Theory of Operations

The NETGEAR's HA311 is a IEEE802.11a wireless PCI adapter which is designed to operate in the 5.15-5.25GHz and 5.25-5.35GHz UNII/LELAN bands and to be installed into a desktop PC to enables users to network various PC's together without physically laying any wire and delivers high-speed wireless performance – up to 54 Mbps, 72 Mbps in turbo mode. It provides small business networks with reliable, standards-based 802.11a LAN connectivity that is protected with industry-standard security against unauthorized access. NETGEAR's 802.11a solution is interference-free and coexists with 802.11b and Bluetooth™ devices. It works with Windows® 98, Me, NT 4.0, 2000, and XP operating systems.

There are two modes of configuring your wireless PCI adapter: ad-hoc mode or infrastructure mode. In an ad-hoc wireless network, there is no access point. Each node communicates with any other node directly. (A node is a network connection point. For example, a PC in a LAN is a node.)

In the infrastructure mode, the wireless access point bridges between the wired LAN and wireless network. Connecting multiple access points via a wired Ethernet backbone can further extend the wireless network coverage. As a mobile computing device moves out of the range of one access point, it moves into the range of another. As a result, wireless clients can freely roam from one Access Point domain to another and still maintain a seamless network connection.

Special FCC 15.407 Requirements

Frequency Stability (15.407 (g))

FCC 15.407(g) states: "Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual."

The DWL-A520 device uses 8 channels between 5.18GHz and 5.32GHz. The carrier is 20MHz wide centered at these frequencies. IE: Channel 6 (5.18GHz) would have the fc centered at 5.18GHz with a band width of 20Mhz or 5.17 to 5.19 GHz. This provides a guard band of 20 MHz (5.17 GHz - 5.15 GHz).

The DWL-A520 device also requires a +/- 20 ppm XTAL over temperature and with aging. This is required per the 802.11a specification. Based on the tolerance of the XTAL and the 20 MHz guard band between 5.15GHz and 5.35 GHz the device will maintain emissions within the UNII 1 and 2 bands under normal operating conditions specified in the user manual.

Insuring Indoor Use in 5.15-5.25 GHz Band (15.407 (e))

FCC 15.407(e) states: "Within the 5.15-5.25 GHz band, U-NII devices will be restricted to indoor operations to reduce any potential for harmful interference to co-channel MSS operations."

The DWL-A520 user manual includes the following statement:

"Radio Frequency interference requirements: The device is restricted to indoor use only. FCC requires this product to be used indoors due to its operation in the frequency range 5.15 to 5.25 GHz. "

Discontinue Transmitting with absence of Data or operational failure (15.407 (c))

FCC 15.407(e) states: "The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signalling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization a description of how this requirement is met."

Data transmission is always initiated by software, which is then passed down through the MAC, through the digital and analog baseband, and finally to the RF chip. Several special packets (ACKs, CTS, PSPoll, etc...) are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which it then turns off at the end of the packet. Therefore, the transmitter will be on only while one of the aforementioned packets is being transmitted.

Theory of Operation

1 Architecture

The DWL-A520 is mainly composed of Atheros's chipset. The Athros AR5110 Radio-on-a-Chip(RoC) is part of the two-chip AR5000 solution for IEEE802.11a 5GHz Wireless Local Area Networks(WLANs). The chipset consists of the following:

AR5210: An IEEE802.11a MAC, Baseband Processor, and CardBus/PCI BUS interface.

AR5110: An all-CMOS single-chip radio that includes the power amplifier and integrated dual conversion filters to convert the signal from 5GHz to the 20 to 40MHz rage used by the AR5210.The AR5110 offers the first fully integrated transmitter, receiver, and frequency synthesizer functions, eliminating the need for external Voltage Control Oscillators (VCOs), Surface Acoustic Wave(SAW) filters, and Power Amplifier(PA). When combined with AR5210, which performs MAC and Baseband Processing functions.

2.1 MAC/Baseband Processor (AR5210)

The AR5210 chipset is an IEEE802.11a-compliant, highly integrated ASIC containing a CardBUS/PCI interface, DMA engine, Protocol Control Unit (PCU, a.k.a, the Media Access Controller[MAC]), and a Baseband Processor(PLCP/PHY). The AR5210 runs on a 2.5V(digital and analog) core and 3.3V I/O. The AR5210 is packaged in a 15x15x1.5mm 196 Plastic Ball Grid Array (PBGA).

2.1.1 DMA Engine (AR5210)

The DMA engine is 32 bits wide and feeds data from the PCU to the CardBus/PCI BUS. The DMA engine coordinates transfers between it and the host through DMA descriptors. These linked descriptors point to data segments being sent or received. They communicate control information from the host to the DMA engine, as well as status information form DMA engine to the host. The host drivers is responsible for building these linked descriptor lists.

2.1.2 Protocol Control Unit (PCU - AR5210)

The PCU, or MAC, buffers transmit and receive frames for the DMA engine in independent 4KB FIFOs. The PCU also contains the state machine logic for implementing Wire Equivalent Privacy(WEP) and CRC capabilities. The AR5210 internal registers are used to configure the PCU.

2.1.3 Baseband Processor (PHY - AR5210)

The Baseband Processor transfers TX data from the PCU and builds the frame that the RF Subsystem(AR5110) will transmit or, conversely, receives the RX frames coming from the RF Subsystem and decodes the frame for transmission to the PCU. The frame format is constructed with short and long training symbols, intermixed with the data and rate/length information.

The Baseband Controller is responsible for the following function on the frame:

- Scramble

- Encode
- Puncture
- PAD
- Interleave
- Map to Constellations
- Scale

The processor runs an IFFT on groups of 48 subcarriers and 4 pilots. Next, the Baseband Processor sends the resulting time-domain waveform – including the guard interval – through the digital filter, up-sampler, and DAC. The AR5210 supports the following constellations:

- BPSK
- QPSK
- 16QAM
- 64QAM

The Baseband Processor will self-calibrate each time it is powered on. Registers can also be programmed by the device driver to force calibration. The interface between the AR5110 and AR5210 is the DAC for the transmit path and an ADC for the receive path.

2.1.4 Phase Locked Loop (PLL - AR5210)

The PLL takes the base 32MHz clock frequency from AR5110 and derives one of the following core frequencies.

- 40MHz
- 80MHz
- 160MHz

The Baseband Processor and the ADC/DAC use these clocks.

2.1.5 ADC (AR5210)

The ADC provides 9 bits of resolution and runs at 80 mega samples per second. It takes the analog received signal on the I and Q channels from the AR5110, through the Anti Aliasing filter, and converts it to digital data for processing by the baseband and subsequent blocks within the AR5210.

2.1.6 DAC (AR5210)

The DAC is 9 bit and runs at 160 mega samples per second. It takes the digital data coming from the baseband and converts it to analog signal that goes to the AR5110 through the external reconstruction filter.

2.2 ADC Filter (F)

External anti-aliasing filters are used between the AR5110 receive I/Q outputs and the ADC inputs of the AR5210. The ADC 20MHz anti-aliasing filter prevents aliasing by attenuating differential RX In-phase and Quadrature-phase signals above the Nyquist frequency. The filters are differential for both the Quadrature-phase and In-Phase components. The second-order elliptical filter operates in Current Mode and band-limits the input signals with a 3dB corner frequency of 35MHz. The filter attenuates out-ofband spectral components and wideband noise.