EMC TECHNOLOGIES REPORT NUMBER M030507_Certification_Ginger_CalWB

ANNEX 2: MINI-PCI WIRELESS LAN (CALEXICO) THEORY OF OPERATION

Calexico Single Band Card Theory of Operation

Overview

The Intel® PRO/Wireless LAN 2100 miniPCI adapter implements the 802.11b physical (RF) specification. It operates at 1, 2, 5.5, and 11 Mbps. The Mini PCI card uses a Complementary code keying (CCK) baseband and SA2400 IC for modulation, demodulation, spreading and despreading of the RF signal.

LAN 2100

The Intel® PRO/Wireless LAN 2100 miniPCI adapter implements the 82531ME, 802.11b CCK Baseband, and the Philips SA2400 radio ICs.

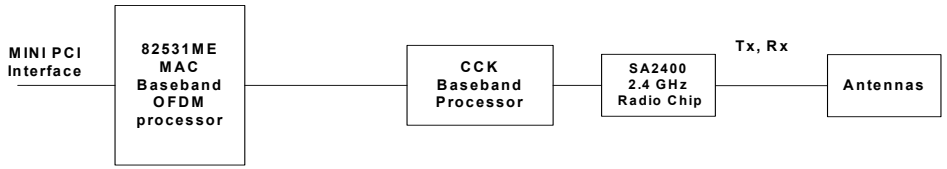

Figure 1: Simplified Block Diagram for the Intel® PRO/Wireless LAN 2100 miniPCI adapter

Transmit mode:

The “upper” Media Access Control (MAC) logic inside the 82531ME is used to send and receive packets and transfers data to/from the host computer via the miniPCI interface.

The 85231ME communicates with the CCK BBP IC through a special parallel interface called the Host Bus (H-BUS) interface. This interface uses registers with double-synchronizing flip-flops on all communication signals to prevent any timing-related problems between the two ICs.

The CCK BBP IC functions as a “lower” MAC for the 80211b standard. This IC is also used to generate differential, analog I/Q voltage levels. The transmit I/Q signals are generated by 10 bit DACs (while the receive I/Q signals are read by 8 bit ADCs). These voltage level signals are first converted to current levels by external resistors networks and then are up-converted inside the SA2400 to the desired transmitting frequency. An integrated 4^{th} order low-pass Butterworth 9.75MHz filter is used in the up-converter section for spectral shaping and reconstruction filtering.

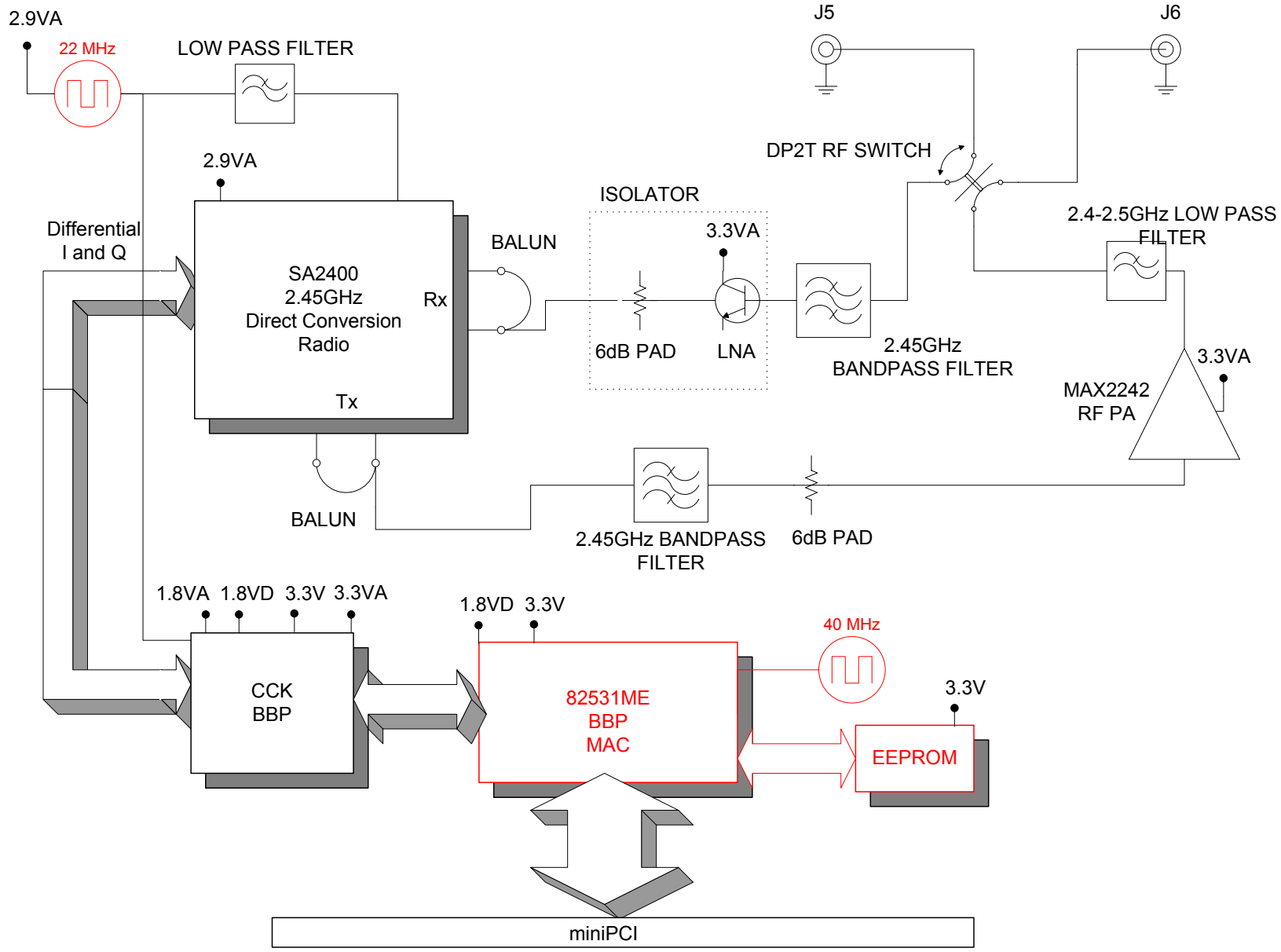

Figure 1: Detailed Block Diagram for the Intel® PRO/Wireless LAN 2100 miniPCI adapter (Red items are on back side of PCB)

Transmit mode (cont'd):

The SA2400 generates a differential RF signal at the desired operating frequency. Please note, that since this is a zero-IF type design, there are no Intermediate Frequency (IF) stages used. The SA2400 beats the IQ modulation directly up to the appropriate frequency of operation set by its built-in PLL. Upon exiting from the SA2400, this differential signal is transformed to single ended form using a discrete balun circuit. The balun is designed to convert 100ohm differential impedance to 50ohms single ended impedance while also supplying proper bias voltage to the output stage of the Philips IC. From the output of the balun, the signal is band pass filtered with a ceramic 2400 to 2500MHz Band Pass filter (BPF).

This filtered signal is then attenuated using a 6dB, 50ohm resistive pi-attenuator network. A MAXIM 2242 chip scale RF Power amplifier (PA) IC is used to amplify the low level filtered composite signal to approximately +20dBm levels.

At the output of the PA, a ceramic 2400 to 2500MHz Low Pass Filter (LPF) is used to reduce harmonic content in the amplified signal.

From this point the signal is routed through the single band antenna diversity switch to one of the two U.FL antennae connectors. A discrete logic IC (not shown in the diagram) is used to decode antennae switching information from the CCK BBP IC in order to correctly operate the antenna switch. This IC is a 74LVC08 IC on the back of the PCB.

An RF signal level of approx -5dBm at the output of the SA2400 IC can be expected to produce an amplified RF signal of approximately +16dBm at the antennae connectors.

Receive mode:

During receive; the signal is first routed through a ceramic 2400 to 2500MHz Band Pass filter (BPF) and through a single transistor, Low Noise Amplifier (LNA). The amplified and filtered signal is then attenuated via a 6dB, 50ohm resistive pi-attenuator network. A 50ohm to 100ohm integrated balun is then used to convert the single ended signal to a differential voltage which can be applied to the receive terminals on the SA2400 IC.

The LNA and attenuator form an isolation network which is required to isolate the low level Voltage Controlled Oscillator (VCO) frequency leakage from the antennae. An isolation network helps to reduce DC offsets that occur when switching antennae in diversity applications.

Inside the SA2400, the received signal is first amplified with an Automatic Gain Controlled (AGC) amplifier and then mixed down in frequency (from RF to DC) using a quadrature IQ up/down mixer. From here the downconverted signal is then low-pass filtered using Chebychev 5^{th} order active filters. A DC cancellation mechanism is able to reduce DC offsets by 70dB hence clipping of the baseband signals can be avoided.

The baseband IQ signals are transmitted differentially via current signal which are converted to voltage by the external resistor networks. These differential analog IQ voltage levels are read by the 6 bit ADCs inside of the CCK BBP IC.

The CCK BBP IC is used to demodulate the IQ signals to produce packets of data which is communicated to the 82531ME upper MAC and onwards to the host computer via the miniPCI bus.

SA2400 Radio

The SA2400 from Philips is a fully integrated single IC RF transceiver designed for 2.4 GHz wireless LAN applications. It is a direct conversion radio architecture device and combines a low-noise automatic gain control (AGC) amplifier, receive and transmit filters, and input/output buffers into a single IC.

82531ME MAC and Baseband

The 82531ME chip incorporates Media Access Control (MAC) logic, baseband processing functions, and a miniPCI interface, as well as Analog-to-Digital and Digital-to-Analog converters (ADC and DAC). This fully integrated digital processor eliminates the need for external RAM and flash memory.

The 82531ME also implements a half duplex OFDM baseband processor supporting IEEE 802.11a modulation which is not used in the single band card.

The 82531ME is compliant with 802.11b protocols. The upper level MAC controls the non-real time protocols such as roaming and scanning and buffering the transmit/receive (Tx, Rx) queues.

Operating in 802.11b mode, the 82531ME sees the CCK BBP IC as an I/O device.

802.11b CCK BBP IC

The external CCK Baseband Processor (BBP) IC was developed to incorporate the lower level MAC tasks for 802.11b communication. It contains integrated analog functions such as transmit I&Q DACs, receive I&Q ADCs, DACs for AGC and clock adjustments, ADC for Rx and Tx AGC, and on chip clock power down control circuitry. The DSP is designed to serve as the Physical Layer Entity for Complementary Code Keying (CCK).

PCI Configuration Space for Intel PRO/Wireless LAN 2100 Mini PCI Adapter

2100 Mini PCI Type3A:
Vendor id = 8086
Device id = 1043
Subsystem vendor id = 8086 (for Intel versions)
Subsystem id = 2523

2100 Mini PCI Type3B:
Vendor id = 8086
Device id = 1043
Subsystem vendor id = 8086 (for Intel versions)
Subsystem id = 2522