

## 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									Frequency Area
0x19	RW	CUS_RF2									
0x1A	RW	CUS_RF3									
0x1B	RW	CUS_RF4	FREQ_PALDO_SEL								
0x1C	RW	CUS_RF5									
0x1D	RW	CUS_RF6									
0x1E	RW	CUS_RF7									
0x1F	RW	CUS_RF8	FSK_SWT								

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.

$$\text{FREQ\_LO} = \text{FREQ\_RF} \times 10^6 + 26 \text{ MHz}/92$$

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

$$\text{N.K} = \text{FREQ\_LO} \times \text{DIVIDER} / 26 \text{ MHz}$$

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<sup>20</sup> 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.

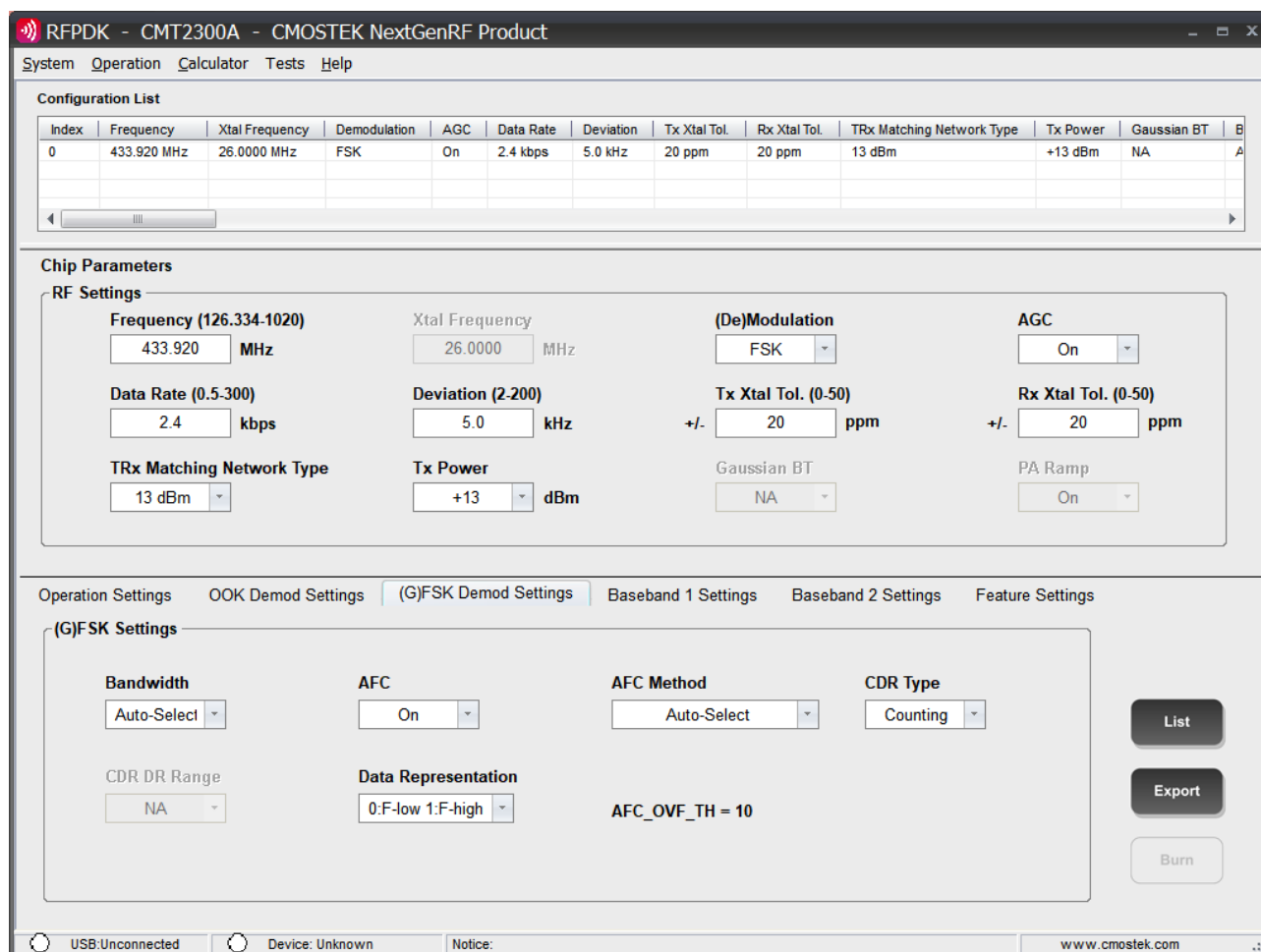


Figure 1. AFC\_OVF\_TH Screen of RFPDK

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.

$$\text{FREQ\_LO} = \text{FREQ\_RF} \times 10^6$$

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

$$\text{N.K} = \text{FREQ\_LO} \times \text{DIVIDER} / 26 \text{ MHz}$$

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
0.7	All	Initial version	2018-10-10

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## 3 Contacts

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