

## MOD-ZIGBEE development board

## Users Manual



All boards produced by Olimex are ROHS compliant

Rev. B, March 2013

Copyright(c) 2011, OLIMEX Ltd, All rights reserved

## INTRODUCTION

MOD-ZIGBEE features a bundle of 8bit PIC18 processor and an 802.15.4 compatible radio module that makes it easy to develop applications based on RF communication and especially ZigBee based protocol stacks. In addition MOD-ZIGBEE implements an on-board digital temperature sensor, for remote temperature reporting.

## BOARD FEATURES

- CPU: PIC18F26K20
- RF Transceiver – MRF24J40 IEEE 802.15.4™ standard compliant 2.4 GHz RF transceiver
- ICSP connector
- On-board antenna
- On-board temperature sensor – TCN75A
- Option for external power supply through EXT\_PWR
- EXT/BAT switch
- Reset circuit
- two user buttons
- two status LEDs
- RST button
- +3V lithium battery holder
- PCB: FR-4, 1.00 mm (0,039"), solder mask, silkscreen component print
- Dimensions: 65.15x20.38 mm (2.56x0.80")

## ELECTROSTATIC WARNING

The MOD-ZIGBEE board is shipped in protective anti-static packaging. The board must not be subject to high electrostatic potentials. General practice for working with static sensitive devices should be applied when working with this board.

## BOARD USE REQUIREMENTS

- Cables:** The cable you will need depends on the programmer/debugger you use. If you use PIC-ICD2-POCKET or PIC-Kit3 you will need 1.8 m A-B USB cable.
- Hardware:** One of Olimex programmers/debuggers – PIC-ICD2-POCKET, PIC-KIT3, or other compatible programming/debugging tool. Also note that you would need adapter for the small ICSP connector (0.05" step) - PIC-ICSP
- Software:** MPLAB IDE

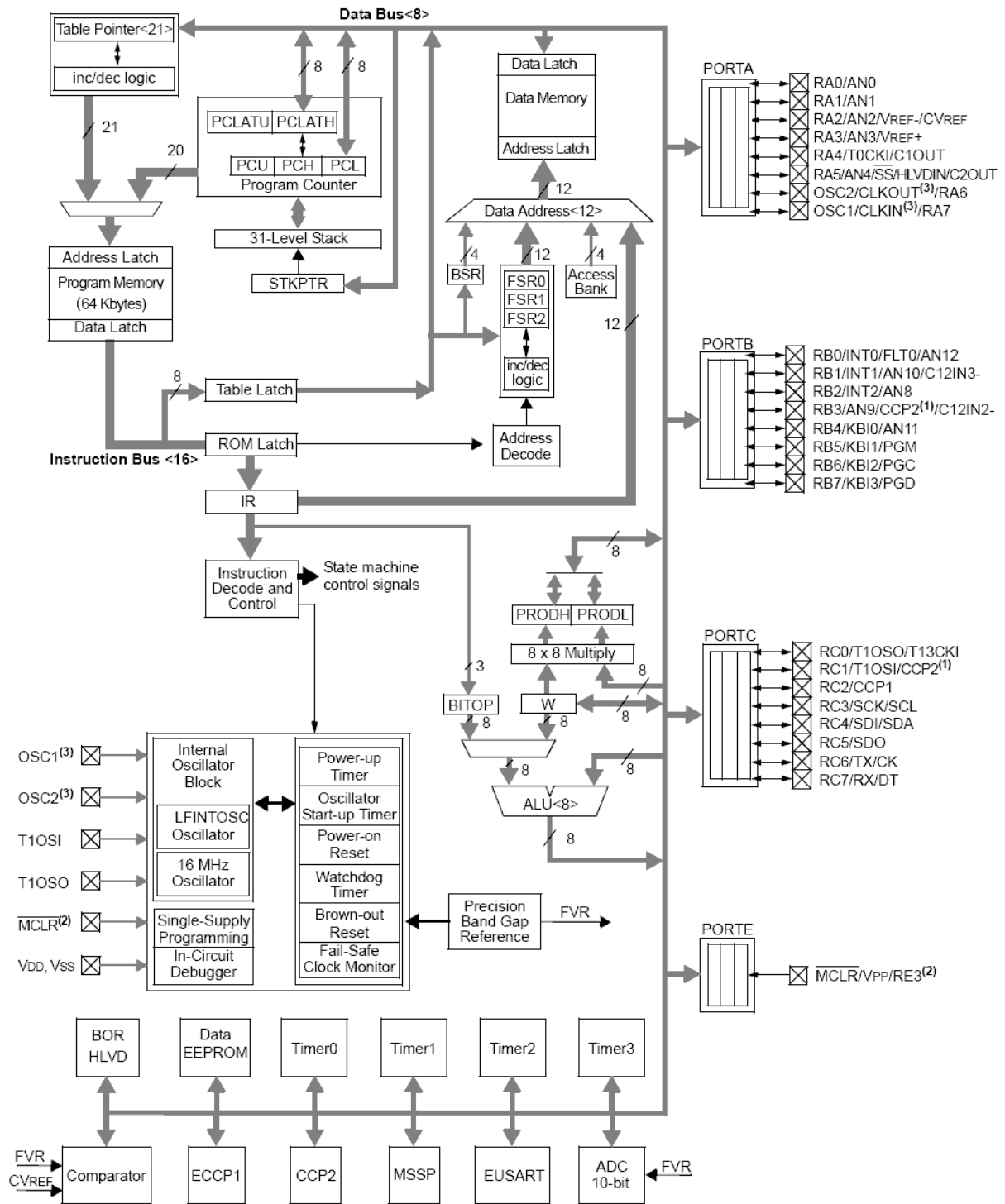
## PROCESSOR FEATURES

**MOD-ZIGBEE** use 28-pin Flash Microcontroller with nano Watt XLP Technology – PIC18F26K20, with these features:

- High-Performance RISC CPU:
  - C Compiler Optimized Architecture:
    - Optional extended instruction set designed to optimize re-entrant code
  - 1024 bytes Data EEPROM
  - 64 Kbytes Linear Program Memory Addressing
  - 3936 bytes Linear Data Memory Addressing
  - Up to 16 MIPS Operation
  - 16-bit Wide Instructions, 8-bit Wide Data Path
  - Priority Levels for Interrupts
  - 31-Level, Software Accessible Hardware Stack
  - 8 x 8 Single-Cycle Hardware Multiplier
- Flexible Oscillator Structure:
  - Precision 16 MHz Internal Oscillator Block:
    - Factory calibrated to  $\pm 1\%$
    - Software selectable frequencies range of 31 kHz to 16 MHz
    - 64 MHz performance available using PLL – no external components required
  - Four Crystal modes up to 64 MHz
  - Two External Clock modes up to 64 MHz
  - 4X Phase Lock Loop (PLL)
  - Secondary Oscillator using Timer1 @ 32 kHz
  - Fail-Safe Clock Monitor:
    - Allows for safe shutdown if peripheral clock stops
    - Two-Speed Oscillator Start-up
- Special Microcontroller Features:
  - Operating Voltage Range: 1.8V to 3.6V
  - Self-Programmable under Software Control
  - Programmable 16-Level High/Low-Voltage Detection (HLVD) module:
    - Interrupt on High/Low-Voltage Detection
  - Programmable Brown-out Reset (BOR):
    - With software enable option
  - Extended Watchdog Timer (WDT):

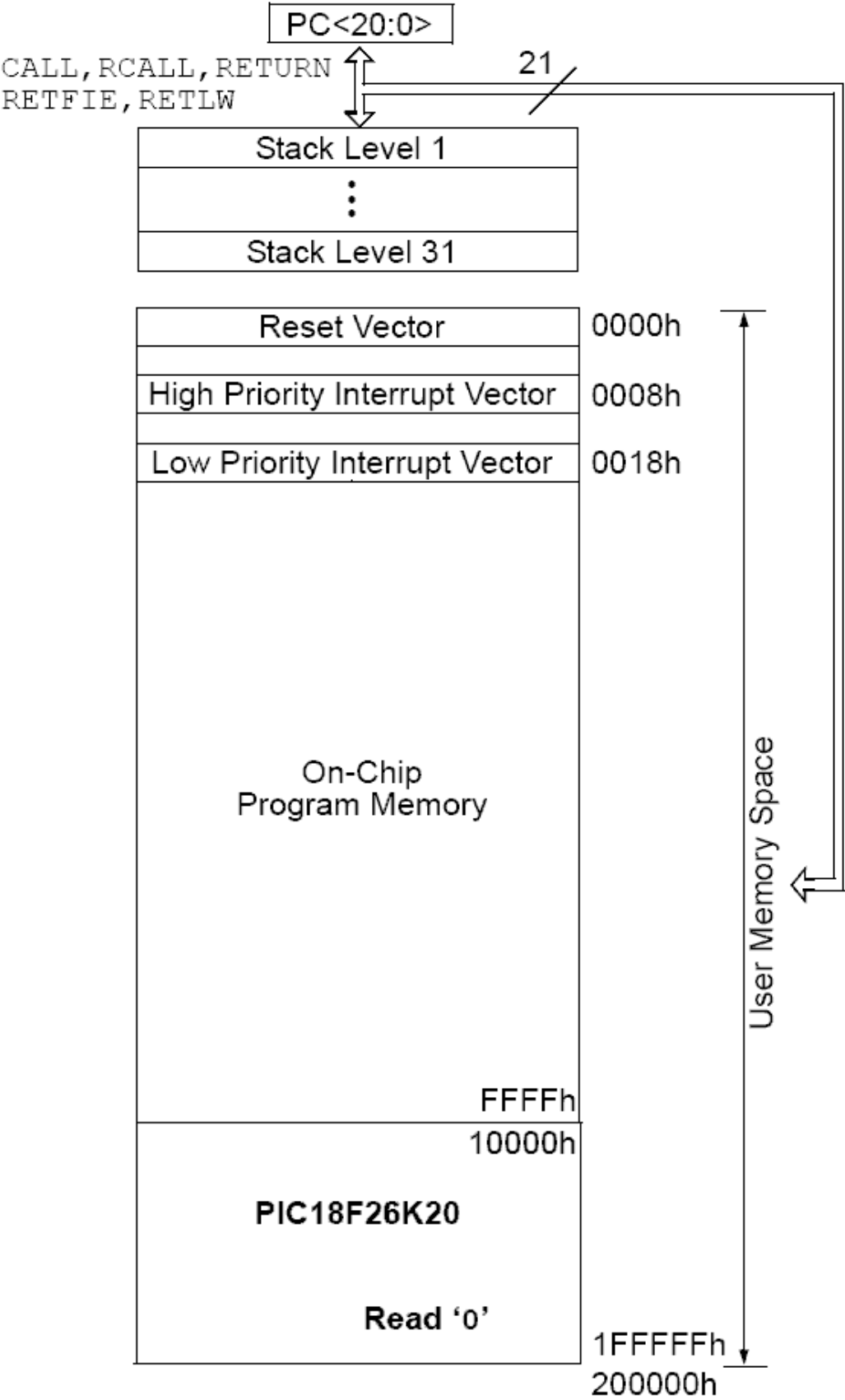
- Programmable period from 4 ms to 131s
  - Single-Supply 3V In-Circuit Serial Programming™ (ICSP™) via Two Pins
  - In-Circuit Debug (ICD) via Two Pins
- Extreme Low-Power Management with nanoWatt XLP:
  - Sleep mode: < 100 nA @ 1.8V
  - Watchdog Timer: < 800 nA @ 1.8V
  - Timer1 Oscillator: < 800 nA @ 32 kHz and 1.8V
- Analog Features:
  - Analog-to-Digital Converter (ADC) module:
    - 10-bit, 10 Channels
    - Auto-acquisition capability
    - Conversion available during Sleep
    - One 1.2V Fixed Voltage Reference (FVR) channel
    - Independent input multiplexing
  - Analog Comparator module:
    - Two rail-to-rail analog comparators
    - Independent input multiplexing
  - Voltage Reference (CVREF) module
    - Programmable (% VDD), 16 steps
    - Two 16-level voltage ranges using VREF pins
- Peripheral Highlights:
  - 24 I/O Pins plus 1 Input-only Pin:
    - High-Current Sink/Source 25 mA/25 mA
    - Three programmable external interrupts
    - Four programmable interrupt-on-change
    - Eight programmable weak pull-ups
    - Programmable slew rate
  - Master Synchronous Serial Port (MSSP) module
    - 3-wire SPI
    - I<sup>2</sup>C™ Master and Slave modes with address mask
  - Enhanced Universal Synchronous Asynchronous Receiver Transmitter (EUSART) module:
    - Supports RS-485, RS-232 and LIN
    - RS-232 operation using internal oscillator
    - Auto-Wake-up on Break
    - Auto-Baud Detect

# BLOCK DIAGRAM



- Note**
- 1: CCP2 is multiplexed with RC1 when Configuration bit CCP2MX is set, or RB3 when CCP2MX is not set.
  - 2: RE3 is only available when MCLR functionality is disabled.
  - 3: OSC1/CLKIN and OSC2/CLKOUT are only available in select oscillator modes and when these pins are not being used as digital I/O.

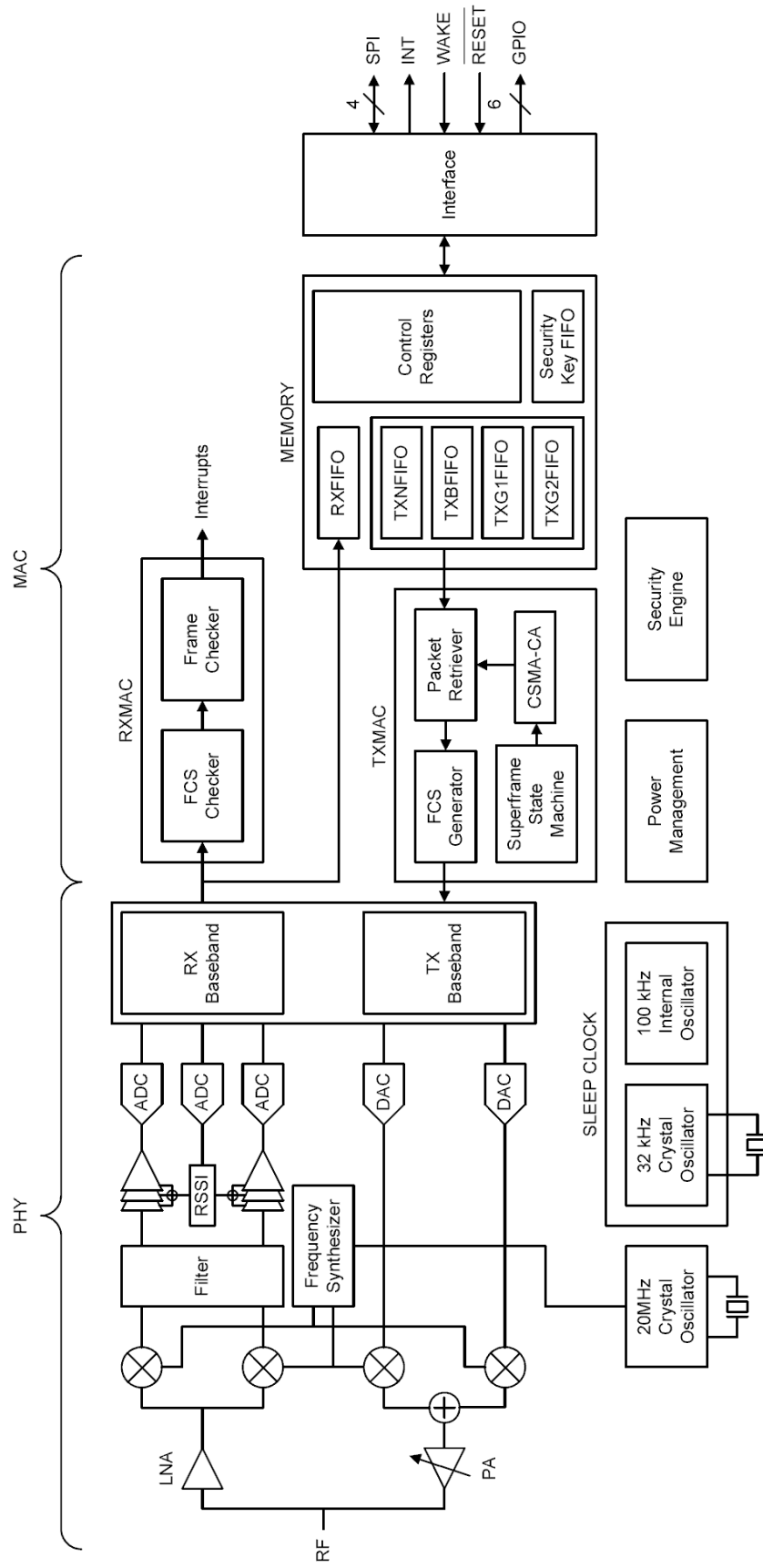
**MEMORY MAP**



## **RF TRANSCEIVER FEATURES**

- IEEE 802.15.4™ Standard Compliant RF Transceiver
- Supports ZigBee®, MiWi™, MiWi P2P and Proprietary Wireless Networking Protocols
- Simple, 4-Wire SPI Interface
- Integrated 20 MHz and 32.768 kHz Crystal Oscillator Circuitry
- Low-Current Consumption:
  - RX mode: 19 mA (typical)
  - TX mode: 23 mA (typical)
  - Sleep: 2  $\mu$ A (typical)
- RF/Analog Features:
  - ISM Band 2.405-2.48 GHz Operation
  - Data Rate: 250 kbps (IEEE 802.15.4); 625 kbps (Turbo mode)
  - -95 dBm Typical Sensitivity with +5 dBm Maximum Input Level
  - +0 dBm Typical Output Power with 36 dB TX Power Control Range
  - Differential RF Input/Output with Integrated TX/RX Switch
  - Integrated Low Phase Noise VCO, Frequency Synthesizer and PLL Loop Filter
  - Digital VCO and Filter Calibration
  - Integrated RSSI ADC and I/Q DACs
  - Integrated LDO
  - High Receiver and RSSI Dynamic Range
- MAC/Baseband Features:
  - Hardware CSMA-CA Mechanism, Automatic Acknowledgement Response and FCS Check
  - Independent Beacon, Transmit and GTS FIFO
  - Supports all CCA modes and RSSI/ED
  - Automatic Packet Retransmit Capability
  - Hardware Security Engine (AES-128) with CTR, CCM and CBC-MAC modes
  - Supports Encryption and Decryption for MAC Sublayer and Upper Layer

# RF TRANSCEIVER BLOCK DIAGRAM

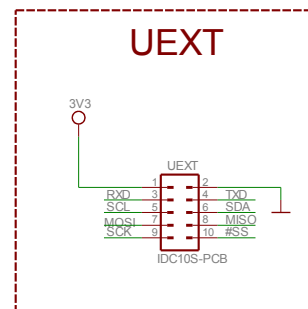
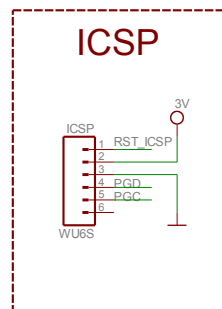
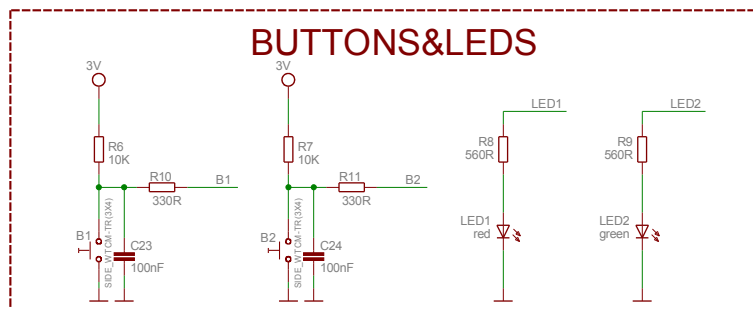
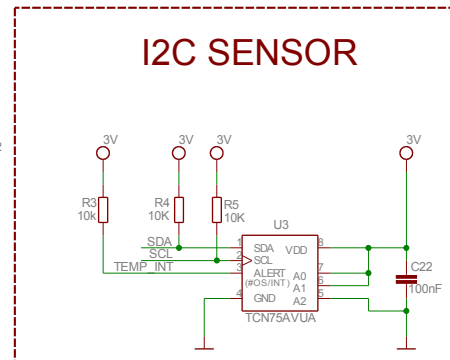
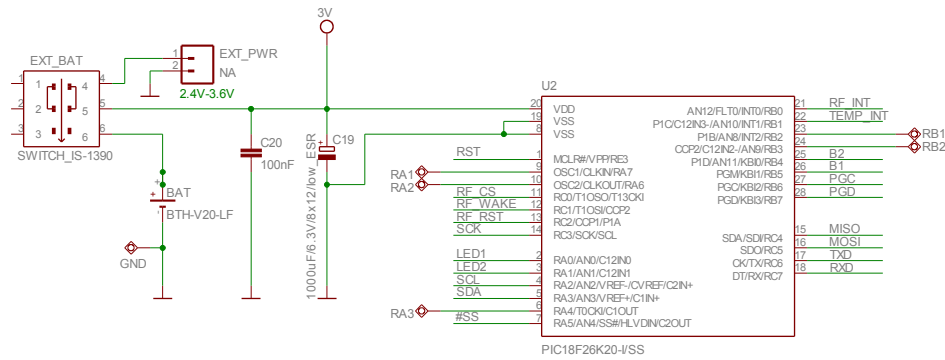
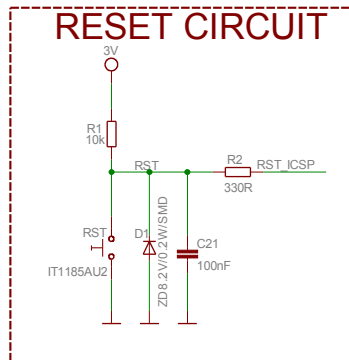
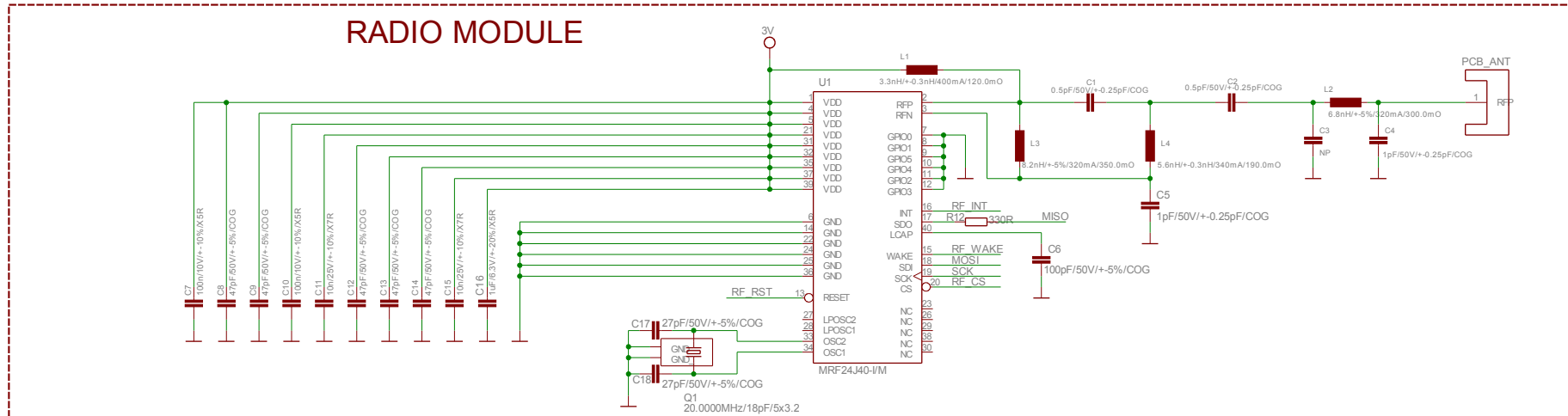




## RF TRANSCEIVER MEMORY MAP

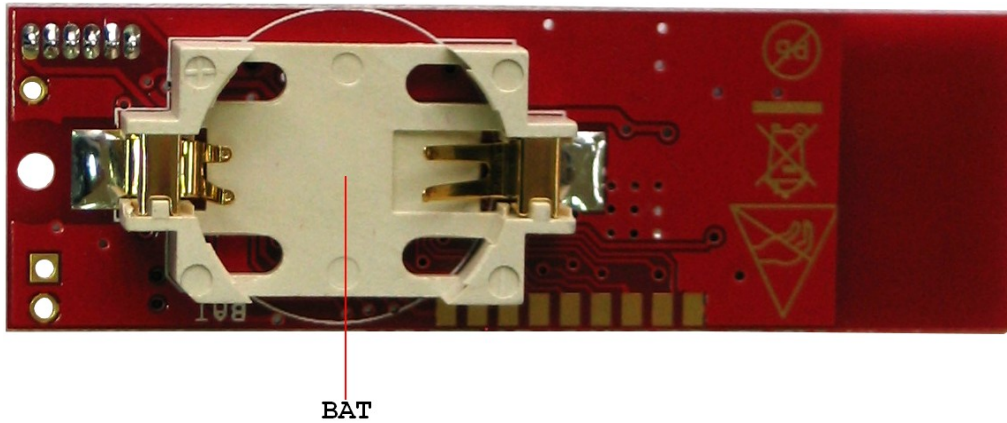
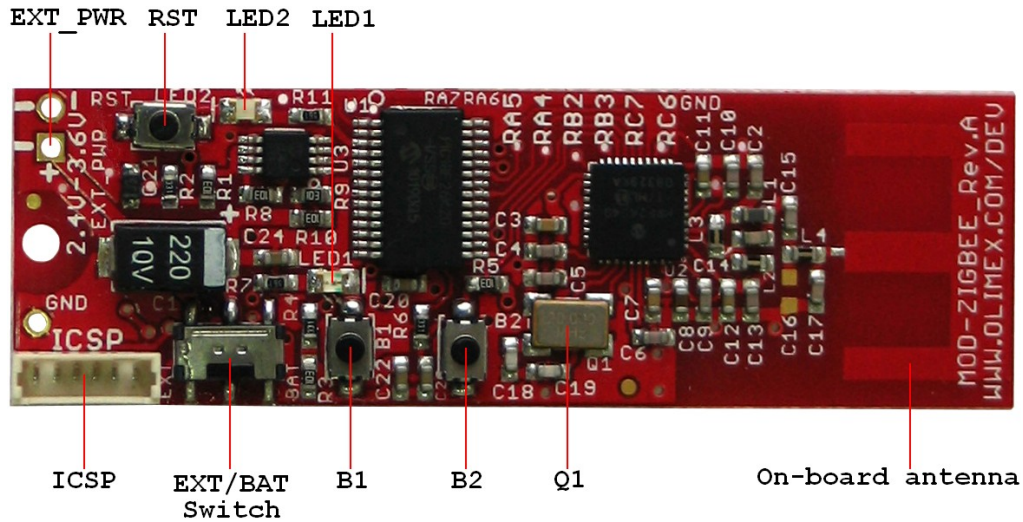
Short Address Memory Space		Long Address Memory Space	
0x00 0x3F	Control Registers	64 bytes	
		0x000	TX Normal FIFO
		128 bytes	
		0x07F 0x080	TX Beacon FIFO
		128 bytes	
		0x0FF 0x100	TX GTS1 FIFO
		128 bytes	
		0x17F 0x180	TX GTS2 FIFO
		128 bytes	
		0x1FF 0x200	Control Registers
		128 bytes	
		0x27F 0x280 0x2BF	Security Key FIFO
		64 bytes	
		0x2C0 0x2FF 0x300	Reserved
			RX FIFO
		144 bytes	
		0x38F	

# SCHEMATIC



MOD-ZIGBEE\_rev\_C  
 OLIMEX LTD, BULGARIA  
<https://www.olimex.com>

## BOARD LAYOUT



## POWER SUPPLY CIRCUIT

MOD-ZIGBEE may be power supplied in different ways: 2.4V - 3.6V via EXT\_PWR; via ICSP connector (useful for debugging); via BAT connector with +3V Lithium battery (CR2032).

The programmed board power consumption is about 30mA with RF transceiver active, and 10 $\mu$ A in deep sleep mode.

## CLOCK CIRCUIT

Crystal Quartz 20 MHz connected to MRF24J40 pin 33 (OSC2) and pin 34 (OSC1).

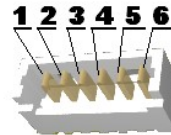
## RESET CIRCUIT

MOD-ZIGBEE reset circuit includes PIC18F26K20 pin 1 (MCLR#/VPP/RE3), R1 (10k) - pull-up, C21 (ZD8.2V/0.2W), R2 (330 Ohm), ICSP connector pin 1 and RST button.

## CONNECTOR DESCRIPTIONS

### ICSP

Pin #	Signal Name
1	RST-ICSP
2	3 V
3	GND
4	PGD
5	PGC
6	NC



### EXT PWR

Pin #	Signal Name
1	2.4 V - 3.6 V
2	GND

\*Note: There is no component mounted for this connector.

## JUMPER DESCRIPTION

There are no jumpers on this board.

## INPUT/OUTPUT

**User button** with name **B1** - connected to PIC18F26K20 pin 26 (PGM/KBI1/RB5).

**User button** with name **B2** - connected to PIC18F26K20 pin 25 (P1D/AN11/KBI0/RB4).

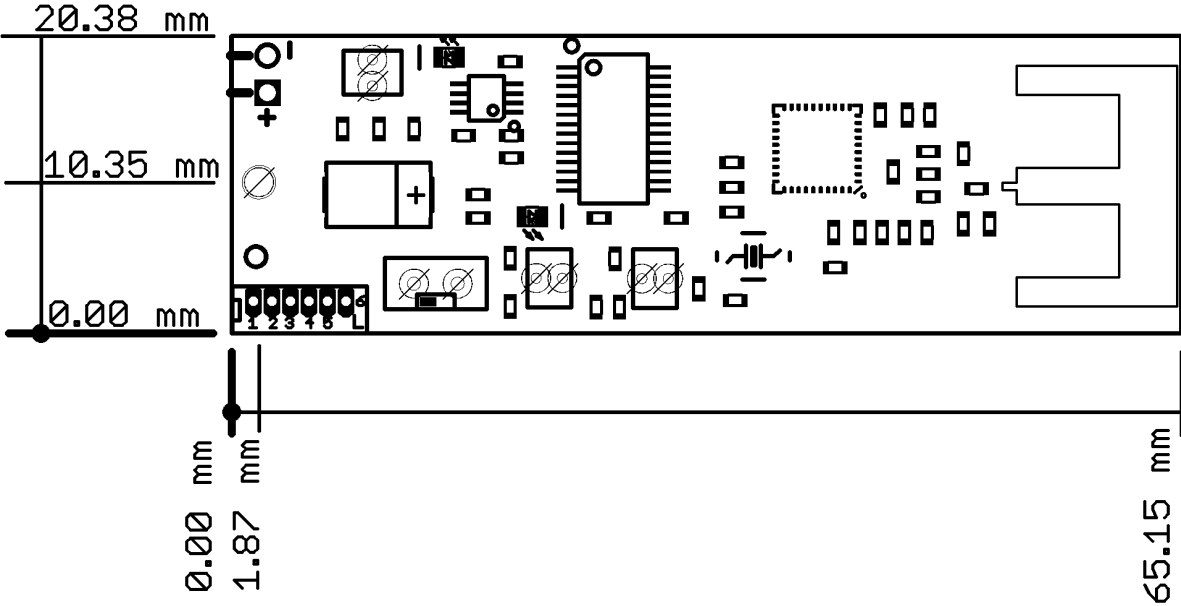
**Reset button** with name **RST** - connected to PIC18F26K20 pin 1 (MCLR#/VPP/RE3).

**Status LED (red)** with name **LED1** - connected to PIC18F26K20 pin 2 (RA0/AN0/C12IN0).

**Status LED (green)** with name **LED2** - connected to PIC18F26K20 pin 3 (RA1/AN1/C12IN1).

**EXT/BAT switch** - select between power supply from EXT\_PWR and BAT.

MECHANICAL DIMENSIONS



## AVAILABLE DEMO SOFTWARE

Available at <https://www.olimex.com>

This sample project demonstrates the functionality of the onboard processor, the radio transceiver and the thermometer. The demo is built upon the following Microchip's freely distributed support libraries:

- Microchip MiWi Development Environment version 3.1

The demo defines 2 types of devices: Coordinator and End Devices. According to Microchip MiWi specifications the MiWi network requires one Coordinator and one or many End Devices. The demo consists of separate projects for the Coordinator (called 'Coordinator') and End Devices (called 'EndDevice').

Upon startup the Coordinator forms a network with PAN ID 0x1234 on the channel with the least amount of noise, LED1 is lit and the program starts waiting for client devices to connect. Status messages are printed over UART and can be displayed on a terminal program on a PC (please see next chapter). The Coordinator is configured to accept connections from up to 10 devices. The Coordinator accepts connections from any device that requests joining but will only recognise messages about name and temperature of end devices using the other part of the demo. Received and recognised messages are printed on the terminal and LED2 toggles at any successful reception. Here is a sample terminal log from the operation of a Coordinator:

-----  
Input Configuration:

Button 1: RB5

Button 2: RB4

Output Configuration:

RS232 port

LED 1: RA0

LED 2: RA1

RF Transceiver: MRF24J40

Demo Instruction:

Power on the board until LED 1 lights up to indicate it is ready to establish new connections. Push Button 1 to perform frequency agility procedure. Push Button 2 to unicast encrypted message. LED 2 will be toggled upon receiving messages.

Feature MiWi DemMRF24J40 Node 1

Starting Active Scan...

Scan Channel 11

Scan Channel 12

Scan Channel 13

Scan Channel 14

Scan Channel 15

Scan Channel 16

Scan Channel 17

Scan Channel 18

```

Scan Channel 19
Scan Channel 20
Scan Channel 21
Scan Channel 22
Scan Channel 23
Scan Channel 24
Scan Channel 25
Scan Channel 26
Active Scanning Energy Scanning
Energy Scan Results:
Channel 11: ----- 48
Channel 12: ----- 41
Channel 13: ----- 58
Channel 14: ----- 5E
Channel 15: ----- 76
Channel 16: ----- 67
Channel 17: ----- 9A
Channel 18: ----- 72
Channel 19: ----- BC
Channel 20: ----- A0
Channel 21: ----- F0
Channel 22: ----- FA
Channel 23: ----- FB
Channel 24: ----- E8
Channel 25: ----- C4
Channel 26: ----- BC
Start Wireless Communication on Channel 12
Start Connection on Channel 12
From 0081, RSSI B4, NAME: DEFAULT NAME 000
From 0081, RSSI BC, TEMPR: 24.0625oC
From 0081, RSSI C3, TEMPR: 24.0000oC
From 0081, RSSI C1, TEMPR: 24.0000oC

```

---

Upon startup an End Device starts searching for a network with PAN ID 0x1234 on any available channel. If such a network is not found then the device enters deep sleep mode and reattempts connecting after some time. When a suitable network is found (formed by the Coordinator) the device joins it and sends to the Coordinator its specific name and measured temperature. Then it enters deep sleep mode and sends its measured temperature again after some time. The sleep may be prematurely terminated by a press of any of the two buttons (not the RESET button!).

If the Coordinator disappears for some reason the end device enters startup state again.

\*Note: With the introduction of MOD-LCD1x9 and MOD-ZIGBEE rev.B you have the ability to make an assembly between the to and have status messages and current temperature value displayed on the LCD, even when deep sleeping. To enable this feature of the End Device demo just uncomment "USING\_MOD\_LCD1x9" in 'main.c'.

Please read README.txt in demo source folder for more details.

## ORDER CODE

**MOD-ZIGBEE** assembled and tested.

How to order?

You can order to us directly or by any of our distributors.

Check our web <https://www.olimex.com/> for more info.

### Revision history:

REV. Initial	- created March 2011
Rev. B	- created January 2013