# Z1 Datasheet

ZOLERTIA™

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v1.1

# Contents

Z1 by Zolertia is a low-power wireless sensor network (WSN) module that serves as a general purpose development platform for WSN developers, re–searchers, enthusiasts and hobbyists.

This module has been devised from the beginning with two clear goals in mind:

> i. maximum backwards compatibility with the successful Tmote-like fam-ily motes while improving the performance in several aspects, and
>
> ii. maximum flexibility and expandability with regards to any combination of power-supplies, sensors and connectors.

It comes with support for some the currently most employed open source operating systems by the WSN community, like TinyOS 2.x (currently available) and Contiki (coming soon). The network stacks supported include 6LowPAN (by means of BLIP in TinyOS), Texas Instruments' SimpliciTI and Z-Stack (up to Zigbee 2006), and soon it will also support: Freaklabs' open source Zigbee stack, and Freaklabs' Chibi.

## Product Summary

The Z1 is a low power wireless module compliant with IEEE 802.15.4 and Zigbee protocols intended to help WSN de–velopers to test and deploy their own applications and prototypes with the best tradeoff between time of development and hardware flexibility.

Its core architecture is based upon the MSP430+CC2420 family of microcontrollers and radio transceivers by Texas Instru–ments, which makes it compatible with motes based on this same architecture. However, the MCU present in Z1 is the MSP430F2xxx instead of the MSP430F1xxx, as is customary among other motes, like Crossbow's TelosB, Moteiv's Tmote, and alike. This fact entails subtle differences due to inner changes between F1xxx and F2xxx devices, but these differences are not expected to arise at the firmware application level if a supported operating system is employed when developing.

## Applications

- Immersing your device in the Internet of Things (IoT)
- Personal healthcare monitoring
- Environmental monitoring
- Emergency detectors
- Safe and rescue devices
- Long-term unattended monitoring
- Energy Metering
- Agricultural monitoring

## Product Features

- Ideal development platform for rapid prototyping/deployment of WSNs
- Industrial-grade temperature range (-40ºC-85ºC)
- 52-pin expansion connector
- 2$^{nd}$ generation MSP430™ ultra-low power 16-bit MCU 16MHz
- 2.4GHz IEEE 802.15.4, 6LowPAN compliant and ZigBee™ ready
- 3-Axis, ±2/4/8/16 g digital accelerometer
- Low-power digital temperature sensor with ±0.5ºC accuracy (in –25°C ~ 85°C range)
- Optional external antenna via U.FL connector
- Micro-USB connector for power and debugging

## Electrical Characteristics

The Z1 WSN Module is specified to be used in the industrial range of temperatures. Nominally, it should be powered at 3V, although it may work partially or totally since 1.8V (w/o radio) or 2.1V (w/ radio). A brief description and approximate current consumption for the integrated circuits in the Z1 are presented in Table 1 as a reference. These values may help the de – veloper compute an estimate of the average consumption depending on how long each IC is working in each mode.

| IC | Operating Range | Current Consumption | Notes |
|---|---|---|---|
| MSP430f2617 | 1.8V to 3.6V | 0.1µA<br>0.5µA<br>0.5mA<br>< 10mA | OFF Mode<br>Standby Mode<br>Active Mode @1MHz<br>Active Mode @16MHz |
| CC2420 | 2.1V to 3.6V | <1µA<br>20µA<br>426µA<br>18.8mA<br>17.4mA | OFF Mode<br>Power Down<br>IDLE Mode<br>RX Mode<br>TX Mode @ 0dBm |
| ADXL345 | 1.8V to 3.6V | 0.1µA<br>40uA to 145uA | Standby<br>Active Mode |
| M25P16 | 2.7V to 3.6V | 1µA<br>4mA to 15mA | Deep Power Down<br>Active Mode |
| TMP102 | 1.4V to 3.6V | 1µA<br>15µA | Shutdown Mode<br>Active Mode |

*Table 1 — Approximate Current Consumption of Z1 circuits.*

### *Absolute Maximum Ratings*

The specifications for the absolute maximum ratings of the Z1 WSN Module as a whole component can be seen in Table 2:

| Description | Rating |
|---|---|
| Power Supply Voltage Vcc | –0.3V to +3.6V |
| Voltage on any digital Pin | –0.3 to Vcc+0.3V |
| Max. RF Input Power | 10dBm |
| Storage Temperature Range | –40°C to +105°C |
| Operating Temperature Range | –40°C to +85°C |

*Table 2 — Absolute Maximum Ratings*

The module is specified to function properly in the industrial temperature range.

## Mechanical Characteristics

In Figure 1 the dimensions of the Z1 are depicted. Note that all the pins of the expansion connector are aligned to a 0.1" (2.54mm) standard grid, and this is as well the pitch of the connectors in order to make it pluggable in any standard perf – board PCB, and the slight asymmetry between JP1A and JP1C avoids misleading when connecting it upwards or down – wards.

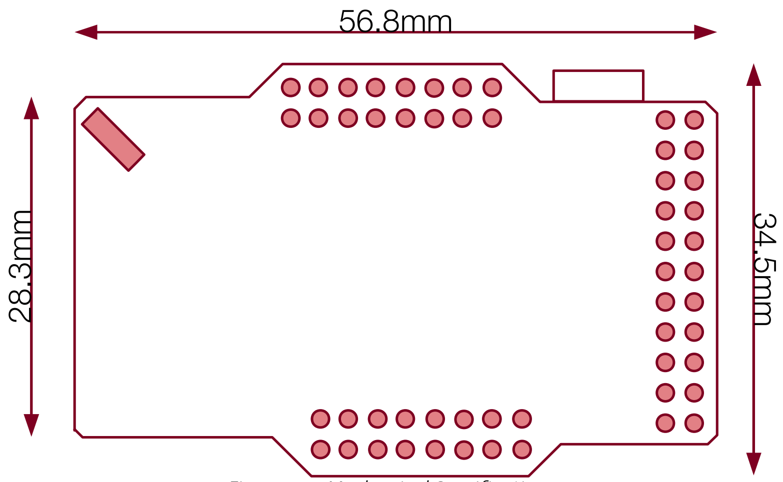


*Figure 1 — Mechanical Specifications*

# Getting Started

## Box Contents

Depending on the kit you have ordered, you may have obtained Z1 WSN modules in different option packages. However, any of the kits will come with the following basic parts:

- 1 or more Z1 WSN modules
- 1 or more USB A to Micro-B cables
- 1 battery pack per ordered module
- (Optional) Enclosure for Z1 with compartment for 2xAAA or 2xAA batteries
- (Optional) 1 or more phidgets connectors soldered on board

## Functional Block Diagram

A general functional block diagram can be seen in Figure 2.

In it, you can see the MCU at the center of the module, controlling all the peripherals except for the programming one. On-board the Z1 has two sensors: a digital temperature sensor with a , and a programmable digital accelerometer.

There is a USB connector for powering, programming and communication while developing, and a JTAG header for full de–bugging capabilities. Along the USB, there are other digital communication buses supported like I2C, SPI and UART. The UART, however, uses 0V and 3V so its voltage levels do not allow the Z1 to be connected to a RS232 (where voltages are +12V and -12V).

There are 2 ports available for 3V phidgets, although up to 4 phidgets (2x5V and 2x3V) could be hooked up to the Z1 (see page 8 for more details). These ports are basically ADCs and DACs, and can be used with other analog sensors as well.

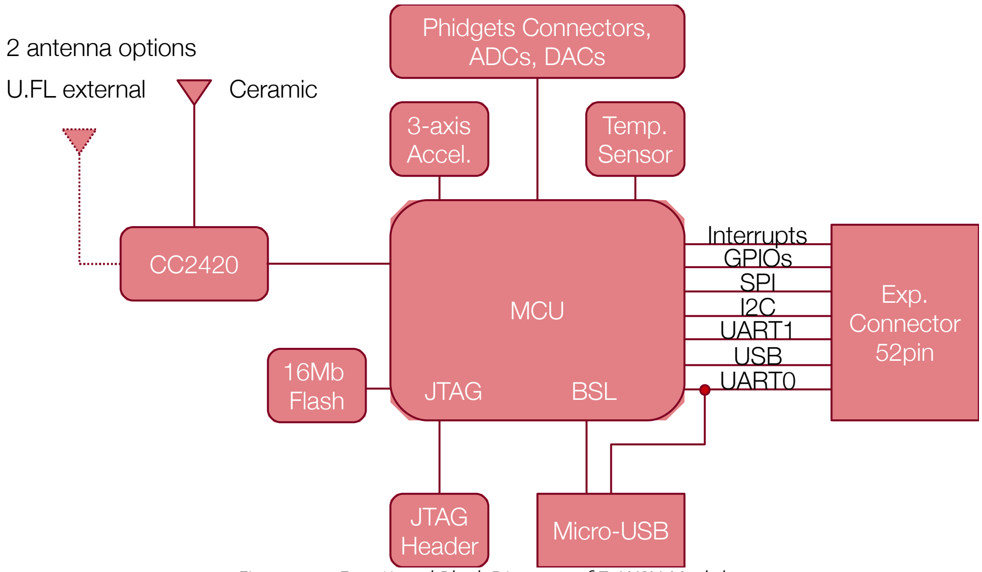


*Figure 2 — Functional Block Diagram of Z1 WSN Module*

## Powering the Z1 (basic)

Z1 can be powered in several ways, depending on the required application. However, the two easiest and most important ways to power the Z1 are

- Battery-powered: using 2xAA or AAA cells or 1xCR2032 coin cell in the battery-holder (depending on order)
- USB-powered: just connect the Z1 to the USB via the supplied microUSB cable

Both power supplies can coexist simultaneously, but it is our recommendation that the batteries are removed from the battery holder if you intend to be using the Z1 connected to the USB cable for a long time while developing.

## Expansion Connector (XPcon)

The Z1 module has been conceived with expandability in mind. For that reason, there exist an expansion connector (XPcon) divided in several ports, basically grouping each type of connectivity in each cardinal direction. So, as it can be seen in Figure 3, there are basically 3 groups of pins with a 0.1”-pitch, plus an RF port that allows the module to be used in a network of any topology (peer-to-peer, star, mesh, etc.). These group of ports are:

- **North port** — Intended for Analog I/O. Here one can find all the available ADCs (up to 8) and DACs (up to 2).
- **East port** — Intended for digital buses connectivity (USB, I2C, SPI, 2xUARTs) as well as some GPIOs and powers and ground.
- **South port** — Intended for GPIOs as well as other configurable functions like interrupt input pins, comparator inputs, 1Wire. Also, some of the pins are already in use by some features of the Z1 and can thus be monitored or intercepted for another application from here.
- **West port** — Intended for wireless communication, either by embedded antenna or external antenna, using any supported wireless network protocol like Zigbee, 6LowPan, etc.

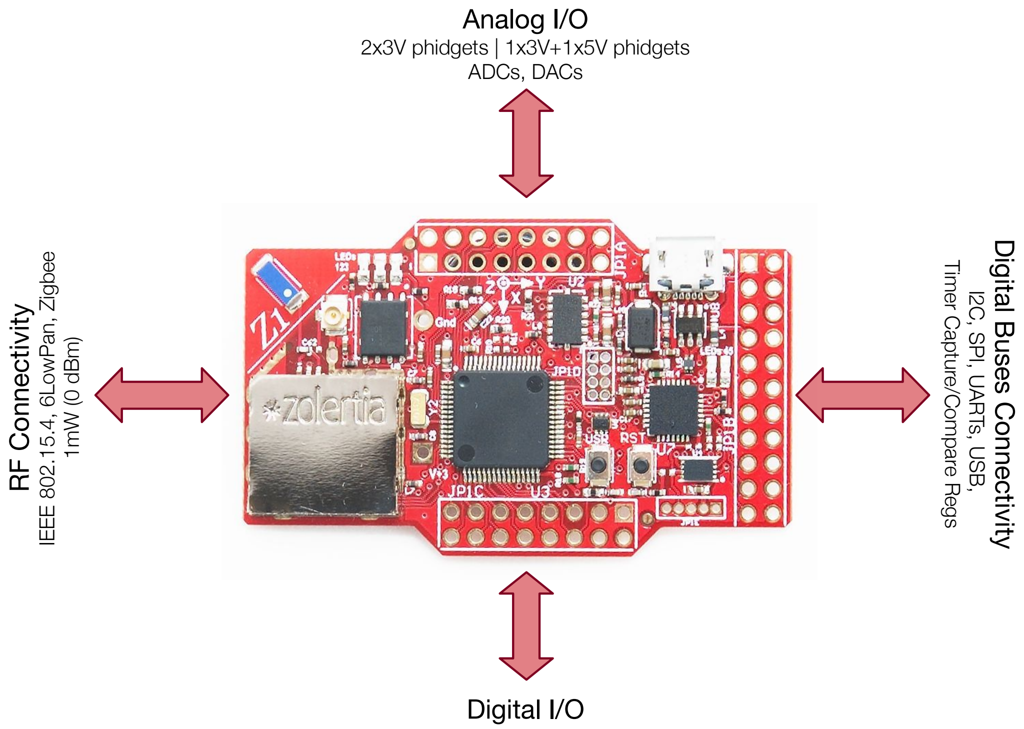



*Figure 3 — Z1 Expansion Capabilities (54-pin XPCon)*

## Expansion Connector Pinout and Description

### *North Port (JP1A)*

The North Port is meant to connect the Z1 to the analog world. There you can find all DACs and ADCs available at the MCU.

Some of the connections are wired so that a *phidget* connector can be soldered directly on the Z1 PCB, and for you to be able to use your Z1 with any of the sensors available by third-party www.phidgets.com, or any of your choice with the same pinout. The pinout for the wires connecting the Z1 and the sensor is the one you can see in Figure 4


*Figure 4 — Phidget Cable Connector*

The Z1 supports 3V analog sensors by default, since the circuitry in the board is powered at this same nominal voltage (al – though note that it may be lower if powered with 2 NiMH cells). However, it also supports two 5V sensors (via ADC3 and ADC0), although in this case it must me taken into account that 5V are required in the USB+5V power net, and also that the level translator at the ADC input is implemented via a resistor divider, as noted in Figure 5 and the following table. Remember you may need to take that input impedance into account when interfacing your own 5V sensors.

| JP1A | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Features** | **MSP430 Port#** | **Pin Name** | **Pin#** | | **Pin Name** | **MSP430 Port#** | **Features** |
| *Phidget powered @5V, ADC input has resistor divider to allow 5V inputs* | | **ADCGND** | 1 | 2 | **ADCGND** | | *Phidget @3V* |
| | | **USB+5V** | 3 | 4 | **Vcc+3V** | | |
| | P6.3 | ADC3* | 5 | 6 | ADC7 | P6.7 | |
| | P6.4 | ADC4 | 7 | 8 | ADC6/DAC0 | P6.6 | |
| | P6.2 | ADC2 | 9 | 10 | ADC5/DAC1 | P6.5 | |
| *Phidget powered @5V, ADC input has resistor divider to allow 5V inputs* | | **ADCGND** | 11 | 12 | **ADCGND** | | *Phidget @3V* |
| | | **USB+5V** | 13 | 14 | **Vcc+3V** | | |
| | P6.0 | ADC0* | 15 | 16 | ADC1 | P6.1 | |

*Table 3 — JP1A Pinout description*

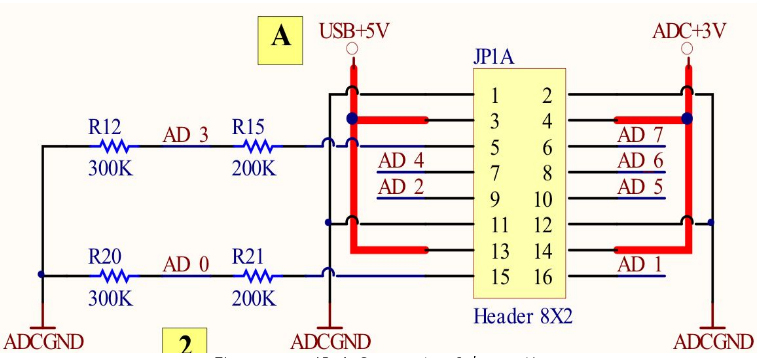



*Figure 5 — JP1A Connector Schematic*

The recommended standard connector headers, housing and crimps for use with phidgets are manufactured by Molex:

- Housing: Molex 3 Position Cable Connector 50-57-9403
- Wire Crimp: Molex Wire Crimp Insert for Cable Connector 16-02-0102
- Header: Molex 3 Position Vertical throughole PCB Connector 70543-0002
- Header: Molex 3 Position Right-Angle throughole PCB Connector 70553-0002 Gold, 70553-0037 Tin, or 15-91-2035 SMT

One can notice from the forementioned and by looking at the Figure 6 that in a standard fashion, due to the size of the head – er, the Z1 supports 2 phidgets at the same time, being each of these either 3V or 5V sensors. However, note also that it is feasible to connect up to 4 phidgets if we carefully chose other header/housing pair different from the Molex connectors suited for phidgets, like e.g. standard 0.1”/2.54mm pins and headers. Of course, it is up to the user to do so.

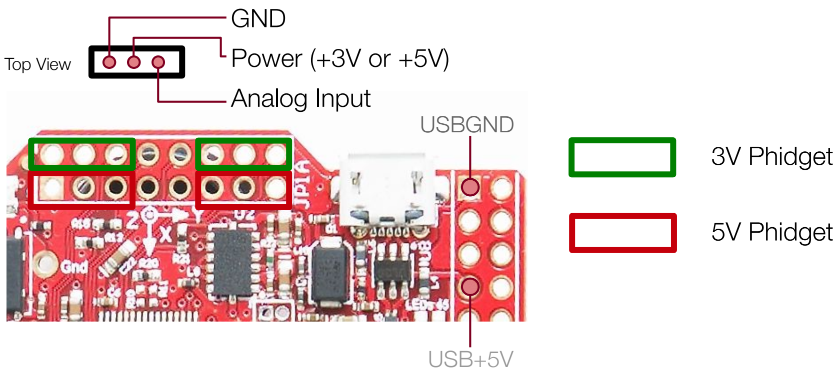



*Figure 6 — JP1A PCB closeup highlighting phidget connectors*

## East Port (JP1B)

This port is mostly dedicated to digital bus interfaces: UART1, UART0, I2C, SPI, as well as USB from the computer host. However, along these pins, you can also find some GPIOs, or capture and compare inputs to the timer B.

| JP1B | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Features** | **MSP430 Port#** | **Pin Name** | **Pin#** | | **Pin Name** | **MSP430 Port#** | **Features** |
| | | **USBGND** | 17 | 18 | **CPDGND** | | |
| | | D_P | 19 | 20 | **CPD+3.3V** | | |
| | | D_N | 21 | 22 | **D+3V** | | |
| | | **USB+5V** | 23 | 24 | **DGND** | | |
| | P5.0 | TEMP_PWR | 25 | 26 | I2C.SCL | P5.2 | |
| | P4.7 | JP.P4.7/TBCLK | 27 | 28 | I2C.SDA | P5.1 | |
| | P5.3 | JP.P5.3/UCB1CLK | 29 | 30 | JP.P4.2/TB2 | P4.2 | |
| | P3.7 | UART1.RX | 31 | 32 | JP.P4.0/TB0 | P4.0 | |
| | P3.6 | UART1.TX | 33 | 34 | SPI.CLK | P3.3 | |
| | P3.5 | UART0.RX | 35 | 36 | SPI.SIMO | P3.1 | |
| | P3.4 | UART0.TX | 37 | 38 | SPI.SOMI | P3.2 | |

*Table 4 — JP1B Pinout description*

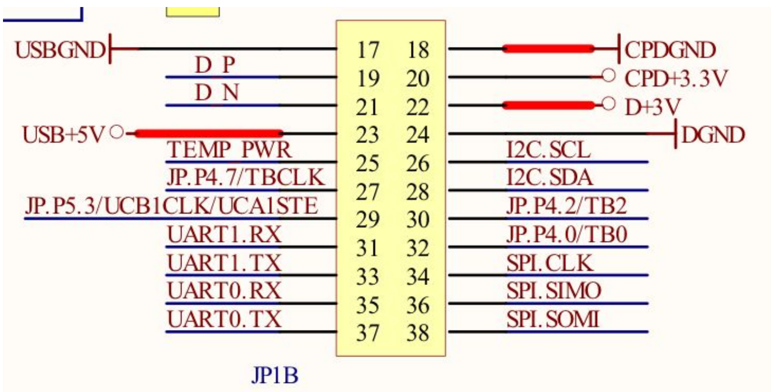



*Figure 8 — JP1B Schematic pinout*

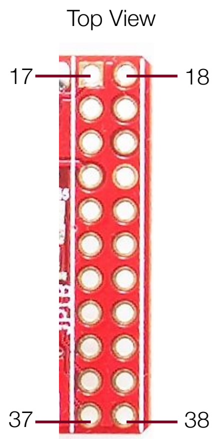



*Figure 7 — JP1B PCB Closeup*

## South Port (JP1C)

In the south port you can find the interrupt-capable pins, comparator outputs and inputs, and Timer A compare/capture among others. As usual, most of these pins can be used also as GPIOs. Note that since all P1.x and P2.x ports have input interrupt capabilities, most of the pins in this port do have such feature, if they are not already being used as such.

| JP1C | | | | | |
|---|---|---|---|---|---|
| **MSP430 Port#** | **Pin Name** | **Pin#** | | **Pin Name** | **MSP430 Port#** |
| P1.0 | JP.INT_P1.0/CAOUT | 54 | 53 | BSL_TX | P1.1 |
| P1.6 | P1.6/TA1 | 52 | 51 | JP.P1.5/TA0 | P1.5 |
| P1.7 | P1.7/TA2 | 50 | 49 | JP.P2.0/ACLK/CA2 | P2.0 |
| P2.1 | JP.P2.1/TAINCLK/CA3 | 48 | 47 | BSL_RX | P2.2 |
| P2.3 | JP.P2.3/CA0/TA1 | 46 | 45 | P2.4/CA1/TA2 | P2.4 |
| P2.5 | UserINT | 44 | 43 | JP.P2.6/ADC12CLK/DMAEO/CA6 | P2.6 |
| P4.3 | JP.P4.3/TB3 | 42 | 41 | ALERT | P2.7 |
| | **D+3V** | 40 | 39 | **DGND** | |

*Table 5 — JP1C Pinout description*

Although some of the pins have a predetermined function and they could theoretically be shared with other functionalities (e.g. BSL_TX, BSL_RX, UserINT, etc.), we do not recommend reusing these pins for other purposes to avoid problems.

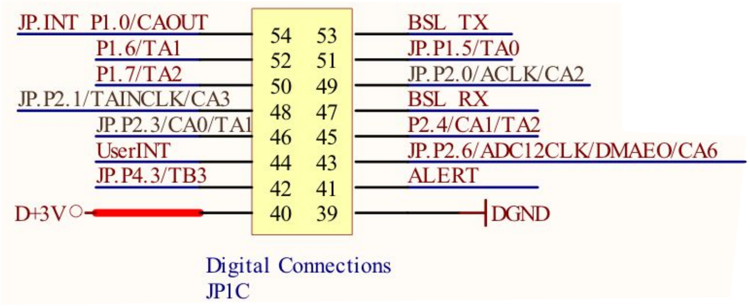



*Figure 9 — JP1C Schematic pinout*

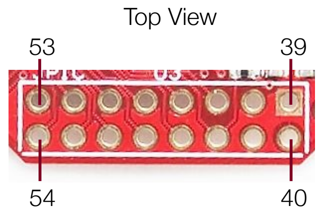



*Figure 10 — JP1B PCB Closeup*

## West Port

The west port is actually the RF port, expected to allow the Z1 to wirelessly link to other Z1 or compatible wireless modules using a compatible wireless stack (Zigbee, 6LowPAN, 802.15.4) in any form of network topology, e.g. point-to-point (P2P), mesh, star, etc. depending on your requirements, current stack availability and so forth.

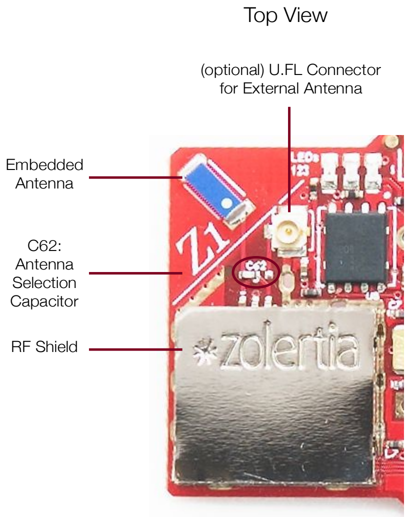



*Figure 11 — RF Closeup*

As you can see in the figure above, there exists an output capacitor (C62) that selects whether the antenna to be used is the embedded antenna or the external U.FL. You can use this connector to attach any other type of antenna you require for your application, like SMA, N, or any other one via an adapter to U.FL.

# Detailed Design Information

## Powering the Z1 (advanced)

The Z1 can be powered in several other ways apart from those explained in page 7. Some of them are more straightforward than others, but all of them carefully executed will hopefully lead to a satisfying application.

The user must keep in mind that by default the mote is intended to run at 3V, either via 2-cell battery or via the 5V to 3V reg – ulator integrated in the CP2102 (USB-to-UART bridge). The 2-cell battery is usually expected to have its connectors soldered on the two big vias between the RF shield and the MSP430, marked as *V+3* and *GND* on the silk, or as **D+3V** and **DGND** in the schematics. Alternatively, it can also be powered via any pair of pins in the XPCon, like (**22**, **24**) or (**40**, **39**).

The advantage of powering the Z1 via USB is that the two ports with 5V phidgets will be powered at 5V, and hence phidgets working at this voltage will be working. The disadvantage of doing so is the current that the USB-to-UART will draw (~80µA).

On the bottom of the Z1 there is a footprint for a coin-cell battery holder, in particular the , for a CR2032. Feel free to employ it in your projects or applications to power the Z1, although you should take into account the caution note below.

### *Important Caution Notes*

- Although there is no problem if the user connect the Z1 to the USB while keeping the batteries in the holder, note that it is highly recommendable to remove the batteries of their holder if it is foreseeable that the Z1 will be connected for a long time to the USB port for development, for example.
- If you power the Z1 with a coin cell battery note that your firmware should employ ultra-low-power consumption techniques if you want to make it last, since these batteries are designed to draw a maximum of 3mA before degrading their performance substantially.

## MSP430 Port Performance

In this section we try to answer the so many times question posed regarding the amount of current the MSP430 is capable of handling in its I/O pins.

From the Texas Instruments' datasheet, we see that the maximum current that the MSP430 can handle, is 1.5mA if we can allow a 0.25V dropout, or 6mA if we can allow for a 0.6V voltage dropout (either from Vcc or from Vss).

**outputs - ports P1 through P8**

| PARAMETER | | TEST CONDITIONS | $V_{CC}$ | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | $I_{OH(max)}$ = −1.5 mA (see Note 1) | 2.2 V | $V_{CC}$−0.25 | $V_{CC}$ | V |
| | | $I_{OH(max)}$ = −6 mA (see Note 2) | | $V_{CC}$−0.6 | $V_{CC}$ | |
| | | $I_{OH(max)}$ = −1.5 mA (see Note 1) | 3 V | $V_{CC}$−0.25 | $V_{CC}$ | |
| | | $I_{OH(max)}$ = −6 mA (see Note 2) | | $V_{CC}$−0.6 | $V_{CC}$ | |
| $V_{OL}$ | Low-level output voltage | $I_{OL(max)}$ = 1.5 mA (see Note 1) | 2.2 V | $V_{SS}$ | $V_{SS}$+0.25 | V |
| | | $I_{OL(max)}$ = 6 mA (see Note 2) | | $V_{SS}$ | $V_{SS}$+0.6 | |
| | | $I_{OL(max)}$ = 1.5 mA (see Note 1) | 3 V | $V_{SS}$ | $V_{SS}$+0.25 | |
| | | $I_{OL(max)}$ = 6 mA (see Note 2) | | $V_{SS}$ | $V_{SS}$+0.6 | |

NOTES: 1. The maximum total current, $I_{OH(max)}$ and $I_{OL(max)}$, for all outputs combined, should not exceed ±12 mA to satisfy the maximum voltage drop specified.

2. The maximum total current, $I_{OH(max)}$ and $I_{OL(max)}$, for all outputs combined, should not exceed ±48 mA to satisfy the maximum voltage drop specified.

*Figure 12 — Output Ports Electrical Characteristics*

This behaviour can be understood as a continuous trade-off between maximum input/output port current, typical of FET-based output drivers. From the same datasheet, we can see the whole curve characteristic, so that we can take it into account when connecting other our sensors or actuators to these ports.

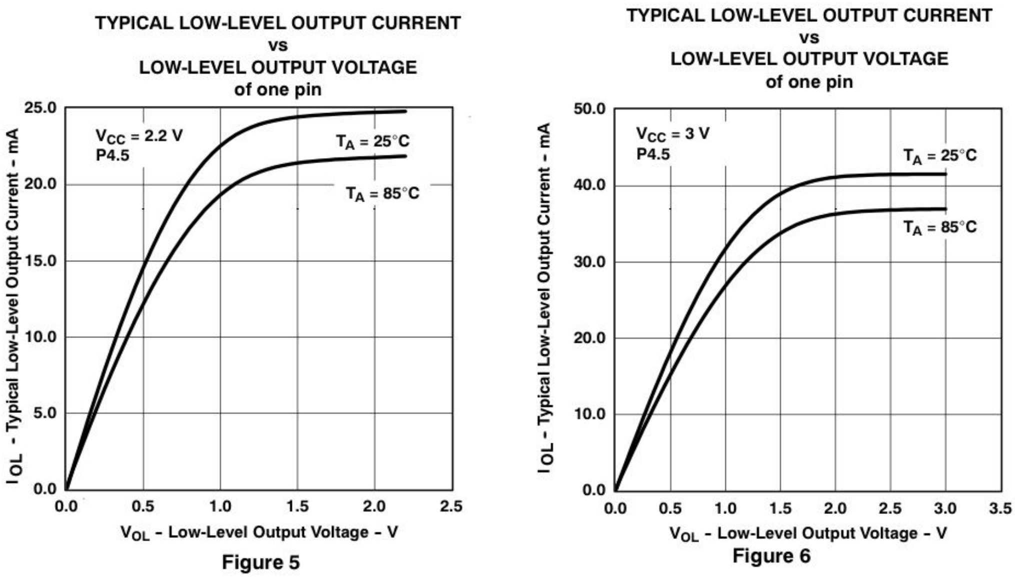



*Figure 13 — MSP430 Ports' Voltage Dropout vs. Output Current Trade-Off (Low-Level)*

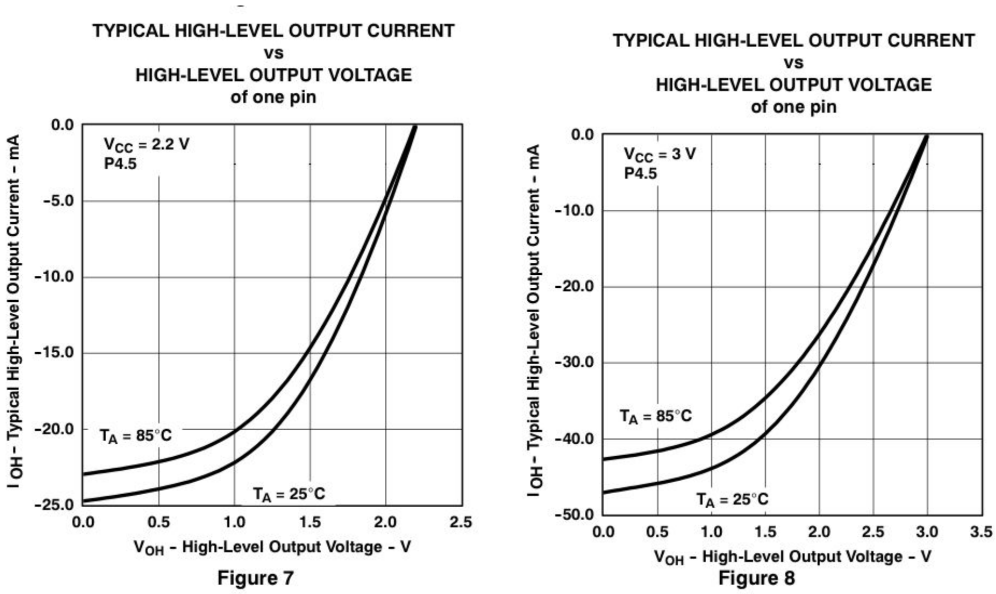



*Figure 14 — MSP430 Ports' Voltage Dropout vs. Output Current Trade-Off (High-Level)*

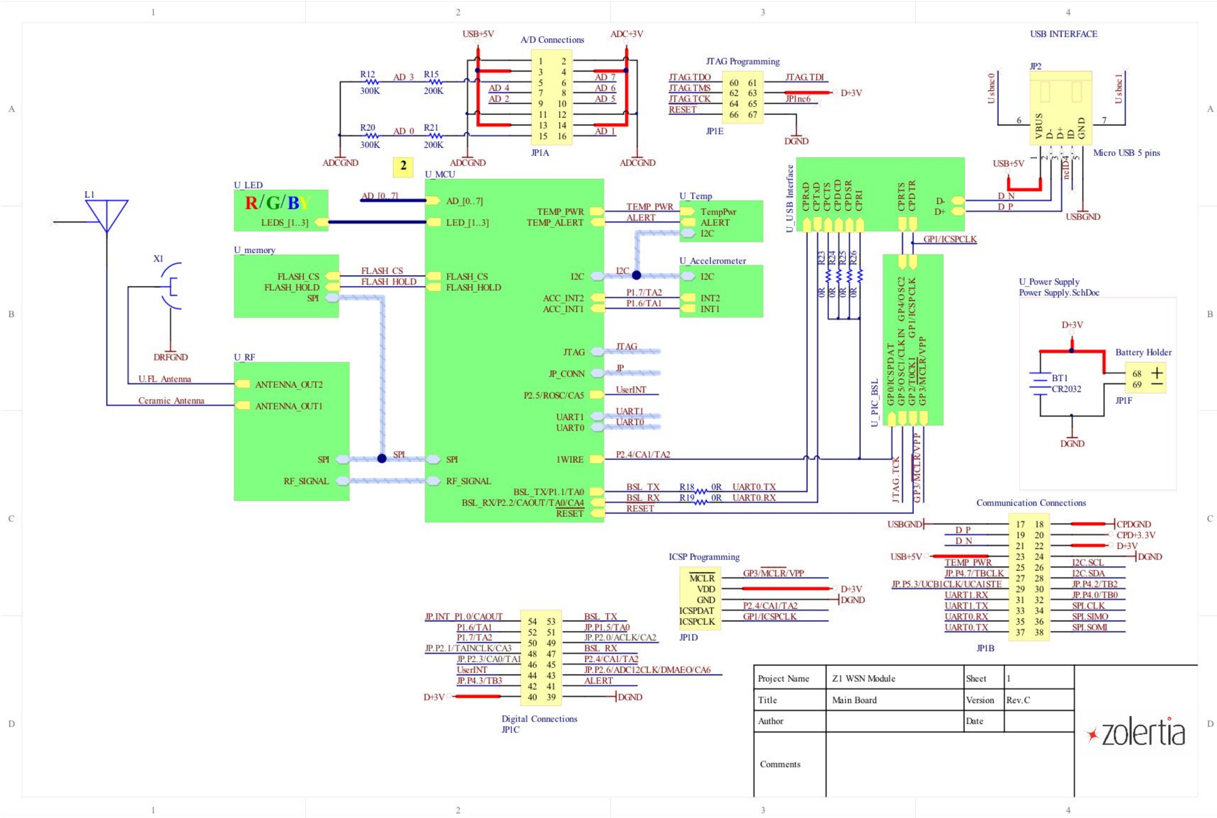
## Temperature Sensor TMP102 by Texas Instruments

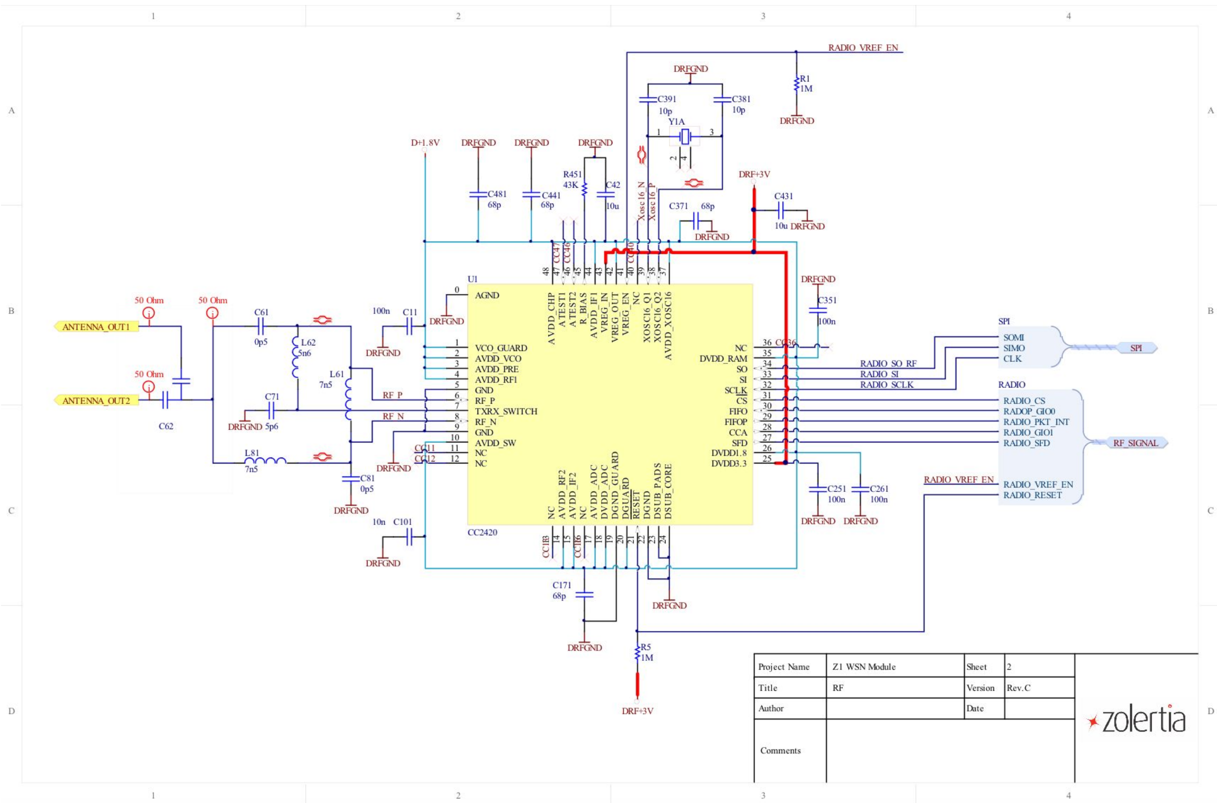
The TMP102 is a two-wire, serial output temperature sensor available in a tiny package, with an accuracy of 0.5°C in the –25°C to +85°C range (although it is specified for operation over the extended –40°C to +125°C range)

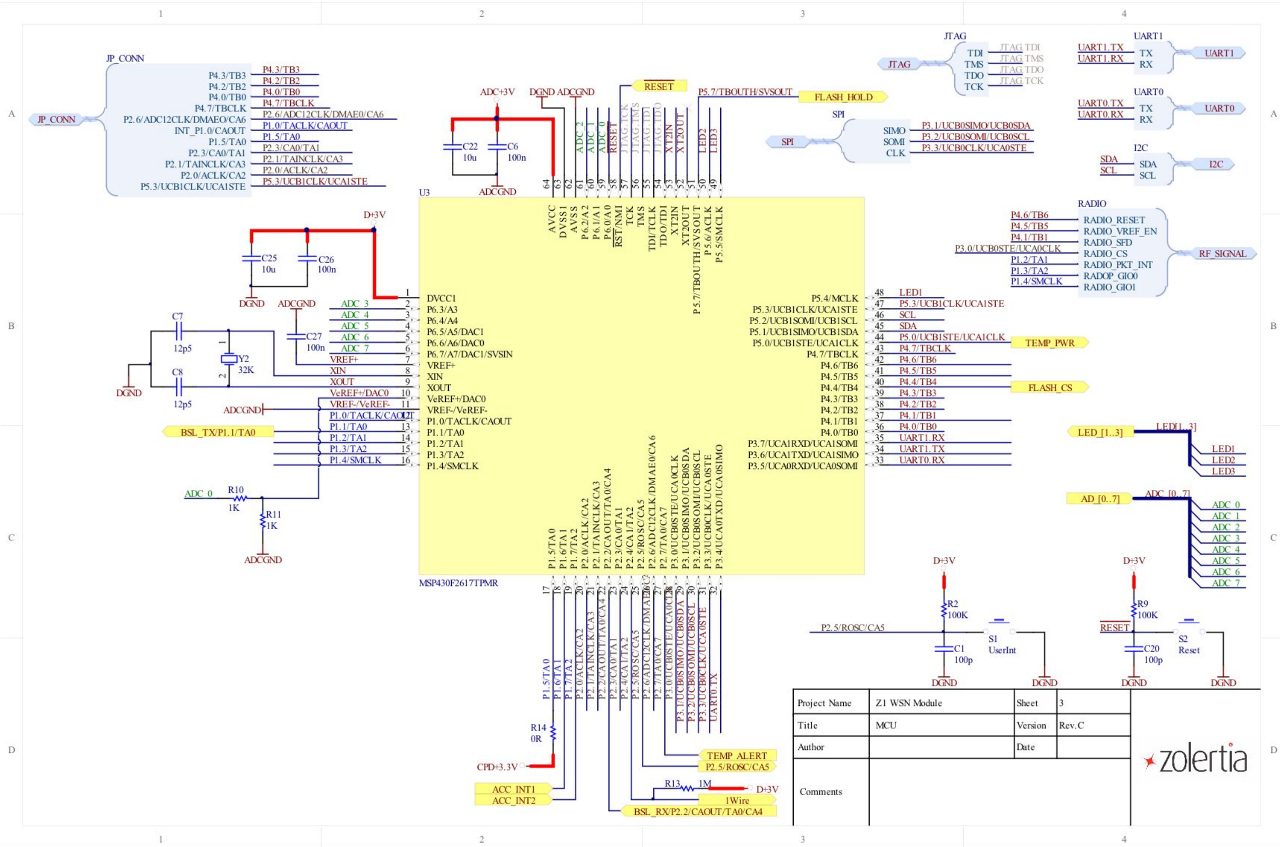
### *Important Caution Note*

- It is possible that, when the Z1 is connected through via the USB port, the temperature sensors reads values biased by up to +2°C. This may happen due to the thermal propagation caused by the voltage regulator inside the CP2102 USB to RS232 converter. This unwanted effect, however, disappears when the module is power via any other method apart from USB, that is, when the CP2102 (and hence its integrated regulator) is not in use.

# Board Schematics



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UART0
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RF_SIGNAL
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RESET
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FLASH_CS
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AD_[0..7]
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U3
MSP430F2617TPMR
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S2 Reset
TEMP_ALERT
ACC_INT1
ACC_INT2
BSL_RX/P2.2/CAOUT/TA0/CA4
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Z1 WSN Module
Sheet
3
Title
MCU
Version
Rev.C
Author
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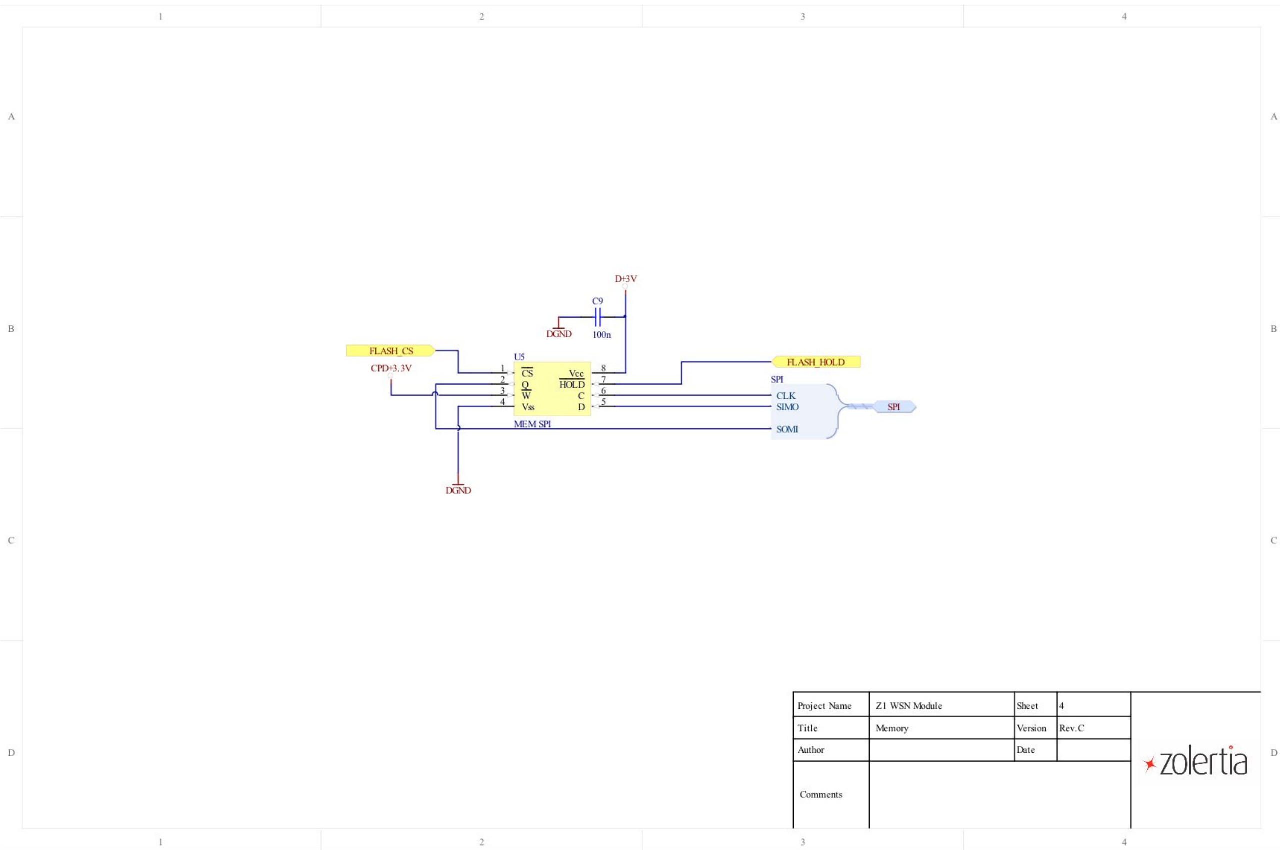
Comments
zolertia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100n
DGND
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CPD+3.3V
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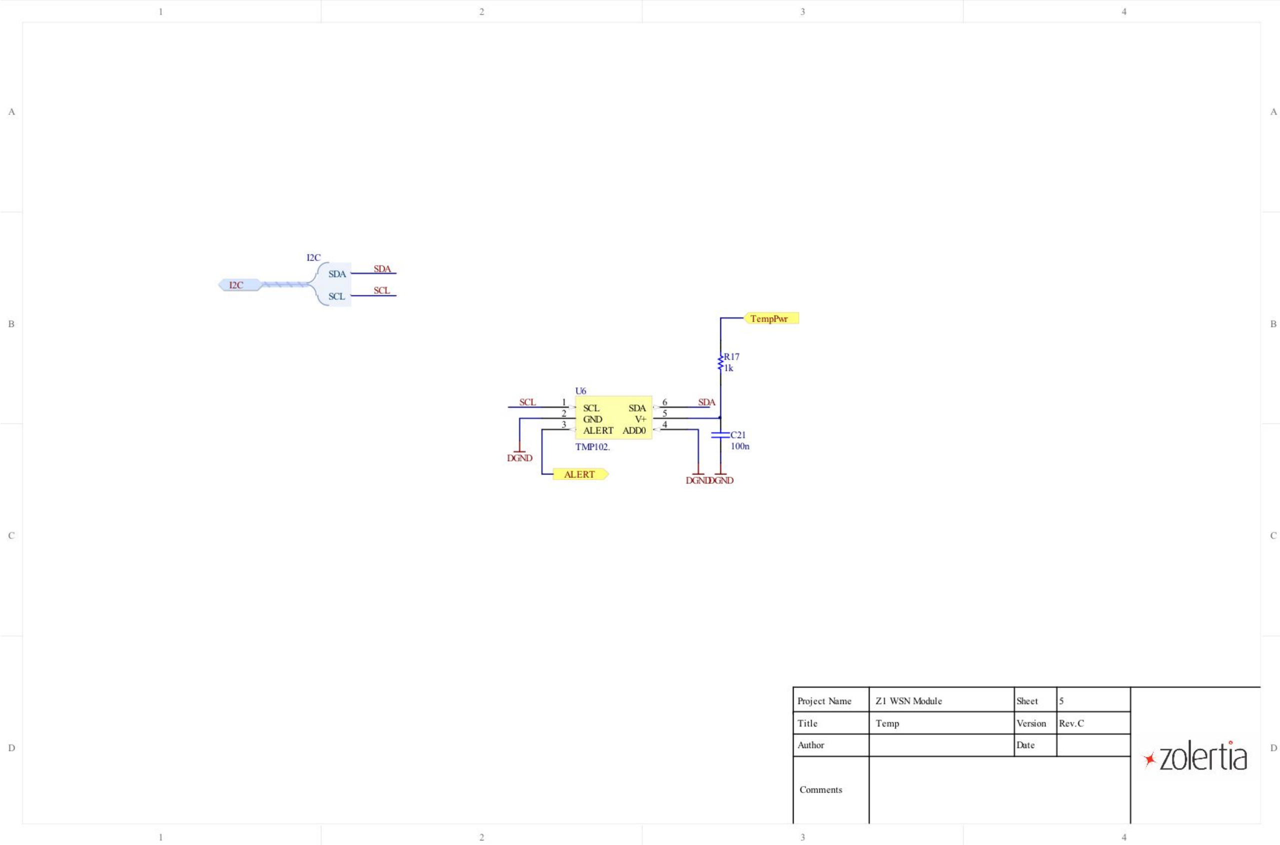
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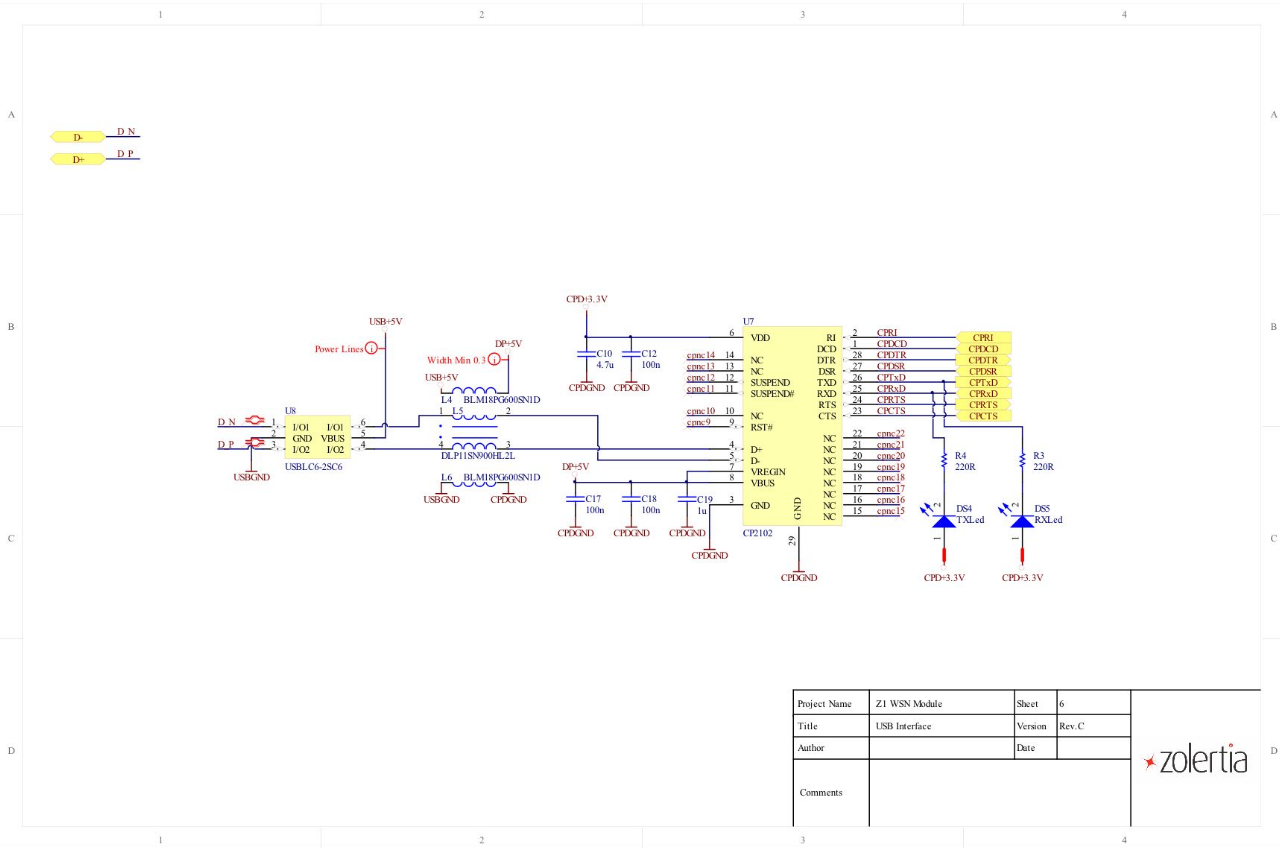
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D+
D P
CPD+3.3V
USB+5V
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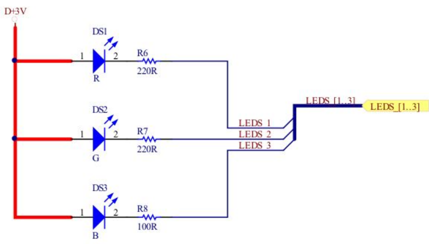
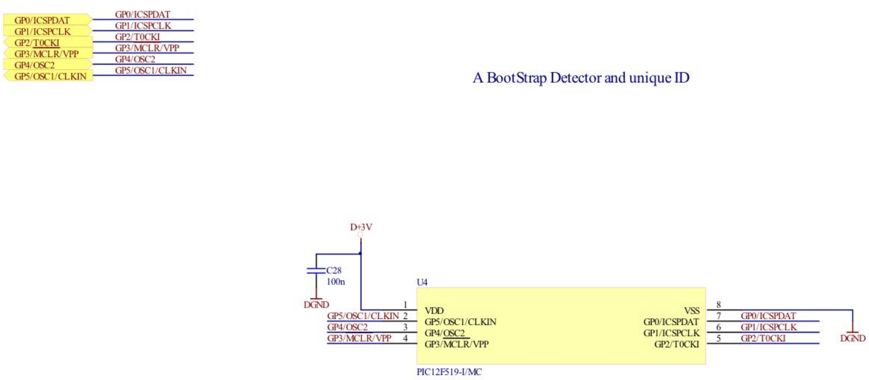
DP+5V
Width Min 0.3
U8
I/O1
GND
I/O2
VBUS
USBLC6-2SC6
USBGND
L4 BLM18PG600SN1D
L5
DLP11SN900HL2L
L6 BLM18PG600SN1D
CPDGND
C10
4.7u
C12
100n
C17
100n
C18
100n
C19
1u
U7
VDD
NC
SUSPEND
SUSPEND#
RST#
D+
D-
VREGIN
VBUS
GND
CP2102
RI
DCD
DTR
DSR
TXD
RXD
RTS
CTS
CPRI
CPDCD
CPDTR
CPDSR
CPTxD
CPRxD
CPRTS
CPCTS
R4
220R
R3
220R
DS4
TXLed
DS5
RXLed
CPD+3.3V
Project Name
Z1 WSN Module
Sheet
6
Title
USB Interface
Version
Rev.C
Author
Date
Comments
zolertia




| Project Name | Z1 WSN Module | Sheet | 7 |
|---|---|---|---|
| Title | LED | Version | Rev.C |
| Author | | Date | |
| Comments | | | |

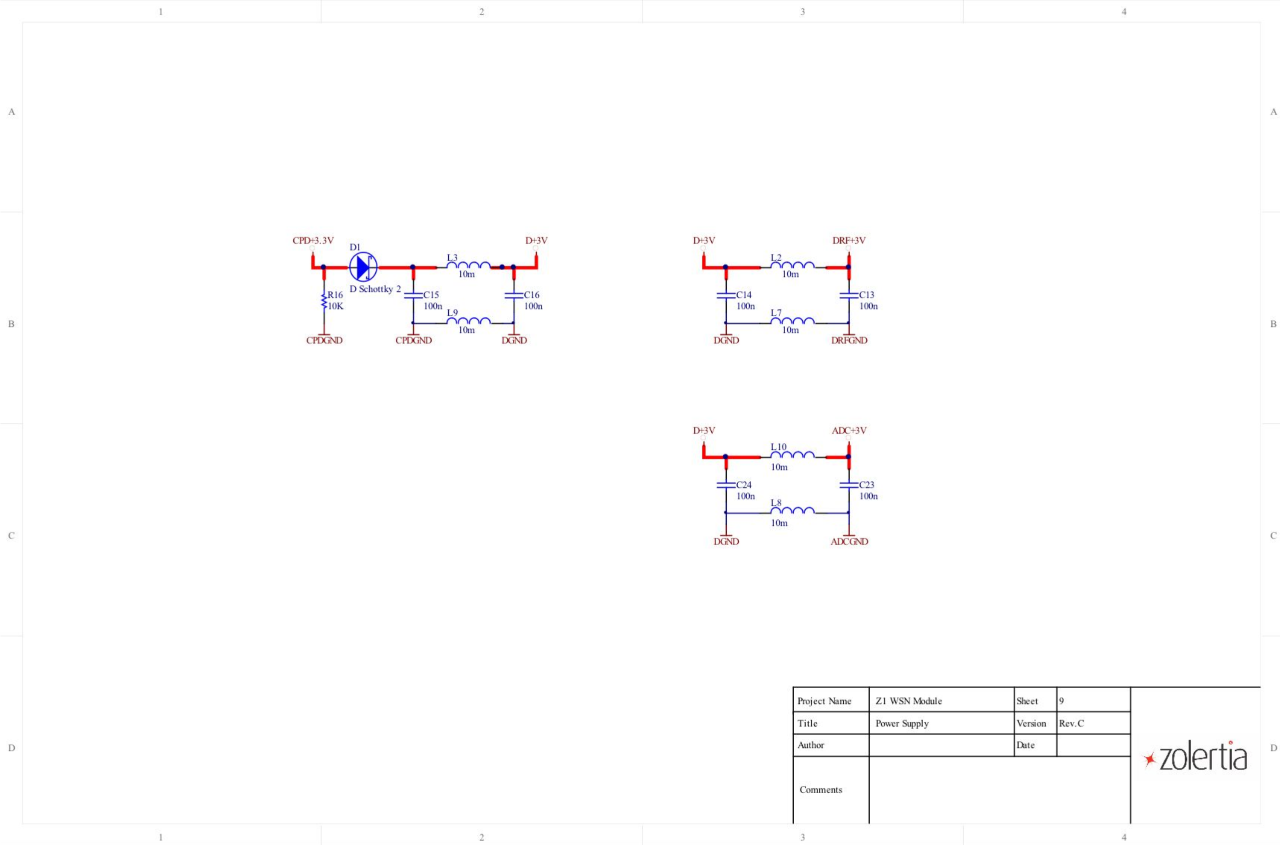
zolertia



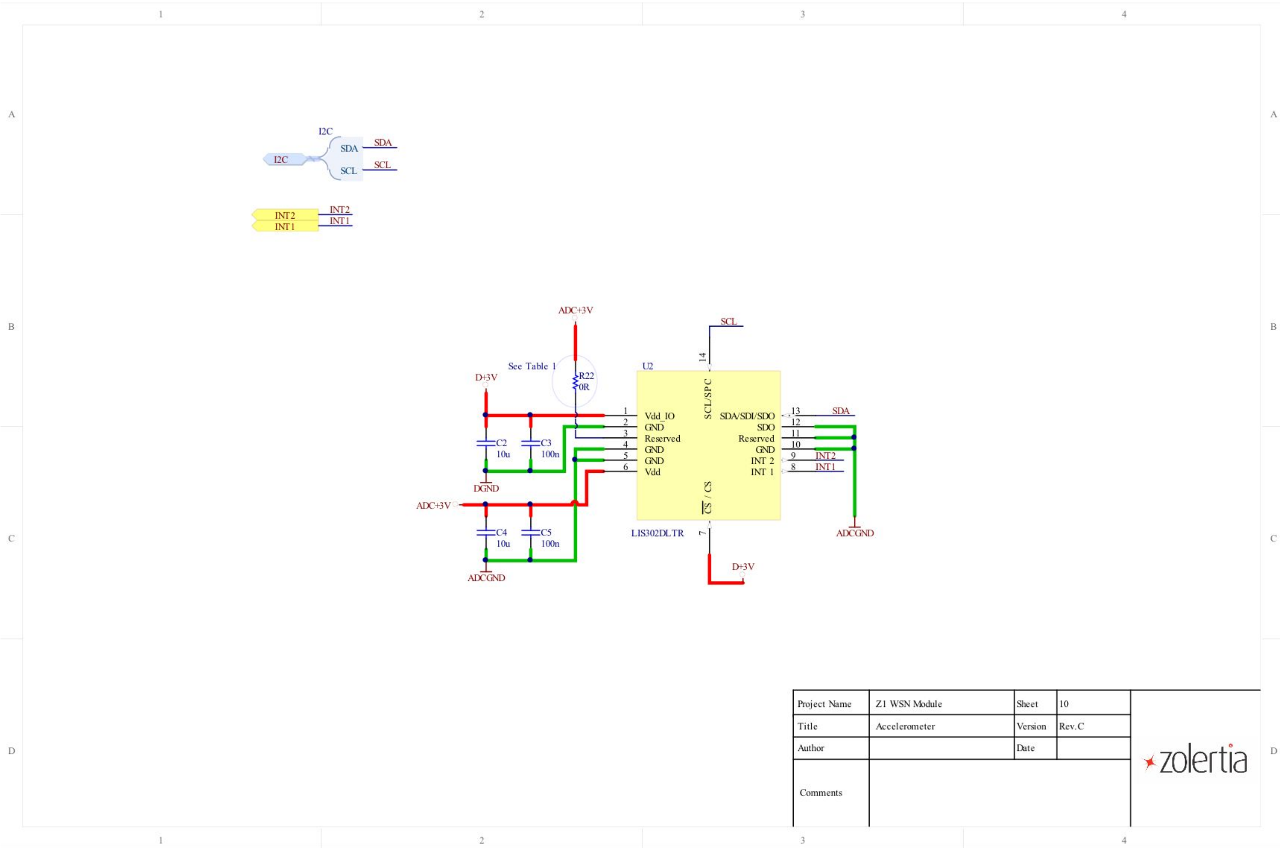

A BootStrap Detector and unique ID

| Project Name | Z1 WSN Module | Sheet | 8 |
|---|---|---|---|
| Title | PIC BSL | Version | Rev.C |
| Author | | Date | |
| Comments | | | |

zolertia



CPD+3.3V
D1
D Schottky 2
R16
10K
CPDGND
L3
10m
C15
100n
L9
10m
CPDGND
D+3V
C16
100n
DGND
D+3V
L2
10m
DRF+3V
C14
100n
L7
10m
C13
100n
DGND
DRFGND
D+3V
L10
10m
ADC+3V
C24
100n
L8
10m
C23
100n
DGND
ADCGND
Project Name
Z1 WSN Module
Sheet
9
Title
Power Supply
Version
Rev.C
Author
Date
Comments
zolertia

I2C
SDA
SCL
I2C
SDA
SCL
INT2
INT1
INT2
INT1
ADC+3V
See Table 1
R22
0R
D+3V
U2
SCL
SCL/SPC
Vdd_IO
GND
Reserved
GND
GND
Vdd
SDA/SDI/SDO
SDO
Reserved
GND
INT 2
INT 1
SDA
INT2
INT1
C2
10u
C3
100n
DGND
ADC+3V
C4
10u
C5
100n
ADCGND
CS / CS
LIS302DLTR
ADCGND
D+3V
Project Name
Z1 WSN Module
Sheet
10
Title
Accelerometer
Version
Rev.C
Author
Date
Comments
zolertia

For the latest information about compatible software, OS's, drivers, as well as latest code snippets, applications, and further hardware information, see [ZOLERTIA] and Zolertia's Z1 Community [Z1COMMUNITY]. There you will be able to find the latest releases for supported or contributed embedded O.S.'s, stacks, drivers, as well as demos and detailed HW/SW details.

## TinyOS

Support for TinyOS with 6LowPAN comes out of the box with drivers for all of its mounted sensors, ICs, as well as a generic interface for all analog sensors, that is, all those that can be regarded as phidgets.

## Contiki OS

Contiki is expected to be supported in the very near future, but so far there is no public release available. Stay tuned to [Z1COMMUNITY] if you want to know when it is available.

# Accessories

Most of the available accessories you can think of for the Z1 available at [ZSTORE].

However, being Z1 an open system means that you can build yourself or buy from third-parties all kinds of accessories, like phidgets, sensors, enclosures, etc.

# References


| | |
|---|---|
| [PHIDGETS] | www.phidgets.com |
| [Z1COMMUNITY] | sf.zolertia.com |
| [ZOLERTIA] | www.zolertia.com |
| [ZSTORE] | store.zolertia.com/ |


# Glossary

| | |
|---|---|
| I2C | Inter-Integrated Circuit Protocol |
| IC | Integrated Circuits |
| MCU | MicroController Unit |
| OS | Operating System |
| SPI | Serial Peripheral Interface Bus |
| TI | Texas Instruments |
| TTM | Time To Market |
| XPCon | Z1's eXPansion Connector |

# Versions

| Date | Version | Release Notes |
|---|---|---|
| 2010-01-18 | v1.0 | First Revision |
| 2010-03-11 | v1.1 | Added MSP430 Ports Performance<br>Added Temp. Sensor Caution Note<br>Corrected South Port Pinout:Table 5 |