

# Application Note

**Document No.: AN1081**

**APM32F4xx\_Quick Start Guide**

**Version: V1.0**

# 1 Introduction

This application note guides beginners to understand APM32F4xx series, and quickly learn to carry out development, operation, debugging and other related tasks.

It mainly contains:

Product overview, document description, development board resource description, functional description of firmware package, and use of development tools.

All materials involved in this application note can be obtained and downloaded from the website of [www.geehy.com](http://www.geehy.com).

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## 2 Product Overview

APM32F405/407 series MCU, based on Arm® Cortex®-M4 core, supports single-precision FPU and enhanced DSP processing instruction; has rich peripheral resources to meet multiple application requirements; supports the high-speed OTG interface of on-chip PHY; supports SM2, SM3, SM4 and other encryption algorithms, which helps to ensure the security of data information, with operating temperature of -40°C~+105°C.

The detailed performance description is shown in the table below. For specific models, see the model table on the official website:

Table 1

<b>System:</b>	<b>I/Os:</b>
<p>Arm® Cortex®-M4 core            Operating dominant frequency 168 MHz            Support single-precision FPU            Support DSP instructions</p>	<p>Up to 140 I/O            They all can be mapped to external interrupt vectors</p>
<b>Memory:</b>	<b>Debugging mode:</b>
<p>FLASH: 1MB            SRAM: 192KB            SDRAM: 2MB (optional)            Support external memory extension</p>	<p>SWD/JTAG</p>
	<b>Security:</b>
	<p>Support state secret algorithm SM2/SM3/SM4</p>
<b>Power supply and power:</b>	<b>Peripheral interface:</b>
<p>VDD/VDDA: 1.8~3.6V            Backup domain power supply VBAT: 1.65~3.6V            Support power-on / power-down reset            Support programmable power supply voltage detector</p>	<p>U(S)ART: 6            I2C: 3            SPI: 3            I2S : 2            DCI: 1            USB OTG: 3            CAN: 2            SDIO: 1            Ethernet: 1            Support SDRAM</p>
<b>Timer:</b>	
<p>16/32-bit general-purpose timer: 8/2            16-bit advanced timer: 2            16-bit basic timer: 2            Watchdog timer: 2            24-bit system timer: 1</p>	
<b>Analog peripherals:</b>	<b>Package:</b>
<p>12-bit ADC: 3; number of external channels: 24            12-bit ADC: 2</p>	<p>LQFP64/100/144/176</p>

## **3 Documentation**

### **3.1 Datasheet**

# **Datasheet**

**APM32F405xG**

**APM32F407xExG**

**Arm® Cortex® -M4 core-based 32-bit MCU**

**Version: V1.2**

*APM32F405xG 407xExG Data Sheet V1.2.pdf*

Including:

1. Product characteristics; 2. Product information
3. Pin information    4. Functional description
5. Electrical characteristics; 6. Sub-packaging information"
7. Packaging information; 8. Ordering Information
9. Common function module naming; 10. Revision history

## 3.2 User Manual

# User Manual

**APM32F405/415xG**

**APM32F407/417xExG**

Arm® Cortex®-M4 based 32-bit MCU

Version: V1.3

*APM32F4xxx User Manual V1.2.pdf*

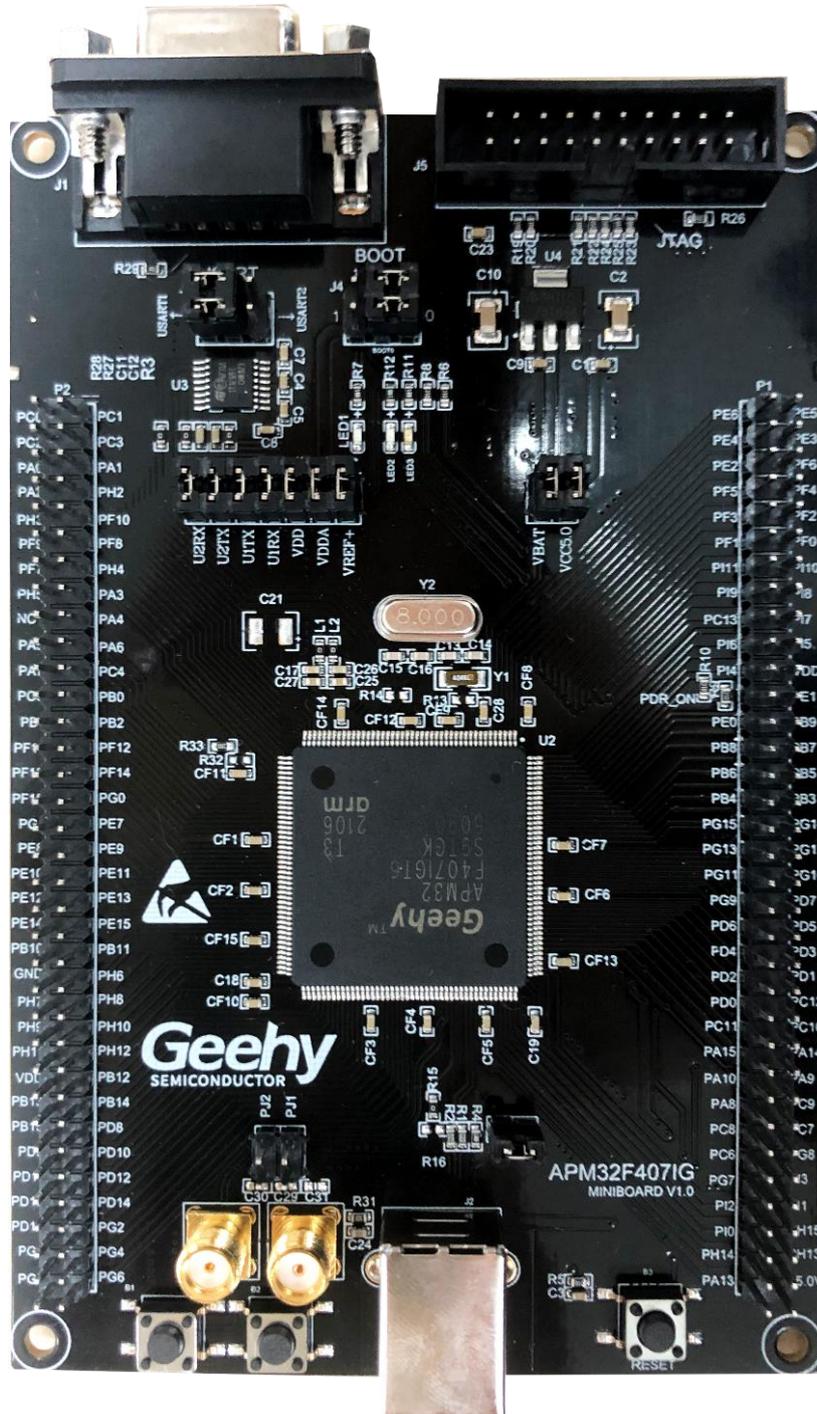
Table 2

1. Introduction and document description rules	2. System architecture	3. Flash memory
4. External memory controller (EMMC)	5. System configuration controller (SYSCFG)	6. Reset and clock management (RCM)
7. Power management unit (PMU)	8. Nested vector interrupt controller (NVIC)	9. External interrupt / event controller (EINT)
10. Direct memory access (DMA)	11. Debug MCU (DBGMCU)	12. General-purpose input / output pin (GPIO)
13. Timer overview	14. Advanced timers (TMR1/8)	15. General-purpose timers (TMR2/3/4/5)
16. General-purpose timers (TMR9/10/11/12/13/14)	17. Basic timers (TMR6/7)	18. Watchdog timer (WDT)
19. Real-time clock (RTC)	20. HASH processor (HASH)	21. Digital camera interface (DCI)
22. Universal synchronous/asynchronous transceiver (USART)	23. Internal integrated circuit interface (I2C)	24. Serial peripheral interface/On-chip audio interface (SPI/I2S)
25. Controller area network (CAN)	26. Secure digital input/output interface (SDIO)	27.USB_OTG
28. Ethernet	29. Analog-to-digital converter (ADC)	30. Digital-to-analog converter (DAC)
31. Random number generator (RNG)	32.CRYP	33. Cyclic redundancy check computing unit (CRC)
34. Chip electronic signature		

## 4 MINI Development Board

According to the chip model difference and sub-packaging types, two kinds of MINI BOARD are designed for users, which are respectively:

### 4.1 APM32F407IG MINIBOARD



According to *APM32F407IG MINI Development Board User Manual V1.1.pdf*

Users can learn:

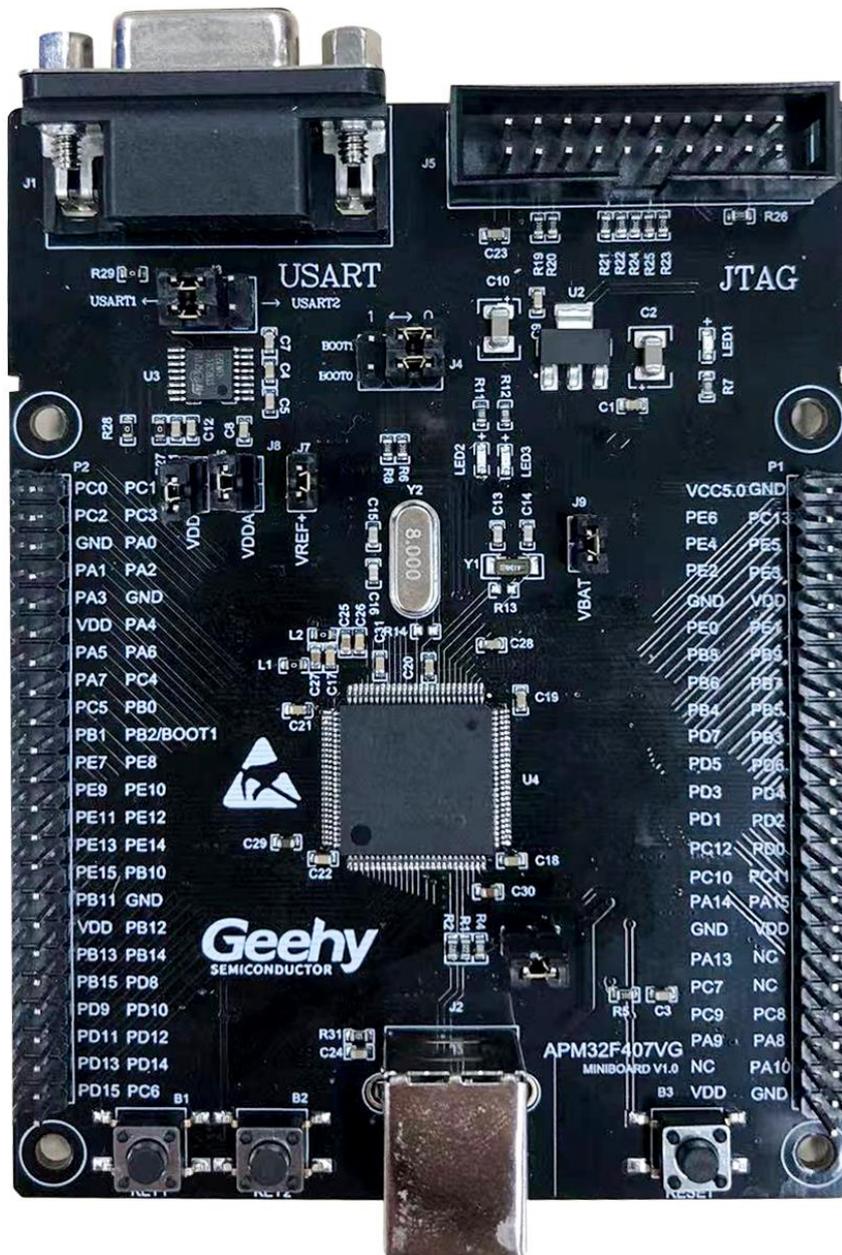
The MINI BOARD design chip is APM32F407IGT6:

- Number of pins: 176
- Memory capacity: 1MB
- RAM capacity: 192+4KB
- Package type: LQFP176
- Temperature range: -40°C~85°C

The design resources of the MINI BOARD contain:

- External high-speed clock (HSE): 8MHz
- I/Os: 140    VCC/VDD: 3    GND: 1    NC: 2    GPIO: 134.
- USART1/2: RS-232; select through J3 jumper cap.
- BOOT0/1: Select through J4 jumper cap.
- USB: Type B / Power; select through J10 jumper cap.
- Support JTAG and SWD two debugging modes.
- LED1 is the power indicator light. LED2 and LED3 are used by users.
- Reset Key has 1 Key1 and Key2 for users.

## 4.2 APM32F407VG MINIBOARD



According to *APM32F407VG MINI Development Board User Manual V1.1.pdf*

Users can learn:

The MINI BOARD design chip is APM32F407VGT6:

- Number of pins: 100
- Memory capacity: 1MB
- RAM capacity: 192+4KB
- Package type: LQFP100
- Temperature range: -40°C~85°C

The design resources of the MINI BOARD contain:

- External high-speed clock (HSE): 8MHz
- I/Os: 92    VCC/VDD: 6    GND: 7    NC: 3    GPIO: 76.
- USART1/2: RS-232; select through J3 jumper cap.
- BOOT0/1: Select through J4 jumper cap.
- USB: Type B / Power; select through J10 jumper cap.
- Support JTAG and SWD two debugging modes.
- LED1 is the power indicator light. LED2 and LED3 are used by users.
- Reset Key has 1 Key1 and Key2 for users.

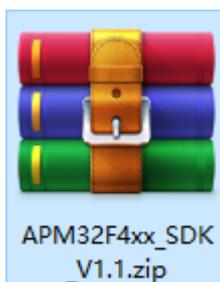
## 5 Firmware Package

In order to enrich product models and give full play to chip performance, our company has developed the following kinds of firmware for users to select:

1. "Geehy.APM32F4xx\_DFP.1.0.1.pack"



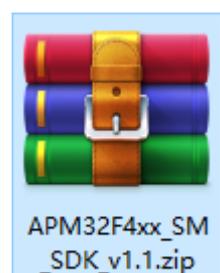
2. "APM32F4xx\_SDK\_V1.1.zip"



3. "APM32F4xx\_OTG\_SDK\_v1.1.rar"



4. "APM32F4xx\_SM\_SDK\_v1.1.zip"



:

## 5.1 MDK5 Packs

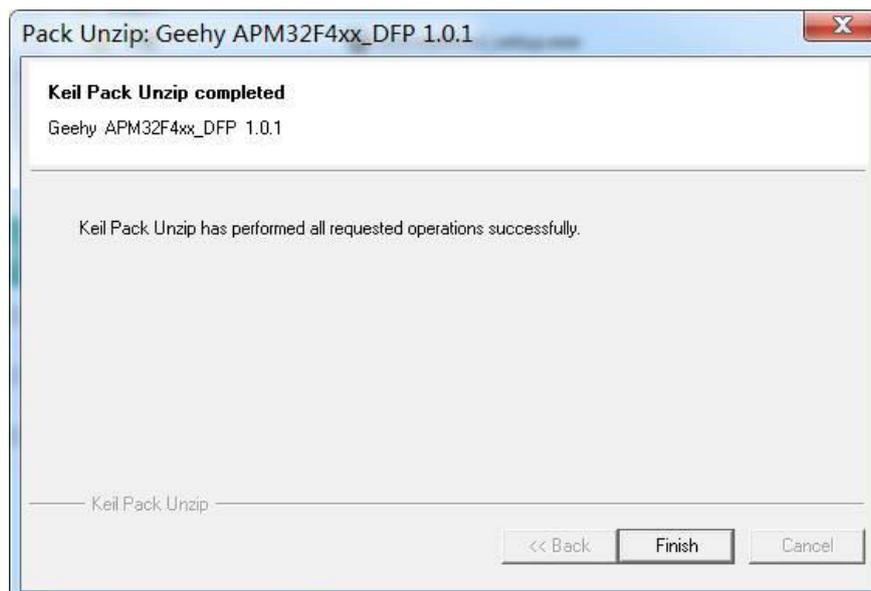
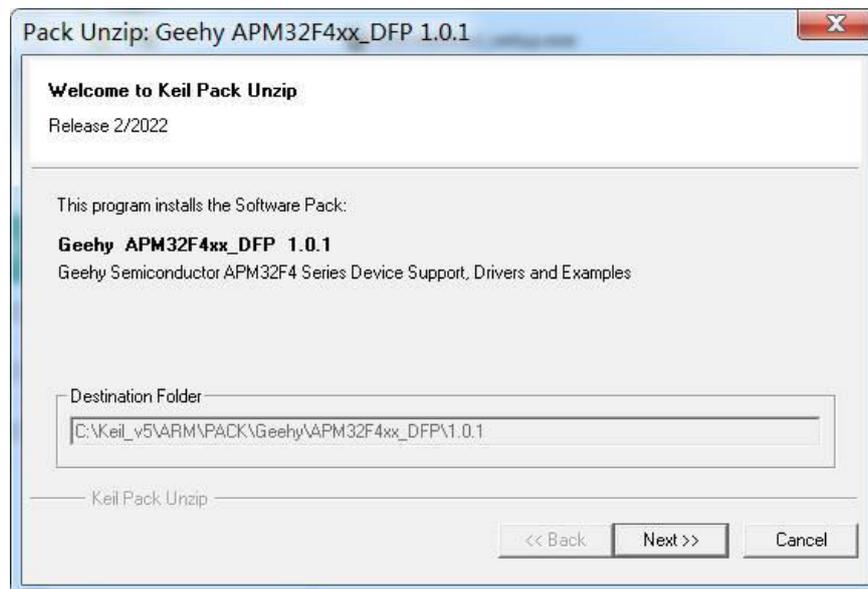
The MDK software package provides additional software components and support for microcontroller devices, DFP for short (Device Family Pack).

Users can choose to download the latest version of pack from [www.geehy.com](http://www.geehy.com).

Or you can choose to download the historical version of pack of Geehy directory from [www.keil.com](http://www.keil.com).

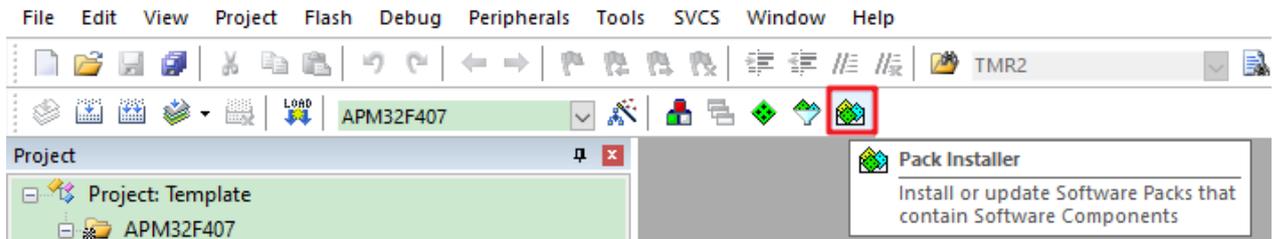
Installation method:

1. Double-click Install

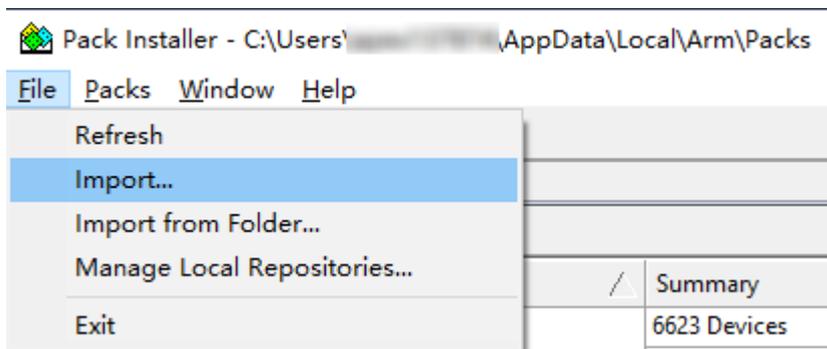


2. MDK5 installation

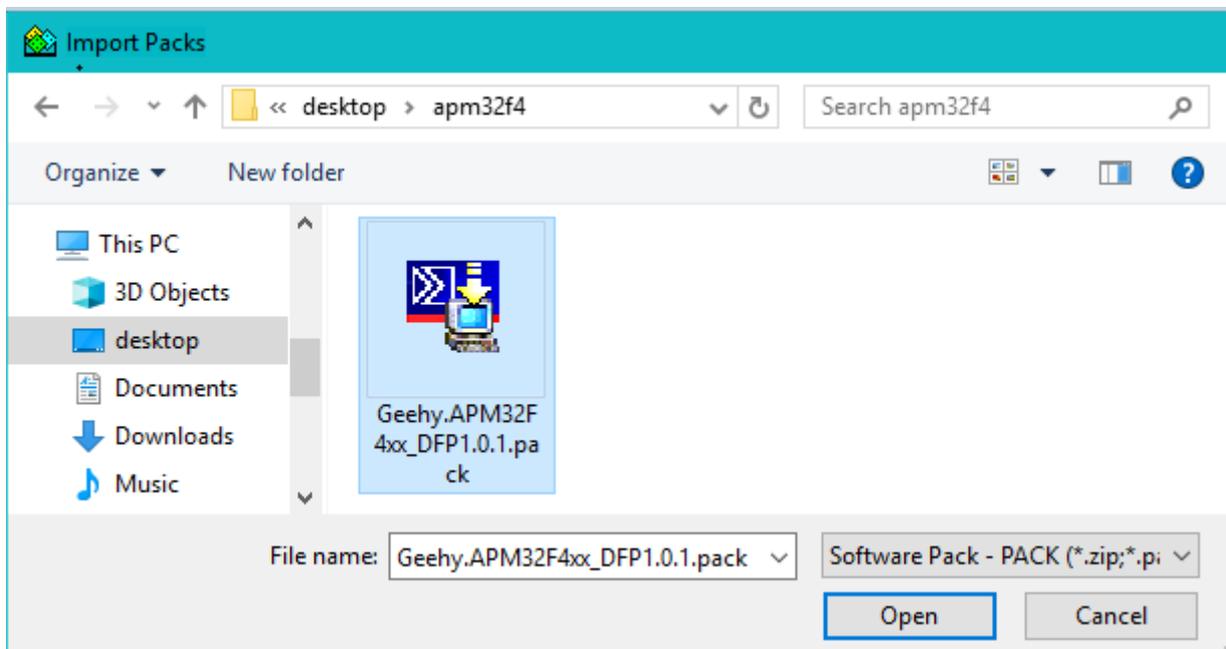
a) Select the red box button



b) Select Import



c) Select pack



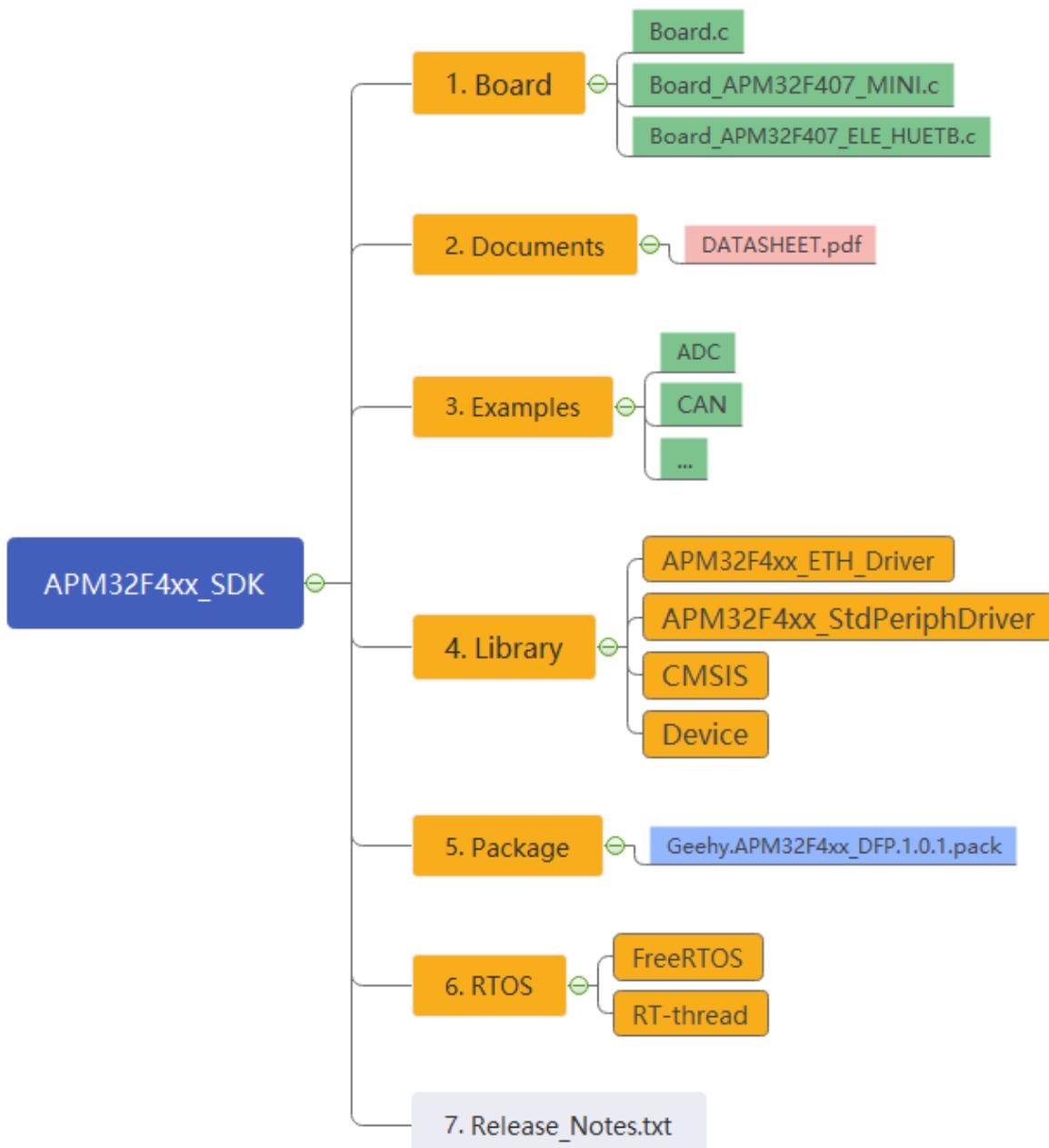
After successful installation, we can see that APM32F4 series currently supports 20 chip models, which are F405/407/415/417:

Device	Summary
Geehy	94 Devices
+ APM32E1 Series	8 Devices
+ APM32F0 Series	31 Devices
+ APM32F1 Series	24 Devices
- APM32F4 Series	20 Devices
- APM32F405	3 Devices
APM32F405RG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F405VG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F405ZG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
- APM32F407	8 Devices
APM32F407IE	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 512 kB ROM</a>
APM32F407IG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F407RE	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 512 kB ROM</a>
APM32F407RG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F407VE	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 512 kB ROM</a>
APM32F407VG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F407ZE	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 512 kB ROM</a>
APM32F407ZG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
- APM32F415	3 Devices
APM32F415RG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F415VG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F415ZG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
- APM32F417	6 Devices
APM32F417IE	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 512 kB ROM</a>
APM32F417IG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F417VE	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 512 kB ROM</a>
APM32F417VG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>
APM32F417ZE	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 512 kB ROM</a>
APM32F417ZG	<a href="#">ARM Cortex-M4, 168 MHz, 192 kB RAM, 1 MB ROM</a>

## 5.2 General SDK

Software Development Kit, SDK for short, generally, refers to the collection of development tools used by software engineers to establish application software for specific software packages, software frameworks, hardware platforms, operating systems, etc. It is a toolkit provided by a third-party service provider to implement the functions of software products. For users, it can shorten development cycle, reduce resource costs, and accelerate product R&D.

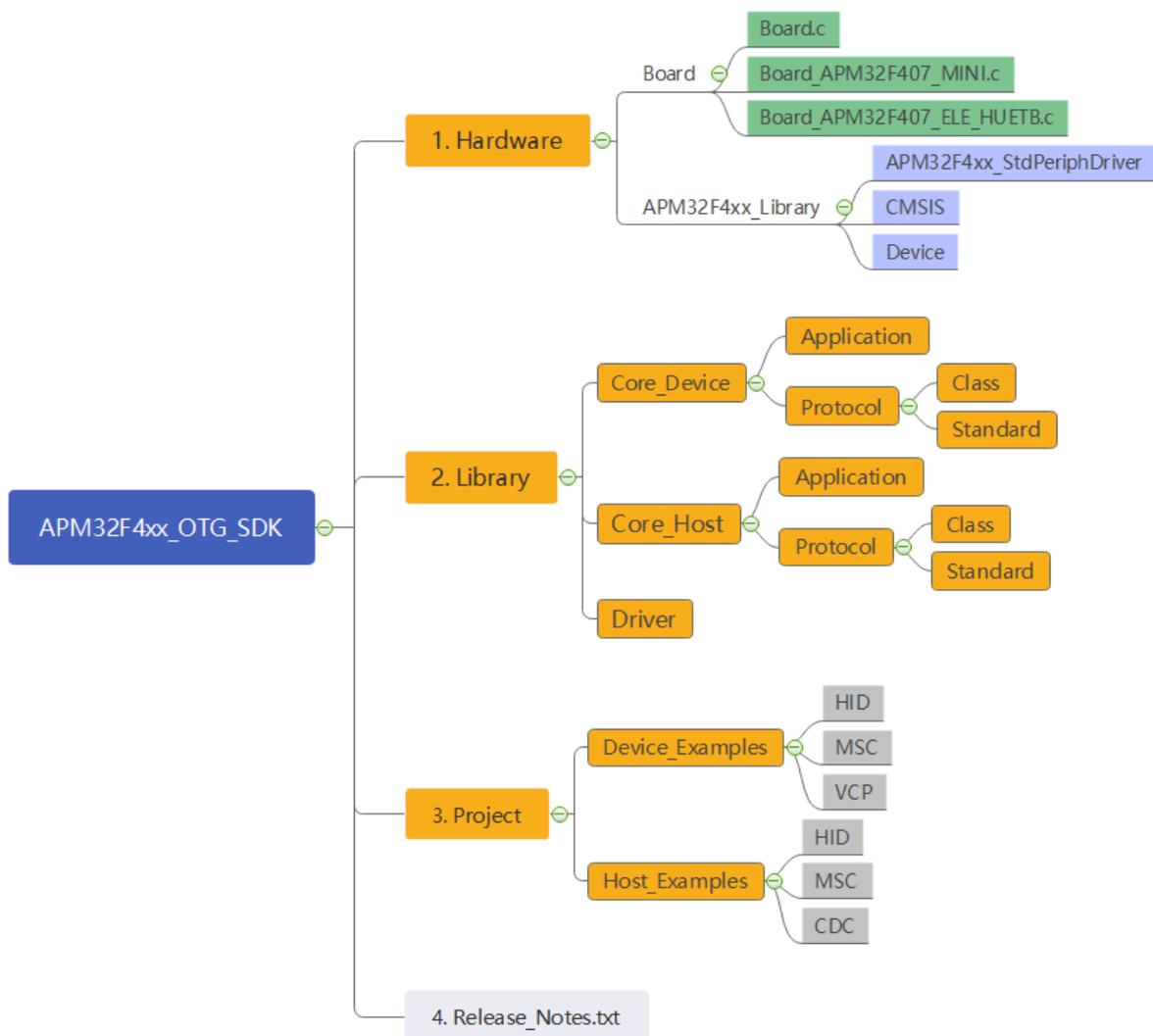
APM32F4xx\_SDK mainly serves the common module of APM32F4xx series MCU, and supports KEIL, IAR and other development platforms. The SDK contains the driver code and application routines of ADC, CAN, DMA and other modules. Users can select appropriate driver for related configuration. At the same time, routines are also used on ROTS.



### 5.3 OTG SDK

OTG is the abbreviation of On-The-Go, which is a technology that develops this year. It is mainly used to connect different devices or mobile devices for data exchange. OTG technology allows data transmission between devices without a host. Through OTG technology, USB interface accessories can be extended to intelligent terminals to enrich the functions of intelligent terminals, such as extending remote controller accessories and turning mobile phones and tablets into universal remote controllers.

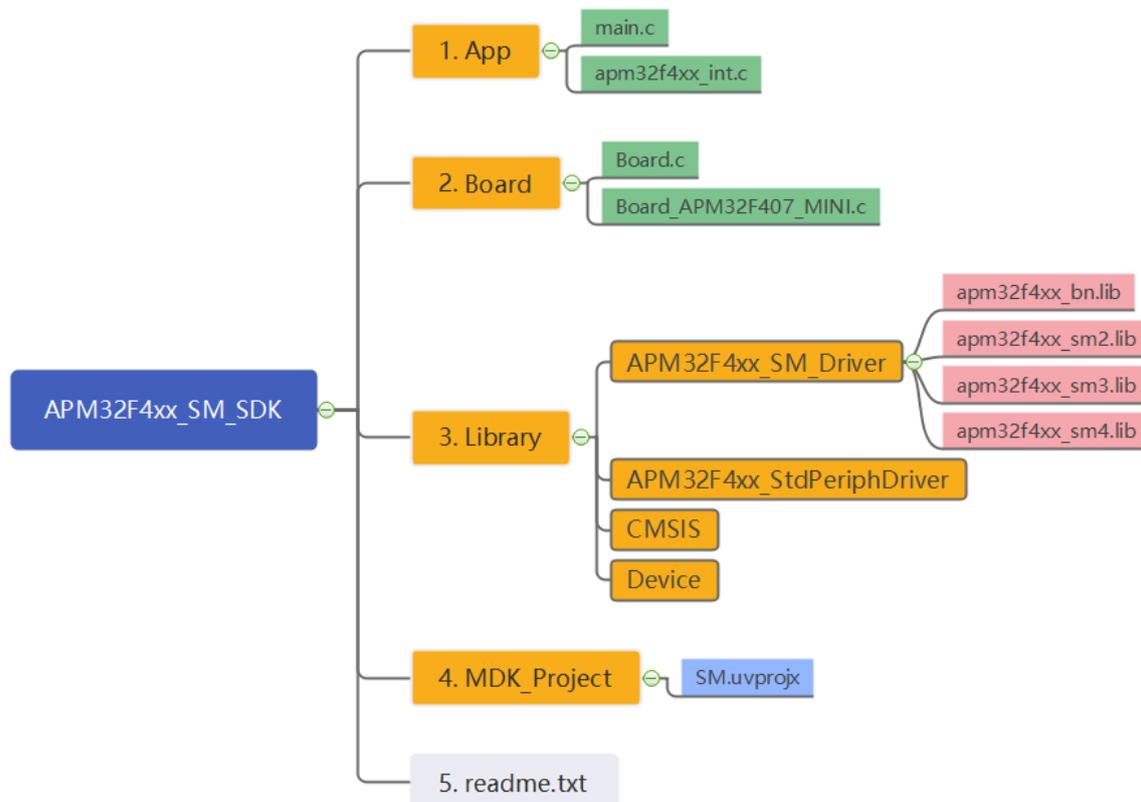
APM32F4xx\_OTG\_SDK mainly serves the USB\_OTG modules of APM32F4xx series MCU. The SDK contains the driver code and corresponding routines of USB host and device, and can support the application of embedded high-speed USB PHY of APM32F4xx. Users can refer to routines and use the driver function interface to realize specific USB applications. USB host driver supports control transmission, interrupt transmission, batch transmission and synchronous transmission, and basically covers the USB applications that meet USB2.0 specifications.



## 5.4 SM SDK

State commercial cryptography uses the phonetic abbreviation SM. It is an independent and controllable domestic algorithm designated by the State Cryptography Administration, including SM1, SM2, SM3, SM4, SM7, SM9, ZUC, etc.

APM32F4xx\_SDK\_SDK mainly serves the state commercial cryptography module of APM32F4xx series MCU. The SDK contains the driver codes of SM2, SM3 and SM4, which have been applied to routines. SM2 asymmetric cryptographic algorithm is implemented by software, and can replace international algorithms such as RSA1024/RSA2048. SM3 hash algorithm is implemented by hardware, and can replace MD5/SHA-1/SH-2 and other international algorithms. SM4 symmetric cryptographic algorithm is implemented by hardware, and can replace TDES/AES256 and other international algorithms. Users can refer to routines and use the driver function interface to realize specific encryption and decryption applications.



## 6 Tool Chain

1. Geehy-Link



2. APM32 PROG



3. DFU



4. ISP

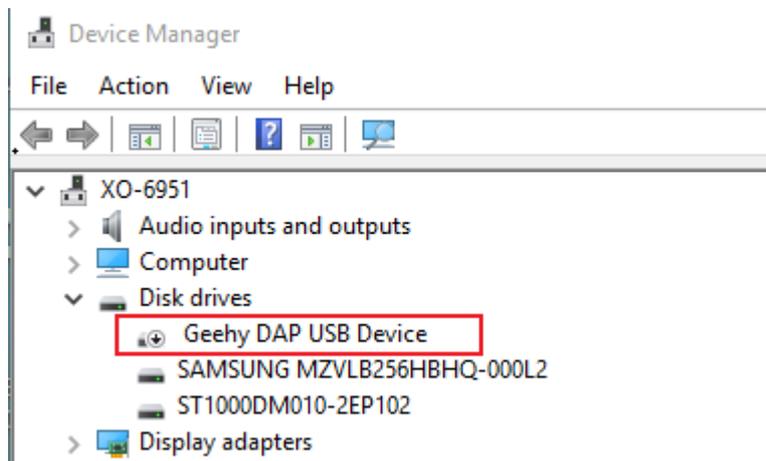


## 6.1 Geehy-Link

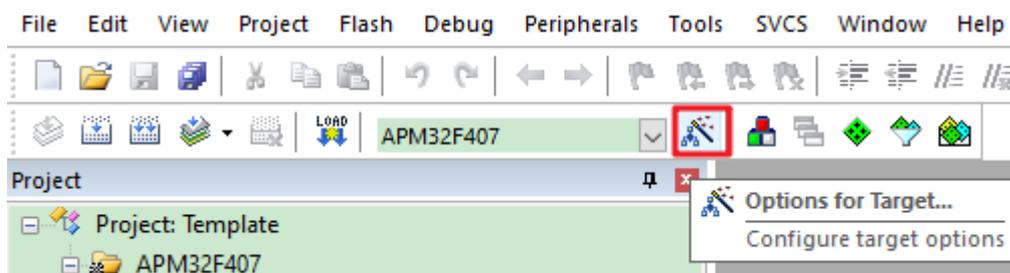
Geehy-LINK is a development tool integrating simulator and programmer, which can debug and simulate the APM32 full-range MCU products online in Keil, IAR and other integrated development environments. Support full-speed operation, single-step debugging, breakpoint setting and other debugging methods. Refer to the document of *GEEHY-LINK User Manual V1.0.0.pdf* on the official website

Keil MDK IDE:

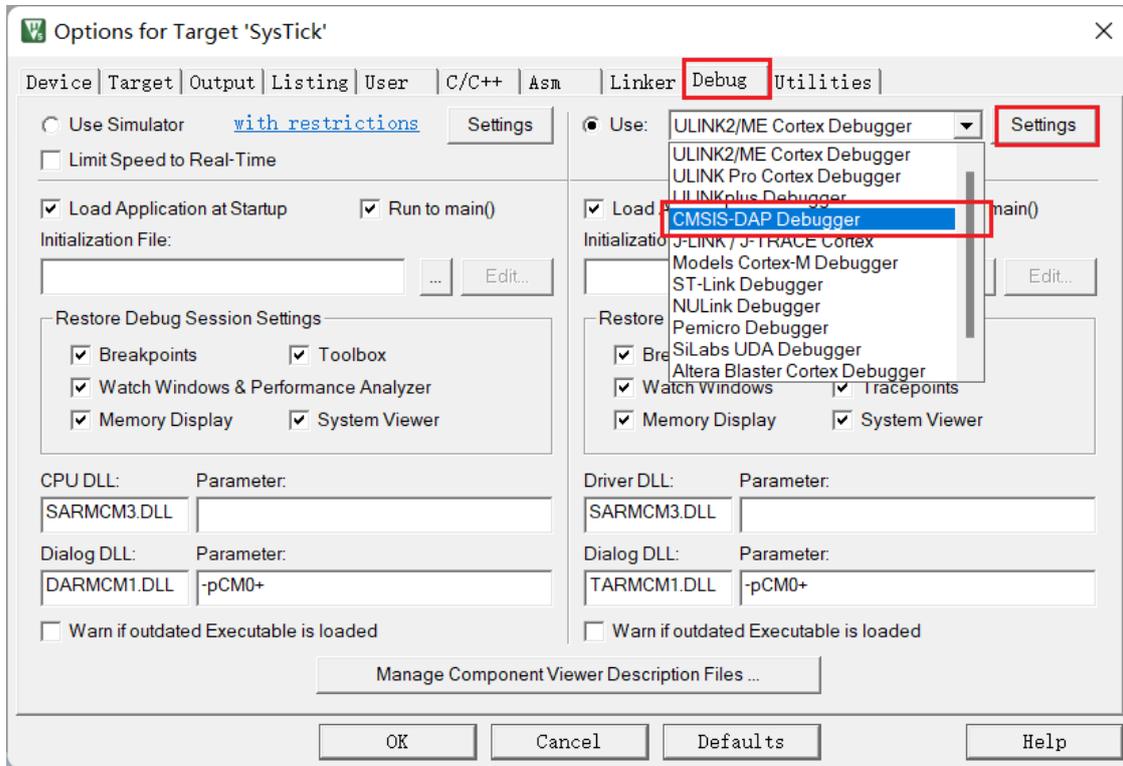
- a) Use the USB cable to connect Geehy-LINK to the computer. After they are connected successfully, Geehy DAP USB Device will appear on the device manager



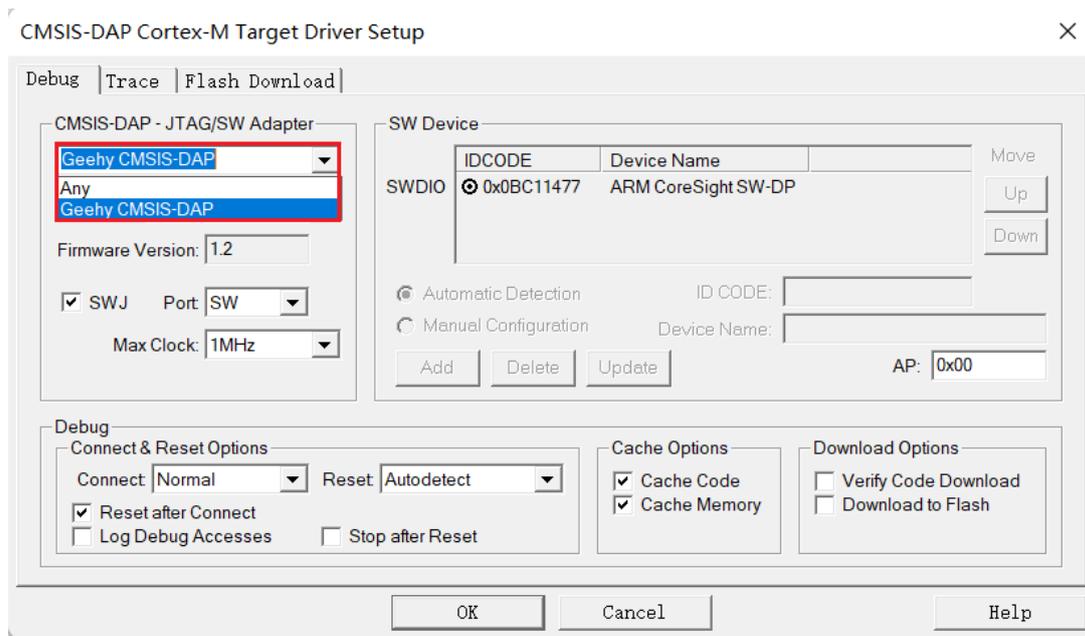
- b) Open the project file and select "Options for Target" tab.



- c) In the "Debug" option, download and select the simulator as "CMSIS-DAP Debugger" and then select "Setting".

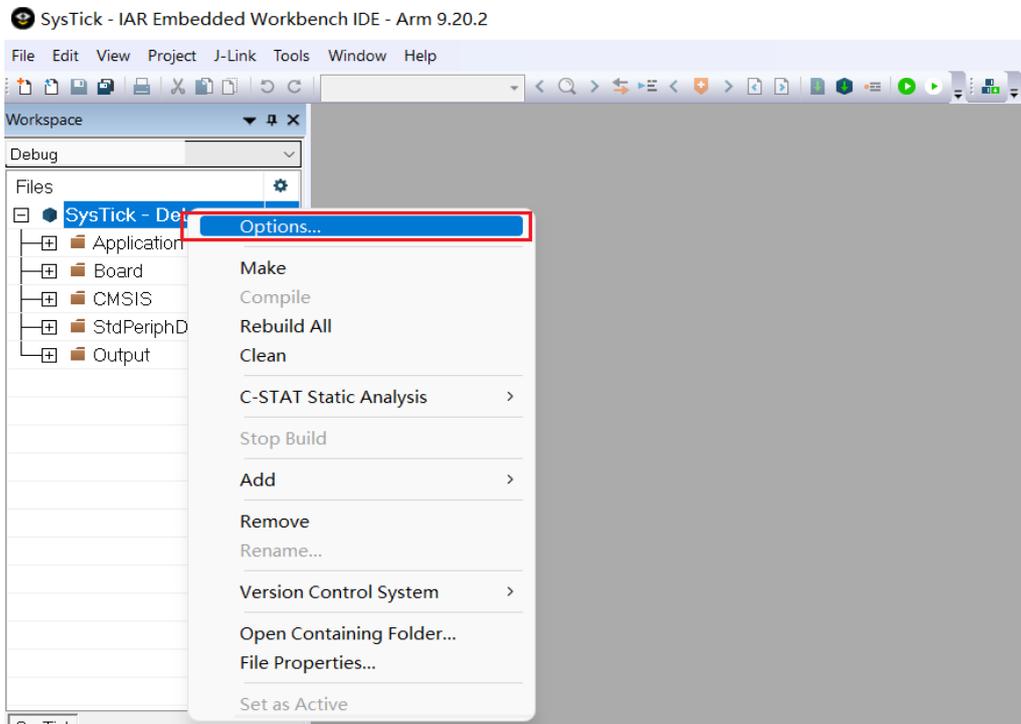


- d) In the "CMSIS-DAP Cortex-M Driver Setup" interface, select "Geehy CMSIS-DAP" (the old version is "Apex CMSIS-DAP") and click "OK".

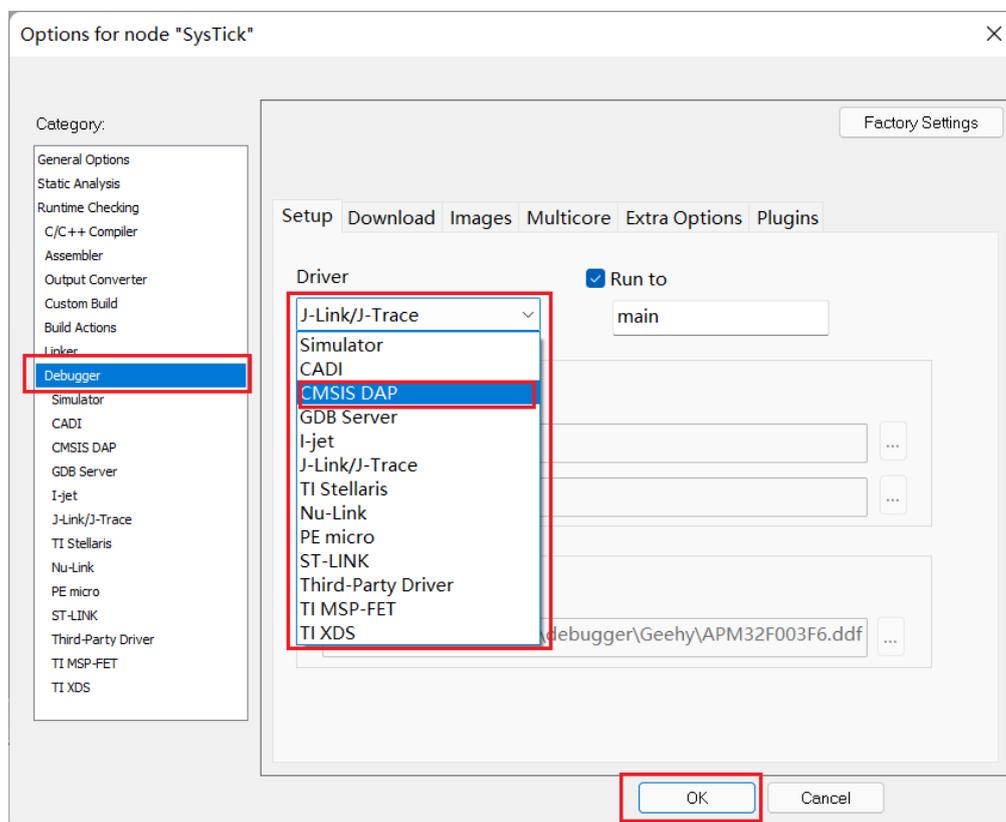


IAR EW for Arm IDE:

a) Open the project file and select "Options" tab.



b) Select "CMSIS DAP" simulator in "Debugger" and click "OK".

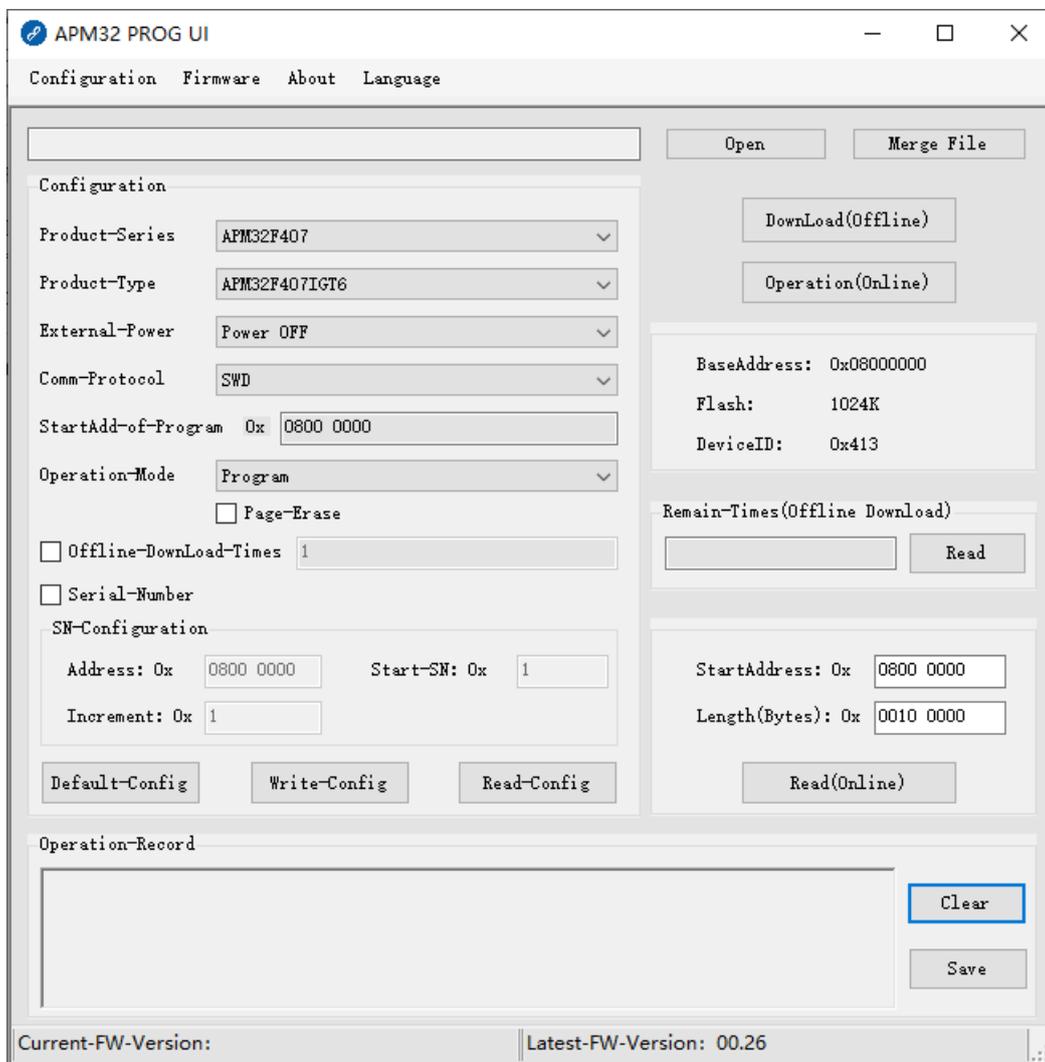


## 6.2 APM32 PROG

APM32-PROG is a tool developed for APM32 series chips. It can be used together with the upper computer software to complete the software programming of MCU chips, supports in-system and offline programming, supports JTAG and SWD programming of the upper computer, and supports WIN7/8/10 drive-free use.

For detailed operation, refer to APM32\_PROG User Manual V1.0.pdf on the official website.

Download the upper computer software [Apex-APM32-Setup.msi](#), and then install it (the installation interface is omitted). Open the software and connect APM32PROG. After successful connection, the upper computer will read the firmware version of the current APM32PROG, as shown in the red box at the bottom of the figure below. If the firmware version of the current APM32PROG is lower than the latest version, you will be prompted to update the firmware version.



The functional area of the APM32PROG upper computer is divided into the file opening area, configuration area (including serial number configuration and configuration writing), and offline or online operation area. APM32PROG, together with the upper computer, can realize such functions as programming, reading, encryption and decryption of the target MCU.

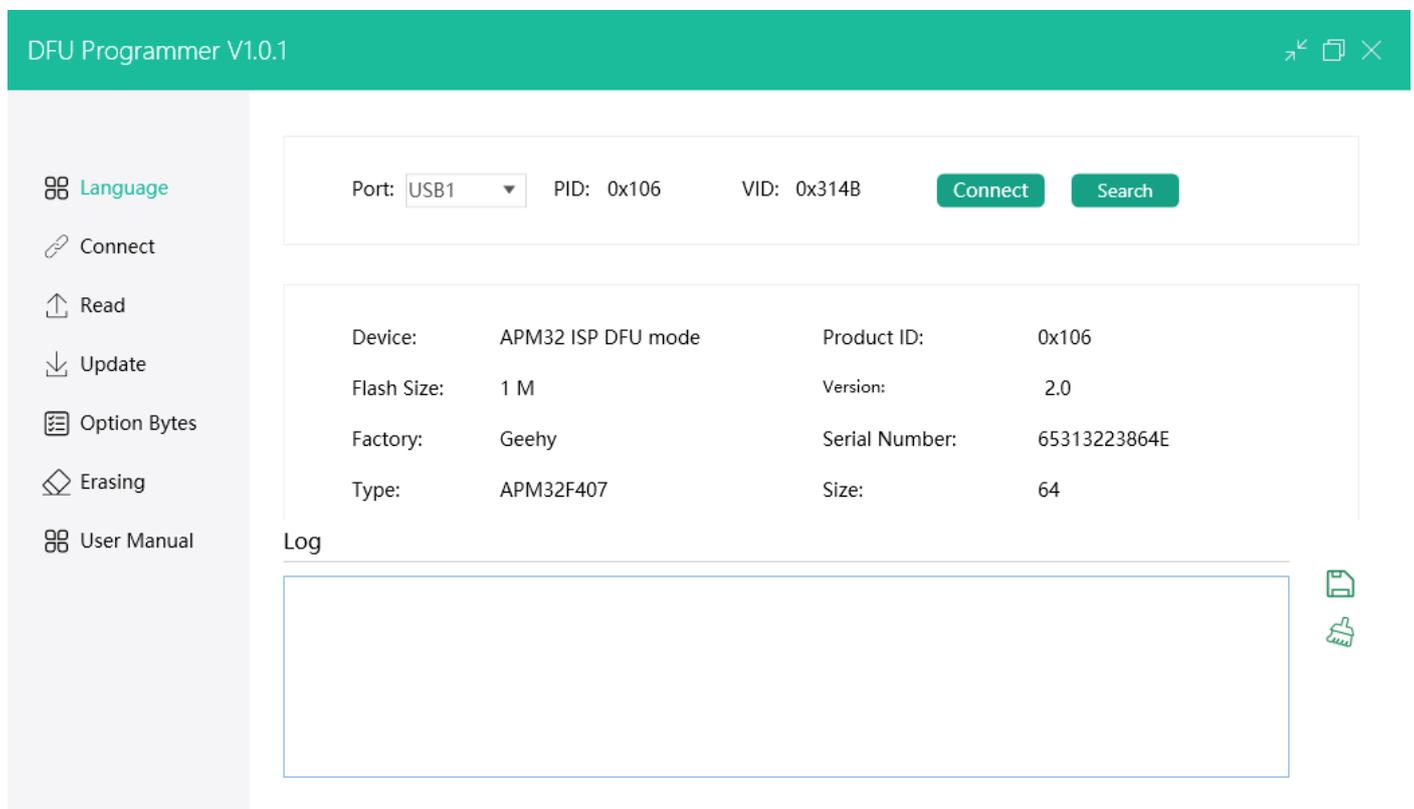
## 6.3 DFU

The full name of DFU is Device Firmware Upgrade.

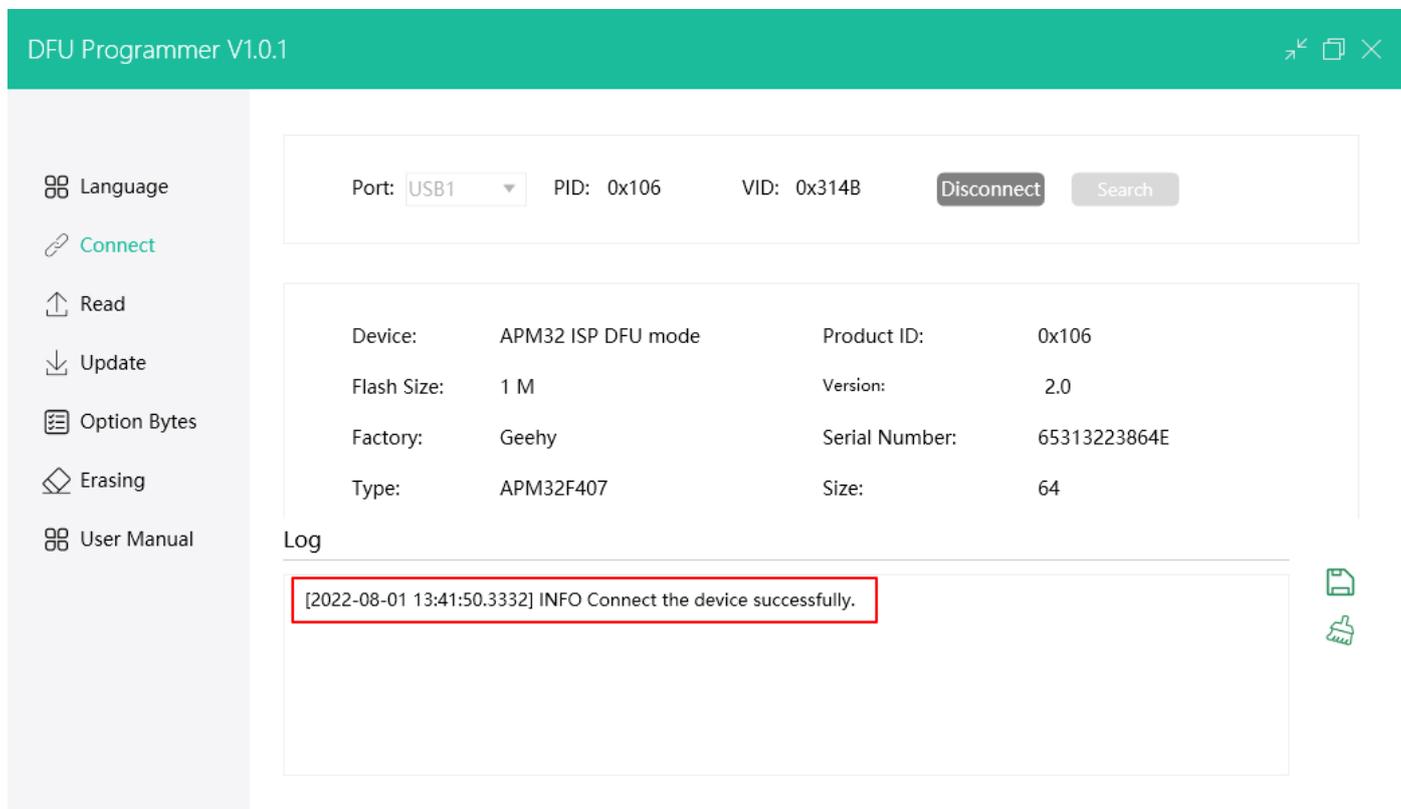
It mainly supports USB BootLoader, and can implement programming of chip FLASH and modification of option bytes. The upper computer of Geehy DFU Programmer is used for DFU upgrade of APM32 series MCU. The operation flow is shown below:

- a) Connect DFUProgrammer connects to MCU

Open DFUProgrammer software. If the computer has been connected to an "APM32 Bootloader" device, the initial interface is shown below. If no device is found, click the "Search device" button to search for the device. Click the "Connect a device" button to connect to the target MCU.



- b) After the target MCU is successfully connected, we can see the corresponding prompt in the log interface.



DFU Programmer V1.0.1

Port: USB1 PID: 0x106 VID: 0x314B Disconnect Search

Device:	APM32 ISP DFU mode	Product ID:	0x106
Flash Size:	1 M	Version:	2.0
Factory:	Geehy	Serial Number:	65313223864E
Type:	APM32F407	Size:	64

Log

[2022-08-01 13:41:50.3332] INFO Connect the device successfully.

- c) DFUProgrammer read program

Click the "Read a chip" button on the left to enter the chip content reading interface. In this interface, you can set the content and size of read chip, click the "Read chip" button to read the corresponding data, and click the "Save data" button to save the data to PC.

DFU Programmer V1.0.1



- ☰ Language
- 🔗 Connect
- ⬆️ Read
- ⬇️ Update
- 📄 Option Bytes
- 🧼 Erasing
- ☰ User Manual

Start address:  Size:     
 8 bit  16 bit  32 bit

Address	0	4	8	C	ASCII
0X08000000	20000688	08000231	08000427	0800041F	? 1'
0X08000010	08000423	08000365	080005A5	00000000	#e?
0X08000020	00000000	00000000	00000000	0800043D	=
0X08000030	08000369	00000000	08000429	0800043F	i)?
0X08000040	00000000	00000000	00000000	00000000	XXXX

Log

```
[2022-08-01 13:52:30.4891] INFO Search device complete.  
[2022-08-01 13:52:31.6478] INFO Connect the device successfully.  
[2022-08-01 13:52:35.0724] INFO read succeeded.
```



- d) After the data is saved successfully, you can get the information of data successfully saved in the log window.

DFU Programmer V1.0.1 ↶ ↷ ✕

Start address:  Size:  ↑ Read ↓ Save

8 bit  16 bit  32 bit

Address	0	4	8	C	ASCII
0X08000000	20000688	08000231	08000427	0800041F	? 1'
0X08000010	08000423	08000365	080005A5	00000000	#e?
0X08000020	00000000	00000000	00000000	0800043D	=
0X08000030	08000369	00000000	08000429	0800043F	i)?
0X08000040	00000000	00000000	00000000	00000000	XXXX

**Log**

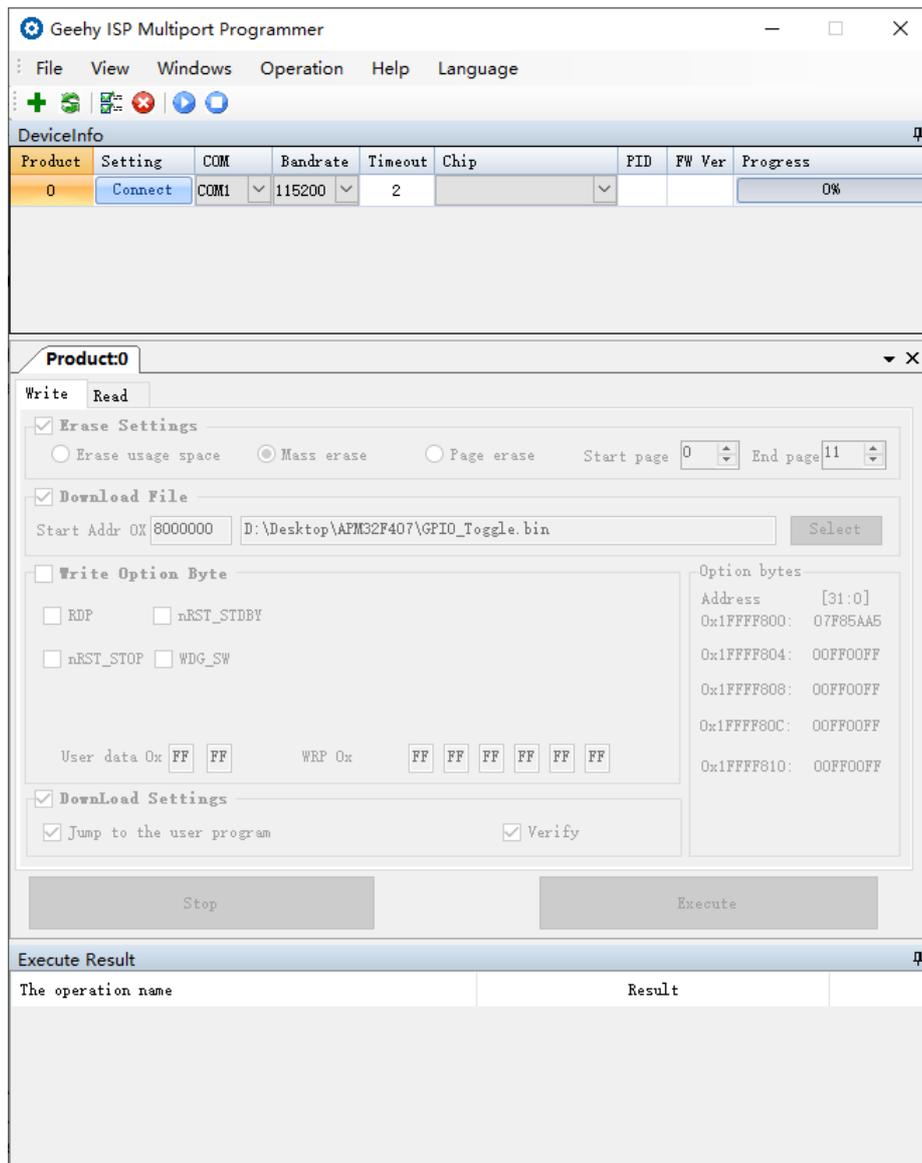
```
[2022-08-01 13:52:31.6478] INFO Connect the device successfully.  
[2022-08-01 13:52:35.0724] INFO read succeeded.  
[2022-08-01 13:54:32.9973] INFO Save data to bin file succeeded.
```


## 6.4 ISP

ISP is In-System-Programming. Chips with ISP function can write or erase programs directly on the circuit board through a simple download cable, can be rewritten by the software of the upper computer through the serial port, and supports online debugging. So that users can test and develop the chips without programmers.

ISP Multiport Programmer is a graphical interface application developed to make it easier for users to use Geehy's MCU. Using this application, users can configure and operate multiple MCU devices of Geehy at the same time through UART port. For details, refer to *Geehy-ISP Multiport Programmer User Manual*.



A segment of BootLoader program and system storage area are built in APM32F4 series MCU before they leave the factory, to facilitate users to implement program downloading, option bytes programming and other operations on MCU through ISP. The BootLoader of each chip has different communication methods to support upgrade.

Table 3

General MCU series	Whether supporting ISP upgrade	Supporting interfaces	BootLoader entry mode
APM32F4x5x7	Yes	USB (PA11/PA12) USART (PA9/PA10、PB11/PB12、PC11/PC12) CAN (PB5/PB13)	Boot0 connects to 0, and Boot1 connects to 1

The general process of connecting APM32 ISP Multiport Programmer to MCU is as follows:

- a) Click the plus sign Add New Window below the main interface to get the setting window.
- b) Select the corresponding USB Serial Port in the setting window like COM3.
- c) Set the required baud rate under the Bandrate in the setting window, e.g. set to 115200.
- d) Set the connection timeout under the Timeout in the setting window, e.g. set to 2.
- e) Finally, click the Connect button under Setting to complete the connection to the target MCU.

## 7 Version History

Table 4 Document Version History

<b>Date</b>	<b>Version</b>	<b>Change History</b>
May 31, 2022	1.0	New

## Statement

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