FULLY INTEGRATED Z-WAVE® WIRELESS MODEM WITH ON-BOARD ANTENNA

The TZM5304 Modem is a fully integrated Z-Wave modem module in a small 27mm x 15.2mm x 5.5mm form factor.

A baseband controller, sub-1 GHz radio transceiver, crystal, decoupling, SAW filter, matching, and the antenna is included to provide a complete Z-Wave solution to an application executing in an external host microcontroller. The TZM5304 Modem is certified with the FCC modular transmitter approval (pending), ready to be used in any product without additional testing and license costs.

The TZM5304 Modem is based on an 8-bit 8051 CPU core, which is optimized to handle the data and link management requirements of a Z-Wave node. The UART0 or USB interface can be used to access the Z-Wave stack available in the on-chip Flash memory, or to easily upgrade the modem firmware.

OVERVIEW

The TZM5304 Modem is a fully integrated module with an on-board antenna that allows the establishment of a Z-Wave network with minimum risk. The SD3503 modem chip is used with an external NVM (EEPROM), 32MHz crystal, power supply decoupling, SAW filter, matching circuit, and a helical antenna. Figure 1 shows the main blocks of the TZM5304 Modem, while Figure 2 illustrates the firmware stack of an example application.

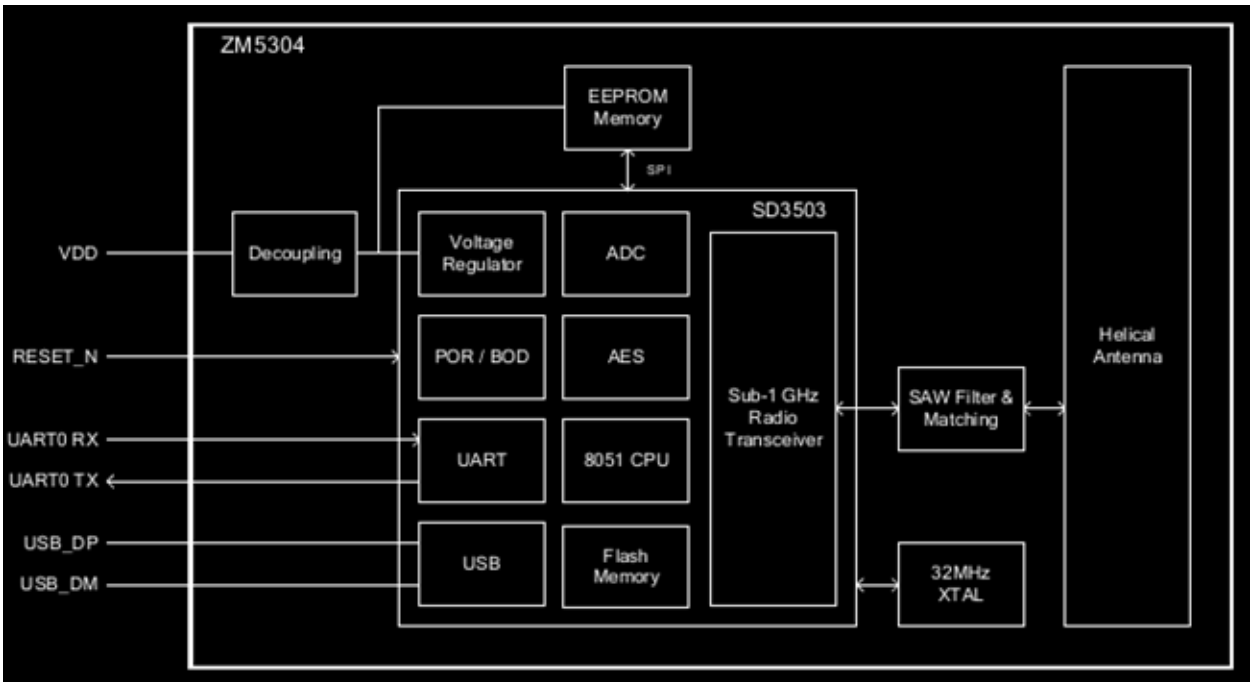

Figure 1: Functional block diagram

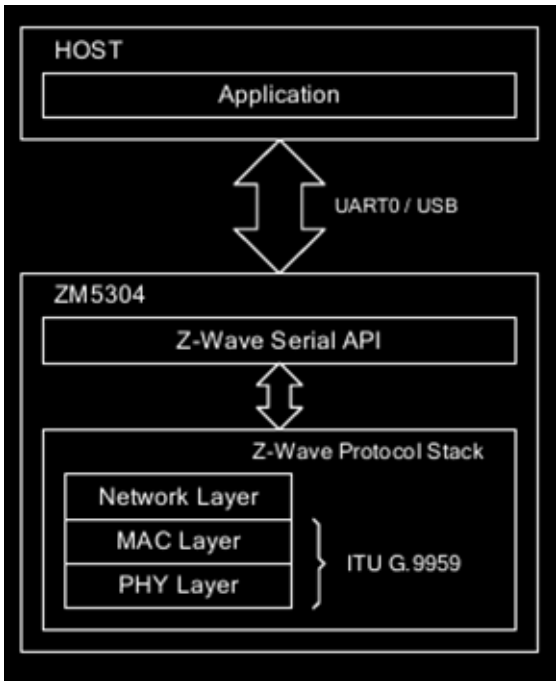

Figure 2: Firmware stack

PERIPHERALS

ADVANCED ENCRYPTION STANDARD SECURITY PROCESSOR

The Z-Wave protocol specifies the use of Advanced Encryption Standard (AES) 128-bit block encryption for secure applications. The built-in Security Processor is a hardware accelerator that encrypts and decrypts data at a rate of 1 byte per 1.5µs. It encodes the frame payload and the message authentication code to ensure privacy and authenticity of messages. The processor supports Output FeedBack (OFB), Cipher-Block Chaining (CBC), and Electronic CodeBook (ECB) modes to target variable length messages. Payload data is streamed in OFB mode, and authentication data is processed in CBC mode as required by the Z-Wave protocol. The processor implements two efficient access methods: Direct Memory Access (DMA) and streaming through Special Function Register (SFR) ports. The processor functionality is exposed via the Z-Wave API for application use.

BROWN-OUT DETECTOR / POWER-ON-RESET

When a cold start-up occurs, an internal Power-On-Reset (POR) circuit ensures that code execution does not begin unless the supply voltage is sufficient. After which, an internal Brown-Out Detector (BOD) circuit guarantees that faulty code execution does not occur by entering the reset state, if the supply voltage drops below the minimum operating level. These guarantees apply equally in both the active and sleep modes.

CRYSTAL DRIVER AND SYSTEM CLOCK

The system clock and RF frequencies are derived from the module mounted 32MHz crystal (XTAL), which internal system performance is factory trimmed to guarantee initial RF frequency precision.

UNIVERSAL ASYNCHRONOUS RECEIVER / TRANSMITTER

The Universal Asynchronous Receiver / Transmitter (UART) is a hardware block operating independently of the 8051 CPU. It offers full-duplex data exchange, up to 230.4kbps, with an external host microcontroller requiring an industry standard NRZ asynchronous serial data format. The UART0 interface is available over pin 4 and pin 5 (refer section 4). A data byte is shifted as a start bit, 8 data bits (lsb first), and a stop bit, respectively, with no parity and hardware handshaking. Figure 3 shows the waveform of a single serial byte. UART0 is compliant with RS-232 when an external level converter is used.

Figure 3: UART0 waveform

WIRELESS TRANSCEIVER

The wireless transceiver is a sub-1 GHz ISM narrowband FSK radio, a modem, and a baseband controller. This architecture provides an all-digital direct synthesis transmitter and a low IF digital receiver. The Z-Wave protocol currently utilizes 2-key FSK/GFSK modulation schemes at 9.6/40/100 kbps data rates.

TYPICAL APPLICATION

The host application located on an external microcontroller accesses the Z-Wave stack via the serial API. Figure 4 depicts the scenario when UART0 is used as the primary interface to the TZM5304 Modem.

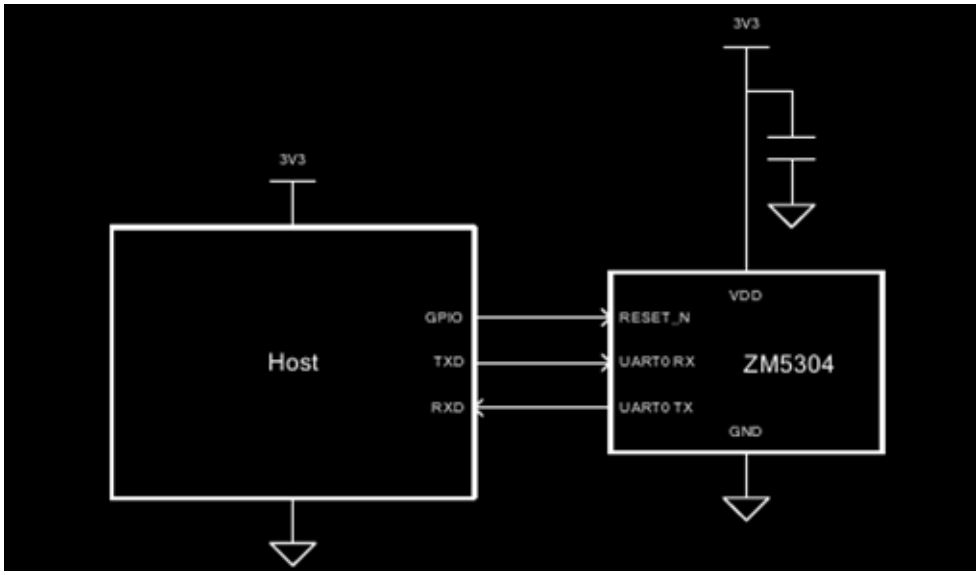

Figure 4: host microcontroller based application using UART0

PIN CONFIGURATION

The layout of the pins on the TZM5304 Modem is shown in Figure 5.

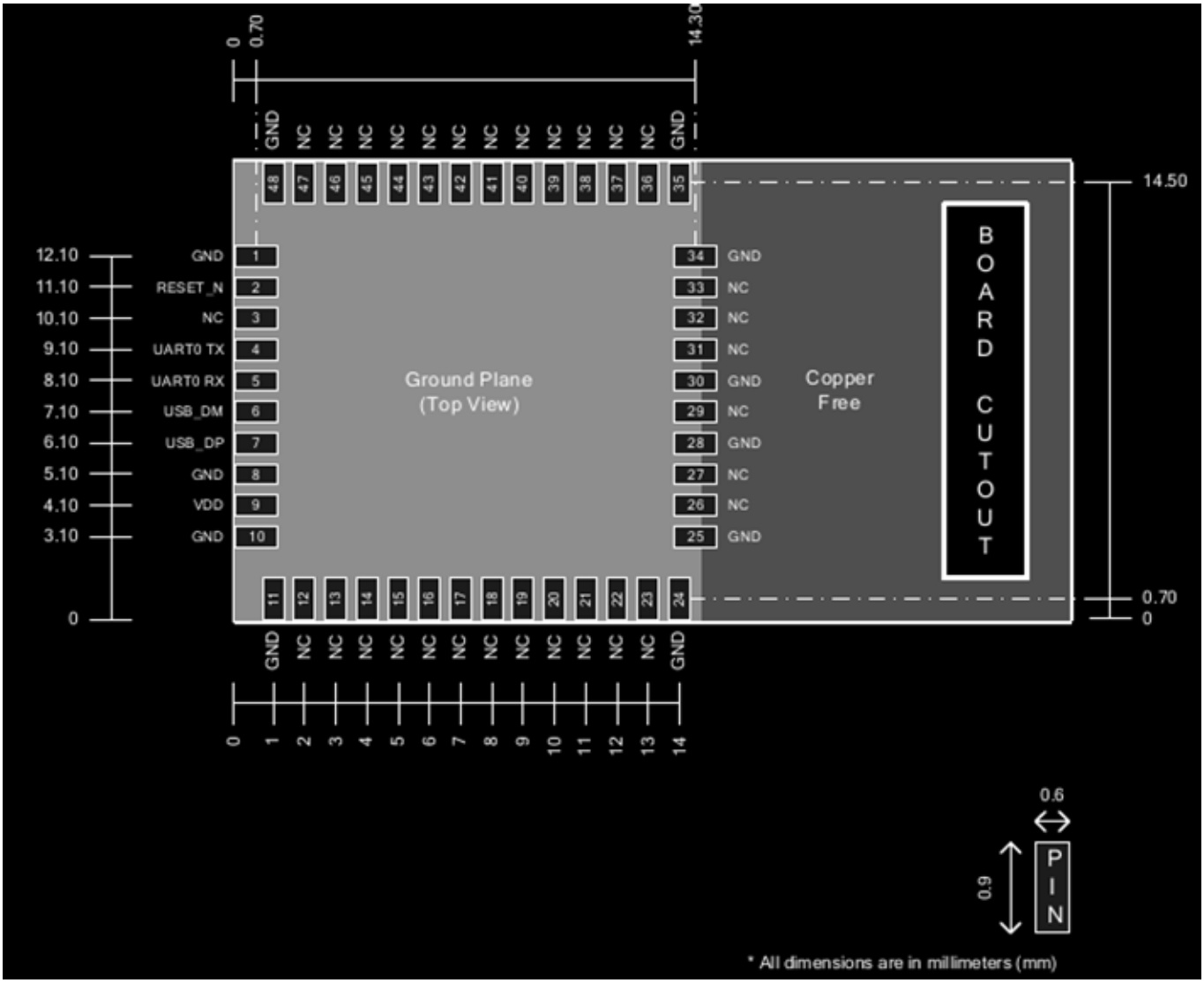

Figure 5: Pin layout (top view)

ELECTRICAL CHARACTERISTICS

This section describes the electrical parameters of the TZM5304 Modem module.

TYPICAL VALUES

Unless otherwise specified, typical data refer to the mean of a data set measured at an ambient temperature of TA=25°C and supply voltage of VDD=+3.3V.

MINIMUM AND MAXIMUM VALUES

Unless otherwise specified the minimum and maximum values are guaranteed in the worst conditions of ambient temperature, supply voltage and frequencies by a final test in production on 100% of the devices at an ambient temperature of TA=25°C and supply voltage of VDD=+3.3V.

For data based on measurements, the minimum and maximum values represent the mean value plus or minus three times the standard deviation (μ±3σ).

ABSOLUTE MAXIMUM RATINGS

Table 1: Voltage characteristics

Symbol	Description	Min	Max	Unit
V_{DD}	Main supply voltage	-0.3	+3.6	V
V_{IN}	Voltage applied on any I/O pin	-0.3	+3.6	V
I_{IN}	Current limit when over driving the input ($V_{IN} > V_{DD}$)	-	+20.0	mA
ESD_{HBM}	JEDEC JESD22-A114F Human Body Model	-	+2000.0	V
ESD_{MM}	JEDEC JESD22-A115C Machine Model	-	+200.0	V
ESD_{CDM}	JEDEC JESD22-C101E Field-Induced Charged-Device Model	-	+500.0	V

Table 2: Current characteristics

Symbol	Description	Min	Max	Unit
I_{VDD}	Current into VDD power supply pin	-	+120	mA
I_{GND}	Sum of the current out of all GND ground pins	-120	-	mA

Table 3: Thermal characteristics

Symbol	Description	Min	Max	Unit
T_J	Junction temperature	-55	+125	°C

GENERAL OPERATING RATINGS

The operating ratings indicate the conditions where the module is guaranteed to be functional.

Table 4: Recommended operating conditions

Symbol	Description	Min	Typ	Max	Unit
V_{DD}	Standard operating supply voltage	+2.3	+3.3	+3.6	V
V_{DD_USB}	Standard operating supply voltage when USB PHY is used	+3.0	+3.3	+3.6	V
f_{SYS}	Internal clock frequency	-	32.0	-	MHz
T_A	Ambient operating temperature	-10.0	+25.0	+85.0	°C

CURRENT CONSUMPTION

Measured at an ambient temperature of TA=-10°C to +85°C and a supply voltage of VDD=+2.3V to +3.6V.

Table 5: Current consumption in active modes

Symbol	Description	Min	Typ	Max	Unit
I_{DD_ACTIVE}	MCU running at 32MHz	-	14.8	15.8	mA
I_{DD_RX}	MCU and radio receiver active	-	32.7	35.0	mA
$I_{DD_TX_63}$	MCU and radio transmitter active	-	42.7	-	mA

Table 6: Current consumption during programming

Symbol	Description	Min	Typ	Max	Unit
$I_{DD_PGM_UART0}$	Programming via UART0	-	15	-	mA
$I_{DD_PGM_USB}$	Programming via USB	-	15	-	mA

RF CHARACTERISTICS

TRANSCEIVER

The radio transceiver of the TZM5304 is based on the SD3503 modem chip and an external SAW filter. Refer to [5] for measurements on the conducted performance of the SD3503. Although the crystal is factory calibrated, it is mandatory to calibrate the transmitter in production. Refer to [6] for more information.

ANTENNA

Table 7: Performance

Symbol	Description	Min	Typ	Max	Unit
f_C	Carrier frequency	-	908.40	-	MHz
TRP	Total radiated power	-	-3.95	-	dBm
ε_R	Radiation efficiency	-	-7.95	-	dB
D	Directivity	-	4.21	-	dBi
G	Peak gain	-	-3.74	-	dBi

Refer to [1] for more information.

REGULATORY COMPLIANCE

The TZM5304 has been tested (pending) to be compliant with the following regulatory standards.

- **FCC COMPLIANCE**
  - o FCC CFR 47 Part 15 Subpart C §15.249
- **IC COMPLIANCE**[3]
  - o RSS-GEN
  - o RSS-210
  - o ANSI C63.10

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[1] This module complies with RSS-210 of the Industry Canada 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. This device is intended only for OEM integrators under the following conditions:

- The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

MODULE INFORMATION

MODULE MARKING

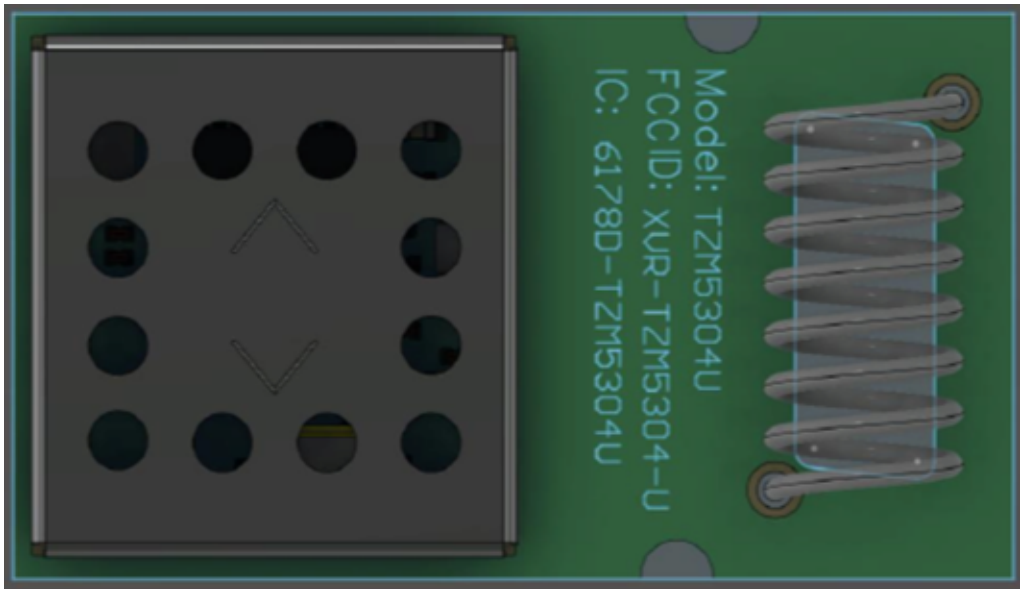

Figure 6: Marking placement

MODULE DIMENSIONS

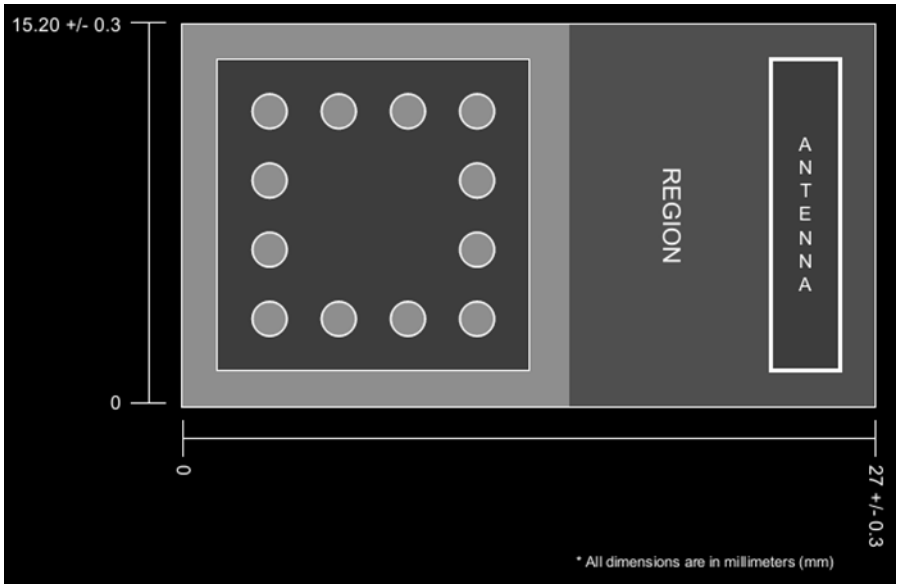

Figure 7: Top view of module

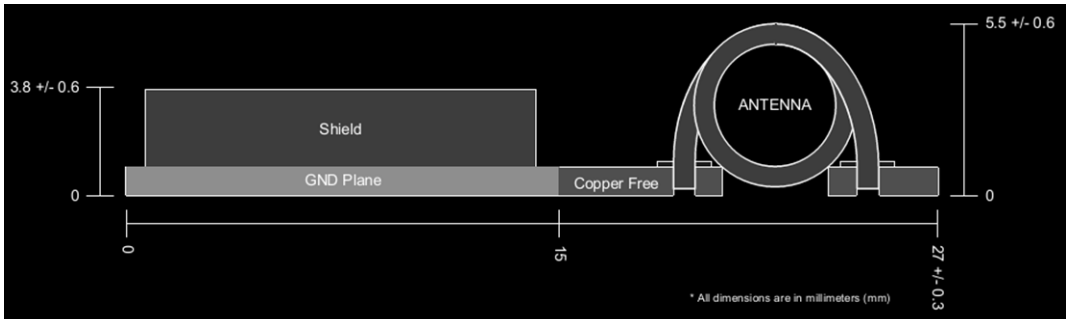

Figure 8: Side view of module

PROCESS SPECIFICATION

Specification	Description
MSL 3	Moisture Sensitivity Level designed and manufactured according to JEDEC J-STD-020C
RoHS	Designed in compliance with **The Restriction of Hazardous Substances Directive (RoHS)**

PCB MOUNTING AND SOLDERING

PCB MOUNTING PATTERN

The land pattern is required to include two drilled holes of diameter 1.8mm at the positions indicated, to ensure clearance to antenna structures.

The recommended land pattern includes a layout of 48 pads of size 1.70 mm x 0.65 mm positioned as indicated in the figure.

All coordinates are relative to the centre of pad 11.

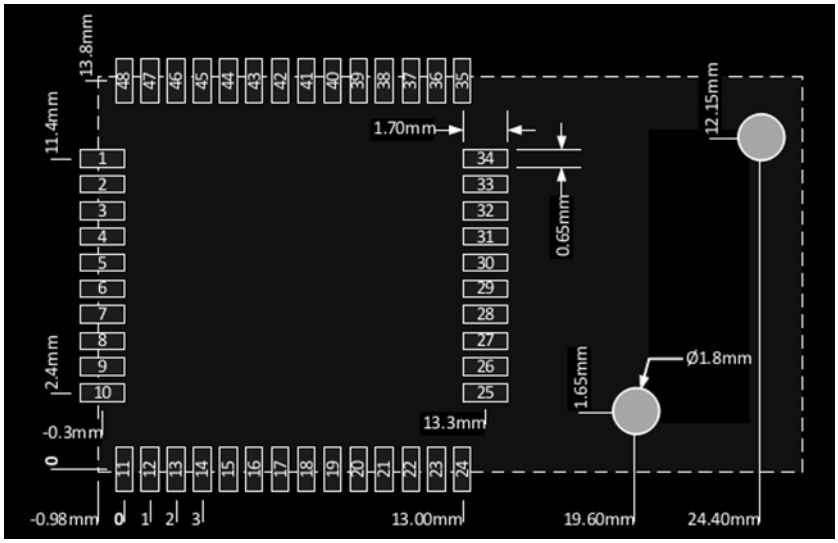

Figure 9: Top view of land pattern

RECOMMENDED PLACEMENT ON PCB

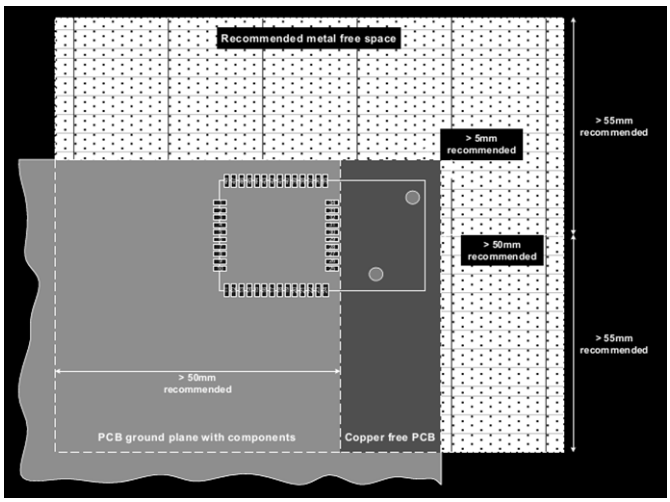

Figure 10: Top view of recommended placement of module on PCB

Federal Communication Commission Interference Statement

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.

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 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.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

This device is intended only for OEM integrators under the following conditions:

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

IMPORTANT NOTE: In the event that these conditions can not 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 can not 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.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: XVR-TZM5304-U". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

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.

CANADA IC STATEMENT

This device complies with RSS-210 of the Industry Canada 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.

Ce dispositif est conforme à la norme CNR-210 d'Industrie Canada applicable aux appareils radio exempts de licence. Son fonctionnement est sujet aux deux conditions suivantes: (1) le dispositif ne doit pas produire de brouillage préjudiciable, et (2) ce dispositif doit accepter tout brouillage reçu, y compris un brouillage susceptible de provoquer un fonctionnement indésirable.

THIS DEVICE IS INTENDED ONLY FOR OEM INTEGRATORS UNDER THE FOLLOWING CONDITIONS: (FOR MODULE DEVICE USE)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and

2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

CET APPAREIL EST CONÇU UNIQUEMENT POUR LES INTÉGRATEURS OEM DANS LES CONDITIONS SUIVANTES: (POUR UTILISATION DE DISPOSITIF MODULE)

1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs, et

2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not 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 Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains IC: ”.

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: ".

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.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module. Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

REFERENCES

[1] DSH12461-14, Datasheet, “DATASHEET: ZM5304”
[2] INS12308, Instruction, “Z-Wave 500 Series Application Programmers Guide”
[3] INS11681, Instruction, “500 Series Z-Wave Single Chip Programming Mode”
[4] DSH12468, Datasheet, “ZDB5304 Z-Wave Development Board”
[5] DSH12469, Datasheet, “SD3503”
[6] INS12213, Instruction, “500 Series Hardware Integration Guide”
[7] DSH11243, Datasheet, “ZDP03A, Z-Wave Development Platform”
[8] INS12350, Instruction, “Serial API Host Application Programming Guide”