DB120 Reference Design Setup Guide

Preliminary

November 2010

1 Overview

The DB120 Reference Design is based on the AR9344, a highly-integrated and feature-rich 2.4/5 GHz IEEE802.11n 2x2 MIMO Premium SoC, the AR8316 Six-Port GB Ethernet Switch, and an on-board AR9380 single-chip 2.4/5 GHz 802.11n 3x3 MIMO MAC/Baseband/Radio. It has these features:

- AR9344 operates at 600 MHz (final operating frequency for 533–600 MHz, to be confirmed)
- Internal MAC/Baseband/Radio that supports IEEE 802.11n 2x2 MIMO at 2 GHz/5 GHz
- Additional on-board AR9380 single-chip 802.11n 3x3 MIMO WLAN operates at 2 GHz or 5 GHz. (**not enabled in DB120-010**)
- PCIE root complex interface that can be used with an external WLAN module such as the Mini Card that based on the AR938x for dual concurrent WLAN configuration
- 4-layer board
- DDR2/DDR1 memory support for 8/16/32/64/128 MBytes, DB120 reference board is configured with 64-MByte 400 MHz DDR2
- SPI NOR and NAND Flash memory support for 2/4/8/16 MBytes, DB120 reference board is configured with 8 MBytes serial flash
- xMII, PCIE endpoint, or USB interface for the external host
- I^2S/SPDIF-out audio interface
- SLIC for VOIP/PCM
- The AR8316 supports 4 LAN + 1 WAN Gigabit Ethernet ports with RJ-45 connectors
- The AR9344 supports 4 LAN + 1 WAN 10/100Mps Ethernet ports with RJ-45 connectors
- USB 2.0 interface
- Supports dual concurrent 2x2 and 3x3 MIMO configuration with these options:
    - Internal 2x2 MAC/BB/radio and external Mini Card 3x3 MIMO WLAN module
    - Internal 2x2 MAC/BB/radio and on-board AR9380 (**not enabled for DB120-010**)
- 20 MHz/144.4 Mbps and 40 MHz/300 Mbps PHY rate for 2x2 WLAN
- 20 MHz/216.7 Mbps and 40 MHz/450 Mbps PHY rate for 3x3 WLAN
- EJTAG, UART, GPIOs

NOTE: This preliminary document is based on DB120-010 reference board and the software is based on the LSDK 9999.12 Alpha release. It is subject to change when new versions of board and software are available. For detailed information on the Reference Design, see the reference design schematic and BOM.

The DB120 reference design kit includes:

- The DB120 reference design board
- 5 VDC power supple
- RS232 UART adapter
- Dipole antennas

2 DB120 Reference Design

Figure 1 depicts the DB120 Reference Design board. See Table 1 to identify the buttons and external interfaces on the board.

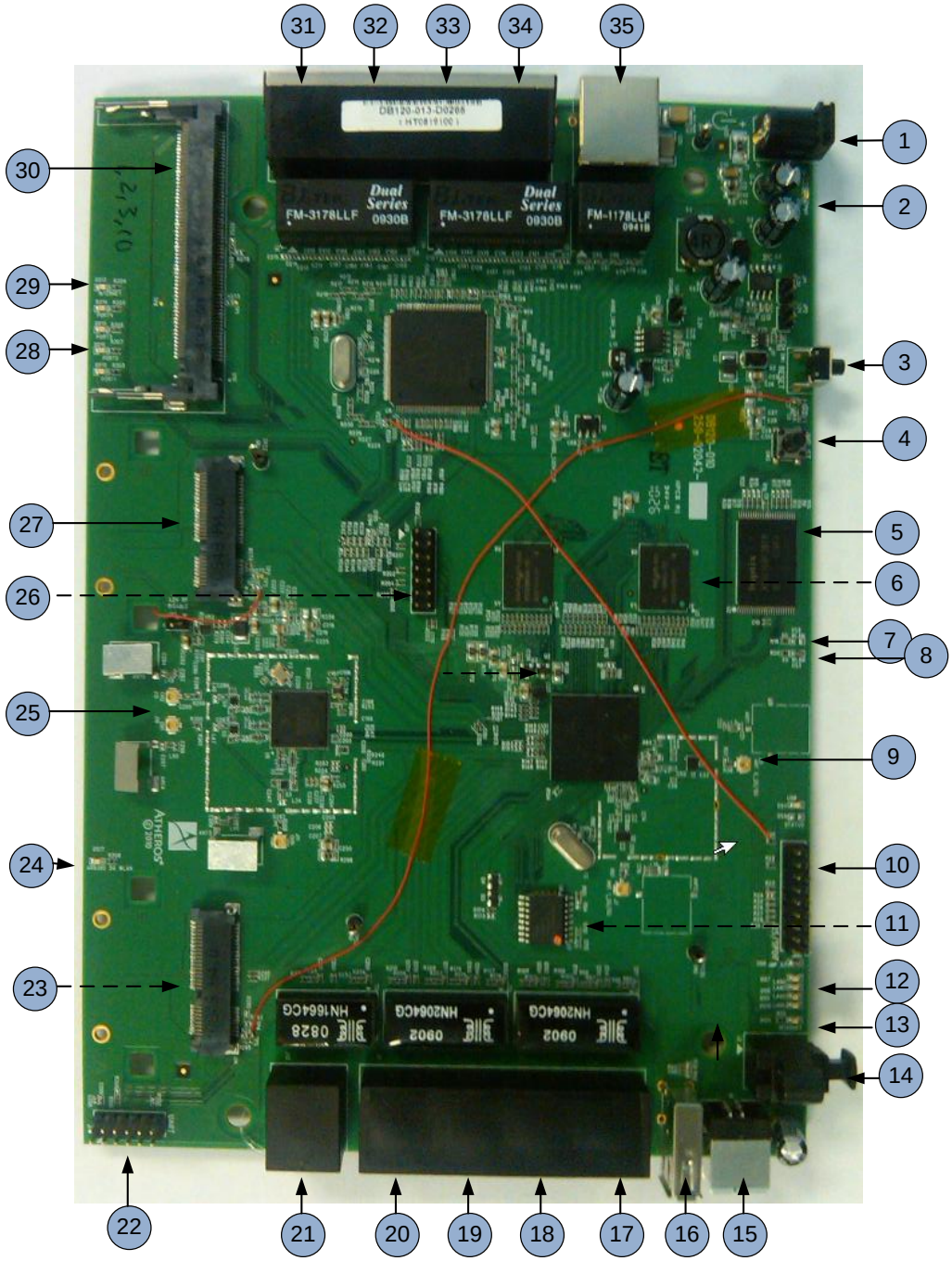

Figure 1 DB120 Reference Design Board

Table 1 DB120 Interface Details

1	DC Power Connector (DC 5V)	16	USB Type A Port
2	Power-up Status LED	17-20	LAN ports (10/100 Mbps)
3	Reset Push Button	21	WAN port (10/100 Mbps)
4	WPS Push Button	22	UART Port Header
5	NAND Flash Memory	23	PCIE Root Complex for external WLAN module
6	DDR Memory	24	AR9380 5 GHz WLAN LED (Not enabled)
7	AR9344 5 GHz WLAN LED	25	AR9380 RF Connectors (Not enabled)
8	AR9344 2 GHz WLAN LED	26	EJAG Header for BDI2000
9	AR9344 RF Connectors	27	PCIE endpoint for external host
10	I2S/SLIC Header	28	10/100/1000 Ethernet LAN LED
11	NOR serial Flash Memory	29	10/100/1000 Ethernet WAN LED
12	10/100 Ethernet LAN LED	30	xMII Interface for external host
13	10/100 Ethernet WAN LED	31-34	LAN ports (10/100/1000 Mbps)
14	SPDIF Header	35	WAN port (10/100/1000 Mbps)
15	USB Type B Port		

2.1 Setting up the DB120

1. Connect the RS232 adapter to the UART port on the DB120. Match the non-sharp edge of the UART header to the non-sharp edge of the RS232 adapter connector. See Figure 2 for the correct orientation.

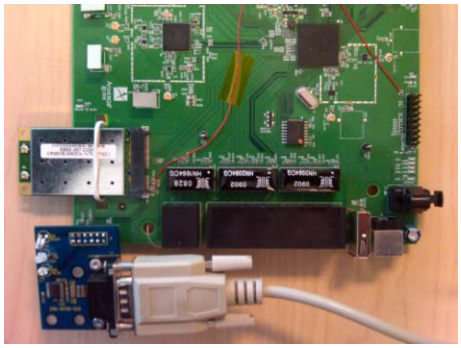

Figure 2 DB120 Setup

WARNING: Wrong orientation may cause damage to the adapter and the DB120 board when power is applied.

2. Connect the antenna terminals to the radio terminals on the board.
3. Connect the 5 VDC power output from the power adapter to the power port of the board
4. Use a RS232 cable to connect the DB120 to an available COM port on the PC. Connect the other end of the RS232 cable to the RS232 adapter (see Figure 1).

> **NOTE:** If the PC has more than one COM port, note the COM port number connected to the cable.

5. Use the CAT5 Ethernet cable to connect to the RJ-45 connector of one of the LAN ports (check whether the 10/100 Fast Ethernet switch or Gigabit Ethernet switch is enabled by pinging the host PC; see Section 2.5 for Ethernet switch choices.)
6. Before powering up the AP, verify all the connections are correct.
7. Plug in the power cord to provide power to the AP.

2.2 Configuring the COM Port

Establish a console session to the AP with either:

- A Telnet connection or
- A direct console connection.
  This method is preferred over a Telnet connection because a Telnet connection will be lost during AP reboot. Use an available PC COM port with the settings:
  - Speed 115200 bits per second
  - 8 data bits, 1 stop bit, 0 parity bit
  - No Flow Control

2.3 Logging Into and Accessing the AP

1. On the opened console window, check Allow for Auto boot Sequence for normal operation, or type Ctrl+Z to stop auto boot to enter U-boot for image upload (see Section 5).
2. Login to the AP with the username "root" and the password "5up". At this point, a new password can be created using the **passwd** utility.
3. By default, eth0 is mapped into the same bridge (br0) using the default IP address 192.168.1.2.
   - To change the br0 IP address, use the command:
     ifconfig <br0> <ip-address> <net-mask> up.
   - To set a new IP address and netmask, use the command **cfg** to change the export variable:
     cfg –a AP_IPADDR=xxx.xxx.xxx.xxx
     cfg -a AP_NETMASK=xxx.xxx.xxx.xxx
     cfg -c

2.4 Setting up the AP Operating Mode

The DB120 operates in both the 2.4 GHz band and 5 GHz bands. For the 2.4 GHz band, these channel lists (selected by setting AP_PRIMARY_CH or AP_PRIMARY_CH_2) show the channels available in HT20 mode (selected by setting AP_CHMODE or AP_CHMODE_2 to 11NGHT20). The default is set for US (only channels 1-11).

- Channel 01 : 2.412 GHz
- Channel 02 : 2.417 GHz
- Channel 03 : 2.422 GHz
- Channel 04 : 2.427 GHz
- Channel 05 : 2.432 GHz
- Channel 06 : 2.437 GHz
- Channel 07 : 2.442 GHz
- Channel 08 : 2.447 GHz
- Channel 09 : 2.452 GHz
- Channel 10 : 2.457 GHz
- Channel 11 : 2.462 GHz
- Channel 12 : 2.467 GHz (not for US)
- Channel 13 : 2.472 GHz (not for US)

These operating modes (AP_CHMODE and AP_CHMODE_2) are available:

- 11NGHT20
- 11NGHT40PLUS
- 11NGHT40MINUS
- 11NGHT40

The DB120 supports HT40 mode with extension channel. These flags are used to set an extension channel:

- 11NGHT40MINUS
  Selects the frequency channels lower than the primary control channel as the extension channel
- 11NGHT40PLUS
  Selects the frequency channels higher than the primary control channel as the extension channel

Table 2 illustrates the setting of the control channel and extension channel in 2 GHz HT40 mode.

- For PCIE WLAN radio, using the AP_PRIMARY_CH, and AP_CHMODE commands. The control channels 1 through 4, AP_CHMODE can only be set to 11NHT40PLUS. For control channels 8 through 13, AP_CHMODE can only be set to 11NHT40MINUS. Either 11NGHT40PLUS or 11NHT40MINUS can be used with control channels 5 through 7.
- For an internal 2x2 radio, the settings are the same but use AP_PRIMARY_CH_2 and AP_CHMODE_2 instead.

Control Channel	Extension Channel	
Set AP_PRIMARY_CH =	Set AP_CHMODE = 11NGHT40PLUS	Set AP_CHMODE = 11NGHT40MINUS
1	5	NA
2	6	NA
3	7	NA
4	8	NA
5	9	1
6	10	2
7	11	3
8	12	4
9	13	5
10	NA	6
11	NA	7
12	NA	8
13	NA	9

Table 2 Control and Extension Channel Setting in HT40 Mode

For the 5 GHz band, these channel lists (selected by setting AP_PRIMARY_CH or AP_PRIMARY_CH_2) show the channels available in HT20 mode (selected by setting AP_CHMODE or AP_CHMODE_2=11NAHT20):

- Channel 036 : 5.180 GHz
- Channel 040 : 5.200 GHz
- Channel 044 : 5.220 GHz
- Channel 048 : 5.240 GHz
- Channel 052 : 5.260 GHz
- Channel 056 : 5.280 GHz
- Channel 060 : 5.300 GHz
- Channel 064 : 5.320 GHz
- Channel 100 : 5.500 GHz
- Channel 104 : 5.520 GHz
- Channel 108 : 5.540 GHz
- Channel 112 : 5.560 GHz
- Channel 116 : 5.580 GHz
- Channel 120 : 5.600 GHz
- Channel 124 : 5.620 GHz
- Channel 128 : 5.640 GHz
- Channel 132 : 5.660 GHz
- Channel 136 : 5.680 GHz
- Channel 140 : 5.700 GHz
- Channel 149 : 5.745 GHz
- Channel 153 : 5.765 GHz
- Channel 157 : 5.785 GHz
- Channel 161 : 5.805 GHz
- Channel 165 : 5.825 GHz

These operating modes (AP_CHMODE and AP_CHMODE_2) are available:

- 11NAHT20
- 11NAHT40PLUS
- 11NAHT40MINUS
- 11NAHT40

The DB120 supports HT40 mode with extension channels. These flags are used to set an extension channel:

- 11NAHT40MINUS
  Selects the frequency channels lower than the primary control channel as the extension channel
- 11NAHT40PLUS
  Selects the frequency channels higher than the primary control channel as the extension channel

Table 3 illustrates the setting of the control channel and extension channel in 5 GHz HT40 mode.

- For PCIE WLAN radio, use the AP_PRIMARY_CH, and AP_CHMODE commands. The control channels 36, 44, 52, 60, 100, 108, 116, 124, 132, 149 and 157, AP_CHMODE can only be set to 11NAHT40PLUS. For control channels 40, 48, 56, 64, 104, 112, 120, 128, 136, 153 and 161, AP_CHMODE can only be set to 11NAHT40MINUS.
- For the internal 2x2 radio, the settings are the same except that they use AP_PRIMARY_CH_2 and AP_CHMODE_2 instead.

Control Channel	Extension Channel	
Set AP_PRIMARY_CH =	Set AP_CHMODE = 11NAHT40PLUS	Set AP_CHMODE = 11NAHT40MINUS
36	40	NA
40	NA	36
44	48	NA
48	NA	44
52	56	NA
56	NA	52
60	64	NA
64	NA	60
100	104	NA
104	NA	100
108	112	NA
112	NA	108
116	120	NA
120	NA	116
124	128	NA
128	NA	124
132	136	NA
136	NA	132
149	153	NA
153	149	NA
157	161	NA
161	NA	157

Table 3 Control and Extension Channel Setting in HT40 Mode

- The **apup** command places the AP into operating mode.
- The **apdown** command stops the AP from operating.
- The **reboot** command reboots the AP.
- The **uname –a** command shows the current version of image loaded into the AP.
- The **help** command provides more information about all available commands.
- The **cfg -a** command sets an AP primary channel and mode.
- The **cfg –c** command saves the settings into flash.

NOTE: Refer to *Atheros AP system User's Guide* for additional information on supported commands and configuration.

2.4.1 Examples

1. This example shows a dual-band dual-concurrent AP set to channel 40 as the primary channel in HT20 mode for the 5 GHz band, with the AP set to channel 8 as the primary channel in HT20 mode for the 2.4 GHz band. It is assumed that an external dual-band module such as the Atheros XB112 or XB114 is plugged into the PCIE root complex connector (see item 23 in Figure 1):

   cfg -a AP_STARTMODE=dual
   cfg -a AP_PRIMARY_CH=40
   cfg -a AP_CHMODE=11NAHT20
   cfg -a AP_PRIMARY_CH_2=8
   cfg -a AP_CHMODE_2=11NGHT20
   cfg –a TX_CHAINMASK=7
   cfg –a RX_CHAINMASK=7
   cfg –a TX_CHAINMASK_2=3
   cfg –a RX_CHAINMASK_2=3
   cfg -c
   apup

2. This example shows a dual-band dual-concurrent AP set to channel 52 as the primary channel in HT40 mode and channel 56 as the extension channel for 5 GHz band , with the AP set to channel 6 as the primary channel in HT40 mode and channel 2 as the extension channel for the 2.4 GHz band:

   cfg -a AP_STARTMODE=dual
   cfg -a AP_PRIMARY_CH=52
   cfg -a AP_CHMODE=11NAHT40PLUS
   cfg -a AP_PRIMARY_CH_2=6
   cfg -a AP_CHMODE_2=11NGHT40MINUS
   cfg –a TX_CHAINMASK=7
   cfg –a RX_CHAINMASK=7
   cfg –a TX_CHAINMASK_2=3
   cfg –a RX_CHAINMASK_2=3
   cfg -c
   apup

3. This example shows a dual-band dual-concurrent AP set to channel 153 as the primary channel in HT40 mode with channel 149 as the extension channel for 5 GHz band and the AP set to channel 6 as the primary channel in HT40 mode with channel 10 as the extension channel for 2.4 GHz band:

   cfg -a AP_STARTMODE=dual
   cfg -a AP_PRIMARY_CH=153
   cfg -a AP_CHMODE=11NAHT40MINUS
   cfg -a AP_PRIMARY_CH_2=6
   cfg -a AP_CHMODE_2=11NGHT40PLUS
   cfg –a TX_CHAINMASK=7
   cfg –a RX_CHAINMASK=7
   cfg –a TX_CHAINMASK_2=3
   cfg –a RX_CHAINMASK_2=3
   cfg -c
   apup

4. This example shows a dual-band dual-concurrent AP set to auto in HT40 mode for both the 2.4 and 5 GHz bands; channel and frequency are automatically selected:

```
cfg -a AP_STARTMODE=dual
cfg -a AP_PRIMARY_CH=11na
cfg -a AP_CHMODE=11NAHT40
cfg -a AP_PRIMARY_CH_2=11ng
cfg -a AP_CHMODE_2=11NGHT40
cfg –a TX_CHAINMASK=7
cfg –a RX_CHAINMASK=7
cfg –a TX_CHAINMASK_2=3
cfg –a RX_CHAINMASK_2=3
cfg -c
apup
```

   By default, the **/etc/ath/apcfg** script adds both eth0 and eth1 to the same bridge, br0. Use the **brctl** utility to change, add, or delete any interface. For more information refer to the **brctl** help page.

5. This example shows the bridge and interface details using the **brctl** utility:

```
~ # brctl show
bridge name     bridge id               STP enabled     interfaces
br0             8000.00037fffffff       no              eth0
```

2.5 Configuring Ports and Interfaces

The DB120 integrates two Ethernet switch choices. Both are supported in LSDK software releases in separate binary images. Users can choose and use the correct driver images to enable either one of these two choices:

- The built-in 10/100 Mbps 4 LAN + 1 WAN switch
- The AR8316 Gigabit 4 LAN + 1 WAN switch

For the AR8316 switch, the WAN port connects to the CPU via RGMII, and the four LAN ports connect to the CPU via RGMII. Eth0 is mapped to the WAN port and all four LAN ports. Eth0 is enabled for promiscuous mode. See the **ifconfig** manual page for more information. The DB120 supports eight ath interfaces per radio. See the software release notes for more information.

2.5.1 Use the iwconfig command to show the created ath interface:

```
~ # iwconfig
lo        no wireless extensions.
eth0      no wireless extensions.
br0       no wireless extensions.
wifi0     no wireless extensions.
wifi1     no wireless extensions.
ath0    IEEE 802.11na  ESSID:"DB120_5G"
          Mode:Master  Frequency:5.2 GHz  Access Point: C4:46:19:65:15:A5
          Bit Rate:450 Mb/s   Tx-Power:17 dBm
          RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:off
          Link Quality=94/94  Signal level=-96 dBm  Noise level=-95 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:0   Missed beacon:0
ath1    IEEE 802.11ng  ESSID:"DB120_2G"
          Mode:Master  Frequency:2.412 GHz  Access Point: 00:03:7F:42:01:09
          Bit Rate:216.7 Mb/s   Tx-Power:18 dBm
          RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:off
          Link Quality=94/94  Signal level=-96 dBm  Noise level=-95 dBm
          Rx invalid nwid:3  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:0   Missed beacon:0
```

2.5.2 To create a new bridge and add an interface to the bridge:

```
~ # brctl addbr bridge
~ # ifconfig bridge 192.168.10.20 netmask 255.255.0.0
~ # ifconfig eth0 0.0.0.0
~ # brctl addif bridge eth0
~ # ifconfig eth0 up
~ # brctl show
bridge name     bridge id               STP enabled     interfaces
bridge          8000.00037fffffff       no              eth0
```

3 USB Interface

The DB120 supports USB 2.0 with a maximum PHY rate of 480 Mbps.

3.1 Configuring the USB Interface

1. Plug a USB device into the USB port and type the command **dmesg** to see whether the USB device is recognized. The **dmesg** command responds with whether the USB Flash drive is at sda1 or sdax.
2. Once the USB device is mounted at sda1 or another block device, create a new directory under the / directory, use the **mount** command to mount the USB device to the newly created directory:

   ~ # **cd /**
   # **pwd**
   # **mkdir mnt**
   # **mount /dev/sda1 /mnt**

3. Type the command **df** with no options. This command will display all the available filesystems' info on the board. If **df** shows the mounted (sda1) partition, then the USB is mounted successfully.

4 Software Update

A software update on the DB120 requires:

- A server system with a TFTP server
- A terminal system with terminal emulation software such as Hyperterm or Minicom

Software updates are performed using the U-boot boot monitor, commands through the serial console, and TFTP file transfers. The same PC can be used for both the TFTP server and terminal emulation.

5 DB120 Image Update

WARNING:

- In the LSDK 9999.12 Alpha release, the 10/100 Ethernet ports (next to the RS232 port) are used to update images. For the future LSDK releases, the Gigabit Ethernet ports will be used instead.
- The image names and update instructions will be changed after Alpha release. Please refer to the release notes in each LSDK release for the most up-to-date instructions.

5.1 Update Instructions

1. Connect the Ethernet port on the server system to the 10/100 Fast Ethernet LAN Port of DB120 (item 17-20 in Figure 1) using CAT5 Ethernet cable.
2. Connect the serial cable between the Terminal system and the AP, using the RS232 adapter board.
3. Ensure that Pin 1 on the adapter board is aligned with Pin 1 on the AP (see Figure 1). The serial port should be set to 115200 Baud, 8 Data Bits, No Parity, 1 Stop bit, No flow control.

This procedure is used to update the DB120 board with the AR8316 Gigabit switch support images. It is assumed that the files **uboot.bin**, **vmlinux_s16.lzma.uImage** and **db12x_s16-jffs2** are located on a suitable TFTP server.

1. Apply power to the board, and boot into the existing U-boot.
2. Hit any key before the script is executed to get to the U-boot prompt
3. Set the IP addresses of TFTP server and DB120:

   setenv serverip <server IP>
   setenv ipaddr <AP IP>
   saveenv
4. Flash the new U-boot with following sequence of commands:

   tftp 0x80060000 u-boot.bin
   erase 0x9f000000 +0x50000
   cp.b $fileaddr 0x9f000000 $filesize
   reset
5. Flash the jffs2 file system using the following sequence of commands at U-boot prompt:

   tftp 0x80060000 db12x_s16-jffs2
   erase 0x9f050000 +0x630000
   cp.b $fileaddr 0x9f050000 $filesize
6. Flash the Linux kernel using the following sequence of commands at U-boot prompt:

   tftp 0x80060000 vmlinux_s16.lzma.uImage
   erase 0x9f680000 +$filesize
   cp.b $fileaddr 0x9f680000 $filesize
7. Type **reset** to reboot the board.

Linux will now boot.

6 Load the ART Image

This procedure is used to load the ART image in the DB120 board. Due to limited flash memory space on the DB120, it is recommended to load the ART image in the RAM. It is assumed that the files **art.ko** and **nart.out** are located on a suitable TFTP server, and the IP address of the TFTP server is 192.168.1.100.

1. Apply power to the board.
2. Wait until Kernel is loaded and executed.
3. Log in using the **root** username and **5up** password.
4. Type these commands:

   # **mknod /dev/dk0 c 63 0**

   # **cd /tmp**

   # **tftp -r art.ko -g 192.168.1.100**

   # **insmod art.ko**

   # **tftp -r nart.out -g 192.168.1.100**

   # **chmod +x nart.out**

   # **./nart.out -console**

The ART client is now running and waiting for connection from host.

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