



Technical Note

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REFERENCE : IMQ/055

INDICE A

Date : 06/02/2024

NIT-STC 24-009

From	Name	To	
☒ STC	TD	☒ STC	☐ SAV
☐ SPC		☐ SPC	☐ VAC
☐ SQC		☐ SQC	☐ Sales
☐		☐ SAC	☐ CM

Zigbee Interface Datasheet

Revision History

Rev	Date	Description
A	06/02/2024	Initial Public release

	DATE	NAME	DPT	VISA
Done By	06/02/2024	FB	Engineering	FB
Verified By	06/02/2024	FD	Engineering	FD
Approved by				

Date : 2024/02/06

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Introduction

The Zigbee Interface module is a high performance Arm® Cortex®-M4 based wireless interface supporting Zigbee protocol to facilitate the development of wireless applications with EnerSys IQ protocol products.

The Arm Cortex-M4 CPU, operating at up to 48 MHz

Features

Microcontroller features

- Application CPU, Arm Cortex-M4 CPU running at a frequency of 48 MHz.
- 2 outputs for Led status indication
- External reset control

USART interface

- Full duplex UART interface, fixed speed 9600 or 250k bps, compatible with EnerSys IQ protocol.

SPI interface

- Optional SPI interface to add additional memory
- Write protect control of memory

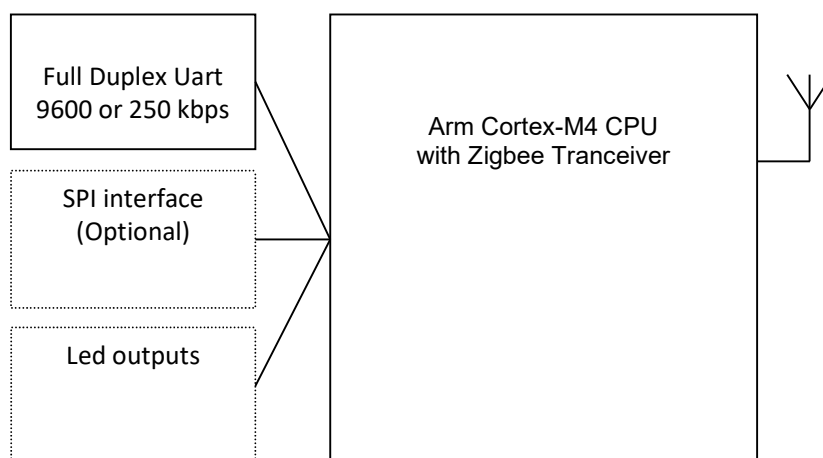
Radio features

- 2.4 GHz IEEE 802.15.4 compliant
- Receive current 4.3 mA
- IEEE 802.15.4 receiver sensitivity -100 dBm
- Output power up to 10 dBm
- Transmit power +10 dBm current 20.28 mA
- 1.9 V to 3.6 V supply voltage
- Integrated antenna

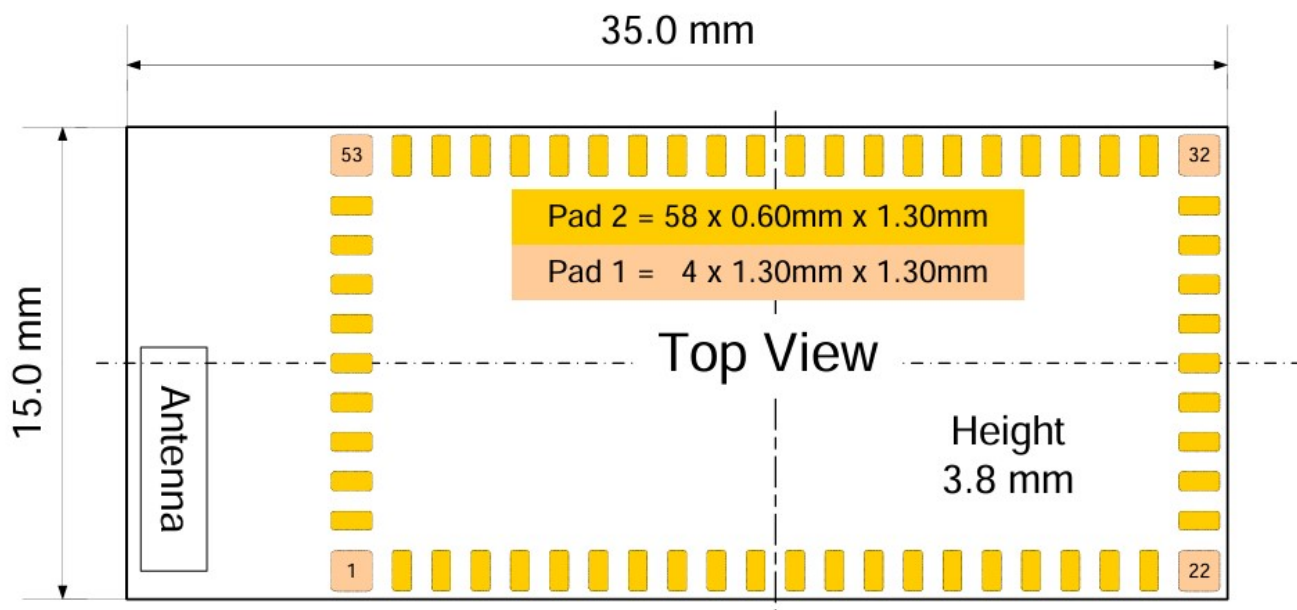
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Block diagram



Pinout diagram



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Pinout description

Symbol	Pin	Type	Description
VBAT	20	Power	VBAT — Supply voltage DCDC input
	23		
	24		
VSS	1	Power	VSS(DCDC) — ground for DCDC section
	22		
	32		
	53		
TXD	8	Output	USART0_TXD — Universal Synchronous/Asynchronous Receiver/Transmitter 0 - transmit data output
RXD	9	Input	USART0_RXD — Universal Synchronous/Asynchronous Receiver/Transmitter 0 - receive data input
RST	27	Input	RSTN — Reset Not input
LED1	12	Output	Led output pin
LED2	18	Output	Led output pin
CS	34	Output	SPI Chip Select
DI	35	Input	SPI MISO
WP	36	Output	SPI Write Protect
DO	37	Output	SPI MOSI
SCK	38	Output	SPI Clk
RES	39	Output	SPI Reset

Functional description

The Zigbee Interface module is a short range, low power, 2.4 GHz ISM band transceiver which includes a complete 802.15.4 physical layer (PHY) modem, designed for the IEEE 802.15.4 wireless standard and an appropriate microcontroller (MCU) which provides a cost effective solution for short-range data links and networks for EnerSys IQ equipments.

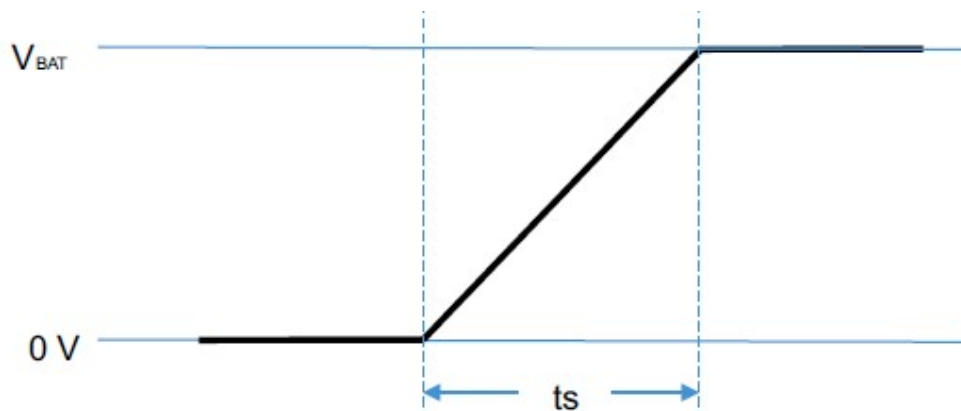
Zigbee Interface is based on the Arm Cortex-M4 CPU. It assumes a full duplex UART for communication with the host device. The Zigbee Interface is a cost optimized module designed for standard range applications of less than 30 meters.

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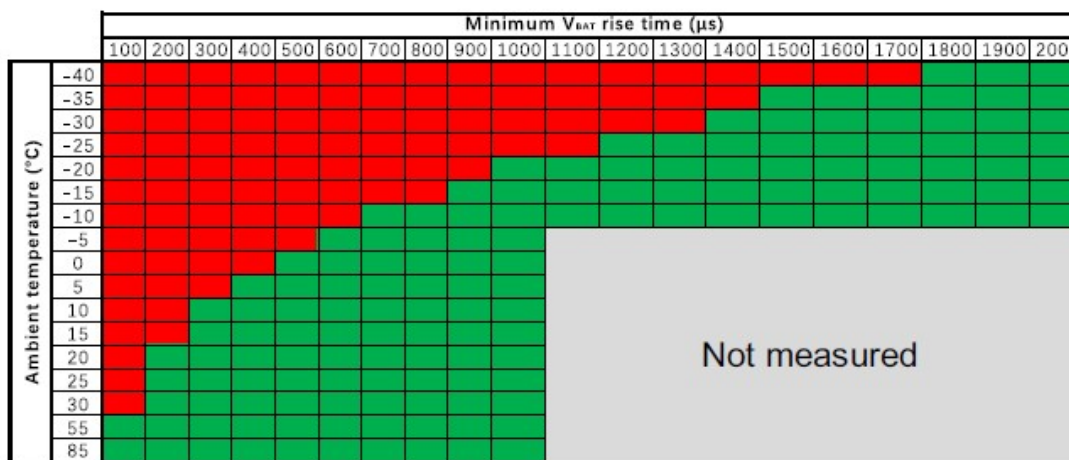
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Absolute maximum ratings

Symbol	Parameter	Conditions	Min	Max	Unit
V _{BAT}	Supply voltage DCDC input		-0.3	3.96	V
V _{IO}	IO pins voltage		-0.3	3.96	V
T _{stg}	Storage temperature		-40	150	°C
V _{ESD}	Electrostatic discharge voltage	HBM ¹		3000	V
	HBM	CDM ²		500	V
t _s	Max. V _{BAT} slope	Ambient temperature: -40 °C ³ V _{BAT} from 0 V up to +3.6 V		2	V/ms



Condition: Ambient temperature: -40 °C, V_{BAT}: 3.6 V



¹ Testing for HBM discharge is performed as specified in JEDEC Standard JS-001

² Testing for CDM discharge is performed as specified in JEDEC Standard JESD22-C101

³ Risk of physical damage if the V_{BAT} slope is out of this specification

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Electrical specifications

Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V _{BAT}	DCDC supply voltage		1.9	3.6	V
V _{DDE}	IO pins voltage		-0.3	3.96	V
T _{stg}	Storage temperature		-40	150	°C
V _{ESD}	Electrostatic discharge voltage	HBM ⁴		3000	V
	HBM	CDM ⁵		500	V
t _s	Max. V _{BAT} slope	Ambient temperature: -40 °C ⁶ V _{BAT} from 0 V up to +3.6 V		2	V/ms

Power consumption

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I _{DD}	supply current	radio in RX mode (IEEE 802.15.4)		4.3		V
		radio in TX mode (IEEE 802.15.4)		20.28		V

IO characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V _{IH}	High-level input voltage	0.7 * V _{DDE}		V _{DDE}	V

⁴ Testing for HBM discharge is performed as specified in JEDEC Standard JS-001

⁵ Testing for CDM discharge is performed as specified in JEDEC Standard JESD22-C101

⁶ Risk of physical damage if the V_{BAT} slope is out of this specification

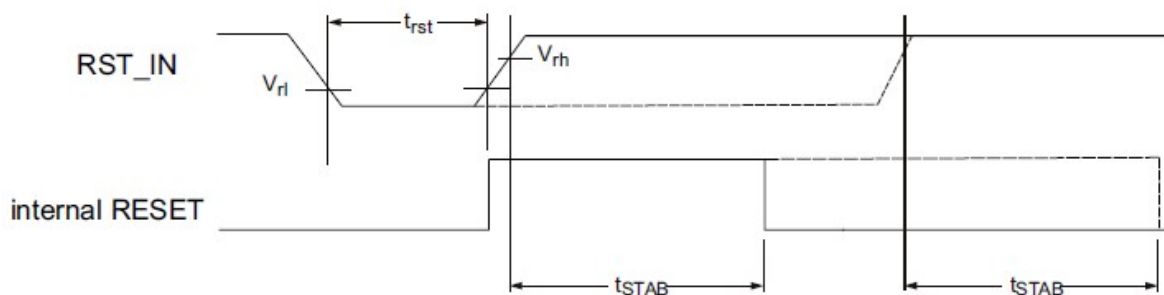
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V _{IL}	Low-level input voltage		20.28	0.27 * V _{DDDE}	V
V _{OH}	High-level output voltage	3.4		V _{DDDE}	
V _{OL}	Low-level output voltage	0		0.4	

Reset and Supply Voltage Monitor

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t _{rst}	Reset time	External reset pulse width to initiate reset sequence ⁷	0.7 * V _{DDDE}		V _{DDDE}	V
V _{rh}	Reset high voltage	External threshold voltage, for reset to be sampled high (inactive) ⁸	0.7 x V _{DDDE}			V
V _{rl}	Reset low voltage	External threshold voltage for reset to be low (active)	3.4		V _{DDDE}	
V _{th(POR)}	Power-on reset threshold voltage	Rise time > 10 ms rising falling		1.85 1.75		V V
t _{STAB}	Stabilisation time	Time after release of reset until application runs			1.9	Ms



Dynamic characteristic: I/O pins⁹

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t _R	Rise time		2.2		5	ns
t _F	Fall time		1.2		3.5	ns

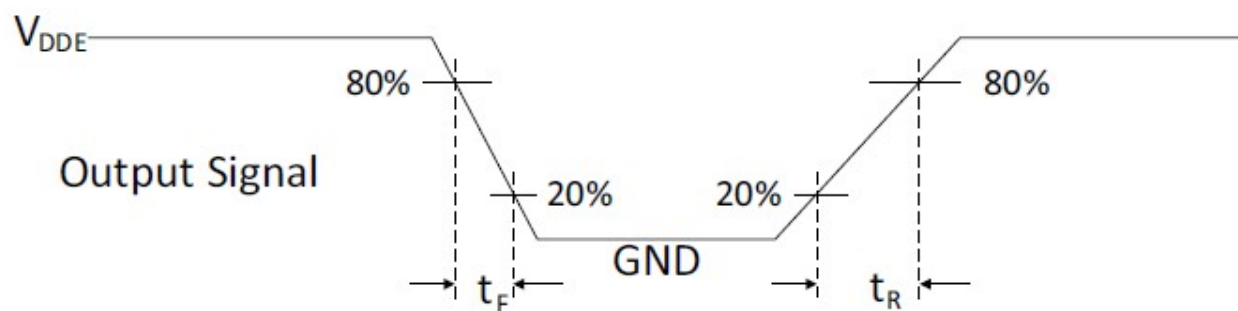
⁷ Assumes internal pull-up resistor value of 100 k · worst case and · 5 pF external capacitance

⁸ Minimum voltage to avoid being reset.

⁹ Pin capacitance load = 10 pF

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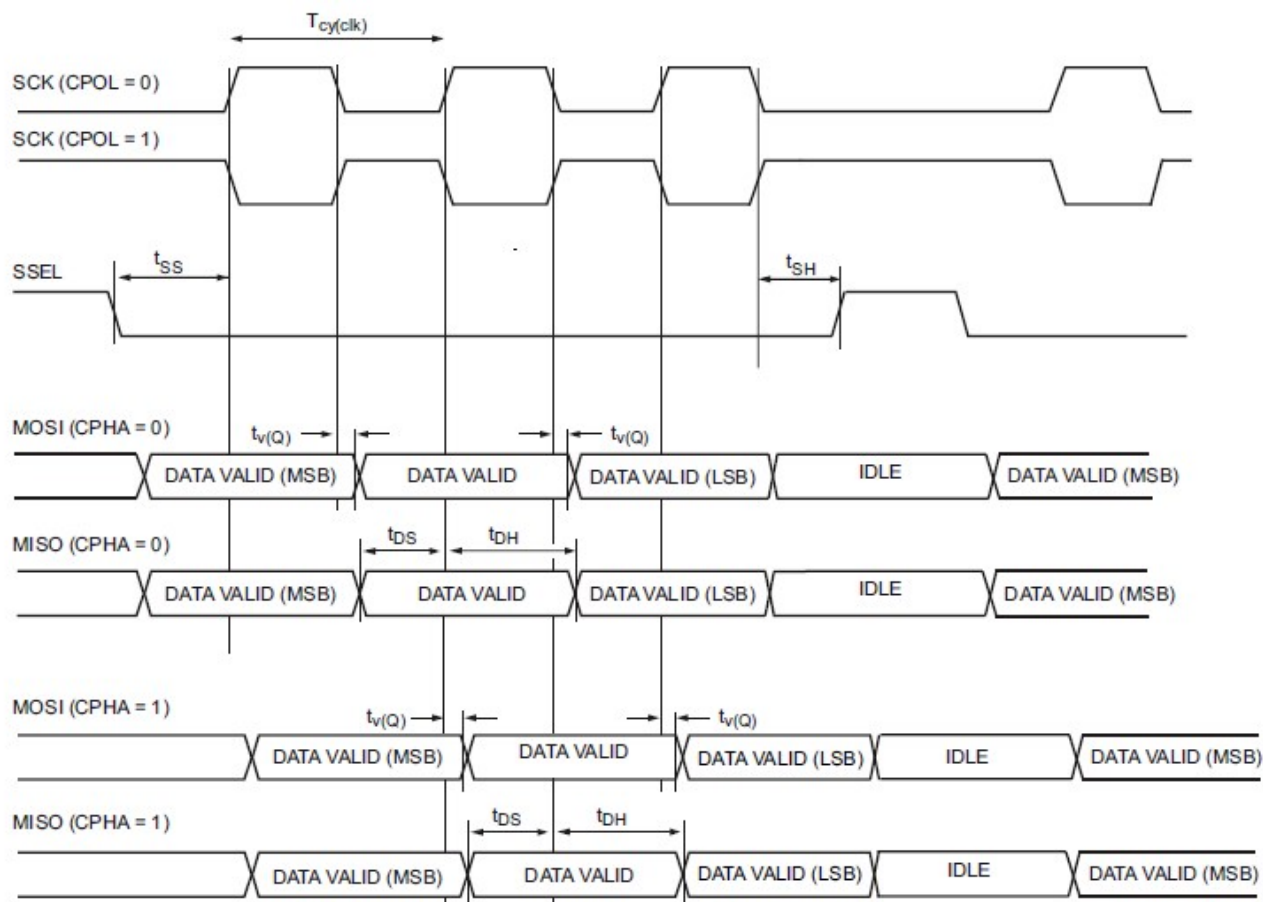


SPI master timing

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{DS}	Data set-up time		10			ns
t_{DH}	Data hold time		5			ns
$t_{V(Q)}$	Data output valid time		-2		15	ns
$t_{cy(SCK)}$	SCK frequency			4		MHz
	Duty cycle		45	50	55	%
t_{SS}	SSEL low before SCK edge		1			SCK cycles
t_{SH}	SSEL low after last SCK edge		0.5			SCK cycles

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Radio transceiver

This JN5189 meets all the requirements of the IEEE 802.15.4 standard over 1.9 V to 3.6 V and offers the improved RF characteristics shown in [Table 42](#). All RF characteristics are measured single ended.

This part also meets the following regulatory body approvals, when used with NXP's Module Reference Designs. Compliant with *FCC part 15 rules*, *IC Canada* and *ETSI ETS 300-328*, refer to the JN5189 Module Reference Design package on the Wireless

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Frang	Frequency range		2.4		2.485	GHz

Radio receiver characteristics: +25 °C

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
SRX	Receiver sensitivity	1 % PER, as per IEEE 802.15.4		- 99.7		dBm

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NF	Noise Figure	Max gain ¹⁰		7.3		dB
PinMaxRX	Maximum receiver input power	% PER, measured as sensitivity			10	dBm
CoCh	Co-channel Interference rejection	1 % PER, with wanted signal 3 dB above sensitivity as per IEEE 802.15.4 ¹¹		-2.1		dB
Rej-5M	Interference rejection, 1% PER, with wanted signal 3 dB above sensitivity as per IEEE 802.15.4 ¹²	Adjacent -5 MHz		35.6		dB
RejProp-5M	Proprietary mode interference rejection. 1% PER, with wanted signal 3 dB above sensitivity as per IEEE 802.15.4 ¹³	Adjacent -5 MHz		56.4		dB
RejCW-5M	CW interference rejection. 1% PER, with wanted signal 3 dB above sensitivity as per IEEE 802.15.4	Adjacent -5 MHz		56.8		dB
RejOOB	Out-of-band rejection	% PER with wanted signal 3 dB above sensitivity, CW interferers at 868 MHz (KNX), RF/2, 2100 MHz (WCDMA), 2500 MHz (LTE), or RF/3 (3GPP-Japan)		61.7		dB
IMP2,4	Inter-modulation Protection	1% PER with wanted signal 3 dB above sensitivity, modulated interferers at 2 and 4 channels separation ¹⁴		42.5		dB
IMP3,6		1% PER with wanted signal 3 dB above sensitivity, modulated interferers at 3 and 6 channels separation ¹⁵		46.5		dB
PinBlocking	Blocking input power	Desired channel IEEE 802.15.4, level = measured sensitivity + 6dB, channels 11 & 26. Unwanted channel		-22		dBm

¹⁰ Considering an integrated BW of 2 MHz, and a minimum SNR of 4 dB for the demodulator.

¹¹ Interference rejection is defined as the value, when 1 % PER is seen with the wanted signal 3 dB above sensitivity, with a modulated interferer as per IEEE 802.15.4.

¹² Interference rejection is defined as the value, when 1 % PER is seen with the wanted signal 3 dB above sensitivity, with a modulated interferer as per IEEE 802.15.4

¹³ Proprietary mode interference rejection is defined as the value, when 1 % PER is seen with the wanted signal 3 dB above sensitivity, with a proprietary mode interferer.

¹⁴ The intermodulation protection level is the difference between the wanted channel power and one of the two interferers power. Both interferers are modulated as per IEEE 802.15.4 and have the same power.

¹⁵ The intermodulation protection level is the difference between the wanted channel power and one of the two interferers power. Both interferers are modulated as per IEEE 802.15.4 and have the same power.

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		CW at 2380 MHz or 2503.5 MHz				
PinBlocking	Blocking input power	Desired channel IEEE 802.15.4, level = measured sensitivity + 6dB, channels 11 & 26. Unwanted channel CW at 2300 MHz, 2330 MHz & 2360 MHz		-21.2		dBm
PinBlocking	Blocking input power	Desired channel IEEE 802.15.4, level = measured sensitivity + 6dB, channels 11 & 26. Unwanted channel CW at 2523.5 MHz, 2553.5 MHz, 2583.5 MHz, 2613.5 MHz, 2643.5 MHz, 2673.5 MHz		-20.4		dBm
RSSIvar	RSSI variation Desired channel	Desired channel IEEE 802.15.4, over the RSSI range -101 dBm to +9 dBm		+/- 2		dB
PspRX	Receiver spurious emission, measured conducted into 50 ohms	30 MHz to 1 GHz, 100 kHz RBW, 300 kHz VBW, Filter type 3 dB (Gaussian), Peak detector, Trace Mode Max hold		-83.3		dBm
PspRX	Receiver spurious emission, measured conducted into 50 ohms	1 GHz to 12.75 GHz, 1 MHz RBW, 3MHz VBW, Filter type 3dB (Gaussian), Peak detector, Trace mode Max hold		-62.7		dBm
LOLeakRX	Local oscillator leakage power			-98		dBm
RejWIFI	WIFI rejection	1 % PER, with wanted signal IEEE 802.15.4 -75 dBm 2470 MHz, WIFI signal IEEE 802.11n 2447 MHz (20MHz mode)		53.7		dB

Radio transmitter characteristics: +25 °C

PoutMax	Maximum output power			11.2		dBm
Pout	Output power +10 dBm accuracy	In-band tilt		9.9 +/- 0.3		dBm
PoutRange	Output power control range			45.7		dB
EVM	Error vector magnitude	With IEEE 802.15.4 channel at +10 dBm		6.3		%



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OEVM	Offset error vector magnitude	With IEEE 802.15.4 channel at +10 dBm	0.33	%
EVM _{Prop}	Error Vector Magnitude	With proprietary mode at +10 dBm	23.2	%
OEVM _{Prop}	Offset error Vector Magnitude	With proprietary mode at +10 dBm	3.2	%
PSD	Power spectral density	Relative density at greater than 3.5 MHz offset as per IEEE 802.15.4 at +10 dBm	-37.4	dBc
PSD	Power spectral density	Absolute density at greater than 3.5 MHz offset at +10 dBm as per IEEE 802.15.4 at +10 dBm	-38.2	dBm
PSD _{Prop}	Proprietary mode power spectral density	Relative density at greater than 3.5 MHz offset with proprietary mode at +10 dBm	-61.2	dBc
PSD _{Prop}	Proprietary mode power spectral density	Absolute density at greater than 3.5 MHz offset with proprietary mode at +10 dBm	-62.2	dBm
TXH2	2nd Harmonic of Transmit Carrier Frequency	With IEEE 802.15.4 channel at +10 dBm	-62.4	dBm/MHz
TXH3	3rd Harmonic of Transmit Carrier Frequency	With IEEE 802.15.4 channel at +10 dBm	-73	dBm/MHz
PspTX	Transmitter spurious emission, measured conducted into 50 ohms	30 MHz to 1 GHz, Peak detector, RBW=100 kHz	-80	dBm
PspTX	Transmitter spurious emission, ETSI exceptions	1.8 GHz to 1.9 GHz	-64.3	dBm
PspTX	Transmitter spurious emission, ETSI exceptions	5.15 GHz to 5.3 GHz	-67.3	dBm

Antenna Design

The following details the chip antenna used in the Zigbee Interface module. The specifications listed are according to the vendor's datasheet.

Chip Antenna Manufacturer	Johanson Technology Inc.
Chip Antenna Part Number	2450AT43B100
Frequency Range	2400–2500 MHz
Peak Gain	1.3 typ.
Average Gain	-0.5 typ.
Return Loss	9.5 min.



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Environmental Specifications

Environmental Compliance

The Zigbee Interface module is built in compliance with the Restriction of Hazardous Substances (RoHS) and Halogen Free (HF) directives. The Zigbee Interface module and components used to produce this module are RoHS and HF compliant.

RF Certification

The Zigbee Interface module is certified under the following RF certification standards:

- FCC: WT5-JN5188
- CE

Environmental Conditions

ESD and EMI Protection

Exposed components require special attention to ESD and electromagnetic interference (EMI).

A grounded conductive layer inside the device enclosure is suggested for EMI and ESD performance. Any openings in the enclosure near the module should be surrounded by a grounded conductive layer to provide ESD protection and a low-impedance path to ground.

Device Handling: Proper ESD protocol must be followed in manufacturing to ensure component reliability.



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Regulatory Information

FCC

FCC NOTICE:

The Zigbee Interface, including the antenna 2450AT43B100 from Johanson Technology, complies with Part 15 of the FCC Rules. The device meets the requirements for modular transmitter approval as detailed in FCC public Notice DA00-1407. transmitter 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.

CAUTION:

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by EnerSys may void the user's authority to operate the equipment.

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

LABELING REQUIREMENTS:

The Original Equipment Manufacturer (OEM) must ensure that FCC labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate EnerSys FCC identifier for this product as well as the FCC Notice above. The FCC identifier is FCC ID: WT5-JN5188.

In any case the end product must be labeled exterior with "Contains FCC ID: WT5-JN5188"

ANTENNA WARNING:

This device is tested with a standard SMA connector and with the antennas listed below. When integrated in the OEMs product, these fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Any antenna not in the following table must be tested to comply with FCC Section 15.203 for unique antenna connectors and Section 15.247 for emissions.

RF EXPOSURE:

To comply with FCC RF Exposure requirements, the Original Equipment Manufacturer (OEM) must ensure to install the approved antenna in the previous.

The preceding statement must be included as a CAUTION statement in manuals, for products operating with the approved antennas defined in Antenna design, to alert users on FCC RF Exposure compliance. Any notification to the end user of installation or removal instructions about the integrated radio module is not allowed.



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The radiated output power of the Zigbee Interface with the chip antenna mounted (FCC ID: WT5-JN5188) is far below the FCC radio frequency exposure limits. Nevertheless, use the Zigbee Interface module in such a manner that minimizes the potential for human contact during normal operation.

End users may not be provided with the module installation instructions. OEM integrators and end users must be provided with transmitter operating conditions for satisfying RF exposure compliance.

ISED

Innovation, Science and Economic Development Canada (ISED) Certification

Zigbee interface module is licensed to meet the regulatory requirements of Innovation, Science and Economic Development Canada (ISED), License: IC: 7922A-2005

Manufacturers of mobile, fixed or portable devices incorporating this module are advised to clarify any regulatory questions and ensure compliance for SAR and/or RF exposure limits. Users can obtain Canadian information on RF exposure and compliance from www.ic.gc.ca.

This device has been designed to operate with the built in antennas listed. Other antennas are strictly prohibited for use with this device. The antenna used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

ISED NOTICE:

The device Zigbee Interface module including the antenna 2450AT43B100 from Johanson technology, complies with Canada RSS-GEN Rules. The device meets the requirements for modular transmitter approval as detailed in RSS-GEN.

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.

ISED RADIATION EXPOSURE STATEMENT FOR CANADA

This device complies with Innovation, Science and Economic Development (ISED) Canada licence-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 à la norme sur l'innovation, la science et le développement économique (ISED) norme RSS exempte de licence. L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

LABELING REQUIREMENTS:

The Original Equipment Manufacturer (OEM) must ensure that ISED labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate EnerSys IC identifier for this product as well as the ISED Notice above. The IC identifier is 7922A-2005. In any case, the end product must be labeled in its exterior with "Contains IC: 7922A-2005"

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European R&TTE Declaration of Conformity

Hereby, EnerSys declares that the Zigbee Interface module complies with the essential requirements and other relevant provisions of Directive 1999/5/EC. As a result of the conformity assessment procedure described in Annex III of the Directive 1999/5/EC, the end-customer equipment should be labeled as follows:



All versions of the Zigbee Interface module in the specified reference design can be used in the following countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, The Netherlands, the United Kingdom, Switzerland, and Norway.