C64-DTV Hacking



About myself

- Hi, I'm Peter
- electrical engineering student
- Interests
 - Electronics
 - Microcontrollers
 - Programmable Logic/ FPGAs
 - Retro computing
- Member of Das Labor



Das Labor



What is the C64-DTV?



What is the C64-DTV?

- Handheld TV game with 30 games
- Clone of the real C64 in an ASIC
- Designed by Jeri Ellsworth
- manufactured in China
- introduced in Europe in 2005
- costs about 25€
- presumably out of production by now

Some Specs

- 6502ish CPU
- 1MHz CPU clock
- 32MHz System clock
- 2MB RAM
- 2MB Flash
- 320x200 dots resolution
- 256 colors

Topics

- Hardware modifications
- How to transfer Data
- Structure of the System / differences to C64
- Flashing the Flash
- Adding new Games
- Development tools
- Some nice casemods
- Maybe: watch a demo

Problems

- We don't have a real keyboard
- It only runs on batteries
- The colors aren't right
- It doesn't run our favorite games/demos

Hardware modifications

- We need:
 - keyboard connector
 - diskdrive connector
 - joystick connector
- nice to have:
 - power supply connector
 - color fix
- maybe:
 - SST flash fix



Power Supply

- DTV's supply is strange:
 - switch switches GND
 - LED is part of discrete 3.3V regulator.
- 2 Options:
 - Use regulated 5V supply instead of Battery
 - Replace discrete regulator with integrated
 3.3V regulator

Color fix

Info and pictures from http://www.kahlin.net/daniel/dtv/

Broken Colors

Should look like this

Video DAC & mixer

Schematic

Sugested fix

Flash Filesystem

- Directory of files in flash at \$010000
- Directory entrys consist of
 - Filename
 - Start of file in flash
 - Load target address
- Files are RLE encoded
 - filelength is determined by decoding
- Additional \$ file for basic directory listing

How to transfer Data

- By floppy disk
- By dtvtrans

Transfer via disk

- Using 1541 or 1581 floppy drive
- Connect drive via XA1541 Cable to PC
- Connect drive to added conector on DTV
- Most games run this way
- Tip: To connect PC and DTV to the diskdrive at the same time:
 - POKE56576,3 on DTV
 - modprobe cbm hold_clk=0 on PC

dtvtrans

- cable
 - connects PC parport to DTV joyport
 - consists only of 2 plugs and 5 diodes
- software
 - special software on dtv & pc
 - BASIC programm for bootstraping
 - transfers data from and to DTV RAM
 - can read the DTVs flash
 - can now even directly write to FLASH!

Structure

- Most features inherited from C64
 - 64k Address space
 - memmory mapped i/o
 - i/o registers resemble C64
 - C64 Bankswitching scheme through \$00/\$01

Structure

- Additional Features added
 - 2MB RAM and 2MB Flash through additional bankswitcher
 - CPU registers remappable
 - Burst Modes
 - VIC improved
 - SID improved
 - DMA Unit added
 - Blitter added

CPU improvements

- Skip internal cycle mode
- Burst mode
 - can fetch and execute 8 RAM bytes per 1MHz cycle!

new VIC features

- 256 color mode
- Can address full 2MB of RAM
- 320x200 @ 256 colors possible!
- Video timing programmable
- Bad line emulation can be disabled
- Borders can be disabled

SID modifications

- audio filters removed
- 8bit sample playback possible
- some other features

Memory map of the C64

Memory map of the C64-DTV

Bankswitching

- 15 CPU registers instead of 3 (a, x, y)
- new registers mappable to a, x, y registers by special opcodes
- registers 12, 13, 14, 15 select the base Address for the 4 memmory banks

Official Guide

Provides in depth info on programming the new features: DTVprogramming.pdf

Known limitations

- No SID filters
- Some VIC bugs
- No RTC in CIAs
- The keyboard matrix can only be read in one dircetion

Flashing the Flash

- Hardware fix needed for SST Flash
- Software:
 - flash tool from TLR
 - dtvtrans +
 - TULF

SST Flash fix

Analyzed and fixed by me http://www.kahlin.net/daniel/dtv/sstfix.php

Magic sequence to write flash

- \$xxxAAA <- \$AA
- \$xxx555 <- \$55
- \$xxxAAA <- \$F0
- target <- Byte

DTV's write access to flash

- green is only the triggerpoint
- problem occurs at the edge before
- that edge is seen twice by flash

Fix: 47pF Capacitor

TLR's flash utility

- Can dump and write blocks
- Can flash new Kernal
- no file-level access

TLR's flash utility

TLR's flash utility

Patching the Kernal

- Why?
 - fix bugs
 - add hook to start bootup programm or soft Kernal
 - other features
- How?
 - use TLR's kernalpatcher
 - write new kernal using TLR's flash utility

dtvtrans +

- Is a mod to dtvtrans done by 1570
- Can type in the bootstrap programm using the joystick keyboard
- Can sync the DTV's flash to an image on the PC (takes ca. 8-20 minutes)

TULF (Tixiv's ULtimate Flasher)

- My work
- Can do file level access on flash
- Can patch the DTV's game menu
- Can load files from disk or via dtvtrans
- needs patched dtvtrans version
- http://noname.c64.org/csdb/release/? id=56394

DTV fixed games repository

- http://symlink.dk/nostalgia/dtv/fixed/
- resource for C64 games patched to run from DTV's flash
- games are in dtvmkfs format (special zip files)
- use dtvmkfs or TULF to get them on the DTV

dtvmkfs

- Utility from Spaceman Spiff
- generates flash filesystem for DTV on PC
- takes games in dtvmkfs format as input

VICEplus emulator

- version of vice that can emulate the C64-DTV
- supports almost all of the DTV's features by now
- great for patching games or developing demos

Coding tools

- acme assembler
- dasm assembler
- cc65 C-compiler
 - TULF is written using it
 - a little slow
- exomizer cross compressor
 - can use DTV's burst mode

Diskdrive emulators

- Microcontroller + MMC card emulates diskdrive
- Slow as a 1541
- Doesn't work with floppy speeders
- Can be integrated in DTV case
- Two projects:
 - MMC2IEC
 - 1541-III

Diskdrive emulators

Some nice Casemods

I want one, where can I buy it?

- Weltbild only 14,99€
- Conrad Electronic 22,95€
- Pearl seems to have only NTSC-DTVs don't buy!

Some Links

- http://www.powerglitch.com
- http://picobay.com/dtv_wiki/
- http://www.kahlin.net/daniel/dtv/
- http://galaxy22.dyndns.org/dtv/