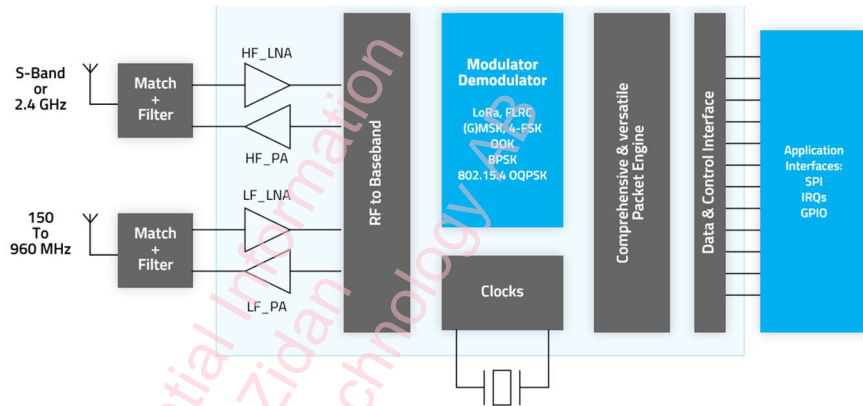




Preliminary Datasheet

Multi-band, Multi-PHY Transceiver

Functional Block Diagram



Generation 4 LoRa® IP

- Multi-SF Receiver
- Multi-region front-end
- Improved CAD
- Increased frequency offset tolerance

FEATURES

- 150 - 960 MHz bands
- 1.6 - 2.5 GHz bands
- FLRC up to 2.6 Mbps
- LoRa up to 200 kbps
- LR-FHSS for SATCOM
- SPI Interface

Applications

- Security and building automation
- Smart city and Logistics
- Smart utility
- Smart Home
- Industrial Automation
- Smart Agriculture

Physical Layer Compatibility

- LoRa® / LoRaWAN® at Sub-GHz and 2.4 GHz
- Sidewalk FSK/CSS PHY
- Sigfox PHY
- Wi-SUN FSK PHY
- W-MBUS PHY (device and collector)
- 4-FSK PHY
- Z-Wave PHY, Z-Wave LR PHY
- 802.15.4 Thread and Zigbee PHY
- Bluetooth LE 5.4 PHY Compatibility

Regulatory Compliance

- ETSI EN 300 220-1
- FCC Part 15.247/249
- All LoRaWAN® supported regions
- Improved Pout for STD-T108

Characteristics

- Receiver (Rx) Performance
 - -142 dBm @ LoRa 125 kHz sub-GHz
 - -111 dBm @ 100kbps DSSS O-QPSK
 - -111 dBm @ FLRC 260 kbps sub-GHz
 - -105 dBm @ FLRC 1 Mbps, -101 @ 2.6Mbps
 - -103 dBm @ 802.15.4 DSSS O-QPSK 250kbps
 - -100 dBm @ GMSK 1Mbps, -97 @ 2Mbps
- Transmitter (Tx) Performance
 - +22 dBm to -10 dBm in 0.5 dB steps
 - +12dBm output at 2.4 GHz
- Low current consumption
 - Rx current 5-6 mA @ sub-GHz
 - Tx current 110mA @ +22dBm, 27mA @ 14dBm, 14mA @ 10dBm sub-GHz
 - Low Sleep current 500 nA
- -40 to +85 °C, 1.8 to 3.7V supply

Packaging and Ordering

- 5 mm x 5mm QFN package
- MOQ 3000 pcs, Tape & Reel
- Ordering code: **LR2021IMLTRT**

Description

The LR2021 is Semtech's first chip in the LoRa Plus family. Incorporating a fourth-generation LoRa® IP, the transceiver supports both Terrestrial and SATCOM networks in the Sub-GHz, 2.4GHz ISM bands, and licensed S-Band. The transceiver is designed to be backward compatible with previous LoRa devices, ensuring seamless LoRaWAN compatibility. The device additionally features expanded physical layer modulations for fast long-range communication (FLRC) and is compatible with various low-power wireless protocols including Amazon Sidewalk, Meshtastic, W-MBUS, Wi-SUN FSK, and Z-Wave when integrated with third-party stack offerings. The LR2021 features an advanced RF and analog architecture that supports a multi-region, single-SKU design, reducing external BOM costs, PCB footprint, and power consumption, while offering superior performance compared to previous LoRa transceivers.



High-Level Specifications

DISCLAIMERS:

The specifications listed below are high-level numbers predicting the performance of the mass-production part under validation. They are in no capacity replacing the specification numbers posted in the final datasheet.

Semtech's products are designed to be used in connection with qualified Bluetooth products and applications but are not certified or qualified Bluetooth® products.

Conditions:

- Published reference design, performance at the antenna port
- Nominal voltage and temperature (3.3V, 25°C)
- Typical numbers are provided

PARAMETER	CONDITIONS	VALUES	UNITS	Note
Output Power max	Sub-GHz	+22	dBm	2 independent Power Amplifiers
	2.4 GHz	+12		
PA Efficiency	868/915 MHz			A single multi-region design from 865 to 928 MHz
	+22 dBm	110	mA	
	+14 dBm	27		
	+10 dBm	14		
	2.4 GHz			
	+12 dBm	23	mA	
PA Dynamic		32 / 0.5 steps	dB	
Sleep current		500	nA	
Rx current		~5	mA	Modulation dependent
Sensitivity	LoRa 125k/SF12	-142	dBm	915 MHz
	LoRa 500k/SF10	-130		915 MHz
	GMSK 1Mbps	-100		Bluetooth LE compatible
	GMSK 2Mbps	-97		
	15.4 O-QPSK DSSS	-103		
	Z-Wave R1 PHY	-115		915 MHz Scanning 4-channel 2ms
	Z-Wave R2 PHY	-111		
	Z-Wave R3 PHY	-111		912 MHz
	Z-Wave LR PHY	-111		915 MHz
	FLRC 2.6 Mbps	-101		915 MHz
	FLRC 1 Mbps	-105		
FLRC 260 kbps	-111			
Resistance to frequency offset	LoRa	+/- 1/3 rd * BW	kHz	+/-42 kHz @ LoRa 125 kHz with marginal sensitivity loss
Data rate ranges	LoRa sub-GHz	0.3 to 62.5	kbps	Usual N * 125 kHz chirping
	LoRa 2.4 GHz	0.5 to 203		SX1280-like N * 200 kHz chirping
	FLRC	0.13 to 2.6	Mbps	Fast Long-Range Communication in either frequency range
	FSK including (G)MSK	0.6 to 2.6		

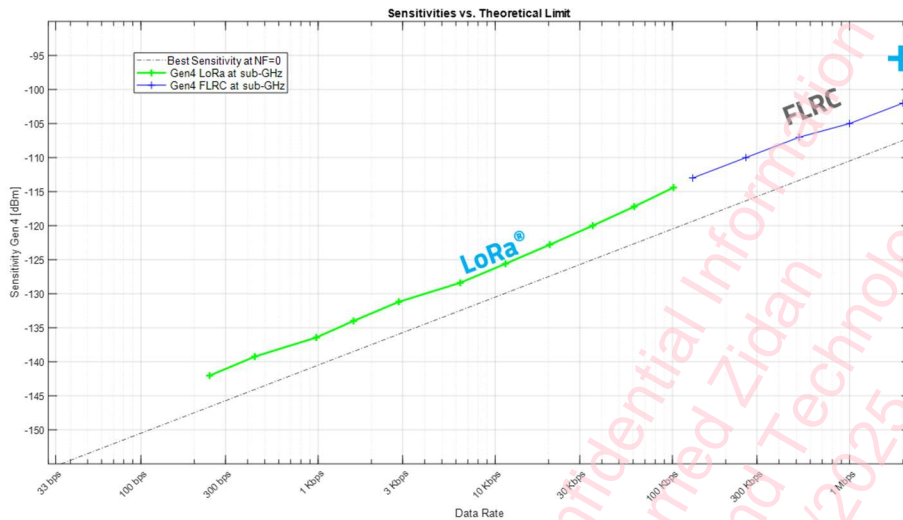
Differentiating Features

This section summarizes the unique characteristics of the LR2021 in terms of its ability to support demanding and cost-efficient applications.

High-speed FLRC Support

FLRC (Fast Long-Range Communication) is a high-speed PHY technology offering 130 kbps to 2.6 Mbps with high spectral efficiency and best theoretical sensitivity.

FLRC offers unique characteristics enabling image and audio transfer applications. Previously available only on the Gen2 SX128x family of chips in the 2.4GHz band, it is now also offered in the sub-GHz band on the LR2021.



Leading Bluetooth® LE SOC

FLRC, used at sub-GHz, will offer >10 dB advantage on path loss, better penetration, and support 130kbps – 2.6 Mbps

Proprietary and Legacy Protocol Support

The LR2021's modem and Packet Engine have been overhauled to provide maximum compatibility with existing legacy protocols. The following modulation schemes are offered:

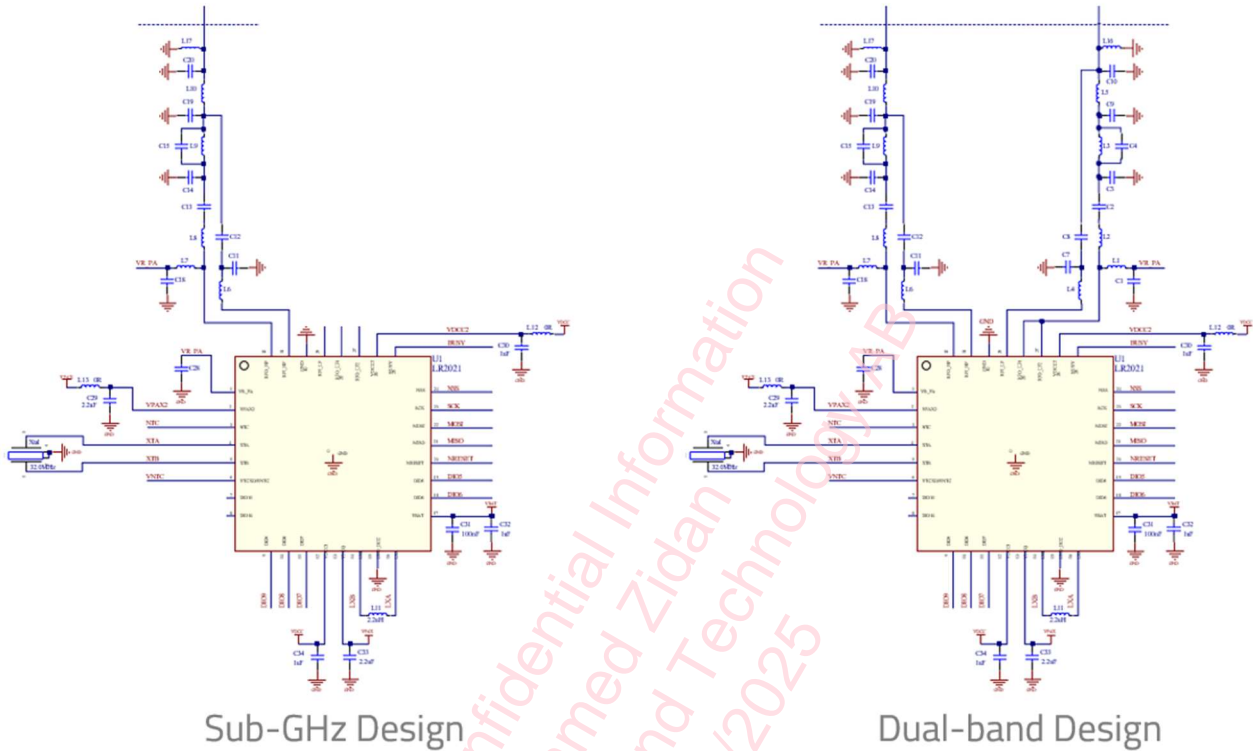
- FSK, MSK, GMSK: short preamble frame detection with high-speed AGC and matched filter to circumvent AFC requirements.
- GMSK with semi-coherent demodulator for improved sensitivity
- OOK
- 4-FSK
- O-QPSK for 802.15.4 support

The Packet Engine offers full flexibility:

- Optional Manchester encoding
- Flexible CRC, Whitening polynomials
- Preamble polarity options
- Exotic Sync Word sizes

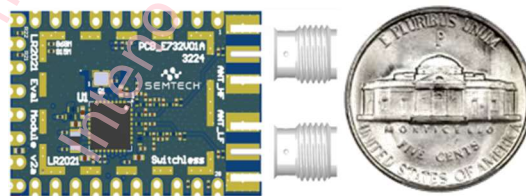
Low Bill of Materials Cost

The transceiver has been designed to minimize the cost of the external Bill of Materials by eliminating the need for an RF switch: optimal performance can be obtained with a direct-tie (switchless) topology, saving significantly on RF switches. The number of external L's and C's is also minimized for cost savings. The integrated DC-DC converter, used to drastically reduce power consumption, can also be disabled so the transceiver will not need its switching inductor for LDO based applications.



Small PCB Footprint

Depicted below is the reference design for dual-band implementation (2.4 GHz and sub-GHz), compared to a "nickel". It has a vertical size of about 2.5mm, and is currently using 0201 component footprints. You can observe that the size of the XTAL's thermal relief protection is greatly reduced, compared to the Gen2 and Gen3 parts, as a result of built-in countermeasures.

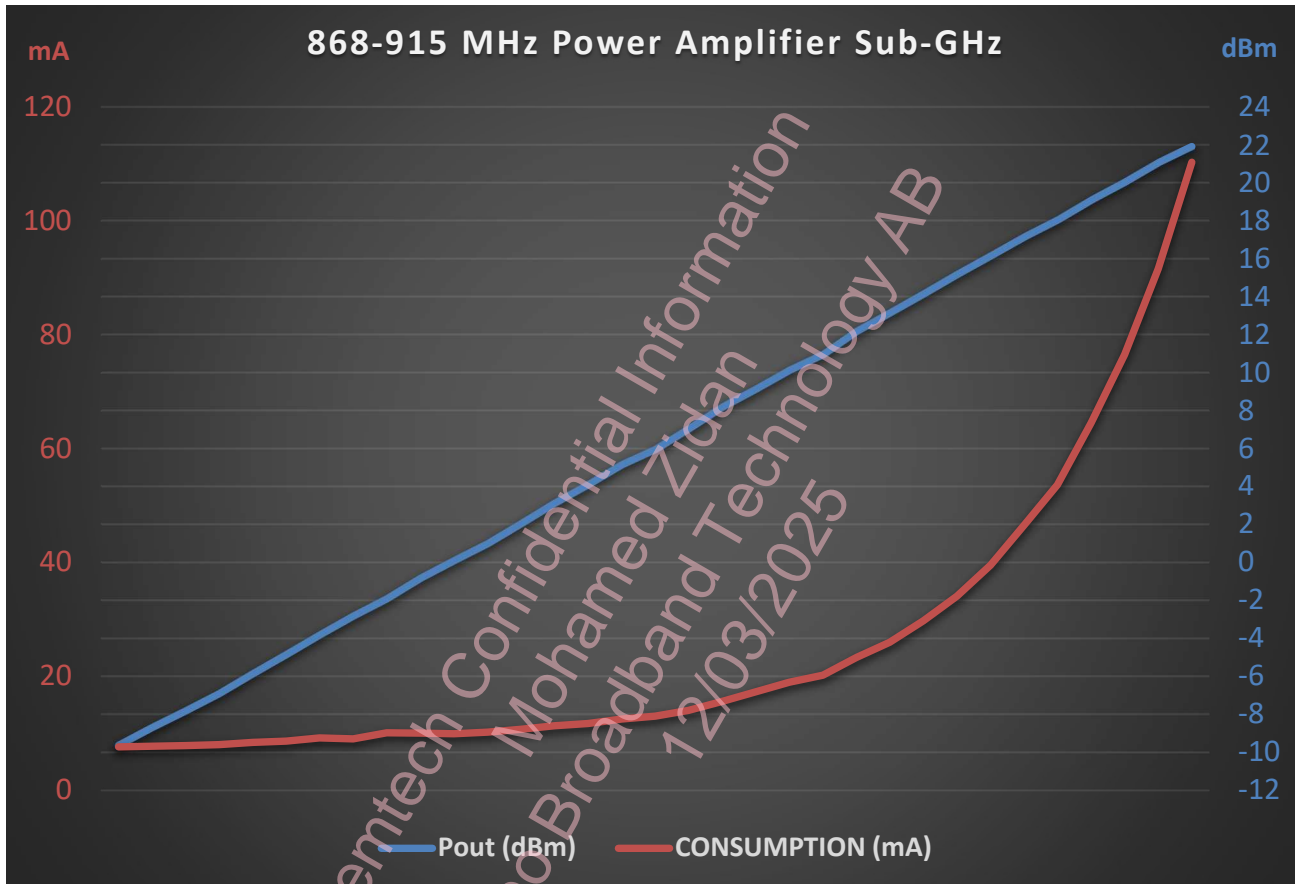


The RF implementation, on a 4-layer PCB, contributes to the cost efficiency of the solution.

Single Front-end for Multi-Regional Designs

The LR2021 offers a single RF Front-end capable of operating at higher power levels (up to +22 dBm) in regions where the regulator allows these transmission levels, and down to +14 or even +10 dBm on the same hardware, yet still offering maximum efficiency at low power. This is achieved by simply dialing down the *Power* setting, and therefore a single SKU can be operated in Europe, Japan, Asia (typically +10-14dBm at 20-27mA) or in India, Australia, North America (typically +22dBm at 110mA) with a simple command.

The standard reference design copes with this and offers regulatory compliance from 865 to 928 MHz.



WM-BUS Improved Support

The transceiver has been tested to comply with the T, C and S modes of the EN13757 standard, and it meets and exceeds the high-performance grade that the standard calls for. Specific configuration commands have been integrated to simplify the setup.

The transceiver also supports the W-MBUS T1 "Collector" specification with the ability to maintain low PER even when the incoming packet Data Rate is erroneous by many %. This makes it capable of both Device and Collector functionality.

O-QPSK Modulator and Demodulator

802.15.4's 2.4 GHz DSSS O-QPSK Physical Layer is fully integrated and verified in the LR2021. It makes the LR2021 suitable for Zigbee, Thread/Matter or other 15.4-based communication protocols with the assistance of a compatible MCU/Stack.

Improved LoRa Performance

One of LoRa’s Unique Selling Points is the ability to support extremely high link budget as low throughput, yet using standard cheap reference oscillators, whereas more traditional narrowband long-distance modulation techniques need highly accurate frequency alignment (typically less than <1ppm for -130 dBm and below).

On the LR2021, this capability has been further improved:

	Required Carrier alignment between Tx and Rx	Comment
Gen 1, Gen 2 and Gen 3	1/4 th of the LoRa bandwidth Meaning +/-31 kHz @ LoRa 125 kHz	Requires a TCXO at one end of the link
Gen 4 LR2021	1/3 rd of the LoRa bandwidth (+/-42 kHz @ LoRa 125 kHz)	More headroom

LoRa® System Improvements

The LR2021 embeds new and improved capability, offering better support for Relay, One-Channel Hub and other LoRa-based systems offering:

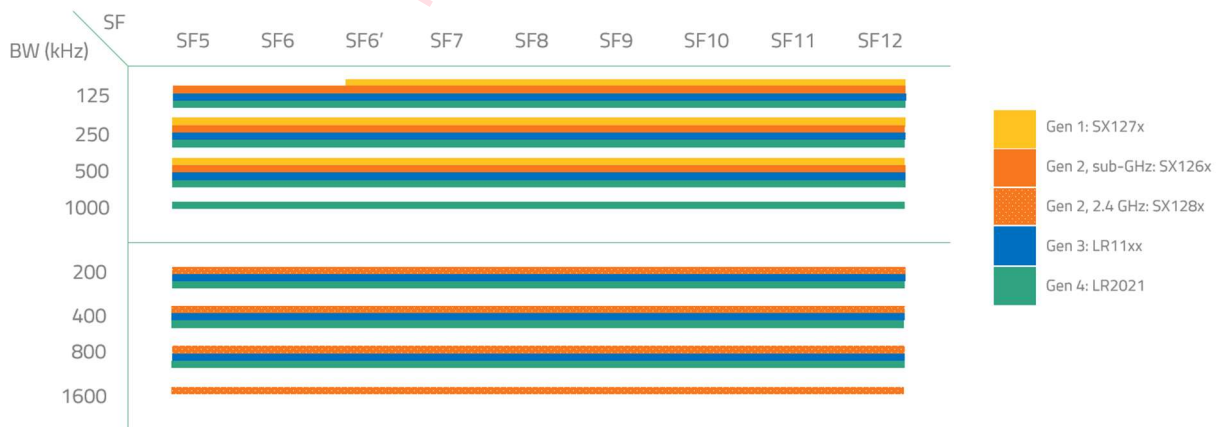
- Multi-SF detection:
The transceiver can detect frames with three distinct Spreading Factors (SF) at full performance at any moment in time and demodulate one of them. This functionality bridges some of the capacity gap between end-device chips, and gateway reference designs where up to 8 channels and 5 SF can be handled at the same time
- Channel Activity Detection (CAD) has been re-engineered to offer:
 - Automated CAD with host fully asleep
 - Fast CAD, that guarantees the same false detection rate for the analysis of a smaller number of symbols than previous generations. This will make Relays more power efficient for example

LoRa® Generational Compatibility Matrix

The LR2021 is designed to offer full backwards compatibility with previous generations of transceivers:

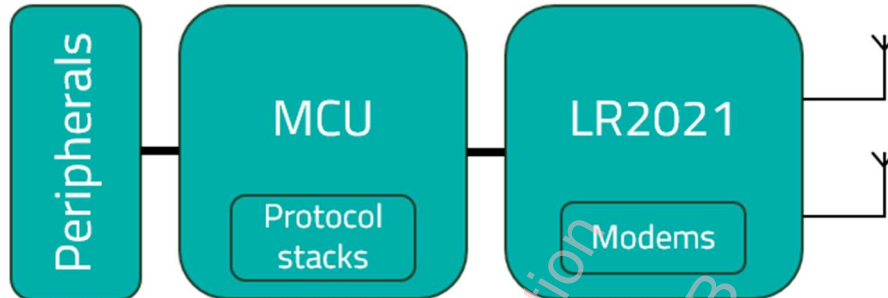
- Full SF5 and SF6 with support of both Gen 1 and Gen 2 options
- Support of N * 200 kHz and M * 125 kHz LoRa bandwidths, compatible with the SX128x product family as shown in the diagram below

Product Family Bandwidth (BW) and Spreading Factor (SF) Compatibility Diagram



System Block Diagram

The LR2021 is designed to be used in conjunction with an MCU capable of hosting Semtech's and/or 3rd party communication stack(s), low-level drivers and user-applications.



Semtech Confidential Information
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12/03/2025

Revision History

Version	Date	Changes and/or Modifications
0.1	March 2025	First Preliminary Datasheet

*Semtech Confidential Information
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12/03/2025*



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