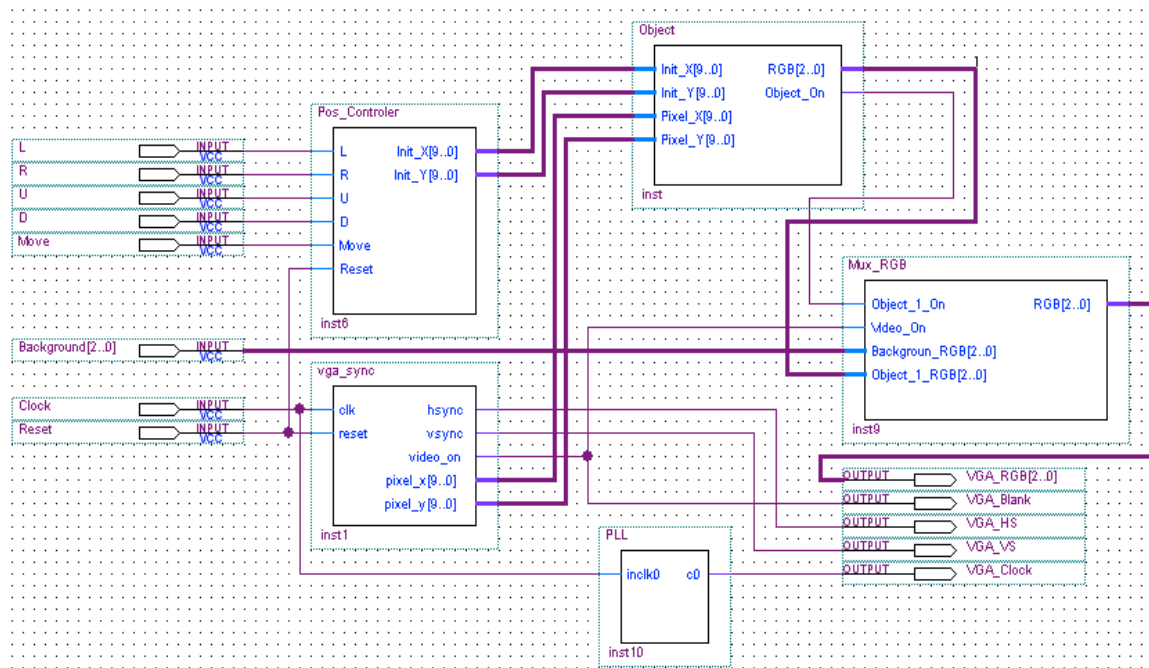


# VGA Lab

**Objective:** To gain some understanding of how video is displayed on a monitor using a VGA connection.

## Design



The above design displays a rectangle on the monitor and lets the user change the position of the rectangle. The user is also able to change the background color. Each component in the above figure is explained in details.

The main component in this design is the “vga\_sync”. Luckily for you, the code for this circuit is available in the appendix section of this lab. The “vga\_sync” is a counter. The pixel\_x and pixel\_y signals indicate the location of the current pixel. The location (pixel\_x, pixel\_y) goes from (0, 0) to (640, 480) and changes every two clock cycles. To display an image on the monitor the RGB color for every pixel has to be specified. The DE2 board goes through all the pixels in less than 1/60th of a second.

The “Mux\_RGB” circuit is a simple multiplexer that chooses which object’s RGB signal is to be routed to the RGB output. In our example we only have one object and a background. Whenever the Object\_1\_On signal is high or in other words whenever the current pixel location falls under the region of the object, the multiplexer routes the Object\_1\_RGB to the output else it routes the Background\_RGB to the output. When video\_on is low, the output will be zero.

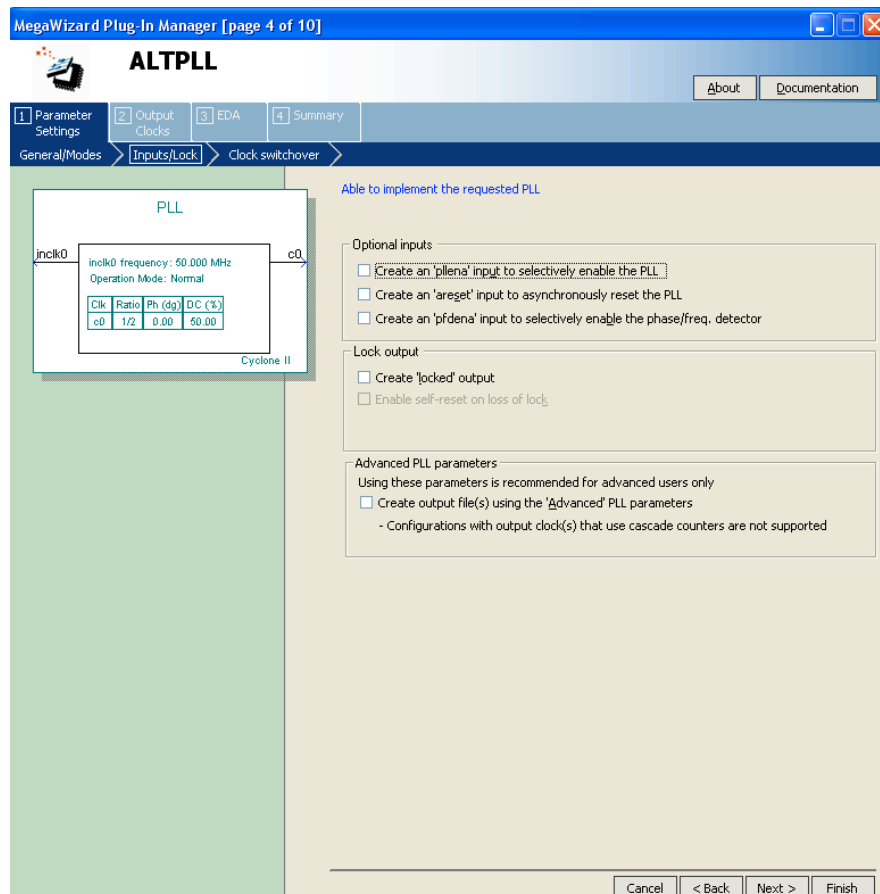
The “Object” component displays a 208 by 64 pixel rectangle (you can change the size if you wish). When the current location is within the region of the object (you have to consider the initial position and the size of the object) it sets the RGB output to the color of the object and also sets the object\_on signal high.

The “Position Controller” defines the position of the object. The L, R, U, D inputs are connected to switches 15 to 12 on the DE2 board. When the move pushbutton is pressed depending on the configuration of the switches, the object should move in one of the eight possible directions. Set the length of the displacement to any number you wish between four and thirty two pixels. The object should always stay inside the monitor’s frame.

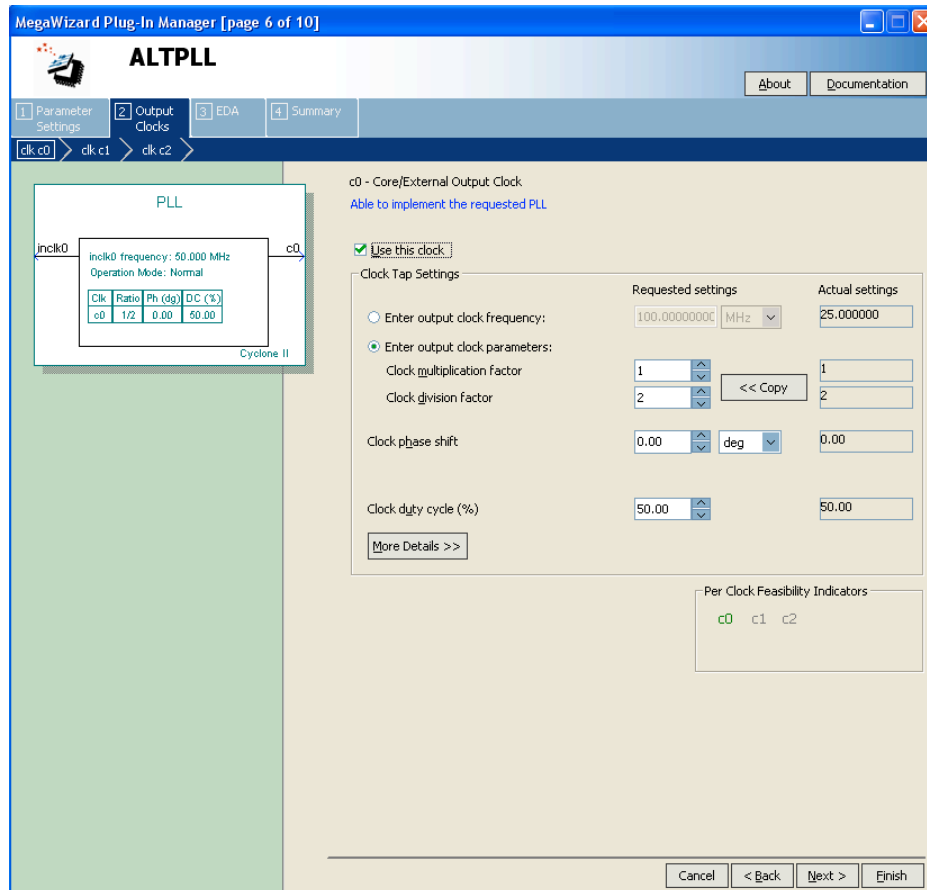
The final component can be created using the Mega wizard manager. A PLL (Phased-Locked Loop) is used to generate a 25MHZ clock for the VGA output of the board.

To create the PLL follow these steps:

- 1- Run MegaWizard Manager and create a new custom megafunction.
- 2- Choose ALTPLL under I/O, and choose an output destination.
- 3- On the next page set the frequency of the inclock0 input to 50 MHZ.
- 4- On the next page uncheck all the checkboxes and press next twice
- 5-



6- Set the clock division factor to 2, and press finish twice.



## Testing

The code for all the components is available on blackboard. Create the symbols for all the components and connect them together in Quartus using the figure in page one. Test the design on the DE2 board using the given pin assignment file.

- Modify object.vhd, so that there is a 3-bit input to change the object color.
- Assign the 3-bit pins to change the object color to switches 4, 5, and 6.