

## Application note

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### N32G430 series HSI Trim application note

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#### Introduction

In practical product applications, HSI (High-Speed Internal) clocks are frequently used. However, when the accuracy of the HSI clock is insufficient, if left unaddressed, some modules may fail to function properly. In such cases, calibration of the HSI becomes necessary.

This document outlines the process of calibrating the HSI using a HSE (High-Speed External) crystal or a LSE (Low-Speed External) crystal, aiming to adjust the HSI frequency to an appropriate range.

This document applies to the N32G430 series of Nations Technologies.

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## 1. HSI TRIM introduction

The HSI (High Speed Internal) clock signal is generated by an internal 8MHz RC oscillator, which can be directly used as the system clock or divided by 2 to serve as the input for the PLL. The HSI RC oscillator offers the convenience of providing a system clock without requiring any external components. It's startup time is shorter than HSE (High Speed External) crystal oscillator. Nevertheless, due to its relatively poor frequency accuracy, calibration is necessary for proper operation.

This document introduces the calibration of the HSI (High Speed Internal) clock using either the HSE (High Speed External) clock or the LSE (Low Speed External) clock.

## 2. Instructions for Using HSI TRIM

In the application note project, the macro definitions "HSI\_TRIM\_BY\_HSE" and "HSI\_TRIM\_BY\_LSE" are used to select whether HSE or LSE will be employed for HSI calibration.

If HSE is chosen for HSI calibration, the HSI\_Triming\_By\_HSE function is utilized to capture the HSE/128 frequency using TIM2 (Timer Input Capture), subsequently calibrating the HSI. The default HSE frequency is 8MHz.

If LSE is selected for HSI calibration, the HSI\_Triming\_By\_LSE function is utilized to capture the LSE frequency using TIM2 (Timer Input Capture), subsequently calibrating the HSI. The default LSE frequency is 32.768KHz.

Additionally, within the application note project, a configuration is set up to output the HSI frequency through pin PA8, allowing for the capture of the HSI frequency using an oscilloscope. If HSE or LSE fails to start, or if the calibration attempts exceed a predetermined limit, the function will return a failure status.

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Options for Target 'N32G430'

Device | Target | Output | Listing | User | C/C++ | Asm | Linker | Debug | Utilities

Preprocessor Symbols

Define: N32G430, USE\_STDPERIPH\_DRIVER, **HSI\_TRIM\_BY\_HSE**

Undefine:

Language / Code Generation

Execute-only Code     Strict ANSI C    Warnings: All Warnings

Optimization: Level 0 (-O0)     Enum Container always int     Thumb Mode

Optimize for Time     Plain Char is Signed     No Auto Includes

Split Load and Store Multiple     Read-Only Position Independent     C99 Mode

One ELF Section per Function     Read-Write Position Independent     GNU extensions

Include Paths: ..\..\..\..\firmware\n32g430\_std\_periph\_driver\inc;..\..\..\..\firmware\CMSIS\core;..\..\..\..\

Misc Controls:

Compiler control string: -c -cpu Cortex-M4 -D \_\_MICROLIB -g -O0 -apcs=interwork -split\_sections -I ..\..\..\..\firmware\n32g430\_std\_periph\_driver\inc -I ..\..\..\..\firmware\CMSIS\core -I

OK    Cancel    Defaults    Help

```

87 #ifdef HSI_TRIM_BY_HSE
88     result = HSI_Trimming_By_HSE();
89 #endif
90 #ifdef HSI_TRIM_BY_LSE
91     result = HSI_Trimming_By_LSE();
92 #endif
93
94     if(result == FAILED)
95     {
96         GPIO_Pins_Reset(GPIOA, GPIO_PIN_7);
97         log_info("HSI TRIM test failed\r\n");
98     }
99     else
100     {
101         GPIO_Pins_Reset(GPIOA, GPIO_PIN_7);
102         log_info("HSI TRIM test passed\r\n");
103     }
104
105     while(1)
106     {
107     }
108 }

```

## 2.1 HSI TRIM Procedure

The HSI calibration process using HSE follows these steps:

1. Configure the system clock source to HSI\_PLL.
2. Enable the HSE clock source and wait for it to stabilize. If a timeout occurs, return a failure.
3. Wait for a period to ensure that the HSE clock source is running stably.
4. Configure TIM2 to capture and calculate the HSE/128 frequency through TIM2 Channel 4.
5. Adjust the HSI trim value based on the measured HSE/128 frequency deviation.
6. If the measured HSI frequency deviation remains significant, repeat steps 4 and 5 until the measured HSI frequency falls within the acceptable deviation range. If a timeout occurs, return a failure.
7. Upon completion of HSI calibration, exit the calibration process.

The HSI calibration process using LSE follows these steps:

1. Configure the system clock source to HSI\_PLL.
2. Enable the LSE clock source and wait for it to stabilize. If a timeout occurs, return a failure.
3. Wait for a period to ensure that the LSE clock source is running stably.
4. Configure TIM2 to capture and calculate the LSE frequency through TIM2 Channel 2.
5. Adjust the HSI trim value based on the measured LSE frequency deviation.
6. If the measured HSI frequency deviation remains significant, repeat steps 4 and 5 until the measured HSI frequency falls within the acceptable deviation range. If a timeout occurs, return a failure.
7. Upon completion of HSI calibration, exit the calibration process.

### 3. Version history

<b>Version</b>	<b>Date</b>	<b>Modify</b>
<b>V1.0.0</b>	<b>2023-11-12</b>	<b>Create a document</b>

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