



Soltec

SolBee user manual

Preliminary

Change control

Revision	Date	Section involved
1	08/01/2018	All
2	17/04/2018	9
3	17/04/2018	9

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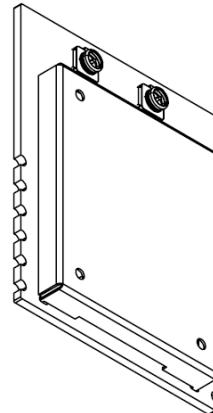
1 Device overview

- **Features:**

- Microchip's MRF24J40 I/ML transceiver based.
- IEEE Std. 802.15.4™ Compliant RF Transceiver. Supports ZigBee.
- SPI serial interface.
- Small size and surface mount.
- Dual U.FL. 50 Ω connector with selectable antenna.
- All-in-one solution. Integrated transceiver, balun, PA, LNA, filter, crystal and bypass capacitors.
- Proportional voltage RF Power Analog output.
- Fully compatible with microchip module MRF24J40MD.
- Serial SPI Interface with interrupt.

- **Operational:**

- Operating Voltage: 2.4V to 3.6V.
- Industrial temperature range: -40°C to 85 °C
- Low current consumption:
 - o Rx Mode: 29 mA
 - o Tx Mode: 132 mA
 - o Sleep: 8uA



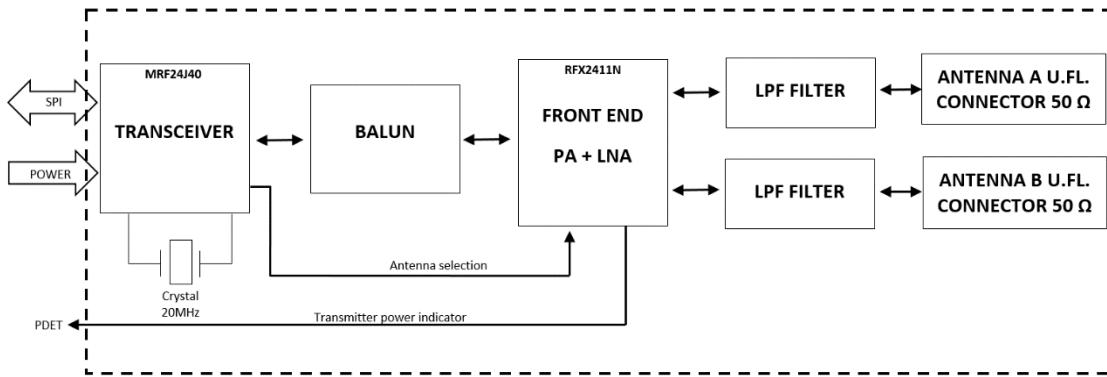
- **RF Features:**

- ISM Band 2.405 MHz – 2.485 MHz.
- Data Rate: 250 kbps.
- -105 dBm typical Sensitivity.
- +20 dBm maximum output power.
- Selectable RF output power.

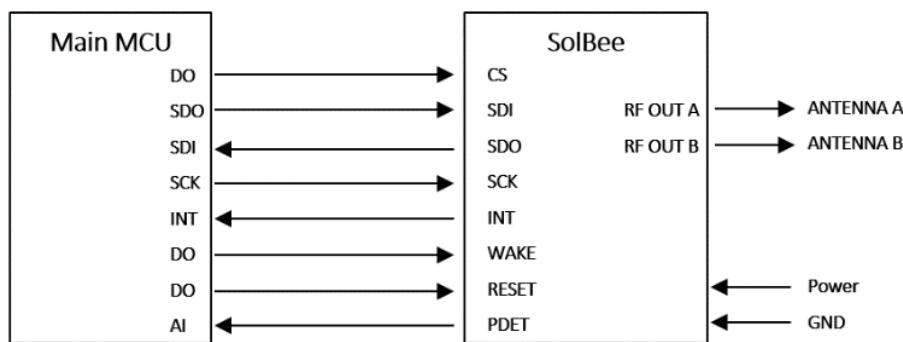
RF Features:

- Hardware CSMA-CA Mechanism, Automatic ACK Response and FCS Check.
- Automatic Packet Tetransmit Capable.
- Independent Beacon, Transmit and GTS FIFO.
- Support encryption and decryption.

2 Block diagram



3 Application connection example



4 Absolute maximum ratings

Absolute maximum ratings				
Parameter	Min	Typ	Max	Units
Operating Ambient Temperature	-40	-	+85	°C
DC VDD Voltage Supply	2,4	-	3,6	V
Voltage on VDD respect to VSS	0	-	3,6	V
Input High Voltage (VIH)	0,5 x V _{DD}	-	V _{DD} + 0,3	V
Input Low Voltage (VIL)	-0,3	-	0,2 x V _{DD}	V

Table 1.

5 Pinout

Pin Number	Pin Name	Type	Description
1	GND	Ground	Ground
2	RESET	DI	Global hardware Reset pin
3	WAKE	DI	External wake-up trigger
4	INT	DO	Interrupt pin to microcontroller
5	SDI	DI	SPI Data input
6	SCK	DI	SPI clock
7	SDO	DO	SPI data output
8	CS	DI	SPI enable
9	PDET	DO	Analog output. DC voltage proportional to PA RF Power Output.
10	Vin	Power	Power Supply
11	GND	Ground	Ground
12	GND	Ground	Ground

Table 2.

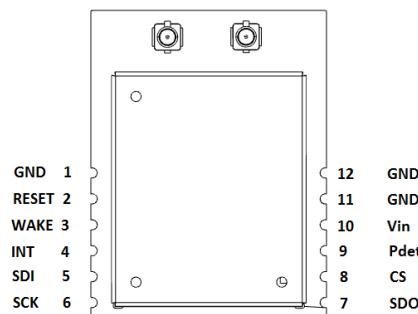


Figure 1.

6 Operation

6.1 Operation

SolBee module is a 2.4 GHz ZigBee module based on MRF24J40 Microchip's transceiver IC. This transceiver contains a standard SPI data interface, to control and configure the RF communications, and a voltage regulator, which provide regulated power to the internal circuits of the transceiver.

In order to obtain the carrier RF frequency, 20 MHz crystal is installed for clocking the IC. This crystal is the only clock source of the module.

After the transceiver, a balun LC circuit connects the RF pin of the transceiver with the RFX2411N Front-end stage. This balun circuit matches the impedance between ICs.

The Front-End IC is formed by two stages: PA stage for increasing the transmit RF power signal and LNA stage to increase the receiver sensitivity. This IC is connected to an inductor (L1) to minimize harmonics.

Finally, the Front-End is connected to two U.FL antenna connectors thought LPF for a transmitted harmonics reduction. Front-End RF pins and antenna connectors have the same impedance, so no extra circuit is necessary for impedance matching. The antenna output is selected by a GPIO connected to the transceiver and controlled by the main external microcontroller.

The transmitter power can be monitored by an external signal (PDET). This output provides an analog voltage proportional to the output transmitted power.

All bypass and decoupling capacitors are provided around the ICs.

The different operative modes of the SolBee module are controlled by the external GPIOs of the MRF24J40 transceiver. The table 3 below shows the different RF stage configurations.

Operation Mode	GPIO1	GPIO2	GPIO5
Shutdown	0	0	0
PA Transmit	1	X	0
LNA Receive	0	1	0
Bypass bidirectional	X	X	1

Table 3.

6.2 Antenna selection

Antenna output can be selected by transceiver GPIO4. Table 4 shows the GPIO4 levels for the selection of each antenna.

Antenna selected	GPIO4
Antenna A enabled	1
Antenna B enabled	0

Table 4

6.3 Transmitted power selection

The SolBee module let select different output power levels for accommodation to the final application. Please consult MRF24J40 and RFX2411N datasheets for selecting the desired output power.

6.4 Received power table

RSSI can be estimated from the received signal power. RSSI is a value from 0 to 255. Figure 2 shows the relationship between the RSSI value and power received. For more detail, please consult MRF24J40 datasheet.

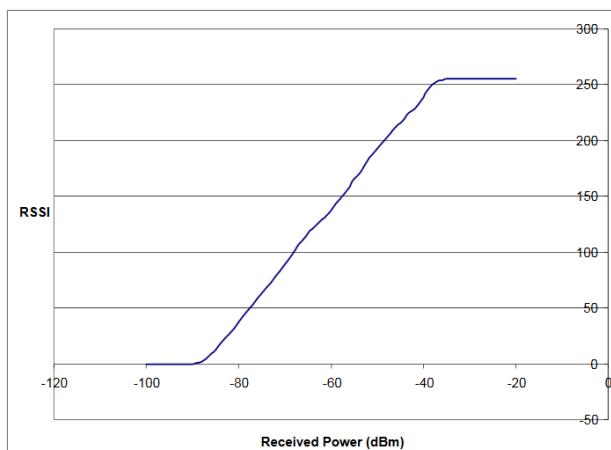


Figure 2. RSSI vs Received power.

6.5 Transmitted power detection

The analog output Pin 9 (PDET) is an analog output signal providing DC voltage proportional to the power at the RF amplifier output. This value has a high dependence of the SolBee power supply level. Please, consult Figure 3 and figure 4 for voltage output.

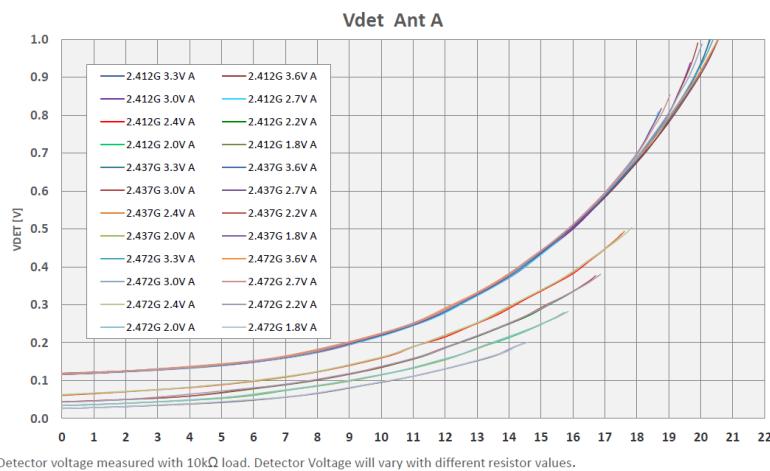


Figure 3. PDET with antenna A selected.

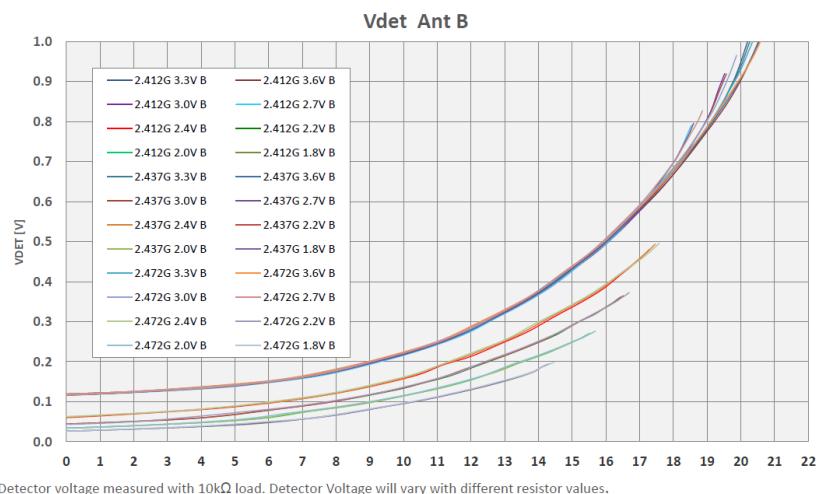


Figure 4. PDET with antenna B selected.

7 Drawing

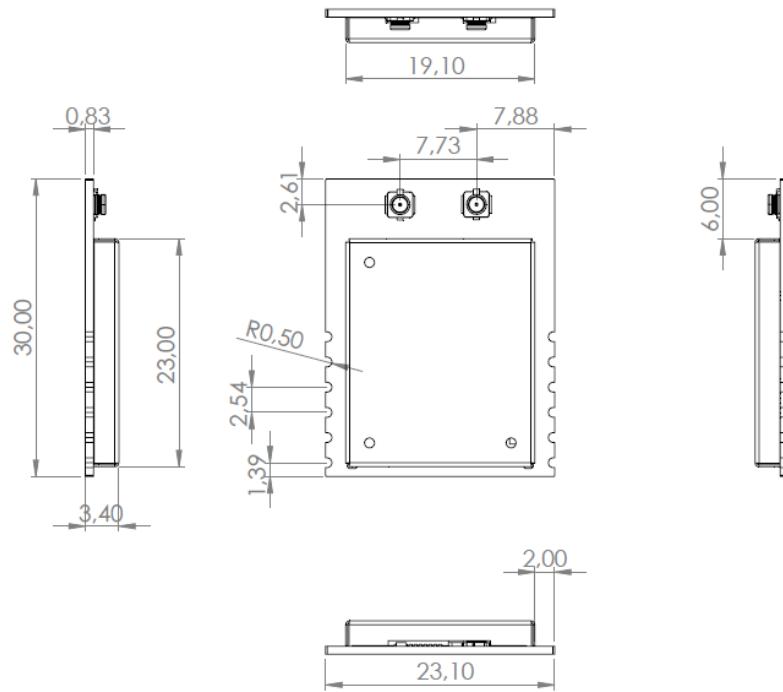
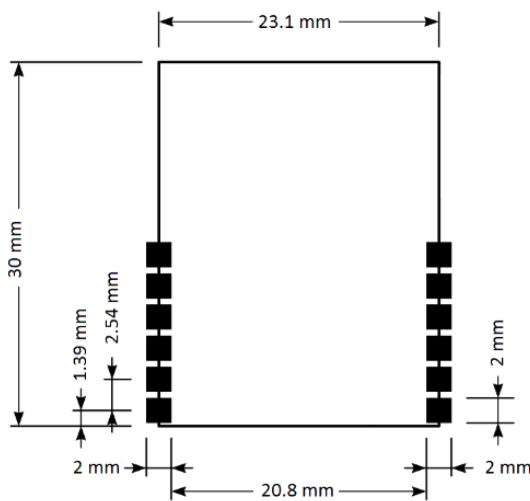


Figure 5

8 Recommended PCB footprint



9 Regulatory approval

This section contains the regulatory information for THE SolBee ZigBee module, for the following countries:

- USA

9.1 USA

SolBee module has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C "Intentional Radiators" modular approval in accordance with Part 15.212 Modular Transmitter approval. This approval allows the end user to integrate this module into a finished product without obtaining subsequent and separate FCC approvals for intentional radiation, provided no changes or modifications are made to the module circuitry. Changes or modifications could void the user's authority to operate the equipment. The end user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance.

9.1.1 Modification statement (FCC 15.21)

Sotec Energías Renovables S.L. has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

9.1.2 Comprehensive integration instructions.

For proper integration of modules in end products, it is required that detailed and comprehensive instructions must be provided to the integrators, so that any subsequent associated party (grantee, host manufacturer, original equipment manufacturer (OEM), integrator, or end-user) can clearly understand the conditions and limitations for authorized uses of the modular transmitter. These instructions must be included as one of the Form 731 exhibits. While modules can provide great flexibility for third parties without requiring additional compliance demonstrations for the transmitter function, additional technical requirements may call for separate equipment authorization information for compliance demonstration (e.g., for RF exposure compliance and hearing-aid compatibility, for devices with specific antennas, or specific host/enclosure configurations). A host product incorporating a certified device cannot take advantage of the pre-existing certification of the component transmitter module without conformity with the specific requirements in the instructions. Also, a transmitter module grantee is responsible for including the necessary details for ensuring compliance for RF exposure requirements and the associated usage conditions for portable, mobile, and fixed-mount equipment configurations, as applicable.

9.1.3 Labeling requirements

The SolBee module has been 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 finished product into

which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording as follows:

Contains Transmitter Module FCC ID: 2AO08SOLBEE

or

Contains FCC ID: 2AO08SOLBEE

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*

The user's manual for the product should include the FCC Class B digital device notice:

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.*

9.1.4 RF exposure

All transmitters regulated by FCC must comply with RF exposure requirements. The user's manual should include the FCC RF exposure statements Section 2.109(d)(3) referred to minimum separation distance required:

To satisfy FCC RF Exposure requirements for mobile and base station transmission devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at closer than this distance is not recommended. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

This device complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines and RSS-102 of the ISED radio frequency (RF) Exposure rules. This transmitter must not be collocated or operating in conjunction with any other antenna or transmitter.

9.1.5 Antenna information

To maintain modular approval in the United States, only the antenna types that have been tested shall be used. It is permissible to use different antenna manufacturer provided the same antenna type and antenna gain (equal to or less than) is used.

Testing of the SolBee module was performed with the antenna types listed below:

- Jinchang Electron JCW015 Antenna:

- Frequency Range: 2400-2500 Mhz
- Polarization: Linear
- Gain 2dBi (Zenith)
- VSWR(min): <2.5
- Connector: Reverse Polarity SMA Male

10 Related documents

1. Microchip MRF24J40 Data sheet DS39776C
2. Skyworks RFX2411N Production Data sheet
3. Skyworks RFX2411N Evaluation Board Technical Notes