ZigBit™ Amp OEM Modules
ZDM-A1281-PN/PN0

Ultra-Compact 2.4GHz 802.15.4/ZigBee Modules with Power Amplifier for Wireless Networking Applications

Product Datasheet

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Summary

ZigBit™-A1281-PN* are ultra-compact, extended range, low-powered, high-sensitivity 2.4GHz 802.15.4/ZigBee OEM modules from MeshNetics. Based on the innovative Atmel's mixed-signal hardware platform, these modules are enhanced by an output power amplifier and an input low-noise amplifier. They are designed for wireless sensing, monitoring & control and data acquisition applications. The ZigBit-A1281-PN* modules eliminate the need for costly and time-consuming RF development, and shorten time to market for wireless applications with extended range requirements.

The ZigBit family of modules represented by ZDM-A1281-A2 and ZDM-A1281-B0 modules [1], [2] is thus extended by the ZigBit-A1281-PN* modules with improved range capability. These modules are designed in two versions: the ZDM-A1281-PN, with U.FL antenna connector, and the ZDM-A1281-PN0, with unbalanced RF output.
In most cases below, the ZigBit-PN* modules are simply referred to as ZigBit.

Applications

ZigBit features the standards-based networking stack, based on IEEE802.15.4 PHY and MAC layers, and ZigBee NWK/APS/ZDO layers. It enables multipoint, multihop communications over thousands of square meters at moderate data rates without expensive infrastructure support. The architecture of the Wireless Sensor Networks (WSN) allows for use of low powered devices. The applications include, but are not limited to:

- Building automation & monitoring
  - Lighting controls
  - Wireless smoke and CO detectors
  - Structural integrity monitoring
- HVAC monitoring & control
- Inventory management
- Environmental monitoring
- Security
- Water metering
- Industrial monitoring
  - Machinery condition and performance monitoring
  - Monitoring of plant system parameters such as temperature, pressure, flow, tank level, humidity, vibration, etc.
- Automated meter reading (AMR)

Key features

- Ultra compact size (38.0 x 13.5 x 2.0 mm)
- High RX sensitivity (-104 dBm)
- Outperforming link budget (124 dB)
- Up to +20 dBm output power
- Very low power consumption:
  - 10 µA in sleep mode,
  - 25 mA in RX mode,
  - 60 mA in TX mode
- Ample memory resources (128K bytes of flash memory, 8K bytes RAM, 4K bytes EEPROM)
- Wide range of interfaces (both analog and digital):
  - spare GPIO, 2 spare IRQ lines
  - 4 ADC lines + 1 line for supply voltage control (up to 9 lines with JTAG disabled)
  - UART with CTS/RTS control
  - USART
  - I2C
  - SPI
  - 1-Wire
  - Up to 30 lines configurable as GPIO
- Capability to use MAC address written into EEPROM
- IEEE 802.15.4 compliance
- 2.4 GHz ISM band
- eZeeNet embedded software, including UART bootloader and AT command set

Benefits

- Up to 4 kilometers (2 ½ miles) outdoor line of sight range
- Ultra low power consumption combined with outperforming range
- Rapid design-in with onboard U.FL connector (ZDM-A1281-PN)
- Flexibility in using a different external antenna for every application
- Small physical footprint and low profile for optimum fit in even the smallest of devices
- Mesh networking capability
- Easy-to-use low cost Development Kit
- Single source of support for HW and SW

ZigBit™ Module Overview

ZigBit™-A1281-PN* is an extended-range low-power, high-sensitivity IEEE802.15.4/ZigBee-compliant OEM module, which occupies less than a square inch of space. Based on a solid combination of Atmel's latest AVR Z-Link hardware platform, power amplifier and low-noise amplifier, the ZigBit-A1281-PN* offers an unmatched combination of superior radio performance, ultra-low power consumption and exceptional ease of integration.

ZigBit contains Atmel's ATmega1281V Microcontroller [3] and AT86RF230 RF Transceiver [4]. The module features 128K bytes flash memory and 8K bytes RAM.

The compact all-in-one-chip integration of output Power Amplifier and input Low-Noise Amplifier, along with RF switches enables digital control of an external RF front-end to dramatically improve ZigBit's range performance on signal transmission and increase its sensitivity. This ensures stable connectivity with larger coverage area without significant increase in module size. The HF U.FL coaxial connector [5] used in the ZDM-A1281-PN module enables the user to choose appropriate external antenna for every type of application.

The ZigBit already contains a complete RF/MCU design with all the necessary passive components included. The module can be easily mounted on a simple 2-layer PCB with a minimum of required external connection. Compared to a single-chip solution, a module-based solution offers considerable savings in development time & NRE cost per unit during the design, prototyping, and mass production phases of product development.

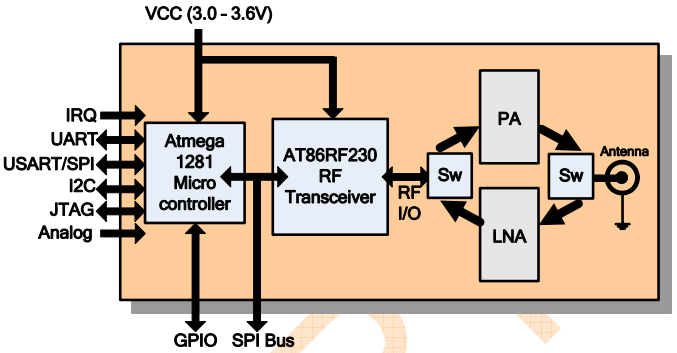
To jumpstart evaluation and development, MeshNetics also offers a complete set of evaluation development tools. The ZigBit Development Kit comes with everything you need to prototype and test an 802.15.4 or ZigBee networking solution. It includes the development boards with multiple interfaces, an out-of-the-box data acquisition software suite, as well as accessories and documentation. The sample data-acquisition application allows network monitoring and sensor data collection, all visualized via a graphic interface.

The ZigBit modules come bundled with the eZeeNet networking firmware, which enables the module-based OEM products to form self-healing, self-organizing mesh networks. The eZeeNet stack conforms to IEEE802.15.4/ ZigBee specifications [6], [7], [8].

Depending on end-user design requirements, the ZigBit modules can operate as a self-contained sensor node, where it would function as a single MCU, or it can be paired with a host processor driving the module as it would be an RF modem.

In the former case, a user application may be used with the eZeeNet Software allowing customization of embedded applications through eZeeNet's C API.

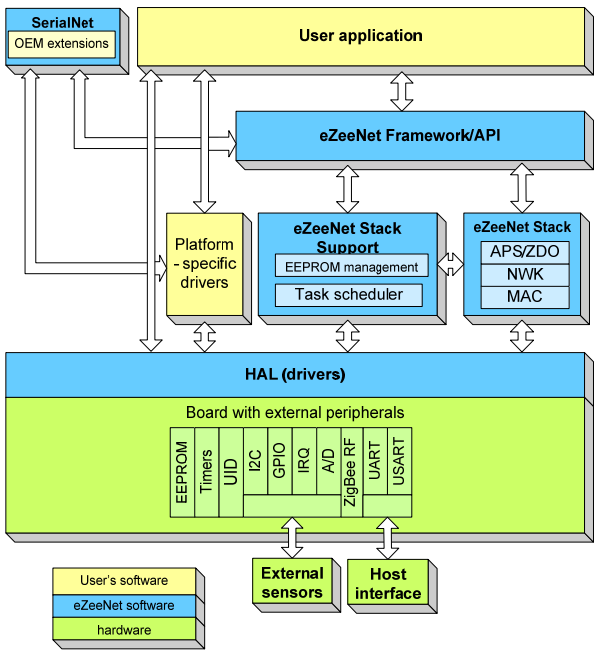
ZDM-A1281-PN/PN0 Block Diagram



In the latter case, the host processor controls data transmission and manages module peripherals via a powerful set of AT commands. Thus, no firmware customization is required for a successful module design-in. Additionally, the sensors can be connected directly to the module, thus expanding the existing set of sensor interfaces. The over-the-air control via AT-commands eases network configuration and speeds up application prototyping. It also enables wireless module configuration during OEM mass-production process and provides flexible commissioning protocol for installation and maintenance of ZigBit-based devices.

The eZeeNet is compact private profile software from MeshNetics that is specifically tailored for data acquisition applications. It allows optimizing the network traffic, reducing power consumption, scheduling, and smart power management. The eZeeNet software comes with a set of drivers for standard peripherals (I^2C, GPIO, ADC, etc.) that ensure the ZigBit module easy integration.

eZeeNet™ Block Diagram



Specifications

Test Conditions (unless otherwise stated): V_{cc}= 3.0 V, f=2.45 GHz, T_{amb}= 25 °C

Parameters	Range	Unit
Supply Voltage (V_{cc})	3.0 to 3.6	V
Current Consumption: RX mode**	25	mA
Current Consumption: TX mode**	60	mA
Current Consumption: Power Save mode**	< 10	µA

**Noted parameters are measured under the following conditions:

- eZeeNet Software is running at 4 MHz clock rate, DTR line management is turned off
- all interfaces are set to the default state (see *Pin Assignment* Table)
- output TX power is +18 dBm
- JTAG is not connected
- V_{cc} = 3.0 V.

Current consumption actually depends on multiple factors, including but not limited to, the board design and materials, eZeeNet settings, network activity, EEPROM read/write operations. It also depends on MCU load and/or peripherals used by an application.

RF Characteristics			
Parameters	**Range**	**Unit**	**Condition**
Frequency Band	2.400 to 2.4835	GHz	
Number of Channels	16		
Channel Spacing	5	MHz	
Transmitter Output Power	0 to + 20	dBm	Adjusted in 16 steps
Receiver Sensitivity***	- 104	dBm	PER = 1%
On-Air Data Rate	250	kbps	
TX Output / Rx Input Nominal Impedance	50	Ohms	Unbalanced RF output
Range, outdoors	Up to 4 000	m	

***Preliminary data

ATmega1281V Microcontroller Characteristics			
Parameters	**Value**	**Unit**	**Condition**
On-Chip Flash Memory Size	128	Kbytes	
On-Chip RAM Size	8	Kbytes	
On-Chip EEPROM Size	4	Kbytes	
Operation Frequency	4	MHz	

Module Interfaces Characteristics			
Parameters	**Value**	**Unit**	**Condition**
UART Maximum Baud Rate	38.4	kbps	
ADC Resolution / Conversion Time	10 / 200	Bits / µs	In the single conversion mode
ADC Input Resistance	> 1	MOhm	
ADC Reference Voltage (Vref)	1.0 to V_{cc} - 0.3	V	
ADC Input Voltage	0 to Vref	V	
I^2C Maximum Clock	222	kHz	
GPIO Output Voltage (High/Low)	2.3 / 0.5	V	(-10 / 5 mA)
Real Time Oscillator Frequency	32.768	kHz	

Absolute Maximum Ratings****

Parameter	Min Value	Max Value
Voltage of any Pin except RESET to Ground	- 0.5 V	V_{cc} + 0.5 V
DC Current per I/O Pin		40 mA
DC Current D_VCC and DGND Pins		300 mA
Input RF Level		+ 5 dBm

****Absolute Maximum Ratings** are the values beyond which damage to the device may occur. Under no circumstances must the absolute maximum ratings given in this table be violated. Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device.

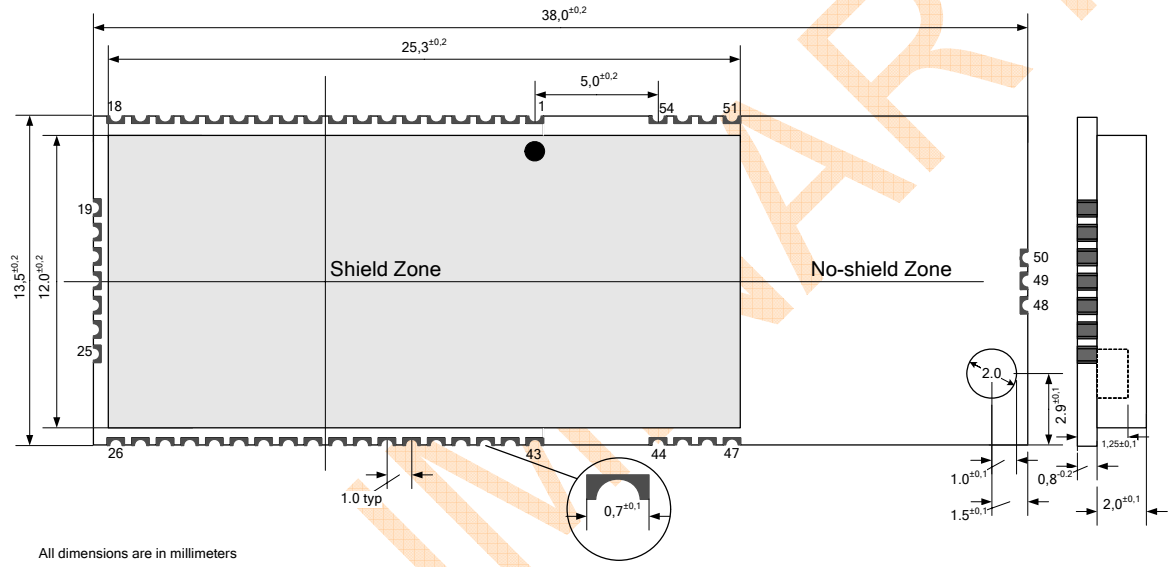
This is a stress rating only. Functional operation of the device at these or other conditions, beyond those indicated in the operational sections of this specification, is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Attention! ZigBit is ESD-sensitive device. Precaution should be taken when handling the device in order to prevent permanent damage.

Physical/Environmental Characteristics and Outline

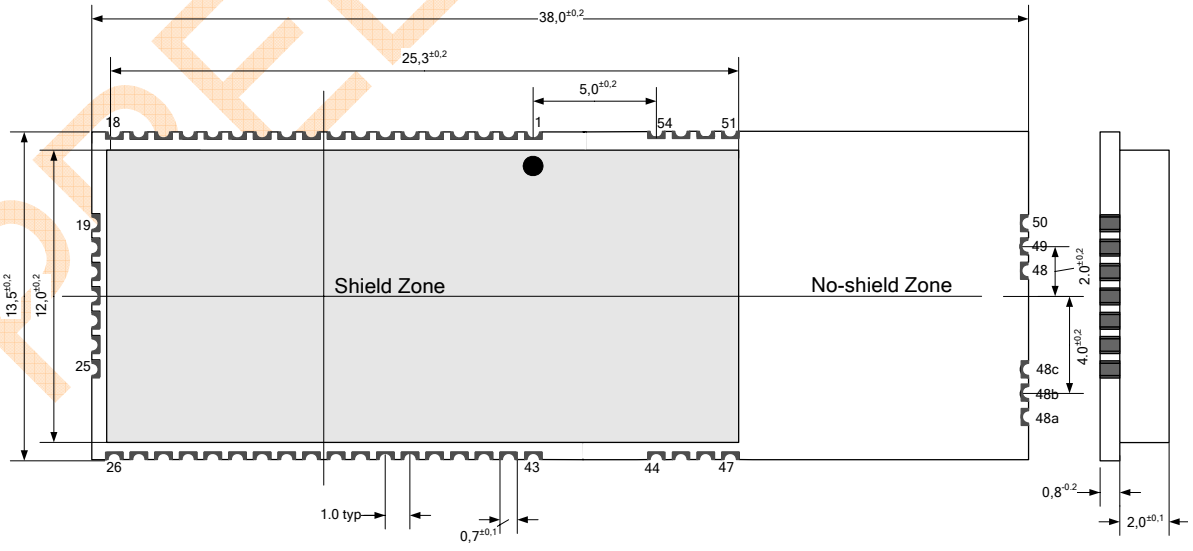
Parameter	Value	Notes
Size, mm	38.0 x 13.5 x 2.0	
Weight, g		ZDM-A1281-PN
	~ 2	ZDM-A1281-PN0
Operating Temperature Range, °C	- 20 to +70	- 40 to + 85 operational†
Operating Relative Humidity Range, %	no more than 80%	

ZDM-A1281-PN Mechanical Drawing



All dimensions are in millimeters

ZDM-A1281-PN0 Mechanical Drawing

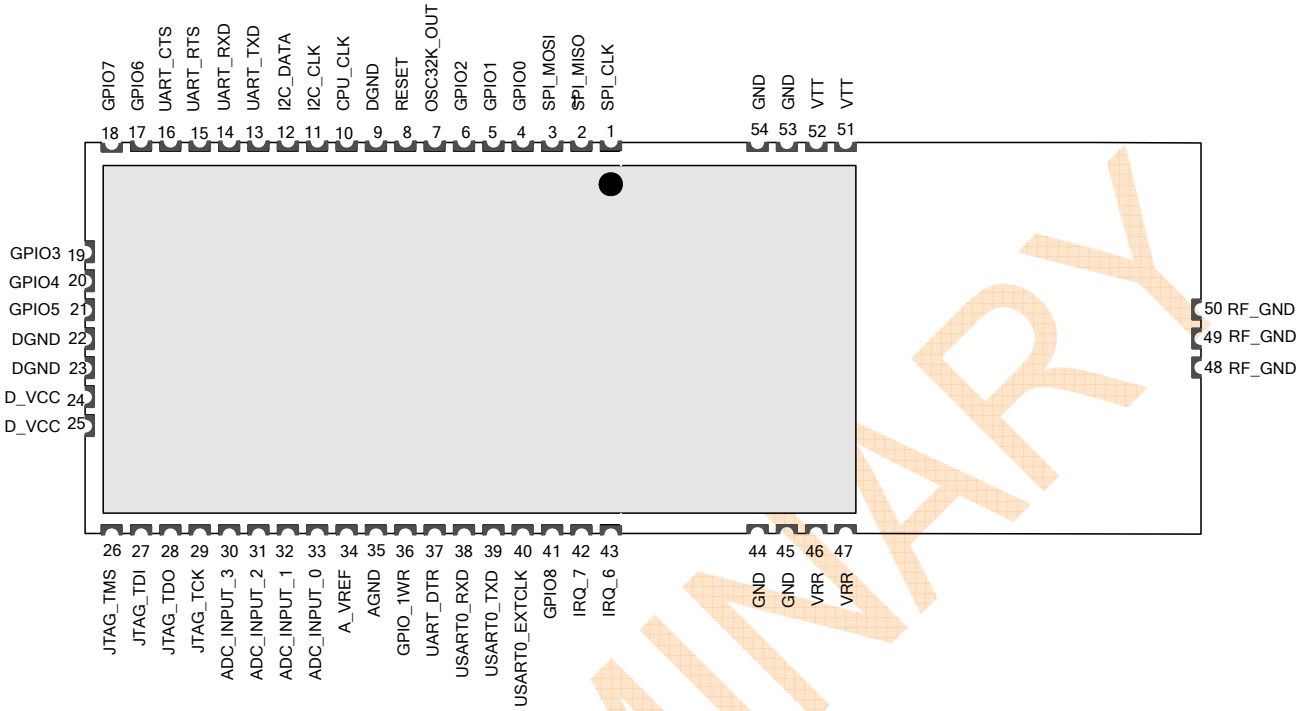


All dimensions are in millimeters

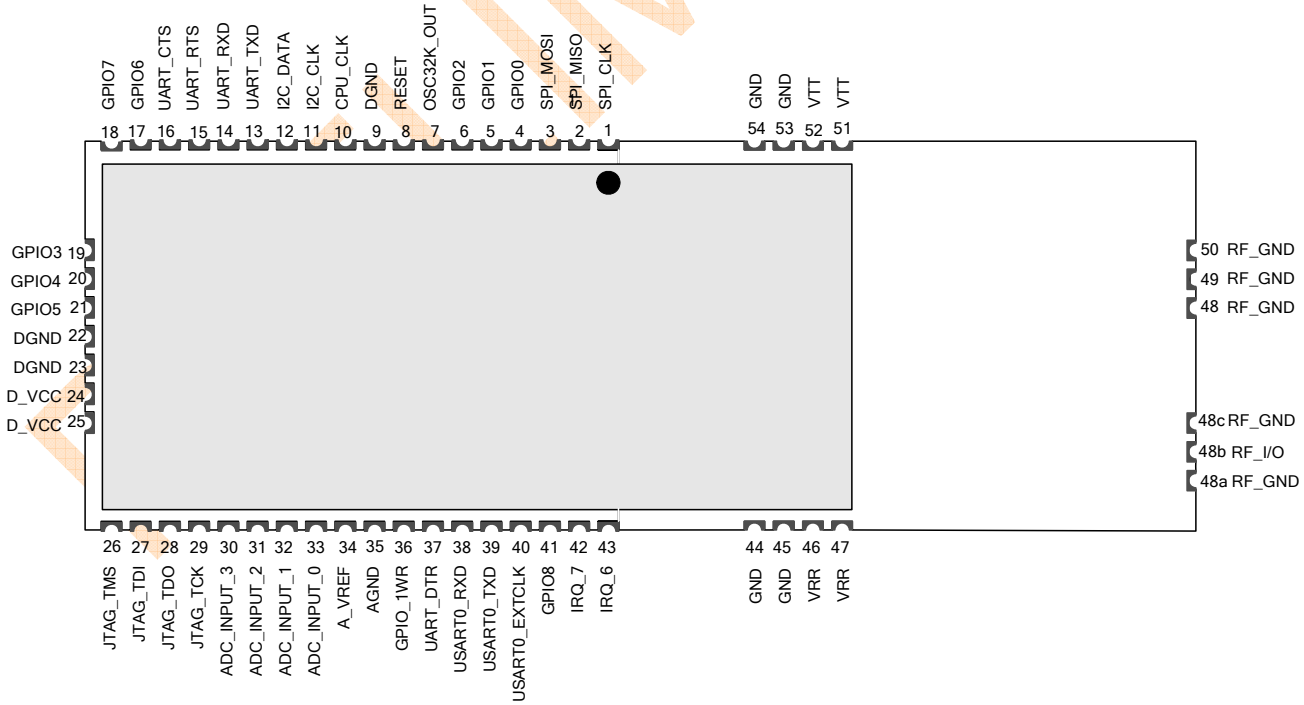
† Minor degradation of clock stability may occur

Pin Configuration

ZDM-A1281-PN Pinout



ZDM-A1281-PN0 Pinout



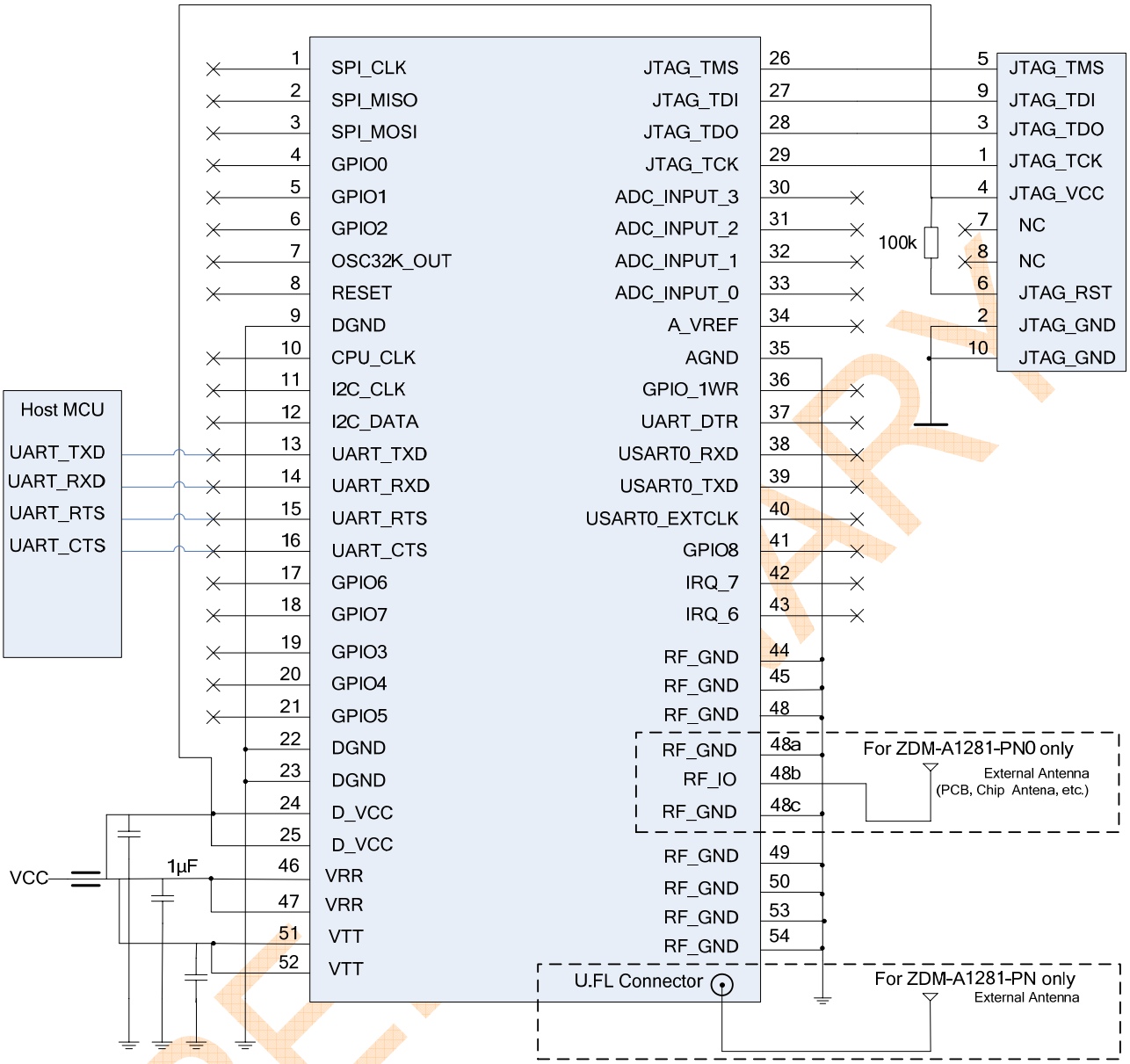
Connector Pin	Pin Name	Description	I/O	Default State after power on	Notes, see the list below
1	SPI_CLK	Reserved for stack operation	O		3
2	SPI_MISO	Reserved for stack operation	I/O		3
3	SPI_MOSI	Reserved for stack operation	I/O		3
4	GPIO0	General purpose digital input/output 0	I/O	tri-state	1, 2, 3, 6
5	GPIO1	General purpose digital input/output 1	I/O	tri-state	1, 2, 3, 6
6	GPIO2	General purpose digital input/output 2	I/O	tri-state	1, 2, 3, 6
7	OSC32K_OUT	32.768 kHz clock output.	O		3, 4
8	RESET	Reset input (active low).	I		3
9, 22, 23	DGND	Digital ground			
10	CPU_CLK	RF clock output. When module is in active state, 4 MHz signal is present on this line. While module is in the sleeping state, clock generation is stopped also.	O		3
11	I2C_CLK	I^2C serial clock output	O	tri-state	1, 2, 3, 6
12	I2C_DATA	I^2C serial data input/output	I/O	tri-state	1, 2, 3, 6
13	UART_TXD	UART receive input	I	tri-state	1, 2, 3, 6
14	UART_RXD	UART transmit output	O	tri-state	1, 2, 3, 6
15	UART_RTS	RTS input (Request To Send) for UART hardware flow control. Active low.	I	tri-state	1, 2, 3, 6
16	UART_CTS	CTS output (Clear To Send) for UART hardware flow control. Active low.	O	tri-state	1, 2, 3, 6, 7
17	GPIO6	General purpose digital input/output 6	I/O	tri-state	1, 2, 3, 6
18	GPIO7	General purpose digital input/output 7	I/O	tri-state	1, 2, 3, 6
19	GPIO3	General purpose digital input/output 3	I/O	tri-state	1, 2, 3, 6
20	GPIO4	General purpose digital input/output 4	I/O	tri-state	1, 2, 3, 6
21	GPIO5	General purpose digital input/output 5	I/O	tri-state	1, 2, 3, 6
24, 25	D_VCC	Digital supply voltage (Vcc)			8
26	JTAG_TMS	JTAG test mode select	I		1, 2, 3, 5
27	JTAG_TDI	JTAG test data input	I		1, 2, 3, 5
28	JTAG_TDO	JTAG test data output	O		1, 2, 3, 5
29	JTAG_TCK	JTAG test clock	I		1, 2, 3, 5
30	ADC_INPUT_3	ADC input channel 3	I	tri-state	1, 2, 6
31	ADC_INPUT_2	ADC input channel 2	I	tri-state	1, 2, 6
32	ADC_INPUT_1	ADC input channel 1	I	tri-state	1, 2, 6
33	ADC_INPUT_0	ADC input channel 0. Used by the stack for battery level measurement. Nominal voltage to AGND is 1 V.	I	tri-state	1, 2, 6
34	A_VREF	Output/Input reference voltage for ADC	I/O	tri-state	
35	AGND	Analog ground			

Connector Pin	Pin Name	Description	I/O	Default State after power on	Notes, see the list below
36	GPIO_1WR	1-Wire interface	I/O		1, 2, 3, 6
37	UART_DTR	DTR input (Data Terminal Ready) for UART. Active low.	I	tri-state	1, 2, 3, 6
38	USART0_RXD	UART/SPI receive pin	I	tri-state	1, 2, 3, 6
39	USART0_TXD	UART/SPI transmit pin	O	tri-state	1, 2, 3, 6
40	USART0_EXTCLK	UART/SPI external clock	I/O	tri-state	1, 2, 3, 6
41	GPIO8	General purpose digital input/output 8	I/O	tri-state	1, 2, 3, 6
42	IRQ_7	Digital input interrupt request 7	I	tri-state	1, 2, 3, 6
43	IRQ_6	Digital input interrupt request 6	I	tri-state	1, 2, 3, 6
44, 45, 48, 48a, 48c, 49, 50, 53, 54	RF_GND	RF analog ground			9
48b	RF_IO	Unbalanced 50 Ohm RF input/output	I/O		9
46, 47	VRR	Receiver supply voltage			8
51, 52	VTT	Transmitter supply voltage			8

Notes:

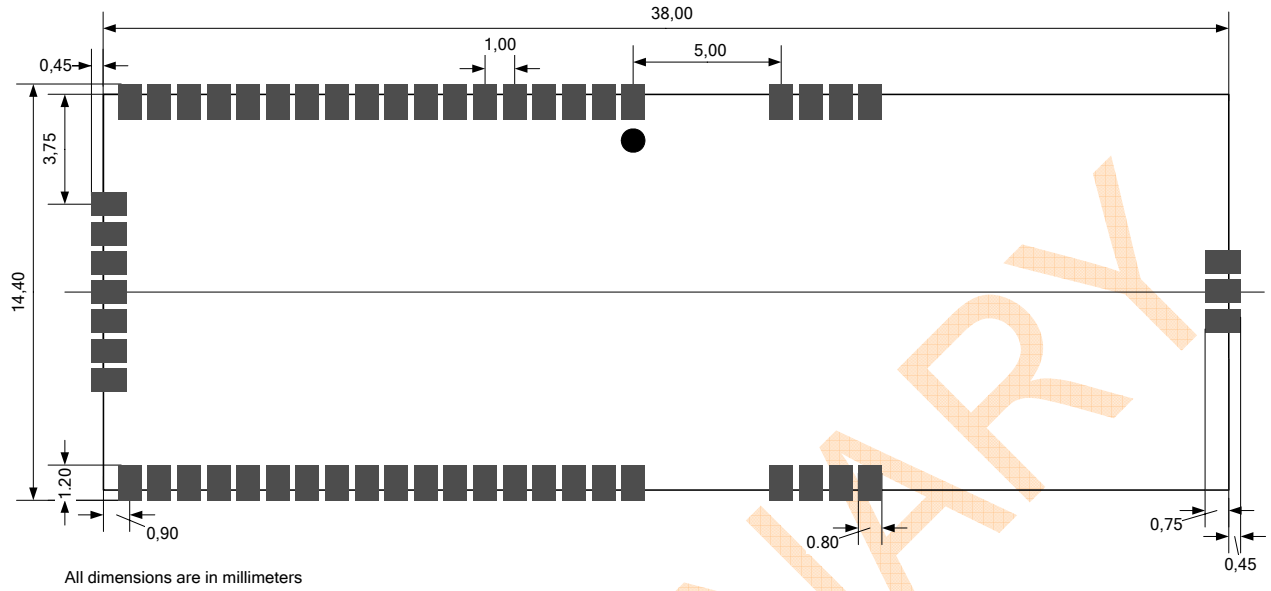
1. Most of pins can be configured for general purpose I/O or for some alternate functions as described in details in the ATmega1281V Datasheet [3].
2. GPIO pins can be programmed either for output, or for input with/without pull-up resistors. Output pin drivers are strong enough to drive LED displays directly (refer to figures on pages 387-388, [3]).
3. All digital pins are provided with protection diodes to D_VCC and DGND.
4. It is strongly recommended to avoid assigning an alternate function for OSC32K_OUT pin because it can be used by eZeeNet Framework. However, this signal can be used in rare cases if other peripheral or host processor requires 32.768 kHz clock, otherwise this pin should be disconnected.
5. Normally, JTAG_TMS, JTAG_TDI, JTAG_TDO, JTAG_TCK pins are used for on-chip debugging and flash burning. They can be used for A/D conversion if JTAGEN fuse is disabled.
6. The following pins can be configured with the eZeeNet software to be general-purpose I/O lines: GPIO0, GPIO1, GPIO2, GPIO3, GPIO4, GPIO5, GPIO6, GPIO7, GPIO8, GPIO_1WR, I2C_CLK, I2C_DATA, UART_TXD, UART_RXD, UART_RTS, UART_CTS, ADC_INPUT_3, ADC_INPUT_2, ADC_INPUT_1, BAT, UART_DTR, USART0_RXD, USART0_TXD, USART0_EXTCLK, IRQ_7, IRQ_6. Additionally, four JTAG lines can be programmed as GPIO as well, but this requires changing the fuse bits. Then, JTAG debugging would be disabled.
7. With eZeeNet, CTS pin can be configured to indicate sleep/active condition of the module thus providing mechanism for power management of host processor. If this function is necessary, connection of this pin to external pull-down resistor is recommended to prevent the undesirable transients during module reset process.
8. Using ferrite bead and 1 µF capacitor located closely to the power supply pin is recommended, as shown in *Typical Application Schematics* below.
9. Pins 48a, 48b and 48c are featured for ZDM-A1281-PN0 module only.

Typical Application Schematics

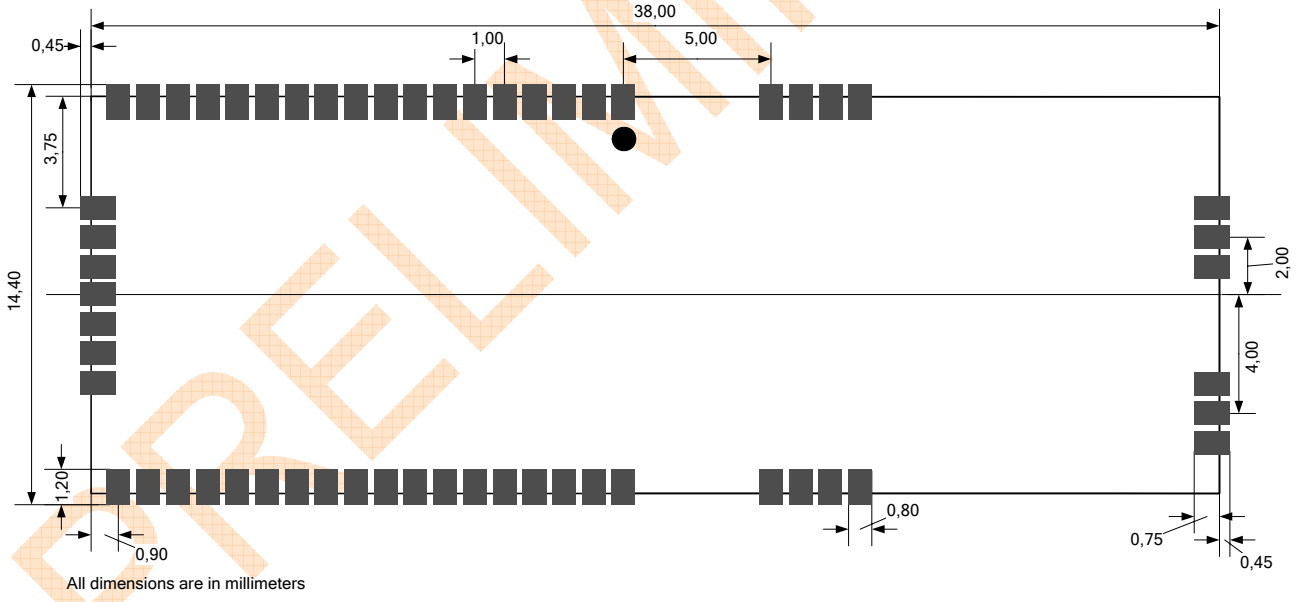


Mounting Information

ZDM-A1281-PN PCB Recommended Layout, Top View



ZDM-A1281-PN0 PCB Recommended Layout, Top View



The above diagrams show the PCB layout recommended for ZigBit module. Neither via-holes nor wires are allowed on the PCB upper layer in area occupied by the module. As a critical requirement, RF_GND pins should be grounded via several holes to be located right next to pins thus minimizing inductance and preventing both mismatch and losses.

Antenna Reference Design

Multiple factors affect proper antenna match, hence, affecting the antenna pattern. The particular factors are the board material and thickness, shields, the material used for enclosure, the board neighborhood, and other components adjacent to antenna.

General Recommendations:

- Metal enclosure should not be used. Using low profile enclosure might also affect antenna tuning.
- Placing high profile components next to antenna should be avoided.
- Having holes punched around the periphery of the board eliminates parasitic radiation from the board edges also distorting antenna pattern.
- ZigBit module should not be placed next to consumer electronics which might interfere with ZigBit's RF frequency band.

The board design should prevent propagation of microwave field inside the board material. Electromagnetic waves of high frequency may penetrate the board thus making the edges of the board radiate, which may distort the antenna pattern. To eliminate this effect, metalized and grounded holes must be placed around the board's edges.

Related Documents

[1] ZigBit™ OEM Modules ZDM-A1281-*. Product Datasheet. MeshNetics Doc. M-251~01

[2] ZigBit™ Development Kit. User's Guide. MeshNetics Doc. S-ZDK-451

[3] Atmel 8-bit AVR Microcontroller with 64K/128K/256K Bytes In-System Programmable Flash. 2549F-AVR-04/06

[4] Atmel Low-Power Transceiver for ZigBee Applications. AT86RF230 Target Specification. 5131A-ZIGB-08/15/05

[5] Ultra Small Surface Mount Coaxial Connectors - Low Profile 1.9mm or 2.4mm Mated Height. http://www.hirose.co.jp/cataloge_hp/e32119372.pdf

[6] IEEE Std 802.15.4-2003 IEEE Standard for Information technology – Part 15.4 Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs)

[7] ZigBee Specification. ZigBee Document 053474r14, November 03, 2006

[8] eZeeNet™ IEEE802.15.4/ZigBee Software. Product Datasheet. MeshNetics Doc. M-251~02

Ordering Information

Contact MeshNetics for ordering ZigBit modules and/or ZigBit Development Kit.

Please specify the product part number and description when ordering ZigBit modules:

Part Number	Description
ZDM-A1281-PN	2.4 GHz IEEE802.15.4/ZigBee Power Amplified OEM Module with U.FL Antenna Connector
ZDM-A1281-PN0	2.4 GHz IEEE802.15.4/ZigBee Power Amplified OEM Module with Unbalanced RF Output

The ZigBit Development Kit is offered with **2 support packages**:

- **ZigBit Development Kit Lite** offers access to standard evaluation and development tools and comes with 45 days of complimentary support. This option is good for product demonstration, platform evaluation and quick application prototyping.
- **ZigBit Development Kit Complete** comes with 1 year of professional support which provides users with continuous software updates, dedicated design-in support, and RF design assistance. It's ideal for customers engaged in a full cycle of developing, prototyping, and launching innovative products made possible by MeshNetics ZigBit wireless platform.

ZDK Edition	Lite	Complete
Support Duration	45 days	1 year
Hardware design support	+	+
RF design support	+	+
Software development support	+	+
Early software release access	-	+
Access to Gerber Files	-	+
Additional sample applications	-	+
Response time	72 h, workdays	72 h, workdays
Support channel	E-mail	E-mail

Disclaimer

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Technical support is provided by MeshNetics.

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Please refer to Support Terms and Conditions for full details.

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