Exercise 7:

a) Graphic Buffer

During one read operation from the RAM, the colour data for 32 consecutive pixels is read. This data must then be buffered and converted from a parallel data word to a serial data stream.

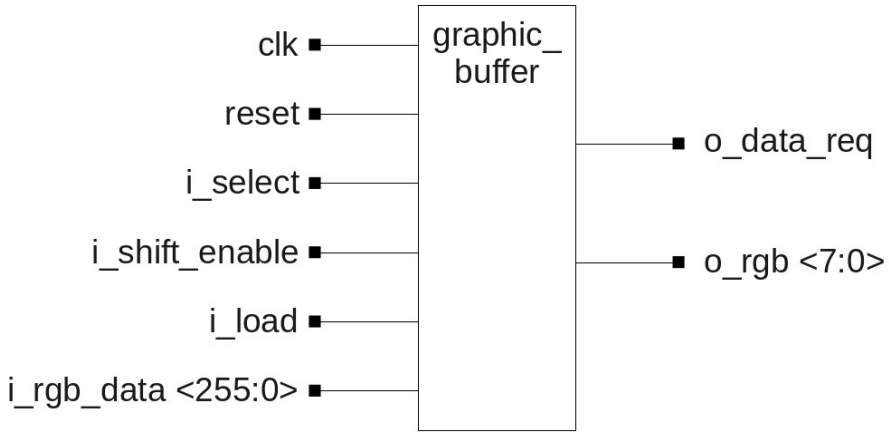

Figure 1: graphic_buffer

Port declaration:

- *clk* : in std_logic
- *reset* : in std_logic
- *i_select* : in std_logic
- *i_shift_enable* : in std_logic
- *i_load* : in std_logic
- *i_rgb_data* : in std_logic_vector (255 downto 0)
- *o_data_req* : out std_logic
- *o_rgb* : out std_logic_vector (7 downto 0)

To serialize the data, you can use a shift register, as shown in figure 2.

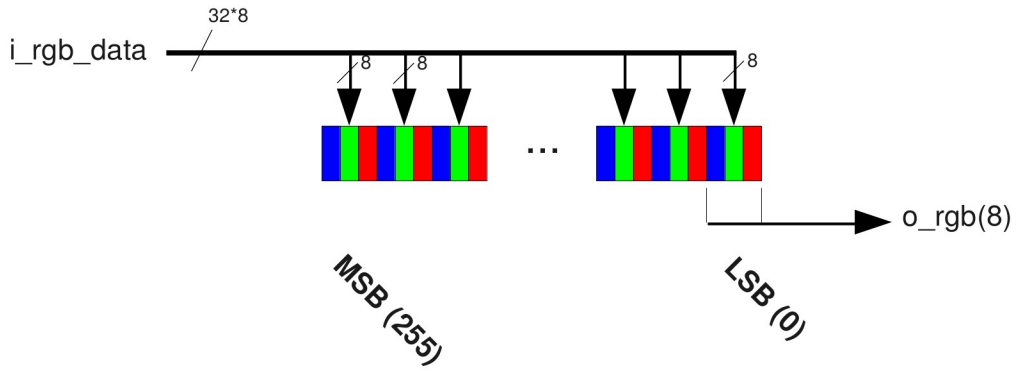

Figure 2: Shift register used to serialize pixel data

Two of these buffers are used, so one can be reloaded while the other is converting its data. Since both buffers may not send data simultaneously to the VGA-port, you have to consider the control of these two buffers.
The active buffer is selected by the input *i_select*. On each rising clock edge, the buffer outputs the data of a new pixel at the output *o_rgb* when both the *i_select* and the *i_shift_enable* inputs are active ('1'). It is important that the output data is valid immediately after a rising edge on the *i_select* input. The value of the output *o_rgb* is never used during the time *i_select* is 0, so it does not have to have a defined value.
The input *i_load* is used to reload the buffer with new data. Because there are two of these buffers and the load signal is connected to both, only the unselected buffer (the buffer that requested new data is disabled by the *graphic_buffer_controller* and its input *i_select* is set to 0) is reloaded.
After all 32 pixels have been displayed, the active buffer requests new data by setting the output signal *o_data_req*. It is important that this signal is already active on the rising edge after the clock cycle in which the 32nd pixel has been displayed, so that the buffer controller can switch the active buffer on the next clock edge. The data request output must be set after a reset, too.