
DL FEN User Manual

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1 Hardware

Figure 1 shows the depiction of the cartridge. Four buttons are present on the front of the cartridge. From left to right, these will be referred to as the PREV, ACT, NEXT, and RESET buttons. The first three buttons are used to operate on emulated floppies. See the [Floppy disk management](#) section for further details. The RESET button resets the cartridge emulation. This button allows changing the game without power cycling the SC-3000.

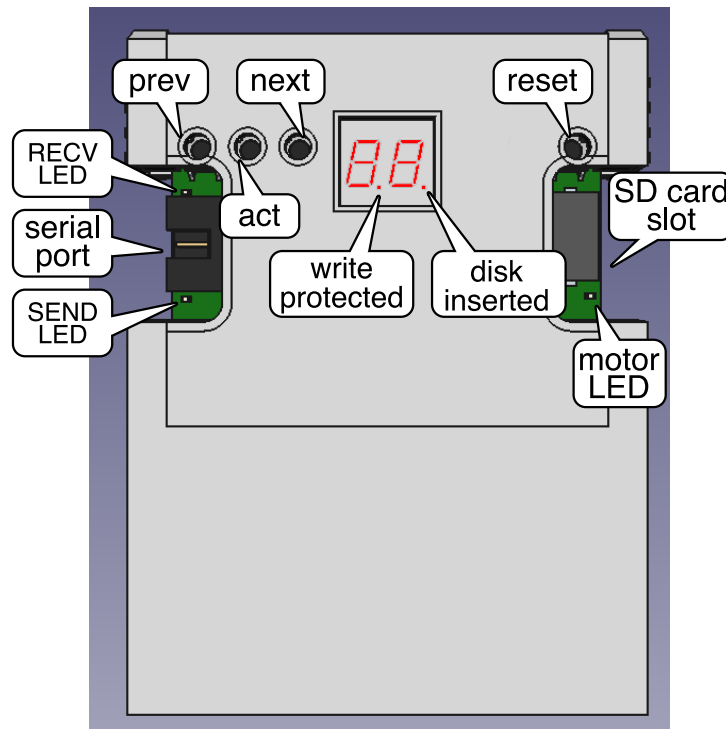


Figure 1: FEN front side.

An SD card slot is accessible on the right recess. The cartridge is unable to boot without an SD card inserted. The SD card should be formatted as FAT32. FAT16 or exFAT formats are currently not supported. The root of the SD card must contain a firmware file, named `f.en.frm`.

A serial port connector is accessible on the left recess. Details on the connector are given in the [Serial](#) section.

Three LEDs are visible through the recesses. On the right recess a MOTOR LED shows when the emulated floppy motor is spinning. The left recess hosts two LEDs, a RECV LED placed above the serial connector and a SEND LED placed below the serial connector. These LEDs indicate serial port activity.

SEND indicates data being sent from the console to the world, and RECV indicated traffic from outside to the console.

A seven-segment display provides information on the active floppy disk or cartridge. The display presents 2 digits, each with a dot on its bottom right. In the following, we denote the dot placed between the two digits as the WRITE PROTECTED indicator and the dot on the bottom right of the rightmost digit as the DISK INSERTED indicator. Refer to the [Display](#) section for further details.

2 Serial

The serial port header accepts a six-position two-row 0.1-inch-pitch IDC connector. The serial is a 3.3V TTL serial. The pinout is shown in the following table. It is advisable not to power other devices using the 5V and 3.3V outputs, to avoid damage to the console's internal voltage regulator IC.

The device is compatible with DL's DM-2000 modem emulator, which allows connecting to BBSes.

Pin	Function
1	+5V
2	TX
3	+3.3V
4	RX
5	GND
6	GND

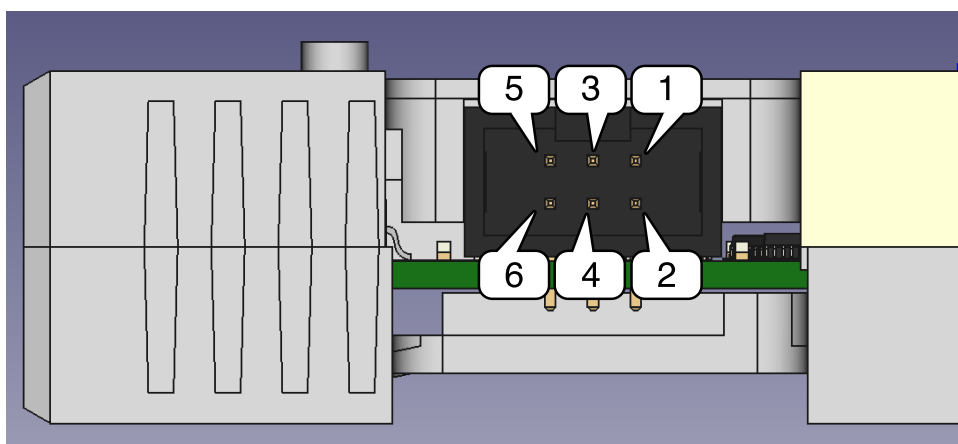


Figure 2: Pinout of the 3.3V serial connector.

3 Display

When a cartridge is being emulated the display will show an `r` (for ROM) followed by either 1,2, or 3. The number indicates the memory configuration, 1 for 1K, 2 for 2K, and 3 for 32K (see the [Emulation settings menu](#) for further details). When the address space 0x0000-0x8000 is set as read-only, the WRITE PROTECTED indicator is lit.

Floppy disks are indicated by a hexadecimal number, 00 to FF. The WRITE PROTECTED indicator shows when a disk is write-protected. A lit indicator corresponds to having the write protection hole opened on a physical floppy. The DISK INSERTED indicator shows when a disk is present. If the DISK inserted indicator is off it means a disk with the specified number does not exist. It is possible to create a new blank disk by pressing the ACT button. The display shows `di` while the disk is being created, and

reverts to its hexadecimal number when the operation is completed. See the [Floppy disk management](#) section for further details on disk assignment.

When the cartridge is powered, the display initially shows `---`. If case of no error, the display transitions to `--`. If errors are present, they are denoted by `_X` where `X` is the error code. The following table summarizes the meaning of the error codes.

Error code	Meaning
0	SD card not present or not correctly formatted
1	Firmware (file <code>fen.frm</code>) is missing
2	Hardware self-check failure
3	IPL (file <code>ipl.rom</code>) is missing

4 Menu

The menu can be controlled using either the joystick or the keyboard. The only keys used on the keyboard are the arrow keys (with the same function as the joystick's D-pad), the CR (enter) key (with the same function of the joystick's left trigger button), and the DEL key (with the same function as the joystick's right trigger button). In the following, we will refer to the CR key/joystick's left trigger button as the OK key and to the DEL key/joystick's right trigger button as the BACK key. UP key, DOWN key, LEFT key, RIGHT key will refer to either the arrow keys or the joystick's D-pad.

4.1 File selection menu

When the system finishes booting the file browser is shown. UP and DOWN keys move the selected (highlighted) file/folder. The OK key opens the folder or the file. Each screen displays up to 24 entries. When the selection is at the last entry and DOWN is pressed, the selection moves back to the top. Similarly, pressing UP at the first entry allows jumping to the last entry. The entries are displayed in the order they are stored in the SD FAT. Use a fat sorter program on the SD card to have them sorted alphabetically.

For folders with more than 24 items, multiple screens are used. The RIGHT key moves to the next screen, the LEFT key moves to the previous screen. When the last screen is reached, pressing the RIGHT key has no effect. Similarly, pressing the LEFT key on the first screen has no effect.

The first 40 characters of each entry's name are shown. When a file with a name up to 40 chars is selected, pressing the OK key directly opens the emulation settings menu. When a file with a name longer than 40 chars is selected, its name is shown in full, with the question "Continue?". The OK key is used to proceed to the emulation settings menu. Pressing the BACK key allows going back to the file selection menu.

Files that are marked as hidden are not shown in the menu. In Windows, files can be hidden in File Explorer by changing the file properties. In Linux, the `fatattr +h filename` command can be used.

4.2 Emulation settings menu

The emulation settings menu allows setting how the selected file should be used. The UP/DOWN key move between the options. The OK key cycles the option values. The BACK key moves back to the file selection menu.

The first selection `Boot as` has the following options

1. system disk
2. data disk
3. disk list
4. ROM

The first three selections allow emulating an SF-7000 with the selected disk inserted. See the [Floppy disk management](#) section for further details. The last selection allows emulating the insertion of a cartridge.

Depending on the type of emulation, SF-7000 or cartridge, different options are shown. When an SF-7000 is emulated it is possible to change the serial baud rate. The baud rate can be chosen among one of the ones available on the SF-7000 (300 up to 9600) and one option specified in the configuration file (see the [Configuration files](#) section), shown as (CONF) followed by the actual value.

When a ROM is emulated the following options are available:

1. **Memory protect.** This option allows choosing whether the address space 0x0000-0x8000 is read-only (value set to `on`) or writable (value set to `off`).
2. **Ram Size.** FEN disables the system's RAM and provides on-cartridge RAM. This option allows selecting whether the simulated ram is 1K (as for the SG-1000), 2K (as for the SC-3000), or 32K (as for the BASIC level III B cartridge).

All the options are guessed automatically from the file extension, file size, and file content. The automatic guess can be improved by placing a per-game configuration file (see the [Configuration files](#) section).

The last entry of the emulation settings menu is `Continue` which starts the emulation. *Notice that to boot floppy images a copy of the IPL (Initial Program Loader) ROM should be placed in the root of the SD card with the filename `ipl.rom` (all lowercase).*

4.3 Checking the firmware version

At the initial file navigation menu, press the BACK key. The firmware version can be checked by accessing the `about` menu. The version is a four-digit hex number. This number is a hash number, and a higher value does *not* imply a more recent version. The about screen can be closed by pressing the BACK key once more.

5 Floppy disk management

FEN supports swapping floppies (up to 256 at a time) using the PREV and NEXT buttons. Floppies are identified by a hexadecimal number from 00 to FF. The mapping depends on how the floppy is booted. As seen in [Emulation settings menu](#) There are three choices:

1. Boot as `system disk`
2. Boot as `data disk`
3. Boot as `disk list`

5.1 Boot as system disk

Floppy disks come in two types¹: system disks (for instance, DISK BASIC), which can be used to boot the system, and data disks, which cannot be used to boot the system (for instance, collections of basic programs).

When boot as `system disk` is used, the selected floppy image becomes floppy number 00. Using the PREV and NEXT buttons it is possible to change the inserted floppy. Except for floppy number 00, floppy number XY (where X and Y are hex digits) is associated with a file named `XY.sf7` placed at the root of the SD card. If the floppy number is changed to XY and file `XY.sf7` is not present on the root of the SD card, the DISK INSERTED indicator will be switched off.

¹For further details, refer to the Super Control Station SF-7000 user's manual, page 194.

5.2 Boot as data disk

Data disks cannot be booted directly. When booted as `data disk` the selected floppy image will be associated with floppy number 01. Floppy number 00 is used to perform the boot. Floppy number 00 corresponds to a file named `00.sf7` on the root of the SD card. It is thus sensible to have a copy of DISK BASIC named `00.sf7` on the root of the SD card. When booting is completed, the user can press the NEXT button to select floppy number 01 (the selected data disk).

5.3 Boot as disk list

The third option in the boot menu is boot as `disk list`. This provides total flexibility in the association between floppy numbers and the image files. Multiple `disk list` files can be created. A `disk list` file is a text file with extension `.txt` in the following format, where the first two digits are the floppy number and the path is an absolute path:

```
00 folder1/diskImage1.sf7
01 folder2/subfolder2/diskImage2.sf7
02 diskImage3.sf7
07 folder4/diskImage4.df7
```

Numbers do not need to be consecutive. For numbers not specified in the list, the floppy number will be assigned to file `XY.sf7` on the root. Initially, floppy number 00 will be used as the system disk. Floppy number 00 can be either specified in the `disk list` or not. If it is not, the file named `00.sf7` on the root of the SD card will be used.

5.4 Creating new floppies

When the DISK INSERTED indicator is switched off, pressing the ACT button will create a new blank floppy on the fly as a new file `XY.sf7` on the root of the SD card.

6 Configuration files

A global configuration file named `config.ini` (all lowercase) can be placed in the root of the SD card. The only option available currently is the default baud rate of the serial port. For instance, to select 4800 as the default baud rate, the `config.ini` file should read

```
BAUDRATE = 4800
```

The default emulation settings for each ROM/disk can be changed by placing a configuration file in the same directory. For instance, to provide more information for a ROM named `MyGame.sg` a file named `MyGame.ini` should be placed in the same folder. Currently, the only information that can be provided is the mapper type in the form

```
MAPPER = RAM32K
```

The accepted mapper types follow MEKA's conventions (<https://www.smspower.org/meka/> and more specifically its database naming (see <https://github.com/ocornut/meka/blob/master/meka/nam>)). The accepted mapper types are

- RAM32K for cartridges with onboard RAM like BASIC.
- TW_EXP_2000 for Taiwanese cartridges with ram expansion at 0x2000-0x3FFF.
- NOMAPPER for cartridges up to 48Kb and that use up to 8Kb of RAM in the range 0xC000-0xFFFF.
- SG1000 for SG1000 carts

Configuration files can be hidden from the menu by setting their hidden attribute (see the [File selection menu](#) section for details).

7 Creating an SD card image

Formatting the SD card as FAT32 and copying the firmware file is all that is required to use FEN. This section provides a fail-proof way to generate a working SD card image. To create the image, a Linux machine, a Linux virtual machine, or WSL (the Windows Subsystem for Linux) is required. The created image 'fenImage.zip' can be written on the SD card using tools like Balena etcher (see <https://www.balena.io/etcher>). The procedure to create the image is as follows:

1. Install the necessary programs. On a Debian-based system, use:

```
sudo apt install fatattr fatsort
```

2. Create a directory named `fenImage`.

```
mkdir fenImage
```

3. Enter `fenImage`.

```
cd fenImage
```

4. Create a directory named `filesystem`

```
mkdir filesystem
```

5. Copy the files to be put into the image into the `filesystem` directory. The firmware file `fen.frm` should be copied to this directory. It is recommended to also place the IPL file (`ipl.rom`) and a copy of DISK BASIC (as `00.sf7`).

6. Copy the following script into a file named `packImage.sh` located in the `fenImage` directory

```
#!/bin/bash
dd if=/dev/zero of=fenImage.img bs=100M count=1
dev=$(sudo losetup -f)
echo using loop device $dev
sudo losetup $dev fenImage.img
sudo mkfs.vfat -F 32 $dev
mkdir -p /tmp/fen
sudo mount -o loop $dev /tmp/fen/
sudo cp -r filesystem/* /tmp/fen
pushd /tmp/fen
sudo find . -iname "*.ini" -exec fatattr +h "{}" \;
sudo fatattr +h fen.frm ipl.rom 00.sf7
sync
popd
sudo umount /tmp/fen
sudo fatsort $dev
sync
sudo losetup -d $dev
zip fenImage.zip fenImage.img
rm fenImage.img
```

7. Execute the script by the command

```
bash ./packImage.sh
```

