R65 System Software

1. General description of the basic R65 software

This manual describes the system software for the R65 computer system. The system software consists of 4 separate modules, which are stored in EPROM.

R65 CRT Controller:

Handles the Video interface and the keyboard.

Adress space: E000-E7FF

R65 Input/Output Controller:

Routines for printing on a RS-232 needle printer, interrupt handling and audio tape io routines. The audio tape is not emulated in the emulator. Printing to a printer is emulated by printing to a text file printout.txt in the working directory of the emulator.

Address space: E800-Efff

R65 Floppy Disk Controller:

Handles 2 floppy disk drives. 80 tracks, 10 sectors of 256 bytes per track. Includes the subroutines for sequential file i/o.

Address space: F000-F7FF

The R65 System Monitor:

Includes all necessary commands to work with Machinge Language Programs using hex numbers.

Address space: F800-FFFF

2. STOP, QUIT and SHUTDOWN

The following keyboard keys are recognized by the R65 Emulator and executed immediately. The buttons on the top left of the screen can also be touched or clicked.

<shift>ESC or STOP button:

Emulate a 6502 non mascable interrupt (NMI)

<shift>MENU or <shift>WINDOWS or QUIT button or x(close window):

Quit R65 emulator, go to dektop

<shift>ALT SHUTDOWN:

Quit R65 emulator and shut down Linux

Note that open sequential files are not closed if one of these keys or buttons are executed. This is not a problem if a sequential file read is in progress, but in the case of a sequential file write this leaves a large useless file on the disk. Deleting this file afterwards and using PACK on the disk will solve the problem. Try to avoid therefore these actions if a sequential disk write is in progress. Disks are closed properly.

3. Installation

The R65 Emulator for Raspbian can be downloaded from GITHUB. Open a terminal and type:

```
cd
git clone --depth 1 git://github.com/rricharz/R65
cd R65
cp R65-Emulator.desktop ~/desktop
cd R65-Emulator
mkdir Files
cd Disks
cp EMPTY.disk WORK.disk
```

Installing the mandatory fonts

```
cd
cd R65/R65-Emulator/Fonts
sudo ./install_fonts
```

Starting the emulator

Now you should be able to start the R65 emulator using the R65 Emulator icon on the desktop. Read chapter 5 Floppy Disk Drives before proceeding.

You can also start the emulator using a terminal window:

```
cd
cd R65/R65-emulator
./emulator
```

“emulator” has the following options:

- full	Display the emulator in a full screen window. Looks much more pretty.
- pixelated	Use a pixelated font for the R65 screen. This resembles the original. Works best together with -full.

As the first thing, you should rename your newly created WORK disk.

Type FLOPPY WORK,1 to ensure that the WORK disk is in drive 1.

Type VOLUME 1<return> and then enter WORK.04 <return> to label your work disk properly.

Adding additional disks

Later, you can create additional disks with the name MYNAME (where MYNAME stands for any name you want to use) as you have done above for WORK. In the Raspbian terminal, type

```
cd
cd R65
cd R65-Emulator/Disks
cp EMPTY.disk MYNAME.disk
```

Then, restart R65-Emulator using the Desktop icon.

Type FLOPPY MYNAME,1 to ensure that the MYNAME disk is in drive 1.

Type VOLUME 1<return> and then enter MYNAME.05 <return> to label your new disk properly. Instead of

05 you can give the floppy any number you wish. It is strongly recommended to label your disks with the same names as the name of the disk file in Raspbian in order to avoid confusion. On the top status line of the R65 emulator the name of the Raspbian disk file is displayed.

Upgrading the R65 Emulator

If you have not modified the PASCAL, SOURCE and PROGRAMS disks, upgrading is easy. If you have modified these disks, you need to first make a backup of your modifications on any other disk. It is necessary that the upgrading process upgrades these disks, because most upgrades are likely programs, libraries and source files on these disks. Also, some of these programs might have been modified to work together properly with any upgraded version of the Emulator.

Type

cd

cd R65

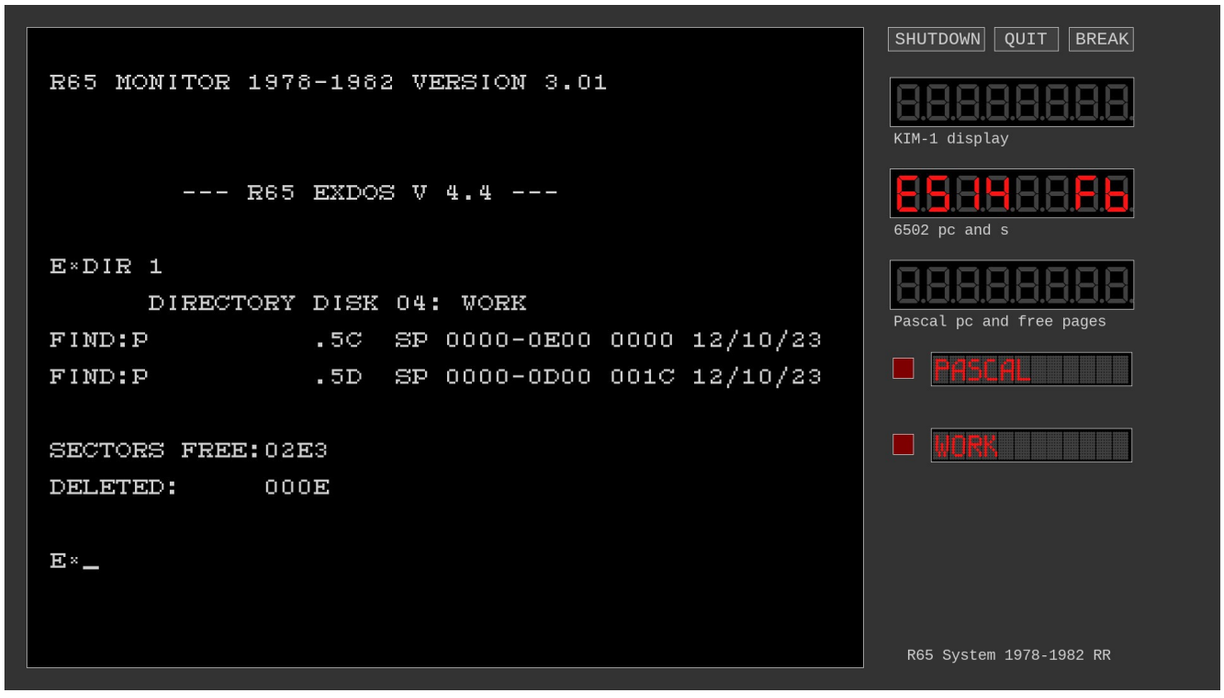
git pull

The git pull file will give an error message, if any file which will be upgraded has been modified. Type

git checkout xxx/xxx

where xxx/xxx is the path and file name for a file which git pull needs to overwrite. Once all the error messages of the git pull command have been corrected, you can perform the git pull to upgrade your software.

4. R65 Emulator front panel



On the left side is the **CRT screen**, using a pixelated font to resemble the original, while still being readable. The original had a 5x7 pixel character set, while the emulator uses a 7x11 matrix to imrove readability on modern high resolution computer screens. It is shown if the emulator is started with the -pixelated option. Without this option, a modern monospace font is used. Do not forget to install the required fonts as described in the installation section of this manual.

On the top right are 3 buttons, which can be pressed with the mouse. “Break” executes a 6502 NMI break as on the original KIM-1 board. “Quit” exits the emulation. “Shutdown” exits the simulation and runs the host Raspberry Pi or Linux system down. On suitable keyboards, <shift><esc> executes the break button, <shift><menu> executes the quit button, and <shift><alt> executes the shutdown button.

The “KIM-1 display” resembles the original KIM-1 seven segment led display. The original had a 6 digit

display with a space between the 6th and 7th character, which was driven by the R65 software using a background, interrupt driven program. This code was unfortunately lost, so that the R65 emulator handles this in the emulator code, using a 8 digit 7 segment display. This display is under control of user programs written in 6502 code or Pascal. See the Pascal “ledlib” library for an example. As long as the user hasn’t written anything onto this display, the emulator shows the current time.

The “6502 pc and s” seven segment display shows the 6502 program counter (pc) and stack pointer (s) in hex. The program counter is frozen while the program waits for user input, even so on the original this was handled in a short 6502 code loop. But to avoid overheating of the host CPU of the emulator this is now done in the emulator software with the proper Linux functions. The stack pointer can be used to monitor the 256 byte stack of the 6502. A too low number suggests that the stack may soon overflow and the program may crash. Typically this happens if a recursive subroutine is called with too many levels of recursion, or if too much data is pushed on the stack, using the corresponding 6502 instructions such as PHP or PHA. There is a delay of 3 seconds at the currently lowest number to allow to monitor this critical level.

The “Pascal pc and free pages” seven segment led display shows the pascal program counter in decimal and the number of free 256 byte pages in hex. The program counter of each program line is shown in the Pascal program listings as printed by the Pascal compiler. The number of free pages is the free memory between the top of the Pascal user memory (topmem), or the heap pointer if heaplib is used, and the Pascal stack pointer, which moves upwords. This should never go below approximately 5 pages to allow the Pascal interpreter enough space to breath. As on the display of the 6502 stack there is a delay of 3 seconds at the currently lowest number to allow to monitor this critical level.

Below the seven segment displays are two LEDs, which glow when the two floppy drives are spinning. Because it took some time to spin up a floppy drive on the original, the drives were kept spinning for several seconds after a read or write was executed. Constantly spinning the drives was not possible to minimize wear out of the floppies. To the right of these LEDs are two dot matrix displays showing the names of the floppies in the drive. I always wanted to have these displays, but they were not yet available in the late 1970s.

5. Monitor Commands

The following abbrevations are used:

exp1	A hexadecimal expression
filnam	A file name of up to 16 characters
drive	0 or 1 for the two floppy drives
cy	a cyclus number for a file
[]	These arguments can be omitted

CLRB exp1

Erase breakpoint at address exp1.

COPY filnam[.cy],from_drive,to_drive

Copy a file from from_drive to to_drive. The drives must both be given and must be different. The wildcard character @ can be used in filnam. Sequential and block files can be copied. The maximal file size to be copied is $9000 (32768) bytes. The memory space $2000-$BFFF is used as a buffer. Extremely large sequential files (such as COMPILE1:P and ASSEMBLER:A) cannot be copied using the copy command. Use EXPORT and IMPORT for these very large files. Do not use the combination of EXPORT and IMPORT for any files except :A and :P files.

DATE

Display actual date. Date can be changed once displayed. <return> returns to monitor. The emulator reads the Linux system dates at startup and stores it in the R65 date memory. Afterwards it can be changed if necessary.

DELETE filnam[.cy][,drive]

Delete a file. The wild card letter @ can be used in filnam.

DFORMAT diskname,drive

Erase the disk directory completey and create a new directory

DIR drive

Display directory of a disk drive.

DIS [exp1][,exp2]

Disassembles machine language program at address exp1 and following. exp2 (default 10) commands are decoded. Use <esc> to return to the monitor.

EDIT filnam[.cy][,drive]

Edit a file with the Linux mousepad editor. Use the command NEW (see below) if you want to edit a new file.

EXPORT filnam[.cy][,drive]

Export a sequential file to the Linux Files directory

FDIR [drive]

Full disk directory, including deleted files which can be recovered with the revive command. Also shows how many sectors can be recovered with the pack command.

FLOPPY disknam[,drive]

Change the floppy disk in drive (default 0) to the one with the name disknam. Floppy disks are stored in the Linux Disks folder with the extension .disk, but disknam must be given without this extension. Additional floppies can be made there by using Linux to make copies of existing disks. The emulator can handle an unlimited number of floppies, but only 2 floppies can be in the 2 drives at the same time.

GO [exp1][,register definitions]

Start executing the machine language code at address exp1. See command REG for the register definitions.

GSB [exp1][,register definitions]

Same as GO, but instead of a jmp to the start address a jsr (subroutine call) starts the execution.

IMPORT filnam[,drive]

Import a Linux file from the Linux Files directory. The Linux file must have the extension .asm or .txt, but filnam must be given without this extension.

LOAD filnam[.cy][,drive][,exp1]

Load a disk file with name filnam (and cyclus) from drive to the stored memory addess. If exp1 is given, the file is loaded to the address exp1.

NEW filnam[.cy][,drive]

Create a new empty sequential file.

PACK [drive]

Permanently erase all deleted files and recover the disk space. FDIR displays how much space can be recoverd with the PACK command.

PROTECT filnam[.cy][,drive]

Protect a file. Delete will ask for permission before deleting protected files.

PRTB

Display the active breakpoints.

REG [register definitions]

Display saved CPU registers, allow to change them. Register definitions are name=exp[,...], where the register names are P,S,F,A,X,Y. Use <esc> to return to the monitor.

RENAME filnam[.cy][,drive]

Rename an existing file. The command asks for the new name and subtype. The file is protected if subtype is preceded with !.

REVIVE entry number[, drive]

Recover a deleted file. Use FDIR to get the entry number.

RESETB

Clear all active break points.

RUN filnam[.cy][,drive],[,exps1]

Loads a file like load, but starts it afterwards automatically. The file type must be "M" (machine language).

SAVE [drive]

Make a backup copy of the disk directory on the last track of the disk.

SETB exp1

Set a breakpoint at address exp1

STEP [exp1]

Execute one machine language instruction. Use <esc> to return to the monitor.

STORE filnam[.cy],[drive],exp1-exp2,[P]S[,exp3]

Store a file from memory exp1-exp2, file type S. If exp3 is not given, the address for LOAD is exp1, otherwise exp3.

SWAP [dive]

Exchange the disk directory with the one backed up with save before.

TRACE [exp1,exp2]

Like STEP, but executes exp2 (default 6) instuctions

VOLUME [drive]

Set the internal name of a disk displayed if DIR or FDIR is run in EXDOS. Does not change the file name of the floppy disk file, which is used in the FLOPPY command. It is therefore recommended to setthis name to the name of the disk file.

/exp1

open memory address at exp1

/exp2	open new address exp2
<return>	open next address
L	open previous address
'C	set memory cell to Ascii code
exp2	set memory cell to exp2

6. PASCAL commands

The PASCAL envirement is started with the command

RUN PASCAL

This assumes, that the disk PASCAL is on drive 0.

In the PASCAL environment, the following commands are available, if they can be found on disk 0. In their PASCAL version, most commands have drive 1 as the default drive for their argument in order to facilitate Pascal development on the WORK disk on drive 1. The source of the Pascal compiler and the Pascal libraries are on the disk SOURCECOMPIL. The source of the other Pascal programs are on the disk SOURCEPASCAL.

ARGLIST arguments

Displays the list of arguments as they are forwarded to Pascal programs.

BOUNCE

Bouncing ball on graphics display.

CALC

A small calculator. Makes basic calculations and displays result in decimal, hexadecimal and binary, when possible.

CLEAN drive

Automatically deletes unnecessary files on the disk drive (default 0).

- All files with the type :Q (compiler temporary files)
- All but the latest cyclus of any file

The command CLEAN does not PACK the disk, in case you decide that you need to REVIVE a file which has been deleted by CLEAN. Use PACK after CLEAN if you want to recover the space.

COMPILE filnam[.cy][,drive] [options]

To compile a Pascal source file (:P). Give the file name without the :P. Options can be several letters stringed together. The Pascal compiler is a 2-pass compiler. The second pass is only executed if the first one is successful.

L Print hard copy (into printout.txt)

R Compile with runtime index checking (slower and larger file)

N Do not produce a loader file for pass 2

Use COMPILE1 instead of COMPILE to compile libraries. Libraries do not need the second pass COMPILE2, and an error message will be produced when COMPILE2 wants to load the loader file :Q of a library. The default drive is drive 1.

COMPILE 1 filnam[.cy][,drive] [options]

Execute only pass 1 of the compiler. The default drive 1 drive 1.

COMPILE 2 filnam[.cy][,drive]

Execute only pass 2 of the compiler. Libraries do not need the second pass of the compiler and cannot be loaded with COMPILE2. The default drive 1 drive 1.

COPY filnam[.cy][,sourcedrive] desdrive

Copy a file file from thesource drive to the destination. Copies all types of sequential files and Pascal binary runtime files. Cannot be used for machine language programs. Lenght of sequential files only limited by available floppy disk space.

DELETE filnam[.cy][,drive]

Delete a file. The wild card letter @ can is not available in Pascal. Use the command CLEAN instead to delete multiple unwanted files. Drive 1 is the default drive in the Pascal version of the command.

DIR drive

Display directory of a disk drive. The entries are displayed in several columns, depending on the longest name and the number of files on the disk. The free space and the space occupied by deleted files is displayed in decimal. The default drive is remains drive 0 as in EXDOS.

EDIT filnam[.cy][,drive]

Edit a file with the Linux mousepad editor. Use the command NEW (see below) if you want to edit a new file. The default drive is drive 1, and the command automatically adds :P to filnam, if no other type is given. Use pedit instead of edit to use the internal Pascal editor.

ERROR errorcode

Display Pascal error code as text.

EXTIME pname,drive arguments

Measure and diplay the execution time of a Pascal program pname, called with its arguments.

FIND pname

Find files on drive 0 and 1. Wildcards * and ? are allowed, except as the first character.
Examples: find name*, find name:?, find name:p

FLOPPY fname[,drive]

Change the floppy disk in drive (default drive 0) to the one with the name fname. Floppy disks are stored in the Linux Disks folder with the extension .disk, but fname must be given without this extension. Additional floppies can be made there by using Linux to make copies of existing disks. The emulator can handle an unlimited number of floppies, but only 2 floppies can be in the 2 drives at the same time.

GETSOURCE pname

Copy a source file from SOURCEPASCAL or SOURCECOMPIL to WORK.

GRAPH

Example of displaying a graph of a table of a real numbers (TABLE.X on disk 1). Create first the table with MAKETABLE. The example demonstrates how to read from a binary random access file.

GRTEST

Display a test pattern on the R65 graphics window.

GRTEST2

Create a test plot on the R65 graphics display. The same plot is available as TEKTEST on an attached tek4010 emulator (see chapter 9).

GR3D

Create a 3D plot on the R65 graphics display. The same plot is available as TEK3D on an attached tek4010 emulator (see chapter 9).

LEDTEST

Create test patterns on the 7-segment display of the R65 replica, or on the top line of the R65 window.

MAKETABLE

Example of creating a binary random access file holding a table of real numbers. The file is created on disk1 and is called TABLE:X. The example created a fading sine wave. A graph of the file can be displayed with GRAPH.

NEW filnam[.cy][,drive]

Create a new empty sequential file. The Pascal version of the command has drive 1 as the default drive, and sets the file type automatically to :P.

PACK [drive]

Permanently erase all deleted files and recover the disk space. DIR displays how much space can be recoverd with the PACK command, and CLEAN automatically deletes certain files (see details in the description of the command). The default drive is remains drive 0 as in EXDOS.

PEDIT filnam[.cy][,drive]

Edit a file with the internal Pascal editor. Use the command NEW (see below) if you want to edit a new file. The default drive is drive 1, and the command automatically adds :P to filnam, if no other type is given. Use edit instead of pedit to use the linux mousepad editor.

PUTSOURCE pname

Move a source file from WORK to SOURCEPASCAL or SOURCECOMPIL.

PUTOBJECT pname

Move a Pacal object file from WORK to PASCAL.

SHOW filnam[.cy][,drive] [start]

Display a sequential file. The first 12 lines are displayed. If start is set, the display starts with line number start. Afterward, use <return> to display one more line, <space> to display 12 more lines. Any other key (including <ESC>) will return to the Pascal command line. The default drive 1 drive 1.

SINETST

Create a sine and cosine graph on the R65 graphics screen.

TEKTEST

Create a test plot on an attached tek4010 emulator (see chapter 9). The same plot is available as GRTEST2 for the R65 graphics display.

TEK3D

Create a 3D plot on an attached tek4010 emulator (see chapter 9). The same plot is available as GR3D for the R65 graphics display.

TGRAPH

Example of displaying a graph of a table of a real numbers (TABLE.X on disk 1) on an attached Tektronix 4010 terminal. Create first the table with MAKETABLE.

THROWSIM

Display a flight path of a thrown object on the R65 graphics screen.

7. Pascal libraries

Look at the source of these libraries on SOURCEPASCAL for details

ARGLIB

Handles arguments given by the pascal system to a program

LEDLIB

Handles output to the 7-segment display

MATHLIB

Handles math functions and the output of floating point numbers

PLOTLIB

Plot library for the R65 graphics screen

RALIB

Random access (binary) file access library

SYSLIB

Main R65 Pascal system library

TEKLIB

Plot library for an attach tek4010 plotter

TIMELIB

Handles system and execution time

8. Pascal games

ALIEN

Save the earth from an alien invasion.

PONG

Play the game of Pong.

REVERSI

Play the game of Reversi. The rules can be found at https://en.wikipedia.org/wiki/Reversi. Please note that the first two moves need to be placed in the center.

9. R65 Graphic Basic

The R65 Graphic Basic includes the basic commands found in Basic Interpreters of that time. The following commands have been added in the R65 version or are working slightly different:

CLOSE [D1]

Close a sequential file (if D1 is given) or all open sequential files

DIR [D]

Dispay the directory of floppy disk drive D (default 0).

FILES

Displays information about all currently open sequential files

GET [#D1;] V1 [,V2….]

Read one character from device D1. If V1 is a string variable, one character is read, otherwise one digit of a number. The following devices are supported:

D1=0: Read from keyboard, wait until a key is ready

D1=1: Read from keyboars, return with empty string if no character available

D1=2: Not implemented in Emulator

D1=3: Read from keyboard and display immediately on Graphics Display

D1>=4: Read from a open disk file

INPUT [#D1] V1 [,V2…]

Read from device D1 (see GET for details). Reads one full string or one number)

LOAD S1[.D1] [,D2}

Load a Basic program from floppy drive D2. Example LOAD “LIFE:B”

LOAD #D1;

Import a basic program from a text file which has previously been opened with OPEN D1

MOVE N1,N2

Move graphic cursor to n1,n2

OPEN D1,S1[.D2][,D3,[D4]]

Open a sequential file (D1>=4). D3 is the floppy drive number, D4=0 for read and 1 for write.

PLOT N1,N2[,D1]

Plot a dot on the graphics display at N1,N2. D1=0 in white, D1=1 in black, D1=2 inverted.

PLOT NEW

Initialize graphics display, Switch alphanumeric display buffer to 16 lines

PLOT CLR

Clear graphics display

PLOT STOP

Go back to alphanumeric display without loosing graphics display buffer

PLOT CONT

Go back to graphics display after a PLOT STOP

PLOT END

Erase graphics display area and go back to alphanumeric display. Switch back alphanumeric display buffer to 42 lines.

PRINT [D1;] ….

Basic print statement. Devices are:

D1=0: Standard display

D1=1: Not implemented in emulator

D1=2: Not implemented in emulator

D1=3: Graphics display at current position of graphic cursor

D1>=4: Open sequential file

STORE S1[.D1] [,D2]

Store Basic program on drive D2.

SYS N1

Execute 6502 code at N1

WAIT N1

Wait N1 times 10 msec. The emulator process is suspended in intervals of 10 msec to avoid overheating of

the Raspberry Pi CPU as during character input.

10. Editing files

Editing on a system without a mouse is quite cumbersome by modern standards. Therefore the adaption for the virtual R65 system includes the EDIT command in exdos and Pascal to use the external mousepad editor.

There is also an internal, Pascal based editor available by using the PEDIT command. It is limited to 500 lines and slow for certain operations. Nevertheless it is quite usefull.

The following escape sequencies are available in PEDIT:

t Move to top of text. Available also with the HOME key where available.

b Move to bottom of text. Available also with the END key where available.

l*n* Put the cursor on line *n* and scroll if necessary.

f Find text. The string to find is entered after typing return. Entering an empty string clears all marked fields.

g Find again using the previous string.

c*n* Copy marks *n* lines for copying. The copying will be done when the paste command is executed. It is therefore possible to modify the marked lines before the paste command is executed.

p Paste the marked (copied) lines to the cursor line. This duplicates the lines.

M Move the marked (copied) lines to the cursor line. The original is deleted.

d*n* Delete *n* lines

w Write the file to disk. The next cyclus number is used. It is therefore possible to save write multiple times.

q write file to disk and quit.

k kill editor without writing to disk.

11. Floppy disk drives (tapes are not emulated)

Drive 0 disk drive A

drive 1 disk drive B

Floppy disks can be changed with the EXDOS command:

FLOPPY disknam[,drive].

The recommended setup is to use PROGRAMS, PASCAL or SOURCE in drive 0, and WORK in drive 1. The defaults are set for this setup. The disks PROGRAMS, PASCAL and SOURCE are distribution disks. They are replaced with their standard version during a software upgrade. Use WORK for your own work and make backup copies on another disk before upgrading the software. The latest version of the R65 emulator supports disks with 256 file entries and 160 tracks of 16 sectors, which results in a capacity of 2560 sectors.

12. Attaching a printer/plotter

The R65 emulator emulates a printer by printing to the Linux file “printout.txt” in the R65 directory. This file is cleared or created each time the emulator starts. The text printed is formatted for Linux, and page headers are added. It is possible to print raw R65 text (without any formatting) by switching the printer driver to raw mode:

Device control 1	hex 11	switch to raw mode
Device control 2	hex 12	switch back to normal formatted mode

If you want to see the printed text while it is generated, open a shell window, go to your R65 directory and type

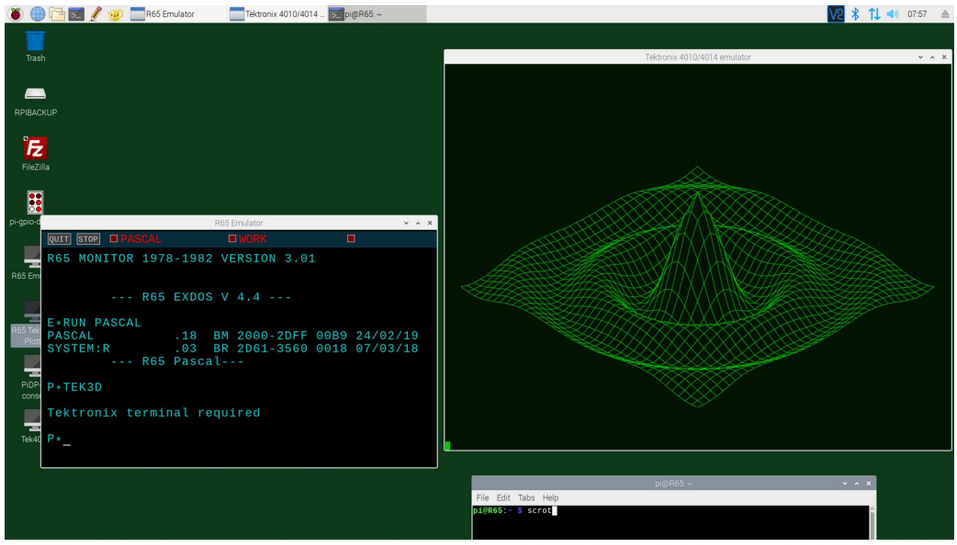
tail -f printout.txt

It is also prossible to use my Tektronix 4010 emulator as a plotter window. Download tek4010 from https://github.com/rricharz/Tek4010. After having tested your installation, put a copy of the executable “tek4010” in your R65 directory.

Now start R65 and afterwards tek4010 by executing the command

./tek4010 -autoClear tail -f printout.txt

You can now see any printed text in the tek4010 window.



With R65 you can PASCAL, also plot tek4010 The library is PASCAL its source in the window. “teklib” on the disk and is on the SOURCECOMPIL disk. There are also examples on the SOURCEPASCAL and PASCAL disks: “tektest”, “tek3D” and “tgraph”. Please note that R65 floating point calculations using the 8-bit R65 Pascal are rather slow as compared to modern standards, but the examples show that it was possible to produce high resolution graphics with a Tektronix 4010 and a 6502 8-bit computer in the late 1970s.

13. File Type

"Block" files (binary files)

M	Machine language program
R :R	Pascal binary runtime file
X :X	Other binary file

Sequential files (text files)

A :A	Assembler source file
P :P	Pascal program or library source file
Q :Q	Pascal loader program file
T :T	Pascal loader library file
L :L	Pascal loader ident table
W :W	Pascal compiler reserved words table
B	Other text file

14. Error Codes

System error codes

01 READ/WRITE ERROR

02 CHECKSUM ERROR

03 ESCAPE EXIT DURING READ/WRITE

04 RECORD NUMBER ERROR

05 FILE TYPE ERROR

06 FILE NOT FOUND

07 DISK NOT READY

08 DIRECTORY FULL, FILE NOT STORED

09 ILLEGAL IRQ

10 EXPRESSION MISSING

11 MEMORY CELL CANNOT BE CHANGED

12 BREAK TABLE FULL, NOT INSERTED

13 ILLEGAL MEMORY CELL FOR BREAK

14 DOUBLE BRAK POINT SETTING

15 END OF LINE EXPECTED

16 SYNTAX WRONG IN REGISTER NAME OR =

17 BREAKPOINT NOT FOUND IN TABLE

18 SYNTAX FRONG IN STORE

19 FILE SUBTYPE WRONG OR MISSING

20 WRONG FILE TYPE NOT RUN

21 UNKNOWN MONITOR COMMAND

22 ILLEGAL OPCODE FOR STEP/TRACE

23 TOO MANY OPEN FILES, NOT OPENED

24 DIRECTION ERROR IN SEQUENTIAL R/W

25 WRONG FILE NUMBER, FILE NOT OPEN

26 DISK FULL, FILE NOT STORED

27 RANDOM ACCESS INDEX OUT OF RANGE

28 ILLEGAL DRIVE FOR RANDOM ACCESS

29 FILE NOT OPEN FOR RANDOM ACCESS WRITE

ASSEMBLER error codes

31 CLOSING) EXPECTED IN EXPRESSION

32 SYNTAX ERROR IN LABEL

33 HEX CHAR EXPECTED AFTER $

34 LABEL TABLE OVERFLOW

35 LOGICAL CHAR EXPECTED AFTER #

36 EXPRESSION NOT RESOLVED (PASS 2)

37 SYNTAX ERROR IN OPCODE

38 MNEMONIC OR ADDRESSING ILLEGAL

39 ILLEGAL ADDRESSING MODE

40 SYNTAX ERROR IN OPERAND

41 ABSOLUTE ADDRESS ILLEGAL

42 MORE THAN 1 UNRESOLVED LABEL IN FORWARD BRANCH

43 BRANCH EXCEEDS BOUNDS

44 FORWARD BRANCH TO THIS LABEL EXCEEDS BOUNDS

45 DOUBLE LABELDEFINITION

46 MISSMATCH IN SECOND PASS

47 LABEL MISSING IN EQU

48 OPERAND OF BYT TOO LONG

49 EXPRESSION MUST BE RESOLVED

50 LINE TOO LONG

51 CHAR FOLLOWS LOGICAL END OF OPERAND

52 TOO MANY UNRESOLVED BRANCHES (NOT INSERTED INTO TEST TABLE)

EXDOS error codes

61: WILD CARD NOT ALLOWED

62: ONLY FOR DISK, NOT TAPE

63: ILLEGAL COPY

64: FILE TOO LARGE

65: WRITE ERROR

66: IMPORT ERROR

67: UNKNOWN EMU COMMAND

68: UNABLE TO RUN MOUSEPAD

PASCAL error codes

81: DIVISION BY ZERO

82: STACK OVERFLOW

83: INDEX OUT OF BOUNDS

84: PROGRAM NOT FOUND, OR NOT PASCAL PROGRAM

85: ILLEGAL P-CODE

86: ESCAPE DURING EXECUTION

87: NO LOADER FILE MADE BY COMPILER

88: HEAP OVERFLOW

15. R65 Control keys

See also capture 2: STOP, QUIT and SHUTDOWN

Video control functions

	CTRL	VCOD	ASCII	
CURSOR DOWN	CDOWN	E9	X	18
CURSOR RIGHT	CRIGHT	E8	V	16
CURSOR LEFT	CLEFT	E7	C	03
CURSOR UP	CUP	E6	Z	1A
CURSOR HOME	CHOME	E5	A	01
INSERT CHAR	INSCHR	E4	U	15 CTRL-RIGHTARROW
DELETE CHAR	DELCHR	E3	Y	19 CTRL-LEFTARROW
CLEAR LINE	CLRLIN	E2	E	17
CLEAR TO END OF SCREEN	CLRDSP	E1	Q	11 CTRL-RETURN
INSERT LINE	INSLIN	C4	D	04
DELETE LINE	DELLIN	C3	F	06
TOGGLE ALPHA/GRAPHICS	TALGRA	E9	L	0C
ESCAPE	ESCAPE	91		1B
SET TABULATOR	SETTAB	8B		
ROLL DOWN	RDOWN	89	B	02 CTRL-DOWNARROW
TO RIGHT MARGIN	CRMARG	88		
TO LEFT MARGIN	CLMARG	87		
ROLL UP	RUP	86	H	08 CRTL-UPARROW
REVERSE HOME	RVHOME	85	P	10
RESUME WRITING	RWRITE	84		
QUIET WRITING	QWRITE	83		
TOGGLE BLACK/WHITE	TBLWHI	82	E	05
CLEAR GRAPHIC DISPLAY	CLRGRA	81		

Other control functions

PRINT ALL ON	PRTON	R	12	
PRINT ALL OFF	PRTOFF	T	14	
DISPLAY CONTROL CHAR	DSPCC	S	13	
CLEAR TABULATOR	CLRTAB	O	0F	
INVERSE VIDEO	INVVIDN	0E		
NORMAL VIDEO	NORVID	K	0B	
CARRIAGE RETURN	EXCR		0D	
LINE FEED	EXLF		0A	
TABULATOR (8)	TAB	I	09	
BELL	BELL	G	07	
PAD CHARACTER	PADCHR	@	00	

16. “Burning” new PROMS/EPROMS

The System software on the original system was burned in EPROMS and used the KIM-1 ROM. The corresponding Assembler source files are:

- KIM1.asm
- CRT.asm
- DISK.asm
- IOCONTROL.asm
- MONITOR.asm
- EXDOS.asm

With the exception of EXDOS, the corresponding object code was read only in the original system, and the R65 Emulator does not allow to write into these memory areas. Nevertheless, it is quite easy to patch these programs (in fact much easier as it was to burn new EPROMS on the original system).

If you just want to make a simple patch (just change a few locations, but not move anything!), or look at the programs, go to RASPIAN and there to R65/R65-Emulator/Assembler. The source files are there with the extension .asm, and the Assembler listings with identical line numbers with the extension txt. The emulator just reads the the object code from the .txt files at startup. This sounds crasy at first, but it is very fast and eliminates the additional step of making binary files. You can therefore just patch those files by editing them carefully. Write down somewhere what you have patched in case you later want to upgrade the software, and make a backup copy before starting to patch, so that you can go back if things don’t work anymore.

17. The usual disclamer

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Please report any problems or suggestions for improvements to r77@bluewin.ch