ZWLR800

Z-Wave Module

Approved	Check	Author

Revision History

Version	Author	Date	Modification(s)
V1.0	Fei	2022-08-05	Create document
V2.0	Fei	2022-10-08	Optimization of radio frequency
V2.1	Fei	2023-06-21	Add IPEX

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1. Introduction

1.1 Overview

ZWLR800 is a small size, and Z-Wave800 module.
It integrates Silicon LABS EFR32ZG23A010F512GM40(800) solution,
512K Flash，64KB RAM.

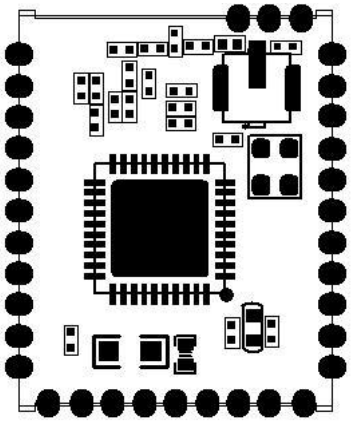


Chart 1.ZWLR800 Module

1.2 Key Features

- Support Z-Wave
- Data Memory: 64KB internal RAM and 512KB internal Flash
- Frequency of crystal : 39MHz;
- Interface: PWMs/I2C/GPIOs/UARTs/ADCs
- Power supply voltage: DC 3.3V
- Operating temperature: -40℃～85℃
- Operating frequency: 865.2 MHz～926.3MHz
- Modulation: FSK、GFSK
- Date Rate: 9.6Kbps、40Kbps、100Kbps
- TX output power:14dBm
- Receiving sensitivity :-110dBm
- Deep sleep mode current: 1.5uA

1.3 Product Application

ZWLR800 is a Z-Wave wireless communication module,
which needs an external antenna for wireless communication.
It provides a variety of interfaces for product applications such as a pair of I^2C interfaces , PWMs interface, GPIOs interface, ADCs interface and two pairs of UART.

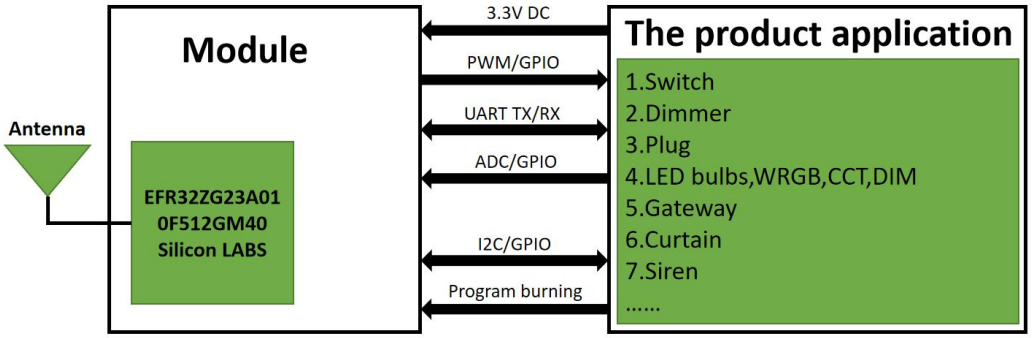


Chart 2.Application Block Diagram

ZWLR800 module can be used in smart products such as switch,dimmer,plug, LED bulbs WRGB,CCT,DIM, gateway,curtain,siren,sensors…… etc.

2. Technical Specification

2.1 Radio Frequency Parameters

Parameter	**Value**			
Protocol	Z-Wave			
Modulation	FSK/GFSK			
Channel Number	5			
Channel Bandwidth	90KHz-1MHz			
Basic Transmitting Rate	R1-9.6Kbps、R2-40Kbps、R3-100Kbps			
Parameter	**Min.**	**Typ.**	**Max.**	**Unit**
Frequency	908.4	--	920	MHz
TX Power	0	--	9	dBm
Frequency Offset	-10	--	+10	KHz
Receiving Sensitivity	-108		-110	dBm
Remark: Above data are based on 25℃ ambient temperature and 3.3V supply voltage;				

Chart 3.RF Parameters

2.2 Pin Definition

2.2.1 Default and Multiplexing Pin Definition

There are 34 pins in ZWLR800 module, refer to below chart 5 for pin definition. “ Default Pin Definition” in Chart 5 means the recommended pin function definition. Usually , customers
need to choose target pins according to the pin definition in this column of Chart 5. In some special projects, if "default pin definition" can’t meet the needs of products, then "Multiplexing Pin Definition" function can be chosen. However, when choosing this multiplexing function, need to consider whether other modules that have the same package, also have the same multiplexing function.

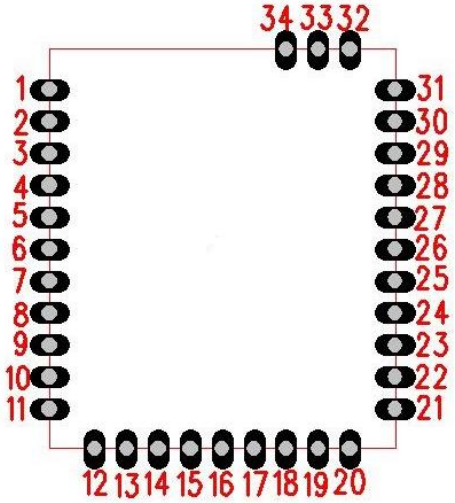


Chart 4.Module Pin Number

Module Pin Number	Pin of IC	Pin Function Description	Remark
1	PB00	GPIO	
2	PA00	GPIO	
3	PA03	GPIO	
4	PB01	GPIO	Interrupt Wakeup，The wake-up pin interface of the lock end to the module
5	PC05	GPIO	
6	PC04	GPIO	
7	/	/	

8	PA04	GPIO	
9	PA06	GPIO	Reuse as TXD, connect the lock end MCU_RX
10	PD02	GPIO	
11	PA05	GPIO	Reuse as RXD, connect the lock end MCU_TX
12	PA08	GPIO, RF_TEST_TX	
13	PA07	GPIO, RF_TEST_RX	
14	GND	GND	
15	PD03	GPIO	
16	PD01	GPIO	
17	PA01/CLK	GPIO/CLK	
18	PA02/TMS	GPIO/TMS	
19	RESET	Chip reset	
20	GND	GND	
21	VDD	3.3V Power supply	
22	PC01	GPIO	
23	PC00	GPIO	
24	PC02	GPIO	
25	PC03	GPIO	
26	PC06	GPIO	
27	PD00	GPIO	
28	/	/	
29	/	/	
30	PC07	GPIO	
31	GND	GND	
32	GND	GND	
33	RF	RF	
34	GND	GND	
	IPEX1	IPEX1	

Chart 5.Pin Definition

2.3 Electrical Performance

Parameter	Min.	Typ.	Max.	Unit	Remark
Operating Voltage	1.71	3.3	3.8	V	
Standby Current	1.5	-	3	uA	Deep sleep mode
RX Current	--	4	--	mA	
TX Current	--	25	--	mA	

Chart 6.Electrical performance parameters

2.4 Operating Condition

Parameter	Unit	Min.	Typ.	Max.	Remark
Operating Temperature	℃	-40	25	85	The ambient temperature on components of ZWLR800 where the module is working.
Storage Temperature	℃	-40	25	85	Recommend to store it in antistatic vacuum bag at 25℃.
Operating Humidity	%	10	--	90	Relative humidity.
Storage Humidity	℃	5	--	95	Relative humidity.

Chart 7.Operating Condition

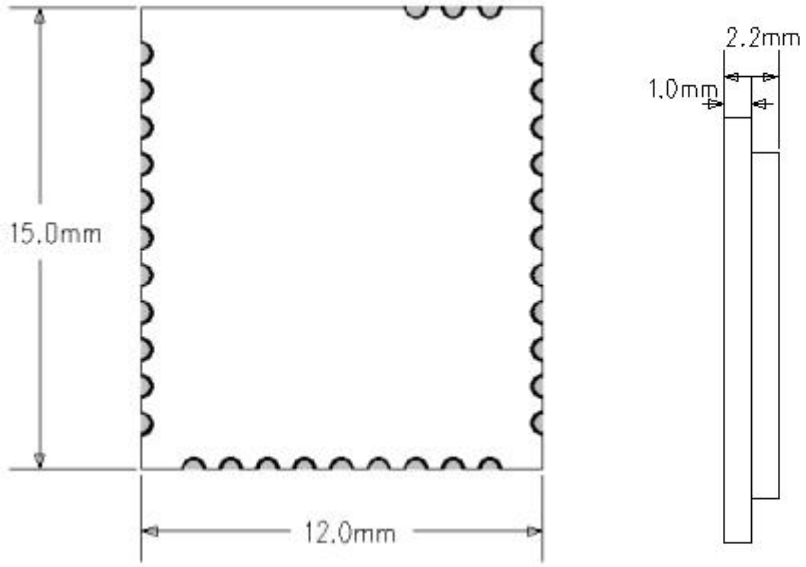
2.5 PCB Features

PCB Material	Number of Layers	Surface Finish	Thickness（mm）	Solder Color	Color of Character	Special Technology
FR-4	2	Immersion Gold	1	Green	White	50Ω Impedance

Chart 8.PCB Features

3. Mechanical Dimension

3.1 Single Module Dimension



12*15*2.2mm（±0.3mm）

Chart 9.Single Module Dimension（Unit: mm）

3.2 Layout Package Suggestion

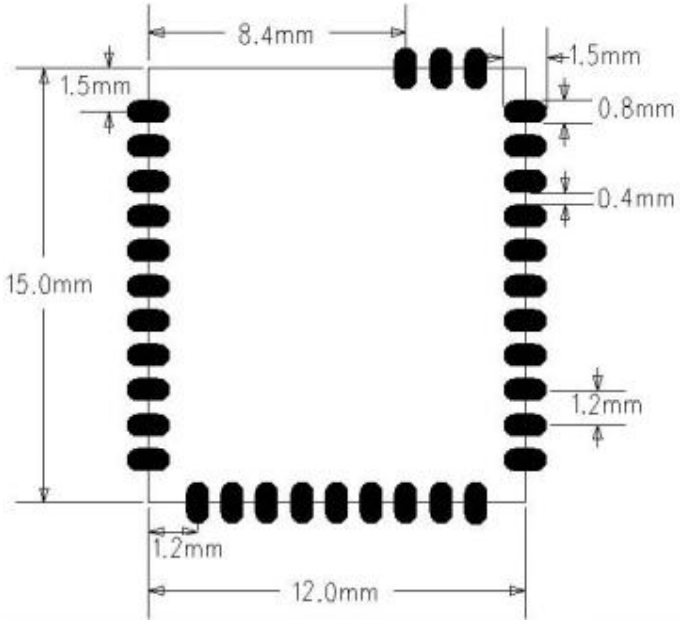


Chart 10.Layout Package Suggestion

4. Application Notes

4.1 Suggestion on Backplane Design

4.1.1 Antenna handling recommendation

Here are the suggestions for antenna design as below:

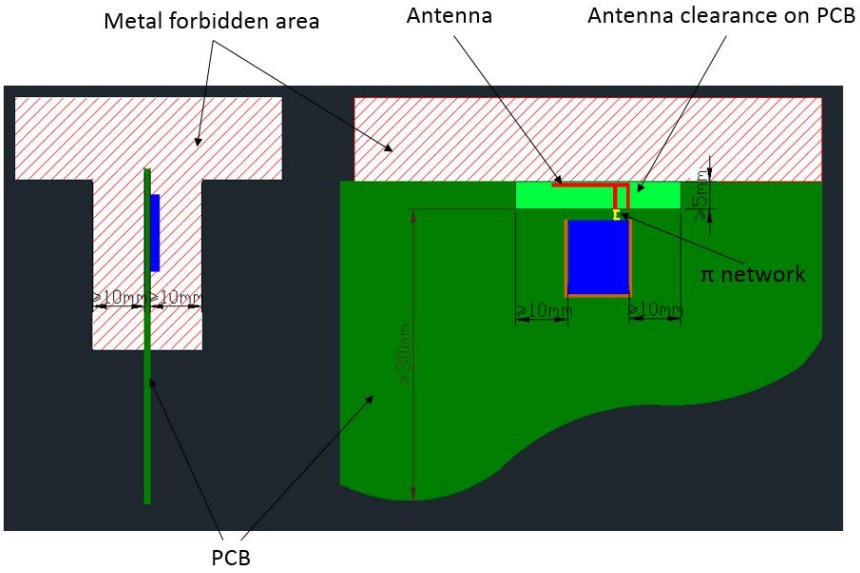


Chart 11. Antenna handling recommendation（Unit: mm）

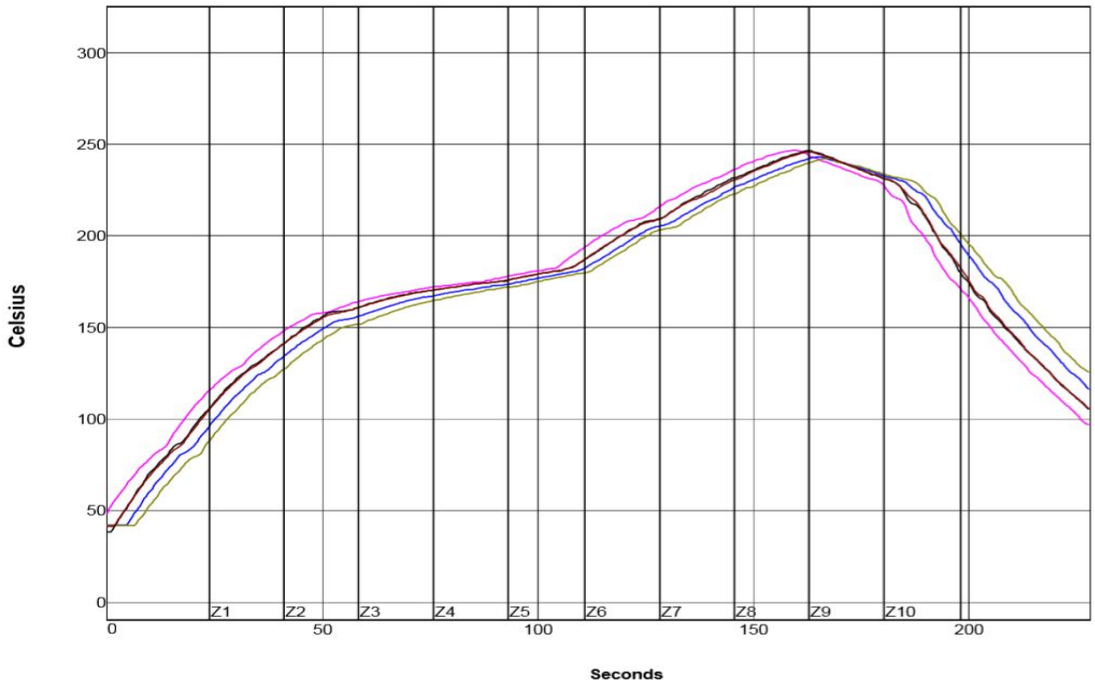
In addition, there are some guidelines that need to be taken into consideration.

1. Make sure that antenna is not in contact with any kind of metal.
2. The antenna should be places as far away from any metal structures as possible. At least 10 mm away is needed.

4.2 Suggestions on SMT Temperature Setting

Refer to below information for SMT temperature setting.

Setpoints(℃)										
Zone	1	2	3	4	5	6	7	8	9	10
Top	140	180	190	180	180	190	245	260	265	210
Bottom	140	180	190	180	180	190	245	260	265	210
Conveyor Speed（cm/min）：130.0										



PWI= 63%	Max Rising Slope		Max Falling Slope		Soak Time 150-200C		Reflow Time /217C		Peak Temp	
<TC2>	2.44	-52%	-3.40	7%	72.53	-16%	56.28	63%	246.66	49%
<TC3>	2.46	-51%	-3.09	28%	72.32	-18%	53.15	32%	243.01	-8%
<TC4>	2.39	-54%	-2.92	38%	70.61	-29%	52.63	26%	242.22	-20%
<TC5>	2.57	-48%	-3.40	7%	73.44	-10%	54.28	43%	246.45	45%
<TC6>	2.52	-49%	-3.42	5%	72.96	-14%	54.68	47%	245.90	37%
Delta	0.18		0.50		2.83		3.65		4.44	

Process Window:

Statistic Name	Low Limit	High Limit	Units
Max Rising Slope (Target=4.0) (Calculate Slope over 40 Seconds)	1	5	Degrees/Second
Max Falling Slope (Calculate Slope over 15 Seconds)	-5	-2	Degrees/Second
Soak Time 150-200C	60	90	Seconds
Time Above Reflow - 217C	40	60	Seconds
Peak Temperature	237	250	Degrees Celsius

Chart 12.SMT Temperature Setting

5. Package Information

5.1 Package Specification

Tape & Reel (TR), QTY 1100PCS.

5.2 Weight

Weight of single module is 0.4g—0.6g.

6. FCC Certification Requirements

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a fixed device.

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based timeaveraging duty factor, antenna gain, and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.

2. The EUT is a fixed device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

3. A label with the following statements must be attached to the host end product: This device contains FCC ID: 2AQY4ZWLR800. This module must not transmit simultaneously with any other antenna or transmitter

4. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093 If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations. For this device, OEM Integrator must be provided with labeling instructions of finished products.

Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs: A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

6.1 Radiation Exposure Statement:

This module support Z-Wave(908.4MHz~916MHz) ,Z-Wave(912MHz~920MHz) which compliance with part 15.249,15.247 and apply for limited module approval . The module is limited to OEM installation only. The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.

OEM integrator shall equipped the antenna to compliance with antenna requirement part 15.203& 15.204 and must not be co-located or operating in conjunction with any other antenna or transmitters. And OEM host shall implement a Class II Permissive Change (C2PC) or a new FCC ID to demonstrate complied with FCC standard. The OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

The final end product must be labeled in a visible area with the following: "FCC ID:2AQY4ZWLR800"

The final host / module combination may also need to be evaluated against the FCC

Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes, or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for

ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier’s Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

6.2 Class B digital device

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

6.3 Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

6.4 Important Note:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

6.5 Summary of specific operating conditions of use:

The ZWLR800 radio module is designed for control applications in the smart door lock series of host products, model: ZWLR800. This radio module is not intended to be sold as a standalone product. ZWLR800 is for indoor use only. The ZWLR800 radio module must not coexist or operate with any other antenna or transmitter.

6.6 How to sell:

This module is not sold separately and is installed into the host by the applicant and sold with the host. Information about test mode and additional test requirements: The host product is tested with the ZWLR800 radio module installed. Radio operation and test mode are controlled by RF test software on a remote laptop connected through an interface board.

6.7 Additional test

Part 15 Subpart B disclaimer: The ZWLR800 radio module is only authorized for the specific rule parts (FCC Part 15.247/15.249) listed on the FCC grant and ISED certificate. The host product, containing unintentional-radiator digital circuitry, complies with Part 15 Subpart B and ICES-003 with the radio module installed.

7.Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01r01

7.1 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C 15.247 &15.249 & 15.205 & 15.207 & 15.209

7.2 Specific operational use conditions

Z-Wave Module Pairing instructions

1. Follow the user guide of your Smart Hub Gateway to enter Learning or Pairing Mode.
2. Touch thekeypad with your hand to activate the lock.
3. Enter Master Mode.

4. Enter “0" to enter Network Settings.
5.Enter "1"+ # to join the network; Enter "2"+ to exit the network.
6. Follow the steps on your Z-Wave" network gateway/controller to connect to the proper Z-Wave" network.

7. The ZWLR800 radio module is installed in a smart door lock and can be used in home, office and commercial environments.

8. The ZWLR800 radio module is not intended to be sold as a standalone product. It must not be co-located or operated in conjunction with any other antenna or transmitter.

7.3 Limited module procedures

The ZWLR800 radio module does not contain its own RF shield. The radio module has been tested in a standalone configuration and complies with FCC Part 15.247/15.249. The RF module has also been tested in a host product line, and each host product model has been verified for AC power line conducted emissions, spurious radiated emissions, and conducted output power. The results of the host product testing indicate that the radio module complies when installed in the host product. Any installation or operation not in accordance with this manual will require further evaluation.

This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.

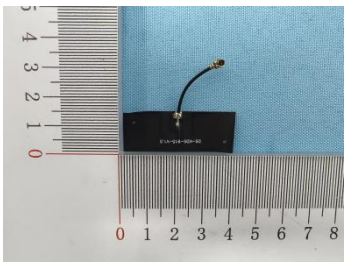
7.4 Trace antenna designs

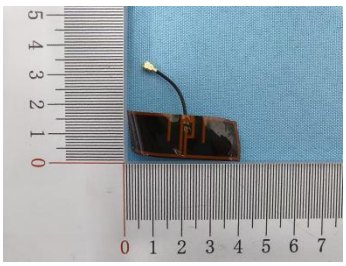
Please perform the Trace antenna design that followed the specifications of the antenna.The concrete contents of a check are the following three points.

1) It is the same type as the antenna type of antenna specifications.
2) An antenna gain is lower than a gain given in antenna specifications.Measure the gain, and confirm the peak gain is less than the application value.
3) The emission level is not getting worse.Measure the spurious, and confirm degradation of less than 3dB than spurious value of worst of report used for the application.

Please refer to the following figure for antenna information.

Characteristics	Specifications	Unit
Frequency	905-925	MHz
Impedance	50	Ω
VSWR	< 2	
Polarization	Linear Polarization	
Gain	-2.13	dBi
Efficiency	>15	%
Connector Type	/	
Operating temperature	-20℃~+85℃	
Storage Temp	-20℃~+50℃	





7.5 RF exposure considerations

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

The module has been evaluated and shown compliant with the FCC RF Exposure limits under Mobile exposure conditions. OEM integrator shall equipped the antenna to compliance with antenna requirement part 15.203 &15.204 and must not be co-located or operating in conjunction with any other antenna or transmitters,otherwise, a Class II Permissive Change (C2PC) must be filed with the FCC and/or a new FCC authorization must be applied.

7.6 Antennas

This radio transmitter FCC ID: 2AQY4ZWLR800 has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. This device does not use antenna types whose gain is greater than the maximum gain of any of the listed types not included below. The antenna is FPC antenna, the antenna gain is -2.13dBi),This antenna is permanently paired with a product to sell.

Antenna Specification are as follows:
Frequency Range：905-925MHz
Antenna Type：FPC antennaAntenna
Gain(Peak)：-2.13dBi

7.7 Label and compliance information

The final end product must be labeled in a visible area with the following :
“FCC ID: 2AQY4ZWLR800”
If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users' manual: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

A user's manual for the finished product should include one of the following statements: For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.
However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to
correct the interference by one or more of the following measures:
--- Reorient or relocate the receiving antenna.
--- Increase the separation between the equipment and receiver.
---Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
--- Consult the dealer or an experienced radio/TV technician for help.

The User's Manual for The finished product should include the following statements:
Any changes or modifications to this equipment not expressly approved by the OEM Integrator may cause harmful interference and void the user's authority to operate this equipment.

RF Exposure
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.This equipment should be installed and operated with minimum distance 20cm between the radiator &your body.

7.8 Information on test modes and additional testing requirements

Data transfer module demo board can control the EUT work in RF test mode at specified conditions. This radio module must not be installed to co-locate and operating simultaneously with other radios in the host system except in accordance with FCC multi-transmitter product procedures. Additional testing and equipment authorization may be required operate simultaneously with other radio.

7.9 Additional testing, Part 15 Subpart B disclaimer

The host product manufacturer is responsible for compliance with any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

General Statements

The module is intended only for OEM integrators.
The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.
The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.
The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed. Note EMI Considerations: Note that a host manufacture is recommended to use KDB 996369 D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.
For standalone mode, reference the guidance in D04 Module Integration Guide and for simultaneous mode7; see D02 Module Q&A Question 12, which permits the host manufacturer to confirm compliance.
How to make changes:
When changing from the conditions of approval, please present technical documentation that it is equivalent to a Class I change.
For example, when adding or changing an antenna, the following technical documents are required.
1) The document indicating the same type as the original antenna
2) Technical document showing that the gain is the same with the gain at the time of the original approval. If the antenna gain is lower than the antenna gain value compared with the original approval, a class II permissive change should be followed.
3) Technical document showing that the radiated emissions level is no more than the worse value than when it was originally certified.

Note EMI Considerations

Note that a host manufacture is recommended to use D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.
For standalone mode, reference the guidance in D04 Module Integration Guide and for simultaneous mode7; see D02 Module Q&A Question 12, which permits the host manufacturer to confirm compliance.

How to make changes

Since . only Grantees are permitted to make permissive changes, it is recommended that module manufactures provide contact information and some guidance to host providers in the integration instructions if they expect their module will be used differently than granted.

IC Warning

This device complies with Innovation, Science and Economic Development Canada’ slicence exempt RSS standard(s).Operation is subject to the following two conditions:
(1)This device may not cause interference;and
(2)This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme aux normes RSS d'Innovation, Sciences et Développement économique Canada en matière d'exemption de licence. Son fonctionnement est soumis aux deux conditions suivantes:
(1) cet appareil ne doit pas provoquer d'interférences et
(2) cet appareil doit accepter toute interférencey compris celles qui peuvent provoquer un fonctionnement indésirable de l'appareil.

This Class B digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003.

IC RF Statement:
When using the product, maintain a distance of 20cm from the body to ensure compliance with RF exposure requirements.
Déclaration IC RF:
Lorsque vous utilisez le produit, maintenez une distance de 20cm par rapport au corps pour garantir la conformité aux exigences d'exposition aux RF.

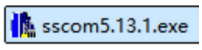
FCC ID: 2AQY4ZWLR800
IC: 24242-ZWLR800
HVIN: ZWLR800

Fixed frequency program

1. Test Arrangement

The module is installed on the host, and the module's TX, RX, VCC (3.3V), and GND pins are connected to the serial port board with Dupont wires. The serial port board is connected to the PC for fixed frequency operation.

2.

Open the sscom5.13.1 serial port debugging tool 

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Then set the baud rate to 115200 and enter the following command in the tool:

Modulation wave settings:
rx 0----------Enter RF test configuration
settxtone 0
setzwavemode 1 3---------Set to Zwave test mode. This step is configured with this value by default and does not require any modification.
setzwaveregion 13----------Setting the frequency of Zwave,
At this time, we use 1 (US) for testing.
For example, value 0: European standard, value 1: US standard, this test is US.
Other notes:
{0:EU-European Union}
{1:US-United States}
{2:ANZ-Australia/New Zealand}
{3:HK-Hong Kong}
{4:MY-Malaysia}
{5:IN-India}
{6:JP-Japan}
{7:RU-Russia}
{8:IL-Israel}
{9:KR-Korea}

{10:CN-China}
{11:USLR1-United States, Long Range 1}
{12:USLR2-United States, Long Range 2}
{13:USLRED-United States, Long Range End Device}}

setchannel 2-------Transmit channel selection, value is 0 1 2.
Note: When testing US, 0: 908.40MHz, 1: 908.42MHz, 2: 916MHz;
When testing US long rage, 0: 912MHz, 1: 920MHz

setTxStream 1 ----------------Transmitted waveform selection
Control stream transmission. [uint32]
0=Disable
1=Enable [uint32opt streamMode:[1=PN9]
2=1010
3=phaseNoise 0=tone [uint32opt]
antenna: [0]/1
settxtone 1--------0 means stop transmitting, 1 means start transmitting. This step is the most important. Every time you set the channel and power, you must stop transmitting first, and then configure it to 1 to start transmitting.

setpower 100-------Set the transmission power, the value is -50~140. Stop transmitting before setting, and then start transmitting after setting.

3.According to step 2, after setting the corresponding operating frequency and power, conduction and radiation tests can be performed.

Test Plan

This module does not contain a shield and therefore is limited. The grantee will be required to file a Class II Permissive Change for each host specific installation. The following testing should be performed to demonstrate continued compliance.

Description of Device (EUT)

Product Name	:	Z-Wave Module
Model No.	:	ZWLR800
Trade Mark	:	Kaadas
Test Power Supply	:	DC 3.3V
Adapter	:	N/A
RF Specification		
Operation Frequency	:	908.4MHz~916MHz
Number of Channel	:	3 Channels
Modulation Type	:	GFSK
Antenna Type	:	FPC Antenna
Antenna Gain(Peak)	:	-2.13dBi

Description of Test Configuration

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	**908.4**						
1	**908.42**						
2	**916**						

Test Standard(s)	**:**	**47 CFR Part 15.249**
Test Method(s)	**:**	**ANSI C63.10: 2020**

Summary of Test Results

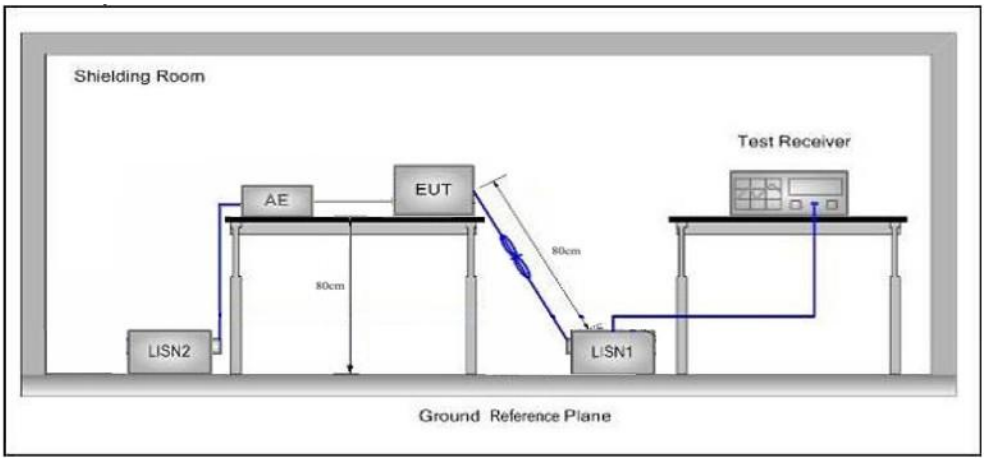
Standard Section	Test Item	Result
15.203	Antenna Requirement	
15.207	Conducted Emission	
15.205/15.209/15.249	Radiated Emission	
15.249(d)	Band Edge	
15.215(c)	20dB Bandwidth	

1. Conducted Emission Test

1.1. Test Standard and Limit

Test Standard	FCC Part15 Section 15.207		
Test Limit	Frequency	Maximum RF Line Voltage (dBuV)	
		Quasi-peak Level	Average Level
	150kHz~500kHz	66 ~ 56 *	56 ~ 46 *
	500kHz~5MHz	56	46
	5MHz~30MHz	60	50
Remark: (1) *Decreasing linearly with logarithm of the frequency. (2) The lower limit shall apply at the transition frequency.			

1.2. Test Setup



1.3. Test Procedure

The EUT system is connected to the power mains through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm coupling impedance for the EUT system. Please refer the block diagram of the test setup and photographs. Both sides of AC line are checked to find out the maximum conducted emission. In order to find the maximum emission levels, the relative positions of equipment and all of the interface cables shall be changed according to FCC ANSI C63.10-2020 on Conducted Emission Measurement.

The bandwidth of test receiver (ESCI) set at 9kHz.

The frequency range from 150kHz to 30MHz is checked.

1.4. Test Data

2. Radiated Emission and Band Edge

2.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.209 and 15.205				
Test Limit	Frequency (MHz)	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz~0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz~88MHz	100	40.0	Quasi-peak	3
	88MHz~216MHz	150	43.5	Quasi-peak	3
	216MHz~960MHz	200	46.0	Quasi-peak	3
	Above 960MHz	500	54.0	Quasi-peak	3
Remark: (1)The lower limit shall apply at the transition frequency. (2) 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.					

Test Standard	FCC Part15 C Section 15.249					
Test Limit	Frequency (MHz)	Field Strength of fundamental (millivolts /meter)	Field Strength of Harmonics (microvolts/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	902~928	50	-	94.0	QP	3
	902~928	-	500	54.0	QP	3
	2400~2483.5	50	-	114.0	Peak	3
	2400~2483.5	50	-	94.0	Average	3
	2400~2483.5	-	500	74.0	Peak	3
	2400~2483.5	-	500	54.0	Average	3
Remark: (1) 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.						

Test Standard	FCC Part15 C Section 15.249(d)
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.	

2.2. Test Setup

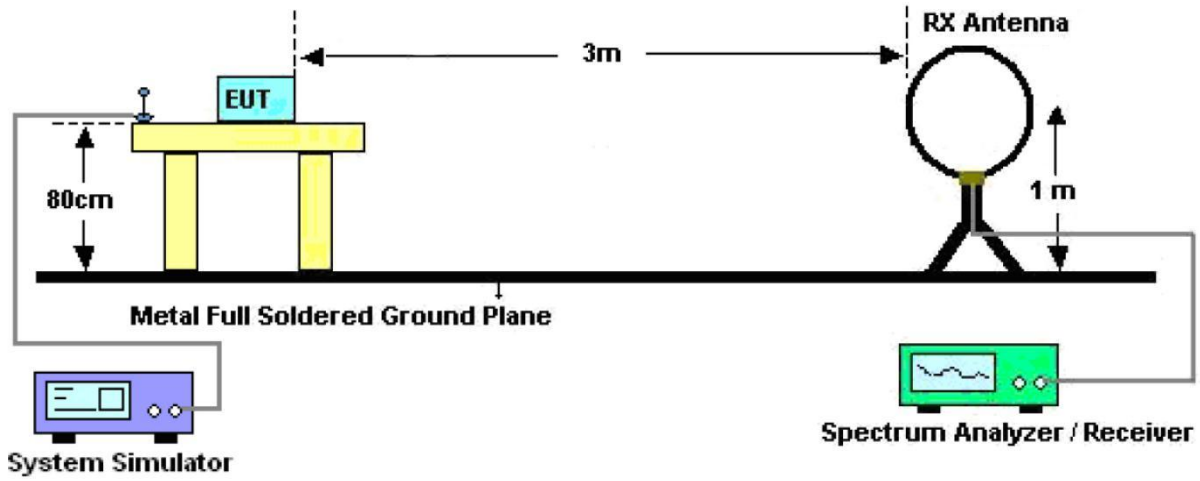


Figure 1. Below 30MHz

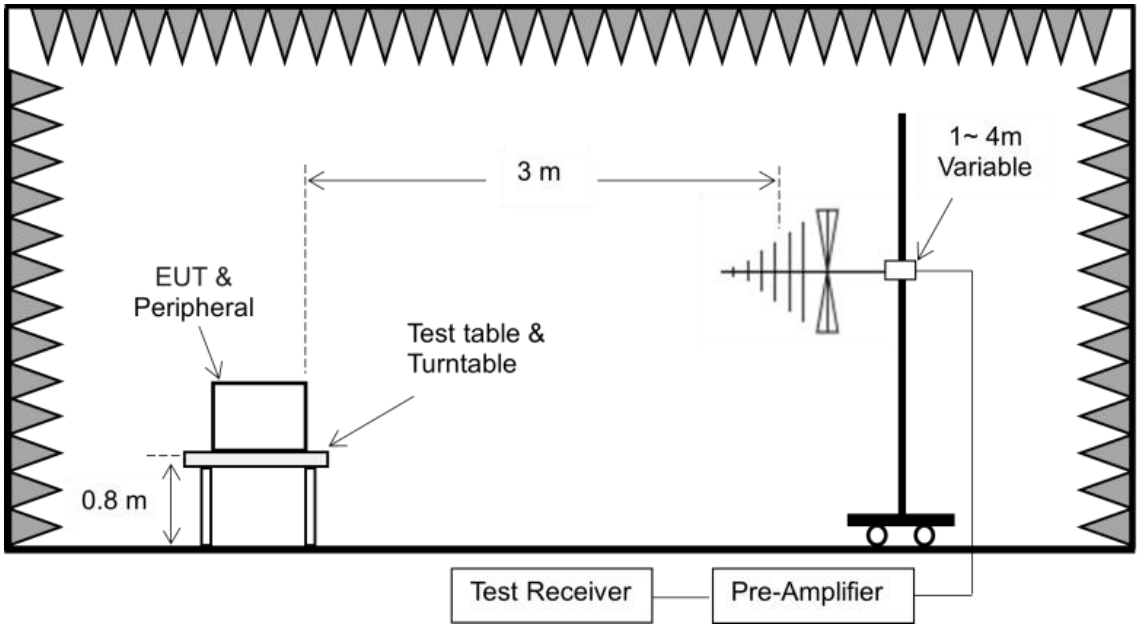


Figure 2. 30MHz to 1GHz

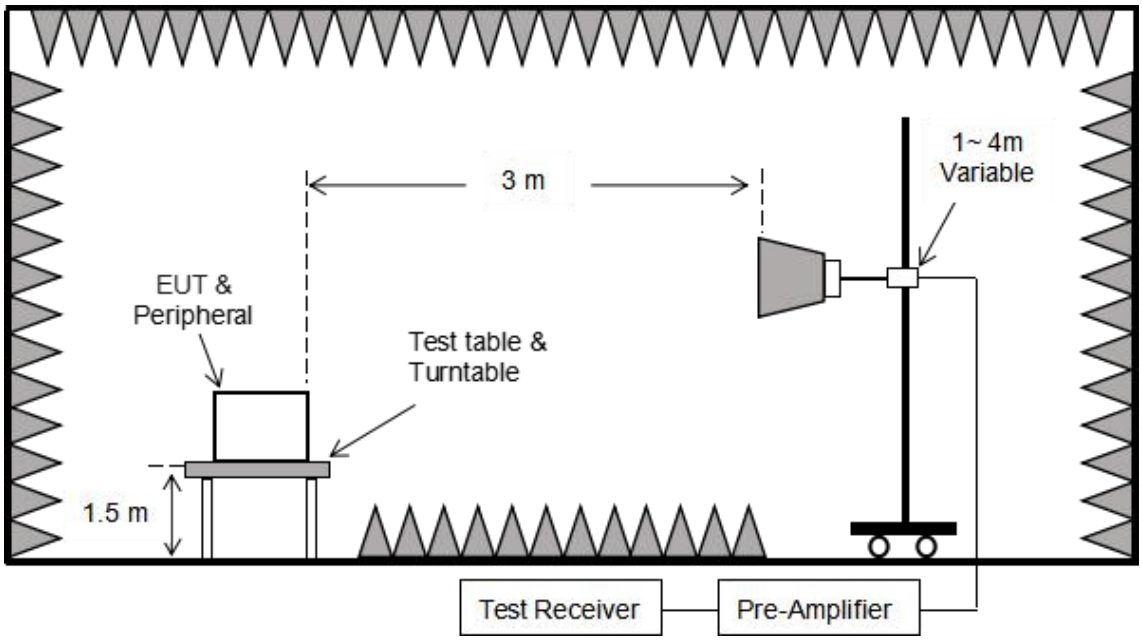


Figure 3. Above 1 GHz

2.3. Test Procedure

For below 1GHz: The EUT is placed on a turntable, which is 0.8m above the ground plane.
For above 1GHz: The EUT is placed on a turntable, which is 1.5m above the ground plane.
The turn table can rotate 360 degrees to determine the position of the maximum emission level. The EUT is set 3 meters away from the receiving antenna which is mounted on a antenna tower. The antenna can be moved up and down from 1 to 4 meters to find out the maximum emission level. Rotated the EUT through three orthogonal axes to determine the maximum emissions, both horizontal and vertical polarization of the antenna are set on test. The EUT is tested in 9*6*6 Chamber. The device is evaluated in xyz orientation.

For the radiated emission test above 1GHz:
Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

For 9kHz to 150kHz, Set the spectrum analyzer as:
RBW = 200Hz, VBW =1kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 150kHz to 30MHz, Set the spectrum analyzer as:
RBW = 9KHz, VBW =30kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 30MHz to 1000MHz, Set the spectrum analyzer as:
RBW = 100kHz, VBW =300kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For above 1GHz,Set the spectrum analyzer as:
RBW =1MHz, VBW =1MHz, Detector= Peak, Trace mode= Max hold, Sweep- auto couple.
RBW =1MHz, VBW =10Hz, Detector= Average, Trace mode= Max hold, Sweep- auto couple.

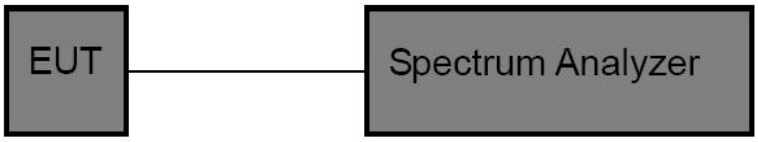
2.4. Test Data

3. 20dB Bandwidth Test

3.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.215(c)
Test Limit	N/A

3.2. Test Setup



3.3. Test Procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as:
   RBW = 30kHz, VBW≥3*RBW =100kHz,
   Detector= Average
   Trace mode= Max hold.
   Sweep- auto couple.
4. Mark the peak frequency and –20dB (upper and lower) frequency.
5. Repeat until all the rest channels are investigated.

3.4. Test Data

4. Antenna Requirement

4.1. Test Standard and Requirement

Test Standard	FCC Part15 Section 15.203
Requirement	1) 15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

4.2. Antenna Connected Construction

The antenna is a FPC Antenna which permanently attached, and the best case gain of the antenna is
-2.13dBi. It complies with the standard requirement.

Description of Device (EUT)

Product Name	:	Z-Wave Module
Model No.	:	ZWLR800
Trade Mark	:	Kaadas
Test Power Supply	:	DC 3.3V
Adapter	:	N/A
RF Specification		
Operation Frequency	:	912MHz~920MHz
Number of Channel	:	2 Channels
Modulation Type	:	GFSK
Antenna Type	:	FPC Antenna
Antenna Gain(Peak)	:	-2.13dBi

Description of Test Configuration

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
1	**912**						
2	**920**						

Test Standard(s)	**:**	**47 CFR Part 15.247**
Test Method(s)	**:**	**ANSI C63.10: 2020, KDB 558074 D01 15.247 Meas Guidance v05r02**

Summary of Test Results

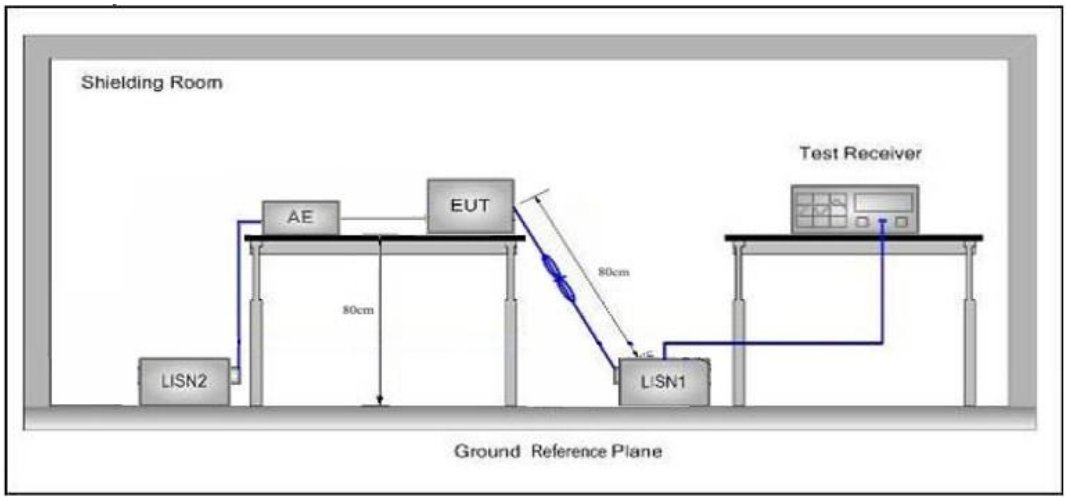
Standard Section	Test Item	Result
15.203/15.247(c)	Antenna Requirement	
15.207	Conducted Emission	
15.205/15.209	Spurious Emission	
15.247(b)(3)	Conducted Peak Output Power	
15.247(a)(2)	6dB Emission Bandwidth	
15.247(e)	Power Spectral Density	
15.247(d)	Band Edge	

1. Conducted Emission Test

1.1. Test Standard and Limit

Test Standard	FCC Part15 Section 15.207		
Test Limit	Frequency	Maximum RF Line Voltage (dBuV)	
		Quasi-peak Level	Average Level
	150kHz~500kHz	66 ~ 56 *	56 ~ 46 *
	500kHz~5MHz	56	46
	5MHz~30MHz	60	50
Remark: (1) *Decreasing linearly with logarithm of the frequency. (2) The lower limit shall apply at the transition frequency.			

1.2. Test Setup



1.3. Test Procedure

The EUT system is connected to the power mains through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm coupling impedance for the EUT system. Please refer the block diagram of the test setup and photographs. Both sides of AC line are checked to find out the maximum conducted emission. In order to find the maximum emission levels, the relative positions of equipment and all of the interface cables shall be changed according to FCC ANSI C63.10: 2020 on Conducted Emission Measurement.

The bandwidth of test receiver (ESCI) set at 9kHz.

The frequency range from 150kHz to 30MHz is checked.

1.4. Test Data

2. Radiation Spurious Emission and Band Edge

2.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.209 and 15.205				
Test Limit	Frequency (MHz)	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz~0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz~88MHz	100	40.0	Quasi-peak	3
	88MHz~216MHz	150	43.5	Quasi-peak	3
	216MHz~960MHz	200	46.0	Quasi-peak	3
	Above 960MHz	500	54.0	Quasi-peak	3

Remark:

(1)The lower limit shall apply at the transition frequency.

(2) 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

2.2. Test Setup

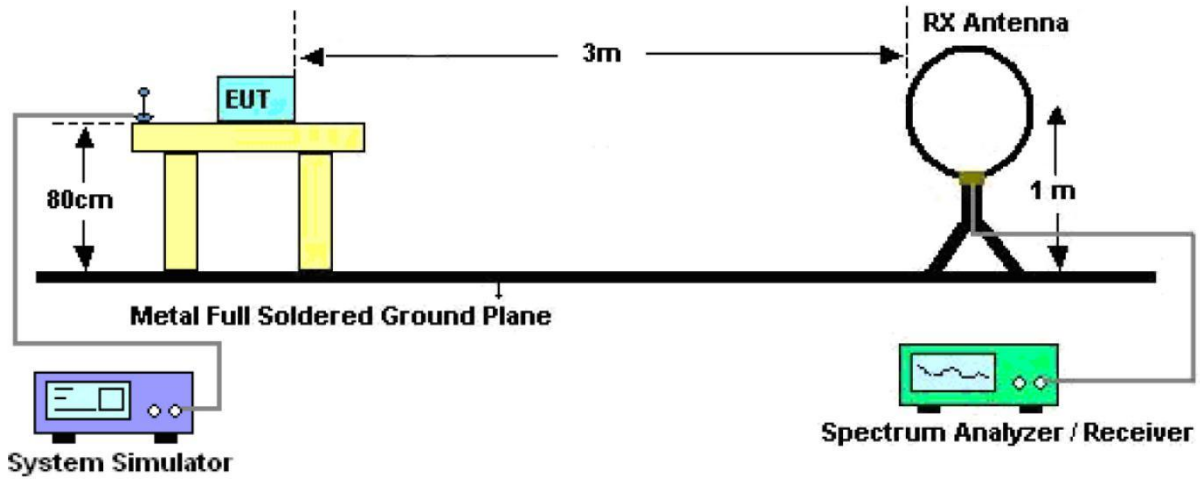


Figure 1. Below 30MHz

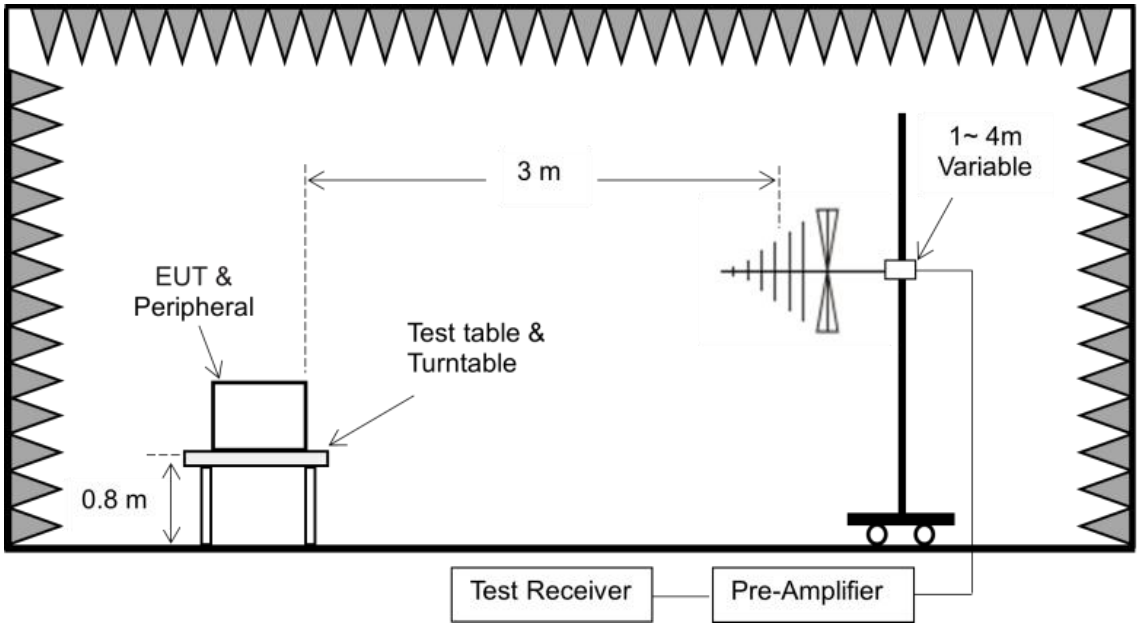


Figure 2. 30MHz to 1GHz

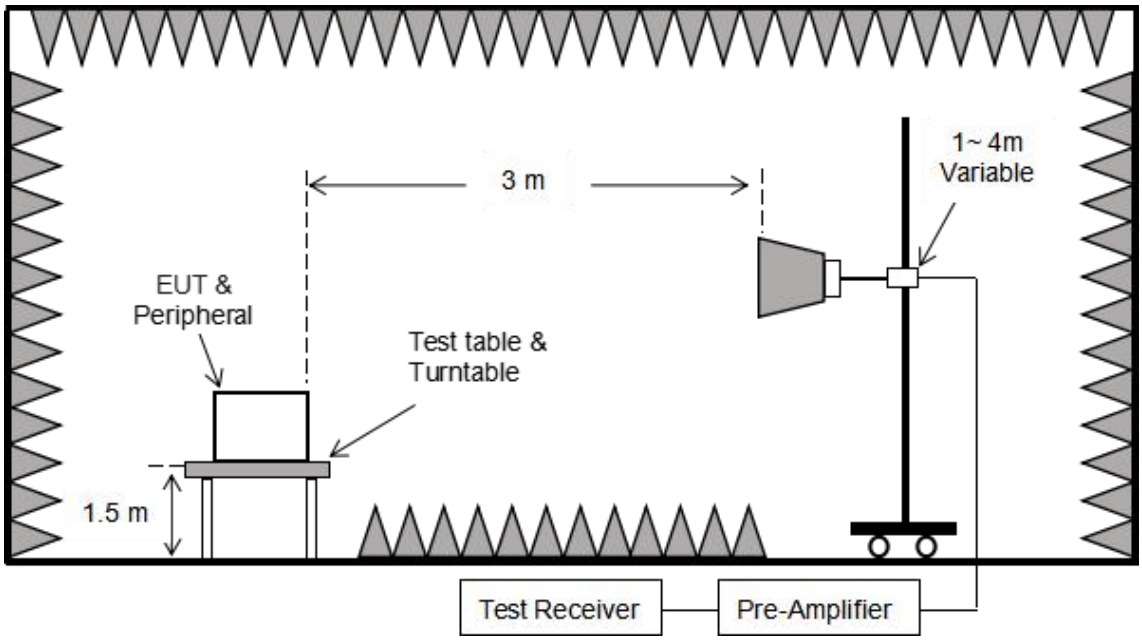


Figure 3. Above 1 GHz

2.3. Test Procedure

For below 1GHz: The EUT is placed on a turntable, which is 0.8m above the ground plane.

For above 1GHz: The EUT is placed on a turntable, which is 1.5m above the ground plane.

The turn table can rotate 360 degrees to determine the position of the maximum emission level. The EUT is set 3 meters away from the receiving antenna which is mounted on a antenna tower. The antenna can be moved up and down from 1 to 4 meters to find out the maximum emission level. Rotated the EUT through three orthogonal axes to determine the maximum emissions, both horizontal and vertical polarization of the antenna are set on test. The EUT is tested in 9*6*6 Chamber. The device is evaluated in xyz orientation.

For the radiated emission test above 1GHz:

Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

For 9kHz to 150kHz, Set the spectrum analyzer as:
RBW = 200Hz, VBW =1kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 150kHz to 30MHz, Set the spectrum analyzer as:
RBW = 9KHz, VBW =30kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 30MHz to 1000MHz, Set the spectrum analyzer as:
RBW = 100kHz, VBW =300kHz,Detector= Quasi-Peak, Trace mode= Max hold, Sweep-auto couple.

For above 1GHz,Set the spectrum analyzer as:
RBW =1MHz, VBW =3MHz, Detector= Peak, Trace mode= Max hold, Sweep- auto couple.

For average measurement:
–VBW=3*RBW, Detector= RMS, When duty cycle is no less than 98 percent
–VBW=3*RBW, Detector= RMS, When duty cycle is less than 98 percent and dutycycle is constant,
average=peak level+correction factor(20log(dutycycle)).
–VBW≥1/T, when duty cycle is less than 98 percent and dutycycle is not constant, where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation, so refer to this clause 5.4 duty cycle.

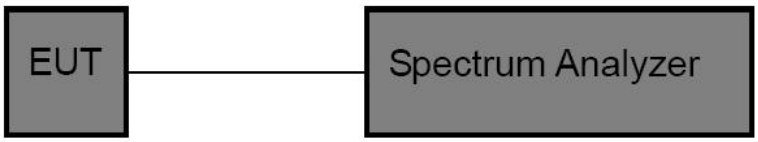
2.4. Test Data

3. Maximum Peak Output Power Test

3.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (b)(3)
Test Limit	1W (30dBm)

3.2. Test Setup



3.3. Test Procedure

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

1. Set the RBW ≥DTS bandwidth.
2. Set the VBW≥3*RBW.
3. Set the span≥ 3*RBW.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use peak marker function to determine the peak amplitude level.

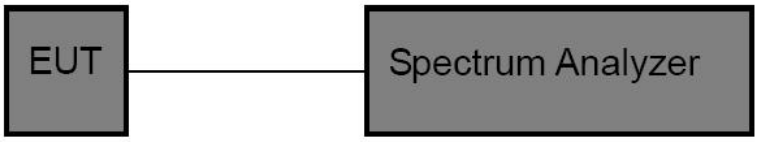
3.4. Test Data

4. 6dB Bandwidth Test

4.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (a)(2)
Test Limit	≥500kHz

4.2. Test Setup



4.3. Test Procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as:

6dB Bandwidth:

a) Set RBW = shall be in the range of 1% to 5% of the OBW but not less than 100 kHz.
b) Set the VBW ≥ [3 × RBW].
c) Detector = peak.
d) Trace mode = max-hold.
e) Sweep = No faster than coupled (auto) time.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission by placing two markers, one at the lowest frequency
and the other at the highest frequency of the envelope of the spectral display, such that each marker
is at or slightly below the “−6 dB down amplitude”. If a marker is below this “−6 dB down amplitude” value, then it shall be as close as possible to this value.

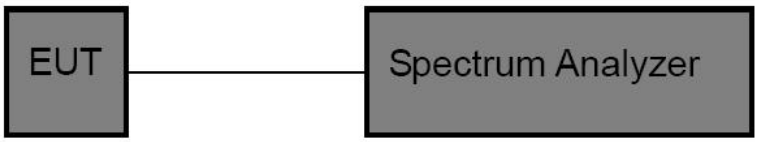
4.4. Test Data

5. Power Spectral Density Test

5.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (e)
Test Limit	8dBm/3KHz

5.2. Test Setup



5.3. Test Procedure

1. Place the EUT on the table and set it in transmitting mode. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
2. Set the spectrum analyzer as RBW = 30kHz, VBW ≥ 3*RBW, Span = 1.5xDTS BW
3. Record the max. reading.
4. Repeat the above procedure until the measurements for all frequencies are completed.

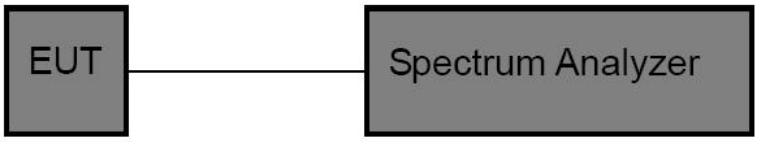
5.4. Test Data

6. Conducted Spurious Emission and Band Edge Test

6.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (d)
Test Limit	In any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a).

6.2. Test Setup



6.3. Test Procedure

Using the following spectrum analyzer setting:

1. Set the RBW = 100KHz.
2. Set the VBW = 300KHz.
3. Sweep time = auto couple.
4. Detector function = peak.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.

6.4. Test Data

7. Antenna Requirement

7.1. Test Standard and Requirement

Test Standard	FCC Part15 Section 15.203 /247(c)
Requirement	1) 15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 2) 15.247(c) (1)(i) requirement: Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

7.2. Antenna Connected Construction

The antenna is a FPC antenna which permanently attached, and the best case gain of the antenna is -2.13dBi . It complies with the standard requirement.

Note: If the module voltage is too low or too high, or the temperature is too low or too high, it will stop working. The module will continue to work after the voltage is restored.