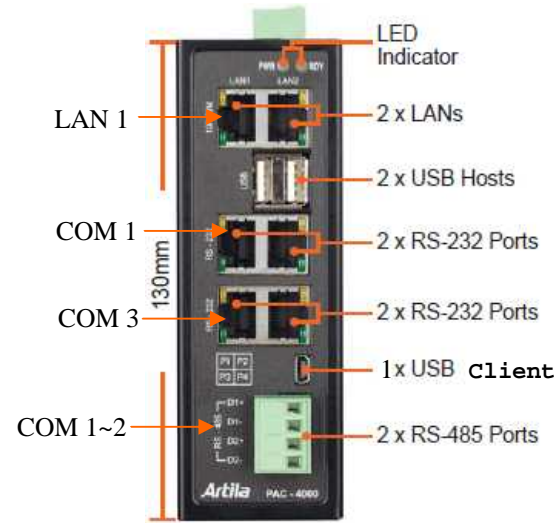


Introduction:

PAC-4000 is an ARM9-based Linux ready industrial controller. The key features are as follow:

1. ARM926EJ-S ARM Thumb Processor 400MHz w/MMU
2. 32-KByte Data Cache and 32-KByte Instruction Cache
3. 64MB SDRAM, 128MB NAND Flash on board
4. Two 10/100 Mbps Ethernet
5. Two USB 2.0 full speed (12 Mbps) Host Ports, one USB device port
6. Multimedia Card Interface for Micro SD memory card
7. Four serial ports: RS-232 x2 and RS-232 x2 or Isolated RS-485 x2
8. 9 to 40VDC power input
9. Pre-installed Standard Linux 2.6 OS
10. GNU tool chain available in Artila CD
11. DIN RAIL mounting

PAC-4000 Layout



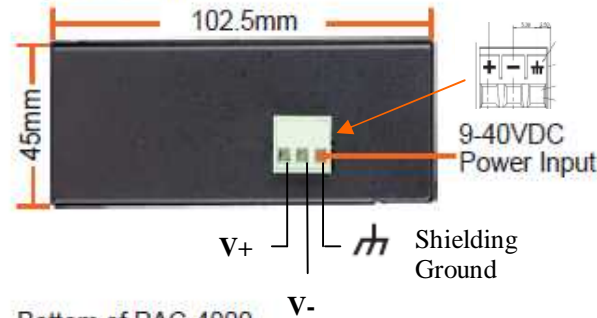
Packing List

1. PAC-4000 Programmable Automation Controller
2. DIN Rail bracket
3. Artila CD

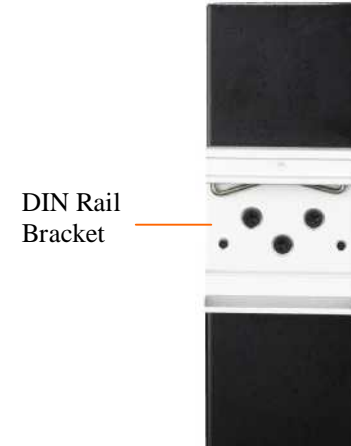
Optional Accessory:

1. CB-RJ45F9-150: RJ45 to DB9 Female Cable
2. CB-BHDB9-020: M-502 console cable
3. PWR-12V-1A

Top of PAC-4000



Back of PAC-4000



Bottom of PAC-4000



Pin Assignment and Definition

Power Input Connector

PAC-4000 uses +9VDC to 40VDC power and input from three ports plug-in screw terminal connector. Auto-polarity and surge protection are included in power input circuitry of PAC-4000 to provide power protection. Shielding ground provides better EMI protection. Please wire the shielding ground to an appropriate grounded metal surface

Reset Button

Press the "Reset" button to activate the hardware reset. You should only use this function if the software does not function properly.

Power LED

The Power LED will show solid green if power is properly applied

Ready LED

The Ready LED will show solid green if Matrix 518 complete system boot up. If Ready LED is off during system boot up, please check if power input is correct. Turn off the power and restart Matrix 518 again. If Ready LED is still off, please contact the manufacture for technical support.

Link and Act LED

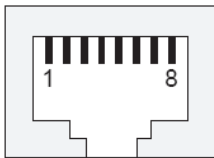
When Ethernet port are connected to the network, Link LED will show solid green. If there is traffic is the Ethernet line, the yellow Act LED will flash.

Serial Port LED

When RXD line is high then Yellow light is ON and when TXD line is high, Green light is ON.

Ethernet Port

Pin	Signal
1	ETx+
2	ETx-
3	ERx+
6	ERx-



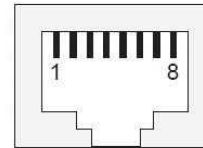
Serial Ports:

Port 1~2: Software selectable RS-232 or isolated RS-485. If RS-485 is chosen, please use terminal block connector for RS-485.

Port 3~4: RS-232 port with hardware flow control

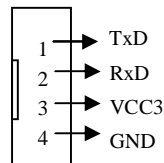
Note: Only Port 2 support RS-232 full modem control DSR,DCD and DTR.

Pin	RS-232
1	DSR
2	RTS
3	GND
4	TXD
5	RXD
6	DCD
7	CTS
8	DTR



Serial Console Port:

Serial console port is located inside the box at JP4 of M-502. You need a special console cable (CB-BHDB9-020) to access it



TxD: RS-232 transmit
 RxD: RS-232 receive
 VCC3: 3.3 VCC Output
 GND: Signal ground

Use any terminal software such as hyper terminal and configure the setting as follow:

Baud Rate: 115200
Data bits: 8
Parity: N
Stop bit: 1
Terminal type: VT100

Note : We provide a utility software, **setconsole** to redirect the console port to any one of the serial port. Therefore user do not need to open the case to access the physical console port. Please refer to **setconsole** command in the Artila utility section.

```

Finished to configure packages.
INIT: Entering runlevel: 5
Starting system message bus: dbus.
Starting ssh server: done.
Starting amgrd: done
Starting syslogd/klogd: done
Starting Telnet Server: done
Starting FTP Server: vsftpd... done.
Starting Lighttpd Web Server: lighttpd.
Starting Ready LED: done

PAC-4000 login: guest
Password:

http://www.artila.com
guest@PAC-4000:~$
  
```

Factory Default Settings

LAN 1 IP Address: 192.168.2.127

LAN 2 IP Address: 192.168.3.127

Login: root or guest (telnet guest only)

Password: root or guest (telnet guest only)

Serial Console Port:

Baud rate: 115200

Data format: 8 Bits, No Parity, 1 Stop bit (N,8,1)

Flow Control: None

Terminal type: VT100

Power on and System boot up

Once PAC-4000 is correctly power on, it will start boot Linux kernel and mount file system. You can use Ethernet and telnet and login PAC-4000. Once kernel loaded, it will find `/sbin/init` and execute it. The initialization configuration is at `/etc/inittab`. Once boot up, you can use telnet to login PAC-4000.



```
Matrix504 login: guest
Password:
http://www.aritla.com
guest@Matrix504:~$
```

Inittab and Run levels:

Inittab contains information of system initialization. The system initialization script `/etc/rc.S.d` runs first then the run level `5 /etc/rc5.d` PAC-4000 uses run level for system setup and the default run level is number 5. Please refer to introduction to linux (<http://tille.garrels.be/training/tldp/>) for information about run level. Following is the run levels setting:

Run level 0: halt

Run level 1 is single user (login and service are disabled)

Run level 2~5 are multiple users

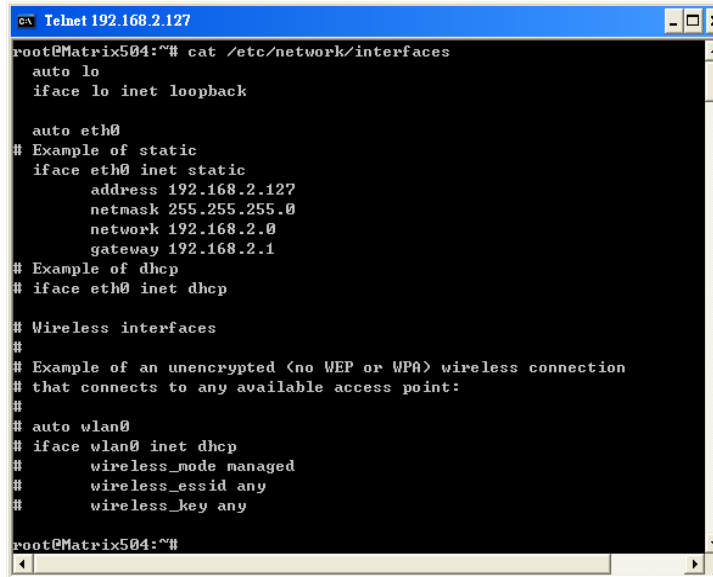
Run level 6 is reboot.

Please refer to loader menu section for selection of run level

Default started service

1. amgrd (Artilla broadcast search daemon)
2. ssh (secured shell) with sftp
3. syslog/klogd (system and kernel log)
4. telnet server (disable root with `/etc/security`)
5. ftp server (vsftp)
6. web server (apache2)
7. Ready LED (debug LED for internal use)

Network Settings



```
root@Matrix504:~# cat /etc/network/interfaces
auto lo
iface lo inet loopback

auto eth0
# Example of static
iface eth0 inet static
address 192.168.2.127
netmask 255.255.255.0
network 192.168.2.0
gateway 192.168.2.1

# Example of dhcp
# iface eth0 inet dhcp

# Wireless interfaces
#
# Example of an unencrypted (no WEP or WPA) wireless connection
# that connects to any available access point:
#
# auto wlan0
# iface wlan0 inet dhcp
# wireless_mode managed
# wireless_essid any
# wireless_key any

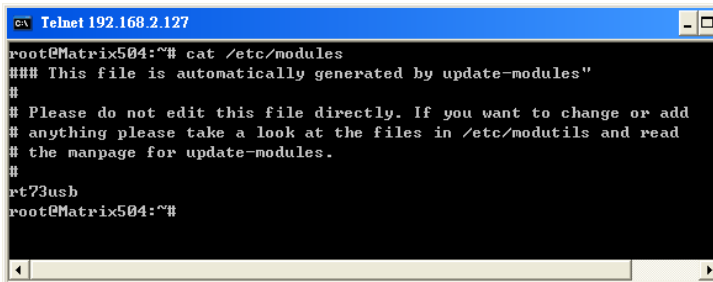
root@Matrix504:~#
```

Insert kernel module

To insert kernel module while system boot up, please use `vi` to edit `/etc/modules` to add module to load e.g.

`rt73usb`

To load the USB WLAN adaptor.



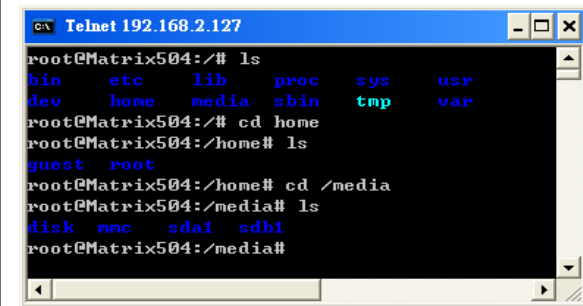
```
root@Matrix504:~# cat /etc/modules
### This file is automatically generated by update-modules"
#
# Please do not edit this file directly. If you want to change or add
# anything please take a look at the files in /etc/modutils and read
# the manpage for update-modules.
#
rt73usb
root@Matrix504:~#
```

Use `vi` editing tool to edit the `/etc/network/interfaces` for network setting. The default setting is static IP 192.168.2.127. PAC-4000 also supports Wireless LAN. Use `wireless_essid XXX` `wireless_key YYY`

To add SSID and WEP key if necessary. XXX is SSID and YYY is WEP Key

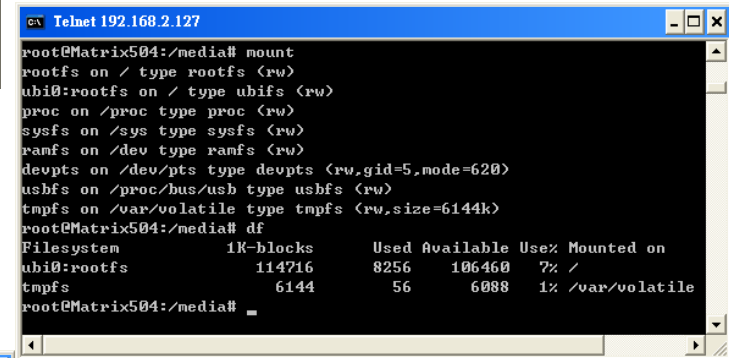
PAC-4000 supports USB WLAN adaptor (Ralink RT2571). You can enable the driver module (`rt73usb`) by adding `rt73usb` in `/etc/modules`

File System



```
root@Matrix504:~# ls
bin  etc  lib  proc  sys  usr
dev  home  media  sbin  tmp  var
root@Matrix504:~# cd home
root@Matrix504:~/home# ls
guest  root
root@Matrix504:~/home# cd /media
root@Matrix504:~/media# ls
disk  mmc  sda1  sdb1
root@Matrix504:~/media#
```

The 128MB NAND Flash memory of PAC-4000 contains Boot loader (uBoot), Linux Kernel, Root File System and user disk (`/home`). The file system and disk space are shown as follow



```
root@Matrix504:~/media# df
Filesystem          1K-blocks      Used Available Use% Mounted on
ubi0:rootfs         114716        8256   106460    7% /
tmpfs               6144          56     6088    1% /var/volatile
root@Matrix504:~/media#
```

Devices list

The supported devices are shown at /dev directory. Following list are most popular ones:

1. ttyS0: serial console port
2. ttyS1 to ttyS4: serial port 1 to port 4
3. sda to sdb: USB flash disk
4. ttyUSB0 to ttyUSB1: USB RS-232 adaptor (fdt_i2c.ko)
5. rtc: Real Time Clock
6. gpio: General Purpose digital I/O
7. ttyACM0 and ttyACM1: USB Modem (CDC compliant)
8. mmc : SD driver

Utility Software:

PAC-4000 includes busybox utility collection and Artila utility software and there are placed at :

/sbin

/bin

/usr/bin

/use/sbin

Please refer to Appendix for the utility collection list

```

Telnet 192.168.2.127
root@Matrix504:~# ls
arp          init          lshusb       setconsole
depmod       init.sysvinit makedevs     shutdown
depmod.26   insmod        mkdosfs      shutdown.sysvinit
fdisk        iwconfig      mkfs.minix   start-stop-daemon
fsck         iwgetid       mkfs.vfat    sulogin
fsck.minix  iwlist        mkswap       swapoff
getty        iwpriv        modprobe     swapon
halt         iwspy         pivot_root   switch_root
halt.sysvinit killall5      poweroff     sysctl
hotplug      klogd         reboot       sysctl.procps
hwclock     ldconfig      reboot.sysvinit syslogd
ifconfig    logread       rmmod        telinit
ifdown      losetup       route        udhcp
ifup        lsmod         runlevel

root@Matrix504:~# cd /bin
root@Matrix504:/bin# ls
addgroup    dmesg         mktemp       sh
adduser     echo          more         sleep
bash        egrep         mount        stty
bashbug     false        mount.util-linux su
busybox     fgrep        mountpoint   sync
cat         grep         mv           tar
chattr      gunzip       netstat     touch
chgrp       gzip         pidof        true
chmod       hostname     pidof.sysvinit umount
chown       ip           ping         umount.util-linux
cp          kill         ps           uname
cpio        kill.procps  ps.procps   usleep
date        ln           pwd          vi
dd          login        rm           zcat
delgroup   ls           rmdir       zcat
deluser    mknod       run-parts
df          mknod       sed

```

Mounting External Storage Memory

To find out the device name of the external memory device which plug into PAC-4000, you can use the command

```
dmesg | grep sd
```

```
dmesg | grep mmc
```

To find out the device type (sda , sdb or mmc)

And use

```
mount /dev/sda1
```

```
mount/dev/mmc
```

to mount the USB disk or SD card and folder is local at `media/sda1` or `/mnt/sda1`

```

Telnet 192.168.2.127
root@Matrix504:~# cat /etc/fstab
# stock fstab - you probably want to override this with a machine specific one

rootfs      /          auto          defaults      1 1
proc        /proc      proc          defaults      0 0
devpts      /dev/pts   devpts       mode=0620,gid=5 0 0
usbfs       /proc/bus/usb usbfs        defaults      0 0
tmpfs       /var/volatile tmpfs        defaults,size=6M 0 0

# mount dev
/dev/sda1   /media/sda1 auto          defaults,sync,noauto 0 0
/dev/sda    /media/sda1 auto          defaults,sync,noauto 0 0
/dev/sdb1   /media/sdb1 auto          defaults,sync,noauto 0 0
/dev/sdb    /media/sdb1 auto          defaults,sync,noauto 0 0

```

Welcome Message

To modify the welcome message, user can use text edit to modify the /etc/motd.

Web Page Directory

The web pages are placed at /usr/www and the /etc/lighttpd.conf contains the lighttpd web server settings. The home page name should be `index.html`

Adjust the system time

To adjust the RTC time, you can follow the command

```
date MMDDhhmmYYYY
```

where

MM=Month (01~12)

DD=Date (01~31)

hh=Hour

mm=minutes

YYYY= Year

```
hwclock -w
```

To write the date information to RTC

User can also use NTP client utility in Artila CD to adjust the RTC time.

```
ntpclient [time server ip]
```

SSH Console

PAC-4000 supports SSH. If you use Linux computer, you can use SSH command to login Matrix 518. The configuration of SSH and key are located at

/etc/ssh

The key generation program is available at /usr/bin



Putty Console Software

For Windows user, you can download the putty software at <http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html> to use SSH to login PAC-4000

ipkg package software management

ipkg is a light software package utility. It can be used to install, upgrade and remove the software package for PAC-4000. Currently user can use ipkg to install the software package from Artila FTP. You can find the configuration at `ipkg.conf`

When PAC-4000 is connected to network and issue command

```
ipkg update
```

To update the package list and use

```
ipkg install
```

to install software package and

```
ipkg remove
```

to remove software

```
ipkg list
```

to list available software

```
ipkg list_installed
```

to list software installed

Please refer to Appendix for more about ipkg

Install GNU Tool Chain

Find a PC with Linux OS installed as followed:
Fedore 7, ubuntu 7.04, OpenSUSE 10.2, Mandriva 2008,
Debian 5.0, Centos (RedHat) 5 and above.

Login as a root user then copy the arm-linux-4.3.2.tar.gz to root directory of PC. Under root directory, type following command to install the PAC-4000 Tool Chain

```
#tar -xvfj arm-linux-4.3.3.tar.bz2
```

The tool chain file name are

```
arm-linux-gnueabi-gcc  
arm-linux-gnueabi-g++  
arm-linux-gnueabi-strip
```

Version: gcc 4.3.3, glibc 2.9, binutils 2.18

For Windows user, please download the toolchain from CodeSourcery at

<http://www.codesourcery.com/sgpp/lite/arm/portal/package4547/public/arm-none-linux-gnueabi/arm-2009q1-203-arm-none-linux-gnueabi.exe>

The tool chain file name are
arm-none-linux-gnueabi-gcc
arm-none-linux-gnueabi-g++
arm-none-linux-gnueabi-strip

Version: gcc 4.3.3, glibc 2.8, binutils 2.19

Getting started with the Hello program

There are many example programs in Artila CD. To compile the sample you can use the Make file and type *make*

To compile and link the library. Once done, use ftp command *ftp 192.168.2.127*

Then login with password. Use bin command to set transfer mode to binary

```
ftp>bin
```

to transfer the execution file to PAC-4000 user disk (/home/guest) and use

```
chmod +x file.o
```

To change it to execution mode and

```
./file.o
```

to run the program

Auto start program on boot:

To start a program on boot, you can use */etc/rc.local*

For example to use *vi* to edit *rc.local*

```
hello &
```

```
exit 0
```

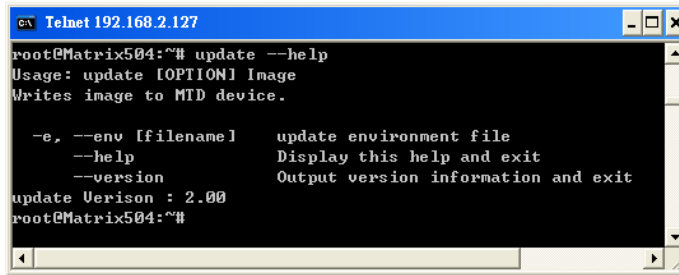
Hello will be executed after system boot up. *rc.local* has the similar function as */etc/rc* in PAC-4000

Artila Utility Software:

The introduction of Artila utility software as follow:

1. *update* : update loader, environment file and kernel image.

Type *update--help* to find the command usage

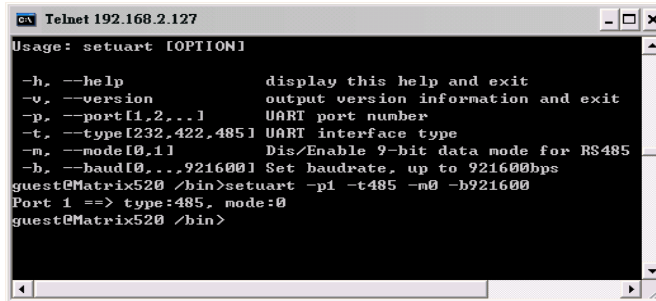


```
Telnet 192.168.2.127
root@Matrix504:~# update --help
Usage: update [OPTION] Image
Writes image to MTD device.

-e, --env [filename]  update environment file
--help                Display this help and exit
--version             Output version information and exit
update Verison : 2.00
root@Matrix504:~#
```

Update can only operated under supervisor mode (password : root). Please use command *su* and login as root

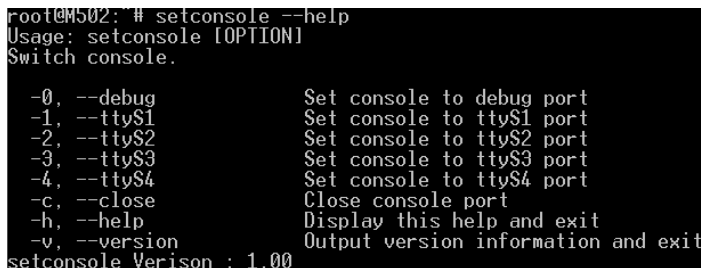
2. *setuart*: configure serial port setting. An example show as followed to configure port 1 as RS-485 interface with baud rate 921600.



```
Telnet 192.168.2.127
Usage: setuart [OPTION]

-h, --help          display this help and exit
-v, --version       output version information and exit
-p, --port[1,2,..] UART port number
-t, --type[232,422,485] UART interface type
-m, --mode[0,1]     Dis/Enable 9-bit data mode for RS485
-b, --baud[0,..,921600] Set baudrate, up to 921600bps
guest@Matrix520 /bin>setuart -p1 -t485 -m0 -b921600
Port 1 ==> type:485, mode:0
guest@Matrix520 /bin>
```

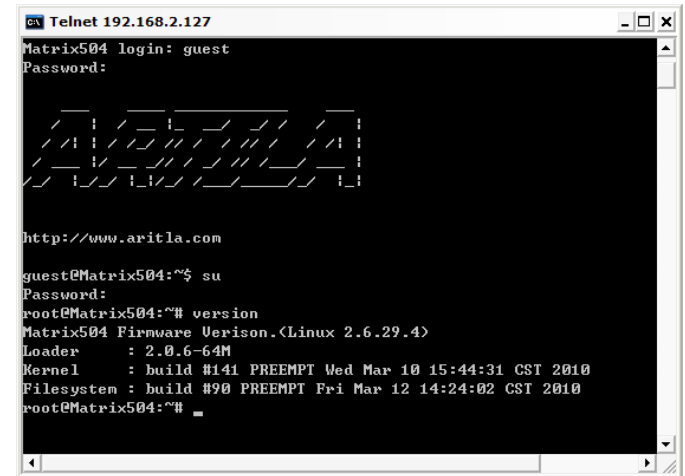
3. *setconsole*: PAC-4000 is designed to use M-502 SoM as its CPU module. The console port is located at JP4 of M-502 module. User can use *setconsole* command to redirect the serial console port to any one of the four serial port of PAC-4000. Therefore user can avoid opening the metal case to access the serial console.



```
root@M502:~# setconsole --help
Usage: setconsole [OPTION]
Switch console.

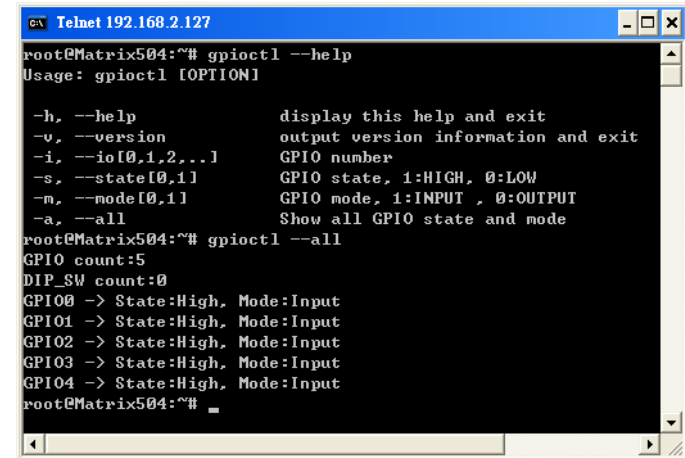
-0, --debug        Set console to debug port
-1, --ttyS1        Set console to ttyS1 port
-2, --ttyS2        Set console to ttyS2 port
-3, --ttyS3        Set console to ttyS3 port
-4, --ttyS4        Set console to ttyS4 port
-c, --close        Close console port
-h, --help        Display this help and exit
-v, --version      Output version information and exit
setconsole Verison : 1.00
```

3. *version*: find out the version of OS.



```
Telnet 192.168.2.127
Matrix504 login: guest
Password:
http://www.aritla.com
guest@Matrix504:~$ su
Password:
root@Matrix504:~# version
Matrix504 Firmware Verison.(Linux 2.6.29.4)
Loader      : 2.0.6-64M
Kernel      : build #141 PREEMPT Wed Mar 10 15:44:31 CST 2010
Filesystem  : build #90 PREEMPT Fri Mar 12 14:24:02 CST 2010
root@Matrix504:~#
```

4. *gpioctl*: The gpio can be configured by *gpioctl* and the usage is as shown followed.



```
Telnet 192.168.2.127
root@Matrix504:~# gpioctl --help
Usage: gpioctl [OPTION]

-h, --help          display this help and exit
-v, --version       output version information and exit
-i, --io[0,1,2,..] GPIO number
-s, --state[0,1]   GPIO state, 1:HIGH, 0:LOW
-m, --mode[0,1]    GPIO mode, 1:INPUT, 0:OUTPUT
-a, --all           Show all GPIO state and mode
root@Matrix504:~# gpioctl --all
GPIO count:5
DIP_SW count:0
GPIO0 -> State:High, Mode:Input
GPIO1 -> State:High, Mode:Input
GPIO2 -> State:High, Mode:Input
GPIO3 -> State:High, Mode:Input
GPIO4 -> State:High, Mode:Input
root@Matrix504:~#
```

Loader Menu

Loader menu helps user to select the run level of system boot up. User need to use serial console to enter loader menu. Please configure the serial port of terminal as follow:

Baud Rate: 115200
Data bits: 8
Parity: N
Stop bit: 1
Flow Control: None
Terminal type: VT100

Once power up PAC-4000, please repeatedly keying “@” and you will see the loader menu appear as follow:

Starting M502.....

```
*****
      Artila Loader Version 2.0.9
      DRAM:64M NAND:128M
*****
G: Loader TFTP      L: Loader Serial
K: Kernel TFTP     S: Kernel Serial
F: Filesys TFTP    T: Filesys Serial
E: Env. Upgrade    M: Ethernet Setting
A: Dataflash Booting U: Runlevel
C: Switch Console  R: Reset
*****
```

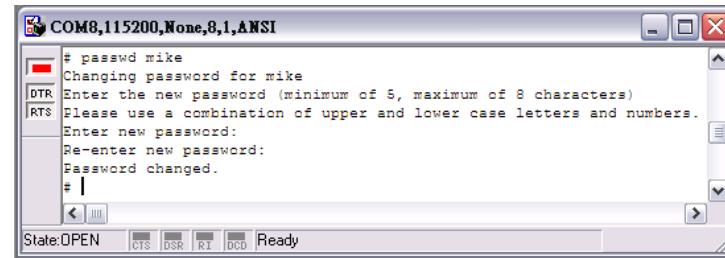
If you miss the timing, please power on again the PAC-4000 and do it again. Select U will prompt the run level selection message. Run level 0 is halt, run level 1 is single user (disable login and service). Run level 2~5 are multiple users and run level 6 is reboot. To view the run level configuration, please check

/etc/inittab

Frequently Asked Question

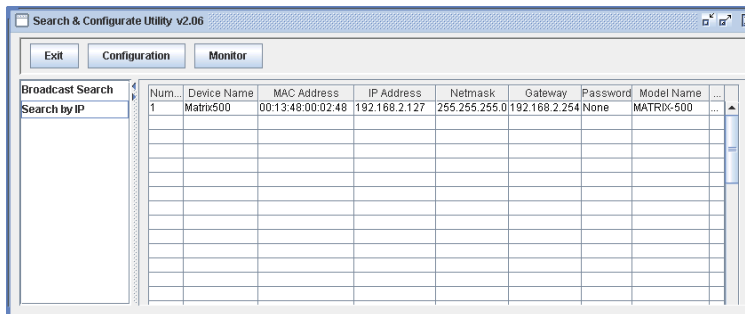
1. *Forgot password:*

If you forgot the password for login, please use serial console and use run level 1 to boot system. Use passwd to change the password setting.



2. *Forgot the IP address*

If you forgot the PAC-4000 IP address, you can use the Java Manager available in Artila CD to search the IP address of PAC-4000 Or use serial console port to find out the IP address by *#ifconfig*

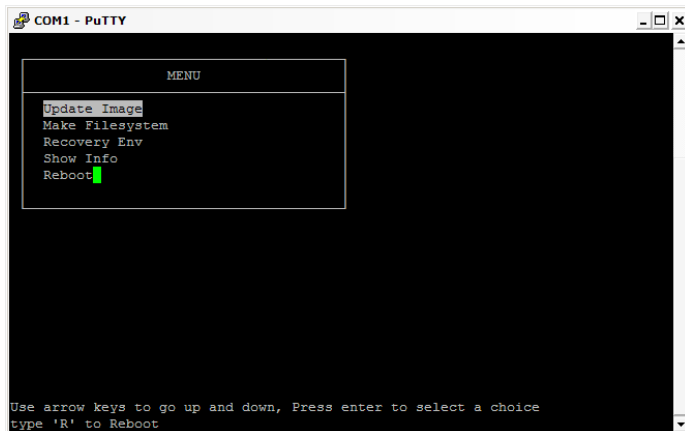


3. *System fail to boot*

If you mess up the root file system and make the system fail to boot, PAC-4000 will automatically switch to boot from Dataflash file system and a console menu will show up at console port to help user perform system recovery. *System Recovery Section* will tell you how to recover the system.

System Recovery

If NAND Flash file system does fail, DataFlash file system will automatically boot up and a Console Menu at console port will appear as follow:



```
COM1 - PuTTY
MENU
Update Image
Make Filesystem
Recovery Env
Show Info
Reboot
Use arrow keys to go up and down, Press enter to select a choice
type 'R' to Reboot
```

1. Update Image: this option can recover the loader, kernel and file system by using an USB disk. The USB disk contains the images files with the path as follow:

Loader: *pac4000/pac4000.alf*
Kernel: *pac4000/pac4000K*
File system: *pac4000/pac4000R*

The files are available in Artila CD. Please prepare an USB disk and copy the image files to it before choosing this option.

Make user's filesystem

2. Make Filesystem: this option is used to create customized file system. Before using this function, you need to copy the folder of *mkimage504* in the Artila CD to an USB disk. This function will create a new file system image for users and they can use it to duplicate the customized file system to other PAC-4000.

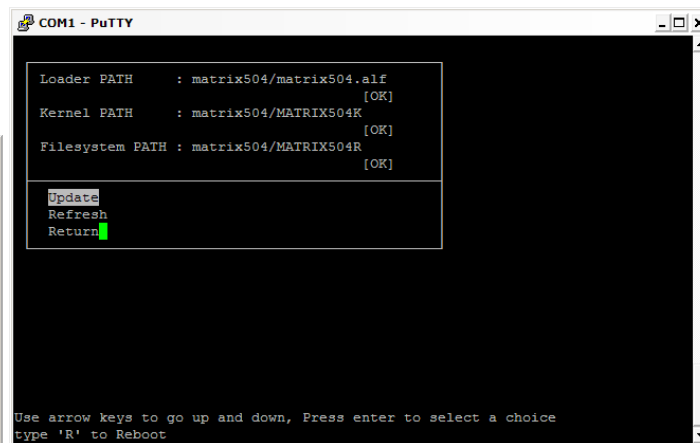
Recover Environment File

3. Recovery Env.: The option will recover the environment files as default setting. Use this function only when the NAND file system crash.

4. Show Info: Show the version information of PAC-4000

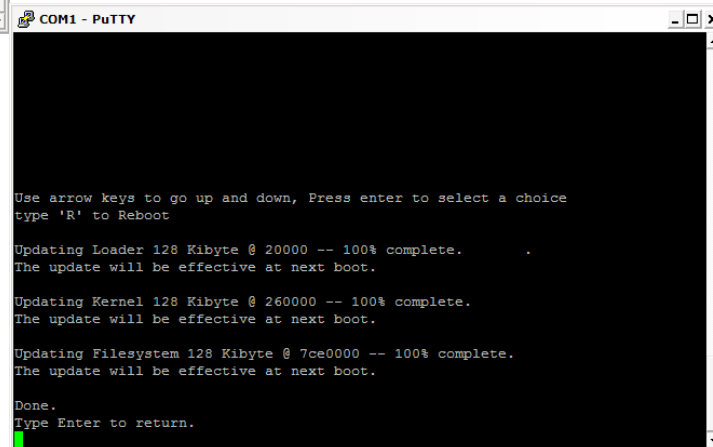
5. Reboot: Reboot the NAND flash file system.

Update Image Starts



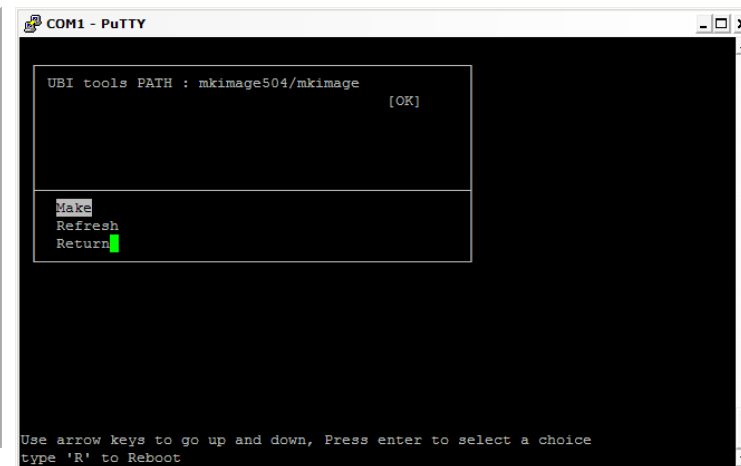
```
COM1 - PuTTY
Loader PATH : matrix504/matrix504.alf [OK]
Kernel PATH : matrix504/MATRIX504K [OK]
Filesystem PATH : matrix504/MATRIX504R [OK]
Update
Refresh
Return
Use arrow keys to go up and down, Press enter to select a choice
type 'R' to Reboot
```

Update Image Completes



```
COM1 - PuTTY
Use arrow keys to go up and down, Press enter to select a choice
type 'R' to Reboot
Updating Loader 128 Kibyte @ 20000 -- 100% complete.
The update will be effective at next boot.
Updating Kernel 128 Kibyte @ 260000 -- 100% complete.
The update will be effective at next boot.
Updating Filesystem 128 Kibyte @ 7ce0000 -- 100% complete.
The update will be effective at next boot.
Done.
Type Enter to return.
```

Make Files System Starts



```
COM1 - PuTTY
UBI tools PATH : mkimage504/mkimage [OK]
Make
Refresh
Return
Use arrow keys to go up and down, Press enter to select a choice
type 'R' to Reboot
```

Note:

1. Use Arrow keys up and down to selection the functions
2. Use Arrow keys left and right to go to higher or lower levels of menu screen

Force DataFlash boot

1. To force system go into DataFlash booting, repeatedly keying “!” (Shift +1) right after PAC-4000 power on.

Appendix

Utility Collection

1. busybox v1.14.2-tiny utility collection
2. sysvinit v2.86 -standard Linux initialization
3. util-linux-mount/umount v2.12r-support long file name
4. ssh v4.6p1- support sftp server
5. usbutils v0.7- USB id program
6. lighttpd v 1.7-web server
7. wget v1.9.1- used in ipkg software
8. iptables v1.3.8- IP routing
9. ipkg v.0.99.163- software package management
10. procps v3.2.7- support webmin process management
11. vsftpd v2.0.5- ftp server
12. bash v3.2-GNU shell
13. wireless_tools v29- wireless LAN utility
14. ppp v2.4.3-ppp dial up utility
15. psmics v22.2- procps supplement
16. artila utility v.1.1- handy utility added by Artila

You can find more utility at Artila Matrix-504 CD and use ipkg to install the utility.

ipkg software package management

PAC-4000 uses *ipkg* to manage the software installation, upgrade and removal. Artila will continuously add the kernel module and utility at our ftp server, user can install these software from Artila's ftp server. In addition user can also setup your ftp server to update the software you want. To install the utility from Artila ftp, please use *vi* to edit the */etc/ipkg.conf*
src/gz arm ftp://ftp:ftp@ftp.artila.com/AT9G20/Artila-CD/Linux/Utility
src/gz kernel ftp://ftp:ftp@ftp.artila.com/AT9G20/Artila-CD/Linux/modules

You can also copy the Utility and module folder from Artila CD to a USB disk, then use USB disk to install the software by changing the *ipkg.conf*
src/gz usb_arm ftp://root:root@127.0.0.1/media/sda1/Utility
src/gz usb_kernel ftp://root:root@127.0.0.1/media/sda1/modules

Make sure the USB disk is correctly mounted, now use command *ipkg update* to update the package list and use *ipkg install webmin*

To install webmin. Webmin is a web-based interface to system administration. To start webmin, go to */etc/webmin* and type *start webmin*

Then you can use browser to visit PAC-4000 port 10000

The webmin for PAC-4000 provides following modules:

1. Webmin: webmin configuration
2. System: system boot, process and log management
3. Server: Apache and SSH server configuration
4. Network: network configuration
5. Hardware: RTC setting
6. Others: File manager, upload and download

Remember to use command

depmod -a /lib/modules/2.6.29.4/modules.dep

To update the dependency list if new kernel module were added.

