

Poster Abstract: The ScatterWeb MSB-430 Platform for Wireless Sensor Networks

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Abstract—Research in wireless sensor networks needs a robust hardware platform that allows access to hardware parameters to achieve optimum solutions. In this poster we present the new ScatterWeb MSB hardware platform which we believe soundly fits the needs of research and prototyping applications of the near future.

Index Terms—wireless sensor networks, embedded systems, hardware architecture, ScatterWeb platform

I. INTRODUCTION

RESEARCH in wireless sensor networks is currently focused on algorithms for data dissemination, self-configuration and energy management. For any real-world application, a robust hardware platform is required, that allows gearing into all important hardware parameters to achieve optimum results in software applications. For this reason we created the ScatterWeb hardware platform, called the “embedded sensor board” (ESB) in 2003. The success of the platform led to the spin-off of ScatterWeb GmbH in 2005. Based on the know-how and experiences gained, an industrial platform was designed and certified for radio spectrum and electromagnetic compatibility. Since demands are manifold and rapidly changing, a new research platform, the “modular sensor board” (MSB) has been created. While still based on an MSP430 series microcontroller, the layout and peripherals have been completely redesigned to better fit research needs of the near future. The new platform is available to the public since the beginning of 2007 through the ScatterWeb GmbH. In the following sections features and design aspects of the MSB platform will be presented.

II. MODULAR ARCHITECTURE

The ESB node included a number of common sensors and some actuators which were thought of being useful for teaching and research but made it quite heavy. In addition to that, an USB gateway and a LAN gateway were built sharing the same core components but different peripherals. This platform was well suited for teaching and research at Freie Universität Berlin and other groups within the past years, but progress in technology and new projects with divers requirements for sensors, connectivity and energy sources demanded a new platform. It currently comprises a core module, shown in Figure 1, which is only 13.5 cm². Add-on boards can be attached sandwich-like to both sides.

These usually would be a carrier module providing power and I/O connectivity and, if needed, a sensor board.

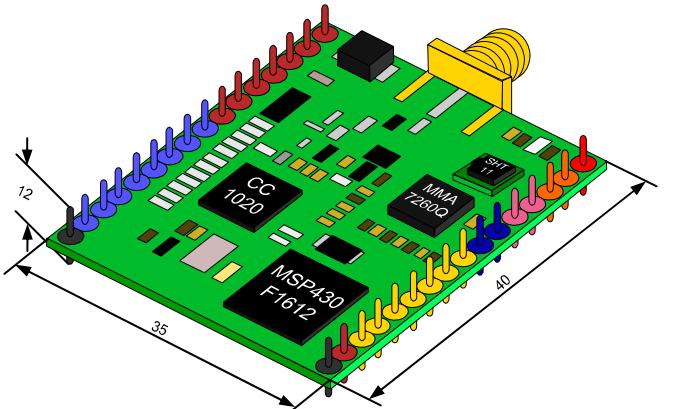


Fig. 1. Scheme of the ScatterWeb core board MSB-430 (drawing by courtesy of Bastian Blywits)

III. CORE MODULE

The core module is a complete sensor node, consisting of microcontroller (MCU), radio, external storage and two sensors. Power is provided externally through a carrier board. For maximum compatibility and because of positive experience, again an MSP430x1xx-series MCU was chosen. Since the 2 KB of RAM available on the ESB, were a very tight limitation, the MSP430F1612 with 5 KB [3] was selected.

This MCU offers 60 KB of memory divided into 5 KB RAM and 55 KB Flash-ROM. It is clocked by a digital controlled oscillator (DCO) which can be configured from software between 1 and 11 MHz. For synchronization the external 32.768 kHz quartz is used. New features over the ESB’s MCU are a DMA-controller, I²C-bus support and two digital-analog-converters (DAC). Instead of EEPROM an SD/MM-card slot is included for secondary storage of up to 4 GB (32 GB with SDHC). It is connected to a UART and accessed using the SPI protocol.

IV. RADIO

The MSB-430 has a new radio design using the license-free 868 MHz ISM band. It has been designed for much larger coverage than the ESB nodes and provides up to 8.6 dBm (= 7.2 mW) output power instead of 0 dBm. A Chipcon CC1020 transceiver [4] is used in combination with an additional low-noise amplifier on the receiver. With appropriate configuration ESB compatibility is possible. The radio frequency can be selected separately for receiver and transmitter by software. This allows usage of multiple

radio channels for advanced routing schemes. Transmission power can also be adjusted to reduce power consumption. While the maximum raw bit rate is 153.6 kbit/s the board is optimized for channel conformity which allows a typical data rate of 19.2 kbit/s when using Manchester encoding. The CC1020 also includes a digital received signal strength indicator (RSSI) which is used for carrier detection and can be used for simple ranging and quality measurements.

Radio emissions have been measured between 9 kHz and 4 GHz operating at 869.525 MHz with 8.6 dBm and 19.2 kbit/s. They are within limits for radio spectrum conformity (ETSI EN 300 220-1/3) and will be certified soon.

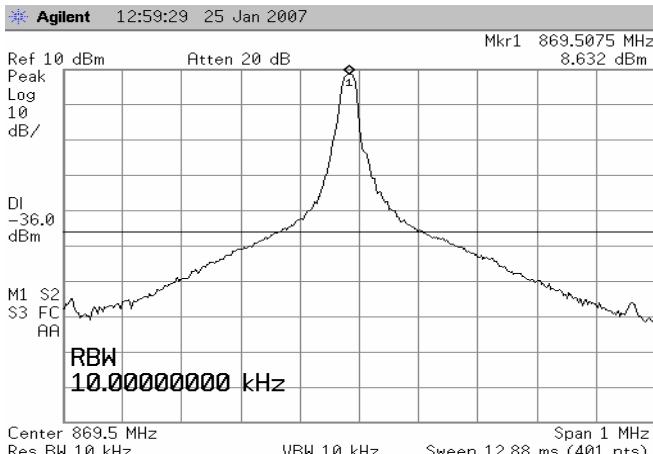


Fig. 2. Spectrum plot of a MSB-430 sending with 19.2 kbit/s

V. SENSORS

Despite the modular concept of the MSB series the core board is equipped with two sensors. For temperature compensation, that is essential for accurate clock frequencies and measurements, the temperature and relative humidity sensor Sensirion SHT11 is used. It provides calibrated digital output with good accuracy at room temperature [6]. The second sensor is the micro machined accelerometer MMA7260Q from Freescale [5]. It measures acceleration in three axes with 1.5 to 6 g sensitivity and can be used in movement detection and to support positioning. Since it is used in many of our research applications, it is mounted on the core module to reduce overall production costs.

For teaching use a general purpose sensor board (MSB-430-S) has been designed. It offers enhanced sensing capabilities to that of the ESB nodes. A serial EEPROM is included for identification or driver code.

VI. I/O INTERFACES

All I/O ports that are available for custom additions are externally accessible. For analog in- and output two 12-Bit DAC and ADC can be used. 18 digital I/O pins (8 with IRQ support) are freely disposable. One UART is available for serial communication. For programming and debugging the JTAG interface is used. The standard carrier board MSB-430-T together with a FTDI converter-cable offers USB connectivity and a JTAG connector. It powers the core board via USB or from three AAA batteries.

VII. SOFTWARE SUPPORT

Apart from programming the sensor boards from scratch embedded operating systems provide libraries for the board's hardware and configuration as well as high-level functionality. All ScatterWeb research platforms are supported by the open-source ScatterWeb operating system, which includes sample code for all the peripherals [1]. The sources are compatible to the GNU compiler for the MSP430. Alternatively ScatterWeb nodes can be programmed graphically without writing a single line of C code using our QMsB software. Our ScatterWeb SDK for Microsoft .NET and a driver for National Instrument's LabVIEW provide convenient abstractions for using ScatterWeb sensor networks. The open-source operating system Contiki [2], featuring protothreads and the μIP-stack was ported to both the ESB and MSB platforms.

VIII. CONCLUSION

We presented the new ScatterWeb MSB hardware platform for wireless sensor networks which we believe will fit most research needs of the near future. The following table provides an overview of the node's key properties.

Microcontroller	TI MSP430F1612 16-bit RISC, 16 registers	
Memory	RAM	5 KB
	Flash-ROM	55 KB + 256 B
Processor frequency		100 kHz >10 MHz
Supply voltage		2.7 - 3.6 V
Power consumption		250 µA - 115 mA
Transceiver		Chipcon CC1020
Radio frequency	overall	804 - 940 MHz
	in ISM band	863 - 870 MHz
Transmitting power		-60.0 - 8.6 dBm
Radio data rate	raw max.	153.6 kbit/s
	typical*	19.2 kbit/s
Input/Output	analog	2 x 12-Bit DAC
		2 x 12-Bit ADC
	digital	18 I/O pins

Tab. 1 Key features of the modular sensor board MSB-430 (* see IV.)

IX. FUTURE WORK

In the near future a mobile GSM gateway and an ethernet-powered LAN gateway will be available as add-on boards for the MSB platform. For long-time outdoor use a solar powered carrier board is planned.

As microcontrollers and radio transceivers are evolving fast, more powerful processors and highly integrated radio hardware will enable more powerful applications on the next platform. Unfortunately, the evolution in advanced micro-sensors, which allows for a broader spectrum of applications, is not as rapid.

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