Application Note

# MSI Frequency Adjustment

## Introduction

This document describes the MSI frequency adjustment method, facilitating users to adjust the frequency of MSI according to their actual requirements during regular operate.

This document is applicable to N32G43x&N32L43x&N32L40x series products of NSING Technology.



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# Contents





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# 1 Overview

After series of N32G43x&N32L43x&N32L40x is packaged by the packaging factory or after mounting and Reflow by the user, it may cause multi-speed internal (MSI) RC oscillator frequency deviation issues. For example, the maximum deviation after Reflow process may be approximately 2.0%. Because frequency deviation in the MSI may lead to operation issues about peripherals relying on the MSI as a clock source, it is essential to correct the frequency of MSI.



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# 2 Multi-speed Internal (MSI) RC Oscillator Electrical Characteristics

**Table 2-1 MSI Oscillator Characteristics [1]**

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $f_{MSI}$ | Range 0 | MSI Frequency after Factory calibration, done at $V_{DD}$ = 3.3V and $T_A$ = 27 °C | - | 100 | - | KHz |
| | Range 1 | | - | 200 | - | KHz |
| | Range 2 | | - | 400 | - | KHz |
| | Range 3 | | - | 800 | - | KHz |
| | Range 4 | | - | 1 | - | MHz |
| | Range 5 | | - | 2 | - | MHz |
| | Range 6 | | 3.96[4] | 4[4] | 4.1[4] | MHz |
| $\Delta_{TEMP}$ (MSI) [2] | MSI oscillator frequency drift over temperature | $T_A$ = 0 to 85 °C | - | ±1%@4M<br>±1.2%@100k | - | % |
| | | $T_A$ = -40 to 105 °C | - | ±2%@4M<br>±3%@100k | - | % |
| $\Delta_{VDD}$(MSI) [2] | MSI oscillator frequency drift over $V_{DD}$ (reference is 3 V) | Range 0, V = 1.8$V_{DD}$ to 3.6V | - | 0.5 / - 1.5 | - | % |
| | | Range 6, V = 1.8$V_{DD}$ to 3.6V | - | 0.5 / - 5 | - | % |
| $t_{SU}$(MSI) [3] | MSI oscillator start-up time | Range 0 /100k | - | 20 | - | us |
| | | Range 1 /200k | - | 12 | - | us |
| | | Range 2 /400k | - | 8 | - | us |
| | | Range 3 /800k | - | 6 | - | us |
| | | Range 4 /1M | - | 10 | - | us |
| | | Range 5 /2M | - | 7 | - | us |
| | | Range 6 /4M | - | 6 | - | us |
| $I_{DD}$(MSI) [3] | MSI oscillator power consumption | Range 0 /100k | - | 1.0 | - | uA |
| | | Range 1 /200k | - | 1.2 | - | uA |
| | | Range 2 /400k | - | 1.8 | - | uA |
| | | Range 3 /800k | - | 3.2 | - | uA |
| | | Range 4 /1M | - | 6 | - | uA |
| | | Range 5 /2M | - | 9 | - | uA |
| | | Range 6 /4M | - | 16 | - | uA |

*Notes:*

*[1] $V_{DD}$ = 3.3V, $T_A$ = -40~105 ℃ unless otherwise specified.*

*[2] This deviation range is the deviation of the oscillator after calibration;*

*[3] Guaranteed by design, not tested in production.*

*[4] After Reflow, the frequency will deviate, and the maximum deviation value is about 2.0%.*

From Table 1-1 of the MSI Oscillator Characteristics, it can observe that the frequency range of the MSI at junction temperature of 27°C is 3.96MHz to 4.1MHz. After chip is packaged by the packaging factory or after mounting production and Reflow by the user, it may cause multi-speed internal (MSI) RC oscillator frequency deviation issues.



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The maximum deviation after Reflow may be approximately 2.0%.

## 2.1 Function Description

Function Prototype: void RCC_MSI_Trimming_Auto(void);
This function allows automatic trimming MSI without manual intervention in order to eliminate MSI frequency deviation issues caused by packaging process at the packaging plant.
Parameter description: void
Return : void

Function Prototype: void RCC_MSI_Trimming_Value_Get_Manual(uint8_t* p_value);
This function can obtain the coarse and fine tuning values of the current MSI.
Parameter description:
p_value[0]: return the current MSI coarse turning value, ranging from 0x00 to 0x0F
p_value[1]: return the current MSI fine turning value, ranging from 0x00 to 0x0F
Return : void

Function Prototype: MSI_TRIM_STATE RCC_MSI_Trimming_Manual(MSI_TRIM_MODE mode, MSI_TRIM_DIRECTION dir, uint8_t value);
This function allows for user adjustment of the MSI frequency, in order to eliminate MSI frequency deviation issues caused by the mount assembly Reflow process.
Parameter description:
mode: MSI_TRIM: select coarse turning MSI_OPT: select fine turning
type: MSI_INC: increase MSI frequency MSI_DEC: decrease MSI frequency
value: The calibration trimming value ranges from 0x00 to 0x0F
Note: The value of the 'value' parameter, when added to the coarse or fine tuning values obtained through the function void RCC_MSI_Trimming_Value_Get_Manual(uint8_t* p_value) cannot be greater than 0x0F
Return : MSI_TRIM_STATE can return the following types:

MSI_TRIM_SUCCESS: MSI frequency turning succeeded
MSI_TRIM_ERROR _MODE: input incorrect mode parameter
MSI_TRIM_ERROR_DIR: input incorrect frequency turning direction parameter
MSI_TRIM_ERROR_VALUE: input invalid value parameter


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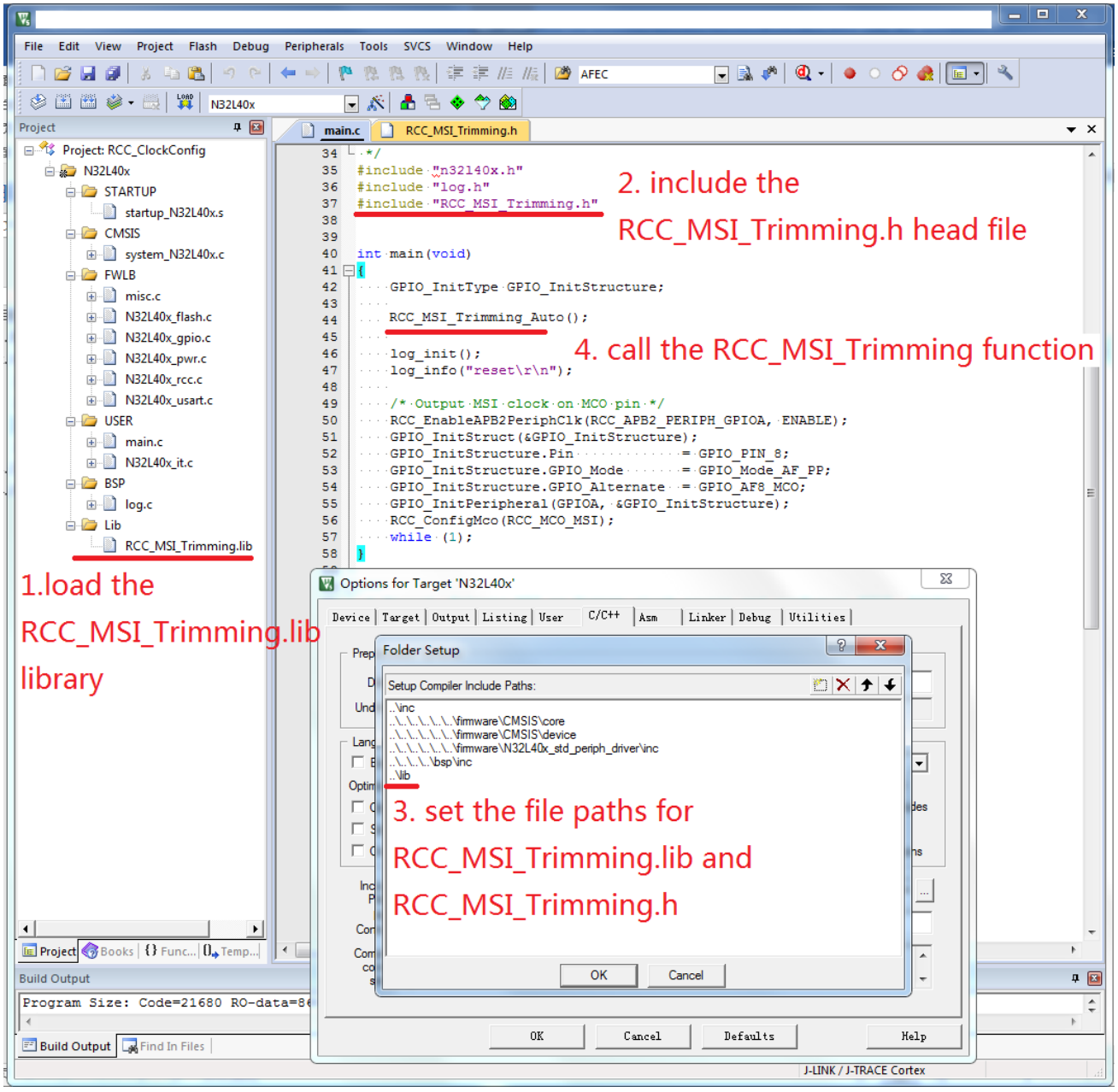
## 2.2 Using Tutorial

Steps for using the RCC_MSI_Trimming.lib library.

1. Load RCC_MSI_Trimming.lib to enter the project.
2. Include the trimming.h header file.
3. Set the file paths for RCC_MSI_Trimming.lib and RCC_MSI_Trimming.h
4. Call the RCC_MSI_Trimming function to complete the MSI trimming work.

**Figure 1-1 Step For Using The RCC_MSI_Trimming.Lib Library**



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## 2.3 Using Demo

Refer to chapter 2.2 to configure the project using the demo. To observe of MSI frequency, Configure the MCO output MSI clock in the program, as shown in the following Figure 1-2.

**Figure 1-2 MCO Output MSI Frequency**

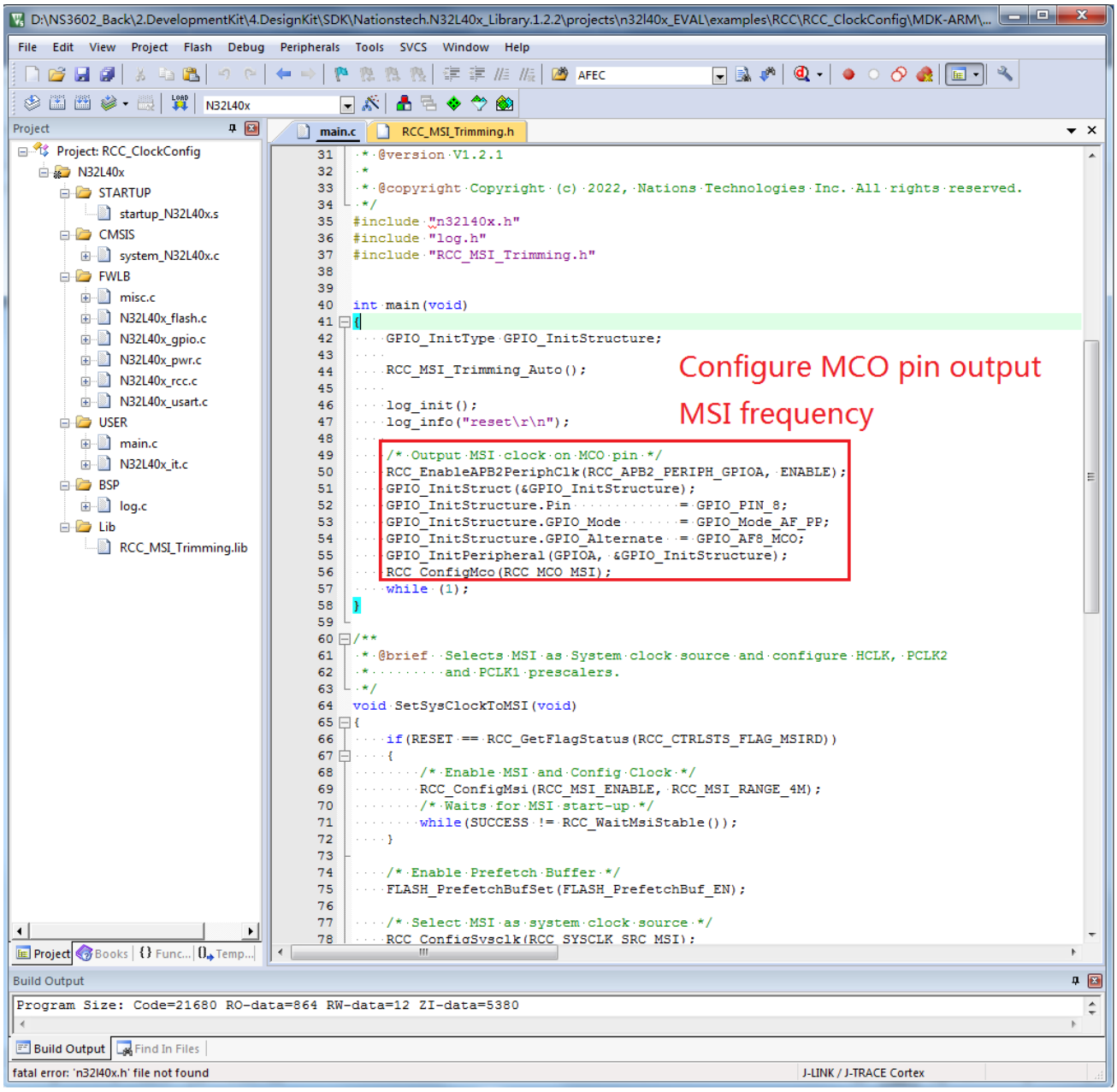




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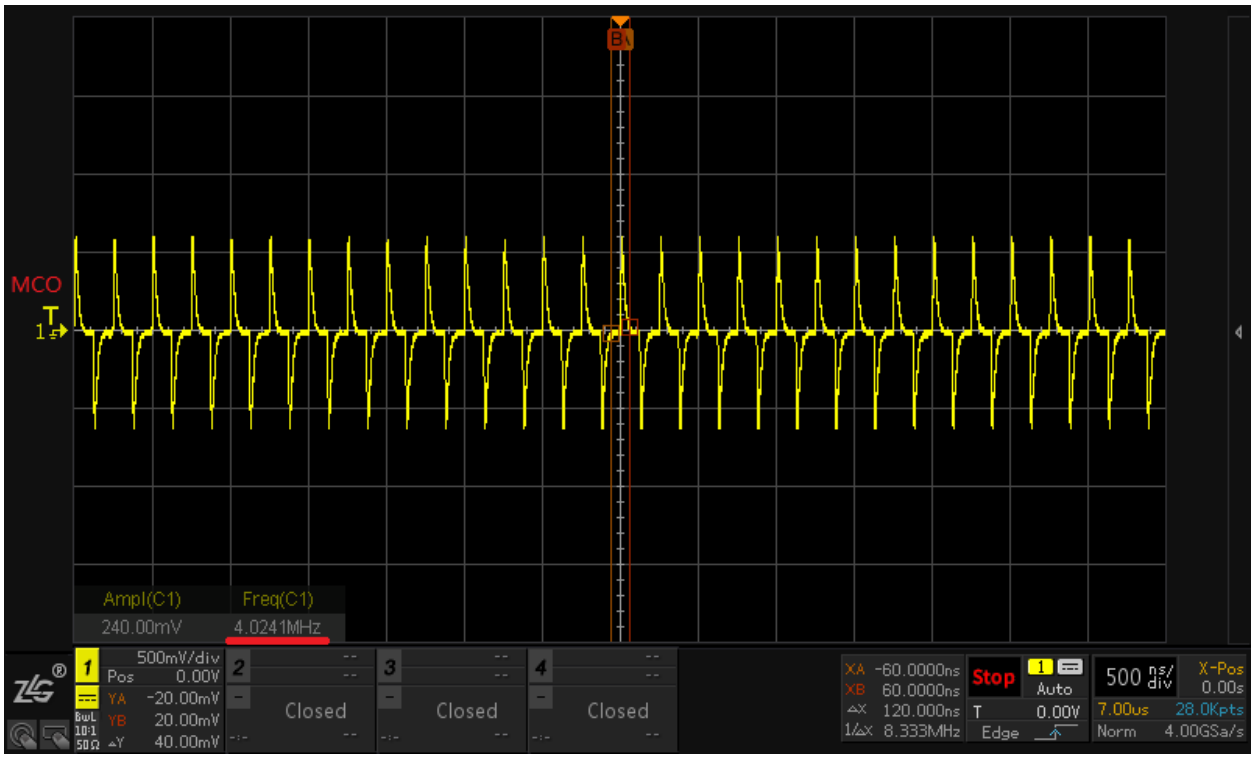
**Figure 1-3 MCO Output MSI Frequency Waveform**




By measuring the MCO output pin through an oscilloscope, MSI frequency is 4.02MHz after trimming.



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# 3 Version History

| Version | Date | Changes |
|---|---|---|
| V1.0 | 2023.03.15 | Initial release |
| | | |



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