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Lab10: VGA 显示

基于Nexys 4 FPGA 平台

Lab 10: VGA 显示

实验简介

本实验旨在使读者学会 Xilinx 的 XPS 和 SDK 工具的使用，导入 VGA 的 IP 核，完成三角函数图像、一次函数图像的显示。

实验目标

在完成本实验后，您将学会：

- VGA 端口的设计过程。

实验过程

本实验旨在指导读者使用 Xilinx 的 XPS 工具，导入 VGA 的 IP 核，编写 C 文件，完成三角函数图像、一次函数图像、抛物线图像在 VGA 显示器上的显示。

实验由以下步骤组成：

1．在 XPS 中建立工程

2．导入 VGA IP 核

3．端口映射

4．将工程导入 SDK

5．在 SDK 中添加 C 语言源程序

6．将 VGA 端口与 Nexys4 链接

7．在 Nexys 上进行测试验证，查看实验结果

实验环境

◆ 硬件环境

1.PC 机

2.Nexys 4 FPGA 平台

3.VGA 显示器

◆软件环境

Xilinx ISE Design Suite 14.3（FPGA 开发工具）

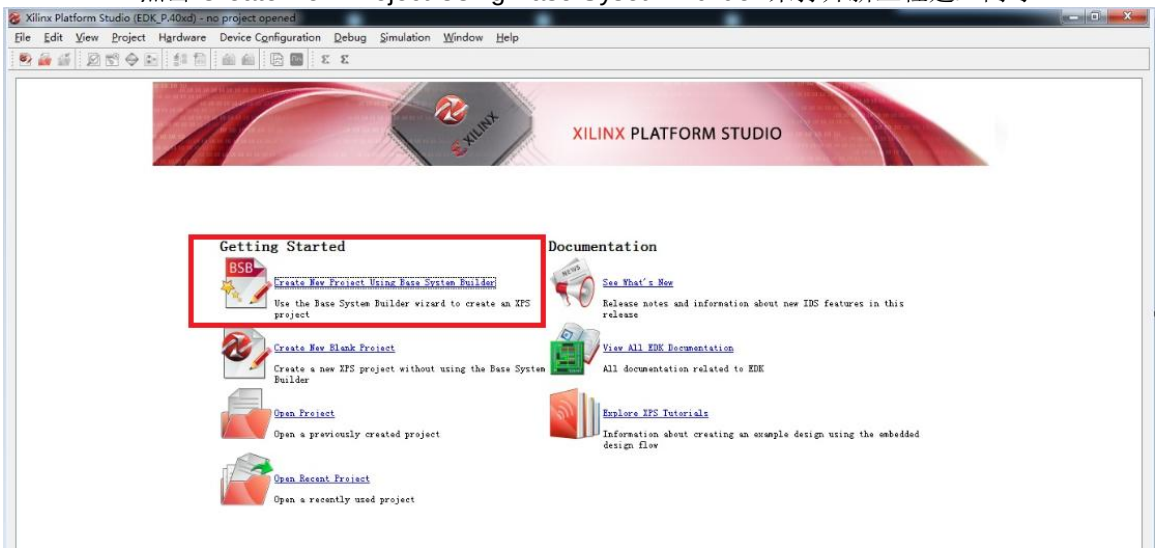
注：所有源代码可在**/lab10/Sources/目下找到

第一步 创建工程

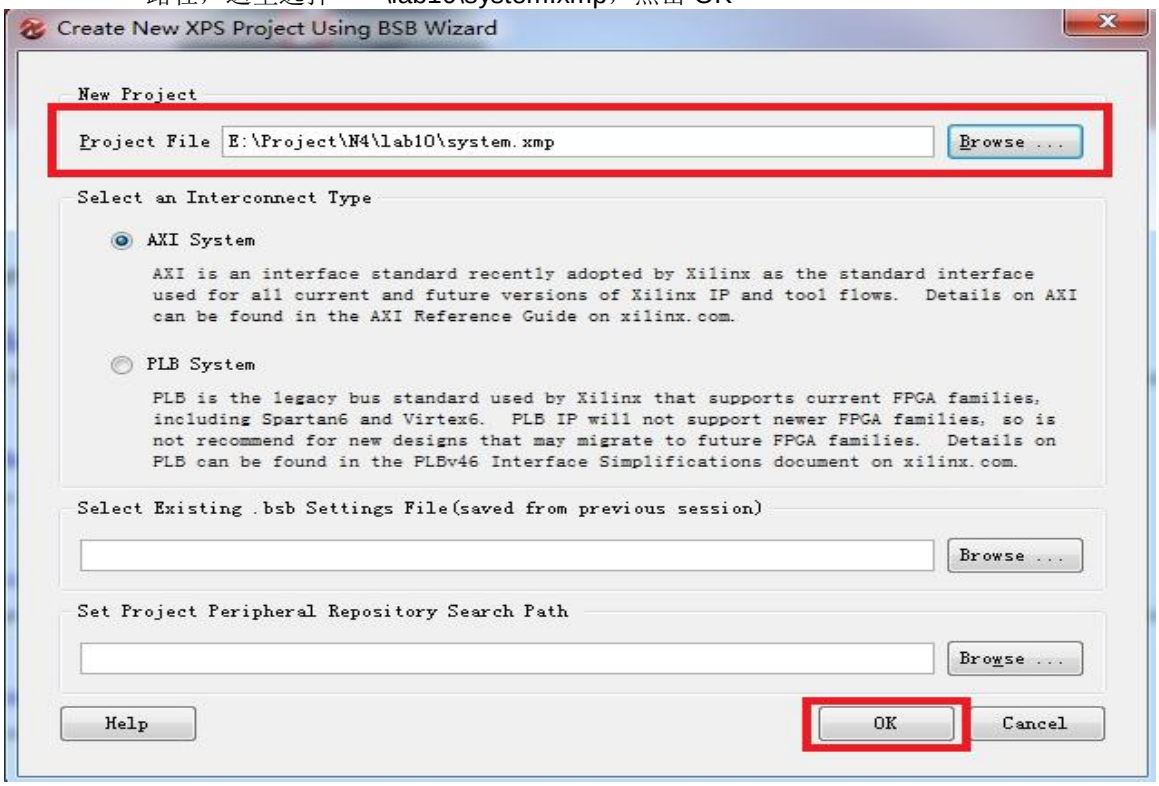
1-1. 运行 Xilinx Platform Studio，创建一个新的工程

1-1.1. 选择开始菜单-所有程序--Xilinx Design Tools--ISE Design Suit 14.3--EDK—Xilinx Platform Studio。点击运行 Xilinx Platform Studio。

1-1.2. 点击 Create New Project Using Base Sysetm Builder 来打开新工程建立向导



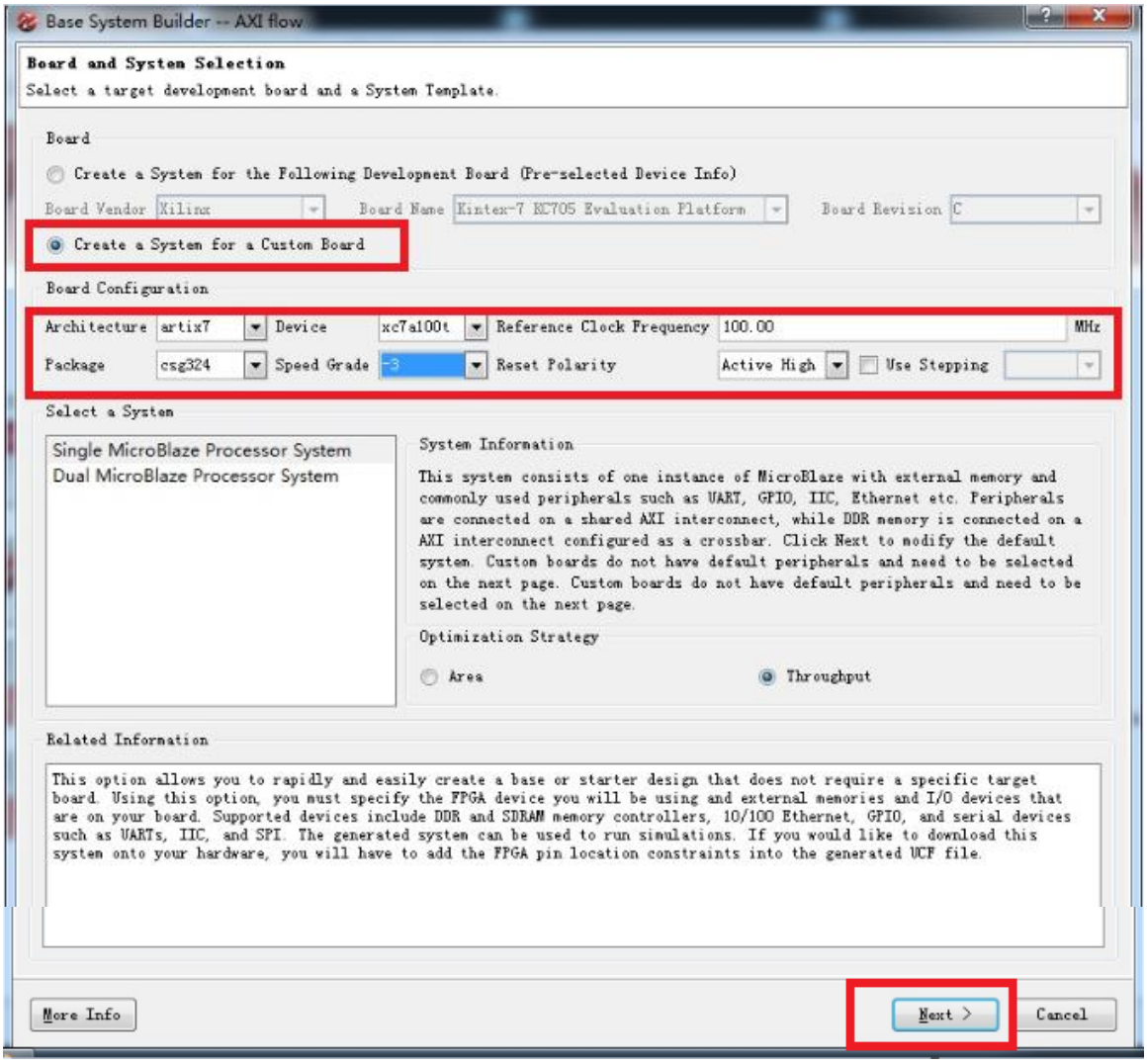
1-1.3. 出现 Create New XPS Project Using BSB Wizard 对话框，在 Project File 处选择自己的工程路径，这里选择*****\lab10\system.xmp，点击 OK



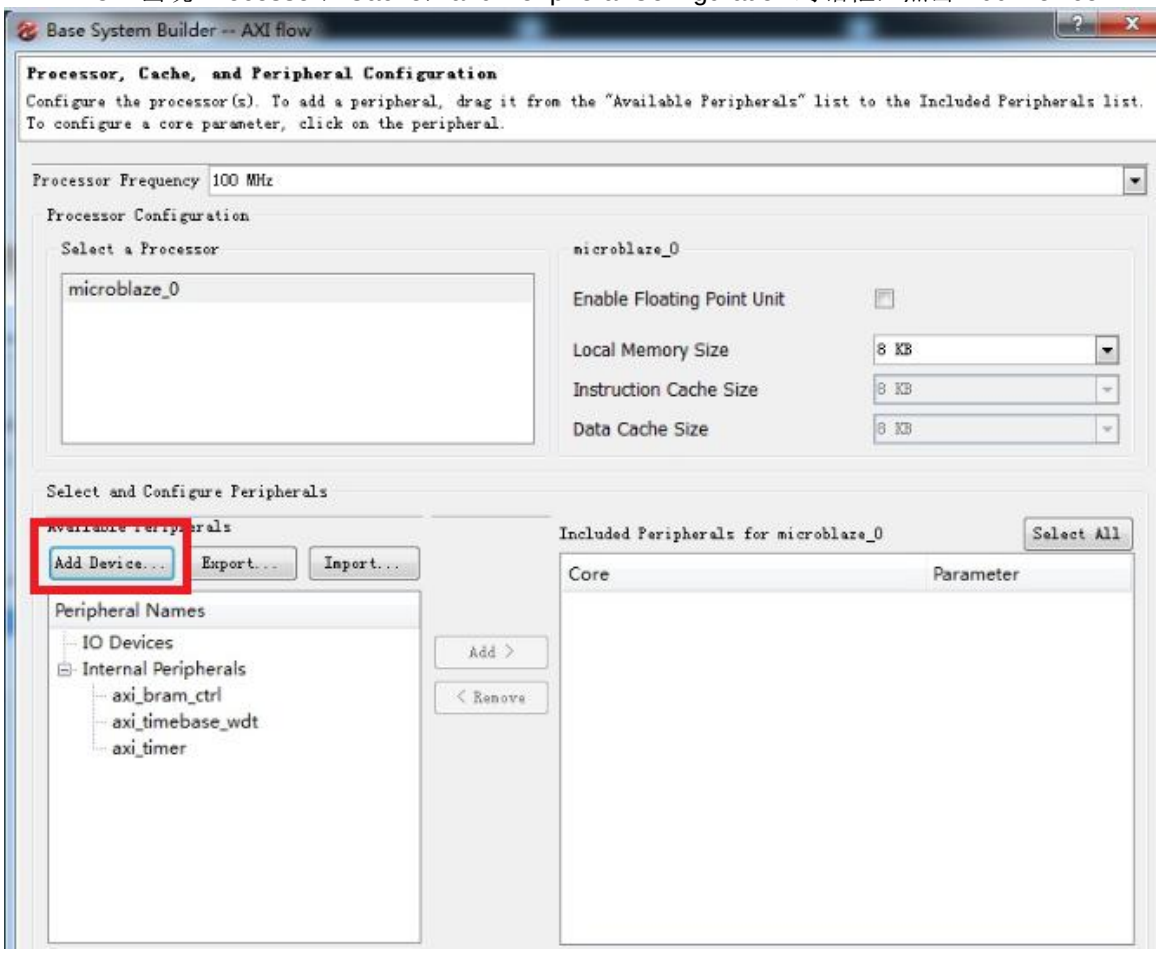
1-1.4. 出现 Board and System Selection 对话框，选择 Create a System for a Custom Board Board Configuration 中的配置信息如下：

Architecture ： **artix7**
Device ： **xc7a100t**
Clock Frequency ： **100.00Mhz**
Package ： **csg324**
Speed Grade ： **-3**
Reset Polarity ： **Active High**

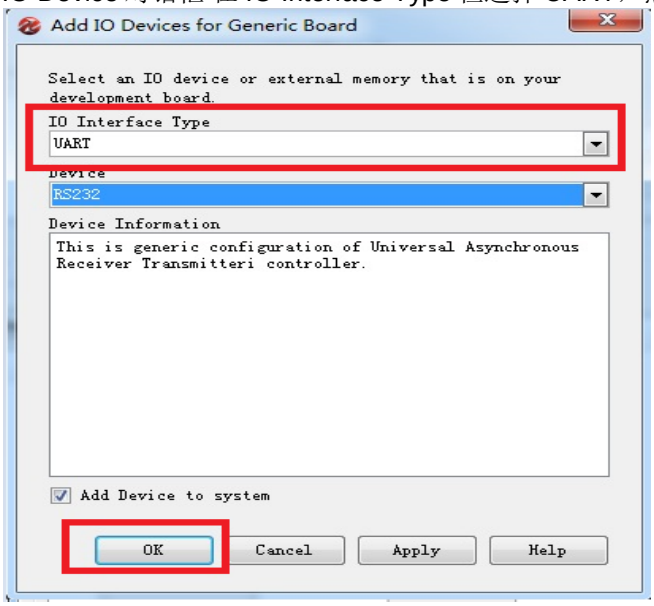
点击 next。



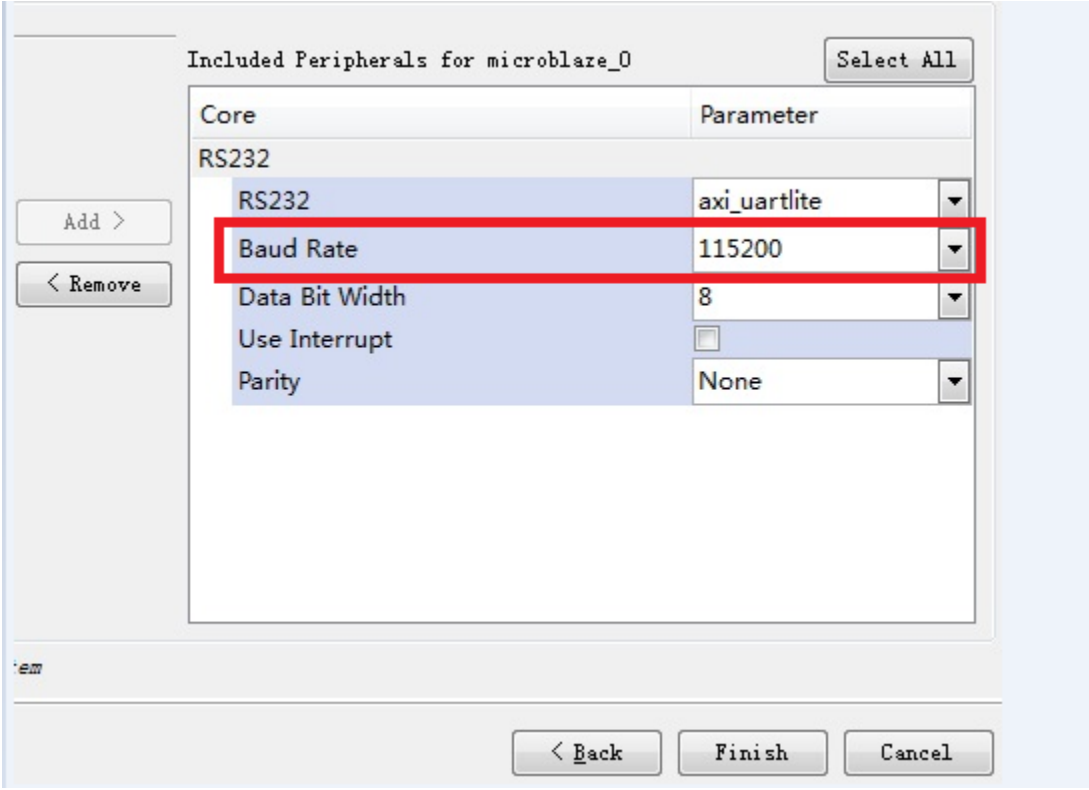
1-1.5. 出现 Processor，Cache，and Peripheral Configuration 对话框，点击 Add Device



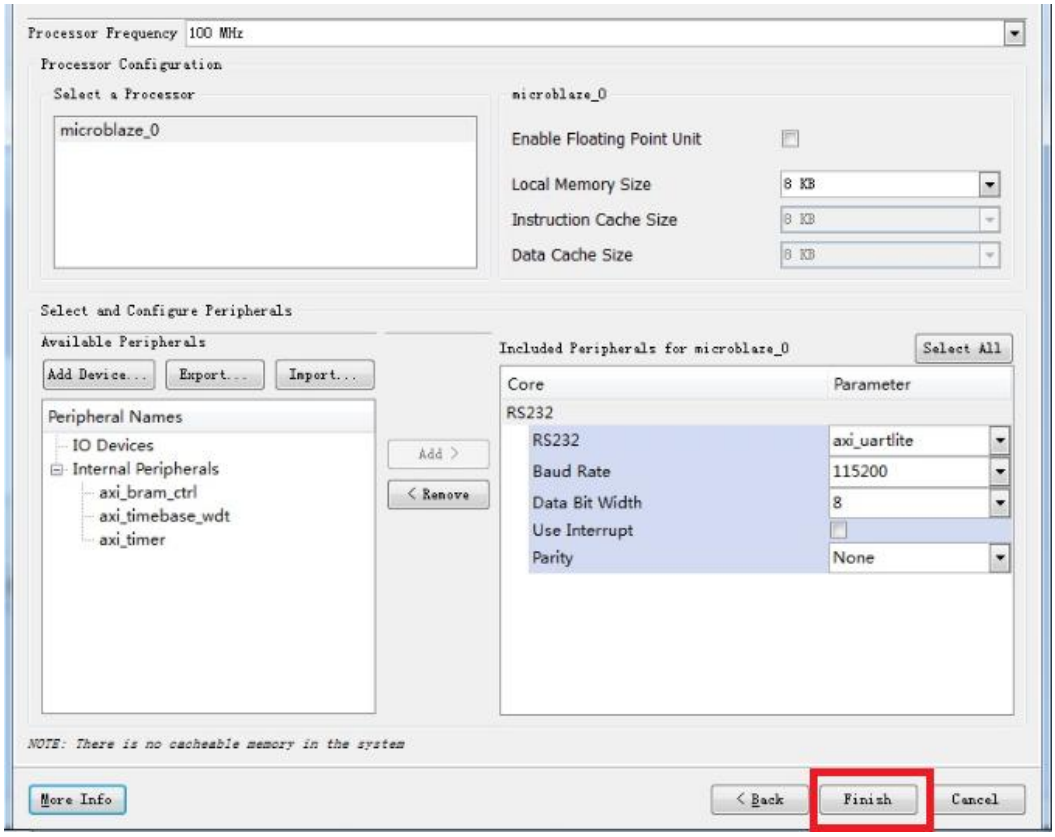
1-1.6. 出现 Add IO Device 对话框 在 IO Interface Type 栏选择 UART，点击 OK



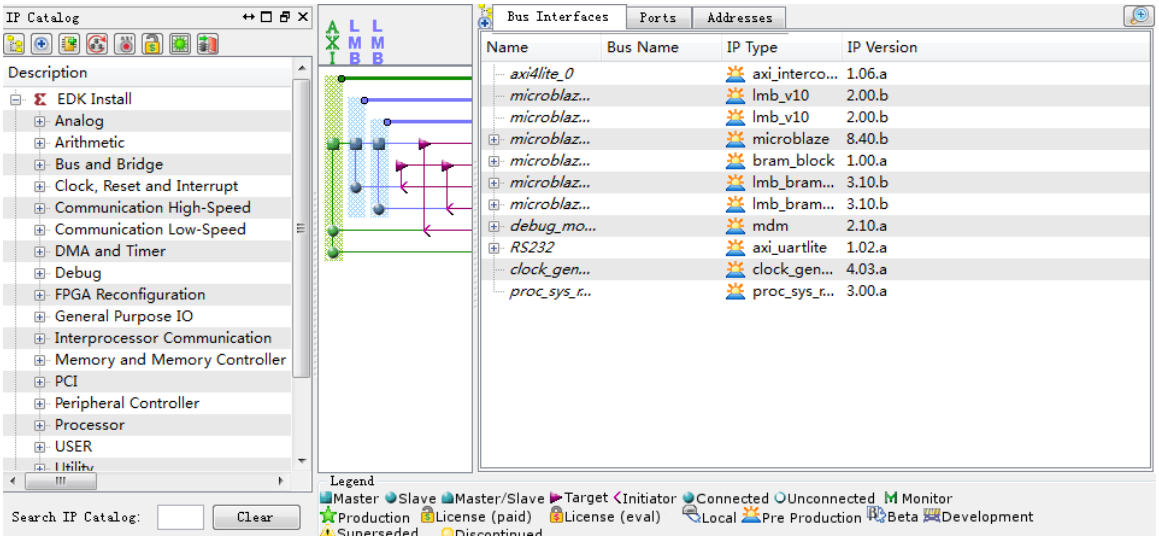
1-1.7. 将 Include Peripherals 栏中 RS232 中 Baud Rate 改为 115200。



修改完毕后，点击 Finish



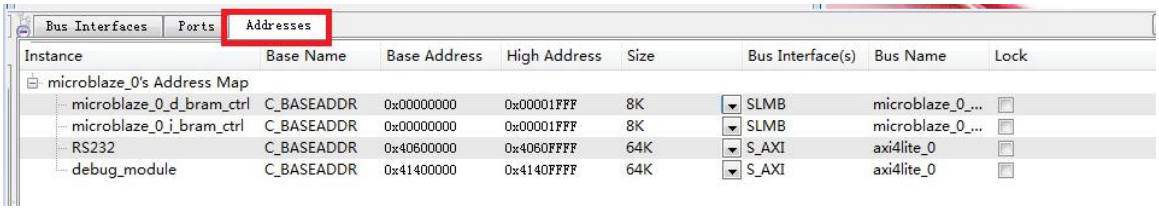
1-1.8.至此，一个只带有串口 IP 核的 EDK 工程创建完毕



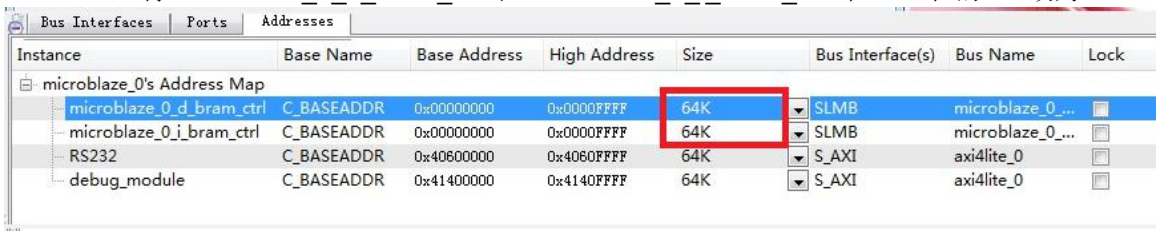
第二步 配置工程参数，添加 VGA IP 核并配置其参数

2-1.修改 Microblaze 的 bram 大小

2-1.1. 选择 Address 栏



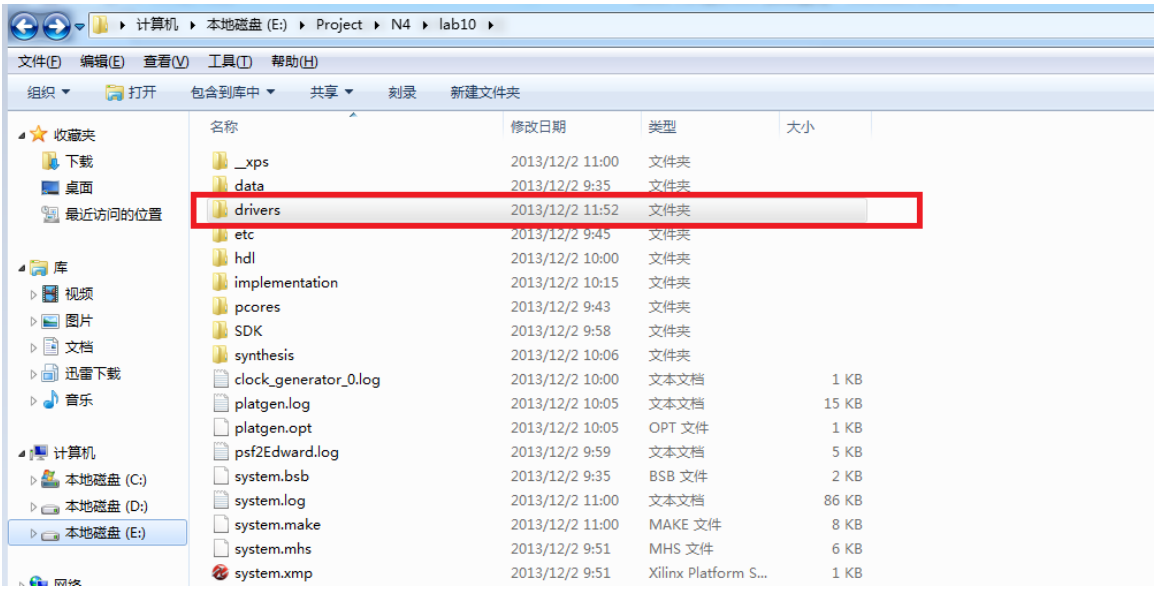
2-1.2. 将 microblaze_0_d_bram_ctrl 和 microblaze_0_i_bram_ctrl 中 Size 栏的 8K 改为 64K



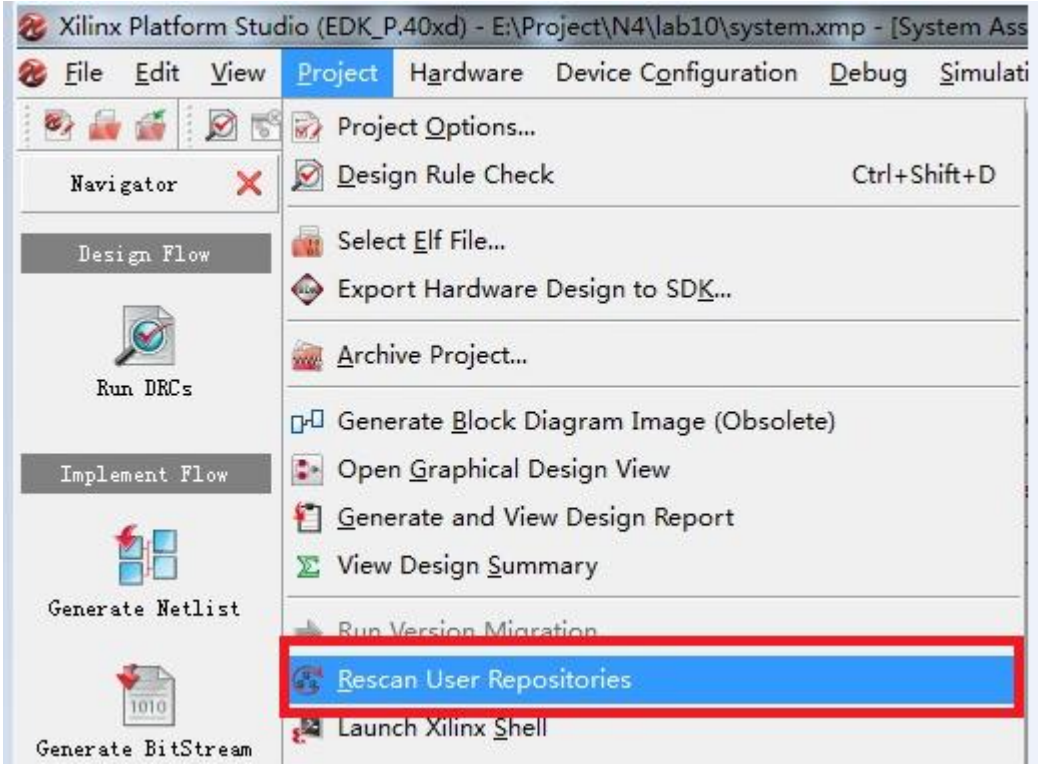
2-2.导入 VGA 的 IP 核，该 IP 核源代码与配置信息可在**\lab10\Source 目录下找到

2-2.1.将 **\lab10\Source\ip_vga_v1_00_a 拷贝到工程目录 **\lab10\pcores\下

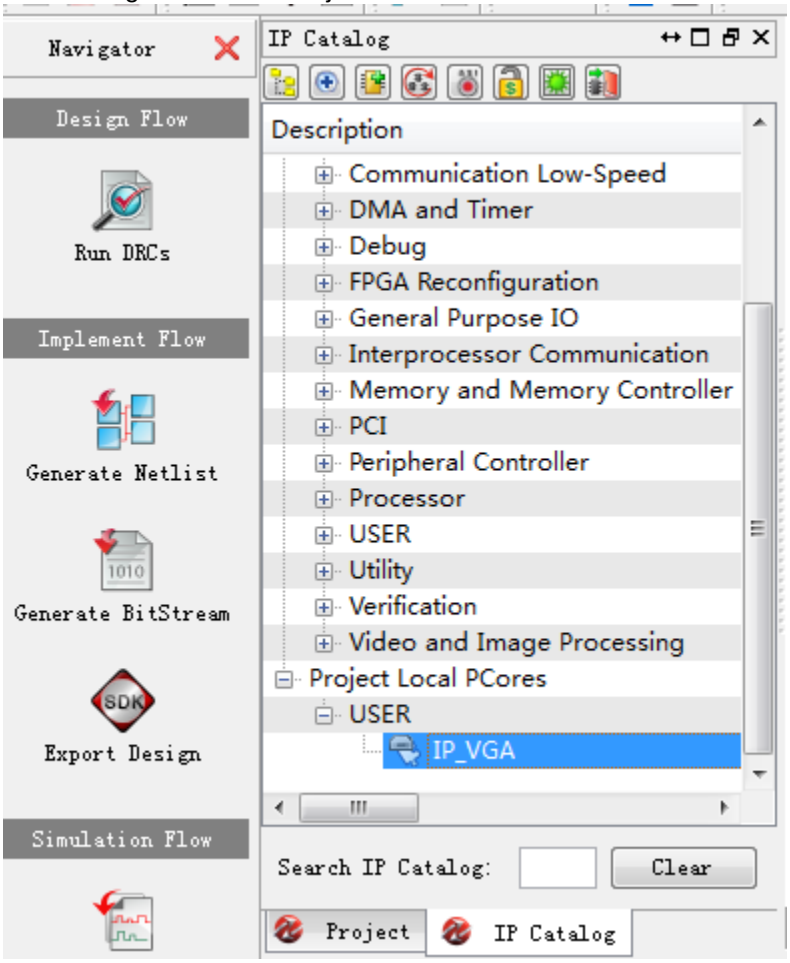
2-2.2. 将**\lab10\Source\drivers 拷贝到工程目录 **lab10\下



2-2.3. 在 XPS 下选择 Project—Rescan User Repositories

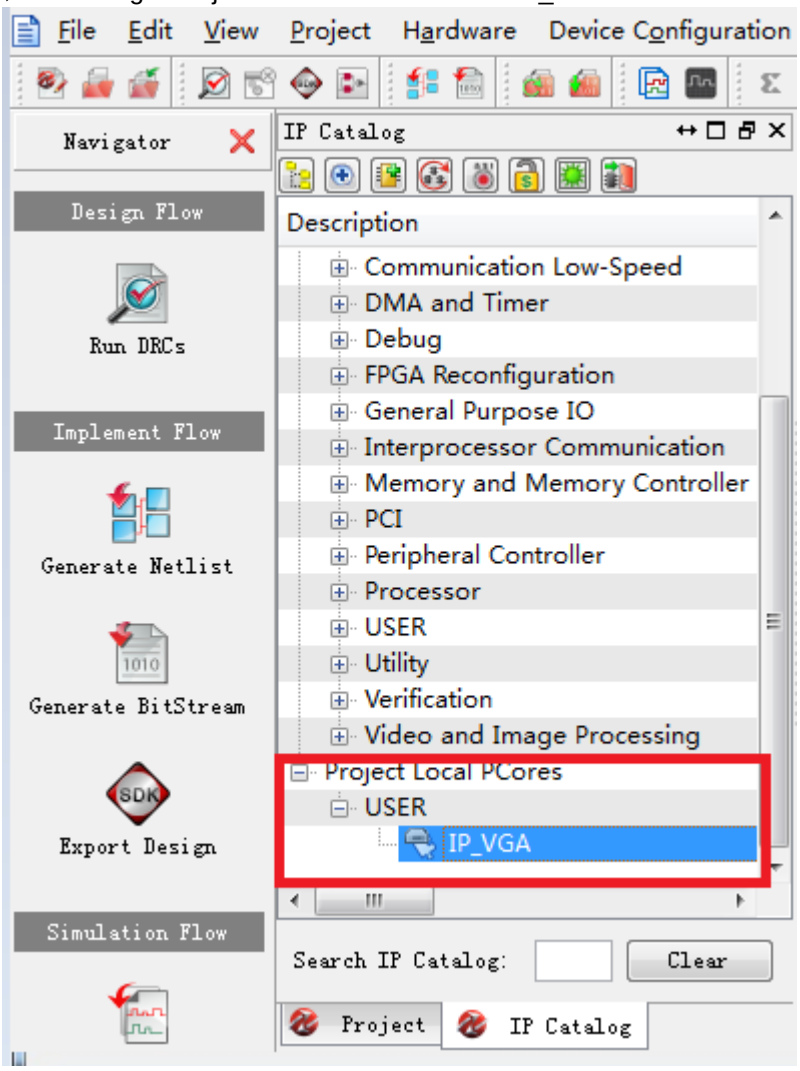


2-2.4. 选择 IP Catalog 可以看到在 Project Local PCores 中添加了刚刚导入的 IP 核 IP_VGA

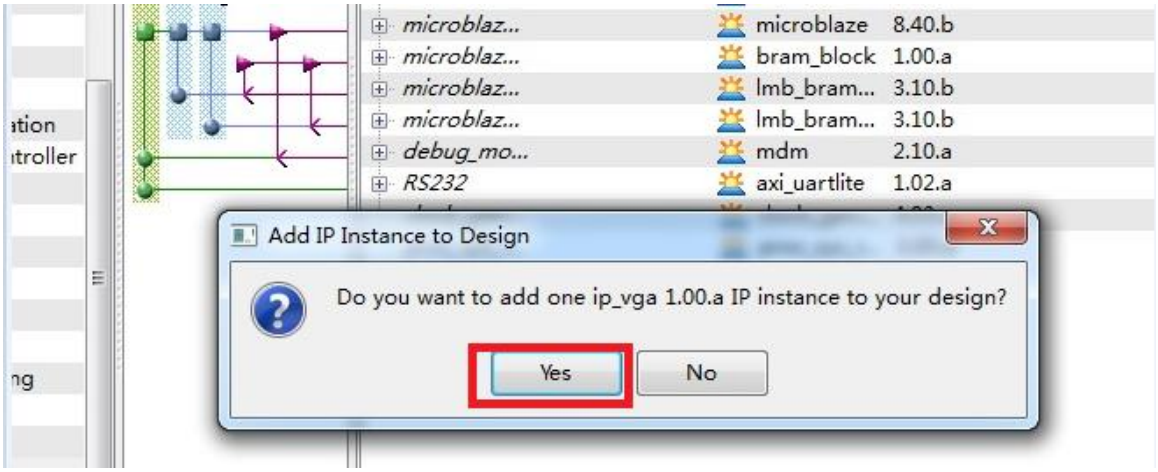


2-3.添加 VGA IP 核到工程中

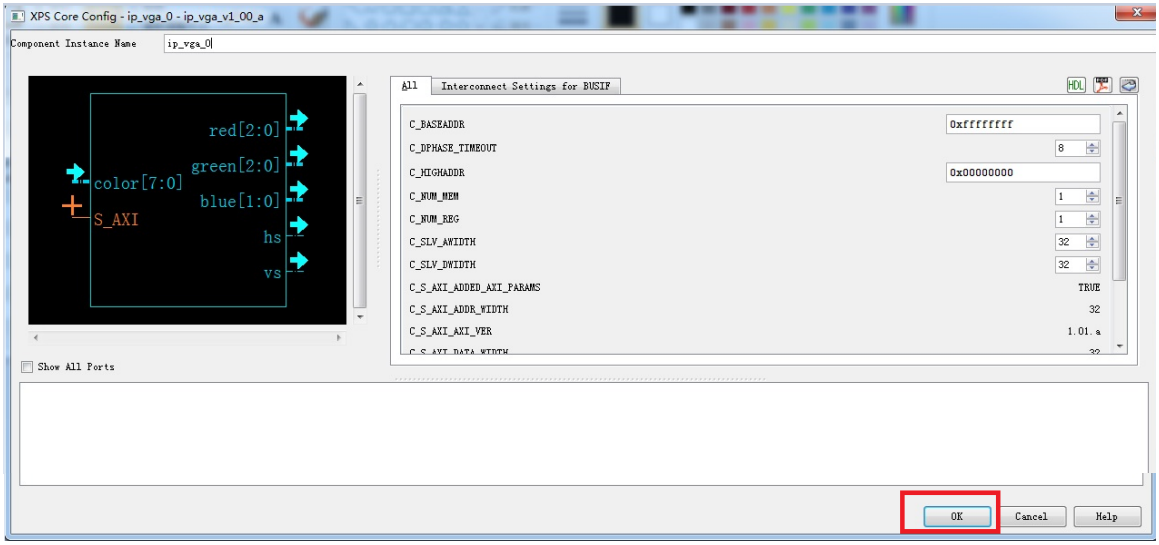
2-3.1. 双击 IP Catalog—Project Local PCores-USER-IP_VGA



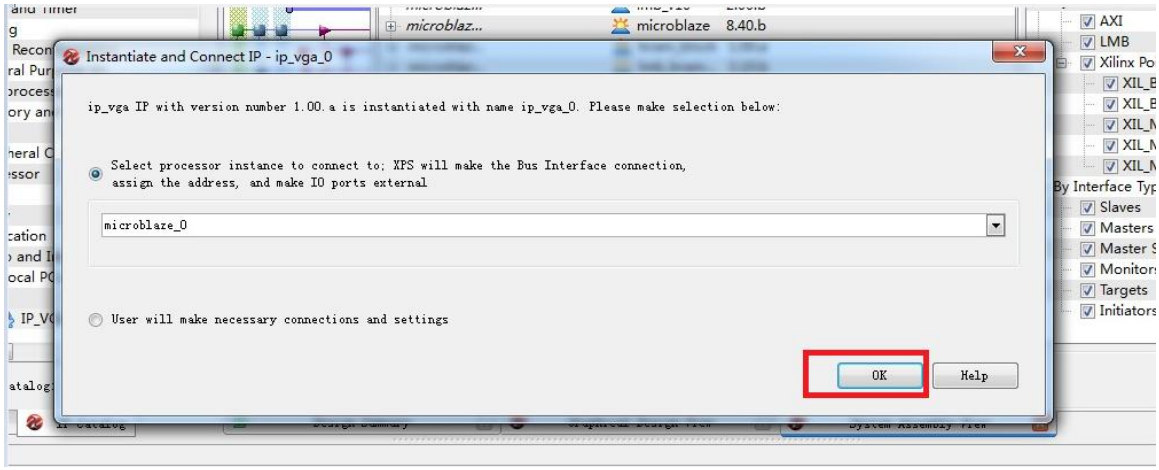
2-3.2. 出现如下对话框，选择 Yes



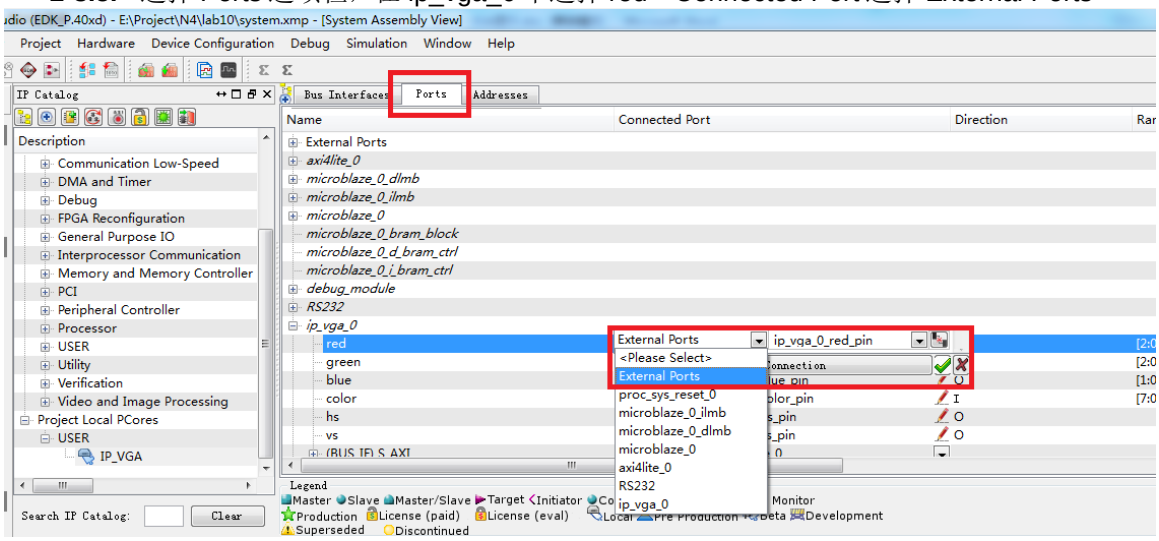
2-3-3. 出现如下对话框，保持默认选项，点击 OK



2-3-4. 出现如下对话框，点击 OK



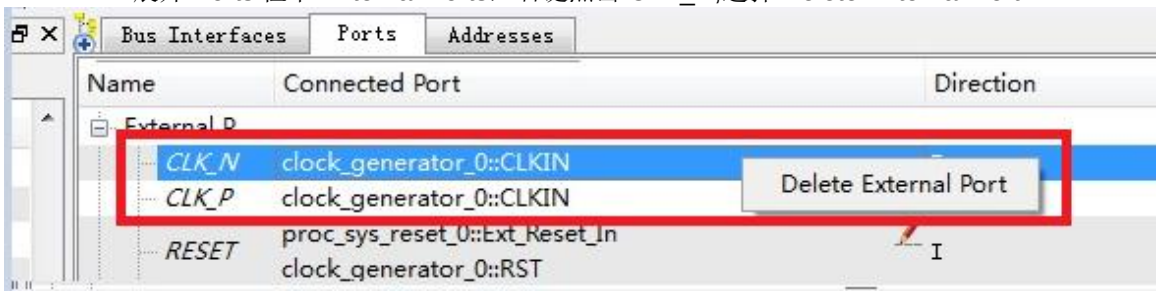
2-3-5. 选择 Ports 选项栏，在 ip_vga_0 中选择 red—Connected Port 选择 External Ports



2-3.6. 重复 2-1.5 将 green,blue,color,hs,vs make External

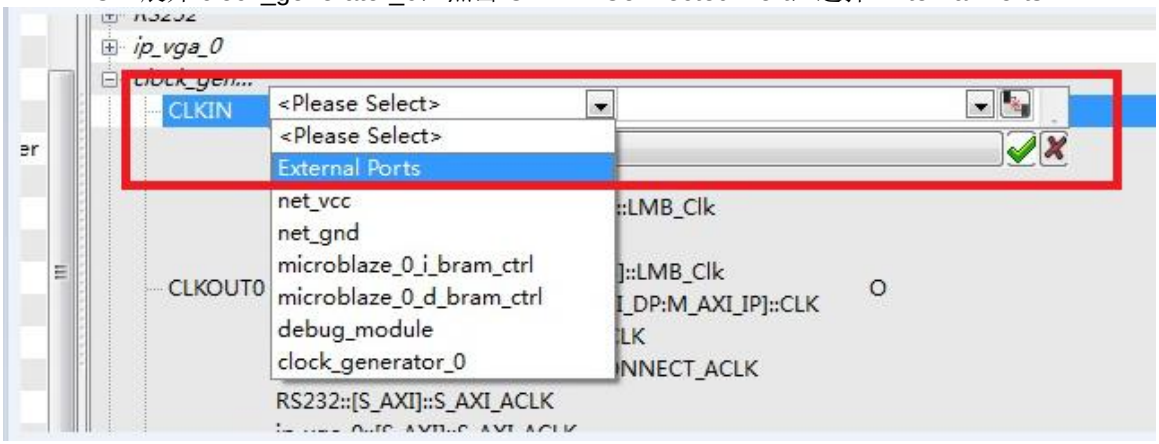
2-4. 修改系统时钟

2-4.1. 展开 Ports 栏中 External Ports，右键点击 CLK_N,选择 Delete External Port

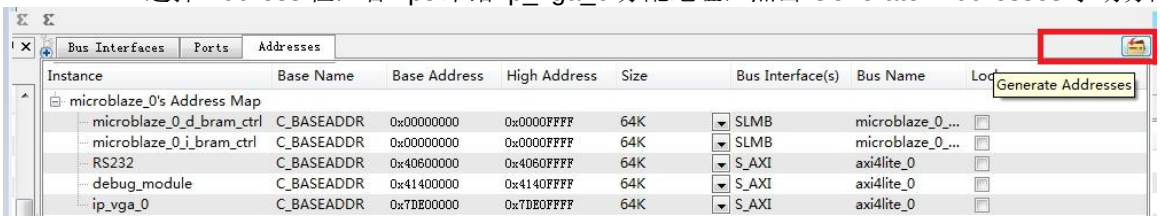


2-4.2. 重复 2-2.1 将 CLK_P delte external port

2-4.3. 展开 clock_generator_0，点击 CLKIN--Connected Port，选择 External Ports



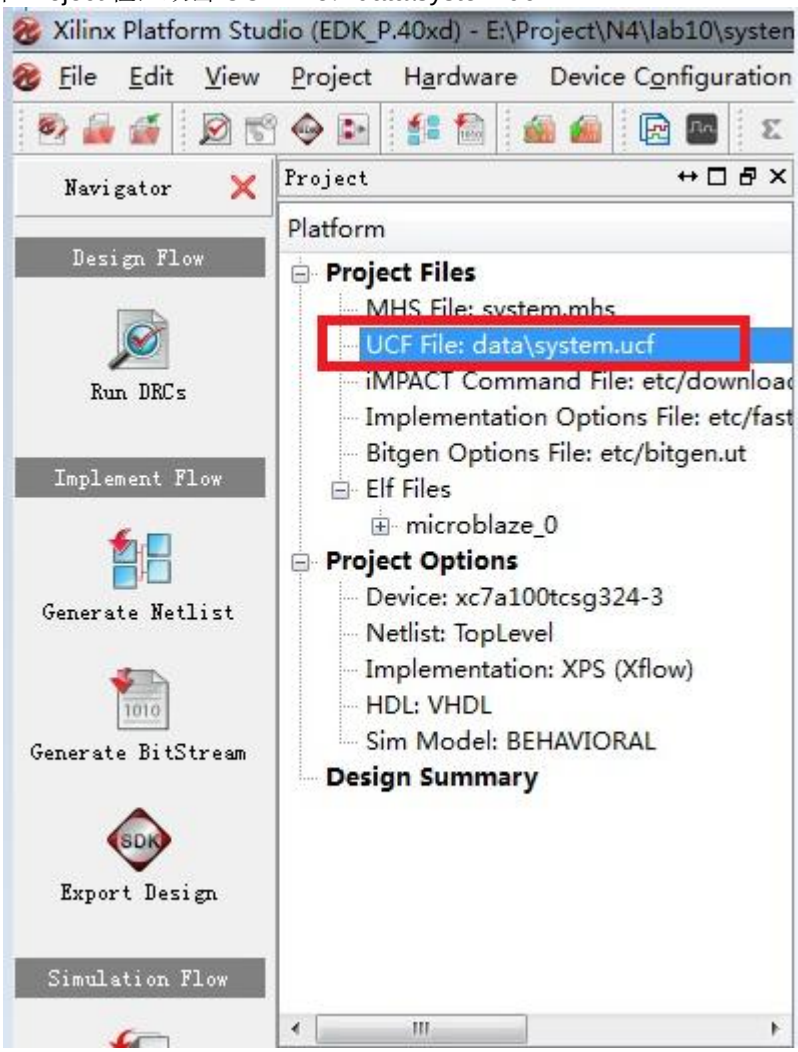
2-4.4. 选择 Address 栏，若 xps 未给 ip_vga_0 分配地址，点击 Generate Addresses 手动分配地址



第三步　添加用户约束文件并将工程导入 SDK

3-1. 打开 UCF 文件，根据需求进行修改

3-1.1. 选择 Project 栏，双击 UCK File：data\system.ucf

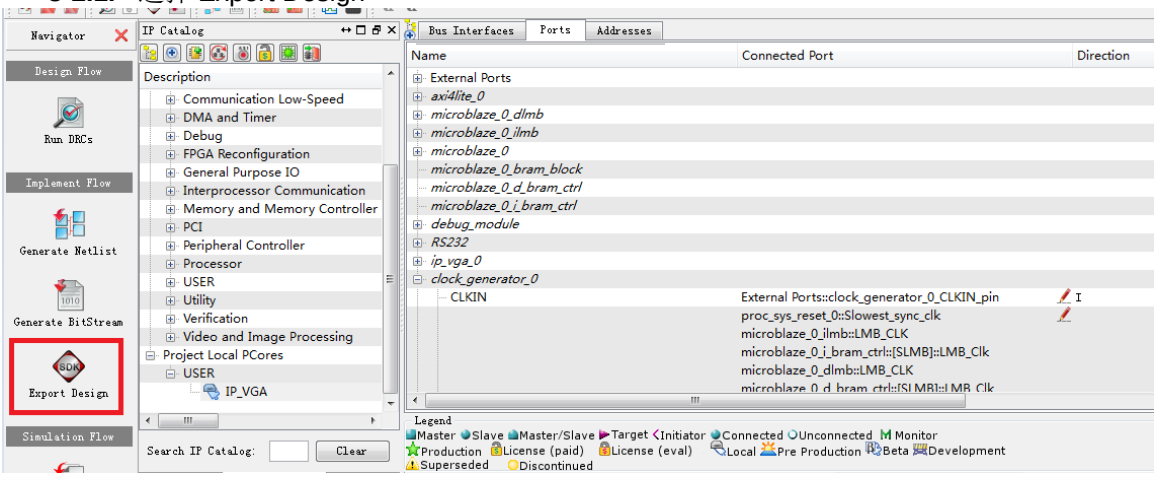


3-1.2. 这里手动输入 LOC（引脚位置）约束代码，保存

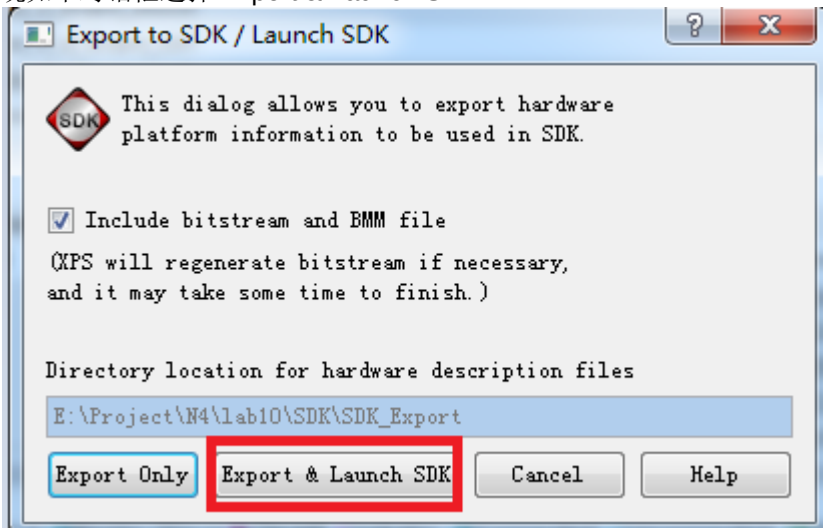
```
# Clock signal
NET "clock_generator_0_CLKIN_pin"    LOC = "E3"   | IOSTANDARD = "LVCMOS33";
NET "clock_generator_0_CLKIN_pin" TNM_NET = sys_clk_pin;
TIMESPEC TS_sys_clk_pin = PERIOD sys_clk_pin 100 MHz HIGH 50%;


NET "RESET"          LOC = "R10" | IOSTANDARD = "LVCMOS33";     #Bank = 14, P


# USB-RS232 Interface
NET "RS232_Uart_1_sin"          LOC = "C4"   | IOSTANDARD = "LVCMOS33";     #
NET "RS232_Uart_1_sout"         LOC = "D4"   | IOSTANDARD = "LVCMOS33";     #


# Switches
NET "ip_vga_0_color_pin<0>"         LOC = "U9"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_color_pin<1>"         LOC = "U8"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_color_pin<2>"         LOC = "R7"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_color_pin<3>"         LOC = "R6"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_color_pin<4>"         LOC = "R5"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_color_pin<5>"         LOC = "V7"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_color_pin<6>"         LOC = "V6"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_color_pin<7>"         LOC = "V5"   | IOSTANDARD = "LVCMOS33";

# VGA Connector
NET "ip_vga_0_red_pin<0>"     LOC = "B4"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_red_pin<1>"     LOC = "C5"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_red_pin<2>"     LOC = "A4"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_blue_pin<1>"    LOC = "D7"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_blue_pin<2>"    LOC = "D8"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_green_pin<0>"      LOC = "A5"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_green_pin<1>"      LOC = "B6"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_green_pin<2>"      LOC = "A6"   | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_hs_pin"         LOC = "B11"  | IOSTANDARD = "LVCMOS33";
NET "ip_vga_0_vs_pin"         LOC = "B12"  | IOSTANDARD = "LVCMOS33";
```

3-2. 生成比特流，将工程导入 SDK

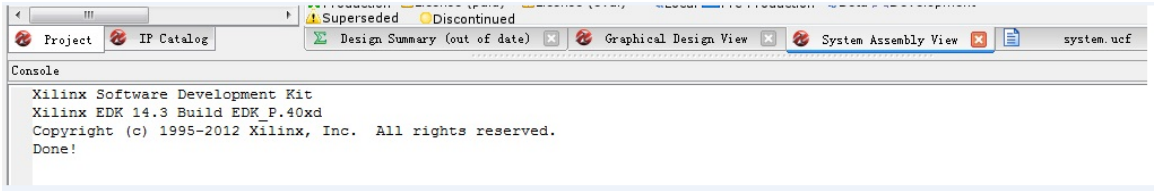
3-2.1. 选择 Export Design



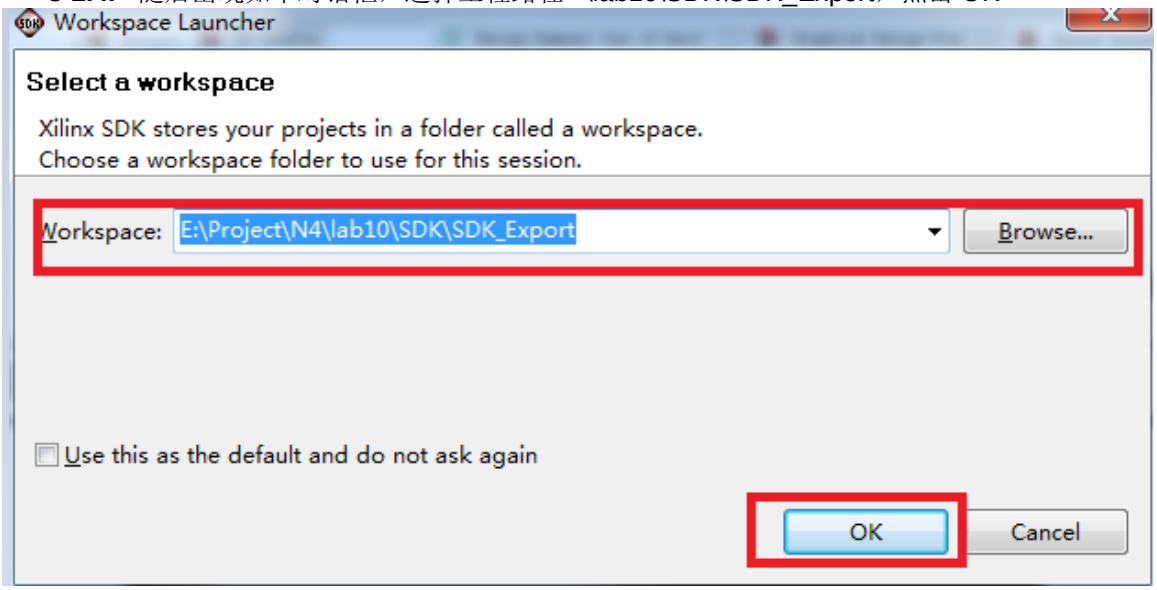
3-2-2. 出现如下对话框选择 Export & Launch SDK



3-2-3. 等待 XPS 生成比特流，并将工程导入 SDK



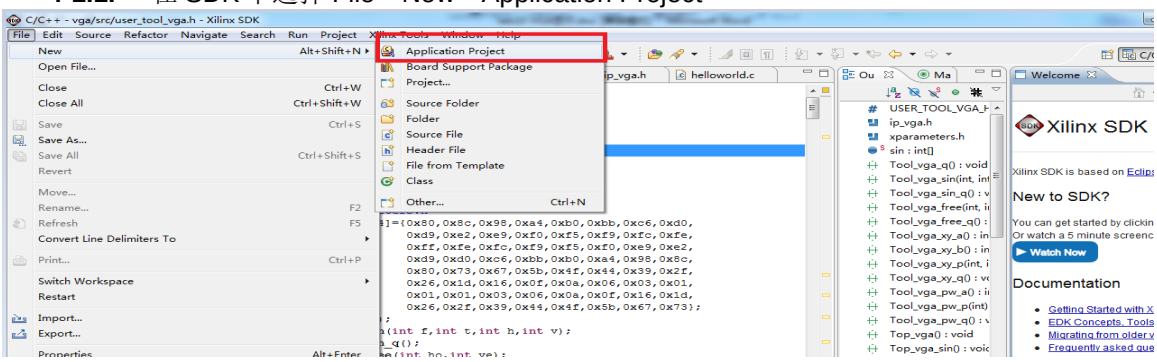
3-2-4. 随后出现如下对话框，选择工程路径**\lab10\SDK\SDK_Export，点击 OK



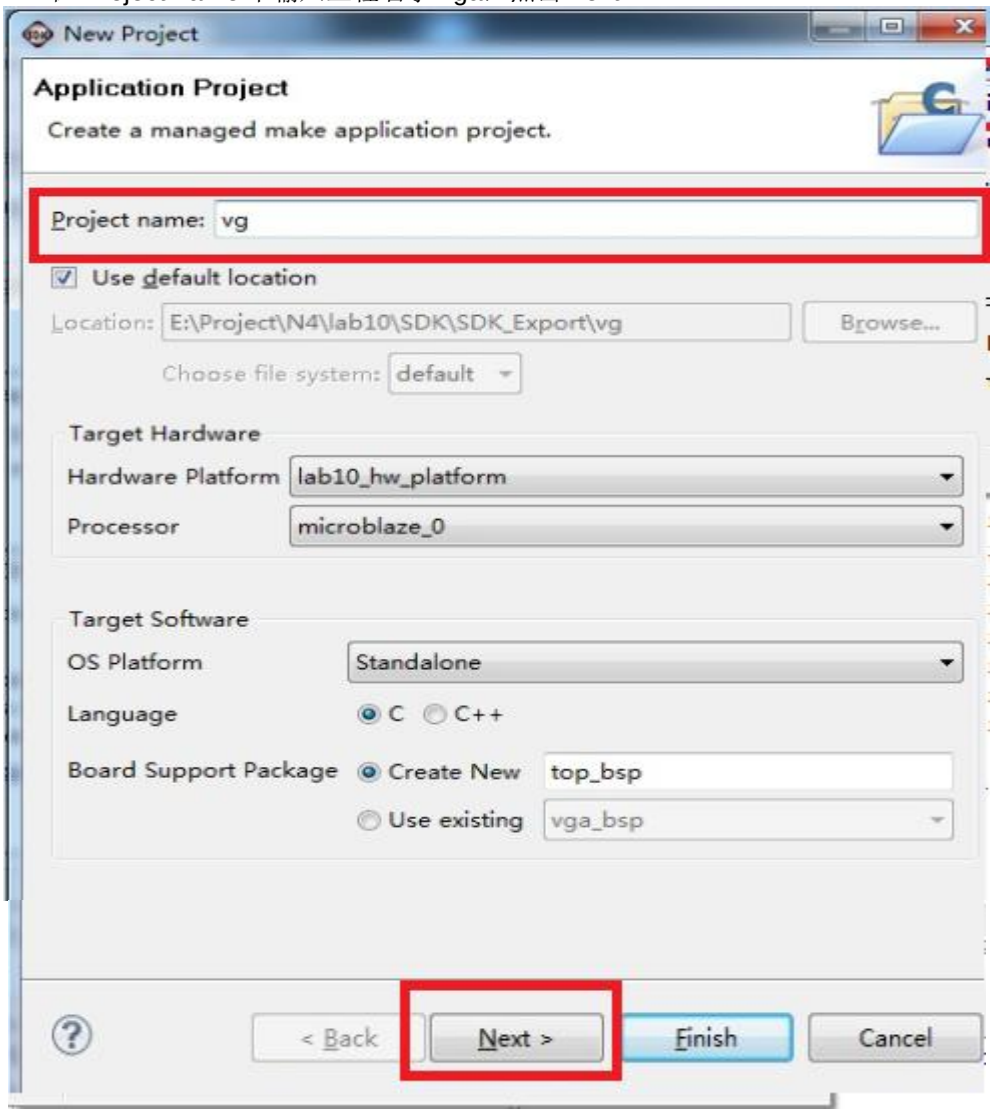
第四步 添加 APP

4-1. 创建新的工程

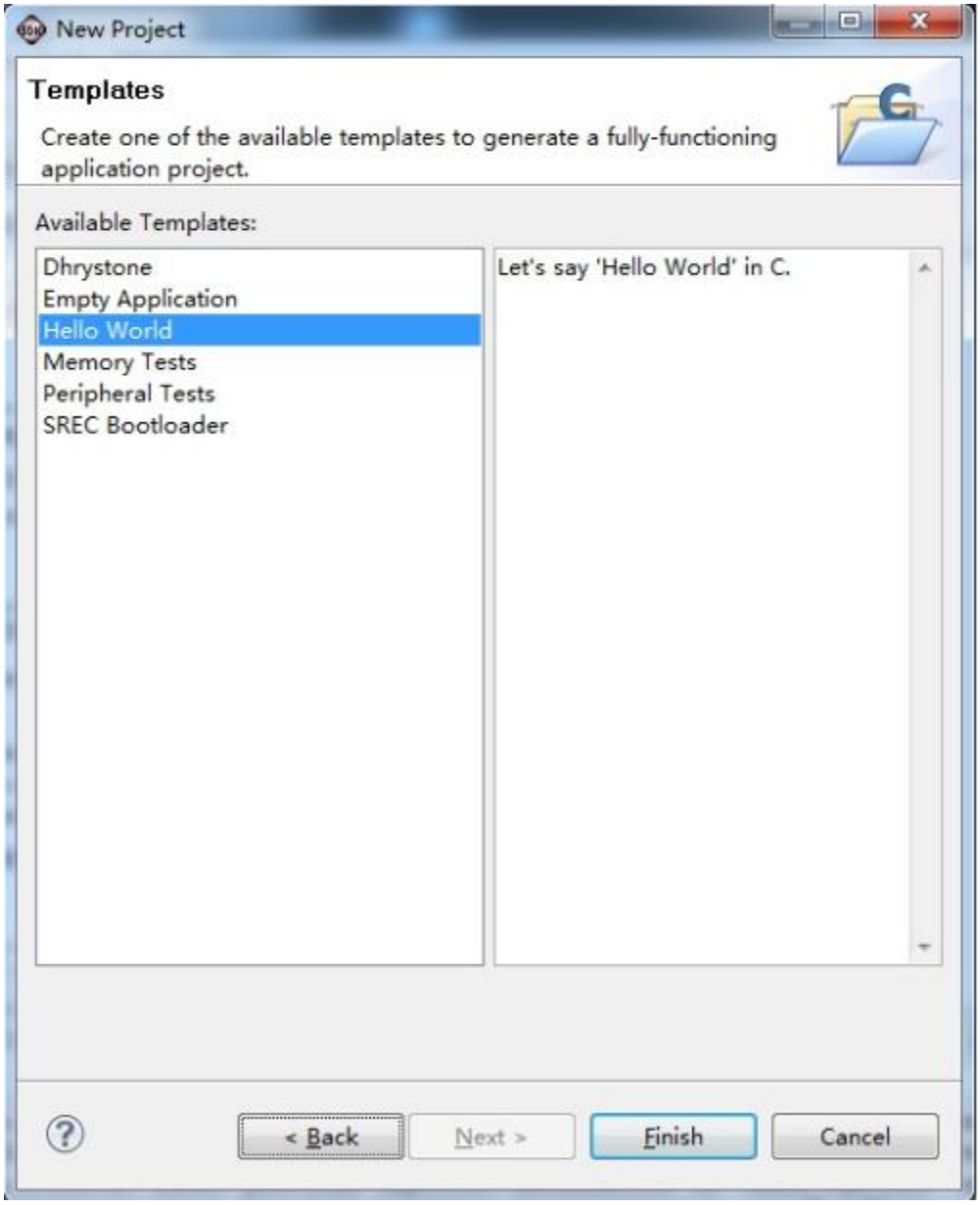
4-1.1. 在 SDK 中选择 File—New—Application Project



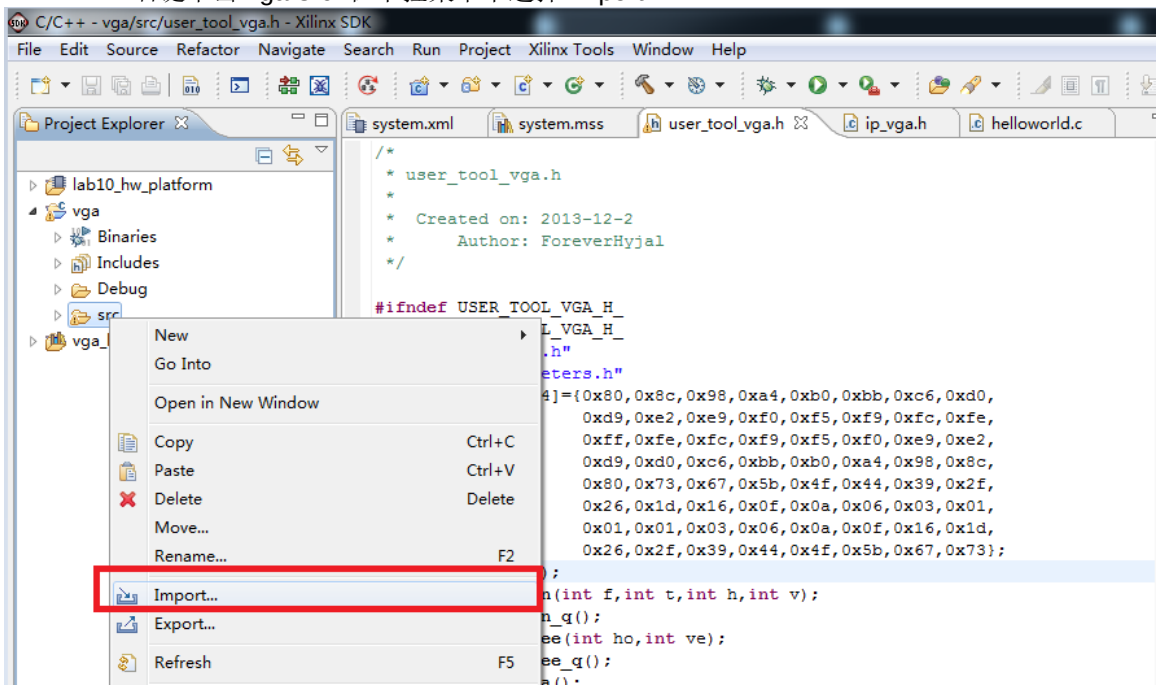
4-1.2. 在 Project name 中输入工程名字 vga，点击 next



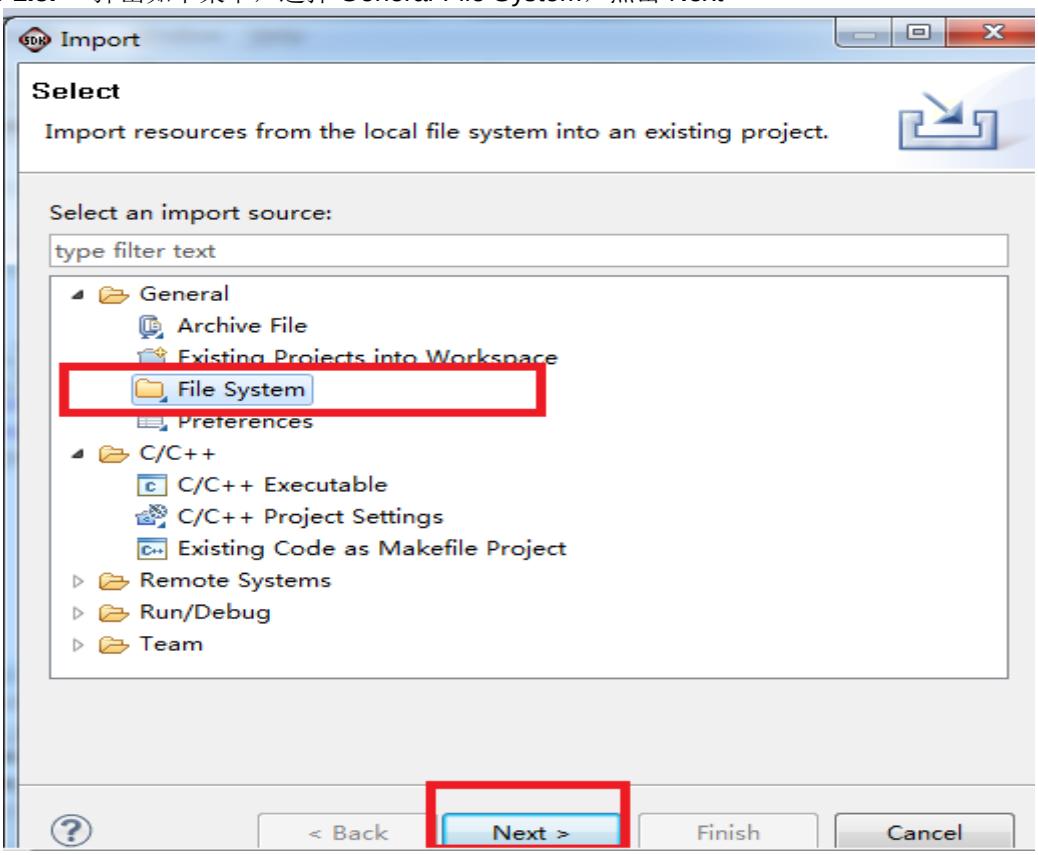
4-1.3. 选择hello world 工程，点击 finish



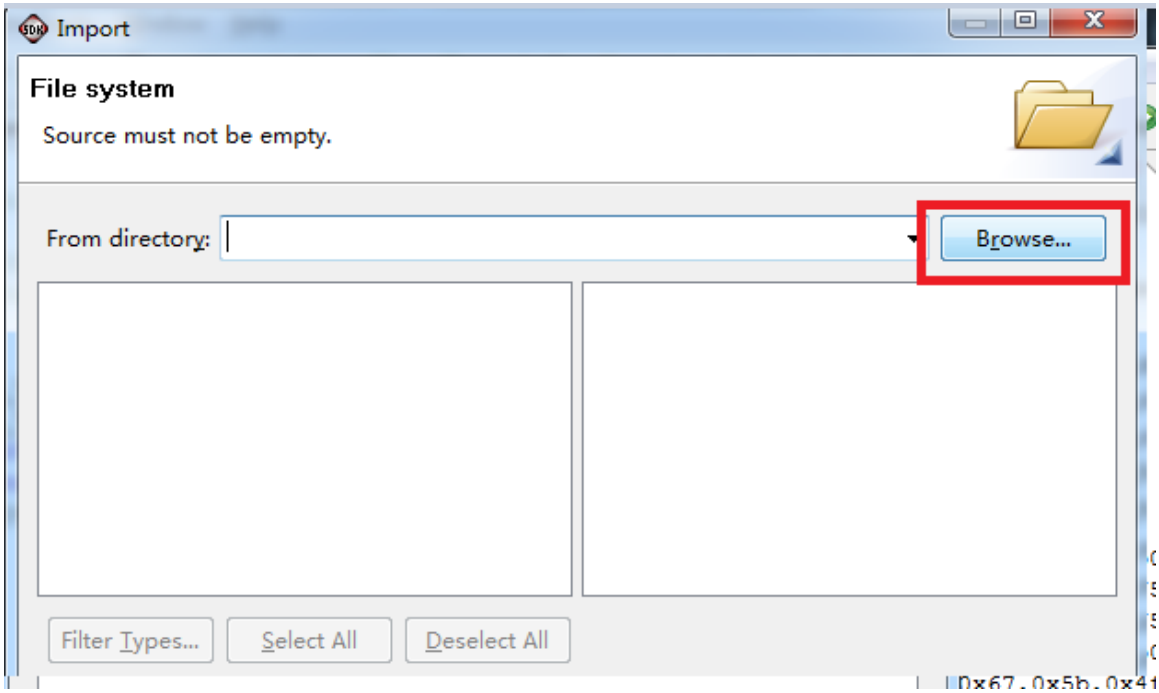
4-1.4. 右键单击 vga-src 在下拉菜单中选择 Import



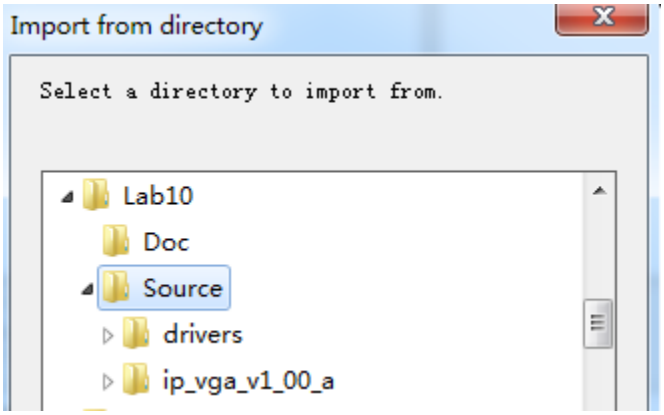
4-1.5. 弹出如下菜单，选择 General-File System，点击 Next



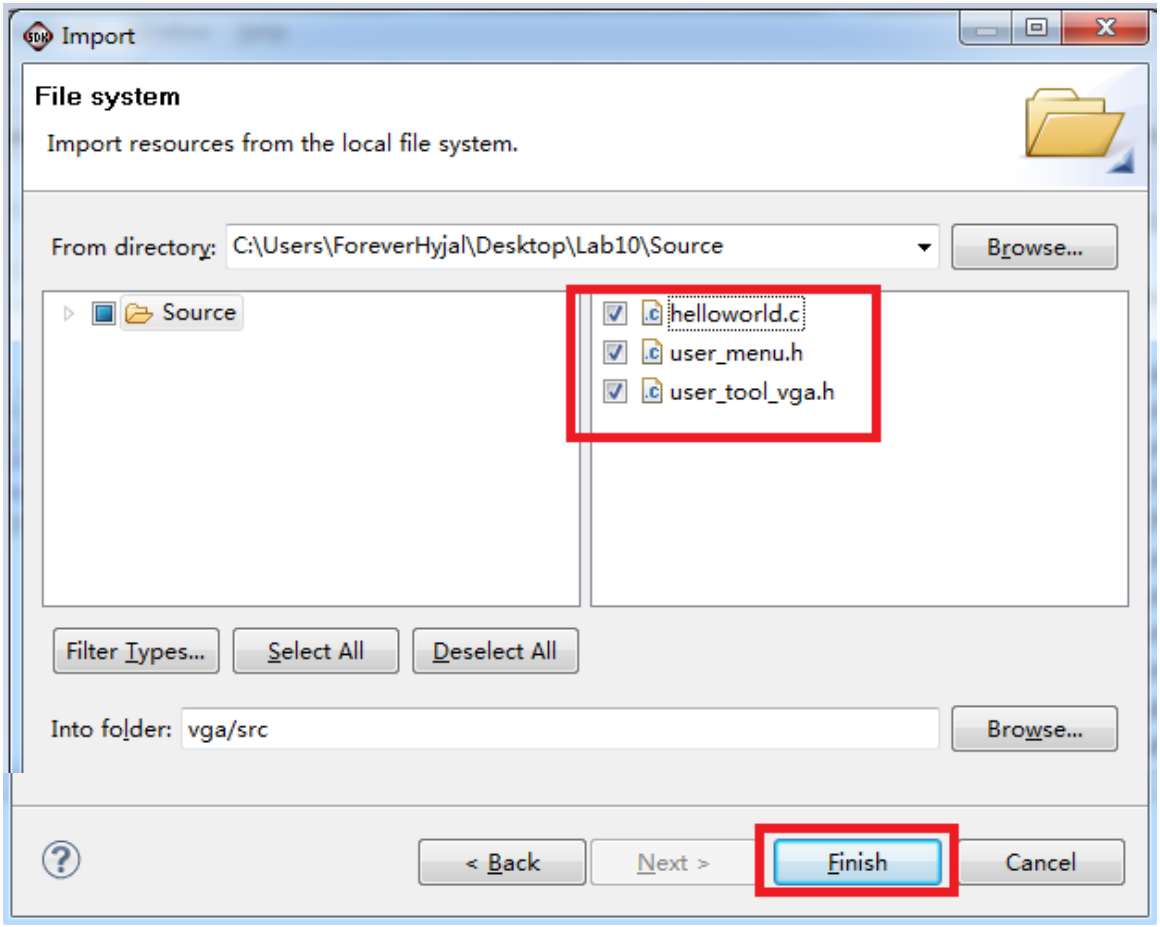
4-1.6. 在如下选框中 选择源文件路径点击 Browse



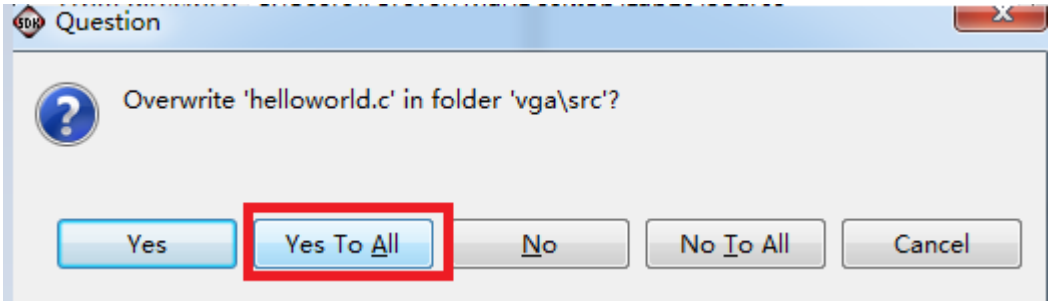
4-1.7. 选择**\lab10\Source，点击确定



4-1.8. 勾选 3 个 C 文件，点击 Finish

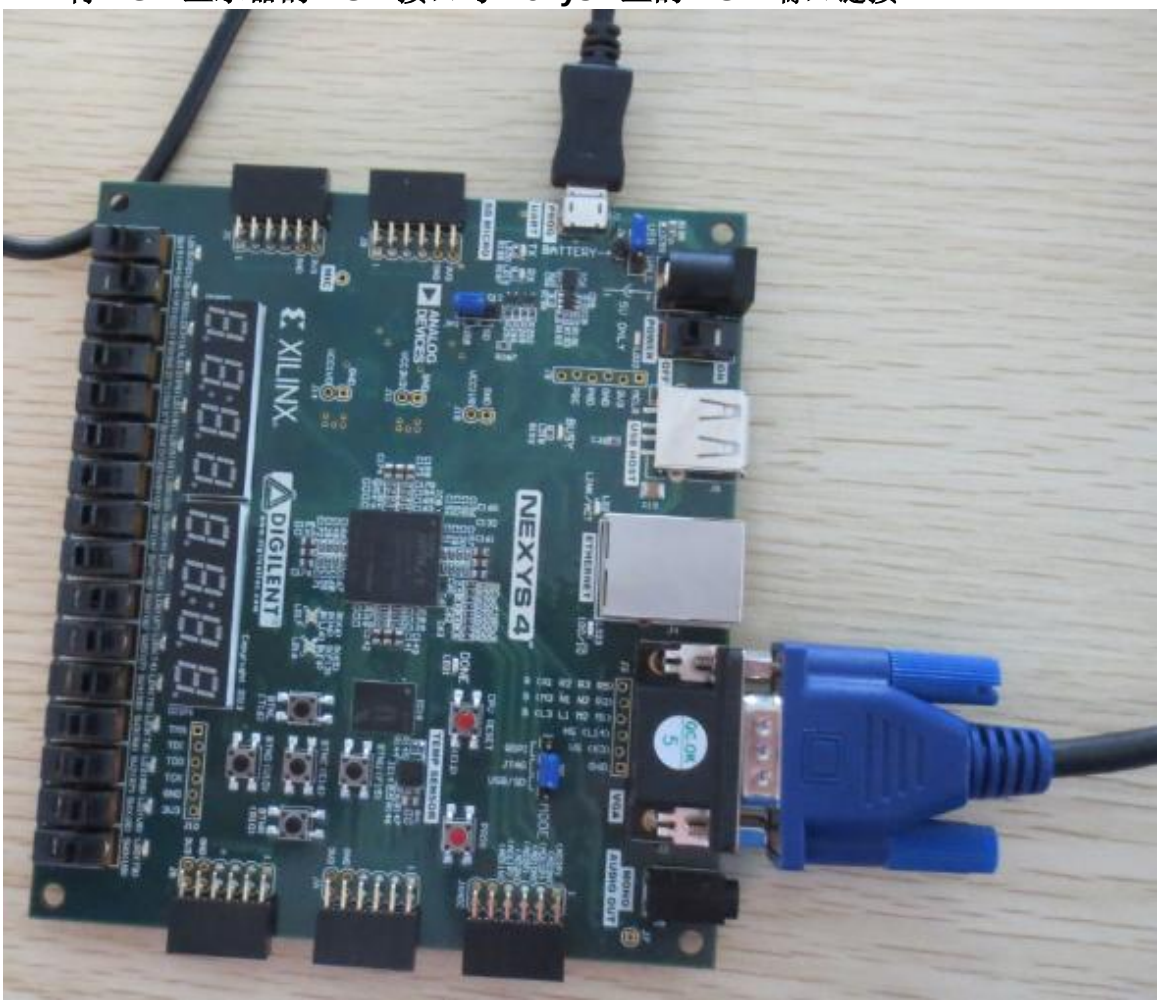


4-1.9.选择 Yes to All



第五步　上板验证

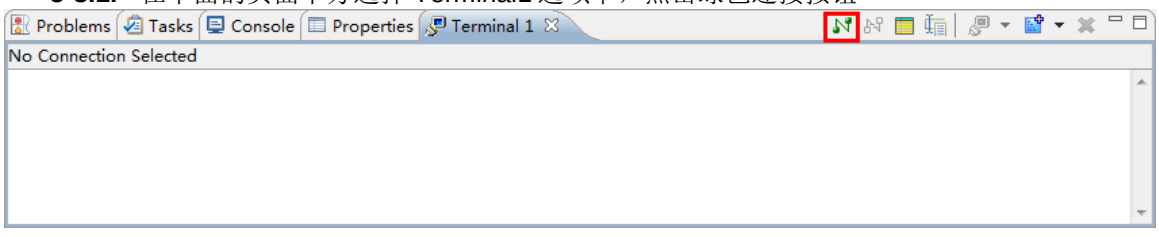
5-1.　将 VGA 显示器的 VGA 接口与 Nexys4 上的 VGA 端口链接



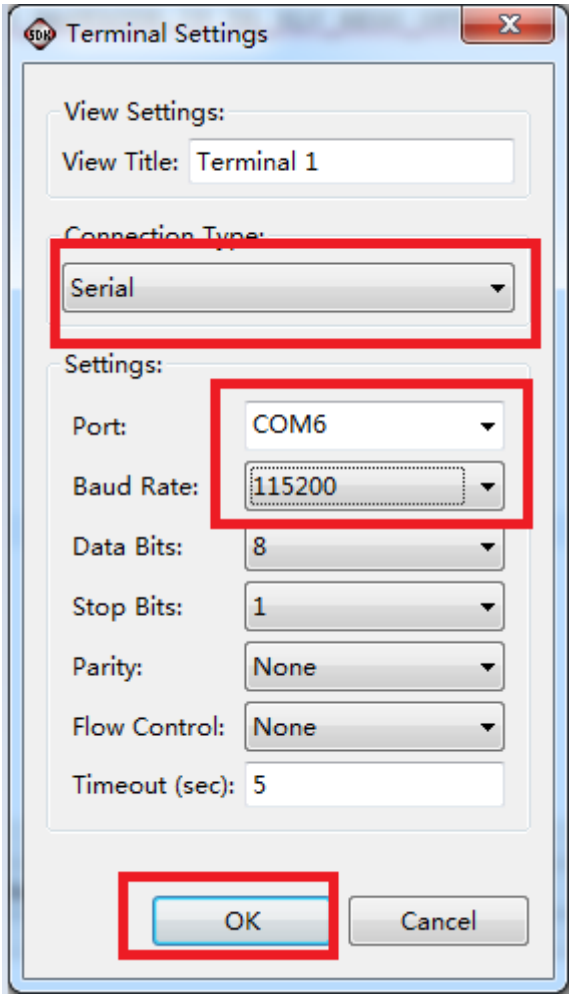
5-2.　将 Nexys4 与 PC 的 USB 接口连接

5-3.　在 SDK 中打开串口

5-3.1.　在下面的页面下方选择 Terminal1 选项卡，点击绿色连接按钮

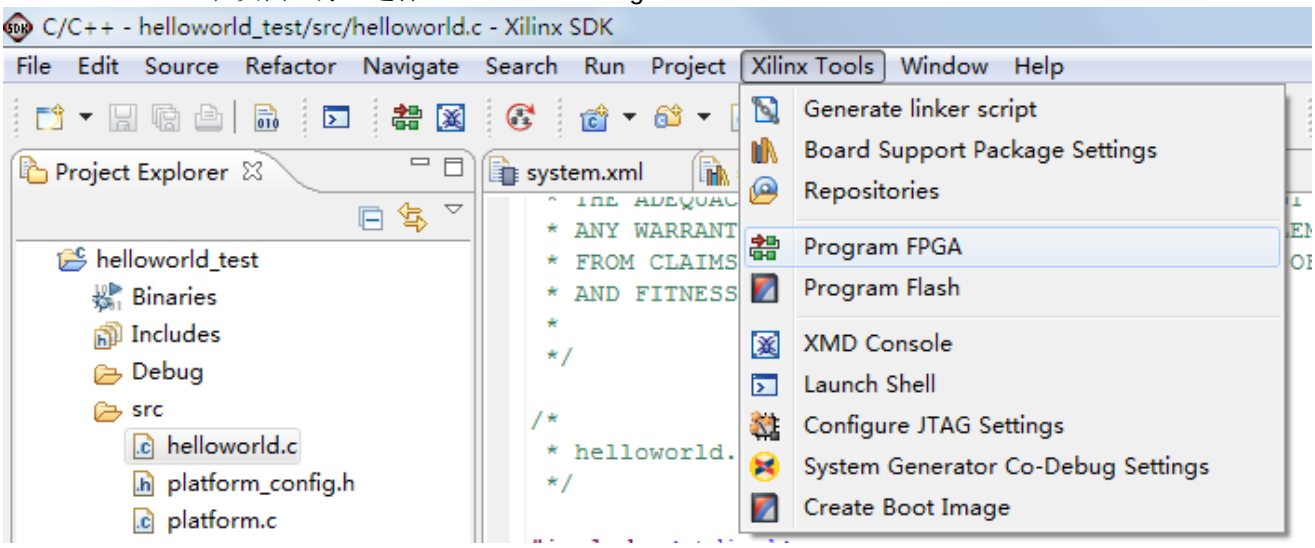


5-3.2. 按照端口号和 XPS 的波特率进行如下设置，点击 OK

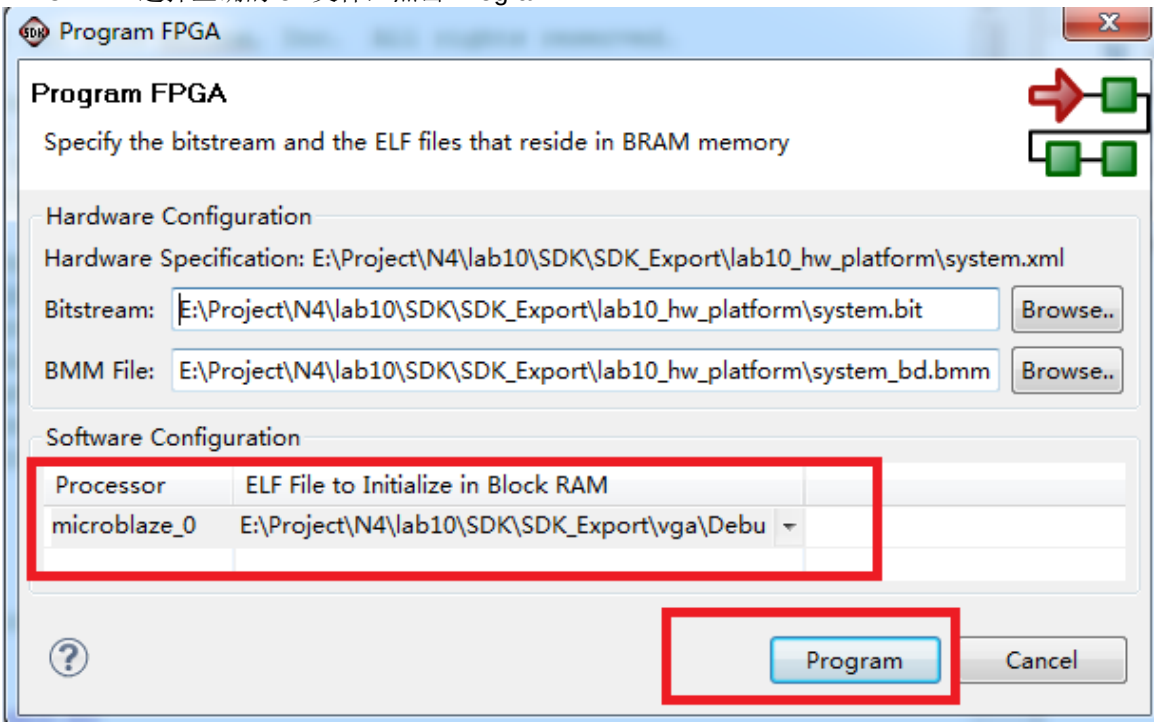


5-4. 将程序下载到板子上并运行

5-4.1. 在页面上方，选择 Xilinx Tools –Program FPGA

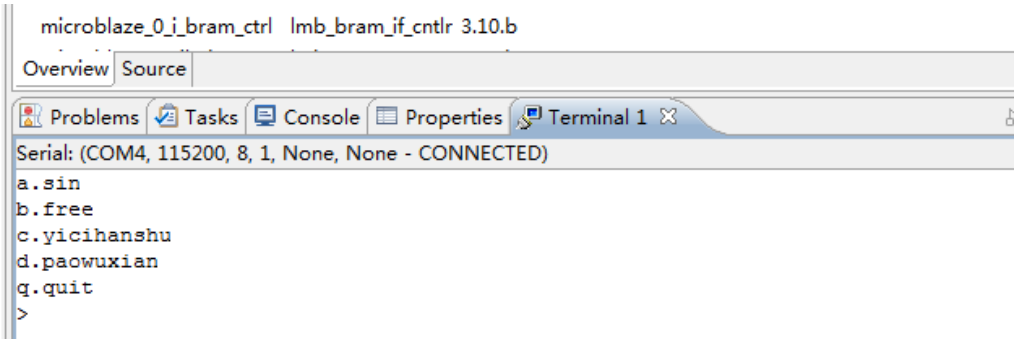


5-4.2. 选择正确的 elf 文件，点击 Program



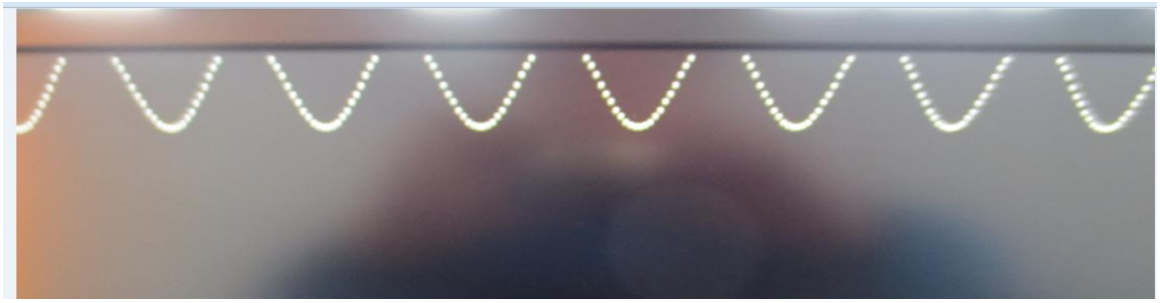
5-5. 查看实验结果

5-5.1. 选择串口栏，查看串口信息

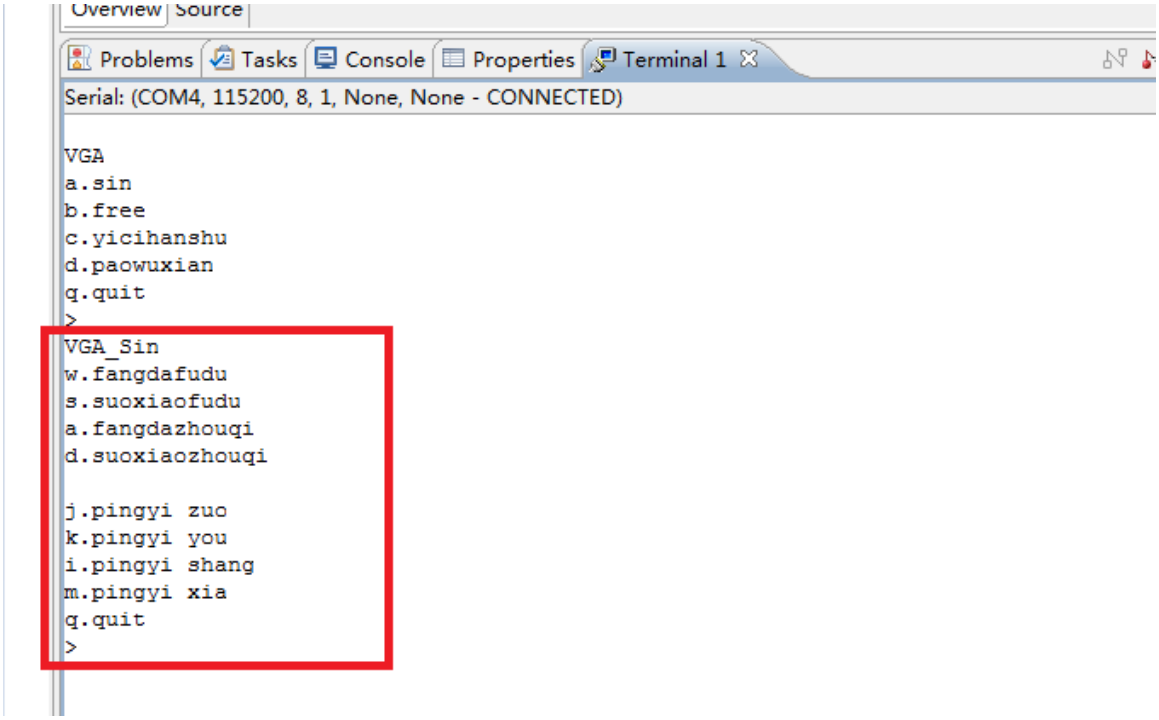


5-5.2. 根据串口信息选择各功能（三角函数、自由画点、一次函数、抛物线、退出）。这里选择 a

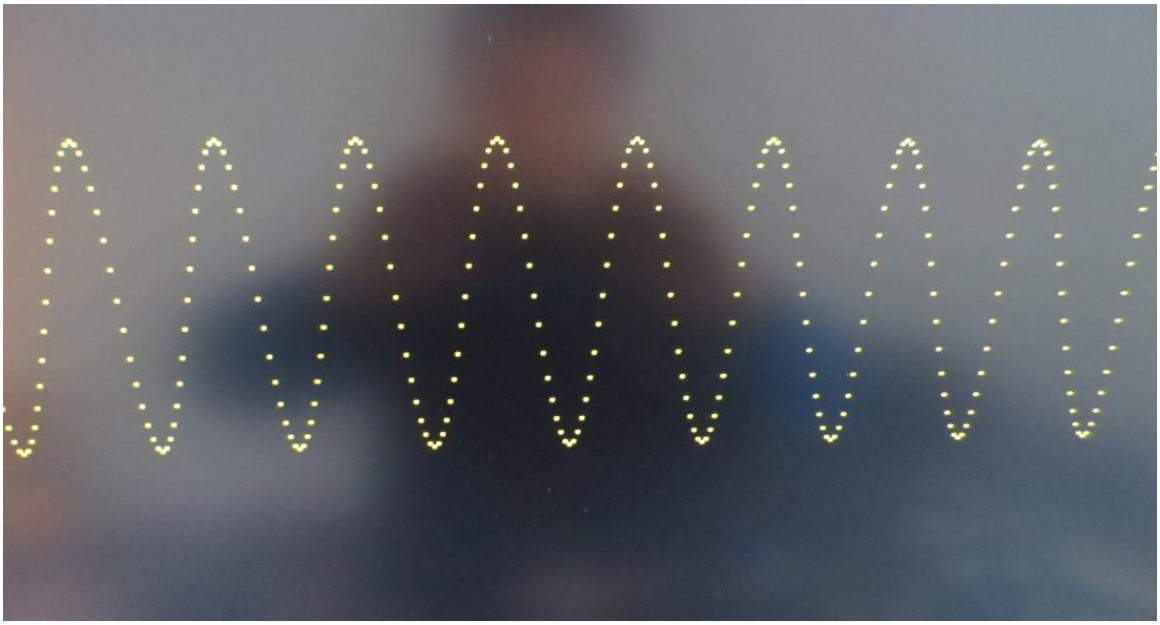
5-5.3. 查看 VGA 显示屏结果。若显示屏上无图像显示，拨动 Nexys4 上开关 SW0-SW7，选择图像颜色，这里选择 8 位全部置 1，图像显示白色



5-5.4. 查看串口输出，查看功能（依次为放大幅度、缩小幅度、放大周期、缩小周期、向左平移、向右平移、向上平移、向下平移），这里可做任意选择



5-5.5. 查看结果，拨动开关，选择颜色



5-5.6. 按下 Nexys4 上按钮 BTNR 进行复位，查看串口，选择 d

```
j.pingyi zuo
k.pingyi you
i.pingyi shang
m.pingyi xia
q.quit
>
VGA
a.sin
b.free
c.yicihanshu
d.paowuxian
q.quit
>
```

5-5.7. 查看串口输出，查看功能（依次为）

```
>
VGA_paowuxian
a. V  #jieshu
b.xianshi
q.quit
>
```

5-5.8. 选择 a 设置 初速度

```
VGA_paowuxian
a. V  #jieshu
b.xianshi
q.quit
>
input V>
```

5-5.9. 输入 10 #，选择 b

5-5.10.查看 VGA 显示器结果