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4 / 5 MAY '24



PAVEL "ZILOG" CIMBAL

Critical software

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The Story of the First Mass Storage Interface for ZX Spectrum

The Story of the divIDE

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How the international demoscene
helped the old ZX Spectrum survive
in the PC dominated world…

Speakers:

🇨🇿	Pavel “zilogat0r” Cimbál (CZ)	divIDE
🇸🇰	Miloš “baze” Bazelides (SK)	FATWare
🇵🇹	Miguel “lordcoxis” Guerreiro (PT)	esxDOS

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The Gap Between ZX Spectrum and PC

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- ZX was quite “speccyfic” in every feature
- Specific hardware, media, floppy disc formats
- Limited interoperability with outer PC world
- Many existing solutions would perish for good together with floppies, and then… tape again?

Why can’t we just have the comfort
of emulators on real machines as well?

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Interoperability with PC was hard

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Really, why can't we enjoy the comfort of emulators on real machines as well?

- Because PC suxxx, you know… :-)
- ZX has no support for PC filepaths in BASIC…
- ZX can't read those PC filesystems anyway…
- There's no HW interface for those PC devices…
- And 16-bit HW for PC can't be connected to 8-bit Z80 (whis is 4-bit actually) anyway…

BECAUSE...



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First ZX-IDE as Proof of Concept

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Really. Why can't we afford the comfort of emulators on real machines as well?

BECAUSE...

Because PC suxxx, you know… Indeed. But still…
ZX has no support for PC media in BASIC… Yes
ZX can't even read those PC filesystems… Yes
There's no interface for PC mass storage… Yes
PC drives can't be connected to ZX anyway… No!


Pera

Actually, first AT-IDE hard disc was connected to ZX Spectrum back in 1995, by Peter "Pera" Putnik, from Yugoslavia…

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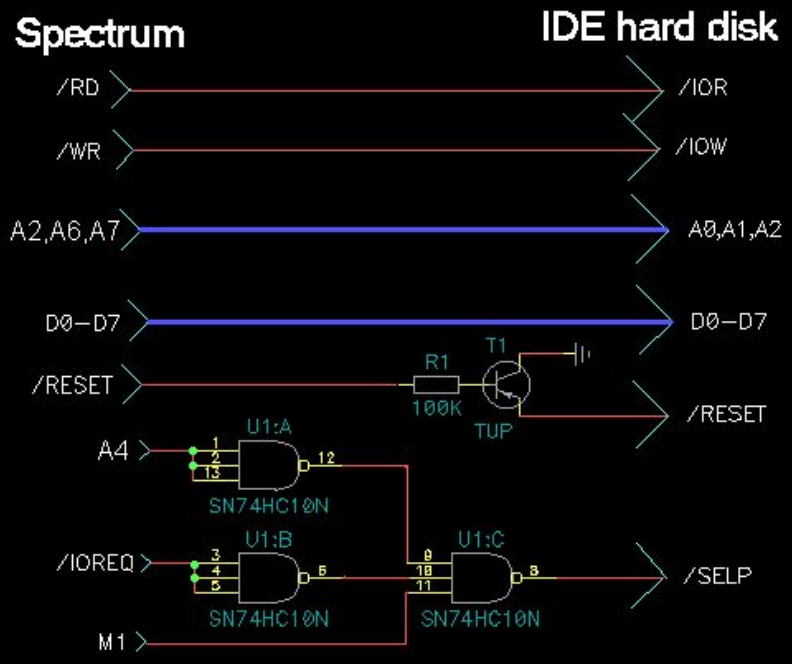
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Pera Putnik's ZX-IDE Interfaces

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His site with original ZX-IDE schematics is still alive https://piters.tripod.com/zx.htm

His 8-bit interface was simple enough, but…



- 50% of HDD visible only
- 256B half-sectors used
- Lack of bus separation
- No PC FAT16/32 support
- Needs modified ZXHDOS ROM with custom FS

The 16-bit ZXIDE variant solved the 50% flaw, but was still Hi-Lo…

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Peter Pera Putnik's 16-bit ZX-IDE

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Actually, AT-IDE, with its 16-bit DATA IO port, violates the memory IO model of IBM PC as well. So, IBM XT would have to solve the same problem. Pera's serialization at the same IO address made the deployment of INIs possible, at 216 KB/s…



His 16-bit ZX-IDE was still Hi-Lo and was quite messy…

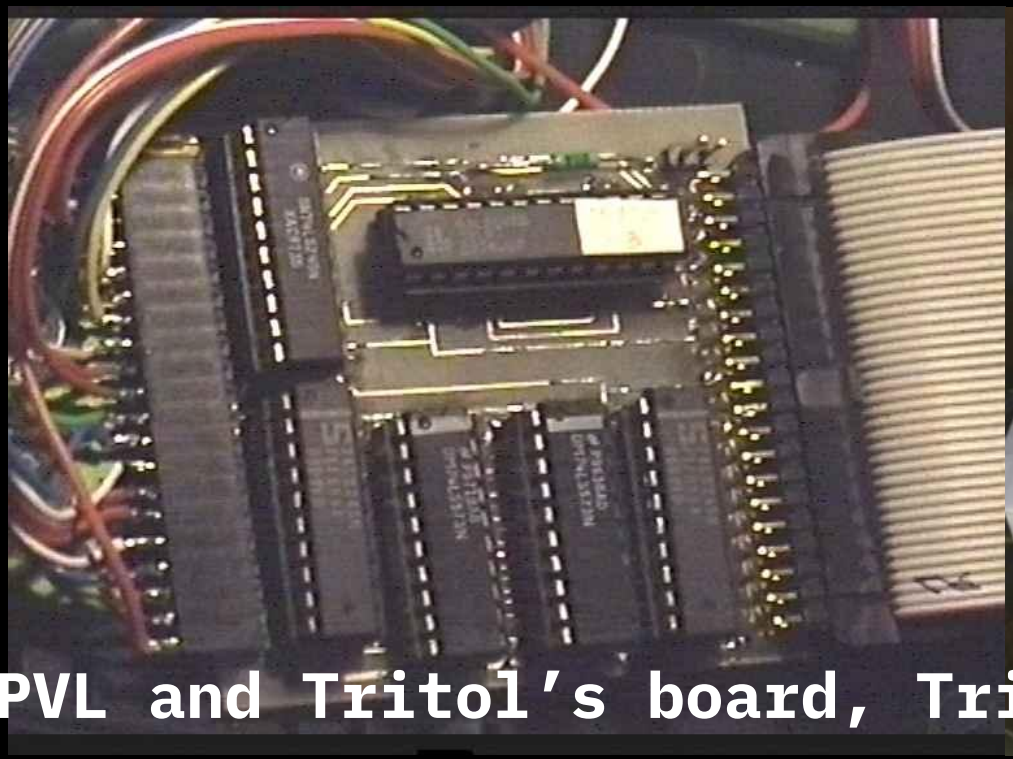
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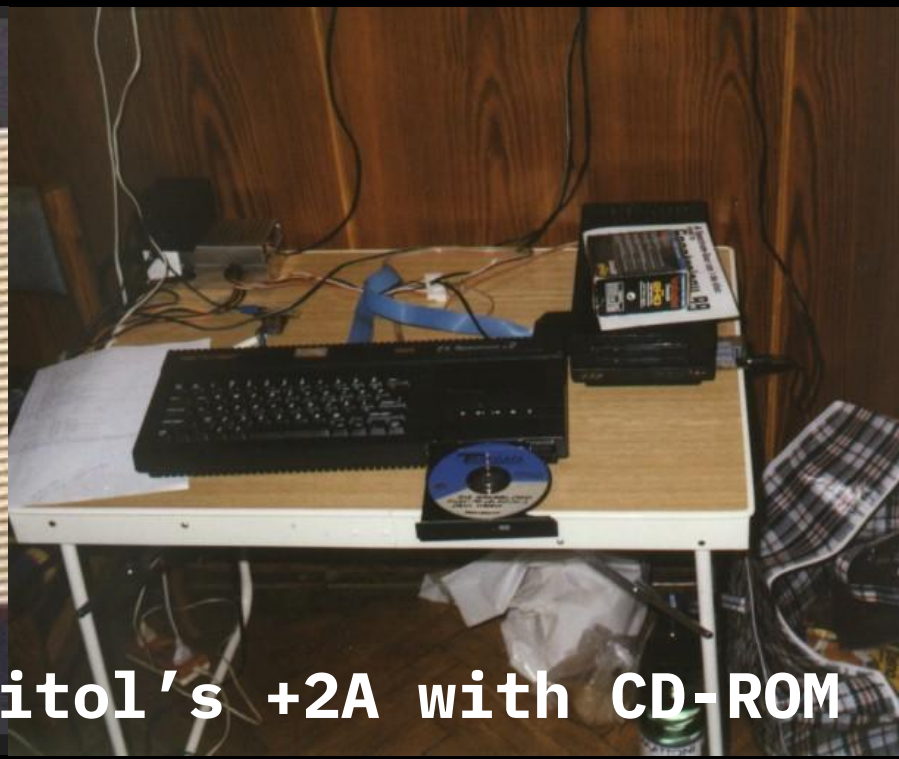
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PVL and Tritol's Internal ZX-IDE

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At DoxyCon'98, Tritol presented PVL's modified version, with Lo-Hi write sequence and separated drivers. He played realtime video out of CD-ROM…





PVL and Tritol's board, Tritol's +2A with CD-ROM

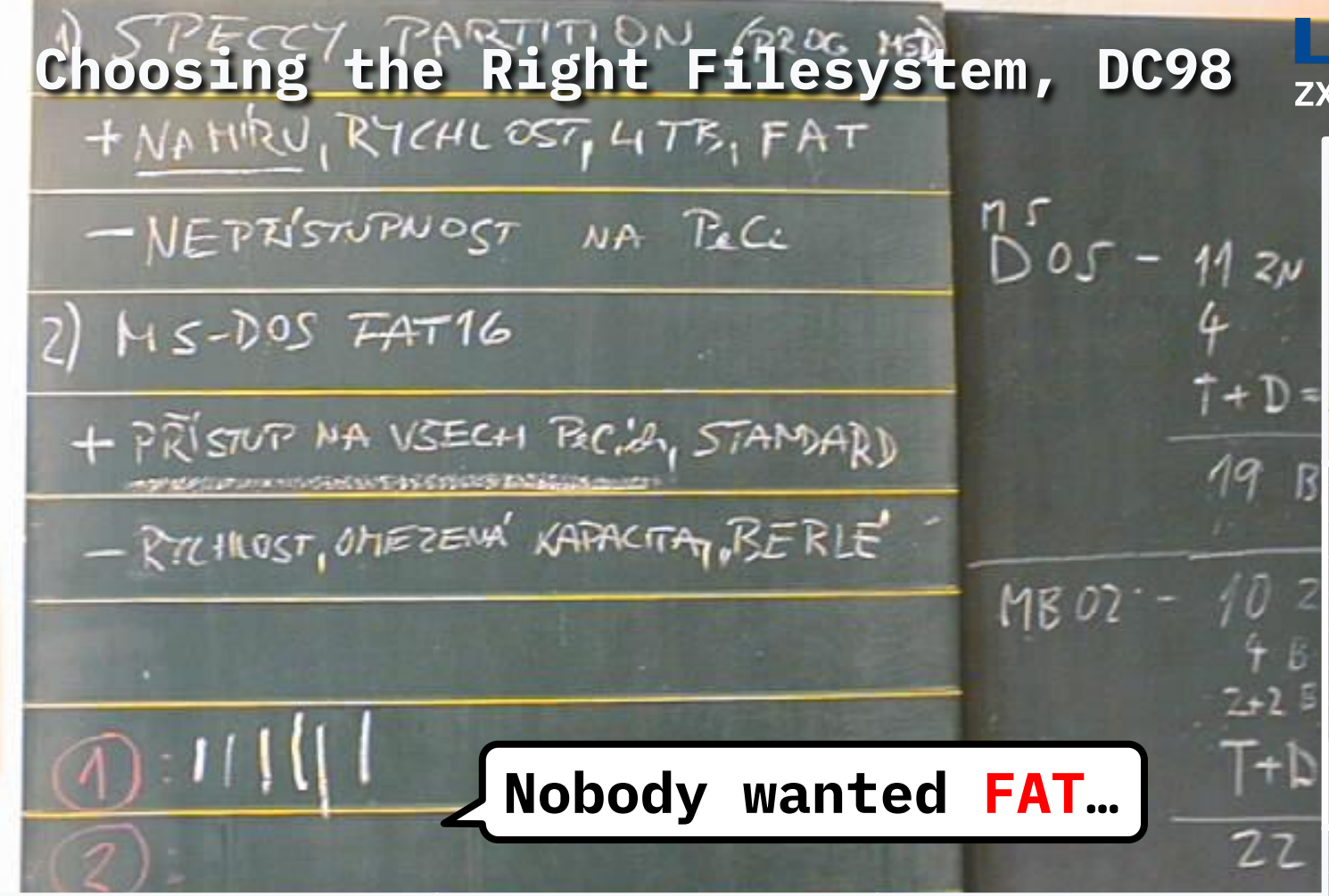
But, it was internal board only. ZX-IDE IO, no system support in ROM…

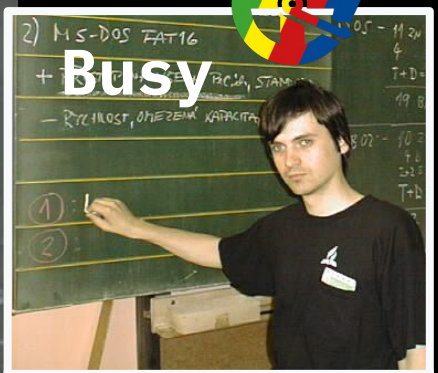
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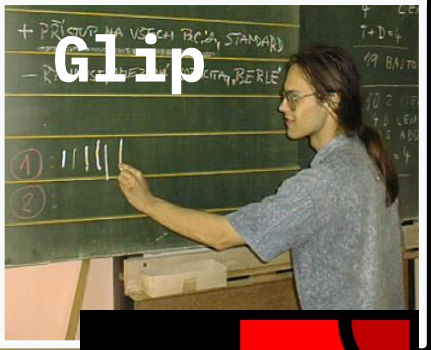
Choosing the Right Filesystem, DC98

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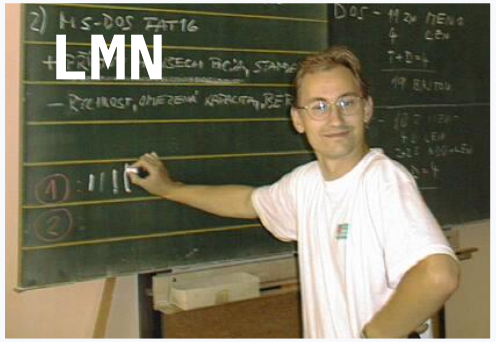














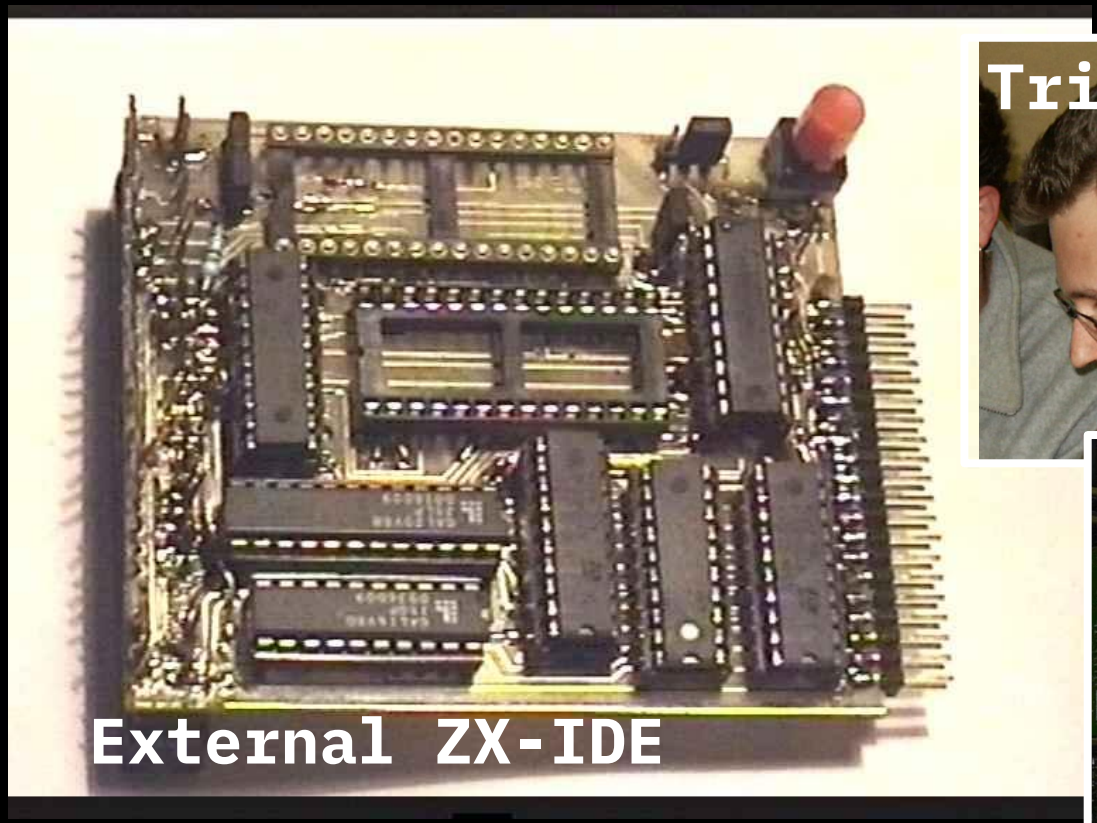
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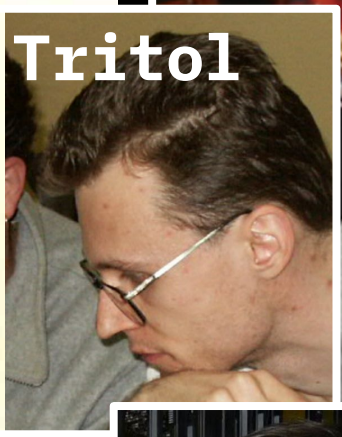
PVL, Tritol and Busy's External IDE

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This prototype of IDE, from '2000, was the last available one, with system support in ROM, but not electrically stable enough to be released…



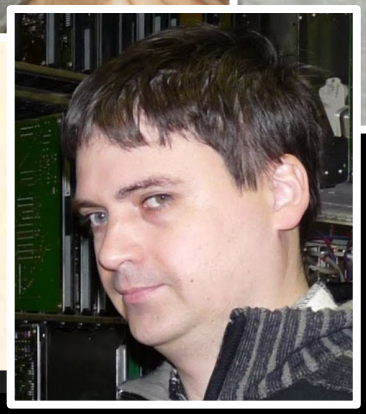
External ZX-IDE



Tritol



Zilog and PVL



Busy

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Sad Conclusion for the Year 2002

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More than 40 different floppy interfaces exist. Mutually incompatible, obsolete, but still expensive, none of them used PC media directly.

Existing IDE interfaces had no PC filesystem support, except ISO, no standardised IO and no transparent integration with BASIC commands. Experimental ones aren't stable, are dependent on legacy systems or need altered ROMs.

Jan 2002

So, when baze uttered, on IRC channel #z80, in January 2002, that he would "try to write some HDD system" and "which IDE interface is the best for it", I answered rather jokingly that "I'll design new one"…

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We Had Some Initial Requirements



- It should be as cheap as possible
- It should be as fast as possible
- It should be durable, detachable and removable
- It should work with all Spectrums and clones
- It should be directly usable out of the box
- It should preserve the original ROM content
- It should be open and free DIY hobby project
- It should be 100% replicable and repairable
- It should look nice'n'sexy even without a box
- It should let the ZX Spectrum do the whole job
- It should allow for easy development at home
- It should support emulation of legacy systems
- It should be reflashable and 100% unbrickable
- Its name should reflect how it works, thus ↴

NEW INTERFACE?!?

How to Met All the Requirements



- Removable - **edge connector** allows for it
- Direct usability - needs **non-volatile memory**
- ROM preservation - **automapping via M1** tracking
- Work with all ZX machines - start in **USR0 mode**
- Fast as possible - no bitbanging, **byte per IO**
- Cheap as possible - the kit **must be under 25€**
- Open and free project - **dump** all project files
- Repairable and replicable - **no SMD** stuff
- Nice look - use **PCB with DILs**, as used in ZX
- Let Spectrum do the job - bare logic, **no MCUs**
- Home development - **MAPRAM**, **EEPROM**, no PGM/UV
- Legacy emulation - superset of **all entrypoints**
- Unbrickable, reflashable - **flash it** by LOAD “”
- Its name should reflect how it works…



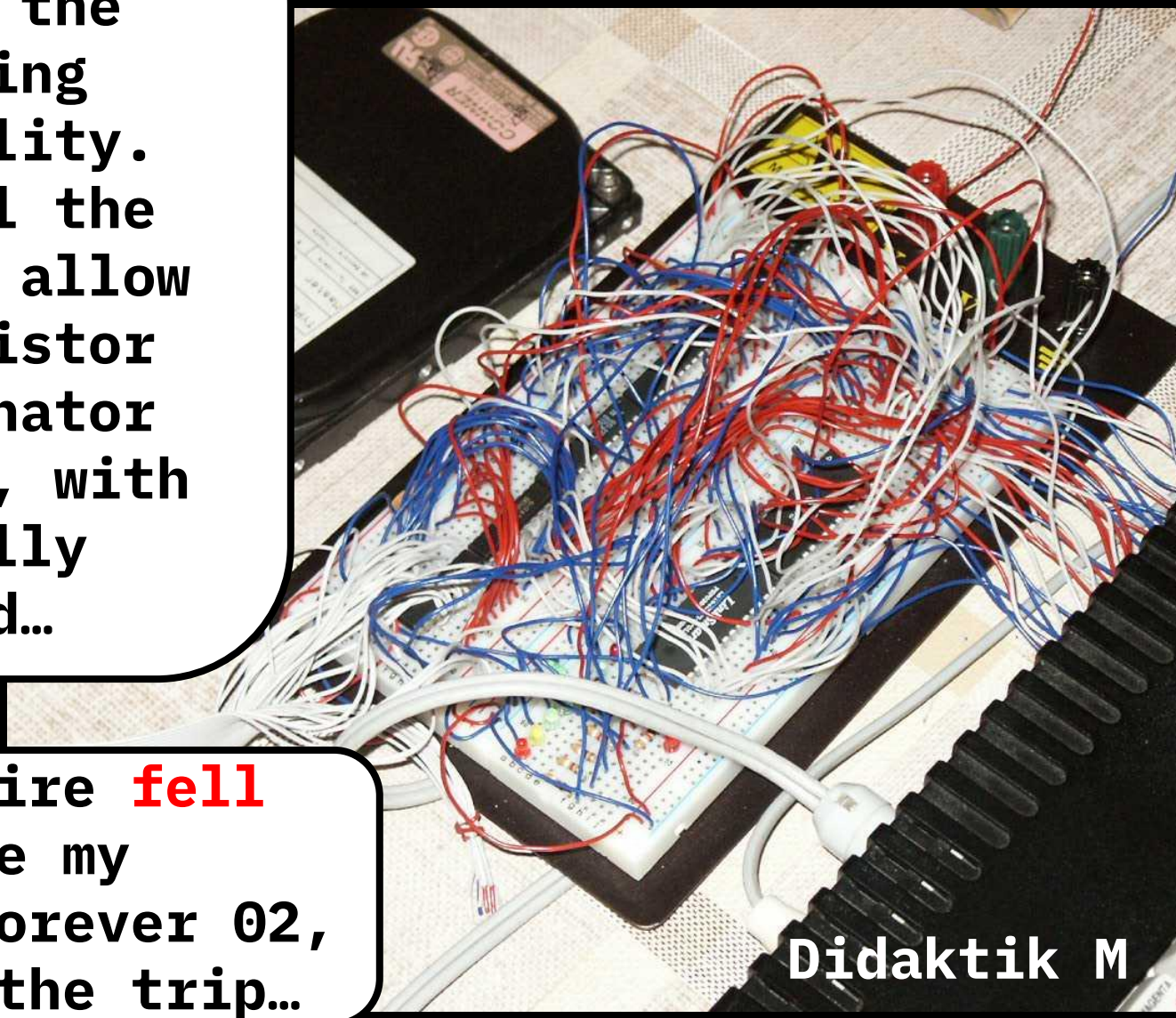
it tackles the AT-IDE hack by dividing
16-bit data words in two, thus…



First Hi-Lo Prototype Was a Nightmare

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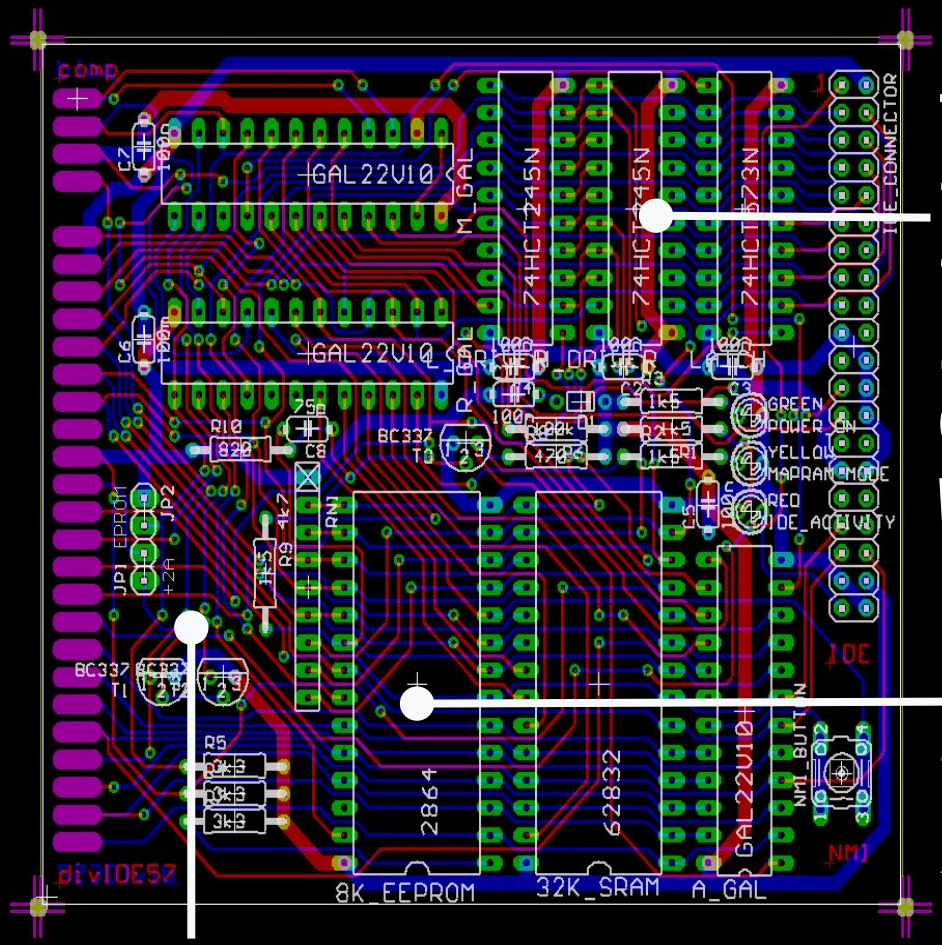
One 6 cm wire on D5, even loose in the air, was causing heavy instability. That's why all the divIDE boards allow for extra resistor network terminator on D-Bus. But, with PCB, it actually never happened…



But, another wire fell out just before my departure to Forever 02, so I canceled the trip…

How Four People Changed Three Things

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This 245-573-245 IC triangle topology was taken from Busy's PVL ZX-IDE Lo-Hi variant. Originally, I was fine With two 574 and Hi-Lo…

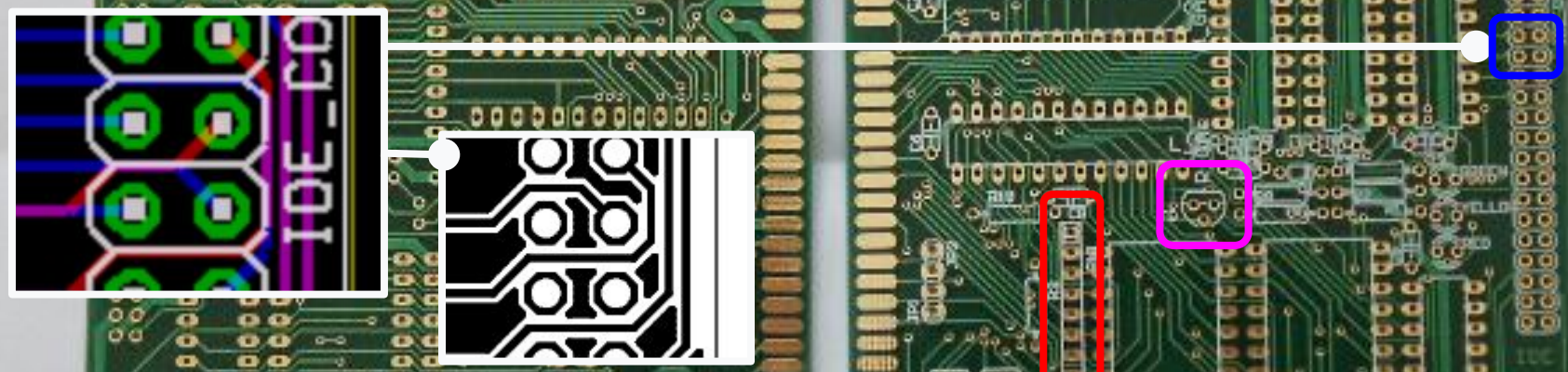
Poke persuaded me to get rid of 8k boot EPROM and to use ATMEL 28C64 EEPROM instead…

The whole project ended in my drawer as I was not confident enough about compatibility, until Flyyn and Johny-X visited me with all those big 128k machines that I have never touched before…

Gold Plated and Silk Printed Boards

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ZX Spectrum

First 30 divIDE boards ever, 57x…
The factory plated all pads with gold and left misplaced silkprints everywhere, out of inattention…



The unused resistor network, non optimal IDE routing and /MREQ inverter with BC337, which had to be immediately replaced with BF199, led to the very next version, 57b…

Preparing Bundles for ZlinCon 2002

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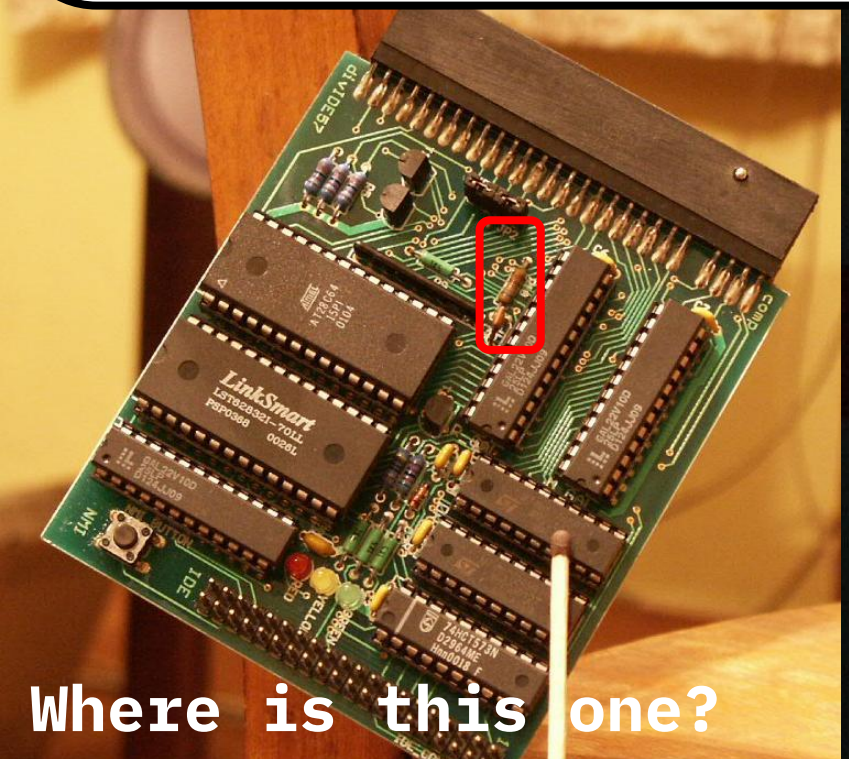
It was pretty annoying to program all 81 GALs and complete all the 25 paper kit bundles…

Two of them were pre-assembled as musters. Some people just wanted to solder it right there…

Baze Got the Very First S/N #000001

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He loves assembly, but it was the pre-assembled one. That resistor was cannibalised from dead SCSI controller from host irc.felk.cvut.cz, a DEC Alpha, where we used to chat on #z80…



Where is this one?



baze

Early DivIDE Owners at ZlinCon 2002

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The price was 600 Kč (24€), cost of the parts…









Sweet (MDOS3), Tritol (DEMFIR), Poke (kit manual, testing), Flyyn (+3 testing) and Factor6 (DIY manual, logos) and others…

As a Teaser, 25Hz DivIDEo Was Played

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It was a Bad Touch…

That posterisation, with chromatic enforcement, is my own big secret…

The format was uncompressed in realtime, by 48k ZX, and dithered according to attribute lumas…

DivIDE Was Sometimes Paid as Barter

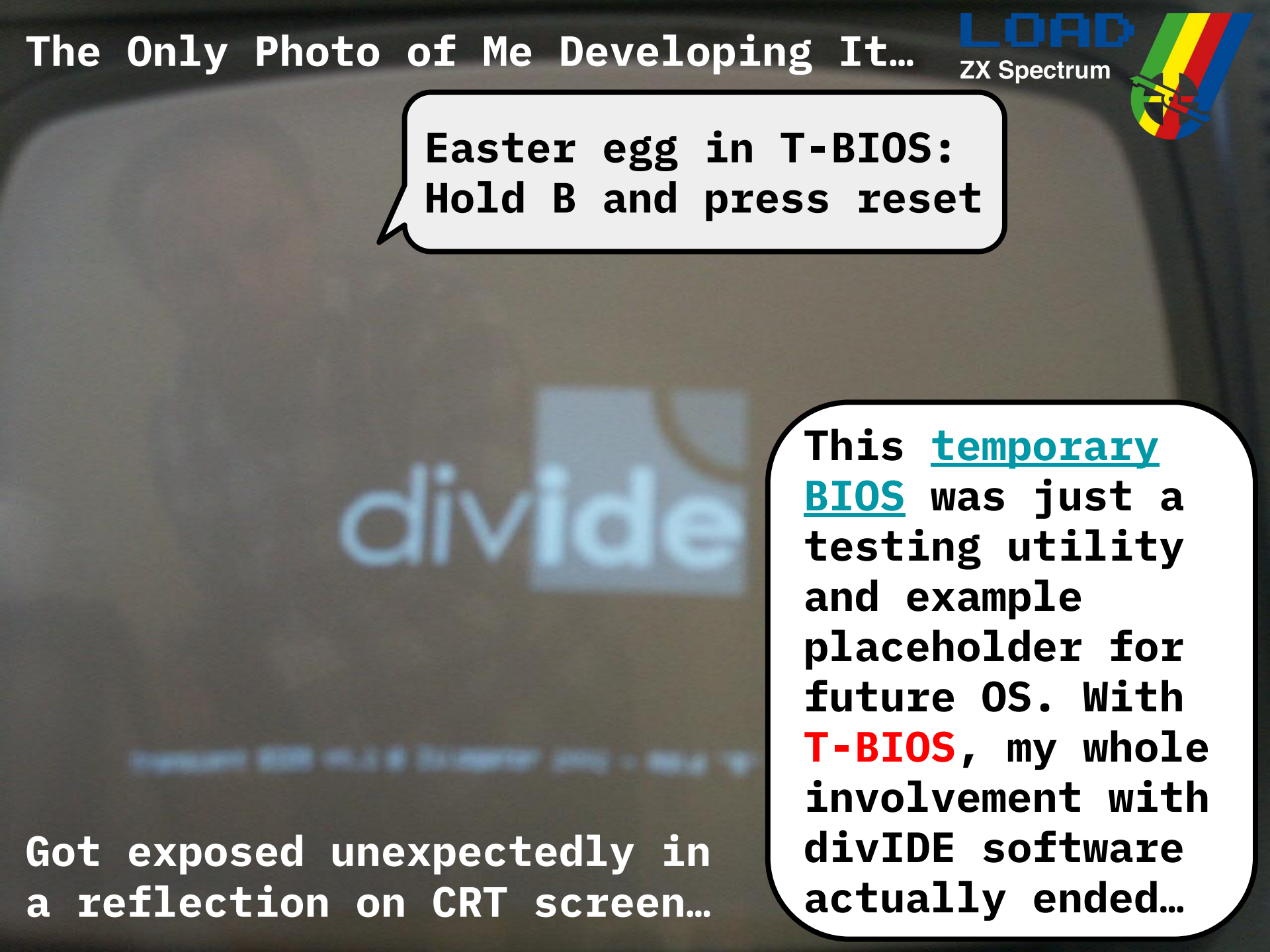


The oscilloscope was 18 GHz one, with vector UI. Got it from Logout, but it overheated and ended in smoke at ShuCon. Dron^K3L gave me the counter.

The Only Photo of Me Developing It…

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Easter egg in T-BIOS:
Hold B and press reset



This temporary BIOS was just a testing utility and example placeholder for future OS. With T-BIOS, my whole involvement with divIDE software actually ended…

Got exposed unexpectedly in a reflection on CRT screen…

T-BIOS Outlined All Necessary Tricks

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T-BIOS tested the board and machine together.
Even automapper itself and EEPROM can be tested.

```
CLOCKING LOGIC TEST:
Skipped, turn off MAPRAM mode to get it work
HOST RAM TEST (128KB):
Page7 16384 OK  Page6 16384 OK  Page5 16384 OK  Page4 16384 OK
Page3 16384 OK  Page2 16384 OK  Page1 16384 OK  Page0 16384 OK
MAPRAM MODE TEST:
Already OK, installed
DIVIDE RAM TEST:
Bank0 08192 OK  Bank1 08192 OK  Bank2 08192 OK  Bank3 08192 OK
DIVIDE EEPROM TEST:
Open EPROM jumper for testing, press key: Eeprom 00000 OK
DETECTING AT-IDE AND ATAPI DEVICES:
DEVICE 0 (MASTER): Disk
Model: SanDisk Drive                                  Rev: 010509
SN: 00000000                    Buffer: 256 sectors
Current CHS: 980/16/32            Default CHS: 980/16/32
Current  capacity: 501760 sectors  Multiple sectors: 0
LBA addressable sectors: 501760  Multiple setting: 0
DEVICE 1 (SLAVE): Disk
Model:                                                Rev:
SN:     rdmi  amed              Buffer: 8224 sectors
Current CHS: 1935/16/63           Default CHS: 1935/16/63
Current  capacity: 1950480 sectors  Multiple sectors: 1
LBA addressable sectors: 1950480  Multiple setting: 0
```

The automapper is a feature that is replicated in **all** later divXXX clones and its successors. Mapping happens in **refresh** Mcycle, so that firmwares can distinguish between inner and outer entrypoint calls…

This gets handy for **NMI** debouncing without filters.
Re-entries can be diverted by JR at entrypoints…

Velesoft Helped to Preserve It All…

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Velesoft's living room. His site is the most complete divIDE archive far and wide…

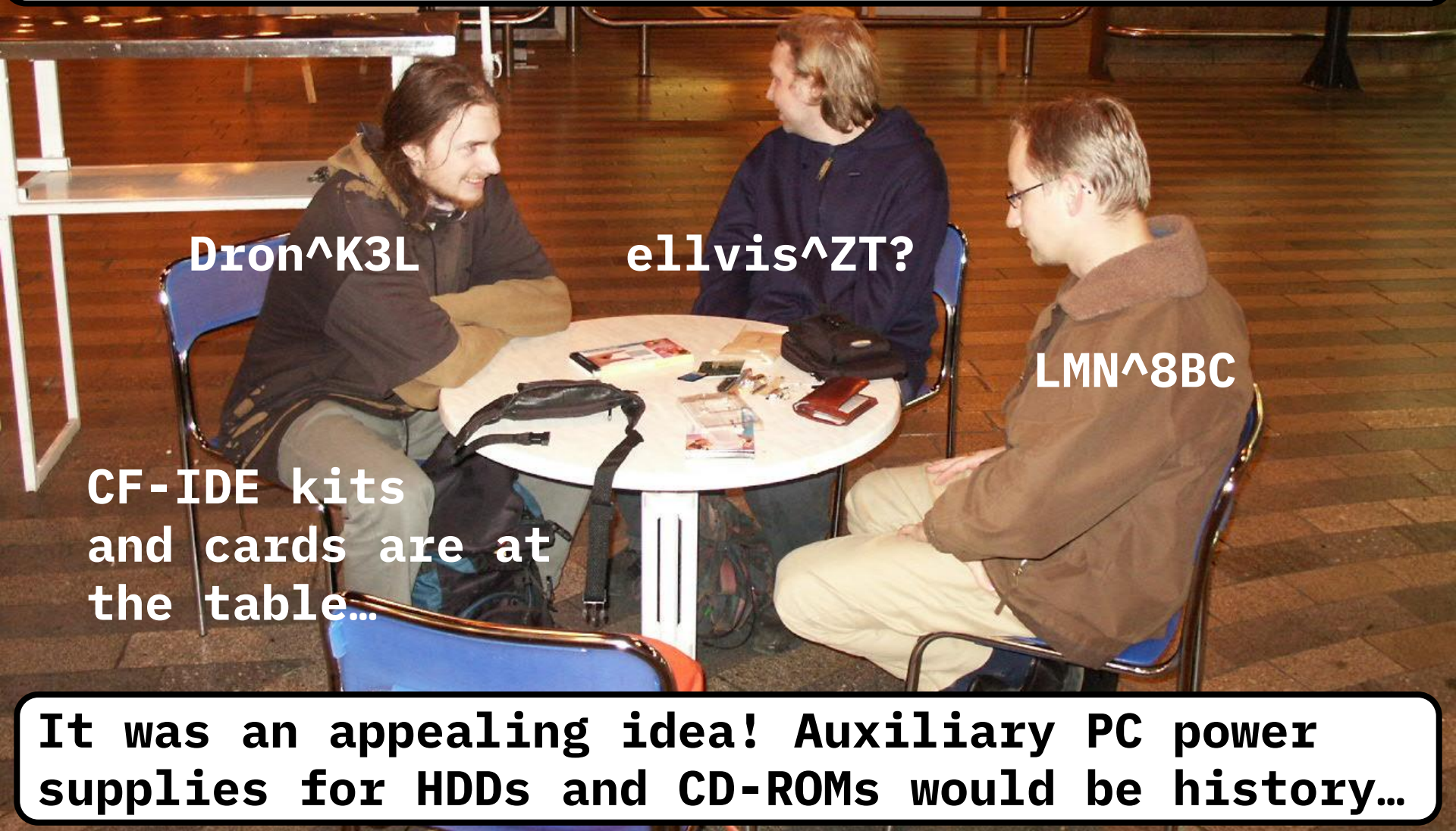


Velesoft helped me to get my first 128k machine. DivIDE was developed blindly without owning any.

Meeting at Main Train Station, Prague

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I have seen Sami Vehmaa's CF adaptor at ZlinCon. It basically converts CompactFlash into AT-IDE.



It was an appealing idea! Auxiliary PC power supplies for HDDs and CD-ROMs would be history…

CF-IDE Was Born and Cloned in China

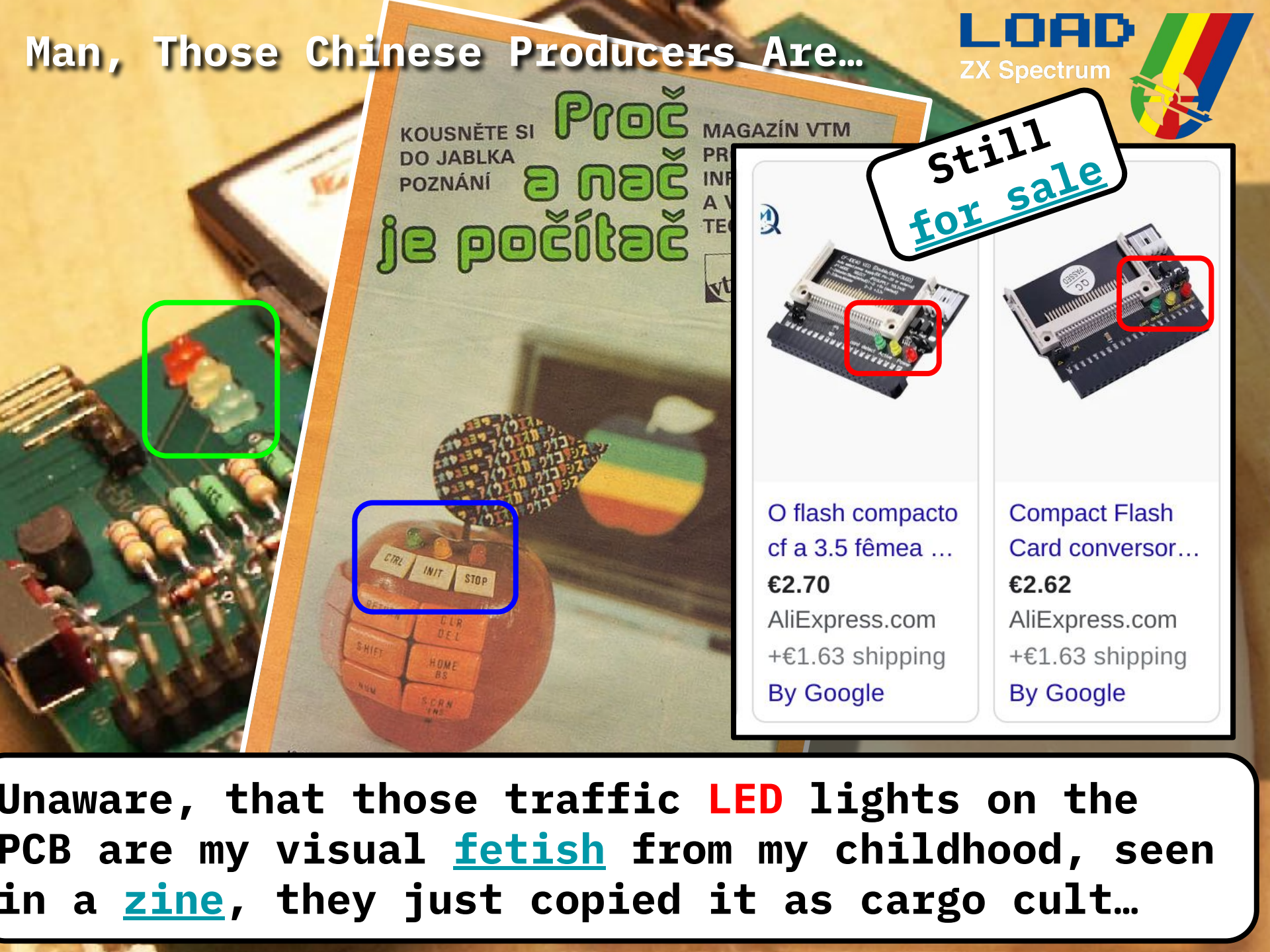
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So the CF-IDE was born, for both MB-02 and divIDE IDEs… But soon, PC users started to order it as well… Voila! My mission was complete. ZX Spectrum was ahead again…

Man, Those Chinese Producers Are…

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Unaware, that those traffic LED lights on the PCB are my visual fetish from my childhood, seen in a zine, they just copied it as cargo cult…

Quarrel with Ryston Electronics…

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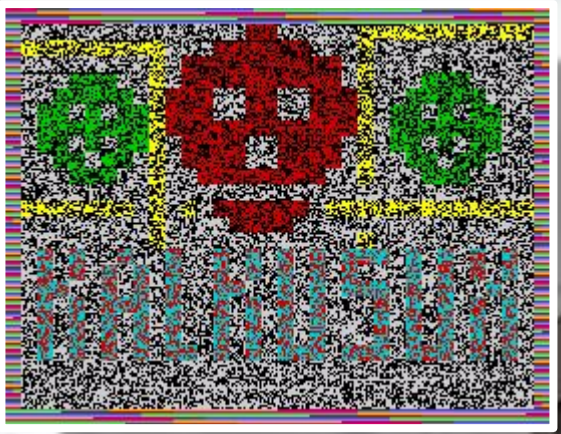
Those 500 year floods of Prague, in 2002, actually helped to bring down the price of first divIDE kits…



Someone pointed me to Ryston Electronics. Their warehouse was affected and they just sold out…

Summons, Demo and Settlement Later…

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When initial 30 pcs were sold out, I ordered next 50 pcs batch but, their manager refused it as too small. Some hate at ZX mailing list sparked, but he was reading it as well somehow and threatened us with pre-trial summons for damaging the company's name. Guess his surname…



DivIDE Enters United Kingdom, 2004

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baze Tritol Zilog

Back In Time event, in St. Luke's cathedral. We brought one divIDE with us, to offer it to our British colleagues. **Nobody** wanted it, actually…



At last we managed to force it on at least this poor gentleman. And then, divIDE conquered the world, thanks to Papaya Labs and other producers