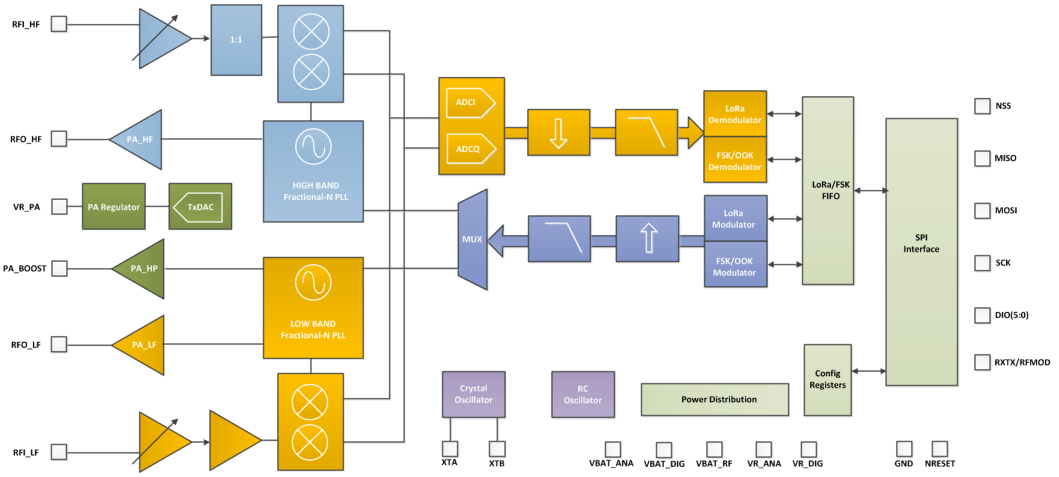
WIRELESS, SENSING & TIMING DATASHEET

SX1276/77/78/79 - 137 MHz to 1020 MHz Low Power Long Range Transceiver



GENERAL DESCRIPTION

The SX1276/77/78/79 transceivers feature the LoRa™ long range modem that provides ultra-long range spread spectrum communication and high interference immunity whilst minimising current consumption.

Using Semtech's patented LoRa™ modulation technique SX1276/77/78/79 can achieve a sensitivity of over -148dBm using a low cost crystal and bill of materials. The high sensitivity combined with the integrated +20 dBm power amplifier yields industry leading link budget making it optimal for any application requiring range or robustness. LoRa™ also provides significant advantages in both blocking and selectivity over conventional modulation techniques, solving the traditional design compromise between range, interference immunity and energy consumption.

These devices also support high performance (G)FSK modes for systems including WMBus, IEEE802.15.4g. The SX1276/77/78/79 deliver exceptional phase noise, selectivity, receiver linearity and IIP3 for significantly lower current consumption than competing devices.

ORDERING INFORMATION

Part Number	Delivery	MOQ / Multiple
SX1276IMLTRT	T&R	3000 pieces
SX1277IMLTRT	T&R	3000 pieces
SX1278IMLTRT	T&R	3000 pieces
SX1279IMLTRT	T&R	3000 pieces

- QFN 28 Package - Operating Range [-40;+85°C]
- Pb-free, Halogen free, RoHS/WEEE compliant product

KEY PRODUCT FEATURES

- LoRa™ Modem
- 168 dB maximum link budget
- +20 dBm - 100 mW constant RF output vs. V supply
- +14 dBm high efficiency PA
- Programmable bit rate up to 300 kbps
- High sensitivity: down to -148 dBm
- Bullet-proof front end: IIP3 = -11 dBm
- Excellent blocking immunity
- Low RX current of 9.9 mA, 200 nA register retention
- Fully integrated synthesizer with a resolution of 61 Hz
- FSK, GFSK, MSK, GMSK, LoRa™and OOK modulation
- Built-in bit synchronizer for clock recovery
- Preamble detection
- 127 dB Dynamic Range RSSI
- Automatic RF Sense and CAD with ultra-fast AFC
- Packet engine up to 256 bytes with CRC
- Built-in temperature sensor and low battery indicator

APPLICATIONS

- Automated Meter Reading.
- Home and Building Automation.
- Wireless Alarm and Security Systems.
- Industrial Monitoring and Control
- Long range Irrigation Systems

1. General Description

The SX1276/77/78/79 incorporates the LoRa™ spread spectrum modem which is capable of achieving significantly longer range than existing systems based on FSK or OOK modulation. At maximum data rates of LoRa™ the sensitivity is 8dB better than FSK, but using a low cost bill of materials with a 20ppm XTAL LoRa™ can improve receiver sensitivity by more than 20dB compared to FSK. LoRa™ also provides significant advances in selectivity and blocking performance, further improving communication reliability. For maximum flexibility the user may decide on the spread spectrum modulation bandwidth (BW), spreading factor (SF) and error correction rate (CR). Another benefit of the spread modulation is that each spreading factor is orthogonal - thus multiple transmitted signals can occupy the same channel without interfering. This also permits simple coexistence with existing FSK based systems. Standard GFSK, FSK, OOK, and GMSK modulation is also provided to allow compatibility with existing systems or standards such as wireless MBUS and IEEE 802.15.4g.

The SX1276 and SX1279 offer bandwidth options ranging from 7.8 kHz to 500 kHz with spreading factors ranging from 6 to 12, and covering all available frequency bands. The SX1277 offers the same bandwidth and frequency band options with spreading factors from 6 to 9. The SX1278 offers bandwidths and spreading factor options, but only covers the lower UHF bands.

1.1. Simplified Block Diagram

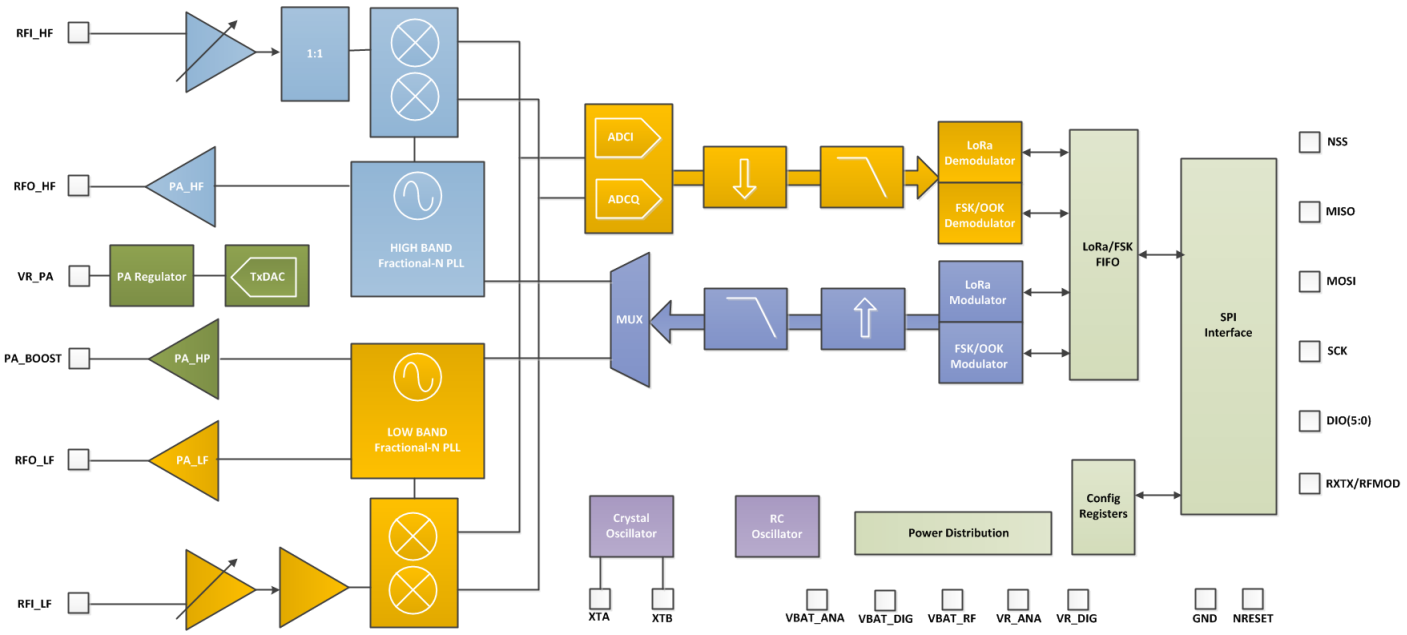


Figure 1. Block Diagram

1.2. Product Versions

The features of the four product variants are detailed in the following table.

Table 1 SX1276/77/78/79 Device Variants and Key Parameters

Part Number	Frequency Range	Spreading Factor	Bandwidth	Effective Bitrate	Est. Sensitivity
SX1276	137 - 1020 MHz	6 - 12	7.8 - 500 kHz	.018 - 37.5 kbps	-111 to -148 dBm
SX1277	137 - 1020 MHz	6 - 9	7.8 - 500 kHz	0.11 - 37.5 kbps	-111 to -139 dBm
SX1278	137 - 525 MHz	6- 12	7.8 - 500 kHz	.018 - 37.5 kbps	-111 to -148 dBm
SX1279	137 - 960MHz	6- 12	7.8 - 500 kHz	.018 - 37.5 kbps	-111 to -148 dBm

1.3. Pin Diagram

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

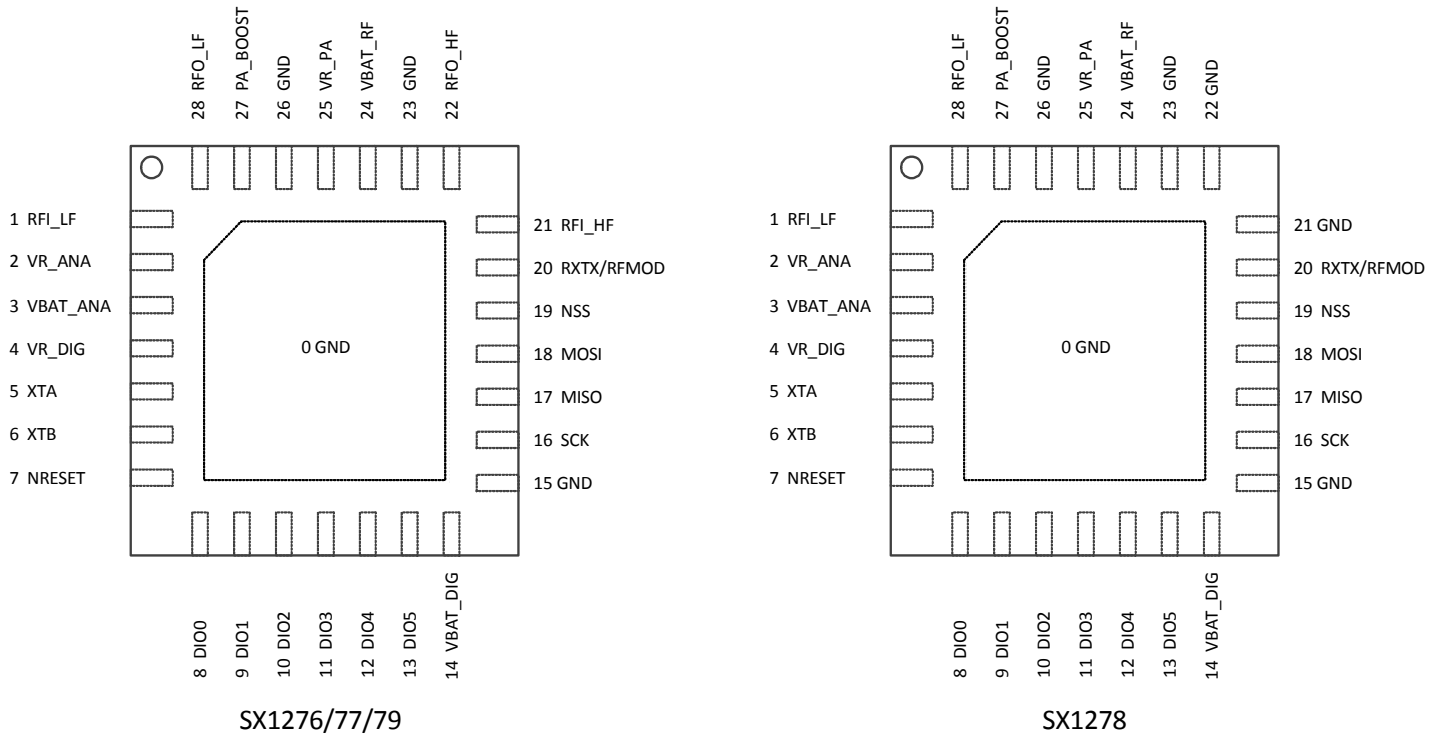


Figure 2. Pin Diagrams

5.5.5. RSSI and SNR in LoRa™ Mode

The RSSI values reported by the LoRa™ modem differ from those expressed by the FSK/OOK modem. The following formula shows the method used to interpret the LoRa™ RSSI values:

RSSI (dBm) = -157 + *Rssi*, (when using the High Frequency (HF) port)

or

RSSI (dBm) = -164 + *Rssi*, (when using the Low Frequency (LF) port)

The same formula can be re-used to evaluate the signal strength of the received packet:

Packet Strength (dBm) = -157 + *Rssi*, (when using the High Frequency (HF) port)

or

Packet Strength (dBm) = -164 + *Rssi*, (when using the Low Frequency (LF) port)

Due to the nature of the LoRa modulation, it is possible to receive packets below the noise floor. In this situation, the SNR is used in conjunction of the PacketRssi to compute the signal strength of the received packet:

Packet Strength (dBm) = -157 + *PacketRssi* + *PacketSnr* * 0.25 (when using the HF port and SNR < 0)

or

Packet Strength (dBm) = -164 + *PacketRssi* + *PacketSnr* * 0.25 (when using the LF port and SNR < 0)

Note:

1. *PacketRssi* (in RegPktRssiValue), is an averaged version of *Rssi* (in RegRssiValue). *Rssi* can be read at any time (during packet reception or not), and should be averaged to give more precise results.

2. The constants, -157 and -164, may vary with the front-end setup of the SX1276/77/78/79 (*LnaBoost* =1 or 0, presence of an external LNA, mismatch at the LNA input…). It is recommended to adjust these values with a single-point calibration procedure to increase RSSI accuracy.

3. As signal strength increases (RSSI>-100dBm), the linearity of PacketRssi is not guaranteed and results will diverge from the ideal 1dB/dB ideal curve. When very good RSSI precision is required over the whole dynamic range of the receiver, two options are proposed:

- *Rssi* in RegRssiValue offers better linearity. *Rssi* can be sampled during the reception of the payload (between ValidHeader and RxDone IRQ), and used to extract a more high-signal RSSI measurement
- When SNR>=0, the standard formula can be adjusted to correct the slope:

RSSI = -157+16/15 * PacketRssi (or RSSI = -164+16/15 * PacketRssi)