NIOS Pixel Display - SW

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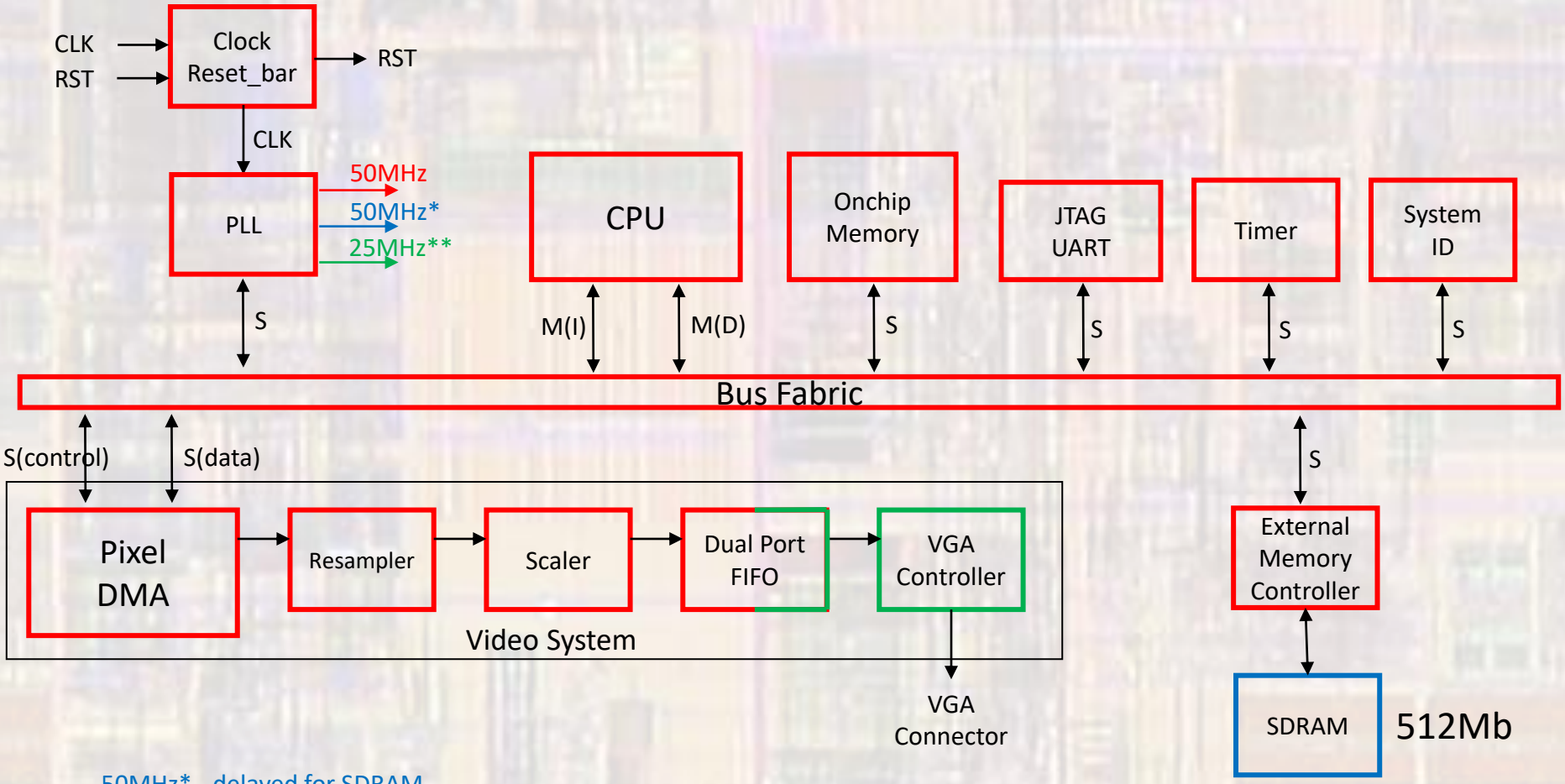
NIOS II Pixel Display - SW



50MHz* - delayed for SDRAM

25MHz** - VGA clk

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- Create Eclipse System
  - Open NIOSII software
    - Tools → NIOSII Software Build Tools for Eclipse
  - Create the BSP
    - File → New → NIOSII Application and BSP from template
    - Blank Template
  - Edit the BSP
    - Right click on the BSP, NIOS II → BSP Editor
    - Change the properties for small systems
      - Small C library
      - Reduced device drivers
  - Re-Generate the BSP

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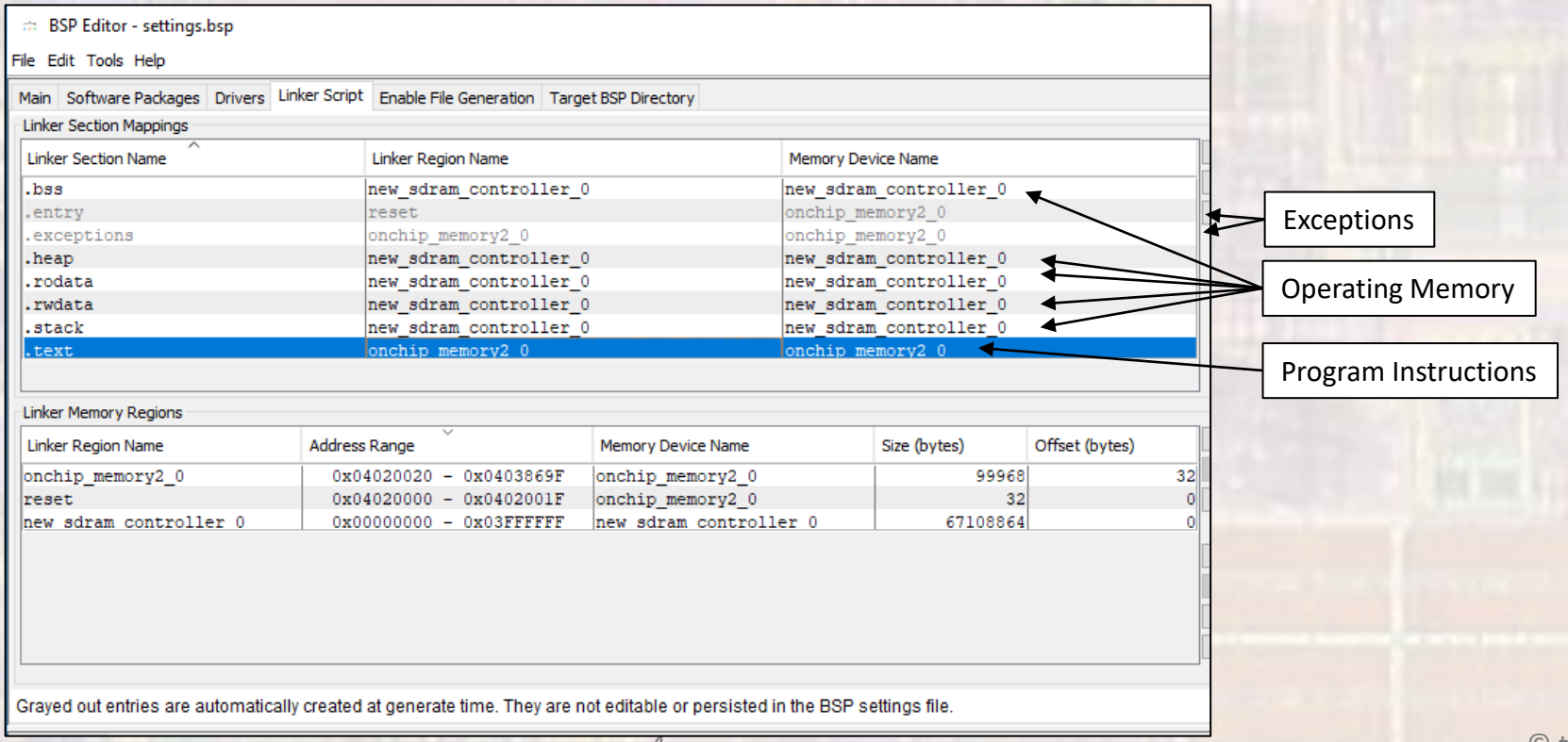
- Create Eclipse System
  - Review the BSP Memory allocations
    - Right click on the BSP, NIOS → BSP Editor → Linker Script Tab
    - Most are in the SDRAM



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- Create Eclipse System
  - In the BSP – under drivers/inc
    - Open altera_up_avalon_video_pixel_buffer_dma.h
    - Find the video pixel buffer structure name

```
/*
 * Device structure definition. Each instance of the driver uses one
 * of these structures to hold its associated state.
 */
typedef struct alt_up_pixel_buffer_dma_dev {
    /// @brief character mode device structure
    /// @sa Developing Device Drivers for the HAL in Nios II Software Developer's Handbook
    alt_dev dev;
    /// @brief the pixel buffer's slave base address
    unsigned int base;
    /// @brief the memory buffer's start address
    unsigned int buffer_start_address;
    /// @brief the memory back buffer's start address
    unsigned int back_buffer_start_address;
```

    - Create a pointer of this type

```
// define a pointer of type pixel_buffer...
// to use as a reference in the dma functions
//
alt_up_pixel_buffer_dma_dev * pixel_buf_dma_dev;
```

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- Create Eclipse System
  - In the BSP – under drivers/inc
    - Open altera_up_avalon_video_pixel_buffer_dma.h
    - Find the function to open the pixel buffer dma device

```
56 //////////////////////////////////////////////////////////////////////////////
57 // direct operation functions
58 /**
59  * @brief Opens the pixel buffer device specified by <em> name </em>
60  *
61  * @param name -- the pixel buffer component name in SOPC Builder.
62  *
63  * @return The corresponding device structure, or NULL if the device is not found
64  **/
65 alt_up_pixel_buffer_dma_dev* alt_up_pixel_buffer_dma_open_dev(const char* name);
66
```

    - Open the device and assign it to the previously defined pointer

```
// open the Pixel Buffer port
//  - command is in drivers/inc/alter...video_pixel_buffer_dma.h
// name reference is in system.h
//  - "/dev/video_pixel_buffer_dma_0"
//
pixel_buf_dma_dev = alt_up_pixel_buffer_dma_open_dev ("/dev/video_pixel_buffer_dma_0");
```

```
349 #define ALT_MODULE_CLASS_video_pixel_buffer_dma_0 altera_up_avalon_video_pixel_buffer_dma
350 #define VIDEO_PIXEL_BUFFER_DMA_0_BASE 0x4041020
351 #define VIDEO_PIXEL_BUFFER_DMA_0_IRQ -1
352 #define VIDEO_PIXEL_BUFFER_DMA_0_IRQ_INTERRUPT_CONTROLLER_ID -1
353 #define VIDEO_PIXEL_BUFFER_DMA_0_NAME "/dev/video_pixel_buffer_dma_0"
354 #define VIDEO_PIXEL_BUFFER_DMA_0_SPAN 16
355 #define VIDEO_PIXEL_BUFFER_DMA_0_TYPE "altera_up_avalon_video_pixel_buffer_dma"
```

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- Create Eclipse System
  - In the BSP – under drivers/inc
    - Open altera_up_avalon_video_pixel_buffer_dma.h
    - The remainder of the pixel buffer dma commands are in this file

```
/**
 * @brief Draw a pixel at the location specified by <em>(x, y)</em> on the VGA monitor
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 * @param color-- the RGB color to be drawn
 * @param x -- the \em x coordinate
 * @param y -- the \em y coordinate
 *
 * @return 0 for success, -1 for error (such as out of bounds)
 **/
int alt_up_pixel_buffer_dma_draw(alt_up_pixel_buffer_dma_dev *pixel_buffer, unsigned int color, unsigned int x, unsigned int y);

/**
 * @brief Changes the back buffer's start address
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 * @param new_address  -- the new start address of the back buffer
 *
 * @return 0 for success
 **/
int alt_up_pixel_buffer_dma_change_back_buffer_address(alt_up_pixel_buffer_dma_dev *pixel_buffer, unsigned int new_address);

/**
 * @brief Swaps which buffer is being sent to the VGA Controller
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 *
 * @return 0 for success
 **/
int alt_up_pixel_buffer_dma_swap_buffers(alt_up_pixel_buffer_dma_dev *pixel_buffer);
```

This actually writes to the back buffer

5 bits R
6 bits G
5 bits B

0 - 319

0 - 239

0xF800 = RED

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- Create Eclipse System

```
/**
 * @brief Check if swapping buffers has completed
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 *
 * @return 0 if complete, 1 if still processing
 **/
int alt_up_pixel_buffer_dma_check_swap_buffers_status(alt_up_pixel_buffer_dma_dev *pixel_buffer);

/**
 * @brief This function clears the screen or the back buffer.
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 * @param backbuffer -- set to 1 to clear the back buffer, otherwise set to 0 to clear the current screen.
 *
 * @return 0 if complete, 1 if still processing
 **/
void alt_up_pixel_buffer_dma_clear_screen(alt_up_pixel_buffer_dma_dev *pixel_buffer, int backbuffer);

/**
 * @brief This function draws a box of a given color between points (x0,y0) and (x1,y1).
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 * @param x0,x1,y0,y1 -- coordinates of the top left (x0,y0) and bottom right (x1,y1) corner of the box
 * @param color -- color of the box to be drawn
 * @param backbuffer -- set to 1 to select the back buffer, otherwise set to 0 to select the current screen.
 *
 * @return 0 if complete, 1 `if still processing
 **/
void alt_up_pixel_buffer_dma_draw_box(alt_up_pixel_buffer_dma_dev *pixel_buffer, int x0, int y0, int x1, int y1, int color, int backbuffer);

/**
 * @brief This function draws a horizontal line of a given color between points (x0,y) and (x1,y).
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 * @param x0,x1,y -- coordinates of the left (x0,y) and the right (x1,y) end-points of the line
 * @param color -- color of the line to be drawn
 * @param backbuffer -- set to 1 to select the back buffer, otherwise set to 0 to select the current screen.
 *
 * @return 0 if complete, 1 if still processing
 **/
void alt_up_pixel_buffer_dma_draw_hline(alt_up_pixel_buffer_dma_dev *pixel_buffer, int x0, int x1, int y, int color, int backbuffer);
```

These actually write to the buffers

NIOS II Pixel Display - SW

- Create Eclipse System

These actually write to the buffers

```
/**
 * @brief This function draws a vertical line of a given color between points (x,y0) and (x,y1).
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 * @param x,y0,y1 -- coordinates of the top (x,y0) and the bottom (x,y1) end-points of the line
 * @param color -- color of the line to be drawn
 * @param backbuffer -- set to 1 to select the back buffer, otherwise set to 0 to select the current screen.
 *
 * @return 0 if complete, 1 if still processing
 **/
void alt_up_pixel_buffer_dma_draw_vline(alt_up_pixel_buffer_dma_dev *pixel_buffer, int x, int y0, int y1, int color, int backbuffer);

/**
 * @brief This function draws a rectangle of a given color between points (x0,y0) and (x1,y1).
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 * @param x0,x1,y0,y1 -- coordinates of the top left (x0,y0) and bottom right (x1,y1) corner of the rectangle
 * @param color -- color of the rectangle to be drawn
 * @param backbuffer -- set to 1 to select the back buffer, otherwise set to 0 to select the current screen.
 *
 * @return 0 if complete, 1 if still processing
 **/
void alt_up_pixel_buffer_dma_draw_rectangle(alt_up_pixel_buffer_dma_dev *pixel_buffer, int x0, int y0, int x1, int y1, int color, int backbuffer);

/**
 * @brief This function draws a line of a given color between points (x0,y0) and (x1,y1).
 *
 * @param pixel_buffer -- the pointer to the VGA structure
 * @param x0,x1,y0,y1 -- coordinates (x0,y0) and (x1,y1) correspond to end points of the line
 * @param color -- color of the line to be drawn
 * @param backbuffer -- set to 1 to select the back buffer, otherwise set to 0 to select the current screen.
 *
 * @return 0 if complete, 1 if still processing
 **/
void alt_up_pixel_buffer_dma_draw_line(alt_up_pixel_buffer_dma_dev *pixel_buffer, int x0, int y0, int x1, int y1, int color, int backbuffer);
```

NIOS II Pixel Display - SW

- Create Eclipse System
  - Write a program to print some Pixels to the screen

Include the DMA functions

```
/////////////////
// Includes
/////////////////
#include "altera_up_avalon_video_pixel_buffer_dma.h"
#include <stdio.h>
#include <unistd.h>

int main(void){
	// define a pointer of type pixel_buffer...
	// to use as a reference in the dma functions
	//
	alt_up_pixel_buffer_dma_dev * pixel_buf_dma_dev;

	// open the Pixel Buffer port
	//  - command is in drivers/inc/alter...video_pixel_buffer_dma.h
	// name reference is in system.h
	//  - "/dev/video_pixel_buffer_dma_0"
	//
	pixel_buf_dma_dev = alt_up_pixel_buffer_dma_open_dev ("/dev/video_pixel_buffer_dma_0");

	// Check for error and output to the console
	//
	if ( pixel_buf_dma_dev == NULL)
	    printf ("Error: could not open pixel buffer device \n");
	else
	    printf ("Opened pixel buffer device \n");
```

Debug code

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- Create Eclipse System
  - Write a program to print some Pixels to the screen

```
// Clear the screen
// - command is in drivers/inc/alter...video_pixel_buffer_dma.h
// - wait until done before continuing
//
alt_up_pixel_buffer_dma_clear_screen (pixel_buf_dma_dev, 0);
usleep(1000000);// 1sec

// Draw a box
// - command is in drivers/inc/alter...video_pixel_buffer_dma.h
//
alt_up_pixel_buffer_dma_draw_box (pixel_buf_dma_dev, 100,  50, 149,  99, 0xF800, 0);
alt_up_pixel_buffer_dma_draw_box (pixel_buf_dma_dev, 150, 100, 199, 149, 0x07E0, 0);
alt_up_pixel_buffer_dma_draw_box (pixel_buf_dma_dev, 200, 150, 249, 199, 0x001F, 0);
```

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- Create Eclipse System
  - Compile the software
    - Select the code file (box.c)
    - Project → Build Project
    - Right Click on the project → run as → Nios II Hardware

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- Create Eclipse System