1 Overview

The AP121 Reference Design is based on the AR9331, a highly integrated and cost effective IEEE 802.11n 1x1 2.4 GHz System-on-a-Chip (SoC) for WLAN AP and router platforms.

- Complete IEEE 802.11n 1x1 AP or router in a single chip
- The AR9331 operates at 400 MHz
- Cost effective 2-layer board, the AP121 reference board works with 5 V/ 3 A DC power supply
- DDR1, DDR2 or SDRAM memory support for 8/16/32/64 Mbytes with 16-bit data bus width; the AP121 reference board is configured with 16 Mbytes, 400 Mbps DDR1
- SPI NOR Flash memory support for 2/4/8/16 Mbytes, AP121 reference board is configured with 2 Mbytes serial flash.
- 4 LAN +1 WAN Fast Ethernet ports with RJ-45 connectors or configurable to 5-port Fast Ethernet switch.
- Fully integrated RF front-end including PA and LNA
- 20 MHz, 72 Mbps PHY rate
- 40 MHz, 150 Mbps PHY rate
- On-chip one-time programmable (OTP) memory for calibration data, no EEPROM needed
- High-speed UART for console application
- USB 2.0 interface port supports host/device mode
- GPIOs
- JTAG-based processor port for debugging

NOTE: This document is based on the AP121-050 reference board and the software is based on the LSDK 9.2.0.113 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 AP121 reference design kit, ordering number AR5KAP-00121A includes:

- The AP121 reference design board
- 5 VDC 3 A power supply
- RS232 UART adapter
- Dipole antennas
- Housing

2   The Atheros AP121-050 Reference Design

Figure 1 depicts the AP121-050 Reference Design board. See Table 1 to identify the buttons and external interfaces on the board.
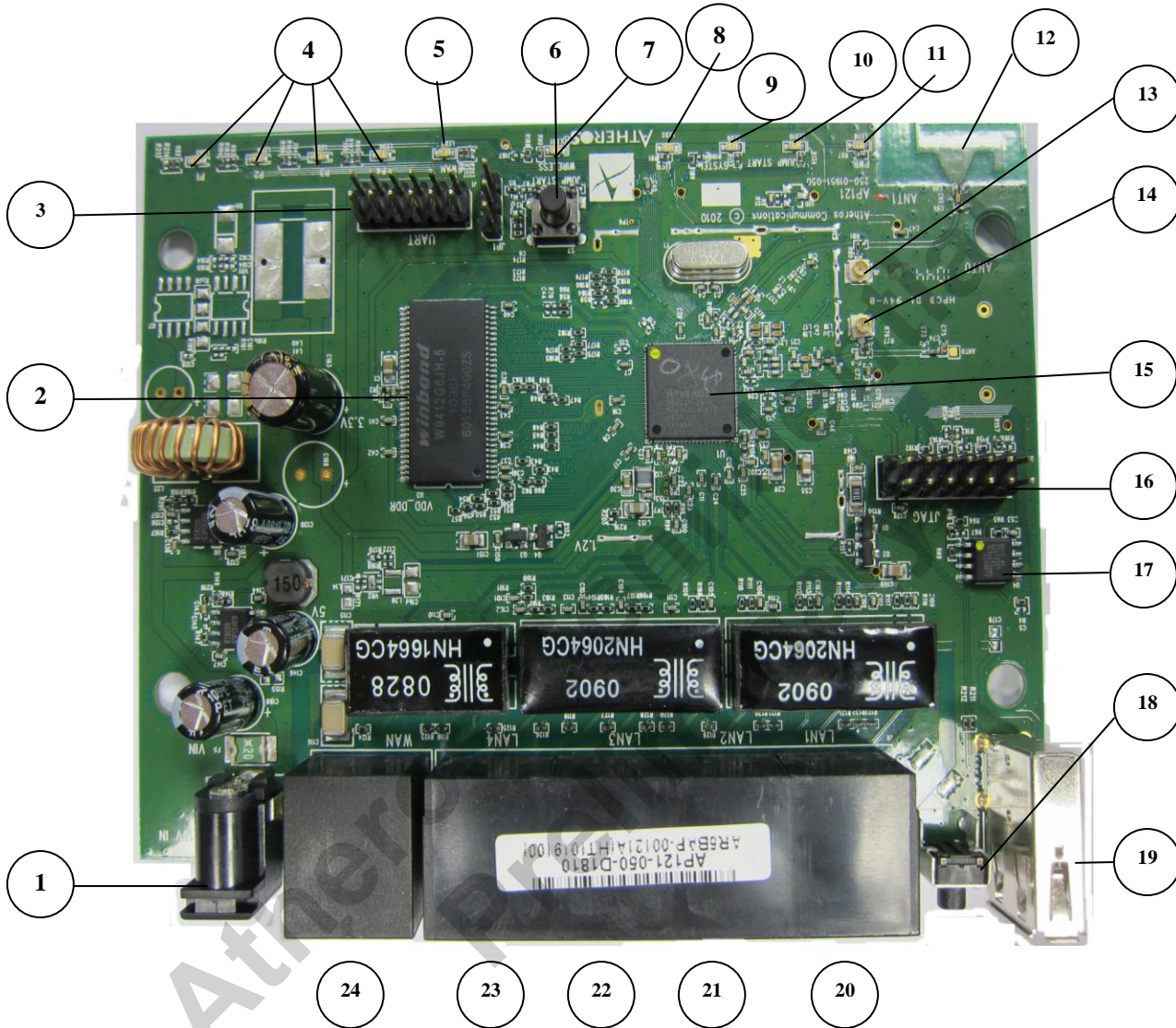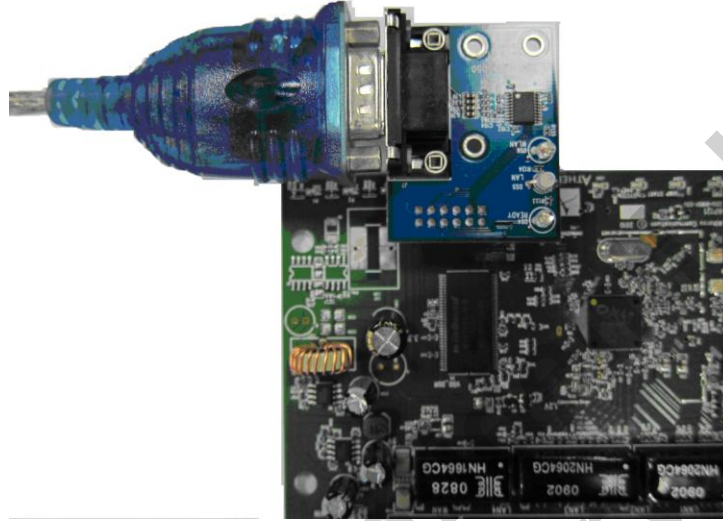

Figure 1 AP121-050 Reference Design Board

1	DC Power Connector (DC 5V)	11	Power-Up Status LED
2	DDR1 Memory	12	Printed antenna (not tested)
3	UART Port Header	13-14	Radio connectors for external dipole antenna (default)
4	10/100 Ethernet LAN LED	15	AR9331 RF Connections
5	10/100 Ethernet WAN LED	16	EJTAG Header
6	WPS Push Button	17	SPI NOR Flash Memory
7	WLAN LED	18	Reset Push Button
8	USB LED	19	USB Type A Port
9	System LED	20-23	LAN Ports (10/100 Mbps)
10	WPS LED	24	WAN Port (10/100 Mbps)

Table 1 AP121 Details

2.1 Setting up the AP121-050

1. Connect the RS232 adapter to the AP121-050 UART port. Match the non-sharp edge of the UART header to non-sharp edge of the RS232 adapter connector (see Figure 2 for correct orientation).

Figure 2 RS232 Adapter Orientation

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 AP121-050 to an available COM port on the PC. Connect the other end of the RS232 cable to the RS232 adapter (see Figure 1).
5. NOTE: If the PC has more than one COM port, note the COM port number connected to the cable.
6. Use the CAT5 Ethernet cable to connect to the RJ-45 connector of one of the LAN ports.
7. Before powering up the AP, verify all the connections are correct.
8. 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 using default IP address of 192.168.1.2, or
- A direct console connection. This method is preferred over a Telnet connection because a Telnet connection will be lost during the AP reboot phase. Use an available PC COM port with the settings:
    - o Speed 115200 bits per second
    - o 8 data bits, 1 stop bit, no parity
    - o 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 and enter U-boot for image upload (see Section 5).

2. Login to the AP with the user name **root** and the password **5up**. At this point, a new password can be created using the **passwd** utility.

3. By default, eth0 and eth1 are mapped into the same bridge (br0) using the default IP address 192.168.1.2.

   - To change the br0 IP address, use the **ifconfig** command:
     ifconfig <br0> <ip-address> <net-mask> up.

   - To set a new IP address and netmask, use the **cfg** command:
     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 AP121-050 operates in the 2.4 GHz band. The following lists the channels (select by setting AP_PRIMARY_CH) that are available in HT20 mode (by setting AP_CHMODE=11NGHT20):

- 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 AP121-050 supports HT40 mode with extension channels. 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.

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	N/A	6
11	N/A	7
12	N/A	8
13	N/A	9

Table 2 Control and Extension Channel Setting in HT40 Mode

Use these commands to configure the AP:

- The **cfg wlan up** command places the AP into operating mode.
- The **cfg wlan down** 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.

The entire environment variables configuration in NVRAM is:

cfg wlan status
cfg ath0 list sta
cfg ath0 list chan
cfg ipaddr <interface> <ipaddress>
cfg netmask <interface> <netmask>

2.5 Examples

1. This example shows that the AP is set to channel 8 as the primary channel in HT20 mode for the 2.4 GHz band:

   cfg -a AP_STARTMODE= standard
   cfg -a AP_PRIMARY_CH=8
   cfg -a AP_CHMODE=11NGHT20
   cfg –a TX_CHAINMASK=1
   cfg –a RX_CHAINMASK=1
   cfg –c
   cfg wlan up

2. This example shows that the AP is 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= standard
   cfg -a AP_PRIMARY_CH=6
   cfg -a AP_CHMODE=11NGHT40MINUS
   cfg –a TX_CHAINMASK=1
   cfg –a RX_CHAINMASK=1
   cfg –c
   cfg wlan up

3. This example shows that the AP is set to channel 6 as the primary channel in HT40 mode with channel 10 as the extension channel for the 2.4 GHz band:

   cfg -a AP_STARTMODE= standard
   cfg -a AP_PRIMARY_CH=6
   cfg -a AP_CHMODE=11NGHT40PLUS
   cfg –a TX_CHAINMASK=1
   cfg –a RX_CHAINMASK=1
   cfg –c
   cfg wlan up

3 Software Update

A software update on the AP121-050 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.

4 AP121-050 Image Update

> **NOTE:** The image names and update instructions may be changed in each release. Please refer to the release notes in each LSDK release for the most up-to-date instructions.

4.1 Update Instructions

Connect the Ethernet port on the server system to the Ethernet port of AP121-050 using CAT5 Ethernet cable. Connect the serial cable between the Terminal system and the AP using the RS232 adapter board. Ensure that Pin 1 on the adapter board is aligned with Pin 1 on the AP (see Figure 2). 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 AP121-050 board. It is assumed that the files **tuboot.bin**, **vmlinux.lzma.uImage** and **ap121-2.6.31-2MB-squashfs** 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 AP121-050:
    setenv serverip *<server IP>*
    setenv ipaddr *<AP IP>*

4. Flash the new U-boot with following sequence of commands:
    tftp 0x80060000 tu-boot.bin
    erase 0x9f000000 +0x10000
    cp.b $fileaddr 0x9f000000 $filesize
    (Power cycle to start with the new U-boot).

5. Flash the squashfs file system using the following sequence of commands at U-boot prompt:

    tftp 0x80060000 ap121-2.6.31-2MB-squashfs
    erase 0x9f010000 +0x130000
    cp.b $fileaddr 0x9f010000 $filesize

6. Flash the Linux kernel using the following sequence of commands at U-boot prompt:

    tftp 0x80060000 vmlinux.lzma.uImage
    erase 0x9f140000 +$filesize
    cp.b $fileaddr 0x9f140000 $filesize

7. Power cycle to reboot the board.

8. Now Linux will boot.

5 Load the ART Image

The following procedure is used to load the ART image in the AP121-050 board. Due to limited flash memory space on the AP121-050, 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.

9. Apply power to the board.

10. Wait until Kernel is loaded and executed.

11. Log in using the **root** username and **5up** password.

12. Type these commands:
    # 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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