SENSINODE

Micro Hardware Manual

Micro Hardware Manual

Table of Contents

1 Introduction

This manual is the hardware reference for Sensinode Micro Series products. It includes a specification of the Micro.bus, Devboard, and all the Micro modules. The block diagram, features, operational values and interfaces are described.

1.1 Micro-series

Currently the following general purpose Sensinode Micro-series products are available:

PN#	Name	Notes
U100	Micro.2420	Also called Micro.4
U100R2	Micro.2420 version 2	
U510	Micro.compass	
U510R2	Micro.compass version 2	Enhanced power down modes
U600	Micro.USB	
U600R2	Micro.USB version 2	
U700	Micro.proto	
U500	Micro.data	
D100	Debug	Limited support for Nano-series programming
D100R2	Debug version 2	Full support for Nano-series programming
A500	Sensor IO board	
A100	USB programmer	special order only
K100	Sensinode Devkit	Sensinode Micro-series development kit 1
K110	Sensinode Devkit V2	Sensinode Micro-series development kit 2

Sensinode is also able to design and build additional Micro-series compatible boards to customer specifications.

1.2 Accessories

The following accessories are currently available

PN#	Name	Notes
A901	Mounting HW kit	board supports, screws.
A902	5VDC power supply	for use with D100
A921	water resistant box	includes mounting HW for single Micro.2420 board[1]
A922	OKW ERGO case	includes mounting HW for single Micro.2420 board

1The cases are built to order and have other customization options available. For these please contact Sensinode.

PN#	Name	Notes
A931	2xAAA battery holder	requires soldering
A932	2xN battery holder	requires soldering
A941	12p cable w/connectors	includes connectors, indicate length when ordering
A942	USB cable	for use with D100, U600, U600R2

2 Handling instructions

2.1 ESD

The Sensinode Micro-series products are sensitive to electrostatic discharges (ESD). ESD events can cause immediate failure of the devices or can cause cumulative damage that can cause problems later. It is important that the devices are only handled at a ESD safe workstation. Any handling of uncased Sensinode Micro-series devices outside ESD safe areas will void the warranty. If the devices are encased then the devices can be used outside ESD safe areas, however replacement of batteries or other actions that necessitate the opening of the cases will need to be done at an ESD safe area.

It is recommended that at least a grounded, semiconductive table mat and a conductive wrist band are used.

2.2 Hot-plugging

The Sensinode Micro-series products do not support hot-plugging. If the Micro-series devices must be disconnected from or connected to each other or other devices the power to the both devices MUST be turned off. Failure to do so will void the warranty and may destroy either or both of devices.

2.3 General

The micro series board use a 50-pin Hirose DF15-series connectors that supports a limited number of connect-disconnect cycles. It is important that the connectors are mated properly, without using too much force. It is also important that the stack of Micro-series boards will not be allowed to bend: the mounting accessories that come with the Sensinode Devkit D100 are meant to be used with the boards. Failure to use the board support may lead to premature connector failure or to other problems.

3 Micro.bus

This section describes the 50-pin Micro.bus which connects Sensinode Micro Series modules into a stack. Each Micro modules has a through connector above and below the PCB. Thus modules can be connected in any order.

3.1 Pinout

Pin	Type	Signal	Pin	Type	Signal
1	POWER	VCC	26	POWER	VCC
2	Programming	DETECT	27	Reset	RESET*
3	SPI1	SCK1	28	GPIO	PLD3
4	SPI1/UART	MISO1/RX1	29	GPIO	PLD2
5	SPI1/UART	MOSI1/TX1	30	GPIO	PLD1
6	SPI1	SS1*	31	Interrupt	BIRQ
7	Parallel	D7	32	GPIO	GPIO1
8	Parallel	D6	33	GPIO	GPIO2
9	Parallel	D5	34	GPIO	GPIO3
10	Parallel	D4	35	GPIO	GPIO4
11	Parallel	D3	36	GPIO	GPIO5
12	Parallel	D2	37	GPIO	GPIO6
13	POWER	GND	38	POWER	GND
14	Parallel	D1	39	Clock	CLK
15	Parallel	D0	40	Reserved	RES0
16	SPI0	SCK0/ALE	41	Reserved	RES1
17	SPI0/UART	MISO0/RX0/RD*	42	1-Wire	1-WIRE
18	SPI0/UART	MOSI0/TX0/WR*	43	Programming	JTAG_SEL
19	SPI0	SS0*/ALE2	44	Programming	PSOC_SEL
20	Mod. Select	CS0	45	Programming	TCK
21	Mod. Select	CS1	46	Programming	TMS
22	Mod. Select	CS2	47	Programming	TDO
23	Mod. Select	CS3	48	Programming	TDI/SDA
24	POWER	VINT	49	POWER	VINT
25	POWER	GND	50	POWER	GND

3.2 Pin descriptions

Descriptions of the various signal groups of the Micro.bus.

3.2.1 Power

Power supply pin VCC is the +3.3V main supply voltage and VINT is an auxiliary 1.8V supply voltage used mainly as a CPLD core supply. VINT is provided by the Micro.2420 module or by the Devboard.

3.2.2 SPI and Parallel

The modules are selected by their unique ID on the CS3:0 bus. Once a module is selected, the controller module starts communication with the specific module. The controller software should be aware of the module's communication type: I2C, SPI, UART, parallel or just plain GPIO controls over the bus.

Pin	Name	SPI	I2C	Parallel	UART	MCU
16	SCK0/RTS/ALE	SCK	SCL	ALE	RTS	P3.3
17	MISO0/RX0/*RD	MISO	GPIO	*RD	RX	P3.2/P3.5
18	MOSI0/TX0/*WR	MOSI	SDA	*WR	TX	P3.1/P3.4
19	SS0/CTS/ALE2	SS0/GPIO	GPIO	ALE2	CTS	P3.0
23	CS3	Module sel.	Module sel.	Module sel.	Module sel.	P2.7
22	CS2	Module sel.	Module sel.	Module sel.	Module sel.	P2.6
21	CS1	Module sel.	Module sel.	Module sel.	Module sel.	P2.5
20	CS0	Module sel.	Module sel.	Module sel.	Module sel.	P2.4
7	D7	GPIO	GPIO	Data/Address	GPIO	P4.7
8	D6	GPIO	GPIO	Data/Address	GPIO	P4.6
9	D5	GPIO	GPIO	Data/Address	GPIO	P4.5
10	D4	GPIO	GPIO	Data/Address	GPIO	P4.4
11	D3	GPIO	GPIO	Data/Address	GPIO	P4.3
12	D2	GPIO	GPIO	Data/Address	GPIO	P4.2
13	D1	GPIO	GPIO	Data/Address	GPIO	P4.1
14	D0	GPIO	GPIO	Data/Address	GPIO	P4.0
42	ID	1-wire bus	1-wire bus	1-wire bus	1-wire bus	CPLD

Parallel port operation

The port may be used as an 8-bit parallel bi-directional bus. The parallel port modules should be selected primarily by the CS3:0 bus and secondarily by address. Simple devices may use just CS bus for selection and *RD and *WR for read/write control. ALE signals may also be used as a 2-bit address bus.

The ALE and ALE2 signals are used for address multiplexing: this allows an address bus of 0-24 bits.

ALE	ALE2	/RD	/WR	D7-0 state
0	0	/WR	/RD	High-Z
0	0	0	1	Data module->controller
0	0	1	0	Data controller -> module
1	0	any	any	Address bits 7:0
0	1	any	any	Address bits 15:8
1	1	any	any	Address bits 23:16

3.2.3 GPIO

These pins are general purpose IO pins and have no predefined functions. User application can assign function for these pins. Care should be taken that the user modules do not block bootstrap loader programming pins GIO3 and GIO5.

Pin	Name	Special functions	MCU
32	GIO1	TA2	P1.3
33	GIO2	TA1	P1.2
34	GIO3	TA0/BSL	P1.1
35	GIO4	TA1/CA0	P2.3
36	GIO5	TA0/CAOUT/BSL	P2.2
37	GIO6	TAINCLK	P2.1

3.2.4 UART

UART 0 and 1 pins are multiplexed SPI0 and SPI1 pins. By default UART 1 is used for the Micro.2420 serial console.

Pin	Name	Special functions	MCU
3	SCK1	SPI clock	P5.3
4	MISO1/RX1	SPI MISO/UART receive	P3.7/P5.2
5	MOSI1/TX1	SPI MOSI/UART transmit	P3.6/P5.1
6	SS1	SPI Slave select	P5.0

3.2.5 Programming

On the programming pins two JTAG buses and a PSoC programming bus are multiplexed. The bus type is selected by using signals PSOC_SEL and JTAG_SEL. If PSOC_SEL is high the PSoC programming bus is selected. If PSOC_SEL is low then JTAG_SEL selects between the MSP430 JTAG chain (JTAG_SEL=1) and the CPLD JTAG chain (JTAG_SEL=0).

The detect pin senses if the module is the topmost one on the stack and if it is closes the JTAG-loop.

3.2.6 Clock

The 8 MHz clock signal originates from the Micro.2420 module. The clock is normally running continuously, however it can be turned off.

3.2.7 Reset

The Sensinode stack can be reset by pulling the RESET* line down.

3.2.8 Interrupt

The bus interrupt should be pulled up by modules with a high-value (100k) resistor and pull down the line only if two conditions are met:

- There is a pending interrupt for the module
- The module is selected (CS=module id) or the bus is free (CS=1111)

Pin	Name	SPI	I2C	Parallel	UART	MCU
31	BIRQ	Bus interrupt	Bus interrupt	Bus interrupt	Bus interrupt	P1.0

3.2.9 1-Wire

All Sensinode Micro series modules have a 1-Wire connected serial ROM memory. These ROM chips can be accessed from the Micro.2420 module or from the development module D100.

4 U100 Micro.2420

4.1 General Description

Micro.2420 is the core of a Micro series node. It is a fully operable standalone communication node with accessible connectors for easy sensor and UI element operation. Micro.2420 runs on 2 NiMH batteries or on bus-supplied 3.3V power. It integrates a flexible TI MSP430 microcontroller with a Chipcon 802.15.4 radio capable of 100 m transmit range. This radio is very flexible, offering a 250 kbps data rate and ad hoc communications with a wide variety of topologies.

The microcontroller and radio are supported by both the FreeRTOS and TinyOS operating systems. Sensinode's NanoStack solution provides an 802.15.4 MAC and communication protocols with drivers for all on-module components.

4.2 Functional Diagram

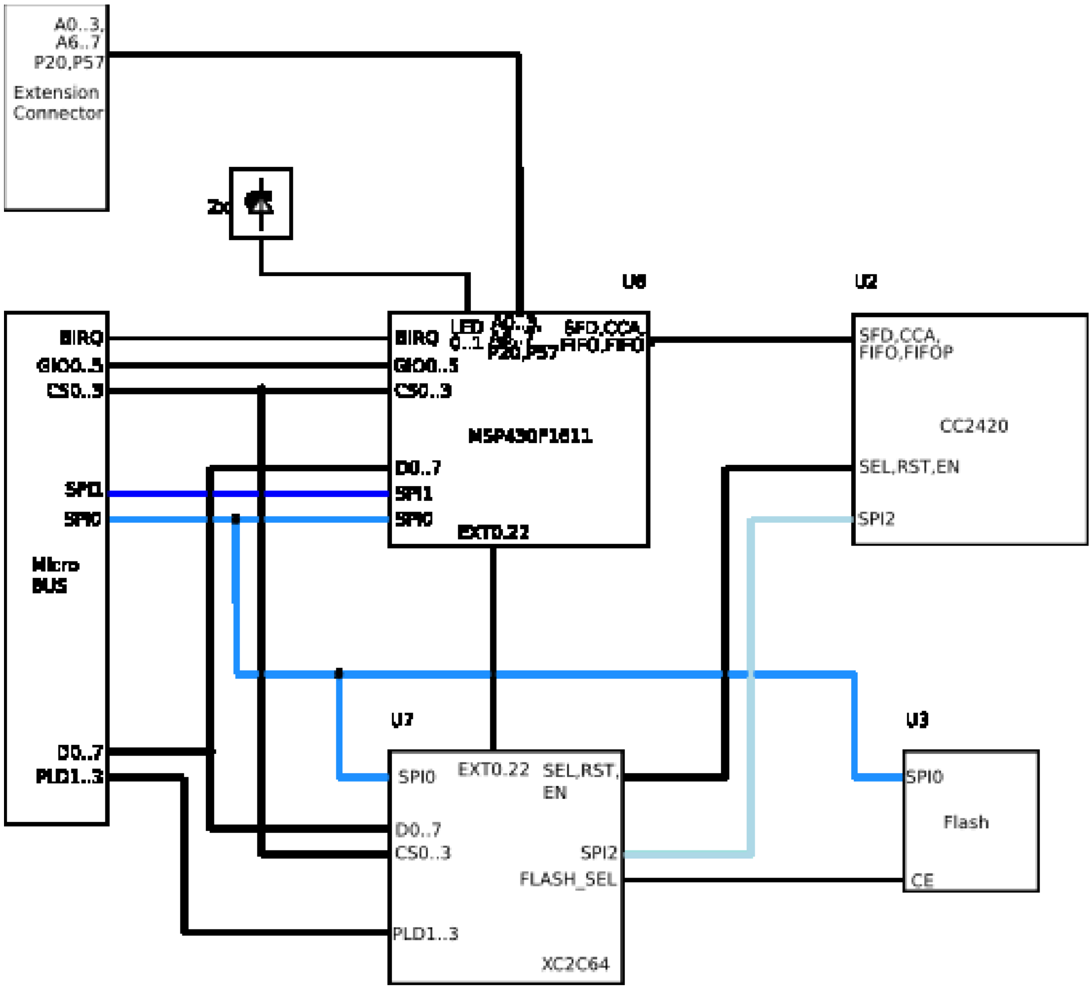


Figure 1: Micro.2420 main block diagram.

4.3 Features

- Powerful MSP430 microcontroller with 10KB RAM and 256KB FLASH memory, running at 8MHz
- Multiple 12 bit AD converters and two 12 bit DA converters
- Chipcon CC2420 802.15.4 compatible RF-transceiver with 250kbps data rate
- 4Mbit serial data FLASH memory
- On module antenna and optional connector for an external antenna
- Modular architecture, easily expandable by adding other micro modules
- Low power consumption, ultra low power sleep and idle modes available
- Each module has a unique ID number
- Case connector with 8 digital/analogue IOs
- RoHS compatible
- Module size 40 mm x 50 mm, including 10mm x 40mm break-away tab with the on-module antenna
- 3.3V operation, minimum battery voltage 1.5V
- Has support for running on 2 NiMH batteries
- Sleep mode current <50uA
- Operating current <25mA (radio in RX mode)

4.4 Functional Description

The major functional blocks of the Micro.2420 module are the microcontroller (MCU), programmable logic device (CPLD), radio transceiver and the battery powered power supply.

The MCU is a MSP430F1611 from Texas Instruments. It has 10kB of RAM and 256kB of FLASH memory. The MCU on the Micro.2420 module can be programmed by using the Micro series devel module D100 or the USB programmer A100. These programmer support both JTAG and bootstrap programming modes. The Micro.2420 module hardware also supports MSP430 self programming where the MCU programs its own FLASH memory. Use of the self programming requires software support. For more information on the MSP430F1611 chip, see the datasheet on Texas Instruments web site www.ti.com.

An external 4Mbit serial FLASH memory is connected to the MCU. This memory chip can for example be used to store measurement data. The chip used is type M25P40 from ST. The Sensinode software manual has more information on how to use the external memory.

The CPLD connects the Micro.2420 system together. It routes reset and clock signals and generates the select signals for the modules.

The RF system consists of TI CC2420 RF transceiver, RF matching circuitry and antenna. The Micro.2420 module by default has a module mounted chip antenna but an external antenna can be used by breaking off the tab with the chip antenna and mounting a MMCX connector. For more information see the CC2420 datasheet from Texas Instruments website and the NanoStack Manual.

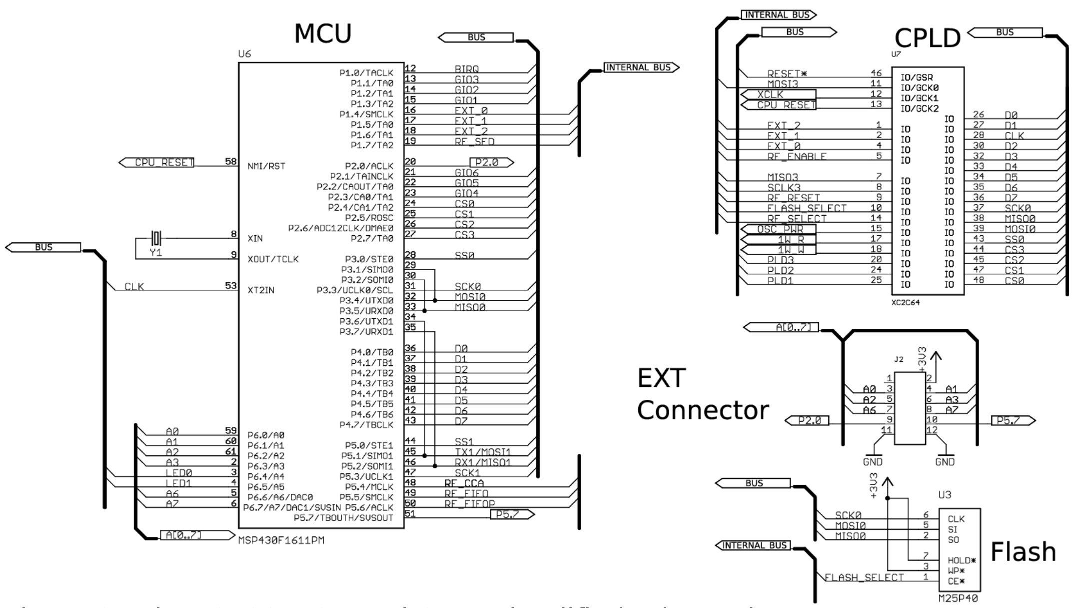


Figure 2: Micro.2420 MCU and CPLD simplified schematic

The Figure 3 shows the locations of the major components on the Micro.2420 module. Pin number one on the extension connector is marked with a square.

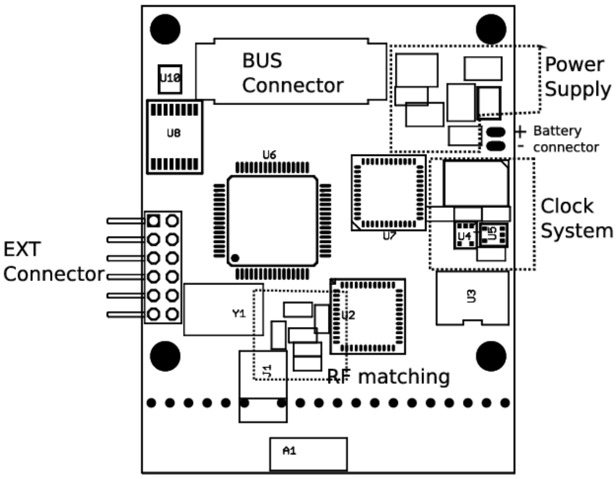


Figure 3: Micro.2420 simplified module layout

4.4.1 Power Supply

The Micro.2420 module can be powered from the Micro.bus or from battery connected to the battery connector. Recommended battery voltage is 1.5V to 2.6V. The battery power must not be used if the Micro.2420 module is powered from the bus.

The module has a +1.8V regulator for CPLD core voltage. The Micro.2420 module does not support and external source of +1.8V. It is not supported to use more than one Micro.2420 module on a same stack. Also remove the +1.8V isolation jumper when connecting the Micro.2420 module to the Devboard D100.

4.4.2 Reset

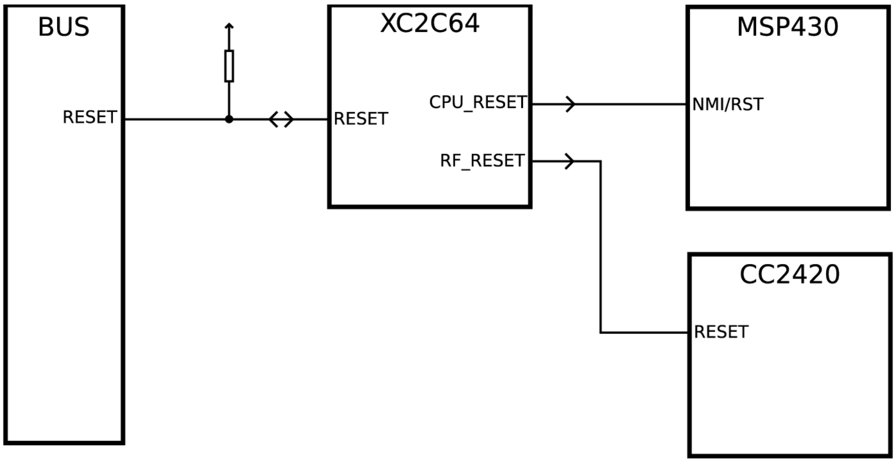


Figure 4: Micro.2420 simplified reset system

The reset signal on the Micro.2420 module is routed through the Xilinx XC2C64 CPLD. All reset-signals on the Micro.2420 module are active low. Either the bus or the CPLD can drive signal RESET*. Reset signal from the bus will always reset both MCU and

CC2420. Power-on-reset originates from the CPLD.

4.4.3 External Connector

The External connector can be used to connect sensors and indicators.

PIN	SIGNAL	PIN	SIGNAL
1	Not connected	2	+3V3
3	P6.0	4	P6.1
5	P6.2	6	P6.3
7	P6.6	8	P6.7
9	P2.0	10	P5.7
11	Ground	12	Ground

4.4.4 Oscillator system

The main clock oscillator consists of U5 and the 16MHz clock crystal. This oscillator is powered from an approximately 2V voltage source. The main clock oscillator can be turned off to save power. The 8MHz clock for the main MCU and for the bus clock is derived from the 16MHz clock by U4. The oscillator power supply can be turned off by pulling CPLD signal OSC_PWR (pin 15 on he CPLD) low. If the oscillator is turned off the MCU must be running on its internal oscillator.

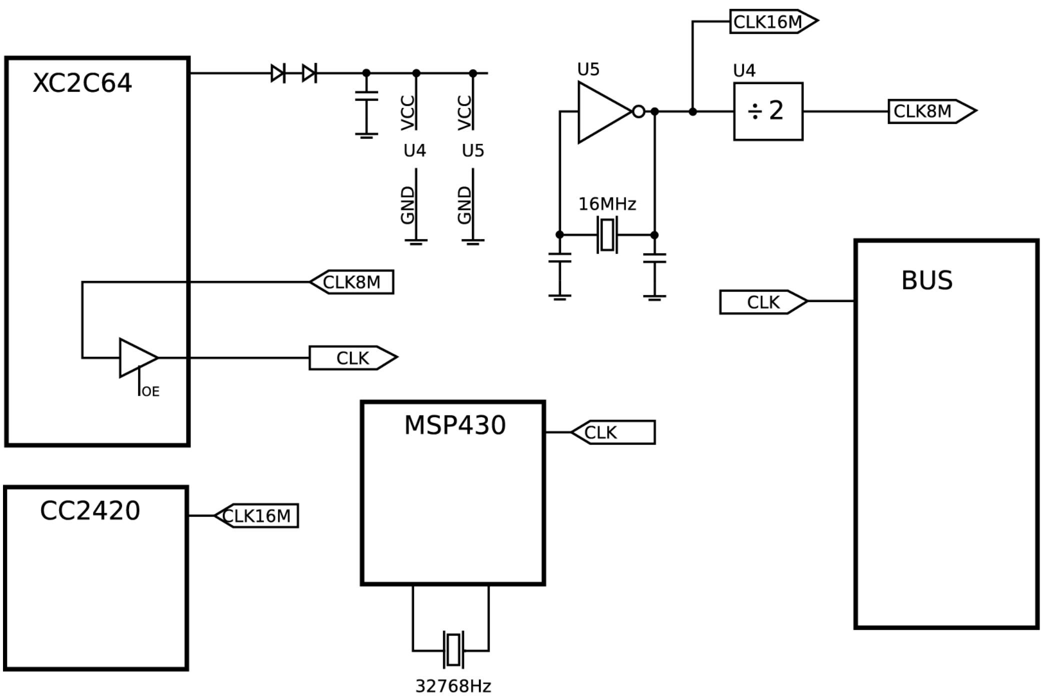


Figure 5: Micro.2420 simplified clock system

4.4.5 SPI-interface

The MCU has two SPI interfaces, SPI0 and SPI1. SPI0 is connected to the bus, to the CPLD and to the FLASH memory. The MCU is the master for SPI0.

SPI1 is connected to the bus and can be used to connect external SPI master devices to the Micro.2420 module.

The CPLD (U7) provides an additional SPI interface (SPI2) that is used to control the radio chip CC2420 (U2).

SPI0 and SPI1 are multiplexed with UART signals TX0/RX0 and TX1/RX11.

4.4.6 UART interfaces

The Micro.2420 module has 2 UART interfaces, UART0 and UART1. These signals are multiplexed with SPI signals. UART1 is used as a serial console.

4.4.7 Radio Interface

The RF-chip CC2420 SPI bus is connected to the CPLD. When the CC2420 is selected by using the CS0-CS3 signals the CC2420 SPI bus is connected to the SPI0 bus.

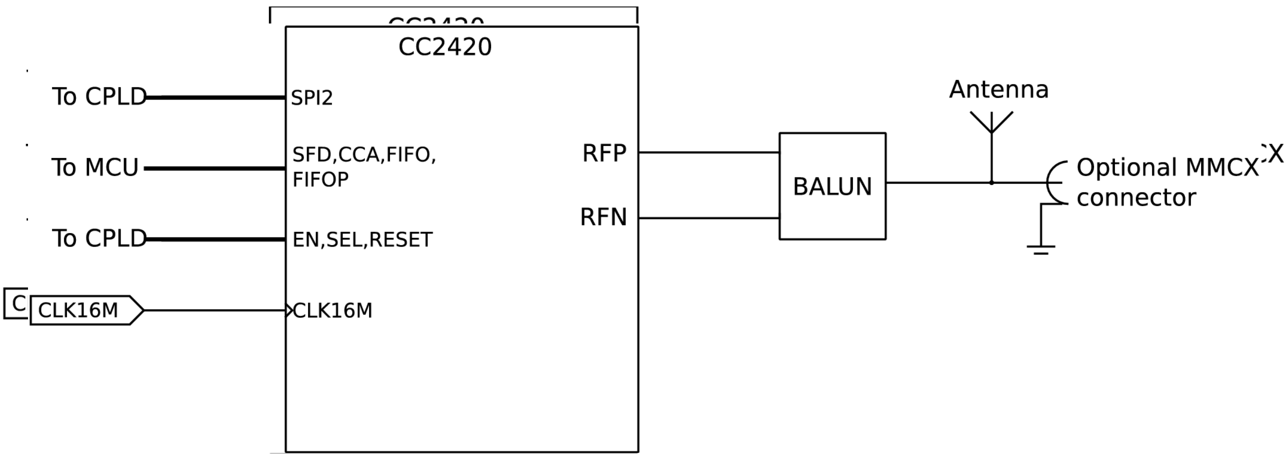


Figure 6: Micro.2420 simplified RF system block diagram

For more information on how to use the radio see the Section 12.

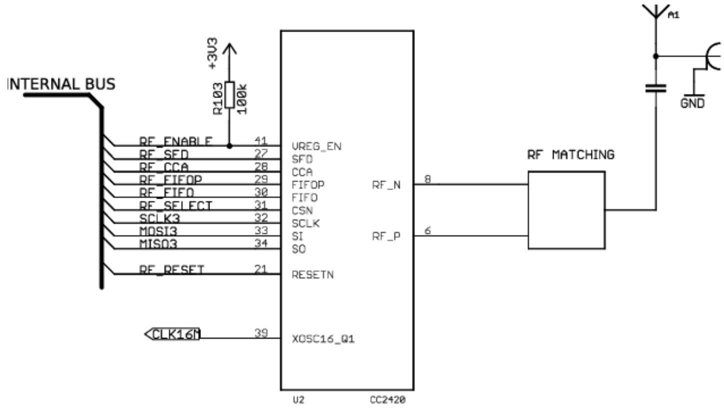


Figure 7: Micro.2420 RF system simplified schematic

If the optional MMCX connector is used to connect an external antenna to the Micro.2420 module the break-away tab with the surface mount antenna must be broken off.

4.4.8 1-Wire interface

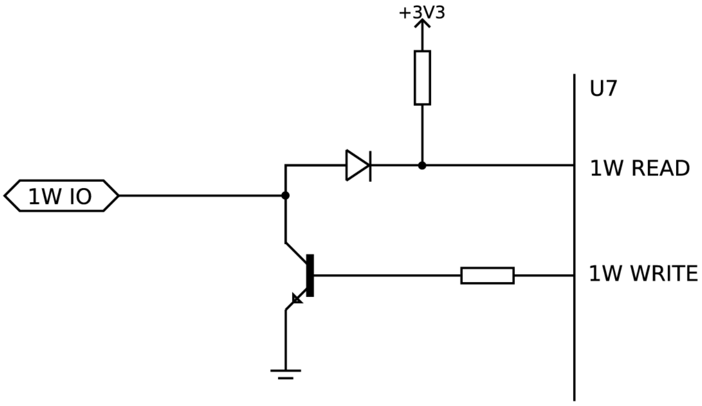


Figure 8: Micro.2420 1-Wire bus interface

The Micro.2420 module has interface circuitry to the 1-Wire bus on the bus connector. The 1-Wire bus is 12V tolerant to support EPROM programming using an external high voltage programmer. The Micro.2420 module cannot program the EPROM chips.

4.4.9 Programming Interface

The Micro.2420 module programming interface support programming both the MSP430F1611 MCU and the XC2C64A CPLD via the JTAG interface. The Sensinode bus has two JTAG buses multiplexed on one set of signals. The JTAG bus that is in use is selected with the JSEL- signal. if JSEL is high the JTAG bus connected to the MCU JTAG bus is selected, if JSEL is low the CPLD JTAG bus is selected. If bus signal PSEL is high regardless of the signal JSEL state then both JTAG buses are disconnected and the Micro.bus is set to PSoC programming mode instead.

On the topmost module of the stack the JTAG bus loop back is activated. The topmost module is detected by using BUS pin DET.

The Sensinode module that is used as programmer (either Devboard D100 or the Micro.proto) must be the bottommost module of the stack.

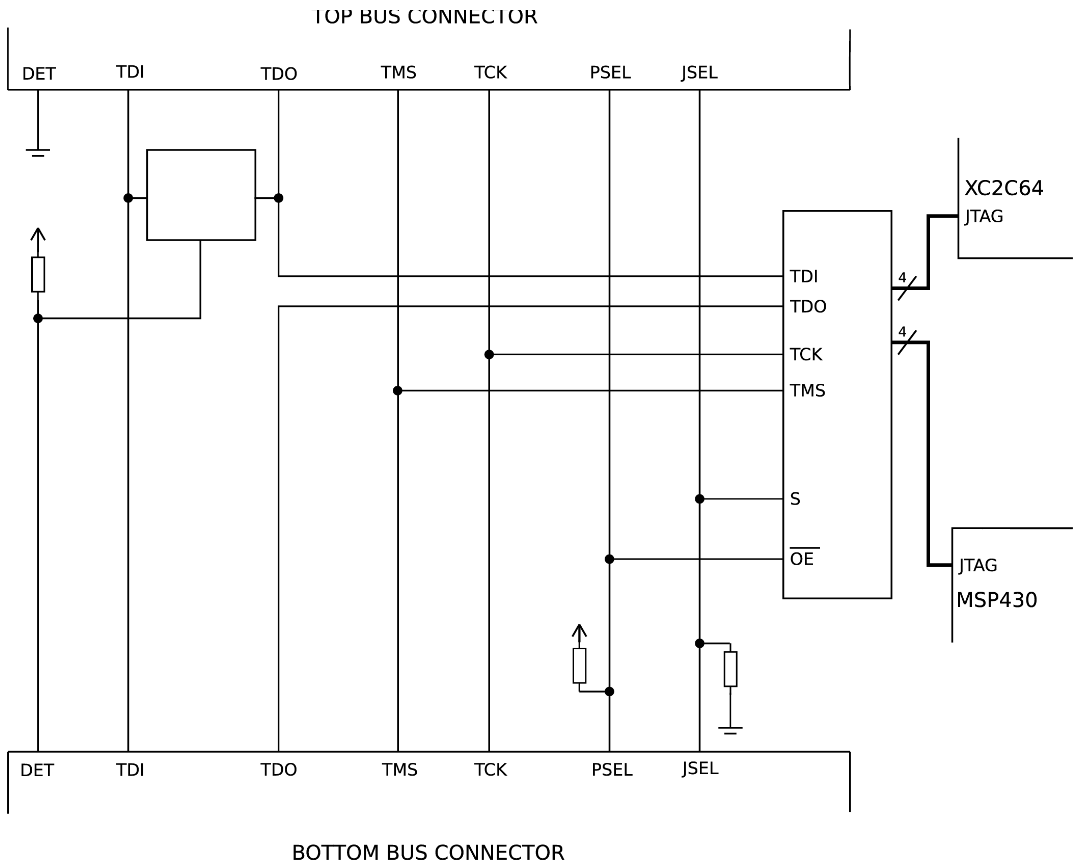


Figure 9: Micro.2420 simplified programming interface

4.5 Absolute maximum ratings

Absolute maximum values are those values beyond which permanent damage to the device may occur.

Supply Voltage Vcc	GND-0.3 to +3.6V
Battery Voltage Vbatt	-0.2V to +3.2V
Data IO Input Voltage	GND-0.3V to Vcc+0.3V
Data IO Output Voltage	GND-0.3V to Vcc+0.3V
Current into Any IO-Pin [2]	+-10mA
1-Wire Bus Voltage	GND-0.5V to +12V

2 All other IO pins unused

4.6 Recommended Operational Conditions and Operating Characteristics

Symbol	Parameter	Min	Typ	Max	Units
Vcc(3V3)	3.3V supply voltage	3.0	3.3	3.5	V
Vbatt	Battery voltage	1.5		2.8	V
Vcc(1V8)	1V8 regulator output	1.7	1.8	1.9	V
Vio(1W)	1-wire bus voltage	2.8	3.3	6.0	V
Toperational	operational temperature	-40		+85	deg C
	operational current, TX mode			30	mA
	idle current		4.5		mA
	sleep mode current			0.5	mA
	LED current		1		mA

5 U500 Micro.data

5.1 General Description

The Micro.data module is a very flexible way to connect a huge variety of sensors and actuators to a Sensinode. A Cypress programmable system-on-a-chip (PSoC) solution allows mixed-signal solutions to be developed on the module including different kinds of amplifiers, filters, ADCs etc. Connectors are included on the module for connecting probes and sensors. All the sensor data processed by the PSoC is available on the Micro.bus using SPI.

5.2 Functional Diagram

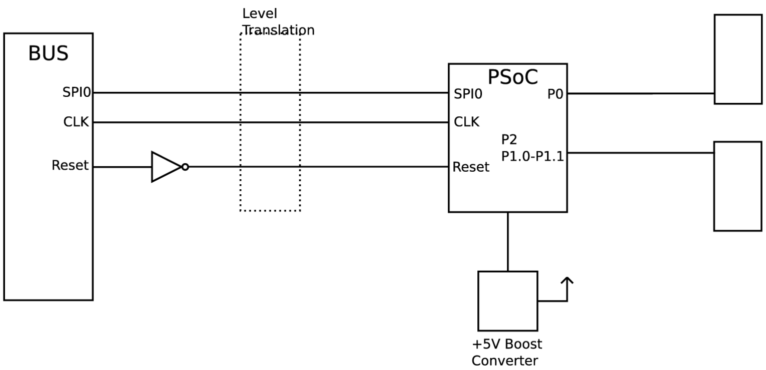


Figure 10: Micro.data simplified block diagram

5.3 Features

- Sensor interface module for the Sensinode Micro Series
- Extremely configurable design
- Can support almost any kind of sensor
- Uses a programmable Cypress PSoC mixed-signal microcontroller
- Can be configured to have analog and digital inputs and outputs
- Supports 3.3V and 5V sensors, the module has a 3.3V to 5V step-up regulator
- Module has an unique ID number
- RoHS compatible
- 40mm x 40 mm module size
- 2 2mm right-angle dual-row connectors

5.4 Functional Description

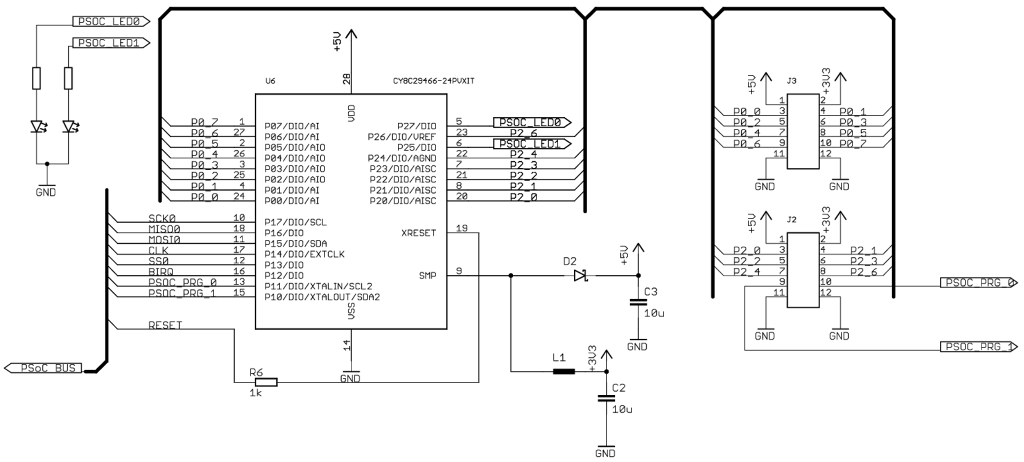


Figure 11: Micro.data simplified schematic

The Micro.data provides a flexible interface to different sensors. A higher operating voltage (+5V) for the PSoC is also supported by using PSoCs integrated SMPS. Voltage level translation circuit protects the Sensinode bus from the higher IO voltages.

5.4.1 PSoC SMP

The PSoC has a configurable boost converter capable of providing a +5V output. This can be used with sensors that need a higher supply voltage. The maximum output current is several tens of milliamp. The SMP adds some noise to the power supply voltage so in some cases it is recommended to turn the SMP off when for example doing an AD conversion.

5.4.2 External Connector

The Micro.data module has two connectors that can be used to connect external sensors to the module.

Connector J2:

Pin	Signal	Pin	Signal
1	+5V	2	+3V3
3	P2.0	4	P2.1
5	P2.2	6	P2.3
7	P2.4	8	P2.6
9	P1.0	10	P1.1
11	GND	12	GND

Connector J3:

Pin	Signal	Pin	Signal
1	+5V	2	+3V3
3	P0.0	4	P0.1
5	P0.2	6	P0.3
7	P0.4	8	P0.5
9	P0.6	10	P0.7
11	GND	12	GND

For detailed information on the PSoC signals see the CY8C29466 datasheet.

5.4.3 SPI-interface

The PSoC on the Micro.data module is connected to the bus by the SPI0 interface. By default the chip select CS0-CS3 for the module is CS=4. This interface has a voltage level translation circuitry between the PSoC and the bus as the PSoC IO voltages will be higher than the bus voltages if the PSoC SMP system is in use.

The default module select can be changed by using the jumper soldering pads on the Micro.data module.

5.4.4 Analog System

A detailed description on the PSoC analog subsystem can be found from the PSoC Technical Reference Manual and from the CY8C29466 datasheet, both are available at the www.cypress.com website.

5.4.5 Programming Interface

The PSoC programming interface uses the same bus signals as the JTAG programming.

PSoC programming mode is selected by pulling the PSEL signal high. This disables all JTAG programming and connects the PSoCs programming pins to the TDI and TCK JTAG pins on the bus. Reset signal from the bus is inverted as the PSoC uses a different polarity reset as the other chips. As the PSoC programming does not support multiple devices on the programming bus only one module with a PSoC can be connected to the stack at time when programming PSoCs. This limitation applies to the following Sensinode modules: Micro.data, Micro.usb and Micro.compass.

The Sensinode PSoC module hardware also supports PSoC self programming, this however needs special software support that is not provided at this time.

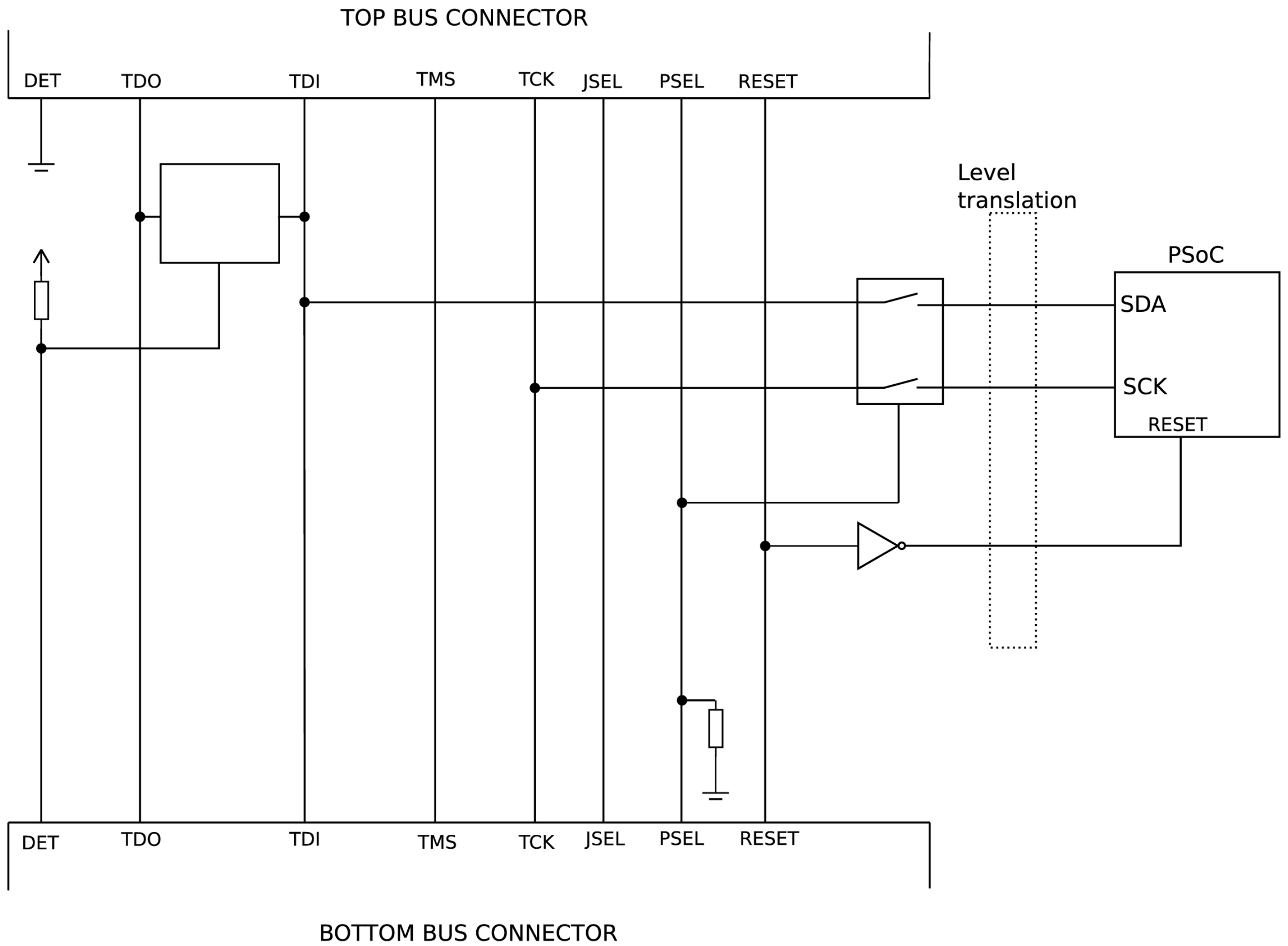


Figure 12: Micro.data simplified programming interface

5.5 Absolute maximum ratings

Absolute maximum values are those values beyond which permanent damage to the device may occur.

Supply Voltage Vcc	GND-0.3 to +3.6V
Psoc Supply Vccpsoc	GND-0.3 to +5.5V

Bus IO Input Voltage	GND-0.3V to Vcc+0.3V
Bus IO Output Voltage	GND-0.3V to Vcc+0.3V
Psoc connector IO or analog voltage	GND-0.3V to Vccpsoc+0.3V
Current into Any IO-Pin	+-10mA
1-Wire Bus Voltage	GND-0.5V to +12V

5.6 Recommended operational conditions

Symbol	Parameter	Min	Typ	Max	Units
Vcc(3V3)	3.3V supply voltage	3.0	3.3	3.5	V
Vio(1W)	1-wire bus voltage	2.8	3.3	6.0	V
Toperational	operational temperature	-40		+85	deg C

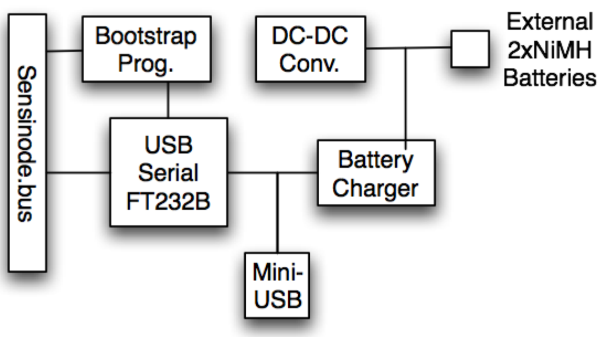
6 U600 Micro.usb

6.1 General Description

The Micro.usb module enables a Micro Sensinode with a convenient way to interface the node with for example a PC, gives a serial connection over USB for debugging, supplies power to the stack, and enables programming the microcontroller. In addition Micro.usb can be used with a rechargeable battery, which is automatically charged when the node is powered by USB.

Micro.usb makes use of the widely supported FTDI USB chip, which has drivers in all major operating systems. When plugged into a PC, the FTDI driver provides a serial port to the Sensinode (directly to the microcontroller). The serial port can then be used with a terminal for debugging or control purposes, or with the NanoStack PC tools.

6.2 Functional Diagram



6.3 Features

- USB serial adapter for the Sensinode Micro Series
- Uses FTDI USB chip (FT232R) solution
- Drivers available for Linux, OS X, and Windows
- Full-speed USB device, up to 1MB/s data rate
- Charges 2 NiMH batteries from the USB bus
- Automatically powers the Sensinode Micro module stack from USB bus
- Enables bootstrap programming of the Micro.2420 over USB
- Each module has a unique ID number
- RoHS compatible
- 40 mm x 40 mm module size

6.4 Functional Description

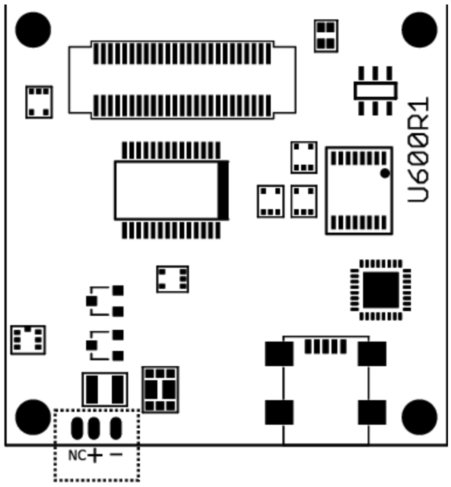


Figure 13: Micro.usb simplified layout diagram

6.4.1 Power Supply

The Micro.usb module can be powered from the USB bus or from the NiMH battery pack. The NiMH battery pack has 2 N-size NiHM batteries on a battery holder. This module only supports NiMH batteries, do not connect any other battery types to the module.

6.4.2 SPI-interface

The charger is controllable via the SPI interface. For a description on available SPI-commands see Section 12.

6.4.3 USB

The USB interface on the Micro.usb module is used for programming the Micro.2420 MSP430 MCU by using bootstrap programming mode. The USB interface is also used as a serial console for the Micro.2420 module. The USB interface is implemented by using a FTDI FT232R series chip. Drivers are available for Linux, OSX and Windows at the FTDI website http://www.ftdichip.com/.

6.4.4 Programming Interface

The on-module PSoC microcontroller can be programmed using the Micro.proto module with an external USB programmer or with the Devboard D100. At this point only Sensinode provided firmwares are supported, no user made modifications are supported. For detailed discussion on the PSoC programming interface see Section 5.4.5.

6.4.5 Micro.USB Version 2

The following improvements were made to the Micro.compass rev.2 board:

- Micro.2420 programming reliability was improved

6.5 Absolute maximum ratings

Absolute maximum values are those values beyond which permanent damage to the device may occur.

Bus supply voltage Vcc	GND-0.3 to +3.6V
Bus IO Input Voltage	GND-0.3V to Vcc+0.3V
Bus IO Output Voltage	GND-0.3V to Vcc+0.3V
Current into Any IO-Pin	+-10mA
1-Wire Bus Voltage	GND-0.5V to +12V

6.6 Recommended operational conditions

Symbol	Parameter	Min	Typ	Max	Units
Vcc(3V3)	3.3V supply voltage	3.0	3.3	3.5	V
Vbatt	Battery voltage	1.5		2.8	V
Vio(1W)	1-wire bus voltage	2.8	3.3	6.0	V
Toperational	operational temperature	0		+85	deg C

7 U510 Micro.compass

7.1 General Description

The Micro.compass modules is an example sensor module for tilt measurement, direction measurement, vibration measurement etc. The module employs a mixed-signal programmable system-on-a-chip (PSoC) for on-module processing. The module provides raw access to the accelerometer and magnetometer readings, along with the preprocessed tilt-adjusted compass reading. The Micro.compass module is supported in NanoStack.

7.2 Functional Diagram

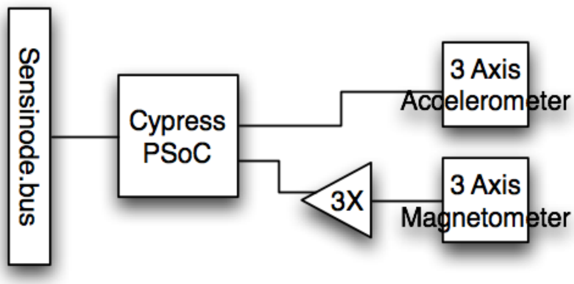


Figure 14: Micro.compass simplified block diagram

7.3 Features

- Accelerometer and magnetometer module for the Sensinode Micro series
- 3-axis 2.5 G - 10 G accelerometers (selectable range)
- 3-axis magnetometers
- Uses a Cypress PSoC microcontroller for on-module processing
- Can be configured as a digital compass or as a general purpose accelerometer/magnetometer module
- Module has a unique ID number
- RoHS compatible
- 40mm x 40 mm module size

7.4 Functional Description

The Micro.compass modules uses a Cypress PSoC MCU as its core. The PSoC implements most of the analog parts and the analog to digital converters. The module also has a preamplifier for the magnetometers.

7.4.1 PSoC MCU

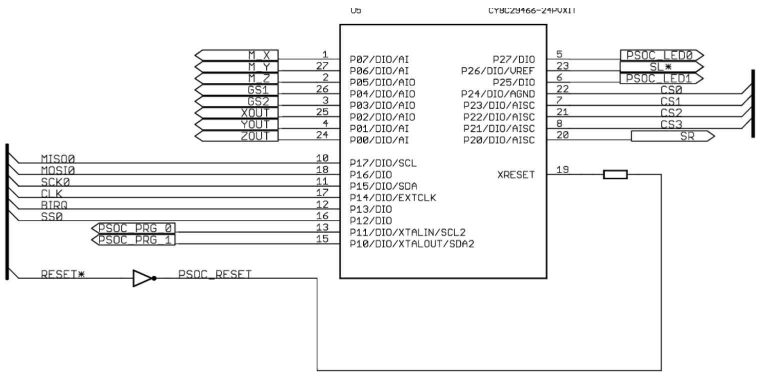


Figure 15: Micro.compass simplified PSoC MCU schematic

The Cypress PSoC used is the same part as on other Sensinode modules, CY8C29466. The PSoC implements analog to digital conversion for the Micro.compass module. Two LEDs are also connected to the PSoC.

7.4.2 Sensor System

The Micro.compass module has both 3-axis magnetometers and 3-axis accelerometers. The PSoC on the Micro.compass module is used to implement signal conditioning and analog to digital conversion for the sensors. Additionally there is a preamplifier for the 3-axis magnetometer. The default PSoC firmware implements a simple compass application.

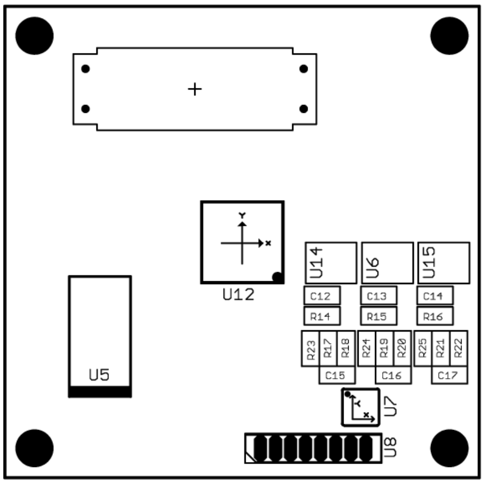


Figure 16: Micro.compass simplified module layout

In the diagram 16 U12 is the accelerometer and U7 and U8 are the magnetometers. The accelerometer is in the geometrical center of the module.

7.4.3 SPI-interface

The Micro.compass module is controlled via the SPI0 interface. Detailed description on how to use the SPI interface and available functions is in Section 12.

7.4.4 Accelerometers

The accelerometer (U12) is type MMA7261Q from Freescale. MMA7261Q has four different selectable sensitivities, 2.5g, 3.3g, 6.7g and 10g. Active current use for the accelerometer is about 0.5mA. Sleep mode can be activated via the SPI interface. For additional information see the MMA7261Q datasheet.

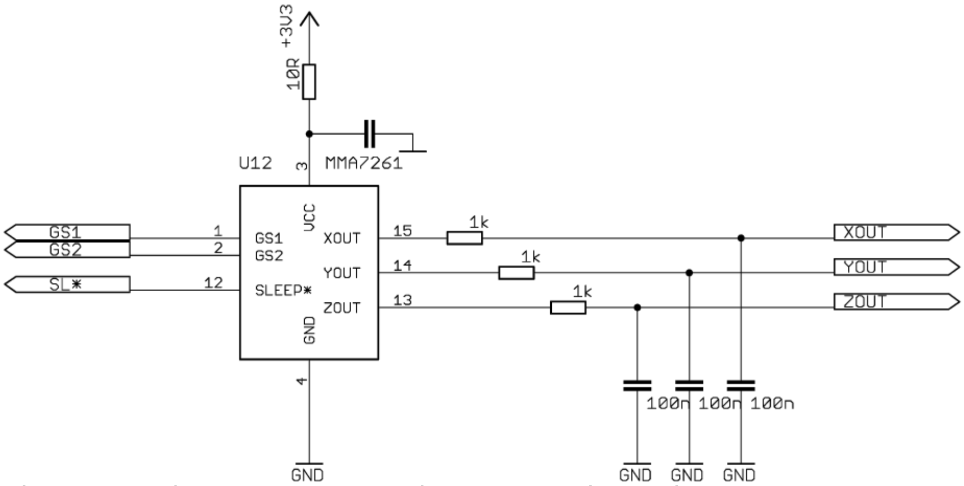


Figure 17: Micro.compass accelerometer schematic

7.4.5 Magnetometers

The magnetometers are types HMC1051Z (U8) (Z-axis) and HMC1052 (U7) (X and Y axis) from Honeywell. The magnetic field range for these sensors is specified as +-6 gauss. A preamplifier with a gain of 213 is used to amplify the output from the sensors. For additional information see the HMC1051Z and HMC1052 datasheets.

For revision 2 of the Micro.Compass board a power switch was added to the magnetometer and preamplifier circuits.

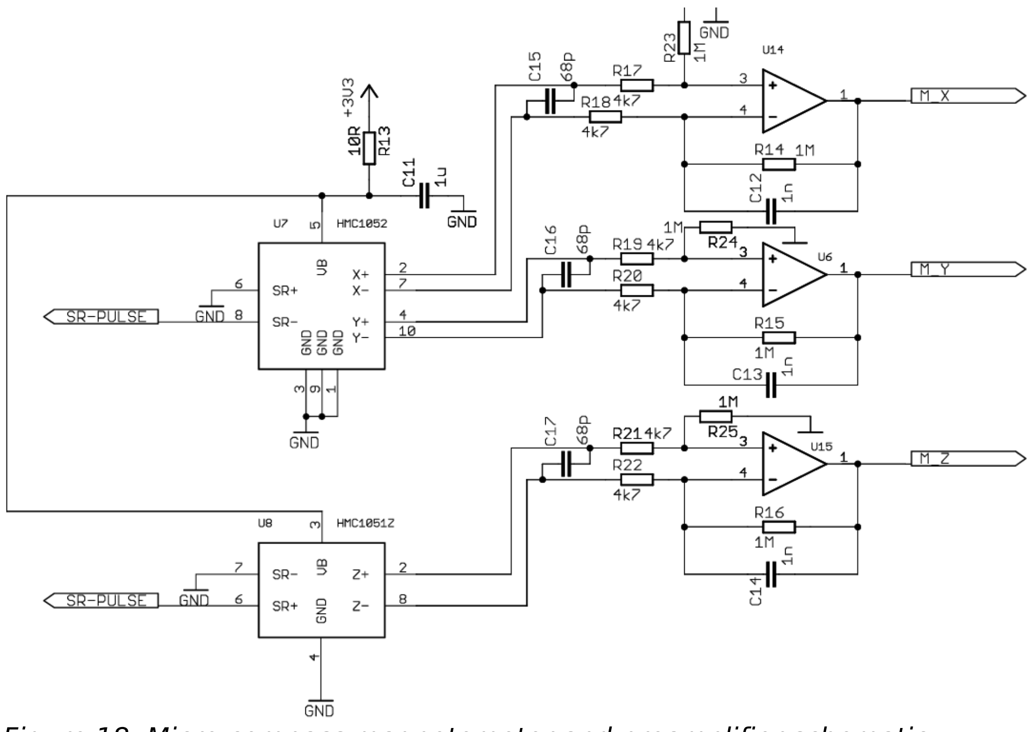


Figure 18: Micro.compass magnetometer and preamplifier schematic

The Micro.Compass module also implements a set/reset circuit for the magnetometers that can be used in some cases to improve accuracy. The set/reset system is operated by pulsing signal SW from the PSoC MCU.

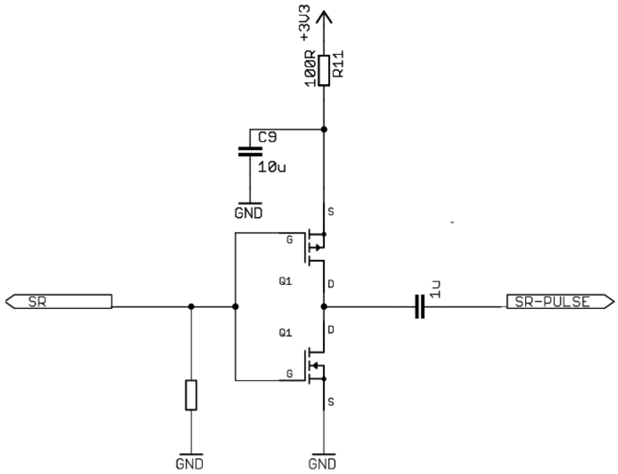


Figure 19: Micro.compass magnetometer Set/Reset schematic

7.4.6 Programming Interface

For detailed information about the Micro.compass programming interface see the Micro.2420 Programming Interface section.

7.4.7 Micro.compass Rev 2

The revision 2 of the Sensinode Micro.compass board has the following improvements:

- Magnetometer and magnetometer preamplifier power supply enable
  - magnetometers are enabled when the PSoC pin 17 is '1'.
- Magnetometer Set/Reset control output was changed to pin P2.4.
- Chip select CS3-CS0 signals were changed to pins P2.3-P2.0.
- Accelerometer signals: AX to P0.1, AY to P0.2, AZ to P0.3 and GS2 moved to pin P0.0
- Accelerometer is changed to MMA7260Q. The maximum measurement rage accelerometer is +-10G.

The revision 2 of the Micro.compass can be recognized by the U510R2 print on the top side of the board.

7.5 Absolute maximum ratings

Absolute maximum values are those values beyond which permanent damage to the device may occur.

Bus supply voltage Vcc GND-0.3 to +3.6V

Bus IO Input Voltage	GND-0.3V to Vcc+0.3V
Bus IO Output Voltage	GND-0.3V to Vcc+0.3V
Current into Any IO-Pin	+-10mA
1-Wire Bus Voltage	GND-0.5V to +12V

7.6 Recommended operational conditions

Symbol	Parameter	Min	Typ	Max	Units
Vcc(3V3)	3.3V supply voltage	3.0	3.3	3.5	V
Vbatt	Battery voltage	1.5		3.0	V
Vio(1W)	1-wire bus voltage	2.8	3.3	6.0	V
Toperational	operational temperature	0		+85	deg C
	operational current			35	mA
	sleep mode current		0.1		mA
	magnetometer preamplifier gain		212		
	accelerometer measurement range		+-6G +-10G		g

8 U700 Micro.Proto

8.1 General Description

The Sensinode Micro.proto module allows for the programming of all modules using a JTAG programming cable. In addition the module provides solder-pad access to many Micro.bus signals, enabling easy prototyping. An on-module programmable logic device gives more flexibility for designing custom solutions.

For example LEDs, buttons, and custom sensors or actuators can be connected to the Sensinode bus by using this module. Micro.proto saves time and cost by allowing a whole embedded system to be prototyped without the need to design and build a new custom PCB.

8.2 Functional Diagram

The Micro.proto module has 3 major functions: the programming interface that is used with the USB Programmer, the CPLD interface to the bus and the prototyping area. The programming interface consists of 12 pin right angle pin header connector and analog switches. The analog switches are used to select which of the three programming signals are connected to the programming connector. the selection is done automatically by the USB Programmer.

The CPLD offers a flexible interface to the Sensinode BUS. The default firmware provides an SPI0 accessible GPIO controller.

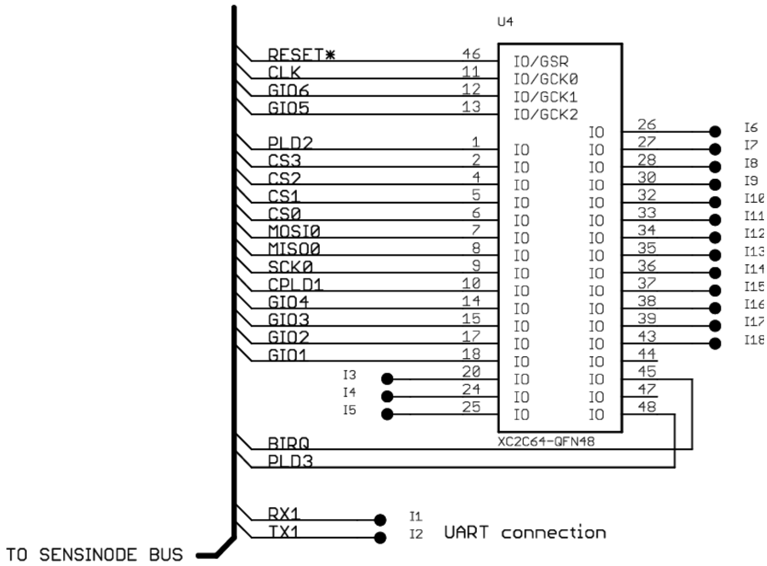


Figure 20: Micro.proto CPLD subsystem

The prototyping area consists of unconnected soldering pads on a 1.27mm raster. Most discrete SMD components and many SMD ICs are compatible with the prototyping area. The CPLD signals and UART 1 TX and RX signals are accessible via the soldering pads T1 to T18. Power supplies 1.8V, 3.3V and ground are also accessible.

8.3 Features

- Can be used to program Sensinode Micro Series modules (External JTAG programming cable or the Sensinode USB Programming dongle needed)
- Module has a prototyping area for user modifications giving access to the Micro.bus signals.
- Includes a 64 macrocell Xilinx Coolrunner-2 series CPLD
- Low cost way to interface custom hardware with a Sensinode Micro module
- RoHS compatible
- 40 mm x 40 mm module size
- Includes a 12 pin connector to be used with the USB programmer board

8.4 Functional Description

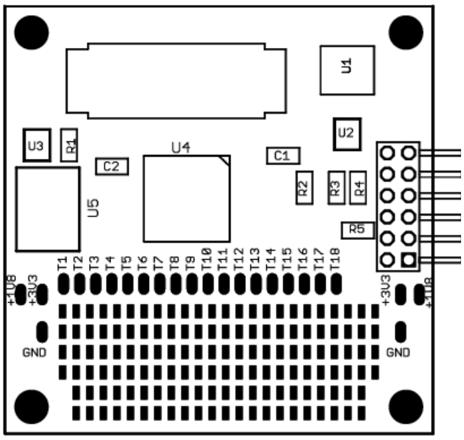


Figure 21: Micro.proto prototyping area and connector locations

8.4.1 SPI-interface

The SPI0 pins from the Sensinode Bus are connected to the CPLD XC2C64A. The default firmware uses the SPI0 to provide a GPIO interface to the GPIO pins connected to the soldering pads T3 to T18. For more information on how to use SPI0 see Section 12.

8.4.2 Programming Interface

For detailed information about the Micro.proto programming interface see the Micro.2420 Programming Interface section.

8.5 Absolute maximum ratings

Absolute maximum values are those values beyond which permanent damage to the device may occur.

Bus supply voltage Vcc	GND-0.3 to +3.6V
Bus IO Input Voltage	GND-0.3V to Vcc+0.3V
Bus IO Output Voltage	GND-0.3V to Vcc+0.3V
Current into Any IO-Pin	+-10mA
1-Wire Bus Voltage	GND-0.5V to +12V

8.6 Recommended operational conditions

Symbol	Parameter	Min	Typ	Max	Units
Vcc(3V3)	3.3V supply voltage	3.0	3.3	3.5	V
Vcc(1V8)	CPLD core voltage	1.7	1.8	1.9	V
Vio(1W)	1-wire bus voltage	2.8	3.3	6.0	V
Toperational	operational temperature	-40		+85	deg C
	operational current (1.8V)		15		uA

9 A500 Sensor IO

9.1 General Description

The Sensor IO module provides an easy way to test analog and digital IO capabilities of the Sensinode Micro.data and Micro.2420 modules. The module can be connected with a 12 pin flat cable to the Micro.2420 extension connector or to either of the Micro.data analog IO connectors.

The Sensor IO module has an illumination sensor (Intersil EL7900), a temperature sensor (Microchip TC1047) and a microphone. The module also has two push buttons and two software controllable LEDs.

9.2 Functional Diagram

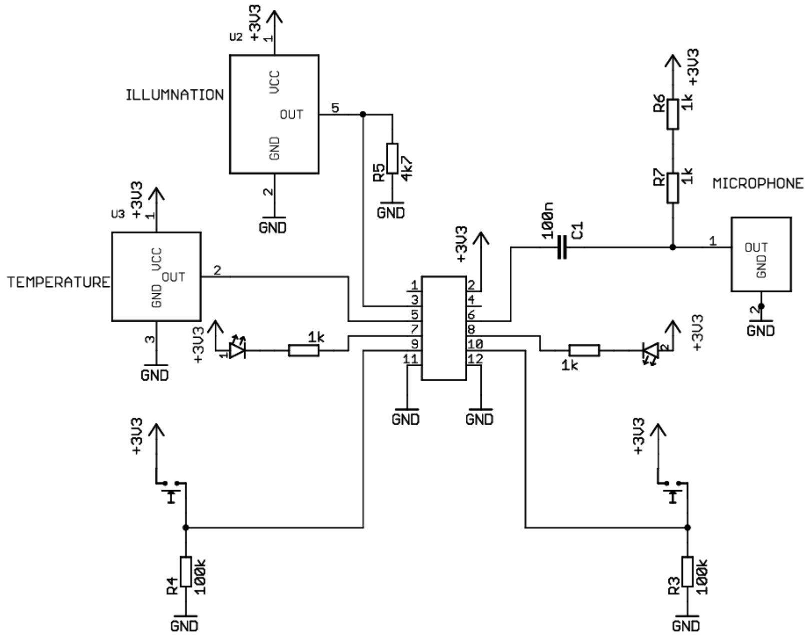


Figure 22: Sensor IO simplified schematic

9.3 Features

- Illumination sensor
- Temperature sensor
- Microphone
- 2 LEDs
- 2 push button switches
- RoHS compatible
- 40mm x 40mm size

9.4 Functional Description

9.4.1 Illumination sensor

The illumination sensor is EL7900 from Intersil. The current output is converted to voltage by R5. The voltage output is available at pin 3 at the connector.

9.4.2 Temperature sensor

The temperature sensor is TC1047 from Microchip. Voltage output is available at pin 5 at the connector.

9.4.3 Microphone

The microphone is a type EM9465P from Horn. The microphone is biased from +3.3V using R6 and R7. The AC coupled output voltage is available at pin 6 at the connector.

9.5 Absolute maximum ratings

Absolute maximum values are those values beyond which permanent damage to the device may occur.

3V3 supply voltage Vcc	GND-0.3 to +3.6V
IO voltage Vio	GND-0.3 to Vcc+0.3

9.6 Recommended operational conditions

Symbol	Parameter	Min	Typ	Max	Units
Vcc(3V3)	3.3V supply voltage	3.0	3.3	3.5	V
Toperational	operational temperature	-40		+85	deg C
Ioperational	operational current		0.4		mA

10 A100 USB Programmer

The A100 is a specialized portable USB programmer for all Sensinode Micro-series boards. It is used with the Sensinode Micro.proto board.

10.1 General Description

The Sensinode A100 USB programmer support the programming of the PLDs, PSoCs and MSP430-microcontrollers used in the Sensinode Micro-series products. The A100 USB programmer is connected to the Micro stack via the Micro.proto board.

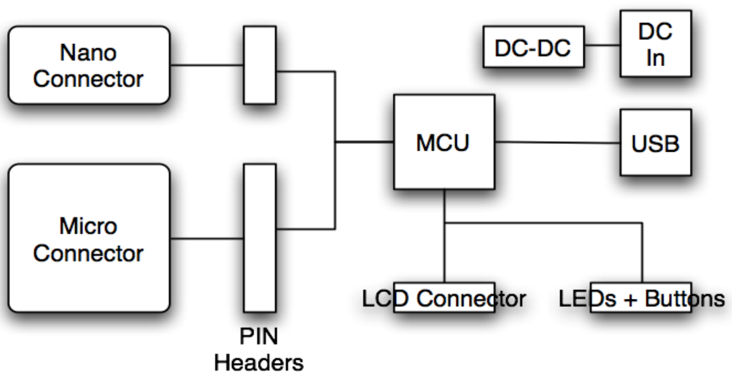
10.2 Features

- Portable programming solution for Sensinode Micro series products
- For use with Micro.compass board
- Can be used to program the PLDs, MSP430s and PSoCs on the micro series boards
- Software support for Linux and Windows (via Cygwin)

11 D100 Devboard

11.1 General Description

The Sensinode Devboard is a professional development tool for the laboratory test bench. The module has connectors for both Sensinode Micro and Nano Series modules and provides them with power. An on-module microcontroller provides programming capabilities for all chips. The module has a USB connector, power input, buttons and LEDs, and a connector for an optional character LCD display. A very handy feature for debugging, the Devboard includes pin headers for all the Micro and Nano Series bus signals.



11.2 Functional Diagram

11.3 Features

- All Sensinode Micro and Nano Series bus signals accessible via pin headers for easy debugging
- Full-speed USB connection to any PC computer
- USB drivers (FTDI 232B chip) available for Linux, OS X, and Windows
- Can program all Sensinode Micro and Nano Series modules
- Connector for a character LCD display (sold separately)
- 2 Buttons, 4 LEDs
- Connector for an external power supply
- RoHS Compatible
- 120 x 80 mm module size

11.4 Connector pinouts

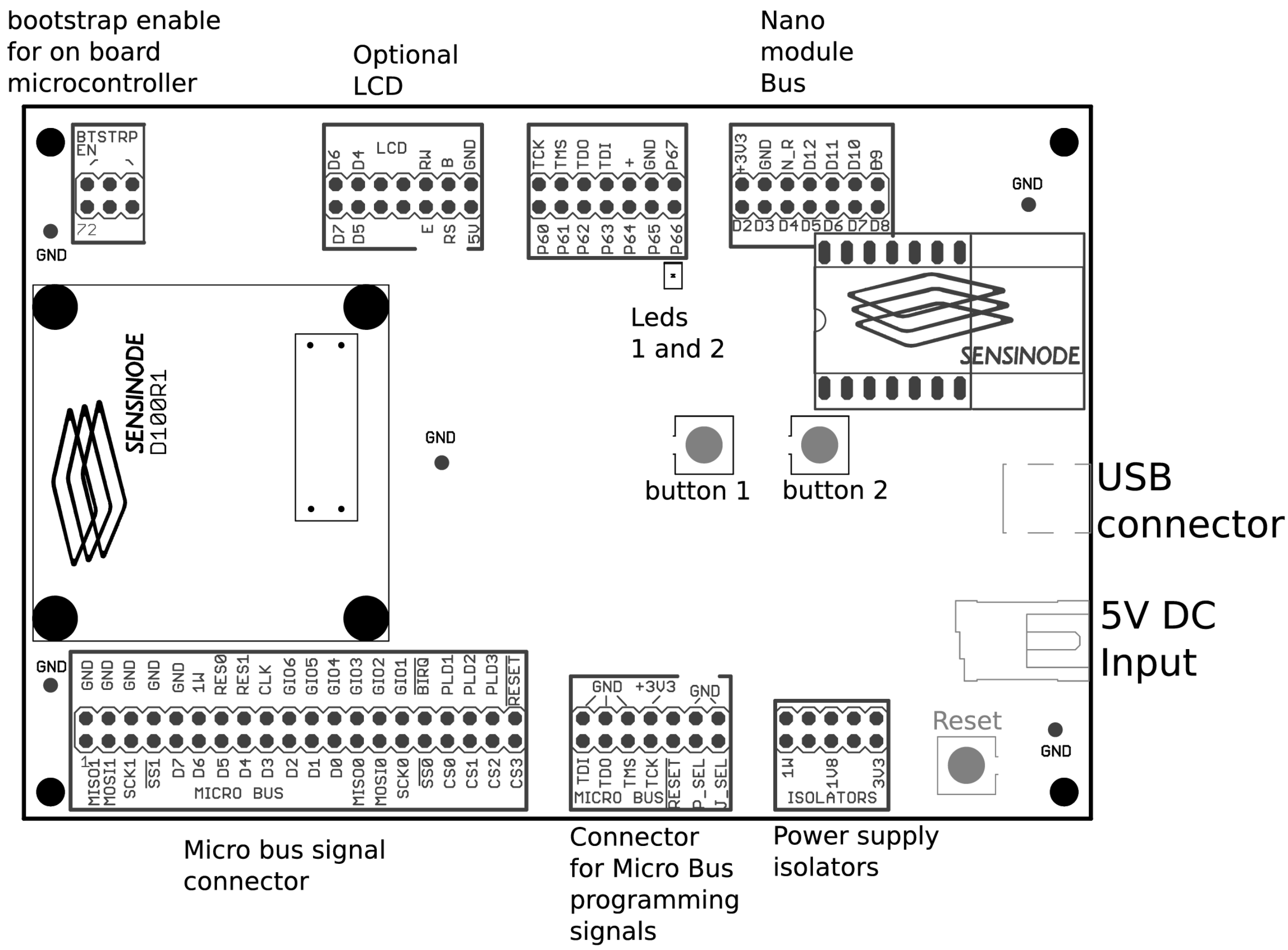


Figure 23: Development module version 1

11.5 Functional Description

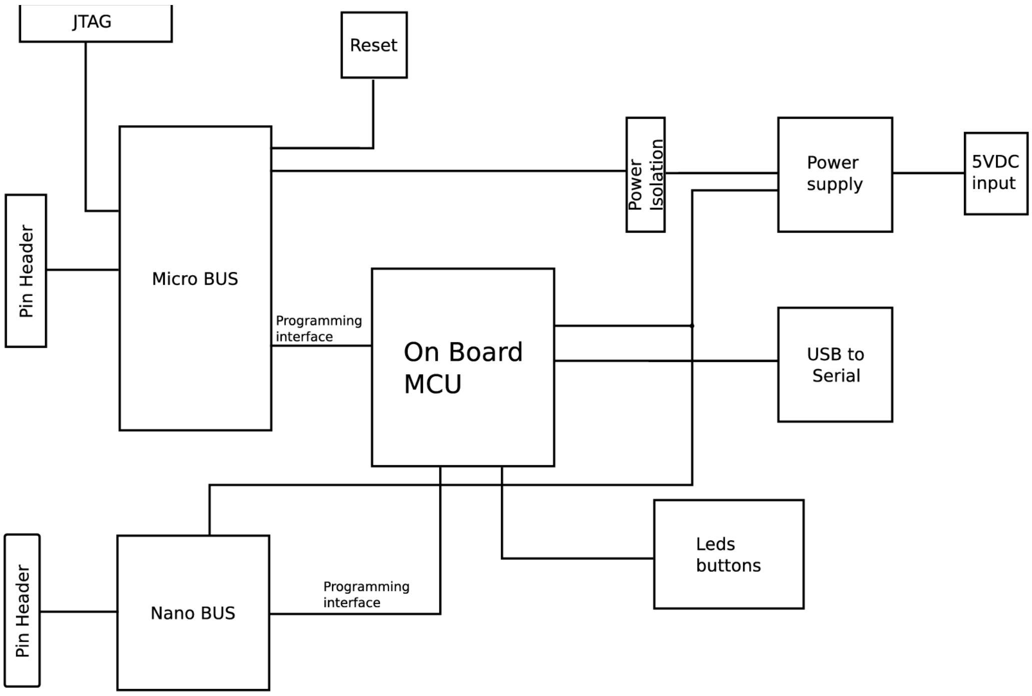


Figure 24: Devboard block diagram

11.5.1 Power Supply

The Devboard can be powered from the USB bus or from the DC input connector. The DC input connector is used with an external regulated 5V DC power supply module. DC connector center pin is ground.

The bus connector can be isolated from the power supply by using the 1V8 and 3V3 isolators on the development module. It should be noted that even when the micro-stack connected to the development module is isolated from the development module power supply the development module should be powered using an external power supply.

11.5.2 USB

The USB port on the Devboard can be used to update the Devboard firmware, to power the Development module and connected stack, to program the Sensinode Micro Series modules and to provide a serial console for debugging purposes. To update the Development module firmware two jumpers must be connected to BTSTRP_EN connector.

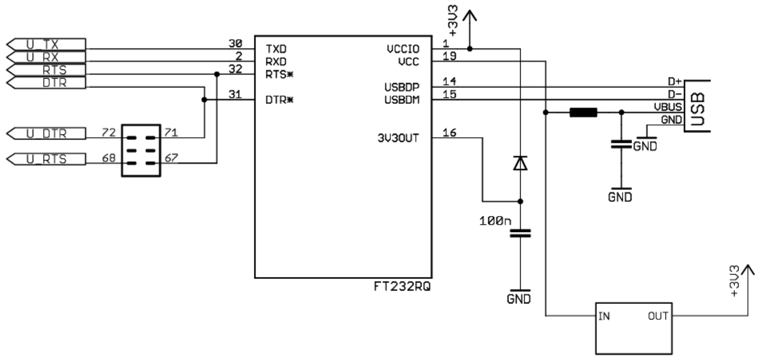


Figure 25: Development module USB subsystem

11.5.3 Reset

The reset button on the Devboard is connected to the bus connector on the board. It can be used to reset the Micro modules currently connected to the Devboard.

11.5.4 External Connectors

All Micro.bus signals are available on the pin header connectors on the Devboard.

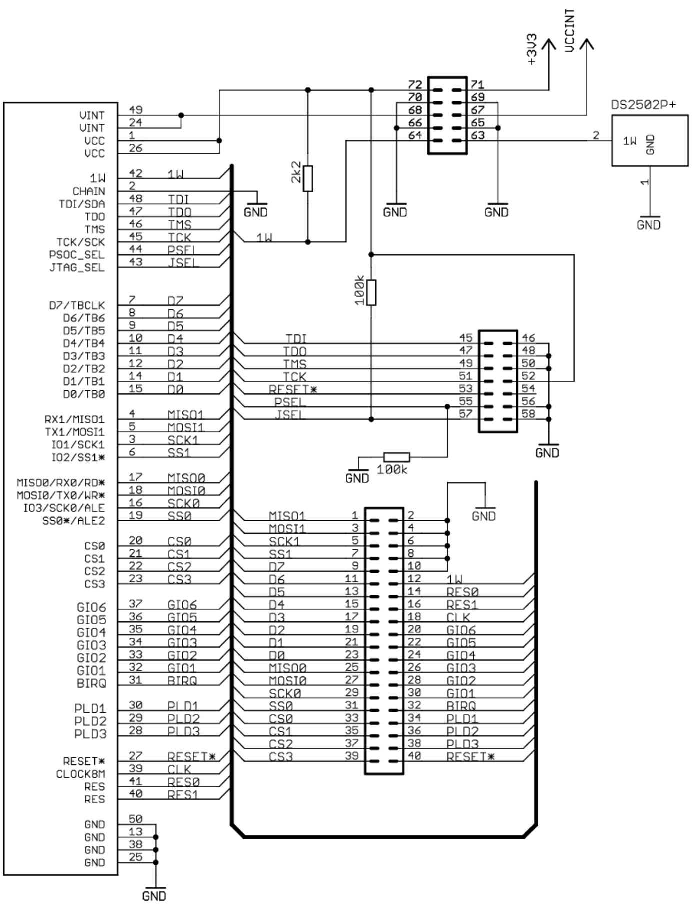


Figure 26: Development module bus connections

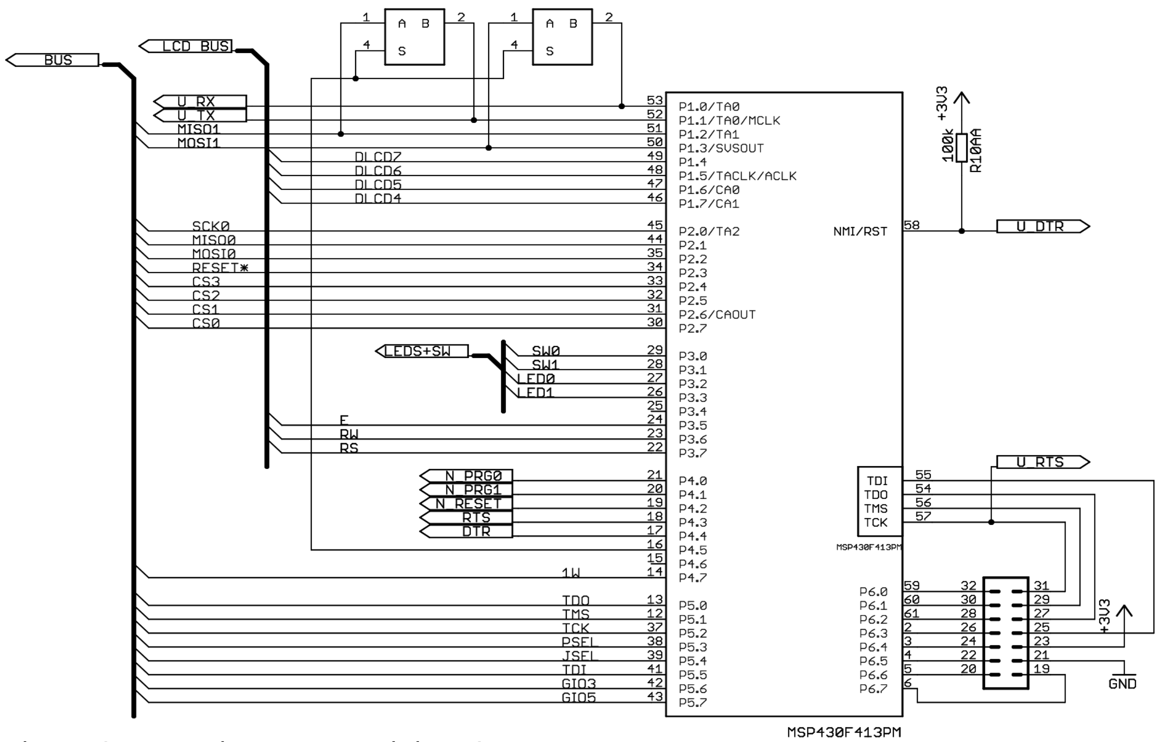


Figure 27: Development module MCU system

11.5.5 LCD connector

The LCD connector is used to connect a character LCD module to the Devboard. A voltage level translator is used to connect 5V LCDs to the Devboard.

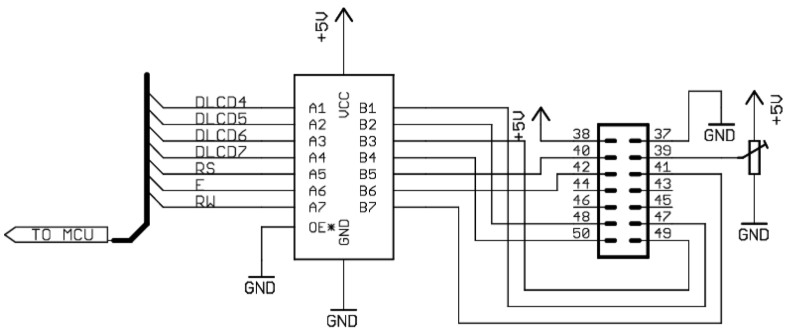


Figure 28: Development module LCD connector

11.6 Power measurements using D100

The Sensinode Micro series Devel board D100 can be used to measure the power consumption of a stack of micro boards. (Two 1 Ohm resistors and two DMMs are needed.)

To measure current using D100 replace the 3.3V and 1.8V power isolator jumpers with 1 Ohm resistors, then connect a Digital voltmeter (DMM) in parallel with each resistor. Set the DMMs to measure voltage. On the DMM display one volt means one ampere of current.

11.7 Absolute maximum ratings

Absolute maximum values are those values beyond which permanent damage to the device may occur.

5V Supply Voltage Vcc5V	GND-0.3 to +6.0V
Bus supply voltage Vcc	GND-0.3 to +3.6V
Bus IO Input Voltage	GND-0.3V to Vcc+0.3V
Bus IO Output Voltage	GND-0.3V to Vcc+0.3V
Current into Any IO-Pin	+-10mA
1-Wire Bus Voltage	GND-0.5V to +12V

11.8 Recommended operational conditions

Symbol	Parameter	Min	Typ	Max	Units
Vcc(3V3)	Bus 3.3V supply voltage	3.0	3.3	3.4	V
Vcc(5V)	DC input from external DC power supply	4.5	5.0	5.5	V
Vio(1W)	1-wire bus voltage	2.8	3.3	6.0	V
Toperational	operational temperature	0		+85	deg C

12 Software drivers

This chapter gives an overview of the Micro.2420 hardware support libraries. For the full API reference consult the NanoStack reference documentation in the `Docs` directory.

12.1 Micro.bus driver

The Micro.bus driver is located in *`Platform/micro`* directory, file *`bus.c`*.

The driver implements functions for module selection, SPI, UART and parallel mode communication over the control pins, basic MCU loop pause functions, basic 1-Wire bus support functions and hardware initialization.

Supporting functions allow:

- limited selection of SPI and UART speeds
- selection of most SPI and UART parameters

- 1-Wire search
- clock initialization
- bus locking

12.2 Micro.2420 GPIO driver

The Micro.2420 GPIO driver is located in *Platform/micro* directory, file *gpio.c*.

The driver implements functions for interrupt handler registration and LED control macros.

Supporting functions allow:

- LED initialization and control
- Port 1 and 2 interrupt handlers per pin
- Interrupt edge selection

12.3 Micro.2420 RF driver

The Micro.2420 RF driver is located in *Platform/micro* directory, file `rf.c`.

The driver implements basic receive and transmit functionality for the Chipcon CC2420 RF chip. It uses FreeRTOS tasks and queues for scheduling and the Micro.2420 bus and GPIO drivers for bus allocation, SPI functionality and interrupt allocation.

The radio chip is initialized in “packet driver” mode, where the host controller has full control over the radio, that is no automatic acknowledgements or beacon sending. The driver does not implement 802.15.4 headers or addresses, these are handled by the NanoStack 802.15.4 module.

Supporting functions allow:

- transmit power selection
- channel selection
- status printouts
- enabling and disabling receiver
- packet transmission with collision detection

12.4 Micro.2420 flash driver

The Micro.2420 flash driver is located in `Platform/micro` directory, in the file `flash.c`.

The driver implements basic support functions for accessing the external data flash on the Micro.2420 modules.

Supporting functions allow:

- writing single blocks
- reading blocks
- erasing sectors

12.5 Micro.Compass driver

The Micro.2420 flash driver is located in `Platform/micro` directory, in the file compass`.c`.

This driver gives an API to automatically configure and access the Micro.Compass board, which uses an SPI interface.

The driver allows the following:

- selection of the board
- setting of sampling intervals
- setting of accelerometer sensitivity
- check for status
- reading of sensor values

The compass board can be set in 4 different modes using *`compass_mode()`*: *`COMPASS_SHUTDOWN`*, where the power is off; *`COMPASS_AUTO`*, in which the compass board otherwise sleeps until an SPI event is detected; *`COMPASS_MAG`*, where magnetometers are continuously on; and *`COMPASS_ACC`*, where accelerometers are continuously on.

`compass_mag_interval()` and *`compass_acc_interval()`* set the time in ms between samples that the board automatically makes.

`compass_acc_range()` sets the sensitivity of the accelerometers, from 1.5G to 6G.

`compass_mag_read()` and *`compass_acc_read()`* are used with either of the modes and read all 3 axis at once from the board.

`compass_mag_read_single()` and *`compass_acc_read_single()`* are used to make a single read when the board is in shutdown mode.

There are limitations to how quickly the on-board processor can read sensors. To maximize reading, leave the board in COMPASS_ACC or COMPASS_MAG mode and do not unselect the board between reads.

12.6 Micro.Data

The Micro.Data board is a platform for developing PSoC firmware which processes analogue and digital inputs to the board and makes it available over SPI. In order to use this board, the user needs to develop software for, and program the PSoC on the board.

13 Firmware upgrades

The programs of all chips in the Sensinode Micro series are upgradeable by the user through the Devboard, including the firmware on the Devboard itself. In this section instructions for using programming tools for upgrading the MSP430, PSoC and PLD chips on Micro series hardware.

Firmware updates can always be downloaded from http://www.sensinode.com, check first that the firmware matches the model and revision of your hardware.

13.1 D100 firmware update

The update procedure is executed as follows:

- Download D100 firmware.
- Place jumpers to jumper positions 72 and 70 (marked BTSTRP EN).
- Use `msp430-bsl --invert-test --invert-reset` to program your board.
- Remove jumpers from positions 72 and 70.

13.2 PSoC firmware update

The update procedure is executed as follows:

- Make sure you have updated your D100 board to version 0.9.4 (or higher)
- Download the required firmware for your product. The product code is printed on the PCB.
- Download the programmer for your PC architecture/OS.
- Place the product on your D100 board. Note that only one module should be attached on the D100 when programming PSoCs.
- The programmer tool has full command line help facility. To program, use the following command line options:

  `programmer -d <serial device> -p -P <firmware.hex>`

13.3 PLD update

- The update procedure is executed as follows:
- Make sure you have updated your D100 board to version 0.9.4 (or higher)
- Download the required firmware for your product. The product code is printed on the PCB.
- Either download the correct XSVF file for your stack configuration or generate one using JED files and an XSVF generation tool such as Xilinx Impact.
- Place your stack on the D100 board.
- Download the programmer for your PC architecture/OS.
- The programmer tool has full command line help facility. To program, use the following command line options:

  `programmer -d <serial device> -j -w <firmware.xsvf>`
- The programming sequence takes a long time. This is caused by the fact

that XSVF processing over the UART is not highly efficient.

14 Drawings

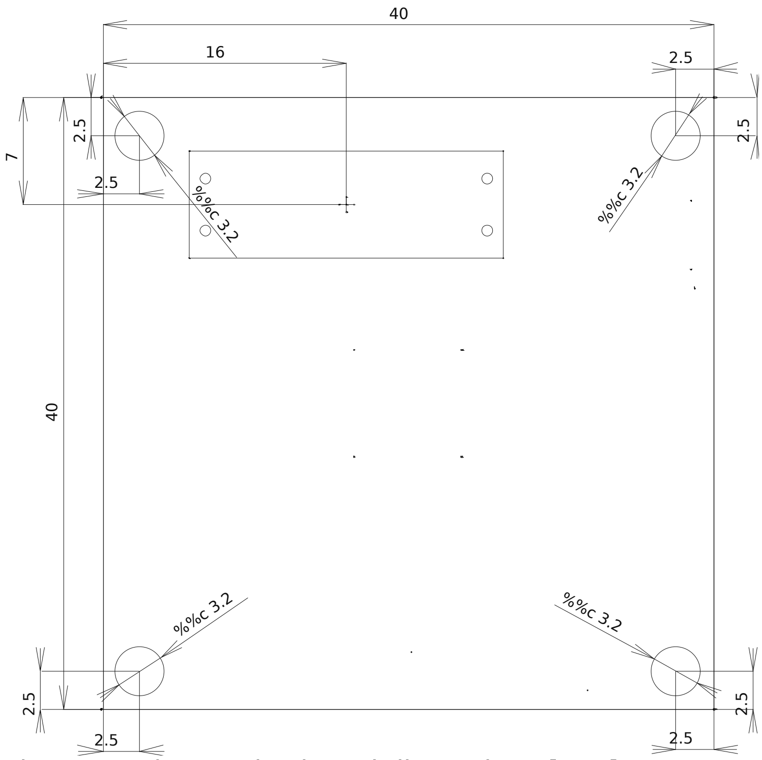


Figure 1: Micro-series board dimensions [mm]