Using Embedded Linux with Nios II Processor

User Guide

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About this Guide

Introduction

This document explains how to create your own Nios II processor system for Linux and run a free, open source Linux distribution on a pre-built system.

Table below shows the revision history of the user guide.

Version	Date	Description
1.1	03 January 2011	Second Release.
1.0	September 2010	First Release.

How to Contact SLS

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Typographic Conventions

The document uses typographic conventions shown as below.

Visual Cue	Meaning
Bold Type with Initial Capital Letters	All Headings and Sub Headings Titles in a document are displayed in bold type with initial capital letters; Example: **Overview, Development Environment**
Bold Type with Italic Letters	All Definitions, Figure and Table Headings are displayed in Italics. Examples: **Figure 1-1. Development Environment**
1. 2.	Numbered steps are used in a list of items, when the sequence of items is important such as steps listed in the procedure.
• ■	Bullets are used in a list of items when the sequence of items is not important.
	The hand points to information that requires special attention.
	The caution indicates required information that needs special consideration and understanding and should be read prior to starting or continuing with the procedure or process.
	The warning indicates information that should be read prior to starting or continuing the procedure or processes.
	The feet direct you to more information on a particular topic.

Contents

1. Getting Started

Overview

This tutorial is designed to make you aware of the usage of Linux in Embedded Systems and its advantages.

FPGAs are highly flexible development platforms for custom embedded systems. Using Altera tools, any combination of hardware designs that includes the Nios II processor and a set of standard as well as custom peripherals can be created. Running Linux on such a customized environment is beneficial but can be a bit challenging if not given a proper start. It is therefore recommended that embedded developers always start with a standard hardware reference platform.

For BSP developers supporting custom hardware designs, the best place to start is the sample BSP provided in the training. As incremental changes are made to the hardware system, you can modify the factory BSP in lock-step, and upgrade your Linux kernel accordingly. It is recommended that all BSP development and enhancements begin with the factory BSP and built upon incrementally.

☞ We assume that you are familiar with the Nios II, Linux and StratixIV Development Board.

You will learn here the following:

1. Development Environment Setup
2. Designing a Nios II Hardware Reference Design
3. Compiling and Running Linux with BSP
4. Creating User Application
5. Configuring Linux Kernel

Development Environment

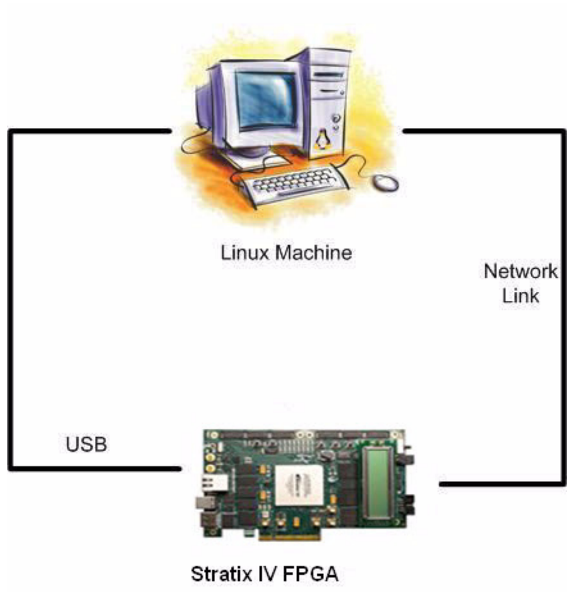
Nios II embedded development environment consists of two systems are:

1. Host system: Host system is used for compiling, linking, remote debugging and associated development activities.

2. Target system: Target system is used for such as the Stratix IV GX FPGA Development Kit, application development and testing (Figure 1-1.). Board acts as a target for application development.

☞ User must have **NEEK** board and Terasic **THDB-SUM** board for testing different IPs connected using **HSMC PORTA** and **PORTB** respectively to target board.

Figure 1-1. Development Environment



Development Host

A PC with Linux OS acts as a development host. It must have the following software installed:

- Linux for Nios II processor development software
  The Linux tool chain for the Nios II processors were tested against Fedora core10 and CentOS 5.3 software. We recommend that you start with these desktop software versions. Alternatively you can try another Linux versions.
  http://www.centos.org/docs/5/
  http://docs.fedoraproject.org/installation-quick-start-guide/
  Following development packages must needed on your Development Host, git-all, git-gui, tcsh, make, gcc, ncurses-devel,bison, libglade2-devel, byacc, flex, gawk, get-text, ccache, zlib-devel, gtk2-devel, lzo-devel, pax-utils

- Altera Quartus II software 9.1 SP2 or 10.0 SP1 and the corresponding Nios II EDS software

It can be download from the Altera Download Centre at location: http://www.altera.com/support/software/licensing/sof-qts-installation.html

Make sure to check the Nios Community Wiki Web site for additional useful information on how to run Quartus on a Linux PC. The Nios Community Wiki Web site is located at: http://www.nioswiki.com/OperatingSystems/UClinux/QuartusforLinux

For FPGA configuration flash programming and host-target communication using the Altera USB Blaster, you need to install the driver for the Altera USB Blaster. To install the USB-Blaster driver on Linux, follow the steps from below link.

www.altera.com/literature/ug/ug_usb_blstr.pdf

```
Plug one end of a USB cable to the USB port on the
Altera Stratix IV GX FPGA Development Kit and other
end to a USB port on the Linux  host to access on-
board USB-Blaster. Type the following command to ver-
ify that the USB-Blaster is working properly.Wiki Web
site is located at:
http://www.nioswiki.com/OperatingSystems/UClinux/
QuartusforLinux
#jtagconfig
```

1. The console displays the devices connected to the USB port as shown below:

```
1) USB-Blaster [USB 4-1.1]
024090DD   EP4SGX230/ES
020A40DD   EPM2210
```

The syntax may vary for different Linux distributions.

Development Target

The Stratix IV GX FPGA Development Kit is used as a Development Target.

Configuring the Development Board

To configure the development board, check all the switches are in default position. If not, then follow the steps below:

1. Set Rotary Switch SW2 at ‘0’ position.
2. Set all switches of user DIP switch bank SW3 in (OFF) ‘1’ position.

3. Set switches 1, 2, 4 in (OFF) '1' position and remaining switches in (ON) '0' position of board setting switch SW4.
4. Set switch 4 in (OFF) ‘1’ position and remaining in (ON) ‘0’ position of PCIe switch SW5.
5. Set switch 1 in (OFF) ‘1’ position and remaining in (ON) ‘0’ position of JTAG switch SW6.

System Setup

This section explains hardware and software required and the system setup to run Linux on the Nios II processor. See Figure 1-1.

Follow the steps below to make the system setup:

1. Connect Stratix IV GX FPGA Development Kit to a 100/1000 Mbps Ethernet switch.

   The host PC should be connected to the aforementioned Nios II target through the Ethernet switch.
2. Connect one end of the standard USB Cable to the host Linux PC and the other end to the Stratix IV GX FPGA Development Kit.

Downloading the BSP Package

Download the bsp-lnx-s4gxdk-110103-0.1.0.0.tar.bz2 from http://www.slscorp.com/pages/bsplnxs4gxdk.php

Table 1-1. BSP Contents

Name	Description
Kernel	v2.6.34
GCC	v4.1.2
Ethernet Driver	Included
JTAG Driver	Included
Serial port Driver	Included
LED Driver	Included
Push Button Driver	Included
PS2 Keyboard Driver	Included
LCD Driver	Included
Touch Panel Driver	Included
USB Host 2.0 Driver	Included
I2C Driver	Included

Table 1-1. BSP Contents	
Name	**Description**
JFFS2 and VFAT Driver	Included
SD Card Driver	Included

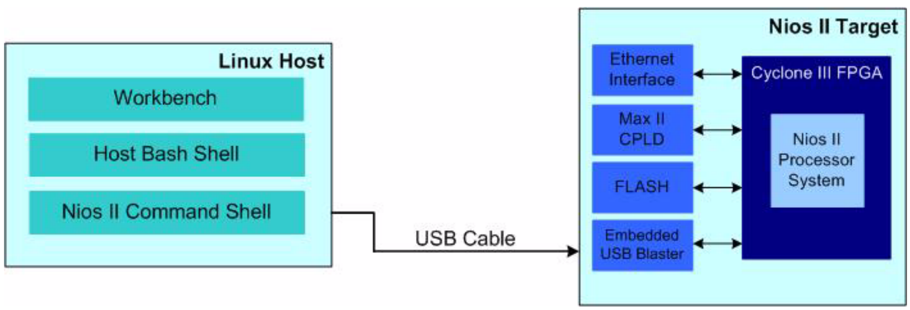
2. Designing a Nios II Hardware Reference Design

Introduction

This section describes how to create a Nios II hardware reference design on Altera Stratix IV GX FPGA Development Kit. The board, when configured as a Nios II target, will boot and run Linux and allow host-target communication and Flash programming over USB cable. The Linux Host should have Nios II processor development package installed.

Figure 2-1. below shows the setup.

Figure 2-1. Hardware Setup



The Nios II Target, the Altera Stratix IV GX FPGA Development Kit has the following key components:

- **Flash Memory**
  Once the on-board Flash memory is programmed with the FPGA configuration image for the Nios II hardware reference design, Stratix IV Edition, the option bits for the MAX II configuration controller and a prebuild kernel image with initramfs; the development board on power up will boot up as a Nios II target running Linux.
- **USB Interface**
  For host-target communication and high-speed Flash programming.

For more information on the Altera Stratix IV GX FPGA Development Kit refer to the documentation at:
http://www.altera.com/products/devkits/altera/kit-siv-gx.html

Creating Hardware Design

Here, we have provided the sample System for Stratix IV GX FPGA Development Kit.

Using the SOPC Builder tool, create a minimum processor system design that includes the following features.

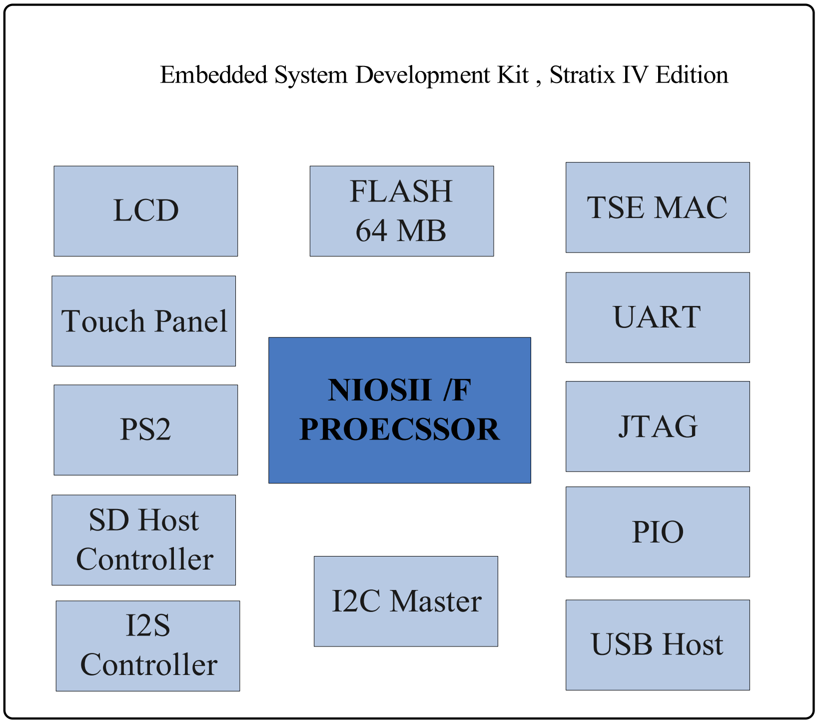
☞ Please consult on-line documentation from www.altera.com on how to use the SOPC Builder tool.

Our example system includes the following features:

- Nios II/f core
- Hardware multiplier
- MMU, use the default MMU settings
- 1K dual-port tightly coupled memory, connect one port to the tightly_coupled_instruction_master of Nios II and the other port to the tightly_coupled_data_master
- Assign "Fast TLB Miss Exception Vector" to the aforementioned tightly coupled memory
- Add DDR3 or SDRAM to the system, you need a minimum of 8MB and a maximum of 128MB
- One full-featured timer, not a hi-res timer
- A JTAG/serial UART
- External Flash
- Ethernet controller
- LED and Button PIO
- LCD controller
- SLS SD Host controller
- Touch Panel controller
- SLS PS2 Keyboard controller
- SLS I2C master for EEPROM, Audio and TV
- SLS I2S controller
- USB Host controller(USB20HC)

☞ The block diagram given below will make the design clearer. See Figure 2-2.

Figure 2-2. Reference Design Block Diagram



☞ Important things to note while you're creating the hardware design are:

- Note in Linux, irq 0 means auto-detected, so you must not use irq 0 for ANY devices, except for the timer.
- Component naming is critical. They must match with the macro defined in your kernel. Please check the kernel source files below to make sure:

  /home/sls/Nios2-linux/Linux_source/linux-2.6/arch/nios2/boards/4s230/config.c
  /home/sls/Nios2-linux/Linux_source/linux-2.6/arch/nios2/boards/4s230/ include/asm/nios.h

Memory Map and Linker Regions

The memory map of the Nios II processor system and the Linker sections are shown in Table 2-1 and Table 2-2 respectively.

All address that fall in the range 0x00000000 to 0x1FFFFFFF are direct mapped while addresses from 0x2000000 and above are managed by the Memory Management Unit (MMU). In order to optimize for fast system performance, the base addresses of all peripherals are mapped outside of the area managed by the MMU.

It is recommended that you allocate your user peripherals in the direct mapped memory range (0x00000000 to 0x1FFFFFFF). It is also recommended that you retain the memory allocations for the peripherals provided to you as part of the Nios II Hardware Reference Design for Linux, Stratix IV Edition.

Table 2-1. Memory Section Map

SR. No.	Device Name	Device Name in the Design	Address Range	Size (bytes)
1	External Flash Memory	ext_flash	0x0000000-0x3FFFFFF	67108864
2	Descriptor Memory	descriptor_memory	0x4000000-0x4001FFF8192	8192
3	Triple Speed Ethernet	MACtse_mac	0x4002000-0x40023FF	1024
4	Receive Scatter Gather DMA	sgdma_rx	0x4002400-0x400243F	64
5	Transmitter Scatter Gather DMA	sgdma_tx	4002440-0x400247F	64
6	TimerLCD lcd_sgdma	timer_1ms	0x4002480-0x40024BF64	64
7	LCD	lcd_sgdma	0x40024C0-0x40024FF	64
8	SLS USB 2.0 Host (USB20HC)	sls_usb20hc	0x4C00000-0x4C03FFF	16384
9	SLS USB20HC PHY RESET	usb20hc_phy_reset	0x4C04000-0x4C0401F	32
10	LED PIO	led_pio	0x4E00000-0x4E0001F	32
11	Button PIO	button_pio	0x4E00020-0x4E0003F	32

Table 2-1. Memory Section Map				
SR. No.	**Device Name**	**Device Name in the Design**	**Address Range**	**Size (bytes)**
12	SLS I2C Master EEPROM	sls_i2c_m_id_eeprom	0x4E00080-0x4E000FF	128
13	SLS SD Host controller	sls_sdhc	0x4E00100-0x4E001FF	256
14	SLS PS2 controller	sls_ps2	0x4E00200-0x4E0023F	64
15	Touch Panel SPI	touch_panel_spi	0x4E00240-0x4E0027F	64
16	Touch Panel PEN	touch_panel_pen_irq_n	0x4E00280-0x4E0029F	32
17	SLS I2C Master Audio & TV	sls_i2c_m_aud_tv	0x4E00300-0x4E0037F	128
18	SLS I2S controller	sls_i2s	0x4E00380-0x4E003BF	64
19	JTAG	jtag_uart	0x4EFFFB0-0x4EFFFBF	16
20	UART	uart	0x4EFFFC0-0x4EFFFFF	64
21	TLB_MISS_RAM 1K Memory	tlb_miss_ram_1k	0x7FFF400-0x7FFF7FF	1024
22	DDR3 SDRAM controller	ddr3_top	0x8000000-0xFFFFFFF	134217728

Table 2-2. Linker Section Map				
Sr. No.	**Linker Section Name**	**Linker Region Name**	**Memory Device**	**Memory Device Name**
1	.bss	ddr2_lo_latency_128m	DDR2 SDRAM	ddr2_lo_latency_128m
2	.exceptions	ddr2_lo_latency_128m	DDR2 SDRAM	ddr2_lo_latency_128m
3	.heap	ddr2_lo_latency_128m	DDR2 SDRAM	ddr2_lo_latency_128m

Table 2-2. Linker Section Map

Sr. No.	Linker Section Name	Linker Region Name	Memory Device	Memory Device Name
4	.rodata	ddr2_lo_latency_128m	DDR2 SDRAM	ddr2_lo_latency_128m
5	.rwdata	ddr2_lo_latency_128m	DDR2 SDRAM	ddr2_lo_latency_128m
6	.stack	ddr2_lo_latency_128m	DDR2 SDRAM	ddr2_lo_latency_128m
7	.text	ddr2_lo_latency_128m	DDR2 SDRAM	ddr2_lo_latency_128m

Compile the Hardware Design

Please consult the *Altera user documentation for Quartus II software* and the *SOPC Builder tool* for information on how to create and compile a new hardware design.

3. Compiling and Running Linux with BSP

Introduction

Nios II Hardware Reference Design by SLS for Stratix IV GX FPGA Development Kit and the matching BSP provide a solid starting point for BSP Development. It is recommended that you always start with the sample BSP, when you create new device drivers or make iterative changes to the provided device drivers as hardware changes are made in the system.

BSP

The BSP (Board Support Package) contains the following:
Quick reference with ready to go pre-built Linux images and SOF

1. Linux Image(with initramfs) without USB2.0 Host controller IP
2. Linux Image(with initramfs) with USB2.0 Host controller

☞ To use Linux Image with USB2.0 Host controller this image Terasic **THDB-SUM** board **HSMC** must be connected to **Stratix IV** board's **HSMC PORT B**.

- Supported and tested Devices/Peripheral Drivers
    - Ethernet: Altera TSE driver (SLS)
    - Flash: Intel CFI Parallel Flash
    - Serial: Altera JTAG UART, Altera Serial UART
    - PIO: LEDs and Push Button Switches
    - SD Card : SD Host controller driver (SLS)
    - LCD: Altera LCD driver
    - Touch Panel: Altera Touch Panel driver (SPI based)
    - PS2 Keyboard:PS2 Keyboard driver (SLS)
    - I2C Master : I2C Master driver for EEPROM and Audio & TV (SLS)
    - USB 2.0 Host: USB20HC controller driver (SLS)
    - I2S Audio controller (SLS) driver (not added)

Configuring the BSP

The package downloaded earlier from www.slscorp.com is to be used here. Please follow the steps mentioned below:

1. Copy the BSP source **bsp-lnx-s4gxdk-110103-0.1.0.0.tar.bz2** at the development folder on your linux PC and extract it.

```
#cd /home/sls/
#tar -xjf bsp-lnx-s4gxdk-110103-0.1.0.0.tar.bz2
```

The **Nios2-Linux** folder will be created. It contains following three folders.

Table 3-1. BSP Installed Directory Structure

Directory Name	Description
BuildTools	Contains pre-built bin tools gcc 4.1.2 for nios2-linux
Linux_source	Contains kernel and application
System-Board	Contains system file for specific board. It contains only for 4SGX230 board files

2. Set the Bintools path on your terminal.

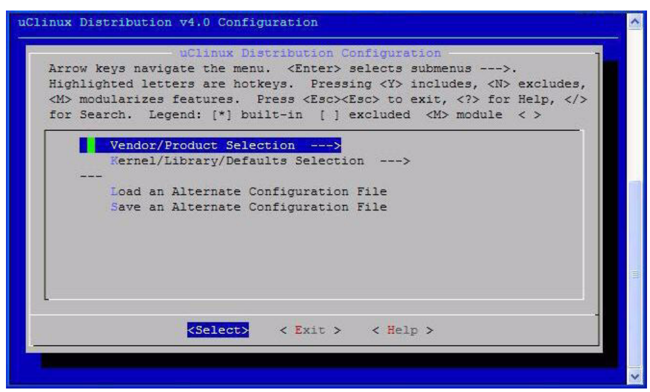
```
#PATH=$PATH:/home/sls/Nios2-Linux/BuildTools/tool-chain-mmu/x86-linux2/bin
```

3. Build the Linux image.

```
#cd/home/sls/Nios2-Linux/Linux_source/uClinux-dist/
#make menuconfig
```

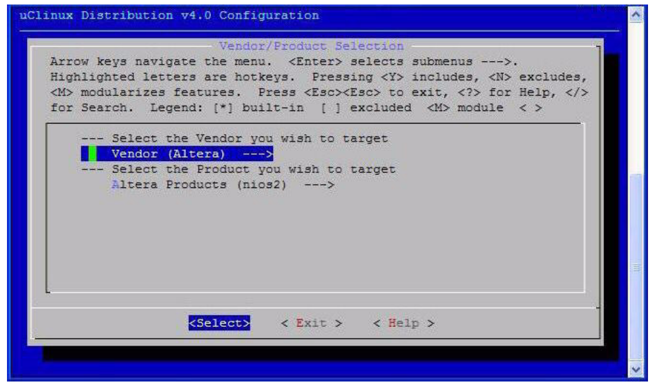
The menuconfig screen displays as shown in Figure 3-1.

Figure 3-1. Menu Configuration Screen



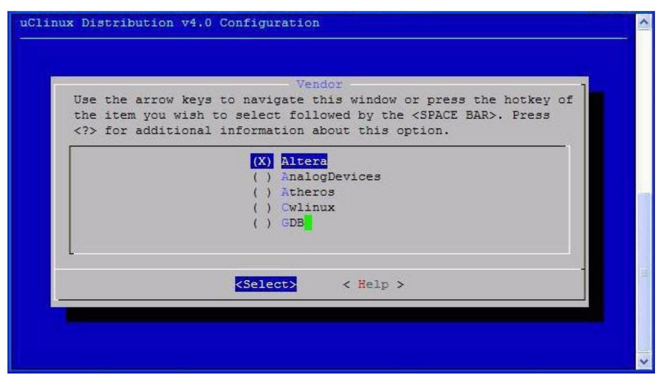
4. Select **Vendor/Product Selection**. See Figure 3-2.

Figure 3-2. Vendor/Product Selection



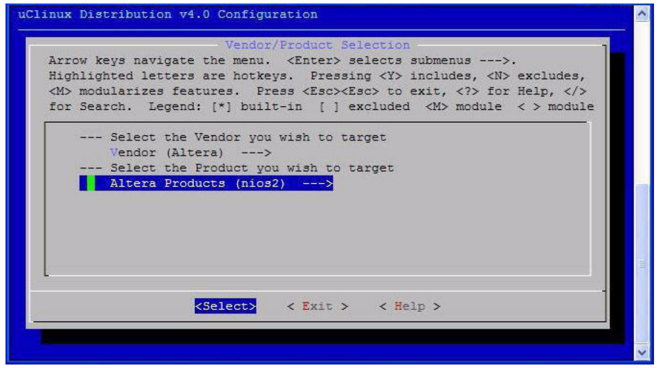
5. Select Vendor (vendor_name) and make sure that Altera is selected as shown in Figure 3-3. To select/de-select the vendor, highlight the vendor name (using arrow keys) and press space- bar or Enter to select or de-select.

Figure 3-3. Vendor selection



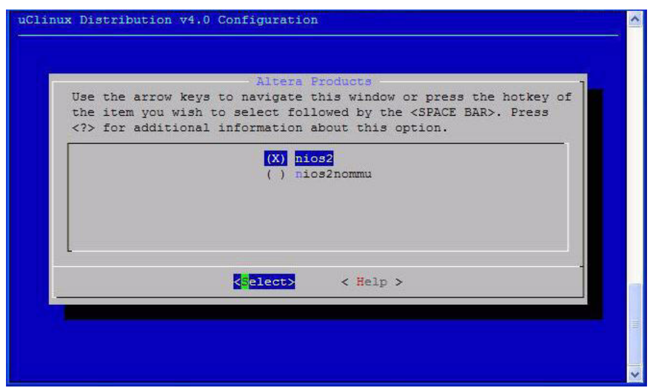
6. Select **Altera Products (*product_name*)** to select the product. See Figure 3-4.

Figure 3-4. Vendor/Product Selection



7. Select **nios2**. See Figure 3-5.

Figure 3-5. Altera Product Selection



8. Press **E** to exit the **Vendor/Product Selection** section.
9. Press **E** again to exit the **kernel configuration**. You will be asked whether to save the configuration or not. See Figure 9
10. Press E again to exit the kernel configuration.

Compiling the BSP

To compile the BSP, follow the steps below:

1. Type the following command to compile the BSP:

   ```
   #make
   ```

   After compilation, you will get different images in the image folder located at:

   /home/sls/Nios2-linux/Linux_source/uClinux-dist/images/

   The **linux.initramfs.gz** file is an elf image with initramfs.

Running the BSP

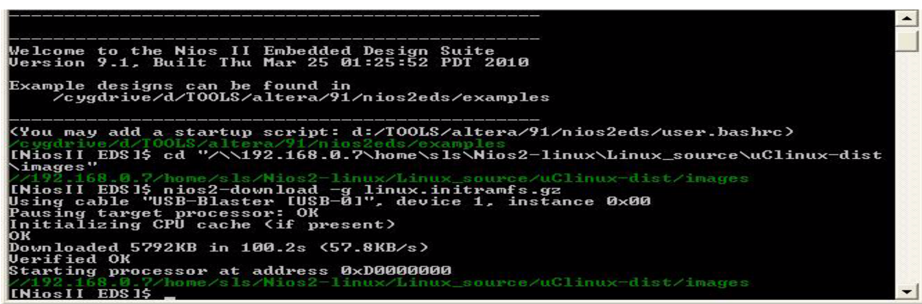
To run the BSP on Nios II reference design, follow the steps below:

1. Download the sof file **sys_qii100sp1_linux_bsp_s4gxdb.sof** located at **/home/sls/Nios2-linux/System-Board/4s230_default**.
2. Download elf file **linux.initramfs.gz** located at

   /home/sls/Nios2-linux/Linux_source/uClinux-dist/images/
3. Download the **ELF** image using the following command:

   ```
   #nios2-download -g linux.initramfs.gz
   ```
4. After successful downloading of SOF and ELF, Linux terminal displays the results as shown in Figure 3-6.

Figure 3-6. Downloading ELF Image



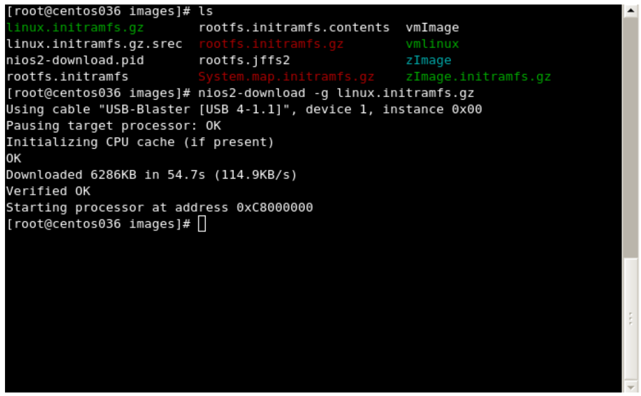
5. Type the following command to open the Nios II terminal.

   ```
   #nios2-terminal
   ```

   Now, this is the embedded Linux running on the 4SGX230 FPGA. We have downloaded the hardware design with the Nios II processor first and then downloaded the image with the kernel and drivers. See Figure 3-7.

☞ Current Kernel configuration does not include support for USB20 Host Controller. **Stratix IV HSMC PORT A** should be connected with **NEEK** board.

Figure 3-7. Running Linux On the Board



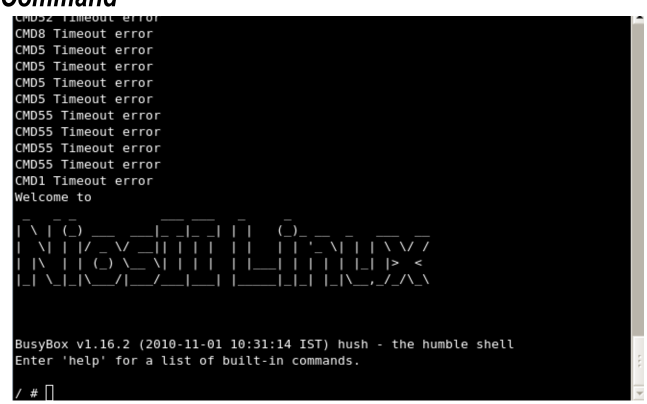
6. Type **ls** to see the directory contents. Similarly we can use the commands like cd, password and other in the same way as we use in Linux. See Figure 3-8.

Login:

Username : **root**

Password : **nios2linux**

Figure 3-8. Running ls Command



If the ethernet cable is connected to a network, we can also view the status, assign IP Address to the board and access other machines in the network as mentioned in the following steps. See Figure 3-9.

7. Type the following command to view the status.

```
ifconfig eth0
```

Figure 3-9. Eternet Configuration Status

8. Type the following command to assign IP address to the 4SGX230 board.

```
ifconfig eth0 192.168.0.181
```

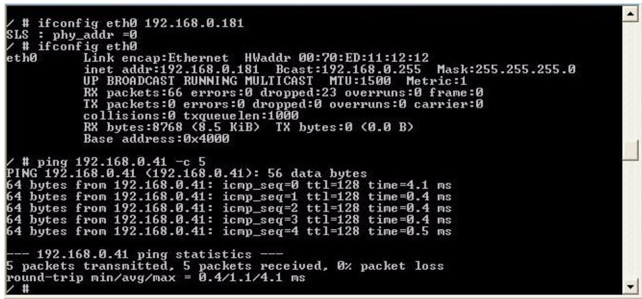
Figure 3-10.Assigning IP Address

☞ The IP address assigned above is only for example. Please ask your instructor to get the IP address to be assigned to 4SGX230 board.

9. Type the following command to access other machine in the network.

```
ping 192.168.0.41 -c 5
```

Figure 3-11.Accessing Other Machine in the Network



```
/ # ifconfig eth0 192.168.0.181
SLS : phy_addr =0
/ # ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:70:ED:11:12:12
          inet addr:192.168.0.181  Bcast:192.168.0.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:66 errors:0 dropped:23 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:8768 (8.5 KiB)  TX bytes:0 (0.0 B)
          Base address:0x4000

/ # ping 192.168.0.41 -c 5
PING 192.168.0.41 (192.168.0.41): 56 data bytes
64 bytes from 192.168.0.41: icmp_seq=0 ttl=128 time=4.1 ms
64 bytes from 192.168.0.41: icmp_seq=1 ttl=128 time=0.4 ms
64 bytes from 192.168.0.41: icmp_seq=2 ttl=128 time=0.4 ms
64 bytes from 192.168.0.41: icmp_seq=3 ttl=128 time=0.4 ms
64 bytes from 192.168.0.41: icmp_seq=4 ttl=128 time=0.5 ms

--- 192.168.0.41 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
round-trip min/avg/max = 0.4/1.1/4.1 ms
/ #
```

10. Please consult your instructor to get the IP address of other machine in the network.

We have learned how to run the given BSP on the board. The next chapters will explain how to create your own application and modify kernel settings.

4. Creating User Application

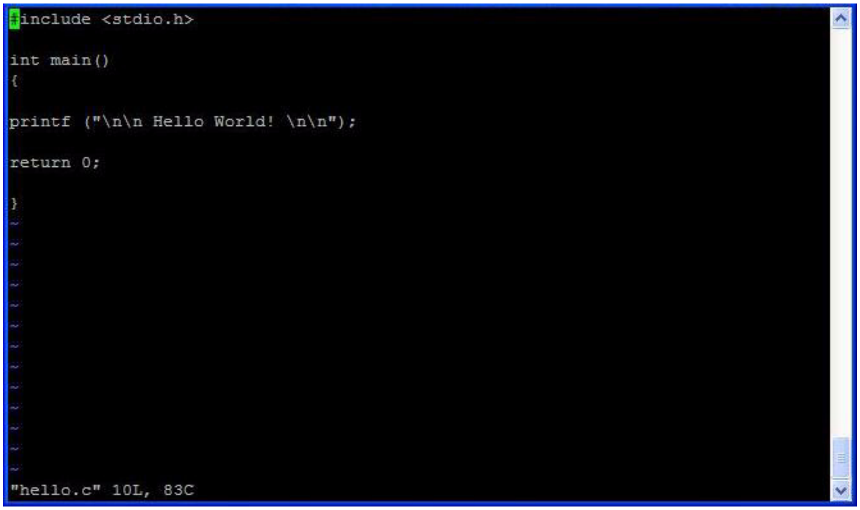
This section explains you about adding a user application named hello in the BSP. This application prints **hello world** on the Nios II terminal. Follow the steps below to add a new user application.

1. Open **Linux** terminal.
2. Locate the directory **sls_test_app** from **/home/sls/Nios2-Linux/Linux_source/uClinux-dist/user/sls_test_app** directory.
3. Type following to create **hello.c** file.

   ```
   vi hello.c
   ```
4. Type the following code in the file.

   ```
   #include <stdio.h>

   int main()
   {

     printf ("\n\nHello World! \n\n");

     return 0;

   }
   ```

Figure 4-1. Creating hello.c file



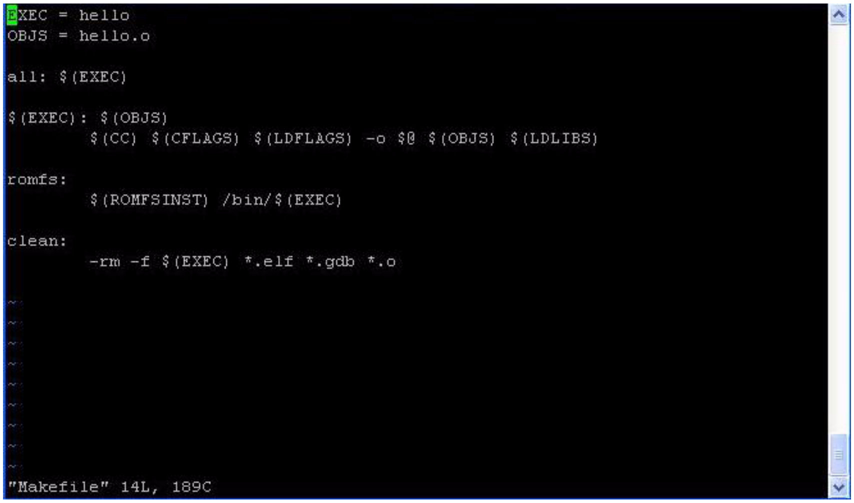
5. Modify the **Makefile** as mentioned below to compile the hello application.

   Type the following command to open the Makefile.

   ```
   vi Makefile
   ```

The user application and the object file are defined by the macros EXEC_USER and EXEC_OBJS respectively. See Figure 4-2.

Figure 4-2. Modifying Makefile



6. Locate the folder **uClinux-dist** from **/home/sls/Nios2-Linux/Linux_source.**

7. Type the following command to compile the BSP:

   ```
   #make
   ```

   After compilation, you will get different images in the image folder located at:

   /home/sls/Nios2-linux/Linux_source/uClinux-dist/images/

   The **linux.initramfs.gz** file is an elf image with initramfs.

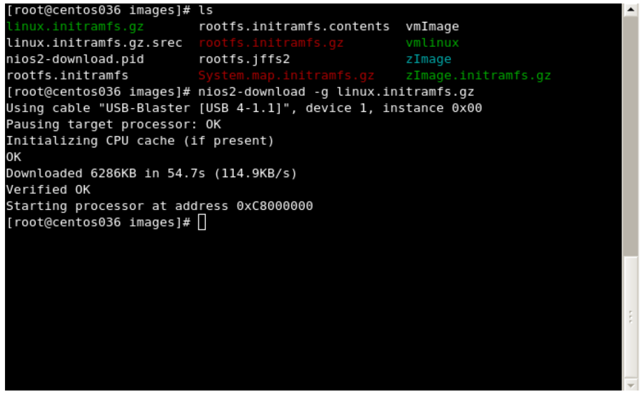
8. Make sure that the **SOF** file is downloaded.

9. Download the **ELF** image using the following command:

   ```
   #nios2-download -g linux.initramfs.gz
   ```

10. After successful downloading of SOF and ELF, Linux terminal displays the results as shown in Figure 4-3.

Figure 4-3. Downloading ELF image



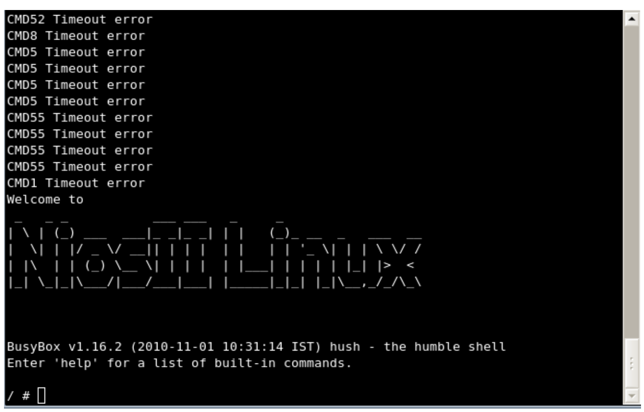
```
[root@centos036 images]# ls
linux.initramfs.gz        rootfs.initramfs.contents  vmImage
linux.initramfs.gz.srec   rootfs.initramfs.gz        vmlinux
nios2-download.pid        rootfs.jffs2               zImage
rootfs.initramfs          System.map.initramfs.gz    zImage.initramfs.gz
[root@centos036 images]# nios2-download -g linux.initramfs.gz
Using cable "USB-Blaster [USB 4-1.1]", device 1, instance 0x00
Pausing target processor: OK
Initializing CPU cache (if present)
OK
Downloaded 6286KB in 54.7s (114.9KB/s)
Verified OK
Starting processor at address 0xC8000000
[root@centos036 images]#
```

11. Type the following command to open the Nios II terminal.

    `#nios2-terminal`

    Now, this is the embedded Linux running on the 4SGX230 FPGA.We have downloaded the hardware design with the Nios II processor first and then downloaded the image with the kernel and drivers.

Figure 4-4. Running Linux on the Board



```
CMD52 Timeout error
CMD8 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD55 Timeout error
CMD55 Timeout error
CMD55 Timeout error
CMD55 Timeout error
CMD1 Timeout error
Welcome to
 _   _ _           ___ ___   _      _
| \ | (_) ___  ___|_ _|_ _| | |    (_)_ __  _   ___  __
|  \| | |/ _ \/ __|| | | |  | |    | | '_ \| | | \ \/ /
| |\  | | (_) \__ \| | | |  | |___ | | | | | |_| |>  <
|_| \_|_|\___/|___/___|___| |_____||_|_| |_|\__,_/_/\_\


BusyBox v1.16.2 (2010-11-01 10:31:14 IST) hush - the humble shell
Enter 'help' for a list of built-in commands.

/ #
```

12. Type **ls** to see the directory contents. Similarly we can use the commands like cd, password and other in the same way as we use in Linux. See Figure 4-5.

Login:

Username: **root**

Password: **nios2linux**

Figure 4-5. Running ls Command

13. Type the following command to locate the **hello application** in the **bin** folder.

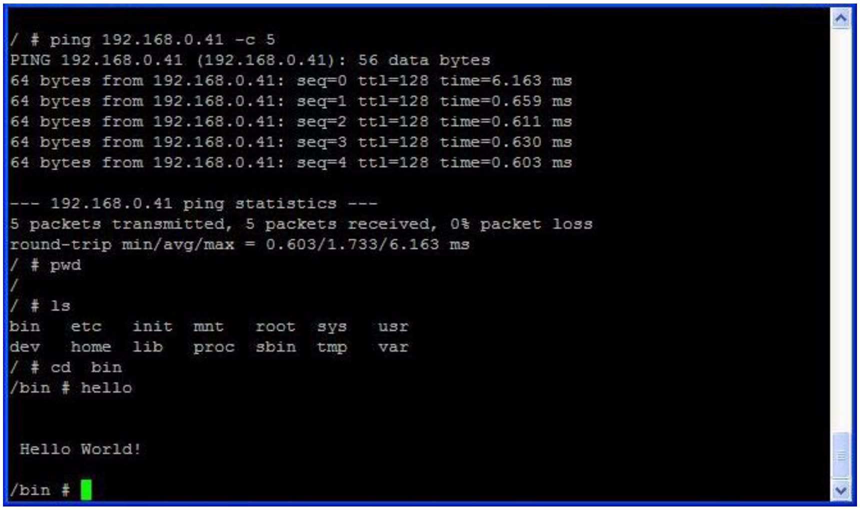
    `cd bin`

14. Type the following to run the application.

    `hello`

15. The message `"Hello World!"` will be displayed on the terminal. See Figure 4-6.

Figure 4-6. Running User Application



Now you have learned how to create your own custom application.You can go back and modify your application, compile the kernel again and download the modified image again to run your custom application. The next chapter will explain you about modifying the kernel settings.

5. Customizing the Kernel

Generate a System Header File

Your hardware design has fixed peripheral component base addresses, which the Linux device drivers access through a static header file called **custom_fpga.h**. This file must be regenerated manually, each time the system memory map changes.

When you make any changes to the hardware design using the SOPC Builder tool, it automatically generates a .**sopcinfo** file after you recompile the hardware design. The .sopcinfo file contains information on the hardware design, including the system memory map. You must manually run the **sopc-create-header-files** command on the **.sopcinfo** file in order to generate the **custom_fpga.h**.

You can learn more about the **sopc-create-header-files** with the --help option from the Nios II Command Shell as shown below:

Follow the steps below to generate a System Header file:

1. Locate the **.sopcinfo** file from
2. Type the following command to create **custom_fpga.h** file.
   ```
   sopc-create-header-files --single custom_fpga.h
   ```
3. Type following command to copy the **custom_fpga.h** file to asm folder.
   ```
   cp custom_fpga.h /home/sls/Nios2-linux/Linux_source/
   linux-2.6/arch/nios2/boards/4s230/include/asm
   ```

Configuring the Kernel

To configure the kernel, follow the steps mentioned below.

Linux Distribution Configuration

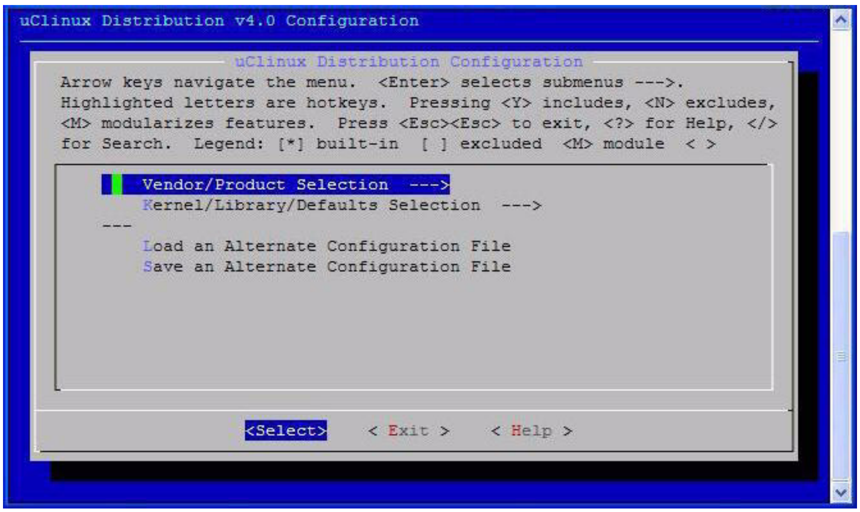
1. Set the Bintools path on your terminal.
   ```
   #PATH=$PATH:/home/sls/Nios2-Linux/BuildTools/
   toolchain-mmu/x86-linux2/bin
   ```
2. Build the Linux image.
   ```
   #cd /home/sls/Nois2-linux/Linux_source/uClinux-dist/
   ```

3. Type the following command to modify kernel settings.

```
#make menuconfig
```

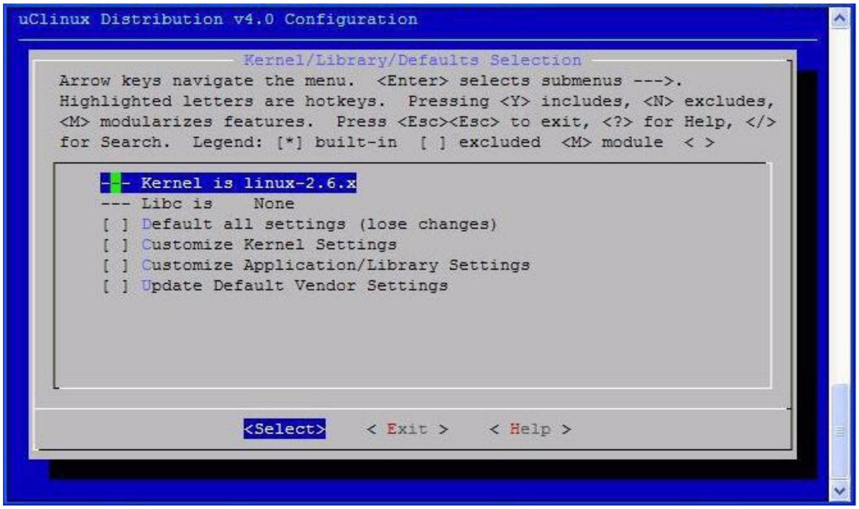
The **uClinux Distribution Configuration** dialog box opens. See Figure 5-1.

Figure 5-1. uClinux Distribution Configuration Dialog Box



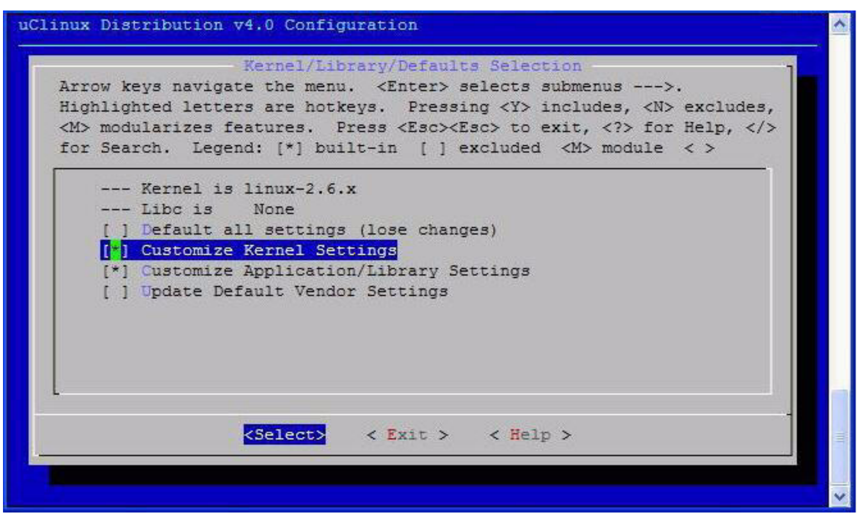
4. Press ↓ and select **Kernel/Library/Defaults Selection**.
5. Press **Enter**.
6. **Kernel/Library/Defaults Selection** dialog box appears. See Figure 5-2.

Figure 5-2. Kernel/Library/Defaults Selection



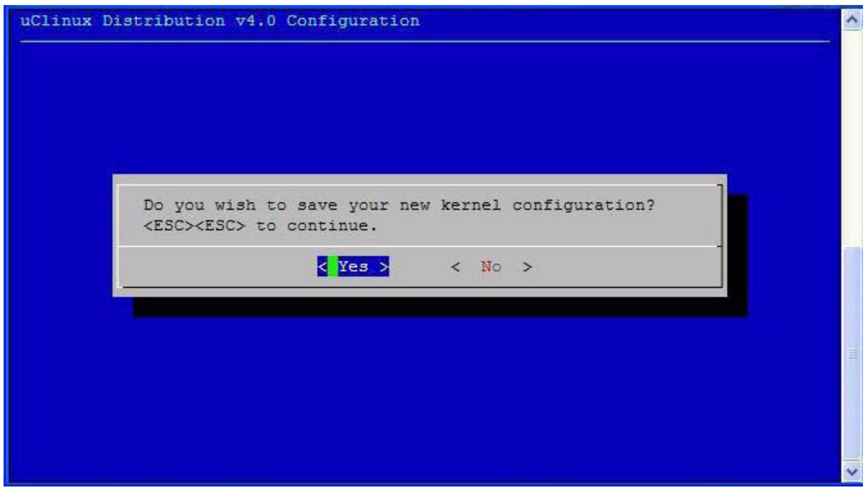
7. Select the following options: See Figure 5-3.
   - **Customize Kernel Settings**
   - **Customize Application/Library Settings**

Figure 5-3. Kernel/Library/Defaults Selection Configuration



8. Press **E** to exit.
9. You will return to the **uClinux Distribution Configuration** dialog box.
10. Press **E** to exit.
11. The **Save** dialog box opens.
12. Press **Y** to save the to the configuration. See Figure 5-4.

Figure 5-4. Saving Linux Distribution Configuration

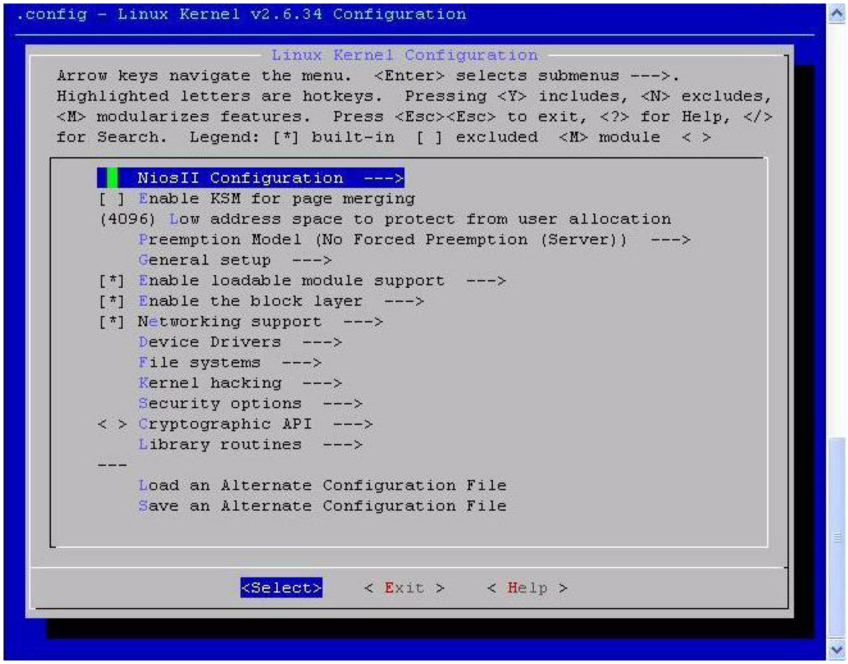


13. The **Linux Kernel Configuration** window opens. See Figure 5-5.

Linux Kernel Configuration

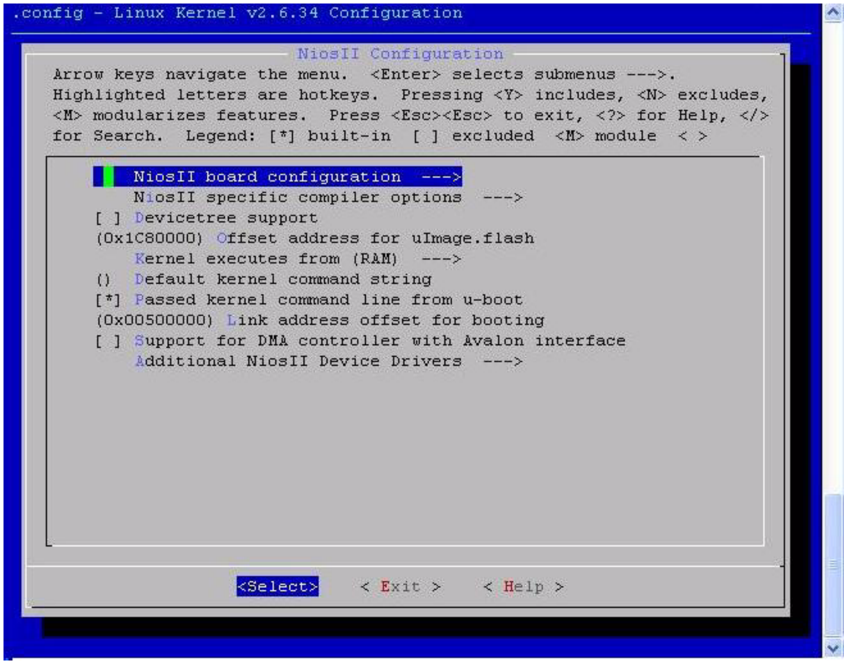
14. Select the following options:
    - **Enable loadable module support**
    - **Enable the block layer**
    - **Networking support**

Figure 5-5. Linux Kernel Configuration Window



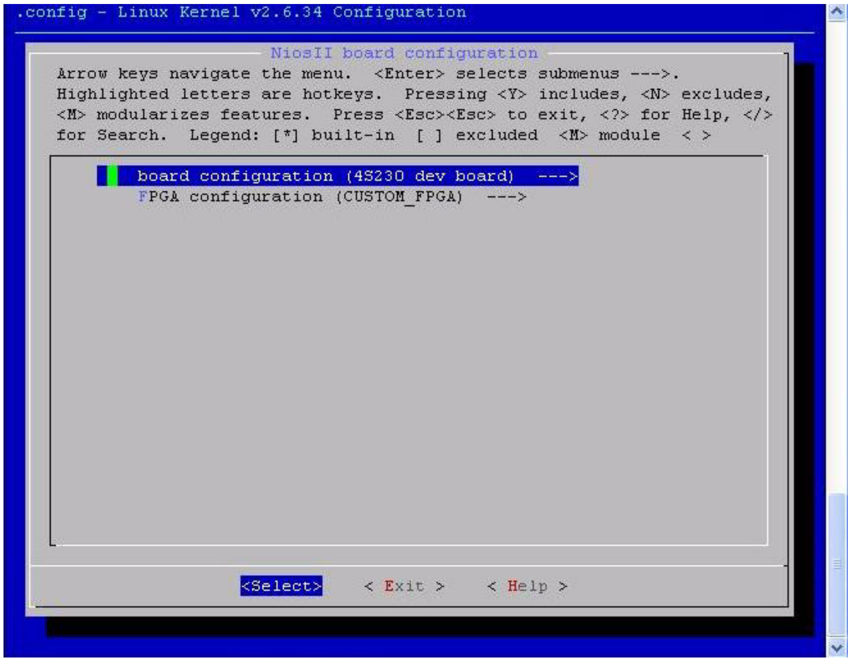
15. Select **NiosII Configuration**.
16. Select **Nios II board configuration**. See Figure 5-6.

Figure 5-6. NiosII Configuration Window



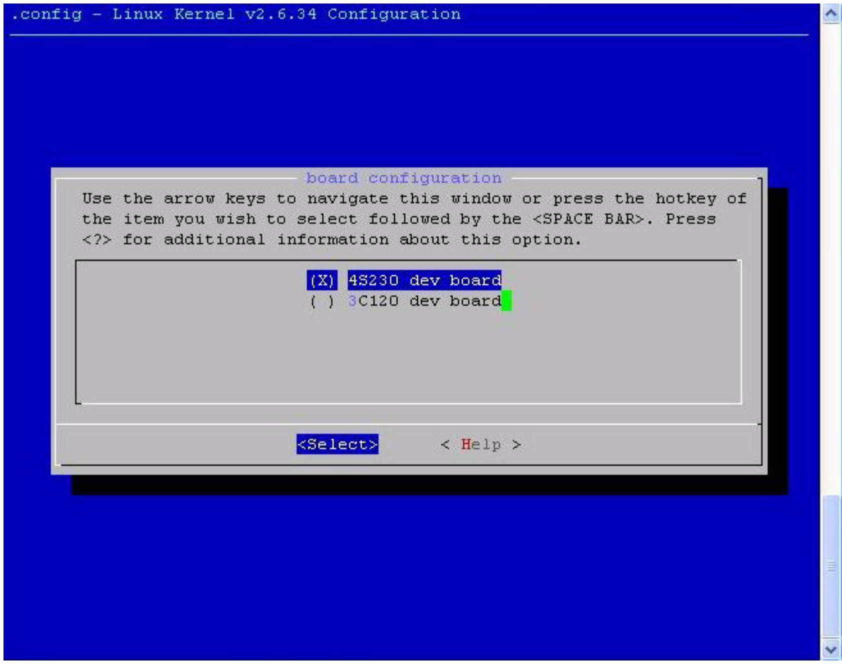
17. Select **board configuration (4S230 dev board)**. See Figure 5-7.

Figure 5-7. Nios II Board Configuration Window



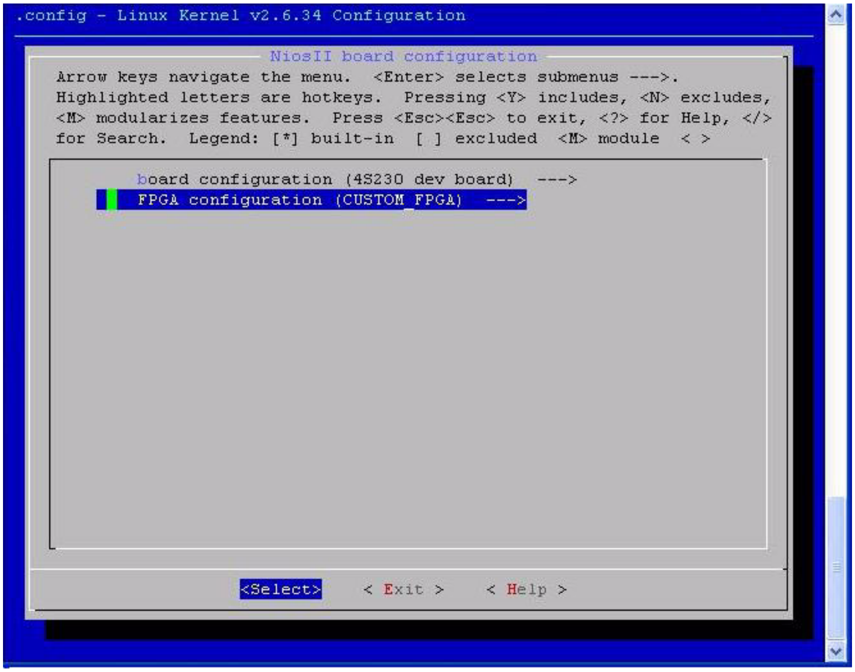
18. Select **4S230 dev board**. See Figure 5-8.

Figure 5-8. Board Configuration Window



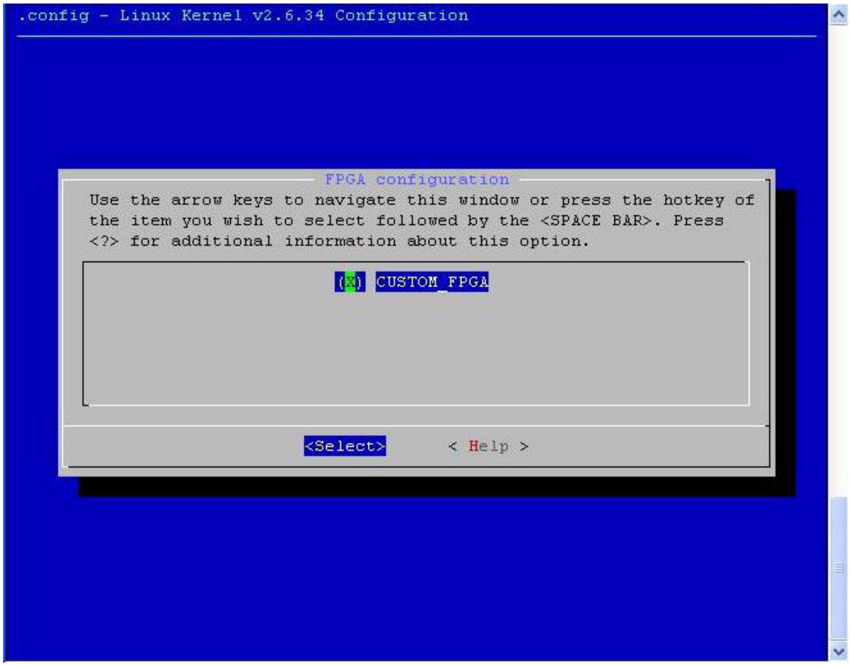
19. Press **Enter**. You will return to **Nios II board configuration** dialog box.
20. Select **FPGA configuration (CUSTOM_FPGA)**.
    See Figure 5-9.

Figure 5-9. FPGA Configuration (CUSTOM_FPGA) Selection



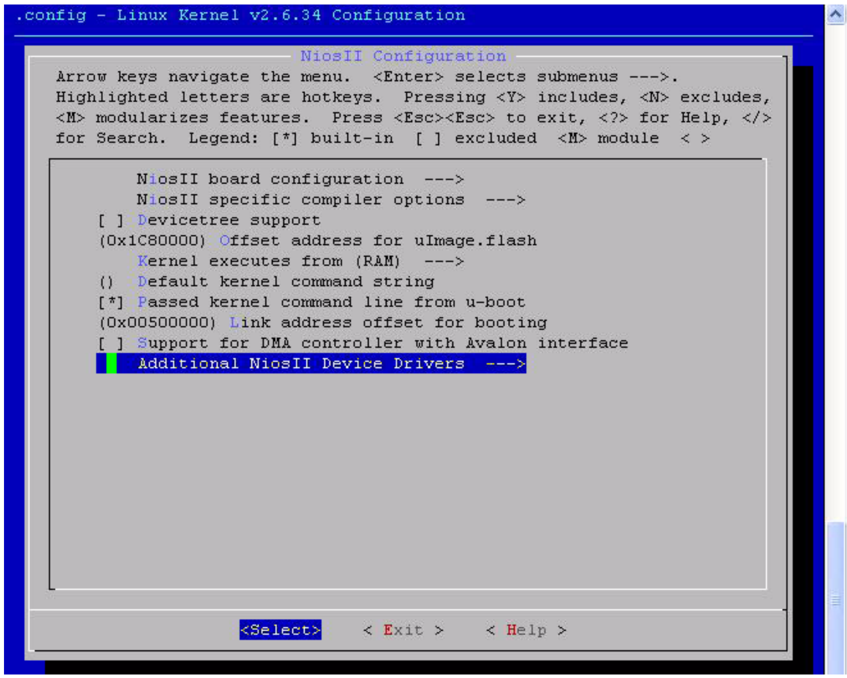
21. Select **CUSTOM_FPGA**. See Figure 5-10.

Figure 5-10. FPGA Configuration Settings



22. Press **Enter**. You will return to **Nios II board configuration** dialog box.
23. Press **<Esc> <Esc>,** you will return to **NiosII configuration** page.
24. Select **Additional NiosII Device Drivers**. See Figure 5-11.

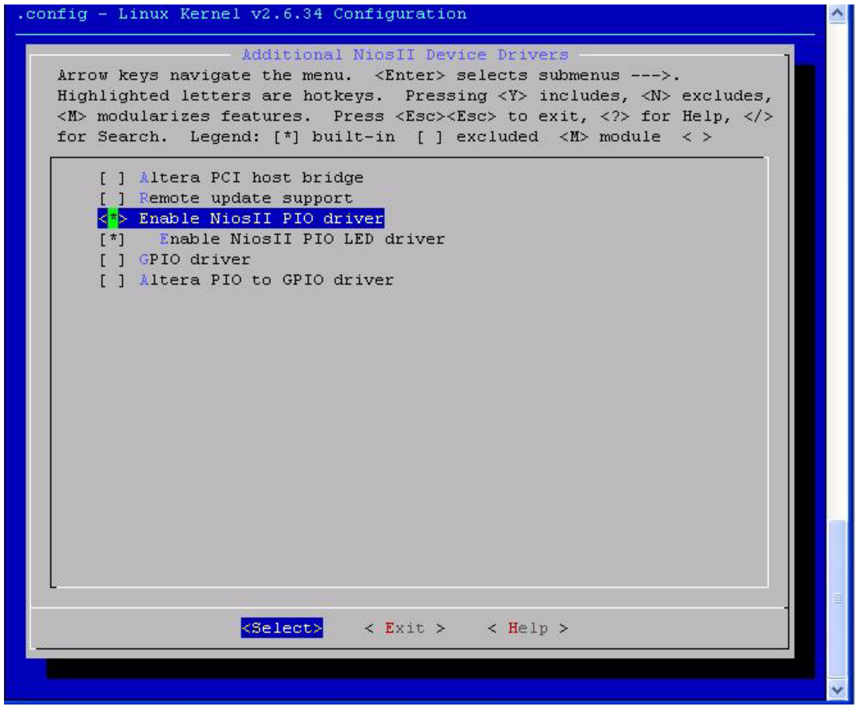
Figure 5-11. Additional NiosII Device Drivers Selection



25. Select following options: See Figure 5-12.

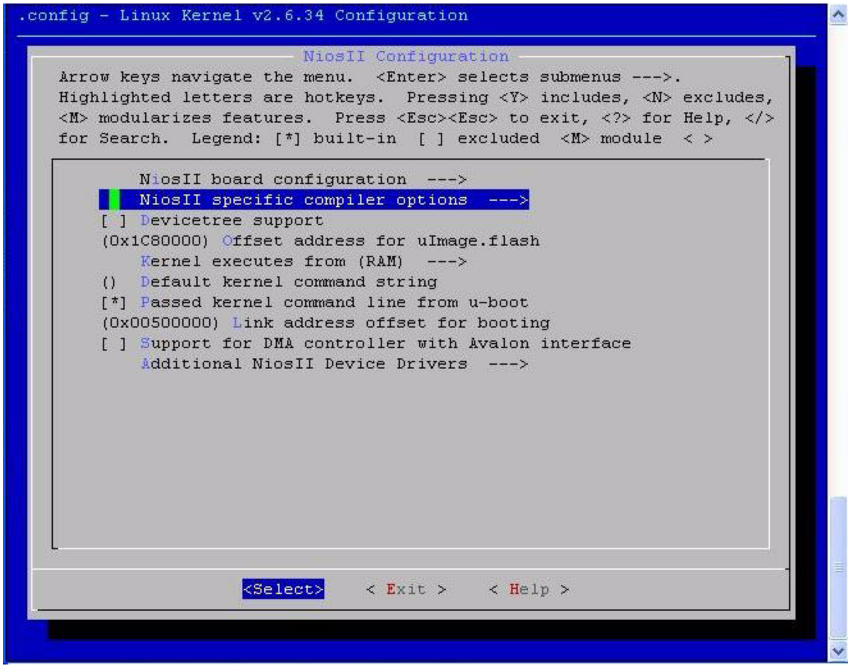
- **Enable NiosII PIO driver**
- **Enable NiosII PIO LED driver**

Figure 5-12. Enable NiosII PIO Driver Selection



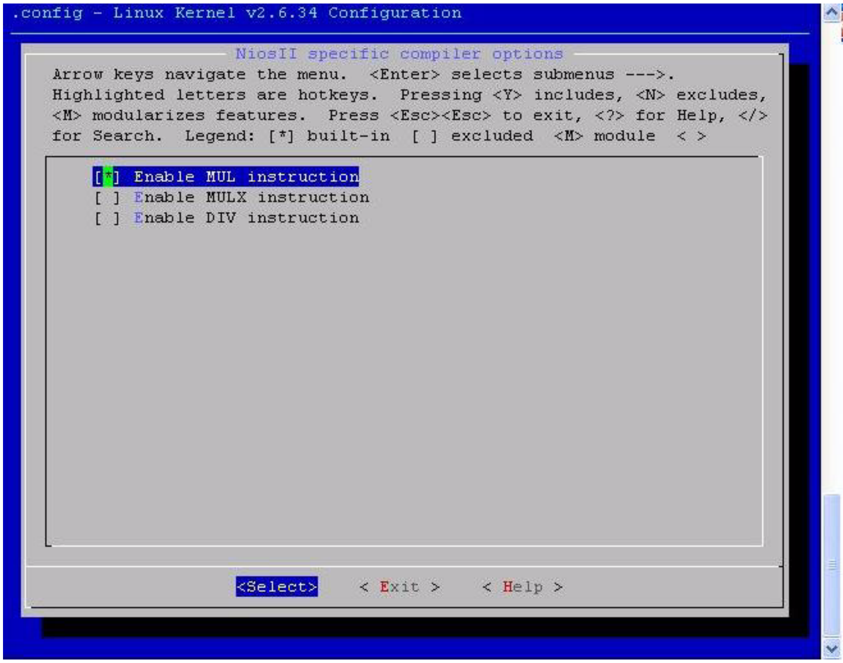
26. Press **Enter**.
27. Press **<Esc> <Esc>**, you will return to **NiosII configuration** page. See Figure 5-6.
28. Select **NiosII specific compiler options**. See Figure 5-13.

Figure 5-13. NiosII Specific Compiler Options Selection



29. Select **Enable MUL instruction**. See Figure 5-14.

Figure 5-14. Enable MUL Instruction Selection

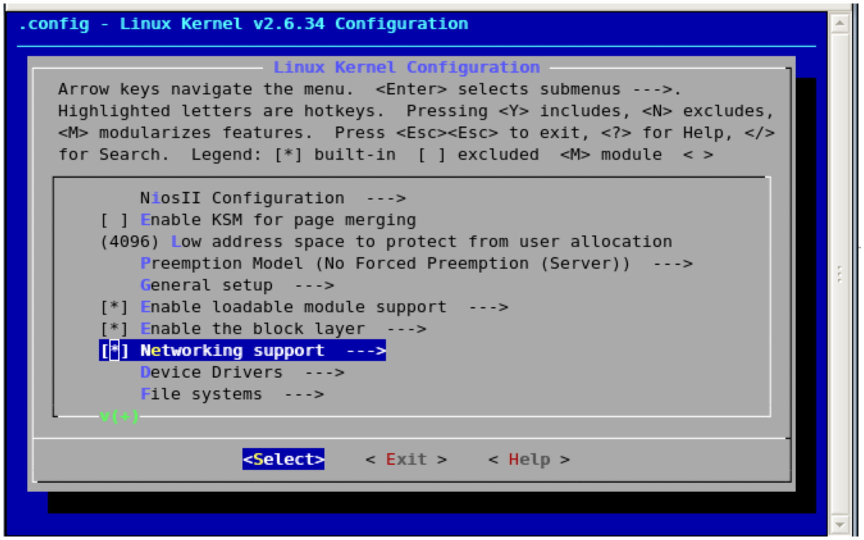


30. Press **<Esc> <Esc>**, you will return to **NiosII configuration** page. See Figure 5-6.

31. Press **<Esc> <Esc>**, you will return to **Linux Kernel configuration** page. See Figure 5-5.

32. See Figure 5-15. Select **Networking Support**.

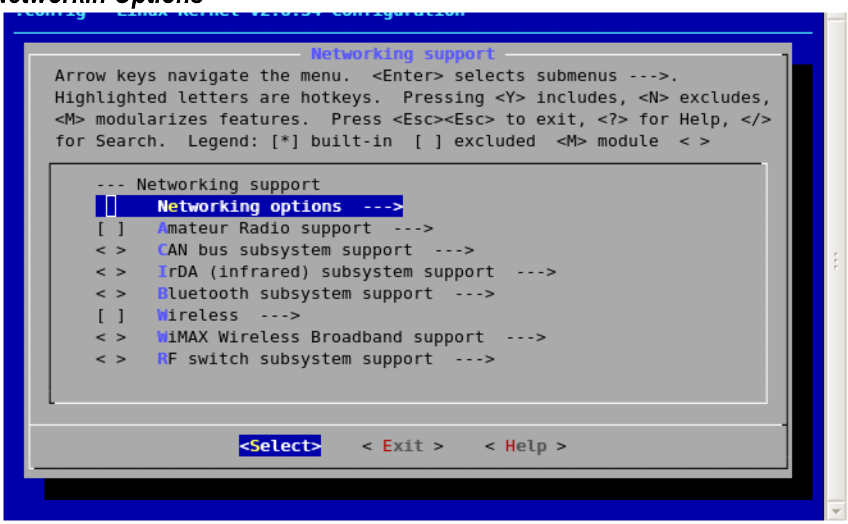
Figure 5-15. Networking Support



33. The **Networking support** dialog box opens. See Figure 5-16.

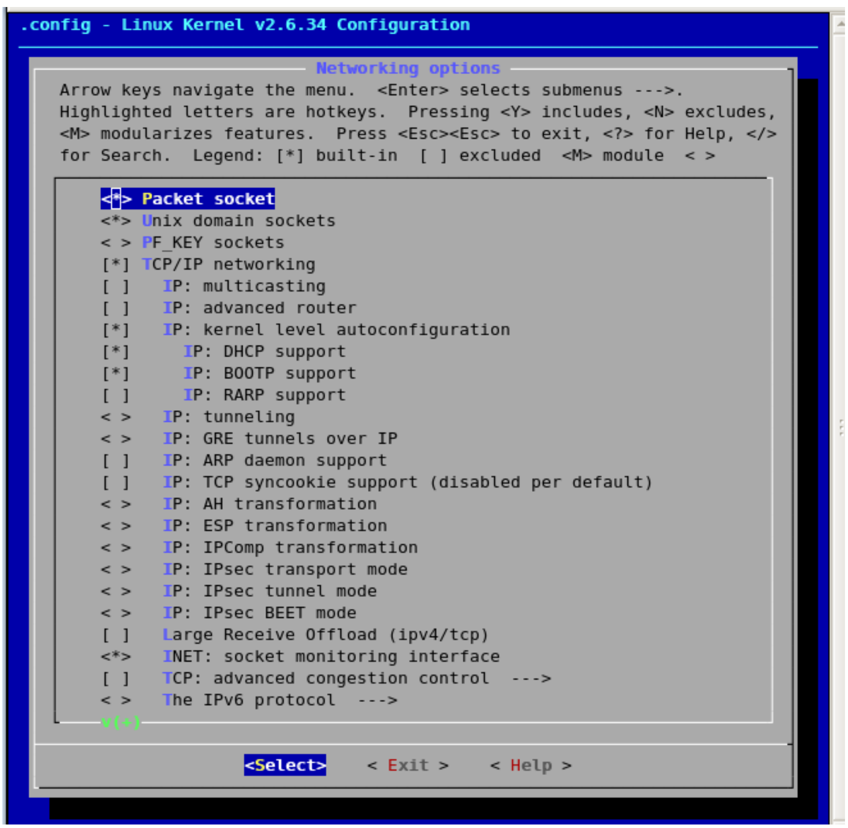
34. Select **Networking Options**

Figure 5-16. Networkin Options



35. Press **Enter**.
36. The Networking Options dialog box opens. See Figure 5-17.
37. Select the following options:
    - **Packet socket**
    - **Packet socket: mmapped IO**
    - **Unix domain sockets**
    - **TCP/IP networking**
    - **IP: kernel level autoconfiguration**
    - **IP: DHCP support**
    - **BOOTP support**
    - **INET: socket monitoring interface**

Figure 5-17. Networking Options (2)



38. Press **<Esc> <Esc>**.

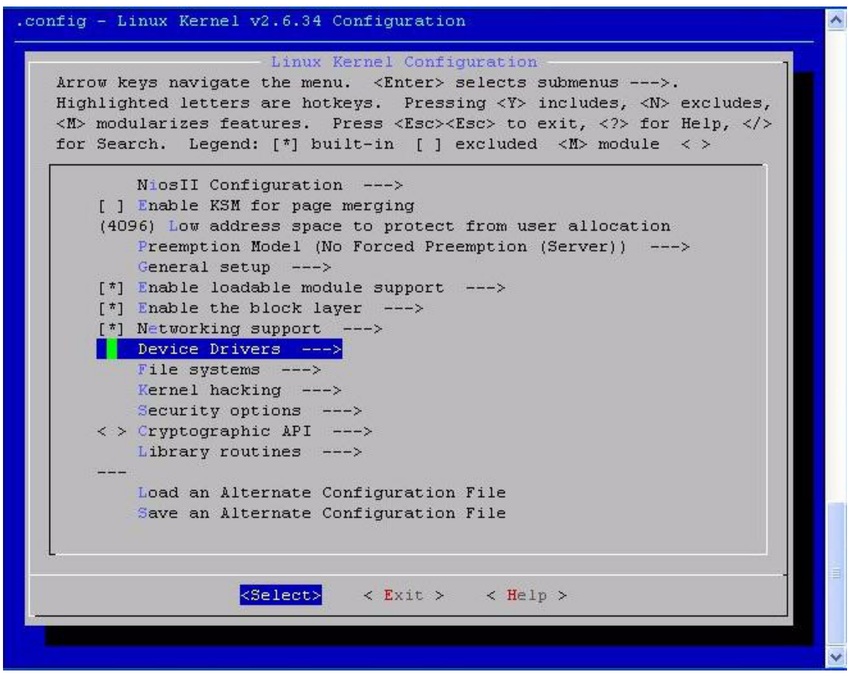
39. Press **<Esc> <Esc>**.

40. You will return to **Linux Kernel configuration page** dialog box.

Device Drivers Configuration

See Figure 5-18.

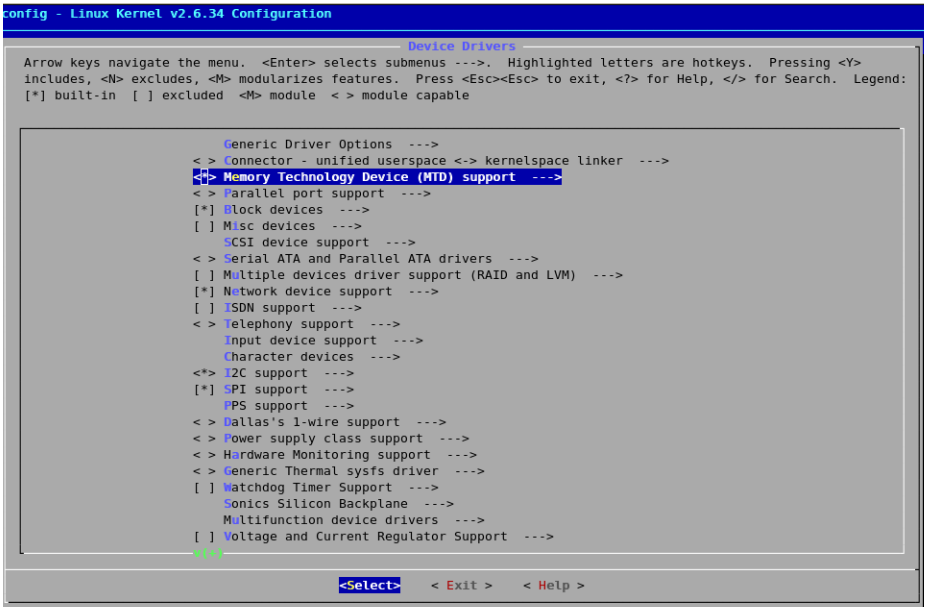
Figure 5-18. Device Drivers



41. Select the following options. See Figure 5-19.
    - **Memory Technology Device (MTD) support**
    - **Block devices**
    - **Network device support**
    - **I2C Support**
    - **SPI Support**
    - **USB Support**

- **MMC/SD/SDIO card Support**

Figure 5-19. Memory Technology Device (MTD) Support (1)

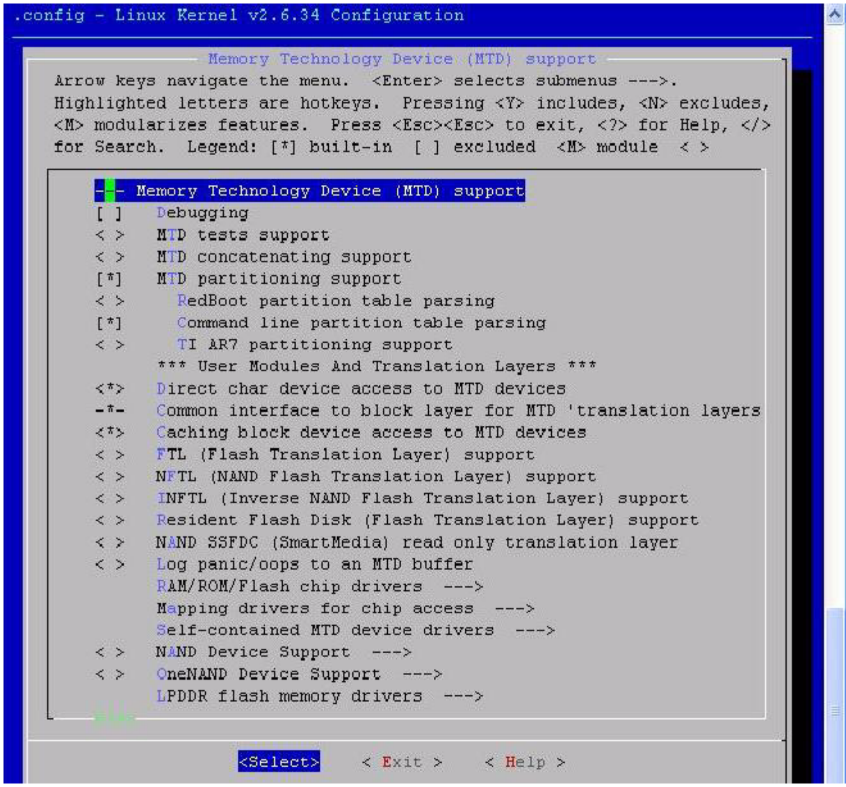


Memory Technology Device (MTD) support

42. Select **Memory Technology Device (MTD)** support.

43. MTD support is used for **JFFS2 File system to create Flash** partitions. See Figure 5-20.

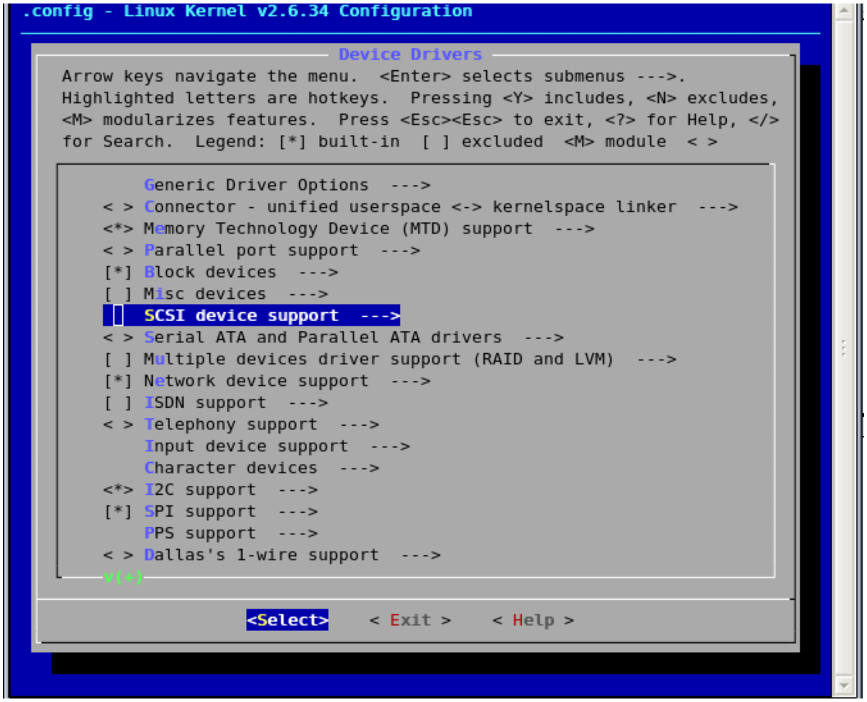
Figure 5-20. Memory Technology Device (MTD) Support (2)



SCSI Device Support

44. Needs for USB Storage device support. See Figure 5-21.

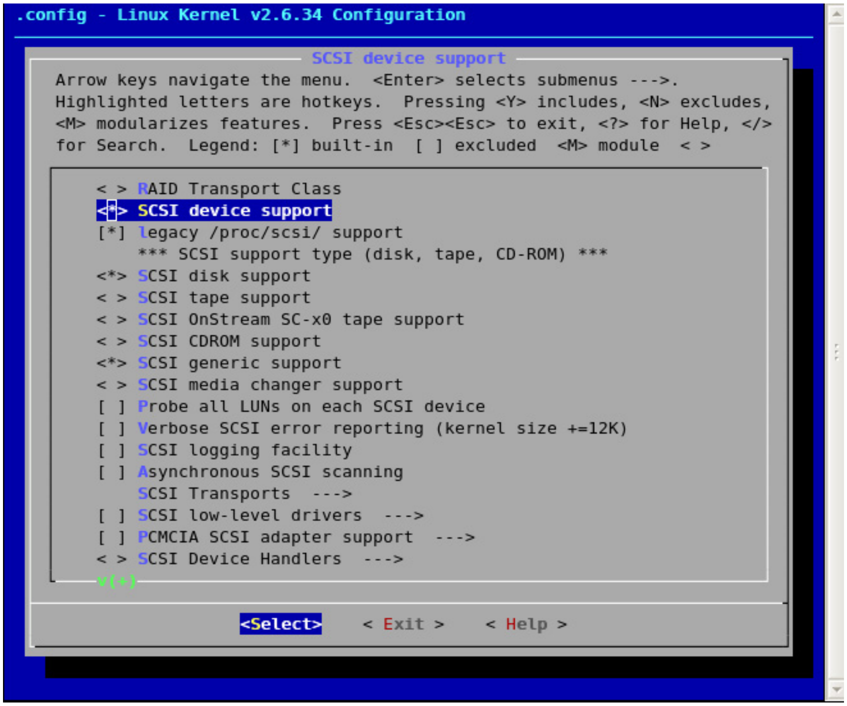
Figure 5-21. SCSI Device Support (1)



45. Select following options:

- **SCSI device support**
- **SCSI disk support**
- **SCSI generic support** See Figure 5-22.

Figure 5-22. SCSI Device Support (2)

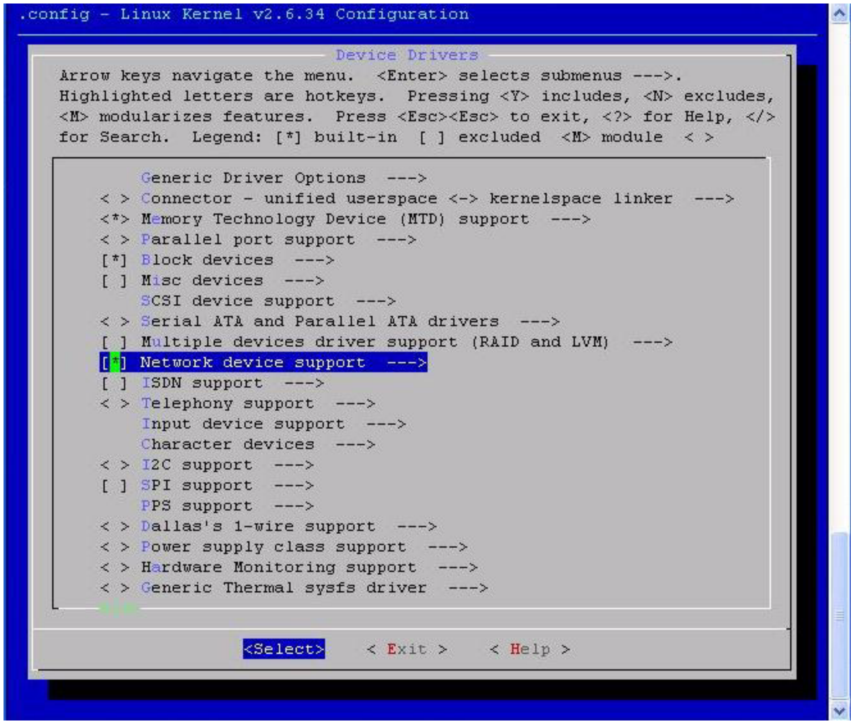


Network Device Support

46. The **Device Drivers** dialog box opens. See Figure 5-23.

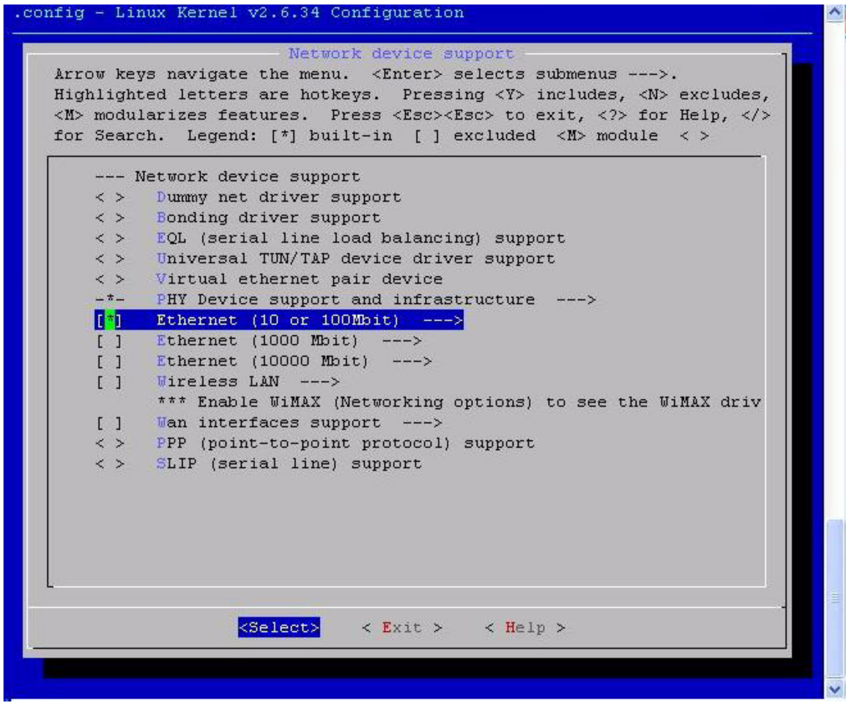
47. Select **Network device** support.

Figure 5-23. Device Drivers Configuration



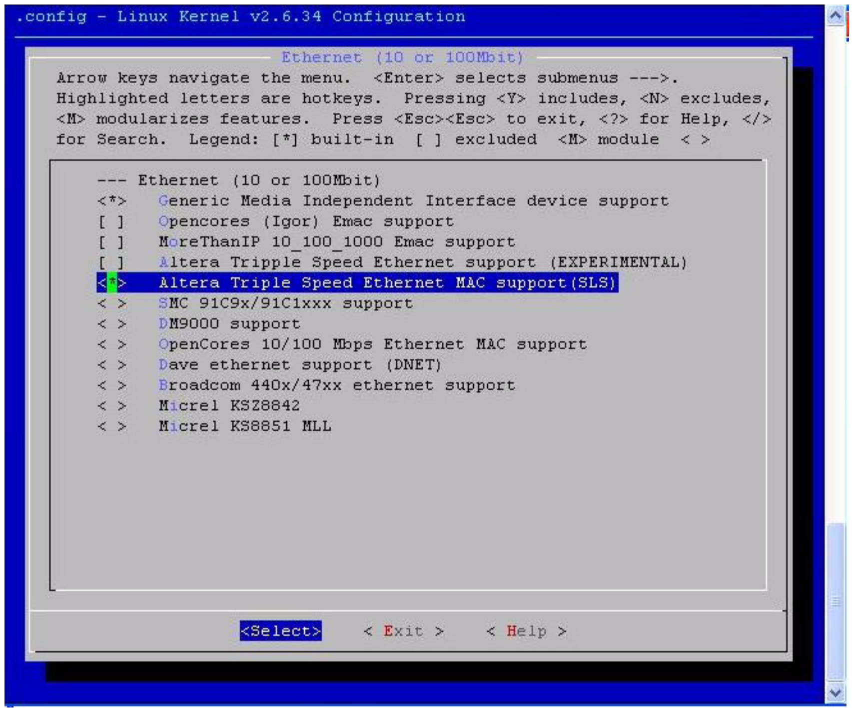
48. Press **Enter**.
49. The **Network Device Support** dialog box opens. See Figure 5-24.
50. Select **Ethernet (10 or 100Mbit)**.

Figure 5-24. Network Device Support Configuration



51. Press **Enter**.
52. The **Ethernet (10 or 100Mbit)** dialog box opens. See Figure 5-25.
53. Select **Altera Triple Speed Ethernet MAC support (SLS)**.
54. Press **<Esc> <Esc>**.
    Press **<Esc> <Esc>**.

Figure 5-25. Ethernet (10 or 100Mbit) Dialog Box

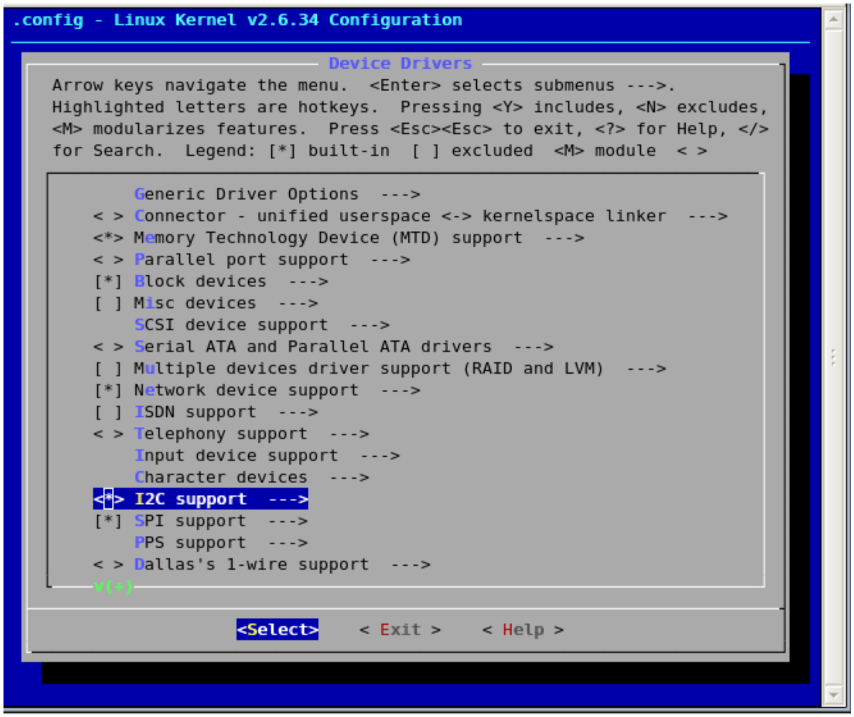


I2C Support

55. I2C support is used for **I2C** based **EEPROM** device and **Audio** and **TV** based on **SLS I2C IP**. See Figure 5-26.

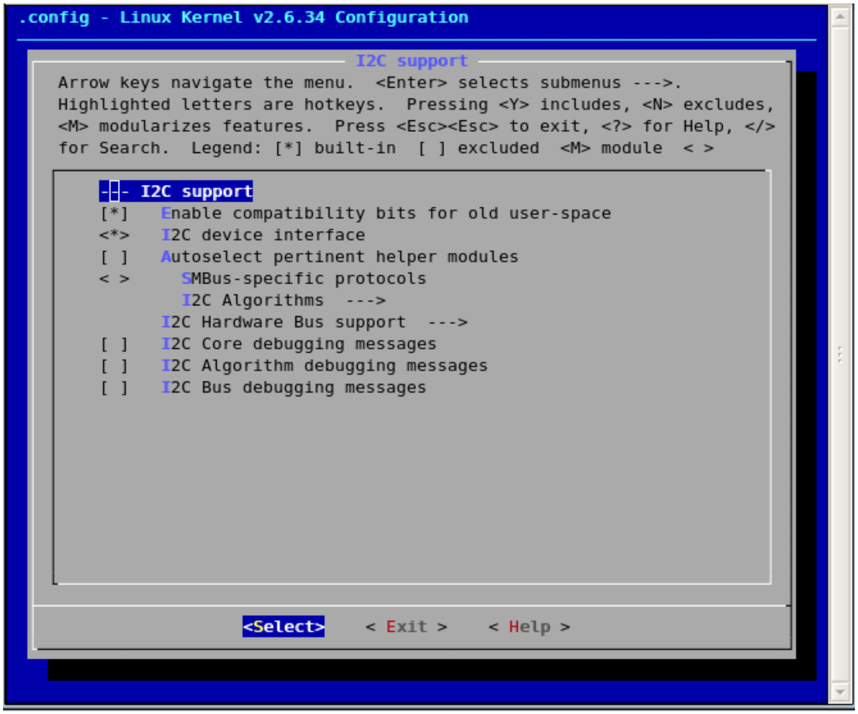
56. Select **I2C Support**

Figure 5-26. I2C Device Support



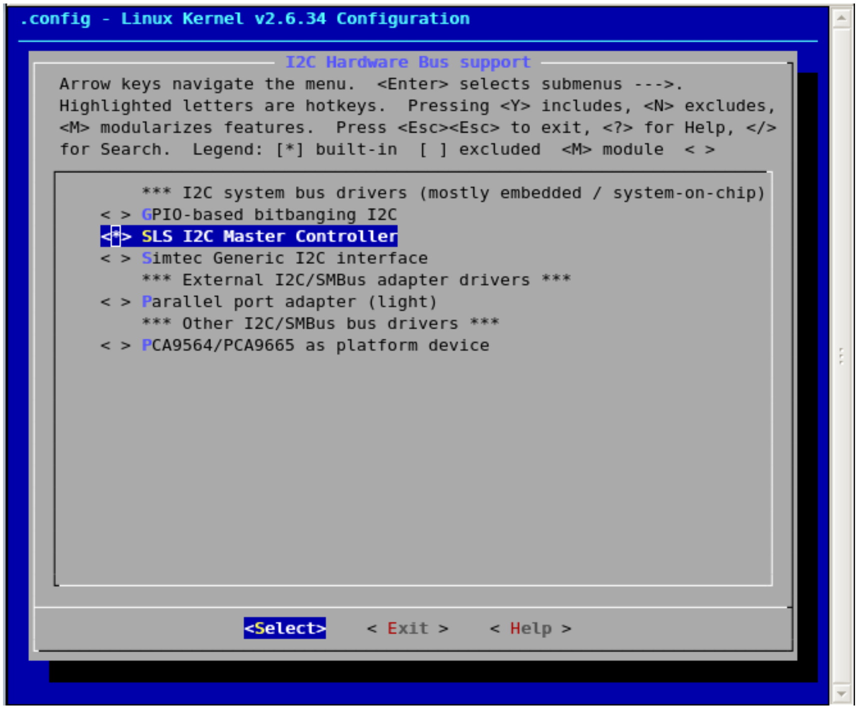
57. Select **I2C Hardware Bus Support**. See Figure 5-27.

Figure 5-27. I2C Hardware Bus Support.



58. I2C Hardware Bus Support. Select **SLS I2C Master Controller**. See Figure 5-28.
59. Press **<Esc> <Esc>**.
60. Press **<Esc> <Esc>** to go Device Driver selection menu.

Figure 5-28. SLS I2C Master Controller

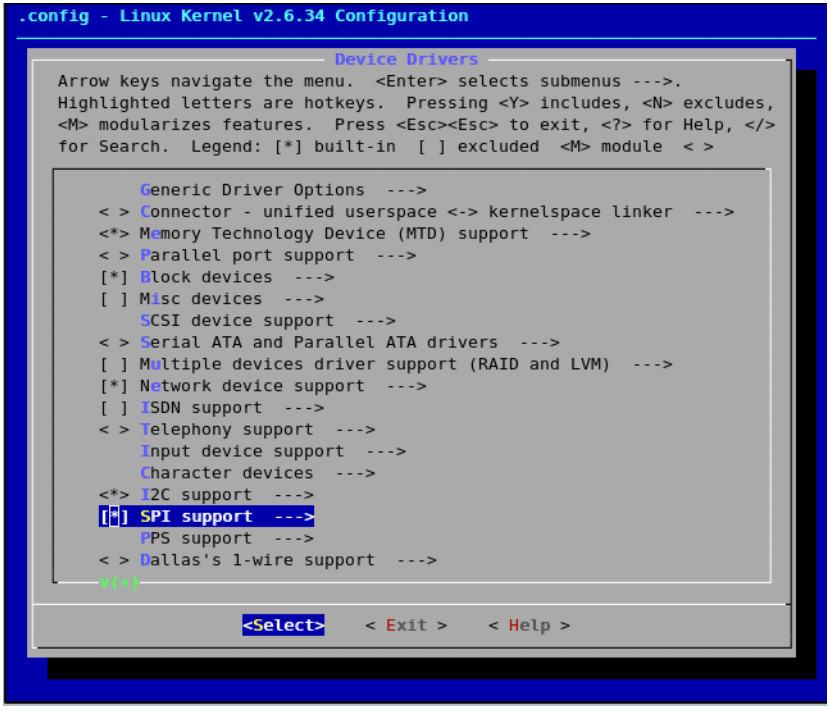


SPI Support

61. SPI support is used **SPI based Touch Panel** and **Flash**.

62. Select **SPI Support**. See Figure 5-29.

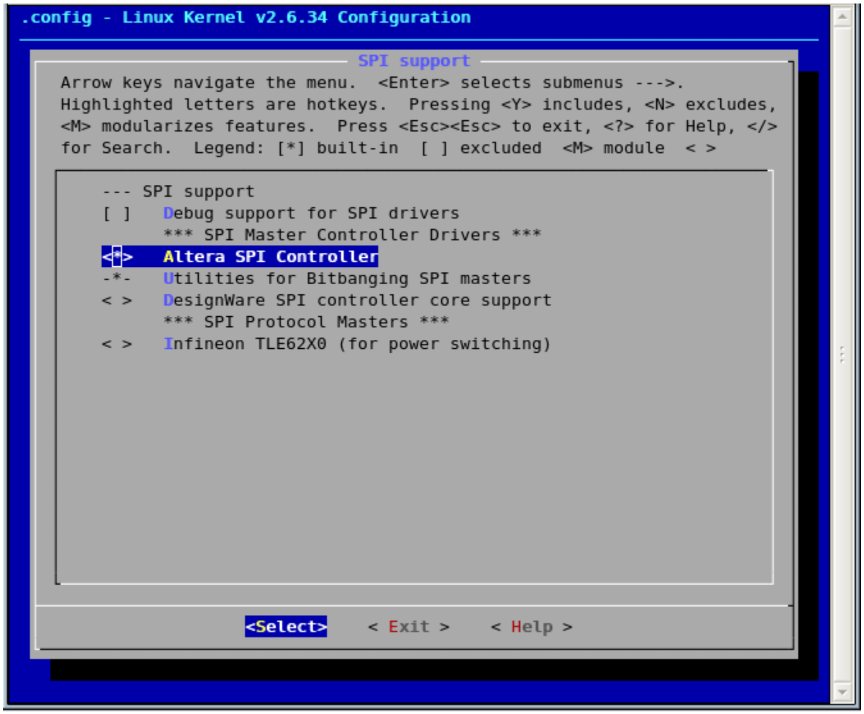
Figure 5-29. SPI Support



63. Select **Altera SPI Controller**. See Figure 5-30.

64. Press **<Esc> <Esc>** to go Device Driver selection menu.

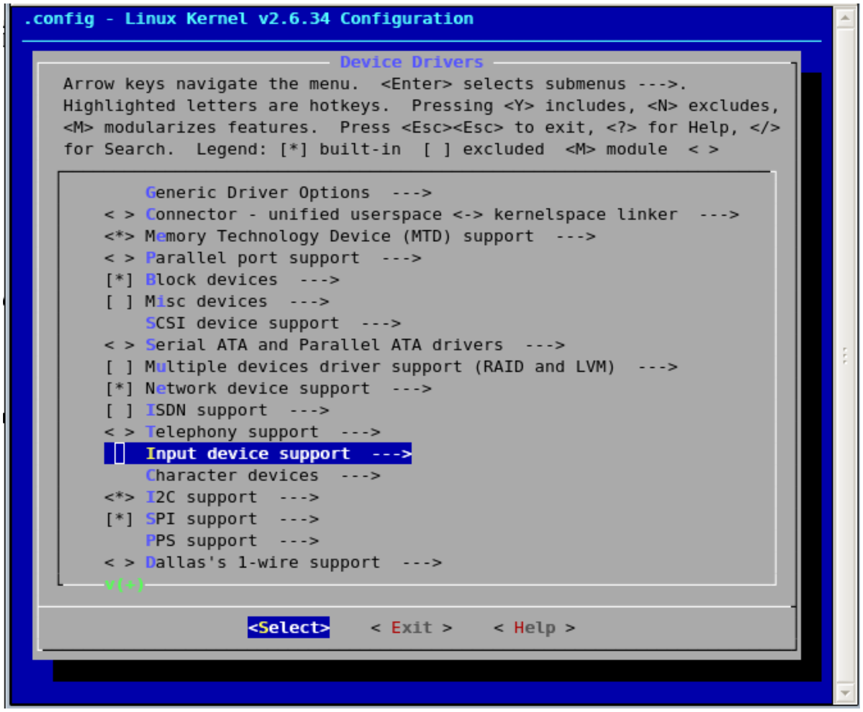
Figure 5-30. Altera SPI Controller



Input Device Support

65. Support for input devices like **PS2 keyboard** and **Touch Panel controller**. See Figure 5-31.

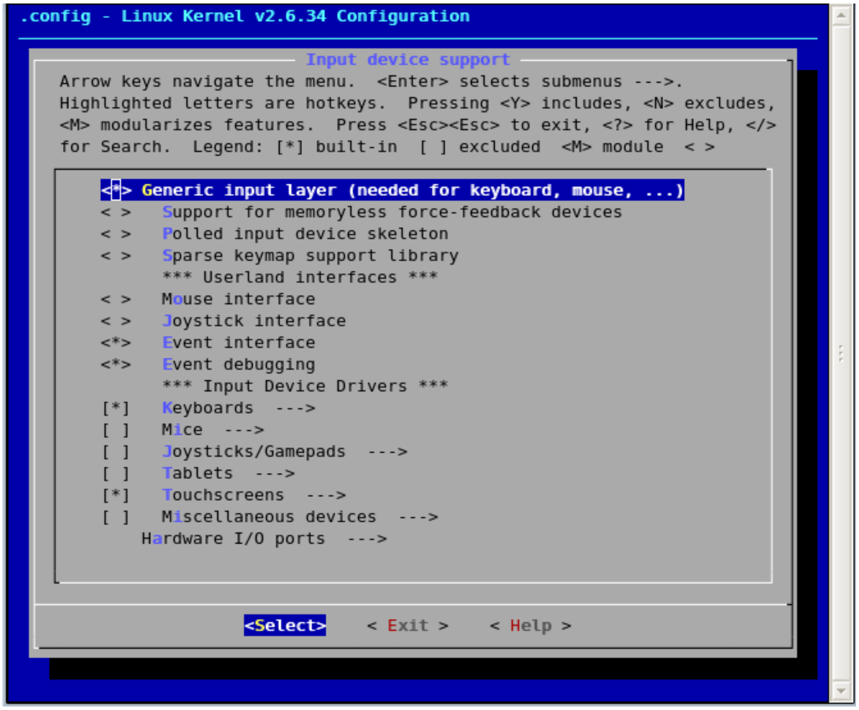
Figure 5-31. Input Device Support



66. Select following options: See Figure 5-32.

- **Generic input layer (needed for keyboard,mouse ...)**
- **Event interface**
- **Event debugging**

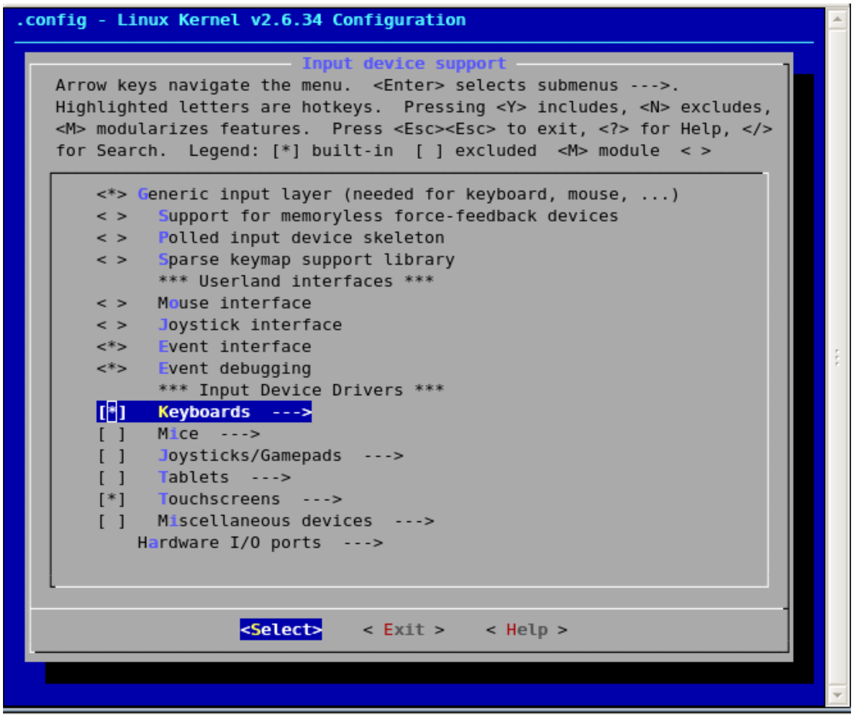
Figure 5-32. Input Device Support (1)



PS2 Keyboard Support

67. Select **Keyboards**. See Figure 5-33.

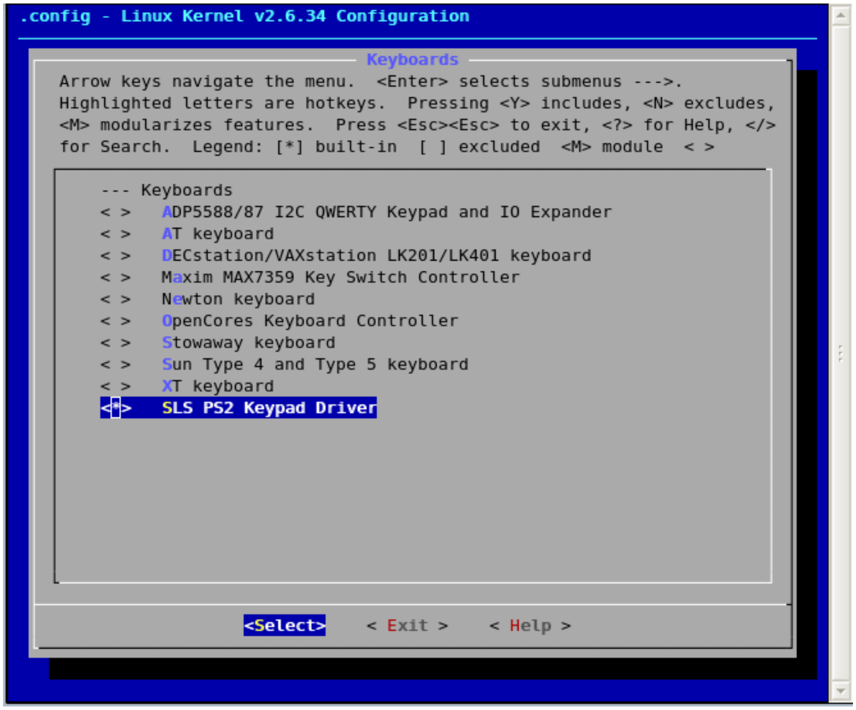
Figure 5-33. Keyboards



68. Select **SLS PS2 Keypad driver**. See Figure 5-34.

69. Press **<Esc> <Esc>**.

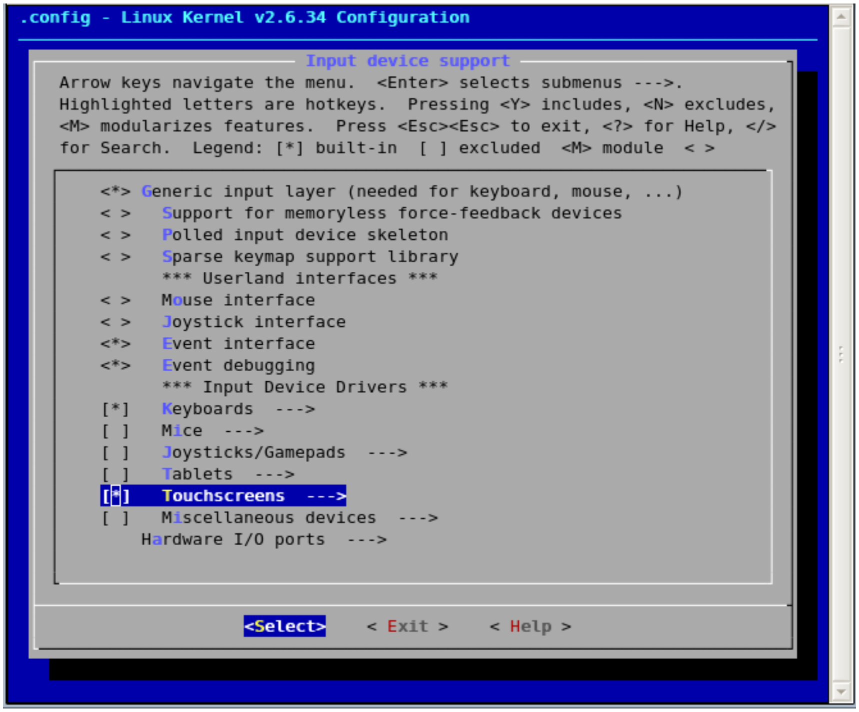
Figure 5-34. SLS PS2 Keypad Driver



Altera Touchscreen Support

70. Select **Touchscreens**. See Figure 5-35.

Figure 5-35. Touchscreens

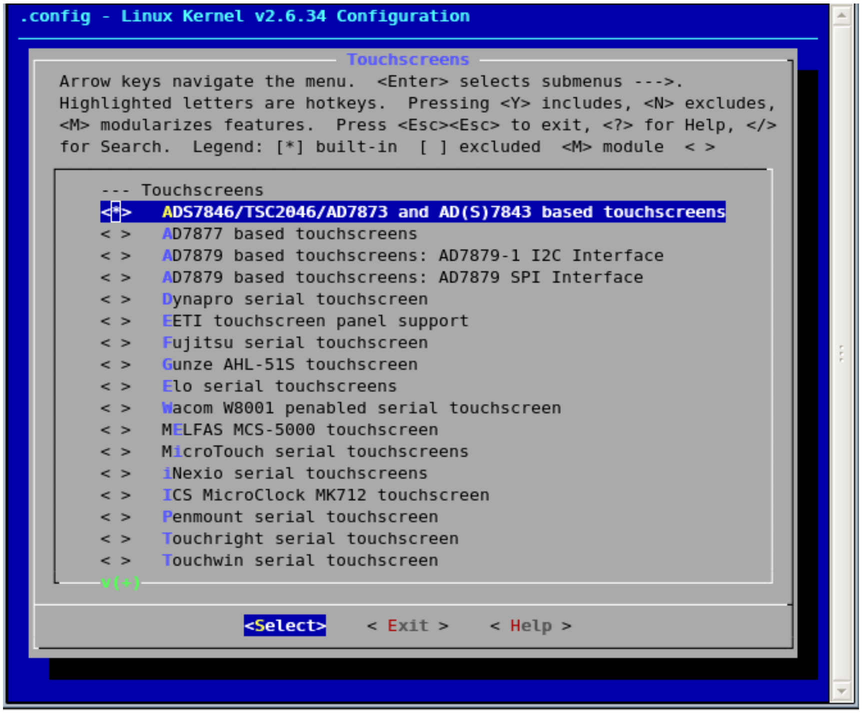


71. Select **ADS7846/TSC2046/AD7873** and **AD(S)7843** based **touchscreens**. See Figure 5-36.

72. Press **<Esc> <Esc>**.

73. Press **<Esc> <Esc>** to go Device Driver selection menu.

Figure 5-36. Based Touchscreens



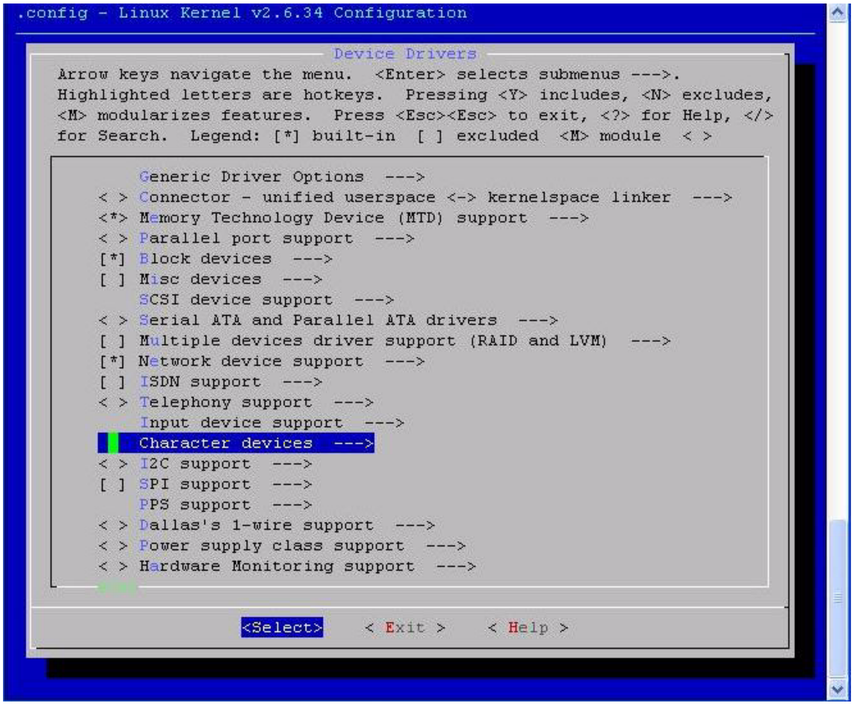
Character Devices

- **JTAG UART Support**
- **Serial UART support**
- **Button PIO support**

Configuring JTAG UART

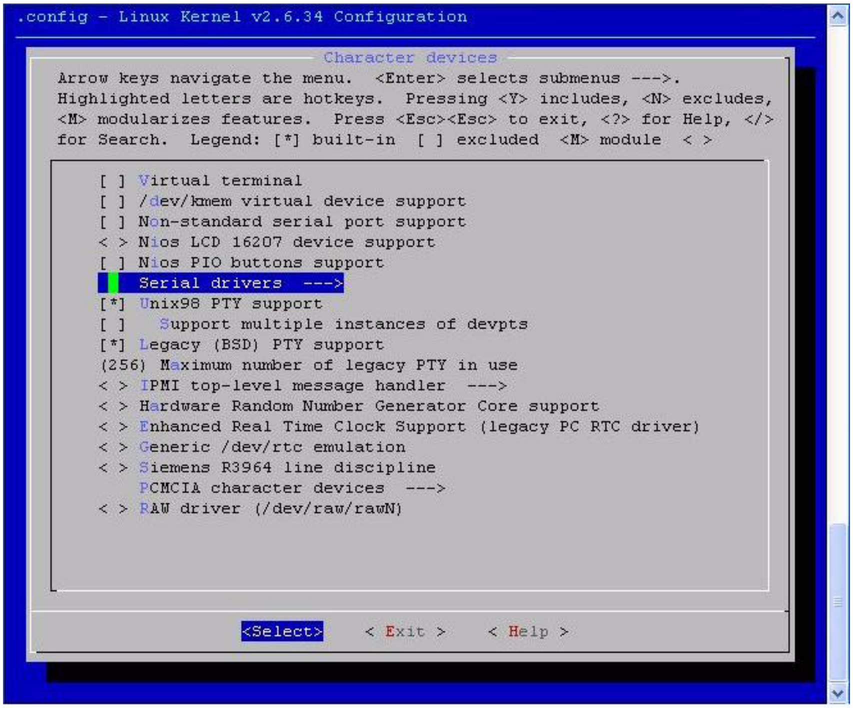
74. The **Device Drivers** dialog box opens. Select **Character devices.** See Figure 5-37.

Figure 5-37. Device Drivers Dialog Box



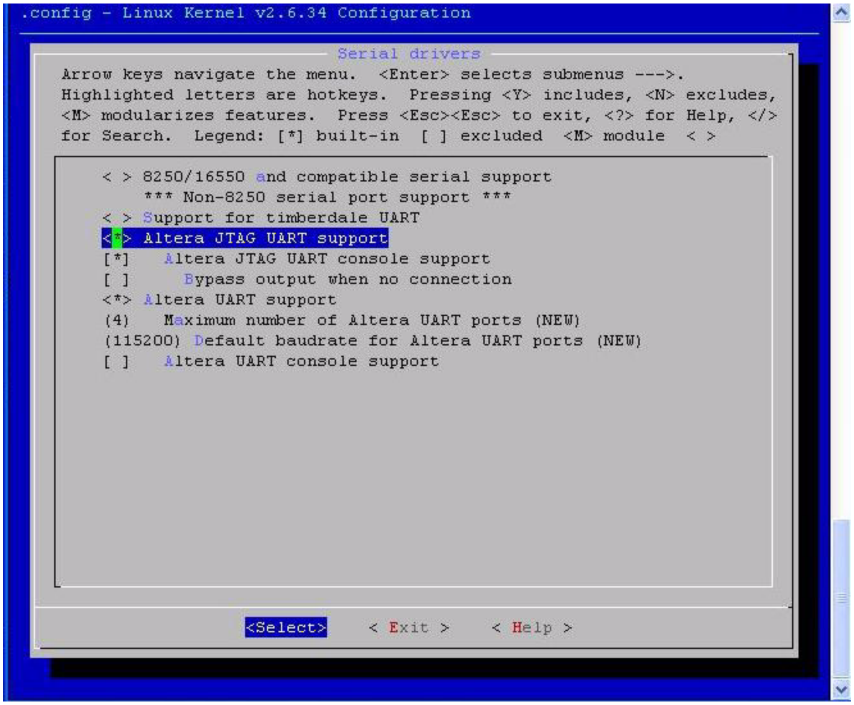
75. The **Character Devices** dialog box opens. See Figure 5-38.
   - Select **Serial drivers**.

Figure 5-38. Character Devices Configuration



76. For **JTAG UART**, select the following options: See Figure 5-39.
    - **Altera JTAG UART support**
    - **Altera JTAG UART console support**

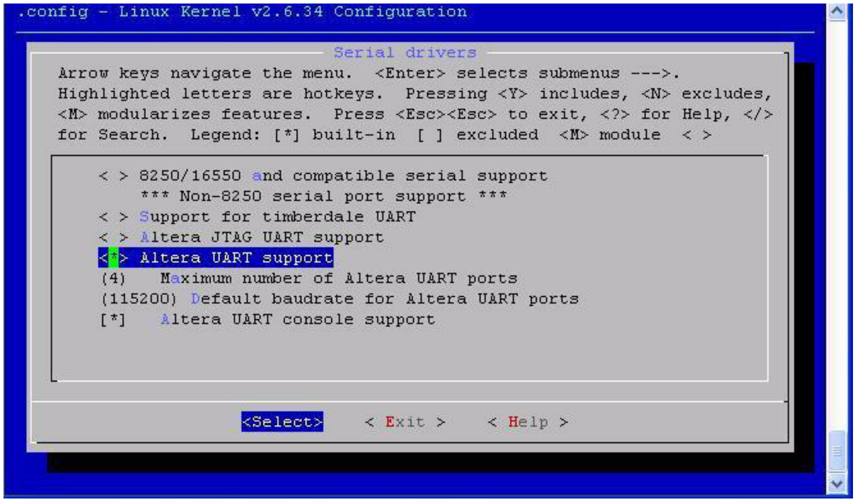
Figure 5-39. Serial Drivers Configuration



☞ If you want to use **UART** instead of JTAG UART then select the following options: See Figure 5-40.

- **Altera UART Support**
- **(4) Maximum number of Altera UART ports**
- **(115200) Default baudrate for Altera UART port**
- **Altera UART console support**

Figure 5-40. Altera UART support

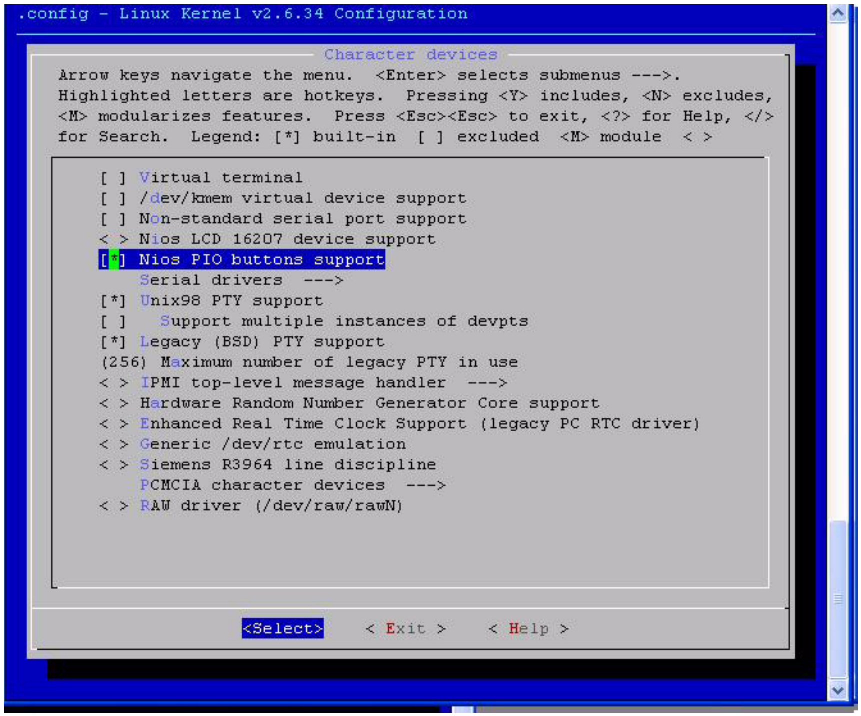


77. Press **<Esc> <Esc>**. You will return to **Character devices** dialog box.

Configuring PIO buttons

78. Select **Nios PIO button support**. See Figure 5-41.

Figure 5-41. Configuring PIO



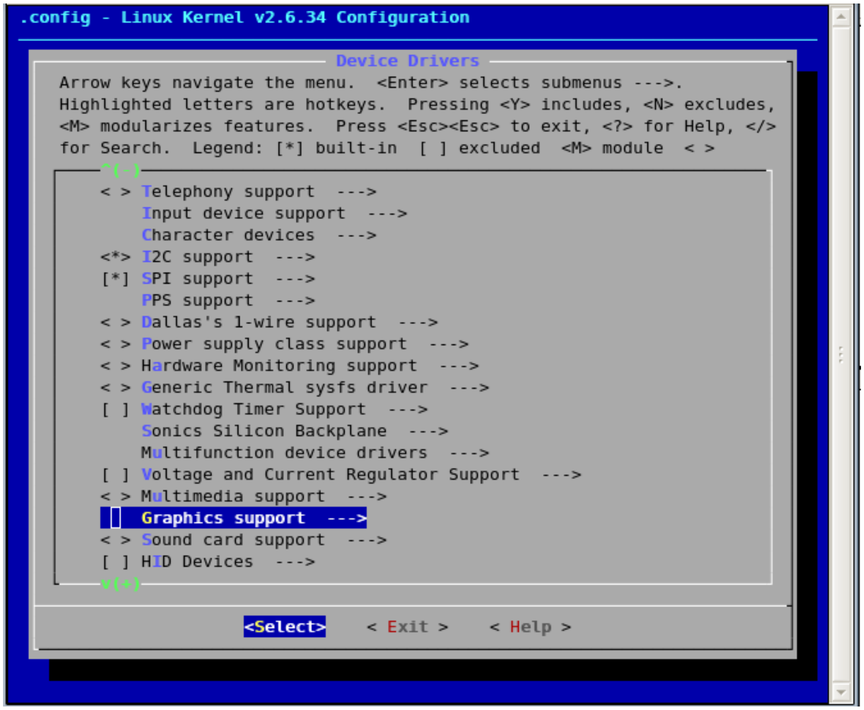
79. Press **<Esc> <Esc>**.
80. Press **<Esc> <Esc>**.
81. Press **<Esc> <Esc>**.
82. Press **Y** to save the configuration settings.
83. You will return to Linux terminal.

Graphics Support

- **LCD Support**

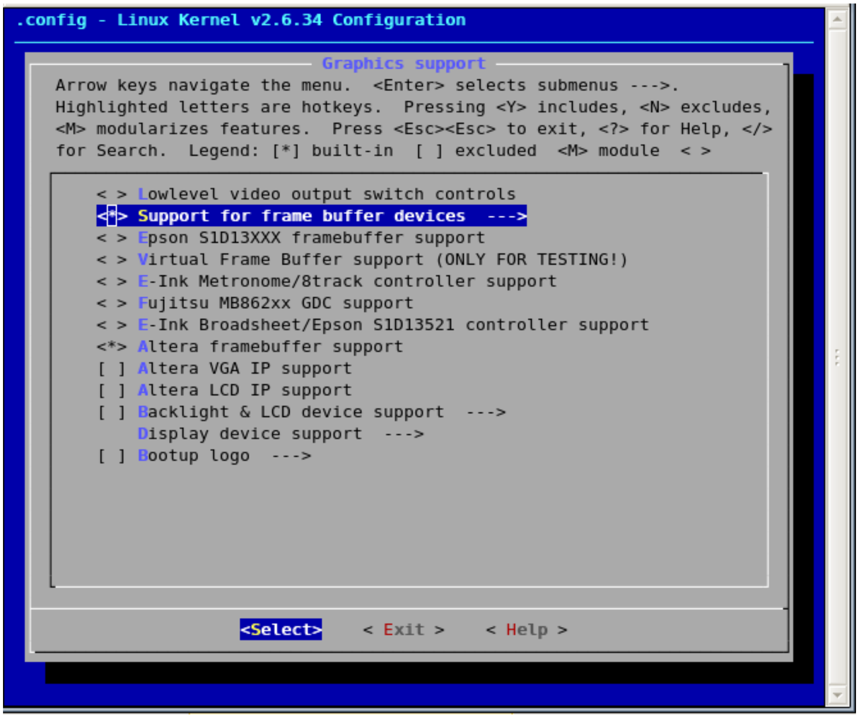
84. Select **Graphics Support**. See Figure 5-42.

Figure 5-42. Graphics Support



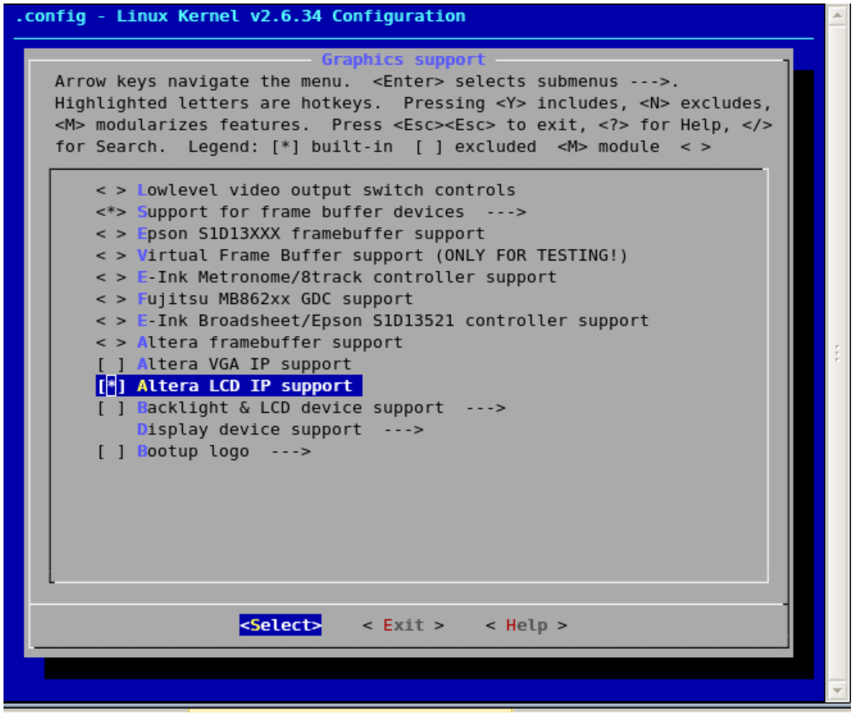
85. Select Support for f**rame buffer devices**. See Figure 5-43.

Figure 5-43. Graphics Support (1)



86. Select **Altera LCD IP Support**. See Figure 5-44.

Figure 5-44. Altera LCD IP Support



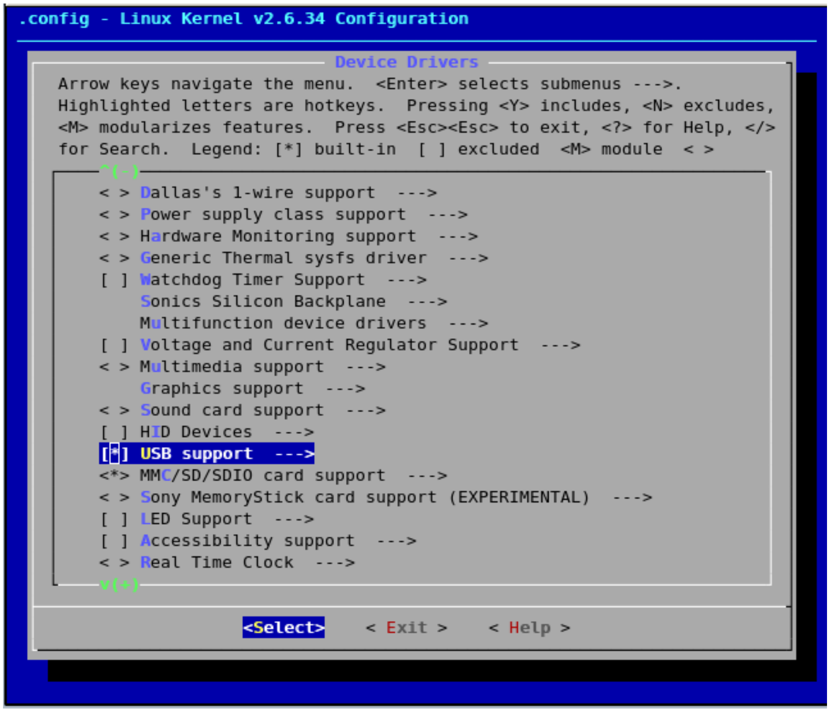
87. Press **<Esc> <Esc>** to go Device Driver selection menu.

USB Host Support

88. USB Host drivers are supported by **SLS USB 2.0 Host controller IP**.

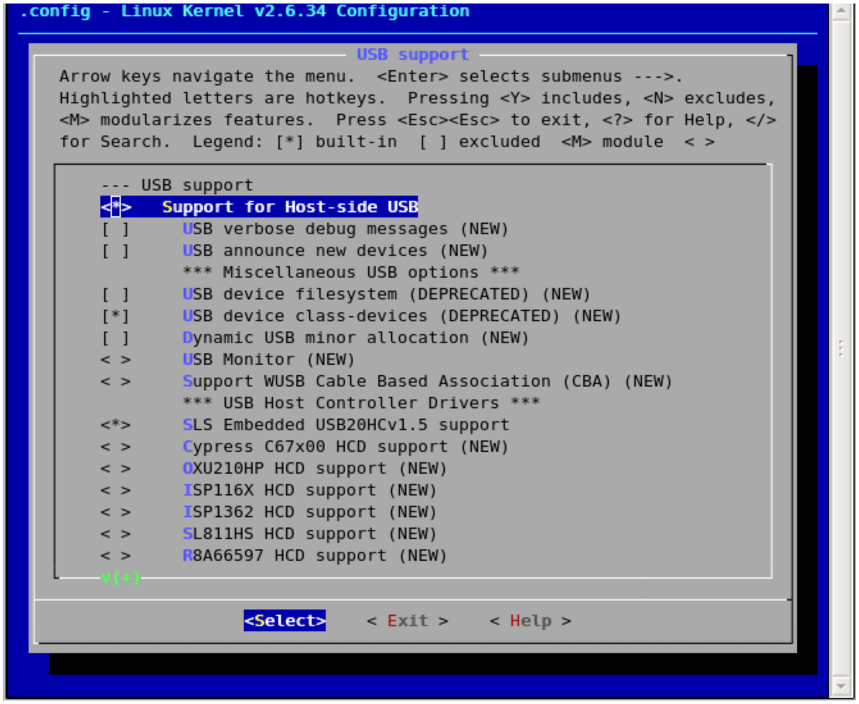
89. Select **USB Support**. See Figure 5-45.

Figure 5-45. USB Support (1)



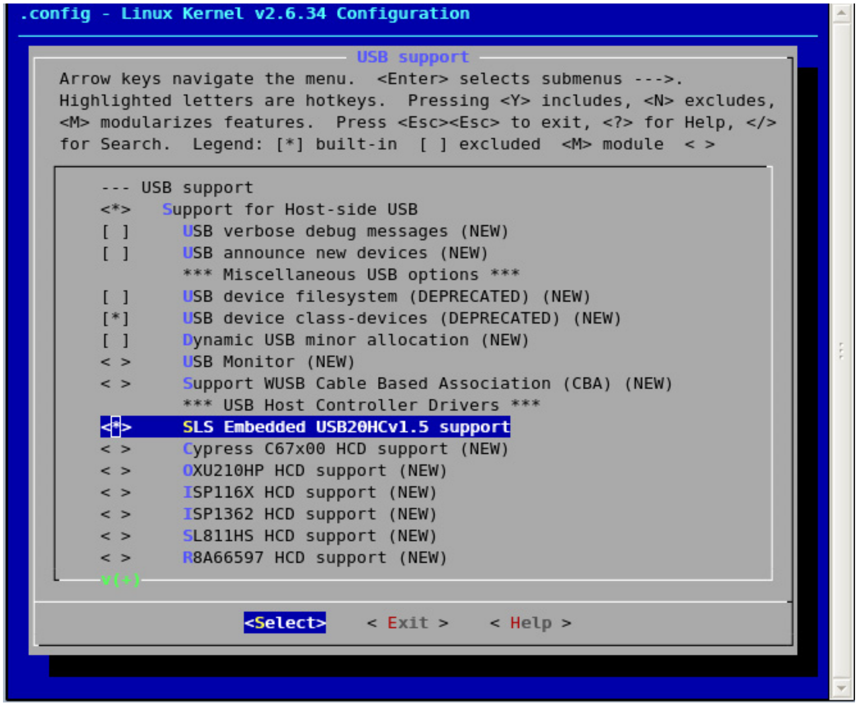
90. Select Support for the **Host-side USB**. See Figure 5-46.

Figure 5-46. Host-side USB



91. Select **SLS Embedded USB20HCv1.5 support**. See Figure 5-47.

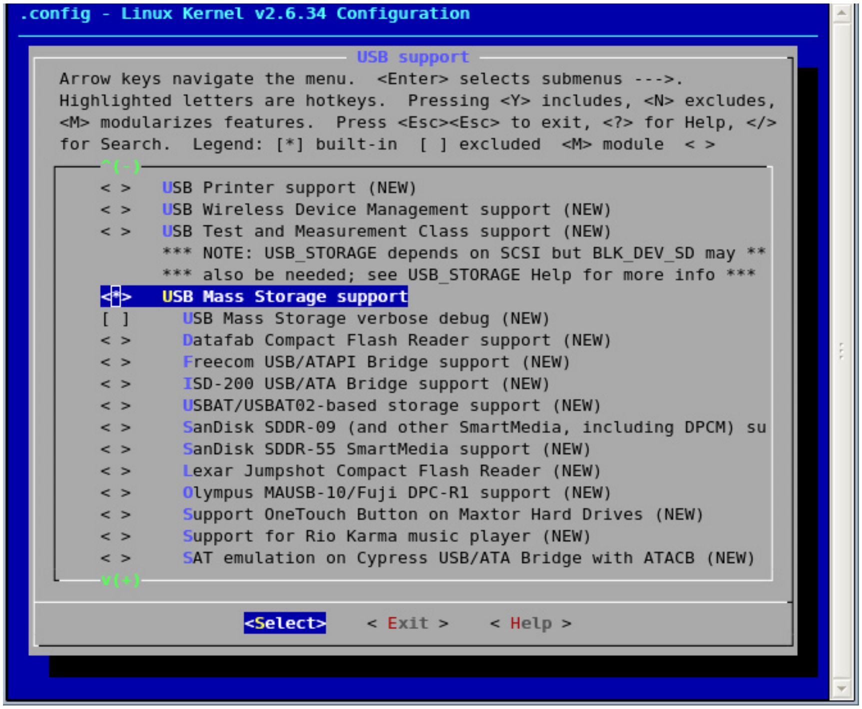
Figure 5-47. USB Support (2)



92. Select **USB Mass Storage support**. See Figure 5-48.

93. Press **<Esc> <Esc>** to go Device Driver selection menu.

Figure 5-48. USB Mass Storage Support

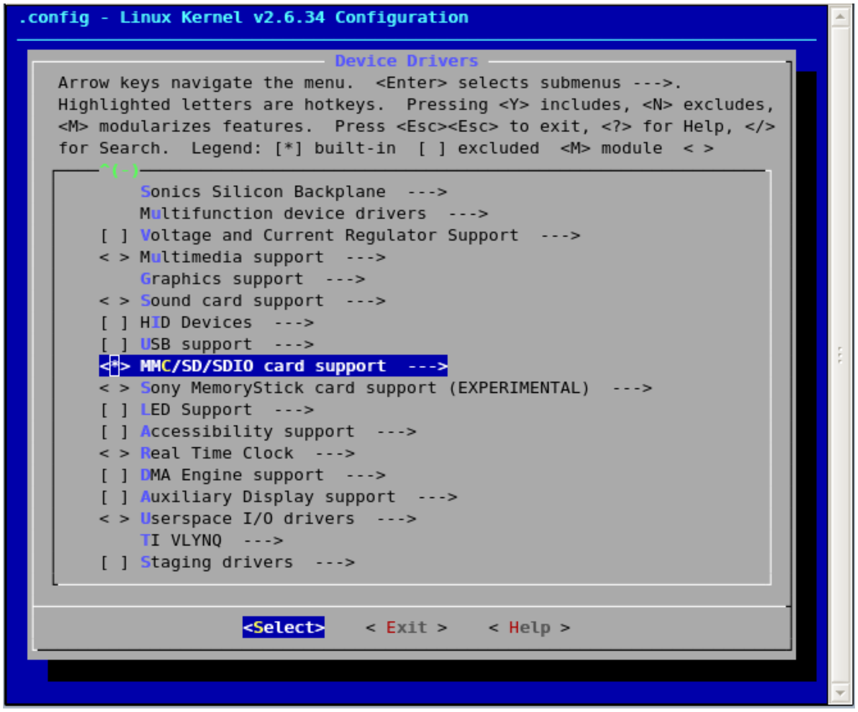


SD Card Support

94. Depends on **VFAT filesystem support**.

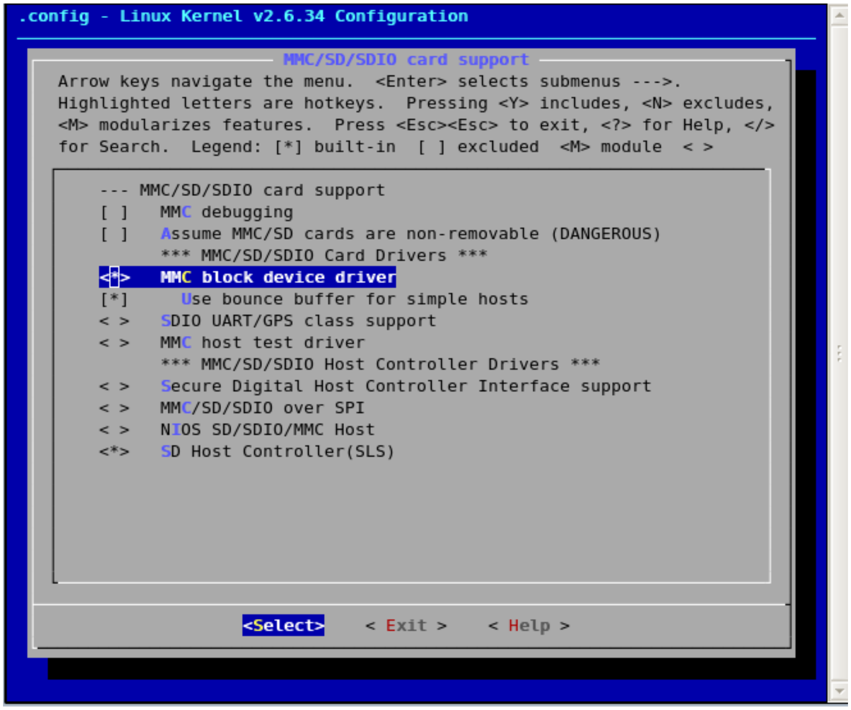
95. Select **MMC/SD/SDIO card Support**. See Figure 5-49.

Figure 5-49. SD Card Support



96. Select **MMC block device driver**. See Figure 5-50.

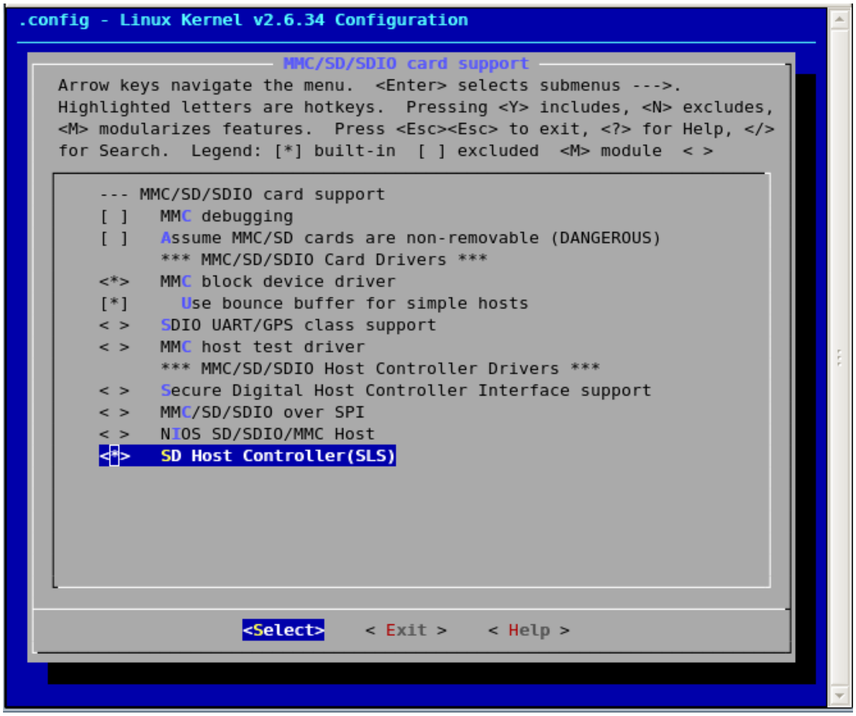
Figure 5-50. Device Driver



97. Select **SD Host Controller (SLS)**. See Figure 5-51.

98. Press **<Esc> <Esc>** to go Device Driver selection menu.

Figure 5-51. SD Host Controller (SLS)



File System

VFAT File System Support & JFFS2 File System Support

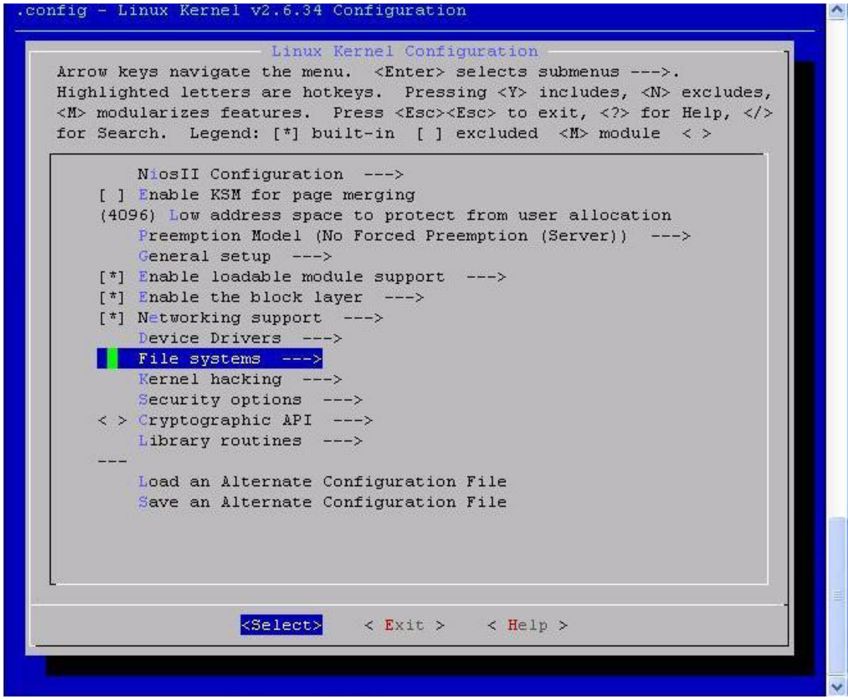
Virtual File Allocation Table (VFAT) is a part of the Windows 95 and later operating system that handles long file names, which otherwise could not be handled by the original file allocation table (FAT) programming. VFAT file system is used with SD Card Follow the steps below to configure the VFAT File system.

99. Press **<Esc> <Esc>**.

100. You will return to the **Linux Kernel Configuration** dialog box. See Figure 5-5.

   - Select **File systems.** See Figure 5-52.

Figure 5-52. File System Selection



101. Press **Enter**.

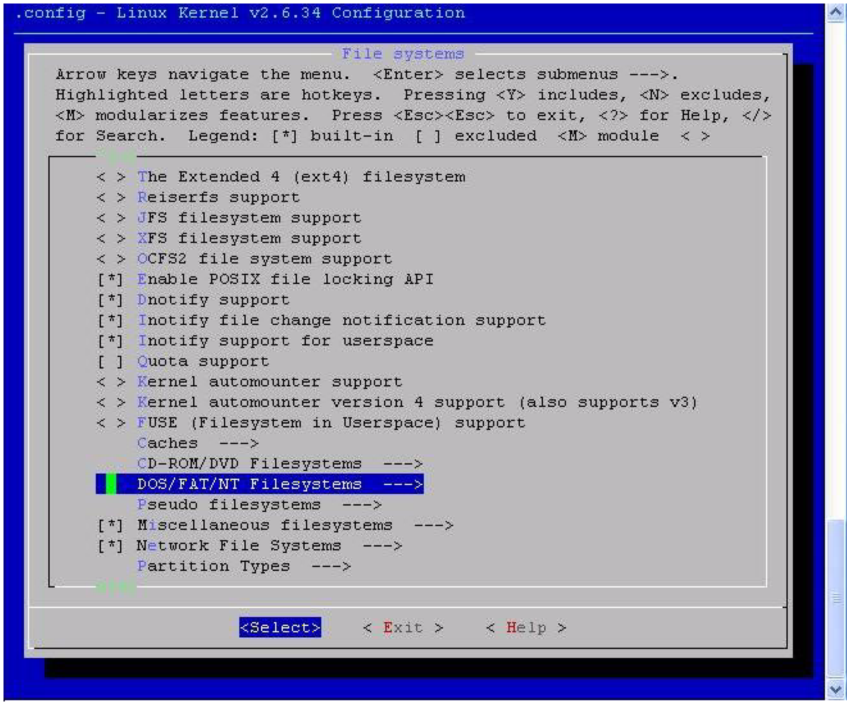
102. The **File Systems** dialog box opens. See Figure 5-52.

103. Select the following options:

- **Enable POSIX file locking API**
- **Dnotify support**
- **Inotify file change notification support**
- **Inotify support for userspace**
- **Miscellaneous filesystems**
- **Network File Systems**

104. Press ↓ and select **DOS/FAT/NT File systems**. See Figure 5-53.

Figure 5-53. File Systems Configuration

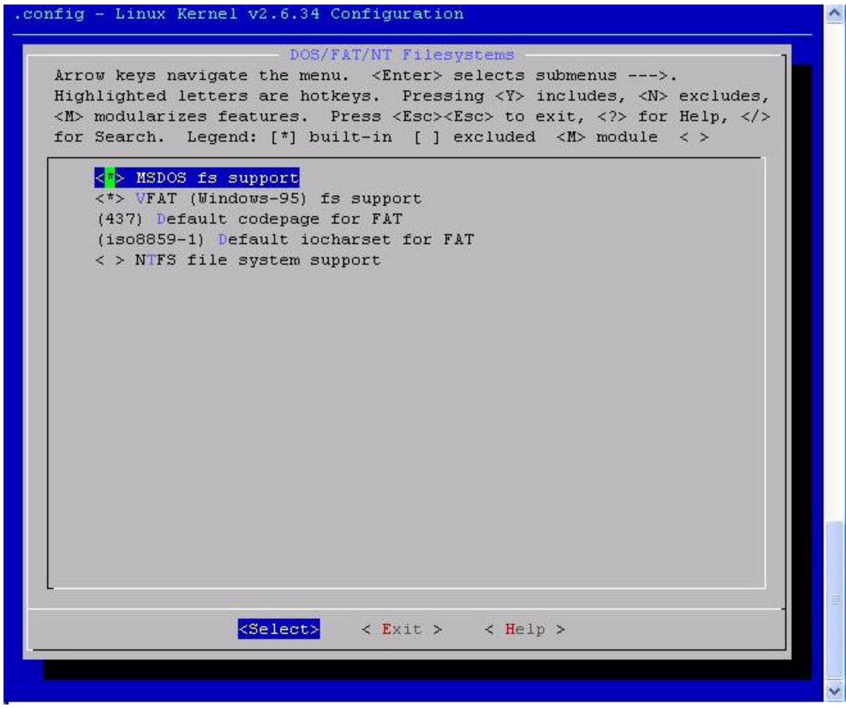


105. Press **Enter**.

106. The **Dos/FAT/NT Filesystems** dialog box opens. See Figure 5-54. Select the following options:

- **MSDOS fs support**
- **VFAT (windows-95) fs support**

Figure 5-54. DOT/FAT/NT File Systems Settings



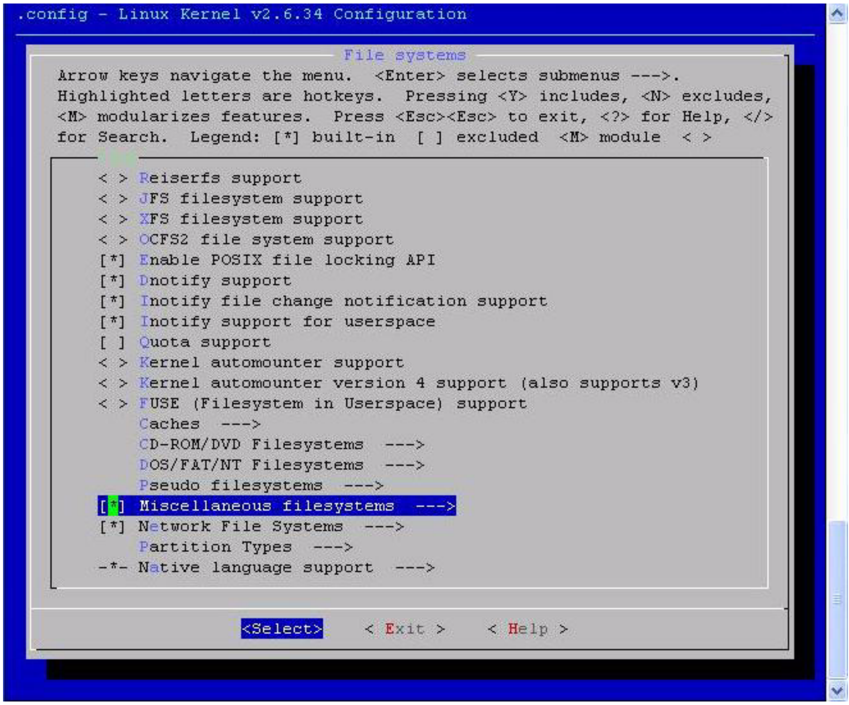
107. Press **<Esc> <Esc>**.

108. You will return to **File systems** dialog box.

Configuring JFFS2 File System

109. Select **Miscellaneous filesystems**. See Figure 5-55.

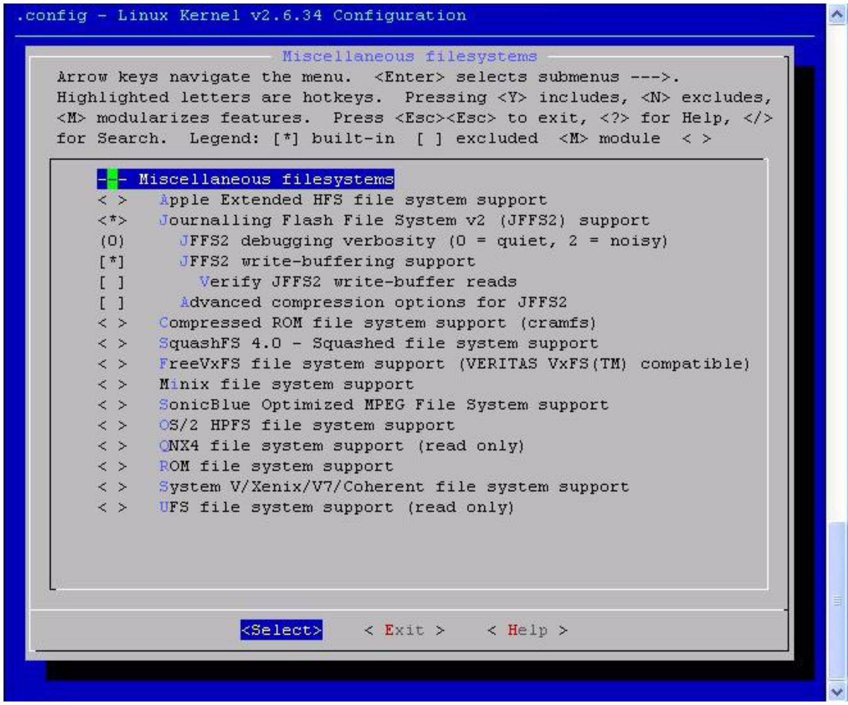
Figure 5-55. File System Dialog Box



110. Select following option: See Figure 5-56.

- **Journalling Flash File System v2 (JFFS2) support**
- **JFFS2 write-buffering support**

Figure 5-56. Miscellaneous FileSystem Dialog Box



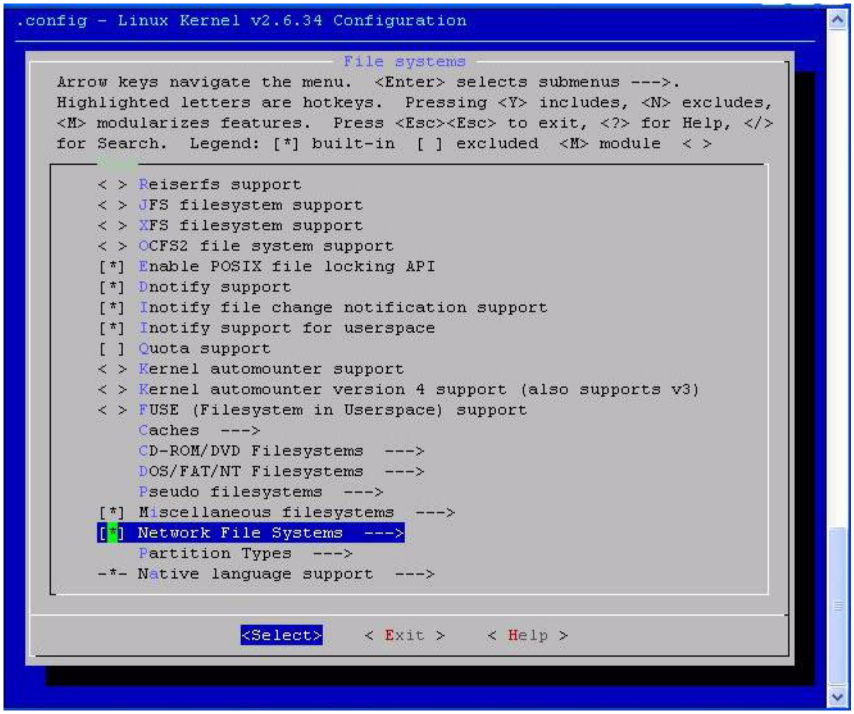
Network File System Support

NFS is a network file system protocol originally developed by Sun Microsystems in 1984, allowing a user on a client computer to access files over a network as easily as if the network devices were attached to its local disks. If you want to use NFS file system on Ethernet then you have to configure the Ethernet IP driver and NFS file system. Ethernet IP driver is already configured. Follow the steps below to configure the NFS File system.

111. Press **<Esc> <Esc>**.

- Select **Networking Support**. See Figure 5-57.

Figure 5-57. File System Configuration

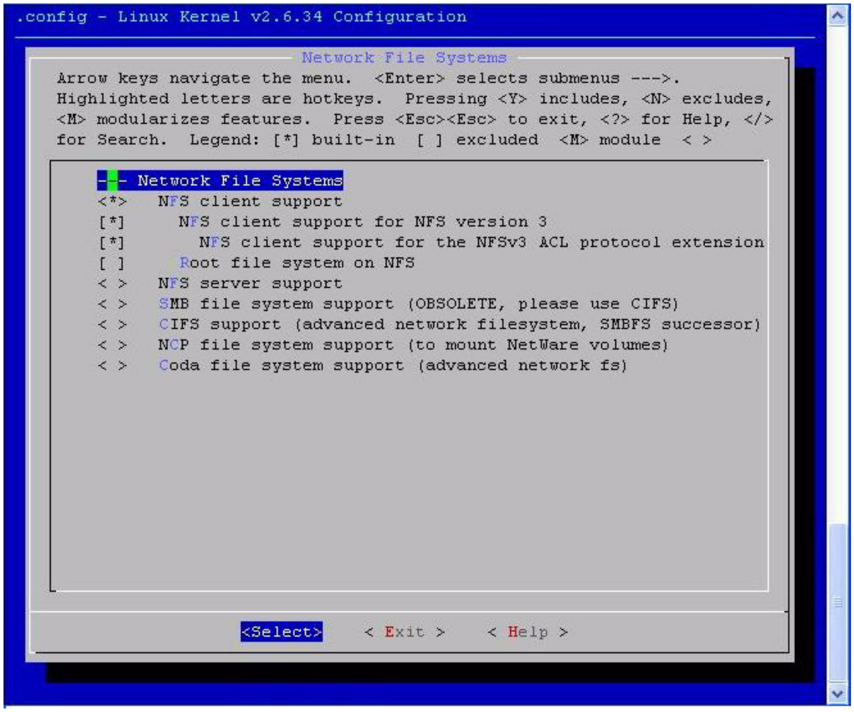


112. The **Network File Systems** dialog box opens. See Figure 5-58.

113. Select the following options:

- **NFS client support**
- **NFS client support for NFS version 3**
- **NFS client support for NFSv3 ACL protocol extension**

Figure 5-58. Network File System Configuration



114. Press <**Esc**> <**Esc**>.

115. Press <**Esc**> <**Esc**>.

116. Now you will enter in **Customize Application/ Library Settings**. See Figure 5-59.

117. Select **Core Applications**. See Figure 5-60.

Figure 5-59. Library Configuration

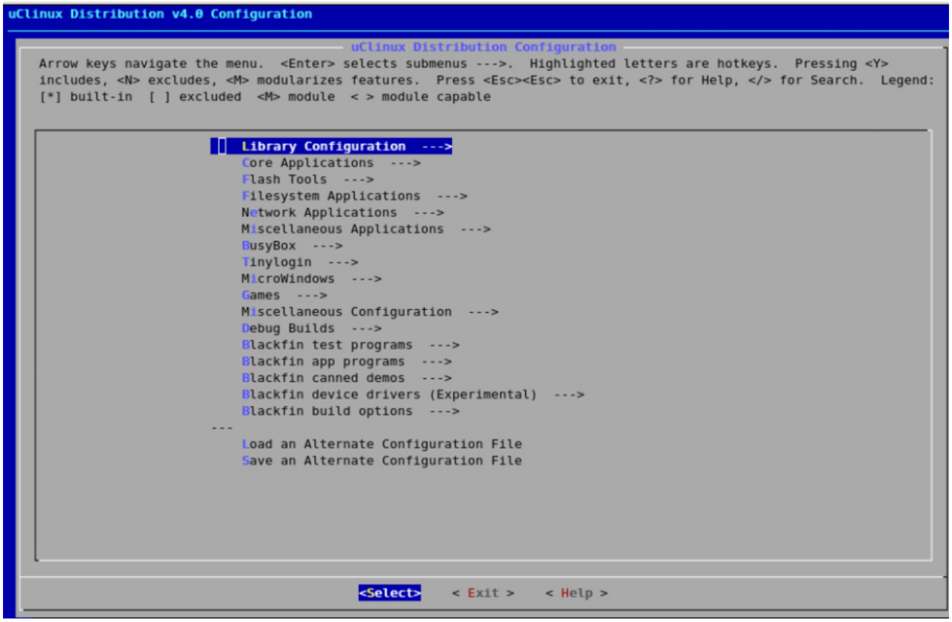
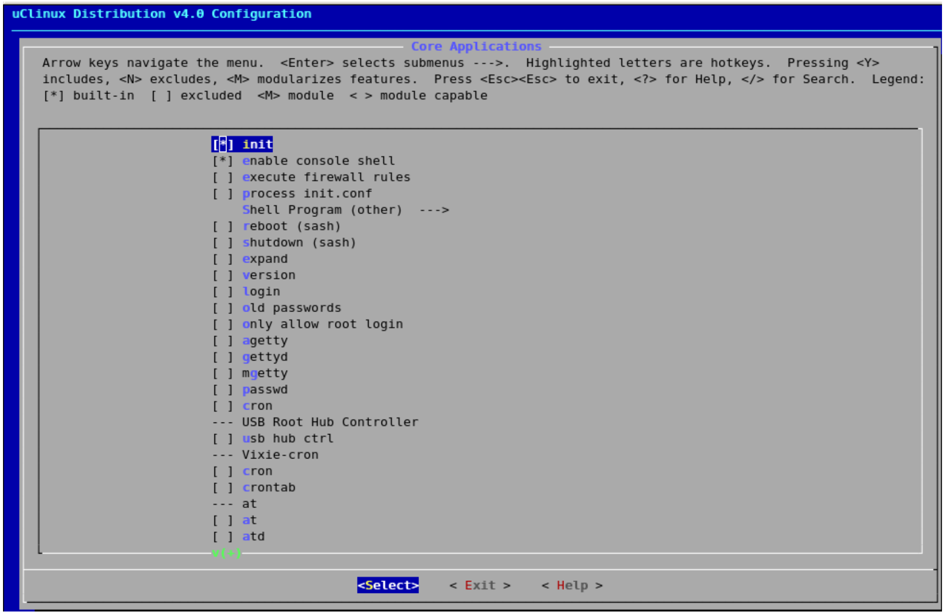


Figure 5-60. Core Applications

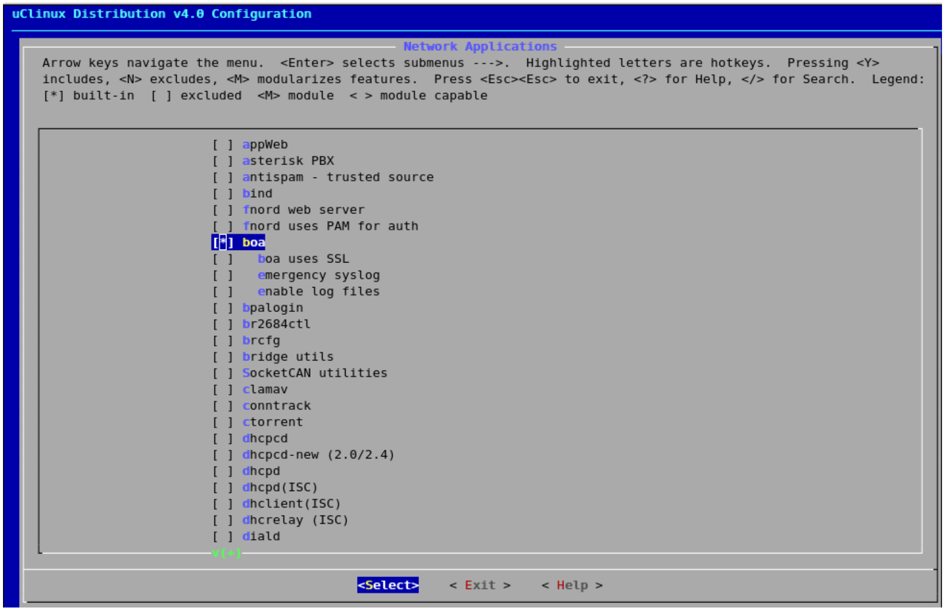


- Select **init**
- Select enable console shell
- Press **<Esc> <Esc>**

118. Select **Network Applications**. See Figure 5-61.

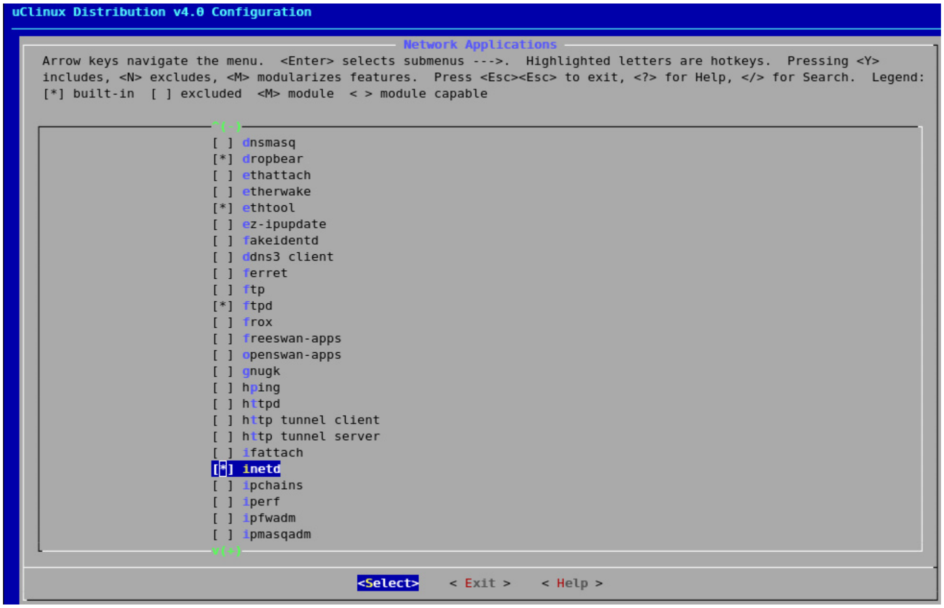
- Select **boa**

Figure 5-61. Network Applications



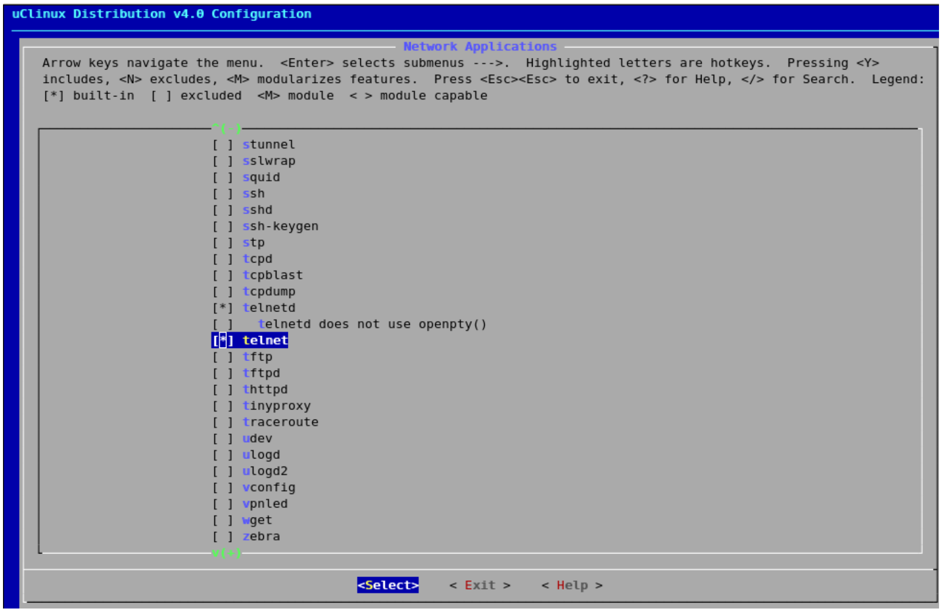
- Select **Dropbear , Ethtool, FTPD, inetd** See Figure 5-62.

Figure 5-62. Network Applications (Dropbear , Ethtool, FTPD, inetd)



- Select **telnet and telnetd** See Figure 5-63.
- Press **<Esc> <Esc>**

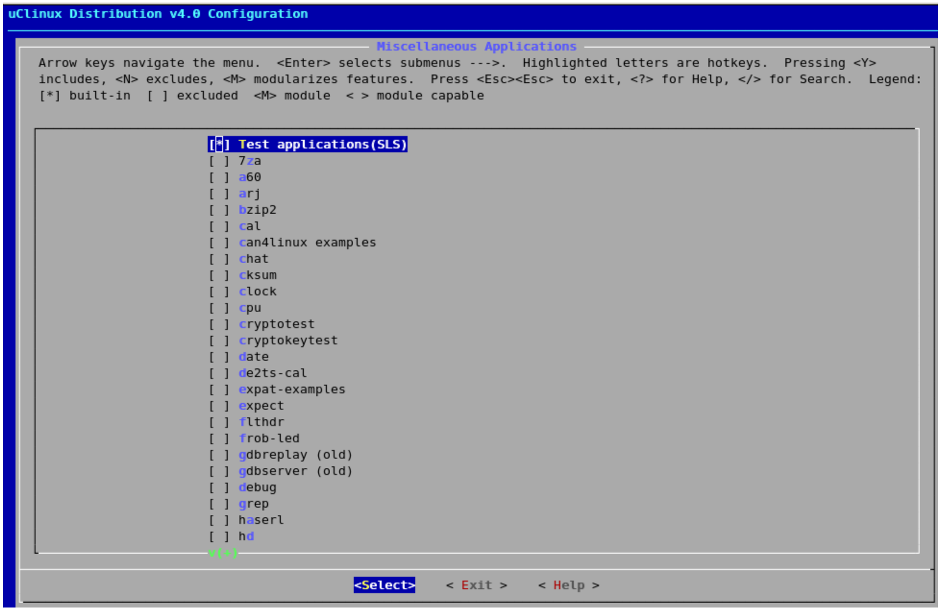
Figure 5-63. Network Applications (telnet and telnetd)



119. Select **Miscellaneous Applications** See Figure 5-64.

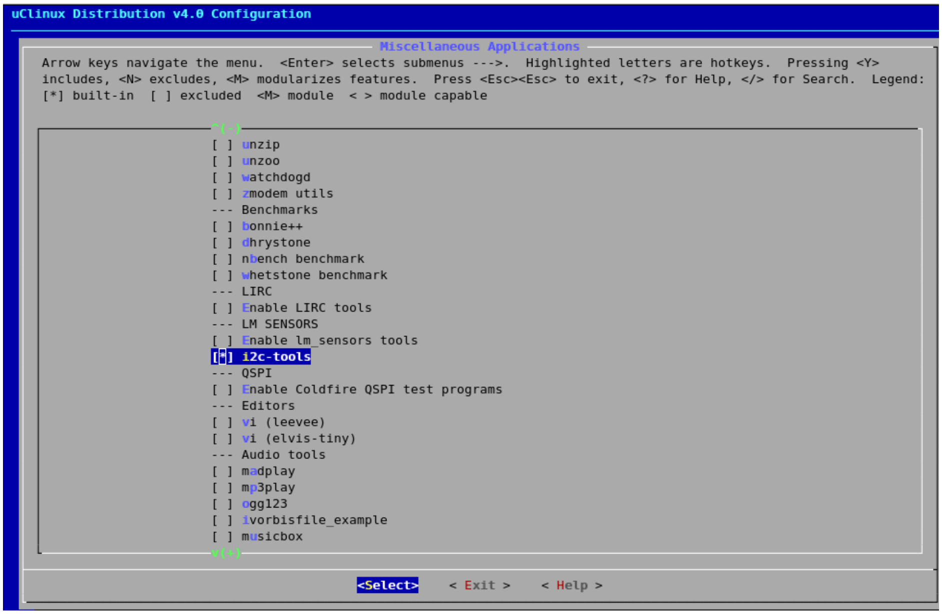
- Select **Test Applications (SLS)**

Figure 5-64. Miscellaneous Applications



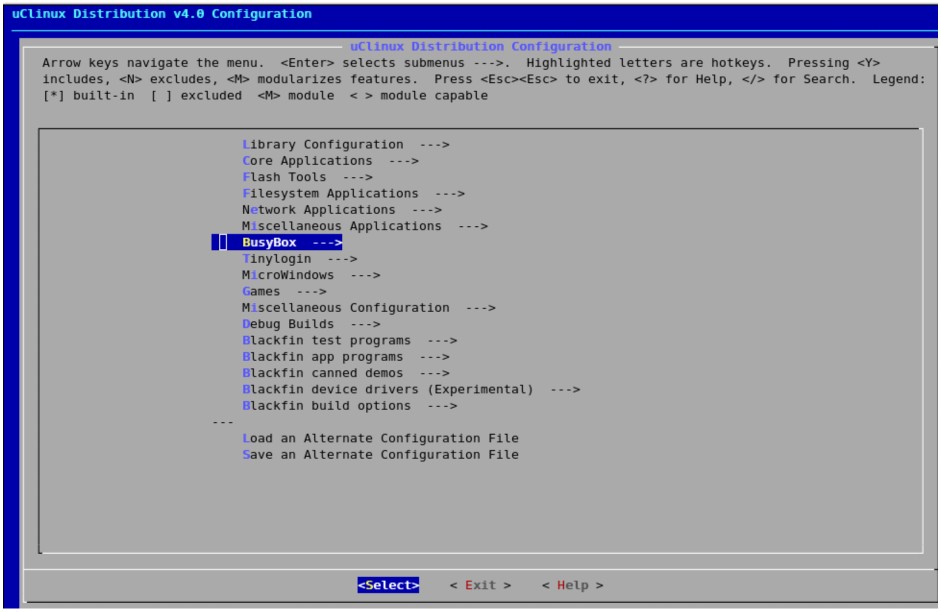
- Select **i2c-tools** See Figure 5-65.
- Press **<Esc> <Esc>**

Figure 5-65. Miscellaneous Applications (i2c-tools)



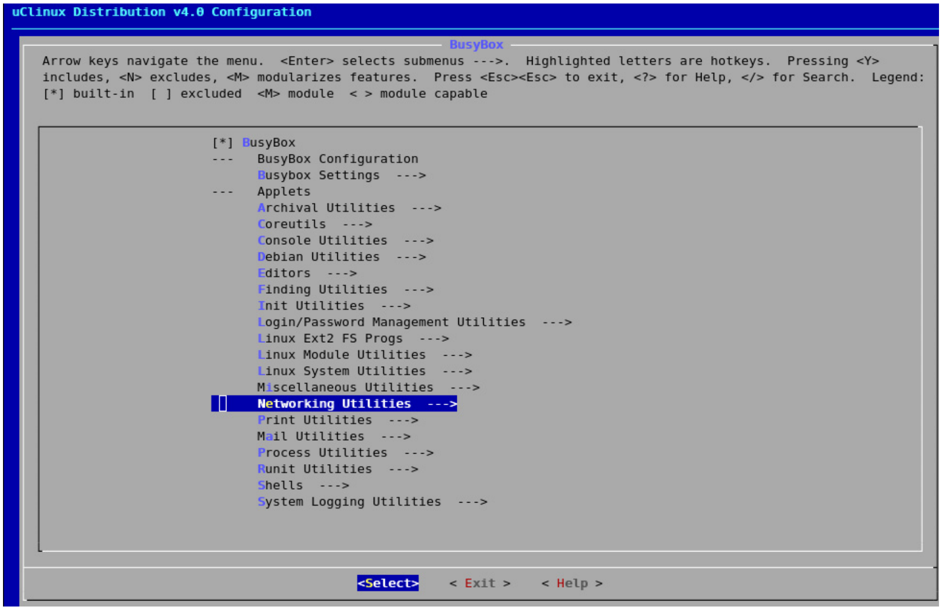
- Select **BusyBox** See Figure 5-66.

Figure 5-66. BusyBox



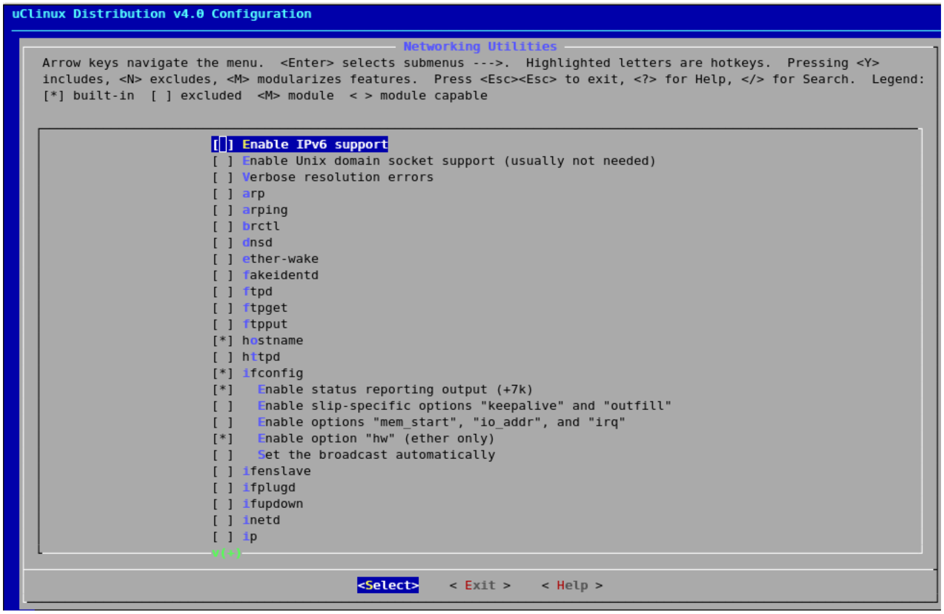
- Select **Networking Utilities** See Figure 5-67.

Figure 5-67. Networking Utilities BusyBox



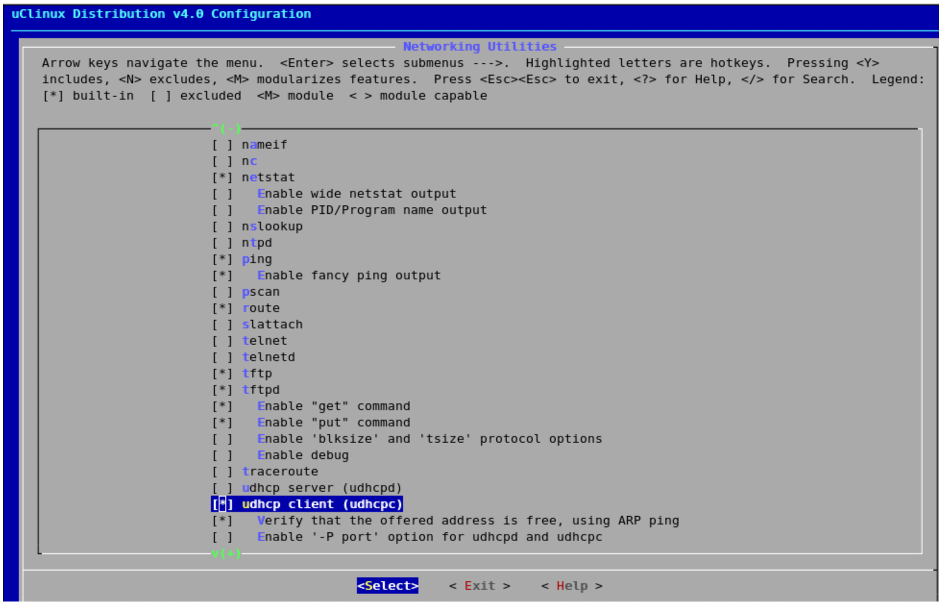
- Select **Hostname**
- Select **ifconfig, Enable status reporting output and Enable option "hw"** See Figure 5-68.

Figure 5-68. Enable T6v6 Support



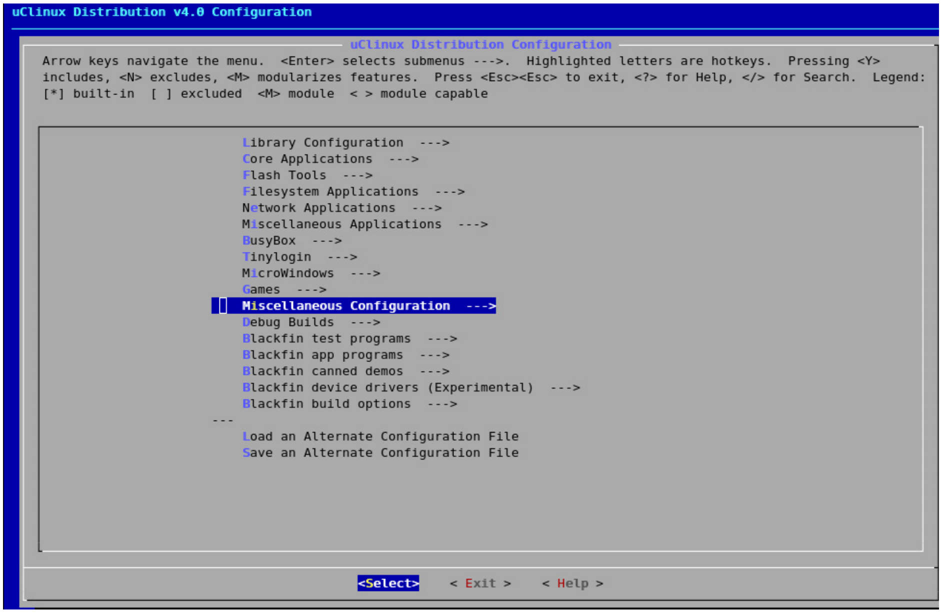
- Select **ping , netstat , tftp, tftpd, udhcp client, uspsvd** See Figure 5-69.
- Press **<Esc> <Esc>**

Figure 5-69. Networking Utilities (udhcpc)



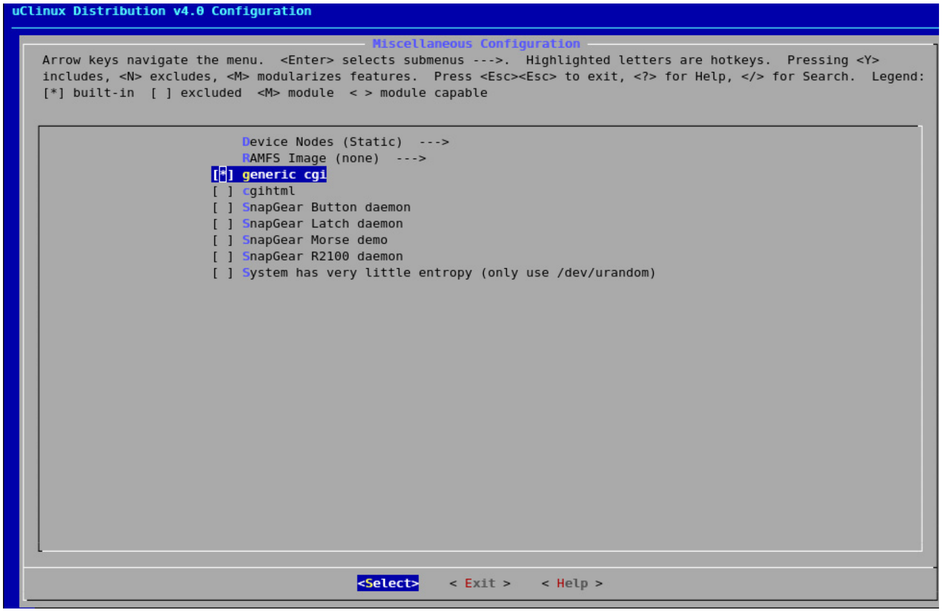
120. Select **Miscellaneous Configuration** See Figure 5-70.

Figure 5-70. Miscellaneous Configuration



- Select **Generic CGI** See Figure 5-71.
- Press **<Esc> <Esc>**

Figure 5-71. Miscellaneous Configuration Generic CGI



121. Press <**Esc**> <**Esc**>.

122. Press Y to save the configuration settings.

123. You will return to Linux terminal.

Compiling the kernel

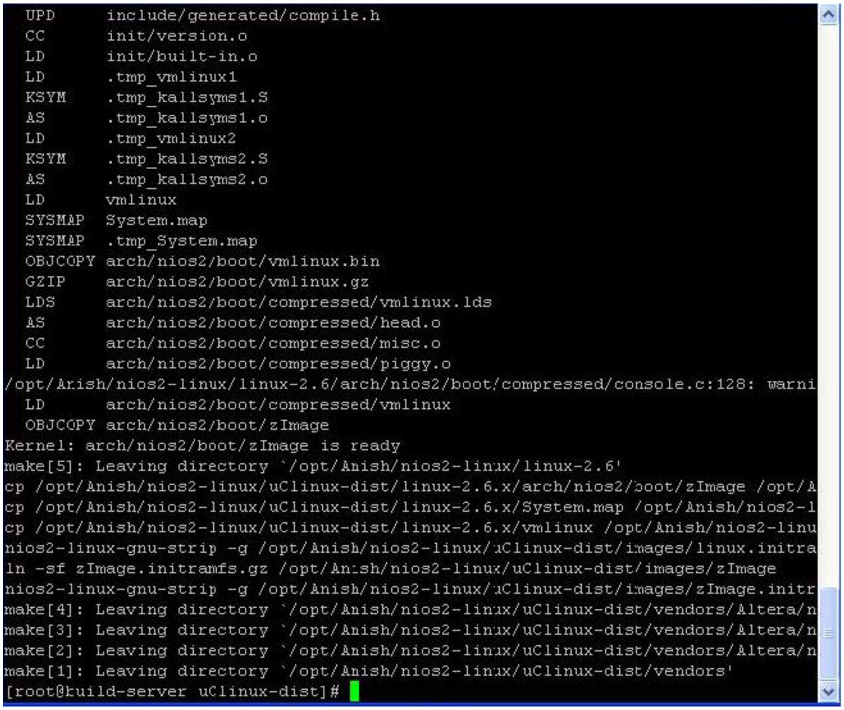
To compile the kernel, follow the steps below:

1. Type the following command to compile the kernel:

   ```
   #make
   ```

   Figure 5-72. show the system compilation.

Figure 5-72. Compilation in Linux



After compilation, you will get different images in the image folder located at:
/home/sls/Nios2-Linux/Linux_source/uClinux-dist/images/
The **linux.initramfs.gz** file is an elf image with initramfs.

Running the BSP

To run BSP on Nios II reference design, follow the steps below:

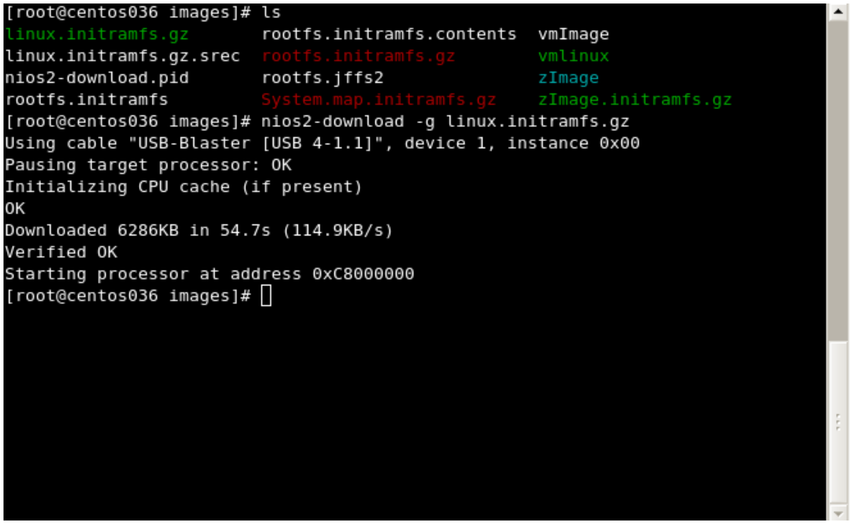
1. Download the **sys_qii100sp1_linux_bsp_s4gxdb.sof** file generated in the previous chapter or from the reference design located at See Figure 5-73.

   /home/sls/Nios2-linux/System-Board/4s230_default.

2. Download the elf file **linux.initramfs.gz** located at

   /home/sls/Nios2-linux/Linux_source/uClinux-dist/images/

Figure 5-73. Downloading ELF Image



3. You will get Linux booting messages on the nios2-terminal window. See Figure 5-74.

```
#nios2-download -g linux.initramfs.gz
#nios2-terminal
```

Figure 5-74. Running Linux On the Board

Login:

Username : **root**

Password : **nios2linux**

To mount the JFFS2 file system on memory, follow the steps below:

4. Type following command to unlock the memory block for erase.

   `#flash_unlock /dev/mtd7`

5. Type following command to erase the memory block.

   `#flash_eraseall -j /dev/mtd7`

6. Type followin command to mount JFFS2 file system on /mnt directory.

   `#mount -t jffs2 /dev/mtdblock7 /mnt`

7. Type following command to go to “mnt” directory.

   `#cd /mnt`

8. Type the command to check mounted file system.

   `#df`

   This message displays mounted file system on memory block 7. See Figure 5-75.

Figure 5-75. Mounting JFFS2 File System

```
TCP cubic registered
NET: Registered protocol family 17
Freeing unused kernel memory: 3052k freed (0xd0208000 - 0xd0502000)
SLS : phy_addr =0
Welcome to

BusyBox v1.16.2 (2010-09-17 21:05:28 IST) hush - the humble shell
Enter 'help' for a list of built-in commands.

/ # flash_unlock /dev/mtd7
/ # flash_eraseall -j /dev/mtd7
Erasing 128 Kibyte @ 380000 -- 100 % complete.Cleanmarker written at 360000.
/ # mount -t jffs2 /dev/mtdblock7 /mnt
/ # cd /mnt
/mnt # df
Filesystem          1K-blocks      Used Available Use% Mounted on
/dev/mtdblock7           3584       388      3196  11% /mnt
/mnt #
```

Applications On Running BSP

For these applications except USB Host, Altera NEEK board's HSMC port should be connected on Stratix IV board's HSMC Port A. For USB/Host application, Altera terasic THDB-SUM board's HSMC port should be connected on Stratix IV board's HSMC Port B.

Mounting VFAT on SD-Card

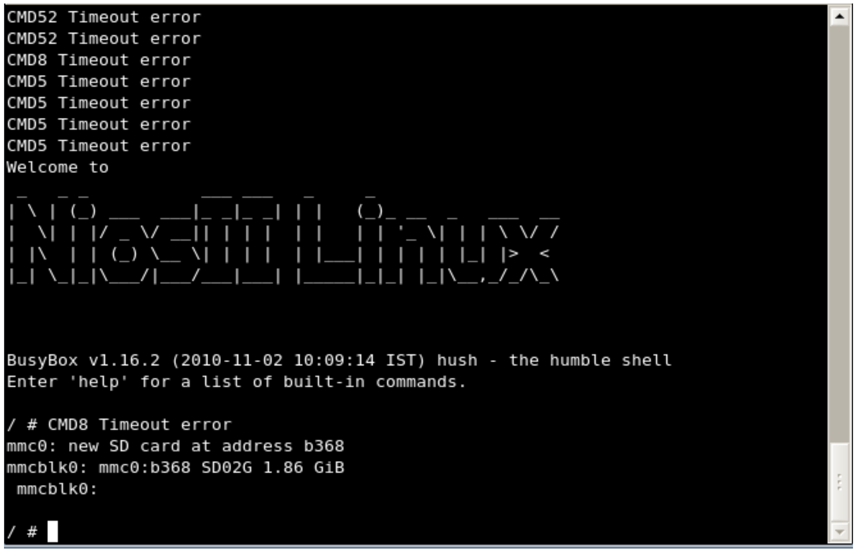
1. Before Power-On board insert **SD-card in NEEK board's SD-Card** slot. See Figure 5-76.

Figure 5-76. Mounting VFAT on SD-Card

```
CMD52 Timeout error
CMD52 Timeout error
CMD8 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD5 Timeout error
Welcome to
 _   _ _            ___ ___   _      _
| \ | (_) ___  ___|_ _|_ _| | |    (_)_ __  _   ___  __
|  \| | |/ _ \/ __|| | | |  | |    | | '_ \| | | \ \/ /
| |\  | | (_) \__ \| | | |  | |___| | | | | |_| |>  <
|_| \_|_|\___/|___/___|___| |_____|_|_| |_|\__,_/_/\_\



BusyBox v1.16.2 (2010-11-02 10:09:14 IST) hush - the humble shell
Enter 'help' for a list of built-in commands.

/ # CMD8 Timeout error
mmc0: new SD card at address b368
mmcblk0: mmc0:b368 SD02G 1.86 GiB
 mmcblk0:

/ #
```

2. SD-card is detected as **mmcblk0** as shown in boot message. See Figure 5-77.

Figure 5-77. Mounting VFAT on SD-Card (1)



3. Mount SD-Card . See Figure 5-78. on **/mnt/sdcard** directory.

```
# mount -t vfat /dev/mmcblk0 /mnt/sdcard
```

4. Check mounted file system using **“df”** or **“mount”** command.

Figure 5-78. Mounting JFFS1 File System

```
/ #
/ # df
Filesystem           1K-blocks      Used Available Use% Mounted on
/ # mkdir /mnt/jffs
/ # mkdir /mnt/sdcard
/ # mkdir /mnt/pendrive
/ # mount -t vfat /dev/mmcblk0 /mnt/sdcard
/ # df
Filesystem           1K-blocks      Used Available Use% Mounted on
/dev/mmcblk0           1956608       304   1956304   0% /mnt/sdcard
/ # ls /mnt/sdcard
Blue hills.jpg    Sunset.jpg        Water lilies.jpg  Winter.jpg
/ #
/ # cat /proc/mtd
dev:    size   erasesize  name
mtd0: 00c00000 00020000 "Kernel"
mtd1: 00ba0000 00020000 "File_System"
/ # flash_unlock /dev/mtd1
/ # flash_eraseall -j /dev/mtd1
Erasing 128 Kibyte @ ba0000 -- 100 % complete.Cleanmarker written at b80000.
/ # mount -t jffs2 /dev/mtdblock1 /mnt/jffs
/ # df
Filesystem           1K-blocks      Used Available Use% Mounted on
/dev/mmcblk0           1956608       304   1956304   0% /mnt/sdcard
/dev/mtdblock1           11904       516     11388   4% /mnt/jffs
/ # cd /mnt/jffs
/mnt/jffs # ls
/mnt/jffs # mkdir sls_test
/mnt/jffs # ls
sls_test
/mnt/jffs #
```

Mounting a JFFS2 File System

1. For JFFS2 file system, Kernel must configured for MTD and JFFS2 file system.
2. To check MTD partitions, use

   ```
   # cat /proc/mtd
   ```

3. To mount /dev/mtd1 partition as JFFS2 file system on /mnt/jffs folder,

   ```
   #flash_unlock /dev/mtd1
   #flash_eraseall -j  /dev/mtd1
   #flash_unlock /dev/mtd1
   #mount -t jffs2 /dev/mtdblock1 /mnt/jffs
   ```

4. Check mounted file system using **"df"** or **"mount"** command.
5. Create any file or directory on mounted file system. See Figure 5-78.

Figure 5-79. Mounting JFFS2 File System

```
/ #
/ # df
Filesystem           1K-blocks      Used Available Use% Mounted on
/ # mkdir /mnt/jffs
/ # mkdir /mnt/sdcard
/ # mkdir /mnt/pendrive
/ # mount -t vfat /dev/mmcblk0 /mnt/sdcard
/ # df
Filesystem           1K-blocks      Used Available Use% Mounted on
/dev/mmcblk0           1956608       304   1956304   0% /mnt/sdcard
/ # ls /mnt/sdcard
Blue hills.jpg    Sunset.jpg        Water lilies.jpg  Winter.jpg
/ #
/ # cat /proc/mtd
dev:    size   erasesize  name
mtd0: 00c00000 00020000 "Kernel"
mtd1: 00ba0000 00020000 "File_System"
/ # flash_unlock /dev/mtd1
/ # flash_eraseall -j /dev/mtd1
Erasing 128 Kibyte @ ba0000 -- 100 % complete.Cleanmarker written at b80000.
/ # mount -t jffs2 /dev/mtdblock1 /mnt/jffs
/ # df
Filesystem           1K-blocks      Used Available Use% Mounted on
/dev/mmcblk0           1956608       304   1956304   0% /mnt/sdcard
/dev/mtdblock1           11904       516     11388   4% /mnt/jffs
/ # cd /mnt/jffs
/mnt/jffs # ls
/mnt/jffs # mkdir sls_test
/mnt/jffs # ls
sls_test
/mnt/jffs #
```

Input Devices Applications

1. Check the boot message which displays configured input devices. See Figure 5-79.

Figure 5-80. Input Devices Applications

```
SLS:number of CFI chips: 2
cmdlinepart partition parsing not available
RedBoot partition parsing not available
Using physmap partition information
Creating 2 MTD partitions on "physmap-flash.0":
0x000002820000-0x000003420000 : "Kernel"
0x000003420000-0x000003fc0000 : "File_System"
physmap-flash.0: failed to claim resource 0
Altera TSE MII Bus: probed
Found PHY with ID=0x1410cc2 at address=0x0
SLS: altera_tse_mdio_register end
Altera Triple Speed MAC IP Driver(v8.0) developed by SLS,August-2008
input: SLSPS2 as /devices/virtual/input/input0
ads7846 spi1.0: touchscreen, irq 24
input: ADS7843 Touchscreen as /devices/platform/spi_altera.1/spi1.0/input/input1
i2c /dev entries driver
i2c-0: SLS I2C Master Bus Adapter, MMIO = 0x4E00080, irq = 23
i2c-0: Using 50000kHz clock source
i2c-1: SLS I2C Master Bus Adapter, MMIO = 0x4E00300, irq = 22
i2c-1: Using 50000kHz clock source
mmc0: SLS SD Host Controller driver at e4e00100

Altera example PIO driver
TCP cubic registered
NET: Registered protocol family 17
Freeing unused kernel memory: 3876k freed (0xc8232000 - 0xc85fa000)
CMD52 Timeout error
CMD52 Timeout error
CMD8 Timeout error
CMD5 Timeout error
CMD5 Timeout error
```

Touch Panel

1. Touch panel is configured as input1 and event1. See Figure 5-81.
2. Run the input_driver_test application as shown,

```
#input_driver_test  /dev/input/event1
```

Figure 5-81. Touch Panel

```
ads7846 spi1.0: touchscreen, irq 24
input: ADS7843 Touchscreen as /devices/platform/spi_altera.1/spi1.0/input/input1
evbug.c: Connected device: input1 (ADS7843 Touchscreen at spi1.0/input0)
i2c /dev entries driver
i2c-0: SLS I2C Master Bus Adapter, MMIO = 0x4E00080, irq = 23
i2c-0: Using 50000kHz clock source
i2c-1: SLS I2C Master Bus Adapter, MMIO = 0x4E00300, irq = 22
i2c-1: Using 50000kHz clock source
mmc0: SLS SD Host Controller driver at e4e00100

Altera example PIO driver
TCP cubic registered
NET: Registered protocol family 17
Freeing unused kernel memory: 3876k freed (0xc8232000 - 0xc85fa000)
CMD52 Timeout error
CMD52 Timeout error
CMD8 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD8 Timeout error
mmc0: new SD card at address b368
mmcblk0: mmc0:b368 SD02G 1.86 GiB
 mmcblk0:
SLS : phy_addr =0
/ #
/ #
/ # input_driver_test /dev/input/event1
INFO: succeeded to open /dev/input/event1
```

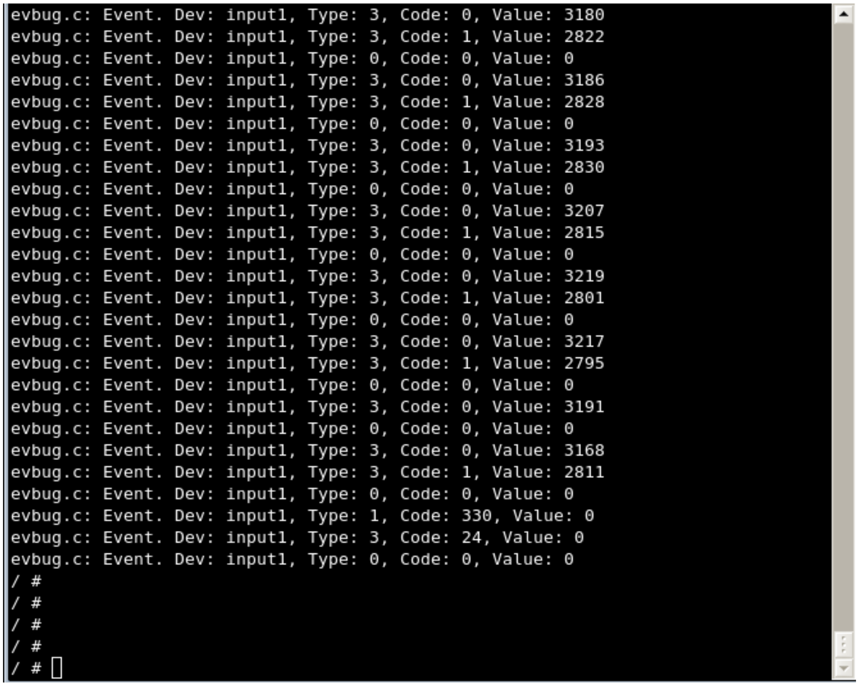
3. On success, touch the NEEK boards touchscreen , it will display co-ordinates values. See Figure 5-82.

Figure 5-82. Touch Panel (1)

```
CMD8 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD5 Timeout error
CMD8 Timeout error
mmc0: new SD card at address b368
mmcblk0: mmc0:b368 SD02G 1.86 GiB
 mmcblk0:
SLS : phy_addr =0
/ #
/ #
/ # input_driver_test /dev/input/event1
INFO: succeeded to open /dev/input/event1
1167609975.398543 type 1 code 330 value 1
type 3 code 0 value 1501
type 3 code 1 value 3136
type 3 code 24 value 7500
type 0 code 0 value 0
type 3 code 0 value 1371
type 3 code 1 value 3424
type 0 code 0 value 0
type 3 code 0 value 1280
type 3 code 1 value 3493
type 0 code 0 value 0
type 3 code 0 value 1270
type 0 code 0 value 0
type 3 code 0 value 1263
type 3 code 1 value 3481
type 0 code 0 value 0
type 3 code 0 value 1260
```

4. Even the resulting messages can also be viewed using **"gmesg"** command. See Figure 5-83.

Figure 5-83. Touch Panel (2)



```
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 3180
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2822
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 3186
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2828
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 3193
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2830
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 3207
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2815
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 3219
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2801
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 3217
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2795
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 3191
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 3168
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2811
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 1, Code: 330, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 24, Value: 0
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
/ #
/ #
/ #
/ #
/ #
```

PS2 Keyboard

1. Connect PS2 Keyboard on PS2 port of NEEK board.
2. PS2 Keyboard is configured as input0 and event0.
3. Run the input_driver_test application as shown,

   ```
   #input_driver_test  /dev/input/event0
   ```

4. On success, press any key of keyboard , it will display code values. See Figure 5-84.

Figure 5-84. PS2 Keyboard

```
/ #
/ #
/ #
/ #
/ # input_driver_test /dev/input/event0
INFO: succeeded to open /dev/input/event0
1167610142.168595 type 1 code 47 value 1
type 0 code 0 value 0
1167610142.262121 type 1 code 47 value 0
type 0 code 0 value 0
1167610142.610938 type 1 code 47 value 1
type 0 code 0 value 0
1167610142.727312 type 1 code 47 value 0
type 0 code 0 value 0
1167610144.337149 type 1 code 37 value 1
type 0 code 0 value 0
1167610144.410376 type 1 code 37 value 0
type 0 code 0 value 0
1167610144.859114 type 1 code 40 value 1
type 0 code 0 value 0
1167610144.914591 type 1 code 40 value 0
type 0 code 0 value 0
1167610146.052530 type 1 code 37 value 1
type 0 code 0 value 0
1167610146.110194 type 1 code 39 value 1
type 0 code 0 value 0
1167610146.135704 type 1 code 37 value 0
type 0 code 0 value 0
1167610146.206448 type 1 code 39 value 0
type 0 code 0 value 0
```

5. Even the resulting messages can also be viewed using **“gmesg”** command. See Figure 5-85.

Figure 5-85. PS2 Keyboard (2)

```
evbug.c: Event. Dev: input0, Type: 1, Code: 47, Value: 0
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 37, Value: 1
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 37, Value: 0
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 40, Value: 1
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 40, Value: 0
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 37, Value: 1
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 39, Value: 1
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 37, Value: 0
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 39, Value: 0
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 2, Value: 1
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 2, Value: 0
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 3, Value: 1
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 3, Value: 0
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 5, Value: 1
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input0, Type: 1, Code: 5, Value: 0
evbug.c: Event. Dev: input0, Type: 0, Code: 0, Value: 0
/ #
```

Button PIO

1. Open /dev/btn as background,

   ```
   #cat /dev/btn &
   ```

2. Pressing of any push button 1 ,2 or 3 will display button number. See Figure 5-86.

Figure 5-86. Button Pio (1)

3. To Kill these process, give kill command with pid of /dev/btn and press any push. See Figure 5-87.

Figure 5-87. Button Pio (2)

I2C Applications

1. Check the boot message which displays configured i2c devices. See Figure 5-88.

   `i2c-0 for eeprom and i2c-1 for audio-codec`

Figure 5-88. I2C Applications

```
SLS:number of CFI chips: 2
cmdlinepart partition parsing not available
RedBoot partition parsing not available
Using physmap partition information
Creating 2 MTD partitions on "physmap-flash.0":
0x000002820000-0x000003420000 : "Kernel"
0x000003420000-0x000003fc0000 : "File_System"
physmap-flash.0: failed to claim resource 0
Altera TSE MII Bus: probed
Found PHY with ID=0x1410cc2 at address=0x0
SLS: altera_tse_mdio_register end
Altera Triple Speed MAC IP Driver(v8.0) developed by SLS,August-2008
input: SLSPS2 as /devices/virtual/input/input0
ads7846 spi1.0: touchscreen, irq 24
input: ADS7843 Touchscreen as /devices/platform/spi_altera.1/spi1.0/input/input1
i2c /dev entries driver
i2c-0: SLS I2C Master Bus Adapter, MMIO = 0x4E00080, irq = 23
i2c-0: Using 50000kHz clock source
i2c-1: SLS I2C Master Bus Adapter, MMIO = 0x4E00300, irq = 22
i2c-1: Using 50000kHz clock source
mmc0: SLS SD Host Controller driver at e4e00100

Altera example PIO driver
TCP cubic registered
NET: Registered protocol family 17
Freeing unused kernel memory: 3876k freed (0xc8232000 - 0xc85fa000)
CMD52 Timeout error
CMD52 Timeout error
CMD8 Timeout error
CMD5 Timeout error
CMD5 Timeout error
```

I2C Detect

1. i2c detect will display the address where i2c devices are connected. See Figure 5-89.

   `#i2cdetect 0 or #i2cdetect 1`

2. I2C EEPROM on NEEK board has address range between 0x50 to 0x57

3. Device address for I2C interface for audio codec is 0x1A.

Figure 5-89. I2C Detect

```
/ # i2cdetect 0
WARNING! This program can confuse your I2C bus, cause data loss and worse!
I will probe file /dev/i2c-0.
I will probe address range 0x03-0x77.
Continue? [Y/n] y
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- 51 52 -- 54 55 56 57 -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- -- --
/ # i2cdetect 1
WARNING! This program can confuse your I2C bus, cause data loss and worse!
I will probe file /dev/i2c-1.
I will probe address range 0x03-0x77.
Continue? [Y/n] y
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- 1a -- -- -- -- --
20: 20 -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- -- --
/ #
```

I2C EEPROM Read and Write

1. To read eeprom's byte value from address 0x01 with eeprom address value 0x51. See Figure 5-90.

   ```
   #i2cget 0 0x51 0x01 b
   ```

2. Address 0x01 has value 0x23
3. To write eeprom 1 byte 0x45 value at address 0x01

   ```
   #i2cset 0 0x51 0x01 0x45 b
   ```

4. Verify the value at address 0x01 using i2cget.

Figure 5-90. I2Cread_write

```
/ # i2cget 0 0x51 0x01 b
WARNING! This program can confuse your I2C bus, cause data loss and worse!
I will read from device file /dev/i2c-0, chip address 0x51, data address
0x01, using read byte data.
Continue? [Y/n] y
0x23
/ # i2cset 0 0x51 0x01 0x45 b
WARNING! This program can confuse your I2C bus, cause data loss and worse!
DANGEROUS! Writing to a serial EEPROM on a memory DIMM
may render your memory USELESS and make your system UNBOOTABLE!
I will write to device file /dev/i2c-0, chip address 0x51, data address
0x01, data 0x45, mode byte.
Continue? [y/N] y
/ # i2cget 0 0x51 0x01 b
WARNING! This program can confuse your I2C bus, cause data loss and worse!
I will read from device file /dev/i2c-0, chip address 0x51, data address
0x01, using read byte data.
Continue? [Y/n] y
0x45
/ #
```

I2C Audio Controller

1. To check i2c audio codec, run application i2c_audio_bypass. See Figure 5-91.
2. Connect **LINE-IN** of **NEEK** board with Host system's **LINE-OUT** using aux cable.
3. Connect **LINE-OUT** of **NEEK** board with Speaker.

Figure 5-91. I2C_audio

```
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 1, Code: 330, Value: 1
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 2042
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2627
evbug.c: Event. Dev: input1, Type: 3, Code: 24, Value: 7500
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 1912
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 1950
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 1986
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 1624
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 1, Code: 330, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 24, Value: 0
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 1, Code: 330, Value: 1
evbug.c: Event. Dev: input1, Type: 3, Code: 0, Value: 2050
evbug.c: Event. Dev: input1, Type: 3, Code: 1, Value: 2072
evbug.c: Event. Dev: input1, Type: 3, Code: 24, Value: 7500
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
evbug.c: Event. Dev: input1, Type: 1, Code: 330, Value: 0
evbug.c: Event. Dev: input1, Type: 3, Code: 24, Value: 0
evbug.c: Event. Dev: input1, Type: 0, Code: 0, Value: 0
/ #
/ #
/ #
/ # i2c_audio_bypass
write done
/ #
```

4. Run audio on player of your Host system with application

```
#i2c_audio_bypass
```

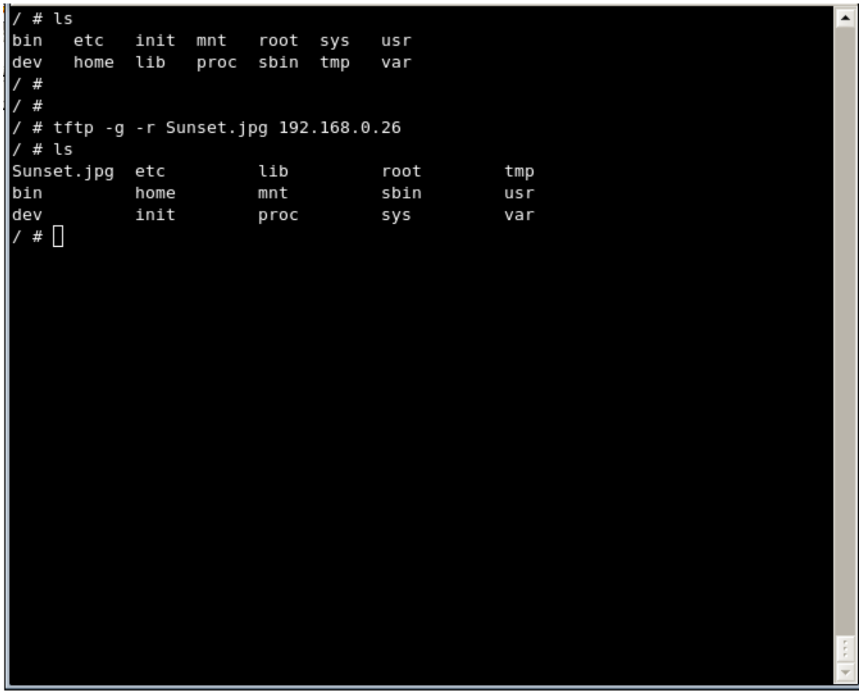
TFTP Applications

TFTP Client

1. Trivial File transfer protocol(tftp) is used for file transfer from Host PC to Stratix IV GX Development kit. See Figure 5-92.
2. To get the remote file from tftp server running on Windows or Linux Host.

```
tftp -g -r [File] [HOST]
#tftp -g -r Sunset.jpg 192.168.0.26
```

Figure 5-92. Trivial File transfer protocol(tftp - 1)



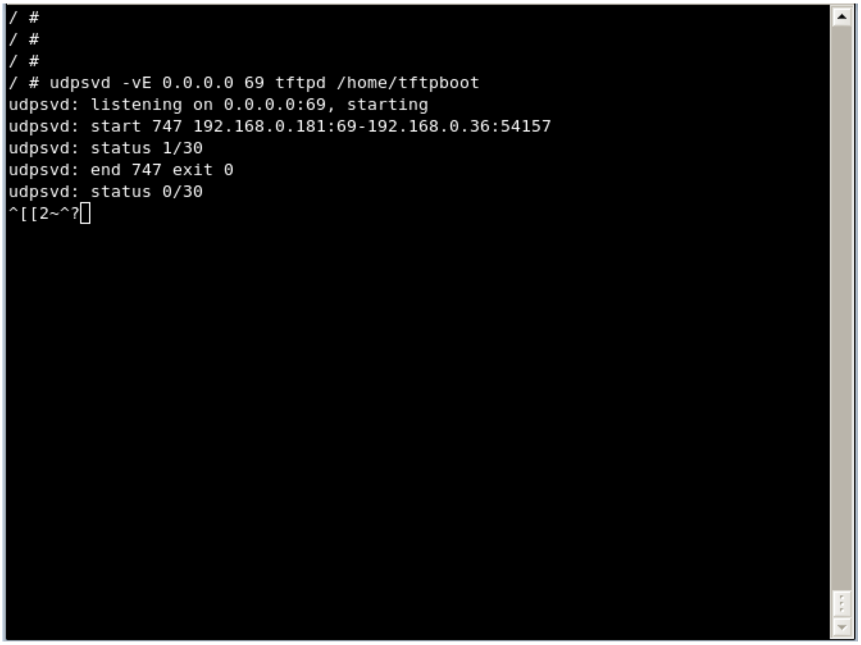
TFTP Server

1. To make Stratix IV GX Development Kit as TFTP Server. See Figure 5-93.
2. After Ethernet configuration, run this command ,

   ```
   #udpsvd -vE 0.0.0.0 69 tftpd /home/tftpboot
   ```

3. Access files from Host system from Stratix IV GX Development Kit's tftpboot folder .

Figure 5-93. Trivial File transfer protocol(tftp - 2)



TELNET Application

1. It is simple utility to access Target board via Ethernet.
2. To access target board via telnet , give telnet command from Windows or Linux Host

```
# telnet 192.168.0.181
```

BOA Application

1. Open any Internet browser on Host and type http://192.168.0.181.

```
# boa -c /etc &
```

http://192.168.0.181

FTP Application

2. Connect target board using FTP application On Host system, run this command.
ftp 192.168.0.181

Dropbear Application

3. Connect the target board using SSH , On host system, run this command
ssh root@192.168.0.181

LCD Application

4. This application will work if you have selected Test Applications (SLS) while configuring applications.

5. Run this command on terminal, you can see output on LCD

```
# jpegview
```