HOPERF **AN244**

CMT2312A Quick Switching of Pre-stored Configuration User Guide

Summary

This article introduces the featured functions of CMT2312A quickly switch between pre-stored configurations.

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

Table1. Product models covered in this document

Product model	Operating frequency	Modulation mode	Main function	Configuration	Package
CMT2312A	113-960 MHz	(4) (G) FSK/OOK	transceiver	register	QFN24

Before reading this document, it is recommended to first understand the CMT2310A and the related AN document, especially the Duty Cycle and SLP functions of the CMT2310A (you can read AN239 "CMT2310A Automatic Transmit and Receive Function User Guide"). CMT2312A is an upgraded version of CMT2310A, which mainly adds the feature of "quickly switching pre-stored configuration". Other basic functions and usage methods are the same as CMT2310A.

Catalogue

1. Introduction to Quickly Switch Pre-Stored Configuration Functions

The fast switching of pre-stored configuration function supported by CMT2312A means that the internal RF controller of CMT2312A quickly transfers the configuration pre-stored in the chip's internal OTP to the chip register at the DMA level, which can save users from configuring register addresses one by one through the SPI of the external MCU. The schematic diagram of its functional framework is as follows.

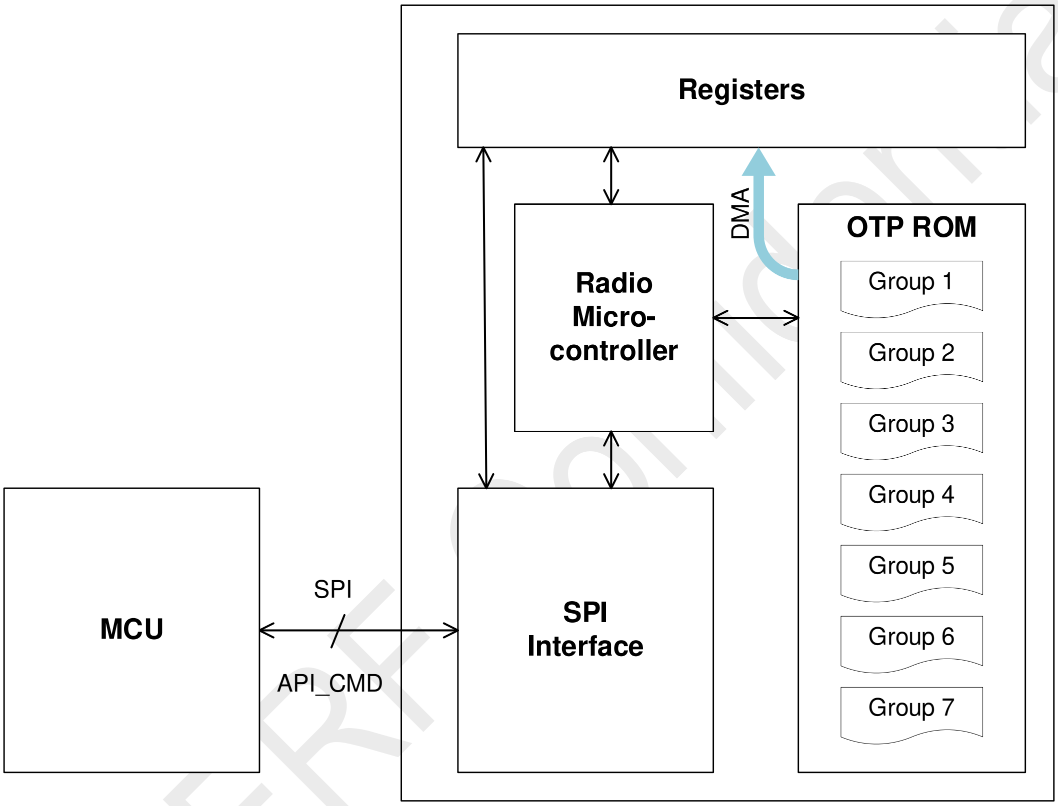


Figure1. CMT2312A Quick Switch Pre-stored Configuration Block Diagram

Table 1. FIFO Related Parameters

Register name	Bit number	R/W	Bit name	Function description
Page0 CTL_REG_8 (0x08)	6:0	W	API _ CMD < 6: 0 >	0x01: Initialization calibration 0x02: Initialization calibration 0x07: Quickly import Group1 configuration 0x08: Quickly import Group2 configuration 0x09: Quickly import Group3 configuration 0x0A: Quickly import Group4 configuration

Register name	Bit number	R/W	Bit name	Function description
				0x0B: Quickly import Group5 configuration 0x0C: Quickly import Group6 configuration 0x0D: Quickly import Group7 configuration
Page0 CTL_REG_9 (0x14)	7	R	API _ CMD _ FLAG	API command flags 0：API commandsin execution 1: API command execution completed
	6:0	R	API _ RESP < 6: 0 >	API command execution value, i.e. API _ CMD < 6: 0 >

Operation process for quickly switching pre-stored configurations:

- Set CMT2312A in Ready mode;
- Set the GroupN configuration that needs to be switched through the API _ CMD command;
- Wait for the API _ CMD command to complete execution;
- Operate by user function, such as switching Rx or Tx states.

Example code for the procedure:

```
    # define CMT2310A _ API _ CMD _ FLAG 0x80
    # define GROUP _ 1 0x07
    # define GROUP _ 2 0x08
    # define GROUP _ 3 0x09
    # define GROUP _ 4 0x0A
    # define GROUP _ 5 0x0B
    # define GROUP _ 6 0x0C
    # define GROUP _ 7 0x0D
    ……
void main (void)
    {
    ……
    Cmt2312a _ go _ ready ();
    Cmt2312a _ delay _ ms (2);
    Cmt2312a _ burst _ cfg (GROUP _ 1);
    Cmt2312a _ go _ rx ();
    ……
    }
```

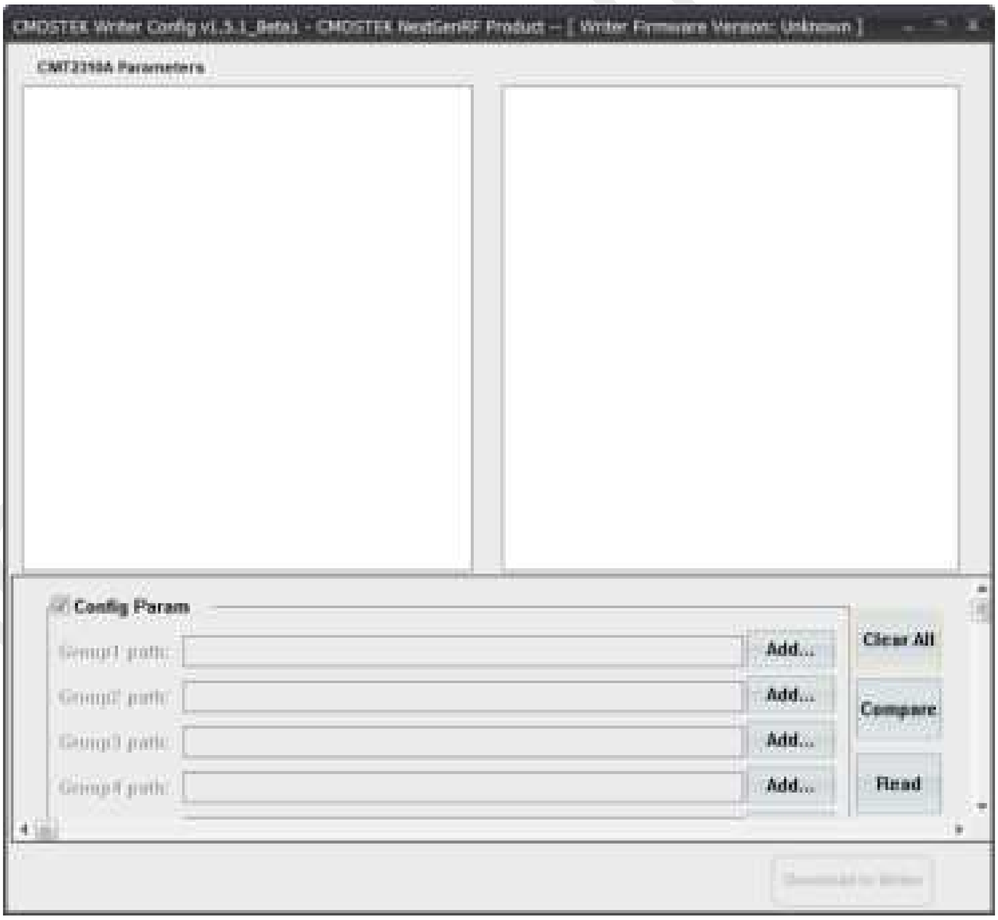
```
Boolean _ t cmt2312a _ burst _ cfg (unsigned char api _ cmd)
    {
    byte i;
    bRadioWriteReg (CMT2312A _ CTL _ REG _ 08, api _ cmd);
    api _ cmd | = CMT2312A _ API _ CMD _ FLAG;
    for (i = 0; i < 10; i + +)
        {
        delay10us (2);
        if (bRadioReadReg (CMT2312A _ CTL _ REG _ 09) = api _ cmd)
            return (TRUE);
        }
    return (FALSE);
    }
```

2. Pre-stored Configuration for Burning Operation

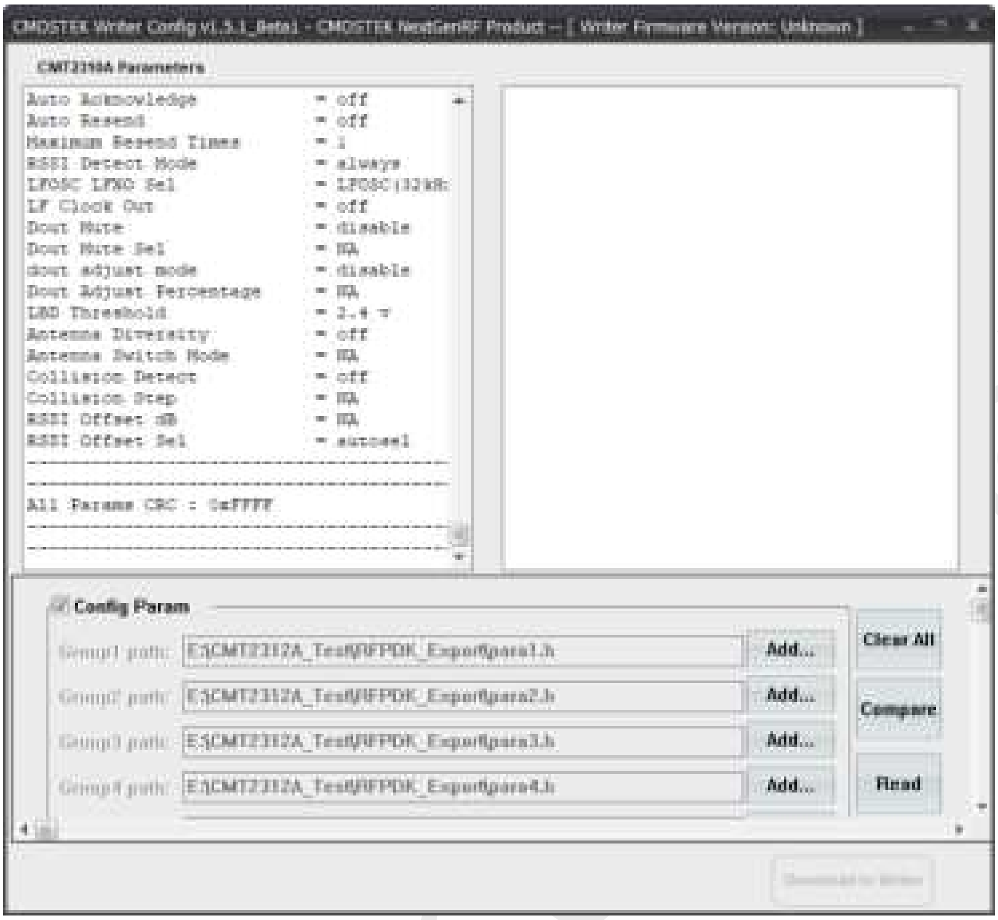
The pre-stored configuration of CMT2312A is stored in the OTP inside the chip. Burning requires the use of offline burner (CMOSTEK Off-line Writer) and Writer Configer user interface software.

Connect the user's computer to the offline burner through a USB cable, then open the Writer Configer interface, as shown in the figure below, and select CMT2312A.

After clicking the "OK" button, the interface switches as follows. At this time, in the "Config Param" box, 7 import paths of pre-stored configurations are provided, and you can configure and import them one by one by clicking "Add...".



The figure below shows 7 sets of configurations imported.



Note:

1. *The import configuration doesn't have to be sequential, nor does it have to be filled, it can be selected arbitrarily. For example: Leave Group1 blank and select Group2 ~ Group7; You can also select only Group2 and leave others blank. However, it should be noted that the group number (GroupN) of the imported configuration corresponds to the API _ CMD input parameter. Users need to ensure that the switching configuration group corresponds to the correct content stored, otherwise it will lead to configuration errors and the chip operation will be abnormal.*
2. *The Clear All button clears all imported configurations.*
3. *The "Compare" button is used for the user to Compare the imported contents of the burned target chip, and can be used to confirm whether the burned contents are correct.*
4. *The "Read" button provides the user with the purpose of reading and saving the pre-stored configuration of the target chip.*

After loading the required burning configuration, click "Download to Writer" in the lower right corner of the interface, and the Writer Config interface software will package and download these imported configurations to the offline burner. After that, the offline burner can provide offline independent burning target chip.

Note: OTP is burned to the inside of the chip, so the interval of the target chip that has been burned cannot be burned repeatedly!

3. Application Scenario Examples

3.1 Application Requirements

Assuming that the user scenario requires this, using CMT2312A as the receiving end, the receiving target needs to adaptively receive the sending end of 3 different protocols. The 3 different protocols are as follows:

- Protocol A, working frequency is 433MHz, FSK modulation mode, rate 50kbps, frequency offset 25kHz, the message format is as follows.
- Protocol B, operating frequency is 433.92 MHz, FSK modulation mode, rate 38.4 kbps, frequency offset 20kHz, message format is as follows.
- Protocol C, working frequency is 438.5 MHz, FSK modulation mode, rate 10kbps, frequency offset 5kHz, the message format is as follows.

The receiving end is required to design adaptive receiving functions for the above three sets of protocols, and it needs to meet the requirements of low power consumption.

agreement	Wake Up + Preamble	SyncWord	Payload	CRC
Protocol A	0xAA * 250Bytes	6Bytes 0xB24D2BD51234	Variable length Length single byte	With CRC32, Polynomial: 0x04C11DB7 Seed = 0, the result is not inverted
Protocol B	0xAA * 200Bytes	4Bytes 0x904E6715	Fixed length 64Bytes	With CRC16, IBM (0x8005), Seed = 0xFFFF, the result is not inverted
Protocol C	0x55 * 50Bytes	3Bytes 0x2D4BD3	Fixed length 20Bytes	Using CRC16, CCITT (0x1021), Seed = 0x1D0F, the result is inverted

3.2 Requirements Analysis

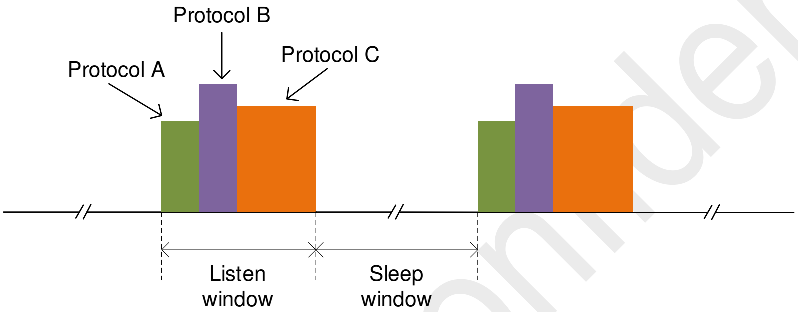
In view of the above requirements, the core requirements are 2 points:

1. It is necessary to meet the protocol that the receiver can adapt to three different settings, so the receiver must switch and listen back and forth between the three different settings. All three

protocols have long enough pilot transmissions in common, so the locking condition of the monitoring window is to detect the pilot conformity as the basis for locking a certain set of settings.

2. Finally, it is mentioned that the requirement of low power consumption is met. Therefore, on the basis of the above three sets of back-and-forth switching monitoring mechanisms, it is also necessary to introduce the time for CMT2312A to go to sleep to achieve a certain degree of low power consumption through duty cycle. The CMT2312A has the same features as the CMT2310A"DutyCycle + SLP" ultra-low power combination operation mode, the same can be implemented in this scheme.

Based on the above core requirements and analysis, the CMT2312A working sequence of the implementation scheme is as shown in the figure below.



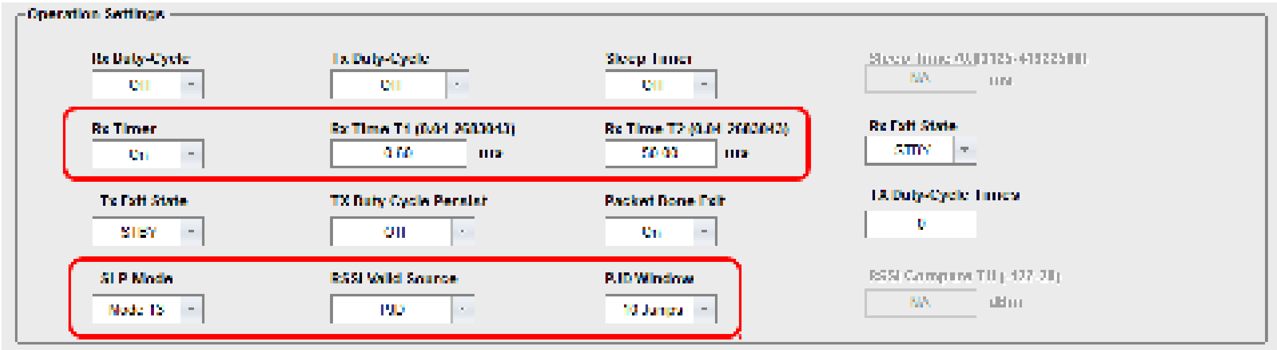
According to the above working sequence, further combined with the "DutyCycle + SLP" ultra-low power combination working mode provided by CMT2312A/CMT2310A, the workflow of this solution is refined as follows:

1. Flash into CMT2312A by Protocol A configuration, where configured:

   a) Enable the RxTimer timing function of CMT2312A (enable RxTime1 and RxTime2), combined with the SLP function (SLP modes 11 ~ 13 can be considered, and mode 13 is selected in this example).

   b) According to the protocol A rate of 50kbps, each symbol is 20us, considering that the RxTime1 window monitoring satisfies 20 ~ 30 symbols, set RxTime1 = 600us; The condition is met to extend the execution of RxTime2, and the time is met to override SyncWord, so it is set to 50ms.

The RFPDK settings are shown in the screenshot below (partially).



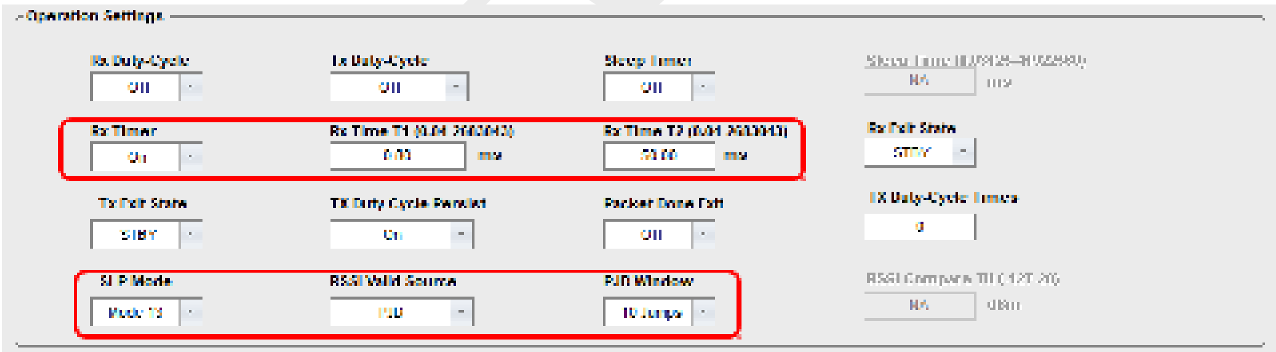
2. Protocol A listening is executed until the listening timed out or valid data is triggered.

3. Flash into CMT2312A according to Protocol B configuration, where configuration:

   a) Enable the RxTimer timing function of CMT2312A (enable RxTime1 and RxTime2), combined with the SLP function (SLP modes 11 ~ 13 can be considered, and mode 13 is selected in this example).

   b) According to the protocol B rate of 38.4 kbps, each symbol is 26us, considering that the RxTime1 window monitoring satisfies 20 ~ 30 symbols, set RxTime1 = 800us; The condition is met to extend the execution of RxTime2, and the time is met to override SyncWord, so it is set to 50ms.

   The RFPDK settings are shown in the screenshot below (partially).



4. Protocol B listening is executed until the listening timed out or valid data is triggered.

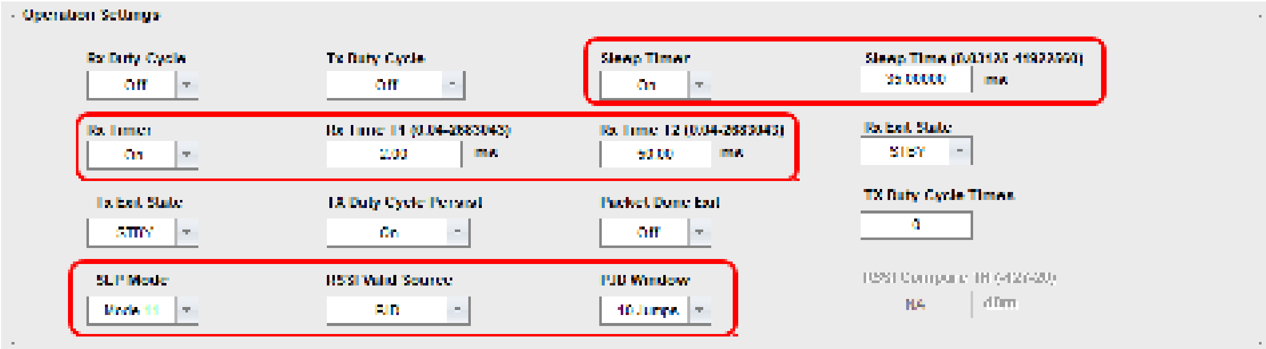
5. Flash into CMT2312A according to Protocol C configuration, where configuration:

   a) Enable the RxTimer timing function of CMT2312A (enable RxTime1 and RxTime2), combined with the SLP function (you can consider SLP modes 11 to 13, this example selects mode 11).

   b) According to the protocol C rate of 10kbps, each symbol is 100us, considering that the RxTime1 window monitoring satisfies 20 ~ 30 symbols, set RxTime1 = 2ms; The condition is met to extend the execution of RxTime2, and the time is met to override SyncWord, so it is set to 50ms.

   c) After listening to Protocol C, the CMT2312A needs to go to sleep in order to achieve the goal of low power consumption. Therefore, it is necessary to enable SleepTimer, and the pilot time of the three sets of protocols is about 40ms, so first set SleepTime = 35ms to implement the functional flow, and then further optimize the specific setting value of this value according to the actual effect.

The RFPDK settings are shown in the screenshot below (partially).



6. Protocol C listening is performed until the listening time-out or valid data is triggered.

7. Set CMT2312A to sleep and wait for the sleep timer to wake up.

8. Return to step 1 and cycle through this.

3.3 Model Building and Comparison

- Model of CMT2312A SPI Configuration

According to the CMT2312A SPI configuration and switching the model established by each group of parameters, the screenshots of timing and measurement time of each stage are as follows:

Wherein:

1) Time scales A1-A2 are the time consumed to flash protocol A configuration, about 1ms (hardware SPI running speed 8MHz);

2) Time scales B1-B2 are the RxTime1 duration of listening protocol A, which is basically the same as the setting 600us;

3) Time scales C1-C2 are the time consumed to brush protocol B configuration, about 1ms (963us);

4) Time scales D1-D2 are the RxTime1 duration of listening protocol B, which is basically the same as the setting 800us (774us);

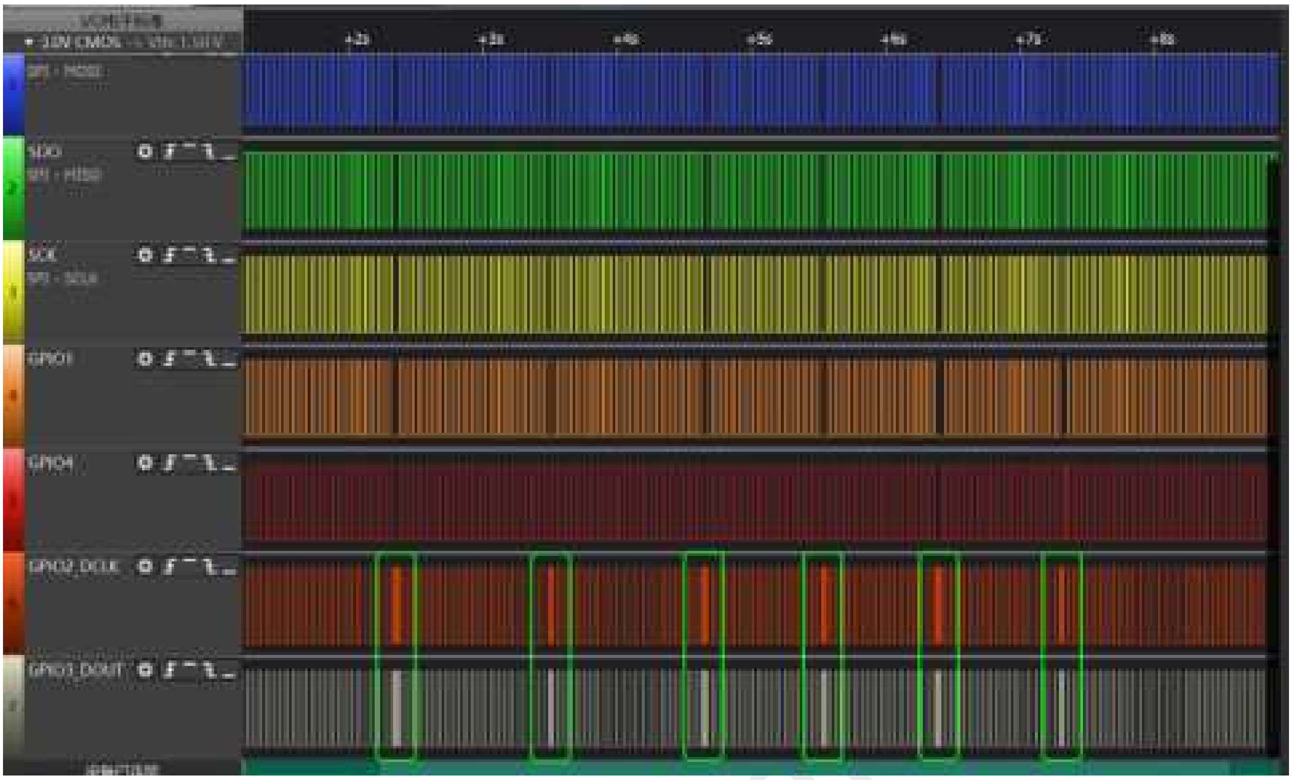
5) Time scales E1-E2 are the time consumed to brush protocol C configuration, about 1ms (962us);

6) The time scale F1-F2 is the RxTime1 duration of the monitoring protocol C, which is basically the same as the setting of 2ms (1.97 ms);

7) Time scales G1-G2 are sleep time-consuming, which is basically the same as the setting of 35ms;

In this way, a monitoring cycle takes about 41.5 ms. It is obviously unreliable to adapt to three sets of protocol pilots in 40ms. In order to ensure that each set of protocol pilots can cover two monitoring opportunities within 40ms, Therefore, it is necessary to modify the sleep time in the configuration of monitoring protocol C from 35ms to 27ms, as shown in the figure below.

Verify that the effect of triggering the report is in line with expectations, as shown in the figure below (each protocol sends 2 packages and receives 6 times):



The power consumption in this mode was tested to be 1.83 mA, as shown in the figure below:

Review the power consumption performance, as described in the CMT2312A datasheet,

- The typical current value in the Ready state is 2.1mA, and in the RFS state it is 7.8mA. The total duration of configuration and state switching is approximately 1ms, with 70% being for configuration and in the Ready state, and 30% in the RFS state (roughly measured by a logic analyzer).
- The typical current value in Rx state is 13.6 mA, and the sum of time in Rx is: 0.6 ms + 0.8 ms + 2ms = 3.4 ms

- In the Sleep state, the current is less than 1uA, which can be ignored. The Sleep time is about 27ms, and the duration of one cycle is 33.6 ms (subject to the measurement of logic analyzer)

So the average power consumption is roughly calculated as:

$$I_{AVG} = \frac{0.7ms \times 3 \times 2.1mA + 0.3 \times 3 \times 7.8mA + 3.4ms \times 13.6mA}{33.6ms} = \frac{57.67}{33.6} = 1.71mA$$

It is slightly lower than the measured value, but the basic expectation is in line with the measured situation. But can we further reduce the power consumption on the basis of 1.71 mA? Yes! The DC - DC function of CMT2312A can be enabled (of course, the hardware also needs to be implemented under the DC - DC enable condition). In the DC - DC enabled mode, the Ready current can be reduced from 2.1mA to 1.9mA, the RFS current can be reduced from 7.8mA to 5.6mA, and the receive current can be reduced from 13.6mA to 9.4mA. Thus, a rough calculation is as follows:

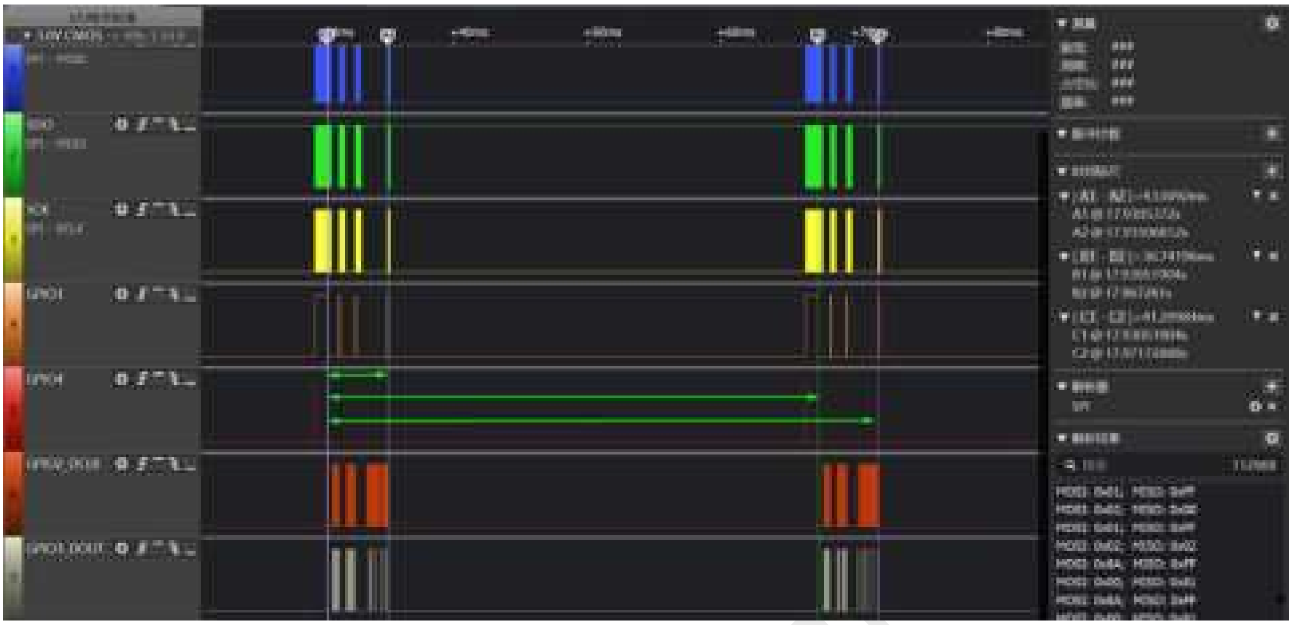
$$I_{AVG} = \frac{0.7ms \times 3 \times 1.9mA + 0.3 \times 3 \times 5.6mA + 3.4ms \times 9.4mA}{33.6ms} = \frac{40.99}{33.6} = 1.22mA$$

The actual measurement is 1.27 mA, as shown in the figure below.

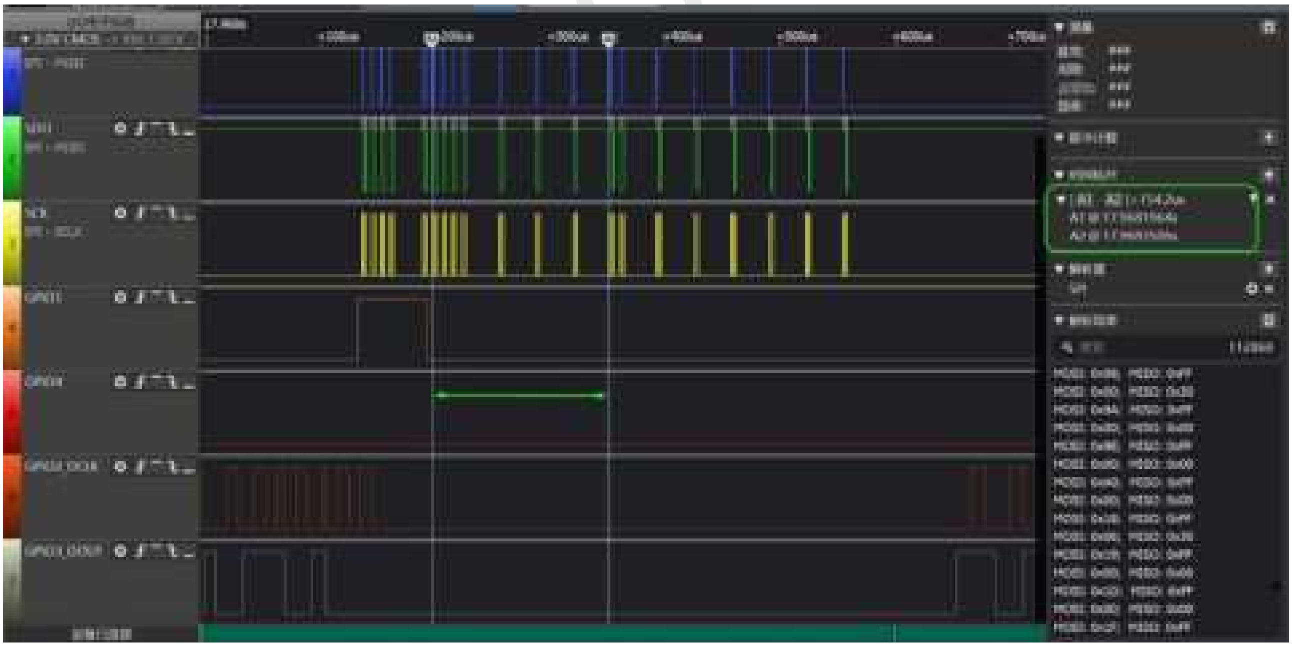
From 1.83 mA to 1.27 mA, it supports the wake-up of 3 sets of protocols, and the effect is still obvious. Then you can consider solidifying the parameters to the OTP inside CMT2312A, and quickly switch the pre-stored configuration to see how effective it is.

- CMT2312A model for quickly switching pre - stored configurations

Before solidifying the parameters according to the above configuration, it is necessary to fine - tune the sleep duration. Because quickly switching the pre - stored configuration can save the time for configuring software parameters. Based on the above implementation, the total monitoring duration of the 3 sets of protocols is 3.4ms (0.6 + 0.8+2), which satisfies the requirement of monitoring 2 times within the pilot duration, that is, 6.8ms is required. Therefore, based on the 40ms duration, 33.2 ms remain. Considering the time margin for state switching, the sleep duration can be adjusted to 31ms. The implementation effect is shown in the following figure:



Thanks to the CMT2312A internal DMA level switching pre-stored configuration, it saves the time of external MCU batch configuration registers. The time for switching internal configuration takes about 150us, as shown in the figure below.



So the average current is roughly calculated as follows:

$$I_{AVG} = \frac{0.16ms \times 3 \times 1.9mA + 0.3 \times 3 \times 5.6mA + 3.4ms \times 9.4mA}{36.7ms} = \frac{37.91}{36.7} = 1.03mA$$

The actual measurement is 1.12 mA, as shown in the figure below.

- Summary of the power consumption of the plan

Scheme	Measured Power Consumption
External MCU switching configuration (DC-DC OFF)	1.83 mA
External MCU switching configuration (DC-DC ON)	1.27 mA
Internal pre-stored configuration switching (DC-DC ON)	1.12 mA

4. Notes

1. This document assumes that all three sets of configurations in the application are in the same frequency band, which can avoid re-calibrating the chip. Because during the initialization process of CMT2312A (or CMT2310A), the frequency band used in the application needs to be calibrated, and the calibration varies for different frequency bands. For example, according to the three sets of configurations in this example, if the frequency point of one of the configurations is 868MHz, simply switching the configuration is not enough, and re-calibration is also required. Of course, this is an extreme assumption. According to actual application scenarios, fixed radio frequency hardware matching should be in a similar frequency band range.

2. From the analysis of the final results of this example, for the pre - stored configuration with fast switching, the measured average operating current is approximately 1.12 mA; while for the external MCU configuration method, the measured value is only 1.27 mA, with an optimization ratio of approximately 12%. The reason for the fast switching of the pre - stored configuration is mainly the omission of the consumption of the external MCU configuration. In this example, the external MCU sets the hardware SPI to a speed of 8 MHz, which is quite fast (the upper limit of CMT2312A is 10 MHz), so the proportion of this part of the consumption is not high. Secondly, in this example, one of the configurations has a rate of 10 kbps and a listening design time of 2 ms, which accounts for the major part of the power consumption. Therefore, if the actual application scenario is for high - speed rate applications, the actual listening time is very short, and the consumption proportion of configuring these intermediate links is high. Then, the advantage of using pre - stored configurations for quick switching is even greater.

5. Documentation Revise Record

Table 34. Document Change Record

Version No.	Chapter	Change Description	Date
1.0	all	Initial version release	2025-07-31

6. Contact Information

Shenzhen Hope Microelectronics Co., Ltd.

Address: 30th floor of 8th Building, C Zone, Vanke Cloud City, Xili Sub-district, Nanshan, Shenzhen, GD, P.R. China

Tel: +86-755-82973805 / 4001-189-180

Fax: +86-755-82973550

Post Code: 518052

Sales: sales@hoperf.com

Website: www.hoperf.com