LEC memory extension

Background:
LEC memory extension was developed by young Czech developer Jiri Lamac in early 1987,
when DRAM 41256 (256K*1) chip became available in surrounding countries.
It allows to map the fast RAM to whole Z80 memory area and run CP/M 2.2 OS on Microdrives,
Beta Disc or RAM disc.
It was easy to build it at home but it needs some soldering skill, because all the
4332 memory chips has to be unsoldered from Speccy mainboard and 41256 has to be soldered
at their place. Small control circuit needs to be built. It fits to the space between ULA and Z80, so
the whole modification fits even to the old rubber 48K models.

There were 3 modifications of LEC memory extension:

- LEC 80KB 4332 removed and 4164 (64K*1) soldered in at their place.
- LEC 272KB 4332 removed and 41256 (256K*1) soldered in at their place.
- LEC 528KB 4332 removed and two sets of 41256 (256K*1) soldered at their place. The
  'upper row' of 41256s has /CAS pin bent out and connected together among all the upper
  row chips.

Control port:

LEC uses one control port at #FD address (all bits are cleared with RESET):

(A1='0' and iorq='0' and wr='0')

- D7 - PG 0= ALLRAM is off
       1= ALLRAM is on and N[3:0] bits are selecting the 32K RAM page at #0000-7FFF.
         also red LED on the panel is connected to this bit, indicating ALLRAM is on.
         PG=1 also A15 on expansion bus connector to 1. It prevents the interfaces
         with own shadow ROM to be paged in.

- D6 - N2 selects the number of 32K RAM page at #0000-7fff, when PG=1. Don't care in LEC
  80K.

- D5 - N1 selects the number of 32K RAM page at #0000-7fff, when PG=1. Don't care in LEC
  80K.

- D4 - N0 selects the number of 32K RAM page at #0000-7fff, when PG=1. Don't care in LEC
  80K.

- D3 - N3 selects the number of 32K RAM page at #0000-7fff, when PG=1. Don't care in LEC
  80K.
- D2 - 0 reserved for LEC 1MB
- D1 - 0 reserved for advanced port settigs.
- D0 - L yellow LED on the panel is connected to this bit, 1=ON. Some SW uses it for
  indication.

At #8000-FFFF, there is always the LAST fast RAM page available:
 1 in LEC 80K
 7 in LEC 272K
15 in LEC 528K

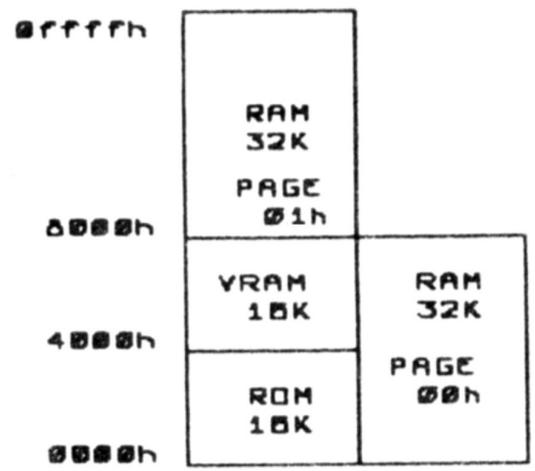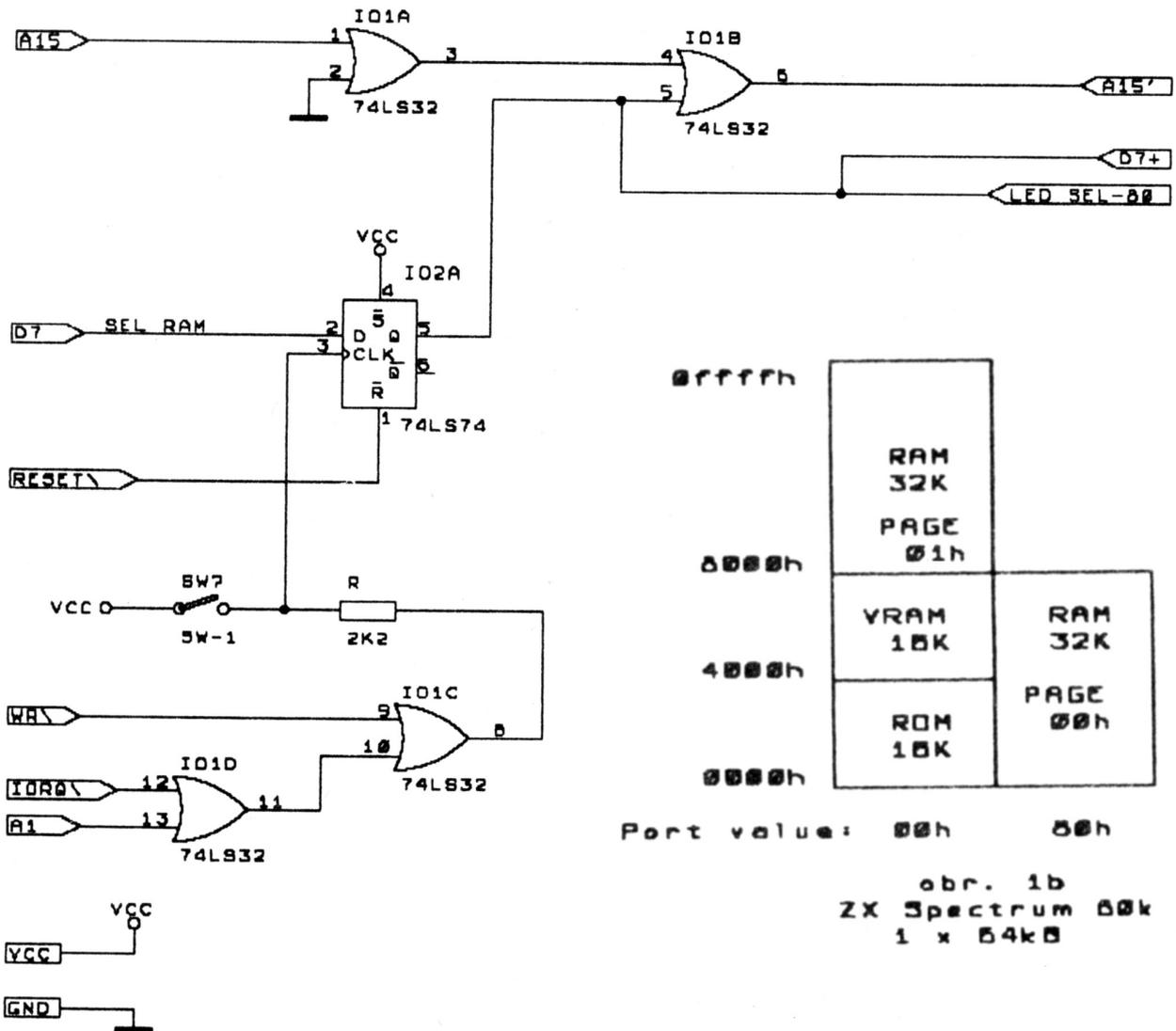so if PG=1 and N[3:0]=0111 in LEC 272K, page 7 will be twice in 64K range.
so if PG=1 and N[3:0]=7111 in LEC 528K, page 15 will be twice in 64K range.
Warning: Because the port address collides with 128K memory control and AY music, a

mechanical switch which blocks the writes to the port is needed. It is labeled SW-1.

Schematics and wiring:
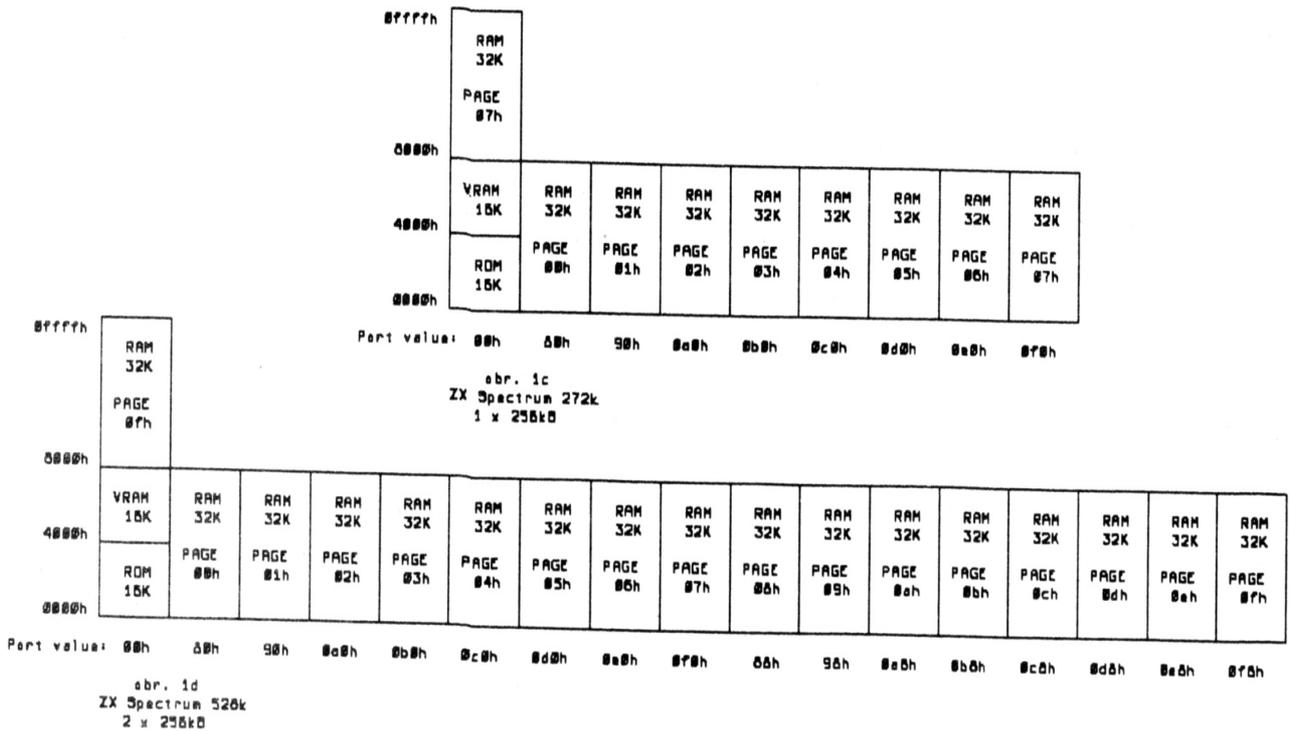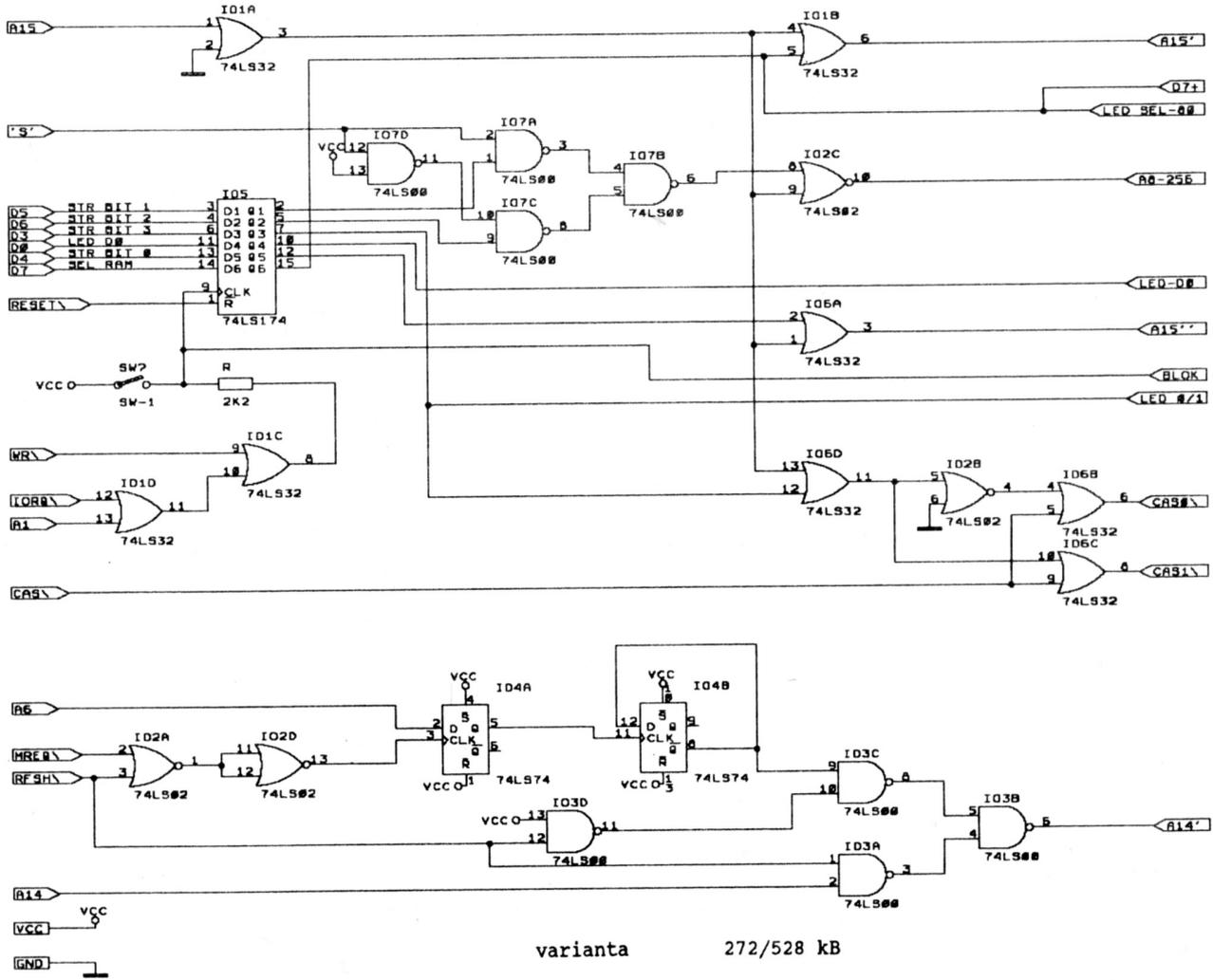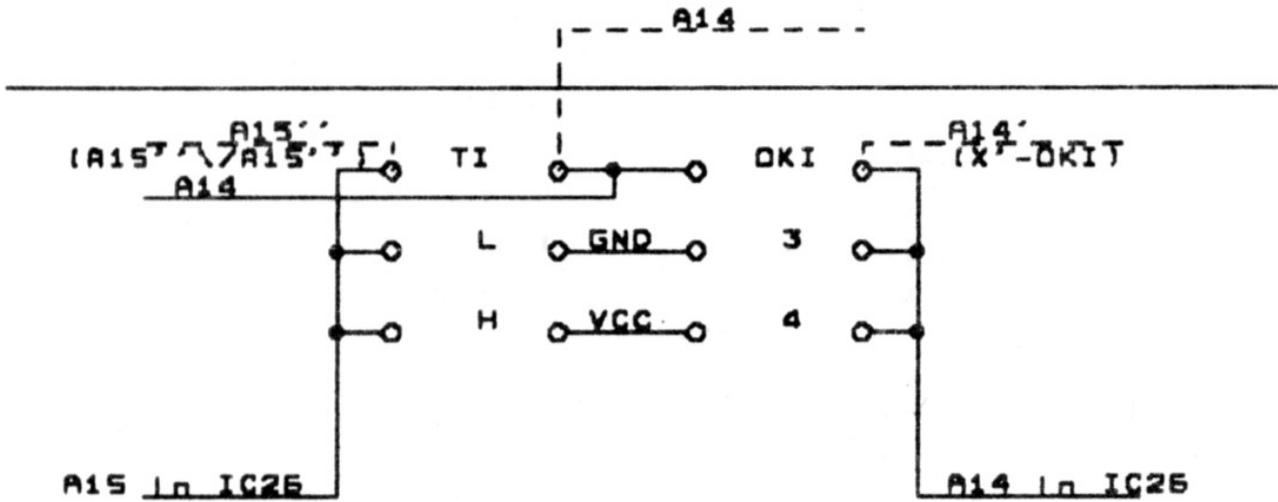Here is the 80KB version schematic diagram and memory map:

IO1A
A15
1
2
3
74LS32

IO1B
4
5
6
74LS32
A15'

D7+
LED SEL-80

VCC
IO2A
4
SEL RAM
D7
2 D 5 Q 5
3 CLK Q 6
R 1
74LS74

RESET\

SW7
VCC O—o o
SW-1
R
2K2

IO1C
WR\ 9
10 8
IO1D
74LS32
IORQ\ 12
A1 13 11
74LS32

VCC
VCC

GND

varianta 80 kB

0ffffh

RAM
32K
PAGE
01h
8000h

VRAM
16K
4000h

ROM
16K
0000h

RAM
32K
PAGE
00h

Port value: 00h   80h

obr. 1b
ZX Spectrum 80k
1 x 64kB

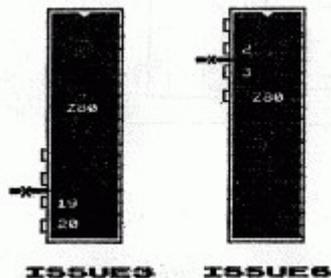Here is the 272/528KB version schematic diagram and memory map:

varianta   272/528 kB

obr. 1c
ZX Spectrum 272k
1 x 256kB

obr. 1d
ZX Spectrum 528k
2 x 256kB

Wiring:

Pole propojek pameti u verzi 3..5
v () pro verze s pametmi 32kb

Pole propojek pameti u verze 2

Where to cut A15:

ISSUE3   ISSUE6
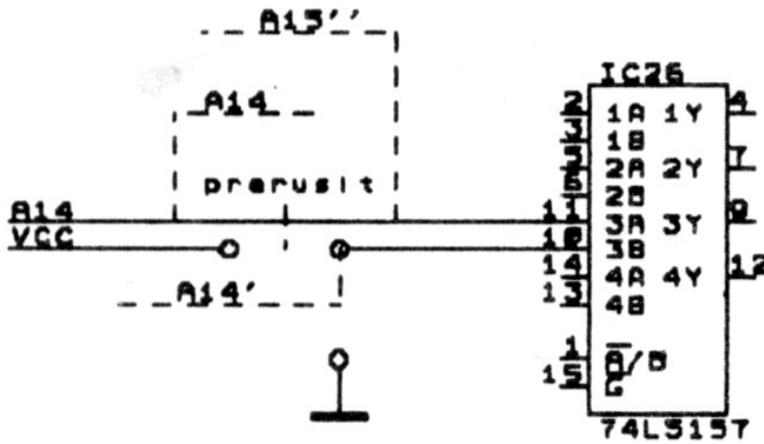
A15 must lead to pin 5 CPU, and cathode D8 located near 8pin keyboard plug.
A15' must lead to the edge connector's A15, to pin 37 of ULA.

Beta Disc hack
It is needed for direct access to the floppy controller, for CP/M BIOS or custom format program etc.
because it hides FDC ports and shadow ROM as soon as an instruction is fetched from RAM.
The modification itself block the paging and unpaging circuit when D4=0 is written to (A1=0 and
A15=0 and iorq=0 and wr=0). When D4=1 is written back, or after RESET, stops this feature.

To emulator programmers:

Microdrive and Beta must be emulated at the level of I/O ports not at the level of ROM calls only. Because Jiri Lamac uses his own rutines and own cartridge format.

The installation tape for LEC 272/528 and Microdrive is included, so you may test if you emulation works fine.

ROM:

Jiri wrote his own ROM called LEC ROM. It fixes some well known bugs of original ROM, delivers the better de-tokenized basic editor and few commands for copying data between RAM banks. But it is just optional, CP/M and custom format programs works with original ROM as well.

Disclaimer:
Jiri Lamac give the formal agreement to archive, use and distribute his 8bit nostalgia computer works for free, as long as no profit is made on it and info about the author(s) is included.
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