

Final Expansion 3 User Guide

Version 1.0

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Version Information

Version	Date	Changes
1.0	2017-02-08	Initial draft

Authors

Simon Rowe <srowe@mose.org.uk>

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Introduction

This guide describes the features of the Final Expansion 3 cartridge for the VIC-20 and how to use them. It also includes reference material for programmers to write software that uses the advanced capabilities of the cartridge.

The information given in this guide is believed to be accurate, however because there are many hardware and software variations the authors cannot guarantee that a specific system will function exactly as described.

The authors would be grateful to hear from you if you find a mistake or omission in this guide.

Where to Get Help

As there are several versions of the cartridge produced by different manufacturers the best source of information specific to yours is wherever you purchased it from.

The on-line forum Denial, <http://sleepingelephant.com/denial/>, is a community of VIC-20 users. They may be able to provide information and suggestions but cannot be expected to resolve your specific problems.

Cartridge Overview

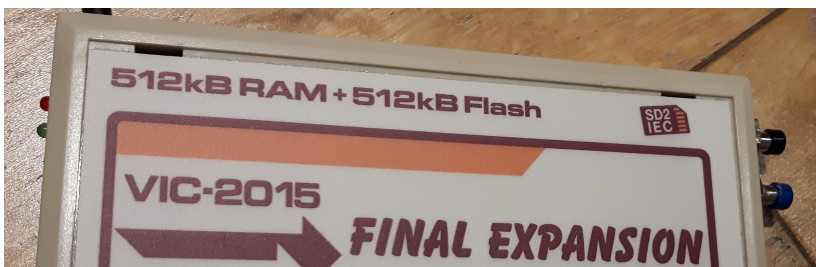
The Final Expansion 3 (FE3) cartridge expands the VIC-20 with:

- 512KB of Random Access Memory (RAM)
- 512KB of Electrically Erasable Read Only Memory (EEPROM)
- storage to Secure Digital cards emulating a serial bus disk drive (SD2IEC)

The memory expansion is highly configurable, both from interactive menus and by commands contained in user-created files. Virtually any type of memory map can be set up to allow all manner of programs to be run.

Additional commands are available to make disk devices easier to use, these are provided using a software wedge (which can be disabled) similar to those that work with physical disk drives such as the 1541.

Loading and saving to serial bus devices is accelerated if they contain support for JiffyDOS, this includes the integrated SD2IEC device.



The two indicators which are located on the left of the cartridge relate to the SD2IEC device

- error (top, red) – flashes when an error message is present on the command channel

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- activity (bottom, green) – lit when a file is open on the device

The two push buttons on the right of the cartridge provide different forms of system reset

- VIC-20 system reset (top) – system resets but memory configurations etc. are retained
- VIC-20 and Final Expansion 3 reset (bottom) – system resets with defaults identical to those at power on.

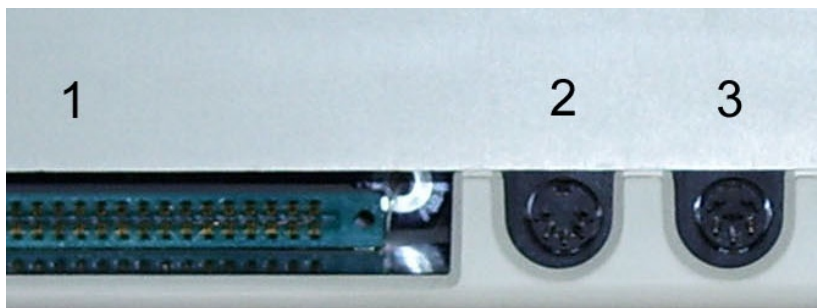
Quick Start

This section aims to help the first time user up and running as quickly as possible. It also covers likely issues that the user may run into.

Setup

The cartridge should be connected to the VIC-20 with the power switched off. It may either be inserted directly into the cartridge port or into a slot of a cartridge expander.

The SD2IEC should then be connected to the serial port of the VIC-20. The serial port is the rightmost round socket (3) when viewing the rear of the VIC-20



Some FE3 cartridges have an integral lead with a plug, others have two sockets. Either

- Connect the plug to the serial port
- Connect one plug of a serial cable into the serial port and one into either socket on the FE3

An SD card should be prepared on a modern PC by formatting it. Only SD

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cards that are FAT formatted can be used with the SD2IEC device.

Insert the SD card, face down, into the slot on the top of the FE3, it should click into place. The card may be removed by gently pressing the top of the card. MicroSD cards may be inserted if an adapter is used.

After checking the cartridge is fully inserted and the serial cable is attached the VIC-20 can now be powered on.

Common Problems

*** text here ***

Start Up Menus

A sequence of menu screens can be used to easily access the features of the FE3.

Main Menu

When the VIC-20 is powered on a menu with the following options is presented

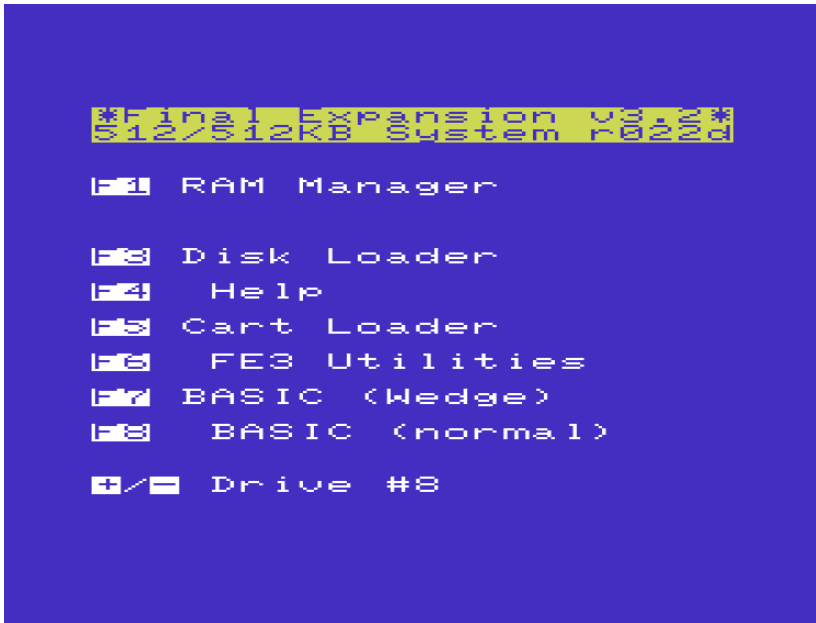
- Select common memory configurations
- Load programs from SD2IEC
- Load programs from flash
- Store programs to flash
- Change the SD2IEC device number

Options are selected by pressing the function keys (along with the Shift key if necessary).

Pressing the **F8** key returns from any submenu.

Bypassing the start up menus can be achieved by holding down one of the following keys during power on:

- **SHIFT** – wedge enabled, no additional memory
- **C=** – wedge disabled, no additional memory



The common configuration of all memory blocks being filled is available by pressing **F7** (with the command wedge) or **F8** (without the command wedge).

The device number used by the SD2IEC device can be changed by pressing the **+** and **-** keys. Values between 8 and 15 are supported.

Pressing the **F4** key displays a brief description of the commands the wedge provides. See “Wedge Commands” on page 19 for more details.

Pressing the **C** key displays a list of credits.

RAM Manager

This submenu allows different memory configurations to be set up. After selection the system will enter BASIC as normal.

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The configurations available are summarized in the following table:

Key	Memory	Blocks	Wedge?
F1	3K	RAM1,2,3	Yes
F2	8K	BLK1	Yes
F3	16K	BLK1,2	Yes
F4	24K	BLK1,2,3	Yes
F5	3K + 24K	RAM1,2,3 & BLK1,2,3	Yes
F6	-	-	No
F7	3K + 24K+8K	RAM1,2,3 & BLK1,2,3,5	Yes

At the bottom of the menu two checkboxes are shown:

- I/O registers (**R**) - Allow software access to the registers which

control the memory configuration of the cartridge

- Command wedge (**W**) – Enable commands listed on page 19

Pressing the given key toggles each checkbox.

Disk Loader

This submenu allows memory configurations to be set up and program files to be loaded by selecting an entry from a list. The selections are defined in loader files, see “Loader Files” on page 25 for details of how to create them.

The menu is navigated by using either the cursor keys or the joystick, an entry is selected by pressing **RETURN** or the fire button. When there is more than one page of entries the **F1** and **F3** keys can be used to move between pages. The **F5** and **F7** keys can be used to move to the start and end of a page respectively.



Cartridge Loader

*** text here ***

Secure Digital Drive

The SD2IEC drive allows Secure Digital (SD) cards to store files which can then be accessed by the VIC-20 in the same way as would if they were on a floppy disk.

As with other devices attached to the serial bus the SD2IEC responds to commands sent to it on the command channel. This can be done using the @ wedge command or the **OPEN** and **PRINT#** BASIC commands. The following sections describe the various commands that are implemented.

DOS Commands

The following commands perform operations in the same manner as physical disk devices. Only the first character of a command needs to be given, a : (colon) must be present between the command and any parameters. Further details of these commands can be found in books such as “1541 User’s Guide”.

SCRATCH

Deletes one or more files given as parameters. Multiple file names must be separated by commas, wildcard patterns containing * and ? may also be used.

RENAME

Changes the name of a file, the existing and replacement file names are specified as **NEWNAME=OLDNAME**.

COPY

Creates a duplicate of a file, the new and existing file names are specified as **NEWNAME=EXISTINGNAME**.

If multiple existing files are specified then the new file will contain the concatenation of them, for example **NEWFILE=START,MIDDLE,END**.

NEW

Erases the contents of a disk image (see below). The disk name and ID must be specified as **NAME,ID**.

This command cannot be used to erase an entire SD card.

Disk Images

As well as accessing files written directly to the SD card the SD2IEC can handle image files that represent an entire floppy disk. These images have track and sector geometry identical to various physical disk devices

Format	Drives	Capacity
.D64	4040, 1541 etc	170K
.D71	1571	340K
.D81	1581	800K

To activate a disk image the **CD** command is used, for example **CD:GAMES.D64**. Once active all further disk operations affect the disk image rather than the SD card. To leave a disk image and return to the SD card the command **CD: ←** is used.

Subdirectories

Subdirectories (directories within directories) may be created, navigated into and deleted on the SD card. Directories may be referred to as follows

- Relative to the current directory, for example **GAMES**
- A directory relative to the current directory, for example **/GAMES/:ARCADE**
- Relative to the root of the SD card, for example **//GAMES/:ARCADE**

Creating Directories

The **MD** command creates an empty directory according to the form of the parameter given.

Changing Directory

The **CD** command make the directory specified by parameter the current directory for future disk operations.

Deleting Directories

The **RD** command removes an empty directory. Only subdirectories of the current directory can be deleted.

Partitions

*** text here ***

Real Time Clock

*** text here ***

Other Commands

*** text here ***

Wedge Commands

The following commands are available in immediate mode, they cannot be included in BASIC programs. They may also be used in loader programs see “Loader Files” on page 25.

The wedge interpreter usually resides in BLK5, if the “All RAM” option was selected in the “RAM Manager” menu then it will reside in the 3K region within BLK0.

Storage Device Commands

The following commands access files stored on the SD card inserted into the SD2IEC device.

File names may be given in quotes or follow the command immediately (unless otherwise stated).

Directory Listing

The **\$** command can be used to display the contents of an SD card (or disk image or subdirectory) without overwriting any program in memory



For long directory listings pressing the **CTRL** key slows down the rate at which the screen scrolls.

The list of files displayed can be reduced to those that only match a wildcard pattern. The character **?** matches any character in any position in the name

[illegible]

The character `*` matches any number of characters at the end of the name

[illegible]

The list can also be reduced to specific file types

[illegible]

Disk Commands

The @ command can be used to send any of the commands mentioned in “Secure Digital Drive” on page 15 to the SD2IEC

```
@R : BOMB=BOMBER
```

The status of the SD2IEC can be read by using the @ command alone

200 000,000.00

Load BASIC Program

The `/` command can be used to load a program from the current device

[illegible]

The start and end addresses are displayed in hex.

Load Machine Code Program

The **%** command can be used to load a machine code program into the correct location in memory

```
%HEMSOAK  
FROM $0400 TO $0A0B  
SYS1024
```

The start and end addresses are displayed in hex, the start address is often used to execute the program.

To load a program at a specific address the file name must be given in quotes followed by the address

```
%"SCREEN", $1000
```

Save BASIC or Machine Code Program

The ← command can be used to save the program in memory to the current device

```
←HELLO  
FROM $1201 TO $1234
```

The start and end addresses are displayed in hex.

To save a machine code program the file name must be given in quotes followed by the start and end addresses

```
←"GRAPHICS", $2000, $3000  
FROM $2000 TO $3000
```

If the file already exists on the device the following prompt is displayed

```
63, FILE EXISTS, 00, 00  
ABORT REPLACE UPDATE
```

Pressing **R** deletes the existing file and saves the current program with the file name given

```
DELETING FILE ...
```

Pressing **U** renames the existing file with a ` (single quote) character at the beginning then saves the current program with the file name given

```
DELETING OLD FILE ...  
RENAMING FILE ...
```

Pressing **A** cancels the operation.

Verify BASIC Program

The **>** command can be used to verify that the program in memory matches the copy saved to the current device

```
>CATACOMBS  
FROM $B4B1 TO $12E4  
OK
```

Show & Change Drive

The **#** command can be used to display the current serial device number

```
#  
DEVICE#8
```

To change to another device a number between 8 and 15 may be appended

```
#9  
DEVICE#9
```

Memory Block Commands

The following commands control the availability of and access to specific memory blocks.

Block Disable

The **BLKD** command causes one or more memory blocks to be disabled. The blocks affected are appended to the command, multiple blocks are separated by commas

```
BLKD1,2,3
```

Block Protect

The **BLKP** command causes one or more memory blocks to become read-

only. This can be useful if a program has copy protection to prevent it being run from RAM. The blocks affected are appended to the command, multiple blocks are separated by commas

```
BLKP1,2,3
```

I/O Register Disable

The **NOIO** command disables the I/O registers used to communicate with the FE3. This can be useful if another cartridge is present that also uses the same I/O region occupied by the FE3.

Miscellaneous Commands

System Reset

The **RESET** command can be used to restart the VIC-20. If an autostart signature is found at the beginning of BLK5 (\$A000) then the cold start routine is called. Otherwise the system enters BASIC.

Wedge Disable

The **OFF** (or **KILL**) command can be used to remove the wedge from memory. Only the standard BASIC commands will be available after running this command

```
OFF  
FE3 WEDGE (OFF)
```

Program Recovery

The **OLD** (or **UNNEW**) command can be used to restore a BASIC program that was in memory before the **NEW** command was run or the system was reset.

Number Format

The `,` command can be used to convert numbers between different number bases

```
'$M00100011''#
```

The `,` may be followed by a decimal, hexadecimal (prefixed with '\$') or a binary number (prefixed with '%'). An integer or floating point variable may also be given.

Loader Files

In order to define the contents of the “Disk Loader” menu a loader file needs exist in root of the SD card and in every subdirectory and image file with programs to be included.

Loader files are BASIC programs that have a specific format and structure. Loader files are always named **LOADER** and can be loaded using the / wedge command

```
/LOADER
```

edited and then saved using the ← command

```
←LOADER
```

Program Name

The text of the menu entry is defined by a line containing the name surrounded by " (double quotes). A program name may be up to 20 characters in length.

Loader Commands

The actions to be performed when the menu entry is selected all start with + (plus). Commands fall into four categories

1. Disk device commands
2. Commands that load the program
3. Memory configuration commands
4. Commands that launch the program

Commands are performed in the order they appear in the loader file except

commands that launch the program (which are performed last).

Disk Commands

Disk commands, for example to activate a disk image, may be executed to prepare the system in some way. Commands start with "@" and end with " (double quotes). Any of the commands mentioned in "Secure Digital Drive" on page 15 may be used.

Program Loading

One or more files may be loaded by giving the file name surrounded by " (double quotes). The program type may be given by appending a , (comma) and one of

- **B** – BASIC program, relocated to start of BASIC memory
- **P** – machine code program, loaded at the start address in the file (or, optionally, at an address that follows)
- **C** – cartridge, loaded at an address that follows

A load address is a hexadecimal number prefixed with \$ and is separated from the program type by a , (comma).

Memory Configuration

Any of the following commands described in "Memory Block Commands" on page 22 may be used to disable or protect specific memory blocks.

Program Launch

To start the program one of the following commands must be used

RUN

Start executing a BASIC program.

SYS

Start executing a machine code program, the start address is a hexadecimal number prefixed with \$.

RESET

The autostart code of a cartridge can be triggered by performing a system reset.

To enter the menu defined in a loader file within a subdirectory or disk image the **RELOAD** command must be used to read the contents of the new file.

Comments

Comments may appear anywhere in a loader file. Comments start with : (colon) and are free-form.

Examples

The following loader file fragments illustrate some of the possible ways of loading programs. By combining the commands described above almost any action can be defined.

Unexpanded BASIC Program

BASIC programs written for unexpanded systems expect BASIC to start at \$1000 and the screen to start at \$1E00. In order for the KERNAL to configure this the memory expansion in RAM1,2,3 and BLK1 need to be disabled as a minimum

```
100 :Snake Byte YC Apr
```

[illegible]

3K expansion BASIC Program

BASIC programs written for unexpanded systems expect BASIC to start at \$0400 and the screen to start at \$1E00. In order for the KERNAL to configure this the memory expansion in BLK1 needs to be disabled as a minimum

[illegible]

Machine Code Program

Machine code programs must be loaded into the correct memory location to work. To launch them the correct address must be passed to **SYS**, usually the same as the load address

[illegible]

Game Cartridge

Most game cartridges contain a ROM that appears at \$A000 (BLK5). They automatically start when the system is powered on so are launched using a loader file with **RESET**

```
4040 4  
W+H00  
M#0 0  
D H  
+0+0 :  
M0-50  
M0 0  
0 001  
F H H  
H 100  
C7  
0 M  
Monsters (P  
Monsters ",
```

Some cartridges have a copy protection check which tries to write to the

memory containing the program. To protect the memory block the **BLKP** command can be used

```
415 +BLKP5
```

Directory & Image Navigation

In order to move into and out of subdirectories and disk images menu entries must be defined. For example if an SD card has a directory called GRAPHICS then in the loader file that contains it there should be the following

```
0000 "GRAPHICS/"
0100 +@CD:GRAPHICS"
0200 +RELOAD
```

In the GRAPHICS directory the loader file should contain the following

```
1100 "
1200 +@CD:"
1300 +RELOAD
```

Similar entries should be defined for disk images.

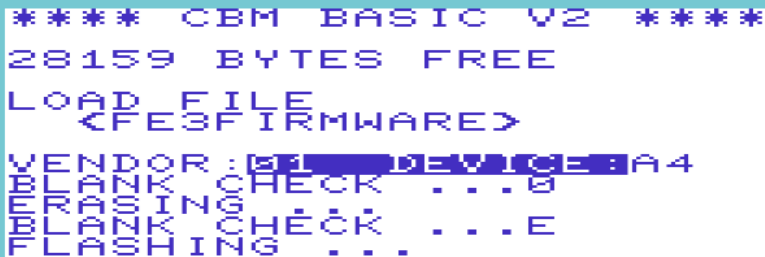
Appendix A – Updating Firmware

The firmware responsible for the menus and wedge can be updated from the “Flash Firmware” option on the “FE3 Utilities” menu.

The firmware binary should be written to the root directory of an SD card with the file name of **FE3FIRMWARE**.

Warning! The VIC-20 must not be powered off or reset while the firmware is being updated.

Warning! Updating the firmware will erase all cartridge images that have been written to flash.

A screenshot of a Commodore VIC-20 BASIC V2 screen. The screen is white with blue text. The text is as follows:
**** CBM BASIC V2 ****
28159 BYTES FREE
LOAD FILE
<FE3FIRMWARE>
VENDOR: B1 DEVICE: A4
BLANK CHECK ...S
FLASHING CHECK ...E
FLASHING ...
The text is displayed in a monospaced font, typical of early computer systems. The background of the entire page is a solid light blue color.

Appendix B – Programmers Reference

*** text here ***

Memory Map

*** text here ***

Register Descriptions

*** text here ***