

Product Overview

The Z-Uno Module ZMExZUNOM is a Z-Wave module that implements the Z-Wave protocol and allows custom user code execution. It is an ideal solution for home control applications such as appliance control, heating control, access control, AV control, building automation, energy management, lighting, environmental and security sensor networks in the “Internet of Things”.

Z-Uno Module have GPIO, ADC, PWM, UART, USB, SPI, I²C and OneWire available out of the box from the user code.

Z-Wave wireless communications and network management is served by the internal firmware of the Z-Uno Module. Works with gateways and directly with other Z-Wave devices.

Z-Uno Module is firmware compatible with the Z-Uno prototyping board (ZMExZUNO) to help prototyping on breadboards.

Key Z-Wave Features

Power modes:

- Always on (45 mA)
- Sleeping mode (~2 uA)
- Frequently Listening (FlIRS) (~70 uA)

Z-Wave Plus compliant:

- Status reports in Life Line
- Control of other Z-Wave devices

Supported channels (up to 32 channels):

- Binary Switch
- Multilevel Switch
- Color Switch
- Binary Sensor (Notification)
- Multilevel Sensor
- Meter
- Thermostat

Association control groups (up to 5 groups):

- Basic
- Multilevel Switch
- Door Locks
- Scene

Built-in Z-Wave Security:

- Non-secure mode
- Security S0 (AES 128 bits)
- Security S2 (AES 128 bits, ECDH)

Protocols:

- ITU G.9959
- Z-Wave Plus



27 pins, 22.4 mm x 15.0 mm x 1.9 mm

Key Hardware Features

Programming in C/C++ language:

- Optimized 8051 CPU Core
- 30 kB (6 kB with S2) Flash
- 2 kB (2kB with S2) RAM

Hardware peripherals:

- Build-in Z-Wave RF, ITU G.9959 compliant
- 26 GPIO
- 4 ADC 12 bits
- 4 PWM
- 2 UART
- 1 USB
- 1 SPI (master or slave)
- 4 IR controllers, 1 IR learn capability
- 8X6 Keypad scanner
- 1 GPT
- 3 Interrupts
- 1 I²C (software on GPIO)
- 1 1-Wire (software on GPIO)
- 256 kB EEPROM

RF antenna:

- 86 mm wire
- u.fl 50 Ohms
- pin 50 Ohms

Applications

For creating Z-Wave actors, sensors, meters, thermostats or adding Z-Wave support to existing devices.

Z-Wave Plus and Z-Wave Security S2 compliant



Language Reference

Z-Uno Module compiler (called Z-Uno uCXX) accepts C and slightly limited C++ programming language. All peripherals are accessible via special functions or libraries in Arduino style. Some Arduino libraries are compatible with Z-Uno, others might require porting. User code should be compiled with special Z-Uno Core Libraries. Learn how to install Z-Uno software package at <https://z-uno.z-wave.me/getting-started>

Z-Wave features are defined in the User Code: Z-Wave channels and associations. The concept of getter and setter (callback functions) is used for incoming events from the Z-Wave network.

Z-Uno Quick Start Guide book describes the concept of channels, associations, getters and setters in more details. <https://z-uno.z-wave.me/files/z-uno/QSG/Z-Uno-Quick-Start-Guide.pdf>

Full language reference is available at <https://z-uno.z-wave.me/Reference/>

Software structure

ZMExZUNOM contains a pre-loaded user code bootloader. Bootloader can be upgraded via USB or OTA. Z-Uno Module have four different bootloaders depending on frequency and desired security scheme.

Z-Uno firmware consist of four parts:

- **User code** also known as sketch in a simplified C language (see Z-Uno language reference) and loaded into Z-Uno using zuno tools. User code controls all pins and logics of the device.
- **Bootloader** for User code sets up Z-Wave Application layer according to User code settings, configures Channels, defines Associations groups and selects power management mode. It also handler inclusion in existing Z-Wave network or and Rescue mode. The main role of this layer is to call callbacks in User code on Get and Set packets coming from Z-Wave Application layer as well as run loop function every time lower layers are idle.
- **Z-Wave Application layer** maps Z-Uno Channel's capabilities and Association groups to Z-Wave Command Classes to fully conform Z-Wave Plus protocol. This layer also provides standard Z-Wave features like firmware upgrade Over-the-Air or via USB, AES encryption of all radio packets, radio power metering, battery monitoring and Z-Wave network management functions.
- **Z-Wave Network layer** is based on Silicon Labs 6.7x SDK handles network and radio layers of Z-Wave communications establishing reliable two-way mesh network between all devices in your smart home. This layer calculates routes to reach destination, prepares and sends radio packets and receives packets from other devices.

User code
 your code

Bootloader
 by Z-Wave.Me

Z-Wave
 Application layer
 by Z-Wave.Me

Z-Wave
 Network layer
 by Silicon Labs

Depending on the security level and operation frequency User code space size differs:

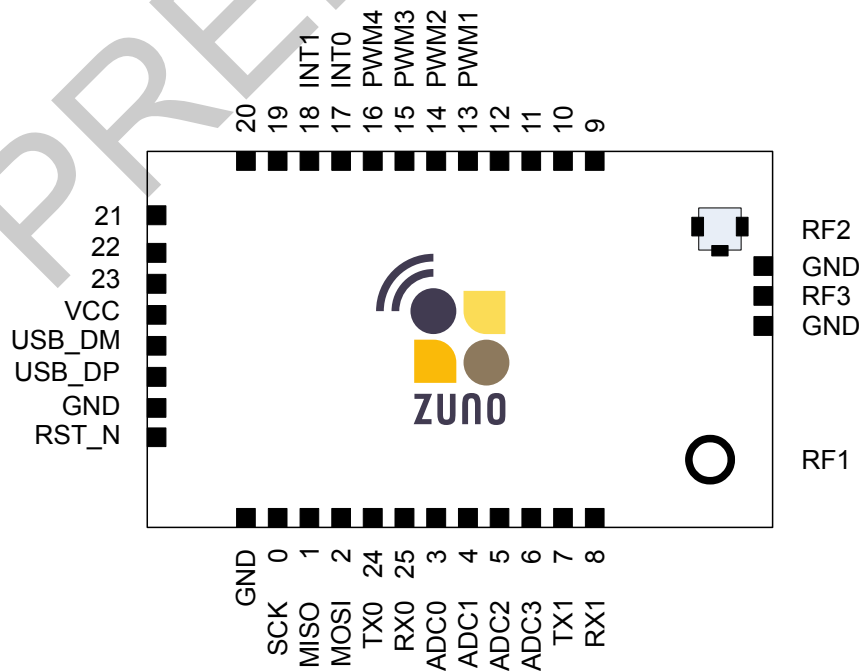
Available User code size	Security	Frequency
30 kB Flash, 2 kB RAM	Non-secure or Security S0	EU/US/RU/IL/ANZ/BR/CN/IN
30 kB Flash, 2 kB RAM	Non-secure or Security S0	JP/TW
6 kB Flash, 2 kB RAM	Security S2	EU/US/RU/IL/ANZ/BR/CN/IN
6 kB Flash, 2 kB RAM	Security S2	JP/TW

Pin Names and Descriptions

Pin	Description
VCC	V _{cc} power supply
GND	Ground pins
USB_DM	USB data
USB_DP	USB data
RST_N	Z-Uno reset pin
0	GPIO, SCK (SPI)
1	GPIO, MISO (SPI)
2	GPIO, MOSI (SPI)
3	GPIO, ADC0, INT2
4	GPIO, ADC1, IR TX2 (IR)
5	GPIO, ADC2, IR TX1 (IR)
6	GPIO, ADC3, IR TX0 (IR)
7	GPIO, TX1 (UART), IR RX2 (IR)
8	GPIO, RX1 (UART), CS (SPI)
9	GPIO, FastPin (I ² C, 1-Wire, fast GPIO)
10	GPIO, FastPin (I ² C, 1-Wire, fast GPIO)
11	GPIO, FastPin (I ² C, 1-Wire, fast GPIO)
12	GPIO, FastPin (I ² C, 1-Wire, fast GPIO)

Pin	Description
13	GPIO, PWM1, FastPin
14	GPIO, PWM2, FastPin
15	GPIO, PWM3, FastPin
16	GPIO, PWM4, FastPin
17	GPIO, INT0
18	GPIO, INT1 (Wakeup)
19	GPIO
20	GPIO
21	GPIO
22	GPIO
23	GPIO
24	GPIO, TX0 (UART)
25	GPIO, RX0 (UART)
RF1	Wire antenna connector
RF2	u.fl connector for antenna
RF3	Pin connector for antenna

Pin Out



Programming

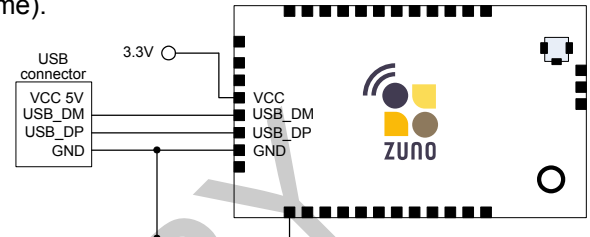
ZMExZUNOM is programmed in C/C++ language. User code is compiled using special Z-Uno uCXX compiler (freely available from z-uno.z-wave.me). Arduino IDE can be used for development and flashing. Alternatively console tools are also available as part of Z-Uno software package.

Z-Uno Module can be programmed via

- USB (USB_DM/USB_DP/GND and 3V power) or
- Over-the-Air (OTA).

OTA upgrade can be done from any OTA-capable Z-Wave controller. Both User Code and Bootloader can be upgraded.

After programming User Code with changed Z-Wave capabilities Z-Uno Modules have to be removed from the Z-Wave network and added again to apply changes.

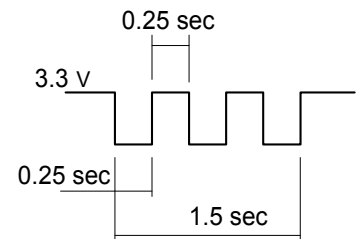


Z-Uno Module programming connection

Z-Wave Features

Z-Uno Module implements Z-Wave Plus protocol. All mandatory Z-Wave Command Classes are automatically implemented. Depending on the type and the number of channels Z-Uno Module will also present its features in Multi Channel Command Class and corresponding Z-Wave Plus Role Type.

To add or remove Z-Uno Module to/from Z-Wave network use Learn Mode sequence on the pin 23 (Service Button pin). Use triple click if a button is connected to this pin. Alternatively use `zunoStartLearn` function in the User code.



Learn Mode sequence

Rescue Mode

It is possible to run Z-Uno Module in «Rescue Mode» with User Code disabled. This is useful in case your User Code is hanging or going into an infinite loop. In Rescue Mode Z-Uno can be excluded from the Z-Wave network.

To start in Rescue Mode pull pin 23 (Service Button pin) to ground and pull reset pin (RST_N) to ground and release it. In rescue mode Z-Uno can be re-programmed, added to network or removed from network.

Z-Uno Module will return in normal state after a power cycle or reset.

Z-Wave Plus Support

ZMExZUNOM supports/controls the following Z-Wave Command Classes:

Standard supported Command Classes:	
Association Group Information V1	
Association V2	
Basic V1	
Configuration V1	
Device Reset Local V1	
Firmware Update V3	
Manufacturer Specific V2	
Multi Cmd V1	
Multi Channel V4	
Powerlevel V1	
Security S0 V1	
Security S2 V1	
Version V2	
Z-Wave Plus Info V2	
Channel specific Command Classes:	Device Type:
Binary Switch V1	Power Switch Binary, Valve, Siren
Multilevel Switch V1	Power Switch Multilevel, Motor Control
Color Switch V1	Color Tunable Multilevel
Notification V5, Sensor Binary V2 (for legacy)	Notification Sensor, Binary Sensor (for legacy)
Sensor Multilevel V7	Multilevel Sensor
Meter V4	Simple Meter
Door Lock V2	Entry Control
Thermostat Mode V3, Thermostat SetPoint V3	General Thermostat
Controlled Command Classes:	Association type:
Basic V1	Binary Switch, Multilevel Switch
Multilevel Switch V1	Multilevel Switch
Door Lock V2	Door Lock
Scene Activation V1	Scene
Standard controlled Command Classes:	
Multi Channel V4	
Multi Cmd V1	
Security S0 V1	
Security S2 V1	

Absolute Maximum Ratings

Parameter	Rating
V _{DD} Main supply voltages	-0.3 to +3.6 V
V _{IN} Voltage applied on any input pin	-0.3 to +3.6 V
I _{VDD} Sum of the current into all V _{DD} power supply pins	120 mA
I _{GND} Sum of the current out of all GND pins	120 mA
T _S Storage temperature	-40 to +100 °C
T _J Junction temperature	-55 to +125 °C

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

Electrical Specifications

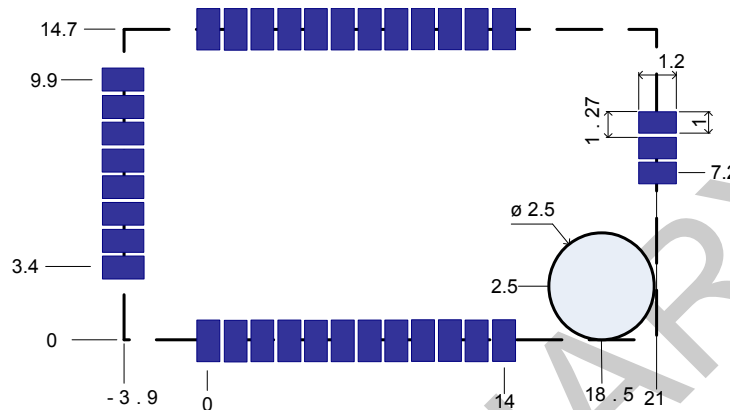
Parameter	Min	Typ	Max	Units
V _{DD} Main supply voltages	+2.6	+3.3	+3.6	V
V _{DD_USB} Main supply voltages when USB is used	+3.0	+3.3	+3.6	V
T _A Ambient operating temperature	-20.0	+25.0	+85.0	°C
I _{DD_ACTIVE} Current, radio off (after sleeping mode before first packet sent)		20	22	mA
I _{DD_RX} Current, radio in receive mode (for mains powered or after packet sent)		37	40	mA
I _{DD_TX} Current, radio in transmit mode		50	55	mA
I _{DD_SLEEP} Current, sleep mode		1		µA
I _{DD_WUT} Current, sleep mode with WUT enabled		2		µA
V _{IH} Logical 1 input voltage high level on GPIO pins ⁽¹⁾	+1.85/+2.10		+3.6	V
V _{IL} Logical 0 input voltage low level on GPIO pins ⁽¹⁾			+0.75/+0.90	V
I _{IH} Logical 1 input high level current leakage ⁽¹⁾			+7.0/+10.0	µA
I _{IL_NPU} Logical 0 input low level current leakage (no internal pull-up) ⁽¹⁾	-7.0/-10.0			µA
I _{IL_PU} Logical 0 input low level current leakage (with internal pull-up) ⁽¹⁾	+35/+40		+90/+120	µA
V _{OH} Logical 1 output voltage high level on GPIO pins ⁽¹⁾	+1.9/+2.4			V
V _{OL} Logical 0 output voltage low level on GPIO pins ⁽¹⁾			+0.40	V
I _{OH} Logical 1 output high level current source ^{(1) (2)}			+6.0/+8.0	µA
I _{OL} Logical 0 output low level current sinking ^{(1) (2)}	-6.0/+8.0			µA
Duration to assert RESET_N to guarantee a full system reset	20			ns

⁽¹⁾ Values for V_{DD} in range +2.8–+3.0V and +3.0–+3.6V respectively

⁽²⁾ Values are twice bigger on pins 3–6

Pads layout

The following layout is recommended for automatic SMD mounting. The gray circle depicts the hole for wire antenna through hole mounting and can be omitted (see below).



Antenna

Z-Uno Module requires an antenna to be connected. SAW filter is already included in the module depending on the Part No.

It is recommended not to place any wires on the host PCB in the area under Z-Uno antenna matching (do not fill with ground).

There are three possible options for antenna:

- 81-86 wire
- 50 Ohm pin
- 50 Ohm u.fl connector (not soldered)

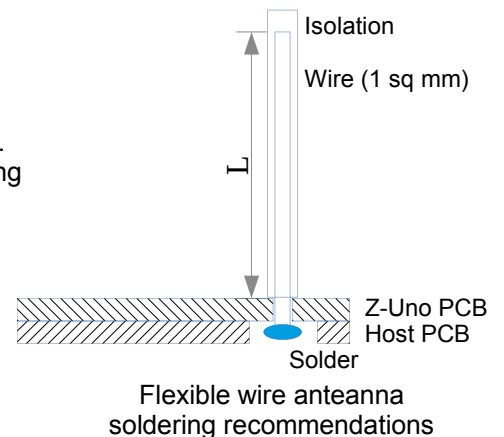
Do not connect more than one antenna to Z-Uno Module.

Wire antenna length should be measured from Z-Uno Module PCB top level. It is recommended not to solder on the antenna side if the wire will need some flexibility, instead solder on the bottom of both Z-Uno and host PCB. In this case make a hole in the host PCB as shown by the gray circle on the pads layout.

For non-flexible wire antenna can be soldered on the top. The hole in the host PCB is not needed in this case.

If 50 Ohm RF pin is not used (u.fl or wire is used), leave this pin non-connected. If used, make sure to take into account the thickness of the PCB and surrounding ground pins when designing the PCB RF path and PCB antenna.

Antenna length (L)	Frequency
86 mm (868 MHz)	EU/RU/IN/CN frequencies
82 mm (914 MHz)	US/IL frequencies
81 mm (923 MHz)	ANZ/BR/JP/TW frequencies



Recommended PCB antenna layout can be taken from Silicon Labs web site:

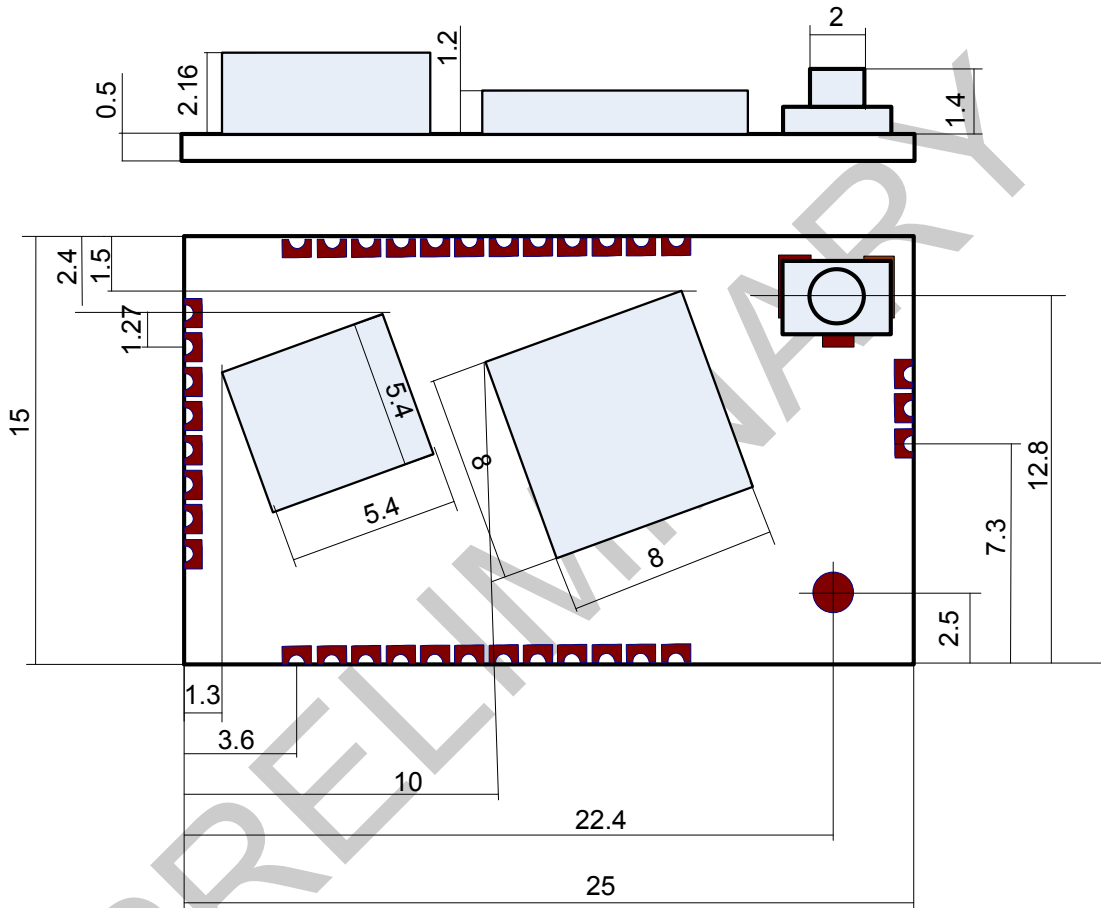
868 MHz <https://www.silabs.com/products/development-tools/wireless/proprietary/868-mhz-antenna-matrix-development-kit>

914/923 MHz: <https://www.silabs.com/products/development-tools/wireless/proprietary/915-mhz-antenna-matrix-development-kit>

We recommend to use the WES0031-01-APL868M-01.

Package Outline

(Dimensions in millimeters)



Ordering Information

Packed in 7" reels per 50 units

Part No.	Frequencies
ZMEEZUNOM	EU/RU/IN/CN
ZMEUZUNOM	US/IL
ZMEAZUNOM	ANZ/BR/JP/TW

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1A	ESDA / JEDEC JS-001-2012
ESD – Charged Device Model (CDM)	Class C1	JEDEC JESD22-C101F
MSL – Moisture Sensitivity Level	Level 3	IPC/JEDEC J-STD-020



Caution!
ESD-Sensitive Device

Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes. Solder profiles available upon request.

Contact plating: NiPdAu

RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

Web: z-uno.z-wave.me

Tel: +7 495 681-38-36

Email: z-uno@z-wave.me

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