

VS1005 VSOS SHELL

VS1005g

All information in this document is provided as-is without warranty. Features are subject to change without notice.

Revision History			
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1 Introduction

The VS1005 VSOS Shell is a powerful tool that allows controlling VS1005 from an external interface, e.g. the UART.

This document will explain how to install and use the VSOS Shell Environment, as well as the UART Controlled Audio Player that is included in this package.

After the disclaimer and definitions in Chapters 2 and 3, an overview of the Shell is given in Chapter 4, *Overview*. It is followed by requirements in Chapter 5, *Requirements*, and shell installation instructions in Chapter 6, *Installing the VSOS Shell Environment*.

Instruction on using the shell is given in Chapter 7, *Using the Shell Environment*.

The UART Player is explained in Chapter 8, *Using the UART Controlled Player*.

The document ends with Chapter 9, *Latest Document Version Changes*, and Chapter 10, *Contact Information*.

2 Disclaimer

VLSI Solution makes everything it can to make this documentation as accurate as possible. However, no warranties or guarantees are given for the correctness of this documentation.

3 Definitions

DSP Digital Signal Processor.

I-mem Instruction Memory.

LSW Least Significant (16-bit) Word.

MSW Most Significant (16-bit) Word.

RISC Reduced Instruction Set Computer.

VS_DSP⁴ VLSI Solution's DSP core.

VSIDE VLSI Solution's Integrated Development Environment.

VSOS VLSI Solution's Operating System.

X-mem X Data Memory.

Y-mem Y Data Memory.

4 Overview

The VS1005 VSOS Shell is a new, powerful tool that allows controlling VS1005 from an external interface, e.g. the UART.

Using the VSOS Shell interface it is possible to create an audio player and recorder system (recorder not yet available) that doesn't require any specific VS1005 programming skills.

Nevertheless, for those who are familiar with programming VS1005, the VSOS Shell Environment makes it possible to create convenient shell commands / programs. By combining these building blocks it is possible to create more complex systems, controlled either by an external microcontroller or VS1005 itself.

5 Requirements

Before installing the VSOS Shell Environment, you need to have the following building blocks:

- VS1005g Developer Board. The VS1005g BreakOut Board should work, too, but these instructions have been tested with the DevBoard.
- Latest version of VSOS installed (at least 3.22, the newer the better).
- USB cable between DevBoard and PC for uploading new software.
- UART or USB->UART cable connected between DevBoard and PC for using the UART interface. Data speed is 115200 bps, format is 8N1.
- Your favorite UART Terminal Emulation program installed on the PC. Note that the current VSOS Shell uses only the line feed character (0x0a) for line feed, and no carriage return (0x0d), so the terminal emulation program needs to be able to handle that (see examples in Chapter 5.1, *Terminal Program Settings*). For Microsoft Windows computers, PuTTY has been tested and found working.

When all of this is in order, you are ready to install the VSOS Shell Environment.

5.1 Terminal Program Settings

This chapter shows recommended settings for two example terminal programs, tested by VLSI. Other terminal programs can also be used, provided that the crucial parameters are set in a similar way.

5.1.1 Settings for PuTTY

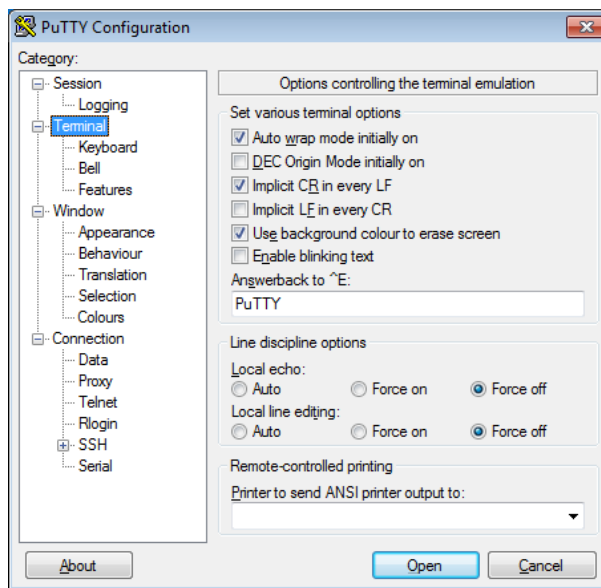


Figure 1: PuTTY Configuration: Terminal

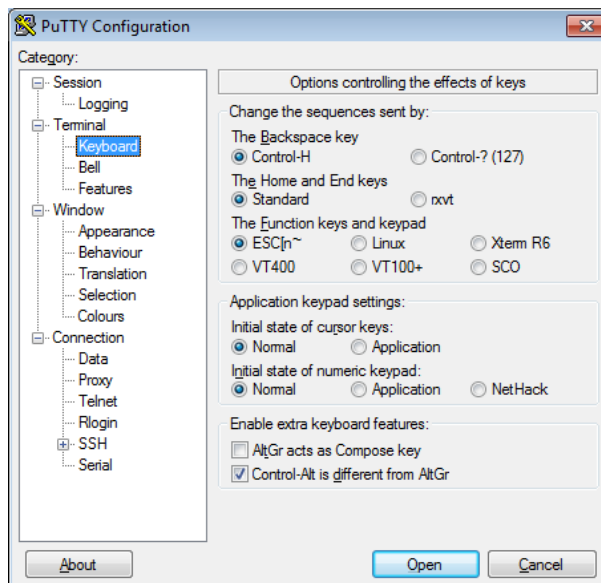


Figure 2: PuTTY Configuration: Keyboard

Figure 1 shows the terminal emulation settings for PuTTY. Make sure you check the “Implicit CR in every LF” box. In the keyboard settings in Figure 2, you may set Backspace key to either Control-H or Control-?.

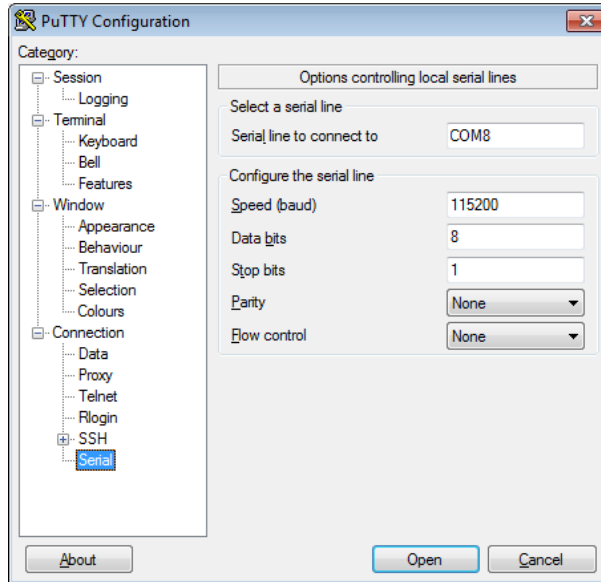


Figure 3: PuTTY Configuration: Serial

Figure 3 shows the serial communication parameters for 115200 bps, 8N1. For binary file transfers to work, it is important to disable flow control.

5.1.2 Settings for Tera Term

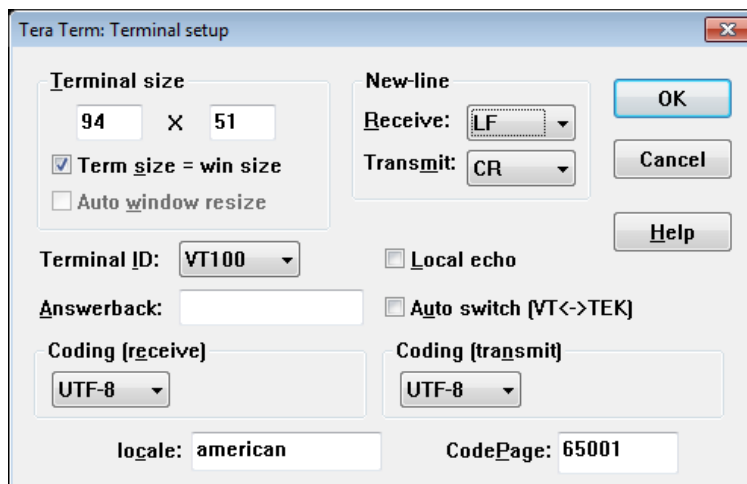


Figure 4: Tera Term: Terminal Setup

Figure 4 shows how to set line feeds and basic terminal emulation mode (VT100) in Tera Term.

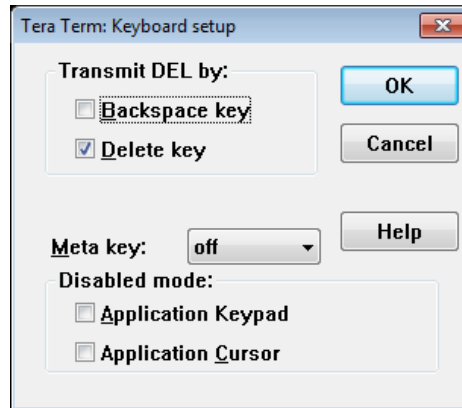


Figure 5: Tera Term: Keyboard Setup

Figure 5 shows a working keyboard setup for Tera Term.

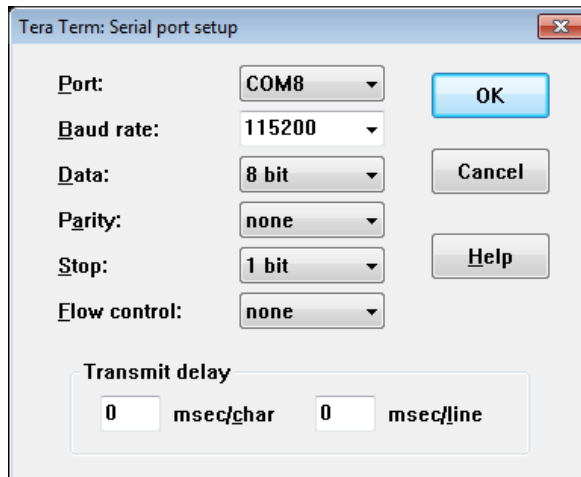


Figure 6: Tera Term: Serial Port Setup

Figure 6 shows how to set serial parameters 115200 bps, 8N1, without flow control.

6 Installing the VSOS Shell Environment

To install the VSOS Shell Environment, you need to do the following:

1. You need to do this first step only if you want to modify and compile the examples in the solutions folder of this package, and if your VSIDE is v2.34 or older!
Copy libvs1005_vsos3/consolestate.h in this package to your PC's VSIDE installation directory libvs1005_vsos3/.
2. Boot your DevBoard in USB Mass Storage Device mode (push S1 while resetting the board).
3. Make a backup of your DevBoard config.txt file in case you want to return to it later.
4. Copy the following files from the root/ directory of this package:
 - config.txt and shell.ap3 to the root directory of your DevBoard.
 - All files in the SYS/ directory to the SYS/ directory of your DevBoard.
5. Safely remove / unmount the VS1005 USB device.
6. Start the UART terminal emulation program on your PC. Set parameters to 115200 bps, 8N1.
7. Reset the DevBoard.

The LCD on the VS1005 DevBoard should stay blank, but you should now see output like the following on your PC's terminal screen:

```
Hello.
VSOS 3.22 build Mar 10 2015 15:51:56
VLSI Solution Oy 2012-2015 - www.vlsi.fi

Starting the kernel..
Starting Devices...
External SPI Flash

Installed system devices:
S: SPI Flash c814, handled by FAT.
Load drivers, config 0...
Driver: RUN... FC00,D Y:0xfc00: 0x2000-13 -> 0x0
Driver: RUN... FC00,C Y:0xfc00: 0x0-12 -> 0x0
Driver: SDSD... D: SD card in SD mode

Driver: UARTIN...
Driver: S:SHELL.AP3...
VSOS SHELL
S:>
```

If this is the case, you have successfully started the VSOS Shell Environment.

7 Using the Shell Environment

The shell environment have the following features:

- Very small (roughly 1/4 kilowords code size).
- Executes commands from the S:SYS/ folder.
- Can also execute .dl3 and .ap3 programs from other locations if full path is provided.
- Interactive command line editing.
- Command history:
 - Up/down arrow (vt100 terminal).
 - “history” shows command history.
 - “!” repeats last command.
 - “!-n” repeats n'th last command. E.g. “!-1” is equivalent to “!”.
 - “!xx” repeats last command that started with xx.
- Concept of current directory.
- Buffered, interrupt-handled UART stdio driver.
- Ctrl-C to notify programs that they should close.
- Ctrl-C three times to hard reset VS1005.
- Interactive (echo +e) or machine-controlled silent (echo -e) mode.

If the shell is in interactive mode, it will present a command prompt.

If in non-interactive mode, the shell will display a line containing the hash character “#” when expecting input from the user. After receiving the full command line, it will output a line containing “:” before executing the command.

This package contains several programs for the shell, many of which take command line arguments.

The shell commands can also be accessed from the C environment through the function RunProgram() in <aploader.h>.

Example:

```
ioresult errorCode = RunProgram("dir", "-st -r")
```

is equivalent to typing

```
S:>dir -st -r
```

in the VSOS Shell command line. Usually programs return S_OK for a successful run, and some other value if there were problems.

The shell environment also allows dynamic loading and unloading of system drivers with the command DRIVER (Chapter 7.1.19). This is very useful in a memory-limited system with lots of functionality.

7.1 Shell Command Programs and VSOS Libraries

This section presents some of the shell programs and drivers included in this package. They are located in the VSOS system disk's directory S:SYS/.

The program are in rapid development, so this documentation will necessarily be somewhat out of date most of the time.

To get more information on how to run these programs / use these libraries:

- If the file is a shell command and not a driver, try running it with the “-h” command line option.
- Some shell commands give help if run without any parameters.
- Source code for most of the shell commands / libraries is available in the VSOS 3.26 Root And Libraries Source Code package (or its current version), in the directory *solutions*. Many of the solutions contain contain README.TXT files that contain very useful documentation beyond the scope of this document.

Many programs offer a “-h” command line option to show what options they can handle. Also running a program without any parameters may give useful information.

7.1.1 audio

Old and obsoleted audio driver.

For information on the current audio drivers that you should use, read the separate document *VSOS Audio Subsystem*.

7.1.2 audiodec

Audio decoder main library. For details on how to use this library, see for instance the source code for *MP3 Model*, or the *Simple MP3 Player*.

See also:

dec* (Chapter 7.1.14), enc* (Chapter 7.1.23).

7.1.3 audiodecdebug

Replacement driver for audiodec, but includes debug outputs approximately once a second if there are underflows in the output buffer, i.e. if playback is too slow.

Example output:

```
Underflows at 28.806s = 1347652, grown 24647
```

```
Underflows at 29.812s = 1372452, grown 24800
```

```
Underflows at 30.819s = 1397269, grown 24817
Underflows at 31.826s = 1422082, grown 24813
```

See also:
audiodec (Chapter 7.1.2).

7.1.4 aui*, auo*, aux*

Audio drivers. For details, read the separate document *VSOS Audio Subsystem*.

7.1.5 AuInfo

```
Usage: AuInfo [-f|+f|-v|+v|-p x] [-h] [files]
-f|+f   Fast mode on/off (don't determine MP2/MP3 file playback time)
-v|+v   Verbose mode on/off
-p x    Copy audioInfo data to p
-h      Show this help
```

AuInfo provides basic information of an audio file, like in the following example:

```
D:>auinfo island.flac
island.flac:
  size: 42159.9 KiB
  format: FLAC
  conf: 2 channels at 44100 Hz
  time: 6:47.1 seconds
  bitrate: 848.4 kbit/s
  analyze: 0.00 seconds
```

7.1.6 AuInput

Controls stdaudioin or other audio inputs. For details, read the separate document *VSOS Audio Subsystem*.

7.1.7 AuOutput

Controls stdaudioout or other audio outputs. For details, read the separate document *VSOS Audio Subsystem*.

7.1.8 cd

```
Usage: cd [-h] [dir1 [dir2 [...]]]
```


-h Show this help
Note: cd without parameters shows the current directory
cd :: lists all available devices

Change or print current directory or list all devices.

7.1.9 cmp

Usage: Cmp [-h] [f1 f2]
f1 File 1
f2 File 2
-h Show this help

Compares two files. If the files are similar, cmp prints nothing. If the files are different, cmp can print one of the two following messages:

cmp: "ro" and "ro2" differ: byte 25083
Files ro and ro2 was similar for the first 25082 bytes, but the next byte differs.

cmp: EOF on "ro2": byte 25085
The two files to compare were similar for the first 25085 bytes, but then ro2 ended.

7.1.10 copyf

Usage: CopyF [-h] [src dst]
src File to be copied
dst Destination file
-h Show this help

Copy a file. Long file names are lost when copying.

7.1.11 copyr

Usage: CopyR [-v|-h] [src dst]
src Directory to be copied
dst Destination directory
-v Be verbose
-h Show this help

Make a recursive copy of a directory. Long file names are lost when copying.

7.1.12 Crc32

Usage: `crc32 file`

Print size and CRC32 checksum for a file.

7.1.13 date

Usage: `Date [formatString] [-h]`

`-t` Print uptime timer
`-q` Quiet mode
`-h` Show this help

FormatString:

<code>%a</code> wdayName	<code>%A</code> weekdayName	<code>%b</code> monName	<code>%B</code> monthName
<code>%c</code> date&time	<code>%d</code> dayOfMonth	<code>%H</code> hour-24	<code>%h</code> hour-12
<code>%j</code> dayOfYear	<code>%m</code> month	<code>%M</code> minute	<code>%p</code> AM/PM
<code>%S</code> second	<code>%w</code> weekDay, S=0	<code>%x</code> date	<code>%X</code> time
<code>%y</code> yr	<code>%Y</code> year	<code>%Z</code> UTC	<code>%%</code> %

Displays the current date, either in default format, or with a user-given format string.

An LR44 battery or similar power source must be connected to the RTC.

See also:

`SetDate` (Chapter 7.1.58), `RtcRead` (Chapter 7.1.52).

7.1.14 dec*

Decoder libraries for different compressed audio formats used by the audiodec library.

NOTE! The following is *not* legal advice!

To the best of VLSI Solution's knowledge all MP2 related patents have expired before the beginning of year 2016. The DECMP3.DL3 library is capable of decoding MP2 files on all VS1005 family ICs. If you want to disable MP2 decoding for any reason, copy file DECMP3_OLD.DL3 on top of DECMP3.DL3.

See also:

`audiodec` (Chapter 7.1.2), `enc*` (Chapter 7.1.23).

7.1.15 del

Usage: `Del [file|-h]`

```
file      Delete file
-h        Show this help
```

Deletes a file.

NOTE! Del currently does not do any sanity checking. So don't try to remove a directory or disk label!

7.1.16 delay

Usage: Delay ms

Delay waits for a given amount of milliseconds, then exits.

7.1.17 dir

```
Usage: dir [-s|-sn|-st|-ss|+s|-r|+r|-d|+d|-a|+a|-f|+f|-h] [path]
-s|-sn  Sort files by name (default)
-st      Sort files by date
-ss      Sort files by size
+s       Don't sort files (faster with large directories)
-r       Reverse sort (if sort selected)
+r       Forwards sort (if sort selected)
-d       Show file date
+d       Don't show file date
-a       Only audio files
+a       All files
-f       Fast listing (don't show play time for MP3 files with -a)
+f       Slower listing (show play time also for MP3 files with -a)
-h       Show this help page
```

dir lists the contents of a directory. It can optionally examine each file and list only those ones that are audio media files.

If "-sn" is defined but the directory is too large to be sorted in memory, dir lists the files in file system order.

The output of dir is as e.g. as follows:

```
D:ManMachine/>dir +s
-   3. 03_MET~1.WAV   63755708 2015-07-17 11:38:17 03_Metropolis.wav
-   4. 04_THE~1.WAV   39508940 2015-07-17 11:38:26 04_TheModel.wav
-   5. 05_NEO~1.WAV   94268204 2015-07-17 11:38:37 05_NeonLights.wav
-   6. 06_THE~1.WAV   58616588 2015-07-17 11:38:45 06_TheManMachine.wav
-   7. 01_THE~1.WAV   65656124 2015-07-17 11:37:58 01_TheRobots.wav
-   8. 02_SPA~1.WAV   62633804 2015-07-17 11:38:08 02_Spaceleb.wav
```

The fields are as follows:

1. Entry type. 'D' is a directory, '-' is a normal file, and 'L' is a volume label.
2. The file system order of the entry
3. Short name
4. File size in bytes
5. File date in YYYY-MM-DD format
6. File time in hh:mm:ss format
7. Long name

When listing audio files, the output format is different:

```
D:ManMachine/>dir -a
-   7. 01_THE~1.WAV      6:12.2  44100 2 2015-07-17 11:37:58 01_TheRobots.wav
-   8. 02_SPA~1.WAV      5:55.1  44100 2 2015-07-17 11:38:08 02_Spaceleb.wav
-   3. 03_MET~1.WAV      6:01.4  44100 2 2015-07-17 11:38:17 03_Metropolis.wav
-   4. 04_THE~1.WAV      3:44.0  44100 2 2015-07-17 11:38:26 04_TheModel.wav
-   5. 05_NEO~1.WAV      8:54.4  44100 2 2015-07-17 11:38:37 05_NeonLights.wav
-   6. 06_THE~1.WAV      5:32.3  44100 2 2015-07-17 11:38:45 06_TheManMachine.wav
```

Now the fields are as follows:

1. Entry type. 'D' is a directory, '-' is a normal file, and 'L' is a volume label.
2. The file system order of the entry
3. Short name
4. File playback time in m:ss.t format
5. Sample rate
6. Number of audio channels
7. File date in YYYY-MM-DD format
8. File time in hh:mm:ss format
9. Long name

Determining playback times for MP3 files requires scanning the whole file, and may be slow. Because of this, unless +f is defined with -a, MP3 file playback times are shown as 0:00.0.

7.1.18 diskfree

```
Usage: DiskFree [-p x|-m x|-v|-h] [D:]
D:      Print results for drive D (: means all drives)
        There may be multiple drive parameters.
        Drive parameters must be after -p/-m options.
-p x    Store last result in KiB to X-memory 32-bit pointer pointed to by x
        (Usable for calling with RunLibraryFunction(); makes operation silent)
-m x    Look only until x MiB (faster operation)
-v      Verbose
-h      Show this help
```

Displays the amount of free space on a drive, or, with the verbose option, also disk size and its fill state.

Because of the way FAT allocation tables work, running DiskFree on a larger drive may take significant amounts of time; e.g. analyzing a 4 GiB SD card can take upto a second. To make DiskFree run faster, option -m may be used.

7.1.19 driver

Usage: DRIVER +libname|-libname|?libname

Can be used to load, unload, and list libraries in memory.

Examples:

- `driver +auiadc 48000 line1_1 line1_3` loads the AUIADC.DL3 driver to memory (if not already there), and gives it parameters.
- `driver -auiadc` unloads the AUIADC.DL3 driver from memory if no other programs are accessing it.
- `driver ?auiadc` checks whether the driver is currently in memory.

See also:

liblist (Chapter 7.1.34), liblist2 (Chapter 7.1.35).

7.1.20 DumpFlash

DumpFlash is a metasolution that allows the user to dump the contents of either the 1 MiB internal or 2 MiB external flash memory for later duplication.

For details, open the solution and read the README.TXT.

See also:

ProgramFlash (Chapter 7.1.49).

7.1.21 echo

Usage: echo [-n|+n|-e|+e|-|-h] string

-n No newline
+n Output newline
-e Turn shell interactive echo mode off
+e Turn shell interactive echo mode on
- End of parameters
-h Show this help

Note: String may contain escape codes such as `\` and `\n`

Echoes its input on the screen.

Options “-e” and “+e” switch the global interactive mode off and on, respectively. The non-interactive mode may be easier to handle when the shell is used with a microcontroller.

7.1.22 edit

```
Usage: Edit [-r rows] [-c columns] [-h] fileName
-h          Show this help
```

Edit is a very simple, VT100-compatible full-screen text editor. It is mainly intended to edit short configuration files. It will *not* preserve CR/LF combinations or any binary codes, so never try to modify a binary file with it.

For a full listing of Edit’s capabilities, start it, then push Ctrl-P.

When Edit starts, it reads the configuration file S:SYS/EDIT.INI. By changing the definitions there, you may change the way backspace and delete keys work.

7.1.23 enc*

Audio encoder drivers for various compressed formats. For details, read the separate document *VSOS Audio Subsystem*.

On how to use this library, see for instance the source code for *Rec*.

See also:

audiodec (Chapter 7.1.2), dec* (Chapter 7.1.14), Rec (Chapter 7.1.51).

7.1.24 FILEBUF

Driver that creates a RAM buffer for writing files. Required by the Rec application to be able to smoothly record to SD cards.

See also:

Rec (Chapter 7.1.51).

7.1.25 Frags / MEMTRACK

```
Usage: Frags [-v|+v|-h]
-v|+v      Verbose on|off
-h          Show this help
```

List all libraries, and show the amount of static Instruction, X-Data and Y-Data memory they consume as ASCII graphics. With the help of the MEMTRACK.DL3 driver Frags can also show dynamically allocated memory.

You can run Frags from the VSOS Shell command line. However, more detailed output can be shown if you add the following line as the first line of config.sys:
MEMTRACK

You may also load the memory tracker from the VSOS Shell as follows:
S:>driver +memtrack

However, in this case the memory tracker cannot give as detailed information as if it was started earlier in the boot process.

The output of Frags looks as follows:

```
S:>frags
Libs: Memtrack Sdsd Auodac auIi2ss auXsyncs auxPlay Run Uartin sHell Frags
I 0000: #####
I 1000: #####
I 2000: #####
I 3000: MMMMMMMSSSSSS SSSSSSSSSAAAAA AAAAAAIIIIIIIX XXXXXXXPPPPRUU
I 4000: UUUUUUHHHFFFFFF FFFFFFF.....
I 5000: .....
I 6000: .....
I 7000: .....#

X 0000: #####
X 1000: #####
X 2000: #IXPP#PPP#HHHH HHHHHFFFFFF#....
X 3000: .....
X 4000: .....
X 5000: .....
X 6000: .....
X 7000: .....

Y 0000: #####
Y 1000: UUUUU.....
Y 2000: .....PPP.....
Y 3000: .....
Y 4000: .....
Y 5000: .....
Y 6000: .....
Y 7000: #####
```

Free: I: 14864 words (45%), X: 22788 words (69%), Y: 23648 words (72%)

The first line shows the libraries that reside in memory. Below that, memory maps for Instruction, X Data, and Y Data memories are shown.

Free areas are marked with '.', allocated unknown areas (usually reserved by VSOS) with '#', and areas allocated by libraries with capital letters (e.g. 'M' of Memtrack). Finally, the total free amount of each memory type is shown.

See also:

liblist (Chapter 7.1.34), liblist2 (Chapter 7.1.35), driver (Chapter 7.1.19).

7.1.26 Ft?Agc

DC Blocker driver. For details, read the separate document *VSOS Audio Subsystem*.

See also:

SetAgc (Chapter 7.1.56), Ft?Equ (Chapter 7.1.28).

7.1.27 Ft?DcBI

DC Blocker driver. For details, read the separate document *VSOS Audio Subsystem*.

See also:

SetAgc (Chapter 7.1.56), Ft?Agc (Chapter 7.1.28).

7.1.28 Ft?Equ

DC Blocker and Equalizer driver. For details, read the separate document *VS1005 VSOS3 Equalizer FtEqu*.

See also:

SetEqu (Chapter 7.1.59).

7.1.29 getcmd

Usage: `getcmd`

Library to reads a command line for the shell.

To see how to call this library, see the source code for The Shell.

7.1.30 GpioDemo

Demonstrates how to use GPIO interrupts in C language. Uses GPIO0_0 through GPIO0_3 (buttons S1-S4).

7.1.31 IntDemo

Demonstrates how to take control of interrupts in C language. Read the accompanying README.TXT for more details.

7.1.32 lcd288, lcd288v

LCD drivers (horizontal, vertical).

See also:

lcdcon (Chapter 7.1.33), touch288 (Chapter 7.1.63).

7.1.33 lcdcon

LCD console driver.

See also:

lcd288 (Chapter 7.1.32), touch288 (Chapter 7.1.63).

7.1.34 liblist

Usage: liblist

List all libraries, their start instruction address, and the amount of static Instruction, X-Data and Y-Data memory they consume.

Below is an example output from liblist:

```
S:>liblist
```

```
10 libs loaded:
3000: memtrack  522i +  14x + 386y
320a: sdsd     1144i + 166x +  34y
3682: auodac   774i +  40x +   4y
3988: auui2ss  550i +  40x +   4y
3bae: auxsyncs 562i +  60x +   8y
3de0: auxplay  336i + 132x +   2y
3f30: run      38i +   0x +   0y
8000: uartin   496i +  16x + 388y
4142: shell    252i + 544x +   0y
423e: liblist  990i + 182x +   2y
Free memory after loading drivers:
I: 14756 words (59024 bytes)
X: 23236 words (46472 bytes)
Y: 23708 words (47416 bytes)
```

See also:

liblist2 (Chapter 7.1.35), Frags (Chapter 7.1.25), driver (Chapter 7.1.19).

7.1.35 liblist2

Usage: liblist

List all libraries, their start instruction address, and the static Instruction, X-Data and Y-Data memory sections they consume.

See also:

liblist2 (Chapter 7.1.35), Frags (Chapter 7.1.25), driver (Chapter 7.1.19).

7.1.36 libtrace

Library that traces which library has caused e.g. a zero pointer violation.

7.1.37 ls

Usage: ls [path]

Show a short listing of a directory in file system file order.

See also:

dir (Chapter 7.1.17).

7.1.38 MEMTRACK

See Frags (Chapter 7.1.25).

7.1.39 metadata

Usage: metadata filename

Shows and/or returns metadata for an audio file. The output is in UTF-8 format, and for the fields it can find, its output looks as follows (but not necessarily in this order):

~0503'Song name

~0504'Album

~0505'Artist

~0506'Year

~050d'Track number

metadata can be used either from the command line, or from another application. For how to use metadata from C code, see the source code for PlayDir.

7.1.40 mkdir

```
Usage: Mkdir [dir|-h]
dir      Directory to create
-h       Show this help
```

Creates a new directory.

7.1.41 more

```
Usage: More [-r rows] [-c columns] [-x|+x] [-h] fileName
-x/+x   Hex mode on / off
-h      Show this help
```

Present an ASCII or binary file one page at a time.

See also:
Type (Chapter 7.1.65).

7.1.42 mp3model

MP3 decoder model library.

7.1.43 paramspl

```
Usage: paramspl parameters
```

Library that splits a parameter string to null-terminated strings, taking into account parenthesis and escape characters, then returns the number of parameters it created by splitting.

To see how to use this library, see the source code for Echo.

See also:
Echo (Chapter 7.1.21).

7.1.44 PlayDir

Usage: PlayDir [-v|+v|-p|+p|-s|+s|-h]

-v Verbose
+v Not verbose
-p Start in pause mode
+p Start in play mode
-s Shuffle mode on
+s Shuffle mode off
-h Show this help page

Plays all audio files in the current directory.

PlayDir is described in detail in Chapter 8.1.

7.1.45 PlayFile

Usage: PlayFile file

Plays one file in the file system. Can output some of the metadata that PlayDir does.

See also:
PlayFileLoop (Chapter 7.1.46).

7.1.46 PlayFileLoop

Usage: PlayFileLoop file

Demonstration for playing a file with a loop. Read the *VSOS Audio Subsystem* document for information on decoders that support looping.

See also:
PlayFile (Chapter 7.1.45).

7.1.47 PlayFiles

Usage: PlayFiles pattern

Plays files in the file system in the order they appear in the file system. Can output some of the metadata that PlayDir does.

Example:
PlayFiles *

7.1.48 preg

Usage: `preg [-h] [reg] [[addr=val|addr|=val|addr&=val|addr^=val]`
`reg` number, number-number, name
`val` value, may be preceded with `~` for bitwise not
 For memory outside of Y space, precede with X: or I:
`-l` List all registers (decrease verbosity to not get all bits)
`-v/+v` Increase / decrease verbosity
`-b/+b` Bit mode on/off
`-h` Show this help

Examples:

```
preg i:0x20-0x3f
preg ana_cf
preg -b 2g
preg +v -l
preg y:0xfec0=0x1010
preg 0xfca1&=~0x0200
```

Debug program that prints / sets / modifies contents of registers or memory. When printing, symbolic register names as defined in `vs1005g.h` may be used.

In addition to setting registers / memory locations with operator (`'='`), `preg` can modify them with bitwise or (`'|='`), bitwise and (`'&='`), or bitwise exclusive or (`'^='`) operations. If any of these operations are used, the contents of the memory location is read from before written to.

7.1.49 ProgramFlash

ProgramFlash is a metasolution that allows the user to program the contents of either the 1 MiB internal or 2 MiB external flash memory with an image earlier created by DumpFlash.

For details, open the solution and read the README.TXT.

See also:

DumpFlash (Chapter 7.1.20).

7.1.50 RdsRadio

This is an experimental RDS radio receiver. Usage is as follows.

Example 1:

```
RdsRadio 93700
```

Start RDS Radio in interactive mode at 93.7 MHz.

Example 2:

```
RdsRadio s
```

Scan full frequency range, then exit.

In interactive mode there are the following keys available:

- n - Search for next channel
- p - Search for previous channel
- ? - Show current frequency and signal level.
- CTRL-C - Exit application.
- . - Adjust current frequency by +10 kHz (debug)
- , - Adjust current frequency by -10 kHz (debug)
- : - Adjust current frequency by +100 kHz (debug)
- ; - Adjust current frequency by -100 kHz (debug)
- T - Print current time count (debug)
- t - Perform automatic channel tuning (debug)
- d - Toggle RDS Debug mode on / off (debug)

To get radio working in background, the following commands may be used:

```
RdsRadio 93700
```

```
[... use the application until you want to put it into background ...]
```

```
[... push CTRL-C ...]
```

```
driver +auxsyncs
```

```
driver +auxplay
```

Now you have radio audio still playing, although without controls or RDS.

7.1.51 Rec

```
Usage: Rec [-fm|-fo|-cs|-cm|-cl|-cr|-q{x}|-b{x}|-r{x}|-h] outFile
```

```
-fm|-fo Format MP3|Ogg Vorbis
```

```
-cs|-cm|-cl|-cr Stereo|Mono|Left|Right
```

```
-qx      Set quality to x (0-10, higher is better)
```

```
-bx      Set bitrate to x kbit/s (1-511)
```

```
-rx      Set sample rate to x Hz, or x kHz if x<1000
```

```
-h       Show this help
```

```
outFile The output file name (e.g. D:REC.MP3)
```

Records audio to a file in MP3 or Ogg Vorbis format.

Rec is described in detail in Chapter 8.2.

7.1.52 rtcread

Usage: `rtcread`

Reads the current contents of the RTC, and locate results into the `currentTime` structure (see `<vsos.h>` for details on the structure).

An LR44 battery or similar power source must be connected to the RTC. If no battery can be found, or if the time is not set, 1999-12-31 12:00:00 is written to `currentTime`.

See also:

`Date` (Chapter 7.1.13), `SetDate` (Chapter 7.1.58).

7.1.53 run

Usage: `run cmd param`

Runs command `cmd` with parameters `param`, then remove `cmd` from memory.

Not for command line use, but useful in the startup script `config.txt`.

7.1.54 SDSD, SDSDR, SDSDX, SDSDMONO

Efficient SD card SD mode driver. There are three versions of the driver:

- SDSD: Read and Write capability. Will call driver SDSDX for initialization. After that the SDSDX driver is removed from memory.
- SDSDR: Like SDSD, but with read-only capability.
- SDSDMONO: Monolithic version of the SD driver that includes the functionality of both SDSD and SDSDX.

See also:

`SDSPI` (Chapter 7.1.55).

7.1.55 SDSPI

Old SD card driver that operates in SPI mode.

See also:

`SDSD` (Chapter 7.1.54).

7.1.56 SetAgc

Controls the Automatic Gain Control driver. For details, read the separate document *VSOS Audio Subsystem*.

See also:

Ft?Agc (Chapter 7.1.26), Ft?DcBl (Chapter 7.1.27).

7.1.57 setclock

Usage: SetClock [f|usb|rtc|-fx|-lx|-cv|-iv|-av|-uf|-sf|-pd|-nf|-df|-rd|
-P|+P|-v|+v|-h]

```

x          Set clock to x MHz, auto-adjust(1)
usb       Set clock to exactly 60 MHz, auto-adjust(1)
rtc       Set to 32.768 kHz RTC clock, auto-adjust(1)
-fx       Set clock to x MHz (USE WITH CAUTION!)
           x may also be "usb" or "rtc"
-lx       Limit top speed to x MHz (USE WITH CAUTION!)
-cv       Set CVDD to v volts (USE WITH CAUTION!)
-iv       Set IOVDD to v volts (USE WITH CAUTION!)
-av       Set AVDD to v volts (USE WITH CAUTION!)
-uf       Set UART speed to f bps
-sf       Set SPI0 speed to f MHz
-pf       Set SPI1 speed to f MHz
-nf       Set NAND FLASH speed to f MHz
-df       Set SD speed to f MHz
-rd       Set RAM delay line to d (range 0(slow)-3(fast))
-P|+P     Disable/Enable Power-On-Reset (USE WITH CAUTION!)
-v|+v     Verbose on/off
-t        Test execution speed
-h        Show this help
  
```

(1) Auto-adjustment affects CVDD, RAM Delay, and POR.

Set and displays VS1005g clock speed, regulator voltages, and other speed-related parameters.

If the clock speed is given in auto-adjustment mode then core voltage, RAM delay and power-on-reset are automatically adjusted to match. If parameters are set individually, it is up to the user to do so in a safe order, and with safe parameter values.

Example output is shown below:

```

S:>setclock
SetClock: CLKI 86.016 MHz, limit 100.000 MHz, src PLL, RAM Delay 1, POR on
          CVDD 1.800V(21), IOVDD 3.48V(28), AVDD 3.48V(25)
          UART nominal 115200 bps, real 114841 bps (0.3% error), reg 0x006b
          SPI0 6.1 Mbit/s, SPI1 43.0 Mbit/s, NAND 43.0 Mbit/s, SD 21.5 Mbit/s
  
```


Warning:

Do *not* exceed maximum voltage limits. Doing so may cause permanent damage to VS1005 and/or external components.

7.1.58 setdate

```
Usage: SetDate [YYYY-MM-DD|YY-MM-DD|HH:MM:SS] [-h]
YYYY-MM-DD      Set date, e.g. 2015-09-18
YY-MM-DD        Set date, e.g. 15-09-18
HH:MM:SS        Set time, e.g. 12:34:56
HH:MM           Set time, e.g. 12:34
-h              Show this help
```

Sets the time of the VS1005's RTC. Both the date and time may be set at the same time.

An LR44 battery or similar power source must be connected to the RTC.

See also:

Date (Chapter 7.1.13), RtcRead (Chapter 7.1.52).

7.1.59 SetEqu

Control the Equalizer driver. For details, read the separate document *VS1005 VSOS3 Equalizer FtEqu*.

See also:

Ft?Equ (Chapter 7.1.28).

7.1.60 Sine

```
Usage: Sine freq1 dbl1 dbr1 [freq2 dbl2 dbr2 [...]] [-rrate|-h]
freq dbl dbr    Set frequency to freq Hz, left volume to dbl dB,
                right volume to dbr dB. If dbl or dbr is greater than zero,
                volume is muted for that channel.
-rrate         Set sample rate to rate Hz
-h             Show this help
```

Generate one or several sine waves.

Examples:

```
S:>Sine 1001.2371 0 0
S:>Sine -r24000 1000 -6 1 2000 1 -6 3000 -6.1 -6.1
```

7.1.61 tasks

Usage: Tasks [-v|+v] [-h]

-v|+v Verbose on/off

-h Show this help

Show running tasks and their timer queues. With the verbose option, also show registers and stacks traces.

An example output for tasks is shown below:

S:>Tasks -v

Task 0x0021, priority 1, in RUNNING, name "MainTask"

State: 3 (TS_READY)

Stack: Start 0x0030, size 0x200, in use 0xd9, max used 0x172 (0x8e free)

Stack Trace: current PC 0x4369, Tasks::main[185]

Next: PC 0x1e42 @ stack 0x008c, KERNEL

Next: PC 0x41d0 @ stack 0x0086, shell::main[43]

Next: PC 0x04c1 @ stack 0x007c, KERNEL

Next: PC 0x0569 @ stack 0x003e, KERNEL

Next: PC 0x0087 @ stack 0x0032, KERNEL

Task 0x1c01, priority 10, in waitQueue, name "cyclic"

State: 4 (TS_WAIT)

Stack: Start 0x1c10, size 0x100, in use 0x29, max used 0x3a (0xc6 free)

Stack Trace: current PC 0x918f, IROM

Next: PC 0x2b79 @ stack 0x1c1e, KERNEL

Next: PC 0x90b5 @ stack 0x1c11, IROM::exit

Registers:

i0:0x1c1f i1:0x0012 i2:0x1beb i3:0x1c08

i4:0x1c1e i5:0x0000 i6:0x1c2b i7:0xfc08

a2:0x0000 a1:0x0004 a0:0x8000 b2:0x0000 b1:0x0000 b0:0x0000

c2:0x0000 c1:0x0000 c0:0x0064 d2:0x0000 d1:0x0005 d0:0x0004

p1:0x0000 p0:0x0000 ls:0xebab le:0xffff lc:0x0000 mr0:0x0210 lr0:0x9184

Task 0x21a1, priority 2, in waitQueue, name "AUXPLAY"

State: 4 (TS_WAIT)

Stack: Start 0x21b0, size 0x100, in use 0x40, max used 0x57 (0xa9 free)

Stack Trace: current PC 0x918f, IROM

Next: PC 0x3b82 @ stack 0x21d5, auii2ss::AudioRead[68]

Next: PC 0x091d @ stack 0x21cc, KERNEL

Next: PC 0x3dfb @ stack 0x21c4, auxplay::AudioTask[27]

Next: PC 0x90b5 @ stack 0x21b1, IROM::exit

Registers:

i0:0x21d6 i1:0x0012 i2:0x0e30 i3:0x21a8

i4:0x21d5 i5:0x0000 i6:0x21e2 i7:0xfc08

a2:0x0000 a1:0x0004 a0:0x8000 b2:0x0000 b1:0x0000 b0:0x0000

c2:0x0000 c1:0x2150 c0:0x0080 d2:0x0000 d1:0x0001 d0:0x0030

p1:0x0000 p0:0x0040 ls:0xebab le:0xffff lc:0x0000 mr0:0x0210 lr0:0x9184

Timer queue 0x1c1f for task 0x1c01 ("cyclic")

Tick count: 0x0064

```
Timer queue 0x21d6 for task 0x21a1 ("AUXPLAY")
  Tick count: 0x0001
```

Interrupts:

```
INT 0 INT_DAC      , pri 2, vector 0x37e5= auodac::DacInterrupt
INT 5 INT_MAC1     , pri 2, vector 0x3a7c= auiadc::Dec6Interrupt
INT 12 INT_UART_TX , pri 1, vector 0x3d70= uartin::UartTransmitInterrupt
INT 13 INT_UART_RX , pri 1, vector 0x3da0= uartin::UartReceiveInterrupt
INT 15 INT_TIMER1  , pri 2, vector 0x2a09= KERNEL
INT 16 INT_TIMER2  , pri 2, vector 0x2a09= KERNEL
```

There are three tasks running, the VSOS MainTask, the VSOS cyclic task, and a task for AUXPLAY driver. The cyclic task is running at the highest priority (10).

There are also two timer queues where cyclic and AUXPLAY are currently waiting. cyclic still has 0x64 ticks = 100/1000 seconds before it will next be wokrnr up, but AUXPLAY will be woken up at the next 1/1000 s.

Stack status for each task is also shown. If the stack for a task ever gets full, memory will be trashed and the system may crash.

With the `-v` option also stack traces are shown for each task. For instance, you can see that current execution of AUXPLAY is in IROM address 0x918f (actually the Delay() function), called by AudioRead() from library auii2ss, which was called by a VSOS Kernel function (read() in this case), which again was called by the AudioTask() function of library AUXPLAY.

Finally, all active interrupts are shown. With the `-v` option the output is as detailed as in the example. There you seen the interrupt numbers, their symbolic names, their priorities (higher is better), jump vectors, and the jump vector's symbolic name if available.

7.1.62 time

```
Usage: time [program [parameters]]|-h
-h      Show this help
```

Measures and displays the time it took to execute a program.

An example output is shown below:

```
S:>time delay 1000
errCode 0, time: 1.010s
```

7.1.63 touch288

LCD touch driver. The same driver works for both the horizontal and vertical LCD driver.

See also:
lcd288 (Chapter 7.1.32), lcdcon (Chapter 7.1.33).

7.1.64 trace

```
Usage: trace startAddr [endAddr] # trace instruction address [or range]
Usage: trace i:startAddr [endAddr] # trace instruction address [or range]
Usage: trace x:startAddr [endAddr] # trace X data mem address [or range]
Usage: trace y:startAddr [endAddr] # trace Y data mem address [or range]
```

Trace (a) memory address(es).

Example:

```
S:>trace i:0x4000
uartin::UartPutChar[44]
```

7.1.65 type

```
Usage: type [-c|+c|-h] [file1 [file2 [...]]]
-c      Print file information line
+c      Don't print file information
-h      Show this help
```

Type a file to screen.

See also:
more (Chapter 7.1.41).

7.1.66 uartin

Interrupt-based UART stdin/stdout driver.

7.1.67 usbhost

USB Host driver.

7.1.68 usbmsc

Usage: usbmsc d

USB Mass Storage driver. Publishes *d* as a USB mass storage drive.

Example:

```
usbmsc s
```

publishes the system drive 'S' as a USB Mass Storage driver (similar to booting the VS1005g Developer Board with button S1 pushed).

7.1.69 WatchdogDemo

Demonstrates how to use the VS1005 hardware watchdog. See source code for details.

7.1.70 ybitclr

Usage: `ybitclr xxxx,y`

Clears bit *y* in Y memory register *xxxx*. Both *xxxx* and *y* must be hexadecimal numbers.

See also:

ybitset (Chapter 7.1.71).

7.1.71 ybitset

Usage: `ybitset xxxx,y`

Sets bit *y* in Y memory register *xxxx*. Both *xxxx* and *y* must be hexadecimal numbers.

See also:

ybitclr (Chapter 7.1.70).

8 Using the UART Controlled Player

To test the UART Controlled Player, you need to do the following steps:

1. Copy some audio files to an SD card.
2. Insert SD card to VS1005 DevBoard.
3. Boot DevBoard to the VSOS Shell Environment.
4. Use `cd` to get to your audio content directory, and potentially `dir -a` or `dir -a +f` to list it.
5. Type `playdir` to run PlayDir.
6. Use PlayDir keyboard shortcuts and control commands described in Chapter 8.1.

8.1 PlayDir: Interactive UART Player

Usage: `PlayDir [-v|+v|-p|+p|-s|+s|-h]`

```
-v      Verbose
+v      Not verbose
-p      Start in pause mode
+p      Start in play mode
-s      Shuffle mode on
+s      Shuffle mode off
-h      Show this help
```

PlayDir plays the files in sorted order in the current directory. If there is not enough memory to sort the files, they are played in file system order.

First it takes a listing of the files in the current directory using `dir`.

Then, it outputs the following line:

```
~0205=Number of audio media files encountered
```

If PlayDir was started with the “-v” command line option, it will then list all audio files with potential metadata.

After the optional list, PlayFile will open the first file, see if it can find metadata, and outputs information for the file. When file playback has finished, PlayFile will play the next file. When it has played all files, it exits.

NOTE!

For systems with a microcontroller, it is strongly recommended that machine-controlled silent mode (echo -e) is switched on before starting PlayDir. For interactive use the default interactive echo mode (echo +e) is recommended.

8.1.1 PlayDir Output

For each file, and depending on whether metadata for the file was found, the following fields may be output (not necessarily in this order):

~0308=PlayDir's playlist track number, always first field, always printed

~0205=PlayDir's song number, always second field, always printed

~050b'File name, always third field, always printed

~0503'Song name

~0504'Album

~0505'Artist

~0506'Year

~050d'Track number

If not in shuffle mode, the Playlist Track Number and Song Number are the same. If in shuffle mode, the Playlist Track number is increasing, while the Song Number is shuffled.

When the song is playing, the following messages are being sent once a second:

~030a'Playback time in seconds

~030b'File position in per cent (0..100), only sent if changed

When master volume changes, the following message is shown:

~0206=*volume*

where *volume* is the attenuation from maximum volume in 0.5 dB steps. Setting for maximum volume is 0 (-0 dB), minimum volume is 254 (-127 dB).

When pause mode is toggled, the following message is shown:

~0104=*pauseMode*

where *pauseMode* is 1 if in pause mode, or 0 if in playback mode.

If the last song of a playlist is playing, and next song is selected, a line containing only the character '>' is printed, and PlayDir exits. If the first song is playing and previous song is selected, a line containing only '<' is printed, and PlayDir exits.

When PlayDir closes, it outputs the following line:

~0205=0

8.1.2 PlayFile Control Keys

PlayFile has the following controls keys:

- n** Next song. If last song was passed, '>' is printed and player exits
- p** Previous song. If first song was passed, '<' is printed and player exits
- whitespace** Toggle pause mode
- <** Lower volume by 0.5 dB
- >** Increase volume by 0.5 dB
- .** Fast forward 10 seconds
- :** Fast forward 60 seconds
- ,** Rewind 10 seconds
- ;** Rewind 60 seconds
- q or Ctrl-C** Exit player

8.1.3 PlayFile Control Commands

In addition to one-character controls, PlayFile also accepts control commands that are of the following format

`~xxxx=y`

where `xxxx` is an exactly 4-character UI Control message in hexadecimal, and `y` is the value as a C formatted number (decimal, hexadecimal, or octal).

An example that sets playback volume to -10 dB of maximum:

`~0206=20`

If the shell is in interactive echo mode (echo +e), then output of file progress messages are suppressed after the command-initiating '~' character to let the user more easily to see what he is typing. In machine-controlled silent mode (echo -e) text output continues as normal.

PlayDir recognizes the following control commands:

Control commands recognized by PlayDir			
Msg	Val		Description
	Min	Max	
0104	0	1	Set pause mode (0=off, 1=on).
0183	0	1	Set shuffle mode (0=off, 1=on).
0308	1	32767	Select track from current playlist. If out of bounds (0 or too large), PlayDir exits. Shuffle mode is automatically deactivated.
0206	0	255	Set volume to -val/2 dB of maximum. Largest value (255) shuts down analog drivers.
030a	0	65534	Go to val seconds in audio file.

If shuffle mode is activated with the set shuffle mode command, shuffle mode starts when the current song ends. When shuffle mode is deactivated, playback is continued from the current track.

8.2 Rec: Interactive UART Recorder

```
Usage: Rec [-fm|-fo|-cs|-cm|-cl|-cr|-q{x}|-b{x}|-r{x}|-h] outFile
-fm|-fo Format MP3|Ogg Vorbis
-cs|-cm|-cl|-cr Stereo|Mono|Left|Right
-qx      Set quality to x (0-10, higher is better)
-bx      Set bitrate to x kbit/s (1-511)
-rx      Set sample rate to x Hz, or x kHz if x<1000
-h       Show this help
outFile  The output file name (e.g. D:REC.MP3)
```

Rec records MP3 or Ogg Vorbis audio to a given file. The user may define the channel modes, sample rate, and either set a quality or a suggested bitrate.

If quality is set, the encoder used Variable BitRate (VBR) encoding, which gives the best quality / file size ratio. If the bitrate is set, the MP3 encoder uses Constant BitRate (CBR).

Sample rate may be set to anything the current audio driver for stdaudioin supports. If not set, the current sample rate for the audio driver is used.

If using an analog input audio driver, it is strongly recommended to start the FtIDcBI (Chapter 7.1.27) or FtIAgc (Chapter 7.1.26) before recording.

NOTE!

For systems with a microcontroller, it is strongly recommended that machine-controlled silent mode (echo -e) is switched on before starting Rec. For interactive use the default interactive echo mode (echo +e) is recommended.

NOTE!

As a safety feature, Rec stops recording whenever the recording file grows to at least one billion bytes (1 GB).

8.2.1 Rec Output

When startingFor each file, and depending on whether metadata for the file was found, the following fields may be output (not necessarily in this order):

```
~050a'fileName
Output buffer size xx bytes
```

When the song is playing, the following message is sent once a second:

```
~030a'Playback time in seconds
```

When pause mode is toggled, the following message is shown:

```
~0104=pauseMode
where pauseMode is 1 if in pause mode, or 0 if in playback mode.
```

When Rec closes, it outputs the following line:

```
~010b=1
```

8.2.2 Rec Control Keys

Rec has the following controls keys:

- n** Next song. (Currently closes the program.)
- whitespace** Toggle pause mode
- q or Ctrl-C** Exit recorder

8.2.3 Rec Control Commands

In addition to one-character controls, Rec also accepts control commands that are of the following format

`~xxxx=y`

where `xxxx` is an exactly 4-character UI Control message in hexadecimal, and `y` is the value as a C formatted number (decimal, hexadecimal, or octal).

Rec also accepts report requests that are of the following format

`~xxxx=y`

where `xxxx` is an exactly 4-character UI Control message in hexadecimal.

An example that sets pause mode on:

`~0104=1`

If the shell is in interactive echo mode (echo +e), then output of file progress messages are suppressed after the command-initiating '~' character to let the user more easily to see what he is typing. In machine-controlled silent mode (echo -e) text output continues as normal.

Rec recognizes the following control commands:

Control commands recognized by Rec			
Msg	Val		Description
	Min	Max	
0104	0	1	Set pause mode (0=off, 1=on).

Rec recognizes the following report requests:

Report requests recognized by Rec	
Msg	Description
030d	Return file position in bytes.
030c	Return average bitrate for file in bps.
0209	Return maximum signal level in dB since last time read.

Request 0209 can be used to build a maximum level VU meter. Such a meter should warn the user (with e.g. yellow vs green colour) whenever the input level exceeds -5 dB, and show a clear overload error (with e.g. red colour or an "OVERLOAD" text) whenever maximum absolute level 0 dB is reached.

9 Latest Document Version Changes

This chapter describes the most important changes to this document.

Version 3.40, 2016-11-03

- Added several new programs to Chapter 7.1, *Shell Command Programs and VSOS Libraries*, and updated documentation for existing ones.

Version 3.30, 2016-06-22

- Added several new programs to Chapter 7.1, *Shell Command Programs and VSOS Libraries*, and updated documentation for existing ones.
- Changed document version numbering to reflect on the VSOS release this document has been written for.

Version 1.50, 2016-03-18

- Documented new features like command history for the VSOS Shell in Chapter 7, *Using the Shell Environment*.
- Added some new programs, most notably AuInfo (Chapter 7.1.5) and Edit (Chapter 7.1.22).

Version 1.40, 2016-02-15

This is an update for VSOS 3.26.

- Added many new programs and libraries to Chapter 7.1, *Shell Command Programs and VSOS Libraries*, and updated documentation for existing ones.
- Updated documentation in Chapter 7.1, *Rec*, to include Ogg Vorbis, and added recommendations on other libraries to use.

Version 1.30, 2015-10-02

- Added many new programs to Chapter 7.1, *Shell Programs*.

Version 1.20, 2015-07-17

- Added an audio recorder program, *Rec*, Chapter 7.1.51.

Version 1.11, 2015-06-01

- Added new functionality to PlayDir, Chapter 7.1.44, and slightly changed its output.
- Added terminal emulation program screen caps to Chapter 5, *Requirements*.

Version 1.10, 2015-05-29

First release with documentation. Added PlayDir.

Version 1.00, 2015-05-20

First release.

10 Contact Information

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