Ten X Technology, Inc.

USB Ember ZigBee Module

Operational Manual

Ten X Technology, Inc.
Project 763

By: Jack Little
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Module Overview

The modules will communicate using a 2.4GHz carrier frequency. The modules will be capable of operating in a variety of computing environments to allow integration into a variety of systems. The following modes of operation will be supported:

USB ZigBee Network mode – in this mode the USB interface is used to communicate to an on-board uP that is running a IEEE 802.15.4 compliant IP stack

Safety Information

FCC

Any modifications to this product not expressly approved by Ten X Technology Inc. may violate the rules of the Federal Communications Commission and make operation of the product unlawful.

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 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.

Industry Canada

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

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Hardware

USB to UART Bridge (CP2103)

The CP2103 is a highly integrated USB-to-UART Bridge Controller providing a simple solution for updating RS-232/RS-485 designs to USB. The CP2103 includes a USB 2.0 full-speed function controller, USB transceiver, oscillator, EEPROM, and synchronous serial data bus (UART) with full modem control signals. The on-chip EEPROM may be used to customize the USB Vendor ID, Product ID, Product Description String, Power Descriptor, Device Release Number, and Device Serial Number as desired for OEM applications.

The CP2103 UART interface implements all RS-232/RS-485 signals, including control and handshaking signals, but the design does not support hardware flow control

Processor (ATMega128L)

The ATMegaXXX is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. The ATmegaXXX provides the following features:

- 128K Bytes of In-System Reprogrammable Flash (ATMega128)
- 256K Bytes of In-System Reprogrammable Flash (ATMega256)
- 4K Bytes EEPROM
- 4K Bytes SRAM
- SPI Interface
- Software Selectable Clock Frequency
- 2-wire Serial Interface

The MCU communicates with the USB Interface via the RS-232 connection. All commands from the Host Computer to the processor are via the USB bus that are converted to RS-232 in the USB Interface and then passed to the processor. The processor then executes code that controls Radio chip.

The signal assignment on the Processor chip for the control of the Radio chip is defined in the following Table:

Processor Pin #	Processor pin Name	Function name
27	PD2/INT2/RXD1	Transmit data from USB chip
28	PD3/INT3/TXD1	Transmit data to USB chip
29	PD4	SFD signal from Radio

30	PD5	CCA signal from Radio
32	PD7	NRESET signal to Radio
10	PB0/SS	SPI Chip Select to Radio
11	PB1/SCK	SPI Clk to Radio
12	PB2/MOSI	SPI MOSI to Radio
13	PB3/MISO	SPI MISO from Radio
15	PB5	VREG_EN to Radio
6	PE4/INT4	FIFOP_INT from Radio
7	PE5/INT5	FIFO_INT from Radio
2	PE0/RXD0	RXD0/PDI from Programming Port
3	PE1/tXD0	TXD0/PDI to Programming Port

Radio Chip (EM2420™)

IEEE 802.15.4 compliant RF transceiver designed for low-power and low-voltage wireless applications. The EM2420 ™ includes a digital direct sequence spread spectrum baseband modem and an effective Data rate of 250 kbps. The EM2420 ™ chip is only available from Ember with a licensed Ember networking stack and is targeted to approved 8-bit processors.

The EM2420™ is a short range, low power, 2.4 – 2.4835 GHz Direct Sequence Spread Spectrum transceiver which contains a complete 802.15.4 physical layer (PHY) modem designed for the IEEE 802.15.4 wireless standard supporting star and mesh networking. When combined with the ATMega128L microcontroller (MCU), the EM2420 ™ provides a cost effective solution for short-range data links and networks. Interface with the MCU is accomplished utilizing a four-wire serial peripheral interface (SPI) connection. The software and processor can be scaled to fit the application from simple point-to-point proprietary systems to ZigBee™ networking.

The transceiver includes a low noise amplifier, 1.0 mW PA, VCO and full spread-spectrum encoding and decoding. The device supports 250 kbps O-QPSK data in 5.0 MHz channels, per the IEEE 802.15.4 standard. A Serial Peripheral Interface (SPI) is used for RX and TX data transfer and control to and from the MCU

Features

- Recommended power supply range: 2.1 to 3.6 V (Set to 3.0v)
- 16 Channels
- 0 dBm (Typical) output power

- Link Quality and Clear Channel Assessment capability
- Buffered Transmit and Receive Data Packet Random Access Memory (RAM)
- Supports 250 kbps O-QPSK Data in 5.0 MHz Channels and Full Spread-Spectrum
- Encode and Decode (Compatible with IEEE Standard 802.15.4)
- RX sensitivity of -94 dBm (Typical) at 1.0% Packet Error Rate
- Seven General Purpose Input/Output ports (GPIO)
- 16.0 MHz external Oscillator with internal VCO to generate the Output Freq
- Operating Temperature Range: -40°C to 85°C

Transmitter/Receive Path Description

The EM2420 ™ has differential RF inputs and outputs. These are connected to a chip baluns to convert to a 50-ohm transmission line interface to a single ended chip antenna. RF-P and RF-N require a DC connection to the TXRX_SWICH signal. In RX mode the TXRX_SWITCH pin is at ground and will bias the LNA. In TX mode the TXRX_SWITCH pin is at supply rail voltage and will properly bias the internal PA.

Receive Path Description

In the receive signal path, the RF input is converted to low IF In-phase and Quadrature (I & Q) signals through two down conversion stages. A Clear Channel Assessment (CCA) can be performed based on the baseband energy integrated over a specific time interval. The digital back end performs Differential Chip Detection (DCD); the correlator de-spreads the Direct Sequence Spread Spectrum (DSSS) Offset QPSK (O-QPSK) signal, determines the symbols and packets, and detects the data.
The preamble, SFD, and frame length are parsed and used. A two-byte FCS is calculated on the incoming data and is compared to the value appended to the transmitted data, generating a Cyclical Redundancy Check (CRC).

Transmit Path Description

The transmit path is the exact reverse of the receive path. The data stored in RAM is retrieved or clocked in via the SPI, formed into packets per the 802.15.4 PHY, spread, and then up converted to the transmit frequency.

Output Power Programming

The RF output power of the device is programmable and is controlled by the TXCTRL.PA_LEVEL register. The table shows the output power for different settings, including the complete programming of the TXCTRL control register. The typical current consumption is also shown.

1. PA_LEVEL	2. TXCTRL register	3. Output Power [dBm]	4. Current Consumption [mA]
31	0xA0FF	0	17.4
27	0xA0FB	-1	16.5
23	0xA0F7	-3	15.2
19	0xA0F3	-5	13.9
15	0xA0EF	-5	12.5
11	0Xa0EB	-10	11.2
7	0xA0E7	-15	9.9
3	0xA0E3	-25	8.5

Table: Output power settings and typical current consumption @ 2.45 GHz

Interfacing With an MCU

The SPI connections to the MCU include CE, MOSI, MISO and SPICLK. Commands from processor is sent and received via these 4 pins. The SPI can run at any frequency of 8 MHz or less.

The RF_VREG_EN line is driven by a GPIO from the MCU and is used to enable the Voltage regulator in the EM2420 ™ is in the power down mode.

RF_FIFO__INT and RF_FIFOP_INT are used to indicate the status of the transmitter and receiver FIFOs.

RF_CCA signal is interface for Clear Channel assessment. The CCA signal is valid when the receiver has been enabled for at least 8 symbol periods.

SFD signal is interface for timing information.

Clocks

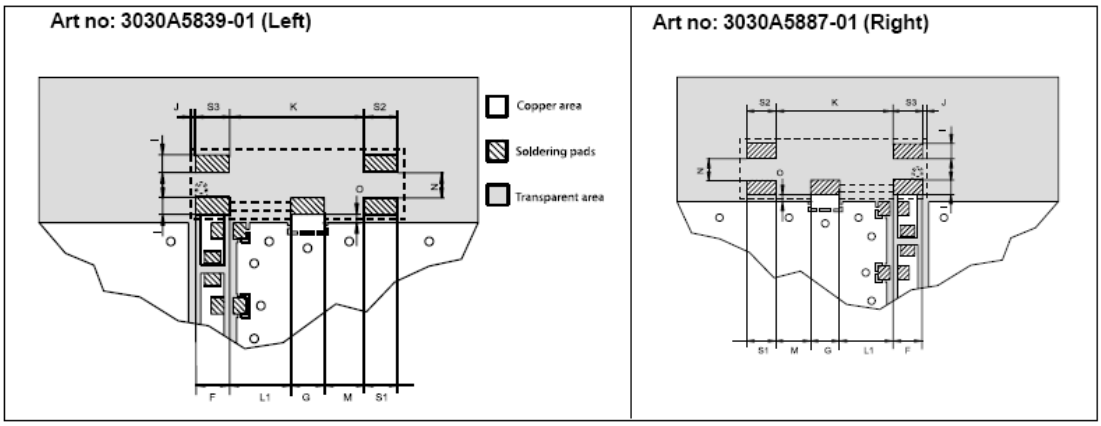
The EM2420 ™ uses a 16 MHz crystal oscillator as the reference oscillator for the system.

Antenna

The antenna is a SMD device that mounts on the module board.

The Rufa antenna is intended for use with all 2.4 GHz applications. The antenna requires a groundplane i.e the module acts as an active part of the antenna. The module contains a complete ground plane except for area that is specified as keep out areas for the antenna. See Foot Print, the Module uses the Left entry.

9. ANTENNA FOOT PRINT



G	F	S1	S2	S3	I	J	K	L1	M	N	O
Ground	Feed	Solder									
2.0±0.1	2.0±0.1	2.0±0.1			1.0±0.1	0.25±0.1	8.1±0.1	3.7±0.1	2.4±0.1	1.3±0.1	0.3±0.15
Dimensions in milimeters											

Electrical Characteristic

Operating Temperature: -40° to +85° C
Input Voltage: 4.0V to 5.25V