M-501

Linux ARM9 System on Module

User Guide

Version 2.0

Table of Contents

1.   Introduction

M-501 is an ARM9-based Linux ready System on Module.   The M-501 is equipped with an ATMEL
AT91RM9200 SoC and features:

- ARM920T ARM Thumb Processor with 200MIPS at 180MHz, Memory Management Unit
- 16-KByte Data Cache and 16-KByte Instruction Cache
- 64MB SDRAM, 16MB Flash
- One 10/100Mbps Ethernet with MAC/PHY and transformer
- Two USB 2.0 full speed (12Mbps) Host Ports
- Multimedia Card Interface for SD memory card
- Four UARTs with hardware and software flow control
- Two-wire Interface (I2C) for Real Time Clock
- 32 Programmable Digital I/O Port
- 8-bit external local bus interface

Linux 2.6 OS is pre-installed in the flash disk of M-501 and many powerful utility programs are also
included.   M-501 is ready to drop in your design to save your time in software porting and hardware
debug.

Artila uses M-501 to design Matrix-510/520.   Please refer to Matrix-510/520 user guide and if you are
interested in those design, please contact Artila.

2. Layout

Front View
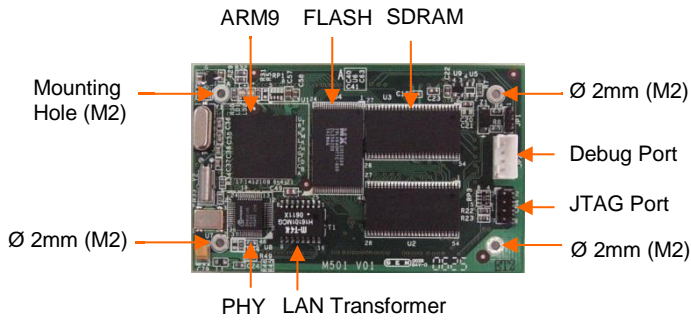
Rear View

Function Block Diagram

3. Hardware Specifications

CPU / Memory

- SoC: ATMEL AT91RM9200
- CPU: ARM920T ARM Thumb Processor with Memory Management Unit (MMU)
- Clock: 180MHz
- SDRAM: 64MB
- Flash: 16MB Intel StrataFlash or Equivalent

Network
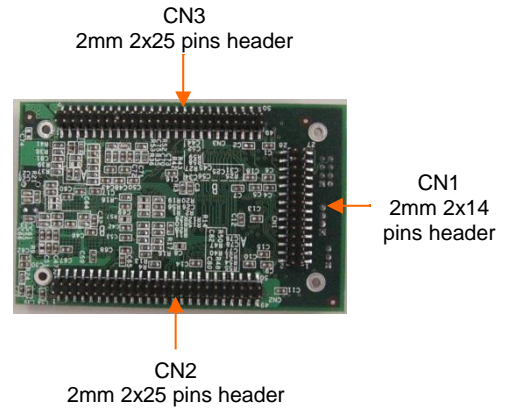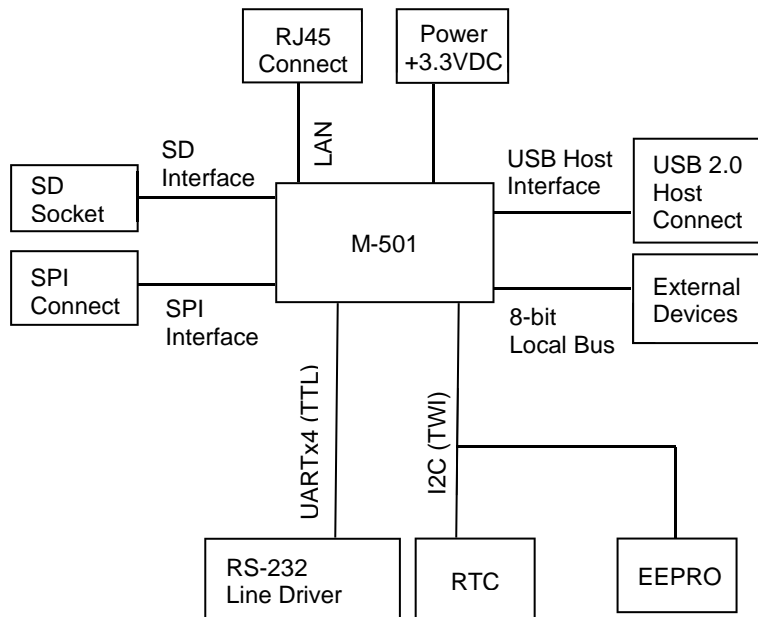
- Ethernet: 10/100Mbps with MAC/PHY and Transformer
- PHY: DAVCOM DM9161
- Transformer: 1.5 KV isolation
- Signal: *ETX0+, ETX0-, ERX0+, ERX-*

USB Port

- Host: USB 2.0 full speed (12Mbps) Host x2
- Signal: *UDataA+, UDataA-, UDataB+, UDataB-*

UART

- Four Universal Asynchronous Receiver and Transmitter
- Data Bits: 5 to 9 bits
- Parity: None, Even, Odd, Mark, Space
- Stop: 1, 1.5, 2 bits
- Baud Rate: Up to 921.6 Kbps
- Flow Control: RTS/CTS, XON/XOFF, None
- Multi-drop Mode with address generation and detection (COM1 only)
- RS-485 Driver Control Signal (COM1: RTS0)
- Signal Level: CMOS/3.3V compatible
- COM1: *TXD0, RXD0, RTS0, CTS0* (RS485 Control: *RTS0*) (Software configurable RS-232/422/485)
- COM2: *TXD1, RXD1, RTS1, CTS1, DCD1, DTR1, DSR1* (RS-232 with full modem control)
- COM3: *TXD2, RXD2, RTS2, CTS2* (RS-232 with hardware flow control)
- COM4: *TXD3, RXD3, RTS3, CTS3* (RS-232 with hardware flow control)

I2C Bus (Inter-IC Bus)

- Compatible with standard two-wire serial memory interface
- Supported Devices: (Driver built-in)
  - Real Time Clock: Ricoh (RS5C372)
  - EEPROM: ATMEL AT24C16 and compatible
- Signal: *TWD, TWDK*

I2S (Internal IC Sound)

- Transmitter: *TSCK, TWS, TSD*
- Receiver: *RSCK, RWS, RSD*

SPI (Serial Peripheral Interface)

- Two chip Selects with external decoder
- Three wires signals: MISO, MOSI and SPCK clock
- Signal: *MISO, MOSI, SPCK, CS1, CS2*

Multimedia Card Interface

- Compatible with SD memory card Specification 1.0
- Signal: *MCCDA, MCCK, MCDA0, MCDA1, MCDA2, MCDA3*

Watchdog Timer:

- CPU built-in WDT and used by Linux Kernel

Programmable DIO

- 32 General Purpose IOs and can be programmable as digital input or output
- Support interrupt function for digital inputs
- Signal Level: CMOS/3.3V Compatible
- Input:
    - Low level: -0.3V min / +0.8V max
    - High level: +2V min / +3.9V max
- Output:
    - Low level: +0.4V max @ 0mA / +0.2V min @ 8mA
    - High level: +3.1V max @ 0mA / +2.9V min @ 8mA
- Signal: *PIO0 to PIO31*

☞ **Note**

- *PIO24 to PIO31* are reserved for RS-232/422/485 interface selection for serial ports 1 to 4.   Please contact Artila if you want to use PIO24 to PIO31.

External Bus Interface

- 8-bit data bus

    Signal: *D0~D7*
- 8-bit address bus

    Signal: *A0~A7*
- 4 Chip Selection

    Signal: *NCS3~NCS6*
- Signal Level: CMOS/3.3V

Predefine Pins

- Reset Button (CN2, pin#35, *RST#1*), input
- Buzzer (CN2, pin#37, *BUZR*), output
- System ready LED (CN2, pin#38, *RDY_LED*), output
- LAN activity LED (CN3, pin#11, *ACT_LED*), output

Undefined Digital IO Pins (reserved)

- CN1: pin#23, #24, #25, #26
- CN3: pin#23, #24

Debug Port:

- Serial Console: Tx/Rx

  Signal: *Tx* share with *RTS2*

  Rx share with *CTS2*
- JTAG: For low level debug

  Signal: *NTRST, TDI, TMS, TCK, TDO*

Power

- Input: 3.0 to 3.6VDC (3.3V nominal)
- Consumption: 2.5W

4. Software Specifications

4.1 General

- OS: Linux 2.6.14
- Boot Loader: U-Boot 1.1.2
- File System: JFFS2, EXT2/EXT3, VFAT/FAT, NFS

4.2 Protocol Stacks

- IPV4, ICMP, ARP, DHCP, NTP, TCP, UDP, FTP, Telnet, HTTP, PPP, PPPoE, CHAP, PAP, SMTP, SNMP V1/V3, SSL, SSH 1/2

4.3 Utilities

- Bash: Shell Command
- Tinylogin: Login and user manager utility
- Telnet: Telnet client program
- Busybox: Linux utility collection
- FTP: FTP client program

4.4 Daemon

- pppd: Dial In/out over serial port and PPPoE
- snmpd: SNMP agent program
- telnetd: Telnet server program
- inetd: TCP server program
- ftpd: FTP server program
- boa: Web server program
- sshd: secured shell server
- iptables: Firewall service manager
- armd: Artila manager daemon

4.5 Toolchain for Windows / Linux

- GCC: C/C++ PC cross compiler
- GLIBC: POSIX Library

4.6 Standard Device Drivers

- ttyS0: serial console port (AT91RM9200 debug port)
- ttyS1~ttyS4: serial ports (AT91RM9200 UART0~UART3)
- gpio: General Purpose I/O
- mmc: SD/MMC:
- rtc: Real Time Clock
- sda: USB flash memory disk
- ttyACM: USB Modem

- ttyUSB: USB RS-232 adaptor

- spi: spi bus

4.7 Default Setting

- Default IP Address: 192.168.2.127

- Netmask: 255.255.255.0

- ssh Login: root

- Password: root

- Telnet Login: guest

- Password: guest

- Terminal type: VT100

4.8 Network Configuration

To configure the IP address, Netmask and Gateway setting, please modify **/disk/etc/rc** as following:

> *#Static IP*
>
> *ifconfig eth0 192.168.2.127 netmask 255.255.255.0*

For DHCP setting:

> *#DHCP*
>
> *dhcpcd eth0 &*

4.9 Wireless LAN Configuration

M-501 supports wireless LAN by using USB WLAN adaptor which uses Ralink RT2571 controller. Please refer to the website: http://ralink.rapla.net for the supporting list of the USB WLAN adaptor. To configure the wireless LAN setting, please use command:

> *ifconfig wlan0 up*
>
> *iwconfig wlan0 essid XXXX key YYYYYYYY mode MMMM*

For infrastructure mode XXXX is the access point name and YYYYYYYY is the encryption key and MMMM should be *managed.*

For Ad-Hoc mode mode XXXX is the M-501 device name and YYYYYYYY is the encryption key MMMM should be *ad-hoc*.

To configure the IP address use command:

> *dhcpcd wlan0 &* or *ifconfig wlan0 192.168.2.127 netmask 255.255.255.0*

4.10 Install GNU Toolchain

Find a PC with Linux 2.6.X Kernel installed and login as a **root** user then copy the

arm-linux-3.3.2.tar.gz to root directory \ of PC.   Under \ directory type following command to install the

M-501 Toolchain.

   #tar zxvf arm-linux-3.3.2.tar.gz

4.11 I/O Devices Control

M-501 uses standard I/O device control to access following devices:

- Ethernet: eth0

- Serial Ports: ttyS1, ttyS2, ttyS3, ttyS4

- Serial Console Port: ttyS0

- Real time clock: rtc

- USB Flash Disk: sda, sda1, sdb, sdb1

- SD memory Card: mmc0

- USB WLAN dongle: wlan0

- USB Serial Cable: ttyUSB0, ttyUSB1

- SPI bus: spi0, spi1

☞ **Note**

Remember to include the "matrix500.h" header file in your program.   Please refer to the example program

included in the M-501 SDK CD to demo the RS-232/422/485 mode configuration of serial port 1 configuration.

4.12 File System

Matrix-500 uses jffs2 file system for the built-in flash memory disk.   The directory are:

   /disk

   /home

   /etc

Write data to these directories are saved to flash memory and will not be erased after power off.

4.13 Mount External Disk

To mount the USB Flash Disk and SD memory card, use following commands after the disk are

installed properly.

To mount USB disk

   mount /mnt/sda or ***mount /mnt/sda1*** or ***mount /mnt/sdb*** or ***mount /mnt/sdb1***

To find out the device name of the USB disk, you can use

   dmesg | grep sd

And to mount SD memory card

mount /mnt/mmc

4.14 Web Page Directory

The web pages are placed at /home/httpd and the boa.conf contains the boa web server settings.   The home page name should be *index.html.*

4.15 Welcome Message

The welcome message "Artila" can be modified by editing the */etc/motd* file.

4.16 Manager Utility Software

The Manager Utility software, **manager.jar** is a java program and is used to discovered the Matrix-500 in the network if the IP address is forgotten.   It can be run at any OS where java run time is available. To install the java run time platform at your computer, please visit **http://java.sun.com** and download the Java 2 Standard Edition (J2SE).   Once the Matrix-500 is found, you can click the Telnet Console to configure the Matrix-500.

4.17 Upload file to M-501

To upload the file to M-501, you can use FTP command in command line or Web Browser such as Microsoft Internet Explorer.   Type **ftp://192.168.2.127** and under the file menu, click log on option to login M-501.   After login, you can see the files system of M-501.
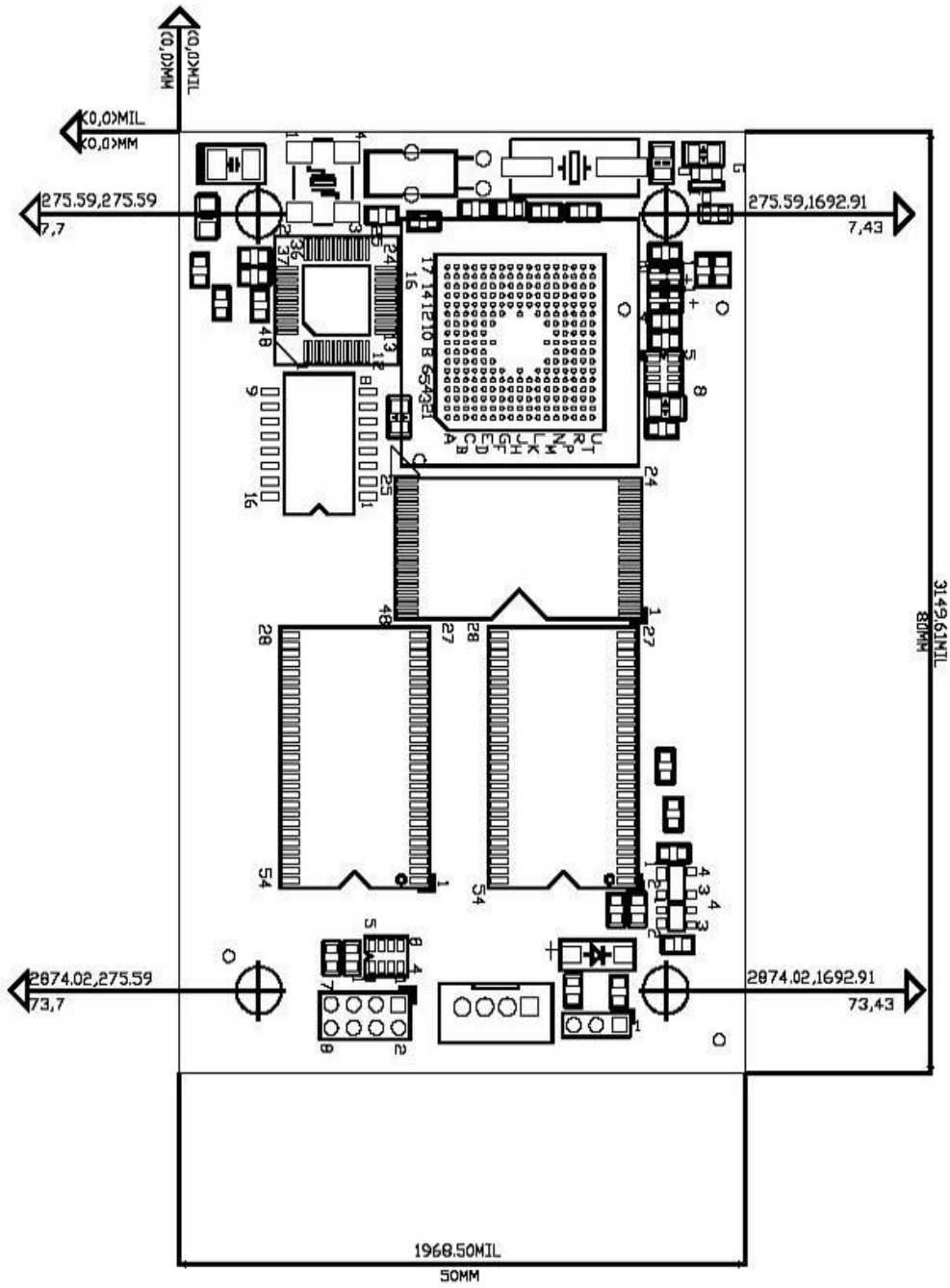
4.18 Compile and upload the C program

Use following command of the GNU cross compiler to compile the C program:
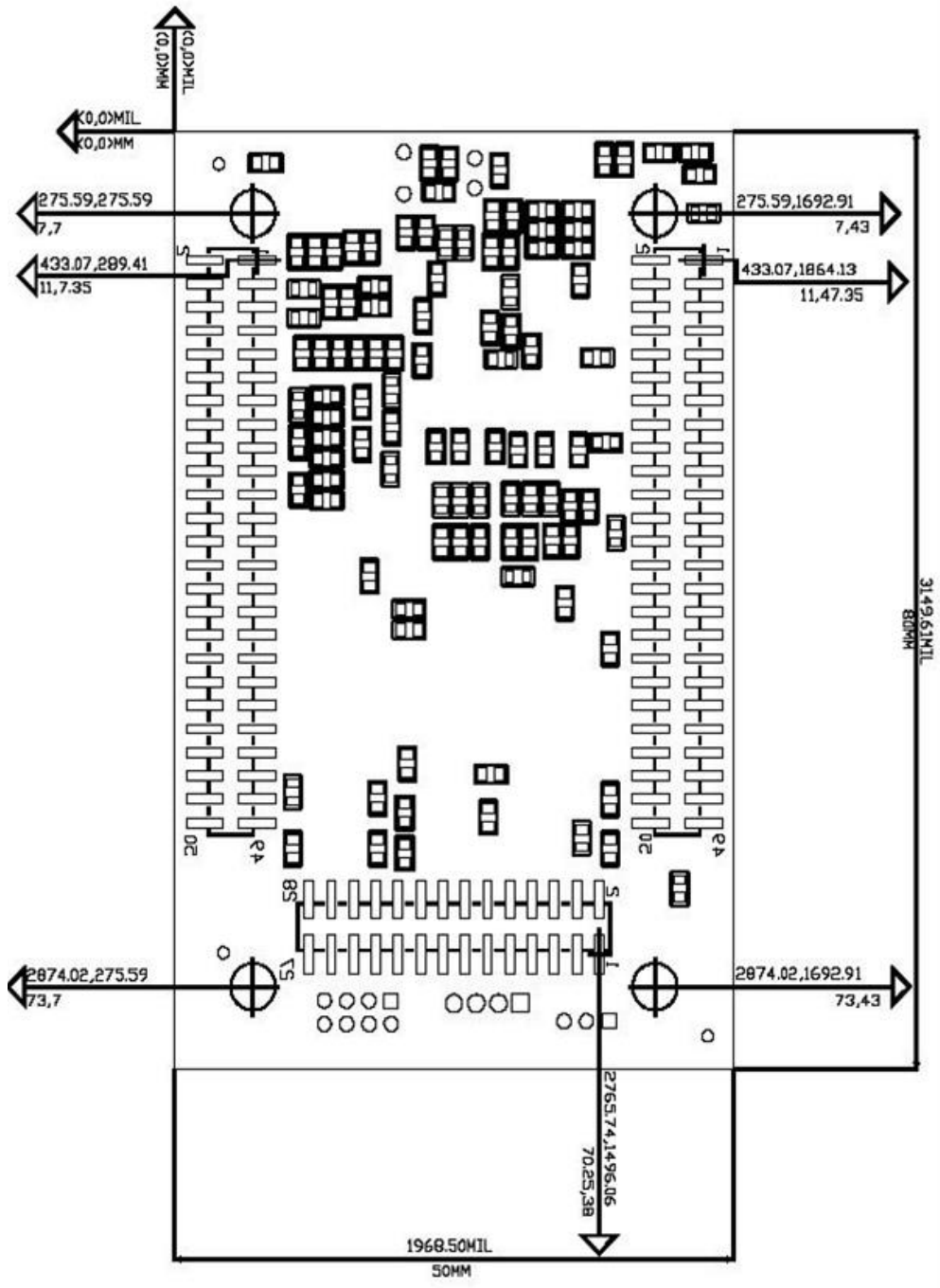
#arm-linux-gcc –o hello hello.c

Then upload the *hello* to M-501.   Remember to change the mode of the file.

After upload to M-501 by *chmod +x hello*

5. Mechanical Dimension

6. Pin Assignment and Definition

Function	CPU	SoM			SoM	CPU	Function
			CN1				
(Addr Bus)	A0		1	2		D0	(Data Bus)
(Addr Bus)	A1		3	4		D1	(Data Bus)
(Addr Bus)	A2		5	6		D2	(Data Bus)
(Addr Bus)	A3		7	8		D3	(Data Bus)
(Addr Bus)	A4		9	10		D4	(Data Bus)
(Addr Bus)	A5		11	12		D5	(Data Bus)
(Addr Bus)	A6		13	14		D6	(Data Bus)
(Addr Bus)	A7		15	16		D7	(Data Bus)
(Write Enable)	NWE NWR0		17	18		NOE NRD	(Read Enable)
(Chip Select)	NCS3	CS3	19	20	CS4	NCS4	(Chip Select)
(Chip Select)	NCS5	CS5	21	22	CS6	NCS6	(Chip Select)
(N/A)	PA21		23	24		PA24	(N/A)
(N/A)	PB7		25	26		PB18	(N/A)
	VCC3		27	28		GND	
			CN1				

Function	CPU	SoM		SoM		CPU	Function
			CN2				
(COM2)	**CTS2**		1	2		**DSR2**	(COM2)
(COM2)	**RTS2**		3	4		**RXD3**	(COM3)
(COM3)	**TXD3**		5	6		**CTS3**	(COM3)
(COM3)	**RTS3**		7	8		**TXD4**	(COM4)
(COM4)	**RXD4**		9	10		**RTS4**	(COM4)
(COM4)	**CTS4**		11	12		**PD22**	(GPIO)
(GPIO)	**PD23**		13	14	**PIO16**	PC14	(GPIO)
(GPIO)	PC15	**PIO17**	15	16	**PIO18**	PD7	(GPIO)
(GPIO)	PD8	**PIO19**	17	18	**PIO20**	PD9	(GPIO)
(GPIO)	PD10	**PIO21**	19	20	**PIO22**	PD11	(GPIO)
(GPIO)	PD12	**PIO23**	21	22	**PIO24**	PD13	(GPIO)
(GPIO)	PD14	**PIO25**	23	24	**PIO26**	PD15	(GPIO)
(GPIO)	PD16	**PIO27**	25	26	**PIO28**	PD17	(GPIO)
(USB B+)	**HDPB**	**UdataB+**	27	28	**UdataB-**	**HDMB**	(USB B-)
(USB A-)	**HDMA**	**UdataA-**	29	30	**UdataA+**	**HDPA**	(USB A+)
(GPIO)	PD18	**PIO29**	31	32	**PIO30**	PD26	(GPIO)
(GPIO)	PD27	**PIO31**	33	34		**VCC3 PWROK**	(System Reset)
(Reset Btn)	**BTNRST#**		35	36		**NTRST**	(JTAG Reset)
(Buzzer)	PB6		37	38		PD6	(System Ready LED)
(I2S transmitter)	**TF2**	**TWS**	39	40	**TSCK**	**TK2**	(I2S transmitter)
(I2S transmitter)	**TD2**	**TSD**	41	42	**RSD**	**RD2**	(I2S receiver)
(I2S receiver)	**RK2**	**RSCK**	43	44	**RWS**	**RF2**	(I2S receiver)
	GND		45	46		GND	
	GND		47	48		GND	
	VCC3		49	50		VCC3	
			CN2				

Function	CPU	SoM			SoM	CPU	Function
			CN3				
	VCC3		1	2		VCC3	
	GND		3	4		GND	
	GND		5	6		GND	
(LAN)	**ERX0-**		7	8		**ERX0+**	(LAN)
(LAN)	**ETX0-**		9	10		**ETX0+**	(LAN)
(LAN LED)		ACTLED#	11	12		**MISO**	(SPI)
(SPI)	**MOSI**		13	14		**SPCK**	(SPI)
(SPI)	**NPCS0**		15	16		**NPCS1**	(SPI)
(SD)	**MCCK**		17	18		**MCCDA**	(SD)
(SD)	**MCDA0**		19	20		**MCDA1**	(SD)
(SD)	**MCDA2**		21	22		**MCDA3**	(SD)
(Card Detect)	PD19		23	24		PD20	(SD Write Protect)
(I2C)	**TWD**		25	26		**TWCK**	(I2C)
(GPIO)	PA19	**PIO1**	27	28	**PIO3**	PB2	(GPIO)
(GPIO)	PB8	**PIO4**	29	30	**PIO5**	PB9	(GPIO)
(GPIO)	PB10	**PIO6**	31	32	**PIO7**	PB11	(GPIO)
(GPIO)	PC0	**PIO8**	33	34	**PIO9**	PC1	(GPIO)
(GPIO)	PC2	**PIO10**	35	36	**PIO11**	PC3	(GPIO)
(GPIO)	PC5	**PIO12**	37	38	**PIO13**	PB22	(GPIO)
(GPIO)	PB28	**PIO14**	39	40	**PIO15**	PB29	(GPIO)
(GPIO)	PD24	**PIO0**	41	42	**PIO2**	PD25	(GPIO)
(COM1)	**TXD1**		43	44		**RXD1**	(COM1)
(COM1)	**CTS1**		45	46		**RTS1**	(COM1)
(COM2)	**DTR2**		47	48		**TXD2**	(COM2)
(COM2)	**RXD2**		49	50		**DCD2**	(COM2)
			CN3				

7. M-501 Evaluation Board Layout
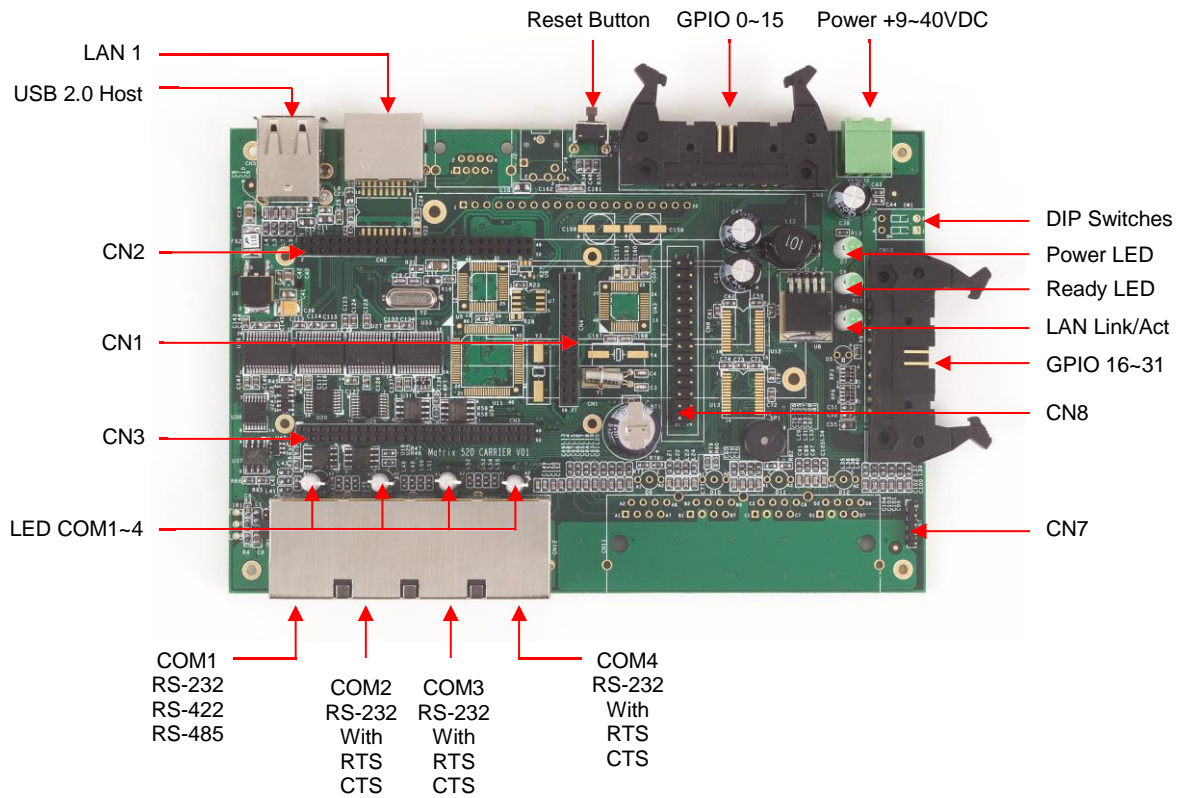
8. Enable Serial Console Port

Step 1: M-501 serial console port (ttyS0) shares three data pins with serial port P3 (RS-232 port ttyS3).

ttyS0. Tx   <=> ttyS3. RTS

ttyS0. Rx   <=> ttyS3. CTS

ttyS0. GND   <=> ttyS3. GND

Connect the Console cable to Port 3 and the serial port of your computer.

Console Port via P3 Connector

Pin No.	RS-232
1	
2	TXD
3	GND
4	
5	
6	
7	RXD
8	

Step 2: Once the serial console (ttyS0) are connected correctly to your PC, you need to use a terminal software such as hyper terminal of Microsoft and the serial port setting as 115200, N, 8, 1 and no flow control. Terminal type is VT100.

Step 3: Power on M-501 then you will see the message from your terminal software as follow:
Once "Starting Matrix 500" appears, please keep typing "@" to trigger the serial load program. Then you will see the Artila loader menu appear. If you miss the trigger procedure, please reset the M-501 and repeat step 3 again.
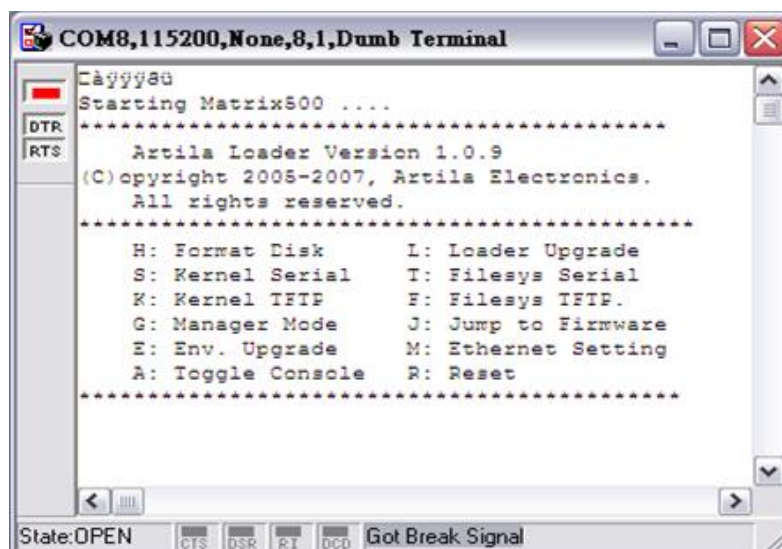
Step 4: Now you can type "A" to enable the serial console function.   Once you see the console is enabled as follow, press "q" to return to main menu of console.   Then please type "R" to reboot the system.

Step 5: Once you complete system debug, please remember to disable the serial console using the Toggle Console item by typing "A".
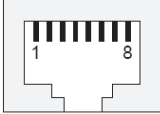
9. Pin Assignment of Connectors

9.1 LAN1 and LAN2

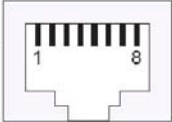| Pin	Signal
1	ETx+
2	ETx-
3	ERx+
6	ERx-

9.2 GPIO Port 0~15 and GPIO Port 16

|			
+3.3V	20	19	+5V
GND	18	17	GND
DIO15	16	15	DIO14
DIO13	14	13	DIO12
DIO11	12	11	DIO10
DIO9	10	9	DIO8
DIO7	8	7	DIO6
DIO5	6	5	DIO4
DIO3	4	3	DIO2
DIO1	2	1	DIO0

+3.3V	20	19	+5V
GND	18	17	GND
DIO31	16	15	DIO30
DIO29	14	13	DIO28
DIO27	12	11	DIO26
DIO25	10	9	DIO24
DIO23	8	7	DIO22
DIO21	6	5	DIO20
DIO19	4	3	DIO18
DIO17	2	1	DIO16

9.3 COM Port

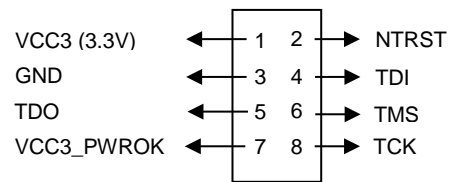| Pin	RS-232	RS-422	RS-485
1		---	---
2	RTS	TXD+	Data+
3	GND	GND	GND
4	TXD	TXD-	Data-
5	RXD	RXD+	---
6		RXD-	---
7	CTS	---	---
8		---	---

9.4 JP2 Serial Console Port

1 → TxD
2 → RxD
3 → VCC3
4 → GND
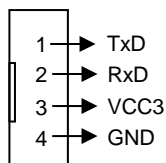
9.5 JP1 of M-501 Boot Mode Selection Jumper

1
2
3

1-2: Internal ROM
2-3: External Flash (Default)

9.6 CN4 JTAG Connector

VCC3 (3.3V) ◄─	1	2	─► NTRST
GND ◄─	3	4	─► TDI
TDO ◄─	5	6	─► TMS
VCC3_PWROK ◄─	7	8	─► TCK

9.7 CN8 Local Bus Connector

1. 1x14 Pin Header Pitch 2.54mm
2. CN8 directly connect to CN1 of M-501

Left	Pin	Pin	Right
A0	1	2	D0
A1	3	4	D1
A2	5	6	D2
A3	7	8	D3
A4	9	10	D4
A5	11	12	D5
A6	13	14	D6
A7	15	16	D7
NWE_NWR0	17	18	NOE_NRD
NCS3	19	20	PC10/NCS4
PC11/NCS5	21	22	PC12/NCS6
PA21	23	24	PA24
PB7	25	26	PB18
VCC3	27	28	GND
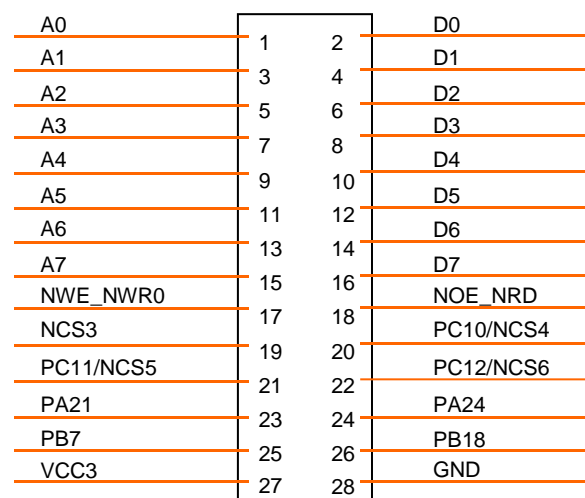
9.8 CN7 (SPI) Pin Assignment

1 ─►	MISO (Master In Slave Out)
2 ─►	MOSI (Master Out Slave In)
3 ─►	SPCK (SPI Serial Clock)
4 ─►	NPCS0 (SPI Chip Select 0)
5 ─►	NPCS1 (SPI Chip Select 1)