

# **Matrix-504**

## **Linux ARM9 Industry Box Computer**

### **User Guide**

Version 1.6





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# 1. Introduction

Matrix-504 is a Linux ready, ARM9-based embedded computer. Its lower power and robust design concept makes it an ideal industrial computer platform for harsh environment. The Linux OS and file system are pre-installed in the on-board Flash memory and the GNU tool chain on Artilla FTP is ready for your application development.

## 1.1 Features

- ARM926EJ-S ARM Thumb Processor 400MHz w/MMU
- 32-KByte Data Cache and 32-KByte Instruction Cache
- 64MB SDRAM, 256MB NAND Flash on board
- One 10/100 Mbps Ethernet
- Two USB 2.0 full speed (12 Mbps) Host Ports
- One software configurable RS-232/422/485 port and three RS-232/485 ports
- One serial console port
- One microSD socket: up to 32GB
- Five programmable GPIO
- 9 to 48VDC power input
- Pre-installed Linux 2.6.29 kernel and file system
- GNU tool chain available on Artilla FTP
- Optional DIN RAIL mounting adaptor

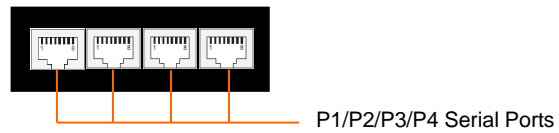
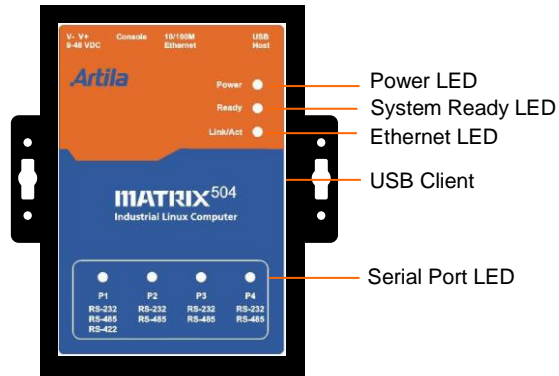
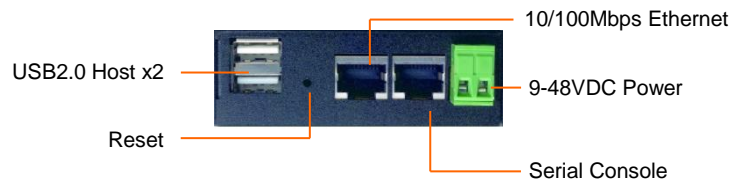
## 1.2 Packing List

- Matrix-504
- Matrix-504T: Wide-temperature (-20~80°C) Version

## 1.3 Optional Accessory

- CB-RJ45F9-150 (91-R45F9-150): Serial Cable (RJ45 to DB9 Female, 150cm)
- CB-RJ2CON-100 (91-RJCON-100): Console Cable (RJ45 to DB9 Female, 100cm)
- DK-35A (36-DK35A-000): DIN RAIL Mounting Kit
- PWR-12V-1A (31-62100-000): 110~240VAC to 12VDC 1A Power Adaptor

## 2. Layout



## 3. Pin Assignment and Definition

### 3.1 USB Port

The USB port is an USB2.0 high speed host port. It can be used to expand the hardware function of Matrix-504 and exchange file and data between PC and Matrix-504 using an USB flash disk.

Currently the hardware support by Matrix-504 USB is shown as follow:

1. USB Storage Device
2. USB to Wireless LAN Adaptor (Ralink RT73)
3. USB to Serial Adaptor (fdti usb to UART)
4. USB to Modem (CDC compliant)
5. USB Camera

The USB client port is reserved for production purpose only. Contact Artila if you find your hardware is not shown on the list.

### 3.2 Reset Button

Press the “Reset” button to activate the hardware reset. Please always use “reboot” command to reset Matrix-504. You should only use this function if the software reboot does not function properly.

### 3.3 Power LED

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

### 3.4 Ready LED

After Power ON, Matrix-504 starts booting. Once system is boot up, the Ready LED will show solid green. The Ready LED will be turned off after Matrix-504 received “halt” command.

### 3.5 Link / Act LED

When Ethernet port is connected to the network, Link/Act will show solid green and if there is traffic in the Ethernet, this LED will flash.

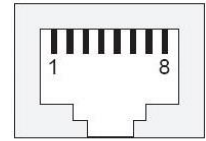
### 3.6 Serial Port LED

These four dual color LEDs indicate the data traffic at the serial ports. When RXD line is high then Green light is ON and when TXD line is high, Yellow light is ON.

### 3.7 Serial Port

The four serial ports can be configured as RS-232, RS-422 or RS-485 by software. They use RJ45 connector and the pin assignment are shown as following table.

Pin	RS-232	RS-422	RS-485
1	DSR	--	--
2	RTS	TXD+	Data+
3	GND	GND	GND
4	TXD	TXD-	Data-
5	RXD	RXD+	--
6	DCD	RXD-	--
7	CTS	--	--
8	DTR	--	--



#### Port 1: RS-232/422/485

RS-232: RXD, TXD, RTS, CTS, DSR, DTR, DCD, GND

RS-422: TXD+, TXD-, RXD+, RXD-, GND

RS-485: DATA+, DATA-, GND

#### Port 2/3/4:

RS-232: RXD, TXD, RTS, CTS, GND

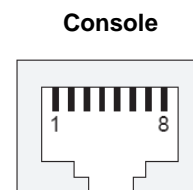
RS-485: DATA+, DATA-, GND

### 3.8 Serial Console Port: (JP1)

Serial console port is used for locally accessing Matrix-504 system using RS-232 port. The console port use RJ45 connector and is next to Ethernet port. Therefore please be careful to plug in the right connector.

Port 0: RS-232: RXD, TXD, GND

Pin	Definition
1	PIO0
2	TXD
3	GND
4	PIO1
5	PIO2
6	PIO3
7	RXD
8	PIO4

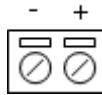




Therefore you need to prepare or purchase the serial console cable (91-RJCON-100) in order to use the serial console port. In addition to the serial console signal, the console RJ45 port also provides GPIO (programmable I/O signal) function. The GPIO port is CMOS I/O and can be programmed as digital input or output. Power up setting is digital input mode with 100K ohm pull up resistor.

### 3.9 Power Connector

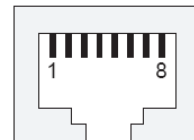
Connect the 9 to 48VDC power line to Matrix-504. If the power is properly supply, the power LED will show a solid green color.



### 3.10 Ethernet Port

The Ethernet Port use RJ45 connector.

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



### 3.11 Factory Default Settings

**LAN 1 IP Address:** 192.168.2.127

**Login:** root or guest (telnet guest only)

**Password:** root or guest (telnet guest only)

**Serial Console Port:**

Baud rate: 115200

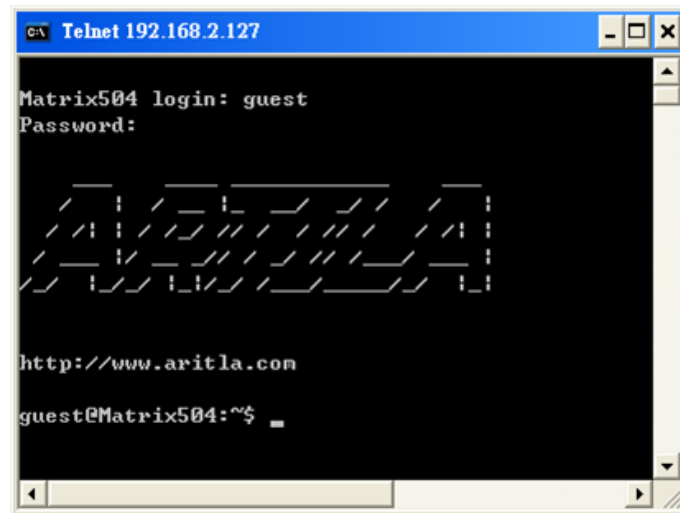
Data format: 8 Bits, No Parity, 1 Stop bit (N,8,1)

Flow Control: None

Terminal type: VT100

### 3.12 Power on and System Boot up

Once Matrix-504 is correctly power on, it will start boot Linux kernel and mount file system. You can use Ethernet and telnet and login Matrix-504. 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 Matrix-504.



### 3.13 Inittab and Run Levels

Inittab contains information of system initialization. The system initialization script */etc/rcS.d* runs first then the run level 5 */etc/rc5.d*. Matrix-504 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.

### 3.14 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/securetty)
5. ftp server (vsftp)
6. web server (lighttpd)
7. Ready LED (debug LED for internal use)

### 3.15 Network Settings

```

Telnet 192.168.2.127
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:~#

```

### 3.16 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.

```

Telnet 192.168.2.127
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. Matrix-504 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.

Matrix-504 supports USB WLAN adaptor (Ralink RT2571). You can enable the driver module (*rt73usb*) by adding *rt73usb* in

***/etc/modules***

### 3.17 File System

```

Telnet 192.168.2.127
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  sdai  sdbi
root@Matrix504:/media#

```

The 256MB NAND Flash memory of Matrix-504 contains Boot loader (uBoot), Linux Kernel, Root File System and user disk (/home). The file system and disk space are shown as follow.

```

Telnet 192.168.2.127
root@Matrix504:/media# mount
rootfs on / type rootfs (rw)
ubi0:rootfs on / type ubifs (rw)
proc on /proc type proc (rw)
sysfs on /sys type sysfs (rw)
ramfs on /dev type ramfs (rw)
devpts on /dev/pts type devpts (rw,gid=5,mode=620)
usbfs on /proc/bus/usb type usbfs (rw)
tmpfs on /var/volatile type tmpfs (rw,size=6144k)
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#

```

### 3.18 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 (fdti\_sio.ko)
5. rtc: Real Time Clock
6. gpio: General Purpose digital I/O
7. ttyACM0 and ttyACM1: USB Modem (CDC compliant)

### 3.19 Utility Software

Matrix-504 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:/sbin# ls
arp                init               lsusb              setconsole
depmod             init.sysvinit     makedevs          shutdown
depmod.26         insmod            mkdosfs           shutdown.sysvinit
fdisk             iwconfig          mkfs.minix       start-stop-daemon
fsck              iugetid          mkfs.vfat         sulogin
fsck.minix        iulist           mkswap           swapoff
getty             iupriv           modprobe         swapon
halt              ivspp            pivot_root       switch_root
halt.sysvinit     killall15        poweroff         sysctl
hotplug          klogd            reboot           sysctl.procps
hwclock          ldconfig         reboot.sysvinit  syslogd
ifconfig         logread          rmmod            telinit
ifdown           losetup          route            udhcpc
ifup             lsmod            runlevel

root@Matrix504:/sbin# 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
deluser          mkdir            run-parts
df              mknod            sed

```

### 3.20 Mounting External Storage Memory

To find out the device name of the external memory device which plug into Matrix-504, you can use the command:

```
dmesg | grep sd
```

To find out the device type (sda or sdb).

And use

```
mount /dev/sda1
```

to mount the USB disk 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         node=0620,gid=5 0 0
ushfs           /proc/bus/usb        ushfs          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
root@Matrix504:~#

```

### 3.21 Welcome Message

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

### 3.22 Web Page Directory

The web pages are placed at */usr/share/apache2* and the */etc/apache2/httpd.conf* contains the apache web server settings. The home page name should be *index.html*.

### 3.23 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.

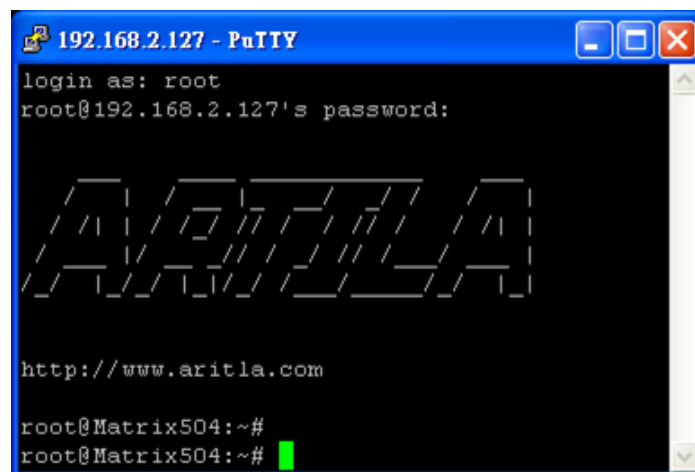
```
ntpclient [time server ip]
```

### 3.24 SSH Console

Matrix-504 supports SSH. If you use Linux computer, you can use SSH command to login Matrix-504.

The configuration of SSH and key are located at */etc/ssh*.

The key generation program is available at */usr/bin*.



### 3.25 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 Matrix-504.

### 3.26 ipkg Package Software Management

ipkg is a light software package utility. It can be used to install, upgrade and remove the software package for Matrix-504. Currently user can use ipkg to install the software package from Artila FTP.

You can find the configuration at *ipkg.conf*.

When Matrix-504 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***.

### **3.27 Install GNU Toolchain**

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 Matrix-504 Toolchain:

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

The toolchain 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 toolchain 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

### 3.28 Getting Started with the Hello Program

There are many example programs on Artila FTP. 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 Matrix-504 user disk (/home/guest) and use

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

To change it to execution mode and

```
./file.o
```

to run the program.

### 3.29 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
```

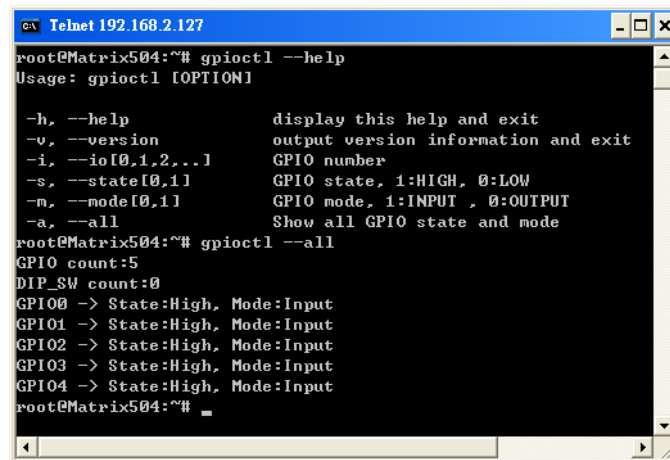
Hello will be executed after system boot up. **rc.local** has the similar function as **/etc/rc** in Matrix-504.





## 4.4 gpioctrl

The gpio can be configured by **gpioctrl** and the usage is as shown followed. The default setting is digital input with 75K ohm pull up resistor.

A terminal window titled "Telnet 192.168.2.127" showing the execution of the gpioctrl command. The user enters "gpioctrl --help" and the terminal displays the usage and options for the command. The user then enters "gpioctrl --all" and the terminal displays the state and mode for GPIOs 0 through 4.

```
root@Matrix504:~# gpioctrl --help
Usage: gpioctrl [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:~# gpioctrl --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:~#
```

## 5. 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 Matrix-504, please repeatedly keying "@" and you will see the loader menu appear as follow:

```
Starting Matrix504.....
*****
          Artila Loader Version 2.0.0
*****
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
R: Reset
*****
```

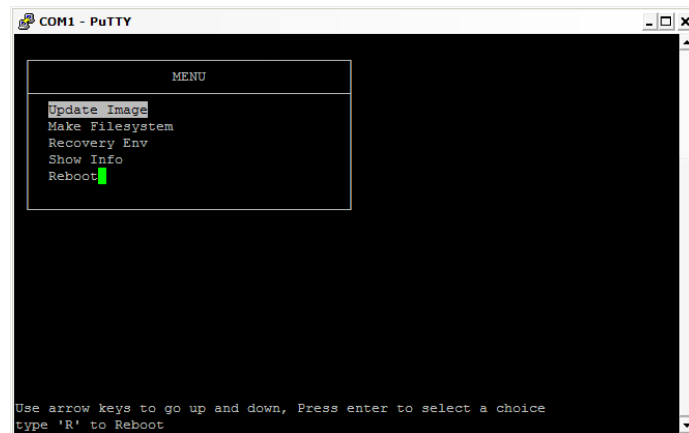
If you miss the timing, please power on again the Matrix-504 and do it again. Select U will prompt the run level selection message. Run level 0 is halt, run level 1 is single user (disable login and service). Run level 2~5 are multiple users and run level 6 is reboot. To view the run level configuration, please check:

***/etc/inittab***



## 7. 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:



### 7.1 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: ***matrix504/matrix504.alf***

Kernel: ***matrix504/matrix504K***

File system: ***matrix504/matrix504R***

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

### 7.2 Make Filesystem

This option is used to create customized file system. Before using this function, you need to copy the folder of ***mkimage504*** on Artila FTP 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 Matrix-504.

### 7.3 Recovery Env.

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

### 7.4 Show Info

Show the version information of Matrix-504.

### 7.5 Reboot

Reboot the NAND flash file system.

## 7.6 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

```

## 7.7 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.

```

## 7.8 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.
3. To force system go into DataFlash booting, repeatedly keying "!" (Shift +1) right after Matrix-504 power on.

## 8. Appendix

### 8.1 Utility Collection

- busybox v1.14.2: tiny utility collection
- sysvinit v2.86: standard Linux initialization
- util-linux-mount/umount v2.12r: support long file name
- ssh v4.6p1: support sftp server
- usbutils v0.7: USB id program
- Apache2 v2.23: web server
- wget v1.9.1: used in ipkg software
- iptables v1.3.8: IP routing
- ipkg v.0.99.163: software package management
- procps v3.2.7: support webmin process management
- vsftpd v2.0.5: ftp server
- bash v3.2: GNU shell
- wireless\_tools v29: wireless LAN utility
- ppp v2.4.3: ppp dial up utility
- psmics v22.2: procps supplement
- artila utility v.1.1: handy utility added by Artila

You can find more utility on Artila FTP and use ipkg to install the utility.

### 8.2 ipkg Software Package Management

Matrix-504 uses *ipkg* to manage the software installation, upgrade and removal. Artila will continuously add the kernel module and utility on Artila FTP, user can install these software from Artila FTP. In addition user can also setup your FTP server to update the software you want.

#### How to setup ipkg via internet

enable DHCP

```
$ udhcpc eth0
```

make sure your network environment can access internet

```
$ ping www.artila.com
```

modify **/etc/ipkg.conf**

*add the following two lines*

```
src/gz arm http://www.artila.com/download/ipkgs/9G20/utility/
```

```
src/gz kernel http://www.artila.com/download/ipkgs/9G20/modules/
```

*comment out other package source*

*save and quit*

execute ipkg update

```
$ ipkg update
```

examples of package installation

```
$ ipkg install pythoncore
```

```
$ ipkg install pythonpyserial
```

### How to setup ipkg via USB disk

You can also copy the Utility and module folder from Artilla FTP 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 Matrix-504 port 10000.



The webmin for Matrix-504 provides following modules:

- Webmin: webmin configuration
- System: system boot, process and log management
- Server: Apache and SSH server configuration
- Network: network configuration



- Hardware: RTC setting
- 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.