HSE trimming for STM32 Wireless MCUs software expansion for STM32Cube

HSE manual calibration
HSE automatic calibration
HSE STM32CubeMonitor-RF calibration
Application

RCC	Flash	TIM	sub-GHz
Other			
HAL drivers			

STM32WB Series	STM32WL Series
Hardware	

STM32WB Nucleo	STM32WL Nucleo
Boards	

Product status link
X-CUBE-CLKTRIM

Features

- STM32 Wireless MCUs high-speed external (HSE) crystal oscillator trimming allowing best RF performance for Bluetooth® Low Energy, IEEE 802.15.4, LoRaWAN® and LPWAN wireless applications
- Trimming parameters can be stored in user OTP Flash area
- Trimming in production procedure suggestion

Description

The X-CUBE-CLKTRIM Expansion Package illustrates the trimming of an HSE crystal oscillator to reach the high-accuracy frequency required by RF applications.

The STM32WB Series microcontrollers support low-power RF standards such as Bluetooth® Low Energy (±50 ppm minimum HSE clock accuracy) and IEEE 802.15.4 (±40 ppm minimum HSE clock accuracy).

The STM32WL Series microcontrollers support sub-GHz RF standards such as LoRaWAN® and other low-power wide area networks (LPWAN). For these standards, the highest the HSE clock accuracy, the best the RF performance.

The frequencies of STM32 Wireless MCUs HSE oscillators can be tuned by means of values saved in dedicated registers. This features saves the extra cost of additional external capacitors and enables the compensation for frequency variations due to production, crystal, and PCB design.

The X-CUBE-CLKTRIM Expansion Package and associated application note (AN5042, AN5515) propose three different trimming procedures (manual, automatic, and with STM32CubeMonitor-RF (STM32CubeMonRF)) for the once-for-all storage of the right trimming parameters in OTP bytes. Each proposes two configurations: the trimming procedure itself and an implementation example of oscillator clock initialization in applications (loading of the trimming parameters in the according registers).

The HSE trimming manual procedure requires the user to use buttons to trim the RF clock frequency, which is output on a pin and can be monitored with a precision frequency meter. The HSE trimming automatic procedure consists in providing a precision clock reference to the STM32 so that it can trim its RF clock frequency (HSE) automatically. The HSE trimming procedure with STM32CubeMonitor-RF is similar to the manual one but uses STM32CubeMonitor-RF scripts instead of buttons.

For HSE trimming, it is not mandatory to trim each board in a production chain. A procedure is given for this purpose in the *Precise HSE frequency trimming using STM32 wireless MCUs* application note (AN5042).

X-CUBE-CLKTRIM firmware is built on the HAL drivers and runs on the Nucleo boards of the STM32 Wireless MCUs.

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For further information contact your local STMicroelectronics sales office.

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1 General information

The X-CUBE-CLKTRIM Expansion Package runs on STM32 microcontrollers based on Arm® cores.

Note: *Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.*

1.1 Ordering information

X-CUBE-CLKTRIM is available for free download from the *www.st.com* website.

1.2 What is STM32Cube?

STM32Cube is an STMicroelectronics original initiative to significantly improve designer's productivity by reducing development effort, time and cost. STM32Cube covers the whole STM32 portfolio.

STM32Cube includes:

- A set of user-friendly software development tools to cover project development from conception to realization, among which are:
    - STM32CubeMX, a graphical software configuration tool that allows the automatic generation of C initialization code using graphical wizards
    - STM32CubeIDE, an all-in-one development tool with peripheral configuration, code generation, code compilation, and debug features
    - STM32CubeProgrammer (STM32CubeProg), a programming tool available in graphical and command-line versions
    - STM32CubeMonitor (STM32CubeMonitor, STM32CubeMonPwr, STM32CubeMonRF, STM32CubeMonUCPD) powerful monitoring tools to fine-tune the behavior and performance of STM32 applications in real-time
- STM32Cube MCU and MPU Packages, comprehensive embedded-software platforms specific to each microcontroller and microprocessor series (such as STM32CubeWB for the STM32WB Series), which include:
    - STM32Cube hardware abstraction layer (HAL), ensuring maximized portability across the STM32 portfolio
    - STM32Cube low-layer APIs, ensuring the best performance and footprints with a high degree of user control over the HW
    - A consistent set of middleware components such as FAT file system, RTOS, USB Device, Touch library, and PWAN
    - All embedded software utilities with full sets of peripheral and applicative examples
- STM32Cube Expansion Packages, which contain embedded software components that complement the functionalities of the STM32Cube MCU and MPU Packages with:
    - Middleware extensions and applicative layers
    - Examples running on some specific STMicroelectronics development boards

2 License

X-CUBE-CLKTRIM is delivered under the *Mix Ultimate Liberty+OSS+3rd-party V1* software license agreement (SLA0048).

The software components provided in this package come with different license schemes as shown in Table 1.

Table 1. Software component license agreements

Software component	Owner	License
Board Support Package (BSP)	STMicroelectronics	BSD-3-Clause
HAL STM32WB and STM32WL	STMicroelectronics	BSD-3-Clause
Project examples	STMicroelectronics	Proprietary

Revision history

Table 2. Document revision history

Date	Version	Changes
4-Oct-2017	1	Initial release.
31-Jan-2020	2	Added automatic and STM32CubeMonitor-RF trimming procedures. Added the support of sub-GHz RF standards including LoRaWAN®. Extended the document scope to the STM32WL Series. Updated the entire document: • Updated title, *Features* and *Description* • Added *What is STM32Cube?* and *License*
3-Jun-2020	3	Updated Bluetooth® Low Energy RF clock accuracy to ±50 ppm in *Description*. Added trimming in production in *Features* and *Description*. Updated *What is STM32Cube?*
2-Nov-2020	4	Added HSE trimming of microcontrollers in the STM32WL Series: updated the cover picture, Features and Description.

IMPORTANT NOTICE – PLEASE READ CAREFULLY