI OS before loading the Memory Editor or exiting back to the TI title screen.

● **6. TURN ON/OFF TI OS**

This selection toggles on or off the ability to access the TI OS in GROM 0. The default upon entering the Gramulator's software is TI OS on. This is a software selection overriding any power-up setting regarding the state of the TI OS. If you load a file into GRAM 0 then the software automatically sets GRAM 0 on.

Note: Turning off GROM 0 without a valid OS loaded into GRAM 0 will cause you to lose keyboard control.

● **7. TURN ON/OFF TI BASIC**

This selection toggles on or off the ability to access the built in TI BASIC in GROMs 1 and 2. The default upon entering Gramulator's software is TI BASIC on. This is a software selection overriding any power-up setting regarding the state of the built-in TI BASIC. If you load a file into GRAM 1 or GRAM 2 then the software automatically sets both GRAMs 1 and 2 on.

● **8. TURN ON/OFF LOADER**

This selection toggles on or off the ability to access the Gramulator's loader. The default upon entering the Gramulator's software is loader off. This is a software selection overriding any power-up setting regarding the state of the Gramulator's loader software. After loading a cartridge from disk the loader is always turned off.

● **9. SWAP RAM BANKS 0 AND 1**

This selection allows you to swap the contents of RAMs 0 and 1. This is useful when you wish to load two different cartridges into these two RAMs. The cartridges must be ROM-based and use no more than one ROM bank. Two of the Atarisoft cartridges — Centipede and Defender — fall into this category.

When you select this function you are asked:

CONTINUE ? Y

To continue swapping RAM banks 0 and 1 press <enter>. Any other response is taken as a **No**. If you answer no, you are asked to PRESS ANY KEY to return to the main menu.

Under normal conditions Centipede will load into RAM 0. If you then load Defender it will simply overwrite Centipede. To fix this problem:
● Save the Centipede and Defender cartridges.
● Load Centipede into the Gramulator. It will go into RAM 0.
● Select Swap RAMs 0 and 1.
● Select Save RAMs and GRAMs.
● Answer No to the MBX prompt. Save only RAM 1. Use the same filename to save as you did to load Centipede.

Now when ever you load Centipede it will go into RAM 1 not RAM 0 as it did when originally saved. Since Defender was saved with the save cartridge option it will always load into RAM 0. This allows you to load both Centipede (RAM 1) and Defender (RAM 0) at the same time. At power-up select which RAM, and thereby which game, you wish to use.

Note: When loading two cartridges you must answer No to the INIT MODULE SPACE prompt.

12.0: Main menu selections not displayed

There are two selections available from the Gramulator main menu that are not fully described on the screen. Instead the line

OTHER ACTIVE KEYS ^C ^M

alerts you that you can use <ctrl C> and <ctrl M>.

12.1: <ctrl C> – Catalog a disk

This allows you to catalog any drive. This includes floppies, ramdisks and hard disks (up to 30-character filenames). Device names for DSK1–DSK4 can be typed as DSKn, DSKn. and n, where n equals the drive number desired. The Myarc ramdisk card can also be accessed by the device name RD.

12.2: <ctrl M> – Load Memory Editor

This allows you to load the Memory Editor from DSK1, if it has not already been loaded. If it was previously loaded then it will skip the load and begin execution immediately. Loading the Memory Editor in this fashion has two advantages:

- You do not need to type the filename. The filename defaults to DSK1.MEMEDITOR.

- You only need to load the editor once from disk during an editing session since you can jump back and forth between the Gramulator's software and the Memory Editor without reloading.

13.0: Loading multiple cartridges

To load multiple cartridges into the Gramulator you must first determine that the two cartridges do not occupy the same RAM or GRAM locations. You will load the first cartridge as normal, including initializing the module space. When you load the second cartridge *do not* choose to initialize the module space. Now press <fctn => (QUIT) and both selections should appear on the menu screen.

14.0: Explanation of switches

Bank ON	RAM 1	Loader OFF	TI OS	TI Basic	Cartridge	Write ON
↑	↓	↑	↑	↑	↓	↑
OFF Switching	RAM 0	ON	GRAM 0	GRAMS 1-2	Gramulator	OFF Protect

Bank Switching ON/OFF:

On power-up this switch determines if the two 8K RAM banks at >6000->7FFF are used as two 8K ROM banks being bank switched by writing to address >7000 for bank 0 or >7002 for bank 1. This is the method used for TI Extended Basic and Atarisoft cartridges. When bank switching is active you cannot write any data to the RAM banks. Writing data only has the effect of selecting, by the state of address line A14, which RAM bank to use for running the program.

RAM 0/RAM 1

On power-up this switch determines which of the two 8K RAM banks at >6000->7FFF is used.

LOADER ON/OFF:

On power-up this switch determines if the Gramulator loader is active. If the loader is not active then the RAM banks at >6000->7FFF are active. Once you select the loader from the TI menu screen the software in the Gramulator moves itself from >6000 (in cartridge space) to >E000 and runs from memory expansion. If a cartridge is loaded and you wish to run it then you should always set this switch off on power-up.

TI OS/GRAM 0:

On power-up this switch determines if the built in TI Operating System or the user-loaded OS (into GRAM 0) is active.

TI Basic/GRAMs 1 and 2:

On power-up this switch determines if the built-in TI Basic or the user-loaded GRAMs 1 and 2 are used. These GRAMs do not need to contain any sort of Basic, they can be used for anything you like.

Cartridge/Gramulator:

This switch is active at all times. When placed in the Gramulator position it allows the Gramulator to function as a cartridge. In the cartridge position it disables all Gramulator functions except that GRAMs 0, 1 and 2 are still active if they were selected at power-up.

Write Protect ON/OFF:

This switch is active at all times. When in the on position this switch write protects *only* the RAM banks at >6000->7FFF. It does not write protect any GRAM space.

*Models GR02 and GR04 only:**
MBX/Normal:

In the MBX position allows the Gramulator to simulate the bank switching used in the MBX expansion system. It also overrides the RAM 0/RAM 1 switch. You must set bank switching off when using an MBX cartridge.

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* See page 1 for model details.

15.0: The Memory Editor

The Memory Editor takes full advantage of the hardware capabilities of the Gramulator. Some of the editor's features may require a little practice before you become comfortable with them. However, you should find that the Memory Editor offers the easiest and most reliable way of altering cartridge-based software to better fit your needs.

15.1: Loading the Memory Editor

To load the memory editor:

1. Load the Gramulator with the cartridge you wish to edit. Follow the instructions on *Loading the Gramulator* on page 10. The cartridge should always be loaded just before editing to ensure that you are working with a good copy.

2. Write down the location(s) that the file(s) are loaded into. You will need them for later re-saving.

3. When the cartridge is loaded return to the Gramulator main menu.

4. Place the disk with the Memory Editor in Drive 1.

5. Press <ctrl M>. The screen displays

   Loading...
   DSK1.MEMEDITOR

   The loading of the editor should only take a few seconds. If the editor had previously been loaded you would have re-started it without reloading.

6. The screen displays:

```
                    THE GRAMULATOR

1   {    F1=RAM 1 ON       F3=GRAMS 1&2 ON
         F2=GRAM 0 ON      F4=LOADER ON
         F5=MBX OPTION ON
         F6=PAGE IN MBX RAM,RAM BANK=0
         F7=STRING SEARCH
2   {    F9=ENTER/EXIT MEMORY WINDOW

3   {    G6000s    ST 0000    FN FFFF
         ============================================

         -   -   -   -   -   -   `   -   -   -
         -   ι   >   -   -   -   -   -   -   -
         `   %   -   E   D   I   T   O   R
         /   A   S   S   E   M   B   L   E
4   {    R   -   -   -   -   -   ε   %   -
         ?   -   -   -   ?   @   ▬   -   J
         -   -   -   -   J   @   V   -   J
         -   -   -   -   -   -   J   -   -
         -   -   J   -   -   J   -   -   -
         J   -   -   @   H   -   ?   -   J
         ============================================
```
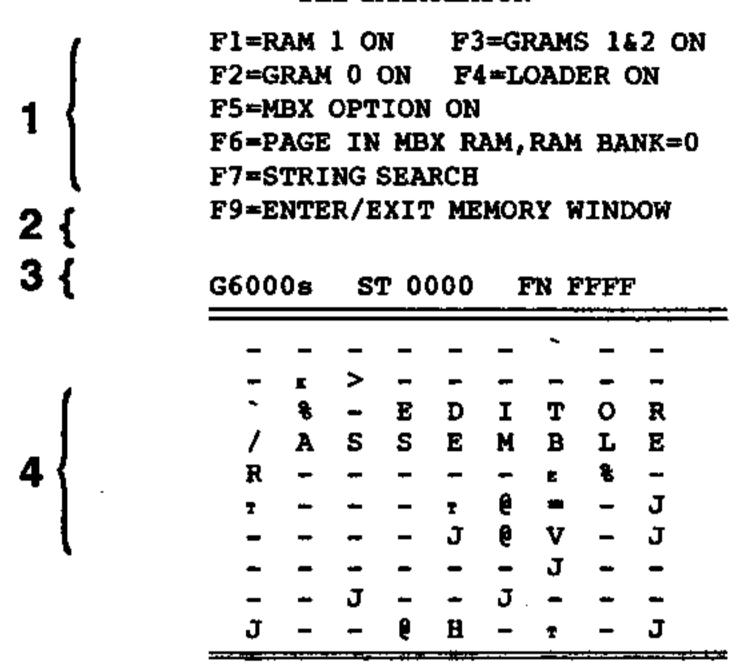
Figure 1–1
Memory Editor screen

Notes

1. **Memory Editor status:**
   This display will change depending on what you select. The state of the program is opposite to the display. For example, if F4=LOADER ON, this means you can press <fctn 4> to turn the loader on. Therefore the loader is currently off.

2. **Information line:**
   This is where you enter information required by various routines, such as string search, fill memory and print memory.

3. **Memory indicator line:**

   G = GRAM memory, C = CPU memory

   s = Standard GRAM bank selected, a = Alternate GRAM bank selected

   ST = STart Address

   FN = FiNish or end address

   BIAS = Basic bias on. This is displayed to the right of the Finish address if Basic bias in on.

4. **Memory window:**
   This is where the contents of memory are displayed. The display is 9 bytes wide by 10 lines deep and depends on what you have loaded in the Gramulator.

16.0: Memory Editor function keys

Once you have started the editor, and you are not inside the memory window, there are 15 function keys available. Eight of these are displayed on screen at all times. The Memory Editor functions are:

<fctn 1>

Toggles between RAM bank 0 and RAM bank 1. These are the RAM banks used by TI Extended Basic and some Atarisoft cartridges. This function is disabled if you are in the MBX mode or if the loader firmware is on.

<fctn 2>

Toggles between GROM 0 and GRAM 0.

<fctn 3>

Toggles between GROMs 1 and 2 and GRAMs 1 and 2.

<fctn 4>

Toggles the state of the loader firmware. If the loader is on you cannot edit any of the RAMs at CPU address >6000->7FFF. This function is disabled if you are in the MBX mode.

<fctn 5>

Toggles MBX mode on or off. This function is disabled if the loader is on. You must have a Gramulator with the MBX option installed for this function to be useful. Use of this function without the option installed will cause unpredictable results.

<fctn 6>

Scrolls through the four available RAM banks at >6000->7FFF in MBX simulation mode. This function is only active when in MBX mode. This function requires a Gramulator with the MBX option installed.

<fctn 7>

Enters or exits the search memory routine. For more information see *Using the string search function* on page 31.

<fctn 8>

Toggles the Basic bias on and off. The Basic bias is used to display the Error Messages in GROMs/GRAMs 1 and 2. Basic offsets its characters by >60 (decimal 96). The letter A contained in the word READY (TI BASIC READY) usually has a value of >41 but Basic adds >60 making it >A1. With Basic bias on this is corrected to be shown as >41 or Ascii A. If Basic bias is on it is indicated by the word BIAS directly to the right of the FiNished address. This function is not displayed on screen.

<fctn 9>

Enters or exits the memory window. For more information see *Entering and using the memory window* on page 35.

<fctn 0> (zero)

Enters or exits the fill function. This function fills memory with the byte selected. For more information see *Filling memory* on page 32. This function is not displayed on screen.

<fctn => (equals)

Toggles between Ascii and hex displays. This function is not displayed on screen.

<fctn A >

Toggles between standard (>9800) or alternate (>9804) GRAM banks. This function is not displayed on screen.

*Models GR03 and GR04 only:**

The memory window is updated and an s or an a is displayed following the current memory address located on the memory indicator line.

*Models GR01 and GR02 only:**

This function will only have the effect of toggling the s and a following the current memory address.

<fctn B>

Scrolls through the colors available for the screen color. This function is not displayed on screen.

---

* See page 1 for model details.

<fctn F>

Scrolls through the colors available for the character foreground color. This function is not displayed on screen.

<fctn M>

Enters or exits the Move memory block function. For more information see *Moving memory blocks* on page 33.

<fctn P>

Enters the memory print (dump) function. This function prints, to disk or a printer, the contents of the selected type and area of memory. For more details see *Printing memory* on page 34. This function is not displayed on screen.

<fctn Q>

Quits the Memory Editor and returns to the Gramulator main menu. Any selections you had made, concerning the state of the loader and such, will be restored to their previous states before entering the editor! There is only one exception and that is which RAM bank, 0 or 1, is active. This exception does not apply if the MBX mode was active. This function is not displayed on screen.

17.0: Selecting memory type and address

There are two types of memory which you may edit. They are CPU RAM and GRAM/GROM. You select which one you wish to edit by placing a C, for CPU RAM, or G, for GRAM/GROM, in the memory indicator. The address in the memory indicator is valid for both CPU RAM and GRAM/GROM and is displayed and entered in hex. See figure 1-1 on page 26.

18.0: Using the string search function

Before executing this function there are three parameters you should set:

1. The type of memory to be searched, for the occurrence of the string, is determined by the present type of memory selected. If you wish to search CPU RAM than you must place a C in the memory indicator. See figure 1-1 on page 26.

2. The starting address (ST) is set by entering the desired hex address immediately following the ST on the main screen. See figure 1-1 on page 26.

3. The ending address (FN) is set by entering the desired hex address immediately following the FN on the main screen. See figure 1-1 on page 26.

The starting and ending addresses allow you to search selected areas of memory rather than the entire 64k bytes.

Pressing <fctn 7> while you are NOT in the memory window will allow you to enter the string search function. Pressing <fctn 7> again will allow you to exit this function.

Once in the search function you are asked to enter the string to be searched for. You may enter the string in either Ascii or hex. This is toggled with <fctn =>. You may also enter the string in with the Basic bias. This is toggled with <fctn 8>. If bias is on then each character will have >60 added to it for the search. If bias is off then each character is shown and searched for as it is really entered. If you wish to search for the phrase TI BASIC the cursor must be placed on the last character in the string, in this case the letter C.

All characters, including the one under the cursor, are used for the search pattern. Press <enter> to begin the search or <fctn 7> to exit. If a pattern match is found, the memory address, the memory window and memory window display mode are changed to reflect the address at which the string was found. In addition the STart address is changed to one byte beyond the address at which the string was found. This allows you to press <enter> to search for the next occurrence of the string. If the search is unsuccessful the message

CAN'T FIND STRING — PRESS ENTER

is displayed. Once you press <enter> you are returned to the search function at the point at which you began the search.

19.0: Filling memory

By pressing <fctn 0> you will enter the fill memory function. This function allows you to fill an area of memory with the value of the byte you enter. The byte value must be entered in hex. If you have BASIC bias on when you enter this function then the byte you enter will have >60 added to it before being written. Remember that you cannot fill GROM or ROM. You can only fill GRAM or RAM.

Before executing this function there are three parameters you should set:

1. The type of memory to be filled is determined by the present type of memory selected. If you wish to fill CPU RAM than you must place a C in the memory indicator. See figure 1-1 on page 26.

2. The starting address (ST) is set by entering the desired hex address immediately following the ST on the main screen. See figure 1-1 on page 26.

3. The ending address (FN) is set by entering the desired hex address immediately following the FN on the main screen. See figure 1-1 on page 26.

Caution: When filling memory be careful not to fill (or edit) >cA000–>cBFFF and >cE000->cFFFF. This is where the Memory Editor and Gramulator software reside respectively. If you do you may cause the Memory Editor or Gramulator software to react unpredictably. Also do not fill or edit >gFFFF. This contains the Gramulator Status Register. Changing this byte can cause unpredictable results.

Note: The Fill Memory function will not fill a single byte location. This function is designed to fill an area – 2 or more bytes – of memory.

20.0: Moving memory blocks

By pressing <fctn M> you will enter the Memory Block Move function. Pressing <fctn M> a second time will abort and exit this function. This function allows you to move an area of memory to or from GROM/GRAM and to or from CPU memory.

Before executing this function there are three parameters you should set:

1. The type of memory you will be moving is determined by the present type of memory selected. If you wish to move data from CPU memory than you must place a C in the memory indicator. See figure 1-1 on page 26.

2. The starting address (ST) is set by entering in the desired hex address immediately following the ST on the main screen. See figure 1-1 on page 26.

3. The ending address (FN) is set by entering in the desired hex address immediately following the FN on the main screen. See figure 1-1 on page 26.

Once these parameters have been set and you have entered the Memory Block Move function you are prompted by:

COPY TO-TYPE + ADDRESS? C0000

At this point you must select the type of memory, indicated by a C or G, and the *beginning* address you wish to have the block of memory selected moved to. Pressing <enter> will begin moving the selected memory. When the block move is complete you will exit back to the main screen.

Caution: When moving blocks of memory be careful not to choose

>cA000->cBFFF   or   >cE000->cFFFF

as your destination. This is where the Memory Editor and Gramulator software reside respectively. If you overwrite these areas you may cause the Memory Editor or Gramulator software to behave unpredictably. You should also not choose >gFFFF as a destination. This contains the Gramulator Status Register. Changing this byte can cause unpredictable results.

21.0: Printing memory

This function allows you to print to disk or a printer the contents of memory in Ascii and hex. You must first select the type of memory you want to print, the start and finish address, and whether you want Basic bias on or off.

To print memory:

1. Select the type of memory by placing a C or G in the memory indicator. See figure 1-1 on page 26 and *Selecting memory type and address* on page 30.

2. Select the STart and FiNish addresses by entering the values you want after the ST and FN indicators above the memory windows.

3. Select whether you want Basic bias on or off by pressing <fctn 8>. If bias is on the program subtracts >60 from each byte of the Ascii and hex dump before printing.

4. Press <fctn P> to print memory. The screen displays

   DEVICE NAME?

   Enter the device you want memory printed to:

   Ex: PIO.

   Ex: RS232/2.BA=1200.

   Ex: DSK3.DUMP.

   Pressing <back> (<fctn 9>) at the device name prompt will exit this function. You may also abort printing by pressing and holding any key during the printing.

Note: The Print Memory function must complete the current line being printed. If the ending address does not end on an even line boundary, enough successive bytes will be printed to finish the line. Therefore, the printed finish address may not equal the specified finish address.

22.0: Entering and using the memory window

Pressing <fctn 9> will move you in and out of the memory window. Once inside of the window there are 11 function keys which are active. Their numbers and effects are listed below. You should not edit >cA000->cBFFF and >cE000->cFFFF. This is where the Memory Editor and Gramulator software are contained respectively. In addition, do not edit >gFFFF. This contains the Gramulator Status Register.

<fctn 8>

Toggles the Basic bias on and off.

<fctn 9>

Exits the memory window.

<fctn 0>

Toggles the display between Ascii and hex modes.

<fctn 6>

Page the memory window back 90 bytes, this is one full window.

<fctn 4>

Page the memory window forward 90 bytes, this is one full window.

<fctn E> or <fctn X>

Move up or down one line, nine bytes, in memory. If you are at the bottom or top edge of the window the memory window and address are adjusted forward or back nine bytes. This allows you to scroll through memory a line at a time.

<fctn S> or <fctn D>

Move forward or backward one byte at a time. If you are at the upper left or lower right corners of the window the memory window and address are adjusted forward or backward one byte. This allows you to scroll through memory a byte at a time.

<fctn F>

Change the color of the characters on screen.

<fctn B>

Change the color of the screen.

When you are editing, in either Ascii or hex, after each valid keystroke the byte you edited is written back to memory. The memory is then read back and re-displayed to show the alteration. If the change is not displayed it means that either the memory is write protected or you are trying to edit ROM or GROM, both of which are read only.

23.0: Saving the altered cartridge

Once you have finished editing the cartridge, operating system or TI Basic, you can save the alterations to disk. This is accomplished by pressing <fctn Q> while outside the memory window. You will be returned to the Gramulator main menu. To save the altered cartridge:

1. Select

   3. SAVE RAM/GRAM

   You should have written down the locations that were displayed when the files were loaded in. If you did not, you can elect to save all locations. The penalty for this is wasted disk space and longer loading times.

2. The screen displays

   ```
   THE GRAMULATOR
   SAVE SELECTED RAMS/GRAMS
   Are you saving a loaded MBX
   cartridge? N
   ```

   Type <enter> to use the default of No if you are not saving an MBX cartridge.

3. *Models GR03 and GR04 only:**
   The following message will appear

   ```
   Alternate GRAM detected
   Save which GRAM bank? 1
   1. Standard (>9800)
   2. Alternate (>9804)
   ```

   At this prompt you are asked to choose the GRAM bank you wish to save. If the saved cartridge was loaded and edited in the standard bank then select 1.

4. You must now enter the RAMs and GRAMs you want saved. You do this by typing a Y or y under the number of the desired RAM or GRAM. For the Extended Basic example above you would type:

   ```
   RAMS      GRAMS
   0 1    0 1 2 3 4 5 6 7
   ---------------------
   Y Y          Y Y Y Y
   ```

   Note: If you are saving an MBX cartridge you will not be prompted to select RAMs. All four MBX RAMs are saved automatically.

---

* See page 1 for model details.

5. Press <enter> to move the cursor from RAMS to GRAMS. Press <enter> when you are done. The screen displays

   Filename for RAMS/GRAMS?

6. Type in the filename you want to save the RAMS/GRAMS under. This name will be used later when you want to load the edited RAMS/GRAMS into the Gramulator. The format is DEVICE.FILENAME. For example, DSK1.MYXBASIC.

7. When the save is complete the screen displays

   PRESS ANY KEY

8. Press any key to return to the Gramulator main menu.

When you use the SAVE CARTRIDGE option of the Gramulator only 6K of data is stored on disk for each GROM. Since GROMs only contain 6K of useful data, this is done to conserve disk space. However, GRAMs contain 8K of useful data and will therefore take up more disk space. A GROM uses 26 sectors while a GRAM uses 34 sectors on disk.

If you load the Gramulator with GROM disk files, you should ensure that you have sufficient disk space if you save these as altered GRAMs.

Note: When you return to the Gramulator main menu the GRAM base address will be restored to its default of >9800.

Appendix A: Loading auto-start cartridges

An auto-start cartridge is one that bypasses the TI master selection list when a key is pressed from the TI master title screen. Examples of auto-start cartridges are: Plato, and most of the Scott, Foresman educational packages, such as Decimals 1, Multiplication 2 and Reading Roundup.

If you load an auto-start cartridge into the Gramulator you will never be able to select the Gramulator from the TI Master selection list because the cartridge bypasses the list and begins to execute immediately.

There are various ways to overcome this limitation. In order of preference, they are:

A1: Eliminate the auto-start

You can eliminate the auto-start from a cartridge by loading it into the Gramulator and adding a cartridge header. The procedure is:

1. Insert the auto-start cartridge into the cartridge slot on the Gramulator. For this example we will use the Scott, Foresman cartridge Multiplication 2.

2. Follow the instructions on *Saving a cartridge on page 8.*

3. Follow the instructions on *Loading the Gramulator* on page 10. Be sure to write down the location that each file loads into. For Models GR03 and GR04* we will, for the sake of clarity, assume you loaded the cartridge into the standard GRAM space.

4. Ensure the Gramulator software diskette is in Drive 1. Press <ctrl M> to load the Memory Editor.

5. G6000 is displayed at the start of the Memory Indicator line. The G indicates you are going to edit GRAM.

6. Press <fctn =>> to toggle the display in the Memory Window to hex.

7. Press <fctn 9> to enter the Memory Window.

8. Change g6001 from >FF to >01. (On other cartridges the initial value may be >81.) This is the auto-start flag. A negative number indicates auto-start.

9. Change g6006 to >78. Change g6007 to >01. This points to the next cartridge header.

---

* See page 1 for model details.

10. Press <fctn 9> to exit the Memory Window.

11. Place g7801 at the start of the Memory Indicator line.

12. Press <fctn 9> to enter the Memory Window.

13. At g7801 enter: >00 >00 >60 >13. The two zero bytes indicate no more headers. >6013 is the address at which the cartridge will begin execution. This is the default address for auto-start cartridges.

14. Select a name for the auto-start cartridge. The name should be 20 characters or less. This name will be displayed on the TI master selection list. Count the number of characters in the name. For this example we will use MULTIPLICATION 2. There are 16 characters (>10) in the name.

15. Enter this length value in hex at g7805, immediately after the 13.

16. Press <fctn => to toggle the display to Ascii.

17. Enter the name that you selected starting at address g7806.

18. The values entered at g7801 are:

```
hex:  00 00 60 13 10 4D 56 4C 54 49 50 4C 49 43 41 54 49 4F 4E 20 32
asc:  -  -  '  -  -  M  U  L  T  I  P  L  I  C  A  T  I  O  N     2
```

19. Now re-save the altered cartridge to disk. This is accomplished by following the directions under *Saving the altered cartridge* on page 37. The header should now appear whenever the altered cartridge is loaded into the Gramulator.

---

20. You can use the following table to convert the length of your name from decimal to hexadecimal.

Decimal to hexadecimal conversion table					
dec	hex	dec	hex	dec	hex
00	00	10	0A	20	14
01	01	11	0B	21	15
02	02	12	0C	22	16
03	03	13	0D	23	17
04	04	14	0E	24	18
05	05	15	0F	25	19
06	06	16	10	26	1A
07	07	17	11	27	1B
08	08	18	12	28	1C
09	09	19	13	29	1D

A2: Zero the cartridge space

You can eliminate an auto-start cartridge by filling the Gramulator's cartridge space with zeroes. The procedure is:

1. Turn the computer off. Plug an Extended Basic or Editor/Assembler cartridge into the Gramulator's cartridge slot.

2. Place the Gramulator software diskette in Drive 1.

3. Set the Cartridge/Gramulator switch to the Cartridge position.

4. Turn the computer on. Press any key and select the cartridge from the TI master selection list.

5. If you are using an Extended Basic cartridge the Memory Editor will automatically load and run. If you are using an Editor/Assembler cartridge select

   5. RUN PROGRAM FILE

   At the prompt FILENAME ? type DSK1.MEMEDITOR.

6. When the Memory Editor has loaded place the Cartridge/Gramulator switch in the Gramulator position.

7. g6000 is displayed at the start of the Memory Indicator line.

8. Set the STart address to 6000.

9. Press <fctn 0> to enter the fill memory function.

10. Select byte 00 to fill with and press <enter>.

11. The cartridge space and the memory window should now be filled with zeroes. If not, check the Cartridge/Gramulator switch. It should be in the Gramulator position.

12. Turn the computer off. Turn the computer on. Press any key. You should now be able to see the TI master selection list.

A3: Removing power from memory

You can destroy the contents of memory by removing the battery back-up power. This will also destroy the contents of GRAMs 0, 1 and 2. The procedure is:

1. Turn the computer off.

2. Remove the Gramulator from the computer cartridge slot. Be sure the battery clip clears the top of the cartridge port. If it does not, gently press down on the battery while sliding the Gramulator out of the computer.

3. Using a piece of thin cardboard, such as a business card, slide it between the top retaining terminal and the battery.

4. Wait 10 seconds and then remove the cardboard.

5. Replace the Gramulator in the computer cartridge slot.

6. Turn the computer on. Press any key. You should now be able to see the TI master selection list.

   Note: For Models GR03 and GR04* this may cause a bug in the built-in TI OS to reveal itself. To patch this bug and prevent any problems, see *Appendix H* on page 53.

* See page 1 for model details.

* See page 1 for model details.

* See page 1 for model details.

* See page 1 for model details.

* See page 1 for model details.

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* See page 1 for model details.

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* See page 1 for model details.

* See page 1 for model details.

* See page 1 for model details.

Appendix B: Altering the Disk Manager 2 cartridge

This example will show you how to alter the Texas Instruments Disk Manager 2 cartridge to access more than 3 drives.

1. Turn the computer off.

2. Plug the Disk Manager 2 cartridge into the Gramulator's cartridge port.

3. Follow the instructions on *Saving a cartridge* on page 8.

4. Follow the instructions on *Loading the Gramulator* on page 10. As the files are being loaded, write down the location that each file of the saved cartridge is loaded into. For the Disk Manager 2 cartridge:

   FILES LOADED INTO
   GRAM 4   GRAM 3

   PRESS ANY KEY

   The locations are: GRAM 4 and GRAM 3.

   Note: For Models GR03 and GR04* we will, for the sake of clarity, assume the cartridge was loaded into the standard GRAM space.

5. Place the Gramulator software diskette in Drive 1. Press <ctrl M> to load the Memory Editor. The screen displays:

   Loading...DSK1.MEMEDITOR

   The Memory Editor screen is displayed.

6. Now you need to find the locations in the program which limit access to 3 drives. In all cases this will be a >33 or Ascii 3. You need to change this value to the number of drives you want to access. For example, if you have four drives, you will change the byte to >34 or Ascii 4. You can find all occurrences of >33 by using the string search function from >g6000 to >g77FF. You will find that >33 occurs 19 times. You only need to change the following 7 addresses:

   63F4   6426   65DC   675D   6850   724D   72C0

7. The previous step was sufficient to alter the program to accept more than 3 drives. However, the prompts will still display (1-3). To have the prompts match the program you need to find all occurrences of (1-3) and change the 3 to match the number you selected. You will find 6 locations containing (1-3). The first two are for English. The remaining four are for the two alternative languages. The addresses are:

       8802   8812   8DB2   8DC5   937B   9390

Note: In the unlikely event that your cartridge does not match the above addresses, you should be able to find the correct byte to change within a range of 5 bytes.

8. After making the changes return to the Gramulator main menu. Follow the instructions on *Saving the altered cartridge* on page 37.

Appendix C: Saving Super Extended BASIC

Since Super Extended BASIC is not a true GROM cartridge it will not save properly using the

2. SAVE A CARTRIDGE

option from the Gramulator main menu. To save this cartridge you need to use

3. SAVE RAM/GRAM

instead. The procedure is:

1. Turn the computer off.

2. Plug the Super Extended BASIC cartridge into the Gramulator's cartridge port.

3. Follow the instructions on *Getting started* on page 6.

4. At the Gramulator main menu select

   3. SAVE RAM/GRAM

5. **Important:** Place the Cartridge/Gramulator switch in the Cartridge position.

6. The screen displays

   THE GRAMULATOR
   SAVE SELECTED RAMS/GRAMS
   Are you saving a loaded MBX
   cartridge? N

7. Type <enter> to use the default of No. If you have the Guion modification in your SXB cartridge (this adds the Editor/Assembler, TI-Writer and Disk Manager III), then the following message will appear

   Save which GRAM bank?
   1. Standard bank (>9800)
   2. Alternate bank (>9804)

8. Type <enter> to use the default of 1. You must now enter the RAMs and GRAMs you want saved. For this cartridge you must save RAMs 0 and 1, and GRAMs 3, 4, 5 and 6. You do this by typing a Y or y under the number of the desired RAM or GRAM. For this cartridge you would type:

   ```
   RAMS      GRAMS
   0 1     0 1 2 3 4 5 6 7
   ----------------------
   Y Y     N N N Y Y Y Y N
   ```

Appendix E: Memory architecture

This diagram shows the memory architecture of the TI-99/4A when the Gramulator is in the cartridge slot.

Gramulator use of 8K cartridge space

7FFF 6000	Loader

or

7FFF	RAM Bank 1
6000	RAM Bank 0

or

7FFF 7000	MBX RAM 3
7FFF 7000	MBX RAM 2
7FFF 7000	MBX RAM 1
7FFF 7000	MBX RAM 0
6FFF 6000	RAM 0

TMS 9900 memory use in TI-99/4A

FFFF E000	24K High Memory Expansion
DFFF C000	
BFFF A000	
9FFF 8000	8K Partly decoded memory space
7FFF 6000	8K Cartridge space
5FFF 4000	8K Device Service Routines
3FFF 2000	8K Low Memory Expansion
1FFF 0000	8K Console ROM

TI-99/4A partly decoded memory space

9C04	GROM Write Data Lib 1
9C02	GROM Write Address Lib 0/Lib 1
9C00	GROM Write Data Lib 0
9804	GROM Read Data Lib 1
9802	GROM Read Address
9800	GROM Read Data Lib 0
9400	Speech Write
9000	Speech Read
8C02	VDP Write Address
8C00	VDP Write Data
8802	VDP Read Status
8800	VDP Read Data
8400	Sound Write Data
83FF 8300	CPU fast RAM

GRAM memory use Library 0

FFFF E800	GROM 7
E7FF E000	
DFFF C800	GROM 6
C7FF C000	
BFFF A800	GROM 5
A7FF A000	
9FFF 8800	GROM 4
87FF 8000	
7FFF 6800	GROM 3
67FF 6000	
5FFF 4800	GROM 2
47FF 4000	
3FFF 2800	GROM 1
27FF 2000	
1FFF 1800	GROM 0
17FF 0000	

GRAM memory use Library 1

FFFF E800	GROM 7
E7FF E000	
DFFF C800	GROM 6
C7FF C000	
BFFF A800	GROM 5
A7FF A000	
9FFF 8800	GROM 4
87FF 8000	
7FFF 6800	GROM 3
67FF 6000	

A GROM occupies 8K of memory space, but actually only contains 6K of usable data. For example, GROM 2 occupies the 8K from >4000 to >5FFF. The usable data in GROM 2 occupies the 6K of memory space from >4000 to >57FF. However, a GRAM can use the full 8K of memory space. This difference in architecture is shown by the dashed lines in the GROM table. This extra 2K of memory allows you to make custom changes to previously saved GROM. This technique was used when altering an auto-start cartridge as described in Appendix A.

Appendix F: File format

Each file saved or loaded by the Gramulator has a six-byte header. The following tables show the format of the header and the meaning of each byte.

Gramulator file header			
Byte #	Description		
0	>FF = more to load >00 = last file		
1	Destination indicator	>00 or >FF	Memory Expansion
		>01	GRAM 0
		>02	GRAM1
		>03	GRAM2
		>04	GRAM3
		>05	GRAM4
		>06	GRAM5
		>07	GRAM6
		>08	GRAM7
		>09	RAM Bank 0
		>0A	RAM Bank 1
		>0B	RAM Bank 0 (MBX)
		>0C	RAM Bank 1 (MBX)
		>0D	RAM Bank 2 (MBX)
		>0E	RAM Bank 3 (MBX)
2,3	Length of data		
4,5	CPU and GROM/GRAM address to move file to and begin execution from (execute E/A5 files only)		

This six-byte header is compatible with the format used by the Gram Kracker and the Geneve 9640 computer. This allows you to use any files created using the Gram Kracker to be loaded and used. In addition, a Gram Kracker can use any file created by the Gramulator. The only exceptions are the MBX cartridge files. They can NOT be used by a Gram Kracker, a Geneve or an unexpanded Gramulator.

The files of the Gramulator are saved in a particular order. The sequence and priority are:

1. ROMs, if there are any, are saved first. If there are two ROMs to be saved, ROM bank 1 and then ROM bank 0 are saved respectively.

2. GROMs/GRAMs are saved from the highest to the lowest. For example, TI Extended Basic would be saved as follows:

   1. ROM 1; 2. ROM 0; 3. GROM 6; 4. GROM 5; 5. GROM 4; 6. GROM 3

   This file order is important only to the Gram Kracker. The Gramulator can handle files in any order.

When the Gramulator saves GROM to disk it only saves 6K of data. This is to conserve space on disk since GROM only contains 6K of useful data. When the Gramulator saves GRAM to disk it saves 8K of data. GRAMs contain 8K of useful data. This extra 2K of space is a good place to add things to cartridges. An example is to add a title to an auto-start cartridge (see *Appendix A* on page 39) or new routines to Extended Basic.

Appendix G: Explanation of Status Register

The Gramulator Status Register is located at GROM/GRAM address >FFFF. The register itself is write only, but since there is also memory located at this same address you can read from here too. The contents of this memory location can only be considered valid after a write. This is because the memory is not updated at power-up, so if the switch positions have changed from the last power-up then the memory may not reflect the true state of the register.

The eight bits and their meanings are:

Gramulator Status Register bits	
Bit number	Description
0 LSB†	1 = TI bank switching on 0 = TI bank switching off
1	1 = Loader off 0 = Loader on
2	1 = GROM 0 on (GRAM 0 off) 0 = GRAM 0 on (GROM 0 off)
3	1 = GROMs 1 + 2 on 0 = GRAMs 1 + 2 on
4‡	1 = MBX bank switching on 0 = MBX bank switching off
5-7 MSB	Unused

† **Note:** This also has the effect of write-protecting the two 8K banks of RAM used in this scheme of bank switching.

‡ **Note:** This is software supported by the Gramulator, but the hardware option must be installed to be useful. TI bank switching must be turned off in order to write to any part of the MBX RAM space.

Appendix H: Patching the TIOS (GROM 0)

The TI operating system, which is built into GROM 0, has a minor bug in the REVIEW MODULE LIBRARY feature. The following steps contain the instructions on how to fix the bug and save the altered OS.

Note: It is not necessary to make this patch. The Gramulator Software Diskette contains a patched version with the filename of ALTGRAM0. If you use the built-in GROM 0 you can probably operate without incident.

The bug occurs when the OS detects the alternate GROM bank and there is no valid cartridge header (>AA) at >6000 in GROM at either the **standard** (>9800) or the **alternate** (>9804) base address. The computer will loop forever looking for >AA to appear at >6000 of either GROM bank. Please note that the computer is not hung. It is simply waiting. The patch to the OS will solve this problem and we strongly suggest you make and use the patch. If the bug occurs before you can make the patch then follow the directions for *Clearing the two GRAM Banks* following these patch directions.

1. Follow the steps under *Getting Started* on page 6.
2. Select 4. SAVE TI OS from the Gramulator main menu.
3. Follow the directions for saving the TI OS on page 15.
4. Select 1. LOAD GRAMULATOR from the Gramulator main menu.
5. Follow the directions for *Loading the Gramulator* on page 10. Remember you wish to load the Gramulator with the file containing the saved TI OS.
6. Place the diskette containing the Gramulator Memory Editor in drive 1. At the main menu press <ctrl M>.
7. Once in the Memory Editor press <fctn 7> to enter the Search Memory function.
8. Press <fctn => to toggle the display to hex.
9. Type the following string

   41 B9 39 00
10. Press the left arrow key <fctn S> the locate the cursor over the last 00.
11. Press <enter> to begin the search. The search should find this string at >0241 plus or minus ten bytes.
12. Press <fctn 7> to exit the Search Memory function.
13. Press <fctn 9> to enter the memory window. Your cursor should now be flashing on the 4 in the string 41 B9.
14. Type 0A 0A. This will replace the 41 B9.

15. Press <fctn 9> to exit the memory window.

16. Press <fctn Q> to return to the Gramulator main menu.

17. Select 3. SAVE RAM/GRAM..

18. Follow the directions under *Saving user-selected RAMs and GRAMs* on page 19. Only select GRAM 0 (zero) to be saved.

Your altered OS is now running. To use it the *next* time you power on your computer, place the TI OS switch into the GRAM 0 position. This will allow you to use your altered OS the next time you power up. If you need to reload your altered OS just follow the directions under *Loading the Gramulator* on page 10 using the filename you saved the new OS as.

H1: Clearing the two GRAM banks

1. Turn off the computer power.

2. Insert one of the following cartridges into the Gramulator's cartridge port: (Editor/Assembler, Extended Basic, TI Writer)

3. Place the diskette containing the Gramulator Memory Editor in drive 1.

4. Set the front switches as outlined under *Getting started* on page 6 with one exception: place the Cartridge/Gramulator switch in the Cartridge position.

5. Turn on the computer power.

6. Select the appropriate cartridge from the TI Selection menu.

7. If you are using Extended Basic the memory editor will auto-load. If you are using the E/A select number 5. If you are using TI Writer select number 3. The filename for the E/A or TI Writer is DSK1.MEMEDITOR.

8. Once the memory loads it will auto-start.

9. Place the Cartridge/Gramulator switch in the Gramulator position.

10. Change the start address (ST) to 6000.

11. Change the finish address (FN) to FFFE.

12. Press <fctn => to toggle the display to hex mode.

13. Press <fctn 0> (zero) to enter the Fill Memory function.

14. Press <enter> to accept the default of >00 to fill memory with.

15. Press <fctn 0> (zero) to exit the Fill Memory function.

16. Press <fctn A> to select the alternate GRAM bank.

17. Press <fctn 0> (zero) to enter the Fill Memory function.

18. Press <enter> to accept the default of >00 to fill memory with.

19. Press <fctn 0> (zero) to exit the Fill Memory function.

20. Turn off the computer.

21. Remove your cartridge and follow the directions under *Getting started* on page 6. The two GRAM bank are now cleared.

Appendix I: Explanation of alternate GRAM banks

This appendix explains, in technical terms, the idea of multiple (alternate) GROM/GRAM libraries (banks). We encourage all users, even the novice, to read this appendix. Some of the material may be too advanced for the novice, but the majority of the material will help all users understand the benefits and limitations of this option.

We assume that the technical reader of this material has an understanding of the following material:

1. 9900 Assembly Language.

2. GROM access on the TI-99/4A.

3. Memory mapped devices.

All of these points are covered in detail in the E/A manual.

TI's decision to use the GROM chip in the 4A was a solid choice. Since a GROM chip is memory mapped, TI only had to give up four memory addresses in order to gain 65,536 more in return. A pretty good trade.

This definitely sounded attractive, but TI decided to carry the idea further. They not only made room for one GROM bank, but carried the number of GROM banks to 16. This was accomplished by dedicating a block of four addresses to each of the 16 possible GROM banks. Each of the GROM base addresses was offset by four, starting at >9800. This meant GROM bank 0 was located at >9800, GROM bank 1 was at >9804, GROM bank 2 at >9808 and so on.

All address decoding for these alternate GROM banks must be done external to the console. The extra decoding was left out to reduce manufacturing costs. Now TI encountered their first problem. The first three GROMs already in the console would not decode an alternate GROM bank access. TI overcame this by simply not allowing any alternate GROMs 0, 1 and 2. This is the reason these GROMs will never appear in a TI cartridge.

Once the hardware was done the next step was software support. TI first developed its GPL interpreter. This interpreter made GPL code machine independent. It also allowed TI to directly execute code from GROMs.

The GPL interpreter is located in the console ROMS. One of the features of the interpreter is that it does not directly access GROM. Instead the interpreter uses a base address located in register 13 of its workspace to find the GROM memory mapped location.

Next TI developed the power-up monitor (OS). This monitor resides in GROM 0 and also supports the alternate GROM banks. The access to the alternate GROMs 3–7 — remember GROMs 0–2 are not allowed alternates — is achieved through the REVIEW

MODULE LIBRARY selection displayed on the TI selection menu. The monitor checks for the alternate GROM banks by comparing the first 31 bytes of GROM starting at >6000 in GROM bank >9800 and >9804. If any of the bytes are different, the REVIEW MODULE LIBRARY selection is displayed. If all 31 bytes are equal then the monitor assumes that >9804 is not decoded and the REVIEW MODULE LIBRARY selection is not displayed.

I1: Limitations

Now we come to the limitations of using these features in the Gramulator:

1. As we pointed out in the previous paragraph, if the first 31 bytes in both Gramulator GRAM banks match (e.g. you loaded the E/A into both banks) then the REVIEW MODULE LIBRARY selection is not displayed. This also applies if both GRAM banks have been cleared (set to all zeros).

2. The next limitation concerns the way some of TI's cartridges access GROM — assuming it is at a base address of >9800. These cartridges (e.g. Buck Rogers) will not run when loaded into the alternate GRAM bank. If a cartridge does not run correctly when loaded into the alternate GRAM bank try it in the standard GRAM bank before assuming the Gramulator is malfunctioning. If the software writers had followed TI protocol and read register 13, this problem would not occur.

3. The third limitation is a bug in the OS (GROM 0). When the OS detects an alternate GROM bank it searches all GROM libraries for a valid cartridge header (>AA) at >6000. The problem is that TI protocol states the cartridge header can be located at >6000, >8000, >A000, >C000 or >E000 – not just >6000. This bug gives the appearance of locking the computer up. To patch this bug refer to *Appendix H* on page 53.

All of the above limitations are TI's and are not inherent in the Gramulator. However there is one limitation of the Gramulator. Since the Alternate GRAM Emulation (AGE) option only adds more GRAM, not RAM, to the Gramulator, multiple cartridge loading is limited to one GROM-only cartridge and one GROM/ROM mixed cartridge (or another GROM-only cartridge). For example, you can load Extended Basic (GROM/ROM) into the standard bank and Disk Manager 2 (GROM only) into the alternate bank.

I2: Benefits

Now for the benefits of this option.

1. The obvious benefit is that you can have two or more cartridges online.

2. The second benefit is much more powerful. When you have true alternate GROM libraries all subprograms added to TI Basic by a cartridge are available no matter which GROM library the subprogram is in. An example: If the TE2 and E/A cartridges are loaded into the Gramulator then you can access both the OPEN SPEECH and CALL LOAD statements from TI Basic automatically. This is possible because the built in ROMs search all GROM libraries for a subprogram before returning an error.

Note: Because of physical and electrical considerations the Gramulator is limited to one standard (>9800) GRAM bank (GRAMs 0-7) and one alternate (>9804) GRAM bank (GRAMs 3-7).

Appendix J: Obtaining additional information

If you need or want additional information, including instructions or user installation of the MBX options, it can be ordered from CaDD directly. Packages, price and description are:

1. **Gramulator EPROM software: $5.00**
   Includes all source files to the software contained in the Gramulator and is supplied on disk. The disk catalog routine is not included in this package (it is not the property of CaDD Electronics).

2. **Memory Editor software: $5.00**
   Includes all source files to the Memory Editor and is supplied on disk.

3. **MBX installation instructions and kit: $15.00**
   Includes instructions and schematics (only for the MBX part) for user installation. In addition it contains the four ICs, one switch and wire to install this option.

4. **Alternate GRAM Emulation kit: $45.00**
   Includes instructions and parts for user installation of the Alternate GRAM Emulation option. See *Appendix H* and *Appendix I* for details. Parts include: 1 32K RAM IC, 1 8K RAM IC, 1 PAL IC and wire.

   Note: Installation by the user of the MBX option or Alternate GRAM option voids the Gramulator warranty. It is also strongly recommended that you have a technical background and good soldering skills if you order this option.

All information described above is released to the public domain by CaDD Electronics under the following conditions:

1. CaDD Electronics is listed as the originator of the program or documents.

2. If altered programs or documents are distributed by any person, a description of the changes made must appear in the documents. This description must state that CaDD Electronics is not responsible for the contents of said program or document. This applies unless you receive in writing a statement indicating otherwise from CaDD Electronics.

Three-month limited warranty

This CaDD GR01 Gramulator warranty extends to the original consumer purchaser of the device.

Warranty duration

This GR01 Gramulator is warranted for a period of three (3) months from the date of the original purchase by the consumer.

Warranty coverage

This GR01 Gramulator is warranted against defective materials or workmanship. This warranty is void if the device has been damaged by accident, unreasonable use, neglect, improper service or other causes not arising out of defects in materials or workmanship.

Warranty disclaimers

Any implied warranties arising out of this sale, including but not limited to the implied warranties of merchantability and fitness for a particular purpose, are limited in duration to the above three-month period. CaDD Electronics shall not be liable for loss of use of the hardware or other incidental or consequential costs, expenses or damages incurred by the consumer or any other user.

Some states do not allow the exclusion or limitation of implied warranties or consequential damages, so the limitations or exclusions may not apply to you in these states.

Legal remedies

This warranty gives you specific legal rights, and you may have other rights that vary from state to state.

Warranty performance

During the above three-month period, your GR01 Gramulator will be repaired or replaced with a new or reconditioned unit of the same or equivalent model (at CaDD Electronics' option) when the unit is returned by prepaid shipment to CaDD Electronics at the address below. Before returning the device you must obtain a Return Materials Authorization (RMA) number by telephoning or writing to the address below. The repaired or replacement unit will be warranted for three months from the date of repair or replacement. Other than the postage requirement, no charge will be made for repair or replacement of in-warranty units.

CaDD Electronics strongly recommends that you insure the device for value before shipping.

Call for RMA number: (603) 895-0119

Ship to: CaDD Electronics
           81 Prescott Road
           Raymond, NH 03077