Low Power Ultra Long Range Transceiver

General Description

The NB-Fi(v1) transceiver feature fully integrated single-chip programmable NB-Fi modem that provides long range communication (10+ km in urban area) with ultra-low power consumption for Internet of Things / LPWAN applications.

Operates in the 430 - 500 MHz and 860 - 925 MHz frequency ranges.

Supports high performance NB-Fi protocol (50 - 25600 bit/sec data rates) with exceptional receiving sensitivity up to -148 dBm.

Complies with European (ETSI EN 300-220 V2.1.1) and North American (FCC part 15.247 and 15.249) regulations.

Key Product Features

- NB-Fi Modem
- Modulation Type DBPSK
- Data Transfer Speeds Supported: 50, 100, 400, 3200, 25600 bit/sec
- Half Duplex (TDD)
- Receiver Sensitivity -148 dBm
- Max Output power 15 dBm
- Frequencies Supported:
  - 430 MHz - 500 MHz
  - 860 MHz - 925 MHz
- Total RX Bandwidth 200 kHz
- Total TX Bandwidth 200 kHz
- Single Channel Bandwidth 50-25600 Hz
- Ultra-low Power Consumption:
  - 50 mA in TX Mode
  - 12 mA in RX Mode
  - 1 µA in Deep Sleep Mode
- Slave SPI Interface
- Max RX Gain 70 dB
- Adjacent Channel Suppression 80 dB

Applications

- Automatic meter reading (AMR)
- Wireless alarm and security systems
- Industrial monitoring and control
- Wireless sensor networks
- Smart Agriculture

Ordering Information

Part Number	Delivery	MOQ / Multiple
NB-Fi(v1)	T&R	48 000 pcs
SDR Node	BOX	1 pcs
NB-Fi Evaluation Kit (2 RF and controller boards with PCB antennas and wiring)	BOX	1 pcs

- QFN 32 5x5 mm Package. Operating Range from -40 to +85°C
- Pb-free, Halogen free, RoHS/WEEE compliant product

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The NB-Fi Transceiver simplified Block Diagram

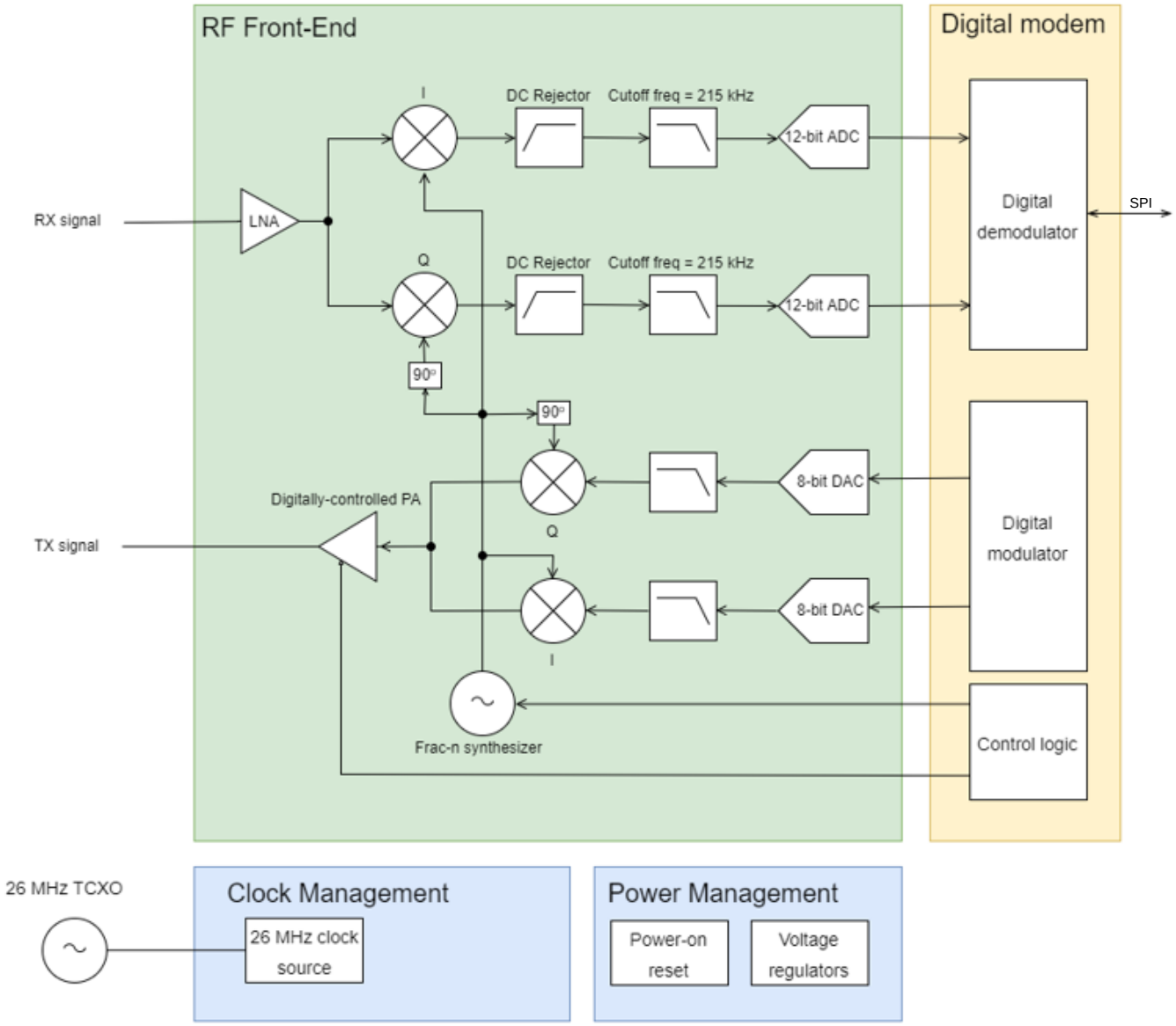

Figure 1: NB-Fi Transceiver Simplified Block Diagram

PIN Diagram

The following diagram shows the pin arrangement of the QFN package, top view.

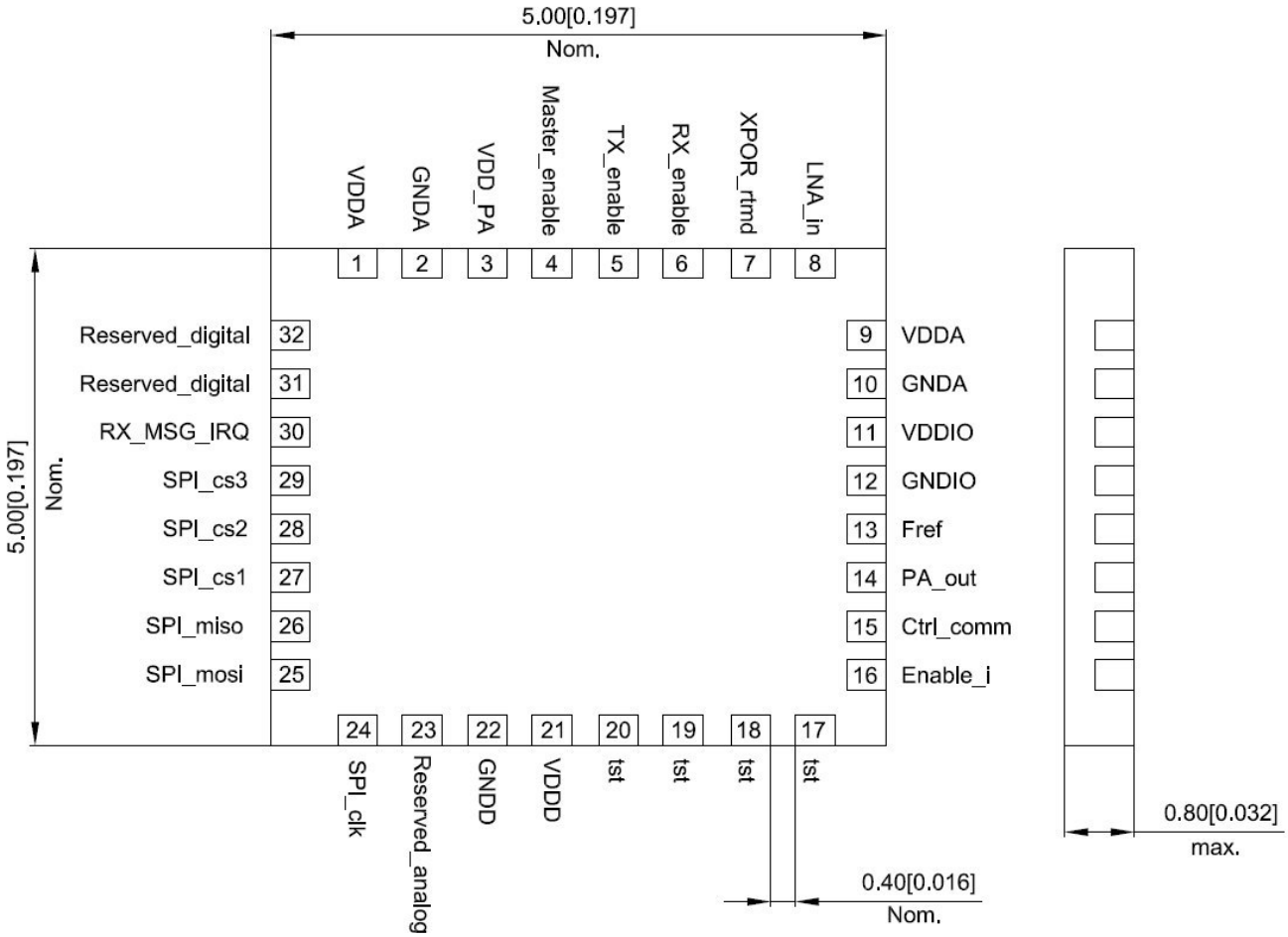

Figure 2: PIN Diagram

PIN Description

Symbol	Pin(s)	Type	Description
VDDA	1	P	Analog power
GNDA	2	P	Analog ground
VDD_PA	3	P	Optional external PA voltage supply
Master_enable	4	I	Enable control of the whole IP. Active low
TX_enable	5	I	Enable control of transmitter. Active low
RX_enable	6	I	Enable control of receiver. Active low

Symbol	Pin(s)	Type	Description
XPOR_rtmd	7	O	XPOR signal to reset the local digital of the transceiver, this is retimed/gated version of XPOR signal of the IP
LNA_in	8	I	LNA differential inputs from the external balun
VDDA	9	P	Analog power
GNDA	10	P	Analog ground
VDDIO	11	P	I/O power
GNDIO	12	P	I/O ground
Fref	13	I	The frequency synthesizer (PLL) reference clock at 26 MHz
PA_out	14	O	Power amplifier output
Ctrl_comm	15	I	Communication lines for setting control bits of the transceiver
Enable_i	16	I	System enable input. The SPI will function only if this pin is asserted. Active low
tst	17-20	-	Test pins
VDDD	21	P	Digital power
GNDD	22	P	Digital ground
Reserved_analog	23	-	TBD
SPI_clk	24	I/O	SPI clock
SPI_mosi	25	I/O	Slave serial data input
SPI_miso	26	I/O	Slave serial data output
SPI_cs1	27	I/O	SPI chip select 1
SPI_cs2	28	I/O	SPI chip select 2
SPI_cs3	29	I/O	SPI chip select 3
RX_MSG_IRQ	30	O	Message available
Reserved_digital	31	-	TBD
Reserved_digital	32	-	TBD

Table 1: PIN Description

Electrical Characteristics

ESD Notice

The NB-Fi(v1) is a high-performance radio frequency device.

It satisfies:

Class II of the JEDEC standard JESD22-A114-B (Human Body Model) on all pins;

Class III of the JEDEC standard JESD22-C101C (Charged Device Model) on all pins.

It should thus be handled with all the necessary ESD precautions to avoid any permanent damage.

Absolute Maximum Ratings

Stresses above the values listed below may cause permanent device failure. Exposure to absolute maximum ratings for extended periods may affect device reliability.

Parameter	Description	Min	Max	Unit
VDD	Supply Voltage	-0.5	3.9	V
Tmr	Temperature	-55	+115	C
Tj	Junction temperature	-	+125	C

Table 2: Absolute Maximum Ratings

Operating Range

Stresses above the values listed below may cause permanent device failure. Exposure to absolute maximum ratings for extended periods may affect device reliability.

Parameter	Description	Min	Max	Unit
VDDop	Supply Voltage	1.8	3.7	V
Top	Operational temperature range	-40	+85	C
Clop	Load capacitance on digital ports	-	25	pF
ML	RF Input Level	-	+10	dBm

Table 3: Operating Range

The NB-Fi standard overview

The NB-Fi standard is developed to establish wireless data exchange network between multiple end-user devices (utility meters with AMR, radio modems, etc.) on the one side, and multiple gateways on the other side, with further data integration in the unique server environment.

Set of all the end-user devices and gateways, connected to the single server allows to efficiently organize data exchange with different "cloud" services, which is basically what the increasingly popular concept "Internet of Things" means.

NB-Fi is a LPWAN[1] standard characterized by high data transmission energy efficiency and high network capacity, which permits to use it for construction of telemetric systems with high number of subscribers. The high energy efficiency allows to use non-licensed frequency ranges with limits for the transmitter power.

The standard is based on the use of ultra-narrow band (UNB) phase-shift signals, which, combined with antinoise coding, allow to reach very high reception sensitivity values (up to -148 dBm). In this case, the total frequency band for the simultaneous transfer of large number of channels should be rather narrow.

To receive uplink (UL) data packets by the gateway, the SDR (software-defined ratio) system principle is applied, where the input radio signal is being digitalized through all the reception band and then undergoes the software processing. This allows to demodulate and decode incoming data packets simultaneously on all the channels and through all the frequency band. Basically, this system does not have any channel network, and the data packet is received by the gateway regardless of the frequency at which the sending has been performed. This is the key standard feature permitting to use cheap frequency generators to form radio signal, which in past was a constraint factor when using UNB signals.

Due to the use of simple modulation types, the UL packets may be formed by means of almost any serial integral transceiver. The UL packet reception is possible only by the gateway. Therefore, in order to implement the downlink (DL) data packet transfer without NB-Fi Transceiver, the modulation and transfer speed options are used which are supported by the specific transceiver used in the end devices.

The NB-Fi network uses the star topology, similarly to mobile networks. In this architecture, the node elements (gateways) should perform simultaneous reception and transmission of multiple channels. To perform the transmission of multiple channels, the gateway output capacity should be increased. Operation in the non-licensed frequency ranges limits the transmitter output capacity, including, the one of the gateway. Therefore, for all the LPWAN networks, the conceptual problem is limitation of the downlink channel throughput capacity. In some countries the permitted frequency ranges are determined allowing operations at increased capacity. To some extent, it allows to solve the aforementioned problem.

Hence, without NB-Fi Transceiver, the NB-Fi standard is applicable for telemetric systems with prevailing uplink data transfer (from the devices to the server). The reverse channel is aimed for the network service data transfer (packet delivery acknowledgement, connection speed regulation) and for sending data necessary for device operation mode configuration and modification.

[1] LPWAN – Low-power Wide-area Network

NB-Fi Transceiver implementing the possibility of UL packet reception and transmission at the hardware level. This will allow to implement symmetric characteristics of the physical layer (use UL packets for data transfers in both directions), as well as organize peer-to-peer data transfer modes.

The NB-Fi standard describes the following layers according to the OSI network model:

- Layer 1: Physical Layer
- Layer 2: MAC (channel) Layer
- Layer 3: Transport Layer
- Layer 4: Presentation Layer

The main technical characteristics of the NB-Fi standard (Physical Layer)

Transmitter packets characteristics	
Modulation type	DBPSK
Data transfer speed for the radio channel	50, 400, 3200, 25600 bit/sec
Channel split method	Frequency
Number of simultaneously received channels for the speed of 50 bit/sec	1024
Number of simultaneously received channels for the speed of 400 bit/sec	128
Reception ultimate capacity of one gateway	20 MB/24 h

The main technical characteristics of the NB-Fi standard (MAC Layer)

Network numbering capacity:	16 mln devices
Effective data transfer speeds	11, 89, 711, 5688 bit/sec
Antinoise coding	ZIGZAG code
Antinoise coding speed	1/2
Payload length per package	8 bytes

The Transport and Presentation Layers are implemented in the software libraries of the NB-Fi standard. The full description of each layer is available on the web-site www.nb-fi.org for the registered members of the NB-Fi alliance.

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