VULCAN

**Arcom Embedded Linux Development Kit
for VULCAN IXP425 PC/104 Board**

Quickstart Manual

Arcom

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Revision History

Manual	PCB	Date	Comments
Issue A		11th June 2004	First full release of manual.
Issue B		19th August 2004	Updated for V3I7 software.
Issue C		4th May 2005	Updated for V4I1 software.
Issue D		16th May 2005	Updated to reflect product name change.

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Contents

Introduction

The VULCAN is a low power PC/104 compatible single board computer based on the Intel 533MHz IXP425 XScale processor. The IXP425 is an implementation of the Intel XScale micro-architecture combined with three Network Processing Engines for two Ethernet ports and hardware accelerated cryptography. Other on-board peripherals include four USB 2.0 ports, one type 2 CF+ socket, four serial ports (three RS232 and one RS422/RS485).

The VULCAN board also offers a number of features suitable for low power communications applications.

This product was known as the MERCURY until 30th June 2005. The internal (numeric) product codes used to identify this product and its variants have not changed. Please contact our sales team if you have any questions (see page 23).

Handling your board safely

Anti-static handling

The SBC and other circuit boards fitted inside the VULCAN ICE contain CMOS devices. These could be damaged in the event of static electricity being discharged through them. Please observe anti-static precautions at all times when handling circuit boards. This includes storing boards in appropriate anti-static packaging and wearing a wrist strap when handling them.

Packaging

Should a board need to be returned to Arcom, please ensure that it is adequately packed, preferably in the original packing material.

About this manual

This manual is designed to help you get your VULCAN single board computer up and running as quickly as possible. It explains the components of the VULCAN Development Kit you have received and tells you how to unpack, connect and configure the board.

Related documents

The Quickstart Manual is supplied as part of the VULCAN Development Kit, which also includes the VULCAN Technical Manual and the VULCAN Industrial Compact Enclosure (ICE) Technical Manual. Other manuals are referred to from time to time. These are provided on the CD-ROM that accompanies your Development Kit.

Detailed information about Arcom Embedded Linux (AEL) can be found in the AEL Technical Manual. This is on the Development Kit CD, in the /manuals/ directory. The AEL Technical Manual provides information about the following:

- Using RedBoot with AEL.
- Configuration files and boot scripts.
- Making an application run automatically at boot.
- AEL contents.
- Installation.
- Utilities.
- Secure Shell (SSH).
- Compiling a kernel.

Conventions

Symbols

The following symbols are used in this guide:

Symbol	Explanation
	Note - information that requires your attention.
	Tip - a handy hint that may provide a useful alternative or save time.
	Caution – proceeding with a course of action may damage your equipment or result in loss of data.

Typographical conventions

This manual contains examples of commands that you can enter. These are shown as follows:

$ **make install DESTDIR=/tmp/target-install**

The initial symbol ($ in this case) indicates the prompt that the command is for, and should not be typed.

The prompts used are explained in the following table:

Prompt	Explanation
$	Linux (bash shell) as a regular user.
#	Linux (bash shell) as root.
RedBoot>	RedBoot command line.

Different fonts are used throughout the manual to identify different types of information, as follows:

Font	Explanation
Italics	Parts of a command that should be substituted with appropriate values.
Bold	Information that you enter yourself.
`Screen text`	Information that is displayed on screen.

Getting started

What's in the Kit?

The VULCAN AEL Development Kit includes the following items:

- VULCAN-533-M64-F16 Processor board and Industrial Compact Enclosure (ICE).

- +5V @ 8A max (90 - 264 VAC input) power supply.

- Power supply interface cable.

- US, UK or EURO power cords.

- Crossover RJ45 Ethernet cable.

- Null modem cable.

- VULCAN AEL Quickstart manual (this document).

- Development Kit storage case.

The AEL Development Kit also includes the following:

- AEL support and installation CD.

- Fedora Core installation media[1].

- AEL Technical Manual on CD.

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[1] fedora.redhat.com

What else do I need?

An x86 Linux system compliant with version 1.3 of the Linux Standard Base[2] is required for the AEL host environment. Suitable systems include PCs with Debian GNU/Linux, RedHat Linux, Fedora Core or SUSE Linux.

The Linux system requires a spare RS232 serial port (capable of 115200 bit/s) with a male DB-9 connector and suitable terminal emulation software, such as minicom.

It is also useful if you can obtain the following information:

- Networking details for the VULCAN. If your network does not have a DHCP server, ask your network or system administrator for the following:

    - IP address and subnet mask (netmask).

    - Default gateway IP address (if required).

    - Name server (DNS) IP address (optional).

- Networking details for the host machine.

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[2] www.linuxbase.org

What peripherals are supported?

Linux supports the following peripherals in this release:

- Four UARTs: COM1, COM2, COM3 and COM4.

- On board Flash array with JFFS2.

- CompactFlash+ socket.

- Two Ethernet interfaces.

- Four USB 2.0 ports.

- SRAM.

- Real time clock.

- External watchdog.

- Unique ID serial number device.

- GPIO.

- PC/104 bus access and interrupt handling. Drivers are available for a range of Arcom and third party PC/104 boards.

Unpacking and connecting up

This section guides you through the process of connecting up the VULCAN and powering up the system for the first time. The VULCAN is delivered 'ready to run'. There is no need to adjust link settings or configuration switches for the board to operate. If you follow the steps described, the board automatically boots AEL from the on-board Flash.

The following diagrams show the locations of the connectors referred to in the procedure:
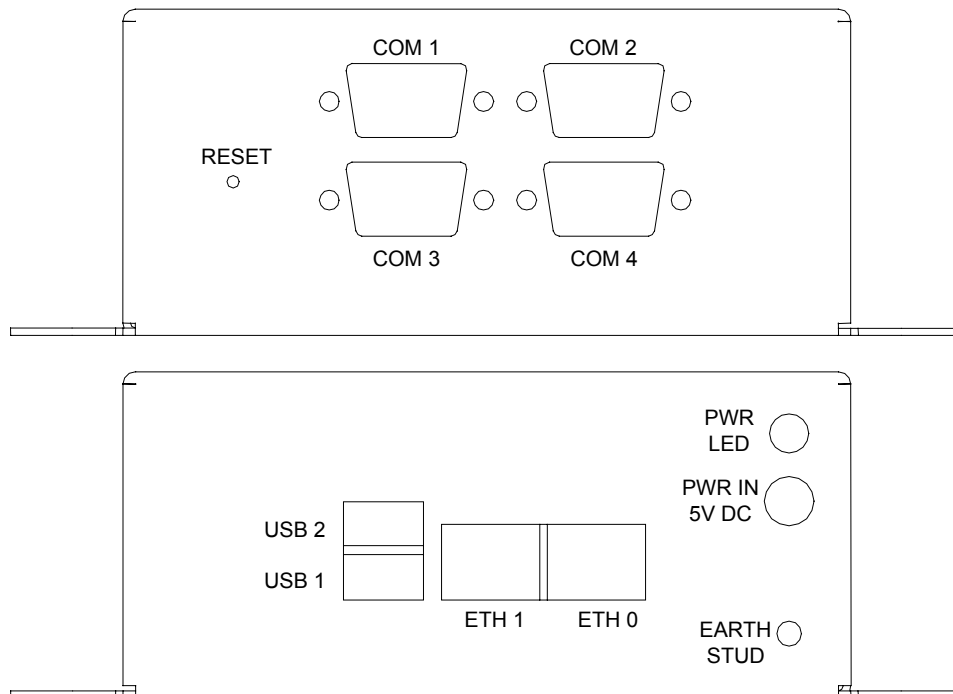
To unpack and connect up your VULCAN board, follow the steps below:

1   Remove the VULCAN ICE (Industrial Compact Enclosure) from the Development Kit packaging. If it shows any signs of damage during transit, please contact Arcom before proceeding.

2   Fit the VULCAN power supply interface cable to the socket on the ICE and to the power supply adapter.

3   Fit the mains cable.

4   Connect a serial terminal emulator[3] to COM1 using the supplied NULL modem cable.

---

[3] Such as Minicom running on a Linux PC or Hyper Terminal on a Windows PC.

5   Configure the serial terminal to 115200 bit/s, no parity, 8 data bits and no flow control.

6   Switch on the VULCAN board once the terminal emulator is set up on the host PC.

The Linux operating system is loaded from the on-board Flash array and the board displays the Linux login prompt.

For further information about AEL, see Arcom Embedded Linux, page 14 and the AEL Technical Manual, which is in the /manuals/ folder on the Development Kit CD.

Removing the lid of the ICE releases the tamper detect switch. This prevents the RTC from functioning.

Power supply

The AC PSU supplied in the kit is rated at +5V DC @ 8A max. This is designed to support the requirements of the VULCAN ICE. If additional devices are powered from this supply please ensure you do not exceed the overall current rating.

RedBoot

What is RedBoot?

RedBoot is a complete bootstrap environment for embedded systems. Based on the eCos Hardware Abstraction Layer, RedBoot inherits the eCos qualities of reliability, compactness, configurability, and portability.

RedBoot enables download and execution of embedded applications via serial or Ethernet, including embedded Linux and eCos applications. It can be used for both product development (debug support) and in deployed products in the field (Flash update and network booting).

Ethernet download and debug support is included. This means RedBoot can retrieve its IP parameters via BOOTP or DHCP, and program images can be downloaded using TFTP or HTTP. Images can also be downloaded over serial (using X- or Y-modem) or loaded from a JFFS2 file system on the on-board Flash.

An interactive command-line interface is accessible via serial or Ethernet and allows management of Flash images, image download, RedBoot configuration, etc. For unattended or automated startup, boot scripts can be stored in Flash. This allows, for example, loading of images from Flash or a TFTP server.

> You cannot use the command-line interface via Ethernet if you have an automatic boot script enabled which launches an application or another operating system, since RedBoot does not stop to listen for TCP/IP activity.

The Arcom Embedded Linux (AEL) Technical Manual contains details of many of the RedBoot commands that are useful when using RedBoot as a boot loader for another operating system (such as Linux) or to launch an application. Full RedBoot documentation is available in the eCos Reference Manual, which is in the /manuals/ folder on the development kit CD.

Default boot script:

The default boot script on the VULCAN loads a Linux kernel from the JFFS2 file system and executes it:

```
mount -t jffs2 -f filesystem
load -r -b %{FREEMEMLO} %{kernel}
exec -c %{cmdline}
```

`%{FREEMEMLO}` is a predefined alias for the lowest address of available memory.

`%{kernel}` is an alias for the full path name of the Linux kernel to boot.

`%{cmdline}` is an alias for the kernel command line to use.

Refer to the AEL Technical Manual for further details.

Arcom Embedded Linux

What is Arcom Embedded Linux?

Arcom Embedded Linux (AEL) is a space optimized standard Linux that includes many of the standard file, shell and text utilities. As well as the basic Linux system, the default installation includes:

- OpenSSH Secure Shell.

- Web server.

For a complete list of software and an explanation of how to add and remove packages, please consult the AEL Technical Manual on the Development Kit CD.

Booting the system

Once the system has been connected and powered up as described in <u>Unpacking and connecting up</u>, page <u>10</u>, the board automatically boots to a Linux prompt, as follows:

```
Uncompressing Linux......................................... done,
booting the kernel.
Linux version n.nn.nn-arcomn-n-vulcan
CPU: XScale-IXP4xx/IXC11xx revision 1
Machine: Arcom VULCAN
...
INIT: version 2.78 booting
...
```

> If you do not have a DHCP server and you have not configured a static IP address, the board pauses at this point while it searches for a DHCP server. See <u>Setting up networking</u>, page <u>17</u>.

```
Configuring network interfaces... done.
...
INIT: Entering runlevel: 2
...
Arcom Embedded Linux VvIi (ttyS0)
vulcan login:
```

Logging in

You may login to the VULCAN as root (the superuser or administrator) using the details below.

Login name: **root**

Default password: **arcom**

Setting up networking

As standard the board uses the DHCP protocol to configure the network. This requires a DHCP server to be available on your network. For details please consult your network administrator. To configure the VULCAN to use a static IP address, follow the steps below:

1   Login to the VULCAN using the following login details:

Login name: **root**

Password: **arcom**

2   Edit the file /etc/network/interfaces using the nano editor:

 # nano /etc/network/interfaces

3   Modify the iface eth0 inet dhcp line to look like the following (substituting your own IP address, netmask and gateway):

```
iface eth0 inet static

    address 10.7.28.2

    netmask 255.255.0.0

    gateway 10.7.1.1
```

4   Save the file by holding down the **CTRL** key and pressing **O**.

5   Exit by holding down the **CTRL** key and pressing **X**.

6   Set up a Domain Name Server (DNS) if required. This is required if you wish to use domain names (such as www.arcom.com) when accessing the Internet.

To set up a DNS, edit the file /etc/resolv.conf and add your DNS server address as follows:

```
nameserver 10.7.1.9
```

7   Reinitialize the networking by typing:

 # /etc/init.d/networking restart

For a useful introduction to TCP/IP networking, see chapters 25 and 26 of the RUTE Manual, which is on the Development Kit CD, in the /manuals/ folder.

The file system

The file system used on the VULCAN Flash is a compressed Journaling Flash File System (JFFS2). JFFS2 has the following advantages:

- Robustness.

- A power fail-safe mechanism.

- No integrity scan (fsck) is required at boot time.

- Flash wear levelling.

- Transparent compression with a typical compression ratio of 2:1.

The onboard Flash is partitioned using RedBoot FIS.

The following table shows the default Flash layout:

Partition #	Block device	Size (KB)	Offset (KB)	Description
0	/dev/mtdblock0	384	0	RedBoot
1	/dev/mtdblock1	(remainder)	384	Filesystem
2	/dev/mtdblock2	60	64 (from end)	RedBoot FIS partition table
3	/dev/mtdblock3	4	4 (from end)	RedBoot configuration

In addition, a 4MB RAM based file system is mounted on /var/tmp for temporary files. These are lost during reboot.

The basic AEL install uses about 8MB of physical Flash. On a board with 16MB of Flash memory fitted, this leaves about 7.5MB free. This is about 15MB of free space, assuming a typical 2:1 compression ratio. Additional space can be made available by removing unused packages. Refer to the AEL Technical Manual, which is in the /manuals/ folder on the Development Kit CD.

The default Flash image is available from the /images/ folder on the Development Kit CD. Please refer to the AEL Technical Manual for an explanation of how to reload a complete Flash image.

Linux kernel

The version of the Linux kernel used on the VULCAN is a standard Linux kernel tree with support for Arcom's boards.

Source and configuration

The kernel sources are installed in the host environment as /opt/arcom/src/linux-source-*VERSION*.tar.gz.

Once you have unpacked the kernel source you can configure the default VULCAN kernel with:

$ **make ARCH=arm vulcan_defconfig**

The kernel may now be built and installed as described in the AEL Technical Manual.

IXP400 access library

The IXP400 access library is a library provided by Intel (in the form of kernel modules) for accessing the 3 NPEs of the IXP425. The source code is available as a standard ael-kernel-build module source package (ixp400-access-library-source-1.4), which will be installed on the host system as part of the host installation procedure. Refer to the AEL Technical Manual for details about building modules from source packages.

Default command line

The default kernel command line is:

```
console=ttyS0,115200 rootfstype=jffs2 root=/dev/mtdblock1 ro
```

Hardware configuration

PCI

The IXP425 has a 64MB PCI memory window, formed from four consecutive 16MB windows, and located at the physical address 0x48000000. The PCI controller performs byte-lane swapping from the big-endian processor side to the little-endian PCI side.

The IXP425 is not capable of producing byte or word (2 byte) PCI read cycles. Attempts to do such a read result in an lword (4 byte) read. This is not an issue with any of the on-board PCI devices but may be an issue for PC/104 boards.

PC/104 bus

The PC/104 bus on the VULCAN is accessed via the second socket of the PCI1520 PC card controller on the PCI bus.

The Linux kernel configures the PCI1520 to map regions of PCI memory and I/O space to ISA memory and I/O as follows:

	PCI	ISA
Memory	0x49000000 – 0x49FFFFFF	0x000000 – 0xFFFFFF
Memory (16-bit)	0x4a000000 – 0x4AFFFFFF	0x000000 – 0xFFFFFF
I/O[1]	0x0000 – 0x0FFF	0x0000 – 0x0FFF
I/O (16-bit)	0x1000 – 0x1FFF	0x0000 – 0x0FFF

[1]   0xF000 - 0xFFFF is reserved for CF+ cards.

The PC card controller does not handle the IOIS16# or MEMIS16# PC/104 bus signal and accesses are split into 8-bit accesses by default. The 16-bit memory and I/O windows listed above can be used for 16-bit accesses.

PCI I/O cannot be mapped to the processor's address space, so PCI I/O must be done via the IXP425 PCI controller's registers. The standard Linux kernel I/O functions (inb, outb, inw, outw, etc.) are provided for this purpose.

VULCAN PC/104 interrupt mapping

The PC/104 interrupts are mapped as shown in the following table:

PC/104 interrupt	VULCAN interrupt
3	22
4	23
5	24
6	25
7	26
10	27
11	28
12	29

For more information, please consult the VULCAN Technical Manual, the IXP425 Developer's Manual and the PCI1520 Data Manual.

RTC and tamper detect

The ds1302_rtc module provides a standard /dev/rtc device for accessing the RTC time and date; as well as a /dev/nvram device for accessing the 31 bytes of RAM in the DS1302 RTC chip.

Unique ID

Access to the unique ID in the DS2401 chip is provided by the ds2401 kernel module. The virtual file /proc/driver/id contains the 48-bit ID in plain text hexadecimal format.

Support software

Target support software

When building applications for the VULCAN board you must use the Arcom Embedded Linux host environment. This is a set of utilities that provide a cross compile environment targeting the VULCAN board. You need a cross compile environment to produce binaries for the XScale processor.

For an explanation of how to install the host environment, see the Arcom Embedded Linux Technical Manual.

The accompanying Development Kit CD also includes examples of the source code required to use the Arcom-specific device drivers and utility programs.

Intel IXP400 access library

The IXP400 access library enables the use of the 3 Network Processor Engines (NPEs) in the IXP425. The library comprises a set of kernel modules which provide an API documented (as HTML) in the access library source code. The NPEs on the VULCAN are available for the two Ethernet ports and accelerated cryptographic operation.

The source code is installed as part of the host environment installation. For details about installing and setting up the source code, see IXP400 access library on page 19.

The header files required to build kernel modules using the Access Library API are available in the ixp400-access-library-headers-1.4 package. The package, when installed as part of the host installation procedure, installs the headers into /opt/arcom/src/ixp400-access-library-headers-1.4/include.

The library contains various modules that are not applicable to the VULCAN due to lack of hardware support. These include ATM, High Speed Serial and USB device.

Appendix – Contacting Arcom

Arcom sales

Arcom's sales team is always available to assist you in choosing the board that best meets your requirements. Contact your local sales office or hotline.

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