

Transceiver Module for 2.4GHz ZigBee / 802.15.4 Development Kit Available

FEATURES

- >100mW output power
- Unmatched sensitivity: >-109dBm*
- Long range: >3 miles
- Miniature footprint: 0.960" x .915"
- Antenna diversity with integrated dual u.fl connectors.
- Low power operation
- Controlled with simple SPI interface
- RoHS compliant
- Low cost design

APPLICATIONS

- Smart Energy
- Security
- Lighting Control
- HVAC Control
- Sensor Networks
- Medical
- Robotics
- Telemetry Data



DESCRIPTION

The DivBee® module is a high performance 2.4GHz IEEE 802.15.4 radio (using the Atmel AT86RF231 transceiver and RFAxis RFX2401 front-end), providing an extremely robust, yet cost effective, pre-certified module in a tiny footprint. Dual antenna diversity helps to eliminate fades and nulls due to multi-pathing and adverse environmental conditions. The module interfaces to any CPU or microcontroller having a SPI port and three available control lines. Mounting options include a simple 10 position (5 x 2) 2mm pitch header or 12 position (6x2) 2mm pitch header.

The information in this document is subject to change without notice. Please download the latest revision of this datasheet from www.divbee.net.

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* Single antenna mode only, diversity mode sensitivity is >-107dBm

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DivBee® Module Summary

1.1 General

The DivBee® module is an extended-range, low-power, highly sensitive IEEE 802.15.4/ZigBee OEM module, which occupies less than one square inch of space. Based on a solid combination of Atmel's MCU wireless transceiver and RFaxis' front-end chip to provide a power amplifier and a low-noise amplifier, the DivBee® module offers unmatched radio performance and exceptional ease of integration. Dual diversity antennas can automatically detect the best signal and use it during reception, virtually eliminating fades and nulls due to environmental conditions. A single antenna can also be used if single antenna operation is desired.

Unlike other Zigbee compatible modules, the DivBee® module does not use a built-in microcontroller. Since end products that use Zigbee modules almost always require a microcontroller to interface the RF module anyways, a much more cost effective solution is to use the same microcontroller to also handle the RF communications. This allows a variety of microcontroller and CPU options as well as numerous free and commercial Zigbee stack options. The RF MCU chosen for the DivBee® module can perform transmit and receive functions asynchronously using an on-board buffer, thus requiring very little CPU time for operations. Modem-only communications are greatly simplified, requiring a simple microcontroller having only a few pins and very little code.

Note: Example source code and schematics for integrating various microcontrollers is freely available from www.divbee.net.

The DivBee® module's RF transceiver is an Atmel AT86RF231 MCU. This chip is controlled through a standard 4 wire SPI port (/SEL, SDI, SDO, CLK), and requires 3 additional control lines for the interrupt (IRQ), reset (/RST), and sleep/transmit (SLP_TR) functions. An optional control line for the power amplifier enable is also available. Any good 2.5v-3.6v regulated power supply can be used.

For further simplicity and design cost reduction, the DivBee® module can output a highly accurate (+/-10ppm) clock (CLKM) at 1MHz, 2MHz, 4MHz, 8MHz, or 16MHz. This clock is tied directly to the internal MCU clock and thus SPI port accesses are perfectly synchronized if the CLKM signal is used to drive an external microcontroller's clock input. Drive current can be adjusted from 2mA to 8mA via software. The start-up frequency for the CLKM output is 1MHz and can be turned off or adjusted to different frequencies through software as part of the initialization procedure.

For more information about the Atmel AT86RF231 MCU, please download the datasheets and other information from the DivBee® website:

www.divbee.net/downloads.php

DivBee® Module Overview

2.1 Overview

Figure 1 shows the internal interconnects of the ICs on the DivBee® module. Consult the respective IC datasheets for details. Note: voltage regulation not shown.

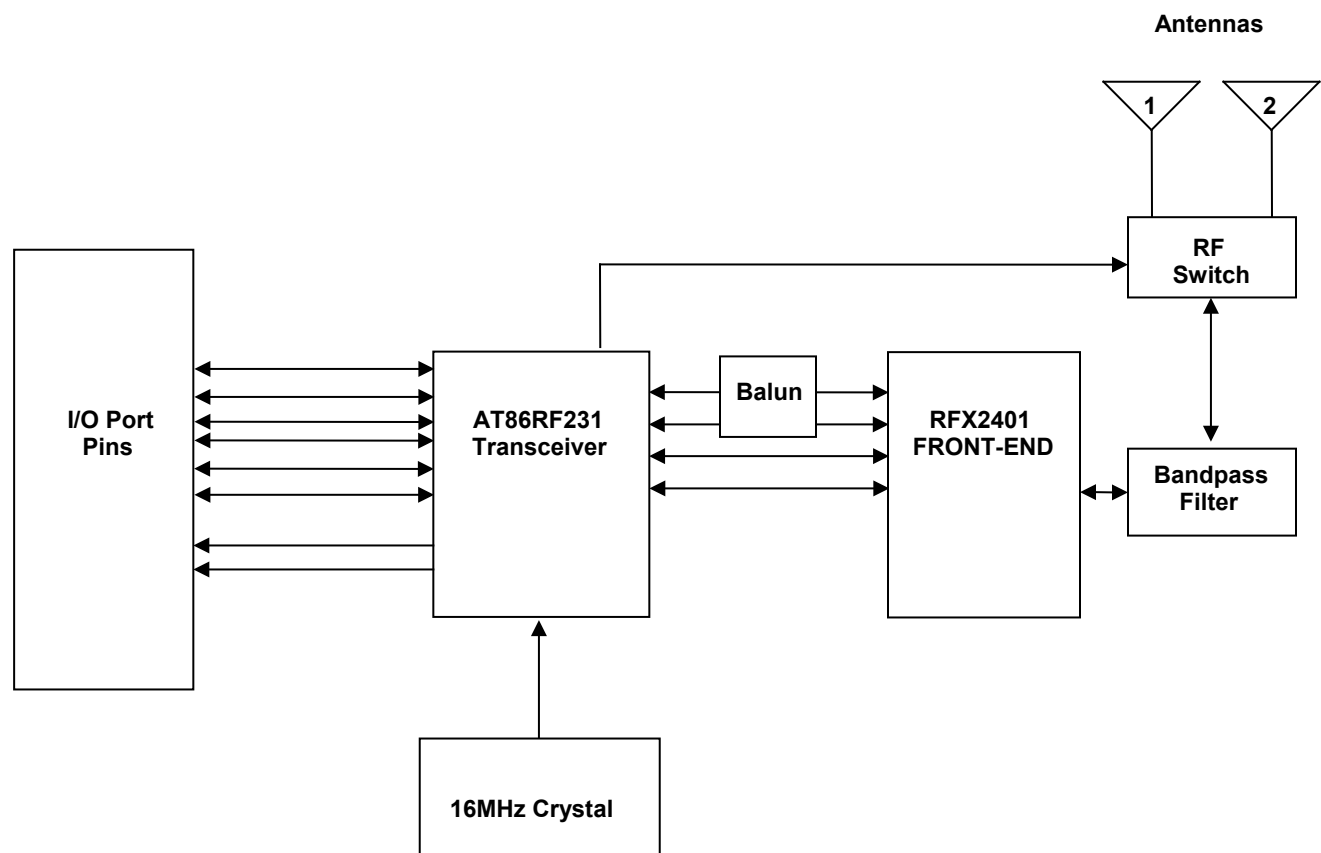


Figure 1. DivBee® Module Block Diagram – Internal Interconnects

Specifications

3.1 Electrical Characteristics

3.1.1 Absolute Maximum Ratings

Table 3-1. Absolute Maximum Ratings⁽¹⁾⁽²⁾

Parameters	Min	Max
Voltage on any pin, except RESET with respect to Ground	-.05v	VCC +.05v
DC Current per I/O Pin		40mA
DC Current DVCC and DGND pins		420mA

Notes: 1. **Absolute Maximum Ratings** are the values beyond which damage to the device may occur. Under no circumstances must the absolute maximum ratings given in this table be violated. Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

This is a stress rating only. Functional operation of the device at these or other conditions, beyond those indicated in the operational sections of this specification, is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

2. **Attention!** The DivBee[®] module contains ESD-sensitive components. Precaution should be taken when handling the device in order to prevent permanent damage.

3.1.2 Test Conditions

Table 3-2. Test conditions (unless otherwise stated) F = 2.45 GHz, V_{CC} = 3.3V, T_{amb} = 25°C

Parameters	Range	Unit
Supply Voltage, VCC	2.5 to 3.6	V
Maximum Current Consumption: RX mode	19.7	mA
Maximum Current Consumption: TX mode ⁽¹⁾	170	mA
Maximum Current Consumption: Power-save mode	.08	μA

Note: 1. The parameters are measured under the following conditions:
 a) Hardware clock at 16MHz clock rate
 b) All interfaces are set to the default state (see Pin Assignment Table)
 c) Output TX power >+21dBm

3.1.3 RF Characteristics

Table 3-3. RF Characteristics

Parameters	Condition	Range	Unit
Frequency Band		2.405 to 2.480	GHz
Numbers of Channels		16	
Channel Spacing		5	MHz
Transmitter Output Power ⁽¹⁾	Adjustable (32 steps)	-17.6 to +21.1	dBm
Receiver Sensitivity ⁽²⁾	PER = 1%	-107/-109	dBm
Over-Air Data Rate ⁽³⁾		250	Kbps
TX Output/ RX Input Nominal Impedance	Unbalanced output	50	Ω
Range, outdoors (ground)	Using 2.15 dBi antenna	> 5000	m

Note: 1. The power amplifier can be disabled by bringing PA_E low. In this mode there are 16 steps of power output from -17.6dBm to +1dBm. With the PA_E line enabled there are 16 steps of power output from 10dBm to 21.1dBm. Power output is at the module itself and does not include antenna gain.

Note: 2. Dual/Single antenna connections. Sensitivity is reduced by 2dBm when using diversity mode.

Note: 3. Zigbee compatible mode. Alternate baud rates are possible. Consult Atmel's AT86RF231 manual for more details.

3.2 Physical/Environmental Characteristics and Outline

Parameters	Value	Comments
Size	.960" x .915"	DivBee® 2.4GHz module
Operating Temperature Range	-40°C to +85°C	-60°C to +100°C operational(1)
Operating Relative Humidity Range	no more than 80%	

Note: 1. Minor degradation of clock stability may occur

Figure 3-1. DivBee® Top View Mechanical Drawing

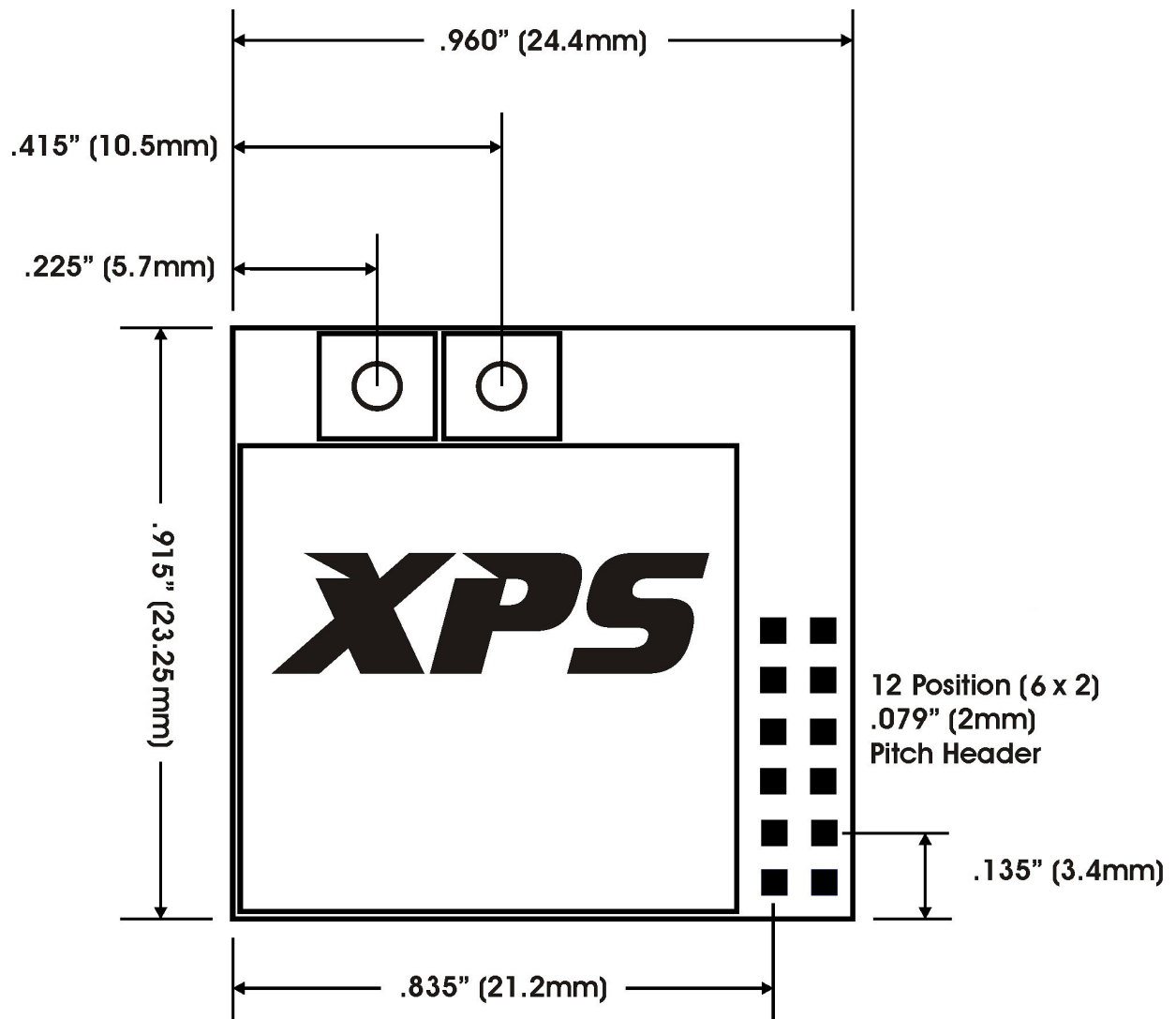
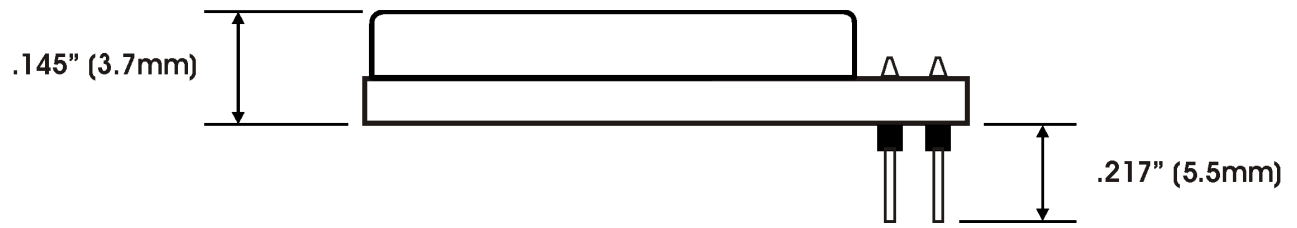


Figure 3-2. DivBee® Side View Mechanical Drawing



3.3 Pin Configuration

Figure 3-3. DivBee® Pinout, Refer to Table 3-4 for pin descriptions

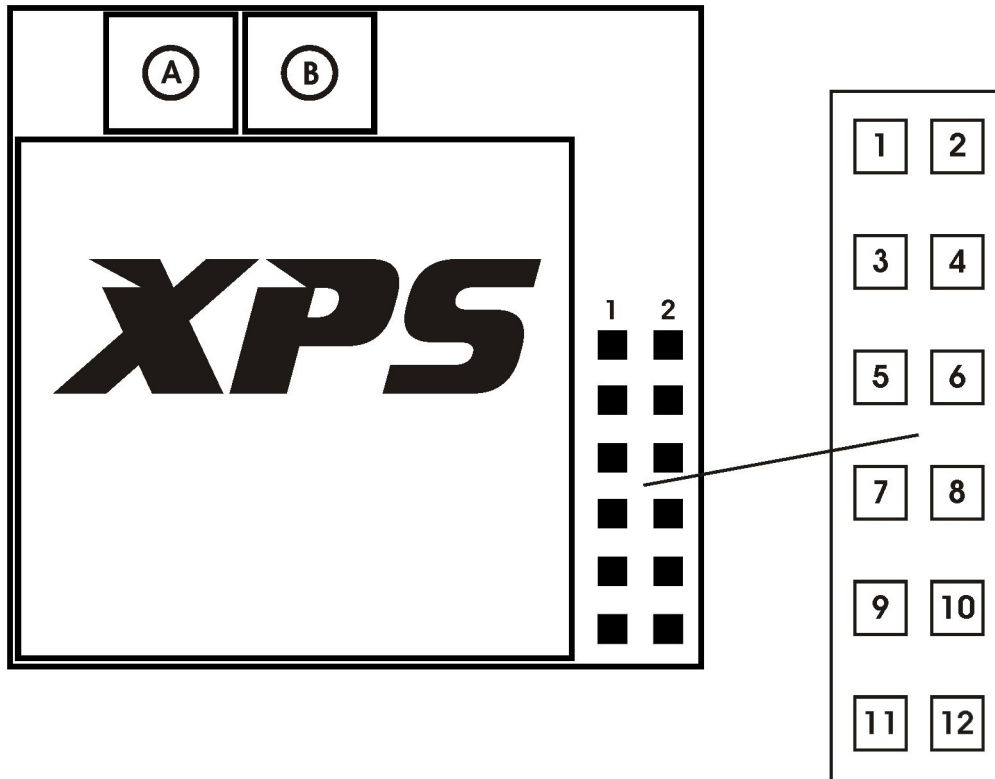


Table 3-4. Pin descriptions

Pin	Pin Name	Description	I/O
1	IRQ	Interrupt request, active high	O
2	/SEL	SPI select signal, active low	I
3	MOSI	SPI data input	I
4	MISO	SPI data output	O
5	SCLK	SPI clock signal	I
6	VCC	Power	
7	CLKM	Clock output (1Mhz, 2MHz, 4MHz, 8MHz, or 16MHz)	O
8	GND	Digital Ground	
9	SLP_TR	Sleep/transmit	I
10	/RESET	Reset, active low	I
11	PA_E	Power Amplifier Enable (optional)	I
12	GND	Digital Ground (optional)	
A	u.fl 1	Antenna 1	
B	u.fl 2	Antenna 2	

3.4 Pin Functions

Refer to Section 6 “Microcontroller Interface” of the Atmel AT86RF231 datasheet for information on the digital interface. The standard interface control lines necessary for use are IRQ, /SEL, /RESET, MOSI, MISO, SCLK, and SLP_TR. The CLKM output can also be set or disabled.

The DivBee[®] modules normally come with the PA_E enable pin pulled low. The DivBee[®] modules can be special ordered with the PA_E enable pin pulled high (enabled). A 100K pull-up or pull-down resistor is used. If control of the power amplifier is not necessary then a 10 position (5x2) connector can be used instead of a 12 position (6x2) connector. Note: to obtain the ultra-low standby current of .08uA it is necessary to disable the PA by pulling pin 11 low. This is why the standard option has this pin always pulled low.

Changing the polarity of the PA_E line requires 100uA of current. When both antenna enable outputs (DIG3 and DIG4 on the AT86RF231) are driven low (off), the CE line on the RFX2401 is also driven low. In this state, no current is used for the PA_E line.

Ordering Information

4.1 Part Numbers

Below is a reference for the available DivBee® module options and their associated part numbers.

Table 4-1.Part numbers

Part Number	Options
DIVA24PL12	2.4GHz DivBee® module, with PA low (disabled) & 12 position connector
*DIVA24PH12	2.4GHz DivBee® module, with PA high (enabled) & 12 position connector
*DIVA24PL10	2.4GHz DivBee® module, with PA low (disabled) & 10 position connector
*DIVA24PH10	2.4GHz DivBee® module, with PA high (enabled) & 10 position connector

* Available as special order only

FCC/IC/ETSI Compliancy

5.1 Compliancy Requirements

In order to maintain FCC/IC compliancy for this device, the maximum power output for each channel must be limited to the values shown in Table 5.1 (while using a 2.15dBi antenna). The maximum duty cycle is also shown for the maximum power. Higher duty cycle can be used with lower power. 17% duty cycle is standard time for a 802.15.4 packet and 3 failed retries, every 100ms. ETSI compliancy requires only that the power output is set to 3 (<100mw) with any duty cycle allowed.

Table 5-1. Maximum power/duty cycle per channel (FCC/IC compliancy only).

Channel	Frequency (MHz)	RF Register Setting / Power Output	Duty Cycle	PA_E
11	2405	9 / +16.31dBm	17%	H
12	2410	6 / +18.46dBm		H
13	2415	2 / +20.17dBm		H
14	2420	2 / +20.17dBm		H
15	2425	2 / +20.17dBm		H
16	2430	2 / +20.17dBm		H
17	2435	2 / +20.17dBm		H
18	2440	2 / +20.17dBm	100%	H
19	2445	2 / +20.17dBm		H
20	2450	2 / +20.17dBm		H
21	2455	2 / +20.17dBm		H
22	2460	2 / +20.17dBm		H
23	2465	4 / +19.60dBm		H
24	2470	6 / +18.46dBm		H
25	2475	8 / +17.69dBm		H
26	2480	15 / -2.27 dBm	34%	L

5.2 Agency Certifications

UNITED STATES (FCC)

This equipment complies with Part 15 of the FCC rules and regulations. To fulfill FCC Certification requirements, an Original Equipment Manufacturer (OEM) must comply with the following regulations:

1. The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module:

Example of label required for OEM product containing DivBee® module

Contains FCC ID: X5L-XPSA24

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i.) this device may not cause harmful interference and (ii.) this device must accept any interference received, including interference that may cause undesired operation.

2. Only the antenna types listed in this documentation are allowed to be used with the DivBee® module. The DivBee® module may be integrated with other custom design antennas after successful certification of the custom antenna design, and filing a Class II permissive change. This is a common practice and typically requires a small fee and simple testing, not a complete re-test of the device.
3. Maximum power output and duty cycle for each channel must be adhered to as shown in table 5.1.

WARNING: Any OEM must ensure that the OEM modular transmitter must be labeled with its own FCC ID number. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown below. If the FCC ID is not visible when the equipment is installed inside another device, then the outside of the device into which the equipment is installed must also display a label referring to the enclosed equipment.

IMPORTANT: This equipment 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 (FCC 15.19). The external antenna(s) used for this mobile transmitter must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance. This device is approved as a mobile device with respect to RF exposure compliance, and may only be marketed to OEM installers. Use in portable exposure conditions (FCC 2.1093) requires separate equipment authorization.

IMPORTANT: Modifications not expressly approved by this company could void the user's authority to operate this equipment (FCC section 15.21).

IMPORTANT: 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.

CANADA (IC) - ENGLISH

Equipment is subject to certification under the applicable RSSs, shall be permanently labeled on each item, or as an inseparable combination. The label must contain the following information for full compliance:

Certification Number: Manufacturer's Name, Trade Name or Brand Name: Model Name:	IC: 8829A-XPSA24 XPS XtremeLink DivBee®
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IMPORTANT: This equipment for which a certificate has been issued is not considered certified if it is not properly labeled. The information on the Canadian label can be combined with the manufacturer's other labeling requirements.

IMPORTANT: 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.

IMPORTANT: To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

IMPORTANT: The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population. Consult Safety Code 6, obtainable from Health Canada's website. Website URL: www.hc-sc.gc.ca/rpb.

This Class B digital apparatus complies with Canadian ICES-003.

CANADA (IC) - FRENCH

L'équipement est soumis à la certification sous le CNR applicable, doivent être étiquetés de façon permanente sur chaque point, ou comme une combinaison indissociable. L'étiquette doit contenir les informations suivantes pour le respect intégral:

<p>Numéro de certification: Nom du fabricant, du commerce ou marque: Nom du modèle:</p>	<p>IC: 8829A-XPSA24 XPS XtremeLink DivBee®</p>
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IMPORTANT: Cet équipement pour lequel un certificat a été délivré n'est pas considéré comme certifié si elle n'est pas correctement étiqueté. Les informations sur l'étiquette canadienne peuvent être combinés avec les exigences d'étiquetage du fabricant d'autres.

IMPORTANT: L'opération est soumise aux deux conditions suivantes: (1) cet appareil ne peut causer d'interférences nuisibles, et (2) cet appareil doit accepter toute interférence reçue, y compris les interférences qui peuvent provoquer un fonctionnement indésirable.

IMPORTANT: Pour réduire le risque d'interférence aux autres utilisateurs, le type d'antenne et son gain doivent être choisis de manière que la puissance isotrope rayonnée équivalente (e.i.r.p.) ne dépasse pas celle permise pour une communication réussie.

IMPORTANT: L'installateur de cet équipement radio doit s'assurer que l'antenne est située ou orientée de telle sorte qu'il n'émet pas de champ RF dépassant les limites de Santé Canada pour la population générale. Consultez le Code de sécurité 6, disponible sur le site Web de Santé Canada. Site Web: www.hc-sc.gc.ca/rpb.

Cette appareil numérique de classe B est conforme à la norme NMB-003 du Canada.

EUROPEAN UNION (ETSI)

The DivBee® module has been certified for use in European Union countries. If the DivBee® module is incorporated into a product, the manufacturer must ensure compliance of the final product to the European harmonized EMC and low-voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in Annex II of the R&TTE Directive.

Furthermore, the manufacturer must maintain a copy of the DivBee® module documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a submission must be made to a notified body for compliance testing to all required standards.

IMPORTANT: The 'CE' marking must be affixed to a visible location on the OEM product. The CE mark shall consist of the initials "CE" taking the following form:

- If the CE marking is reduced or enlarged, the proportions given in the above graduated drawing must be respected.
- The CE marking must have a height of at least 5mm except where this is not possible on account of the nature of the apparatus.
- The CE marking must be affixed visibly, legibly, and indelibly.

More detailed information about CE marking requirements you can find at "**DIRECTIVE 1999/5/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL**" on 9 March 1999 at section 12.

Certification Approved Antennas list is presented below.

5.3 Compliance Information/Markings



Model: DivBee®
FCC ID: X5L-XPSA24
IC ID: 8829A-XPSA24

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i.) this device may not cause harmful interference and (ii.) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.



WARNING: To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. The antennas used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

L'appareil ci-joint est conforme à la Partie 15 des règlements de la FCC. L'opération est soumise aux deux conditions suivantes: (i) cet appareil ne peut causer d'interférences nuisibles et (ii) cet appareil doit accepter toute interférence reçue, y compris les interférences qui peuvent provoquer un fonctionnement indésirable.

Les changements ou modifications non expressément approuvés par la partie responsable de la conformité pourrait priver l'utilisateur de faire fonctionner l'équipement.



ATTENTION: Pour satisfaire aux exigences de la FCC d'exposition RF pour les appareils mobiles de transmission, sur une distance de séparation de 20 cm ou plus doit être maintenue entre l'antenne de cet appareil et des personnes lors de fonctionnement du dispositif. Pour assurer la conformité des opérations au plus près que cette distance n'est pas recommandée. Les antennes utilisées pour ce transmetteur ne doit pas être co-localisés en conjonction avec toute autre antenne ou transmetteur.



This device complies with ETSI EN-300-328 v1.71 rules when 100mw EIRP or less of power is used.

5.4 Approved Antenna List

The DivBee® module has been tested and approved for use with the antenna(s) listed in the table below.

The DivBee® module may be integrated with other custom design antennas which OEM installer must authorize with respective regulatory agencies.

Table 5-2. Approved Antenna specifications

Part Number	Manufacturer / Description	Maximum Gain [dBi]	Minimum separation [cm]
XPS-AN01	XPS, swivel antenna (1/4 wave antenna) w/ RP-SMA connector, frequency range 2.4 - 2.5 GHz	2.15	20

6.1 Contact Information

World-wide sales

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