DSH, Datasheet

ZM1220 Z-Wave Module

Document Part Number:	**903501208**
Document Revision:	**01.08**
Description:	**Datasheet for the Integrated Z-Wave Module based on ZW0102 Z-Wave Single Chip. Two versions are described within this document, US version (908.42MHz) and a EU version (868.42MHz).**
Written By:	**Thomas Jørgensen**
Date:	**October 28, 2004**
Reviewed By:	**MVO, OPP, JFP, MHA, TBA, LAF, NTJ, TCA**
Audience:	**No restrictions**

Approved by: Authority	Date
Niels T. Johansen, R&D	December 2004

REVISION RECORD

CONFIDENTIAL

REVISION RECORD

Doc. Rev	Date	By	Pages affected	Brief description of changes
00.01	October 28, 2004	TJO	ALL	Initial Draft
01.00	June 13, 2002	TJO	ALL	First release
01.01	August 19, 2002	TJO	7, 9, 11, 12, 16	Table 2: “AD1: Can be used as voltage reference input” removed Section 4.2.4: “external voltage reference” removed Table 5: RF receiver sensitivity updated Table 6: “Absolute Maximum Ratings” updated Table 7: Updated Chapter 6: Reference 1 updated
01.02	September 20, 2002	TJO	All, 21	“Z-Wave RF Controller” changed to “ZW0102 Single Chip” Table 5: Typical RF sensitivity changed from –92dBm to –94dBm Table 7: TX power consumption added.
01.03	November 29, 2002	TJO	12, 16	Table 6: “Operating Temperature” updated Table 7: “Operating Temperature” and “Operating Relative Humidity” Page 12: references updated.
01.04	February 5, 2003	TJO	All	“ZW0102 Z-Wave Module” replaced with “ZM1220 Z-Wave Module”. Section 4.14 added
01.05	May 1, 2003	TJO	11, 12	Table 4: Crystal data updated Table 7: Operating temperature extended (-10 to +85°C)
01.06	November 6, 2003	TJO	6, 7, 13	Some API’s do not support all HW interfaces. Z-Wave Module naming updated with “B” version
01.07	December 3, 2003	TJO	Table 2	UART speed updated from 56Kbps to 115kbps
01.08	October 28, 2004	TJO	Table 7, 10, 15	Reset signal timing added Section 4.7 added. Available resources deleted - refers to Programming Guideline.

Table of Contents

1 ABBREVIATIONS

Abbreviation	Explanation
ADC	Analog-to-Digital Converter
API	Application Programming Interface
FSK	Frequency Shift Keying
GPIO	General Purpose Input/Output
HW	Hardware
I/O	Input/Output
LSB	Least Significant Bit
MCU	Micro Controller Unit
MSB	Most Significant Bit
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
RF	Radio Frequency
RTC	Real-Time-Clock
RX	Receive
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
SRD	Short Range Devices
SW	Software
TX	Transmit
UART	Universal Asynchronous Receive Transmit
ZM1220	Integrated ZW0102 based Z-Wave Module
ZW0102	Zensys developed Z-Wave Controller Chip, 52-pin

2 INTRODUCTION

2.1 Purpose

The purpose of this document is to present all the technical specifications for the Zensys ZM1220 Z-Wave Module available in a US version and a EU version, which is based on Zensys' Z-Wave ZW0102 Single Chip.

2.2 Audience and Prerequisites

The audience of this document is R&D external readers. No prerequisites required.

3 PRODUCT DESCRIPTION

3.1 Overview

The ZM1220 Z-Wave Module is a central part of Zensys' Integrated Z-Wave Module family and is based on Zensys' Z-Wave Single Chip ZW0102. The ZW0102 is a single chip containing a RF transceiver, an 8051 micro-controller, a wide range of HW interfaces and Z-Wave SW Application Programming Interface (API). The Z-Wave Module contains all the necessary hardware (HW) and software (SW) needed for Z-Wave protocol handling and RF transmission/reception.

The ZM1220 Z-Wave Module can be used for designing both a Z-Wave Slave Node and a Z-Wave Controller Node. A Z-Wave Slave Node is capable of executing commands requested by a Z-Wave Controller Node. A Z-Wave Controller Node is capable of initiating commands, creating routing tables etc., e.g. function as a remote control. For more node type information see [5].

The ZM1220 Z-Wave Module contains the ZW0102 Single Chip with integrated flash and SRAM. Additionally the Module contains an RF front-end and a PCB antenna. Moreover the Module has mounting option for Real-Time-Clock crystal, EEPROM, push button, DC/DC converter and wire antenna or whip antenna (SMA connector).

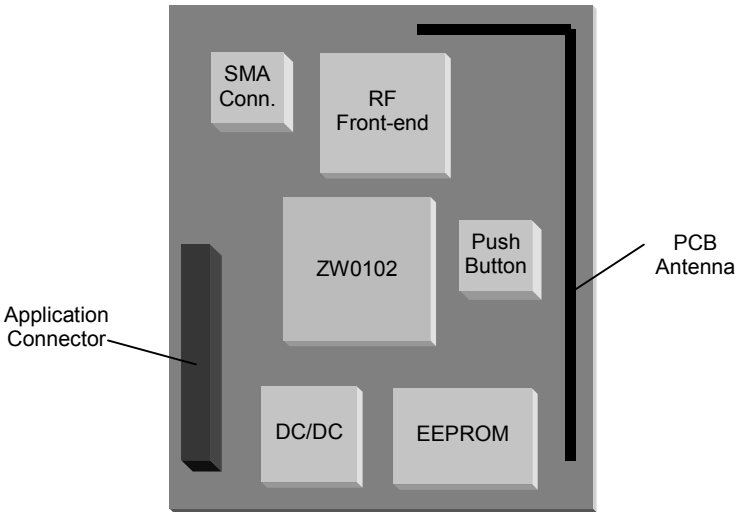


Figure 1 ZM1220 Z-Wave Module

An Application Module can be connected to the ZM1220 Z-Wave Module through an Application Connector (see Figure 1). The Application Connector contains multiple user programmable General Purpose I/O's (GPIO's) for interconnection with a wide range of Application Modules.

The RF data rate is 9600bps, and the carrier frequency is 868.42 MHz (model 7027) or 908.42 MHz (model 7023). Frequency Shift Keying (FSK) is used as modulation type.

In addition to the Integrated Z-Wave Module family described within this datasheet a Small Form Factor (SFF) Z-Wave Module Family is available. The SFF Z-Wave Module ZM1206 has no PCB antenna and has double-sided component mount and has a size of 6cm^2 where as the ZM1220 has an integrated PCB antenna and is single-sided component mount and has a size of 20cm^2. For more information about the ZM1206 Z-wave Module see [2].

The Application Connector interfacing the Z-Wave Module with the Application Module is a standard 2.00mm pitch 2x10 pin-row. The Application Connector contains the following signals:

- 11 General Purpose I/O pins (dual function)
- One interrupt input pin
- Serial UART interface
- SPI interface (Serial Peripheral Interface)
- Two ADC inputs
- Zero Crossing Detection input (used for dimmer applications)
- TRIAC control output (used for dimmer applications)
- Reset input
- 5V and 3V power inputs
- Ground

All 11 GPIO's have a dual function meaning they support "special" signals (interrupt, SPI etc.) see Table 2. All signals on the Application Connector are 3.3V CMOS signaling compatible, and are all controlled by the application SW.

The software modules handling the Z-Wave protocol and RF transmission are a part of the ZM1220 Z-Wave Module. OEM application software can be added to the Z-Wave protocol software via a well-defined Application Programming Interface (API). Different API's are available to support different kind of application, see [6] for further information. Note that some API's do not support all the above-mentioned interfaces, please check [6].

In the following chapter the HW specifications for the Z-Wave Module is described. The specifications of the ZW0102 Single Chip will not be described within this datasheet but can be found in [1].

4 HW SPECIFICATIONS

4.1 Application Connector Specification

The Application Connector interfacing the Z-Wave Module with the Application Module is a 2x10 pin row.

The connector layout shown in Table 1 is a part of a Zensys defined Application Connector layout, which has been designed to allow exchange of the ZM1220 Z-Wave Module with another Z-Wave Module type.

Pin No.	Pin Name	Pin Name	Pin No.
1	N.C.	PROG_N	2
3	ZEROX	PWM2	4
5	TRIAC	INT0_n	6
7	AD1	IO9	8
9	N.C.	MISO	10
11	5V	CLK	12
13	GND	MOSI	14
15	RESET_n	TXD	16
17	VCC	RXD	18
19	IO10	AD2	20

Table 1 Application Connector Layout

Name	I/O	Description
IO[10:9]	I/O	IN/OUT[10:9]: General purpose I/O signals
INT0_n	I	Interrupt: Active low external interrupt signals. The signal is level or edge trigged. The signals are also connected to the push button on the Z-Wave Module. When in power down mode the Z-Wave Module MCU is woken up by activating this interrupt signal. Can also be used as GPIO pin.
TXD	I/O	UART Transmit Data. Supports 2.4kbps – 115kbps. Can be used as GPIO pin.
RXD	I/O	UART Receive Data. Supports 2.4kbps – 115kbps. Can be used as GPIO pin.
RESET_n	I/O	Reset. Active low Z-Wave Module reset. The Z-Wave RF Controller chip has an integrated reset circuitry. As mounting option a reset circuitry can be implemented on the Z-Wave Module. Note: the reset circuitry will not be available on the future Z-Wave Controller Chip Z-Wave Modules.
CLK	I/O	SPI Clock: Clock input for Flash programming. Can be used as master SPI clock signal or GPIO signal.
MOSI	I/O	Master Out Slave In SPI interface: SPI data input used for Flash programming. Can in normal operation be used as MOSI signal or as GPIO signal.
MISO	I/O	Master In Slave Out SPI interface: SPI data output used for Flash programming. Can in normal operation be used as MISO signal or as GPIO signal.
PROG_N	I	Program Enable. Active low flash programming signal. The pin cannot be used after programming. Programming instruction see section 4.9 and [6].
AD[2:1]	I	Analog-to-Digital converter input 1 and 2.
ZEROX	I/O	Zero Cross Detection: Zero cross detection signal used on dimmer modules detecting 120/240V zero crossing. Can be used as GPIO signal.
TRIAC	I/O	TRIAC Control. Can control a triac on the Application Module like light dimmer modules etc. Can be used as GPIO signal.
PWM2	I/O	Pulse Width Modulator Output. Used for frequency variation applications. Can be used as GPIO signal.
VCC	Power	Module 3.3V supply input. If the DC/DC is mounted 3.3V must not be added to this pin from the Application Module.
5V	Power	Module 5V supply input. Should only be added if the 5V-to-3.3V DC/DC converter is mounted.
GND	Power	Ground

Table 2 Application Connector Signal Description

Note: some API's do not support all the above-mentioned interfaces, please see [6].

4.2 Application Connector Signals

4.2.1 GPIO Pins

Some of the signals, which have a special feature, can also be used as General Purpose Inputs/Outputs pin (GPIO) if wanted. All GPIO's signals have true Read-Modify-Write functionality when used as general digital I/O ports. The "special" purpose signals, which can be used as GPIO are listed in the table below.

- INT0_n
- TXD
- RXD
- MOSI
- MISO
- CLK
- TRIAC
- XEROX

For electrical characteristics see section 4.13.

4.2.2 UART

The ZM1220 Z-Wave Module features a full duplex Universal Asynchronous Receiver and Transmitter (UART), which enables real time control of the Z-Wave Module, either by a CPU on the Application Module or by a PC, requiring a RS232 driver on the Application Module. The interface supports the following features:

- Data rate: 2.4kbps – 115.2kbps (default 9.6kbps)
- 8 bits per word
- One Stop bit
- No parity
- 3.3V signaling

When powering up the Z-Wave Module for the first time the data rate of the serial interface is 9.6kbps, and can afterward be changed to the wanted data rate.

4.2.3 SPI Interface

The Serial Peripheral Interface (SPI) allows high-speed synchronous data transfer between the Z-Wave Module and the Application Module. The Z-Wave Module SPI include the following features:

• Full-duplex, 3-wire Synchronous Data Transfer
• Master Operation
• LSB First or MSB First Data Transfer
• Four Programmable Bit Rates in Master Mode (f_{sys} /8, f_{sys} /16, f_{sys} /32 or f_{sys}/64)

The signals MISO, MOSI and CLK on the Application Connector are used. For SPI timing characteristics see [1]. The SPI controller does not support Slave operation in normal mode only in flash programming mode. If Slave operation is needed it must be implemented in SW using a GPIO pin.

4.2.4 Analog-to-Digital Converter

Either AD1 or AD2 on the Application Connector can be used as Analog-to-Digital Converter (ADC) input. The ADC is a 10-bit ADC. An internal (ZW0102) voltage reference can be used. For detailed description and electrical specifications see [1].

4.2.5 TRIAC & ZEROX

The Z-Wave Module has a triac control output signal (TRIAC). The control of the TRIAC signal depends on the ZEROX signal generated on the Application Module (when “Dimmer” SW is downloaded to the Z-Wave Module). The Z-Wave Module generates a fire pulse to an external triac, when “closing” the triac. The fire pulse is generated in both the high and the low period of the mains’ voltage. For detailed triac control description and electrical characteristics see [1].

4.2.6 Pulse Width Modulator Output

The Pulse Width Modulator Output (PWM2) is controlled by an internal 16-bit Timer/Counter. The prescaling of the Timer/Counter is:

- CLK : 7.376974 MHz
- CLK/2 : 3.688487 MHz
- CLK/4 : 1.844244 MHz
- CLK/8 : 922.1218 kHz
- CLK/16 : 461.0609 kHz
- CLK/32 : 230.5304 kHz
- CLK/64 : 115.2652 kHz
- CLK/128 : 57.63261 kHz
- CLK/256 : 28.81630 kHz

Where CLK is the system frequency determined by the crystal frequency (7.376974 MHz). The PWM2 output can also be used as GPIO.

4.3 Real-Time-Clock

A RTC crystal can be mounted for real-time application like hour/minute/second indication in for example remote controls or for battery operated slaves that powers down and wakes up at certain time intervals.

4.4 EEPROM

The ZM1220 Z-Wave Module has mounting option for an external onboard EEPROM used for misc. data storage. When used as Z-Wave Controller Node the EPPROM is used for routing table storage. Up to 256kbit EEPROM can be mounted, see [3] or [4] for further details.

4.5 Reset

The Z-Wave Module can be reset either by the integrated reset circuitry (with Brown-out detection) in the ZW0102 Single Chip or by the Application Module via the Application Connector signal RESET_n. The reset signal must have rise and fall time of less than 400uSec (seeTable 7).

4.6 Power

The Z-Wave Module can be powered by either 3.3V or 5V by the Application Module. If powered by 5V a 5V-to-3.3V DC/DC converter must be mounted on the Z-Wave Module. As indicated in Table 7 the power supply must be quite stable, so it does not create noise in the noise circuitry, resulting in reduced RF sensitivity.

4.7 EMC

As default two 330@100MHz Ferrite Beads (Murata BLM21AG331SN1D) are mounted between the Application Connector ground and module ground (L6, see Figure 3) and also between the Application Connector VCC and module VCC (L1) to filter noise from the Application Circuitry. This mounting option is good for lower power digital circuitries like battery-operated products. In high power products like dimmer products etc. high current noise may generate a noise-voltage over the ground Ferrite Bead (L6). It is therefore recommended to replace the L6 Ferrite Bead with a zero ohm resistor in these kind of products.

For schematic see [8] or [9].

4.8 Antenna

In order to implement the Z-Wave Module in various products different types of antennas can be implemented to get the best RF performance, i.e. range and reliability. The following antennas can be implemented:

- PCB Antenna (low cost, already integrated on the PCB)
- Wire/brace Antenna
- Whip Antenna

The PCB antenna can be disabled by removing a resistor and the wire (or brace) antenna can be implemented by soldering the wire directly onto the Z-Wave Module. Alternatively a SMA connector can be mounted in order to mount a Whip antenna, either directly or via a coax cable.

4.9 Z-Wave Module Programming

The ZM1220 Z-Wave Module is programmed using the SPI interface, RESET_n and the program enable signal PROG_N (see section 0). For programming instruction and recommended programming tool(s) see [6].

4.10 MCU Specification

MCU	Description
MCU Type	Optimized 8-bit 8051 MCU core (4 clock cycles per instruction), See [1].
MCU speed	7.376974 MHz
Flash	32kbyte. Programmed through the SPI interface.
SRAM	2kbyte
SRAM (CPU)	128 byte
MCU Peripherals	10-bit ADC, UART, SPI, 8 bit timer, 2x16 bit timer one with PWM mode, watch dog timer, Power-on Reset/Brown-Out Detector.
Interrupt sources	Internal and external.

Table 3 MCU Specifications

4.11 ZW0102 Single Chip Peripherals

Peripherals	Description
Crystal	System Clock: 7.376974 MHz, ±8ppm@25°C, ±8ppm@-10°C to +85°C, 3ppm aging per year. Real-Time Clock: 32.768kHz
DC/DC circuit	3.3V±2%, 100mA Low Drop-out Voltage Regulator
Push button	Tiny SMD
Optional Peripherals	DC/DC converter, Push button, EEPROM and RTC crystal

Table 4 MCU external peripherals

4.12 RF Specification

RF	Description
RF Data rate	9.6 kbps
RF frequency (center frequency)	868.42 MHz EU ZM1220 908.42 MHz US ZM1220
Modulation frequency	Center frequency ± 20kHz
Typical RF output power	Optimized for (PCB antenna): US: FCC Part 15 ERC 70-03 on SRD
Typical RF receiver sensitivity	-94dBm
Range (typical)	Indoor >30 meters line of sight, in unobstructed environment. Outdoor > 60 meters line of sight
Modulation	Frequency Shift Keying (FSK)
Signal coding	Manchester Encoded
RF regulatory	Model EU ZM1220: R&TTE Directive 1999/5/EC, EN 300 220-3/2000 Model US ZM1220: FCC Part 15, April 16 1999

Table 5 RF Specifications

4.13 Electrical Specification

4.13.1 Absolute Maximum Ratings

The “Absolute Maximum Ratings” specifies the conditions in which the Z-Wave Module is guaranteed not to be destroyed but correct operations are not guaranteed. Exceeding the “Absolute Maximum Ratings” may destroy the Z-Wave Module. See “DC Characteristics” for guaranteed operation limits.

Electrical	Value
Operating Temperature	-30°C to +100°C
Storage Temperature	-40°C to +105°C
Voltage on input pins	-0.3V to V_{CC}+0.3V (5V max)
Minimum Operating Voltage (V_{CC})	-0.3V
Maximum Operating Voltage (V_{CC})	5V
Maximum Operating Voltage (5V)	20V
DC Current per GPIO Pin	±4mA

Table 6 Absolute Maximum Ratings

4.13.2 DC Characteristics

The following DC characteristics are for the Z-Wave Module. DC characteristics related to the ZW0102 Single Chip are to be found in [1] and are not listed in this datasheet.

T_A = 25°C, V_{CC} = 3.3V (unless otherwise noted)

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{CC}	Main Supply voltage(1)	(Max. 20mVpp ripple from DC to 300kHz)	2.7	3.3	3.6	V
5V	5V Supply voltage (2) (for DC/DC Converter)	Max. 50mVpp ripple from DC to 300kHz Max. 100mVpp ripple >300kHz	3.6		18V	V
RRST	Reset Pull-up Resistor	Integrated in ZW0102	48		60	kΩ
R_{AC}	Application Connector Serial Resistor	All signals except TRIAC	0.9	1.0	1.1	KΩ
I_{CC}	Transmitting (Xtal: 7.376974 MHz)	-5dBm, V_{CC} = 3.3V -2dBm, V_{CC} = 3.3V 0dBm, V_{CC} = 3.3V +2dBm, V_{CC} = 3.3V +4dBm, V_{CC} = 3.3V		22.9 24.5 26.6 25.5 30.0		mA
	Receiving (Xtal: 7.376974 MHz)	V_{CC} = 3.3V,		26		mA
	Power Down	V_{CC} = 3.3V, RTC running, Power-on-reset disabled		35		µA
	Power Down	Power-On-Reset and DC/DC converter not mounted, V_{CC} = 3.3V, temp.= 25°C, Power-on-reset disabled		1		µA

Symbol	Parameter	Condition	Min	Typ	Max	Units
t_{reset}	Input reset pulse		$1024 \cdot f_{clk}$ [1)]			
t_{resetR}	Rise time	10% to 90%			400	µs
t_{resetF}	Fall time	90% to 10%			400	µs
T_{OP}	Operating Temperature		-10		85	°C
H_{OP}	Operating Relative Humidity		8		80	%

(1) When integrated Reset circuitry is enabled min. supply voltage is 3.1V

(2) Required when DC/DC converter is mounted on Z-Wave Module

Table 7 DC Characteristics

4.14 Physical Specification

Physical	Description
Dimension (H x W x D)	7 mm x 50 mm x 40.5 mm
Mounting holes	Two holes.

Table 8 Physical Specifications

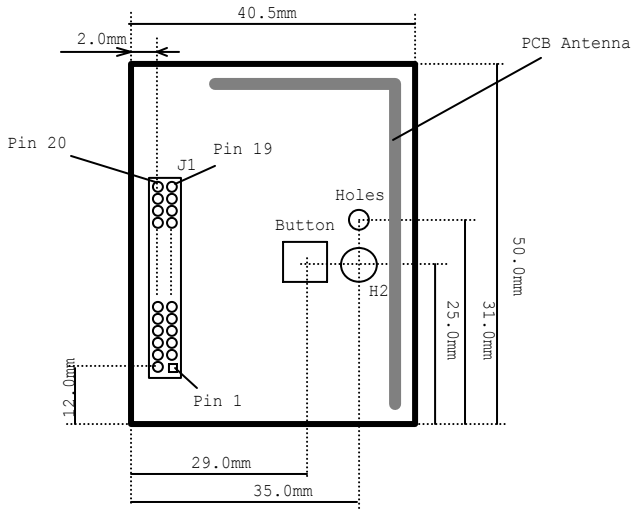


Figure 2 ZM1220 Z-Wave Module PCB outline

The Application Connector is a standard 2mm pitch 2x10 pin-row. The pad hole is a Ø0.9mm plated hole. When implementing the ZM1220 Z-Wave Module in a product together with an Application Module any metallic objects must be min. 10mm from the PCB antenna. For detailed design recommendations see [7].

4.15 ZM1220 Z-Wave Module Outline

When reference is made to ZM1220 Z-Wave Module signals and component names within this guideline, please refer to the schematic on the Z-Wave Module Blueprint Documentation CD. For datasheet of the ZM1220 Z-Wave Module see **Error! Reference source not found.**. The component placement on the ZM1220 Z-Wave Module is shown in the following figure.

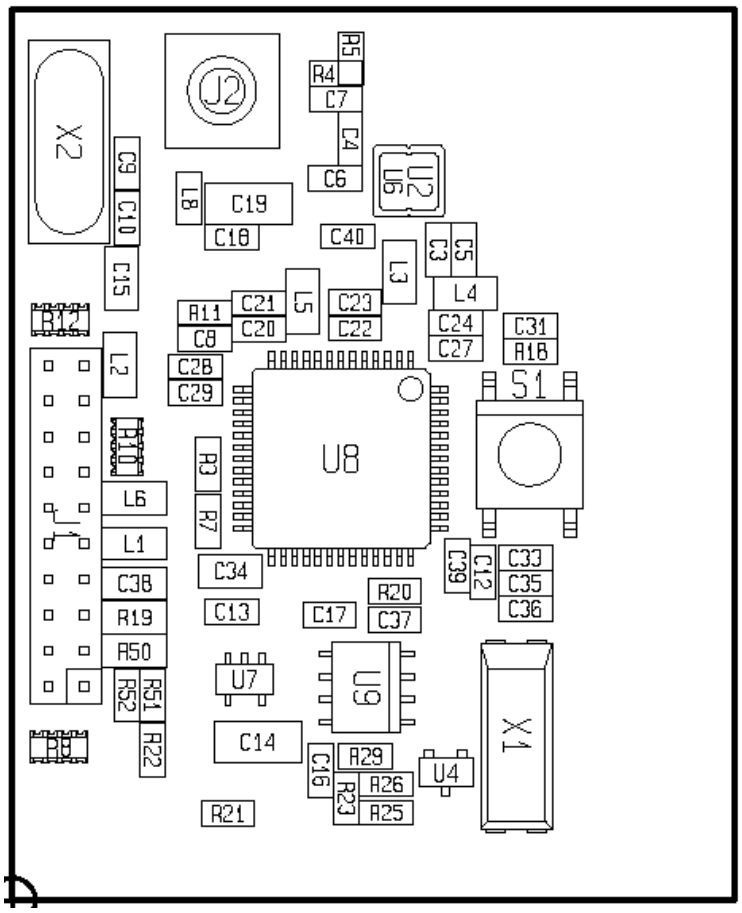
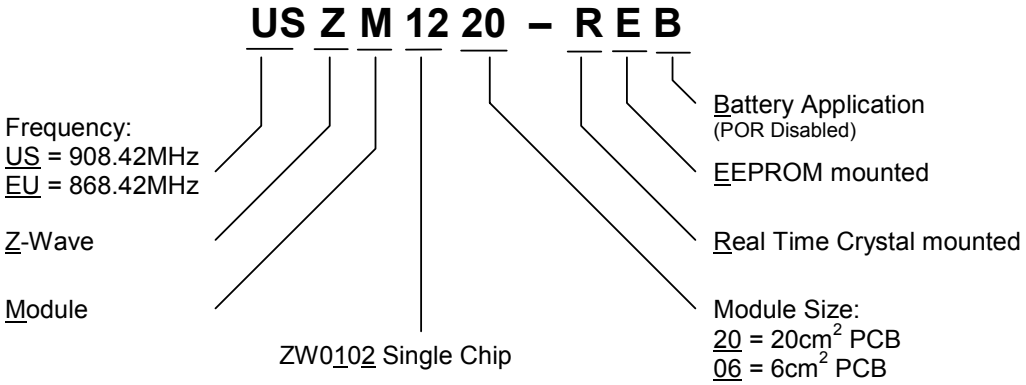


Figure 3 ZM1220 Z-Wave Module

4.16 Module Naming

Explanation of the Z-Wave Module naming.



For more information on the ZM1206 Z-Wave Module see [2].

5 SW SPECIFICATION

5.1 Free SW resources

The Z-Wave protocol does not use all of the available SW resources on the ZM1220 Z-Wave Module. For description of available flash, SRAM, EEPROM, HW timer and SW timer resources see [6] for the different API stacks.

6 REFERENCES

A Zensys documentation part number consists of 9 digits where the last two digits refer to the revision of the document. When the revision is listed as “XX” please refer to the latest revision of the document.

[1] Datasheet, ZW0102 Single Chip, Doc. P/N: 9035016xx
[2] Datasheet, ZM1206 Z-Wave Module. Doc. P/N: 9035018xx
[3] Bill-Of-Material, US ZM1220 Z-Wave Module, P/N: 370100410 or 370100411
[4] Bill-Of-Material, EU ZM1220 Z-Wave Module, P/N: 370100480 or 370100481
[5] Z-Wave Node Type overview and Network Installation Guide, P/N: 9520068xx
[6] Z-Wave ASIC Application Programming Guide, P/N: 9002008xx
[7] Datasheet, ZM1220 and ZM1206 Implementation Guidelines, P/N: 9002029xx
[8] Schematic, US ZM1220 Z-Wave Module, P/N: 9540050xx
[9] Schematic, EU ZM1220 Z-Wave Module, P/N: 9540062xx