AR5004/AR5005/ AR5006 Atheros Radio Test Reference Guide

PRELIMINARY

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Revision History

Revision	Description of Changes
November 2003	Initial AR5004 release.
June 2004	Updated for the AR5523.
July 2004	Updated for AR5513
November 2004	Updated for AR5005 Family chipsets
March 2005	Updated for AR5006 Family chipsets

Contents

Preface

This document is intended to provide a description of the installation and operation of the Atheros Radio Test (ART) application.

ART is a manufacturing and radio evaluation tool that can be used with the Atheros family of devices.

About this Document

The document consists of the following chapters:

Chapter 1 **Overview**—Gives a brief description of ART and its current feature set.

Chapter 2 **Atheros Radio Test Reference Guide for AR5004/AR5005/AR5006-Based Devices**—Describes the installation and operational procedures.

Chapter 3 **Atheros Radio Test Reference Guide for AR5005-Based USB Devices**—Describes the installation and operational procedures.

Chapter 4 **Atheros Radio Test Reference Guide for AR5513-Based MIMO Devices**—Describes the installation and operational procedures.

Chapter 5 **ART Extensions For Command Line Testing**—Describes the extensions that have been added to enable tests to be run from the command line.

Audience

This document is intended for users of ART who will be performing radio evaluation or setting up a manufacturing flow with the Atheros AR5002 and later.

Additional Resources

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The following resources should be referenced regarding topics that are not addressed in this document:

- *AR2112 Multi-Mode, Radio-on-a-Chip for IEEE 802.11b/g Wireless LANs data sheet*
- *AR5112 Dual-Band, Multi-Mode, Radio-on-a-Chip for IEEE 802.11a/b/g Wireless LANs data sheet*
- *AR5212 Multiprotocol MAC/Baseband Processor for 5 GHz and 2.4 GHz Wireless LANs data sheet*
- *AR5213 Multiprotocol MAC/Baseband Processor for 5 GHz and 2.4 GHz Wireless LANs data sheet*
- *AR2312 Wireless System-on-a-Chip (WiSoC) for 2.4 GHz and 5 GHz Wireless LANs data sheet*
- *AR5312 Wireless System-on-a-Chip (WiSoC) for 2.4 GHz and 5 GHz Wireless LANs data sheet*
- *AR5005 Sample Manufacturing Test Flow*
- *AR5005 EEPROM Device Configuration Guide*
- *AR5004 Manufacturing Library Reference*

1 Overview

The Atheros Radio Test (ART) is a tool used for radio evaluation and manufacturing tests. It performs various transmission tests, receive and link tests, and calibrates and tests adapters during a manufacturing flow.

NOTE: All information related to EEPROM for Reference Designs based on the AR5212 and AR5213 also, unless otherwise specified, applies to Flash memory in AR5002AP and AR5004AP Access Point Reference Designs based on the AR5312 and AR2312.

ART v4.8 supports the following:

- AR5001x, AR5002, AR5004 client adapters and AR5002-based APs (see "ART Operation" on page 2-3 and "Using ART with an AP" on page 2-4).
- Switching between 5 GHz and 2.4 GHz orthogonal frequency division multiplexing (OFDM) modes (see "Toggle Mode (o)" on page 2-17).
- Continuous transmission tests (see "Continuous Transmit Options (c)" on page 2-18).
- Receive tests (see "Continuous RF Receive Options (r)" on page 2-21).
- Link tests (see "Link Test (l)" on page 2-22).
- Throughput tests (see "Throughput Menu (T)" on page 2-22).
- EEPROM programming (see "EEPROM Function (p)" on page 2-23).
- Manufacturing tests (see "Manufacturing Test & Calibration (m)" on page 2-24).
- Logging (see "Enable Logging (g)" on page 2-25).
- A utilities menu for register access and other miscellaneous utilities (see "Utility Menu (u)" on page 2-26).

This version of ART only supports AR5006, AR5005, AR5004 and AR5002 adapters. Older versions of ART should be used for other adapters. Table 1-1 summarizes which adapters are supported by which versions of ART.

Table 1-1. **Adapters and EEPROM Versions Supported by ART Calibration**

ART Version	EEPROM Version Supported by Calibration	Adapter Types Supported
5.2	5.2 (builds greater than 50)	AR5006, AR5005, AR5004, AR5002
5.2	5.2 (builds less than 50)	AR5005, AR5004, AR5002
4.9	4.9	AR5513 1.0 ONLY; will be discontinued upon production release of AR5513
4.8	4.8	AR5004, AR5002, AR5001+
4.0	4.0	AR5002, AR5001+
2.5	3.4	AR5001+
2.4	3.3	AR5001
2.3	3.3	AR5001
2.2	3.2	AR5001
2.1	3.2	AR5001

2

Atheros Radio Test Reference Guide for AR5004/AR5005/ AR5006-Based Devices

The Atheros Radio Test (ART) utility provides tests that can evaluate the performance and functionality of Atheros chipsets. ART serves as both an evaluation tool and a manufacturing test tool. This chapter describes how to install and run ART.

Installation

NOTE: In versions 2.2 and later of ART, the low level driver changed to an Atheros Native Windows Driver (ANWI), therefore the installation procedure for ART has changed. Care should be taken to remove the older driver used by previous versions of ART, before installing the new driver.

To install ART:

1. Copy files from the **art\bin** release directory to a directory on the system that will contain the Atheros adapter. It is best to install ART before installing the adapter.
2. Copy, or refer to the ART driver release directory, **art_driver\bin**. One directory here contains the Windows 2000 driver, and another contains the Windows XP driver. Both directories contain the driver and batch files needed to install the driver for either operating system.

If an installation of the Windows 2000 ART driver (prior to version 2.2) is present, run the file **art_driver\bin\2000\uninst_old_drv.bat** to remove it. This batch file will:

- Remove **windrvr.sys**, **wdusb.sys** and **dkkernel.sys** from the directory **\winnt\system32\drivers**
- Remove **DKar500x.inf** from **\winnt\inf**

Prior to installing the new driver, remove any instances of the "Atheros AR5002 Diagnostics Kernel Driver" from the Windows Device manager.

To install the driver for ART versions 2.2+, run the batch file **art_driver\bin\2000\inst_new_drv_2000.bat** (Windows 2000) or **art_driver\bin\xp\inst_new_drv_xp.bat** (Windows XP).

These batch files will:

- Copy **anwiwdm.sys** to the directory **C:\winnt\system32\drivers for Windows 2000, or to C:\windows\system32\drivers** for Windows XP.
- Copy **anwi.inf** to **\winnt\inf**.

NOTE: The batch file assumes that Windows 2000 is installed in **C:\winnt** and Windows XP is installed in **C:\windows**. If this is not where the OS is installed, change the batch file to copy to the **system32\drivers** and **inf OS** directories.

A scan for new hardware changes within Windows installs an instance of "Atheros AR5002 Anwi Diagnostics Kernel Driver", as shown in Figure 2-1

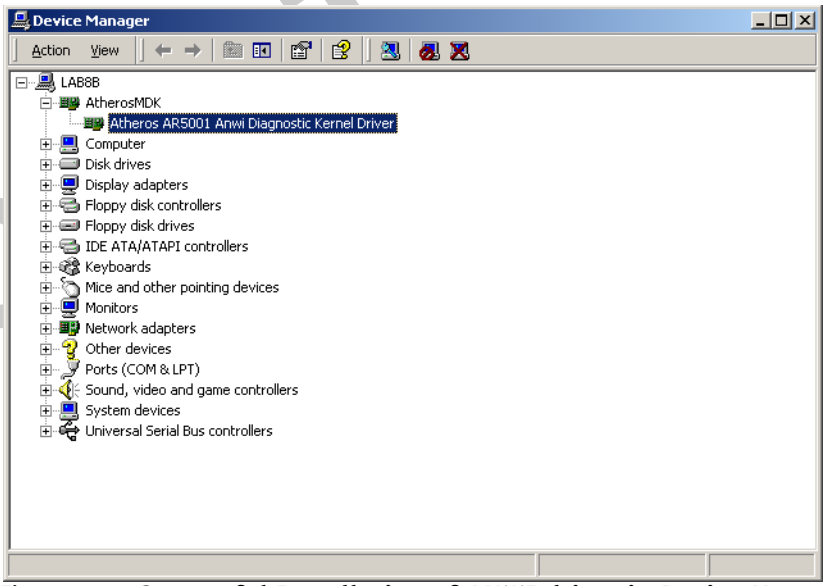

Figure 2-1. **Successful Installation of ANWI driver in Device Manager**

NOTE: Refer to "Atheros Radio Test Reference Guide for AR5005-Based USB Devices" on page 3-1 for details on installing the driver needed for AR5523 based adapters

ART Operation

The current version of ART operates only within either the Windows 2000 or the Windows XP environment, and runs as a console mode application. ART tests run with AR5002, AR5004, ar5005 and ar5006 adapters including APs. Client adapters should be part of the system running ART. To run with an access point (AP), commands are sent from a Windows host machine to the AP over Ethernet.

To start the ART utility for client cards, enter ART at the command prompt of the system containing the client adapter. Figure 2-2 shows the initial ART startup menu.

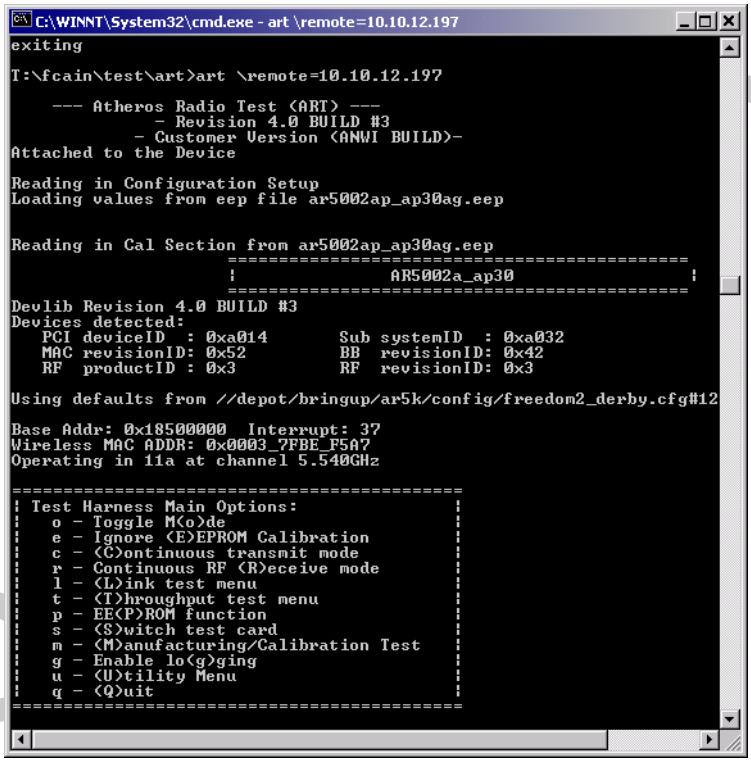

Figure 2-2. **ART Initial Screen**

See "Using ART with an AP" on page 2-4 for details on how to run on an AP. On startup (or whenever a Reference Design card is replaced), ART accesses the adapter or AP and reads device version, base address, interrupt, and MAC address information. It also performs a simple interrupt and register test on the devices. The main menu is displayed if all this is successful. Failure to display the main menu could indicate an incorrect installation of the software or hardware, or it could indicate a faulty adapter. Verify software and adapter installation to rule out installation problems.

NOTE: ART checks whether the adapter has already been calibrated. If so, it automatically loads the EEPROM settings on startup.

ART Command Line Options

The current version of ART supports four optional command line arguments (as well as the command line test arguments described in "ART Extensions For Command Line Testing" on page 5-1): a remote command line option, a card-identification command line option, EEPROM programming option, and an instance specification when dealing with multiple radios on one system.

```
C:\art> art \remote=1.2.3.4 \id=1022 \prog \instance=1
```

1.2.3.4 is the IP address of the remote stations and the ID identifies which .eep file should be loaded for this card. \prog programs locations 0 through 0xbe of the EEPROM, and \instance specifies on which of the multiple cards in the system ART should execute.

- See "ART Remote Command Line Option" on page 2-7 for more details on the \remote option.
- See "Running ART with Multiple Radios" on page 2-11 for more details on the \instance option.
- See "Determining the .eep File to Use" on page 2-15 for more details on the \id option.

Using ART with an AP

This section describes using ART with an Atheros AP.

ART Setup for AP

For an AP, the ART utility executes on the host PC and it communicates with the ART client running on the AP. So it is necessary to install the ART utility and the low level drivers on the host PC. Refer to the "Installation" on page 2-1 on how to install the ART utility and the low level drivers. Figure 2-3 shows the setup required to run ART for an AP.

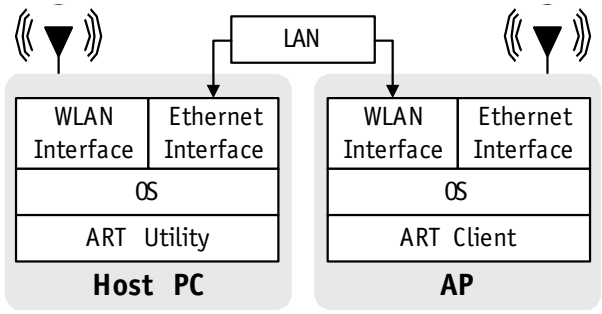

Figure 2-3. **ART Setup for AP**

A client application (ART client) executes on the AP, which waits for the commands from the ART running on the PC. This client application starts automatically when the AP boots.

NOTE: Access point (AP) refers to Atheros Access Point Reference Designs.

Configuring the IP Address for the AP

The ART client communicates with the ART running on the host PC using TCP/IP sockets.

A default IP address (192.168.1.20) is initially stored in the AP's flash memory, although it might be necessary to change this default address, to the LANs network address. Configure the IP address of the AP (stored in the AP's flash memory) before using ART, because the OS kernel reads this IP address and configures the Ethernet interface during boot time.

To change this default IP address:

1. Create a network with a network address of 192.168.1.0, and connect the AP to that network.
2. In any PC connected to that network, open a DOS console window and type the following from the prompt:

   ```
   > telnet 192.168.1.20
   ```

   This starts a command shell on the AP. The command prompt (->) appears on that console.
3. If the new IP address is "a.b.c.d", type the following commands at the prompt. Change only the inet on Ethernet field. Hostname can refer to the IP address of the AP, or to an IP name associated with the IP address.)

   ```
   ->bootChange
   '.' = clear field; '-' = go to previous field;  ^D = quit
   boot device                         : tffs:0
   processor number                    : 0
   hostname                            :
   filename                            : /fl/APIMG1
   inet on ethernet (e)                : 192.168.1.20 a.b.c.d
   inet on backplane (b)               :
   host inet (h)                       :
   gateway inet(g)                     : <gateway address if required>
   user (u)                            :
   ftp password(pw)(blank = use rsh) :
   flags (f)                           : 0x0
   target name (tn)                    :
   startup script (s)                  : factory
   other (o)                           : ae
   value = 0 = 0x0
   ->reboot
   ```

   The AP reboots with the new IP address. This may hang the DOS console window for around 15 seconds, but then the AP should be able to communicate using this new IP address. If incorrect inputs are given, restore the factory default settings by using the external switch (press the switch for about four seconds), then configure the IP address again.

Configuring the AP's WLAN and Ethernet MAC Addresses

It may sometimes be necessary to configure the WLAN or Ethernet MAC addresses if they conflict with the existing network interface addresses. Open a telnet connection to the AP and type the command `bdChange` at the shell prompt. Comments written inside curly braces do not appear on the display.

```
-> bdChange
Update board data (enter to keep, ^D to finish):
name [Atheros AR5002AP default]
HW watchdog [n]
memcap valid [n]
cpufreq valid [y] {enter y to get the CPU frequency}
cpufreq [80000000] {
sysfreq valid [y] {enter y to get the system bus frequency}
sysfreq [80000000]
wlan mac address [00:03:7f:fe:00:12]: <new wlan mac address>
enet0 mac address [00:03:7f:fe:00:13]: <new enet0 mac address>
enet1 mac address [ff:ff:ff:ff:ff:ff]:
major [1]:
minor [0]:
pciid [0011]:
wlan enabled [y]:
enet0 enabled [y]:
enet1 enabled [n]:
external serial clock enabled [n]: {internal serial clock always}
uart0 (console) enabled [y]: {high-speed UART which supports DMA}
sysled enabled [y]
sysled gpio [7] {System LED is connected to GPIO 7}
factory reset enabled [y]
factory reset gpio [6]

name:    Atheros AR5002AP default
magic:   35333131
rev:     1
major:   1
minor:   0
pciid:   0011
wlan:    yes 00:03:7f:fe:00:12 {new wlan address should appear here}
enet0:   yes 00:03:7f:fe:00:13 {new enet0 address should appear here}
enet1:   no  ff:ff:ff:ff:ff:ff
uart0:   yes
uart1:   no
sysled:  yes, gpio 7
factory: yes, gpio 6
serclk:  internal
cpufreq: calculated 80000000 Hz
sysfreq: calculated 80000000 Hz
memcap: disabled
watchdg: disabled
done.  Reboot to activate
value = 0 = 0x0
->reboot
```

ART Remote Command Line Option

The remote command line option instructs the host PC ART to send the commands to the ART client running on the remote AP. It is always necessary to use this command line option for an AP.

To start the ART utility for the AP:

Type the following at the DOS command prompt:

```
C:\> art \remote=a.b.c.d
```

where: a.b.c.d is the AP's IP address.

Example Run

To set up ART for an AP:

1. Configure the AP's IP address, WLAN MAC address, and Ethernet MAC address.
2. Connect the AP to the configured LAN network.
3. Reboot the AP.
4. Ping the AP to verify that is up and running.
5. On any PC connected to the same network:
   a. Open a telnet connection to the AP on a DOS console window (A). The shell prompt (->) should appear on the DOS window.
   b. Open another DOS console window (B) and start the ART utility.

   The example shown below is for an AP with IP Address 10.10.12.34:

   ```
   ->art \remote=10.10.12.34
   ```

Figure 2-4 shows the DOS console window that appears when the PC Host ART utility is started. The error and debug messages printed by the ART client appear on the telnet DOS window.

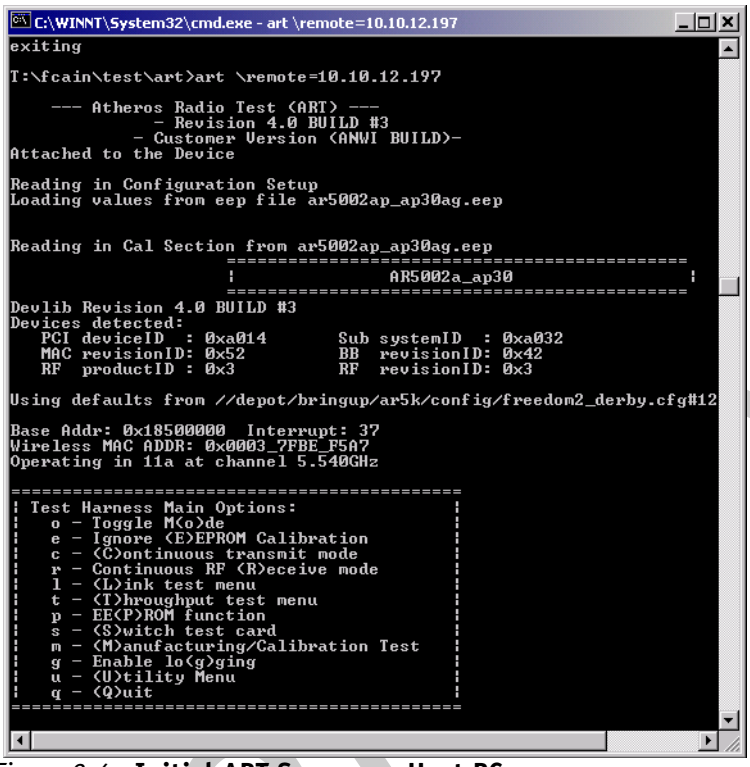

Figure 2-4. **Initial ART Screen on Host PC**

Figure 2-5 shows the telnet DOS window that appears when the ART utility is started on the host.

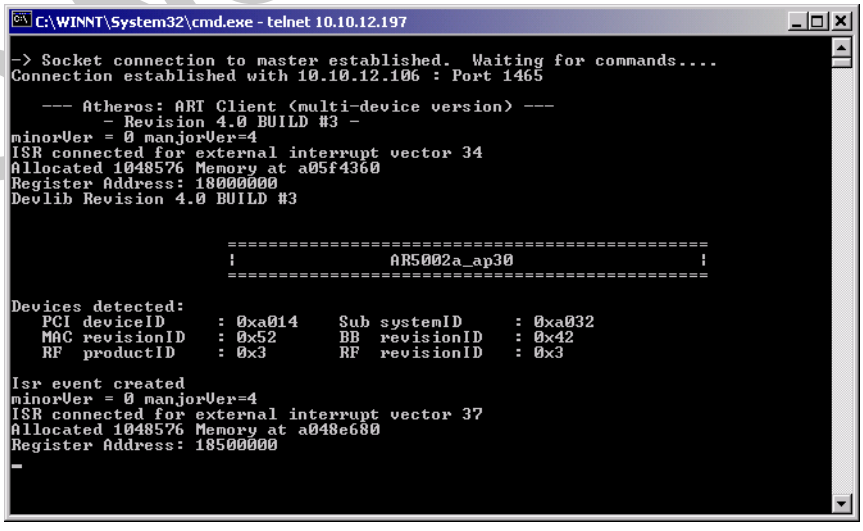

Figure 2-5. **ART Client Messages on Startup**

Updating New ART Client Executable Image

When updating the ART client executable, it is necessary to update the executable image in the AP's flash memory. This can be done in two ways:

- Using flash.bin binary image
- Using APIMG1 executable image

Using flash.bin Binary Image

The binary file **flash.bin** contains a snapshot of the entire four MB flash memory on the AP. This image can be programmed into the flash memory device using the flash programmer, and the device then mounted on the AP. Use this method the first time the flash memory device is programmed.

Using the APIMG1 Executable Image

APIMG1 is a binary file that contains the ART client image in ELF executable format. Use this executable image when the flash memory is programmed and the new ART client image needs updating in the flash memory. This method uses the FTP protocol to download the image. Use any desired FTP server software.

To use the APIMG1 executable image to update the ART client executable image:

On any PC connected to the same network as the AP:

1. Start the FTP server on the PC.
2. Open a telnet connection to the AP on a DOS console window (A). The shell prompt (->) should appear on the DOS window.
3. Type this command at the shell prompt to download the new **APIMG1** image from the PC to the AP flash memory:

```
->ftpdownload
hostname: <PC's IP address>
Username: anonymous
Password: guest
Remote File: APIMG1 <or path to the directory where the file APIMG1
is stored>
Local File: APIMG1
```

   Downloading the new image overwrites the previous image from the AP flash memory. Wait until the download completes before rebooting the AP, as the FTP download process sometimes fails with "remote read" or "local write" errors. Repeat this step until the download succeeds.
4. Reboot the AP to load the new ART client image from the flash.

Updating Bootrom

New bootrom can be updated from the VxWorks command shell.

To update the bootrom:

Download the bootrom image (**bootrom.bin**) from the PC to the AP using FTP download. Type the following at the VxWorks shell prompt:

```
-> bootrom "bootrom.bin"
Bootrom overwriteen with file bootrom.bin
->reboot
```

Testing Ethernet Interface(s)

The ART client running on the AP communicates with the ART utility running on the host by using TCP/IP sockets through the Ethernet 0 interface. Successful communication between the two indicates the Ethernet 0 interface is working.

For boards with two Ethernet interfaces, it is necessary to test the second Ethernet interface. Although there are two Ethernet interfaces, the ART client does not currently support the concurrent use of both Ethernet interfaces. It is necessary to enable and assign a unique MAC address to the second interface before it can be used. Refer to section "Configuring the AP's WLAN and Ethernet MAC Addresses" on page 2-6 for information on how to enable and assign a MAC address to the Ethernet interface.

To test the Ethernet interface(s) in the AP:

1. Connect the Ethernet cable to the first Ethernet interface.
2. Ping the AP using its assigned IP address. The Ping should receive a reply from the AP. A successful ping reply indicates the first Ethernet interface is working.
3. For boards with two Ethernet interfaces:
   a. Remove the Ethernet cable from the first interface and connect it to the second interface.
   b. Ping the AP using its assigned IP address. The Ping should receive a reply from the AP. A successful ping reply indicates the first Ethernet interface is working.

Creating Flash Image

The flashCopy command takes a snapshot of the entire flash memory content as a binary file on the host PC. This binary file can be used to program other flash memory devices before they are mounted on the board. This command uses the FTP protocol to download the flash image and takes the flash memory size (in kilobytes) as its argument. It is necessary to run the FTP server in the host PC.

To copy the four MB flash image as flash.bin on the host PC:

From a VxWorks prompt, type the flashCopy command.

```
->flashCopy 4096
hostname:10.10.12.34
Username:<valid user name>
Password:
Remote File:flash.bin
######################################
######################################
.
done
```

Running ART with Multiple Radios

The Atheros AR5002 AP-2X access point contains two radios, one supporting 802.11a and the other supporting 802.11b/g. The dual-slot development platforms (PB22 and PB32) also provide the ability to support two Atheros radio adapters. ART provides the ability to communicate with one or the other of these radios using the \instance command line option. The first radio is always instance=1 (ART default), while the second radio is instance=2. Two sessions of ART are needed to run the two radios concurrently, one with the command line option \instance=1 and the other with the command line option \instance=2.

When running with the AR5002AP-2X access point, if no instance is specified on the command line, ART runs in a special mode. It automatically switches radios between instance 1 and instance 2 when changing modes. For example, it communicates with radio 1 when 802.11a is selected, with radio 2 when 802.11g or 802.11b is selected. Note that to run both radios concurrently, \instance=1 and \instance=2 must be specified on the command line. When running on the AR5002 AP, it is the user's responsibility to ensure that only 802.11a is used for instance 1, and 802.11g or 802.11b with instance 2.

External Configuration Files

The external text files used with ART to control the ART operation include **artsetup.txt**, **calsetup.txt**, **ar500*.eep** files, and **calTrgtPwr** files. **Artsetup.txt** allows specification of the initial operation environment: for example, which channel transmission or reception should start on, whether or not to enable Atheros Turbo Mode™, and whether to load the calibration information from the EEPROM. The **ar500*.eep** files contain adapter-specific information, with one file for each of the supported adapters detailing the optimal configuration settings for card operation and calibration. The **calsetup.txt** and **calTrgtPwr** files contain adapter-specific and generic information used during adapter calibration. See the document *AR5004 Sample Manufacturing Test Flow* for descriptions of the **calTrgtPwr**, **calsetup.txt**, and part of the **ar500*.eep** files.

This section describes the **artsetup.txt** and the other section of the **ar500*.eep** files.

Environment Configuration File: artsetup.txt

The **artsetup.txt** file allows control of these options:

```
#initial configuration options
5_CHANNEL_MHZ = 5260     #The initial 5GHz channel in MHz
2_4_CHANNEL_MHZ = 2412   #The initial 2.4GHz channel in MHz
#ALL_2G_CHANNELS = 1

#eeprom configuration
EEPROM_LOAD_OVERRIDE = 0         #set to 1 override loading of eeprom
                                  calibration info
TURBO = 0                #set to 1 to enable turbo mode
MODE = 0

#register configuration files, comment out line touse defaults
#LOG_FILE = artout.log
LOGGING = 0
LOAD_EAR = 1

RATE_MASK = 0X7fff

#BLANK_EEP_ID = 0x1031 #which subsytem ID to use for lookup if blank
eeprom
DUT_CARD_SSID = 0x1031
APPLY_CTL = 0 #set to 1 to enable power limiting by specified CTL
CTL_VALUE = 0x10 #specify which CTL to apply when APPLY_CTL is set
DEBUG_INFO = 0 #set to see additional debug info (used for engineering
debug)

#              subsystemID filename
CFG_TABLE =     0x1031      ar5002x_cb32ag.eep
CFG_TABLE =     0x2031      ar5002x_mb32ag.eep
CFG_TABLE =     0x1030      ar5002g_cb31g.eep
CFG_TABLE =     0x2030      ar5002g_mb31g.eep
CFG_TABLE =     0xa032  ar5002ap_ap30ag.eep        240_ap30ag_02.ear
CFG_TABLE =     0xa033  ar5002ap_ap31g.eep         240_ap31g_02.ear
CFG_TABLE =     0xa034  ar5002ap_ap30ag_040.eep 240_ap30ag_040_02.ear
CFG_TABLE =     0xa035  ar5002ap_ap38ag.eep        240_ap38ag_02.ear
CFG_TABLE =     0xa036  ar5002ap_ap39g.eep        240_ap39g_02.ear
CFG_TABLE =     0xa037  ar5002ap_ap33g.eep        240_ap33g_02.ear
CFG_TABLE =     0xa038  ar5002ap_ap36ag.eep        240_ap36ag_02.ear
CFG_TABLE =     0xa043  ar5004ap_ap43g.eep    240_ap43g_01.ear
CFG_TABLE =     0xa048  ar5004ap_ap48ag.eep   240_ap48ag_01.ear
CFG_TABLE =     0xa041  ar5004ap_ap41g.eep    240_ap41g_01.ear
CFG_TABLE =     0x1042  ar5004x_cb42ag.eep  240_cb42ag_02.ear
CFG_TABLE =     0x1041  ar5004g_cb41g.eep   240_cb41g_02.ear
CFG_TABLE =     0x1043  ar5004g_cb43g.eep   240_cb43g_02.ear
CFG_TABLE =     0x2042  ar5004x_mb42ag.eep  240_mb42ag_02.ear
CFG_TABLE =     0x2041  ar5004g_mb41g.eep   240_mb41g_02.ear
```

```
CFG_TABLE =     0x1052  ar5005g_cb51g.eep
CFG_TABLE =     0x2052  ar5005g_mb51g.eep
CFG_TABLE =     0x1054  ar5005g_cb53g.eep
CFG_TABLE =     0x2054  ar5005g_mb53g.eep
CFG_TABLE =     0x1051  ar5005gs_cb51g.eep
CFG_TABLE =     0x2051  ar5005gs_mb51g.eep
CFG_TABLE =     0x1053  ar5005gs_cb53g.eep
CFG_TABLE =     0x2053  ar5005gs_mb53g.eep
CFG_TABLE =     0xb051  ar5005ug_ub51g.eep
CFG_TABLE =     0xb052  ar5005ux_ub52ag.eep
CFG_TABLE =     0x2062  ar5006xs_mb62ag.eep
CFG_TABLE =     0x1062  ar5006xs_cb62ag.eep
CFG_TABLE =     0x2063  ar5006x_mb62ag.eep
CFG_TABLE =     0x1063  ar5006x_cb62ag.eep
CFG_TABLE =     0xa051  ar5006apgs_ap51g.eep
CFG_TABLE =     0xa052  ar5006apg_ap51g.eep
CFG_TABLE =     0x3062  ar5006exs_xb62ag.eep
CFG_TABLE =     0x3063  ar5006ex_xb62ag.eep
```

The channel, turbo, logging, and mode settings take effect at the initial execution of ART. If any of these are changed within the application, then the new value takes effect for the remainder of the ART session.

The RATE_MASK setting controls which rates send packets when ART runs a link test. Each rate uses one bit. Table 2-1 shows the rate mask mapping for the various modes. Combine as many rates as required. If non-applicable masks are set, they are ignored for the modes that do not use them.

Table 2-1. **RATE_MASK Encoding Per Rate**

Mask	Rate Encoding by Mode			
	802.11a	802.11b	802.11g	OFDM@2.4
0x01	6 Mbps	1 Mbps Long	6 Mbps	6 Mbps
0x02	9 Mbps	N/A	9 Mbps	9 Mbps
0x04	12 Mbps	2 Mbps Long	12 Mbps	12 Mbps
0x08	18 Mbps	2 Mbps Short	18 Mbps	18 Mbps
0x10	24 Mbps	5.5 Mbps Long	24 Mbps	24 Mbps
0x20	36 Mbps	5.5 Mbps Short	36 Mbps	36 Mbps
0x40	48 Mbps	11 Mbps Long	48 Mbps	48 Mbps
0x80	54 Mbps	11 Mbps Short	54 Mbps	54 Mbps
0x100	N/A	N/A	1 Mbps Long	N/A
0x200	N/A	N/A	2 Mbps Long	N/A
0x400	N/A	N/A	2 Mbps Short	N/A
0x800	N/A	N/A	5.5 Mbps Long	N/A
0x1000	N/A	N/A	5.5 Mbps Short	N/A
0x2000	N/A	N/A	11 Mbps Long	N/A
0x4000	N/A	N/A	11 Mbps Short	N/A
0x8000	0.25 (XR)	N/A	0.25 (XR)	0.25 (XR)
0x10000	0.5 (XR)	N/A	0.5 (XR)	0.5 (XR)
0x20000	1 (XR)	N/A	1 (XR)	1 (XR)
0X40000	2 (XR)	N/A	2 (XR)	2 (XR)
0X80000	3 (XR)	N/A	3 (XR)	3 (XR)

If an adapter has been calibrated with power tables, ART automatically loads and runs with the EEPROM information. Cancel this automatic EEPROM load by setting the flag EEPROM_LOAD_OVERRIDE.

If the LOAD_EAR flag is set, ART loads the EEPROM Added Registers (EAR) section from the EEPROM. When running in this mode, ART loads an older set of configuration values, then applies the EAR registers to create an up-to-date configuration. When LOAD_EAR is not set, ART loads the newest configuration parameters. Whether loading EAR or not, the resulting configuration should be the same. The intention of LOAD_EAR is to test the EAR. Refer to the *AR5005 16K EEPROM Configuration Guide* for a detailed description of the EAR.

The EEPROM contains adapter-specific settings needed for the adapter to perform optimally. Before the adapter programs the EEPROM, it reads these settings from the adapter-specific .eep file, and uses the setting CFG_TABLE to associate the adapter subsystem ID with the appropriate .eep file. Using the subsystem ID rather than the EEP lookup table (in the file **artsetup.txt**) allows any adapter subsystem ID to associate to the correct configuration settings to load in the absence of an EEPROM load. If the .eep files are resident in a different directory, then the adapter uses the setting EEP_FILE_DIR to specify an alternative.

In versions 4.4+, the CFG_TABLE includes an additional optional column that specifies the EAR file to load into the EEPROM during the manufacturing of that adapter type. If the table does not specify an EAR file, then the EEPROM includes no EAR section. Note that this file only comes into use during the manufacturing process, and is not used in conjunction with the LOAD_EAR flag. If no EAR section exists within the EEPROM and the LOAD_EAR flag is set, the EEPROM does not load the EAR.

ART v4.8 allows users to limit power by applying one of the EEPROM conformance testing limits (CTLs) using the flags ENABLE_CTL and CTL_VALUE. To apply them, set ENABLE_CTL to 1 and CTL_VALUE to the value of the CTL (use one of the CTLs programmed into the EEPROM of the card).

ART v4.8 also includes the flag DEBUG_INFO. Set this flag when requested by Atheros to enable printing of additional debug information used to troubleshoot problems.

Determining the .eep File to Use

On startup, ART reads the subsystemID from the EEPROM, then looks for a match to this ID within the CFG_TABLE entries in the file **artsetup.txt**. If a match is found, the EEPROM parses the corresponding .eep file and applies it to the adapter. If it reads a subsystem ID from the EEPROM, but finds no match in the CFG_TABLE entries, ART exits with an error. If the EEPROM is blank, ART requires that the BLANK_EEP_ID setting specify the subsystem ID to use as the lookup for the CFG_TABLE entries. Table 2-2 lists the .eep files together with reference boards they apply to.

Table 2-2. **.eep Filenames for Atheros Reference Designs**

.eep Filename	Subsystem ID	Reference Board Description
ar5002x_cb32ag.eep	1031	AR5002X 802.11a/b/g CardBus Reference Design
ar5002g_cb31g.eep	1030	AR5002G 802.11b/g CardBus Reference Design
ar5002x_mb32ag.eep	2031	AR5002X 802.11a/b/g Mini PCI Reference Design
ar5002g_mb31g.eep	2030	AR5002G 802.11b/g Mini PCI Reference Design
ar5002ap_ap30ag_040.eep	a034	AR5002AP 802.11a/b/g AP with Ethernet Router
ar5002ap_ap31g.eep	a033	AR5002AP 802.11b/g AP with Ethernet Router
ar5002ap_ap38ag.eep	a035	AR5002AP 802.11a/b/g AP bridge
ar5002ap_ap33g.eep	a037	AR5002AP 802.11 b/g AP with Ethernet Router
ar5004x_cb42ag.eep	1042	AR5004X 802.11a/b/g Cardbus Reference Design
ar5004g_cb41g.eep	1041	AR5004G 802.11b/g Cardbus Reference Design
ar5004g_cb43g.eep	1043	AR5004G 802.11b/g Cardbus Reference Design (cost reduced)
ar5004x_mb42ag.eep	2042	AR5004X 802.11a/b/g Mini PCI Reference Design
ar5004g_mb41g.eep	2041	AR5004G 802.11b/g Mini PCI Reference Design
ar5004ap_ap48ag.eep	a048	AR5004AP 802.11a/b/g AP Bridge
ar5004ap_ap43g.eep	a043	AR5004AP 802.11b/g AP with Ethernet Router
ar5005gs_cb51g.eep	1051	AR5005g 802.11g Cardbus Reference Design wit Super G
ar5005g_cb51g.eep	1052	AR5005gs 802.11g Cardbus reference Design
ar5005gs_mb51g.eep	2051	AR5005g 802.11g Mini PCI Reference Design with Super G
ar5005g_mb51g.eep	2052	AR5005gs 802.11g Mini PCI reference Design
ar5005ug_ub51g.eep	b051	AR5005ug 802.11g USB Reference Design
ar5005ux_ub52ag.eep	b052	AR5005ug 802.11ag USB Reference Design
ar5006xs_cb62ag.eep	1062	AR5006x 802.11a/g Cardbus Reference Design with Super A/G
ar5006x_cb62ag.eep	1063	AR5006x 802.11a/g Cardbus Reference Design
ar5006xs_mb62ag.eep	2062	AR5006x 802.11a/g Mini PCI Reference Design with Super A/G
ar5006x_mb62ag.eep	2063	AR5006x 802.11a/g Mini PCI Reference Design
ar5006apgs_ap51g.eep	a051	AR5006g 802.11g AP Reference design with super G
ar5006apg_ap51g.eep	a052	AR5006g 802.11g AP Reference design
ar5006exs_xb62ag.eep	3062	AR5006x 802.11a/g PCI Express Reference Design with Super A/G
ar5006ex_xb62ag.eep	3063	AR5006x 802.11a/g PCI Express Reference Design

The command line option \ID overrides the above mechanism, and it uses whichever subsystem ID is given on the command line as the lookup to the CFG_TABLE entries.

Specifying DUT Adapter Type to Golden Station

During manufacturing testing, the golden station needs to know which .eep file the device under test (DUT) station uses, allowing it to open the correct target power file so the manufacturing tests stay synced between the golden and DUT stations. The golden machine option DUT_CARD_SSID specifies the subsystem ID it uses to look up the correct .eep file for the DUT.

Environment Configuration File: ar500*.eep

The **ar500*.eep** files contain the sections @cal_section, which contains information used by calibration, and @config_section, which contains information for operation and calibration. This document describes the @config_section of the **ar500*.eep** files. The other section of the these files is described in the document *AR5004 Sample Manufacturing Test Flow*.

The @config_section of the files specifies the values of the registers to apply to a specific adapter for that adapter to work at optimal performance. For example, the antenna control switch table, the ob, db, or xpd_gain values to apply for that adapter. The registers specified in these files are the same register values written to the EEPROM during calibration. The values read from the .eep files in the absence of an EEPROM load. Two subsections can be present in this section of the file:

```
bb_tx_frame_to_xpaa_on          0x0e
bb_tx_end_to_xlna_on               2
#---------------------------------------------------------------------------
@MODE: MODE_SPECIFIC             11a   11a_turbo        11b         11g
#---------------------------------------------------------------------------
bb_switch_settling              0x2d         0x5a        0x23       0x2d
bb_txrxatten                    0x0d         0x0d        0x0c       0x0d
bb_pga_desired_size              -80          -80         -80        -80
bb_adc_desired_size              -32          -32         -38        -38
```

The first subsection is for registers that are not mode-specific, and uses two columns: one for the name of the field, and one for the value of the field. The AR5001xAP supports only this format.

The second subsection, identified by the @MODE: MODE_SPECFIC tag, is for registers that change values between modes. It uses columns containing the field name and values for 802.11a, 802.11a Turbo, 802.11b, and 802.11g modes. Adapters that do not support all modes ignore the unsupported values.

NOTE: The software identifies register fields as mode-specific or mode-independent. Mode-specific register fields appear in the mode-specific, and mode-independent registers in the mode-independent section of the .eep file. Users should keep the register fields in these sections identified in the .eep files provided by Atheros.

For a description of the register fields, refer to the document *AR5004 Sample Manufacturing Test Flow*.

ART Commands

Once **art.exe** is executed, a menu with test options appears. To run a test, press the character key assigned to the test option. For example, press **c** to run the continuous transmit test.

```
=========================================
| Test Options:                         |
|   o - Toggle M(o)de                   |
|   e - Load (E)EPROM Calibration       |
|   c - (C)ontinuous transmit mode      |
|   r - Continuous (R)eceive mode       |
|   l - (L)ink test menu                |
|   t - (T)hroughput test menu          |
|   p - EE(P)ROM function               |
|   s - (S)witch test card              |
|   m - (M)anufacturing test & calibration |
|   g - Enable lo(g)ging                |
|   u - (U)tility Menu                  |
|   i - (N)oise Immunity Menu           |
|   q - (Q)uit                          |
=========================================
```

Toggle Mode (o)

The toggle mode switches mode of operation between 5 GHz orthogonal frequency division multiplexing (OFDM) and 2.4 GHz OFDM. Once selected, transmission occurs in that mode for the remainder of the ART session unless the uses changes the mode during that session. Control the initial mode of operation using the mode option in **artsetup.txt**.

Load EEPROM Calibration (e)

This menu toggles between loading from EEPROM and ignoring EEPROM values. Loading from EEPROM causes the data from the EEPROM to load into the appropriate registers. In this mode, the EEPROM data overwrites the register values applied by the register configuration file as well as the parameter changes (i.e., PCDAC or Power) made during the ART session. When in the ignore EEPROM mode, the register file values apply.

NOTE: The text on this menu applies to what action occurs if selecting the menu. For example, when the menu states Load EEPROM, then the EEPROM values are not currently loaded. When the menu states Ignore EEPROM, then the EEPROM values are currently loaded.

Continuous Transmit Options (c)

Continuous transmit options allow dynamic change of the channel frequency, data rate, and a number of radio characteristics. They also allow switching between single-carrier mode and 99 percent, 100 percent, or dynamic (FRAME) duty cycle data mode (with different data patterns such as RANDOM and PN9).

Users can also select antenna choice and Atheros Turbo Mode™, which toggles between turbo mode, normal speed, half and quarter rate. In half and quarter rate mode, the subcarrier bandwidth is cut in half or quarter respectively, resulting in half or quarter the occupied bandwidth and data rates. The half and quarter rate modes accommodate the 5 and 10 MHz bandwidth requirement in the Japanese lower band 4.9–5.15 GHz.

Toggle scramble mode allows turning off of data scrambling, necessary when estimating carrier suppression in CCK mode.

ART versions 2.3+ allow toggling of dynamic optimization. With dynamic optimization enabled, ART constantly makes chip set adjustments to provide optimum transmit performance. See "Dynamic Optimization" on page 2-21 for a detailed explanation of the dynamic optimization process.

Press ESC to return to the main Test Options menu when finished.

```
=================================================================
| Continous Transmit Options                                    |
|   p - Increase Center Frequency by 10 MHz (P inc by 100 MHz)  |
|   l - Decrease Center Frequency by 10 MHz (L dec by 100 MHz)  |
|   o - Increase Data Rate                                      |
|   k - Decrease Data Rate                                      |
|   i - Increase pcdac (I inc by 10)                            |
|   j - Decrease pcdac (J dec by 10)                            |
|   f - Increase power output by 0.5dBm (F inc by 5dBm)         |
|   c - Decrease power output by 0.5dBm (C dec by 5dBm)         |
|   u - Increase ob by 1 (w - increase b-ob)                    |
|   h - Increase db by 1 (q - increase b-db)                    |
|   v - Toggle power override (ovr)                             |
|   x - Toggle external power                                   |
|   y - Increase gainI by 1 (Y inc by 10)                       |
|   g - decrease gainI by 1 (G dec by 10)                       |
|   m - Increase rf Gain Boost                                  |
|   s - Toggle output mode (tx100 | tx99 | single carrier)      |
|   b - Toggle turbo mode                                       |
|   a - Toggle antenna                                          |
|   d - Toggle Data Pattern                                     |
|   z - Toggle Scramble mode                                    |
|   t - Increase interframe spacing slots                       |
|   r - Decrease interframe spacing slots                       |
|   9 - Toggle dynamic optimization                             |
|   4 - Increment Fixed gain                                    |
| ESC - exit                                                    |
=================================================================
```

Menu items in red are not always available and depend on power override state. If power override is off, the ability to toggle external power is available, but the ability to adjust gainI is not. If power override is on, the ability to change gainI is available, but external power control is not. The ability to increment the fixed gain is only available when dynamic optimization is inactive. Interframe spacing control is only available in FRAME mode and enables the user to control the output duty cycle.

In addition to allowing the user to control the duty cycle, FRAME mode also differs from TX99 in that the packet size varies so that each of the rates have the same transmit time per packet (i.e., slow rates send a smaller packet than the faster rates).

NOTE: Not all the menu items are available for the AR2413/2414 and AR5413/5414 based adapters. For example, dynamic optimization, power override and external power toggling are not available or needed for these chipsets which implement a different power scheme than previous chipsets.

Power Control

To obtain accurate power control within 0.5 dBm, ensure that the EEPROM calibration information has been loaded from the main menu, then use the 'c' and 'f' options from this menu. Once selected, the power value shown by the software is the measurable power output by the AR5111. To gain accurate power output it is important that the EEPROM calibration information be loaded. The calibration calculates which PCDAC values will produce the desired power level, then loads these values into the 64-entry power table in the device, where each entry is a step of 0.5 dBm. The software then points to the appropriate entry in this table to set the power. Note that the maximum power output will be limited by the capabilities of the adapter.

Figure 2-6, Figure 2-7, and Figure 2-8 show how to change other RF parameters to manually affect output power for the AR5111, AR5112, and AR2413/AR2414, respectively.

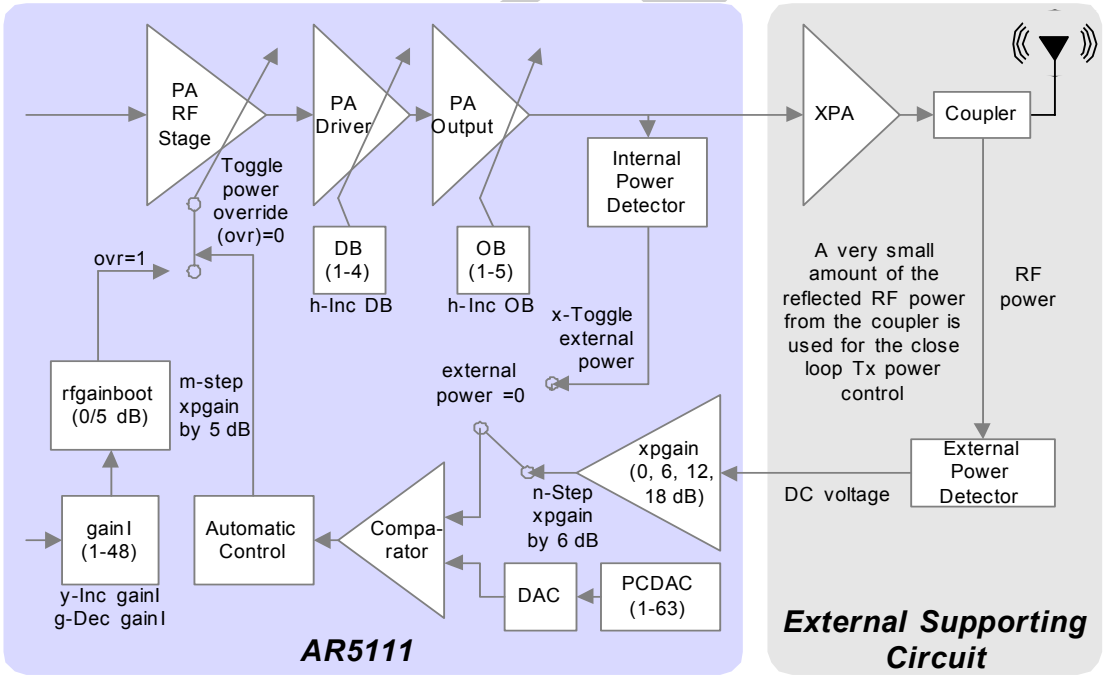

Figure 2-6. **AR5111 Tx Power Control Diagram**

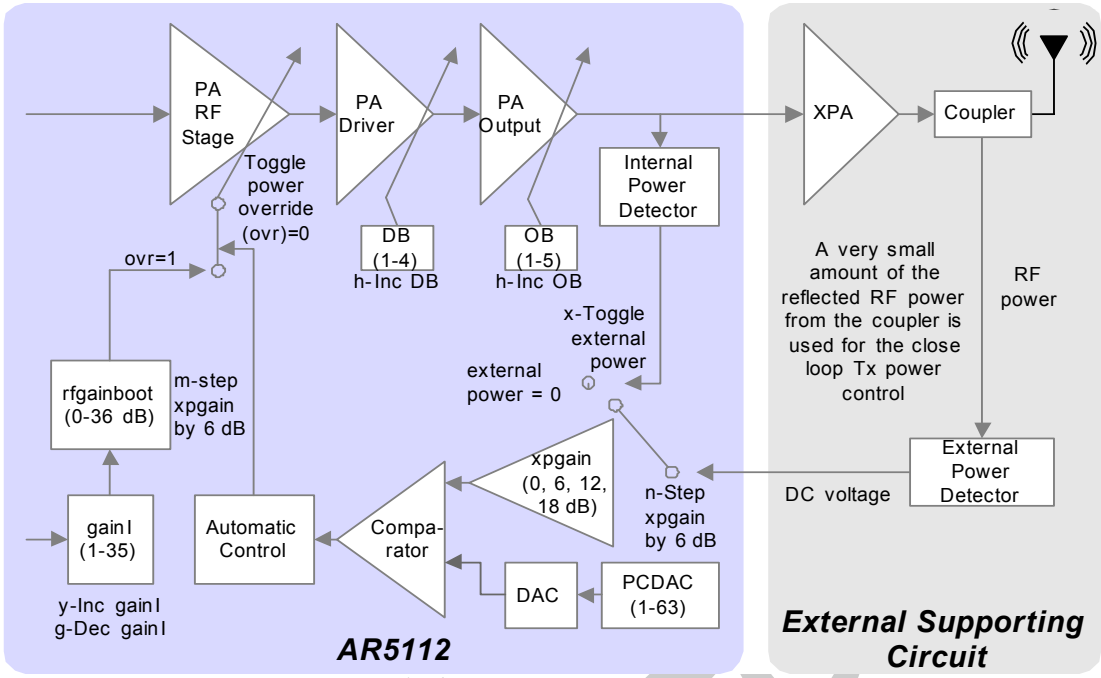

Figure 2-7. **AR5112 Tx Power Control Diagram**

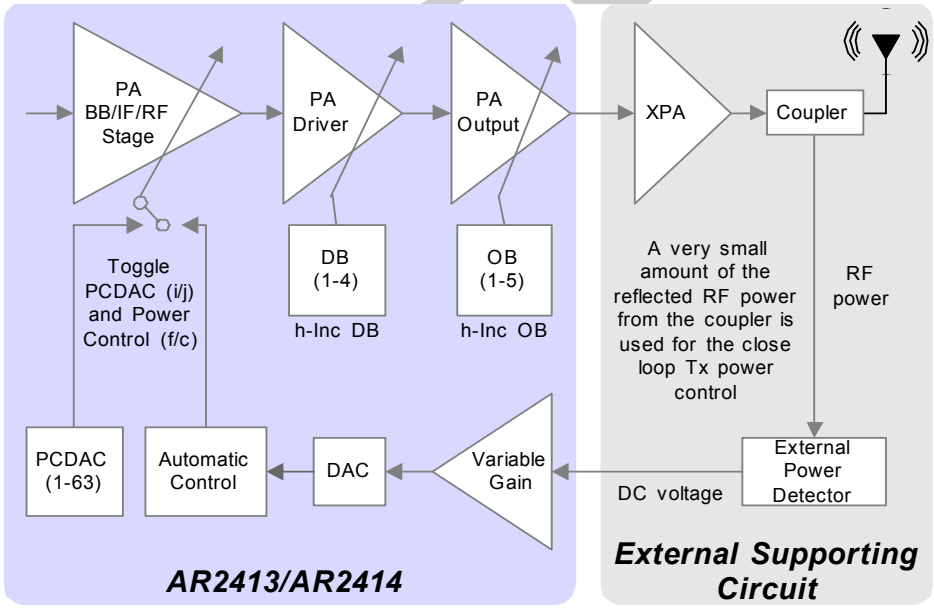

Figure 2-8. **AR2413/AR2414 and AR5413/AR5414 Tx Power Control Diagram**

Dynamic Optimization

For optimal performance at all rates, accurate control and target power maintenance for various rates is absolutely necessary. Some variable gain is at the disposal of the transmit power control (TPC) state machine in Atheros chipsets. It is used to control the power on a per-packet basis. (The parameter GainF reflects the variable gain used for the last packet transmitted). Be sure to have sufficient headroom on the higher and lower ends of the variable gain available to the TPC state machine to ensure attainability of the range of target powers for all rates. Some factors might diminish this headroom, including temperature and the quality of matching between various rf stages.

As the temperature changes, the actual gain provided in various stages varies; it decreases with increasing temperature, and increases with decreasing temperature. The variable gain must compensate for this difference. Similarly, additional gain must compensate for poor matching. Both effects occur on a longer time scale than per-packet, thus the software can periodically probe whether GainF is running out of headroom (at the higher or lower ends) and appropriately add or remove some fixed gain in the rf chain. Dynamic optimization in ART performs using nine sets of available fixed gains referred to as FG0...FG8, which provide from –6dB to +6dB of fixed gain. Dynamic optimization periodically probes the GainF and selects an appropriate fixed gain (FG0...FG8) to keep the GainF within a target range of 20–35 (the total range for GainF being 0–50), ensuring headroom in the variable gain.

This procedure is also mimicked in the driver, which probes GainF once every 60 seconds. Performing this optimization dynamically for each card on every channel guarantees the best achievable performance for each card and maximizes the supported temperature range.

Continuous RF Receive Options (r)

Continuous RF receive options set the radio in receive mode to allow for radio measurements and evaluation. The antenna, channel, and receive gain can be changed. Press ESC to return to the main Test Options menu when done.

NOTE: This is not a data receive mode. Receive information is not reflected on screen. It is intended for instrumentation measurement only.

```
=================================================================
| Continous RF Receive Options                                  |
|   p - Increase Center Frequency by 10 MHz (P inc by 100 MHz)  |
|   l - Decrease Center Frequency by 10 MHz (L dec by 100 MHz)  |
|   i - Increase rx Gain (I inc by 10)                          |
|   j - Decrease rx Gain (J dec by 10)                          |
|   a - Toggle antenna                                          |
| ESC - exit                                                    |
=================================================================|
```

Link Test (l)

The link test requires that two stations running **art.exe**. One station transmits 100 packets for all eight data rates (6 Mbps to 54 Mbps), and the other station receives and displays statistics including packet error rate (PER) and received signal strength indication (RSSI). Packets can either be interleaved, with loop sending one packet at each rate (the default setting), or send all 100 at one rate before switching to the next rate. The antenna, center frequency, and various radio characteristics can be selected prior to or during the test. Press ESC to return to the main Test Options menu when finished.

ART has the ability to toggle dynamic optimization. With dynamic optimization enabled, ART constantly makes chipset adjustments to provide optimum transmit performance.

```
================================================================
| Link Test Mode                                               |
|    t - Tx                                                    |
|    r - Rx                                                    |
|    p - Increase Center Frequency by 10 MHz (P inc by 100 MHz)|
|    l - Decrease Center Frequency by 10 MHz (L inc by 100 MHz)|
|    i - Increase pcdac (I inc by 10)                          |
|    j - Decrease pcdac (J dec by 10)                          |
|    f - Increase power output by 0.5dBm (F inc by 5dBm)       |
|    c - Decrease power output by 0.5dBm (C dec by 5dBm)       |
|    u - Increase ob by 1 (w - increase b-ob)                  |
|    h - Increase db by 1 (q - increase b-db)                  |
|    z - Toggle packet interleave                              |
|    v - Toggle power override (ovr)                           |
|    x - Toggle external power                                 |
|    y - Increase gainI by 1 (Y inc by 10)                     |
|    g - decrease gainI by 1 (G dec by 10)                     |
|    m - Increase rf Gain Boost                                |
|    b - Toggle turbo mode                                     |
|    a - Toggle antenna                                        |
|    d - Toggle Data Pattern                                   |
|    9 - Toggle dynamic optimization                           |
|    4 - Increment Fixed gain                                  |
| ESC - exit                                                   |
================================================================
```

Menu items in red are not always available and depend on the power override state. If power override is off, the ability to toggle external power is available, but not the ability to adjust gainI. If power override is enabled, the ability to change gainI is available, but not external power control. The ability to increment fixed gain is only available with dynamic optimization inactive.

NOTE: Not all the menu items are available for the AR2413/2414 and AR5413/5414 based adapters. For example, dynamic optimization, power override and external power toggling are not available or needed for these chipsets which implement a different power scheme than previous chipsets.

Throughput Menu (T)

The throughput menu requires two stations running ART. One station acts as a transmitter, the other as a receiver. Throughput is calculated on the transmit side and, when unicast packets are used, is based on the number of packets completed with the successful reception of an 802.11 ACK packet. The receive station sits in a passive receive state and only sends ACK packets back to the transmitting station. No information about the packets it receives is shown on the receive station. If the transmit station sends broadcast packets, no receive station is required. The type of packet, number of packets, packet size, and number of retries should be attempted are configured on the transmit side. Like the other ART menus, the frequency, data rate antenna and other radio characteristics can be configured on either the transmit or receive side.

ART has the ability to toggle dynamic optimization. When dynamic optimization is enabled, ART constantly looks to make chipset adjustments to provide optimum transmit performance.

```
================================================================
| Throughput Test Mode                                         |
|   t - Tx                                                     |
|   r - Rx                                                     |
|   p - Increase Center Frequency by 10 MHz (P inc by 100 MHz) |
|   l - Decrease Center Frequency by 10 MHz (L dec by 100 MHz) |
|   o - Increase Data Rate                                     |
|   k - Decrease Data Rate                                     |
|   s - Toggle packet size (500 | 1000 | 1500 | 2000)         |
|   e - Increase HW retries                                    |
|   d - Decrease HW retries                                    |
|   z - Toggle number of packets (5000 | 10000)               |
|   i - Increase pcdac (I inc by 10)                           |
|   j - Decrease pcdac (J dec by 10)                           |
|   f - Increase power output by 0.5dBm (F inc by 5dBm)        |
|   c - Decrease power output by 0.5dBm (C dec by 5dBm)        |
|   u - Increase ob by 1 (w - increase b-ob)                   |
|   h - Increase db by 1 (q - increase b-db)                   |
|   v - Toggle power override (ovr)                            |
|   x - Toggle external power                                  |
|   y - Increase gainI by 1 (Y inc by 10)                      |
|   g - decrease gainI by 1 (G dec by 10)                      |
|   m - Increase rf Gain Boost                                 |
|   n - Step xpd gain by 6dB                                   |
|   b - Toggle turbo mode                                      |
|   a - Toggle antenna                                         |
|   1 - Toggle unicast/broadcast packets                       |
|   9 - Toggle dynamic optimization                            |
|   4 - Increment Fixed gain                                   |
| ESC - exit                                                   |
================================================================
```

Menu items in red are not always available. If power override is off, the ability to toggle external power is available, but not the ability to adjust gainI. If power override is on, the ability to change gainI is available, but no external power control. The ability to increment the fixed gain is only available when dynamic optimization is inactive

NOTE: For the slower rates it is recommended to set the number of packets to 5000 for the test to complete in a reasonable amount of time.

NOTE: Not all the menu items are available for the AR2413/2414 and AR5413/5414 based adapters. For example, dynamic optimization, power override and external power toggling are not available or needed for these chipsets which implement a different power scheme than previous chipsets.

EEPROM Function (p)

This option can back up to file, read from a file, erase, or display EEPROM contents as either a byte stream or formatted information. It can also load an EAR file into EEPROM, or read and display an existing EAR file. Press ESC to return to the main Test Options menu when finished.

ART versions 4.4+ support EEPROM version 4.4. Older versions of the EEPROM display this menu of ART:

```
=======================================================
| EEPROM                                              |
|   P -  Blank EEPROM (P)rogramming mode              |
|   B - (B)ack up EEPROM content to file              |
|   R - (R)estore EEPROM content from file            |
|   E - (E)rase EEPROM content                        |
|   S - Re-calculate check(S)um for calibration date  |
|   C - Display (C)alibration data                    |
|   D - (D)isplay EEPROM content on the screen        |
|   W - (W)rite single EEPROM location                |
|   G - (G)et (read) single EEPROM location           |
|   L - (L)oad EAR into EEPROM                        |
|   A - Display E(A)R contents in EEPROM              |
| ESC - exit                                          |
=======================================================
```

NOTE: The Blank EEPROM programming mode (P) programs EEPROM locations 0 through 0xBE using the values in the file **atheros-eep.txt** and the subsystem ID specified in the file **artsetup.txt**. The same functionality occurs when using the \prog ART command line option.

NOTE: To load an EAR file into EEPROM, the adapter must be calibrated to set up the EEPROM location that specifies the start of the EAR.

Switch Test Card (s)

This option allows a card to be removed and a new one inserted. On reinsertion, ART searches for the new card and program it with the last set of register values held for the removed card.

Manufacturing Test & Calibration (m)

The manufacturing and calibration tests provide options for performing card calibration and demonstrate a sample manufacturing and test process.

NOTE: It is strongly recommended that the contents of EEPROM be backed up before any execution of the test program. For the test program to produce accurate results, the entire test setup (instruments and cable) must be calibrated and the appropriate loss figures entered.

The test consists of using a golden, known good, system as a reference (the golden system test should be started first), against the device to be tested. The tests that run between the DUT and golden system are configurable, and an option is provided to view which configurations are enabled. Press ESC to return to the main menu when finished.

```
=========================================
| Manufacturing Test & Calibration Options: |
|   d - (D)evice Under Test Begin          |
|   g - (G)olden Unit Test Begin           |
|   q - (Q)uit                             |
=========================================
```

Note that ART supports reading older versions of EEPROM, however calibration of cards to specific EEPROM versions is supported only by specific versions of ART as shown in Table 1-1.

For a full description of the testing performed, refer to the *AR5004 Sample Manufacturing Test Flow.*

Enable Logging (g)

Enable logging causes all information printed on screen, with the exception of the menus, to be logged to a file. If the file **artsetup.txt** does not specify a log file with the LOG_FILE setting, the system prompts for a logging filename. If the file already exists, it appends new information at the end of the existing file. This is a toggle menu. If logging is already enabled, then selecting 'g' from the menu disables it. Logging is enabled default if the flag LOGGING is set in **artsetup.txt**.

Utility Menu (u)

This menu provides some miscellaneous utilities, including the ability to read and write single registers, to write register fields, to tune to a new channel (useful when a large channel jump is required), to display a noise-floor histogram of channel noise, and to put the adapter into sleep mode.

```
==================================================================
| Utility Menu                                                   |
|   r - Read a register offset                                   |
|   w - Write to a register offset                               |
|   p - (P)ut/write a field                                      |
|   c = (C)hange current channel value                           |
|   n = (N)oise floor histogram                                  |
|   s = (S)leep mode toggle                                      |
| ESC - exit                                                     |
==================================================================
```

Noise Immunity Menu (u)

This menu provides the ability to experiment with noise immunity parameters.

```
==================================================================
| Noise Immunity Menu                                            |
|   e - (E)nable noise Immunity Level                            |
|   n - (N)oise Immunity Level                                   |
|   b - (B)arker Immunity Level                                  |
|   s - (S)pur Immunity Level                                    |
|   a - (A)utomatic Noise Immunity [Not available yet]           |
| ESC - exit                                                     |
==================================================================
```

3

Atheros Radio Test Reference Guide for AR5005-Based USB Devices

The Atheros Radio Test (ART) utility provides tests that can evaluate the performance and functionality of Atheros chipsets. The ART serves as both an evaluation tool and a manufacturing test tool. This chapter describes how to install and run ART for AR5005-based USB devices.

Installation

NOTE: The AR5523 is a USB 2.0 device. For best performance, plug the device into an USB 2.0 host controller.

To install ART:

1. Copy files from the **art\bin** release directory, to a directory on the system that contains the Atheros adapter. It is best to install ART before installing the adapter.

2. Copy the driver/inf using the batch files in the directory **art_driver\bin\USB**:

   – **inst_usb_drv_win2k.bat** (Windows 2000)

   – **inst_usb_drv_xp.bat** (Windows XP)

These batch files:

- Copy the files **athusb.sys, athfmwdl.sys and ar5523.bin** to the directory **C:\Winnt\System32\Drivers** (Windows 2000), or **C:\Windows\System32\Drivers** (Windows XP).
- Copy the files **athusb.inf and athfmwdl.inf** to the directory **C:\Winnt\inf**.

NOTE: The batch file assumes that Windows 2000 is installed in **C:\Winnt** and that Windows XP is installed in **C:\Windows**. If the OS is installed in a different directory, change the batch file to copy to the corresponding **%SystemRoot%** directories.

3. Plug the USB device into an USB port. The device appears as a Booloader device.
   a. When the system prompts for a driver, point to the **%SystemRoot%\inf** directory.
   b. When prompted to copy the sys file, point to the **%SystemRoot%\System32\Drivers** directory.
   c. Once the driver is installed, the target downloads and executes the ART client image (**%SystemRoot%/Drivers/ar5523.bin**).
4. This ART client image announces as a new USB device, with a new product ID.
   a. When the system prompts for a driver, point to the **%SystemRoot%\inf** directory.
   b. When prompted to copy the sys file, point to the **%SystemRoot%\system32\drivers** directory.

c. Once the device is installed and ready for use, use the device manager to find the string “Atheros AR5523 USB Board” under the USB controllers section, as shown in Figure 3-1

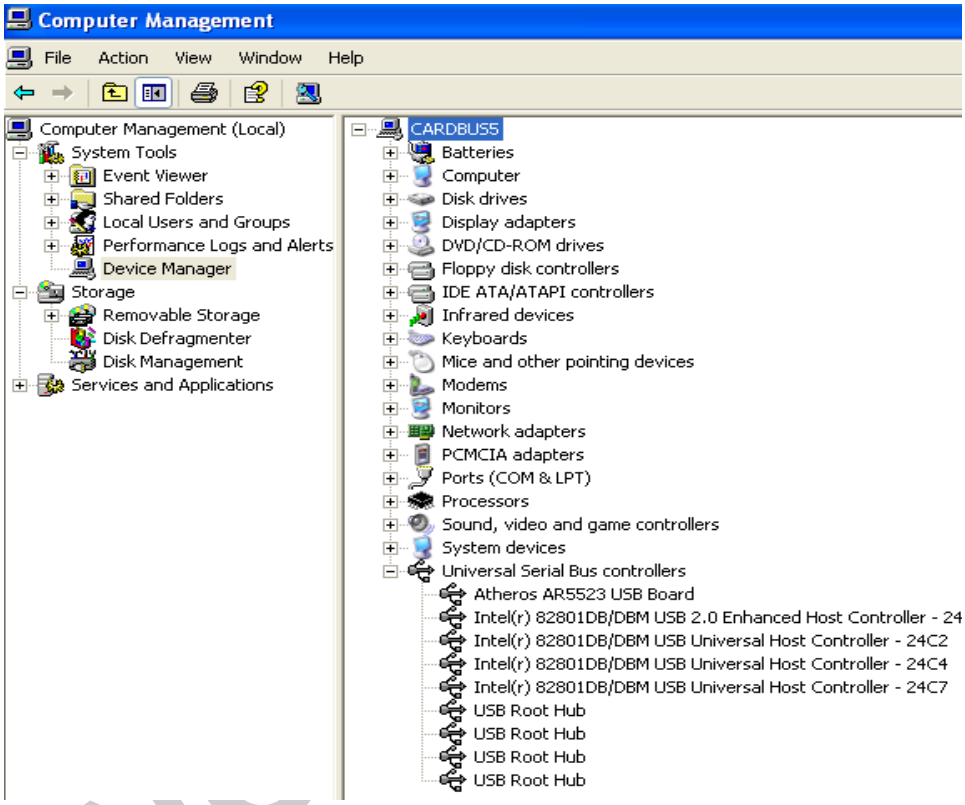

Figure 3-1. **Successful Installation of AR5523 USB device in Device Manager**

Using ART with AR5005-Based USB Devices

ART for AR5005-based USB devices has a similar architecture to ART architecture for AP platforms in that a client executes the commands issued by a master (host). However, the transport layer is USB, so the commands and responses are exchanged over USB.

Only limited (256 K) memory is available for code and data in AR5523 devices, so only minimal commands can be interpreted by the AR5523 or sent by the master (host). The software present in the AR5523 is thus called a ThinClient due to its minimal functionality.

ART Remote Command Line Option

After the device is plugged in, use the remote command line option to set up the host PC ART to send the commands to the ART client running on the remote USB device. It is always necessary to use this command line option for an AR5005-based USB device.

To start the ART utility, type this command at the DOS command prompt:

```
C:\> art \remote=usb
```

Updating the ART Client Executable Image

For a pre-built ART client executable image, update the **%SystemRoot%\system32\drivers\ar5523.bin** with the new image, then unplug and re-plug in the device. Check that the devices in installed as shown in Figure 3-1.

Calibration File for AR5005-Based USB Devices

A USB device starts with an enumeration that contains device-specific information including the product ID, the product string, the device ID, the device version, the device description string, and so on. This information is stored in the EEPROM or Flash that the USB device firmware image reads and uses during enumeration.

This information is stored in a text file called **atheros-usb-eep.txt**. This file is parsed and written along with the calibrated power information into the EEPROM or Flash during calibration. The calibration data is written at different offsets for:

- EEPROM device at absolute location 0xf000
- Flash device at absolute location 0x10000

The enumeration information starts at offset location 0x40 in the calibration data.

Version Information Display

The client and bootrom versions are displayed during ART startup. Figure 3-2 displays the window output containing the version information. The client version is aligned with ART/DEVLIB version.

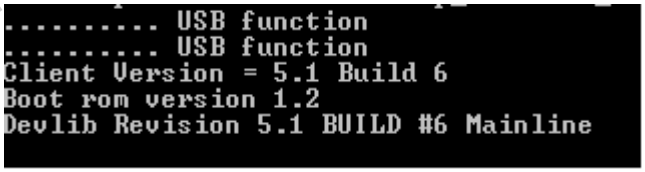

Figure 3-2. **Version Information Display.**

4

Atheros Radio Test Reference Guide for AR5513-Based MIMO Devices

The Atheros Radio Test (ART) utility provides tests that can evaluate the performance and functionality of Atheros chipsets. ART serves as both an evaluation tool and a manufacturing test tool. This chapter describes the differences relevant to multiple-input-multiple-output (MIMO) operation for AR5513-based adapters.

ART Operation

ART for AR5513-based adapters runs similarly to other chipsets.Launch ART by typing the command **`art \id=3031`** at the command prompt.

Selecting Transmit/Receive Chain

For MIMO operation, the AR5513 supports two chains for transmit and two for receive. Choosing Main Menu > Utility Menu selects which chain to test. The utility menu provides miscellaneous utilities, including the ability to read and write single registers, to write register fields, to tune to a new channel (useful for a large channel jump), to display a channel noise noise-floor histogram, and to put the adapter into sleep mode. For AR5513-based adapters, this menu also allows chain selection toggle, antenna fast diversity toggle, and changing phase delta.

```
=================================================================
| Utility Menu                                                  |
|   r - Read a register offset                                  |
|   w - Write to a register offset                              |
|   p - (P)ut/write a field                                     |
|   c = (C)hange current channel value                          |
|   n = (N)oise floor histogram                                 |
|   s = (S)leep mode toggle                                     |
|   h = c(H)ain selection toggle : 0                            |
|   f = antenna (F)ast diversity toggle : 0                     |
|   i = Increase phase delta by 5 deg (I inc by 50) : 65        |
|   j = Decrease phase delta by 5 deg (J dec by 50) : 65        |
=================================================================
```

Chain Selection Toggle

By pressing '**h**', the chain selection cycles through 0, 1, and 2, and the current value is displayed in the menu. This selection remains even after the user exits the utility menu. So if the user switches to the contMenu, linkMenu, or thoughputMenu, and the chain selection the user made remains. A chain selection of 2 enables the dual chain mode of operation, beamforming on transmit, and the MRC recombination on receive. Note that beamforming only occurs after the transmitter receives a valid packet or an ACK from the other node. Until that point, even though the chain selection is 2, the transmitter only uses a single chain to transmit. This caveat is necessary because the transmitter uses the received packet to compute channel information and beamforming weights. The contMenu can not transmit on both chains, because no packet is ever received from the other node.

Antenna Fast Diversity Toggle

Usually the ART antenna selection is static and measurements are cabled. However, for the AR5513, it is possible to enable the antenna fast diversity. With fast diversity, the chip looks at the signal strength at the two antennas in the beginning of each packet, and chooses the stronger antenna for each chain. This configuration is helpful in making over the air measurements.

This selection persists through other menus as well.

Changing Phase Delta

Each card is calibrated for relative phase delta between the two chains at various frequencies. ART computes the interpolated phase delta for the current channel, and that value is displayed in the utility menu. Although it is possible to force the phase delta to be a different value than the calibrated value, user is advised that the performance may be suboptimal with inaccurate phase delta.

This selection persists through other menus as well.

5

ART Extensions For Command Line Testing

This chapter describes the extensions added to enable running tests from the command line.

Additional Commands

ART versions 2.5+ include tests that can run from the command line, and therefore are incorporated into scripts for batch runs. The following additional command line options are supported:

```
C:\art> art \golden \txtest \rxtest \beacon=NN-NN-NN-NN-NN-NN
\tptestup \tptestdown \macaddr \ch=NNNNx,NNNNx \ant=a|b|m
\goldant=a|b|m \iterations=N \log
```

ART supports five test types: txtest, rxtest, tptest (up and down), macaddr, and beacon test. One, some, or all of these tests can be specified on the command line and run one after the other. The order of the tests is fixed. Changing the order of the tests on the command line does not change the order in which the tests run. Table 5-1 describes each command line option.

Table 5-1. **Additional Command Line Options**

Option	Description
\golden	Make this station the golden unit for the transmit and receive link tests. When in golden mode, other command line options are ignored and the golden unit sits in an infinite loop waiting for connection from a device under test (DUT).
\txtest	Perform a transmit link test, with this station (DUT) as the transmitter, and another running in golden mode as the receiver. The DUT displays test statistics accumulated by the golden receiver.
\rxtest	Perform a receive link test, with this station (DUT) as the receiver, and another running in golden mode as transmitter. The DUT displays test statistics of packets it receives.
\beacon= NN-NN-NN-NN-NN-NN	Receive the number of beacons specified in the setting NUM_PACKETS in the file **arttest.txt** for the specified BSSID. It collects beacons for the BSSID (MACID) NN-NN-NN-NN-NN-NN. This BSSID must be specified in the dash notation as shown. Only beacons from this BSSID are counted.

Table 5-1. **Additional Command Line Options (continued)**

Option	Description
\tptestup	Perform an uplink throughput test with this station (DUT) as the transmitter, and another station running on golden mode as the receiver. Throughput is calculated on the transmit side by sending unicast packets and waiting for ACKs.
\tptestdown	Perform a downlink throughput test with the station running in golden mode as the transmitter and this station (DUT) as the receiver. Throughput is calculated on the transmit side, by sending unicast packets and waiting for ACKs.
\macaddr	Perform a simple test on this station's wireless MAC address. This test verifies that the MAC address lies within the range specified in the file **arttest.txt** by the MAC_ADDRESS_MIN and MAC_ADDRESS_MAX parameters.
\ch=NNNNx,NNNNx...	Specify a list of channels and modes to perform command line tests on. *NNNN* is channel value in MHz, and *x* is mode: a = 802.11a, b = 802.11b, g = 802.11g, o = ofdm@2.4 GHz, t = 802.11a turbo, u = 802.11g turbo Specify any number of channels (including modes). Each test on the command line performs on every channel in the list.
\ant=a|b|m	Specify which DUT antenna to perform the tests at. Valid selections are antenna A (*a*), B (*b*), or both A and B (*m*). For *m*, each test performs on each antenna on every channel listed.
\goldant=a|b|m	Specify which golden station antenna to perform the test at. Valid selections are antenna A (*a*), B (*b*), or both A and B (*m*).
\log=logfilename	Enable logging of screen display to file. *Logfilename* is the name of the file to log to.
\iterations=N	Override the NUM_ITERATIONS specified in the file **arttest.txt**. This number specifies how many times to perform each test. *N* is the number of iterations.

Examples

The command line:

```
C:\art> art \txtest \rxtest \ch=5300a,2412b \ant=m \iterations=10
```

performs the transmit and receive test at channel 5300 in 802.11a mode, and at 2412 in 802.11b mode. Each test and each channel runs first on antenna A, then on antenna B. Each transmit test and receive test runs for ten iterations.

The command:

```
C:\art> art \golden
```

causes this station to enter golden station mode, where it waits on a DUT to initiate a transmit (Tx) or receive (Rx) test. It is not necessary to list any channels for the golden station, because at the start of each test the DUT sends the channel and test information to the golden unit.

The command:

```
C:\art> art \beacon=00-12-23-ab-cd-ef \ch=5280a
```

causes the station to listen on channel 5280 in mode 802.11a for beacons with the BSSID of 00-12-34-ab-cd-ef.

The command:

```
c:\art> art \tptestup \tptestdown \ch=5360a,2412g \ant=m \goldant=m
```

performs the throughput uplink and downlink at channel 5360 in 802.11a and at channel 2412 in 802.11g. Each test and each channel performs on each of the DUT and golden antenna combinations.

Test Configurations

The "Additional Commands" tests are configured through parameters specified in the file **arttest.txt**, which controls parameters for how tests run and for the criteria for the tests to pass. Table 5-2 describes these parameters.

Table 5-2. **ARTTEST.TXT Parameter Descriptions**

Parameter	Description
NUM_ITERATIONS	Specifies how many iterations of the test to run
NUM_PACKETS	For the beacon test, specifies how many beacons to receive; for transmit and link tests, specifies how many packets per rate to transmit (valid values 1–100).
PACKET_SIZE	Specifies the size of each packet transmitted in the link tests (ignored in beacon test)
TP_PACKET_SIZE	Specifies the size of packet to use for the throughput test
TP_RATE_MASK	Specifies which rates to perform the throughput test for. The rate mask uses the format specified in RATE_MASK in the file **artsetup.txt**.
BEACON_TIMEOUT	Time (in ms) that the beacon test should wait to receive the expected number of beacons
TP_NUM_PACKETS	Sets how many packets to send in the throughput test
TP_CCK_NUM_PACKETS	Specifies the number of CCK packets to send during the throughput menu. For speed reasons, it is sometimes a good idea to make this less than TP_NUM_PACKETS
5G_SIDE_CHANNEL	Specifies which frequency (in MHz) to use for the DUT to golden test synchronization packets for 802.11a tests
2G_SIDE_CHANNEL	Specifies which frequency (in MHz) to use for the DUT to golden test synchronization packets for 802.11b tests.
MAC_ADDRESS_MIN	Minimum MAC address in the range used by the MAC address test, specified as NN-NN-NN-NN-NN-NN.
MAC_ADDRESS_MAX	Maximum MAC address in the range used by the MAC address test, specified as NN-NN-NN-NN-NN-NN.
PER_THRESHOLD	Sets how many good packets per rate to receive in link tests for the test to pass. Ignored for the beacon test
TP_THRESHOLD_11A	Specifies how many good OFDM packets per rate to receive in the throughput tests for the test to pass
TP_THRESHOLD_11B	Sets how many good CCK packets per rate to receive in the throughput tests for the test to pass
PPM_MIN	Minimum acceptable PPM value per iteration for the test to pass (used only in link tests, ignored in beacon test)
PPM_MAX	Maximum acceptable PPM value per iteration for the test to pass (used only in link tests, ignored in beacon test)
RSSI_THRESHOLD_11a_antA	Minimum allowable RSSI value for 802.11a on antenna A
RSSI_THRESHOLD_11b_antA	Minimum allowable RSSI value for 802.11b on antenna A
RSSI_THRESHOLD_11g_antA	Minimum allowable RSSI value for 802.11g on antenna A
RSSI_THRESHOLD_11a_antB	Minimum allowable RSSI value for 802.11a on antenna B
RSSI_THRESHOLD_11b_antB	Minimum allowable RSSI value for 802.11b on antenna B
RSSI_THRESHOLD_11g_antB	Minimum allowable RSSI value for 802.11g on antenna B
CRC_THRESHOLD	Sets the maximum number of packets with CRC errors per iteration to receive for the test to pass (used only in link tests, ignored in beacon test).
BEACON_TIMEOUT	Specifies how long (in ms) the beacon test waits to receive the required number of beacons before timing out in error. Calculate a reasonable timeout value based on the number of beacons expected and the BSS beacon interval (used only in link tests, ignored in beacon test).

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