AT32 Work Bench User Manual

Introduction

This user manual gives an overview of AT32 Work Bench. The AT32 Work Bench can generate initialization C code and corresponding IDE project through MCU graphical configuration, so as to reduce the development workload, time and cost.

AT32 Work Bench has the following features:
1. Support peripheral initialization configuration
2. Support PIN MUX configuration and customized PIN label
3. Support automatic system clock configuration
4. Support online code view
5. Support “add user code” function (existing code is not overwritten by the new project)
6. Support automatic project generation in Keil, IAR and AT32 IDE
7. Record recent designs
8. Generate configuration report (.pdf)
9. Support simplified Chinese & English menu
10. Support Windows and Linux
11. Support middleware such as FREERTOS, USB_DEVICE and USB_HOST
12. Support online software upgrade

Contents

List of tables

List of figures

1 Introduction

1.1 Environmental requirements

- Software

Windows

Windows 7 and above is required.

Linux

Ubuntu or Fedora that supports AMD x86_64.

- Hardware

At least 2GB RAM.

At least 4GB hard drive space.

2 Installation

2.1 Set up AT32 Work Bench on Windows

Run the executable AT32_Work_Bench.exe directly, without the need for installation.

2.2 Set up AT32 Work Bench on Linux

This software supports Ubuntu 16.4 and above.

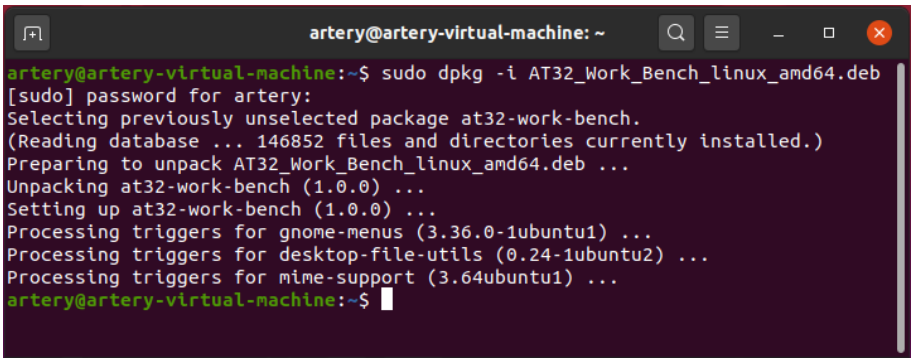
Installation methods on Linux: dpkg command and graphical installation.

- dpkg command

As shown in Figure 1, enter the following command in the terminal for setup:

sudo dpkg –i AT32_Work_Bench_linux_amd64_V1.0.0.deb

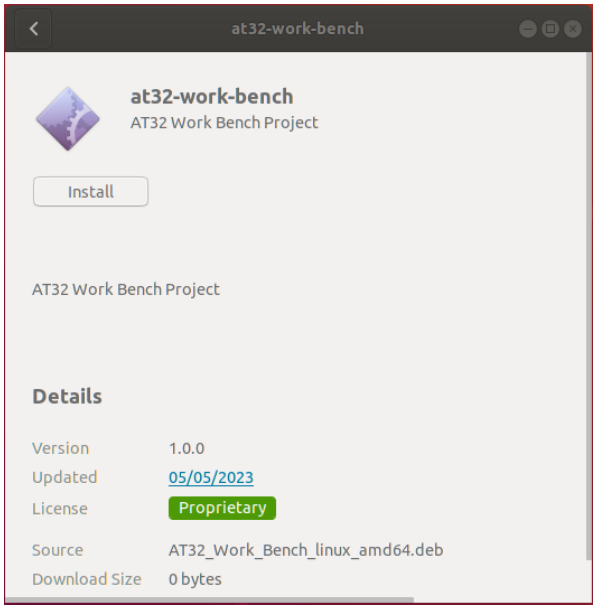
Figure 1. dpkg command in Linux



- Graphical installation

Copy the AT32_Work_Bench_linux_amd64_V1.0.0.deb to Linux and double click. Then, click on the “Install”, as shown in Figure 2.

Figure 2. Graphical installation



After the installation is complete, click the "All Programs" button at the bottom of the left taskbar, find and click on the "AT32 Work Bench" in the program list to start AT32 Work Bench.

3 Getting started

The getting started page is the first window that opens when AT32 Work Bench is started. It includes three options, i.e., “Start a New Design”, “Open an Existing Design” and “Recent Designs”.

- Start a new design

Select the MCU serials and model, and the package, Flash and SRAM are filled in automatically according to the model. Click on “New” to create a new project.

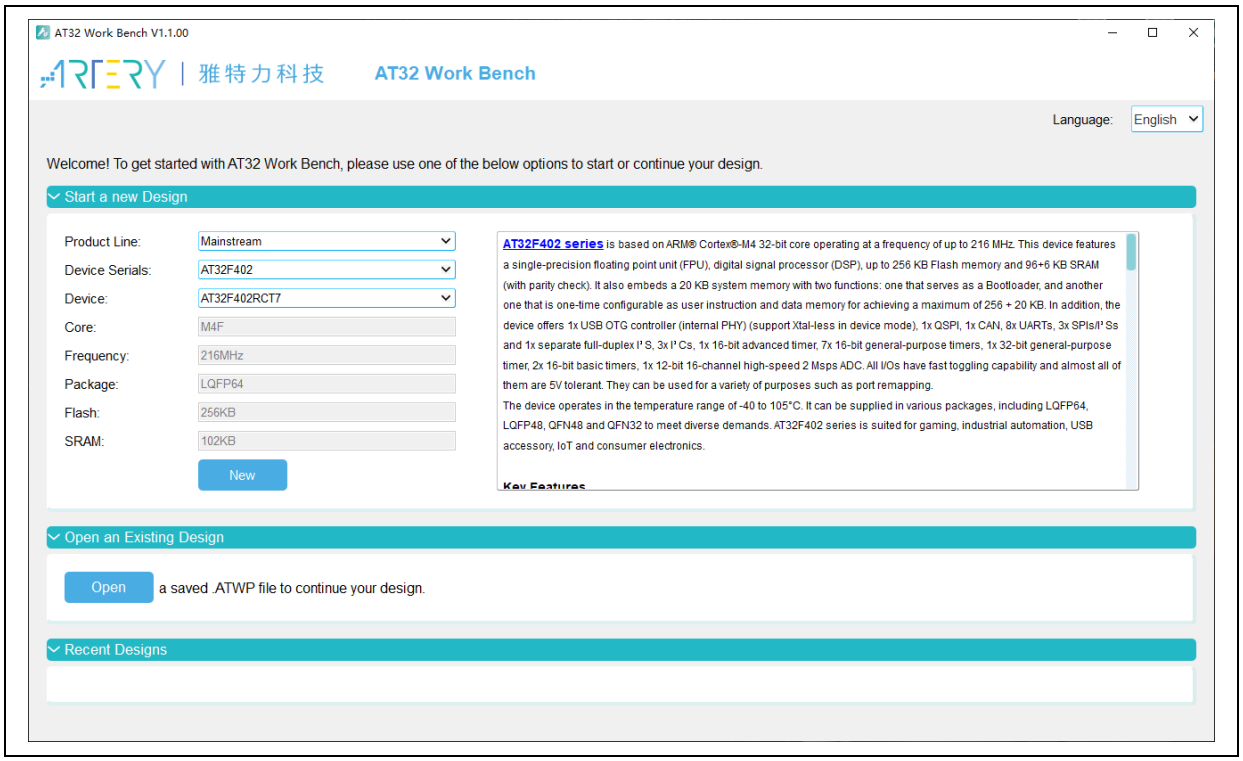
- Open an existing design

Users can find a saved project through File Explorer and then open it (*.ATWP file).

- Recent designs

It displays a list of recently created projects. Users can select one to open.

Figure 3. Getting started page

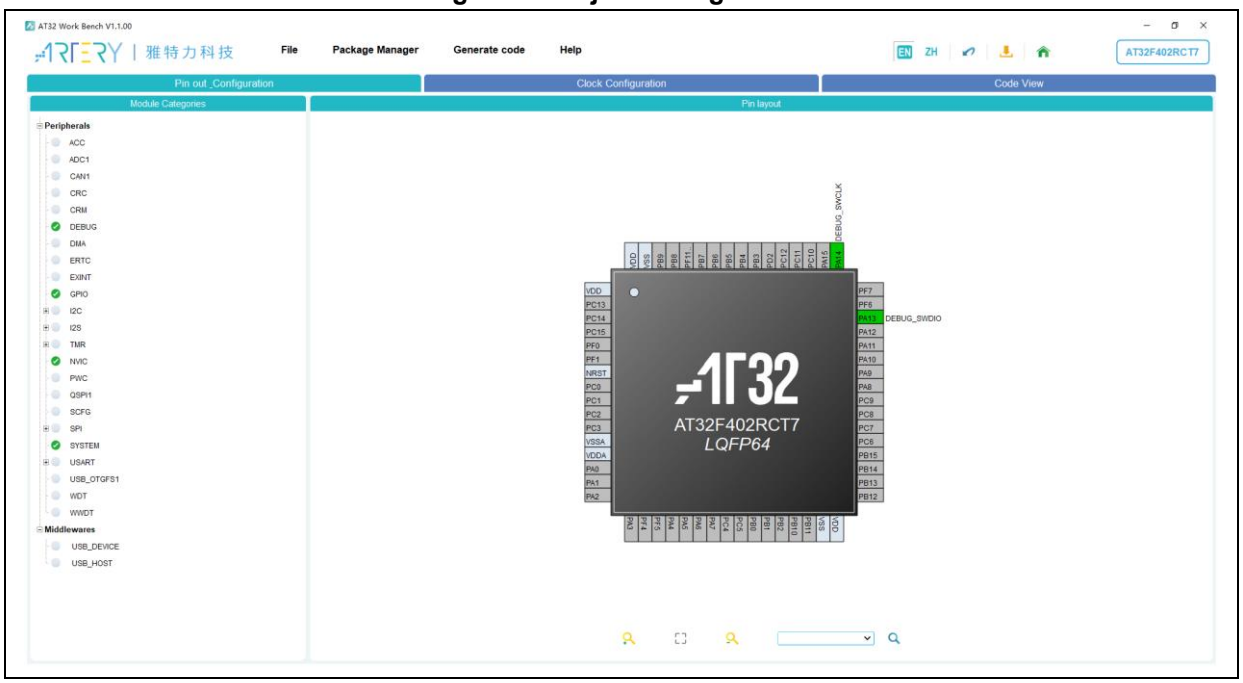


4 Project configuration

After a new project is created or a saved file is loaded, the project configuration page opens. It contains a menu bar, a toolbar, and the following set of views:

- Pin out configuration
- Clock configuration
- Code view

Figure 4. Project configuration



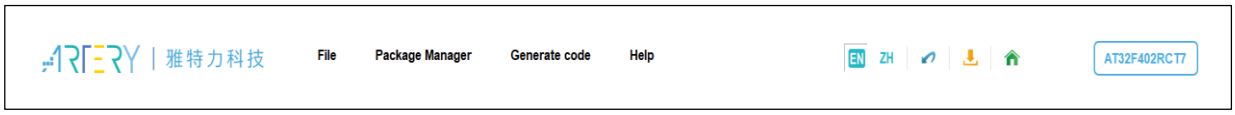
Pin out configuration: Users can configure peripheral pins and relevant parameters.
Clock configuration: Users can configure MCU clock as needed.
Code view: Users can view the code automatically generated according to the current configuration.

Click on the “Generate code” in the menu bar or the icon in the toolbar to generate the corresponding user code and project.

4.1 Menu bar and toolbar

Figure 5 shows the menu bar and toolbar.

Figure 5. Menu bar and toolbar



4.1.1 Menu bar

- **File**

New design	Create a new project.
Open design	Open a saved project.
Save design	Save the current project.
Design save as	Save the current project as…

Generate report	Generate a project report (.pdf).
Recent design	Display recent projects.

- **Package Manager**

Package Manager	Install and manage BSP.

- **Generate code**

  After the peripheral parameters and clock are configured as needed, click on “Generate code” to select the project location and generate the corresponding project file.

- **Help**

Open manual	Open the user manual.
New version download	Download the new version online.
Go to Artery home page	Open browser to visit the official website of Artery.
Version	View the current version.

4.1.2 Toolbar

EN: Select English as the display language.

ZH: Select simplified Chinese as the display language.

: Reset. Reset all peripheral parameters, pins and clock.

: Generate code. Open “Project Manager” window and generate the corresponding code. Refer to Section 4.5.

: Visit the official website of Artery.

AT32F421C8T7: Display the current MCU model.

4.2 Pin out configuration

Pin out configuration: Configure pins and parameters of MCU peripherals.
It contains the “Peripherals”, “Mode and Configuration” and “Pin layout” windows. Users can adjust the window size as follows: hover the mouse over the window border and then a two-way arrow appears; then, hold down the left mouse button and move to expand or shrink the window size.

4.2.1 Peripherals

The “Peripherals” window displays a list of available peripherals and middleware for the selected MCU model. The icon in front of peripheral name indicates the peripheral configuration status.

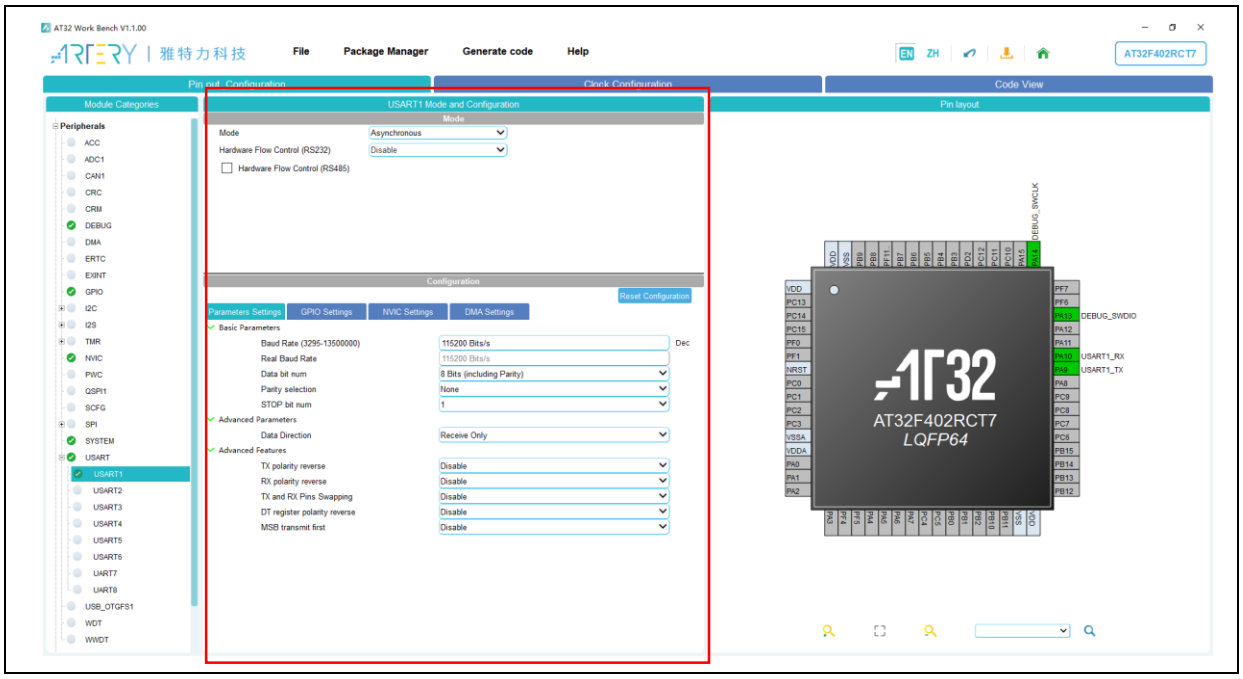
Table 1. Peripheral status

Icon	Status	Description
	Not configured	Mode and parameters are not configured.
	Configured successfully	Mode and parameters are configured successfully.
	Configuration parameter error	The mode or relevant parameters are incorrect. Please confirm and re-configure as needed.

4.2.2 Mode and configuration

Select a peripheral from the list of peripherals, and then the corresponding “Mode and Configuration” window opens. Users can select peripheral mode and the corresponding MCU pins in the “Mode”. For AT32 MCUs, same pins can be used for different peripherals and multiple features; therefore, once the mode is selected, the optimum pin layout will be configured automatically.

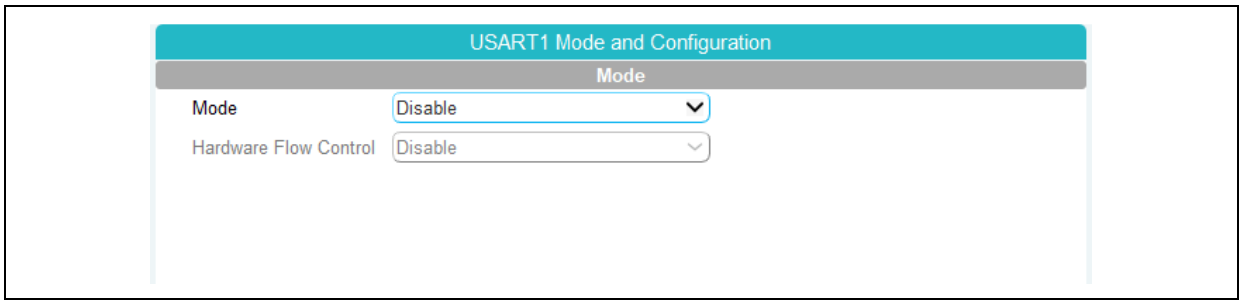
Figure 6. Peripheral mode and configuration



Take the USART1 as an example:

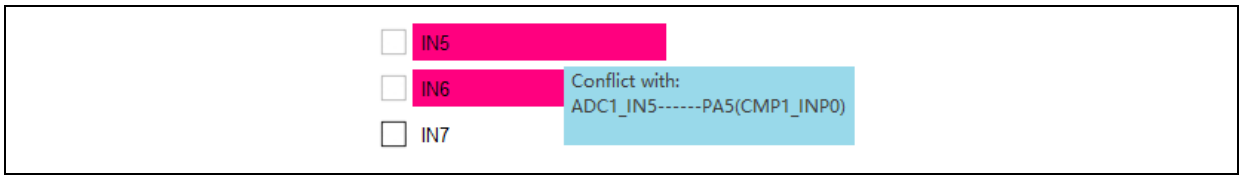
- USART1 mode

Figure 7. USART1 mode and configuration



As shown in Figure 7, when the USART1 is set to asynchronous mode, PA9 and PA10 are mapped to “USART1_TX” and “USART1_RX automatically; when “CTS/RTS” is selected for hardware flow control, PA11 and PA12 are mapped to “USART1_CTS” and “USART1_RTS” automatically. When the condition is not satisfied or in case of signal conflict, the corresponding content is displayed in a different color or background color, as shown in Table 2. Move the mouse over the corresponding content, and a message appears to prompt users to modify or re-configure, as shown in Figure 8.

Figure 8. Mode error prompt



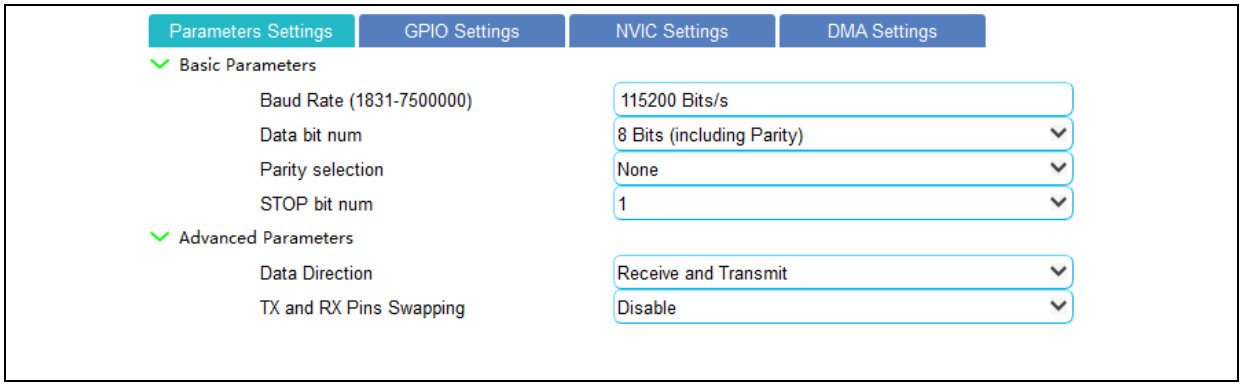
Examples of status of mode and parameters:

Table 2. Status of mode and parameters

Icon	Status	Description
Hardware Flow Control CTS/RTS	Configurable	
Clock Output	Condition not satisfied	Configure other parameters as prompted.
Please select a Inverting input selection (Input [-])	Configure the corresponding mode	Select “Inverting input selection (Input[-])”.
IN5	Signal conflict	There is a conflict with other function signals.
Parameters Settings GPIO Settings NVIC Settings DMA Settings Basic Parameters Baud Rate (3-14648) 115200 Bits/s	Parameter error	The parameter is beyond the required value range.

■ Parameters settings

Figure 9. Parameters settings

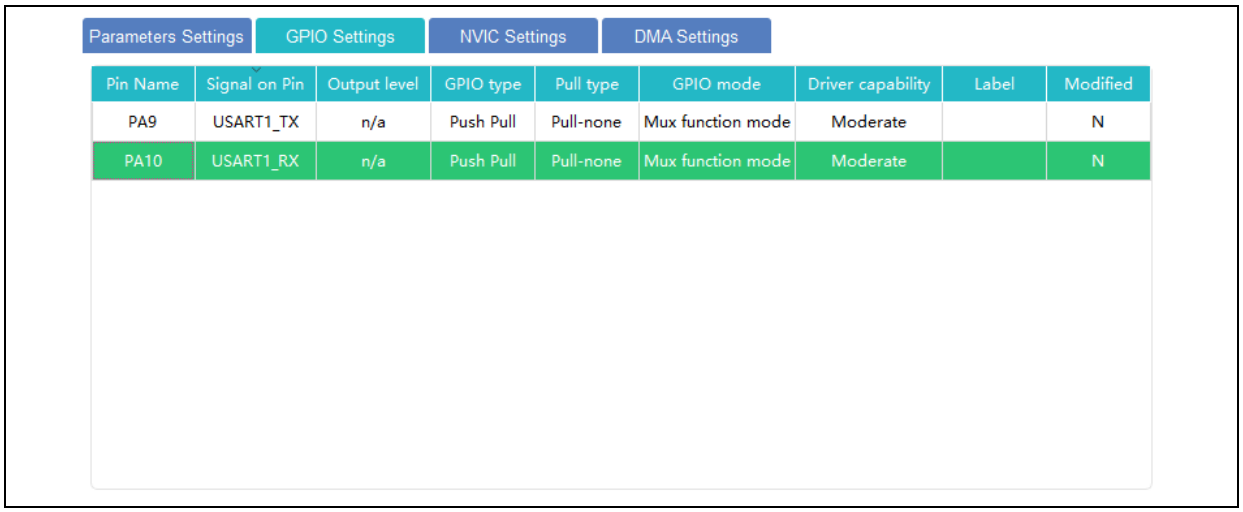


This window displays configurable USART1 parameters, including the “baud rate” and “data bit number” in the “Basic Parameters” and “data direction” and “Tx and Rx pins swapping” in the “Advanced Parameters”.

If an invalid setting is detected, the corresponding parameter will be optimized automatically according to the value range. For example, when the user-defined value is lower than the minimum value (or greater than the maximum value), it is automatically reset to the minimum (or maximum) value.

■ GPIO settings

Figure 10. GPIO settings

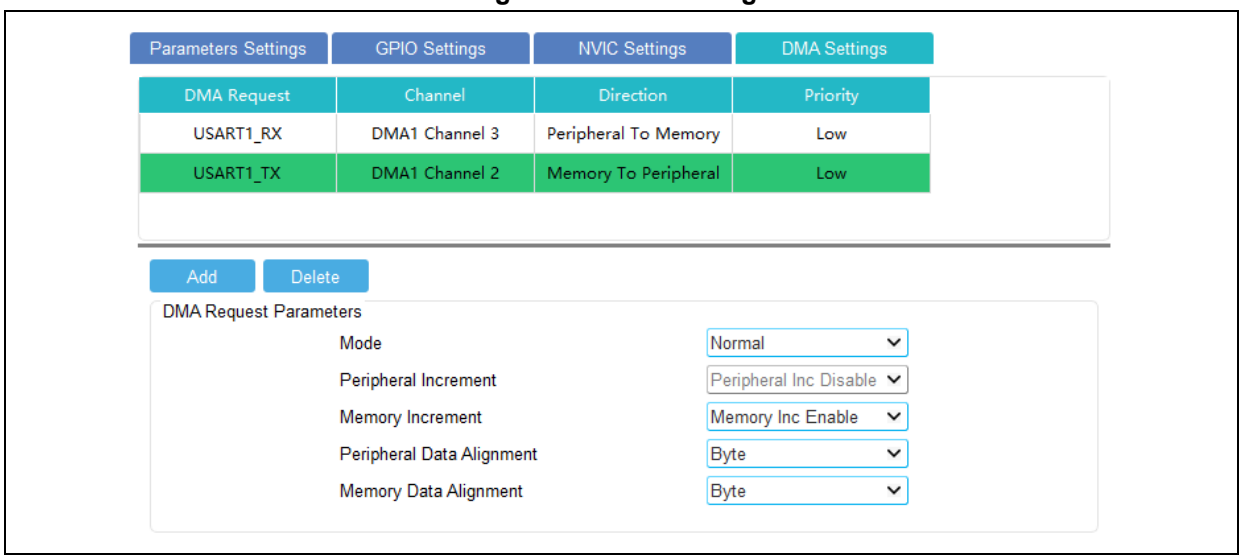


This window displays configurable GPIOs, for example, GPIOs for “USART1_TX” and “USART1_RX” in Figure 10.

For details about GPIO settings, refer to Section 4.2.4.

- DMA settings

Figure 11. DMA settings

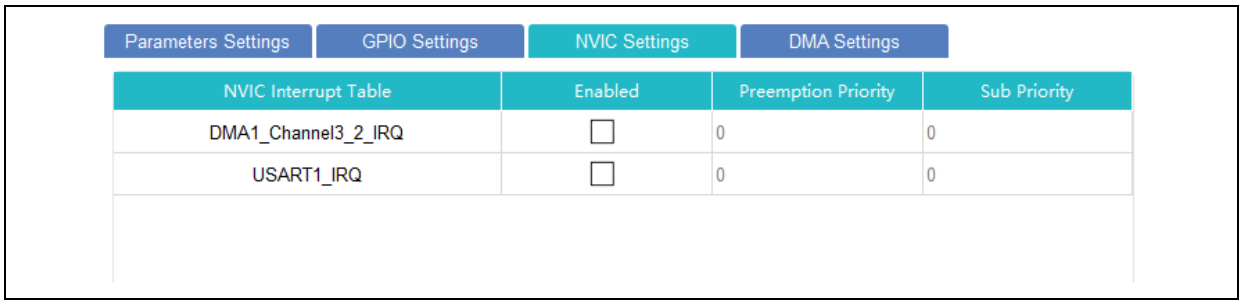


This window allows users to add configurable DMA requests for the current peripheral, for example, the corresponding DMA channels and DMA requests for “USART1_TX” and “USART1_RX” in Figure 11.

For details about DMA settings, refer to Section 4.2.5.

- NVIC settings

Figure 12. NVIC settings



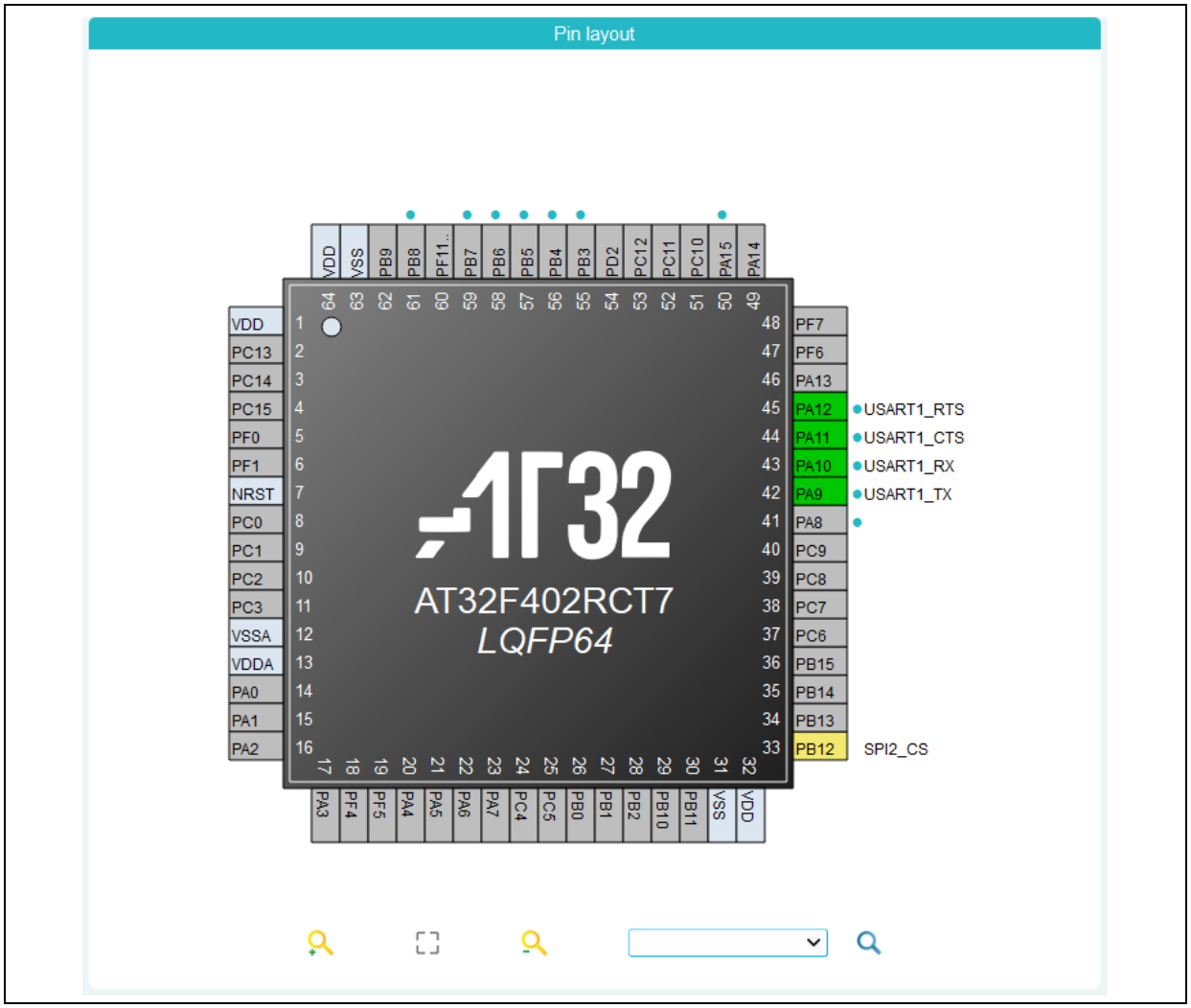
This window displays configurable interrupts for the current peripheral. When the corresponding DMA channel is enabled, the corresponding DMA channel interrupt can be configured, for example, the “USART1_IRQ” and “DAMA1_Channel3_2_IRQ” in Figure 12.

The “preemption priority” and “sub priority” are configured in the “NVIC Mode and configuration” window. Refer to Section 4.2.6.

4.2.3 Pin layout

The pin layout of the selected package (such as LQFP48, QFN32 and TSSOP20) is displayed in graphic. Each pin is represented by its name (such as PA9), configuration status, and current signal distribution.

Figure 13. PIN layout



Pins are displayed in different colors and have different functions according to their status, as shown in Table 3.

Table 3. Status of pins

Icon	Status	Description
	Pin not in use	Users can configure signals for this pin.
	Pin in use	A valid signal is configured, and it has a corresponding peripheral mode.
	Pin no mode	A signal is configured, but it has no corresponding peripheral mode.
	Fixed mode	Fixed configuration, not support other functions.
	Pin searched	Click on the “Search” icon, and the searched pins are displayed in blinking blue.
	Peripheral pin label	Click on a peripheral in the peripheral list on the left to label all pin positions for that peripheral.

Users can press the Ctrl + scroll mouse wheel to adjust the pin layout window size, and move the mouse to relocate its position.
Click on the chip internal area to show or hide the pin number.
In addition, users can zoom in/out the pin layout by using the below toolbar to view the global configuration or local details. Click on the “Reset” icon to restore the pin layout to its initial size.
Select the corresponding pin, signal or label in the search box and press Enter; then, the searched pins are displayed in blinking blue.

: Zoom into the pin layout.

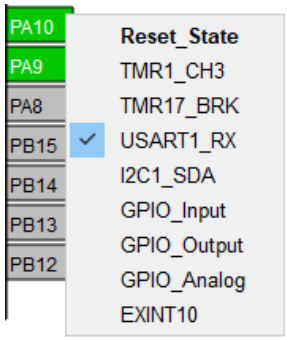
: Restore to the initial size and position.

: Zoom out the pin layout.

: Search. Find the positions of pins, signals and labels in the pin layout.

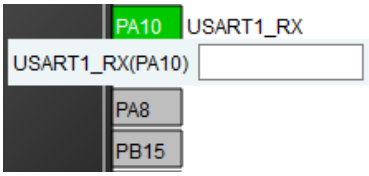
User can press the Ctrl + click on the signal to search for the pin where the signal is located.
In the pin layout, left click on the pin (except for pins in fixed mode), and then a right-click menu pops up, showing configurable signals for the pin. Select “Reset_State” to reset this pin to the unused status, as shown in Figure 14.

Figure 14. Pin configuration menu



Right click on the configured pin, and then an “Enter label” button pops up. Users can click on the button to specify a custom label for this signal. The new label replaces the signal name set in the pin layout.

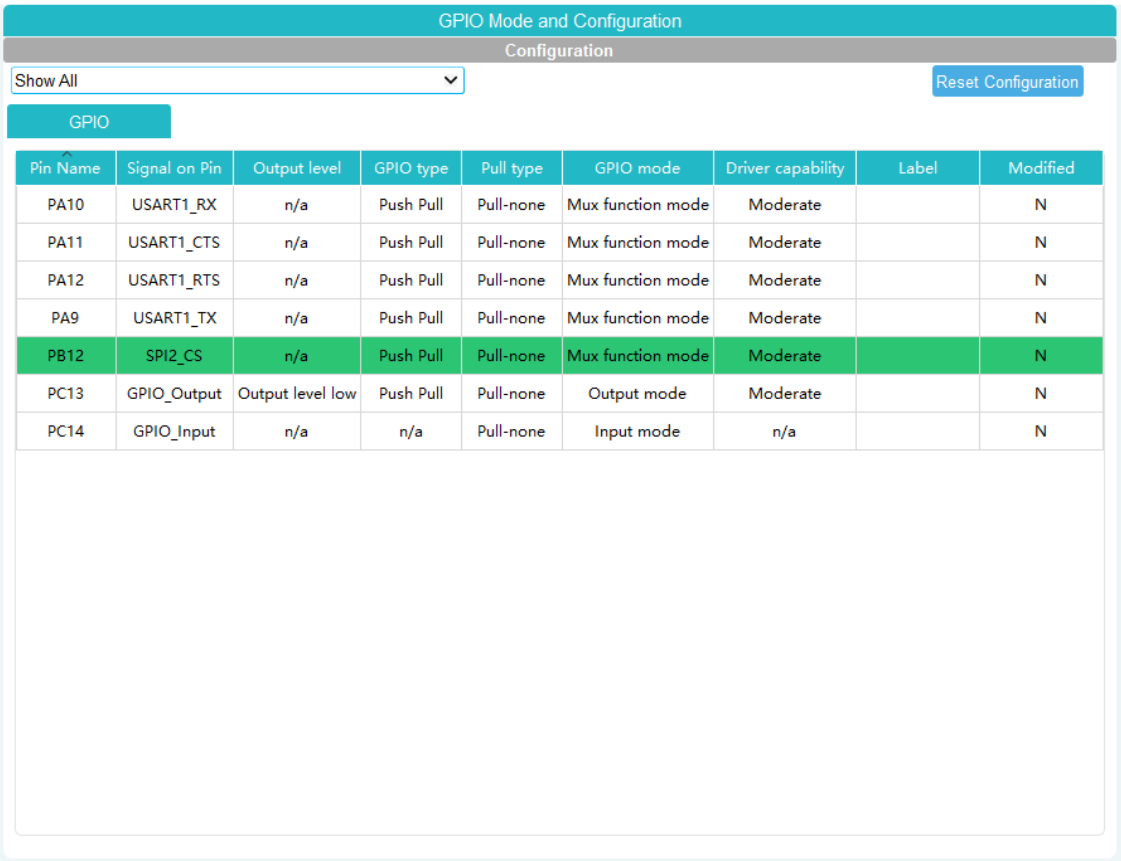
Figure 15. Custom label



4.2.4 GPIO mode and configuration

Click on “GPIO” under “Peripherals” to open the GPIO Mode and Configuration window. Users can also configure GPIO for specific peripherals in a dedicated window for GPIO configuration.
Click on the drop-down box to select “Show All” or “Groups by Peripherals”.
Click on “Reset Configuration” button to reset all GPIO parameters.

Figure 16. GPIO mode and configuration



Pin Name	Signal on Pin	Output level	GPIO type	Pull type	GPIO mode	Driver capability	Label	Modified
PA10	USART1_RX	n/a	Push Pull	Pull-none	Mux function mode	Moderate		N
PA11	USART1_CTS	n/a	Push Pull	Pull-none	Mux function mode	Moderate		N
PA12	USART1_RTS	n/a	Push Pull	Pull-none	Mux function mode	Moderate		N
PA9	USART1_TX	n/a	Push Pull	Pull-none	Mux function mode	Moderate		N
PB12	SPI2_CS	n/a	Push Pull	Pull-none	Mux function mode	Moderate		N
PC13	GPIO_Output	Output level low	Push Pull	Pull-none	Output mode	Moderate		N
PC14	GPIO_Input	n/a	n/a	Pull-none	Input mode	n/a		N

Double click to modify GPIO parameters for each signal. The configurable GPIO parameters include:

- Pin Name

The name of the pin where the signal is located. If several pins have the same signal and the pin is not used, double click to switch signal to this pin.
(This function is not supported on AT32F403A/F407/A403A/F413/F415 devices)

- Output level

When the current signal is “GPIO_Output”, it can be configured as “Output level low” or “Output level high”.

- GPIO type

Configure the GPIO type (push-pull/open-drain).

- Pull type

It is set to a default value, which can be configured accordingly.

- GPIO mode (analog, input, output and MUX function)

Select a mode in the pin layout, and the corresponding pin is configured according to the MUX function and GPIO mode.

- Driver capability

Configure the I/O port drive capability (moderate sourcing/sinking strength and stronger sourcing/sinking strength).

- Label

Change the default name to a user-defined name, and the pin layout changes accordingly.

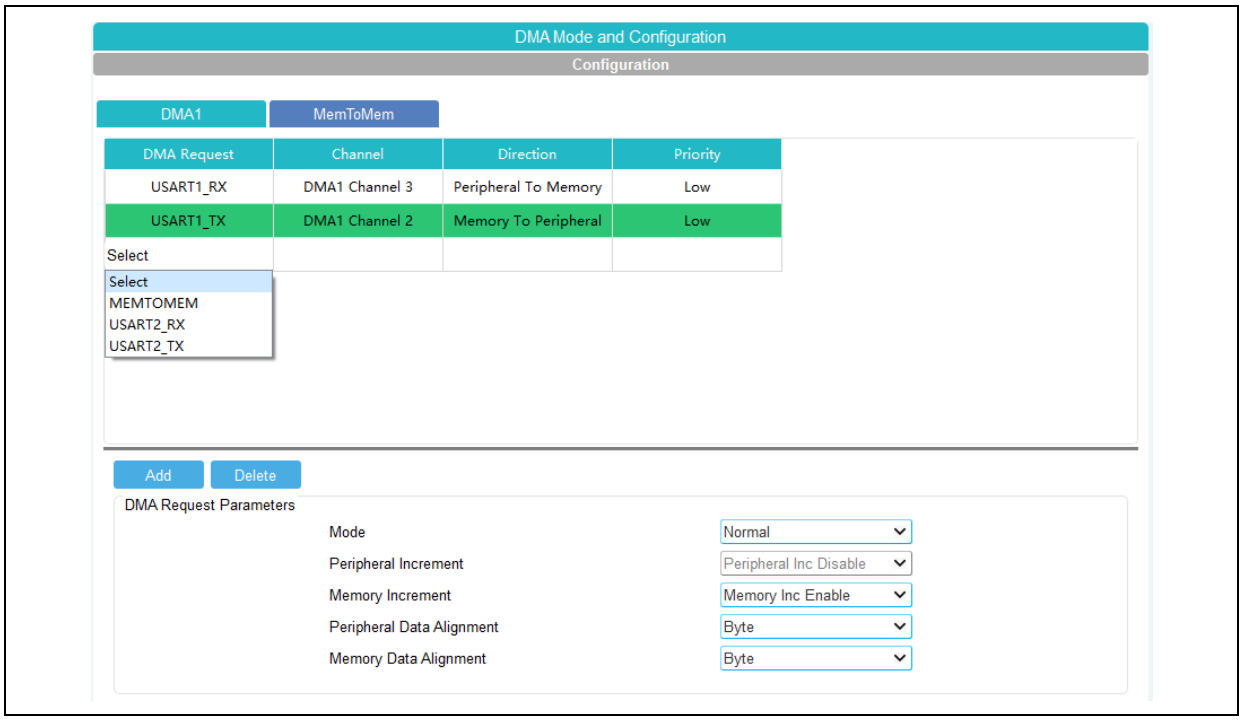
4.2.5 DMA mode and configuration

Click on “DMA” under “Peripherals” to open the DMA Mode and Configuration window to configure available general-purpose DMA controller. DMA interface supports data transfer between memory and peripherals and memory-to-memory data transfer when CPU is running.

Some peripherals have a dedicated DMA controller, which by default can be configured in the “DMA Mode and Configuration” window.

Click on “Add” to add a new line in the last row of the table in “Configuration” window. Optional DMA requests are listed in the combo box.

Figure 17. DMA mode and configuration



DMA request is used to reserve a data flow for data transfer between peripherals and memory. The priority determines which flow to select for the next DMA transfer.

Users can configure DMA in the “DMA Mode and Configuration” window.

- Direction

Peripheral-to-memory, memory-to-peripheral, and memory-to-memory transfers.

- Priority

There are four levels, including very high priority, high priority, medium priority and low priority. If the two channels have the same priority level, then the channel with lower number will get priority over the one with higher number. For example, channel 1 has priority over channel 2

- Mode

There are normal mode, circular mode and peripheral flow control mode.

- Peripheral increment

Configure peripheral increment type and enable peripheral increment. Once enabled, the peripheral address increments after each transfer.

- Memory increment

Configure memory increment type and enable memory increment. Once enabled, the memory address increments after each transfer.

- Peripheral data alignment

Configure peripheral data bit width (byte: 8-bit, half-word: 16-bit, word: 32-bit).

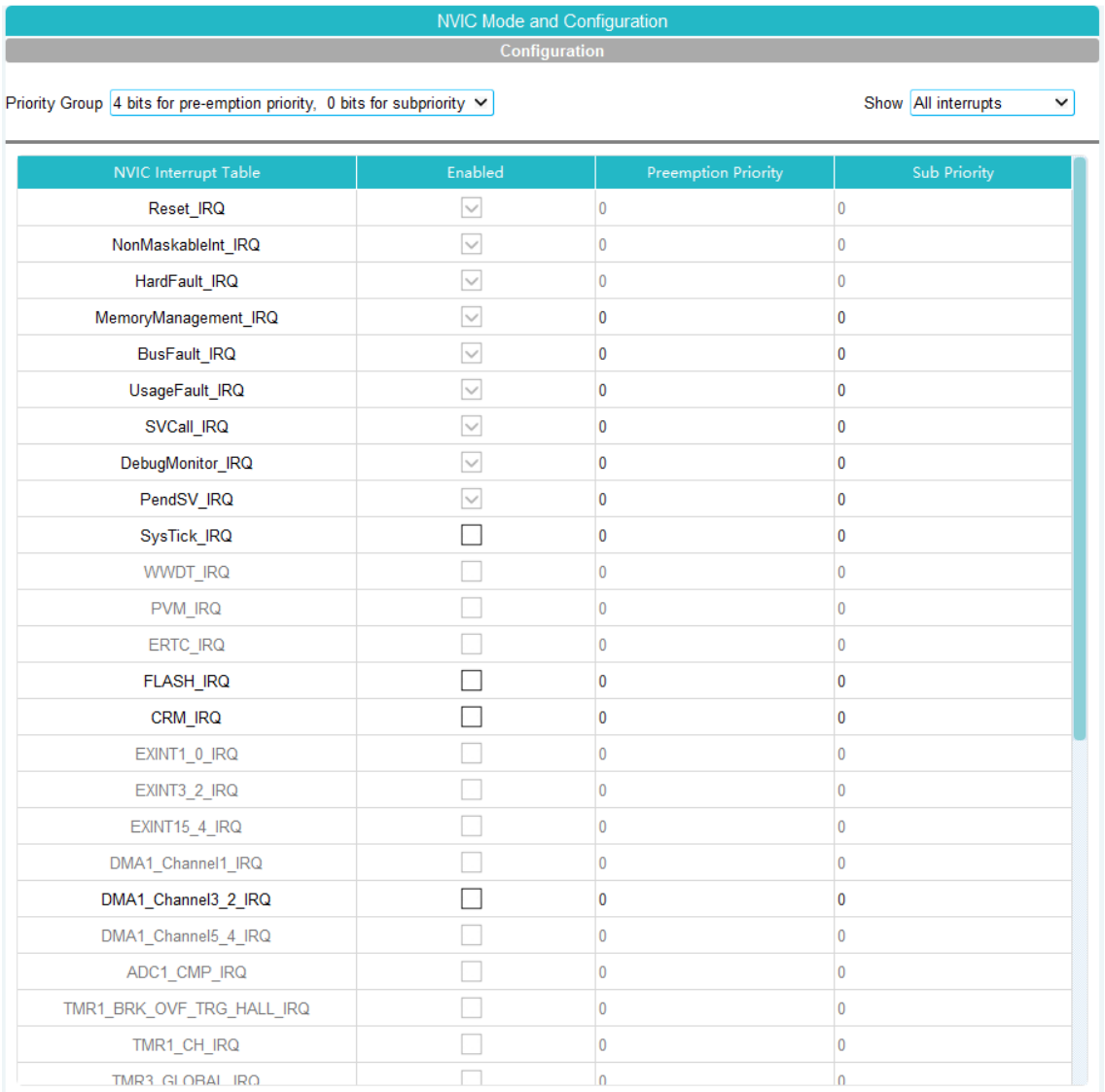
- Memory data alignment

Configure memory data bit width (byte: 8-bit, half-word: 16-bit, word: 32-bit).

4.2.6 NVIC mode and configuration

Click on “NVIC” under “Peripherals” to open the NVIC Mode and Configuration window.
Click on the “Show” drop-down box to select to display all interrupts, available interrupts and enabled interrupts.

Figure 18. NVIC mode and configuration



As shown in Figure 18, interrupts in gray are not configurable and the corresponding peripheral mode needs to be enabled; interrupts with the “Enabled” check box ticked and cannot be modified are system interrupts, and these interrupts cannot be disabled.

NVIC configuration includes “Priority Group”, “Enabled” (check box) and interrupt priority (preemption priority and sub priority).

1. Priority Group

   The priority group has multiple bits that can be used to define the NVIC priority. These bits are divided into two priority groups, corresponding to two priority types, i.e., preemption priority and sub priority. Priority bits indicate the number of priorities that can be configured, for example, 0: only one priority0, 4: 16 priorities (0-15).

2. Click on an interrupt in the “NVIC Interrupt Table” to configure:
   - Enabled: tick/untick to enable/disable this interrupt.
   - Preemption priority: Select a preemption priority. It defines the ability of one interrupt to interrupt another.
   - Sub priority: Select a sub priority. It defines the interrupt priority.

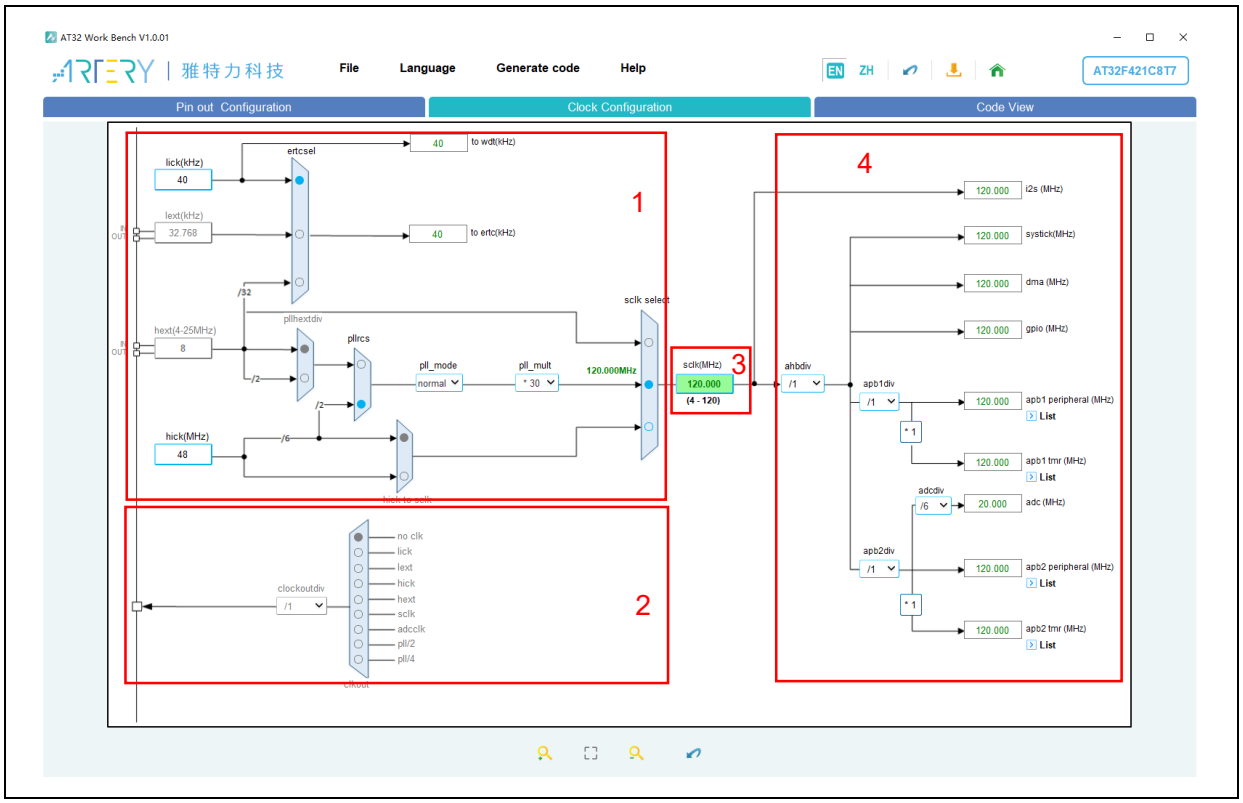
Dedicated peripheral interrupts also can be configured in the NVIC Mode and Configuration window.

4.3 Clock configuration

Users can configure the clock path and parameters in the Clock Configuration window, and use drop-down menus and input boxes to modify the actual clock tree configuration to meet application requirements.

As shown in Figure 19, the Clock Configuration window mainly includes four blocks.

Figure 19. Clock configuration



1. Configuration: Select and configure the clock path and parameters as needed.
2. Output: Configure the clock output (CLKOUT).
3. SCLK: It is an input box when PLL is used as the system clock. Users can input the desired system clock frequency to automatically configure the frequency multiplication factor.
4. Result: Display the clock frequency of the current peripheral, and peripherals on bus.

Users can press the Ctrl + scroll mouse wheel to adjust the MCU clock configuration window size. The toolbar of the Clock Configuration window has the following functions:

: Zoom into the clock configuration view.

: Restore the clock configuration view to the initial size and position.

: Zoom out the clock configuration view.

: Reset clock configuration.

Note 1: Set the "LEXT" mode in the "CRM Mode and Configuration" window to enable LEXT.
Note 2: Set the "HEXT" mode in the "CRM Mode and Configuration" window to enable HEXT.
Note 3: Tick "Clock Output" in the "CRM Mode and Configuration" window to enable clockout.

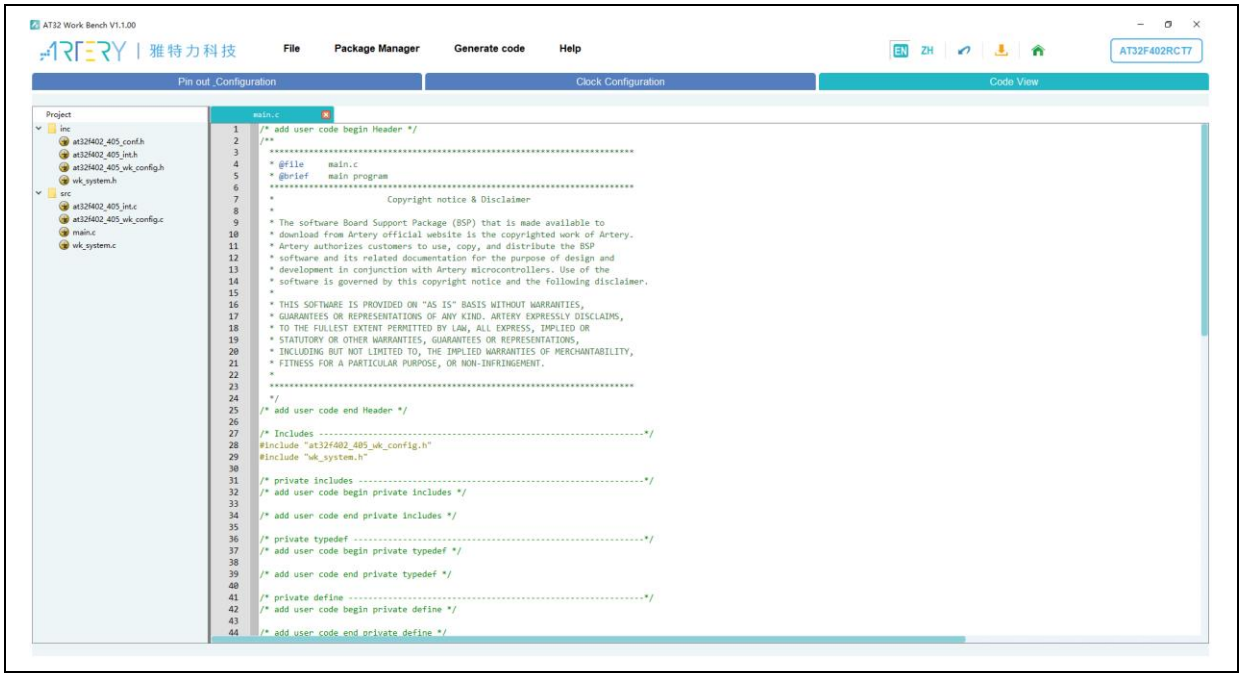
4.4 Code view

Click on the “Code View” to generate code automatically. Code files are listed in the left, and the corresponding code is shown in the right window.

- main.c: main source file, which is used to call peripheral initialization functions.
- AT32xxxx_wk_config.h: header file for peripheral configuration, which is used for declaration of each peripheral initialization function.
- AT32xxxx_wk_config.c: source code for peripheral configuration, which is used to define each peripheral initialization function.
- AT32xxxx_int.h: header file of interrupt functions.
- AT32xxxx_int.c: source file of interrupt functions.
- AT32xxxx_conf.h: header file for library configuration.

Users can view the code generated automatically according to the current configuration.

Figure 20. Code view



Users can press the Ctrl + scroll mouse wheel to adjust the code view size, and use the right click menu to:

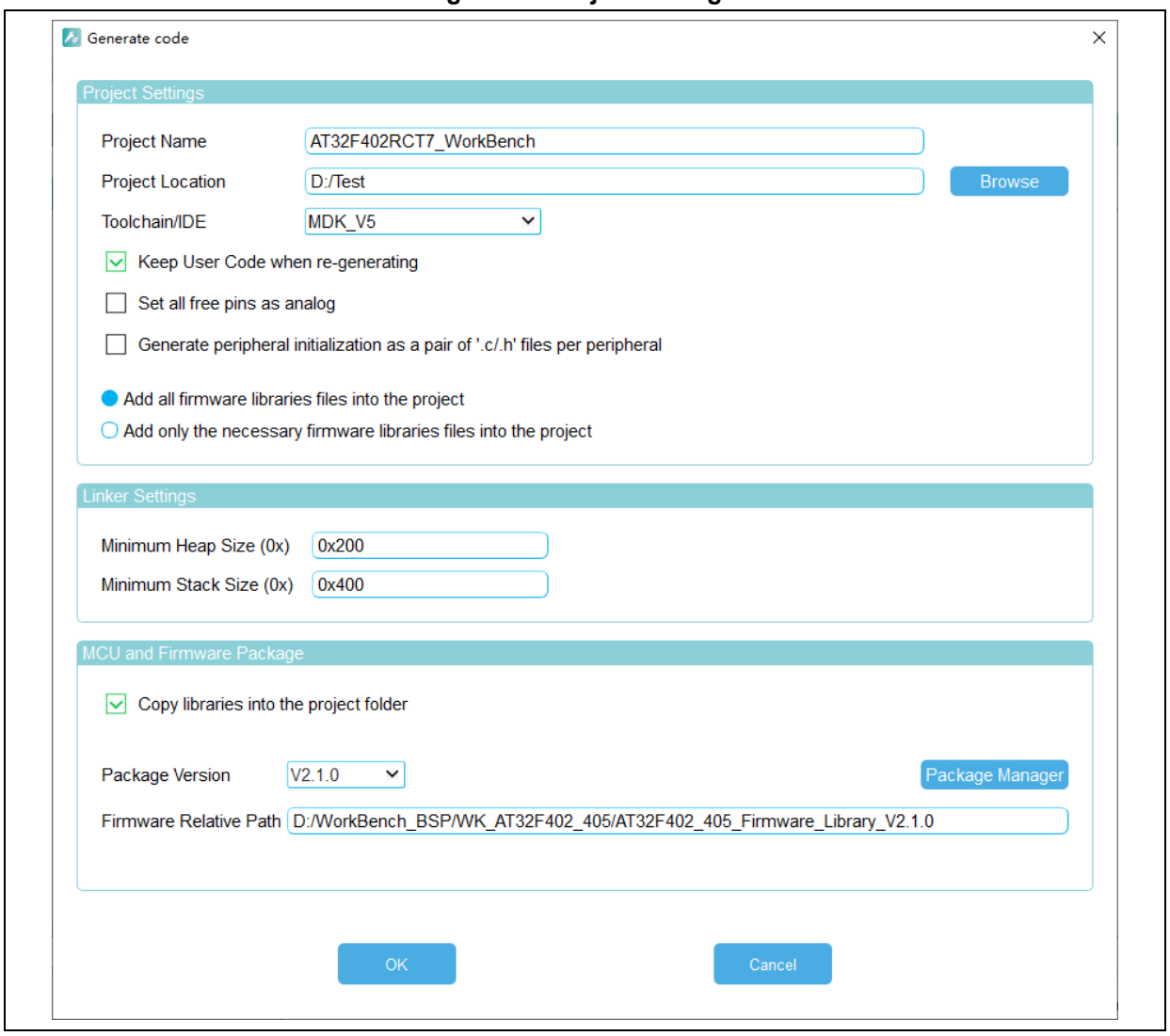
- Fold all: fold code to view its structure;
- Expand all: expand all folded code;
- Copy: cope the selected code;
- Select all: select all of the code.
- Find: Search keywords in the preview code;
- EnCoding: Switch the encoding format to display code.

4.5 Generate code

Click on the “Generate code” in the menu bar or the icon in the toolbar, and then the “Project Manager” window pops up.

4.5.1 Project manager

Figure 21. Project manager



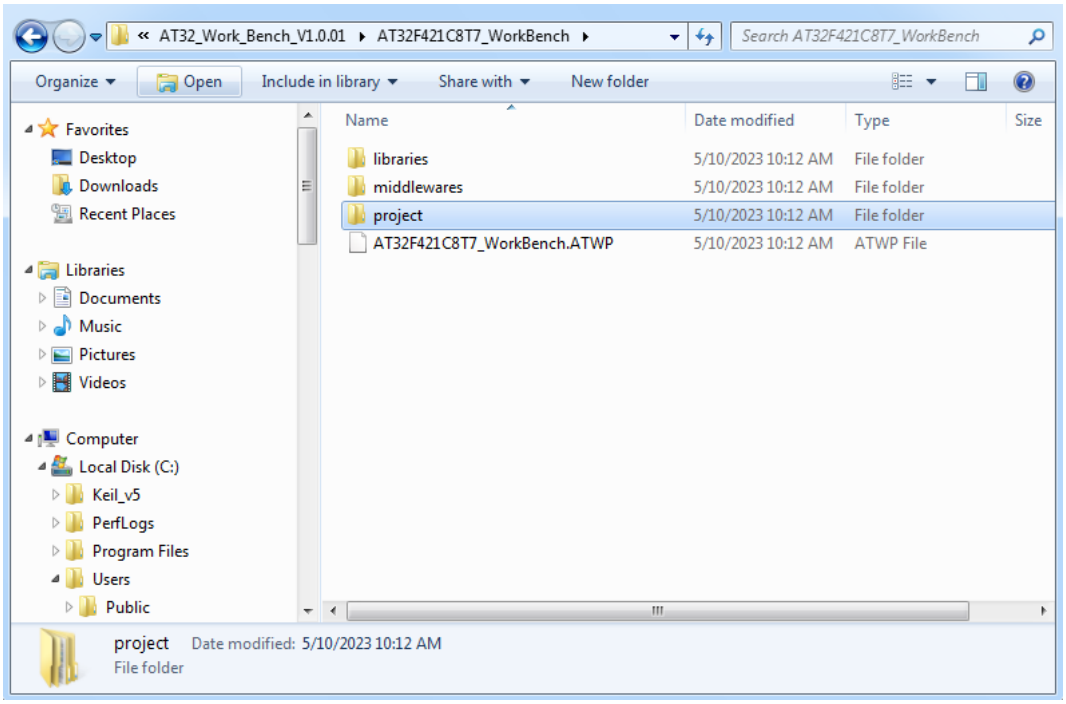
Users can configure required parameters as follows:

- **Project Settings**
  - Project name: create the project name.
  - Project location: storage directory for the project folder.
  - Toolchain/IDE: Generate a project of the selected toolchain/IDE.
  - Keep User Code when re-generating code. Refer to Section 4.5.2 for details.
  - Set all free pins as analog (to optimize the power consumption).
  - Generate peripheral initialization as a pair of “.c/.h” files per peripheral: The peripheral initialization code is configured to a separate “.c/.h” file when the code is generated. For example, “usart.c” and “usart.h” are generated for USART.
  - Add all firmware libraries files into the project.
  - Add only the necessary firmware libraries files into the project.

- **Linker Settings**
  - Minimum heap size and minimum stack size. Default values are 0x200 and 0x400, respectively. Users can modify the value when middleware stack is used.
- **MCU and Firmware Package**
  - Copy libraries into the project folder: Tick this check box, and libraries in the firmware package are copied automatically into the project folder when generating code.
  - Package Version: Select the firmware package version. If the package is not setup, click on "Package Manager" to install.
  - Package Manager: Install and manage firmware package. Refer to Section 4.6 for details.
  - Firmware Relative File: Display the path of the selected firmware package.

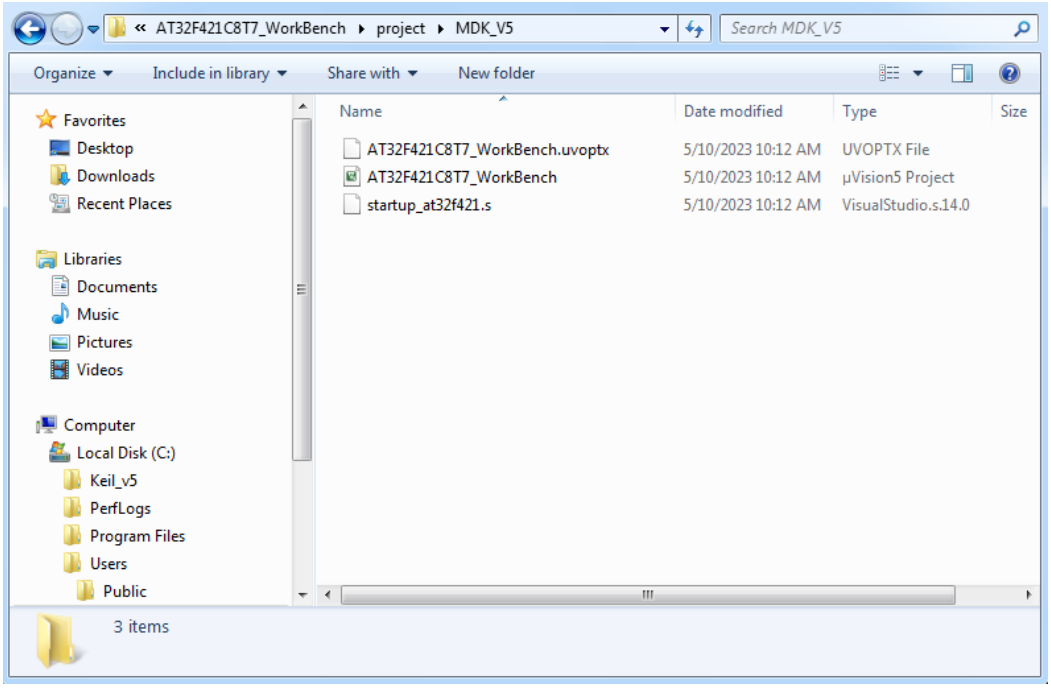
Finally, click on "OK" to generate user code and project of the selected IDE automatically. The generated project file structure is shown in Figure 22.

Figure 22. Project file directory



The file directory contains the "*libraries*" and "*middleware*" folders copied from the firmware package, as well as the generated project folder "*Project*". The "*Project*" contains a header file folder "*inc*", source code folder "*src*" and "*MDK_V5*" (generated according to the selected toolchain/IDE). The *MDK_V5* folder contains MDK project files that can be opened in Keil.

Figure 23. MDK_V5 project files



4.5.2 Keep user code when re-generating

The AT32 Work Bench generated C code allows users to add custom code. The custom code needs to be inserted into the software-defined location and can be reserved for the next generation of C code. The software-defined location is as follows:

```
/* add user code begin …... */

/* add user code end ..... */
```

When re-generating code, user codes in the software-defined position are reserved and not moved or renamed, while user codes not in the software-defined location are ignored and discarded.

Note 1: User-defined "add user code" tag is not supported. Custom code can be added to software-defined tags only.

Note 2: Code annotation cannot be the same as the software-defined "add user code" tag.

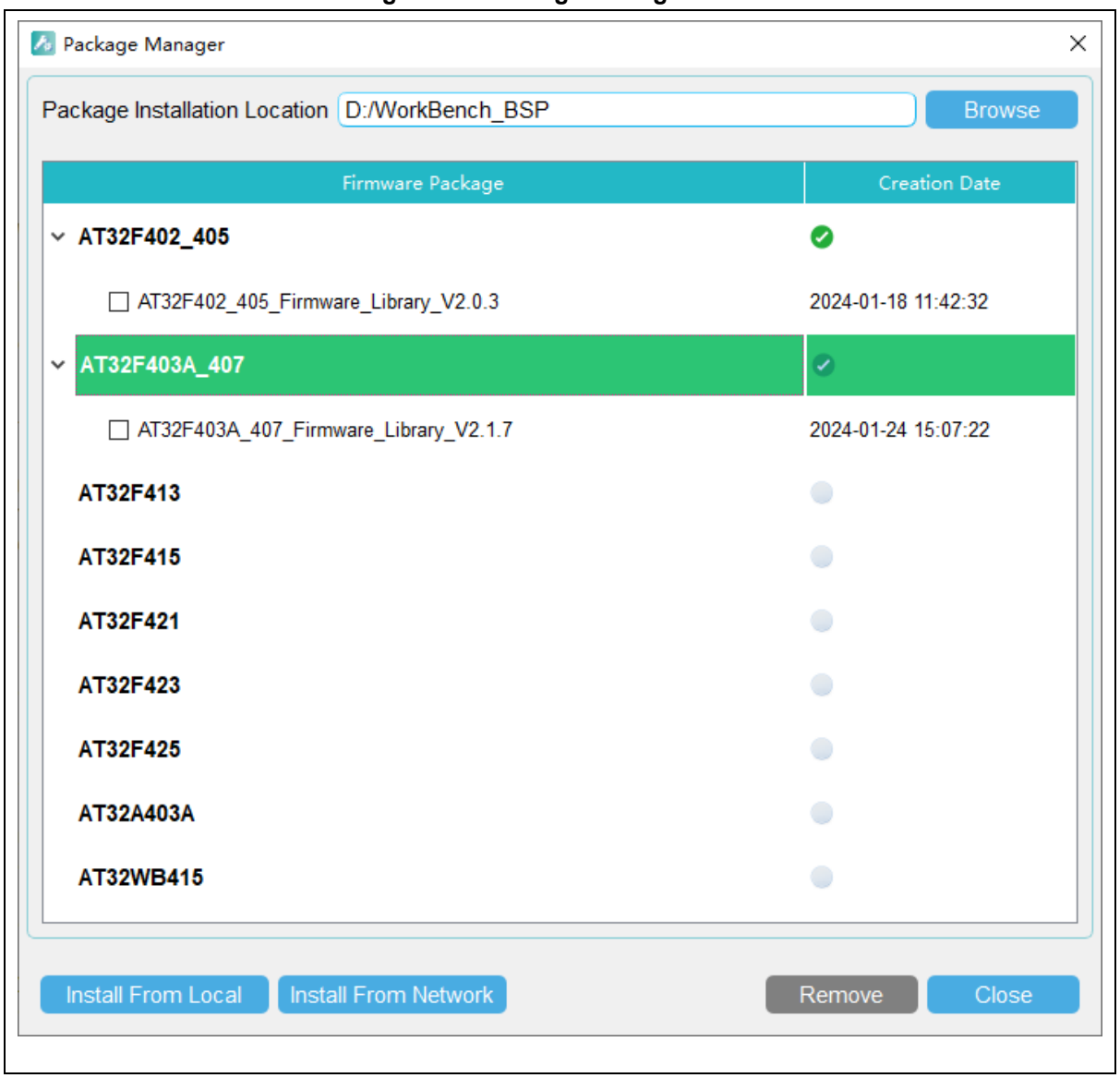
Take the main function in *main.c* as an example. User code can be added to the software-defined positions (in bold).

```
int main(void)
{
  /* add user code begin 1 */

  /* add user code end 1 */

  /* system clock config. */
  wk_system_clock_config();

  /* nvic config. */
  wk_nvic_config();

  /* add user code begin 2 */

  /* add user code end 2 */

  while(1)
  {
    /* add user code begin 3 */

    /* add user code end 3 */
  }
}
```

4.6 Package manager

Click on “File” – “Package Manager”, and the Package Manager window pops up, as shown below.

Figure 24. Package Manager window



■ Package installation location

Select and confirm the package installation path. The software scans for the installed package at this location each time it starts up.

The installed package is stored in the “WK_AT32xxx” directory, such as WK_AT32F425.

Note: Users need to select the installation location after software update.

■ Install from local

Install the firmware package that has been downloaded. This local package (*.ZIP) should be selected manually.

■ Install from Network

Download firmware package from Network and then set up automatically.

- Remove

Tick the installed package and then remove it.

5 Revision history

Table 4. Document revision history

Date	Version	Revision note
2024/12/30	V1.08	Updated some descriptions.
2024/12/25	V1.07	Updated some descriptions.
2024/10/28	V1.06	Updated some descriptions and figures.
2024/08/15	V1.05	Updated some descriptions and figures.
2024/03/05	V1.04	Updated some descriptions.
2024/01/26	V1.03	Added Section 4.6 “Package manager”.
2023/11/28	V1.02	Updated some figures.
2023/09/08	V1.01	Updated some descriptions.
2023/05/09	V1.00	Initial release.