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RF-Modem II

Theory of Operation

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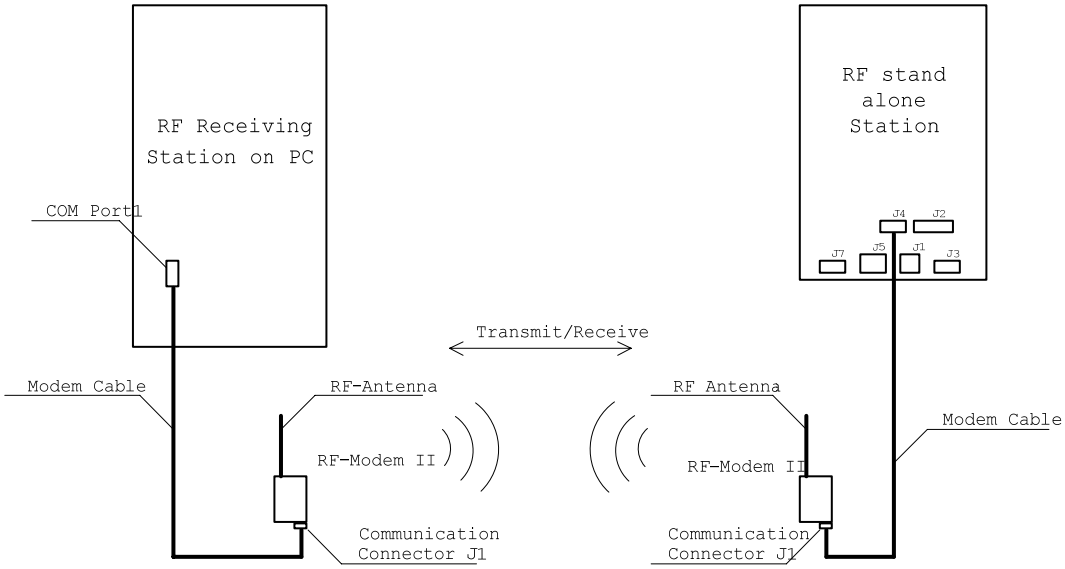
Applications

The RF-Modem-II is used as 433MHz transceiver for wireless communications data logger and control systems.

The System operates on radio frequency communication between the systems RF Stand alone Control Unit and the Management PC.



The unit transmits digital (control and information) data to the main data logger pc.

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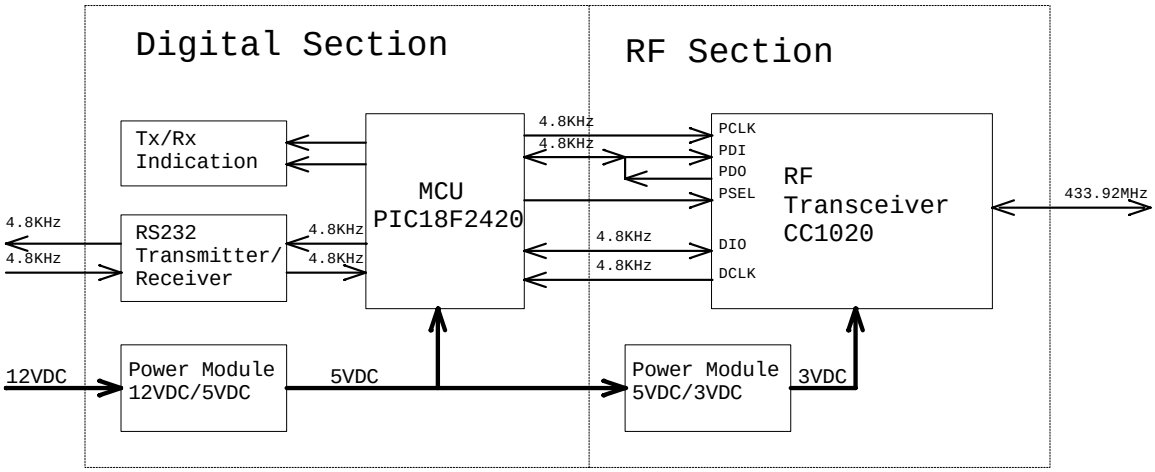
Principles of Operation

The RF-Modem-II is based on Texas Instruments CC1020 UHF transceiver with TI recommended external passive RF components.

CC1020 is a true single-chip UHF transceiver designed for very low power and very low voltage wireless applications and suited for narrow-band systems.

The RF-Modem-II includes CC1020 together with a Microchip's MCU like PIC18F2420 which provides CC1020 programming and data exchange between transceiver and microcontroller. At the other hand, MCU provides RS232 Communications between RF-Modem-II and external units like Management PC and other source unit.

RF-Modem-II block Diagram.



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RF Circuit Description

CC1020 UHF transceiver includes a low-IF receiver. The received RF signal is amplified by the low-noise amplifier (LNA and LNA2) and down-converted in quadrature (I and Q) to the intermediate frequency (IF). At IF, the I/O signal is complex filtered and amplified, and then digitized by the ADCs. Automatic gain control, fine channel filtering, demodulation and bit synchronization is performed digitally. CC1020 outputs the digital demodulated data on the DIO pin. A synchronized data clock is available at the DCLK pin. RSSI is available in digital format and can be read via the serial interface. The RSSI also features a programmable carrier sense indicator.

In transmit mode, the synthesized RF frequency is fed directly to the power amplifier (PA). The RF output is frequency shift keyed (FSK) by the digital bit stream that is fed to the DIO pin.

The frequency synthesizer includes a completely on-chip LC VCO and a 90 degrees phase splitter for generating the LO_I and LO_Q signals to the down-conversion mixers in receive mode. The CHP_OUT pin is the charge pump output and VC is the control node of the on-chip VCO. The external loop filter is placed between these pins. A crystal is to be connected between XOSC_Q1 and XOSC_Q2. A lock signal is available from the PLL.

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Microcontroller Interface

CC1020 interfaces to a microcontroller through two serial interfaces. Using ones microcontroller is able to:

• Program CC020 into different modes via the 4-wire serial configuration interface (PDI, PDO, PCLK and PSEL)

• Interface to the bi-directional synchronous data signal interface (DIO and DCLK)

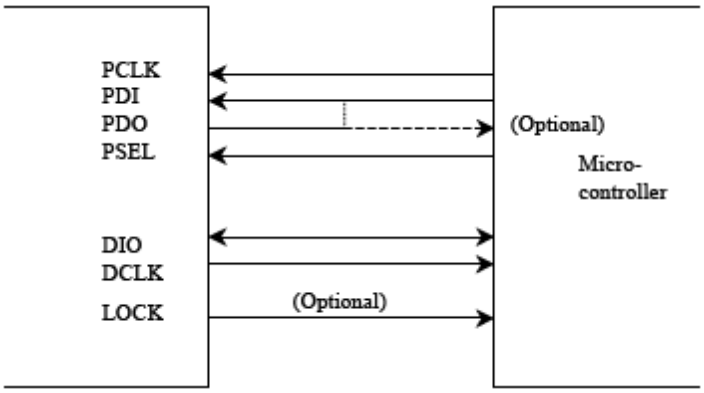
• Optionally, the microcontroller can do data encoding / decoding

• Optionally, the microcontroller can monitor the LOCK pin for frequency lock status, carrier sense status or other status information.

• Optionally, the microcontroller can read back the digital RSSI value and other status information via the 4-wire serial interface

The microcontroller uses 3 or 4 I/O pins for the configuration interface (PDI, PDO, PCLK and PSEL). PDO should be connected to a microcontroller input. PDI, PCLK and PSEL must be microcontroller outputs. One I/O pin can be saved if PDI and PDO are connected together and a bi-directional pin is used at the microcontroller.

The microcontroller interface is shown below.



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Embedded and PC Software

Stand alone unit with embedded software is used for data monitoring, recording and downloading to the RF-Modem-II unit on the Stand alone side for the further transmitting to the Management PC.

At the other hand, Management PC with software called “PC Receiving Station” is used for data receiving from the RF-Modem-II unit on the PC side.
Then data received this way is used for global data monitoring, processing, billing and system analysis for Management purposes.

Embedded stand alone and PC software allows setting the modem parameter such as: type of operation, receiving/transmitting digital data with FSK (Frequency Shift Keying), modulation and NRZ (Non-Return-to-Zero) Data format.
Communication data rate is 4,8kBaud, duration of each transmission and silent period between each transmission.

The transmission duration and silent periods are limited to be less than 1 second and 30 sec correspondingly

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Configuration Overview

CC1020 is configured to achieve optimum performance. Through the programmable configuration registers the following key parameters are programmed:

• Receive / transmit mode

• RF output power

• Frequency synthesizer key parameters: RF output frequency, FSK frequency separation, crystal oscillator reference frequency

• Power-down / power-up mode

• Crystal oscillator power-up / power-down

• Data rate and data format (NRZ, Manchester coded or UART interface)

• Synthesizer lock indicator mode

• Digital RSSI and carrier sense

• FSK / GFSK / OOK modulation

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PCB Layout and Ground system

The bottom layer is designed for RF-signal layout without any vias. The area under the CC1020 chip is used for grounding and is connected to the internal RF-ground plane with several vias. In the RF-Modem-II design 9 vias are placed inside the CC1020 exposed die attached pad.

Each decoupling capacitor is placed close to the supply pin it is supposed to decouple. Each decoupling capacitor is connected to the power plane by separate via. The routing is carried out from the power plane to the decoupling capacitor and then to the CC1020 supply pin. Supply power filtering is used for CC1020 pins 23, 22, 20 and 18.

Each decoupling capacitor ground pad is connected to the ground plane using a separate via.
The external RF components are mostly 0402-sized and surface mount devices.
In order to avoid noise interfering with the RF circuitry microcontroller has its own digital grounding plane connected to the RF-grounding plane through the 0R jumpers.