# CMT2300A/CMT2119B/CMT2219B RF Frequency Calculation Guide

## Overview

This document discusses the RF frequency calculation formula for CMT2300A / CMT2119B / CMT2219B, which helps on further design and application based on the products.

The product models covered in this document are shown in the below table.

**Table 1. Product Models Covered in This Document**

| Product Model | Frequency Range | Modulation Type | Main Function | Configuration Mode | Packaging |
|---|---|---|---|---|---|
| CMT2300A | 126.33 - 1020 MHz | (G)FSK/OOK | Transceiver | Register | QFN16 |
| CMT2119B | 126.33 - 1020 MHz | (G)FSK/OOK | Transmitter | Register | QFN16 |
| CMT2219B | 126.33 - 1020 MHz | (G)FSK/OOK | Receiver | Register | QFN16 |

Before reading this document, it is recommended to read the *AN142-CMT2300A Quick Start Guide, AN184-CMT2119B Quick Start Guide* and AN161-CMT2219B *Quick Start Guide* to understand the basic information of the 3 products.

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# 1 RF Frequency Calculation

The RF frequency calculation and manual configuration methods for the 3 products are described below. Note that the description of RX part is not applicable to the CMT2119B and the statement of TX part is not applicable to the CMT2219B.

In general, when configuring RF frequency, it's recommended for users to generate parameters using RFPDK and write them to the registers in the frequency area. If users need to configure the frequency of TX and RX separately in applications while not using the fast frequency hopping mechanism, it's required for users to know the detail information of the register configuration and related value calculation. The registers in the frequency area are listed in the below table.

**Table 2. Registers in Frequency Area**

| Addr | R/W | Name | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x18 | RW | CUS_RF1 | FREQ_RX_N [7:0] | | | | | | | | Frequency Area |
| 0x19 | RW | CUS_RF2 | FREQ_RX_K [7:0] | | | | | | | | |
| 0x1A | RW | CUS_RF3 | FREQ_RX_K [15:8] | | | | | | | | |
| 0x1B | RW | CUS_RF4 | FREQ_PALDO_SEL | FREQ_DIVX_CODE [2:0] | | | FREQ_RX_K [19:16] | | | | |
| 0x1C | RW | CUS_RF5 | FREQ_TX_N [7:0] | | | | | | | | |
| 0x1D | RW | CUS_RF6 | FREQ_TX_K [7:0] | | | | | | | | |
| 0x1E | RW | CUS_RF7 | FREQ_TX_K [15:8] | | | | | | | | |
| 0x1F | RW | CUS_RF8 | FSK_SWT | FREQ_VCO_BANK [2:0] (000) | | | FREQ_TX_K [19:16] | | | | |

In the table, the value of FSK_SWT is generated by RFPDK, with no depending on frequency. Do not change this value when configuring other bits of the register.

## 1.1 Configuring RF Parameters of RX

To configure the frequency of RX, the below items need to be configured.

- FREQ_VCO_BANK <2:0>
- FREQ_DIVX_CODE <2:0>
- FREQ_RX_N <7:0>
- FREQ_RX_K <19:0>
- AFC_OVF_TH <7:0>

Among them, N is the integer part of the frequency word, K is the fractional part of the frequency word, DIVX CODE is used to select the division factor of the PLL, and VCO BANK is used to select the operating frequency range of the VCO. The calculation is as follows.

First, check the table to get the value of FREQ_VCO_BANK<2:0> and FREQ_DIVX_CODE<2:0> (both need to be written to the registers) and DIVIDER (frequency dividing factor, used to calculate N and K) according to the target frequency band where the configured frequency is located.

**Table 3. Correspondence between PLL Analysis Parameters and Target Frequencies**

| Target Frequency Band | | FREQ_DIVX_CODE <2:0> | DIVIDER |
|---|---|---|---|
| FREQ_VCO_BANK<2:0> = 110 | FREQ_VCO_BANK<2:0> = 001 | | |
| 758 – 840 MHz | 840 – 1020 MHz | 000 | 2 |
| 379 – 420 MHz | 420 – 510 MHz | 001 | 4 |
| 189.5 – 210 MHz | 210 – 255 MHz | 010 | 8 |
| 126.33 – 140 MHz | 140 – 170 MHz | 011 | 12 |
| 252.67 – 280 MHz | 280 – 340 MHz | 101 | 6 |

Then calculate the frequency of the LO (local oscillator). In the formula below, FREQ_RF is the target RF frequency in MHz. FREQ_LO is the calculated local oscillator frequency in Hz.

**FREQ_LO = FREQ_RF x 10^6 + 26 MHz/92**

Then calculate the value of the frequency word N.K.

**N.K = FREQ_LO x DIVIDER / 26 MHz**

Obtain the integer part of N.K and convert it to binary, which is the value of FREQ_RX_N <7:0>. The fractional part is multiplied by 2^20 and rounded off, which is the value of the register FREQ_RX_K <19:0>.

The last step is to get the value of AFC_OVF_TH <7:0>. This register is not in the frequency area. As an key parameter of the receiver AFC algorithm, it is calculated based on such parameters of receivers as RX RF frequency, data rate, deviation, and crystal PPM. When the calculation completes, the result displays on the RFPDK screen as shown in the below figure.

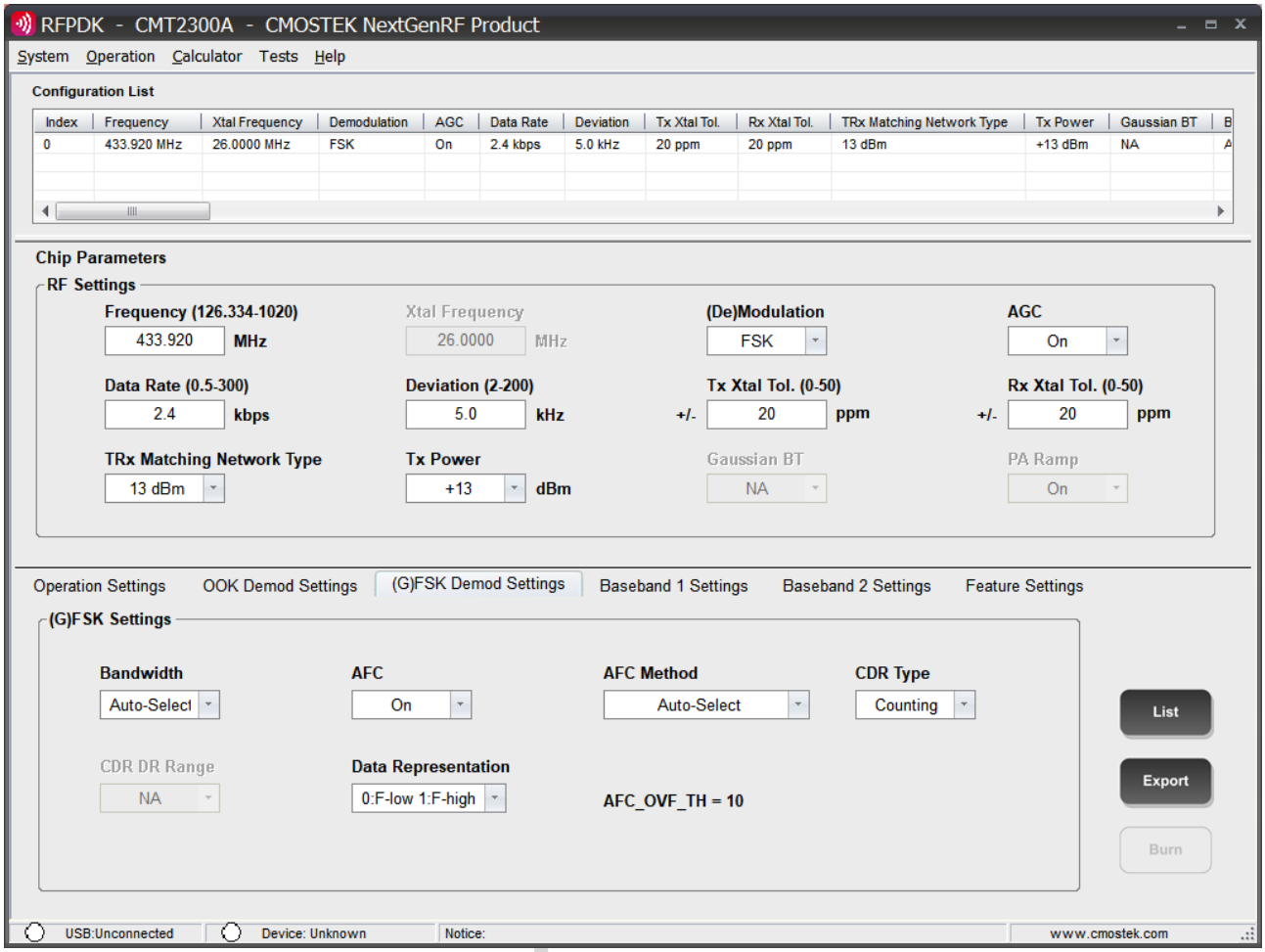


**Figure 1. AFC_OVF_TH Screen of RFPDK**

Users need to fill in the desired RF frequency of RX for manual configure in RFPDK, then get the value of AFC_OVF_TH <7:0>. As the last step, fill it into the register with an address of 0x27 CUS_FSK4 to make the receiver work normally, otherwise the receiver may have error when performing AFC, which may cause receiving failure.

For example, if the target RF frequency for RX to be configured is 433.92 MHz, according to the above calculation, it can obtain the followings.

- FREQ_VCO_BANK <2:0> is 001.
- FREQ_DIVX_CODE <2:0> is 001, and DIVIDER is 4.
- FREQ_LO is 434202608.7.
- N.K is 66.80040135.
- FREQ_RX_N <7:0> is 66 and the corresponding binary is 01000010.
- FREQ_RX_K <19:0> is 839282 and the corresponding binary is 11001100111001110010.
- AFC_OVF_TH <7:0> is available in RFPDK.

## 1.2 Configuring RF Parameters of TX

Followings need to be configured for TX.

- FREQ_VCO_BANK <2:0>
- FREQ_DIVX_CODE <2:0>
- FREQ_TX_N <7:0>
- FREQ_TX_K <19:0>
- FREQ_PALDO_SEL

Among them, FREQ_VCO_BANK<2:0> and FREQ_DIVX_CODE <2:0> are obtained in the same way as in RX, that is, TX and RX share DIVX CODE and VCO BANK. If the target frequency bands are not the same, when each time TX or RX is configured, recalculation and writing to these two registers is needed.

Then calculate the frequency of the LO (local oscillator), which is different from the LO frequency of RX. In the formula below, FREQ_RF is the target RF frequency in MHz. FREQ_LO is the calculated local oscillator frequency in Hz.

**FREQ_LO = FREQ_RF x 10^6**

Then calculate the value of the frequency word N.K, which is the same as the N.K value calculation formula for RX:

**N.K = FREQ_LO x DIVIDER / 26 MHz**

At last, check the table below to get the value of FREQ_PALDO_SEL:

| TX Frequency | FREQ_PALDO_SEL |
|---|---|
| < 500 MHz | 0 |
| >= 500 MHz | 1 |

For example, if the target RF frequency for TX to be configured is 433.92 MHz, according to the above calculation, it can obtain the followings.

- FREQ_VCO_BANK <2:0> is 001.
- FREQ_DIVX_CODE <2:0> is 001, and DIVIDER is 4.
- FREQ_LO is 433920000.
- N.K is 66.75692308.
- FREQ_TX_N <7:0> is 66 and the corresponding binary is 01000010
- FREQ_TX_K <19:0> is 793691 and the corresponding binary is 11000001110001011011.
- FREQ_PALDO_SEL is 0.

# 2 Revise History

**Table 1. Revise History Records**

| Version No. | Chapter | Description | Date |
|---|---|---|---|
| 0.8 | All | Initial version | 2018-10-10 |

# 3 Contacts

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