UM0004

User Manual

AT-Link connector user manual

# Introduction

This user manual is written to give a complete account of AT-Link connector that is designed to make it easier and more convenient for users to perform MCU programming and configuratons.

Applicable products:

| | |
|---|---|
| Type | ARTERY MCU family |

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# 1 Overview

## 1.1 Introduction

Artery AT-Link is an online/offline downloader (referred to as “AT-Link” in this document) that is stable, reliable, portable and easy-to-use. Its main features are shown in Table 1.

**Table 1. AT-Link specifications**

| Main features | AT-Link | AT-Link EZ | AT-Link Pro | AT-Link-ISO |
|---|---|---|---|---|
| IDE compiling and debugging such as Keil/IAR | Support | Support | Support | Support |
| USB to USART interface | Support | Support | Support | Support |
| Simultaneously programming multi-section codes of discontinuous address area | Support | Support | Support | Support |
| Multiple offline projects storage | Support | Not support | Support | Support |
| User system area programming | Support | Support | Support | Support |
| SWD online/offline download | Support | Online only | Support | Support |
| ISP-USART offline download | Support | Not support | Support | Support |
| Machine programming control | Support | Not support | Support | Support |
| Serial number programming | Support | Support | Support | Support |
| Button free mode | Support | Online only | Support | Support |
| Programming times limit | Support | Not support | Support | Support |
| Remote file/project encryption | Support | Support | Support | Support |
| Limit the number of times of using remote project | Support | Not support | Support | Support |
| Remote project is bound to the only AT-Link | Support | Not support | Support | Support |
| Remote file is bound to the only AT-Link | Support | Not support | Support | Support |
| Online auto/manual firmware upgrade | Support | Support | Support | Support |
| sLib | Support | Support | Support | Support |
| Download/verify in ciphertext mode | Support | Not support | Support | Support |
| Buzzer on | Support | Not support | Support | Support |
| LED indicators | Support | Support | Support | Support |
| Output voltage regulation | Not support | Not support | Support | Support |
| LCD screen prompt | Not support | Not support | Support | Support |
| Offline parameter settings | Not support | Not support | Support | Support |
| Anti-interference | Common | Common | Common | Enhanced |

## 1.2 Glossary

- **AT-Link**

ARTERY AT-Link connector.

- **ICP**

This is an in-circuit programmer software that can be used for various functions by AT-Link.

- **ISP**

This is an in-system programmer that supports write or erase operation to the chip.

- **IDE**

Third-party development programming software, such as Keil, IAR and other compiling and debugging tools.

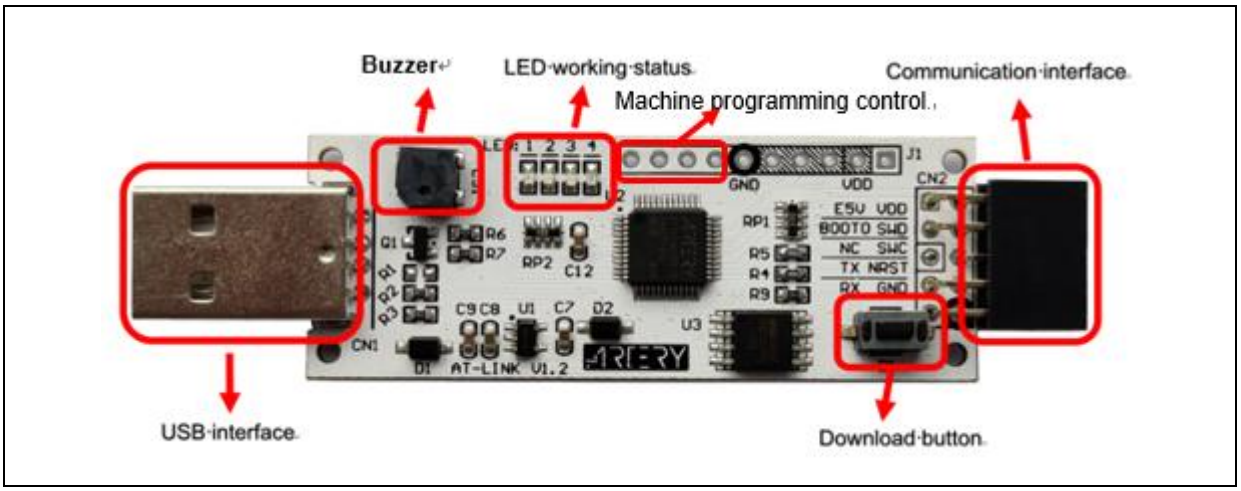
# 2 Hardware specifications

## 2.1 AT-Link

AT-Link is a basic debugger and programmer that supports IDE online debugging, online/offline programming, USB to serial interface and other functions.

It can be connected to PC USB interface, LED, buzzer, buttons, machine programming control interface. It can also be connected to various communication interfaces (such as SWD, SWO, serial port, NRST and BOOT0) and power interface (3V3 and E5V). Figure 1 shows the appearance of an AT-Link.

**Figure 1. AT-Link hardware appearance**




### 2.1.1 USB interface

It is used to communicate with PC during online debugging and download or ICP parameter configuration. It can also be used as AT-Link power supply interface in offline mode.

### 2.1.2 Communication interfaces

- **SWD:** A serial wire debug interface (including SWCLK and SWDIO) can be used for IDE online debugging or ICP online and offline configuration programming.
- **SWO:** It supports SWO_UART feature and can be used for print information output in debug mode (For AT-Link with hardware V1.3 and above).
- **USB-to-serial port:** Includes TX and RX, can be connected to the serial interface of the target board for ISP offline download or used as a common serial interface.
- **NRST:** It can be connected to the NRST reset pin of the target board to provide a hardware reset signal, and cooperates with BOOT0 pin for boot mode switch during ISP offline download.
- **BOOT0:** It can be connected to the B00T0 pin of the target board, and cooperates with NRST pin for boot mode switch during ISP offline download.

### 2.1.3 Power supply interface

- **3V3:** used as 3.3 V power output port, output 3.3 V.
- **E5V**: used as 5 V power output or input port. As output: when the USB interface is powered, it outputs about 4.7 V; as input: the outside can input 4.5V~5.5V through this interface to supply for AT-Link.
- **GND:** connected to the GND of the target board.

### 2.1.4 LED and buzzer

LED1-LED4 are “connected” (red), “run” (green), “USB_status” (blue), and power (orange) respectively.

- **LED1:** indicating connection state during offline/online operation.
- **LED2:** indicating running state during offline/online operation.
- **LED3:** indicates the connection status between AT-Link and PC USB. LED is always on after successful connection.
- **LED4:** After power-on, LED light is always on, indicating that AT-Link is working normally.
- **Buzzer:** It is used to indicate download status, and the switch on/off can be configured through ICP.

This table below shows the status of LED1 and LED2 during IDE, ICP online and offline operations:

**Table 2. AT-Link LED and buzzer status**

| Working status | LED1-Connected(red) | LED2-Run (green) | Buzzer status |
|---|---|---|---|
| Power-on initialization | All LEDs blink once | | Short beep |
| Idle state | OFF | OFF | Mute |
| IDE operation settings | ON | OFF | Mute |
| IDE debugging stops | ON | OFF | Mute |
| IDE debugging in progress | ON | ON | Mute |
| ICP configuration in progress | ON | OFF | Mute |
| Online/offline download on-going | Blink alternately | Blink alternately | Mute |
| End of online/offline download: PASS | OFF | Blink slowly | Short beep |
| End of online/offline download: FAIL | Quick blink | OFF | Ring quickly for 3S |
| End of continuous download: Remove target | OFF | OFF | Mute |
| Long press the key 3s to switch to offline download mode: button free download | Blink quickly for 3S | Blink quickly for 3S | Keep ringing for 3s |
| Long press the key 3s to switch to offline download mode: single download | OFF | Blink fast for 3S | Ring for 3s intermittently |

### 2.1.5 Machine programming control interface

Machine programming control contains START, BUSY, PASS, and FAIL interfaces. The parameters include machine programming control signal enable, active level polarity, START active level pulse width and BUSY delay setup time, which can be programmed in ICP and saved after power-off. Refer to *Section 3.4* for more information on the pin definitions and timing of machine programming control.

- START: Input interface. Download starts when the received active level pulse width is greater than the programmed value.
- BUSY: Output interface, it remains in the active level state during download.
- PASS: Output interface, it will remain active until the next operation after a successful download.
- FAIL: Output interface. If the download fails, the interface remains active until the next operation.

### 2.1.6 Button

Button is mainly used for offline download, and download mode switch.

- Short press 3s and release: For a single offline download.
- Press and hold 3s without release: Switch button free download or single download, with LED and buzzer indicating the switched mode

***Note: Button operation can take effect only when AT-Link is in idle state. If offline download is on-going or the target board is being operated, it will not respond.***

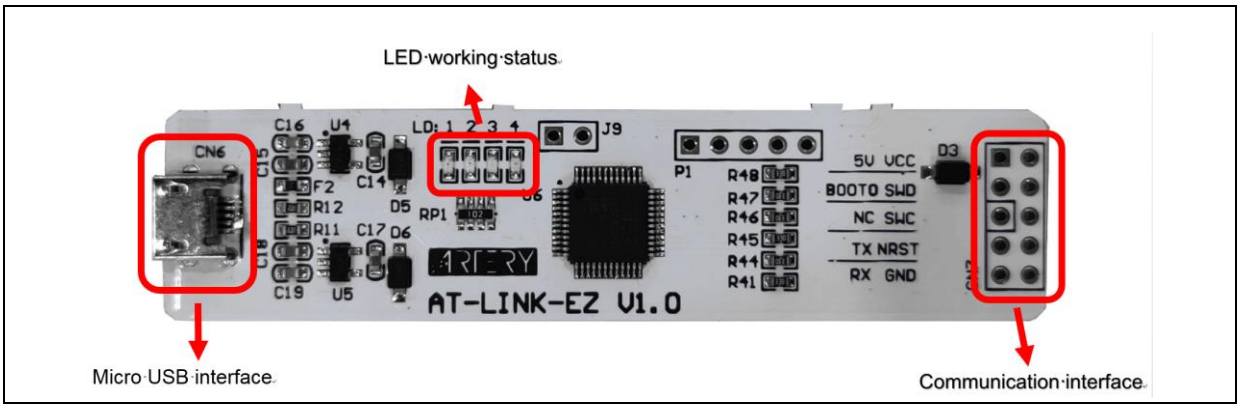
## 2.2 AT-Link-EZ

AT-Link EZ is a simplified debugger and programmer, which can be used in conjunction with AT-START get-started board, or work with other circuit boards after being disassembled. It supports IDE online debugging, online programming, USG to serial interface and other functions.

Its hardware specification includes:

It can be connected to PC micro USB interface, LED, various communication interfaces (such as SWD, SWO, serial port, NRST and BOOT0) and power interface (3V3 and E5V). Figure 2 shows the appearance of an AT-Link-EZ.

**Figure 2. AT-Link-EZ hardware appearance**



### 2.2.1 Micro USB interface

It is used to communicate with PC during online download and debugging or parameter configuration. It must be connected to the USB port on PC to supply for AT-Link EZ.

### 2.2.2 Communication interfaces

- **SWD:** A serial wire debug interface (including SWCLK and SWDIO) can be used for IDE online debugging or ICP online programming.
- **SWO:** It supports SWO_UART feature and can be used for print information output in debug mode (For AT-Link-EZ with hardware V1.1 and above).
- **USB-to-serial port:** Includes TX and RX, can be connected to the serial interface of the target board as a common serial interface.
- **NRST:** It can be connected to the NRST reset pin of the target board to provide a hardware reset signal.
- **BOOT0:** Reserved.

### 2.2.3 Power supply interface

- **3V3:** used as 3.3 V power output port, output 3.3 V.
- **5V**: used as 5 V power output port, output 4.7 V.
- **GND:** connected to the GND of the target board.

### 2.2.4 LED

LED1-LED4 are “connected” (red), “run” (green), “USB_status” (blue), and power (orange) respectively.

- **LED1:** indicating connection state during offline/online operation.
- **LED2:** indicating running state during offline/online operation.
- **LED3:** indicates the connection status between AT-Link-EZ and PC USB. LED is always on after successful connection.
- **LED4:** After power-on, LED light is always on, indicating that AT-Link-EZ is working normally.

This table below shows the status of LED1 and LED2 during IDE, ICP online operations:

**Table 3. AT-Link-EZ LED status**

| Working status | LED1-Connected (red) | LED2-Run (green) |
|---|---|---|
| Power-on initialization | All LEDs blink once | |
| Idle state | OFF | OFF |
| IDE operation settings | ON | OFF |
| IDE debugging stops | ON | OFF |
| IDE debugging in progress | ON | ON |

| Working status | LED1-Connected (red) | LED2-Run (green) |
|---|---|---|
| ICP configuration in progress | ON | OFF |
| Online download in progress | Blink alternately | Blink alternately |
| End of online download: PASS | OFF | Blink slowly |
| End of online download: FAIL | Blink quickly | OFF |

## 2.3 AT-Link-Pro

AT-Link Pro is a professional debugger and programmer that supports IDE online debugging, online/offline programming, VDD output voltage range control, offline parameter settings, USB to serial interface and other functions.

It can be connected to PC micro USB interface, LCD display, LED, buzzer, buttons, machine programming control interface, various communication interfaces (such as SWD, SWO, serial port, NRST and BOOT0) and power interface (VDD and E5V). Figure 3 shows the appearance of an AT-Link-Pro.

**Figure 3. AT-Link-Pro hardware appearance**


### 2.3.1 Micro USB interface

It is used to communicate with PC during online download and debugging or parameter configuration. It can also act as a power supply interface for AT-Link-Pro in offline mode.

### 2.3.2 LCD touch screen display

LCD screen is used to display information and for touch operations. Regular settings can be done through the touch screen.

The screen is a resistive touch screen. It is recommended to use touch pen or other hard objects for more sensitive operation.

### 2.3.3 Communication interfaces

- **SWD:** A serial wire debug interface (including SWCLK and SWDIO) can be used for IDE online debugging or ICP online/offline programming.
- **SWO:** It supports SWO_UART feature and can be used for print information output in debug mode (For AT-Link-Pro with hardware V1.2 and above).
- **USB-to-serial port:** Includes TX and RX, can be connected to the serial interface of the target board for ISP offline download, or used as a common serial interface.
- **NRST:** It can be connected to the NRST reset pin of the target board to provide a hardware reset signal, and cooperates with BOOT0 pin for boot mode switch during ISP offline download.
- **BOOT0:** It can be connected to the B00T0 pin of the target board, and cooperates with NRST pin for boot mode switch during ISP offline download.

The voltage status of these pins depends on the VDD input voltage or output setting range.

### 2.3.4 Power supply interfaces

- **VDD:** Used as power output or input port.
  - As output: Output 3.0 V, 3.3 V or from 1.62 V to 5.0 V (customized), depending on the voltage output range configured by ICP host or LCD touch
  - As input: The voltage between 1.62 V and 5.5 V can be used for the working power of AT-Link Pro. In this case, VDD output is invalid.
- **E5V：** Used as 5V power input or output port.
  - As output: When the USB interface is powered, the output voltage is close to 4.7 V;
  - As input: The external source inputs 4.5 V~5.5 V via this interface to supply power for AT-Link Pro.
- **GND:** Connected to the GND of the target board.

### 2.3.5 LED and buzzer

LED1-LED2 are “connected” (red) and “run” (green), respectively.

- **LED1:** indicating connection state during offline/online operation.
- **LED2:** indicating running state during offline/online operation.
- **Buzzer:** It is used to indicate download status, and the switch on/off can be configured through ICP.

This table below shows the status of LED1 and LED2 during IDE, ICP online and offline operations:

Table 4. AT-Link-Pro LED and buzzer status

| Working status | LED1<br>Connected (red) | LED2-<br>Run (green) | Buzzer status |
|---|---|---|---|
| Power-on initialization | All LEDs blink once | | Short beep |
| Idle | OFF | OFF | Mute |
| IDE operation settings | ON | OFF | Mute |
| IDE debugging stops | ON | OFF | Mute |
| IDE debugging in progress | ON | ON | Mute |
| ICP configuration in progress | ON | OFF | Mute |
| Online/offline download<br>on-going | Blink alternately | Blink alternately | Mute |
| End of online/offline download:<br>PASS | OFF | Blink slowly | Short beep |
| End of online/offline download:<br>FAIL | Blink fast | OFF | Ring quickly for 3S |
| End of button free download<br>Remove target | OFF | OFF | Mute |

### 2.3.6 Machine programming control interface

Machine programming control contains START, BUSY, PASS, and FAIL interfaces. The parameters include machine programming control signal enable, active level polarity, START active level pulse width and BUSY delay setup time, which can be programmed in ICP and saved after power-off. Refer to *Section 3.4* for more information on the pin definitions and timing of machine programming control.

- START: Input interface. Download starts when the received active level pulse width is greater than the programmed value.
- BUSY: Output interface, it remains in the active level state during download.
- PASS: Output interface, it will remain active until the next operation after a successful download.
- FAIL: Output interface. If the download fails, the interface remains active until the next operation.

### 2.3.7 Button

Button is mainly used for offline download, and download mode switch.

- Short press 3s and release: For a single offline download.
  - When the LCD is in the offline programming page, it serves as a download key for a single offline download.
  - When the LCD is on other pages, it serves as a return key to return to the home page; if the LCD is in sleep mode, it can be used to wakeup the screen.
- Long press and hold 3s without release: When AT-Link Pro is in the online debug mode, it acts as an exit key to exit this mode.

***Note: Button operation can take effect only when AT-Link is in idle state. If offline download is on-going or the target board is being operated, it will not respond.***

## 2.4 AT-Link-ISO

AT-Link-ISO literally refers to the AT-Link with isolation protection feature.Thus it has the exact same function as that of AT-Link, and shows almost no difference when used in regular scenarios compared to AT-Link.

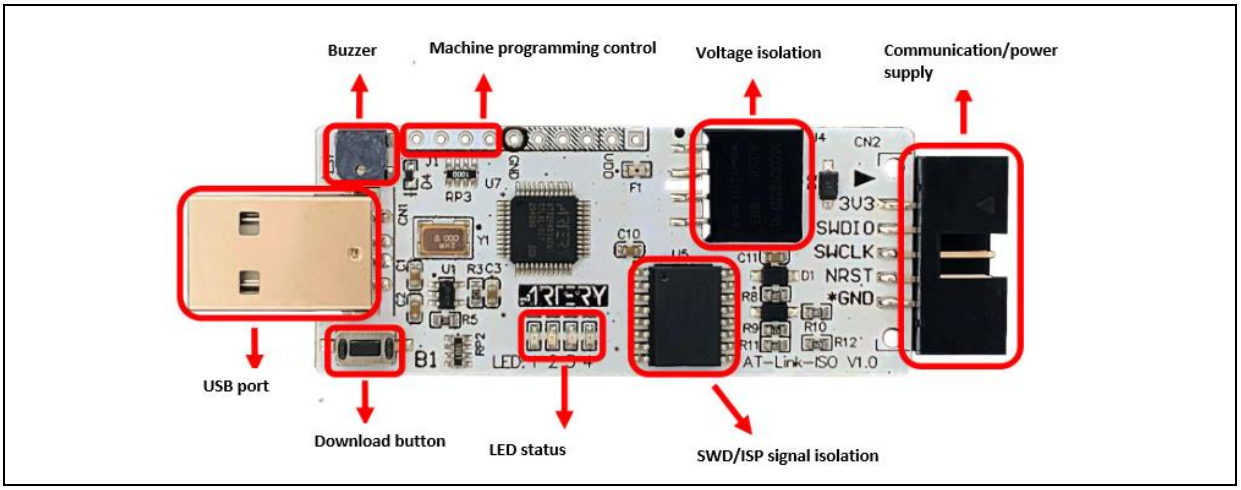
AT-Link-ISO comes with enhanced isolation protection to ensure it is capable of isolating 3000V power supply and signals. Such design also makes it the best choice for the application development under strong interference environment such as motors, high-power supplies and high voltage. It is recommended for the users to select AT-Link-ISO if they meet the above mentiond scenarios so as to get a stable developement environment.

Slight differences between AT_Link_ISO and AT_Link are as follows:

- E5V pin cannot be used as a power input. AT-Link-ISO is always powered through USB port.
- The maximum total power output on the isolation side is around 200 mA, slightly weaker than AT-Link. It is not recommended to exceed this limit.

In addition, in consideration of cost and practicality, the machine programming control interface is not included in the isolation protection part of AT-Link-ISO, so it is necessary to ensure that the good connection state should be maintained between AT-Link-ISO and the programming machine during mass production.

**Figure 4. AT-Link-ISO hardware appearance**



# 3 Functional overview

## 3.1 PC connection and driver installation

AT-Link is a USB composite device that integrates HID and CDC device types, and is connected to PC through a USB cable. Except for USB to USART feature, other related functions do not need a driver, which are recognized as a HID device in the device manager. Some operating systems require to install a driver manually, which are recognized as HID and CDC devices (AT Link-USART) in the device manager after installation.

### 3.1.1 How to install a driver

Double click on "*Artery_ATLink-USART_DriverInstall.exe"* and follow the prompts to install:

**Figure 5. Driver installation illustration**

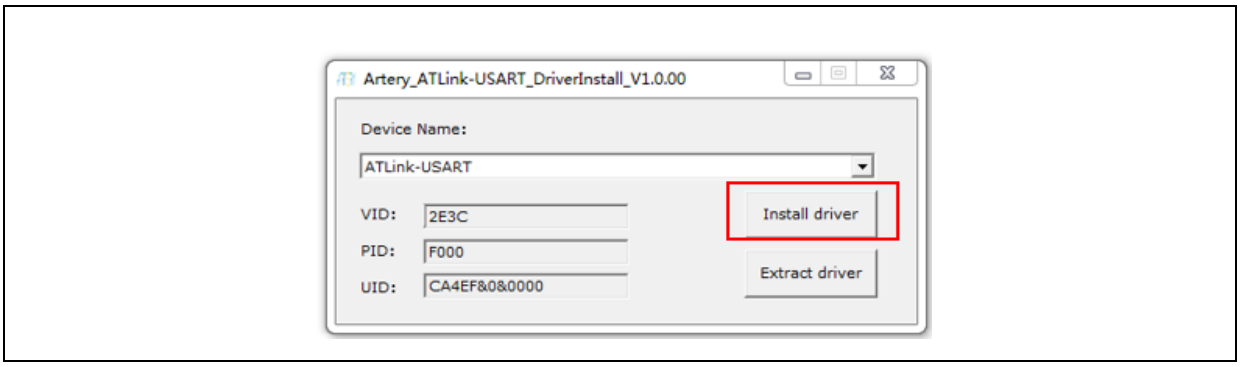
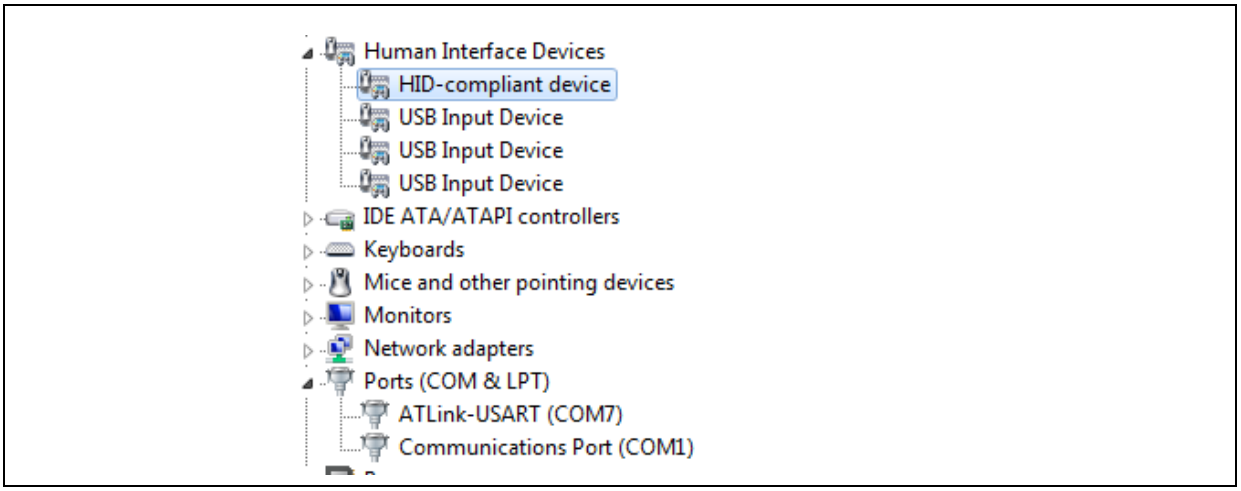



**Figure 6. Win7 system device manager recognition**




## 3.2 IDE operation

AT-Link can be used for debugging and download on the third-party development tools such as Keil and IAR. It supports up to 6 hardware breakpoints.

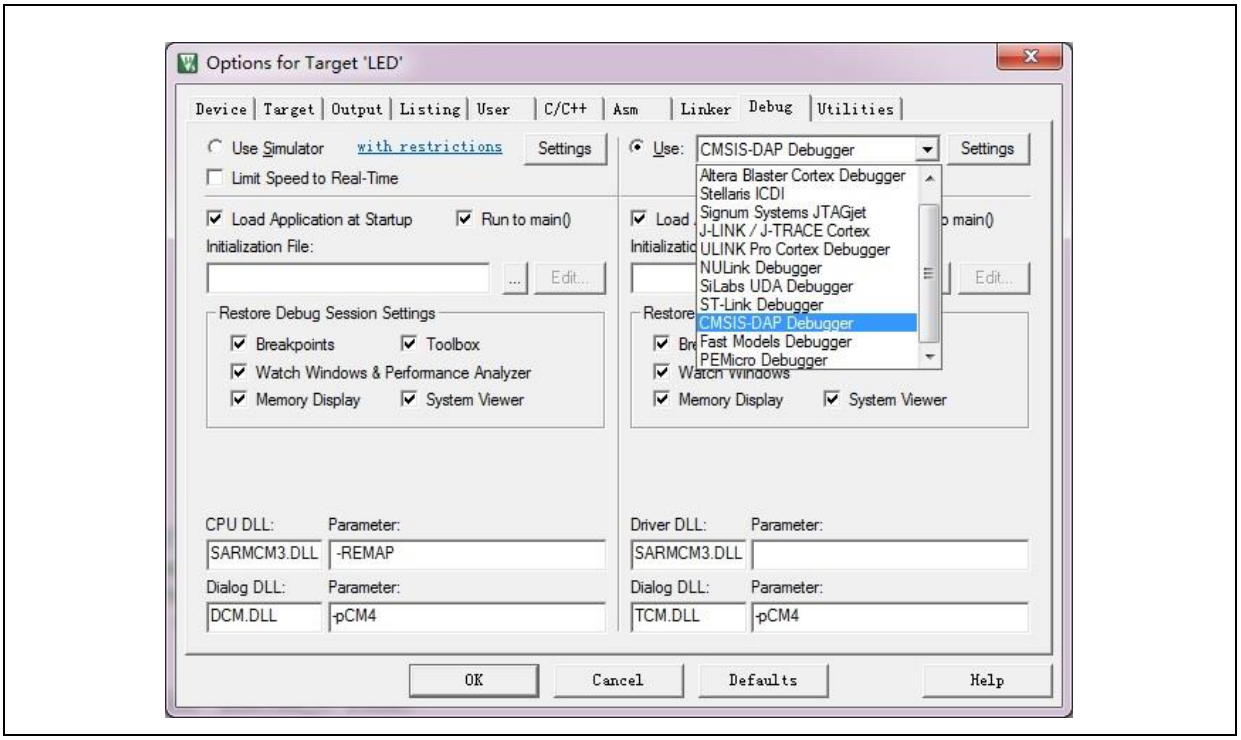
### 3.2.1 Keil IDE environment

Take Keil V5.18.0.0 as an example in this document.

- **Initialization:**

Select "*CMSIS-DAP Debugger* "in "*Options-Debug",* as shown Figure 7:

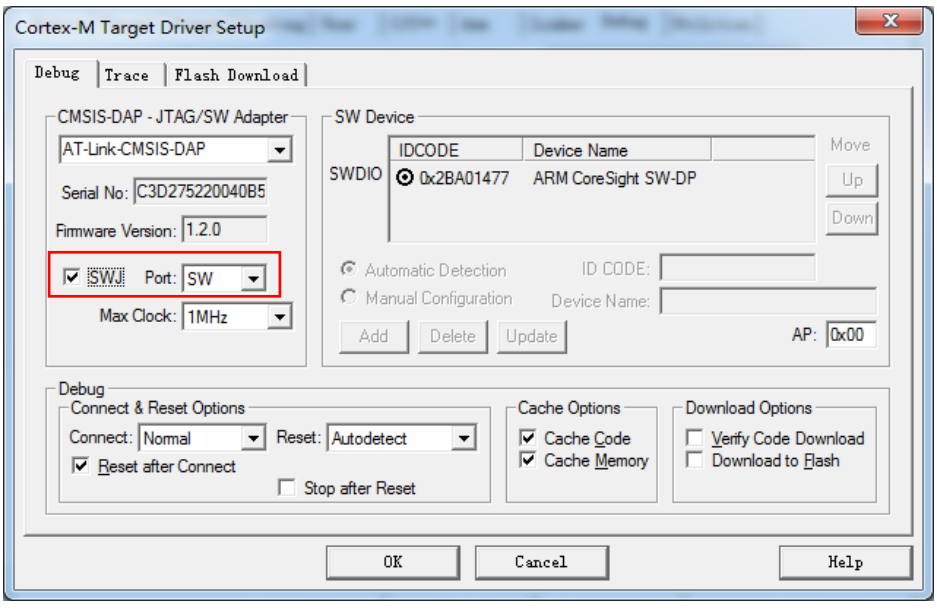
**Figure 7. Select CMSIS-DAP Debugger in KeiL**




Go to Debug Settings, tick "*SWJ*", select "*SW* "from Port drop-down list, and select "*1 MHz*" or above in *"Max Clock"* to get the best AT-Link performance, as shown in figure 8:

***Note:*** ***The target board MCU must be connected normally to display AT-Link information correctly. The target board RDP enable, SWJ disable and other conditions will result in incorrect display.***

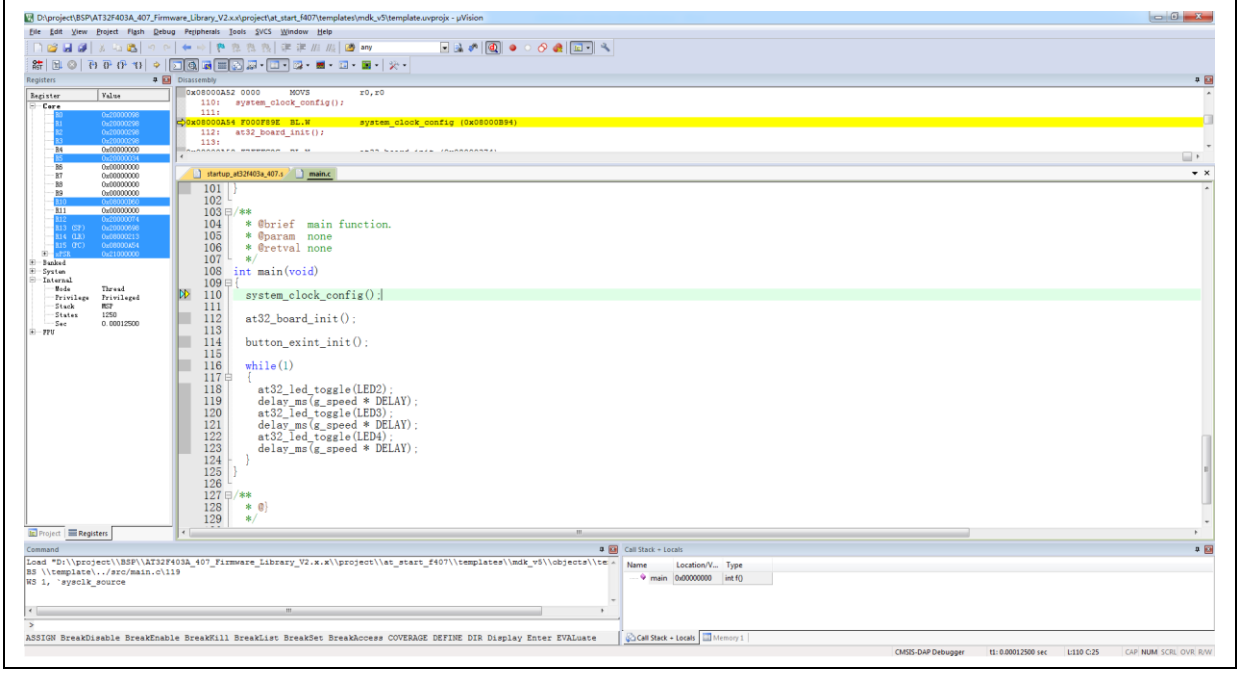
**Figure 8. Debug settings in Keil**




- **Debugging:**

Click on "*Debug"* button on the software to enter the debugging mode, and follow Keil window for various operations.

Figure 9. Keil debugging



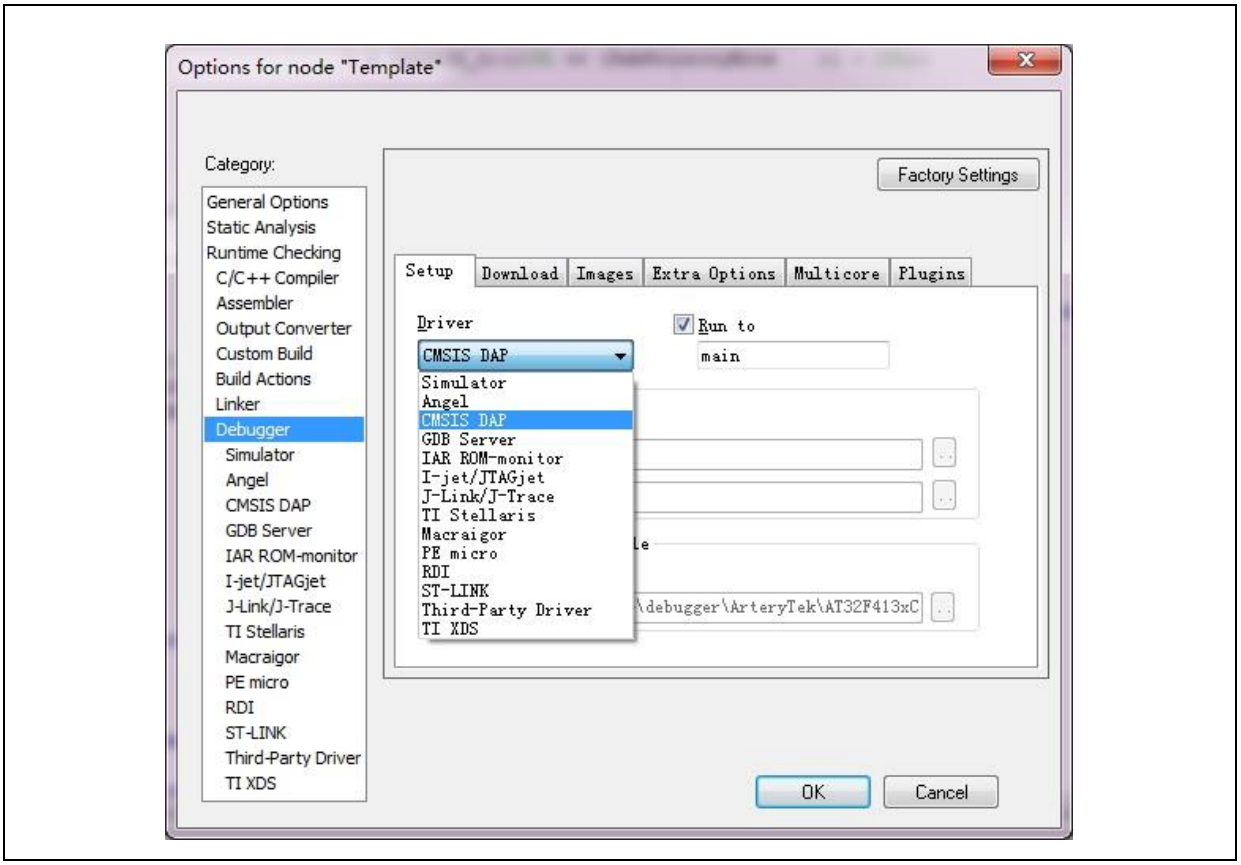
## 3.2.2 IAR IDE environment

-AT-Link is applicable to IAR V7.10 and above only. Take IAR V7.40 as an example here.

- **Initialization:**

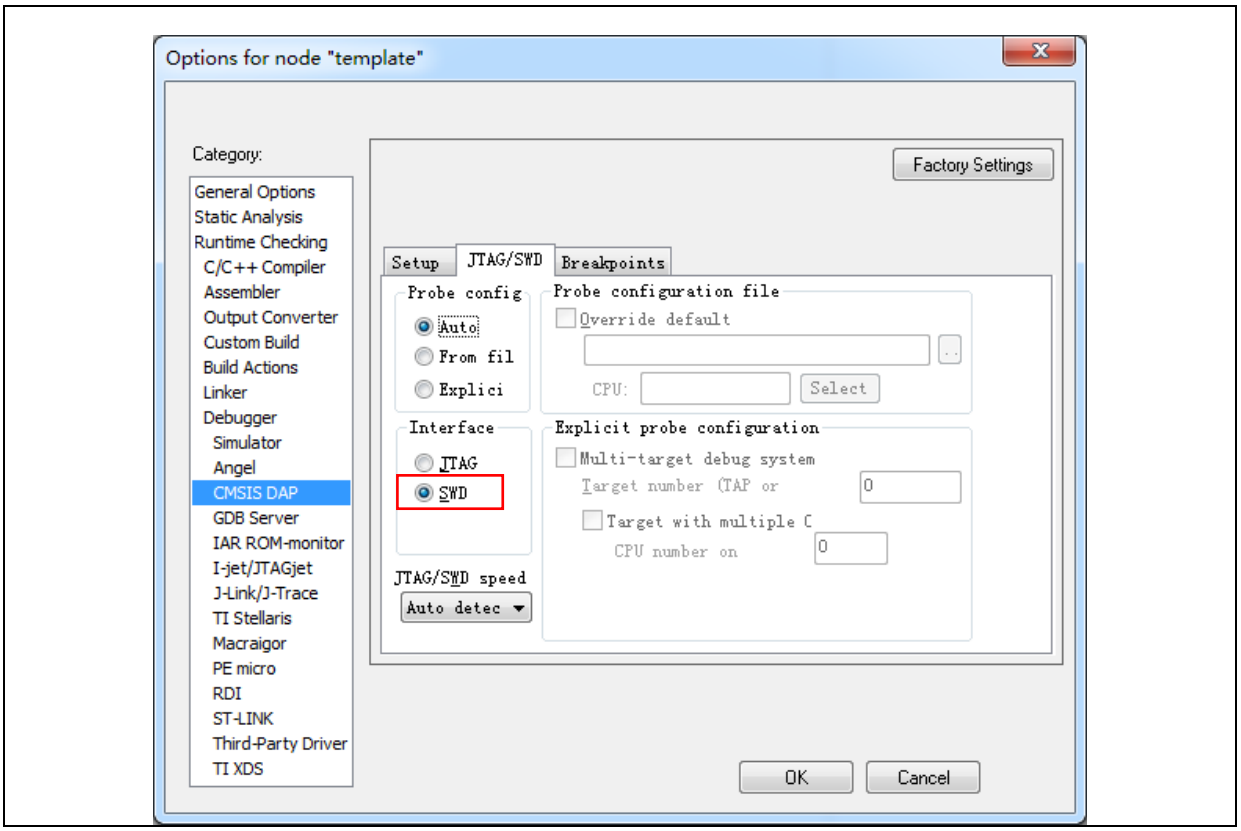
Select "*CMSIS DAP*" in "*Options-Debugger-Setup-Driver*," as shown in figure 10:

Figure 10. Select CMSIS DAP in IAR



Then, select "*SWD*" Interface in "*Options-Debugger-CMSIS DAP*", as shown in Figure 10:

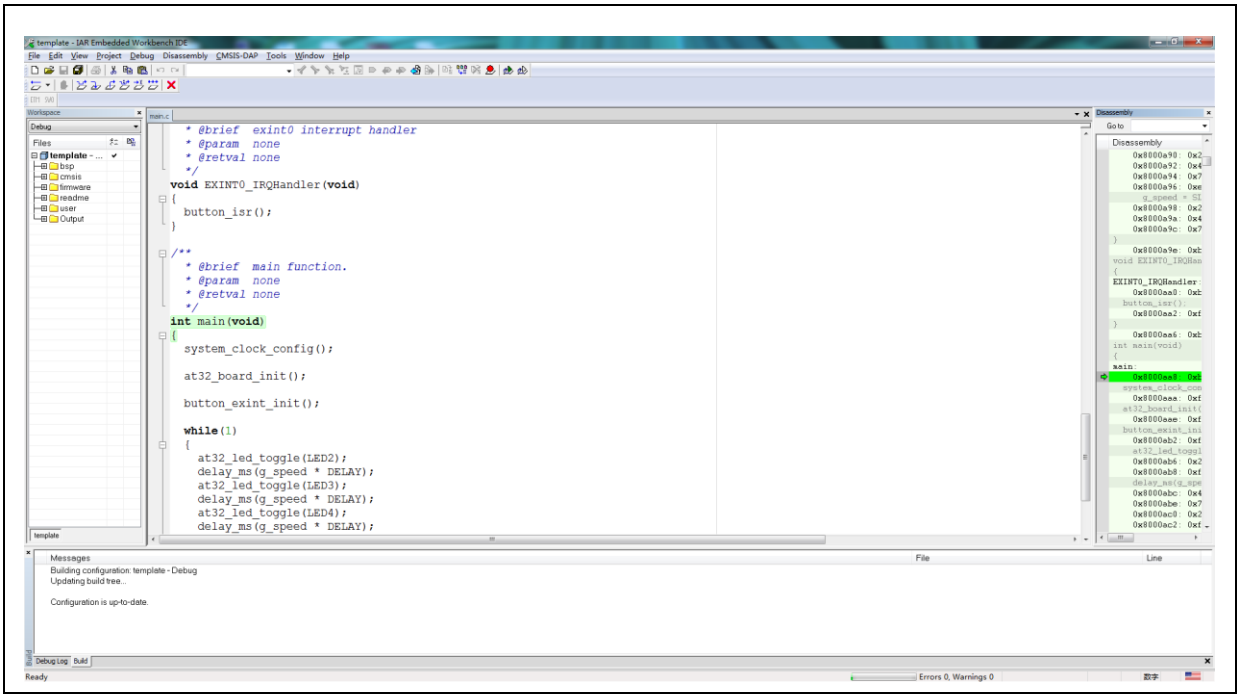
**Figure 11. Select SWD interface in IAR**




- Debugging

Click on "*debug*" to enter the debug mode, and follow IAR window for various operations.

**Figure 12. IAR debugging**



## 3.3 ICP tool operation

ICP tool can be used to perform online operations such as Flash memory download/read and parameter configurations on Artery MCU chips, and also configure AT-Link encryption files, online/offline operation and monitoring, firmware upgrade and so on.

### 3.3.1 How to use encryption files

- To protect files against leakage and copying during remote transfers, the contents of firmware can be encrypted into the corresponding benc/henc/senc files for encryption download;
- The encryption key must be the same as that of the target AT-Link;
- Each AT-Link has its unique serial number, which is the initial factory default encryption key.

**The steps for using encryption files are as follows:**

1) Obtain the encryption key of the target AT-Link

The factory default encryption key is AT-Link serial number, which is available on the ICP homepage by connecting to the target AT-link. Users can also customize the encryption key according to their needs, modify and save it in the AT-Link setting-parameter setting of ICP.

**Figure 13. Encryption key location**

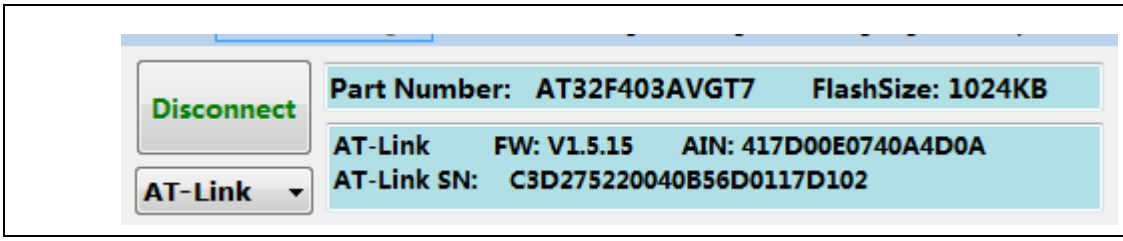
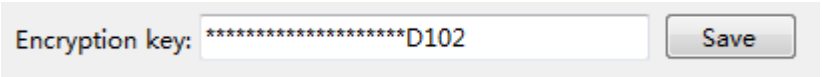
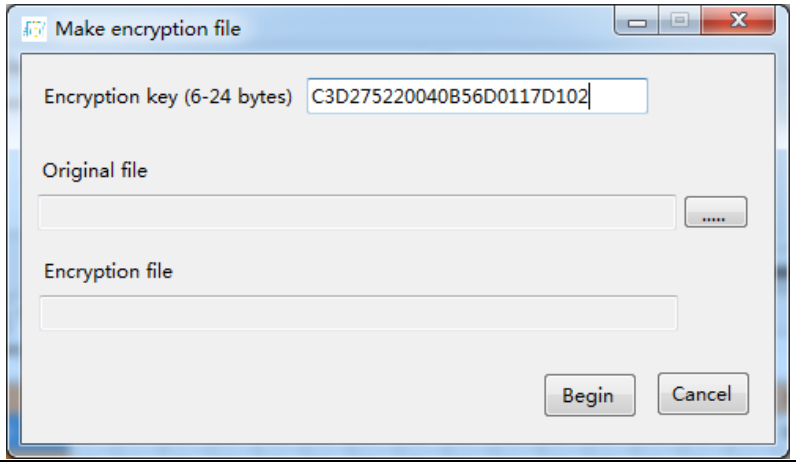



**Figure 14. Customize the encryption key**




1) In ICP, click on "*file-make encryption file*", enter the encryption key, then the firmware contents in the format of bin/hex/srec/s19 generated by tools such as Keil and IAR are changed into encrypted files in the format of benc/henc/senc.

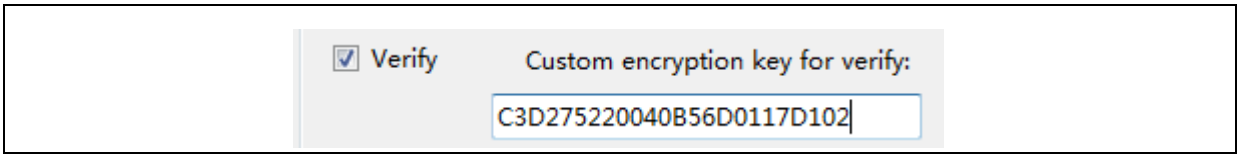
**Figure 15. Make encryption file**



2) Encrypted files are transferred remotely to the corresponding AT-Link for online/offline download.

- Online download: Add encrypted files to the download file box and click on "*Begin*". If "Verify" box is ticked, you need to input an encryption key.

**Figure 16. Verify after online download**




- Offline download: Add encrypted files to the offline project configuration，and save them to the corresponding AT-Link for offline download.

## 3.3.2 Paramete settings

This section describes how to configure AT-Link parameters.

- **Number of data storage area:** This indicates the number of codes stored offline, which can be configured as 1/2/4/8/16, with their individual maximum capacity 16/8/4/2/1 MB respectively. Offline download also supports downloading several code files (up to 5) at one time, which occupy multiple storage areas.

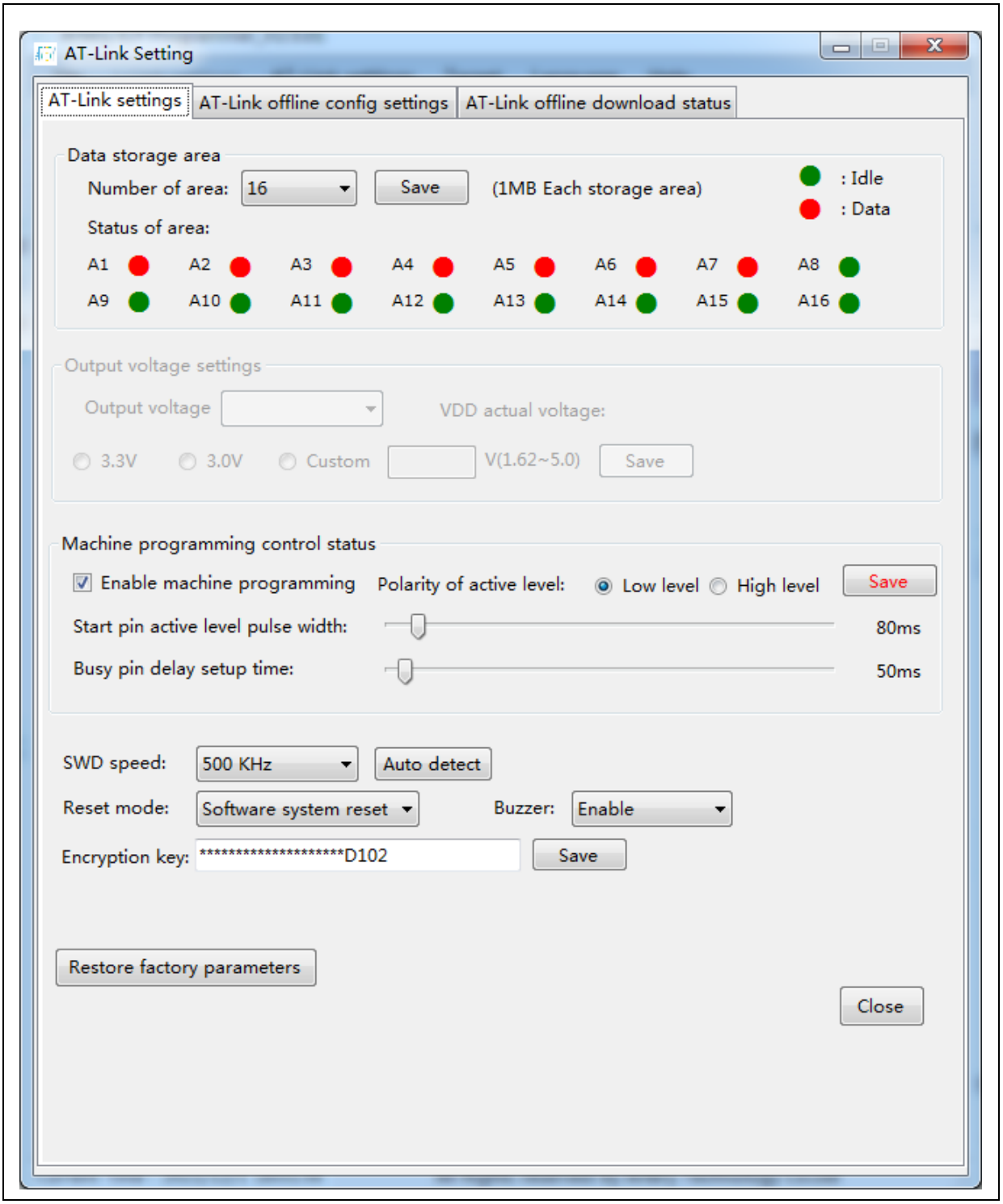
*Note: Modifying this option will clear all offline stored data.*

- **Machine programming control：**
  - - Machine programming control enable: Tick it and click on "*Save* "to enable machine programming control.
  - - Polarity of active level: Select low level or high level.
  - - START pin active level pulse width: 20-1000 ms
  - - Busy pin delay setup time of: 20-1000 ms
- **SWD speed:** Configure the SWD transfer speed for online/offline operation during non-IDE operation. It is recommended to click on "*Auto detect* "to let AT-Link automatically obtain the best SWD speed according to the actual circuit. Users can also select SWD speed from the drop-down list. Depending on the line length between AT-Link and target board, it is advisable to reduce the SWD speed if the line distance is long. To take into account the programming quality, it is recommended to connect AT-Link and target board using a flat cable thicker than AWG28. Measuring at AWG28 cable, the line length is around 10 meters for 1MHz SWD, 5 meters for 2 MHz SWD, and 3 meters for 5 MHz SWD.
- **Reset mode:** It contains software system reset and hardware NRST pin reset, which is used to select the reset mode after the target board connection and download completed.
- **Buzzer:** Buzzer enable/disable. When this function is disabled, all other operations are mute except for power-on initialization.
- **Encryption key:** Supports the combined configuration of 6-24 bytes of letters or numbers, which is customized by AT-Link users. Its initial default value is a 24-byte AT-Link serial number.

***Note: Modifying this option will clear all existing offline stored data.***

- **Restore factory parameters:** Clear all AT-Link parameters and stored data, and return to factory default values.

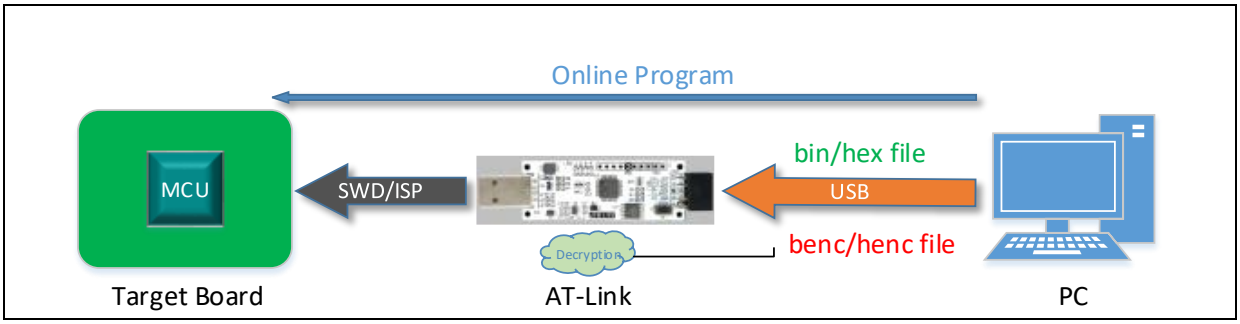
**Figure 17. Parameters settings**



### 3.3.3 Online operations

AT-Link supports online programming. The data transfer can be the original bin/hex/srec/s19 data or encrypted benc/henc/senc data. For encrypted benc/henc/senc data, the encryption key to generate data must be the same as that of AT-Link during programming.

**Figure 18. Online programming process**



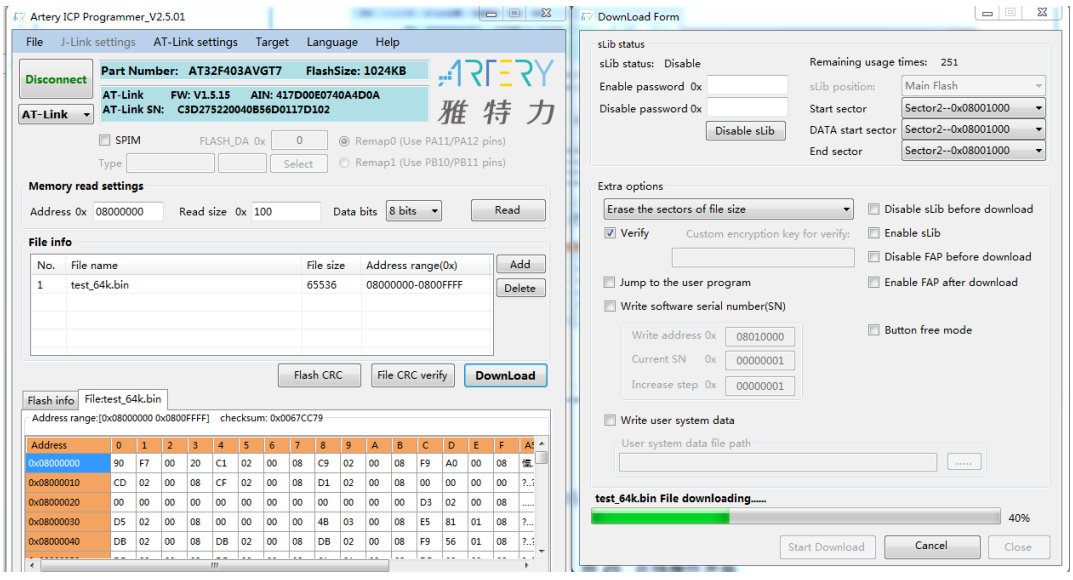

**Online download**

Select AT-Link and connect. If the connection is successful, the information such as model, serial number and firmware version will be displayed, and each AT-Link has its unique serial number. If the target board is connected successfully, its MCU part number and Flash size will be shown, and will halt the target board MCU. If failed, related online operations cannot be performed.

- Supports downloading multi-section files (up to five) at one time, in the format of original bin, hex, srec, s19 or encrypted benc, henc, senc.
- A few chips have SPIM feature. If the download file address goes beyond SPIM address (0x08400000), users need to tick "*SPIM*", and select the correct external Flash part number, Remap, FLASH_DA 0x and other parameters according to the needs.
- Download Form allows users to set various options, where the user system files only support bin or hex format.

***Note:*** ***If the downloaded files are encrypted, you need to enter the encryption key to enable verify after download.***

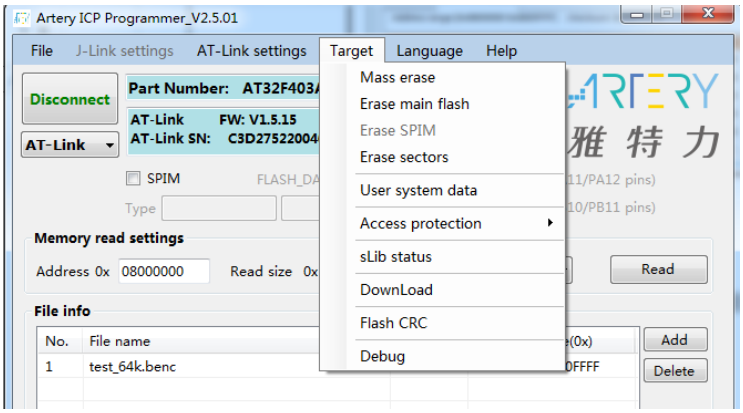
**Figure 19. Online download window**



### Online configurations

This page describes online MCU configurations such as erase, user system data, RDP, sLib, bootloader AP mode.

**Figure 20. Online operation**



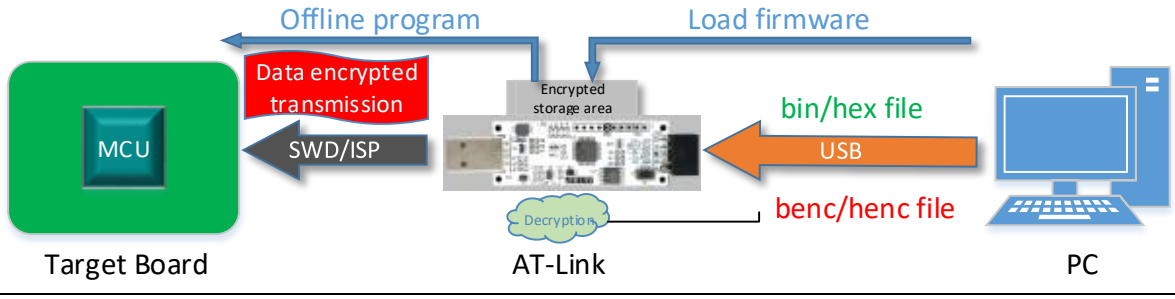

## 3.3.4 Offline operations

AT-Link supports offline download, and works with the Hex Encryption function of Artery MCU to implement encrypted data transfer during offline programming.

- Data transfer can be original bin/hex/srec/s19 format or encrypted benc/henc/senc format;
- For encrypted benc/henc/senc data, the encryption key to generate data must be the same as that of AT-Link used during programming.
- For AT-Link that has saved offline projects, offline programming mode is supported.

***Note:*** ***All AT-Link parameters can be saved after power-off.***

**Figure 21. Offline programming process**




### Offline project configurations

This page describes the configurations of offline download, including information, user system data and code. All the configuration contents are collectively referred to as an offline project.

- **Offline project:** Indicates the saved offline projects, and select a project from the drop-down list to view its configuration parameters;
- **Delete/Create:** Delete the selected project or create a new one in the drop-down list;
- **Project name:** When creating a project, the project name can be customized, supporting up to 16 bytes.

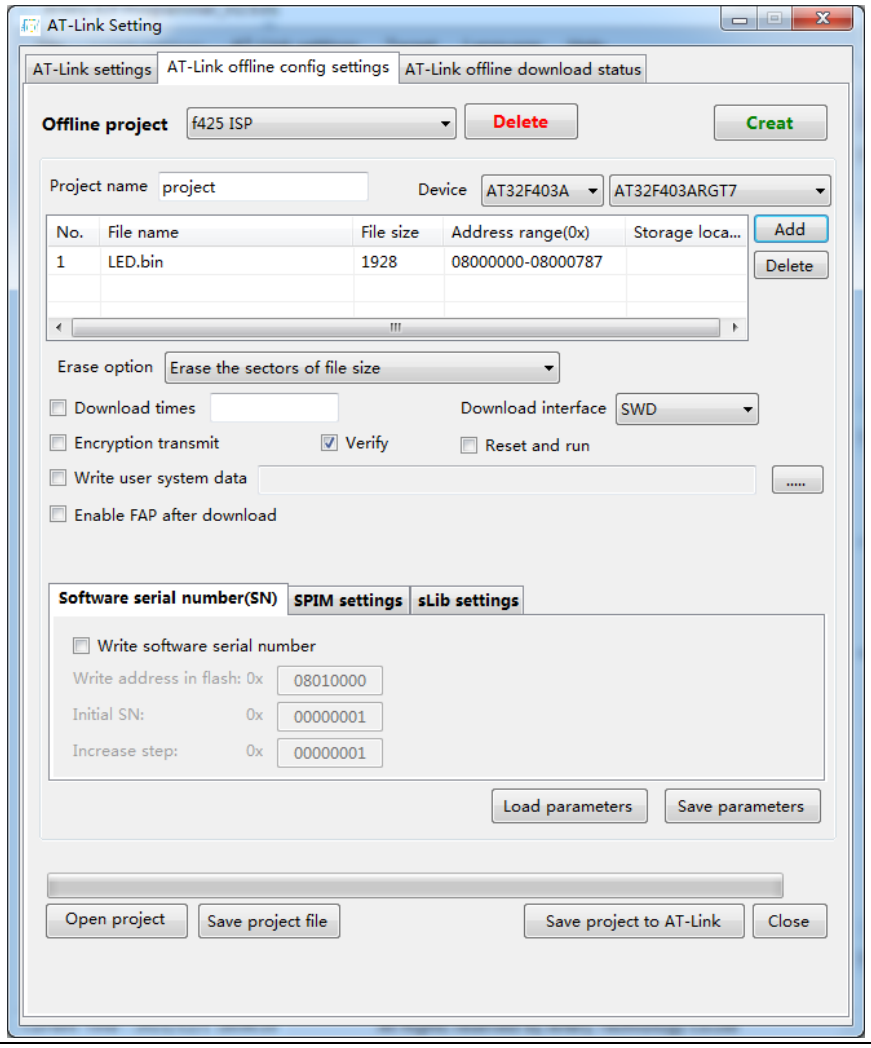
- **Device:** When creating a new project, users can select “Only download a specific MCU” or “All MCUs under certain series”. For example, if users select AT32F413 Universal-1Kbytes/sector, it means that all 1KB MCUs/sector under F413 series can be downloaded;
- **Add/Delete:** When creating a new project, add/delete the code file to be downloaded. The format can be original bin/hex/ srec/s19 or encrypted benc/henc/senc. Multiple code files can be configured, but their storage addresses cannot be on the same Flash page. The maximum length of a file name is 32 bytes;
- **Erase option:** Configure as required. Perform various erase operations before downloading.
- **Download interface:** Select SWD or ISP interface when creating a new project;
- **Download times:** If this option is ticked, it means that the total number of downloads is limited ranging from 1 to 4000000. Both successes and failures are included in the total number. If the total number is exceeded, no more downloads are allowed.
- **Reset and run:** Reset and run after the completion of download. This option and *Enable RDP after download* cannot be enabled at the same time
- **Encryption transmit:** The download process works with the Hex Encryption feature of Artery MCU to implement encrypted transfer so as to ensure data security;
- **Verify:** Verify whether the data is correct after download, and a hardware check method will be used during transfer encryption to ensure data security.
- **Enable RDP after download:** RDP is enabled when the download is complete. This option and *Reset and Run* cannot be enabled at the same time.
- **Bootloader AP mode：** For some MCUs, their bootloader memory can be configured as an extended user code area to store user code. To avoid misuse, users need to enter the encryption key 0xA35F6D24 to make it effective.

***Note: This mode setting is irreversible and can only be modified once.***

- **Write user system data:** Users can choose to download user system data at the same time. The format can only be either bin or hex;
- **Software serial number:** 32-bit data. The programming address can be customized. This address and code address cannot be on the same flash page. Serial number value = initial serial number + number of successful downloads x each incremented value. If overflow occurs, the high bits will be cleared and the low 32 bits reserved;
- **SPIM:** When there are files with their address range in SPIM (including code or serial number), users need to select the corresponding external Flash model, Remap and FLASH_DA and other information;
- **sLib settings:** Configure sLib-related parameters, including disabling sLib before download or enabling sLib when download, the sLib password and sLib range must be programmed;
- **Save project file:** After the completion of all configurations, they can be packaged to generate an encrypted * .atcp project file for remote transfer or local storage. When saving, it is up to the user to tick the option “This project is only used at the specified AT-Link” (AT-Link SN is required) or “This project is only used once” (AT-Link AIN is required)
- **Open project:** Open an existing atcp format project file and load its content into software for viewing.

- **Save project to AT-Link**: Save the configured project or open project file into the AT-Link through a dynamic encryption algorithm for the purpose of offline download.

**Figure 22. Offline project configuration window**




## Offline download status monitoring

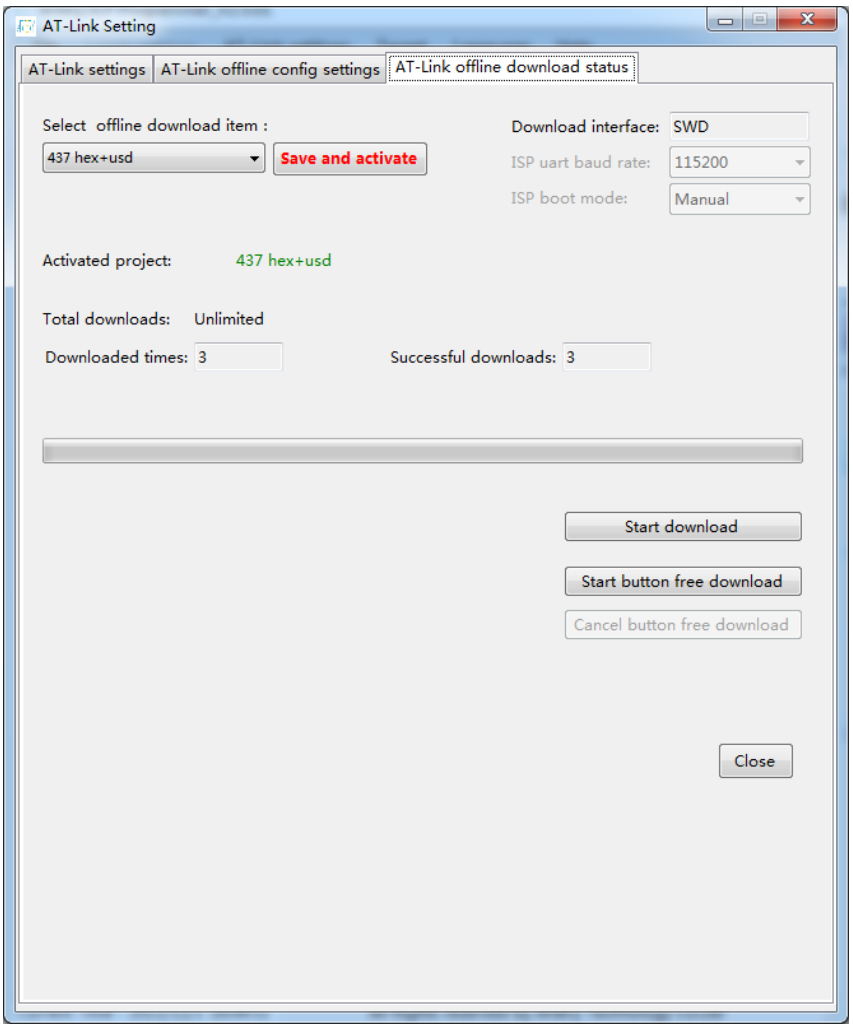
This page gives a description of AT-Link offline download status monitoring and configurations.

- **Select offline download item:** Because AT-Link can store multiple offline projects, users need to select one project to activate. The activated project will be selected for downloading. If the activated project is deleted, users need to select it again.
- **Download interface:** It only indicates the interfaces for the current project and cannot be changed. If it is an ISP interface, the baud rate and boot mode can be modified according to the target board circuit.
- **Total downloads:** It only indicates the total number of downloads of the activated project.
- **Download times:** It indicates the number of download of the active project, including the successes and failures. When the total downloads is reached, the project file can no longer be downloaded so as to prevent download times control function from being maliciously cracked.
- **Successful downloads:** It indicates the number of successful downloads of the active project.
- **Start download:** Start a single offline download, and the corresponding prompt message will be displayed according to the download progress. If it fails, error message will be displayed.

- **Start/Cancel button free download:** Once started, there is no need to operate ICP interface, only need to replace the target board MCU according to the prompts to complete automatic continuous download. The switching of *Start/Cancel* can be allowed only when AT-Link is in idle state.

***Note:*** ***Other operations are not allowed in button free download mode. Users must cancel button free download mode before operation.***

**Figure 23. Offline download window**

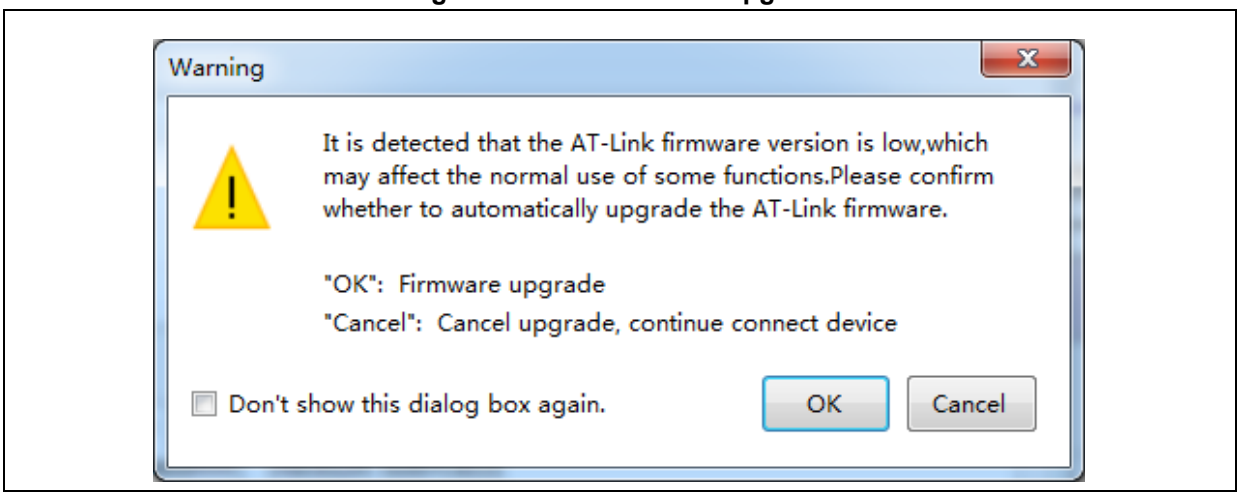



## 3.3.5 Firmware upgrade

AT-Link, AT-Link EZ and AT-Link Pro support auto network and manual upgrade, which is shown in the "*Help*" menu. This is used to upgrade various functions and support more MCU models.

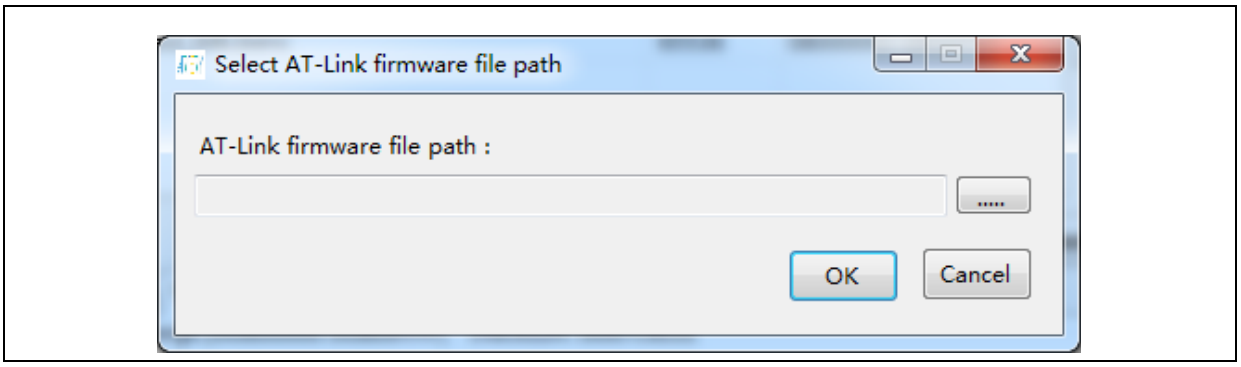
- **Auto upgrade:** When connecting, the ICP software will detect the current connected AT-Link version. If it is lower than the latest version on the internet or the firmware version embedded in ICP, users are prompted to perform auto upgrade.

**Figure 24. Auto firmware upgrade**




- **Manual upgrade:** Users can download the latest firmware in benc format on Artery official website, and select a firmware and upgrade it.

**Figure 25. Firmware manual upgrade**



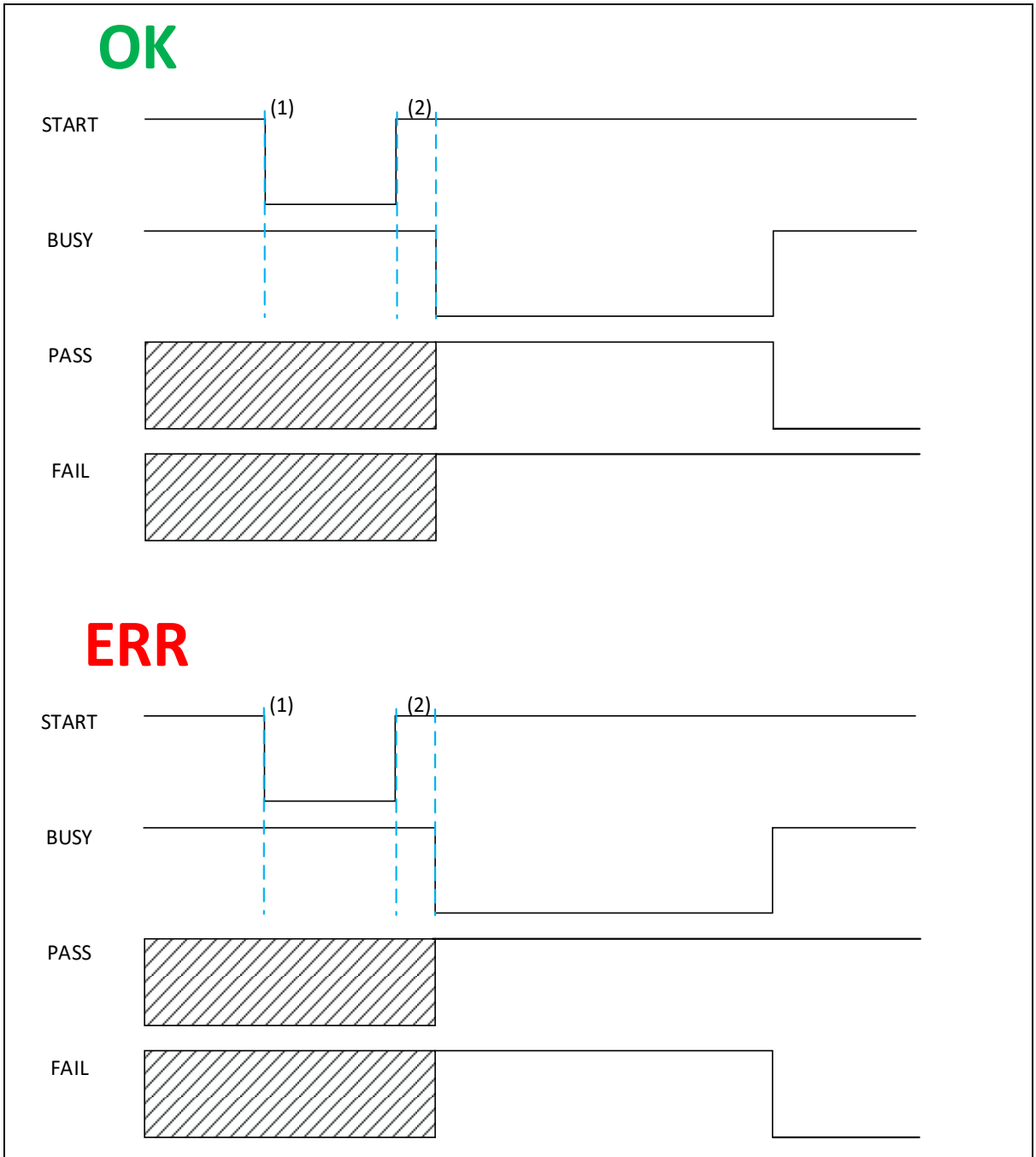

## 3.4 Machine programming control

After offline project configurations are stored, select a project for offline download through a machine programming control interface, withoug the need of ICP software.

The auto programming machine sends a sufficient active level pulse width to the START pin and calculates the debounce time so that the AT-Link starts programming to the target board. In this case, the BUSY pin will output active level and toggle at the end of programming. Then the auto programming machine can read PASS/FAIL pin to judge whether the programming is OK or ERR.

The parameters of machine programming control can be customized in AT-Link parameter settings according to the needs.

**Figure 26. Typical timing diagram of machine programming control**




## 3.5 Button operations

After the offline project configurations are stored, select a project for offline download through buttons, without the need of ICP software.

When AT-Link is in idle state, press and hold the key for 3s to switch between button free download mode and single download mode.

- **Single download:** In a single download mode, short press the key once to download an offline project, and the download result can be incidated through LCD, LED or buzzer.

- **Button free download：** In button free mode, when the download is completed, the target board is directly replaced for continuous download. The download result can be indicated through LCD, LED or buzzer.

## 3.6 LCD touch operations

To facilitate mass programming, users can directly configure some AT-Link parameters offline on the LCD screen, such as output voltage, machine programming, SWD speed, offline project file operation, switching single/button free download mode, etc. All configurations, similar to ICP Tool operations, can be saved after power-off.

It is possible to perform special operations through LCD display:

- Online debugging: Once it is enabled, the LCD screen operation and offline download is disabled temporarily, and the AT-Link-Pro is used as an online debugger.
- Low-power consumption mode: To address the problem of insufficient USB power supply in some circumstances, after this mode is enabled, when the LCD is in idle state for more than 30s, the screen will be OFF to reduce power consumption. The screen can be waken up temporarily through touching.

## 3.7 Offline programming procedure

For mass programming, offline programming mode can be used to significantly shorten the programming time and save cost. This section describes how to create and use offline project files.

1. **Create offline project**

   Go to offline project configuration window, tick "*Create offline project*", select a MCU part number to be programmed, enter offline project name, add the corresponding code, and set other parameters according to your needs (user system data, sLib setting, download times.etc.)

2. **Save offline project (two methods)**

   a) Save the configured offline project to PC (it is up to the user to tick the option "This project is only used at the specified AT-Link" or "This project is only used once"), and send to the programming factory, who will open the project and save it to the connected AT-Link.

   b) Directly save the configured offline project to the currently connected AT-Link.

3. **Activate offline project**

   AT-Link can save up to 16 offline projects. Access to offline download page of ICP software, select an offline project to be programmed, save and activated it (For AT-Link-Pro, the user can select the offline project through touch operation on offline programming window)

# 4 Notes

## 4.1 ISP interface offline download

- Bootloader code mode must be selected and used to enable ISP download;
- When FAP is enabled, after the debugger interface (SWD) is connected to the device, the bootloader fails to run, in this case, power-on reset must be performed. Therefore, if ICP is used to connect to the FAP-enabled device, it is impossible to perform ISP offline download.
- If FAP-enabled device needs ISP offline download, it is the simplest solution to not connect to the SWD interface of AT-Link.

# 5 Revision history

Table 5. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 2021.9.2 | 2.0.0 | Initial release |

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