VPI_BINARY_FILE_IO

AIR FORCE RESEARCH LABORATORY

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Contents

1 Usage

1.1 Introduction

This library provides two functions.

- read_binary_file(FILE_NAME, VECTOR)
- write_binary_file(FILE_NAME, VECTOR)

Each instance is a new instance, and will start reading the file from the start. The vector has to be in size bytes from 1 to any number of bytes. Each function returns the number of bytes read or writen. Z or X place in the vector indicates bytes not available for read, or do not write these bytes for write. The read funciton will return a negative number of bytes when the end of file is reached.

You can use the following for including the library in your project:

```
src :
  files :
    − src/read_binary_file.c   : {file_type : cSource}
    − src/write_binary_file.c  : {file_type : cSource}
    − src/binary_file_io.c     : {file_type : cSource}
    − src/binary_file_io.h     : {file_type : cSource,
        ↪ is_include_file : true}
    − src/read_binary_file.h   : {file_type : cSource,
        ↪ is_include_file : true}
    − src/write_binary_file.h  : {file_type : cSource,
        ↪ is_include_file : true}
    − src/binary_file_io.sft   : {file_type : user}

lib :
  files :
    − lib_ringbuffer/build/libringBuffer.a : {file_type :
        ↪  user, copyto : .}

header :
  files :
    − lib_ringbuffer/ringBuffer.h : {file_type : cSource,
        ↪  is_include_file : true}

vpi:
  bin_file_io_vpi:
    filesets : [src, header]
    libs : [ringBuffer −L., pthread]

generate:
  gen_git:
    generator: git_pull
    parameters:
      repo_url: https://github.com/sparkletron/
         ↪ C89_pthread_ring_buffer.git
      repo_dir: lib_ringbuffer
      tag: release_v1.6.1
  gen_lib:
    generator: gen_cmake
    parameters:
      src_dir:  lib_ringbuffer
      cmake_args: ["-DCMAKE_POSITION_INDEPENDENT_CODE=ON"
         ↪ ]

targets:
  default: &default
    description: Intergration default target for
       ↪ simulations.
    filesets: [lib, dep_gen]
    generate: [gen_git, gen_lib]
    vpi: [bin_file_io_vpi]
```

1.2 Dependencies

The following are the dependencies of the cores.

- fusesoc 2.X
- iverilog (simulation)

1.2.1 fusesoc_info Depenecies

- dep_tb
  - AFRL:utility:sim_helper
- dep_gen
  - AFRL:utility:generators:1.0.0

2 Architecture

This VPI library provides two functions for the user to use during simulation, read_binary_file and write_binary_file. These will read and write from binary files. These functions use ringbuffers and multi-threading to seperate file I/O from the simulation so file access will not slow down the simulation.

The read_binary_file will read any binary file till it runs out of data. When it does, if it can not complete the word (one byte left, for say a 4 byte word output) then the unused bytes for the aval/bval pairs are set to Z. Meaning in the simulation they will show up as Z, not 0 or 1. It will also assert the EOF (end of file) signal from the core showing that this is the last of the data.

The write_binary_file will write any binary data till it is given that is a 0 or a 1. Any bytes that contain a Z will not be written to the output file. This allows for any file that is read to be written in a one to one manner.

Please see 5 for more information per target.

3 Building

The all VPI binary file IO source files are written in C to target the VPI API from Verilog 2001. They should simulate in any modern simulation tool that has VPI support. The library comes as a fusesoc packaged core and can be included in any other testbench. Be sure to make sure you have meet the dependencies listed in the previous section.

3.1 fusesoc

Fusesoc is a system for building FPGA software without relying on the internal project management of the tool. Avoiding vendor lock in to Vivado or Quartus. These cores, when included in a project, can be easily integrated and targets created based upon the end developer needs. The core by itself is not a part of a system and should be integrated into a fusesoc based system. Simulations are setup to use fusesoc and are a part of its targets.

3.2 Source Files

3.2.1 fusesoc_info File List

- src
  - ’src/read_binary_file.c’: ’file_type’: ’cSource’
  - ’src/write_binary_file.c’: ’file_type’: ’cSource’
  - ’src/binary_file_io.c’: ’file_type’: ’cSource’
  - ’src/binary_file_io.h’: ’file_type’: ’cSource’, ’is_include_file’: True

  - ’src/read_binary_file.h’: ’file_type’: ’cSource’, ’is_include_file’: True
  - ’src/write_binary_file.h’: ’file_type’: ’cSource’, ’is_include_file’: True
  - ’src/binary_file_io.sft’: ’file_type’: ’user’
- lib
  - ’lib_ringbuffer/build/libringBuffer.a’: ’file_type’: ’user’, ’copyto’: ’.’
- header
  - ’lib_ringbuffer/ringBuffer.h’: ’file_type’: ’cSource’, ’is_include_file’: True
- tb
  - ’tb/tb_vpi.v’: ’file_type’: ’verilogSource’

3.3 Targets

3.3.1 fusesoc_info Targets

- default

  Info: Intergration default target for simulations.
- sim

  Info: Test VPI file io.
- sim_rand_data

  Info: Test VPI file io with random data.
- sim_8bit_count_data

  Info: Test VPI file io with count data.

3.4 Directory Guide

Below highlights important folders from the root of the directory.

1. **docs** Contains all documentation related to this project.
   - **manual** Contains user manual and github page that are generated from the latex sources.
2. **src** Contains source files for vpi binary file io.
3. **tb** Contains test bench files.

4 Simulation

A barebones test bench for iverilog is included in tb/tb_vpi.v . This can be run from fusesoc with the following.

```
$ fusesoc run --target=sim AFRL:vpi:binary_file_io:1.0.0
```

5 Code Documentation

- **VPI BINARY FILE SOURCE, DOXYGEN**

The next section documents the library.

VPI_BINARY_FILE_IO

1.0

Generated by Doxygen 1.9.1

Chapter 1

Data Structure Documentation

1.1 s_process_data Struct Reference

```
#include <binary_file_io.h>
```

Data Fields

- PLI_INT32 error
- PLI_INT32 num_ab_val_pairs
- PLI_INT32 array_byte_size
- char ∗ p_file_name
- struct s_ringBuffer ∗ p_ringbuffer
- FILE ∗ p_file
- pthread_t thread
- vpiHandle systf_handle
- vpiHandle arg2_handle

1.1.1 Field Documentation

1.1.1.1 arg2_handle

```
vpiHandle s_process_data::arg2_handle
```

1.1.1.2 array_byte_size

```
PLI_INT32 s_process_data::array_byte_size
```

1.1.1.3 error

```
PLI_INT32 s_process_data::error
```

1.1.1.4 num_ab_val_pairs

```
PLI_INT32 s_process_data::num_ab_val_pairs
```

1.1.1.5 p_file

```
FILE* s_process_data::p_file
```

1.1.1.6 p_file_name

```
char* s_process_data::p_file_name
```

1.1.1.7 p_ringbuffer

```
struct s_ringBuffer* s_process_data::p_ringbuffer
```

1.1.1.8 systf_handle

```
vpiHandle s_process_data::systf_handle
```

1.1.1.9 thread

```
pthread_t s_process_data::thread
```

The documentation for this struct was generated from the following file:

- binary_file_io.h

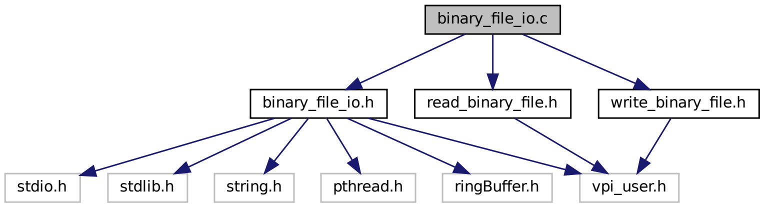
Chapter 2

File Documentation

2.1 binary_file_io.c File Reference

```
#include "binary_file_io.h"
#include "read_binary_file.h"
#include "write_binary_file.h"
```

Include dependency graph for binary_file_io.c:



Functions

- PLI_INT32 binary_end_compile_cb (p_cb_data data)

  BINARY FILE END COMPILE CALLBACK.
- PLI_INT32 binary_end_sim_cb (p_cb_data data)

  BINARY FILE END SIM CALLBACK.
- PLI_INT32 binary_sizetf (PLI_BYTE8 ∗user_data)

  Returns the size, in bits, of the function return type.
- PLI_INT32 binary_compiletf (PLI_BYTE8 ∗user_data)

  Compile time call, check the arguments for validity.
- void read_binary_reg_systf (void)

  Setup read_binary_file function.
- void write_binary_reg_systf (void)

  Setup write_binary_file function.

Variables

- void(∗ vlog_startup_routines [ ])(void)
  register the new file functions

2.1.1 Function Documentation

2.1.1.1 binary_compiletf()

```
PLI_INT32 binary_compiletf (
            PLI_BYTE8 * user_data )
```

Compile time call, check the arguments for validity.

2.1.1.2 binary_end_compile_cb()

```
PLI_INT32 binary_end_compile_cb (
            p_cb_data data )
```

BINARY FILE END COMPILE CALLBACK.

2.1.1.3 binary_end_sim_cb()

```
PLI_INT32 binary_end_sim_cb (
            p_cb_data data )
```

BINARY FILE END SIM CALLBACK.

2.1.1.4 binary_sizetf()

```
PLI_INT32 binary_sizetf (
            PLI_BYTE8 * user_data )
```

Returns the size, in bits, of the function return type.

2.1.1.5 read_binary_reg_systf()

```
void read_binary_reg_systf (
             void  )
```

Setup read_binary_file function.

2.1.1.6 write_binary_reg_systf()

```
void write_binary_reg_systf (
             void  )
```

Setup write_binary_file function.

2.1.2 Variable Documentation

2.1.2.1 vlog_startup_routines

```
void(* vlog_startup_routines[ ])(void) (
             void  )
```

Initial value:

```
= {
  read_binary_reg_systf,
  write_binary_reg_systf,
  0
}
```

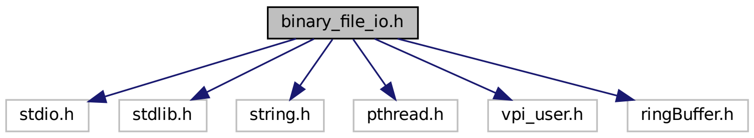
register the new file functions

2.2 binary_file_io.h File Reference

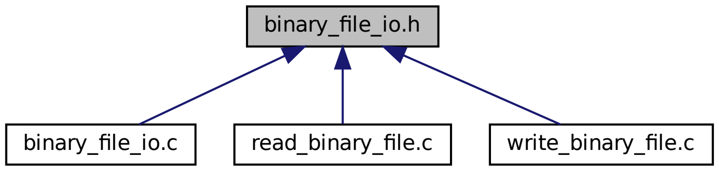
Functions to write raw binary files properly in verilog.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <pthread.h>
#include <vpi_user.h>
#include "ringBuffer.h"
```

Include dependency graph for binary_file_io.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct s_process_data

Macros

- #define BUFFSIZE (1 $<<$ 23)
- #define DATACHUNK (1 $<<$ 21)
- #define READ_NAME "$read_binary_file"
- #define WRITE_NAME "$write_binary_file"

Functions

- PLI_INT32 binary_end_compile_cb (p_cb_data data)

  BINARY FILE END COMPILE CALLBACK.
- PLI_INT32 binary_end_sim_cb (p_cb_data data)

  BINARY FILE END SIM CALLBACK.
- PLI_INT32 binary_sizetf (PLI_BYTE8 $*$user_data)

  Returns the size, in bits, of the function return type.

2.2.1 Detailed Description

Functions to write raw binary files properly in verilog.

Author

Jay Convertino(`johnathan.convertino.1@us.af.mil`)

Date

2023-20-1

2.2.2 Macro Definition Documentation

2.2.2.1 BUFFSIZE

```
#define BUFFSIZE (1 << 23)
```

2.2.2.2 DATACHUNK

```
#define DATACHUNK (1 << 21)
```

2.2.2.3 READ_NAME

```
#define READ_NAME "$read_binary_file"
```

2.2.2.4 WRITE_NAME

```
#define WRITE_NAME "$write_binary_file"
```

2.2.3 Function Documentation

2.2.3.1 binary_end_compile_cb()

```
PLI_INT32 binary_end_compile_cb (
            p_cb_data data )
```

BINARY FILE END COMPILE CALLBACK.

2.2.3.2 binary_end_sim_cb()

```
PLI_INT32 binary_end_sim_cb (
            p_cb_data data )
```

BINARY FILE END SIM CALLBACK.

2.2.3.3 binary_sizetf()

```
PLI_INT32 binary_sizetf (
            PLI_BYTE8 * user_data )
```

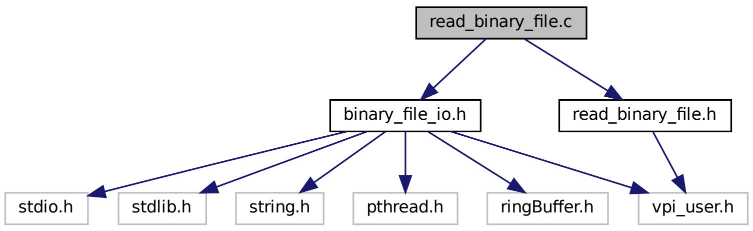
Returns the size, in bits, of the function return type.

2.3 read_binary_file.c File Reference

Functions to read raw binary files properly in verilog.

```
#include "binary_file_io.h"
#include "read_binary_file.h"
```

Include dependency graph for read_binary_file.c:



Functions

- void * read_thread (void *data)

  READ BINARY FILE THREAD TO FILL RINGBUFFER.
- PLI_INT32 read_binary_start_sim_cb (p_cb_data data)

  READ BINARY FILE START SIM CALLBACK.
- PLI_INT32 read_binary_calltf (PLI_BYTE8 *user_data)

  Called by the simulator, each time it is requested.

2.3.1 Detailed Description

Functions to read raw binary files properly in verilog.

Author

Jay Convertino(johnathan.convertino.1@us.af.mil)

Date

2022-12-19

2.3.2 Function Documentation

2.3.2.1 read_binary_calltf()

```
PLI_INT32 read_binary_calltf (
            PLI_BYTE8 * user_data )
```

Called by the simulator, each time it is requested.

read_binary_calltf is a callback for the read_binary_file function.

2.3.2.2 read_binary_start_sim_cb()

```
PLI_INT32 read_binary_start_sim_cb (
            p_cb_data data )
```

READ BINARY FILE START SIM CALLBACK.

2.3.2.3 read_thread()

```
void* read_thread (
            void * data )
```

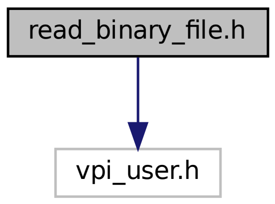
READ BINARY FILE THREAD TO FILL RINGBUFFER.

2.4 read_binary_file.h File Reference

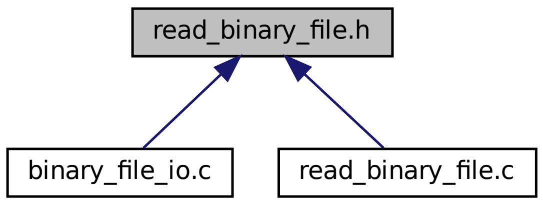
Functions to write raw binary files properly in verilog.

```
#include <vpi_user.h>
```

Include dependency graph for read_binary_file.h:



This graph shows which files directly or indirectly include this file:



Functions

- PLI_INT32 read_binary_start_sim_cb (p_cb_data data)
  READ BINARY FILE START SIM CALLBACK.
- PLI_INT32 read_binary_calltf (PLI_BYTE8 *user_data)
  read_binary_calltf is a callback for the read_binary_file function.

2.4.1 Detailed Description

Functions to write raw binary files properly in verilog.

Author

Jay Convertino(johnathan.convertino.1@us.af.mil)

Date

2023-20-1

$read_binary_file takes 2 arguments. First the file name, next a register for data in size bytes. The function returns the number of bytes read. If it is a negative number, that indicates EOF.

2.4.2 Function Documentation

2.4.2.1 read_binary_calltf()

```
PLI_INT32 read_binary_calltf (
            PLI_BYTE8 * user_data )
```

read_binary_calltf is a callback for the read_binary_file function.

read_binary_calltf is a callback for the read_binary_file function.

2.4.2.2 read_binary_start_sim_cb()

```
PLI_INT32 read_binary_start_sim_cb (
            p_cb_data data )
```

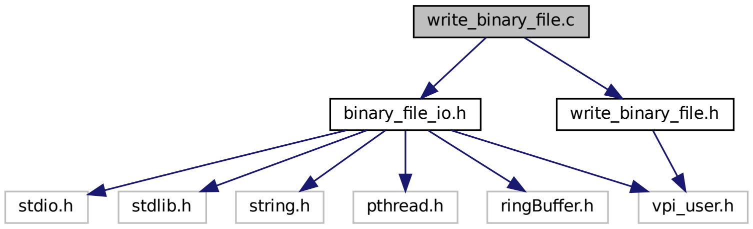
READ BINARY FILE START SIM CALLBACK.

2.5 write_binary_file.c File Reference

Functions to write raw binary files properly in verilog.

```
#include "binary_file_io.h"
#include "write_binary_file.h"
```

Include dependency graph for write_binary_file.c:



Functions

- void ∗ write_thread (void ∗data)

  WRITE BINARY FILE THREAD TO EMPTY RINGBUFFER.
- PLI_INT32 write_binary_start_sim_cb (p_cb_data data)

  WRITE BINARY FILE START SIM CALLBACK.
- PLI_INT32 write_binary_calltf (PLI_BYTE8 ∗user_data)

  Called by the simulator, each time it is requested. TODO.

2.5.1 Detailed Description

Functions to write raw binary files properly in verilog.

Author

Jay Convertino(johnathan.convertino.1@us.af.mil)

Date

2023-20-1

2.5.2 Function Documentation

2.5.2.1 write_binary_calltf()

```
PLI_INT32 write_binary_calltf (
            PLI_BYTE8 * user_data )
```

Called by the simulator, each time it is requested. TODO.

2.5.2.2 write_binary_start_sim_cb()

```
PLI_INT32 write_binary_start_sim_cb (
            p_cb_data data )
```

WRITE BINARY FILE START SIM CALLBACK.

2.5.2.3 write_thread()

```
void* write_thread (
            void * data )
```

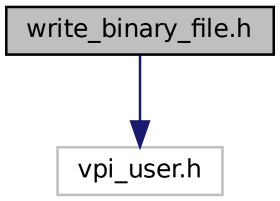
WRITE BINARY FILE THREAD TO EMPTY RINGBUFFER.

2.6 write_binary_file.h File Reference

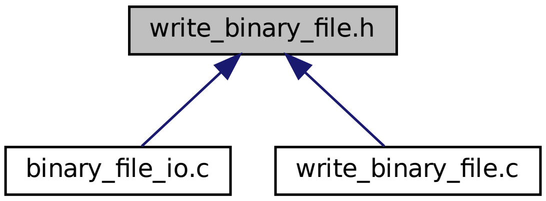
Functions to write raw binary files properly in verilog.

`#include <vpi_user.h>`

Include dependency graph for write_binary_file.h:



This graph shows which files directly or indirectly include this file:



Functions

- PLI_INT32 write_binary_start_sim_cb (p_cb_data data)

  WRITE BINARY FILE START SIM CALLBACK.
- PLI_INT32 write_binary_calltf (PLI_BYTE8 ∗user_data)

  Called by the simulator, each time it is requested. TODO.

2.6.1 Detailed Description

Functions to write raw binary files properly in verilog.

Author

Jay Convertino(`johnathan.convertino.1@us.af.mil`)

Date

2023-20-1

2.6.2 Function Documentation

2.6.2.1 write_binary_calltf()

```
PLI_INT32 write_binary_calltf (
            PLI_BYTE8 * user_data )
```

Called by the simulator, each time it is requested. TODO.

2.6.2.2 write_binary_start_sim_cb()

```
PLI_INT32 write_binary_start_sim_cb (
            p_cb_data data )
```

WRITE BINARY FILE START SIM CALLBACK.

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