PAN1070 CLKTRIM 测试说明

PAN-CLT-VER-A0, Rev 0.1

PanchipMicroelectronics

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修订历史

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目录

第1章 测试目的

1. 通用 CLKTRIM 功能等测试。
2. 通过测试，对 CLKTRIM 库进行查漏补缺，并生成一个稳定版本的库文件。
3. 生成 CLKTRIMAPI 接口文档。
4. 给出对 CLKTRIM 模块的一个使用说明文档

第2章 测试内容

2.1 测试内容

a) 相关寄存器
b) 时钟测量
c) 时钟校准
d) 中断测试

2.2 环境准备

2.2.1 软件环境

2.2.1.1 待测代码

测试工程文件：

<PAN1070-DK>\03_MCU\mcu_samples\CLK_TRIM\keil\clk_trim.uvprojx

测试源文件目录：

<PAN1070-DK>\03_MCU\mcu_samples\CLK_TRIM \src

2.2.1.2 软件工具

1、SecureCRT（用于显示 PC 与 Test Board 的交互过程，打印 log 等）

2、逻辑分析仪

2.2.2 硬件环境

1. PAN1070 COB
   a) UART0（测试交互接口，TX：P16，RX：P17，波特率：921600）
   b) SWD（用来调试和烧录程序，SWDCLK: P00，SWDIO: P01）
2. Secure CRT（串口打印窗口）
3. 稳压电源（输入电压）

第3章 测试流程

3.1 环境说明

1、 编译测试工程，烧录

2、 连接芯片串口和 swd 管脚如 2.2.2 硬件环境说明

3、 通过串口输入测试命令，命令说明见串口打印信息

3.2 CLKTRIM 工作流程

参考 User Manual 文档。

3.3 测试程序初始化

硬件连线完成并烧录测试程序后，Test Board 上电，观察 Debug Port 是否正常打印测试主菜单。

```
+-------------------------------------------------------------------------------+
|                      PAN1080 CLK TRIM Sample Code.                            |
+-------------------------------------------------------------------------------+
|    Press key to start specific testcase:                                      |
|                                                                               |
|    Input '0'    Testcase 0: Register Default Value Check.                     |
|    Input '1'    Testcase 1: measure function test.                            |
|    Input '2'    Testcase 2: tuning function test.                             |
|    Input '3'    Testcase 3: Interrupt Mode.                                   |
+-------------------------------------------------------------------------------+
```

3.4 基本功能验证

3.4.1 CLKTRIM 所有寄存器状态

输入‘0’命令：

查看所有 CLKTRIM 相关寄存器状态。

测试现象：

```
+-------------------------------------------------------------------------------+
0
clk trim default value check ok
TRIM Test OK, Success case: 0

+-------------------------------------------------------------------------------+
```

测试分析：

寄存器默认值对比 PN108_RC 时钟测量文档正确，符合预期。

3.4.2 CLKTRIM 的测量模式

输入‘1’命令 ：

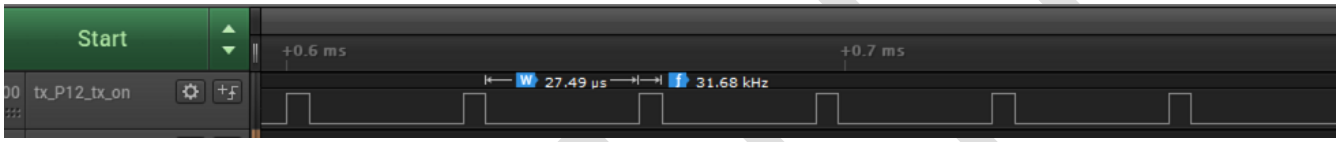
测试测量模式下，能否采集不同时钟的 cnt 值。

测试现象：

```
+--------------------------------------------------------------------------------+
1
input the wait count u want
4
 input wait cnt value:4
input the clac count u want
100
 input clac cnt value:100
real cnt :100990
TRIM Test OK, Success case: 1

+--------------------------------------------------------------------------------+
```

32K 实际频率



测试分析：

由打印信息可知：测量 100 次目标时钟得到的参考时钟周期的 cnt 值为 32M/32K(real freq)*100 个，系统时钟为 32M，也就参考时钟为 32M，目标时钟约为 31.68K（变动值），一次计算应为 32M/31.68K = 1010.10 个时钟周期，100 次为 100*1010.10 = 101010 个，实际测试值为 100990，测量频率为 32M/1009.9=31.686K，符合预期目标。

3.4.3 CLKTRIM 的校准模式测试

输入‘2’命令 ：

测试校准模式，各个调试 code 能否校准到最佳值

测试现象：

粗调校准：

```
.
2

+--------------------------------------------------------------------------------+
|    Press key to start specific testcase:                                       |
|    Input 'a'    coarse tuning test                                             |
|    Input 'b'    fine tuning test                                               |
|    Input 'c'    precision tuning test                                          |
|    Input 'd'    cp all tuning test                                             |
|    Press ESC key to back to the top level case list.                           |
+--------------------------------------------------------------------------------+
acoarse tuning test select
real cnt :20219,c/f/p code:4,20,20,cur_freq:31653.396484
```

细调校准：

```
+-------------------------------------------------------------------------------+
|    Press key to start specific testcase:                                      |
|    Input 'a'    coarse tuning test                                            |
|    Input 'b'    fine tuning test                                              |
|    Input 'c'    precision tuning test                                         |
|    Input 'd'    cp all tuning test                                            |
|    Press ESC key to back to the top level case list.                          |
+-------------------------------------------------------------------------------+
bfine tuning test select
real cnt :50154,c/f/p code:4,21,20,cur_freq:31901.742188
```

精调校准：

```
+-------------------------------------------------------------------------------+
|    Press key to start specific testcase:                                      |
|    Input 'a'    coarse tuning test                                            |
|    Input 'b'    fine tuning test                                              |
|    Input 'c'    precision tuning test                                         |
|    Input 'd'    cp all tuning test                                            |
|    Press ESC key to back to the top level case list.                          |
+-------------------------------------------------------------------------------+
cprecision tuning test select
real cnt :99980,c/f/p code:4,21,30,cur_freq:32006.402344
```

Cp 模式全局校准：

```
+-------------------------------------------------------------------------------+
|    Press key to start specific testcase:                                      |
|    Input 'a'    coarse tuning test                                            |
|    Input 'b'    fine tuning test                                              |
|    Input 'c'    precision tuning test                                         |
|    Input 'd'    cp all tuning test                                            |
|    Press ESC key to back to the top level case list.                          |
+-------------------------------------------------------------------------------+
dall tuning test select
real cnt :99832,c/f/p code:4,22,15,cur_freq:32053.851563
real cnt :99831,c/f/p code:4,22,15,cur_freq:32054.171875
real cnt :100008,c/f/p code:4,22,e,cur_freq:31997.439453
```

测试分析：

由打印信息可知

粗调：初始 code 为 0x4，校准完成后 code 值为 0x4，频率为 31.653K

细调：初始 code 为 0x20，校准完成后 code 值为 0x21，频率为 31.901K

精调：初始 code 为 0x20，校准完成后 code 值为 0x30，频率为 32.006K

全局：粗调时设置粗调、细调、精调初始值为 0x4,0x20,0x20，完成粗调、细调、精调三次校准后，各个校准 code 分别依次变为 0x4,0x22,0xe，校准功能生效,最终频率为 31.997K，符合预期

3.4.4 CLKTRIM 的中断模式

输入‘3’命令 ：

测试中断触发是否正常

测试现象：

输入‘A’命令，粗调校准：

```
[13:55:42.161]发→◇A□
[13:55:42.167]收←◆coarse tuning test select
err range:15
1—TRIM->TRIM_CTRL:f0f02
c
2—TRIM->TRIM_REAL_CNT:4f4f
real cnt :20303, c/f code:8, b4, cur_freq:31520.000000
```

输入‘B’命令，细调校准：

```
[13:57:27.969]发→◇B□
[13:57:27.978]收←◆fine tuning test select
err range:37
1—TRIM->TRIM_CTRL:250f02
f
2—TRIM->TRIM_REAL_CNT:c36f
real cnt :50031, c/f code:8, e0, cur_freq:31950.000000
```

输入‘C’命令，Cp 模式全局校准：

```
[13:57:44.426]发→◇C□
[13:57:44.432]收←◆all tuning test select
1—TRIM->TRIM_CTRL:4b0f00
c
2—TRIM->TRIM_REAL_CNT:1815e
real cnt :98654, c/f code:a, 20, cur_freq:32400.000000

[13:57:44.472]收←◆1—TRIM->TRIM_CTRL:4b0f00
f
2—TRIM->TRIM_REAL_CNT:184ea
real cnt :99562, c/f code:a, 0, cur_freq:32100.000000
```

测试分析：

粗调、细调中断正常触发分别打印字母 c、f，由打印信息可知中断触发正常

3.4.5 CLKTRIM 的硬件校准模式

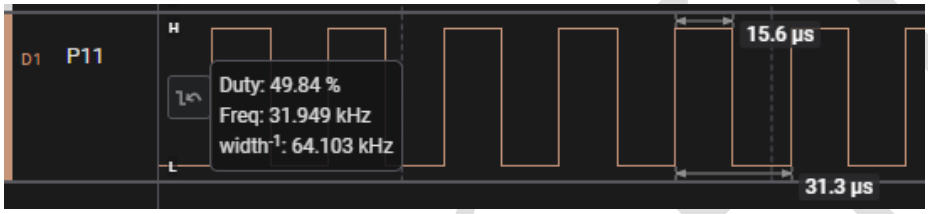
输入‘4’命令 ：

测试硬件校准是否正常

```
+-------------------------------------------------------------------------+
|    Press key to start specific testcase:                                |
|    Input 'a'     hardware tuning test                                   |
|    Input 'b'     hardware tuning after deepsleep test                   |
|    Input 'c'     hardware tuning after standby m1 test                  |
|    Press ESC key to back to the top level case list.                    |
+-------------------------------------------------------------------------+
```

测试现象：

输入‘A’命令，硬件校准：




```
[16:21:58.053]发→◇A□
[16:21:58.059]收←◆hardware tuning test

[16:21:59.060]收←◆1—TRIM->TRIM_CTRL:70402
2—TRIM->TRIM_CTRL:70402
success
real cnt :30004,c/f code:8,e2

+-------------------------------------------------------------------------+
|    Press key to start specific testcase:                                |
|    Input 'a'     hardware tuning test                                   |
|    Input 'b'     hardware tuning after deepsleep test                   |
|    Input 'c'     hardware tuning after standby m1 test                  |
|    Press ESC key to back to the top level case list.                    |
+-------------------------------------------------------------------------+

[16:22:00.011]收←◆1—TRIM->TRIM_CTRL:70402
2—TRIM->TRIM_CTRL:70402

[16:22:00.975]收←◆1—TRIM->TRIM_CTRL:70402
2—TRIM->TRIM_CTRL:70402

[16:22:01.935]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406

[16:22:02.896]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406

[16:22:03.851]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406

[16:22:04.811]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406

[16:22:05.772]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406

[16:22:06.732]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406

[16:22:07.696]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406

[16:22:08.652]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406

[16:22:09.616]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_CTRL:70406
```

输入‘B’命令，硬件校准后进入 Deepsleep 模式，并唤醒：

```
[14:02:53.031]收←◆Deepsleep
deep sleep mode run continue
1—TRIM->TRIM_CTRL:70402
2—TRIM->TRIM_REAL_CNT:752e
success
real cnt :29998,c/f code:8,e2

+------------------------------------------------------------------------------+
|    Press key to start specific testcase:                                     |
|    Input 'a'    hardware tuning test                                         |
|    Input 'b'    hardware tuning after deepsleep test                         |
|    Input 'c'    hardware tuning after standby m1 test                        |
|    Press ESC key to back to the top level case list.                         |
+------------------------------------------------------------------------------+

[14:02:53.992]收←◆1—TRIM->TRIM_CTRL:70402
2—TRIM->TRIM_REAL_CNT:752c

[14:02:54.956]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:753f

[14:02:55.914]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:752d

[14:02:56.876]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:753f

[14:02:57.835]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:7529

[14:02:58.793]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:752b

[14:02:59.753]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:752c

[14:03:00.712]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:752a

[14:03:01.673]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:752e

[14:03:02.633]收←◆1—TRIM->TRIM_CTRL:70406
2—TRIM->TRIM_REAL_CNT:7530
```

输入‘C’命令，硬件校准后进入 Standby M0 模式，并唤醒 ：

```
[14:03:39.777]发→◇C□
[14:03:39.782]收←◆hardware tuning after standby test

  wake up by rcl 32k

[14:03:40.771]收←◆Standby M1
1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:7522

CPU @ 48000000Hz
code :7e308

+------------------------------------------------------------------------------+
|                      PAN1070 CLK TRIM Sample Code.                           |
+------------------------------------------------------------------------------+
|    Press key to start specific testcase:                                     |
|                                                                              |
|    Input '0'    Testcase 0: Register Default Value Check.                    |
|    Input '1'    Testcase 1: measure function test.                           |
|    Input '2'    Testcase 2: tuning function test.                            |
|    Input '3'    Testcase 3: Interrupt Mode.                                  |
|    Input '4'    Testcase 4: hardware tuning function test.                   |
+------------------------------------------------------------------------------+

[14:03:41.735]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:753c

[14:03:42.692]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:753d

[14:03:43.652]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:753d

[14:03:44.613]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:753b

[14:03:45.574]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:7537

[14:03:46.533]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:753d

[14:03:47.498]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:752b

[14:03:48.454]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:7525

[14:03:49.414]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:752a

[14:03:50.374]收←◆1—TRIM->TRIM_CTRL:f0f02
2—TRIM->TRIM_REAL_CNT:7528
```

```
[16:27:21.889]发→◇C□
[16:27:21.895]收←◆hardware tuning after standby test

  wake up
[16:27:22.885]收←◆鹧tandby M1
1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

CPU @ 48000000Hz
code :7e308

+-------------------------------------------------------------------------+
|                    PAN1070 CLK TRIM Sample Code.                        |
+-------------------------------------------------------------------------+
|    Press key to start specific testcase:                                |
|                                                                         |
|    Input '0'    Testcase 0: Register Default Value Check.               |
|    Input '1'    Testcase 1: measure function test.                      |
|    Input '2'    Testcase 2: tuning function test.                       |
|    Input '3'    Testcase 3: Interrupt Mode.                             |
|    Input '4'    Testcase 4: hardware tuning function test.              |
+-------------------------------------------------------------------------+

[16:27:23.851]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:24.807]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:25.772]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:26.727]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:27.687]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:28.647]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:29.606]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:30.566]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:31.526]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:32.485]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02

[16:27:33.445]收←◆1—TRIM->TRIM_CTRL: f0f02
2—TRIM->TRIM_CTRL: f0f02
```

测试分析：

校准成功后 LOG 打印 success。

第4章 注意事项

1、 设置校准比特位宽时，位宽 = 位宽设置值 + 1。

2、 读取 reference cnt 值时，cnt = 读取 cnt + 1

3、 Early termination 要配合 error range 同时使用，否则设置 error range 不生效，还是会全比特位寻找最优值

4、 粗调可用于调试的比特位为 3 位，细调可用于调试的比特位为 6 位，精调可用于调试的比特位为 6 位，可以设置任意比特位开始调试，但位宽的最高位 bit 初始值需为 1，example：假设读取的精调 code 为 0x3f，设置精调比特位为 3 位，那么校准的总共比特位为 4 位，启动小范围精调的 code 初始值可设为 0x38，0x28，按经验来配置，但 bit3 必须设置为 1

第5章 测试结论

5.1 测试结论

Modular	Test mode		Test Result
CLKTRIM	CLKTRIM_Register		OK
	CLKTRIM_MeasureTest		OK
	CLKTRIM_TuningTest	粗调校准	OK
		细调校准	OK
		精调校准	OK
		全局校准	OK
	CLKTRIM_InterruptTest		OK