Lab 5

MPEG-2 System Integration and Testing Evaluation

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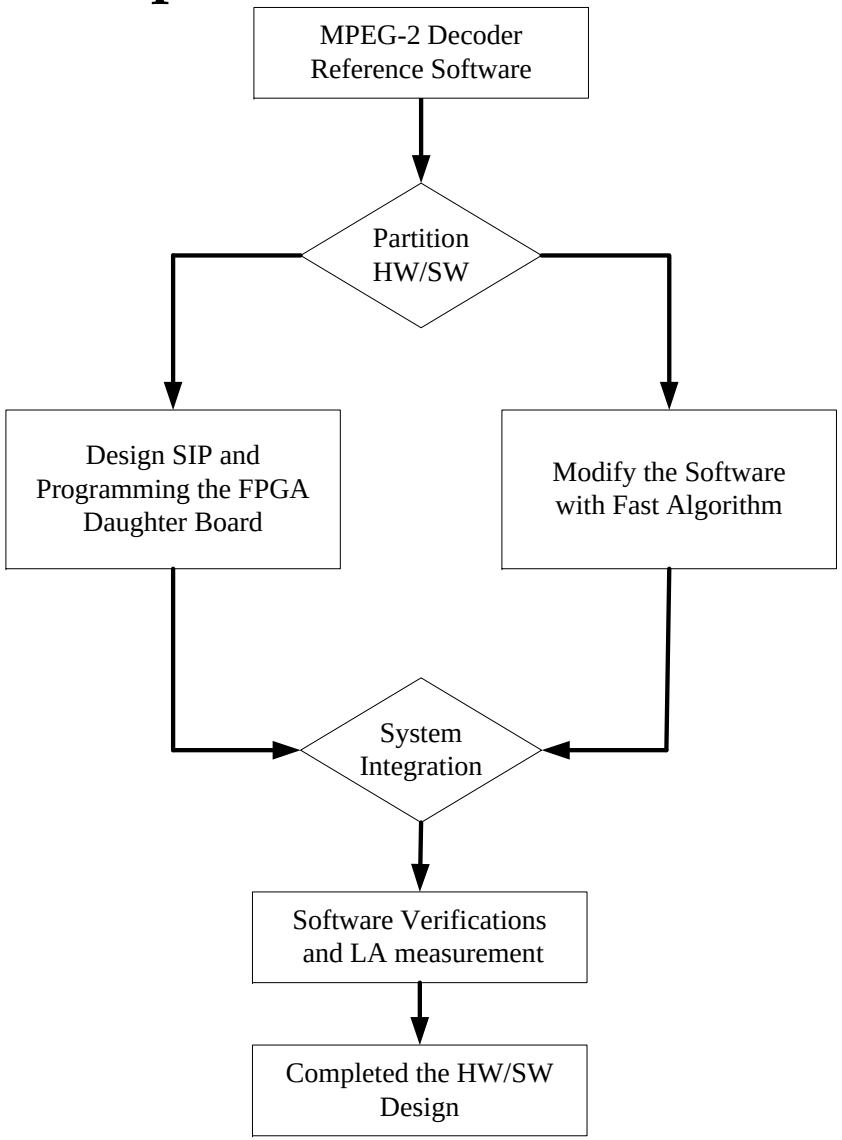
Outline

5.1 MPEG-2 Decoder HW & SW Integration Flow

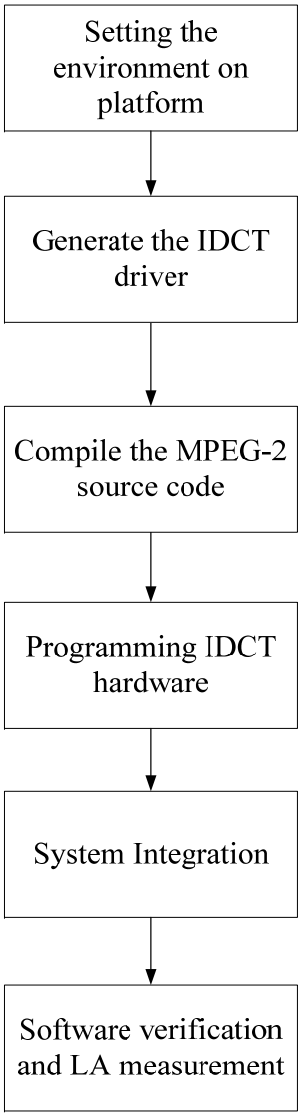
5.1 MPEG-2 Decoder HW & SW Integration Flow

- **Integration Flow Graph:**



5.1 MPEG-2 Decoder HW & SW Integration Flow

Design Flows of Lab5



Download the bootloader、kernel、filesystem

Gernerate the IDCT driver

Modify the source code for the HW/SW codesign. Compile the source code to generate the IDCT driver.

Programming IDCT hardware into the FPGA daughter board.

Integrate the files. Execute the MPEG-2 software to complete the HW/SW codesign.

Execute the MPEG-2 decoder . Verification with the software and LA measurement.

5.1 MPEG-2 Decoder HW & SW Integration Flow

- Prepared Design Files
  - Software Design Files
    - MPEG-2 Decoder Execution File : mpeg2decode
    - IDCT Driver : idct_driver.o
  - Hardware Design Files
    - IDCT Hardware : idct.pof

5.2 Download the Linux Kernel

5.1 MPEG-2 Decoder HW & SW Integration Flow

5.2 Download the Linux Kernel

5.3 IDCT Driver Programming

5.4 Compilation the MPEG-2 Source Code

5.5 Programming IDCT SIP

5.6 System Integrations

5.7 Software Verification and LA Measurement

5.2 Download the Linux Kernel

- Modify Kernel Source Code File:

  2.4.18-rmk7-pxa1-XSBase\arch\arm\mach-pxa\xhyper255.c
  - CPU->FPGA : bus width 16bits -> 32bits

```
-----------------------------------------------------------------------
/* setup memory timing for CS4 */
MSC2 = MSC_CS(4, MSC_RBUFF(MSC_RBUFF_SLOW) |
                 MSC_RRR (2) |
                 MSC_RDN (4) |
                 MSC_RDF (4) |
                 MSC_RBW (1) |
                 MSC_RT  (0))
-----------------------------------------------------------------------
```

Rom Bus Width 16 Bits

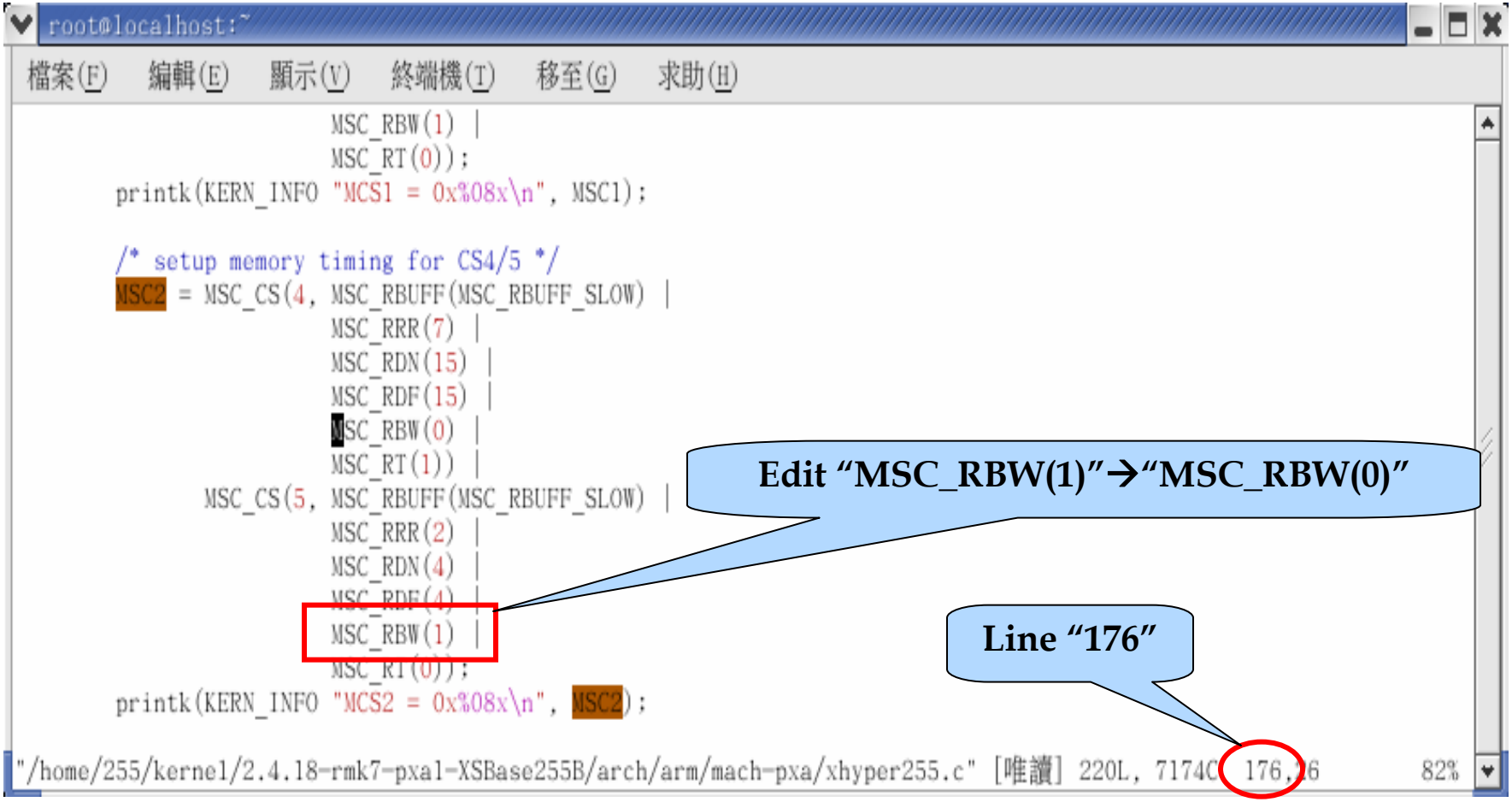
Modify Rom Bus (line 176)

```
-----------------------------------------------------------------------
MSC2 = MSC_CS(4, MSC_RBUFF(MSC_RBUFF_SLOW) |
                 MSC_RRR (7) |
                 MSC_RDN (15)|
                 MSC_RDF (15)|
                 MSC_RBW (0) |
                 MSC_RT  (1))
-----------------------------------------------------------------------
```

Rom Bus Width 32 Bits

5.2 Download the Linux Kernel

- [root$super root]# vi /home/255/kernel/2.4.18-rmk7-pxa1-XSBase255B/arch/arm/mach-pxa/xhyper255.c



5.2 Download the Linux Kernel

- Install Toolchain
  - [root$super root]# vi ~/.bash_profile
    - bash_profile : Setup the Environment

  - [root$super root]# source ~/.bash_profile
  - Logout and Login Linux System

5.2 Download the Linux Kernel

- Compile Kernel
  - [root$super root]# cd /home/255/kernel/2.4.18-rmk7-pxal-XSBase255B/
  - [root$super 2.4.18-rmk7-pxal-XSBase255B]# make clean
  - [root$super 2.4.18-rmk7-pxal-XSBase255B]# make dep
  - [root$super 2.4.18-rmk7-pxal-XSBase255B]# make zImage
- Generation kernel image file “zImage” in “arch/arm/boot” directory

5.2 Download the Linux Kernel

- Setup TFTP and BOOTP Server Environment:
  - [root$super root]# vi /etc/xinetd.d/bootp

  - [root$super root]# vi /etc/bootptab

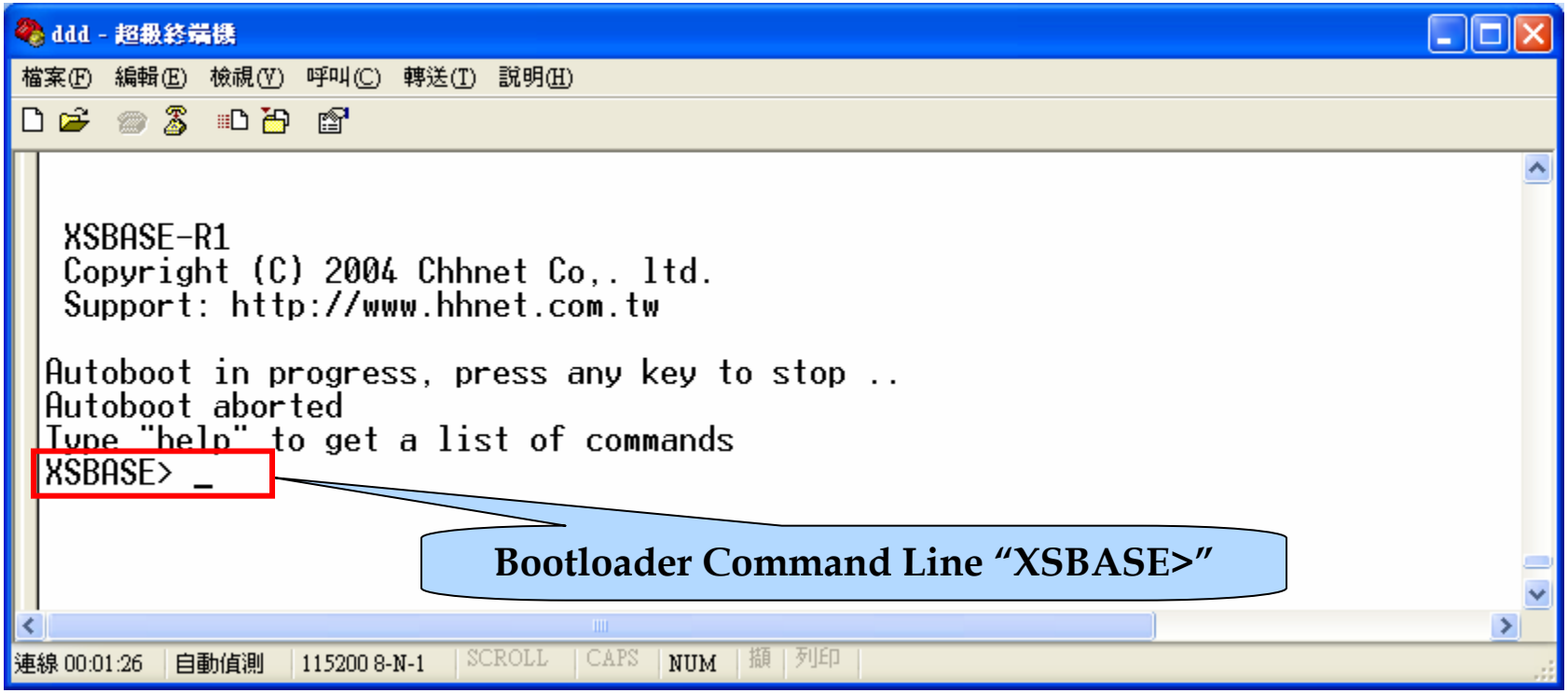
5.2 Download the Linux Kernel

- Restart “Xined” Server
  - [root$super root]# /etc/rc.d/init.d/xinetd restart

- Copy Kernel Image to TFTP Server
  - [root$super root]# cp /home/255/kernel/2.4.18-rmk7-pxal-XSBase255B/arch/arm/boot/zImage /tftpboot
- Open Terminal and Power On XScale/PXA255

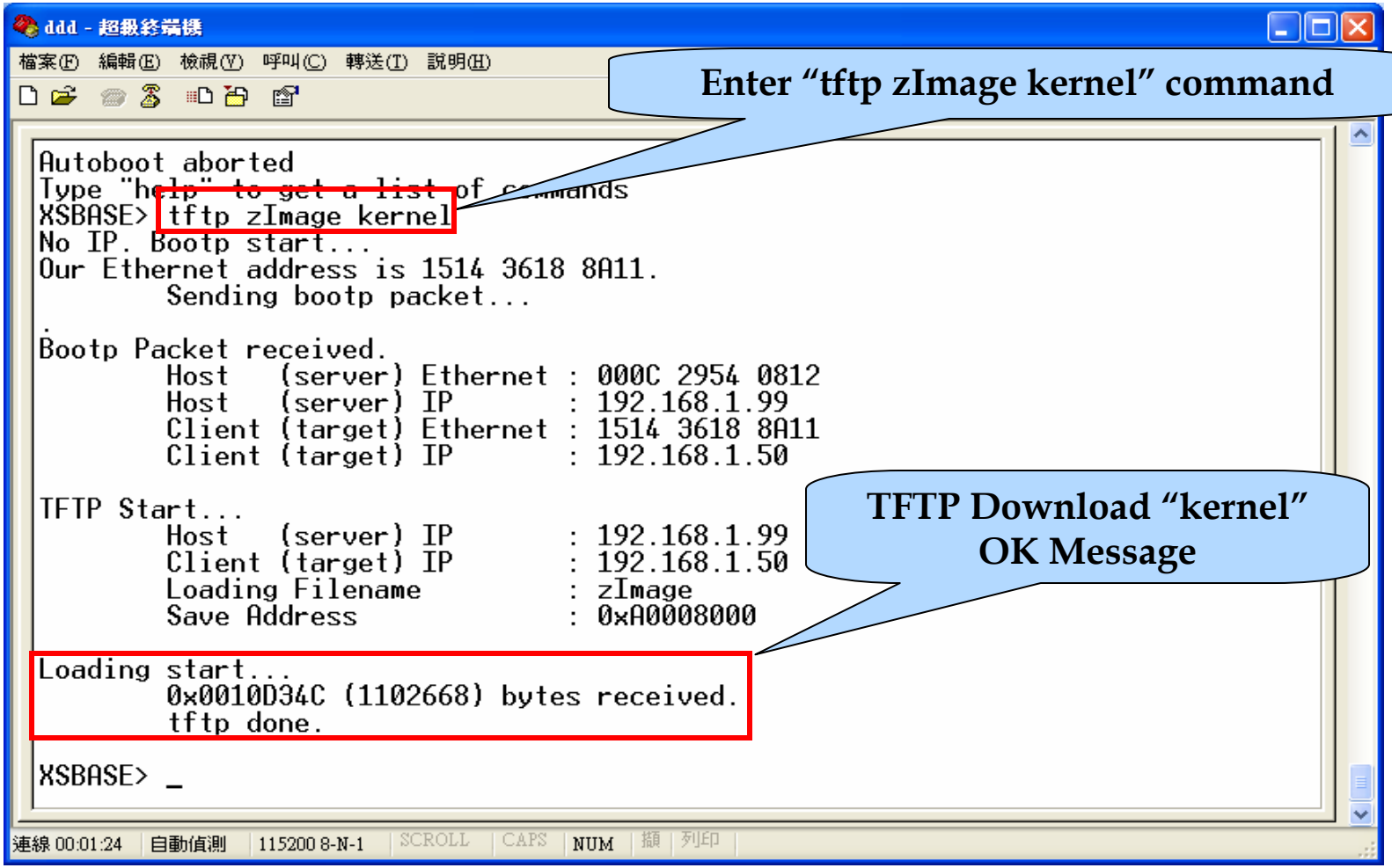
5.2 Download the Linux Kernel

- After booting. Terminal will show the message “Autoboot in progess”.
- Press any key to stop the process in three seconds. Enter command mode on Bootloader.



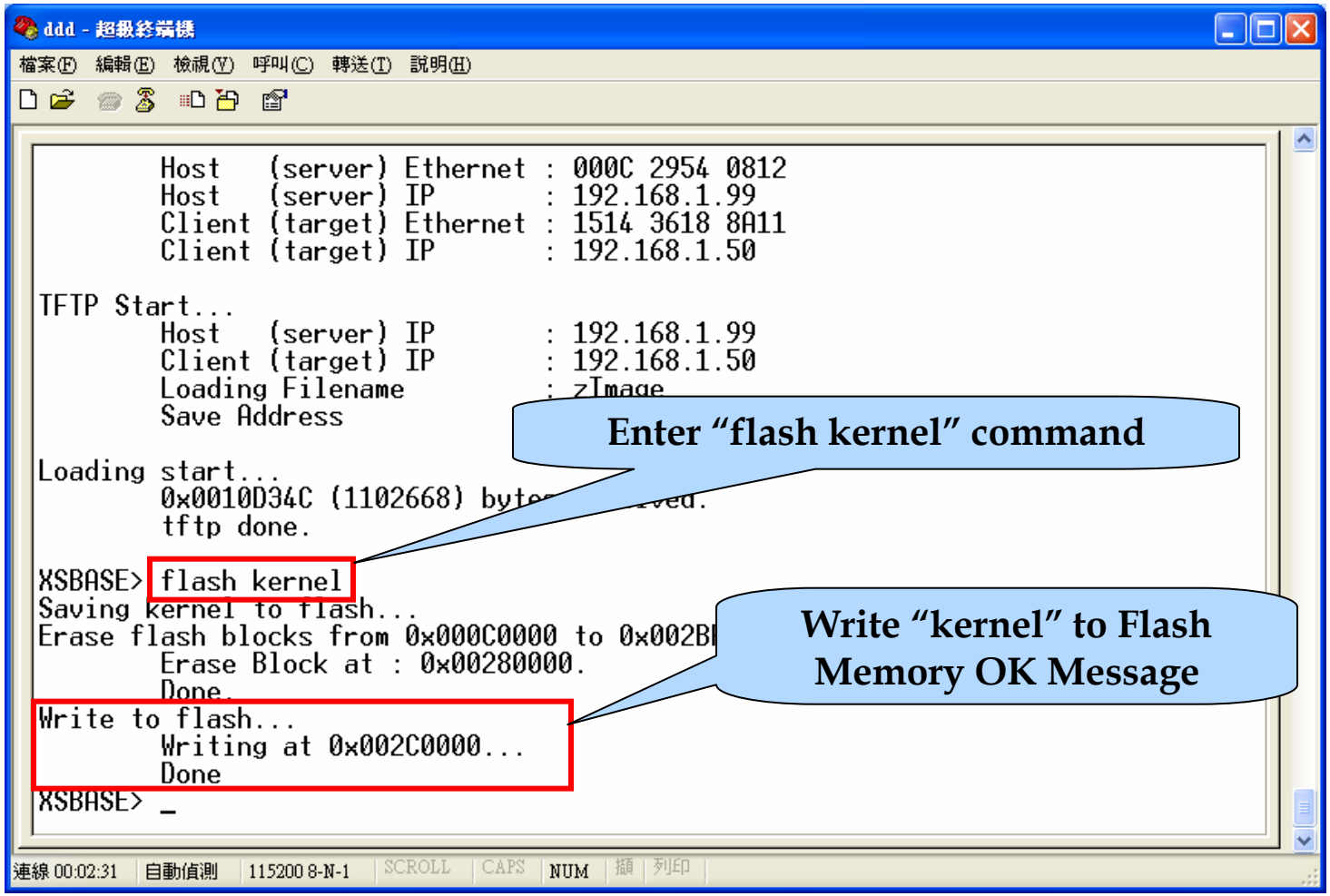
5.2 Download the Linux Kernel

- Use TFTP Command Download Kernel
  - [root$super root]# tftp zImage kernel



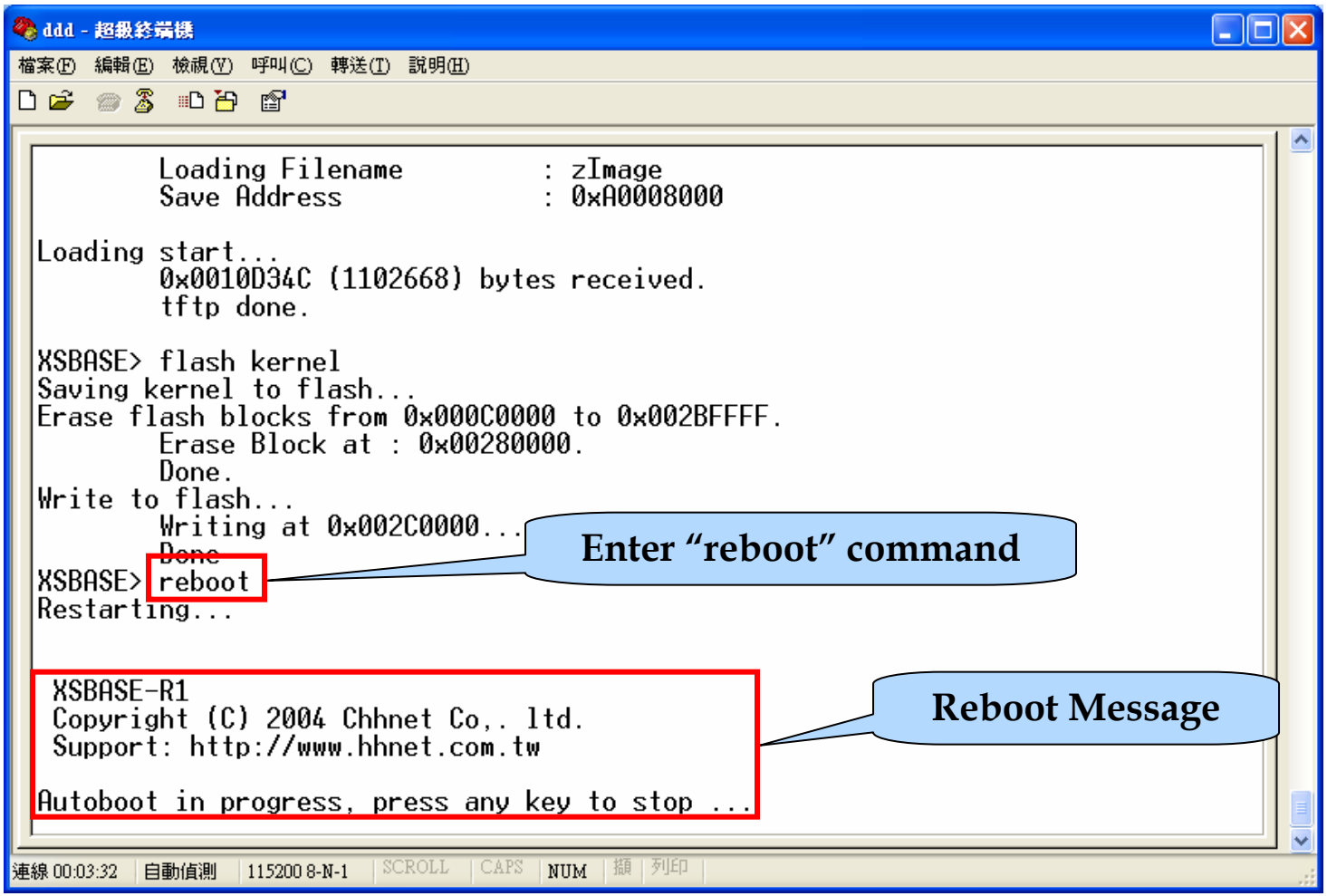
5.2 Download the Linux Kernel

- [root$super root]# flash kernel



5.2 Download the Linux Kernel

- Reboot with XScale PXA255
  - XSCALE> reboot



5.3 IDCT Driver Programming

5.1 MPEG-2 Decoder HW & SW Integration Flow

5.2 Download the Linux Kernel

5.3 IDCT Driver Programming

5.4 Compilation the MPEG-2 Source Code

5.5 Programming IDCT SIP

5.6 System Integrations

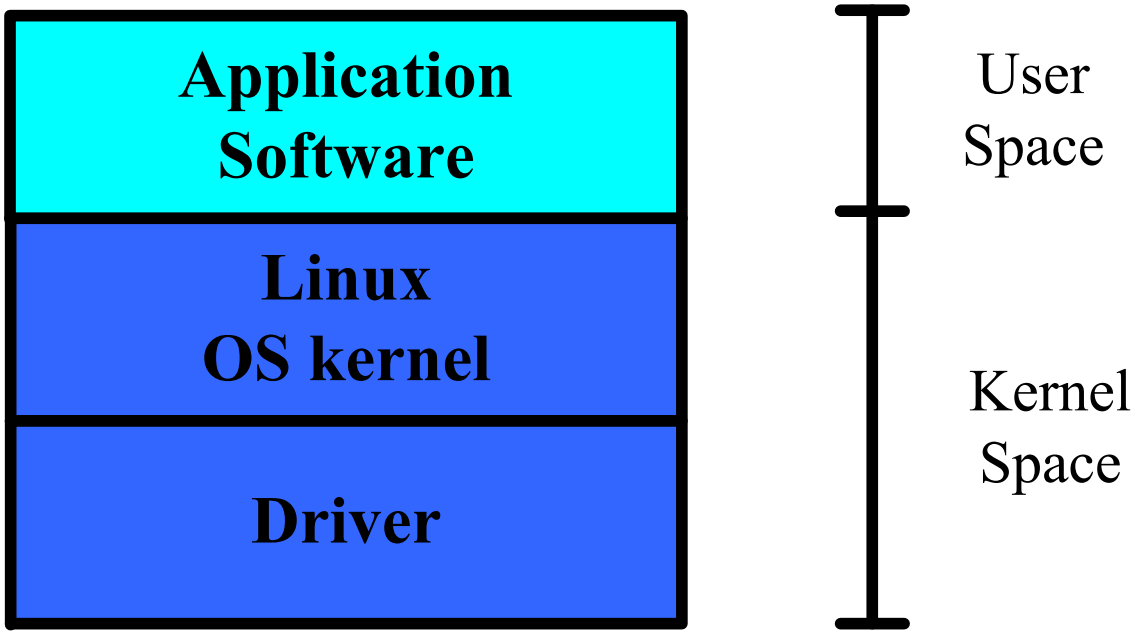
5.7 Software Verification and LA Measurement

5.3 IDCT Driver Programming

- Programming the IDCT Driver Functions
  - Open()
  - Read()
  - Write()
  - Close()
- Compile the IDCT Driver
  - Create the Driver Module

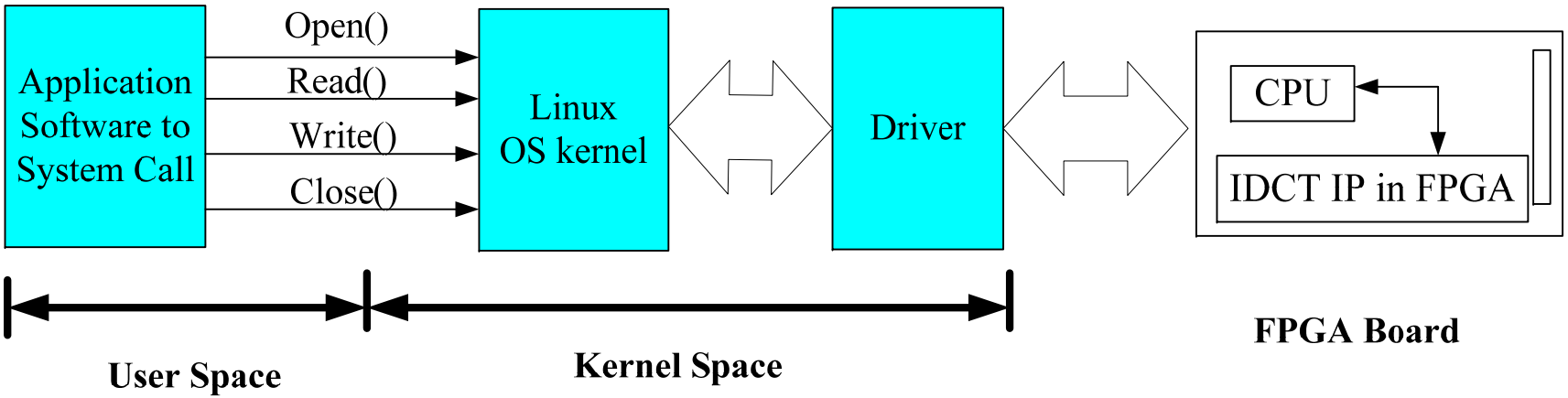
5.3 IDCT Driver Programming

- Kernel Space : Linux OS kernel and the IDCT Driver
- User Space : Application Software



5.3 IDCT Driver Programming

- Flow of the Software Functions to Hardware Operations



5.3 IDCT Driver Programming

Programming the IDCT Driver(1/6)

- File Name : idct_driver.c

```
-----------------------------------------------------------------------
#include "fpga_board_ioctl.h“
#include "fpga_reg_set.h“

#define FPGA_BOARD_MAJOR 72            //Major number
#define DEVICE_NAME "FPGA_BOARD_6“
#define INT_OWNER   "FPGA_BOARD_6“

//open(),read(),wrtite(),close()
static struct file_operations fpga_board_fops={
open:     fpga_board_open,
release:  fpga_board_release,
read:     fpga_board_read,
write:    fpga_board_write,
};
-----------------------------------------------------------------------
```

5.3 IDCT Driver Programming

Programming the IDCT Driver(2/6)

- File Name : idct_driver.c

```
-----------------------------------------------------------------------
int __init init_fpga_board_module_6(void) //When insmod the driver
{
 register_chrdev(FPGA_BOARD_MAJOR,
                 DEVICE_NAME, &fpga_board_fops); //Register the driver
 //printk("Init v1\n");//Make sure the driver activity
 //printk("frank\n");
 return(0);
}

void __exit  cleanup_fpga_board_module_6(void) //When remod the driver
{
 unregister_chrdev(FPGA_BOARD_MAJOR, DEVICE_NAME ); //Unregister the driver
 //printk("cleanup FPGA Board\n"); //Make sure the driver activity
}
-----------------------------------------------------------------------
```

5.3 IDCT Driver Programming

Programming the IDCT Driver(3/6)

- Open()
- File Name : idct_driver.c

```
//Physical memory address map virtual memory address
static void phy_to_vir(FPGA_BOARD * f_b_p)
{
 request_mem_region(DARAM_PHY_ADDR, 1024, "test");
 f_b_p->DARAM_VIR_ADDR = (unsigned long)ioremap(DARAM_PHY_ADDR,1024);
 //Map function 1024 bytes
}

//When open the driver
static int fpga_board_open(struct inode * inode_p, struct file * filp)
{
 static FPGA_BOARD f_b;
 phy_to_vir(&f_b); //Call the “phy_to_vir” function
 filp->private_data = &f_b;
 return(0);
}
```

5.3 IDCT Driver Programming

Programming the IDCT Driver(4/6)

- Write()
- File Name : idct_driver.c

```
-------------------------------------------------------------------------
 static ssize_t fpga_board_write(struct file * filp, const char * buff,
                                 size_t count, loff_t *offp)
 {                               //“count” value from application
  unsigned long value;
  int i,j;
  FPGA_BOARD *  f_b_p;
  char *p = kmalloc(count, GFP_KERNEL); //require the memory “count” bytes
  f_b_p = filp->private_data;
  for(i=0; i<count; i+=4)
  {
   value = (p[i] | p[i+1]<<8 | p[i+2]<<16 | p[i+3]<<24);
   writel(value, f_b_p->DARAM_VIR_ADDR+i); //Write 32-bits data
  }                              The virtual address
  return(count);
 }
-------------------------------------------------------------------------
```

5.3 IDCT Driver Programming

Programming the IDCT Driver(5/6)

- read()
- File Name : idct_driver.c

```
-------------------------------------------------------------------------
 static ssize_t fpga_board_read(struct file * filp, char * buff,
                                size_t count, loff_t *offp)
 {
  int i;
  unsigned long value; //require the memory “count” bytes
  char *p = kmalloc(count, GFP_KERNEL);
  FPGA_BOARD * f_b_p;
  f_b_p = filp->private_data;
  memcpy_fromio(p, f_b_p->DARAM_VIR_ADDR, count); //Read data from HW
  copy_to_user((char *)buff, (char *)p, count); //copy data from kernel
                                                  space to user space
  return(count);
 }
-------------------------------------------------------------------------
```

5.3 IDCT Driver Programming

Programming the IDCT Driver(6/6)

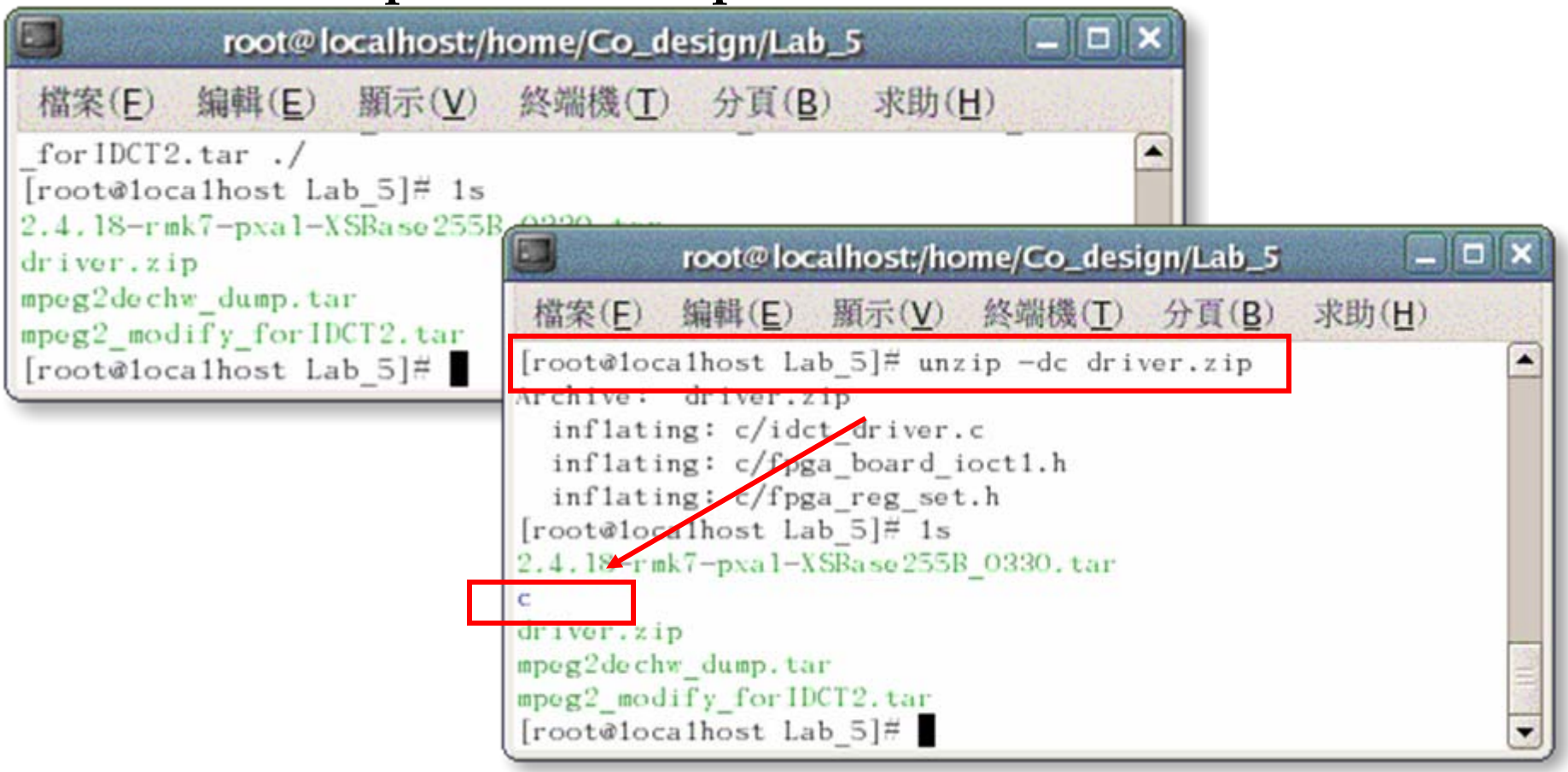
- Close()
- File Name : idct_driver.c

```
-------------------------------------------------------------------------
 //When the user application call close()
   The close system in Linux kernel mean “release”
 static int fpga_board_release(struct inode * inode_p, struct file * filp)
 {
  FPGA_BOARD * f_b_p;
  f_b_p = filp->private_data;
  iounmap((void *)f_b_p->DARAM_VIR_ADDR  );
  return(0) //Driver close, release the memory
 }
-------------------------------------------------------------------------
```

5.3 IDCT Driver Programming

Compilation the Driver

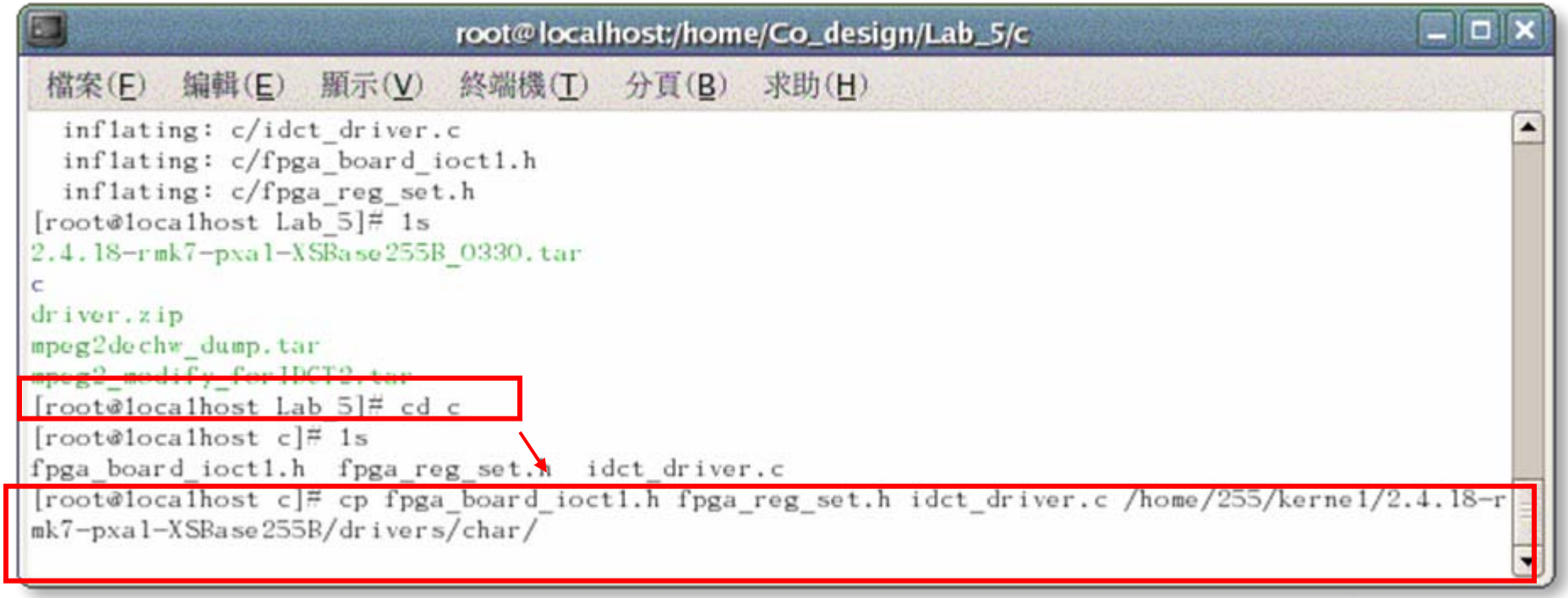
- Decompress "idct_driver.zip" to get Driver Source Code
  - Lab_5>ls
  - Lab_5>unzip –dc driver.zip



5.3 IDCT Driver Programming

Compilation the Driver

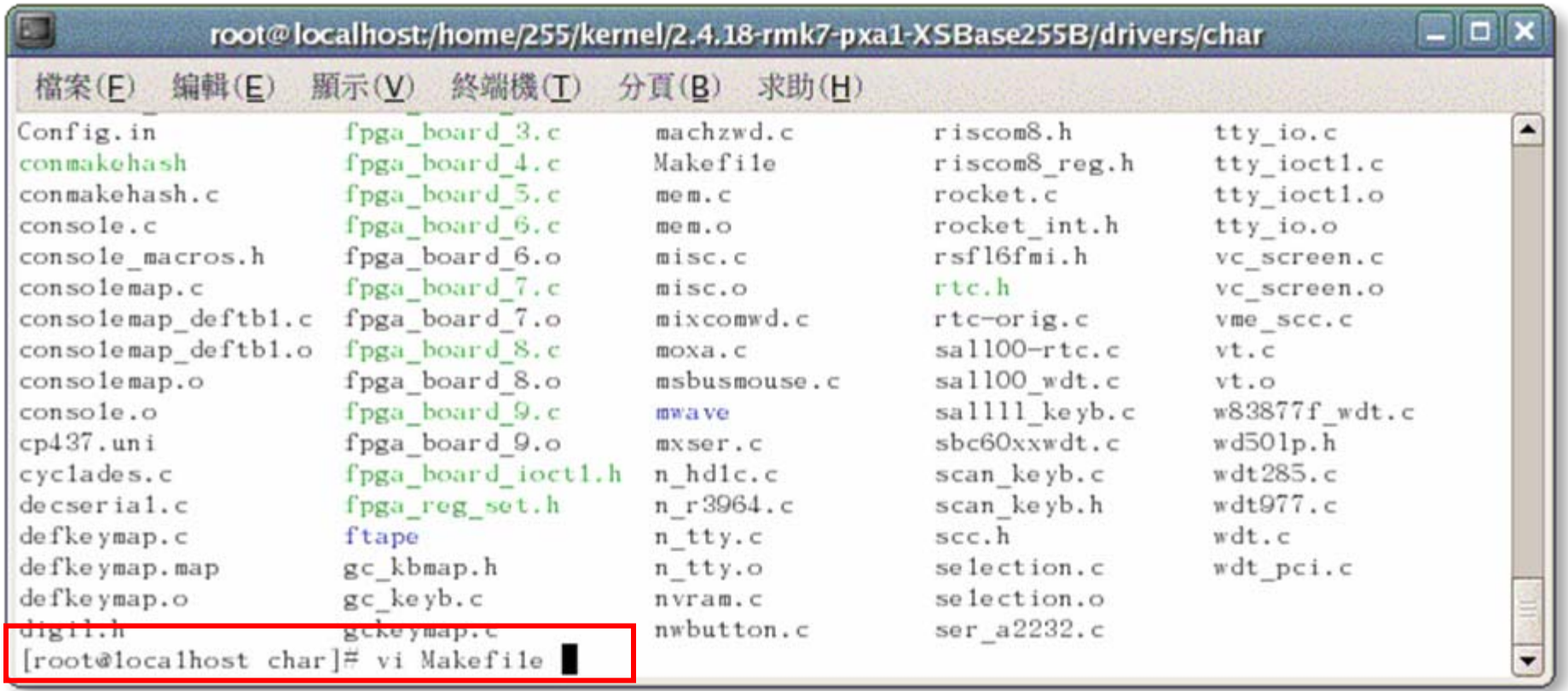
- Copy “idct_driver.c”,”fpga_board_ioctl.h”,” fpga_reg_set.h” into “2.4.18-rmk7-pxa1-XSBase255B/drivers/char” directory
  - Lab_5>cd c
  - C>cp fpga_board_ioctl.h fpga_reg_set.h idct_driver.c /home/2.4.18-rmk7-pxal-XSBase255B/drivers/char/



5.3 IDCT Driver Programming

Compilation the Driver

- Modify Makefile to Compile the Driver
  - #>cd /home/255/kernel/2.4.18-rmk7-pxa1-XSBase255B/drivers/char
  - char>vi Makefile



5.3 IDCT Driver Programming

Compilation the Driver

- Modify obj-$(CONFIG_FPGA)
- Add “idct_driver.o” in “Makefile”
  - #char>vi Makefile

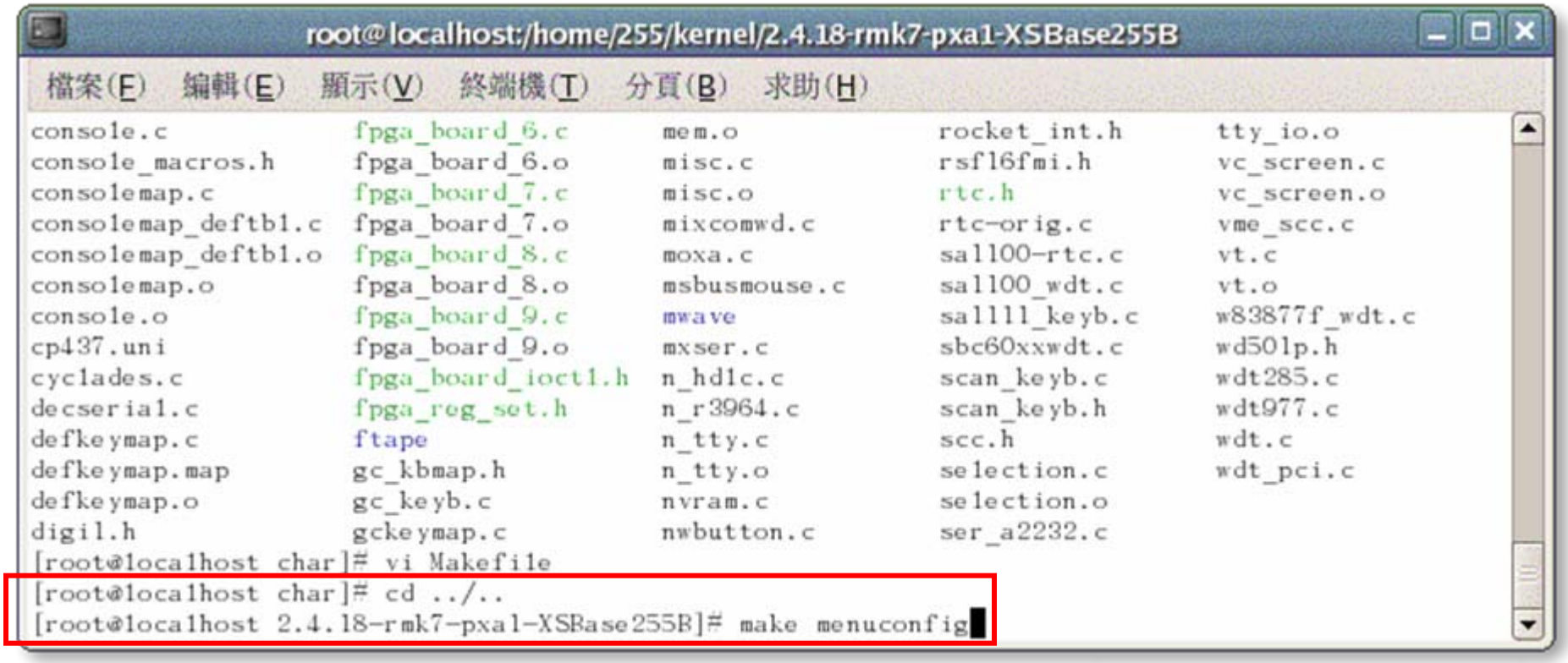
```
obj-$(CONFIG_BVME6000_SCC) += generic_serial.o vme_scc.o
obj-$(CONFIG_SERIAL_TX3912) += generic_serial.o serial_tx3912.o
obj-$(CONFIG_ADS7843) += ads7843_ts.o
obj-$(CONFIG_BG_LIGHT) += lcd_ajust.o
#obj-$(CONFIG_RTC4513) += rtc.o
#obj-$(CONFIG_FPGA) += fpga_board_0.o fpga_board_1.o fpga_board_2.o fpga_board_3.o fpga_board_
4.o fpga_board_5.o f_6_read.o

obj-$(CONFIG_FPGA) +=  fpga_board_7.o fpga_board_8.o fpga_board_9.o fpga_board_10.o f_6_read.o
 idct_driver.o
```

- Push “Esc” button,use “:wq” to save and exit “Makefile”

5.3 IDCT Driver Programming

Compilation the Driver

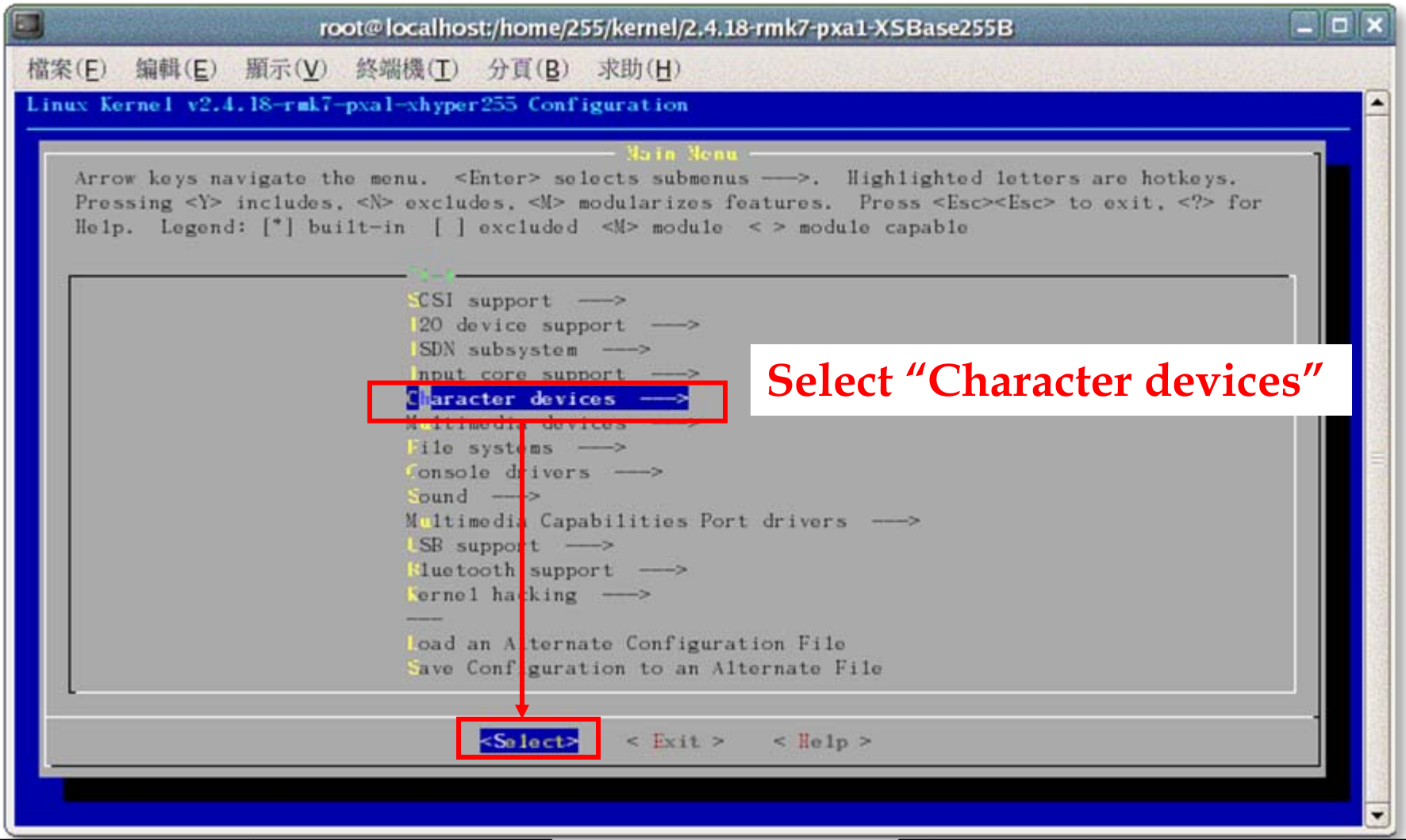
- #char>cd ../../
  - Top Folder of the Kernel Package.
- #2.4.18-rmk7-pxa1-XSBase255B>>make menuconfig



5.3 IDCT Driver Programming

■ Compilation the Driver

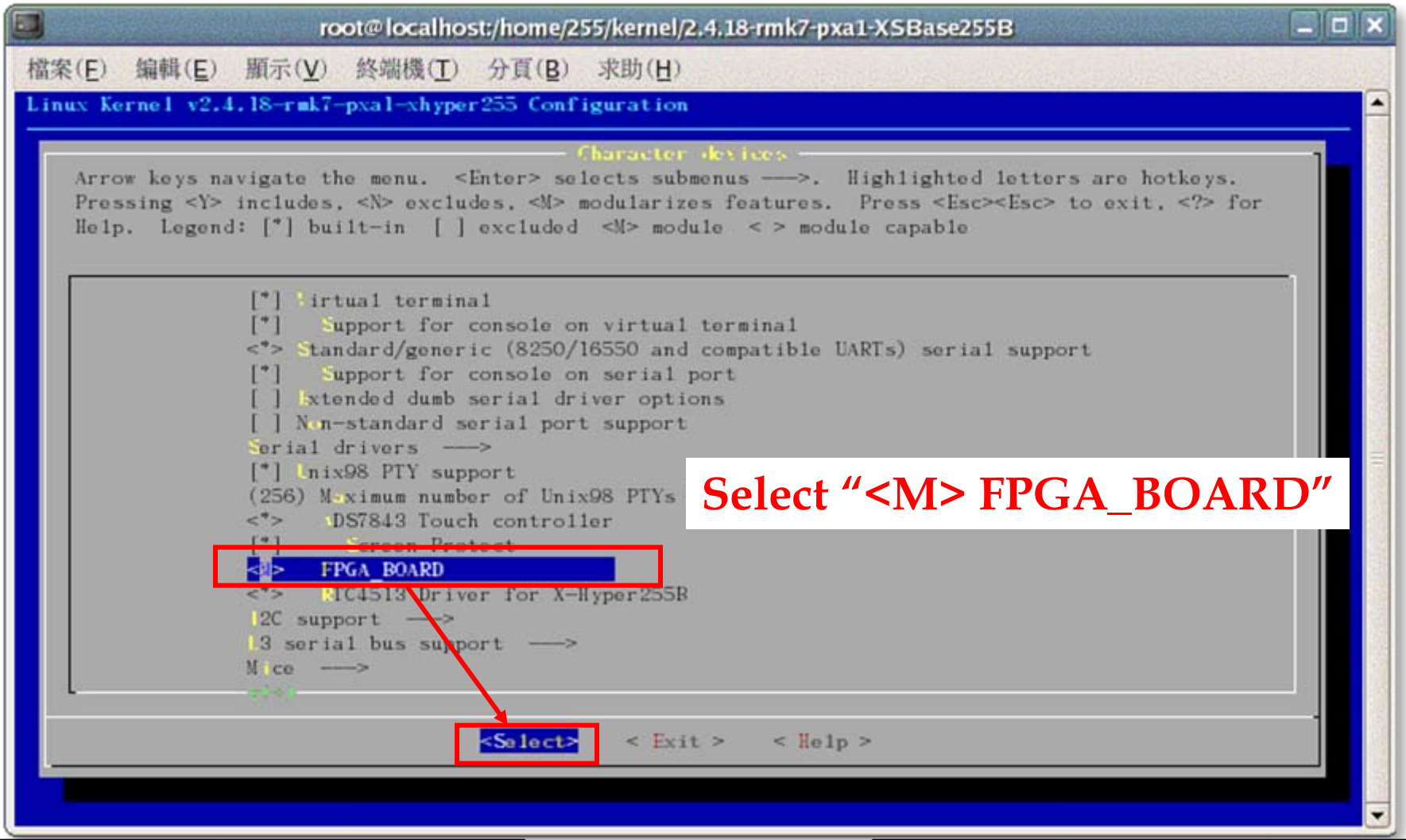
◆ Choose Character Devices



5.3 IDCT Driver Programming

■ Compilation the Driver

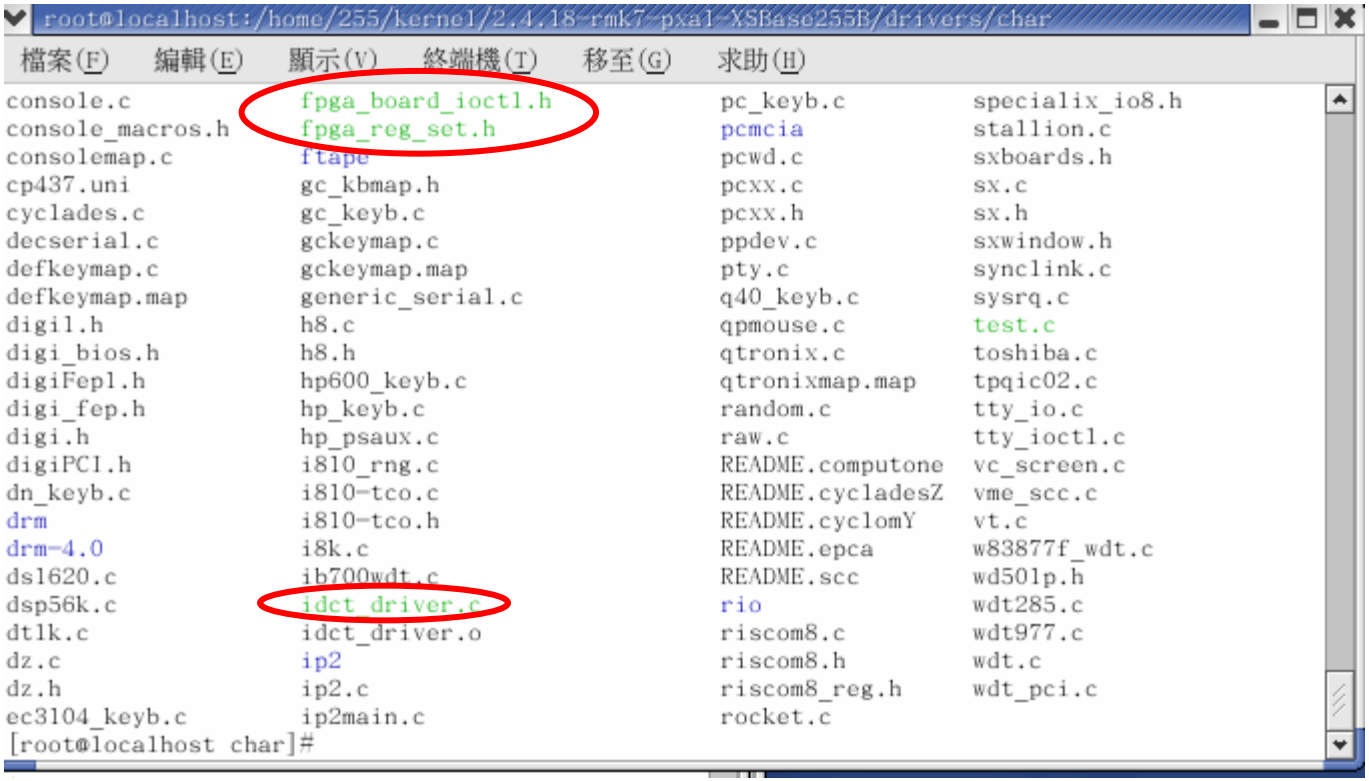
◆ Choose Module



5.3 IDCT Driver Programming

Compilation the Driver

- Compile the Driver
  - #2.4.18-rmk7-pxa1-XSBase255B>make modules
  - Path :2.4.18-rmk7-pxa1-XSBase255B/drivers/char
  - Find the driver –"idct_driver.o"



5.4 Compilation the MPEG-2 Source Code

5.1 MPEG-2 Decoder HW & SW Integration Flow

5.2 Download the Linux Kernel

5.3 IDCT Driver Programming

5.4 Compilation the MPEG-2 Source Code

5.5 Programming IDCT SIP

5.6 System Integrations

5.7 Software Verification and LA Measurement

5.4 Compilation the MPEG-2 Source Code

- Step 1. Modify MPEG2 decoder source to complete the HW/SW co-design
  - Modify files : getpic.c , idct.c
- getpic.c : mpeg2/src/mpeg2dec/getpic.c
- File Name : getpic.c

```
------------------------------------------------------------------------
……
//Add these header file to implement the HW/SW
#include <sys/types.h> #include <sys/stat.h>
#include <fcntl.h>
#include "fpga_board_ioctl.h“
#include "fpga_reg_set.h“
int ffd;
void Decode_Picture(…)
{
……
}
------------------------------------------------------------------------
```

5.4 Compilation the MPEG-2 Source Code

- Step 2. getpic.c : mpeg2/src/mpeg2dec/getpic.c
- File Name : getpic.c

```
-----------------------------------------------------------------------
void Decode_Picture(bitstream_framenum,sequence_framenum)
int bitstream_framenum, sequence_framenum;
{
 ffd = open("/dev/fpga_board_6", O_RDWR); //Open driver
 //The IDCT driver is lined to "/dev/fpga_board_6"
 ……
 close(ffd); //Close driver
}
-----------------------------------------------------------------------
```

5.4 Compilation the MPEG-2 Source Code

- Step 3. getpic.c : mpeg2/src/mpeg2dec/getpic.c
- File Name : getpic.c

```
-------------------------------------------------------------------------
static void motion_compensation(…)
{
 …
 // if (Reference_IDCT_Flag)      //Mask these code
 //    Reference_IDCT(ld->block[comp]);
 // else
 //    Fast_IDCT(ld->block[comp]);
 put_idct_FPGA(ld->block[comp],ffd);
 //Add source code to call the modify IDCT function to implement HW/SW
 …
}
-------------------------------------------------------------------------
```

5.4 Compilation the MPEG-2 Source Code

- Step 4. getpic.c : mpeg2/src/mpeg2dec/getpic.c
- File Name : getpic.c

```
-------------------------------------------------------------------------
void put_idct_FPGA(short *block,int ffd)
{
 int y = 0;
 int buffer[32];
 int  count;
 for(y = 0; y < 8; y++)
 {
  //Merge data to transfer into the hardware
  buffer[(0 + 4 * y)]=(block[0 + y] & 0x0ffff)|(block[8 + y] << 16);
  buffer[(1 + 4 * y)]=(block[16 + y] & 0x0ffff)|(block[24 + y] << 16);
  buffer[(2 + 4 * y)]=(block[32 + y] & 0x0ffff)|(block[40 + y] << 16);
  buffer[(3 + 4 * y)]=(block[48 + y] & 0x0ffff)|(block[56 + y] << 16);
 }
 write(ffd, &buffer[0], 128);
 for(y=0; y <= 4000; y++)
 count =2;
 ……
}
-------------------------------------------------------------------------
```

5.4 Compilation the MPEG-2 Source Code

■ Modify the Software for SW/HW

- Step 5. getpic.c : mpeg2/src/mpeg2dec/getpic.c
- File Name : getpic.c

```
-----------------------------------------------------------------------
{
 ……
 read (ffd, &buffer[0], 128); //Read the data from the wardware
 for(y = 0; y < 8; y++)
 {
  block[0 + (8 * y) ] = (short)(buffer[(0 + 4 * y)] & 0x0ffff);
  block[1 + (8 * y) ] = (short)(buffer[(0 + 4 * y)] >>16);
  block[2 + (8 * y) ] = (short)(buffer[(1 + 4 * y)] & 0x0ffff);
  block[3 + (8 * y) ] = (short)(buffer[(1 + 4 * y)] >>16);
  block[4 + (8 * y) ] = (short)(buffer[(2 + 4 * y)] & 0x0ffff);
  block[5 + (8 * y) ] = (short)(buffer[(2 + 4 * y)] >>16);
  block[6 + (8 * y) ] = (short)(buffer[(3 + 4 * y)] & 0x0ffff);
  block[7 + (8 * y)] = (short)(buffer[(3 + 4 * y) ] >>16);
 }
 ……
}
-----------------------------------------------------------------------
```

5.4 Compilation the MPEG-2 Source Code

- Step 6. Compile MPEG-2 Source Code for ARM
  - Modify Makefile
  - Path : /mpeg2/Makefile
  - Method 1
    - CC = gcc ➔ Absolute Patch/arm-linux-gcc
      - Modify the Makefile with the path of the compiler tool
  - Example
    - CC = /home/toolchain/bin/arm-linux-gcc

5.4 Compilation the MPEG-2 Source Code

■ Modify Makefile with Method 1

- Push the Button “Esc” to exit Makefile
- Type “:wq!” to Quit Makefile and Save

```
#
# GNU gcc
#
CC = /usr/local/hybus-arm-linux-R1.1/bin/arm-linux-gcc
CFLAGS = -O2

all: mpeg2decode mpeg2encode

mpeg2decode:
-- INSERT --
```

Press “Esc”

```
all: mpeg2decode mpeg2encode

mpeg2decode:
:wq!
```

5.4 Compilation the MPEG-2 Source Code

Modify Makefile with Method 1

- **Step 7. Get the MPEG-2 decoder execute file**
  - **#mpeg2>make clean; make**

```
getbits.c           getvlc.h      motion.c    mpeg2d
getbits.o           getvlc.o      motion.o    mpeg2d
getblk.c            global.h      mpeg2dec.c  mpeg2d
[root@localhost mpeg2dec]# cd ..
[root@localhost src]# ls
foreman.m2v  mpeg2dec  mpeg2enc  xdpyinfo
[root@localhost src]# cd ..
[root@localhost mpeg2]# ls
doc  Makefile  par  README  src  verify
[root@localhost mpeg2]# make clean;make
```

  - **#mpeg2>cd src/mpeg2dec/**
  - **#mpeg2>ls**

5.4 Compilation the MPEG-2 Source Code

Modify Makefile with Method 1

- Get **mpeg2decode**

```
.o puthdr.o putmpg.o putvlc.o putbits.o motion.o predict.o readpic.o writepic.o transf
ntize.o ratectl.o stats.o -lm
make[1]: Leaving directory `/frank/ffff/mpeg2/src/mpeg2enc'
[root@localhost mpeg2]# ls
doc  Makefile  par  README  src  verify
[root@localhost mpeg2]# cd src/mpeg2dec/
[root@localhost mpeg2dec]# ls
CHANGES              getblk.o      idct.c      mpeg2dec.h                mpeg2decode_hw
config.h             gethdr.c      idct.c.bak  mpeg2dec.o                mpeg2decodesof
display.c            gethdr.o      idct.o      mpeg2decode               README
display.o            getpic.c      idctref.c   mpeg2decode_0402_2ip.out  recon.c
EXAMPLES             getpic.c.bak  idctref.o   mpeg2decode0402.out       recon.o
fpga_board_ioctl.h   getpic.o      IEEE1180    mpeg2decode0430           SPATIAL.DOC
fpga_reg_set.h       getvlc.c      Makefile    mpeg2decode0430-4000      spatscal.c
getbits.c            getvlc.h      motion.c    mpeg2decodels             spatscal.o
getbits.o            getvlc.o      motion.o    mpeg2decode3slow          store.c
getblk.c             global.h      mpeg2dec.c  mpeg2decodef              store.c.bak
[root@localhost mpeg2dec]#
```

5.4 Compilation the MPEG-2 Source Code

Modify Makefile with Method 2

- Step 6. Compile MPEG-2 Source Code for ARM
  - Modify Makefile
  - Path : /mpeg2/Makefile
  - Method 2
    - CC = gcc → arm-linux-gcc
      - Modify the compiler for ARM
      - Need export the environment variable in the Linux
    - Example
      - Modify the Makefile

        CC= gcc → arm-linux-gcc
      - Exit the Makefile
      - Export the environment variable in the Linux and use “make” to comple

5.4 Compilation the MPEG-2 Source Code

■ Modify Makefile with Method 2

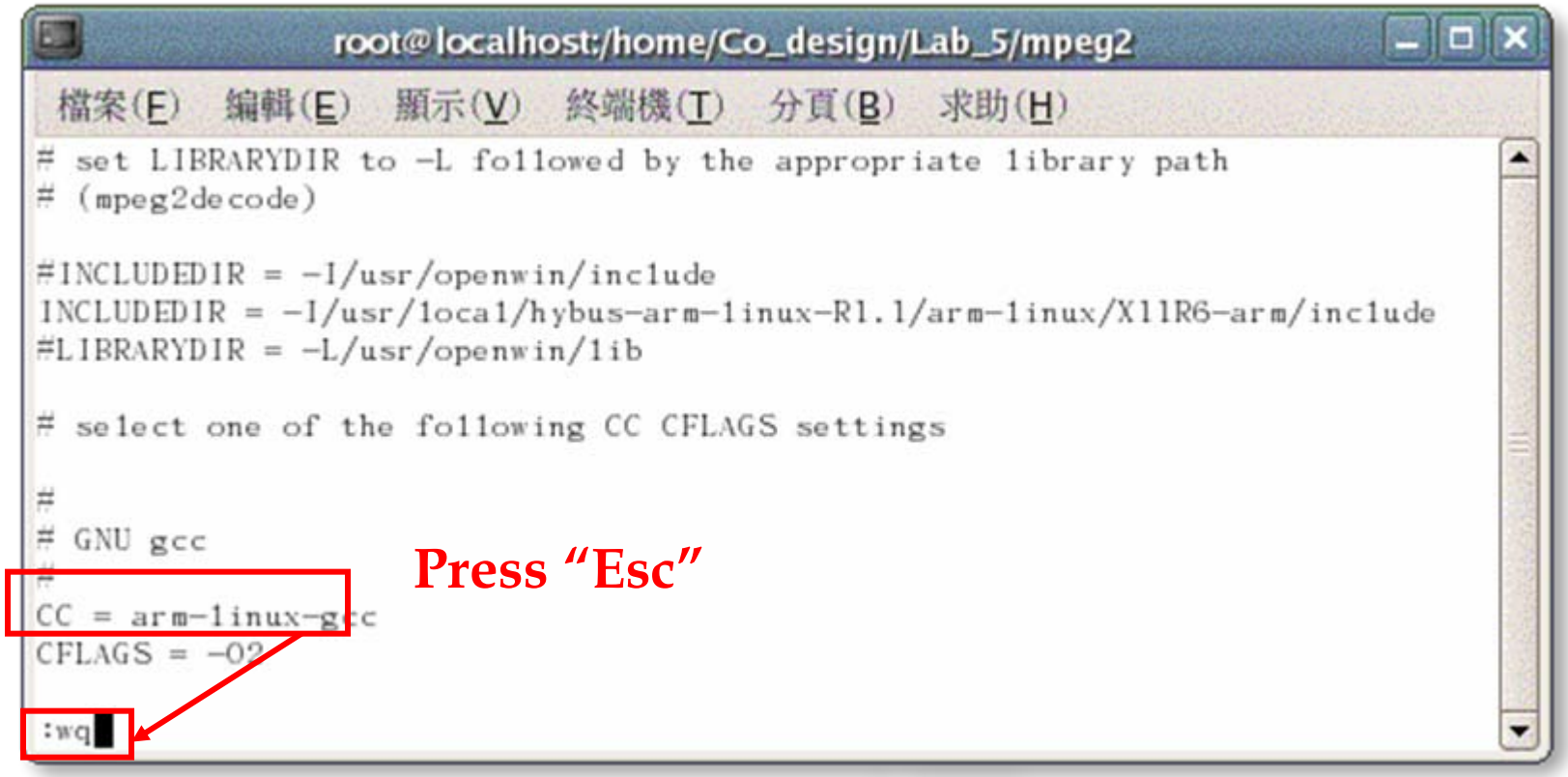
- #mpeg2>vi Makefile

```
[root@localhost frank]# cd mpeg2
[root@localhost mpeg2]# ls
doc  Makefile  par  README  src  verify
[root@localhost mpeg2]# ls
doc  Makefile  par  README  src  verify
[root@localhost mpeg2]# vi Makefile
```

5.4 Compilation the MPEG-2 Source Code

■ Modify Makefile with Method 2

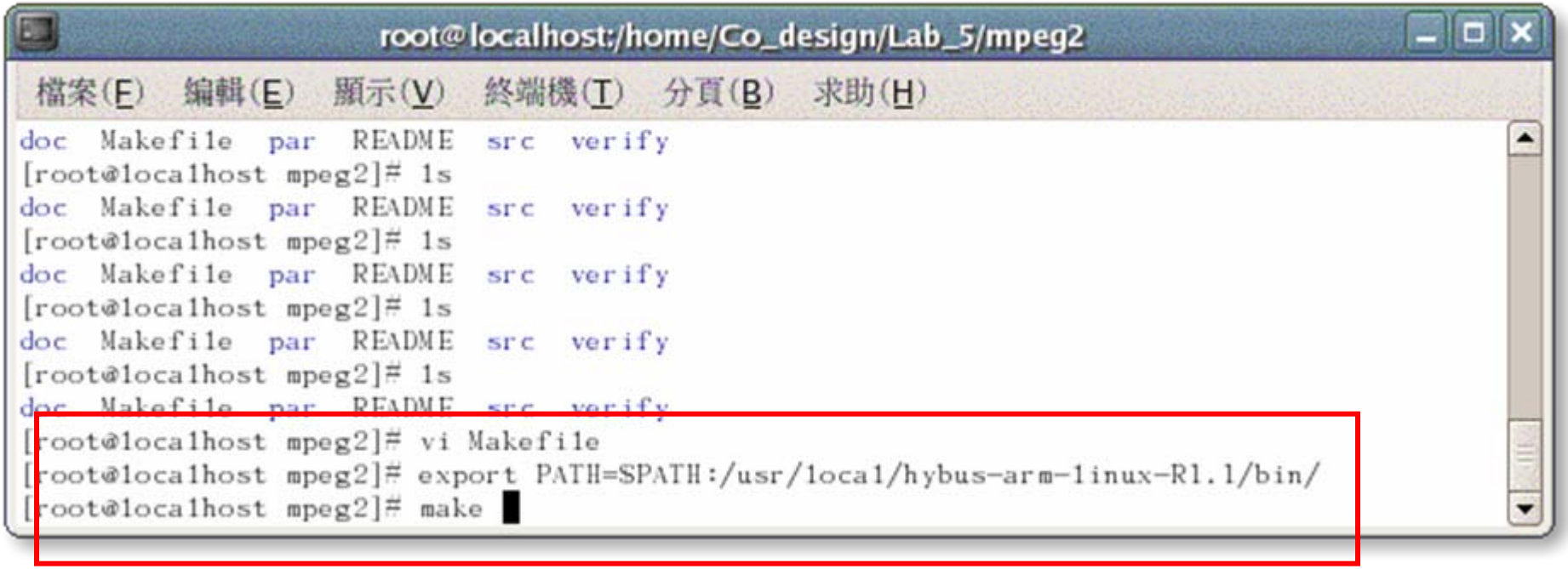
- Modify “Makefile” : CC = arm-linux-gcc
- Press “Esc” button.
- Use “:wq” the save and exit.



5.4 Compilation the MPEG-2 Source Code

■ Modify Makefile with Method 2

- #mpeg2>export PATH=$PATH:/usr/local/hybus-arm-linux-R1.1/bin/
- #mpeg2>make
- Compile the Source Code



5.4 Compilation the MPEG-2 Source Code

■ Modify Makefile with Method 2

- Get the MPEG-2 decoder file
  - #mpeg2>cd src/mpeg2dec/
  - #mpeg2>ls
  - Get mpeg2decode

```
make[1]: Nothing to be done for `all'.
make[1]: Leaving directory `/home/Co_design/Lab_5/mpeg2/src/mpeg2enc'
[root@localhost mpeg2]# cd src/mpeg2dec/
[root@localhost mpeg2dec]# ls
CHANGES              getpic.o     mpeg2dec.h                spatsca1.c
config.h             getv1c.c     mpeg2dec.o                spatsca1.o
display.c            getv1c.h     mpeg2decode               store.c
display.o            getv1c.o     mpeg2decode_0402_2ip.out  store.c.bak
EXAMPLES             global.h     mpeg2decode0402.out       store.o
fpga_board_ioctl.h   idct.c       mpeg2decode0430           subspic.c
fpga_reg_set.h       idct.c.bak   mpeg2decode0430-4000       subspic.o
getbits.c            idct.o       mpeg2decodels             systems.c
getbits.o            idctref.c    mpeg2decode3slow          systems.o
getblk.c             idctref.o    mpeg2decodef              TODO
getblk.o             IEEE1180     mpeg2decodesofe           verify.c
gethdr.c             Makefile     README                    verify.o
gethdr.o             motion.c     recon.c                   yuv2rgb.c
getpic.c             motion.o     recon.o                   yuv2rgb.o
getpic.c.bak         mpeg2dec.c   SPATIAL.DOC
[root@localhost mpeg2dec]#
```

5.5 Programming IDCT SIP

5.1 MPEG-2 Decoder HW & SW Integration Flow

5.2 Download the Linux Kernel

5.3 IDCT Driver Programming

5.4 Compilation the MPEG-2 Source Code

5.5 Programming IDCT SIP

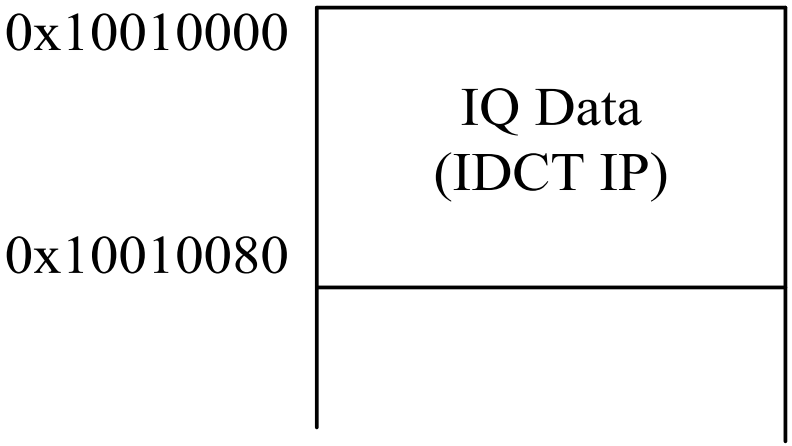
5.6 System Integrations

5.7 Software Verification and LA Measurement

5.5 Programming IDCT SIP

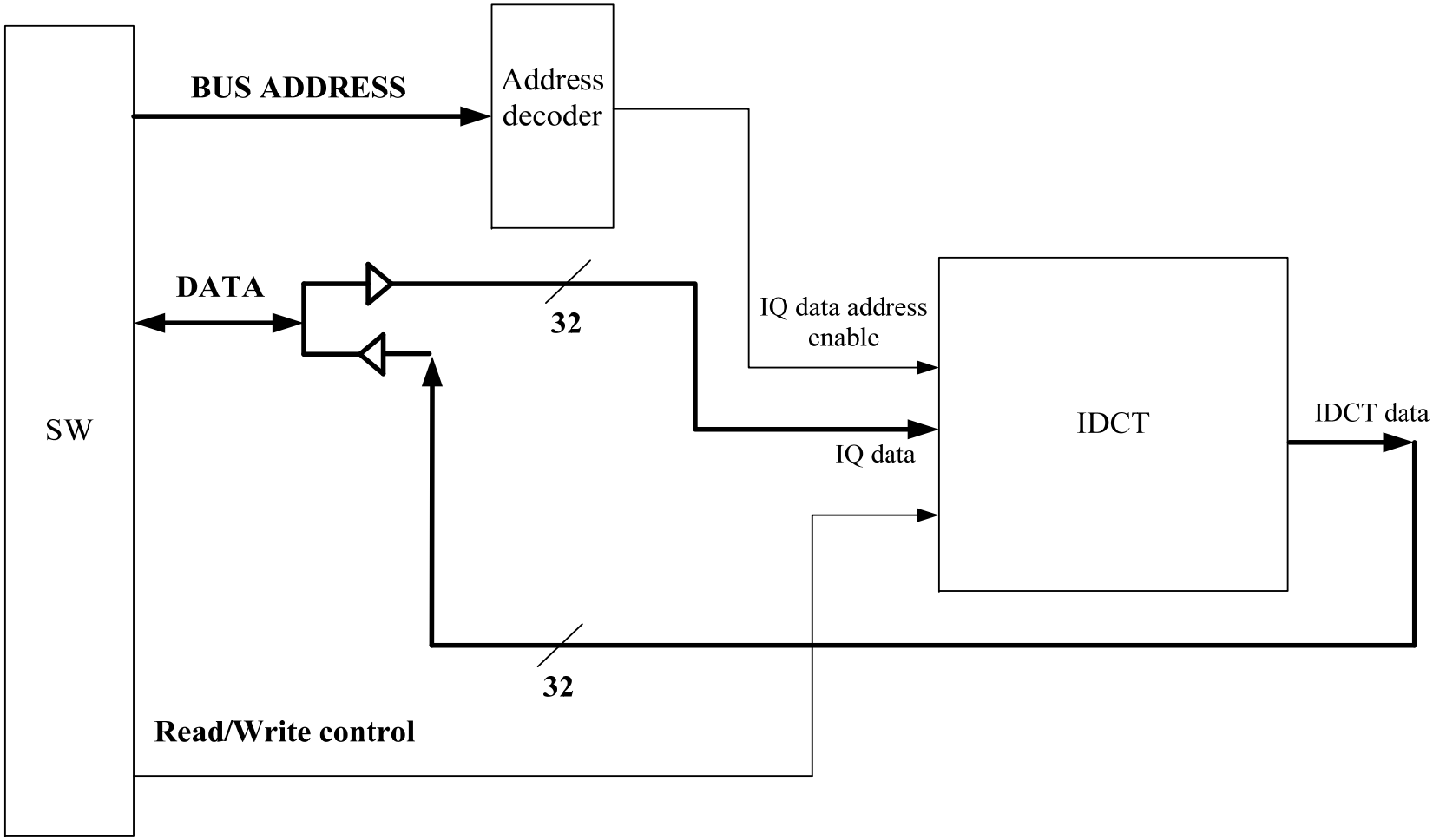
■ System Memory Map

◆ System Memory Map



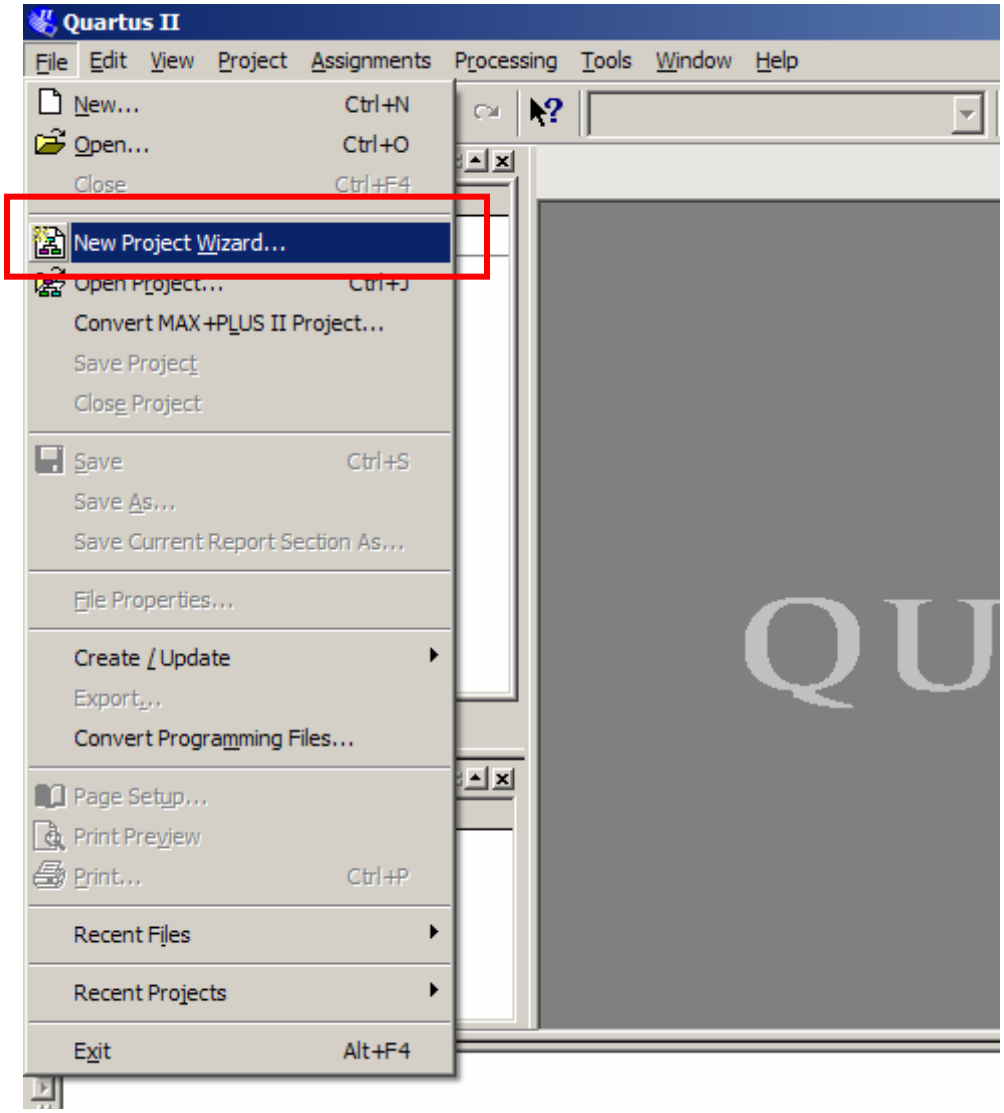
5.5 Programming IDCT SIP

■ MPEG-2 HW System



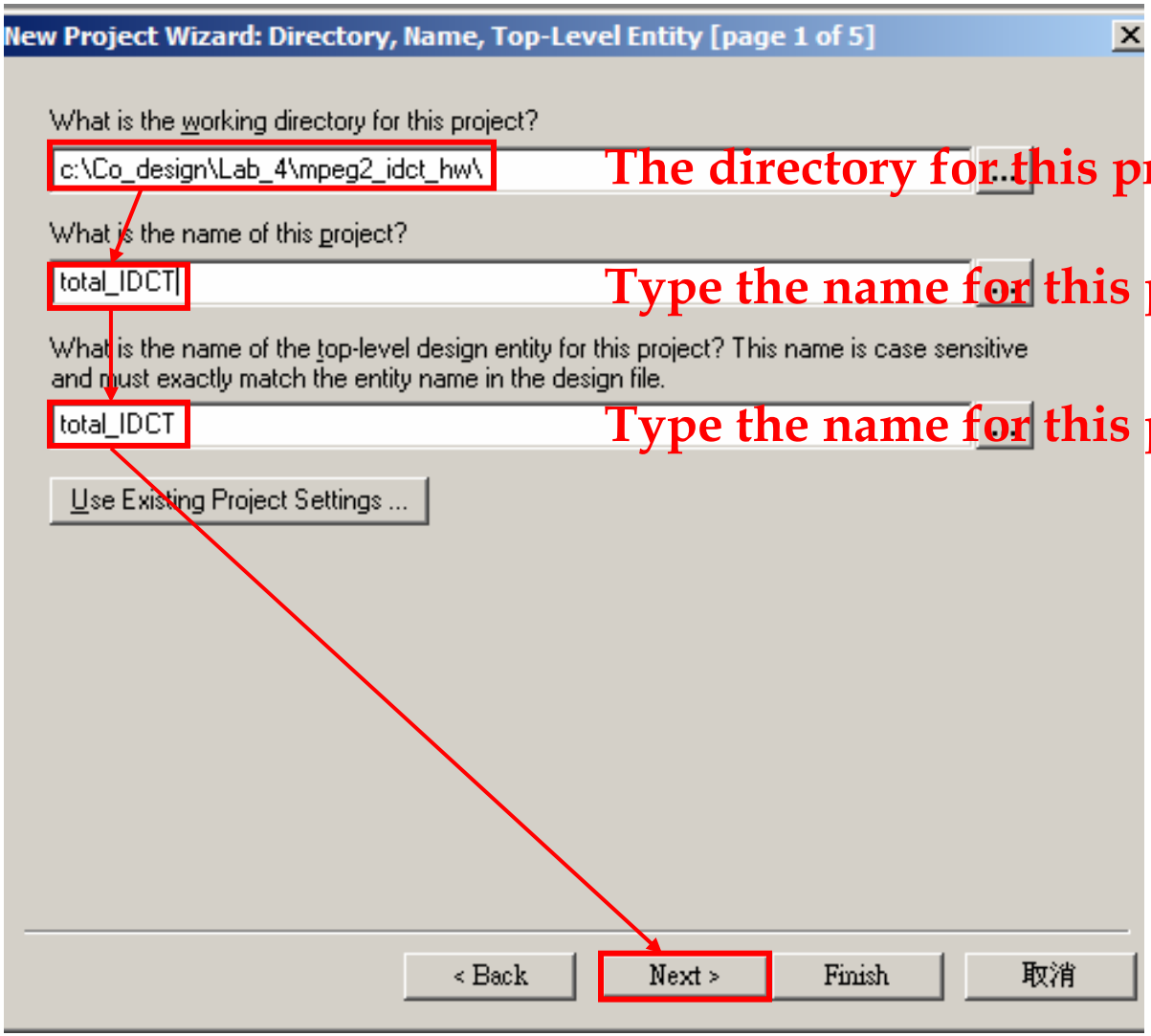
5.5 Programming IDCT SIP

- Step 1. File/New/New Project Wizard



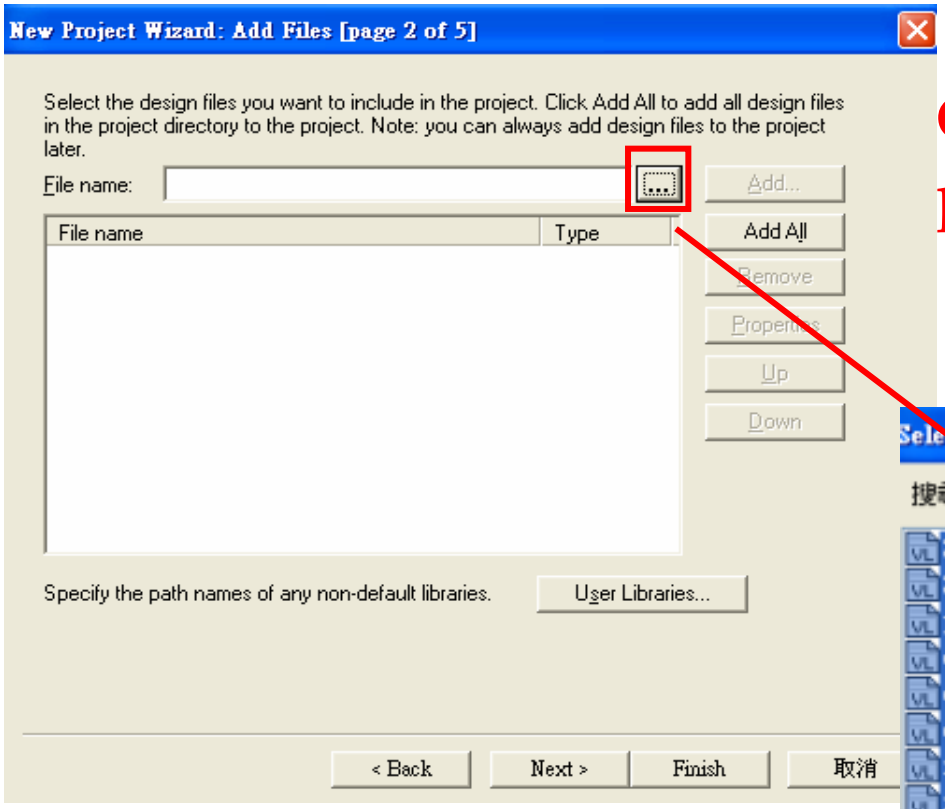
5.5 Programming IDCT SIP

- Step 2.Type the Name for this Project. And type “Next>”.

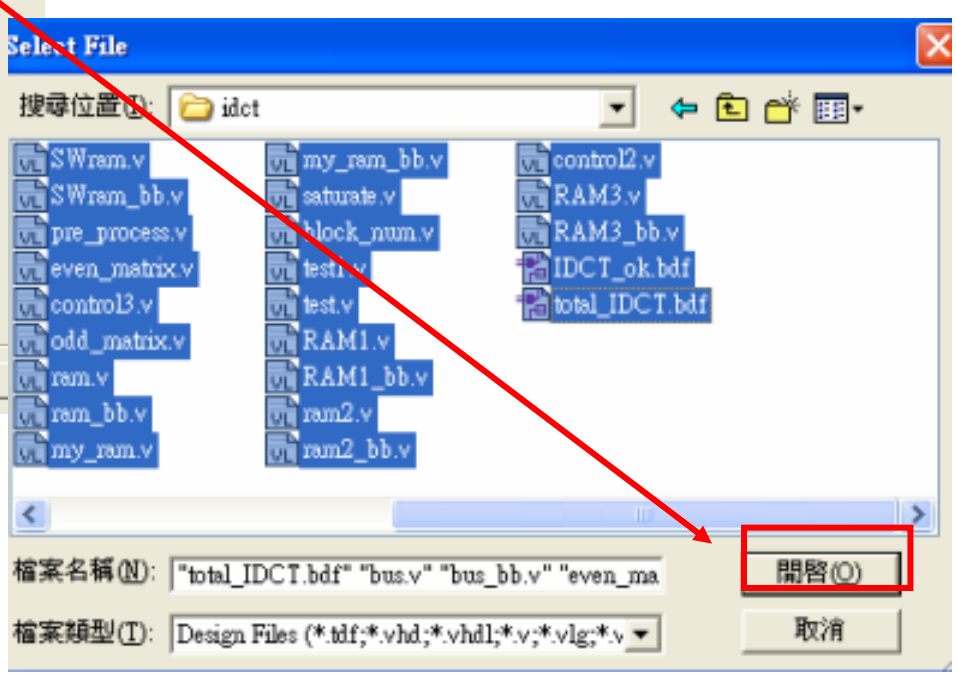


5.5 Programming IDCT SIP

- **Step 3. Add the Previous IP into this Project.**

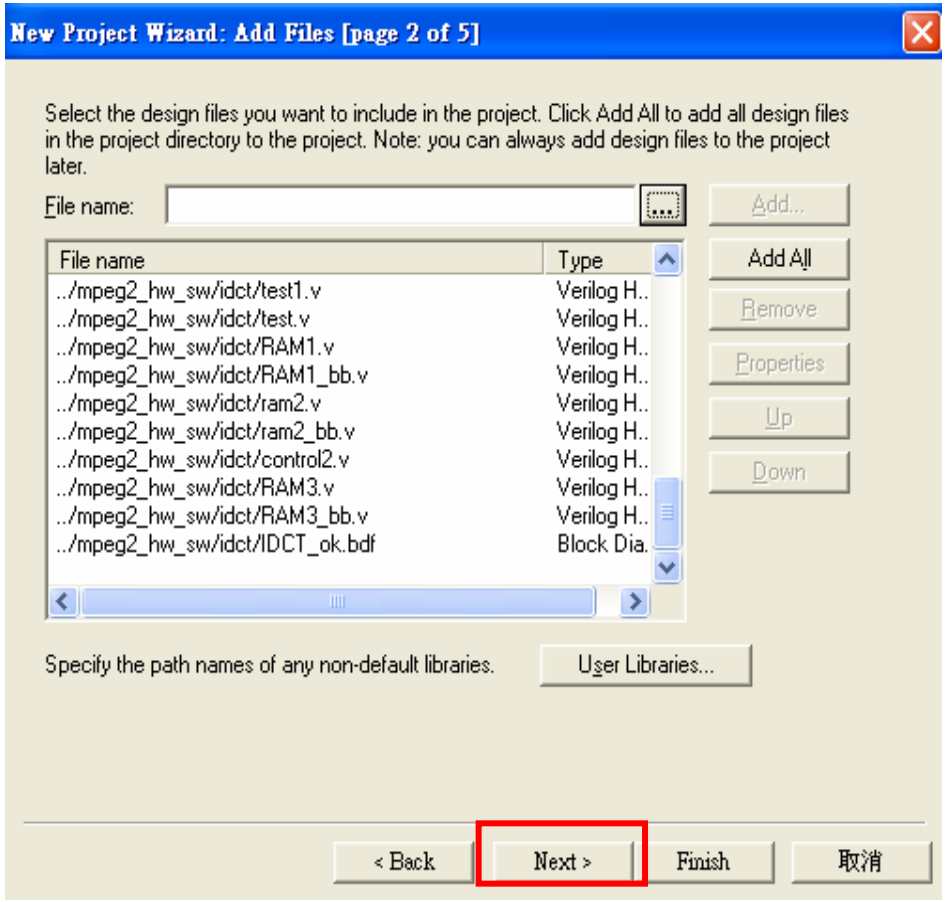


Click ,select the files of the previous IP into this project.



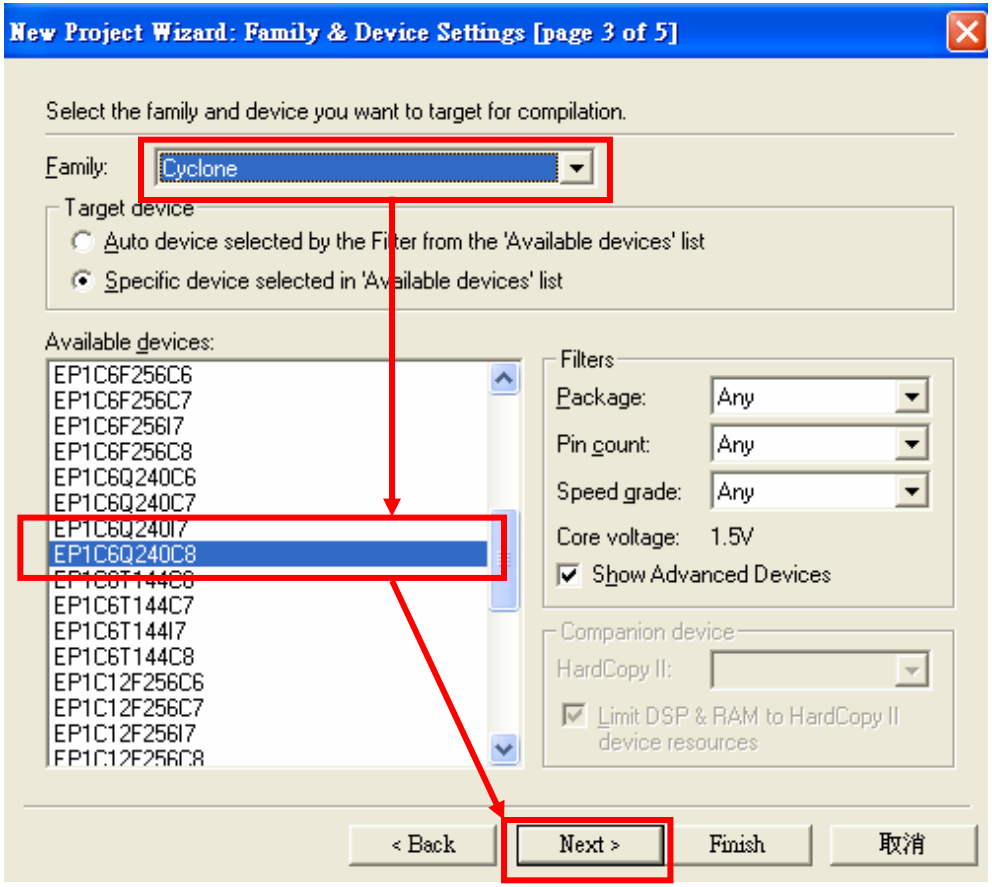
5.5 Programming IDCT SIP

- **Step 4.The Selected Files add into this Project.**



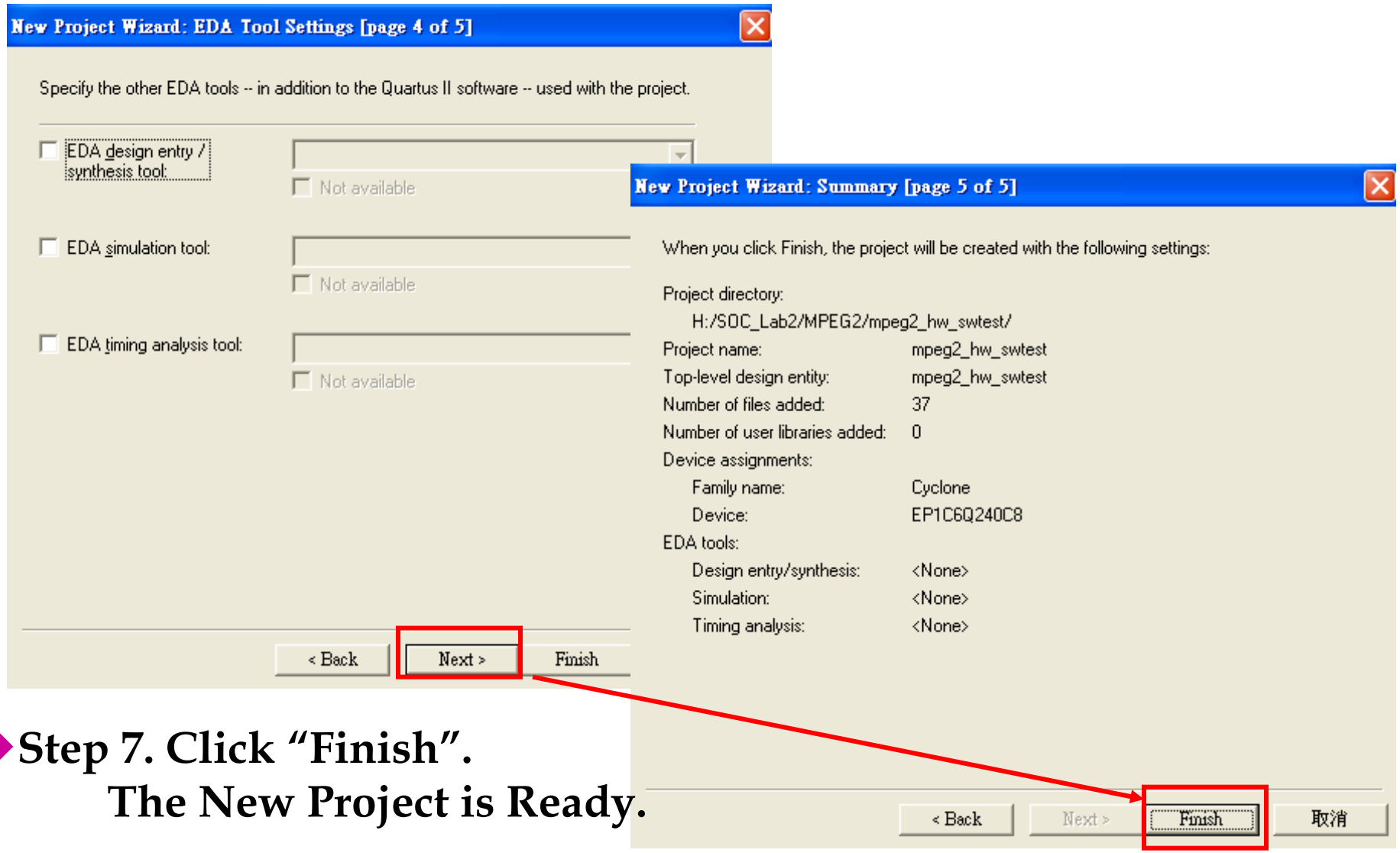
5.5 Programming IDCT SIP

- **Step 5.Select Family as "Cyclone".**
  Select Available Devices as "EP1C6Q240C8 "



5.5 Programming IDCT SIP

- Step 6. Click "Next>" to Continue.

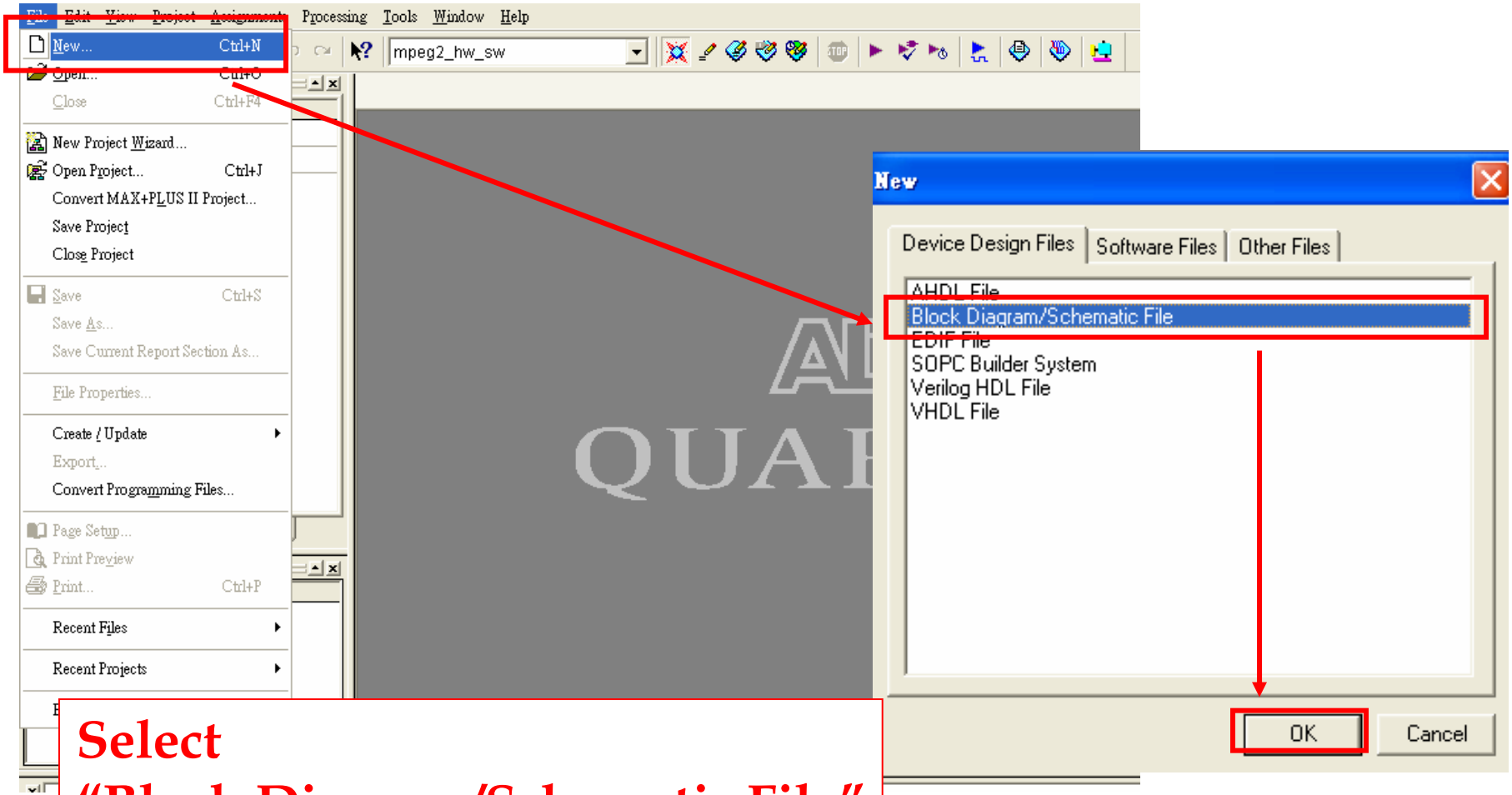


- Step 7. Click "Finish".
  The New Project is Ready.

5.5 Programming IDCT SIP

- Step 8.Open New “Block Diagram/Schematic File”

  “File/New”

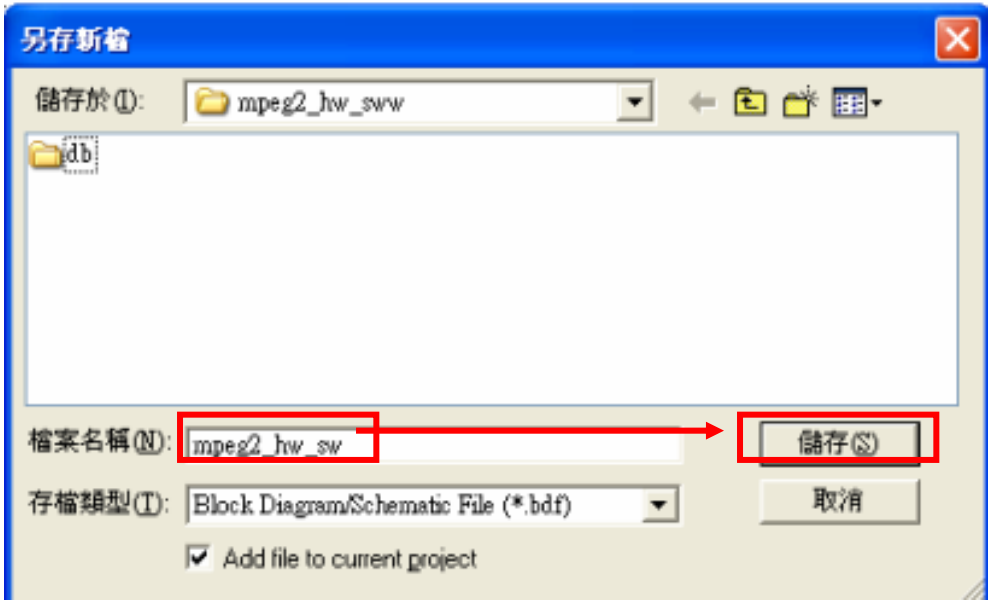


Select
“Block Diagram/Schematic File”

5.5 Programming IDCT SIP

- **Step 9.Save New File.**

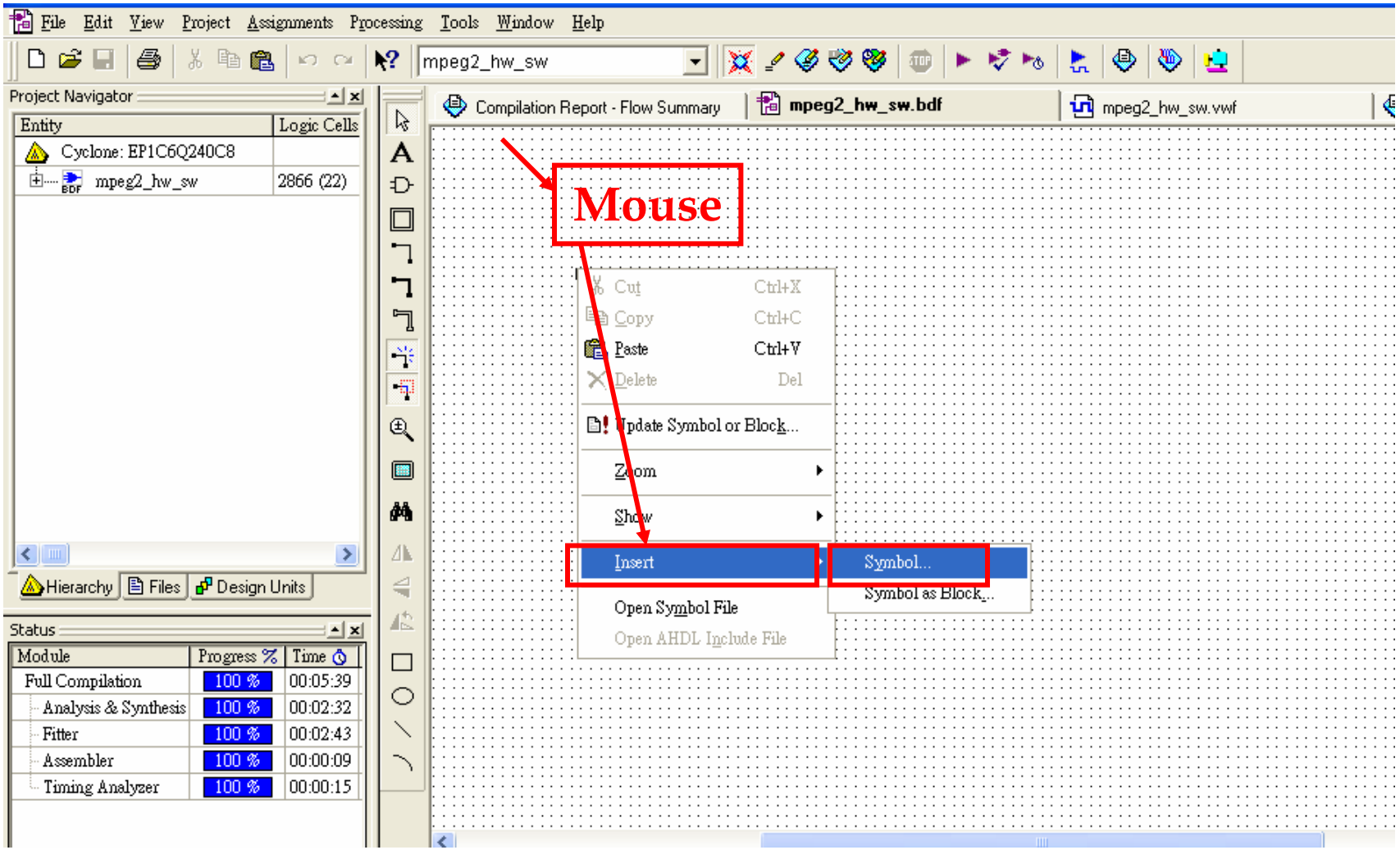
The Name of File is the Same as the Name of this Project.



5.5 Programming IDCT SIP

- **Step 10. Click the Right Button of the Genius mouse.**

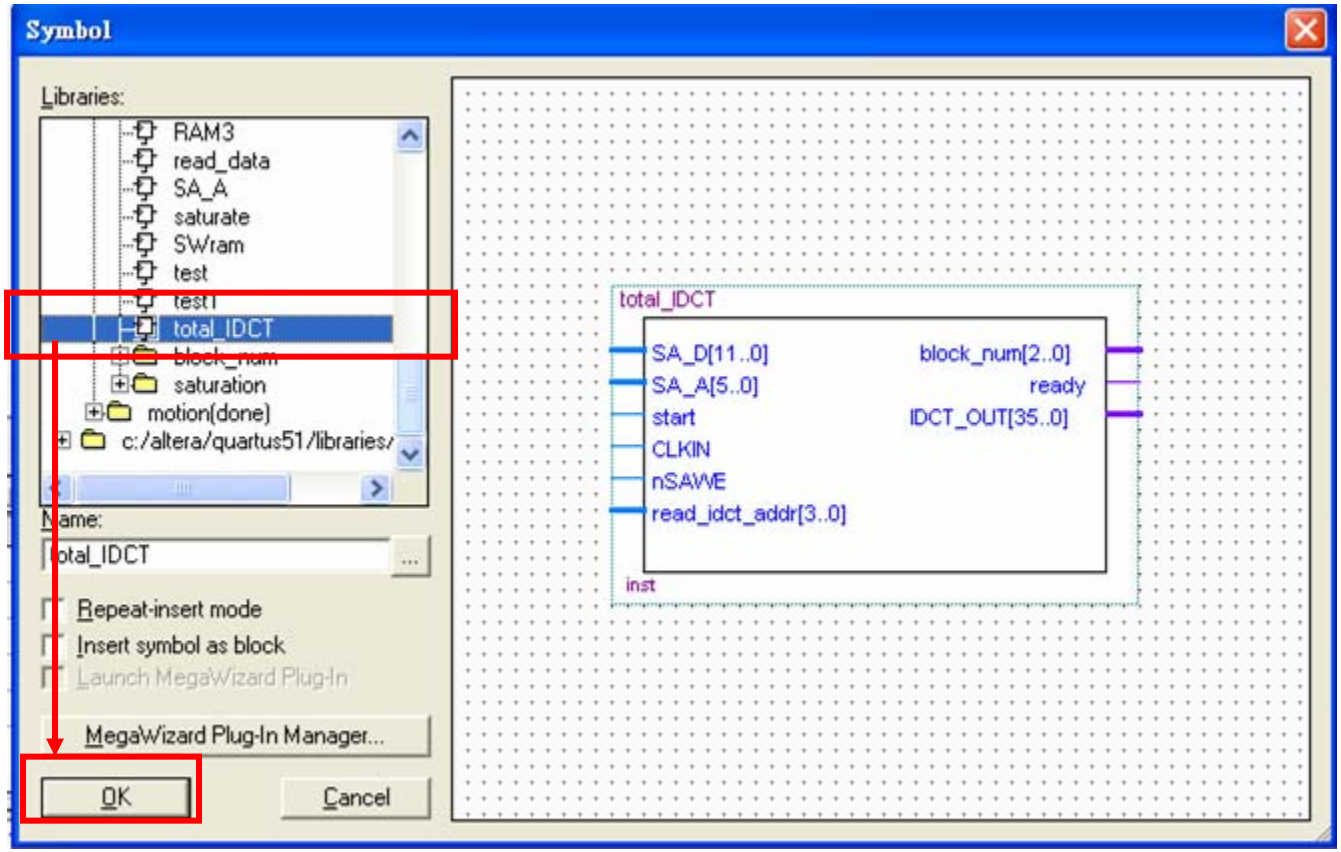
  "Insert / Symbol…"



5.5 Programming IDCT SIP

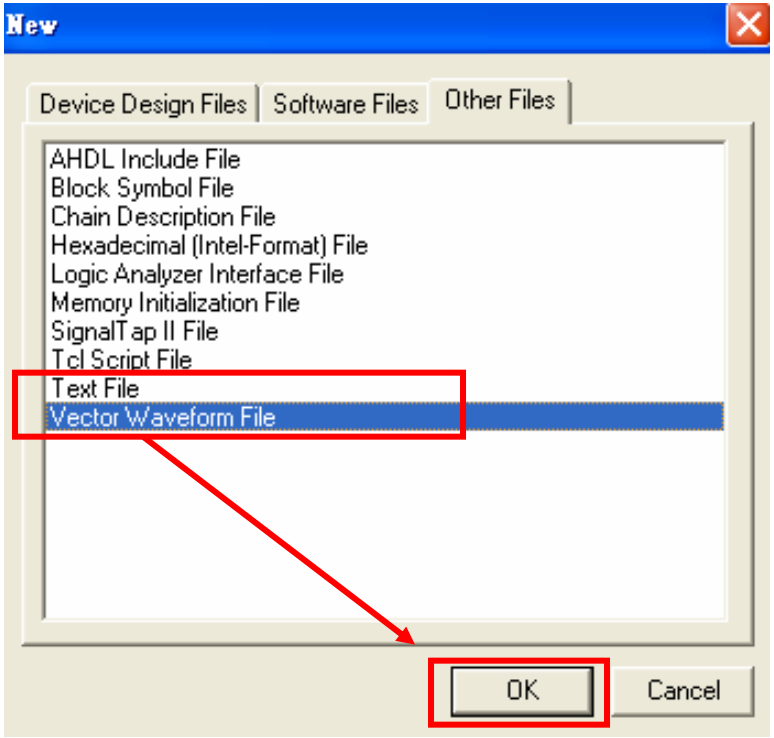
- **Step 11. Select the Symbol of the Previous IPs.**

Select the Top of IDCT Design : total IDCT



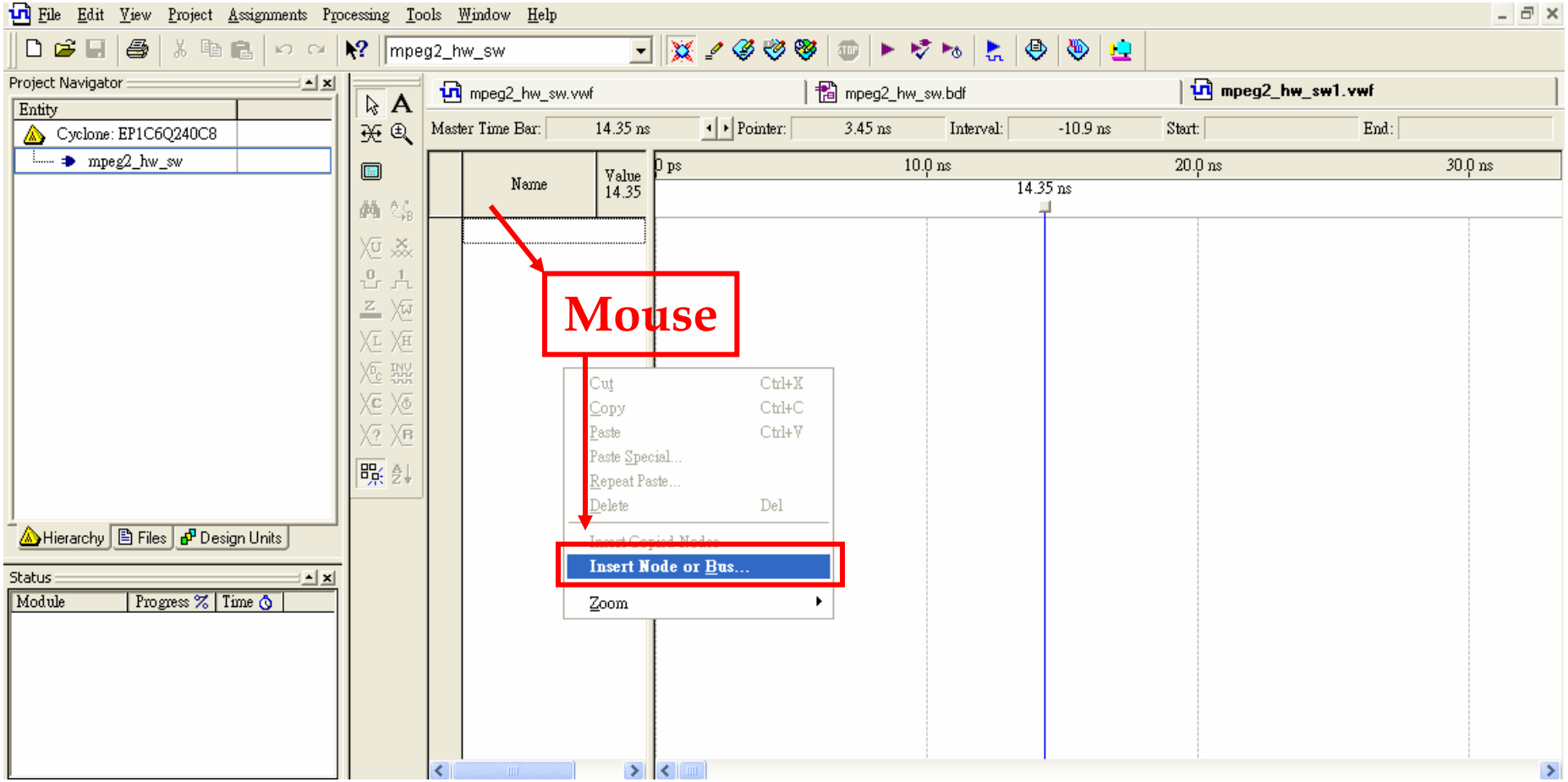
5.5 Programming IDCT SIP

- **Step 12.Click "File/New" ,Open the "Vector Waveform File" to Simulate the Waveform.**



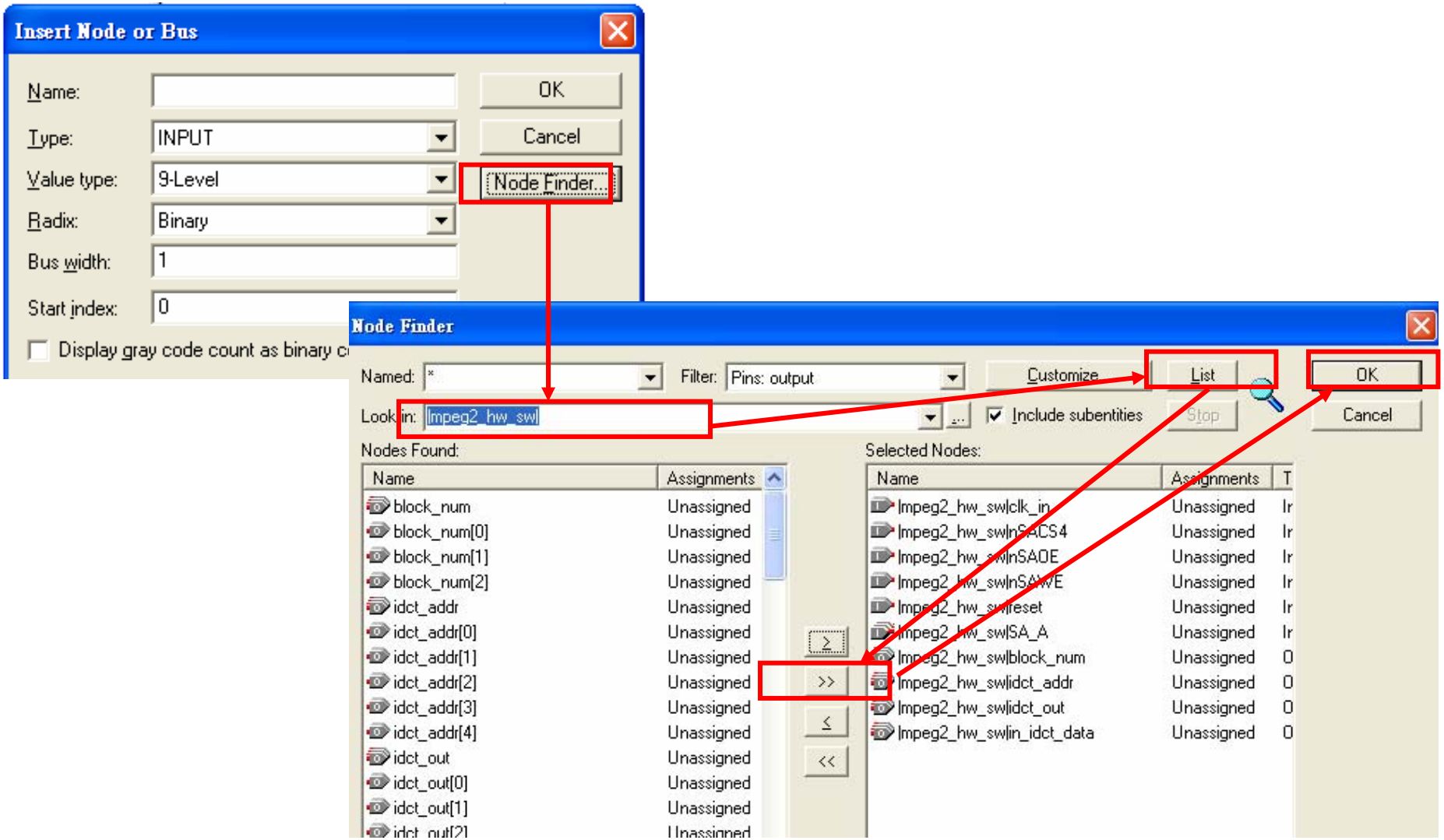
5.5 Programming IDCT SIP

- **Step 13.Click the Right key of the Genius Mouse .**
  Click “Insert Nod or Bus…”



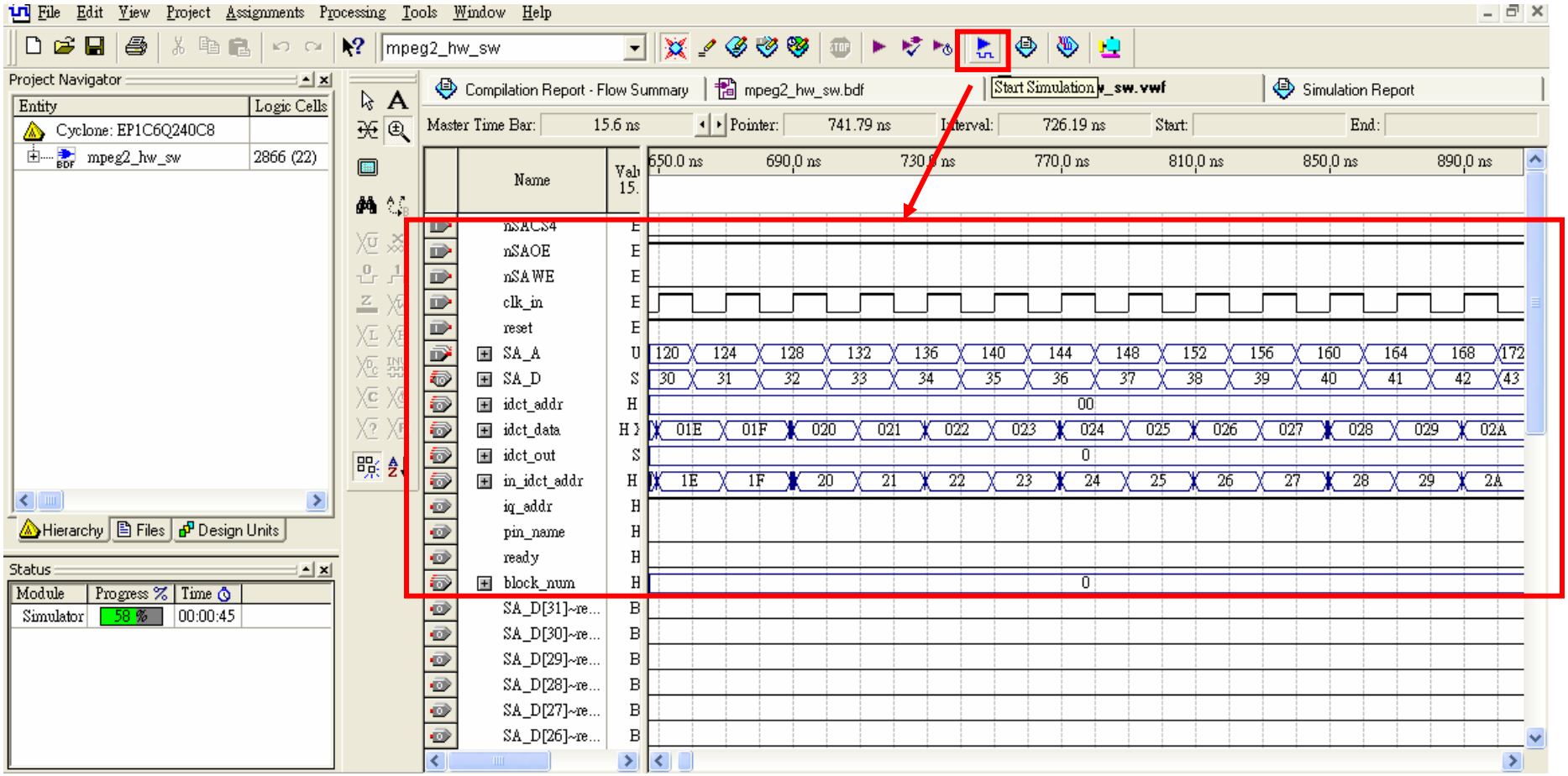
5.5 Programming IDCT SIP

- **Step 14.Click "Node Finder". Select the Inputs and Outputs to Simulate.**



5.5 Programming IDCT SIP

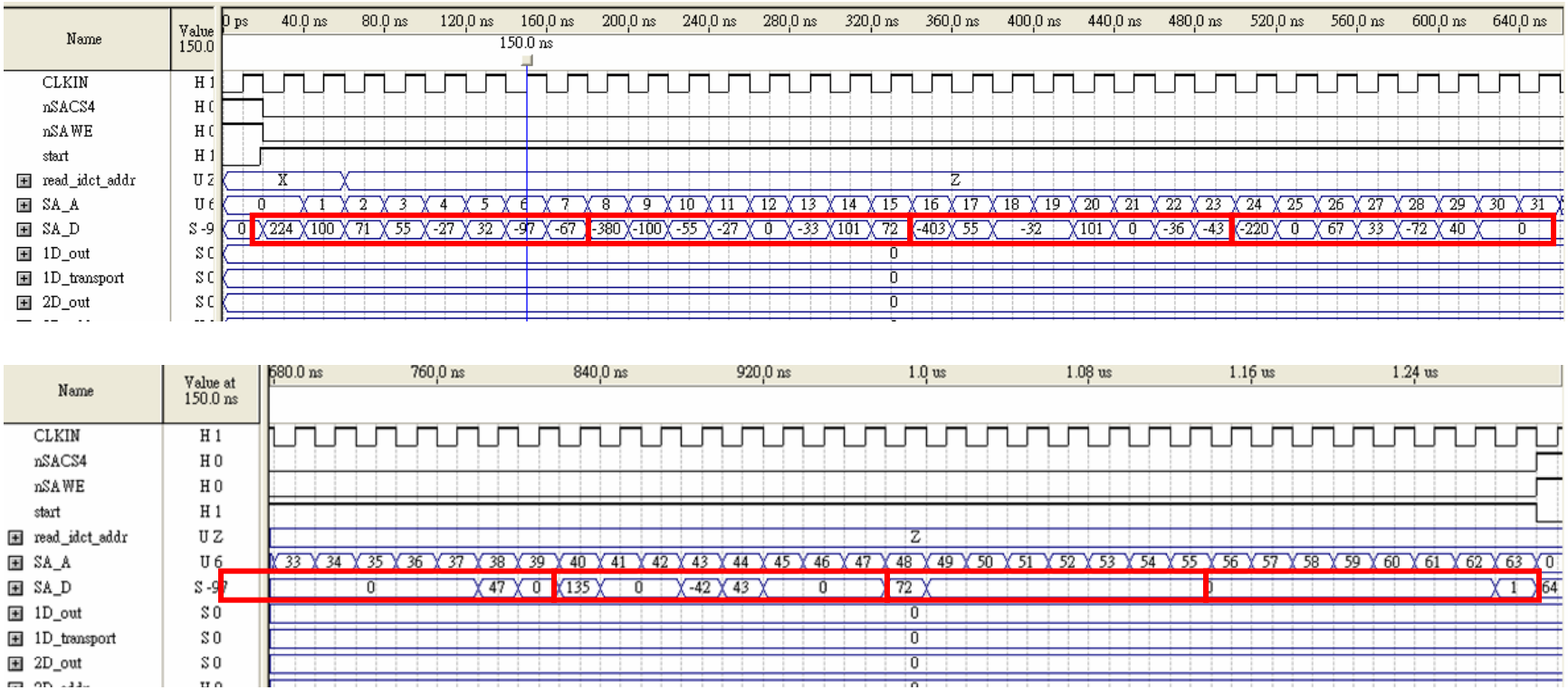
- **Step 15. Click the Button to Simulate.**



5.5 Programming IDCT SIP

Waveform simulation

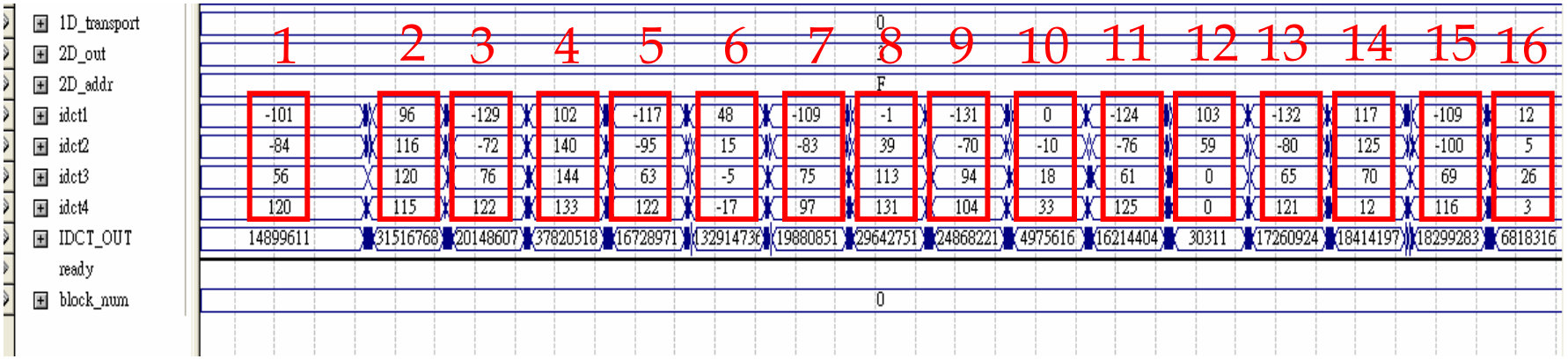
- **IP Operation Result**
  - **IQ_data**



5.5 Programming IDCT SIP

Waveform simulation

- IP Operation Result
  - IDCT-IP



5.5 Programming IDCT SIP

Download IDCT hardware

- Hardware Design
  - IDCT Hardware Progrmming File : idct.pof
- Download the IDCT Hardware
  - Refer to Lab. 3

5.6 System Integrations

5.1 MPEG-2 Decoder HW & SW Integration Flow

5.2 Download the Linux Kernel

5.3 IDCT Driver Programming

5.4 Compilation the MPEG-2 Source Code

5.5 Programming IDCT SIP

5.6 System Integrations

5.7 Software Verification and LA Measurement

5.6 System Integration

- NFS environment
  - Mount Linux operation system to execute files
- Execute on PXA255 platform
  - Integrate the hardware and the software

5.6 System Integration

- Prepared design files:
  - Software design
    - MPEG-2 decoder execute file : mpeg2decode
    - Driver : idct_driver.o
  - Hardware
    - IDCT hardware : idct.pof

5.6 System Integration

■ NFS environment

- **Step 1. Setup Network**
  - **#>ifconfig eth0 192.168.1.99**
  - **#>ifconfig**

root@localhost:/

檔案(F) 編輯(E) 顯示(V) 終端機(T) 分頁(B) 求助(H)

```
[root@localhost Xscale_execute_file]# cp /home/Co_design/Lab_5/idct_driver.o ./
[root@localhost Xscale_execute_file]# cp /home/Co_design/Lab_5/foreman.m2v ./
[root@localhost Xscale_execute_file]# ls
foreman.m2v  idct_driver.o  mpeg2decode_hw
[root@localhost Xscale_execute_file]# cd /
[root@localhost /]# ifconfig eth0 192.168.1
.[root@localhost /]# ifconfig eth0 192.168.1.99
[root@localhost /]# ifconfig
eth0      Link encap:Ethernet  HWaddr 00:0C:29:8A:4E:0C
          inet addr:192.168.1.99  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: fe80::20c:29ff:fe8a:4e0c/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:1128 errors:0 dropped:0 overruns:0 frame:0
          TX packets:121 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:84053 (82.0 KiB)  TX bytes:6683 (6.5 KiB)
          Interrupt:10 Base address:0x1400

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
```

5.6 System Integration

NFS environment

- Step 2. Setup NFS in VMware
  - PATH:/mnt/nfs
  - Create Folder : nfs, Xscale_execute_tile
  - PATh:/mnt/nfs/Xscale_execute_tile
  - #>vi /etc/export
  - Add “/mnt/nfs *(rw,no_root_squash)” in the File

5.6 System Integration

■ NFS environment

- **Step 3. Restart the NFS Service**
  - **#>/etc/rc.d/init.d/nfs restart**

```
[root@localhost ~]# vi /etc/exports
[root@localhost ~]# /etc/rc.d/init.d/nfs restart
關閉 NFS mountd:                                           [  確定  ]
停止 NFS 系統程式:                                         [  確定  ]
關閉 NFS 磁碟配額:                                         [  確定  ]
關閉 NFS 服務:                                             [  確定  ]
啓動 NFS 服務:                                             [  確定  ]
啓動 NFS quotas:                                           [  確定  ]
啓動 NFS 系統程式:                                         [  確定  ]
啓動 NFS mountd:                                           [  確定  ]
[root@localhost ~]#                                        [  確定  ]
```

5.6 System Integration

NFS environment

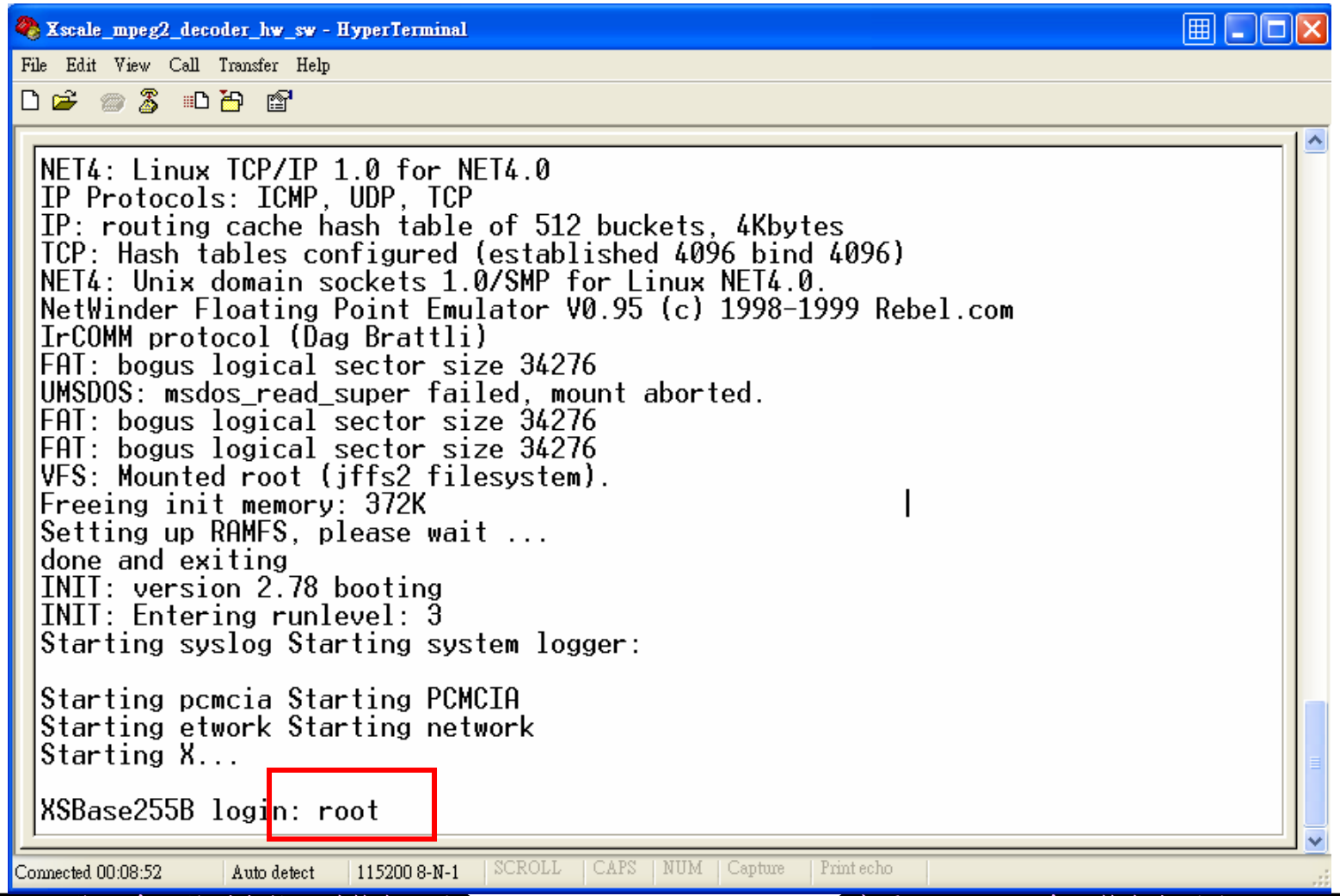
- Step 4. Copy “mpeg2decode_hw”, “idct_driver.o”,”foreman.m2v” into Xscale_execute_file folder
  - #>cd /mnt/nfs/Xscale_execute_file/
  - Xscale_execute_file>cp /home/Co_design_Lab5/mpeg2decode_hw ./
  - Xscale_execute_file>cp /home/Co_design_Lab5/idct_driver.o ./
  - Xscale_execute_file>cp /home/Co_design_Lab5/foreman.m2v ./

```
[root@localhost nfs]# cd Xscale_execute_file/
[root@localhost Xscale_execute_file]# ls
[root@localhost Xscale_execute_file]# cd /mnt/nfs/Xscale_execute_file/
[root@localhost Xscale_execute_file]# ls
[root@localhost Xscale_execute_file]# cp /home/Co_design/Lab_5/mpeg2decode_hw ./
[root@localhost Xscale_execute_file]# cp /home/Co_design/Lab_5/idct_driver.o ./
[root@localhost Xscale_execute_file]# cp /home/Co_design/Lab_5/foreman.m2v ./
[root@localhost Xscale_execute_file]# ls
foreman.m2v  idct_driver.o  mpeg2decode_hw
[root@localhost Xscale_execute_file]#
```

5.6 System Integration

■ Execute on PXA255 platform

◆ Step 1 : Power on the platform



5.6 System Integration

Execute on PXA255 platform

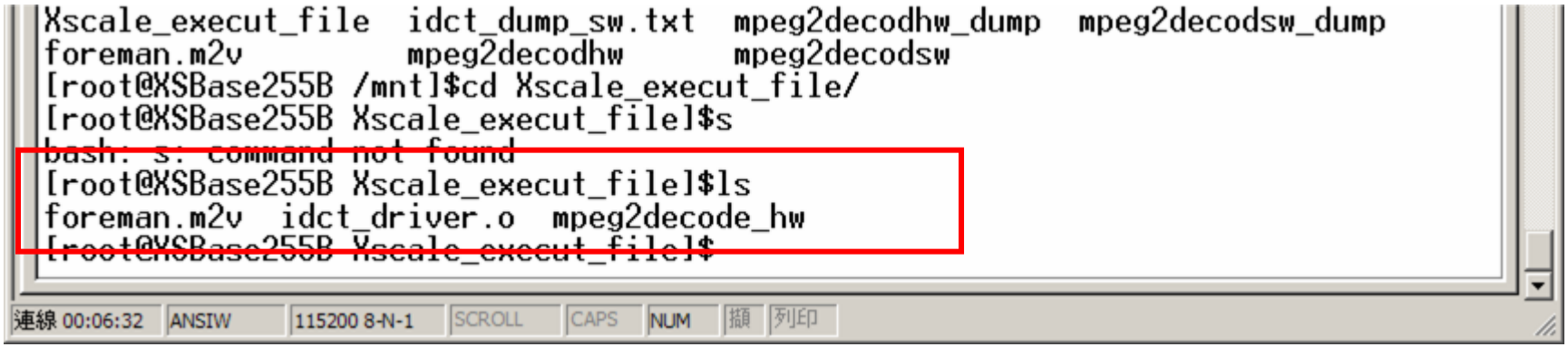
- **Step 2 : Make the Device Node**
  - #root>cd /dev
  - #root>mknod fpga_board_6 c 72 0

```
INIT: version 2.78 booting
INIT: Entering runlevel: 3
Starting syslog Starting system logger:

Starting pcmcia Starting PCMCIA
Starting etwork Starting network
Starting X...

XSBase255B login: root
[root@XSBase255B /root]$cd /dev
[root@XSBase255B /dev]$mknod fpga_board_6 c 72 0
[root@XSBase255B /dev]$ls -al fpga_board_6
crw-r--r--    1 root     root      72,   0 Feb 29 15:58 fpga_board_6
[root@XSBase255B /dev]$_
```

5.6 System Integration

Execute on PXA255 platform

- Step 3. Mount the NFS service
  - #root>ifconfig eth0 192.168.1.30
  - #root>mount 192.168.1.99:/mnt/nfs /mnt
  - #root>cd /mnt
  - #mnt>cd Xscale_execute_file/
  - #Xscale_execute_file>ls



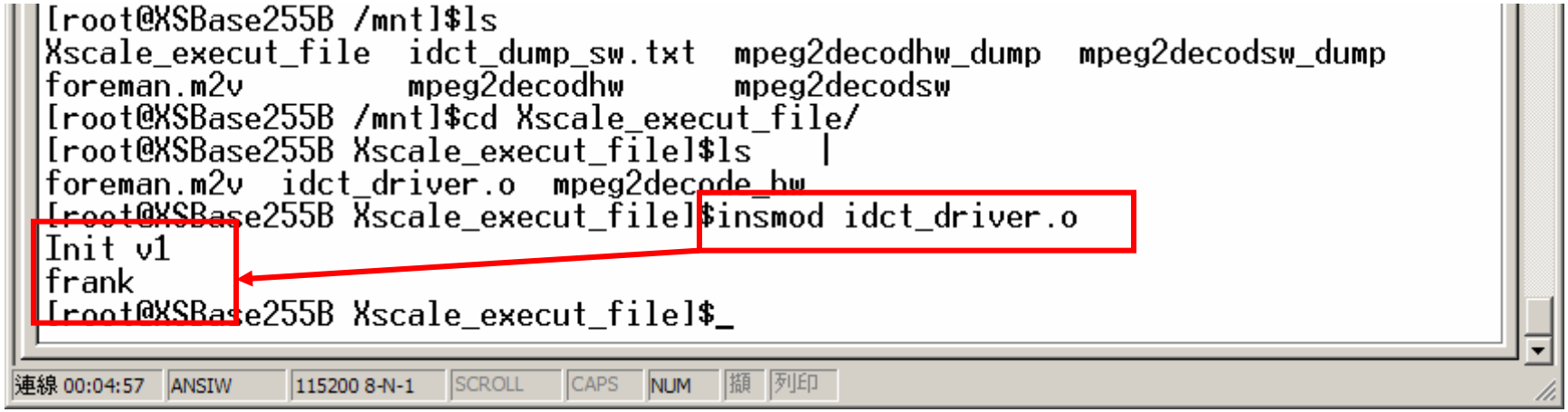
Get idct_driver.o (driver), mpeg2decode_hw ,foreman.m2v

5.6 System Integration

■ Execute on PXA255 platform

◆ **Step 4 : Insmod the driver**

■ **#Xscale_execute_file> insmod idct_driver.o**

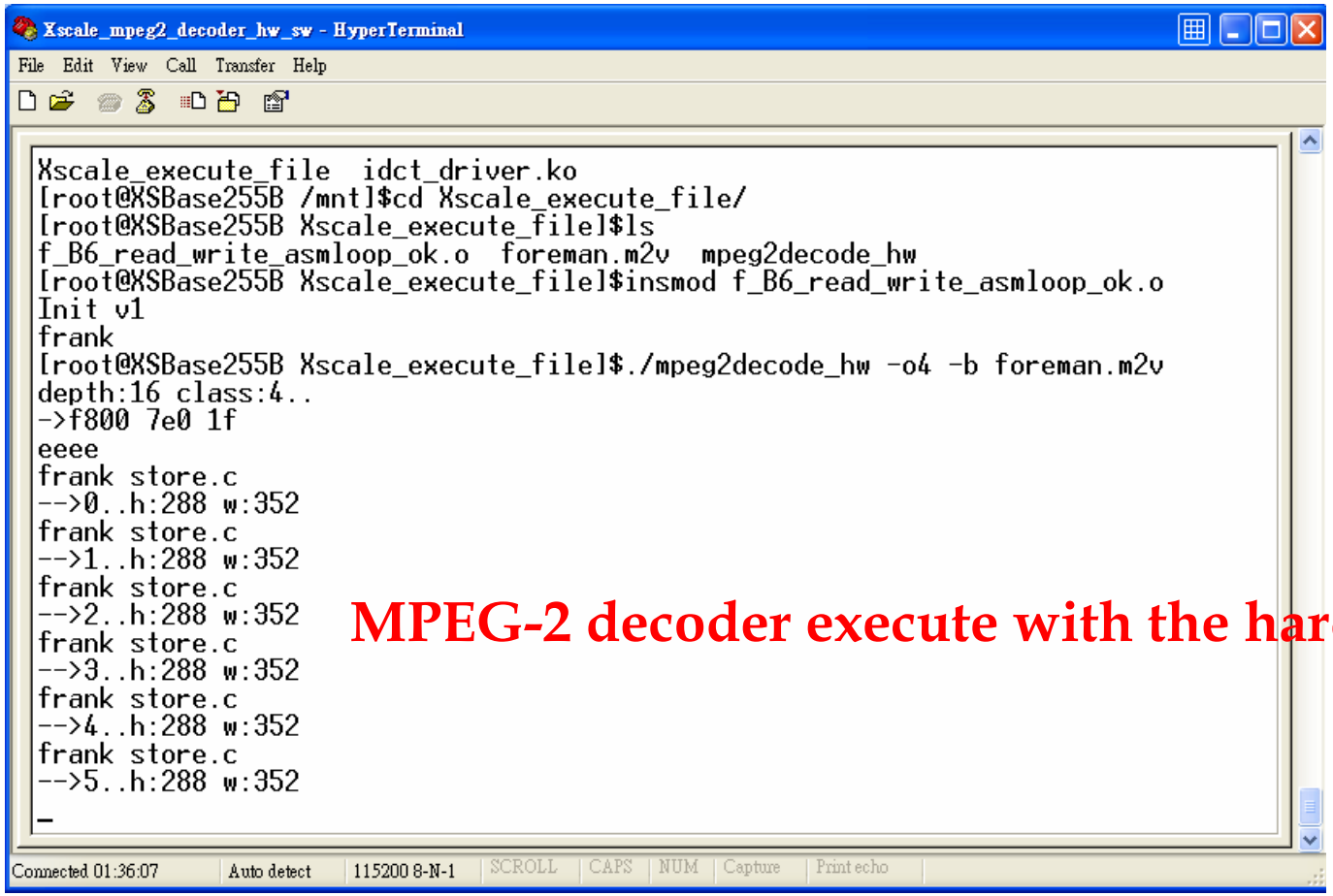


Insmod driver success!!

5.6 System Integration

■ Execute on PXA255 platform

- **Step 5 : execute the MPEG-2 decoder file**
  - **#Xscale_execute_file>./mpeg2decode_hw -o4 –b foreman.m2v**

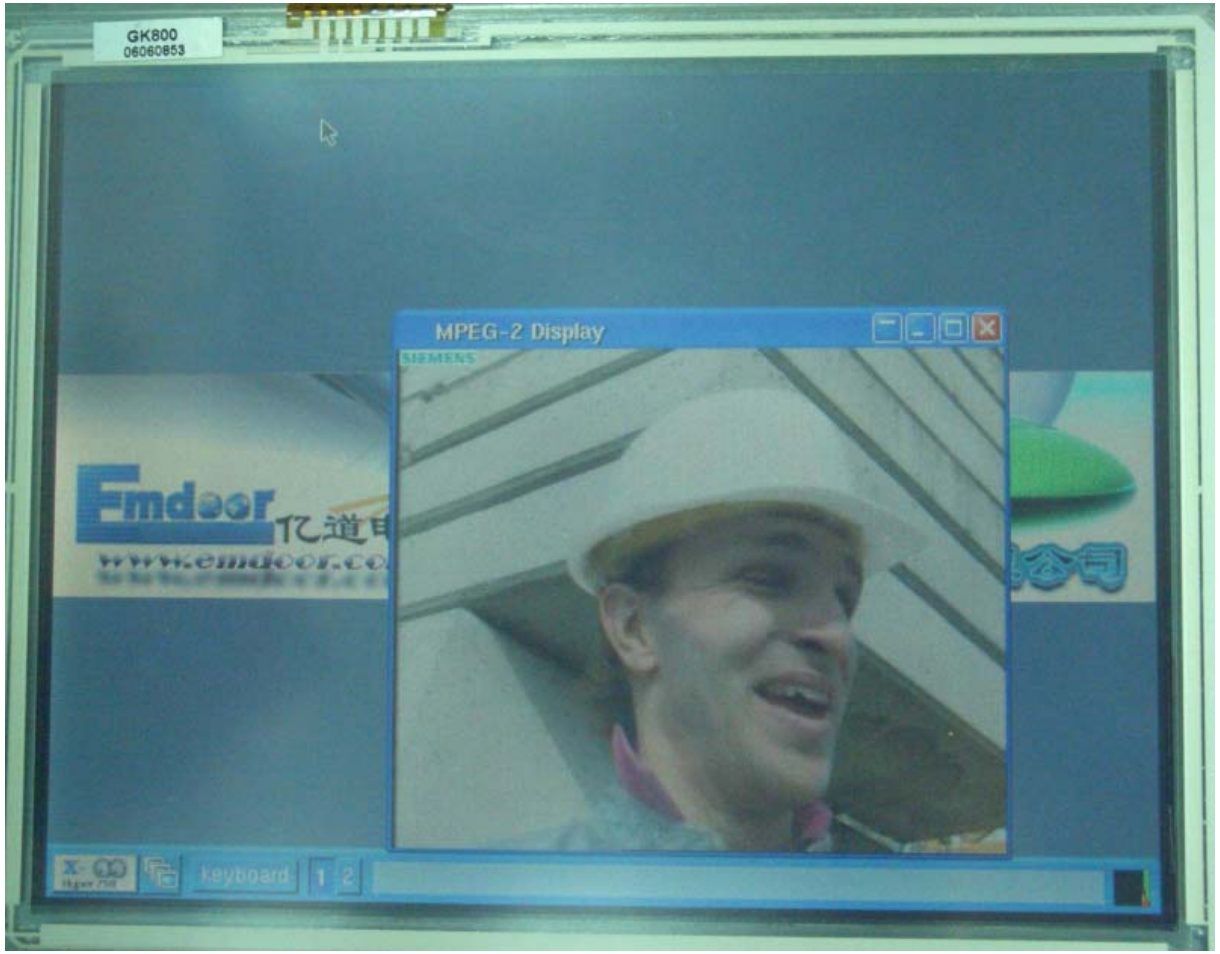


MPEG-2 decoder execute with the hardware.

5.6 System Integration

■ Execute on PXA255 platform

- **Display on TFT LCD**



5.7 Software Verification and LA Measurement

5.1 MPEG-2 Decoder HW & SW Integration Flow

5.2 Download the Linux Kernel

5.3 IDCT Driver Programming

5.4 Compilation the MPEG-2 Source Code

5.5 Programming IDCT SIP

5.6 System Integrations

5.7 Software Verification and LA Measurement

5.7 Software Verification and LA Measurement

- Software Verification
  - Modify Software to Dump IDCT Data
  - Dump IDCT Data with Software Version
  - Dump IDCT Data with SW/HW Version
- LA Measurement
  - Use Logic Analyser
  - Physical Waveform

5.7 Software Verification and LA Measurement

■ Modify software to dump IDCT data(1/3)

- getpic.c : mpeg2/src/mpeg2dec/getpic.c
- File Name : getpic.c

```
-------------------------------------------------------------------------
int idct_mb_count=0;    //MB count
int idct_block_count;   //8x8 block count
FILE *idct_dump_ptr;    //Dump file

static void motion_compensation(…)
…
{
 …
 int di;
 int dj;
 short *idct_dump;
 …
}
-------------------------------------------------------------------------
```

5.7 Software Verification and LA Measurement

■ Modify software to dump IDCT data(2/3)

- getpic.c : mpeg2/src/mpeg2dec/getpic.c
- File Name : getpic.c

```
-------------------------------------------------------------------------
static void motion_compensation(…)
{
 …
 idct_block_count=0; //Open the file to dump data
 idct_dump_ptr=fopen("idct_dump_sw.txt","ab");
 /* copy or add block data into picture */
 for (comp=0; comp<block_count; comp++)
 {
  …
 }
 idct_mb_count=idct_mb_count+1;
 // printf("s"); //Make sure the function call
 fclose(idct_dump_ptr);
}
-------------------------------------------------------------------------
```

5.7 Software Verification and LA Measurement

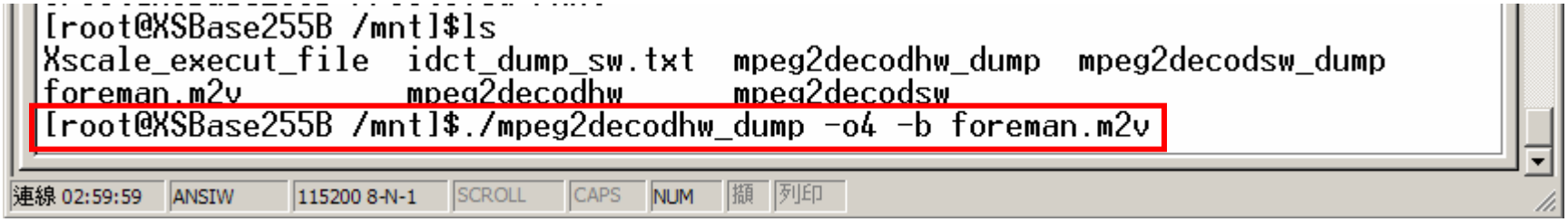
■ Modify software to dump IDCT data(3/3)

◆ File Name : getpic.c (mpeg2/src/mpeg2dec/getpic.c)

```
-----------------------------------------------------------------------
for (comp=0; comp<block_count; comp++)
{
 Fast_IDCT(ld->block[comp]);
 idct_dump=ld->block[comp];      //Get the IDCT data
 fprintf(idct_dump_ptr,"idct_mb_count=%d",idct_mb_count);//MB number
 fprintf(idct_dump_ptr,"idct_block_count=%d\n",idct_block_count);
 for(dj=0;dj<8;dj++)
 {
  for(di=0;di<8;di++)
  {                  //Dump data into the output file
   fprintf(idct_dump_ptr,"idct[%d]=%d ;",8*dj+di,idct_dump[8*dj+di]);
  }
  fprintf(idct_dump_ptr,"\n");
 }
 idct_block_count++;
 fprintf(idct_dump_ptr,"\n\n\n");
 Add_Block(comp,bx,by,dct_type,(macroblock_type & MACROBLOCK_INTRA)==0);
}
-----------------------------------------------------------------------
```

5.7 Software Verification and LA Measurement

- Modify MPEG-2 Source Code
  - Compile the MPEG-2 Source Code
  - Get the File that Dump Data



XSase255B>./mpeg2decodhw_dump -o4 -b foreman.m2v

Get the dump file : idct_dump_hw.txt

5.7 Software Verification and LA Measurement

■ Dump IDCT data

◆ Dump the Data with the Software Version and Hardware Version

idct_dump_sw.txt

idct_mb_count=0 idct_block_count=2
idct[0]=-139 ;idct[1]=-68 ;idct[2]=61 ;idct[3]=134 ;idct[4]=120 ;idct[5]=115 ;idct[6]=126 ;idct[7]=109 ;
idct[8]=-124 ;idct[9]=-90 ;idct[10]=-29 ;idct[11]=32 ;idct[12]=58 ;idct[13]=36 ;idct[14]=8 ;idct[15]=-1 ;
idct[16]=-97 ;idct[17]=-76 ;idct[18]=-26 ;idct[19]=31 ;idct[20]=49 ;idct[21]=28 ;idct[22]=23 ;idct[23]=45 ;
idct[24]=-122 ;idct[25]=-105 ;idct[26]=-24 ;idct[27]=40 ;idct[28]=34 ;idct[29]=42 ;idct[30]=84 ;idct[31]=102 ;
idct[32]=-112 ;idct[33]=-102 ;idct[34]=-34 ;idct[35]=31 ;idct[36]=52 ;idct[37]=84 ;idct[38]=108 ;idct[39]=89 ;
idct[40]=-117 ;idct[41]=-87 ;idct[42]=-42 ;idct[43]=14 ;idct[44]=70 ;idct[45]=96 ;idct[46]=87 ;idct[47]=69 ;
idct[48]=-114 ;idct[49]=-84 ;idct[50]=-31 ;idct[51]=34 ;idct[52]=83 ;idct[53]=97 ;idct[54]=92 ;idct[55]=91 ;
idct[56]=-95 ;idct[57]=-107 ;idct[58]=-41 ;idct[59]=47 ;idct[60]=76 ;idct[61]=88 ;idct[62]=98 ;idct[63]=82 ;

idct_dump_hw.txt

idct_mb_count=0 idct_block_count=2
idct[0]=-142 ;idct[1]=-68 ;idct[2]=58 ;idct[3]=132 ;idct[4]=118 ;idct[5]=114 ;idct[6]=126 ;idct[7]=108 ;
idct[8]=-126 ;idct[9]=-90 ;idct[10]=-30 ;idct[11]=31 ;idct[12]=55 ;idct[13]=36 ;idct[14]=8 ;idct[15]=0 ;
idct[16]=-99 ;idct[17]=-76 ;idct[18]=-26 ;idct[19]=30 ;idct[20]=48 ;idct[21]=28 ;idct[22]=22 ;idct[23]=43 ;
idct[24]=-123 ;idct[25]=-105 ;idct[26]=-26 ;idct[27]=39 ;idct[28]=33 ;idct[29]=42 ;idct[30]=83 ;idct[31]=101 ;
idct[32]=-113 ;idct[33]=-101 ;idct[34]=-35 ;idct[35]=31 ;idct[36]=51 ;idct[37]=83 ;idct[38]=107 ;idct[39]=89 ;
idct[40]=-118 ;idct[41]=-86 ;idct[42]=-44 ;idct[43]=13 ;idct[44]=69 ;idct[45]=96 ;idct[46]=86 ;idct[47]=68 ;
idct[48]=-115 ;idct[49]=-84 ;idct[50]=-32 ;idct[51]=33 ;idct[52]=81 ;idct[53]=96 ;idct[54]=90 ;idct[55]=89 ;
idct[56]=-96 ;idct[57]=-106 ;idct[58]=-42 ;idct[59]=47 ;idct[60]=75 ;idct[61]=88 ;idct[62]=96 ;idct[63]=80 ;

5.7 Software Verification and LA Measurement

■ Dump IDCT data

- ◆ Compare Data with the Software Version and Hardware Version
  - ■ Check OK

IDCT with Software Version

```
idct_mb_count=0   idct_block_count=1
idct[0]=100 ;idct[1]=132 ;idct[2]=126 ;idct[3]=121 ;idct[4]=133 ;idct[5
idct[8]=125 ;idct[9]=130 ;idct[10]=125 ;idct[11]=132 ;idct[12]=128 ;idc
idct[16]=131 ;idct[17]=85 ;idct[18]=4 ;idct[19]=53 ;idct[20]=125 ;idct[
idct[24]=120 ;idct[25]=86 ;idct[26]=-28 ;idct[27]=32 ;idct[28]=141 ;idc
idct[32]=107 ;idct[33]=104 ;idct[34]=10 ;idct[35]=46 ;idct[36]=116 ;idc
idct[40]=65 ;idct[41]=92 ;idct[42]=-7 ;idct[43]=39 ;idct[44]=134 ;idct[
idct[48]=51 ;idct[49]=103 ;idct[50]=-6 ;idct[51]=34 ;idct[52]=129 ;idct
idct[56]=45 ;idct[57]=88 ;idct[58]=9 ;idct[59]=58 ;idct[60]=126 ;idct[6



idct_mb_count=0   idct_block_count=2
idct[0]=-139 ;idct[1]=-68 ;idct[2]=61 ;idct[3]=134 ;idct[4]=120 ;idct[5
idct[8]=-124 ;idct[9]=-90 ;idct[10]=-29 ;idct[11]=32 ;idct[12]=58 ;idct
idct[16]=-97 ;idct[17]=-76 ;idct[18]=-26 ;idct[19]=31 ;idct[20]=49 ;idc
idct[24]=-122 ;idct[25]=-105 ;idct[26]=-24 ;idct[27]=40 ;idct[28]=34 ;i
idct[32]=-112 ;idct[33]=-102 ;idct[34]=-34 ;idct[35]=31 ;idct[36]=52 ;i
idct[40]=-117 ;idct[41]=-87 ;idct[42]=-42 ;idct[43]=14 ;idct[44]=70 ;id
idct[48]=-114 ;idct[49]=-84 ;idct[50]=-31 ;idct[51]=34 ;idct[52]=83 ;id
idct[56]=-95 ;idct[57]=-107 ;idct[58]=-41 ;idct[59]=47 ;idct[60]=76 ;id
```

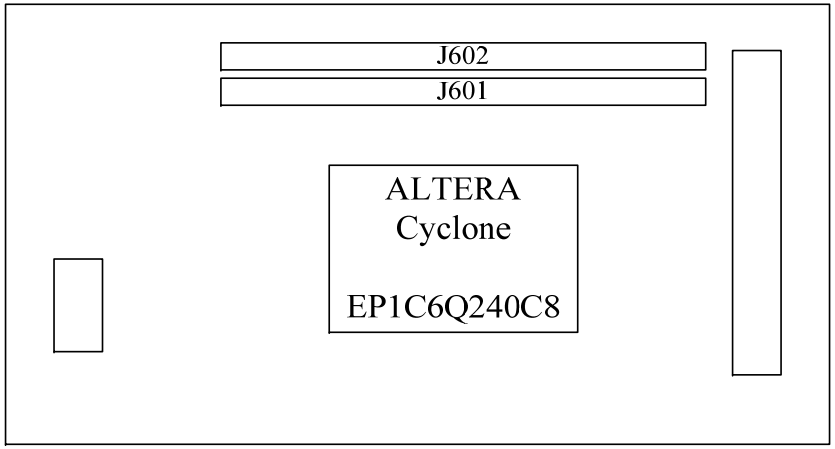
IDCT with Hardware Version

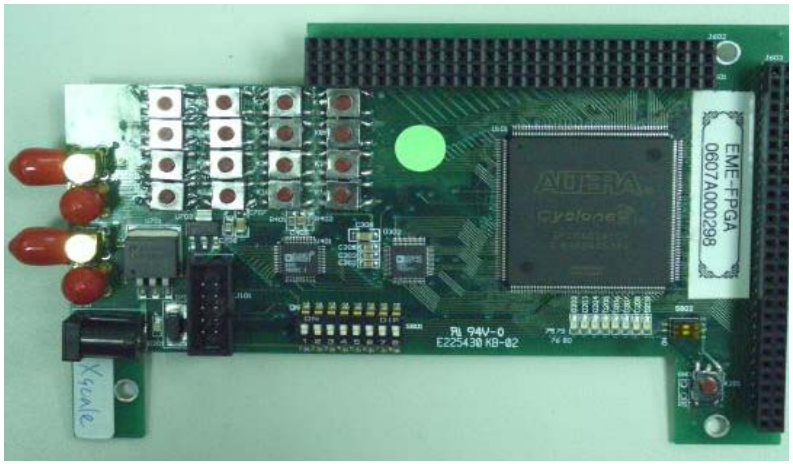
```
idct_mb_count=0   idct_block_count=1
idct[0]=97 ;idct[1]=129 ;idct[2]=124 ;idct[3]=118 ;idct[4]=132 ;idct[5]
idct[8]=121 ;idct[9]=129 ;idct[10]=123 ;idct[11]=129 ;idct[12]=127 ;idc
idct[16]=126 ;idct[17]=84 ;idct[18]=4 ;idct[19]=50 ;idct[20]=124 ;idct[
idct[24]=114 ;idct[25]=84 ;idct[26]=-30 ;idct[27]=29 ;idct[28]=139 ;idc
idct[32]=105 ;idct[33]=102 ;idct[34]=10 ;idct[35]=44 ;idct[36]=116 ;idc
idct[40]=64 ;idct[41]=91 ;idct[42]=-8 ;idct[43]=37 ;idct[44]=133 ;idct[
idct[48]=49 ;idct[49]=101 ;idct[50]=-7 ;idct[51]=32 ;idct[52]=128 ;idct
idct[56]=43 ;idct[57]=88 ;idct[58]=7 ;idct[59]=56 ;idct[60]=124 ;idct[6



idct_mb_count=0   idct_block_count=2
idct[0]=-142 ;idct[1]=-68 ;idct[2]=58 ;idct[3]=132 ;idct[4]=118 ;idct[5
idct[8]=-126 ;idct[9]=-90 ;idct[10]=-30 ;idct[11]=31 ;idct[12]=55 ;idct
idct[16]=-99 ;idct[17]=-76 ;idct[18]=-26 ;idct[19]=30 ;idct[20]=48 ;idc
idct[24]=-123 ;idct[25]=-105 ;idct[26]=-26 ;idct[27]=39 ;idct[28]=33 ;i
idct[32]=-113 ;idct[33]=-101 ;idct[34]=-35 ;idct[35]=31 ;idct[36]=51 ;i
idct[40]=-118 ;idct[41]=-86 ;idct[42]=-44 ;idct[43]=13 ;idct[44]=69 ;id
idct[48]=-115 ;idct[49]=-84 ;idct[50]=-32 ;idct[51]=33 ;idct[52]=81 ;id
idct[56]=-96 ;idct[57]=-106 ;idct[58]=-42 ;idct[59]=47 ;idct[60]=75 ;id
```

5.7 Software Verification and LA Measurement

■ LA Measurement

◆ FPGA Daughter Board

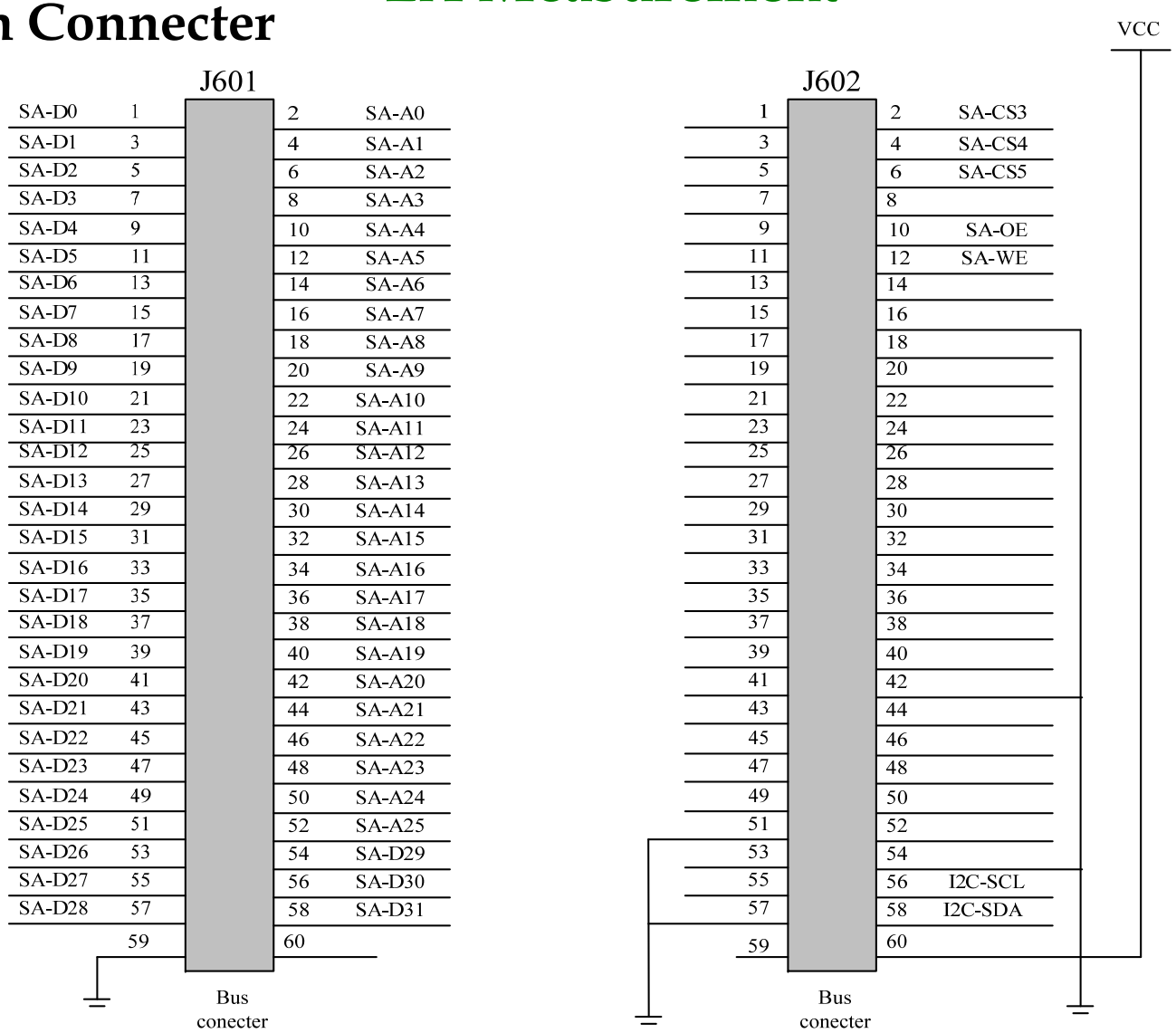




5.7 Software Verification and LA Measurement

■ LA Measurement

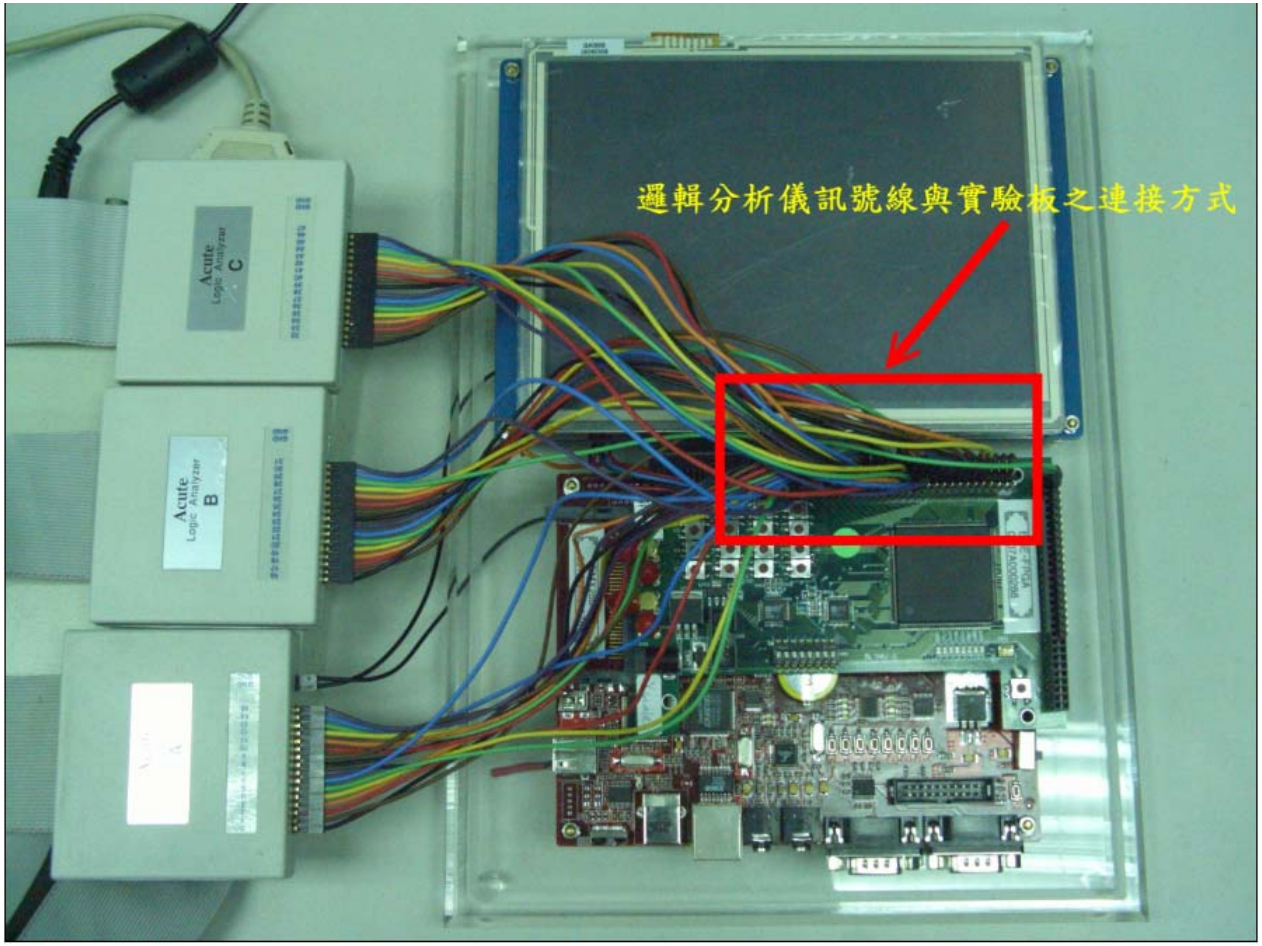
◆ Bus Pin Connecter



5.7 Software Verification and LA Measurement

■ LA Measurement

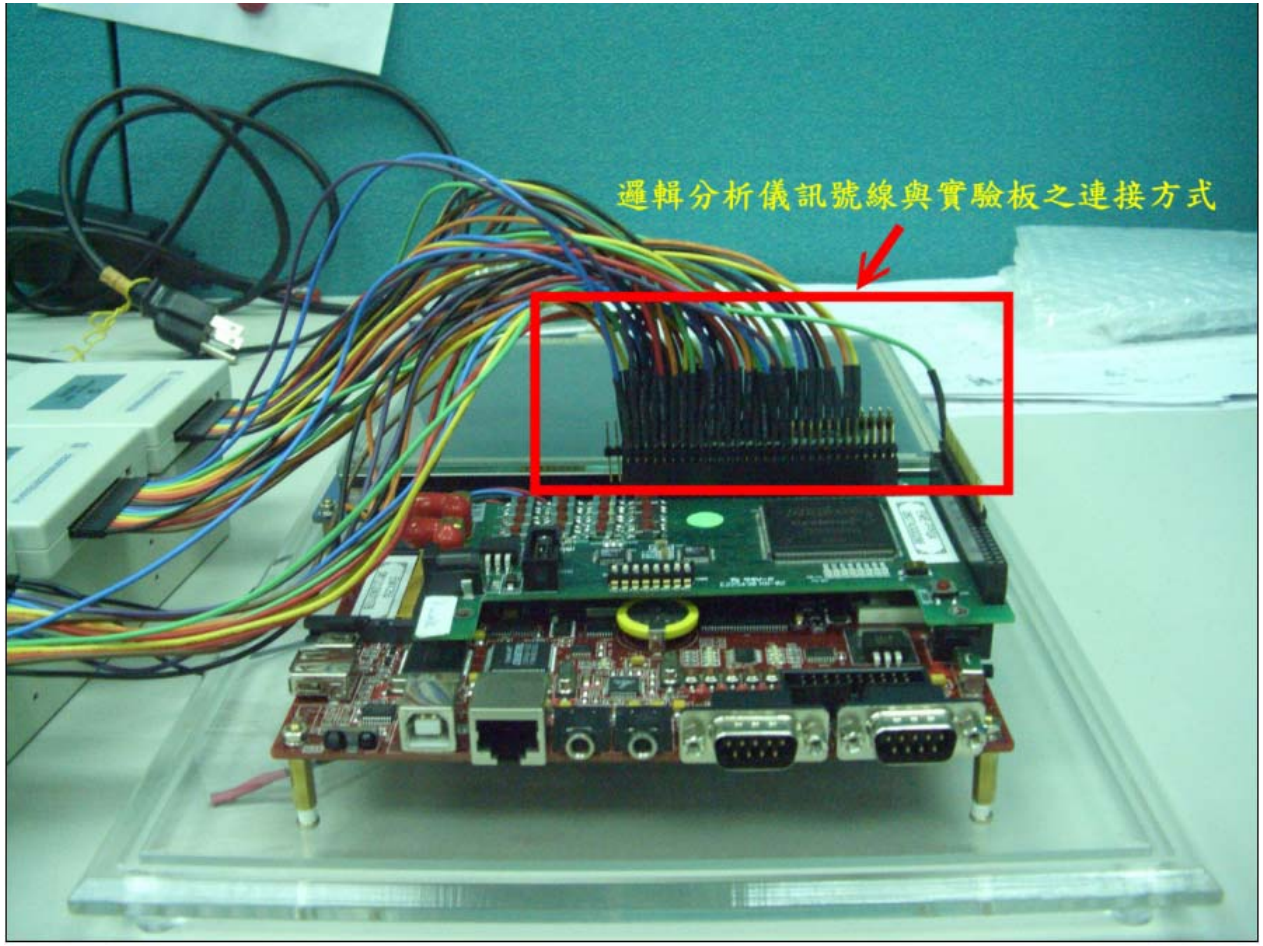
- Connect the Signals on PXA255 Platform to the Logic Analyser



5.7 Software Verification and LA Measurement

■ LA Measurement

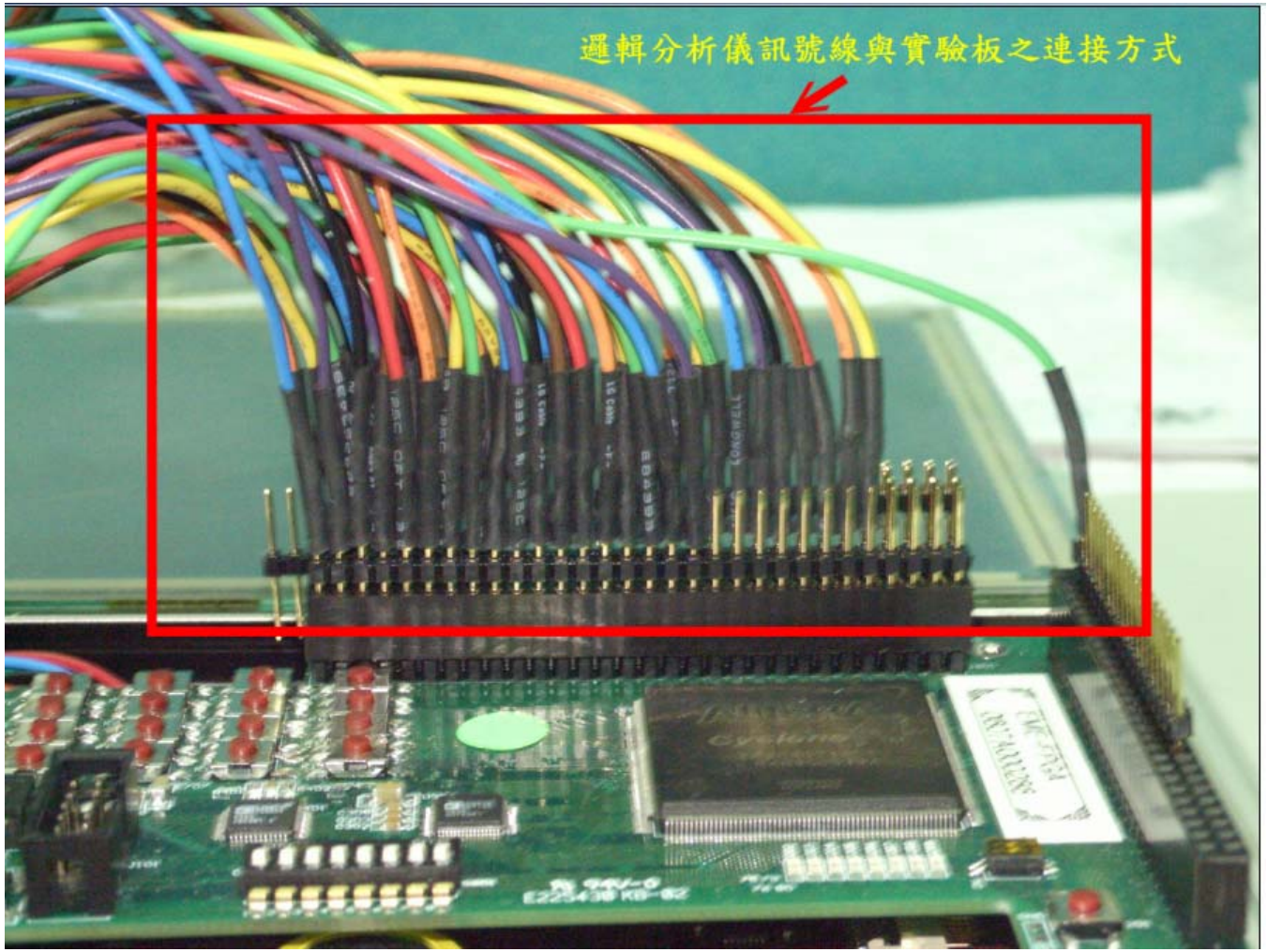
- Connect the Signals on PXA255 Platform to the Logic Analyser



5.7 Software Verification and LA Measurement

■ LA Measurement

- Connect the Signals on PXA255 Platform to the Logic Analyser



5.7 Software Verification and LA Measurement

■ LA Measurement

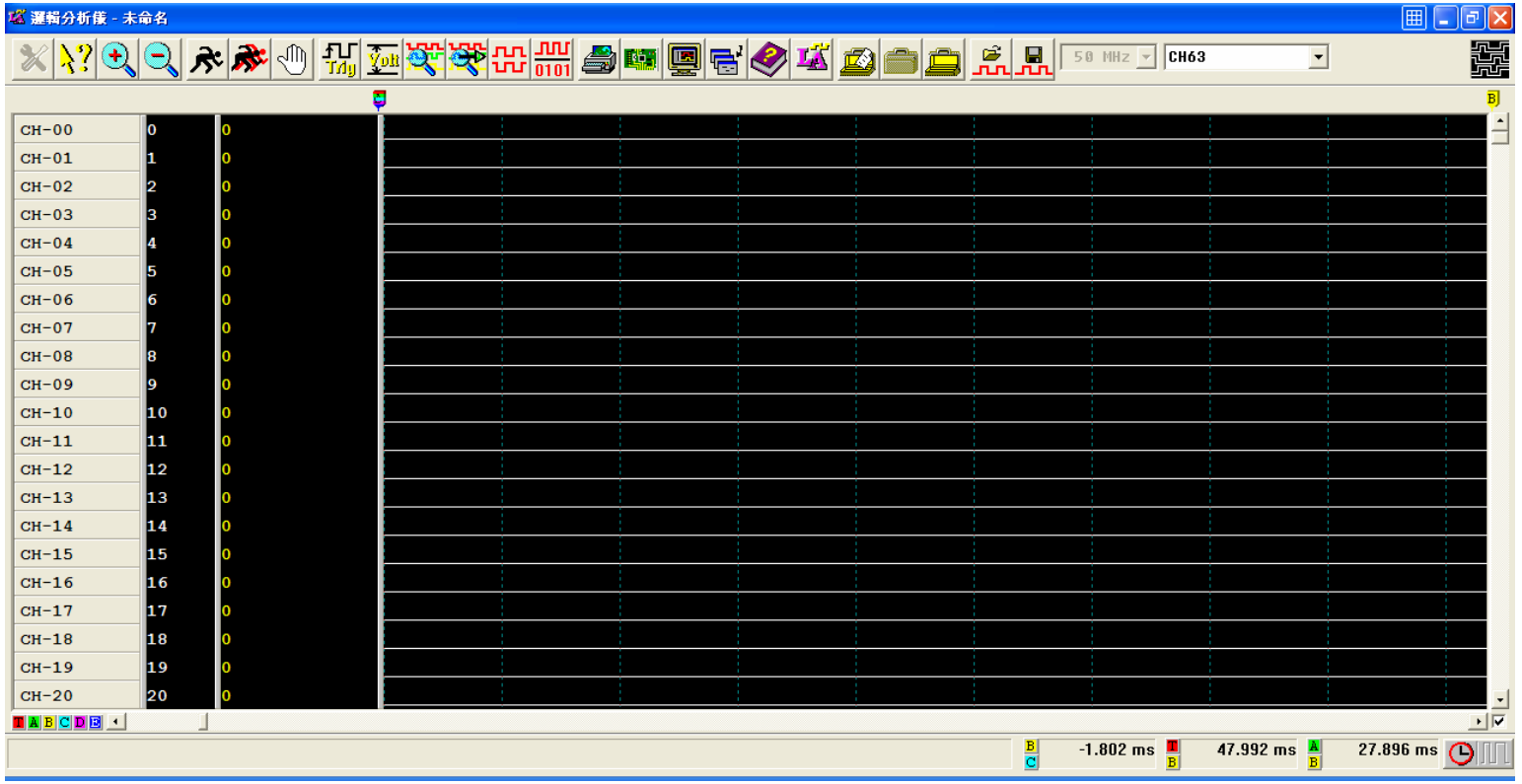
◆ Use Logic Analyser

■ Open the PC-based Logic Analyser

5.7 Software Verification and LA Measurement

LA Measurement

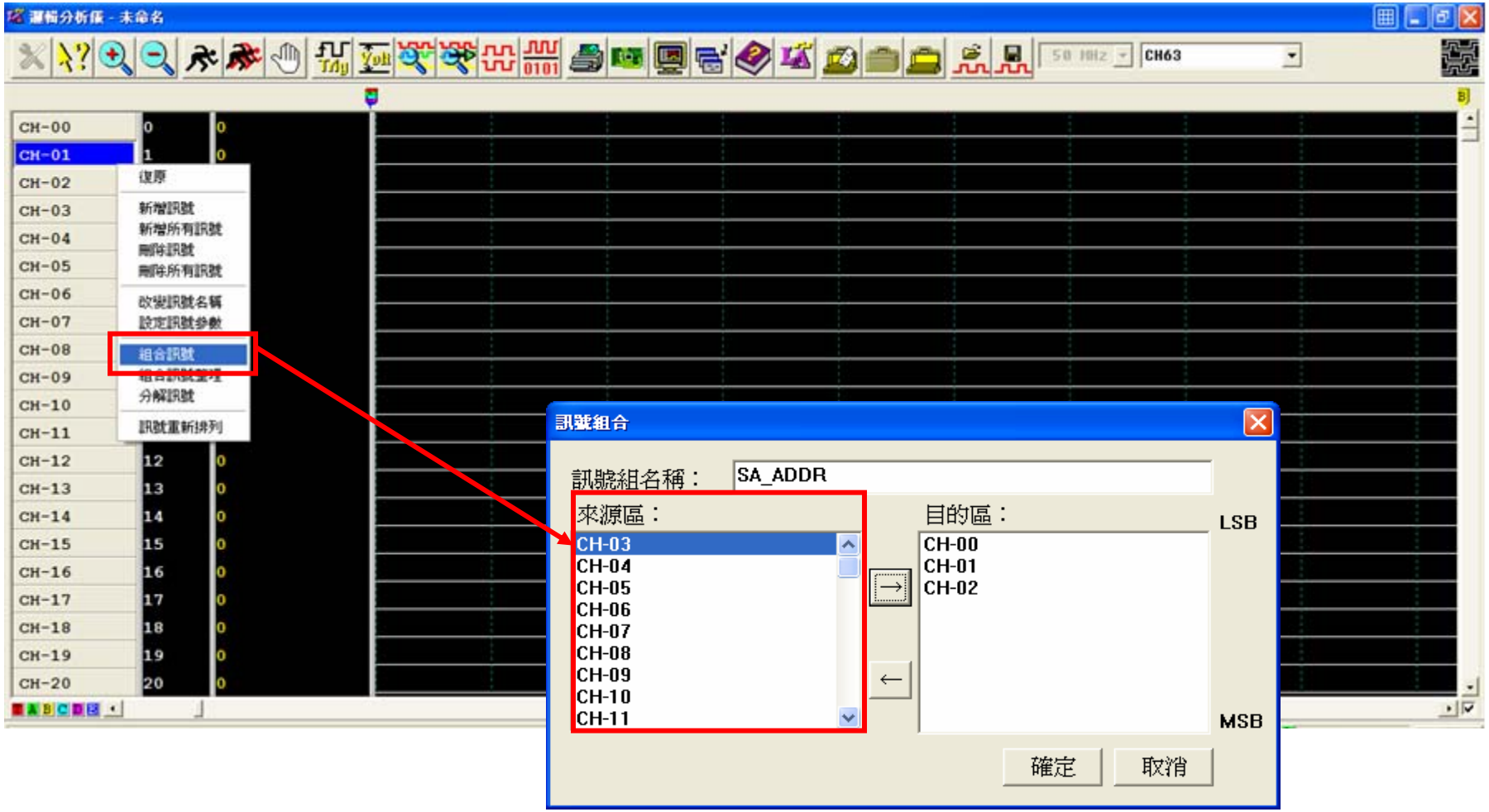
- The PC-based Logic Analyser
  - GUI Interface



5.7 Software Verification and LA Measurement

■ LA Measurement

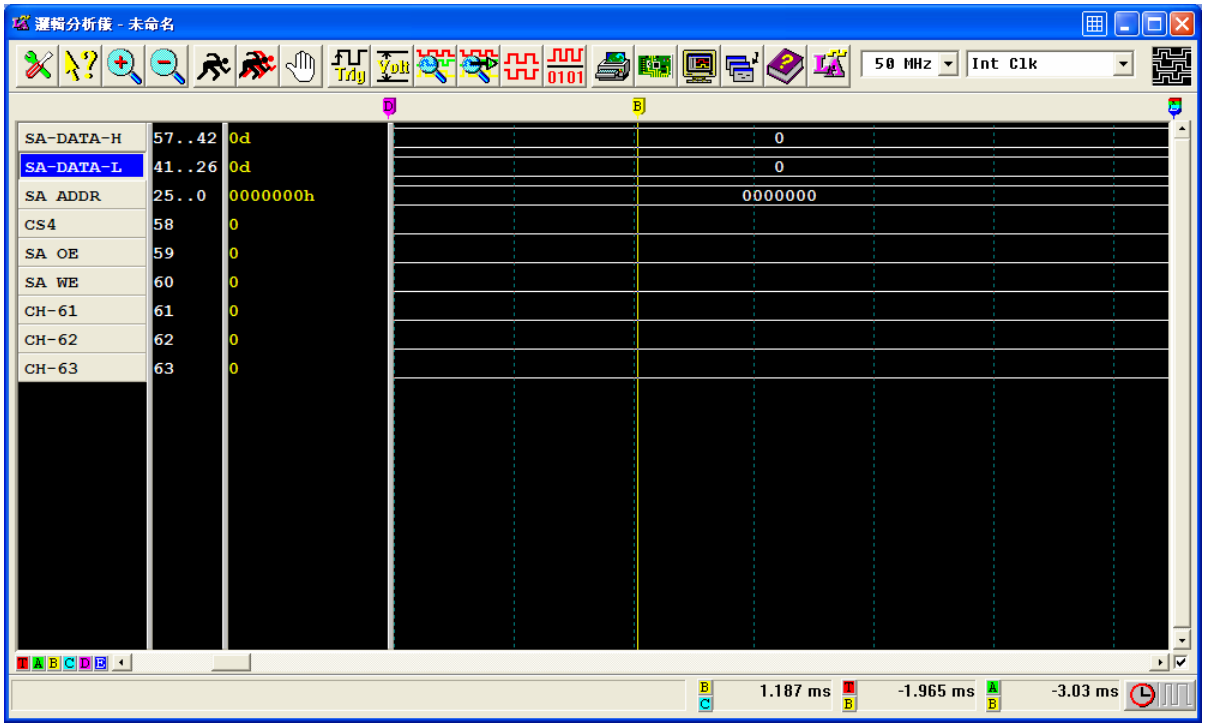
◆ Assign the Name to Each Signal



5.7 Software Verification and LA Measurement

LA Measurement

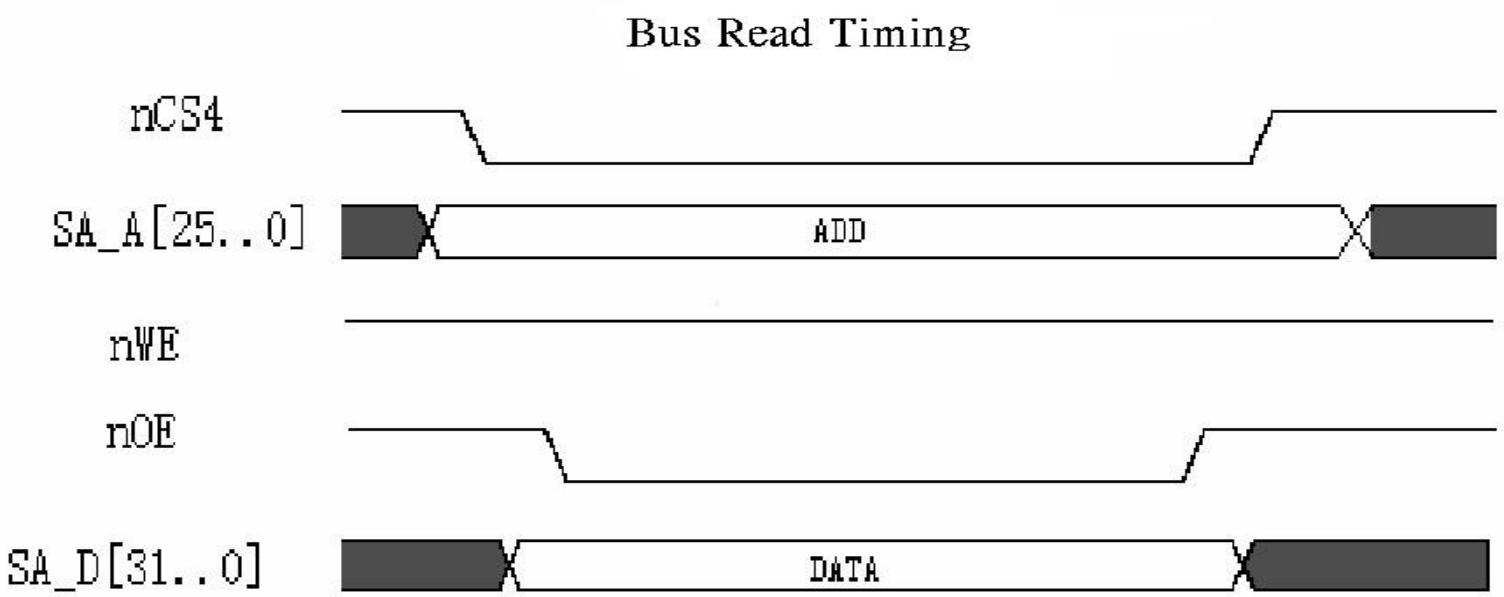
- Set Group for the Signals
  - SA-ADDR :Pin0~Pin25
  - SA-DATA-L:Pin26~Pin41
  - SA-DATA-H:Pint42~Pin57
  - CS4:Pin58
  - SA-WE:Pin59
  - SA-OE:Pin60



5.7 Software Verification and LA Measurement

■ LA Measurement

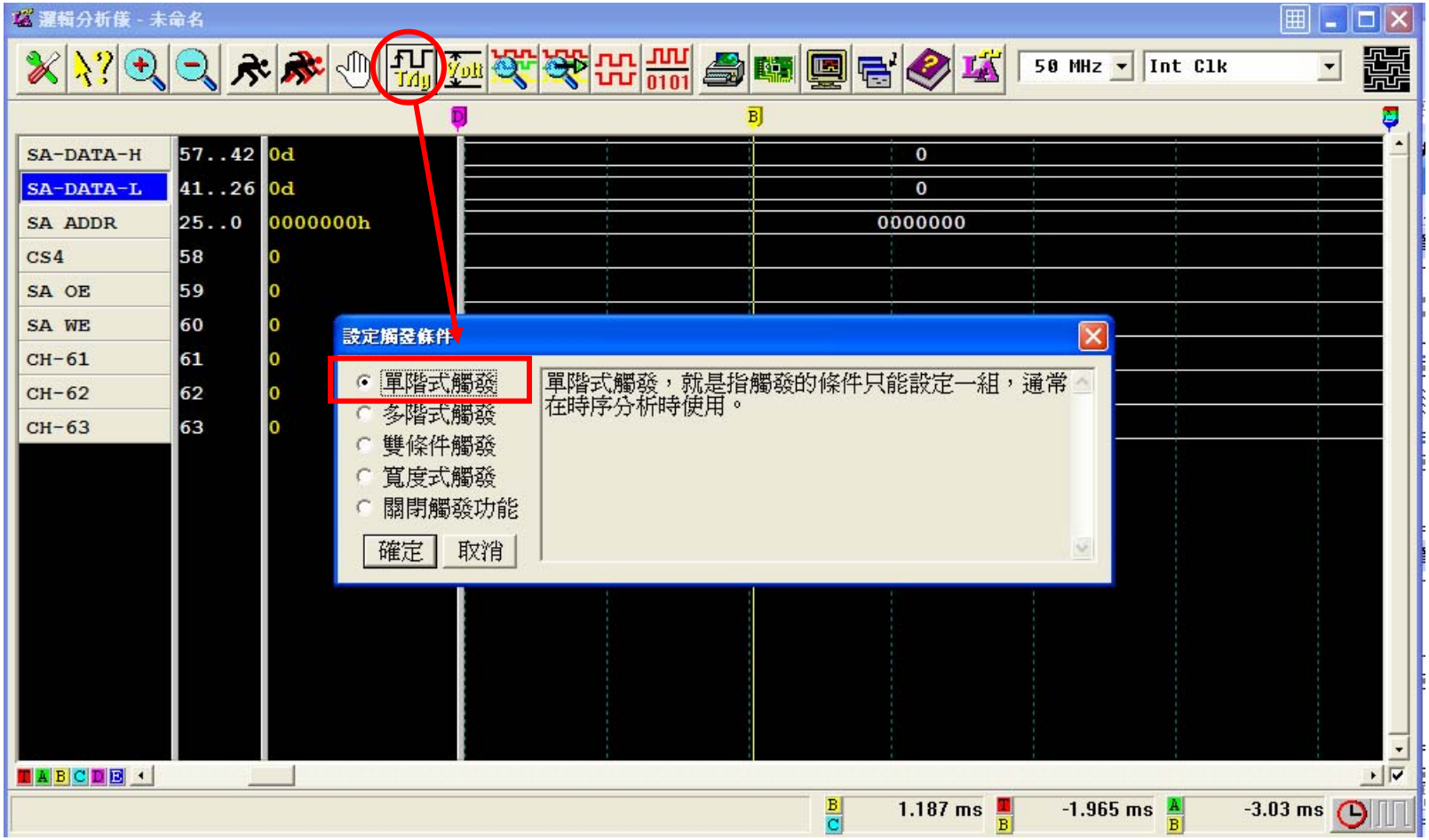
◆ The Read Timing



5.7 Software Verification and LA Measurement

■ LA Measurement

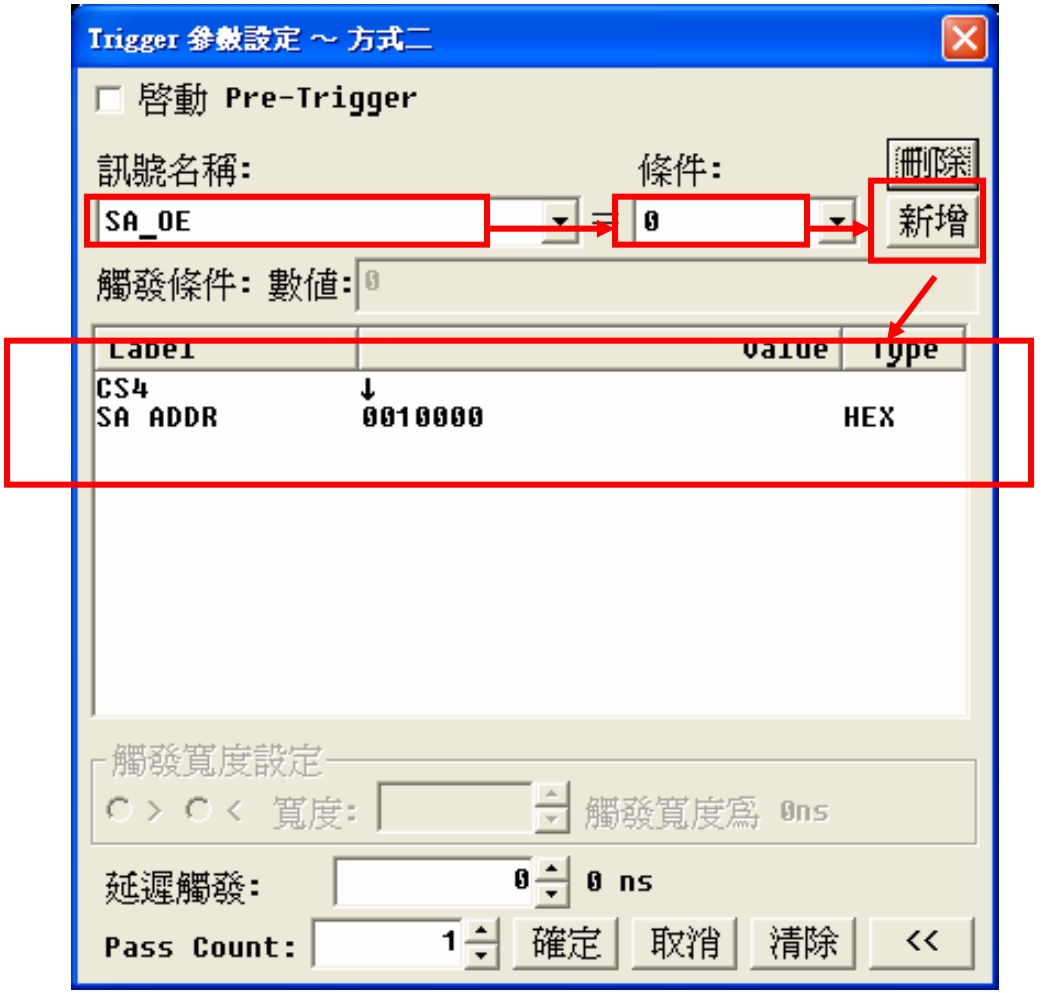
◆ Set the Condition to Trigger



5.7 Software Verification and LA Measurement

LA Measurement

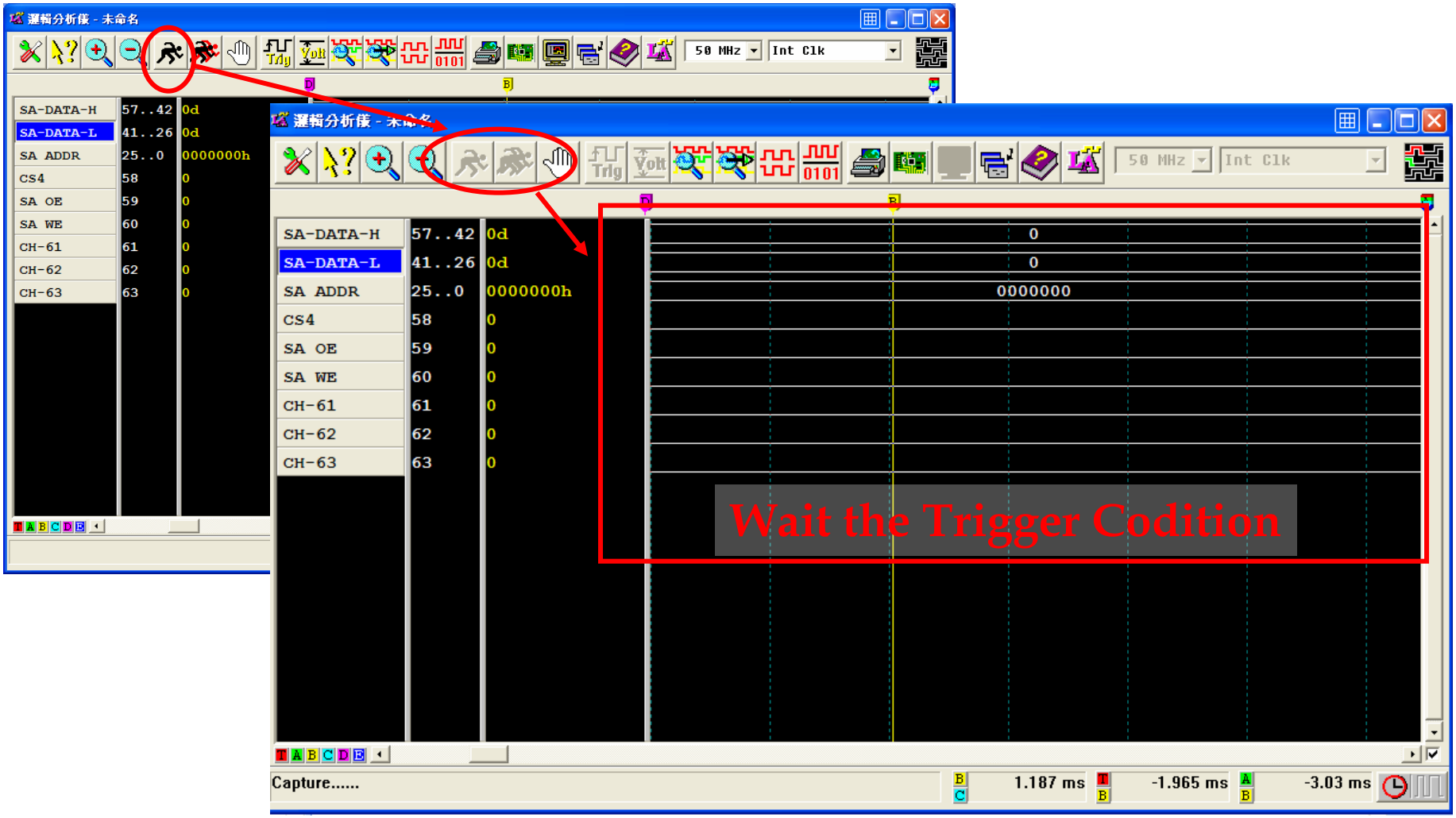
- Set the Condition to Trigger
  - CS4 Negative Edge
  - SA ADDR = 0x10000



5.7 Software Verification and LA Measurement

■ LA Measurement

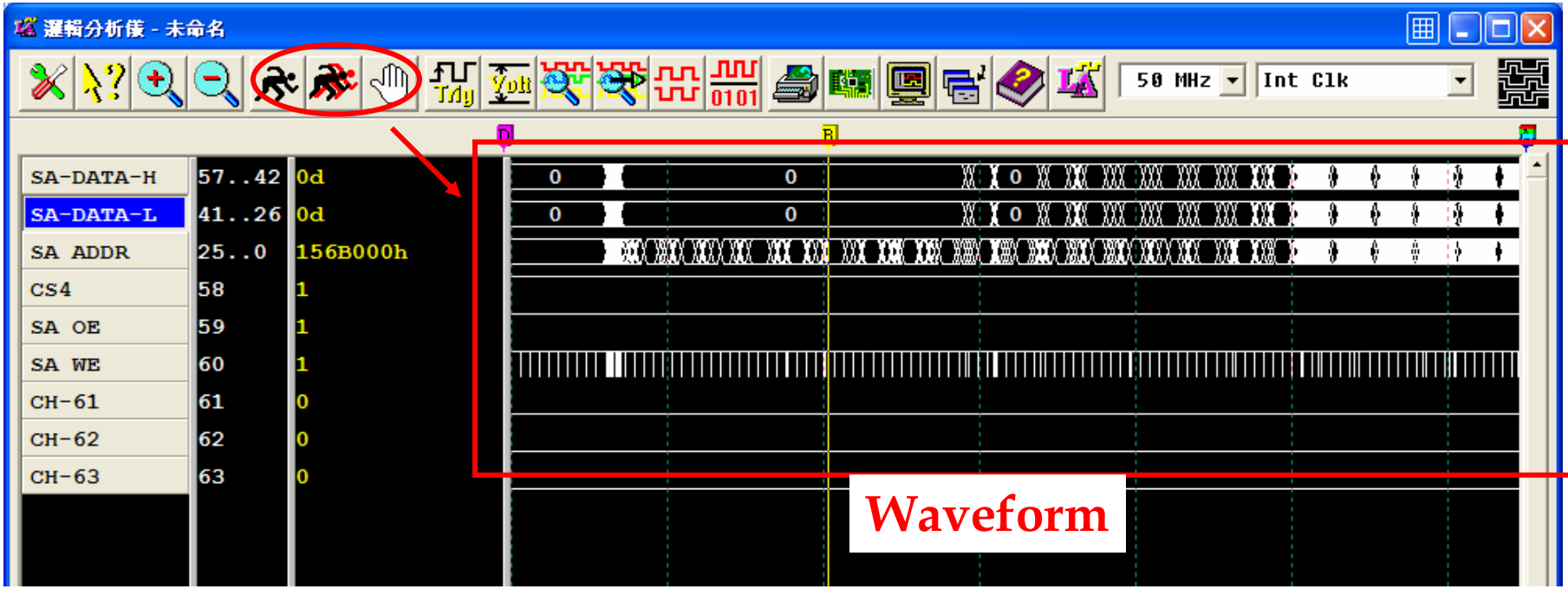
- Run. Click the icon



5.7 Software Verification and LA Measurement

LA Measurement

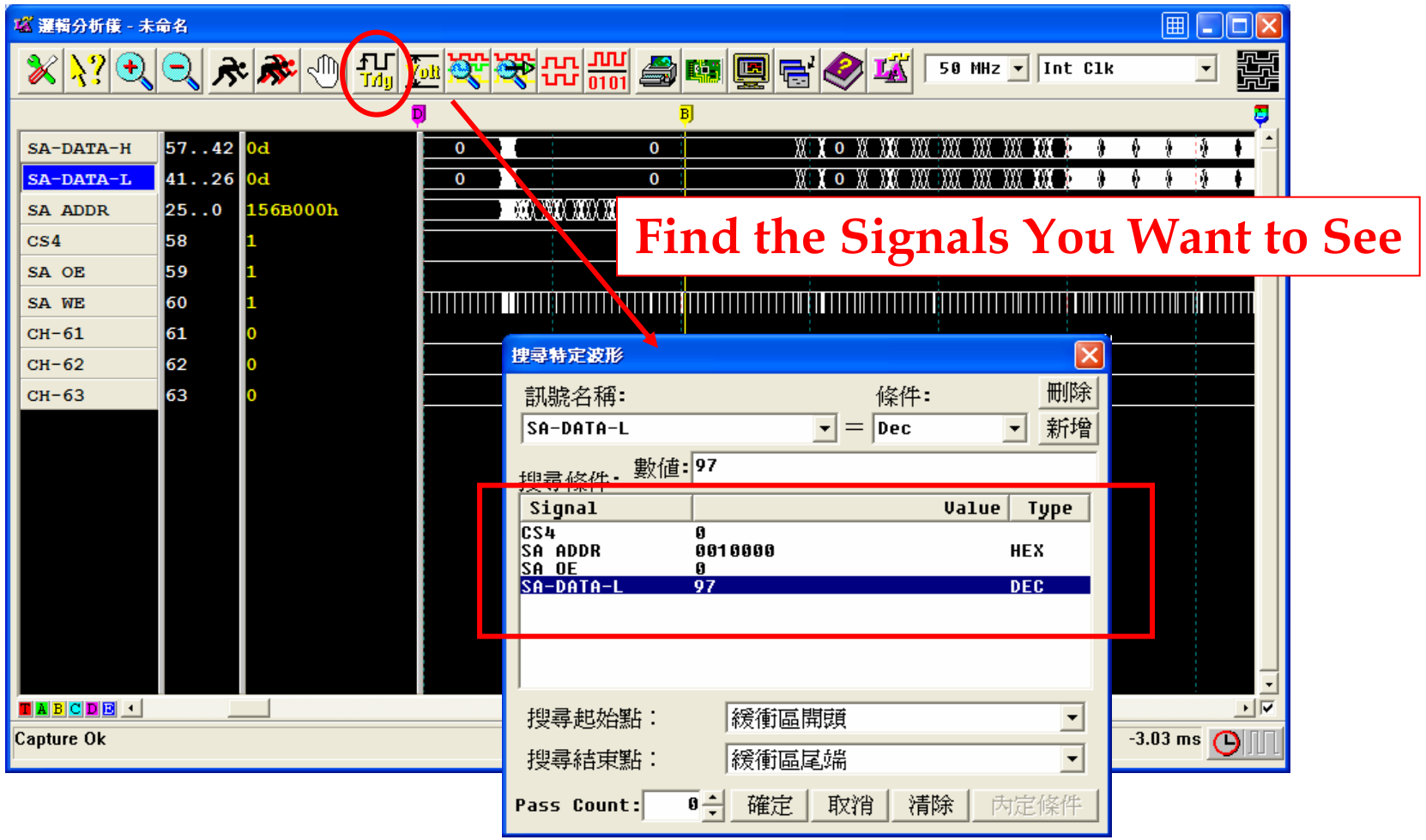
- The Trigger Condition
  - Execute the Software Application. Get the Waveform.



5.7 Software Verification and LA Measurement

■ LA Measurement

◆ Set the Condition to Find the Waveform



5.7 Software Verification and LA Measurement

■ LA Measurement

- Find the Data Compare with the Dump Data .Correct!!