

# **Matrix-518**

## **Linux ARM9 Industry Box Computer**

### **User Guide**

Version 1.2





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# 1. Introduction

Matrix-518 is an ARM9-based Linux ready industrial computer. The key features are as follow:

- ARM926EJ-S ARM Thumb Processor 400MHz w/MMU
- 32-KByte Data Cache and 32-KByte Instruction Cache
- 64MB SDRAM, 256MB NAND Flash on board
- Two 10/100 Mbps Ethernet
- Two USB 2.0 full speed (12 Mbps) Host Ports, one USB device port
- Multimedia Card Interface for microSD memory card
- Eight 3-in-1 RS-232/422/485 ports
- 21 programmable Digital I/O port
- Audio Output
- 9 to 40VDC power input
- Pre-installed Standard Linux 2.6 OS
- GNU tool chain available on Artilla FTP
- Optional DIN RAIL mounting adaptor

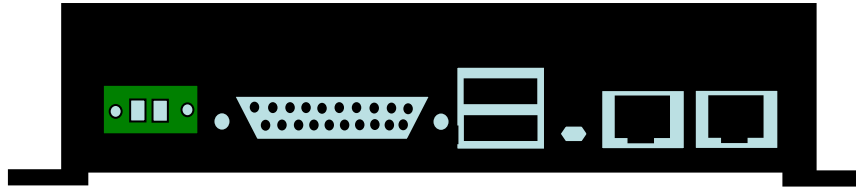
## 1.1 Packing List

- Matrix-518 Box Computer
- Wall mount bracket

## 1.2 Optional Accessory

- CB-RJ45F9-150 (91-R45F9-150): Serial Cable (RJ45 to DB9 Female, 150cm)
- CBL-F10M9-20 (91-0P9M9-001): Console Cable (10Pin Header to DB9 Male, 20cm)
- DK-35A (36-DK35A-000): DIN RAIL Mounting Kit

## 2. Layout



## 3. Pin Assignment and Definition

### 3.1 Reset Button

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

### 3.2 Power LED

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

### 3.3 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.

### 3.4 Link / Act LED

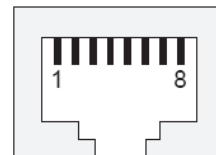
When Ethernet port are connected to the network, Link/Act will show solid green and if there is traffic is the Ethernet port, this LED will flash.

### 3.5 Serial Port LED

These eight 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.

### 3.6 Ethernet Port

Pin No.	Signal
1	ETx+
2	ETx-
3	ERx+
6	ERx-



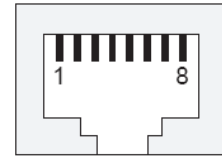
### 3.7 Serial Ports

Port 1~8: 3-in-1 Software Configurable  
RS-232/422/485

#### Note

- Only Port 2, 5, 6, 7, 8 have full modem signals DSR, DTR, DCD.

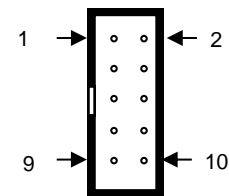
Pin No.	RS-232	RS-422	RS-485
1	DSR	-	-
2	RTS	TXD+	Data+
3	GND	GND	GND
4	TXD	TXD-	Data-
5	RXD	RXD+	-
6	DCD	RXD-	-
7	CTS	-	-
8	DTR	-	-



### 3.8 Serial Console Port

Serial console port is located inside the box at CON1. You need to use console cable (91-0P9M9-001) to access it.

Serial Console RS-232			
1	N/C	2	N/C
3	RXD	4	N/C
5	TXD	6	N/C
7	N/C	8	N/C
9	GND	10	N/C



To use the serial console port, you need to open the metal case of Matrix-518 and the CON1 connector is near the reset button and LEDs. Use any terminal software such as hyper terminal and configure the setting as follow:

*Baud Rate: 115200*

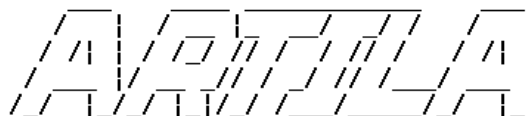
*Data bits: 8*

*Parity: N*

*Stop bit: 1*

*Terminal type: VT100*

```
Matrix518 login: root
Password:
```



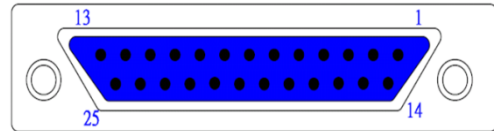
```
http://www.artila.com
```

```
root@Matrix518:~# _
```



### 3.9 Digital I/O Port (DB25 Female)

Pin No.	Function	Pin No.	Function
1	DIO0	14	DIO13
2	DIO1	15	DIO14
3	DIO2	16	DIO15
4	DIO3	17	DIO16
5	DIO4	18	DIO17
6	DIO5	19	DIO18
7	DIO6	20	DIO19
8	DIO7	21	DIO20
9	DIO8	22	GND
10	DIO9	23	GND
11	DIO10	24	VCC3
12	DIO11	25	VCC5
13	DIO12		



#### Note

1. VCC3: 3.3 VDC output
2. VCC5: 5 VDC output
3. GND: Digital Ground

#### Input:

Low level: -0.5V min  
+0.9V max

High level: +2.3V min  
+5.5V max

#### Output:

Low level: +0.5V min @ 8mA

High level: +1.8V min @ 8mA

### 3.10 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

### 3.11 Power on and System Boot up

Once Matrix-518 is correctly power on, it will start boot Linux kernel and mount file system. You can use Ethernet and telnet and login Matrix-518. 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-518.



### 3.12 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-518 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

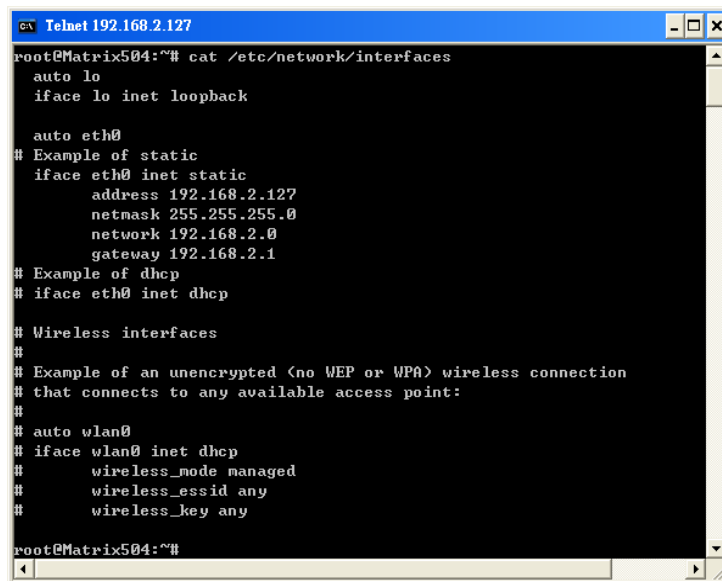
Run level 6 is reboot

Please refer to loader menu section for selection of run level.

### 3.13 Default Started Service

1. amgrd (Artila 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)

### 3.14 Network Settings



```

ex 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:~#

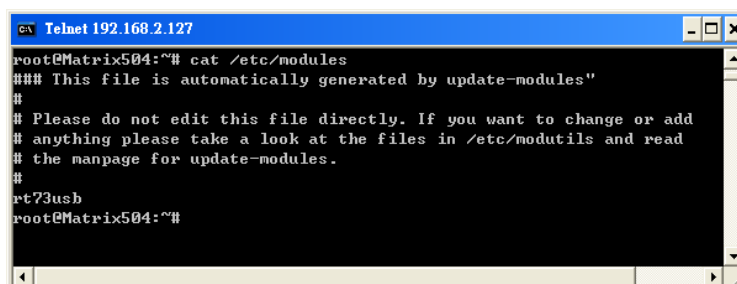
```

### 3.15 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.



```

ex 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-518 also supports Wireless LAN. Use

***wireless\_essid XXX***

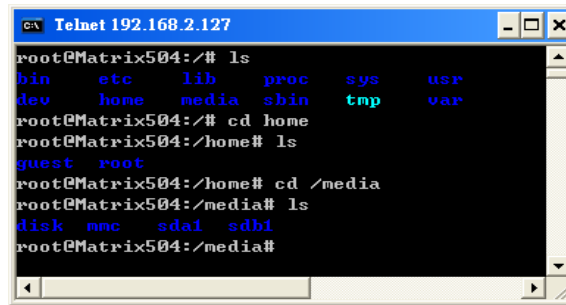
***wireless\_key YYY***

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

Matrix-518 supports USB WLAN adaptor (Ralink RT2571). You can enable the driver module (rt73usb) by adding `rt73usb` in

**`/etc/modules`**

### 3.16 File System

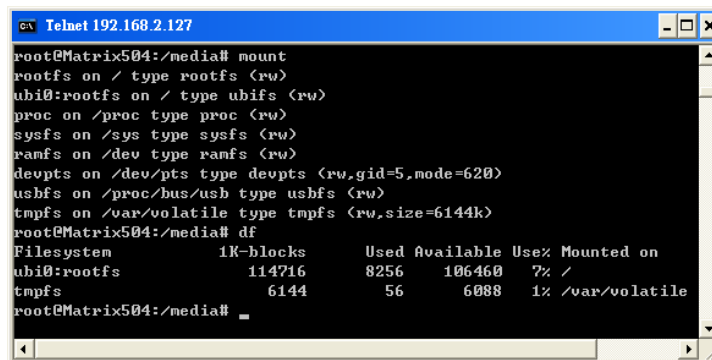


```

ca 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      sda1     sdb1
root@Matrix504:/media#

```

The 256MB NAND Flash memory of Matrix-518 contains Boot loader (uBoot), Linux Kernel, Root File System and user disk (/home). The file system and disk space are shown as follow:



```

ca 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#

```

### 3.17 Devices List

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

1. ttyS0: serial console port
2. ttyS1 to ttyS8: serial port 1 to port 8
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

### 3.18 Utility Software

Matrix-518 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               lsush              setconsole
depmod             init.sysvinit     mkdevs            shutdown
depmod.26         insmod            mkdosfs           shutdown.sysvinit
fdisk              iwconfig          mkfs.minix        start-stop-daemon
fsck               iugetid          mkfs.vfat         sulogin
fsck.minix        iolist           mkswap           swapoff
getty              iupriv           modprobe          swapon
halt              iuspy            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

```

### 3.19 Mounting External Storage Memory

To find out the device name of the external memory device which plug into Matrix-518, you can use the command:

***dmesg | grep sd***

***dmesg | grep mmc***

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

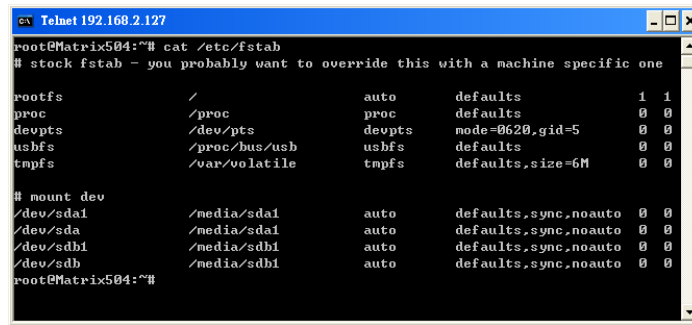
And use

***mount/dev/sda1***

***mount/dev/mmc***

to mount the USB disk or SD card and folder is local at

***media/sda1 or /mnt/sda1***

A screenshot of a Telnet window titled 'Telnet 192.168.2.127'. The window shows a root prompt at 'root@Matrix504:~#' and the command 'cat /etc/fstab' being executed. The output displays the contents of the /etc/fstab file, which includes entries for rootfs, proc, devpts, usbfs, tmpfs, and several mount entries for /dev/sda1, /dev/sda, /dev/sdb1, and /dev/sdb. The window has standard window controls (minimize, maximize, close) in the top right corner.

```
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
root@Matrix504:~#
```

### 3.20 Welcome Message

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

### 3.21 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`.

### 3.22 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 on Artilla FTP to adjust the RTC time.

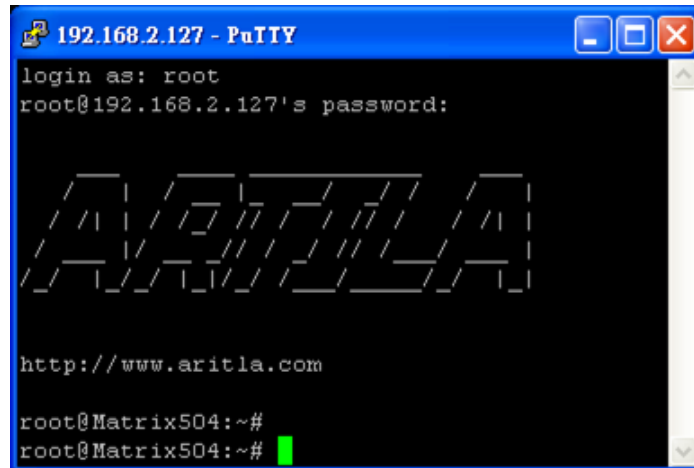
**`ntpclient [time server ip]`**

### 3.23 SSH Console

Matrix-518 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*.



### 3.24 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-518.

### 3.25 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-518. Currently user can use ipkg to install the software package from Artila FTP.

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

When Matrix-518 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*.

### 3.26 Install GNU Toolchain

Find a PC with Linux OS installed as followed:

Fedora 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-518 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

### 3.27 Getting Started with the Hello Program

There are many example programs on Artilla 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-518 user disk (/home/guest) and use

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

To change it to execution mode and

```
./file.o
```

to run the program.



### 3.28 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
```

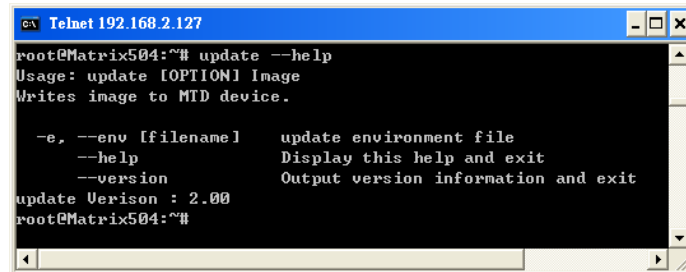
Hello will be executed after system boot up. *rc.local* has the similar function as */etc/rc* in Matrix-518.

## 4. Artila Utility Software

The introduction of Artila utility software as follow:

### 4.1 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.

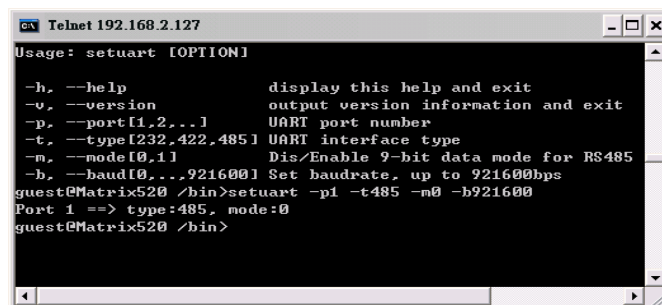
  -e, --env [filename]  update environment file
  --help                Display this help and exit
  --version             Output version information and exit
update Verison : 2.00
root@Matrix504:~#

```

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

### 4.2 setuart

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



```

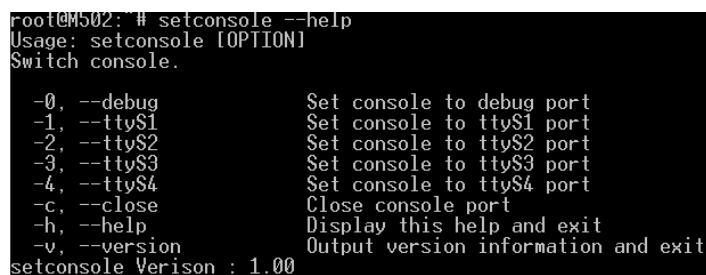
Telnet 192.168.2.127
Usage: setuart [OPTION]

  -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>

```

### 4.3 setconsole

Unlike Matrix-510 which shares the serial console port with the serial port 3, Matrix-518 uses dedicated pins for serial console (debug port). *setconsole* command allows user to redirect the serial console port to any one of the eight serial port of Matrix-518. 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, --tty$1          Set console to tty$1 port
  -2, --tty$2          Set console to tty$2 port
  -3, --tty$3          Set console to tty$3 port
  -4, --tty$4          Set console to tty$4 port
  -c, --close          Close console port
  -h, --help           Display this help and exit
  -v, --version        Output version information and exit
setconsole Verison : 1.00

```



## 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-518, 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
*****
```

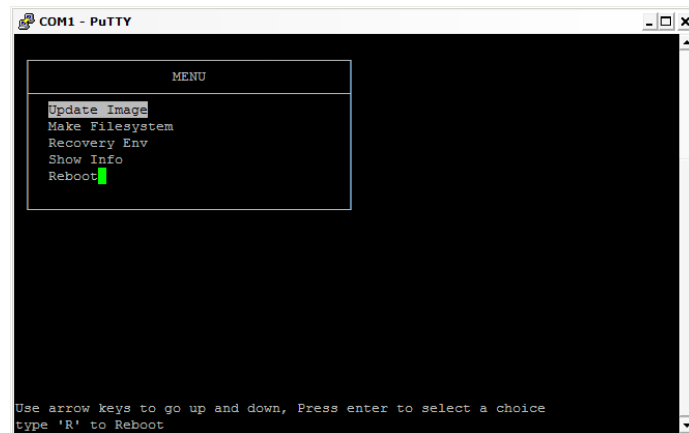
If you miss the timing, please power on again the Matrix-518 and do it again. Select U will prompt the run level selection message. Run level 0 is halt, run level 1 is single user (disable login and service). Run level 2~5 are multiple users and run level 6 is reboot. To view the run level configuration, 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: ***matrix518/m518.alf***

Kernel: ***matrix518/MATRIX518K***

File system: ***matrix518/MATRIX518R***

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-518.

### 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-518.

### 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-518 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
- lighttpd v 1.7: 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-518 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 Artila 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-518 port 10000.

http: //192.168.2.127 : 10000



The webmin for Matrix-518 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.