PS/2 Core for Altera DE-Series Boards

For Quartus II 12.0

1 Core Overview

The PS/2 Serial Port on Altera DE2/DE1 boards is intended for connecting a keyboard or a mouse to the board. The PS/2 Core provides a connection to the PS/2 Serial Port and presents an easy-to-use communication interface to PS/2 peripherals.

2 Functional Description

The PS/2 Core handles the timing of the PS/2 Serial Data Transmission Protocol. A device driver can communicate with it by reading from and writing to its data and control registers.

3 Instantiating the Core in Qsys

Designers can implement a PS/2 Core by using Qsys. There is no need to configure the core. The core comes with a 256-word FIFO for storing data received from a PS/2 device.

4 Software Programming Model

4.1 Register Map

Device drivers control and communicate with the PS/2 Core through two 32-bit registers. Communication with the PS/2 peripheral is done by writing or reading the registers through the Avalon Slave Port. Table 1 shows the details for the registers.

Table 1. PS/2 Core register map

Offset in bytes	Register Name	R/W/C	Bit description							
			31...16	15	14...11	10	9	8	7...1	0
0	`data`	R/W	RAVAIL	RVALID	*(1)*				DATA	
4	`control`	R/C	*(1)*			CE	*(1)*	RI	*(1)*	RE

Notes on Table 1:

(1) Reserved. Read values are undefined. Write zero.

4.1.1 *data* Register

Table 2. data register bits

Bit number	Bit name	Read/Write/Clear	Description
7...0	DATA	R/W	The value to transfer to/from the PS/2 core. When writing, the DATA field is interpreted as a command to be sent to the PS/2 device. When reading, the DATA field is data from the PS/2 device.
15	RVALID	R	Indicates whether the DATA field is valid. If RVALID=1, then the DATA field is valid, else the DATA is undefined.
31...16	RAVAIL	R	The number of data items remaining in the read FIFO (including this read).

4.1.2 *control* Register

Table 3. control register bits

Bit number	Bit name	Read/Write/Clear	Description
0	RE	R/W	Interrupt-enable bit for read interrupts.
8	RI	R	Indicates that a read interrupt is pending.
10	CE	C	Indicates that an error occurred while trying to send a command to a PS/2 device.

4.2 Software Functions

The PS/2 Core is packaged with C-language functions accessible through the the hardware abstraction layer (HAL) as listed below. These functions implement common operations that users need for the PS/2 Core.

To use the functions, the C code must include the statement:

```
#include "altera_up_avalon_ps2.h"
```

In addition, some sample functions for specific communication with the keyboard or mouse are also provided. They serve as a good starting point if the user wishes to develop more features with the PS/2 Port. To use the keyboard or mouse communication functions, the corresponding header files, `altera_up_ps2_keyboard.h` and `altera_up_ps2_mouse.h`, have to be included. These functions are described below.

4.3 PS/2 Port Documentation

4.3.1 PS2_DEVICE

Prototype:

```
typedef enum {
    PS2_MOUSE = 0;
    PS2_KEYBOARD = 1;
    PS2_UNKNOWN = 2;
} PS2_DEVICE;
```

Include: `<altera_up_avalon_ps2.h>`
Fields: `PS2_MOUSE` — Indicate that the device is a PS/2 Mouse.
`PS2_KEYBOARD` — Indicate that the device is a PS/2 Keyboard.
`PS2_UNKNOWN` — The program cannot determine what type the device is.

4.3.2 alt_up_ps2_init

Prototype: `void alt_up_ps2_init(alt_up_ps2_dev *ps2)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `ps2` – the PS/2 device structure.
Description: Initialize the PS/2 device and detect device type (mouse or keyboard).
Notes: The function will set the `device_type` field of *ps2* to `PS2_MOUSE` or `PS2_KEYBOARD` upon successful initialization, otherwise the intialization is unsuccessful.

4.3.3 alt_up_ps2_enable_read_interrupt

Prototype: `void alt_up_ps2_enable_read_interrupt(alt_up_ps2_dev *ps2)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `ps2` – the PS/2 device structure.
Returns: nothing
Description: Enable read interrupts for the PS/2 port.

4.3.4 alt_up_ps2_disable_read_interrupt

Prototype: `void alt_up_ps2_disable_read_interrupt(alt_up_ps2_dev *ps2)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `ps2` – the PS/2 device structure.
Returns: nothing
Description: Diaable read interrupts for the PS/2 port.

4.3.5 alt_up_ps2_write_data_byte

Prototype: `int alt_up_ps2_write_data_byte(alt_up_ps2_dev *ps2, unsigned char byte)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `ps2` – the PS/2 device structure.
`byte` – the byte to be written to the PS/2 port.
Returns: 0 on success, or `-EIO` on failure.
Description: Write a byte to the PS/2 port.

4.3.6 alt_up_ps2_write_data_byte_with_ack

Prototype: `int alt_up_ps2_write_data_byte_with_ack(alt_up_ps2_dev *ps2, unsigned char byte)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `ps2` – the PS/2 device structure.
`byte` – the byte to be written to the PS/2 port.
Returns: 0 on success, `-EIO` on write failure, or `-ETIMEDOUT` on timeout when waiting for the acknowledgment.
Description: Write a byte to the PS/2 port and wait for the acknowledgment.
Notes: The timeout value is defined in the PS/2 device structure .

4.3.7 alt_up_ps2_read_data_byte

Prototype: `int alt_up_ps2_read_data_byte(alt_up_ps2_dev *ps2, unsigned char *byte)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `ps2` – the PS/2 device structure.
`byte` – pointer to the memory location to store the byte.
Returns: 0 on success, or `-ETIMEDOUT` when timeout.
Description: Read a byte from the PS/2 port.
Notes: User can set disable the timeout by setting the `timeout` in to 0.

4.3.8 alt_up_ps2_clear_fifo

Prototype: `void alt_up_ps2_clear_fifo(alt_up_ps2_dev *ps2)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `ps2` – the PS/2 device structure.
Description: Clear the FIFO for the PS/2 port.

4.3.9 alt_up_ps2_read_fd

Prototype: `int alt_up_ps2_read_fd(alt_fd *fd, char *ptr, int len)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `fd` – the file descriptor for the PS/2 device.
`ptr` – memory location to store the bytes read.
`len` – number of bytes to be read.
Returns: the number of bytes actually read.
Description: Read *len* bytes from the PS/2 device.

4.3.10 alt_up_ps2_write_fd

Prototype: `int alt_up_ps2_write_fd(alt_fd *fd, const char *ptr, int len)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `fd` – the file descriptor for the PS/2 device.
`ptr` – memory location storing the bytes to write.
`len` – number of bytes to write.
Returns: the number of bytes actually written.
Description: Write *len* bytes to the PS/2 device from memory location pointed by *ptr* .

4.3.11 alt_up_ps2_open_dev

Prototype: `alt_up_ps2_dev* alt_up_ps2_open_dev(const char *name)`
Include: `<altera_up_avalon_ps2.h>`
Parameters: `name` the specified name of the device in Qsys
Returns: the PS/2 device structure
Description: Open a PS/2 device structure with *name* in Qsys.

4.4 PS/2 Keyboard Documentation

4.4.1 KB_CODE_TYPE

Prototype:

```
typedef enum {
    KB_ASCII_MAKE_CODE = 1;
    KB_BINARY_MAKE_CODE = 2;
    KB_LONG_BINARY_MAKE_CODE = 3;
    KB_BREAK_CODE = 4;
    KB_LONG_BREAK_CODE = 5;
    KB_INVALID_CODE = 6;
} KB_CODE_TYPE;
```

Include: `<altera_up_ps2_keyboard.h>`

Fields: `KB_ASCII_MAKE_CODE` — Make code that corresponds to an ASCII character. For example, the ASCII make code for key `[ A ]` is 1C.
`KB_BINARY_MAKE_CODE` — Make code that corresponds to a non-ASCII character. For example, the binary (non-ASCII) make code for key `[Left Alt]` is 11.
`KB_LONG_BINARY_MAKE_CODE` — Make code that has two bytes (the first byte is E0). For example, the long binary make code for key `[Right Alt]` is "E0 11".
`KB_BREAK_CODE` — Break code that has two bytes (the first byte is F0). For example, the break code for key `[ A ]` is "F0 1C".
`KB_LONG_BREAK_CODE` — Long break code that has three bytes (with the first two bytes "E0 F0"). For example, the long break code for key `[Right Alt]` is "E0 F0 11".
`KB_INVALID_CODE` — Scan codes that the decoding FSM is unable to decode.

Description: The enum type for the type of keyboard code received.

4.4.2 decode_scancode

Prototype: `int decode_scancode(alt_up_ps2_dev *ps2, KB_CODE_TYPE *decode_mode, alt_u8 *buf, char *ascii)`
Include: `<altera_up_ps2_keyboard.h>`
Parameters: `ps2` – the PS/2 device structure. The actually connected PS/2 device has to be a keyboard otherwise the function's behavior is undefined.
`decode_mode` – indicates which type of code (Make Code, Break Code, etc.) is received from the keyboard when the key is pressed.
`buf` – points to the location that stores the make/break code of the key pressed.
`ascii` – pointer to the memory location to store the pressed ASCII character. If a non-ASCII key is pressed, *ascii* will be set to 0
Returns: 0 for success, or negative errno for corresponding errors.
Description: Communicate with the PS/2 keyboard and get the make code of the key when a key is pressed.
Notes: For `KB_LONG_BINARY_MAKE_CODE` and `KB_BREAK_CODE` , only the second byte is returned. For `KB_LONG_BREAK_CODE` , only the third byte is returned.

4.4.3 set_keyboard_rate

Prototype: `alt_u32 set_keyboard_rate(alt_up_ps2_dev *ps2, alt_u8 rate)`
Include: `<altera_up_ps2_keyboard.h>`
Parameters: `rate` – an 8-bit number that represents the repeat/delay rate of the keyboard.
Returns: 0 on success, negative value on error.
Description: Set the repeat/delay rate of the keyboard.

4.4.4 translate_make_code

Prototype: `void translate_make_code(KB_CODE_TYPE decode_mode, alt_u8 makecode, char *str)`
Include: `<altera_up_ps2_keyboard.h>`
Parameters: `decode_mode` – the type of the make code (ASCII, binary, or long binary)
`makecode` – the last byte of the make code (if the make code has multiple bytes)
`str` – the pointer to the memory location to store the description string
Description: Translate the make code into string description.

4.4.5 reset_keyboard

Prototype: `alt_u32 reset_keyboard()`
Include: `<altera_up_ps2_keyboard.h>`
Parameters: –
Returns: 0 on passing the BAT (Basic Assurance Test), negative value on error.
Description: Send the reset command to the keyboard.

4.5 PS/2 Mouse Documentation

4.5.1 alt_up_ps2_mouse_reset

Prototype: `int alt_up_ps2_mouse_reset(alt_up_ps2_dev *ps2)`
Include: `<altera_up_ps2_mouse.h>`
Parameters: `ps2` – the PS/2 mouse device strcture
Returns: 0 on BAT is passed, `-EINVAL` when the PS/2 device is not mouse, or `-EIO` if error occurs.
Description: Reset the mouse.

4.5.2 alt_up_ps2_mouse_set_mode

Prototype: `int alt_up_ps2_mouse_set_mode(alt_up_ps2_dev *ps2, alt_u8 byte)`
Include: `<altera_up_ps2_mouse.h>`
Parameters: `ps2` – the PS/2 mouse device strcture
`byte` – the byte representing the mode (see macro definitions for details).
Returns: 0 on receiving acknowledgment, or negative number for errors.
Description: Set the operation mode of the mouse.
See also: PS/2 Mouse document