

GLOSSARY

RSSI – Received signal strength indicator (RSSI) is a measure of the power present in a received radio signal.

dBm – A unit of measure of the absolute radio power level in decibels scale vs 1mW of power. It means 1 mW is 0 dBm, 10 mW is 10 dBm, 100 mW is 20 dBm, etc...

dB – The measure of the relative difference between 2 radio power levels. This is expressed in log10 scale which is more convenient for such measurements.

DCDC converter – An electronic circuit that provides an output regulated voltage that is different (higher / lower) than its input voltage. In a radio chipset and battery-operated system, its purpose is to convert the battery voltage to a lower regulated level (also called a “buck converter”).

RF balun – This RF circuit filters RF signals (ensuring compliance with local radio regulations such as ETSI, FCC, and ARIB) and performing 50-Ohm adaptation with an antenna connector to ensure optimal RF transmission and reception performance.

PLL – Phase Lock Loop is a circuit that generates the required phase or frequency in a radio system. This is basis of the analog part of a radio transceiver to perform radio modulation & demodulation.

HS XTAL – High-speed crystal oscillator required to provide the reference frequency to the PLL in order to generate the correct RF frequency.

Xtal Ppm – Parts per million frequency inaccuracy of the crystal means the maximum frequency offset of the crystal oscillator. As the Crystal is used to feed the reference frequency to the transceiver PLL, it means that the RF transceiver application is affected by the crystal tolerance. As an example, a ±10ppm Xtal in a 868 MHz radio band leads to maximum ±8.68 kHz deviation from the desired channel frequency.

AFC – Automatic Frequency Compensation is a Receiver feature that measures and corrects a transmitter's frequency offset. Frequency offset is introduced by HS Xtal ppm.

TCXO – Temperature Compensated Crystal Oscillator is a high-speed crystal that has ultra-low frequency variation thanks to temperature measurement & compensation circuitry. This architecture ensures a very accurate frequency regardless of the application temperature.

RO – A ring oscillator is an internal circuit (low-cost vs external 32 kHz crystal oscillator) that is required for low-power management of transceivers. Internal transceiver timers run based on the RO frequency.

PCB antenna – PCB antenna is designed on a printed circuit board using copper lines. Its advantage in terms of cost is that its one-quarter wavelength ensures good RF performance.

50-Ohm adaptation – In RF applications, all measurements are based on 50-Ohm connectors to ensure a reference setup for radio & power consumption measurements. Moreover it eases radio designs with antennas which are close to 50-Ohms impedance.

FSK, OOK modulations – modulations proposed by transceiver include Frequency Shift Keying modulations (FSK) with either 2-frequency (2-FSK) or 4-frequency (4-FSK). GFSK is also defined to smooth binary transitions to ease compliance with local radio regulations (ETSI, FCC, and ARIB). The principle of FSK modulations is to change the binary encoding by changing the frequency of the transmitted signal. OOK is amplitude modulation (On Off Keying) which means turning power on/off to modulate data.

Sub-1GHz connectivity Quick reference guide

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Sub-1GHz connectivity is key for various applications operating in ISM bands (Industrial, Scientific and Medical wireless devices). This type of connectivity provides the benefits of both a wide radio range and low power consumption that are used in metering, LPWAN, Smart Home & Smart Building applications.

This guide focuses on Sub-1GHz Key Performances Indicators (KPIs) and demonstrates how our Sub-1GHz S2-LP transceiver (transmit and receiver capable) and S2-LPTX transmitter (transmit-only) offer best-in-class performance in terms of:

- Range capability
- System power consumption efficiency
- Application topology and associated software enablers

RANGE CAPABILITY - RF LINK BUDGET

A common term used to describe the range capability of an RF system is its link budget. The link budget is a comparison (or ratio) between the transmit power and sensitivity level. In an operating RF link, the transmitter will transmit at a specified RF power level, and a fraction of that RF power will be picked up by the receiving antenna and fed to the receiver.

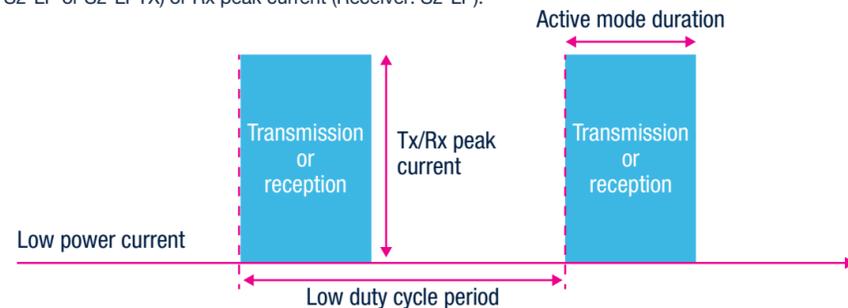
$$\text{Link budget (dB)} = \text{Tx Power level (dBm)} - \text{Receiver sensitivity level (dBm)} *$$

The higher the Tx power level and/or the lower the Receiver Sensitivity, the better the wireless application range. Thanks to its state-of-the-art performance, our S2-LP offers a best-in-class Link Budget of more than 145 dB.

(* Note that this formula is also valid for the S2-LPTX, but only for the Tx Power Level.

POWER CONSUMPTION AND BATTERY LIFETIME

The optimization of the average current consumption is key for extending the battery lifetime of Sub-1GHz applications. Battery-operated applications are not continuously running in Tx (transmitter) or Rx (Receiver) modes all of the time. Transmit or Receive Low Duty Cycle is applied in order to decrease the average current consumption to a fraction of the Tx peak current (Transmitter: S2-LP or S2-LPTX) or Rx peak current (Receiver: S2-LP).

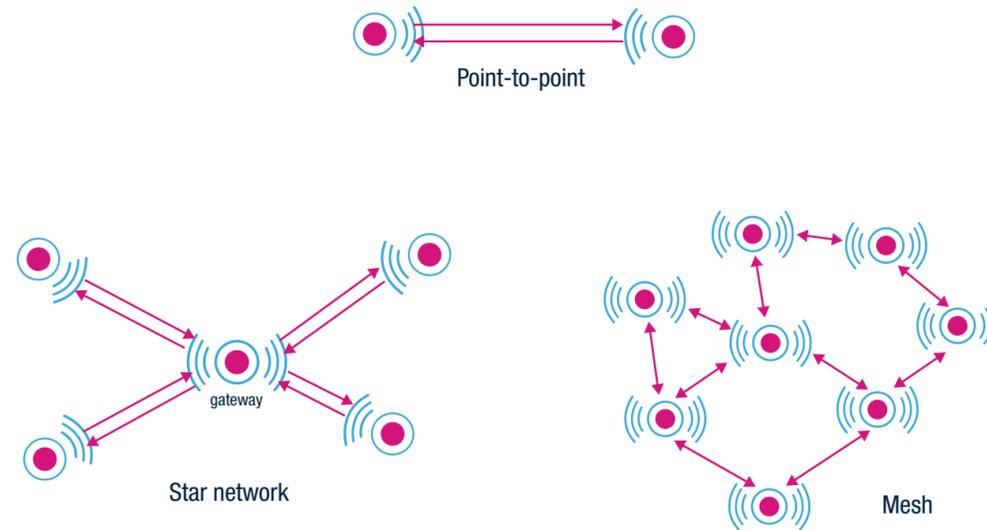


$$\text{Average current} = \frac{(\text{Active duration} \times \text{Peak current})}{\text{Low duty cycle period}} + \text{Low Power current}$$

SPMS integration and design constraints allow to achieve ultra-low power performance over our S2-LP or S2-LPTX devices.

NETWORK TOPOLOGY AND PROTOCOL SUPPORT

When choosing a Sub-1GHz solution, we need to think about the application's network topology: point-to-point, star network or mesh topology.



A Sub-1GHz application enables products which communicate with each other over a specific topology. The communication mode also needs to be considered: Transmit only or bidirectional, Auto-retransmission, or Auto-Acknowledgment management.

The S2-LP (and S2-LPTX) in conjunction with a host microcontroller can be used in each topology. Moreover, thanks to the specific hardware block, the S2-LP (and S2-LPTX) can leverage the host microcontroller's power impact and processing, and autonomously handle auto-retransmission and acknowledgment modes.

The radio band spectrum used by the Sub-1GHz technology enables lots of wireless standards designed to ensure interoperability between different device manufacturers. By providing a strong protocol flexibility, customers can easily enable their own proprietary protocol over S2-LP and S2-LPTX solutions using ISM resources.



S2-LP supports a wide range of Radio Protocols. Native support to IEEE 802.15.4g packet format makes S2-LP WiSun ready; KNX-RF standard support for Smart Home and Building Automation markets; Sigfox support unleashes the Sensor-to-Cloud connectivity and Asset Tracking management; Wireless M-Bus support ensures very power efficient Smart Metering and Advanced Metering Infrastructure (AMI) applications for electricity, gas, water and heat metering; IPv6 support over low power wireless personal area networks (6LoWPAN) allows devices embedding S2-LP to build a micro mesh network in the Smart Grid

SUB-1 GHZ SOFTWARE ENABLERS

S2-LP and S2-LPTX bring flexibility to enable proprietary protocols, while S2-LP software packages help developers design applications that required protocol compliancy.

Thanks to such flexibility, a wide variety of solutions can be addressed using our S2-LP and S2-LPTX devices. The following chart describes which software package is best for a specific application solution.

The chart helps developers understand which software resources are available to address specific needs covered by our Sub-1GHz portfolio: Spirit1 & S2-LP transceivers and STS1TX and S2-LPTX transmitters.

STM32 Open Development Environment				
Smart Things	Sigfox IOT	STSW-BNRG-S2LP BlueNRG	STSW-S2LP-SFX-DK sigfox	X-CUBE-SFXS2LP1
Smart Industry	Asset Tracking	sigfox	sigfox	FP-ATR-Sigfox1
	Industrial communication			X-CUBE-SUBG1 X-CUBE-SUBG2
Smart Home and City	Street lighting			M-Bus wireless
	Electricity metering			LoWPAN
	Gas, heat, water metering			
Smart Home and City	Remote control			
	Home security			
	Garage door opener			
	Windows and roller-shutters			
		STSW-S2LP-DK (S2-LP)		SPIRIT
		STSW-CONNECT009 (Spirit1)		