

VICE, the Versatile Commodore Emulator

Copyright © 1998-2011 Dag Lem Copyright © 1999-2011 Andreas Matthies Copyright © 1999-2011 Martin Pottendorfer Copyright © 2000-2011 Spiro Trikaliotis Copyright © 2005-2011 Marco van den Heuvel Copyright © 2006-2011 Christian Vogelgsang Copyright © 2007-2011 Fabrizio Gennari Copyright © 2007-2011 Daniel Kahlin Copyright © 2008-2011 Antti S. Lankila Copyright © 2009-2011 Groepaz Copyright © 2009-2011 Ingo Korb Copyright © 2009-2011 Errol Smith Copyright © 2010-2011 Olaf Seibert

Copyright © 2007-2011 Hannu Nuotio Copyright © 1998-2010 Andreas Boose Copyright © 1998-2010 Tibor Biczo Copyright © 2007-2010 M. Kiesel Copyright © 1999-2007 Andreas Dehmel Copyright © 2003-2005 David Hansel Copyright © 2000-2004 Markus Brenner Copyright © 1999-2004 Thomas Bretz Copyright © 1997-2001 Daniel Sladic Copyright © 1996-2001 Andr Fachat Copyright © 1996-1999 Ettore Perazzoli Copyright © 1993-1994, 1997-1999 Teemu Rantanen Copyright © 1993-1996 Jouko Valta Copyright © 1993-1994 Jarkko Sonninen

Permission is granted to make and distribute verbatim copies of this manual provided the copyright notice and this permission notice are preserved on all copies.

Permission is granted to copy and distribute modified versions of this manual under the conditions for verbatim copying, provided that the entire resulting derived work is distributed under the terms of a permission notice identical to this one.

1 GNU GENERAL PUBLIC LICENSE

Version 2, June 1991

Copyright © 1989, 1991 Free Software Foundation, Inc. 675
Mass Ave, Boston, MA 02111-1307, USA

Everyone is permitted to copy and distribute verbatim copies
of this license document, but changing it is not allowed.

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change free software—to make sure the software is free for all its users. This General Public License applies to most of the Free Software Foundation’s software and to any other program whose authors commit to using it. (Some other Free Software Foundation software is covered by the GNU Library General Public License instead.) You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

To protect your rights, we need to make restrictions that forbid anyone to deny you these rights or to ask you to surrender the rights. These restrictions translate to certain responsibilities for you if you distribute copies of the software, or if you modify it.

For example, if you distribute copies of such a program, whether gratis or for a fee, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their rights.

We protect your rights with two steps: (1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software.

Also, for each author’s protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors’ reputations.

Finally, any free program is threatened constantly by software patents. We wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone’s free use or not licensed at all.

The precise terms and conditions for copying, distribution and modification follow.

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The “Program”, below, refers to any such program or work, and a “work based on the Program” means either the Program or any derivative work under copyright law: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. (Hereinafter, translation is included without limitation in the term “modification”.) Each licensee is addressed as “you”.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running the Program is not restricted, and the output from the Program is covered only if its contents constitute a work based on the Program (independent of having been made by running the Program). Whether that is true depends on what the Program does.

1. You may copy and distribute verbatim copies of the Program’s source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and give any other recipients of the Program a copy of this License along with the Program.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:
 - a. You must cause the modified files to carry prominent notices stating that you changed the files and the date of any change.
 - b. You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.
 - c. If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:
 - a. Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,
 - b. Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,
 - c. Accompany it with the information you received as to the offer to distribute corresponding source code. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts as distribution of the source code, even though third parties are not compelled to copy the source along with the object code.

4. You may not copy, modify, sublicense, or distribute the Program except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense or distribute the Program is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.
5. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Program or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Program (or any work based on the Program), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Program or works based on it.

6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties to this License.
7. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system, which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

8. If the distribution and/or use of the Program is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Program under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.
9. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.
Each version is given a distinguishing version number. If the Program specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of this License, you may choose any version ever published by the Free Software Foundation.
10. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software

which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

11. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM “AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.
12. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the “copyright” line and a pointer to where the full notice is found.

```
one line to give the program's name and an idea of what it does.
Copyright (C) 19yy name of author
```

```
This program is free software; you can redistribute it and/or
modify it under the terms of the GNU General Public License
as published by the Free Software Foundation; either version 2
of the License, or (at your option) any later version.
```

```
This program is distributed in the hope that it will be useful,
but WITHOUT ANY WARRANTY; without even the implied warranty of
MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
GNU General Public License for more details.
```

```
You should have received a copy of the GNU General Public License
along with this program; if not, write to the Free Software
Foundation, Inc., 59 Temple Place - Suite 330, Boston, MA 02111-1307, USA.
```

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

```
Gnomovision version 69, Copyright (C) 19yy name of author
Gnomovision comes with ABSOLUTELY NO WARRANTY; for details
type 'show w'. This is free software, and you are welcome
to redistribute it under certain conditions; type 'show c'
for details.
```

The hypothetical commands ‘show w’ and ‘show c’ should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than ‘show w’ and ‘show c’; they could even be mouse-clicks or menu items—whatever suits your program.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a “copyright disclaimer” for the program, if necessary. Here is a sample; alter the names:

```
Yoyodyne, Inc., hereby disclaims all copyright
interest in the program 'Gnomovision'
(which makes passes at compilers) written
by James Hacker.
```

```
signature of Ty Coon, 1 April 1989
Ty Coon, President of Vice
```

This General Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Library General Public License instead of this License.

2 About VICE

VICE is the one and only *Versatile Commodore Emulator*. It provides emulation of the Commodore C64, C64DTV, C128, VIC20, PET, PLUS4 and CBM-II computers within a single package. The emulators run as separate programs, but have the same user interface, share the same settings and support the same file formats.

Important notice: If you have no idea what a Commodore 8-bit computer is, or have questions about how these machines are used, how the file formats work or anything else that is not strictly related to VICE, you should read the appropriate FAQs *first*, as that kind of information is not available here. See [Chapter 18 \[Contacts\]](#), [page 132](#). for information about how to retrieve the FAQs.

All the emulators provide an accurate 6502/6510 emulator, with emulation of all the opcodes (both documented and undocumented ones) and accurate timing. Unlike other emulators, VICE aims to be cycle accurate; it tries to emulate chip timings as precisely as possible and does so *efficiently*.

Please do *not* expect the C64DTV, C128, PET, PLUS4 and CBM-II emulators to be as good as the C64 or VIC20 one, as they are still under construction.

Notice: This documentation is written for the Unix release of VICE.

2.1 C64 emulator features

As of version 2.3, two C64 emulators are provided: ‘x64’ (fast) and ‘x64sc’ (accurate).

The fast C64 emulator, called ‘x64’, features a fairly complete emulation of the VIC-II video chip: sprites, all registers and all video modes are fully emulated. The emulation has been fully cycle-accurate since version 0.13.0.

The accurate C64 emulator, called ‘x64sc’, features a cycle-based and pixel-accurate VIC-II emulation. This requires a much faster machine than the old ‘x64’.

A rather complete emulation of the SID sound chip is also provided. All the basic features are implemented as well as most of the complex ones including synchronisation, ring modulation and filters. There are three emulators of the SID chip available: first is the “standard” VICE emulator, available since VICE 0.12; the second is Dag Lem’s reSID engine and the third one is reSID-fp. The reSID engines are a lot more accurate than the standard engine, but they are also a lot slower, and only suitable for faster machines.

Naturally, also both CIAs (or VIAs, in some cases) are fully emulated and cycle accurate.

2.2 C64DTV emulator features

The C64DTV emulator, called ‘x64dtv’, features emulation of C64DTV revisions 2 and 3. The emulator is under construction, but most of the DTV specific features are already supported (with varying accuracy).

Video cache is disabled by default as it currently doesn’t work with some of C64DTV’s new video modes. The new video modes have a simple “fake” video cache implementation that may give incorrect results and decreased performance.

2.3 C128 emulator features

The C128 emulator, called ‘x128’, features a complete emulation of the internal MMU (*Memory Management Unit*), 80 column VDC screen, fast IEC bus emulation, 2 MHz mode, Z80 emulation plus all the features of the C64 emulation.

2.4 VIC20 emulator features

The VIC20 emulates all the internal hardware, including the VIA chips. The VIC-I video chip is fully emulated except NTSC interlace mode, so most graphical effects will work correctly.

Sound support is implemented, but is still at an experimental stage. If you think it could be improved and know how to do so, feel free to contact us (see [Chapter 18 \[Contacts\]](#), [page 132](#)).

The VIC20 emulator now allows the use of the VIC1112 IEEE488 interface. You have to enable the hardware (by menu, resource, or commandline option) and then load the IEEE488 ROM (see for example <http://www.funet.fi/pub/cbm/schematics/cartridges/vic20/ieee-488/325329-04.bin>, but you have to double the size to 4k for now). The IEEE-488 code is then started by SYS45065.

2.5 PET emulator features

The PET emulator emulates the 2001, 3032, 4032, 8032, 8096, 8296 and SuperPET (MicroMainFrame 9000) models, covering practically the whole series. The hardware is pretty much the same in each and that is why one single program is enough to emulate all of them. For more detailed information about PET hardware please refer to the ‘PETdoc’ file.

Both the 40 column and 80 column CRTC video chips are emulated (from the 4032 onward), but a few of the features are not implemented yet (numbers of rasterlines per char and lines per screen). Fortunately, they are not very important for average applications.

Sound is available for the PET as well, but like the VIC20’s it is still under construction.

The PET 8096 is basically a PET 8032 with a 64k extension board which allows remapping the upper 32k with RAM. You have to write to a special register at \$fff0 to remap the memory. The PET 8296 is a 8096 but with a completely redesigned motherboard with 128k RAM in total. Of the additional 32k RAM you can use only some in blocks of 4k, but you have to set jumpers on the motherboard for it. VICE uses the command line options ‘-petram9’ and ‘-petramA’ instead. Also, the video controller can handle a larger address range. The PET 8x96 model emulations run the Commodore LOS-96 operating system - basically an improved BASIC 4 version with up to 32k for BASIC text and 32k for variables. See ‘PETdoc’ for more information.

The SuperPET also is a PET 8032 with an expansion board. It can map 4k at a time out of 64k into the \$9*** area. Also it has an ACIA 6551 for RS232 communication. The 6809 that is built into the SuperPET is not emulated, though.

The PET computers came with three major ROM revisions, so-called BASIC 1, 2 and 4, all of which are provided. The PET 2001 uses the version 1, the PET 3032 uses version 2, and the others use version 4. The 2001 ROM is horribly broken with respect to IEEE488

(they shipped it before they tested it with the floppy drive, so only tape worked. Therefore the emulator patches the ROM to fix the IEEE488 routines.

As well as other low-level fixes the 2001 patch obtains the load address for a program file from the first two bytes of the file. This allows the loading of both PET2001-saved files (that have \$0400 as their load address) and other PET files (that have \$0401). The PET2001 saves from \$0400 and not from \$0401 as other PETs do.

Moreover, the secondary addresses used are now 0 and 1 for load and save, respectively, and not arbitrary unused secondary addresses.

To select which model to run, specify it on the command line with the `-model MODEL` option, where `MODEL` can be one of a list of PET model numbers, all described in see [Section 7.6.1 \[PET model\]](#), page 79

2.6 CBM-II emulator features

The CBM-II emulator emulates several types of CBM-II models. Those models are known under different names in the USA and Europe. In the States they have been sold as B128 and B256, in Europe as CBM 610, CBM 620 (low-profile case) or CBM 710 and CBM 720 (high-profile case with monitor). In addition to that now an experimental C510 emulation is included. The C510 (also known as P500) is the little brother of the C600/700 machines. It runs at roughly 1 MHz and, surprise, it has a VIC-II instead of the CRTIC. Otherwise the different line of computers are very similar.

These computers are prepared to take a coprocessor board with an 8088 or Z80 CPU. Indeed there are models CBM 630 and CBM 730 that supposedly had those processors. However these models are not emulated.

The basic difference is the amount of RAM these machines have been supplied with. The B128 and the CBM *10 models had 128k RAM, the others 256k. This implies some banking scheme, as the 6502 can only address 64k. And indeed those machines use a 6509, that can address 1 MByte of RAM. It has 2 registers at addresses 0 and 1. The indirect bank register at address 1 determines the bank (0-15) where the opcodes LDA (zp),Y and STA (zp),Y take the data from. The exec bank register at address 0 determines the bank where all other read and write addresses take place.

The business line machines (C6xx/7xx) have the RAM in banks 1-2, resp. 1-4. All available banks are used for BASIC, where program code is separated from all variables, resp. from normal variables, strings and arrays that are distributed over other banks. The C510 instead has RAM in banks 0 and 1, and uses bank 1 for program and all variables. Bank 0, though, can be accessed by the VIC-II to display graphics.

Many models have been expanded to more than the built-in memory. In fact some machines have been expanded to the full 1M. Bank 15 is used as system bank, with only little RAM, and lots of expansion cartridge ROM area, the I/O and the kernal/basic ROMs. Some models have been modified to map RAM into the expansion ROM area. Those modifications can be emulated as well.

The different settings are described in see [Section 7.7.1 \[CBM-II model\]](#), page 83.

2.7 The keyboard emulation

There are two ways of emulating the keyboard in VICE.

The default way (*symbolic mapping*) is to map every key combination to the corresponding key combination on the real machine: for example, if you press *****, which is bound to **Shift-8** on a U.S. keyboard, in the C64 emulator, the emulated machine will have just the *unshifted* ***** key pressed (as ***** is unshifted on the C64 keyboard). Likewise, pressing **'** on the same U.S. keyboard without any shift key will cause the combination **Shift-7** to be pressed in the emulated C64. This way, it becomes quite obvious what keys should be typed to obtain all the symbols.

There is, however, one problem with symbolic mapping: some keys really need to be mapped specially regardless. The most important examples being, in the VIC20, C64 and C128 emulators, that **CTRL** is mapped to **Tab** and that the **Commodore** key is mapped to the left **Control**). The **RUN/STOP** key is mapped to the **ESC** key on the PC keyboard. The PET emulator, lacking the **Commodore** key but having an **ESC** key, uses the left **Control** key as **RUN/STOP** and the **ESC** key as **ESC** of course.

The second way (*positional mapping*) is to map every key on the “real” keyboard to the key which has the same position on the keyboard of the emulated machine. This way, no **Shift** key is forced by the program (with the exception of the function keys **F2**, **F4**, **F6** and **F8**, which require **Shift** on the Commodore keyboards), and the keyboard is more comfortable to use in those programs (such as some games) that require the keys to be in the correct positions.

Warning: unlike the real C64, VICE “presses” the **Shift** key *together* with the key to shift when the **Shift** must be forced. In most cases this should work fine, but some keyboard routines are quite picky and tend not to recognize the shift key because of this. For instance, **F6** (which on the real C64 is obtained with **Shift + F5**) could be recognized as **F5**. In that case, use the shift key manually (i.e., type **Shift + F5** in the example). Yes, we know this is a bug.

The **RESTORE** key is mapped to *Page Up* (or *Prev*) by default.

2.8 The joystick emulation

Joysticks can be emulated both via the keyboard and via a real joystick connected to the host machine (the latter only works on GNU/Linux systems).

There are two keyboard layouts for joystick use, known as *numpad* and *custom*.

The *numpad* layout uses the numeric keypad keys, i.e., the numbers **1 . . . 9** which emulate all the directions including the diagonal ones; **0** emulates the fire button.

The *custom* layout uses the keys **w**, **e**, **r**, **s**, **d**, **f**, **x**, **c**, **v** for the directions and **space** for the fire button instead.

2.9 The disk drive emulation

All the emulators support up to 4 external disk drives as devices 8, 9, 10 and 11. Each of these devices can emulate virtual Commodore 1541, 1541-II, 1571, 1581, 2031, 2040, 3040, 4040, 1001, 8050 and 8250 drives in one of four ways:

- using disk images, i.e., files that contain a dump of all the blocks contained in a real floppy disk (if you want more information about what a disk image is, consult the `comp.emulators.cbm` FAQ);

- accessing file system directories, thus giving you the use of files without having to copy them to disk images; this also allows you to read and write files in the P00 format (again, consult the `comp.emulators.cbm` FAQ for more info).
- accessing a real device connected to the host machine. As of VICE 1.11 it is possible to connect real drives like Commodore 1541 to the printer port of the host using the XA1541 or XM1541 cable. Currently this only works on Linux or Windows using the OpenCBM library. You can get it from <http://www.lb.shuttle.de/puffin/cbm4linux> (cbm4linux, Linux version) or from <http://cbm4win.sf.net/> (cbm4win, Windows version).
- directly using the disk drive of the host. The 3.5" disk drive of the host can be used to read or write Commodore 1581 formatted disks. Currently this raw drive access feature is only available for Linux hosts.

When using disk images there are two available types of drive emulation. One of them the *virtual drive* emulation. It does *not* really emulate the serial line, but patches the kernal ROM (with the so-called *kernal traps*) so that serial line operations can be emulated via C language routines. This emulation is very fast, but only allows use of standard DOS functions (and not even all of them). For real device or raw drive access it is required to enable this type of emulation.

The IEEE488 drives (2031, 2040, 3040, 4040, 1001, 8050 and 8250) do not use kernal traps. Instead the IEEE488 interface lines are monitored and the data is passed to the drive emulation. To use them on the C64, you need to enable the IEEE488 interface emulation. Only if the IEEE488 emulation is enabled, those drives can be selected.

The other alternative is a *true drive* emulation. The Commodore disk drives are provided with their own CPU (a 6502 as the VIC20 and the PETs) and their own RAM and ROM. So, in order to more closely emulate its features, a complete emulation of this hardware must be provided and that is what the *hardware level* emulation does. When the *hardware level* emulation is used, the kernal routines are remain unpatched and the serial line is fully emulated. The problem with this emulation is that it needs a lot of processing power, mainly because the emulator has to emulate two CPUs instead of one.

The PETs do not use a serial IEC bus to communicate with the floppy drive but instead use the parallel IEEE488 bus. This does *byte by byte* transfers, as opposed to the *bit by bit* transfers of the C64 and VIC20, so making it feasible to emulate the parallel line completely while emulating the drive at DOS level only. The IEEE488 line interpreter maps the drives 8-11 (as described above) to the IEEE488 disk units, and no kernal traps are needed. The same emulation of the Commodore IEEE488 bus interface is available for the C64 and the VIC20. With IEEE488 drives you can have true 2031 emulation at unit #8, and still have filesystem access at units #10 or #11, because monitoring the IEEE488 lines does not interfere with the true drive emulation.

The IEEE488 disk drives 3040, 4040, 8050 and 8250 are Dual Drive Floppy Disks. This means that these drives handle two disks. To Accomplish the emulation, only one disk can be emulated, namely unit #8. The attached image, track display and LED display of unit #9 are used for the second drive of the dual disk drives. On unix the unit number display (8 or 9) in the emulation window changes to the drive number display (0 or 1).

The Commodore 3040, 4040, 1001, 8050 and 8250 disk drives are so-called "old-style" disk drives. Their architecture includes not one, but two processors of the 6502 type,

namely a 6502 for the file handling and communication with the PET (IP), and a 6504 (which is a 6502 with reduced address space) for the drive handling (FDC). Both processors communicate over a shared memory area. The IP writes commands to read/write blocks to this area and the FDC executes them. To make the emulation feasible, the FDC processor is not emulated cycle-exactly as a 6504, but simply by checking the commands and executing them on the host. This provides a fast FDC emulation, but disallows the sending the FDC processor commands to execute code. Applications where this is necessary are believed to be rather seldom. Only the format command uses this feature, but this is checked for.

The dual disk drive 2040 emulates one of the very first CBM disk drives. This drive has DOS version 1. DOS1 uses an own disk type, that is closely related to the 1541 disk image. Only on tracks 18-24 DOS1 disks have a sector more than 1541 disks. DOS1 disk images have the extension .d67.

The dual disk drives 3040 and 4040 use the same logical disk format as the VC1541 and the 2031. In fact, the 4040 was the first disk with DOS version 2. The 3040 emulated here originally was the same as 2040, only for the european 30xx PET series. As many of the original DOS1 disk drives were upgraded (a simple ROM upgrade!) to DOS2, I use the 3040 number for a DOS 2.0 disk drive, and 4040 for a revised DOS 2 disk drive. It is, however, not yet clear whether the disks here are write compatible to the 1541, as rumors exist that the write gap between sectors is different. But read compatible they are. As VICE emulates the FDC processor in C and not as 6504 emulation, this does not matter in VICE.

The drives 1001, 8050 and 8250 do actually have the very same DOS ROM. Only the code in the FDC is different, which is taken care of by VICE. So for all three of those disk drives, only `dos1001` is needed. The DOS version used is 2.7.

2.10 Supported file formats

VICE supports the most popular Commodore file formats:

- X64 (preferred) or D64 disk image files; Used by the 1541, 2031, 3040, 4040 drives.
- G64 GCR-encoded 1541 disk image files;
- D67 CBM2040 (DOS1) disk image format
- D71 VC1571 disk image format
- D81 VC1581 disk image format
- D80 CBM8050 disk image format
- D82 CBM8250/1001 disk image format
- T64 tape image files (read-only);
- P00 program files;

An utility (`c1541`, see [Chapter 12 \[c1541\]](#), [page 111](#)) is provided to allow transfers and conversions between these formats.

Notice that the use of the X64 file format is depreciated now.

You can convert an X64 file back into a D64 file with the UNIX `dd` command:

```
dd bs=64 skip=1 if=IMAGE.X64 of=IMAGE.D64
```

See [Chapter 15 \[File formats\]](#), [page 119](#). for a technical description of the supported file formats.

2.11 Common problems

This section tries to describe the most common known problems with VICE, and how to resolve them.

2.11.1 Sound problems

VICE should compile and run without major problems on many UNIX systems, but there are some known issues related to the sound driver. In fact, the sound code is the least portable part of the emulator and has not yet been thoroughly tested on all the supported platforms.

Linux, AIX and SGI systems should play sound without any problems; if you are running Linux please use a 2.x kernel, as VICE needs some features that were not implemented in older versions of the Linux sound driver.

On the other hand, HP-UX and Solaris machines are known to cause troubles. If you think you can help debugging the code for these systems, your help would be really appreciated. We are having troubles finding HP-UX and SUN consoles to work at. . .

Some problems have been reported with the proprietary version of the Open Sound System for Linux. With a Crystal sound card, sound output was significantly delayed and, apparently, the allocated buffer size was completely wrong. This is not a VICE bug, but rather an OSS bug.

2.11.2 Shared memory problems

If you cannot start VICE because you get errors about shared memory, try to run it with the `+mitshm` command-line option (see [Section 6.4.2 \[Video options\]](#), page 29). This will completely disable usage of the MITSHM extensions, that are normally used to speed up the emulation window updates. Of course, this will also result in a big loss in speed.

Reasons for this failure could be:

- IPC support has been disabled at the system level; some system administrators disable this for security reasons. If *you* are the system administrator, use a kernel that has IPC support compiled in and enabled.
- You are attempting to run the emulator across the network (i.e., the emulator runs on one machine, and the output is displayed on another machine that works as an X terminal) and for some reason VICE does not recognize this fact. In this case, you have found a bug, so please report it to us.

If you want to avoid running the emulator with `+mitshm` every time, run it once with `+mitshm` and then choose "Save settings" from the right-button menu.

2.11.3 Printer problems

VICE supports the emulation of a printer either on the userport or as IEC device 4. Unfortunately the Commodore IEC routines do not send all commands to the IEC bus. For example an `OPEN 1,4` is not seen on the IEC bus. Also a `CLOSE 1` after that is not seen. VICE can see from printing that there was an `OPEN`, but it cannot see when the close was. Also a "finish print job" cannot be seen on the userport device. To flush the printer buffer (write to `print.dump` or to the printer) now a menu entry can be used. Disabling and re-enabling the printer should work as well.

The printing services have not been extensively tested but apart from the problem mentioned above it should work fine now.

2.11.4 PET keyboard problems

If you find that the German keyboard mapping (plus German charset) does not print uppercase umlauts, then you are right. The umlauts replace the [,\ and] characters in the charset. The keys that make these characters do not have a different entry in the PET editor ROM tables when shifted. Thus it is not possible to get the uppercase umlauts in the editor. Nevertheless other programs are reported to change the keyboard mapping table and thus allow the use of the shifted (uppercase) umlauts.

Anyway, the VICE keyboard mappings are far from being perfect and we are open to any suggestions.

3 Invoking the emulators

The names of the available emulators are:

- **x64**, the fast C64 emulator
- **x64sc**, the accurate C64 emulator
- **x64dtv**, the C64DTV emulator
- **x128**, the C128 emulator
- **xvic**, the VIC20 emulator
- **xpet**, the PET emulator
- **xplus4**, the PLUS4 emulator
- **xcbm2**, the CBM-II emulator

You can run each of them by simply typing the name from a shell. If you want to run them from another application (e.g., a window manager or some other sort of program launcher) you should always run them from a terminal window such as **xterm** or **rxvt** since VICE provides a lot of debugging information that is sent to the terminal and has built-in monitor that also appears there. For example, you could do

```
xterm -e x64
```

3.1 Command-line options used during initialization

There are several options you can specify on the command line. Some of them are used to specify emulation settings and will be described in detail later (see [Chapter 6 \[Settings and resources\]](#), [page 25](#) for a complete list). The remaining options are used only to give usage information or to initialize the emulator in some way:

- help**
- ?** List all the available command-line options and their meaning.
- default** Set default resources (see [Chapter 6 \[Settings and resources\]](#), [page 25](#)). This will override all the settings specified before, but not the settings specified afterwards on the command line.

`-config <filename>`
Specify config file

`-logfile <name>`
Specify log file name

`-verbose` Enable verbose log output.

`-keybuf <string>`
Put the specified string into the keyboard buffer.

`-console` Console mode (for music playback)

`-chdir <directory>`
Change the working directory.

`-autostart IMAGE`
Autostart 'IMAGE' (see [Section 3.2 \[Command-line autostart\]](#), page 16).

`-autoload <name>`
Attach and autoload tape/disk image <name>

`-basicload`
On autostart, load to BASIC start (without ',1')

`+basicload`
On autostart, load with ',1'

`-autostartwithcolon`
On autostart, use the 'RUN' command with a colon, i.e., 'RUN:'

`+autostartwithcolon`
On autostart, do not use the 'RUN' command with a colon; i.e., 'RUN'

`-autostart-handle-tde`
`+autostart-handle-tde`
Handle/Do not handle True Drive Emulation on autostart

`+autostart-warp`
Enable/Disable warp mode during autostart

`-autostartprgmode`
Set autostart mode for PRG files

`-autostartprgdiskimage`
Set disk image for autostart of PRG files

`-1 NAME` Attach 'NAME' as a tape image file.

`-8 NAME`

`-9 NAME`

`-10 NAME`

`-11 NAME` Attach 'NAME' as a disk image to device 8, 9, 10 or 11.

`-attach8ro`

`-attach9ro`

`-attach10ro`

`-attach11ro`
Attach disk image for drive #8-11 read only

```
-attach8rw
-attach9rw
-attach10rw
-attach11rw
```

Attach disk image for drive #8-11 read write (if possible)

3.2 Autostarting programs from the command-line

It is possible to let the emulator *autostart* a disk or tape image file, by simply specifying its name as the *last* argument on the command line, for example

```
x64 lovelygame.x64.gz
```

will start the C64 emulator, attaching ‘lovelygame.x64.gz’ as a disk image and running the first program on it. You can also specify the name of the program on the disk image by appending a colon (‘:’) the name itself to the argument; for example

```
x64 "lovelygame.x64.gz:run me"
```

will run the program named ‘run me’ on ‘lovelygame.x64.gz’ instead of the first one.

Using the command-line option `-autostart` is equivalent; so the same result can be obtained with

```
x64 -autostart "lovelygame.x64.gz:run me"
```

If you specify a raw CBM or P00 file, the emulator will setup the file system based drive emulation so that it is enabled and accesses the directory containing the file first. This is a very convenient way to start multi-file programs stored in file system directories and not requiring “true” drive emulation.

See [Section 5.5 \[Disk and tape images\]](#), page 23. for more information about images and autostart.

4 System files

In order to work properly, the emulators need to load a few system files:

- the *system ROMs*, raw binary files containing copies of the original ROMs of the machine you are emulating;
- the *keyboard maps*, text files describing the keyboard layout;
- the *palette files*, text files describing the colors of the machine you are emulating.
- the *romset files*, text files describing the different ROMs to load.

The place where they will be searched for depends on the value of the **Directory** resource, which is a colon (:)-separated search path list, like the UNIX **PATH** environment variable. The default value is

```
PREFIX/lib/vice/EMU:$HOME/.vice/EMU:BOOTPATH/EMU
```

Where **PREFIX** is the installation prefix (usually ‘/usr/local’), **EMU** is the name of the emulated machine (C64, C128, PET, CBM-II or VIC20) and **BOOTPATH** is the directory where the executable resides. The disk drive ROMs are looked for in a directory with **EMU** set to **DRIVES**. **\$HOME** is the user’s home directory.

For example, if you have the C64 emulator installed in

```
/usr/local/bin/x64
```

then the value will be

```
/usr/local/lib/vice/C64:$HOME/.vice/C64:/usr/local/bin/C64
```

And system files will be searched for under the following directories, in the specified order:

1. `/usr/local/lib/VICE/C64`
2. `$HOME/.vice/C64`
3. `/usr/local/bin/C64`

System files can still be installed in a different directory if you specify a complete path instead of just a file name. For example, if you specify `./kernal` as the kernal image name, the kernal image will be loaded from the current directory. This can be done by using command-line options or by modifying resource values (see [Section 6.1 \[Resource files\]](#), page 26).

4.1 ROM files

Every emulator requires its own ROM set. For the VIC20 and the C64, the ROM set consists of the following files:

- `'kernal'`, the Kernal ROM (8 KBytes)
- `'basic'`, the Basic ROM (8 KBytes)
- `'chargen'`, the character generator ROM (4 Kbytes)

The C128 needs the following files:

- `'kernal'`, the Kernal ROM (8 Kbytes)
- `'basic'`, the Basic + Editor ROM (32 Kbytes)
- `'chargen'`, the character generator ROM (4 Kbytes)

The C128, VIC20 and C64 emulators also need the following DOS ROMs for the hardware-level emulation of the 1541, 1571 and 1581 disk drives:

- `'dos1541'`, the 1541 drive ROM (16 Kbytes)
- `'dos1541II'`, the 1541-II drive ROM (16 Kbytes)
- `'dos1571'`, the 1571 drive ROM (32 Kbytes)
- `'dos1581'`, the 1581 drive ROM (32 Kbytes)

In addition to those all emulators can handle a parallel IEEE488 interface (the C64 and C128 via `$df**` extension, the VIC20 via VIC1112 emulation) so they also need the DOS ROM for the IEEE disk drives:

- `'dos2031'`, the 2031 drive ROM (16 Kbytes) (DOS 2.6, Commodore ROM images 901484-03 and 901484-05)
- `'dos2040'`, the 2040 drive ROM (8 Kbytes) (DOS 1, Commodore ROM images 901468-06, 901468-07)
- `'dos3040'`, the 3040 drive ROM (12 Kbytes) (DOS 2, Commodore ROM images 901468-11, 901468-12 and 901468-13)
- `'dos4040'`, the 4040 drive ROM (12 Kbytes) (DOS 2, Commodore ROM images 901468-14, 901468-15 and 901468-16)

- ‘dos1001’, the 1001/8050/8250 drive ROM (16 Kbytes) (DOS 2.7, Commodore ROM images 901887-01 and 901888-01)

Note that there are other DOS images on the internet. The DOS 2.5 images might be used with the 8050, but it cannot handle the double sided drives of the 1001 and 8250 and it is not supported by VICE.

The PET emulator uses an expanded setup, because there are three major versions of the Basic and the Kernal, and many versions of the Editor ROM. In addition there are cartridge ROM sockets.

The Kernal files contain the memory from range \$F000-\$FFFF, the Basic ROMs either the range \$C000-\$DFFF or \$B000-\$DFFF. To handle the different screen sizes and keyboards, different so-called “editor-ROMs” for the memory range \$E000-\$E800 are provided. The PET ROMs have the following names:

- ‘kernal1’, the PET2001 Kernal ROM (4 KBytes) (Commodore ROM images 901447-06 and 901447-07)
- ‘kernal2’, the PET3032 Kernal ROM (4 KBytes) (Commodore ROM image 901465-03)
- ‘kernal4’, the PET4032/8032 Kernal ROM (4 KBytes) (Commodore ROM image 901465-22)
- ‘basic1’, the PET2001 Basic 1 ROM (8 KBytes) (Commodore ROM images 901447-09, 901447-02, 901447-03, 901447-04.bin. The -09 ROM is the revised -01 ROM)
- ‘basic2’, the PET3032 Basic 2 ROM (8 KBytes) (Commodore ROM images 901465-01 and 901465-01)
- ‘basic4’, the PET4032/8032 Basic 4 ROM (12 KBytes) (Commodore ROM images 901465-23, 901465-20 and 901465-21. The -23 ROM is a revised -19 ROM)
- ‘edit1g’, the PET2001 editor for graphics keyboards (2 KBytes) (Commodore ROM image 901447-05)
- ‘edit2b’, the PET3032 editor for business keyboards (2 KBytes) (Commodore ROM image 901474-01)
- ‘edit2g’, the PET3032 editor for graphics keyboards (2 KBytes) (Commodore ROM image 901447-24)
- ‘edit4g40’, the PET4032 editor for graphics keyboards (2 KBytes) (Commodore ROM image 901498-01)
- ‘edit4b40’, the PET4032 editor for business keyboards (2 KBytes) (Commodore ROM image 901474-02)
- ‘edit4b80’, the PET8032 editor for business keyboards (2 KBytes) (Commodore ROM image 901474-04-?)
-
- ‘chargen’, the character generator ROM (2k). It has two sets with 128 chars each. The second (inverted) half of each set is computed from the first half by inverting it. This is a PET hardware feature. (Commodore ROM image 901447-10)
- ‘chargen.de’, the character generator ROM (2k). This version is a patched German charset, with the characters [, \ and] replaced by umlauts. It has been provided by U. Guettich and he reports that it is supported by some programs.

The PETs also have sockets for extension ROMs for the addresses \$9000-\$9FFF, \$A000-\$AFFF and \$B000-\$BFFF (the last one for PET2001 and PET3032 only). You can specify ROM image files for those extensions command line options `-petrom9`, `-petromA` and `-petromB` resp.

An alternative would be to specify a long kernal ROM with the `-kernal` option that includes the extension ROM areas.

Also, you can specify replacements for the basic ROM at \$B000-\$DFFF with the `-petromBasic` option and for the editor ROM at \$E000-\$E7FF with the `-petromEditor` option.

The CBM-II emulator again uses another setup. For those models the kernal used is the same for all. However, for different amounts of memory exist different versions of the BASIC ROMs. The 128k RAM version (C610, C710, B128) uses one bank of 64k for the BASIC text and another one for all the variables. The 256k RAM version uses one bank for text, one for variables, one for arrays and one for strings.

Also the character generator ROMs have a format different from the above. The other character ROMs have 8 bytes of pixel data per character. Those ROMs have 16 bytes per character instead. The C6x0 only uses the first 8 of it, but the C7x0 uses 14 lines per character and needs those increased ROMs. Both ROMs hold, like the PET, two character sets with 128 characters each. Again the second half of the full (256 char) character set is computed by inverting.

- ‘kernal’, the KERNAL (8k) for the business machines (6xx/7xx)
- ‘kernal.500’, the KERNAL (8k) for the personal machine (510) (901234-02)
- ‘basic.128’, the CBM-II 128k BASIC (16k)
- ‘basic.256’, CBM-II 256k BASIC (16k)
- ‘basic.500’, C510 BASIC (16k) (901236-02 + 901235-02)
- ‘chargen.500’, character generator ROM for the C5x0 (4k) (901225-01)
- ‘chargen.600’, character generator ROM for the C6x0 (4k)
- ‘chargen.700’, character generator ROM for the C7x0 (4k)

4.2 Keymap files

Keymap files are used to define the keyboard layout, defining which key (or combination of keys) must be mapped to each keysym.

In other words, the keyboard emulation works like this: whenever the user presses or releases a key while the emulation window has the input focus, the emulator receives an X-Window event with a value that identifies that key. That value is called a *keysym* and is unique to that key. The emulator then looks up that keysym in an internal table that tells it which key(s) to press or release on the emulated keyboard.

This table is described by the keymap file, which is made up of lines like the following:

```
KEYSYM ROW COLUMN SHIFTFLAG
```

Where:

- **KEYSYM** is a string identifying the keysym: you can use the `xev` utility (shipped with the X Window system) to see what keysym is bound to any key;

- ROW and COLUMN identify the key on the emulated keyboard;
- SHIFTFLAG can have one of the following values:
 - 0: the key is never shifted;
 - 1: the key is shifted;
 - 2: the key is the left shift;
 - 4: the key is the right shift;
 - 8: the key can be (optionally) shifted by the user.

The SHIFTFLAG is useful if you want certain keys to be “artificially” shifted by the emulator, and not by the user. For example, F2 is shifted on the C64 keyboard, but you might want it to be mapped to the unshifted F2 key on the PC keyboard. To do so, you just have to use a line like the following:

```
F2 0 4 1
```

where 0 and 4 identify the key (row 0, column 4 on the keyboard matrix), and 1 specifies that every time the user presses F2 the shift key on the C64 keyboard must be pressed.

There are also some special commands you can put into the keyboard file; they are recognized because they start with an exclamation mark:

- !CLEAR clears the currently loaded keyboard map; it is necessary to put this at the beginning of the file if you want the keymap file to override all of the current internal settings;
- !LSHIFT, !RSHIFT, followed by a row and a column value, specify where the left and right shift keys are located on the emulated keyboard; for example, C64 default keymaps will specify

```
!LSHIFT 1 7
!RSHIFT 6 4
```

Any line starting with the # sign, instead, is completely ignored. This is useful for adding comments within the keymap file.

VICE keymap files have the ‘.vkm’ default extension, and every emulator comes with a default positional mapping and a default symbolic mapping.

4.3 Palette files

Palette files are used to specify the colors used in the emulators. They are made up of lines like the following:

```
RED GREEN BLUE DITHER
```

where RED, GREEN and BLUE are hexadecimal values ranging from 0 to FF and specifying the amount of red, green and blue you want for each color and DITHER is a 4-bit hexadecimal number specifying the pattern you want when rendering on a B/W display.

You have to include as many lines as the number of colors the emulated machine has, and the order of the lines must respect the one used in the machine (so the N’t line must contain the specifications for color N - 1 in the emulated machine).

Lines starting with the # sign are completely ignored. This is useful for adding comments (such as color names) within the palette file.

For example, the default PET palette file (which has only two colors, 0 for background and 1 for foreground), looks like the following:

```
#
# VICE Palette file
#
# Syntax:
# Red Green Blue Dither
#

# Background
00 00 00 0

# Foreground
00 FF 00 F
```

4.4 Romset files

The Romset files are not used by default on all emulators. You might have recognized that the names of the ROM images are saved in resources. Loading a Romset file now just means a ‘shortcut’ to changing all the resources with ROM image names and reloading the ROMs.

The PET and CBM-II emulators use this feature to change between the different ROM versions available for those machines. E.g. the Romset file for the PET 2001 is

```
KernalName="pet2001"
EditorName=
ChargenName="chargen"
RomModule9Name=
RomModuleAName=
RomModuleBName=
```

As you can see, the file even uses the same syntax as the resource file, it is just a bit stripped down.

5 Basic operation

This section describes the basic things you can do once the emulator has been fired up.

5.1 The emulation window

When the emulator is run, the screen of the emulated machine is displayed in a standard X Window which we will call the *emulation window*. This window will be updated in real time, displaying the same contents that a real monitor or TV set would.

Below the emulation window there is an area which is used to display information about the state of the emulator; we will call this area the *status bar*.

On the extreme left of the status bar, there is a *performance meter*. This displays the current relative speed of the emulator (as a percentage) and the update frequency (in frames per second). All the machines emulated are PAL, so the update frequency will be 50 frames per second if your system is fast enough to allow emulation at the speed of the real machine.

On the extreme right of the status bar, there is a *drive status indicator*. This is only visible if the hardware-level (“True”) 1541 emulation is turned on. In that case, the drive status indicator will contain a rectangle emulating the drive LED and will display the current track position of the drive’s read/write head.

5.2 Using the menus

It is possible to execute some commands and change emulation parameters while the emulator is running: when the pointer is over the emulation window, two menus are available by pressing either the left or right mouse buttons. The left mouse button will open the *command menu* from which several emulation-related commands can be executed; the right mouse button will open the *settings menu* from which emulation parameters can be changed. The basic difference between the command and the settings menu is that, while commands have only effect on the current session, settings can be saved and later used with the “Save settings” and “Load settings” right-button menu items, respectively. “Restore default settings” restores the factory defaults. See [Chapter 6 \[Settings and resources\], page 25](#). for more information about how settings work in VICE.

Sometimes commands can be reached via *shortcuts* or *hotkeys*, i.e., it is possible to execute them by pressing a sequence of keys instead of going through the menu with the mouse. Where shortcuts exist, they are displayed in parentheses at the right edge of the menu item. In VICE, all shortcuts must begin with the **Meta** or **Alt** key. So, for example, to attach a disk image to drive #8 (the corresponding menu item displays “M-8”), you have to press the **Meta** (or **Alt**) and then 8.

Note that no other key presses are passed on to the emulated machine while either **Meta** or **Alt** are held down.

5.3 Getting help

At any time, if you get stuck or do not remember how to perform a certain action, you can use the “Browse manuals” command (left button menu). This will popup a browser and open the HTML version of this documentation. Notice that this requires VICE to be properly (and fully) installed with a ‘**make install**’.

The browser can be specified via the `HTMLBrowserCommand` string resource (see [Chapter 6 \[Settings and resources\], page 25](#) for information about resources). Every ‘%s’ in the string will be replaced with a URL to the VICE HTML pages.

5.4 Using the file selector

In those situations where it is necessary to specify a file name, all of the VICE emulators will pop up a file selector window allowing you to select or specify a file interactively.

To the left of the file selector, there is a list of ancestor directories: by clicking on them, you can ascend the directory tree. To the right, there is a list of the files in the current directory; files can be selected by clicking on them. If you click on a directory, that directory becomes the current one; if you click on an ordinary file, it becomes the active selection.

At the top, there is a *directory box*, with the complete path of the current directory, and a *file name box*, with the name of the currently selected file. At the bottom there are two

buttons: “OK” confirms the selected file and “Cancel” abandons the file selector without cancelling the operation.

It is also possible to specify what files you want to show in the file selector by writing an appropriate shell-like pattern in the directory box; e.g., ‘~/*. [dx]64’ will only show files in the home directory whose name ends with either ‘.d64’ or with ‘.x64’.

5.5 Using disk and tape images

The emulator is able to emulate disk drives and (read-only) tape recorders if provided with suitable *disk images* or *tape images*. An *image* is a raw dump of the contents of the media, and must be *attached* before the emulator can use it. “Attaching” a disk or tape image is like “virtually” inserting a diskette or a cassette into the disk drive or the tape recorder: once an image is attached, the emulator is able to use it as a storage media.

There are five commands (in the left button menu) that deal with disk and tape images:

- Attach Disk Image
- Detach Disk Image
- Attach Tape Image
- Detach Tape Image
- Smart-attach a file

The first four commands are used to insert and remove the virtual disks and cassettes from the respective units. On the other hand, the last commands tries to guess the type of the image you are attaching from its name and size, and attaches it to the most reasonable device.

Supported formats are D64 and X64 for disk images (devices 8, 9 and 10) and T64 for tape images. Notice that T64 support is *read-only*, and that the cassette is automatically rewound when you reach its end.

Another important feature is that raw Commodore BASIC binary files and .P00 files can be attached as tapes. As you can autostart a tape image when it is attached (see [Section 5.5.2 \[Autostart\], page 24](#)), this allows you to autostart these particular files as well.

You can attach a disk for which you do not have write permissions: when this happens, the 1541 emulator will emulate a write-protected disk. This is also useful if you want to prevent certain disk images from being written to; in the latter case, just remove the write permission for that file, e.g., by doing a `chmod a-w`.

5.5.1 Previewing the image contents

It is possible to examine the directory of a disk or tape image before attaching it. Just press the “Contents” button in the file selector window and a new window will pop up with the contents of the selected image.

Notice that this function automatically translates the directory from PETSCII to ASCII; but, due to differences in the two encodings, it is not always possible to translate all the characters, so you might get funny results when “weird” characters such as the semi-graphical ones are being used.

5.5.2 “Autostarting” an image

If you want to reset the machine and run the first program on a certain image without typing any commands at the Commodore BASIC prompt, you can use the “Autostart” button in the file selector window after selecting a proper disk or tape image file.

Notice that, if true drive emulation is turned on, it will be turned off before running the program and then turned on again after it has been loaded. This way, you get the maximum possible speed while loading the file, but you do not lose compatibility once the program itself is running.

This method is not completely safe, because some autostarting methods might cause the true drive emulation not to be turned on again. In such cases, the best thing to do is to disable kernal traps (which will cause true drive emulation to be always kept turned on), or to manually load the program with true drive emulation turned on.

5.5.3 Using compressed files

It is also possible to attach disk or tape images that have been compressed through various algorithms; compression formats are identified from the file extension. The following formats are supported (the expected file name extension is in parenthesis):

- GNU Zip (`.gz` or `.z`);
- BZip version 2 (`.bz2`);
- PkZip (`.zip`);
- GNU Zipped TAR archives (`.tar.gz`, `.tgz`);
- Zoo (`.zoo`).

PkZip, `tar.gz`, `lha` and `zoo` support is *read-only* and always uses the *first* T64 or D64 file in the archive. So archives containing multiple files will always be handled as if they contain only a single file.

Windows and MSDOS don’t contain the needful programs to handle compressed archives. Get `gzip` and `unzip` for Windows at <ftp://ftp.freeware.com/pub/infozip/WIN32> and for MSDOS at <ftp://ftp.freeware.com/pub/infozip/MSDOS>. Don’t use `pkunzip` for MSDOS, it doesn’t work. The programs to use BZip2 archives may be found at <http://sourceware.cygnus.com/bzip2>. Just put the programs (`unzip.exe`, `gzip.exe`, `bzip2.exe`) into a directory of your search path (e.g. `C:\DOS` or `C:\WINDOWS\COMMAND`; have a look at the `PATH` variable).

5.5.4 Using Zipcode and Lynx images

Since version 0.15, the VICE emulators have been able to attach disks packed with Zipcode or Lynx directly, removing the need to manually convert them into D64 or X64 files with `c1541`. This is achieved by automatically invoking `c1541`, letting it decode the file into a temporary image and attaching the resulting temporary image read-only. For this to work, the directory containing `c1541` must be in your `PATH`.

This uses the `-unlynx` and `-zcreate` options of `c1541` (see [Section 12.3 \[c1541 commands and options\], page 112](#)); these commands are not very reliable yet, and could fail with certain kinds of Lynx and Zipcode images (for example, they cannot deal with `DEL` files properly). So please use them with caution.

Lynx files usually come as ‘.lnx’ files which are unpacked into single disk images. On the other hand, Zipcode files do not have a particular extension (although ‘.z64’ is sometimes used), and represent a disk by means of component files, named as follows:

- ‘1!NAME’
- ‘2!NAME’
- ‘3!NAME’
- ‘4!NAME’

If you attach as a disk image (or smart-attach) any one of these files, the emulator will simply pick up the other three (by examining the name) and then build a disk image using all four.

5.6 Resetting the machine

You can reset the emulated machine at any time by using the “Reset” command from the command menu. There are two types of reset:

- *soft reset*, which simply resets the CPU and all the other chips;
- *hard reset*, which also clears up the contents of RAM.

A *soft reset* is the same as a hardware reset achieved by pulling the RESET line down; a *hard reset* is more like a power on/power off sequence in that it makes sure the whole RAM is cleared.

It is possible that a soft reset may not be enough to take the machine to the OS initialization sequence: in such cases, you will have to do a hard reset instead.

This is especially the case for the CBM-II emulators. Those machines examine a memory location and if they find a certain "magic" value they only do what you know from the C64 as Run/Stop-Restore. Therefore, to really reset a CBM-II use hard reset.

6 Settings and resources

In the VICE emulators, all the settings are stored in entities known as called *resources*. Each resource has a name and a value which may be either an integer or a string. Integer values are often used as boolean values with the usual convention of using zero for “false” and any other value for “true”.

Resource values can be changed via the right-button menu (the *settings* menu), via command-line options or via the *resource file*.

The *resource file* is a human-readable file containing resource values: it is called ‘vicerc’ and is stored in the directory ‘.vice/’ in the user’s home directory. It is possible to dump the current values of the resources into that file or load the values stored into that file as the current values, at any time. This is achieved with the “Save settings” and “Load settings” right menu items. A third menu item, “Restore Default Settings”, can be used to reset all the values to the factory defaults.

A special resource, **SaveResourcesOnExit**, if set to a non zero value, causes the emulator to ask you if you want to save the current (changed) settings before exiting, and can be toggled with the “Save settings on exit” command from the right-button menu.

Notice that not all the resources can be changed from the menus; some of them can only be changed by manually modifying the resource file or by using command-line options.

6.1 Format of resource files

A resource file is made up of several sections; sections have the purpose of separating the resources of a certain emulator from the ones of the other emulators. A section starts with the name of an emulator in brackets (e.g., '[C64]') and ends when another section starts or when the file ends.

Every line in a section has the following format:

RESOURCE=VALUE

where RESOURCE is the name of a resource and VALUE is its assigned value. Resource names are case-sensitive and resource values are either strings or integers. Strings must start and end with a double quote character ("), while integers must be given in decimal notation.

Here is an example of a stripped-down '.vice/vicerc' file:

```
[VIC20]
HTMLBrowserCommand="netscape %s"
SaveResourcesOnExit=0
FileSystemDevice8=1
FSDevice8ConvertP00=1
FSDevice8Dir="/home/ettore/cbm/stuff/vic20p00"
FSDevice8SaveP00=1
FSDevice8HideCBMFiles=1
[C64]
HTMLBrowserCommand="netscape %s"
SaveResourcesOnExit=1
FileSystemDevice8=1
FSDevice8ConvertP00=1
FSDevice8Dir="/home/ettore/cbm/stuff/c64p00"
FSDevice8SaveP00=1
FSDevice8HideCBMFiles=1
```

Notice that, when resource values are saved with “Save settings”, the emulator only modifies its own section, leaving the others unchanged.

6.2 Using command-line options to change resources

Resources can also be changed via command-line options.

Command-line options always override the defaults from .vice/vicerc, and their assignments last for the whole session. So, if you specify a certain command-line option that changes a certain resource from its default value and then use “Save Settings”, the value specified with the command-line option will be saved back to the resource file.

Command-line options can begin with with a minus sign ('-') or with a plus sign ('+'). Options beginning with a minus sign may require an additional parameter, while the ones beginning with the plus sign never require one.

Moreover, options beginning with a plus sign always have a counterpart with the same name, but with a minus sign; in that case, the option beginning with a minus sign is used to *enable* a certain feature, while the one beginning with a plus sign is used to *disable* the same feature (this is an X11 convention). For example, `-mitshm` enables support of MITSHM, while `+mitshm` disables it.

6.3 Performance settings

It is possible to control the emulation speed by using the “Maximum speed” menu item in the right-button menu. The default setting is 100, which causes the emulation to never run faster than the real machine. A higher value allows the emulator to run faster, a lower one may force it to run slower. The setting “No limit” means to run as fast as possible, without limiting speed.

It is also possible to control the emulator’s rate of frame update using the “Refresh rate” setting; the value ranges from “1/1” (update 1/1 of the frames of the real machine, that is 50 frames per second) to “1/10” (update 1 every 10 frames) and can be changed via the “Refresh Rate” submenu. The “Auto” setting means to dynamically adapt the refresh rate to the current speed of the host machine, making sure the maximum speed specified by the via “Maximum speed” is always reached if possible. In any case, the refresh rate will never be worse than 1/10 if this option is specified.

Note that you cannot simultaneously specify “Auto” as the refresh rate and “No limit” as the maximum speed..

Moreover, a special *warp speed* mode is provided and can be toggled with the “Enable Warp Mode” menu item. If this mode is enabled, it will cause the emulator to disable any speed limit, turn sound emulation off and use a 1/10 refresh rate, so that it will run at the maximum possible speed.

6.3.1 Performance resources

Speed Integer specifying the maximum relative speed, as a percentage. 0 stands for “no limit”.

RefreshRate Integer specifying the refresh rate; a value of *n* specifies a refresh rate of 1/*n*. A value of 0 enables automatic frame skipping.

WarpMode Boolean specifying whether “warp mode” is turned on or not.

6.3.2 Performance command-line options

-speed VALUE Specifies the maximum speed as a percentage. 0 stands for “no limit”. (Same as setting the **Speed** resource.)

-refresh VALUE Specifies refresh rate; a value of *n* specifies a refresh rate of 1/*n*. A value of 0 enables automatic frame skipping. (Same as setting the **RefreshRate** resource.)

-warp

+warp Enables/disables warp mode (**WarpMode**=1, **WarpMode**=0).

6.4 Video settings

The following right-button menu items control the video output. On emulators that include two video chips (like `x128`) all options but `XSync` exist twice, once for each chip. `XSync` is shared between the video chips.

- “Video Cache” enables a video cache that can speed up the emulation when little graphics activity is going on; it is especially useful when you run the emulator on a networked X terminal as it can reduce the network bandwidth required. However, this setting can actually make the emulator slower when there is little graphics activity and the amount of work needed to maintain the cache is greater than the amount of work that would be wasted by not using it (if any).
- “Double Size” toggles *double-size mode*, which makes the emulation window twice as big. When emulating a 80-column PET, only the height is doubled, so that the aspect ratio is closer to that of the real thing.
- “Double Scan” toggles *double-scan mode*, which causes the emulator to draw only odd lines when running in double-size mode (this saves some CPU time and also makes the emulation window look more like an old monitor).
- “Use XSync()” causes the emulator to call the X11 function `XSync()` before updating the emulation window: this might be necessary on low-end systems to prevent it from consuming so many system resources that it becomes impossible for the user to interact with it.

6.4.1 Video resources

The following resources affect the screen emulation. The prefix of some of the resources and commandline options denote the video chip the values apply to.

UseXSync Boolean specifying whether `XSync()` is called after updating the emulation window.

MITSHM Integer specifying whether VICE should try to use the shared memory extensions (MITSHM) when starting up. The shared memory extensions make things a lot faster but might not be available on your system. You will not be able to use these extensions if you are sitting at an X terminal while running the emulator on a remote machine across a network. Valid values are: 0 = do not use MITSHM, 1 = do use MITSHM, -1 = try to autodetect availability on startup (default). The last is a simple test if the emulator runs across a network and if so disables MITSHM (If you have problems with this test please report it).

PrivateColormap

Boolean specifying whether VICE should install a private colormap at startup. This makes sense for 8-bit displays that could run out of colors if other color-hungry applications are running at the same time.

DisplayDepth

Integer specifying the depth of the host display. The value ‘0’ (the default) causes the emulator to autodetect it.

6.4.2 Video command-line options

-xsync
+xsync Enable/disable usage of `XSync()` when updating the emulation window (`UseXSync=1`, `UseXSync=0`).

-mitshm
+mitshm Enable/disable usage of the MITSHM extensions (`MITSHM=1`, `MITSHM=0`).

-install
+install Enable/disable installation of a private colormap (`PrivateColormap=1`, `PrivateColormap=0`).

-displaydepth DEPTH
 Specify the display depth (`DisplayDepth`).

-fullscreen
+fullscreen
 Enable/disable fullscreen mode

6.5 Keyboard settings

It is possible to specify whether the “positional” or “symbolic” keyboard mapping should be used with the “Keyboard mapping type” submenu (see [Section 2.7 \[Keyboard emulation\]](#), [page 9](#) for an explanation of positional and symbolic mappings).

The keyboard settings submenu also allows you to:

- Load custom-made positional and symbolic keymap files (“Set symbolic keymap file” and “Set positional keymap file”).
- Dump the current keymap to a user-defined keymap file (“Dump to keymap file”).

6.5.1 Keyboard resources

KeymapIndex

Integer identifying which keymap is being used; 0 indicates symbolic mapping, 1 positional mapping. For the PET the even values represent symbolic mapping, odd positional. Then add 0 for UK business keyboard or 2 for graphics keyboard.

KeymapSymFile

String specifying the name of the keymap file for the symbolic mapping (see [Section 2.7 \[Keyboard emulation\]](#), [page 9](#), all but PET and CBM-II).

KeymapPosFile

String specifying the name of the keymap file for the positional mapping (see [Section 2.7 \[Keyboard emulation\]](#), [page 9](#), all but PET and CBM-II).

KeymapBusinessUKSymFile

KeymapBusinessUKPosFile

String specifying the name of the keymap file for the symbolic and positional mapping for the UK business keyboard (see [Section 2.7 \[Keyboard emulation\]](#), [page 9](#), PET and CBM-II).

KeymapGraphicsSymFile

KeymapGraphicsPosFile

String specifying the name of the keymap file for the symbolic and positional mapping for the graphics keyboard (see [Section 2.7 \[Keyboard emulation\]](#), [page 9](#), PET only).

KeymapBusinessDESymFile

KeymapBusinessDEPosFile

String specifying the name of the keymap file for the symbolic and positional mapping for the German business keyboard. (see [Section 2.7 \[Keyboard emulation\]](#), [page 9](#), PET only).

6.5.2 Keyboard command-line options

-keymap N Specifies which keymap is being used; 0 indicates symbolic mapping, 1 positional mapping (as for the `KeymapIndex` resource).

-symkeymap NAME

Specify ‘NAME’ as the symbolic keymap file (`KeymapSymFile`).

-poskeymap NAME

Specify ‘NAME’ as the positional keymap file (`KeymapPosFile`).

-symdekeymap NAME

Specify ‘NAME’ as the symbolic keymap file (`KeymapSymDeFile`).

-bksymkeymap NAME

-bukposkeymap NAME

Specify ‘NAME’ as the symbolic/positional keymap file for the UK business keyboard (`KeymapBusinessUKSymFile`, `KeymapBusinessUKPosFile`, PET and CBM-II).

-grsymkeymap NAME

-grposkeymap NAME

Specify ‘NAME’ as the symbolic/positional keymap file for the graphics keyboard (`KeymapGraphicsSymFile`, `KeymapGraphicsPosFile`, PET only).

-bdesymkeymap NAME

-bdeposkeymap NAME

Specify ‘NAME’ as the symbolic/positional keymap file for the German business keyboard (`KeymapBusinessDESymFile`, `KeymapBusinessDEPosFile`, PET only).

6.6 Joystick settings

6.6.1 Joystick command-line options

-joydev1 <0-8>

-joydev2 <0-8>

Set the device for joystick emulation of port 1 and 2, respectively (`JoyDevice1`, `JoyDevice2`).


```

-extrajoydev1 <0-8>
-extrajoydev2 <0-8>
    Set device for extra joystick port 1 and 2.

-mouse
+mouse    Enable/Disable mouse grab

-mousetype <value>
    Select the mouse type (0 = 1351, 1 = NEOS, 2 = Amiga, 3 = Paddles)

-mouseport <value>
    Select the joystick port the mouse is attached to

-lightpen
+lightpen
    Enable/Disable lightpen emulation

-lightpentype <type>
    Set lightpen type

```

6.7 Sound settings

The following menu items control sound output:

- “Enable sound playback” turns sound emulation on and off.
- “Sound synchronization” specifies the method for synchronizing the sound playback. Possible settings are:
 - “Flexible”, i.e., the audio renderer flexibly adds/removes samples to the output to smoothly adapt the playback to slight changes in the speed of the emulator.
 - “Adjusting” works like “flexible”, but supports bigger differences in speed. For example, if the emulation speed drops down from 100% to 50%, audio slows down by the same amount too.
 - “Exact”, instead, makes the audio renderer output always the same sounds you would hear from the real thing, without trying to adapt the ratio; to compensate the tolerances in speed, some extra frames will be skipped or added.
- “Sample rate” specifies the sampling frequency, ranging from 8000 to 48000 Hz (not all the sound cards and/or sound drivers can support all the frequencies, so actually the nearest candidate will be chosen).
- “Buffer size” specifies the size of the audio buffer; the bigger the buffer, the longer the delay with which sounds are played. You should pick the smallest value your machine can handle without problems.
- “Sound suspend time”, will cause the audio playback to pause for the specified number of seconds whenever some clicking happens. If “Keep going” is selected, no pausing is done.
- “Oversample” specifies an oversampling factor, from 1 to 8 times (warning: this eats CPU cycles!).

6.7.1 Sound resources

Sound Boolean specifying whether audio emulation is turned on.

SoundSpeedAdjustment

Integer specifying what speed adjustment method the audio renderer should use. Possible values are:

- 0: “flexible”
- 1: “adjusting”
- 2: “exact”

SoundSampleRate

Integer specifying the sampling frequency, ranging from 8000 to 48000 Hz (not all the sound cards and/or sound drivers can support all the frequencies, so actually the nearest candidate will be chosen).

SoundBufferSize

Integer specifying the size of the audio buffer, in milliseconds.

SoundSuspendTime

Integer specifying the pause interval when audio underflows (“clicks”) happen. 0 means no pause is done.

SoundDeviceName

String specifying the audio driver.

Implemented drivers are:

- **aix**, for the IBM AIX sound driver.
- **uss**, for the Linux/FreeBSD Universal Sound System driver (**SoundDeviceArg** specifies the audio device, `‘/dev/dsp’` by default);
- **sgi**, for the Silicon Graphics audio device (**SoundDeviceArg** specifies the audio device, `‘/dev/audio’` by default);
- **sun**, for the Solaris audio device (unfinished; **SoundDeviceArg** specifies the audio device, `‘/dev/audio’` by default).
- **hpux**, for the HP-UX audio device (unfinished; **SoundDeviceArg** specifies the audio device, `‘/dev/audio’` by default).
- **sd1**, for the Simple DirectMedia Layer audio driver.
- **esd**, for Esound, the Enlightened Sound Daemon; **SoundDeviceArg** specifies the ESD server (`‘host:port’`) to connect, empty by default.
- **dummy**, fully emulating the SID, but not actually playing samples.
- **dump**, writing all the write accesses to the registers to a file (specified by **SoundDeviceArg**, default value is `vicesnd.sid`);
- **speed**, like **dummy** but also calculating samples (mainly used to evaluate the speed of the sample generator);
- **fs**, writing samples to a file (specified by **SoundDeviceArg**; default is `‘vicesnd.raw’`);

These drivers will actually be present only if the VICE configuration script detected the corresponding devices at the time of compilation.

SoundDeviceArg

String specifying an additional parameter for the audio driver (see **SoundDeviceName**).

6.7.2 Sound command-line options

-sound
+sound Turns sound emulation on (**Sound=1**) and off (**Sound=0**).
-soundsync N
 Specify **N** as the sound speed adjustment method (**SoundSpeedAdjustment**).
-soundrate RATE
 Specifies the sound playback sample rate (**SoundSampleRate**).
-soundbufsize SIZE
 Specifies the size of the audio buffer in milliseconds (**SoundBufferSize**).
-soundfragsize <value>
 Set sound fragment size (0 = small, 1 = medium, 2 = large)
-sounddev NAME
 Specifies the name of the audio device (**SoundDeviceName**).
-soundarg ARG
 Specifies an additional parameter for the audio device (**SoundDeviceArg**).
-soundrecdev <name>
 Specify recording sound driver
-soundrecarg <args>
 Specify initialization parameters for recording sound driver

6.8 Tape settings

These settings are used to control the hardware-level emulation of the Tape drive.

6.8.1 Tape command-line options

-dsresetwithcpu
+dsresetwithcpu
 Enable/Disable automatic Datasette-Reset
-dszerogapdelay <value>
 Set delay in cycles for a zero in the tap
-dsspeedtuning <value>
 Set number of cycles added to each gap in the tap

6.9 Drive settings

These settings are used to control the hardware-level emulation of the Disk drives. When hardware-level emulation is turned on, only drives 8 and 9 are being emulated.

The following settings affect both drives:

- “Enable true drive emulation” enables the (slow) hardware-level emulation of the drives for maximum compatibility. This must be turned on for any of the following settings to have effect.

- “Drive sync factor” specifies the speed of the drive’s CPU. This can be used to help loading certain programs that have trouble with the default PAL setting (for example, programs designed for NTSC machines). The ratio is calculated as follows:

$$\text{sync_factor} = 65536 * \text{clk_drive} / \text{clk_machine}$$

where `clk_drive` and `clk_machine` are clock speeds in MHz. The menu lets you choose between the PAL and NTSC values, and also lets you specify whatever value you want. Be careful when changing it, though, because a wrong value can break things and even corrupt disk images.

The following settings, instead, are specific of each drive:

- “Drive model” specifies the model of the drive being emulated. **Warning:** This will reset the drive.
- “Enable parallel cable” enables emulation of a SpeedDOS parallel cable; if you switch this option on and replace the original Commodore ROMs with SpeedDOS-compatible ones, you can speed up loading/saving times.
- “Idle method” specifies which method the drive emulation should use to save CPU cycles in the host CPU. There are three methods:
 - *Skip cycles*: Each time the serial line is accessed by the C64, the drive executes all the cycles since the last time it ran. If the number of elapsed cycles is larger than a certain value, the drive discards part of them.
 - *Trap idle*: The disk drive is still emulated upon serial line accesses as with the previous option, but it is also always emulated at the end of each screen frame. If the drive gets into the DOS idle loop, only pending interrupts are emulated to save time.
 - *No traps*: Like “Trap idle”, but without any traps at all. So basically the drive works exactly as with the real thing, and nothing is done to reduce the power needs of the drive emulation.

The first option (“Skip cycles”) is usually best for performance, as the drive is emulated as little as possible; on the other hand, you may notice sudden slowdowns (when the drive executes several cycles at once) and the LED status is never updated (because it would not be possible to do correctly so). Moreover, if the drive tries to get in sync with the computer in some weird way and the computer does not access the serial line for a long time, it is possible that some cycles are discarded and the sync is lost. Notice that this hack will have no effect on performance if a program continuously reads from the IEC port, as the drive will have to be fully emulated in any case (some stupid programs do this, even when they don’t actually need to use the drive).

The second option (“Trap idle”) is usually a bit slower, as at least interrupts are always emulated, but ensures the LED state is always updated correctly and always keeps the drive and the computer in sync. On the other hand, if a program installs a non-standard idle loop in the drive, the drive CPU has to be emulated even when not necessary and the global emulation speed is then *much* slower.

- “40-track image support” specifies how 40-track (“extended”) disk images should be supported. There are three possible ways:
 - “Never extend” never extends disk images at all (so if a program tries to write tracks beyond the 35th, it is not allowed to do so);

- “Ask on extend” prompts the user as soon as a program tries to write tracks beyond the 35th, and the user can then choose whether he wants the disk image to be extended or not;
- “Extend on access” simply extends the disk image as soon the program needs it, without prompting the user.

6.9.1 Drive resources

DriveTrueEmulation

Boolean controlling whether the “true” drive emulation is turned on.

Drive8Type

Drive9Type

Integers specifying the model number for drives 8 and 9. Possible values are 1541, 1571, 1581 and 2031.

Drive8ParallelCable

Drive9ParallelCable

Booleans controlling whether the SpeedDOS-compatible cable is emulated or not for drives 8 and 9.

Drive8ExtendImagePolicy

Drive9ExtendImagePolicy

Integer specifying the policy for 40-track support for drives 8 and 9. Possible values are 0 (never extend), 1 (ask on extend), 2 (extend on access).

Drive8IdleMethod

Drive9IdleMethod

Integers specifying the idling method for the drive CPU. Possible values are 0 (none), 1 (skip cycles), 2 (trap idle). See [Section 6.9 \[Drive settings\], page 33](#).

DosName1541

DosName1571

DosName1581

DosName2031

Strings specifying the names of the ROM images for the drive emulation.

6.9.2 Drive command-line options

-truedrive

+truedrive

Turns true drive emulation on (**DriveTrueEmulation=1**) and off (**DriveTrueEmulation=0**), respectively.

-drive8type TYPE

-drive9type TYPE

-drive10type TYPE

-drive11type TYPE

Specifies the drive types for drives 8-11, respectively. Possible values for TYPE are 1541, 1571, 1581 and 2031.

```
-parallel8 <type>
-parallel9 <type>
-parallel10 <type>
-parallel11 <type>
```

Set parallel cable type (0: none, 1: standard, 2: Dolphin DOS)

```
-drive8idle NUM
-drive9idle NUM
-drive10idle NUM
-drive11idle NUM
```

Specifies NUM as the idling method for drives 8-11 (0: no traps, 1: skip cycles, 2: trap idle), respectively (Drive8IdleMethod, Drive9IdleMethod), Drive10IdleMethod, Drive11IdleMethod).

```
-drive8extend NUM
-drive9extend NUM
-drive10extend NUM
-drive11extend NUM
```

Specifies NUM as the track 40 extend policy in drives 8 and 9, respectively (Drive8ExtendImagePolicy, Drive9ExtendImagePolicy).

```
-dos1541 <name>
-dos1541II <name>
-dos1551 <name>
-dos1570 <name>
-dos1571 <name>
-dos1571cr <name>
-dos1581 <name>
-dos2031 <name>
-dos2040 <name>
-dos3040 <name>
-dos4040 <name>
-dos1001 <name>
```

Specify the ROM names for the 1541, 1541II, 1551, 1570, 1571, 1571cr, 1581, 2031, 2040, 3040, 4040 and 1001 emulation respectively.

```
-drive8ram2000, +drive8ram2000
-drive9ram2000, +drive9ram2000
-drive10ram2000, +drive10ram2000
-drive11ram2000, +drive11ram2000
```

Enable/Disable 8KB RAM expansion at \$2000-\$3FFF

```
-drive8ram4000, +drive8ram4000
-drive9ram4000, +drive9ram4000
-drive10ram4000, +drive10ram4000
-drive11ram4000, +drive11ram4000
```

Enable/Disable 8KB RAM expansion at \$4000-\$5FFF

```

-drive8ram6000, +drive8ram6000
-drive9ram6000, +drive9ram6000
-drive10ram6000, +drive10ram6000
-drive11ram6000, +drive11ram6000
    Enable/Disable 8KB RAM expansion at $6000-$7FFF

-drive8ram8000, +drive8ram8000
-drive9ram8000, +drive9ram8000
-drive10ram8000, +drive10ram8000
-drive11ram8000, +drive11ram8000
    Enable/Disable 8KB RAM expansion at $8000-$9FFF

-drive8rama000, +drive8rama000
-drive9rama000, +drive9rama000
-drive10rama000, +drive10rama000
-drive11rama000, +drive11rama000
    Enable/Disable 8KB RAM expansion at $A000-$BFFF

-drive8profdos, +drive8profdos
-drive9profdos, +drive9profdos
-drive10profdos, +drive10profdos
-drive11profdos, +drive11profdos
    Enable/Disable Professional DOS

-profdos1571 <name>
Specify name of Professional DOS 1571 ROM image

```

6.10 Peripheral settings

VICE is able to support some special peripherals:

- *file system devices*, pseudo-drives accessing the Unix file system;
- printers.

These features depend on some *kernal traps* that replace the existing routines in the original Commodore operating system with custom-made C routines.

6.10.1 Settings for file system devices

These settings deal with the drive-like peripherals connected to the bus of the emulated machine. The first setting relates to the parallel IEEE488 interface. With this interface a special engine is used to listen to the bus lines to translates them to the filesystem code. Thus the PET will always detect a drive for example, but it can also use drives 10 and 11 even together with true disk drive emulation.

- “Enable virtual devices”, enables the peripheral access via the fast disk emulation (either kernal traps or IEEE488 interface). Both, filesystem and disk image access via fast drive emulation, are affected.

Four peripherals, numbered from 8 to 11, are accessible; each of them provides the following settings:

- “File system access”, if enabled, allows the device to emulate a drive accessing a file system directory; note that when a disk image is attached to the same drive, the directory is no longer visible and the attached disk is used instead.

- “File system directory” specifies the directory to be accessed by the drive.
- “Convert P00 file names”, if enabled, allows access to P00 files using their built-in name instead of the Unix one.
- “Create P00 files on save”, if enabled, creates P00 files (instead of raw CBM files) whenever a program creates a file.

Note that, by default, all drives except 11 create P00 files on save, while drive 11 creates raw CBM files. Those files come without any header, but also with the filename restrictions given by the operating system VICE runs on.

6.10.1.1 Resources for file system devices

`FSDevice8ConvertP00`

`FSDevice9ConvertP00`

`FSDevice10ConvertP00`

`FSDevice11ConvertP00`

Booleans specifying whether on-read support for P00 files is enabled on drives 8, 9, 10 and 11 respectively (on by default).

`FSDevice8SaveP00`

`FSDevice9SaveP00`

`FSDevice10SaveP00`

`FSDevice11SaveP00`

Booleans specifying whether the drives should create P00 files instead of plain CBM ones (on by default for drives 8-10, off for 11).

`FSDevice8HideCBMFiles`

`FSDevice9HideCBMFiles`

`FSDevice10HideCBMFiles`

`FSDevice11HideCBMFiles`

Booleans specifying whether non-P00 files should be invisible to programs running in the emulator (do not hide by default).

`FSDevice8Dir`

`FSDevice9Dir`

`FSDevice10Dir`

`FSDevice11Dir`

Strings specifying the directories to which drives 8, 9, 10 and 11 have access.

6.10.1.2 Command-line options for file system devices

`-iecdevice8`

`+iecdevice8`

Enable/Disable IEC device emulation for device #8

`-iecdevice9`

`+iecdevice9`

Enable/Disable IEC device emulation for device #9

`-iecdevice10`

`+iecdevice10`

Enable/Disable IEC device emulation for device #10


```

-iecdevice11
+iecdevice11
    Enable/Disable IEC device emulation for device #11

-device8 <type>
-device9 <type>
-device10 <type>
-device11 <type>
    Set device type for device 8-11 (0: NONE, 1: FILESYSTEM, 2: OPENCBM,
    3: BLOCK DEVICE)

-fs8 PATH
-fs9 PATH
-fs10 PATH
-fs11 PATH
    Specify the paths for the file system access on drives 8, 9, 10 and 11, respectively
    (FSDevice8Dir, FSDevice9Dir, FSDevice10Dir and FSDevice11Dir).

-flipname <name>
    Specify name of the flip list file image

```

6.10.2 Printer settings

The VICE emulators can emulate printers connected to either the IEC buffer or the user port. Emulation can be achieved by redirecting the printer output to a file or by piping it through an external process. This is defined by so-called *printer device file names*; a printer device file name can be either a simple path, or a command name preceded by a pipe symbol ‘|’.

For example, printer device ‘filename’ will cause the output to be appended to the file ‘filename’, while printer device ‘|lpr’ will cause the lpr command to be executed and be fed the printer output. The printer output will not be converted but saved as printed by the emulated machine.

Up to three printer devices may be specified through the following resources:

- device 1, whose default value is `print.dump`;
- device 2, whose default value is `|lpr`.
- device 3, whose default value is `|petlp -F PS|lpr`;

So, basically, by default printer device 1 will dump printer output to ‘print.dump’; printer device 2 will print it via `lpr` directly to the printer and device 3 will print it via `petlp` (a not-yet-complete utility that will produce Postscript output from the Commodore printer code) and then to the printer via `lpr`.

6.10.2.1 Printer resources

```

PrinterTextDevice1
PrinterTextDevice2
PrinterTextDevice3

```

Strings specifying the printer devices (see [Section 6.10.2 \[Printer settings\]](#), [page 39](#)).

Printer4TextDevice

Printer5TextDevice

Integer (ranging from 0 to 2, for device 1-3) specifying what printer device (see [Section 6.10.2 \[Printer settings\], page 39](#)) the IEC printer is using.

Printer4

Printer5 Integer specifying how the IEC printer (device 4-5) is being emulated. (0: NONE, 1: FS, 2: REAL)

Printer4Driver

Printer5Driver

String specifying the IEC printer output driver.

Printer4Output

Printer5Output

String specifying the IEC printer output device.

PrinterUserport

Boolean specifying if the user-port printer is being emulated.

PrinterUserportTextDevice

Integer (ranging from 0 to 2, for device 1-3) specifying what printer device the user-port printer is using.

PrinterUserportDriver

String specifying the user-port printer output driver.

PrinterUserportOutput

String specifying the user-port printer output device.

6.10.2.2 Printer command-line options

-iecdevice4

+iecdevice4

Enable/Disable IEC device emulation for device #4

-iecdevice5

+iecdevice5

Enable/Disable IEC device emulation for device #5

-device4 <type>

-device5 <type>

Set device type for device 4-5 (0: NONE, 1: FS, 2: REAL)

-prttxtdev1 <name>

-prttxtdev2 <name>

-prttxtdev3 <name>

Specify name of printer text device or dump file

-pr4txtdev <0-2>

-pr5txtdev <0-2>

Specify printer text output device for IEC printer #4-5

```

-pr4output <name>
-pr5output <name>
    Specify name of output device for device #4-5 Specify name of output device
    for device #5-5

-pr4drv <name>
-pr5drv <name>
    Specify name of printer driver for device #4-5 Specify name of printer driver
    for device #5-5

-pruser
+pruser    Enable/disable emulation of the userport printer emulation (PrUser=1,
    PrUser=0).

-prusertxtdev <0-2>
    Specify printer text output device for userport printer

-pruseroutput <name>
    Specify name of output device for the userport printer

-pruserdrv <name>
    Specify name of printer driver for the userport printer

```

6.10.3 Disabling kernal traps

If you have compatibility problems, you can completely disable Kernal traps with the “Disable kernal traps” option. This will of course disable all the features that depend on it, such as the fast 1541 emulation (so you will have to turn true 1541 emulation on if you want to be able to read or write disk images) and tape support.

6.10.3.1 Resources to control Kernal traps

VirtualDevices

Boolean specifying whether all the mechanisms for virtual device emulation should be enabled. Serial IEC devices use kernal traps, parallel IEEE488 devices use an own IEEE488 engine. Both are switched on and off with this resource.

6.10.3.2 Command-line options to control Kernal traps

```

-virtualdev
+virtualdev
    Enable (VirtualDevices=1) or disable (VirtualDevices=0) virtual devices.

```

6.11 RS232 settings

The VICE emulators can emulate the RS232 device most of the machines have. The C64, C128 and VIC20 emulators emulate the userport RS232 interface at 300 and 1200 baud. The C64 and C128 can also use the 9600 baud interface by Daniel Dallmann, using the shift registers of the two CIA 6526 chips. The PET can have a 6551 ACIA RS232 interface when running as a SuperPET, and the CBM-II has such an ACIA by default. The C64 and C128 emulators can emulate an ACIA 6551 (also known as Datapump for example) as extension at \$de**.

Emulation can be achieved by either:

- connecting a real UNIX serial device;
- dumping to a file;
- piping through a process.

It is possible to define up to four UNIX serial devices, and then decide which interface should be connected to which device. This is done by so-called *rs232 device file names*; an rs232 device file name can be either a simple path, or a command name preceded by a pipe symbol '|'. If the path specifies a special device (e.g. `/dev/ttyS0`) it is recognized by VICE and the emulator can set the baudrate.

For example, rs232 device `'filename'` will cause the output to be written (not appended) to the file `'filename'`, while printer device `'|lpr'` will cause the `lpr` command to be executed and be fed the rs232 output. The rs232 output will not be converted but saved as sent by the emulated machine. The same holds true for the rs232 input. If the command writes data to the standard output it will be caught by VICE and sent back to the emulator. Also the data sent by the pseudo device will be sent back to VICE.

For example you can setup a null-modem cable between two serial ports of your PC, setup one port for login and use the other in VICE. Then you can login from your emulator via the RS232 emulation and the null-modem cable to your machine again.

You can not simply run a shell from VICE, as the shell will notice that it does not run on its own pseudo terminal and will thus buffer its output. You need to write some program that opens an own pseudo terminal and runs the shell from there (not yet finished).

Up to four RS232 devices may be specified through the following resources:

- device 1, whose default value is `/dev/ttyS0`;
- device 2, whose default value is `/dev/ttyS1`;
- device 3, whose default value is `rs232.dump`;
- device 4, whose default value is `|lpr`.

For the first two devices you can change the baudrate the tty device is set to by specifying it on the commandline or in the menu. This baudrate is 9600 by default for the latter two, but can be changed only by resources (The baudrate is independent from the baudrate the emulator actually expects).

6.11.1 RS232 resources

`RsDevice1`

`RsDevice2`

`RsDevice3`

`RsDevice4`

Strings specifying the RS232 devices (see [Section 6.11 \[RS232 settings\]](#), [page 41](#)).

`RsDevice1Baud`

`RsDevice2Baud`

`RsDevice3Baud`

`RsDevice4Baud`

Integer specifying the RS232 baudrate devices if the device file points to a special device (like `/dev/ttyS0`; see [Section 6.11 \[RS232 settings\]](#), [page 41](#)).

Acia1Dev	Integer (ranging from 0 to 3, for device 1-4) specifying what RS232 device (see Section 6.11 [RS232 settings], page 41) the ACIA is using (all except VIC20).
Acia1Irq	Integer specifying which interrupt to use. 0 = none, 1 = IRQ, 2 = NMI (C64 and C128 only)
RsUserEnable	Boolean specifying if the user-port RS232 interface is being emulated (C64, C128 and VIC20).
RsUserBaud	Integer specifying the baudrate of the user-port RS232 interface (C64, C128 and VIC20).
RsUserDev	Integer (ranging from 0 to 3, for device 1-4) specifying what RS232 device the user-port interface is using (C64, C128 and VIC20).

6.11.2 RS232 command-line options

-rsdev1 NAME	
-rsdev2 NAME	
-rsdev3 NAME	
-rsdev4 NAME	Specify NAME as RS232 devices 1, 2, 3 and 4, respectively (RsDevice1, RsDevice2 RsDevice3 and RsDevice4).
-rsdev1 BAUDRATE	
-rsdev2 BAUDRATE	
-rsdev3 BAUDRATE	
-rsdev4 BAUDRATE	Specify BAUDRATE as baudrate for the RS232 devices if the device name specifies a special device (like '/dev/ttyS0' for example, see Section 6.11 [RS232 settings], page 41 ; RsDevice1Baud, RsDevice2Baud RsDevice3Baud and RsDevice4Baud).
-myaciadev <0-3>	Specify RS232 device the ACIA should work on
-rsuser	
+rsuser	Enable or disable emulation of the userport RS232 emulation (RsUser; C64, C128 and VIC20)
-rsuserbaud <baud>	Set the baud rate of the RS232 userport emulation.
-rsuserdev <0-3>	Specify device for the userport RS232 emulation (RsUserDev; C64, C128 and VIC20).

6.11.3 RS232 usage example

Here we give you a simple example how to set up an emulated C64 using the modem connected to your PC. The following list shows each step.

Attach your modem to your PC at a serial port.

Normally you should set it up to use the modem as `"/dev/modem"`.

start VICE

Setup VICE to use your modem as "serial device 1"

Go to the RS232 settings menu and change "Serial 1 device" to `"/dev/modem"` (or the device where you attached your modem to) Then go to the RS232 settings menu and change "Serial 1 baudrate" to the baudrate your modem should run at. Watch out, e.g. on Linux there is an additional multiplier to multiply with the baudrate (so e.g. 19200 gives 115200 or so baud) See the "setserial" manpage on Linux for example. However, most modems should be able to autodetect the speed to the computer as well.

Select the RS232 emulation your programs use

If you want to use the Userport emulation, go to the RS232 settings and change "Userport RS232 Device" to "Serial 1". If you want ACIA emulation (swiftlink or what's it called?) then change "ACIA \$DE** device" to "Serial 1".

Enable the emulation

Go to the RS232 settings and select either "ACIA \$DE** emulation" or Userport 300/1200 baud or CIA 9600 baud emulation.

Load your program and start it.

If it is able to detect an RS232 cartridge like swiftlink or so, try to detect the ACIA emulation if enabled. Otherwise just set the baudrate to either 300, 1200 or 9600 according to what you enabled in the VICE menu for the userport.

6.12 Monitor settings

This section lists command-line options specific to the built-in monitor.

6.12.1 Monitor command-line options

`-moncommands FILENAME`

Execute the commands from the file `FILENAME` in the monitor after starting up. This command line switch is mainly thought to load labels and to set breakpoints. Not all other commands are useful to be executed in this way, some may even lead to strange effects.

`-initbreak <address>`

Set an initial breakpoint for the monitor. Addresses with prefix `"0x"` are hexadecimal.

`-remotemonitor`

`+remotemonitor`

Enable/Disable remote monitor

`-remotemonitoraddress <name>`

The local address the remote monitor should bind to

6.13 Machine settings

6.13.1 Machine command-line options

- pal Use PAL sync factor
- ntsc Use NTSC sync factor
- ntscold Use old NTSC sync factor
- paln Use PAL-N sync factor

6.14 Memory settings

6.14.1 Memory command-line options

- raminitstartvalue <value>
Set the value for the very first RAM address after powerup
- raminitvalueinvert <num of bytes>
Length of memory block initialized with the same value
- raminitpatterninvert <num of bytes>
Length of memory block initialized with the same pattern

6.15 Miscellaneous settings

This section lists generic resources that do not fit in the other categories.

6.15.1 Miscellaneous resources

Directory

String specifying the search path for system files. It is defined as a sequence of directory names, separated by colons (':'), just like the PATH variable in the shell. The special string '\$\$' stands for the default search path, which is initialized at startup to the following value:

LIBDIR/EMUID:\$HOME/.vice/EMUID:BOOTPATH/EMUID:LIBDIR/DRIVES:\$HOME/.vice/DRIVES

where:

- LIBDIR is the VICE installation directory (usually '/usr/local/lib/vice', '/usr/lib/vice' or '/opt/vice/lib');
- EMUID is the emulation identification string (C64, C128, VIC20 or PET);
- BOOTPATH is the directory where the binary lies (usually '/usr/local/bin', '/usr/bin' or '/opt/vice/bin').
- DRIVES is the directory called "DRIVES", where the disk drive ROMs are. (The disk drive ROMs are used by all emulators, so there is an extra directory for them.)

Notice that the middle entry points to a default location in the user's home directory. Here private ROM versions (e.g. speeddos or JiffyDos) can be stored for example.

See [Chapter 4 \[System files\]](#), page 16. for a description of the method used to load the emulator's system files.

HTMLBrowserCommand

String specifying the command to run the help browser. The help browser can be any HTML browser, and every ‘%s’ in the string is replaced with the name of the toplevel file of the VICE documentation. For example, the default value ‘netscape %s’ runs Netscape Navigator.

SaveResourcesOnExit

Boolean specifying whether the emulator should save changed settings before exiting. If this is enabled, the user will be always prompted first, in case the settings have changed.

DoCoreDump

Boolean specifying whether the emulator should dump core when it gets a signal.

JoyDevice1**JoyDevice2**

Integer specifying which joystick device the emulator should use for joystick emulation for ports 1 and 2, respectively (0=None, 1=Numpad, 2=Custom keys, 3=Analog joystick 1, 4=Analog joystick 2, 5=Digital joystick 1, 6=Digital joystick 2 on Unix) The available joysticks might differ depending on operating system and joystick support in the OS (Linux joystick module must be available for example).

6.15.2 Miscellaneous command-line options

-directory SEARCHPATH

Specify the system file search path (Directory).

-htmlbrowser COMMAND

Specify the command to run the HTML browser for the on-line help (HTMLBrowserCommand).

-saveres

+saveres Enable/disable automatic saving of settings on exit (SaveResourcesOnExit=1, SaveResourcesOnExit=0).

-confirmexit

Confirm quitting VICE

+confirmexit

Never confirm quitting VICE

-core

+core Enable/disable generation of core dumps (DoCoreDump=1, DoCoreDump=0).

7 Machine-specific features

7.1 C64/128-specific commands and settings

This section lists the settings and commands that are C64/128 specific and thus are not present in the other emulators.

7.1.1 Using cartridges

The cartridge system is organized in "Slots" to allow more than one cartridge connected at a time, like it can be done using an expansion port expander on a real C64 (see below).

Generally a cartridge can be enabled by attaching its respective cartridge image, or using the respective menu option for cartridges that do not require an image.

x64, x64sc and x128 allow you to attach the following kinds of images:

- ‘.crt’ images, as used by the CCS64 emulator by Per Hkan Sundell
- raw ‘.bin’ images, with or without load address

Cartridge images are like disk images, but contain the contents of cartridge ROM and/or RAM images instead of disk images.

To attach cartridges, use the “Attach a cartridge image” submenu. When using ‘.crt’ images, this will work for every cartridge which is supported. For raw ‘.bin’ images you might have to use command line options.

When you have successfully attached a cartridge image, you should then reset the machine to make sure the cartridge initializes itself. (Or enable the "reset on cartridge change" option).

Of course, it is also possible to detach a currently attached cartridge image (“Detach cartridge image”).

If you are using a freezer cart like an Action Replay cartridge, you can emulate the cartridge’s freeze button with the “Cartridge freeze” command.

The imaginary expansion port expander is organized in 4 slots, the cartridges are associated with them like this:

7.1.1.1 Slot 0

All carts that have a passthrough connector go here. Once a "Slot 0" cartridge is enabled all further cartridges are connected to its respective passthrough port.

Only one cartridge of this type can be active at a time.

"Slot 0" carts have individual "enable" switches, enabling means enabling permanently.

The following cartridges are emulated in this slot:

- IEEE-488 Interface (<http://www.funet.fi/pub/cbm/schematics/cartridges/c64/ieee-488/eprom.bin>)
- Magic Voice
- MMC64

7.1.1.2 Slot 1

Mostly RAM based cartridges which for one reason or the other might make sense to be enabled together with one of the "Main Slot" cartridges go here.

Only one cartridge of this type can be active at a time.

"Slot 1" carts have individual "enable" switches, enabling means enabling permanently. The following cartridges are emulated in this slot:

- Double Quick Brown Box (DQBB)
- Expert Cartridge
- ISEPIC
- RamCart

7.1.1.3 Main Slot

All other cartridges which are not pure i/o extensions go here.

Only one cartridge of this type can be active at a time.

Cartridges in the "Main Slot" must be explicitly set as default to enable them permanently.

The following cartridges are emulated in this slot:

- generic 4K, 8K and 16K game- and ultimax cartridges
- Action Replay V5
- Action Replay MK2
- Action Replay MK3
- Action Replay MK4
- Atomic Power
- C64 Games System
- Capture
- Comal 80
- Dela EP64
- Dela EP7x8
- Dela EP256
- Diashow-Maker
- Dinamic
- EasyFlash
- Epyx FastLoad
- EXOS
- The Final Cartridge
- The Final Cartridge III
- Final Cartridge Plus
- Freeze Frame
- Freeze Machine
- Fun Play
- Game Killer
- IDE64 (<http://www.volny.cz/dundera/>)
- KCS Power Cartridge

- MACH 5
- Magic Desk
- Magic Formel
- Mikro Assembler
- MMC Replay
- Ocean
- Prophet64
- REX 256k EPROM Cart
- REX Utility
- Retro Replay
- ROSS
- Simons' BASIC
- Snapshot 64
- Stardos
- Structured BASIC
- Super Explode V5.0
- Super Games
- Super Snapshot V4
- Super Snapshot V5
- Warp Speed
- Westermann Learning
- Zaxxon

7.1.1.4 I/O Slot

All carts that are pure I/O extensions go here.

Any number of "I/O Slot" Carts may be active at a time.

"I/O Slot" carts have individual "enable" switches, enabling means enabling permanently.

The following cartridges are emulated in this slot:

- ACIA (Swiftlink, Turbo232)
- DigiMAX
- Ethernet (The Final Ethernet, RR-Net)
- GEO-RAM
- MIDI (Passport, Datel, Maplin, Namesoft, Sequential)
- RAM Expansion Module (REU)
- SFX Sound Expander
- SFX Sound Sampler

7.1.1.5 Expected behaviour

When the emulator is run without arguments, all settings from the config file should be applied and arguments override settings from the config file.

When saving the settings to the config file it is expected that on the next run of the emulator all settings will be in the same state as they were when saved.

There is an exception to this rule: the cartridge in the "Main Slot" must be explicitly set as default before it gets saved to the config file.

+cart should disable ALL cartridges, including eventually activated REU, Swithlink and all similar expansionport devices.

-cartXYZ options should generally attach AND activate a cart of type XYZ. As a consequence, attaching carts this way which are NOT in the "Main Slot" will also enable the cart permanently.

7.1.1.6 Common problems

If attaching a cartridge does not work as expected, this may be because of various reasons:

- Not seldomly the CRT type is incorrectly set in `.crt` files found "in the wild". Make sure this is not the case (if in doubt use `cartconv` to verify and/or fix).
- You may have unintentionally enabled more than one cartridge at once, for example by saving the settings with REU enabled, and then later attaching a game cartridge from the command-line. The cartridge system will allow certain combinations, but (as on the real thing) not all do (can) actually work. To make sure this is not the case, either detach all cartridges from the menus, or use **+cart** on the command-line.
- The cartridge image might be broken. Try one from a different source. If you are sure the dump is ok (for example because you dumped it yourself) then make sure it is in proper linear order (on some cartridges, for example "capture", address and/or data lines at the eeprom are shuffled around so a dump made with an eeprom burner can not be used as is).
- Last not least you might have encountered a bug in the emulation. If you suspect this is the case, and you can still reproduce the bug after checking the things above, please file a bug report including the following information:
 - attach your vicerc and a reference to the cartridge binaries
 - if you can, comment in the respective DEBUGXYZ macros prominently defined at the top of these files: `src/c64/cart/c64cart.c` `src/c64/cart/c64cartmem.c` `src/c64/c64io.c` `src/c64/c64export.c` and then recompile. this will add debug output that might make it much easier to locate certain problems.

7.1.1.7 IEEE-488 interface

To be able to use an IEEE drive, you need to enable IEEE emulation for the emulator. To do this, follow the following steps:

Download the IEEE 488 ROM image from the CBM archives (formerly known as FUNET) Attach that image with File/Attach cartridge image/IEEE488 interface image.

Make sure you have a one-drive system only (that is, go to Settings/Peripheral Setting, uncheck "use IEC device" for all devices, go to Settings/Drive Settings and select "Floppy type" as "none" for all drives other than drive 8.

After this, all drives can be selected in x64 and x128.

7.1.1.8 The Final Cartridge 3

The Final Cartridge 3 detects whether a mouse is connected when it starts and disables mouse support if it doesn't detect one. So to make mouse emulation work you must either enable it on the command line, or reset the cartridge after enabling it from the user interface.

7.1.2 C64 cartridge settings

7.1.2.1 C64 cartridge resources

CartridgeReset

CartridgeType

CartridgeFile

DQBB Boolean specifying whether the Double Quick Brown Box should be emulated or not.

DQBBfilename

DQBBImpageWrite

ExpertCartridgeEnabled

Boolean specifying whether the Expert Cartridge should be emulated or not.

Expertfilename

ExpertImageWrite

ExpertCartridgeMode

IDE64Image1

IDE64Image2

IDE64Image3

IDE64Image4

IDE64Config

IDE64Cylinders

IDE64Heads

IDE64Sectors

IDE64AutodetectSize

IDE64version4

IDE64RTCOffset

IEEE488 Boolean specifying whether the IEEE488 interface should be emulated or not.

IEEE488Image

IsepPicCartridgeEnabled

Boolean specifying whether ISEPIC should be emulated or not.

IsepPicfilename

IsepPicSwitch

IsepPicImageWrite

MagicVoiceCartridgeEnabled

Boolean specifying whether the Magic Voice should be emulated or not.

MagicVoiceImage

MMC64 Boolean specifying whether the MMC64 should be emulated or not.

```

MMC64BIOSfilename
MMC64_bios_write
MMC64_flashjumper
MMC64_revision
MMC64imagefilename
MMC64_RO

MMC64_sd_type
MMCRCardImage
MMCREEPROMImage
MMCRRescueMode
MMCRImageWrite
MMCRCardRW
MMCRSDType
MMCREEPROMRW
RAMCART    Boolean specifying whether the RAMCart should be emulated or not.

RAMCARTfilename
RAMCARTImageWrite
RAMCART_RO
RAMCARTsize
RRFlashJumper
RRBankJumper
RRBiosWrite

```

7.1.2.2 C64 cartridge command-line options

```

+cart      Disable all cartridges (which would eventually be enabled in the config file).

-cartreset
+cartreset
            Reset/Do not reset machine if a cartridge is attached or detached

-cart8 <name>
            Attach generic 8KB cartridge image

-cart16 <name>
            Attach generic 16KB cartridge image

-cartultimax <name>
            Attach generic 16kB Ultimax cartridge image

-cartcrt <name>
            Attach CRT cartridge image

-cartap <name>
            Attach raw 32KB Atomic Power cartridge image

-cartar2 <name>
            Attach raw 16kB Action Replay MK2 cartridge image

-cartar3 <name>
            Attach raw 16KB Action Replay MK3 cartridge image

```

`-cartar4 <name>`
Attach raw 32KB Action Replay MK4 cartridge image

`-cartar5 <name>`
Attach raw 32KB Action Replay cartridge image

`-cartcap <name>`
Attach raw 8kB Capture cartridge image

`-cartcomal <name>`
Attach raw 64kB Comal 80 cartridge image

`-cartdep256 <name>`
Attach raw Dela EP256 cartridge image

`-cartdep64 <name>`
Attach raw Dela EP64 cartridge image

`-cartdep7x8 <name>`
Attach raw Dela EP7x8 cartridge image

`-cartdin <name>`
Attach raw 128kB Dinamic cartridge image

`-cartdsm <name>`
Attach raw 8kB Diashow-Maker cartridge image

`-cartdqbb <name>`
Attach raw 16kB Double Quick Brown Box cartridge image

`-dqbb`
`+dqbb` Enable/Disable Double Quick Brown Box

`-dqbbimage <name>`
Specify Double Quick Brown Box filename

`-dqbbimagerw`
`+dqbbimagerw`
Allow/Disallow writing to DQBB image

`-carteasy <name>`
Attach raw EasyFlash cartridge image

`-easyflashjumper`
`+easyflashjumper`
Enable/Disable EasyFlash jumper

`-easyflashcrtwrite`
`+easyflashcrtwrite`
Allow/Disallow writing to EasyFlash .crt image

`-cartepyx <name>`
Attach raw 8KB Epyx FastLoad cartridge image

`-cartexos <name>`
Attach raw 8kB EXOS cartridge image

`-cartexpert <name>`
Attach raw 8kB Expert Cartridge image

`-expert`
`+expert` Enable/Disable the Expert Cartridge

`-expertimagename <name>`
Set Expert Cartridge image name

`-expertimagerw`
`+expertimagerw`
Allow/Disallow writing to Expert Cartridge image

`-cartfc1 <name>`
Attach raw 16kB Final Cartridge image

`-cartfc3 <name>`
Attach raw 64kB Final Cartridge III image

`-cartfcplus <name>`
Attach raw 32kB Final Cartridge Plus image

`-cartff <name>`
Attach raw 8kB Freeze Frame image

`-cartfm <name>`
Attach raw 32kB Freeze Machine image

`-cartfp <name>`
Attach raw 128kB Fun Play/Power Play cartridge image

`-cartgk <name>`
Attach raw 8KB Game Killer cartridge image

`-cartgs <name>`
Attach raw 512kB Game System cartridge image

`-cartide64 <name>`
Attach raw 64KB IDE64 cartridge image

`-IDE64image1 <name>`
Specify name of IDE64 image file

`-IDE64image2 <name>`
Specify name of IDE64 image file

`-IDE64image3 <name>`
Specify name of IDE64 image file

`-IDE64image4 <name>`
Specify name of IDE64 image file

`-IDE64cyl <value>`
Set number of cylinders for the IDE64 emulation

`-IDE64hds <value>`
Set number of heads for the IDE64 emulation

-IDE64sec <value>
Set number of sectors for the IDE64 emulation

-IDE64autosize
+IDE64autosize
Autodetect/do not autodetect geometry of formatted images

-IDE64version4
+IDE64version4
Emulate version 4 hardware/Emulate pre version 4 hardware

-cartieee <name>
Attach CBM IEEE-488 cartridge image

-ieee488
+ieee488 Enable (IEEE488=1) or disable (IEEE488=0) emulation of the IEEE488 interface.

-ieee488image <name>
Set IEEE488 interface image name

-isepic
+isepic Enable/Disable the ISEPIC cart

-cartisepic <name>
Attach raw 2kB ISEPIC cartridge image

-isepicimagename <name>
Set ISEPIC image name

-isepicimagerw
+isepicimagerw
Allow/Disallow writing to ISEPIC image

-cartkcs <name>
Attach raw 16kB KCS Power cartridge image

-cartmach5 <name>
Attach raw 8kB MACH 5 cartridge image

-cartmd <name>
Attach raw 32/64/128kB Magic Desk cartridge image

-cartmf <name>
Attach raw Magic Formel cartridge image

-cartmikro <name>
Attach raw 8kB Mikro Assembler cartridge image

-mmc64
+mmc64 Enable/Disable the MMC64 expansion

-cartmmc64 <name>
Attach raw 8kB MMC64 cartridge image

-mmc64bios <name>
Specify name of MMC64 BIOS image

`-mmc64image <name>`
Specify name of MMC64 image

`-mmc64readonly`
Set the MMC64 card to read-only

`-mmc64readwrite`
Set the MMC64 card to read/write

`-mmc64bioswrite`
Save the MMC64 bios when changed

`-cartmmcr <name>`
Attach raw 512kB MMC Replay cartridge image

`-mmcrrescue`
`+mmcrrescue`
Enable/Disable MMC Replay rescue mode

`-mmcrimagerw`
`+mmcrimagerw`
Allow/Disallow writing to MMC Replay image

`-mmcrcardimage <filename>`
Specify MMC Replay card image filename

`-mmcrcardrw`
`+mmcrcardrw`
Allow/Disallow writes to MMC Replay card image

`-mmcreepromimage`
Specify MMC Replay EEPROM image filename

`-mmcreepromrw`
`+mmcreepromrw`
Allow/Disallow writes to MMC Replay EEPROM image

`-cartmv <name>`
Attach raw 16kB Magic Voice cartridge image

`-cartocean <name>`
Attach raw Ocean cartridge image

`-cartp64 <name>`
Attach raw 256KB Prophet 64 cartridge image

`-cartramcart <name>`
Attach raw RamCart cartridge image

`-ramcart`
`+ramcart` Enable/Disable the RAMCART expansion

`-ramcartsize <size in KB>`
Size of the RAMCART expansion

`-ramcartimage <name>`
Specify name of RAMCART image

```
-ramcartimagerw
+ramcartimagerw
    Allow/Disallow writing to RAMCart image

-cartrep256 <name>
    Attach raw REX EP256 cartridge image

-cartross <name>
    Attach raw 16/32kB ROSS cartridge image

-cartrr <name>
    Attach raw 64KB Retro Replay cartridge image

-rrbioswrite
+rrbioswrite
    Enable/Disable saving of the RR ROM at exit

-rrbankjumper
+rrbankjumper
    Set/Unset RR Bank Jumper

-rrflashjumper
+rrflashjumper
    Set/Unset RR Flash Jumper

-cartru <name>
    Attach raw 8kB REX Utility cartridge image

-carts64 <name>
    Attach raw 4kB Snapshot 64 cartridge image

-cartsb <name>
    Attach raw Structured Basic cartridge image

-cartse5 <name>
    Attach raw 16kB Super Explode V5 cartridge image

-cartsg <name>
    Attach raw 64kB Super Games cartridge image

-cartsimon <name>
    Attach raw 16kB Simons Basic cartridge image

-cartss4 <name>
    Attach raw 32KB Super Snapshot V4 cartridge image

-cartss5 <name>
    Attach raw 64KB Super Snapshot V5 cartridge image

-cartstar <name>
    Attach raw 16KB Stardos cartridge image

-cartwl <name>
    Attach raw 16KB Westermann Learning cartridge image

-cartws <name>
    Attach raw 8kB Warp Speed cartridge image
```

`-cartzaxxon <name>`
 Attach raw 16kB Zaxxon cartridge image

7.1.3 CIA settings

7.1.3.1 CIA command-line options

`-ciamodel <model>`
 Set both CIA models (0 = old 6526, 1 = new 6526A)

`-cia1model <model>`
 Set CIA 1 model (0 = old 6526, 1 = new 6526A)

`-cia2model <model>`
 Set CIA 2 model (0 = old 6526, 1 = new 6526A)

7.1.4 VIC-II settings

These settings control the emulation of the VIC-II (MOS6569) video chip used in both the C64 and the C128.

- “Sprite-sprite collisions” and “Sprite-background collisions”, if enabled, cause the hardware detection of sprite-to-sprite and sprite-to-background collisions of the VIC-II to be emulated. This feature is used by many games, and disabling either of the two detection systems can sometimes make you invincible (although there is also a chance that also enemies become invincible then).
- “Color set” can be used to dynamically change the palette file being used by choosing one of the available predefined color sets:
 - ‘default.vpl’ (“default”), the default VICE palette;
 - ‘c64s.vpl’ (“C64S”), palette taken from the shareware C64S emulator by Miha Peternel.
 - ‘ccs64.vpl’ (“CCS64”), palette taken from the shareware CCS64 emulator by Per Hkan Sundell.
 - ‘frodo.vpl’ (“Frodo”), palette taken from the free Frodo emulator by Christian Bauer (<http://www.uni-mainz.de/~bauec002/FRMain.html>).
 - ‘pc64.vpl’ (“PC64”), palette taken from the free PC64 emulator by Wolfgang Lorenz.
 - ‘godot.vpl’ (“GoDot”), palette as suggested by the authors of the C64 graphics package GoDot (<http://users.aol.com/howtogodot/welcome.htm>).

7.1.4.1 VIC-II resources

`VICIICheckSsColl`
 Boolean specifying whether the sprite-sprite hardware collision detection must be emulated.

`VICIICheckSbColl`
 Boolean specifying whether the sprite-background hardware collision detection must be emulated.

VICIIVideoCache

Boolean specifying whether the video cache is turned on.

VICIIDoubleSize

Boolean specifying whether double-size mode is turned on.

VICIIDoubleScan

Boolean specifying whether double-scan mode is turned on.

VICIIPaletteFile

String specifying the name of the palette file being used. The ‘.vpl’ extension is optional.

7.1.4.2 VIC-II command-line options**-VICIICheckss****+VICIICheckss**

Enable (VICIICheckSsColl=1) and disable (VICIICheckSsColl=0) emulation of hardware sprite-sprite collision detection, respectively.

-VICIIChecksb**+VICIIChecksb**

Enable (VICIICheckSbColl=1) and disable (VICIICheckSbColl=0) emulation of hardware sprite-background collision detection, respectively.

-VICIIVcache**+VICIIVcache**

Enable/disable the video cache (VICIIVideoCache=1, VICIIVideoCache=0).

-VICIIDsize**+VICIIDsize**

Enable/disable the double size mode (VICIIDoubleSize=1, VICIIDoubleSize=0).

-VICIIDscan**+VICIIDscan**

Enable/disable the double scan mode (VICIIDoubleScan=1, VICIIDoubleScan=0).

-VICIIhwscale**+VICIIhwscale**

Enable/Disable hardware scaling

-VICIIscale2x**+VICIIscale2x**

Enable/Disable Scale2x

-VICIIintpal

Use an internal calculated palette

-VICIIextpal

Use an external palette (file)

-VICIIPalette NAME

Specify NAME as the palette file (VICIIPaletteFile).

```

-VICIIfulldevice <device>
    Select fullscreen device

-VICIIIXRANDRfullmode <mode>
    Select fullscreen mode

-VICIIvidmodefullmode <mode>
    Select fullscreen mode

-VICIIborders <mode>
    Set VIC-II border display mode (0: normal, 1: full, 2: debug)

-VICIImodel <model>
    Set VIC-II model (6569/6569r1/8565/6567/8562/6567r56a). This setting is
    only available in x64sc.

-newluminance
+newluminance
    Enable/Disable new luminances.

-saturation <0-2000>
    Set saturation of internal calculated palette [1000]

-contrast <0-2000>
    Set contrast of internal calculated palette [1000]

-brightness <0-2000>
    Set brightness of internal calculated palette [1000]

-gamma <0-4000>
    Set gamma of internal calculated palette [2200]

-tint <0-2000>
    Set tint of internal calculated palette [1000]

-oddlinesphase <0-2000>
    Set phase for color carrier in odd lines [1250]

-oddlinesoffset <0-2000>
    Set phase offset for color carrier in odd lines [750]

-crtblur <0-1000>
    Amount of horizontal blur for the CRT emulation. [500]

-crtscanlinesshade <0-1000>
    Amount of scan line shading for the CRT emulation [667]

```

7.1.5 SID settings

These settings control the emulation of the SID (MOS6581 or MOS8580) audio chip.

- “Second SID” maps a second SID chip into the address space for stereo sound. This emulates e.g. the “SID Symphony Stereo Cartridge” from Dr. Evil Laboratories. The second SID can be used with software such as “Stereo SID Player” by Mark Dickenson or “The Enhanced Sidplayer” by Craig Chamberlain.

- “Second SID base address” sets the start address for the second SID chip. Software normally uses \$DE00 or \$DF00, since \$DE00-\$DEFF and \$DF00-\$DFFF can be mapped through the cartridge port of the C64. The default start address is \$DE00.
- “Emulate filters” causes the built-in programmable filters of the SID chip to be emulated. A lot of C64 music requires them to be emulated properly, but their emulation requires some additional processor power.
- “ChipModel” specifies the model of the SID chip being emulated: there are two slightly different generations of SID chips: MOS6581 ones and MOS8580 ones.
- “Use reSID emulation” specifies whether the more accurate (and resource hungry) reSID emulation is turned on or off.
- “reSID sampling method” selects the method for conversion of the SID output signal to a sampling rate appropriate for playback by standard digital sound equipment. Possible settings are:
 - “Fast” simply clocks the SID chip at the output sampling frequency, picking the nearest sample. This yields acceptable sound quality, but sampling noise is noticeable in some cases, especially with SID combined waveforms. The sound emulation is still cycle exact.
 - “Interpolating” clocks the SID chip each cycle, and calculates each sample with linear interpolation. The sampling noise is now strongly attenuated by the SID external filter (as long as “Emulate filters” is selected), and the linear interpolation further improves the sound quality.
 - “Resampling” clocks the SID chip each cycle, and uses the theoretically correct method for sample generation. This delivers CD quality sound, but is extremely CPU intensive, and is thus most useful for non-interactive sound generation. Unless you have a very fast machine, that is.
- “reSID resampling passband” specifies the percentage of the total bandwidth allocated to the resampling filter passband. The work rate of the resampling filter is inversely proportional to the remaining transition band percentage. This implies that e.g. with the transition band starting at $\sim 20\text{kHz}$, it is faster to generate 48kHz than 44.1kHz samples. For CD quality sound generation at 44.1kHz the passband percentage should be set to 90 (i.e. the transition band starting at almost 20kHz).

7.1.5.1 SID resources

SidStereo

Boolean selecting emulation of a second SID.

SidStereoAddressStart

Integer specifying the start address for the second SID.

SidFilters

Boolean specifying whether the built-in SID filters must be emulated.

SidModel Integer specifying what model of the SID must be emulated (0: MOS6581, 1: MOS8580).

SidEngine

SidResidSampling

Integer specifying the sampling method (0: Fast, 1: Interpolation, 2: Resampling)

SidResidPassband

Integer specifying the resampling filter passband in percentage of the total bandwidth (0 - 90).

7.1.5.2 SID command-line options

-sidstereo

Emulates a second SID chip for stereo sound (**SidStereo**).

-sidstereoaddress ADDRESS

Specifies the start address for the second SID chip (**SidStereoAddressStart**).

-sidenginemodel <engine and model>

Specify SID engine and MODEL for the emulated SID chip (0: FastSID 6581, 1: FastSID 8580, 256: ReSID 6581, 257: ReSID 8580, 258: ReSID 8580 + digiboost, 1024: ParSID in par port 1, 1280: ParSID in par port 2, 1536: ParSID in par port 3, 1800: ReSID-FP 6581R3 4885, 1801: ReSID-FP 6581R3 0486S, 1802: ReSID-FP 6581R3 3984, 1803: ReSID-FP 6581R4 AR 3789, 1804: ReSID-FP 6581R3 4485, 1805: ReSID-FP 6581R4 1986S, 1808: ReSID-FP 8580R5 3691, 1809: ReSID-FP 8580R5 3691 + digiboost, 1810: ReSID-FP 8580R5 1489, 1811: ReSID-FP 8580R5 1489D).

-sidfilters

+sidfilters

Enable (**SidFilters=1**) or disable (**SidFilters=0**) emulation of the built-in SID filters.

-residsamp METHOD

Specifies the sampling method; fast (**SidResidSampling=0**), interpolating (**SidResidSampling=1**), resampling (**SidResidSampling=2**), fast resampling (**SidResidSampling=3**).

-residpass PERCENTAGE

Specifies the resampling filter passband in percentage of the total bandwidth (**SidResidPassband=0-90**).

-residgain PERCENTAGE

Specifies reSID gain in percent (90 - 100).

-residfilterbias <number>

reSID filter bias setting, which can be used to adjust DAC bias in millivolts.

7.1.6 C64 I/O extension settings

I/O extensions are (usually) cartridges which do not map into ROM space, but use only the I/O space at address range \$DE00 ... \$DEFF and/or \$DF00 ... \$DFFF.

Please use these extensions only when needed, as they might cause compatibility problems.

The following I/O extensions are available:

- ACIA (Swiftlink, Turbo232)
- DigiMAX
- Ethernet (The Final Ethernet, RR-Net)
- GEO-RAM
- MIDI (Passport, Datel, Maplin, Namesoft, Sequential)
- REU - The “RAM Expansion Module” extension emulates a standard Commodore RAM Expansion Unit; this can be used with GEOS and other programs that are designed to take advantage of it. This currently works only in the C64 emulator.
- SFX Sound Expander
- SFX Sound Sampler

7.1.6.1 C64 I/O extension resources

TODO

`Acia1Enable`

Boolean specifying whether the ACIA (Swiftlink, Turbo232) cartridge should be emulated or not.

`DIGIMAX` Boolean specifying whether the DigiMAX cartridge should be emulated or not.

`DIGIMAXbase`

`ETHERNET_INTERFACE`

`ETHERNET_DISABLED`

`ETHERNET_ACTIVE`

`ETHERNET_AS_RR`

`GEORAM` Boolean specifying whether the GEO-RAM cartridge should be emulated or not.

`GEORAMfilename`

`GEORAMImageWrite`

`GEORAMsize`

`MIDIEnable`

Boolean specifying whether the MIDI cartridge should be emulated or not.

`MIDIMode`

`REU` Boolean specifying whether the RAM Expansion Module should be emulated or not.

`REUfilename`

`REUImageWrite`

`REUsize`

`SFXSoundExpander`

Boolean specifying whether the SFX Sound Expander should be emulated or not.

SFXSoundExpanderChip

SFXSoundSampler

Boolean specifying whether the SFX Sound Sampler should be emulated or not.

7.1.6.2 C64 I/O extension command-line options

-acia1

+acia1 Enable/Disable the \$DE** ACIA RS232 interface emulation

-digimax

+digimax Enable/Disable the DigiMAX cartridge

-digimaxbase <base address>

Base address of the DigiMAX cartridge

-miditype <0-4>

MIDI interface type (0: Sequential, 1: Passport, 2: DATEL, 3: Namesoft, 4: Maplin)

-midi

+midi Enable/Disable MIDI emulation

-midiin <name>

Specify MIDI-In device

-midiout <name>

Specify MIDI-Out device

-mididrv <driver>

Specify MIDI driver (0 = OSS, 1 = ALSA)

-georam

+georam Enable/Disable the GEORAM expansion unit

-cartgeoram <name>

Attach raw GEO-RAM cartridge image

-georamimage <name>

Specify name of GEORAM image

-georamimagerw

+georamimagerw

Allow/Disallow writing to GEORAM image

-georamsize <size in KB>

Size of the GEORAM expansion unit

-reu

+reu Enable (REU=1) or disable (REU=0) emulation of the RAM Expansion Module.

-cartreu <name>

Attach raw REU cartridge image

-reuimage <name>

Specify name of REU image

```

-reuimagerw
+reuimagerw      Allow/Disallow writing to REU image

-reusize <size in KB>
                Size of the RAM expansion unit

-sfxse
+sfxse           Enable/Disable the SFX soundexpander cartridge

-sfxsetype <type>
                Set YM chip type (3526 / 3812)

-sfxss
+sfxss           Enable/Disable the SFX Sound Sampler cartridge

-tfe
+tfe             Enable/Disable the TFE ("The Final Ethernet") unit

-tfeif <name>
                Set the system ethernet interface for TFE emulation

-tferrnet
+tferrnet        Enable/Disable RNet mode of TFE emulation

```

7.1.7 C64/128 system ROM settings

These settings can be used to control what system ROMs are loaded in the C64/128 emulators at startup. They cannot be changed from the menus.

7.1.7.1 C64/128 system ROM resources

KernalName
String specifying the name of the Kernal ROM (default 'kernal').

BasicName
String specifying the name of the Basic ROM (default 'basic'). In the C128 emulator, the ROM image must actually include the editor ROM too.

ChargenName
String specifying the name of the character generator ROM (default 'chargen').

KernalRev
String specifying the Kernal revision. This resource can be used to control what revision of the C64 kernal is being used; it cannot be changed at runtime. VICE is able to automatically convert one ROM revision into another, by manually patching the loaded image. This way, it is possible to use any of the ROM revisions without changing the ROM set. Valid values are:

0	Kernal revision 0;
3	Kernal revision 3;
sx	
67	Commodore SX-64 ROM;

100

4064 Commodore 4064 (also known as “PET64” or “Educator 64”) ROM.

7.1.7.2 C64/128 system ROM command-line options

-kernal NAME

Specify ‘NAME’ as the Kernal ROM file (`KernalName`).

-basic NAME

Specify ‘NAME’ as the Basic ROM file (`BasicName`).

-chargen NAME

Specify ‘NAME’ as the character generator ROM file (`ChargenName`).

-kernalrev REVISION

Specify Kernal revision (`KernalRev`).

7.1.8 C64 settings

7.1.8.1 C64 command-line options

-gluelogictype <type>

Set glue logic type (0 = discrete, 1 = 252535-01)

-plus60k

+plus60k Enable/Disable the PLUS60K RAM expansion

-plus60kimage <name>

Specify name of PLUS60K image

-plus60kbase <base address>

Base address of the PLUS60K expansion

-plus256k

+plus256k

Enable/Disable the PLUS256K RAM expansion

-plus256kimage <name>

Specify name of PLUS256K image

-256k

+256k Enable/Disable the 256K RAM expansion

-256kimage <name>

Specify name of 256K image

-256kbase <base address>

Base address of the 256K expansion

7.2 C128-specific commands and settings

7.2.1 VDC settings

7.2.1.1 VDC command-line options

`-VDCvcache`
`+VDCvcache`
Enable/Disable the video cache

`-VDCdsize`
`+VDCdsize`
Enable/Disable double size

`-VDCdscan`
`+VDCdscan`
Enable/Disable double scan

`-VDChwscale`
`+VDChwscale`
Enable/Disable hardware scaling

`-VDCintpal`
Use an internal calculated palette

`-VDCextpal`
Use an external palette (file)

`-VDCpalette <name>`
Specify name of file of external palette

`-VDCfulldevice <device>`
Select fullscreen device

`-VDCXRANDRfullmode <mode>`
Select fullscreen mode

`-VDCVidmodefullmode <mode>`
Select fullscreen mode

`-VDC16KB` Set the VDC memory size to 16KB

`-VDC64KB` Set the VDC memory size to 64KB

`-VDCRevision <number>`
Set VDC revision (0..2)

`-saturation <0-2000>`
Set saturation of internal calculated palette [1000]

`-contrast <0-2000>`
Set contrast of internal calculated palette [1000]

`-brightness <0-2000>`
Set brightness of internal calculated palette [1000]

`-gamma <0-4000>`
Set gamma of internal calculated palette [2200]

`-tint <0-2000>`
Set tint of internal calculated palette [1000]

`-oddlinesphase <0-2000>`
Set phase for color carrier in odd lines [1250]

`-oddlinesoffset <0-2000>`
Set phase offset for color carrier in odd lines [750]

`-crtblur <0-1000>`
Amount of horizontal blur for the CRT emulation. [500]

`-crtscanlineshade <0-1000>`
Amount of scan line shading for the CRT emulation [667]

7.2.2 C128 system ROM settings

7.2.2.1 C128 system ROM command-line options

`-basic64 <name>`
Specify name of C64 mode BASIC ROM image

`-kernal64 <name>`
Specify name of C64 mode Kernal ROM image

`-basiclo <name>`
Specify name of BASIC ROM image (lower part)

`-basichi <name>`
Specify name of BASIC ROM image (higher part)

`-kernal <name>`
Specify name of international Kernal ROM image

`-kernalde <name>`
Specify name of German Kernal ROM image

`-kernalfi <name>`
Specify name of Finnish Kernal ROM image

`-kernalfr <name>`
Specify name of French Kernal ROM image

`-kernalit <name>`
Specify name of Italian Kernal ROM image

`-kernalno <name>`
Specify name of Norwegian Kernal ROM image

`-kernalse <name>`
Specify name of Swedish Kernal ROM image

`-chargen <name>`
Specify name of international character generator ROM image

`-chargde <name>`
Specify name of German character generator ROM image

`-chargfr <name>`
Specify name of French character generator ROM image

```

-charge <name>
    Specify name of Swedish character generator ROM image

-intfunc
+intfunc  Enable/Disable the internal Function ROM

-intfrom <name>
    Specify name of internal Function ROM image

-extfunc
+extfunc  Enable/Disable the external Function ROM

-extfrom <name>
    Specify name of external Function ROM image

```

7.2.3 C128 settings

7.2.3.1 C128 command-line options

```

-40col    Activate 40 column mode
-80col    Activate 80 column mode
-go64     Always switch to C64 mode on reset
+go64     Always switch to C128 mode on reset

```

7.3 C64DTV-specific commands and settings

This section lists the settings and commands that are C64DTV specific and thus are not present in the other emulators.

7.3.1 C64DTV ROM image

The DTV has a 2MB Flash chip which contains the kernal, basic and character set ROMs along with other data, such as games in the case of the original C64DTV ROM.

The image file is a dump of the flash chip. It is exactly 2MB (2097152 bytes).

If you do not have a suitable image file, an image using the C64 kernal, basic and charset is automatically created.

If writing to the C64DTV ROM is enabled, the image file is rewritten with the current data when exiting x64dtv.

Note that x64dtv tries to load the image file from the C64DTV directory first, and if it isn't found there, x64dtv tries to load it from the current directory. If you do not have 'dtvrom.bin' in your C64DTV directory and writing to DTV ROM is enabled, the 'dtvrom.bin' file is created to the current directory.

NOTE: The original C64DTV ROM has somewhat distorted colors, normally you should use a patched rom.

```

-c64dtvromimage NAME
    Specify 'NAME' as the C64DTV ROM image

-c64dtvromrw
+c64dtvromrw
    Enable or disable writing to C64DTV ROM image

```

The `trueflashfs` option is analogous to True drive emulation. If disabled, any file access to the flash filesystem (device 1) will go to the local file system instead.

`-trueflashfs`

`+trueflashfs`

Enable or disable true hardware flash file system

`-fsflash NAME`

Specify 'NAME' as directory for flash file system device

7.3.2 DTV revision

The DTV revision 2 has a bug in the Blitter. Using revision 3 is recommended. Emulation of DTV revision 2 including Blitter bug is intended for testing DTV software.

`-dtvrev REVISION`

Specify DTV 'REVISION' (2 or 3)

7.3.3 LumaFix

The PAL C64DTVs have wrong resistors in the video output circuit, which causes incorrect luminances. Several hardware solutions ("LumaFixes") have been developed to fix this flaw.

The fixed video output is emulated by selecting "New Luminances". The unmodified C64DTV video output can be emulated with "Old Luminances".

The default setting is "New Luminances".

7.3.4 Userport

The C64DTV userport emulation currently supports three devices: Hummer ADC, userport joystick and PS/2 mouse.

The joystick that controls either the Hummer ADC or userport joystick can be selected using the same parameter or menu option.

While using the Hummer ADC, joystick UP and DOWN are mapped to the Hummer buttons A and B respectively. LEFT and RIGHT set the ADCs output to 0 and 255. Centering the joystick results in the ADC value of 128.

Currently the Hummer ADC and userport joystick are mutually exclusive. This means that enabling one disables the other. PS/2 mouse emulation can be used simultaneously with either Hummer ADC or userport joystick.

`-hummeradc`

`+hummeradc`

Enable/Disable Hummer ADC

`-ps2mouse`

`+ps2mouse`

Enable or disable PS/2 mouse on userport

7.3.5 Debug

Debugging information on Blitter, DMA and Flash can be enabled with command line parameters. This can be useful for DTV software development.


```
-dtvblitterlog
+dtvblitterlog
    Enable or disable DTV Blitter log

-dtvdmalog
+dtvdmalog
    Enable or disable DTV DMA log

-dtvflashlog
+dtvflashlog
    Enable or disable DTV Flash log
```

7.3.6 Monitor DTV features

Currently the registers A, Y and X are registers R0, R1 and R2 regardless of the mapping, which can be seen and modified via the registers ACM and XYM.

The monitor can access all 2MB of RAM and 2MB of Flash, but only 64 kB at a time. The 64kB bank can be selected with "bank ram00".. "ram1f" for RAM and "bank rom00".. "rom1f" for Flash.

The "load" command can load large files (>64kB) correctly if the bank is set to "ramXX", where XX is the starting bank (usually "bank00").

7.4 VIC20-specific commands and settings

This section lists the settings and commands that are VIC20-specific and thus are not present in the other emulators.

7.4.1 Using cartridge images

As with the C64 (see [Section 7.1.1 \[C64 cartridges\]](#), [page 47](#)), it is possible to attach several types of cartridge images:

- 4 or 8 Kbyte cartridges located at \$2000;
- 4 or 8 Kbyte cartridges located at \$4000;
- 4 or 8 Kbyte cartridges located at \$6000;
- 4 or 8 Kbyte cartridges located at \$A000;
- 4 Kbyte cartridges located at \$B000.

This can all be done via the “Attach cartridge image. . .” command in the left-button menu. It is also possible to let xvic “guess” the type of cartridge using “Smart-attach cartridge image. . .”.

Notice that several cartridges are actually made up of two pieces (and two files), that need to be loaded separately at different addresses. In that case, you have to know the addresses (which are usually specified in the file name) and use the “attach” command twice.

A special kind of cartridge file is where the two files mentioned above are concatenated (with removing the two byte load address of the second image) into one 16k image. There are only few of those images, though. Normally the second part is located at \$A000. Vice can now attach such concatenated files at the start address \$2000, \$4000, and \$6000. The second half of such an image is moved to \$A000. If you encounter 16k images that have the

second half not at \$A000 you can split the image into two halves (i.e. one 8194 byte and one 8192 byte, because the first has the load address) and attach both files separately.

One cartridge that is currently only partially supported here is the VIC1112 IEEE488 interface. You have to load the ROM as a cartridge, but you also have to enable the IEEE488 hardware by menu.

7.4.2 VIC20 cartridge settings

7.4.2.1 VIC20 cartridge command-line options

```
-cart2 <name>
    Specify 4/8/16K extension ROM name at $2000
-cart4 <name>
    Specify 4/8/16K extension ROM name at $4000
-cart6 <name>
    Specify 4/8/16K extension ROM name at $6000
-cartA <name>
    Specify 4/8K extension ROM name at $A000
-cartB <name>
    Specify 4K extension ROM name at $B000
-cartgeneric <name>
    Specify generic extension ROM name
-cartmega <name>
    Specify Mega-Cart extension ROM name
-mcnvramfile <name>
    Set Mega-Cart NvRAM filename
-mcnvramwriteback
+mcnvramwriteback
    Enable/Disable Mega-Cart NvRAM writeback
-cartfe <name>
    Specify Final Expansion extension ROM name
-fewriteback
+fewriteback
    Enable/Disable Final Expansion write back to ROM file
-cartfp <name>
    Specify Vic Flash Plugin extension ROM name
-fpwriteback
+fpwriteback
    Enable/Disable Vic Flash Plugin write back to ROM file
-ieee488
+ieee488  Enable/Disable VIC-1112 IEEE488 interface
-sidcart
+sidcart  Enable/Disable SID Cartridge
```

7.4.3 VIC settings

7.4.3.1 VIC resources

VICVideoCache

Boolean specifying whether the video cache is turned on.

VICDoubleSize

Boolean specifying whether double-size mode is turned on.

VICDoubleScan

Boolean specifying whether double-scan mode is turned on.

VICPaletteFile

String specifying the name of the palette file being used. The ‘.vpl’ extension is optional.

7.4.3.2 VIC command-line options

-VICvcache

+VICvcache

Enable/disable the video cache (VICVideoCache=1, VICVideoCache=0).

-VICdsize

+VICdsize

Enable/disable the double size mode (VICDoubleSize=1, VICDoubleSize=0).

-VICdscan

+VICdscan

Enable/disable the double scan mode (VICDoubleScan=1, VICDoubleScan=0).

-VIChwscale

+VIChwscale

Enable/Disable hardware scaling

-VICscale2x

+VICscale2x

Enable/Disable Scale2x

-VICpalette NAME

Specify NAME as the palette file (VICPaletteFile).

-VICintpal

Use an internal calculated palette

-VICextpal

Use an external palette (file)

-VICfulldevice <device>

Select fullscreen device

-VICXRANDRfullmode <mode>

Select fullscreen mode

-VICvidmodefullmode <mode>

Select fullscreen mode

```

-saturation <0-2000>
    Set saturation of internal calculated palette [1000]
-contrast <0-2000>
    Set contrast of internal calculated palette [1000]
-brightness <0-2000>
    Set brightness of internal calculated palette [1000]
-gamma <0-4000>
    Set gamma of internal calculated palette [2200]
-tint <0-2000>
    Set tint of internal calculated palette [1000]
-oddlinesphase <0-2000>
    Set phase for color carrier in odd lines [1250]
-oddlinesoffset <0-2000>
    Set phase offset for color carrier in odd lines [750]
-crtblur <0-1000>
    Amount of horizontal blur for the CRT emulation. [500]
-crtscanlineshade <0-1000>
    Amount of scan line shading for the CRT emulation [667]

```

7.4.4 Changing memory configuration

It is possible to change the VIC20 memory configuration in two ways: by enabling and/or disabling certain individual memory blocks, or by choosing one among a few typical memory configurations. The former can be done by modifying resource values directly or from the right-button menu; the latter can only be done from the menu.

There are 5 RAM expansion blocks in the VIC20, numbered 0, 1, 2, 3 and 5:

- block 0 (3 Kbytes at \$0400-\$0FFF);
- block 1 (8 Kbytes at \$2000-\$3FFF);
- block 2 (8 Kbytes at \$4000-\$5FFF);
- block 3 (8 Kbytes at \$6000-\$7FFF);
- block 5 (8 Kbytes at \$A000-\$BFFF).

These blocks are called *expansion blocks* because they are not present a stock (“unexpanded”) machine. Each of them is associated to a boolean `RamBlockX` resource (where `X` is the block number) that specifies whether the block is enabled or not.

There are also some common memory configurations you can pick from the right-button menu:

- no RAM expansion blocks at all;
- all RAM expansion blocks enabled;
- 3K expansion (only block 0 is enabled);
- 8K expansion (only block 1 is enabled);
- 16K expansion (only blocks 1 and 2 are enabled);
- 24K expansion (only blocks 1, 2 and 3 are enabled).

7.4.4.1 VIC20 memory configuration resources

RAMBlock0
RAMBlock1
RAMBlock2
RAMBlock3
RAMBlock5

Booleans specifying whether RAM blocks 0, 1, 2, 3 and 5 must be enabled.

7.4.4.2 VIC20 memory configuration command-line options

-memory CONFIG

Specify memory configuration. It must be a comma-separated list of options, each of which can be one the following:

- **none** (no extension);
- **all** (all blocks);
- **3k** (3k space in block 0);
- **8k** (first 8k extension block);
- **16k** (first and second 8k extension blocks);
- **24k** (first, second and 3rd extension blocks);
- **0, 1, 2, 3, 5** (memory in respective blocks);
- **04, 20, 40, 60, A0** (memory at respective address).

For example,

```
xvic -memory none
```

gives an unexpanded VIC20. While

```
xvic -memory 60,a0
```

or

```
xvic -memory 3,5
```

enables memory in blocks 3 and 5, which is the usual configuration for 16k ROM modules.

7.4.5 VIC20 system ROM settings

These settings can be used to control what system ROMs are loaded in the VIC20 emulator at startup. They cannot be changed from the menus.

7.4.5.1 VIC20 system ROM resources

KernalName

String specifying the name of the Kernal ROM (default 'kernal').

BasicName

String specifying the name of the Basic ROM (default 'basic').

ChargenName

String specifying the name of the character generator ROM (default 'chargen').

GenericCartridgeFile2000
 GenericCartridgeFile4000
 GenericCartridgeFile6000
 GenericCartridgeFileA000
 GenericCartridgeFileB000

String specifying the name of the respective cartridge ROM images.

7.4.5.2 VIC20 system ROM command-line options

-kernal NAME

Specify 'NAME' as the Kernal ROM file (KernalName).

-basic NAME

Specify 'NAME' as the Basic ROM file (BasicName).

-chargen NAME

Specify 'NAME' as the character generator ROM file (ChargenName).

-cart2 NAME

-cart4 NAME

-cart6 NAME

-cartA NAME

-cartB NAME

Specify 'NAME' as the cartridge image to attach. (CartridgeFile2000,...,CartridgeFileB000).

7.4.6 VIC20 settings

7.4.6.1 VIC20 command-line options

-OEMjoy

+OEMjoy Enable/Disable the OEM userport joystick adapter

7.5 PLUS4-specific commands and settings

7.5.1 TED settings

7.5.1.1 TED command-line options

-TEDvcache

+TEDvcache

Enable/Disable the video cache

-TEDdsize

+TEDdsize

Enable/Disable double size

-TEDdscan

+TEDdscan

Enable/Disable double scan

-TEDscale2x

+TEDscale2x

Enable/Disable Scale2x filter

`-TEDhwscale`
`+TEDhwscale`
 Enable/Disable hardware scaling

`-TEDintpal`
 Use an internal calculated palette

`-TEDextpal`
 Use an external palette (file)

`-TEDpalette <name>`
 Specify name of file of external palette

`-TEDfulldevice <device>`
 Select fullscreen device

`-TEDXRANDRfullmode <mode>`
 Select fullscreen mode

`-TEDVidmodefullmode <mode>`
 Select fullscreen mode

`-saturation <0-2000>`
 Set saturation of internal calculated palette [1000]

`-contrast <0-2000>`
 Set contrast of internal calculated palette [1000]

`-brightness <0-2000>`
 Set brightness of internal calculated palette [1000]

`-gamma <0-4000>`
 Set gamma of internal calculated palette [2200]

`-tint <0-2000>`
 Set tint of internal calculated palette [1000]

`-oddlinesphase <0-2000>`
 Set phase for color carrier in odd lines [1250]

`-oddlinesoffset <0-2000>`
 Set phase offset for color carrier in odd lines [750]

`-crtblur <0-1000>`
 Amount of horizontal blur for the CRT emulation. [500]

`-crtscanlineshade <0-1000>`
 Amount of scan line shading for the CRT emulation [667]

7.5.2 PLUS4 I/O extension settings

7.5.2.1 PLUS4 I/O extension command-line options

`-digiblaster`
`+digiblaster`
 Enable/Disable the digiblaster add-on

```

-sidcart
+sidcart  Enable/Disable SID Cartridge
-sidcartjoy
+sidcartjoy
           Enable/Disable SID cartridge joystick
-speech
+speech   Enable/Disable the v364 speech add-on
-speechrom <name>
           Attach Speech ROM image

```

7.5.3 PLUS4 system ROM settings

7.5.3.1 PLUS4 system ROM command-line options

```

-functionlo <name>
            Specify name of Function low ROM image
-functionhi <name>
            Specify name of Function high ROM image
-c1lo <name>
            Specify name of Cartridge 1 low ROM image
-c1hi <name>
            Specify name of Cartridge 1 high ROM image
-c2lo <name>
            Specify name of Cartridge 2 low ROM image
-c2hi <name>
            Specify name of Cartridge 2 high ROM image

```

7.5.4 PLUS4 settings

7.5.4.1 PLUS4 command-line options

```

-ramsize <ramsize>
            Specify size of RAM installed in kb (16/32/64)
-h256k     Enable the HANNES 256K RAM expansion
-h1024k    Enable the HANNES 1024K RAM expansion
-h4096k    Enable the HANNES 4096K RAM expansion
-cs256k    Enable the CSORY 256K RAM expansion

```

7.6 PET-specific commands and settings

This section lists the settings and commands that are PET-specific and thus are not present in the other emulators.

7.6.1 Changing PET model settings

With `xpet`, it is possible to change at runtime the characteristics of the emulated PET so that it matches (or not) the ones of a certain PET model, and it is also possible to select from a common set of PET models so that all the features are selected accordingly.

The former is done by changing the following resources (via resource file, command line options or right-menu items):

<code>RamSize</code>	Size of memory in kByte. 96k denotes a 8096, 128k a 8296.
<code>IOSize</code>	Size of I/O area in Byte. Either 2048 or 256 for 8296.
<code>VideoSize</code>	The number of columns on the screen (40 or 80). A 0 auto-detects this from the ROM.
<code>Ram9</code>	The 8296 can map RAM into the address range \$9***
<code>RamA</code>	The 8296 can map RAM into the address range \$A***
<code>SuperPET</code>	This resource enables the SuperPET (MicroMainFrame 9000) I/O and disables the 8x96 mappings.
<code>Basic1</code>	If (by checksum) a version 1 kernal is detected, then the kernal ROM is patched to make the IEEE488 interface work.
<code>Basic1Chars</code>	Exchanges some character in the character ROM that have changed between the first PET 2001 and all newer versions.
<code>EoiBlank</code>	This resource enables the "blank screen on EOI" feature of the oldest PET 2001.
<code>DiagPin</code>	Set the diagnosis pin on the PET userport (see below).
<code>ChargenName</code>	Specify 'NAME' as the character generator ROM file
<code>KernalName</code>	Specify 'NAME' as the kernal ROM file. This file contains the complete BASIC, EDITOR and KERNAL ROMs and is either 16k (BASIC 1 and 2) or 20k (BASIC 4) in size.
<code>EditorName</code>	Specify 'NAME' as the editor ROM file. This file contains an overlay for the editor ROM at \$E000-\$E7FF if necessary.
<code>RomModule9Name</code>	Specify 'NAME' as the \$9*** Expansion ROM file. This file contains an expansion ROM image of 4k.
<code>RomModuleAName</code>	Specify 'NAME' as the \$A*** Expansion ROM file. This file contains an expansion ROM image of 4k.

RomModuleBName

Specify ‘NAME’ as the \$B*** Expansion ROM file. This file contains an expansion ROM image of 4k. This file overlays the lowest 4k of a BASIC 4 ROM.

Choosing a common PET model is done from the right-button menu instead, by choosing an item from the “Model defaults” submenu. Available models are:

- PET 2001-8N
- PET 3008
- PET 3016
- PET 3032
- PET 3032B
- PET 4016
- PET 4032
- PET 4032B
- PET 8032
- PET 8096
- PET 8296
- SuperPET

Notice that this will **reset the emulated machine**.

It is also possible to select the PET model at startup, with the `-model` command-line option: for example, ‘`xpet -model 3032`’ will emulate a PET 3032 while ‘`xpet -model 8296`’ will emulate a PET 8296.

7.6.2 CRTC Settings

7.6.2.1 CRTC resources

Crtc Enables CRTC 6545 emulation (all models from 40xx and above)

CrtcVideoCache

Boolean specifying whether the video cache is turned on.

CrtcDoubleSize

Boolean specifying whether double-size mode is turned on.

CrtcDoubleScan

Boolean specifying whether double-scan mode is turned on.

CrtcPaletteFile

String specifying the name of the palette file being used. The ‘.vpl’ extension is optional.

7.6.2.2 CRTC command-line options

`-Crtcvcache`

`+Crtcvcache`

Enable/Disable the video cache

`-Crtcdsize`
`+Crtcdsize`
 Enable/Disable double size

`-Crtcdscan`
`+Crtcdscan`
 Enable/Disable double scan

`-Crtcscale2x`
`+Crtcscale2x`
 Enable/Disable Scale2x filter

`-Crtchwscale`
`+Crtchwscale`
 Enable/Disable hardware scaling

`-Crtcintpal`
 Use an internal calculated palette

`-Crtcextpal`
 Use an external palette (file)

`-Crtcpalette NAME`
 Specify NAME as the palette file (`CrtcPaletteFile`).

`-Crtcfulldevice <device>`
 Select fullscreen device

`-CrtcXRANDRfullmode <mode>`
 Select fullscreen mode

`-CrtcVidmodefullmode <mode>`
 Select fullscreen mode

`-saturation <0-2000>`
 Set saturation of internal calculated palette [1000]

`-contrast <0-2000>`
 Set contrast of internal calculated palette [1000]

`-brightness <0-2000>`
 Set brightness of internal calculated palette [1000]

`-gamma <0-4000>`
 Set gamma of internal calculated palette [2200]

`-tint <0-2000>`
 Set tint of internal calculated palette [1000]

`-oddlinesphase <0-2000>`
 Set phase for color carrier in odd lines [1250]

`-oddlinesoffset <0-2000>`
 Set phase offset for color carrier in odd lines [750]

`-crtblur <0-1000>`
 Amount of horizontal blur for the CRT emulation. [500]

-crtscanlineshade <0-1000>

Amount of scan line shading for the CRT emulation [667]

7.6.3 The PET diagnostic pin

It is possible to enable or disable emulation of the PET diagnostic pin via the `DiagPin` resource, or the “PET userport diagnostic pin” item in the right-button menu.

When the diagnostic pin is set, the Kernal does not try to initialize the BASIC, but directly jumps into the builtin machine monitor.

7.6.4 PET command line options

These are the commandline options specific for the CBM-II models.

-model MODEL

Specify the PET model you want to emulate.

-kernal NAME

Specify ‘NAME’ as the Kernal/BASIC ROM file (`KernalName`).

-editor NAME

Specify ‘NAME’ as the editor ROM file (`EditorName`).

-chargen NAME

Specify ‘NAME’ as the character generator ROM file (`ChargenName`).

-rom9 NAME, **-romA** NAME, **-romB** NAME

Specify ‘NAME’ as the ROM image file for the respective cartridge areas (`RomModule9Name`, `RomModuleAName`, `RomModuleBName`).

-petram9, **+petram9**

Switch on RAM mapping on addresses \$9000-\$9fff (`Ram9`).

-petramA, **+petramA**

Switch on RAM mapping on addresses \$a000-\$afff (`RamA`).

-superpet, **+superpet**

Enable/Disable SuperPET I/O emulation (`SuperPET`).

-basic1, **+basic1**

Enable/Disable patching the IEEE488 section of the PET2001 ROM when detected (`Basic1`).

-basic1char, **+basic1char**

Enable/Disable PET 2001 character generator (`Basic1Chars`).

-eoiblack, **+eoiblack**

Enable/Disable EOI blanking the screen (`EoiBlank`).

-diagpin

+diagpin Enable (`DiagPin=1`) or disable (`DiagPin=0`) the diagnostic pin at the PET userport.

-petreu

+petreu Enable or disable the PET Memory Expansion Unit.

-petreuimage <name>
Specify name of PET Ram and Expansion Unit image

-petreuramsize <size in KB>
Size of the PET Ram and Expansion Unit

-userportdac, +userportdac
Enable or disable the userport DAC.

-petdww
+petdww Enable/Disable the PET DWW hi-res board

-petdwwimage <name>
Specify name of PET DWW image

-sidcart
+sidcart Enable/Disable SID Cartridge

7.6.5 Changing screen colors

It is also possible to choose what color set is used for the emulation window. This is done by specifying a palette file name (see [Section 4.3 \[Palette files\], page 20](#)) in the `PaletteName` resource. The menu provides the following values:

- `green.vpl` (default, “green”), the good old green-on-black feeling;
- `amber.vpl` (“amber”), an amber phosphor lookalike;
- `white.vpl` (“white”), simple white-on-black palette.

7.7 CBM-II-specific commands and settings

This section lists the settings and commands that are CBM-II-specific and thus are not present in the other emulators.

7.7.1 Changing CBM-II model

With `xcbm2`, it is possible to change at runtime the characteristics of the emulated CBM so that it matches (or not) the ones of a certain CBM model, and it is also possible to select from a common set of CBM models so that all the features are selected accordingly.

The former is done by changing the following resources (via resource file, command line options or right-menu items):

UseVicII Whether to use VIC-II for video output (value 1) or the CRTC for the other machines (value 0)

RamSize Size of memory in kByte. Possible values are 128, 256, 512 and 1024

Ram08, Ram1, Ram2, Ram4, Ram6, RamC

Expanded CBM-II models could map RAM to the expansion ROM areas at \$0800-\$0fff, \$1000-\$1fff, \$2000-\$3FFF, \$4000-\$5FFF, \$6000-\$7FFF and \$c000-\$cfff respectively.

Cart2Name, Cart4Name, Cart6Name

Specify ‘NAME’ as the \$2000-\$3FFF, \$4000-\$5FFF or \$6000-\$6FFF Expansion ROM file. This file contains an 8k ROM dump.

ModelLine

The CBM-II business models have two hardcoded lines at one of the I/O ports. From those lines the kernal determines how it should init the CRTC video chip for either 50Hz (Europe) or 60Hz (North America), and either for 8 (C6x0) or 14 (C7x0) scanlines per character. 0 = CBM 7x0 (50Hz), 1 = 60Hz C6x0, 2 = 50Hz C6x0).

Choosing a common CBM-II model is done from the right-button menu instead, by choosing an item from the “Model defaults” submenu. Available models are:

- C510 (128k RAM)
- C610 (128k RAM)
- C620 (256k RAM)
- C620+ (1024k RAM, expanded)
- C710 (128k RAM)
- C720 (256k RAM)
- C720+ (1024k RAM, expanded)

Notice that this will **reset the emulated machine**.

Warning: At this time switching between 510 and other machines during runtime is not supported and will not work.

It is also possible to select the CBM model at startup, with the `-model` command-line option: for example, `'xcbm2 -model 610'` will emulate a CBM 610 while `'xcbm2 -model 620'` will emulate a CBM 620. Notably this is the only way to start a C510 emulation, with `-model 510`.

7.7.2 CBM-II command line options

These are the commandline options specific for the CBM-II models.

- `-ramsize <ramsize>`
Specify size of RAM (64/128/256/512/1024 kByte)
- `-usevicii`
`+usevicii`
Specify whether to use (`-usevicii`) or not to use (`+usevicii`) the VIC-II emulation.
- `-kernal NAME`
Specify 'NAME' as the Kernal ROM file (`KernalName`).
- `-basic NAME`
Specify 'NAME' as the Basic ROM file (`BasicName`).
- `-chargen NAME`
Specify 'NAME' as the character generator ROM file (`ChargenName`).
- `-cart1 <name>`
Specify 'NAME' as the ROM image file for the cartridge area \$1000-\$1FFF (`Cart1Name`).
- `-cart2 <name>`
Specify 'NAME' as the ROM image file for the cartridge area \$2000-\$3fff (`Cart2Name`).

-cart4 <name>
Specify ‘NAME’ as the ROM image file for the cartridge area \$4000-\$5fff (Cart4Name).

-cart6 <name>
Specify ‘NAME’ as the ROM image file for the cartridge area \$6000-\$7fff (Cart6Name).

-ram08
+ram08 Enable/Disable RAM mapping in bank 15 on addresses \$0800-\$0FFF resp (Ram08).

-ram1
+ram1 Enable/Disable RAM mapping in bank 15 on addresses \$1000-\$1FFF resp (Ram1).

-ram2
+ram2 Enable/Disable RAM mapping in bank 15 on addresses \$2000-\$3FFF resp (Ram2).

-ram4
+ram4 Enable/Disable RAM mapping in bank 15 on addresses \$4000-\$5FFF resp (Ram4).

-ram6
+ram6 Enable/Disable RAM mapping in bank 15 on addresses \$6000-\$7FFF resp (Ram6).

-ramC
+ramC Enable/Disable RAM mapping in bank 15 on addresses \$C000-\$CFFF resp (RamC).

-modelline
Define the hardcoded model switch in the CBM-II models.

7.7.3 Changing screen colors

It is also possible to choose what color set is used for the emulation window. This is done by specifying a palette file name (see [Section 4.3 \[Palette files\], page 20](#)) in the `PaletteName` resource. The menu provides the following values:

- `green.vpl` (default, “green”), the good old green-on-black feeling;
- `amber.vpl` (“amber”), an amber phosphor lookalike;
- `white.vpl` (“white”), simple white-on-black palette.

7.8 VSID-specific commands and settings

7.8.1 VSID settings

7.8.1.1 VSID command-line options

-vsid SID player mode (x64 only).

-keepenv Override PSID settings for Video standard and SID model

`-tune <number>`
Specify PSID tune <number>

8 Snapshots

Every VICE emulator has a built-in snapshot feature, that saves the complete emulator state into one file for later use. You can therefore save the emulator state - including the state of the game you are playing for example - in a single file.

8.1 Snapshot usage

A snapshot is one file containing the complete emulator state. A snapshot file can be generated by selecting the “Save snapshot” command at any time. This will pop up a requester from which you can specify whether the snapshot should also contain the disk and ROM status.

A snapshot file can be used to restore the emulator state by selecting the **load snapshot** menu entry at any time. Unfortunately attached ROM images/cartridges are only supported in the VIC20, the PET and the CBM-II emulators at this time.

The memory configuration of the emulator is saved in the snapshot file as well. This configuration is restored when the snapshot is loaded.

A quick snapshot can now be made by pressing the **M-F11** key and reloaded by pressing the **M-F10** key.

8.2 Snapshot format

A snapshot file consists of several modules of mostly different types. Each module has a name and saves the state of an entity like a CIA, the CPU, or the memory.

8.2.1 Emulator modules

This section lists the modules that are contained in each of the emulators snapshot files.

8.2.1.1 x64 modules

The modules in the x64 emulator are:

Name	Type	Description
MAINCPU	6502	The Main CPU - although it is a 6510, only the 6502 core is saved here
C64MEM	Memory	Holds the RAM contents of the C64. Also the CPU I/O register contents are saved here.
C64ROM	ROM images	Dump of the system ROMs
VIC-II	656*	The VIC-II of the C64/128
CIA1	6526	The CIA for the interrupts and the keyboard
CIA2	6526	The CIA for the userport, IEC-bus and RS232.
SID	6581	The SID sound chip of the C64/C128

REU*		The RAM Extension Unit state (optional)
ACIA1	6551	An ACIA (RS232 interface) at \$DE00 (optional)
TPI	6525	A TPI at \$DF00 for a parallel IEEE488 interface (optional)
*	Drive modules	The emulated drive(s) have their own modules see Section 8.2.1.6 [Drive modules] , page 89

Some of the modules are optional and are only saved if the specific feature is enabled at save-time. If the module is found when restoring the state the optional features are enabled, and disabled otherwise.

8.2.1.2 x128 modules

The modules in the x128 emulator are:

Name	Type	Description
MAINCPU	6502	The Main CPU - although it is a 6510, only the 6502 core is saved here
C128MEM	Memory	Holds the RAM contents of the C64. Also the CPU I/O register contents are saved here.
C128ROM	ROM images	Dump of the system ROMs
VIC-II	656*	The VIC-II of the C64/128
CIA1	6526	The CIA for the interrupts and the keyboard
CIA2	6526	The CIA for the userport, IEC-bus and RS232.
SID	6581	The SID sound chip of the C64/C128
ACIA1	6551	An ACIA at \$DE00 (optional)
TPI	6525	A TPI at \$DF00 for a parallel IEEE488 interface (optional)
*	Drive modules	The emulated drive(s) have their own modules see Section 8.2.1.6 [Drive modules] , page 89

Some of the modules are optional and are only saved if the specific feature is enabled at save-time. If the module is found when restoring the state the optional features are enabled, and disabled otherwise.

Not yet supported are the 80 column video chip, cartridges and RAM expansion unit.

8.2.1.3 xvic modules

The modules in the xvic emulator are:

Name	Type	Description
MAINCPU	6502	The Main CPU
VIC20MEM	Memory	Holds the RAM contents of the VIC20.
VIC20ROM	ROM images	Holds the ROM images of the VIC20, including possibly attached cartridges

VIC-I	656*	The VIC-I of the VIC20
VIA1	6522	The VIA for the interrupts and the keyboard
VIA2	6522	The VIA for the userport, IEC-bus and RS232.
*	Drive modules	The emulated drive(s) have their own modules see Section 8.2.1.6 [Drive modules] , page 89

8.2.1.4 xpet modules

The modules in the xpet emulator are:

Name	Type	Description
MAINCPU	6502	The Main CPU
PETMEM	Memory	Holds the RAM contents of the PET.
PETROM	ROM images	Holds the ROM images of the PET, including possibly attached cartridges
CRTC	6545	The CRTC of the PET. This is also included if it is a dump of a PET without CRTC, because the video state is saved here anyway.
PIA1	6520	The PIA for the interrupts, tape and the keyboard
PIA2	6520	The PIA for the IEEE488-bus
VIA	6522	The VIA for IEEE488, userport, sound
ACIA1	6551	The ACIA for the SuperPET. This module is optional.
*	Drive modules	The emulated drive(s) have their own modules see Section 8.2.1.6 [Drive modules] , page 89

8.2.1.5 xcbm2 modules

The modules in the xcbm2 emulator are:

Name	Type	Description
MAINCPU	6502	The Main CPU - although it is a 6509, only the 6502 core is saved here
CBM2MEM	Memory	Holds the RAM contents of the CBM-II models. Also holds the exec-bank and indirection bank registers
C500DATA		Holds additional state information necessary for the C500 (e.g. cycles till the next IRQ)
CBM2ROM	Memory	optional. Holds the ROM images.
CRTC	6545	The video chip for the C6*0 and C7*0 models (only those models).

VIC-II	656?	The video chip for the C5*0 models (only the C5*0 models).
CIA1	6526	The CIA for IEEE 488 and userport.
TPI1	6525	TPI 1 for IEEE488
TPI2	6525	TPI 2 for interrupts and keyboard.
ACIA1	6551	The RS232 interface
SID	6581	The CBM2s SID sound chip
*	Drive modules	The emulated drive(s) have their own modules see Section 8.2.1.6 [Drive modules] , page 89

The snapshot either contains CRTC or VIC-II snapshot modules, but not both. Currently switching between the two video emulations is not possible at runtime, so only snapshots that fit the current UseVicII resource are accepted.

8.2.1.6 Drive modules

The modules for the real disk drive emulation are included in the emulator when the emulation is enabled during the writing of the snapshot.

Name	Type	Description
*CPU	6502	The Drive 0 CPU
*	*	*

8.2.2 Module formats

This section shows the basic module framework and the contents of the different types of modules.

The single chip modules contain the **chip** state, not the state of the emulator. We tried to make the format as implementation-independent as possible, to allow reuse of snapshots in later versions of this emulator, or even in other emulators.

8.2.2.1 Terminology

In this section we use certain abbreviations to define the types of the data saved in the snapshot.

BYTE	8 bit integer.
WORD	16 bit integer. Saved with low-byte first, high-byte last.
DWORD	32 bit integer. Saved with low-word first, then high-word. Each word saved with its low-byte first.
ARRAY	Array of BYTE values. Length depends on the description.

The tables for the single modules state the type, name and description of the data saved in the modules. The data is saved in the order it is in the tables, so no offset is given.

8.2.2.2 Module framework

The VICE snapshot file starts with the magic string and includes the fileformat version number.

Type	Name	Description
------	------	-------------

19 BYTE	MAGIC	"VICE Snapshot File\032", padded with 0
BYTE	VMAJOR	fileformat major version number
BYTE	VMINOR	fileformat minor version number
16 BYTE	MACHINENAME	Name of emulated machine, like "PET", "CBM-II", "VIC20", "C64" or "C128". zerobyte-padded.

The file header is followed by a number of different snapshot modules.

Each module has a header with the information given in the table below. The header includes two version numbers, VMAJOR and VMINOR. Modules with the same VMAJOR should be able to be exchanged. I.e. higher VMINOR numbers only append to the data for lower VMINOR. This additional data is ignored by older restore routines. The other way around newer restore routines must accept the fewer info from lower VMINOR dumps. Changes in VMAJOR might introduce any incompatibility you like, but that's what VMAJOR is for after all :-)

Type	Name	Description
16 BYTE	MODULENAME	The name of the module in ASCII, padded with 0 to 16 byte.
BYTE	VMAJOR	major version number
BYTE	VMINOR	minor version number
DWORD	SIZE	size of the module, including this header

8.2.2.3 CPU module

This module saves the core 6502 state. You will find a clock value there. All other modules save their own clock values relative to this value. However, the drive modules save their clocks relative to their appropriate CPUs of course.

Warning: This module is still under construction and saves some information that is not sure to be VICE-independent. If in doubt, read the source.

Type	Name	Description
DWORD	CLK	the current CPU clock value. All other clock values are relative to this.
BYTE	AC	Accumulator
BYTE	XR	X index register
BYTE	YR	Y index register
BYTE	SP	Stack Pointer
WORD	PC	Programm Counter
BYTE	ST	Status Registers
DWORD	LASTOPCODE	?
DWORD	IRQCLK	absolute CLK when the IRQ line came active
DOWRD	NMICLK	absolute CLK when the NMI line came active
DWORD	?	?
DWORD	?	?

8.2.2.4 CIA module

The CIA 6526 is an I/O port chip with 2 8-bit I/O ports, a shift register, two timers, a Time of Day clock and interrupts.

Version numbers: Major 1, Minor 1.

Type	Name	Description
BYTE	ORA	Output register A
BYTE	ORB	Output register B
BYTE	DDRA	Data direction register A
BYTE	DDRB	Data direction register B
WORD	TAC	Timer A counter value
WORD	TBC	Timer B counter value
BYTE	TOD_TEN	Time of Day - current tenth of second
BYTE	TOD_SEC	Time of Day - current seconds
BYTE	TOD_MIN	Time of Day - current minutes
BYTE	TOD_HR	Time of Day - current hours
BYTE	SDR	contents of shift register
BYTE	IER	mask of enabled interrupt masks
BYTE	CRA	Control register A
BYTE	CRB	Control register B
WORD	TAL	Timer A latch value
WORD	TBL	Timer B latch value
BYTE	IFR	mask of currently active interrupts
BYTE	PBSTATE	Bit 6/7 reflect the PB6/7 toggle bit state. Bit 2/3 reflect the corresponding port bit state.
BYTE	SRHBITS	number of half-bits to still shift in/out SDR
BYTE	ALARM_TEN	Time of Day - alarm tenth of second
BYTE	ALARM_SEC	Time of Day - alarm seconds
BYTE	ALARM_MIN	Time of Day - alarm minutes
BYTE	ALARM_HR	Time of Day - alarm hours
BYTE	READICR	current clock minus the clock when ICR was read last plus 128.
BYTE	TODLATCHED	Bit 0: 1= latched for reading, Bit 1: 2=stopped for writing
BYTE	TODL_TEN	Time of Day - latched tenth of second
BYTE	TODL_SEC	Time of Day - latched seconds
BYTE	TODL_MIN	Time of Day - latched minutes
BYTE	TODL_HR	Time of Day - latched hours
DWORD	TOD_TICKS	clk ticks till next tenth of second
—	—	The next items have been added in V1.1
WORD	TASTATE	The state bits of the CIA timer A, according to ciatimer.h
WORD	TBSTATE	The state bits of the CIA timer B, according to ciatimer.h

The last two items have been added in CIA snapshot version 1.1 due to the improved CIA emulation in the newer VICE versions. Some state bits correspond to the CIA state as described in the "A Software Model of the CIA 6526" document by Wolfgang Lorenz, some are delayed versions. For more read the source file `ciatimer.h`.

8.2.2.5 VIA module

The VIA 6522 is the predecessor of the CIA and also an I/O port chip with 2 8-bit I/O ports, a shift register, two timers and interrupts.

Version numbers: Major 1, Minor 0.

Type	Name	Description
BYTE	ORA	Output register A
BYTE	DDRA	Data direction register A
BYTE	ORB	Output register B
BYTE	DDRB	Data direction register B
WORD	T1L	Timer 1 Latch value
WORD	T1C	Timer 1 counter value
BYTE	T2L	Timer 2 latch (8 bit as only lower byte is used)
WORD	T2C	Timer 2 counter value
BYTE	RUNFL	bit 7: timer 1 will generate IRQ on underflow; bit 6: timer 2 will generate IRQ on underflow
BYTE	SR	Shift register value
BYTE	ACR	Auxiliary control register
BYTE	PCR	Peripheral control register
BYTE	IFR	active interrupts
BYTE	IER	interrupt mask
BYTE	PB7	bit 7 = pb7 state
BYTE	SRHBITS	number of half-bits to shift out on SR
BYTE	CABSTATE	bit 7: state of CA2 pin, bit 6: state of CB2 pin
BYTE	ILA	Port A Input Latch (see ACR bit 0)
BYTE	ILB	Port B Input Latch (see ACR bit 1)

8.2.2.6 PIA module

The PIA 6520 is a chip with two I/O ports (Parallel Interface Adapter) and four additional handshake lines. The chip is pretty the same for Port A and B, only that Port A implements handshake on read operation and port B on write operation.

Version numbers: Major 1, Minor 0.

Type	Name	Description
UBYTE	ORA	Output register A
UBYTE	DDRA	Data Direction Register A
UBYTE	CTRLA	Control Register A
UBYTE	ORB	Output register B
UBYTE	DDRB	Data Direction Register B

UBYTE	CTRLB	Control Register B
UBYTE	CABSTATE	Bit 7 = state of CA2, Bit 6 = state of CB2

8.2.2.7 TPI module

The TPI 6525 is a chip with three I/O ports (Tri-Port-Interface). One of the ports can double as an interrupt prioritizer. Therefore we also have to save the states of the interrupt stack etc.

Version numbers: Major 1, Minor 0.

Type	Name	Description
BYTE	PRA	Port A output register
BYTE	PRB	Port B output register
BYTE	PRC	Port C output register (doubles as IRQ latch register)
BYTE	DDRA	Port A data direction register
BYTE	DDRB	Port B data direction register
BYTE	DDRC	Port C data direction register (doubles as IRQ mask register)
BYTE	CR	Control Register
BYTE	AIR	Active interrupt register
BYTE	STACK	Interrupt stack - the interrupt bits that are not (yet) served.
BYTE	CABSTATE	State of CA/CB pins. Bit 7 = state of CA, Bit 6 = state of CB

8.2.2.8 RIOT module

The RIOT 6532 is a chip with two I/O ports, some RAM and a Timer. The chip contains 128 byte RAM, but the RAM is not saved in the RIOT snapshot, but in the memory section.

Warning: This module is still under construction

Version numbers: Major 0, Minor 0.

Type	Name	Description
BYTE	ORA	Port A output register
BYTE	DDRA	Port A data direction register
BYTE	ORB	Port B output register
BYTE	DDRB	Port B data direction register
BYTE	EDGECTRL	Bit 0/1: A0/A1 address bits written to edgecontrol registers
BYTE	IRQFL	Bit 6/7: A6/A7 IRQ flag register. Bit 0: state of the IRQ line (0=inactive, 1=active)
BYTE	N	timer value
WORD	DIVIDER	Pre-scale divider value (1, 8, 64, or 1024)
WORD	REST	cycles since the last counter change
BYTE	IRQEN	Bit 0: 0= timer IRQ disabled, 1= timer IRQ enabled

8.2.2.9 SID module

Warning: This module is still under construction.

8.2.2.10 ACIA module

The ACIA 6551 is an RS232 interface chip. VICE emulates RS232 connections via `/dev/ttyS*` (Unix) or `COM:` (DOS/WIN - not yet?). When saving a snapshot, those connections are of course lost. The state of the ACIA however is restored if possible. I.e. if a connection is already open when restoring the snapshot, this connection is used instead. If no connection is open, a carrier/DTR drop is emulated.

Version numbers: Major 1, Minor 0.

Type	Name	Description
BYTE	TDR	Transmit Data Register
BYTE	RDR	Receiver Data Register
BYTE	SR	Status Register
BYTE	CMD	Command Register
BYTE	CTRL	Ctrl Register
BYTE	INTX	0 = no data to tx; 1 = Data is being transmitted; 2 = Data is being transmitted while data in TDR waiting to be put to internal transmit register
DWORD	TICKS	Clock ticks till the next TDR empty interrupt

8.2.2.11 VIC-I module

Warning: This module is still under construction.

8.2.2.12 VIC-II module

Warning: This module is still under construction.

8.2.2.13 CRTC module

Warning: After VICE version 1.0 the CRTC emulation has improved considerably. Especially it is now cycle exact. Therefore a lot more variables must be saved. The snapshot module version jumped from 0.0 to 1.0. Newer versions of VICE can read the old snapshots, but older versions (1.0 and below) cannot read the new snapshots.

Warning: This module is still under construction. Especially the `RASTERY` and `RASTERLINE` values might be bogus.

Version numbers: Major 1, Minor 1.

Type	Name	Description
		Hardware options
WORD	VADDR_MASK	Mask of the address bits valid when accessing the video memory
WORD	VADDR_CHARSWITCH	If one bit in the video address is used to switch the character generator, it is masked here.

WORD	VADDR_CHAROFFSET	The offset in characters in the character generator that CHARSWITCH switches.
WORD	VADDR_REVSWITCH	If one bit in the video address inverts the screen, it is masked here.
WORD	CHARGEN_MASK	size of character generator in byte - 1
WORD	CHARGEN_OFFSET	offset given by external circuitry
BYTE	HW_CURSOR	external hardware cursor circuitry enabled
BYTE	HW_COLS	number of displayed columns during one character clock cycle
BYTE	HW_BLANK	set if the hardware blank feature is available
20	REGISTERS	CRTC register
BYTE		register DUMP of the CRTC registers 0-19.
		CRTC internal registers
BYTE	REGNO	The current index in the CRTC register file
BYTE	CHAR	The current cycle within the current rasterline
BYTE	CHARLINE	The current character line
BYTE	YCOUNTER	The current rasterline in the character
BYTE	CRSRCNT	Framecounter for the blinking cursor
BYTE	CRSRSTATE	if set the hardware cursor is visible
BYTE	CRSRLINES	set if ycounter is within the active cursor rasterlines for a char
WORD	CHARGEN_REL	relative base of currently used character generator in ROM (in byte)
WORD	SCREEN_REL	screen address to load the counter at the beginning of the next rasterline
WORD	VSUNC	number of rasterlines left within vsync; 0 = not in vsync
BYTE	VENABLE	vertical enable flipflop; 1= display, 0= blank.
		(VICE-dependent?) variables
WORD	SCREEN_WIDTH	width of the current display window
WORD	SCREEN_HEIGHT	height of the current display window
WORD	SCREEN_XOFFSET	x position where the first character in a line starts in the window...
WORD	HJITTER	...but only after adding this jitter
WORD	SCREEN_YOFFSET	x position where the first character in a line starts in the window...
WORD	FRAMELINES	expected number of rasterlines for the current frame
WORD	CURRENT_LINE	current rasterline as seen from the CRTC This value has been added in module version V1.1

BYTE FLAG Bit 0: If 1 then bit in VADDR.REVSWITCH must be set for reverse; if 0 then bit must be cleared for reverse.

Here is the reference for the previous CRTC snapshot module. It is outdated and will not be read by this and later versions of VICE.

Version numbers: Major 0, Minor 0.

Type	Name	Description
BYTE	RASTERY	The number of clock cycles from rasterlines start
WORD	RASTERLINE	The current rasterline
WORD	ADDRMASK	The address mask valid for the CRTC. All memory accesses are masked with this value
BYTE	HWFLAG	Bit 0: 1= hardware cursor available. Bit 1: 1= number of columns is doubled by external hardware
20 BYTE	REGISTERS	register DUMP of the CRTC registers 0-19.
BYTE	CRSRSTATE	Hardware cursor: Bits 0-3: frame counter till next crsr line toggle. Bit 7: 1= cursor line active

8.2.2.14 C64 memory module

The C64 memory module actually consists of two modules. The "C64MEM" module is mandatory and contains the RAM dump. The "C64ROM" module is optional and contains a dump of the ROM images.

The size of the C64 memory modules differs with each different memory configuration. The RAM configuration is saved in the snapshot, and restored when the snapshot is loaded. The attached cartridges are **not yet(!)** saved and not yet restored upon load.

Version numbers: Major 0, Minor 0

The C64MEM module

Type	Name	Description
BYTE	CPUDATA	CPU port data byte
BYTE	CPUDIR	CPU port direction byte
BYTE	EXROM	state of the EXROM line (?)
BYTE	GAME	state of the GAME line (?)
ARRAY	RAM	64k RAM dump

The C64ROM module

Type	Name	Description
ARRAY	KERNAL	8k dump of the kernal ROM
ARRAY	BASIC	8k dump of the basic ROM
ARRAY	CHARGEN	4k dump of the chargen ROM

8.2.2.15 C128 memory module

The C128 memory module actually consists of two modules. The "C128MEM" module is mandatory and contains the RAM dump. The "C128ROM" module is optional and contains a dump of the ROM images.

The size of the C128 memory modules differs with each different memory configuration. The RAM configuration is saved in the snapshot, and restored when the snapshot is loaded. The attached cartridges are also restored upon load if they have been saved in the snapshot.

Version numbers: Major 0, Minor 0

The C128MEM module

Type	Name	Description
12 BYTE	MMU	dump of the 12 MMU registers
ARRAY	RAM	128k RAM dump banks 0 and 1

The C128ROM module

Type	Name	Description
ARRAY	KERNAL	8k dump of the kernal ROM
ARRAY	BASIC	32k dump of the basic ROM
ARRAY	EDITOR	4k dump of the editor ROM
ARRAY	4k CHARGEN	dump of the chargen ROM

8.2.2.16 VIC20 memory module

The VIC20 memory module actually consists of two modules. The "VIC20MEM" module is mandatory and contains the RAM dump. The "VIC20ROM" module is optional and contains a dump of the ROM images.

The size of the VIC20 memory modules differs with each different memory configuration. The RAM configuration is saved in the snapshot, and restored when the snapshot is loaded. The attached cartridges are also restored upon load if they have been saved in the snapshot.

The VIC20MEM module

Version numbers: Major 1, Minor 0

Type	Name	Description
BYTE	CONFIG	Configuration register. Bits 0,1,2,3,5 reflect if the corresponding memory block is RAM (bit=1) or not (bit=0).
ARRAY	RAM0	1k RAM dump \$0000-\$03ff
ARRAY	RAM1	4k RAM dump \$1000-\$1fff
ARRAY	COLORRAM	2k Color RAM, \$9400-\$9bff
ARRAY	BLK0	if CONFIG & 1 then: 3k RAM dump \$0400-\$0fff
ARRAY	BLK1	if CONFIG & 2 then: 8k RAM dump \$2000-\$3fff
ARRAY	BLK2	if CONFIG & 4 then: 8k RAM dump \$4000-\$5fff
ARRAY	BLK3	if CONFIG & 8 then: 8k RAM dump \$6000-\$7fff

ARRAY BLK5

if CONFIG & 32 then: 8k RAM dump
\$a000-\$bfff

The VIC20ROM module

Version numbers: Major 1, Minor 1

Type	Name	Description
BYTE	CONFIG	Bit 0: 1= ROM block \$2*** enabled. Bit 1: 1= ROM block \$3*** enabled. Bit 2: 1= ROM block \$4*** enabled. Bit 3: 1= ROM block \$5*** enabled. Bit 4: 1= ROM block \$6*** enabled. Bit 5: 1= ROM block \$7*** enabled. Bit 6: 1= ROM block \$A*** enabled. Bit 7: 1= ROM block \$B*** enabled.
ARRAY	KERNAL	8k KERNAL ROM image \$e000-\$ffff
ARRAY	BASIC	16k BASIC ROM image \$c000-\$dfff
ARRAY	CHARGEN	4k CHARGEN ROM image
ARRAY	BLK1A	4k ROM image \$2*** (if CONFIG & 1)
ARRAY	BLK1B	4k ROM image \$3*** (if CONFIG & 2)
ARRAY	BLK3A	4k ROM image \$6*** (if CONFIG & 16)
ARRAY	BLK3B	4k ROM image \$7*** (if CONFIG & 32)
ARRAY	BLK5A	4k ROM image \$A*** (if CONFIG & 64)
ARRAY	BLK5B	4k ROM image \$B*** (if CONFIG & 128)
ARRAY	BLK2A	4k ROM image \$4*** (if CONFIG & 4; added in V1.1)
ARRAY	BLK2B	4k ROM image \$5*** (if CONFIG & 8; added in V1.1)

8.2.2.17 PET memory module

The PET memory module actually consists of two modules. The "PETMEM" module is mandatory and contains the RAM dump. The "PETROM" module is optional and contains a dump of the ROM images.

The size of the PET memory modules differs with each different memory configuration. The RAM configuration is saved in the snapshot, and restored when the snapshot is loaded.

The PETMEM module

Version numbers: Major 1, Minor 2

Type	Name	Description
BYTE	CONFIG	Configuration value. Bits 0-3: 0= 40 col PET without CRTC; 1= 40 col PET with CRTC; 2 = 80 col PET (with CRTC); 3= SuperPET; 4= 8096; 5= 8296. Bit 6: 1= RAM at \$9***. Bit 7: 1= RAM at \$A***.
BYTE	KEYBOARD	Keyboard type. 0= UK business; 1= Graphics; 2= German business
BYTE	MEMSIZE	memory size of low 32k in k (possible values 4, 8, 16, 32)

BYTE	CONF8X96	Value of the 8x96 configuration register
BYTE	SUPERPET	SuperPET config. Bit 0: 1= \$9*** RAM enabled. Bit 1: 1= RAM write protected. Bit 2: 1= CTRL register write protected. Bit 3: 0= DIAG pin active. Bits 4-7: RAM block in use.
ARRAY	RAM	4-32k RAM (not 8296, size depends on MEMSIZE)
ARRAY	VRAM	2/4k RAM (not 8296, size depends on CONFIG)
ARRAY	EXTRAM	64k expansion RAM (SuperPET and 8096 only)
ARRAY	RAM	128k RAM (8296 only)
—	—	The following item has been added in V1.1
BYTE	POSITIONAL	bit 0=0 = symbolic keyboard mapping, bit 0=1 = positional mapping.
—	—	The following item has been added in V1.1
BYTE	EOIBLANK	bit 0=0 = EOI does not blank screen, bit 0=1 = EOI blanks screen.

The last item has been added in PETMEM snapshot version 1.1. It is ignored by earlier restore routines (V1.0) and the V1.1 restore routines do not change the current setting when reading a V1.0 snapshot.

In V1.2 the new EOIBLANK variable has been added. This implements the "blank screen on EOI" feature that was previously linked to a wrong resource.

The PETROM module

Version numbers: Major 1, Minor 0

Type	Name	Description
BYTE	CONFIG	Bit 0: 1= \$9*** ROM included. Bit 1: 1= \$A*** ROM included. Bit 2: 1= \$B*** ROM included. Bit 3: 1= \$e900-\$efff ROM included
ARRAY	KERNAL	4k KERNAL ROM image \$f000-\$ffff
ARRAY	EDITOR	2k EDITOR ROM image \$e000-\$e7ff
ARRAY	CHARGEN	2k CHARGEN ROM image
ARRAY	ROM9	4k \$9*** ROM image (if CONFIG & 1)
ARRAY	ROMA	4k \$A*** ROM image (if CONFIG & 2)
ARRAY	ROMB	4k \$B*** ROM image (if CONFIG & 4)
ARRAY	ROMC	4k \$C*** ROM image
ARRAY	ROMD	4k \$D*** ROM image
ARRAY	ROME9	7 blocks \$e900-\$efff ROM image (if CONFIG & 8)

8.2.2.18 CBM-II memory module

The CBM-II memory module actually consists of two modules. The "CBM2MEM" module is mandatory and contains the RAM dump. The "CBM2ROM" module is optional and contains a dump of the ROM images.

The size of the CBM-II memory modules differs with each different memory configuration. The RAM configuration is saved in the snapshot, and restored when the snapshot is loaded.

Version numbers: Major 1, Minor 0

The CBM2MEM module

Type	Name	Description
UBYTE	MEMSIZE	Memory size in 128k blocks (1=128k, 2=256k, 4=512k, 8=1024k)
UBYTE	CONFIG	Bit 0 = \$f0800-\$f0fff RAM, Bit 1 = \$f1000-\$f1fff RAM, Bit 2 = \$f2000-\$f3fff RAM, Bit 3 = \$f4000-\$f5fff RAM, Bit 4 = \$f6000-\$f7fff RAM, Bit 5 = \$fc000-\$fcfff RAM, Bit 6 = is a C500
UBYTE	HWCONFIG	Bit 0/1: model line configuration
UBYTE	EXECBANK	CPUs execution bank register
UBYTE	INDBANK	CPUs indirection bank register
ARRAY	SYSRAM	2k system RAM \$f0000-\$f07ff
ARRAY	VIDEO	2k video RAM \$fd000-\$fd7ff
ARRAY	RAM	RAM dump, size according to MEMSIZE
ARRAY	RAM08	if memsize < 1M and CONFIG & 1 : 2k RAM \$f0800-\$f0fff
ARRAY	RAM1	if memsize < 1M and CONFIG & 2 : 4k RAM \$f1000-\$f1fff
ARRAY	RAM2	if memsize < 1M and CONFIG & 4 : 8k RAM \$f2000-\$f3fff
ARRAY	RAM4	if memsize < 1M and CONFIG & 8 : 8k RAM \$f4000-\$f5fff
ARRAY	RAM6	if memsize < 1M and CONFIG & 16 : 8k RAM \$f6000-\$f7fff
ARRAY	RAMC	if memsize < 1M and CONFIG & 32 : 4k RAM \$fc000-\$fcfff

The RAM* arrays are only saved if the RAM itself is less than 1M. If the memory size is 1M then those areas are taken from the bank 15 area of the normal RAM.

The memory array starts at \$10000 if the memory size is less than 512k, or at \$00000 if 512k or more. In case of a C510, then the memory array also always starts at \$00000.

The CBM2ROM module

Type	Name	Description
------	------	-------------

UBYTE	CONFIG	Bit 1: 1= \$1*** ROM image included. Bit 2: 1= \$2000-\$3fff ROM image included. Bit 3: 1= \$4000-\$5fff ROM image included. Bit 4: 1= \$6000-\$7fff ROM image included. Bit 5: 1= chargen ROM is VIC-II chargen, 0= CRTC chargen.
ARRAY	KERNAL	8 KERNAL ROM image (\$e000-\$efff)
ARRAY	BASIC	BASIC ROM image (\$8000-\$bfff)
ARRAY	CHARGEN	4k CHARGEN ROM image
ARRAY	ROM1	4k cartridge ROM image for \$1*** (if CONFIG & 2)
ARRAY	ROM2	8k cartridge ROM image for \$2000-\$3fff (if CONFIG & 4)
ARRAY	ROM4	8k cartridge ROM image for \$4000-\$5fff (if CONFIG & 8)
ARRAY	ROM6	8k cartridge ROM image for \$6000-\$7fff (if CONFIG & 16)

8.2.2.19 C500 data module

The C500 data module contains simple state information not already saved in the other modules.

Version numbers: Major 0, Minor 0

The C500DATA module

Type	Name	Description
DWORD	IRQCLK	CPU clock ticks till next 50Hz IRQ

9 Media images

9.1 Media images command-line options

-doodleoversize <method>

Select the way the oversized input should be handled, (0: scale down, 1: crop left top, 2: crop center top, 3: crop right top, 4: crop left center, 5: crop center, 6: crop right center, 7: crop left bottom, 8: crop center bottom, 9: crop right bottom)

-doodlemc <method>

Select the way the multicolor to hires should be handled, (0: b&w, 1: 2 colors, 2: 4 colors, 3: gray scale, 4: best cell colors)

-doodletedlum <method>

Select the way the TED luminosity should be handled, (0: ignore, 1: dither)

-doodlecrtctextcolor <color>

Select the CRTC text color (0: white, 1: amber, 2: green)

`-ffmpegaudiobitrate <value>`
Set bitrate for audio stream in media file

`-ffmpegvideobitrate <value>`
Set bitrate for video stream in media file

10 Event history

10.1 Event history command-line options

`-playback`
Playback recorded events

11 Monitor

Every VICE emulator has a complete built-in monitor, which can be used to examine, disassemble and assemble machine language programs, as well as debug them through break-points. It can be activated by using the “Activate monitor” command (left button menu). Notice that you have to run the emulator from a terminal emulation program (such as `rxvt` or `xterm`) in order to use the monitor.

Warning: this version of the monitor is still under construction, and some of the features are not fully working yet.

11.1 Terminology

‘address_space’
This refers to the range of memory locations and a set of registers. This can be the addresses available to the computer’s processor, the disk drive’s processor or a specific memory configuration of one of the mentioned processors.

‘bankname’
The CPU can only see 64k of memory at any one time, due to its 16 bit address bus. The C64 and other computers have more than this amount, and this is handled by banking: a memory address can have different contents, depending on the active memory bank. A bankname names a specific bank in the current address_space.

‘register’
One of the following: program counter (PC), stack pointer (SP), accumulator (A), X register (X), or Y register (Y).

‘address’ A specific memory location in the range \$0000 to \$FFFF.

‘address_range’
Two addresses. If the second address is less than the first, the range is assumed to wraparound from \$FFFF to \$0000. Both addresses must be in the same address space.

<code>'address_opt_range'</code>	An address or an address range.
<code>'label'</code>	<code>label</code> is the name of a label. it must start with a dot (".") in order for the monitor to recognize it as a label.
<code>'prompt'</code>	The prompt has the format <code>[x:y]</code> . If <code>x</code> is <code>-</code> , memory reads from the monitor do not have side effects. Otherwise, <code>x</code> is <code>S</code> . The second part of the prompt, <code>y</code> , shows the default address space.
<code>'checkpoint'</code>	The monitor has the ability to setup triggers that perform an action when a specified situation occurs. There are three types of checkpoints; breakpoints, tracepoints and watchpoints.
<code>'breakpoint'</code>	A breakpoint is triggered based on the program counter. When it is triggered, the monitor is entered.
<code>'tracepoint'</code>	Like breakpoints, a tracepoint is triggered based on the program counter. Instead of entering the monitor, the program counter is printed and execution continues.
<code>'watchpoint'</code>	Watchpoints are triggered by a read and/or write to an address. When a watchpoint is triggered, the monitor is entered.
<code>'memmap'</code>	The memmap keeps track of RAM/ROM/IO read/write/execute accesses. The feature must be enabled with <code>"-enable-memmap"</code> configure option, as it might decrease performance notably on slower hardware. The option also enables CPU history.
<code>'<...>'</code>	A data type.
<code>'*'</code>	Zero or more occurrences.
<code>'[...]'</code>	An optional argument.

11.2 Machine state commands

`backtrace`

`bt` Print JSR call chain (most recent call first). Stack offset relative to `SP+1` is printed in parentheses. This is a best guess only.

`cpuhistory [<count>]`

`chis [<count>]`

Show `<count>` last executed commands. (disabled by default; configure with `-enable-memmap` to enable)

`dump "<filename>"`

Write a snapshot of the machine into the file specified. This snapshot is compatible with a snapshot written out by the UI. Note: No ROM images are included into the dump.

goto <address>

g <address>

Change the PC to address and continue execution.

io [<address>]

Display i/o registers. Invoking without an address shows a dump of the entire io range, if an address is given then details for the chip at the respective (base-)address are displayed (if available).

next [<count>]

n [<count>]

Advance to the next instruction. Subroutines are treated as a single instruction.

registers [<reg_name> = <number> [, <reg_name> = <number>]*]

r [<reg_name> = <number> [, <reg_name> = <number>]*]

Assign respective registers. With no parameters, display register values.

reset [<type>]

Reset the machine or drive. **type**: 0 = soft, 1 = hard, 8-11 = drive.

return

ret Continues execution and returns to the monitor just after the next RTS or RTI is executed.

step [<count>]

z [<count>]

Single step through instructions. An optional count allows stepping more than a single instruction at a time.

undump "<filename>"

Read a snapshot of the machine from the file specified.

11.3 Memory commands

bank [<bankname>]

Without a bankname, display all available banks for the current address_space. With a bankname given, switch to the specified bank. If a bank is not completely filled (ROM banks for example) normally the **ram** bank is used where the bank has holes. The **cpu** bank uses the bank currently used by the CPU.

compare <address_range> <address>

c <address_range> <address>

Compare memory from the source specified by the address range to the destination specified by the address. The regions may overlap. Any values that miscompare are displayed using the default displaytype.

device [c:|8:|9:]

Set the default address space to either the computer 'c:' or the specified drive '8:' or '9:'

fill <address_range> <data_list>

f <address_range> <data_list>

Fill memory in the specified address range with the data in <data_list>. If the size of the address range is greater than the size of the data_list, the data_list is repeated.

hunt <address_range> <data_list>

h <address_range> <data_list>

Hunt memory in the specified address range for the data in <data_list>. If the data is found, the starting address of the match is displayed. The entire range is searched for all possible matches. The data list may have 'xx' as a wildcard.

i <address_opt_range>

Display memory contents as PETSCII text.

ii <address_opt_range>

Display memory contents as screen code text

mem [<data_type>] [<address_opt_range>]

m [<data_type>] [<address_opt_range>]

Display the contents of memory. If no datatype is given, the default is used. If only one address is specified, the length of data displayed is based on the datatype. If no addresses are given, the 'dot' address is used.

memmapshow [<mask>] [<address_opt_range>]

mmsh [<mask>] [<address_opt_range>]

Show the memmap. The mask can be specified to show only those locations with accesses of certain type(s). The mask is a number with the bits "ioRWXrwx", where RWX are for ROM and rwx for RAM. Optionally, an address range can be specified. (disabled by default; configure with `-enable-memmap` to enable)

memmapzap

mmzap Clear the memmap. (disabled by default; configure with `-enable-memmap` to enable)

memmapsave "<filename>" <format>

mmsave "<filename>" <format>

Save the memmap as a picture. **format**: 0 = BMP, 1 = PCX, 2 = PNG, 3 = GIF, 4 = IFF. (disabled by default; configure with `-enable-memmap` to enable)

memchar [<data_type>] [<address_opt_range>]

mc [<data_type>] [<address_opt_range>]

Display the contents of memory as character data. If only one address is specified, only one character is displayed. If no addresses are given, the "dot" address is used.

memsprite [<data_type>] [<address_opt_range>]

ms [<data_type>] [<address_opt_range>]

Display the contents of memory as sprite data. If only one address is specified, only one sprite is displayed. If no addresses are given, the "dot" address is used.

move <address_range> <address>

t <address_range> <address>

Move memory from the source specified by the address range to the destination specified by the address. The regions may overlap.

screen

sc Displays the contents of the screen.

sidefx [on|off|toggle]

sfx [on|off|toggle]

Control how monitor generated reads affect memory locations that have read side-effects, like CIA interrupt registers for example. If the argument is 'on' then reads may cause side-effects. If the argument is 'off' then reads don't cause side-effects. If the argument is 'toggle' then the current mode is switched. No argument displays the current state.

> [<address>] <data_list>

Write the specified data at address.

11.4 Assembly commands

a <address> [<instruction> [: <instruction>]*]

Assemble instructions to the specified address. If only one instruction is specified, enter assembly mode (enter an empty line to exit assembly mode).

disass [<address> [<address>]]

d [<address> [<address>]]

Disassemble instructions. If two addresses are specified, they are used as a start and end address. If only one is specified, it is treated as the start address and a default number of instructions are disassembled. If no addresses are specified, a default number of instructions are disassembled from the dot address.

11.5 Checkpoint commands

break [<address> [if <cond_expr>]]

This command allows setting a breakpoint or listing the current breakpoints. If no address is given, the currently valid checkpoints are printed. If an address is given, a breakpoint is set for that address and the breakpoint number is printed. A conditional expression can also be specified for the breakpoint. For more information on conditions, see the **CONDITION** command.

enable <checknum>

disable <checknum>

Each checkpoint can be enabled or disabled. This command allows changing between these states.

command <checknum> "<command>"

When checkpoint **checknum** is hit, the specified command is executed by the monitor. Note that the **x** command is not yet supported as a command argument.

```
condition <checknum> if <cond_expr>
cond <checknum> if <cond_expr>
```

Each time the specified checkpoint is examined, the condition is evaluated. If it evaluates to true, the checkpoint is activated. Otherwise, it is ignored. If registers are specified in the expression, the values used are those at the time the checkpoint is examined, not when the condition is set.

Currently, the `cond_expr` is very limited. You can use registers (`.A`, `.X`, `.Y`, `.PC`, and `.SP`) and compare against other registers or absolute values. For example, the following are all valid conditions: `.A == 0`, `.X == .Y`, `8:.X == .X`, `.A != 5`, `.A < .X`.

However, you cannot specify memory contents and compare that.

```
delete <checknum>
del <checknum>
```

Delete the specified checkpoint.

```
ignore <checknum> [<count>]
```

Ignore a checkpoint after a given number of crossings. If no count is given, the default value is 1.

```
trace [address [address]]
tr [address [address]]
```

This command is similar to the `break` command except that it operates on tracepoints. A tracepoint differs from a breakpoint by not stopping execution but simply printing the PC, giving the user an execution trace. The second optional address can be used to specify the end of an range of addresses to be traced.

```
until [<address>]
un [<address>]
```

If no address is given, the currently valid breakpoints are printed. If an address is given, a temporary breakpoint is set for that address and the breakpoint number is printed. Control is returned to the emulator by this command. The breakpoint is deleted once it is hit.

```
watch [loadstore] [address [address]]
w [loadstore] [address [address]]
```

This command is similar to the previous two commands except that it operates on watchpoints. A watchpoint differs from the others by stopping on a read and/or write to an address or range of addresses. If no addresses are given, a list of all the watchpoints is printed. The `loadstore` parameter can be either "load" or "store" to determine on which operation the monitor breaks. If not specified, the monitor breaks on both operations.

11.6 General commands

```
cd <directory>
```

Change the working directory.

`device [c:d:]`
`dev [c:d:]`
 Set the default memory device to either the computer (c:) or the disk (d:).

`dir [<directory>]`
`ls [<directory>]`
 Display the directory contents.

`pwd`
 Show current working directory.

`radix [H|D|O|B]`
`rad [H|D|O|B]`
 Set the default radix to hex, decimal, octal, or binary. With no argument, the current radix is printed.

11.7 Disk commands

`attach <filename> <device>`
 Attach file to device. (device 32 = cart)

`block_read <track> <sector> [<address>]`
`br <track> <sector> [<address>]`
 Read the block at the specified track and sector. If an address is specified, the data is loaded into memory. If no address is given, the data is displayed using the default datatype.

`block_write <track> <sector> <address>`
`bw <track> <sector> <address>`
 Write a block of data at `address` to the specified track and sector of disk in drive 8.

`detach <device>`
 Detach file from device. (device 32 = cart)

`@<disk command>`
 Perform a disk command on the currently attached disk image on drive 8. The specified disk command is sent to the drive's channel #15.

`load "<filename>" <device> [<address>]`
`l "<filename>" <device> [<address>]`
 Load the specified file into memory. If no address is given, the file is loaded to the address specified by the first two bytes read from the file. If address is given, the file is loaded to the specified address and the first two bytes read from the file are skipped. If device is 0, the file is read from the file system.

`list [<directory>]`
 List disk contents.

`bload "<filename>" <device> <address>`
`bl "<filename>" <device> <address>`
 Load the specified file into memory at the specified address. If device is 0, the file is read from the file system.

```
save "<filename>" <device> <address1> <address2>
s "<filename>" <device> <address1> <address2>
    Save the memory from address1 to address2 to the specified file. Write two-byte
    load address. If device is 0, the file is written to the file system.

bsave "<filename>" <device> <address1> <address2>
bs "<filename>" <device> <address1> <address2>
    Save the memory from address1 to address2 to the specified file. If device is 0,
    the file is written to the file system.
```

11.8 Command file commands

```
playback "<filename>"
pb "<filename>"
    Monitor commands from the specified file are read and executed. This command
    stops at the end of file or when a STOP command is read.

record "<filename>"
rec "<filename>"
    After this command, all commands entered are written to the specified file until
    the STOP command is entered.

stop
    Stop recording commands. See record.
```

11.9 Label commands

```
add_label <address> <label>
al <address> <label>
    Map a given address to a label. This label can be used when entering assembly
    code and is shown during disassembly. Additionally, it can be used whenever
    an address must be specified.

    <label> is the name of the label; it must start with a dot (".") in order for the
    monitor to recognize it as a label.

delete_label [<memspace>] <label>
dl [<memspace>] <label>
    Remove the specified label from the label tables. If no memory space is checked,
    all tables are checked.

load_labels [<memspace>] "<filename>"
ll [<memspace>] "<filename>"
    Load a file containing a mapping of labels to addresses. If no memory space is
    specified, the default readspace is used.

    The file must contain commands the monitor understands, e.g. add_label. The
    compiler cc65 can create such label files.

    Vice can also load label files created by the Acme assembler. Their syntax is e.g.
    "labelname = $1234 ; Maybe a comment". A dot will be added automatically
    to label names assigned in this way to fit to the Vice label syntax. Normally
    the semicolon separates commands but after an assignment of this kind it may
```

be used to start a comment to end of line, so unchanged Acme label files can be fed into Vice.

`save_labels [<memspace>] "<filename>"`

`sl [<memspace>] "<filename>"`

Save labels to a file. If no memory space is specified, all of the labels are saved.

`show_labels [<memspace>]`

`shl [<memspace>]`

Display current label mappings. If no memory space is specified, show all labels.

11.10 Miscellaneous commands

`cartfreeze`

Use cartridge freeze.

`cpu <type>`

Specify the type of CPU currently used (6502/z80).

`exit`

`x` Leave the monitor and return to execution.

`export`

`exp` Print out list of attached expansion port devices.

`help [<command>]`

If no argument is given, prints out a list of all available commands. If an argument is given, prints out specific help for that command.

`keybuf "<string>"`

Put the specified string into the keyboard buffer.

`print <expression>`

`p <expression>`

Evaluate the specified expression and output the result.

`resourceget "<resource>"`

`resget "<resource>"`

Displays the value of the `resource`.

`resourceset "<resource>" "<value>"`

`reset "<resource>" "<value>"`

Sets the value of the `resource`.

`screenshot "<filename>" [<format>]`

`scrsh "<filename>" [<format>]`

Take a screenshot. `format`: default = BMP, 1 = PCX, 2 = PNG, 3 = GIF, 4 = IFF.

`tapectrl <command>`

Control the datasette. `command`: 0 = stop, 1 = start, 2 = forward, 3 = rewind, 4 = record, 5 = reset, 6 = reset counter.

`quit`

Exit the emulator immediately.

`~ <number>`

Display the specified number in decimal, hex, octal and binary.

12 c1541

VICE is provided with a complete stand-alone disk image maintenance utility, called **c1541**.

You can either invoke it from the command line or from within one of the VICE emulators, using the “Run c1541” command which will open a new **xterm** window with a running **c1541** in it.

The syntax is:

```
c1541 [IMAGE1 [IMAGE2]] [COMMAND1 COMMAND2 ... COMMANDN]
```

IMAGE1 and **IMAGE2** are disk image names that can be attached before **c1541** starts. **c1541** can handle up to two disk images at the same time by using two virtual built-in drives, numbered 8 and 9; **IMAGE1** (if present) is always attached to drive 8, while **IMAGE2** is attached to drive 9.

COMMANDS specified on the command-line all begin with the minus sign (-); if present, **c1541** executes them in the same order as they are on the command line and returns a zero error code if they were successful. If any of the **COMMANDS** fails, **c1541** stops and returns a nonzero error code.

If no **COMMANDS** are specified at all, **c1541** enters interactive mode, where you can type commands manually. Commands in interactive mode are the same as commands in batch mode, but do not require a leading -. As with the monitor, file name completion and command line editing with history are provided via GNU **readline**. Use the command ‘quit’ or press **C-d** to exit.

12.1 Specifying files in c1541

When accessing CBM DOS files (i.e. files that reside on disk images), **c1541** uses a special syntax that lets you access files on both drive 8 and 9. If you prepend the file name with **@8:** or **@9:**, you will specified that file is to be found or created on drive 8 and 9, respectively.

For instance,

```
@8:somefile
```

will name file named **somefile** on unit 8, while

```
@9:somefile
```

will name file named **somefile** on unit 9.

12.2 Using quotes and backslashes

You can use quotes (") in a command to embed spaces into file names. For instance,

```
read some file
```

will read file **some** from the disk image and write it into the file system as **file**, while

```
read "some file"
```

will copy **some file** into the file system, with the name **some file**.

The backslash character (\) has a special meaning too: it lets you literally insert the following character no matter what it is. For example,

```
read some\ file
```

will copy file **some file** into the file system, while

```
read some\ file this\"file
```

will copy `some file` into the file system with name `this"file` (with an embedded quote).

12.3 c1541 commands and options

This is a list of the `c1541` commands. They are shown in their interactive form, without the leading `-`. Square brackets `[]` indicate an optional part, and "`<COMMAND>`" translates to a disk command according to CBM DOS, like `"i0"` for example.

```
[<command>]
    Execute specified CBM DOS command and print the current status of the drive.
    If no command is specified, just print the status.
```

```
? [<command>]
    Explain specified command. If no command is specified, list available ones.
```

```
attach <diskimage> [<unit>]
    Attach diskimage to unit (default unit is 8).
```

```
block <track> <sector> <disp> [<drive>]
    Show specified disk block in hex form.
```

```
copy <source1> [<source2> ... <sourceN>] <destination>
    Copy source1 ... sourceN into destination. If N > 1, destination must be a
    simple drive specifier (@n:).
```

```
delete <file1> [<file2> ... <fileN>]
    Delete the specified files.
```

```
exit
    Exit (same as quit).
```

```
extract
    Extract all the files to the file system.
```

```
format <diskname,id> [<type> <imagename>] [<unit>]
    If unit is specified, format the disk in unit unit. If type and imagename are
    specified, create a new image named imagename, attach it to unit 8 and format
    it. type is a disk image type, and must be either x64, d64 (both VC1541/2031),
    g64 (VC1541/2031 but in GCR coding), d71 (VC1571), d81 (VC1581), d80
    (CBM8050) or d82 (CBM8250/1001). Otherwise, format the disk in the current
    unit, if any.
```

```
gcrformat <diskname,id> <imagename>
    Create and format a G64 disk image named imagename.
```

```
help [<command>]
    Explain specified command. If no command is specified, list available ones.
```

```
info [<unit>]
    Display information about unit unit (if unspecified, use the current one).
```

```
list [<pattern>]
    List files matching pattern (default is all files).
```

```
quit
    Exit (same as exit).
```

```

read <source> [<destination>]
    Read source from the disk image and copy it into destination in the file
    system. If destination is not specified, copy it into a file with the same name
    as source.",

rename <oldname> <newname>
    Rename oldname into newname. The files must be on the same drive.

tape <t64name> [<file1> ... <fileN>]
    Extract files from a T64 image.

unit <number>
    Make unit number the current unit.

unlynx <lynxname> [<unit>]
    Extract the specified Lynx image file into the specified unit (default is the
    current unit).

validate [<unit>]
    Validate the disk in unit unit. If unit is not specified, validate the disk in the
    current unit.

write <source> [<destination>]
    Write source from the file system into destination on a disk image.

zcreate <x64name> <zipname> [<label,id>]
    Create an X64 disk image out of a set of four Zipcoded files named 1!zipname,
    2!zipname, 3!zipname and 4!zipname.

```

12.4 Executing shell commands

If you want to execute a shell command from within **c1541**, just prepend it with an exclamation mark (!). For example,

```
!ls -la
```

will execute the command **ls -la**, which will show you all the files in the current directory.

12.5 c1541 examples

```

c1541 -attach test.d64 -write test.prg testfile
    Write test.prg to test.d64 as testfile.

```

13 cartconv

The **cartconv** program is a cartridge conversion utility, it can convert between binary and .crt images and it can 'insert' binary and/or .crt images into the EPROM type of cartridges.

13.1 cartconv command line options

The cartconv program has the following parameters:

- i "input name"**
This parameter is mandatory, it should contain the name of the binary/.crt file you want to convert. For the EPROM type of cartridges this parameter can be used multiple times to insert images into the resulting file.
- o "output name"**
This parameter is mandatory, it should contain the name of the binary/.crt file you want to convert the input file to.
- t carttype**
This parameter is optional. It is only needed when converting to a .crt file. See below for the supported cartridge types.
- n "cart name"**
This parameter is optional and is used as the cartridge name when creating a .crt file.
- l loadaddress**
This parameter is optional and is used as the load-address when converting a .crt file to a .prg file, or when converting to a generic type .crt file.
- f "input name"**
This parameter is optional, and is meant to output information about the named file. It can't be used in conjunction with any of the other parameters.
- r**
This parameter is optional, it enables repair mode (accept broken input files)

The following cartridge types are supported:

bin	Binary .bin file (Default crt->bin)
normal	Generic 8kB/12kB/16kB .crt file (Default bin->crt)
prg	Binary C64 .prg file with load-address
ulti	Ultimax mode 4kB/8kB/16kB .crt file
ap	Atomic Power .crt file
ar2	Action Replay MK2 .crt file
ar3	Action Replay MK3 .crt file
ar4	Action Replay MK4 .crt file
ar5	Action Replay V5 .crt file
cap	Capture .crt file
comal	Comal 80 .crt file
dep256	Dela EP256 .crt file, extra files can be inserted (1)(2)
dep64	Dela EP64 .crt file, extra files can be inserted (1)
dep7x8	Dela EP7x8 .crt file, extra files can be inserted (1)(2)(3)

din	Dinamic .crt file
dsm	Diashow-Maker .crt file
easy	EasyFlash .crt file
epyx	Epyx FastLoad .crt file
exos	EXOS .crt file
expert	Expert Cartridge .crt file
fc1	The Final Cartridge .crt file
fc3	The Final Cartridge III .crt file
fcpx	Final Cartridge Plus .crt file
ff	Freeze Frame .crt file
fm	Freeze Machine .crt file
fp	Fun Play .crt file
gk	Game Killer .crt file
gs	C64 Games System .crt file
ide64	IDE64 .crt file
ieee	IEEE-488 Interface .crt file
kcs	KCS Power Cartridge .crt file
mach5	MACH 5 .crt file
md	Magic Desk .crt file
mf	Magic Formel .crt file
mikro	Mikro Assembler .crt file
mmc64	MMC64 .crt file
mmcr	MMC Replay .crt file
mv	Magic Voice .crt file
ocean	Ocean .crt file
p64	Prophet64 .crt file
rep256	REX 256k EPROM Cart .crt file, extra files can be inserted (1)(2)(3)
ross	ROSS .crt file
rr	Retro Replay .crt file
ru	REX Utility .crt file
s64	Snapshot 64 .crt file
sb	Structured BASIC .crt file
se5	Super Explode V5.0 .crt file

sg Super Games .crt file
simon Simons' BASIC .crt file
ss4 Super Snapshot V4 .crt file
ss5 Super Snapshot V5 .crt file
star Stardos .crt file
wl Westermann Learning .crt file
ws Warp Speed .crt file
zaxxon Zaxxon .crt file

- (1) insertion of 32kB EPROM files supported.
- (2) insertion of 8kB .crt/binary files supported.
- (3) insertion of 16kB .crt/binary files supported.

13.2 cartconv examples

`cartconv -i foo.crt -o foo.bin`

Convert a .crt file to a binary file with no load-address.

`cartconv -t prg -i foo.crt -o foo.prg`

Convert a .crt file to a .prg file with default load-address.

`cartconv -t prg -l 49152 -i foo.crt -o foo.prg`

Convert a .crt file to a .prg file with 49152 as the load-address.

`cartconv -t ocean -i foo.bin -o foo.crt`

Convert a binary file to an ocean type cartridge.

`cartconv -t dep64 -i dep64.bin -i eprom.prg -o foo.crt`

Inserting a 32kB EPROM file into an dep64 type cartridge.

- step 1 : use the dep64 binary file in VICE as a generic 8kB cartridge.
- step 2 : generate an EPROM file.
- step 3 : get the EPROM file to the host computer.
- step 4 : insert the EPROM file into the final dep64 .crt file:

`cartconv -t dep256 -i dep256.bin -i somegame.crt -o foo.crt`

Insert an 8kB .crt file into a dep256 type cartridge.

`cartconv -t rep256 -i rep256.bin -i foo1.crt -i foo2.crt -i foo3.crt -o foo.crt`

Insert multiple 8kB .crt files into a rep256 type cartridge.

`cartconv -f foo.crt`

Get information about a .crt file.

14 petcat

The petcat program is a text conversion utility, it can convert between ASCII, PETSCII and tokenized BASIC.

14.1 petcat command line options

- help** Output help text
- v** Same as above
- c** controls (interpret also control codes) (default if textmode)
- nc** no controls (suppress control codes in printout) (default if non-textmode)
- ic** interpret control codes case-insensitive
- h** write header (default if output is stdout)
- nh** no header (default if output is a file)
- skip <n>** Skip <n> bytes in the beginning of input file. Ignored on P00.
- text** Force text mode
- <version>**
 use keywords for <version> instead of the v7.0 ones
- w<version>**
 tokenize using keywords on specified Basic version.
- k<version>**
 list all keywords for the specified Basic version
- k** list all Basic versions available.
- l** Specify load address for program (in hex, no loading chars!).
- o <name>** Specify the output file name
- f** Force overwritten the output file. The default depends on the BASIC version.

BASIC Versions:

- 1** PET Basic V1.0
- 2** Basic v2.0
- superexp** Basic v2.0 with Super Expander (VIC20)
- turtle** Basic v2.0 with Turtle Basic by Craig Bruce (VIC20)
- mighty** Basic v2.0 with Mighty Basic by Craig Bruce (VIC20)
- a** Basic v2.0 with AtBasic (C64)
- simon** Basic v2.0 with Simon's Basic extension (C64)
- speech** Basic v2.0 with Speech Basic v2.7 (C64)
- F** Basic v2.0 with Final Cartridge III (C64)

ultra	Basic v2.0 with Ultrabasic-64 (C64)
graph	Basic v2.0 with Graphics basic (C64)
WSB	Basic v2.0 with WS basic (C64)
WSBF	Basic v2.0 with WS basic final (C64)
Pegasus	Basic v2.0 with Pegasus basic 4.0 (C64)
Xbasic	Basic v2.0 with Xbasic (C64)
Drago	Basic v2.0 with Drago basic 2.2 (C64)
REU	Basic v2.0 with REU-basic (C64)
Lightning	Basic v2.0 with Basic Lightning (C64)
magic	Basic v2.0 with Magic Basic (C64)
easy	Basic v2.0 with Easy Basic (VIC20)
blarg	Basic v2.0 with Blarg (C64)
Game	Basic v2.0 with Game Basic (C64)
BSX	Basic v2.0 with Basex (C64)
superbas	Basic v2.0 with Super Basic (C64)
exp20	Basic 2.0 with Expanded Basic (VIC20)
exp64	Basic 2.0 with Expanded Basic (C64)
sxc	Basic 2.0 with Super Expander Chip (C64)
warsaw	Basic 2.0 with Warsaw Basic (C64)
4v	Basic 2.0 with Basic 4.0 extensions (VIC20)
4 -w4e	PET Basic v4.0 program (PET/C64)
5	Basic 2.0 with Basic 5.0 extensions (VIC20)
3	Basic v3.5 program (C16)
70	Basic v7.0 program (C128)
71	Basic v7.1 program (C128)
10	Basic v10.0 program (C64DX)

14.2 petcat examples

```
petcat -2 -o outputfile.txt -- inputfile.prg
```

Convert inputfile.prg to a text file in outputfile.txt, using BASIC V2 only

```
petcat -wsimon -o outputfile.prg -- inputfile.txt
```

Convert inputfile.txt to a PRG file in outputfile.prg, using Simon's BASIC

15 The emulator file formats

This chapter gives a technical description of the various files supported by the emulators.

15.1 The T64 tape image format

(This section was taken from the C64S distribution.)

The T64 File Structure was developed by Miha Peternel for use in the C64S emulator. It is easy to use and allows future extensions.

15.1.1 T64 File structure

Offset	Size	Description
0	64	tape record
64	32*n	file records for n directory entries
64+32*n	varies	binary contents of the files

15.1.2 Tape Record

Offset	Size	Description
0	32	DOS tape description + EOF (for type)
32	2	tape version (\$0200)
34	2	number of directory entries
36	2	number of used entries (can be 0 in my loader)
38	2	free
40	24	user description as displayed in tape menu

15.1.3 File record

Offset	Size	Description
0	1	entry type (see below)
1	1	C64 file type
2	2	start address
4	2	end address
6	2	free
8	4	offset of file contents start within T64 file
12	4	free
16	16	C64 file name

Valid entry types are:

Code	Explanation
0	free entry
1	normal tape file
2	tape file with header: header is saved just before file data
3	memory snapshot v0.9, uncompressed
4	tape block

5 digitized stream
 6 . . . 255 reserved

Notes:

- VICE only supports file type 1.
- Types 3, 4 and 5 are subject to change (and are rarely used).

15.2 The G64 GCR-encoded disk image format

(This section was contributed by Peter Schepers and slightly edited by Ettore Perazzoli.)

This format was defined in 1998 as a cooperative effort between several emulator people, mainly Per Hkan Sundell, author of the CCS64 C64 emulator, Andreas Boose of the VICE CBM emulator team and Joe Forster/STA, the author of Star Commander. It was the first real public attempt to create a format for the emulator community which removed almost all of the drawbacks of the other existing image formats, namely D64.

The intention behind G64 is not to replace the widely used D64 format, as D64 works fine with the vast majority of disks in existence. It is intended for those small percentage of programs which demand to work with the 1541 drive in a non-standard way, such as reading or writing data in a custom format. The best example is with speeder software such as Action Cartridge in Warp Save mode or Vorpul which write track/sector data in another format other than standard GCR. The other obvious example is copy-protected software which looks for some specific data on a track, like the disk ID, which is not stored in a standard D64 image.

G64 has a deceptively simply layout for what it is capable of doing. We have a signature, version byte, some predefined size values, and a series of offsets to the track data and speed zones. It is what's contained in the track data areas and speed zones which is really at the heart of this format.

Each track entry is simply the raw stream of GCR data, just what a read head would see when a diskette is rotating past it. How the data gets interpreted is up to the program trying to access the disk. Because the data is stored in such a low-level manner, just about anything can be done. Most of the time I would suspect the data in the track would be standard sectors, with SYNC, GAP, header, data and checksums. The arrangement of the data when it is in a standard GCR sector layout is beyond the scope of this document.

Since it is a flexible format in both track count and track byte size, there is no “standard” file size. However, given a few constants like 42 tracks and halftracks, a track size of 7928 bytes and no speed offset entries, the typical file size will a minimum of 333744 bytes.

Below is a dump of the header, broken down into its various parts. After that will be an explanation of the track offset and speed zone offset areas, as they demand much more explanation.

Addr	00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
-----	-----
0000:	47 43 52 2D 31 35 34 31 00 54 F8 1E

Offset	Description
\$0000-0007	File signature (GCR-1541)
\$0008	G64 version (presently only \$00 defined)
\$0009	Number of tracks in image (usually \$54, decimal 84)

\$000A-000B Size of each stored track in bytes (usually 7928, or \$1EF8) in LO/HI format.

An obvious question here is “why are there 84 tracks defined when a normal D64 disk only has 35 tracks?” Well, by definition, this image includes all half-tracks, so there are actually 42 tracks and 42 half tracks. The 1541 stepper motor can access up to 42 tracks and the in-between half-tracks. Even though using more than 35 tracks is not typical, it was important to define this format from the start with what the 1541 is capable of doing, and not just what it typically does.

At first, the defined track size value of 7928 bytes may seem to be arbitrary, but it is not. It is determined by the fastest write speed possible (speed zone 0), coupled with the average rotation speed of the disk (300 rpm). After some math, the answer that actually comes up is 7692 bytes. Why the discrepancy between the actual size of 7692 and the defined size of 7928? Simply put, not all drives rotate at 300 rpm. Some can be faster or slower, so a upper safety margin of +3% was built added, in case some disks rotate slower and can write more data. After applying this safety factor, and some rounding-up, 7928 bytes per track was arrived at.

Also note that this upper limit of 7928 bytes per track really only applies to 1541 and compatible disks. If this format were applied to another disk type like the SFD1001, this value would be higher.

Below is a dump of the first section of a G64 file, showing the offsets to the data portion for each track and half-track entry. Following that is a dump of the speed zone offsets.

```

Addr  00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
-----
0000:  .. .. .. .. .. .. .. .. .. .. .. .. AC 02 00 00
0010:  00 00 00 00 A6 21 00 00 00 00 00 00 00 A0 40 00 00
0020:  00 00 00 00 9A 5F 00 00 00 00 00 00 00 94 7E 00 00
0030:  00 00 00 00 8E 9D 00 00 00 00 00 00 00 88 BC 00 00
0040:  00 00 00 00 82 DB 00 00 00 00 00 00 00 7C FA 00 00
0050:  00 00 00 00 76 19 01 00 00 00 00 00 00 70 38 01 00
0060:  00 00 00 00 6A 57 01 00 00 00 00 00 00 64 76 01 00
0070:  00 00 00 00 5E 95 01 00 00 00 00 00 00 58 B4 01 00
0080:  00 00 00 00 52 D3 01 00 00 00 00 00 00 4C F2 01 00
0090:  00 00 00 00 46 11 02 00 00 00 00 00 00 40 30 02 00
00A0:  00 00 00 00 3A 4F 02 00 00 00 00 00 00 34 6E 02 00
00B0:  00 00 00 00 2E 8D 02 00 00 00 00 00 00 28 AC 02 00
00C0:  00 00 00 00 22 CB 02 00 00 00 00 00 00 1C EA 02 00
00D0:  00 00 00 00 16 09 03 00 00 00 00 00 00 10 28 03 00
00E0:  00 00 00 00 0A 47 03 00 00 00 00 00 00 04 66 03 00
00F0:  00 00 00 00 FE 84 03 00 00 00 00 00 00 F8 A3 03 00
0100:  00 00 00 00 F2 C2 03 00 00 00 00 00 00 EC E1 03 00
0110:  00 00 00 00 E6 00 04 00 00 00 00 00 00 E0 1F 04 00
0120:  00 00 00 00 DA 3E 04 00 00 00 00 00 00 D4 5D 04 00
0130:  00 00 00 00 CE 7C 04 00 00 00 00 00 00 C8 9B 04 00
0140:  00 00 00 00 C2 BA 04 00 00 00 00 00 00 BC D9 04 00
0150:  00 00 00 00 B6 F8 04 00 00 00 00 00 00 .. .. .. ..

```

Offset

Description

\$000C-000F	Offset to stored track 1.0 (\$000002AC, in LO/HI format, see below for more)
\$0010-0013	Offset to stored track 1.5 (\$00000000)
\$0014-0017	Offset to stored track 2.0 (\$000021A6)
...	
\$0154-0157	Offset to stored track 42.0 (\$0004F8B6)
\$0158-015B	Offset to stored track 42.5 (\$00000000)

	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
0150:	..	..	..	..	..	..	..	..	..	..	..	..	03	00	00	00
0160:	00	00	00	00	03	00	00	00	00	00	00	00	03	00	00	00
0170:	00	00	00	00	03	00	00	00	00	00	00	00	03	00	00	00
0180:	00	00	00	00	03	00	00	00	00	00	00	00	03	00	00	00
0190:	00	00	00	00	03	00	00	00	00	00	00	00	03	00	00	00
01A0:	00	00	00	00	03	00	00	00	00	00	00	00	03	00	00	00
01B0:	00	00	00	00	03	00	00	00	00	00	00	00	03	00	00	00
01C0:	00	00	00	00	03	00	00	00	00	00	00	00	03	00	00	00
01D0:	00	00	00	00	03	00	00	00	00	00	00	00	03	00	00	00
01E0:	00	00	00	00	02	00	00	00	00	00	00	00	02	00	00	00
01F0:	00	00	00	00	02	00	00	00	00	00	00	00	02	00	00	00
0200:	00	00	00	00	02	00	00	00	00	00	00	00	02	00	00	00
0210:	00	00	00	00	02	00	00	00	00	00	00	00	01	00	00	00
0220:	00	00	00	00	01	00	00	00	00	00	00	00	01	00	00	00
0230:	00	00	00	00	01	00	00	00	00	00	00	00	01	00	00	00
0240:	00	00	00	00	01	00	00	00	00	00	00	00	00	00	00	00
0250:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0260:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0270:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0280:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0290:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
02A0:	00	00	00	00	00	00	00	00	00	00	00	00	..	..	..	..

Offset	Description
\$015C-015F	Speed zone entry for track 1 (\$03, in LO/HI format, see below for more)
\$0160-0163	Speed zone entry for track 1.5 (\$03)
...	
\$02A4-02A7	Speed zone entry for track 42 (\$00)
\$02A8-02AB	Speed zone entry for track 42.5 (\$00)

Starting here at \$02AC is the first track entry (from above, it is the first entry for track 1.0)

The track offsets (from above) require some explanation. When one is set to all 0's, no track data exists for this entry. If there is a value, it is an absolute reference into the file (starting from the beginning of the file). From the track 1.0 entry we see it is set for \$000002AC. Going to that file offset, here is what we see...

```
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
```

```

02A0:  .. .. .. .. .. .. .. .. .. .. .. .. 0C 1E FF FF
02B0:  FF FF FF 52 54 B5 29 4B 7A 5E 95 55 55 55 55
02C0:  55 55 55 55 55 55 FF FF FF FF FF 55 D4 A5 29 4A
02D0:  52 94 A5 29 4A 52 94 A5 29 4A 52 94 A5 29 4A 52

```

Offset	Description
\$02AC-02AD	Actual size of stored track (7692 or \$1E0C, in LO/HI format)
\$02AE-	Track data
02AE+\$1E0C	

Following the track data is filler bytes. In this case, there are 368 bytes of unused space. This space can contain anything, but for the sake of those wishing to compress these images for storage, they should all be set to the same value. In the sample I used, these are all set to \$FF.

Below is a dump of the end of the track 1.0 data area. Note the actual track data ends at address \$20B9, with the rest of the block being unused, and set to \$FF.

```

      00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
      -----
1FE0:  52 94 A5 29 4A 52 94 A5 29 4A 52 94 A5 29 4A 52
1FF0:  94 A5 29 4A 52 94 A5 29 4A 52 94 A5 29 4A 52 94
2000:  A5 29 4A 52 94 A5 29 4A 52 94 A5 29 4A 52 94 A5
2010:  29 4A 52 94 A5 29 4A 52 94 A5 29 4A 52 94 A5 29
2020:  4A 52 94 A5 29 4A 52 94 A5 29 4A 52 94 A5 29 4A
2030:  55 55 55 55 55 55 FF FF FF FF FF FF FF FF FF
2040:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2050:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2060:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2070:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2080:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2090:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20A0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20B0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20C0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20D0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20E0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20F0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2100:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2110:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2120:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2130:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2140:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2150:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2160:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2170:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2180:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
2190:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
21A0:  FF FF FF FF FF FF .. .. .. .. .. .. .. ..

```

The speed offset entries can be a little more complex. The 1541 has four speed zones defined, which means the drive can write data at four distinct speeds. On a normal 1541 disk, these zones are as follows:

Track Range	Speed Zone
1-17	3 (highest writing speed)
18-24	2
25-30	1
31 and up	0 (lowest writing speed)

Note that you can, through custom programming of the 1541, change the speed zone of any track to something different (change the 3 to a 0) and write data differently. From the dump of the speed offset entries above, we see that all the entries are in the range of 0-3. If any entry is less than 4, this is not considered a speed offset but defines the whole track to be recorded at that one speed.

In the example I had, there were no offsets defined, so no speed zone dump can be shown. However, I can define what should be there. You will have a block of data, 1982 bytes long. Each byte is encoded to represent the speed of 4 bytes in the track offset area, and is broken down as follows:

```
Speed entry $FF:  in binary %11111111
                  |'|'|'|'
                  | | | |
                  | | | +- 4'th byte speed (binary 11, 3 dec)
                  | | +--- 3'rd byte speed (binary 11, 3 dec)
                  | +----- 2'nd byte speed (binary 11, 3 dec)
                  +----- 1'st byte speed (binary 11, 3 dec)
```

It was very smart thinking to allow for two speed zone settings, one in the offset block and another defining the speed on a per-byte basis. If you are working with a normal disk, where each track is one constant speed, then you don't need the extra blocks of information hanging around the image, wasting space.

What may not be obvious is the flexibility of this format to add tracks and speed offset zones at will. If a program decides to write a track out with varying speeds, and no speed offset exist, a new block will be created by appending it to the end of the image, and the offset pointer for that track set to point to the new block. If a track has no offset yet, meaning it doesn't exist (like a half-track), and one needs to be added, the same procedure applies. The location of the actual track or speed zone data is not important, meaning they do not have to be in any particular order since they are all referenced by the offsets at the beginning of the image.

16 Acknowledgments

VICE derives from X64, the first Commodore 64 emulator for the X Window System. Here is an informal list of the people who were mostly involved in the development of X64 and VICE:

The VICE core team:

- **Dag Lem** Implemented the reSID SID emulation engine and video hardware scaling.

- **Andreas Matthies** Improved the datasette support, the VIC20 video emulation and some UI stuff in the Win32 and DOS ports. He also wrote the BeOS port and implemented video/audio capture support. Improved history recording/playback and implemented support for video recording and the netlink feature. Made the Win32 user changable keyboard shortcut system. Improved CIA and VIA emulation. Worked on x64sc, especially interrupt timing. Wrote test programs. Various bug(fixe)s. ;-)
- **Martin Pottendorfer** Implemented the Gnome Port based on Oliver Schaertels GTK+ port. Added support code for internationalization based on gettext. Improved the *nix fullscreen support. Translated the UI to German. Implemented the fliplists + UI (*nix).
- **Spiro Trikaliotis** Wrote the Win32 console implementation for the built-in monitor, corrected some REU related bugs, improved the CIA emulation, added com-port CIA support to the Win32 port, added text copy and paste support to the Win32 port, added support for the TFE and RR-Net (cs8900a), and wrote some further patches.
- **Marco van den Heuvel** Translated the UI to Dutch. Made the internationalization support for the Win32 and Amiga ports. Wrote the GEO-RAM and RamCart cartridge code. Wrote the c64 +60K, +256K and 256K memory expansions code. Wrote the pet REU code. Wrote the plus4 memory expansions code. Made the ethernet support for the DOS port. Maintains the QNX 4.x, QNX 6.x, Solaris, Openserver, Unixware, Minix 3.x, Amiga, BeOS, Syllable and OS/2 binary ports. Maintains the Win64 and Watcom project files. Maintains the SDL port(s). Added new .crt support. Added new screenshot formats. Added new sound recording support. Added SIDcart support for xpet, xplus4 and xvic. Improved the MMC64 emulation. Added 2 MHz mode and banks 2/3 support for x128. Added the various userport joystick emulations. Added text copy and paste support to the Amiga and BeOS ports. Added DQBB and ISEPIC cartridge support. Added SFX Sound Sampler and SFX Sound Expander support. Added digiblaster support. And lots of other fixes and improvements.
- **Christian Vogelgsang** Maintains the Mac OS X port. Added Intel Mac support and universal binary creation. Wrote the build scripts for all external Mac libraries and the bindist bundle tool. Improved the TFE chip emulation. Added some GTK+ fixes.
- **Fabrizio Gennari** Added some improvements to the DOS and GTK+ ports.
- **Daniel Kahlin** Worked on DTV VIC emulation, palette, DTV SID support in resid, better DMA/Blitter support and did lots of refactoring. Added new monitor commands and features. Improved the VIC emulation for xvic. Made MIDI driver code for Win32. Rewrote the xvic cartridge system. Added Mega-Cart and Final Expansion V3.2 support to xvic. Wrote large parts of the new VIC-II emulation used in x64sc, especially the dot clock domain emulation. Wrote many test programs for hardware analysis.
- **Antti S. Lankila** Made the ReSID-fp engine, rewrote the PAL emulation code and fixed the sound core for lower latency. Rewrote DTV SID support (ReSID-dtv). Improved 1541 drive rotation emulation. Worked on x64sc.
- **Groepaz/Hitmen** Added new more precise CRT emulation. Added support for the new cartridge system and many new cartridges. Fixed up parts of cartconv. Implemented many bug fixes. Wrote test programs.

- **Ingo Korb** Corrected block allocation and interleave for c1541/vdrive, added rudimentary xplus4 tape recording support, corrected a case of missing Pi symbols in petcat, changed the trap opcode byte, stopped the high-level serial drive code from responding to addresses 16-30 and was forced to update this entry himself.
- **Errol Smith** Improved VDC emulation.
- **Olaf Seibert** Contributed some PET, including PET DWW hires, Xaw, lightpen, hardware scaling, and disk drive patches. Maintains the Xaw UI.
- **Stefan Haubenthal** Added some Amiga fixes.
- **Thomas Giesel** Added new monitor commands and features.
- **Marcus Sutton** Made some console, dialog and joystick fixes for the BeOS port.
- **Ulrich Schulz** Maintains the Dingoo port(s).

Former/inactive team members:

- **Hannu Nuotio** Copyright © 2007-2011 Implemented DTV flash emulation, DTV support in the monitor, large parts of the DTV VIC, burst mode and skip cycle emulation as well as many other things. Added NEOS and Amiga mouse, paddle and light pen support. Added new monitor commands and features, including memmap. Made MIDI support and OSS MIDI driver. Implemented most of the SDL UI. Rewrote xvic CPU/VIC-I core for cycle based emulation. Implemented C64 cartridge snapshot support. Initiated and worked on all parts of implementing x64sc. Wrote test programs.
- **Andreas Boose** Copyright © 1998-2010 Gave lots of information and bug reports about the VIC-II, the 6510 and the CIAs; moreover, he wrote several test-routines that were used to improve the emulation. He also added cartridge support and has been the main head behind the drive and datasette emulation since version 0.15. Also added several UI elements to the DOS, Win32 and *nix ports. He rewrote the C128 emulation adding Z80 mode, C64 mode and function ROM support, wrote the screenshot and the event system and started the plus4 emulator. Restructured the serial bus emulation and added realdrive and rawdrive support.
- **Tibor Biczo** Copyright © 1998-2010 Improved the Win32 port and plus4 emulation.
- **M. Kiesel** Copyright © 2007-2010 Started implementing x64dtv. The C64DTV memory model and early versions of the DMA and Blitter engine have been implemented by him. Added new monitor commands and features.
- **Andreas Dehmel** Copyright © 1999-2007 Wrote the Acorn RISC OS port.
- **David Hansel** Copyright © 2003-2005 Wrote the Star NL10 printer driver, implemented IEC devices and improved the tape emulation.
- **Markus Brenner** Copyright © 2000-2004 Added VDC emulation to x128 and added support for some more cartridges.
- **Thomas Bretz** Copyright © 1999-2004 Started the OS/2 port.
- **Daniel Sladic** Copyright © 1997-2001 Started the work on hardware-level 1541 emulation and wrote the new monitor introduced with VICE 0.15.
- **Andr Fachat** Copyright © 1996-2001 Wrote the PET and CBM-II emulators, the CIA and VIA emulation, the IEEE488 interface, implemented the IEC serial bus in 'xvic' and made tons of bug fixes.

- **Ettore Perazzoli** Copyright © 1996-1999 Made the 6510, VIC-II, VIC-I and CRTC emulations, part of the hardware-level 1541 emulation, speed optimizations, bug fixes, the event-driven cycle-exact engine, the Xt/Xaw/Xfwf-based GUI for X11, a general code reorganization, the new resource handling, most of the documentation. He also wrote the DOS port and the initial Win32 port (well, somebody had to do it).
- **Teemu Rantanen** Copyright © 1993-1994, 1997-1999 Implemented the SID emulation and the trap-based disk drive and serial bus implementation; added support for multiple display depths under X11. Also wrote `c1541`
- **Jouko Valta** Copyright © 1993-1996 Wrote `petcat` and `c1541`, T64 handling, user service and maintenance (most of the work in x64 0.3.x was made by him); retired from the project in July 96, after VICE 0.10.0.
- **Jarkko Somminen** Copyright © 1993-1994 He was the founder of the project, wrote the old version of the 6502 emulation and the XDebugger, and retired from the project after x64 0.2.1.

Internationalization Team:

- **Mikkel Holm Olsen** Provided the Danish user interface translations and fixed a few monitor bugs.
- **Paul Dub** From Rivire-du-Loup, Quebec, provided the French user interface translations.
- **Czirkos Zoltan** and **Karai Csaba** Provided the Hungarian user interface translations.
- **Andrea Musuruane** Provided the Italian user interface translations.
- **Jesse Lee** Provided the Korean user interface translations.
- **Flooder** Provided parts of the Polish user interface translations.
- **Michael Litvinov** Provided the Russian user interface translations.
- **Peter Krefting** Provided the Swedish user interface translations.
- **Emir Akaydin** Provided the Turkish user interface translations (in world record time).

External contributors:

- **Christian Bauer** Wrote the very interesting “VIC article” from which we got invaluable information about the VIC-II chip: without this, the VIC-II implementation would not have been possible.
- **Eliseo Bianchi** Provided the italian Amiga translations.
- **ck!** Provided a win32 cbm character font.
- **iAN CooG** Added win32 vsid GUI and contributed various patches.
- **Mike Dawson** Provided the GP2X port.
- **Paul David Doherty** Wrote `zip2disk`, on which the Zipcode support in `c1541` is based.
- **Peter Edwards** Implemented the SDL UI slider control and fixed some GP2X/Dingoo SDL UI issues.
- **Daniel Fandrich** Contributed some disk drive patches.
- **Dirk Farin** Rewrote the MITSHM code.
- **Georg Feil** Added support for toggling CB2 sound output line in the PET emulator.
- **Peter Andrew Felvegi aka Petschy** Fixed a couple of bugs in the fast serial emulation.

- **Ricardo Ferreira** Contributed the `unlynx` and `system` commands in `c1541` and added aRts sound support.
- **Robert H. Forsman Jr.** Provided parts of the widget set for implementing the Xaw GUI.
- **Peter Gordon** Provided support for native AmigaOS4 compiling.
- **Richard Hable** Contributed the initial version of the REU emulation.
- **Shawn Hargreaves** Wrote Allegro, the graphics and audio library used in the DOS version.
- **Ville-Matias Heikkila** Rewrote the vic20 sound code.
- **David Holz** Provided a label file which gives the built-in monitor the labels for the C64.
- **Nathan Huizinga** Added support for Expert and Super Snapshot carts.
- **Craig Jackson** Contributed miscellaneous patches in the old X64 times.
- **Dirk Jagdmann** Wrote the Catweasel sound driver.
- **Lasse Jyrkinen** Contributed miscellaneous patches in the old X64 times.
- **Peter Karlsson** Provided the swedish UI translations in the past.
- **Greg King** Added a working RTC to the emulation of the IDE64 cartridge.
- **Michael Klein** Contributed the ESD sound driver, basic support for the OPENCBM library and some other patches.
- **Frank Knig** Contributed the Win32 joystick autofire feature.
- **Bernd Kortz** Provided some fixes for ZETA and the ZETA binary package.
- **Bernhard Kuhn** Made some joystick improvements for Linux.
- **Alexander Lehmann** Added complete support for all the VIC20 memory configurations for the old VICE 0.12.
- **Ilkka "itix" Lehtoranta** Provided the routines for the cybergraphics support for the Amiga ports.
- **Wolfgang Lorenz** Wrote an excellent 6510 test suite that helped us to debug the CPU emulation.
- **Marko Mkel** Wrote lots of CPU documentation. Wrote the VIC Flash Plugin cartridge emulation in `xvic`.
- **Robert W. McMullen** Provided parts of the widget set for implementing the Xaw GUI.
- **Jennifer Medkief** Checked the windows gui dialog items in various languages for things that look wrong and suggested changes needed to make the gui more user friendly.
- **Dan Miner** Contributed some patches to the fast disk drive emulation.
- **Luca Montecchiani** Contributed a new Unix joystick driver.
- **Wolfgang Moser** Provided small optimization fixes to the GCR code, provided an excellent REU test suite and added REU fixes, and is always the good guy reviewing and commenting changes in the background.
- **Roberto Muscedere** Improved support for REL files.
- **Tomi Ollila** Donated `findpath.c`.
- **Per Olofsson** Digitalized the C64 colors used in the (old) default palette.
- **Lasse rni** Contributed the Windows Multimedia sound driver

- **Frank Prindle** Contributed some patches.
- **Giuliano Procida** Used to maintain the VICE deb package for the Debian distribution, and also helped proofreading the documentation.
- **Vesa-Matti Puro** Wrote the very first 6502 CPU emulator in x64 0.1.0. That was the beginning of the story. . .
- **Rami Rasanen** Rewrote the VIC20 sound code.
- **David Roden** Fixed various issues related to ffmpeg settings.
- **Pablo Roldn** Contributed initial patch for VIC-II PAL-N model selection.
- **Mathias Roslund** Provided the AmigaOS4 port.
- **Gunnar Ruthenberg** Provided some VIC-II enhancements and improved the Win32 port.
- **Johan Samuelsson** Provided the Swedish Amiga translations.
- **Oliver Schaertel** Wrote the X11 full screen, parts of custom ROM set support and 1351 mouse emulation for unix.
- **Peter Schepers** Contributed a document describing the G64 image format.
- **Michael Schwendt** Helped with the SID (audio) chip emulation, bringing important suggestions and bug reports, as well as the wave tables and filter emulation from his SIDplay emulator.
- **Heiko Selber** Contributed some VIC20 I/O patches.
- **John Selck** Improved the video rendering and added the fast PAL emulation. Implemented new color generation based on P. Timmermanns knowledge.
- **Chris Sharp** Wrote the AIX sound driver.
- **Andr351 "JoBBo" Siegel** Provided the native MorphOS icons.
- **Harry "Piru" Sintonen** Provided lots of fixes and improvements for the Amiga ports.
- **Manfred Spraul** Wrote the Win32 text lister.
- **Markus Stehr** Provided the MMC64 emulation.
- **Dominique Strigl** Contributed miscellaneous patches in the old X64 times.
- **Samuli Suominen** Fixed XShm includes for newer xextproto versions and updated libpng check for newer versions.
- **Steven Tieu** Added initial support for 16/24 bpp X11 displays.
- **Philip Timmermann** Did a lot of research about the VIC-II colors.
- **Brian Totty** Provided parts of the widget set for implementing the Xaw GUI.
- **Mustafa "GnoStiC" Tufan** Made improvements to the GP2x port.
- **Lionel Ulmer** Implemented joystick support for Linux and a first try of a SID emulation for SGI machines.
- **Krister Walfridsson** Implemented joystick and sound support for NetBSD.
- **webulator** Provided Win32 drag & drop support
- **Robert Willie** Added some additional commands to the fsdevice emulation.
- **Peter Weighill** Gave many ideas and contributed the ROM patcher.
- **Gerhard Wesp** Contributed the `extract` command in `c1541`.

- **Maciej Witkowiak** Did some IDE64 and C1541 fixes.
- **Kajtar Zsolt** Wrote the IDE64 interface emulation and did some small fixes.

(We hope we have not forgotten anybody; if you think we have, please tell us.)

The people around the world providing results from running our test programs on various machines deserve a special mention:

- **hedning** (Drean C64 PAL-N, various C64 PAL boxes)
- **Jason Compton** (Various C64 and C128 NTSC boxes)
- **The Woz** (Drean C64 PAL-N)
- **Thierry** (Drean C64 PAL-N)
- **MOS6569** (C64C PAL)
- **Mike** (VIC-20 PAL)
- **Wilson** (VIC-20 NTSC)
- **Vicassembly** (VIC-20 NTSC)
- **David "jbevren" Wood** (C64 NTSC-OLD)

Thanks also to everyone else for sending suggestions, ideas, bug reports, questions and requests. In particular, a warm thanks goes to the following people:

- **Lutz Sammer**
- **Ralph Mason**
- **George Caswell**
- **Jasper Phillips**
- **Luca Forcucci**
- **Asger Alstrup**
- **Bernhard Schwall**
- **Salvatore Valente**
- **Arthur Hagen**
- **Douglas Carmichael**
- **Ferenc Veres**
- **Frank Reichel**
- **Ullrich von Bassewitz**
- **Holger Busse**
- **David "jbevren" Wood**

Last but not least, a very special thank to Andreas Arens, Lutz Sammer, Edgar Tornig, Christian Bauer, Wolfgang Lorenz, Miha Peternel, Per Hkan Sundell and David Horrocks for writing cool emulators to compete with. :-)

17 Copyright

- Copyright © 1998-2011 Dag Lem
- Copyright © 1999-2011 Andreas Matthies
- Copyright © 1999-2011 Martin Pottendorfer
- Copyright © 2000-2011 Spiro Trikaliotis
- Copyright © 2005-2011 Marco van den Heuvel
- Copyright © 2006-2011 Christian Vogelgsang
- Copyright © 2007-2011 Fabrizio Gennari
- Copyright © 2007-2011 Daniel Kahlin
- Copyright © 2008-2011 Antti S. Lankila
- Copyright © 1998-2010 Tibor Biczó
- Copyright © 1998-2010 Andreas Boose
- Copyright © 2007-2010 M. Kiesel
- Copyright © 2007-2011 Hannu Nuotio
- Copyright © 1999-2007 Andreas Dehmel
- Copyright © 2003-2005 David Hansel
- Copyright © 2000-2004 Markus Brenner
- Copyright © 1999-2004 Thomas Bretz
- Copyright © 1997-2001 Daniel Sladic
- Copyright © 1996-1999 Ettore Perazzoli
- Copyright © 1996-1999 Andr Fachat
- Copyright © 1993-1994, 1997-1999 Teemu Rantanen
- Copyright © 1993-1996 Jouko Valta
- Copyright © 1993-1994 Jarkko Sonninen

This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA

18 Contact information

18.1 VICE home page

You can find the latest news about VICE at the official VICE home page:

<http://vice-emu.sourceforge.net/>

VICE has moved its source repository to public services provided by SourceForge. You can find it at

<http://sf.net/projects/vice-emu>.

We would like to thank the SourceForge staff for that help.

If you are going to report a bug, please check those pages *first*; it is possible that the problem you encountered has already been fixed with a newer version.

Please, also have a look at the VICE knowledge base at

<http://vicekb.trikaliotis.net/>

18.2 How to send feedback

Before contacting us, have a look at the VICE knowledge base at <http://vicekb.trikaliotis.net/> if your question is answered there. Keep in mind that we work on VICE in our spare-time, so the more time we don't need to answer the same questions over and over again, the more time we have to improve the emulation itself. On the other hand, that does not mean that you should not contact us, especially if you find bugs or have suggestions which might improve the emulation.

Bug reports, suggestions, support requests should be directed to the SourceForge trackers at

- http://sourceforge.net/tracker/?group_id=223021.

This way, you, the users, and we, the developers, can track what has been reported and what has been already fixed. Ideally, also sent the report to the mailing address of the Vice team at

- VICE Mailing List (vice-devel@firenze.linux.it) for all general questions, bug reports, suggestions.

You can also contact (some of) us on IRC, at #vice-dev on freenode.

It's always nice to receive feedback and/or bugreports about VICE, but please read these few notes before sending mail to anybody in the team.

- Please put the word 'VICE' *in all capitals* in your subject line (e.g., 'VICE fails to run game XXX'). This helps mail splitting and reduces chances that your message is unintentionally deleted, forgotten or lost.
- Please don't send any HTML mail (we really hate that!). If you use M\$ Outlook or Netscape Communicator, make sure you turn off the "rich text" (HTML) feature.
- Please don't send *any* binaries without asking first.
- Please read the following documents carefully before reporting a bug or a problem you cannot solve:

- the VICE documentation (you are reading it!);
- the VICE FAQ (it is available on the Internet, and reachable from the VICE home page: <http://vice-emu.sourceforge.net/>);
- The VICE knowledge base (it is available on the Internet at <http://vicekb.trikaliotis.net/>);
- the `comp.emulators.cbm` and `comp.sys.cbm` FAQs (see [Section 18.5 \[FAQs you should read\]](#), page 134).
- When you report a bug, please try to be as accurate as possible and describe how it can be reproduced to the very detail. You should also tell us what machine you are running on, what operating system you are using as well as the version of it.
- Please don't ask us how to transfer original C64 disk or tapes to your PC; this has been asked a gazillion times through email. To transfer disks, you can use the Star Commander (<http://sta.c64.org/sc.html>) on DOS, and OpenCBM (<http://www.trikaliotis.net/opencbm>) on Windows and Linux. And no, you cannot read C64 disks with your old 5"1/4 PC drive.
- Please don't ask us where to find games for the emulator on the Internet.
- Please don't ask us when the next version will be out, because we really don't know.
- Please write in English.

In any case, we would be *really* glad to receive your comments about VICE. We cannot always answer all the email, but we surely read all of it.

Thanks!

18.3 How to contribute

If you want to make a major contribution, please *ask* first. It has already happened a couple of times that somebody started working at something that had already been done but not released to the public yet, and we really do *not* want anybody to waste time.

If you are going to make a patch, please make sure the patch is relative to the very latest version, and provide us with the following:

- Make sure you are giving us a diff against the latest Subversion trunk version of VICE. For instructions on accessing the Subversion repository, first read http://sourceforge.net/svn/?group_id=223021 and get it with the command:

```
'svn co https://vice-emu.svn.sourceforge.net/svnroot/vice-emu/trunk vice-src'
```
- send a unified diff file against the trunk version of VICE (see above bullet point) by using the command: `'svn diff'` inside of the SVN workspace you checked out before.
- If you cannot use SVN for one or the other reason, send a unified diff file containing all the changes you have made `'diff -u'`; please don't use plain `'diff'`, as it adds much work for us to get it working;
- GNU-style `'ChangeLog'` entries with a description of the changes you have made (look at the `'ChangeLog'`s provided with the original VICE sources for an example).

This is very important, and makes adding patches much smoother and safer.

People willing to port VICE to other platforms are always welcome. But notice from experience it will take at least a full year of continuous work to write a well working and stable port.

18.4 Interesting newsgroups

There are some Usenet newsgroups you might be interested in:

- `comp.emulators.cbm`, discussing about emulators of Commodore 8-bit machines (definitely not Amiga emulators).
- `comp.sys.cbm`, discussing various topics regarding real Commodore 8-bit machines. This newsgroup is mainly for people who actually use original Commodore equipment (so please don't talk about emulation here).
- `comp.emulators.misc`, discussing emulators in general.

18.5 FAQs you should read

We recommend reading the `comp.emulators.cbm` and `comp.sys.cbm` FAQs, which are posted regularly on the corresponding newsgroups and are also available via FTP from <ftp://rtfm.mit.edu>.

Concept Index

+		
+cart	52	
-		
-?	14	
-1	15	
-10	15	
-11	15	
-256k, +256k	66	
-256kbase	66	
-256kimage	66	
-40col	69	
-8	15	
-80col	69	
-9	15	
-acial, +acial	64	
-attach10ro	15	
-attach10rw	15	
-attach11ro	15	
-attach11rw	15	
-attach8ro	15	
-attach8rw	15	
-attach9ro	15	
-attach9rw	15	
-autoload	15	
-autostart	15, 16	
-autostart-handle-tde, +autostart-handle-tde ...	15	
-autostart-warp, +autostart-warp	15	
-autostartprgdiskimage	15	
-autostartprgmode	15	
-autostartwithcolon, +autostartwithcolon	15	
-basic	66, 76, 84	
-basic1, +basic1	82	
-basic1char, +basic1char	82	
-basic64	68	
-basichi	68	
-basiclo	68	
-basicload, +basicload	15	
-bdesymkeymap, -bdeposkeymap	30	
-brightness	60, 67, 74, 77, 81	
-bksymkeymap, -bukposkeymap	30	
-c	117	
-c1hi	78	
-c1lo	78	
-c2hi	78	
-c2lo	78	
-c64dtvromimage	69	
-c64dtvromrw, +c64dtvromrw	69	
-cart1	84	
-cart16	52	
-cart2	72, 76, 84	
-cart4	72, 76, 84	
-cart6	72, 76, 85	
-cart8	52	
-cartA	72, 76	
-cartap	52	
-cartar2	52	
-cartar3	52	
-cartar4	52	
-cartar5	53	
-cartB	72, 76	
-cartcap	53	
-cartcomal	53	
-cartert	52	
-cartdep256	53	
-cartdep64	53	
-cartdep7x8	53	

-cartdin	53	-ciamodel	58
-cartdqbb	53	-config	14
-cartdsm	53	-confirmexit, +confirmexit	46
-carteasy	53	-console	15
-cartepyx	53	-contrast	60, 67, 74, 77, 81
-cartexos	53	-core, +core	46
-cartexpert	53	-crtblur	60, 68, 74, 77, 81
-cartfc1	54	-Crtcdscan, +Crtcdscan	81
-cartfc3	54	-Crtcdsize, +Crtcdsize	80
-cartfcplus	54	-Crtcextpal	81
-cartfe	72	-Crtcfulldevice	81
-cartff	54	-Crtchwscale, +Crtchwscale	81
-cartfm	54	-Crtcintpal	81
-cartfp	54, 72	-Crtcpalette	81
-cartgeneric	72	-Crtcscale2x, +Crtcscale2x	81
-cartgeoram	64	-Crtcvcache, +Crtcvcache	80
-cartgk	54	-CrtcVidmodefullmode	81
-cartgs	54	-CrtcXRANDRfullmode	81
-cartide64	54	-crtscanlineshade	60, 68, 74, 77, 81
-cartiee	55	-cs256k	78
-cartisepic	55	-default	14
-cartkcs	55	-device10	39
-cartmach5	55	-device11	39
-cartmd	55	-device4	40
-cartmega	72	-device5	40
-cartmf	55	-device8	39
-cartmikro	55	-device9	39
-cartmmc64	55	-diagpin, +diagpin	82
-cartmmcr	56	-digiblast, +digiblast	77
-cartmv	56	-digimax, +digimax	64
-cartocean	56	-digimaxbase	64
-cartp64	56	-directory	46
-cartramcart	56	-displaydepth	29
-cartrep256	57	-doodlecrtctextcolor	101
-cartreset, +cartreset	52	-doodlemc	101
-cartreu	64	-doodleoversize	101
-cartross	57	-doodledlum	101
-carrr	57	-dos1001	36
-cartru	57	-dos1541	36
-carts64	57	-dos1541II	36
-cartsb	57	-dos1551	36
-cartse5	57	-dos1570	36
-cartsg	57	-dos1571	36
-cartsimon	57	-dos1571cr	36
-cartss4	57	-dos1581	36
-cartss5	57	-dos2031	36
-cartstar	57	-dos2040	36
-cartultimax	52	-dos3040	36
-cartwl	57	-dos4040	36
-cartws	57	-dqbb, +dqbb	53
-cartzaxxon	57	-dqbbimage	53
-chargde	68	-dqbbimagerw, +dqbbimagerw	53
-chargen	66, 68, 76, 82, 84	-drive10extend	36
-chargfr	68	-drive10idle	36
-chargse	68	-drive10profdos, +drive10profdos	37
-chdir	15	-drive10ram2000, +drive10ram2000	36
-cia1model	58	-drive10ram4000, +drive10ram4000	36
-cia2model	58	-drive10ram6000, +drive10ram6000	36

-drive10ram8000, +drive10ram8000	37	-fsflash	70
-drive10rama000, +drive10rama000	37	-fullscreen, +fullscreen	29
-drive10type	35	-functionhi	78
-drive11extend	36	-functionlo	78
-drive11idle	36	-gamma	60, 67, 74, 77, 81
-drive11profdos, +drive11profdos	37	-georam, +georam	64
-drive11ram2000, +drive11ram2000	36	-georamimage	64
-drive11ram4000, +drive11ram4000	36	-georamimagerw, +georamimagerw	64
-drive11ram6000, +drive11ram6000	36	-georamsize	64
-drive11ram8000, +drive11ram8000	37	-gluelogictype	66
-drive11rama000, +drive11rama000	37	-go64, +go64	69
-drive11type	35	-grsymkeymap, -grposkeymap	30
-drive8extend	36	-h	117
-drive8idle	36	-h1024k	78
-drive8profdos, +drive8profdos	37	-h256k	78
-drive8ram2000, +drive8ram2000	36	-h4096k	78
-drive8ram4000, +drive8ram4000	36	-help	14, 117
-drive8ram6000, +drive8ram6000	36	-htmlbrowser	46
-drive8ram8000, +drive8ram8000	37	-hummeradc, +hummeradc	70
-drive8rama000, +drive8rama000	37	-i	114
-drive8type	35	-ic	117
-drive9extend	36	-IDE64autosize, +IDE64autosize	55
-drive9idle	36	-IDE64cyl	54
-drive9profdos, +drive9profdos	37	-IDE64hds	54
-drive9ram2000, +drive9ram2000	36	-IDE64image1	54
-drive9ram4000, +drive9ram4000	36	-IDE64image2	54
-drive9ram6000, +drive9ram6000	36	-IDE64image3	54
-drive9ram8000, +drive9ram8000	37	-IDE64image4	54
-drive9rama000, +drive9rama000	37	-IDE64sec	54
-drive9type	35	-IDE64version4, +IDE64version4	55
-dsresetwithcpu, +dsresetwithcpu	33	-iecdevice10, +iecdevice10	38
-dsspeedtuning	33	-iecdevice11, +iecdevice11	38
-dszerogapdelay	33	-iecdevice4, +iecdevice4	40
-dtvblitterlog, +dtvblitterlog	71	-iecdevice5, +iecdevice5	40
-dtvdmalog, +dtvdmalog	71	-iecdevice8, +iecdevice8	38
-dtvflashlog, +dtvflashlog	71	-iecdevice9, +iecdevice9	38
-dtvrev	70	-ieee488, +ieee488	55, 72
-easyflashcrtwrite, +easyflashcrtwrite	53	-ieee488image	55
-easyflashjumper, +easyflashjumper	53	-initbreak	44
-editor	82	-install, +install	29
-eoiblack, +eoiblack	82	-intfrom	69
-expert, +expert	54	-intfunc, +intfunc	69
-expertimagename	54	-isepic, +isepic	55
-expertimagerw, +expertimagerw	54	-isepicimagename	55
-extfrom	69	-isepicimagerw, +isepicimagerw	55
-extfunc, +extfunc	69	-joydev1	30
-extrajoydev1	30	-joydev2	30
-extrajoydev2	30	-k	117
-f	114, 117	-k<version>	117
-fewriteback, +fewriteback	72	-keepenv	85
-ffmpegaudio bitrate	101	-kernal	66, 68, 76, 82, 84
-ffmpegvideobitrate	102	-kernal64	68
-flipname	39	-kernalde	68
-fpwriteback, +fpwriteback	72	-kernalfi	68
-fs10	39	-kernalfr	68
-fs11	39	-kernalit	68
-fs8	39	-kernalno	68
-fs9	39	-kernalrev	66

-kernalse	68	-petreuramsize	83
-keybuf	15	-playback	102
-keymap	30	-plus256k, +plus256k	66
-l	114, 117	-plus256kimage	66
-lightpen, +lightpen	31	-plus60k, +plus60k	66
-lightpentype	31	-plus60kbase	66
-logfile	15	-plus60kimage	66
-mcnvramfile	72	-poskeymap	30
-mcnvramwriteback, +mcnvramwriteback	72	-pr4drv	41
-memory	75	-pr4output	40
-midi, +midi	64	-pr4txtdev	40
-mididrv	64	-pr5drv	41
-midiin	64	-pr5output	40
-midiout	64	-pr5txtdev	40
-miditype	64	-profdos1571	37
-mitshm, +mitshm	13, 29	-prtxtdev1	40
-mmc64, +mmc64	55	-prtxtdev2	40
-mmc64bios	55	-prtxtdev3	40
-mmc64bioswrite	56	-pruser, +pruser	41
-mmc64image	55	-pruserdrv	41
-mmc64readonly	56	-pruseroutput	41
-mmc64readwrite	56	-prusertxtdev	41
-mmccardimage	56	-ps2mouse, +ps2mouse	70
-mmccardrw, +mmccardrw	56	-r	114
-mmcreepromimage	56	-ram08, +ram08	85
-mmcreepromrw, +mmcreepromrw	56	-ram1, +ram1	85
-mmcrimagerw, +mmcrimagerw	56	-ram2, +ram2	85
-mmcrrescue, +mmcrrescue	56	-ram4, +ram4	85
-model	82	-ram6, +ram6	85
-modelline	85	-ramC, +ramC	85
-moncommands	44	-ramcart, +ramcart	56
-mouse, +mouse	31	-ramcartimage	56
-mouseport	31	-ramcartimagerw, +ramcartimagerw	56
-mousetype	31	-ramcartsize	56
-myaciadev	43	-raminitpatterninvert	45
-n	114	-raminitstartvalue	45
-nc	117	-raminitvalueinvert	45
-newluminance, +newluminance	60	-ramsize	78, 84
-nh	117	-refresh	27
-ntsc	45	-remotemonitor, +remotemonitor	44
-ntscold	45	-remotemonitoraddress	44
-o	114	-residfilterbias	62
-o <name>	117	-residgain	62
-oddlinesoffset	60, 68, 74, 77, 81	-residpass	62
-oddlinesphase	60, 67, 74, 77, 81	-residsamp	62
-OEMjoy, +OEMjoy	76	-reu, +reu	64
-pal	45	-reuimage	64
-paln	45	-reuimagerw, +reuimagerw	64
-parallel10	35	-reusize	65
-parallel11	35	-rom9	82
-parallel8	35	-romA	82
-parallel9	35	-romB	82
-petdww, +petdww	83	-rrbankjumper, +rrbankjumper	57
-petdwwimage	83	-rrbioswrite, +rrbioswrite	57
-petram9, +petram9	82	-rrflashjumper, +rrflashjumper	57
-petramA, +petramA	82	-rsdev1	43
-petreu, +petreu	82	-rsdev1baud	43
-petreuimage	82	-rsdev2	43

-rsdev2baud	43	-VDC16KB	67
-rsdev3	43	-VDC64KB	67
-rsdev3baud	43	-VDCdscan, +VDCdscan	67
-rsdev4	43	-VDCdsize, +VDCdsize	67
-rsdev4baud	43	-VDCextpal	67
-rsuser, +rsuser	43	-VDCfulldevice	67
-rsuserbaud	43	-VDChwscale, +VDChwscale	67
-rsuserdev	43	-VDCintpal	67
-saturation	60, 67, 73, 77, 81	-VDCpalette	67
-saveres, +saveres	46	-VDCRevision	67
-sfxse, +sfxse	65	-VDCvcache, +VDCvcache	67
-sfxsetype	65	-VDCVidmodefullmode	67
-sfxss, +sfxss	65	-VDCXRANDRfullmode	67
-sidcart, +sidcart	72, 77, 83	-verbose	15
-sidcartjoy, +sidcartjoy	78	-VICdscan, +VICdscan	73
-sidenginemodel	62	-VICdsize, +VICdsize	73
-sidfilters, +sidfilters	62	-VICextpal	73
-sidstereo	62	-VICfulldevice	73
-sidstereoaddress	62	-VIChwscale, +VIChwscale	73
-skip <n>	117	-VICIiborders	60
-sound, +sound	33	-VICIichecks, +VICIichecks	59
-soundarg	33	-VICIicheckss, +VICIicheckss	59
-soundbufsize	33	-VICIIdscan, +VICIIdscan	59
-sounddev	33	-VICIIdsize, +VICIIdsize	59
-soundfragsize	33	-VICIiextpal	59
-soundrate	33	-VICIiIhwscale, +VICIiIhwscale	59
-soundrecarg	33	-VICIiintpal	59
-soundrecdev	33	-VICIimodel	60
-soundsync	33	-VICIipalette	59
-speech, +speech	78	-VICIiscale2x, +VICIiscale2x	59
-speechrom	78	-VICIivcache, +VICIivcache	59
-speed	27	-VICIiVidmodefullmode	60
-superpet, +superpet	82	-VICIiXRANDRfullmode	60
-symdekeymap	30	-VICintpal	73
-symkeymap	30	-VICpalette	73
-t	114	-VICscale2x, +VICscale2x	73
-TEDdscan, +TEDdscan	76	-VICvcache, +VICvcache	73
-TEDdsize, +TEDdsize	76	-VICVidmodefullmode	73
-TEDextpal	77	-VICXRANDRfullmode	73
-TEDfulldevice	77	-virtualdev, +virtualdev	41
-TEDhwscale, +TEDhwscale	76	-vsid	85
-TEDintpal	77	-w<version>	117
-TEDpalette	77	-warp, +warp	27
-TEDscale2x, +TEDscale2x	76	-xsync, +xsync	29
-TEDvcache, +TEDvcache	76		
-TEDVidmodefullmode	77		
-TEDXRANDRfullmode	77		
-text	117		
-tfe, +tfe	65		
-tfeif	65		
-tferrnet, +tferrnet	65		
-tint	60, 67, 74, 77, 81		
-truedrive, +truedrive	35		
-trueflashfs, +trueflashfs	70		
-tune <number>	85		
-userportdac, +userportdac	83		
-usevicii, +usevicii	84		
-v	117		

A

ACIA (Swiftlink, Turbo232)	63
Audio buffer size	31

C

Converting X64 files into D64	12
-------------------------------	----

D

DigiMAX	63
---------	----

Double-scan mode	28
Double-size mode	28

E

Ethernet (The Final Ethernet, RR-Net)	63
---	----

G

GEO-RAM	63
---------------	----

H

HP-UX and Solaris audio problems	13
--	----

L

Limiting emulation speed	27
Loosing control on low-end systems	28

M

MIDI (Passport, Datel, Maplin, Namesoft, Sequential)	63
MITSHM	13

O

OSS/Linux problems	13
Oversampling	31

R

Refresh rate	27
reSID resampling passband	61

Index of Resources

A

Acia1Dev	42
Acia1Enable	63
Acia1Irq	43

B

Basic1	79
Basic1Chars	79
BasicName	65, 75

C

Cart2Name	83
Cart4Name	83
Cart6Name	83

reSID sampling method	61
REU	63

S

Sample rate	31
Second SID	60
Second SID base address	60
SFX Sound Expander	63
SFX Sound Sampler	63
SID filters	61
SID models	61
Sound buffer size	31
Sound speed adjustment	31
Sound suspend time	31
Sound synchronization	31
Sprite collision detection	58

T

Toggling reSID emulation	61
Turning sound playback on/off	31

U

Using XSync()	28
---------------------	----

V

VIC-II color sets	58
Video cache	28

W

Warp speed mode	27
-----------------------	----

CartridgeFile	51
CartridgeReset	51
CartridgeType	51
ChargenName	65, 75, 79
Crtc	80
CrtcDoubleScan	80
CrtcDoubleSize	80
CrtcPaletteFile	80
CrtcVideoCache	80

D

DiagPin	79
DIGIMAX	63
DIGIMAXbase	63
Directory	45
DisplayDepth	28

DoCoreDump.....	46
DosName1541	35
DosName1571	35
DosName1581	35
DosName2031	35
DQBB	51
DQBBfilename	51
DQBBImageWrite.....	51
Drive8ExtendImagePolicy.....	35
Drive8IdleMethod.....	35
Drive8ParallelCable.....	35
Drive8Type.....	35
Drive9ExtendImagePolicy.....	35
Drive9IdleMethod.....	35
Drive9ParallelCable.....	35
Drive9Type.....	35
DriveTrueEmulation	35

E

EditorName.....	79
EoiBlank.....	79
ETHERNET_ACTIVE.....	63
ETHERNET_AS_RR.....	63
ETHERNET_DISABLED.....	63
ETHERNET_INTERFACE	63
ExpertCartridgeEnabled.....	51
ExpertCartridgeMode	51
Expertfilename.....	51
ExpertImageWrite.....	51

F

FSDevice10ConvertP00	38
FSDevice10Dir	38
FSDevice10HideCBMFiles.....	38
FSDevice10SaveP00.....	38
FSDevice11ConvertP00	38
FSDevice11Dir	38
FSDevice11HideCBMFiles.....	38
FSDevice11SaveP00.....	38
FSDevice8ConvertP00	38
FSDevice8Dir	38
FSDevice8HideCBMFiles.....	38
FSDevice8SaveP00.....	38
FSDevice9ConvertP00	38
FSDevice9Dir	38
FSDevice9HideCBMFiles.....	38
FSDevice9SaveP00.....	38

G

GenericCartridgeFile2000	75
GenericCartridgeFile4000	75
GenericCartridgeFile6000	75
GenericCartridgeFileA000	75
GenericCartridgeFileB000	75
GEORAM	63

GEORAMfilename.....	63
GEORAMImageWrite.....	63
GEORAMsize.....	63

H

HTMLBrowserCommand	45
--------------------------	----

I

IDE64AutodetectSize	51
IDE64Config.....	51
IDE64Cylinders.....	51
IDE64Heads.....	51
IDE64Image1.....	51
IDE64Image2.....	51
IDE64Image3.....	51
IDE64Image4.....	51
IDE64RTCOffset.....	51
IDE64Sectors.....	51
IDE64version4.....	51
IEEE488.....	51
IEEE488Image.....	51
IOSize.....	79
IsepicCartridgeEnabled.....	51
Isepicfilename.....	51
IsepicImageWrite.....	51
IsepicSwitch.....	51

J

JoyDevice1.....	46
JoyDevice2.....	46

K

KernalName	65, 75, 79
KernalRev.....	65
KeymapBusinessDEPosFile.....	30
KeymapBusinessDESymFile.....	30
KeymapBusinessUKPosFile.....	29
KeymapBusinessUKSymFile.....	29
KeymapGraphicsPosFile.....	29
KeymapGraphicsSymFile.....	29
KeymapIndex	29
KeymapPosFile	29
KeymapSymFile	29

M

MagicVoiceCartridgeEnabled.....	51
MagicVoiceImage.....	51
MIDIEnable.....	63
MIDIMode.....	63
MITSHM.....	28
MMC64	51
MMC64_bios_write.....	52
MMC64_flashjumper.....	52

MMC64_revision.....	52
MMC64_R0.....	52
MMC64_sd_type.....	52
MMC64BIOSfilename.....	51
MMC64imagefilename.....	52
MMCRCardImage.....	52
MMCRCardRW.....	52
MMCREEPROMImage.....	52
MMCREEPROMRW.....	52
MMCRImageWrite.....	52
MMCRRescueMode.....	52
MMCRSDType.....	52
Modelline.....	83

P

Printer4.....	40
Printer4Driver.....	40
Printer4Output.....	40
Printer4TextDevice.....	39
Printer5.....	40
Printer5Driver.....	40
Printer5Output.....	40
Printer5TextDevice.....	40
PrinterTextDevice1.....	39
PrinterTextDevice2.....	39
PrinterTextDevice3.....	39
PrinterUserport.....	40
PrinterUserportDriver.....	40
PrinterUserportOutput.....	40
PrinterUserportTextDevice.....	40
PrivateColormap.....	28

R

Ram08.....	83
Ram1.....	83
Ram2.....	83
Ram4.....	83
Ram6.....	83
Ram9.....	79
RamA.....	79
RAMBlock0.....	75
RAMBlock1.....	75
RAMBlock2.....	75
RAMBlock3.....	75
RAMBlock5.....	75
RamC.....	83
RAMCART.....	52
RAMCART_R0.....	52
RAMCARTfilename.....	52
RAMCARTImageWrite.....	52
RAMCARTsize.....	52
RamSize.....	79, 83
RefreshRate.....	27
REU.....	63
REUfilename.....	63
REUImageWrite.....	63

REUsize.....	63
RomModule9Name.....	79
RomModuleAName.....	79
RomModuleBName.....	79
RRBankJumper.....	52
RRBiosWrite.....	52
RRFlashJumper.....	52
RsDevice1.....	42
RsDevice1Baud.....	42
RsDevice2.....	42
RsDevice2Baud.....	42
RsDevice3.....	42
RsDevice3Baud.....	42
RsDevice4.....	42
RsDevice4Baud.....	42
RsUserBaud.....	43
RsUserDev.....	43
RsUserEnable.....	43

S

SaveResourcesOnExit.....	46
SFXSoundExpander.....	63
SFXSoundExpanderChip.....	63
SFXSoundSampler.....	64
SidEngine.....	61
SidFilters.....	61
SidModel.....	61
SidResidPassband.....	62
SidResidSampling.....	62
SidStereo.....	61
SidStereoAddressStart.....	61
Sound.....	31
SoundBufferSize.....	32
SoundDeviceArg.....	32
SoundDeviceName.....	32
SoundSampleRate.....	32
SoundSpeedAdjustment.....	31
SoundSuspendTime.....	32
Speed.....	27
SuperPET.....	79

U

UseVicII.....	83
UseXSync.....	28

V

VICDoubleScan.....	73
VICDoubleSize.....	73
VICIICheckSbColl.....	58
VICIICheckSsColl.....	58
VICIIDoubleScan.....	59
VICIIDoubleSize.....	59
VICIIPaletteFile.....	59
VICIIVideoCache.....	58
VICPaletteFile.....	73

VICVideoCache 73
VideoSize..... 79
VirtualDevices..... 41

W

WarpMode..... 27

Table of Contents

1	GNU GENERAL PUBLIC LICENSE	1
	Preamble.....	1
	TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION.....	2
	How to Apply These Terms to Your New Programs	6
2	About VICE	7
2.1	C64 emulator features.....	7
2.2	C64DTV emulator features.....	7
2.3	C128 emulator features.....	8
2.4	VIC20 emulator features	8
2.5	PET emulator features	8
2.6	CBM-II emulator features.....	9
2.7	The keyboard emulation.....	9
2.8	The joystick emulation	10
2.9	The disk drive emulation	10
2.10	Supported file formats	12
2.11	Common problems	13
2.11.1	Sound problems.....	13
2.11.2	Shared memory problems	13
2.11.3	Printer problems	13
2.11.4	PET keyboard problems	14
3	Invoking the emulators.....	14
3.1	Command-line options used during initialization.....	14
3.2	Autostarting programs from the command-line	16
4	System files	16
4.1	ROM files.....	17
4.2	Keymap files.....	19
4.3	Palette files	20
4.4	Romset files.....	21
5	Basic operation	21
5.1	The emulation window	21
5.2	Using the menus	22
5.3	Getting help	22
5.4	Using the file selector	22
5.5	Using disk and tape images	23
5.5.1	Previewing the image contents.....	23
5.5.2	“Autostarting” an image	24
5.5.3	Using compressed files.....	24

5.5.4	Using Zipcode and Lynx images	24
5.6	Resetting the machine.....	25
6	Settings and resources	25
6.1	Format of resource files.....	26
6.2	Using command-line options to change resources.....	26
6.3	Performance settings	27
6.3.1	Performance resources	27
6.3.2	Performance command-line options	27
6.4	Video settings.....	28
6.4.1	Video resources	28
6.4.2	Video command-line options.....	29
6.5	Keyboard settings.....	29
6.5.1	Keyboard resources	29
6.5.2	Keyboard command-line options.....	30
6.6	Joystick settings	30
6.6.1	Joystick command-line options	30
6.7	Sound settings	31
6.7.1	Sound resources	31
6.7.2	Sound command-line options	33
6.8	Tape settings	33
6.8.1	Tape command-line options	33
6.9	Drive settings	33
6.9.1	Drive resources	35
6.9.2	Drive command-line options	35
6.10	Peripheral settings	37
6.10.1	Settings for file system devices	37
6.10.1.1	Resources for file system devices.....	38
6.10.1.2	Command-line options for file system devices	38
6.10.2	Printer settings	39
6.10.2.1	Printer resources	39
6.10.2.2	Printer command-line options	40
6.10.3	Disabling kernal traps.....	41
6.10.3.1	Resources to control Kernal traps.....	41
6.10.3.2	Command-line options to control Kernal traps.....	41
6.11	RS232 settings.....	41
6.11.1	RS232 resources.....	42
6.11.2	RS232 command-line options	43
6.11.3	RS232 usage example	43
6.12	Monitor settings	44
6.12.1	Monitor command-line options	44
6.13	Machine settings.....	44
6.13.1	Machine command-line options	45
6.14	Memory settings.....	45
6.14.1	Memory command-line options	45
6.15	Miscellaneous settings.....	45
6.15.1	Miscellaneous resources	45
6.15.2	Miscellaneous command-line options.....	46

7	Machine-specific features	46
7.1	C64/128-specific commands and settings	47
7.1.1	Using cartridges	47
7.1.1.1	Slot 0	47
7.1.1.2	Slot 1	47
7.1.1.3	Main Slot	48
7.1.1.4	I/O Slot	49
7.1.1.5	Expected behaviour	50
7.1.1.6	Common problems	50
7.1.1.7	IEEE-488 interface	50
7.1.1.8	The Final Cartridge 3	51
7.1.2	C64 cartridge settings	51
7.1.2.1	C64 cartridge resources	51
7.1.2.2	C64 cartridge command-line options	52
7.1.3	CIA settings	58
7.1.3.1	CIA command-line options	58
7.1.4	VIC-II settings	58
7.1.4.1	VIC-II resources	58
7.1.4.2	VIC-II command-line options	59
7.1.5	SID settings	60
7.1.5.1	SID resources	61
7.1.5.2	SID command-line options	62
7.1.6	C64 I/O extension settings	62
7.1.6.1	C64 I/O extension resources	63
7.1.6.2	C64 I/O extension command-line options	64
7.1.7	C64/128 system ROM settings	65
7.1.7.1	C64/128 system ROM resources	65
7.1.7.2	C64/128 system ROM command-line options	66
7.1.8	C64 settings	66
7.1.8.1	C64 command-line options	66
7.2	C128-specific commands and settings	66
7.2.1	VDC settings	66
7.2.1.1	VDC command-line options	67
7.2.2	C128 system ROM settings	68
7.2.2.1	C128 system ROM command-line options	68
7.2.3	C128 settings	69
7.2.3.1	C128 command-line options	69
7.3	C64DTV-specific commands and settings	69
7.3.1	C64DTV ROM image	69
7.3.2	DTV revision	70
7.3.3	LumaFix	70
7.3.4	Userport	70
7.3.5	Debug	70
7.3.6	Monitor DTV features	71
7.4	VIC20-specific commands and settings	71
7.4.1	Using cartridge images	71
7.4.2	VIC20 cartridge settings	72
7.4.2.1	VIC20 cartridge command-line options	72

7.4.3	VIC settings	73
7.4.3.1	VIC resources	73
7.4.3.2	VIC command-line options	73
7.4.4	Changing memory configuration	74
7.4.4.1	VIC20 memory configuration resources	75
7.4.4.2	VIC20 memory configuration command-line options ..	75
7.4.5	VIC20 system ROM settings	75
7.4.5.1	VIC20 system ROM resources	75
7.4.5.2	VIC20 system ROM command-line options	76
7.4.6	VIC20 settings	76
7.4.6.1	VIC20 command-line options	76
7.5	PLUS4-specific commands and settings	76
7.5.1	TED settings	76
7.5.1.1	TED command-line options	76
7.5.2	PLUS4 I/O extension settings	77
7.5.2.1	PLUS4 I/O extension command-line options	77
7.5.3	PLUS4 system ROM settings	78
7.5.3.1	PLUS4 system ROM command-line options	78
7.5.4	PLUS4 settings	78
7.5.4.1	PLUS4 command-line options	78
7.6	PET-specific commands and settings	78
7.6.1	Changing PET model settings	79
7.6.2	CRTC Settings	80
7.6.2.1	CRTC resources	80
7.6.2.2	CRTC command-line options	80
7.6.3	The PET diagnostic pin	82
7.6.4	PET command line options	82
7.6.5	Changing screen colors	83
7.7	CBM-II-specific commands and settings	83
7.7.1	Changing CBM-II model	83
7.7.2	CBM-II command line options	84
7.7.3	Changing screen colors	85
7.8	VSID-specific commands and settings	85
7.8.1	VSID settings	85
7.8.1.1	VSID command-line options	85
8	Snapshots	86
8.1	Snapshot usage	86
8.2	Snapshot format	86
8.2.1	Emulator modules	86
8.2.1.1	x64 modules	86
8.2.1.2	x128 modules	87
8.2.1.3	xvic modules	87
8.2.1.4	xpet modules	88
8.2.1.5	xcbm2 modules	88
8.2.1.6	Drive modules	89
8.2.2	Module formats	89
8.2.2.1	Terminology	89

8.2.2.2	Module framework	89
8.2.2.3	CPU module	90
8.2.2.4	CIA module	91
8.2.2.5	VIA module	92
8.2.2.6	PIA module	92
8.2.2.7	TPI module	93
8.2.2.8	RIOT module	93
8.2.2.9	SID module	94
8.2.2.10	ACIA module	94
8.2.2.11	VIC-I module	94
8.2.2.12	VIC-II module	94
8.2.2.13	CRTC module	94
8.2.2.14	C64 memory module	96
8.2.2.15	C128 memory module	97
8.2.2.16	VIC20 memory module	97
8.2.2.17	PET memory module	98
8.2.2.18	CBM-II memory module	100
8.2.2.19	C500 data module	101
9	Media images	101
9.1	Media images command-line options	101
10	Event history	102
10.1	Event history command-line options	102
11	Monitor	102
11.1	Terminology	102
11.2	Machine state commands	103
11.3	Memory commands	104
11.4	Assembly commands	106
11.5	Checkpoint commands	106
11.6	General commands	107
11.7	Disk commands	108
11.8	Command file commands	109
11.9	Label commands	109
11.10	Miscellaneous commands	110
12	c1541	111
12.1	Specifying files in c1541	111
12.2	Using quotes and backslashes	111
12.3	c1541 commands and options	112
12.4	Executing shell commands	113
12.5	c1541 examples	113
13	cartconv	113
13.1	cartconv command line options	114
13.2	cartconv examples	116

14	petcat	117
14.1	petcat command line options	117
14.2	petcat examples	118
15	The emulator file formats	119
15.1	The T64 tape image format	119
15.1.1	T64 File structure	119
15.1.2	Tape Record	119
15.1.3	File record	119
15.2	The G64 GCR-encoded disk image format	120
16	Acknowledgments	124
17	Copyright	131
18	Contact information	132
18.1	VICE home page	132
18.2	How to send feedback	132
18.3	How to contribute	133
18.4	Interesting newsgroups	134
18.5	FAQs you should read	134
	Concept Index	134
	Index of Resources	139