

libpynq

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Chapter 4

Module Documentation

4.1 ADC library

Enumerations

- enum `adc_channel_t` {
 `ADC0` = ((0x240 / 4) + 1) , `ADC1` = ((0x240 / 4) + 9) , `ADC2` = ((0x240 / 4) + 6) , `ADC3` = ((0x240 / 4) + 15) ,
 `ADC4` = ((0x240 / 4) + 5) , `ADC5` = ((0x240 / 4) + 13) }

Functions

- bool `initialized_adc` (void)
- void `adc_init` (void)
- void `adc_destroy` (void)
- double `adc_read_channel` (`adc_channel_t` channel)
- uint32_t `adc_read_channel_raw` (`adc_channel_t` channel)

4.1.1 Detailed Description

Functions to use the Analog to Digital Conversion (ADC) of analog pins (A0..A5).

Note that GPIO numbering (SWB_A0..SWB_A5) used in [gpio.h](#) and [pinmap.h](#) is different from A0..A5.

4.1.2 Enumeration Type Documentation

4.1.2.1 `adc_channel_t`

enum `adc_channel_t`

Enumerate the different available ADC channels.

Enumerator

ADC0	ADC channel for pin SWB_A0
ADC1	ADC channel for pin SWB_A1
ADC2	ADC channel for pin SWB_A2
ADC3	ADC channel for pin SWB_A3
ADC4	ADC channel for pin SWB_A4
ADC5	ADC channel for pin SWB_A5

Definition at line 43 of file [adc.h](#).

4.1.3 Function Documentation

4.1.3.1 `adc_destroy()`

```
void adc_destroy (
    void )
```

De-initialize the ADC library and free up the used memory in the shared memory space.

Definition at line 80 of file [adc.c](#).

Here is the call graph for this function:

4.1.3.2 `adc_init()`

```
void adc_init (
    void )
```

Initialization of the ADC library.

Definition at line 78 of file [adc.c](#).

Here is the call graph for this function:

4.1.3.3 `adc_read_channel()`

```
double adc_read_channel (
    adc_channel_t channel )
```

Parameters

<i>channel</i>	The channel to read the analog value from. Read ADC channel #channel and return the read out voltage.
----------------	-------------------------------------------------------------------------------------------------------

Returns

a value between 0.0 and 3.3V.

Warning

Fails with program exit when channel is outside valid range or has not been initialized..

Definition at line 87 of file [adc.c](#).

Here is the call graph for this function:

4.1.3.4 adc_read_channel_raw()

```
uint32_t adc_read_channel_raw (  
    adc_channel_t channel )
```

Parameters

<i>channel</i>	The channel to read the analog value from. Read ADC channel #channel and return the raw value.
----------------	------------------------------------------------------------------------------------------------

Returns

a value between 0 and 65535.

Warning

Fails with program exit when channel is outside valid range.

Definition at line 97 of file [adc.c](#).

Here is the call graph for this function:

4.1.3.5 initialized_adc()

```
bool initialized_adc (  
    void )
```

Check if ADC has been initialized.

Returns

True when initialized, false otherwise.

Definition at line 57 of file [adc.c](#).

Here is the caller graph for this function:

4.2 ARM MMIO library

Data Structures

- struct [arm_shared_t](#)

Typedefs

- typedef struct [arm_shared_t](#) [arm_shared](#)

Functions

- void * [arm_shared_init](#) ([arm_shared](#) *handle, const uint32_t address, const uint32_t length)
- void [arm_shared_close](#) ([arm_shared](#) *handle)

4.2.1 Detailed Description

Do not use. Low-level functions for MMIO access to the FPGA fabric.

This library gives low-level memory-mapped access to the hardware units in the FPGA.

This is an internal library and should not be directly used.

4.2.2 Typedef Documentation

4.2.2.1 `arm_shared`

```
typedef struct arm_shared_t arm_shared
```

Object handle.

Definition at line 48 of file `arm_shared_memory_system.h`.

4.2.3 Function Documentation

4.2.3.1 `arm_shared_close()`

```
void arm_shared_close (  
    arm_shared * handle )
```

Parameters

<i>handle</i>	a handle to its internal state.
---------------	---------------------------------

closes the shared memory region, invalidating the previously accessed pointer.

Definition at line 70 of file `arm_shared_memory_system.c`.

Here is the caller graph for this function:

4.2.3.2 `arm_shared_init()`

```
void * arm_shared_init (  
    arm_shared * handle,  
    const uint32_t address,  
    const uint32_t length )
```

Parameters

<i>handle</i>	a handle to store its internal state.
<i>address</i>	address to access (should be in the shared memory range).
<i>length</i>	the length of the section to access.

Open a shared memory for reading and writing.

Returns

a pointer to the shared memory region.

Definition at line 32 of file [arm_shared_memory_system.c](#).

Here is the caller graph for this function:

4.3 Audio library

Macros

- #define [LINE_IN](#) 0
- #define [MIC](#) 1
- #define [IIC_SLAVE_ADDR](#) 0x3B
- #define [IIC_SCLK_RATE](#) 400000
- #define [I2S_DATA_RX_L_REG](#) 0x00
- #define [I2S_DATA_RX_R_REG](#) 0x04
- #define [I2S_DATA_TX_L_REG](#) 0x08
- #define [I2S_DATA_TX_R_REG](#) 0x0C
- #define [I2S_STATUS_REG](#) 0x10

Enumerations

- enum [audio_adau1761_regs](#) {
[R0_CLOCK_CONTROL](#) = 0x00 , [R1_PLL_CONTROL](#) = 0x02 , [R2_DIGITAL_MIC_JACK_DETECTION_CONTROL](#) = 0x08 , [R3_RECORD_POWER_MANAGEMENT](#) = 0x09 ,
[R4_RECORD_MIXER_LEFT_CONTROL_0](#) = 0x0A , [R5_RECORD_MIXER_LEFT_CONTROL_1](#) = 0x0B ,
[R6_RECORD_MIXER_RIGHT_CONTROL_0](#) = 0x0C , [R7_RECORD_MIXER_RIGHT_CONTROL_1](#) = 0x0D
,
[R8_LEFT_DIFFERENTIAL_INPUT_VOLUME_CONTROL](#) = 0x0E , [R9_RIGHT_DIFFERENTIAL_INPUT_VOLUME_CONTROL](#) = 0x0F , [R10_RECORD_MICROPHONE_BIAS_CONTROL](#) = 0x10 , [R11_ALC_CONTROL_0](#) = 0x11 ,
[R12_ALC_CONTROL_1](#) = 0x12 , [R13_ALC_CONTROL_2](#) = 0x13 , [R14_ALC_CONTROL_3](#) = 0x14 ,
[R15_SERIAL_PORT_CONTROL_0](#) = 0x15 ,
[R16_SERIAL_PORT_CONTROL_1](#) = 0x16 , [R17_CONVERTER_CONTROL_0](#) = 0x17 , [R18_CONVERTER_CONTROL_1](#) = 0x18 , [R19_ADC_CONTROL](#) = 0x19 ,
[R20_LEFT_INPUT_DIGITAL_VOLUME](#) = 0x1A , [R21_RIGHT_INPUT_DIGITAL_VOLUME](#) = 0x1B ,
[R22_PLAYBACK_MIXER_LEFT_CONTROL_0](#) = 0x1C , [R23_PLAYBACK_MIXER_LEFT_CONTROL_1](#) = 0x1D ,
[R24_PLAYBACK_MIXER_RIGHT_CONTROL_0](#) = 0x1E , [R25_PLAYBACK_MIXER_RIGHT_CONTROL_1](#) = 0x1F , [R26_PLAYBACK_LR_MIXER_LEFT_LINE_OUTPUT_CONTROL](#) = 0x20 , [R27_PLAYBACK_LR_MIXER_RIGHT_LINE_OUTPUT_CONTROL](#) = 0x21 ,
[R28_PLAYBACK_LR_MIXER_MONO_OUTPUT_CONTROL](#) = 0x22 , [R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL](#) = 0x23 , [R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL](#) = 0x24 , [R31_PLAYBACK_LINE_OUTPUT_LEFT_VOLUME_CONTROL](#) = 0x25 ,
[R32_PLAYBACK_LINE_OUTPUT_RIGHT_VOLUME_CONTROL](#) = 0x26 , [R33_PLAYBACK_MONO_OUTPUT_CONTROL](#) = 0x27 , [R34_PLAYBACK_POP_CLICK_SUPPRESSION](#) = 0x28 , [R35_PLAYBACK_POWER_MANAGEMENT](#) = 0x29 ,
[R36_DAC_CONTROL_0](#) = 0x2A , [R37_DAC_CONTROL_1](#) = 0x2B , [R38_DAC_CONTROL_2](#) = 0x2C ,
[R39_SERIAL_PORT_PAD_CONTROL](#) = 0x2D ,
[R40_CONTROL_PORT_PAD_CONTROL_0](#) = 0x2F , [R41_CONTROL_PORT_PAD_CONTROL_1](#) = 0x30 ,
[R42_JACK_DETECT_PIN_CONTROL](#) = 0x31 , [R67_DEJITTER_CONTROL](#) = 0x36 ,
[R58_SERIAL_INPUT_ROUTE_CONTROL](#) = 0xF2 , [R59_SERIAL_OUTPUT_ROUTE_CONTROL](#) = 0xF3 ,
[R61_DSP_ENABLE](#) = 0xF5 , [R62_DSP_RUN](#) = 0xF6 ,
[R63_DSP_SLEW_MODES](#) = 0xF7 , [R64_SERIAL_PORT_SAMPLING_RATE](#) = 0xF8 , [R65_CLOCK_ENABLE_0](#) = 0xF9 , [R66_CLOCK_ENABLE_1](#) = 0xFA }

Functions

- void [audio_init](#) (void)
- void [audio_select_input](#) (int input)
- void [write_audio_reg](#) (unsigned char u8RegAddr, unsigned char u8Data, int iic_fd)
- void [config_audio_pll](#) (void)
- void [config_audio_codec](#) (void)
- void [select_line_in](#) (void)
- void [select_mic](#) (void)
- void [deselect](#) (void)
- void [audio_bypass](#) (unsigned int audio_mmap_size, unsigned int nsamples, unsigned int volume, int uio_index)
- void [audio_record](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, int uio_index)
- void [audio_play](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, unsigned int volume, int uio_index)
- void [audio_repeat_play](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, unsigned int volume, unsigned int repetitions)
- void [audio_generate_tone](#) (unsigned int frequency, uint32_t time_ms, unsigned int volume)

4.3.1 Detailed Description

Low-level audio functions.

mic+ph and line_in can be used as audio input and mic+ph as output.

An example of using this library to play audio from line_in to mic+Ph:

```
#include <libpynq.h>
int main (void)
{
    pynq_init();
    audio_init();
    audio_select_input (MIC);
    while (1) {
        audio_bypass (64*1024, 32*1024, 50, 0);
    }
    deselect();
    pynq_destroy();
    return EXIT_SUCCESS;
}
```

4.3.2 Macro Definition Documentation

4.3.2.1 I2S_DATA_RX_L_REG

```
#define I2S_DATA_RX_L_REG 0x00
```

Definition at line 42 of file [audio.h](#).

4.3.2.2 I2S_DATA_RX_R_REG

```
#define I2S_DATA_RX_R_REG 0x04
```

Definition at line 43 of file [audio.h](#).

4.3.2.3 I2S_DATA_TX_L_REG

```
#define I2S_DATA_TX_L_REG 0x08
```

Definition at line 44 of file [audio.h](#).

4.3.2.4 I2S_DATA_TX_R_REG

```
#define I2S_DATA_TX_R_REG 0x0C
```

Definition at line 45 of file [audio.h](#).

4.3.2.5 I2S_STATUS_REG

```
#define I2S_STATUS_REG 0x10
```

Definition at line 46 of file [audio.h](#).

4.3.2.6 IIC_SCLK_RATE

```
#define IIC_SCLK_RATE 400000
```

Definition at line 39 of file [audio.h](#).

4.3.2.7 IIC_SLAVE_ADDR

```
#define IIC_SLAVE_ADDR 0x3B
```

Definition at line 36 of file [audio.h](#).

4.3.2.8 LINE_IN

```
#define LINE_IN 0
```

Definition at line 32 of file [audio.h](#).

4.3.2.9 MIC

```
#define MIC 1
```

Definition at line 33 of file [audio.h](#).

4.3.3 Enumeration Type Documentation

4.3.3.1 audio_adau1761_regs

```
enum audio\_adau1761\_regs
```

Enumerator

R0_CLOCK_CONTROL
R1_PLL_CONTROL
R2_DIGITAL_MIC_JACK_DETECTION_CONTROL
R3_RECORD_POWER_MANAGEMENT
R4_RECORD_MIXER_LEFT_CONTROL_0
R5_RECORD_MIXER_LEFT_CONTROL_1
R6_RECORD_MIXER_RIGHT_CONTROL_0
R7_RECORD_MIXER_RIGHT_CONTROL_1
R8_LEFT_DIFFERENTIAL_INPUT_VOLUME_CONTROL
R9_RIGHT_DIFFERENTIAL_INPUT_VOLUME_CONTROL
R10_RECORD_MICROPHONE_BIAS_CONTROL
R11_ALC_CONTROL_0
R12_ALC_CONTROL_1
R13_ALC_CONTROL_2
R14_ALC_CONTROL_3
R15_SERIAL_PORT_CONTROL_0
R16_SERIAL_PORT_CONTROL_1
R17_CONVERTER_CONTROL_0
R18_CONVERTER_CONTROL_1
R19_ADC_CONTROL
R20_LEFT_INPUT_DIGITAL_VOLUME
R21_RIGHT_INPUT_DIGITAL_VOLUME
R22_PLAYBACK_MIXER_LEFT_CONTROL_0
R23_PLAYBACK_MIXER_LEFT_CONTROL_1
R24_PLAYBACK_MIXER_RIGHT_CONTROL_0
R25_PLAYBACK_MIXER_RIGHT_CONTROL_1
R26_PLAYBACK_LR_MIXER_LEFT_LINE_OUTPUT_CONTROL
R27_PLAYBACK_LR_MIXER_RIGHT_LINE_OUTPUT_CONTROL
R28_PLAYBACK_LR_MIXER_MONO_OUTPUT_CONTROL
R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL
R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL
R31_PLAYBACK_LINE_OUTPUT_LEFT_VOLUME_CONTROL
R32_PLAYBACK_LINE_OUTPUT_RIGHT_VOLUME_CONTROL
R33_PLAYBACK_MONO_OUTPUT_CONTROL
R34_PLAYBACK_POP_CLICK_SUPPRESSION
R35_PLAYBACK_POWER_MANAGEMENT
R36_DAC_CONTROL_0
R37_DAC_CONTROL_1
R38_DAC_CONTROL_2
R39_SERIAL_PORT_PAD_CONTROL
R40_CONTROL_PORT_PAD_CONTROL_0
R41_CONTROL_PORT_PAD_CONTROL_1
R42_JACK_DETECT_PIN_CONTROL
R67_DEJITTER_CONTROL
R58_SERIAL_INPUT_ROUTE_CONTROL
R59_SERIAL_OUTPUT_ROUTE_CONTROL
R61_DSP_ENABLE
R62_DSP_RUN
R63_DSP_SLEW_MODES

Enumerator

R64_SERIAL_PORT_SAMPLING_RATE	
R65_CLOCK_ENABLE_0	
R66_CLOCK_ENABLE_1	

Definition at line 49 of file [audio.h](#).

4.3.4 Function Documentation

4.3.4.1 audio_bypass()

```
void audio_bypass (
    unsigned int audio_mmap_size,
    unsigned int nsamples,
    unsigned int volume,
    int uio_index )
```

Record and play the audio without storing in DRAM.

Parameters

<i>audio_mmap_size</i>	is the address range of the audio codec.
<i>nsamples</i>	is the number of samples to read and output.
<i>uio_index</i>	is the uio index in /dev list.

Definition at line 304 of file [audio.c](#).

Here is the call graph for this function:

4.3.4.2 audio_generate_tone()

```
void audio_generate_tone (
    unsigned int frequency,
    uint32_t time_ms,
    unsigned int volume )
```

Definition at line 570 of file [audio.c](#).

Here is the call graph for this function:

4.3.4.3 audio_init()

```
void audio_init (
    void )
```

Initializes the audio register. Sets the sampling frequency. defines several values such as audio record volume and playback volume. output is always played over mic+ph aux output.

Definition at line 72 of file [audio.c](#).

Here is the call graph for this function:

4.3.4.4 audio_play()

```
void audio_play (
    unsigned int audio_mmap_size,
    unsigned int * BufAddr,
    unsigned int nsamples,
    unsigned int volume,
    int uio_index )
```

Definition at line 430 of file [audio.c](#).

Here is the call graph for this function:

4.3.4.5 audio_record()

```
void audio_record (
    unsigned int audio_mmap_size,
    unsigned int * BufAddr,
    unsigned int nsamples,
    int uio_index )
```

Function to support audio recording without the audio codec controller.

Notice that the buffer has to be twice the size of the number of samples, because both left and right channels are sampled.

Parameters

<i>audio_mmap_size</i>	is the address range of the audio codec.
<i>BufAddr</i>	is the buffer address.
<i>nsamples</i>	is the number of samples.
<i>uio_index</i>	is the uio index in /dev list.

Definition at line 381 of file [audio.c](#).

Here is the call graph for this function:

4.3.4.6 audio_repeat_play()

```
void audio_repeat_play (
    unsigned int audio_mmap_size,
    unsigned int * BufAddr,
    unsigned int nsamples,
    unsigned int volume,
    unsigned int repetitions )
```

Function to play one audio fragment for multiple repetitions.

Parameters

<i>audio_mmap_size</i>	is the address range of the audio codec.
<i>BufAddr</i>	is the buffer address.
<i>nsamples</i>	is the number of samples.
<i>volume</i>	is the volume of the output.
<i>repetitions</i>	is the number of repetitions.

Definition at line [502](#) of file [audio.c](#).

Here is the call graph for this function:

4.3.4.7 audio_select_input()

```
void audio_select_input (
    int input )
```

selects the audio input channel.

Parameters

<i>input</i>	defines the input. Can be 0 LINE_IN or 1 MIC
--------------	----------------------------------------------

Warning

Fails with program exit when input is not valid.

Definition at line [77](#) of file [audio.c](#).

Here is the call graph for this function:

4.3.4.8 config_audio_codec()

```
void config_audio_codec (
    void )
```

Definition at line [174](#) of file [audio.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.3.4.9 config_audio_pll()

```
void config_audio_pll (
    void )
```

Definition at line [102](#) of file [audio.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.3.4.10 deselect()

```
void deselect (
    void )
```

Function to deselect input, either LINE_IN, or MIC.

Definition at line [286](#) of file [audio.c](#).

Here is the call graph for this function:

4.3.4.11 select_line_in()

```
void select_line_in (
    void )
```

Function to select LINE_IN as input.

Definition at line 234 of file [audio.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.3.4.12 select_mic()

```
void select_mic (
    void )
```

Function to select MIC as input.

Definition at line 257 of file [audio.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.3.4.13 write_audio_reg()

```
void write_audio_reg (
    unsigned char u8RegAddr,
    unsigned char u8Data,
    int iic_fd )
```

Definition at line 90 of file [audio.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.4 Button library

Macros

- `#define` [BUTTON_NOT_PUSHED](#) 0
- `#define` [BUTTON_PUSHED](#) 1
- `#define` [SWITCH_OFF](#) 0
- `#define` [SWITCH_ON](#) 1

Enumerations

- `enum` [button_index_t](#) {
 [BUTTON0](#) , [BUTTON1](#) , [BUTTON2](#) , [BUTTON3](#) ,
 [NUM_BUTTONS](#) }
- `enum` [switches_index_t](#) { [SWITCH0](#) , [SWITCH1](#) , [NUM_SWITCHES](#) }

Functions

- void [switches_init](#) (void)
- void [switches_destroy](#) (void)
- void [buttons_init](#) (void)
- void [buttons_destroy](#) (void)
- int [get_button_state](#) (const int button)
- int [wait_until_button_state](#) (const int button, const int state)
- int [sleep_msec_button_pushed](#) (const int button, const int msec)
- void [sleep_msec_buttons_pushed](#) (int button_states[], const int ms)
- int [wait_until_button_pushed](#) (const int button)
- int [wait_until_button_released](#) (const int button)
- int [wait_until_any_button_pushed](#) (void)
- int [wait_until_any_button_released](#) (void)
- int [get_switch_state](#) (const int switch_num)

4.4.1 Detailed Description

Wrappers to simplify the use of buttons.

- Buttons are numbered 0..NUM_BUTTONS-1, and return values are BUTTON_PUSHED and BUTTON_↵NOT_PUSHED
- Switches are numbered 0..NUM_SWITCHES-1, and return values are SWITCH_ON and SWITCH_OFF.
- wait_ functions return early, i.e. as soon as the stated condition is true.
- sleep_ functions do not return early, i.e. always wait until the specified number of milliseconds.

An example of how to use this library.

```
#include <libpynq.h>
int main (void)
{
    // initialise all I/O
    pynq_init();
    buttons_init();

    printf("Waiting until button 0 is pushed...\n");
    printf("Waited %d milliseconds\n\n", wait_until_button_pushed(0));
    printf("Waiting until button 0 is released...\n");
    printf("Waited %d milliseconds\n\n", wait_until_button_released(0));

    // clean up after use
    buttons_destroy();
    pynq_destroy();
    return EXIT_SUCCESS;
}
```

Buttons can also be used through GPIO (see [gpio.h](#) and [pinmap.h](#)). Note that GPIO numbering (SWB_↵BTN0..SWB_BTN3) is then used instead of 0..NUM_BUTTONS-1 (BUTTON0..BUTTON3). GPIO return values are GPIO_LEVEL_LOW/HIGH instead of BUTTON_(NOT_)PUSHED.

Switches can also be used through GPIO (see [gpio.h](#) and [pinmap.h](#)). Note that GPIO numbering (SWB_↵SW0..SWB_SW1) is then used instead of 0..NUM_SWITCHES-1 (SWITCH0..SWITCH1). GPIO return values are GPIO_LEVEL_LOW/HIGH instead of SWITCH_ON/OFF.

4.4.2 Macro Definition Documentation

4.4.2.1 BUTTON_NOT_PUSHED

```
#define BUTTON_NOT_PUSHED 0
```

Definition at line 74 of file [buttons.h](#).

4.4.2.2 BUTTON_PUSHED

```
#define BUTTON_PUSHED 1
```

Definition at line 75 of file [buttons.h](#).

4.4.2.3 SWITCH_OFF

```
#define SWITCH_OFF 0
```

Definition at line 76 of file [buttons.h](#).

4.4.2.4 SWITCH_ON

```
#define SWITCH_ON 1
```

Definition at line 77 of file [buttons.h](#).

4.4.3 Enumeration Type Documentation

4.4.3.1 button_index_t

```
enum button_index_t
```

Enum of buttons.

Functions use a button numbered from 0..NUM_BUTTONS-1. Alternatively, you can use BUTTONi instead of just i if you find that clearer.

Enumerator

BUTTON0	
BUTTON1	
BUTTON2	
BUTTON3	
NUM_BUTTONS	

Definition at line 86 of file [buttons.h](#).

4.4.3.2 switches_index_t

```
enum switches_index_t
```

Enum of switches. Functions use a switch numbered from 0..NUM_SWITCHES-1. Alternatively, you can use SWITCHi instead of just i if you find that clearer.

Enumerator

SWITCH0	
SWITCH1	
NUM_SWITCHES	

Definition at line 94 of file [buttons.h](#).

4.4.4 Function Documentation**4.4.4.1 buttons_destroy()**

```
void buttons_destroy (
    void )
```

Unitialize the buttons.

Definition at line 50 of file [buttons.c](#).

4.4.4.2 buttons_init()

```
void buttons_init (
    void )
```

Initialise the buttons before they can be used.

Definition at line 39 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.3 get_button_state()

```
int get_button_state (
    const int button )
```

Return the state of the button (BUTTON_(NOT_)PUSHED).

Parameters

<i>button</i>	The button the state of which is returned.
---------------	--------------------------------------------

Warning

Fails with program exit when button is outside valid range.

Fails with program exit when the direction of the button was not set to input (e.g. because buttons_init was not called before).

Definition at line 71 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.4 `get_switch_state()`

```
int get_switch_state (
    const int switch_num )
```

Returns

The state of the switch number (1 for on, 0 for off).

Warning

Fails with program exit when switch is outside valid range.

Fails with program exit when the direction of any switch was not set to input (e.g. because `buttons_init` was not called before).

Definition at line 218 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.5 `sleep_msec_button_pushed()`

```
int sleep_msec_button_pushed (
    const int button,
    const int msec )
```

Check if the given button is pushed in msec milliseconds. The function does NOT return early.

Parameters

<i>button</i>	The button of which the state is monitored.
<i>msec</i>	The number of milliseconds to wait.

Returns

`BUTTON_PUSHED` or `BUTTON_NOT_PUSHED`.

Warning

Fails with program exit when button is outside valid range.

Fails with program exit when the direction of the button was not set to input (e.g. because `buttons_init` was not called before).

Definition at line 110 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.6 `sleep_msec_buttons_pushed()`

```
void sleep_msec_buttons_pushed (
    int button_states[],
    const int ms )
```

Check if any button is pushed in msec milliseconds. The function does NOT return early.

Parameters

<i>button_states</i>	The array of button states that are updated with <code>BUTTON_PUSHED</code> or <code>BUTTON_NOT_PUSHED</code> .
----------------------	-----------------------------------------------------------------------------------------------------------------

Warning

Fails with program exit when the direction of any button was not set to input (e.g. because `buttons_init` was not called before).

Definition at line 141 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.7 switches_destroy()

```
void switches_destroy (  
    void )
```

Unitalize the buttons.

Definition at line 65 of file [buttons.c](#).

4.4.4.8 switches_init()

```
void switches_init (  
    void )
```

Initialise the switches before they can be used.

Definition at line 56 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.9 wait_until_any_button_pushed()

```
int wait_until_any_button_pushed (  
    void )
```

Wait until any button is not pushed (which may be immediately).

Returns

Wait until any button is pushed, return the number of the button that was pushed (0..`NUM_BUTTONS`-1).

Warning

Fails with program exit when the direction of any button was not set to input (e.g. because `buttons_init` was not called before).

Definition at line 177 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.10 wait_until_any_button_released()

```
int wait_until_any_button_released (
    void )
```

Wait until the given button is not pushed (which may be immediately).

Returns

Wait until any button is released, return the number of the button that was pushed (0..NUM_BUTTONS-1).

Warning

Fails with program exit when the direction of any button was not set to input (e.g. because buttons_init was not called before).

Definition at line 198 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.11 wait_until_button_pushed()

```
int wait_until_button_pushed (
    const int button )
```

Wait until the given button is pushed (which may be immediately).

Parameters

<i>button</i>	The button of which the state is monitored.
---------------	---------------------------------------------

Returns

The number of milliseconds waited until the button was pushed.

Warning

Fails with program exit when button is outside valid range.

Fails with program exit when the direction of the button was not set to input (e.g. because buttons_init was not called before).

Definition at line 167 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.12 wait_until_button_released()

```
int wait_until_button_released (
    const int button )
```

Wait until the given button is not pushed (which may be immediately).

Parameters

<i>button</i>	The button of which the state is monitored.
---------------	---------------------------------------------

Returns

The number of milliseconds waited until the button was released.

Warning

Fails with program exit when button is outside valid range.

Fails with program exit when the direction of the button was not set to input (e.g. because `buttons_init` was not called before).

Definition at line 172 of file [buttons.c](#).

Here is the call graph for this function:

4.4.4.13 wait_until_button_state()

```
int wait_until_button_state (
    const int button,
    const int state )
```

Wait until the given button is in state (which may be immediately).

Parameters

<i>button</i>	The button of which the state is monitored.
<i>state</i>	The state that is waited for. Must be <code>BUTTON_PUSHED</code> or <code>BUTTON_NOT_PUSHED</code> .

Returns

The number of milliseconds that was waited.

Warning

Fails with program exit when button is outside valid range.

Fails with program exit when the direction of the button was not set to input (e.g. because `buttons_init` was not called before).

Definition at line 84 of file [buttons.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.5 Display library

Data Structures

- struct [display_t](#)

Macros

- `#define DISPLAY_HEIGHT 240`
- `#define DISPLAY_WIDTH 240`

Enumerations

- enum `colors` {
`RGB_RED = 0xf800` , `RGB_GREEN = 0x07e0` , `RGB_BLUE = 0x001f` , `RGB_BLACK = 0x0000` ,
`RGB_WHITE = 0xffff` , `RGB_GRAY = 0x8c51` , `RGB_YELLOW = 0xFFE0` , `RGB_CYAN = 0x07FF` ,
`RGB_PURPLE = 0xF81F` }
- enum `directions` {
`TEXT_DIRECTION0 = 0` , `TEXT_DIRECTION90 = 1` , `TEXT_DIRECTION180 = 2` , `TEXT_DIRECTION270 = 3` ,
`NUM_TEXT_DIRECTIONS` }

Functions

- void `display_init` (`display_t` *display)
- void `display_destroy` (`display_t` *display)
- void `displayDrawPixel` (`display_t` *display, uint16_t x, uint16_t y, uint16_t color)
- void `displayDrawFillRect` (`display_t` *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void `displayFillScreen` (`display_t` *display, uint16_t color)
- void `displayDrawLine` (`display_t` *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void `displayDrawRect` (`display_t` *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void `displayDrawRectAngle` (`display_t` *display, uint16_t xc, uint16_t yc, uint16_t w, uint16_t h, uint16_t angle, uint16_t color)
- void `displayDrawTriangleCenter` (`display_t` *display, uint16_t xc, uint16_t yc, uint16_t w, uint16_t h, uint16_t angle, uint16_t color)
- void `displayDrawCircle` (`display_t` *display, uint16_t x_center, uint16_t y_center, uint16_t r, uint16_t color)
- void `displayDrawFillCircle` (`display_t` *display, uint16_t x_center, uint16_t y_center, uint16_t r, uint16_t color)
- void `displayDrawRoundRect` (`display_t` *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t r, uint16_t color)
- uint16_t `rgb_conv` (uint16_t r, uint16_t g, uint16_t b)
- int `displayDrawChar` (`display_t` *display, `FontxFile` *fx, uint16_t x, uint16_t y, uint8_t ascii, uint16_t color)
- int `displayDrawString` (`display_t` *display, `FontxFile` *fx, uint16_t x, uint16_t y, uint8_t *ascii, uint16_t color)
- void `displaySetFontDirection` (`display_t` *display, uint16_t dir)
- void `displaySetFontFill` (`display_t` *display, uint16_t color)
- void `displayUnsetFontFill` (`display_t` *display)
- void `displaySetFontUnderLine` (`display_t` *display, uint16_t color)
- void `displayUnsetFontUnderLine` (`display_t` *display)
- void `displayDisplayOff` (`display_t` *display)
- void `displayDisplayOn` (`display_t` *display)
- void `displayBacklightOff` (`display_t` *display)
- void `displayBacklightOn` (`display_t` *display)
- void `displayInversionOff` (`display_t` *display)
- void `displayInversionOn` (`display_t` *display)
- void `displayDrawTriangle` (`display_t` *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t x3, uint16_t y3, uint16_t color)
- void `display_set_flip` (`display_t` *display, bool xflip, bool yflip)

4.5.1 Detailed Description

Wrappers to simplify the use of the TFT LCD display.

Define a `display_t` display (called the display "handle"), initialise it, and pass this as the first parameter to all functions.

Warning

All functions fail with program exit if any pixel of the shape that is drawn is outside the display dimensions.

An example of how to use this library.

```
#include <libpynq.h>
int main (void)
{
    // initialise all I/O
    pynq_init();
    display_t display;
    display_init(&display);

    displayFillScreen(&display, RGB_RED);
    // drawing is simple
    displayDrawPixel(&display, 50, 50, RGB_YELLOW);
    displayDrawFillRect(&display, 10, 100, 110, 200, RGB_RED);
    displayDrawCircle(&display, 60, 40, 15, RGB_RED);
    // text is more involved
    FontxFile fx16G[2];
    // the font file must be reachable from the directory
    // from which the executable is run -- see InitFontx
    InitFontx(fx16G, "../../fonts/ILGH16XB.FNT", "");
    GetFontx(fx16G, 0, buffer_fx16G, &fontWidth_fx16G, &fontHeight_fx16G);
    displaySetFontDirection(&display, TEXT_DIRECTION0);
    uint8_t text[] = "hello";
    displayDrawString(&display, fx16G, 15, fontHeight_fx16G * 6, text1,
    RGB_WHITE);

    // clean up after use
    display_destroy(&display);
    pynq_destroy();
    return EXIT_SUCCESS;
}
```

4.5.2 Macro Definition Documentation

4.5.2.1 DISPLAY_HEIGHT

```
#define DISPLAY_HEIGHT 240
```

Definition at line 79 of file `display.h`.

4.5.2.2 DISPLAY_WIDTH

```
#define DISPLAY_WIDTH 240
```

Definition at line 80 of file `display.h`.

4.5.3 Enumeration Type Documentation

4.5.3.1 colors

```
enum colors
```

Colors that can be used with the display.

Enumerator

RGB_RED	
RGB_GREEN	
RGB_BLUE	
RGB_BLACK	
RGB_WHITE	
RGB_GRAY	
RGB_YELLOW	
RGB_CYAN	
RGB_PURPLE	

Definition at line 85 of file [display.h](#).

4.5.3.2 directions

```
enum directions
```

Enum of directions the text can be printed on on the display.

Enumerator

TEXT_DIRECTION0	
TEXT_DIRECTION90	
TEXT_DIRECTION180	
TEXT_DIRECTION270	
NUM_TEXT_DIRECTIONS	

Definition at line 100 of file [display.h](#).

4.5.4 Function Documentation

4.5.4.1 display_destroy()

```
void display_destroy (
    display_t * display )
```

Stop using the display.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 3 of file [display.c](#).

4.5.4.2 display_init()

```
void display_init (
```

```
display_t * display )
```

Initialize the display display.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 297 of file [display.c](#).

Here is the call graph for this function:

4.5.4.3 display_set_flip()

```
void display_set_flip (
    display_t * display,
    bool xflip,
    bool yflip )
```

Flip the drawing off the screen.

Parameters

<i>display</i>	Handle to display
<i>xflip</i>	Flip in the X direction
<i>yflip</i>	Flip in the Y direction

Definition at line 275 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.5.4.4 displayBacklightOff()

```
void displayBacklightOff (
    display_t * display )
```

Turn off the display backlight.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 1010 of file [display.c](#).

Here is the call graph for this function:

4.5.4.5 displayBacklightOn()

```
void displayBacklightOn (
    display_t * display )
```

Turn on the display backlight.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 1019 of file [display.c](#).

Here is the call graph for this function:

4.5.4.6 displayDisplayOff()

```
void displayDisplayOff (  
    display_t * display )
```

Turn off the display.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 399 of file [display.c](#).

Here is the call graph for this function:

4.5.4.7 displayDisplayOn()

```
void displayDisplayOn (  
    display_t * display )
```

Initialize DISPLAY screen.

Parameters

<i>display</i>	Handle to display.
<i>width</i>	Width of screen in pixels.
<i>height</i>	Height of screen in pixels.
<i>offsetx</i>	Horizontal offset.
<i>offsety</i>	Vertical offset.

Definition at line 406 of file [display.c](#).

Here is the call graph for this function:

4.5.4.8 displayDrawChar()

```
int displayDrawChar (  
    display_t * display,
```

```

FontxFile * fx,
uint16_t x,
uint16_t y,
uint8_t ascii,
uint16_t color )

```

Draws a character on the given coordinates of the display.

Parameters

<i>display</i>	Handle to display.
<i>fx</i>	Pointer to font-file that is used for drawing the text.
<i>x</i>	The x-coordinate of the text on the display.
<i>y</i>	The y-coordinate of the text on the display.
<i>ascii</i>	The ascii character to draw.
<i>color</i>	The 16-bit color value to write.

Returns

The x-value of the next character to be printed on the display.

Warning

The font-file path must be valid from the directory in which the executable is called, otherwise the error message "cannot get font from font file" will be thrown. Absolute paths (starting with /) are safe. See documentation for InitFontx.

Definition at line 778 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.5.4.9 displayDrawCircle()

```

void displayDrawCircle (
    display_t * display,
    uint16_t x_center,
    uint16_t y_center,
    uint16_t r,
    uint16_t color )

```

Draw a circle without infill on the display.

Parameters

<i>display</i>	Handle to display.
<i>x_center</i>	X-coordinate of the center of the circle.
<i>y_center</i>	Y-coordinate of the center of the circle.
<i>r</i>	The radius of the circle in pixels.
<i>color</i>	The 16-bit color value to write.

Definition at line 617 of file [display.c](#).

Here is the call graph for this function:

4.5.4.10 displayDrawFillCircle()

```
void displayDrawFillCircle (
    display_t * display,
    uint16_t x_center,
    uint16_t y_center,
    uint16_t r,
    uint16_t color )
```

Draw a circle with infill on the display.

Parameters

<i>display</i>	Handle to display.
<i>x_center</i>	X-coordinate of the center of the circle.
<i>y_center</i>	Y-coordinate of the center of the circle.
<i>r</i>	The radius of the circle in pixels.
<i>color</i>	The 16-bit color value to write.

Definition at line 658 of file [display.c](#).

Here is the call graph for this function:

4.5.4.11 displayDrawFillRect()

```
void displayDrawFillRect (
    display_t * display,
    uint16_t x1,
    uint16_t y1,
    uint16_t x2,
    uint16_t y2,
    uint16_t color )
```

Draw a filled rectangle to the display.

Parameters

<i>display</i>	Handle to display.
<i>x1</i>	The X coordinate of the top-left corner of the rectangle.
<i>y1</i>	The Y coordinate of the top-left corner of the rectangle.
<i>x2</i>	The X coordinate of the bottom-right corner of the rectangle.
<i>y2</i>	The Y coordinate of the bottom-right corner of the rectangle.
<i>color</i>	The 16-bit color value to write.

Definition at line 357 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.5.4.12 displayDrawLine()

```
void displayDrawLine (
    display_t * display,
    uint16_t x1,
    uint16_t y1,
    uint16_t x2,
    uint16_t y2,
    uint16_t color )
```

Draw a line from two coordinates.

Parameters

<i>display</i>	Handle to display.
<i>x1</i>	Starting x-coordinate of line.
<i>y1</i>	Starting y-coordinate of line.
<i>x2</i>	Ending x-coordinate of line.
<i>y2</i>	Ending y-coordinate of line.
<i>color</i>	The 16-bit color value to write.

Definition at line [421](#) of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.5.4.13 displayDrawPixel()

```
void displayDrawPixel (
    display_t * display,
    uint16_t x,
    uint16_t y,
    uint16_t color )
```

Draw a single pixel to the display.

Parameters

<i>display</i>	Handle to display.
<i>x</i>	The X coordinate of the pixel.
<i>y</i>	The Y coordinate of the pixel.
<i>color</i>	The 16-bit color value to write.

Definition at line [313](#) of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.5.4.14 displayDrawRect()

```
void displayDrawRect (
    display_t * display,
```

```

uint16_t x1,
uint16_t y1,
uint16_t x2,
uint16_t y2,
uint16_t color )

```

Draw a filled rectangle.

Parameters

<i>display</i>	Handle to display.
<i>x1</i>	Top-left x-coordinate of rectangle.
<i>y1</i>	Top-left y-coordinate of rectangle.
<i>x2</i>	Bottom-right x-coordinate of rectangle.
<i>y2</i>	Bottom-right y-coordinate of rectangle.
<i>color</i>	The 16-bit color value to write.

Definition at line 474 of file [display.c](#).

Here is the call graph for this function:

4.5.4.15 displayDrawRectAngle()

```

void displayDrawRectAngle (
    display_t * display,
    uint16_t xc,
    uint16_t yc,
    uint16_t w,
    uint16_t h,
    uint16_t angle,
    uint16_t color )

```

Draws a rectangle with rounded corners at a specified angle on the display.

Parameters

<i>display</i>	Handle to display.
<i>xc</i>	X-coordinate of the center of the rectangle.
<i>yc</i>	Y-coordinate of the center of the rectangle.
<i>w</i>	Width of the rectangle.
<i>h</i>	Height of the rectangle.
<i>angle</i>	Angle of rotation in degrees.
<i>color</i>	The 16-bit color value to write.

Definition at line 492 of file [display.c](#).

Here is the call graph for this function:

4.5.4.16 displayDrawRoundRect()

```

void displayDrawRoundRect (
    display_t * display,

```

```

uint16_t x1,
uint16_t y1,
uint16_t x2,
uint16_t y2,
uint16_t r,
uint16_t color )

```

Draw a rectangle with rounded angles.

Parameters

<i>display</i>	Handle to display.
<i>x1</i>	Top-left x-coordinate of rectangle.
<i>y1</i>	Top-left y-coordinate of rectangle.
<i>x2</i>	Bottom-right x-coordinate of rectangle.
<i>y2</i>	Bottom-right y-coordinate of rectangle.
<i>r</i>	The radius of the circle that is used for the edges.
<i>color</i>	The 16-bit color value to write.

Definition at line 704 of file [display.c](#).

Here is the call graph for this function:

4.5.4.17 displayDrawString()

```

int displayDrawString (
    display_t * display,
    FontxFile * fx,
    uint16_t x,
    uint16_t y,
    uint8_t * ascii,
    uint16_t color )

```

Function to draw a string on the display.

Parameters

<i>display</i>	Handle to display.
<i>fx</i>	Pointer to font-file that is used for drawing the text.
<i>x</i>	The x-coordinate of the text on the display.
<i>y</i>	The y-coordinate of the text on the display.
<i>ascii</i>	The ascii characters to draw.
<i>color</i>	The 16-bit color value to write.

Returns

The x or y coordinate of the next character, depending on the orientation of the display.

Warning

The font-file path must be valid from the directory in which the executable is called, otherwise the error message "cannot get font from font file" will be thrown. Absolute paths (starting with /) are safe. See documentation for InitFontx.

Definition at line 947 of file [display.c](#).

Here is the call graph for this function:

4.5.4.18 displayDrawTriangle()

```
void displayDrawTriangle (
    display_t * display,
    uint16_t x1,
    uint16_t y1,
    uint16_t x2,
    uint16_t y2,
    uint16_t x3,
    uint16_t y3,
    uint16_t color )
```

Draw a triangle without infill between the three given points in the given color.

Parameters

<i>display</i>	Handle to display.
<i>x1</i>	The first X-coordinate of the triangle.
<i>y1</i>	The first Y-coordinate of the triangle.
<i>x2</i>	The second X-coordinate of the triangle.
<i>y2</i>	The second Y-coordinate of the triangle.
<i>x3</i>	The third X-coordinate of the triangle.
<i>y3</i>	The third Y-coordinate of the triangle.
<i>color</i>	The 16-bit color value to write.

Definition at line 549 of file [display.c](#).

Here is the call graph for this function:

4.5.4.19 displayDrawTriangleCenter()

```
void displayDrawTriangleCenter (
    display_t * display,
    uint16_t xc,
    uint16_t yc,
    uint16_t w,
    uint16_t h,
    uint16_t angle,
    uint16_t color )
```

Draws a triangle at a specified angle on the display.

Parameters

<i>display</i>	Handle to display.
<i>xc</i>	X-coordinate of the center of the rectangle.
<i>yc</i>	Y-coordinate of the center of the rectangle.
<i>w</i>	Width of the rectangle.
<i>h</i>	Height of the rectangle.
<i>angle</i>	Angle of rotation in degrees.
<i>color</i>	The 16-bit color value to write.

Definition at line 576 of file [display.c](#).

Here is the call graph for this function:

4.5.4.20 displayFillScreen()

```
void displayFillScreen (
    display_t * display,
    uint16_t color )
```

Fill entire display with a single color using the `ldcDrawFillRect` function.

Parameters

<i>display</i>	Handle to display.
<i>color</i>	Fill color in RGB format.

Definition at line 413 of file [display.c](#).

Here is the call graph for this function:

4.5.4.21 displayInversionOff()

```
void displayInversionOff (
    display_t * display )
```

Turn off inversion of the colors.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 1028 of file [display.c](#).

Here is the call graph for this function:

4.5.4.22 displayInversionOn()

```
void displayInversionOn (
    display_t * display )
```

Turn on inversion of the colors.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 1035 of file [display.c](#).

Here is the call graph for this function:

4.5.4.23 displaySetFontDirection()

```
void displaySetFontDirection (
    display_t * display,
    uint16_t dir )
```

Changes the direction the characters will be printed.

Parameters

<i>display</i>	Handle to display.
<i>dir</i>	The direction to set the font in the display handle.

Definition at line 978 of file [display.c](#).

4.5.4.24 displaySetFontFill()

```
void displaySetFontFill (
    display_t * display,
    uint16_t color )
```

Enables the `_font_fill` and sets the `_font_fill_color` in the display handle.

Parameters

<i>display</i>	Handle to display.
<i>color</i>	The fill-color the font should have

Definition at line 985 of file [display.c](#).

4.5.4.25 displaySetFontUnderLine()

```
void displaySetFontUnderLine (
    display_t * display,
    uint16_t color )
```

Turns on `_font_underline` in the display handle and sets the `_font_underline_color` to the specified color.

Parameters

<i>display</i>	Handle to display.
<i>color</i>	The 16-bit color value to write.

Definition at line 995 of file [display.c](#).

4.5.4.26 displayUnsetFontFill()

```
void displayUnsetFontFill (  
    display_t * display )
```

Sets the `_font_fill` parameter to false in the display handle, turns off the font fill.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 993 of file [display.c](#).

4.5.4.27 displayUnsetFontUnderLine()

```
void displayUnsetFontUnderLine (  
    display_t * display )
```

Turns off `_font_underline` in the display handle.

Parameters

<i>display</i>	Handle to display.
----------------	--------------------

Definition at line 1003 of file [display.c](#).

4.5.4.28 rgb_conv()

```
uint16_t rgb_conv (  
    uint16_t r,  
    uint16_t g,  
    uint16_t b )
```

RGB conversion for generating a color.

Parameters

<i>r</i>	Red value, 5 least significant bits.
<i>g</i>	Green value, 6 least significant bits.
<i>b</i>	Blue value, 5 least significant bits.

Definition at line 774 of file [display.c](#).

4.6 Font library

Data Structures

- struct [FontxFile](#)

Typedefs

- typedef struct _IO_FILE [FILE](#)

Functions

- void [AaddFontx](#) ([FontxFile](#) *fx, const char *path)
- void [InitFontx](#) ([FontxFile](#) *fxs, const char *f0, const char *f1)
- bool [OpenFontx](#) ([FontxFile](#) *fx)
- void [CloseFontx](#) ([FontxFile](#) *fx)
- void [DumpFontx](#) ([FontxFile](#) *fxs)
- uint8_t [GetFontWidth](#) ([FontxFile](#) *fx)
- uint8_t [GetFontHeight](#) ([FontxFile](#) *fx)
- bool [GetFontx](#) ([FontxFile](#) *fxs, uint8_t ascii, uint8_t *pGlyph, uint8_t *pw, uint8_t *ph)
- void [Font2Bitmap](#) (uint8_t *fonts, uint8_t *line, uint8_t w, uint8_t h, uint8_t inverse)
- void [UnderlineBitmap](#) (uint8_t *line, uint8_t w, uint8_t h)
- void [ReversBitmap](#) (uint8_t *line, uint8_t w, uint8_t h)
- void [ShowFont](#) (uint8_t *fonts, uint8_t pw, uint8_t ph)
- void [ShowBitmap](#) (uint8_t *bitmap, uint8_t pw, uint8_t ph)
- uint8_t [RotateByte](#) (uint8_t ch)

4.6.1 Detailed Description

Do not use. Low-level library to work with bitmap fonts on the display.

It provides functionality for loading and manipulating font files, rendering fonts and bitmaps to the screen, and performing various transformations on bitmaps. The library also includes a struct, [FontxFile](#), which represents a font file and contains metadata about the font.

This is an internal library and should not be directly used.

4.6.2 Typedef Documentation

4.6.2.1 FILE

```
typedef struct _IO_FILE FILE
```

Definition at line 23 of file [fontx.h](#).

4.6.3 Function Documentation

4.6.3.1 AaddFontx()

```
void AaddFontx (
    FontxFile * fx,
    const char * path )
```

Adds a font file to the given [FontxFile](#) structure.

Parameters

<i>fx</i>	Pointer to the FontxFile structure
<i>path</i>	Path to the font file

Definition at line 2 of file [fontx.c](#).

4.6.3.2 CloseFontx()

```
void CloseFontx (
    FontxFile * fx )
```

Closes the font file.

Parameters

<i>fx</i>	Pointer to the FontxFile structure
-----------	----------------------------------------------------

Definition at line 5 of file [fontx.c](#).

4.6.3.3 DumpFontx()

```
void DumpFontx (
    FontxFile * fxs )
```

Dumps the font data stored in the [FontxFile](#) structure.

Parameters

<i>fxs</i>	Pointer to the FontxFile structure
------------	----------------------------------------------------

Definition at line 6 of file [fontx.c](#).

4.6.3.4 Font2Bitmap()

```
void Font2Bitmap (
    uint8_t * fonts,
    uint8_t * line,
    uint8_t w,
    uint8_t h,
    uint8_t inverse )
```

Converts a font data buffer into a bitmap.

Parameters

<i>fonts</i>	Pointer to the font data buffer
<i>line</i>	Pointer to the bitmap buffer
<i>w</i>	Width of the bitmap in pixels
<i>h</i>	Height of the bitmap in pixels
<i>inverse</i>	If true, the bitmap will be inverted

Definition at line 135 of file [fontx.c](#).

Here is the call graph for this function:

4.6.3.5 GetFontHeight()

```
uint8_t GetFontHeight (
    FontxFile * fx )
```

Gets the height of a character in the font.

Parameters

<i>fx</i>	Pointer to the FontxFile structure
-----------	----------------------------------------------------

Returns

The height of a character in pixels

Definition at line 8 of file [fontx.c](#).

4.6.3.6 GetFontWidth()

```
uint8_t GetFontWidth (
    FontxFile * fx )
```

Gets the width of a character in the font.

Parameters

<i>fx</i>	Pointer to the FontxFile structure
-----------	----------------------------------------------------

Returns

The width of a character in pixels

Definition at line 7 of file [fontx.c](#).

4.6.3.7 GetFontx()

```
bool GetFontx (
    FontxFile * fxs,
    uint8_t ascii,
    uint8_t * pGlyph,
    uint8_t * pw,
    uint8_t * ph )
```

Gets the glyph data for the specified ASCII character.

Parameters

<i>fxs</i>	Pointer to the FontxFile structure
<i>ascii</i>	ASCII value of the character to get the glyph for
<i>pGlyph</i>	Pointer to the buffer to store the glyph data
<i>pw</i>	Pointer to the variable to store the width of the glyph
<i>ph</i>	Pointer to the variable to store the height of the glyph

Returns

True if the glyph was found, false otherwise

Definition at line 9 of file [fontx.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.6.3.8 InitFontx()

```
void InitFontx (
    FontxFile * fxs,
    const char * f0,
    const char * f1 )
```

Initializes the given [FontxFile](#) structure with the specified font files.

Parameters

<i>fxs</i>	Pointer to the FontxFile structure
<i>f0</i>	Path to the 8x16 font file
<i>f1</i>	Path to the 16x16 font file

Definition at line 3 of file [fontx.c](#).

Here is the call graph for this function:

4.6.3.9 OpenFontx()

```
bool OpenFontx (
    FontxFile * fx )
```

Opens the font file and reads the font data into the [FontxFile](#) structure.

Parameters

<i>fx</i>	Pointer to the FontxFile structure
-----------	----------------------------------------------------

Returns

True if the font file was opened successfully, false otherwise

Warning

The font-file path must be valid from the directory in which the executable is called, otherwise the error message "cannot get font from font file" will be thrown. Absolute paths (starting with /) are safe.

Definition at line 4 of file [fontx.c](#).

Here is the caller graph for this function:

4.6.3.10 ReversBitmap()

```
void ReversBitmap (
    uint8_t * line,
    uint8_t w,
    uint8_t h )
```

Reverses the bits in each byte of a bitmap.

Parameters

<i>line</i>	Pointer to the bitmap buffer
<i>w</i>	Width of the bitmap in pixels
<i>h</i>	Height of the bitmap in pixels

Definition at line 12 of file [fontx.c](#).

4.6.3.11 RotateByte()

```
uint8_t RotateByte (
    uint8_t ch )
```

Rotates a byte by 90 degrees.

Parameters

<i>ch</i>	Byte to be rotated
-----------	--------------------

Returns

The rotated byte

Definition at line 15 of file [fontx.c](#).

Here is the caller graph for this function:

4.6.3.12 ShowBitmap()

```
void ShowBitmap (
    uint8_t * bitmap,
    uint8_t pw,
    uint8_t ph )
```

Displays a bitmap on the screen.

Parameters

<i>bitmap</i>	Pointer to the bitmap buffer
<i>pw</i>	Width of the font in pixels
<i>ph</i>	Height of the font in pixels

Definition at line 14 of file [fontx.c](#).

4.6.3.13 ShowFont()

```
void ShowFont (
    uint8_t * fonts,
    uint8_t pw,
    uint8_t ph )
```

Displays a font on the screen.

Parameters

<i>fonts</i>	Pointer to the font buffer
<i>pw</i>	Width of the font in pixels
<i>ph</i>	Height of the font in pixels

Definition at line 13 of file [fontx.c](#).

4.6.3.14 UnderlineBitmap()

```
void UnderlineBitmap (
    uint8_t * line,
    uint8_t w,
    uint8_t h )
```

Adds an underline to a bitmap.

Parameters

<i>line</i>	Pointer to the bitmap buffer
<i>w</i>	Width of the bitmap in pixels
<i>h</i>	Height of the bitmap in pixels

Definition at line 11 of file [fontx.c](#).

4.7 GPIO library

Macros

- `#define gpio_t pin_t`

Enumerations

- enum `gpio_direction_t` { `GPIO_DIR_INPUT` = 0 , `GPIO_DIR_OUTPUT` = 1 }
- enum `gpio_level_t` { `GPIO_LEVEL_LOW` = 0 , `GPIO_LEVEL_HIGH` = 1 }

Functions

- void `gpio_init` (void)
- void `gpio_destroy` (void)
- void `gpio_reset_pin` (const `pin_t` pin)
- void `gpio_set_direction` (const `pin_t` pin, const `gpio_direction_t` direction)
- `gpio_direction_t` `gpio_get_direction` (const `pin_t` pin)
- void `gpio_set_level` (const `pin_t` pin, const `gpio_level_t` level)
- `gpio_level_t` `gpio_get_level` (const `pin_t` pin)
- void `gpio_reset` (void)
- bool `gpio_is_initialized` (void)

4.7.1 Detailed Description

Functions for General Purpose I/O (GPIO) access to leds, buttons, etc.

All functions use a GPIO number from 0..NUM_PINS_SWITCHBOX-1.

The LED and button libraries are built on top of this library, but do not expose the full functionality of this library. Use this library when that is required. Also see the I/O switchbox ([switchbox.h](#)) and pin mapping ([pinmap.h](#)).

In particular, be aware that the numbering used in the high-level libraries is different from the underlying GPIO numbering.

- The button library uses 0..3 or `BUTTON0..BUTTON3`, and 0..1 or `SWITCH0..SWITCH1`, whereas GPIO uses `SWB_BTN0..SWB_BTN3` and `SWB_SW0..SWB_SW1`.
- The LED library uses 0..3 or `LED0..LED1` for green LEDs whereas GPIO uses `SWB_LD0..SWB_LD3`. It uses 0..1 or `COLOR_LED0..COLOR_LED1` and the three color components (RGB) whereas GPIO uses `SWB_LD4/5R/G/B`.
- The PWM library uses 0..5 or `PWM0..PWM5`, whereas GPIO uses `SWB_PWM0..SWB_PWM5`.
- The UART library uses 0..1 or `UART0..UART1`, whereas GPIO uses `SWB_UART0..SWB_UART1`.
- The ADC library is slightly different. It uses `ADC0..ADC5` (these are non-consecutive numbers), whereas GPIO uses `SWB_A0..SWB_A5` (which are consecutive).

An example of using this library to turn LED0 on:

```
#include <libpynq.h>
int main (void)
{
    // initialize the Library
    gpio_init();
    // set LED 0 as output
    gpio_set_direction(SWB_LD0, GPIO_DIR_OUTPUT);
    // turn LED 0 on
    gpio_set_level(SWB_LD0, GPIO_LEVEL_HIGH);
    sleep_msec(1000);
    // cleanup after use
    leds_destroy(); // turn LEDs off
    pynq_destroy();
    return EXIT_SUCCESS;
}
```

4.7.2 Macro Definition Documentation

4.7.2.1 gpio_t

```
#define gpio_t pin_t
```

For backwards compatibility. Map gpio_t to the pin_t type.

Definition at line 102 of file [gpio.h](#).

4.7.3 Enumeration Type Documentation

4.7.3.1 gpio_direction_t

```
enum gpio_direction_t
```

Enumerate the direction state (input/output) of the pin

Enumerator

GPIO_DIR_INPUT	The GPIO pin is an input.
GPIO_DIR_OUTPUT	The GPIO pin is an output.

Definition at line 81 of file [gpio.h](#).

4.7.3.2 gpio_level_t

```
enum gpio_level_t
```

Enumerate the signal level.

Enumerator

GPIO_LEVEL_LOW	A low signal
GPIO_LEVEL_HIGH	A high signal

Definition at line 91 of file [gpio.h](#).

4.7.4 Function Documentation

4.7.4.1 gpio_destroy()

```
void gpio_destroy (
    void )
```

De-initialize the GPIO library. This releases the memory map and memory allocated by gpio_init.

Definition at line 3 of file [gpio.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.7.4.2 gpio_get_direction()

```
gpio_direction_t gpio_get_direction (
    const pin_t pin )
```

Returns the direction the set pin is initialized in.

Parameters

<i>pin</i>	The GPIO pin to read the direction set in the shared memory system on the ARM processor.
------------	------------------------------------------------------------------------------------------

Warning

Fails with program exit when pin is outside valid range.

Definition at line 95 of file [gpio.c](#).

4.7.4.3 gpio_get_level()

```
gpio_level_t gpio_get_level (
    const pin_t pin )
```

Return the level of the GPIO pin.

Parameters

<i>pin</i>	The GPIO pin to read it state.
------------	--------------------------------

Returns

the output level of pin using enum `gpio_level_t`.

Warning

Fails with program exit when pin is outside valid range.

Definition at line 118 of file [gpio.c](#).

4.7.4.4 gpio_init()

```
void gpio_init (
    void )
```

Initializes the GPIO library.

Definition at line 2 of file [gpio.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.7.4.5 gpio_is_initialized()

```
bool gpio_is_initialized (
    void )
```

Check if gpio library is initialized.

Returns

true if initialize, false if not.

Definition at line 35 of file [gpio.c](#).

Here is the caller graph for this function:

4.7.4.6 gpio_reset()

```
void gpio_reset (
    void )
```

Reset all GPIO pins.

Definition at line 18 of file [gpio.c](#).

Here is the caller graph for this function:

4.7.4.7 gpio_reset_pin()

```
void gpio_reset_pin (
    const pin_t pin )
```

Function is currently a no-op placeholder for arduino compatibility.

Parameters

<i>pin</i>	The GPIO pin to reset.
------------	------------------------

Warning

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 55 of file [gpio.c](#).

Here is the call graph for this function:

4.7.4.8 gpio_set_direction()

```
void gpio_set_direction (
    const pin_t pin,
    const gpio_direction_t direction )
```

Set the GPIO pin as in input or output.

Parameters

<i>pin</i>	The GPIO pin to modify direction for.
<i>direction</i>	The direction to set on the pin.

Warning

Fails with program exit when pin or direction is outside valid range.

Definition at line 81 of file [gpio.c](#).

4.7.4.9 gpio_set_level()

```
void gpio_set_level (
    const pin_t pin,
    const gpio_level_t level )
```

Set the level of the output GPIO pin. If the pin is configured as input, this function does nothing.

Parameters

<i>pin</i>	The GPIO pin to modify direction for
<i>level</i>	The level to set on the pin.

Warning

Fails with program exit when pin is outside valid range.

Definition at line 104 of file [gpio.c](#).

4.8 IIC library

Enumerations

- enum [iic_index_t](#) { [IIC0](#) = 0 , [IIC1](#) = 1 , [NUM_IICS](#) = 2 }

Functions

- void [iic_init](#) (const [iic_index_t](#) iic)
- void [iic_destroy](#) (const [iic_index_t](#) iic)
- bool [iic_read_register](#) (const [iic_index_t](#) iic, const uint8_t addr, const uint8_t reg, uint8_t *data, uint16_t length)
- bool [iic_write_register](#) (const [iic_index_t](#) iic, const uint8_t addr, const uint8_t reg, uint8_t *data, uint16_t length)

4.8.1 Detailed Description

Functions to use the Inter-Integrated Circuit (IIC).

High-level functions to read/write to clients connected to the two integrated IIC modules.

4.8.2 Enumeration Type Documentation

4.8.2.1 iic_index_t

```
enum iic_index_t
```

Enum of IICs. Functions use a switch numbered from 0..NUM_IICS-1.

Enumerator

IIC0	
IIC1	
NUM_IICS	

Definition at line 42 of file [iic.h](#).

4.8.3 Function Documentation

4.8.3.1 iic_destroy()

```
void iic_destroy (
    const iic_index_t iic )
```

Close the shared memory handle for the specified IIC index.

Parameters

<i>uart</i>	The IIC index to remove from the shared memory space.
-------------	-------------------------------------------------------

Warning

Fails with program exit if the IIC channel is outside valid range.

Definition at line 3 of file [iic.c](#).

Here is the call graph for this function:

4.8.3.2 iic_init()

```
void iic_init (
    const iic_index_t iic )
```

Initialize the IIC specified by the index with a shared memory handle and a buffer size of 4096 bytes.

Parameters

<i>uart</i>	The IIC index to initialize.
-------------	------------------------------

Warning

Fails with program exit if the IIC channel is outside valid range or when the shared memory system has not been instantiated.

Definition at line 2 of file [iic.c](#).

Here is the call graph for this function:

4.8.3.3 iic_read_register()

```
bool iic_read_register (
    const iic_index_t iic,
    const uint8_t addr,
    const uint8_t reg,
    uint8_t * data,
    uint16_t length )
```

Parameters

<i>iic</i>	The IIC index to initialize.
<i>addr</i>	The IIC address of the client to access.
<i>reg</i>	The clients register address.
<i>data</i>	Buffer where the register content is stored. [out]
<i>length</i>	The amount of data to read.

Reads the content of the register into data.

Returns

0 if successful, 1 on error

Definition at line 4 of file [iic.c](#).

Here is the call graph for this function:

4.8.3.4 iic_write_register()

```
bool iic_write_register (
    const iic_index_t iic,
    const uint8_t addr,
    const uint8_t reg,
    uint8_t * data,
    uint16_t length )
```

Parameters

<i>iic</i>	The IIC index to initialize.
<i>addr</i>	The IIC address of the client to access.
<i>reg</i>	The clients register address.
<i>data</i>	Buffer where new the register content is stored.
<i>length</i>	The amount of data to write.

Writes data to register.

Returns

0 if successful, 1 on error

Definition at line 7 of file [iic.c](#).

Here is the call graph for this function:

4.9 Interrupt library

Functions

- int [gpio_interrupt_init](#) (void)
- void [gpio_ack_interrupt](#) (void)
- void [verify_interrupt_request](#) (const [pin_t](#) pin)
- void [gpio_print_interrupt](#) (void)
- void [gpio_enable_interrupt](#) (const [pin_t](#) pin)
- void [gpio_disable_interrupt](#) (const [pin_t](#) pin)
- void [gpio_disable_all_interrupts](#) (void)
- uint64_t [gpio_get_interrupt](#) (void)
- uint8_t * [gpio_get_interrupt_pins](#) (uint8_t *positions)
- void [gpio_wait_for_interrupt](#) (const [pin_t](#) pin)

4.9.1 Detailed Description

Functions for interrupt handling.

An example of using this library

```
#include <libpynq.h>
int main (void)
{
    gpio_init(void);
    gpio_reset(void);
    switchbox_init(void);
    switchbox_reset(void);
    gpio_set_direction(SWB_LD0, GPIO_DIR_OUTPUT);
    // initialize the interrupt
    gpio_interrupt_init(void);
    gpio_enable_interrupt(SWB_BTN0);
    gpio_set_direction(SWB_LD0, GPIO_DIR_OUTPUT);
    while(1) {
        gpio_wait_for_interrupt(64); //Wait untill an interrupt arrives
        uint8_t* interruptPin = gpio_get_interrupt_pins(void);
        if (interruptPin[0] == SWB_BTN0) {
            printf("interrupt on SWB_BTN0, turning on SWB_LD0\n");
            gpio_set_level(SWB_LD0, 1);
        } else {
            printf("interrupt on pin %d\n", interruptPin[0]);
            gpio_set_level(SWB_LD0, 0);
        }
        gpio_ack_interrupt(void);
    }
    gpio_destroy(void);
    switchbox_destroy(void);
    return EXIT_SUCCESS;
}
```

4.9.2 Function Documentation

4.9.2.1 gpio_ack_interrupt()

```
void gpio_ack_interrupt (
    void )
```

acknowledges the raised interrupts and resets the interrupt word. Allows new interrupts to occur on the previously triggered pins.

Definition at line 3 of file [interrupt.c](#).

Here is the call graph for this function:

4.9.2.2 gpio_disable_all_interrupts()

```
void gpio_disable_all_interrupts (
    void )
```

Disables all interrupts from being raised.

Definition at line 8 of file [interrupt.c](#).

Here is the call graph for this function:

4.9.2.3 gpio_disable_interrupt()

```
void gpio_disable_interrupt (
    const pin_t pin )
```

Disables interrupts from occurring on the specific pin. Hereafter, the pin will not trigger an interrupt.

Parameters

<i>pin</i>	to be disabled from obtaining interrupts
------------	------------------------------------------

Definition at line 72 of file [interrupt.c](#).

Here is the call graph for this function:

4.9.2.4 gpio_enable_interrupt()

```
void gpio_enable_interrupt (
    const pin_t pin )
```

enables a specific pin to raise interrupts.

Parameters

<i>pin</i>	to raise interrupts
------------	---------------------

Definition at line 59 of file [interrupt.c](#).

Here is the call graph for this function:

4.9.2.5 gpio_get_interrupt()

```
uint64_t gpio_get_interrupt (
    void )
```

Returns

the 64 bits on which interrupts are indicated by a one. The bits are in accordance with the pins described in [pinmap.h](#)

Definition at line 9 of file [interrupt.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.9.2.6 gpio_get_interrupt_pins()

```
uint8_t * gpio_get_interrupt_pins (
    uint8_t * positions )
```

Gets all pins on which an interrupt occurred.

Returns

a pointer to an array of maximum 64 intergers. The integers correspond to pins with a pending interrupt.

Definition at line 10 of file [interrupt.c](#).

Here is the call graph for this function:

4.9.2.7 gpio_interrupt_init()

```
int gpio_interrupt_init (
    void )
```

Enables interrupts to be set and read.

Definition at line 2 of file [interrupt.c](#).

4.9.2.8 gpio_print_interrupt()

```
void gpio_print_interrupt (
    void )
```

prints the current interrupt word

Definition at line 5 of file [interrupt.c](#).

Here is the call graph for this function:

4.9.2.9 gpio_wait_for_interrupt()

```
void gpio_wait_for_interrupt (
    const pin_t pin )
```

Waits untill an interrupt occurs on the specified pin or if the value of pin is larger than 63, if any interrupt has occurred.

Parameters

<i>pin</i>	The pin on which an interrupt should occur
------------	--------------------------------------------

Definition at line 138 of file [interrupt.c](#).

Here is the call graph for this function:

4.9.2.10 `verify_interrupt_request()`

```
void verify_interrupt_request (
    const pin\_t pin )
```

Checks for error in enabled pin. Terminates the process if the pin is not enabled.

Parameters

<i>pin</i>	indicates a specific pin or if larger than 63, if any interrupt pin is enabled
------------	--------------------------------------------------------------------------------

Definition at line 96 of file [interrupt.c](#).

4.10 LED library

Macros

- `#define NUM_LED_COLORS 3 /* # colors per color LED (RGB) */`
- `#define NUM_LEDS (NUM_GREEN_LEDS + NUM_COLOR_LEDS)`
- `#define LED_OFF 0`
- `#define LED_ON 255`

Enumerations

- `enum green_led_index_t {
 LED0 , LED1 , LED2 , LED3 ,
 NUM_GREEN_LEDS }`
- `enum color_led_index_t { COLOR_LED0 , COLOR_LED1 , NUM_COLOR_LEDS }`

Functions

- `void leds_init_onoff (void)`
- `void green_leds_init_pwm (void)`
- `void color_leds_init_pwm (void)`
- `void leds_destroy (void)`
- `void green_led_onoff (const int led, const int onoff)`
- `void green_led_on (const int led)`
- `void green_led_off (const int led)`
- `void color_led_red_onoff (const int onoff)`
- `void color_led_green_onoff (const int onoff)`
- `void color_led_blue_onoff (const int onoff)`
- `void color_led_onoff (const int red_onoff, const int green_onoff, const int blue_onoff)`
- `void color_led_on (void)`
- `void color_led_off (void)`

4.10.1 Detailed Description

Wrappers to simplify the use of LEDs.

- Green LEDs are numbered 0 to NUM_GREEN_LEDS-1.
- Only color LED 0 is used.
- The color LED has three components R, G, B that can be set independently to mix to a color.

LEDs can be used in three modes:

1. on/off mode for all green LEDs and all color LEDs
2. PWM mode for green LEDs (PWM0..PWM3 are routed to green LEDs 0..3)
3. PWM mode for color LED 0 (PWM0..PWM3 are routed to color LED 0)

An example of how to use this library.

```
#include <libpynq.h>
int main (void)
{
    // initialise all I/O
    gpio_reset();
    leds_init_onoff();

    for (int led = 0; led < NUM_GREEN_LEDS; led++)
        green_led_on(led);
    sleep_msec(500);
    for (int led = 0; led < NUM_GREEN_LEDS; led++)
        green_led_off(led);

    // clean up after use
    leds_destroy(); // switches all leds off
    pynq_destroy();
    return EXIT_SUCCESS;
}
```

LEDs can also be used through GPIO (see [gpio.h](#) and [pinmap.h](#)). Note that GPIO numbering (SWB_LD0..SWB_LD3) is then used instead of 0..NUM_GREEN_LEDS-1 (LED0..LED3). In the PWM mode for color LED 0, SWB_LD0..SWB_LD3 are routed to color LED 0 (GPIO SWB_LD4R, SWB_LD4G, SWB_LD4B).

4.10.2 Macro Definition Documentation

4.10.2.1 LED_OFF

```
#define LED_OFF 0
```

Definition at line 102 of file [leds.h](#).

4.10.2.2 LED_ON

```
#define LED_ON 255
```

Definition at line 103 of file [leds.h](#).

4.10.2.3 NUM_LED_COLORS

```
#define NUM_LED_COLORS 3 /* # colors per color LED (RGB) */
```

Definition at line 100 of file [leds.h](#).

4.10.2.4 NUM_LEDS

```
#define NUM_LEDS (NUM_GREEN_LEDS + NUM_COLOR_LEDS)
```

Definition at line 101 of file [leds.h](#).

4.10.3 Enumeration Type Documentation

4.10.3.1 color_led_index_t

```
enum color_led_index_t
```

Enum of color LEDs. Functions for color LEDs use a led number from 0..NUM_COLOR_LEDS-1. Alternatively, you can use COLOR_LED*i* instead of just *i* if you find that clearer.

Enumerator

COLOR_LED0	
COLOR_LED1	
NUM_COLOR_LEDS	

Definition at line 94 of file [leds.h](#).

4.10.3.2 green_led_index_t

```
enum green_led_index_t
```

Enum of green LEDs. Functions for green LEDs use a led number from 0..NUM_GREEN_LEDS-1. Alternatively, you can use LED*i* instead of just *i* if you find that clearer.

Enumerator

LED0	
LED1	
LED2	
LED3	
NUM_GREEN_LEDS	

Definition at line 80 of file [leds.h](#).

4.10.4 Function Documentation

4.10.4.1 `color_led_blue_onoff()`

```
void color_led_blue_onoff (
    const int onoff )
```

Switches on/off the blue component of color LED 0.

Parameters

<i>onoff</i>	If the LEDs are in onoff mode then onoff must be either LED_ON or LED_OFF. If the LEDs are in one of the PWM modes then onoff must be 0.255.
--------------	----------------------------------------------------------------------------------------------------------------------------------------------

Warning

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 11 of file [leds.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.10.4.2 `color_led_green_onoff()`

```
void color_led_green_onoff (
    const int onoff )
```

Switches on/off the green component of color LED 0.

Parameters

<i>onoff</i>	If the LEDs are in onoff mode then onoff must be either LED_ON or LED_OFF. If the LEDs are in one of the PWM modes then onoff must be 0.255.
--------------	----------------------------------------------------------------------------------------------------------------------------------------------

Warning

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 10 of file [leds.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.10.4.3 `color_led_off()`

```
void color_led_off (
    void )
```

Set color LED 0 to black. Same as `color_led_onoff(LED_OFF, LED_OFF, LED_OFF)`.

Warning

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 15 of file [leds.c](#).

Here is the call graph for this function:

4.10.4.4 color_led_on()

```
void color_led_on (
    void )
```

Set color LED 0 to white. Same as `color_led_onoff(LED_ON, LED_ON, LED_ON)`.

Warning

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 14 of file [leds.c](#).

Here is the call graph for this function:

4.10.4.5 color_led_onoff()

```
void color_led_onoff (
    const int red_onoff,
    const int green_onoff,
    const int blue_onoff )
```

Switches on/off the red/green/blue components of color LED 0.

Parameters

<i>onoff</i>	If the LEDs are in onoff mode then *_onoff must be either LED_ON or LED_OFF. If the LEDs are in one of the PWM modes then *_onoff must be 0.255.
--------------	--------------------------------------------------------------------------------------------------------------------------------------------------

Warning

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 12 of file [leds.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.10.4.6 color_led_red_onoff()

```
void color_led_red_onoff (
    const int onoff )
```

Switches on/off the red component of color LED 0.

Parameters

<i>onoff</i>	If the LEDs are in onoff mode then onoff must be either LED_ON or LED_OFF. If the LEDs are in one of the PWM modes then onoff must be 0.255.
--------------	----------------------------------------------------------------------------------------------------------------------------------------------

Warning

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 9 of file [leds.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.10.4.7 color_leds_init_pwm()

```
void color_leds_init_pwm (
    void )
```

Initialize the color LEDs for use with variable intensity. The LED intensity can range from 0.255.

Warning

Fails with program exit when LEDs have already been to another mode.

Definition at line 4 of file [leds.c](#).

Here is the call graph for this function:

4.10.4.8 green_led_off()

```
void green_led_off (
    const int led )
```

Same as green_led_onoff(led, LED_OFF). Works in all modes.

Parameters

<i>led</i>	The green LED.
------------	----------------

Warning

Fails with program exit when led is outside valid range.

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 8 of file [leds.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.10.4.9 green_led_on()

```
void green_led_on (
    const int led )
```

Same as green_led_onoff(led, LED_ON). Works in all modes.

Parameters

<i>led</i>	The green LED.
------------	----------------

Warning

Fails with program exit when led is outside valid range.

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 7 of file [leds.c](#).

Here is the call graph for this function:

4.10.4.10 green_led_onoff()

```
void green_led_onoff (
    const int led,
    const int onoff )
```

Parameters

<i>led</i>	The green LED.
<i>onoff</i>	If the LEDs are in onoff mode then onoff must be either LED_ON or LED_OFF. If the LEDs are in one of the PWM modes then onoff must be 0.255.

Warning

Fails with program exit when led is outside valid range.

Fails with program exit when LEDs were not initialized with the correct mode.

Definition at line 6 of file [leds.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.10.4.11 green_leds_init_pwm()

```
void green_leds_init_pwm (
    void )
```

Initialize the green LEDs for use with variable intensity. The LED intensity can range from 0.255.

Warning

Fails with program exit when LEDs have already been to another mode.

Definition at line 3 of file [leds.c](#).

Here is the call graph for this function:

4.10.4.12 leds_destroy()

```
void leds_destroy (
    void )
```

Initialize the LEDs, such that the mode of the LEDs can be changed. Switch all LEDs off.

Definition at line 5 of file [leds.c](#).

Here is the call graph for this function:

4.10.4.13 leds_init_onoff()

```
void leds_init_onoff (
    void )
```

Initialize the green LEDs for on/off use.

Warning

Fails with program exit when LEDs have already been to another mode.

Definition at line 2 of file [leds.c](#).

Here is the call graph for this function:

4.11 Logging library

Macros

- `#define pynq_info(...) pynq_log(LOG_LEVEL_INFO, LOG_DOMAIN, __FUNCTION__, __LINE__, __VA_ARGS__)`
- `#define pynq_warning(...) pynq_log(LOG_LEVEL_WARNING, LOG_DOMAIN, __FUNCTION__, __LINE__, __VA_ARGS__)`
- `#define pynq_error(...)`

Typedefs

- typedef enum [LogLevel](#) LogLevel

Enumerations

- enum [LogLevel](#) { LOG_LEVEL_INFO , LOG_LEVEL_WARNING , LOG_LEVEL_ERROR , NUM_LOG_LEVELS }

Functions

- void [pynq_log](#) (const [LogLevel](#) level, char const *domain, char const *location, unsigned int lineno, char const *fmt,...)

4.11.1 Detailed Description

Functions for error handling and logging.

```
#include <log.h>

int main (void)
{
    pynq_log("Print my information message");
    pynq_warning("Print my warning message");
    pynq_error("Failed on error");
    return EXIT_SUCCESS;
}
```

Or with a custom log domain

```
#include <log.h>

#undef LOG_DOMAIN
#define LOG_DOMAIN "MyApp"

int main ( int argc, char **argv)
{
    pynq_log("Print my information message");
    pynq_warning("Print my warning message");
    pynq_error("Failed on error");
    return EXIT_SUCCESS;
}
```

4.11.2 Macro Definition Documentation

4.11.2.1 pynq_error

```
#define pynq_error(
    ... )
```

Value:

```
do {
    pynq_log(LOG_LEVEL_ERROR, LOG_DOMAIN, __FUNCTION__, __LINE__,
             __VA_ARGS__);
    for (;;)
        ;
} while (0)
```

```

/
/
/
/
/
```

Parameters

...	
-----	--

Wrapper around pynq_log to print error messages. This expects LOG_DOMAIN to be set.

Definition at line 118 of file [log.h](#).

4.11.2.2 pynq_info

```
#define pynq_info(
    ... )    pynq_log(LOG_LEVEL_INFO, LOG_DOMAIN, __FUNCTION__, __LINE__, __VA_ARGS__
__)
```

Parameters

...	
-----	--

Wrapper around `pynq_log` to print info messages. This expects `LOG_DOMAIN` to be set.

Definition at line 100 of file [log.h](#).

4.11.2.3 `pynq_warning`

```
#define pynq_warning(  
    ... )    pynq_log(LOG_LEVEL_WARNING, LOG_DOMAIN, __FUNCTION__, __LINE__, __VA_  
ARGS__)
```

Parameters

...	
-----	--

Wrapper around `pynq_log` to print warning messages. This expects `LOG_DOMAIN` to be set.

Definition at line 109 of file [log.h](#).

4.11.3 Typedef Documentation

4.11.3.1 `LogLevel`

```
typedef enum LogLevel LogLevel
```

4.11.4 Enumeration Type Documentation

4.11.4.1 `LogLevel`

```
enum LogLevel
```

Enumerator

<code>LOG_LEVEL_INFO</code>	Informational messages.
<code>LOG_LEVEL_WARNING</code>	Warning messages
<code>LOG_LEVEL_ERROR</code>	Error messages
<code>NUM_LOG_LEVELS</code>	Number of log levels

Definition at line 65 of file [log.h](#).

4.11.5 Function Documentation

4.11.5.1 `pynq_log()`

```
void pynq_log (  
    const LogLevel level,
```

```

char const * domain,
char const * location,
unsigned int lineno,
char const * fmt,
... )

```

Parameters

<i>level</i>	The LogLevel of this message.
<i>domain</i>	The log domain.
<i>fmt</i>	The format string.
<i>location</i>	The location string of the message origin.
<i>lineno</i>	The line number of the message origin.
...	The arguments to the format string.

Print log messages with loglevel WARNING and higher. Messages of level ERROR will result in an abort().

Environment DEBUG will print out level LOG_LEVEL_INFO Environment FATAL_WARNING will abort after a warning.

Definition at line 11 of file [log.c](#).

4.12 I/O pin mapping

Macros

- #define [NUM_ANALOG_REFERENCE_PINS](#) 14 /* # analog reference pins */
- #define [NUM_ANALOG_IN_PINS](#) 6 /* # analog input pins */
- #define [PIN_CHECK\(pin\)](#)

Enumerations

- enum [pin_t](#) {
[SWB_AR0](#) = 0 , [SWB_AR1](#) = 1 , [SWB_AR2](#) = 2 , [SWB_AR3](#) = 3 ,
[SWB_AR4](#) = 4 , [SWB_AR5](#) = 5 , [SWB_AR6](#) = 6 , [SWB_AR7](#) = 7 ,
[SWB_AR8](#) = 8 , [SWB_AR9](#) = 9 , [SWB_AR10](#) = 10 , [SWB_AR11](#) = 11 ,
[SWB_AR12](#) = 12 , [SWB_AR13](#) = 13 , [SWB_A0](#) = 14 , [SWB_A1](#) = 15 ,
[SWB_A2](#) = 16 , [SWB_A3](#) = 17 , [SWB_A4](#) = 18 , [SWB_A5](#) = 19 ,
[SWB_SW0](#) = 20 , [SWB_SW1](#) = 21 , [SWB_BTN0](#) = 22 , [SWB_BTN1](#) = 23 ,
[SWB_BTN2](#) = 24 , [SWB_BTN3](#) = 25 , [SWB_LD0](#) = 26 , [SWB_LD1](#) = 27 ,
[SWB_LD2](#) = 28 , [SWB_LD3](#) = 29 , [SWB_AR_SCL](#) = 31 , [SWB_AR_SDA](#) = 30 ,
[SWB_LD4B](#) = 32 , [SWB_LD4R](#) = 33 , [SWB_LD4G](#) = 34 , [SWB_LD5B](#) = 35 ,
[SWB_LD5R](#) = 36 , [SWB_LD5G](#) = 37 , [SWB_RBPI40](#) = 38 , [SWB_RBPI37](#) = 39 ,
[SWB_RBPI38](#) = 40 , [SWB_RBPI35](#) = 41 , [SWB_RBPI36](#) = 42 , [SWB_RBPI33](#) = 43 ,
[SWB_RBPI18](#) = 44 , [SWB_RBPI32](#) = 45 , [SWB_RBPI10](#) = 46 , [SWB_RBPI27](#) = 47 ,
[SWB_RBPI28](#) = 48 , [SWB_RBPI22](#) = 49 , [SWB_RBPI23](#) = 50 , [SWB_RBPI24](#) = 51 ,
[SWB_RBPI21](#) = 52 , [SWB_RBPI26](#) = 53 , [SWB_RBPI19](#) = 54 , [SWB_RBPI31](#) = 55 ,
[SWB_RBPI15](#) = 56 , [SWB_RBPI16](#) = 57 , [SWB_RBPI13](#) = 58 , [SWB_RBPI12](#) = 59 ,
[SWB_RBPI29](#) = 60 , [SWB_RBPI08](#) = 61 , [SWB_RBPI07](#) = 62 , [SWB_RBPI05](#) = 63 ,
[SWB_NUM_PINS](#) = 64 }

Variables

- char *const [pin_names](#) [64]

4.12.1 Detailed Description

Definitions of I/O pin numbers and names for the switchbox and GPIO.

For example, when calling a function, use SWB_AR0 to specify analog reference pin AR0. Specifically, symbolic pin names are prefixed with SWB_ because they are used as inputs to switchbox functions, but the pin name when printed omits the SWB_.

4.12.2 Macro Definition Documentation

4.12.2.1 NUM_ANALOG_IN_PINS

```
#define NUM_ANALOG_IN_PINS 6 /* # analog input pins */
```

Definition at line 43 of file [pinmap.h](#).

4.12.2.2 NUM_ANALOG_REFERENCE_PINS

```
#define NUM_ANALOG_REFERENCE_PINS 14 /* # analog reference pins */
```

Definition of the number of I/O pins we have for each category.

Definition at line 42 of file [pinmap.h](#).

4.12.2.3 PIN_CHECK

```
#define PIN_CHECK(  
    pin )
```

Value:

```
do {  
    if (pin >= SWB_NUM_PINS) {  
        pynq_error("pin %u is invalid, must be 0..%u-1.", pin, SWB_NUM_PINS);  
    }  
} while (0);
```

macro that checks if the pin number is valid, throws an error if not.

Definition at line 150 of file [pinmap.h](#).

4.12.3 Enumeration Type Documentation

4.12.3.1 pin_t

```
enum pin\_t
```


Enumerator

SWB_AR0	Analog reference pins.
SWB_AR1	
SWB_AR2	
SWB_AR3	
SWB_AR4	
SWB_AR5	
SWB_AR6	
SWB_AR7	
SWB_AR8	
SWB_AR9	
SWB_AR10	
SWB_AR11	
SWB_AR12	
SWB_AR13	
SWB_A0	Analog input pins.
SWB_A1	
SWB_A2	
SWB_A3	
SWB_A4	
SWB_A5	
SWB_SW0	Switch input pins.
SWB_SW1	
SWB_BTN0	Button input pins.
SWB_BTN1	
SWB_BTN2	
SWB_BTN3	
SWB_LD0	LED output pins.
SWB_LD1	
SWB_LD2	
SWB_LD3	
SWB_AR_SCL	I2C pins.
SWB_AR_SDA	
SWB_LD4B	The RGB addresses for SWB_LD4 and SWB_LD5.
SWB_LD4R	
SWB_LD4G	
SWB_LD5B	
SWB_LD5R	
SWB_LD5G	
SWB_RBPI40	The RaspberryPi header-pin indexing.
SWB_RBPI37	
SWB_RBPI38	
SWB_RBPI35	
SWB_RBPI36	
SWB_RBPI33	
SWB_RBPI18	
SWB_RBPI32	
SWB_RBPI10	
SWB_RBPI27	
SWB_RBPI28	

Enumerator

SWB_RBPI22	
SWB_RBPI23	
SWB_RBPI24	
SWB_RBPI21	
SWB_RBPI26	
SWB_RBPI19	
SWB_RBPI31	
SWB_RBPI15	
SWB_RBPI16	
SWB_RBPI13	
SWB_RBPI12	
SWB_RBPI29	
SWB_RBPI08	
SWB_RBPI07	
SWB_RBPI05	
SWB_NUM_PINS	

Definition at line 45 of file [pinmap.h](#).

4.12.4 Variable Documentation

4.12.4.1 pin_names

```
char* const pin_names[64] [extern]
```

Pin names.

Definition at line 24 of file [pinmap.c](#).

4.13 PWM library

Enumerations

- enum [pwm_index_t](#) {
[PWM0](#) , [PWM1](#) , [PWM2](#) , [PWM3](#) ,
[PWM4](#) , [PWM5](#) , [NUM_PWMS](#) }

Functions

- bool [pwm_initialized](#) (const int pwm)
- void [pwm_init](#) (const int pwm, const uint32_t period)
- void [pwm_destroy](#) (const int pwm)
- void [pwm_set_duty_cycle](#) (const int pwm, const uint32_t duty)
- void [pwm_set_period](#) (const int pwm, const uint32_t period)
- uint32_t [pwm_get_period](#) (const int pwm)
- uint32_t [pwm_get_duty_cycle](#) (const int pwm)
- void [pwm_set_steps](#) (const int pwm, const uint32_t steps)
- uint32_t [pwm_get_steps](#) (const int pwm)

4.13.1 Detailed Description

Functions to use Pulse Width Modulation (PWM).

Each of the 6 PWM channels (numbered 0..NUM_PWMS-1) can be linked to any mappable pin (e.g. green or color LEDs, buttons).

PWM can also be used through GPIO (see [gpio.h](#) and [pinmap.h](#)). Note that GPIO numbering (SWB_PWM0..SWB_PWM5) is then used instead of 0..NUM_PWMS-1 (PWM0..PWM5).

4.13.2 Enumeration Type Documentation

4.13.2.1 pwm_index_t

```
enum pwm_index_t
```

Enum of PWM channels.

All functions use a PWM channel from 0..NUM_PWMS-1. Alternatively, you can use PWMi instead of just i if you find that clearer.

Enumerator

PWM0	
PWM1	
PWM2	
PWM3	
PWM4	
PWM5	
NUM_PWMS	

Definition at line 47 of file [pwm.h](#).

4.13.3 Function Documentation

4.13.3.1 pwm_destroy()

```
void pwm_destroy (
    const int pwm )
```

Removes the instantiated shared memory system of the PWM channel.

Parameters

<i>pwm</i>	The PWM channel to destroy.
------------	-----------------------------

Warning

Fails with program exit if pwm is outside valid range.

Definition at line 4 of file [pwm.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.13.3.2 `pwm_get_duty_cycle()`

```
uint32_t pwm_get_duty_cycle (  
    const int pwm )
```

Gets the duty cycle of the specified PWM channel.

Parameters

<i>pwm</i>	The PWM channel.
------------	------------------

Returns

The duty cycle of the specified PWM channel.

Warning

Fails with program exit if *pwm* is outside valid range or if *pwm* has not been initialized.

Definition at line 8 of file [pwm.c](#).

Here is the call graph for this function:

4.13.3.3 `pwm_get_period()`

```
uint32_t pwm_get_period (  
    const int pwm )
```

Returns the period of a certain PWM channel.

Parameters

<i>pwm</i>	The PWM channel.
------------	------------------

Returns

The period of the specified PWM channel as an `uint32_t`.

Warning

Fails with program exit if *pwm* is outside valid range or if *pwm* has not been initialized.

Definition at line 7 of file [pwm.c](#).

Here is the call graph for this function:

4.13.3.4 pwm_get_steps()

```
uint32_t pwm_get_steps (
    const int pwm )
```

Get the number of steps a certain channel has taken so far.

Parameters

<i>pwm</i>	PWM channel.
------------	--------------

Returns

The number of steps that have been taken; 0 is off and -1 is continous.

Warning

Fails with program exit if pwm is outside valid range or if pwm has not been initialized.

Definition at line 10 of file [pwm.c](#).

Here is the call graph for this function:

4.13.3.5 pwm_init()

```
void pwm_init (
    const int pwm,
    const uint32_t period )
```

Initializes the PWM channel with the specified period.

Parameters

<i>pwm</i>	the PWM channel to initialize.
<i>period</i>	The period to set for the PWM channel.

Warning

Fails with program exit if pwm is outside valid range.

Definition at line 3 of file [pwm.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.13.3.6 pwm_initialized()

```
bool pwm_initialized (
    const int pwm )
```

Checks if the channel index is initialized.

Parameters

<i>pwm</i>	The PWM channel
------------	-----------------

Returns

True if initialized, false if not

Warning

Fails with program exit if *pwm* is outside valid range.

Definition at line 2 of file [pwm.c](#).

4.13.3.7 pwm_set_duty_cycle()

```
void pwm_set_duty_cycle (
    const int pwm,
    const uint32_t duty )
```

Sets the duty cycle for the specified PWM channel.

Parameters

<i>pwm</i>	The PWM channel.
<i>duty</i>	The duty cycle to set for the PWM channel.

Warning

Fails with program exit if *pwm* is outside valid range or if *pwm* has not been initialized.

Definition at line 5 of file [pwm.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.13.3.8 pwm_set_period()

```
void pwm_set_period (
    const int pwm,
    const uint32_t period )
```

Sets the period for the specified PWM channel.

Parameters

<i>pwm</i>	The PWM channel.
<i>period</i>	The period to set for the PWM channel.

Warning

Fails with program exit if pwm is outside valid range or if pwm has not been initialized.

Definition at line 6 of file [pwm.c](#).

Here is the call graph for this function:

4.13.3.9 pwm_set_steps()

```
void pwm_set_steps (
    const int pwm,
    const uint32_t steps )
```

Generates steps steps on the PWM channel.

Parameters

<i>pwm</i>	The PWM channel.
<i>steps</i>	The number of steps to cycle, 0 to turn off and -1 to run continuously.

Warning

Fails with program exit if pwm is outside valid range or if pwm has not been initialized.

Definition at line 9 of file [pwm.c](#).

Here is the call graph for this function:

4.14 I/O Switchbox library**Macros**

- #define [NUM_SWITCHBOX_NAMES](#) 40

Enumerations

- enum [io_configuration](#) {
[SWB_GPIO](#) = 0x00 , [SWB_Interrupt_In](#) = 0x01 , [SWB_UART0_TX](#) = 0x02 , [SWB_UART0_RX](#) = 0x03 ,
[SWB_SPI0_CLK](#) = 0x04 , [SWB_SPI0_MISO](#) = 0x05 , [SWB_SPI0_MOSI](#) = 0x06 , [SWB_SPI0_SS](#) = 0x07 ,
[SWB_SPI1_CLK](#) = 0x08 , [SWB_SPI1_MISO](#) = 0x09 , [SWB_SPI1_MOSI](#) = 0x0A , [SWB_SPI1_SS](#) = 0x0B ,
[SWB_IIC0_SDA](#) = 0x0C , [SWB_IIC0_SCL](#) = 0x0D , [SWB_IIC1_SDA](#) = 0x0E , [SWB_IIC1_SCL](#) = 0x0F ,
[SWB_PWM0](#) = 0x10 , [SWB_PWM1](#) = 0x11 , [SWB_PWM2](#) = 0x12 , [SWB_PWM3](#) = 0x13 ,
[SWB_PWM4](#) = 0x14 , [SWB_PWM5](#) = 0x15 , [SWB_TIMER_G0](#) = 0x18 , [SWB_TIMER_G1](#) = 0x19 ,
[SWB_TIMER_G2](#) = 0x1A , [SWB_TIMER_G3](#) = 0x1B , [SWB_TIMER_G4](#) = 0x1C , [SWB_TIMER_G5](#) = 0x1D
, [SWB_TIMER_G6](#) = 0x1E , [SWB_TIMER_G7](#) = 0x1F , [SWB_UART1_TX](#) = 0x22 , [SWB_UART1_RX](#) = 0x23 ,
[SWB_TIMER_IC0](#) = 0x38 , [SWB_TIMER_IC1](#) = 0x39 , [SWB_TIMER_IC2](#) = 0x3A , [SWB_TIMER_IC3](#) = 0x3B
, [SWB_TIMER_IC4](#) = 0x3C , [SWB_TIMER_IC5](#) = 0x3D , [SWB_TIMER_IC6](#) = 0x3E , [SWB_TIMER_IC7](#) = 0x3F
, [NUM_IO_CONFIGURATIONS](#) }

Functions

- void [switchbox_init](#) (void)
- void [switchbox_set_pin](#) (const [pin_t](#) pin_number, const uint8_t pin_type)
- void [switchbox_reset](#) (void)
- void [switchbox_destroy](#) (void)
- uint8_t [switchbox_get_pin](#) (const [pin_t](#) pin_number)

Variables

- char *const [switchbox_names](#) [[NUM_SWITCHBOX_NAMES](#)]

4.14.1 Detailed Description

The switchbox enables run-time (re)mapping of I/O pins.

For example, output pin of UART 0 ([SWB_UART0_TX](#)) can be mapped to analog pins 0 and 1 ([SWB_AR0](#) & [SWB_AR1](#)). Or output pin PWM 0 ([SWB_PWM0](#)) can be mapped to green LED 0 ([SWB_LD0](#)). Or output pin PWM 0 ([SWB_PWM0](#)) can be mapped to the green component of color LED 0 ([SWB_LD0](#)).

Warning

For switchbox functions use the [SWB_*](#) naming of pins that is part of [switchbox.h](#) (enum [io_configuration](#)), *not* the names in [pinmap.h](#).

```
#include<pinmap.h>
#include<switchbox.h>

int main (void)
{
    switchbox_init();
    // setup UART here (not shown)
    // remap pin SWB_AR0 (analog reference pin 0) to UART 0 transmit
    switchbox_set_pin(SWB_AR0, UART0_TX);
    // remap pin SWB_AR1 (analog reference pin 1) to UART 0 receive
    switchbox_set_pin(SWB_AR1, UART0_RX);
    // your code here
    switchbox_destroy();
}
```

4.14.2 Macro Definition Documentation

4.14.2.1 NUM_SWITCHBOX_NAMES

```
#define NUM_SWITCHBOX_NAMES 40
```

Definition at line 134 of file [switchbox.h](#).

4.14.3 Enumeration Type Documentation

4.14.3.1 io_configuration

```
enum io_configuration
```


Enumerator

SWB_GPIO	Map pin to GPIO
SWB_Interrupt_In	Map pin to internal interrupt (UNUSED)
SWB_UART0_TX	Map pin to TX channel of UART 0
SWB_UART0_RX	Map pin to RX channel of UART 0
SWB_SPI0_CLK	Map pin to clock channel of SPI 0
SWB_SPI0_MISO	Map pin to miso channel of SPI 0
SWB_SPI0_MOSI	Map pin to mosi channel of SPI 0
SWB_SPI0_SS	Map pin to ss channel of SPI 0
SWB_SPI1_CLK	Map pin to clock channel of SPI 1
SWB_SPI1_MISO	Map pin to miso channel of SPI 1
SWB_SPI1_MOSI	Map pin to mosi channel of SPI 1
SWB_SPI1_SS	Map pin to ss channel of SPI 1
SWB_IIC0_SDA	Map pin to sda channel of IIC 0
SWB_IIC0_SCL	Map pin to scl channel of IIC 0
SWB_IIC1_SDA	Map pin to sda channel of IIC 1
SWB_IIC1_SCL	Map pin to scl channel of IIC 1
SWB_PWM0	Map pin to output channel of PWM 0
SWB_PWM1	Map pin to output channel of PWM 1
SWB_PWM2	not connected
SWB_PWM3	not connected
SWB_PWM4	not connected
SWB_PWM5	not connected
SWB_TIMER_G0	
SWB_TIMER_G1	
SWB_TIMER_G2	not connected
SWB_TIMER_G3	not connected
SWB_TIMER_G4	not connected
SWB_TIMER_G5	not connected
SWB_TIMER_G6	not connected
SWB_TIMER_G7	not connected
SWB_UART1_TX	
SWB_UART1_RX	
SWB_TIMER_IC0	
SWB_TIMER_IC1	
SWB_TIMER_IC2	
SWB_TIMER_IC3	
SWB_TIMER_IC4	
SWB_TIMER_IC5	
SWB_TIMER_IC6	
SWB_TIMER_IC7	
NUM_IO_CONFIGURATIONS	number elements in this enum

Definition at line 61 of file [switchbox.h](#).

4.14.4 Function Documentation

4.14.4.1 `switchbox_destroy()`

```
void switchbox_destroy (
    void )
```

Resets all pins of the switch box to be input.

Definition at line 6 of file [switchbox.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.14.4.2 `switchbox_get_pin()`

```
uint8_t switchbox_get_pin (
    const pin_t pin_number )
```

Sets the mode of a specified pin.

Parameters

<i>pin_number</i>	The pin number to set the mode for
<i>pin_type</i>	The mode to set the pin to (input/output)

Sets the mode of the specified pin on the io switch

Definition at line 7 of file [switchbox.c](#).

Here is the caller graph for this function:

4.14.4.3 `switchbox_init()`

```
void switchbox_init (
    void )
```

Initializes the switch box.

Initializes the shared memory and sets the io switch base address

Definition at line 3 of file [switchbox.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.14.4.4 `switchbox_reset()`

```
void switchbox_reset (
    void )
```

Resets all pins of the switch box to be input.

Definition at line 5 of file [switchbox.c](#).

Here is the caller graph for this function:

4.14.4.5 switchbox_set_pin()

```
void switchbox_set_pin (
    const pin_t pin_number,
    const uint8_t pin_type )
```

Set the type of a switch pin.

Parameters

<i>pin_number</i>	The number of the pin to set
<i>pin_type</i>	The type of the pin (0 for input, 1 for output)

Definition at line 4 of file [switchbox.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.14.5 Variable Documentation

4.14.5.1 switchbox_names

```
char* const switchbox_names[NUM_SWITCHBOX_NAMES] [extern]
```

Taken from scpi_names.h, lookup table for channels in the mapping_info function.

Definition at line 2 of file [switchbox.c](#).

4.15 UART library

Enumerations

- enum [uart_index_t](#) { [UART0](#) = 0 , [UART1](#) = 1 , [NUM_UARTS](#) }

Functions

- void [uart_init](#) (const int uart)
- void [uart_destroy](#) (const int uart)
- void [uart_send](#) (const int uart, const uint8_t data)
- uint8_t [uart_recv](#) (const int uart)
- bool [uart_has_data](#) (const int uart)
- bool [uart_has_space](#) (const int uart)
- void [uart_reset_fifos](#) (const int uart)

4.15.1 Detailed Description

Functions to use the Universal Asynchronous Receiver-Transmitter (UART).

Two UART channels can be instantiated, UART0 and UART1. Before sending and receiving bytes the UART must be connect to some I/O pins through the switchbox, e.g.

```
switchbox_set_pin(SWB_AR0, SWB_UART0_RX);
switchbox_set_pin(SWB_AR1, SWB_UART0_TX);
```

After that, an example of how to use this library for the MASTER.

```
#include <libpynq.h>
int main (void)
{
    // initialise all I/O
    pynq_init();

    // initialize UART 0
    uart_init(UART0);
    // flush FIFOs of UART 0
    uart_reset_fifos(UART0);

    uint8_t byte[] = "Hello\n";
    int i = 0;
    while (byte[i] != '\0') {
        uart_send (UART0, byte[i]);
        printf("sent byte %d\n", byte[i]);
        i++;
    }

    // clean up after use
    pynq_destroy();
    return EXIT_SUCCESS;
}
```

An example of how to use this library for the SLAVE.

```
#include <libpynq.h>
int main (void)
{
    // initialise all I/O
    pynq_init();

    // initialize UART channel 0
    uart_init(UART0);
    // flush FIFOs of UART 0
    uart_reset_fifos (UART0);

    printf("listening\n");
    do {
        // get a byte from UART 0
        uint8_t msg = uart_recv(UART0);
        printf("received byte %d\n", msg);
    } while (1);

    // clean up after use
    pynq_destroy();
    return EXIT_SUCCESS;
}
```

UARTs can also be used through GPIO (see [gpio.h](#) and [pinmap.h](#)). Note that GPIO numbering (SWB_↔UART0..SWB_UART1) is then used instead of 0..NUM_UARTS-1 (UART0..UART1).

4.15.2 Enumeration Type Documentation

4.15.2.1 uart_index_t

```
enum uart_index_t
```

Enum of UARTs. Functions use a switch numbered from 0..NUM_UARTS-1. Alternatively, you can use UARTi instead of just i if you find that clearer.

Enumerator

UART0	
UART1	
NUM_UARTS	

Definition at line 107 of file [uart.h](#).

4.15.3 Function Documentation

4.15.3.1 `uart_destroy()`

```
void uart_destroy (
    const int uart )
```

Close the shared memory handle for the specified UART index.

Parameters

<i>uart</i>	The UART index to remove from the shared memory space.
-------------	--------------------------------------------------------

Warning

Fails with program exit if the UART channel is outside valid range.

Definition at line 3 of file [uart.c](#).

Here is the call graph for this function:

4.15.3.2 `uart_has_data()`

```
bool uart_has_data (
    const int uart )
```

Check if the receive FIFO for the specified UART index has data available.

Parameters

<i>uart</i>	The UART index used to check for data.
-------------	----------------------------------------

Returns

True if the receive FIFO has data, false otherwise.

Warning

Fails with program exit if the UART channel is outside valid range.

Definition at line 6 of file [uart.c](#).

4.15.3.3 `uart_has_space()`

```
bool uart_has_space (
    const int uart )
```

Check if the transmit FIFO for the specified UART index has space available.

Parameters

<i>uart</i>	The UART index to check for space.
-------------	------------------------------------

Returns

True if the FIFO has space, false otherwise.

Warning

Fails with program exit if the UART channel is outside valid range.

Definition at line 7 of file [uart.c](#).

4.15.3.4 `uart_init()`

```
void uart_init (
    const int uart )
```

Initialize the UART specified by the index with a shared memory handle and a buffer size of 4096 bytes.

Parameters

<i>uart</i>	The UART index to initialize.
-------------	-------------------------------

Warning

Fails with program exit if the UART channel is outside valid range or when the shared memory system has not been instantiated.

Definition at line 2 of file [uart.c](#).

Here is the call graph for this function:

4.15.3.5 `uart_recv()`

```
uint8_t uart_recv (
    const int uart )
```

Receive a byte of data from the specified UART index by waiting for the receive FIFO to have data and then reading the data from the receive buffer.

Parameters

<i>uart</i>	The UART index to receive data from.
-------------	--------------------------------------

Returns

The received data byte.

Warning

Fails with program exit if the UART channel is outside valid range.

Definition at line 5 of file [uart.c](#).

4.15.3.6 `uart_reset_fifos()`

```
void uart_reset_fifos (
    const int uart )
```

This function resets both the transmit and receive FIFOs of the UART specified by the `uart` parameter. This can be useful when there is data stuck in the FIFOs or when the FIFOs are not behaving as expected.

Parameters

<i>uart</i>	The UART index of the UART whose FIFOs should be reset.
-------------	---------------------------------------------------------

Warning

This function is specific to UARTs that have FIFOs, and will have no effect on UARTs that do not have FIFOs.

Resetting the FIFOs will result in the loss of any data that is currently in the FIFOs. Therefore, this function should be used with caution, and only when it is absolutely necessary to do so.

Fails with program exit if the UART channel is outside valid range.

Definition at line 8 of file [uart.c](#).

4.15.3.7 `uart_send()`

```
void uart_send (
    const int uart,
    const uint8_t data )
```

Send a byte of data on the specified UART index by waiting for the transmit FIFO to have space and then writing the data to the transmit buffer.

Parameters

<i>uart</i>	The UART index to send data to.
<i>data</i>	The data to send to the UART index.

Warning

Fails with program exit if the UART channel is outside valid range.

Definition at line 4 of file [uart.c](#).

4.16 Utility library

Functions

- void [sleep_msec](#) (int msec)
- void [mapping_info](#) (void)

4.16.1 Detailed Description

Some simple helper functions.

4.16.2 Function Documentation

4.16.2.1 [mapping_info\(\)](#)

```
void mapping_info (
    void )
```

Displays a table to see where all pins have been mapped, what channels have been linked where and the i/o of each mappable pin.

Definition at line 3 of file [util.c](#).

Here is the call graph for this function:

4.16.2.2 [sleep_msec\(\)](#)

```
void sleep_msec (
    int msec )
```

Wait for msec milliseconds.

Parameters

<i>ms</i>	The amount of milliseconds the PYNQ should stay idle
-----------	------------------------------------------------------

Definition at line 2 of file [util.c](#).

Here is the caller graph for this function:

4.17 Versioning library

Data Structures

- struct [version_t](#)

Functions

- void [print_version](#) (void)
- void [check_version](#) (void)

Variables

- const [version_t](#) [libpynq_version](#)

4.17.1 Detailed Description

Typedef and functions to check the version and compatibility of the libpynq library and the FPGA bitstream.

Semantic versioning (<https://semver.org>) is used. Given a version number MAJOR.MINOR.PATCH, increment the:

- MAJOR version when you make incompatible API changes between libpynq and FPGA bitstream (SD-card image)
- MINOR version when you add functionality in a backward compatible manner.
- PATCH version when you make backward compatible bug fixes.

When the libpynq library version and the FPGA bitstream version are not the same:

- libpynq.MAJOR < bitstream.MAJOR: you MUST update libpynq to the latest version compatible with the bitstream version. The `check_version` function will fail and exit your program.
- libpynq.MAJOR > bitstream.MAJOR: you MUST update the bitstream to the latest version compatible with the libpynq version (or downgrade the libpynq version to bitstream.MAJOR). The `print/check_version` function will fail and exit your program.
- libpynq.MINOR > bitstream.MINOR: it is recommended to update the bitstream to the latest version compatible with the libpynq version. The `print_version` function will print an INFO message.
- libpynq.MINOR < bitstream.MINOR: it is recommended to update the libpynq to the latest version compatible with the bitstream version. The `print_version` function will print an INFO message.
- libpynq.PATCH != bitstream.PATCH: no action required

4.17.2 Function Documentation

4.17.2.1 `check_version()`

```
void check_version (
    void )
```

Check the version of the hardware (bitstream) and the libpynq library. Called by e.g. the switchbox but can also be called in user code.

Warning

Fails with program exit when versions are incompatible.

Definition at line 19 of file [version.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.17.2.2 `print_version()`

```
void print_version (
    void )
```

Print the version of the hardware (bitstream) and the libpynq library.

Prints INFO message when minor/patch versions are different.

Definition at line 18 of file [version.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

4.17.3 Variable Documentation

4.17.3.1 `libpynq_version`

```
const version\_t libpynq_version [extern]
```

Constant containing the version of this the libpynq library.

Definition at line 12 of file [version.c](#).

Chapter 5

Data Structure Documentation

5.1 arm_shared_t Struct Reference

```
#include <arm_shared_memory_system.h>
```

Data Fields

- int [file_descriptor](#)
- uint32_t [address](#)
- uint32_t [length](#)
- void * [mmaped_region](#)

5.1.1 Detailed Description

Definition at line [39](#) of file [arm_shared_memory_system.h](#).

5.1.2 Field Documentation

5.1.2.1 address

```
uint32_t arm_shared_t::address
```

Definition at line [41](#) of file [arm_shared_memory_system.h](#).

5.1.2.2 file_descriptor

```
int arm_shared_t::file_descriptor
```

Definition at line [40](#) of file [arm_shared_memory_system.h](#).

5.1.2.3 length

```
uint32_t arm_shared_t::length
```

Definition at line 42 of file [arm_shared_memory_system.h](#).

5.1.2.4 mmaped_region

```
void* arm_shared_t::mmaped_region
```

Definition at line 43 of file [arm_shared_memory_system.h](#).

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

- library/[arm_shared_memory_system.h](#)

5.2 display_t Struct Reference

```
#include <display.h>
```

Data Fields

- [uint16_t _width](#)
- [uint16_t _height](#)
- [uint16_t _offsetx](#)
- [uint16_t _offsety](#)
- [uint16_t _font_direction](#)
- [uint16_t _font_fill](#)
- [uint16_t _font_fill_color](#)
- [uint16_t _font_underline](#)
- [uint16_t _font_underline_color](#)
- [int16_t _dc](#)
- [int16_t _bl](#)

5.2.1 Detailed Description

Internal type, do not use. Type of display that stores parameters for usage in different functions.

Definition at line 112 of file [display.h](#).

5.2.2 Field Documentation

5.2.2.1 _bl

```
int16_t display_t::_bl
```

Definition at line 123 of file [display.h](#).

5.2.2.2 _dc

```
int16_t display_t::_dc
```

Definition at line 122 of file [display.h](#).

5.2.2.3 _font_direction

```
uint16_t display_t::_font_direction
```

Definition at line 117 of file [display.h](#).

5.2.2.4 _font_fill

```
uint16_t display_t::_font_fill
```

Definition at line 118 of file [display.h](#).

5.2.2.5 _font_fill_color

```
uint16_t display_t::_font_fill_color
```

Definition at line 119 of file [display.h](#).

5.2.2.6 _font_underline

```
uint16_t display_t::_font_underline
```

Definition at line 120 of file [display.h](#).

5.2.2.7 _font_underline_color

```
uint16_t display_t::_font_underline_color
```

Definition at line 121 of file [display.h](#).

5.2.2.8 _height

```
uint16_t display_t::_height
```

Definition at line 114 of file [display.h](#).

5.2.2.9 _offsetx

```
uint16_t display_t::_offsetx
```

Definition at line 115 of file [display.h](#).

5.2.2.10 `_offsety`

```
uint16_t display_t::_offsety
```

Definition at line 116 of file [display.h](#).

5.2.2.11 `_width`

```
uint16_t display_t::_width
```

Definition at line 113 of file [display.h](#).

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

- [library/display.h](#)

5.3 FontxFile Struct Reference

```
#include <fontx.h>
```

Data Fields

- `const char *` [path](#)
- `char` [fxname](#) [10]
- `bool` [opened](#)
- `bool` [valid](#)
- `bool` [is_ank](#)
- `uint8_t` [w](#)
- `uint8_t` [h](#)
- `uint16_t` [fsz](#)
- `uint8_t` [bc](#)
- `FILE *` [file](#)

5.3.1 Detailed Description

Struct representing a font file.

Definition at line 28 of file [fontx.h](#).

5.3.2 Field Documentation

5.3.2.1 `bc`

```
uint8_t FontxFile::bc
```

Background color of the font file.

Definition at line 38 of file [fontx.h](#).

5.3.2.2 file

```
FILE* FontxFile::file
```

Pointer to the font file stream.

Definition at line 39 of file [fontx.h](#).

5.3.2.3 fsz

```
uint16_t FontxFile::fsz
```

Size of the font file in bytes.

Definition at line 37 of file [fontx.h](#).

5.3.2.4 fxname

```
char FontxFile::fxname[10]
```

Name of the font file.

Definition at line 30 of file [fontx.h](#).

5.3.2.5 h

```
uint8_t FontxFile::h
```

Height of each character in the font file.

Definition at line 36 of file [fontx.h](#).

5.3.2.6 is_ank

```
bool FontxFile::is_ank
```

Flag indicating whether the font file contains only ASCII characters.

Definition at line 33 of file [fontx.h](#).

5.3.2.7 opened

```
bool FontxFile::opened
```

Flag indicating whether the font file is open.

Definition at line 31 of file [fontx.h](#).

5.3.2.8 path

```
const char* FontxFile::path
```

Path to the font file.

Definition at line 29 of file [fontx.h](#).

5.3.2.9 valid

```
bool FontxFile::valid
```

Flag indicating whether the font file is valid.

Definition at line 32 of file [fontx.h](#).

5.3.2.10 w

```
uint8_t FontxFile::w
```

Width of each character in the font file.

Definition at line 35 of file [fontx.h](#).

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

- [library/fontx.h](#)

5.4 pin Struct Reference

Data Fields

- char * [name](#)
- char * [state](#)
- uint8_t [channel](#)

5.4.1 Detailed Description

Definition at line 99 of file [switchbox.c](#).

5.4.2 Field Documentation

5.4.2.1 channel

```
uint8_t pin::channel
```

Definition at line 102 of file [switchbox.c](#).

5.4.2.2 name

```
char* pin::name
```

Definition at line 100 of file [switchbox.c](#).

5.4.2.3 state

```
char* pin::state
```

Definition at line 101 of file [switchbox.c](#).

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

- [library/switchbox.c](#)

5.5 pin_state_t Struct Reference

Data Fields

- char * [name](#)
- [gpio_direction_t](#) state
- [uint8_t](#) channel
- char * [level](#)

5.5.1 Detailed Description

Definition at line 25 of file [util.c](#).

5.5.2 Field Documentation

5.5.2.1 channel

```
uint8_t pin_state_t::channel
```

Definition at line 28 of file [util.c](#).

5.5.2.2 level

```
char* pin_state_t::level
```

Definition at line 29 of file [util.c](#).

5.5.2.3 name

```
char* pin_state_t::name
```

Definition at line 26 of file [util.c](#).

5.5.2.4 state

```
gpio_direction_t pin_state_t::state
```

Definition at line 27 of file [util.c](#).

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

- [library/util.c](#)

5.6 version_t Struct Reference

```
#include <version.h>
```

Data Fields

- `uint8_t` [release](#) [64]
- `uint32_t` [major](#)
- `uint32_t` [minor](#)
- `uint32_t` [patch](#)

5.6.1 Detailed Description

Typedef of version.

Definition at line 63 of file [version.h](#).

5.6.2 Field Documentation

5.6.2.1 major

```
uint32_t version_t::major
```

Definition at line 65 of file [version.h](#).

5.6.2.2 minor

```
uint32_t version_t::minor
```

Definition at line 66 of file [version.h](#).

5.6.2.3 patch

```
uint32_t version_t::patch
```

Definition at line 67 of file [version.h](#).

5.6.2.4 release

```
uint8_t version_t::release[64]
```

Definition at line 64 of file [version.h](#).

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

- [library/version.h](#)

Chapter 6

File Documentation

6.1 library/adc.h File Reference

```
#include <stdbool.h>
#include <stdint.h>
```

Include dependency graph for adc.h: This graph shows which files directly or indirectly include this file:

Enumerations

- enum [adc_channel_t](#) {
 [ADC0](#) = ((0x240 / 4) + 1) , [ADC1](#) = ((0x240 / 4) + 9) , [ADC2](#) = ((0x240 / 4) + 6) , [ADC3](#) = ((0x240 / 4) + 15) ,
 [ADC4](#) = ((0x240 / 4) + 5) , [ADC5](#) = ((0x240 / 4) + 13) }

Functions

- bool [initialized_adc](#) (void)
- void [adc_init](#) (void)
- void [adc_destroy](#) (void)
- double [adc_read_channel](#) ([adc_channel_t](#) channel)
- uint32_t [adc_read_channel_raw](#) ([adc_channel_t](#) channel)

6.2 adc.h

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
```

```

00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef ADC_H
00023 #define ADC_H
00024
00025 #include <stdbool.h>
00026 #include <stdint.h>
00027
00043 typedef enum {
00045     ADC0 = ((0x240 / 4) + 1),
00047     ADC1 = ((0x240 / 4) + 9),
00049     ADC2 = ((0x240 / 4) + 6),
00051     ADC3 = ((0x240 / 4) + 15),
00053     ADC4 = ((0x240 / 4) + 5),
00055     ADC5 = ((0x240 / 4) + 13),
00056 } adc_channel_t;
00057
00062 extern bool initialized_adc(void);
00063
00067 extern void adc_init(void);
00068
00073 extern void adc_destroy(void);
00074
00082 extern double adc_read_channel(adc_channel_t channel);
00083
00090 extern uint32_t adc_read_channel_raw(adc_channel_t channel);
00091
00096 #endif // ADC_H

```

6.3 library/arm_shared_memory_system.h File Reference

```
#include <stdint.h>
```

Include dependency graph for arm_shared_memory_system.h: This graph shows which files directly or indirectly include this file:

Data Structures

- struct [arm_shared_t](#)

Typedefs

- typedef struct [arm_shared_t](#) [arm_shared](#)

Functions

- void * [arm_shared_init](#) ([arm_shared](#) *handle, const uint32_t address, const uint32_t length)
- void [arm_shared_close](#) ([arm_shared](#) *handle)

6.4 arm_shared_memory_system.h

[Go to the documentation of this file.](#)

```

00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
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00009 furnished to do so, subject to the following conditions:

```

```

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00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
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00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef __ARM_SHARED_MEMORY_SYSTEMH_
00023 #define __ARM_SHARED_MEMORY_SYSTEMH_
00024
00037 #include <stdint.h>
00038
00039 struct arm_shared_t {
00040     int file_descriptor;
00041     uint32_t address;
00042     uint32_t length;
00043     void *mmaped_region;
00044 };
00048 typedef struct arm_shared_t arm_shared;
00049
00060 extern void *arm_shared_init(arm_shared *handle, const uint32_t address,
00061                             const uint32_t length);
00062
00069 extern void arm_shared_close(arm_shared *handle);
00070
00074 #endif // ARM_READ_SHARED_H

```

6.5 library/audio.h File Reference

#include <stdint.h>

Include dependency graph for audio.h: This graph shows which files directly or indirectly include this file:

Macros

- #define [LINE_IN](#) 0
- #define [MIC](#) 1
- #define [IIC_SLAVE_ADDR](#) 0x3B
- #define [IIC_SCLK_RATE](#) 400000
- #define [I2S_DATA_RX_L_REG](#) 0x00
- #define [I2S_DATA_RX_R_REG](#) 0x04
- #define [I2S_DATA_TX_L_REG](#) 0x08
- #define [I2S_DATA_TX_R_REG](#) 0x0C
- #define [I2S_STATUS_REG](#) 0x10

Enumerations

- enum [audio_adau1761_regs](#) {
[R0_CLOCK_CONTROL](#) = 0x00 , [R1_PLL_CONTROL](#) = 0x02 , [R2_DIGITAL_MIC_JACK_DETECTION_CONTROL](#)
= 0x08 , [R3_RECORD_POWER_MANAGEMENT](#) = 0x09 ,
[R4_RECORD_MIXER_LEFT_CONTROL_0](#) = 0x0A , [R5_RECORD_MIXER_LEFT_CONTROL_1](#) = 0x0B ,
[R6_RECORD_MIXER_RIGHT_CONTROL_0](#) = 0x0C , [R7_RECORD_MIXER_RIGHT_CONTROL_1](#) = 0x0D
,
[R8_LEFT_DIFFERENTIAL_INPUT_VOLUME_CONTROL](#) = 0x0E , [R9_RIGHT_DIFFERENTIAL_INPUT_VOLUME_CONTROL](#)
= 0x0F , [R10_RECORD_MICROPHONE_BIAS_CONTROL](#) = 0x10 , [R11_ALC_CONTROL_0](#) = 0x11 ,
[R12_ALC_CONTROL_1](#) = 0x12 , [R13_ALC_CONTROL_2](#) = 0x13 , [R14_ALC_CONTROL_3](#) = 0x14 ,
[R15_SERIAL_PORT_CONTROL_0](#) = 0x15 ,
[R16_SERIAL_PORT_CONTROL_1](#) = 0x16 , [R17_CONVERTER_CONTROL_0](#) = 0x17 , [R18_CONVERTER_CONTROL_1](#)
= 0x18 , [R19_ADC_CONTROL](#) = 0x19 ,

```

R20_LEFT_INPUT_DIGITAL_VOLUME = 0x1A , R21_RIGHT_INPUT_DIGITAL_VOLUME = 0x1B ,
R22_PLAYBACK_MIXER_LEFT_CONTROL_0 = 0x1C , R23_PLAYBACK_MIXER_LEFT_CONTROL_1
= 0x1D ,
R24_PLAYBACK_MIXER_RIGHT_CONTROL_0 = 0x1E , R25_PLAYBACK_MIXER_RIGHT_CONTROL_1 =
0x1F , R26_PLAYBACK_LR_MIXER_LEFT_LINE_OUTPUT_CONTROL = 0x20 , R27_PLAYBACK_LR_MIXER_RIGHT_LINE_
= 0x21 ,
R28_PLAYBACK_LR_MIXER_MONO_OUTPUT_CONTROL = 0x22 , R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CON
= 0x23 , R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL = 0x24 , R31_PLAYBACK_LINE_OUTPUT_LEFT_VO
= 0x25 ,
R32_PLAYBACK_LINE_OUTPUT_RIGHT_VOLUME_CONTROL = 0x26 , R33_PLAYBACK_MONO_OUTPUT_CONTROL
= 0x27 , R34_PLAYBACK_POP_CLICK_SUPPRESSION = 0x28 , R35_PLAYBACK_POWER_MANAGEMENT
= 0x29 ,
R36_DAC_CONTROL_0 = 0x2A , R37_DAC_CONTROL_1 = 0x2B , R38_DAC_CONTROL_2 = 0x2C ,
R39_SERIAL_PORT_PAD_CONTROL = 0x2D ,
R40_CONTROL_PORT_PAD_CONTROL_0 = 0x2F , R41_CONTROL_PORT_PAD_CONTROL_1 = 0x30 ,
R42_JACK_DETECT_PIN_CONTROL = 0x31 , R67_DEJITTER_CONTROL = 0x36 ,
R58_SERIAL_INPUT_ROUTE_CONTROL = 0xF2 , R59_SERIAL_OUTPUT_ROUTE_CONTROL = 0xF3 ,
R61_DSP_ENABLE = 0xF5 , R62_DSP_RUN = 0xF6 ,
R63_DSP_SLEW_MODES = 0xF7 , R64_SERIAL_PORT_SAMPLING_RATE = 0xF8 , R65_CLOCK_ENABLE_0
= 0xF9 , R66_CLOCK_ENABLE_1 = 0xFA }

```

Functions

- void [audio_init](#) (void)
- void [audio_select_input](#) (int input)
- void [write_audio_reg](#) (unsigned char u8RegAddr, unsigned char u8Data, int iic_fd)
- void [config_audio_pll](#) (void)
- void [config_audio_codec](#) (void)
- void [select_line_in](#) (void)
- void [select_mic](#) (void)
- void [deselect](#) (void)
- void [audio_bypass](#) (unsigned int audio_mmap_size, unsigned int nsamples, unsigned int volume, int uio_↵
index)
- void [audio_record](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, int uio_↵
index)
- void [audio_play](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, unsigned int
volume, int uio_index)
- void [audio_repeat_play](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, un-
signed int volume, unsigned int repetitions)
- void [audio_generate_tone](#) (unsigned int frequency, uint32_t time_ms, unsigned int volume)

6.6 audio.h

[Go to the documentation of this file.](#)

```

00001 #ifndef AUDIO_H
00002 #define AUDIO_H
00003 #include <stdint.h>
00004
00032 #define LINE_IN 0
00033 #define MIC 1
00034
00035 // Slave address for the ADAU audio controller 8
00036 #define IIC_SLAVE_ADDR 0x3B
00037
00038 // I2C Serial Clock frequency in Hertz
00039 #define IIC_SCLK_RATE 400000
00040
00041 // I2S Register
00042 #define I2S_DATA_RX_L_REG 0x00

```



```

00043 #define I2S_DATA_RX_R_REG 0x04
00044 #define I2S_DATA_TX_L_REG 0x08
00045 #define I2S_DATA_TX_R_REG 0x0C
00046 #define I2S_STATUS_REG 0x10
00047
00048 // Audio registers
00049 enum audio_adau1761_regs {
00050     R0_CLOCK_CONTROL = 0x00,
00051     R1_PLL_CONTROL = 0x02,
00052     R2_DIGITAL_MIC_JACK_DETECTION_CONTROL = 0x08,
00053     R3_RECORD_POWER_MANAGEMENT = 0x09,
00054     R4_RECORD_MIXER_LEFT_CONTROL_0 = 0x0A,
00055     R5_RECORD_MIXER_LEFT_CONTROL_1 = 0x0B,
00056     R6_RECORD_MIXER_RIGHT_CONTROL_0 = 0x0C,
00057     R7_RECORD_MIXER_RIGHT_CONTROL_1 = 0x0D,
00058     R8_LEFT_DIFFERENTIAL_INPUT_VOLUME_CONTROL = 0x0E,
00059     R9_RIGHT_DIFFERENTIAL_INPUT_VOLUME_CONTROL = 0x0F,
00060     R10_RECORD_MICROPHONE_BIAS_CONTROL = 0x10,
00061     R11_ALC_CONTROL_0 = 0x11,
00062     R12_ALC_CONTROL_1 = 0x12,
00063     R13_ALC_CONTROL_2 = 0x13,
00064     R14_ALC_CONTROL_3 = 0x14,
00065     R15_SERIAL_PORT_CONTROL_0 = 0x15,
00066     R16_SERIAL_PORT_CONTROL_1 = 0x16,
00067     R17_CONVERTER_CONTROL_0 = 0x17,
00068     R18_CONVERTER_CONTROL_1 = 0x18,
00069     R19_ADC_CONTROL = 0x19,
00070     R20_LEFT_INPUT_DIGITAL_VOLUME = 0x1A,
00071     R21_RIGHT_INPUT_DIGITAL_VOLUME = 0x1B,
00072     R22_PLAYBACK_MIXER_LEFT_CONTROL_0 = 0x1C,
00073     R23_PLAYBACK_MIXER_LEFT_CONTROL_1 = 0x1D,
00074     R24_PLAYBACK_MIXER_RIGHT_CONTROL_0 = 0x1E,
00075     R25_PLAYBACK_MIXER_RIGHT_CONTROL_1 = 0x1F,
00076     R26_PLAYBACK_LR_MIXER_LEFT_LINE_OUTPUT_CONTROL = 0x20,
00077     R27_PLAYBACK_LR_MIXER_RIGHT_LINE_OUTPUT_CONTROL = 0x21,
00078     R28_PLAYBACK_LR_MIXER_MONO_OUTPUT_CONTROL = 0x22,
00079     R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL = 0x23,
00080     R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL = 0x24,
00081     R31_PLAYBACK_LINE_OUTPUT_LEFT_VOLUME_CONTROL = 0x25,
00082     R32_PLAYBACK_LINE_OUTPUT_RIGHT_VOLUME_CONTROL = 0x26,
00083     R33_PLAYBACK_MONO_OUTPUT_CONTROL = 0x27,
00084     R34_PLAYBACK_POP_CLICK_SUPPRESSION = 0x28,
00085     R35_PLAYBACK_POWER_MANAGEMENT = 0x29,
00086     R36_DAC_CONTROL_0 = 0x2A,
00087     R37_DAC_CONTROL_1 = 0x2B,
00088     R38_DAC_CONTROL_2 = 0x2C,
00089     R39_SERIAL_PORT_PAD_CONTROL = 0x2D,
00090     R40_CONTROL_PORT_PAD_CONTROL_0 = 0x2F,
00091     R41_CONTROL_PORT_PAD_CONTROL_1 = 0x30,
00092     R42_JACK_DETECT_PIN_CONTROL = 0x31,
00093     R67_DEJITTER_CONTROL = 0x36,
00094     R58_SERIAL_INPUT_ROUTE_CONTROL = 0xF2,
00095     R59_SERIAL_OUTPUT_ROUTE_CONTROL = 0xF3,
00096     R61_DSP_ENABLE = 0xF5,
00097     R62_DSP_RUN = 0xF6,
00098     R63_DSP_SLEW_MODES = 0xF7,
00099     R64_SERIAL_PORT_SAMPLING_RATE = 0xF8,
00100     R65_CLOCK_ENABLE_0 = 0xF9,
00101     R66_CLOCK_ENABLE_1 = 0xFA
00102 };
00103
00109 extern void audio_init(void);
00110
00116 extern void audio_select_input(int input);
00117
00118 // Original ADAU1761 code
00119
00120 extern void write_audio_reg(unsigned char u8RegAddr, unsigned char u8Data,
00121                             int iic_fd);
00122
00123 extern void config_audio_pll(void);
00124
00125 extern void config_audio_codec(void);
00126
00130 extern void select_line_in(void);
00131
00135 extern void select_mic(void);
00136
00140 extern void deselect(void);
00141
00149 extern void audio_bypass(unsigned int audio_mmap_size, unsigned int nsamples,
00150                          unsigned int volume, int uio_index);
00151
00164 extern void audio_record(unsigned int audio_mmap_size, unsigned int *BufAddr,
00165                          unsigned int nsamples, int uio_index);
00166
00167 /*

```

```

00168  * @brief Function to support audio playing without the audio codec controller.
00169  *
00170  * Notice that the buffer has to be twice the size of the number of samples,
00171  * because both left and right channels are sampled.
00172  * Consecutive indexes are played synchronisly on left and right output.
00173  *
00174  * @param  audio_mmap_size is the address range of the audio codec.
00175  * @param  BufAddr is the buffer address.
00176  * @param  nsamples is the number of samples.
00177  * @param  uio_index is the uio index in /dev list.
00178  * @param  volume is the volume of the output.
00179  */
00180 extern void audio_play(unsigned int audio_mmap_size, unsigned int *BufAddr,
00181                       unsigned int nsamples, unsigned int volume,
00182                       int uio_index);
00183
00193 extern void audio_repeat_play(unsigned int audio_mmap_size,
00194                              unsigned int *BufAddr, unsigned int nsamples,
00195                              unsigned int volume, unsigned int repetitions);
00196
00197 /*
00198  * @brief Function to generate a specific tone on the audio output.
00199  * @param  frequency is the frequency in Hz to be played.
00200  * @param  time_ms is the time the frequency should be played in ms.
00201  * @param  volume is the volume of the output.
00202  */
00203 extern void audio_generate_tone(unsigned int frequency, uint32_t time_ms,
00204                                unsigned int volume);
00205
00210 #endif

```

6.7 library/buttons.h File Reference

```
#include <gpio.h>
```

Include dependency graph for buttons.h: This graph shows which files directly or indirectly include this file:

Macros

- #define `BUTTON_NOT_PUSHED` 0
- #define `BUTTON_PUSHED` 1
- #define `SWITCH_OFF` 0
- #define `SWITCH_ON` 1

Enumerations

- enum `button_index_t` {
 `BUTTON0` , `BUTTON1` , `BUTTON2` , `BUTTON3` ,
 `NUM_BUTTONS` }
- enum `switches_index_t` { `SWITCH0` , `SWITCH1` , `NUM_SWITCHES` }

Functions

- void `switches_init` (void)
- void `switches_destroy` (void)
- void `buttons_init` (void)
- void `buttons_destroy` (void)
- int `get_button_state` (const int button)
- int `wait_until_button_state` (const int button, const int state)
- int `sleep_msec_button_pushed` (const int button, const int msec)
- void `sleep_msec_buttons_pushed` (int button_states[], const int ms)
- int `wait_until_button_pushed` (const int button)
- int `wait_until_button_released` (const int button)
- int `wait_until_any_button_pushed` (void)
- int `wait_until_any_button_released` (void)
- int `get_switch_state` (const int switch_num)

6.8 buttons.h

[Go to the documentation of this file.](#)

```

00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef BUTTONS_H
00023 #define BUTTONS_H
00024
00025 #include <gpio.h>
00026
00074 #define BUTTON_NOT_PUSHED 0
00075 #define BUTTON_PUSHED 1
00076 #define SWITCH_OFF 0
00077 #define SWITCH_ON 1
00078
00086 typedef enum { BUTTON0, BUTTON1, BUTTON2, BUTTON3, NUM_BUTTONS } button_index_t;
00087
00094 typedef enum { SWITCH0, SWITCH1, NUM_SWITCHES } switches_index_t;
00095
00099 extern void switches_init(void);
00100
00104 extern void switches_destroy(void);
00105
00109 extern void buttons_init(void);
00110
00114 extern void buttons_destroy(void);
00115
00123 extern int get_button_state(const int button);
00124
00135 extern int wait_until_button_state(const int button, const int state);
00136
00147 extern int sleep_msec_button_pushed(const int button, const int msec);
00148
00157 extern void sleep_msec_buttons_pushed(int button_states[], const int ms);
00158
00167 extern int wait_until_button_pushed(const int button);
00168
00177 extern int wait_until_button_released(const int button);
00178
00186 extern int wait_until_any_button_pushed(void);
00187
00195 extern int wait_until_any_button_released(void);
00196
00203 extern int get_switch_state(const int switch_num);
00204
00209 #endif

```

6.9 library/display.c File Reference

```

#include <arm_shared_memory_system.h>
#include <display.h>
#include <gpio.h>
#include <lcdconfig.h>
#include <log.h>
#include <math.h>
#include <platform.h>
#include <string.h>

```

```
#include <switchbox.h>
#include <unistd.h>
#include <util.h>
Include dependency graph for display.c:
```

Macros

- `#define LOG_DOMAIN "display"`
- `#define TAG "ST7789"`
- `#define _DEBUG_ 0`
- `#define M_PI 3.14159265358979323846`
- `#define GPIO_MODE_OUTPUT 1`

Enumerations

- `enum spi_mode_t { SPI_Data_Mode = 1 , SPI_Command_Mode = 0 }`

Functions

- `gpio_level_t spi_to_gpio (spi_mode_t mode)`
- `bool spi_master_write_command (display_t *display, uint8_t cmd)`
- `bool spi_master_write_data_byte (display_t *display, uint8_t data)`
- `bool spi_master_write_data_word (display_t *display, uint16_t data)`
- `bool spi_master_write_addr (display_t *display, uint16_t addr1, uint16_t addr2)`
- `bool spi_master_write_color (display_t *display, uint16_t color, uint16_t size)`
- `bool spi_master_write_colors (display_t *display, uint16_t *colors, uint16_t size)`
- `void spi_master_init (display_t *display)`
- `void displayInit (display_t *display, int width, int height, int offsetx, int offsety)`
- `void display_set_flip (display_t *display, bool xflip, bool yflip)`
- `void display_init (display_t *display)`
- `void display_destroy (display_t *display __attribute__((unused)))`
- `void displayDrawPixel (display_t *display, uint16_t x, uint16_t y, uint16_t color)`
- `void displayDrawMultiPixels (display_t *display, uint16_t x, uint16_t y, uint16_t size, uint16_t *colors)`
- `void displayDrawFillRect (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)`
- `void displayDisplayOff (display_t *display)`
- `void displayDisplayOn (display_t *display)`
- `void displayFillScreen (display_t *display, uint16_t color)`
- `void displayDrawLine (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)`
- `void displayDrawRect (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)`
- `void displayDrawRectAngle (display_t *display, uint16_t xc, uint16_t yc, uint16_t w, uint16_t h, uint16_t angle, uint16_t color)`
- `void displayDrawTriangle (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t x3, uint16_t y3, uint16_t color)`
- `void displayDrawTriangleCenter (display_t *display, uint16_t xc, uint16_t yc, uint16_t w, uint16_t h, uint16_t angle, uint16_t color)`
- `void displayDrawCircle (display_t *display, uint16_t x_center, uint16_t y_center, uint16_t r, uint16_t color)`
- `void displayDrawFillCircle (display_t *display, uint16_t x_center, uint16_t y_center, uint16_t r, uint16_t color)`
- `void displayDrawRoundRect (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t r, uint16_t color)`
- `uint16_t rgb_conv (uint16_t r, uint16_t g, uint16_t b)`
- `int displayDrawChar (display_t *display, FontxFile *fxs, uint16_t x, uint16_t y, uint8_t ascii, uint16_t color)`
- `int displayDrawString (display_t *display, FontxFile *fx, uint16_t x, uint16_t y, uint8_t *ascii, uint16_t color)`

- void [displaySetFontDirection](#) ([display_t](#) *display, uint16_t dir)
- void [displaySetFontFill](#) ([display_t](#) *display, uint16_t color)
- void [displayUnsetFontFill](#) ([display_t](#) *display)
- void [displaySetFontUnderLine](#) ([display_t](#) *display, uint16_t color)
- void [displayUnsetFontUnderLine](#) ([display_t](#) *display)
- void [displayBacklightOff](#) ([display_t](#) *display)
- void [displayBacklightOn](#) ([display_t](#) *display)
- void [displayInversionOff](#) ([display_t](#) *display)
- void [displayInversionOn](#) ([display_t](#) *display)

6.9.1 Macro Definition Documentation

6.9.1.1 `_DEBUG_`

```
#define _DEBUG_ 0
```

Definition at line 38 of file [display.c](#).

6.9.1.2 `GPIO_MODE_OUTPUT`

```
#define GPIO_MODE_OUTPUT 1
```

Definition at line 48 of file [display.c](#).

6.9.1.3 `LOG_DOMAIN`

```
#define LOG_DOMAIN "display"
```

Definition at line 35 of file [display.c](#).

6.9.1.4 `M_PI`

```
#define M_PI 3.14159265358979323846
```

Definition at line 40 of file [display.c](#).

6.9.1.5 `TAG`

```
#define TAG "ST7789"
```

Definition at line 37 of file [display.c](#).

6.9.2 Enumeration Type Documentation

6.9.2.1 `spi_mode_t`

```
enum spi\_mode\_t
```

Enumerator

SPI_Data_Mode	
SPI_Command_Mode	

Definition at line 46 of file [display.c](#).

6.9.3 Function Documentation

6.9.3.1 display_destroy()

```
void display_destroy (
    display_t *display __attribute__((unused)) )
```

Definition at line 302 of file [display.c](#).

Here is the call graph for this function:

6.9.3.2 displayDrawMultiPixels()

```
void displayDrawMultiPixels (
    display_t * display,
    uint16_t x,
    uint16_t y,
    uint16_t size,
    uint16_t * colors )
```

Definition at line 332 of file [display.c](#).

Here is the call graph for this function:

6.9.3.3 displayInit()

```
void displayInit (
    display_t * display,
    int width,
    int height,
    int offsetx,
    int offsety )
```

Definition at line 225 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.9.3.4 spi_master_init()

```
void spi_master_init (
    display_t * display )
```

Definition at line 144 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.9.3.5 spi_master_write_addr()

```
bool spi_master_write_addr (
    display_t * display,
    uint16_t addr1,
    uint16_t addr2 )
```

Definition at line 92 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.9.3.6 spi_master_write_color()

```
bool spi_master_write_color (
    display_t * display,
    uint16_t color,
    uint16_t size )
```

Definition at line 111 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.9.3.7 spi_master_write_colors()

```
bool spi_master_write_colors (
    display_t * display,
    uint16_t * colors,
    uint16_t size )
```

Definition at line 126 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.9.3.8 spi_master_write_command()

```
bool spi_master_write_command (
    display_t * display,
    uint8_t cmd )
```

Definition at line 61 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.9.3.9 spi_master_write_data_byte()

```
bool spi_master_write_data_byte (
    display_t * display,
    uint8_t data )
```

Definition at line 70 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.9.3.10 spi_master_write_data_word()

```
bool spi_master_write_data_word (
    display_t * display,
    uint16_t data )
```

Definition at line 79 of file [display.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.9.3.11 spi_to_gpio()

```
gpio_level_t spi_to_gpio (
    spi_mode_t mode )
```

Definition at line 50 of file [display.c](#).

Here is the caller graph for this function:

6.10 display.c

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <arm_shared_memory_system.h>
00023 #include <display.h>
00024 #include <gpio.h>
00025 #include <lcdconfig.h>
00026 #include <log.h>
00027 #include <math.h>
00028 #include <platform.h>
00029 #include <string.h>
00030 #include <switchbox.h>
00031 #include <unistd.h>
00032 #include <util.h>
00033
00034 #undef LOG_DOMAIN
00035 #define LOG_DOMAIN "display"
00036
00037 #define TAG "ST7789"
00038 #define _DEBUG_ 0
00039
00040 #define M_PI 3.14159265358979323846
00041
00042 static arm_shared spi0_handle;
00043 static volatile uint32_t *spi0 = NULL;
00044
00045 // states that are set for usage of the DC pin in SPI
00046 typedef enum { SPI_Data_Mode = 1, SPI_Command_Mode = 0 } spi_mode_t;
00047
```



```

00048 #define GPIO_MODE_OUTPUT 1
00049
00050 gpio_level_t spi_to_gpio(spi_mode_t mode) {
00051     switch (mode) {
00052         case SPI_Data_Mode:
00053             return GPIO_LEVEL_HIGH;
00054         case SPI_Command_Mode:
00055             return GPIO_LEVEL_LOW;
00056         default:
00057             return GPIO_LEVEL_LOW;
00058     }
00059 }
00060
00061 bool spi_master_write_command(display_t *display, uint8_t cmd) {
00062     gpio_set_level(display->_dc, spi_to_gpio(SPI_Command_Mode));
00063     spi0[0x68 / 4] = cmd;
00064     while (((spi0[0x64 / 4]) & 4) == 0) {
00065     }
00066     usleep(1);
00067     return true;
00068 }
00069
00070 bool spi_master_write_data_byte(display_t *display, uint8_t data) {
00071     gpio_set_level(display->_dc, spi_to_gpio(SPI_Data_Mode));
00072
00073     spi0[0x68 / 4] = data;
00074     while (((spi0[0x64 / 4]) & 4) == 0) {
00075     }
00076     return true;
00077 }
00078
00079 bool spi_master_write_data_word(display_t *display, uint16_t data) {
00080     static uint8_t Byte[2];
00081     Byte[0] = (data >> 8) & 0xFF;
00082     Byte[1] = data & 0xFF;
00083     gpio_set_level(display->_dc, spi_to_gpio(SPI_Data_Mode));
00084     spi0[0x68 / 4] = Byte[0];
00085     spi0[0x68 / 4] = Byte[1];
00086
00087     while (((spi0[0x64 / 4]) & 4) == 0) {
00088     }
00089     return true;
00090 }
00091
00092 bool spi_master_write_addr(display_t *display, uint16_t addr1, uint16_t addr2) {
00093     static uint8_t Byte[4];
00094     Byte[0] = (addr1 >> 8) & 0xFF;
00095     Byte[1] = addr1 & 0xFF;
00096     Byte[2] = (addr2 >> 8) & 0xFF;
00097     Byte[3] = addr2 & 0xFF;
00098     gpio_set_level(display->_dc, spi_to_gpio(SPI_Data_Mode));
00099
00100     // check ordering
00101     spi0[0x68 / 4] = Byte[0];
00102     spi0[0x68 / 4] = Byte[1];
00103     spi0[0x68 / 4] = Byte[2];
00104     spi0[0x68 / 4] = Byte[3];
00105
00106     while (((spi0[0x64 / 4]) & 4) == 0) {
00107     }
00108     return true;
00109 }
00110
00111 bool spi_master_write_color(display_t *display, uint16_t color, uint16_t size) {
00112     gpio_set_level(display->_dc, spi_to_gpio(SPI_Data_Mode));
00113     for (int i = 0; i < size; i++) {
00114         while (((spi0[0x64 / 4]) & 8) == 8) {
00115         }
00116         spi0[0x68 / 4] = (color >> 8) & 0xFF;
00117         while (((spi0[0x64 / 4]) & 8) == 8) {
00118         }
00119         spi0[0x68 / 4] = (color) & 0xFF;
00120     }
00121     while (((spi0[0x64 / 4]) & 4) == 0) {
00122     }
00123     return -1;
00124 }
00125
00126 bool spi_master_write_colors(display_t *display, uint16_t *colors,
00127                             uint16_t size) {
00128     gpio_set_level(display->_dc, spi_to_gpio(SPI_Data_Mode));
00129     for (int i = 0; i < size; i++) {
00130         while (((spi0[0x64 / 4]) & 8) == 8) {
00131         }
00132         spi0[0x68 / 4] = (colors[i] >> 8) & 0xFF;
00133         while (((spi0[0x64 / 4]) & 8) == 8) {
00134         }
00135     }

```

```

00135     spi0[0x68 / 4] = (colors[i]) & 0xFF;
00136 }
00137 // wait till empty, then add a small extra buffer
00138 // because last byte we don't exactly know when send.
00139 while (((spi0[0x64 / 4]) & 4) == 0) {
00140 }
00141 return true;
00142 }
00143
00144 void spi_master_init(display_t *display) {
00145     // linking given pins in the switchbox
00146     switchbox_set_pin(LCD_MOSI, SWB_SPI1_MOSI);
00147     switchbox_set_pin(LCD_SCLK, SWB_SPI1_CLK);
00148     switchbox_set_pin(LCD_CS, SWB_SPI1_SS);
00149     switchbox_set_pin(LCD_DC, SWB_GPIO);
00150     switchbox_set_pin(LCD_RESET, SWB_GPIO);
00151     switchbox_set_pin(LCD_BL, SWB_GPIO);
00152
00153     // setting the appropriate direction of each protocol pin
00154     gpio_set_direction(LCD_DC, GPIO_DIR_OUTPUT);
00155     gpio_set_direction(LCD_RESET, GPIO_DIR_OUTPUT);
00156     gpio_set_direction(LCD_BL, GPIO_DIR_OUTPUT);
00157     gpio_set_level(LCD_DC, GPIO_LEVEL_LOW);
00158     gpio_set_level(LCD_RESET, GPIO_LEVEL_LOW);
00159     gpio_set_level(LCD_BL, GPIO_LEVEL_LOW);
00160
00161     // creating a shared memory instance for communicating the hardware addresses
00162     // of the linked pins
00163     spi0 = arm_shared_init(&spi0_handle, axi_quad_spi_1, 4096);
00164     if (_DEBUG_)
00165         printf("spi reset: %08X\n", spi0[0x40 / 4]);
00166     spi0[0x40 / 4] = 0x0000000a;
00167     if (_DEBUG_)
00168         printf("spi control: %08X\n", spi0[0x60 / 4]);
00169     spi0[0x60 / 4] = (1 << 4) | (1 << 3) | (1 << 2) | (1 << 1);
00170     if (_DEBUG_)
00171         printf("spi control: %08X\n", spi0[0x60 / 4]);
00172     if (_DEBUG_)
00173         printf("spi status: %08X\n", spi0[0x64 / 4]);
00174
00175     // select slave 1
00176     spi0[0x70 / 4] = 0;
00177     if (_DEBUG_)
00178         printf("spi control: %08X\n", spi0[0x60 / 4]);
00179     if (_DEBUG_)
00180         printf("testing DISPLAY\n");
00181     if (_DEBUG_)
00182         printf("LCD_CS=%d\n", LCD_CS);
00183     if (LCD_CS >= 0) {
00184         gpio_reset_pin(LCD_CS);
00185         gpio_set_direction(LCD_CS, GPIO_MODE_OUTPUT);
00186         gpio_set_level(LCD_CS, 0);
00187     }
00188
00189     if (_DEBUG_)
00190         printf("LCD_DC=%d", LCD_DC);
00191     gpio_reset_pin(LCD_DC);
00192     gpio_set_direction(LCD_DC, GPIO_MODE_OUTPUT);
00193     gpio_set_level(LCD_DC, 0);
00194     if (_DEBUG_)
00195         printf("LCD_RESET=%d", LCD_RESET);
00196
00197     if (LCD_RESET >= 0) {
00198         gpio_reset_pin(LCD_RESET);
00199         gpio_set_direction(LCD_RESET, GPIO_MODE_OUTPUT);
00200         gpio_set_level(LCD_RESET, 1);
00201         sleep_msec(100);
00202         gpio_set_level(LCD_RESET, 0);
00203         sleep_msec(500);
00204         gpio_set_level(LCD_RESET, 1);
00205         sleep_msec(300);
00206     }
00207
00208     if (_DEBUG_)
00209         printf("LCD_BL=%d", LCD_BL);
00210     if (LCD_BL >= 0) {
00211         gpio_reset_pin(LCD_BL);
00212         gpio_set_direction(LCD_BL, GPIO_MODE_OUTPUT);
00213         gpio_set_level(LCD_BL, 0);
00214     }
00215
00216     if (_DEBUG_)
00217         printf("LCD_MOSI=%d", LCD_MOSI);
00218     if (_DEBUG_)
00219         printf("LCD_SCLK=%d\n", LCD_SCLK);
00220
00221     display->_dc = LCD_DC;

```

```

00222     display->_bl = LCD_BL;
00223 }
00224
00225 void displayInit(display_t *display, int width, int height, int offsetx,
00226                 int offsety) {
00227     spi_master_init(display);
00228     display->_width = width;
00229     display->_height = height;
00230     display->_offsetx = offsetx;
00231     display->_offsety = offsety;
00232     display->_font_direction = TEXT_DIRECTION0;
00233     display->_font_fill = false;
00234     display->_font_underline = false;
00235
00236     spi_master_write_command(display, 0x01); // software Reset
00237     sleep_msec(150);
00238
00239     spi_master_write_command(display, 0x11); // sleep Out
00240     sleep_msec(255);
00241
00242     spi_master_write_command(display, 0x3A); // Interface Pixel Format
00243     spi_master_write_data_byte(display, 0x55);
00244     sleep_msec(10);
00245
00246     spi_master_write_command(display, 0x36); // Memory Data Access Control
00247     spi_master_write_data_byte(display, 0x00);
00248
00249     spi_master_write_command(display, 0x2A); // Column Address Set
00250     spi_master_write_data_byte(display, 0x00);
00251     spi_master_write_data_byte(display, 0x00);
00252     spi_master_write_data_byte(display, 0x00);
00253     spi_master_write_data_byte(display, 0xF0);
00254
00255     spi_master_write_command(display, 0x2B); // Row Address Set
00256     spi_master_write_data_byte(display, 0x00);
00257     spi_master_write_data_byte(display, 0x00);
00258     spi_master_write_data_byte(display, 0x00);
00259     spi_master_write_data_byte(display, 0xF0);
00260
00261     spi_master_write_command(display, 0x21); // Display Inversion On
00262     sleep_msec(10);
00263
00264     spi_master_write_command(display, 0x13); // Normal Display Mode On
00265     sleep_msec(10);
00266
00267     spi_master_write_command(display, 0x29); // Display ON
00268     sleep_msec(255);
00269
00270     if (display->_bl >= 0) {
00271         gpio_set_level(display->_bl, 1);
00272     }
00273 }
00274
00275 void display_set_flip(display_t *display, bool xflip, bool yflip) {
00276     if (display == NULL) {
00277         pyng_error("display_destroy: display has not been initialized\n");
00278     }
00279     if (display->_width != DISPLAY_WIDTH || display->_height != DISPLAY_HEIGHT) {
00280         pyng_error("display_destroy: internal error (wrong display hardware)\n");
00281     }
00282     spi_master_write_command(display, 0x36); // Memory Data Access Control
00283     uint8_t set = (yflip << 7) | (xflip << 6);
00284     spi_master_write_data_byte(display, set);
00285     if (yflip) {
00286         display->_offsety = 320 - display->_height;
00287     } else {
00288         display->_offsety = 0;
00289     }
00290     if (xflip) {
00291         display->_offsetx = 240 - display->_width;
00292     } else {
00293         display->_offsetx = 0;
00294     }
00295 }
00296
00297 void display_init(display_t *display) {
00298     displayInit(display, DISPLAY_WIDTH, DISPLAY_HEIGHT, 0, 0);
00299     display_set_flip(display, true, true);
00300 }
00301
00302 void display_destroy(display_t *display __attribute__((unused))) {
00303     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00304         pyng_error("display_destroy: display has not been initialized\n");
00305     }
00306     // if channel is open
00307     if (spi0 != NULL) {
00308         (void)arm_shared_close(&spi0_handle);

```

```

00309     spi0 = NULL;
00310 }
00311 }
00312
00313 void displayDrawPixel(display_t *display, uint16_t x, uint16_t y,
00314                      uint16_t color) {
00315     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00316         pynq_error("displayDrawPixel: display has not been initialized\n");
00317     }
00318     if (x >= display->_width || y >= display->_height) {
00319         pynq_error("displayDrawPixel: x=%d y=%d outside screen boundaries\n", x, y);
00320     }
00321     uint16_t _x = x + display->_offsetx;
00322     uint16_t _y = y + display->_offsety;
00323
00324     spi_master_write_command(display, 0x2A); // set column(x) address
00325     spi_master_write_addr(display, _x, _x);
00326     spi_master_write_command(display, 0x2B); // set Page(y) address
00327     spi_master_write_addr(display, _y, _y);
00328     spi_master_write_command(display, 0x2C); // memory write
00329     spi_master_write_data_word(display, color);
00330 }
00331
00332 void displayDrawMultiPixels(display_t *display, uint16_t x, uint16_t y,
00333                             uint16_t size, uint16_t *colors) {
00334     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00335         pynq_error("displayDrawMultiPixels: display has not been initialized\n");
00336     }
00337     if (x > display->_width || x + size > display->_width ||
00338         y >= display->_height) {
00339         pynq_error(
00340             "displayDrawMultiPixels: x=%d y=%d size=%d outside screen boundaries\n",
00341             x, y, size);
00342     }
00343
00344     uint16_t _x1 = x + display->_offsetx;
00345     uint16_t _x2 = _x1 + size;
00346     uint16_t _y1 = y + display->_offsety;
00347     uint16_t _y2 = _y1;
00348
00349     spi_master_write_command(display, 0x2A); // set column(x) address
00350     spi_master_write_addr(display, _x1, _x2);
00351     spi_master_write_command(display, 0x2B); // set Page(y) address
00352     spi_master_write_addr(display, _y1, _y2);
00353     spi_master_write_command(display, 0x2C); // memory write
00354     spi_master_write_colors(display, colors, size);
00355 }
00356
00357 void displayDrawFillRect(display_t *display, uint16_t x1, uint16_t y1,
00358                          uint16_t x2, uint16_t y2, uint16_t color) {
00359     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00360         pynq_error("displayDrawPixel: display has not been initialized\n");
00361     }
00362     if (x1 >= display->_width || x2 >= display->_width ||
00363         y1 >= display->_height || y2 >= display->_height) {
00364         pynq_error("displayDrawFillRect: x1=%d y1=%d x2=%d y2=%d outside screen "
00365             "boundaries\n",
00366             x1, y1, x2, y2);
00367     }
00368     // swapping points so that it is always plotted from x1 y1 bottom left, x2 y2
00369     // top right
00370     uint16_t x1_temp = x1, x2_temp = x2;
00371     uint16_t y1_temp = y1, y2_temp = y2;
00372     if (x1 > x2) {
00373         x1 = x2_temp;
00374         x2 = x1_temp;
00375     }
00376
00377     if (y1 > y2) {
00378         y1 = y2_temp;
00379         y2 = y1_temp;
00380     }
00381
00382     // printf("offset(x)=%d offset(y)=%d", display->_offsetx, display->_offsety);
00383     uint16_t _x1 = x1 + display->_offsetx;
00384     uint16_t _x2 = x2 + display->_offsetx;
00385     uint16_t _y1 = y1 + display->_offsety;
00386     uint16_t _y2 = y2 + display->_offsety;
00387
00388     spi_master_write_command(display, 0x2A); // set column(x) address
00389     spi_master_write_addr(display, _x1, _x2);
00390     spi_master_write_command(display, 0x2B); // set Page(y) address
00391     spi_master_write_addr(display, _y1, _y2);
00392     spi_master_write_command(display, 0x2C); // memory write
00393     for (int i = _x1; i <= _x2; i++) {
00394         uint16_t size = _y2 - _y1 + 1;
00395         spi_master_write_color(display, color, size);

```

```

00396     }
00397 }
00398
00399 void displayDisplayOff(display_t *display) {
00400     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00401         pynq_error("displayDisplayOff: display has not been initialized\n");
00402     }
00403     spi_master_write_command(display, 0x28); // display off
00404 }
00405
00406 void displayDisplayOn(display_t *display) {
00407     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00408         pynq_error("displayDisplayOn: display has not been initialized\n");
00409     }
00410     spi_master_write_command(display, 0x29); // display on
00411 }
00412
00413 void displayFillScreen(display_t *display, uint16_t color) {
00414     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00415         pynq_error("displayFillScreen: display has not been initialized\n");
00416     }
00417     displayDrawFillRect(display, 0, 0, display->_width - 1, display->_height - 1,
00418         color);
00419 }
00420
00421 void displayDrawLine(display_t *display, uint16_t x1, uint16_t y1, uint16_t x2,
00422     uint16_t y2, uint16_t color) {
00423     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00424         pynq_error("displayDrawLine: display has not been initialized\n");
00425     }
00426     if (x1 >= display->_width || y1 >= display->_height) {
00427         pynq_error("displayDrawLine: x1=%d y1=%d outside screen boundaries\n", x1,
00428             y1);
00429     } else if (x2 >= display->_width || y2 >= display->_height) {
00430         pynq_error("displayDrawLine: x2=%d y2=%d outside screen boundaries\n", x2,
00431             y2);
00432     }
00433     int i;
00434     int dx, dy;
00435     int sx, sy;
00436     int E;
00437
00438     /* distance between two points */
00439     dx = (x2 > x1) ? x2 - x1 : x1 - x2;
00440     dy = (y2 > y1) ? y2 - y1 : y1 - y2;
00441
00442     /* direction of two point */
00443     sx = (x2 > x1) ? 1 : -1;
00444     sy = (y2 > y1) ? 1 : -1;
00445
00446     /* inclination < 1 */
00447     if (dx > dy) {
00448         E = -dx;
00449         for (i = 0; i <= dx; i++) {
00450             displayDrawPixel(display, x1, y1, color);
00451             x1 += sx;
00452             E += 2 * dy;
00453             if (E >= 0) {
00454                 y1 += sy;
00455                 E -= 2 * dx;
00456             }
00457         }
00458
00459         /* inclination >= 1 */
00460     } else {
00461         E = -dy;
00462         for (i = 0; i <= dy; i++) {
00463             displayDrawPixel(display, x1, y1, color);
00464             y1 += sy;
00465             E += 2 * dx;
00466             if (E >= 0) {
00467                 x1 += sx;
00468                 E -= 2 * dy;
00469             }
00470         }
00471     }
00472 }
00473
00474 void displayDrawRect(display_t *display, uint16_t x1, uint16_t y1, uint16_t x2,
00475     uint16_t y2, uint16_t color) {
00476     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00477         pynq_error("displayDrawRect: display has not been initialized\n");
00478     }
00479     if (x1 >= display->_width || y1 >= display->_height) {
00480         pynq_error("displayDrawRect: x1=%d y1=%d outside screen boundaries\n", x1,
00481             y1);
00482     } else if (x2 >= display->_width || y2 >= display->_height) {

```

```

00483     pynq_error("displayDrawRect: x2=%d y2=%d outside screen boundaries\n", x2,
00484                y2);
00485 }
00486 displayDrawLine(display, x1, y1, x2, y1, color);
00487 displayDrawLine(display, x2, y1, x2, y2, color);
00488 displayDrawLine(display, x2, y2, x1, y2, color);
00489 displayDrawLine(display, x1, y2, x1, y1, color);
00490 }
00491
00492 void displayDrawRectAngle(display_t *display, uint16_t xc, uint16_t yc,
00493                          uint16_t w, uint16_t h, uint16_t angle,
00494                          uint16_t color) {
00495     double xd, yd, rd;
00496     int x1, y1;
00497     int x2, y2;
00498     int x3, y3;
00499     int x4, y4;
00500     rd = -angle * M_PI / 180.0;
00501     xd = 0.0 - w / 2;
00502     yd = h / 2;
00503     x1 = (int)(xd * cos(rd) - yd * sin(rd) + xc);
00504     y1 = (int)(xd * sin(rd) + yd * cos(rd) + yc);
00505
00506     yd = 0.0 - yd;
00507     x2 = (int)(xd * cos(rd) - yd * sin(rd) + xc);
00508     y2 = (int)(xd * sin(rd) + yd * cos(rd) + yc);
00509
00510     xd = w / 2;
00511     yd = h / 2;
00512     x3 = (int)(xd * cos(rd) - yd * sin(rd) + xc);
00513     y3 = (int)(xd * sin(rd) + yd * cos(rd) + yc);
00514
00515     yd = 0.0 - yd;
00516     x4 = (int)(xd * cos(rd) - yd * sin(rd) + xc);
00517     y4 = (int)(xd * sin(rd) + yd * cos(rd) + yc);
00518
00519     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00520         pynq_error("displayDrawRectAngle: display has not been initialized\n");
00521     }
00522     if (x1 >= display->_width || y1 >= display->_height) {
00523         pynq_error("displayDrawRectAngle: x1=%d y1=%d outside screen boundaries\n",
00524                    x1, y1);
00525     } else if (x2 >= display->_width || y2 >= display->_height) {
00526         pynq_error("displayDrawRectAngle: x2=%d y2=%d outside screen boundaries\n",
00527                    x2, y2);
00528     } else if (x3 >= display->_width || y3 >= display->_height) {
00529         pynq_error("displayDrawRectAngle: x3=%d y3=%d outside screen boundaries\n",
00530                    x3, y3);
00531     } else if (x4 >= display->_width || y4 >= display->_height) {
00532         pynq_error("displayDrawRectAngle: x4=%d y4=%d outside screen boundaries\n",
00533                    x4, y4);
00534     }
00535
00536     displayDrawLine(display, x1, y1, x2, y2, color);
00537     displayDrawLine(display, x1, y1, x3, y3, color);
00538     displayDrawLine(display, x2, y2, x4, y4, color);
00539     displayDrawLine(display, x3, y3, x4, y4, color);
00540 }
00541
00542 // x1: First X coordinate of triangle point
00543 // y1: First Y coordinate of triangle point
00544 // x2: Second X coordinate of triangle point
00545 // y2: Second Y coordinate of triangle point
00546 // x3: Third X coordinate of triangle point
00547 // y3: Third Y coordinate of triangle point
00548 // color:color
00549 void displayDrawTriangle(display_t *display, uint16_t x1, uint16_t y1,
00550                          uint16_t x2, uint16_t y2, uint16_t x3, uint16_t y3,
00551                          uint16_t color) {
00552     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00553         pynq_error("displayDrawTriangle: display has not been initialized\n");
00554     }
00555     if (x1 >= display->_width || y1 >= display->_height) {
00556         pynq_error("displayDrawRectAngle: x1=%d y1=%d outside screen boundaries\n",
00557                    x1, y1);
00558     } else if (x2 >= display->_width || y2 >= display->_height) {
00559         pynq_error("displayDrawRectAngle: x2=%d y2=%d outside screen boundaries\n",
00560                    x2, y2);
00561     } else if (x3 >= display->_width || y3 >= display->_height) {
00562         pynq_error("displayDrawRectAngle: x3=%d y3=%d outside screen boundaries\n",
00563                    x3, y3);
00564     }
00565
00566     // draw the lines for the basic triangle
00567     displayDrawLine(display, x1, y1, x2, y2, color);
00568     displayDrawLine(display, x2, y2, x3, y3, color);
00569     displayDrawLine(display, x3, y3, x1, y1, color);

```

```

00570 }
00571
00572 // when the origin is (0, 0), the point (x1, y1) after rotating the point (x, y)
00573 // by the angle is obtained by the following calculation.
00574 // x1 = x * cos(angle) - y * sin(angle)
00575 // y1 = x * sin(angle) + y * cos(angle)
00576 void displayDrawTriangleCenter(display_t *display, uint16_t xc, uint16_t yc,
00577                               uint16_t w, uint16_t h, uint16_t angle,
00578                               uint16_t color) {
00579     double xd, yd, rd;
00580     int x1, y1;
00581     int x2, y2;
00582     int x3, y3;
00583     rd = -angle * M_PI / 180.0;
00584     xd = 0.0;
00585     yd = h / 2;
00586     x1 = (int)(xd * cos(rd) - yd * sin(rd) + xc);
00587     y1 = (int)(xd * sin(rd) + yd * cos(rd) + yc);
00588
00589     xd = w / 2;
00590     yd = 0.0 - yd;
00591     x2 = (int)(xd * cos(rd) - yd * sin(rd) + xc);
00592     y2 = (int)(xd * sin(rd) + yd * cos(rd) + yc);
00593
00594     xd = 0.0 - w / 2;
00595     x3 = (int)(xd * cos(rd) - yd * sin(rd) + xc);
00596     y3 = (int)(xd * sin(rd) + yd * cos(rd) + yc);
00597
00598     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00599         pynq_error("displayDrawTriangleCenter: display has not been initialized\n");
00600     }
00601     if (x1 >= display->_width || y1 >= display->_height) {
00602         pynq_error("displayDrawRectAngle: x1=%d y1=%d outside screen boundaries\n",
00603                   x1, y1);
00604     } else if (x2 >= display->_width || y2 >= display->_height) {
00605         pynq_error("displayDrawRectAngle: x2=%d y2=%d outside screen boundaries\n",
00606                   x2, y2);
00607     } else if (x3 >= display->_width || y3 >= display->_height) {
00608         pynq_error("displayDrawRectAngle: x3=%d y3=%d outside screen boundaries\n",
00609                   x3, y3);
00610     }
00611
00612     displayDrawLine(display, x1, y1, x2, y2, color);
00613     displayDrawLine(display, x1, y1, x3, y3, color);
00614     displayDrawLine(display, x2, y2, x3, y3, color);
00615 }
00616
00617 void displayDrawCircle(display_t *display, uint16_t x_center, uint16_t y_center,
00618                       uint16_t r, uint16_t color) {
00619     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00620         pynq_error("displayDrawCircle: display has not been initialized\n");
00621     }
00622     if (r == 0) {
00623         pynq_error(
00624             "displayDrawCircle: x_center=%d y_center=%d r=%d r cannot be 0\n",
00625             x_center, y_center, r);
00626     }
00627
00628     int x_max = x_center + r, x_min = x_center - r, y_max = y_center + r,
00629         y_min = y_center - r;
00630
00631     if (x_max >= display->_width || x_min < 0 || y_max >= display->_height ||
00632         y_min < 0) {
00633         pynq_error("displayDrawCircle: x_center=%d y_center=%d r=%d outside screen "
00634                   "boundaries\n",
00635                   x_center, y_center, r);
00636     }
00637
00638     int x;
00639     int y;
00640     int err;
00641     int old_err;
00642
00643     x = 0;
00644     y = -r;
00645     err = 2 - 2 * r;
00646     do {
00647         displayDrawPixel(display, x_center - x, y_center + y, color);
00648         displayDrawPixel(display, x_center - y, y_center - x, color);
00649         displayDrawPixel(display, x_center + x, y_center - y, color);
00650         displayDrawPixel(display, x_center + y, y_center + x, color);
00651         if ((old_err = err) <= x)
00652             err += ++x * 2 + 1;
00653         if (old_err > y || err > x)
00654             err += ++y * 2 + 1;
00655     } while (y < 0);
00656 }

```

```

00657
00658 void displayDrawFillCircle(display_t *display, uint16_t x_center,
00659                             uint16_t y_center, uint16_t r, uint16_t color) {
00660     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00661         pynq_error("displayDrawFillCircle: display has not been initialized\n");
00662     }
00663     if (r == 0) {
00664         pynq_error(
00665             "displayDrawFillCircle: x_center=%d y_center=%d r=%d r cannot be 0\n",
00666             x_center, y_center, r);
00667     }
00668
00669     int x_max = x_center + r, x_min = x_center - r, y_max = y_center + r,
00670         y_min = y_center - r;
00671
00672     if (x_max >= display->_width || x_min < 0 || y_max >= display->_height ||
00673         y_min < 0) {
00674         pynq_error("displayDrawFillCircle: x_center=%d y_center=%d r=%d outside "
00675             "screen boundaries\n",
00676             x_center, y_center, r);
00677     }
00678
00679     int x;
00680     int y;
00681     int err;
00682     int old_err;
00683     int ChangeX;
00684
00685     x = 0;
00686     y = -r;
00687     err = 2 - 2 * r;
00688     ChangeX = 1;
00689     do {
00690         if (ChangeX) {
00691             displayDrawLine(display, x_center - x, y_center - y, x_center - x,
00692                             y_center + y, color);
00693             displayDrawLine(display, x_center + x, y_center - y, x_center + x,
00694                             y_center + y, color);
00695         } // endif
00696         ChangeX = (old_err = err) <= x;
00697         if (ChangeX)
00698             err += ++x * 2 + 1;
00699         if (old_err > y || err > x)
00700             err += ++y * 2 + 1;
00701     } while (y <= 0);
00702 }
00703
00704 void displayDrawRoundRect(display_t *display, uint16_t x1, uint16_t y1,
00705                             uint16_t x2, uint16_t y2, uint16_t r,
00706                             uint16_t color) {
00707     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00708         pynq_error("displayDrawRoundRect: display has not been initialized\n");
00709     }
00710     if (r == 0) {
00711         pynq_error("displayDrawRoundRect: x_center=%d x1=%d y1=%d r cannot be 0\n",
00712             x1, y1, r);
00713     } else if (x1 >= display->_width || y1 >= display->_height) {
00714         pynq_error("displayDrawRoundRect: x1=%d y1=%d outside screen boundaries\n",
00715             x1, y1);
00716     } else if (x2 >= display->_width || y2 >= display->_height) {
00717         pynq_error("displayDrawRoundRect: x2=%d y2=%d outside screen boundaries\n",
00718             x2, y2);
00719     }
00720     int x;
00721     int y;
00722     int err;
00723     int old_err;
00724     unsigned char temp;
00725
00726     if (x1 > x2) {
00727         temp = x1;
00728         x1 = x2;
00729         x2 = temp;
00730     }
00731
00732     if (y1 > y2) {
00733         temp = y1;
00734         y1 = y2;
00735         y2 = temp;
00736     }
00737
00738     if (_DEBUG_)
00739         printf("x1=%d x2=%d delta=%d r=%d", x1, x2, x2 - x1, r);
00740     if (_DEBUG_)
00741         printf("y1=%d y2=%d delta=%d r=%d", y1, y2, y2 - y1, r);
00742     if (x2 - x1 < r)
00743         return; // TODO add 20190517?

```



```

00744     if (y2 - y1 < r)
00745         return; // TODO add 20190517?
00746
00747     x = 0;
00748     y = -r;
00749     err = 2 - 2 * r;
00750
00751     do {
00752         if (x) {
00753             displayDrawPixel(display, x1 + r - x, y1 + r + y, color);
00754             displayDrawPixel(display, x2 - r + x, y1 + r + y, color);
00755             displayDrawPixel(display, x1 + r - x, y2 - r - y, color);
00756             displayDrawPixel(display, x2 - r + x, y2 - r - y, color);
00757         }
00758         if ((old_err = err) <= x)
00759             err += ++x * 2 + 1;
00760         if (old_err > y || err > x)
00761             err += ++y * 2 + 1;
00762     } while (y < 0);
00763
00764     if (_DEBUG_)
00765         printf("x1+r=%d x2-r=%d", x1 + r, x2 - r);
00766     displayDrawLine(display, x1 + r, y1, x2 - r, y1, color);
00767     displayDrawLine(display, x1 + r, y2, x2 - r, y2, color);
00768     if (_DEBUG_)
00769         printf("y1+r=%d y2-r=%d", y1 + r, y2 - r);
00770     displayDrawLine(display, x1, y1 + r, x1, y2 - r, color);
00771     displayDrawLine(display, x2, y1 + r, x2, y2 - r, color);
00772 }
00773
00774 uint16_t rgb_conv(uint16_t r, uint16_t g, uint16_t b) {
00775     return ((r & 0xF8) << 8) | ((g & 0xFC) << 3) | (b >> 3);
00776 }
00777
00778 int displayDrawChar(display_t *display, FontxFile *fxs, uint16_t x, uint16_t y,
00779                     uint8_t ascii, uint16_t color) {
00780     uint16_t xx, yy, bit, ofs;
00781     unsigned char fonts[128]; // font pattern
00782     unsigned char pw, ph;
00783     int h, w;
00784     uint16_t mask;
00785     bool rc = GetFontx(fxs, ascii, fonts, &pw, &ph);
00786
00787     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00788         pyng_error("displayDrawChar: display has not been initialized\n");
00789     }
00790     if (_DEBUG_) {
00791         printf("_font_direction=%d\n", display->_font_direction);
00792         printf("GetFontx rc=%d pw=%d ph=%d\n", rc, pw, ph);
00793     }
00794
00795     if (!rc) {
00796         pyng_error("displayDrawChar: cannot get font from font file\n");
00797     }
00798
00799     switch (display->_font_direction) {
00800     case TEXT_DIRECTION0:
00801         if (x + pw >= display->_width || y + ph >= display->_height) {
00802             pyng_error("displayDrawChar: x=%d y=%d for font height=%d width=%d and "
00803                       "direction=%d outside screen boundaries\n",
00804                       x, y, ph, pw, display->_font_direction);
00805         }
00806         break;
00807     case TEXT_DIRECTION90:
00808         if (x + ph >= display->_height || y + pw >= display->_width) {
00809             pyng_error("displayDrawChar: x=%d y=%d for font height=%d width=%d and "
00810                       "direction=%d outside screen boundaries\n",
00811                       x, y, ph, pw, display->_font_direction);
00812         }
00813         break;
00814     case TEXT_DIRECTION180:
00815         if (x - pw <= 0 || y - ph <= 0) {
00816             pyng_error("displayDrawChar: x=%d y=%d for font height=%d width=%d and "
00817                       "direction=%d outside screen boundaries\n",
00818                       x, y, ph, pw, display->_font_direction);
00819         }
00820         break;
00821     case TEXT_DIRECTION270:
00822         if (x - ph <= 0 || y - pw <= 0) {
00823             pyng_error("displayDrawChar: x=%d y=%d for font height=%d width=%d and "
00824                       "direction=%d outside screen boundaries\n",
00825                       x, y, ph, pw, display->_font_direction);
00826         }
00827         break;
00828     }
00829
00830     int16_t xd1 = 0, yd1 = 0, xd2 = 0, yd2 = 0;

```

```

00831     uint16_t xss = 0, yss = 0;
00832     int16_t xsd = 0, ysd = 0, next = 0;
00833     uint16_t x0 = 0, x1 = 0, y0 = 0, y1 = 0;
00834     if (display->_font_direction == 0) {
00835         xd1 = +1;
00836         yd1 = +1; //-1;
00837         xd2 = 0;
00838         yd2 = 0;
00839         xss = x;
00840         yss = y - (ph - 1);
00841         xsd = 1;
00842         ysd = 0;
00843         next = x + pw;
00844
00845         x0 = x;
00846         y0 = y - (ph - 1);
00847         x1 = x + (pw - 1);
00848         y1 = y;
00849     } else if (display->_font_direction == 2) {
00850         xd1 = -1;
00851         yd1 = -1; //+1;
00852         xd2 = 0;
00853         yd2 = 0;
00854         xss = x;
00855         yss = y + ph + 1;
00856         xsd = 1;
00857         ysd = 0;
00858         next = x - pw;
00859
00860         x0 = x - (pw - 1);
00861         y0 = y;
00862         x1 = x;
00863         y1 = y + (ph - 1);
00864     } else if (display->_font_direction == 1) {
00865         xd1 = 0;
00866         yd1 = 0;
00867         xd2 = -1;
00868         yd2 = +1; //-1;
00869         xss = x + ph;
00870         yss = y;
00871         xsd = 0;
00872         ysd = 1;
00873         next = y + pw; // y - pw;
00874
00875         x0 = x;
00876         y0 = y;
00877         x1 = x + (ph - 1);
00878         y1 = y + (pw - 1);
00879     } else if (display->_font_direction == 3) {
00880         xd1 = 0;
00881         yd1 = 0;
00882         xd2 = +1;
00883         yd2 = -1; //+1;
00884         xss = x - (ph - 1);
00885         yss = y;
00886         xsd = 0;
00887         ysd = 1;
00888         next = y - pw; // y + pw;
00889
00890         x0 = x - (ph - 1);
00891         y0 = y - (pw - 1);
00892         x1 = x;
00893         y1 = y;
00894     }
00895
00896     // TODO: fix the problem of underflow properly some time
00897     if (display->_font_fill && x0 < DISPLAY_WIDTH && y0 < DISPLAY_HEIGHT &&
00898         x1 < DISPLAY_WIDTH && y1 < DISPLAY_HEIGHT) {
00899         displayDrawFillRect(display, x0, y0, x1, y1, display->_font_fill_color);
00900     }
00901
00902     int bits;
00903     if (_DEBUG_)
00904         printf("xss=%d yss=%d\n", xss, yss);
00905     ofs = 0;
00906     yy = yss;
00907     xx = xss;
00908     for (h = 0; h < ph; h++) {
00909         if (xsd)
00910             xx = xss;
00911         if (ysd)
00912             yy = yss;
00913         bits = pw;
00914         for (w = 0; w < ((pw + 4) / 8); w++) {
00915             mask = 0x80;
00916             for (bit = 0; bit < 8; bit++) {
00917                 bits--;

```

```

00918         if (bits < 0)
00919             continue;
00920         // TODO: fix the problem of underflow properly some time
00921         if (fonts[ofs] & mask && xx < DISPLAY_WIDTH && yy < DISPLAY_HEIGHT) {
00922             displayDrawPixel(display, xx, yy, color);
00923         }
00924         // TODO: fix the problem of underflow properly some time
00925         if (h == (ph - 2) && display->_font_underline && xx < DISPLAY_WIDTH &&
00926             yy < DISPLAY_HEIGHT)
00927             displayDrawPixel(display, xx, yy, display->_font_underline_color);
00928         // TODO: fix the problem of underflow properly some time
00929         if (h == (ph - 1) && display->_font_underline && xx < DISPLAY_WIDTH &&
00930             yy < DISPLAY_HEIGHT)
00931             displayDrawPixel(display, xx, yy, display->_font_underline_color);
00932         xx = xx + xd1;
00933         yy = yy + yd2;
00934         mask = mask » 1;
00935     }
00936     ofs++;
00937 }
00938 yy = yy + yd1;
00939 xx = xx + xd2;
00940 }
00941
00942 if (next < 0)
00943     next = 0;
00944 return next;
00945 }
00946
00947 int displayDrawString(display_t *display, FontxFile *fx, uint16_t x, uint16_t y,
00948     uint8_t *ascii, uint16_t color) {
00949     int length = strlen((char *)ascii);
00950     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00951         pynq_error("displayDrawString: display has not been initialized\n");
00952     }
00953     if (_DEBUG_)
00954         printf("displayDrawString length=%d\n", length);
00955     for (int i = 0; i < length; i++) {
00956         if (_DEBUG_)
00957             printf("ascii[%d]=%x x=%d y=%d\n", i, ascii[i], x, y);
00958         if (display->_font_direction == 0)
00959             x = displayDrawChar(display, fx, x, y, ascii[i], color);
00960         if (display->_font_direction == 1)
00961             y = displayDrawChar(display, fx, x, y, ascii[i], color);
00962         if (display->_font_direction == 2)
00963             x = displayDrawChar(display, fx, x, y, ascii[i], color);
00964         if (display->_font_direction == 3)
00965             y = displayDrawChar(display, fx, x, y, ascii[i], color);
00966     }
00967     if (display->_font_direction == 0)
00968         return x;
00969     if (display->_font_direction == 2)
00970         return x;
00971     if (display->_font_direction == 1)
00972         return y;
00973     if (display->_font_direction == 3)
00974         return y;
00975     return 0;
00976 }
00977
00978 void displaySetFontDirection(display_t *display, uint16_t dir) {
00979     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00980         pynq_error("displaySetFontDirection: display has not been initialized\n");
00981     }
00982     display->_font_direction = dir;
00983 }
00984
00985 void displaySetFontFill(display_t *display, uint16_t color) {
00986     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00987         pynq_error("displaySetFontFill: display has not been initialized\n");
00988     }
00989     display->_font_fill = true;
00990     display->_font_fill_color = color;
00991 }
00992
00993 void displayUnsetFontFill(display_t *display) { display->_font_fill = false; }
00994
00995 void displaySetFontUnderLine(display_t *display, uint16_t color) {
00996     if (display == NULL || display->_width != DISPLAY_WIDTH) {
00997         pynq_error("displaySetFontUnderLine: display has not been initialized\n");
00998     }
00999     display->_font_underline = true;
01000     display->_font_underline_color = color;
01001 }
01002
01003 void displayUnsetFontUnderLine(display_t *display) {
01004     if (display == NULL || display->_width != DISPLAY_WIDTH) {

```

```

01005     pynq_error("displayUnsetFontUnderLine: display has not been initialized\n");
01006 }
01007 display->_font_underline = false;
01008 }
01009
01010 void displayBacklightOff(display_t *display) {
01011     if (display == NULL || display->_width != DISPLAY_WIDTH) {
01012         pynq_error("displayBacklightOff: display has not been initialized\n");
01013     }
01014     if (display->_bl >= 0) {
01015         gpio_set_level(display->_bl, 0);
01016     }
01017 }
01018
01019 void displayBacklightOn(display_t *display) {
01020     if (display == NULL || display->_width != DISPLAY_WIDTH) {
01021         pynq_error("displayBacklightOn: display has not been initialized\n");
01022     }
01023     if (display->_bl >= 0) {
01024         gpio_set_level(display->_bl, 1);
01025     }
01026 }
01027
01028 void displayInversionOff(display_t *display) {
01029     if (display == NULL || display->_width != DISPLAY_WIDTH) {
01030         pynq_error("displayInversionOff: display has not been initialized\n");
01031     }
01032     spi_master_write_command(display, 0x21); // display Inversion Off
01033 }
01034
01035 void displayInversionOn(display_t *display) {
01036     if (display == NULL || display->_width != DISPLAY_WIDTH) {
01037         pynq_error("displayInversionOn: display has not been initialized\n");
01038     }
01039     spi_master_write_command(display, 0x20); // display Inversion On
01040 }

```

6.11 library/empty-library/display.c File Reference

#include <display.h>
 Include dependency graph for display.c:

Functions

- void [display_init](#) (display_t *display)
- void [display_destroy](#) (display_t *display)
- void [displayDrawPixel](#) (display_t *display, uint16_t x, uint16_t y, uint16_t color)
- void [displayDrawFillRect](#) (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void [displayFillScreen](#) (display_t *display, uint16_t color)
- void [displayDrawLine](#) (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void [displayDrawRect](#) (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void [displayDrawRectAngle](#) (display_t *display, uint16_t xc, uint16_t yc, uint16_t w, uint16_t h, uint16_t angle, uint16_t color)
- void [displayDrawTriangleCenter](#) (display_t *display, uint16_t xc, uint16_t yc, uint16_t w, uint16_t h, uint16_t angle, uint16_t color)
- void [displayDrawCircle](#) (display_t *display, uint16_t x_center, uint16_t y_center, uint16_t r, uint16_t color)
- void [displayDrawFillCircle](#) (display_t *display, uint16_t x_center, uint16_t y_center, uint16_t r, uint16_t color)
- void [displayDrawRoundRect](#) (display_t *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t r, uint16_t color)
- uint16_t [rgb_conv](#) (uint16_t r, uint16_t g, uint16_t b)
- int [displayDrawChar](#) (display_t *display, FontxFile *fx, uint16_t x, uint16_t y, uint8_t ascii, uint16_t color)
- int [displayDrawString](#) (display_t *display, FontxFile *fx, uint16_t x, uint16_t y, uint8_t *ascii, uint16_t color)
- void [displaySetFontDirection](#) (display_t *display, uint16_t dir)
- void [displaySetFontFill](#) (display_t *display, uint16_t color)
- void [displayUnsetFontFill](#) (display_t *display)

- void `displaySetFontUnderLine` (`display_t` *display, uint16_t color)
- void `displayUnsetFontUnderLine` (`display_t` *display)
- void `displayDisplayOff` (`display_t` *display)
- void `displayDisplayOn` (`display_t` *display)
- void `displayBacklightOff` (`display_t` *display)
- void `displayBacklightOn` (`display_t` *display)
- void `displayInversionOff` (`display_t` *display)
- void `displayInversionOn` (`display_t` *display)
- void `displayDrawTriangle` (`display_t` *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t x3, uint16_t y3, uint16_t color)
- void `display_set_flip` (`display_t` *display, bool xflip, bool yflip)

6.12 display.c

[Go to the documentation of this file.](#)

```
00001 #include <display.h>
00002 void display_init(display_t *display){};
00003 void display_destroy(display_t *display){};
00004 void displayDrawPixel(display_t *display, uint16_t x, uint16_t y,
00005                      uint16_t color){};
00006 void displayDrawFillRect(display_t *display, uint16_t x1, uint16_t y1,
00007                          uint16_t x2, uint16_t y2, uint16_t color){};
00008 void displayFillScreen(display_t *display, uint16_t color){};
00009 void displayDrawLine(display_t *display, uint16_t x1, uint16_t y1, uint16_t x2,
00010                      uint16_t y2, uint16_t color){};
00011 void displayDrawRect(display_t *display, uint16_t x1, uint16_t y1, uint16_t x2,
00012                      uint16_t y2, uint16_t color){};
00013 void displayDrawRectAngle(display_t *display, uint16_t xc, uint16_t yc,
00014                           uint16_t w, uint16_t h, uint16_t angle,
00015                           uint16_t color){};
00016 void displayDrawTriangleCenter(display_t *display, uint16_t xc, uint16_t yc,
00017                                uint16_t w, uint16_t h, uint16_t angle,
00018                                uint16_t color){};
00019 void displayDrawCircle(display_t *display, uint16_t x_center, uint16_t y_center,
00020                        uint16_t r, uint16_t color){};
00021 void displayDrawFillCircle(display_t *display, uint16_t x_center,
00022                             uint16_t y_center, uint16_t r, uint16_t color){};
00023 void displayDrawRoundRect(display_t *display, uint16_t x1, uint16_t y1,
00024                             uint16_t x2, uint16_t y2, uint16_t r, uint16_t color){};
00025 uint16_t rgb_conv(uint16_t r, uint16_t g, uint16_t b){};
00026 int displayDrawChar(display_t *display, FontxFile *fx, uint16_t x, uint16_t y,
00027                     uint8_t ascii, uint16_t color){};
00028 int displayDrawString(display_t *display, FontxFile *fx, uint16_t x, uint16_t y,
00029                       uint8_t *ascii, uint16_t color){};
00030 void displaySetFontDirection(display_t *display, uint16_t dir){};
00031 void displaySetFontFill(display_t *display, uint16_t color){};
00032 void displayUnsetFontFill(display_t *display){};
00033 void displaySetFontUnderLine(display_t *display, uint16_t color){};
00034 void displayUnsetFontUnderLine(display_t *display){};
00035 void displayDisplayOff(display_t *display){};
00036 void displayDisplayOn(display_t *display){};
00037 void displayBacklightOff(display_t *display){};
00038 void displayBacklightOn(display_t *display){};
00039 void displayInversionOff(display_t *display){};
00040 void displayInversionOn(display_t *display){};
00041 void displayDrawTriangle(display_t *display, uint16_t x1, uint16_t y1,
00042                           uint16_t x2, uint16_t y2, uint16_t x3, uint16_t y3,
00043                           uint16_t color){};
00044 void display_set_flip(display_t *display, bool xflip, bool yflip){};
```

6.13 library/display.h File Reference

```
#include <fontx.h>
#include <stdbool.h>
#include <stdint.h>
#include <stdio.h>
#include <string.h>
```

Include dependency graph for display.h: This graph shows which files directly or indirectly include this file:

Data Structures

- struct [display_t](#)

Macros

- #define [DISPLAY_HEIGHT](#) 240
- #define [DISPLAY_WIDTH](#) 240

Enumerations

- enum [colors](#) {
[RGB_RED](#) = 0xf800 , [RGB_GREEN](#) = 0x07e0 , [RGB_BLUE](#) = 0x001f , [RGB_BLACK](#) = 0x0000 ,
[RGB_WHITE](#) = 0xffff , [RGB_GRAY](#) = 0x8c51 , [RGB_YELLOW](#) = 0xFFE0 , [RGB_CYAN](#) = 0x07FF ,
[RGB_PURPLE](#) = 0xF81F }
- enum [directions](#) {
[TEXT_DIRECTION0](#) = 0 , [TEXT_DIRECTION90](#) = 1 , [TEXT_DIRECTION180](#) = 2 , [TEXT_DIRECTION270](#) =
3 ,
[NUM_TEXT_DIRECTIONS](#) }

Functions

- void [display_init](#) ([display_t](#) *display)
- void [display_destroy](#) ([display_t](#) *display)
- void [displayDrawPixel](#) ([display_t](#) *display, uint16_t x, uint16_t y, uint16_t color)
- void [displayDrawFillRect](#) ([display_t](#) *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void [displayFillScreen](#) ([display_t](#) *display, uint16_t color)
- void [displayDrawLine](#) ([display_t](#) *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void [displayDrawRect](#) ([display_t](#) *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t color)
- void [displayDrawRectAngle](#) ([display_t](#) *display, uint16_t xc, uint16_t yc, uint16_t w, uint16_t h, uint16_t angle, uint16_t color)
- void [displayDrawTriangleCenter](#) ([display_t](#) *display, uint16_t xc, uint16_t yc, uint16_t w, uint16_t h, uint16_t angle, uint16_t color)
- void [displayDrawCircle](#) ([display_t](#) *display, uint16_t x_center, uint16_t y_center, uint16_t r, uint16_t color)
- void [displayDrawFillCircle](#) ([display_t](#) *display, uint16_t x_center, uint16_t y_center, uint16_t r, uint16_t color)
- void [displayDrawRoundRect](#) ([display_t](#) *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t r, uint16_t color)
- uint16_t [rgb_conv](#) (uint16_t r, uint16_t g, uint16_t b)
- int [displayDrawChar](#) ([display_t](#) *display, [FontxFile](#) *fx, uint16_t x, uint16_t y, uint8_t ascii, uint16_t color)
- int [displayDrawString](#) ([display_t](#) *display, [FontxFile](#) *fx, uint16_t x, uint16_t y, uint8_t *ascii, uint16_t color)
- void [displaySetFontDirection](#) ([display_t](#) *display, uint16_t dir)
- void [displaySetFontFill](#) ([display_t](#) *display, uint16_t color)
- void [displayUnsetFontFill](#) ([display_t](#) *display)
- void [displaySetFontUnderLine](#) ([display_t](#) *display, uint16_t color)
- void [displayUnsetFontUnderLine](#) ([display_t](#) *display)
- void [displayDisplayOff](#) ([display_t](#) *display)
- void [displayDisplayOn](#) ([display_t](#) *display)
- void [displayBacklightOff](#) ([display_t](#) *display)
- void [displayBacklightOn](#) ([display_t](#) *display)
- void [displayInversionOff](#) ([display_t](#) *display)
- void [displayInversionOn](#) ([display_t](#) *display)
- void [displayDrawTriangle](#) ([display_t](#) *display, uint16_t x1, uint16_t y1, uint16_t x2, uint16_t y2, uint16_t x3, uint16_t y3, uint16_t color)
- void [display_set_flip](#) ([display_t](#) *display, bool xflip, bool yflip)

6.14 display.h

[Go to the documentation of this file.](#)

```

00001  /*
00002  Copyright (c) 2023 Eindhoven University of Technology
00003
00004  Permission is hereby granted, free of charge, to any person obtaining a copy
00005  of this software and associated documentation files (the "Software"), to deal
00006  in the Software without restriction, including without limitation the rights
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00009  furnished to do so, subject to the following conditions:
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00013
00014  THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015  IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016  FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017  AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018  LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019  OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020  SOFTWARE.
00021  */
00022  #ifndef SCREEN_H
00023  #define SCREEN_H
00024
00025  #include <fontx.h>
00026  #include <stdbool.h>
00027  #include <stdint.h>
00028  #include <stdio.h>
00029  #include <string.h>
00030
00079  #define DISPLAY_HEIGHT 240
00080  #define DISPLAY_WIDTH 240
00081
00085  enum colors {
00086      RGB_RED = 0xf800,
00087      RGB_GREEN = 0x07e0,
00088      RGB_BLUE = 0x001f,
00089      RGB_BLACK = 0x0000,
00090      RGB_WHITE = 0xffff,
00091      RGB_GRAY = 0x8c51,
00092      RGB_YELLOW = 0xffe0,
00093      RGB_CYAN = 0x07ff,
00094      RGB_PURPLE = 0xf81f
00095  };
00096
00100  enum directions {
00101      TEXT_DIRECTION0 = 0,
00102      TEXT_DIRECTION90 = 1,
00103      TEXT_DIRECTION180 = 2,
00104      TEXT_DIRECTION270 = 3,
00105      NUM_TEXT_DIRECTIONS
00106  };
00107
00112  typedef struct {
00113      uint16_t _width;
00114      uint16_t _height;
00115      uint16_t _offsetx;
00116      uint16_t _offsety;
00117      uint16_t _font_direction;
00118      uint16_t _font_fill;
00119      uint16_t _font_fill_color;
00120      uint16_t _font_underline;
00121      uint16_t _font_underline_color;
00122      int16_t _dc;
00123      int16_t _bl;
00124  } display_t;
00125
00130  extern void display_init(display_t *display);
00131
00136  extern void display_destroy(display_t *display);
00137
00145  extern void displayDrawPixel(display_t *display, uint16_t x, uint16_t y,
00146                               uint16_t color);
00147
00157  extern void displayDrawFillRect(display_t *display, uint16_t x1, uint16_t y1,
00158                               uint16_t x2, uint16_t y2, uint16_t color);
00159
00166  extern void displayFillScreen(display_t *display, uint16_t color);
00167
00177  extern void displayDrawLine(display_t *display, uint16_t x1, uint16_t y1,
00178                               uint16_t x2, uint16_t y2, uint16_t color);
00179

```

```

00189 extern void displayDrawRect(display_t *display, uint16_t x1, uint16_t y1,
00190                             uint16_t x2, uint16_t y2, uint16_t color);
00191
00204 extern void displayDrawRectAngle(display_t *display, uint16_t xc, uint16_t yc,
00205                                 uint16_t w, uint16_t h, uint16_t angle,
00206                                 uint16_t color);
00207
00218 extern void displayDrawTriangleCenter(display_t *display, uint16_t xc,
00219                                     uint16_t yc, uint16_t w, uint16_t h,
00220                                     uint16_t angle, uint16_t color);
00221
00230 extern void displayDrawCircle(display_t *display, uint16_t x_center,
00231                               uint16_t y_center, uint16_t r, uint16_t color);
00232
00241 extern void displayDrawFillCircle(display_t *display, uint16_t x_center,
00242                                   uint16_t y_center, uint16_t r,
00243                                   uint16_t color);
00244
00255 extern void displayDrawRoundRect(display_t *display, uint16_t x1, uint16_t y1,
00256                                 uint16_t x2, uint16_t y2, uint16_t r,
00257                                 uint16_t color);
00258
00265 extern uint16_t rgb_conv(uint16_t r, uint16_t g, uint16_t b);
00266
00281 extern int displayDrawChar(display_t *display, FontxFile *fx, uint16_t x,
00282                             uint16_t y, uint8_t ascii, uint16_t color);
00283
00299 extern int displayDrawString(display_t *display, FontxFile *fx, uint16_t x,
00300                              uint16_t y, uint8_t *ascii, uint16_t color);
00301
00307 extern void displaySetFontDirection(display_t *display, uint16_t dir);
00308
00315 extern void displaySetFontFill(display_t *display, uint16_t color);
00316
00323 extern void displayUnsetFontFill(display_t *display);
00324
00332 extern void displaySetFontUnderLine(display_t *display, uint16_t color);
00333
00338 extern void displayUnsetFontUnderLine(display_t *display);
00339
00344 extern void displayDisplayOff(display_t *display);
00345
00354 extern void displayDisplayOn(display_t *display);
00355
00360 extern void displayBacklightOff(display_t *display);
00361
00366 extern void displayBacklightOn(display_t *display);
00367
00372 extern void displayInversionOff(display_t *display);
00373
00378 extern void displayInversionOn(display_t *display);
00379
00393 extern void displayDrawTriangle(display_t *display, uint16_t x1, uint16_t y1,
00394                                 uint16_t x2, uint16_t y2, uint16_t x3,
00395                                 uint16_t y3, uint16_t color);
00396
00403 void display_set_flip(display_t *display, bool xflip, bool yflip);
00408 #endif /* MAIN_ST7789_H_ */

```

6.15 library/adc.c File Reference

```

#include <adc.h>
#include <arm_shared_memory_system.h>
#include <errno.h>
#include <log.h>
#include <platform.h>
#include <stdio.h>
#include <stdlib.h>

```

Include dependency graph for adc.c:

6.16 adc.c

[Go to the documentation of this file.](#)


```

00001 /*
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00003
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00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <adc.h>
00023 #include <arm_shared_memory_system.h>
00024 #include <errno.h>
00025 #include <log.h>
00026 #include <platform.h>
00027 #include <stdio.h>
00028 #include <stdlib.h>
00029
00030 static struct arm_shared_t adc_handle;
00031 static volatile uint32_t *adc = NULL;
00032
00033 static const uint32_t twopow16 = 0b100000000000000000;
00034
00035 bool invalid_channel_adc(const adc_channel_t channel) {
00036     if (channel == ADC0) {
00037         return false;
00038     }
00039     if (channel == ADC1) {
00040         return false;
00041     }
00042     if (channel == ADC2) {
00043         return false;
00044     }
00045     if (channel == ADC3) {
00046         return false;
00047     }
00048     if (channel == ADC4) {
00049         return false;
00050     }
00051     if (channel == ADC5) {
00052         return false;
00053     }
00054     return true;
00055 }
00056
00057 bool initialized_adc(void) {
00058     if (adc == NULL) {
00059         return false;
00060     }
00061     return true;
00062 }
00063
00064 bool check_initialized_adc(void) {
00065     if (!initialized_adc()) {
00066         pyng_error("The ADC has not been initialized\n");
00067     }
00068     return true;
00069 }
00070
00071 bool check_channel_adc(const adc_channel_t channel) {
00072     if (invalid_channel_adc(channel)) {
00073         pyng_error("Invalid ADC channel %d\n", channel);
00074     }
00075     return true;
00076 }
00077
00078 void adc_init(void) { adc = arm_shared_init(&adc_handle, xadc_wiz_0, 4096); }
00079
00080 void adc_destroy(void) {
00081     if (adc != NULL) {
00082         (void)arm_shared_close(&adc_handle);
00083         adc = NULL;
00084     }
00085 }
00086
00087 double adc_read_channel(const adc_channel_t channel) {

```

```

00088     (void)check_channel_adc(channel);
00089     (void)check_initialized_adc();
00090
00091     // TODO we need to calibrate this
00092     double value = adc[channel] * (3.23 / twopow16);
00093
00094     return value;
00095 }
00096
00097 uint32_t adc_read_channel_raw(adc_channel_t channel) {
00098     (void)check_channel_adc(channel);
00099     (void)check_initialized_adc();
00100
00101     if (adc == NULL) {
00102         return UINT32_MAX;
00103     }
00104     uint32_t value = adc[channel];
00105
00106     return value;
00107 }

```

6.17 library/empty-library/adc.c File Reference

```

#include <adc.h>
#include <arm_shared_memory_system.h>

```

Include dependency graph for adc.c:

Functions

- bool [initialized_adc](#) (void)
- void [adc_init](#) (void)
- void [adc_destroy](#) (void)
- double [adc_read_channel](#) ([adc_channel_t](#) channel)
- uint32_t [adc_read_channel_raw](#) ([adc_channel_t](#) channel)

6.18 adc.c

[Go to the documentation of this file.](#)

```

00001 #include <adc.h>
00002 #include <arm_shared_memory_system.h>
00003 bool initialized_adc(void) {};
00004 void adc_init(void) {};
00005 void adc_destroy(void) {};
00006 double adc_read_channel(adc_channel_t channel) {};
00007 uint32_t adc_read_channel_raw(adc_channel_t channel) {};

```

6.19 library/arm_shared_memory_system.c File Reference

```

#include <arm_shared_memory_system.h>
#include <errno.h>
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/mman.h>
#include <sys/types.h>
#include <unistd.h>

```

Include dependency graph for arm_shared_memory_system.c:

Functions

- void * [arm_shared_init](#) (arm_shared *handle, const uint32_t address, const uint32_t length)
- void [arm_shared_close](#) (arm_shared *handle)

6.20 arm_shared_memory_system.c

[Go to the documentation of this file.](#)

```

00001 /*
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00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
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00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
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00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
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00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <arm_shared_memory_system.h>
00023 #include <errno.h>
00024 #include <fcntl.h>
00025 #include <stdio.h>
00026 #include <stdlib.h>
00027 #include <string.h>
00028 #include <sys/mman.h>
00029 #include <sys/types.h>
00030 #include <unistd.h>
00031
00032 void *arm_shared_init(arm_shared *handle, const uint32_t address,
00033                      const uint32_t length) {
00034     if (handle == NULL) {
00035         fprintf(stderr, "You need to pass a valid handle to %s\n", __FUNCTION__);
00036         exit(EXIT_FAILURE);
00037     }
00038
00039     handle->address = address;
00040     handle->length = length;
00041     handle->file_descriptor = open("/dev/mem", O_RDWR | O_SYNC);
00042     if (handle->file_descriptor < 0) {
00043         fprintf(stderr,
00044             "FAILED open memory: %s, please run with sufficient permissions "
00045             "(sudo).\n",
00046             strerror(errno));
00047         exit(EXIT_FAILURE);
00048     }
00049
00050     long page_size = sysconf(_SC_PAGE_SIZE);
00051
00052     uint32_t start_address = handle->address;
00053     uint32_t page_offset = start_address % page_size;
00054     start_address -= page_offset;
00055     handle->length += page_offset;
00056
00057     handle->mmapped_region =
00058         mmap(NULL, handle->length, PROT_READ | PROT_WRITE, MAP_SHARED,
00059             handle->file_descriptor, start_address);
00060
00061     if (handle->mmapped_region == MAP_FAILED) {
00062         fprintf(stderr, "FAILED to memory map requested region: %s\n",
00063             strerror(errno));
00064         close(handle->file_descriptor);
00065         exit(EXIT_FAILURE);
00066     }
00067     return (void *)(((uint32_t)(handle->mmapped_region)) + page_offset);
00068 }
00069
00070 void arm_shared_close(arm_shared *handle) {
00071     if (handle == NULL) {
00072         fprintf(stderr, "You need to pass a valid handle to %s\n", __FUNCTION__);

```

```

00073     exit(EXIT_FAILURE);
00074 }
00075 if (handle->mmapped_region != MAP_FAILED) {
00076     munmap(handle->mmapped_region, handle->length);
00077 }
00078 if (handle->file_descriptor >= 0) {
00079     close(handle->file_descriptor);
00080 }
00081 }

```

6.21 library/empty-library/arm_shared_memory_system.c File Reference

#include <arm_shared_memory_system.h>
 Include dependency graph for arm_shared_memory_system.c:

Functions

- void * [arm_shared_init](#) ([arm_shared](#) *handle, const uint32_t address, const uint32_t length)
- void [arm_shared_close](#) ([arm_shared](#) *handle)

6.22 arm_shared_memory_system.c

[Go to the documentation of this file.](#)

```

00001 #include <arm_shared_memory_system.h>
00002 void *arm_shared_init(arm\_shared *handle, const uint32_t address, const uint32_t length) {};
00003 void arm_shared_close(arm\_shared *handle) {};

```

6.23 library/audio.c File Reference

```

#include "audio.h"
#include <libpynq.h>
#include <stdint.h>
#include "i2cps.h"
#include "uio.h"
#include <fcntl.h>
#include <linux/i2c-dev.h>
#include <math.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/ioctl.h>
#include <sys/mman.h>
#include <sys/stat.h>
#include <time.h>
#include <unistd.h>

```

Include dependency graph for audio.c:

Macros

- #define [SAMPLE_RATE](#) 44100
- #define [LOG_DOMAIN](#) "audio"

Functions

- void [audio_init](#) (void)
- void [audio_select_input](#) (int input)
- void [write_audio_reg](#) (unsigned char u8RegAddr, unsigned char u8Data, int iic_fd)
- void [config_audio_pll](#) (void)
- void [config_audio_codec](#) (void)
- void [select_line_in](#) (void)
- void [select_mic](#) (void)
- void [deselect](#) (void)
- void [audio_bypass](#) (unsigned int audio_mmap_size, unsigned int nsamples, unsigned int volume, int uio_index)
- void [audio_record](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, int uio_index)
- void [audio_play](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, unsigned int volume, int uio_index)
- void [audio_repeat_play](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, unsigned int volume, unsigned int repetitions)
- void [audio_generate_tone](#) (unsigned int frequency, uint32_t time_ms, unsigned int volume)

6.23.1 Macro Definition Documentation

6.23.1.1 LOG_DOMAIN

```
#define LOG_DOMAIN "audio"
```

Definition at line 70 of file [audio.c](#).

6.23.1.2 SAMPLE_RATE

```
#define SAMPLE_RATE 44100
```

Definition at line 67 of file [audio.c](#).

6.24 audio.c

[Go to the documentation of this file.](#)

```
00001 /*****
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00003  * All rights reserved.
00004  *
00005  * Redistribution and use in source and binary forms, with or without
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00008  * 1. Redistributions of source code must retain the above copyright notice,
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00010  *
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00014  *
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```

```

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00028 * OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF
00029 * ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
00030 *
00031 *****/
00032
00033 /*****
00034 * @file audio_adau1761.c
00035 *
00036 * Functions to control audio controller.
00037 *
00038 * <pre>
00039 * MODIFICATION HISTORY:
00040 *
00041 * Ver    Who        Date    Changes
00042 * ----   -
00043 * 1.00   Yun Rock Qu  12/04/17 Support for audio codec ADAU1761
00044 * 1.01   Yun Rock Qu  01/02/18 Enable microphone for CTIA and OMTP standards
00045 *
00046 * </pre>
00047 *
00048 *****/
00049 #include "audio.h"
00050 #include <libpynq.h>
00051 #include <stdint.h>
00052
00053 #include "i2cps.h"
00054 #include "uio.h"
00055 #include <fcntl.h>
00056 #include <linux/i2c-dev.h>
00057 #include <math.h>
00058 #include <stdio.h>
00059 #include <stdlib.h>
00060 #include <string.h>
00061 #include <sys/ioctl.h>
00062 #include <sys/mman.h>
00063 #include <sys/stat.h>
00064 #include <time.h>
00065 #include <unistd.h>
00066
00067 #define SAMPLE_RATE 44100
00068
00069 #undef LOG_DOMAIN
00070 #define LOG_DOMAIN "audio"
00071
00072 void audio_init(void) {
00073     config_audio_pll();
00074     config_audio_codec();
00075 }
00076
00077 void audio_select_input(int input) {
00078     if (input == MIC) {
00079         selectMic();
00080     } else if (input == LINE_IN) {
00081         select_line_in();
00082     } else {
00083         pynq_error("audio_select_input: invalid input %d, must be LINE_IN or MIC\n",
00084             input);
00085     }
00086 }
00087
00088 // Original ADAU1761 code
00089
00090 void write_audio_reg(unsigned char u8RegAddr, unsigned char u8Data,
00091     int iic_fd) {
00092     unsigned char u8TxData[3];
00093     u8TxData[0] = 0x40;
00094     u8TxData[1] = u8RegAddr;
00095     u8TxData[2] = u8Data;
00096     if (writeI2C_asFile(iic_fd, u8TxData, 3) < 0) {
00097         pynq_error("write_audio_reg: unable to write audio register, ensure sudo "
00098             "chmod 666 /dev/i2c-1 has been executed. \n");
00099     }
00100 }
00101
00102 void config_audio_pll(void) {
00103     int iic_index = 1;
00104     unsigned char u8TxData[8], u8RxData[6];
00105     int iic_fd;
00106     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00107     if (iic_fd < 0) {
00108         pynq_error("config_audio_pll: unable to set I2C %d\n", iic_index);

```

```

00109     }
00110
00111     // Disable Core Clock
00112     write_audio_reg(R0_CLOCK_CONTROL, 0x0E, iic_fd);
00113     /* MCLK = 10 MHz
00114      * R = 0100 = 4, N = 0x064C = 1612, M = 0x0C35 = 3125
00115      * PLL required output = 1024x44.1 KHz = 45.1584 MHz
00116      * PLLout/MCLK = 45.1584 MHz/10 MHz = 4.51584 MHz
00117      * = R + (N/M)
00118      * = 4 + (1612/3125)
00119      * Fs = PLL/1024 = 44.1 KHz
00120     */
00121
00122     // Register write address [15:8]
00123     u8TxData[0] = 0x40;
00124     // Register write address [7:0]
00125     u8TxData[1] = 0x02;
00126     // byte 6 - M[15:8]
00127     u8TxData[2] = 0x0C;
00128     // byte 5 - M[7:0]
00129     u8TxData[3] = 0x35;
00130     // byte 4 - N[15:8]
00131     u8TxData[4] = 0x06;
00132     // byte 3 - N[7:0]
00133     u8TxData[5] = 0x4C;
00134     // byte 2 - bits 6:3 = R[3:0], 2:1 = X[1:0], 0 = PLL operation mode
00135     u8TxData[6] = 0x21;
00136     // byte 1 - 1 = PLL Lock, 0 = Core clock enable
00137     u8TxData[7] = 0x03;
00138     // Write bytes to PLL control register R1 at 0x4002
00139     if (writeI2C_asFile(iic_fd, u8TxData, 8) < 0) {
00140         pyng_error("config_audio_pll: unable to write audio register, ensure sudo "
00141             "chmod 666 /dev/i2c-1 has been executed. \n");
00142     }
00143
00144     // Poll PLL Lock bit
00145     u8TxData[0] = 0x40;
00146     u8TxData[1] = 0x02;
00147     do {
00148         if (writeI2C_asFile(iic_fd, u8TxData, 2) < 0) {
00149             pyng_error("writeI2C_asFile: unable to write audio register, ensure sudo "
00150                 "chmod 666 /dev/i2c-1 has been executed. \n");
00151         }
00152         if (readI2C_asFile(iic_fd, u8RxData, 6) < 0) {
00153             pyng_error("readI2C_asFile: unable to write audio register, ensure sudo "
00154                 "chmod 666 /dev/i2c-1 has been executed. \n");
00155         }
00156     } while ((u8RxData[5] & 0x02) == 0);
00157
00158     /* Clock control register: bit 3          CLKSRC = PLL Clock input
00159      *                          bit 2:1        INFREQ = 1024 x fs
00160      *                          bit 0          COREN = Core Clock enabled
00161     */
00162     write_audio_reg(R0_CLOCK_CONTROL, 0x0F, iic_fd);
00163
00164     if (unsetI2C(iic_fd) < 0) {
00165         pyng_error("config_audio_pll: unable to set I2C %d\n", iic_fd);
00166     }
00167 }
00168
00169 /*****
00170  * Function to configure the audio codec.
00171  * @param iic_index is the i2c index in /dev list.
00172  * @return none.
00173  *****/
00174 void config_audio_codec(void) {
00175     int iic_index = 1;
00176     int iic_fd;
00177     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00178     if (iic_fd < 0) {
00179         pyng_error("config_audio_codec: unable to set I2C %d\n", iic_index);
00180     }
00181
00182     /*
00183      * Input path control registers are configured
00184      * in select_mic and select_line_in
00185     */
00186
00187     // Mute Mixer1 and Mixer2 here, enable when MIC and Line In used
00188     write_audio_reg(R4_RECORD_MIXER_LEFT_CONTROL_0, 0x00, iic_fd);
00189     write_audio_reg(R6_RECORD_MIXER_RIGHT_CONTROL_0, 0x00, iic_fd);
00190     // Set LDVOL and RDVOL to 21 dB and Enable left and right differential
00191     write_audio_reg(R8_LEFT_DIFFERENTIAL_INPUT_VOLUME_CONTROL, 0xB3, iic_fd);
00192     write_audio_reg(R9_RIGHT_DIFFERENTIAL_INPUT_VOLUME_CONTROL, 0xB3, iic_fd);
00193     // Enable MIC bias
00194     write_audio_reg(R10_RECORD_MICROPHONE_BIAS_CONTROL, 0x01, iic_fd);
00195     // Enable ALC control and noise gate

```

```

00196 write_audio_reg(R14_ALC_CONTROL_3, 0x20, iic_fd);
00197 // Put CODEC in Master mode
00198 write_audio_reg(R15_SERIAL_PORT_CONTROL_0, 0x01, iic_fd);
00199 // Enable ADC on both channels, normal polarity and ADC high-pass filter
00200 write_audio_reg(R19_ADC_CONTROL, 0x33, iic_fd);
00201 // Mute play back Mixer3 and Mixer4 and enable when output is required
00202 write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x00, iic_fd);
00203 write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x00, iic_fd);
00204 // Mute left input to mixer3 (R23) and right input to mixer4 (R25)
00205 write_audio_reg(R23_PLAYBACK_MIXER_LEFT_CONTROL_1, 0x00, iic_fd);
00206 write_audio_reg(R25_PLAYBACK_MIXER_RIGHT_CONTROL_1, 0x00, iic_fd);
00207 // Mute left and right channels output; enable them when output is needed
00208 write_audio_reg(R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL, 0xE5, iic_fd);
00209 write_audio_reg(R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL, 0xE5, iic_fd);
00210 // Enable play back right and left channels
00211 write_audio_reg(R35_PLAYBACK_POWER_MANAGEMENT, 0x03, iic_fd);
00212 // Enable DAC for both channels
00213 write_audio_reg(R36_DAC_CONTROL_0, 0x03, iic_fd);
00214 // Set SDATA_In to DAC
00215 write_audio_reg(R58_SERIAL_INPUT_ROUTE_CONTROL, 0x01, iic_fd);
00216 // Set SDATA_Out to ADC
00217 write_audio_reg(R59_SERIAL_OUTPUT_ROUTE_CONTROL, 0x01, iic_fd);
00218 // Enable DSP and DSP Run
00219 write_audio_reg(R61_DSP_ENABLE, 0x01, iic_fd);
00220 write_audio_reg(R62_DSP_RUN, 0x01, iic_fd);
00221 /*
00222  * Enable Digital Clock Generator 0 and 1.
00223  * Generator 0 generates sample rates for the ADCs, DACs, and DSP.
00224  * Generator 1 generates BCLK and LRCLK for the serial port.
00225  */
00226 write_audio_reg(R65_CLOCK_ENABLE_0, 0x7F, iic_fd);
00227 write_audio_reg(R66_CLOCK_ENABLE_1, 0x03, iic_fd);
00228
00229 if (unsetI2C(iic_fd) < 0) {
00230     pynq_error("config_audio_codec: unable to unset I2C %d\n", iic_index);
00231 }
00232 }
00233
00234 void select_line_in(void) {
00235     int iic_index = 1;
00236     int iic_fd;
00237     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00238     if (iic_fd < 0) {
00239         pynq_error("select_line_in: unable to set I2C %d\n", iic_index);
00240     }
00241
00242     // Mixer 1 (left channel)
00243     write_audio_reg(R4_RECORD_MIXER_LEFT_CONTROL_0, 0x01, iic_fd);
00244     // Enable LAUX (MX1AUXG)
00245     write_audio_reg(R5_RECORD_MIXER_LEFT_CONTROL_1, 0x07, iic_fd);
00246
00247     // Mixer 2
00248     write_audio_reg(R6_RECORD_MIXER_RIGHT_CONTROL_0, 0x01, iic_fd);
00249     // Enable RAUX (MX2AUXG)
00250     write_audio_reg(R7_RECORD_MIXER_RIGHT_CONTROL_1, 0x07, iic_fd);
00251
00252     if (unsetI2C(iic_fd) < 0) {
00253         pynq_error("select_line_in: unable to unset I2C %d\n", iic_index);
00254     }
00255 }
00256
00257 void select_mic(void) {
00258     int iic_index = 1;
00259     int iic_fd;
00260     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00261     if (iic_fd < 0) {
00262         pynq_error("select_mic: unable to set I2C %d, ensure sudo chmod 666 "
00263             "/dev/i2c-1 has been executed\n",
00264             iic_index);
00265     }
00266
00267     // Mixer 1 (left channel)
00268     write_audio_reg(R4_RECORD_MIXER_LEFT_CONTROL_0, 0x01, iic_fd);
00269     // LDBOOST, set to 20 dB
00270     write_audio_reg(R5_RECORD_MIXER_LEFT_CONTROL_1, 0x10, iic_fd);
00271     // LDVOL, set to 21 dB
00272     write_audio_reg(R8_LEFT_DIFFERENTIAL_INPUT_VOLUME_CONTROL, 0xB3, iic_fd);
00273
00274     // Mixer 2 (right channel)
00275     write_audio_reg(R6_RECORD_MIXER_RIGHT_CONTROL_0, 0x01, iic_fd);
00276     // RDBOOST, set to 20 dB
00277     write_audio_reg(R7_RECORD_MIXER_RIGHT_CONTROL_1, 0x10, iic_fd);
00278     // RDVOL, set to 21 dB
00279     write_audio_reg(R9_RIGHT_DIFFERENTIAL_INPUT_VOLUME_CONTROL, 0xB3, iic_fd);
00280
00281     if (unsetI2C(iic_fd) < 0) {
00282         pynq_error("select_mic: unable to unset I2C %d\n", iic_index);

```



```

00283     }
00284 }
00285
00286 void deselect(void) {
00287     int iic_index = 1;
00288     int iic_fd;
00289     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00290     if (iic_fd < 0) {
00291         pynq_error("deselect: unable to set I2C %d\n", iic_index);
00292     }
00293
00294     // mute mixer 1 in left channel
00295     write_audio_reg(R4_RECORD_MIXER_LEFT_CONTROL_0, 0x00, iic_fd);
00296     // mute mixer 2 in right channel
00297     write_audio_reg(R6_RECORD_MIXER_RIGHT_CONTROL_0, 0x00, iic_fd);
00298
00299     if (unsetI2C(iic_fd) < 0) {
00300         pynq_error("deselect: unable to unset I2C %d\n", iic_index);
00301     }
00302 }
00303
00304 void audio_bypass(unsigned int audio_mmap_size, unsigned int nsamples,
00305                  unsigned int volume, int uio_index) {
00306     if (uio_index > 2) {
00307         pynq_error("audio_bypass: uio_index outside of range. is %d, should be "
00308                  "below 3. \n",
00309                  uio_index);
00310     }
00311     if (volume > 100) {
00312         pynq_error("audio_bypass: volume outside allowed range. Is %d, should be "
00313                  "below 100 \n",
00314                  volume);
00315     }
00316
00317     int iic_index = 1;
00318     int status;
00319     void *uio_ptr;
00320     int DataL, DataR;
00321     int iic_fd;
00322
00323     uio_ptr = setUIO(uio_index, audio_mmap_size);
00324     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00325     if (iic_fd < 0) {
00326         pynq_error("audio_bypass: unable to set I2C %d, ensure sudo chmod 666 "
00327                  "/dev/i2c-1 has been executed\n",
00328                  iic_index);
00329     }
00330
00331     // Mute mixer1 and mixer2 input
00332     write_audio_reg(R23_PLAYBACK_MIXER_LEFT_CONTROL_1, 0x00, iic_fd);
00333     write_audio_reg(R25_PLAYBACK_MIXER_RIGHT_CONTROL_1, 0x00, iic_fd);
00334     // Enable Mixer3 and Mixer4
00335     write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x21, iic_fd);
00336     write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x41, iic_fd);
00337
00338     unsigned char vol_register = (unsigned char)volume << 2 | 0x3;
00339     // Enable Left/Right Headphone out
00340     write_audio_reg(R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL, vol_register,
00341                    iic_fd);
00342     write_audio_reg(R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL, vol_register,
00343                    iic_fd);
00344
00345     for (unsigned int i = 0; i < nsamples; i++) {
00346         // wait for RX data to become available
00347         do {
00348             status = *((volatile unsigned *)(((uint8_t *)uio_ptr) + I2S_STATUS_REG));
00349         } while (status == 0);
00350         *((volatile unsigned *)(((uint8_t *)uio_ptr) + I2S_STATUS_REG)) =
00351             0x00000001;
00352
00353         // Read the sample from the input
00354         DataL = *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_RX_L_REG));
00355         DataR = *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_RX_R_REG));
00356
00357         // Write the sample to output
00358         *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_TX_L_REG)) = DataL;
00359         *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_TX_R_REG)) = DataR;
00360     }
00361
00362     write_audio_reg(R23_PLAYBACK_MIXER_LEFT_CONTROL_1, 0x00, iic_fd);
00363     write_audio_reg(R25_PLAYBACK_MIXER_RIGHT_CONTROL_1, 0x00, iic_fd);
00364     write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x00, iic_fd);
00365     write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x00, iic_fd);
00366     write_audio_reg(R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL, 0xE5, iic_fd);
00367     write_audio_reg(R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL, 0xE5, iic_fd);
00368
00369     if (unsetUIO(uio_ptr, audio_mmap_size) < 0) {

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00370     pynq_error("audio_bypass: unable to free UIO %d, ensure sudo chmod 666 "
00371               "/dev/i2c-1 has been executed\n",
00372               uio_index);
00373 }
00374 if (unsetI2C(iic_fd) < 0) {
00375     pynq_error("audio_bypass: unable to unset I2C %d, ensure sudo chmod 666 "
00376               "/dev/i2c-1 has been executed\n",
00377               iic_index);
00378 }
00379 }
00380
00381 void audio_record(unsigned int audio_mmap_size, unsigned int *BufAddr,
00382                  unsigned int nsamples, int uio_index) {
00383     if (uio_index > 2) {
00384         pynq_error("audio_record: uio_index outside of range. is %d, should be "
00385                   "below 3. \n",
00386                   uio_index);
00387     }
00388     int iic_index = 1;
00389     unsigned int i, status;
00390     void *uio_ptr;
00391     int DataL, DataR;
00392     int iic_fd;
00393
00394     uio_ptr = setUIO(uio_index, audio_mmap_size);
00395     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00396     if (iic_fd < 0) {
00397         pynq_error("audio_record: unable to set I2C %d, ensure sudo chmod 666 "
00398                   "/dev/i2c-1 has been executed\n",
00399                   iic_index);
00400     }
00401
00402     for (i = 0; i < nsamples; i++) {
00403         do {
00404             status = *((volatile unsigned *)(((uint8_t *)uio_ptr) + I2S_STATUS_REG));
00405         } while (status == 0);
00406         *((volatile unsigned *)(((uint8_t *)uio_ptr) + I2S_STATUS_REG)) =
00407             0x00000001;
00408
00409         // Read the sample from the input
00410         DataL = *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_RX_L_REG));
00411         DataR = *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_RX_R_REG));
00412
00413         // Write the sample into memory
00414         *(BufAddr + 2 * i) = DataL;
00415         *(BufAddr + 2 * i + 1) = DataR;
00416     }
00417
00418     if (unsetUIO(uio_ptr, audio_mmap_size) < 0) {
00419         pynq_error("audio_record: unable to free UIO %d, ensure sudo chmod 666 "
00420                   "/dev/i2c-1 has been executed\n",
00421                   uio_index);
00422     }
00423     if (unsetI2C(iic_fd) < 0) {
00424         pynq_error("audio_record: unable to unset I2C %d, ensure sudo chmod 666 "
00425                   "/dev/i2c-1 has been executed\n",
00426                   iic_index);
00427     }
00428 }
00429
00430 void audio_play(unsigned int audio_mmap_size, unsigned int *BufAddr,
00431                unsigned int nsamples, unsigned int volume, int uio_index) {
00432     if (uio_index > 2) {
00433         pynq_error(
00434             "audio_play: uio_index outside of range. is %d, should be below 3. \n",
00435             uio_index);
00436     }
00437     if (volume > 100) {
00438         pynq_error("audio_play: volume outside allowed range. Is %d, should be "
00439                   "below 100 \n",
00440                   volume);
00441     }
00442     int iic_index = 1;
00443     unsigned int i, status;
00444     void *uio_ptr;
00445     int DataL, DataR;
00446     int iic_fd;
00447
00448     uio_ptr = setUIO(uio_index, audio_mmap_size);
00449     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00450     if (iic_fd < 0) {
00451         pynq_error("audio_play: unable to set I2C %d, ensure sudo chmod 666 "
00452                   "/dev/i2c-1 has been executed\n",
00453                   iic_index);
00454     }
00455
00456     // Unmute left and right DAC, enable Mixer3 and Mixer4

```

```

00457 write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x21, iic_fd);
00458 write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x41, iic_fd);
00459
00460 unsigned char vol_register = (unsigned char)volume << 2 | 0x3;
00461 // Enable Left/Right Headphone out
00462 write_audio_reg(R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL, vol_register,
00463               iic_fd);
00464 write_audio_reg(R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL, vol_register,
00465               iic_fd);
00466
00467 for (i = 0; i < nsamples; i++) {
00468     do {
00469         status = *((volatile unsigned *)(((uint8_t *)uio_ptr) + I2S_STATUS_REG));
00470     } while (status == 0);
00471     *((volatile unsigned *)(((uint8_t *)uio_ptr) + I2S_STATUS_REG)) =
00472         0x00000001;
00473
00474     // Read the sample from memory
00475     DataL = *(BufAddr + 2 * i);
00476     DataR = *(BufAddr + 2 * i + 1);
00477
00478     // Write the sample to output
00479     *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_TX_L_REG)) = DataL;
00480     *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_TX_R_REG)) = DataR;
00481 }
00482
00483 // Mute left and right DAC
00484 write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x01, iic_fd);
00485 write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x01, iic_fd);
00486 // Mute left input to mixer3 (R23) and right input to mixer4 (R25)
00487 write_audio_reg(R23_PLAYBACK_MIXER_LEFT_CONTROL_1, 0x00, iic_fd);
00488 write_audio_reg(R25_PLAYBACK_MIXER_RIGHT_CONTROL_1, 0x00, iic_fd);
00489
00490 if (unsetUIO(uio_ptr, audio_mmap_size) < 0) {
00491     pyng_error("audio_play: unable to free UIO %d, ensure sudo chmod 666 "
00492              "/dev/i2c-1 has been executed\n",
00493              uio_index);
00494 }
00495 if (unsetI2C(iic_fd) < 0) {
00496     pyng_error("audio_play: unable to unset I2C %d, ensure sudo chmod 666 "
00497              "/dev/i2c-1 has been executed\n",
00498              iic_index);
00499 }
00500 }
00501
00502 void audio_repeat_play(unsigned int audio_mmap_size, unsigned int *BufAddr,
00503                      unsigned int nsamples, unsigned int volume,
00504                      unsigned int repetitions) {
00505     if (volume > 100) {
00506         pyng_error("audio_repeat_play: volume outside allowed range. Is %d, should "
00507                  "be below 100\n",
00508                  volume);
00509     }
00510     int iic_index = 1;
00511     unsigned int i, status;
00512     void *uio_ptr;
00513     int DataL, DataR;
00514     int iic_fd;
00515
00516     uio_ptr = setUIO(0, audio_mmap_size);
00517     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00518     if (iic_fd < 0) {
00519         pyng_error("audio_repeat_play: unable to set I2C %d, ensure sudo chmod 666 "
00520                  "/dev/i2c-1 has been executed\n",
00521                  iic_index);
00522     }
00523
00524     // Unmute left and right DAC, enable Mixer3 and Mixer4
00525     write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x21, iic_fd);
00526     write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x41, iic_fd);
00527
00528     unsigned char vol_register = (unsigned char)volume << 2 | 0x3;
00529     // Enable Left/Right Headphone out
00530     write_audio_reg(R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL, vol_register,
00531                   iic_fd);
00532     write_audio_reg(R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL, vol_register,
00533                   iic_fd);
00534
00535     for (unsigned int repeat = 0; repeat < repetitions; repeat++) {
00536         for (i = 0; i < nsamples; i++) {
00537             do {
00538                 status =
00539                     *((volatile unsigned *)(((uint8_t *)uio_ptr) + I2S_STATUS_REG));
00540             } while (status == 0);
00541             *((volatile unsigned *)(((uint8_t *)uio_ptr) + I2S_STATUS_REG)) =
00542                 0x00000001;
00543         }

```

```

00544     // Read the sample from memory
00545     DataL = *(BufAddr + 2 * i);
00546     DataR = *(BufAddr + 2 * i + 1);
00547
00548     // Write the sample to output
00549     *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_TX_L_REG)) = DataL;
00550     *((volatile int *)(((uint8_t *)uio_ptr) + I2S_DATA_TX_R_REG)) = DataR;
00551 }
00552 }
00553 // Mute left and right DAC
00554 write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x01, iic_fd);
00555 write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x01, iic_fd);
00556 // Mute left input to mixer3 (R23) and right input to mixer4 (R25)
00557 write_audio_reg(R23_PLAYBACK_MIXER_LEFT_CONTROL_1, 0x00, iic_fd);
00558 write_audio_reg(R25_PLAYBACK_MIXER_RIGHT_CONTROL_1, 0x00, iic_fd);
00559
00560 if (unsetUIO(uio_ptr, audio_mmap_size) < 0) {
00561     pynq_error("audio_repeat_play: unable to free UIO %d\n", 0);
00562 }
00563 if (unsetI2C(iic_fd) < 0) {
00564     pynq_error("audio_repeat_play: unable to unset I2C %d, ensure sudo chmod "
00565               "666 /dev/i2c-1 has been executed\n",
00566               iic_index);
00567 }
00568 }
00569
00570 void audio_generate_tone(unsigned int frequency, uint32_t time_ms,
00571                        unsigned int volume) {
00572
00573     if (frequency < 10) {
00574         pynq_error("audio_generate_tone: frequency should be 10 or higher, "
00575                   "frequency is: %d\n",
00576                   frequency);
00577     }
00578     if (volume > 100) {
00579         pynq_error("audio_generate_tone: volume outside allowed range. Is %d, "
00580                   "should be below 100\n",
00581                   volume);
00582     }
00583     double period = 1 / ((double)(frequency));
00584     unsigned int samplesPerPeriod = (int)(SAMPLE_RATE * period);
00585     double time_s = ((double)(time_ms)) / 1000;
00586     int totalPeriods = (int)(time_s / period); // Number of times one period must
00587                                                // be played to play for time_ms
00588
00589     uint32_t audioBuffer[16 * 1024 + 1] = {0};
00590     unsigned int i, status;
00591
00592     for (i = 0; i < samplesPerPeriod; i++) {
00593         double t = (double)i / SAMPLE_RATE;
00594         double value = sin(6.28318531 * frequency * t); // 6.28... = 2pi
00595         value = value + 1;
00596         value = value * 16000;
00597         audioBuffer[2 * i] = (uint32_t)value;
00598         audioBuffer[2 * i + 1] = (uint32_t)value;
00599     }
00600
00601     unsigned int audio_mmap_size = 64 * 1024;
00602     unsigned int *BufAddr = audioBuffer;
00603     int iic_index = 1;
00604     void *uio_ptr;
00605     int DataL, DataR;
00606     int iic_fd;
00607
00608     uio_ptr = setUIO(0, audio_mmap_size);
00609     iic_fd = setI2C(iic_index, IIC_SLAVE_ADDR);
00610     if (iic_fd < 0) {
00611         pynq_error("audio_generate_tone: unable to set I2C %d, ensure sudo chmod "
00612                   "666 /dev/i2c-1 has been executed\n",
00613                   iic_index);
00614     }
00615
00616     // Unmute left and right DAC, enable Mixer3 and Mixer4
00617     write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x21, iic_fd);
00618     write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x41, iic_fd);
00619
00620     unsigned char vol_register = (unsigned char)volume << 2 | 0x3;
00621     // Enable Left/Right Headphone out
00622     write_audio_reg(R29_PLAYBACK_HEADPHONE_LEFT_VOLUME_CONTROL, vol_register,
00623                   iic_fd);
00624     write_audio_reg(R30_PLAYBACK_HEADPHONE_RIGHT_VOLUME_CONTROL, vol_register,
00625                   iic_fd);
00626
00627     for (int period = 0; period < totalPeriods; period++) {
00628         for (i = 0; i < samplesPerPeriod; i++) {
00629             do {
00630                 status =

```

```

00631         *((volatile unsigned *) ((uint8_t *)uio_ptr) + I2S_STATUS_REG));
00632     } while (status == 0);
00633     *((volatile unsigned *) ((uint8_t *)uio_ptr) + I2S_STATUS_REG) =
00634         0x00000001;
00635
00636     // Read the sample from memory
00637     DataL = *(BufAddr + 2 * i);
00638     DataR = *(BufAddr + 2 * i + 1);
00639
00640     // Write the sample to output
00641     *((volatile int *) ((uint8_t *)uio_ptr) + I2S_DATA_TX_L_REG) = DataL;
00642     *((volatile int *) ((uint8_t *)uio_ptr) + I2S_DATA_TX_R_REG) = DataR;
00643 }
00644 }
00645 // Mute left and right DAC
00646 write_audio_reg(R22_PLAYBACK_MIXER_LEFT_CONTROL_0, 0x01, iic_fd);
00647 write_audio_reg(R24_PLAYBACK_MIXER_RIGHT_CONTROL_0, 0x01, iic_fd);
00648 // Mute left input to mixer3 (R23) and right input to mixer4 (R25)
00649 write_audio_reg(R23_PLAYBACK_MIXER_LEFT_CONTROL_1, 0x00, iic_fd);
00650 write_audio_reg(R25_PLAYBACK_MIXER_RIGHT_CONTROL_1, 0x00, iic_fd);
00651
00652 if (unsetUIO(uio_ptr, audio_mmap_size) < 0) {
00653     pynq_error("audio_generate_tone: unable to free UIO %d, ensure sudo chmod "
00654               "666 /dev/i2c-1 has been executed\n",
00655               0);
00656 }
00657 if (unsetI2C(iic_fd) < 0) {
00658     pynq_error("audio_generate_tone: unable to unset I2C %d, ensure has been "
00659               "executed\n",
00660               iic_index);
00661 }
00662 }

```

6.25 library/empty-library/audio.c File Reference

```
#include <audio.h>
```

Include dependency graph for audio.c:

Functions

- void [audio_init](#) (void)
- void [audio_select_input](#) (int input)
- void [write_audio_reg](#) (unsigned char u8RegAddr, unsigned char u8Data, int iic_fd)
- void [config_audio_pll](#) (void)
- void [config_audio_codec](#) (void)
- void [select_line_in](#) (void)
- void [select_mic](#) (void)
- void [deselect](#) (void)
- void [audio_bypass](#) (unsigned int audio_mmap_size, unsigned int nsamples, unsigned int volume, int uio_index)
- void [audio_record](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, int uio_index)
- void [audio_play](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, unsigned int volume, int uio_index)
- void [audio_repeat_play](#) (unsigned int audio_mmap_size, unsigned int *BufAddr, unsigned int nsamples, unsigned int volume, unsigned int repetitions)
- void [audio_generate_tone](#) (unsigned int frequency, uint32_t time_ms, unsigned int volume)

6.26 audio.c

[Go to the documentation of this file.](#)

```
00001 #include <audio.h>
00002 void audio_init(void){};
00003 void audio_select_input(int input){};
00004 void write_audio_reg(unsigned char u8RegAddr, unsigned char u8Data, int iic_fd){};
00005 void config_audio_pll(void){};
00006 void config_audio_codec(void){};
00007 void select_line_in(void){};
00008 void select_mic(void){};
00009 void deselect(void){};
00010 void audio_bypass(unsigned int audio_mmap_size, unsigned int nsamples,
00011                 unsigned int volume, int uio_index){};
00012 void audio_record(unsigned int audio_mmap_size, unsigned int *BufAddr,
00013                 unsigned int nsamples, int uio_index){};
00014 void audio_play(unsigned int audio_mmap_size, unsigned int *BufAddr,
00015               unsigned int nsamples, unsigned int volume, int uio_index){};
00016 void audio_repeat_play(unsigned int audio_mmap_size, unsigned int *BufAddr,
00017                      unsigned int nsamples, unsigned int volume,
00018                      unsigned int repetitions){};
00019 void audio_generate_tone(unsigned int frequency, uint32_t time_ms,
00020                       unsigned int volume){};
00021
```

6.27 library/buttons.c File Reference

```
#include <buttons.h>
#include <gpio.h>
#include <log.h>
#include <pinmap.h>
#include <platform.h>
#include <stdbool.h>
#include <stdio.h>
#include <stdlib.h>
#include <sys/time.h>
#include <unistd.h>
Include dependency graph for buttons.c:
```

Macros

- `#define LOG_DOMAIN "buttons"`

Functions

- void `buttons_init` (void)
- void `buttons_destroy` (void)
- void `switches_init` (void)
- void `switches_destroy` (void)
- int `get_button_state` (const int button)
- int `wait_until_button_state` (const int button, const int state)
- int `sleep_msec_button_pushed` (const int button, const int ms)
- void `sleep_msec_buttons_pushed` (int button_states[], const int ms)
- int `wait_until_button_pushed` (const int button)
- int `wait_until_button_released` (const int button)
- int `wait_until_any_button_pushed` (void)
- int `wait_until_any_button_released` (void)
- int `get_switch_state` (const int switch_num)

6.27.1 Macro Definition Documentation

6.27.1.1 LOG_DOMAIN

```
#define LOG_DOMAIN "buttons"
```

Definition at line 34 of file [buttons.c](#).

6.28 buttons.c

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <buttons.h>
00023 #include <gpio.h>
00024 #include <log.h>
00025 #include <pinmap.h>
00026 #include <platform.h>
00027 #include <stdbool.h>
00028 #include <stdio.h>
00029 #include <stdlib.h>
00030 #include <sys/time.h>
00031 #include <unistd.h>
00032
00033 #undef LOG_DOMAIN
00034 #define LOG_DOMAIN "buttons"
00035
00036 static bool buttons_initialized = false;
00037 static bool switches_initialized = false;
00038
00039 void buttons_init(void) {
00040     if (buttons_initialized == true) {
00041         pyng_error("buttons_destroy: buttons already initialized\n");
00042     }
00043     gpio_set_direction(SWB_BTN0, GPIO_DIR_INPUT);
00044     gpio_set_direction(SWB_BTN1, GPIO_DIR_INPUT);
00045     gpio_set_direction(SWB_BTN2, GPIO_DIR_INPUT);
00046     gpio_set_direction(SWB_BTN3, GPIO_DIR_INPUT);
00047     buttons_initialized = true;
00048 }
00049
00050 void buttons_destroy(void) { /* Anything to do here? */
00051     if (buttons_initialized == false) {
00052         pyng_error("buttons_destroy: buttons weren't initialized\n");
00053     }
00054 }
00055
00056 void switches_init(void) {
00057     if (switches_initialized == true) {
00058         pyng_error("switches_destroy: switches already initialized\n");
00059     }
00060     gpio_set_direction(SWB_SW0, GPIO_DIR_INPUT);
00061     gpio_set_direction(SWB_SW1, GPIO_DIR_INPUT);
00062     switches_initialized = true;
00063 }
00064
00065 void switches_destroy(void) { /* Anything to do here? */
00066     if (switches_initialized == false) {
```

```

00067     pynq_error("switches_destroy: switches weren't initialized\n");
00068 }
00069 }
00070
00071 int get_button_state(const int button) {
00072     if (buttons_initialized == false) {
00073         pynq_error("get_button_state: buttons weren't initialized\n");
00074     }
00075     if (button < 0 || button >= NUM_BUTTONS) {
00076         pynq_error("get_button_state: invalid button=%d, must be 0..%d-1\n",
00077             NUM_BUTTONS);
00078     }
00079     return (gpio_get_level(SWB_BTNO + button) == GPIO_LEVEL_LOW
00080         ? BUTTON_NOT_PUSHED
00081         : BUTTON_PUSHED);
00082 }
00083
00084 int wait_until_button_state(const int button, const int state) {
00085     if (buttons_initialized == false) {
00086         pynq_error("wait_until_button_state: buttons weren't initialized\n");
00087     }
00088     if (button < 0 || button >= NUM_BUTTONS) {
00089         pynq_error("get_button_state: invalid button=%d, must be 0..%d-1\n", button,
00090             NUM_BUTTONS);
00091     }
00092     const pin_t btn = SWB_BTNO + button;
00093     if (gpio_get_direction(btn) != GPIO_DIR_INPUT) {
00094         pynq_error("get_button_state: button %d has not been set as input\n",
00095             button);
00096     }
00097     struct timeval call, close;
00098     int dTime;
00099     gettimeofday(&call, NULL);
00100     const unsigned int check =
00101         (state == BUTTON_NOT_PUSHED ? GPIO_LEVEL_LOW : GPIO_LEVEL_HIGH);
00102     while (gpio_get_level(btn) != check) {
00103     }
00104     gettimeofday(&close, NULL);
00105     dTime = (close.tv_sec - call.tv_sec) * 1000.0; // # of ms
00106     dTime += (close.tv_usec - call.tv_usec) / 1000.0; // # of usec in ms
00107     return dTime;
00108 }
00109
00110 int sleep_msec_button_pushed(const int button, const int ms) {
00111     if (buttons_initialized == false) {
00112         pynq_error("sleep_msec_button: buttons weren't initialized\n");
00113     }
00114     if (button < 0 || button >= NUM_BUTTONS) {
00115         pynq_error("sleep_msec_button_pushed: invalid button=%d, must be 0..%d-1\n",
00116             button, NUM_BUTTONS);
00117     }
00118     const pin_t btn = SWB_BTNO + button;
00119     if (gpio_get_direction(btn) != GPIO_DIR_INPUT) {
00120         pynq_error(
00121             "sleep_msec_button_pushed: button %d has not been set as input\n",
00122             button);
00123     }
00124     int status;
00125     struct timeval call, close;
00126     double dTime;
00127     // mapping call time to call struct
00128     gettimeofday(&call, NULL);
00129     do {
00130         // update level and latch if is pushed
00131         if (status != GPIO_LEVEL_HIGH) {
00132             status = gpio_get_level(btn);
00133         }
00134         (void)gettimeofday(&close, NULL);
00135         dTime = (close.tv_sec - call.tv_sec) * 1000.0; // # of ms
00136         dTime += (close.tv_usec - call.tv_usec) / 1000.0; // # of usec in ms
00137     } while (dTime < ms);
00138     return (status == GPIO_LEVEL_LOW ? BUTTON_NOT_PUSHED : BUTTON_PUSHED);
00139 }
00140
00141 void sleep_msec_buttons_pushed(int button_states[], const int ms) {
00142     if (buttons_initialized == false) {
00143         pynq_error("sleep_msec_buttons_pushed: buttons weren't initialized\n");
00144     }
00145     if (button_states == NULL) {
00146         pynq_error("sleep_msec_buttons_pushed: button_states is NULL\n");
00147     }
00148     struct timeval call, close;
00149     int dTime;
00150     const pin_t buttons[NUM_BUTTONS] = {SWB_BTNO, SWB_BTNO1, SWB_BTNO2, SWB_BTNO3};
00151     // mapping call time to call struct
00152     (void)gettimeofday(&call, NULL);
00153     do {

```



```

00154     for (int i = 0; i < NUM_BUTTONS; i++) {
00155         if (button_states[i] != BUTTON_PUSHED) {
00156             button_states[i] =
00157                 (gpio_get_level(buttons[i]) == GPIO_LEVEL_HIGH ? BUTTON_PUSHED
00158                  : BUTTON_NOT_PUSHED);
00159         }
00160     }
00161     (void)gettimeofday(&close, NULL);
00162     dTime = (close.tv_sec - call.tv_sec) * 1000.0;    // # of ms
00163     dTime += (close.tv_usec - call.tv_usec) / 1000.0; // # of usec in ms
00164 } while (dTime < ms);
00165 }
00166
00167 int wait_until_button_pushed(const int button) {
00168     // all checks are done in wait_until_button state
00169     return wait_until_button_state(button, BUTTON_PUSHED);
00170 }
00171
00172 int wait_until_button_released(const int button) {
00173     // all checks are done in wait_until_button state
00174     return wait_until_button_state(button, BUTTON_NOT_PUSHED);
00175 }
00176
00177 int wait_until_any_button_pushed(void) {
00178     const pin_t buttons[NUM_BUTTONS] = {SWB_BTN0, SWB_BTN1, SWB_BTN2, SWB_BTN3};
00179     if (buttons_initialized == false) {
00180         pyng_error("wait_until_any_button_pushed: buttons weren't initialized\n");
00181     }
00182     for (int b = 0; b < NUM_BUTTONS; b++) {
00183         if (gpio_get_direction(b) != GPIO_DIR_INPUT) {
00184             pyng_error(
00185                 "wait_until_any_button_pushed: button %d has not been set as input\n",
00186                 b);
00187         }
00188     }
00189     do {
00190         for (int b = 0; b < NUM_BUTTONS; b++) {
00191             if (gpio_get_level(buttons[b]) == GPIO_LEVEL_HIGH) {
00192                 return b; // we return the index, i.e. 0..NUM_BUTTONS-1
00193             }
00194         }
00195     } while (true);
00196 }
00197
00198 int wait_until_any_button_released(void) {
00199     const pin_t buttons[NUM_BUTTONS] = {SWB_BTN0, SWB_BTN1, SWB_BTN2, SWB_BTN3};
00200     if (buttons_initialized == false) {
00201         pyng_error("wait_until_any_button_released: buttons weren't initialized\n");
00202     }
00203     for (int b = 0; b < NUM_BUTTONS; b++) {
00204         if (gpio_get_direction(b) != GPIO_DIR_INPUT) {
00205             pyng_error("wait_until_any_button_released: button %d has not been set "
00206                 "as input\n",
00207                 b);
00208         }
00209     }
00210     do {
00211         for (int b = 0; b < NUM_BUTTONS; b++) {
00212             if (gpio_get_level(buttons[b]) == GPIO_LEVEL_LOW)
00213                 return b; // we return the index, i.e. 0..NUM_BUTTONS-1
00214         }
00215     } while (true);
00216 }
00217
00218 int get_switch_state(const int switch_num) {
00219     if (switches_initialized == false) {
00220         pyng_error("get_switch_state: switches weren't initialized\n");
00221     }
00222     if (switch_num != SWITCH0 && switch_num != SWITCH1) {
00223         pyng_error("get_switch_state: invalid switch_num=%d, must be 0..%i-1\n",
00224             switch_num, NUM_SWITCHES);
00225     }
00226     return (gpio_get_level(SWB_SW0 + switch_num) == GPIO_LEVEL_LOW ? SWITCH_ON
00227             : SWITCH_OFF);
00228 }

```

6.29 library/empty-library/buttons.c File Reference

#include <buttons.h>

Include dependency graph for buttons.c:

Functions

- void `switches_init` (void)
- void `switches_destroy` (void)
- void `buttons_init` (void)
- void `buttons_destroy` (void)
- int `get_button_state` (const int button)
- int `wait_until_button_state` (const int button, const int state)
- int `sleep_msec_button_pushed` (const int button, const int msec)
- void `sleep_msec_buttons_pushed` (int button_states[], const int ms)
- int `wait_until_button_pushed` (const int button)
- int `wait_until_button_released` (const int button)
- int `wait_until_any_button_pushed` (void)
- int `wait_until_any_button_released` (void)
- int `get_switch_state` (const int switch_num)

6.30 buttons.c

[Go to the documentation of this file.](#)

```
00001 #include <buttons.h>
00002 void switches_init(void){};
00003 void switches_destroy(void){};
00004 extern void buttons_init(void){};
00005 extern void buttons_destroy(void){};
00006 extern int get_button_state(const int button){};
00007 extern int wait_until_button_state(const int button, const int state){return 0;};
00008 extern int sleep_msec_button_pushed(const int button, const int msec){return 0;};
00009 extern void sleep_msec_buttons_pushed(int button_states[], const int ms){};
00010 extern int wait_until_button_pushed(const int button){return 0;};
00011 extern int wait_until_button_released(const int button){return 0;};
00012 extern int wait_until_any_button_pushed(void){return 0;};
00013 extern int wait_until_any_button_released(void){return 0;};
00014 extern int get_switch_state(const int switch_num){return 0;};
```

6.31 library/empty-library/fontx.c File Reference

```
#include <fontx.h>
```

Include dependency graph for fontx.c:

Functions

- void `AaddFontx` (FontxFile *fx, const char *path)
- void `InitFontx` (FontxFile *fxs, const char *f0, const char *f1)
- bool `OpenFontx` (FontxFile *fx)
- void `CloseFontx` (FontxFile *fx)
- void `DumpFontx` (FontxFile *fxs)
- uint8_t `GetFontWidth` (FontxFile *fx)
- uint8_t `GetFontHeight` (FontxFile *fx)
- bool `GetFontx` (FontxFile *fxs, uint8_t ascii, uint8_t *pGlyph, uint8_t *pw, uint8_t *ph)
- void `UnderlineBitmap` (uint8_t *line, uint8_t w, uint8_t h)
- void `ReversBitmap` (uint8_t *line, uint8_t w, uint8_t h)
- void `ShowFont` (uint8_t *fonts, uint8_t pw, uint8_t ph)
- void `ShowBitmap` (uint8_t *bitmap, uint8_t pw, uint8_t ph)
- uint8_t `RotateByte` (uint8_t ch)

6.32 fontx.c

[Go to the documentation of this file.](#)

```
00001 #include <fontx.h>
00002 void AaddFontx(FontxFile *fx, const char *path){};
00003 void InitFontx(FontxFile *fxs, const char *f0, const char *f1){};
00004 bool OpenFontx(FontxFile *fx){};
00005 void CloseFontx(FontxFile *fx){};
00006 void DumpFontx(FontxFile *fxs){};
00007 uint8_t GetFontWidth(FontxFile *fx){};
00008 uint8_t GetFontHeight(FontxFile *fx){};
00009 bool GetFontx(FontxFile *fxs, uint8_t ascii, uint8_t *pGlyph, uint8_t *pw,
00010             uint8_t *ph){};
00011 void UnderlineBitmap(uint8_t *line, uint8_t w, uint8_t h){};
00012 void ReversBitmap(uint8_t *line, uint8_t w, uint8_t h){};
00013 void ShowFont(uint8_t *fonts, uint8_t pw, uint8_t ph){};
00014 void ShowBitmap(uint8_t *bitmap, uint8_t pw, uint8_t ph){};
00015 uint8_t RotateByte(uint8_t ch){};
```

6.33 library/fontx.c File Reference

```
#include "fontx.h"
#include <stdbool.h>
#include <stdint.h>
#include <stdio.h>
#include <string.h>
#include <sys/stat.h>
#include <sys/unistd.h>
Include dependency graph for fontx.c:
```

Macros

- `#define FontxDebug 0`

Functions

- void `AddFontx` (`FontxFile` *fx, const char *path)
- void `InitFontx` (`FontxFile` *fxs, const char *f0, const char *f1)
- bool `OpenFontx` (`FontxFile` *fx)
- void `CloseFontx` (`FontxFile` *fx)
- void `DumpFontx` (`FontxFile` *fxs)
- uint8_t `getFortWidth` (`FontxFile` *fx)
- uint8_t `getFortHeight` (`FontxFile` *fx)
- bool `GetFontx` (`FontxFile` *fxs, uint8_t ascii, uint8_t *pGlyph, uint8_t *pw, uint8_t *ph)
- void `Font2Bitmap` (uint8_t *fonts, uint8_t *line, uint8_t w, uint8_t h, uint8_t inverse)
- void `UnderlineBitmap` (uint8_t *line, uint8_t w, uint8_t h)
- void `ReversBitmap` (uint8_t *line, uint8_t w, uint8_t h)
- void `ShowFont` (uint8_t *fonts, uint8_t pw, uint8_t ph)
- void `ShowBitmap` (uint8_t *bitmap, uint8_t pw, uint8_t ph)
- uint8_t `RotateByte` (uint8_t ch1)

6.33.1 Macro Definition Documentation

6.33.1.1 FontxDebug

```
#define FontxDebug 0
```

Definition at line 9 of file [fontx.c](#).

6.33.2 Function Documentation

6.33.2.1 AddFontx()

```
void AddFontx (
    FontxFile * fx,
    const char * path )
```

Definition at line 11 of file [fontx.c](#).

Here is the caller graph for this function:

6.33.2.2 getFortHeight()

```
uint8_t getFortHeight (
    FontxFile * fx )
```

Definition at line 93 of file [fontx.c](#).

6.33.2.3 getFortWidth()

```
uint8_t getFortWidth (
    FontxFile * fx )
```

Definition at line 88 of file [fontx.c](#).

6.34 fontx.c

[Go to the documentation of this file.](#)

```
00001 #include "fontx.h"
00002 #include <stdbool.h>
00003 #include <stdint.h>
00004 #include <stdio.h>
00005 #include <string.h>
00006 #include <sys/stat.h>
00007 #include <sys/unistd.h>
00008
00009 #define FontxDebug 0
00010
00011 void AddFontx(FontxFile *fx, const char *path) {
00012     memset(fx, 0, sizeof(FontxFile));
00013     fx->path = path;
00014     fx->opened = false;
00015 }
00016
00017 void InitFontx(FontxFile *fxs, const char *f0, const char *f1) {
00018     AddFontx(&fxs[0], f0);
00019     AddFontx(&fxs[1], f1);
00020 }
00021
00022 bool OpenFontx(FontxFile *fx) {
00023     FILE *f;
00024     if (!fx->opened) {
00025         if (FontxDebug)
00026             printf("[openFont]fx->path=[%s]\n", fx->path);
00027         f = fopen(fx->path, "r");
00028         if (FontxDebug)
00029             printf("[openFont]fopen=%p\n", f);
00030         if (f == NULL) {
00031             fx->valid = false;
00032             printf("Fontx:%s not found.\n", fx->path);
00033             return fx->valid;
```

```

00034     }
00035     fx->opened = true;
00036     fx->file = f;
00037     char buf[18];
00038     if (fread(buf, 1, sizeof(buf), fx->file) != sizeof(buf)) {
00039         fx->valid = false;
00040         printf("Fontx:%s not FONTX format.\n", fx->path);
00041         fclose(fx->file);
00042         return fx->valid;
00043     }
00044
00045     if (FontxDebug) {
00046         for (uint32_t i = 0; i < strlen(buf); i++) {
00047             printf("buf[%d]=0x%x\n", i, buf[i]);
00048         }
00049     }
00050     memcpy(fx->fxname, &buf[6], 8);
00051     fx->w = buf[14];
00052     fx->h = buf[15];
00053     fx->is_ank = (buf[16] == 0);
00054     fx->bc = buf[17];
00055     fx->fsz = (fx->w + 7) / 8 * fx->h;
00056     if (fx->fsz > FontxGlyphBufSize) {
00057         printf("Fontx:%s is too big font size.\n", fx->path);
00058         fx->valid = false;
00059         fclose(fx->file);
00060         return fx->valid;
00061     }
00062     fx->valid = true;
00063 }
00064 return fx->valid;
00065 }
00066
00067 void CloseFontx(FontxFile *fx) {
00068     if (fx->opened) {
00069         fclose(fx->file);
00070         fx->opened = false;
00071     }
00072 }
00073
00074 void DumpFontx(FontxFile *fxs) {
00075     for (int i = 0; i < 2; i++) {
00076         printf("fxs[%d]->path=%s\n", i, fxs[i].path);
00077         printf("fxs[%d]->opened=%d\n", i, fxs[i].opened);
00078         printf("fxs[%d]->fxname=%s\n", i, fxs[i].fxname);
00079         printf("fxs[%d]->valid=%d\n", i, fxs[i].valid);
00080         printf("fxs[%d]->is_ank=%d\n", i, fxs[i].is_ank);
00081         printf("fxs[%d]->w=%d\n", i, fxs[i].w);
00082         printf("fxs[%d]->h=%d\n", i, fxs[i].h);
00083         printf("fxs[%d]->fsz=%d\n", i, fxs[i].fsz);
00084         printf("fxs[%d]->bc=%d\n", i, fxs[i].bc);
00085     }
00086 }
00087
00088 uint8_t getFortWidth(FontxFile *fx) {
00089     printf("fx->w=%d\n", fx->w);
00090     return (fx->w);
00091 }
00092
00093 uint8_t getFortHeight(FontxFile *fx) {
00094     printf("fx->h=%d\n", fx->h);
00095     return (fx->h);
00096 }
00097
00098 bool GetFontx(FontxFile *fxs, uint8_t ascii, uint8_t *pGlyph, uint8_t *pw,
00099              uint8_t *ph) {
00100     int i;
00101     uint32_t offset;
00102
00103     if (FontxDebug)
00104         printf("[GetFontx]ascii=0x%x\n", ascii);
00105     for (i = 0; i < 2; i++) {
00106         if (!OpenFontx(&fxs[i]))
00107             continue;
00108         if (FontxDebug)
00109             printf("[GetFontx]openFontxFile[%d] ok\n", i);
00110
00111         if (fxs[i].is_ank) {
00112             if (FontxDebug)
00113                 printf("[GetFontx]fxs.is_ank fxs.fsz=%d\n", fxs[i].fsz);
00114             offset = 17 + ascii * fxs[i].fsz;
00115             if (FontxDebug)
00116                 printf("[GetFontx]offset=%d\n", offset);
00117             if (fseek(fxs[i].file, offset, SEEK_SET)) {
00118                 printf("Fontx:seek(%u) failed.\n", offset);
00119                 return false;
00120             }

```

```

00121         if (fread(pGlyph, 1, fxs[i].fsz, fxs[i].file) != fxs[i].fsz) {
00122             printf("Fontx:fread failed.\n");
00123             return false;
00124         }
00125         if (pw)
00126             *pw = fxs[i].w;
00127         if (ph)
00128             *ph = fxs[i].h;
00129         return true;
00130     }
00131 }
00132 return false;
00133 }
00134
00135 void Font2Bitmap(uint8_t *fonts, uint8_t *line, uint8_t w, uint8_t h,
00136                 uint8_t inverse) {
00137     int x, y;
00138     for (y = 0; y < (h / 8); y++) {
00139         for (x = 0; x < w; x++) {
00140             line[y * 32 + x] = 0;
00141         }
00142     }
00143
00144     int mask = 7;
00145     int fontp;
00146     fontp = 0;
00147     for (y = 0; y < h; y++) {
00148         for (x = 0; x < w; x++) {
00149             uint8_t d = fonts[fontp + x / 8];
00150             uint8_t linep = (y / 8) * 32 + x;
00151             if (d & (0x80 >> (x % 8)))
00152                 line[linep] = line[linep] + (1 << mask);
00153         }
00154         mask--;
00155         if (mask < 0)
00156             mask = 7;
00157         fontp += (w + 7) / 8;
00158     }
00159
00160     if (inverse) {
00161         for (y = 0; y < (h / 8); y++) {
00162             for (x = 0; x < w; x++) {
00163                 line[y * 32 + x] = RotateByte(line[y * 32 + x]);
00164             }
00165         }
00166     }
00167 }
00168
00169 void UnderlineBitmap(uint8_t *line, uint8_t w, uint8_t h) {
00170     int x, y;
00171     uint8_t wk;
00172     for (y = 0; y < (h / 8); y++) {
00173         for (x = 0; x < w; x++) {
00174             wk = line[y * 32 + x];
00175             if ((y + 1) == (h / 8))
00176                 line[y * 32 + x] = wk + 0x80;
00177         }
00178     }
00179 }
00180
00181 void ReversBitmap(uint8_t *line, uint8_t w, uint8_t h) {
00182     int x, y;
00183     uint8_t wk;
00184     for (y = 0; y < (h / 8); y++) {
00185         for (x = 0; x < w; x++) {
00186             wk = line[y * 32 + x];
00187             line[y * 32 + x] = ~wk;
00188         }
00189     }
00190 }
00191
00192 void ShowFont(uint8_t *fonts, uint8_t pw, uint8_t ph) {
00193     int x, y, fpos;
00194     printf("[ShowFont pw=%d ph=%d]\n", pw, ph);
00195     fpos = 0;
00196     for (y = 0; y < ph; y++) {
00197         printf("%02d", y);
00198         for (x = 0; x < pw; x++) {
00199             if (fonts[fpos + x / 8] & (0x80 >> (x % 8))) {
00200                 printf("*");
00201             } else {
00202                 printf(".");
00203             }
00204         }
00205         printf("\n");
00206         fpos = fpos + (pw + 7) / 8;
00207     }

```

```

00208     printf("\n");
00209 }
00210
00211 void ShowBitmap(uint8_t *bitmap, uint8_t pw, uint8_t ph) {
00212     int x, y, fpos;
00213     printf("[ShowBitmap pw=%d ph=%d]\n", pw, ph);
00214
00215     fpos = 0;
00216     for (y = 0; y < ph; y++) {
00217         printf("%02d", y);
00218         for (x = 0; x < pw; x++) {
00219
00220             if (bitmap[x + (y / 8) * 32] & (0x80 » fpos)) {
00221                 printf("*");
00222             } else {
00223                 printf(".");
00224             }
00225         }
00226         printf("\n");
00227         fpos++;
00228         if (fpos > 7)
00229             fpos = 0;
00230     }
00231     printf("\n");
00232 }
00233
00234 uint8_t RotateByte(uint8_t ch1) {
00235     uint8_t ch2 = 0;
00236     int j;
00237     for (j = 0; j < 8; j++) {
00238         ch2 = (ch2 « 1) + (ch1 & 0x01);
00239         ch1 = ch1 » 1;
00240     }
00241     return ch2;
00242 }

```

6.35 library/empty-library/gpio.c File Reference

#include <gpio.h>

Include dependency graph for gpio.c:

Functions

- void [gpio_init](#) (void)
- void [gpio_destroy](#) (void)
- void [gpio_reset_pin](#) (const [gpio_t](#) pin)
- void [gpio_set_direction](#) (const [gpio_t](#) pin, const [gpio_direction_t](#) direction)
- [gpio_direction_t](#) [gpio_get_direction](#) (const [gpio_t](#) pin)
- void [gpio_set_level](#) (const [gpio_t](#) pin, const [gpio_level_t](#) level)
- [gpio_level_t](#) [gpio_get_level](#) (const [gpio_t](#) pin)
- void [gpio_reset](#) (void)

6.35.1 Function Documentation

6.35.1.1 [gpio_get_direction\(\)](#)

```

gpio\_direction\_t gpio_get_direction (
    const gpio\_t pin )

```

Definition at line 6 of file [gpio.c](#).

Here is the caller graph for this function:

6.35.1.2 gpio_get_level()

```
gpio_level_t gpio_get_level (
    const gpio_t pin )
```

Definition at line 8 of file [gpio.c](#).

Here is the caller graph for this function:

6.35.1.3 gpio_reset_pin()

```
void gpio_reset_pin (
    const gpio_t pin )
```

Definition at line 4 of file [gpio.c](#).

Here is the caller graph for this function:

6.35.1.4 gpio_set_direction()

```
void gpio_set_direction (
    const gpio_t pin,
    const gpio_direction_t direction )
```

Definition at line 5 of file [gpio.c](#).

Here is the caller graph for this function:

6.35.1.5 gpio_set_level()

```
void gpio_set_level (
    const gpio_t pin,
    const gpio_level_t level )
```

Definition at line 7 of file [gpio.c](#).

Here is the caller graph for this function:

6.36 gpio.c

[Go to the documentation of this file.](#)

```
00001 #include <gpio.h>
00002 void gpio_init(void){};
00003 void gpio_destroy(void){};
00004 void gpio_reset_pin(const gpio_t pin){};
00005 void gpio_set_direction(const gpio_t pin, const gpio_direction_t direction){};
00006 gpio_direction_t gpio_get_direction(const gpio_t pin){};
00007 void gpio_set_level(const gpio_t pin, const gpio_level_t level){};
00008 gpio_level_t gpio_get_level(const gpio_t pin){};
00009 /*
00010 void gpio_ack_interrupt(){};
00011 void gpio_print_interrupt(){};
00012 void gpio_enable_interrupt(const gpio_t pin){};
00013 void gpio_disable_interrupt(const gpio_t pin){};
00014 void gpio_disable_all_interrupts(){};
00015 uint8_t *gpio_get_interrupt_pins(){};
00016 uint64_t gpio_get_interrupt(){};
00017 */
00018 void gpio_reset(void){};
```


6.37 library/gpio.c File Reference

```
#include "gpio.h"
#include "arm_shared_memory_system.h"
#include <log.h>
#include <pinmap.h>
#include <platform.h>
#include <stdio.h>
#include <stdlib.h>
#include <version.h>
Include dependency graph for gpio.c:
```

Functions

- bool [gpio_is_initialized](#) (void)
- void [gpio_init](#) (void)
- void [gpio_destroy](#) (void)
- void [gpio_reset_pin](#) (const [pin_t](#) pin)
- void [gpio_reset](#) (void)
- void [gpio_set_direction](#) (const [pin_t](#) pin, const [gpio_direction_t](#) dir)
- [gpio_direction_t](#) [gpio_get_direction](#) (const [pin_t](#) pin)
- void [gpio_set_level](#) (const [pin_t](#) pin, const [gpio_level_t](#) level)
- [gpio_level_t](#) [gpio_get_level](#) (const [pin_t](#) pin)

Variables

- volatile uint32_t * [gpio](#) = NULL
- volatile uint32_t * [intc0](#) = NULL

6.37.1 Variable Documentation

6.37.1.1 gpio

```
volatile uint32_t* gpio = NULL
```

Definition at line 32 of file [gpio.c](#).

6.37.1.2 intc0

```
volatile uint32_t* intc0 = NULL
```

Definition at line 33 of file [gpio.c](#).

6.38 gpio.c

[Go to the documentation of this file.](#)

```

00001  /*
00002  Copyright (c) 2023 Eindhoven University of Technology
00003
00004  Permission is hereby granted, free of charge, to any person obtaining a copy
00005  of this software and associated documentation files (the "Software"), to deal
00006  in the Software without restriction, including without limitation the rights
00007  to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008  copies of the Software, and to permit persons to whom the Software is
00009  furnished to do so, subject to the following conditions:
00010
00011  The above copyright notice and this permission notice shall be included in all
00012  copies or substantial portions of the Software.
00013
00014  THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015  IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016  FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017  AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018  LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019  OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020  SOFTWARE.
00021  */
00022  #include "gpio.h"
00023  #include "arm_shared_memory_system.h"
00024  #include <log.h>
00025  #include <pinmap.h>
00026  #include <platform.h>
00027  #include <stdio.h>
00028  #include <stdlib.h>
00029  #include <version.h>
00030
00031  static arm_shared gpio_handle, intc0_handle;
00032  volatile uint32_t *gpio = NULL;
00033  volatile uint32_t *intc0 = NULL;
00034
00035  bool gpio_is_initialized(void) {
00036      /* if gpio == NULL we know we are not inialized */
00037      return (gpio != NULL) ? true : false;
00038  }
00039
00040  void gpio_init(void) {
00041      pyng_info("Initialize");
00042      check_version();
00043      gpio = arm_shared_init(&gpio_handle, axi_gpio_0, 4096);
00044      intc0 = arm_shared_init(&intc0_handle, axi_intc_0, 4096);
00045  }
00046
00047  void gpio_destroy(void) {
00048      pyng_info("Destroy");
00049      arm_shared_close(&gpio_handle);
00050      arm_shared_close(&intc0_handle);
00051      gpio = NULL;
00052      intc0 = NULL;
00053  }
00054
00055  void gpio_reset_pin(const pin_t pin) {
00056      PIN_CHECK(pin);
00057      pyng_info("Reset pin: %d", pin);
00058      gpio_set_direction(pin, GPIO_DIR_INPUT);
00059      gpio_set_level(pin, GPIO_LEVEL_LOW);
00060  }
00061
00062  void gpio_reset(void) {
00063      pyng_info("Reset all pins");
00064      // set all pins as input
00065      gpio[1] = 0xFFFFFFFF;
00066      // re-set all outputs to 0
00067      gpio[0] = 0x0;
00068
00069      // set all pins as input
00070      gpio[3] = 0xFFFFFFFF;
00071      // re-set all outputs to 0
00072      gpio[2] = 0x0;
00073      // disable all interrupts
00074      intc0[0] = 0;
00075      intc0[1] = 0;
00076      // remove all pending interrupts
00077      intc0[2] = 0;
00078      intc0[3] = 0;
00079  }
00080
00081  void gpio_set_direction(const pin_t pin, const gpio_direction_t dir) {
00082      PIN_CHECK(pin);

```

```

00083     if (!(dir == GPIO_DIR_INPUT || dir == GPIO_DIR_OUTPUT)) {
00084         pyng_error("gpio_set_direction: invalid direction %d", dir);
00085     }
00086     int pin_bank = pin % 32;
00087     int bank = pin < 32 ? 1 : 3;
00088     if (dir == GPIO_DIR_INPUT) {
00089         gpio[bank] = gpio[bank] | (1 << pin_bank);
00090     } else {
00091         gpio[bank] = gpio[bank] & ~(1 << pin_bank);
00092     }
00093 }
00094
00095 gpio_direction_t gpio_get_direction(const pin_t pin) {
00096     PIN_CHECK(pin);
00097     int pin_bank = pin % 32;
00098     int bank = pin < 32 ? 1 : 3;
00099     int dir =
00100         ((gpio[bank] & (1 << pin_bank)) != 0) ? GPIO_DIR_INPUT : GPIO_DIR_OUTPUT;
00101     return dir;
00102 }
00103
00104 void gpio_set_level(const pin_t pin, const gpio_level_t level) {
00105     PIN_CHECK(pin);
00106     if (!(level == GPIO_LEVEL_HIGH || level == GPIO_LEVEL_LOW)) {
00107         pyng_error("gpio_set_level: level %d is invalid", level);
00108     }
00109     int pin_bank = pin % 32;
00110     int bank = pin < 32 ? 0 : 2;
00111     if (level == GPIO_LEVEL_HIGH) {
00112         gpio[bank] = gpio[bank] | (1 << pin_bank);
00113     } else {
00114         gpio[bank] = gpio[bank] & ~(1 << pin_bank);
00115     }
00116 }
00117
00118 gpio_level_t gpio_get_level(const pin_t pin) {
00119     PIN_CHECK(pin);
00120     int pin_bank = pin % 32;
00121     int bank = pin < 32 ? 0 : 2;
00122     return (gpio[bank] & (1 << pin_bank)) != 0 ? GPIO_LEVEL_HIGH : GPIO_LEVEL_LOW;
00123 }

```

6.39 library/empty-library/i2cps.c File Reference

```
#include <i2cps.h>
```

Include dependency graph for i2cps.c:

Functions

- int [setI2C](#) (unsigned int index, long slave_addr)
- int [unsetI2C](#) (int i2c_fd)
- int [writel2C_asFile](#) (int i2c_fd, unsigned char writebuffer[], unsigned char bytes)
- int [readI2C_asFile](#) (int i2c_fd, unsigned char readbuffer[], unsigned char bytes)

6.39.1 Function Documentation

6.39.1.1 readI2C_asFile()

```

int readI2C_asFile (
    int i2c_fd,
    unsigned char readbuffer[],
    unsigned char bytes )

```

Definition at line 6 of file [i2cps.c](#).

Here is the caller graph for this function:

6.39.1.2 setI2C()

```
int setI2C (
    unsigned int index,
    long slave_addr )
```

Definition at line 2 of file [i2cps.c](#).

Here is the caller graph for this function:

6.39.1.3 unsetI2C()

```
int unsetI2C (
    int i2c_fd )
```

Definition at line 3 of file [i2cps.c](#).

Here is the caller graph for this function:

6.39.1.4 writel2C_asFile()

```
int writeI2C_asFile (
    int i2c_fd,
    unsigned char writebuffer[],
    unsigned char bytes )
```

Definition at line 4 of file [i2cps.c](#).

Here is the caller graph for this function:

6.40 i2cps.c

[Go to the documentation of this file.](#)

```
00001 #include <i2cps.h>
00002 int setI2C(unsigned int index, long slave_addr){};
00003 int unsetI2C(int i2c_fd){};
00004 int writel2C_asFile(int i2c_fd, unsigned char writebuffer[],
00005                    unsigned char bytes){};
00006 int readI2C_asFile(int i2c_fd, unsigned char readbuffer[], unsigned char bytes){};
```

6.41 library/i2cps.c File Reference

```
#include "i2cps.h"
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/ioctl.h>
#include <unistd.h>
Include dependency graph for i2cps.c:
```

Functions

- int [setI2C](#) (unsigned int index, long slave_addr)
- int [unsetI2C](#) (int i2c_fd)
- int [writel2C_asFile](#) (int i2c_fd, unsigned char writebuffer[], unsigned char bytes)
- int [readI2C_asFile](#) (int i2c_fd, unsigned char readbuffer[], unsigned char bytes)

6.41.1 Function Documentation

6.41.1.1 readI2C_asFile()

```
int readI2C_asFile (  
    int i2c_fd,  
    unsigned char readbuffer[],  
    unsigned char bytes )
```

Definition at line 88 of file [i2cps.c](#).

6.41.1.2 setI2C()

```
int setI2C (  
    unsigned int index,  
    long slave_addr )
```

Definition at line 60 of file [i2cps.c](#).

6.41.1.3 unsetI2C()

```
int unsetI2C (  
    int i2c_fd )
```

Definition at line 74 of file [i2cps.c](#).

6.41.1.4 writel2C_asFile()

```
int writeI2C_asFile (  
    int i2c_fd,  
    unsigned char writebuffer[],  
    unsigned char bytes )
```

Definition at line 79 of file [i2cps.c](#).

6.42 i2cps.c

[Go to the documentation of this file.](#)

```

00001 /*****
00002  * Copyright (c) 2016, Xilinx, Inc.
00003  * All rights reserved.
00004  *
00005  * Redistribution and use in source and binary forms, with or without
00006  * modification, are permitted provided that the following conditions are met:
00007  *
00008  * 1. Redistributions of source code must retain the above copyright notice,
00009  *    this list of conditions and the following disclaimer.
00010  *
00011  * 2. Redistributions in binary form must reproduce the above copyright
00012  *    notice, this list of conditions and the following disclaimer in the
00013  *    documentation and/or other materials provided with the distribution.
00014  *
00015  * 3. Neither the name of the copyright holder nor the names of its
00016  *    contributors may be used to endorse or promote products derived from
00017  *    this software without specific prior written permission.
00018  *
00019  * THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS"
00020  * AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO,
00021  * THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR
00022  * PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR
00023  * CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL,
00024  * EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO,
00025  * PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS;
00026  * OR BUSINESS INTERRUPTION). HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY,
00027  * WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR
00028  * OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF
00029  * ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
00030  *
00031  *****/
00032 /*****
00033  *
00034  *
00035  * @file i2cps.c
00036  *
00037  * Functions to interact with linux I2C. No safe checks here, so users must
00038  * know what they are doing.
00039  *
00040  * <pre>
00041  * MODIFICATION HISTORY:
00042  *
00043  * Ver   Who   Date     Changes
00044  * ----  ---  -
00045  * 1.00a gn   02/03/16 release
00046  * 1.00b yrq 08/31/16 add license header
00047  *
00048  * </pre>
00049  *
00050  *****/
00051
00052 #include "i2cps.h"
00053 #include <fcntl.h>
00054 #include <stdio.h>
00055 #include <stdlib.h>
00056 #include <string.h>
00057 #include <sys/ioctl.h>
00058 #include <unistd.h>
00059
00060 int setI2C(unsigned int index, long slave_addr) {
00061     int i2c_fd;
00062     char buf[50];
00063     sprintf(buf, "/dev/i2c-%d", index);
00064     // printf("buf = %s\n",buf);
00065     if ((i2c_fd = open(buf, O_RDWR)) < 0) {
00066         return -1;
00067     }
00068     if (ioctl(i2c_fd, I2C_SLAVE, slave_addr) < 0) {
00069         return -1;
00070     }
00071     return i2c_fd;
00072 }
00073
00074 int unsetI2C(int i2c_fd) {
00075     close(i2c_fd);
00076     return 0;
00077 }
00078
00079 int writeI2C_asFile(int i2c_fd, unsigned char writebuffer[],
00080                     unsigned char bytes) {
00081     unsigned char bytesWritten = write(i2c_fd, writebuffer, bytes);
00082     if (bytes != bytesWritten) {

```

```

00083     return -1;
00084 }
00085     return 0;
00086 }
00087
00088 int readI2C_asFile(int i2c_fd, unsigned char readbuffer[],
00089                   unsigned char bytes) {
00090     unsigned char bytesRead = read(i2c_fd, readbuffer, bytes);
00091     if (bytes != bytesRead)
00092         return -1;
00093     return 0;
00094 }

```

6.43 library/empty-library/iic.c File Reference

```
#include <iic.h>
```

Include dependency graph for iic.c:

Functions

- void [iic_init](#) (const [iic_index_t](#) iic)
- void [iic_destroy](#) (const [iic_index_t](#) iic)
- bool [iic_read_register](#) (const [iic_index_t](#) iic, const [uint8_t](#) addr, const [uint8_t](#) reg, [uint8_t](#) *data, [uint16_t](#) length)
- bool [iic_write_register](#) (const [iic_index_t](#) iic, const [uint8_t](#) addr, const [uint8_t](#) reg, [uint8_t](#) *data, [uint16_t](#) length)

6.44 iic.c

[Go to the documentation of this file.](#)

```

00001 #include <iic.h>
00002 extern void iic_init(const iic_index_t iic){};
00003 extern void iic_destroy(const iic_index_t iic){};
00004 extern bool iic_read_register(const iic_index_t iic, const uint8_t addr,
00005                             const uint8_t reg, uint8_t *data,
00006                             uint16_t length){};
00007 extern bool iic_write_register(const iic_index_t iic, const uint8_t addr,
00008                              const uint8_t reg, uint8_t *data,
00009                              uint16_t length){};

```

6.45 library/iic.c File Reference

```

#include "iic.h"
#include "arm_shared_memory_system.h"
#include "log.h"
#include "xiic_l.h"
#include <platform.h>
#include <stdio.h>
#include <string.h>

```

Include dependency graph for iic.c:

Macros

- #define [IIC_REG_SOFT_RESET](#) (0x40 / 4)

Functions

- void `iic_init` (const `iic_index_t` iic)
- void `iic_destroy` (const `iic_index_t` iic)
- bool `iic_read_register` (const `iic_index_t` iic, const `uint8_t` addr, const `uint8_t` reg, `uint8_t` *data, `uint16_t` data_length)
- bool `iic_write_register` (const `iic_index_t` iic, const `uint8_t` addr, const `uint8_t` reg, `uint8_t` *data, `uint16_t` data_length)

6.45.1 Macro Definition Documentation

6.45.1.1 IIC_REG_SOFT_RESET

```
#define IIC_REG_SOFT_RESET (0x40 / 4)
```

Definition at line 35 of file `iic.c`.

6.46 iic.c

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include "iic.h"
00023 #include "arm_shared_memory_system.h"
00024 #include "log.h"
00025 #include "xiic_l.h"
00026 #include <platform.h>
00027 #include <stdio.h>
00028 #include <string.h>
00029
00030 static arm_shared iic_handles[NUM_IICS];
00031 static volatile uint32_t *iic_ptrs[NUM_IICS] = {
00032     NULL,
00033 };
00034
00035 #define IIC_REG_SOFT_RESET (0x40 / 4)
00036
00037 void iic_init(const iic_index_t iic) {
00038     if (!(iic >= IIC0 && iic < NUM_IICS)) {
00039         pynq_error("invalid IIC %d, must be 0..%d\n", iic, NUM_IICS);
00040     }
00041     if (iic == IIC0) {
00042         iic_ptrs[iic] = arm_shared_init(&(iic_handles[iic]), axi_iic_0, 4096);
00043     } else if (iic == IIC1) {
00044         iic_ptrs[iic] = arm_shared_init(&(iic_handles[iic]), axi_iic_1, 4096);
00045     }
00046     // Reset
00047     iic_ptrs[iic][IIC_REG_SOFT_RESET] = 0xA;
00048 }
00049
00050 void iic_destroy(const iic_index_t iic) {
```



```

00051     if (!(iic >= IIC0 && iic < NUM_IICS)) {
00052         pynq_error("invalid IIC %d, must be 0..%d-1\n", iic, NUM_IICS);
00053     }
00054     arm_shared_close(&(iic_handles[iic]));
00055     iic_ptrs[iic] = NULL;
00056 }
00057
00058 bool iic_read_register(const iic_index_t iic, const uint8_t addr,
00059                      const uint8_t reg, uint8_t *data, uint16_t data_length) {
00060     if (!(iic >= IIC0 && iic < NUM_IICS)) {
00061         pynq_error("invalid IIC %d, must be 0..%d-1\n", iic, NUM_IICS);
00062     }
00063     XIic_Send((UINTPTR)iic_ptrs[iic], addr, (u8 *)&reg, 1, XIIC_REPEATED_START);
00064     uint8_t ByteCount =
00065         XIic_Recv((UINTPTR)iic_ptrs[iic], addr, data, data_length, XIIC_STOP);
00066     return (ByteCount == data_length) ? 0 : 1;
00067 }
00068
00069 bool iic_write_register(const iic_index_t iic, const uint8_t addr,
00070                       const uint8_t reg, uint8_t *data,
00071                       uint16_t data_length) {
00072     if (!(iic >= IIC0 && iic < NUM_IICS)) {
00073         pynq_error("invalid IIC %d, must be 0..%d-1\n", iic, NUM_IICS);
00074     }
00075     uint8_t buffer[1 + data_length];
00076     buffer[0] = reg;
00077     memcpy(&(buffer[1]), data, data_length);
00078     uint8_t ByteCount = XIic_Send((UINTPTR)iic_ptrs[iic], addr, &(buffer[0]),
00079                                  1 + data_length, XIIC_STOP);
00080     return (ByteCount == (data_length + 1)) ? 0 : 1;
00081 }

```

6.47 library/empty-library/leds.c File Reference

```
#include <leds.h>
```

Include dependency graph for leds.c:

Functions

- void [leds_init_onoff](#) (void)
- void [green_leds_init_pwm](#) (void)
- void [color_leds_init_pwm](#) (void)
- void [leds_destroy](#) (void)
- void [green_led_onoff](#) (const int led, const int onoff)
- void [green_led_on](#) (const int led)
- void [green_led_off](#) (const int led)
- void [color_led_red_onoff](#) (const int onoff)
- void [color_led_green_onoff](#) (const int onoff)
- void [color_led_blue_onoff](#) (const int onoff)
- void [color_led_onoff](#) (const int red_onoff, const int green_onoff, const int blue_onoff)
- void [color_led_on](#) (void)
- void [color_led_off](#) (void)

6.48 leds.c

[Go to the documentation of this file.](#)

```

00001 #include <leds.h>
00002 void leds_init_onoff(void) {};
00003 void green_leds_init_pwm(void) {};
00004 void color_leds_init_pwm(void) {};
00005 void leds_destroy(void) {};
00006 void green_led_onoff(const int led, const int onoff) {};
00007 void green_led_on(const int led) {};
00008 void green_led_off(const int led) {};

```

```
00009 void color_led_red_onoff(const int onoff){};
00010 void color_led_green_onoff(const int onoff){};
00011 void color_led_blue_onoff(const int onoff){};
00012 void color_led_onoff(const int red_onoff, const int green_onoff,
00013                      const int blue_onoff){};
00014 void color_led_on(void){};
00015 void color_led_off(void){};
```

6.49 library/leds.c File Reference

```
#include <gpio.h>
#include <leds.h>
#include <log.h>
#include <pinmap.h>
#include <pwm.h>
#include <stdio.h>
#include <stdlib.h>
Include dependency graph for leds.c:
```

Macros

- `#define LOG_DOMAIN "leds"`

Typedefs

- `typedef enum _led_mode led_mode`

Enumerations

- `enum _led_mode { uninitialized , binary , pwm_green , pwm_color }`

Functions

- void `leds_init_onoff` (void)
- void `green_leds_init_pwm` (void)
- void `color_leds_init_pwm` (void)
- void `leds_destroy` (void)
- void `green_led_onoff` (const int led, const int onoff)
- void `green_led_on` (const int led)
- void `green_led_off` (const int led)
- void `color_led_red_onoff` (const int onoff)
- void `color_led_green_onoff` (const int onoff)
- void `color_led_blue_onoff` (const int onoff)
- void `color_led_onoff` (const int red_onoff, const int green_onoff, const int blue_onoff)
- void `color_led_on` (void)
- void `color_led_off` (void)

6.49.1 Macro Definition Documentation

6.49.1.1 LOG_DOMAIN

```
#define LOG_DOMAIN "leds"
```

Definition at line 31 of file [leds.c](#).

6.49.2 Typedef Documentation

6.49.2.1 led_mode

```
typedef enum _led_mode led_mode
```

6.49.3 Enumeration Type Documentation

6.49.3.1 _led_mode

```
enum _led_mode
```

Enumerator

uninitialized	
binary	
pwm_green	
pwm_color	

Definition at line 33 of file [leds.c](#).

6.50 leds.c

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <gpio.h>
00023 #include <leds.h>
```

```

00024 #include <log.h>
00025 #include <pinmap.h>
00026 #include <pwm.h>
00027 #include <stdio.h>
00028 #include <stdlib.h>
00029
00030 #undef LOG_DOMAIN
00031 #define LOG_DOMAIN "leds"
00032
00033 typedef enum _led_mode { uninitialized, binary, pwm_green, pwm_color } led_mode;
00034 static led_mode mode = uninitialized;
00035
00036 // LEDs are either on or off
00037 void leds_init_onoff(void) {
00038     if (mode == binary)
00039         return;
00040     if (mode != uninitialized) {
00041         pynq_error("leds_init_onoff: mode=%d should be uninitialized\n", mode);
00042     }
00043     gpio_set_direction(SWB_LD0, GPIO_DIR_OUTPUT);
00044     gpio_set_direction(SWB_LD1, GPIO_DIR_OUTPUT);
00045     gpio_set_direction(SWB_LD2, GPIO_DIR_OUTPUT);
00046     gpio_set_direction(SWB_LD3, GPIO_DIR_OUTPUT);
00047     gpio_set_direction(SWB_LD4B, GPIO_DIR_OUTPUT);
00048     gpio_set_direction(SWB_LD4G, GPIO_DIR_OUTPUT);
00049     gpio_set_direction(SWB_LD4R, GPIO_DIR_OUTPUT);
00050     gpio_set_direction(SWB_LD5B, GPIO_DIR_OUTPUT);
00051     gpio_set_direction(SWB_LD5G, GPIO_DIR_OUTPUT);
00052     gpio_set_direction(SWB_LD5R, GPIO_DIR_OUTPUT);
00053     mode = binary;
00054 }
00055
00056 // can change the intensity of LEDs, the onoff parameters are then in the range
00057 // 0..255
00058 void green_leds_init_pwm(void) {
00059     if (mode == pwm_green)
00060         return;
00061     if (mode != uninitialized) {
00062         pynq_error("green_leds_init_pwm: mode=%d should be uninitialized\n", mode);
00063     }
00064     // initialize switchbox and routing PWM to LEDs
00065     switchbox_set_pin(SWB_LD0, SWB_PWM0);
00066     switchbox_set_pin(SWB_LD1, SWB_PWM1);
00067     switchbox_set_pin(SWB_LD2, SWB_PWM2);
00068     switchbox_set_pin(SWB_LD3, SWB_PWM3);
00069     // initialize the PWM channels
00070     pwm_init(PWM0, 256);
00071     pwm_init(PWM1, 256);
00072     pwm_init(PWM2, 256);
00073     pwm_init(PWM3, 256);
00074     mode = pwm_green;
00075 }
00076
00077 // can change the intensity of LEDs, the onoff parameters are then in the range
00078 // 0..255
00079 void color_leds_init_pwm(void) {
00080     if (mode == pwm_color)
00081         return;
00082     if (mode != uninitialized) {
00083         pynq_error("color_leds_init_pwm: mode=%d should be uninitialized\n", mode);
00084     }
00085     // initialize switchbox and routing PWM to LEDs
00086     switchbox_set_pin(SWB_LD4R, SWB_PWM0);
00087     switchbox_set_pin(SWB_LD4G, SWB_PWM1);
00088     switchbox_set_pin(SWB_LD4B, SWB_PWM2);
00089     // initialize the PWM channels
00090     pwm_init(PWM0, 256);
00091     pwm_init(PWM1, 256);
00092     pwm_init(PWM2, 256);
00093     mode = pwm_color;
00094 }
00095
00096 void leds_destroy(void) {
00097     // note that pynq_destroy will also reset all GPIO and switch off all LEDs
00098     if (mode == binary) {
00099         for (int i = 0; i < NUM_GREEN_LEDS; i++)
00100             green_led_off(i);
00101     }
00102     if (mode == pwm_green || mode == pwm_color) {
00103         green_led_off(0);
00104         green_led_off(1);
00105         green_led_off(2);
00106         pwm_destroy(PWM0);
00107         pwm_destroy(PWM1);
00108         pwm_destroy(PWM2);
00109     }
00110     if (mode == pwm_green) {

```

```

00111     green_led_off(3);
00112     pwm_destroy(PWM3);
00113 }
00114 mode = uninitialized;
00115 }
00116
00117 void green_led_onoff(const int led, const int onoff) {
00118     if (led < 0 || led >= NUM_GREEN_LEDS) {
00119         pynq_error("green_led_onoff: invalid led=%d, must be 0..%d-1\n",
00120                 NUM_GREEN_LEDS);
00121     }
00122     int oo = onoff;
00123     switch (mode) {
00124     case binary:
00125         gpio_set_level(SWB_LD0 + led,
00126                 (onoff == LED_OFF ? GPIO_LEVEL_LOW : GPIO_LEVEL_HIGH));
00127         break;
00128     case pwm_green:
00129     case pwm_color:
00130         if (onoff < 0) {
00131             oo = 0;
00132         } else {
00133             if (onoff > 255) {
00134                 oo = 255;
00135             }
00136         }
00137         pwm_set_duty_cycle(PWM0 + led, oo);
00138         break;
00139     default:
00140         pynq_error("green_led_onoff: LEDs have not been initialized with "
00141                 "green_leds_init_pwm\n");
00142         break;
00143     }
00144 }
00145
00146 void green_led_on(const int led) { green_led_onoff(led, LED_ON); }
00147 void green_led_off(const int led) { green_led_onoff(led, LED_OFF); }
00148 void color_led_red_onoff(const int onoff) {
00149     int oo = onoff;
00150     switch (mode) {
00151     case binary:
00152         gpio_set_level(SWB_LD4R,
00153                 (onoff == LED_OFF ? GPIO_LEVEL_LOW : GPIO_LEVEL_HIGH));
00154         break;
00155     case pwm_green:
00156     case pwm_color:
00157         if (onoff < 0) {
00158             oo = 0;
00159         } else {
00160             if (onoff > 255) {
00161                 oo = 255;
00162             }
00163         }
00164         pwm_set_duty_cycle(PWM0, oo);
00165         break;
00166     default:
00167         pynq_error("color_led_red_onoff: LEDs have not been initialized with "
00168                 "color_leds_init_pwm\n");
00169     }
00170 }
00171
00172 void color_led_green_onoff(const int onoff) {
00173     int oo = onoff;
00174     switch (mode) {
00175     case binary:
00176         gpio_set_level(SWB_LD4G,
00177                 (onoff == LED_OFF ? GPIO_LEVEL_LOW : GPIO_LEVEL_HIGH));
00178         break;
00179     case pwm_color:
00180         if (onoff < 0) {
00181             oo = 0;
00182         } else {
00183             if (onoff > 255) {
00184                 oo = 255;
00185             }
00186         }
00187         pwm_set_duty_cycle(PWM1, oo);
00188         break;
00189     default:
00190         pynq_error("color_led_green_onoff: LEDs have not been initialized with "
00191                 "color_leds_init_pwm\n");
00192     }
00193 }
00194
00195 void color_led_blue_onoff(const int onoff) {
00196     int oo = onoff;
00197     switch (mode) {

```

```

00198     case binary:
00199         gpio_set_level(SWB_LD4B,
00200             (onoff == LED_OFF ? GPIO_LEVEL_LOW : GPIO_LEVEL_HIGH));
00201         break;
00202     case pwm_color:
00203         if (onoff < 0) {
00204             oo = 0;
00205         } else {
00206             if (onoff > 255) {
00207                 oo = 255;
00208             }
00209         }
00210         pwm_set_duty_cycle(PWM2, oo);
00211         break;
00212     default:
00213         pynq_error("color_led_blue_onoff: LEDs have not been initialized with "
00214             "color_leds_init_pwm\n");
00215     }
00216 }
00217
00218 void color_led_onoff(const int red_onoff, const int green_onoff,
00219     const int blue_onoff) {
00220     color_led_red_onoff(red_onoff);
00221     color_led_green_onoff(green_onoff);
00222     color_led_blue_onoff(blue_onoff);
00223 }
00224
00225 void color_led_on(void) { color_led_onoff(LED_ON, LED_ON, LED_ON); }
00226 void color_led_off(void) { color_led_onoff(LED_OFF, LED_OFF, LED_OFF); }

```

6.51 library/empty-library/pinmap.c File Reference

6.52 pinmap.c

[Go to the documentation of this file.](#)

6.53 library/pinmap.c File Reference

```
#include <pinmap.h>
Include dependency graph for pinmap.c:
```

Variables

- char *const [pin_names](#) []

6.54 pinmap.c

[Go to the documentation of this file.](#)

```

00001 /*
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00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
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00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
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```

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00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <pinmap.h>
00023
00024 char *const pin_names[] = {
00025     "AR0",
00026     "AR1",
00027     "AR2",
00028     "AR3",
00029     "AR4",
00030     "AR5",
00031     "AR6",
00032     "AR7",
00033     "AR8",
00034     "AR9",
00035     "AR10",
00036     "AR11",
00037     "AR12",
00038     "AR13",
00039     "A0",
00040     "A1",
00041     "A2",
00042     "A3",
00043     "A4",
00044     "A5",
00045     "SW0",
00046     "SW1",
00047     "BTN0",
00048     "BTN1",
00049     "BTN2",
00050     "BTN3",
00051     "LD0",
00052     "LD1",
00053     "LD2",
00054     "LD3",
00055     "AR_SDA",
00056     "AR_SCL",
00057     "LD4B",
00058     "LD4G",
00059     "LD4R",
00060     "LD5B",
00061     "LD5G",
00062     "LD5R",
00063     "RBPI40",
00064     "RBPI37",
00065     "RBPI38",
00066     "RBPI35",
00067     "RBPI36",
00068     "RBPI33",
00069     "RBPI18",
00070     "RBPI32",
00071     "RBPI10",
00072     "RBPI27",
00073     "RBPI28",
00074     "RBPI22",
00075     "RBPI23",
00076     "RBPI24",
00077     "RBPI21",
00078     "RBPI26",
00079     "RBPI19",
00080     "RBPI31",
00081     "RBPI15",
00082     "RBPI16",
00083     "RBPI13",
00084     "RBPI12",
00085     "RBPI29",
00086     "RBPI08",
00087     "RBPI07",
00088     "RBPI05",
00089 };
```

6.55 library/empty-library/pwm.c File Reference

```
#include <pwm.h>
```

Include dependency graph for pwm.c:

Functions

- bool [pwm_initialized](#) (const int pwm)
- void [pwm_init](#) (const int pwm, const uint32_t period)
- void [pwm_destroy](#) (const int pwm)
- void [pwm_set_duty_cycle](#) (const int pwm, const uint32_t duty)
- void [pwm_set_period](#) (const int pwm, const uint32_t period)
- uint32_t [pwm_get_period](#) (const int pwm)
- uint32_t [pwm_get_duty_cycle](#) (const int pwm)
- void [pwm_set_steps](#) (const int pwm, const uint32_t steps)
- uint32_t [pwm_get_steps](#) (const int pwm)

6.56 pwm.c

[Go to the documentation of this file.](#)

```
00001 #include <pwm.h>
00002 bool pwm_initialized(const int pwm){};
00003 void pwm_init(const int pwm, const uint32_t period){};
00004 void pwm_destroy(const int pwm){};
00005 void pwm_set_duty_cycle(const int pwm, const uint32_t duty){};
00006 void pwm_set_period(const int pwm, const uint32_t period){};
00007 uint32_t pwm_get_period(const int pwm){};
00008 uint32_t pwm_get_duty_cycle(const int pwm){};
00009 void pwm_set_steps(const int pwm, const uint32_t steps){};
00010 uint32_t pwm_get_steps(const int pwm){};
```

6.57 library/pwm.c File Reference

```
#include <libpynq.h>
```

Include dependency graph for pwm.c:

Enumerations

- enum [PWM_Regs](#) { [PWM_REG_DUTY](#) = 0 , [PWM_REG_PERIOD](#) = 1 , [PWM_REG_NEW_STEP_COUNT](#) = 2 , [PWM_REG_CUR_STEP_COUNT](#) = 3 }

Functions

- bool [pwm_initialized](#) (const int pwm)
- bool [check_initialized_pwm](#) (const int pwm)
- void [pwm_init](#) (const int pwm, const uint32_t period)
- void [pwm_destroy](#) (const int pwm)
- uint32_t [pwm_get_duty_cycle](#) (const int pwm)
- uint32_t [pwm_get_period](#) (const int pwm)
- void [pwm_set_period](#) (const int pwm, const uint32_t period)
- void [pwm_set_duty_cycle](#) (const int pwm, const uint32_t duty)
- uint32_t [pwm_get_steps](#) (const int pwm)
- void [pwm_set_steps](#) (const int pwm, const uint32_t steps)

6.57.1 Enumeration Type Documentation

6.57.1.1 PWM_Regs

enum [PWM_Regs](#)

Enumerator

PWM_REG_DUTY	
PWM_REG_PERIOD	
PWM_REG_NEW_STEP_COUNT	
PWM_REG_CUR_STEP_COUNT	

Definition at line 24 of file [pwm.c](#).

6.57.2 Function Documentation

6.57.2.1 check_initialized_pwm()

```
bool check_initialized_pwm (
    const int pwm )
```

Definition at line 49 of file [pwm.c](#).

Here is the caller graph for this function:

6.58 pwm.c

[Go to the documentation of this file.](#)

```
00001 /*
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00003
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00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
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00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <libpynq.h>
00023
00024 enum PWM_Regs {
00025     PWM_REG_DUTY = 0,
00026     PWM_REG_PERIOD = 1,
00027     PWM_REG_NEW_STEP_COUNT = 2,
00028     PWM_REG_CUR_STEP_COUNT = 3,
00029 };
00030
00031 static struct arm_shared_t channels[NUM_PWMs] = {
00032     0,
```

```

00033 };
00034 static volatile uint32_t *initializedChannel[NUM_PWMMS] = {
00035     NULL,
00036 };
00037
00038 bool pwm_initialized(const int pwm) {
00039     if (pwm < 0 || pwm >= NUM_PWMMS) {
00040         pyng_error("pwm_initialized: invalid pwm=%d, must be 0..%d-1\n", pwm,
00041             NUM_PWMMS);
00042     }
00043     if (initializedChannel[pwm] == NULL) {
00044         return false;
00045     }
00046     return true;
00047 }
00048
00049 bool check_initialized_pwm(const int pwm) {
00050     if (pwm < 0 || pwm >= NUM_PWMMS) {
00051         pyng_error("pwm_initialized: invalid pwm=%d, must be 0..%d-1\n", pwm,
00052             NUM_PWMMS);
00053     }
00054     if (initializedChannel[pwm] == NULL) {
00055         pyng_error("pwm_initialized: channel of pwm %d has not been initialized\n",
00056             pwm);
00057     }
00058     return true;
00059 }
00060
00061 void pwm_init(const int pwm, const uint32_t period) {
00062     if (pwm < 0 || pwm >= NUM_PWMMS) {
00063         pyng_error("pwm_init: invalid pwm=%d, must be 0..%d-1\n", pwm, NUM_PWMMS);
00064     }
00065     uint32_t channelAddr = axi_pwm_base + (pwm * 0x10000);
00066     initializedChannel[pwm] = arm_shared_init(&channels[pwm], channelAddr, 512);
00067     initializedChannel[pwm][PWM_REG_DUTY] = 0;
00068     initializedChannel[pwm][PWM_REG_PERIOD] = period;
00069     initializedChannel[pwm][PWM_REG_NEW_STEP_COUNT] = -1;
00070 }
00071
00072 void pwm_destroy(const int pwm) {
00073     (void)check_initialized_pwm(pwm);
00074     arm_shared_close(&channels[pwm]);
00075     initializedChannel[pwm] = NULL;
00076 }
00077
00078 uint32_t pwm_get_duty_cycle(const int pwm) {
00079     (void)check_initialized_pwm(pwm);
00080     return initializedChannel[pwm][PWM_REG_DUTY];
00081 }
00082
00083 uint32_t pwm_get_period(const int pwm) {
00084     (void)check_initialized_pwm(pwm);
00085     return initializedChannel[pwm][PWM_REG_PERIOD];
00086 }
00087
00088 void pwm_set_period(const int pwm, const uint32_t period) {
00089     (void)check_initialized_pwm(pwm);
00090     initializedChannel[pwm][PWM_REG_PERIOD] = period;
00091 }
00092
00093 void pwm_set_duty_cycle(const int pwm, const uint32_t duty) {
00094     (void)check_initialized_pwm(pwm);
00095     initializedChannel[pwm][PWM_REG_DUTY] = duty;
00096 }
00097
00098 uint32_t pwm_get_steps(const int pwm) {
00099     (void)check_initialized_pwm(pwm);
00100     return initializedChannel[pwm][PWM_REG_NEW_STEP_COUNT];
00101 }
00102
00103 void pwm_set_steps(const int pwm, const uint32_t steps) {
00104     (void)check_initialized_pwm(pwm);
00105     initializedChannel[pwm][PWM_REG_NEW_STEP_COUNT] = steps;
00106 }

```

6.59 library/empty-library/README.txt File Reference

Functions

- Use these implementations when compiling on Onconrise Bit of a hack since ideally this would have been done with If a new function doesn't get added here then it'll give an error **only** when it's used in the **application** (relatively unlikely). Note that return values of reading button state etc. will not behave correctly. Overall

- Use these implementations when compiling on Oncourse Bit of a hack since ideally this would have been done with If a new function doesn't get added here then it'll give an error only when it's used in the this hack will work only for Oncourse programs that use PYNQ output [only](#) (e.g. sorting)

6.59.1 Function Documentation

6.59.1.1 application()

Use these implementations when compiling on Oncourse Bit of a hack since ideally this would have been done with If a new function doesn't get added here then it'll give an error [only](#) when it's used in the application (
 relatively unlikely)

6.59.1.2 only()

Use these implementations when compiling on Oncourse Bit of a hack since ideally this would have been done with If a new function doesn't get added here then it'll give an error only when it's used in the this hack will work only for Oncourse programs that use PYNQ output only (
 e.g. sorting)

6.60 library/empty-library/switchbox.c File Reference

```
#include <switchbox.h>
```

Include dependency graph for switchbox.c:

Functions

- void [switchbox_init](#) (void)
- void [switchbox_set_pin](#) (const [pin_t](#) pin_number, const uint8_t pin_type)
- void [switchbox_reset](#) (void)
- void [switchbox_destroy](#) (void)
- uint8_t [switchbox_get_pin](#) (const [pin_t](#) pin_number)

Variables

- char *const [switchbox_names](#) [NUM_SWITCHBOX_NAMES] = {}

6.61 switchbox.c

[Go to the documentation of this file.](#)

```
00001 #include <switchbox.h>
00002 char *const switchbox_names[NUM_SWITCHBOX_NAMES] = {};
00003 void switchbox_init(void) {};
00004 void switchbox_set_pin(const pin_t pin_number, const uint8_t pin_type) {};
00005 void switchbox_reset(void) {};
00006 void switchbox_destroy(void) {};
00007 uint8_t switchbox_get_pin(const pin_t pin_number) {};
```

6.62 library/switchbox.c File Reference

```
#include "switchbox.h"
#include <libpynq.h>
Include dependency graph for switchbox.c:
```

Data Structures

- struct [pin](#)

Functions

- void [switchbox_init](#) (void)
- void [switchbox_destroy](#) (void)
- void [switchbox_reset](#) (void)
- void [switchbox_set_pin](#) (const [pin_t](#) pin_number, const uint8_t pin_type)
- uint8_t [switchbox_get_pin](#) (const [pin_t](#) pin_number)

Variables

- char *const [switchbox_names](#) [[NUM_SWITCHBOX_NAMES](#)]
- [arm_shared](#) [ioswitch_handle](#)
- volatile uint32_t * [ioswitch](#) = NULL

6.62.1 Variable Documentation

6.62.1.1 ioswitch

```
volatile uint32_t* ioswitch = NULL
```

Definition at line 97 of file [switchbox.c](#).

6.62.1.2 ioswitch_handle

```
arm\_shared ioswitch_handle
```

Definition at line 96 of file [switchbox.c](#).

6.63 switchbox.c

[Go to the documentation of this file.](#)

```

00001  /*
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00005  of this software and associated documentation files (the "Software"), to deal
00006  in the Software without restriction, including without limitation the rights
00007  to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
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00017  AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018  LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019  OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020  SOFTWARE.
00021  */
00022  #include "switchbox.h"
00023  #include <libpyng.h>
00024
00025  char *const switchbox_names[NUM_SWITCHBOX_NAMES] = {
00026      "SWB_GPIO",
00027      "SWB_Interrupt_In",
00028      "SWB_UART0_TX",
00029      "SWB_UART0_RX",
00030      "SWB_SPI0_CLK",
00031      "SWB_SPI0_MISO",
00032      "SWB_SPI0_MOSI",
00033      "SWB_SPI0_SS",
00034      "SWB_SPI1_CLK",
00035      "SWB_SPI1_MISO",
00036      "SWB_SPI1_MOSI",
00037      "SWB_SPI1_SS",
00038      "SWB_IIC0_SDA",
00039      "SWB_IIC0_SCL",
00040      "SWB_IIC1_SDA",
00041      "SWB_IIC1_SCL",
00042      "SWB_PWM0",
00043      "SWB_PWM1",
00044      "SWB_PWM2",
00045      "SWB_PWM3",
00046      "SWB_PWM4",
00047      "SWB_PWM5",
00048      "SWB_TIMER_G0",
00049      "SWB_TIMER_G1",
00050      "SWB_TIMER_G2",
00051      "SWB_TIMER_G3",
00052      "SWB_TIMER_G4",
00053      "SWB_TIMER_G5",
00054      "SWB_TIMER_G6",
00055      "SWB_TIMER_G7",
00056      "SWB_UART1_TX",
00057      "SWB_UART1_RX",
00058      "SWB_TIMER_IC0",
00059      "SWB_TIMER_IC1",
00060      "SWB_TIMER_IC2",
00061      "SWB_TIMER_IC3",
00062      "SWB_TIMER_IC4",
00063      "SWB_TIMER_IC5",
00064      "SWB_TIMER_IC6",
00065      "SWB_TIMER_IC7",
00066  };
00067
00068  arm_shared ioswitch_handle;
00069  volatile uint32_t *ioswitch = NULL;
00070
00071  typedef struct {
00072      char *name;
00073      char *state;
00074      uint8_t channel;
00075  } pin;
00076
00077  void switchbox_init(void) {
00078      // allocate shared memory for the switchbox and store the pointer in
00079      // `ioswitch`
00080      check_version();
00081      ioswitch = arm_shared_init(&ioswitch_handle, io_switch_0, 4096);
00082  }

```

```

00111
00112 void switchbox_destroy(void) {
00113     // free the sared memory in the switchbox
00114     arm_shared_close(&ioswitch_handle);
00115 }
00116
00117 // reset all switchbox pins to 0
00118 void switchbox_reset(void) {
00119     // 32 pins to remap, 4 per word.
00120     for (uint_fast32_t i = 0; i < (64 / 4); i++) {
00121         // set all words to 0
00122         ioswitch[i] = 0;
00123     }
00124 }
00125
00126 // pin_number: the number of the pin to set.
00127 // pin_type: the type to set the pin to (0 or 1).
00128 void switchbox_set_pin(const pin_t pin_number, const uint8_t pin_type) {
00129     int numWordstoPass, byteNumber;
00130     uint32_t switchConfigValue;
00131
00132     PIN_CHECK(pin_number);
00133
00134     // If gpio is initialized, set the pin as input, if PIN_TYPE is
00135     // not gpio
00136     if (pin_type != SWB_GPIO && gpio_is_initialized()) {
00137         // set pin as input.
00138         if (gpio_get_direction(pin_number) != GPIO_DIR_INPUT) {
00139             pynq_warning("pin: %s is set as GPIO ouput, but not mapped as GPIO. "
00140                 "Reconfiguring as input.",
00141                 pin_names[pin_number]);
00142             gpio_set_direction(pin_number, GPIO_DIR_INPUT);
00143         }
00144     }
00145
00146     // calculate the word and byte number for the given pin number
00147     numWordstoPass = pin_number / 4;
00148     byteNumber = pin_number % 4;
00149
00150     // get the current value of the word containing the pin
00151     switchConfigValue = ioswitch[numWordstoPass];
00152
00153     // clear the byte containing the pin type and set it to the new value
00154     switchConfigValue = (switchConfigValue & ~(0xFF << (byteNumber * 8))) |
00155         (pin_type << (byteNumber * 8));
00156
00157     // update the word in the switchbox with the new value
00158     ioswitch[numWordstoPass] = switchConfigValue;
00159 }
00160
00161 // pin_number: the number of the pin to get
00162 // returns: the type of the given pin
00163 uint8_t switchbox_get_pin(const pin_t pin_number) {
00164     int numWordstoPass, byteNumber;
00165     uint32_t switchConfigValue;
00166
00167     PIN_CHECK(pin_number);
00168
00169     // calculate the word and byte number for the given pin number
00170     numWordstoPass = pin_number / 4;
00171     byteNumber = pin_number % 4;
00172
00173     // get the value of the word containing the pin and extract the value of the
00174     // byte containing the pin type
00175     switchConfigValue = ioswitch[numWordstoPass];
00176     switchConfigValue = (switchConfigValue >> (byteNumber * 8)) & 0xFF;
00177
00178     // return pintype
00179     return switchConfigValue;
00180 }

```

6.64 library/empty-library/uart.c File Reference

#include <uart.h>

Include dependency graph for uart.c:

Functions

- void `uart_init` (const int uart)

- void [uart_destroy](#) (const int uart)
- void [uart_send](#) (const int uart, const uint8_t data)
- uint8_t [uart_rcv](#) (const int uart)
- bool [uart_has_data](#) (const int uart)
- bool [uart_has_space](#) (const int uart)
- void [uart_reset_fifos](#) (const int uart)

6.65 uart.c

[Go to the documentation of this file.](#)

```
00001 #include <uart.h>
00002 void uart_init(const int uart){};
00003 void uart_destroy(const int uart){};
00004 void uart_send(const int uart, const uint8_t data){};
00005 uint8_t uart_rcv(const int uart){};
00006 bool uart_has_data(const int uart){};
00007 bool uart_has_space(const int uart){};
00008 void uart_reset_fifos(const int uart){};
```

6.66 library/uart.c File Reference

```
#include "uart.h"
#include "arm_shared_memory_system.h"
#include "log.h"
#include <platform.h>
#include <stdio.h>
Include dependency graph for uart.c:
```

Macros

- #define [UART_REG_RECEIVE_FIFO](#) 0
- #define [UART_REG_TRANSMIT_FIFO](#) 1
- #define [UART_REG_STATUS](#) 2
- #define [UART_REG_CONTROL](#) 3
- #define [UART_REG_STATUS_BIT_RX_FIFO_HAS_DATA](#) 1
- #define [UART_REG_STATUS_BIT_RX_FIFO_FULL](#) 2
- #define [UART_REG_STATUS_BIT_TX_FIFO_EMPTY](#) 4
- #define [UART_REG_STATUS_BIT_TX_FIFO_FULL](#) 8
- #define [UART_REG_CONTROL_BIT_CLEAR_TX_FIFO](#) 1
- #define [UART_REG_CONTROL_BIT_CLEAR_RX_FIFO](#) 2
- #define [UART_REG_CONTROL_BIT_CLEAR_FIFOS](#) ([UART_REG_CONTROL_BIT_CLEAR_RX_FIFO](#) | [UART_REG_CONTROL_BIT_CLEAR_TX_FIFO](#))

Functions

- void [uart_init](#) (const int uart)
- void [uart_destroy](#) (const int uart)
- void [uart_send](#) (const int uart, const uint8_t data)
- uint8_t [uart_rcv](#) (const int uart)
- bool [uart_has_data](#) (const int uart)
- bool [uart_has_space](#) (const int uart)
- void [uart_reset_fifos](#) (const int uart)

6.66.1 Macro Definition Documentation

6.66.1.1 UART_REG_CONTROL

```
#define UART_REG_CONTROL 3
```

Definition at line 31 of file [uart.c](#).

6.66.1.2 UART_REG_CONTROL_BIT_CLEAR_FIFOS

```
#define UART_REG_CONTROL_BIT_CLEAR_FIFOS (UART_REG_CONTROL_BIT_CLEAR_RX_FIFO | UART_REG_CONTROL_BIT_CLEAR_TX_FIFO)
```

Definition at line 40 of file [uart.c](#).

6.66.1.3 UART_REG_CONTROL_BIT_CLEAR_RX_FIFO

```
#define UART_REG_CONTROL_BIT_CLEAR_RX_FIFO 2
```

Definition at line 39 of file [uart.c](#).

6.66.1.4 UART_REG_CONTROL_BIT_CLEAR_TX_FIFO

```
#define UART_REG_CONTROL_BIT_CLEAR_TX_FIFO 1
```

Definition at line 38 of file [uart.c](#).

6.66.1.5 UART_REG_RECEIVE_FIFO

```
#define UART_REG_RECEIVE_FIFO 0
```

Definition at line 28 of file [uart.c](#).

6.66.1.6 UART_REG_STATUS

```
#define UART_REG_STATUS 2
```

Definition at line 30 of file [uart.c](#).

6.66.1.7 UART_REG_STATUS_BIT_RX_FIFO_FULL

```
#define UART_REG_STATUS_BIT_RX_FIFO_FULL 2
```

Definition at line 34 of file [uart.c](#).

6.66.1.8 UART_REG_STATUS_BIT_RX_FIFO_HAS_DATA

```
#define UART_REG_STATUS_BIT_RX_FIFO_HAS_DATA 1
```

Definition at line 33 of file [uart.c](#).

6.66.1.9 UART_REG_STATUS_BIT_TX_FIFO_EMPTY

```
#define UART_REG_STATUS_BIT_TX_FIFO_EMPTY 4
```

Definition at line 35 of file [uart.c](#).

6.66.1.10 UART_REG_STATUS_BIT_TX_FIFO_FULL

```
#define UART_REG_STATUS_BIT_TX_FIFO_FULL 8
```

Definition at line 36 of file [uart.c](#).

6.66.1.11 UART_REG_TRANSMIT_FIFO

```
#define UART_REG_TRANSMIT_FIFO 1
```

Definition at line 29 of file [uart.c](#).

6.67 uart.c

[Go to the documentation of this file.](#)

```
00001 /*
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00006 in the Software without restriction, including without limitation the rights
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00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
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00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include "uart.h"
00023 #include "arm_shared_memory_system.h"
00024 #include "log.h"
00025 #include <platform.h>
00026 #include <stdio.h>
00027
00028 #define UART_REG_RECEIVE_FIFO 0
00029 #define UART_REG_TRANSMIT_FIFO 1
00030 #define UART_REG_STATUS 2
00031 #define UART_REG_CONTROL 3
00032
00033 #define UART_REG_STATUS_BIT_RX_FIFO_HAS_DATA 1
00034 #define UART_REG_STATUS_BIT_RX_FIFO_FULL 2
00035 #define UART_REG_STATUS_BIT_TX_FIFO_EMPTY 4
```

```

00036 #define UART_REG_STATUS_BIT_TX_FIFO_FULL 8
00037
00038 #define UART_REG_CONTROL_BIT_CLEAR_TX_FIFO 1
00039 #define UART_REG_CONTROL_BIT_CLEAR_RX_FIFO 2
00040 #define UART_REG_CONTROL_BIT_CLEAR_FIFOS \
00041     (UART_REG_CONTROL_BIT_CLEAR_RX_FIFO | UART_REG_CONTROL_BIT_CLEAR_TX_FIFO)
00042
00043 static arm_shared uart_handles[NUM_UARTS];
00044 static volatile uint32_t *uart_ptrs[NUM_UARTS] = {
00045     NULL,
00046 };
00047
00048 void uart_init(const int uart) {
00049     if (!(uart >= UART0 && uart < NUM_UARTS)) {
00050         pynq_error("invalid UART %d, must be 0..%d-1\n", uart, NUM_UARTS);
00051     }
00052     if (uart == UART0) {
00053         uart_ptrs[uart] =
00054             arm_shared_init(&(uart_handles[uart]), axi_uartlite_0, 4096);
00055     } else if (uart == UART1) {
00056         uart_ptrs[uart] =
00057             arm_shared_init(&(uart_handles[uart]), axi_uartlite_1, 4096);
00058     }
00059 }
00060
00061 void uart_destroy(const int uart) {
00062     if (!(uart >= UART0 && uart < NUM_UARTS)) {
00063         pynq_error("invalid UART %d, must be 0..%d-1\n", uart, NUM_UARTS);
00064     }
00065     if (uart_ptrs[uart] == NULL) {
00066         pynq_error("UART%d has not been initialized.\n", uart);
00067     }
00068     arm_shared_close(&(uart_handles[uart]));
00069     uart_ptrs[uart] = NULL;
00070 }
00071
00072 void uart_send(const int uart, const uint8_t data) {
00073     if (!(uart >= UART0 && uart < NUM_UARTS)) {
00074         pynq_error("invalid UART %d, must be 0..%d-1\n", uart, NUM_UARTS);
00075     }
00076     if (uart_ptrs[uart] == NULL) {
00077         pynq_error("UART%d has not been initialized.\n", uart);
00078     }
00079     while ((uart_ptrs[uart][UART_REG_STATUS] &
00080             UART_REG_STATUS_BIT_TX_FIFO_FULL) == UART_REG_STATUS_BIT_TX_FIFO_FULL)
00081         ;
00082     uart_ptrs[uart][UART_REG_TRANSMIT_FIFO] = data;
00083 }
00084
00085 uint8_t uart_recv(const int uart) {
00086     if (!(uart >= UART0 && uart < NUM_UARTS)) {
00087         pynq_error("invalid UART %d, must be 0..%d-1\n", uart, NUM_UARTS);
00088     }
00089     if (uart_ptrs[uart] == NULL) {
00090         pynq_error("UART%d has not been initialized.\n", uart);
00091     }
00092     while ((uart_ptrs[uart][UART_REG_STATUS] &
00093             UART_REG_STATUS_BIT_RX_FIFO_HAS_DATA) == 0) {
00094     }
00095     return uart_ptrs[uart][UART_REG_RECEIVE_FIFO];
00096 }
00097
00098 bool uart_has_data(const int uart) {
00099     if (!(uart >= UART0 && uart < NUM_UARTS)) {
00100         pynq_error("invalid UART %d, must be 0..%d-1\n", uart, NUM_UARTS);
00101     }
00102     if (uart_ptrs[uart] == NULL) {
00103         pynq_error("UART%d has not been initialized.\n", uart);
00104     }
00105     return ((uart_ptrs[uart][UART_REG_STATUS] &
00106             UART_REG_STATUS_BIT_RX_FIFO_HAS_DATA) ==
00107             UART_REG_STATUS_BIT_RX_FIFO_HAS_DATA);
00108 }
00109
00110 bool uart_has_space(const int uart) {
00111     if (!(uart >= UART0 && uart < NUM_UARTS)) {
00112         pynq_error("invalid UART %d, must be 0..%d-1\n", uart, NUM_UARTS);
00113     }
00114     if (uart_ptrs[uart] == NULL) {
00115         pynq_error("UART%d has not been initialized.\n", uart);
00116     }
00117     return ((uart_ptrs[uart][UART_REG_STATUS] &
00118             UART_REG_STATUS_BIT_TX_FIFO_FULL) == 0);
00119 }
00120
00121 void uart_reset_fifos(const int uart) {
00122     if (!(uart >= UART0 && uart < NUM_UARTS)) {

```

```

00123     pynq_error("invalid UART %d, must be 0..%d-1\n", uart, NUM_UARTS);
00124 }
00125 if (uart_ptrs[uart] == NULL) {
00126     pynq_error("UART%d has not been initialized.\n", uart);
00127 }
00128 uart_ptrs[uart][UART_REG_CONTROL] = UART_REG_CONTROL_BIT_CLEAR_FIFOS;
00129 }

```

6.68 library/empty-library/uio.c File Reference

```
#include <uio.h>
```

Include dependency graph for uio.c:

Functions

- void * [setUIO](#) (int uio_index, int length)
- int [unsetUIO](#) (void *uio_ptr, int length)

6.68.1 Function Documentation

6.68.1.1 setUIO()

```

void * setUIO (
    int uio_index,
    int length )

```

Definition at line 2 of file [uio.c](#).

Here is the caller graph for this function:

6.68.1.2 unsetUIO()

```

int unsetUIO (
    void * uio_ptr,
    int length )

```

Definition at line 3 of file [uio.c](#).

Here is the caller graph for this function:

6.69 uio.c

[Go to the documentation of this file.](#)

```

00001 #include <uio.h>
00002 void *setUIO(int uio_index, int length){};
00003 int unsetUIO(void *uio_ptr, int length){};

```

6.70 library/uio.c File Reference

```
#include "uio.h"
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/mman.h>
#include <unistd.h>
Include dependency graph for uio.c:
```

Functions

- void * [setUIO](#) (int uio_index, int length)
- int [unsetUIO](#) (void *uio_ptr, int length)

6.70.1 Function Documentation

6.70.1.1 setUIO()

```
void * setUIO (
    int uio_index,
    int length )
```

Definition at line [65](#) of file [uio.c](#).

6.70.1.2 unsetUIO()

```
int unsetUIO (
    void * uio_ptr,
    int length )
```

Definition at line [86](#) of file [uio.c](#).

6.71 uio.c

[Go to the documentation of this file.](#)

```
00001 /*****
00002  * Copyright (c) 2016, Xilinx, Inc.
00003  * All rights reserved.
00004  *
00005  * Redistribution and use in source and binary forms, with or without
00006  * modification, are permitted provided that the following conditions are met:
00007  *
00008  * 1. Redistributions of source code must retain the above copyright notice,
00009  *    this list of conditions and the following disclaimer.
00010  *
00011  * 2. Redistributions in binary form must reproduce the above copyright
00012  *    notice, this list of conditions and the following disclaimer in the
00013  *    documentation and/or other materials provided with the distribution.
00014  *
00015  * 3. Neither the name of the copyright holder nor the names of its
00016  *    contributors may be used to endorse or promote products derived from
00017  *    this software without specific prior written permission.
00018  *
00019  * THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS"
```

```

00020 * AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO,
00021 * THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR
00022 * PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR
00023 * CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL,
00024 * EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO,
00025 * PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS;
00026 * OR BUSINESS INTERRUPTION). HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY,
00027 * WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR
00028 * OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF
00029 * ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
00030 *
00031 *****/
00032 /*****/
00033 *
00034 *
00035 * @file uio.c
00036 *
00037 * Functions to interact with linux UIO. No safe checks here, so users must
00038 * know what they are doing.
00039 *
00040 * <pre>
00041 * MODIFICATION HISTORY:
00042 *
00043 * Ver   Who   Date       Changes
00044 * ----  ---  -
00045 * 1.00a  yrq  12/05/17 Initial release
00046 *
00047 * </pre>
00048 *
00049 *****/
00050
00051 #include "uio.h"
00052 #include <fcntl.h>
00053 #include <stdio.h>
00054 #include <stdlib.h>
00055 #include <string.h>
00056 #include <sys/mman.h>
00057 #include <unistd.h>
00058
00059 /*****/
00060 * Function to set the UIO device.
00061 * @param uio_index is the uio index in /dev list.
00062 * @param length is the length of the MMAP in bytes.
00063 * @return A pointer pointing to the MMAP of the UIO.
00064 *****/
00065 void *setUIO(int uio_index, int length) {
00066     char uio_buf[32];
00067     int uio_fd;
00068     void *uio_ptr;
00069
00070     sprintf(uio_buf, "/dev/uio%d", uio_index);
00071     uio_fd = open(uio_buf, O_RDWR);
00072     if (uio_fd < 1) {
00073         printf("Invalid UIO device file: %s.\n", uio_buf);
00074     }
00075     // mmap the UIO devices
00076     uio_ptr = mmap(NULL, length, PROT_READ | PROT_WRITE, MAP_SHARED, uio_fd, 0);
00077     return uio_ptr;
00078 }
00079
00080 /*****/
00081 * Function to set the UIO device.
00082 * @param uio_ptr is the uio pointer to be freed.
00083 * @param length is the length of the MMAP.
00084 * @return 0 on success; -1 otherwise.
00085 *****/
00086 int unsetUIO(void *uio_ptr, int length) { return munmap(uio_ptr, length); }

```

6.72 library/empty-library/version.c File Reference

#include <version.h>
 Include dependency graph for version.c:

Macros

- #define LIBPYNQ_RELEASE "ONCOURSE"
- #define LIBPYNQ_VERSION_MAJOR 0
- #define LIBPYNQ_VERSION_MINOR 2
- #define LIBPYNQ_VERSION_PATCH 0

Functions

- void [print_version](#) (void)
- void [check_version](#) (void)

Variables

- const [version_t](#) [libpynq_version](#)

6.72.1 Macro Definition Documentation

6.72.1.1 LIBPYNQ_RELEASE

```
#define LIBPYNQ_RELEASE "ONCOURSE"
```

Definition at line 8 of file [version.c](#).

6.72.1.2 LIBPYNQ_VERSION_MAJOR

```
#define LIBPYNQ_VERSION_MAJOR 0
```

Definition at line 9 of file [version.c](#).

6.72.1.3 LIBPYNQ_VERSION_MINOR

```
#define LIBPYNQ_VERSION_MINOR 2
```

Definition at line 10 of file [version.c](#).

6.72.1.4 LIBPYNQ_VERSION_PATCH

```
#define LIBPYNQ_VERSION_PATCH 0
```

Definition at line 11 of file [version.c](#).

6.73 version.c

[Go to the documentation of this file.](#)

```
00001 #include <version.h>
00002 /*****
00003  * WARNING
00004  * only change the numbers in these 4 #defs; do not change anything else
00005  * the libpynq version in doxygen ryb.doxy is updated automatically based
00006  * on the next 4 lines
00007  *****/
00008 #define LIBPYNQ_RELEASE "ONCOURSE"
00009 #define LIBPYNQ_VERSION_MAJOR 0
00010 #define LIBPYNQ_VERSION_MINOR 2
00011 #define LIBPYNQ_VERSION_PATCH 0
00012 const version_t libpynq_version = {
00013     LIBPYNQ_RELEASE,
00014     LIBPYNQ_VERSION_MAJOR,
00015     LIBPYNQ_VERSION_MINOR,
00016     LIBPYNQ_VERSION_PATCH,
00017 };
00018 void print_version(void) {};
00019 void check_version(void) {};
```

6.74 library/version.c File Reference

```
#include <libpynq.h>
```

Include dependency graph for version.c:

Macros

- `#define LIBPYNQ_RELEASE "5EWC0-2023"`
- `#define LIBPYNQ_VERSION_MAJOR 0`
- `#define LIBPYNQ_VERSION_MINOR 2`
- `#define LIBPYNQ_VERSION_PATCH 2`
- `#define LOG_DOMAIN "version"`

Functions

- void `print_version` (void)
- void `check_version` (void)

Variables

- const `version_t libpynq_version`

6.74.1 Macro Definition Documentation

6.74.1.1 LIBPYNQ_RELEASE

```
#define LIBPYNQ_RELEASE "5EWC0-2023"
```

Definition at line 30 of file [version.c](#).

6.74.1.2 LIBPYNQ_VERSION_MAJOR

```
#define LIBPYNQ_VERSION_MAJOR 0
```

Definition at line 31 of file [version.c](#).

6.74.1.3 LIBPYNQ_VERSION_MINOR

```
#define LIBPYNQ_VERSION_MINOR 2
```

Definition at line 32 of file [version.c](#).

6.74.1.4 LIBPYNQ_VERSION_PATCH

```
#define LIBPYNQ_VERSION_PATCH 2
```

Definition at line 33 of file [version.c](#).

6.74.1.5 LOG_DOMAIN

```
#define LOG_DOMAIN "version"
```

Definition at line 42 of file [version.c](#).

6.75 version.c

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <libpynq.h>
00023
00024 /*****
00025  * WARNING
00026  * only change the numbers in these 4 #defs; do not change anything else
00027  * the libpynq version in doxygen ryb.doxy is updated automatically based
00028  * on the next 4 lines
00029  *****/
00030 #define LIBPYNQ_RELEASE "5EWC0-2023"
00031 #define LIBPYNQ_VERSION_MAJOR 0
00032 #define LIBPYNQ_VERSION_MINOR 2
00033 #define LIBPYNQ_VERSION_PATCH 2
00034 const version_t libpynq_version = {
00035     LIBPYNQ_RELEASE,
00036     LIBPYNQ_VERSION_MAJOR,
00037     LIBPYNQ_VERSION_MINOR,
00038     LIBPYNQ_VERSION_PATCH,
00039 };
00040
00041 #undef LOG_DOMAIN
00042 #define LOG_DOMAIN "version"
00043
00044 void print_version(void) {
00045     arm_shared t;
00046     version_t volatile *hardwareVersion =
00047         (version_t volatile *)arm_shared_init(&t, axi_version_0, 4096);
00048     printf("Bitstream version: %d.%d.%d\r\n", hardwareVersion->major,
00049         hardwareVersion->minor, hardwareVersion->patch);
00050     printf("Libpynq release %s version %d.%d.%d\r\n", libpynq_version.release,
00051         libpynq_version.major, libpynq_version.minor, libpynq_version.patch);
00052     if (libpynq_version.major != hardwareVersion->major) {
00053         pynq_error(
00054             "ERROR: the bitstream (hardware) and the libpynq library versions "
00055             "are incompatible. Please update your SD-card image and libpynq "
00056             "library.\n");
00057     } else if (libpynq_version.minor > hardwareVersion->minor) {
00058         printf("INFO: the libpynq library is newer than the bitstream (hardware). "
00059             "Please check if there is a newer version of the SD-card image.\n");
00060     } else if (libpynq_version.minor < hardwareVersion->minor) {
00061         printf(
00062             "INFO: the bitstream (hardware) is newer than the libpynq library. "
00063             "Please check if there is a newer version of the libpynq library.\n");
00064     }
00065     arm_shared_close(&t);
00066 }
00067
00068 void check_version(void) {
00069     arm_shared t;
```



```

00070     version_t volatile *hardwareVersion =
00071         (version_t volatile *)arm_shared_init(&t, axi_version_0, 4096);
00072     if (libpyng_version.major != hardwareVersion->major) {
00073         print_version();
00074     }
00075     arm_shared_close(&t);
00076 }

```

6.76 library/empty-library/xiic_l.c File Reference

```

#include <xiic_l.h>
Include dependency graph for xiic_l.c:

```

Functions

- unsigned [Xlic_Recv](#) (UINTPTR BaseAddress, u8 Address, u8 *BufferPtr, unsigned ByteCount, u8 Option)
- unsigned [Xlic_Send](#) (UINTPTR BaseAddress, u8 Address, u8 *BufferPtr, unsigned ByteCount, u8 Option)
- unsigned [Xlic_DynRecv](#) (UINTPTR BaseAddress, u8 Address, u8 *BufferPtr, u8 ByteCount)
- unsigned [Xlic_DynSend](#) (UINTPTR BaseAddress, u16 Address, u8 *BufferPtr, u8 ByteCount, u8 Option)
- int [Xlic_DynInit](#) (UINTPTR BaseAddress)
- u32 [Xlic_CheckIsBusBusy](#) (UINTPTR BaseAddress)
- u32 [Xlic_WaitBusFree](#) (UINTPTR BaseAddress)

6.76.1 Function Documentation

6.76.1.1 Xlic_CheckIsBusBusy()

```

u32 XIic_CheckIsBusBusy (
    UINTPTR BaseAddress )

```

Definition at line 11 of file [xiic_l.c](#).

Here is the caller graph for this function:

6.76.1.2 Xlic_DynInit()

```

int XIic_DynInit (
    UINTPTR BaseAddress )

```

Definition at line 10 of file [xiic_l.c](#).

6.76.1.3 Xlic_DynRecv()

```

unsigned XIic_DynRecv (
    UINTPTR BaseAddress,
    u8 Address,
    u8 * BufferPtr,
    u8 ByteCount )

```

Definition at line 6 of file [xiic_l.c](#).

6.76.1.4 Xlic_DynSend()

```
unsigned XIic_DynSend (
    UINTPTR BaseAddress,
    u16 Address,
    u8 * BufferPtr,
    u8 ByteCount,
    u8 Option )
```

Definition at line 8 of file [xiic_l.c](#).

6.76.1.5 Xlic_Recv()

```
unsigned XIic_Recv (
    UINTPTR BaseAddress,
    u8 Address,
    u8 * BufferPtr,
    unsigned ByteCount,
    u8 Option )
```

Definition at line 2 of file [xiic_l.c](#).

Here is the caller graph for this function:

6.76.1.6 Xlic_Send()

```
unsigned XIic_Send (
    UINTPTR BaseAddress,
    u8 Address,
    u8 * BufferPtr,
    unsigned ByteCount,
    u8 Option )
```

Definition at line 4 of file [xiic_l.c](#).

Here is the caller graph for this function:

6.76.1.7 Xlic_WaitBusFree()

```
u32 XIic_WaitBusFree (
    UINTPTR BaseAddress )
```

Definition at line 12 of file [xiic_l.c](#).

Here is the caller graph for this function:

6.77 xiic_l.c

[Go to the documentation of this file.](#)

```
00001 #include <xiic_l.h>
00002 unsigned XIic_Recv(UINTPTR BaseAddress, u8 Address, u8 *BufferPtr,
00003                    unsigned ByteCount, u8 Option) {};
00004 unsigned XIic_Send(UINTPTR BaseAddress, u8 Address, u8 *BufferPtr,
00005                   unsigned ByteCount, u8 Option) {};
00006 unsigned XIic_DynRecv(UINTPTR BaseAddress, u8 Address, u8 *BufferPtr,
00007                      u8 ByteCount) {};
00008 unsigned XIic_DynSend(UINTPTR BaseAddress, u16 Address, u8 *BufferPtr,
00009                      u8 ByteCount, u8 Option) {};
00010 int XIic_DynInit(UINTPTR BaseAddress) {};
00011 u32 XIic_CheckIsBusBusy(UINTPTR BaseAddress) {};
00012 u32 XIic_WaitBusFree(UINTPTR BaseAddress) {};
```

6.78 library/xiic_l.c File Reference

```
#include <unistd.h>
#include "xiic_l.h"
#include "xil_types.h"
Include dependency graph for xiic_l.c:
```

Macros

- `#define _DEFAULT_SOURCE`

Functions

- unsigned [Xlic_Recv](#) (UINTPTR BaseAddress, u8 Address, u8 *BufferPtr, unsigned ByteCount, u8 Option)
- unsigned [Xlic_Send](#) (UINTPTR BaseAddress, u8 Address, u8 *BufferPtr, unsigned ByteCount, u8 Option)
- u32 [Xlic_CheckIsBusBusy](#) (UINTPTR BaseAddress)
- u32 [Xlic_WaitBusFree](#) (UINTPTR BaseAddress)

6.78.1 Macro Definition Documentation

6.78.1.1 _DEFAULT_SOURCE

```
#define _DEFAULT_SOURCE
```

This file contains low-level driver functions that can be used to access the device in normal and dynamic controller mode. The user should refer to the hardware device specification for more details of the device operation.

MODIFICATION HISTORY:

Ver	Who	Date	Changes
1.01b	jhl	05/13/02	First release
1.01b	jhl	10/14/02	Corrected bug in the receive function, the setup of the interrupt status mask was not being done in the loop such that a read would sometimes fail on the last byte because the transmit error which should have been ignored was being used. This would leave an extra byte in the FIFO and the bus throttled such that the next operation would

also fail. Also updated the receive function to not disable the device after the last byte until after the bus transitions to not busy which is more consistent with the expected behavior.

1.01c ecm 12/05/02 new rev

1.02a mta 03/09/06 Implemented Repeated Start in the Low Level Driver.

1.03a mta 04/04/06 Implemented Dynamic IIC core routines.

1.03a ecm 06/15/06 Fixed the hang in `low_level_eeprom_test` with -00 Added polling loops for BNB to allow the slave to respond correctly. Also added polling loop prior to reset in `_Recv`.

1.13a wgr 03/22/07 Converted to new coding style.

1.13b ecm 11/29/07 added BB polling loops to the `DynSend` and `DynRecv` routines to handle the race condition with BNB in `IISR`.

2.00a sdm 10/22/09 Converted all register accesses to 32 bit access. Updated to use the HAL APIs/macros. Some of the macros have been renamed to remove `_m` from the name and Some of the macros have been renamed to be consistent, see the `xiic_i.h` and `xiic_l.h` files for further information.

2.02a sdm 10/08/10 Updated to disable the device at the end of the transfer, only when addressed as slave in `XIic_Send` for CR565373.

2.04a sdm 07/22/11 Removed a compiler warning by adding parenthesis around & at line 479.

2.08a adk 29/07/13 In Low level driver In repeated start condition the Direction of Tx bit must be disabled in Receive condition It Fixes the CR:685759 Changes are done in the function `XIic_Recv`.

3.2 sk 11/10/15 Used `UINTPTR` instead of `u32` for Baseaddress CR# 867425. Changed the prototypes of `RecvData`, `SendData`, `DynRecvData`, `DynSendData` APIs.

3.2 sd 18/02/16 In Low level driver in repeated start condition NACK for last byte is added. Changes are done in `XIic_Recv` for CR# 862303

3.3 sk 06/17/16 Added bus busy checks for slave send/recv and master send/recv.

3.3 als 06/27/16 Added Low-level `XIic_CheckIsBusBusy` API.

3.3 als 06/27/16 Added low-level `XIic_WaitBusFree` API.

3.4 nk 16/11/16 Reduced sleeping time in Bus-busy check.

3.5 sd 08/29/18 Fix bus busy check for the NACK case.

Definition at line 71 of file [xiic_l.c](#).

6.78.2 Function Documentation

6.78.2.1 `XIic_CheckIsBusBusy()`

```
u32 XIic_CheckIsBusBusy (
    UINTPTR BaseAddress )
```

Definition at line 604 of file [xiic_l.c](#).

6.78.2.2 `XIic_Recv()`

```
unsigned XIic_Recv (
    UINTPTR BaseAddress,
    u8 Address,
```

```
u8 * BufferPtr,  
unsigned ByteCount,  
u8 Option )
```

Receive data as a master on the IIC bus. This function receives the data using polled I/O and blocks until the data has been received. It only supports 7 bit addressing mode of operation. This function returns zero if bus is busy.

Parameters

<i>BaseAddress</i>	contains the base address of the IIC device.
<i>Address</i>	contains the 7 bit IIC address of the device to send the specified data to.
<i>BufferPtr</i>	points to the data to be sent.
<i>ByteCount</i>	is the number of bytes to be sent.
<i>Option</i>	indicates whether to hold or free the bus after reception of data, XIIC_STOP = end with STOP condition, XIIC_REPEATED_START = don't end with STOP condition.

Returns

The number of bytes received.

Note

None.

Definition at line 113 of file [xiic_l.c](#).

Here is the call graph for this function:

6.78.2.3 Xlic_Send()

```
unsigned XIic_Send (  
    UINTPTR BaseAddress,  
    u8 Address,  
    u8 * BufferPtr,  
    unsigned ByteCount,  
    u8 Option )
```

Send data as a master on the IIC bus. This function sends the data using polled I/O and blocks until the data has been sent. It only supports 7 bit addressing mode of operation. This function returns zero if bus is busy.

Parameters

<i>BaseAddress</i>	contains the base address of the IIC device.
<i>Address</i>	contains the 7 bit IIC address of the device to send the specified data to.
<i>BufferPtr</i>	points to the data to be sent.
<i>ByteCount</i>	is the number of bytes to be sent.
<i>Option</i>	indicates whether to hold or free the bus after transmitting the data.

Returns

The number of bytes sent.

Note

None.

Definition at line 369 of file [xiic_l.c](#).

Here is the call graph for this function:

6.78.2.4 Xlic_WaitBusFree()

```
u32 XIic_WaitBusFree (
    UINTPTR BaseAddress )
```

This function will wait until the I2C bus is free or timeout.

Parameters

<i>BaseAddress</i>	contains the base address of the I2C device.
--------------------	----------------------------------------------

Returns

- XST_SUCCESS if the I2C bus was freed before the timeout.
- XST_FAILURE otherwise.

Note

None.

Definition at line 628 of file [xiic_l.c](#).

Here is the call graph for this function:

6.79 xiic_l.c

[Go to the documentation of this file.](#)

```
00001 /*****
00002  * Copyright (C) 2002 - 2021 Xilinx, Inc. All rights reserved.
00003  * SPDX-License-Identifier: MIT
00004  *****/
00005
00006 /*****
00007  *****/
00008 /***** Include Files *****/
00009 #define _DEFAULT_SOURCE
00010 #include <unistd.h>
00011
00012 #include "xiic_l.h"
00013 #include "xil_types.h"
00014
00015 /***** Constant Definitions *****/
00016
00017 /***** Type Definitions *****/
```

```

00080
00081 /***** Macros (Inline Functions) Definitions *****/
00082
00083 /***** Function Prototypes *****/
00084
00085 static unsigned RecvData(UINTPTR BaseAddress, u8 *BufferPtr, unsigned ByteCount,
00086                          u8 Option);
00087 static unsigned SendData(UINTPTR BaseAddress, u8 *BufferPtr, unsigned ByteCount,
00088                          u8 Option);
00089
00090 /***** Variable Definitions *****/
00091
00092 /*****
00113 unsigned XIic_Recv(UINTPTR BaseAddress, u8 Address, u8 *BufferPtr,
00114                   unsigned ByteCount, u8 Option) {
00115     u32 CntlReg;
00116     unsigned RemainingByteCount;
00117     volatile u32 StatusReg;
00118
00119     /* Tx error is enabled in case the address (7 or 10) has no device to
00120      * answer with Ack. When only one byte of data, must set NO ACK before
00121      * address goes out therefore Tx error must not be enabled as it will go
00122      * off immediately and the Rx full interrupt will be checked. If full,
00123      * then the one byte was received and the Tx error will be disabled
00124      * without sending an error callback msg
00125      */
00126     XIic_ClearIisr(BaseAddress, XIIC_INTR_RX_FULL_MASK | XIIC_INTR_TX_ERROR_MASK |
00127                   XIIC_INTR_ARB_LOST_MASK);
00128
00129     /* Set receive FIFO occupancy depth for 1 byte (zero based) */
00130     XIic_WriteReg(BaseAddress, XIIC_RFD_REG_OFFSET, 0);
00131
00132     /* Check to see if already Master on the Bus.
00133      * If Repeated Start bit is not set send Start bit by setting MSMS bit
00134      * else Send the address
00135      */
00136     CntlReg = XIic_ReadReg(BaseAddress, XIIC_CR_REG_OFFSET);
00137     if ((CntlReg & XIIC_CR_REPEATED_START_MASK) == 0) {
00138         /* 7 bit slave address, send the address for a read operation
00139          * and set the state to indicate the address has been sent
00140          */
00141         XIic_Send7BitAddress(BaseAddress, Address, XIIC_READ_OPERATION);
00142
00143         /* MSMS gets set after putting data in FIFO. Start the master
00144          * receive operation by setting CR Bits MSMS to Master, if the
00145          * buffer is only one byte, then it should not be acknowledged
00146          * to indicate the end of data
00147          */
00148         CntlReg = XIIC_CR_MSMS_MASK | XIIC_CR_ENABLE_DEVICE_MASK;
00149         if (ByteCount == 1) {
00150             CntlReg |= XIIC_CR_NO_ACK_MASK;
00151         }
00152
00153         /* Write out the control register to start receiving data and
00154          * call the function to receive each byte into the buffer
00155          */
00156         XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET, CntlReg);
00157
00158         /* Clear the latched interrupt status for the bus not busy bit
00159          * which must be done while the bus is busy
00160          */
00161         StatusReg = XIic_ReadReg(BaseAddress, XIIC_SR_REG_OFFSET);
00162
00163         while ((StatusReg & XIIC_SR_BUS_BUSY_MASK) == 0) {
00164             StatusReg = XIic_ReadReg(BaseAddress, XIIC_SR_REG_OFFSET);
00165         }
00166
00167         XIic_ClearIisr(BaseAddress, XIIC_INTR_BNB_MASK);
00168     } else {
00169         /* Before writing 7bit slave address the Direction of Tx bit
00170          * must be disabled
00171          */
00172         CntlReg &= ~XIIC_CR_DIR_IS_TX_MASK;
00173         if (ByteCount == 1) {
00174             CntlReg |= XIIC_CR_NO_ACK_MASK;
00175         }
00176         XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET, CntlReg);
00177         /* Already owns the Bus indicating that its a Repeated Start
00178          * call. 7 bit slave address, send the address for a read
00179          * operation and set the state to indicate the address has been
00180          * sent
00181          */
00182         XIic_Send7BitAddress(BaseAddress, Address, XIIC_READ_OPERATION);
00183     }
00184     /* Try to receive the data from the IIC bus */
00185
00186     RemainingByteCount = RecvData(BaseAddress, BufferPtr, ByteCount, Option);

```

```

00187
00188     CntlReg = XIic_ReadReg(BaseAddress, XIIC_CR_REG_OFFSET);
00189     if ((CntlReg & XIIC_CR_REPEATED_START_MASK) == 0) {
00190         /* The receive is complete, disable the IIC device if the Option
00191          * is to release the Bus after Reception of data and return the
00192          * number of bytes that was received
00193          */
00194         XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET, 0);
00195     }
00196
00197     /* Wait until I2C bus is freed, exit if timed out. */
00198     if (XIic_WaitBusFree(BaseAddress) != XST_SUCCESS) {
00199         return 0;
00200     }
00201
00202     /* Return the number of bytes that was received */
00203     return ByteCount - RemainingByteCount;
00204 }
00205
00206 /*****
00207  *
00208  * Receive the specified data from the device that has been previously addressed
00209  * on the IIC bus. This function assumes that the 7 bit address has been sent
00210  * and it should wait for the transmit of the address to complete.
00211  *
00212  * @param BaseAddress contains the base address of the IIC device.
00213  * @param BufferPtr points to the buffer to hold the data that is
00214  *         received.
00215  * @param ByteCount is the number of bytes to be received.
00216  * @param Option indicates whether to hold or free the bus after reception
00217  *         of data, XIIC_STOP = end with STOP condition,
00218  *         XIIC_REPEATED_START = don't end with STOP condition.
00219  *
00220  * @return The number of bytes remaining to be received.
00221  *
00222  * @note
00223  *
00224  * This function does not take advantage of the receive FIFO because it is
00225  * designed for minimal code space and complexity. It contains loops that
00226  * that could cause the function not to return if the hardware is not working.
00227  *
00228  * This function assumes that the calling function will disable the IIC device
00229  * after this function returns.
00230  *
00231  *****/
00232 static unsigned RecvData(UINTPTR BaseAddress, u8 *BufferPtr, unsigned ByteCount,
00233                          u8 Option) {
00234     u32 CntlReg;
00235     u32 IntrStatusMask;
00236     u32 IntrStatus;
00237
00238     /* Attempt to receive the specified number of bytes on the IIC bus */
00239
00240     while (ByteCount > 0) {
00241         /* Setup the mask to use for checking errors because when
00242          * receiving one byte OR the last byte of a multibyte message an
00243          * error naturally occurs when the no ack is done to tell the
00244          * slave the last byte
00245          */
00246         if (ByteCount == 1) {
00247             IntrStatusMask = XIIC_INTR_ARB_LOST_MASK | XIIC_INTR_BNB_MASK;
00248         } else {
00249             IntrStatusMask = XIIC_INTR_ARB_LOST_MASK | XIIC_INTR_TX_ERROR_MASK |
00250                             XIIC_INTR_BNB_MASK;
00251         }
00252
00253         /* Wait for the previous transmit and the 1st receive to
00254          * complete by checking the interrupt status register of the
00255          * IPIF
00256          */
00257         while (1) {
00258             IntrStatus = XIic_ReadIisr(BaseAddress);
00259             if (IntrStatus & XIIC_INTR_RX_FULL_MASK) {
00260                 break;
00261             }
00262             /* Check the transmit error after the receive full
00263              * because when sending only one byte transmit error
00264              * will occur because of the no ack to indicate the end
00265              * of the data
00266              */
00267             if (IntrStatus & IntrStatusMask) {
00268                 return ByteCount;
00269             }
00270         }
00271
00272         CntlReg = XIic_ReadReg(BaseAddress, XIIC_CR_REG_OFFSET);
00273

```



```

00274     /* Special conditions exist for the last two bytes so check for
00275     * them. Note that the control register must be setup for these
00276     * conditions before the data byte which was already received is
00277     * read from the receive FIFO (while the bus is throttled)
00278     */
00279     if (ByteCount == 1) {
00280         if (Option == XIIC_STOP) {
00281
00282             /* If the Option is to release the bus after the
00283             * last data byte, it has already been read and
00284             * no ack has been done, so clear MSMS while
00285             * leaving the device enabled so it can get off
00286             * the IIC bus appropriately with a stop
00287             */
00288             XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET,
00289                           XIIC_CR_ENABLE_DEVICE_MASK);
00290         }
00291     }
00292
00293     /* Before the last byte is received, set NOACK to tell the slave
00294     * IIC device that it is the end, this must be done before
00295     * reading the byte from the FIFO
00296     */
00297     if (ByteCount == 2) {
00298         /* Write control reg with NO ACK allowing last byte to
00299         * have the No ack set to indicate to slave last byte
00300         * read
00301         */
00302         XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET,
00303                       CntlReg | XIIC_CR_NO_ACK_MASK);
00304     }
00305
00306     /* Read in data from the FIFO and unthrottle the bus such that
00307     * the next byte is read from the IIC bus
00308     */
00309     *BufferPtr++ = (u8)XIic_ReadReg(BaseAddress, XIIC_DRR_REG_OFFSET);
00310
00311     if ((ByteCount == 1) && (Option == XIIC_REPEATED_START)) {
00312
00313         /* RSTA bit should be set only when the FIFO is
00314         * completely Empty.
00315         */
00316         XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET,
00317                       XIIC_CR_ENABLE_DEVICE_MASK | XIIC_CR_MSMS_MASK |
00318                       XIIC_CR_REPEATED_START_MASK);
00319     }
00320
00321     /* Clear the latched interrupt status so that it will be updated
00322     * with the new state when it changes, this must be done after
00323     * the receive register is read
00324     */
00325     XIic_ClearIisr(BaseAddress, XIIC_INTR_RX_FULL_MASK |
00326                    XIIC_INTR_TX_ERROR_MASK |
00327                    XIIC_INTR_ARB_LOST_MASK);
00328     ByteCount--;
00329 }
00330
00331 if (Option == XIIC_STOP) {
00332
00333     /* If the Option is to release the bus after Reception of data,
00334     * wait for the bus to transition to not busy before returning,
00335     * the IIC device cannot be disabled until this occurs. It
00336     * should transition as the MSMS bit of the control register was
00337     * cleared before the last byte was read from the FIFO
00338     */
00339     while (1) {
00340         if (XIic_ReadIisr(BaseAddress) & XIIC_INTR_BNB_MASK) {
00341             break;
00342         }
00343     }
00344 }
00345
00346 return ByteCount;
00347 }
00348
00349 /*****
00369 unsigned XIic_Send(UINTPTR BaseAddress, u8 Address, u8 *BufferPtr,
00370                   unsigned ByteCount, u8 Option) {
00371     unsigned RemainingByteCount;
00372     u32 ControlReg;
00373     volatile u32 StatusReg;
00374
00375     /* Wait until I2C bus is freed, exit if timed out. */
00376     if (XIic_WaitBusFree(BaseAddress) != XST_SUCCESS) {
00377         return 0;
00378     }
00379

```

```

00380  /* Check to see if already Master on the Bus.
00381  * If Repeated Start bit is not set send Start bit by setting
00382  * MSMS bit else Send the address.
00383  */
00384  ControlReg = XIic_ReadReg(BaseAddress, XIIC_CR_REG_OFFSET);
00385  if ((ControlReg & XIIC_CR_REPEATED_START_MASK) == 0) {
00386  /*
00387  * Put the address into the FIFO to be sent and indicate
00388  * that the operation to be performed on the bus is a
00389  * write operation
00390  */
00391  XIic_Send7BitAddress(BaseAddress, Address, XIIC_WRITE_OPERATION);
00392  /* Clear the latched interrupt status so that it will
00393  * be updated with the new state when it changes, this
00394  * must be done after the address is put in the FIFO
00395  */
00396  XIic_ClearIisr(BaseAddress, XIIC_INTR_TX_EMPTY_MASK |
00397                XIIC_INTR_TX_ERROR_MASK |
00398                XIIC_INTR_ARB_LOST_MASK);
00399
00400  /*
00401  * MSMS must be set after putting data into transmit FIFO,
00402  * indicate the direction is transmit, this device is master
00403  * and enable the IIC device
00404  */
00405  XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET,
00406                XIIC_CR_MSMS_MASK | XIIC_CR_DIR_IS_TX_MASK |
00407                XIIC_CR_ENABLE_DEVICE_MASK);
00408
00409  /*
00410  * Clear the latched interrupt
00411  * status for the bus not busy bit which must be done while
00412  * the bus is busy
00413  */
00414  StatusReg = XIic_ReadReg(BaseAddress, XIIC_SR_REG_OFFSET);
00415  while ((StatusReg & XIIC_SR_BUS_BUSY_MASK) == 0) {
00416      StatusReg = XIic_ReadReg(BaseAddress, XIIC_SR_REG_OFFSET);
00417  }
00418
00419  XIic_ClearIisr(BaseAddress, XIIC_INTR_BNB_MASK);
00420  } else {
00421  /*
00422  * Already owns the Bus indicating that its a Repeated Start
00423  * call. 7 bit slave address, send the address for a write
00424  * operation and set the state to indicate the address has
00425  * been sent.
00426  */
00427  XIic_Send7BitAddress(BaseAddress, Address, XIIC_WRITE_OPERATION);
00428  }
00429
00430  /* Send the specified data to the device on the IIC bus specified by the
00431  * the address
00432  */
00433  RemainingByteCount = SendData(BaseAddress, BufferPtr, ByteCount, Option);
00434
00435  ControlReg = XIic_ReadReg(BaseAddress, XIIC_CR_REG_OFFSET);
00436  if ((ControlReg & XIIC_CR_REPEATED_START_MASK) == 0) {
00437  /*
00438  * The Transmission is completed, disable the IIC device if
00439  * the Option is to release the Bus after transmission of data
00440  * and return the number of bytes that was received. Only wait
00441  * if master, if addressed as slave just reset to release
00442  * the bus.
00443  */
00444  if ((ControlReg & XIIC_CR_MSMS_MASK) != 0) {
00445      XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET,
00446                    (ControlReg & ~XIIC_CR_MSMS_MASK));
00447  }
00448
00449  if ((XIic_ReadReg(BaseAddress, XIIC_SR_REG_OFFSET) &
00450       XIIC_SR_ADDR_AS_SLAVE_MASK) != 0) {
00451      XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET, 0);
00452  } else {
00453      StatusReg = XIic_ReadReg(BaseAddress, XIIC_SR_REG_OFFSET);
00454      while ((StatusReg & XIIC_SR_BUS_BUSY_MASK) != 0) {
00455          StatusReg = XIic_ReadReg(BaseAddress, XIIC_SR_REG_OFFSET);
00456      }
00457  }
00458  }
00459
00460  return ByteCount - RemainingByteCount;
00461 }
00462
00463 /*****
00464  *
00465  * Send the specified buffer to the device that has been previously addressed
00466  * on the IIC bus. This function assumes that the 7 bit address has been sent

```

```

00467 * and it should wait for the transmit of the address to complete.
00468 *
00469 * @param   BaseAddress contains the base address of the IIC device.
00470 * @param   BufferPtr points to the data to be sent.
00471 * @param   ByteCount is the number of bytes to be sent.
00472 * @param   Option indicates whether to hold or free the bus after
00473 *           transmitting the data.
00474 *
00475 * @return   The number of bytes remaining to be sent.
00476 *
00477 * @note
00478 *
00479 * This function does not take advantage of the transmit FIFO because it is
00480 * designed for minimal code space and complexity. It contains loops that
00481 * that could cause the function not to return if the hardware is not working.
00482 *
00483 *****/
00484 static unsigned SendData(UINTPTR BaseAddress, u8 *BufferPtr, unsigned ByteCount,
00485                          u8 Option) {
00486     u32 IntrStatus;
00487
00488     /*
00489      * Send the specified number of bytes in the specified buffer by polling
00490      * the device registers and blocking until complete
00491      */
00492     while (ByteCount > 0) {
00493         /*
00494          * Wait for the transmit to be empty before sending any more
00495          * data by polling the interrupt status register
00496          */
00497         while (1) {
00498             IntrStatus = XIic_ReadIshr(BaseAddress);
00499
00500             if (IntrStatus & (XIIC_INTR_TX_ERROR_MASK | XIIC_INTR_ARB_LOST_MASK |
00501                             XIIC_INTR_BNB_MASK)) {
00502                 return ByteCount;
00503             }
00504
00505             if (IntrStatus & XIIC_INTR_TX_EMPTY_MASK) {
00506                 break;
00507             }
00508         }
00509         /* If there is more than one byte to send then put the
00510          * next byte to send into the transmit FIFO
00511          */
00512         if (ByteCount > 1) {
00513             XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET, *BufferPtr++);
00514         } else {
00515             if (Option == XIIC_STOP) {
00516                 /*
00517                  * If the Option is to release the bus after
00518                  * the last data byte, Set the stop Option
00519                  * before sending the last byte of data so
00520                  * that the stop Option will be generated
00521                  * immediately following the data. This is
00522                  * done by clearing the MSMS bit in the
00523                  * control register.
00524                  */
00525                 XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET,
00526                               XIIC_CR_ENABLE_DEVICE_MASK | XIIC_CR_DIR_IS_TX_MASK);
00527             }
00528
00529             /*
00530              * Put the last byte to send in the transmit FIFO
00531              */
00532             XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET, *BufferPtr++);
00533
00534             if (Option == XIIC_REPEATED_START) {
00535                 XIic_ClearIshr(BaseAddress, XIIC_INTR_TX_EMPTY_MASK);
00536                 /*
00537                  * Wait for the transmit to be empty before
00538                  * setting RSTA bit.
00539                  */
00540                 while (1) {
00541                     IntrStatus = XIic_ReadIshr(BaseAddress);
00542                     if (IntrStatus & XIIC_INTR_TX_EMPTY_MASK) {
00543                         /*
00544                          * RSTA bit should be set only
00545                          * when the FIFO is completely
00546                          * Empty.
00547                          */
00548                         XIic_WriteReg(BaseAddress, XIIC_CR_REG_OFFSET,
00549                                       XIIC_CR_REPEATED_START_MASK |
00550                                       XIIC_CR_ENABLE_DEVICE_MASK |
00551                                       XIIC_CR_DIR_IS_TX_MASK | XIIC_CR_MSMS_MASK);
00552                     }
00553                     break;
00554                 }
00555             }

```

```

00554     }
00555     }
00556 }
00557
00558 /*
00559  * Clear the latched interrupt status register and this must be
00560  * done after the transmit FIFO has been written to or it won't
00561  * clear
00562  */
00563 XIic_ClearIisr(BaseAddress, XIIC_INTR_TX_EMPTY_MASK);
00564
00565 /*
00566  * Update the byte count to reflect the byte sent and clear
00567  * the latched interrupt status so it will be updated for the
00568  * new state
00569  */
00570 ByteCount--;
00571 }
00572
00573 if (Option == XIIC_STOP) {
00574     /*
00575      * If the Option is to release the bus after transmission of
00576      * data, Wait for the bus to transition to not busy before
00577      * returning, the IIC device cannot be disabled until this
00578      * occurs. Note that this is different from a receive operation
00579      * because the stop Option causes the bus to go not busy.
00580      */
00581     while (1) {
00582         if (XIic_ReadIisr(BaseAddress) & XIIC_INTR_BNB_MASK) {
00583             break;
00584         }
00585     }
00586 }
00587
00588 return ByteCount;
00589 }
00590
00591 /*****
00592  *
00593  * This is a function which tells whether the I2C bus is busy or free.
00594  *
00595  * @param   BaseAddr is the base address of the I2C core to work on.
00596  *
00597  * @return
00598  *     - TRUE if the bus is busy.
00599  *     - FALSE if the bus is NOT busy.
00600  *
00601  * @note     None.
00602  *
00603  *****/
00604 u32 XIic_CheckIsBusBusy(UINTPTR BaseAddress) {
00605     u32 StatusReg;
00606
00607     StatusReg = XIic_ReadReg(BaseAddress, XIIC_SR_REG_OFFSET);
00608     if (StatusReg & XIIC_SR_BUS_BUSY_MASK) {
00609         return TRUE;
00610     } else {
00611         return FALSE;
00612     }
00613 }
00614
00615 /*****
00628 u32 XIic_WaitBusFree(UINTPTR BaseAddress) {
00629     u32 BusyCount = 0;
00630
00631     while (XIic_CheckIsBusBusy(BaseAddress)) {
00632         if (BusyCount++ > 10000) {
00633             return XST_FAILURE;
00634         }
00635         usleep(100);
00636     }
00637     return XST_SUCCESS;
00638 }
00639 }

```

6.80 library/fontx.h File Reference

```
#include <stdbool.h>
```

```
#include <stdint.h>
```

Include dependency graph for fontx.h: This graph shows which files directly or indirectly include this file:

Data Structures

- struct [FontxFile](#)

Macros

- `#define FontxGlyphBufSize (32 * 32 / 8)`

Typedefs

- typedef struct _IO_FILE [FILE](#)

Functions

- void [AaddFontx](#) ([FontxFile](#) *fx, const char *path)
- void [InitFontx](#) ([FontxFile](#) *fxs, const char *f0, const char *f1)
- bool [OpenFontx](#) ([FontxFile](#) *fx)
- void [CloseFontx](#) ([FontxFile](#) *fx)
- void [DumpFontx](#) ([FontxFile](#) *fxs)
- uint8_t [GetFontWidth](#) ([FontxFile](#) *fx)
- uint8_t [GetFontHeight](#) ([FontxFile](#) *fx)
- bool [GetFontx](#) ([FontxFile](#) *fxs, uint8_t ascii, uint8_t *pGlyph, uint8_t *pw, uint8_t *ph)
- void [Font2Bitmap](#) (uint8_t *fonts, uint8_t *line, uint8_t w, uint8_t h, uint8_t inverse)
- void [UnderlineBitmap](#) (uint8_t *line, uint8_t w, uint8_t h)
- void [ReversBitmap](#) (uint8_t *line, uint8_t w, uint8_t h)
- void [ShowFont](#) (uint8_t *fonts, uint8_t pw, uint8_t ph)
- void [ShowBitmap](#) (uint8_t *bitmap, uint8_t pw, uint8_t ph)
- uint8_t [RotateByte](#) (uint8_t ch)

6.80.1 Macro Definition Documentation

6.80.1.1 FontxGlyphBufSize

```
#define FontxGlyphBufSize (32 * 32 / 8)
```

Definition at line 3 of file [fontx.h](#).

6.81 fontx.h

[Go to the documentation of this file.](#)

```

00001 #ifndef MAIN_FONTX_H_
00002 #define MAIN_FONTX_H_
00003 #define FontxGlyphBufSize (32 * 32 / 8)
00004 #include <stdbool.h>
00005 #include <stdint.h>
00006
00023 typedef struct _IO_FILE FILE;
00024
00028 typedef struct {
00029     const char *path;
00030     char fxname[10];
00031     bool opened;
00032     bool valid;
00033     bool is_ank;
00035     uint8_t w;
00036     uint8_t h;
00037     uint16_t fsz;
00038     uint8_t bc;
00039     FILE *file;
00040 } FontxFile;
00041
00048 void AaddFontx(FontxFile *fx, const char *path);
00049
00058 void InitFontx(FontxFile *fxs, const char *f0, const char *f1);
00059
00073 bool OpenFontx(FontxFile *fx);
00074
00080 void CloseFontx(FontxFile *fx);
00081
00087 void DumpFontx(FontxFile *fxs);
00088
00096 uint8_t GetFontWidth(FontxFile *fx);
00097
00105 uint8_t GetFontHeight(FontxFile *fx);
00106
00118 bool GetFontx(FontxFile *fxs, uint8_t ascii, uint8_t *pGlyph, uint8_t *pw,
00119               uint8_t *ph);
00120
00130 void Font2Bitmap(uint8_t *fonts, uint8_t *line, uint8_t w, uint8_t h,
00131                 uint8_t inverse);
00132
00140 void UnderlineBitmap(uint8_t *line, uint8_t w, uint8_t h);
00141
00149 void ReversBitmap(uint8_t *line, uint8_t w, uint8_t h);
00150
00158 void ShowFont(uint8_t *fonts, uint8_t pw, uint8_t ph);
00159
00167 void ShowBitmap(uint8_t *bitmap, uint8_t pw, uint8_t ph);
00168
00176 uint8_t RotateByte(uint8_t ch);
00177
00182 #endif

```

6.82 library/gpio.h File Reference

```

#include <pinmap.h>
#include <stdbool.h>
#include <stdint.h>

```

Include dependency graph for gpio.h: This graph shows which files directly or indirectly include this file:

Macros

- #define `gpio_t pin_t`

Enumerations

- enum `gpio_direction_t` { `GPIO_DIR_INPUT` = 0 , `GPIO_DIR_OUTPUT` = 1 }
- enum `gpio_level_t` { `GPIO_LEVEL_LOW` = 0 , `GPIO_LEVEL_HIGH` = 1 }

Functions

- void `gpio_init` (void)
- void `gpio_destroy` (void)
- void `gpio_reset_pin` (const `pin_t` pin)
- void `gpio_set_direction` (const `pin_t` pin, const `gpio_direction_t` direction)
- `gpio_direction_t` `gpio_get_direction` (const `pin_t` pin)
- void `gpio_set_level` (const `pin_t` pin, const `gpio_level_t` level)
- `gpio_level_t` `gpio_get_level` (const `pin_t` pin)
- void `gpio_reset` (void)
- bool `gpio_is_initialized` (void)

6.83 gpio.h

[Go to the documentation of this file.](#)

```

00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef GPIO_H
00023 #define GPIO_H
00024 #include <pinmap.h>
00025 #include <stdbool.h>
00026 #include <stdint.h>
00027
00081 typedef enum {
00083     GPIO_DIR_INPUT = 0,
00085     GPIO_DIR_OUTPUT = 1
00086 } gpio_direction_t;
00087
00091 typedef enum {
00093     GPIO_LEVEL_LOW = 0,
00095     GPIO_LEVEL_HIGH = 1
00096 } gpio_level_t;
00097
00102 #define gpio_t pin_t
00103
00107 extern void gpio_init(void);
00112 extern void gpio_destroy(void);
00113
00120 extern void gpio_reset_pin(const pin_t pin);
00121
00129 extern void gpio_set_direction(const pin_t pin,
00130                               const gpio_direction_t direction);
00131
00138 extern gpio_direction_t gpio_get_direction(const pin_t pin);
00139
00147 extern void gpio_set_level(const pin_t pin, const gpio_level_t level);
00148
00155 extern gpio_level_t gpio_get_level(const pin_t pin);
00156
00160 extern void gpio_reset(void);
00161
00167 extern bool gpio_is_initialized(void);
00171 #endif // GPIO_H

```

6.84 library/i2cps.h File Reference

```
#include <linux/i2c-dev.h>
```

Include dependency graph for i2cps.h: This graph shows which files directly or indirectly include this file:

Macros

- #define [writel2C_byte](#)(i2c_fd, u8RegAddr, u8Data) i2c_smbus_write_byte_data(i2c_fd, u8RegAddr, u8Data);
- #define [writel2C_word](#)(i2c_fd, u8RegAddr, u16Data) i2c_smbus_write_word_data(i2c_fd, u8RegAddr, u16Data);

Functions

- int [setI2C](#) (unsigned int index, long slave_addr)
- int [unsetI2C](#) (int i2c_fd)
- int [writel2C_asFile](#) (int i2c_fd, unsigned char writebuffer[], unsigned char bytes)
- int [readI2C_asFile](#) (int i2c_fd, unsigned char readbuffer[], unsigned char bytes)

6.84.1 Detailed Description

Functions to interact with linux I2C.

MODIFICATION HISTORY:

Ver	Who	Date	Changes
1.00a	gn	01/24/15	First release
1.00b	yrq	08/31/16	Added license header

Definition in file [i2cps.h](#).

6.84.2 Macro Definition Documentation

6.84.2.1 writel2C_byte

```
#define writeI2C_byte(  
    i2c_fd,  
    u8RegAddr,  
    u8Data ) i2c_smbus_write_byte_data(i2c_fd, u8RegAddr, u8Data);
```

Definition at line 63 of file [i2cps.h](#).

6.84.2.2 writel2C_word

```
#define writeI2C_word(  
    i2c_fd,  
    u8RegAddr,  
    u16Data )  i2c_smbus_write_word_data(i2c_fd, u8RegAddr, u16Data);
```

Definition at line 66 of file [i2cps.h](#).

6.84.3 Function Documentation

6.84.3.1 readI2C_asFile()

```
int readI2C_asFile (  
    int i2c_fd,  
    unsigned char readbuffer[],  
    unsigned char bytes )
```

Definition at line 6 of file [i2cps.c](#).

Here is the caller graph for this function:

6.84.3.2 setI2C()

```
int setI2C (  
    unsigned int index,  
    long slave_addr )
```

Definition at line 2 of file [i2cps.c](#).

Here is the caller graph for this function:

6.84.3.3 unsetI2C()

```
int unsetI2C (  
    int i2c_fd )
```

Definition at line 3 of file [i2cps.c](#).

Here is the caller graph for this function:

6.84.3.4 writel2C_asFile()

```
int writeI2C_asFile (  
    int i2c_fd,  
    unsigned char writebuffer[],  
    unsigned char bytes )
```

Definition at line 4 of file [i2cps.c](#).

Here is the caller graph for this function:

6.85 i2cps.h

[Go to the documentation of this file.](#)

```

00001 /*****
00002  * Copyright (c) 2016, Xilinx, Inc.
00003  * All rights reserved.
00004  *
00005  * Redistribution and use in source and binary forms, with or without
00006  * modification, are permitted provided that the following conditions are met:
00007  *
00008  * 1. Redistributions of source code must retain the above copyright notice,
00009  *    this list of conditions and the following disclaimer.
00010  *
00011  * 2. Redistributions in binary form must reproduce the above copyright
00012  *    notice, this list of conditions and the following disclaimer in the
00013  *    documentation and/or other materials provided with the distribution.
00014  *
00015  * 3. Neither the name of the copyright holder nor the names of its
00016  *    contributors may be used to endorse or promote products derived from
00017  *    this software without specific prior written permission.
00018  *
00019  * THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS"
00020  * AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO,
00021  * THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR
00022  * PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR
00023  * CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL,
00024  * EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO,
00025  * PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS;
00026  * OR BUSINESS INTERRUPTION). HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY,
00027  * WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR
00028  * OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF
00029  * ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
00030  *
00031  *****/
00032
00033 /*****
00052 #ifndef __I2CPS_H__
00053 #define __I2CPS_H__
00054
00055 #include <linux/i2c-dev.h>
00056
00057 int setI2C(unsigned int index, long slave_addr);
00058 int unsetI2C(int i2c_fd);
00059 int writeI2C_asFile(int i2c_fd, unsigned char writebuffer[],
00060                    unsigned char bytes);
00061 int readI2C_asFile(int i2c_fd, unsigned char readbuffer[], unsigned char bytes);
00062
00063 #define writeI2C_byte(i2c_fd, u8RegAddr, u8Data) \
00064     i2c_smbus_write_byte_data(i2c_fd, u8RegAddr, u8Data);
00065
00066 #define writeI2C_word(i2c_fd, u8RegAddr, u16Data) \
00067     i2c_smbus_write_word_data(i2c_fd, u8RegAddr, u16Data);
00068
00069 #endif // __I2CPS_H__

```

6.86 library/iic.h File Reference

```
#include <stdbool.h>
```

```
#include <stdint.h>
```

Include dependency graph for iic.h: This graph shows which files directly or indirectly include this file:

Enumerations

- enum [iic_index_t](#) { [IIC0](#) = 0 , [IIC1](#) = 1 , [NUM_IICS](#) = 2 }

Functions

- void [iic_init](#) (const [iic_index_t](#) iic)
- void [iic_destroy](#) (const [iic_index_t](#) iic)
- bool [iic_read_register](#) (const [iic_index_t](#) iic, const uint8_t addr, const uint8_t reg, uint8_t *data, uint16_t length)
- bool [iic_write_register](#) (const [iic_index_t](#) iic, const uint8_t addr, const uint8_t reg, uint8_t *data, uint16_t length)

6.87 iic.h

[Go to the documentation of this file.](#)

```

00001  /*
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00003
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00005  of this software and associated documentation files (the "Software"), to deal
00006  in the Software without restriction, including without limitation the rights
00007  to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008  copies of the Software, and to permit persons to whom the Software is
00009  furnished to do so, subject to the following conditions:
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00014  THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
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00018  LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019  OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020  SOFTWARE.
00021  */
00022  #ifndef IIC_H
00023  #define IIC_H
00024  #include <stdbool.h>
00025  #include <stdint.h>
00026
00042  typedef enum { IIC0 = 0, IIC1 = 1, NUM_IICS = 2 } iic_index_t;
00043
00051  extern void iic_init(const iic_index_t iic);
00052
00058  extern void iic_destroy(const iic_index_t iic);
00059
00071  extern bool iic_read_register(const iic_index_t iic, const uint8_t addr,
00072                               const uint8_t reg, uint8_t *data,
00073                               uint16_t length);
00074
00086  extern bool iic_write_register(const iic_index_t iic, const uint8_t addr,
00087                                const uint8_t reg, uint8_t *data,
00088                                uint16_t length);
00089
00093  #endif

```

6.88 library/empty-library/interrupt.c File Reference

```
#include <interrupt.h>
Include dependency graph for interrupt.c:
```

Functions

- int [gpio_interrupt_init](#) (void)
- void [gpio_ack_interrupt](#) (void)
- void [verify_interrupt_request](#) (const [gpio_t](#) pin)
- void [gpio_print_interrupt](#) (void)
- void [gpio_enable_interrupt](#) (const [gpio_t](#) pin)
- void [gpio_disable_interrupt](#) (const [gpio_t](#) pin)
- void [gpio_disable_all_interrupts](#) (void)
- uint64_t [gpio_get_interrupt](#) (void)
- uint8_t * [gpio_get_interrupt_pins](#) (uint8_t *positions)
- void [gpio_wait_for_interrupt](#) (const [gpio_t](#) pin)

6.88.1 Function Documentation

6.88.1.1 `gpio_disable_interrupt()`

```
void gpio_disable_interrupt (
    const gpio\_t pin )
```

Definition at line 7 of file [interrupt.c](#).

6.88.1.2 `gpio_enable_interrupt()`

```
void gpio_enable_interrupt (
    const gpio\_t pin )
```

Definition at line 6 of file [interrupt.c](#).

6.88.1.3 `gpio_wait_for_interrupt()`

```
void gpio_wait_for_interrupt (
    const gpio\_t pin )
```

Definition at line 11 of file [interrupt.c](#).

6.88.1.4 `verify_interrupt_request()`

```
void verify_interrupt_request (
    const gpio\_t pin )
```

Definition at line 4 of file [interrupt.c](#).

Here is the caller graph for this function:

6.89 `interrupt.c`

[Go to the documentation of this file.](#)

```
00001 #include <interrupt.h>
00002 int gpio_interrupt_init(void){};
00003 void gpio_ack_interrupt(void){};
00004 void verify_interrupt_request(const gpio\_t pin){};
00005 void gpio_print_interrupt(void){};
00006 void gpio_enable_interrupt(const gpio\_t pin){};
00007 void gpio_disable_interrupt(const gpio\_t pin){};
00008 void gpio_disable_all_interrupts(void){};
00009 uint64_t gpio_get_interrupt(void){};
00010 uint8_t *gpio_get_interrupt_pins(uint8_t *positions){};
00011 void gpio_wait_for_interrupt(const gpio\_t pin){};
```

6.90 library/interrupt.c File Reference

```
#include "arm_shared_memory_system.h"
#include <fcntl.h>
#include <gpio.h>
#include <log.h>
#include <platform.h>
#include <stdbool.h>
#include <stdint.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <util.h>
```

Include dependency graph for interrupt.c:

Macros

- `#define DOMAIN "Interrupt"`

Functions

- void [check_initialization](#) (void)
- int [gpio_interrupt_init](#) (void)
- void [gpio_enable_interrupt](#) (const [pin_t](#) pin)
- void [gpio_disable_interrupt](#) (const [pin_t](#) pin)
- void [gpio_disable_all_interrupts](#) (void)
- [uint64_t](#) [gpio_get_interrupt](#) (void)
- void [gpio_ack_interrupt](#) (void)
- void [verify_interrupt_request](#) (const [pin_t](#) pin)
- void [gpio_print_interrupt](#) (void)
- void [findSetBitPositions](#) ([uint64_t](#) word, [uint8_t](#) *positions)
- void [gpio_wait_for_interrupt](#) (const [pin_t](#) pin)
- [uint8_t](#) * [gpio_get_interrupt_pins](#) ([uint8_t](#) *positions)

Variables

- [uint32_t](#) * [gpio](#)
- [uint32_t](#) * [intc0](#)

6.90.1 Macro Definition Documentation

6.90.1.1 DOMAIN

```
#define DOMAIN "Interrupt"
```

Definition at line 34 of file [interrupt.c](#).

6.90.2 Function Documentation

6.90.2.1 `check_initialization()`

```
void check_initialization (
    void )
```

Definition at line 41 of file [interrupt.c](#).

Here is the caller graph for this function:

6.90.2.2 `findSetBitPositions()`

```
void findSetBitPositions (
    uint64_t word,
    uint8_t * positions )
```

Definition at line 126 of file [interrupt.c](#).

Here is the caller graph for this function:

6.90.3 Variable Documentation

6.90.3.1 `gpio`

```
uint32_t* gpio [extern]
```

Definition at line 32 of file [gpio.c](#).

6.90.3.2 `intc0`

```
uint32_t* intc0 [extern]
```

Definition at line 33 of file [gpio.c](#).

6.91 interrupt.c

[Go to the documentation of this file.](#)

```

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00019  OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020  SOFTWARE.
00021  */
00022  #include "arm_shared_memory_system.h"
00023  #include <fcntl.h>
00024  #include <gpio.h>
00025  #include <log.h>
00026  #include <platform.h>
00027  #include <stdbool.h>
00028  #include <stdint.h>
00029  #include <stdio.h>
00030  #include <stdlib.h>
00031  #include <unistd.h>
00032  #include <util.h>
00033
00034  #define DOMAIN "Interrupt"
00035
00036  extern uint32_t *gpio;
00037  extern uint32_t *intc0;
00038
00039  static bool gpio_initialized = false;
00040
00041  void check_initialization(void) {
00042      if (gpio_initialized == false) {
00043          pynq_error("Interrupts have not been initialized. Call "
00044                  "gpio_interrupt_init() first.\n");
00045      }
00046  }
00047
00048  int gpio_interrupt_init(void) {
00049      int fd = open("/dev/uiol", O_RDWR, O_CLOEXEC);
00050      if (fd < 0) {
00051          pynq_error("failed to open interrupts\n");
00052      }
00053      int32_t m = 1;
00054      write(fd, &m, 4);
00055      gpio_initialized = true;
00056      return fd;
00057  }
00058
00059  void gpio_enable_interrupt(const pin_t pin) {
00060      check_initialization();
00061      int pin_bank = pin % 32;
00062      int bank = pin < 32 ? 0 : 1;
00063      if (bank == 0) {
00064          printf("interrupt set 0: %08X %08X\r\n", pin, pin_bank);
00065          intc0[0] |= (1 << pin_bank);
00066      } else {
00067          printf("interrupt set 1: %08X %08X\r\n", pin, pin_bank);
00068          intc0[1] |= (1 << (pin_bank));
00069      }
00070  }
00071
00072  void gpio_disable_interrupt(const pin_t pin) {
00073      check_initialization();
00074      intc0[0] &= ~(1 << pin);
00075  }
00076
00077  void gpio_disable_all_interrupts(void) {
00078      check_initialization();
00079      intc0[0] = 0;
00080      intc0[1] = 0;
00081  }
00082

```

```

00083 uint64_t gpio_get_interrupt(void) {
00084     check_initialization();
00085     uint64_t retv = intc0[3];
00086     retv <= 32;
00087     retv |= intc0[2];
00088     return retv;
00089 }
00090
00091 void gpio_ack_interrupt(void) {
00092     check_initialization();
00093     intc0[2] = 1;
00094 }
00095
00096 void verify_interrupt_request(const pin_t pin) {
00097     // TODO check if interrupts are initialized when using other interrupt
00098     // functions
00099     uint64_t retv = intc0[1];
00100     retv <= 32;
00101     retv |= intc0[0];
00102     if (pin < 64) {
00103         uint64_t bitMask = 1ULL << pin;
00104         if (!(bitMask & retv)) {
00105             pynq_error("Pin %d is not enabled. Enable by using "
00106                 "gpio_enable_interrupt(pin). \n",
00107                 pin);
00108         }
00109     } else {
00110         if (retv == 0) {
00111             pynq_error("No interrupts enabled. Enable by using "
00112                 "gpio_enable_interrupt(pin). \n");
00113         }
00114     }
00115 }
00116
00117 void gpio_print_interrupt(void) {
00118     check_initialization();
00119     // printf("11c: %08X\r\n", gpio[0x11c / 4]);
00120     // printf("128: %08X\r\n", gpio[0x128 / 4]);
00121     // printf("120: %08X\r\n", gpio[0x120 / 4]);
00122     printf("interrupt 0: %08X %08X\r\n", intc0[0], intc0[2]);
00123     printf("interrupt 1: %08X %08X\r\n", intc0[1], intc0[3]);
00124 }
00125
00126 void findSetBitPositions(uint64_t word, uint8_t *positions) {
00127     int index = 0;
00128     int count = 0;
00129     while (word) {
00130         if (word & 1) {
00131             positions[count++] = index;
00132         }
00133         word >>= 1;
00134         index++;
00135     }
00136 }
00137
00138 void gpio_wait_for_interrupt(const pin_t pin) {
00139     check_initialization();
00140     verify_interrupt_request(pin);
00141     if (pin > 63) {
00142         while (1) {
00143             uint64_t interrupt = gpio_get_interrupt();
00144             if (interrupt != 0) {
00145                 break;
00146             }
00147         }
00148     } else {
00149         while (1) {
00150             uint64_t interrupt = gpio_get_interrupt();
00151             uint64_t bitMask = 1ULL << pin;
00152             if (bitMask & interrupt) {
00153                 break;
00154             }
00155             sleep_msec(100);
00156         }
00157     }
00158 }
00159
00160 uint8_t *gpio_get_interrupt_pins(uint8_t *positions) {
00161     check_initialization();
00162     verify_interrupt_request(64); // check if any interrupt pin is enabled
00163     // uint8_t *positions = (uint8_t *)malloc(64 * sizeof(uint8_t));
00164     uint64_t pin = (uint64_t)((uint64_t)(intc0[3]) << 32 | intc0[2]);
00165     findSetBitPositions(pin, positions);
00166     // printf("Interrupted pin(s): ");
00167     bool empty = true;
00168     for (int i = 0; i < 64; i++) {
00169         if (positions[i] != 0) {

```



```

00170         empty = false;
00171         // printf("%d ", positions[i]);
00172         break;
00173     }
00174 }
00175 if (empty) {
00176     printf("WARNING: gpio_get_interrupt_pins: No pins interrupted. ");
00177 }
00178 printf("\n");
00179 return (positions);
00180 }

```

6.92 library/interrupt.h File Reference

```
#include <gpio.h>
```

Include dependency graph for interrupt.h: This graph shows which files directly or indirectly include this file:

Functions

- int [gpio_interrupt_init](#) (void)
- void [gpio_ack_interrupt](#) (void)
- void [verify_interrupt_request](#) (const [pin_t](#) pin)
- void [gpio_print_interrupt](#) (void)
- void [gpio_enable_interrupt](#) (const [pin_t](#) pin)
- void [gpio_disable_interrupt](#) (const [pin_t](#) pin)
- void [gpio_disable_all_interrupts](#) (void)
- uint64_t [gpio_get_interrupt](#) (void)
- uint8_t * [gpio_get_interrupt_pins](#) (uint8_t *positions)
- void [gpio_wait_for_interrupt](#) (const [pin_t](#) pin)

6.93 interrupt.h

[Go to the documentation of this file.](#)

```

00001 /*
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00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
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00012 copies or substantial portions of the Software.
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00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
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00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef INTERRUPT_H
00023 #define INTERRUPT_H
00024
00025 #include <gpio.h>
00026
00072 extern int gpio_interrupt_init(void);
00073
00079 extern void gpio_ack_interrupt(void);
00080
00089 extern void verify_interrupt_request(const pin_t pin);
00090

```

```

00094 extern void gpio_print_interrupt(void);
00095
00101 extern void gpio_enable_interrupt(const pin_t pin);
00102
00109 extern void gpio_disable_interrupt(const pin_t pin);
00110
00114 extern void gpio_disable_all_interrupts(void);
00115
00121 extern uint64_t gpio_get_interrupt(void);
00122
00129 extern uint8_t *gpio_get_interrupt_pins(uint8_t *positions);
00130
00137 extern void gpio_wait_for_interrupt(const pin_t pin);
00138
00142 #endif

```

6.94 library/leds.h File Reference

```

#include <gpio.h>
#include <pinmap.h>

```

Include dependency graph for leds.h: This graph shows which files directly or indirectly include this file:

Macros

- #define NUM_LED_COLORS 3 /* # colors per color LED (RGB) */
- #define NUM_LEDS (NUM_GREEN_LEDS + NUM_COLOR_LEDS)
- #define LED_OFF 0
- #define LED_ON 255

Enumerations

- enum green_led_index_t {
LED0, LED1, LED2, LED3,
NUM_GREEN_LEDS }
- enum color_led_index_t { COLOR_LED0, COLOR_LED1, NUM_COLOR_LEDS }

Functions

- void leds_init_onoff(void)
- void green_leds_init_pwm(void)
- void color_leds_init_pwm(void)
- void leds_destroy(void)
- void green_led_onoff(const int led, const int onoff)
- void green_led_on(const int led)
- void green_led_off(const int led)
- void color_led_red_onoff(const int onoff)
- void color_led_green_onoff(const int onoff)
- void color_led_blue_onoff(const int onoff)
- void color_led_onoff(const int red_onoff, const int green_onoff, const int blue_onoff)
- void color_led_on(void)
- void color_led_off(void)

6.95 leds.h

[Go to the documentation of this file.](#)

```

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00003
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00006  in the Software without restriction, including without limitation the rights
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00014  THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
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00017  AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018  LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019  OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020  SOFTWARE.
00021  */
00022  #ifndef LED_H
00023  #define LED_H
00024
00025  #include <gpio.h>
00026  #include <pinmap.h>
00027
00080  typedef enum {
00081      LED0,
00082      LED1,
00083      LED2,
00084      LED3,
00085      NUM_GREEN_LEDS,
00086  } green_led_index_t;
00087
00094  typedef enum {
00095      COLOR_LED0,
00096      COLOR_LED1,
00097      NUM_COLOR_LEDS,
00098  } color_led_index_t;
00099
00100  #define NUM_LED_COLORS 3 /* # colors per color LED (RGB) */
00101  #define NUM_LEDS (NUM_GREEN_LEDS + NUM_COLOR_LEDS)
00102  #define LED_OFF 0
00103  #define LED_ON 255
00104
00109  extern void leds_init_onoff(void);
00110
00116  extern void green_leds_init_pwm(void);
00117
00123  extern void color_leds_init_pwm(void);
00124
00129  extern void leds_destroy(void);
00130
00139  extern void green_led_onoff(const int led, const int onoff);
00140
00148  extern void green_led_on(const int led);
00149
00157  extern void green_led_off(const int led);
00158
00166  extern void color_led_red_onoff(const int onoff);
00167
00175  extern void color_led_green_onoff(const int onoff);
00176
00184  extern void color_led_blue_onoff(const int onoff);
00185
00194  extern void color_led_onoff(const int red_onoff, const int green_onoff,
00195                             const int blue_onoff);
00196
00203  extern void color_led_on(void);
00204
00211  extern void color_led_off(void);
00212
00217  #endif

```

6.96 library/empty-library/libpynq.c File Reference

```
#include <libpynq.h>  
Include dependency graph for libpynq.c:
```

Functions

- void [pynq_init](#) (void)
- void [pynq_destroy](#) (void)

6.96.1 Function Documentation

6.96.1.1 [pynq_destroy\(\)](#)

```
void pynq_destroy (  
    void )
```

Reset and destroy the switchbox and GPIO of the PYNQ.

Definition at line 3 of file [libpynq.c](#).

6.96.1.2 [pynq_init\(\)](#)

```
void pynq_init (  
    void )
```

Initialise the switchbox and GPIO of the PYNQ.

Definition at line 2 of file [libpynq.c](#).

6.97 libpynq.c

[Go to the documentation of this file.](#)

```
00001 #include <libpynq.h>  
00002 void pynq_init(void){};  
00003 void pynq_destroy(void){};
```

6.98 library/libpynq.c File Reference

```
#include "libpynq.h"  
Include dependency graph for libpynq.c:
```

Functions

- void [pynq_init](#) (void)
- void [pynq_destroy](#) (void)

6.98.1 Function Documentation

6.98.1.1 pynq_destroy()

```
void pynq_destroy (
    void )
```

Reset and destroy the switchbox and GPIO of the PYNQ.

Definition at line 35 of file [libpynq.c](#).

Here is the call graph for this function:

6.98.1.2 pynq_init()

```
void pynq_init (
    void )
```

Initialise the switchbox and GPIO of the PYNQ.

Definition at line 24 of file [libpynq.c](#).

Here is the call graph for this function:

6.99 libpynq.c

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include "libpynq.h"
00023
00024 void pynq_init(void) {
00025     gpio_init();
00026     gpio_reset();
00027     switchbox_init();
00028     switchbox_reset();
00029
00030     // set line buffering on the output, should help with logging
00031     setlinebuf(stdout);
00032     setlinebuf(stderr);
00033 }
00034
00035 void pynq_destroy(void) {
00036     gpio_reset();
00037     gpio_destroy();
00038     switchbox_reset();
00039     switchbox_destroy();
00040 }
```

6.100 library/libpynq.h File Reference

```
#include <stdbool.h>
#include <stdint.h>
#include <adc.h>
#include <arm_shared_memory_system.h>
#include <audio.h>
#include <buttons.h>
#include <display.h>
#include <fontx.h>
#include <gpio.h>
#include <i2cps.h>
#include <iic.h>
#include <interrupt.h>
#include <leds.h>
#include <log.h>
#include <pinmap.h>
#include <pwm.h>
#include <switchbox.h>
#include <uart.h>
#include <uio.h>
#include <util.h>
#include <version.h>
#include <lcdconfig.h>
#include <platform.h>
```

Include dependency graph for libpynq.h: This graph shows which files directly or indirectly include this file:

Functions

- void [pynq_init](#) (void)
- void [pynq_destroy](#) (void)

6.100.1 Function Documentation

6.100.1.1 [pynq_destroy\(\)](#)

```
void pynq_destroy (
    void )
```

Reset and destroy the switchbox and GPIO of the PYNQ.

Definition at line 3 of file [libpynq.c](#).

Here is the call graph for this function:

6.100.1.2 [pynq_init\(\)](#)

```
void pynq_init (
    void )
```

Initialise the switchbox and GPIO of the PYNQ.

Definition at line 2 of file [libpynq.c](#).

Here is the call graph for this function:

6.101 libpynq.h

[Go to the documentation of this file.](#)

```

00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef PYNQLIB_H
00023 #define PYNQLIB_H
00024
00025 #ifdef __cplusplus
00026 extern "C" {
00027 #endif // all of your legacy C code here
00028
00029 // standard libraries
00030 #include <stdbool.h>
00031 #include <stdint.h>
00032
00033 // library > (...)
00034 #include <adc.h>
00035 #include <arm_shared_memory_system.h>
00036 #include <audio.h>
00037 #include <buttons.h>
00038 #include <display.h>
00039 #include <fontx.h>
00040 #include <gpio.h>
00041 #include <i2cps.h>
00042 #include <iic.h>
00043 #include <interrupt.h>
00044 #include <leds.h>
00045 #include <log.h>
00046 #include <pinmap.h>
00047 #include <pwm.h>
00048 #include <switchbox.h>
00049 #include <uart.h>
00050 #include <uio.h>
00051 #include <util.h>
00052 #include <version.h>
00053
00054 // platform > (...)
00055 #include <lcdconfig.h>
00056 #include <platform.h>
00057
00061 extern void pynq_init(void);
00062
00066 extern void pynq_destroy(void);
00067
00068 #ifdef __cplusplus
00069 }
00070 #endif
00071
00072 #endif

```

6.102 library/empty-library/log.c File Reference

```

#include <log.h>
#include <stdarg.h>
#include <stdbool.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

```

Include dependency graph for log.c:

Functions

- void `pynq_log` (const `LogLevel` level, char const *domain, char const *location, unsigned int lineno, char const *fmt,...)

6.103 log.c

[Go to the documentation of this file.](#)

```
00001 #include <log.h>
00002 #include <stdarg.h>
00003 #include <stdbool.h>
00004 #include <stdio.h>
00005 #include <stdlib.h>
00006 #include <string.h>
00007
00008 static LogLevel critical_level = LOG_LEVEL_ERROR;
00009 static LogLevel min_log_level = LOG_LEVEL_WARNING;
00010
00011 void pynq_log(const LogLevel level, char const *domain, char const *location,
00012              unsigned int lineno, char const *fmt, ...){
00013     va_list arg_list;
00014     if (level < min_log_level) {
00015         return;
00016     }
00017     va_start(arg_list, fmt);
00018     vfprintf(stderr, fmt, arg_list);
00019     va_end(arg_list);
00020     if (fmt[strlen(fmt) - 1] != '\\n') {
00021         fputc("\\n", stderr);
00022     }
00023     if (level >= critical_level) {
00024         abort();
00025     }
00026 }
```

6.104 library/log.c File Reference

```
#include <stdarg.h>
#include <stdbool.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "log.h"
```

Include dependency graph for log.c:

Macros

- #define `DOMAIN` "LOGGER"

Functions

- void `pynq_log` (const `LogLevel` level, char const *domain, char const *location, unsigned int lineno, char const *fmt,...)

6.104.1 Macro Definition Documentation

6.104.1.1 DOMAIN

```
#define DOMAIN "LOGGER"
```

Logging domain for this file.

Definition at line 31 of file [log.c](#).

6.105 log.c

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <stdarg.h>
00023 #include <stdbool.h>
00024 #include <stdio.h>
00025 #include <stdlib.h>
00026 #include <string.h>
00027
00028 #include "log.h"
00029
00031 #define DOMAIN "LOGGER"
00032
00034 static const char color_escape_calls[NUM_LOG_LEVELS][8] = {
00036     "\033[1;32m",
00038     "\033[1;33m",
00040     "\033[1;31m"};
00042 static const char log_level_name[NUM_LOG_LEVELS][10] = {
00043     "INFO: ", "WARNING: ", "ERROR: "};
00045 static const char color_escape_blue[] = "\033[1;34m";
00046 static const char color_escape_reset[] = "\033[0m";
00047
00048 static bool pynq_log_init = false;
00049 static LogLevel critical_level = LOG_LEVEL_ERROR;
00050 static LogLevel min_log_level = LOG_LEVEL_WARNING;
00051
00052 void pynq_log(const LogLevel level, char const *domain, char const *location,
00053              unsigned int lineno, char const *fmt, ...) {
00054     va_list arg_list;
00055
00056     // on first call, initialize based on input arguments
00057     if (!pynq_log_init) {
00058         // if DEBUG is set, we also print log level INFO
00059         char const *env = getenv("DEBUG");
00060         if (env != NULL) {
00061             min_log_level = LOG_LEVEL_INFO;
00062         }
00063         // make warnings fatal
00064         env = getenv("FATAL_WARNING");
00065         if (env != NULL) {
00066             critical_level = LOG_LEVEL_WARNING;
00067         }
00068         pynq_log_init = true;
00069     }
00070     // check if the log level is valid
```

```

00071  if (level < LOG_LEVEL_INFO || level > LOG_LEVEL_ERROR) {
00072      printf("pynq_log: invalid log level specified (%d)\r\n", level);
00073      return;
00074  }
00075
00076  if (level < min_log_level) {
00077      return;
00078  }
00079  fputs(color_escape_calls[level], stderr);
00080  fputs(log_level_name[level], stderr);
00081
00082  fputs(color_escape_blue, stderr);
00083  if (domain != NULL) {
00084      fprintf(stderr, "%s:", domain);
00085  }
00086  fprintf(stderr, "%s:%d ", location, lineno);
00087  fputs(color_escape_reset, stderr);
00088
00089  va_start(arg_list, fmt);
00090  vfprintf(stderr, fmt, arg_list);
00091  va_end(arg_list);
00092  if (fmt[strlen(fmt) - 1] != '\n') {
00093      fputs("\n", stderr);
00094  }
00095
00096  if (level >= critical_level) {
00097      abort();
00098  }
00099 }

```

6.106 library/log.h File Reference

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

Macros

- `#define LOG_DOMAIN NULL`
- `#define pynq_info(...) pynq_log(LOG_LEVEL_INFO, LOG_DOMAIN, __FUNCTION__, __LINE__, __VA_ARGS__)`
- `#define pynq_warning(...) pynq_log(LOG_LEVEL_WARNING, LOG_DOMAIN, __FUNCTION__, __LINE__, __VA_ARGS__)`
- `#define pynq_error(...)`

Typedefs

- `typedef enum LogLevel LogLevel`

Enumerations

- `enum LogLevel { LOG_LEVEL_INFO, LOG_LEVEL_WARNING, LOG_LEVEL_ERROR, NUM_LOG_LEVELS }`

Functions

- `void pynq_log (const LogLevel level, char const *domain, char const *location, unsigned int lineno, char const *fmt,...)`

6.106.1 Macro Definition Documentation

6.106.1.1 LOG_DOMAIN

```
#define LOG_DOMAIN NULL
```

Definition at line 25 of file [log.h](#).

6.107 log.h

[Go to the documentation of this file.](#)

```
00001 /*
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00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef LOG_H
00023 #define LOG_H
00024
00025 #define LOG_DOMAIN NULL
00026
00027 typedef enum LogLevel {
00028     LOG_LEVEL_INFO,
00029     LOG_LEVEL_WARNING,
00030     LOG_LEVEL_ERROR,
00031     NUM_LOG_LEVELS
00032 } LogLevel;
00033
00034 void pynq_log(const LogLevel level, char const *domain, char const *location,
00035              unsigned int lineno, char const *fmt, ...);
00036
00037 #define pynq_info(...) \
00038     pynq_log(LOG_LEVEL_INFO, LOG_DOMAIN, __FUNCTION__, __LINE__, __VA_ARGS__)
00039
00040 #define pynq_warning(...) \
00041     pynq_log(LOG_LEVEL_WARNING, LOG_DOMAIN, __FUNCTION__, __LINE__, __VA_ARGS__)
00042
00043 #define pynq_error(...) \
00044     do { \
00045         pynq_log(LOG_LEVEL_ERROR, LOG_DOMAIN, __FUNCTION__, __LINE__, \
00046                 __VA_ARGS__); \
00047         for (;;) \
00048             ; \
00049     } while (0)
00050
00051 #endif // LOG_H
```

6.108 library/pinmap.h File Reference

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

Macros

- `#define NUM_ANALOG_REFERENCE_PINS 14 /* # analog reference pins */`
- `#define NUM_ANALOG_IN_PINS 6 /* # analog input pins */`
- `#define PIN_CHECK(pin)`

Enumerations

- `enum pin_t {`
`SWB_AR0 = 0, SWB_AR1 = 1, SWB_AR2 = 2, SWB_AR3 = 3,`
`SWB_AR4 = 4, SWB_AR5 = 5, SWB_AR6 = 6, SWB_AR7 = 7,`
`SWB_AR8 = 8, SWB_AR9 = 9, SWB_AR10 = 10, SWB_AR11 = 11,`
`SWB_AR12 = 12, SWB_AR13 = 13, SWB_A0 = 14, SWB_A1 = 15,`
`SWB_A2 = 16, SWB_A3 = 17, SWB_A4 = 18, SWB_A5 = 19,`
`SWB_SW0 = 20, SWB_SW1 = 21, SWB_BTN0 = 22, SWB_BTN1 = 23,`
`SWB_BTN2 = 24, SWB_BTN3 = 25, SWB_LD0 = 26, SWB_LD1 = 27,`
`SWB_LD2 = 28, SWB_LD3 = 29, SWB_AR_SCL = 31, SWB_AR_SDA = 30,`
`SWB_LD4B = 32, SWB_LD4R = 33, SWB_LD4G = 34, SWB_LD5B = 35,`
`SWB_LD5R = 36, SWB_LD5G = 37, SWB_RBPI40 = 38, SWB_RBPI37 = 39,`
`SWB_RBPI38 = 40, SWB_RBPI35 = 41, SWB_RBPI36 = 42, SWB_RBPI33 = 43,`
`SWB_RBPI18 = 44, SWB_RBPI32 = 45, SWB_RBPI10 = 46, SWB_RBPI27 = 47,`
`SWB_RBPI28 = 48, SWB_RBPI22 = 49, SWB_RBPI23 = 50, SWB_RBPI24 = 51,`
`SWB_RBPI21 = 52, SWB_RBPI26 = 53, SWB_RBPI19 = 54, SWB_RBPI31 = 55,`
`SWB_RBPI15 = 56, SWB_RBPI16 = 57, SWB_RBPI13 = 58, SWB_RBPI12 = 59,`
`SWB_RBPI29 = 60, SWB_RBPI08 = 61, SWB_RBPI07 = 62, SWB_RBPI05 = 63,`
`SWB_NUM_PINS = 64 }`

Variables

- `char *const pin_names [64]`

6.109 pinmap.h

[Go to the documentation of this file.](#)

```
00001 /*
00002 Copyright (c) 2023 Eindhoven University of Technology
00003
00004 Permission is hereby granted, free of charge, to any person obtaining a copy
00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
00010
00011 The above copyright notice and this permission notice shall be included in all
00012 copies or substantial portions of the Software.
00013
00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
00015 IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
00016 FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
00017 AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef PINMAP_H
00023 #define PINMAP_H
00024
00042 #define NUM_ANALOG_REFERENCE_PINS 14 /* # analog reference pins */
00043 #define NUM_ANALOG_IN_PINS 6 /* # analog input pins */
00044
00045 typedef enum {
00049 SWB_AR0 = 0, /* reference pin 0 */
```

```

00050 SWB_AR1 = 1, /* reference pin 1 */
00051 SWB_AR2 = 2, /* reference pin 2 */
00052 SWB_AR3 = 3, /* reference pin 3 */
00053 SWB_AR4 = 4, /* reference pin 4 */
00054 SWB_AR5 = 5, /* reference pin 5 */
00055 SWB_AR6 = 6, /* reference pin 6 */
00056 SWB_AR7 = 7, /* reference pin 7 */
00057 SWB_AR8 = 8, /* reference pin 8 */
00058 SWB_AR9 = 9, /* reference pin 9 */
00059 SWB_AR10 = 10, /* reference pin 10 */
00060 SWB_AR11 = 11, /* reference pin 11 */
00061 SWB_AR12 = 12, /* reference pin 12 */
00062 SWB_AR13 = 13, /* reference pin 13 */
00063
00067 SWB_A0 = 14, /* analog input pin 0 */
00068 SWB_A1 = 15, /* analog input pin 1 */
00069 SWB_A2 = 16, /* analog input pin 2 */
00070 SWB_A3 = 17, /* analog input pin 3 */
00071 SWB_A4 = 18, /* analog input pin 4 */
00072 SWB_A5 = 19, /* analog input pin 5 */
00073
00077 SWB_SW0 = 20, /* switch input pin 0 */
00078 SWB_SW1 = 21, /* switch input pin 1 */
00079
00083 SWB_BTN0 = 22, /* button input pin 0 */
00084 SWB_BTN1 = 23, /* button input pin 1 */
00085 SWB_BTN2 = 24, /* button input pin 2 */
00086 SWB_BTN3 = 25, /* button input pin 3 */
00087
00091 SWB_LD0 = 26, /* LED output pin 0 */
00092 SWB_LD1 = 27, /* LED output pin 1 */
00093 SWB_LD2 = 28, /* LED output pin 2 */
00094 SWB_LD3 = 29, /* LED output pin 3 */
00095
00099 SWB_AR_SCL = 31, /* I2C clock pin */
00100 SWB_AR_SDA = 30, /* I2C data pin */
00101
00106 SWB_LD4B = 32, /* color LED 0 blue input pin */
00107 SWB_LD4R = 33, /* color LED 0 red input pin */
00108 SWB_LD4G = 34, /* color LED 0 green input pin */
00109
00110 SWB_LD5B = 35, /* color LED 1 blue input pin */
00111 SWB_LD5R = 36, /* color LED 1 red input pin */
00112 SWB_LD5G = 37, /* color LED 1 green input pin */
00113
00117 SWB_RBPI40 = 38, /* RaspberryPi header pin */
00118 SWB_RBPI37 = 39, /* RaspberryPi header pin */
00119 SWB_RBPI38 = 40, /* RaspberryPi header pin */
00120 SWB_RBPI35 = 41, /* RaspberryPi header pin */
00121 SWB_RBPI36 = 42, /* RaspberryPi header pin */
00122 SWB_RBPI33 = 43, /* RaspberryPi header pin */
00123 SWB_RBPI18 = 44, /* RaspberryPi header pin */
00124 SWB_RBPI32 = 45, /* RaspberryPi header pin */
00125 SWB_RBPI10 = 46, /* RaspberryPi header pin */
00126 SWB_RBPI27 = 47, /* RaspberryPi header pin */
00127 SWB_RBPI28 = 48, /* RaspberryPi header pin */
00128 SWB_RBPI22 = 49, /* RaspberryPi header pin */
00129 SWB_RBPI23 = 50, /* RaspberryPi header pin */
00130 SWB_RBPI24 = 51, /* RaspberryPi header pin */
00131 SWB_RBPI21 = 52, /* RaspberryPi header pin */
00132 SWB_RBPI26 = 53, /* RaspberryPi header pin */
00133 SWB_RBPI19 = 54, /* RaspberryPi header pin */
00134 SWB_RBPI31 = 55, /* RaspberryPi header pin */
00135 SWB_RBPI15 = 56, /* RaspberryPi header pin */
00136 SWB_RBPI16 = 57, /* RaspberryPi header pin */
00137 SWB_RBPI13 = 58, /* RaspberryPi header pin */
00138 SWB_RBPI12 = 59, /* RaspberryPi header pin */
00139 SWB_RBPI29 = 60, /* RaspberryPi header pin */
00140 SWB_RBPI08 = 61, /* RaspberryPi header pin */
00141 SWB_RBPI07 = 62, /* RaspberryPi header pin */
00142 SWB_RBPI05 = 63, /* RaspberryPi header pin */
00143
00144 SWB_NUM_PINS = 64,
00145 } pin_t;
00146
00150 #define PIN_CHECK(pin)
00151 do {
00152     if (pin >= SWB_NUM_PINS) {
00153         pyng_error("pin %u is invalid, must be 0..%u-1.", pin, SWB_NUM_PINS);
00154     }
00155 } while (0);
00156
00160 extern char *const pin_names[64];
00164 #endif // PINMAP_H

```

6.110 library/pwm.h File Reference

#include <libpynq.h>

Include dependency graph for pwm.h: This graph shows which files directly or indirectly include this file:

Enumerations

- enum `pwm_index_t` {
`PWM0`, `PWM1`, `PWM2`, `PWM3`,
`PWM4`, `PWM5`, `NUM_PWMS`}

Functions

- bool `pwm_initialized` (const int pwm)
- void `pwm_init` (const int pwm, const uint32_t period)
- void `pwm_destroy` (const int pwm)
- void `pwm_set_duty_cycle` (const int pwm, const uint32_t duty)
- void `pwm_set_period` (const int pwm, const uint32_t period)
- uint32_t `pwm_get_period` (const int pwm)
- uint32_t `pwm_get_duty_cycle` (const int pwm)
- void `pwm_set_steps` (const int pwm, const uint32_t steps)
- uint32_t `pwm_get_steps` (const int pwm)

6.111 pwm.h

[Go to the documentation of this file.](#)

```
00001 /*
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00003
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00005 of this software and associated documentation files (the "Software"), to deal
00006 in the Software without restriction, including without limitation the rights
00007 to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
00008 copies of the Software, and to permit persons to whom the Software is
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00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef PWM_H
00023 #define PWM_H
00024 #include <libpynq.h>
00025
00047 typedef enum { PWM0, PWM1, PWM2, PWM3, PWM4, PWM5, NUM_PWMS } pwm_index_t;
00048
00055 extern bool pwm_initialized(const int pwm);
00056
00063 extern void pwm_init(const int pwm, const uint32_t period);
00064
00070 extern void pwm_destroy(const int pwm);
00071
00079 extern void pwm_set_duty_cycle(const int pwm, const uint32_t duty);
00080
00088 extern void pwm_set_period(const int pwm, const uint32_t period);
00089
00097 uint32_t pwm_get_period(const int pwm);
00098
00106 extern uint32_t pwm_get_duty_cycle(const int pwm);
00107
00116 extern void pwm_set_steps(const int pwm, const uint32_t steps);
00117
00126 extern uint32_t pwm_get_steps(const int pwm);
00127
00131 #endif
```

6.112 library/switchbox.h File Reference

```
#include <pinmap.h>
#include <stdbool.h>
#include <stdint.h>
```

Include dependency graph for switchbox.h: This graph shows which files directly or indirectly include this file:

Macros

- `#define NUM_SWITCHBOX_NAMES 40`

Enumerations

- enum `io_configuration` {
`SWB_GPIO = 0x00` , `SWB_Interrupt_In = 0x01` , `SWB_UART0_TX = 0x02` , `SWB_UART0_RX = 0x03` ,
`SWB_SPI0_CLK = 0x04` , `SWB_SPI0_MISO = 0x05` , `SWB_SPI0_MOSI = 0x06` , `SWB_SPI0_SS = 0x07` ,
`SWB_SPI1_CLK = 0x08` , `SWB_SPI1_MISO = 0x09` , `SWB_SPI1_MOSI = 0x0A` , `SWB_SPI1_SS = 0x0B` ,
`SWB_IIC0_SDA = 0x0C` , `SWB_IIC0_SCL = 0x0D` , `SWB_IIC1_SDA = 0x0E` , `SWB_IIC1_SCL = 0x0F` ,
`SWB_PWM0 = 0x10` , `SWB_PWM1 = 0x11` , `SWB_PWM2 = 0x12` , `SWB_PWM3 = 0x13` ,
`SWB_PWM4 = 0x14` , `SWB_PWM5 = 0x15` , `SWB_TIMER_G0 = 0x18` , `SWB_TIMER_G1 = 0x19` ,
`SWB_TIMER_G2 = 0x1A` , `SWB_TIMER_G3 = 0x1B` , `SWB_TIMER_G4 = 0x1C` , `SWB_TIMER_G5 = 0x1D`
 ,
`SWB_TIMER_G6 = 0x1E` , `SWB_TIMER_G7 = 0x1F` , `SWB_UART1_TX = 0x22` , `SWB_UART1_RX = 0x23` ,
`SWB_TIMER_IC0 = 0x38` , `SWB_TIMER_IC1 = 0x39` , `SWB_TIMER_IC2 = 0x3A` , `SWB_TIMER_IC3 = 0x3B`
 ,
`SWB_TIMER_IC4 = 0x3C` , `SWB_TIMER_IC5 = 0x3D` , `SWB_TIMER_IC6 = 0x3E` , `SWB_TIMER_IC7 = 0x3F`
 ,
`NUM_IO_CONFIGURATIONS` }

Functions

- void `switchbox_init` (void)
- void `switchbox_set_pin` (const `pin_t` pin_number, const `uint8_t` pin_type)
- void `switchbox_reset` (void)
- void `switchbox_destroy` (void)
- `uint8_t` `switchbox_get_pin` (const `pin_t` pin_number)

Variables

- char *const `switchbox_names` [`NUM_SWITCHBOX_NAMES`]

6.113 switchbox.h

[Go to the documentation of this file.](#)

```

00001  /*
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00003
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00020  SOFTWARE.
00021  */
00022  #ifndef SWITCHBOX_H
00023  #define SWITCHBOX_H
00024  #include <pinmap.h>
00025  #include <stdbool.h>
00026  #include <stdint.h>
00027
00061  enum io_configuration {
00063      SWB_GPIO = 0x00,
00065      SWB_Interrupt_In = 0x01,
00067      SWB_UART0_TX = 0x02,
00069      SWB_UART0_RX = 0x03,
00071      SWB_SPI0_CLK = 0x04,
00073      SWB_SPI0_MISO = 0x05,
00075      SWB_SPI0_MOSI = 0x06,
00077      SWB_SPI0_SS = 0x07,
00079      SWB_SPI1_CLK = 0x08,
00081      SWB_SPI1_MISO = 0x09,
00083      SWB_SPI1_MOSI = 0x0A,
00085      SWB_SPI1_SS = 0x0B,
00087      SWB_IIC0_SDA = 0x0C,
00089      SWB_IIC0_SCL = 0x0D,
00091      SWB_IIC1_SDA = 0x0E,
00093      SWB_IIC1_SCL = 0x0F,
00095      SWB_PWM0 = 0x10,
00097      SWB_PWM1 = 0x11,
00099      SWB_PWM2 = 0x12,
00101      SWB_PWM3 = 0x13,
00103      SWB_PWM4 = 0x14,
00105      SWB_PWM5 = 0x15,
00106      SWB_TIMER_G0 = 0x18,
00107      SWB_TIMER_G1 = 0x19,
00109      SWB_TIMER_G2 = 0x1A,
00111      SWB_TIMER_G3 = 0x1B,
00113      SWB_TIMER_G4 = 0x1C,
00115      SWB_TIMER_G5 = 0x1D,
00117      SWB_TIMER_G6 = 0x1E,
00119      SWB_TIMER_G7 = 0x1F,
00120      SWB_UART1_TX = 0x22,
00121      SWB_UART1_RX = 0x23,
00122      SWB_TIMER_IC0 = 0x38,
00123      SWB_TIMER_IC1 = 0x39,
00124      SWB_TIMER_IC2 = 0x3A,
00125      SWB_TIMER_IC3 = 0x3B,
00126      SWB_TIMER_IC4 = 0x3C,
00127      SWB_TIMER_IC5 = 0x3D,
00128      SWB_TIMER_IC6 = 0x3E,
00129      SWB_TIMER_IC7 = 0x3F,
00131      NUM_IO_CONFIGURATIONS,
00132  };
00133
00134  #define NUM_SWITCHBOX_NAMES 40
00139  extern char *const switchbox_names[NUM_SWITCHBOX_NAMES];
00140
00146  extern void switchbox_init(void);
00147
00154  extern void switchbox_set_pin(const pin_t pin_number, const uint8_t pin_type);
00155
00160  extern void switchbox_reset(void);
00161
00165  extern void switchbox_destroy(void);
00166

```



```
00175 extern uint8_t switchbox_get_pin(const pin_t pin_number);
00176
00180 #endif // SWITCHBOX_H
```

6.114 library/uart.h File Reference

```
#include <stdbool.h>
#include <stdint.h>
```

Include dependency graph for uart.h: This graph shows which files directly or indirectly include this file:

Enumerations

- enum `uart_index_t` { `UART0` = 0 , `UART1` = 1 , `NUM_UARTS` }

Functions

- void `uart_init` (const int uart)
- void `uart_destroy` (const int uart)
- void `uart_send` (const int uart, const uint8_t data)
- uint8_t `uart_rcv` (const int uart)
- bool `uart_has_data` (const int uart)
- bool `uart_has_space` (const int uart)
- void `uart_reset_fifos` (const int uart)

6.115 uart.h

[Go to the documentation of this file.](#)

```
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00003
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00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef UART_H
00023 #define UART_H
00024 #include <stdbool.h>
00025 #include <stdint.h>
00026
00107 typedef enum { UART0 = 0, UART1 = 1, NUM_UARTS } uart_index_t;
00108
00116 extern void uart_init(const int uart);
00117
00123 extern void uart_destroy(const int uart);
00124
00132 extern void uart_send(const int uart, const uint8_t data);
00133
00142 extern uint8_t uart_rcv(const int uart);
00143
00151 extern bool uart_has_data(const int uart);
00152
00160 extern bool uart_has_space(const int uart);
00161
00174 extern void uart_reset_fifos(const int uart);
00175
00180 #endif // UART_H
```

6.116 library/uiio.h File Reference

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

Functions

- void * [setUIO](#) (int *uio_index*, int *length*)
- int [unsetUIO](#) (void **uio_ptr*, int *length*)

6.116.1 Detailed Description

Functions to interact with linux UIO.

MODIFICATION HISTORY:

Ver	Who	Date	Changes
-----	-----	-----	-----
1.00	yrq	12/05/17	Initial release

Definition in file [uio.h](#).

6.116.2 Function Documentation

6.116.2.1 setUIO()

```
void * setUIO (
    int uio_index,
    int length )
```

Definition at line 2 of file [uio.c](#).

Here is the caller graph for this function:

6.116.2.2 unsetUIO()

```
int unsetUIO (
    void * uio_ptr,
    int length )
```

Definition at line 3 of file [uio.c](#).

Here is the caller graph for this function:

6.117 uio.h

[Go to the documentation of this file.](#)

```

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00004  *
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00015  * 3. Neither the name of the copyright holder nor the names of its
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00027  * WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR
00028  * OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF
00029  * ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
00030  *
00031  *****/
00032
00033 /*****
00051 #ifndef __UIO_H__
00052 #define __UIO_H__
00053
00054 void *setUIO(int uio_index, int length);
00055 int unsetUIO(void *uio_ptr, int length);
00056
00057 #endif // __UIO_H__

```

6.118 library/empty-library/util.c File Reference

```
#include <util.h>
Include dependency graph for util.c:
```

Functions

- void [sleep_msec](#) (int msec)
- void [mapping_info](#) (void)

6.119 util.c

[Go to the documentation of this file.](#)

```

00001 #include <util.h>
00002 void sleep_msec(int msec){};
00003 void mapping_info(void){};

```

6.120 library/util.c File Reference

```
#include <libpynq.h>
#include <unistd.h>
Include dependency graph for util.c:
```

Data Structures

- struct [pin_state_t](#)

Functions

- void [sleep_msec](#) (int msec)
- void [mapping_info](#) (void)

6.121 util.c

[Go to the documentation of this file.](#)

```

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00003
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00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
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00014 THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
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00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #include <libpynq.h>
00023 #include <unistd.h>
00024
00025 typedef struct {
00026     char *name;
00027     gpio_direction_t state;
00028     uint8_t channel;
00029     char *level;
00030 } pin_state_t;
00031
00032 void sleep_msec(int msec) {
00033     if (msec > 0)
00034         usleep(msec * 1000);
00035 }
00036
00037 void mapping_info(void) {
00038     const char *const dir[2] = {"Input", "Output"};
00039     printf("Pin\tName\tI/O\tLevel\tChannel\tCh_Name\t\tState\n");
00040     for (int i = 0; i < SWB_NUM_PINS; i++) {
00041         pin_state_t pin_array = {
00042             0,
00043         };
00044         pin_array.name = pin_names[i];
00045         pin_array.state = gpio_get_direction(i);
00046         if (gpio_get_level(i) == GPIO_LEVEL_HIGH) {
00047             pin_array.level = "high";
00048         } else if (gpio_get_level(i) == GPIO_LEVEL_LOW) {
00049             pin_array.level = "low";
00050         } else {
00051             pin_array.level = "undef";
00052         }
00053         // get the index of the channel the pin is mapped to, 0 for none
00054         pin_array.channel = switchbox_get_pin(i);
00055
00056         printf("%i\t%s\t%s\t%s\t%u\t", i, pin_array.name, dir[pin_array.state],
00057             pin_array.level, pin_array.channel);
00058
00059         printf("%s\t", switchbox_names[pin_array.channel]);
00060         if (pin_array.channel != SWB_GPIO && pin_array.state != GPIO_DIR_INPUT) {
00061             printf("Invalid\n");
00062         } else {
00063             printf("Valid\n");
00064         }
00065     }
00066 }

```

6.122 library/util.h File Reference

```
#include <stdlib.h>
#include <switchbox.h>
```

Include dependency graph for util.h: This graph shows which files directly or indirectly include this file:

Functions

- void [sleep_msec](#) (int msec)
- void [mapping_info](#) (void)

6.123 util.h

[Go to the documentation of this file.](#)

```
00001 /*
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00008 copies of the Software, and to permit persons to whom the Software is
00009 furnished to do so, subject to the following conditions:
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00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef UTIL_H
00023 #define UTIL_H
00024
00025 #include <stdlib.h>
00026 #include <switchbox.h>
00027
00041 extern void sleep\_msec(int msec);
00042
00047 extern void mapping\_info(void);
00048
00052 #endif
```

6.124 library/version.h File Reference

```
#include <stdint.h>
```

Include dependency graph for version.h: This graph shows which files directly or indirectly include this file:

Data Structures

- struct [version_t](#)

Functions

- void [print_version](#) (void)
- void [check_version](#) (void)

Variables

- const [version_t](#) [libpynq_version](#)

6.125 version.h

[Go to the documentation of this file.](#)

```
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00003
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00018 LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
00019 OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
00020 SOFTWARE.
00021 */
00022 #ifndef VERSION_H
00023 #define VERSION_H
00024
00058 #include <stdint.h>
00059
00063 typedef struct {
00064     uint8_t release[64];
00065     uint32_t major;
00066     uint32_t minor;
00067     uint32_t patch;
00068 } version_t;
00069
00073 extern const version_t libpynq_version;
00074
00080 extern void print_version(void);
00081
00088 extern void check_version(void);
00089
00094 #endif
```

6.126 library/xiic_i.h File Reference

```
#include "xiic.h"
#include "xil_assert.h"
#include "xil_types.h"
#include "xstatus.h"
Include dependency graph for xiic_i.h:
```

Macros

- #define [XIIC_I_H](#) /* by using protection macros */
- #define [Xlic_Send10BitAddrByte1](#)(SlaveAddress, Operation)
- #define [Xlic_Send10BitAddrByte2](#)(SlaveAddress)
- #define [Xlic_Send7BitAddr](#)(SlaveAddress, Operation)
- #define [Xlic_DisableIntr](#)(BaseAddress, InterruptMask) [Xlic_Writelier](#)((BaseAddress), [Xlic_Readlier](#)(BaseAddress) & ~(InterruptMask))

- `#define Xlic_EnableIntr(BaseAddress, InterruptMask) Xlic_Writelier((BaseAddress), Xlic_Readlier(BaseAddress) | (InterruptMask))`
- `#define Xlic_ClearIntr(BaseAddress, InterruptMask) Xlic_Writelir((BaseAddress), Xlic_Readlir(BaseAddress) & (InterruptMask))`
- `#define Xlic_ClearEnableIntr(BaseAddress, InterruptMask)`
- `#define Xlic_FlushRxFifo(InstancePtr)`
- `#define Xlic_FlushTxFifo(InstancePtr)`
- `#define Xlic_ReadRecvByte(InstancePtr)`
- `#define Xlic_WriteSendByte(InstancePtr)`
- `#define Xlic_SetControlRegister(InstancePtr, ControlRegister, ByteCount)`

Functions

- `void Xlic_TransmitFifoFill (Xlic *InstancePtr, int Role)`

Variables

- `Xlic_Config Xlic_ConfigTable []`
- `void(* Xlic_AddrAsSlaveFuncPtr)(Xlic *InstancePtr)`
- `void(* Xlic_NotAddrAsSlaveFuncPtr)(Xlic *InstancePtr)`
- `void(* Xlic_RecvSlaveFuncPtr)(Xlic *InstancePtr)`
- `void(* Xlic_SendSlaveFuncPtr)(Xlic *InstancePtr)`
- `void(* Xlic_RecvMasterFuncPtr)(Xlic *InstancePtr)`
- `void(* Xlic_SendMasterFuncPtr)(Xlic *InstancePtr)`
- `void(* Xlic_ArbLostFuncPtr)(Xlic *InstancePtr)`
- `void(* Xlic_BusNotBusyFuncPtr)(Xlic *InstancePtr)`

6.126.1 Macro Definition Documentation

6.126.1.1 Xlic_ClearEnableIntr

```
#define XIic_ClearEnableIntr(  
    BaseAddress,  
    InterruptMask )
```

Value:

```
{  
    XIic_WriteIisr(BaseAddress,  
        (XIic_ReadIisr(BaseAddress) & (InterruptMask)));  
  
    XIic_WriteIier(BaseAddress,  
        (XIic_ReadIier(BaseAddress) | (InterruptMask)));  
}
```

Definition at line 206 of file [xiic_i.h](#).

6.126.1.2 Xlic_ClearIntr

```
#define XIic_ClearIntr(  
    BaseAddress,  
    InterruptMask ) Xlic_WriteIisr((BaseAddress), XIic_ReadIisr(BaseAddress) &  
(InterruptMask))
```

Definition at line 187 of file [xiic_i.h](#).

6.126.1.3 Xlic_DisableIntr

```
#define XIic_DisableIntr(
    BaseAddress,
    InterruptMask )  XIic_WriteTier( (BaseAddress), XIic_ReadTier( BaseAddress) &
~(InterruptMask))
```

Definition at line 151 of file [xiic_i.h](#).

6.126.1.4 Xlic_EnableIntr

```
#define XIic_EnableIntr(
    BaseAddress,
    InterruptMask )  XIic_WriteTier( (BaseAddress), XIic_ReadTier( BaseAddress) | (Interrupt←
Mask))
```

Definition at line 169 of file [xiic_i.h](#).

6.126.1.5 Xlic_FlushRxFifo

```
#define XIic_FlushRxFifo(
    InstancePtr )
```

Value:

```
{
    int LoopCnt;
    u8 BytesToRead =
        XIic_ReadReg(InstancePtr->BaseAddress, XIIC_RFO_REG_OFFSET) + 1;
    for (LoopCnt = 0; LoopCnt < BytesToRead; LoopCnt++) {
        XIic_ReadReg(InstancePtr->BaseAddress, XIIC_DRR_REG_OFFSET);
    }
}
```

Definition at line 229 of file [xiic_i.h](#).

6.126.1.6 Xlic_FlushTxFifo

```
#define XIic_FlushTxFifo(
    InstancePtr )
```

Value:

```
;
{
    u32 CntlReg = XIic_ReadReg(InstancePtr->BaseAddress, XIIC_CR_REG_OFFSET);
    XIic_WriteReg(InstancePtr->BaseAddress, XIIC_CR_REG_OFFSET,
        CntlReg | XIIC_CR_TX_FIFO_RESET_MASK);
    XIic_WriteReg(InstancePtr->BaseAddress, XIIC_CR_REG_OFFSET, CntlReg);
}
```

Definition at line 253 of file [xiic_i.h](#).

6.126.1.7 XIIC_I_H

```
#define XIIC_I_H /* by using protection macros */
```

This header file contains internal identifiers, which are those shared between Xlic components. The identifiers in this file are not intended for use external to the driver.

MODIFICATION HISTORY:

Ver	Who	Date	Changes
1.01a	rfp	10/19/01	release
1.01c	ecm	12/05/02	new rev
1.13a	wgr	03/22/07	Converted to new coding style.
2.00a	sdm	10/22/09	Converted all register accesses to 32 bit access. Removed the macro XIIC_CLEAR_STATS, user has to use the the XIic_ClearStats API in its place. Removed the macro XIic_mEnterCriticalRegion, XIic_IntrGlobalDisable should be used in its place. Removed the macro XIic_mExitCriticalRegion, XIic_IntrGlobalEnable should be used in its place. Removed the _m prefix from all the macros XIic_mSend10BitAddrByte1 is now XIic_Send10BitAddrByte1 XIic_mSend10BitAddrByte2 is now XIic_Send10BitAddrByte2 XIic_mSend7BitAddr is now XIic_Send7BitAddr XIic_mDisableIntr is now XIic_DisableIntr XIic_mEnableIntr is now XIic_EnableIntr XIic_mClearIntr is now XIic_ClearIntr XIic_mClearEnableIntr is now XIic_ClearEnableIntr XIic_mFlushRxFifo is now XIic_FlushRxFifo XIic_mFlushTxFifo is now XIic_FlushTxFifo XIic_mReadRecvByte is now XIic_ReadRecvByte XIic_mWriteSendByte is now XIic_WriteSendByte XIic_mSetControlRegister is now XIic_SetControlRegister
2.07a	adk	18/04/13	Updated the code to avoid unused variable warnings when compiling with the -Wextra -Wall flags. Changes done in files xiic.c and xiic_i.h . CR:705001

Definition at line 51 of file [xiic_i.h](#).

6.126.1.8 Xlic_ReadRecvByte

```
#define XIic_ReadRecvByte(  
    InstancePtr )
```

Value:

```
{  
    *InstancePtr->RecvBufferPtr++ =  
        XIic_ReadReg(InstancePtr->BaseAddress, XIIC_DRR_REG_OFFSET);  
    InstancePtr->RecvByteCount--;  
    InstancePtr->Stats.RecvBytes++;  
}
```

Definition at line 275 of file [xiic_i.h](#).

6.126.1.9 Xlic_Send10BitAddrByte1

```
#define XIic_Send10BitAddrByte1(
    SlaveAddress,
    Operation )
```

Value:

```
{
    u8 LocalAddr = (u8)((SlaveAddress) >> 7);
    LocalAddr = (LocalAddr & 0xF6) | 0xF0 | (Operation);
    XIic_WriteReg(InstancePtr->BaseAddress, XIIC_DTR_REG_OFFSET,
        (u32) LocalAddr);
}
```

Definition at line 88 of file [xiic_i.h](#).

6.126.1.10 Xlic_Send10BitAddrByte2

```
#define XIic_Send10BitAddrByte2(
    SlaveAddress )
```

Value:

```
XIic_WriteReg(InstancePtr->BaseAddress, XIIC_DTR_REG_OFFSET,
    (u32) (SlaveAddress));
```

Definition at line 110 of file [xiic_i.h](#).

6.126.1.11 Xlic_Send7BitAddr

```
#define XIic_Send7BitAddr(
    SlaveAddress,
    Operation )
```

Value:

```
{
    u8 LocalAddr = (u8)(SlaveAddress << 1);
    LocalAddr = (LocalAddr & 0xFE) | (Operation);
    XIic_WriteReg(InstancePtr->BaseAddress, XIIC_DTR_REG_OFFSET,
        (u32) LocalAddr);
}
```

Definition at line 128 of file [xiic_i.h](#).

6.126.1.12 Xlic_SetControlRegister

```
#define XIic_SetControlRegister(
    InstancePtr,
    ControlRegister,
    ByteCount )
```

Value:

```
{
    (ControlRegister) &= ~(XIIC_CR_NO_ACK_MASK | XIIC_CR_DIR_IS_TX_MASK);
    if (InstancePtr->Options & XII_SEND_10_BIT_OPTION) {
        (ControlRegister) |= XIIC_CR_DIR_IS_TX_MASK;
    } else {
        if ((ByteCount) == 1) {
            (ControlRegister) |= XIIC_CR_NO_ACK_MASK;
        }
    }
}
```

Definition at line 323 of file [xiic_i.h](#).

6.126.3.6 Xlic_RecvMasterFuncPtr

```
void(* Xlic_RecvMasterFuncPtr) (Xlic *InstancePtr) (
    Xlic * InstancePtr ) [extern]
```

6.126.3.7 Xlic_RecvSlaveFuncPtr

```
void(* Xlic_RecvSlaveFuncPtr) (Xlic *InstancePtr) (
    Xlic * InstancePtr ) [extern]
```

6.126.3.8 Xlic_SendMasterFuncPtr

```
void(* Xlic_SendMasterFuncPtr) (Xlic *InstancePtr) (
    Xlic * InstancePtr ) [extern]
```

6.126.3.9 Xlic_SendSlaveFuncPtr

```
void(* Xlic_SendSlaveFuncPtr) (Xlic *InstancePtr) (
    Xlic * InstancePtr ) [extern]
```

6.127 xiic_i.h

[Go to the documentation of this file.](#)

```
00001 /*****
00002  * Copyright (C) 2002 - 2021 Xilinx, Inc. All rights reserved.
00003  * SPDX-License-Identifier: MIT
00004  *****/
00005
00006 /*****
00050 #ifndef XIIC_I_H /* prevent circular inclusions */
00051 #define XIIC_I_H /* by using protection macros */
00052
00053 #ifdef __cplusplus
00054 extern "C" {
00055 #endif
00056
00057 /***** Include Files *****/
00058
00059 #include "xiic.h"
00060 #include "xil_assert.h"
00061 #include "xil_types.h"
00062 #include "xstatus.h"
00063
00064 /***** Constant Definitions *****/
00065
00066 /***** Type Definitions *****/
00067
00068 /***** Macros (Inline Functions) Definitions *****/
00069
00070 /*****
00071  *
00072  * This macro sends the first byte of the address for a 10 bit address during
00073  * both read and write operations. It takes care of the details to format the
00074  * address correctly.
00075  *
00076  * address = 1111_0xxD   xx = address MSBits
00077  *                      D = Tx direction = 0 = write
00078  *
00079  * @param   SlaveAddress contains the address of the slave to send to.
00080  * @param   Operation indicates XIIC_READ_OPERATION or XIIC_WRITE_OPERATION
00081  *
00082  * @return  None.
00083  *
00084  *****/
```

```

00084 * @note      Signature:
00085 *      void XIic_Send10BitAddrByte1(u16 SlaveAddress, u8 Operation);
00086 *
00087 *****/
00088 #define XIic_Send10BitAddrByte1(SlaveAddress, Operation) \
00089 { \
00090     u8 LocalAddr = (u8)((SlaveAddress) >> 7); \
00091     LocalAddr = (LocalAddr & 0xF6) | 0xF0 | (Operation); \
00092     XIic_WriteReg(InstancePtr->BaseAddress, XIIC_DTR_REG_OFFSET, \
00093         (u32)LocalAddr); \
00094 }
00095
00096 /*****
00097 *
00098 * This macro sends the second byte of the address for a 10 bit address during
00099 * both read and write operations. It takes care of the details to format the
00100 * address correctly.
00101 *
00102 * @param   SlaveAddress contains the address of the slave to send to.
00103 *
00104 * @return  None.
00105 *
00106 * @note      Signature: void XIic_Send10BitAddrByte2(u16
00107 *SlaveAddress, u8 Operation);
00108 *
00109 *****/
00110 #define XIic_Send10BitAddrByte2(SlaveAddress) \
00111     XIic_WriteReg(InstancePtr->BaseAddress, XIIC_DTR_REG_OFFSET, \
00112         (u32)(SlaveAddress)); \
00113
00114 /*****
00115 *
00116 * This macro sends the address for a 7 bit address during both read and write
00117 * operations. It takes care of the details to format the address correctly.
00118 *
00119 * @param   SlaveAddress contains the address of the slave to send to.
00120 * @param   Operation indicates XIIC_READ_OPERATION or XIIC_WRITE_OPERATION
00121 *
00122 * @return  None.
00123 *
00124 * @note      Signature:
00125 *      void XIic_Send7BitAddr(u16 SlaveAddress, u8 Operation);
00126 *
00127 *****/
00128 #define XIic_Send7BitAddr(SlaveAddress, Operation) \
00129 { \
00130     u8 LocalAddr = (u8)(SlaveAddress << 1); \
00131     LocalAddr = (LocalAddr & 0xFE) | (Operation); \
00132     XIic_WriteReg(InstancePtr->BaseAddress, XIIC_DTR_REG_OFFSET, \
00133         (u32)LocalAddr); \
00134 }
00135
00136 /*****
00137 *
00138 * This macro disables the specified interrupts in the Interrupt enable
00139 * register. It is non-destructive in that the register is read and only the
00140 * interrupts specified is changed.
00141 *
00142 * @param   BaseAddress is the base address of the IIC device.
00143 * @param   InterruptMask contains the interrupts to be disabled
00144 *
00145 * @return  None.
00146 *
00147 * @note      Signature:
00148 *      void XIic_DisableIntr(u32 BaseAddress, u32 InterruptMask);
00149 *
00150 *****/
00151 #define XIic_DisableIntr(BaseAddress, InterruptMask) \
00152     XIic_WriteTier((BaseAddress), XIic_ReadTier(BaseAddress) & ~(InterruptMask)) \
00153
00154 /*****
00155 *
00156 * This macro enables the specified interrupts in the Interrupt enable
00157 * register. It is non-destructive in that the register is read and only the
00158 * interrupts specified is changed.
00159 *
00160 * @param   BaseAddress is the base address of the IIC device.
00161 * @param   InterruptMask contains the interrupts to be disabled
00162 *
00163 * @return  None.
00164 *
00165 * @note      Signature:
00166 *      void XIic_EnableIntr(u32 BaseAddress, u32 InterruptMask);
00167 *
00168 *****/
00169 #define XIic_EnableIntr(BaseAddress, InterruptMask) \
00170     XIic_WriteTier((BaseAddress), XIic_ReadTier(BaseAddress) | (InterruptMask))

```

```

00171
00172 /*****
00173  *
00174  * This macro clears the specified interrupt in the Interrupt status
00175  * register. It is non-destructive in that the register is read and only the
00176  * interrupt specified is cleared. Clearing an interrupt acknowledges it.
00177  *
00178  * @param   BaseAddress is the base address of the IIC device.
00179  * @param   InterruptMask contains the interrupts to be disabled
00180  *
00181  * @return  None.
00182  *
00183  * @note     Signature:
00184  *           void XIic_ClearIntr(u32 BaseAddress, u32 InterruptMask);
00185  *
00186  *****/
00187 #define XIic_ClearIntr(BaseAddress, InterruptMask) \
00188     XIic_WriteIisr((BaseAddress), XIic_ReadIisr(BaseAddress) & (~InterruptMask))
00189
00190 /*****
00191  *
00192  * This macro clears and enables the specified interrupt in the Interrupt
00193  * status and enable registers. It is non-destructive in that the registers are
00194  * read and only the interrupt specified is modified.
00195  * Clearing an interrupt acknowledges it.
00196  *
00197  * @param   BaseAddress is the base address of the IIC device.
00198  * @param   InterruptMask contains the interrupts to be cleared and enabled
00199  *
00200  * @return  None.
00201  *
00202  * @note     Signature:
00203  *           void XIic_ClearEnableIntr(u32 BaseAddress, u32 InterruptMask);
00204  *
00205  *****/
00206 #define XIic_ClearEnableIntr(BaseAddress, InterruptMask) \
00207 { \
00208     XIic_WriteIisr(BaseAddress, \
00209         (XIic_ReadIisr(BaseAddress) & (~InterruptMask))); \
00210 \
00211     XIic_WriteIier(BaseAddress, \
00212         (XIic_ReadIier(BaseAddress) | (InterruptMask))); \
00213 } \
00214
00215 /*****
00216  *
00217  * This macro flushes the receive FIFO such that all bytes contained within it
00218  * are discarded.
00219  *
00220  * @param   InstancePtr is a pointer to the IIC instance containing the FIFO
00221  *           to be flushed.
00222  *
00223  * @return  None.
00224  *
00225  * @note     Signature:
00226  *           void XIic_FlushRxFifo(XIic *InstancePtr);
00227  *
00228  *****/
00229 #define XIic_FlushRxFifo(InstancePtr) \
00230 { \
00231     int LoopCnt; \
00232     u8 BytesToRead = \
00233         XIic_ReadReg(InstancePtr->BaseAddress, XIIC_RFO_REG_OFFSET) + 1; \
00234     for (LoopCnt = 0; LoopCnt < BytesToRead; LoopCnt++) { \
00235         XIic_ReadReg(InstancePtr->BaseAddress, XIIC_DRR_REG_OFFSET); \
00236     } \
00237 } \
00238
00239 /*****
00240  *
00241  * This macro flushes the transmit FIFO such that all bytes contained within it
00242  * are discarded.
00243  *
00244  * @param   InstancePtr is a pointer to the IIC instance containing the FIFO
00245  *           to be flushed.
00246  *
00247  * @return  None.
00248  *
00249  * @note     Signature:
00250  *           void XIic_FlushTxFifo(XIic *InstancePtr);
00251  *
00252  *****/
00253 #define XIic_FlushTxFifo(InstancePtr) \
00254 ; \
00255 { \
00256     u32 CntlReg = XIic_ReadReg(InstancePtr->BaseAddress, XIIC_CR_REG_OFFSET); \
00257     XIic_WriteReg(InstancePtr->BaseAddress, XIIC_CR_REG_OFFSET,

```

```

00258         CntlReg | XIIC_CR_TX_FIFO_RESET_MASK);
00259     Xiic_WriteReg(InstancePtr->BaseAddress, XIIC_CR_REG_OFFSET, CntlReg);
00260 }
00261
00262 /*****
00263  *
00264  * This macro reads the next available received byte from the receive FIFO
00265  * and updates all the data structures to reflect it.
00266  *
00267  * @param InstancePtr is a pointer to the IIC instance to be operated on.
00268  *
00269  * @return None.
00270  *
00271  * @note Signature:
00272  *        void Xiic_ReadRecvByte(Xiic *InstancePtr);
00273  *
00274  *****/
00275 #define Xiic_ReadRecvByte(InstancePtr)
00276 {
00277     *InstancePtr->RecvBufferPtr++ =
00278         Xiic_ReadReg(InstancePtr->BaseAddress, XIIC_DRR_REG_OFFSET);
00279     InstancePtr->RecvByteCount--;
00280     InstancePtr->Stats.RecvBytes++;
00281 }
00282
00283 /*****
00284  *
00285  * This macro writes the next byte to be sent to the transmit FIFO
00286  * and updates all the data structures to reflect it.
00287  *
00288  * @param InstancePtr is a pointer to the IIC instance to be operated on.
00289  *
00290  * @return None.
00291  *
00292  * @note Signature:
00293  *        void Xiic_WriteSendByte(Xiic *InstancePtr);
00294  *
00295  *****/
00296 #define Xiic_WriteSendByte(InstancePtr)
00297 {
00298     Xiic_WriteReg(InstancePtr->BaseAddress, XIIC_DTR_REG_OFFSET,
00299         *InstancePtr->SendBufferPtr++);
00300     InstancePtr->SendByteCount--;
00301     InstancePtr->Stats.SendBytes++;
00302 }
00303
00304 /*****
00305  *
00306  * This macro sets up the control register for a master receive operation.
00307  * A write is necessary if a 10 bit operation is being performed.
00308  *
00309  * @param InstancePtr is a pointer to the IIC instance to be operated on.
00310  * @param ControlRegister contains the contents of the IIC device control
00311  *        register
00312  * @param ByteCount contains the number of bytes to be received for the
00313  *        master receive operation
00314  *
00315  * @return None.
00316  *
00317  * @note Signature:
00318  *        void Xiic_SetControlRegister(Xiic *InstancePtr,
00319  *                                     u8 ControlRegister,
00320  *                                     int ByteCount);
00321  *
00322  *****/
00323 #define Xiic_SetControlRegister(InstancePtr, ControlRegister, ByteCount)
00324 {
00325     (ControlRegister) &= ~(XIIC_CR_NO_ACK_MASK | XIIC_CR_DIR_IS_TX_MASK);
00326     if (InstancePtr->Options & XII_SEND_10_BIT_OPTION) {
00327         (ControlRegister) |= XIIC_CR_DIR_IS_TX_MASK;
00328     } else {
00329         if ((ByteCount) == 1) {
00330             (ControlRegister) |= XIIC_CR_NO_ACK_MASK;
00331         }
00332     }
00333 }
00334
00335 /***** Function Prototypes *****/
00336
00337 extern Xiic_Config Xiic_ConfigTable[];
00338
00339 /* The following variables are shared across files of the driver and
00340  * are function pointers that are necessary to break dependencies allowing
00341  * optional parts of the driver to be used without condition compilation
00342  */
00343 extern void (*Xiic_AddrAsSlaveFuncPtr)(Xiic *InstancePtr);
00344 extern void (*Xiic_NotAddrAsSlaveFuncPtr)(Xiic *InstancePtr);

```

```

00345 extern void (*XIic_RecvSlaveFuncPtr) (XIic *InstancePtr);
00346 extern void (*XIic_SendSlaveFuncPtr) (XIic *InstancePtr);
00347 extern void (*XIic_RecvMasterFuncPtr) (XIic *InstancePtr);
00348 extern void (*XIic_SendMasterFuncPtr) (XIic *InstancePtr);
00349 extern void (*XIic_ArbLostFuncPtr) (XIic *InstancePtr);
00350 extern void (*XIic_BusNotBusyFuncPtr) (XIic *InstancePtr);
00351
00352 void XIic_TransmitFifoFill(XIic *InstancePtr, int Role);
00353
00354 #ifdef __cplusplus
00355 }
00356 #endif
00357
00358 #endif /* end of protection macro */

```

6.128 library/xiic_l.h File Reference

```

#include "xil_io.h"
#include "xil_types.h"

```

Include dependency graph for xiic_l.h: This graph shows which files directly or indirectly include this file:

Macros

- #define [XIIC_L_H](#) /* by using protection macros */

Register Map

Register offsets for the Xlic device.

- #define [XIIC_DGIER_OFFSET](#) 0x1C
- #define [XIIC_IISR_OFFSET](#) 0x20
- #define [XIIC_IIER_OFFSET](#) 0x28
- #define [XIIC_RESETR_OFFSET](#) 0x40
- #define [XIIC_CR_REG_OFFSET](#) 0x100
- #define [XIIC_SR_REG_OFFSET](#) 0x104
- #define [XIIC_DTR_REG_OFFSET](#) 0x108
- #define [XIIC_DRR_REG_OFFSET](#) 0x10C
- #define [XIIC_ADR_REG_OFFSET](#) 0x110
- #define [XIIC_TFO_REG_OFFSET](#) 0x114
- #define [XIIC_RFO_REG_OFFSET](#) 0x118
- #define [XIIC_TBA_REG_OFFSET](#) 0x11C
- #define [XIIC_RFD_REG_OFFSET](#) 0x120
- #define [XIIC_GPO_REG_OFFSET](#) 0x124

Device Global Interrupt Enable Register masks (CR) mask(s)

- #define [XIIC_GINTR_ENABLE_MASK](#) 0x80000000

IIC Device Interrupt Status/Enable (INTR) Register Masks

Interrupt Status Register (IISR)

This register holds the interrupt status flags for the Spi device.

Interrupt Enable Register (IIER)

This register is used to enable interrupt sources for the IIC device. Writing a '1' to a bit in this register enables the corresponding Interrupt. Writing a '0' to a bit in this register disables the corresponding Interrupt.

IISR/IIER registers have the same bit definitions and are only defined once.

- #define [XIIC_INTR_ARB_LOST_MASK](#) 0x00000001
- #define [XIIC_INTR_TX_ERROR_MASK](#) 0x00000002

- #define [XIIC_INTR_TX_EMPTY_MASK](#) 0x00000004
- #define [XIIC_INTR_RX_FULL_MASK](#) 0x00000008
- #define [XIIC_INTR_BNB_MASK](#) 0x00000010
- #define [XIIC_INTR_AAS_MASK](#) 0x00000020
- #define [XIIC_INTR_NAAS_MASK](#) 0x00000040
- #define [XIIC_INTR_TX_HALF_MASK](#) 0x00000080
- #define [XIIC_TX_INTERRUPTS](#) ([XIIC_INTR_TX_ERROR_MASK](#) | [XIIC_INTR_TX_EMPTY_MASK](#) | [XIIC_INTR_TX_HALF_MASK](#))
- #define [XIIC_TX_RX_INTERRUPTS](#) ([XIIC_INTR_RX_FULL_MASK](#) | [XIIC_TX_INTERRUPTS](#))

Reset Register mask

- #define [XIIC_RESET_MASK](#) 0x0000000A

Control Register masks (CR) mask(s)

- #define [XIIC_CR_ENABLE_DEVICE_MASK](#) 0x00000001
- #define [XIIC_CR_TX_FIFO_RESET_MASK](#) 0x00000002
- #define [XIIC_CR_MSMS_MASK](#) 0x00000004
- #define [XIIC_CR_DIR_IS_TX_MASK](#) 0x00000008
- #define [XIIC_CR_NO_ACK_MASK](#) 0x00000010
- #define [XIIC_CR_REPEATED_START_MASK](#) 0x00000020
- #define [XIIC_CR_GENERAL_CALL_MASK](#) 0x00000040

Status Register masks (SR) mask(s)

- #define [XIIC_SR_GEN_CALL_MASK](#) 0x00000001
- #define [XIIC_SR_ADDR_AS_SLAVE_MASK](#) 0x00000002
- #define [XIIC_SR_BUS_BUSY_MASK](#) 0x00000004
- #define [XIIC_SR_MSTR_RDING_SLAVE_MASK](#) 0x00000008
- #define [XIIC_SR_TX_FIFO_FULL_MASK](#) 0x00000010
- #define [XIIC_SR_RX_FIFO_FULL_MASK](#) 0x00000020
- #define [XIIC_SR_RX_FIFO_EMPTY_MASK](#) 0x00000040
- #define [XIIC_SR_TX_FIFO_EMPTY_MASK](#) 0x00000080

Data Tx Register (DTR) mask(s)

- #define [XIIC_TX_DYN_START_MASK](#) 0x00000100
- #define [XIIC_TX_DYN_STOP_MASK](#) 0x00000200
- #define [IIC_TX_FIFO_DEPTH](#) 16

Data Rx Register (DRR) mask(s)

- #define [IIC_RX_FIFO_DEPTH](#) 16
- #define [XIIC_TX_ADDR_SENT](#) 0x00
- #define [XIIC_TX_ADDR_MSTR_RECV_MASK](#) 0x02
- #define [XIIC_READ_OPERATION](#) 1
- #define [XIIC_WRITE_OPERATION](#) 0
- #define [XIIC_MASTER_ROLE](#) 1
- #define [XIIC_SLAVE_ROLE](#) 0
- #define [XIIC_STOP](#) 0x00
- #define [XIIC_REPEATED_START](#) 0x01
- #define [Xlic_In32](#) Xil_In32
- #define [Xlic_Out32](#) Xil_Out32
- #define [Xlic_ReadReg](#)(BaseAddress, RegOffset) [Xlic_In32](#)((BaseAddress) + (RegOffset))

- `#define Xlic_WriteReg(BaseAddress, RegOffset, RegisterValue) Xlic_Out32((BaseAddress) + (RegOffset), (RegisterValue))`
- `#define Xlic_IntrGlobalDisable(BaseAddress) Xlic_WriteReg((BaseAddress), XIIC_DGIER_OFFSET, 0)`
- `#define Xlic_IntrGlobalEnable(BaseAddress) Xlic_WriteReg((BaseAddress), XIIC_DGIER_OFFSET, XIIC_GINTR_ENABLE_MASK)`
- `#define Xlic_IsIntrGlobalEnabled(BaseAddress) (Xlic_ReadReg((BaseAddress), XIIC_DGIER_OFFSET) == XIIC_GINTR_ENABLE_MASK)`
- `#define Xlic_Writelisr(BaseAddress, Status) Xlic_WriteReg((BaseAddress), XIIC_IISR_OFFSET, (Status))`
- `#define Xlic_Readlisr(BaseAddress) Xlic_ReadReg((BaseAddress), XIIC_IISR_OFFSET)`
- `#define Xlic_Writelier(BaseAddress, Enable) Xlic_WriteReg((BaseAddress), XIIC_IIER_OFFSET, (Enable))`
- `#define Xlic_Readlier(BaseAddress) Xlic_ReadReg((BaseAddress), XIIC_IIER_OFFSET)`
- `#define Xlic_Clearlisr(BaseAddress, InterruptMask) Xlic_Writelisr((BaseAddress), Xlic_Readlisr(BaseAddress) & (InterruptMask))`
- `#define Xlic_Send7BitAddress(BaseAddress, SlaveAddress, Operation)`
- `#define Xlic_DynSend7BitAddress(BaseAddress, SlaveAddress, Operation)`
- `#define Xlic_DynSendStartStopAddress(BaseAddress, SlaveAddress, Operation)`
- `#define Xlic_DynSendStop(BaseAddress, ByteCount)`
- `unsigned Xlic_Recv (UINTPTR BaseAddress, u8 Address, u8 *BufferPtr, unsigned ByteCount, u8 Option)`
- `unsigned Xlic_Send (UINTPTR BaseAddress, u8 Address, u8 *BufferPtr, unsigned ByteCount, u8 Option)`
- `unsigned Xlic_DynRecv (UINTPTR BaseAddress, u8 Address, u8 *BufferPtr, u8 ByteCount)`
- `unsigned Xlic_DynSend (UINTPTR BaseAddress, u16 Address, u8 *BufferPtr, u8 ByteCount, u8 Option)`
- `int Xlic_DynInit (UINTPTR BaseAddress)`
- `u32 Xlic_CheckIsBusBusy (UINTPTR BaseAddress)`
- `u32 Xlic_WaitBusFree (UINTPTR BaseAddress)`

6.128.1 Macro Definition Documentation

6.128.1.1 IIC_RX_FIFO_DEPTH

```
#define IIC_RX_FIFO_DEPTH 16
```

Rx fifo capacity

Definition at line 191 of file [xiic_l.h](#).

6.128.1.2 IIC_TX_FIFO_DEPTH

```
#define IIC_TX_FIFO_DEPTH 16
```

Tx fifo capacity

Definition at line 184 of file [xiic_l.h](#).

6.128.1.3 XIIC_ADR_REG_OFFSET

```
#define XIIC_ADR_REG_OFFSET 0x110
```

Address Register

Definition at line 86 of file [xiic_l.h](#).

6.128.1.4 Xlic_Clearlisr

```
#define XIic_ClearIisr(
    BaseAddress,
    InterruptMask ) Xlic_WriteIisr((BaseAddress), XIic_ReadIisr(BaseAddress) &
    (InterruptMask))
```

This macro clears the specified interrupt in the Interrupt status register. It is non-destructive in that the register is read and only the interrupt specified is cleared. Clearing an interrupt acknowledges it.

Parameters

<i>BaseAddress</i>	is the base address of the IIC device.
<i>InterruptMask</i>	is the bit mask of the interrupts to be cleared.

Returns

None.

Note

C-Style signature: void [Xlic_ClearIsr\(u32 BaseAddress, u32 InterruptMask\)](#);

Definition at line [432](#) of file [xiic_.h](#).

6.128.1.5 XIIC_CR_DIR_IS_TX_MASK

```
#define XIIC_CR_DIR_IS_TX_MASK 0x00000008
```

Dir of Tx. Txing=1

Definition at line [152](#) of file [xiic_.h](#).

6.128.1.6 XIIC_CR_ENABLE_DEVICE_MASK

```
#define XIIC_CR_ENABLE_DEVICE_MASK 0x00000001
```

Device enable = 1

Definition at line [149](#) of file [xiic_.h](#).

6.128.1.7 XIIC_CR_GENERAL_CALL_MASK

```
#define XIIC_CR_GENERAL_CALL_MASK 0x00000040
```

Gen Call enabled = 1

Definition at line [155](#) of file [xiic_.h](#).

6.128.1.8 XIIC_CR_MSMS_MASK

```
#define XIIC_CR_MSMS_MASK 0x00000004
```

Master starts Txing=1

Definition at line [151](#) of file [xiic_.h](#).

6.128.1.9 XIIC_CR_NO_ACK_MASK

```
#define XIIC_CR_NO_ACK_MASK 0x00000010
```

Tx Ack. NO ack = 1

Definition at line 153 of file [xiic_l.h](#).

6.128.1.10 XIIC_CR_REG_OFFSET

```
#define XIIC_CR_REG_OFFSET 0x100
```

Control Register

Definition at line 82 of file [xiic_l.h](#).

6.128.1.11 XIIC_CR_REPEATED_START_MASK

```
#define XIIC_CR_REPEATED_START_MASK 0x00000020
```

Repeated start = 1

Definition at line 154 of file [xiic_l.h](#).

6.128.1.12 XIIC_CR_TX_FIFO_RESET_MASK

```
#define XIIC_CR_TX_FIFO_RESET_MASK 0x00000002
```

Transmit FIFO reset=1

Definition at line 150 of file [xiic_l.h](#).

6.128.1.13 XIIC_DGIER_OFFSET

```
#define XIIC_DGIER_OFFSET 0x1C
```

Global Interrupt Enable Register

Definition at line 78 of file [xiic_l.h](#).

6.128.1.14 XIIC_DRR_REG_OFFSET

```
#define XIIC_DRR_REG_OFFSET 0x10C
```

Data Rx Register

Definition at line 85 of file [xiic_l.h](#).

6.128.1.15 XIIC_DTR_REG_OFFSET

```
#define XIIC_DTR_REG_OFFSET 0x108
```

Data Tx Register

Definition at line 84 of file [xiic_l.h](#).

6.128.1.16 Xlic_DynSend7BitAddress

```
#define XIic_DynSend7BitAddress(  
    BaseAddress,  
    SlaveAddress,  
    Operation )
```

Value:

```
{  
    u8 LocalAddr = (u8)(SlaveAddress << 1);  
    LocalAddr = (LocalAddr & 0xFE) | (Operation);  
    XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET,  
                  XIIC_TX_DYN_START_MASK | LocalAddr);  
}
```

This macro sends the address for a 7 bit address during both read and write operations. It takes care of the details to format the address correctly. This macro is designed to be called internally to the drivers for Dynamic controller functionality.

Parameters

<i>BaseAddress</i>	is the base address of the IIC Device.
<i>SlaveAddress</i>	is the address of the slave to send to.
<i>Operation</i>	indicates XIIC_READ_OPERATION or XIIC_WRITE_OPERATION.

Returns

None.

Note

C-Style signature: void [Xlic_DynSend7BitAddress\(u32 BaseAddress, u8 SlaveAddress, u8 Operation\)](#);

Definition at line 479 of file [xiic_l.h](#).

6.128.1.17 Xlic_DynSendStartStopAddress

```
#define XIic_DynSendStartStopAddress(  
    BaseAddress,  
    SlaveAddress,  
    Operation )
```

Value:

```
{  
    u8 LocalAddr = (u8)(SlaveAddress << 1);  
    LocalAddr = (LocalAddr & 0xFE) | (Operation);  
    XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET,  
                  XIIC_TX_DYN_START_MASK | XIIC_TX_DYN_STOP_MASK | LocalAddr);  
}
```

This macro sends the address, start and stop for a 7 bit address during both write operations. It takes care of the details to format the address correctly. This macro is designed to be called internally to the drivers.

Parameters

<i>BaseAddress</i>	is the base address of the IIC Device.
<i>SlaveAddress</i>	is the address of the slave to send to.
<i>Operation</i>	indicates XIIC_WRITE_OPERATION.

Returns

None.

Note

C-Style signature: void [Xlic_DynSendStartStopAddress\(u32 BaseAddress, u8 SlaveAddress, u8 Operation\)](#);

Definition at line [506](#) of file [xiic_l.h](#).

6.128.1.18 Xlic_DynSendStop

```
#define XIic_DynSendStop(
    BaseAddress,
    ByteCount )
```

Value:

```
{
    XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET,
                  XIIC_TX_DYN_STOP_MASK | ByteCount);
}
```

\\
\\
\\

This macro sends a stop condition on IIC bus for Dynamic logic.

Parameters

<i>BaseAddress</i>	is the base address of the IIC Device.
<i>ByteCount</i>	is the number of Rx bytes received before the master. doesn't respond with ACK.

Returns

None.

Note

C-Style signature: void [Xlic_DynSendStop\(u32 BaseAddress, u32 ByteCount\)](#);

Definition at line [529](#) of file [xiic_l.h](#).

6.128.1.19 XIIC_GINTR_ENABLE_MASK

```
#define XIIC_GINTR_ENABLE_MASK 0x80000000
```

Global Interrupt Enable Mask

Definition at line [98](#) of file [xiic_l.h](#).

6.128.1.20 XIIC_GPO_REG_OFFSET

```
#define XIIC_GPO_REG_OFFSET 0x124
```

Output Register

Definition at line 91 of file [xiic_l.h](#).

6.128.1.21 XIIC_IIER_OFFSET

```
#define XIIC_IIER_OFFSET 0x28
```

Interrupt Enable Register

Definition at line 80 of file [xiic_l.h](#).

6.128.1.22 XIIC_IISR_OFFSET

```
#define XIIC_IISR_OFFSET 0x20
```

Interrupt Status Register

Definition at line 79 of file [xiic_l.h](#).

6.128.1.23 Xlic_In32

```
#define XIic_In32 Xil_In32
```

Definition at line 225 of file [xiic_l.h](#).

6.128.1.24 XIIC_INTR_AAS_MASK

```
#define XIIC_INTR_AAS_MASK 0x00000020
```

1 = When addr as slave

Definition at line 121 of file [xiic_l.h](#).

6.128.1.25 XIIC_INTR_ARB_LOST_MASK

```
#define XIIC_INTR_ARB_LOST_MASK 0x00000001
```

1 = Arbitration lost

Definition at line 116 of file [xiic_l.h](#).

6.128.1.26 XIIC_INTR_BNB_MASK

```
#define XIIC_INTR_BNB_MASK 0x00000010
```

1 = Bus not busy

Definition at line 120 of file [xiic_l.h](#).

6.128.1.27 XIIC_INTR_NAAS_MASK

```
#define XIIC_INTR_NAAS_MASK 0x00000040
```

1 = Not addr as slave

Definition at line 122 of file [xiic_l.h](#).

6.128.1.28 XIIC_INTR_RX_FULL_MASK

```
#define XIIC_INTR_RX_FULL_MASK 0x00000008
```

1 = Rx FIFO/reg=OCY level

Definition at line 119 of file [xiic_l.h](#).

6.128.1.29 XIIC_INTR_TX_EMPTY_MASK

```
#define XIIC_INTR_TX_EMPTY_MASK 0x00000004
```

1 = Tx FIFO/reg empty

Definition at line 118 of file [xiic_l.h](#).

6.128.1.30 XIIC_INTR_TX_ERROR_MASK

```
#define XIIC_INTR_TX_ERROR_MASK 0x00000002
```

1 = Tx error/msg complete

Definition at line 117 of file [xiic_l.h](#).

6.128.1.31 XIIC_INTR_TX_HALF_MASK

```
#define XIIC_INTR_TX_HALF_MASK 0x00000080
```

1 = Tx FIFO half empty

Definition at line 123 of file [xiic_l.h](#).

6.128.1.32 Xlic_IntrGlobalDisable

```
#define XIic_IntrGlobalDisable(  
    BaseAddress ) XIic_WriteReg((BaseAddress), XIIC_DGIER_OFFSET, 0)
```

This macro disables all interrupts for the device by writing to the Global interrupt enable register.

Parameters

<i>BaseAddress</i>	is the base address of the IIC device.
--------------------	----------------------------------------

Returns

None.

Note

C-Style signature: void [Xlic_IntrGlobalDisable\(u32 BaseAddress\)](#);

Definition at line 287 of file [xiic_l.h](#).

6.128.1.33 Xlic_IntrGlobalEnable

```
#define XIic_IntrGlobalEnable(  
    BaseAddress )  XIic_WriteReg((BaseAddress), XIIC_DGIER_OFFSET, XIIC_GINTR_ENABLE_MASK)
```

This macro writes to the global interrupt enable register to enable interrupts from the device. This function does not enable individual interrupts as the Interrupt Enable Register must be set appropriately.

Parameters

<i>BaseAddress</i>	is the base address of the IIC device.
--------------------	----------------------------------------

Returns

None.

Note

C-Style signature: void [Xlic_IntrGlobalEnable\(u32 BaseAddress\)](#);

Definition at line 305 of file [xiic_l.h](#).

6.128.1.34 Xlic_IsIntrGlobalEnabled

```
#define XIic_IsIntrGlobalEnabled(  
    BaseAddress )  (XIic_ReadReg((BaseAddress), XIIC_DGIER_OFFSET) == XIIC_GINTR_ENABLE_MASK)
```

This function determines if interrupts are enabled at the global level by reading the global interrupt register.

Parameters

<i>BaseAddress</i>	is the base address of the IIC device.
--------------------	----------------------------------------

Returns

- TRUE if the global interrupt is enabled.
- FALSE if global interrupt is disabled.

Note

C-Style signature: int [Xlic_IsIntrGlobalEnabled\(u32 BaseAddress\)](#);

Definition at line 324 of file [xiic_l.h](#).

6.128.1.35 XIIC_L_H

```
#define XIIC_L_H /* by using protection macros */
```

This header file contains identifiers and driver functions (or macros) that can be used to access the device in normal and dynamic controller mode. High-level driver functions are defined in [xiic.h](#).

MODIFICATION HISTORY:

Ver	Who	Date	Changes
-----	----	-----	-----
1.00b	jhl	05/07/02	First release
1.01c	ecm	12/05/02	new rev
1.01d	jhl	10/08/03	Added general purpose output feature
1.02a	mta	03/09/06	Implemented Repeated Start in the Low Level Driver.
1.03a	mta	04/04/06	Implemented Dynamic IIC core routines.
1.03a	rpm	09/08/06	Added include of xstatus.h for completeness
1.13a	wgr	03/22/07	Converted to new coding style.
1.16a	ktn	07/18/09	Updated the notes in XIIC_RESET macro to clearly indicate that only the Interrupt Registers are reset.
1.16a	ktn	10/16/09	Updated the notes in the XIIC_RESET macro to mention that the complete IIC core is Reset on giving a software reset to the IIC core. Some previous versions of the core only reset the Interrupt Logic/Registers, please refer to the HW specification for further details.
2.00a	sdm	10/22/09	Converted all register accesses to 32 bit access, the register offsets are defined to be on 32 bit boundary. Removed the macro XIIC_RESET, XIic_Reset API should be used in its place. Some of the macros have been renamed to be consistent - XIIC_GINTR_DISABLE is renamed as XIic_IntrGlobalDisable, XIIC_GINTR_ENABLE is renamed as XIic_IntrGlobalEnable, XIIC_IS_GINTR_ENABLED is renamed as XIic_IsIntrGlobalEnabled, XIIC_WRITE_IISR is renamed as XIic_WriteIisr, XIIC_READ_IISR is renamed as XIic_ReadIisr, XIIC_WRITE_IIER is renamed as XIic_WriteIier The _m prefix in the name of the macros has been removed - XIic_mClearIisr is now XIic_ClearIisr, XIic_mSend7BitAddress is now XIic_Send7BitAddress, XIic_mDynSend7BitAddress is now XIic_DynSend7BitAddress, XIic_mDynSendStartStopAddress is now XIic_DynSendStartStopAddress, XIic_mDynSendStop is now XIic_DynSendStop.
3.2	sk	11/10/15	Used UINTPTR instead of u32 for Baseaddress CR# 867425. Changed the prototypes of XIic_Recv, XIic_Send, XIic_DynRecv, XIic_DynSend and XIic_DynInit APIs.
3.3	als	06/27/16	Added Low-level XIic_CheckIsBusBusy API.
3.3	als	06/27/16	Added low-level XIic_WaitBusFree API.

Definition at line 61 of file [xiic_l.h](#).

6.128.1.36 XIIC_MASTER_ROLE

```
#define XIIC_MASTER_ROLE 1
```

The following constants are used with the transmit FIFO fill function to specify the role which the IIC device is acting as, a master or a slave. Master on the IIC bus

Definition at line 208 of file [xiic_l.h](#).

6.128.1.37 Xlic_Out32

```
#define XIic_Out32 Xil_Out32
```

Definition at line 226 of file [xiic_l.h](#).

6.128.1.38 XIIC_READ_OPERATION

```
#define XIIC_READ_OPERATION 1
```

The following constants are used to specify whether to do Read or a Write operation on IIC bus. Read operation on the IIC bus

Definition at line 201 of file [xiic_l.h](#).

6.128.1.39 Xlic_ReadIier

```
#define XIic_ReadIier(  
    BaseAddress ) XIic_ReadReg((BaseAddress), XIIC_IIER_OFFSET)
```

This function gets the Interrupt Enable Register contents.

Parameters

<i>BaseAddress</i>	is the base address of the IIC device.
--------------------	----------------------------------------

Returns

The contents read from the Interrupt Enable Register. Bit positions of 1 indicate that the corresponding interrupt is enabled. Bit positions of 0 indicate that the corresponding interrupt is disabled.

Note

C-Style signature: u32 [Xlic_ReadIier](#)(u32 [BaseAddress](#))

Definition at line 414 of file [xiic_l.h](#).

6.128.1.40 Xlic_ReadIisr

```
#define XIic_ReadIisr(  
    BaseAddress ) XIic_ReadReg((BaseAddress), XIIC_IISR_OFFSET)
```

This function gets the contents of the Interrupt Status Register. This register indicates the status of interrupt sources for the device. The status is independent of whether interrupts are enabled such that the status register may also be polled when interrupts are not enabled.

Parameters

<i>BaseAddress</i>	is the base address of the IIC device.
--------------------	----------------------------------------

Returns

The value read from the Interrupt Status Register.

Note

C-Style signature: u32 [Xlic_ReadIisr\(u32 BaseAddress\)](#);

Definition at line [371](#) of file [xiic_l.h](#).

6.128.1.41 Xlic_ReadReg

```
#define XIic_ReadReg(  
    BaseAddress,  
    RegOffset ) XIic_In32((BaseAddress) + (RegOffset))
```

Read from the specified IIC device register.

Parameters

<i>BaseAddress</i>	is the base address of the device.
<i>RegOffset</i>	is the offset from the 1st register of the device to select the specific register.

Returns

The value read from the register.

Note

C-Style signature: u32 [Xlic_ReadReg\(u32 BaseAddress, u32 RegOffset\)](#);

This macro does not do any checking to ensure that the

register exists if the register may be excluded due to parameterization, such as the GPO Register.

Definition at line [247](#) of file [xiic_l.h](#).

6.128.1.42 XIIC_REPEATED_START

```
#define XIIC_REPEATED_START 0x01
```

Donot Send a stop on the IIC bus after \ the current data transfer

Definition at line 221 of file [xiic_.h](#).

6.128.1.43 XIIC_RESET_MASK

```
#define XIIC_RESET_MASK 0x0000000A
```

RESET Mask

Definition at line 142 of file [xiic_.h](#).

6.128.1.44 XIIC_RESETR_OFFSET

```
#define XIIC_RESETR_OFFSET 0x40
```

Reset Register

Definition at line 81 of file [xiic_.h](#).

6.128.1.45 XIIC_RFD_REG_OFFSET

```
#define XIIC_RFD_REG_OFFSET 0x120
```

Rx FIFO Depth reg

Definition at line 90 of file [xiic_.h](#).

6.128.1.46 XIIC_RFO_REG_OFFSET

```
#define XIIC_RFO_REG_OFFSET 0x118
```

Rx FIFO Occupancy

Definition at line 88 of file [xiic_.h](#).

6.128.1.47 XIic_Send7BitAddress

```
#define XIic_Send7BitAddress(  
    BaseAddress,  
    SlaveAddress,  
    Operation )
```

Value:

```
{  
    u8 LocalAddr = (u8)(SlaveAddress << 1);  
    LocalAddr = (LocalAddr & 0xFE) | (Operation);  
    XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET, LocalAddr);  
}
```

This macro sends the address for a 7 bit address during both read and write operations. It takes care of the details to format the address correctly. This macro is designed to be called internally to the drivers.

Parameters

<i>BaseAddress</i>	is the base address of the IIC Device.
<i>SlaveAddress</i>	is the address of the slave to send to.
<i>Operation</i>	indicates XIIC_READ_OPERATION or XIIC_WRITE_OPERATION

Returns

None.

Note

C-Style signature: void [Xlic_Send7BitAddress\(u32 BaseAddress, u8 SlaveAddress, u8 Operation\)](#);

Definition at line [453](#) of file [xiic_l.h](#).

6.128.1.48 XIIC_SLAVE_ROLE

```
#define XIIC_SLAVE_ROLE 0
```

Slave on the IIC bus

Definition at line [209](#) of file [xiic_l.h](#).

6.128.1.49 XIIC_SR_ADDR_AS_SLAVE_MASK

```
#define XIIC_SR_ADDR_AS_SLAVE_MASK 0x00000002
```

1 = When addressed as \ slave

Definition at line [167](#) of file [xiic_l.h](#).

6.128.1.50 XIIC_SR_BUS_BUSY_MASK

```
#define XIIC_SR_BUS_BUSY_MASK 0x00000004
```

1 = Bus is busy

Definition at line [168](#) of file [xiic_l.h](#).

6.128.1.51 XIIC_SR_GEN_CALL_MASK

```
#define XIIC_SR_GEN_CALL_MASK 0x00000001
```

1 = A Master issued \ a GC

Definition at line [164](#) of file [xiic_l.h](#).

6.128.1.52 XIIC_SR_MSTR_RDING_SLAVE_MASK

```
#define XIIC_SR_MSTR_RDING_SLAVE_MASK 0x00000008
```

1 = Dir: Master <- \ slave

Definition at line 171 of file [xiic_l.h](#).

6.128.1.53 XIIC_SR_REG_OFFSET

```
#define XIIC_SR_REG_OFFSET 0x104
```

Status Register

Definition at line 83 of file [xiic_l.h](#).

6.128.1.54 XIIC_SR_RX_FIFO_EMPTY_MASK

```
#define XIIC_SR_RX_FIFO_EMPTY_MASK 0x00000040
```

1 = Rx FIFO empty

Definition at line 174 of file [xiic_l.h](#).

6.128.1.55 XIIC_SR_RX_FIFO_FULL_MASK

```
#define XIIC_SR_RX_FIFO_FULL_MASK 0x00000020
```

1 = Rx FIFO full

Definition at line 173 of file [xiic_l.h](#).

6.128.1.56 XIIC_SR_TX_FIFO_EMPTY_MASK

```
#define XIIC_SR_TX_FIFO_EMPTY_MASK 0x00000080
```

1 = Tx FIFO empty

Definition at line 175 of file [xiic_l.h](#).

6.128.1.57 XIIC_SR_TX_FIFO_FULL_MASK

```
#define XIIC_SR_TX_FIFO_FULL_MASK 0x00000010
```

1 = Tx FIFO full

Definition at line 172 of file [xiic_l.h](#).

6.128.1.58 XIIC_STOP

```
#define XIIC_STOP 0x00
```

The following constants are used with Transmit Function (Xlic_Send) to specify whether to STOP after the current transfer of data or own the bus with a Repeated start. Send a stop on the IIC bus after \ the current data transfer

Definition at line 218 of file [xiic_l.h](#).

6.128.1.59 XIIC_TBA_REG_OFFSET

```
#define XIIC_TBA_REG_OFFSET 0x11C
```

10 Bit Address reg

Definition at line 89 of file [xiic_l.h](#).

6.128.1.60 XIIC_TFO_REG_OFFSET

```
#define XIIC_TFO_REG_OFFSET 0x114
```

Tx FIFO Occupancy

Definition at line 87 of file [xiic_l.h](#).

6.128.1.61 XIIC_TX_ADDR_MSTR_RECV_MASK

```
#define XIIC_TX_ADDR_MSTR_RECV_MASK 0x02
```

Definition at line 195 of file [xiic_l.h](#).

6.128.1.62 XIIC_TX_ADDR_SENT

```
#define XIIC_TX_ADDR_SENT 0x00
```

Definition at line 194 of file [xiic_l.h](#).

6.128.1.63 XIIC_TX_DYN_START_MASK

```
#define XIIC_TX_DYN_START_MASK 0x00000100
```

1 = Set dynamic start

Definition at line 182 of file [xiic_l.h](#).

6.128.1.64 XIIC_TX_DYN_STOP_MASK

```
#define XIIC_TX_DYN_STOP_MASK 0x00000200
```

1 = Set dynamic stop

Definition at line 183 of file [xiic_l.h](#).

6.128.1.65 XIIC_TX_INTERRUPTS

```
#define XIIC_TX_INTERRUPTS (XIIC_INTR_TX_ERROR_MASK | XIIC_INTR_TX_EMPTY_MASK | XIIC_INTR_TX_HALF_MASK)
```

All Tx interrupts commonly used.

Definition at line 128 of file [xiic_l.h](#).

6.128.1.66 XIIC_TX_RX_INTERRUPTS

```
#define XIIC_TX_RX_INTERRUPTS (XIIC_INTR_RX_FULL_MASK | XIIC_TX_INTERRUPTS)
```

All interrupts commonly used

Definition at line 134 of file [xiic_l.h](#).

6.128.1.67 XIIC_WRITE_OPERATION

```
#define XIIC_WRITE_OPERATION 0
```

Write operation on the IIC bus

Definition at line 202 of file [xiic_l.h](#).

6.128.1.68 XIic_Writelier

```
#define XIic_WriteIier(  
    BaseAddress,  
    Enable ) XIic_WriteReg((BaseAddress), XIIC_IIER_OFFSET, (Enable))
```

This function sets the contents of the Interrupt Enable Register.

This function writes only the specified value to the register such that some interrupt sources may be enabled and others disabled. It is the caller's responsibility to get the value of the interrupt enable register prior to setting the value to prevent a destructive behavior.

Parameters

<i>BaseAddress</i>	is the base address of the IIC device.
<i>Enable</i>	is the value to be written to the Interrupt Enable Register. Bit positions of 1 will be enabled. Bit positions of 0 will be disabled.

Returns

None

Note

C-Style signature: void [Xlic_Writelier\(u32 BaseAddress, u32 Enable\)](#);

Definition at line [394](#) of file [xiic_l.h](#).

6.128.1.69 Xlic_Writelisr

```
#define XIic_WriteIisr(  
    BaseAddress,  
    Status )   XIic\_WriteReg((BaseAddress), XIIC\_IISR\_OFFSET, (Status))
```

This function sets the Interrupt status register to the specified value.

This register implements a toggle on write functionality. The interrupt is cleared by writing to this register with the bits to be cleared set to a one and all others to zero. Setting a bit which is zero within this register causes an interrupt to be generated.

This function writes only the specified value to the register such that some status bits may be set and others cleared. It is the caller's responsibility to get the value of the register prior to setting the value to prevent an destructive behavior.

Parameters

<i>BaseAddress</i>	is the base address of the IIC device.
<i>Status</i>	is the value to be written to the Interrupt status register.

Returns

None.

Note

C-Style signature: void [Xlic_Writelisr\(u32 BaseAddress, u32 Status\)](#);

Definition at line [352](#) of file [xiic_l.h](#).

6.128.1.70 Xlic_WriteReg

```
#define XIic_WriteReg(  
    BaseAddress,  
    RegOffset,  
    RegisterValue )   XIic\_Out32((BaseAddress) + (RegOffset), (RegisterValue))
```

Write to the specified IIC device register.

Parameters

<i>BaseAddress</i>	is the base address of the device.
<i>RegOffset</i>	is the offset from the 1st register of the device to select the specific register.
<i>RegisterValue</i>	is the value to be written to the register.

Returns

None.

Note

C-Style signature: void [Xlic_WriteReg\(u32 BaseAddress, u32 RegOffset, u32 RegisterValue\)](#); This macro does not do any checking to ensure that the register exists if the register may be excluded due to parameterization, such as the GPO Register.

Definition at line [270](#) of file [xiic_l.h](#).

6.128.2 Function Documentation

6.128.2.1 Xlic_CheckIsBusBusy()

```
u32 XIic_CheckIsBusBusy (
    UINTPTR BaseAddress )
```

Definition at line [11](#) of file [xiic_l.c](#).

Here is the caller graph for this function:

6.128.2.2 Xlic_DynInit()

```
int XIic_DynInit (
    UINTPTR BaseAddress )
```

Definition at line [10](#) of file [xiic_l.c](#).

6.128.2.3 Xlic_DynRecv()

```
unsigned XIic_DynRecv (
    UINTPTR BaseAddress,
    u8 Address,
    u8 * BufferPtr,
    u8 ByteCount )
```

Definition at line [6](#) of file [xiic_l.c](#).

6.128.2.4 Xlic_DynSend()

```
unsigned XIic_DynSend (
    UINTPTR BaseAddress,
    u16 Address,
    u8 * BufferPtr,
    u8 ByteCount,
    u8 Option )
```

Definition at line 8 of file [xiic_l.c](#).

6.128.2.5 Xlic_Recv()

```
unsigned XIic_Recv (
    UINTPTR BaseAddress,
    u8 Address,
    u8 * BufferPtr,
    unsigned ByteCount,
    u8 Option )
```

Receive data as a master on the IIC bus. This function receives the data using polled I/O and blocks until the data has been received. It only supports 7 bit addressing mode of operation. This function returns zero if bus is busy.

Parameters

<i>BaseAddress</i>	contains the base address of the IIC device.
<i>Address</i>	contains the 7 bit IIC address of the device to send the specified data to.
<i>BufferPtr</i>	points to the data to be sent.
<i>ByteCount</i>	is the number of bytes to be sent.
<i>Option</i>	indicates whether to hold or free the bus after reception of data, XIIC_STOP = end with STOP condition, XIIC_REPEATED_START = don't end with STOP condition.

Returns

The number of bytes received.

Note

None.

Definition at line 2 of file [xiic_l.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.128.2.6 Xlic_Send()

```
unsigned XIic_Send (
    UINTPTR BaseAddress,
    u8 Address,
    u8 * BufferPtr,
    unsigned ByteCount,
    u8 Option )
```

Send data as a master on the IIC bus. This function sends the data using polled I/O and blocks until the data has been sent. It only supports 7 bit addressing mode of operation. This function returns zero if bus is busy.

Parameters

<i>BaseAddress</i>	contains the base address of the IIC device.
<i>Address</i>	contains the 7 bit IIC address of the device to send the specified data to.
<i>BufferPtr</i>	points to the data to be sent.
<i>ByteCount</i>	is the number of bytes to be sent.
<i>Option</i>	indicates whether to hold or free the bus after transmitting the data.

Returns

The number of bytes sent.

Note

None.

Definition at line 4 of file [xiic_.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.128.2.7 Xlic_WaitBusFree()

```
u32 XIic_WaitBusFree (
    UINTPTR BaseAddress )
```

This function will wait until the I2C bus is free or timeout.

Parameters

<i>BaseAddress</i>	contains the base address of the I2C device.
--------------------	----------------------------------------------

Returns

- XST_SUCCESS if the I2C bus was freed before the timeout.
- XST_FAILURE otherwise.

Note

None.

Definition at line 12 of file [xiic_.c](#).

Here is the call graph for this function: Here is the caller graph for this function:

6.129 xiic_l.h

[Go to the documentation of this file.](#)

```

00001 /*****
00002  * Copyright (C) 2002 - 2021 Xilinx, Inc. All rights reserved.
00003  * SPDX-License-Identifier: MIT
00004  *****/
00005
00006 /*****
00060 #ifndef XIIC_L_H /* prevent circular inclusions */
00061 #define XIIC_L_H /* by using protection macros */
00062
00063 #ifdef __cplusplus
00064 extern "C" {
00065 #endif
00066
00067 /***** Include Files *****/
00068
00069 #include "xil_io.h"
00070 #include "xil_types.h"
00071
00072 /***** Constant Definitions *****/
00073
00078 #define XIIC_DGIER_OFFSET 0x1C
00079 #define XIIC_IISR_OFFSET 0x20
00080 #define XIIC_IIER_OFFSET 0x28
00081 #define XIIC_RESETR_OFFSET 0x40
00082 #define XIIC_CR_REG_OFFSET 0x100
00083 #define XIIC_SR_REG_OFFSET 0x104
00084 #define XIIC_DTR_REG_OFFSET 0x108
00085 #define XIIC_DRR_REG_OFFSET 0x10C
00086 #define XIIC_ADR_REG_OFFSET 0x110
00087 #define XIIC_TFO_REG_OFFSET 0x114
00088 #define XIIC_RFO_REG_OFFSET 0x118
00089 #define XIIC_TBA_REG_OFFSET 0x11C
00090 #define XIIC_RFD_REG_OFFSET 0x120
00091 #define XIIC_GPO_REG_OFFSET 0x124
00092 /* @} */
00093
00098 #define XIIC_GINTR_ENABLE_MASK 0x80000000
00099 /* @} */
00100
00116 #define XIIC_INTR_ARB_LOST_MASK 0x00000001
00117 #define XIIC_INTR_TX_ERROR_MASK 0x00000002
00118 #define XIIC_INTR_TX_EMPTY_MASK 0x00000004
00119 #define XIIC_INTR_RX_FULL_MASK 0x00000008
00120 #define XIIC_INTR_BNB_MASK 0x00000010
00121 #define XIIC_INTR_AAS_MASK 0x00000020
00122 #define XIIC_INTR_NAAS_MASK 0x00000040
00123 #define XIIC_INTR_TX_HALF_MASK 0x00000080
00128 #define XIIC_TX_INTERRUPTS \
00129     (XIIC_INTR_TX_ERROR_MASK | XIIC_INTR_TX_EMPTY_MASK | XIIC_INTR_TX_HALF_MASK)
00130
00134 #define XIIC_TX_RX_INTERRUPTS (XIIC_INTR_RX_FULL_MASK | XIIC_TX_INTERRUPTS)
00135
00136 /* @} */
00137
00142 #define XIIC_RESET_MASK 0x0000000A
00143 /* @} */
00144
00149 #define XIIC_CR_ENABLE_DEVICE_MASK 0x00000001
00150 #define XIIC_CR_TX_FIFO_RESET_MASK 0x00000002
00151 #define XIIC_CR_MSMS_MASK 0x00000004
00152 #define XIIC_CR_DIR_IS_TX_MASK 0x00000008
00153 #define XIIC_CR_NO_ACK_MASK 0x00000010
00154 #define XIIC_CR_REPEATED_START_MASK 0x00000020
00155 #define XIIC_CR_GENERAL_CALL_MASK 0x00000040
00156 /* @} */
00157
00162 #define XIIC_SR_GEN_CALL_MASK \
00163     0x00000001
00165 #define XIIC_SR_ADDR_AS_SLAVE_MASK \
00166     0x00000002
00168 #define XIIC_SR_BUS_BUSY_MASK 0x00000004
00169 #define XIIC_SR_MSTR_RDING_SLAVE_MASK \
00170     0x00000008
00172 #define XIIC_SR_TX_FIFO_FULL_MASK 0x00000010
00173 #define XIIC_SR_RX_FIFO_FULL_MASK 0x00000020
00174 #define XIIC_SR_RX_FIFO_EMPTY_MASK 0x00000040
00175 #define XIIC_SR_TX_FIFO_EMPTY_MASK 0x00000080
00176 /* @} */
00177
00182 #define XIIC_TX_DYN_START_MASK 0x00000100
00183 #define XIIC_TX_DYN_STOP_MASK 0x00000200
00184 #define XIIC_TX_FIFO_DEPTH 16

```

```

00185 /* @} */
00186
00191 #define IIC_RX_FIFO_DEPTH 16
00192 /* @} */
00193
00194 #define XIIC_TX_ADDR_SENT 0x00
00195 #define XIIC_TX_ADDR_MSTR_RECV_MASK 0x02
00196
00201 #define XIIC_READ_OPERATION 1
00202 #define XIIC_WRITE_OPERATION 0
00208 #define XIIC_MASTER_ROLE 1
00209 #define XIIC_SLAVE_ROLE 0
00216 #define XIIC_STOP \
00217     0x00
00219 #define XIIC_REPEATED_START \
00220     0x01
00223 /***** Macros (Inline Functions) Definitions *****/
00224
00225 #define XIic_In32 Xil_In32
00226 #define XIic_Out32 Xil_Out32
00227
00228 /*****/
00247 #define XIic_ReadReg(BaseAddress, RegOffset) \
00248     XIic_In32((BaseAddress) + (RegOffset))
00249
00250 /*****/
00270 #define XIic_WriteReg(BaseAddress, RegOffset, RegisterValue) \
00271     XIic_Out32((BaseAddress) + (RegOffset), (RegisterValue))
00272
00273 /*****/
00287 #define XIic_IntrGlobalDisable(BaseAddress) \
00288     XIic_WriteReg((BaseAddress), XIIC_DGIER_OFFSET, 0)
00289
00290 /*****/
00305 #define XIic_IntrGlobalEnable(BaseAddress) \
00306     XIic_WriteReg((BaseAddress), XIIC_DGIER_OFFSET, XIIC_GINTR_ENABLE_MASK)
00307
00308 /*****/
00324 #define XIic_IsIntrGlobalEnabled(BaseAddress) \
00325     (XIic_ReadReg((BaseAddress), XIIC_DGIER_OFFSET) == XIIC_GINTR_ENABLE_MASK)
00326
00327 /*****/
00352 #define XIic_WriteIISR(BaseAddress, Status) \
00353     XIic_WriteReg((BaseAddress), XIIC_IISR_OFFSET, (Status))
00354
00355 /*****/
00371 #define XIic_ReadIISR(BaseAddress) XIic_ReadReg((BaseAddress), XIIC_IISR_OFFSET)
00372
00373 /*****/
00394 #define XIic_WriteIier(BaseAddress, Enable) \
00395     XIic_WriteReg((BaseAddress), XIIC_IIER_OFFSET, (Enable))
00396
00397 /*****/
00414 #define XIic_ReadIier(BaseAddress) XIic_ReadReg((BaseAddress), XIIC_IIER_OFFSET)
00415
00416 /*****/
00432 #define XIic_ClearIISR(BaseAddress, InterruptMask) \
00433     XIic_WriteIISR((BaseAddress), XIic_ReadIISR(BaseAddress) & (InterruptMask))
00434
00435 /*****/
00453 #define XIic_Send7BitAddress(BaseAddress, SlaveAddress, Operation) \
00454     { \
00455         u8 LocalAddr = (u8)(SlaveAddress < 1); \
00456         LocalAddr = (LocalAddr & 0xFE) | (Operation); \
00457         XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET, LocalAddr); \
00458     } \
00459
00460 /*****/
00479 #define XIic_DynSend7BitAddress(BaseAddress, SlaveAddress, Operation) \
00480     { \
00481         u8 LocalAddr = (u8)(SlaveAddress < 1); \
00482         LocalAddr = (LocalAddr & 0xFE) | (Operation); \
00483         XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET, \
00484             XIIC_TX_DYN_START_MASK | LocalAddr); \
00485     } \
00486
00487 /*****/
00506 #define XIic_DynSendStartStopAddress(BaseAddress, SlaveAddress, Operation) \
00507     { \
00508         u8 LocalAddr = (u8)(SlaveAddress < 1); \
00509         LocalAddr = (LocalAddr & 0xFE) | (Operation); \
00510         XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET, \
00511             XIIC_TX_DYN_START_MASK | XIIC_TX_DYN_STOP_MASK | LocalAddr); \
00512     } \
00513
00514 /*****/
00529 #define XIic_DynSendStop(BaseAddress, ByteCount) \

```

```

00530 {
00531     XIic_WriteReg(BaseAddress, XIIC_DTR_REG_OFFSET,
00532                 XIIC_TX_DYN_STOP_MASK | ByteCount);
00533 }
00534
00535 /***** Function Prototypes *****/
00536
00537 unsigned XIic_Recv(UINTPTR BaseAddress, u8 Address, u8 *BufferPtr,
00538                 unsigned ByteCount, u8 Option);
00539
00540 unsigned XIic_Send(UINTPTR BaseAddress, u8 Address, u8 *BufferPtr,
00541                 unsigned ByteCount, u8 Option);
00542
00543 unsigned XIic_DynRecv(UINTPTR BaseAddress, u8 Address, u8 *BufferPtr,
00544                 u8 ByteCount);
00545
00546 unsigned XIic_DynSend(UINTPTR BaseAddress, u16 Address, u8 *BufferPtr,
00547                 u8 ByteCount, u8 Option);
00548
00549 int XIic_DynInit(UINTPTR BaseAddress);
00550
00551 u32 XIic_CheckIsBusBusy(UINTPTR BaseAddress);
00552
00553 u32 XIic_WaitBusFree(UINTPTR BaseAddress);
00554
00555 #ifdef __cplusplus
00556 }
00557 #endif
00558
00559 #endif /* end of protection macro */

```

6.130 library/xil_io.h File Reference

#include "xil_types.h"

Include dependency graph for xil_io.h: This graph shows which files directly or indirectly include this file:

Macros

- #define [XIL_IO_H](#) /* by using protection macros */
- #define [SYNCHRONIZE_IO](#)
- #define [INST_SYNC](#)
- #define [DATA_SYNC](#)
- #define [INST_SYNC](#)
- #define [DATA_SYNC](#)
- #define [INLINE](#) __inline
- #define [Xil_In16LE](#) Xil_In16
- #define [Xil_In32LE](#) Xil_In32
- #define [Xil_Out16LE](#) Xil_Out16
- #define [Xil_Out32LE](#) Xil_Out32
- #define [Xil_Htons](#) Xil_EndianSwap16
- #define [Xil_Htonl](#) Xil_EndianSwap32
- #define [Xil_Ntohs](#) Xil_EndianSwap16
- #define [Xil_Ntohl](#) Xil_EndianSwap32

6.130.1 Macro Definition Documentation

6.130.1.1 [DATA_SYNC](#) [1/2]

```
#define DATA_SYNC
```

Definition at line 64 of file [xil_io.h](#).

6.130.1.2 DATA_SYNC [2/2]

```
#define DATA_SYNC
```

Definition at line 64 of file [xil_io.h](#).

6.130.1.3 INLINE

```
#define INLINE __inline
```

Definition at line 72 of file [xil_io.h](#).

6.130.1.4 INST_SYNC [1/2]

```
#define INST_SYNC
```

Definition at line 63 of file [xil_io.h](#).

6.130.1.5 INST_SYNC [2/2]

```
#define INST_SYNC
```

Definition at line 63 of file [xil_io.h](#).

6.130.1.6 SYNCHRONIZE_IO

```
#define SYNCHRONIZE_IO
```

Definition at line 62 of file [xil_io.h](#).

6.130.1.7 Xil_Htonl

```
#define Xil_Htonl Xil_EndianSwap32
```

Definition at line 315 of file [xil_io.h](#).

6.130.1.8 Xil_Htons

```
#define Xil_Htons Xil_EndianSwap16
```

Definition at line 314 of file [xil_io.h](#).

6.130.1.9 Xil_In16LE

```
#define Xil_In16LE Xil_In16
```

Definition at line 310 of file [xil_io.h](#).

6.130.1.10 Xil_In32LE

```
#define Xil_In32LE Xil_In32
```

Definition at line 311 of file [xil_io.h](#).

6.130.1.11 XIL_IO_H

```
#define XIL_IO_H /* by using protection macros */
```

The [xil_io.h](#) file contains the interface for the general I/O component, which encapsulates the Input/Output functions for the processors that do not require any special I/O handling.

MODIFICATION HISTORY:

Ver	Who	Date	Changes
5.00	pkp	05/29/14	First release
6.00	mus	08/19/16	Remove checking of <code>__LITTLE_ENDIAN__</code> flag for ARM processors
7.20	har	01/03/20	Added Xil_SecureOut32 for avoiding blindwrite for CR-1049218
7.30	kpt	09/21/20	Moved Xil_EndianSwap16 and Xil_EndianSwap32 to xil_io.h and made them as static inline
	am	10/13/20	Changed the return type of Xil_SecureOut32 function from u32 to int
7.50	dp	02/12/21	Fix compilation error in Xil_EndianSwap32() that
			*occur when -Werror=conversion compiler flag is enabled 7.5 mus 05/17/21
			*Update the functions with comments. It fixes CR#1067739.

Definition at line 36 of file [xil_io.h](#).

6.130.1.12 Xil_Ntohl

```
#define Xil_Ntohl Xil_EndianSwap32
```

Definition at line 317 of file [xil_io.h](#).

6.130.1.13 Xil_Ntohs

```
#define Xil_Ntohs Xil_EndianSwap16
```

Definition at line 316 of file [xil_io.h](#).

6.130.1.14 Xil_Out16LE

```
#define Xil_Out16LE Xil_Out16
```

Definition at line 312 of file [xil_io.h](#).

6.130.1.15 Xil_Out32LE

```
#define Xil_Out32LE Xil_Out32
```

Definition at line 313 of file [xil_io.h](#).

6.131 xil_io.h

[Go to the documentation of this file.](#)

```
00001 /*****
00002  * Copyright (c) 2014 - 2021 Xilinx, Inc. All rights reserved.
00003  * SPDX-License-Identifier: MIT
00004  *****/
00005
00006 /*****
00035 #ifndef XIL_IO_H /* prevent circular inclusions */
00036 #define XIL_IO_H /* by using protection macros */
00037
00038 #ifdef __cplusplus
00039 extern "C" {
00040 #endif
00041
00042 /***** Include Files *****/
00043
00044 #include "xil_types.h"
00045
00046 /***** Function Prototypes *****/
00047 #ifdef ENABLE_SAFETY
00048 extern u32 XStl_RegUpdate(u32 RegAddr, u32 RegVal);
00049 #endif
00050
00051 /***** Macros (Inline Functions) Definitions *****/
00052 #if defined __GNUC__
00053 #if defined(__MICROBLAZE__)
00054 #define INST_SYNC mbar(0)
00055 #define DATA_SYNC mbar(1)
00056 #else
00057 #define SYNCHRONIZE_IO dmb()
00058 #define INST_SYNC isb()
00059 #define DATA_SYNC dsb()
00060 #endif
00061 #else
00062 #define SYNCHRONIZE_IO
00063 #define INST_SYNC
00064 #define DATA_SYNC
00065 #define INST_SYNC
00066 #define DATA_SYNC
00067 #endif
00068
00069 #if defined(__GNUC__) || defined(__ICCARM__) || defined(__MICROBLAZE__)
00070 #define INLINE inline
00071 #else
00072 #define INLINE __inline
00073 #endif
00074
00075 /*****
00088 static INLINE u8 Xil_In8(UINTPTR Addr) { return *(volatile u8 *)Addr; }
00089
00090 /*****
00102 static INLINE u16 Xil_In16(UINTPTR Addr) { return *(volatile u16 *)Addr; }
00103
00104 /*****
00116 static INLINE u32 Xil_In32(UINTPTR Addr) { return *(volatile u32 *)Addr; }
00117
00118 /*****
00130 static INLINE u64 Xil_In64(UINTPTR Addr) { return *(volatile u64 *)Addr; }
00131
00132 /*****
00145 static INLINE void Xil_Out8(UINTPTR Addr, u8 Value) {
00146     /* write 8 bit value to specified address */
00147     volatile u8 *LocalAddr = (volatile u8 *)Addr;
00148     *LocalAddr = Value;
00149 }
00150
00151 /*****
00163 static INLINE void Xil_Out16(UINTPTR Addr, u16 Value) {
00164     /* write 16 bit value to specified address */
00165     volatile u16 *LocalAddr = (volatile u16 *)Addr;
```

```

00166     *LocalAddr = Value;
00167 }
00168
00169 /*****
00182 static INLINE void Xil_Out32(UINTPTR Addr, u32 Value) {
00183     /* write 32 bit value to specified address */
00184     #ifndef ENABLE_SAFETY
00185         volatile u32 *LocalAddr = (volatile u32 *)Addr;
00186         *LocalAddr = Value;
00187     #else
00188         XStl_RegUpdate(Addr, Value);
00189     #endif
00190 }
00191
00192 /*****
00205 static INLINE void Xil_Out64(UINTPTR Addr, u64 Value) {
00206     /* write 64 bit value to specified address */
00207     volatile u64 *LocalAddr = (volatile u64 *)Addr;
00208     *LocalAddr = Value;
00209 }
00210
00211 /*****
00227 static INLINE int Xil_SecureOut32(UINTPTR Addr, u32 Value) {
00228     int Status = XST_FAILURE;
00229     u32 ReadReg;
00230     u32 ReadRegTemp;
00231
00232     /* writing 32 bit value to specified address */
00233     Xil_Out32(Addr, Value);
00234
00235     /* verify value written to specified address with multiple reads */
00236     ReadReg = Xil_In32(Addr);
00237     ReadRegTemp = Xil_In32(Addr);
00238
00239     if ((ReadReg == Value) && (ReadRegTemp == Value)) {
00240         Status = XST_SUCCESS;
00241     }
00242
00243     return Status;
00244 }
00245
00246 /*****
00256 static INLINE __attribute__((always_inline)) u16 Xil_EndianSwap16(u16 Data) {
00257     return (u16)((Data & 0xFF00U) >> 8U) | ((Data & 0x00FFU) << 8U);
00258 }
00259
00260 /*****
00270 static INLINE __attribute__((always_inline)) u32 Xil_EndianSwap32(u32 Data) {
00271     u16 LoWord;
00272     u16 HiWord;
00273
00274     /* get each of the half words from the 32 bit word */
00275
00276     LoWord = (u16)(Data & 0x0000FFFFU);
00277     HiWord = (u16)((Data & 0xFFFF0000U) >> 16U);
00278
00279     /* byte swap each of the 16 bit half words */
00280
00281     LoWord = (u16)(((LoWord & 0xFF00U) >> 8U) | ((LoWord & 0x00FFU) << 8U));
00282     HiWord = (u16)(((HiWord & 0xFF00U) >> 8U) | ((HiWord & 0x00FFU) << 8U));
00283
00284     /* swap the half words before returning the value */
00285
00286     return (((u32)LoWord) << (u32)16U) | (u32)HiWord;
00287 }
00288
00289 #if defined(__MICROBLAZE__)
00290 #ifdef __LITTLE_ENDIAN__
00291     #define Xil_In16LE Xil_In16
00292     #define Xil_In32LE Xil_In32
00293     #define Xil_Out16LE Xil_Out16
00294     #define Xil_Out32LE Xil_Out32
00295     #define Xil_Htons Xil_EndianSwap16
00296     #define Xil_Htonl Xil_EndianSwap32
00297     #define Xil_Ntohs Xil_EndianSwap16
00298     #define Xil_Ntohl Xil_EndianSwap32
00299 #else
00300     #define Xil_In16BE Xil_In16
00301     #define Xil_In32BE Xil_In32
00302     #define Xil_Out16BE Xil_Out16
00303     #define Xil_Out32BE Xil_Out32
00304     #define Xil_Htons(Data) (Data)
00305     #define Xil_Htonl(Data) (Data)
00306     #define Xil_Ntohs(Data) (Data)
00307     #define Xil_Ntohl(Data) (Data)
00308 #endif
00309 #else

```

```

00310 #define Xil_In16LE Xil_In16
00311 #define Xil_In32LE Xil_In32
00312 #define Xil_Out16LE Xil_Out16
00313 #define Xil_Out32LE Xil_Out32
00314 #define Xil_Htons Xil_EndianSwap16
00315 #define Xil_Htonl Xil_EndianSwap32
00316 #define Xil_Ntohs Xil_EndianSwap16
00317 #define Xil_Ntohl Xil_EndianSwap32
00318 #endif
00319
00320 #if defined(__MICROBLAZE__)
00321 #ifdef __LITTLE_ENDIAN__
00322 static INLINE u16 Xil_In16BE(UINTPTR Addr)
00323 #else
00324 static INLINE u16 Xil_In16LE(UINTPTR Addr)
00325 #endif
00326 #else
00327 static INLINE u16 Xil_In16BE(UINTPTR Addr)
00328 #endif
00329 {
00330     u16 value = Xil_In16(Addr);
00331     return Xil_EndianSwap16(value);
00332 }
00333
00334 #if defined(__MICROBLAZE__)
00335 #ifdef __LITTLE_ENDIAN__
00336 static INLINE u32 Xil_In32BE(UINTPTR Addr)
00337 #else
00338 static INLINE u32 Xil_In32LE(UINTPTR Addr)
00339 #endif
00340 #else
00341 static INLINE u32 Xil_In32BE(UINTPTR Addr)
00342 #endif
00343 {
00344     u32 value = Xil_In32(Addr);
00345     return Xil_EndianSwap32(value);
00346 }
00347
00348 #if defined(__MICROBLAZE__)
00349 #ifdef __LITTLE_ENDIAN__
00350 static INLINE void Xil_Out16BE(UINTPTR Addr, u16 Value)
00351 #else
00352 static INLINE void Xil_Out16LE(UINTPTR Addr, u16 Value)
00353 #endif
00354 #else
00355 static INLINE void Xil_Out16BE(UINTPTR Addr, u16 Value)
00356 #endif
00357 {
00358     Value = Xil_EndianSwap16(Value);
00359     Xil_Out16(Addr, Value);
00360 }
00361
00362 #if defined(__MICROBLAZE__)
00363 #ifdef __LITTLE_ENDIAN__
00364 static INLINE void Xil_Out32BE(UINTPTR Addr, u32 Value)
00365 #else
00366 static INLINE void Xil_Out32LE(UINTPTR Addr, u32 Value)
00367 #endif
00368 #else
00369 static INLINE void Xil_Out32BE(UINTPTR Addr, u32 Value)
00370 #endif
00371 {
00372     Value = Xil_EndianSwap32(Value);
00373     Xil_Out32(Addr, Value);
00374 }
00375
00376 #ifdef __cplusplus
00377 }
00378 #endif
00379
00380 #endif /* end of protection macro */

```

6.132 library/xil_types.h File Reference

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

6.133 xil_types.h

[Go to the documentation of this file.](#)

```

00001 /*****
00002  * Copyright (c) 2010 - 2021 Xilinx, Inc. All rights reserved.
00003  * Copyright (c) 2022 Advanced Micro Devices, Inc. All Rights Reserved.
00004  * SPDX-License-Identifier: MIT
00005  *****/
00006
00007 /*****
00034 #ifndef XIL_TYPES_H /* prevent circular inclusions */
00035 #define XIL_TYPES_H /* by using protection macros */
00036
00037 #ifdef __cplusplus
00038 extern "C" {
00039 #endif
00040
00041 #include <stddef.h>
00042 #include <stdint.h>
00043
00044 /***** Constant Definitions *****/
00045
00046 #define XST_SUCCESS 0L
00047 #define XST_FAILURE 1L
00048 #ifndef TRUE
00049 #define TRUE 1U
00050 #endif
00051
00052 #ifndef FALSE
00053 #define FALSE 0U
00054 #endif
00055
00056 #ifndef NULL
00057 #define NULL 0U
00058 #endif
00059
00060 #define XIL_COMPONENT_IS_READY \
00061     0x11111111U
00066 #define XIL_COMPONENT_IS_STARTED \
00067     0x22222222U
00072 /* @name New types
00073  * New simple types.
00074  * @{
00075  */
00076 #ifndef __KERNEL__
00077 #ifndef XBASIC_TYPES_H
00078 /*
00079  * guarded against xbasic_types.h.
00080  */
00081 typedef uint8_t u8;
00082 typedef uint16_t u16;
00083 typedef uint32_t u32;
00085 #define __XUINT64__
00086 typedef struct {
00087     u32 Upper;
00088     u32 Lower;
00089 } Xuint64;
00090
00091 /*****
00100 #define XUINT64_MSW(x) ((x).Upper)
00101
00102 /*****
00111 #define XUINT64_LSW(x) ((x).Lower)
00112
00113 #endif /* XBASIC_TYPES_H */
00114
00115 /*
00116  * xbasic_types.h does not typedef s* or u64
00117  */
00119 typedef char char8;
00120 typedef int8_t s8;
00121 typedef int16_t s16;
00122 typedef int32_t s32;
00123 typedef int64_t s64;
00124 typedef uint64_t u64;
00125 typedef int sint32;
00126
00127 #if defined(__MICROBLAZE__) && !defined(__arch64__) && \
00128     (XPAR_MICROBLAZE_ADDR_SIZE > 32)
00129 typedef uint64_t UINTPTR;
00130 typedef int64_t INTPTR;
00131 #else
00132 typedef uintptr_t UINTPTR;
00133 typedef intptr_t INTPTR;
00134 #endif
00135
00136 typedef ptrdiff_t PTRDIFF;
00138 #if !defined(LONG) || !defined(ULONG)
00139 typedef long LONG;
00140 typedef unsigned long ULONG;

```

```
00141 #endif
00142
00143 #define ULONG64_HI_MASK 0xFFFFFFFF00000000U
00144 #define ULONG64_LO_MASK ~ULONG64_HI_MASK
00145
00146 #else
00147 #include <linux/types.h>
00148 #endif
00149
00155 typedef void (*XInterruptHandler)(void *InstancePtr);
00156
00161 typedef void (*XExceptionHandler)(void *InstancePtr);
00162
00172 #if defined(__aarch64__) || defined(__arch64__)
00173 #define UPPER_32_BITS(n) ((u32)((n) >> 16) >> 16)
00174 #else
00175 #define UPPER_32_BITS(n) 0U
00176 #endif
00182 #define LOWER_32_BITS(n) ((u32)(n))
00183
00189 #if defined(__aarch64__) || defined(__arch64__)
00190 #define LEFT_SHIFT_BY_32_BITS(n) (u64)((u64)n << 32)
00191 #else
00192 #define LEFT_SHIFT_BY_32_BITS(n) 0U
00193 #endif
00194
00195 /***** Constant Definitions *****/
00196
00197 #ifndef TRUE
00198 #define TRUE 1U
00199 #endif
00200
00201 #ifndef FALSE
00202 #define FALSE 0U
00203 #endif
00204
00205 #ifndef NULL
00206 #define NULL 0U
00207 #endif
00208
00209 #ifdef __cplusplus
00210 }
00211 #endif
00212
00213 #endif /* end of protection macro */
```


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