Basic Operation Principle of 802CA WLAN Cards

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This description is based upon the "Block Diagram of 802CA WLAN Cards".

Actiontec 802CA is an IEEE 802.11a 5GHz Wireless Local Area Networking (WLAN) card, which consists of AR5210, AR5110 chipset of Atheros Communications.

AR5210 --- MAC/Baseband Processor

AR5210 integrates the media access control (MAC), baseband processing functions, CardBus interface, and A/D, D/A converters. It also contains a PLL (phase lock loop), which provides different core operating frequencies when running on 802.11a normal mode or turbo mode (40MHz for normal mode, 80MHz for turbo mode). MAC functionality is partitioned between the host and the baseband processor (PHY). MAC data service is provided by protocol control unit (PCU, part of MAC), while the host software, with the aid of DMA engine (also part of MAC), controls transmit and receive queue processing, and antenna selection protocol. The digital physical layer is a half duplex, OFDM baseband processor compliant with IEEE 802.11a. All data rates defined by the 802.11a standard are supported including modulation schemes BPSK for 6, 9Mb/s, QPSK for 12, 18Mb/s, 16-QAM for 24, 36Mb/s and 64-QAM for 48, 54Mb/s. In addition, enhanced turbo mode provides data rate up to 72Mb/s, which is even higher than the rates specified by IEEE 802.11a. The I/Q signals on TX side will output through DAC, and the I/Q signals on RX side will input to ADC.

EEPROM

This EEPROM is 256x16 bits in size and is used for storing configuration information for the CardBus. The AR5210 provides a serial interface for accessing the external EEPROM.

F --- Anti aliasing filter

There are two sets of reconstruction filters, one for TX and another for RX, partitioned between AR5210 and AR5110, which have 20MHz band width. They are used for shaping the channel spectrum, removing spectral images and out of band noise.

AR5110 --- TX/RX with Modulation/Demodulation

The AR5110 is a fully integrated tranceiver with a built in preamplifier, synthesizer, mixers and modulation/demodulation functions. The transmitter combines baseband in-phase (I) and quadrature (Q) signals, up-converts them to the desired channels (5.15~5.35GHz), and drivers the RF signal off-chip through the integrated pre-amp. The receiver down converts the RF signal to IF (intermediate frequency), then through dual conversion IF mixer demodulates I and Q. The frequency synthesizer operates over the entire band with 10MHz steps to match the channel frequency defined by IEEE 802.11a, as well as supporting the turbo mode. The TX, RX and frequency synthesizer are controlled using AR5210 through a serial programming bus and on-chip control registers.

LPF --- Low pass filter

This is the loop filter of the on chip synthesizer. It's band width is 15KHz.

CH F --- Channel filters

The channel select filters are third order elliptical filters designed to pass 8MHz when running in 802.11a normal mode, or 16MHz for turbo mode. The band width control bit is set through the on-chip digital control logic. These filters are to attenuate the out of band interference signals. AR5110 will switch automatically to the correct filter based on the selected normal or turbo mode.

32MHz Crystal

The 32MHz crystal provides core clock for AR5110. It's attached to AR5110, which has an on-chip oscillator. The output of the oscillator connects to its internal frequency synthesizer, and also routs the output of the oscillator to an interface pin for use by AR5210. The absolute error of crystal frequency has to be held within ±20ppm across the operating temperature range. During the final tests, ATE (automatic test equipment) software is going to check the frequency error of channel carriers. If it's over ±20ppm, a "Fail" warning will show up on PC screen. The reason of doing this is that there is a 30MHz guard band between the band edges and the lowest channel frequency of 5.18GHz and the highest channel frequency of 5.32GHz. With ±20ppm tolerance, the max frequency deviation will be less than 110KHz, so that the emissions are going to be completely contained within UNII 1 and 2 bands under the normal operation specified by IEEE802.11a.

M/B --- Matching Baluns

There are two Balun transformers in the whole system, one for TX and another for RX. The TX Balun is used to convert a differential balanced signal into an unbalanced signal for transmission, and also provides matching between AR5110 and high pass filter. The RX Balun converts unbalanced signals from the antenna into differential balanced signals, and also provides matching between LNA and AR5110.

HPF --- High pass filter

Adding HPF between AR5110 and Booster is to reject the LO leakage.

LNA --- Low noise amplifier

The LNA provides an additional 12dB gain and reduces overall noise figure by approximately 5dB, so that the system receiving sensitivity can be guaranteed within 802.11a standard.

OPB --- Output Booster

OPB boosts the output power of AR5110 up to 18~20dBm. It's a single stage amplifier.

BPF --- Band pass filter

The BPF is designed to pass frequencies between 5.15 and 5.35 GHz and is used to protect the receiver from the unwanted frequencies.

TX/RX ANT Switch --- Transmitter, receiver antenna switch

This switch enables the connection of either the LNA or the PA to one of two diversity antennae.

LPF --- Low pass filters

Two LPFs are inserted between two antennae and TX/RX switch. They are designated for getting rid of any harmonics of channel frequencies.

Compliance with FCC requirement 15.407 (c): The TX path of the digital signal processor board will only output a baseband signal to the baseband board when DS3 data is present at it's input. The baseband board has a TX baseband detector circuit that sends a signal to the micro processor to indicate if a TX baseband signal is present. If a TX baseband signal is not present the micro processor sends a control signal to the RF board that turns off the transmitter circuitry.

RF Board Description

Synthesizer section: A VCO runs at one third of the RF transmit frequency (1.925 GHz for the 5.775 GHz transmit radio and 1.767 GHz for the 5.301 GHz transmit radio). The VCO is phase locked in a PLL to the 4 MHz reference oscillator that is input from the baseband board. The VCO design is optimized for significant energy at it's third harmonic. This third harmonic is selected by a bandpass filter and amplified to produce the RF local oscillator frequency. This signal is then routed to the transmit and receive mixers for full duplex operation.

TX section: The filtered and buffered baseband signal is applied to a mixer IF input. The RF local oscillator is applied to the mixer LO input. The output of the mixer is a direct up conversion modulated signal. This results in a phase and amplitude modulated RF carrier at 5.301 GHz for the CR45-A-53 radio model and 5.775 GHz for the CR45-A-58 radio model. The modulated RF signal is then amplified and output to the diplexer filter.

RX section: An incoming modulated RF signal is accepted from the diplexer filter. The RF signal is then amplified and applied to a mixer RF input. An RF local oscillator is applied to the LO input of the mixer and down converts the modulated RF signal to a 474 MHz IF frequency. The IF signal is then highpass filtered to reject any unwanted energy from the transmitter. The IF signal is then amplified and output to the baseband board.

Note: all of the filtering to prevent transmission of out of band emissions, and harmonics are accomplished in the diplex filter. The diplex filter is a dual combline bandpass filter that provides isolation from transmit to receive to make full duplex operation possible.