TI DSP, MCU 및 Xilinx Zynq FPGA 프로그래밍 전문가 과정

강사 – Innova Lee(이상훈)
gcccompil3r@gmail.com
학생 – GJ (박현우)
uc820@naver.com

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1) Petalinux 설치 및 환경설정 1

Petalinux | 교재

Elcid(sile****) 카페매니저 1:1

https://www.xilinx.com/support/download.html

Embedded Development -> Archive -> 2015.4 Petalinux Installer

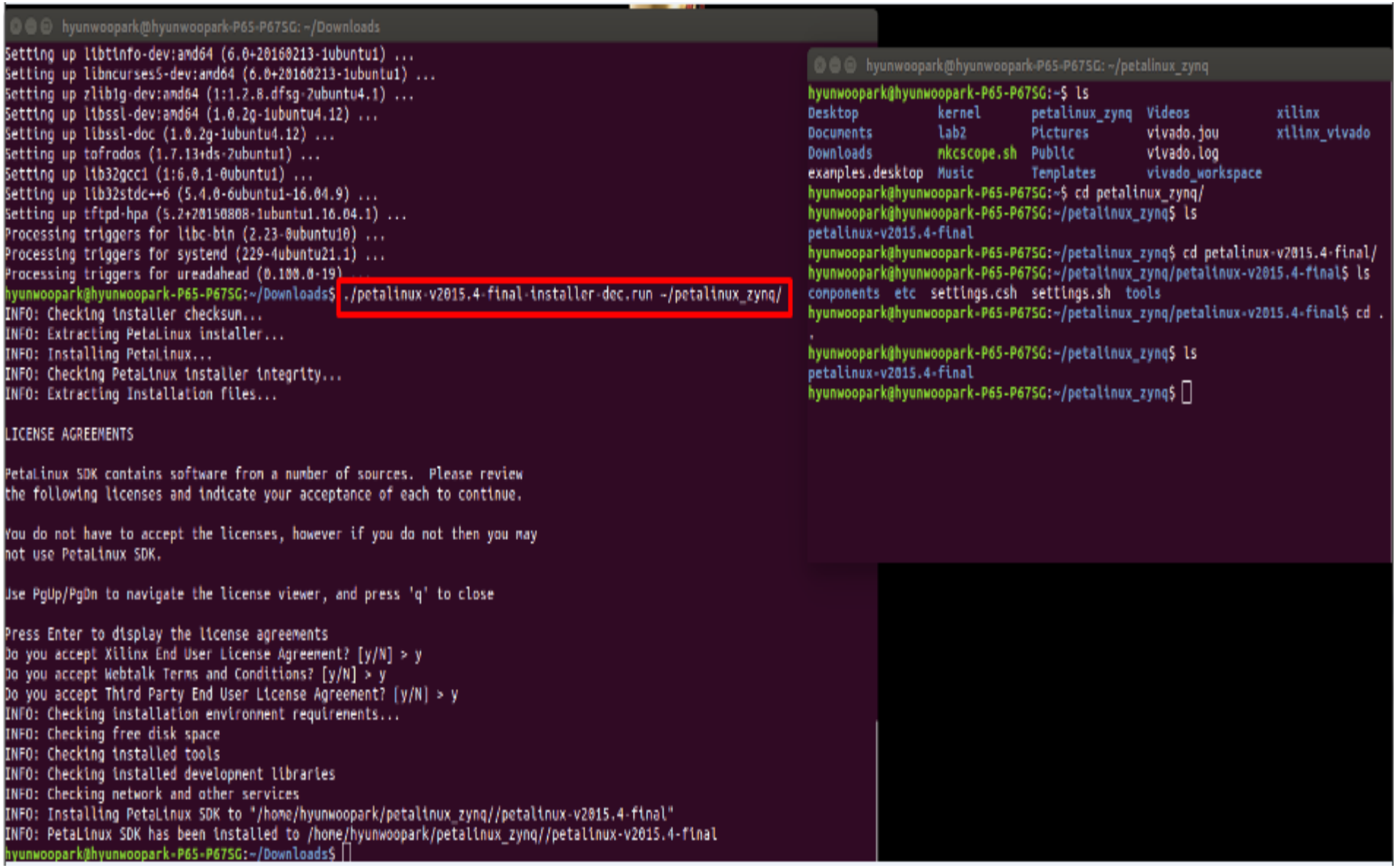
```
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/petalinux-v2015.4-final/components/linux-kernel/xlnx-4.0/drivers/uio$ pwd
/home/hyunwoopark/petalinux_zynq/petalinux-v2015.4-final/components/linux-kernel/xlnx-4.0/drivers/uio
```

```
#ifdef CONFIG_OF
static struct of_device_id uio_of_genirq_match[] = {
    { .compatible = "generic-uio", },
    { /* This is filled with module_parm */ },
    { /* Sentinel */ },
};
MODULE_DEVICE_TABLE(of, uio_of_genirq_match);
module_param_string(of_id, uio_of_genirq_match[0].compatible, 128, 0);
MODULE_PARM_DESC(of_id, "Openfirmware id of the device to be handled by uio");
#endif
```

Elcid 작성자 2018.05.30. 10:57 답글 신고

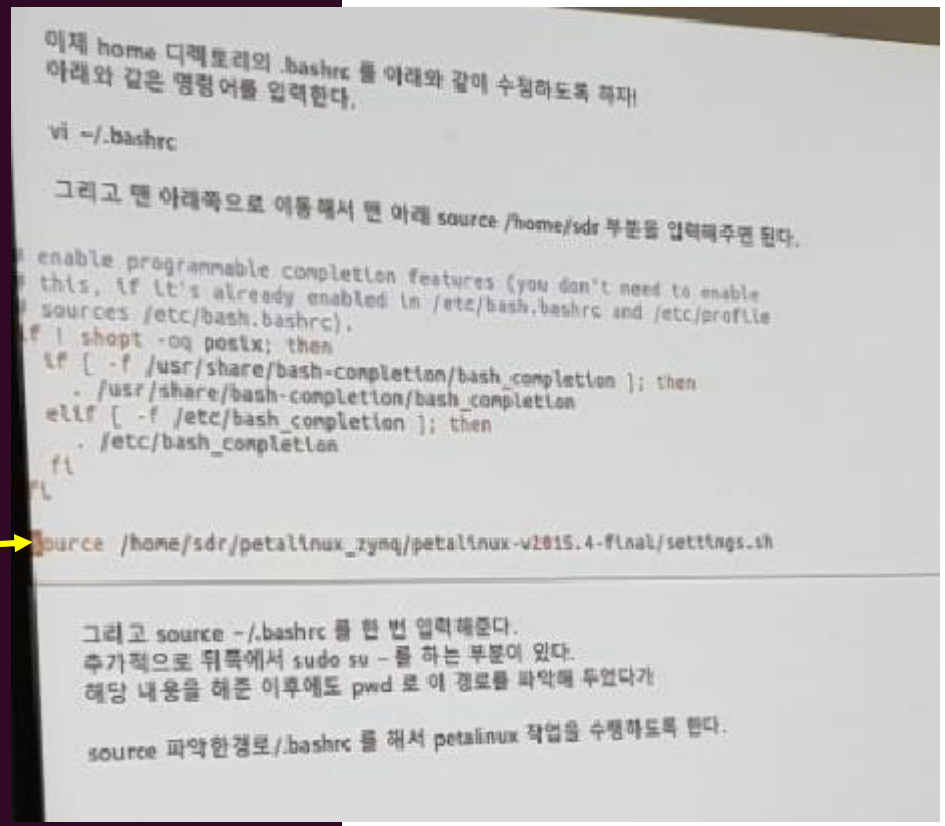
https://www.xilinx.com/support/documentation/university/vivado/workshops/vivado-embedded-linux-zynq/materials/2015x/LiveUSB_2015.4.zip

1) Petalinux 설치 및 환경설정 2



1) Petalinux 설치 및 환경설정 3

```
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ ls
petalinux-v2015.4-final  ZYBO_petalinux_v2015_4.bsp
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ cd petalinux-v2015.4-final/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/petalinux-v2015.4-final$ ls
components  etc  settings.csh  settings.sh  tools
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/petalinux-v2015.4-final$ cd ..
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ ls
petalinux-v2015.4-final  ZYBO_petalinux_v2015_4.bsp
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ cd ..
hyunwoopark@hyunwoopark-P65-P67SG:~$ ls
Desktop     examples.desktop  mkcscope.sh     Pictures   Videos      vivado_workspace
Documents   kernel            Music           Public     vivado.jou  xilinx
Downloads   lab2              petalinux_zynq  Templates  vivado.log  xilinx_vivado
hyunwoopark@hyunwoopark-P65-P67SG:~$ cd petalinux_zynq/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ ls
petalinux-v2015.4-final  ZYBO_petalinux_v2015_4.bsp
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ chmod -R 755 petalinux-v2015.4-final/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ ls
petalinux-v2015.4-final  ZYBO_petalinux_v2015_4.bsp
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ chmod -R 755 petalinux-v2015.4-final/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ chmod -R 755 ZYBO_petalinux_v2015_4.bsp
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ ls
petalinux-v2015.4-final  ZYBO_petalinux_v2015_4.bsp
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ vi ~/.bashrc
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ source ~/.bashrc
PetaLinux environment set to '/home/hyunwoopark/petalinux_zynq/petalinux-v2015.4-final'
INFO: Checking free disk space
INFO: Checking installed tools
INFO: Checking installed development libraries
INFO: Checking network and other services
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ vi ~/.bashrc
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ cd ..
hyunwoopark@hyunwoopark-P65-P67SG:~$ ls
Desktop     examples.desktop  lab2            petalinux_zynq  Templates   vivado.log        xilinx_vivado
Documents   fpga_test         mkcscope.sh     Pictures        Videos      vivado_workspace
Downloads   kernel            Music           Public          vivado.jou  xilinx
hyunwoopark@hyunwoopark-P65-P67SG:~$ cd fpga_test/
hyunwoopark@hyunwoopark-P65-P67SG:~/fpga_test$ petalinux-create -t project -n test --template zynq
INFO: Create project: test
INFO: New project successfully created in /home/hyunwoopark/fpga_test/test
hyunwoopark@hyunwoopark-P65-P67SG:~/fpga_test$
```



1) Petalinux 설치 및 환경설정 4

```
hyunwoopark@hyunwoopark-P65-P67SG:~/fpga_test$ ls
ZYBO_petalinux_v2015_4  ZYBO_petalinux_v2015_4.bsp
hyunwoopark@hyunwoopark-P65-P67SG:~/fpga_test$ cd ZYBO_petalinux_v2015_4/
hyunwoopark@hyunwoopark-P65-P67SG:~/fpga_test/ZYBO_petalinux_v2015_4$ ls
build  components  config.project  hardware  hw-description  images  pre-built  subsystems
hyunwoopark@hyunwoopark-P65-P67SG:~/fpga_test/ZYBO_petalinux_v2015_4$ petalinux-boot --qemu --kernel
INFO: The image provided is a zImage
INFO: Set QEMU tftp to /home/hyunwoopark/fpga_test/ZYBO_petalinux_v2015_4/images/linux
INFO: TCP PORT is free
```

→ Login : root, password : root

Petalinux 설치 전체 코드

```
224  sudo apt-get install tofrodos iproute tftpd-hpa gawk gcc git-core make net-tools
libncurses5-dev zlib1g-dev libssl-dev flex bison lib32z1 lib32ncurses5 lib32stdc++6 libselinux1
225  ./petalinux-v2015.4-final-installer-dec.run ~/petalinux_zynq/
226  cd ~/petalinux_zynq/
+ 구조체 추가 해야함.


229  cp ~/Downloads/LiveUSB_2015.4/ZYBO_petalinux_v2015_4.bsp ./
235  chmod 755 ZYBO_petalinux_v2015_4.bsp
245  chmod -R 755 petalinux-v2015.4-final/
248  chmod -R 755 ZYBO_petalinux_v2015_4.bsp
250  vi ~/.bashrc
251  source ~/.bashrc
252  vi ~/.bashrc
254  mkdir fpga_test( home 폴더에 만들고 홈으로 이동)
255  cd fpga_test/
256  petalinux-create -t project -n test --template zynq
259  cd test/
263  cp ~/Downloads/LiveUSB_2015.4/ZYBO_petalinux_v2015_4.bsp ./
265  petalinux-create -t project -s ZYBO_petalinux_v2015_4.bsp
267  rm -rf test


273  cd ZYBO_petalinux_v2015_4/
274  petalinux-build
275  sudo dpkg-reconfigure dash
276  sudo dpkg --add-architecture i386
277  sudo apt-get update
278  sudo apt-get install libbz2-1.0:i386
279  sudo apt-get install tofrodos iproute tftpd-hpa gawk gcc git-core make net-tools
libncurses5-dev zlib1g-dev libssl-dev flex bison lib32z1 lib32ncurses5 lib32stdc++6 libselinux1
283  sudo apt-get install xinetd tftpd-hpa
284  sudo apt-get install tofrodos iproute tftpd-hpa gawk gcc git-core make net-tools
libncurses5-dev zlib1g-dev libssl-dev flex bison lib32z1 lib32ncurses5 libselinux1


297  sudo apt-get install linaro-image-tools
298  sudo apt-get install qemu-user-static qemu-system
299  sudo apt-get install gcc-arm-linux-gnueabi


285  petalinux-build


302  cd ZYBO_petalinux_v2015_4/
303  ls
304  petalinux-boot --qemu --kernel
```

1) Vivado 환경설정 2

Zybo 보드 드라이버 설치

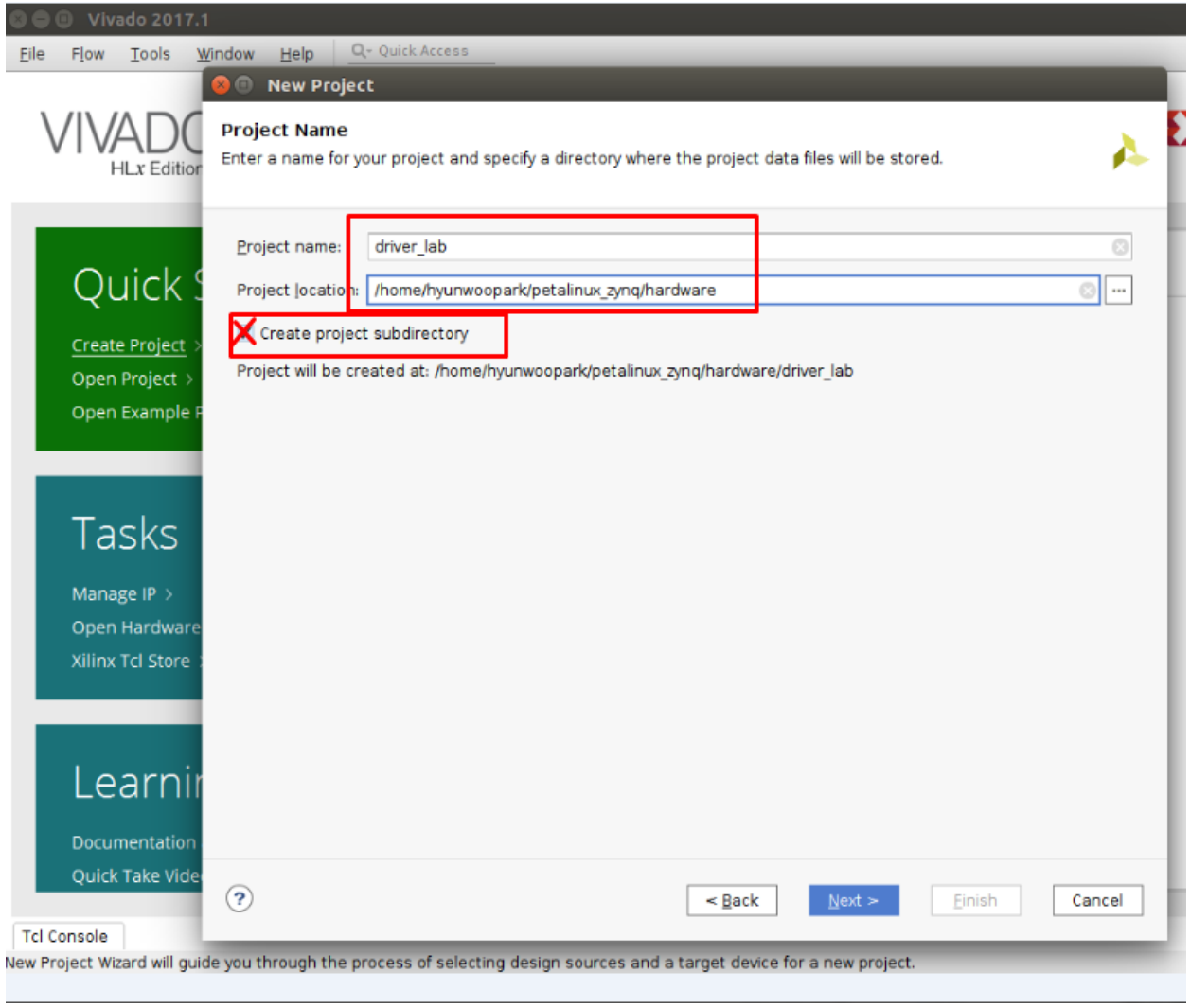
```
hyunwoopark@hyunwoopark-P65-P67SG:~/xilinx/Vivado/2017.1/data/xicom$ cd cable_drivers/lin64/install_script/install_drivers/
hyunwoopark@hyunwoopark-P65-P67SG:~/xilinx/Vivado/2017.1/data/xicom/cable_drivers/lin64/install_script/install_drivers$ sudo ./install_drivers
[sudo] password for hyunwoopark:
INFO: Installing cable drivers.
INFO: Script name = ./install_drivers
INFO: HostName = hyunwoopark-P65-P67SG
INFO: Current working dir = /home/hyunwoopark/xilinx/Vivado/2017.1/data/xicom/cable_drivers/lin64/install_script/install_drivers
INFO: Kernel version = 4.13.0-36-generic.
INFO: Arch = x86_64.
Successfully installed Digilent Cable Drivers
--File /etc/udev/rules.d/52-xilinx-ftdi-usb.rules does not exist.
--File version of /etc/udev/rules.d/52-xilinx-ftdi-usb.rules = 0000.
--Updating rules file.
--File /etc/udev/rules.d/52-xilinx-pcusb.rules does not exist.
--File version of /etc/udev/rules.d/52-xilinx-pcusb.rules = 0000.
--Updating rules file.

INFO: Digilent Return code = 0
INFO: Xilinx Return code = 0
INFO: Xilinx FTDI Return code = 0
INFO: Return code = 0
INFO: Driver installation successful.
CRITICAL WARNING: Cable(s) on the system must be unplugged then plugged back in order for the driver scripts to update the cables.
hyunwoopark@hyunwoopark-P65-P67SG:~/xilinx/Vivado/2017.1/data/xicom/cable_drivers/lin64/install_script/install_drivers$
```

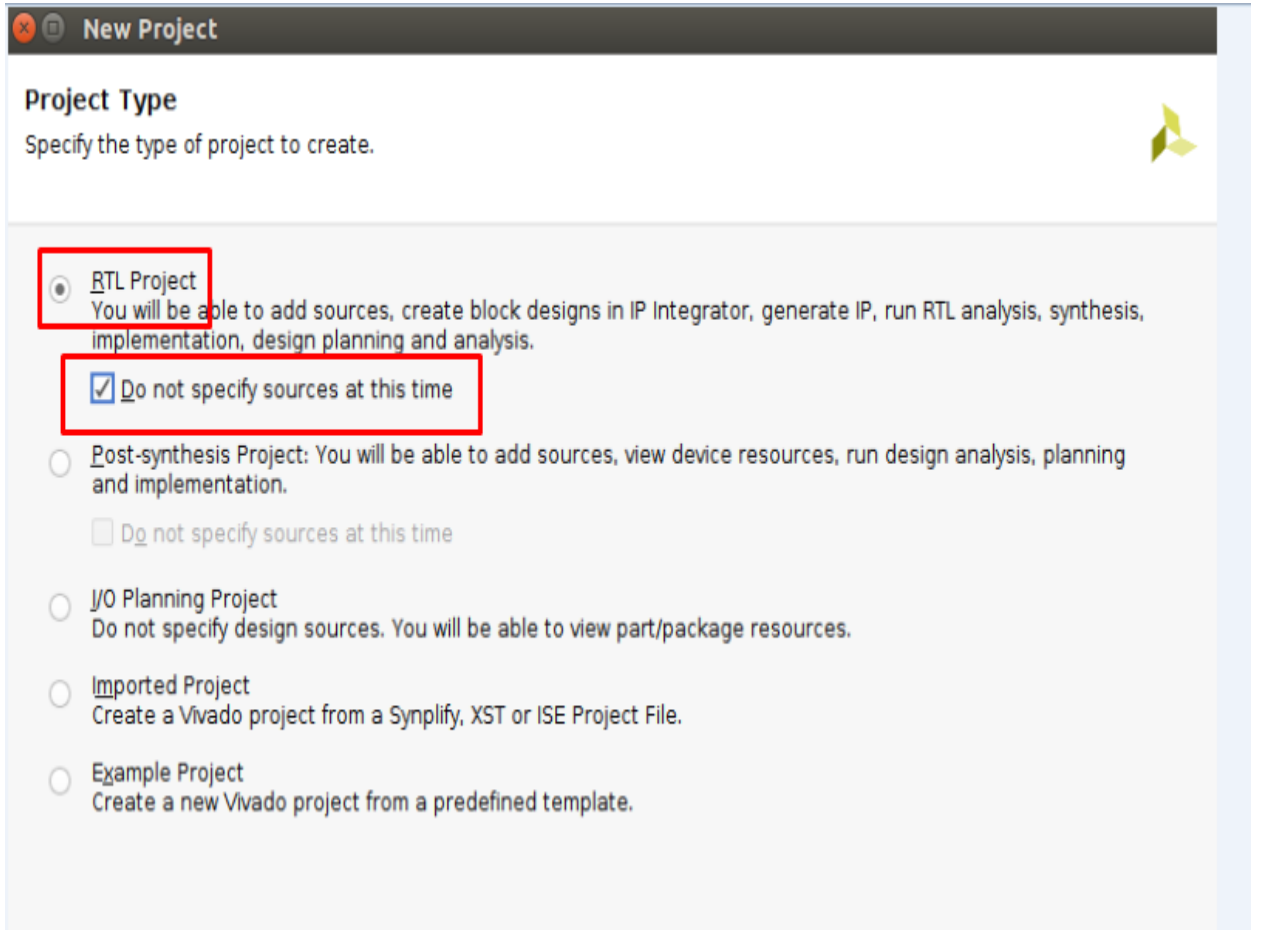
드라이버 설치가 제대로 안될 수 있기 때문에 드라이버 설치 권장.

2) Vivado hardware 설계 1

1

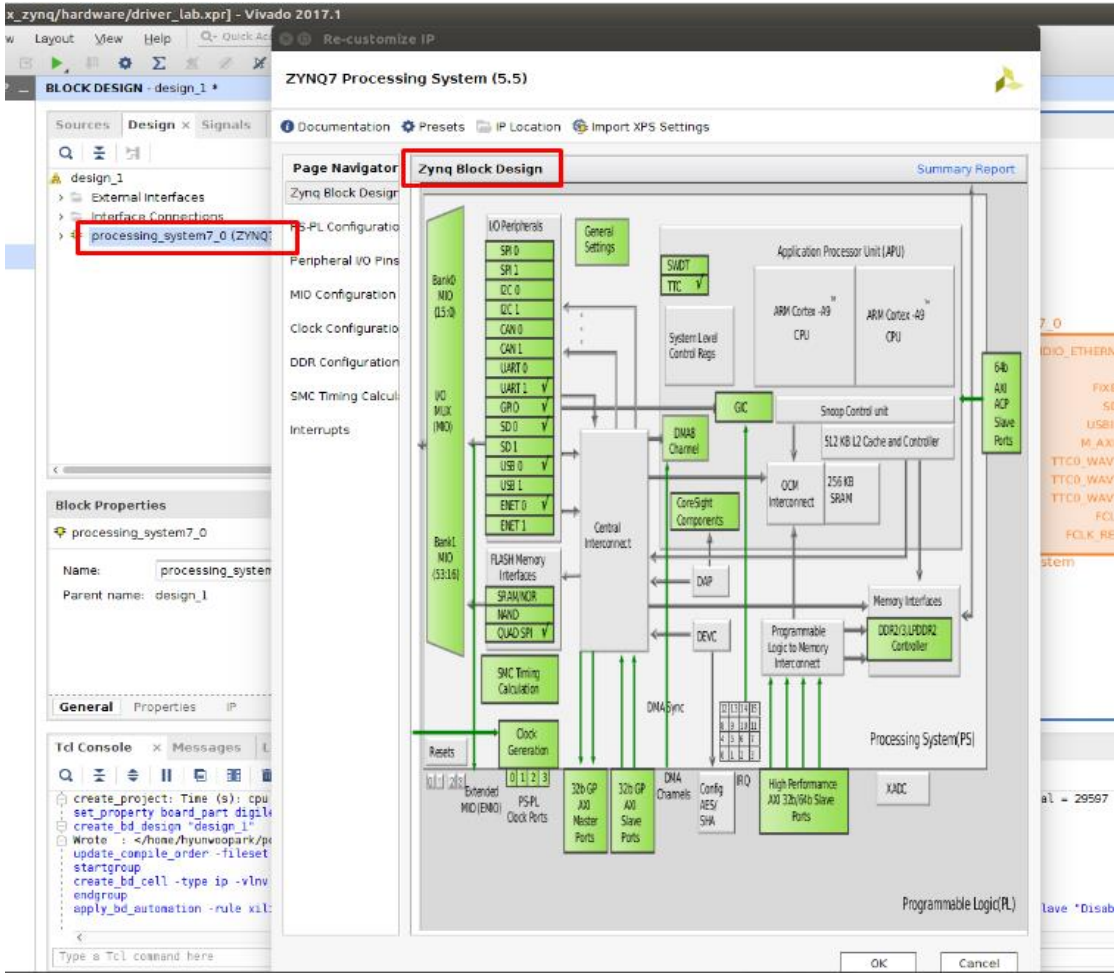


2

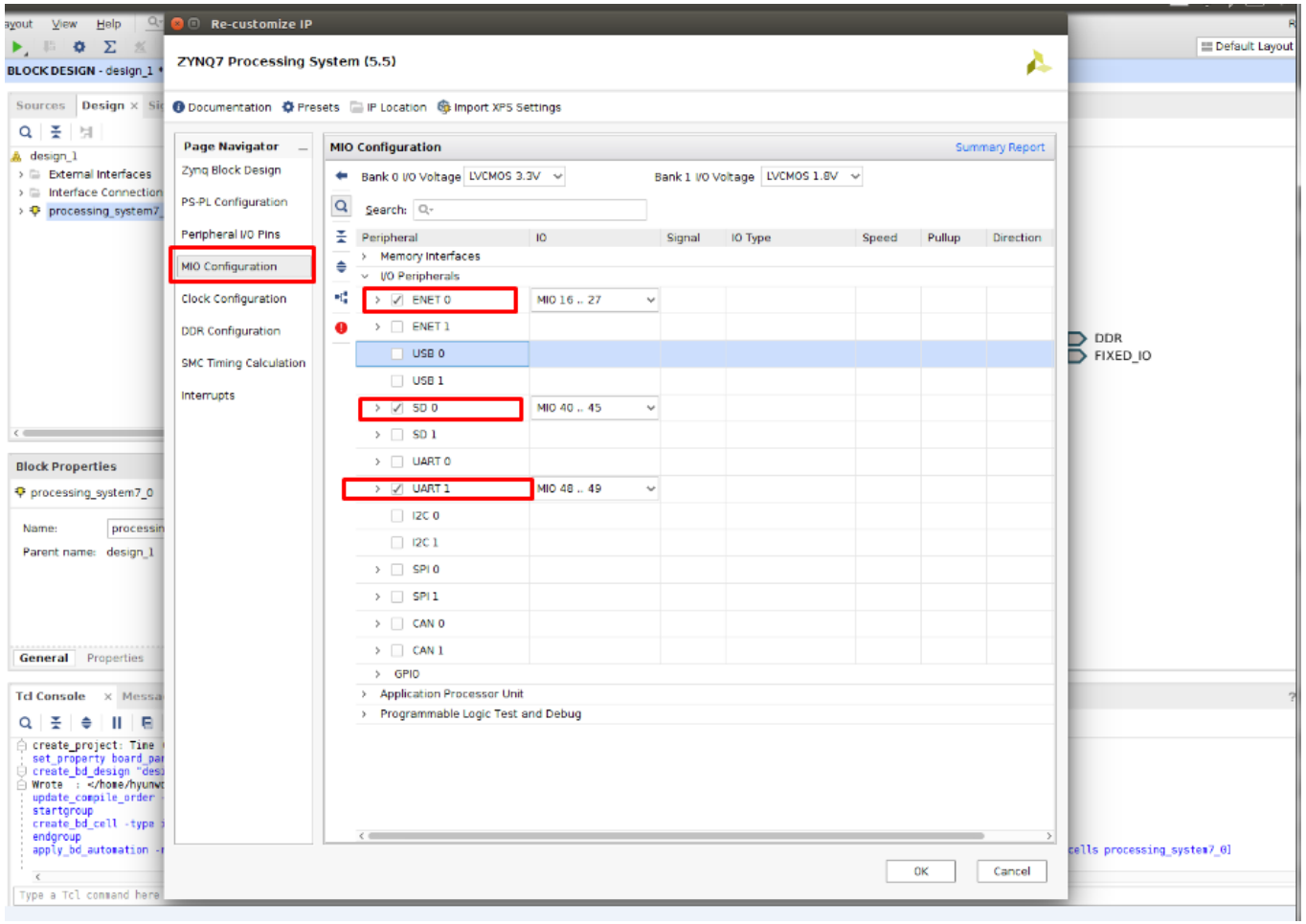


2) Vivado hardware 설계 2

3

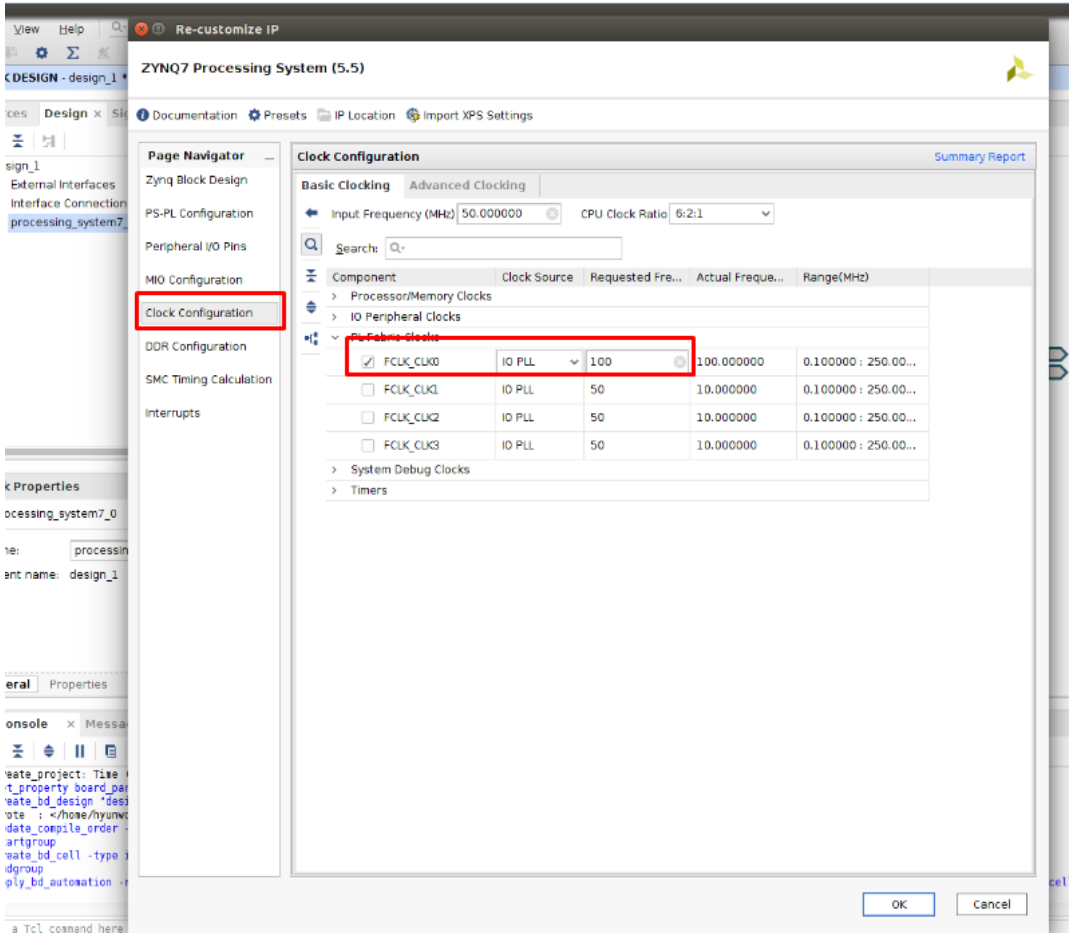


4

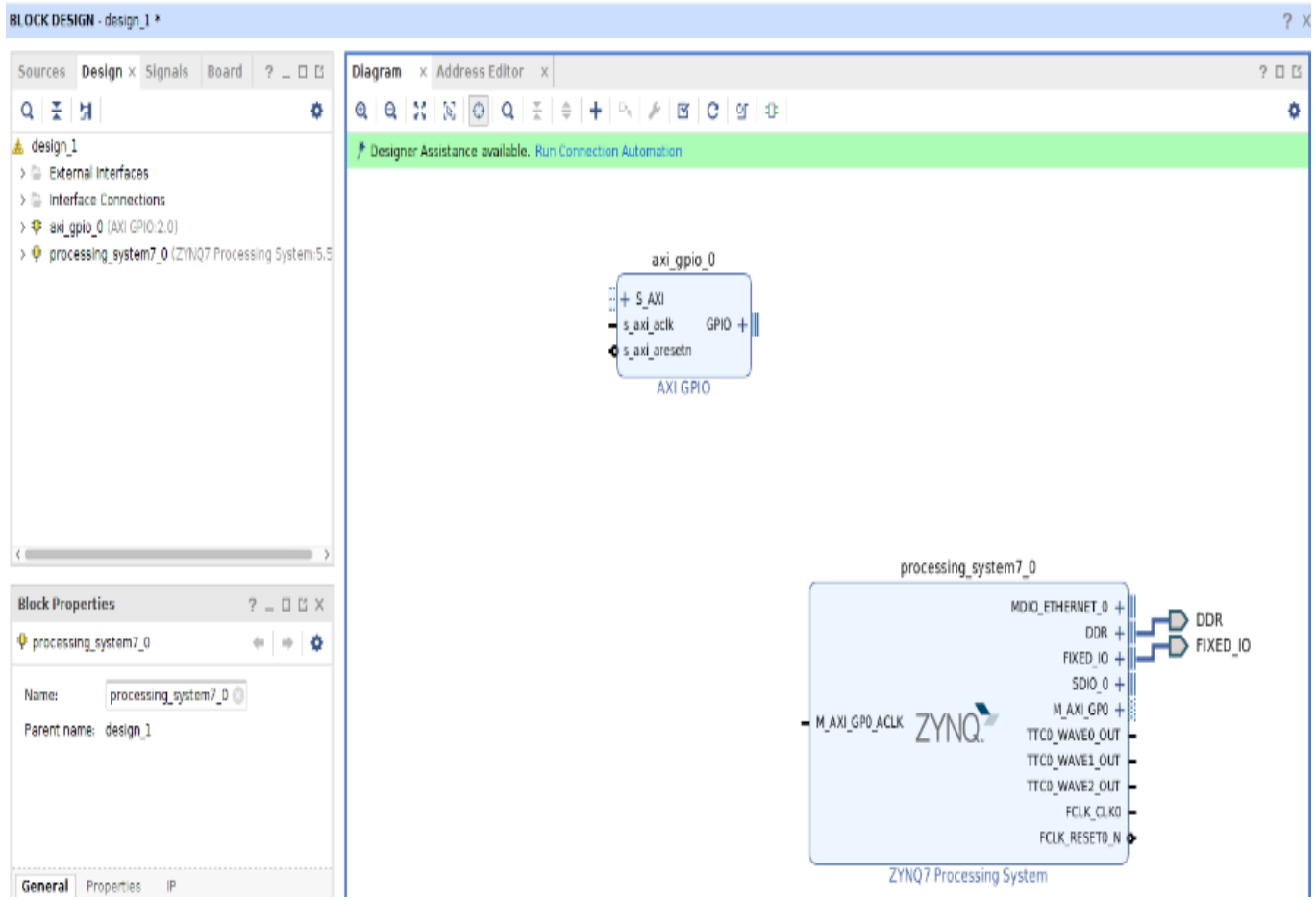


2) Vivado hardware 설계 3

5

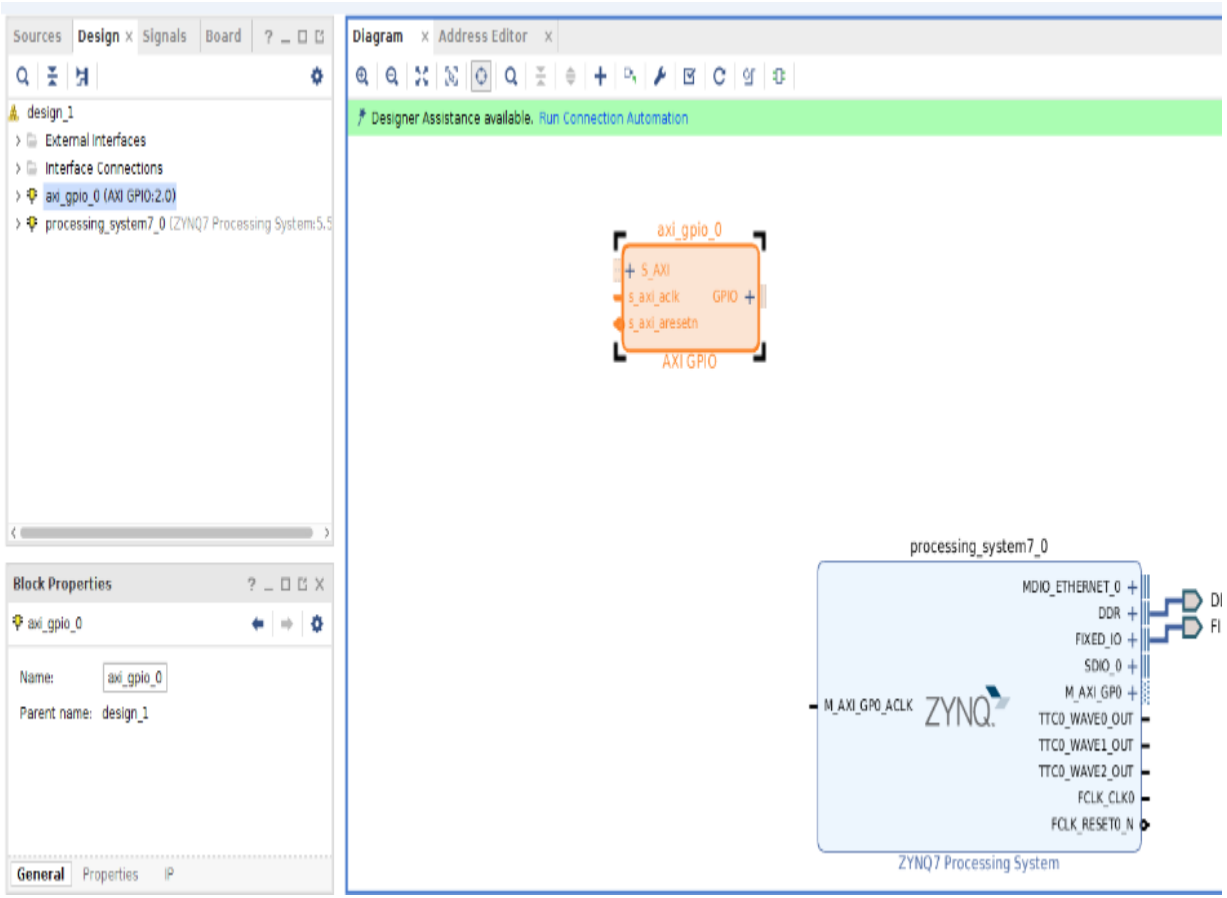


6

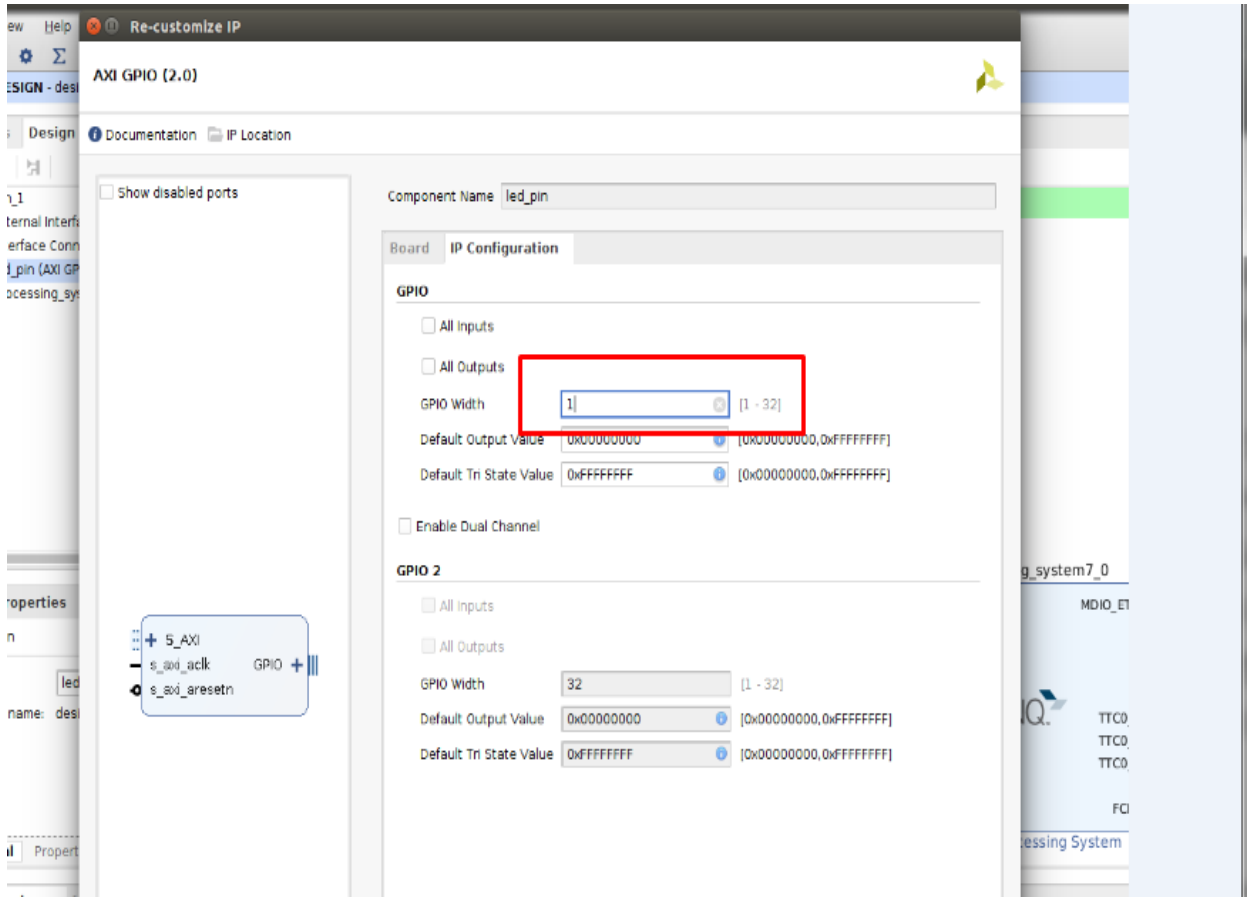


2) Vivado hardware 설계 4

7

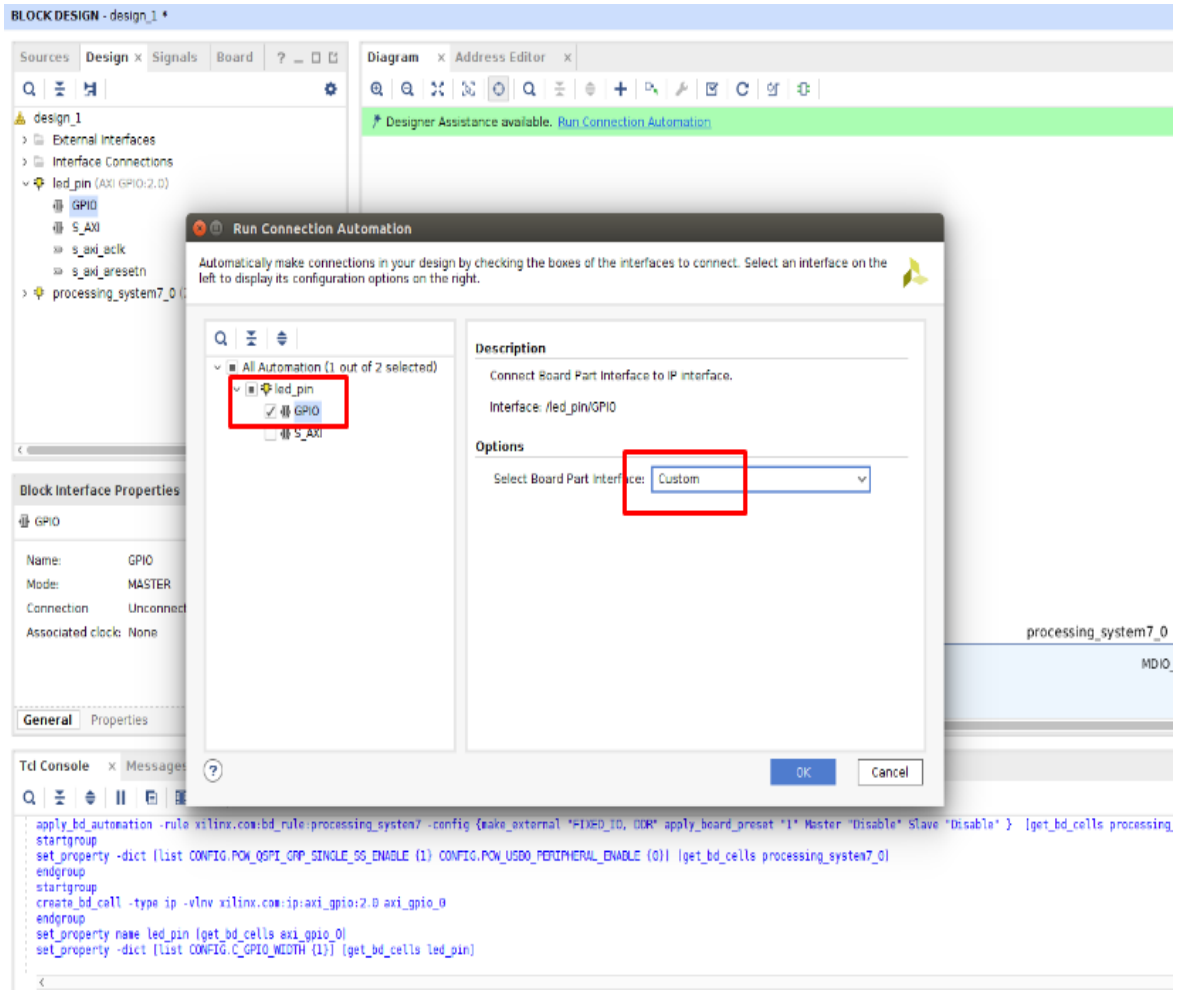


8

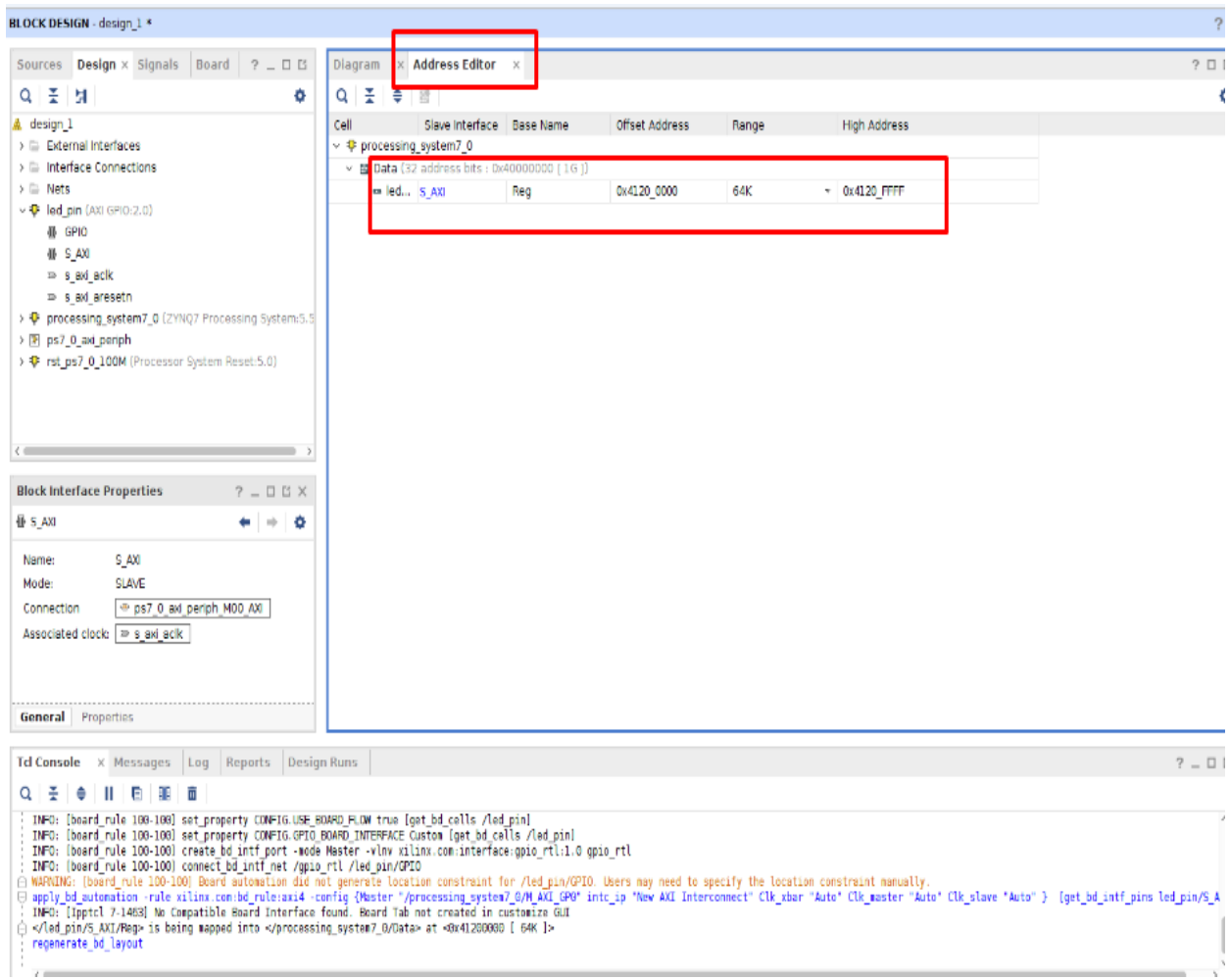


2) Vivado hardware 설계 5

9

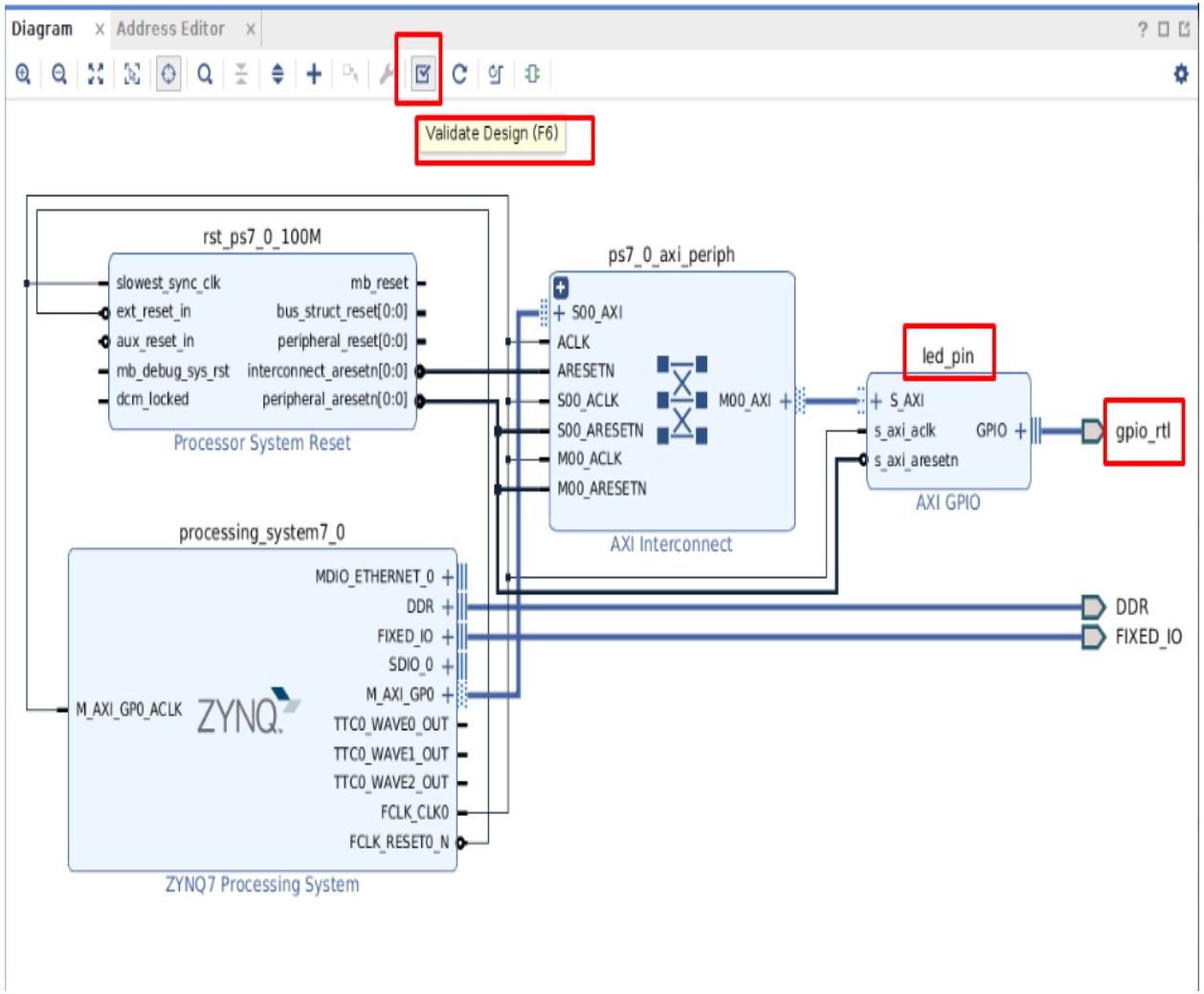


10

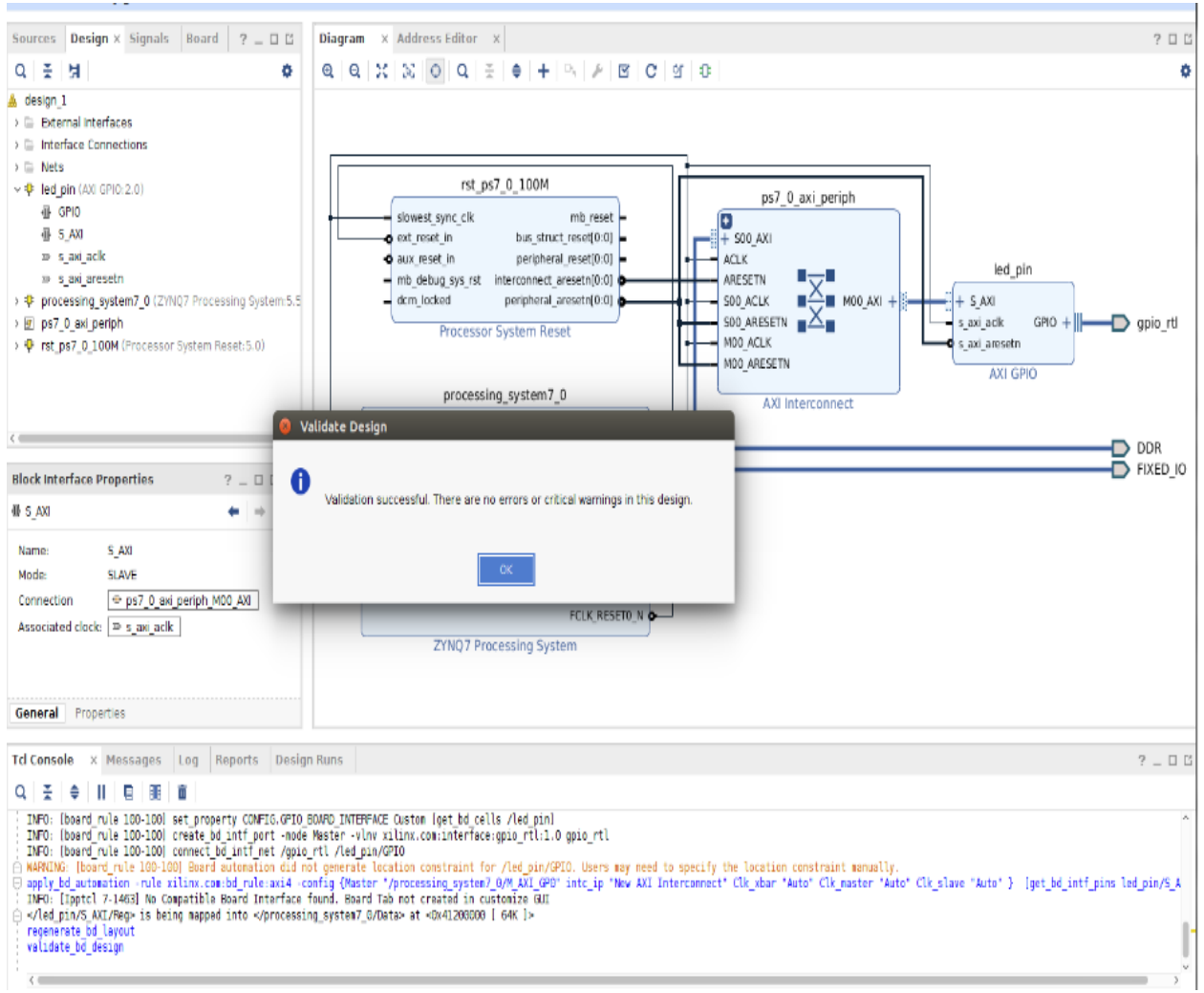


2) Vivado hardware 설계 6

11

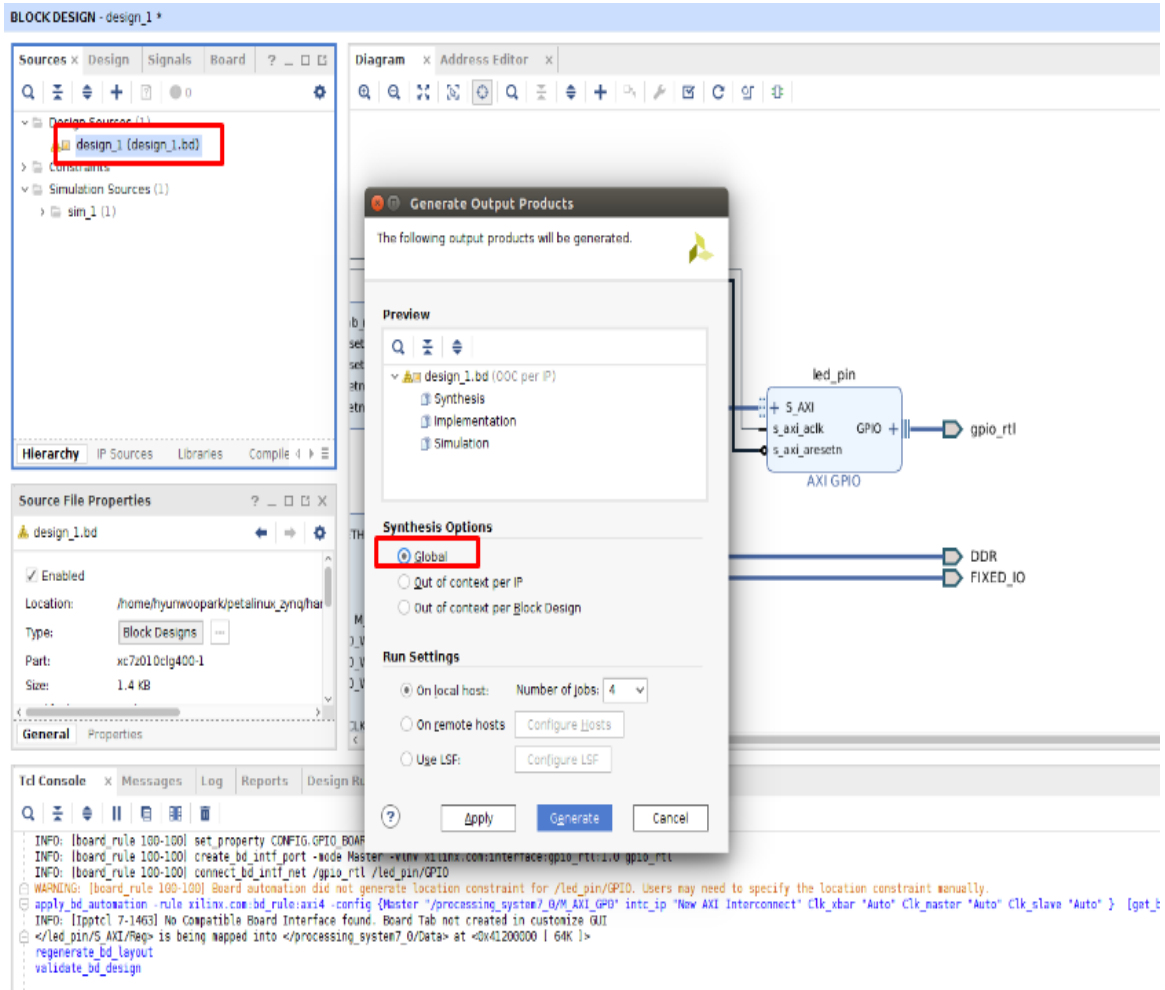


12

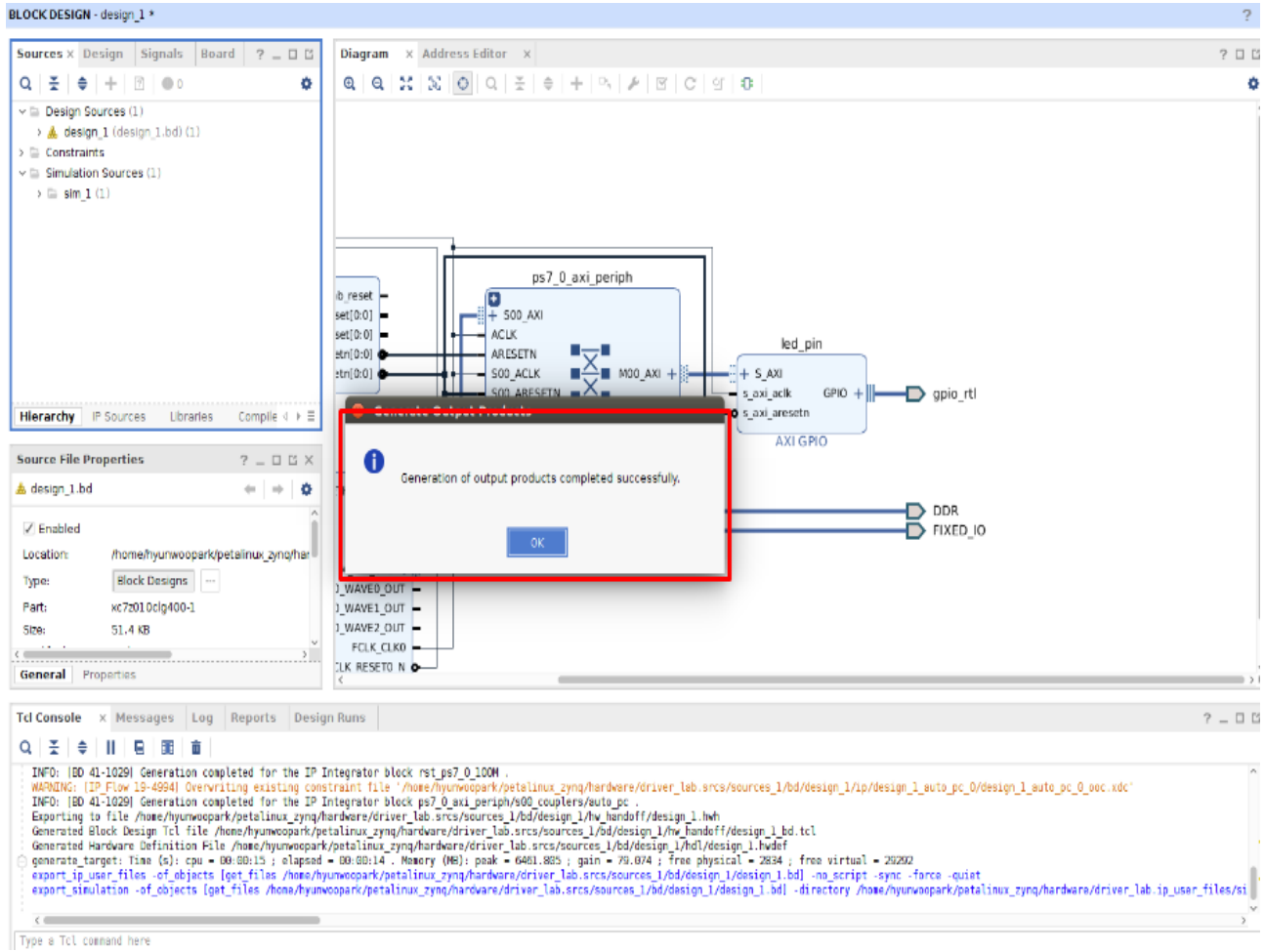


2) Vivado hardware 설계 7

13

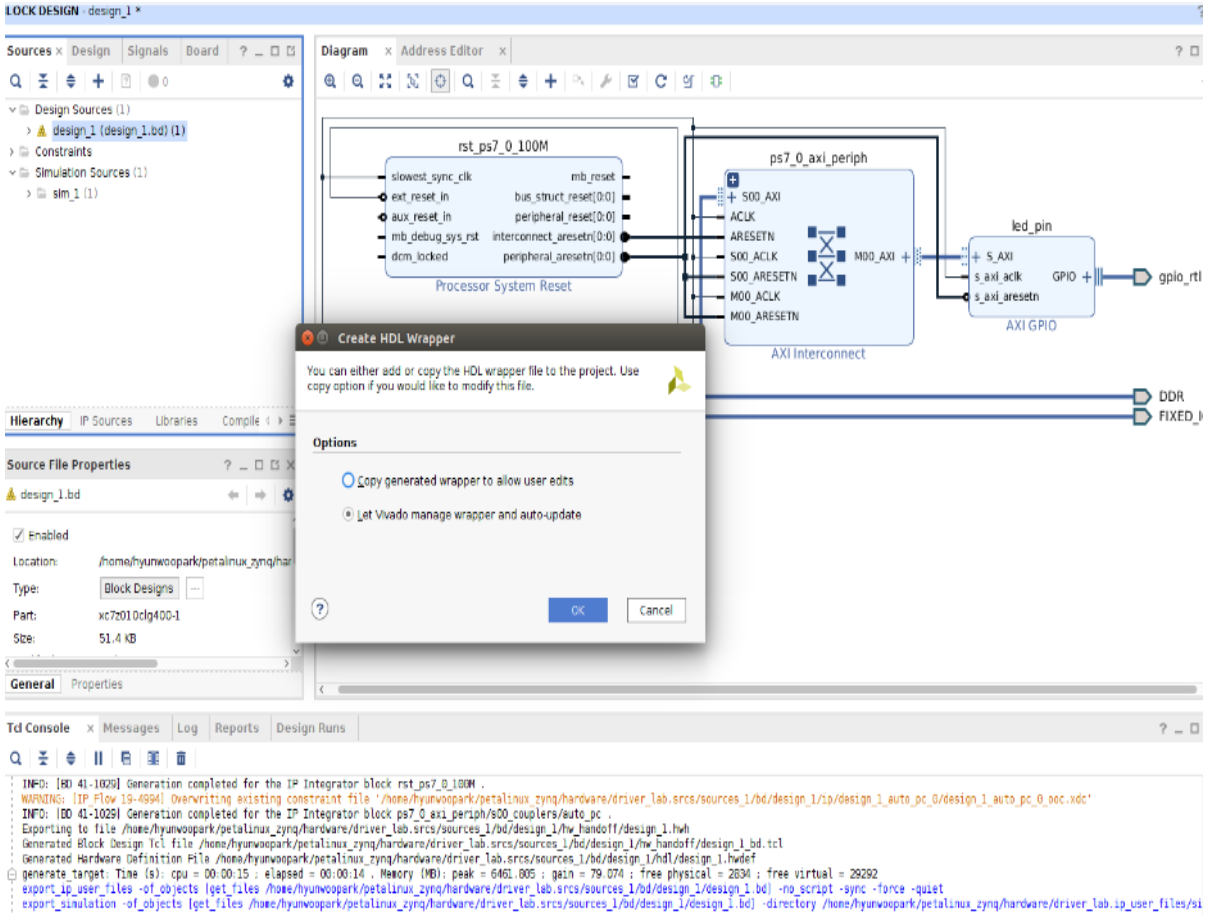


14

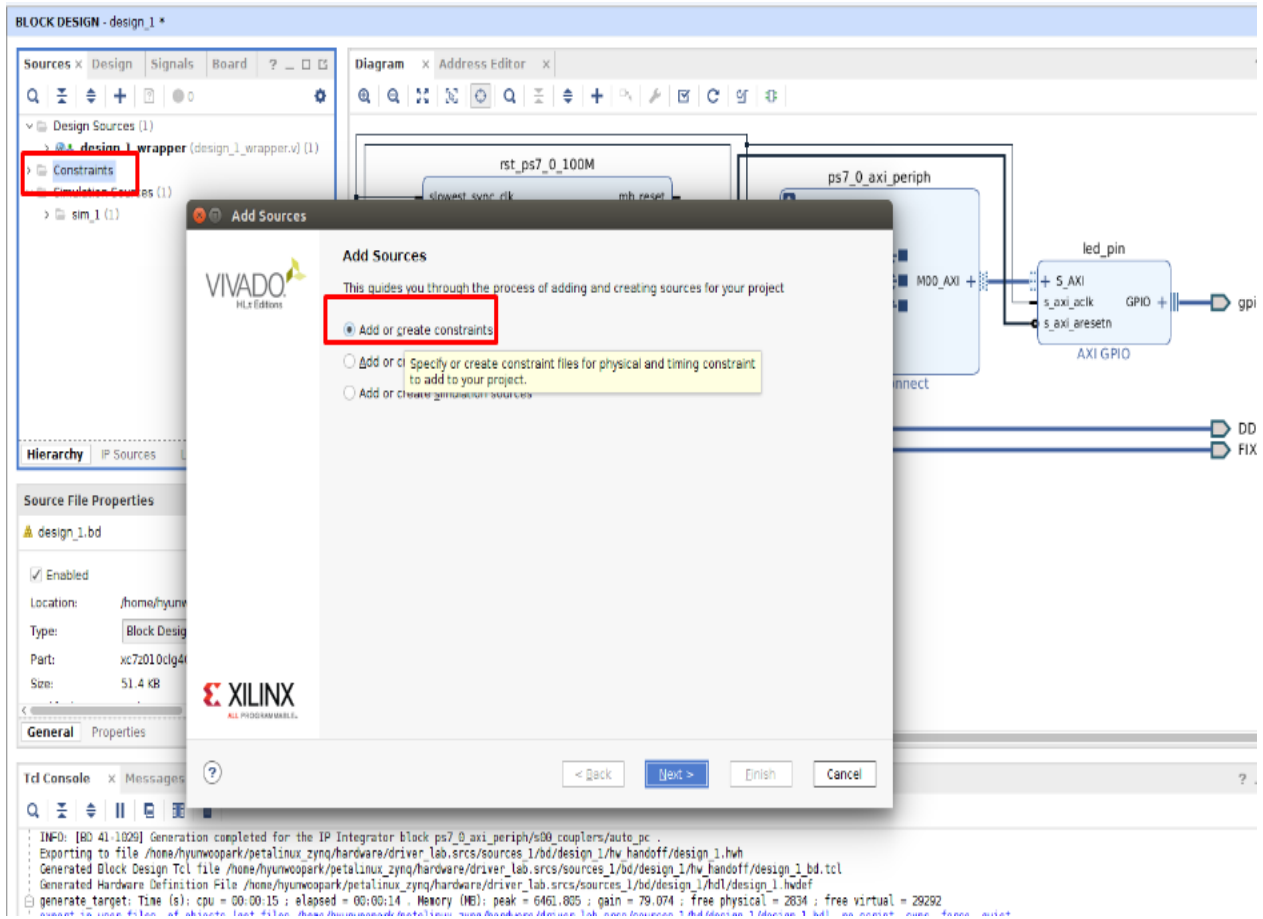


2) Vivado hardware 설계 8

15

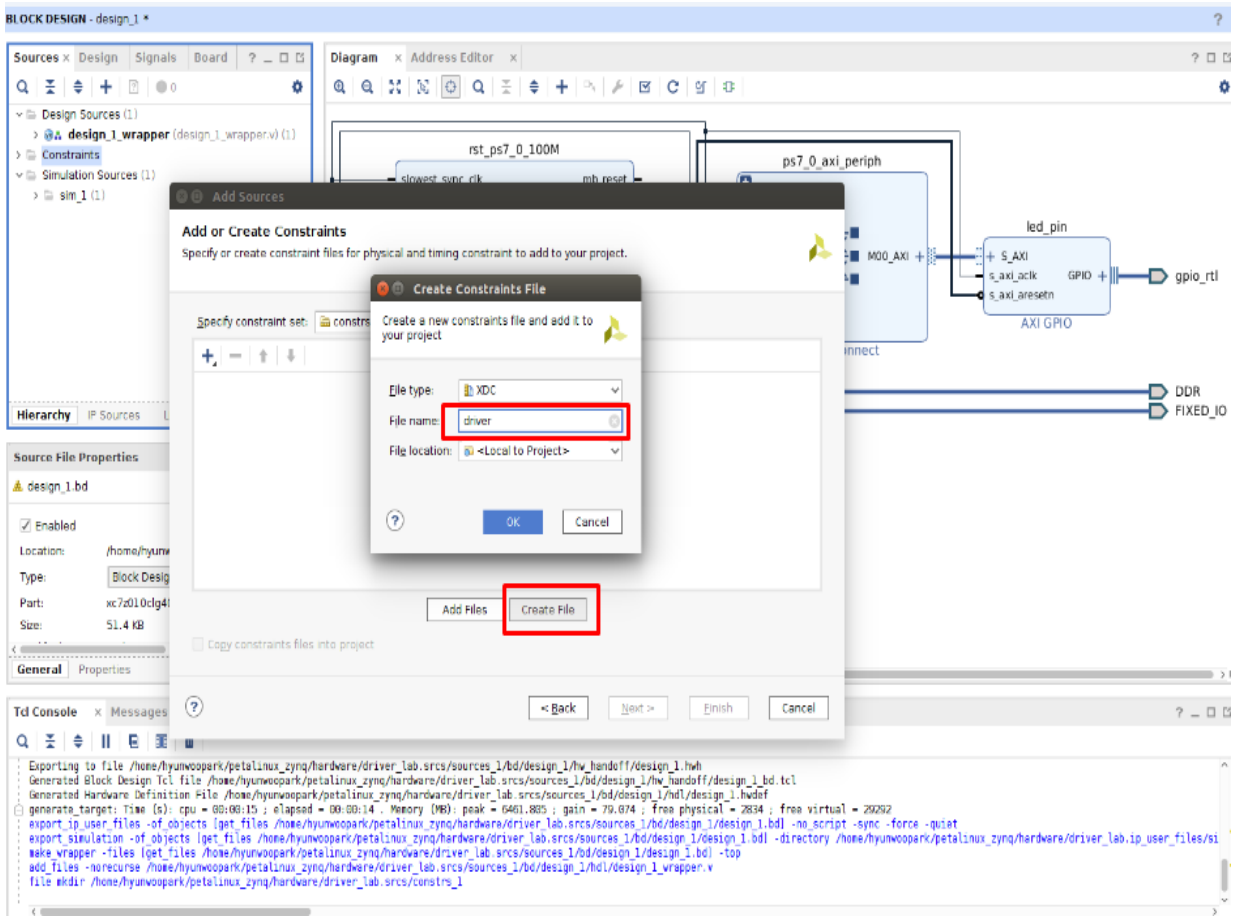


16

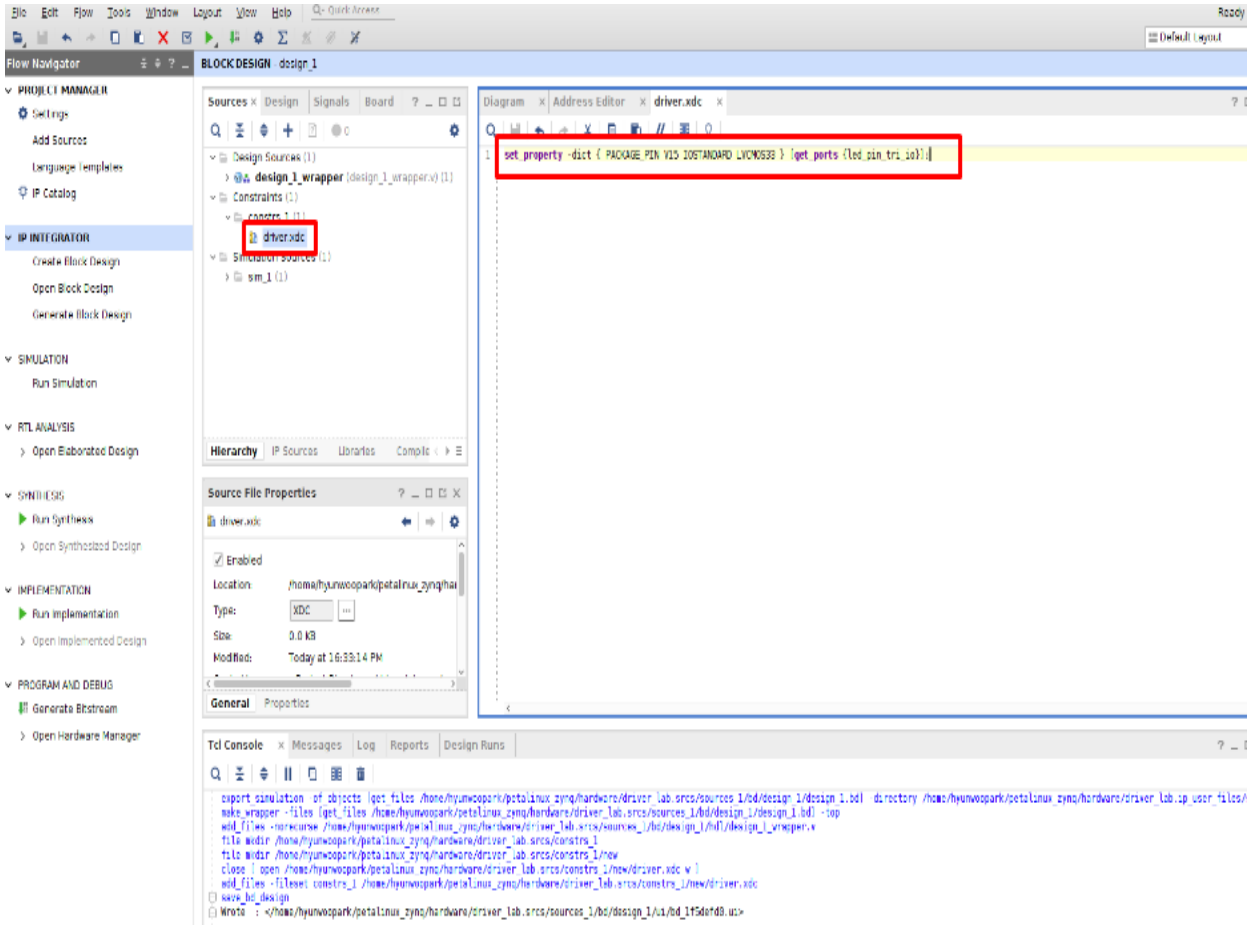


2) Vivado hardware 설계 9

17



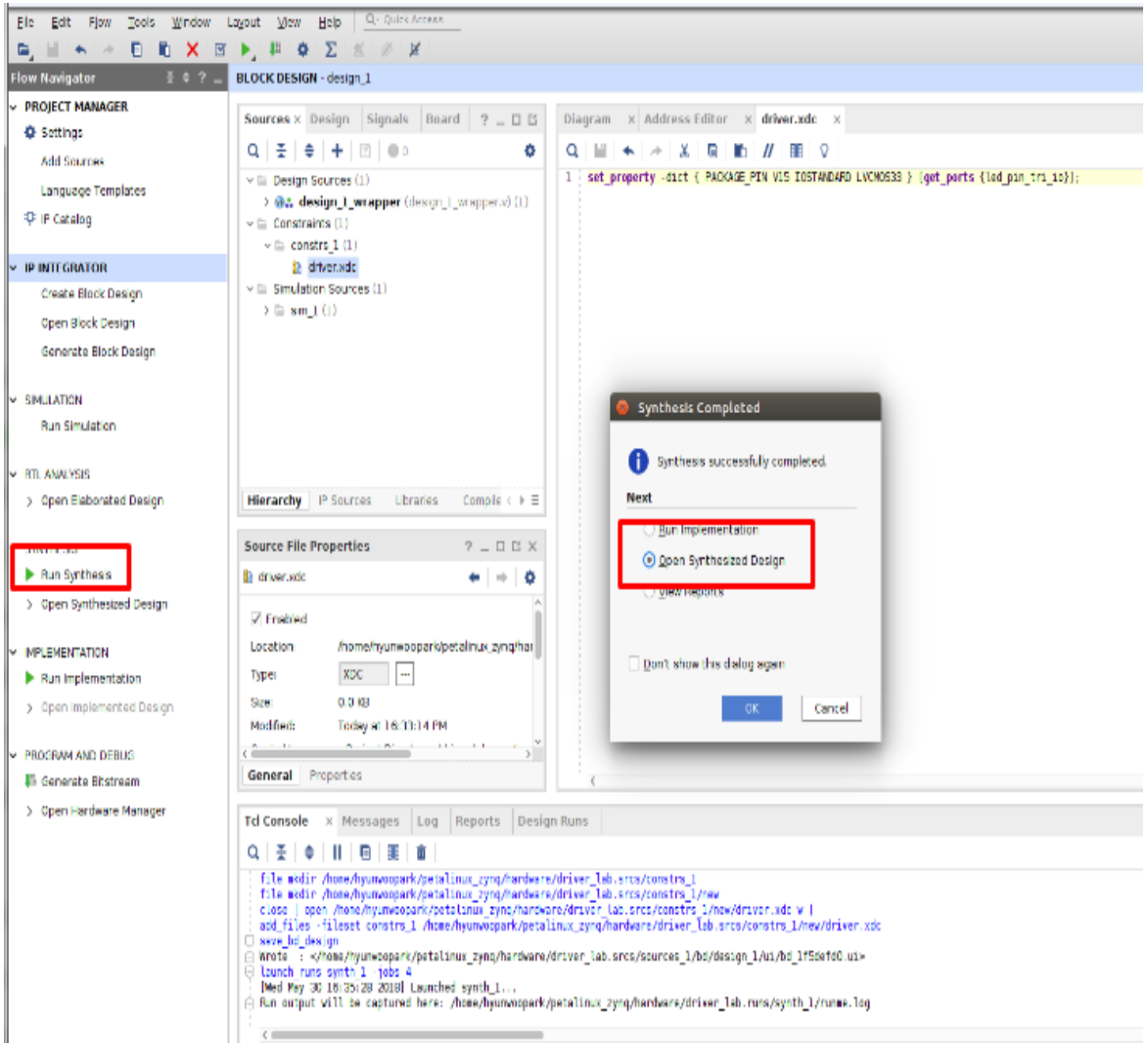
18



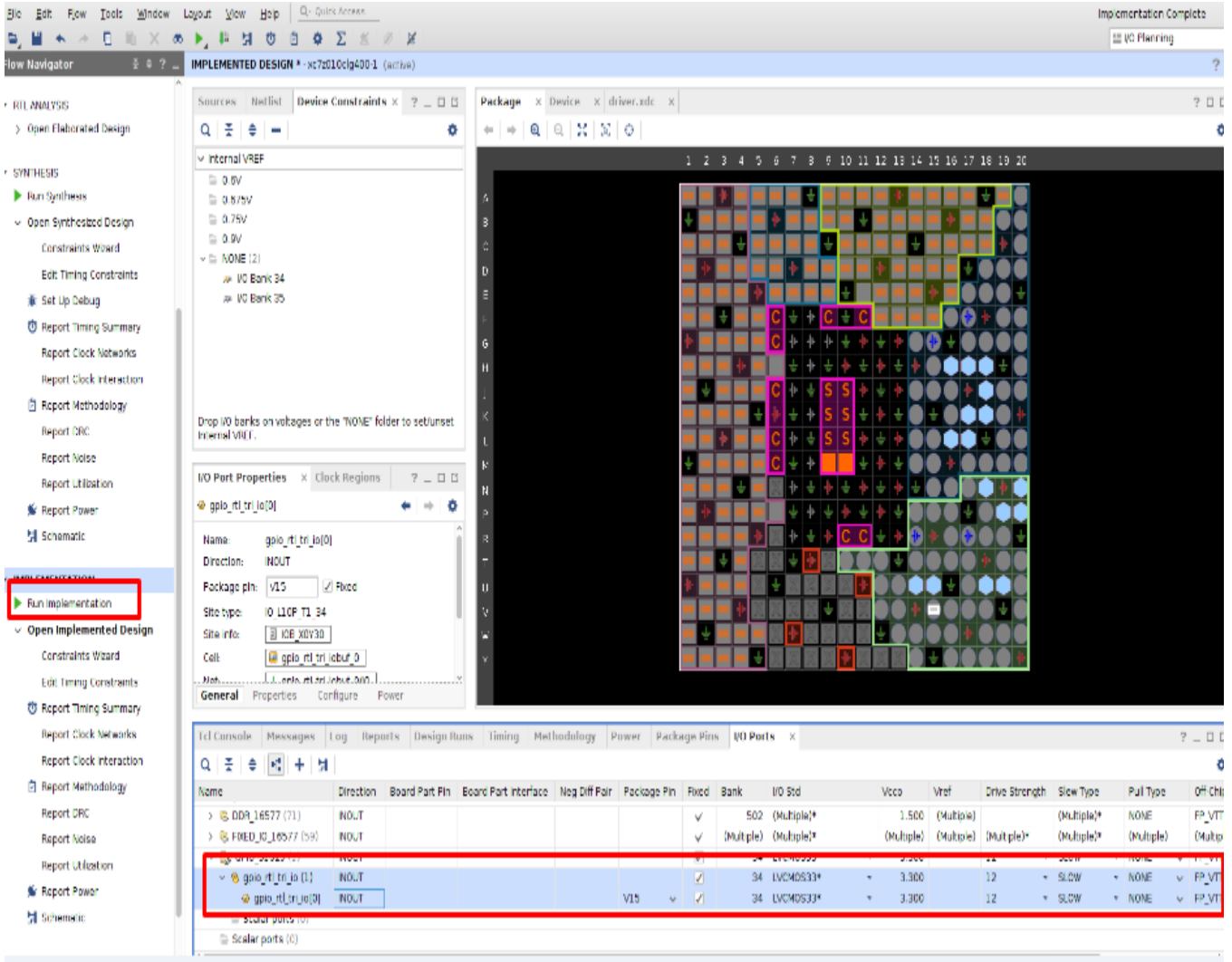
set_property -dict { PACKAGE_PIN V15 IOSTANDARD LVCMOS33 } [get_ports {gpio_rtl_tri_io}];

2) Vivado hardware 설계 10

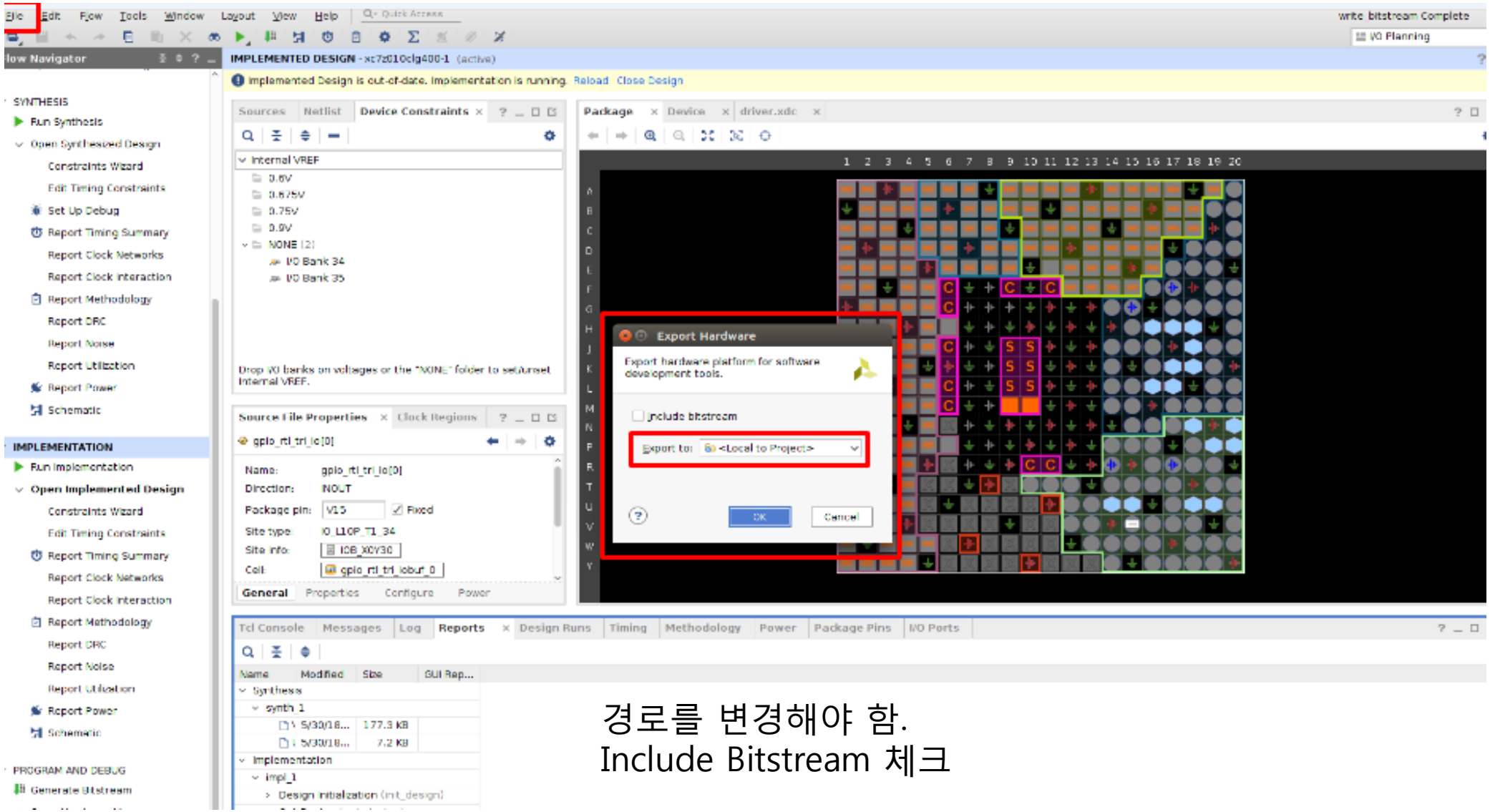
19



20



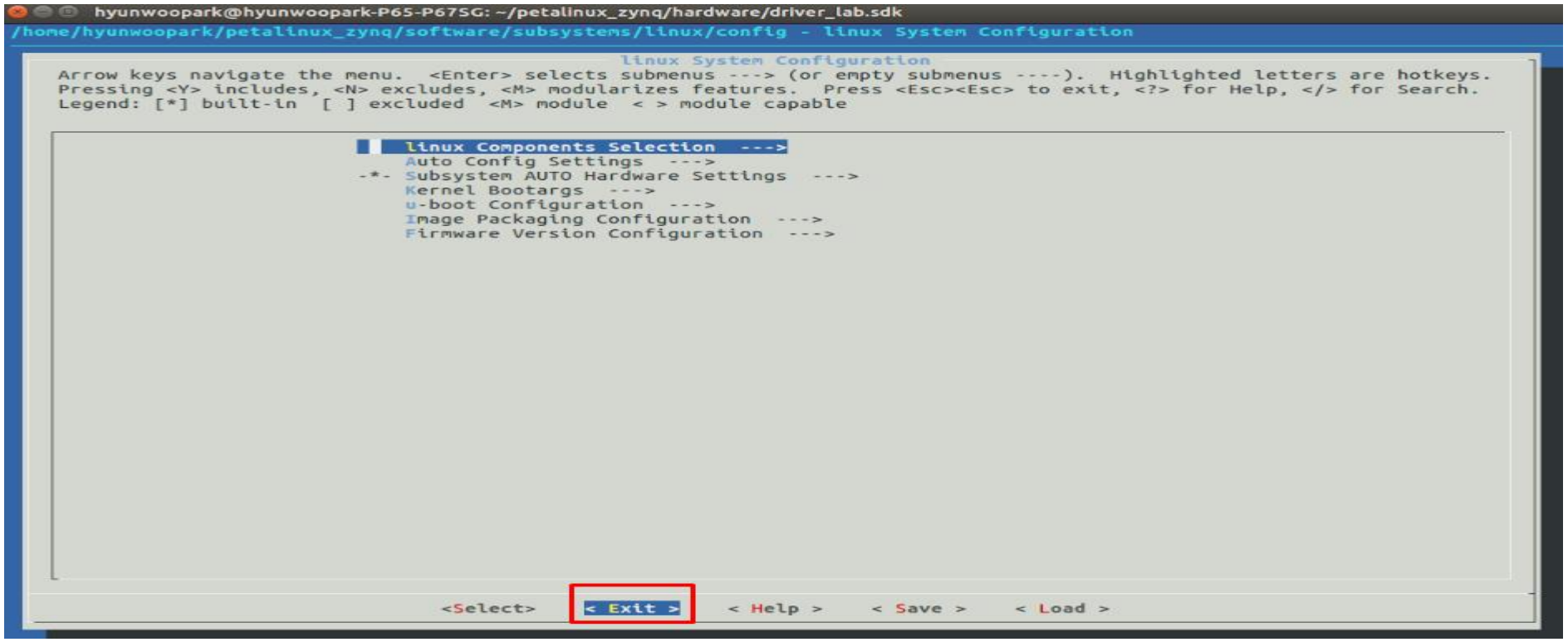
2) Vivado hardware 설계 11



경로를 변경해야 함.
Include Bitstream 체크

2) Vivado hardware 설계 12


```
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ petalinux-create -t project -n software --template zynq
INFO: Create project: software
INFO: New project successfully created in /home/hyunwoopark/petalinux_zynq/software
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ cd hardware/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/hardware$ ls
driver_lab.cache  driver_lab.ioplanning     driver_lab.runs  driver_lab.sim   driver_lab.xpr
driver_lab.hw     driver_lab.ip_user_files  driver_lab.sdk   driver_lab.srcs
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/hardware$ cd driver_lab.sdk/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/hardware/driver_lab.sdk$ petalinux-config --get-hw-description -p ~/petalinux_zyn
q/software/
```



2) Vivado hardware 설계 13


```
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ petalinux-create -t project -s ./ZYBO_petalinux_v2015_4.bsp
INFO: Create project:
INFO: Projects:
INFO:   * ZYBO_petalinux_v2015_4
INFO: has been successfully installed to /home/hyunwoopark/petalinux_zynq/
INFO: New project successfully created in /home/hyunwoopark/petalinux_zynq/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$
```

```
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ cd ZYBO_petalinux_v2015_4/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/ZYBO_petalinux_v2015_4$ petalinux-create -t apps --name gpio-dev-mem-test
INFO: Create apps: gpio-dev-mem-test
INFO: New apps successfully created in /home/hyunwoopark/petalinux_zynq/ZYBO_petalinux_v2015_4/components/apps/gpio-dev-mem-test
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/ZYBO_petalinux_v2015_4$
```

```
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/ZYBO_petalinux_v2015_4$ ls
components  config.project  hardware  hw-description  pre-built  subsystems
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/ZYBO_petalinux_v2015_4$ cd ..
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ ls
hardware  petalinux-v2015.4-final  software  ZYBO_petalinux_v2015_4  ZYBO_petalinux_v2015_4.bsp
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq$ cd software/
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/software$ ls
build  components  config.project  hw-description  subsystems
hyunwoopark@hyunwoopark-P65-P67SG:~/petalinux_zynq/software$ petalinux-build
```

2) Vivado hardware 설계 14

38) 이제 HW 설계와 SW 연동을 수행해보도록 한다.
그 이전에 각종 설계를 수행할 것인데
관리를 위해 디렉토리를 한 단계 더 분할하도록 한다.
mkdir hw_sw_co_design

(39) cd hw_sw_co_design

(40) FPGA 로 설계한 HW 를 보관할 디렉토리를 만든다.
mkdir hardware

(41) Xilinx Vivado 툴을 실행한다.

(42) 수업에서 진행하였듯이 아래와 같은 각종 HW 를 설계한다.
(GPIO, ADC, I2C, SPI, PWM, 기타 전용 HW 등등)
프로젝트 저장을 방금 만든 hardware 디렉토리에 저장하도록 한다.
hardware 의 위치는 아래와 같다.
fpga_dev_driver/hw_sw_co_design/hardware

(43) petalinux-create -t project -n kernel --template zynq

(44) cd kernel

(45) petalinux-config --get-hw-description=~/fpga_dev_driver/hw_sw_co_design/hardware/~~~.sdk
여기서 sdk 는 Vivado 에서 HW 설계한 내용에 해당한다.

(46) cd components/bootloader/zynq_fsbl
(47) ls
FPGA 베이스의 Cortex-A9 부트 코드를 볼 수 있다
(48) cd ../../..

(49) petalinux-config -c u-boot
(50) petalinux-build
(51) petalinux-create -t apps -n device_driver --enable
(52) cd components/apps/device_driver
(53) vi device_driver.c

HW 를 제어하기 위한 SW 코드인 Device Driver 코드를 작성한다.

(54) cd ~/fpga_dev_driver/hw_sw_co_design/kernel/images/linux
(55) ls
여기에 부트 로더와 리눅스 이미지가 있는 것을 볼 수 있을 것이다.

(56) petalinux-build

(57) petalinux-package --boot --fsbl zynq_fsbl.elf --fpga ./비트스트림 --u-boot --force
Vivado 에서 설계한 HW 와 관련한 비트스트림 정보가 여기에 있다.
예로 비트스트림 파일명이 test_wrapper.bit 라면
./비트스트림은 ./test_wrapper.bit 로 변경되어야 한다.

Re: petalinux bootgen missing

export PATH=$PATH:/home/hyunwoopark/xilinx/SDK/2017.1/bin/

Ps. 이거 때문에 진짜... 새벽까지 잠도 못자고 진짜 고생했다. 하;;;

3) SD 카드 설정 및 보드에 올리기

(58) 수업중 제공한 문서를 기반으로 SD 카드에
부트 로더와 리눅스 이미지를 옮긴다.

(59) FPGA 보드의 점퍼를 SD 카드 부팅으로 변경한다.
(60) 컴퓨터와 FPGA 보드를 USB 로 연결한다.
(61) 전원을 인가한다.

(62) dmesg 를 통해 USB Device Driver 가 잘 잡히는지 확인한다.
(63) sudo apt-get install putty
(64) 푸티의 폰트 등 각종 설정을 수행한다.
(65) sudo chmod 666 /dev/ttyUSB1
(66) Buad Rate 를 115200 으로 지정하고 연결한다.

(67) 리눅스 부팅되는 모습을 볼 수 있다.**[출처]** 64 회차 교육 로그|**작성자** silenc3502