CMOSTEK

# CMT2210LH

## Low Power 315MHz/433.92MHz OOK Receiver

### Instruction:

CMT2210LH is a low power, high performance OOK RF receiver. It is suitable for ISM band 315MHz/433.92MHz wireless applications. The CMT2210LH is a real plug and play chip without the register configuration or manual tuning. By selecting 19.7029MHz or 27.1412MHz crystal, the chip can operate at 315MHz or 433.92MHz. This chip supports the symbol rate range of 1~5 Kbps and is ideal for pairing with the low end transmitter based on the encoder or MCU. By selecting the VDD5V pin and VDDL pin open circuit or short circuit on the PCB, the CMT2210LH can operate at two voltage ranges of 3.0V-5.5V or 2.0V-3.6V. When the chip operates at 433.92MHz, the receiver sensitivity of the -109dBm can be achieved with only 4.5mA current. The device is packaged in SOP8 to facilitate the simple and low cost manufacturing. CMT2210LH receiver matching CMT211x transmitter can achieve the cost-effective RF application. For the higher performance receiver chip needs, users can choose CMT221xA, CMT2300A and other chips in the NextGenRF series.

### Applications:

- Low cost applications in the consumer electronics and appliances
- Automatic control of homes and buildings
- Infrared receiver replacement
- Industrial monitoring and control
- Wireless metering reading
- Wireless lighting control system
- Wireless alarm and security system
- Remote Keyless Entry (RKE)

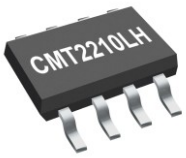
### Features:

- Working frequency：315MHz/ 433.92MHz
- OOK demodulation
- Symbol rate：1.0 - 5.0 kbps
- Sensitivity：-109 dBm（3.0 kbps），0.1％BER
- Receiver bandwidth：330kHz
- Image rejection ratio：30dB
- Maximum input signal：10 dBm
- Run independently. Input from the antenna. Output the data.
- Configure without the register.
- Supply voltage (optional):
  - 3.0 – 5.5 V (High voltage mode)
  - 2.0 – 3.6 V (Low voltage mode)
- Low power consumption: 4.5 mA
- RoHS Compliant
- SOP8 packaging

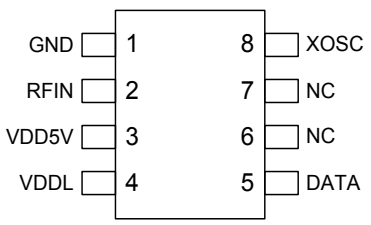
### Ordering information

| Product No. | Frequency | Packaging | MOQ |
|---|---|---|---|
| CMT2210LH-ESR | 315MHz/433.92MHz | SOP8/Tape | 2,500pcs |
| CMT2210LH-ESB | 315MHz/433.92MHz | SOP8/Tube | 1,000pcs |

For more ordering information, please see page15.




SOP8




CMT2210LH PIN ARRANGEMENT DIAGRAM

## Typical Applications:

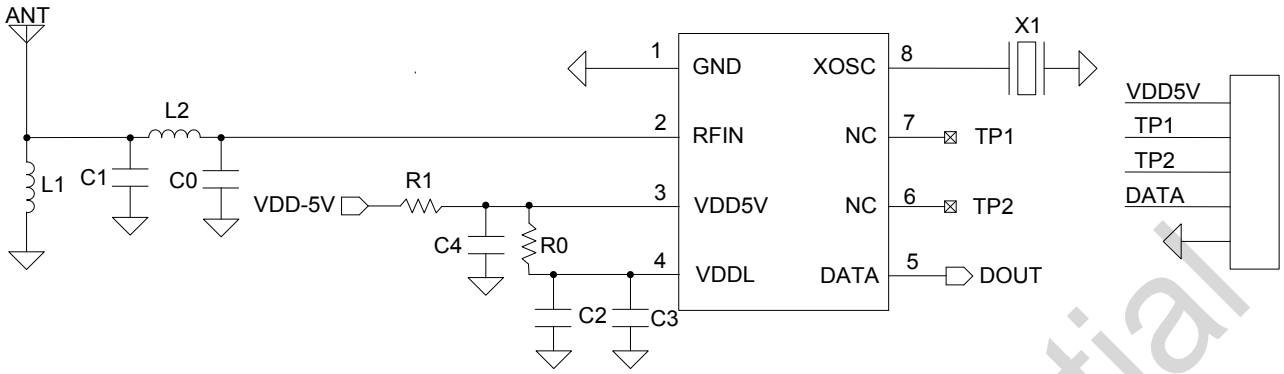



**Figure1. CMT2210LH Typical Application Schematic Diagram**

Remarks：

1. When the CMT2210LH needs to select the 3.0V-5.5V operating voltage range, the R0 is not soldered, that is, the connection between the VDD5V pin and VDDL pin is broken.
2. When the CMT2210LH needs to select the 2.0V-3.6V operating voltage range, R0 is 0, that is, the VDD5V is shorted to the VDDL;
3. The purpose of connecting R1 to VDD-5V is to prevent chips power-up in a complex power environment, so as to better protect the chip.

**Table1. Typical Application BOM**

| Symbol | Description | Value(Match to the λ/4 antenna) | | Unit | Supplier |
|---|---|---|---|---|---|
| | | 315MHz | 433.92MHz | | |
| U1 | CMT2210LH, low power 315MHz/433.92MHz OOK receiver | -- | | -- | CMOSTEK |
| X1 | ±20 ppm, SMD32*25 mm, crystal | 19.7029 | 27.1412 | MHz | EPSON |
| L1 | ±10%, 0603 stacked inductor | 62 | 36 | nH | Sunlord |
| L2 | ±10%, 0603 stacked inductor | 68 | 36 | nH | Sunlord |
| C0 | ±0.25 pF, 0402 NP0, 50 V | 3 | 3 | pF | Sunlord |
| C1 | ±0.25 pF, 0402 NP0, 50 V | 12 | 10 | pF | Sunlord |
| C2 | ±20%, 0603 X7R, 25 V | 0.1 | | uF | Sunlord |
| C3 | ±20%, 0603 NP0, 50 V | 470 | | pF | Sunlord |
| C4 | ±20%, 0603 X7R, 25 V | 0.1 | | uF | Sunlord |
| R0 | Option：<br>No welded between 3.0V and 5.5V working environment.<br>Welded between 2.0V and 3.6V working environment. | 0 | | Ω | |
| R1 | Protective resistor in series | 4.7 | | Ω | |

## Terminology:

The terminologies used in this article are described below:

| | | | |
|---|---|---|---|
| AGC | Automatic Gain Control | PC | Personal computer |
| AN | Application note | PCB | Printed circuit board |
| BER | Bit Error Rate | PLL | Phase-locked loop |
| BOM | Bill of material | PN9 | Pseudo-Random Binary Sequence |
| SC | Basic Spacing between Centers | POR | Power on reset |
| BW | Bandwidth | PUP | Power up |
| DC | Direct current | QFN | Quad Flat Non-lead |
| EEPROM | Electrically erasable programmable read-only memory | RF | Radio frequency |
| ESD | Electro-Static discharge | RFPDK | RF product development kit |
| SR | Equivalent series resistance | RoHS | Restriction of Hazardous Substances |
| IF | Intermediate frequency | RSSI | Received signal strength indicator |
| LNA | Low Noise Amplifier | Rx | Receiving, receiver |
| LO | Local oscillator | SAR | Successive approximation register |
| LPOSC | Low power oscillator | SOP | Small outline package |
| Max | Maximum | SPI | Serial Peripheral Interface |
| MCU | Micro controller unit | TH | Threshold |
| Min | Minimum | Tx | Transmitting, transmitter |
| MOQ | Minimum Order Quantity | Typ | Typical |
| NP0 | Temperature compensation characteristic | VCO | Voltage controlled oscillator |
| NC | Not connected | XOSC | Crystal oscillator |
| OOK | On-off keying | XTAL/Xtal | Crystal |

# Table of Contents

# 1. Electrical Characteristics

When $V_{DD}$= 3.3V，$T_{OP}$= 25 °C，$F_{RF}$ = 433.92 MHz，the sensitivity is measured by receiving a PN9 sequence and matching to 50Ω according to the 0.1%BER standard. All results are tested on the CMT2210LH-EM unless otherwise stated.

## 1.1 Recommended Operating Conditions

**Table2. Recommended Operating Conditions**

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Operating supply voltage | $V_{DD}$ | When the VDD5V and VDDL are open-circuit, the temperature range is between -40 ℃and +85 ℃. | 3.0 | | 5.5 | V |
| | | When the VDD5V and VDDL are short-circuit, the temperature range is between -40 ℃and +85 ℃. | 2.0 | | 3.6 | V |
| Operating temperature | $T_{OP}$ | | -40 | | 85 | ℃ |
| Supply voltage slope | | | 1 | | | mV/us |

## 1.2 Absolute Maximum Rating

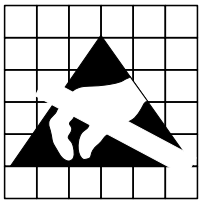
**Table3. Absolute Maximum Rating[1]**

| Parameter | Symbol | Condition | Min. | Max. | Unit |
|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | VDD5V and VDDL are open-circuit. | -0.3 | 5.5 | V |
| | | VDD5V and VDDL are short-circuit. | -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 | ℃ |
| Welding temperature | $T_{SDR}$ | Last at least 30 seconds | | 255 | ℃ |
| ESD grade [2] | | Human Body Model (HBM) | -2 | 2 | kV |
| Latching current | | @ 85 ℃ | -100 | 100 | mA |

**Remarks：**

[1]. Exceeding the "absolute maximum rating" may cause the permanent damage to the device. This value is a pressure rating and does not mean that the equipment function is affected under this pressure condition. But if the device is exposed in the absolute maximum rating condition for a long time, its reliability may be affected.

[2]. CMT2210LH is a high performance RF IC. The operation and assembly of this chip should only be performed on a workbench with good ESD protection.



**Warning! It is ESD sensitive device. In the operation of the chip, the user should pay attention to ESD precautions, so as to avoid the chip performance degradation or loss of function.**

## 1.3 Receiver

**Table4. Receiver Specification**

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Frequency range | $F_{RF}$ | $F_{XTAL}$ = 19.7029 MHz | | 315 | | MHz |
| | | $F_{XTAL}$ = 27.1412 MHz | | 433.92 | | MHz |
| Symbol rate | DR | | 1 | | 5 | kbps |
| Sensitivity | $S_{315}$ | $F_{RF}$ = 315 MHz, DR = 3 kbps, BER = 0.1% | | -109 | | dBm |
| | $S_{433.92}$ | $F_{RF}$ = 433.92 MHz, DR = 3 kbps, BER = 0.1% | | -109 | | dBm |
| Saturation input signal level | $P_{LVL}$ | | | 10 | | dBm |
| Working current | $I_{DD315}$ | $F_{RF}$ = 315 MHz | | 4.2 | | mA |
| | $I_{DD433.92}$ | $F_{RF}$ = 433.92 MHz | | 4.5 | | mA |
| Frequency synthesizer settle time | $T_{LOCK}$ | Start from XOSC stability | | 150 | | us |
| Anti blocking | BI | ±1 MHz, continuous wave interference | | 32 | | dB |
| | | ±2 MHz, continuous wave interference | | 42 | | dB |
| | | ±10 MHz, continuous wave interference | | 61 | | dB |
| Input 3rd order intercept point | IIP3 | FDEV = 1 MHz and 2 MHz double tone test, maximum system gain setting | | -23 | | dBm |
| Receiver bandwidth | $BW_{315}$ | $F_{RF}$ = 315 MHz | | 240 | | kHz |
| | $BW_{433.92}$ | $F_{RF}$ = 433.92 MHz | | 330 | | kHz |
| Receiver startup time [1] | $T_{START-UP}$ | From power up to receiving | | 4.5+$T_{XTAL}$ | | ms |

**Remarks:**

[1]. $T_{XTAL}$ is the oscillation time of crystal, which is related to the crystal itself and has nothing to do with the chip.

## 1.4 Crystal Oscillator

**Table5. Crystal Oscillator Specification**

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Crystal frequency [1] | $F_{XTAL315}$ | $F_{RF}$ = 315 MHz | | 19.7029 | | MHz |
| | $F_{XTAL433.92}$ | $F_{RF}$ = 433.92 MHz | | 27.1412 | | MHz |
| Crystal frequency accuracy [2] | | | | ±20 | | ppm |
| Load capacitance | $C_{LOAD}$ | | | 15 | | pF |
| Crystal equivalent resistance | Rm | | | | 60 | Ω |

| | | | | | | |
|---|---|---|---|---|---|---|
| Crystal start-up time [3] | $t_{XTAL}$ | | | 400 | | us |

**Remarks:**

[1]. CMT2210LH can use the external reference clock to drive the XIN pin through the coupling capacitor. The peak value of the external clock signal is between 0.3 and 0.7 V.

[2]. The value includes (1) an initial error; (2) a crystal load; (3) aging; and (4) a change with the temperature. The acceptable crystal frequency error is limited by the receiver's bandwidth and the RF frequency deviation between the transmitter and the receiver.

[3]. The parameter is largely related to the crystal.

## 2. Pin Description

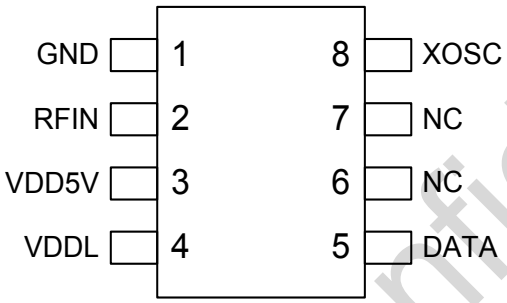



**Figure2. CMT2210LH Pin Arrangement**

**Table1. CMT2210LH Pin Description**

| Pin No. | Name | I/O | Function Description |
|---|---|---|---|
| 1 | GND | I | GND |
| 2 | RFIN | I | The RF signal is input to the LNA |
| 3 | VDD5V | I | Power input |
| 4 | VDDL | O | Power output |
| 5 | DATA | O | Received signal output |
| 6 | NC | -- | Unconnected |
| 7 | NC | -- | Unconnected |
| 8 | XIN | I | A crystal oscillator input or an external reference clock input |

## 3. Typical Performance

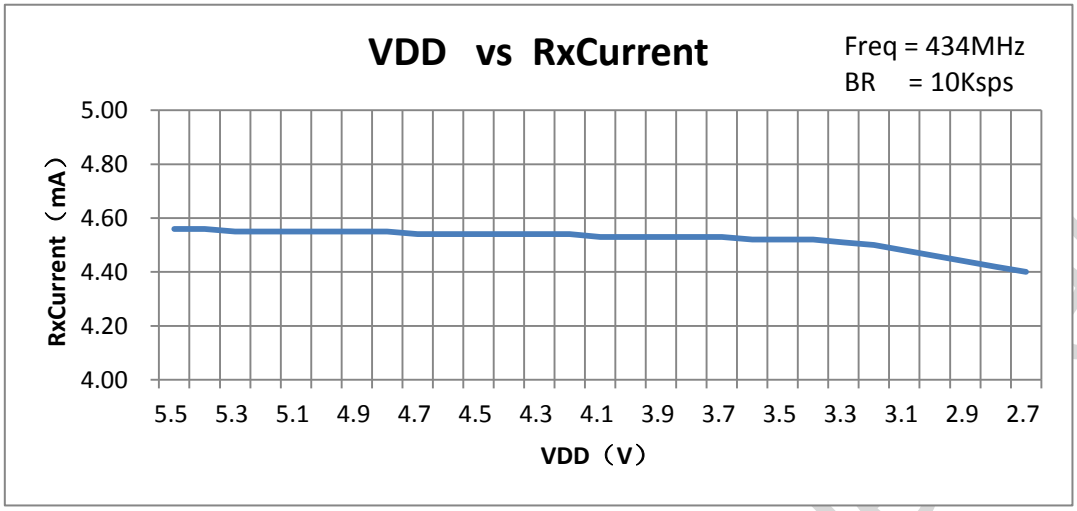



**Figure3. Rx Current vs Supply Voltage**

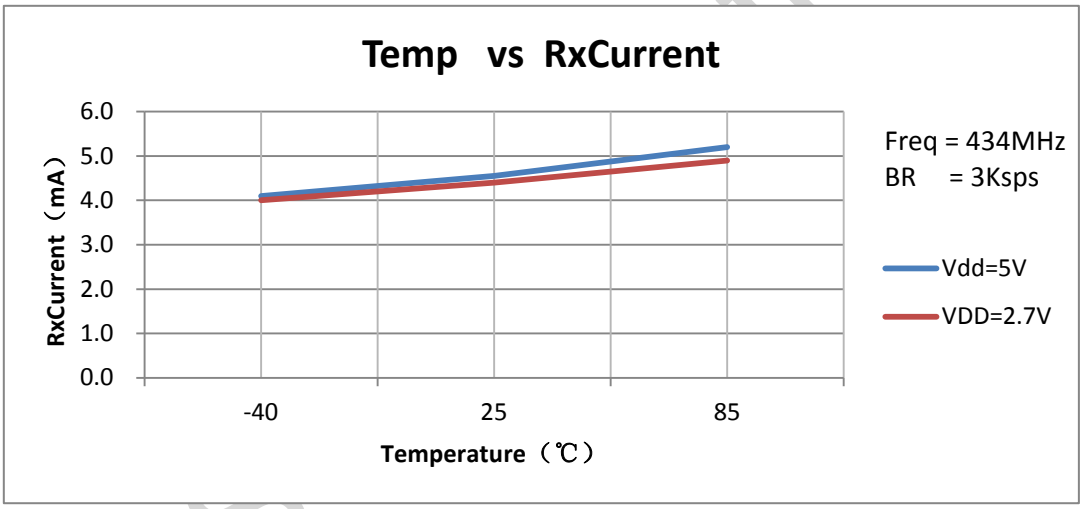



**Figure4. Rx Current vs Working Temperature**

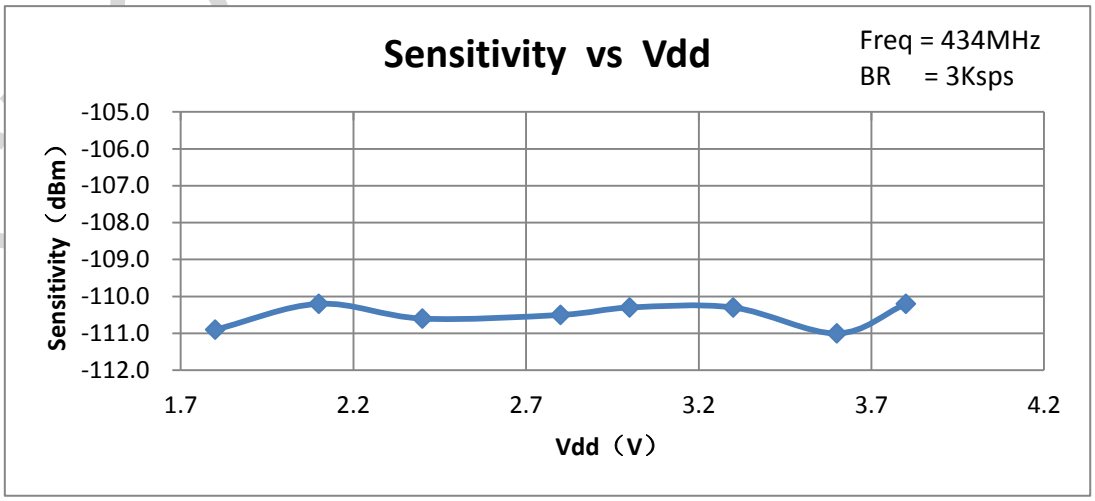



**Figure5. Sensitivity vs Supply Voltage**

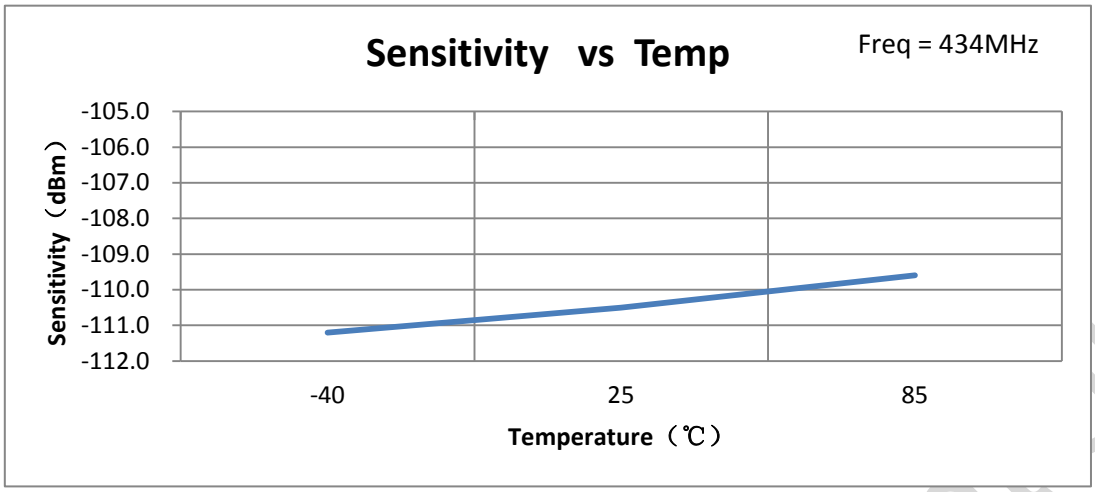



**Figure6. Sensitivity vs Working Temperature**

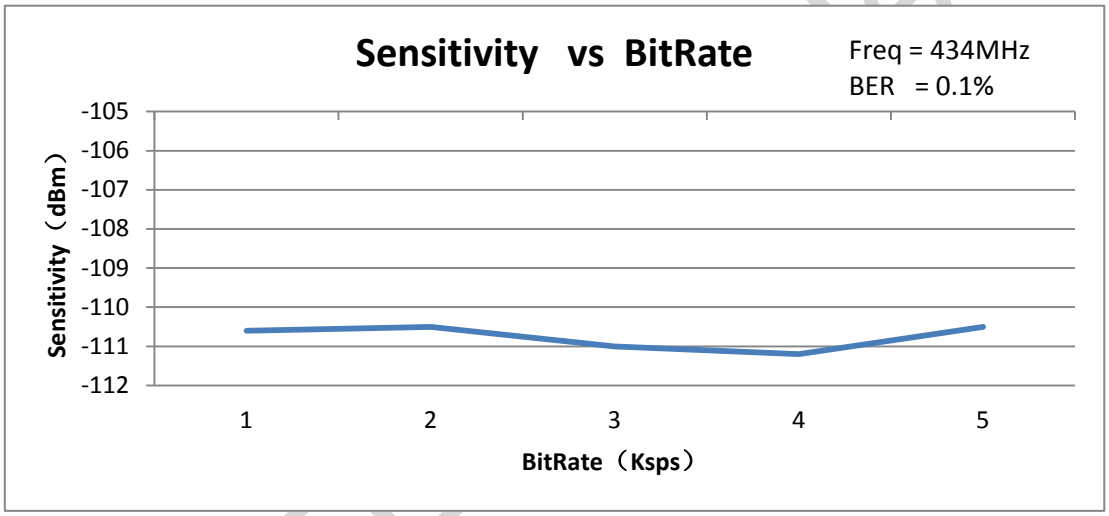



**Figure7. Sensitivity vs Bit Rate**

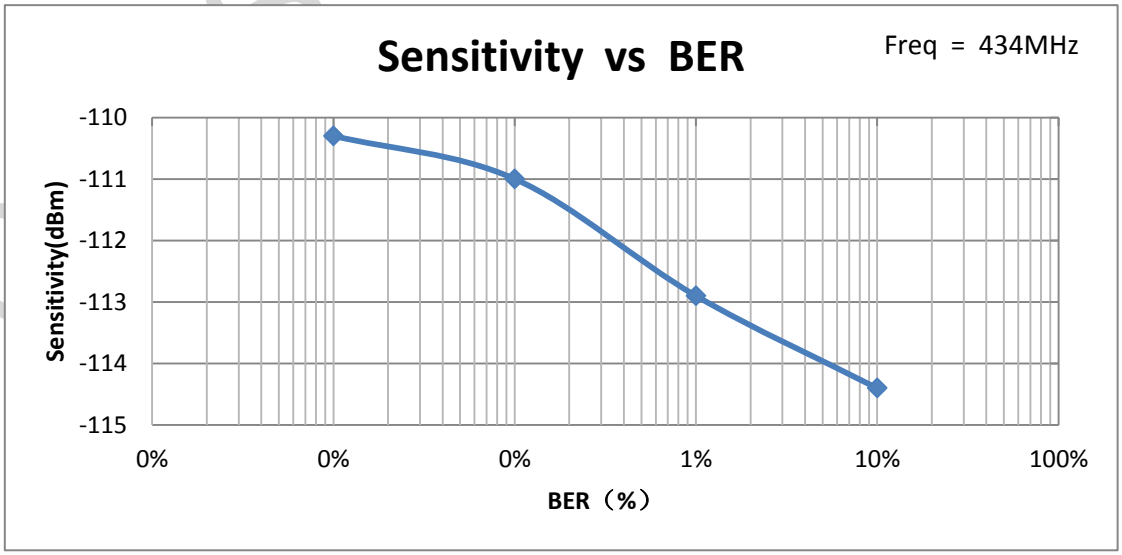



**Figure8. Sensitivity vs Bit Error Rate**

# 4. Typical Application Schematic Diagram

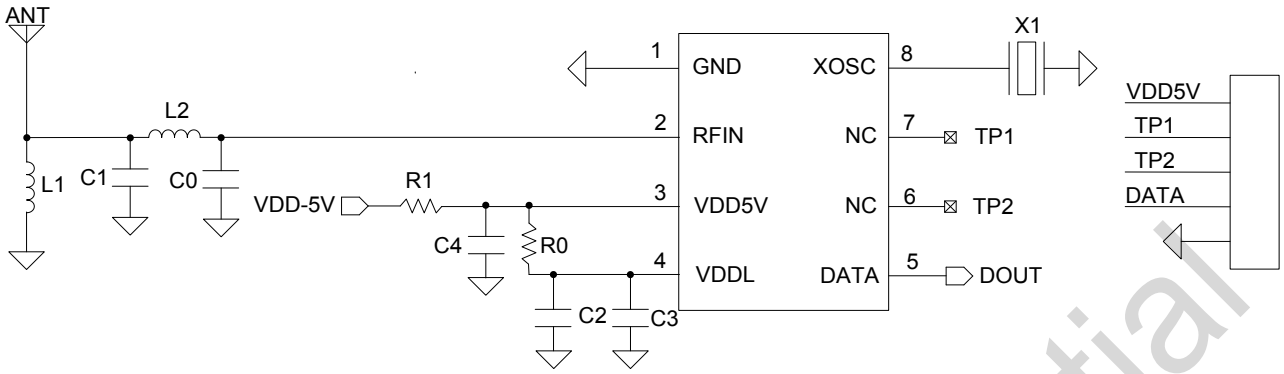



**Figure9. Typical Application Schematic Diagram**

**Application Notes:**

1. The PCB LAYOUT rules are shown below：
   - Try to design the large and continuous ground.
   - L1, L2, C0 and C1 are as close to the chip as possible, to reduce the distribution parameters of LNA and its loop, to prevent the loop from too long and to introduce noise signals.
   - Crystal X1 should be as close as possible to the chip CMT2210LH, so as to shorten the track between the crystal and the chip.
   - As many as possible grounding vias are placed along the edge of the plate to reduce the radiation of the RF signal and the interference from the outside. The spacing of the vias is much smaller than the 1/10 wavelength (operating frequency).
   - C2, C3, and C4 try to be near CMT2210LH to achieve better filtering results.
   - The metal case of the crystal grounds.
2. For more details on the design, please refer to the *AN158 CMT2210LH schematic and the PCB layout guidelines.*

**Table7. BOM matching the 315MHz / 433.92MHz typical application**

| Symbol | Description | Value(Match to the λ/4 antenna) | | Unit | Supplier |
|---|---|---|---|---|---|
| | | 315MHz | 433.92MHz | | |
| U1 | CMT2210LH, low power 315MHz/433.92 MHz OOK receiver | -- | | -- | CMOSTEK |
| X1 | ±20 ppm, SMD32*25 mm, crystal | 19.7029 | 27.1412 | MHz | EPSON |
| L1 | ±10%, 0603 stacked inductor | 62 | 36 | nH | Sunlord |
| L2 | ±10%, 0603 stacked inductor | 68 | 36 | nH | Sunlord |
| C0 | ±0.25 pF, 0402 NP0, 50 V | 3 | 3 | pF | Sunlord |
| C1 | ±0.25 pF, 0402 NP0, 50 V | 12 | 10 | pF | Sunlord |
| C2 | ±20%, 0603 X7R, 25 V | 0.1 | | uF | Sunlord |
| C3 | ±20%, 0603 NP0, 50 V | 470 | | pF | Sunlord |
| C4 | ±20%, 0603 X7R, 25 V | 0.1 | | uF | Sunlord |

| | | | | |
|---|---|---|---|---|
| R0 | Option：<br>No welded between 3.0V and 5.0V working environment.<br>Welded between 2.0V and 3.6V working environment. | 0 | Ω | |
| R1 | Protective resistor in series | 4.7 | Ω | |

# 5. Function Descriptions:

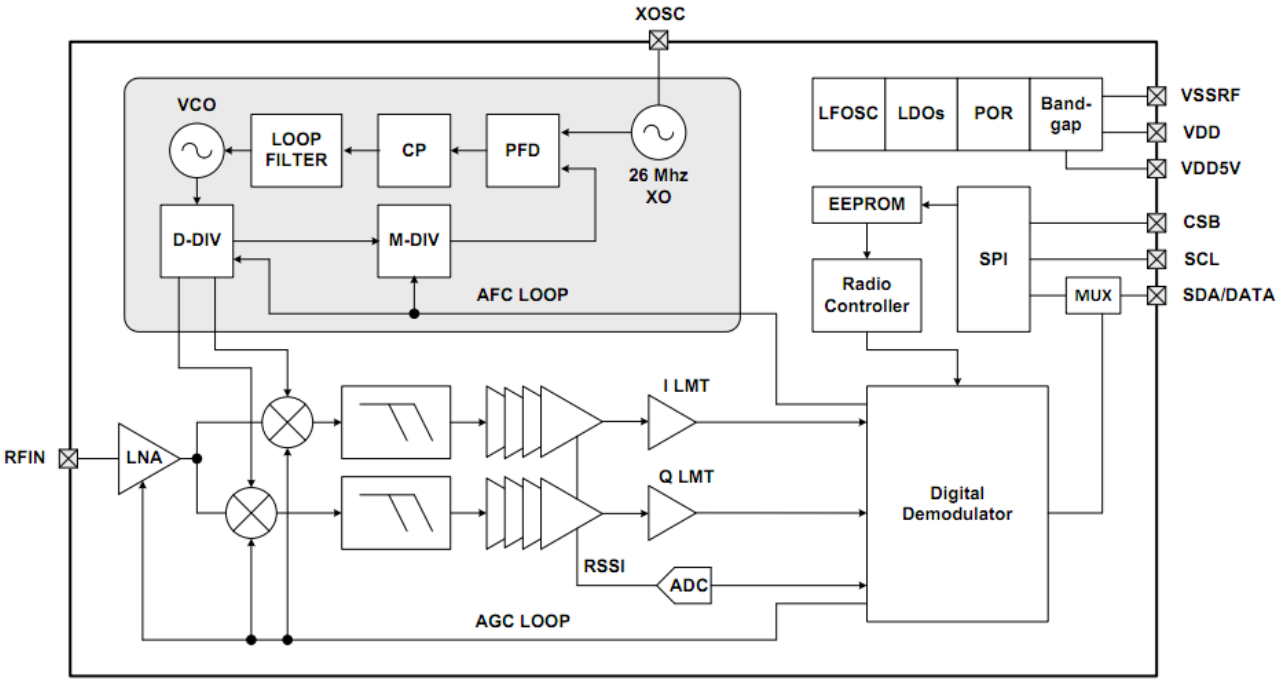



**Figure10. Function Module Diagram**

## 5.1 Summary

CMT2210LH is a digital-analog hybrid receiver. The product adopts the 26MHz crystal to provide the reference frequency and digital clock for PLL, supports OOK demodulation output with the data rate of 1.0-5.0Ksps, and supports the periodic reset with the configurable time to avoid the crash phenomenon caused by various external reasons. CMT2210LH supports two kinds of voltage, which can be used in the application of 5V system, and also can be chosen as the application of 3V system.

The chip uses LNA+MIXER+IFFILTER+LIMITTER+PLL's low intermediate frequency structure to achieve the wireless reception function below Sub-1G frequency. The analog front-end is responsible for mixing RF signals into intermediate frequency, and converting the real time RSSI into the 8-bit digital signal through SAR-ADC, and sending them to the interior to do the OOK demodulation and correlation processing. At the same time, the internal circuit will mix the intermediate frequency signal down to the zero frequency

(Baseband) and do a series of filtering and judging process, while AGC dynamically control the analog front-end. Finally, the original signal is demodulated and output through the DATA pin.

The parameters of the chip are stored in an internal EEPROM, and the user can modify or adjust the working parameters of the chip by the RFPDK.

## 5.2 Demodulation Mode, Frequency and Symbol Rate

CMT2210LH supports the OOK demodulation of 1.0-5.0ksps symbol rate. It supports for free ISM bands near 315 MHz and 433.92MHz. The following table gives the information about the demodulation mode, frequency and symbol rate of the CMT2210LH.

**Table 9. Demodulation mode, frequency and symbol rate**

| Parameter | Value | Unit |
|---|---|---|
| Demodulation mode | OOK | - |
| Frequency | 315 / 433.92 | MHz |
| Symbol rate | 1.0–5.0 | Ksps |

## 5.3 Function Module Description

### 5.3.1 RF Front-end and Automatic Gain Control

CMT2210LH is an OOK modulated receiver with the low intermediate frequency architecture. The receiver's RF front-end consists of a low noise amplifier (LNA), an I / Q mixer (Mixer), an intermediate frequency filter (IF Filter), and a wideband power detector (WB Power Detector). The RF front-end amplifies and converts the RF input signals from the antenna to the intermediate frequency for the further processing.

With the help of the broadband power detector and RF attenuation network of RF front-end, the automatic gain control (AGC) loop can adjust the RF front-end gain. The chip can also achieve the best system linearity, selectivity and sensitivity even under the condition of strong interference outside the band.

With only one low-cost matching circuit, the LNA input can be matched to 50Ω or other types of antennas.

### 5.3.2 Intermediate Frequency (IF) Filter

The signal from the RF front-end is filtered by an integrated 3rd order band pass image rejection filter. When the device operates at 433.92 MHz, the intermediate frequency bandwidth is 330 kHz. The center frequency and bandwidth will be adjusted automatically according to the selected crystal frequency.

### 5.3.3 Received Signal Strength Indicator

The output signal of the IF filter is amplified by the cascade I/Q logarithmic amplifier, and then sent to the

demodulator for demodulation. I/Q dual logarithmic amplifiers include the received signal strength indicator (RSSI). The indicator generates the DC level in proportion to the input signal level within the I/Q path. The sum of levels of these two paths is used as an indication of the received signal strength, with a dynamic range of more than 66dB.

### 5.3.4 Successive Approximation Register

The 8-bit SAR-ADC in CMT2210LH transforms the RSSI output into the digital signal for OOK demodulation.

### 5.3.5 Crystal Oscillator

CMT2210LH uses a single ended crystal oscillator circuit with the required load capacitance integrated within the chip. The recommended crystal is 19.7029MHz/27.1412MHz, with an accuracy of + 20 ppm, an equivalent resistance (ESR) <60 and a load capacitance (CLOAD) of 15pF. In order to save the external load capacitance, the load capacitance required by the crystal oscillation is integrated in the CMT2210LH chip.

If there is a suitable clock source (RCLK) in the application system, which can be used as the reference clock of CMT2210LH, the user can drive the XIN pin of the chip through the DC blocking capacitor. This will save one crystal and further reduce the system cost. The recommended RCLK peak to peak value is between 0.3V to 0.7V (at the XTAL pin).

### 5.3.6 Frequency Synthesizer

The frequency synthesizer is used to generate the local oscillator (LO) frequency required for the I/Q mixer. By the 19.7029 MHz or 27.1412 MHz reference clock provided by a crystal or external clock source, the frequency synthesizer can generate the 315MHz /433.92MHz working frequency. The internal high performance VCO operates at the 2x LO frequency without the external inductor. The chip can work stably in various conditions when it is powered up, and further save the system power consumption and stray radiation.

# 6. Ordering Information

**Table10. CMT2210LH Ordering Information**

| Product Number | Descriptions | Packaging | Packing | Condition | MOQ/ Integer multiple |
|---|---|---|---|---|---|
| CMT2210LH-ESR[1] | Low power 315MHz/433.92MHz OOK receiver | SOP8 | Tape & Reel | 2.0 to 3.6 V<br>3.0 to 5.5 V<br>-40 to 85 ℃ | 2,500 |
| CMT2210LH-ESB[1] | Low power 315MHz/433.92MHz OOK receiver | SOP8 | Tube | 2.0 to 3.6 V<br>3.0 to 5.5 V<br>-40 to 85 ℃ | 1,000 |

**Remarks:**

[1]. “E” represents the extended industrial grade. The temperature range is from -40 to +85.

“S” represents the SOP8 packaging.

"R" represents the tape reel packing. MOQ is 2500pcs; "B" represents the tube packing.MOQ is 1000pcs.

For more information about the product, please visit www.cmostek.com.

For purchasing or price requirements, please contact sales@cmostek.com or local sales representative.

## 7. Packaging Information

CMT2210LH packaging is SOP8. The packaging information is as below.

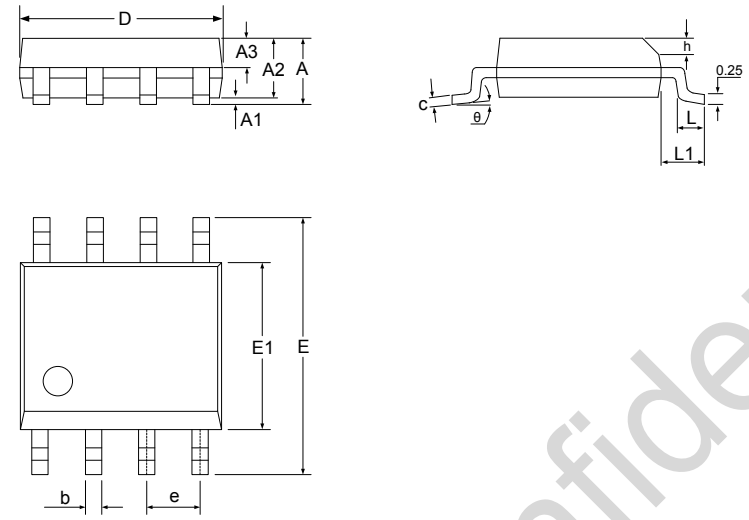



**Figure11. SOP8 Packaging**

**Table11. SOP8 Packaging Size**

| Symbol | Size (mm) | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | - | - | 1.75 |
| A1 | 0.10 | - | 0.225 |
| A2 | 1.30 | 1.40 | 1.50 |
| A3 | 0.60 | 0.65 | 0.70 |
| b | 0.39 | - | 0.48 |
| c | 0.21 | - | 0.26 |
| D | 4.70 | 4.90 | 5.10 |
| E | 5.80 | 6.00 | 6.20 |
| E1 | 3.70 | 3.90 | 4.10 |
| e | 1.27 BSC | | |
| h | 0.25 | - | 0.50 |
| L | 0.50 | - | 0.80 |
| L1 | 1.05 BSC | | |
| θ | 0 | - | 8° |

## 8. Top Marking

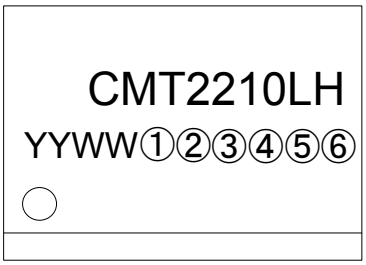



**Figure12. CMT2210LH Top Marking**

**Table12. CMT2210LH Top Marking Description**

| | |
|---|---|
| **Marking method** | Laser |
| **Pin 1 mark** | Circle diameter = 1 mm |
| **Font height** | 0.6 mm, right aligned. |
| **Font width** | 0.4 mm |
| **Line 1 marking** | CMT2210LH represents the model. |
| **Line 2 marking** | YYWW is the date code set by the packaging factory. YY represents the last 2 digits of the year. WW represents the manufacturing week. ①②③④ represents the internal tracking coding |

# 9. Other Documents

**Table13. CMT2210LH Related Documents**

| Doc. No. | Doc. name | Descriptions |
|---|---|---|
| AN157 | CMT2210LH Configuration Guideline | Introduce the configuring CMT2210LH details by RFPDK |
| AN158 | CMT2210LH schematic and PCB layout guideline | Introduce CMT2210LH schematic and PCB layout design rules, RF matching network and other layout considerations. It is the Chinese version. |

# 10. Document Modification Record

**Table14. Document Modification Record Sheet**

| Version | Chapter | Modification descriptions | Date |
|---|---|---|---|
| 0.1 | All | Initial release version | 2017-10-08 |
| 0.2 | All | Fix spelling and grammar mistakes | 2017-10-10 |
| 0.3 | 1 | Page2，Table1，3.0～5.5V | 2018-02-07 |

## 11. Contact Information

Wuxi CMOSTEK Microelectronics Co., Ltd. Shenzhen branch

Room 203, Honghai Building, Qianhai Road, Nanshan District, Shenzhen, Guangdong, China

Zip Code： 518000

Tel： +86 - 755 - 83235017

Fax： +86 - 755 - 82761326

Sales： sales@cmostek.com

Technical support： support@cmostek.com

Website： www.cmostek.com