CMOSTEK

AN199

CMT2300A / CMT2119B / CMT2219B 射频频率计算指南

概要

This document discusses the RF frequency calculation formula for CMT2300A / CMT2119B / CMT2219B, which helps on user design and applications.

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

Table 1. Product Models Covered in This Document

产品型号	工作频率	调制方式	主要功能	配置方式	封装
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* and AN184-CMT2119B *Quick Start Guide* to understand the basic information of the 3 products.

目录

1. RF frequency calculation

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

通常情况下，我们建议用户直接使用 RFPDK 来生成参数，并将参数写入频率区的寄存器来完成对射频频率的配置。如果用户希望在应用程序中单独配置 TX 和 RX 的频率，而又不希望使用快速跳频的机制，那么就需要了解具体配置哪些寄存器，以及这些寄存器的值是如何计算的。下面是频率区的寄存器列表：

In general, when doing the configuration of RF frequency, it's recommend for users to generate parameters directly 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 without using the fast frequency hopping mechanism, then it's required 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 the Frequency Area

表 2. 频率区的寄存器

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]								频率区
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, irrelevant to frequency. Users do not need to change its value when configuring other bits of the register.

1.1 Configuring RF Parameters of RX

To configure the frequency of the 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>

其中 N 值是频率字的整数部分，K 值是频率字的小数部分，DIVX CODE 用于选择 PLL 的分频系数，VCO BANK 用于选择 VCO 的工作频率区域。计算方式如下：

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.

首先根据希望配置的 RX 频率所属的目标频段，查表得到 FREQ_VCO_BANK<2:0>和 FREQ_DIVX_CODE<2:0>的值（两者都需要写入寄存器），和分频系数 DIVIDER 的值（用于后续计算 N.K 值）：

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 in which 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

然后计算出 LO（本振）的频率。在下面的公式中，FREQ_RF 是目标射频频率，单位是 MHz。FREQ_LO 是计算出的本振频率，单位是 Hz。

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 which is an important parameter of the receiver AFC algorithm, it is calculated based on the parameters of receivers such as RX RF frequency, data rate, deviation, and crystal PPM. RFPDK will complete this calculation and display it on the UI screen as follows.

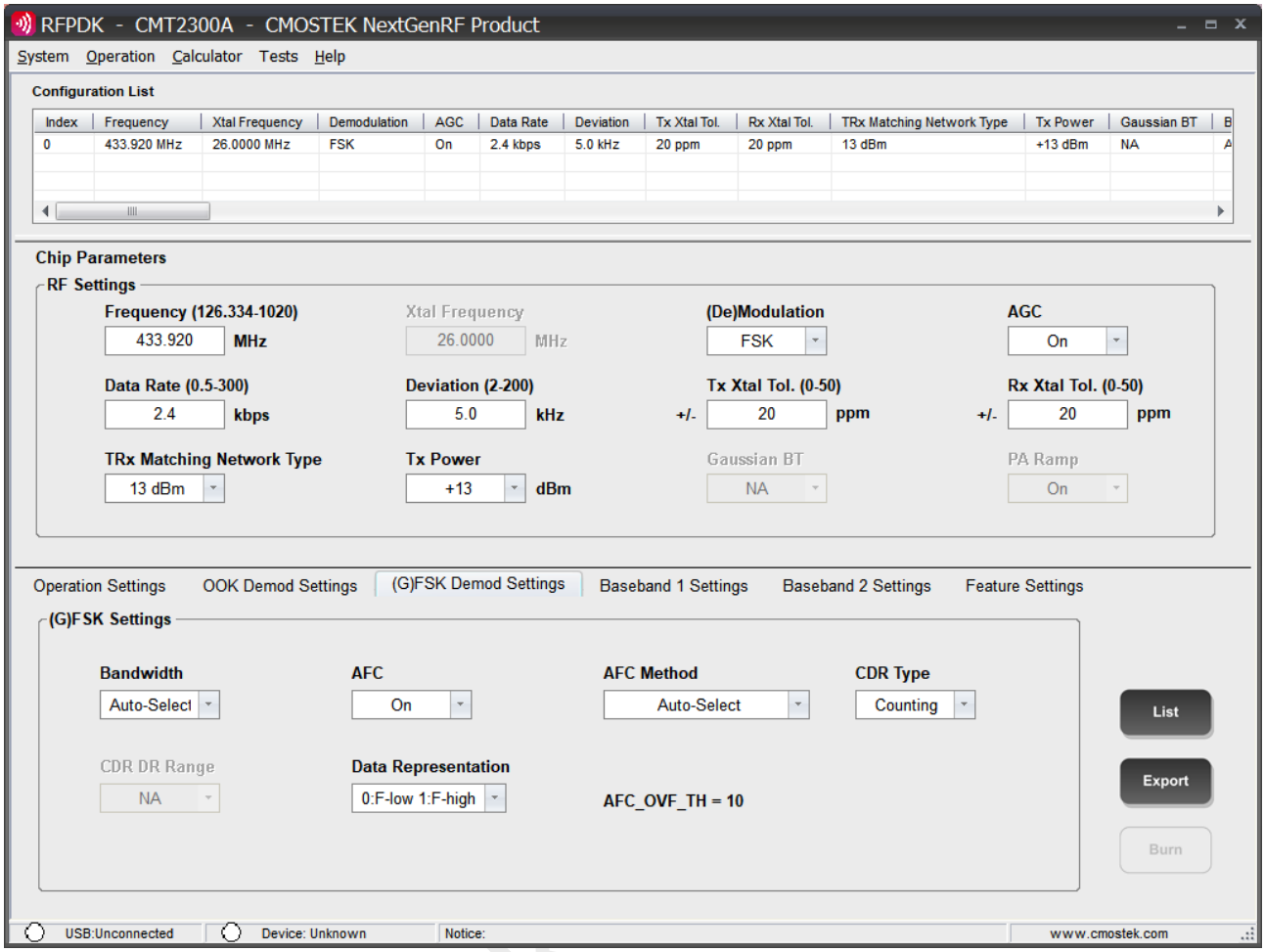

Figure 1. AFC_OVF_TH Screen of RFPDK

User needs to fill in the RF frequency of the RX desired 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 the address 0x27 CUS_FSK4, to make the receiver works normally, otherwise the receiver may have error when doing 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 is 11001100111001110010.
AFC_OVF_TH <7:0> is available in RFPDK.

To configure the TX frequency, you need to configure:

1.2 配置 TX 的射频参数 Configure RF Parameters for 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 R.N.K value calculation formula:

N.K = FREQ_LO x DIVIDER / 26MHz

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

举个例子，如果需要配置的 TX 目标射频频率是 433.92 MHz，根据上面的计算步骤，得出：

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_RX_N <7:0> is 66 and the corresponding binary is 01000010
FREQ_RX_K <19:0> is 793691 and the corresponding is 11000001110001011011.
FREQ_PALDO_SEL is 0..

- FREQ_VCO_BANK <2:0>的值是 001
- FREQ_DIVX_CODE <2:0>是 001，DIVIDER 的值是 4
- FREQ_LO 的值是 433920000
- N.K 的值是 66.75692308
- FREQ_RX_N <7:0>的值是 66，二进制是 01000010
- FREQ_RX_K <19:0>的值是 793691，二进制是 11000001110001011011
- FREQ_PALDO_SEL 是 0

2. 文档变更记录

表 3. 文档变更记录表

版本号	章节	变更描述	日期
0.8	所有	初始版本发布	2017-10-31

3. 联系方式

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