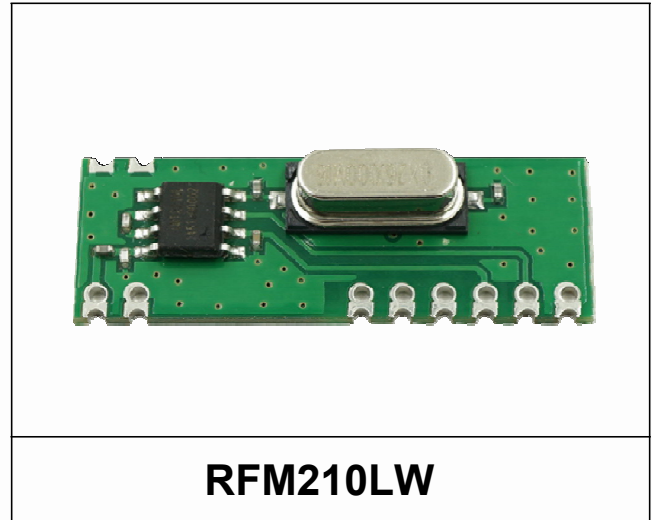# HOPERF

RFM210LW

Features

Frequency Range: 315 /433.92 MHz

Symbol Rate: 0.1 to 3.4 kbps

Sensitivity: -108dBm at 2.4 kbps, 0.1% BER

Receiver Bandwidth: 200 kHz

Image Rejection Ratio: 25 dB

Large Signal Handling:10 dBm

Supply Voltage: 1.8 to 3.6 V

Low Power Consumption: 3.8 Ma
    3.3 mA @ 315 MHz
    3.8 mA @ 433.92 MHz

Low Sleep Current

RoHS Compliant
Module Size:32*11*5.0mm

RFM210LW

Descriptions

The RFM210LW is an ultra low-cost, low power, high performance OOK stand-alone RF receiver for 315/433.92MHz wireless applications. It is part of the CMOSTEK NextGenRFTM family, which includes a complete line of transmitters, receivers and transceivers. The RFM210LW is a true plug-and- run device, no register configuration and manually- tune is required. The RFM210LW operates from

1.8 V to3.6 V, finely work till the end of most batteries' power. It consumes 3.3 mA current while achieving -109 dBm receiving sensitivity at 315 MHz and consumes 3.8 mA current while achieving -108 dBm receiving sensitivity at433.92 MHz.

Applications

z   Low-Cost Consumer Electronics Applications

z   Home and Building Automation

z   Infrared Receiver Replacements z Industrial Monitoring and Controls

z   Remote Automated Meter Reading

z   Remote Lighting Control System

z   Wireless Alarm and Security Systems

z   Remote Keyless Entry (RKE)

Abbreviations

Abbreviations used in this data sheet are described below

AGC	Automatic Gain Control	**PC**	Personal Computer
AN	Application Notes	**PCB**	Printed Circuit Board
BER	Bit Error Rate	**PLL**	Phase Lock Loop
BOM	Bill of Materials	**PN9**	Pseudorandom Noise 9
BSC	Basic Spacing between Centers	**POR**	Power On Reset
BW	Bandwidth	**PUP**	Power Up
DC	Direct Current	**QFN**	Quad Flat No-lead
EEPROM	Electrically Erasable Programmable Read-Only Memory	**RF**	Radio Frequency
		RFPDK	RF Products Development Kit
ESD	Electro-Static Discharge	**RoHS**	Restriction of Hazardous Substances
ESR	Equivalent Series Resistance	**RSSI**	Received Signal Strength Indicator
Ext	Extended	**Rx**	Receiving, Receiver
IF	Intermediate Frequency	**SAR**	Successive Approximation Register
LNA	Low Noise Amplifier	**SPI**	Serial Port Interface
LO	Local Oscillator	**TH**	Threshold
LPOSC	Low Power Oscillator	**Tx**	Transmission, Transmitter
Max	Maximum	**Typ**	Typical
MCU	Microcontroller Unit	**USB**	Universal Serial Bus
Min	Minimum	**VCO**	Voltage Controlled Oscillator
MOQ	Minimum Order Quantity	**WOR**	Wake On Radio
NP0	Negative-Positive-Zero	**XOSC**	Crystal Oscillator
NC	Not Connected	**XTAL/Xtal**	Crystal
OOK	On-Off Keying		

RFM210LW

Table of Contents

1. Electrical Characteristics

VDD = 3.3 V, T_{OP} = 25 ℃, F_{RF} = 433.92 MHz, sensitivities are measured in receiving a PN9 sequence and matching to 50 Ω impedance, with the BER of 0.1%. All measurements are performed using the board RFM210LW-EM V1.0, unless otherwise noted.

1.1 Recommended Operation Conditions

Table 2. Recommended Operation Conditions

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operation Voltage Supply	V_{DD}		1.8		3.6	V
Operation Temperature	T_{OP}		-40		85	℃
Supply Voltage Slew Rate			1			mV/us

1.2 Absolute Maximum Ratings

Table 3. Absolute Maximum Ratings[1]

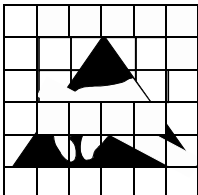| Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	V_{DD}		-0.3	3.6	V
Interface Voltage	V_{IN}		-0.3	V_{DD} + 0.3	V
Junction Temperature	T_J		-40	125	℃
Storage Temperature	T_{STG}		-50	150	℃
Soldering Temperature	T_{SDR}	Lasts at least 30 seconds		255	℃
ESD Rating[2]		Human Body Model (HBM)	-2	2	kV
Latch-up Current		@ 85 ℃	-100	100	mA

Notes:

[1]. Stresses above those listed as "absolute maximum ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

[2]. The RFM210LW is high-performance RF integrated circuits with VCON/P pins having an ESD rating < 2 kV HBM. Handling and assembly of this device should only be done at ESD-protected workstations.

Caution! ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage.

RFM210LW

1.3 Receiver Specifications

Table 4. Receiver Specifications

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Frequency Range	F_{RF}		300		480	MHz
Symbol Rate	SR		0.1		3.4	kbps
Sensitivity	S_{315}	F_{RF} = 315 MHz, SR = 2.4 kbps, BER = 0.1%		-109		dBm
	$S_{433.92}$	F_{RF} = 433.92 MHz, SR = 1 kbps, BER = 0.1%		-108		dBm
Saturation Input Signal Level	P_{LVL}			10		dBm
Working Current	I_{DD}	F_{RF} = 315 MHz		3.5		mA
		F_{RF} = 433.92 MHz		3.8		mA
Sleep Current	I_{SLEEP}	When sleep timer is off		60		nA
Frequency Resolution	F_{RES}			24.8		Hz
Frequency Synthesizer Settle Time	T_{LOCK}	From XOSC settled		150		us
Blocking Immunity	BI	SR = 1 kbps, ±1 MHz offset, CW interference		52		dB
		SR = 1 kbps, ±2 MHz offset, CW interference		74		dB
		SR = 1 kbps, ±10 MHz offset, CW interference		75		dB
Image Rejection Ratio	IMR	IF = 280 kHz		35		dB
Input 3rd Order Intercept Point	IIP3	Two tone test at 1 MHz and 2 MHz offset frequency. Maximum system gain settings		-25		dBm
Receiver Bandwidth	BW			200		kHz
Receiver Start-up Time	$T_{START-UP}$	From power up to receive		7.3		ms

1.4 Crystal Oscillator

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Crystal Frequency[1]	$F_{XTAL\,315}$	F_{RF} = 315 MHz		18.8744		MHz
	$F_{XTAL\,433.92}$	F_{RF} = 433.92 MHz		26		MHz
Crystal Tolerance[2]				±20		ppm
Load Capacitance	C_{LOAD}		10	15	20	pF
Crystal ESR	Rm				60	Ω
Drive Level					100	uw
Aging Per Year				±2		ppm
XTAL Startup Time[3]	t_{XTAL}			400		us

Notes:

[1]. The RFM210LW can directly work with external reference clock input to XIN pin (a coupling capacitor is required) with peak-to-peak amplitude of 0.3 to 0.7 V.

[2]. This is the total tolerance including (1) initial tolerance, (2) crystal loading, (3) aging, and (4) temperature dependence. The acceptable crystal tolerance depends on RF frequency and channel spacing/bandwidth.

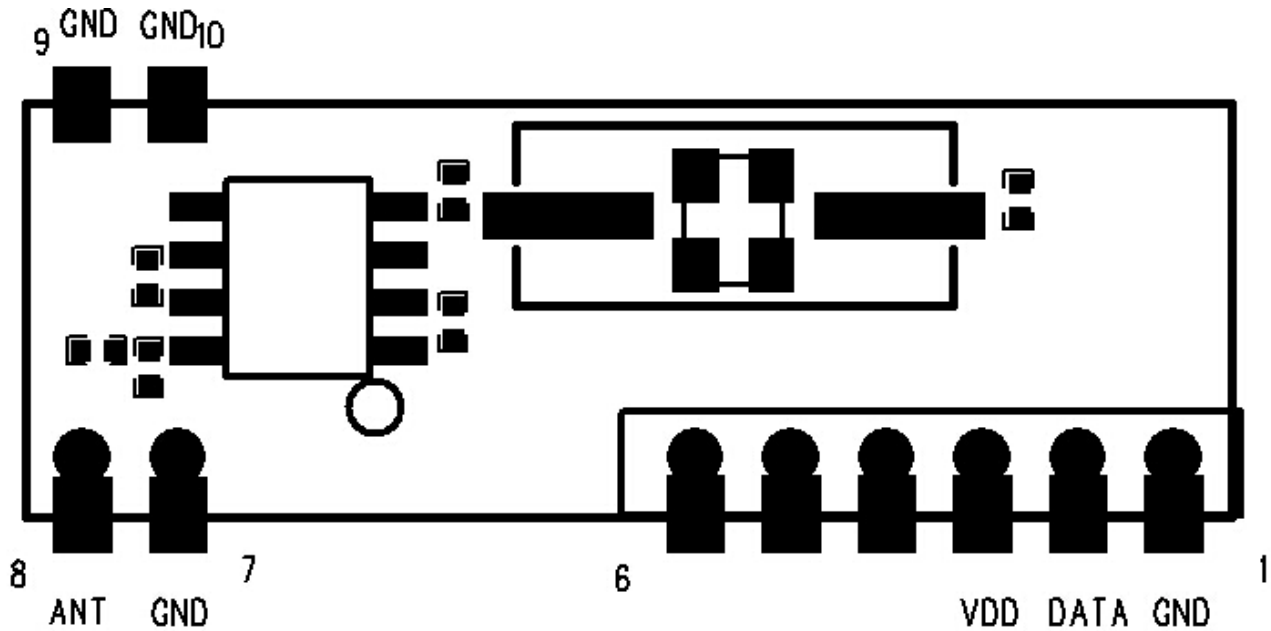[3]. This parameter is to a large degree crystal dependent.

2. Pin Descriptions

Figure 2. Pin Diagram

Table 6. RFM210LW Pin Descriptions

Pin Number	Name	I/O	Descriptions
1	GND	I	Ground
2	DATA	O	Received data output
3	VDD	I	Power supply input
4	CLK	I	3-wire SPI clock input for EEPROM programming
5	SDA	I/O	3-wire SPI data input and output for EEPROM programming
6	CSB	I	3-wire SPI chip select input for EEPROM programming I
7	GND	I	Ground
8	ANT	I	RF signal input to the LNA
9	GND	I	Ground
10	GND	I	Ground

3. Typical Performance Characteristics

Current vs. Supply Voltage
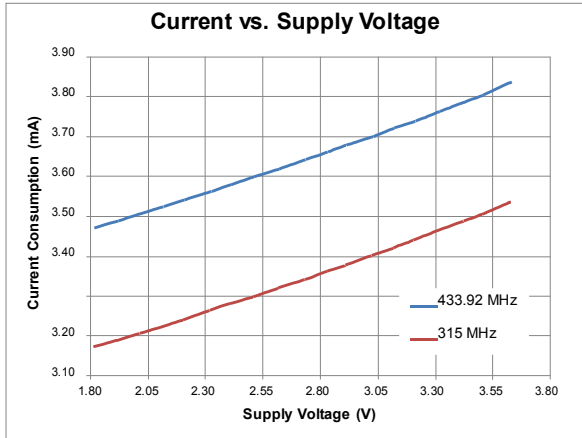
Figure 3.1 Current vs. Voltage, F_{RF} = 315 / 433.92 MHz, SR = 1 kbps

Current vs. Temperature
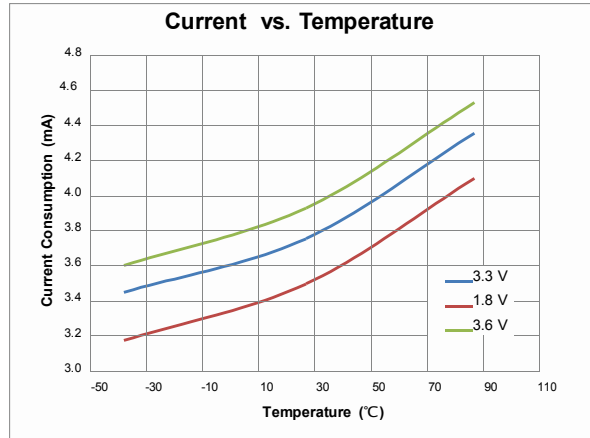
Figure 3.2 Current vs. Temperature, F_{RF} = 433.92 MHz, SR = 1 kbps

Sensitivity vs. Supply Voltage
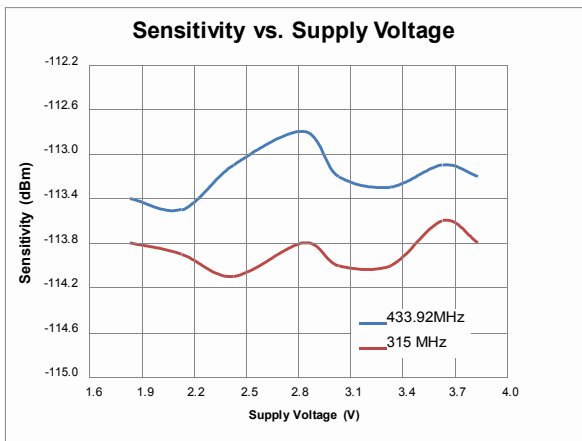
Figure 3.3 Sensitivity vs. Supply Voltage, SR = 1 kbps, BER = 0.1%

Sensitivity vs. Temperature
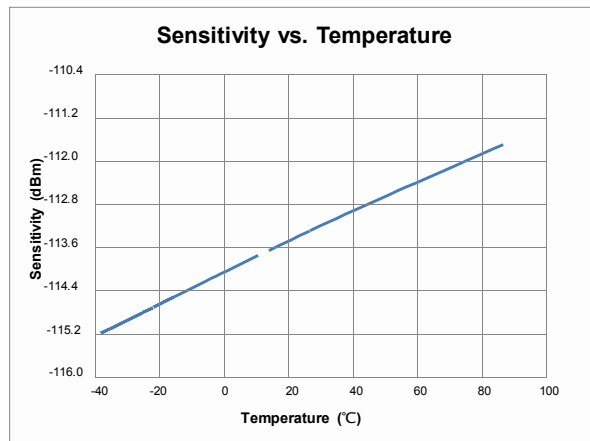
Figure 3.4 Sensitivity vs. Temperature, F_{RF} = 433.92 MHz, V_{DD} = 3.3 V, SR = 1 kbps, BER = 0.1%

Sensitivity vs. Symbol Rate
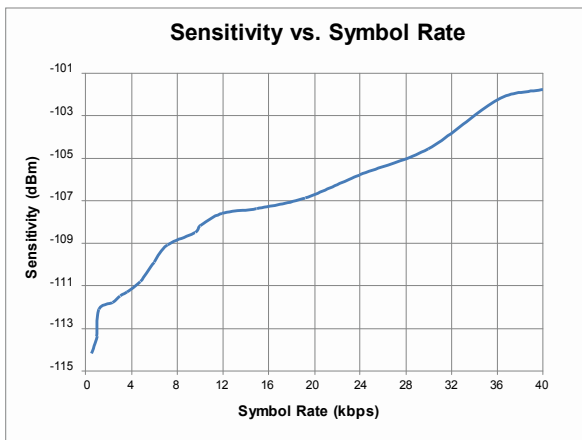
Figure 3.5 Sensitivity vs. SR, F_{RF} = 433.92 MHz, V_{DD} = 3.3 V, BER = 0.1%
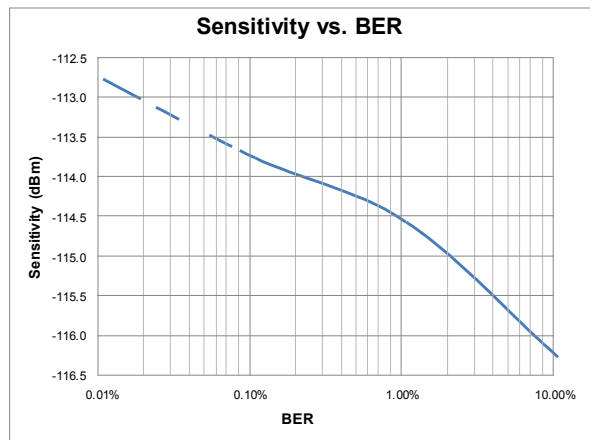
Sensitivity vs. BER

Figure 3.6 Sensitivity vs. BER, F_{RF} = 433.92 MHz, V_{DD} = 3.3 V, SR = 1 kbps
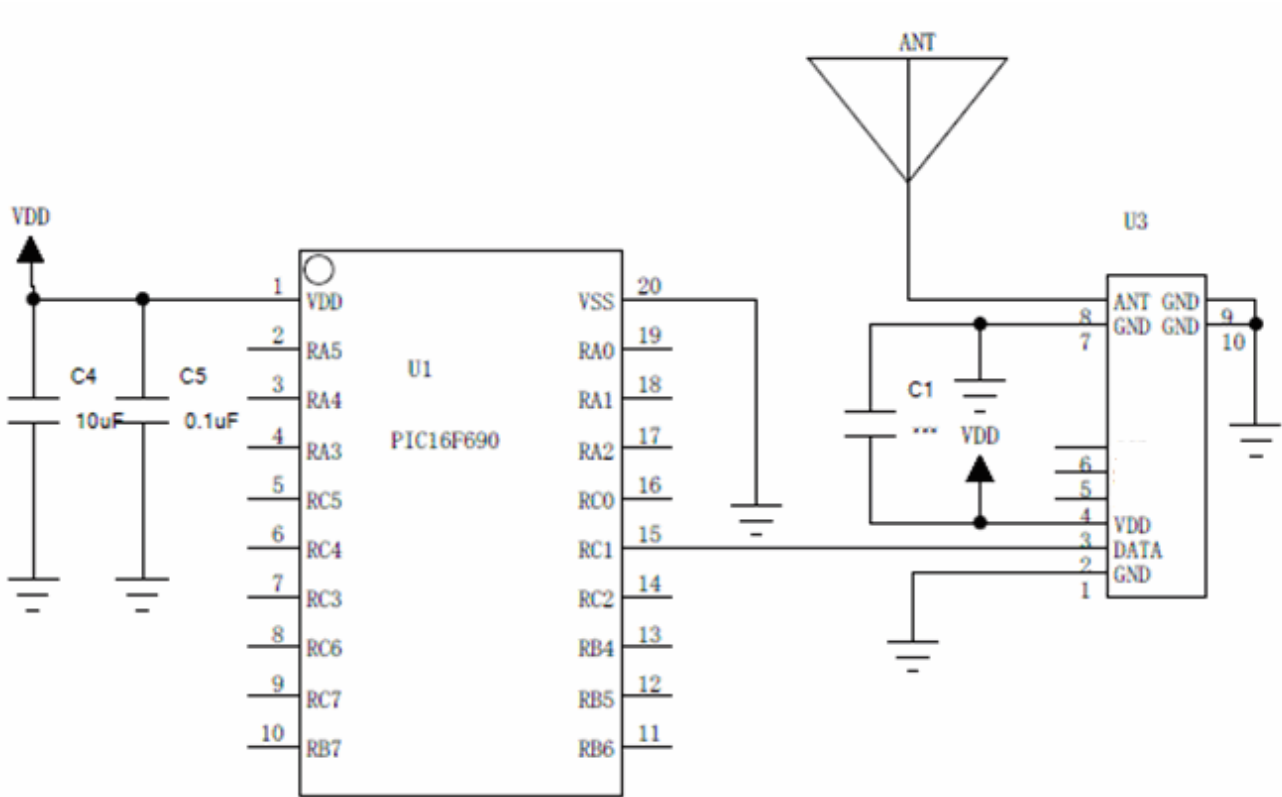
Figure 9: Typical Application Schematic
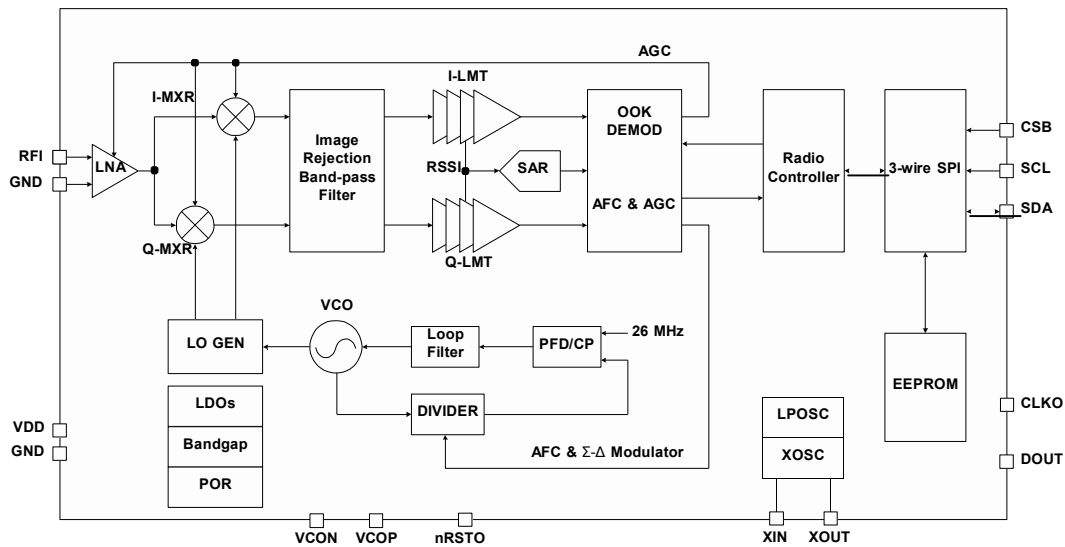
5. Functional Descriptions

Figure 5. Functional Block Diagram

5.1 Overview

The RFM210LW is an ultra low power, high performance, low-cost OOK stand-alone RF receiver for various 300 / 480 MHz wireless applications. It is part of the CMOSTEK NextGenRF™ family, which includes a complete line of transmitters, receivers and transceivers. The chip is based on a fully integrated, low-IF receiver architecture. The low-IF architecture facilitates a very low external component count and does not suffer from powerline - induced interference problems. The synthesizer contains a VCO and a low noise fractional-N PLL with an output frequency resolution of 24.8 Hz. The VCO operates at 2x the Local Oscillator (LO) frequency to reduce spurious emissions. Every analog block is calibrated on each Power-on Reset (POR) to the internal reference voltage. The calibration helps the device to finely work under different temperatures and supply voltages. The baseband filtering and demodulation is done by the digital demodulator. The demodulated signal is output to the external MCU via the DOUT pin. No external MCU control is needed in the applications.

The 3-wire SPI interface is only used for configuring the device. The configuration can be done with the RFPDK and the USB Programmer. The RF Frequency, symbol rate and other product features are all configurable. This saves the cost and simplifies the design, development and manufacture. Alternatively, in stock products of 315/433.92 MHz are available for immediate demands with no need of EEPROM programming. The RFM210LW operates from 1.8 to 3.6 V so that it can finely work with most batteries to their useful power limits. The receive current is only 3.8 mA. The RFM210LW receiver together with the CMT211x transmitter enables an ultra low cost RF link.

5.2 Modulation, Frequency and Symbol Rate

The RFM210LW supports OOK demodulation with the symbol rate from 0.1 to 40 kbps. It continuously covers the frequency range from 300 to 480 MHz, including the license free ISM frequency band around 315 MHz and 433.92 MHz. The internal frequency synthesizer contains a high-purity VCO and a low noise fractional-N PLL with an output frequency resolution of 24.8 Hz. See Table 9 for the demodulation, frequency and symbol rate information.

Table 7. Modulation, Frequency and Symbol Rate

Parameter	Value	Unit
Demodulation	OOK	-
Frequency	300 to 480	MHz
Frequency Resolution	24.8	Hz
Symbol Rate	0.1 to 3.4	kbps

5.3 Main Configurations

Unlike other NextGenRF^{TM} receivers, the RFM210LW does not need any register control or manufacturing programming. The configuration of the device is fixed in order to save the development effort, reduce system cost and simplify the manufacturing process. The main configurations are listed in the table below. Please note that if more flexibility is needed in the system, the user can use other NextGenRF^{TM} receivers like CMT2210A and etc. For those products, an embedded EEPROM is available on chip for the user to configure all the product features.

Table 8. RFM210L Main Configurations

Parameters		CMT2210L-ESR	Unit
RF Settings	Frequency	315/433.92	MHz
	Modulation	OOK	-
	Symbol Rate	0.1 – 3.4	ksps
	Receiver Bandwidth	200	kHz
	Xtal Stabilizing Time	310	us
Operation Settings	Sleep Time	3	ms
	Rx Time	2000	ms
OOK Settings	Demod Method	Fixed TH	-
	Fixed Demod TH	60	-

5.4 Internal Blocks Description

5.4.1 RF Front-end and AGC

The RFM210LW features a low-IF receiver. The RF front-end of the receiver consists of a Low Noise Amplifier (LNA), I/Q mixer and a wide-band power detector. Only a low-cost inductor and a capacitor are required for matching the LNA to any 50 Ω antennas. The input RF signal induced on the antenna is amplified and down-converted to the IF frequency for further processing.

By means of the wide-band power detector and the attenuation networks built around the LNA, the Automatic Gain Control (AGC) loop regulates the RF front-end's gain to get the best system linearity, selectivity and sensitivity performance, even though the receiver suffers from strong out-of-band interference.

5.4.2 IF Filter

The signals coming from the RF front-end are filtered by the fully integrated 3rd-order band-pass image rejection IF filter which

achieves over 25 dB image rejection ratio typically. The IF center frequency is dynamically adjusted to enable the IF filter to locate to the right frequency band, thus the receiver sensitivity and out-of-band interference attenuation performance are kept optimal despite the manufacturing process tolerances. The IF bandwidth is fixed at 200 kHz.

5.4.3 RSSI

The subsequent multistage I/Q Log amplifiers enhance the output signal from IF filter before it is fed for demodulation. Receive Signal Strength Indicator (RSSI) generators are included in both Log amplifiers which produce DC voltages that are directly proportional to the input signal level in both of I and Q path. The resulting RSSI is a sum of both these two paths. Extending from the nominal sensitivity level, the RSSI achieves dynamic range over 66 dB.

The RFM210LW integrates a patented DC-offset cancellation engine. The receiver sensitivity performance benefits a lot from the novel, fast and accurate DC-offset removal implementation.

5.4.4 SAR ADC

The on-chip 8-bit SAR ADC digitalizes the RSSI for OOK demodulation.

5.4.5 Crystal Oscillator

The crystal oscillator is used as the reference clock for the PLL frequency synthesizer and system clock for the digital blocks. A crystal should be used with appropriate loading capacitors (C2 and C3 in Figure 9 of Page 9). The values of the loading capacitors depend on the total load capacitance C_L specified for the crystal. The total load capacitance seen between the XIN and XOUT pin should equal C_L for the crystal to oscillate at desired frequency.

$$C_L = \cfrac{1}{\cfrac{1}{C_2} + \cfrac{1}{C_3}} + C_{parasitic}$$

The parasitic capacitance is constituted by the input capacitance and PCB tray capacitance. The ESR of the crystal should be within the specification in order to ensure a reliable start-up. An external signal source can easily be used in place of a conventional XTAL and should be connected to the XIN pin. The incoming clock signal is recommended to have a peak-to-peak swing in the range of 300 mV to 700 mV and AC-coupled to the XIN pin.

5.4.6 Frequency Synthesizer

A fractional-N frequency synthesizer is used to generate the LO frequency for the down conversion I/Q mixer. The frequency synthesizer is fully integrated except the VCO tank inductor which enables the ultra low-power receiver system design. Using the 26 MHz reference clock provided by the crystal oscillator or the external clock source, it can generate receive frequencies of 315 and 433.92 MHz with a frequency resolution of 24.8 Hz.

The VCO always operates at 2x of LO frequency. A high Q (at VCO frequency) tank inductor should be chosen to ensure the VCO oscillates at any conditions meanwhile burns less power and gets better phase noise performance. In addition, properly layout the inductor matters a lot of achieving a good phase noise performance and less spurious emission. The recommended VCO inductors for different LO frequency bands are shown as bellow.

Table 9. VCO Inductor for 315/433.92 MHz Frequency Band

LO Frequency Band (MHz)	315	433.92
VCO Inductor (nH)	33	22

Multiple subsystem calibrations are performed dynamically to ensure the frequency synthesizer operates reliably in any working condition

5.5 Operation States

As the RFM210LW is operating in duty cycle receiving mode, the device will go through the states shown as the figure below after the power up.
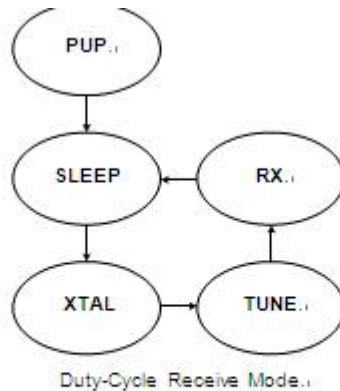

Figure 11. Operation States in Duty Cycle Receive Mode

Power Up (PUP) State

Once the device is powered up, the device will go through the Power Up (PUP) sequence which includes the task of releasing the Power-On Reset (POR), turning on the crystal and calibrating the internal blocks. The PUP takes about 4 ms to finish in the always receive mode. The average current of the PUP sequence is about 0.9 mA.

SLEEP State

In this state, all the internal blocks are powered down except the sleep timer. The sleep time is fixed at 3 ms. The sleep current is about 60 nA.

XTAL State

Once the device wakes up from the SLEEP State, the crystal oscillator restarts to work. The current consumption in this state is about 520 uA.

TUNE State

The device is tuned to the desired frequency and ready to receive. It usually takes approximately 300 us to complete the tuning sequence. The current consumption in this state is about 2 mA.

RX State

The device receives the incoming signals and outputs the demodulated data on the DOUT pin. The current in this state is about 3.3 mA (315 MHz) or 3.8 mA (433.92 MHz).

5.6 Duty Cycle Receive Mode

In the duty-cycle mode, after the PUP the device will automatically repeat the sequence of SLEEP, XTAL, TUNE and RX until the device is powered down. This allows the device to re-tune the synthesizer regularly to adept to the changeable environment and therefore remain its highest performance. The device will continuously receive any incoming signals during the RX state and send out the demodulated data on the DOUT pin. The PUP sequence consumes about 4 ms. See the figure below for the timing and current consumption of the duty cycle receive mode
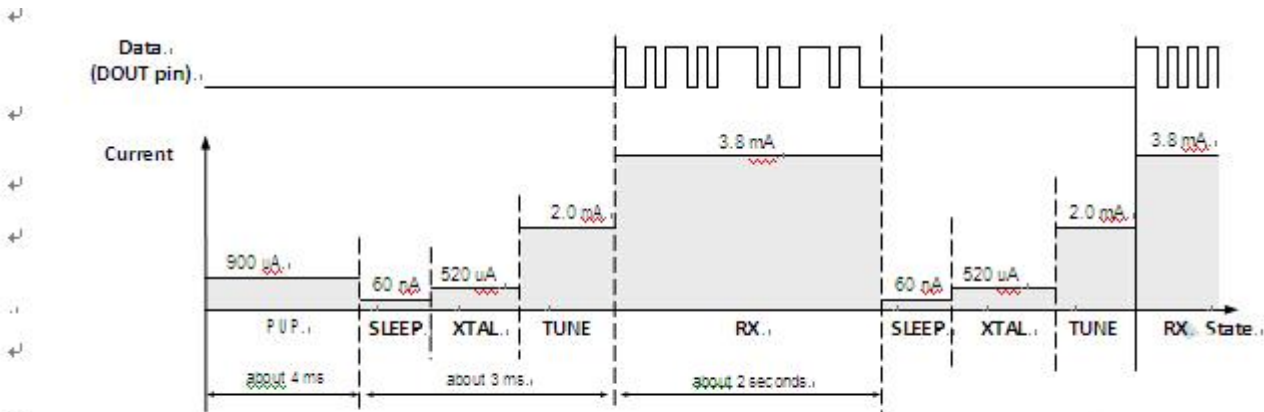
Figure 12. Timing and Current Consumption for Duty-Cycle Receive Mode

The advantages of the duty-cycle receive mode are listed below.

Maintaining the highest performance of the device by regular frequency re-tune.
Increasing the system stability by regular sleep (resetting most of the blocks).

If more current saving is required in the application, or other parameter need to be configured, the user can also use CMT2210A or other NextGenRF™ receivers with embedded EEPROM built-in and all product features configurable. For the more details, please refer to the "AN108 CMT2210A Configuration Guideline".

6. Ordering Information

RFM210LW-433 S1
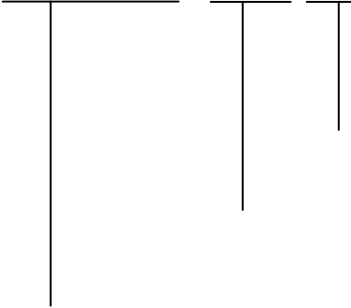
➤ Package

➤ Operation Band

➤ Mode Type

P/N: RFM210LW-315S1

   RFM210LW module at 315MHz band,SMD Package

P/N: RFM210LW-433S1

   RFM210LW module at 433MHz band,SMD Package
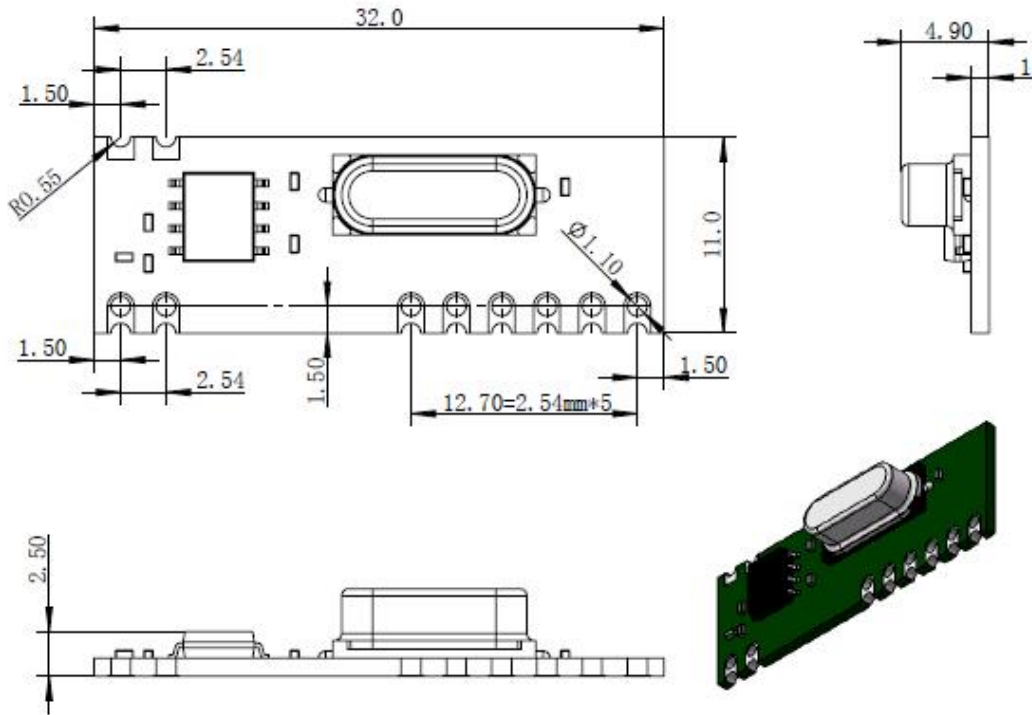
7. Package Outline

Figure 13 S1 Package Outline Drawi

8. Contact Information

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