EM-1240-LX User's Manual

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EM-1240-LX User's Manual

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Introduction

The Moxa EM-1240-LX Series of Mini RISC-based Ready-to-Run Embedded Computer features dual 10/100 Mbps Ethernet ports and four RS-232/422/485 serial ports in a built-in µClinux ARM9 module. In addition, the EM-1240-LX supports an SD memory card for storage expansion, offers high performance communication and unlimited storage in a super compact, palm-sized module. The EM-1240-LX is an ideal solution for embedded applications that use a lot of memory and must be housed in a small physical space without sacrificing performance.

In this chapter we cover the following topics:

Overview

The EM-1240-LX Series of mini RISC-based communication platforms are ideal for your embedded applications. The EM-1240-LX comes with 4 RS-232/422/485 serial ports and dual 10/100 Mbps Ethernet LAN ports to provide users with a versatile communication platform.

The EM-1240-LX uses the Moxa ART ARM9 RISC CPU. Unlike the X86 CPU, which uses a CISC design, the ARM9's RISC design architecture and modern semiconductor technology provide the EM-1240-LX with a powerful computing engine and communication functions, but without generating too much heat. The built-in 8 MB NOR Flash ROM and 16 MB SDRAM give you enough storage capacity and an additional SD socket provides you with flexible storage expansion to run applications. The dual LAN ports built into the ARM9 make the EM-1240-LX an ideal communication platform for simple data acquisition and protocol conversion applications, and the two RS-232/422/485 serial ports allow you to connect a variety of serial devices.

The pre-installed μClinux operating system provides an open software operating system for software program development. Software written for desktop PCs is easily ported to the EM-1240-LX with a GNU cross compiler, so that you will not need to spend time modifying existing software code. The operating system, device drivers, and your own software can all be stored in the EM-1240-LX's Flash memory.

Package Checklist

EM-1240-LX

Mini RISC-based ready-to-run embedded computer with 4 serial ports, dual Ethernet, SD, μClinux OS

EM-1240-LX Series products are shipped with the following items:

- 1 EM-1240-LX embedded module
- 1 EM-1240-LX Development Kit (optional)
- Quick Installation Guide
- Document & Software CD
- Cross-over Ethernet cable
- CBL-RJ45M9-150: 150 cm, 8-pin RJ45 to male DB9 serial port cable
- CBL-RJ45F9-150: 150 cm, 8-pin RJ45 to female DB9 console port cable
- Power cord
- Product Warranty Statement

NOTE*: Notify your sales representative if any of the above items are missing or damaged.*

Product Features

EM-1240-LX Series products have the following features:

- MOXA ART ARM9 32-bit 192 MHz communication processor
- On-board 16 MB RAM, 8 MB Flash ROM
- 4 software-selectable RS-232/422/485 serial ports
- 2 10/100 Mbps Ethernet ports
- RS-232 console, with full signal and PPP support
- Ready-to-run μCLinux Kernel 2.6.9 communication platform
- SD signal supported

Product Specifications

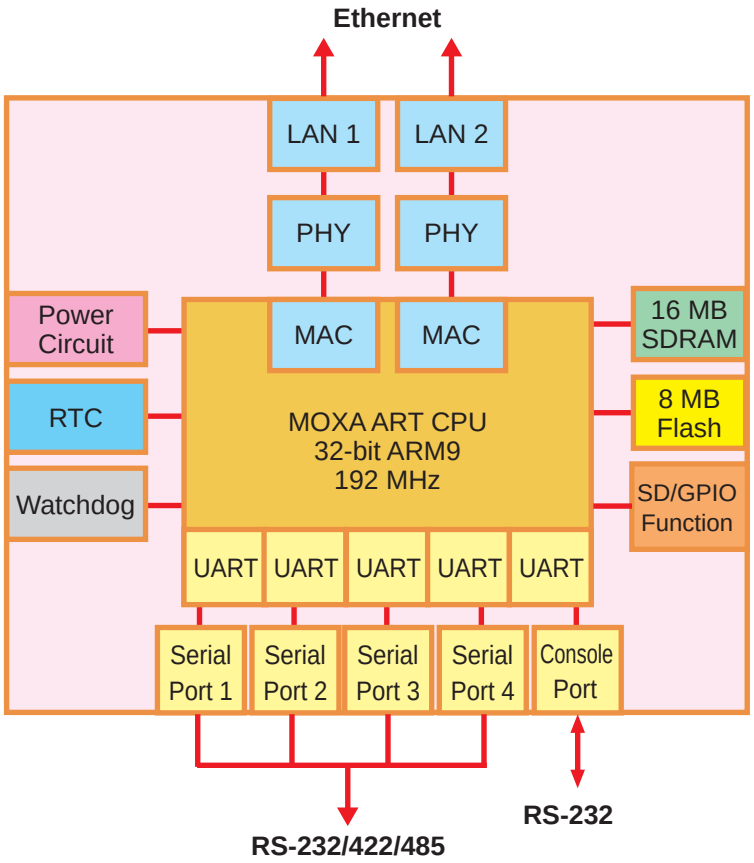
Hardware Specifications

Model	**EM-1240 Embedded Module**
CPU	Moxa ART ARM9 32-bit 192 MHz processor
RAM	16 MB
Flash	8 MB
LAN	Auto-sensing 10/100 Mbps × 2
LAN Protection	Built-in 1.5 KV magnetic isolation
Serial Ports	**Four serial ports supporting RS-232/422/485 signals** **RS-232 signals:** TxD, RxD, DTR, DSR, RTS, CTS, DCD, GND **RS-422 signals:** TxD+, TxD-, RxD+, RxD-, GND **4 wire RS-485 signals:** TxD+, TxD-, RxD+, RxD-, GND **2 wire RS-485 signals:** Data+, Data-, GND
	Serial Protection: 15 KV ESD for all signals
	Data bits: 5, 6, 7, 8
	Stop bit(s): 1, 1.5, 2
	Parity: None, even, odd, space, mark
	Flow Control: RTC/CTS, XON/XOFF
	Speed: 50 bps to 921.6 Kbps, supports Any Baudrate
Serial Console	RS-232 × 1, TxD, RxD, DTR, DSR, RTS, CTS, DCD, GND
Storage Expansion	SD signals for external Secure Digital (SD) socket connection
GPIO	GPIO × 10 (to enable GPIO, SD must be disabled.)
Real-time Clock	Yes
Watchdog Timer	Yes
Buzzer Signals	Buzzer signals reserved for external buzzer connection
LED Signals	LAN 10/100 × 2 on LAN Connector Reserve signals for the following LED connections: System Ready × 1 Serial Port Status × 4 pairs (TxD, RxD, 2 for each pair)
Reset Signal	Reserve signal for external "Reset to Default" button connection
Power Input	Accepts external 5 VDC through pin header
Dimensions (W × L)	90 × 80 mm
Operating temperature	-10 to 60°C (14 to 141°F), 5 to 95% RH
Storage temperature	-20 to 80°C (-4 to 176°F), 5 to 95% RH
Module Interface	Two 2 × 28 pin-headers; pitch: 1.27 × 1.27 (mm)

Software Specifications

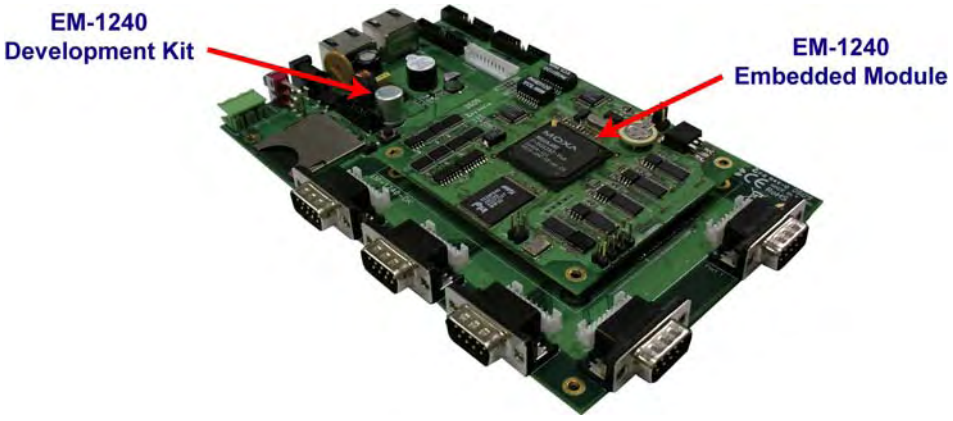
Kernel	µClinux Kernel 2.6.9 Supports dynamic driver module load / unload
Protocol Stack	ARP, ICMP, IPV4, TCP, UDP, FTP, Telnet, SNMP V1/V2c, HTTP, CHAP, PAP, DHCP, NTP, NFS V2/V3, SMTP, Telnet, FTP, PPP, PPPoE
File System	JFFS2 for Kernel, Root File System (Read Only) and User Directory (Read / Write)
Msh	Minix shell command
pppd	Dial in/out over serial port daemon
PPPoE	Point-to-Point over Ethernet daemon
snmpd	SNMP V1/V2c Agent daemon
busybox	Linux normal command utility
Tinylogin	login and user manager utility
Telnetd	Telnet server daemon
telnet	Telnet client program
inetd	TCP server manager program
ftpd	FTP server program
ftp	FTP client program
boa	Web server daemon
ntpdate	Network Time Protocol client utility
Tool Chain	
Linux Tool Chain	Arm-elf-gcc (V2.95.3): C/C++ PC Cross Compiler uClibc (V0.9.26): POSIX standard C library

Hardware Block Diagram

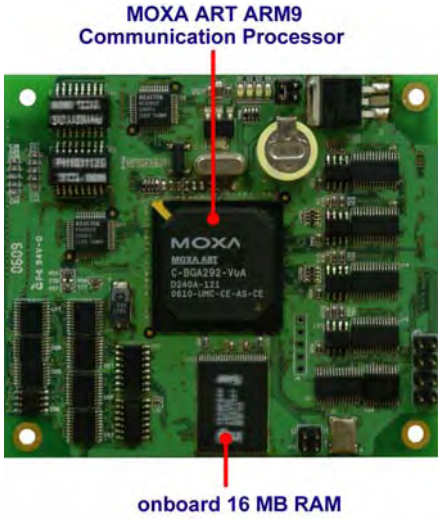


Appearance

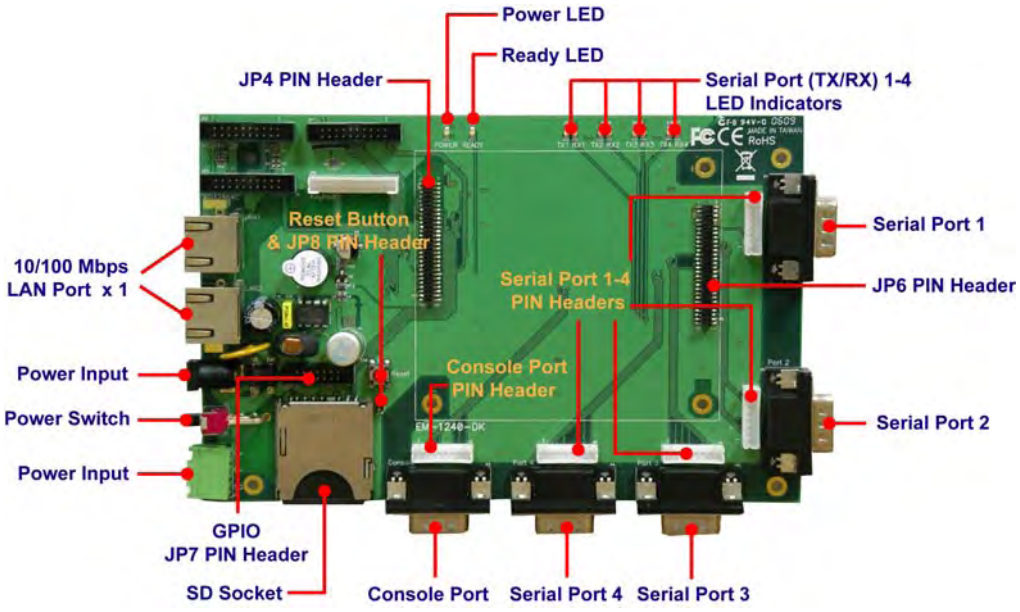
EM-1240 Embedded Module + Development Kit



EM-1240 Embedded Module

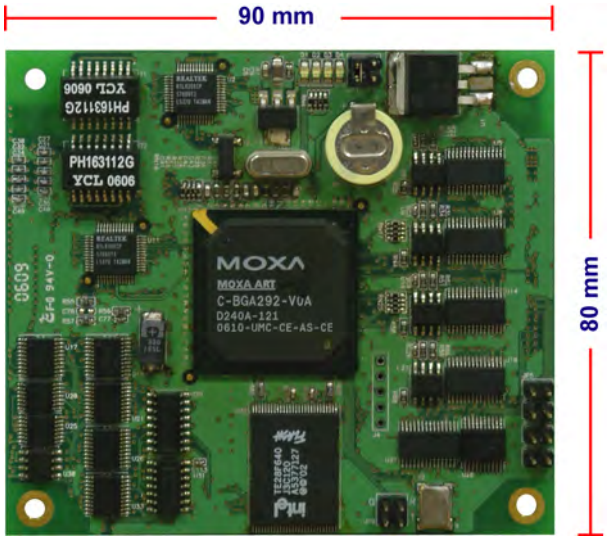


EM-1240 Development Kit

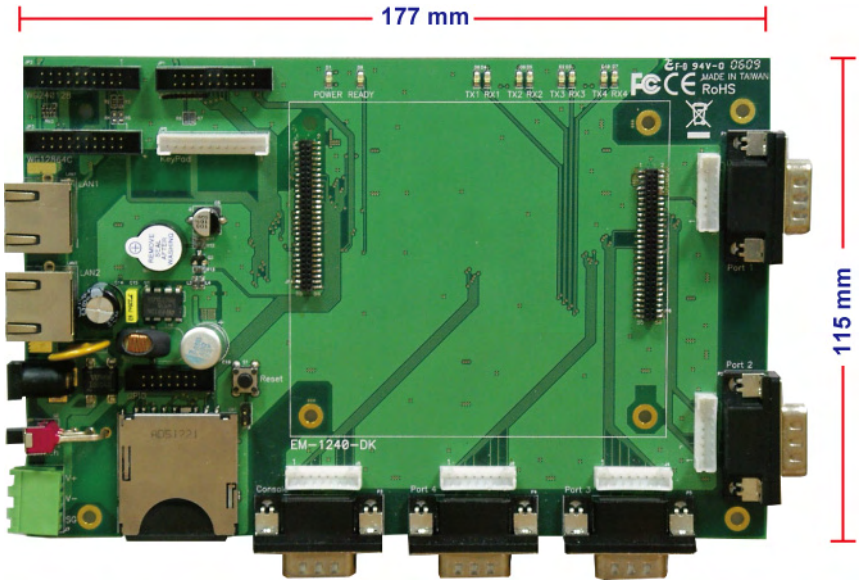


Dimensions

EM-1240 Embedded Module



EM-1240 Development Kit



Installing the EM-1240-LX

If you would like to use the EM-1240 Embedded Module and the EM-1240 Development Kit, insert the EM-1240 Embedded Module vertically onto the Development Kit. Note that the pin marked "JP4" on the Embedded Module must be matched with the pin marked "JP6" on the Development Kit; and the Pin marked "JP3" on the Embedded Module must be matched with the Pin marked "JP4" on the Development Kit. Be careful when inserting the module to avoid damaging the product.

LED Indicators

The following table explains the function of the five LED indicators located on the EM-1240-LX's top panel.

LED Name	LED Color	LED Function
Ready	Green	Power is on and functioning normally.
P1/P2 (Tx)	Green	Serial port 1 or 2 is transmitting data.
	Off	Serial port 1 or 2 is not transmitting data.
P1/P2 (Rx)	Yellow	Serial port 1 or 2 is receiving data.
	Off	Serial port 1 or 2 is not receiving data.

Wiring Requirements

This section describes how to connect the EM-1240-LX to serial devices.

You should pay attention to the following common safety precautions before proceeding with the installation of any electronic device:

- Use separate paths to route wiring for power and devices. If power wiring and device wiring paths must cross, make sure the wires are perpendicular at the intersection point.

  NOTE: Do not run signal or communication wiring and power wiring in the same wire conduit. To avoid interference, wires with different signal characteristics should be routed separately.

- Use the type of signal transmitted through a wire to determine which wires should be kept separate. The rule of thumb is that wiring that shares similar electrical characteristics can be bundled together.
- Keep input wiring and output wiring separate.
- It is advisable to label the wiring to all devices in the system.

ATTENTION

Safety First!

Be sure to disconnect the power cord before installing and/or wiring your EM-1240-LX.

Wiring Caution!

Calculate the maximum possible current in each power wire and common wire. Observe all electrical codes dictating the maximum current allowable for each wire size.

If the current goes above the maximum ratings, the wiring could overheat, causing serious damage to your equipment.

Temperature Caution!

Be careful when handling the EM-1240-LX. When plugged in, the EM-1240-LX's internal components generate heat, and consequently the outer casing may feel hot to the touch.

Connecting the Power

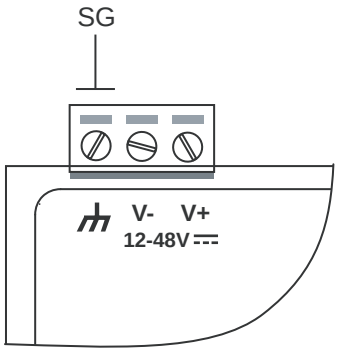
Connect the "live-wire" end of the 12-48 VDC power adaptor to the EM-1240-LX's terminal block. If the power is properly supplied, the "Ready" LED will glow a solid green after a 25 to 30 second delay.

Grounding the EM-1240-LX

Grounding and wire routing help limit the effects of noise due to electromagnetic interference (EMI). Run the ground wire from the ground screw to the grounding surface prior to connecting devices.

ATTENTION

This product should be mounted to a well-grounded mounting surface such as a metal panel.



SG: The ***Shielded Ground*** (sometimes called Protected Ground) contact is the left most contact of the 3-pin power terminal block connector when viewed from the angle shown here. Connect the SG wire to an appropriate grounded metal surface.

Connecting Data Transmission Cables

This section describes how to connect the EM-1240-LX to the network, serial devices, and serial COM terminal.

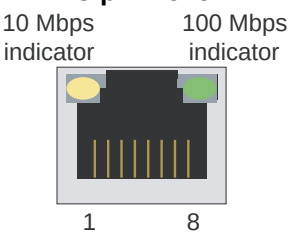
Connecting to the Network

Connect one end of the Ethernet cable to the EM-1240-LX's 10/100M Ethernet port and the other end of the cable to the Ethernet network. If the cable is properly connected, the EM-1240-LX will indicate a valid connection to the Ethernet in the following ways:

- The top-right LED on the connector glows a solid green when connected to a 100 Mbps Ethernet network.
- The top-left LED on the connector glows a solid orange when connected to a 10 Mbps Ethernet network.
- The LEDs will flash when Ethernet packets are being transmitted or received.

The 10/100 Mbps Ethernet LAN 1 and LAN 2 ports use 8-pin RJ45 connectors. Pinouts for these ports are given in the following diagram.

8-pin RJ45



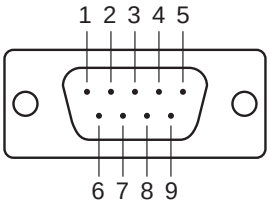
Pin	Signal
1	ETx+
2	ETx-
3	ERx+
4	---
5	---
6	ERx-
7	---
8	---

Connecting to a Serial Device

Connect the serial cable between the EM-1240-LX and the serial device(s).

Serial ports P1 and P2 use male DB9 connectors, and can be configured for RS-232/422/485 by software. The pin assignments are shown in the following table:

DB9 Male Port



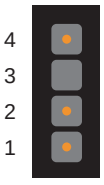
RS-232/422/485 Pinouts

Pin	RS-232	RS-422	RS-485 (4-wire)	RS-485 (2-wire)
1	DCD	TxDA(-)	TxDA(-)	---
2	RxD	TxDB(+)	TxDB(+)	---
3	TxD	RxDB(+)	RxDB(+)	DataB(+)
4	DTR	RxDA(-)	RxDA(-)	DataA(-)
5	GND	GND	GND	GND
6	DSR	---	---	---
7	RTS	---	---	---
8	CTS	---	---	---

Serial Console Port

The serial console port is a 4-pin pin-header RS-232 port. It is designed for serial console terminals, which are useful for identifying the EM-1240-LX boot up message.

Serial Console Port & Pinouts



Pin	Signal
1	TxD
2	RxD
3	NC
4	GND

Serial Console Cable

Internal SD Socket

The EM-1240-LX provides an internal SD socket for storage expansion. It allows users to plug in a Secure Digital (SD) memory card compliant with the SD 1.0 standard for up to 1 GB of additional memory space. To install an additional SD card, you must first remove the EM-1240-LX's outer cover to access the slot. The internal SD socket is located on the backside of the EM-1240-LX's bottom board; you can find the SD plug-in slot at the right of the EM-1240-LX, lower than the cover screw. Plug the SD card into the socket directly and remember to press the SD card first if you want to take it out. Please note that the SD function shares the same chipset with the DIO. If you would like to enable the SD function, the DIO must be disabled. If you would like to enable the DIO, the SD function must be disabled.

Additional Functions

Reset Button

Press the **Reset** button on the EM-1240-DK continuously for at least 5 seconds to load the factory default configuration. After the factory default configuration has been loaded, the system will reboot automatically. We recommend that you only use this function if the software is not working properly and you want to load factory default settings. To reset an embedded Linux system, always use the software reboot command />**reboot** to protect the integrity of data being transmitted or processed. The Reset button is not designed to hard reboot the EM-1240 Development Kit.

ATTENTION

Resetting to factory defaults will not format the user directory and erase all of the user's data. Loading factory defaults will only load the configuration file. The files in the EM-1240-LX that will be replaced include:

a. /etc/boa.conf
b. /etc/hosts
c. /etc/inittab
d. /etc/password
e. /etc/ramfs.img
f. /etc/resolv.conf
g. /etc/version
h. /etc/group
i. /etc/inetd.conf
j. /etc/motd
k. /etc/protocols
l. /etc/rc
m. /etc/services
n. /home/httpd/index.html

ATTENTION

This function only takes effect when the user directory is working correctly. If the user directory has crashed, the kernel will automatically load the factory defaults.

Real-time Clock

The EM-1240-LX's real time clock is powered by a lithium battery. We strongly recommend that you do not replace the lithium battery without the help of Moxa's support team. If the battery needs to be changed, contact the Moxa RMA service team for RMA service.

ATTENTION

The battery may explode if replaced by an incorrect type. To avoid this potential danger, always be sure to use the correct type of battery.

2

Getting Started

In this chapter, we explain the basic procedure for getting the EM-1240-LX connected and ready for your needs.

In this chapter we cover the following topics:

- **Powering on the EM-1240-LX**
- **Connecting the EM-1240-LX to a PC**
  - Console Port
  - Telnet
- **Configuring the Ethernet Interface**
- **Installing a Secure Digital (SD) Memory Card**
- **Developing Your Applications**
  - Installing the EM-1240-LX Tool Chain
  - Compiling Hello.c
  - Uploading “Hello” to the EM-1240-LX
  - Running “Hello” on the EM-1240-LX
  - Make File Example Code

Powering on the EM-1240-LX

Connect the SG wire to the Shielded Contact located on the upper left corner of the EM-1240-LX, and then power on the EM-1240-LX by connecting the power adaptor. It takes about 16 seconds for the system to boot up. Once the system is ready, the Ready LED will light up.

ATTENTION

After connecting the EM-1240-LX to the power supply, it will take about 16 seconds for the operating system to boot up. The green Ready LED will not turn on until the operating system is ready.

Connecting the EM-1240-LX to a PC

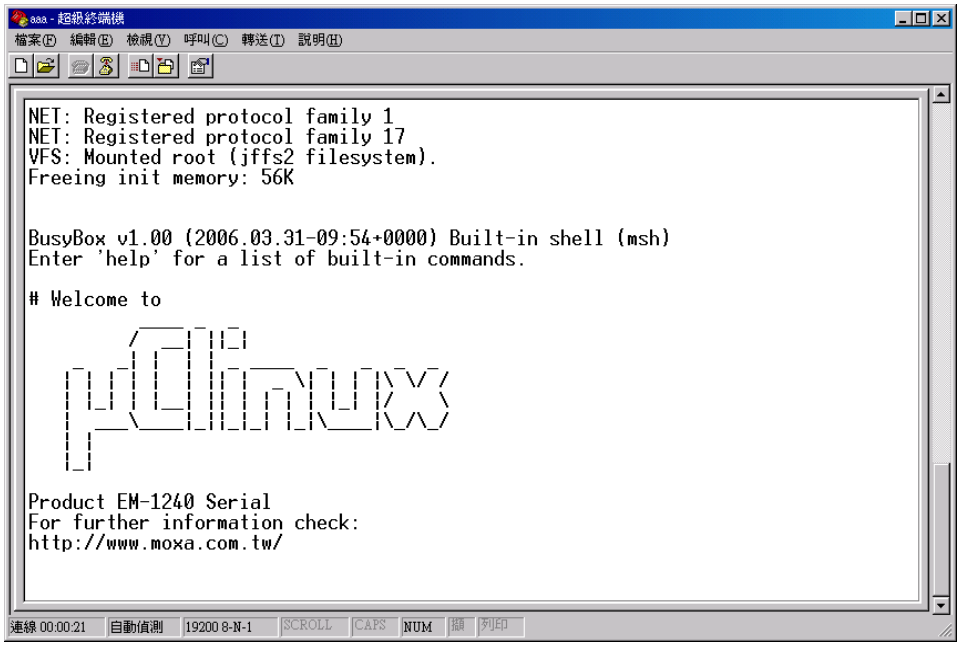
There are two ways to connect the EM-1240-LX to a PC.

Console Port

The serial console port offers users a convenient means of connecting to the EM-1240-LX. This method is particularly useful when using the EM-1240-LX for the first time. Since the communication is over a direct serial connection, you do not need to know either of the IP addresses in order to make contact.

Use the serial console port settings shown on the right. Once the connection is established, the following window will open.

Serial Console Port Settings	
Baudrate	19200 bps
Parity	None
Data bits	8
Stop bits	1
Flow Control	None
Terminal	VT100



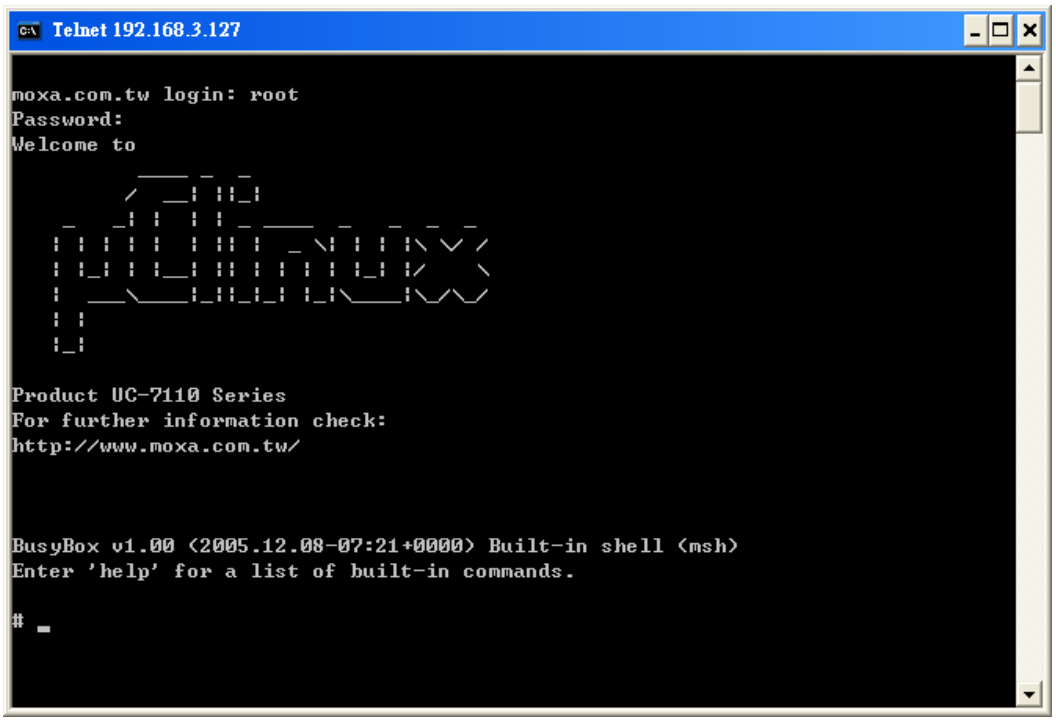
Telnet

If you know at least one of the two IP addresses and netmasks, then you can use Telnet to connect to the EM-1240-LX's console.

	Default IP Address	Default Netmask
LAN 1	**192.168.3.127**	**255.255.255.0**
LAN 2	**192.168.4.127**	**255.255.255.0**

Telnet can be used locally by using a crossover Ethernet cable to connect your computer to the EM-1240-LX, or over a LAN or the Internet. The default IP addresses and netmasks are shown above. To login, type the Login name and password as requested. The defaults are:

Login: **root**
Password: **root**



Once you open the "msh command shell" you can proceed to configure the EM-1240-LX's network settings, as described in the next section.

ATTENTION

- **Serial Console Reminder**: Remember to choose VT100 as the terminal type. Use the CBL-RJ45F9-150 cable that comes with the EM-1240-LX to connect to the serial console port. If you are not able to conect on the first try, unplug and then re-plug the EM-1240-LX's power cord.
- **Telnet Reminder**: When connecting to the EM-1240-LX over a LAN, you must configure your PC's Ethernet card to be on the same subnet as the EM-1240-LX you wish to contact.

Configuring the Ethernet Interface

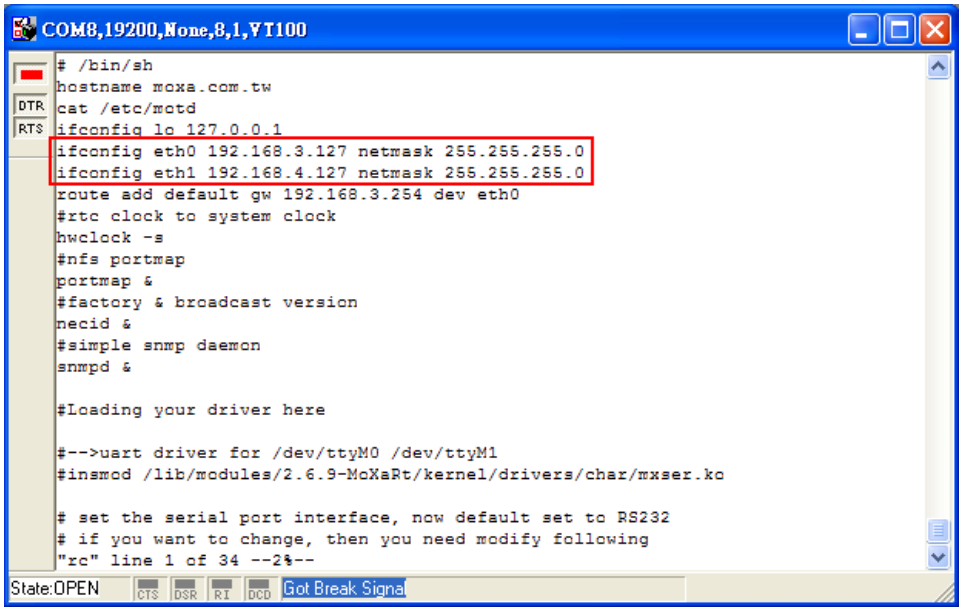
In this section, we use the serial console to explain how to modify the EM-1240-LX's network settings.

1. Change directories by issuing the command *cd /etc*.

2. Type the command *vi rc* to use the VI Editor to edit the configuration file. The IP addresses for the EM-1240-LX's LAN1 and LAN2 are given as

ifconfig eth0 192.168.3.127
ifconfig eth1 192.168.4.127

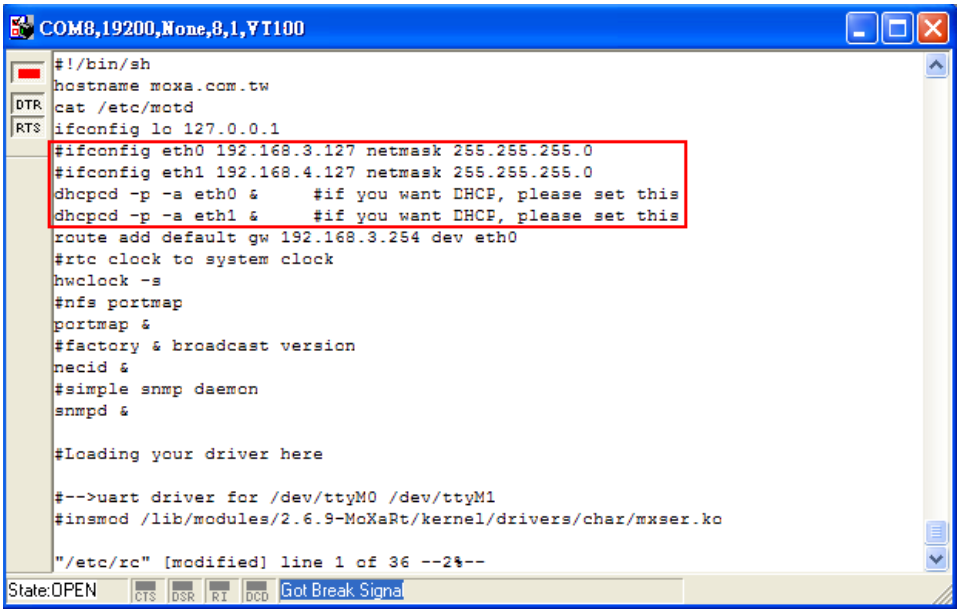
as shown in the following figure. Edit these two lines to modify the static IP addresses.



3. You may also configure the EM-1240-LX to request IP addresses from a DHCP server. In this case, use the sharp sign (#) to comment out one or both "ifconfig" lines, and then add the setting about the "dhcpcd" into the rc file as below.

```
dhcpcd -p -a eth0 &
dhcpcd -p -a eth1 &
```

Note that the EM-1240-LX will send out DHCP broadcast packets, and then get the IP addresses from the first DHCP server that responds.



4. Issue the vi "write" command to save the file, and then reboot. Since the EM-1240-LX only reads the "rc" file when booting up, you must reboot (e.g., by issuing the vi **`reboot`** command) for the changes to take affect.

ATTENTION

You may reset the IP address immediately by issuing the command

`ifconfig eth0 192.168.5.127`

(This will change the IP address of LAN1.) Issuing this command will NOT however update the "rc" file in the EM-1240-LX's flash memory, so the next time you reboot, the IP address will revert to its previous value.

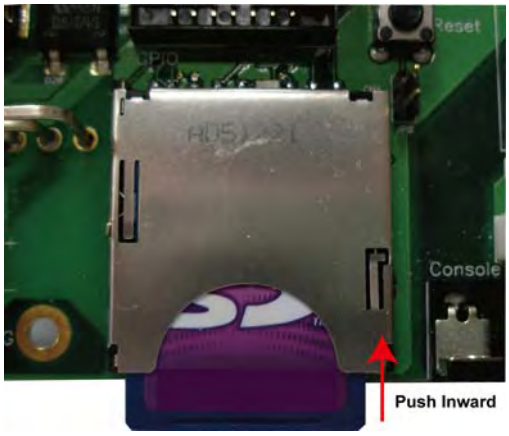
Installing a Secure Digital (SD) Memory Card

The EM-1240-LX provides an internal SD socket for storage expansion. To access this socket, perform the following steps to install the SD memory card.

Step 1: Find the exact location of the SD socket.

Step 2: Insert the SD card into the socket. Make sure the card is situated correctly.

Step 3: Push the SD card inward.



Step 4: Before using the SD card, check the /etc/rc file to ensure that the driver module for the SD card control is loaded. The loading sequence should be as follows:

```
insmod /lib/modules/2.6.9-MoXaRt/kernel/drivers/mmc/mmc_core.ko
insmod /lib/modules/2.6.9-MoXaRt/kernel/drivers/mmc/mmc_block.ko
insmod /lib/modules/2.6.9-MoXaRt/kernel/drivers/mmc/moxasd.ko
```

Step 5: To take out the SD memory card, press the SD card again. The card will pop out part of the way, after which you can pull it out directly.

Developing Your Applications

Step 1:
Connect the EM-1240-LX to a Linux PC.

Step 2:
Install Tool Chain (GNU Cross Compiler & uClibc).

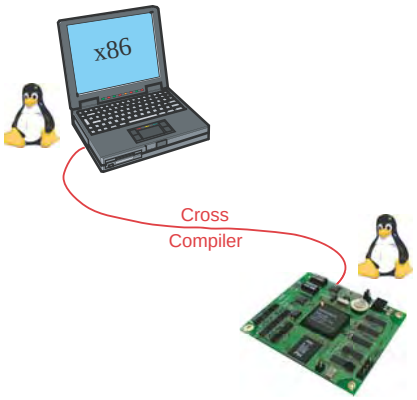
Step 3:
Configure cross compiler and uClibc environment variables.

Step 4:
Code & compile your program.

Step 5:
Download program to the EM-1240-LX via FTP or NFS.

Step 6:
Debug the program. If the program is OK, proceed to Step 7. If the program needs to be modified, go back to Step 4.

Step 7:
Back up the user directory, and distribute the code to additional EM-1240-LX units.



Installing the EM-1240-LX Tool Chain

Linux

The PC must have the Linux Operating System pre-installed to install the EM-1240-LX Linux GNU Tool Chain. Debian 3.0R-Woody, Redhat 7.3/8.0 and compatible versions are recommended. The Tool Chain requires about 100 MB of hard disk space (on your PC). The EM-1240-LX Tool Chain can be found on the EM-1240-LX Document & Software CD. To install the Tool Chain, insert the CD into your PC and then issue the following command:

```
#mount –t iso9660 /dev/cdrom /mnt/cdrom
```

Next, run the following script from the root to install the compilers, linkers, and libraries in the **/usr/local** directory:

```
#sh /mnt/cdrom/tool-chain/linux/installer/arm-elf-moxa-toolchain-1.1.sh
```

The Tool Chain installation will take a few minutes to complete.

ATTENTION

The Tool Chain can be downloaded from Moxa's website. To do this, navigate to the EM-1240-LX product page, click the Documentation & Drivers link, and then click **Go** under Driver & Software Downloads.

Compiling Hello.c

The Tool Chain path is:

```
PATH=/usr/local/bin:$PATH
```

The EM-1240-LX CD includes several example programs. We use **Hello.c** to illustrate how to compile and run applications.

Issue the following commands from your PC to compile **Hello.c**:

```
# cd /tmp/
# mkdir example
# cp –r /mnt/cdrom/example/* /tmp/example
```

Go to the Hello subdirectory, and then issue the command **#make** to compile Hello.c. Finally, execute the program to generate **hello** and **hello.gdb**.

```
[root@localhost hello]# ls -al
total 20
drwxr-xr-x    2 root     root         4096 Aug 18 10:58 .
drwxr-xr-x    5 root     root         4096 Aug  5 10:34 ..
-rw-rw-rw-    1 root     root         1498 Jan  6  2004 elf2flt.ld
-rw-rw-rw-    1 root     root           74 Jan  6  2004 hello.c
-rw-rw-rw-    1 root     root          875 Jan  6  2004 Makefile
[root@localhost hello]# make
/usr/local/bin/arm-elf-gcc  -g -O2 -pipe -Wall -I.   -c -o hello.o hello.c
/usr/local/bin/arm-elf-gcc  -o hello hello.o -g,-Wl,-T,/usr/local/arm-elf/lib/el
f2flt.ld -elf2flt
[root@localhost hello]# ls -al
total 116
drwxr-xr-x    2 root     root         4096 Aug 18 10:59 .
drwxr-xr-x    5 root     root         4096 Aug  5 10:34 ..
-rw-rw-rw-    1 root     root         1498 Jan  6  2004 elf2flt.ld
-rwxr--r--    1 root     root        28624 Aug 18 10:59 hello
-rw-rw-rw-    1 root     root           74 Jan  6  2004 hello.c
-rwxr-xr-x    1 root     root        84543 Aug 18 10:59 hello.gdb
-rw-r--r--    1 root     root         7608 Aug 18 10:59 hello.o
-rw-rw-rw-    1 root     root          875 Jan  6  2004 Makefile
[root@localhost hello]#
```

Uploading "Hello" to the EM-1240-LX

To use FTP to upload **hello** to the EM-1240-LX, issue the following commands on the PC:

```
#ftp 192.168.3.127
ftp> cd /home
ftp> bin
ftp> put ./hello
ftp> quit
#telnet 192.168.3.127
```

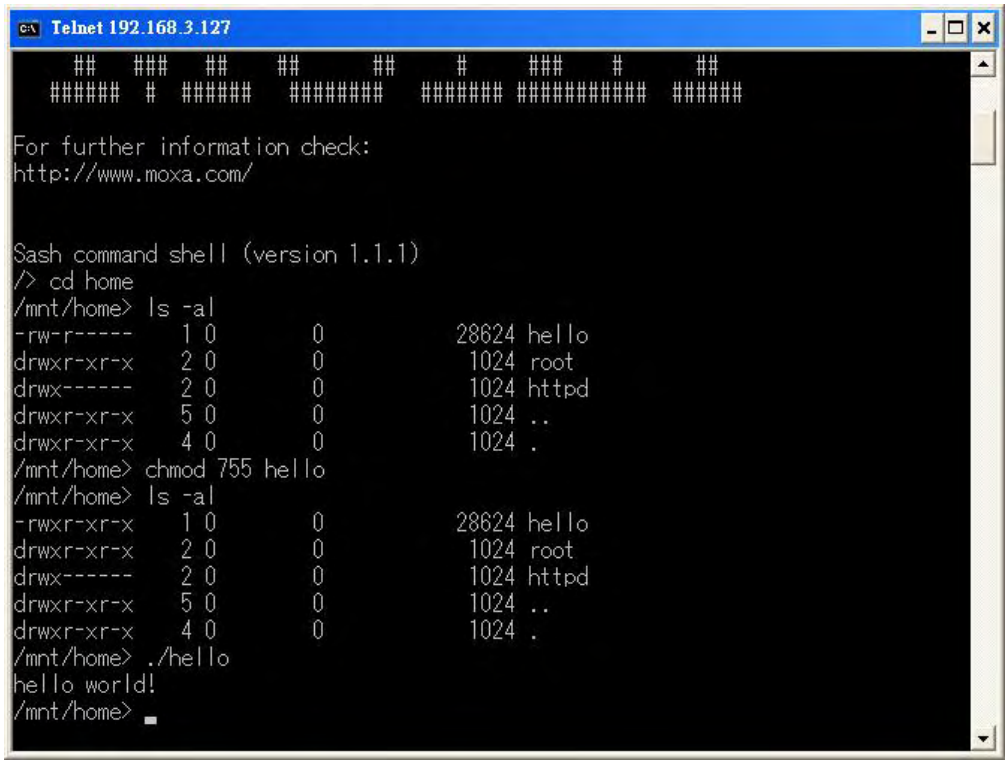
```
230 User root logged in.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> ls
227 Entering Passive Mode (192,168,3,127,8,0)
150 Opening ASCII mode data connection for '/bin/ls'.
lrwxrwxrwx    1 0        0               9 home -> /mnt/home
lrwxrwxrwx    1 0        0               8 etc -> /mnt/etc
lrwxrwxrwx    1 0        0               8 tmp -> /var/tmp
drwxr-xr-x    1 0        0              32 ramdisk
drwxr-xr-x    1 0        0              32 _home
drwxr-xr-x    1 0        0              32 _etc
drwxr-xr-x    1 0        0               0 var
dr-xr-xr-x    2 0        0               0 proc
drwxr-xr-x    5 0        0            1024 mnt
drwxr-xr-x    1 0        0              32 dev
drwxr-xr-x    1 0        0              32 bin
drwxr-xr-x    1 0        0              32 lib
226 Transfer complete.
ftp> cd /home
250 CWD command successful.
ftp> pwd
257 "/mnt/home" is current directory.
ftp>
```

Running "Hello" on the EM-1240-LX

To run the **Hello** program issue the following commands on the EM-1240-LX:

```
# chmod 755 hello
#./hello
```

The words "hello world" are printed on the screen.



ATTENTION

Be sure to calculate the amount of Flash Memory used by the User File System in the Flash ROM. Use one of the following two commands to determine the amount of memory in use:

 # df -k or **# df**

```
# df
Filesystem           1k-blocks      Used Available Use% Mounted on
rootfs                    1525      1525         0 100% /
/dev/rom0                 1525      1525         0 100% /
/dev/mtdblock2            4096       688      3408  17% /mnt
```

If the flash memory is full, you will no longer be able to save data to the Flash ROM. To free up some memory, use the console cable to connect to the EM-1240-LX's serial console terminal, and then delete files from the Flash ROM.

Make File Example Code

The following Make File example codes are copied from the Hello example on the EM-1240-LX's CD-ROM.

```
srcdir = .
LDFLAGS =  -Wl,-elf2flt
LIBS =
CFLAGS =

# Change these if necessary

CC = arm-elf-gcc
CPP = arm-elf-gcc -E

all:  hello

hello:
  $(CC) -o $@ $(CFLAGS) $(LDFLAGS) $(LIBS) $@.c

clean:
  rm -f $(OBJS) hello core *.gdb
```

3

Software Package

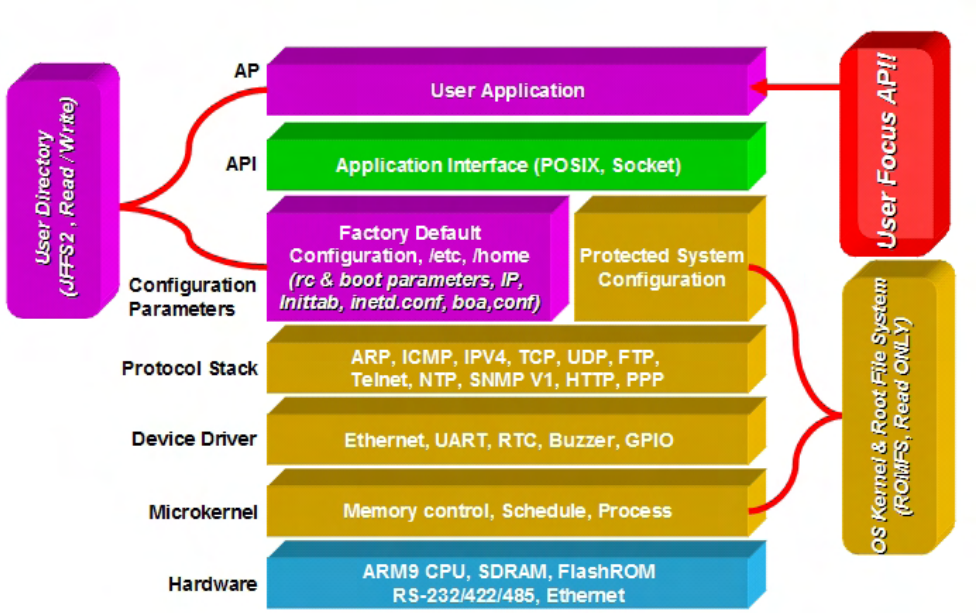
This chapter includes information about the software that is used with EM-1240-LX Series products.

In this chapter, we cover the following topics:

- **EM-1240-LX Software Architecture**
  - Journaling Flash File System (JFFS2)
- **EM-1240-LX Software Package**

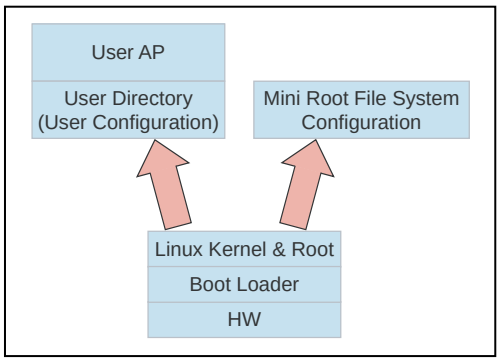
EM-1240-LX Software Architecture

The pre-installed µClinux Operating System used by the EM-1240-LX follows the standard µClinux architecture. This means that programs following the POSIX standard are easily ported to the EM-1240-LX with the GNU Tool Chain provided by www.uClinux.org. In addition to the Standard POSIX API, device drivers for the buzzer and UART for the serial ports are also included.



The EM-1240-LX's Flash ROM is divided into smaller partitions, including the Boot Loader, Linux Kernel & Root (/) File System Image, and User Directory partitions.

For most applications, users often spend a lot time maintaining the operating system and modifying the system configuration. In order to save on the total cost of development and maintenance, the EM-1240-LX is specially designed to partition a "User Directory" for storing the user's system configuration parameters.



The EM-1240-LX has a built-in mechanism that prevents system crashes to help preserve system reliability. The procedure is described below.

When the Linux kernel boots up, the kernel mounts the root file system and then enables services and daemons. The kernel also looks for system configuration parameters via rc or inittab.

Normally, the kernel uses the User Directory to boot up the system. The kernel will only use the default configuration _etc & _home when the User Directory crashes.

The EM-1240-LX uses ROMFS for the Linux kernel image, Root File System, and Protected configuration, and uses JFFS2 for the User Directory.

The partition sizes are hard coded into the kernel binary. You must rebuild the kernel to change the partition sizes. The flash memory map is shown in the following table.

Flash Context	Flash Address	Size	Access control
Boot loader	0 – 0x3ffff	256 K	Read ONLY
Kernet & Root File System	0x40000– 0x3fffff	4 M	Read ONLY **JFFS2**
User Directory	0x400000 – 0x7fffff	4 M – 256 K	Read / Write **JFFS2**

Developers should store their own programs only to partitions **/etc**, **/home**, **/tmp**, and **/usr/bin**. In addition, executable files should be stored in **/usr/bin**, as doing so will allow developers to use hotkeys.

In addition to the flash file systems, a RAM based file system is mounted on **/var/**.

Journaling Flash File System (JFFS2)

The flash User Directory is formatted by the Journaling Flash File System (JFFS2), which places a compressed file system on the flash, transparent to the user.

Axis Communications in Sweden developed the Journaling Flash File System (JFFS2).

JFFS2 provides a file system directly on flash, rather than emulating a block device designed for use on flash-ROM chips. It recognizes flash-ROM chips' special write requirements, does wear-leveling to extend flash life, keeps the flash directory structure in RAM at all times, and implements a log-structured file system that is always consistent—even if the system crashes or unexpectedly powers down. It does not require fsck on boot up.

JFFS2, a later version of JFFS, provides improved wear-leveling and garbage-collection performance, improved RAM footprint and response to system-memory pressure, improved concurrency and support for suspending flash erases, marking of bad sectors with continued use of the remaining good sectors (thus enhancing the write-life of the devices), native data compression inside the file system design; and support for hard links.

Key features of JFFS2 are:

- Directly targeted to Flash ROM
- Robust
- Consistent across power failure
- No integrity scan (fsck) is required at boot time after normal or abnormal shutdown
- Explicit wear leveling
- Transparent compression

Although JFFS2 is a journaling file system, this does not preclude the loss of data. The file system will remain in a consistent state across power failures, and will always be mountable. However, if the board is powered down during a write, then the incomplete write will be rolled back on the next boot. Any writes that were already completed will not be affected.

Additional information about JFFS2 is available at
http://sources.redhat.com/jffs2/jffs2.pdf
http://developer.axis.com/software/jffs/
http://www.linux-mtd.infradead.org/

EM-1240-LX Software Package

bin	dev
upkernel	mtdblock1
passwd -> tinylogin	mtdr1
login -> tinylogin	mtd1
tinylogin	mtdblock0
telnetd	mtdr0
snmpd	mtd0
mail	cum1
sh	cum0
routed	ttyM1
netstat	ttyM0
arp	urandom
chat	random
pppd	zero
portmap	ttypf
ntpdate	ttype
necid	ttypd
eraseall	ttypc
kversion	ttypb
init	ttypa
expand	ttyp9
inetd	ttyp8
hwclock	ttyp7
ftpd	ttyp6
ftp	ttyp5
mke2fs	ttyp4
e2fsck	ttyp3
discard	ttyp2
dhcpcd	ttyp1
cpu	ttyp0
busybox	ttyS0
boa	tty3
downramdisk	tty2
upramdisk	tty1
	tty0
	rom1
	rom0
	ptypf
	ptype
	ptypd
	ptypc
	ptypb
	ptypa
	ptyp9
	ptyp8
	ptyp7
	ptyp6
	ptyp5
	ptyp4
	ptyp3
	ptyp2
	ptyp1

bin	dev
	ptyp0 ppp pio rtc ram1 ram0 null kmem mem cua0 console tty

4

Configuring the EM-1240-LX

In this chapter, we describe how to configure the EM-1240-LX Series products.

The following topics are covered in this chapter:

- **Enabling and Disabling Daemons**
- **Adding a Web Page**
- **IPTABLES**
  - Observe and erase chain rules
  - Define policy for chain rules
  - Append or delete rules:
- **NAT**
  - NAT Example
  - Enabling NAT at Bootup
- **Configuring Dial-in/Dial-out Service**
  - Dial-out Service
  - Dial-in Service
- **Configuring PPPoE**
- **How to Mount a Remote NFS Server**
- **Dynamic Driver Module Load/Unload**
- **Upgrading the Kernel**
- **Upgrading the Root File System & User Directory**
- **Loading Factory Defaults**
- **Autostarting User Applications on Bootup**
- **Checking the Kernel and Root File System Versions**

Enabling and Disabling Daemons

The following daemons are enabled when the EM-1240-LX boots up for the first time.

- SNMP Agent daemon: **snmpd**
- Telnet Server / Client daemon: **telnetd**
- Internet Daemons: **inetd**
- FTP Server / Client daemon: **ftpd**
- WWW Server daemon: **boa**

ATTENTION

How to enable/disable telnet/ftp server

a. Edit the file '/etc/inetd.conf'
Example (default enable):
discard dgram udp wait root /bin/discard
discard stream tcp nowait root /bin/discard
telnet stream tcp nowait root /bin/telnetd
ftp stream tcp nowait root /bin/ftpd -l
b. Disable the daemon by typing '#' in front of the first character of the row.

How to enable/disable /etc/inittab www server

a. Edit the file '/etc/inittab'
b. Disable the www service by typing "#" in front of the first character of the row.

How to enable Network Time Protocol

ntpdate is a time adjusting client utility. The EM-1240-LX plays the role of Time client, and sends requests to the Network Time Server to request the correct time.

Set the time server address for adjusting the system time with the command:
/>ntpdate ntp_server_ip

Save the system time to the hardware's real time clock, with the command:
/>hwclock -w

Visit http://www.ntp/org for a recommended public NTP server list.

How to update the system time periodically with Network Time Protocol

1. Create a shell script file that includes the following description.
```
#!/bin/sh
ntpdate ntp_server_ip
hwclock –w
sleep 100        ← The minimum time is 100 ms.
```
2. Save and make this shell script executable by typing
chmod 755 <shell-script_name>

Edit the file '/etc/inittab' by adding the following line:
ntp: unknown: /directory/<shell_script_name>

Adding a Web Page

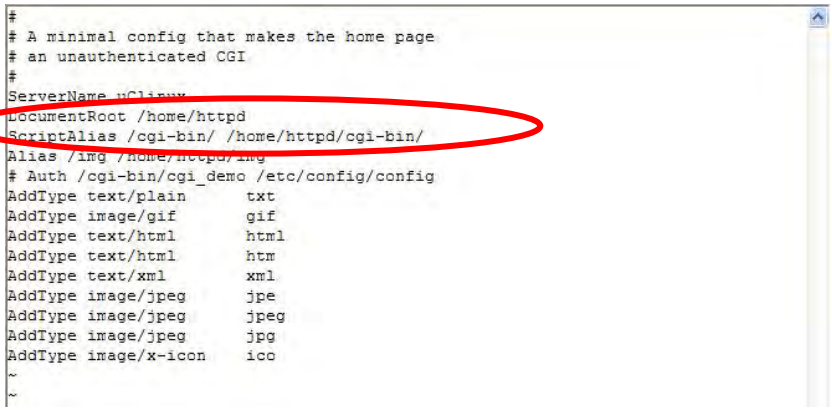
Default Home Page address:

`/home/httpd/index.html`

You may change the default home page directory by editing the web server's configuration file, located at: **`/etc/boa.conf`**

Type the following command to edit the boa.conf file:

`/etc>vi boa.conf`



To add your web page, place your home page in the following directory:

`/home/httpd/`

IPTABLES

IPTABLES is an administrative tool for setting up, maintaining, and inspecting the Linux kernel's IP packet filter rule tables. Several different tables are defined, with each table containing built-in chains and user-defined chains.

Each chain is a list of rules that apply to a certain type of packet. Each rule specifies the action to be taken with a matching packet. A rule (such as a jump to a user-defined chain in the same table) is called a "target."

The EM-1240-LX supports three types of IPTABLES tables: Filter tables, NAT tables, and Mangle tables:

A. **Filter Table**—includes three chains:

INPUT chain
OUTPUT chain
FORWARD chain

B. **NAT Table**—includes three chains:

PREROUTING chain—transfers the destination IP address (DNAT)
POSTROUTING chain—works after the routing process and before the Ethernet device process to transfer the source IP address (SNAT)
OUTPUT chain—produces local packets

sub-tables

Source NAT (SNAT)—changes the first source packet IP address

Destination NAT (DNAT)—changes the first destination packet IP address

MASQUERADE—a special form for SNAT. If one host can connect to the Internet, then other computers that connect to this host can connect to the Internet when the computer does not have an actual IP address.

REDIRECT—a special form of DNAT that re-sends packets to a local host independent of the destination IP address.

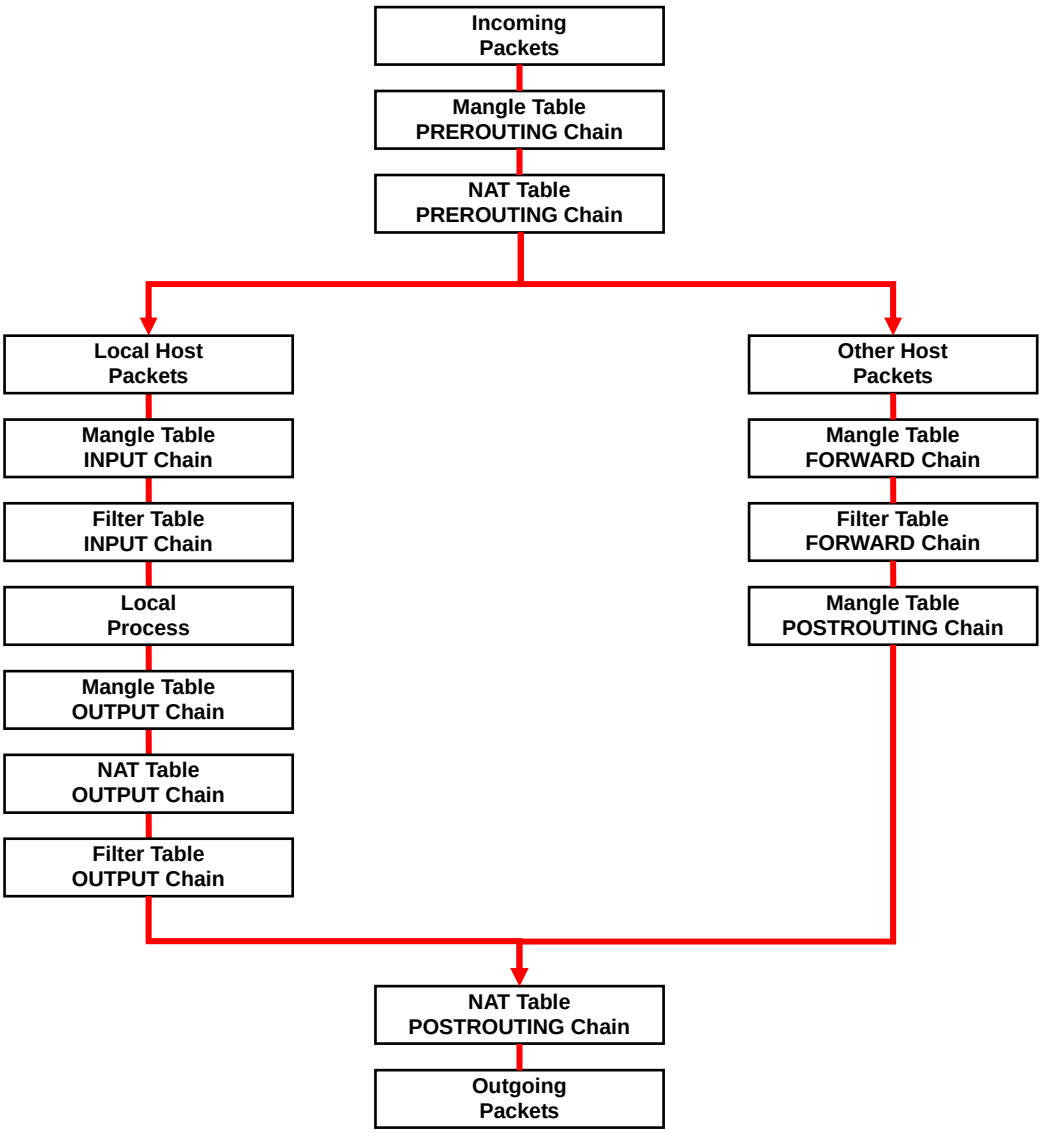
C. **Mangle Table**—includes two chains

PREROUTING chain—pre-processes packets before the routing process.

OUTPUT chain—processes packets after the routing process.

It has three extensions—TTL, MARK, TOS.

The following figure shows the IPTABLES hierarchy.



The EM-1240-LX supports the following sub-modules. Be sure to use the module that matches your application. You must load a module before you can use it. Use the **insmod** command to load a module.

x_tables	xt_conntrack	xt_helper	xt_mark
xt_pkttype	xt_state	xt_tcpudp	xt_CLASSIFY
xt_dccp	xt_length	xt_MARK	xt_quota
xt_statistic	xt_comment	xt_dscp	xt_multiport
xt_realm	xt_string	xt_connbytes	xt_esp
xt_mac	xt_NFQUEUE	xt_sctp	xt_tcpmss
xt_limit			
arptable_filter	ip_nat	iptable_raw	ipt_hashlimit
ipt_owner	ipt_time	arp_tables	ip_nat_snmp_basic
ip_tables	ipt_iprange	ipt_recent	ipt_tos
arpt_mangle	ip_nat_tftp	ipt_addrtype	ipt_layer7
ipt_REDIRECT	ipt_TOS	ip_nat_amanda	iptable_filter
ipt_ah	ipt_LOG	ipt_REJECT	ipt_ttl
ip_nat_ftp	iptable_mangle	ipt_ecn	ipt_MASQUERADE
ipt_SAME	ipt_TTL	ip_nat_irc	iptable_nat
ipt_ECN	ipt_NETMAP	ipt_TCPMSS	ipt_ULONG

NOTE The EM-1240-LX does NOT support IPV6 and ipchains.
IPTABLES supports packet filtering or NAT. Take care when setting up the IPTABLES rules. If the rules are not correct, remote hosts that connect via a LAN or PPP may be denied access. We recommend using the Serial Console to set up IPTABLES.

Click on the following links for more information about iptables.

http://www.linuxguruz.com/iptables/
http://www.netfilter.org/documentation/HOWTO//packet-filtering-HOWTO.html

Since the IPTABLES command is very complex, to illustrate the IPTABLES syntax we have divided our discussion of the various rules into three categories: **Observe and erase chain rules**, **Define policy rules**, and **Append or delete rules**.

Observe and erase chain rules

Usage:

```
# iptables [-t tables] [-L] [-n]
```

-t tables: Table to manipulate (default: 'filter'); example: nat or filter.
-L [chain]: List List all rules in selected chains. If no chain is selected, all chains are listed.
-n: Numeric output of addresses and ports.

```
# iptables [-t tables] [-FXZ]
```

-F: Flush the selected chain (all the chains in the table if none is listed).
-X: Delete the specified user-defined chain.
-Z: Set the packet and byte counters in all chains to zero.

Examples:

```
# iptables -L -n
```

In this example, since we do not use the -t parameter, the system uses the default 'filter' table. Three chains are included: INPUT, OUTPUT, and FORWARD. INPUT chains are accepted automatically, and all connections are accepted without being filtered.

```
#iptables –F
#iptables –X
#iptables –Z
```

Define policy for chain rules

Usage:

```
# iptables [-t tables] [-P] [INPUT, OUTPUT, FORWARD, PREROUTING, OUTPUT, POSTROUTING]
[ACCEPT, DROP]
```

-P:	Set the policy for the chain to the given target.
INPUT:	For packets coming into the EM-1240-LX.
OUTPUT:	For locally-generated packets.
FORWARD:	For packets routed out through the EM-1240-LX.
PREROUTING:	To alter packets as soon as they come in.
POSTROUTING:	To alter packets as they are about to be sent out.

Examples:

```
#iptables –P INPUT DROP
#iptables –P OUTPUT ACCEPT
#iptables –P FORWARD ACCEPT
#iptables –t nat –P PREROUTING ACCEPT
#iptables –t nat –P OUTPUT ACCEPT
#iptables -t nat –P POSTROUTING ACCEPT
```

In this example, the policy accepts outgoing packets and denies incoming packets.

Append or delete rules:

Usage:

```
# iptables [-t table] [-AI] [INPUT, OUTPUT, FORWARD] [-io interface] [-p tcp, udp, icmp,
all] [-s IP/network] [--sport ports] [-d IP/network] [--dport ports] –j [ACCEPT. DROP]
```

-A:	Append one or more rules to the end of the selected chain.
-I:	Insert one or more rules in the selected chain as the given rule number.
-i:	Name of an interface via which a packet is going to be received.
-o:	Name of an interface via which a packet is going to be sent.
-p:	The protocol of the rule or of the packet to check.
-s:	Source address (network name, host name, network IP address, or plain IP address).
--sport:	Source port number.
-d:	Destination address.
--dport:	Destination port number.
-j:	Jump target. Specifies the target of the rules; i.e., how to handle matched packets. For example, ACCEPT the packet, DROP the packet, or LOG the packet.

Examples:

Example 1: Accept all packets from lo interface.

```
# iptables –A INPUT –i lo –j ACCEPT
```

Example 2: Accept TCP packets from 192.168.0.1.

```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.0.1 –j ACCEPT
```

Example 3: Accept TCP packets from Class C network 192.168.1.0/24.

```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.1.0/24 –j ACCEPT
```

Example 4: Drop TCP packets from 192.168.1.25.
```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.1.25 –j DROP
```

Example 5: Drop TCP packets addressed for port 21.
```
# iptables –A INPUT –i eth0 –p tcp --dport 21 –j DROP
```

Example 6: Accept TCP packets from 192.168.0.24 to the EM-1240-LX's port 137, 138, 139
```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.0.24 --dport 137:139 –j ACCEPT
```

Example 7: Log TCP packets that visit EM-1240-LX's port 25.
```
# iptables –A INPUT –i eth0 –p all –m mac –-mac-source 01:02:03:04:05:06 –j DROP
```

Example 8: Drop all packets from MAC address 01:02:03:04:05:06.
```
# iptables –A INPUT –i eth0 –p all –m mac –mac-source 01:02:03:04:05:06 –j DROP
```

NAT

NAT (Network Address Translation) protocol translates IP addresses used on one network into different IP addresses used on another network. One network is designated the inside network and the other is the outside network. Typically, the EM-1240-LX connects several devices on a network and maps local inside network addresses to one or more global outside IP addresses, and remaps the global IP addresses on incoming packets back into local IP addresses.

NOTE Click the following link for more information about iptables and NAT:
http://www.netfilter.org/documentation/HOWTO/NAT-HOWTO.html

NAT Example

The IP addresses of all packets leaving LAN1 are changed to 192.168.3.127 (you will need to load the module ipt_MASQUERADE):

1. **First load the following device drivers:**
   - **x_tables.ko**
   - **xt_multiport.ko**
   - **xt_MARK.ko**
   - **xt_tcpudp.ko**
   - **ip_tables.ko**
   - **ip_nat.ko**
   - **iptable_nat.ko**
   - **ipt_MASQUERADE.ko**
2. `#echo 1 > /proc/sys/net/ipv4/ip_forward`
3. `#iptables -t nat –A POSTROUTING –o eth0 –j SNAT --to-source 192.168.3.127`
   or
4. `#iptables –t nat –A POSTROUTING –o eth0 –j MASQUERADE`

Enabling NAT at Bootup

In most real world situations, you should use a simple shell script to enable NAT when the EM-1240-LX boots up, as indicated by the following:

1. setting iptables
2. iptables-save > /home/xxx.file (xxx.file is the user defined file name)
3. vi /etc/rc
4. Append echo 1 > /proc/sys/net/ipv4/ip_forward
5. Append iptables-restore /home/xxx.file (xxx.file is the user defined file name)

Configuring Dial-in/Dial-out Service

Dial-out Service

Direct cable connection:

- *Without* username and password, use:
  />pppd connect 'chat –v' /dev/ttyM0 38400 crtscts&
- *With* username and password, use:
  />pppd connect 'chat –v' user xxxxx password xxxxx /dev/ttyM0 38400 crtscts&

Connect Using a Modem:

- Use:
  />pppd connect 'chat –v ATDT<phone_number> CONNECT' user xxxxx password xxxxx /dev/ttyM0 38400 crtscts&

ATTENTION

If dial out fails, the pppd connection will be blocked, and users will need to shut down pppd, and re-dial. Since the return value is always OK (regardless of whether or not the connection is blocked), the API must be set up to check the network status to determine if the connection is complete.

Dial-in Service

Direct cable connection:

- Use either of the following:
  />pppd <Local_IP_Address>:<Remote_IP_Address> /dev/ttyM1 38400 local crtscts
  or
  />pppd <Local_IP_Address>:<Remote_IP_Address> /dev/ttyM0 38400 local crtscts login auth

Connect Using a Modem:

- Use:
  />pppd connect 'chat –v AT CONNECT' <local_IP_Address>:<Remote_IP_Address> /dev/ttyM0 38400 crtscts login auth

Configuring PPPoE

PPPoE relies on two widely accepted standards: PPP and Ethernet, which permits the use of PPPoE(Point-to-Point Over Ethernet).

PPPoE is a specification for connecting users on an Ethernet to the Internet through a common broadband medium, such as a single DSL line, wireless device or cable modem, used by many ADSL service providers. All users on the Ethernet share a common connection, so the Ethernet principles that support multiple users on a LAN combine with the PPP principles, which apply to serial connections.

- Create the Connection:
  />pppd pty "pppoe -I <ETHERNET_INTERFACE> -m 1412" user <USER_NAME> password <USER_PASSWORD>&

<ETHERNET_INTERFACE>: Ethernet card connected to ADSL modem, for example, eth0
<USER_NAME>: User account, for example, moxa@adsl.net
<USER_PASSWORD>: Password for user account

To check if PPPOE is successfully connected, use the command:

- **/>ifconfig ppp0**

How to Mount a Remote NFS Server

Currently, the EM-1240-LX only supports NFS (Network File System) clients. Users can open NFS service on a Linux PC to enable the EM-1240-LX to push data to it. The EM-1240-LX can use NFS to mount a remote disk as a local disk for data or log purposes.

1. First, the NFS server must open an export directory and allow access to the IP address. Edit the file "/etc/exports" on your Linux PC, and then run the NFS daemon. The following example gives one possibility (refer to the NFS-HOWTO document at http://nfs.sourceforge.net/nfs-howto/server.html):

   /home/usr 192.168.3.1 (rw,no_root_squash,no_all_squash)

2. The EM-1240-LX must run the "portmap" utility. This program is enabled by default in the "/etc/rc" file. Use the following command to mount the remote NFS server:

   />mount –t nfs <remote-ip>:<remote-export-directory> <local-directory>

Dynamic Driver Module Load/Unload

Besides supporting traditional static drivers, the EM-1240-LX also supports the dynamic driver module load / unload mechanism. It allows users to load a special driver into the kernel to enable hardware features for specific applications. To load / unload a dynamic driver module, use the following commands.

Load module:
/>insmod <module-directory>/<module file name>

For example, to load the UART driver, type the following command:
/>insmod /lib/modules/2.6.9-MoXaRt/kernel/drivers/char/mxser.ko

Show module list:
/>lsmod

Unload module:
/>rmmod <module-name listed by lsmod command>

For example, to unload the UART driver, type the following command:
/>rmmod mxser

For the EM-1240-LX, the factory default is to load the UART driver **mxser.ko**. An additional driver module for controlling the SD/MMC memory card is loaded for the EM-1240-LX. The location and file name for these driver modules is given below.

UART:

/lib/modules/2.6.9-MoXaRt/kernel/drivers/char/mxser.ko

SD/MMC:

/lib/modules/2.6.9-MoXaRt/kernel/drivers/mmc/mmc_core.ko
/lib/modules/2.6.9-MoXaRt/kernel/drivers/mmc/mmc_block.ko
/lib/modules/2.6.9-MoXaRt/kernel/drivers/mmc/moxasd.ko

Upgrading the Kernel

The EM-1240-LX kernel is **em1240-*1.x..bin***, which can be downloaded from www.moxa.com. You must first download this file to your PC, and then use Console Terminal or Telnet Console to copy the file to the EM-1240-LX.

You can save this file to the EM-1240-LX's RAM disk, and then upgrade the kernel. The following is a step-by-step example.

To enable the RAM disk, use the following command:

```
/>upramdisk
```

As illustrated below, after executing "upramdisk", you may use "mount" to determine if the new ramdisk was created successfully or not.

```
# upramdisk
# mount
/dev/mtdblock2 on / type jffs2 (ro,noatime)
/proc on /proc type proc (rw,nodiratime)
/dev/ram0 on /var type ext2 (rw)
/dev/mtdblock3 on /var/tmp type jffs2 (rw,noatime)
/dev/mtdblock3 on /home type jffs2 (rw,noatime)
/dev/mtdblock3 on /etc type jffs2 (rw,noatime)
/dev/mtdblock3 on /usr/bin type jffs2 (rw,noatime)
/dev/ram0 on /ramdisk type ramfs (rw)
#
```

Use the following command to navigate to the device node:

```
/>cd ramdisk
```

Use the built-in FTP client to download the file **em1240-1.x.bin** from the PC.

```
/ramdisk>ftp <destination PC's IP>
Login Name: xxxx
Login Password: xxxx
ftp> bin
ftp> get em1240-1.x.bin
```

Use the **upkernel** command to upgrade the kernel and root file system.

```
/ramdisk>upkernel em1240-1.x.bin
/ramdisk>reboot
```

```
# upramdisk
# cd /ramdisk
# upkernel em1240-1.0.bin
To check the source file context.
The kernel source file is OK.
The version is 1.0.
This step will destory your old kernel.
Do you want to continue it ? (Y/N) : Y
Formating disk !!!
Erased 2048 Kibyte @ 0 -- 100% complete.
Format OK. Now update the kernel.
Please wait ...
Update the kernel OK. Please restart system.
#
```

Upgrading the Root File System & User Directory

The EM-1240-LX uses JFFS2 for the root file system and user directory. By default, the root file system is pre-set to READ only. The EM-1240-LX provides a read/write user's directory in the JFFS2 file system. By using this user's directory, the system configuration file and user's program can be stored on this disk.

Search the EM-1240-LX's CD-ROM for the latest user directory file, or download the file from www.moxa.com. The format is **em1240-1.x.dsk**. You must download this file to a PC first, and then use Console Terminal or Telnet Console to copy the file to the EM-1240-LX.

You can save this file to the EM-1240-LX's RAM disk, and then upgrade the user directory. The following is a step-by-step example.

To enable the RAM disk, use the following commands.

```
/>upramdisk
/>cd ramdisk
```

Use the built-in FTP client to download the em1240-1.x.dsk file from the PC.

```
/ramdisk>ftp  <destination PC's IP>
Login Name: xxxx
Login Password: xxxx
ftp> bin
ftp> get em1240-1.x.dsk
ftp>quit
/ramdisk>upkernel /ramdisk/em1240-1.x.dsk
/reboot
```

Loading Factory Defaults

The easiest way to "Load Factory Defaults" is with the "Upgrade User directory" operation.

Refer to the previous section, "Upgrading the Root File System & User Directory," for an introduction.

You may also press the RESET button for more than 5 seconds to load the factory default configuration, or input the command "ldfactory" from the Telnet console to restore the factory defaults.

Autostarting User Applications on Bootup

Edit the **/etc/rc** file by adding your application program. E.g.,

```
/ap-directory/ap-program &
```

Checking the Kernel and Root File System Versions

Use the following commands to check the version of the kernel and root file system:

To check the kernel version:

```
/>kversion
```

To check the root file system (firmware) version of the EM-1240-LX, type:

```
/>fsversion
```

You may also check the user directory version of the EM-1240-LX by using the following command:

```
/>cat /etc/version
```

5

EM-1240-LX Device API

In this chapter, we discuss the Device API for the EM-1240-LX Series. We introduce the APIs for the following functions:

- **RTC (Real-time Clock)**
- **Buzzer**
- **UART Interface**
- **GPIO**

RTC (Real-time Clock)

The device node is located at **/dev/rtc**. The EM-1240-LX supports µClinux standard simple RTC control. You must include **<linux/rtc.h>** to use these functions.

```
1. Function: RTC_RD_TIME
       int ioctl(fd, RTC_RD_TIME, struct rtc_time *time);
       Description: Reads time information from RTC.

2. Function: RTC_SET_TIME
       int ioctl(fd, RTC_SET_TIME, struct rtc_time *time);
       Description: Sets RTC time.
```

Buzzer

The device node is located at **/dev/console**. The EM-1240-LX supports µClinux standard buzzer control. The EM-1240-LX's buzzer runs at a fixed frequency of 100 Hz. You must include **<sys/kd.h>** to use these functions.

```
1. Function: KDMKTONE
       ioctl(fd, KDMKTONE, unsigned int arg);
       Description: Buzzer will beep, as stipulated by the function
       arguments.
```

UART Interface

The normal tty device node is located at **/dev/ttyM0…ttyM1**, and the modem tty device node is located at **/dev/com0 … com1**. The EM-1240-LX Series supports µClinux standard termios control. The Moxa UART Device API supports configurations ttyM0 to ttyM1, as RS-232/422/485. To use these functions, after the Tool Chain package is installed, include **<moxadevice.h>** in your application.

```
#define RS232_MODE          0
#define RS485_2WIRE_MODE        1
#define RS422_MODE          2
#define RS485_4WIRE_MODE        3

1. Function: MOXA_SET_OP_MODE

          int mode;
          mode=which mode you want to set;
          int ioctl(fd, MOXA_SET_OP_MODE, &mode)

   Description: Sets the interface mode.

2. Function: MOXA_GET_OP_MODE

          int mode;
          int ioctl(fd, MOXA_GET_OP_MODE, &mode)

   Description: Gets the interface mode.
```

GPIO

GPIO stands for General Purpose I/O. GPIOs are user-programmable, and can be used for either digital input or digital output, since the signals are all in TTL format.

Moxa GPIO API

Moxa provides an API library with static link for customers using the EM-1220 or EM-1240 (note that dynamic link is not supported). Users can use source code provided by Moxa so that the ioctl() command can be used by the operating system to communicate with drivers.

API List

int get_gpio_mode(unsigned int pio)

--to check if the current GPIO setting is DI or DO.

Input:

unsigned int pio - GPIO port number

Each GPIO point will be regarded as a port. We support from Port 0 to Port 9 for the EM-1240, and from Port 0 to Port 7 for the EM-1220.

Output:

1 represents DI.
0 represents DO.

Return:

< 0 is wrong.
= 0 is correct.

int get_gpio_data(unsigned int pio)

--to check the current status of the GPIO, either high or low voltage.

Input:

unsigned int pio - GPIO port number

Each GPIO point will be regarded as a port. We support from Port 0 to Port 9 for the EM-1240, and from Port 0 to Port 7 for the EM-1220.

Output:

1 represents high.
0 represents low.

Return:

< 0 is wrong.
= 0 is correct.

int set_gpio_mode(unsigned int pio, int mode)

--to configure GPIO ports to be DI ports or DO ports.

Input:

unsigned int pio - GPIO port number

Each GPIO point will be regarded as a port. We support from Port 0 to Port 9 for the EM-1240, and from Port 0 to Port 7 for the EM-1220.

int mode
1 represents DI.
0 represents DO.

Output:

1 represents high.
0 represents low.

Return:

< 0 is wrong.
= 0 is correct.

int set_gpio_data(unsigned int pio, int data)

--to check the current status of the GPIO, either high or low voltage, used when the GPIO points are configured as DO.

Input:

unsigned int pio - GPIO port number

Each GPIO point will be regarded as a port. We support from Port 0 to Port 9 for the EM-1240, and from Port 0 to Port 7 for the EM-1220.

int data
1 represents high.
0 represents low.

Output:

1 represents high.
0 represents low.

Return:

< 0 is wrong.
= 0 is correct.

How to use the GPIO

1. The device driver must be loaded.
   > insmod gpio.ko
2. The program must include **<moxadevice.h>** and link to **libmoxalib.a**. Here is an example:
   > arm-elf-gcc –wl, -elf2flt –o TestGpioAp TestGpioAp.c –lmoxalib –lpthread

Limits

1. Both the SD card and GPIO share the same signals. To enable the GPIO, the SD card must be disabled, and vice versa. Drivers will not automatically check if the signal is from the SD or GPIO; users must determine where the signal comes from before using the signal.
2. Both **moxadevice.h** and **libmoxalib.a** are supported in Tool Chain v1.6 and newer versions.

GPIO Library Source Code

```
/*
 * History:
 * Date         Author              Comment
 * 12-06-2005 Victor Yu.        Create it.
 */
#include <stdio.h>
#include <stdlib.h>
#include <fcntl.h>


// following about GPIO API implement
#define GPIO_DEVICE_NODE "/dev/pio"

#define IOCTL_GPIO_GET_MODE   1
#define IOCTL_GPIO_SET_MODE   2
#define IOCTL_GPIO_GET_DATA   3
#define IOCTL_GPIO_SET_DATA   4

#define MAX_GPIO        10
#define GPIO_NO_ERROR           -1 // the GPIO number error
#define GPIO_MODE_ERROR         -2 // the GPIO mode error
#define GPIO_DATA_ERROR         -3 // the GPIO data error
#define GPIO_NODE_ERROR         -4 // open GPIO device node error
#define GPIO_ERROR          -5 // some error, get error number from errno
#define GPIO_INPUT          1 // the GPIO mode is input
#define GPIO_OUTPUT         0 // the GPIO mode is output
#define GPIO_HIGH       1 // the GPIO data is high
#define GPIO_LOW        0 // the GPIO data is low
#define GPIO_OK             0 // function is OK


#define CHECK_GPIO_NO(p) { \
    if ( (p) >= MAX_GPIO ) \
        return GPIO_NO_ERROR; \
}
#define CHECK_GPIO_MODE(m) { \
    if ( (m) != GPIO_INPUT && (m) != GPIO_OUTPUT ) \
        return GPIO_MODE_ERROR; \
}


#define CHECK_GPIO_DATA(d) { \
    if ( (d) != GPIO_HIGH && (d) != GPIO_LOW ) \
        return GPIO_DATA_ERROR; \
}
```

```
typedef struct   gpio_set_struct {
    int     io_number;
    int     mode_data;
} gpio_t;


/*
 * To get the GPIO mode now.
 * Input: unsigned int pio   - the GPIO number, from 0 to MAX_GPIO-1
 * Output: < 0               - some error
 *             1             - input
 *             0             - ouput
 */
int get_gpio_mode(unsigned int gpio_no)
{

    int     fd;
    gpio_t        pset;


    CHECK_GPIO_NO(gpio_no);
    fd = open(GPIO_DEVICE_NODE, O_RDWR);
    if ( fd < 0 )
        return GPIO_NODE_ERROR;
    pset.io_number = gpio_no;
    if ( ioctl(fd, IOCTL_GPIO_GET_MODE, &pset) != 0 ) {
        close(fd);
        return GPIO_ERROR;
    }
    close(fd);
    return pset.mode_data;
}


/*
 * To get the GPIO data now.
 * Input: unsigned int pio   - the GPIO number, from 0 to MAX_GPIO-1
 * Output: < 0               - some error
 *             1             - high
 *             0             - low
 */


int get_gpio_data(unsigned int gpio_no)
{
    int     fd;
    gpio_t        pset;
    CHECK_GPIO_NO(gpio_no);
    fd = open(GPIO_DEVICE_NODE, O_RDWR);
    if ( fd < 0 )
        return GPIO_NODE_ERROR;
    pset.io_number = gpio_no;
    if ( ioctl(fd, IOCTL_GPIO_GET_DATA, &pset) != 0 ) {
```

```
        close(fd);
        return GPIO_ERROR;
    }
    close(fd);
    return pset.mode_data;
}


/*
 * To set the GPIO now mode.
 * Input: unsigned int pio  - the GPIO number, from 0 to MAX_GPIO-1
 *          int mode        - want to set mode, 1 for input, 0 for output
 * Output: < 0              - some error
 *          = 0                     - OK
 */
int set_gpio_mode(unsigned int gpio_no, int mode)


{
    int     fd;
    gpio_t      pset;



    CHECK_GPIO_NO(gpio_no);
    CHECK_GPIO_MODE(mode);
    fd = open(GPIO_DEVICE_NODE, O_RDWR);
    if ( fd < 0 )
        return GPIO_NODE_ERROR;
    pset.io_number = gpio_no;
    pset.mode_data = mode;
    if ( ioctl(fd, IOCTL_GPIO_SET_MODE, &pset) != 0 ) {
        close(fd);
        return GPIO_ERROR;
    }
    close(fd);
    return GPIO_OK;
}


/*
 * To set the GPIO now data.
 * Input: unsigned int pio  - the GPIO number, from 0 to MAX_GPIO-1
 *          int data        - 1 for high, 0 for low
 * Output: < 0              - some error
 *          = 0                     - OK
 */
int set_gpio_data(unsigned int gpio_no, int data)
{
    int     fd;
    gpio_t      pset;
```

```
    CHECK_GPIO_NO(gpio_no);
    CHECK_GPIO_DATA(data);
    fd = open(GPIO_DEVICE_NODE, O_RDWR);
    if ( fd < 0 )
        return GPIO_NODE_ERROR;
    pset.io_number = gpio_no;
    pset.mode_data = data;
    if ( ioctl(fd, IOCTL_GPIO_SET_DATA, &pset) != 0 ) {
        close(fd);
        return GPIO_ERROR;
    }
    close(fd);
    return GPIO_OK;
}
```

A

System Commands

µClinux normal command utility collection

File manager

cp	copy file
ls	list file
ln	make symbolic link file
mount	mount and check file system
rm	delete file
chmod	change file owner & group & user
chown	change file owner
chgrp	change file group
sync	sync file system; save system file buffer to hardware
mv	move file
pwd	display active file directly
df	list active file system space
du	estimate file space usage
mkdir	make new directory
rmdir	delete directory
head	print the first 10 lines of each file to standard output
tail	print the last 10 lines of each file to standard output
touch	update the access and modification times of each file to the current time

Editor

vi	text editor
cat	dump file context
grep	print lines matching a pattern
cut	remove sections from each line of files
find	search for files in a directory hierarchy
more	dump file by one page
test	test if file exists or not
echo	echo string

Network

ping	ping to test network
route	routing table manager
netstat	display network status
ifconfig	set network IP address
tftp	tftp protocol
telnet	user interface to TELNET protocol
ftp	file transfer protocol
iptables	iptables command

Process

kill	kill process
killall	kill process by name
ps	report process status
sleep	suspend command on time

Other

dmesg	dump kernel log message
stty	set serial port
mknod	make device node
free	display system memory usage
date	print or set the system date and time
env	run a program in a modified environment
clear	clear the terminal screen
reboot	reboot / power off/on the server
halt	halt the server
gzip, gunzip, zcat	compress or expand files
hostname	show system's host name
tar	tar archiving utility

Moxa Special Utilities

cat /etc/version	show user directory version
upramdisk	mount ramdisk
downramdisk	unmount ramdisk
kversion	show kernel version
setinterface	set UART interfaces program

B

SNMP Agent with MIB II & RS-232 Like Group

The EM-1240-LX has a built-in SNMP (Simple Network Management Protocol) agent that supports RFC1317 RS-232 like group and RFC 1213 MIB-II. The following table lists the variable implementation for the EM-1240-LX.

The full SNMP object ID of EM-1240-LX is **.iso.3.6.1.4.1.8691.12.7112** and **.iso.3.6.1.4.1.8691.12.1240**.

Note: The EM-1240-LX does not support SNMP trap.

RFC1213 MIB-II supported SNMP variables:

system MIB	interface MIB	at MIB	icmp MIB
sysDescr	ifNumber	atTable	icmpInMsgs
sysObjectID	ifTable	atIfIndex	icmpInErrors
sysUpTime	ifIndex		icmpInDestUnreachs
sysContact	ifDescr	atPhysAddress	icmpInTimeExcds
sysName	ifType	atNetAddress	icmpInParmProbs
sysLocation	ifMtu		icmpInSrcQuenchs
sysServices	ifSpeed		icmpInRedirects
	ifPhysAddress		icmpInEchos
	ifAdminStatus		icmpInEchoReps
	ifOperStatus		icmpInTimestamps
	ifLastChange		icmpInAddrMasks
	ifInOctets		icmpInAddrMaskReps
	ifInUcastPkts		icmpOutMsgs
	ifInNUcastPkts		icmpOutErrors
	ifInDiscards		icmpOutDestUnreachs
	ifInErrors		icmpOutTimeExcds
	ifInUnknownProtos		icmpOutParmProbs
	ifOutOctets		icmpOutSrcQuenchs
	ifOutUcastPkts		icmpOutRedirects
	ifOutNUcastPkts		icmpOutEchos
	ifOutDiscards		icmpOutEchoReps
	ifOutErrors		icmpOutTimestamps
	ifOutQLen		icmpOutAddrMasks
	ifSpecific		icmpOutAddrmaskReps

ip MIB	tcp MIB	udp MIB
ipForwarding	tcpRtoAlgorithm	udpInDatagrams
ipDefaultTTL	tcpRtoMin	udpNoPorts
ipInReceives	tcpRtoMax	udpInErrors
ipInHdrErrors	tcpMaxConn	udpOutDatagrams
ipInAddrErrors	tcpActiveOpens	udpTable
ipForwDatagrams	tcpPassiveOpens	udpLocalAddress
ipInUnknownProtos	tcpAttemptFails	udpLocalPort
ipInDiscards	tcpEstabResets	
ipInDelivers	tcpCurrEstab	
ipOutRequests	tcpInSegs	
ipOutDiscards	tcpOutSegs	
ipOutNoRoutes	tcpRetransSegs	
ipReasmTimeout	tcpConnTable	
ipReasmReqds	tcpConnState	
ipReasmFails	tcpConnLocalAddress	
ipFragOKs	tcpConnLocalPort	
ipFragFails	tcpConnRemAddress	
ipFragCreates	tcpConnRemPort	
ipAddrTable	tcpInErrs	
ipAdEntAddr	tcpOutRsts	
ipAdEntIfIndex		
ipAdEntNetMask		
ipAdEntBcastAddr		
ipAdEntReasmMaxSize		
ipRouteTable		
ipRouteDest		
ipRouteIfIndex		
ipRouteMetric1		
ipRouteMetric2		
ipRouteMetric3		
ipRouteMetric4		
ipRouteNextHop		
ipRouteType		
ipRouteProto		
ipRouteAge		
ipRouteMask		
ipRouteMetric5		
ipRouteInfo		
ipNetToMediaTable		
ipNetToMediaIfIndex		
ipNetToMediaPhysAddress		
ipNetToMediaNetAddress		
ipNetToMediaType		
ipRoutingDiscards		

snmp MIB
snmpInPkts
snmpOutPkts
snmpInBadVersions
snmpInBadCommunityNames
snmpInBadCommunityUses
snmpInASNParseErrs
snmpInTooBigs
snmpInNoSuchNames
snmpInBadValues
snmpInReadOnlys
snmpInGenErrs
snmpInTotalReqVars
snmpInTotalSetVars
snmpInGetRequests
snmpInGetNexts
snmpInSetRequests
snmpInGetResponses
snmpInTraps
snmpOutTooBigs
snmpOutNoSuchNames
snmpOutBadValues
snmpOutGenErrs
snmpOutGetRequests
snmpOutGetNexts
snmpOutSetRequests
snmpOutTraps
snmpEnableAuthenTraps

RFC1317 RS-232 like group supported variables

rs232 MIB
rs232Number
rs232PortTable
rs232PortIndex
rs232PortType
rs232PortInSigNumber
rs232PortOutSigNumber
rs232PortInSpeed
rs232PortOutSpeed
rs232AsyncPortTable
rs232AsyncPortIndex
rs232AsyncPortBits
rs232AsyncPortStopBits
rs232AsyncPortParity
rs232InSigTable
rs232InSigPortIndex
rs232InSigName
rs232InSigState
rs232OutSigTable
rs232OutSigPortIndex
rs232OutSigName
rs232OutSigState

C

EM-1240-LX FAQ

FAQ 1 Why can I only use vfork( ),and am not able to use fork( )?

Answer 1 μClinux only supports vfork( ). It does not support fork( ). Note that when using vfork( ), the parent process will hang until the child process calls an exec group API, or exits.

FAQ 2 When using a pthread group API, why can't I use SIGUSR1 and SIGUSR2?

Answer 2 Since a pthread group API uses SIGUSR1 and SIGUSR2 to do a pthread control suspend and restart the exit function, we cannot use the SIGUSR1 and SIGUSR2 signals. You will get the same result if you link the pthread. This means that you cannot use **`-1pthread`** to add an option to the linker.

FAQ 3 What is the correct format for linking to an API?

Answer 3 **`arm-elf-gcc –W1, -elf2flt`**
(In this example, the API converts elf format to flat format.)