



PS/2 Core for Altera DE-Series Boards

For Quartus Prime 16.0

1 Core Overview

The PS/2 Serial Port on Altera DE-series 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. The core comes with a 256-word fifo for storing data received from a PS/2 device. The core can be configured to provide either a memory-mapped or streaming interface to the input fifo and output port.

3 Instantiating the Core

The PS/2 core can be instantiated in a system using Qsys or as a standalone component from the IP Catalog within the Quartus II software. There are two parameters that need to be set, **Avalon Type** and **Incoming clock rate**. It is recommended to set the **Avalon Type** to **Memory Mapped** when connecting to a processor, otherwise set it to **Streaming**. The **Incoming clock rate** must be set to the value of the frequency of the clock that will be driving the PS2 Controller.

4 Software Programming Model

4.1 Register Map

When using this core with Qsys, 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 when Memory-Mapped Avalon Type is selected for the core. 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 Device Driver for the Nios II Processor

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 initialization 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: Disable 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 structure
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 structure
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