lamaPLC Communication: NRF24

nRF2401 is a single-chip radio transceiver for the world wide 2.4 - 2.5 GHz ISM band. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator and a modulator. Output power and frequency channels are easily programmable by use of the 3-wire serial interface. Current consumption is very low, only 10.5mA at an output power of -5dBm and 18mA in receive mode. Built-in Power Down modes makes power saving easily realizable.

Technical data

- True single chip GFSK transceiver in a small 24-pin package (QFN24 5x5mm)
- Data rate 0 to 1 Mbps
- Only 2 external components
- Multi channel operation
  - 125 channels
  - Channel switching time <200µs
  - Support frequency hopping
- Data slicer / clock recovery of data
- Address and CRC computation
- DuoCeiver™ for simultaneous dual receiver topology
- ShockBurst™ mode for ultra-low power operation and relaxed MCU performance
- Power supply range: 1.9 to 3.6 V
- Low supply current (TX), typical 10.5mA peak @ -5dBm output power
- Low supply current (RX), typical 18mA peak in receive mode
- 100% RF tested
- No need for external SAW filter
- World wide use

Operational Modes

You can configure the RF transceiver to power down, standby, RX and TX mode. This section describes these modes in detail.

RX mode

The RX mode is an active mode where the RF transceiver is used as a receiver. To enter this mode, the RF transceiver must have the *PWR_UP* bit, *PRIM_RX* bit and the rfce bit is set high.

In RX mode the receiver demodulates the signals from the RF channel, constantly presenting the demodulated data to the baseband protocol engine. The baseband protocol engine constantly

searches for a valid packet. If a valid packet is found (by a matching address and a valid CRC) the payload of the packet is presented in a vacant slot in the RX FIFOs. If the RX FIFOs are full, the received packet is discarded.

The RF transceiver remains in RX mode until the MCU configures it to standby-I mode or power down mode. However, if the automatic protocol features (Enhanced ShockBurst™) in the baseband protocol engine are enabled, the RF transceiver can enter other modes in order to execute the protocol.

In RX mode a *Received Power Detector* (**RPD**) signal is available. The RPD is a signal that is set high when a RF signal higher than -64 dBm is detected inside the receiving frequency channel. The internal RPD signal is filtered before presented to the RPD register. The RF signal must be present for at least 40µs before the RPD is set high.

RX mode

The TX mode is an active mode for transmitting packets. To enter this mode, the RF transceiver must have the PWR_UP bit set high, PRIM_RX bit set low, a payload in the TX FIFO and a high pulse on the rfce bit for more than 10 µs.

The RF transceiver stays in TX mode until it finishes transmitting a packet. If rfce = 0, RF transceiver returns to standby-I mode. If rfce = 1, the status of the TX FIFO determines the next action. If the TX FIFO is not empty the RF transceiver remains in TX mode and transmits the next packet. If the TX FIFO is empty the RF transceiver goes into standby-II mode. The RF transceiver transmitter PLL operates in open loop when in TX mode. It is important never to keep the RF transceiver in TX mode for more than 4ms at a time. If the Enhanced ShockBurst™ features are enabled, RF transceiver is never in TX mode longer than 4 ms.

Air data rate

The air data rate is the modulated signaling rate the RF transceiver uses when transmitting and receiving data. It can be 250 kbps, 1 Mbps or 2 Mbps. Using lower air data rate gives better receiver sensitivity than higher air data rate. But, high air data rate gives lower average current consumption and reduced probability of on-air collisions.

The air data rate is set by the *RF_DR* bit in the *RF_SETUP* register. A transmitter and a receiver must be programmed with the same air data rate to communicate with each other. The RF transceiver is fully compatible with nRF24L01. For compatibility with nRF2401A, nRF2402, nRF24E1, and nRF24E2 the air data rate must be set to 250 kbps or 1 Mbps.

RF channel frequency

The RF channel frequency determines the center of the channel used by the RF transceiver. The channel occupies a bandwidth of less than 1 MHz at 250kbps and 1Mbps and a bandwidth of less than 2 MHz at 2Mbps. The RF transceiver can operate on frequencies from 2.400 GHz to 2.525 GHz. The programming resolution of the RF channel frequency setting is 1 MHz.

At 2Mbps the channel occupies a bandwidth wider than the resolution of the RF channel frequency setting. To ensure non-overlapping channels in 2Mbps mode, the channel spacing must be 2 MHz or

more. At 1Mbps and 250kbps the channel bandwidth is the same or lower than the resolution of the RF frequency. The RF channel frequency is set by the *RF_CH* register according to the following formula:

F_0= 2400 + *RF_CH* MHz

You must program a transmitter and a receiver with the same RF channel frequency to communicate with each other.

Sources

Nordic Semiconductor: nRF24LE1 Product Specification v1.6

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Page	Date	Tags
• ISM Band	2025/11/10 18:53	ism, ism band, rfid, nfc, dash7, hc-12, arduino, zigbee, z-wave, bluetooth, wi-fi, thread, miwi, nrf24, starlink, wiegand, rf, communication, bus, radio, ku band, ka band, k band, x band
• lamaPLC Communication: NRF24	2024/11/16 01:26	bus, communication, nrf24, ism, ism band, gfsk, rpd, arduino

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This page has been accessed for: Today: 1, Until now: 1

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Last update: **2024/11/16 01:26**