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Nanoradio WLAN Module, market, design challenges and performance

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Abstract:

This paper describes the market, design challenges and performance of a highly integrated WLAN System in Package (SiP). The WLAN SiP is designed to meet the challenges of providing WiFi capability to the smallest portable devices in which size, power consumption and cost are the key driving factors.

The paper outlines the key design challenges that have been met for each part of the complete system, including RF transceiver and power amplifier, base-band processor, firmware and protocol stack and overall SiP integration.

The paper reports the performance that has been achieved for the complete system.

Extended Abstract of the topic:

The functional specifications for the module are: extremely small size (8 x 8 x 1.4 mm), full compatibility with IEEE802.11b/g and very low power consumption (0.3mW in power save mode)

The initial feasibility study led to the choice of a solution based on a System in Package approach, allowing each portion of the system to use the most appropriate technology. Furthermore this study showed the need to use wafer scale flip chip technologies to meet the overall size constraints.

The main technologies used are SiGe for the RF transceiver and power amplifier, 0.13um CMOS for the base-band and LTCC for the passive integration, band filter, baluns and packaging.

The major PDA, Smart Phone and wireless headset players require extremely high performance WLAN nodes in order to produce next generation products incorporating as many as 7 different RF systems in an ever decreasing physical envelope.

The WLAN module described here clearly fits into this strategy.

The market for Fixed Mobile Convergence (FMC) phones (Cellular/WLAN) is poised for rapid growth. Potential customers are already excited about the prospect of being able to switch seamlessly between their chosen mobile network and their Wireless LAN. A FMC handset allows you to use one device in the street, office and your home and substantially reduce your phone bill.

The low-power WLAN SiP enables FMC handsets to use VoIP by extending the phone's standby time by a factor of 10. The module additionally enables fast internet connection with the lowest power consumption and best throughput for FMC phones.

The module is also designed to handle MP3 music and digital camera connectivity with built in support for audio and hi-fi. These features are achieved with significant improvements compared to Bluetooth, notably for audio (x6 to x10 less average power consumption) and for music download (x20 reduction in time).

The RFIC design has focussed on integrating the complete WLAN RF transceiver with power amplifier, VCO and PLL on a single die. The die includes an advanced power save mode, regulators for each part of the transceiver and the loop filter for the PLL. Some of the details of the design process will be presented in the full paper. The power amplifier has been optimised to give up to +18dBm output power to the antenna port.

The base-band processor/MAC is optimised for data, voice and hi-fi audio applications and supports all 802.11b/g data rates up to 54 Mbps.

The design process, including the use of a complete FPGA model of the base-band to facilitate first pass design success will be outlined.

The design is based on an ARM processor together with RAM and eliminates the need for external

Flash, EPROM and RAM in a host based application. The base-band also includes power save modes and a DC/DC converter to allow optimal use of the low digital supply voltage whilst operating from a single 3.3V supply. In addition the base-band includes specific features to facilitate coexistence with Bluetooth.

The WLAN SiP includes a complete software package that optimises the system performance. This includes several diagnostic tools and a software development kit for design of efficient embedded applications. Support is provided for Windows/CE, Linux and Symbian plus other proprietary OS. The SDIO driver has been optimised for maximum data rate.

Software features have also been carefully designed to control the overall power management.

A UDP/IP stack has been developed for embedded applications.

The overall WLAN SiP uses an LTCC substrate together with flip chip and surface mount assembly techniques to produce a single package solution. The choice of LTCC as opposed to a laminate based SiP was made during the feasibility phase, since it was shown to offer similar costs to the laminate based approach, whilst offering a 30% reduction in size.

The key design challenges that were addressed at the SiP level were the design of high performance RF functions and the high density interconnect between the RF and base-band die.

The design methodology uses a closed loop approach for the buried RF functions to avoid multiple prototype iterations (Insight SiP). A high performance channel filter and 2 balanced transformers are incorporated into the substrate.

The filter is designed to prevent noise from the WLAN system affecting the UMTS receiver in a co-located system and to reduce the effect of 2G and 3G signals on the WLAN receiver (smart phone or PDA with 3G connection).

The paper includes the performance achieved by the WLAN SiP and some detailed photographs showing the extremely high level of integration achieved.

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About the Authors

Pär Bergsten. Engineering graduate from Royal Institute of Technology, Stockholm, Sweden. MBA from Stockholm School of Economics. More than 20 years experience as an entrepreneur in the RF and telecom arena. He is the CEO and key founder of Nanoradio and previously has been involved in setting up and selling of start up companies in the wireless space. He also has a strong technical background in RF and was instrumental in implementing RFICs into Ericsson base-stations in the early 90s.

Chris Barratt. Engineering graduate from Cambridge and London Universities UK.
28 years experience in RF and Microwave design with specialization in filters and active circuits in thin film, thick film, laminate and LTCC. Prior to Insight SiP he was instrumental in setting up National Semiconductor's Design Centre in Sophia Antipolis and designing their Bluetooth SiP.