SensLAB

D1.1a

SENSLAB NODE HARDWARE

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Résumé
This document describes the hardware design for the SensLAB nodes (wsn430 boards and SensLAB-GW board).

Mots clés
wsn430, SensLAB-Gw

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1 License

2 Functional overview

2.1 Main features

SensLAB nodes are composed of 2 wsn430 boards, and one gateway board. The aim of this board set is to offer the essential SensLAB features, such as :

- Automated firmware deployment on open node
- Accurate power monitoring of open nodes (on battery and DC power supply)
- Radio environment monitoring control, (rssi measures and nois injection), thanks to the control node
- Configurable sensor polling on control node (temperature, light, acoustic activity)
- Fixed (Ethernet) as well as mobile (Wifi) communication with Node Handler
- Power over Ethernet support for a standardized and easy power management
- Sink capability for each open node (in and out characters stream redirection)
- Option for daughter cards on open and control node
- Remote software update ability for control nodes and gateway

The following figure describes the different pieces of hardware and software composing a SensLAB node.

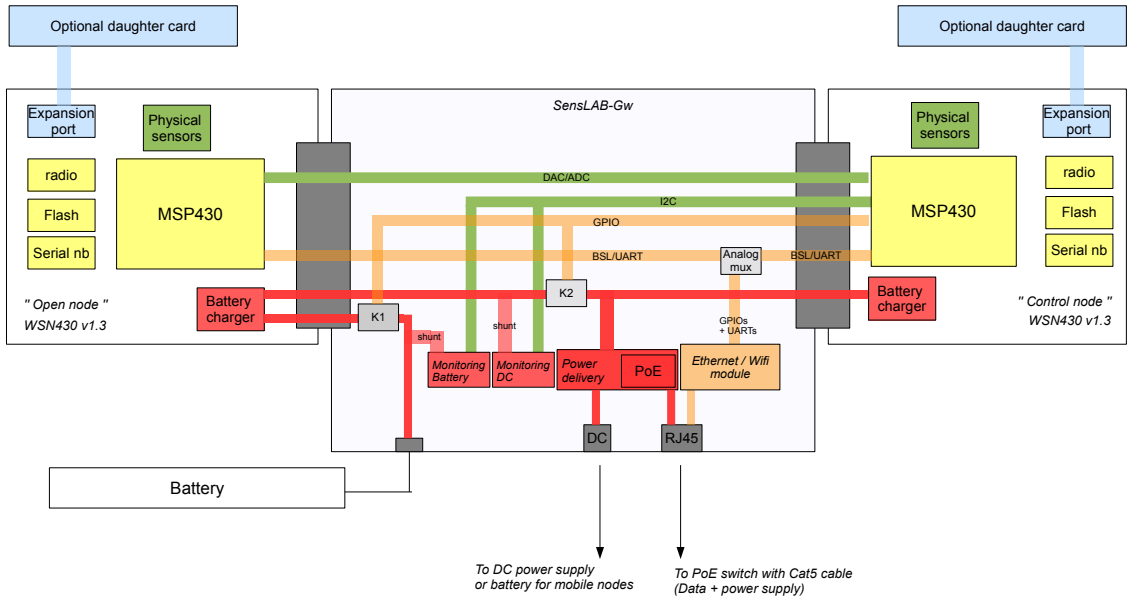

FIG. 1 – Node Overview

3 wsn430 boards

3.1 Overview

WSN430 nodes are designed to offer a target board for WSN experiments and protocols development. They are based on Worldsens previous designs, offering a low power MSP430-based platform, with a fully functional ISM radio interface, and a set of standard sensors.

Two versions are developed for the SensLAB project, the only difference between them will be the radio interface. Version 1.3 presents a open 868MHz radio interface, while vesion 1.4 has an IEEE 802.15.4 radio interface at 2.4GHz.

This document presents version 1.3b and 1.4 specifications.

3.2 Components

Micro-controller MSP430 The MSP430 core used is MSP430F1611, offering 48kbyte ROM, and 10kbyte RAM. 2 USARTs modules offers SPI, I2C, and UART communications. We also get various I/O lines, interruptables or not, plus 6 ADC channels, an 2 ADC/DAC channels (12 bits resolution).

Sensors 3 physical sensors Are mounted on WSN430 nodes :

- temperature (Maxim DS1722), with digital SPI output (connected on USART1 module).
- sound (omnidirectional microphone, Kingstate KEEG1540), with analog output. (connected on ADC5)
- ambient light (Taos TSL2550), with digital I2C output. (connected on USART0 module)

Please refer to specific datasheets for more information on sensors.

868MHz Radio interface (wsn430v1.3b) wsn430 nodes in version 1.3b get a 868MHz radio interface. The radio chip is the Chipcon CC1101 (software and pin compatible with previous CC1100 version).

Two types of antenna are available. The main is an omnidirectionnal PCB antenna. There is an option for an external SMA antenna. (The SMA connector is not mounted, but pads exists). The selection between the 2 antennas is realized with 2 capacitors (mounted or not) (see c6 and C25 in design files). Note that the PCB antenna is designed to be used with a Varta Polyflex battery at the node bottom for right radio propagation.

2.4GHz radio interface (wsn430v1.4) wsn430 nodes in version 1.34 get a 2.4GHz radio interface. The radio chip is the Chipcon CC2420, offering a IEEE 802.15.4 compliant interface. The chosen antenna is an omnidirectional SMD chip antenna (reference Fractus Compact Reach Xtend).

Serial Number An EEPROM serial number is available thanks to a Maxim DS2411 chip, allowing unique identifier, readable by the MPS430 firmware.

Flash memory Additionnal external flash memory is provided with a 1MByte chip (ST M25P80) accessed through SPI bus.

Battery charger The power supply is controled by a Microchip MCP73861 chip. It allows battery charge, and provides 2 digital outputs (connected to MSP430 GPIOs) for supervision by MSP430 firmware.

Please refer to specific datasheet for more information on these peripherals.

3.3 Connectors

Battery connector A battery can be plugged in JP4, at the bottom side. The battery reference to use is varta Polyflex 383562. Use of another battery reference is at your own risk...

Main connector (JP1) The main connector is a 26 points JAE connector. It allows access to a broad variety of signals.

- Jtag interface (Rst, Tms, tck, tdi, tdo)
- power supply (Vcc and gnd)
- Vbat
- 3 interruptables GPIOs
- 4 ADC and 2 DAC
- both UART0 and UART1
- I2C bus on USART0 block
- bootstrap loader UART pins

Look at the schematics for more details.

Expansion port wsn430 nodes will provide an expansion port through a Hirose DF17 series stackable connector. The goal is to get the daughter card as a mezzanine-style card (with 7mm between the 2 PCBs). Mechanical fixation will be done with the DF17 connectors, and a additional M3 screw (with plastic washer and spacer).

The DF17 receptacle connector reference mounted on the wsn430 nodes is "DF17(3.0)-20DS-0.5V(51)". The matching connector reference supposed to be mounted on daughter cards is "DF17(4.0)-20DP-0.5V(51)".

The DF17 connector will provide to the daughter card various signals :

- DC Power
- I2C bus
- both UART0 and UART1
- 6 ADC/DAC
- 4 interruptables GPIOS + 1 non interruptable
- 1wire bus (access to DS2411 chip)

Warning : Not all of these connexions should be available, they have to be shared among the SensLAB-Gw card, and the other WSN430 peripherals. That sharing is software-based.

Daughter cards are powered from the expansion (Dvcc should be around 3.5V). But you must take care that the power is shared between the WSN430 node and its daughter cards.

3.4 Planned daughter card designs

SensLAB special needs lead to plan design for 2 types of daughter cards :

- GPS localization and accelerometer
- Wifi

3.5 wsn430 quick start user guide

(This quick start guide only applies for v1.3b and 1.4 version of the wsn430 boards.)

3.5.1 Power issues

You can power the wsn430 board by 3 ways :

via non rechargeable battery The battery should have a 4V nominal voltage. You have to plug positive and negative pins to the JP4 connector (bottom side), and use a 2mm jumper on JP5 (top side, position marked "pile"). Do not try to connect a non rechargeable battery through JP1 :1 and JP1 :25.

via a rechargeable battery You must use a Varta Polyflex 383562 battery in this case.
There are two ways for plugging it :

- You can plug positive and negative pins to the JP4 connector (bottom side), and use a 2mm jumper on JP5 (top side, position marked "bat"). This jumper position allows the battery charger (MCP73861) to sense if there is a battery.
- Or you can connect your positive battery pin JP1 :1, and negative pin JP1 :25. In this case you don't have to use any jumper.

The battery will be recharged if the right voltage is applied at JP1 :26 (External-Supply) and JP1 :25 (GND).

via a DC external supply You have to apply a voltage between 5 and 6.5V at JP1 :26 (External supply), and JP1 :25 (GND). No specific jumper position is needed.

3.5.2 Programming the MSP430 main memory

The MSP430F1611 main program memory is stored in internal flash (48kB, from 0xFFFF to 0x4000).
Two ways to modify that memory :

Via JTAG interface That's the standard approach for the firmware development process. You need to use 5 pins of the MSP430 to access it (Reset, TCK, TMS, TDI, TDOUT). All of these pins are routed on the JP1 connector.

Via bootstrap loader The TI MSP430 offers another alternative for firmware update, specifically designed for production/field update. Two pins are needed to launch the Bootstrap Loader (Kind of alternative Reset sequence). Then you get a standard 9600 baud UART to communicate through specific commands. See slaa089d ("Features of the MSP430 Bootstrap Loader") for more details. All the pins needed for BSL access are present on the JP1 connector.

4 SensLAB-Gw board

4.1 Board description

Here is a short description on how the main functionalities are implemented on the SensLAB-Gw board. Please refer to schematics and components datasheets for more details.

4.1.1 Ethernet/Wifi interface

The main functionality for the Gw is to get an Ethernet or Wifi communication with the Node Handler. This is done with a Digi Connect EM module (Ethernet version), or a Digi Connect Wi-EM for the Wifi version. Exact Digi references are DC-EM-02T-NC and DC-WEM-02T-C. These 2 references are pin-to-pin compatibles, allowing only 1 unique board design, with either an Ethernet or a Wifi module on it.

These modules embed an ARM7-based module plus Ethernet or Wifi specialized chips. 2 UARTs and 5 GPIOs are available. They are used for UART communication with the wsn430 boards, as well as Bootstrap Loader communications (msp430 firmware update).

4.1.2 UART multiplexing

Each wsn430 boards need to be connected to two 2-wires UARTs. The first UART is the standard UART0 for msp430 communication. The second one is used for BSL operations (firmware update). Since the Digi modules have only 2 UARTs available, they are multiplex with a simple analog mux, which is controlled with Digi module GPIO5.

4.1.3 Open node supply

The open node can be supplied by 2 ways (main supply), or battery supply. Both "supply lines" are controlled by the control node with the relays K1 and K2. Note that the control node is continuously supplied by the SensLAB-Gw board. These 2 "supply lines" are equipped to measure the current and voltage. 1 ohm precision resistors are used for the shunt, and measures are done with TI INA209 chips. Expected measure precision is 10uA, and power sampling around 1kHz. These INA209 chips are configured and controlled from the control node with an I2C bus.

4.1.4 Connectors

The SensLAB-Gw have 5 connectors :
- 2 26 pins connects for connection with the 2 wsn430 boards
- 1 RJ45 connector (Ethernet)
- 1 jack connector for external supply (if no PoE)
- 1 Jst connector for the open node battery

4.2 Power management

There are 2 ways to power the nodes : by a 5V DC power (jack connector), or by PoE in midspan mode

4.2.1 Power over Ethernet

If PoE is used, we must use a midspan injector, in order to apply a compliant IEEE 802.3af detection and power on the 4/5 and 7/8 pairs. PoE interoperability has been validated with PowerDsine 65xx equipments.

4.2.2 DC 5V

If DC 5V is used, the voltage MUST be in the range 5.0V to 5.5V, and apply on the Jack connector (external diameter = 4.4mm; internal diameter = 1.6mm) .

4.2.3 Node consumption

Consumption of the complete node (senslab-Gw + 1 wsn430 boards + 1 battery charging on the open node) is limited around 4W. In idle use the SensLAB-Gw board consumption is around 1W.

4.2.4 Software controlled reset

Global hardware reset can be done by the Node Handler. To use this feature, we must use the PoE method, with an SNMP enable midspan injector like PowerDsine 65xx family.

If a Powerdsine 65xx injector is used, reset can be done through a standard SNMP v2c request on OOID 1.3.6.1.2.1.105.1.1.1.3.1

5 Additional files

5.1 design files

All the design files for the 3 boards (wsn430v1.3b and 1.4, and SensLAB-Gw v1.0), are available in a zip archive next to this document. For each boards are available in a printable version (pdf), and also available original files (Altium Designer files).

design_files
- printable_version
  - senslab-gw
    - SensLABGw_v1.0_BoM.pdf
    - SensLABGw_v1.0_layout.pdf
    - SensLABGw_v1.0_schematics.pdf
  - wsn430_v1.3b
    - wsn430_v1.3b_BoM.pdf
    - wsn430_v1.3b_layout.pdf
    - wsn430_v1.3b_schematics.pdf
  - wsn430_v1.4
    - wsn430_v1.4_BoM.pdf
    - wsn430_v1.4_layout.pdf
    - wsn430_v1.4_schematics.pdf
- original_version
  - senslab-gw
    - SensLABGw_v1.0_BoM.xls : Bill of Materials in MS Excel format
    - SENSLAB-GW-V1.0 (11-07-2008 09-15-35).zip : Altium Designer project packaging
  - wsn430_v1.3b
    - wsn430_v1.3b_BoM.xls
    - WSN430v1.3B (11-07-2008 09-12-55).zip
  - wsn430_v1.4
    - wsn430_v1.4_BoM.xls
    - WSN430v1.4 (11-07-2008 09-14-36).zip

5.2 Pictures

Some pictures of the prototypes boards are also available next to this document in the pictures.zip archive file.