Turbo Chameleon 64
User Manual

Draft Version (Beta 9c)

24/01/15

1. Contents

2. Getting started

Thank you for purchasing an Individual Computers product. The Chameleon is one of the most complex projects that we've ever made for any computer, and it will take much more than this user manual to explain all the features and possibilities of this cartridge. Take your time to read all of this document.

You've been made aware a number of times that the current state of the firmware is beta, and we appreciate that you've bought the unit anyway. If you find any bugs, please report them either directly to Individual Computers, or to the Yahoo mailing list:

http://tech.groups.yahoo.com/group/chameleon_64/

This is where the developers meet, and where your questions will be answered by the people who made the cartridge. We will also make important announcements on that list, so even if you don't have anything to report, please subscribe to that list.

Please download the latest version of the FPGA Core and ChaCo, the Chameleon Control software, from:

http://wiki.icomp.de/wiki/Chameleon

2.1. What's in the Box?

- upper left corner: mini USB cable (for data transfers, 180cm)

- middle bottom: Turbo Chameleon 64 :-)

- upper right corner: breakout cable with connectors for USB (power supply, 80cm), keyboard and mouse (both PS/2, 20cm), IEC (DIN, 20cm)

- a short user manual (which you do not need any more now that you have found this one)

A battery (CR-1220) required to make use of the RTC feature is **not** included and must be supplied by the user. See page 61, 12.5 Opening the Cartridge.

2.2. Operation in standalone mode
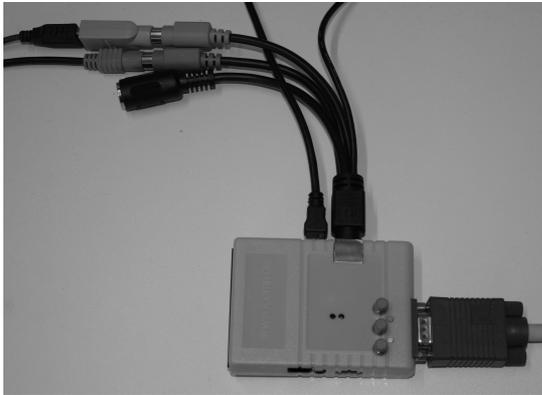
In stand-alone mode, you will need at least the breakout cable to connect to Chameleon, because it will provide power to the cartridge. Make sure that the power supply can deliver at least the 2.5W (5V and 500mA) that's specified for a USB connection. The Chameleon hardware will take about 2 Watts of power, so make sure that your keyboard and mouse don't overload the power supply! Most PCs don't have any trouble supplying Chameleon with power. Note that some PCs don't provide power without a data connection on a USB port. In that case, please use a separate power supply.

Connect your monitor to the VGA output. By default the Turbo Chameleon 64 FPGA core uses a standard 800x600 mode with a refresh rate of 72Hz. Some monitors don't support this high frequency. Please consult your monitor's manual if you have any trouble with Chameleon's VGA output.

Connect your keyboard to the purple PS/2 connector, and your mouse to the green PS/2 connector. The IEC connector can be left open. If you want to use ChaCo with the cartridge, you also need to connect the mini-USB cable to that PC. (see chapter 6 ChaCo, the Chameleon Control Software)

2.2.1. Using the docking station

The Chameleon docking station extends the available ports of your Chameleon by the following:

- four joystick ports
- one C64 keyboard connector
- one Amiga 500 keyboard connector
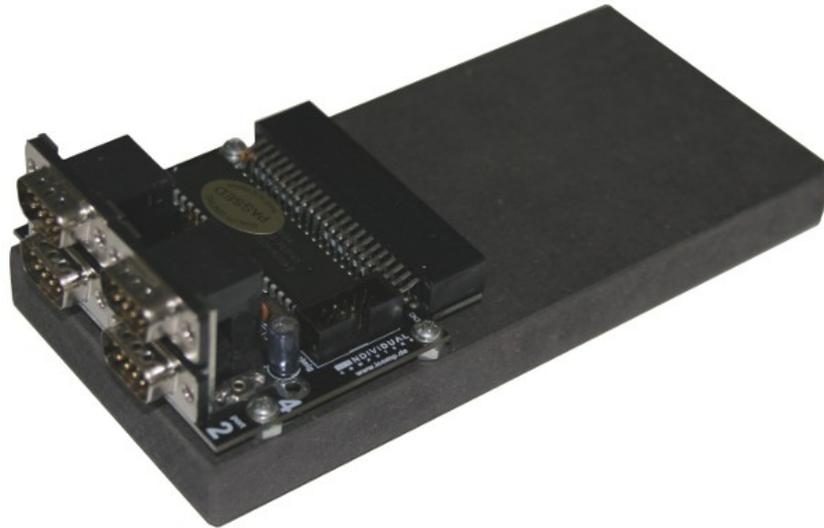
Both keyboard connectors are keyed, which means that they have a missing pin in order to help you finding the correct orientation of the connector. However, the A500 keyboard connector is not always keyed, so you have to take a close look at the colours. The black wire of the A500 keyboard is marked next to the connector. Wrong connection may destroy both, the docking station and the keyboard! Better double-check before you apply power to the unit.

All C64 keyboards that we have encountered have been keyed. There is no danger when plugging in the keyboard the wrong way round – you will just observe funny behaviour. Caution: This only applies to the Chameleon docking station! You may actually destroy a C64 if you connect the keyboard the wrong way round!

Please download and install Chameleon core Beta-7 or higher before you use the docking station. It's available from http://wiki.icomp.de/wiki/Chameleon. Older cores will not support the docking station, and the ports won't be of any use to you. For flashing, please disconnect all external hardware: Remove the mouse, remove the PS/2 keyboard and remove the SD card from the slot. Do not connect the docking station to Chameleon when you're updating the flash!

There is only one way that Chameleon fits the docking station: It's with the button side up. Slide the cartridge all the way in until the black connector is at least covered half by the Chameleon. Make sure that there's proper contact between the docking station and the Chameleon – the cartridge may not be tilted at all.
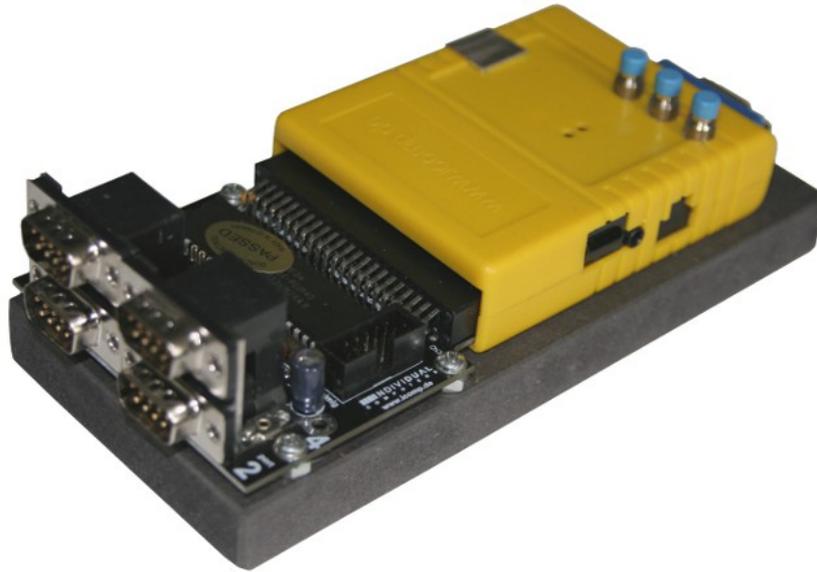
Connect the breakout cable and supply power to the whole setup through the USB connector of the breakout cable. Make sure that your power supply is strong enough! With the docking station, we recommend to use a 5V/1000mA power supply. If available, use a 5.2V/1000mA power supply, but **never** use any higher voltage than 5.2V. Only use regulated power supplies.

2.3. Operation in cartridge mode

WARNING: Chameleon is a C64 cartridge. **It does not work in the C128.** Don't even try, as this **might cause damage to the computer, the cartridge or both.** Don't experiment, it can not work and you risk damage to valuable equipment that's not covered by warranty.

WARNING: Also, Chameleon does not work in cartridge port expanders – neither as the only cartridge, nor together with other cartridges. It will only work if it's plugged directly to the C64. **Don't experiment with combinations of cartridges!** It cannot work, and you risk damage to valuable equipment that's not covered by warranty.

2.3.1. Operation on a C64

Remove the protective plastic from the Chameleon expansion connector. Just push it in and rotate it until it comes out – be gentle, there's no force required! The brown rubber is glued in place. Don't try to peel it out, it is required if you want to put the protection back in. The rubber will not conflict with the C64's expansion port.
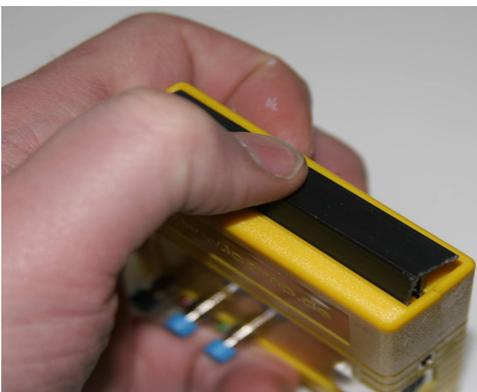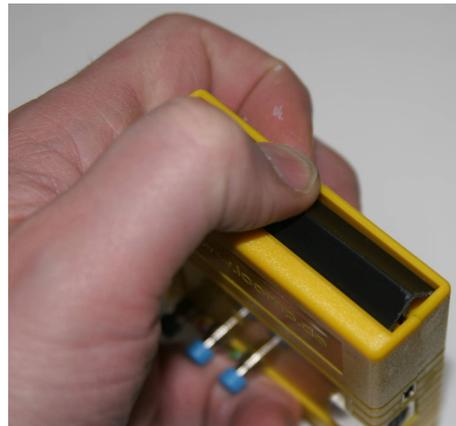
Now insert the cartridge into the C64 expansion port with the buttons facing up. Connect your VGA monitor to the VGA output of Chameleon. At this point, we recommend to also connect your old 15kHz screen, so you can compare the output of Chameleon against the output of the original VIC chip.

Use of the breakout cable is optional on the C64. If you want to use a PS/2 keyboard or mouse, you'll need it.

If you want to use the ChaCo software with this setup, you also need to connect the mini-USB cable to your PC. (see chapter 6 ChaCo, the Chameleon Control Software)

Note for SX-64 users

- If for some reason the Chameleon fails to start the menu system, power-cycle the computer and hold "2" during power-on. This will make the menu use a fail safe configuration (skips booting from SD card and copying ROMs from C64)

- There seems to be a timing problem that makes copying ROMs from the C64 fail on some SX-64s, this will result in a crash when exiting the menu system. If this is the case, disable the "copy ROMs from C64" option (see chapter 5.4 Options), write options and power-cycle the computer. Optionally you can enable "boot from SD card" and put a SX-64 kernal (or whatever else you want to use) ROM image on it (see chapter 5.1 Boot Loader).

2.4. Sound output

Chameleon and C64 each have their own audio outputs, the Chameleon doesn't get the audio from the C64 and the C64 doesn't get the audio from the Chameleon so each must be connected seperately.

The Chameleon has a stereo output (it can emulate 2 SIDs). You connect it to your speakers with an 3.5 mm stereo-audio plug similar what portable players and many laptops have. You need speakers with build-in amplifier (or separate amplifier as Chameleon doesn't have one).

3. Updating the Chameleon

Each release archive contains a combined ChaCo, core and software update. The two files needed to update manually (*.rbf for the core and *.bin for the menu and ROMs) can be found in the UPDATE directory. The CHAM64 directory contains files used by the menu system, such as the online help. Just copy the entire directory to the root of your SD card.

Updates are made available at <u>http://wiki.icomp.de/wiki/Chameleon</u> on a regular basis. Please make sure that you are running the latest firmware and are using the latest version of ChaCo before reporting problems.

3.1. Updating using update.prg

Copy the UPDATE directory and UPDATE.PRG to the root of your SD card (or simply unpack the entire release archive to it), insert the SD card and power-cycle the Chameleon. (If you are updating from beta-7a or earlier, run UPDATE.PRG from the file-browser.)

In addition to the files contained in the release archive, the UPDATE directory may contain the following custom ROM files:

- "BASIC.ROM" - C64 basic ROM
- "KERNAL.ROM" - C64 kernal ROM
- "CHARGEN.ROM" - C64 character ROM
- "MMC64.ROM" - MMC64 BIOS ROM
- "SLOT1.ROM" - Cartridge slot 1 ROM (*1)
- "SLOT2.ROM" - Cartridge slot 2 ROM (*1)
- "DRIVE1.ROM" - 1541 drive 1 ROM
- "DRIVE2.ROM" - 1541 drive 2 ROM

*1) Cartridge ROMs must be plain binaries (without load address), NOT .crt files. Files in proper format can be created by the ROM saver (see chapter 5.5.2 User / File menu). Cartridges which are bigger than 64k can not be used in slot 1 and 2, see chapter 12.4 supported Cartridge types for details. To make cartridges readily available for use, the respective cartridge type must be configured in the settings first (see chapter 5.4 Options).

It is highly recommended to first test custom ROM files by loading them from SD card (see 5.1 Boot Loader) before flashing them permanently. Flashing broken ROM files may render the C64 unusable (you will have to fix it by updating the chameleon via USB in that case).

3.2. Updating via USB

3.2.1. Preparations

Before updating your Chameleon, please make sure that it has sufficient power. Any and all trouble that has been reported so far was related to power problems that were caused by external power draining. To be safe, please:

- disconnect the Chameleon docking station

- disconnect the PS2 keyboard

- disconnect the PS2 mouse

- you MUST remove the SD/MMC card from the card slot (else you will get an error message and can not update)

If you are using a USB charger as your power supply, please make sure it's a 1000mA type. Although Chameleon takes just over 400mA of power, many 500mA types are already at their limit with a Chameleon. If possible, use a 5.2V/1000mA type instead of 5V/1000mA. However, do **not** go over 5.2V for supply voltage!

3.2.2. Using the updater program

Windows users just double-click the `update.exe` file in Windows explorer and follow the instructions on screen. In Windows 8 and above use right mouse click and choose "Run as Administrator" (on `update.exe`).

Linux und OSX users may run the respective updater program from a terminal. Since the executable bit of the binary is not preserved in the archive, you will have to set it manually first like this:

```
$ sudo chmod +x ./update-linux32
```

After that run the updater as root:

```
$ sudo ./update-linux32
```

3.2.3. Using ChaCo

You may also update the Chameleon manually using ChaCo or chacocmd, you can find the required files in the UPDATE directory. (See chapter 6.5.2 Flashing a Core)

3.3. If something goes wrong

First, don't panic :) There is no way to "brick" the Chameleon by updating, the Chameleon might not start, but it can always be fixed by updating with a valid FPGA core image. In case updating using UPDATE.PRG failed (please report this), re-try updating via USB (see 3.2 Updating via USB above).

If you have trouble flashing, try again. Before a re-try:

- Double check that you have sufficient power. Maybe try another USB port.

- Make sure to select the correct files (when updating manually)

- PLEASE POWER-CYCLE YOUR CHAMELEON. It may then give an error-blink on the red LED, but there's nothing to worry about. Updating will fix it.

4. Overview

Upon power-up, Chameleon will load the OS from its on board flash. It will then start the menu system which lets you perform various actions. (see chapter 5 Chameleon Menu System)

The outermost button (right button) is your reset button. The middle button is the freeze and menu button. The left button can be used to perform various actions such as change disks in the emulated floppy.

Press and hold the reset button for more than 0.7 seconds to re-launch the Chameleon core. This is (almost) equivalent to a fresh power-up. Press and hold the Freeze button for more than 0.7 seconds to enter the menu system.

Button	PS/2 Key	remote	Function
Left button	F11	GENLOCK	Multi purpose, see chapter 5.4 Options
Middle button	F12	CD/TV	Freeze, hold longer than 0.7s to enter menu
Right button	PrntScrn	POWER	Reset, enter menu if "reset to menu" option is enabled

4.1. Flash memory organization

There is a flash chip built into Chameleon that's purely for system purposes and hence can't be utilized by the user. The flash carries FPGA cores and their respective ROM files. The FPGA core is the true core of Chameleon's operations – it defines the hardware behaviour. If we fix a bug in the hardware (such as a VIC effect emulation or register functions of a freezer), we will provide the fix in the form of an FPGA core file.

The size of the on-board flash is 16 MByte, organized in 16 slots of 1 MByte each. Every slot can carry one FPGA core and the corresponding ROM file. If Chameleon is powered up, the FPGA is started from slot number 0.

If starting the FPGA was not successful, then the micro-controller will tell you so by sending out a blink code on the red LED of Chameleon. The blink code will tell you which slot was attempted to be used. Just count the number of blinks, subtract one and you'll know which slot of the flash chip is corrupted. If for example slot 0 is corrupted, then the LED will flash once, then pause for a second and start over. If the LED blinks four times, then slot number three is the one you should take a closer look at.

4.2. Using disk images

4.2.1. Disk slot organization

There are two emulated 1541 floppy drives of which each handles up to 4 different disk images which can be mounted via the file browser and then changed by pressing the left button (see chapter 5.4 Options).

4.2.2. Mounting images

Before you can mount a disk image, one of the emulated drives must be enabled, and to use more than one disk slot per drive, the left button must be configured accordingly (see chapter 5.4 Options).

To mount a D64 or G64 image press CBM+M on the selected image or RETURN on a PRG file inside an image (see chapter 5.5.1 Keys). You will then be prompted to select a drive and whether to start a new list ("first disk") or to add the image to the existing list ("next disk") for this drive. Starting a new list means that all mounted images for this drive will get unmounted and the selected image will become the first image in the list for the selected drive.

4.2.3. Unmounting images

To write changes made to a mounted image back to the D64 file on SD card you will either have to make a copy manually (see chapter 5.5.2 User / File menu) or unmount it by pressing CBM+U (see chapter 5.5.1 Keys). Also the menu will check if changes to an image have been made when entering the menu system and when mounting images, and ask whether the image on SD card should get updated or not.

WARNING: If you choose to ignore this the menu system will "forget" about the respective image being changed and not ask again. You will have to make sure to save the image manually if you want to keep these changes.

Note: due to the current limits of the drive emulation, G64 images will not get written back automatically (as the disk layout is not exactly preserved, which would most likely result in a corrupted G64)

4.3. Using cartridges

Please note that a real-world cartridge consists of two major building blocks: The hardware, and the software. By switching a slot to a specific cartridge type, you merely select the hardware, but you don't have the contained software yet. Real C64 cartridges bring their software typically on EPROMs, which are emulated in the RAM space of Chameleon. Just choosing a cartridge type for a slot therefore does not mean that you actually can already use the cartridge, because it would appear like an empty shell to the computer. Compared to a real-world cartridge, it can be compared to removing the EPROM chips from the cartridge and then plugging it into the computer, which will not work.

Note that the EPROM contents of the Retro Replay freezer and the MMC64 come with every menu system, which is why you can use these cartridges after power-up and without an SD-card. However, it would be a waste of memory space to keep all the EPROM contents of all supported cartridges in the menu system: They would not even fit in Chameleon's memory! This is why all other cartridges require the use of a .crt or .rom file containing a binary image of the cartridge EPROM. Please see chapter 4.3.2 Mounting cartridge images below for a detailed description of how to use cartridge image files.

4.3.1. Cartridge slot organization

There are 4 cartridge slots. Slot 1 and 2 can hold cartridges of max. 64k, slot 3 and 4 can hold max 1Mb. Slot 1 and 2 will get loaded from flash when the Chameleon boots, by default there is a PAL Retro Replay ROM in slot 1 and an NTSC Retro Replay ROM in slot 2. Additional/other cartridge ROMs can be loaded by the boot-loader (see chapter 5.1 Boot Loader) or by the CRT loader in the file-browser (see chapter 5.5 File Browser). Slot 3 is configured as expert cartridge by default, and slot 4 remains empty.

4.3.2. Mounting cartridge images

Cartridge images can be mounted by the boot loader (see chapter 5.1 Boot Loader) or the file browser. In the file browser simply press return on a ROM or CRT file. Unless configured to always use slot 4, you will be asked which cartridge slot to use and the cartridge will be started.

Note that ROM files must be in a Chameleon specific layout (which may be different from what you get from converting a CRT file to a flat binary using common tools such as cartconv), you can create such files using the ROM saver in the file browser (see chapter 5.5.2 User / File menu). Also when using ROM files, you will have to set up the correct cartridge type manually.(see chapter 5.4 Options).
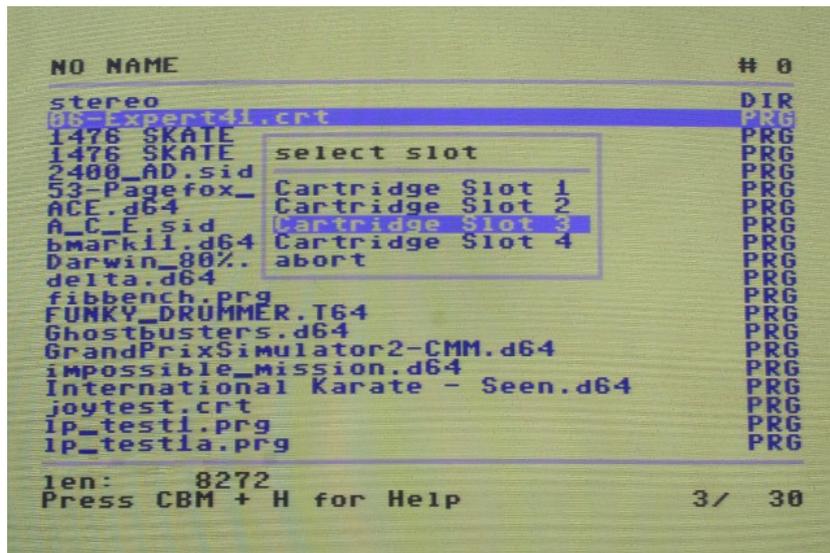
4.3.3. some notes on specific cartridges

Expert Cartridge

The original expert cartridge has a 3-position switch that is emulated by the left button on the Chameleon. The button configuration must be set to "cartridge" when using the expert emulation. A short press toggles the expert emulation between ON and OFF (green LED is lit when the cartridge is on). A long press puts the expert in programming mode PRG (green LED is flashing when the cartridge is in programming mode).

Please understand that this manual cannot cover the use of all cartridges in detail. Using this cartridge requires software on a disk (image) that is not included with Chameleon.

As the Expert Cartridge is RAM based, it's contents may change – you may save the current contents by using the ROM saver, see 5.5.2 User / File menu below.

Easyflash

The Flash-ROM chip of the Easyflash is not emulated. Instead if the EAPI signature is found in the first ROM bank, the EAPI area will get replaced by one that properly updates the chameleon's RAM. That means actually flashing it using the regular programming tool will not work (because there is no flash chip) – but cartridges that incorporate the EAPI will.

You may save the current contents by using the ROM saver, see 5.5.2 User / File menu below.

Retro Replay

The Flash-ROM chip of the Retro Replay is not emulated. To permanently replace the default ROM you may flash it as described in 3.1 Updating using update.prg above.

MMC64

The Flash-ROM chip of the MMC64 is not emulated. To permanently replace the default ROM you may flash it as described in 3.1 Updating using update.prg above.

4.4. using custom ROM images

You may use custom ROM files that replace the kernal, basic and character ROMs of the c64 or the ROM of the emulated 1541 floppy drives. To do this you may either place the respective ROM images in the CHAM64 directory and enable booting from SD card (see chapter 5.1 Boot Loader below) or load the respective images through the file browser (see chapter 5.5 File Browser).

Note that loading custom ROM images has several implications. For example loading a broken kernal will make the C64 crash, loading an invalid character ROM will eventually render the menu system unusable.

Also note that the timing of the drive emulation is not perfect yet, which causes problems with some speed loaders whose timing is very much "on the edge". One such known case is Jiffy DOS on PAL setups, which is even unreliable on some real C64s, so problems are expected.

5. Chameleon Menu System

5.1. Boot Loader

The boot loader is executed once at start-up, it's job is to do some basic initialization:

- load the configuration data from flash

- set up default MMU mapping

If "copy ROMs from C64" is enabled:

- copy C64 kernal- and basic-ROM to Chameleon RAM

If "UPDATE.PRG" is present:

- load and execute "UPDATE.PRG" (Chameleon updater)

If "boot from SD-card" is enabled:

- load a custom menu binary "MENU.BIN" (if present)

- load a REU image "BOOT.REU" (if present)

- load a GEORAM image "BOOT.GEO" (if present)

- load a custom boot program "BOOT.PRG" (if present)

- load custom ROMs from "/CHAM64" directory (if present):

  - "CHAM64/BASIC.ROM" - C64 basic ROM

  - "CHAM64/KERNAL.ROM" - C64 kernal ROM

  - "CHAM64/CHARGEN.ROM" - C64 character ROM

  - "CHAM64/MMC64.ROM" - MMC64 BIOS ROM

  - "CHAM64/SLOT1.ROM" - Cartridge slot 1 ROM (*1)

  - "CHAM64/SLOT2.ROM" - Cartridge slot 2 ROM (*1)

  - "CHAM64/SLOT3.ROM" - Cartridge slot 3 ROM (*1)

  - "CHAM64/SLOT4.ROM" - Cartridge slot 4 ROM (*1)

  - "CHAM64/DRIVE1.ROM" - 1541 drive 1 ROM

  - "CHAM64/DRIVE2.ROM" - 1541 drive 2 ROM

and finally:

- if a boot program was loaded, execute it. If not, execute the menu system.

*1) Cartridge ROMs must be plain binaries (without load address), NOT .crt files. Files in proper format can be created by the ROM saver (see chapter 5.5.2 User / File menu). Cartridges which are bigger than 64k can only be used in slot 3 and 4, see chapter 12.4 supported Cartridge types for details. To make cartridges readily available for use after loading, the respective cartridge type must be configured in the settings (see chapter 5.4 Options).

5.1.1. Hotkeys during boot process

At start-up the boot loader will check the following "magic keys":

key	remote	
Space	0	Presse and hold down when loading core to see config-ROM messages (pause before starting the boot-loader). This shows the FPGA core version and current mode.
← (Arrow left)	ESCAPE	Hold down when loading core to skip boot loader (see NOTE)
1		Hold to force default configuration.
2		Hold to force fail safe configuration
3		Hold to skip menu
Any other		Hold to see boot-loader messages (pause before starting the menu application)

NOTE

When skipping the boot loader, a hard-coded default setup will be used (MMC64 + PAL Retro Replay) which is meant for testing and to eventually recover from a broken boot loader and/or menu system.

If you press the menu button to enter the menu after skipping the boot-loader, the result will be that the boot loader will run and initialize the Chameleon the same way as if was not skipped - meaning various settings may change or even a boot program may get executed.

Bottom line: Usually the boot loader should not be skipped. If you don't want the Chameleon to start up with the menu system, use the "skip menu at boot" option (see chapter 5.4 Options). This will then result in the Chameleon starting up using the settings used in the options menu, and further freezing/ restarting will work as expected.

5.1.2. Limitations of the boot-loader

- MMC, SD, SDHC cards supported (max. medium size: 32GB)
- File-system must be FAT12, FAT16 or FAT32
- no long file-names

The limits of the boot-loader do not apply to the file-browser, see chapter 5.5.6 Limitations of the file-browser below.

5.2. Keys

The menu system can be controlled by the following keys / buttons:

Key	PS/2 Key	Remote	Joy #2	Function
<- (arrow left) RUN/STOP	ESCAPE	ESCAPE		exit menu/one level up
Cursor up/down	Cursor up/down	PLAY/STOP	up/down	navigate up/down
Cursor left/right	Cursor left/right	REW/FWD	left/right	enter sub menu/toggle item
RETURN	Enter	ENTER	Fire	enter sub menu/toggle item
F1	Page up	1		Page up
F2	F2	2		Go to first menu item
F7	Page down	7		Page down
F8	F8	8		Go to last menu item

5.3. Main Menu

This is the main user interface and provides access to all features of the Chameleon core.
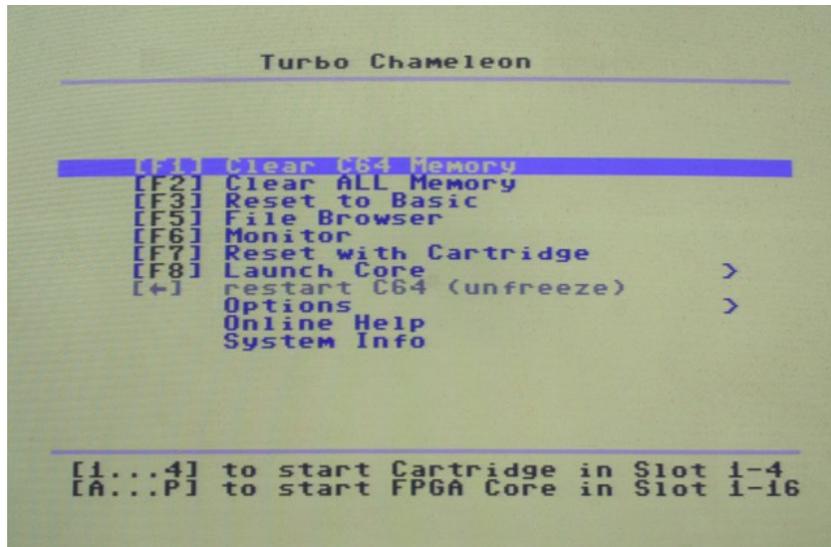
Hotkey	Menu Option	Function
F1	Clear C64 Memory	fill C64 memory with zeros and reset
F2	Clear ALL Memory	fill C64 memory, reu, georam with 0 and reset
F3	Reset to Basic	reset with all cartridges and expansions disabled
F5	File Browser	enter file browser (see chapter 5.5 File Browser)
F6	Monitor	enter machine language monitor (see chapter 5.6 ML Monitor)
F7	Reset with Cartridge	reset with selected default cartridge enabled
F8	Launch Core	start another FPGA core
← (Arrow left)	restart C64 (unfreeze)	restart currently running program (*1)
	Options	enter options menu
	Online Help	Enter help system (see chapter 5.7 Online Help)
	System Info	show some general info
1..4		start with cartridge in slot 1..4
A..P		start FPGA core slot 1-16

*1) Only if the menu was entered by pressing the menu button ("freeze"). Not all options can/will be changed when restarting, see chapter 5.4 Options NOTE.

5.4. Options
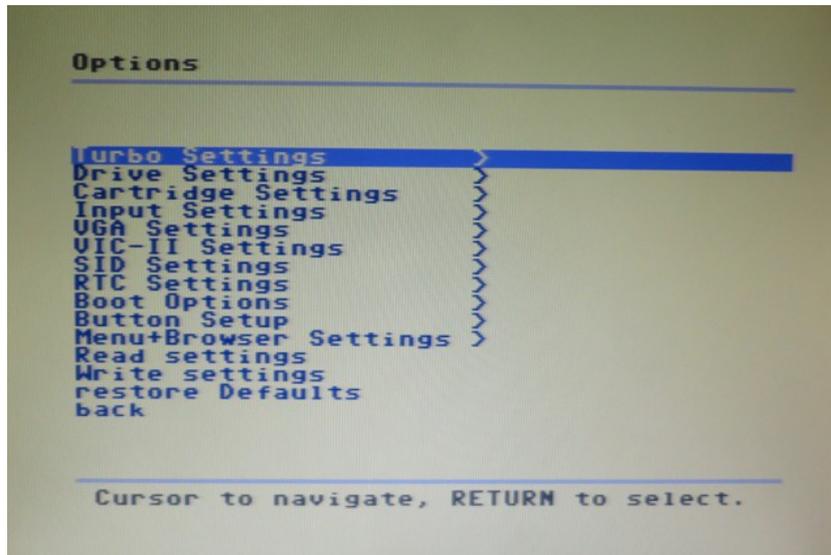
5.4.1. CPU Turbo

Option	
Turbo Mode	Enable turbo mode.
Turbo Speed Limit	Set maximum speed if turbo is enabled.
Turbo d030 bit	Enable emulation of the VIC-IIe (C128) 2Mhz bit.
Turbo IEC sensitive	When enabled, the turbo will automatically slow down on IEC accesses. It is recommended to always have this enabled.

5.4.2. Emulated drives

Option	
Emu Drive 1 Device ID	Set device number for first emulated drive. This option can not be changed while a disk image is mounted.
Emu Drive 2 Device ID	Set device number for second emulated drive. This option can not be changed while a disk image is mounted.
Update mounted images	Set whether the menu should ask to update mounted image, or never or always update them automatically.
IEC bus connection	Choose whether the IEC bus of the emulated drive is connected internally or only to the breakout cable (use this if you want to use the Chameleon as a standalone drive emulator).
Real C64 IEC bus	Enable / disable the C64's IEC bus. SX-64 users may use this to "disconnect" the internal drive.
Reset emulated Drives	Send a reset to all emulated IEC devices.

5.4.3. Cartridges and Memory Expansions

Option	
MMC64	Enable MMC64 emulation.
default Cartridge	Set default cartridge slot used by "reset with cartridge" and with "browser exec setup" set to "custom"
Cartridge Type Slot 1	Set type of cartridge in slot 1. (see chapter 12.4 supported Cartridge types)
Cartridge Type Slot 2	Set type of cartridge in slot 2. (see chapter 12.4 supported Cartridge types)
Cartridge Type Slot 3	Set type of cartridge in slot 3. (see chapter 12.4 supported Cartridge types)
Cartridge Type Slot 4	Set type of cartridge in slot 4. (see chapter 12.4 supported Cartridge types)
Cartridge mount slot	Set whether the menu should ask for the cartridge slot to use or to always use slot 4 when loading a cartridge image file in the file browser.
Clock Port	Select clock port mapping. If "auto" is selected, then the clock-port will be mapped to de02 if RR is active, to df20 if MMC64 is active and RR is not, and disabled in all other cases.
RR-NET MAC Address	Set default MAC Address for RR-NET.
REU Size	Enable REU and set emulated size.
GeoRAM Size	Enable GeoRAM and set emulated size.

These settings can not be changed if "browser exec setup" is set to "compatible" (because then the browser will disable them anyway). Also changes to these settings will not get applied when unfreezing (instead the respective registers will be restored by the freezer), so to apply them you will have to reset through the menu. See NOTE below.

5.4.4. Input devices

Option	
PS/2 Mouse	Auto-detect or disable emulated mouse.
PS/2 Mouse port	Set port for emulated mouse.
IR Receiver	Toggle CDTV IR enable.

5.4.5. VGA output

Option	
VGA Mode	Set display mode/resolution used for VGA output.
VGA Buffers	Selects number of VGA frame-buffers (Single, Double, Triple). When triple buffering is enabled, the current frame is blended with the previous frame to reduce frame-rate conversion artefacts (jerky scrolling, strange looking interlace pictures).
VGA Filter	Selects VGA scaling filter (nearest neighbour, Scale2x, Alien)
VGA Scanlines	Select the amount of scanline shading to simulate the look of a CRT (off, 75% brightness, 50% brightness, 25% brightness)
VGA VIC-II sync	When enabled, the VGA output is synced to the VIC-II. When used with 50 or 60 Hz modes this enables perfect scrolling and interlace.
VGA Mode Test	Test selected mode and options. Press RETURN once to switch to selected mode, then RETURN again to confirm or any other to switch back to previous settings.
VGA Debug Overlay	Toggle VGA debug overlay.

Note: due to the varying capabilities of VGA monitors it is hard to give general advice on what the "best" settings are. We recommend doing the following:

- start with all settings at their respective default (Mode: 800x600@72Hz, Buffers: Single, Filter: nearest neighbour, VIC-II sync: off)
- now try finding a 50Hz (PAL) or 60Hz (NTSC) mode that your monitor is capable of displaying.
    - If you found one, try enabling VIC-II sync
- if you can not use a 50 or 60 Hz mode, choose one of the available standard modes
    - choose suitable VGA Buffer setting (Double buffering removes tearing, Triple buffering adds frame blending)

5.4.6. Emulation settings

Option	
VIC-II type	Choose VIC-II type. This setting has no effect in cartridge mode.
VIC-II VGA Output	Enable VIC-II output to VGA. Disabling this will allow to use the frame-buffer from within a running program.
SID Emulation	Select type and mapping of emulated SID(s)
SID Real Stereo Chip	Select type and mapping of real SID(s). This setting has no effect in standalone mode.
SID Type (first)	Toggle between 6581 (old) and 8580 (new) for first SID
SID Type (second)	Toggle between 6581 (old) and 8580 (new) for second SID

5.4.7. RTC

Option	
RTC Time	Set current Time (Hours:Minutes:Seconds).
RTC Date	Set current Date (Day:Month:Year).
RTC Weekday	Day of the week. This item is informal only and can not be changed directly.

5.4.8. Boot-loader settings

Option	
boot from SD card	Enable loading various files at boot time (see chapter 5.1 Boot Loader).
boot skips menu	If enabled the C64 starts with default cartridge.
copy ROMs from C64	Copy basic- and kernal- ROM from C64 at boot time.

5.4.9. Button settings

Option	
Left Button	Select function for the leftmost button (see chapter 5.4.12 Buttons below).
Reset goes to menu	If enabled, pressing reset goes to menu instead of resetting the emulated C64.

5.4.10. File Browser and Menu settings

Option	
Browser Exec Setup	Execution setup that applies when starting programs and/ or cartridges via the file browser. "custom" will use the setup from config menu, "compatible" will disable most things and configure a bare stock C64.
Browser auto sort	When enabled, always sort SD cards directories.
Browser start-up	Browser may start in 1 or 2 panel mode.
Browser charset	The character set used by default.
Menu colour scheme	Select menu colour scheme.
Menu input scheme	Select input scheme (*)

(*) When "CDTV remote" is selected as input scheme that has the following consequences:
- Some features will get deactivated because they are not usable without a keyboard. (ML Monitor in the main menu)
- The "Mount" and "Unmount" features are called by F5 and F6

5.4.11. Load and Save the settings

Option	
Read Settings	Read configuration from flash.
Write Settings	Write configuration to flash to make it permanent.
restore Defaults	Restore default configuration.
back	Go back to main menu.

5.4.12. Buttons

Left

The left button is the multi-purpose button of the Chameleon core and can be configured to be used as the following:

Option	Function
Menu	Start the menu system
File-browser	Start the menu system and directly go to the File-browser
Monitor	Start the menu system and directly go to the ML Monitor
Cartridge	Short: cartridge on/off Long: Emulated cartridge button (see chapter 4.3 Using cartridges)
Turbo	Enable / Disable the CPU turbo
Disk Drive 1	Short button press: Cycle through mounted disk images on drive 1 Long button press: select first mounted disk image
Disk Drive 2	Cycle through mounted disk images on drive 2 Long button press: select first mounted disk image

Middle

The middle button is generally used as the "freezer" button. A "short" button press (shorter than 0.7 seconds) will activate the freezer of an activated cartridge (such as retro replay or the final cartridge 3). A "long" button press (longer than 0.7 seconds) will activate the menu freezer and go to the main menu of the menu system.

Right

The right button is the "reset" button. Generally a "short" button press (shorter than 0,7 seconds) will reset the C64, and a "long" button press (longer than 0,7 seconds) will reload the Chameleon core (equalling a "hard" reset, or power-cycle).

If "reset goes to menu" is enabled, then the menu system will be started on every reset (instead of resetting the C64).

NOTE

All options will generally, and always, get applied when leaving the menu. However there are some exceptions that apply when the menu was entered by "freezing" using the menu button and then "unfreezing" the running C64. This is needed so for example Chameleon-aware programs can also be interrupted.

- Cartridge settings have no effect when unfreezing (would almost certainly result in a crash anyway, and this way interrupting a game cartridge is possible). You will have to reset through the menu to apply new cartridges settings.

- Changing GEORAM or REU settings will have no effect when unfreezing. (again, this would almost certainly result in a crash anyway).

- VIC-II settings have no effect when unfreezing. (this allows to interrupt Chameleon-aware programs that change them)

- Turbo settings will be copied from the register(s) to the options when entering the menu by freezing. (so they can be changed after freezing, and restarting does not alter them otherwise)

A Chameleon-aware program should generally not touch any of the above settings (or their respective registers), with the following exceptions (which are handled by the freezer and not altered when unfreezing):

- enabling config mode

- Register settings (`CFGREG`)

- Turbo settings (`CFGTUR`)

- Cartridge settings (`CFGCRT`)

- GEORAM and REU settings (`CFGREU`)

- VIC-II extension settings (upper 4 bits of `CFGVIC`)

- MMU settings (all MMU registers)

- all Cartridge registers, with the following precautions:

  - freezing during an ongoing SPI transfer (RTC, flash, SD-card) is impossible to handle, for this reason the result is completely undefined.

  - freezing while RR-NET is in use, and then entering a menu option that uses it may result in undefined behaviour when restarting.

  - freezing during a REU transfer may be problematic, although the menu itself does not use the REU registers.

5.5. File Browser

Press F5 in the main menu to enter the file browser:
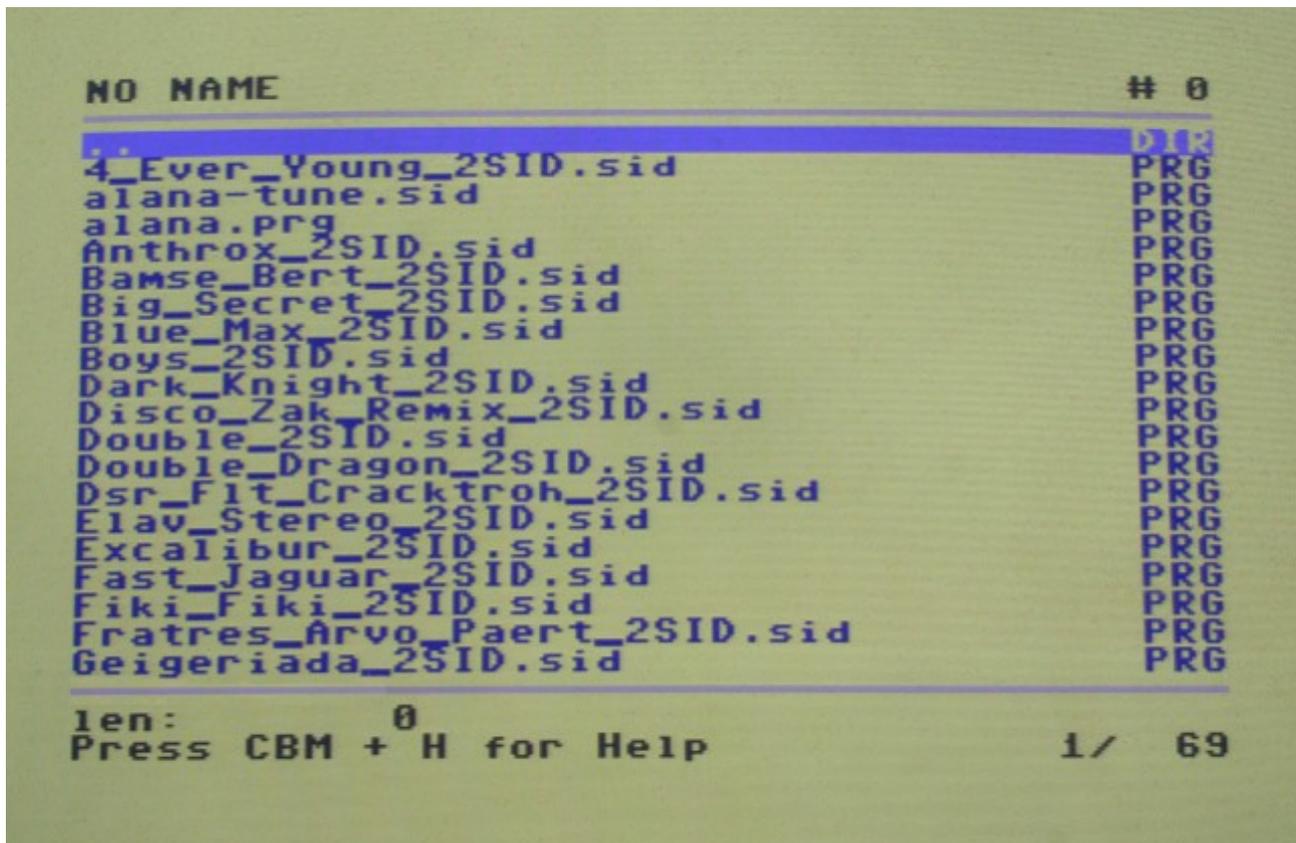
5.5.1. Keys

C64 Key	PS/2 Key	Remote	Joy #2	
← (Arrow left) "RUN/STOP"	ESCAPE	ESCAPE		exit file browser
Cursor up/down	Cursor up/down	PLAY/ STOP	Up/ Down	navigate up/down
Cursor left/right	Cursor left/right	REW/ FWD	Left/ Right	choose left or right tab
F1 / F7	Page up/down	1 / 7		page up / page down
F2 / F8	F2 / F8	2 / 8		start / end of list
A - Z	A - Z			Quickfind – type filename to jump to with max 500ms delay between keypresses
RETURN	Enter	ENTER	Fire	enter directory, open file
F3	F3	3		view file
F4	F4	4		user menu (see chapter below)

C64 Key	PS/2 Key	Remote	Joy #2	
F5	F5	5		Copy file
F6	F6	6		copy image
£ (Pound)	F9			select SD-card (device 0)
1..7, 8..0	1..7, 8..0			select IEC device 11-17,8-10
+ / -	F10 / "-" (US) "ß" (DE)	VOL UP/ DOWN		choose device number
@	"[" (US) "Ü" (DE)			send DOS command (to IEC drive)
CBM + H	ALT + H			show quick reference / help
CBM + P	ALT + P			toggle panel size
CBM + R	ALT + R			(re)read directory of active panel
CBM + S	ALT + S			sort directory of active panel
CBM + M	ALT + M			mount image file
CBM + U	ALT + U			Unmount images
CBM + L	ALT + L			load file
CBM + E	ALT + E			load and execute file. note that this will NOT mount the image it is used in and just load the selected file.
CBM + D	ALT + D			delete file or directory (must be empty)
CBM + N	ALT + N			rename file
CBM + X	ALT + X			View file as hex dump
CBM + T	ALT + T			View file as text
space		0		File action menu (see below)
⇑ (Arrow up)	"\" (US) "#" (DE)			toggle upper-/lower-case display

5.5.2. User / File menu

The user/file menu is brought up by pressing F4 any time in the file browser: (currently only on SD-card)
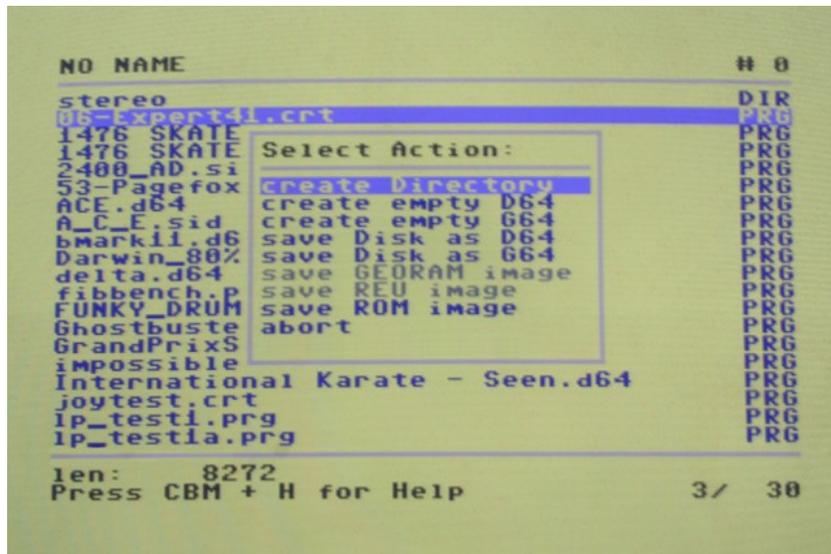
| Menu option	Function
create Directory	creates a new directory
create empty D64	creates an empty D64 file
create empty G64	creates an empty G64 file (*1)
save Disk as D64	save contents of a mounted disk as D64 image (*2)
save Disk as G64	save contents of a mounted disk as G64 image (*3)
save GEORAM image	save current GEORAM content to a file (*4)
save REU image	save current REU content to a file (*4)
save ROM image	save content of various ROMs to a file
abort	Abort menu

*1) Note that the created file will really be empty, as in a blank disk - it must be formatted before it can be used.

*2) Note that the limits of the D64 format apply. This item will not be available if no disk has been mounted.

*3) Note that current limits of the drive emulation apply. This item will not be available if no disk has been mounted.

*4) These items will not be available if GEORAM or REU are not enabled.

5.5.3. File-Action menu
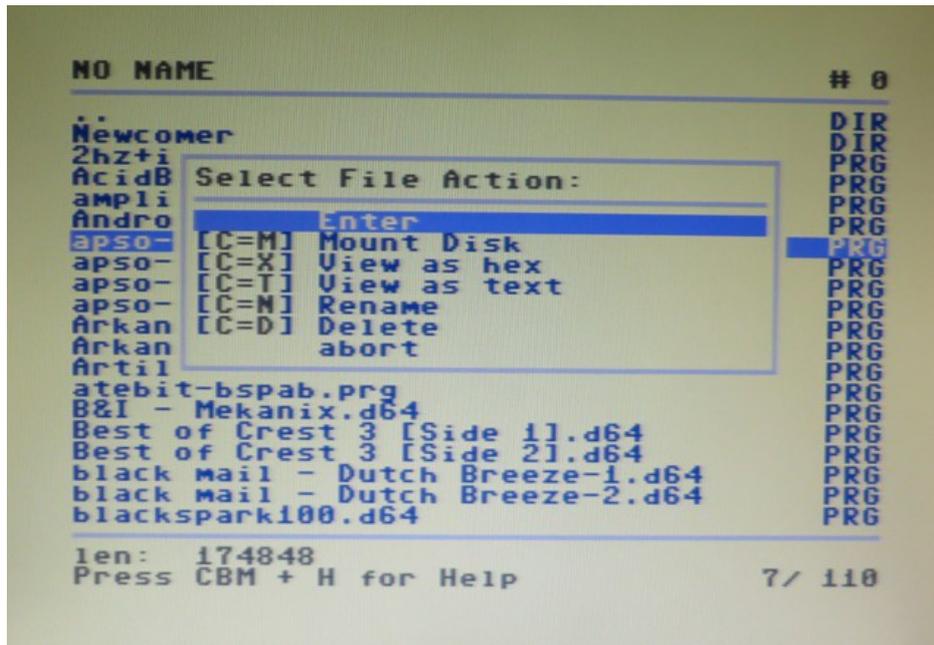
This menu is "context sensitive" and shows possible operations depending on the currently selected file. It can be invoked at any time using **space**.

5.5.4. Supported File types

Extension	File type
`.d64`	1541 Disk image
`.t64`	C64S Tape image (read only)
`.g64`	1541 GCR image
`.sid`	Playsid SID tune
`.mus, .str`	Compute Gazette (stereo) Sidplayer tune
`.prg`	Plain program file (with load address)
`.p00`	Plain program file (PC64 format)
`.crt`	CCS64 Cartridge Image. Also see chapter 12.4 supported Cartridge types
`.reu`	REU image
`.geo`	GEORAM image
`.rom`	ROM images
`.koa`	Koala Paint image
`.rpm`	Runpaint image
`.cdu`	CDU Paint image
`.blp`	Blazing Paddles image
`.pmg`	Paint Magic image
`.art, .ocp`	OCP Art Studio image (v1 and v2)
`.ddl`	Doodle image
`.hed`	Hi-Eddi image
`.hpi`	Hires Picture (same as Art Studio v1)
`.txt`	Ascii text file
`.wav`	Windows WAVE file. Supported formats are: 11khz mono, 11khz stereo, 22khz mono, 44khz mono, 48khz mono.

5.5.5. Plugins

default action: (RETURN)

Type	Action
`.d64`	enter image
`.t64`	enter image
`.g64`	mount G64 image (see chapter 4.2.2 Mounting images)
`.sid`	play sid file
`.mus, .str`	Play sidplayer tune
`.wav`	Play .wav file.
`.prg`	load and execute. inside images also mount image.
`.p00`	load and execute
`.crt`	load and start cartridge image. (see chapter 12.4 supported Cartridge types)
`.reu`	load REU image
`.geo`	load GEORAM image
`.rom`	load ROM images
`.koa`	view Koala Paint image
`.rpm`	view Runpaint image
`.cdu`	view CDU Paint image
`.blp`	view Blazing Paddles image
`.pmg`	view Paint Magic image
`.art, .ocp`	view OCP Art Studio image (v1 and v2)
`.ddl`	view Doodle image
`.hed`	view Hi-Eddi image
`.hpi`	view Hires Picture (same as Art Studio v1)
`.txt`	view text file
other	view hex file

mount action: (CBM + M)

Type	Action
`.d64`	mount disk image on emulated drive (see chapter 4.2.2 Mounting images)
`.g64`	mount disk image on emulated drive (see chapter 4.2.2 Mounting images)
`.rom`	load ROM images

load action: (CBM + L)

Type	Action
.prg	load prg file to C64 memory (*)
.p00	load prg file to C64 memory
.reu	load REU image
.geo	load GeoRAM image
.rom	load ROM images

*) note that this will NOT mount the image it is located in and just load the selected file.

execute action: (CBM + E)

Type	Action
.prg	load and run prg file (*)
.p00	load and run file.
.crt	load and start cartridge image. see chapter 12.4 supported Cartridge types

*) note that this will NOT mount the image it is located in and just load the selected file.

view action: (F3)

Type	Action
.koa	view Koala Paint image
.rpm	view Runpaint image
.cdu	view CDU Paint image
.blp	view Blazing Paddles image
.pmg	view Paint Magic image
.art, .ocp	view OCP Art Studio image (v1 and v2)
.ddl	view Doodle image
.hed	view Hi-Eddi image
.hpi	view Hires Picture (same as Art Studio v1)
.txt	view text file
.sid	play sid file
.mus, .str	Play sidplayer tune
.wav	Play .wav file.
other	view file as hex dump. this is also the fallback used in some other cases when a certain action is not available. Use CBM+X and CBM+T to explicitly view a file as hex dump or text instead.

copy file: (F5)

Type	Action
any	Copy file (to other panel)

To copy a file, switch to two panel mode (CBM+P) and press F5 (on any file).

This currently works on SD card and IEC drives in both directions. Write support for (d64) images is work in progress and currently disabled.

copy image: (F6)

Type	Action
.d64	write .d64 file to drive (other panel)

To read an image from an IEC drive to a file, switch to two panel mode (CBM+P), then change to the drive panel and press F6 (on any file).

5.5.6. Limitations of the file-browser

- MMC, SD, SDHC cards supported (max. medium size: 32GB)

- File-system must be FAT12, FAT16 or FAT32

- max. 1023 entries per directory

- max. 40 characters per file-name (including extension and the dot) are displayed

- max. 255 characters per file-name are handled before the name is replaced by its short 8.3 file-name.

- For speed reasons, file-types will only be determined by looking at the file extension (and not by reading their header)

5.6. ML Monitor
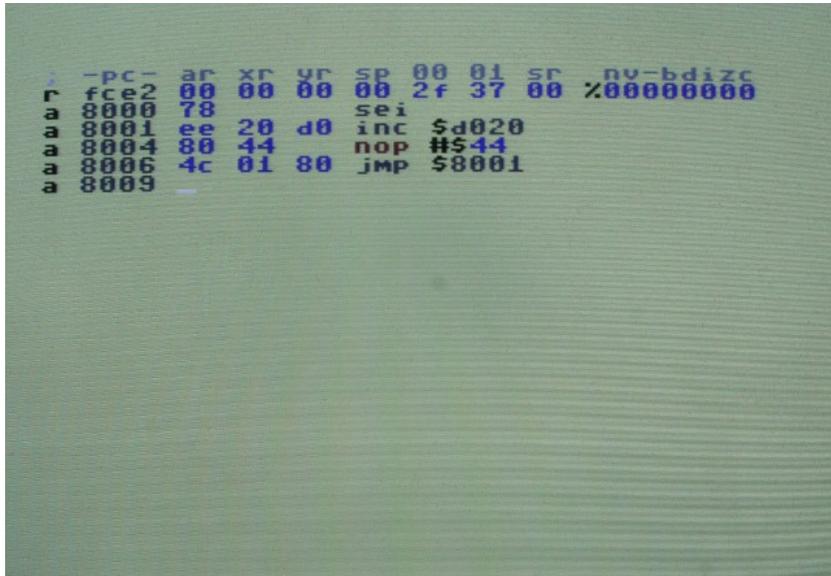
5.6.1. Features

- illegal opcodes for assembling and disassembling
- The whole 32Mb memory can be accessed via bank switching.
- edit binary, character maps, sprite maps
- edit CPU registers and I/O registers to be set when you leave the monitor and then unfreeze

5.6.2. Number formats

By default all numbers are interpreted as hexadecimal, unless stated differently. A specific format can be specified using the prefixes:

Prefix	Base	
&	10	decimal
$	16	hexadecimal
%	2	binary

5.6.3. Converting values

To convert values just type them on a line and press return – it will then be shown in hexadecimal, binary and decimal notation.

5.6.4. Commands

`*`

Switches to bank 0 (C64 memory), and toggles between ROM and RAM mapping.

`@`

DOS wedge. A single @ shows the device number and status of the currently active device `@$` shows the directory of the active device. `@<device>` changes the active device, where 0 represents the SD-card. `@<command>` sends a regular CBM DOS command, where the SD-card device can be used with the following:

`i`	**i**nitialize	(re) initialize the SD-card
`cd`	**c**hange **d**irectory	Change active working directory

`$`

A single $ shows the directory of the current device

`a`ssemble `<addr>`

enter assembly code

`b`ank `<addr>`

set upper 9 bits of memory address.

`c`ompare `<start>` `<limit>` `<dest>`

Compare command, compare block from start to limit with block at dest

`d`isassemble `<addr>`

show disassembly

`f`ill `<start>` `<limit>` `<byte1>` `[<byte2> ...]`

Fill an address range with a byte pattern

`g`o `<addr>`

Start program on given address. If parameter is omitted use freezer address.

`h`unt `<start>` `<limit>` `<byte1>` `[<byte2> ...]`

Search for byte(s) in an address range

`io` `<addr>`

show/edit i/o area

`l`oad `"<filename>"` `<addr>`

load a PRG file to memory. If the address is omitted the load address found in the PRG file is used

`memory <addr>`

> show/edit memory

`mchar <addr>`

> Show/Edit chars

`msprite <addr>`

> Show/Edit sprite

`registers`

> Show/Edit CPU registers

`save "<file name>" <start addr> <end addr+1> <new start>`

> Save a block of memory to a PRG file. If `<new start>` is given then this address will be used as load adress for the resulting PRG file.

`transfer <start> <end> <dest>`

> Transfer command, copy block from start to end to dest

`x`

> exit monitor (goes back to main menu)

5.7. Online Help

To use the online help, please copy the `CHAMHELP.HLP` file into the `CHAM64` directory of your SD card.

Please note that the help file is work in progress, it will get updated when time permits.

5.7.1. Keys

The help system can be controlled by the following keys / buttons:

Key	PS/2 Key	Remote	Function
<- (arrow left) RUN/STOP	ESCAPE	ESCAPE	exit to main menu
RETURN	Enter	ENTER	Go to main screen
F1	Page up	1	Previous page
F2	F2	2	Go to last visited page
F7 SPACE	Page down	7	Next page

additionally, cross linked pages can be accessed by pressing the highlighted hotkeys.

5.8. System Info

The system info screen shows some basic information, such as the menu software version, the currently used FPGA slot, the RTC time and some details on the inserted SD card.

6. ChaCo, the Chameleon Control Software

ChaCo is an application that uses WxWidgets for the GUI. This makes it look different from other (Windows) applications, but gives us the chance to compile it for Linux or for the Mac.

6.1. Preparations

Please notice that due to the way ChaCo accesses the USB port, it may need to run as administrator (windows) or root (linux) respectively.

6.1.1. Linux / Mac OSX

Because the executable bit for the binaries are not preserved in the release archive, you will have to set them manually like this:

```
$ sudo chmod +x ./Chaco ./chacocmd
```

If you want to be able to run Chaco or chacocmd as a regular user without using sudo and typing your password all the time, you can change it to "suid root" like this:

```
$ sudo chown root:root ./Chaco ./chacocmd
```

```
$ sudo chmod u+s ./Chaco ./chacocmd
```

6.2. Linux notes

We currently provide a dynamically linked 32- and 64- bit linux binary with the following dependencies:

- libc 2.6
- libusb v1.x
- wxwidgets 2.8 (and related render engine, eg GTK). Only needed for the GUI.

6.3. Mac OSX notes

Included in the release package is a OSX binary kindly provided by Christian Vogelgsang. It has the following requirements:

- Intel or PowerPC based Mac
- Mac OS X 10.5 or higher

This port does not include the GUI yet. See chapter 6.7 chacocmd below.

6.4. Overview

With a Chameleon connected, ChaCo will open with this screen:
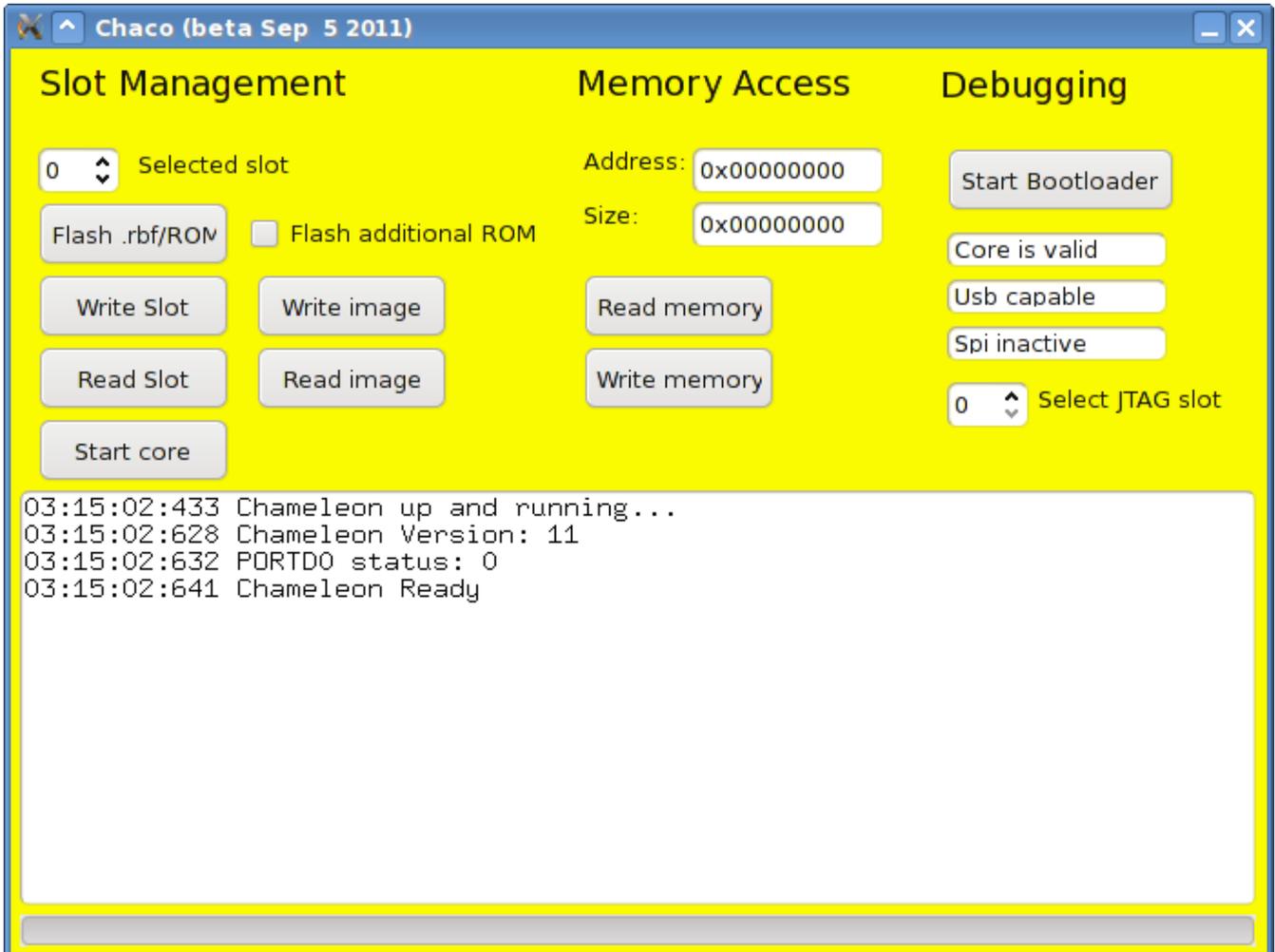
6.4.1. Slot Management

Selected slot: Enter the number of the slot that you want to flash /read/write/start into this field.

Flash .rbf/ROM: This button starts the flash procedure of writing a core to a selected slot. (see chapter 6.5.2 Flashing a Core)

Flash additional ROM: Tick this box if you want to add a rom file to the core file. Some cores may not need a rom file, some other cores will *require* a rom file to work properly. Please read the documentation of the core you're about to flash. Remember that this box must be ticked *before* clicking the "**Flash .rbf/ROM**" button.

"**Read Slot**" and "**Write Slot**" will let you backup/restore one flash slot into or from a single file.

The buttons "**Read image**" and "**Write image**" will let you backup/restore the whole 16MByte flash into or from a single file.

Start Core: Click this button to launch the selected slot.

6.4.2. Memory Access

Address: address of memory block to read/write

Size: size of memory block

Read memory, **Write Memory**: These will let you access the memory of the running FPGA core (see chapter 6.5.3 Accessing memory).

6.4.3. Debugging

Start Boot-loader: Start boot-loader of the USB micro-controller to prepare it for reprogramming. WARNING: you usually will not need to do this. The Chameleon will have to be power cycled to resume normal operation.

Select JTAG slot: This is a setting for FPGA developers. If you launch the FPGA through the JTAG interface, the micro-controller will report this number to the core. It will behave as if the FPGA was launched from this slot.

6.4.4. Status display

The three fields "Core is valid", "USB capable", "SPI inactive" are status fields. You cannot enter anything here.

"Core is valid" is shown if the Chameleon is currently running a valid FPGA core. "Core is invalid" indicates invalid core data. (see chapter 6.5.1 Starting a core below)

"USB capable" means that the running core supports memory access using ChaCo (see chapter 6.5.3 Accessing memory below)

SPI active / SPI inactive shows whether the SPI bus is/was active. This is only useful for debugging ChaCo itself and will be removed later, it will show "inactive" most of the time.

6.5. Examples

6.5.1. Starting a core

Let's cause an error, so you can see the LED blink: Set "selected slot" to 6 and click on the "Start Core" button.
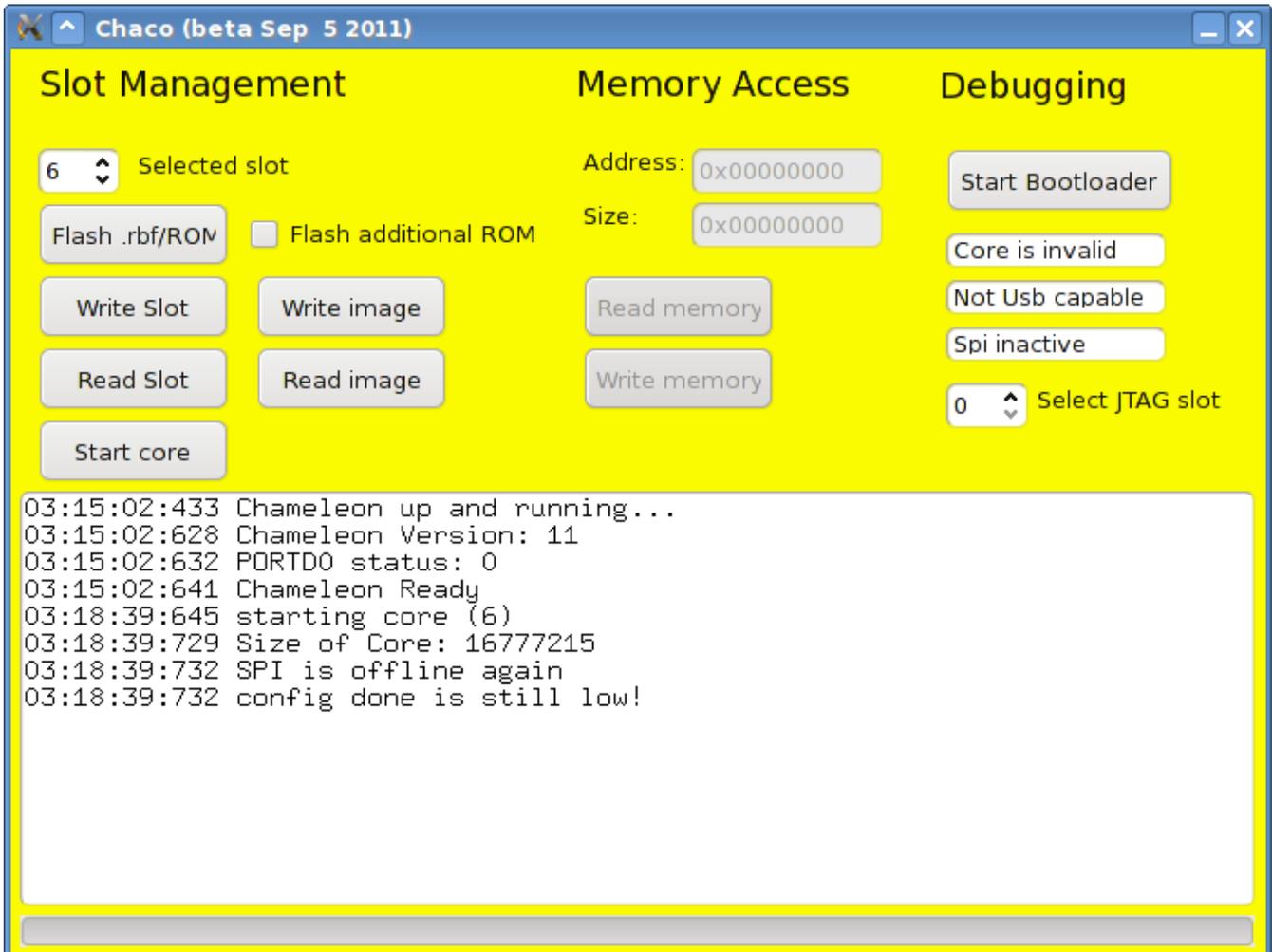
The error message in the window reflects what you should see on Chameleon: The red LED should blink seven times, then pause, then start over with blinking.

Now set "selected slot" back to 0 and click on the "Start Core" button. The Turbo Chameleon core should now start again.

6.5.2. Flashing a Core

First of all, remove the SD card from the Chameleon. (The internal flash memory and the SD card use the sampe SPI bus internally, which sometimes causes flashing to fail)

Now set the Selected slot number back to 0. Tick the box "**flash additional ROM**" and click on "**Flash .rbf/ROM**". Two file requesters will open – please observe closely what each file requester is for! The first file you need to choose is the FPGA core, the second file is the ROM file that belongs to the core. These two files will be distributed with each Chameleon update. After choosing the second file, the flash process will be started without further notice. Again, this is an engineering tool, so we have to give another word of **Caution:** The contents of the flash slot will be erased without any user interaction!

Now click on "**Start Core**" to test the core you've just flashed.
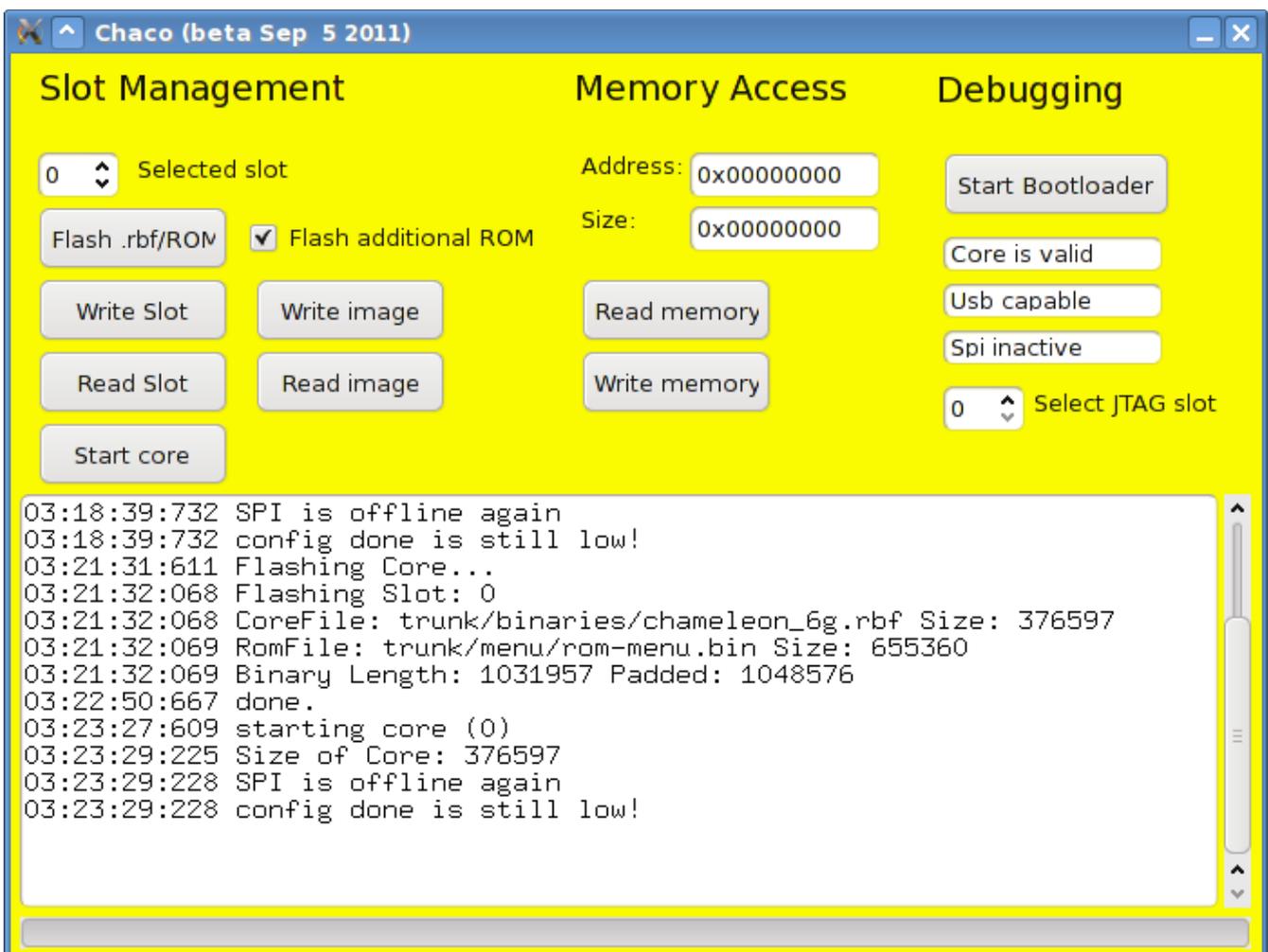
6.5.3. Accessing memory

Now let's use ChaCo for some remote debugging! Power up the Chameleon and then select "reset with cartridge" (F7) followed by "INSTALL FASTLOAD" (again F7). The VGA screen should show something like this:
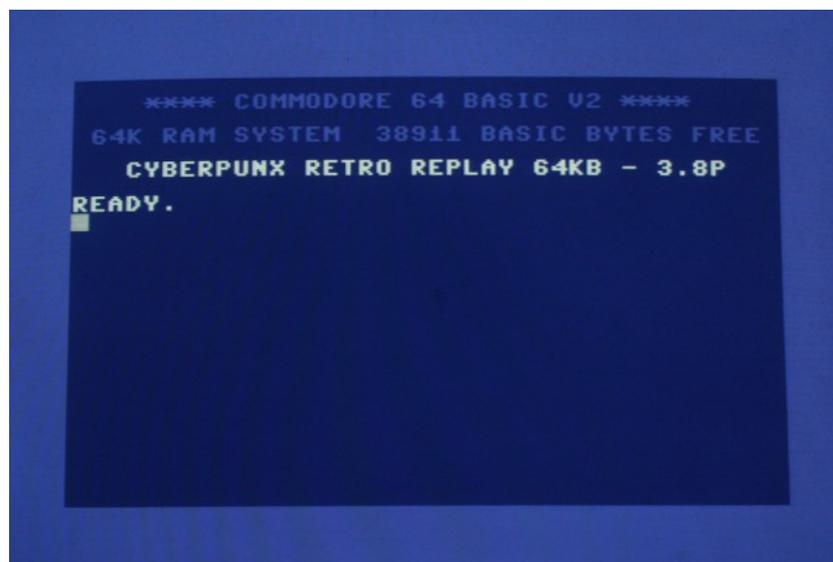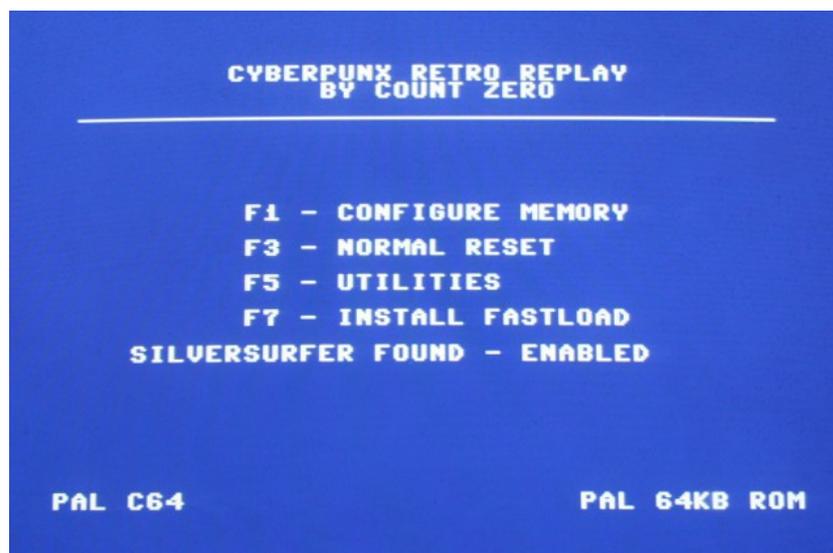
Now in ChaCo enter address 0x400 and size 360 into the fields for memory access. Then click on "**Read memory**". ChaCo will read the memory of the C64 into a file that you can save to your PC's hard-disk. Let's call this file "screen.bin".
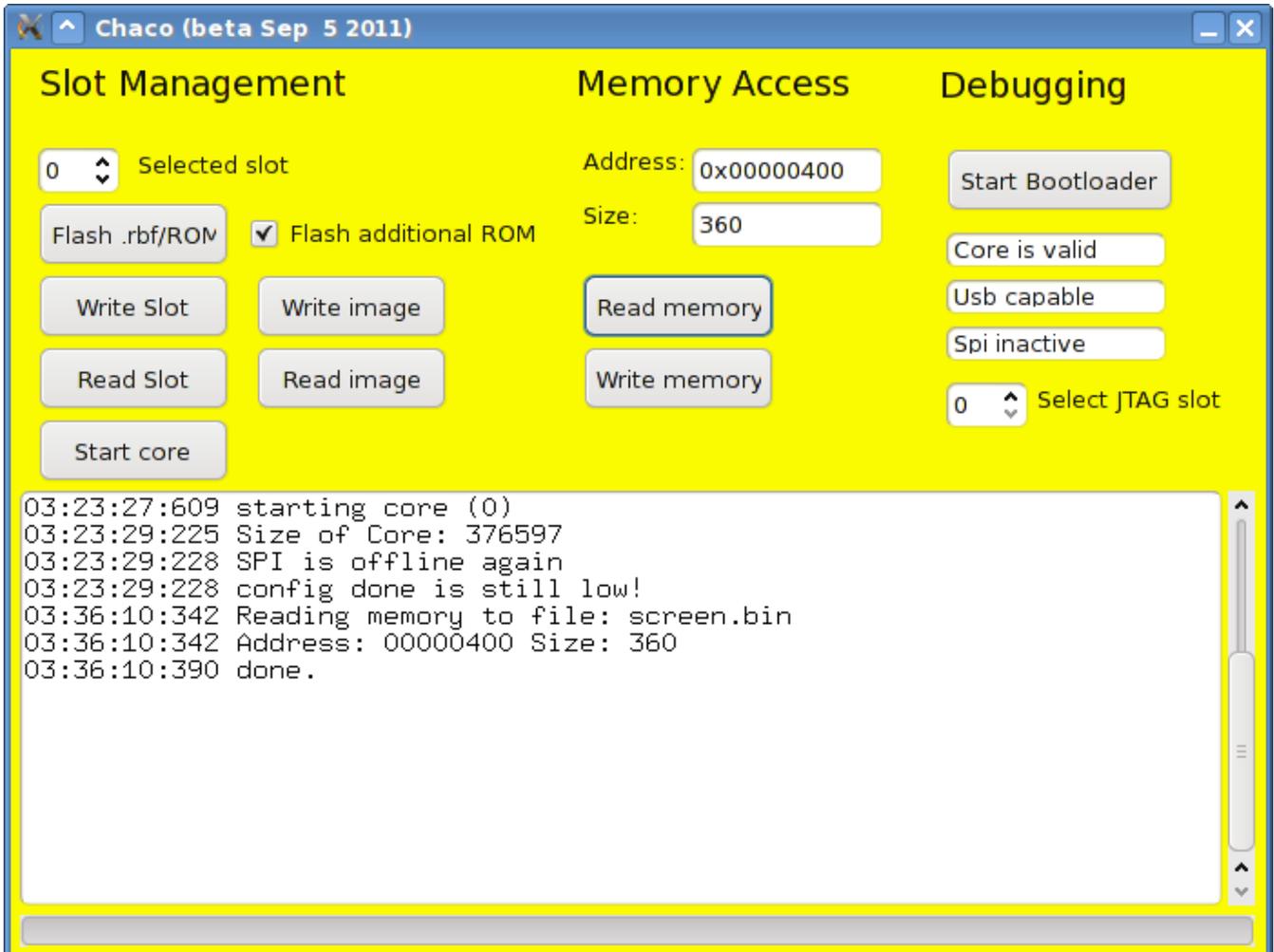
In a second step, we'll write back this same file to the C64 memory, but to a different address. Let's use address 0x590. Then click on "**Write memory**" and choose the file you've just saved (screen.bin).
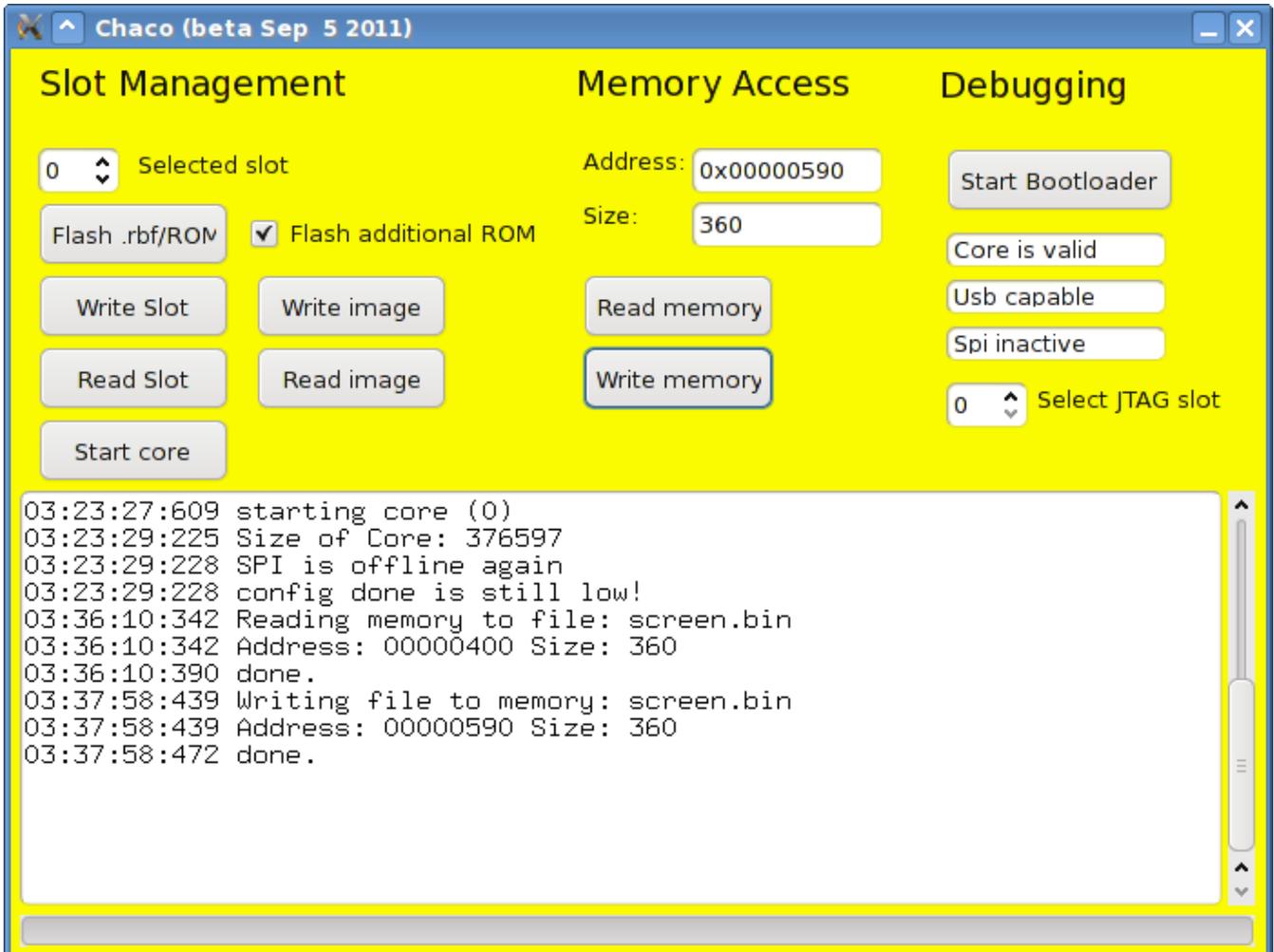
The resulting display on the Chameleon VGA screen should be like this:
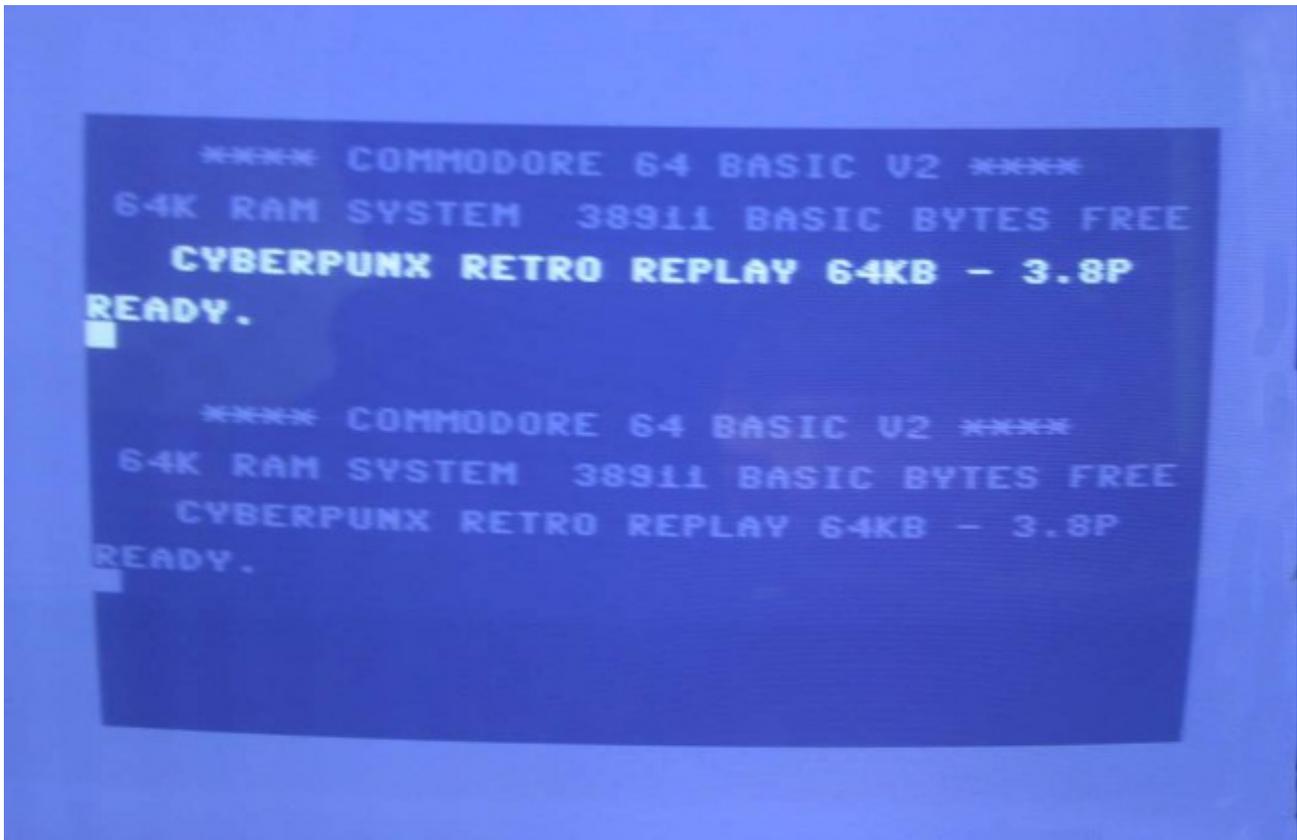
What you've just done is to copy the first nine lines of the screen memory to lines ten and following of the C64 screen memory.

6.6. Command-line options

ChaCo recognizes these command-line options:

--verbose	enable verbose messages
--debug	enable (perhaps lots) more messages

6.7. chacocmd

`chacocmd` is a small command-line tool with essentially the same functionality as ChaCo, intended for use by developers in makefiles and scripts.

`chacocmd` recognizes these command-line options:

-h --help	Show all options
--verbose	enable verbose messages
--debug	enable debug messages
--info	show status and flash info
--addr <num>	set start address
--len <num>	set length
--dumpmem	show memory dump
--readmem <name>	read RAM to file
--writemem <name>	write file to RAM
--dumpflash	show flash dump
--readslot <slot> <name>	read slot image to file
--readimage <name>	read full image to file
--flashrbf <slot> <corename> <romname>	flash .rbf/.rom
--flashslot <slot> <name>	flash slot image
--flashimage <name>	flash full image
--eraseslot <slot>	Erase slot
--start <slot>	start core
--jtagslot <slot>	set JTAG slot

6.7.1. examples

Flash Chameleon core with menu rom to slot 0 and then start it:

`$ chacocmd --flashrbf 0 chameleon_6g.rbf rom-menu.bin --start 0`

write test.bin to address 0x1000 in c64 memory:

`$ chacocmd --addr 0x1000 --writemem test.bin`

7. Frequently asked questions

Since the Chameleon is under constant development, and this section did not really fit the nature of this manual, the FAQ was moved to the Individual Computers WIKI:

http://wiki.icomp.de/wiki/Chameleon_FAQ

8. known Bugs and Limitations

Since the Chameleon is under constant development, this section of the manual has been removed to reduce maintenance. Please refer to the Individual Computers WIKI for up to date information on currently known bugs: http://wiki.icomp.de/wiki/Chameleon_Bugs

http://wiki.icomp.de/wiki/Chameleon_Core_Bugs has a detailed list of known problems in the FPGA core, http://wiki.icomp.de/wiki/Chameleon_Menu_Bugs is the equivalent for the Menu system and http://wiki.icomp.de/wiki/ChaCo_Bugs collects bugs in ChaCo.

http://wiki.icomp.de/wiki/Chameleon_SD_Card_Problems lists a few problematic SD cards.

http://wiki.icomp.de/wiki/Chameleon_Monitors lists some working (and non working) monitors.

9. Reporting Bugs

If you find any bugs, please report them either directly to Individual Computers, or to the Yahoo mailing list (http://tech.groups.yahoo.com/group/chameleon_64/). Before doing so, please make sure you are running the latest version of the Turbo Chameleon FPGA Core, which can be downloaded at http://wiki.icomp.de/wiki/Chameleon .

To make it easier and more efficient for us to handle bug reports, please provide the following information with them:

- whether you are using the Chameleon in standalone or cartridge mode, and whether you are using PAL or NTSC

- if you are using cartridge mode, then it would be helpful to know which kind of C64 it is (board revision, type of CIAs, VIC, SID)

- a detailed description that enables us to reproduce the bug

Have a look at http://wiki.icomp.de/wiki/Chameleon_Bugs for details.

10. Developer information

Information for developers is made available separately from this manual. Look at the turbo Chameleon 64 project page (http://www.syntiac.com/chameleon.html) for the most recent version of these documents:

- `chameleon_progmanual.pdf` – contains register description and programming information for the turbo Chameleon 64 FPGA core.

- `chameleon_coredef.pdf` – hardware overview for FPGA core developers

- `chameleon_schematics.pdf` – Chameleon board schematics for FPGA core developers

- `chameleon_fpga_pins.zip` - a pin file that you can add to the Quartus *.qsf project settings file.

- `chameleon_v5_hwtest_src.zip` – the source code for the FPGA hardware test core

- `cdtv_remote.zip` - protocol description of the CDTV remote in open-office format.

We are working on making more example- and framework FPGA code available, please contact us if you have specific questions which are not yet answered in the above documents.

To get in touch with other Chameleon users and developers you might want to subscribe to the mailinglist (http://tech.groups.yahoo.com/group/chameleon_64/).

11. Related projects

This section of the manual has been removed to reduce maintenance. Please refer to the Individual Computers WIKI (http://wiki.icomp.de/wiki/Chameleon) for up to date information on related projects, such as other FPGA cores.

12. Appendix

12.1. PS/2 Keyboard Key Assignment

PS/2 Key (US)	PS/2 Key (DE)	C64 Function
ALT	ALT	CBM Key
ESCAPE	ESCAPE	RUN/STOP
F1	F1	F1
F2	F2	RShift + F2
F3	F3	F3
F4	F4	RShift + F4
F5	F5	F5
F6	F6	RShift + F5
F7	F7	F7
F8	F8	RShift + F7
F9	F9	£ (Pound)
F10	F10	+
F11	F11	Left cartridge button
F12	F12	Middle (Freeze) cartridge button
Print Screen	Print Screen	Right (Reset) cartridge button
PAUSE	PAUSE	RESTORE
~	^ / °	⇐ (Arrow left)
–	ß / ?	–
= / +	´ / `	=
Backspace	Backspace	DEL/INST
Home	Home	HOME/CLR
Page Up	Page Up	F1
Page Down	Page Down	F7
[/ {	Ü	@
] / }	+ / *	*
\ /		# / '	⇑ (Arrow up)
	Ö	:
	Ä	;
	- / _	/

12.2. PS/2 Keyboard Joystick Assignment

PS/2 Key	C64 Function
NUM-LOCK	Select port 1 or port 2
Numeric 0	Joystick Fire Button
Numeric 1	Joystick Left + Down
Numeric 2	Joystick Down
Numeric 3	Joystick Right + Down
Numeric 4	Joystick Left
Numeric 6	Joystick Right
Numeric 7	Joystick Left + Up
Numeric 8	Joystick Up
Numeric 9	Joystick Right + Up

Take note that it is possible with the keyboard to press both "Joystick Left" and "Joystick Right" at the same time (same is true for up and down). There are a few games that crash when you do so. Don't blame Chameleon for the crash, but the programmer that wrote the fragile game code.

12.3. CDTV Remote Control Key Assignment

Infrared CDTV Remote Key	C64 Function
1	F1
2	RShift + F1
3	F3
4	RShift + F3
5	F5
6	RShift + F5
7	F7
8	RShift + F7
9	RUN/STOP
0	Space bar
ESCAPE	Left Arrow
ENTER	RETURN
REW	CRSR Left (RShift + CRSR Right)
PLAY/PAUSE	CRSR Up (RShift + CRSR Down)
FF	CRSR Right
STOP	CRSR Down
GENLOCK	Left Push Button
CD/TV	Middle Push Button (Freeze / Menu)
POWER	Right Push Button (Reset)
Vol Up	+
Vol Down	-
M/J Switch in MOUSE Position	Select Joystick 1
M/J Switch in JOY Position	Select Joystick 2
A	Fire
B	Auto Fire (8 Hz)

12.4. supported Cartridge types

CRT ID	
0	generic (8k Game, 16k Game, Ultimax)
1	Action Replay v5 (v4.2 and higher ROMs)
2	KCS Power Cartridge
3	Final Cartridge 3
4	Simons Basic
5	Ocean (*1)
6	Expert Cartridge
7	Funplay / Powerplay (*1)
8	Supergames
10	Epyx Fastload
11	Westermann
15	C64 Game System (System 3) (*1)
16	Warpspeed
17	Dinamic (*1)
18	Zaxxon
19	Magic Desk (*1)
20	Super Snapshot v5
21	Comal 80
23	ROSS
28	Mikro Assembler
31	Stardos
32	Easyflash (*1)
34	Capture
36	Retro Replay
37	MMC64 (*2)
43	Prophet64 (*1)
51	Mach5
53	Pagefox
54	Kingsoft (Business Basic, S'more)

*1) These types of cartridges can only be used in slot 3 and 4, because they are (or may be) larger than 64k.

*2) MMC64 is handled separately and can not be loaded to normal cartridge slots.

12.5. Opening the Cartridge

To install the RTC battery (CR-1220) or a RR-NET, you will have to open the Cartridge - it may look difficult, but if you know where to lever it open, it's really easy. All you need is a flat screwdriver. Please follow the steps given here, don't change the order of the steps, because you might break the case otherwise!

Use the flat screwdriver as a lever. Be sure not to touch the Chameleon board, only the case must be touched! There will be no warranty for scratched boards.

Use the zoom-function of your PDF viewer to exactly see where the lever needs to be placed.
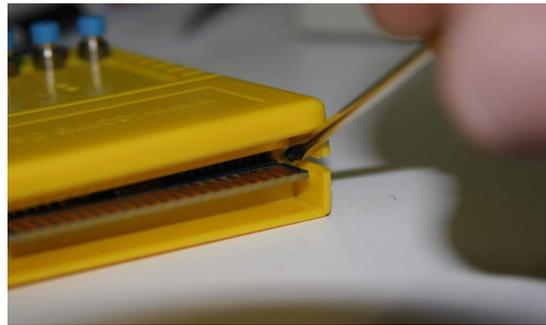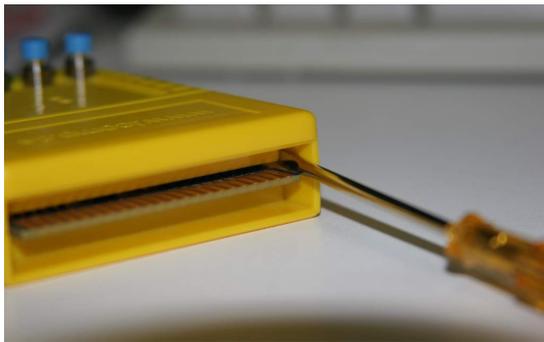
Next, use the screwdriver on the left side of the Chameleon case. Again, be sure to only lever the case, not the board!
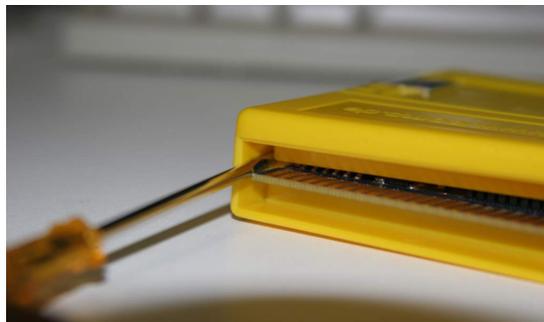
With the opening in the Chameleon case for the mini-DIN connector, the left half of the case top is fairly weak. We therefore recommend to open the right side of the case first:
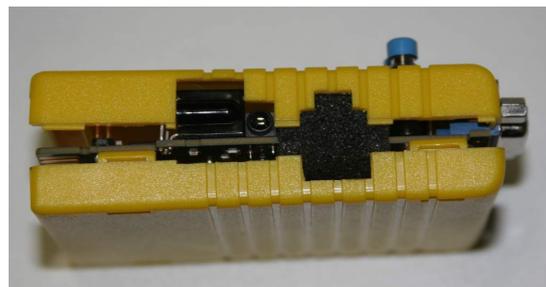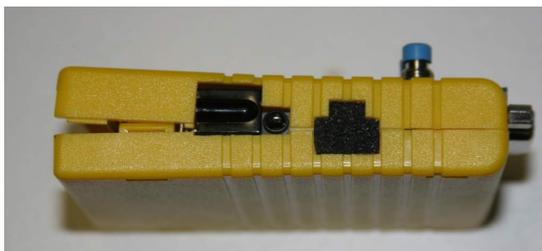
Remove the bottom by tilting it away; the left side (weakest side of the top) will now come off fairly easy, almost no force is required. Remove the foam from the case and keep it in a safe place. The foam on your cartridge may look different.
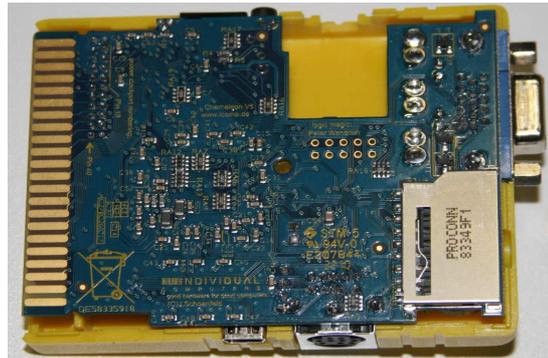
12.6. Re-programming the USB micro-controller

WARNING: It is very unlikely that this kind of update must be done in the field. It is only documented for completeness. It's the worst-case scenario – Please do not attempt to do any of the following unless being told by us to do so. In the unlikely event that you will have to update the micro-controller, you will receive an appropriate .hex file and detailed instructions directly from individual computers. The micro-controller is a core component which is not meant to be user programmable, thus refrain from experimenting with it.

UPDATING THE MICRO-CONTROLLER WITHOUT BEING TOLD DO SO AND/ OR USING A .HEX FILE NOT ENDORSED BY INDIVIDUAL COMPUTERS VOIDS WARRANTY.

Should the micro-controller require an update, you will need the "FLIP" tool from the Atmel website. FLIP is a Java application available for Windows and Linux. If you run under Linux, remember to run the tool as "root", otherwise it will not get access to the USB port. You can easily find FLIP using Google – URL not given here, as links might change in the future. FLIP is the same for a large family of micro-controllers, the tool is the same for all of them.

If you run under Windows, you will need a FLIP driver. New Windows versions (Vista, 64-bit versions) either require some expert settings, or they require a signed driver. Download the signed driver from our website and install it. Also, you may need to download and update Java. Even if Java does not prompt you to re-start the computer after an update, it may be required. Especially if FLIP exits with a null-pointer error message, just restart the computer, and it'll work.

Start FLIP – it will come up with an error message that a device was not found. This is expected behaviour. Click OK on that requester.

Now click on "settings" and select "preferences". Within the preferences dialogue, select the rightmost tab "connect/closing". Tick the box "Auto-connect", then click on OK.

Now locate the de-brick jumper of Chameleon and close it:
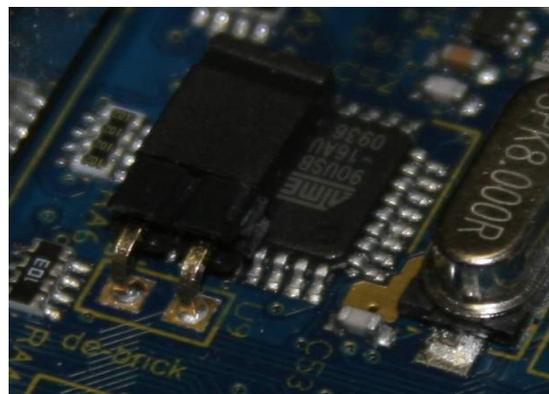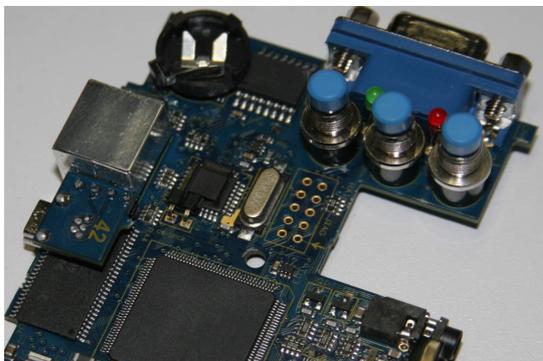
Now make two USB connections to your PC and switch on the PC. The USB connection of the breakout cable provides power to Chameleon, and the mini USB connection is your data connection:
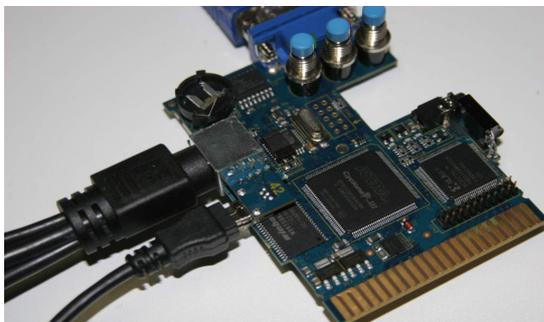
Now place the micro-controller into de-brick mode with the following combination of button presses. Press and hold the left button, then press the right (reset) button:
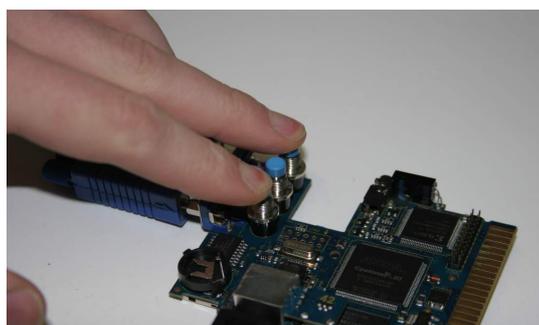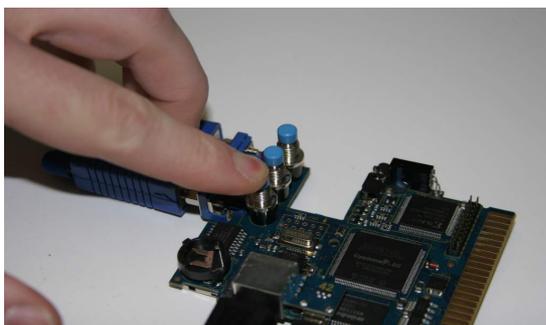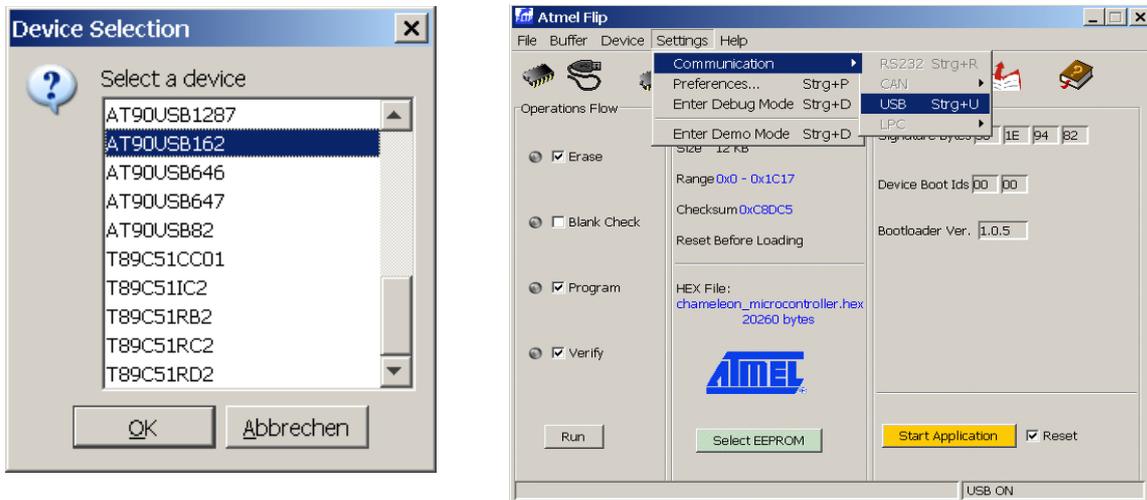

Then release the right (reset) button, but keep on holding the left button. As the last step, release the left button:
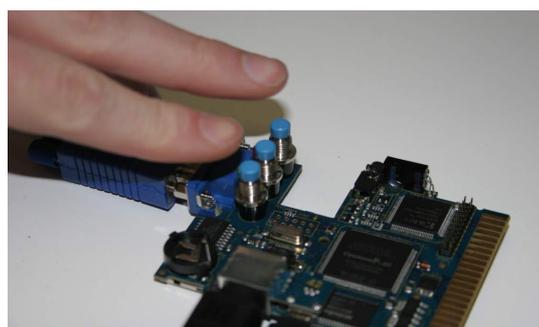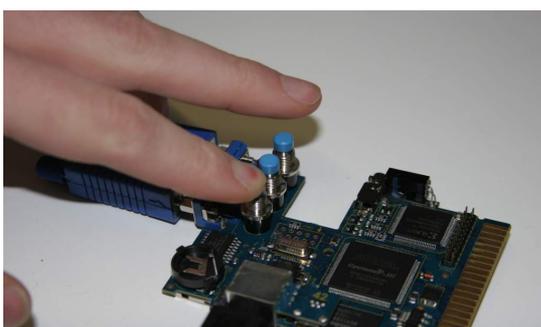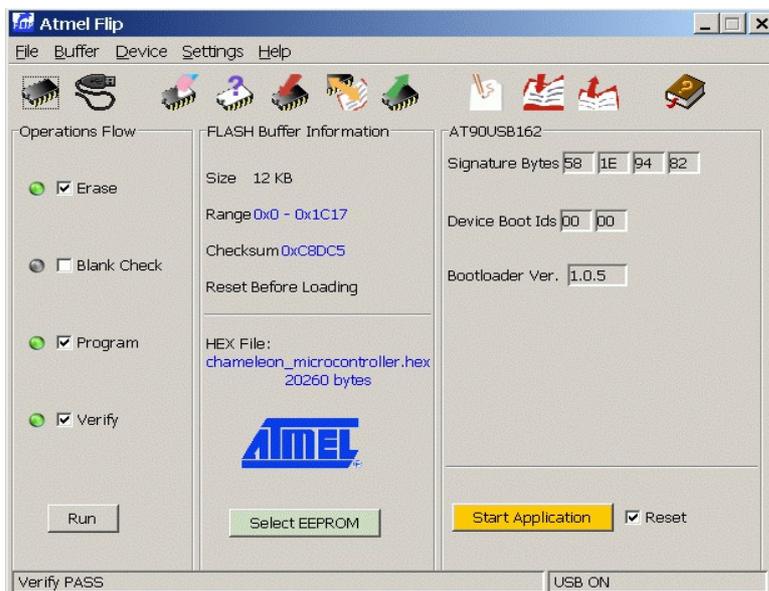
The micro-controller is now in de-brick mode and the FLIP tool will now find it.

First, select the processor type AT90USB162, then select Settings->Communication->USB:

Now load the micro-controller hex file by clicking on file->Load hex file. The final step is to click on the "Run" button within FLIP (at the bottom left of the window) and watch the program do its magic. After programming the micro controller, FLIP will indicate the successful steps with a green light next to the action tags:

Note: The checksum may be different for a possible update.

That's it – the micro-controller is now up to date, and you can leave de-brick mode by powering off and opening the de-brick jumper. Before you can make use of the new micro-controller software, you may need to update your version of ChaCo (the Chameleon Control software), and you may also have to update one of the flash slots. Please read the respective instructions for ChaCo for those steps.

12.6.1. Linux

In Linux "dfu-programmer" (http://dfu-programmer.sourceforge.net/) may be used:

```
$ sudo chacocmd --bootloader
$ sudo dfu-programmer at90usb162 erase
$ sudo dfu-programmer at90usb162 flash
chameleon_microcontroller.hex
$ sudo dfu-programmer at90usb162 start
```

## 12.7. configuring Quartus for JTAG

Drivers are needed for the USB Blaster - they can be found in the Quartus II installation directory (quartus/drivers/usb-blaster).

Click Hardware settings and select USB Blaster from the drop-down box.
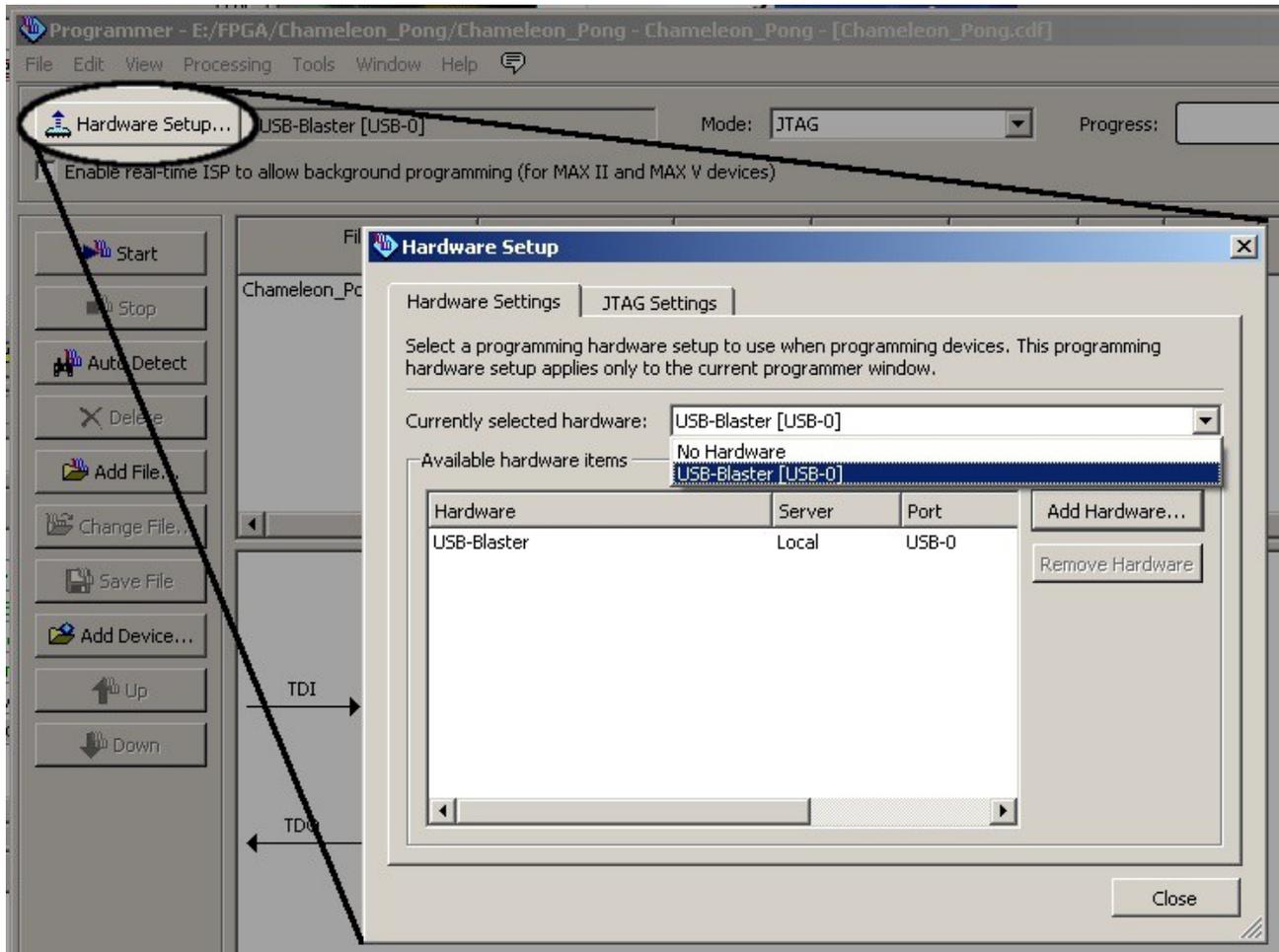
The project's default settings won't work, because there's another device on the JTAG chain (the flash chip), so to solve that: Click the "Autodetect" button to reveal the second device. You'll also be asked whether the FPGA is an EP3C25 or EP4CE22. Pick the first.
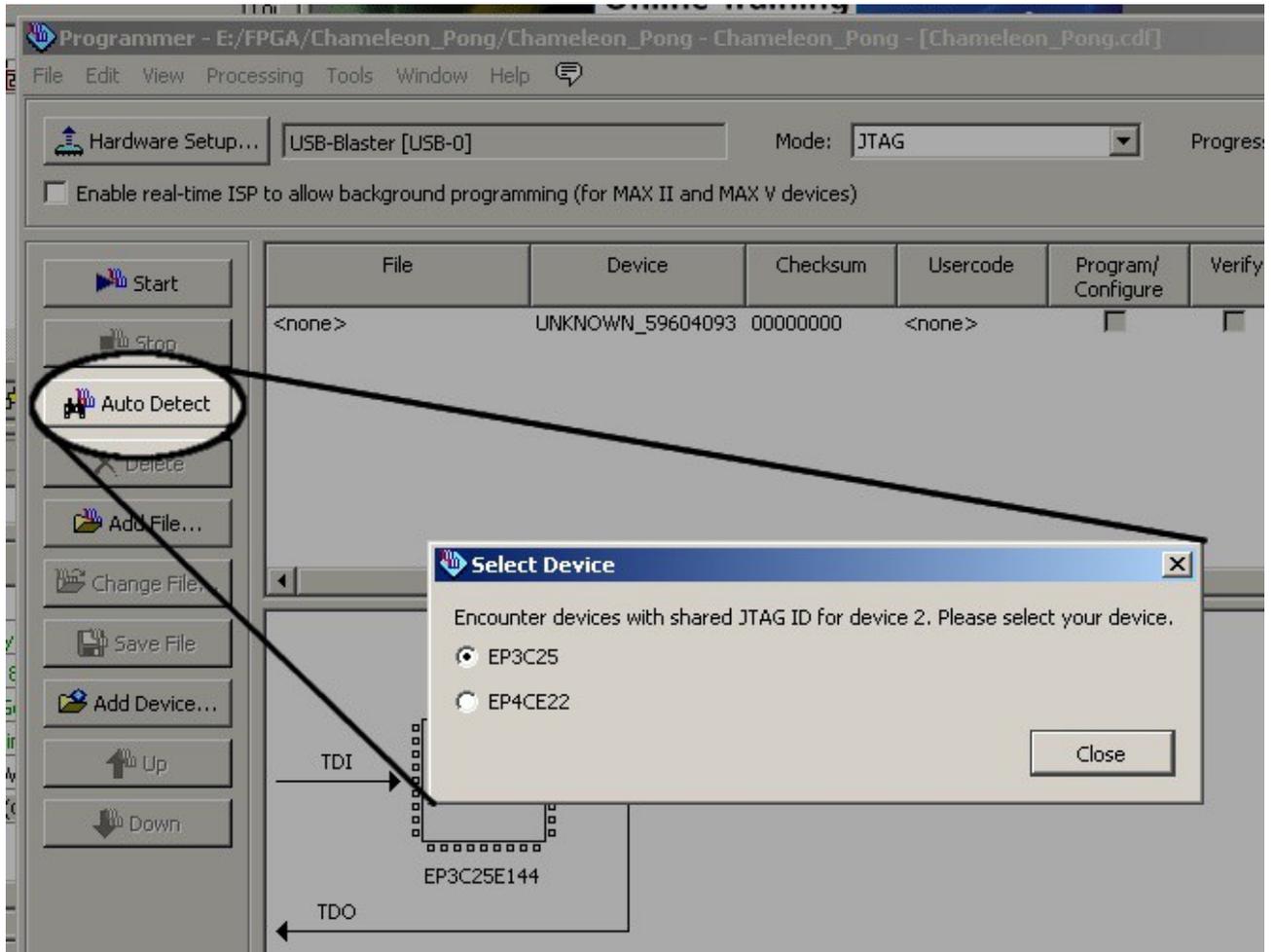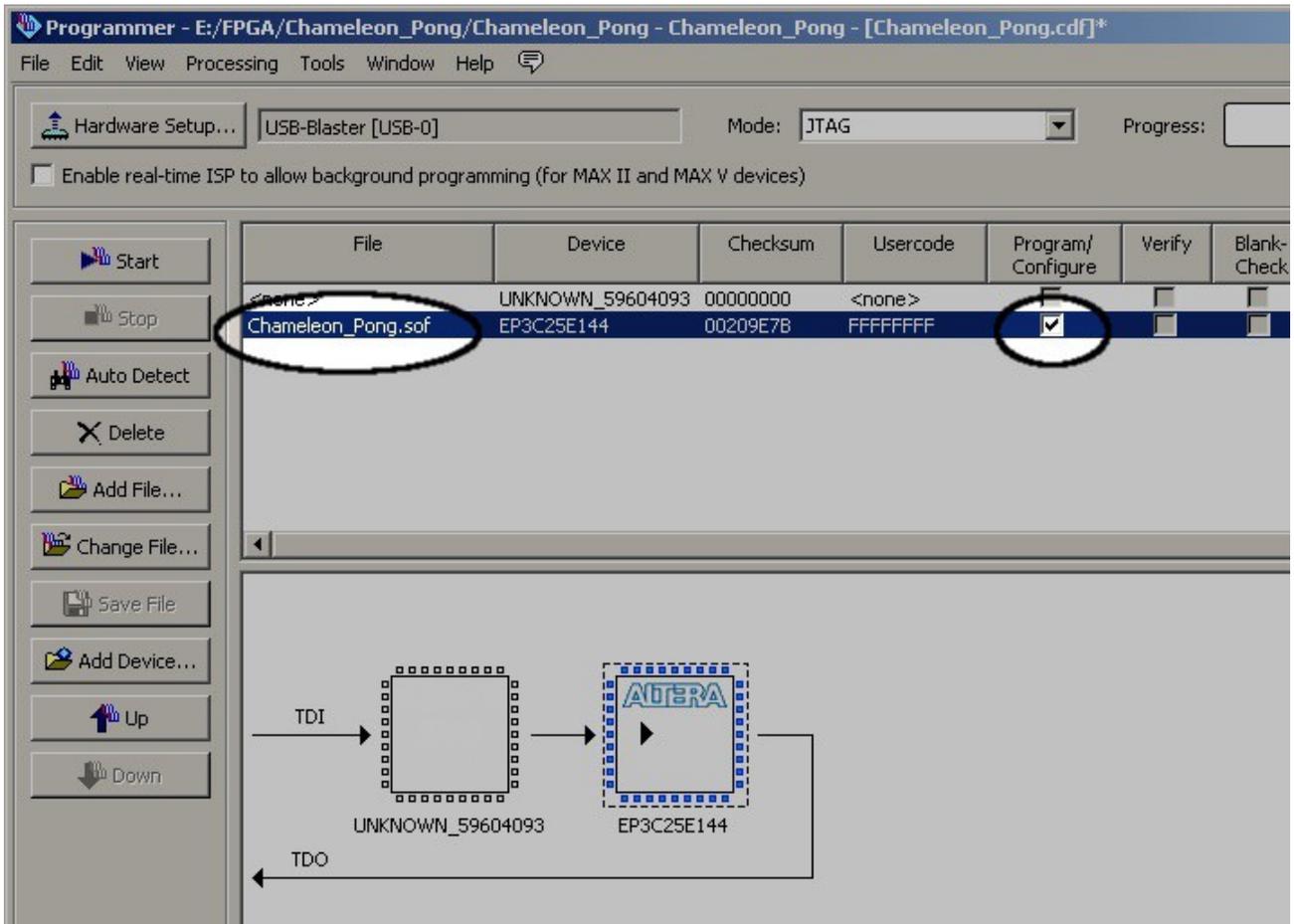
Now either click on the picture of the EP3C25 and click the Change File button, or double-click the "<none>" in the File column of the EP3C25's line in the top panel.

Pick the .sof file in the file dialog.

Check the "Program/Configure" checkbox in the EP3C25's row of the top panel.

Finally, click Start, and the project should be uploaded to the FPGA.

There's one more complication to take care of: When closing the programming window, Quartus will offer to save changes to the device chain, so you don't have to repeat this procedure each time you program the device. Unfortunately, saving will fail while the extra device is classed as "Unknown". This can be fixed just by giving the extra device a name.

In the top list, right-click on "Unknown_59604093" and select "Change Device".
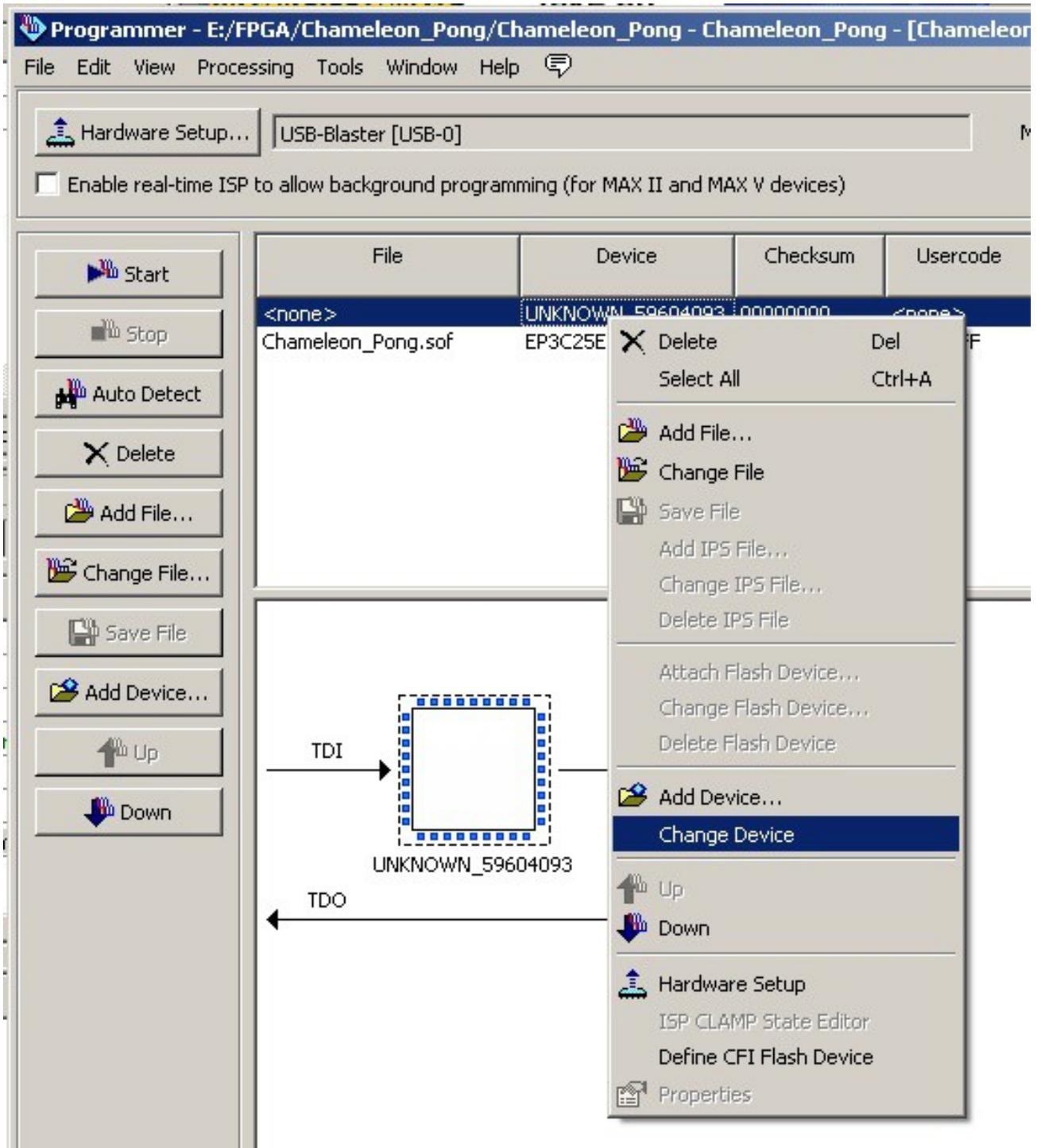
In the dialog that appears, the Unknown device should already be selected, so just click "Edit", and change the name to something else.
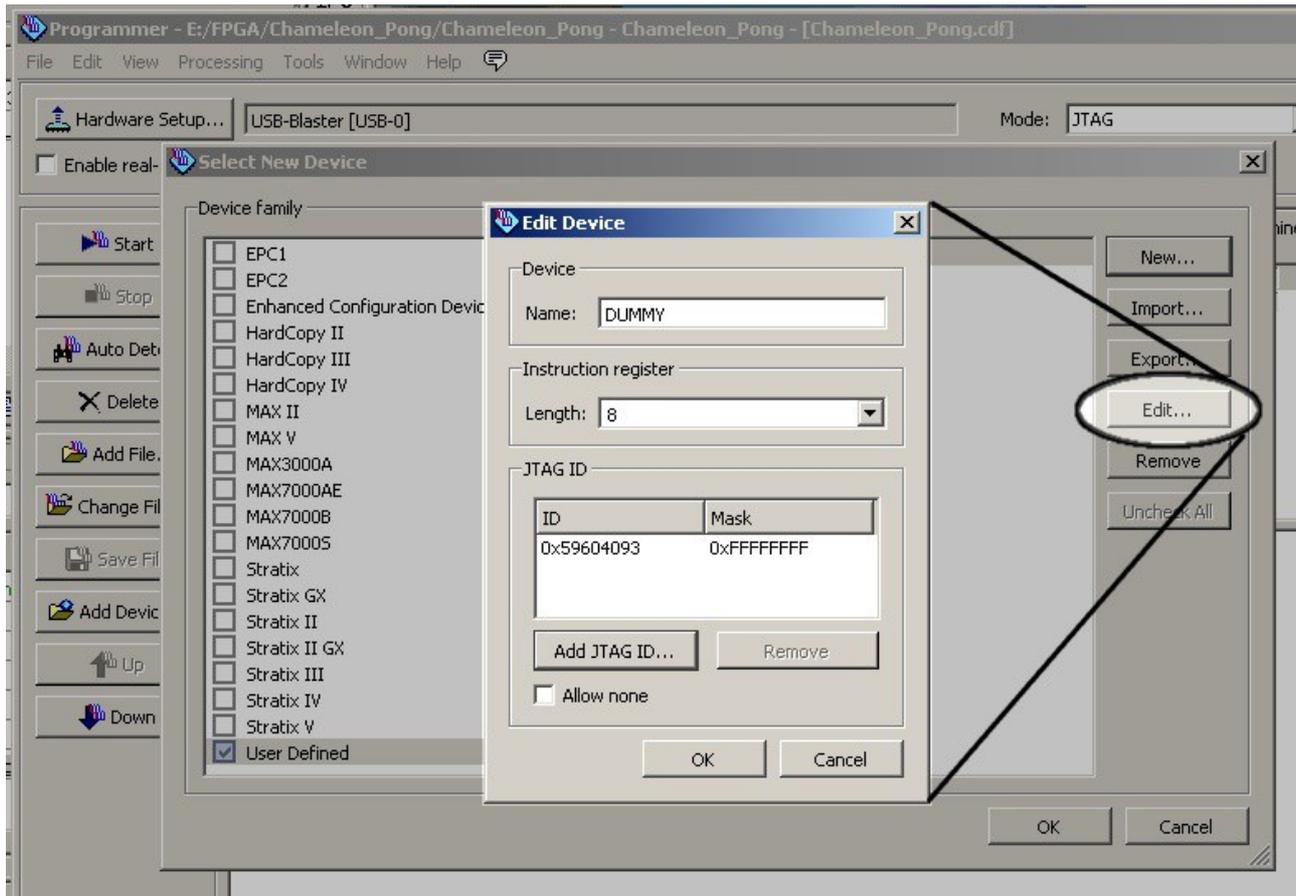
Quartus should now be able to save the device chain for future use.

12.8. Chameleon cable pinouts

CN1: Mini DIN 9 connector pinout:

shield: GND
1: IEC_CLK
2: KDat
3: MDat
4: KClk
5: MClk
6: Vcc
7: IEC_SRQ
8: IEC_DAT
9: IEC_ATN

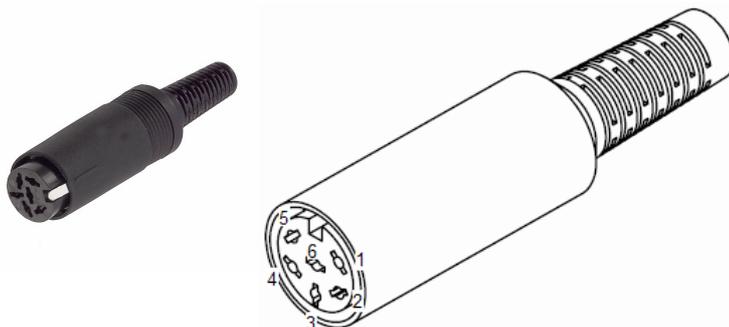Mating connector for RM158-DN508H-9. Pin numbering is taken from drawing.

CN2 and **CN3** are coloured female Mini-DIN6 connectors:

purple CN2: **green CN3:**
shield: GND   shield: GND
1: KDat   1: MDat
2: NC   2: NC
3: GND   3: GND
4: Vcc   4: Vcc
5: KClk   5: MClk
6: NC   6: NC

CN4 is a female hex DIN6 connector:

shield: GND
1: IEC_SRQ
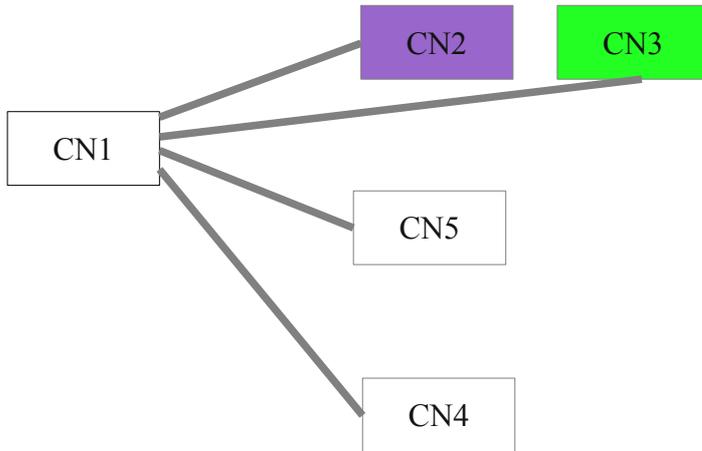2: GND
3: IEC_ATN
4: IEC_CLK
5: IEC_DAT
6: n.c.

CN5 is a USB Type A connector:

shield: GND
1: Vcc
2: n.c.
3: n.c.
4: GND

Wiring diagram

Connection CN1 to CN2 is a 4-core shielded AWG26 cable, length 200mm:

```
CN1     CN2
shield  -       shield and pin 3
pin 2   -       pin 1
pin 4   -       pin 5
pin 6   -       pin 4
```

Connection CN1 to CN3 is a 4-core shielded AWG26 cable, length 200mm:

```
CN1     CN3
shield  -       shield and pin 3
pin 3   -       pin 1
pin 5   -       pin 5
pin 6   -       pin 4
```

Connection CN1 to CN4 is a 4-core shielded AWG26 cable, length 200mm:

```
CN1     CN4
shield  -       shield and pin 2
pin 1   -       pin 4
pin 7   -       pin 1
pin 8   -       pin 5
pin 9   -       pin 3
```

Connection CN1 to CN5 is a single-core shielded AWG18 cable, length 800mm:

```
CN1                             CN5
shield  -                               shield and pin 4
pin 6   -       diode K (ring)  –       diode A         -       pin 1
```

12.9. Technical Data

- Altera EP3C25 FPGA with 24624 LEs
- 16Mb Flash Memory, 32Mb RAM
- VGA connector
- MMC/SD card slot
- Connectors for PS/2 mouse, PS/2 keyboard and IEC bus via breakout cable
- Battery-backed real time clock (CR-1220 battery not included)
- IR receiver for CDTV remote control
- Connector for RR-NET (only with real C64 or docking station)
- USB link to a PC for debugging and data transfer

12.9.1. Turbo Chameleon FPGA Core

- Turbo function with full 6510 processor compatibility (incl. illegal opcodes)
- Cycle-exact REU (memory expansion) with up to16 MB RAM
- GEORAM (memory expansion) with up to 4 MB RAM
- Freezer (compatible with Retro Replay)
- VGA-output with 60 Hz refresh rate or more
- MMC/SD card slot with MMC64 compatibility
- 1541-emulation (2 drives)
- emulation of 1351 and Micromys on PS/2 mouse port

13. Credits

- Jens Schönfeld – Hardware design, production and documentation

- Peter Wendrich – Turbo Chameleon FPGA Core, programmers manual, first version of the ml monitor and help system

- Tobias Korbmacher – Menu System, ChaCo, user manual

- Stefan Seitz – USB Micro-controller code, first version of ChaCo

- Andreas Postler - case modifications, other manual steps in production

- Andreas Muttke - logo design

- Christian Vogelgsang – provided the chacocmd Mac OSX port

- Alastair M. Robinson – contributed chapter 12.7 configuring Quartus for JTAG

14. Fine print

The Chameleon is not designed, authorized or warranted to be suitable for use in life-support devices or systems or other critical operations. Inclusion of the product in such applications is understood to be fully at the customer's risk.

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For updates and further information visit http://wiki.icomp.de/wiki/Chameleon .

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