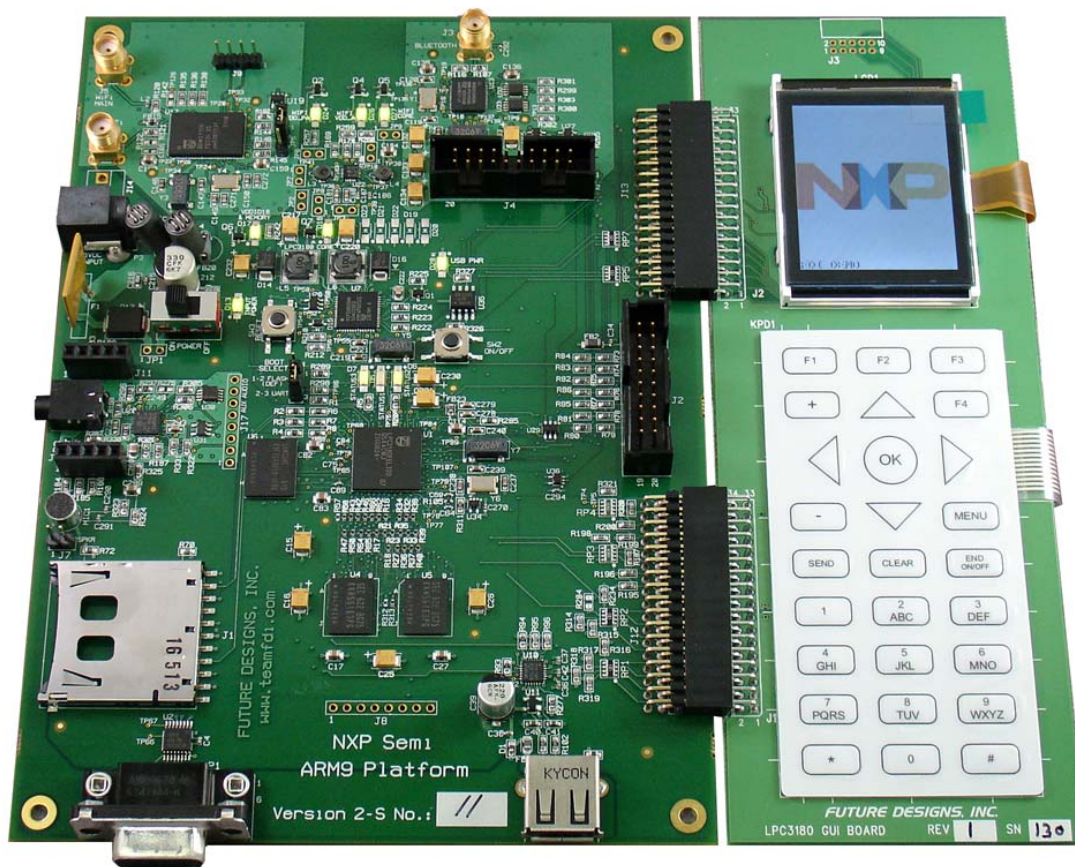


LPC3180 Development Kit

User's Manual



For Software and Documentation please go to:
www.teamfdi.com/lpc3180

Information in this document is provided solely to enable the use of Future Designs products. FDI assumes no liability whatsoever, including infringement of any patent or copyright. FDI reserves the right to make changes to these specifications at any time, without notice. No part of this document may be reproduced or transmitted in any form or by any means, electronic or mechanical, for any purpose, without the express written permission of Future Designs, Inc. 2702 Triana Boulevard, Huntsville, AL 35805

NOTE: The inclusion of vendor software products in an FDI kit does not imply an endorsement of the product by Future Designs, Inc.

© 2007 Future Designs, Inc. All rights reserved.

Microsoft, MS-DOS, Windows, Microsoft Word are registered trademarks of Microsoft Corporation
Other brand names are trademarks or registered trademarks of their respective owners.

Revision 2, 9/7/2007 11:04:00 AM
Printed in the United States of America

Table of Contents

1.0	Introduction.....	5
2.0	Guide to Kit.....	5
2.1	Kit Contents	5
2.2	Software and Documentation.....	5
2.3	Power Requirements	5
2.4	Jumpers	6
2.5	JTAG Connectors.....	6
2.6	Serial Connection.....	6
2.7	GUI Board.....	7
3.0	Hardware Setup.....	8
4.0	Software Installation	10
4.1	Host PC	10
4.2	Build System.....	11
5.0	Boot Process.....	12
5.1	SIBL.....	12
5.2	U-Boot.....	13
5.3	Linux Boot	13
5.4	SDRAM Memory Map	13
5.5	NAND Flash Memory Map	14
6.0	Downloading New Software.....	15
6.1	Loading Images Into SDRAM Memory	15
6.2	Writing SDRAM to NAND Flash.....	17
7.0	Building Images in Linux	19
7.1	Building U-Boot.....	19
7.2	Building the Linux Kernel	19
7.2.1.	Kernel Modules.....	20
7.3	Editing the root file system.....	20
8.0	Linux Features	21
8.1	USB Block Device.....	21
8.2	JFFS2	21
8.3	WIFI.....	21
8.4	Bluetooth.....	22
8.5	Framebuffer.....	22
9.0	Functional Tests	24
9.1	Entering Functional Test Mode	24
9.2	Functional Test Menu	24
9.3	Test LEDs	25
9.4	Test I2C1.....	25
9.5	Test I2C2.....	26
9.6	Test SPI.....	26
9.7	Test UART2 to Bluetooth.....	27
9.8	Exhaustive Memory Test	28
9.9	ST Codec Loopback test	28
10.0	Technical Support.....	30

- 11.0 General Sales and Contact Information 31
 - 11.1 General Sales 31
 - 11.2 Contact Information 31
- 12.0 APPENDIX A: Board Layout and Connectors..... 32
- 13.0 APPENDIX B: Schematic and Parts List 33
- 14.0 APPENDIX C: Framebuffer API..... 34
 - 14.1 IOCTL Calls..... 34
- 15.0 APPENDIX D: GUI Keypad Mapping..... 38

1.0 Introduction

The NXP LPC3180 Demo Board is a Linux based reference design that shows the ARM9-based microcontroller interfacing to an audio codec for VoIP, an 802.11b/g wireless network, Bluetooth transceiver, and user interface board. Features include:

- 200 MHz ARM926EJ-S Microprocessor (NXP LPC3180)
- 64 MB SDRAM Memory (Samsung K4M56163PG)
- 128 MB NAND Flash Memory (Samsung K9F1G08R0A)
- Wireless LAN 802.11b/g (NXP BGW211 SIP, Low power)
- Bluetooth 1.2 (NXP BGB203 SIP with 1SPP 1.2.4 firmware)
- Power Management (NXP PCF50606 & PCG50685)
- Optional Voice Codec (NXP PCF87757 1.8V Low power, low-noise)
- Audio Codec (STMicroelectronics STw5095)
- JTAG ports (CPU and Bluetooth)
- Low Power USB Port
- DB9 Serial Port
- SD Card slot
- LCD and Keypad expansion board (optional)

2.0 Guide to Kit

2.1 Kit Contents

The following items are included in the NXP LPC3180 Kit.

- LPC3180 Board Revision 2.0
- LPC3180 GUI Board Revision 1
- Condor AC Adapter 5V, 2.5A
- Serial Cable
- User's Manual

2.2 Software and Documentation

Currently, all software and documentation related to the LPC3180 Development Kit can be downloaded from the FDI website at www.teamfdi.com/lpc3180. The release distribution includes Gerber files, schematics, module datasheets, software currently on the board, as well as all other patches and setup software required to begin development.

2.3 Power Requirements

The LPC3180 Demo Board is powered by a wall mounted UL and FCC listed power supply designed for 110VAC outlets. It provides 5V DC at 2.5 Amp. The power connector is a 2.1mm plug with center positive polarity.

For some International Applications where a special 220V Power Supply is required, or for larger power supply options, contact Condor Power Supplies at phone number (408) 745-7141 or DigiKey at (800) 344-4539.

2.4 Jumpers

The following table lists all jumpers on the LPC3180 board, their default configurations, and a description on the manipulation of their positions.

NOTE: The silkscreen markings on Rev2 for JP4 are wrong. Please see the table below to see the correct configuration settings.

<i>Jumper</i>	<i>Positions</i>	<i>Description</i>
JP4	1-2	Allows Boot from UART Connection.
	2-3 (default)	Allows Boot from NAND Flash.
JP5	1-2 (default)	Allows PMU/JTAG to reset BGW211
	2-3	BGW211 can only be reset by POR

Table 1: Jumper Descriptions

2.5 JTAG Connectors

The following table lists the JTAG connectors of the LPC3180 board and the devices to which they connect.

<i>JTAG Connector</i>	<i>Device Connecting</i>
J2	LPC3180
J4	BGB203 Bluetooth

Table 2: JTAG Connections

2.6 Serial Connection

A serial connection may be made to the LPC3180 board from a host PC by connecting a serial cable from an open COM port on the host PC to connector P1 on the LPC3180 board. Jumpers JP2 and JP3 should both be in the 1-2 positions as described in Table 1. This connection allows the user to observe the full boot process and log into Linux after a successful boot. A proper configuration in HyperTerminal is described below:

```

Baud rate:      115200
Data bits:     8
Parity:        None
Stop bits:     1
Flow Control:  None
  
```

2.7 GUI Board

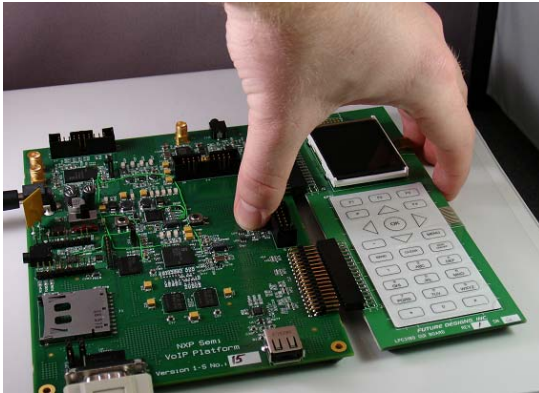
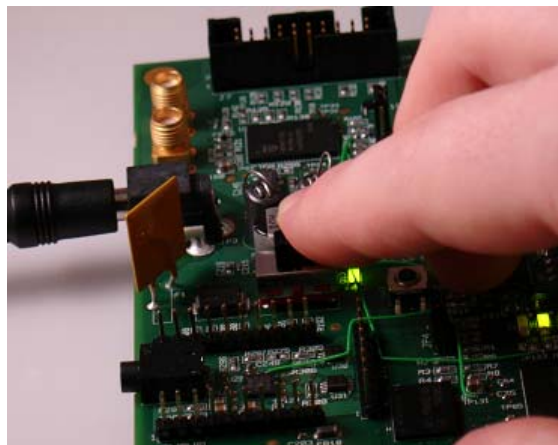
The GUI board provides an input/output interface to the LPC3180 board. The board contains a simple keypad with cellular phone-like buttons as well as the Densitron DVC40406 LCD module. The LCD module allows for a resolution of 128x160 and up to 65K Colors.

With the power off, the GUI board may be connected to the LPC3180 board by lining up connectors J12 and J13 of the LPC3180 board with connectors J1 and J2 of the GUI board, respectively, and pushing the boards together until a complete connection is made.

3.0 Hardware Setup

The list below outlines the necessary steps for getting the LPC3180 and optional GUI board up and running. Images are provided where necessary as visual aides to the setup process.

1. Place LPC3180 and GUI boards on a flat surface.
2. **OPTIONAL:** Connect GUI board to LPC3180 board by lining up connectors J12 and J13 of the LPC3180 board with connectors J1 and J2 of the GUI board, respectively. Push the boards together until a complete connection is made (see Figure 1).
3. Connect Condor Power supply from wall outlet to P3 on the LPC3180 board (see Figure 3).
4. Setup serial connection and HyperTerminal as described in section 2.6 (see Figure 2).
5. Toggle switch SW1 to provide power to the board(s) (see Figure 3). Text should be immediately visible in the HyperTerminal window and on the LCD panel (if connected).
6. If JTAG is immediately required, please consult section 0 on connecting JTAG for downloading software.

**Figure 1: GUI Board Connection****Figure 2: Serial Connection****Figure 3: Power Switch**

4.0 Software Installation

4.1 Host PC

To download images into the LPC3180 board's NAND flash, the J-Link Commander tool should be used. To install this product, double-click on the "Setup_JLinkARM_V356b.exe" file included in the distribution. After executing the file, the user will be prompted with the install wizard. Click "Next" to advance to the License Agreement:

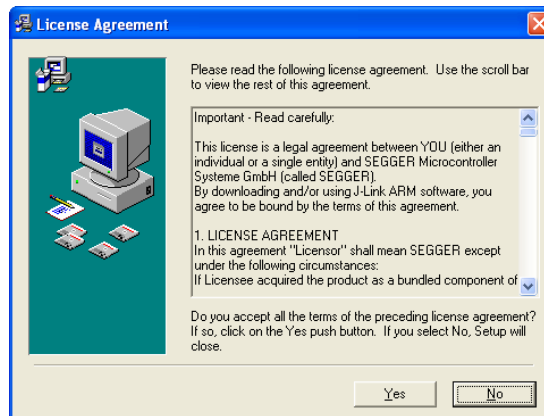


Figure 4: JLink License Agreement

Click "Yes" to agree to the license and "Next" to advance to the "Destination Location" window. The software should be installed in C:\Program Files\SEGGER\JLinkARM_V356b. Batch files included in the distribution reference the binary at this location. Therefore, if this installation path is modified the batch files must be updated with the new path:

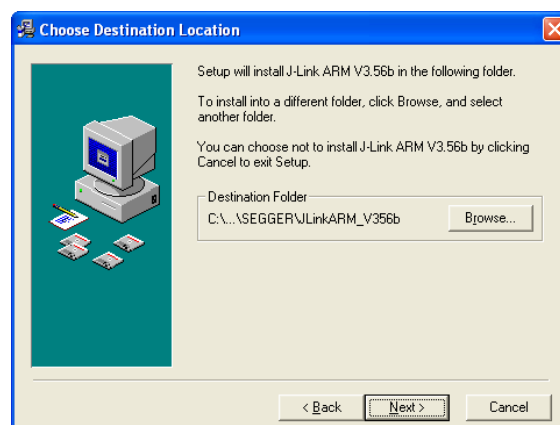
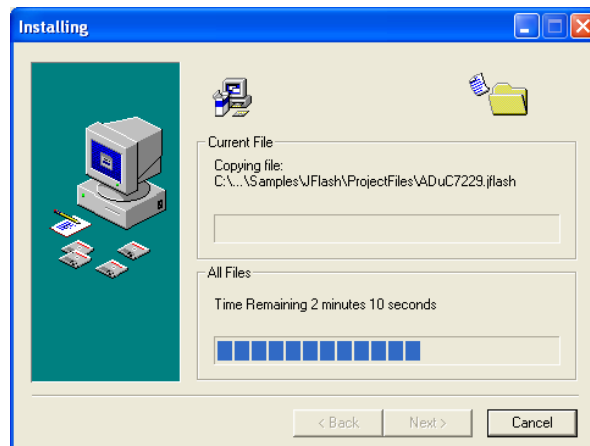
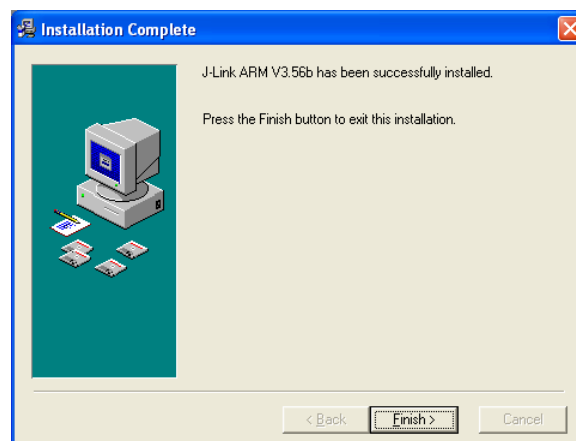


Figure 5: Destination Location

Click "Next" and "Next" again to begin the installation process. The install process will be reflected as files are copied to your machine:

**Figure 6: Install Progress**

Finally, click “Finish” to end the installation. Shortcuts should now be placed on your desktop which will allow you to open JLink Commander and run the programming scripts.

**Figure 7: Finish Installation**

4.2 Build System

To successfully re-build kernel, u-boot, and root filesystem images for the LPC3180 board, a build system must be set up. This requires setting up a proper environment for cross-compiling ARM binaries. Please see www.gnuarm.com for details on how to set up such a system.

5.0 Boot Process

This section provides a detailed description of the boot process for the LPC3180 board. First, a general list of steps is given as an overview to the boot process. A more detailed explanation is then provided for the main applications responsible for loading Linux on the LPC3180.

The boot process of the LPC3180 project is broken up into the following general steps:

1. On power-up, the LPC3180 begins booting by reading block 0 from the NAND flash.
2. The secondary boot loader called SIBL is loaded from NAND flash, stored in the LPC3180's internal RAM, and executed.
3. SIBL performs initialization commands on the LPC3180 and loads the u-boot, Linux Kernel, and root filesystem images from NAND flash into SDRAM at predefined locations.
4. U-Boot is then executed which performs other checks and initialization steps and finally executes the Linux Kernel image already in memory.
5. Linux boots using standard SysV Init and automatically modprobes all required kernel modules.
6. The user may then log into the LPC3180 board as superuser "root" with no password.

5.1 SIBL

The SIBL is the secondary boot loader that is executed before U-Boot. SIBL is responsible for most of the required initialization and also provides a mechanism to run functional tests on the LPC3180 board. A list of SIBL's main responsibilities includes:

1. Lock in the PLL to allow the LPC3180 to run at 208 MHz
2. Initialize, configure, and perform a quick read/write test on the SDRAM
3. Setup NAND controller and load the images out of Flash to SDRAM
4. Perform a CRC check on loaded images to verify their integrity
5. Walk through blocks in SDRAM until an executable image (U-Boot) is located and run.

On startup, the three LEDs located just above the LPC3180 will blink indicating CPU activity. Following this the LEDs will count from 1 to 5 in binary as SIBL progresses through various stages. This is useful in circumstances when the GUI board is not plugged in and a HyperTerminal connection is not being made from a Host PC.

The functional test mode may be entered by either holding down the F1 key on the keypad of the GUI board or the space key on the keyboard of the Host PC running HyperTerminal. For details on the purpose and use of the functional tests, please consult section 8.0 Functional Test.

The SIBL must be programmed into NAND flash with a special tool that also sets the first 512 bytes of the NAND flash to an appropriate configuration.

5.2 U-Boot

U-Boot is another boot loader which is mainly responsible for loading the Linux Kernel. It also provides a number of useful utilities. For example, the auto-boot process can be aborted and a command line system accessed to handle flashing of the NAND, memory testing, and other basic low level features (read/write individual bytes). If left to run, U-Boot will automatically start up the Linux system.

5.3 Linux Boot

Linux is loaded using a standard SysV Init method. As the kernel enters various run-levels scripts are executed which start specific daemons. One script run is the /etc/rcS.d/S40modprobe.sh script. This file is actually a symbolic link to a script located in /lib/modules/2.6.10/S40modprobe.sh. This script modprobes drivers on boot and may be modified depending on the level of functionality desired in the bootable kernel.

After the kernel finishes booting, the login prompt is observable from the HyperTerminal window. At this prompt, the user may log in by typing 'root' as the username with no password:

```
Copacabana - ARM Embedded Linux version 1.1-vfp
Monday 20 December 2004 @ 20:40
(none) login:
```

5.4 SDRAM Memory Map

Although the images loaded into SDRAM depend on the parameters in the .ubt files, below is the standard configuration used. The follow depicts where the images are loaded into memory, but the memory map may change as sections are uncompressed and/or moved.

Section	Address Start
RootFS	0x80000000
Linux Kernel	0x80620000
U-Boot	0x81EC0000

5.5 NAND Flash Memory Map

The NAND Flash is split into the following sections:

Section	Address Start
Interface Configuration data (ICR)	0x00000000
Secondary Boot Loader (SIBL)	0x00000800
RootFS	0x00020000
Linux Kernel	0x00620000
U-Boot	0x00800000
JFFS2 file system	0x01000000

6.0 Downloading New Software

Please consult the FDI website, www.teamfdi.com/lpc3180 for updated board images and other related software.

Updated software may be downloaded to the LPC3180's NAND flash memory using a two stage process. First, all images must be transferred via JTAG to the LPC3180's SDRAM. Next, these images in SDRAM are programmed into NAND flash using a utility within U-Boot. This section outlines the steps necessary to accomplish these tasks.

6.1 Loading Images Into SDRAM Memory

If the images for download have not been provided, they will need to be built following section 7.0

Building Images. Otherwise, the following steps may be used to transfer images to SDRAM:

The serial connection to the LPC3180 board should be configured according to the steps outlined in *2.6 Serial Connection*.

To properly communicate with the board using J-Link Commander, the J-Link-ARM-KS JTAG dongle should be connected to J2 on the LPC3180 Board (see Figure 8). J2 is located between GUI board connectors J12 and J13 on the right-hand side of the LPC3180 board. For assistance in installing J-Link Commander, please consult section *4.1*.

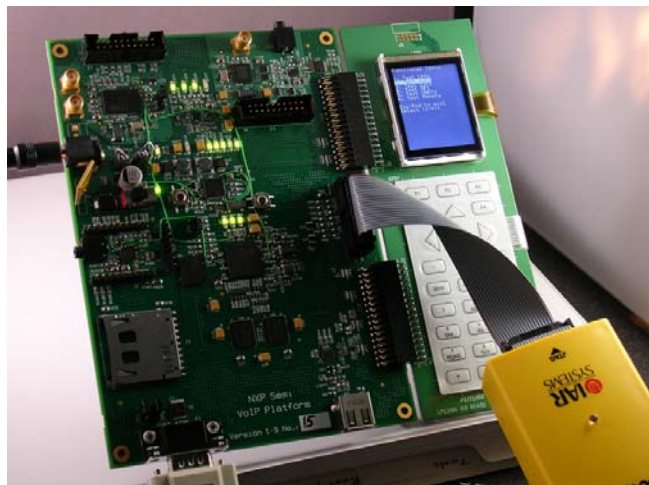


Figure 8: LPC3180 JTAG Connection

After connecting the LPC3180 Board to the power supply (+5VDC, 2.5A, center +), use the power switch SW1 to apply power on the board. If at any time the board needs to be reset, push button SW3 may be pressed to reset the LPC3180 without toggling the power switch.

Images may be downloaded to the LPC3180 Board's SDRAM by double-clicking on the "NXP Demo Setup" shortcut file or by entering the following commands manually into the JLink Commander prompt window:

```
r
loadbin SIBL_208Mhz.bin, 0
setpc 0
g
h
s
s
s
s
speed 4000
// Switch the Thumb -> ARM
w2 0x0 0xa000
```



```
w2 0x2 0x4700
w4 0x4 0xeaffffe
setpc 0
g
h
loadbin u-boot.bin, 81EC0000
loadbin rootfs.ubt, 80020000
loadbin kernel.ubt, 80620000
loadbin uboot.ubt, 80800000
setpc 81EC0000
```

NOTE: The “NXP Demo Setup” shortcut (..\Software\Binaries\Programmed_Images) expects JLink.exe to be located at "C:\Program Files\SEGGER\JLinkARM_V356b\JLink.exe". If this is not the case on your system, please modify the “NXP Demo Setup” shortcut.

NOTE: All .bin and .ubt files, except rootfs.ubt, should transfer to the LPC3180's SDRAM within a few minutes. The rootfs.ubt file may take up to 5 minutes to finish downloading depending on its size.

To run u-boot for NAND flash programming, it is necessary to enter the following commands into a J-Link Commander window. A new J-Link Commander window must be opened if the above commands were not typed in manually.

```
setpc 81EC0000
g
```

After performing the above command, you will only have a few seconds to react and enter U-Boot command prompt mode.

6.2 Writing SDRAM to NAND Flash

After the following u-boot banner appears, press any key to get to the command prompt.

```
Using default environment

In:      serial
Out:     serial
Err:     serial
Hit any key to stop autoboot:  2
```

After reaching the LPC3180 # prompt, the following commands should be executed sequentially:

```
LPC3180 # nand erase 00020000 00A00000
LPC3180 # nand write 80020000 00020000 500000
LPC3180 # nand write 80620000 00620000 160000
LPC3180 # nand write 80800000 00800000 040000
```

The first command erases the entire portion of NAND memory to which the images will be written. The second command writes the rootfs.ubt image to NAND and may take

several minutes to complete. The third command writes the kernel.ubt image to NAND and the fourth command writes the uboot.ubt image to NAND.

If it is desirable to only erase a particular image, the following commands are useful:

```
LPC3180 # nand erase 00020000 500000 (filesystem)
LPC3180 # nand erase 00620000 160000 (kernel)
LPC3180 # nand erase 00800000 040000 (u-boot)
```

All commands listed here are also provided within the “nand prg commands.txt” file in the distribution (..\Software\Programmed_Images).

Following the successful execution of the above commands, the board must be reset by pressing SW3 or power cycling the board.

7.0 Building Images in Linux

The following section explains the direct steps needed to compile the UBT files from their standard sources.

7.1 Building U-Boot

Currently, a patch should be applied against the standard u-boot-1.1.1 release. This release can be downloaded from **<ftp://ftp.denx.de/pub/u-boot/u-boot-1.1.1.tar.bz2>**. Next, the tarfile should be unzipped/extracted and the included patch applied to the source:

```
tar jxvf u-boot-1.1.1.tar.bz2
cd u-boot-1.1.1
patch -p1 < ../path/to/u-boot-1.1.1-lpc3180_FDI.patch
```

To compile U-boot, enter these commands (requires gnu arm-tools installed in /usr/local/arm/gnu):

```
export PATH=$PATH:/usr/local/arm/gnu/release-3.4.0-vfp/bin/arm-
linux-gcc
export ARCH=arm
export CROSS_COMPILE=arm-linux-
make distclean
make lpc3180db_config
make
make u-boot.axf
./tools/mkimage -A arm -O u-boot -T Firmware -C none -a 81EC0000 -e
81EC0000 -n "NXP Demo U-Boot v0.01" -d u-boot.bin uboot.ubt
```

7.2 Building the Linux Kernel

Currently, the patch provided should be applied against the vanilla linux-2.6.10 kernel. Therefore, this tree should be downloaded from **www.kernel.org**. Next, the tarfile should be unzipped/extracted and the included patch applied to the source:

```
tar zxvf linux-2.6.10.tar.gz
cd linux-2.6.10
patch -p1 < ../path/to/linux-2.6.10-lpc3180_FDI.patch
```

To compile the kernel, use the following commands (requires gnu arm-tools installed in /usr/local/arm/gnu):

```
export PATH=$PATH:/usr/local/arm/gnu/release-3.4.0-vfp/bin/arm-
linux-gcc
export ARCH=arm
export CROSS_COMPILE=arm-linux-
source ./setup_links
make clean
make lpc3000evb_defconfig
make
make uImage
```

```
mkimage -A arm -O Linux -T Kernel -C none -a 80620000 -e 80620000 -n  
"NXP Demo Linux-2.6.10" -d arch/arm/boot/uImage kernel.ubt
```

7.2.1. Kernel Modules

In the case where kernel modules must change, it is necessary to install the kernel modules into the root file system image and re-download the image onto the board (see section 6.0 *Downloading New Software*). This is performed by mounting the root file system (see section 7.3 *Editing the root file system*) and performing the following commands:

```
export INSTALL_MOD_PATH=/path/to/mnt_rootfs  
make modules_install
```

This will install all newly compiled kernel modules into the directory `/path/to/mnt_rootfs/lib/modules/2.6.10`.

Unfortunately, the ST Codec and WIFI kernel modules are over-written when this occurs. The modules should be copied over into their respective locations:

```
cp vhw.ko /path/to/mnt_rootfs/lib/modules/2.6.10/kernel/drivers/i2c  
cp ga_linuxdrv_211_pnx4008_spi.ko  
/path/to/mnt_rootfs/lib/modules/2.6.10/kernel/drivers/net
```

Additionally, the file `/path/to/mnt_rootfs/lib/modules/2.6.10/modules.dep` must be modified so that the “modprobe” command may be used to insert and remove the `vhw.ko` driver. The following line should be added:

```
/lib/modules/2.6.10/kernel/drivers/i2c/vhw.ko:
```

This indicates to the module loader that the kernel module has no dependencies.

7.3 Editing the root file system

Before editing the file system, you must mount it. On a Linux build machine, enter

```
gzip -d ../Software/rootfs/root_fs.gz  
mount -o loop root_fs ../path/to/mnt_rootfs/
```

Make changes to the files in `mnt_rootfs` and then enter these commands:

```
umount mnt_rootfs  
gzip root_fs  
mkimage -A arm -O Linux -T Filesystem -C none -a 80800000 -e 0 -n  
"NXP Demo RootFS v0.00" -d root_fs.gz rootfs.ubt
```

8.0 Linux Features

8.1 USB Block Device

To connect a USB block device such as a USB Flash Drive to the LPC3180 board, simply insert it into connector P2 on the lower-right of the board. As of Rev2, the board now provides USB power to external devices. The following command should be issued to force USB into host mode:

```
echo host > /sys/devices/platform/container-dev-1/forced_mode
```

The device may then be connected to the hub. Some messages should print to hyperterminal following the insertion of the device informing the user a device has been located. For the first device inserted, the first partition is found at /dev/sda1 whereas the second device will be found at /dev/sdb, and so on. After the device settles, the following commands may be used to create a mount point and mount the device:

```
mkdir /mnt/usb  
mount -t auto /dev/sda1 /mnt/usb
```

NOTE: As of Release 1.03, the command above is already issued on boot and it is not necessary to re-issue it within Linux. As a result, following boot a USB Block Device may be inserted at any time.

8.2 JFFS2

In the on-board NAND Flash, a space of 15 Megs has been reserved for a JFFS2 image. Follow these instructions to mount the drive:

```
mkdir /nv  
mount -t jffs2 /dev/mtdblock0 /nv
```

NOTE: As of Release 1.03, the above commands are already issued on boot and it is not necessary to re-issue them within Linux. Furthermore, a check is made on startup for the existence of the file /nv/startup.sh. If this file exists, it is executed. This allows the user to include custom startup utilities without reprogramming the board.

8.3 WIFI

Disclaimer: BGW211 drivers available on the reference design are available for use. They are supported "as is" and there is no commitment from NXP or FDI for bug fixing. An updated driver will likely be available in Q4-2007. Existing driver on the system has been tested in the lab environment, but has not been certified by any SIG. If a problem is found, refer to the "as is" statement above.

To enable WIFI on the LPC3180 board, special commands must be issued prior to the loading of the module. The commands are:

```
echo "cs=1,client=wlan,cs_pin=GPO_21,flags=1,mbx_int=36,mbx_pin=
spi_11" > /sys/devices/platform/spi-pnx1/cs_table

cat /sys/devices/platform/spi-pnx1/cs_table
```

The module itself can be found in the kernel module repository (/lib/modules/2.6.10/kernel/drivers/net/ga_linuxdrv_211_pnx4008_spi.ko), but is not loaded in the same manner as the other drivers due to the necessity of the two above commands. To facilitate driver setup and configuration, a startup script called "startWIFI.sh" is created and placed within the /nv directory on the LPC3180 board. By default, each script is setup to statically assign the IP and MAC addresses of the board according to the serial number on the board. For example, if the board's serial number is 32, its IP address is 192.168.1.32 and the MAC address is aabbcc7ea32. Please note that if the serial number is only 1 or 2 digits, the place-holder for the 100's and 10's digit in the MAC address is replaced with the letter 'a'. The ESSID, MODE, and WEP key are left unmodified in the script to be configured by the user. Standard 'wireless-tools' commands are used to configure WIFI within the scripts.

8.4 Bluetooth

Each LPC3180 board is equipped with the NXP BGB203 Bluetooth module programmed with version 1.2.4 of the NXP 1SPP firmware.

For correct operation, a modified version of the pshs_uart.ko kernel module must be used which raises the reset line to the BGB203 upon initialization. Also, the pshs_uart.ko module creates three high-speed UART devices according to the layout of the LPC3180. The BGB203 is connected to UART2 which corresponds to /dev/ttyPSHS0 within the device filesystem. Communication with the BGB203 is accomplished with modem commands sent over the UART. Please consult the 1SPP user's manual for more information.

8.5 Framebuffer

The included GUI board comes equipped with an LCD panel controlled by the Solomon Systech SSD1783U2 LCD Controller. For access within Linux, a framebuffer kernel module was written and is included in the kernel patch file.

The following table shows a list of files and their purpose as they relate to the framebuffer module. Each file is placed into the kernel tree after the linux-2.6.10-lpc3180_FDI.patch file is applied.

<i>File</i>	<i>Location</i>	<i>Description</i>
ssdfb.c	\${LINUX}/drivers/video	The framebuffer driver code. This code interacts with the linux kernel to create and manipulate the framebuffer device.

ssdfb.h	\${LINUX}/include/linux	Contains IOCTL defines and others used by ssdfb.c. Should be included by user applications to access IOCTL commands.
LCD_SSD1783B.c	\${LINUX}/drivers/video	This file contains the low-level code to communicate with the SSD1783U2 controller. It must be linked with the ssdfb.c code during module compilation.
LCD_SSD1783B.h	\${LINUX}/include/linux	This file contains defines and functional prototypes for all capabilities of the SSD1783U2 controller.
LPC3180_GPIO.h	\${LINUX}/include/linux	This file contains defines for working with the LPC3180 GPIO pins.
Makefile	\${LINUX}/drivers/video	This file has been modified to include framebuffer support directly into the linux kernel. Also, lines were added to successfully compile ssdfb.c and link it during the 'make modules' stage of compilation.
lpc3000evb_defconfig	\${LINUX}/arch/arm/configs	This file contains modifications to enable framebuffer support directly in the kernel when building kernel images.
setup_links	\${LINUX}	This file is sourced prior to cross-compiling the linux kernel for the ARM architecture. It specifically sets the CONFIG_FB_SOLSYS environment variable to 'm' to compile the ssdfb as a module.

During kernel compilation, it is important to set the following environment variable to build the framebuffer module with the rest of the kernel:

```
export CONFIG_FB_SOLSYS=m
```

If desirable, this command can be placed within the setup_links file within the kernel root.

Please consult section *14.0 APPENDIX C Framebuffer API* for a detailed list of IOCTL commands to interact with the framebuffer in a user-space application.

9.0 Functional Tests

A group of functional tests are bundled with SIBL for verification and debugging purposes on the LPC3180 board. This section describes these functional tests and shows how they are useful in trouble-shooting the board. A list of the functional tests is provided below:

1. LED Test
2. I2C Tests
3. SPI Tests
4. Uart2 to Bluetooth Test
5. Exhaustive Memory Test

9.1 Entering Functional Test Mode

To access the functional tests within SIBL, the F1 key should be pressed and held while the power switch (SW1) is toggled. Alternatively if the GUI board is not present, the space key may be tapped after observing the following text in HyperTerminal:

```
NXP LPC3180 Demo  
FDI SIBL v1.00
```

SIBL will perform initialization and the quick memory test before going into Functional Test Mode.

9.2 Functional Test Menu

Figure 9 shows the main menu listing all functional tests to choose from. The number keys on the keyboard or GUI keypad may be used to make selections. The particular test selected will be highlighted in white. For example, in Figure 9, functional test “2. Test I2C1” is selected. After pressing the number of the test desired, the Enter key/OK button should be pressed to enter the test.

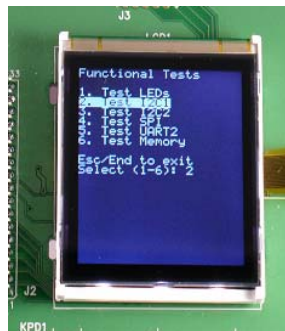


Figure 9: Functional Tests Menu

Also, if using the GUI board, the up and down keys on either side of the ‘OK’ button may be used to scroll through the tests.

Pressing the Esc key/End button will exit functional test mode and boot the LPC3180 board into Linux as normal.

9.3 Test LEDs

This test verifies functional GPIO pins from the LPC3180 as well as proper operation from the LEDs themselves. After selecting the test, the user may repeatedly press the space key/OK button to light up LED 1, LED 2, or LED 3. The LEDs should follow the pattern 1, 2, 3, and then repeat. As the user continually presses the test will echo out the LED number currently lit. Figure 10 shows the LCD and LEDs after pressing the OK button a number of times.

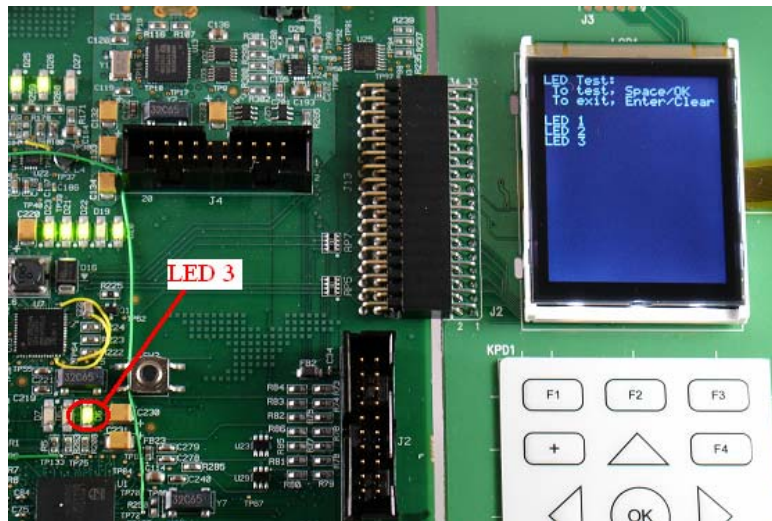


Figure 10: LED Test

To end the test, the Enter key/Clear button may be pressed. This will bring up the main menu.

9.4 Test I2C1

The I2C1 Test proceeds to probe a range of addresses for devices connected to the I2C1 bus. This test begins immediately when the user selects it from the main menu. If an address times out, a message is printed to the screen and the word “FAILED” is printed in red indicating there was a problem with the test. If the test runs correctly, two devices should be found at 0x10 and 0x48. Figure 11 shows a successful test run for I2C1.

**Figure 11: I2C1 Test**

After the test runs, the user may press the Enter key/OK button to return to the main menu.

9.5 Test I2C2

This test is exactly like the I2C1 test outlined in the previous section. However, devices are probed for at a different location, and devices should be found at different locations. For this test, devices should be located at 0x34 and 0xE2.

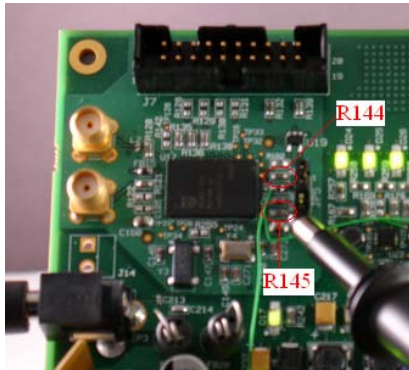
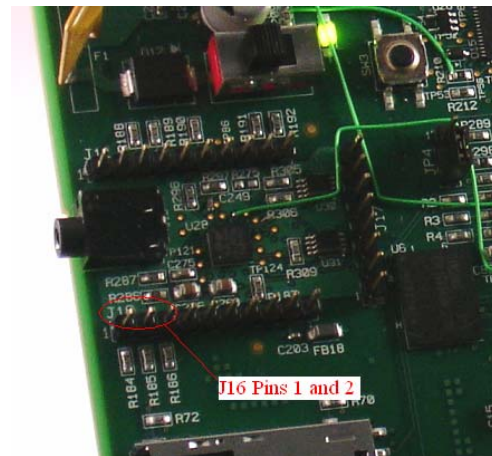
9.6 Test SPI

The SPI1 and SPI2 tests are currently wrapped up into a single SPI test from the main menu. This test verifies correct operation of the SPI bus by sending out a pattern which may be observed using an oscilloscope.

The oscilloscope should be configured with a trigger value of 1V and 1ms/Div. The ground may be connected to pin 20 of JTAG connector J4 as shown in Figure 12.

**Figure 12 Oscilloscope Ground Connection**

After selecting the test, place the probe on the right side of resistor R145 and press the Space key/OK button to issue the test. A spike should be observed on the oscilloscope output indicating successful communication across the SPI1 bus. If the spike is not observed, verify the probe is on the resistor properly, and press the Space key/OK button again to re-issue the test. This process should be repeated for R144. The locations of these resistors are shown in Figure 13.

**Figure 13: Probe locations for SPI1 Test****Figure 14: Probe locations for SPI2 Test**

After satisfactory results are obtained, the Enter key/Clear button may be pressed to advance to the SPI2 test. During this test, the oscilloscope probe should be moved to pins 1 and 2 on connector J16 (see Figure 14), and the same procedure should be used to issue the test.

To exit the test and return to the main menu, the Enter key/Clear button may be pressed.

9.7 Test UART2 to Bluetooth

This test verifies the connection of UART2 from the LPC3180 to the Bluetooth device. After selecting the test from the main menu, the Space key/OK button may be used to send the 'U' character over the UART. To verify this actually takes place, the oscilloscope should be configured as described in the previous section. The oscilloscope probe should be connected to pin 2 of U33 as shown in Figure 15. A similar spike as in the previous test should be observable on the oscilloscope output when the 'U' is sent across the UART.

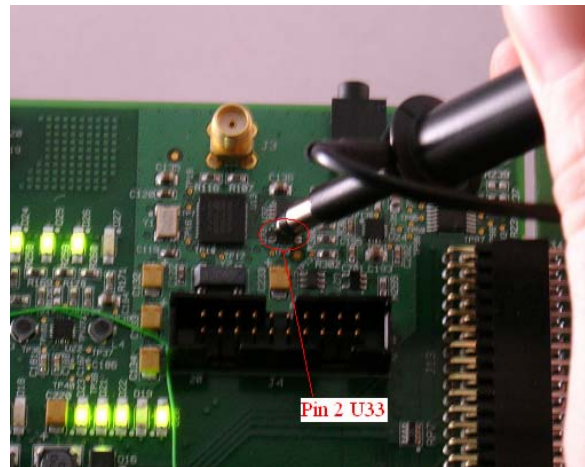


Figure 15: Probe Connections for UART Test

9.8 Exhaustive Memory Test

The memory test within the functional test code is very different from the quick memory check implemented in the SIBL POST code. This memory test will continually write a different pattern to each location in SDRAM and read back the pattern to make sure the write was successful. The sequence of the test goes as follows:

1. Write a pattern to each location in SDRAM
2. Read back the pattern from each location to make sure the write was successful.
3. Complement the pattern and repeats steps 1 and 2.
4. Increment the pattern and repeats steps 1 through 4.

Due to the nature of the test, it may be exited at any time by pressing and holding the “Clear” key on the GUI keypad until the test returns to the main menu. Also, if using HyperTerminal, the space key may be tapped and the test will return to the main menu following its current iteration.

9.9 ST Codec Loopback test

The current ST Codec kernel module only provides minimal initialization commands for the chip and currently cannot be used for any particular purpose without modification.

To verify chip activity a special version of this driver was created to affectively re-transmit all sound received on a headset microphone to the headset speaker. By default, this driver is not loaded, but a slight modification within the `/nv/startup.sh` file allows it to be enabled on boot. Simply uncomment the following lines in the file to test the loopback driver:

```
#####
### ST Codec Loopback
#####
# Uncomment the following lines to remove the ST Codec driver
# and insmod the loopback one

#/bin/lsmod | grep -q vhw
```

```
#if [ $? -eq 0 ]  
#then  
#     echo "Unloading vhw module..."  
#     modprobe -r vhw  
#fi  
  
#echo "Loading loopback vhw module..."  
#insmod /nv/STloopback/vhw.ko
```

NOTE: In some cases it was necessary to directly connect the digital and analog grounds to successfully hear the loopback. This is accomplished by connecting pin 2 of J11 to pin 8 of J17.

10.0 Technical Support

NXP Semiconductors provides technical support for the LPC3180 and other NXP devices utilized on this board. Please contact your local NXP sales office or Field Applications Engineer.

IAR Systems provides technical support for the J-Link Commander Software and J-Link-ARM-KS dongle. You may request assistance for any issues encountered by filling out a request form at <http://supp.iar.com/Support/Request/>.

Technical support for the LPC3180 Development Kit is provided by Future Designs, Inc. For fastest response;

- e-mail: **support@teamfdi.com**
- fax: (256) 883-1241
- phone: (256) 883-1240.

FDI also provides a Web site at: <http://www.teamfdi.com>. This web site provides the latest product information and updates for all FDI products.

11.0 General Sales and Contact Information

11.1 General Sales

Authorized sales representatives for the LPC3180 Development Kit include:

Worldwide contact:

FDI <http://www.teamfdi.com> (256) 883-1240

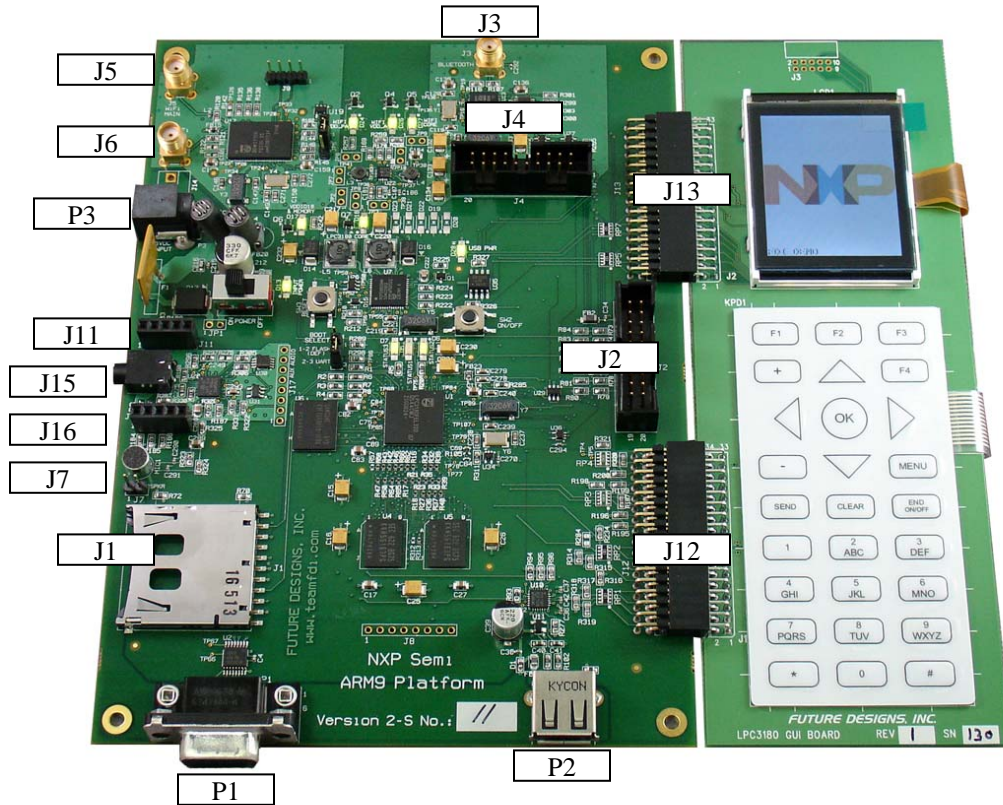
11.2 Contact Information

The following is a list of company contact information related to the NXP LPC3180 Kit.

NXP Semiconductors web site: <http://www.nxp.com>

IAR Systems web site at <http://www.iar.com>

12.0 APPENDIX A: Board Layout and Connectors



Connection	Usage
J1	SDCard
J2	JTAG (LPC3180)
J3	50 Ohm Antenna (Bluetooth)
J4	JTAG (Bluetooth)
J5	50 Ohm Main Antenna (WLAN)
J6	50 Ohm AUX Antenna (WLAN)
J7	8 Ohm External Speaker Connection
J9	BGW211 UART Header
J11	Daughter Board Connector 1
J12	GUI Keypad Connector
J13	GUI Display Connector
J15	Headset Jack (to Audio Codec - STw5095)
J16	Daughter Board Connector 2
P1	DB9 Serial (Female)
P2	USB (Type-A, Female)
P3	Power (5V, 2.4A, center positive)

Table 3: LPC3180 Connectors

13.0 APPENDIX B: Schematic and Parts List

Please refer to the Hardware documentation within the distribution for latest schematics and parts list for the LPC3180 Demo Board.

14.0 APPENDIX C: Framebuffer API

14.1 IOCTL Calls

Applications in the userspace may manipulate the LCD controller using certain IOCTL commands provided by the framebuffer module. This section outlines these IOCTL calls, lists expected arguments, and provides an example of its use.

1. FBIO_DUMPSCREEN

- a. Purpose: Updates the screen with the latest data written to memory. The 4 arguments allow the user to update a localized portion of the screen or the whole screen if desired.
- b. Arguments: Address of 4 element unsigned int array using the following format: { x_Location, y_Location, x_Resolution, y_Resolution }
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
unsigned int to_send[4]={0, 0, 128, 160};

if (ioctl(fbfd, FBIO_DUMPSCREEN, &to_send )) {
    printf("Error dumping memory to LCD.\n");
    exit(1);
}
```

2. FBIO_TOGGLEONOFF

- a. Purpose: This command turns off the LCD Controller if it is on or turns it on if the LCD Controller is off.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_TOGGLEONOFF)) {
    printf("Error toggling screen on/off.\n");
    exit(1);
}
```

3. FBIO_SCREENOFF

- a. Purpose: Turns off the screen if it is on. If the screen is already off, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_SCREENOFF)) {
    printf("Error turning screen off.\n");
    exit(1);
}
```

4. FBIO_SCREENON

- a. Purpose: Turns on the screen if it is off. If the screen is already on, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_SCREENON)) {  
    printf("Error turning screen on.\n");  
    exit(1);  
}
```

5. FBIO_TOGGLESLEEP

- a. Purpose: This command puts the LCD panel to sleep if it is awake or wakes it if the LCD panel is asleep.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_TOGGLESLEEP)) {  
    printf("Error toggling screen sleep.\n");  
    exit(1);  
}
```

6. FBIO_SLEEPON

- a. Purpose: If the LCD panel is awake, this command explicitly puts it to sleep. If the LCD panel is asleep, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_SLEEPON)) {  
    printf("Error turning sleep on.\n");  
    exit(1);  
}
```

7. FBIO_SLEEPOFF

- a. Purpose: If the LCD panel is asleep, this command explicitly wakes it up. If the LCD panel is awake, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_SLEEPOFF)) {  
    printf("Error turning sleep off.\n");  
    exit(1);  
}
```

8. FBIO_TOGGLEINVERT

- a. Purpose: If the screen is not inverted, this command places the screen in inverted mode. If the screen is inverted, this command places the screen in normal mode:
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_TOGGLEINVERT)) {  
    printf("Error toggling screen invert.\n");  
    exit(1);  
}
```

9. FBIO_INVERTON

- a. Purpose: If the screen is in normal mode, this command places the screen in inverted mode. If the screen is already inverted, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_INVERTON)) {  
    printf("Error inverting screen.\n");  
    exit(1);  
}
```

10. FBIO_INVERTOFF

- a. Purpose: If the screen is in inverted mode, this command places the screen in normal mode. If the screen is already in normal mode, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_INVERTOFF)) {  
    printf("Error inverting screen.\n");  
    exit(1);  
}
```

11. FBIO_CONTRASTPLUS

- a. Purpose: Increments the screen's contrast adjustment by 1. If the contrast adjustment is at its highest possible value, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_CONTRASTPLUS)) {  
    printf("Error increasing screen contrast.\n");  
    exit(1);  
}
```

12. FBIO_CONTRASTMINUS

- a. Purpose: Decrements the screen's contrast adjustment by 1. If the contrast adjustment is at its lowest possible value, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_CONTRASTMINUS)) {  
    printf("Error decreasing screen contrast.\n");  
    exit(1);  
}
```

13. FBIO_BRIGHTNESSPLUS

- a. Purpose: Increments the screen's brightness adjustment by 1. If the brightness adjustment is at its highest possible value, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_BRIGHTNESSPLUS)) {  
    printf("Error increasing screen brightness.\n");  
    exit(1);  
}
```

14. FBIO_BRIGHTNESSMINUS

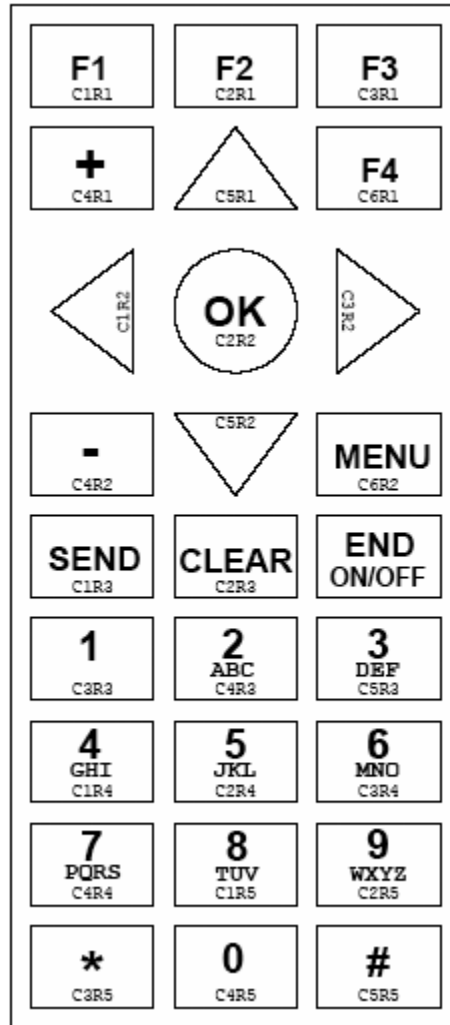
- a. Purpose: Decrements the screen's brightness adjustment by 1. If the brightness adjustment is at its lowest possible value, this command has no effect.
- b. Arguments: None
- c. Returns: 1 on failure, 0 on success
- d. Example:

```
if (ioctl(fbfd, FBIO_BRIGHTNESSMINUS)) {  
    printf("Error decreasing screen brightness.\n");  
    exit(1);  
}
```

NOTE: In addition to the IOCTL commands above, the IOCTL calls FBIOGET_FSCREENINFO and FBIOGET_VSCREENINFO are also available through the generic Linux framebuffer interface.

15.0 APPENDIX D: GUI Keypad Mapping

Each button is assigned a column (Cx) and row (Ry) as shown below.



FDI *Future Designs, Inc.*
Your Development Partner
2702 Triana Boulevard SW, Huntsville, AL 35805