1 Theory of Operation

1.1 Transceiver Front-End

The MC1320x RF transceiver has an RF front-end, which can be configured in two ways:

- Single-port I/O with integral RX/TX switch — allows for very few external components. This is the solution that is utilized on the 13202-RFD.
- Dual port with separate RX input/TX output and external switch — allows for an external LNA and/or PA. (Also allows for an external low-loss RX/TX switch.).

Changing between single-port and dual-port modes is software controlled.

1.2 DC Biasing

To ensure correct operation, the inputs and outputs should have the following bias:

- RX inputs: Grounded.
- TX outputs: Connected to VDDA

This is handled automatically by the CT_Bias pin 3, such that DC bias is enabled during transmission and disabled during receive.

The DC bias path is through the balun Z101 and matching network L101 – L103.

1.3 RF Matching

The differential output impedance of the MC1320x is approximately 300-450 ohms and 0.6 pF in parallel. The impedance is slightly different between RX and TX.

An LC-matching network steps the impedance down to 50 Ohms balanced and a small ceramic balun allows the differential to single-ended transformation. A 50:50 ohm balun is used.

Although the best component values are slightly different for RX and TX, only one intermediate match L101 – L103 can be used to accommodate highest dynamic range between transmit power and receive sensitivity. Optimum procedure is to match for best RX and TX individually and then search for common components that provide acceptable performance for both modes.

The low-pass LC network configuration L104 and C113 reduces TX harmonics.

The center tap on the balun provides DC ground for the RX input pins and biases the TX output pins to VDDA as described in section 1.2 DC Biasing. The TX balun is RF decoupled by C112.

By desolder/solder a 0 ohm resistor to another position, it is possible to select between the on-board F-antenna or the SMA connector (J100). The SMA connector may only be used for conducted RF measurements.

1.4 On-Board Antenna

For ease of use, a PCB F-antenna resides on the board. The antenna bandwidth measured an approximate –10 dB return loss point at approximately 350 MHz. The resonant frequency is 2.44 GHz.

- Return loss across the ISM band is better than –15 dB
- The radiation pattern is omnidirectional and is very efficient
- The antenna is enabled (default)

1.5 Power Supply

The 13202-RFD is configured to use a 3.3 – 5.0V supply without problems by means of the on-board regulator IC102. Please note that interface logic levels will always be at 3.3V, which applies to the 13202-RFD intended usage.

The MC1320x has built in voltage regulators for the internal RF circuits (1.8V nominal). RF performance is not affected by varying supply voltage and the regulators provide some noise suppression allowing less stringent supply requirements.

1.6 Reference Oscillator

The MC1320x reference oscillator is a very low power oscillator to save battery consumption in Sleep and Doze Modes.

The current consumption is controlled by software. The default value is 12 µA. In Doze Mode, it is possible to lower the current to 6 µA, but this sets tighter requirements on the XTAL to ensure oscillation.

The Reference frequency is 16.000 MHz only. CLK0 supplies the MCU on the host board with a clock through J101 or J102.

To fulfill the 802.15.4 Standard requirements, the reference frequency must be within ± 40 ppm of nominal. This includes the following:

- Initial tolerance
- Aging

- Crystal temperature drift
- Spread on the external loading capacitors

The MC1321x has a built-in trimming facility that allows the initial tolerance to be calibrated out during production.

For –10 to 60 °C operation, the following crystal is recommended:

- KDS ZD00882

For –40 to +85 °C operation, the following crystals are recommended:

- NDK (LN-G102-1341)
- Toyocom (OUT1-2B-4395)
- KDS (ZD01812)

NOTE
Some of these crystals require different values of the external loading capacitors to center the frequency.

1.7 TX Power

The output power is software adjustable with a tuning range of more than 20 dB.

The default power setting (Register 12: BC) is -1 dBm. This is a slight compromise between output power and current consumption. The obtainable maximum output power is 3 dBm. This setting assumes a higher current consumption can be tolerated.

Tolerance: ±1 dBm

The 802.15.4 Standard requirement is greater than -3 dBm.

1.8 Harmonics

2nd harmonic is typically -40 dBm or lower.

3rd harmonic is low, but does not exceed -60 dBm.

The 802.15.4 Standard requirement is less than -30 dBm

1.9 RX Sensitivity

Sensitivity was measured at -95 dBm, ±2 dBm (1% PER, 20 byte payload).

The 802.15.4 Standard requirement is less than -85 dBm.