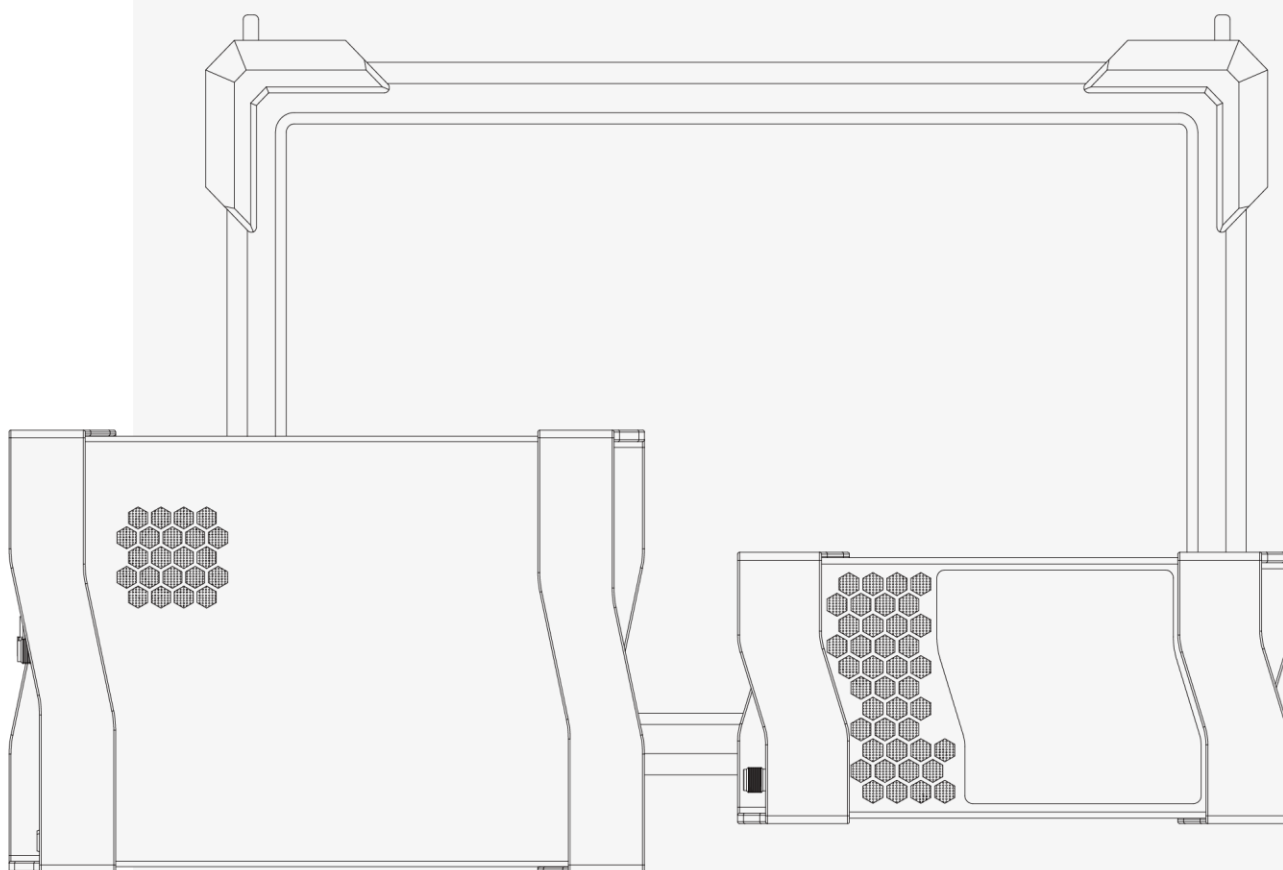




API Example Usage Guide



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Version Management

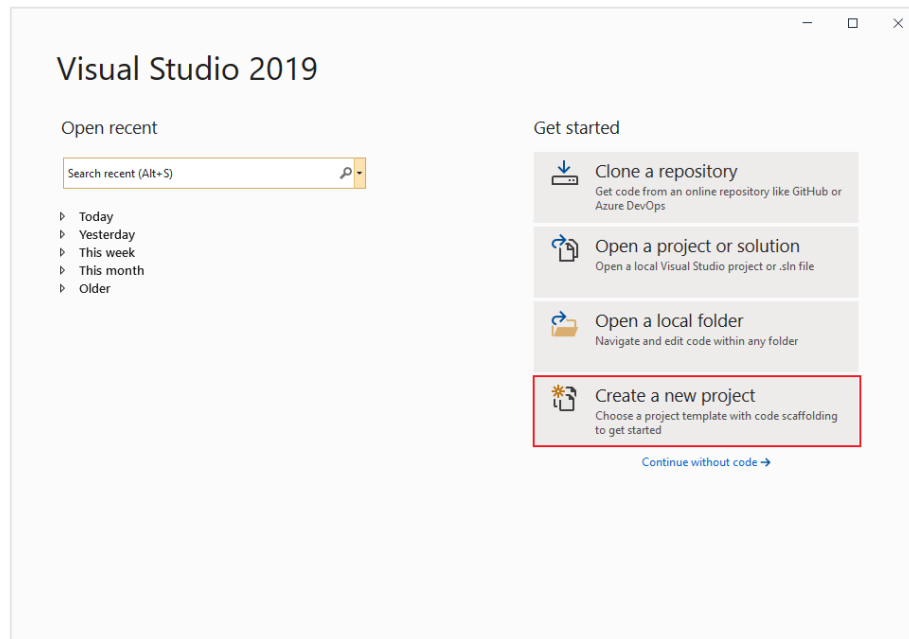
Updated Description Sheet

Version	Description	Date
V1.10	1. Modified: Modify the translation content 2. Added: Add Version Management Chapter 3. Added: Supplementing GNU Radio usage examples	11/14/2025
V1.9	1.Added: Add GNU Radio Module Construction and Use chapter	10/24/2025
V1.8	1. Initial Version	9/20/2025

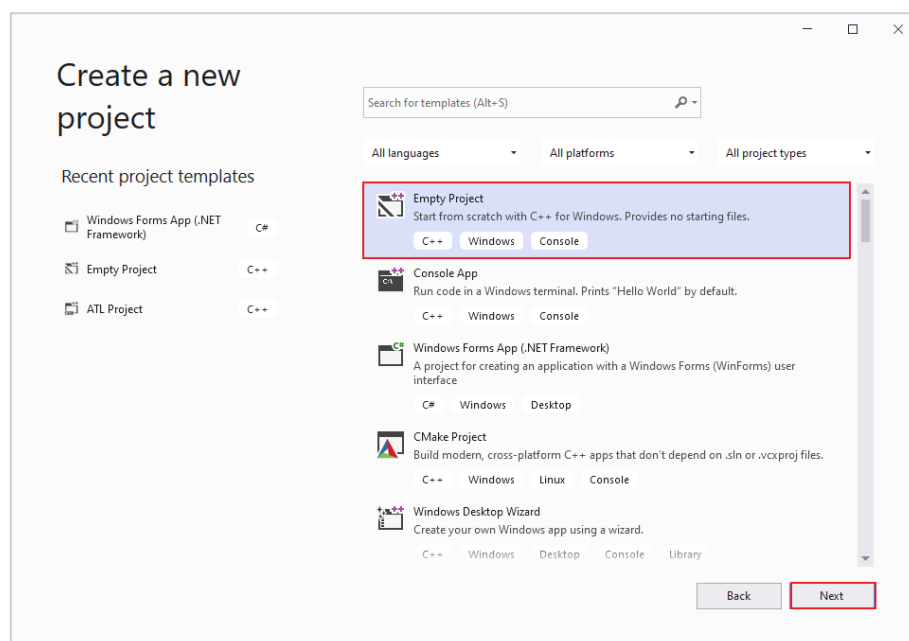
1. C/C++

1.1 Configure Development Environment

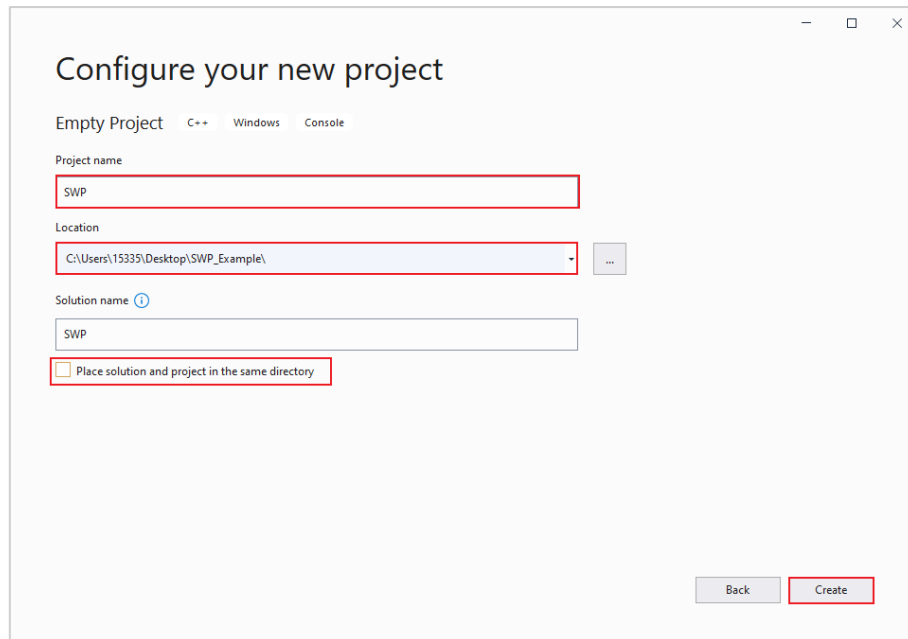
1. Open Visual Studio 2019 and create a new project.



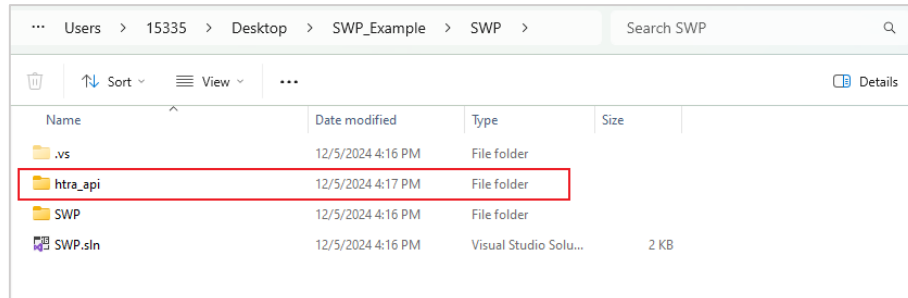
2. Select the Empty project, and click next.



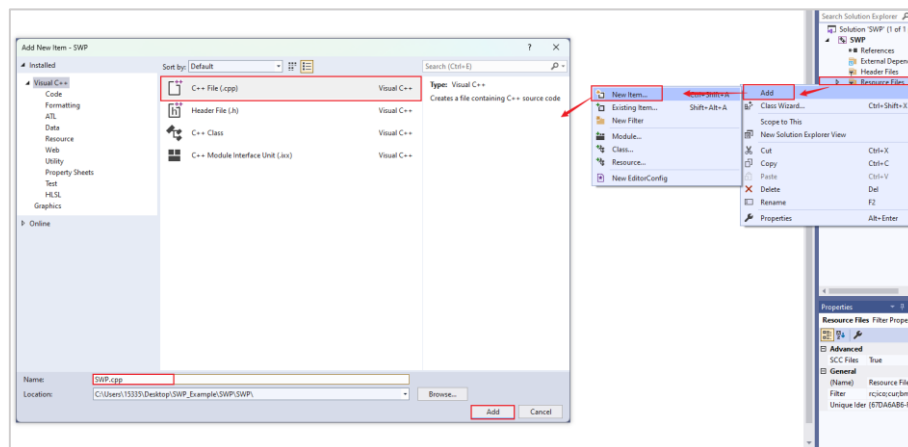
3. Fill in the project name and storage location, uncheck "Place solution and project in the same directory", and then click Create.



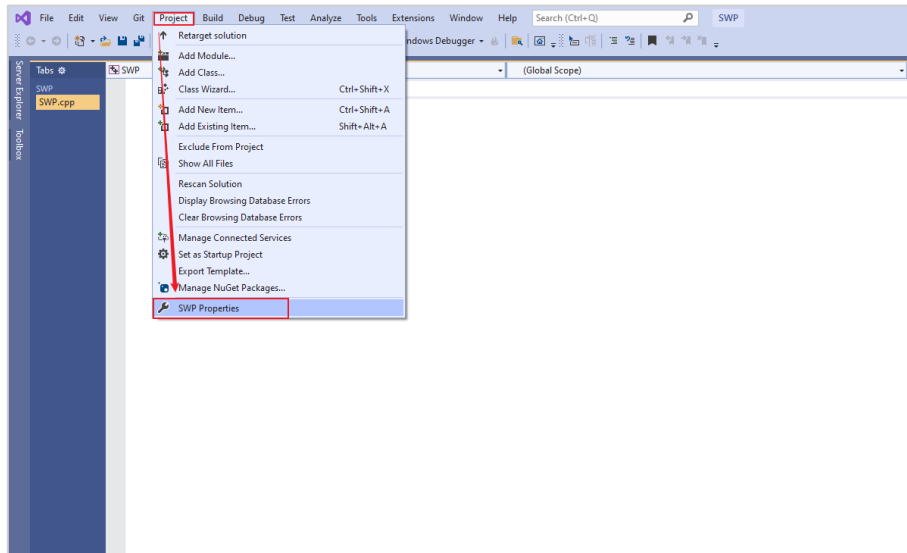
4. Once created, copy the htra_api folder from the delivery USB drive Windows\HTRA_API\x86 to the same level directory of the project (this example is for configuring an x86 architecture project; if you want to configure an x64 architecture project, copy the Windows\HTRA_API\x64\htra_api folder).



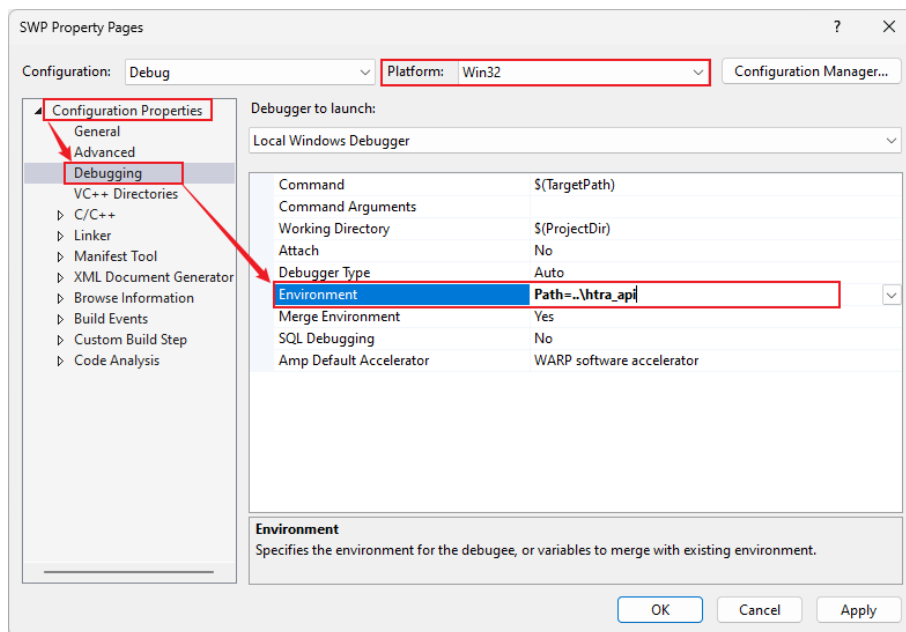
5. Double-click to open SWP.sln, and create a new SWP.cpp file in the source files.



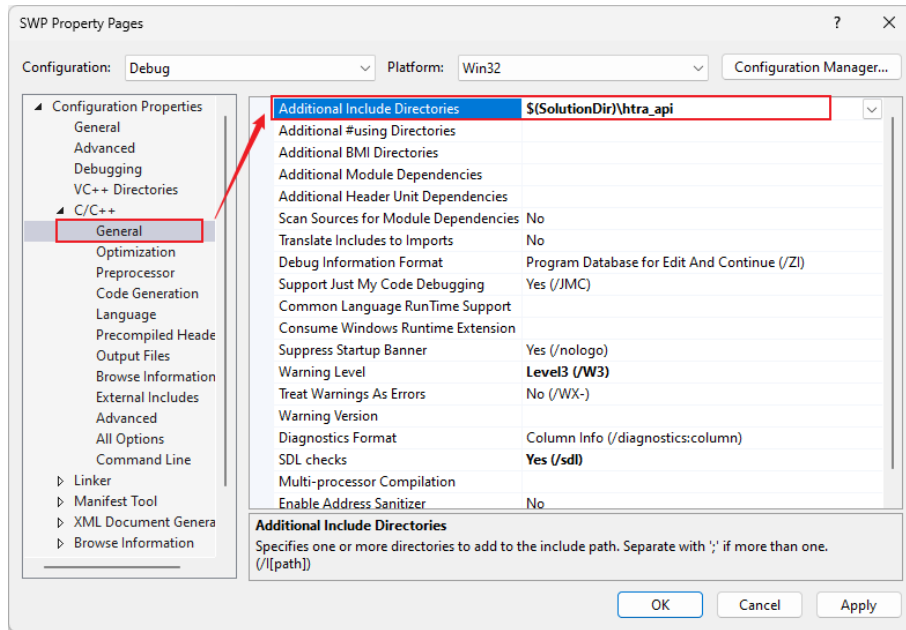
6. Click on "Project" in the menu bar and select "Properties".



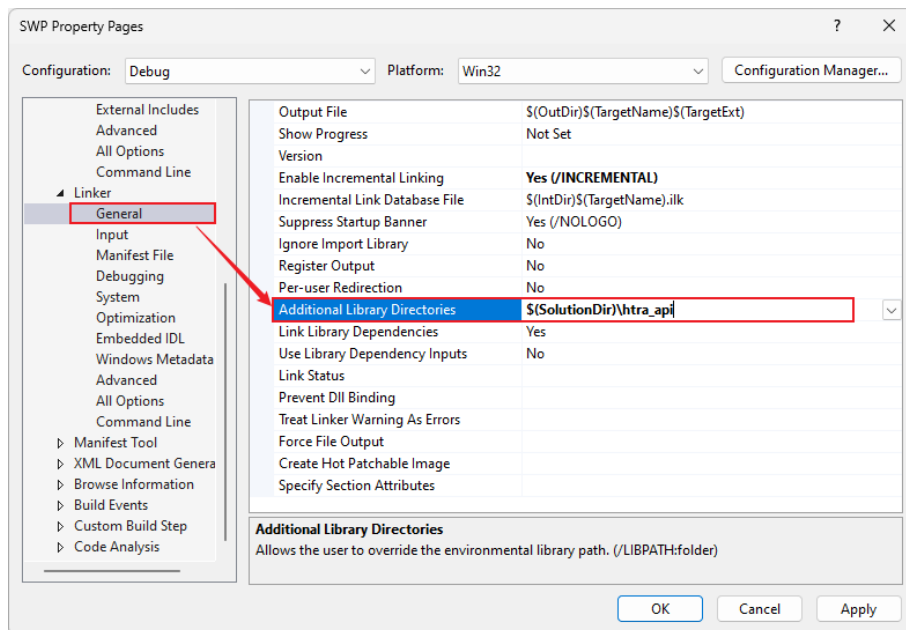
7. Select "Win32" for the configuration platform, and set the environment variable in Configuration Properties -> Debug to Path=..\htra_api (when configuring for the x64 architecture, select "x64" for the configuration platform; otherwise, steps 7-10 of the configuration process are the same as for the x86 architecture (Win32)).



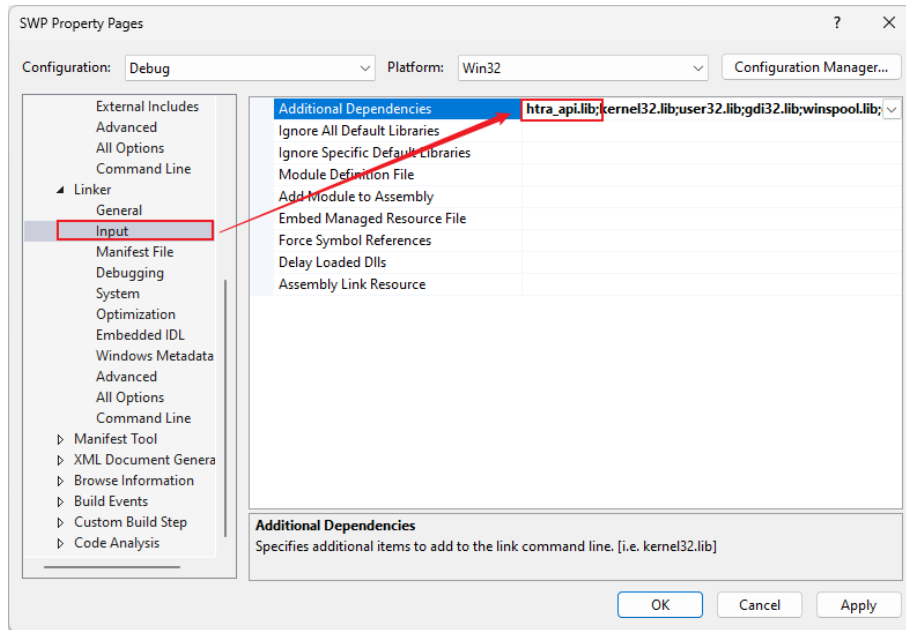
8. Set the Additional Include Directories in Configuration Properties -> C/C++ -> General to \$(SolutionDir)\htra_api.



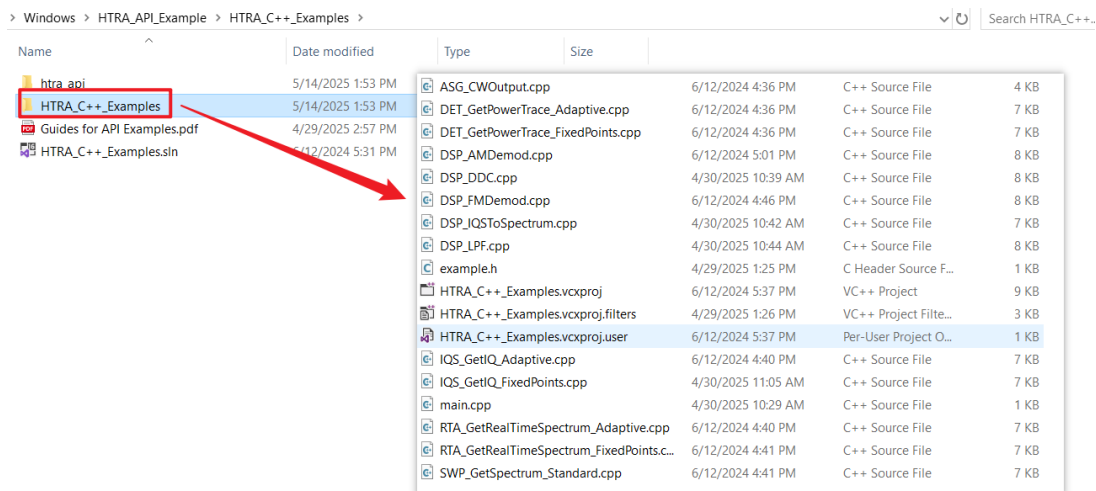
9. Set the Additional Library Directories in Configuration Properties -> Linker -> General to \$(SolutionDir)\htra_api.



10. Add htra_api.lib to the Additional Dependencies in Configuration Properties -> Linker -> Input.

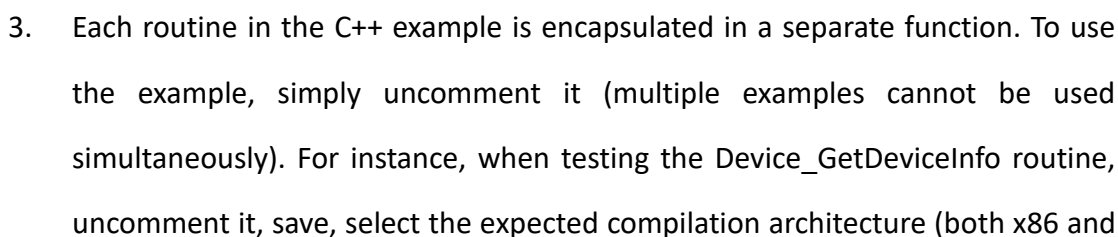
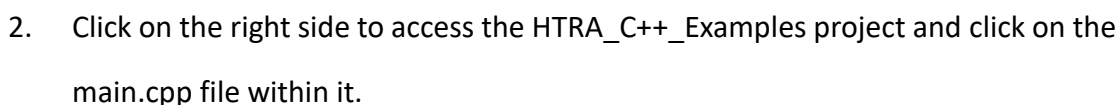


11. At this point, the environment configuration is complete, and programming development can begin. You can refer to the C/C++ examples included on the USB drive, specifically in
- Windows\HTRA_API_Example\HTRA_C++_Examples\HTRA_C++_Examples.

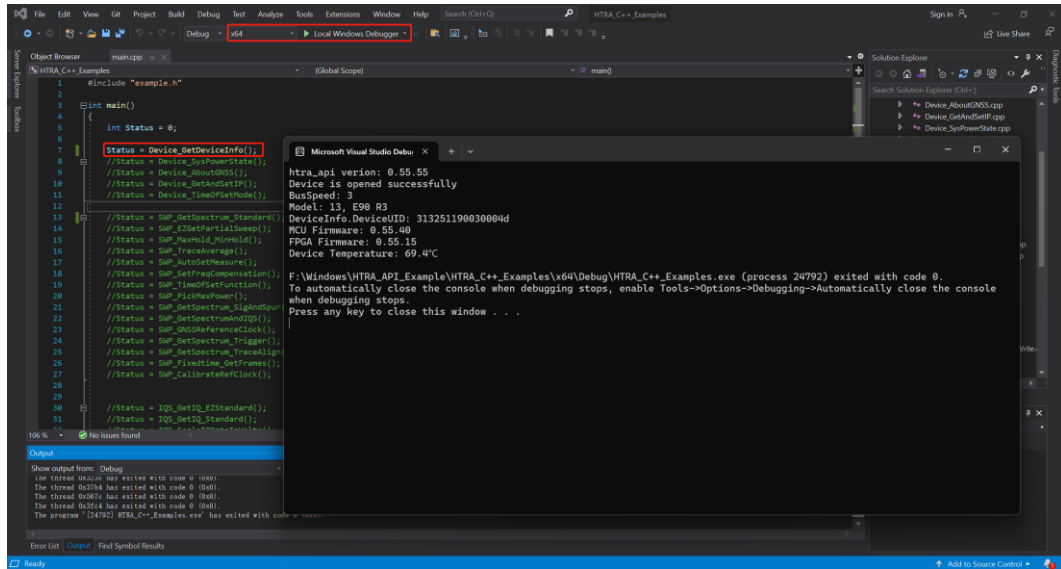


1.2.1 Usage of General C++ Examples

1. Use Visual Studio to open the solution HTRA_C++_Examples.sln located in the folder Windows\HTRA_API_Example\HTRA_C++_Examples on the provided USB drive.

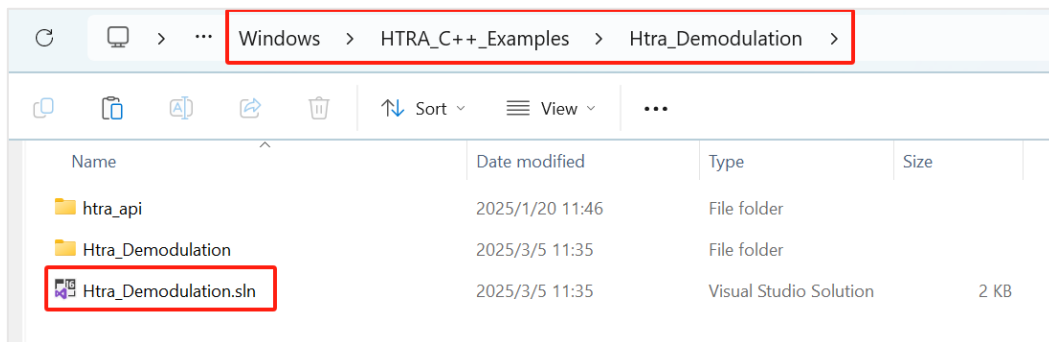


x64 are acceptable), and click run. The image shown indicates that the device is running normally.

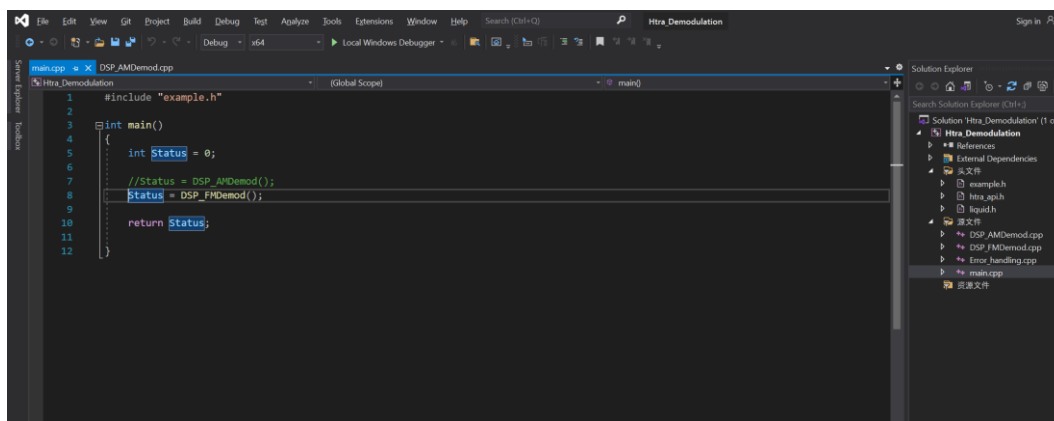


1.2.2 Use of the AM/FM demodulation example

1. Open the solution Htra_Demodulation.sln in the folder Windows\HTRA_C++_Examples\Htra_Demodulation on the supplied USB drive using Visual Studio.

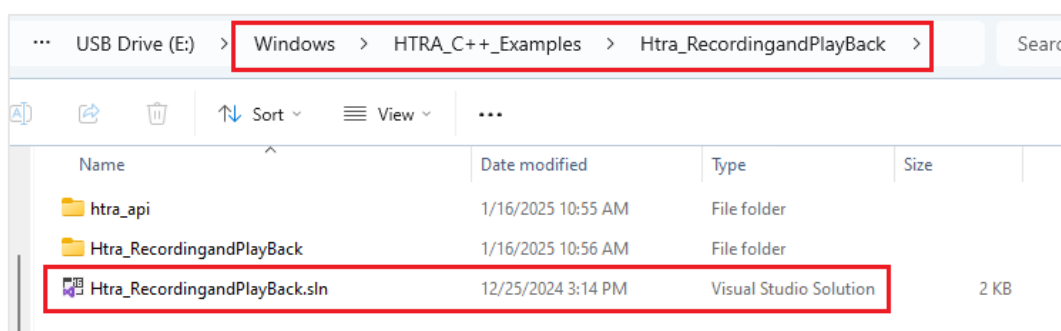


2. Click on the HTRA_C++_Examples project on the right and click on the main.cpp file.
3. C++ send with the example of each routine is encapsulated in a separate function, the use of the example can be uncommented (not at the same time to use more than one example). For example, to test the DSP_FMDemod routine, uncomment it and save it, select the compilation architecture (both x86 and x64), and click run.

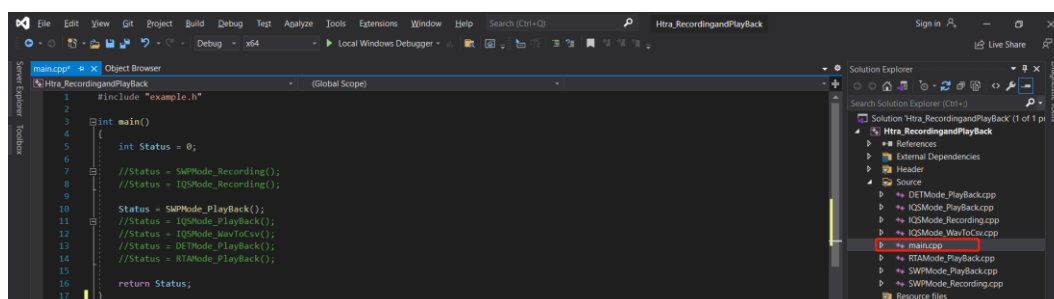


1.2.3 Usage of the recording and playback example

1. Open the solution Htra_RecordingandPlayBack.sln located in the folder Windows\HTRA_API_Example\Htra_RecordingandPlayBack on the provided USB drive using Visual Studio.

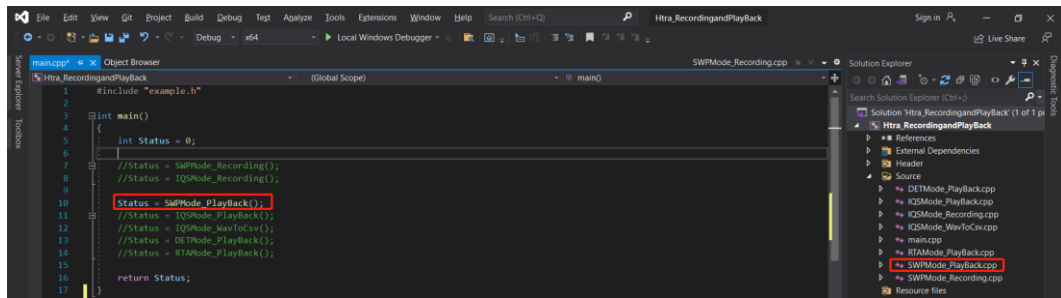


2. Click on the right side to access the Htra_RecordingandPlayBack project and click on the main.cpp file within it.
3. Each routine in the recording and playback example is encapsulated in a separate function. To use the example, simply uncomment it (multiple examples cannot be used simultaneously).

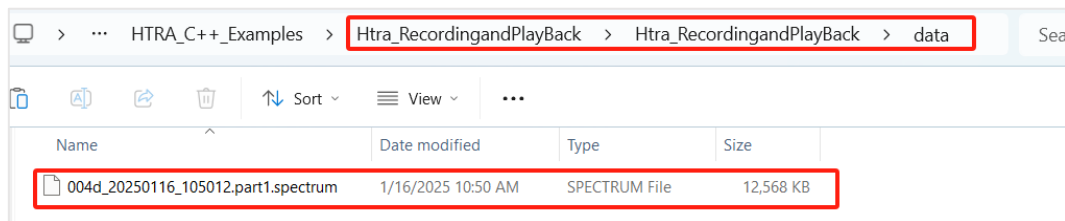


1. Usage of the reading example:
 - 1) For example, when reading SWP mode stream disk data, uncomment the

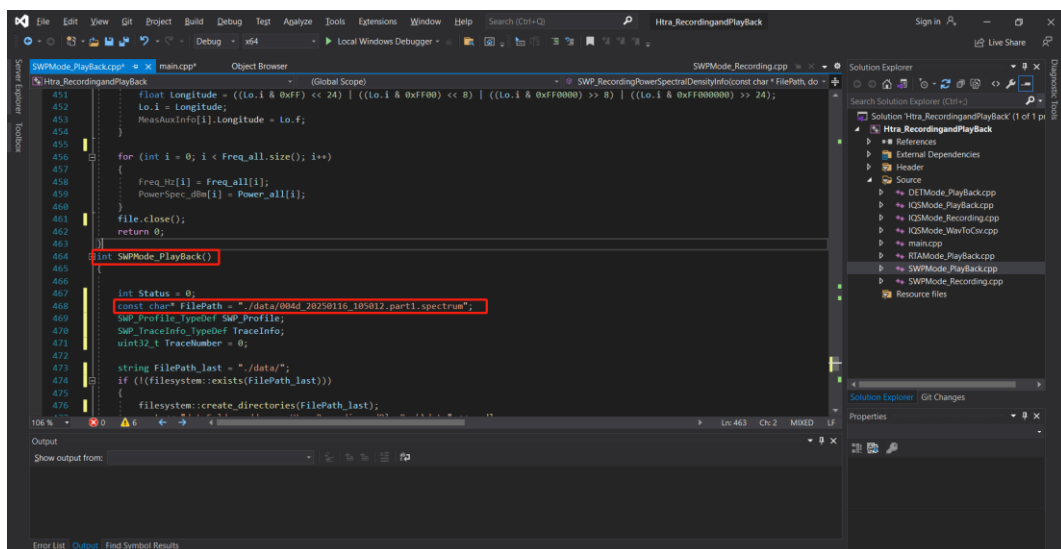
SWPMode_PlayBack function and save.



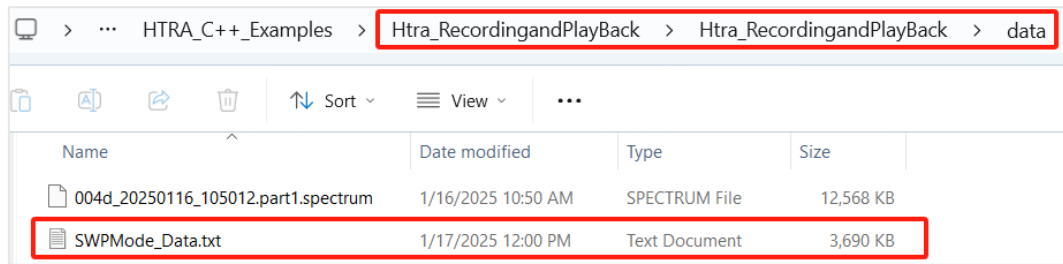
- 2) Place the recorded file data from SWP mode into the folder "Windows\HTRA_C++_Examples\Htra_RecordingandPlayBack\Htra_RecordingandPlayBack\data".



- 3) Click to enter SWPMode_PlayBack.cpp and modify the name of the recorded file in the SWPMode_PlayBack() function.

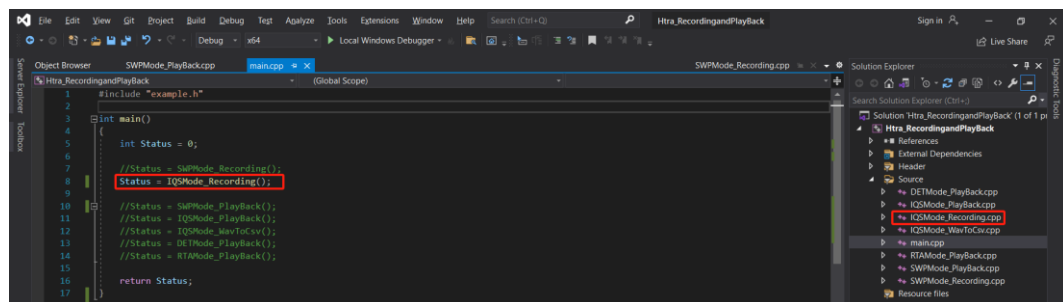


- 4) Running the program will generate the parsed data file "SWPMode_Data.txt" in the data folder under the SWP mode.

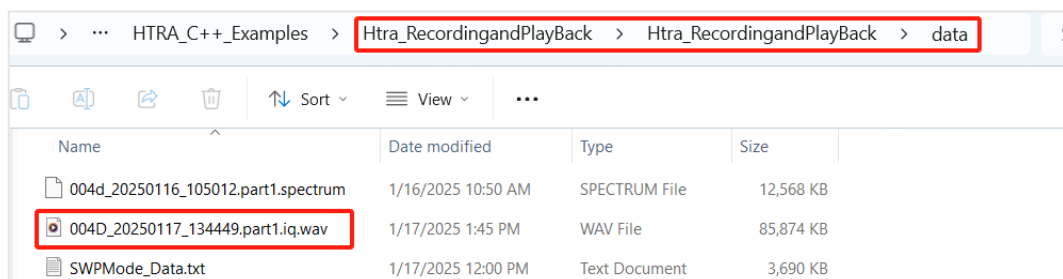


2. Usage of the recording example:

- 1) For example, when testing the IQSMode_Recording routine, uncomment and save.



- 2) Click to enter the IQSMode_Recording() function, configure the parameters, and run the program. You can find the recorded file data in the "Windows\HTRA_C++_Examples\Htra_RecordingandPlayBack\Htra_RecordingandPlayBack\data" folder under the IQS mode.



1.3 Device-related

1.3.1 Get device information

Device_GetDeviceInfo.cpp: Get device information, including API version, USB version, device model, device UID, MCU version, FPGA version, and device temperature.

1.3.2 Device standby

Device_SysPowerState.cpp: An example of setting the device's standby state, which can be configured to normal operating state or RF powered down state (low power).

1.3.3 GNSS-related

Device_AboutGNSS.cpp: Retrieves information such as latitude, longitude, altitude, and time obtained from the GNSS module, acquires GNSS-related latitude and time information from MeasAuxInfo in SWP mode, and obtains latitude and time information from IQStream.DeviceState in IQS mode.

1.3.4 Get and modify the IP address of the NX device

Device_GetAndSetIP.cpp: Retrieve the device's IP address and modify it using the device UID or the device's current IP address.

1.3.5 Mode switching time consumption

Device_MeasureModeSwitchTime.cpp: Get the time required for the current host computer to switch between different modes.

1.4 SWP mode

1.4.1 Standard spectrum acquisition

SWP_GetSpectrum_Standard.cpp: Obtain spectrum data by calling the function

interface.

1.4.2 Simplified configuration mode

SWP_EZGetPartialSweep.cpp: Quickly acquire spectrum data using a simplified configuration.

1.4.3 Maximum and minimum hold

SWP_MaxHold_MinHold.cpp: Set the trace mode to MaxHold or MinHold, and use SWP_ResetTraceHold to reset the hold.

1.4.4 Average Trace

SWP_TraceAverage.cpp: Average processing of the acquired trace.

1.4.5 Automatic Configuration Measurement

SWP_AutoSetMeasure.cpp: Automatically configures relevant parameters based on specific SWP applications, completing measurements by issuing automatic configuration parameters.

1.4.6 Frequency Compensation

SWP_SetFreqCompensation.cpp: When an external attenuator is present, compensation can be applied to the corresponding frequency band to ensure that the test results remain accurate.

1.4.7 Function execution time, sweep speed, and throughput

SWP_TimeOfSetFunction.cpp: Obtains the call duration of the SWP_Configuration, SWP_GetPartialSweep, and SWP_GetFullSweep functions, along with the sweep speed and throughput under the current configuration.

1.4.8 Obtain spectrum peak values

SWP_PickMaxPower.cpp: Obtain the maximum power point of the current spectrum and its corresponding frequency point.

1.4.9 Signals and Spurious

SWP_GetSpectrum_SigAndSpur.cpp: This can distinguish between signals and spurious after obtaining spectrum data.

1.4.10 Simultaneous Acquisition of Spectrum and IQ

SWP_GetSpectrumAndIQS.cpp: This allows for the simultaneous acquisition of spectrum data and IQ data.

1.4.11 Reading SWP Stream Disk Data from Application Software

SWPMode_PlayBack.cpp: This can read the recorded file data in SWP mode from Application Software and write the read spectrum data into SWP Mode_Data.txt.

1.4.12 Using GNSS 10MHz Reference Clock

SWP_GNSSReferenceClock.cpp: This uses a high-quality GNSS module's 10MHz reference clock in SWP mode.

1.4.13 External Trigger Mode

SWP_GetSpectrum_Trigger.cpp: This obtains spectrum data when the trigger source is set to external trigger.

1.4.14 Trace Alignment Method

SWP_GetSpectrum_TraceAlign.cpp: Obtain spectrum data when the trace alignment method is set to align to the starting frequency or align to the center frequency.

1.4.15 Number of Spectrum Frames Obtainable within a Certain Time

SWP_Fixedtime_GetFrames.cpp: Loop 50 times to obtain 10 seconds of spectrum data, resulting in the average number of spectrum frames that can be obtained within 10 seconds.

1.4.16 External Trigger Calibration of Internal 10MHz Reference Clock

SWP_GetSpectrum_Calibration.cpp: An example of the device calibrating the clock via GNSS-1PPS or through external trigger.

1.4.17 Phase noise measurement

SWP_Meas_PhaseNoise.cpp: Measuring the single-sideband phase noise (unit: dBc/Hz) of the received signal at the user-specified frequency deviation, supports multi-frequency point configuration.

1.4.18 Channel power measurement

SWP_Meas_ChannelPower.cpp: measures the channel power of the received signal.

1.4.19 Adjacent Channel Power Ratio Measurement

SWP_Meas_ACPR.cpp: measure the adjacent channel power ratio of the received signal.

1.4.20 Percentage occupied bandwidth Measurement

SWP_Meas_OBW.cpp: measures the occupied bandwidth of the received signal in percentage.

1.4.21 XdB Occupied Bandwidth Measurement

SWP_Meas_XdBBW.cpp: measures the occupied bandwidth of the received signal in XdB.

1.4.22 IM3 measurements

SWP_Meas_IM3.cpp: IM3 measurement of the received signal.

1.4.23 Frequency interval matching RBW

SWP_RBW_Spaced_Trace.cpp: makes the frequency interval between two points of the trace close to the set RBW value.

1.4.24 Using an External 10MHz Reference Clock

SWP_RefCLKSource_External.cpp: use external 10MHz reference clock. (Take the use of external 10MHz reference clock in SWP mode as an example, the same method is used in other modes).

1.5 IQS Mode

1.5.1 Obtain Fixed Number or Continuous Stream of IQ Data

IQS_GetIQ_Standard.cpp: Obtain a fixed number or continuous stream of IQ data under professional configuration.

1.5.2 Simplified configuration mode

IQS_GetIQ_EZStandard.cpp: Quickly obtain IQ data using a simplified configuration.

1.5.3 IQ data converted to voltage V units

IQS_ScaleIQDataToVolts.cpp: Converts the acquired IQ data into data in volts (V).

1.5.4 Time taken to issue configuration and acquire IQ

IQS_ConfigandGetIQ_Time.cpp: Obtains the call duration of the IQS_Configuration and IQS_GetIQStream_PM1 functions.

1.5.5 IQ to Spectrum Data

DSP_IQSToSpectrum.cpp: Converts the acquired time-domain IQ data into spectrum data using spectral analysis methods.

1.5.6 IQ to Spectrum (using liquid library version)

IQS_ToSpectrumByLiquid.cpp: Uses the liquid library to convert the acquired time-domain IQ data into spectrum data through spectral analysis methods.

1.5.7 FM Demodulation Playback

DSP_FMDemod.cpp: Performs FM demodulation on the IQ data and plays the demodulated audio.

1.5.8 FM Demodulation Data Analysis

IQS_FMDDataAnalysis.cpp: Audio analysis of the IQ data after FM demodulation to get the audio voltage, audio frequency, SINAD and total harmonic distortion.

1.5.9 AM Demodulation Playback

DSP_AM_Demod.cpp: Performs AM demodulation on IQ data and plays the demodulated audio.

1.5.10 AM Demodulation Data Analysis

IQS_FMDDataAnalysis.cpp: Audio analysis of the IQ data after AM demodulation to get the audio voltage, audio frequency, SINAD and total harmonic distortion.

1.5.11 Digital Downconversion

DSP_DDC.cpp: Resamples the obtained IQ data.

1.5.12 Digital Low-Pass Filter

DSP_LPF.cpp: Perform low-pass filtering on the obtained IQ data.

1.5.13 Audio Analysis

IQS_AudioAnalysis.cpp: Performs audio analysis on the demodulated IQ data to obtain audio voltage, audio frequency, SINAD, and total harmonic distortion.

1.5.14 Read the IQS stream disk data from Application Software

IQSMode_PlayBack.cpp: Parses the recorded file data in IQS mode from Application Software and writes the read spectrum data into the IQSMode_Data.txt file.

1.5.15 Record IQ data in .wav format

IQSMode_Recording.cpp: Stores the acquired IQ data in .wav format.

1.5.16 .wav changed to .csv

IQSMode_WavToCsv.cpp: Parses and extracts I and Q channel data from the .wav recording file data in IQS mode, converting it into a .CSV format file for saving.

1.5.17 Streaming and reading IQ data

IQS_GetIQToTxt.cpp: Writes the obtained IQ data into a .txt file.

1.5.18 Multithreaded acquisition, processing, and streaming of IQ data

IQS_Multithread_GetIQ_FFT_Write: Simultaneously acquires IQ data, performs FFT, and writes IQ data into a .txt file.

1.5.19 GNSS1PPS trigger

IQS_GNSS_1PPS.cpp: Configure the trigger source to be the 1PPS signal provided by the internal GNSS system.

1.5.20 IQS multi-device synchronization

`IQS_MultiDevSync_fixed.cpp`: Multiple devices simultaneously collect the same signal at the same time.

1.5.21 External Trigger

`IQS_ExternalTrigger.cpp`: Configure the trigger source as external trigger.

1.5.22 Timer Trigger

`IQS_TimerTrigger.cpp`: Configure the trigger source as timer trigger.

1.5.23 Level Trigger(pre-trigger)

`IQS_LevelTrigger_PreTriggerr.cpp`: configure the trigger source as level trigger and set the pre-trigger time.

1.5.24 Level Trigger (Trigger delay)

`IQS_LevelTrigger_TriggerDelay.cpp`: configure the trigger source to be level trigger and set the trigger delay time.

1.5.25 Using GNSS 10MHz Reference Clock

`IQS_Enable_GNSS_10MHz.cpp`: Use a high-quality GNSS module's 10MHz reference clock in IQS mode.

1.5.26 Fixed Step Multi-Frequency IQ Data Acquisition

`IQS_SetFreqScan`: Configure the start and end frequencies and frequency points of IQ in advance. After configuring once, the data will be collected sequentially according to the set frequency points.

1.6 DET Mode

1.6.1 Obtain detection data for fixed points or continuous streams.

DETMMode_Standard.cpp: Obtain detection data for fixed points or continuous streams.

1.6.2 Simplified configuration mode

DETMMode_EZStandard.cpp: Quickly obtain detection data through a simplified configuration.

1.6.3 Read the DET stream disk data of Application Software

DETMMode_PlayBack.cpp: Read the recorded files in DET mode from Application Software and output the detection data to the DETMode_Data.txt file.

1.6.4 Pulse detection (to be opened later)

1.7 RTA mode

1.7.1 Obtain real-time spectrum data for fixed points or continuous stream

RTAMode_Standard.cpp: Obtain real-time spectrum data for a fixed number of points (duration) or continuous stream.

1.7.2 Simplified configuration mode

RTAMode_EZStandard.cpp: Quickly obtain real-time spectrum data through simple configuration.

1.7.3 Read the RTA stream disk data of Application Software

RTAMode_PlayBack.cpp: Read the recorded file data in RTA mode from Application

Software, while being able to specify reading a certain packet of data, and write the read spectrum data to the RTAMode_Data.txt file.

1.7.4 Time consumption of each frame of data in RTA mode

RTAMode_Standard_perframe.cpp: Acquire 100 frames of data and calculate the average processing time for each frame.

1.8 ASG Signal Source (optional)

1.8.1 Output single tone/sweep/power scan signals

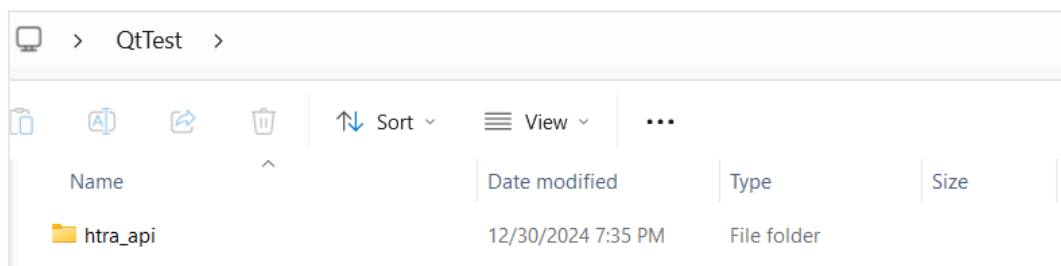
ASG_SignalOutput.cpp: Output single tone/sweep/power scan signals as needed.

2. Digital Demodulation (optional)

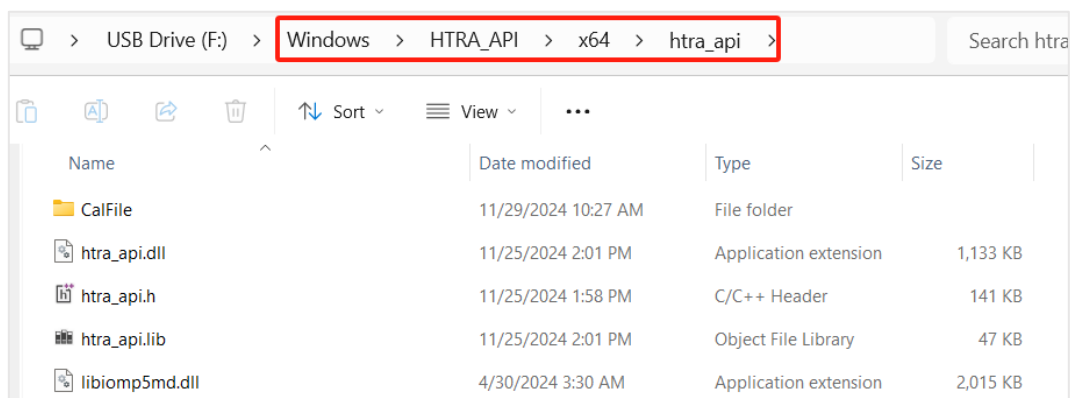
3. Qt

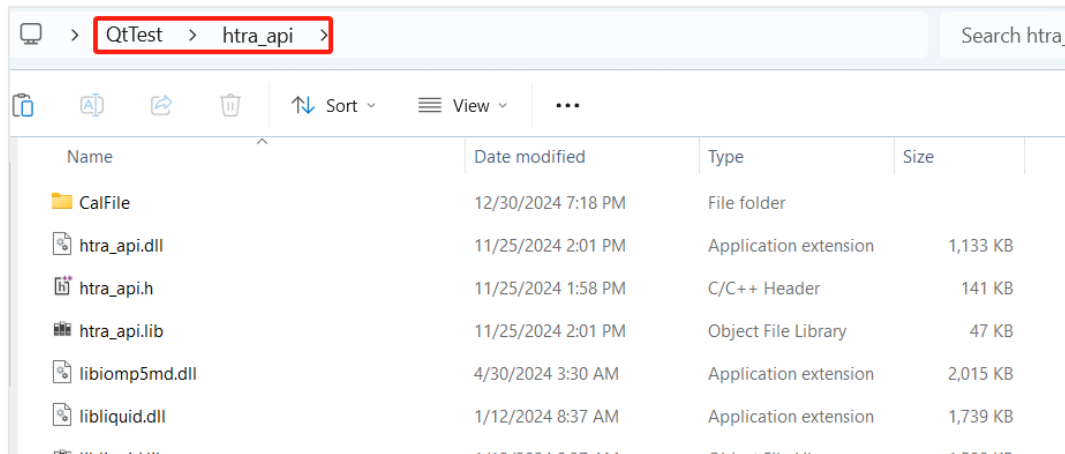
3.1 Configure Development Environment

1. As shown in the figure, first create a new folder to store the entire project (taking QTest as an example, it is recommended not to use a Chinese path), and then create a htra_api folder within the folder to store the dynamic link libraries and calibration files.

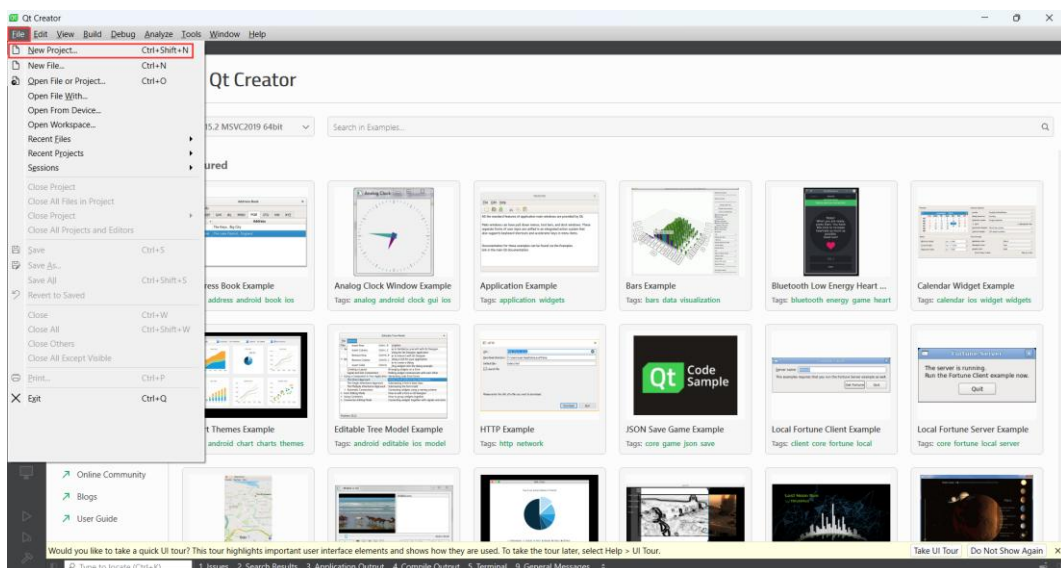


2. Copy all files from the Windows\HTRA_API\x64\htra_api folder on the USB drive to the newly created QTest\htra_api folder (taking the x64 architecture program as an example; for the x86 architecture program, simply copy the corresponding architecture's libraries).

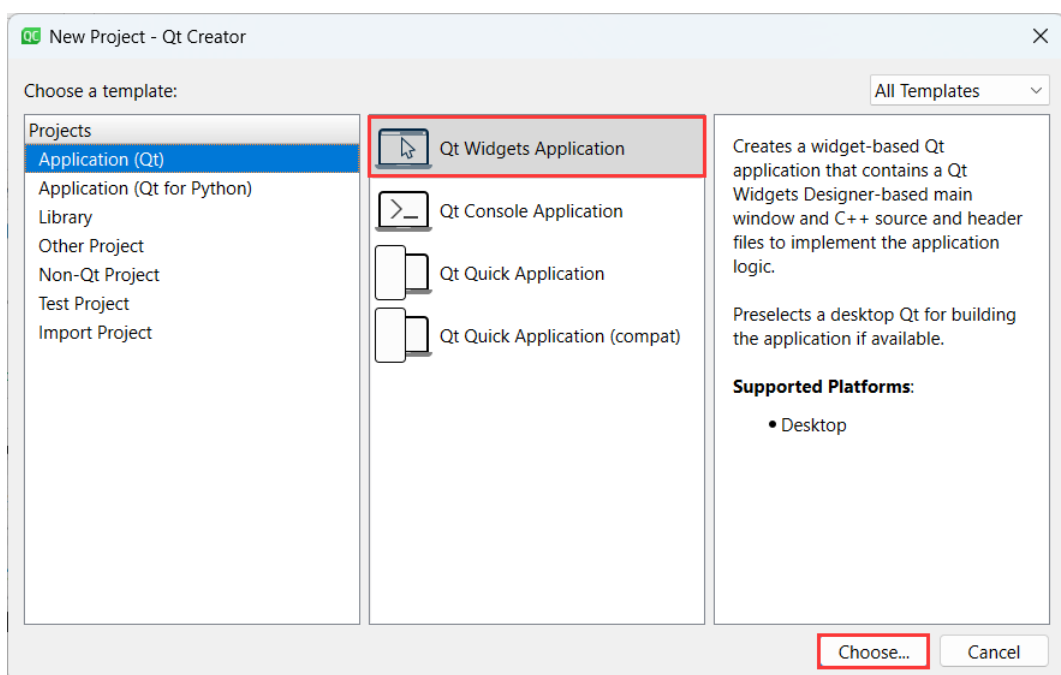




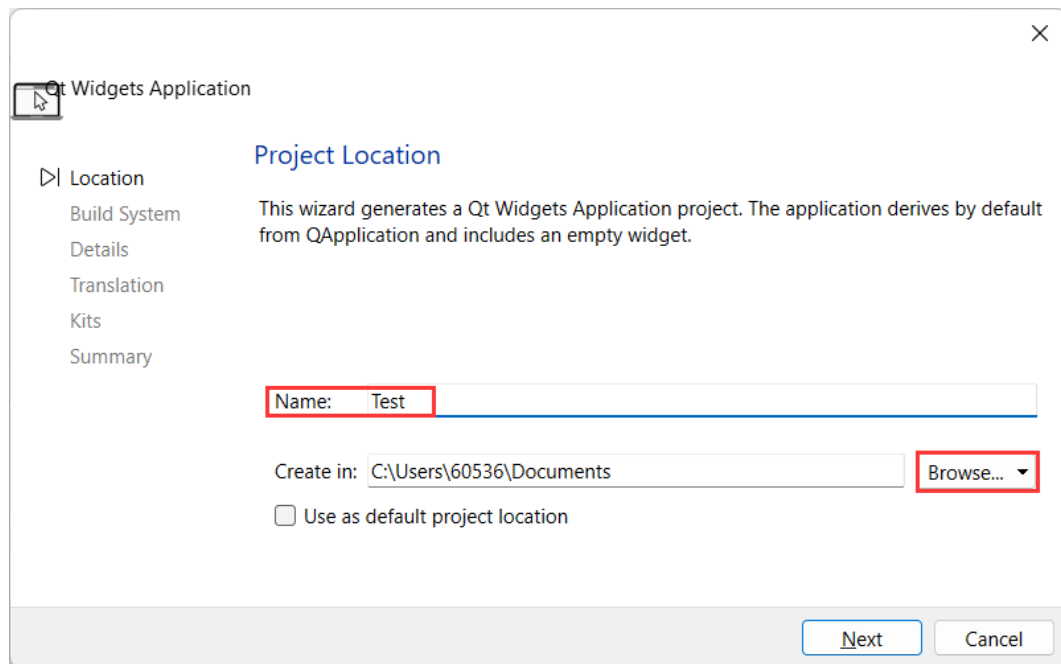
3. Open Qt Creator, click on File, and select New File or Project.



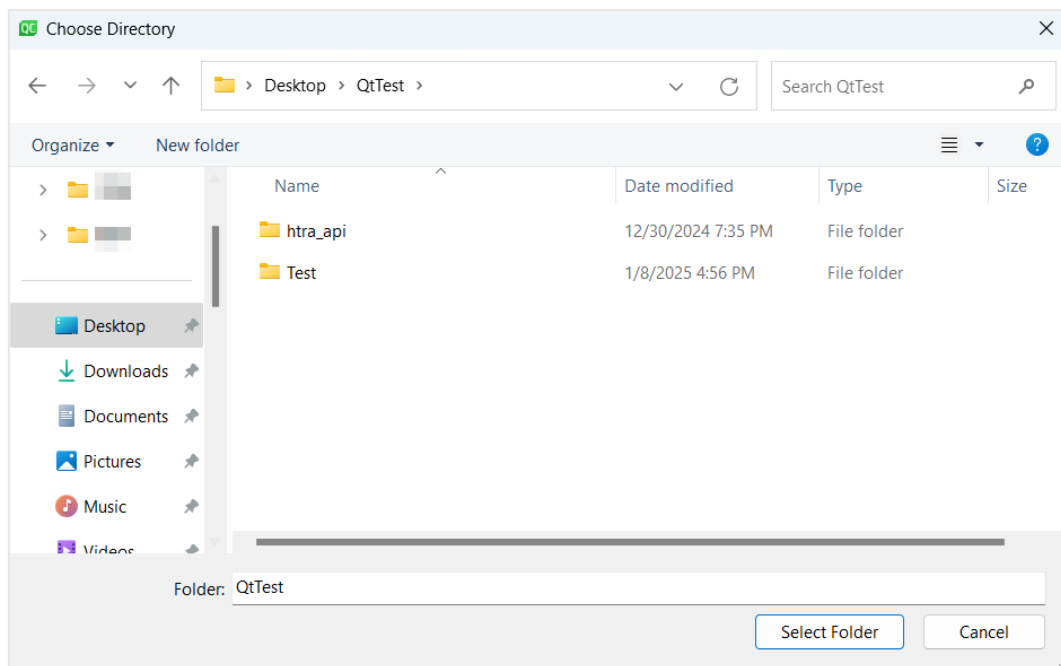
4. Select Create Form Application.



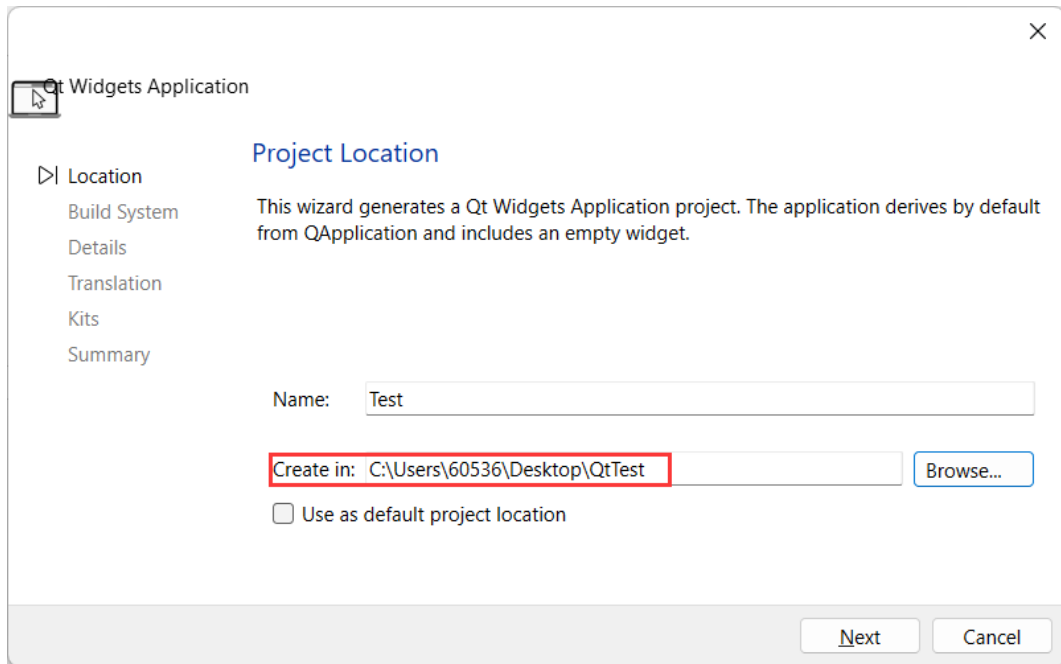
5. After filling in the project name, click Browse to change the project path.



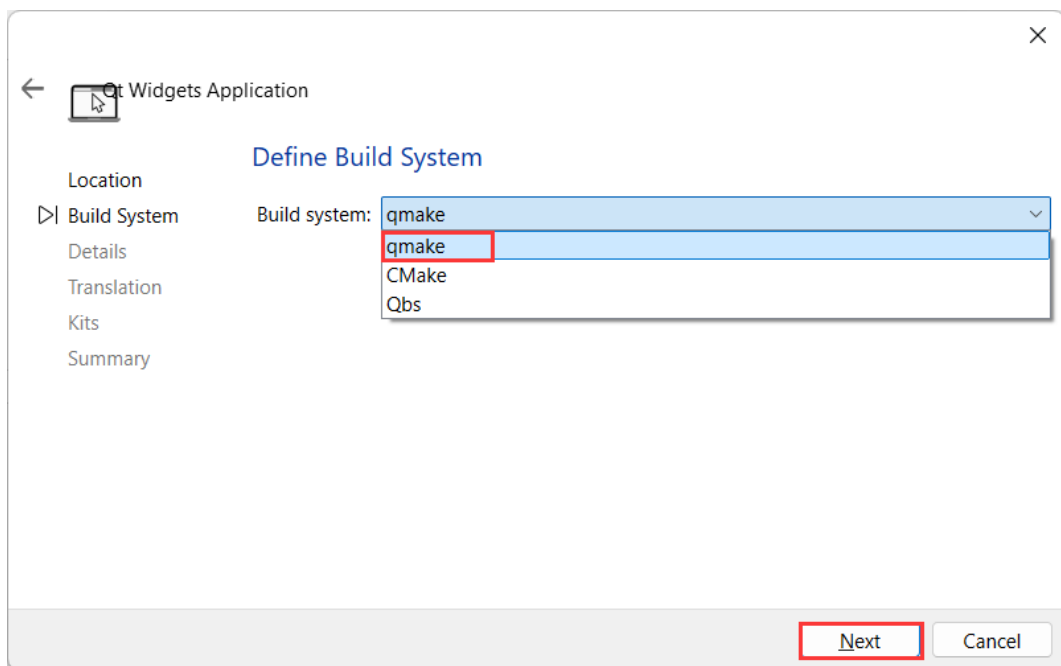
6. Select the directory as the QTest address created in the first step and click Open.



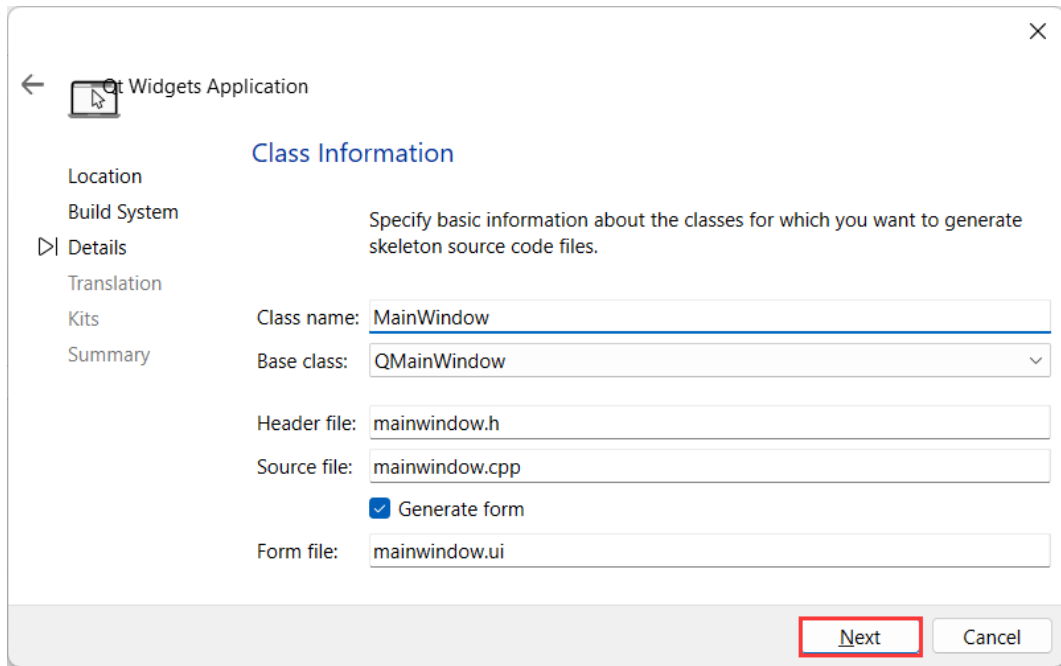
7. After selecting the path, click Next.



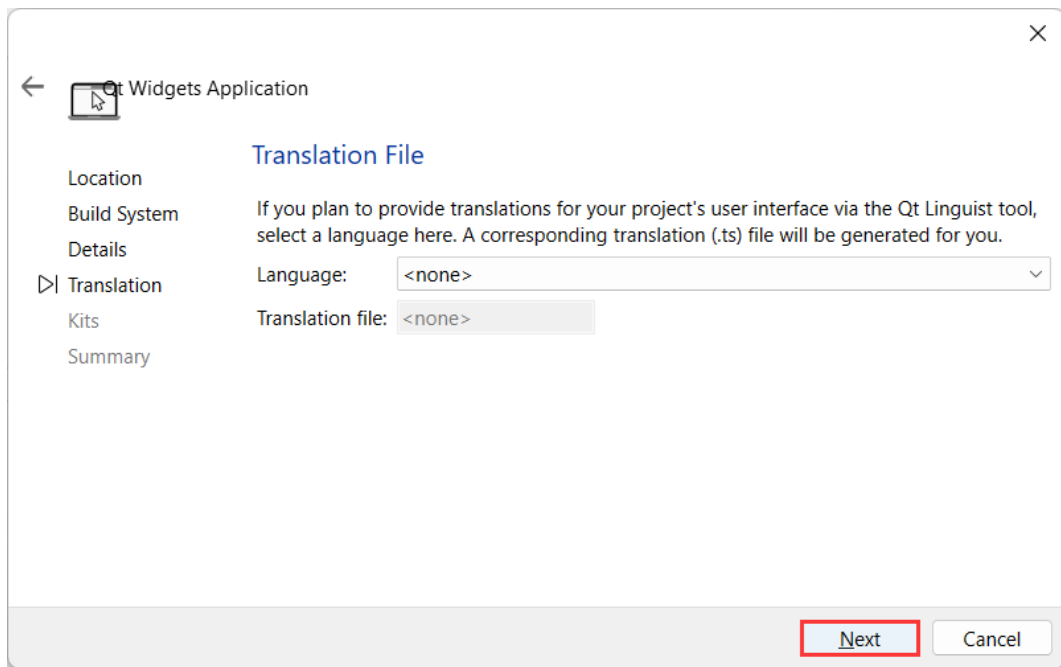
8. Select qmake and click Next to continue.



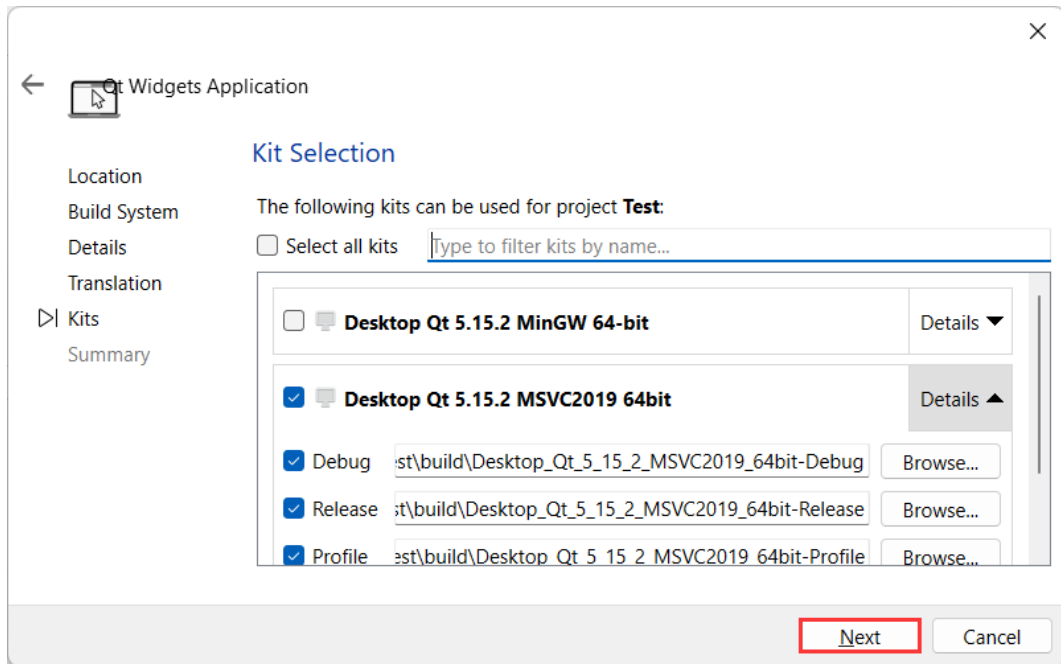
9. Click Next to continue.



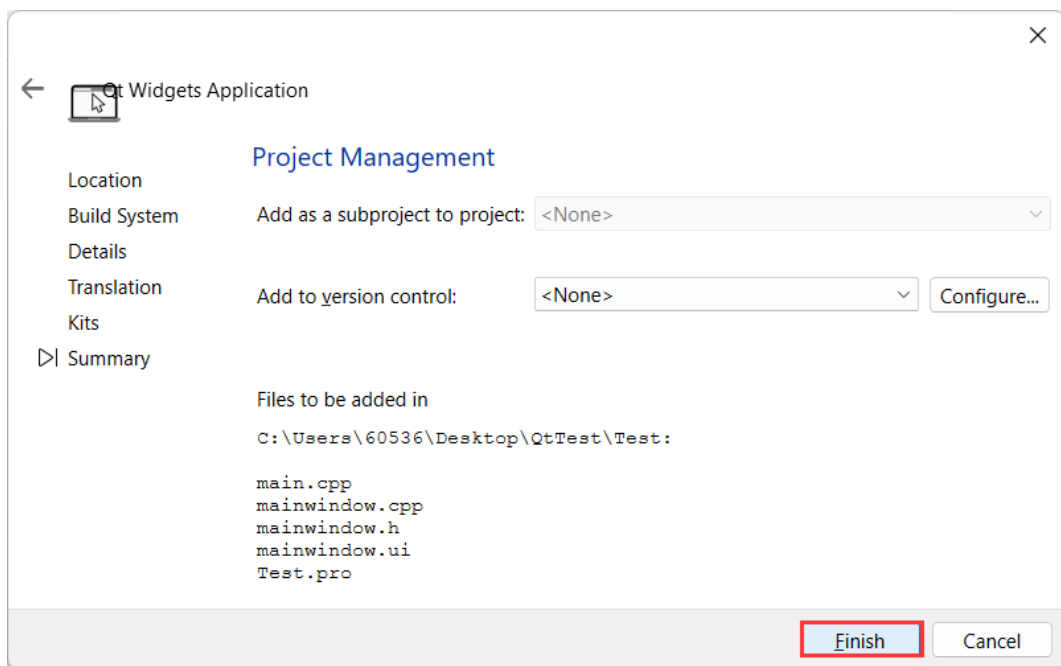
10. Click Next to continue.



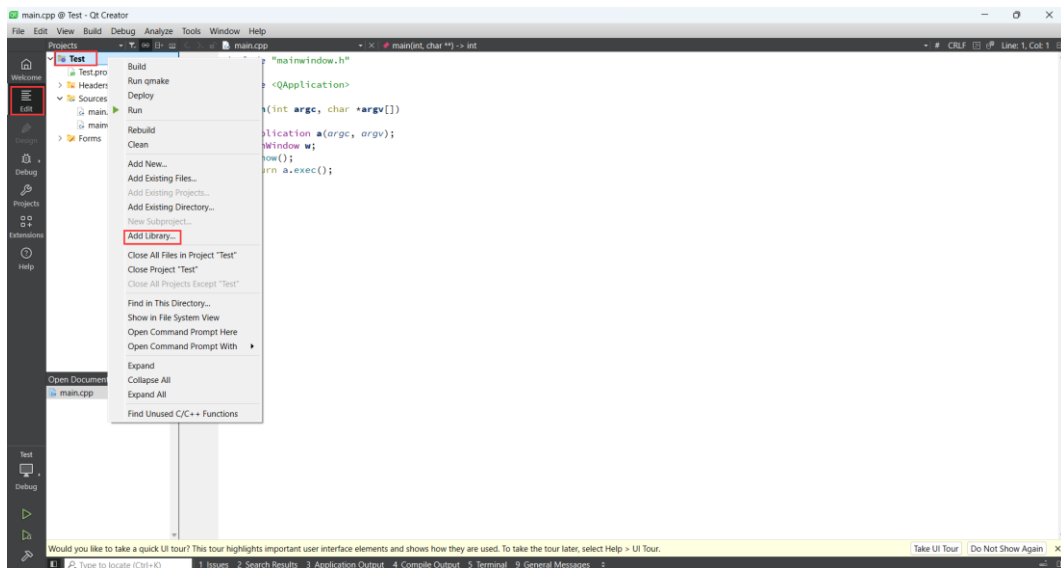
11. Select a build environment for the project and click Next to continue.



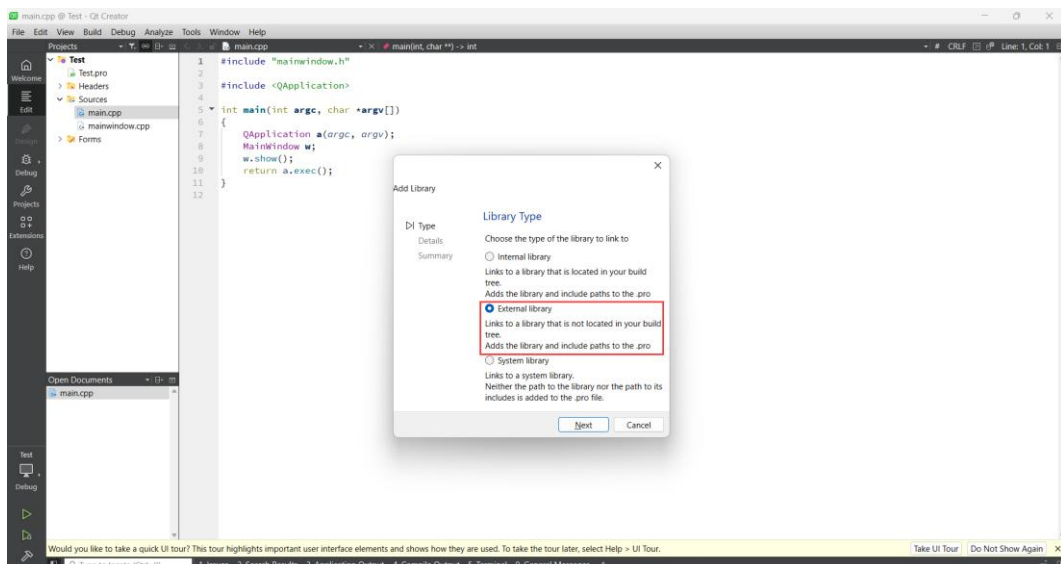
12. Click Finish to create the project.



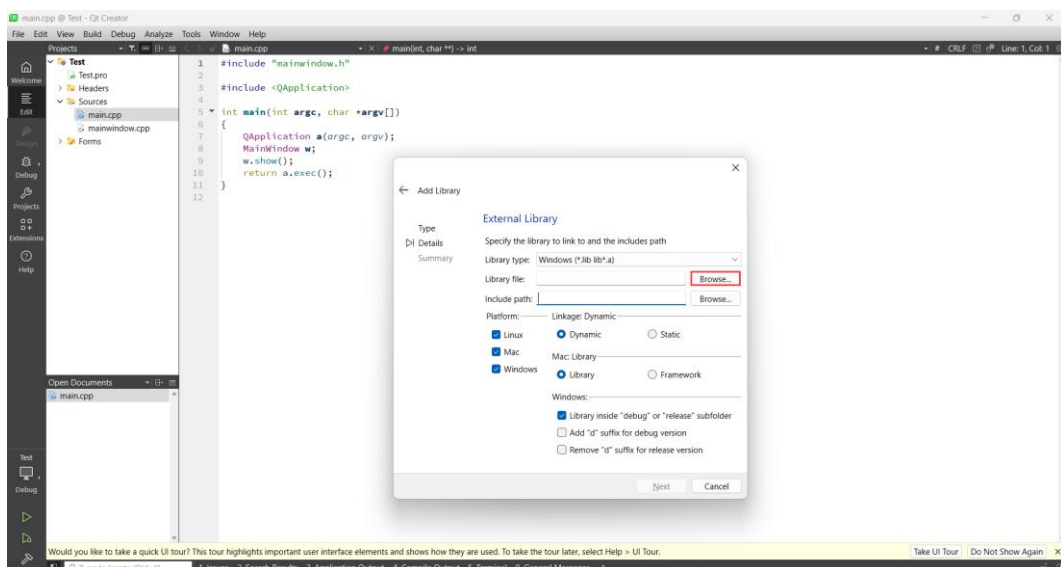
13. Click Edit, right-click the Test project, and click Add Library.



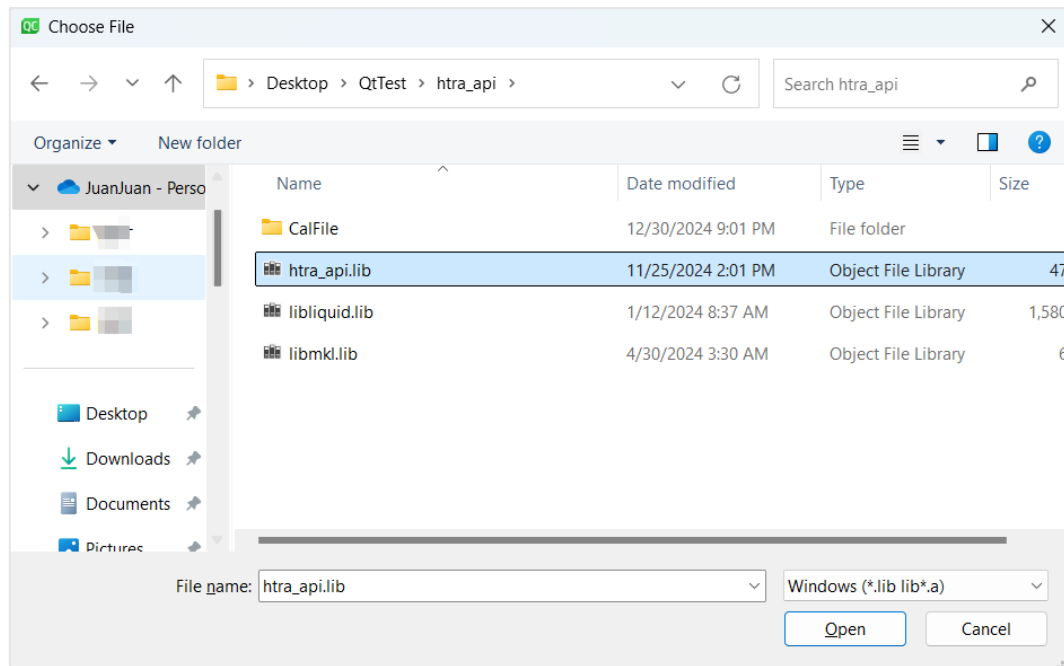
14. Select External Library and click Next.



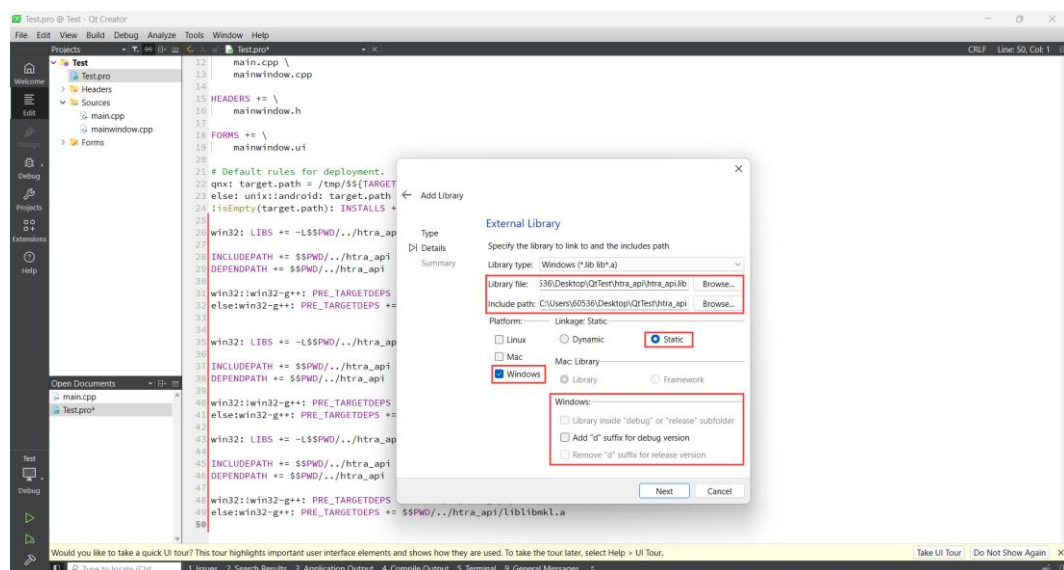
15. Click Browse Library File.



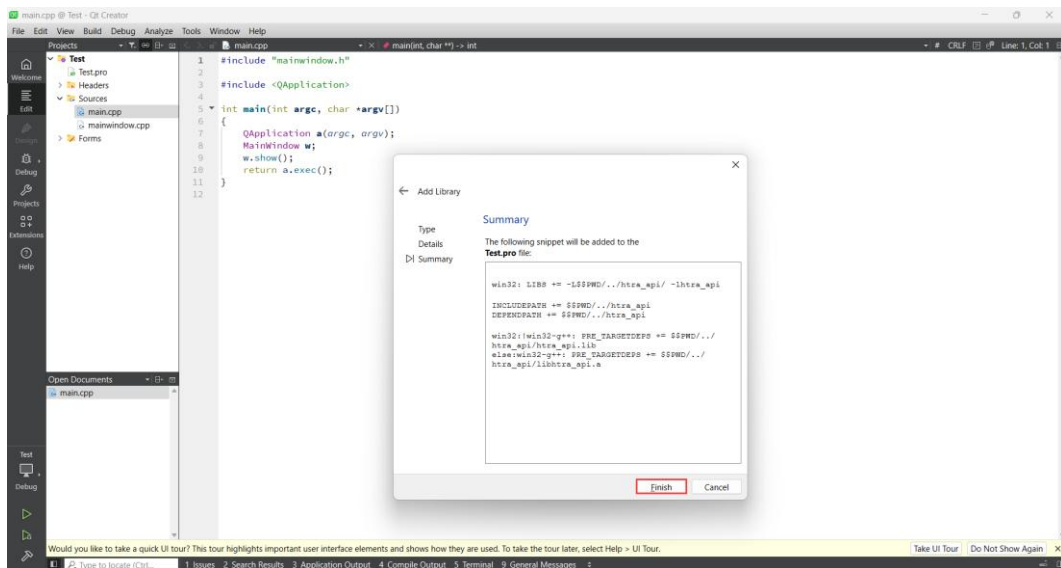
16. Select the htra_api.lib library in QTest\htra_api and click Open.



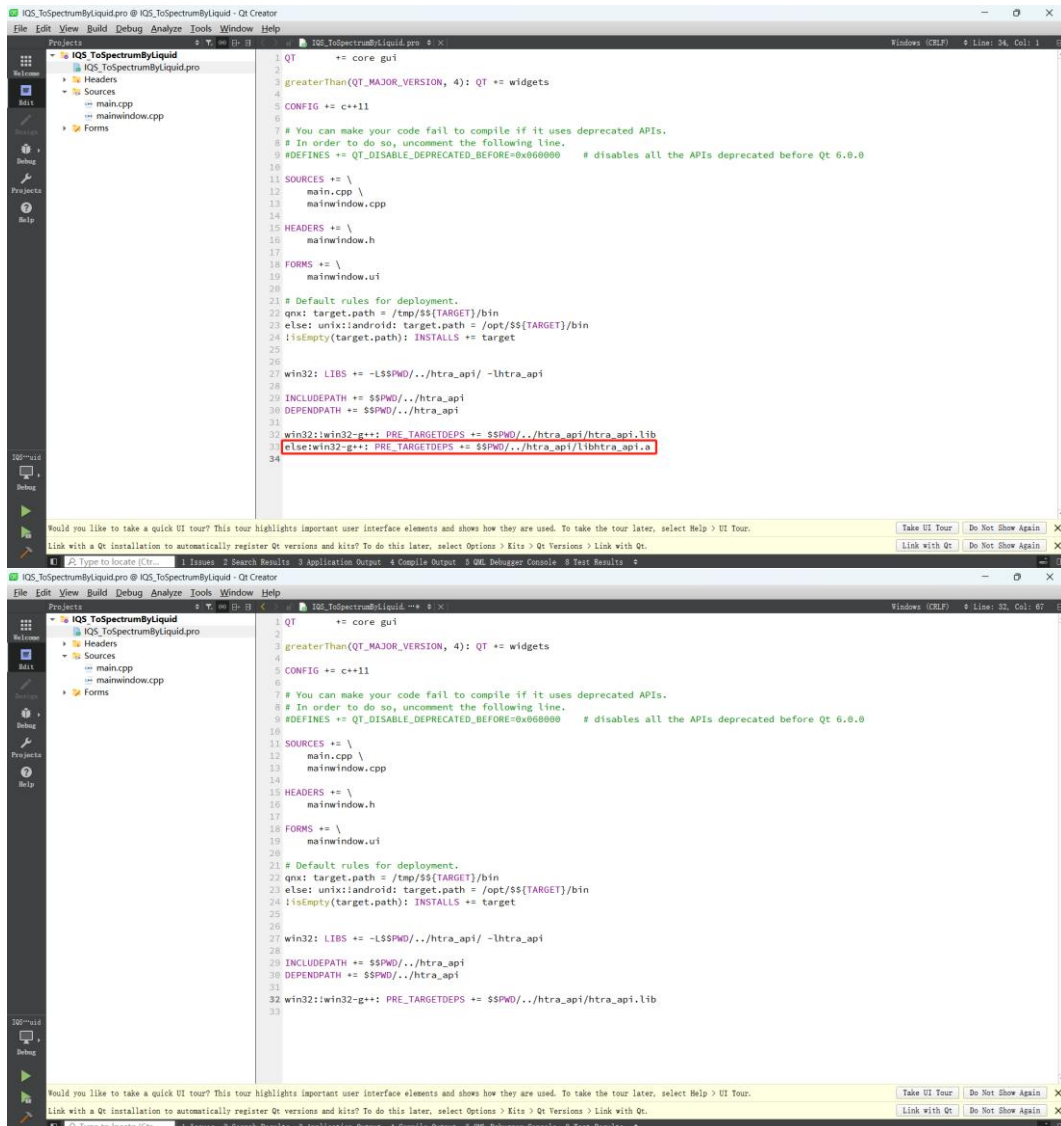
17. Uncheck all options in Windows, click on Static Library, select the Windows platform, and click Next.



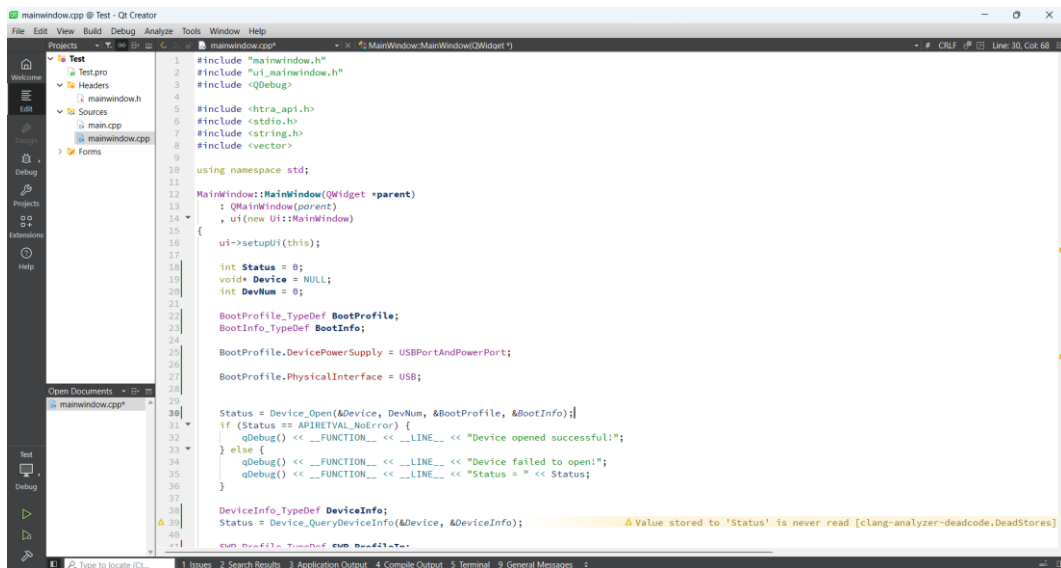
18. Click Finish to add the external library.



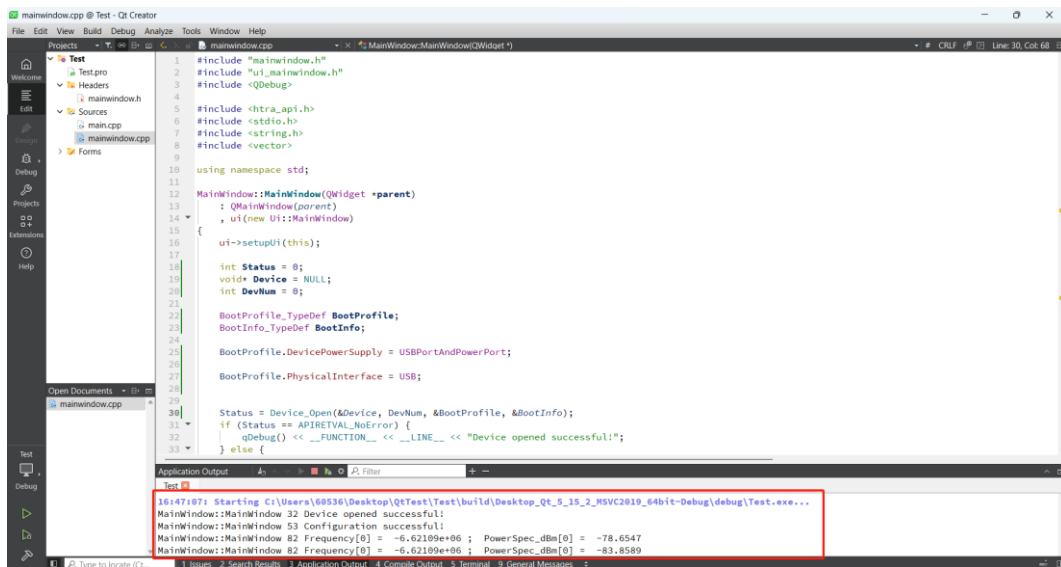
19. Delete the last line "else: win32-g++: PRE_TARGETDEPS+=\$\$PWD/..
/htra_api/libhtra_api.a".



20. Save the Test.pro file, and then you can write the code normally.



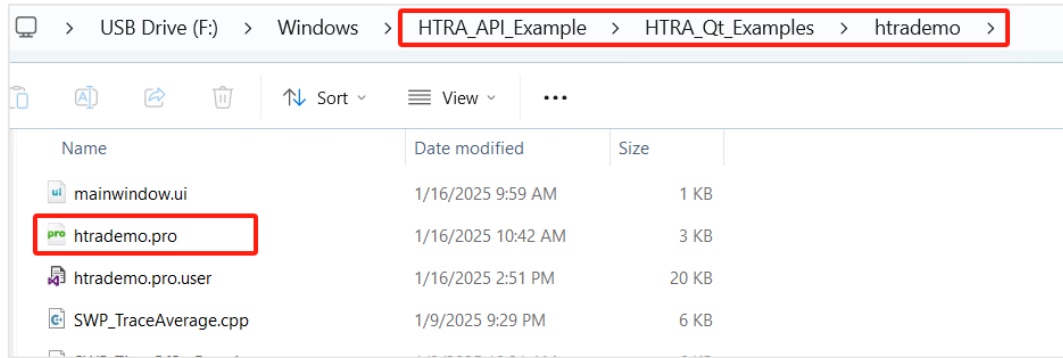
21. After writing the code, click Run. The device should function normally as shown in the figure.



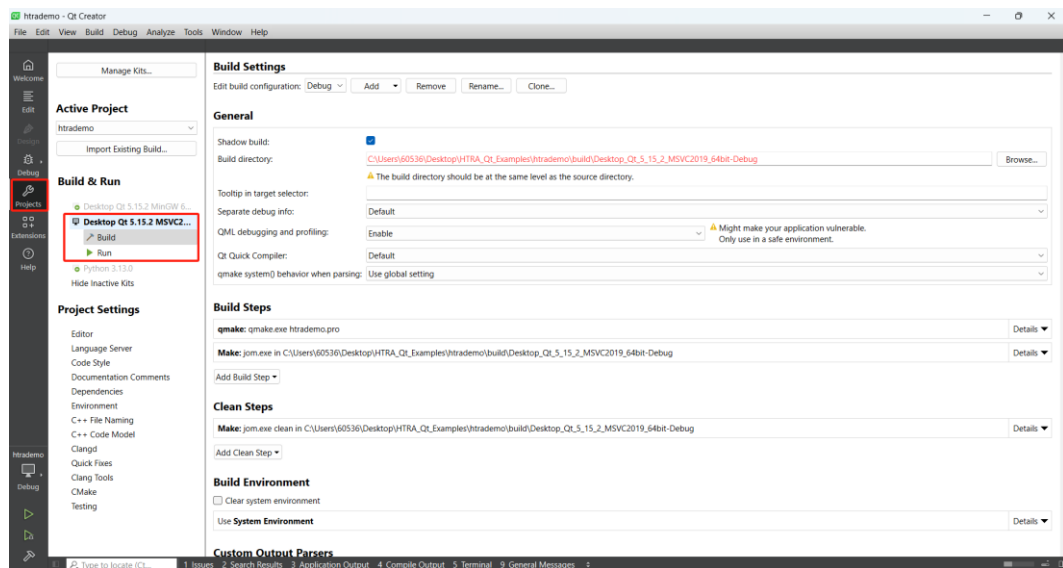
3.2 Qt Example Usage Process

The usage process for the Qt examples included in the USB drive is as follows:

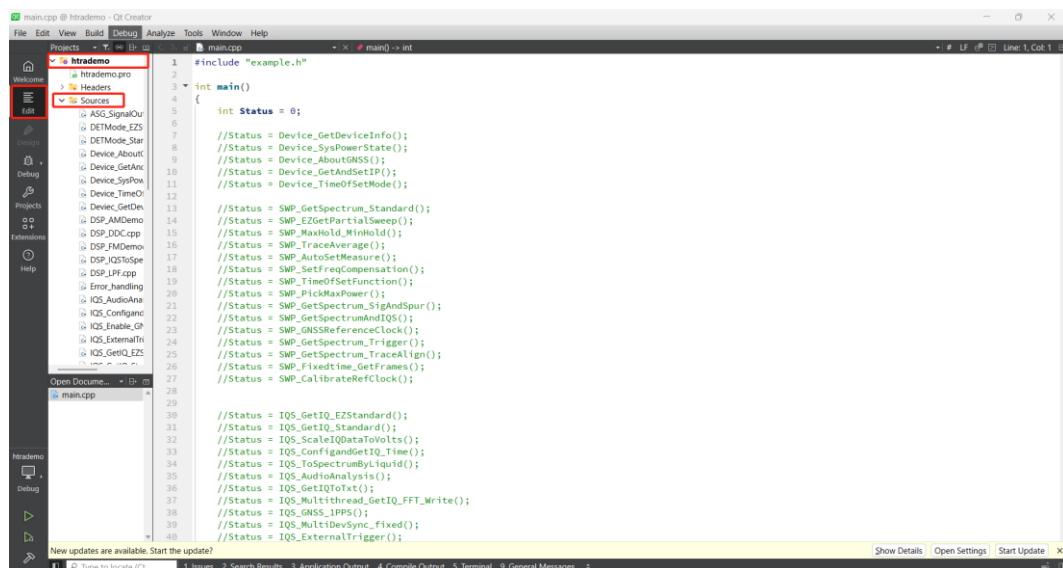
1. As shown in the figure, use Qt Creator to open the htrdemo.pro file located in the Windows\HTRA_API_Example\HTRA_Qt_Examples\htrdemo folder on the USB drive (please ensure the project path does not contain Chinese characters).



- Click on the project to configure a build environment for it.

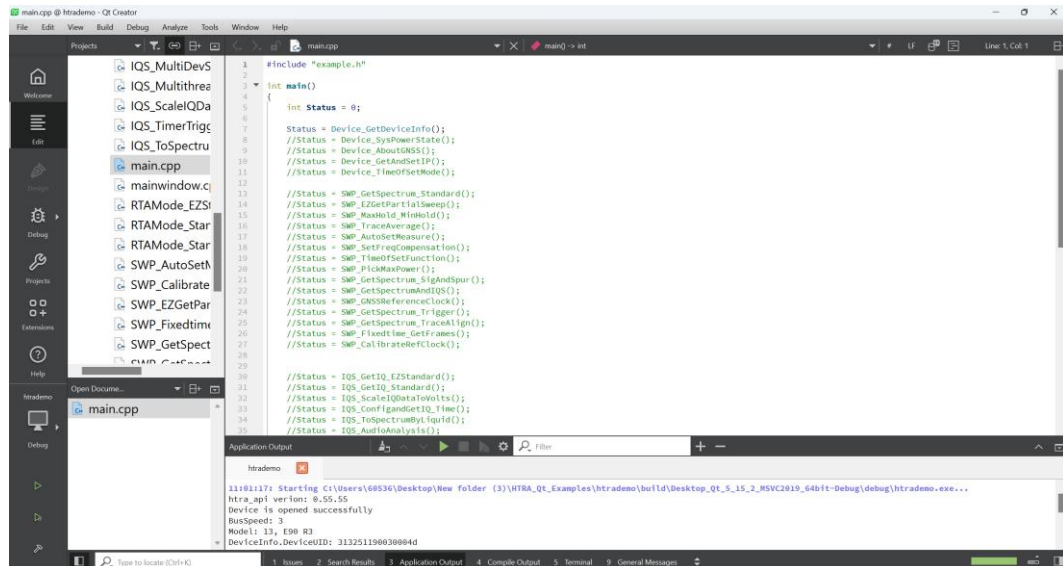


- After configuring the build environment, click on Edit, and then click on main.cpp in the Sources folder of the htrdemo project.



- Since each example in the Qt provided examples is encapsulated in a separate function, you can simply uncomment the desired example when using it (multiple

examples cannot be used simultaneously). For instance, when testing the Device_GetDeviceInfo example, uncomment it, save, and click run. The image shown indicates that the device is operating normally.



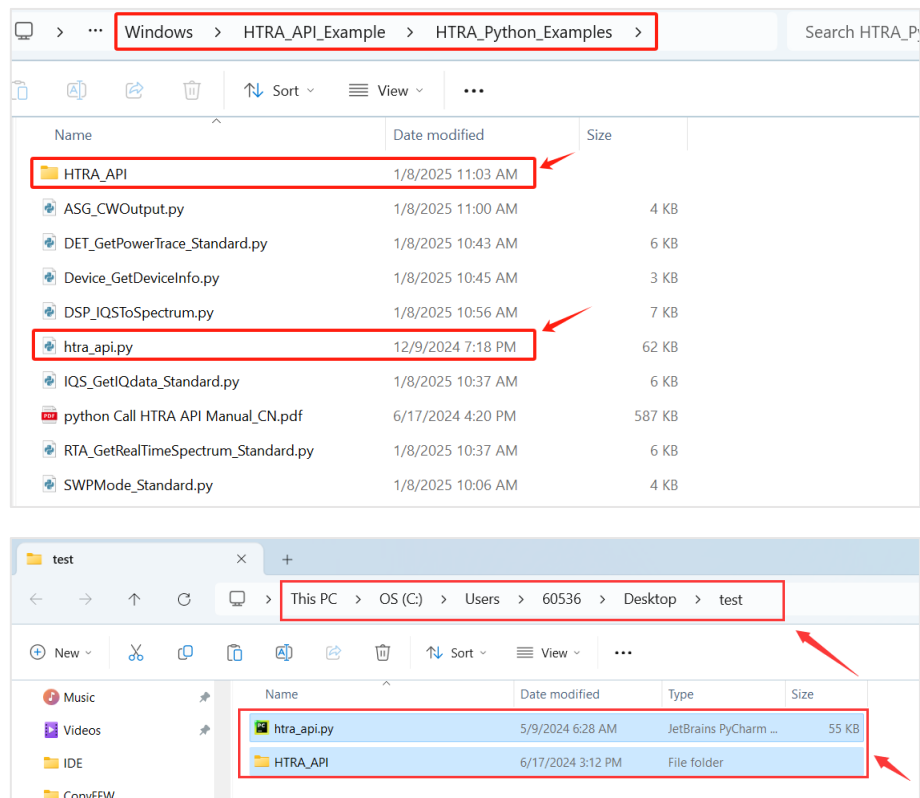
3.3 Qt Example Description

The Qt examples on the USB stick include a general example (HTRA_Qt_Example), an FM and AM demodulation example (HTRA_Demodulation), and an IQ to Spectrum example (IQS_ToSpectrumBuLiquid) using the Liquid library, refer to the C/C++ examples chapter for specific examples.

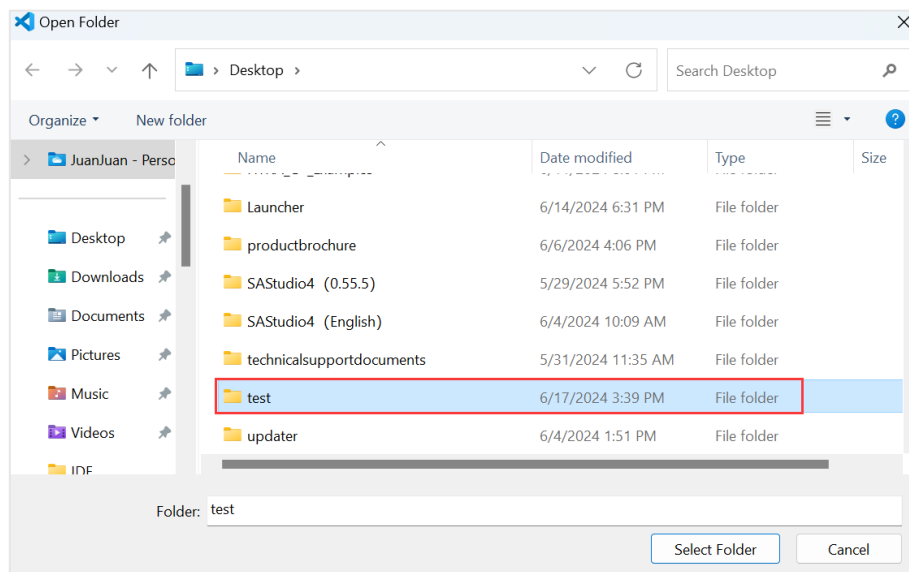
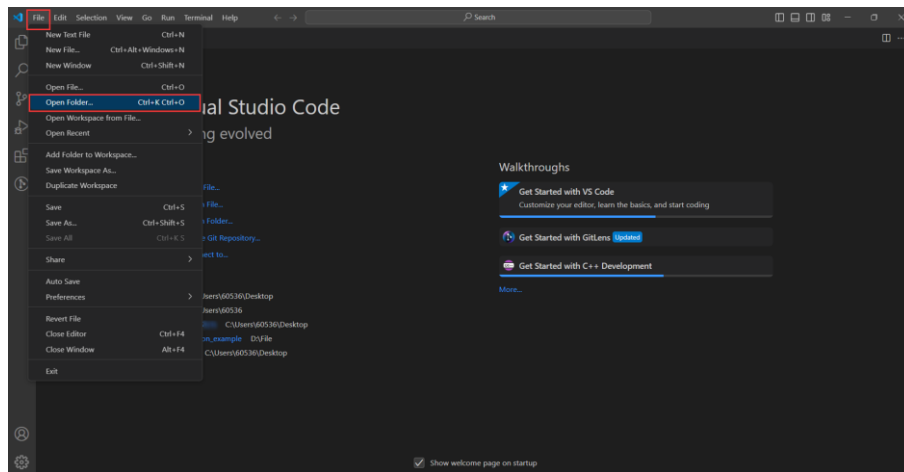
4. Python

4.1 Configure Development Environment

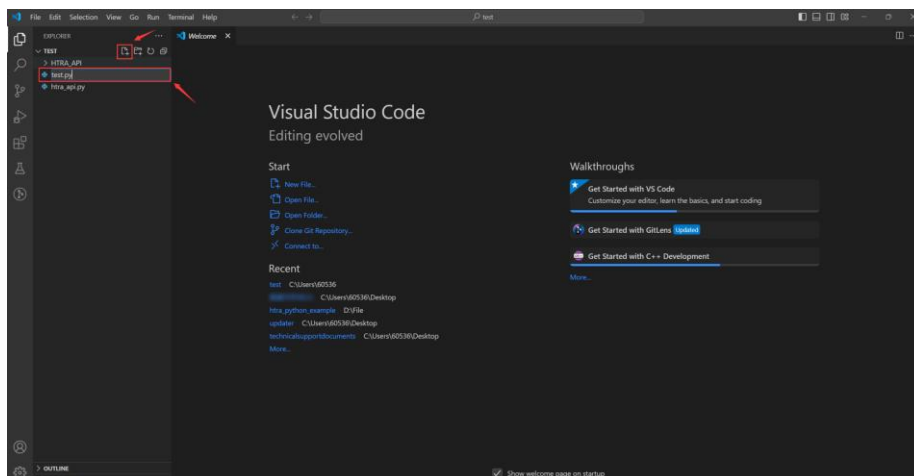
1. Create a folder on the desktop and name it, for example, test. Open the USB drive and copy the "HTRA_API" folder and "htra_api.py" file from "\\Windows\\HTRA_API_Example\\HTRA_Python_Examples" on the USB drive to the newly created folder.



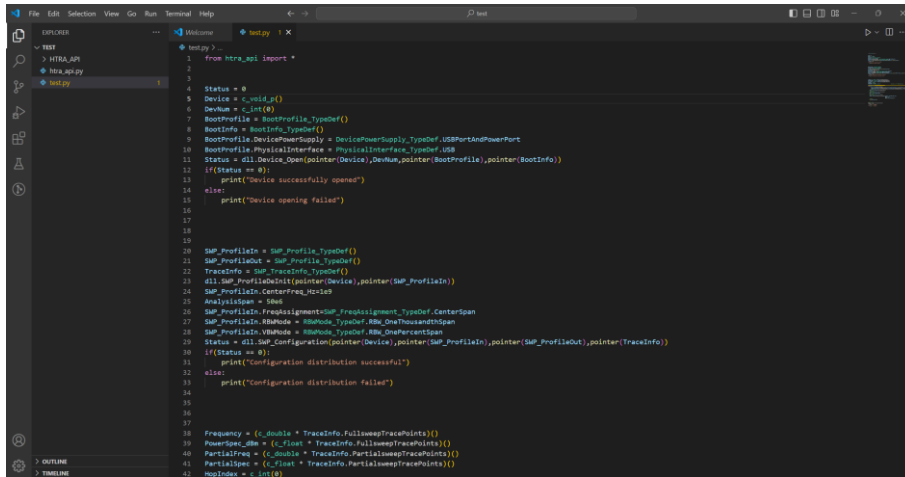
2. Open Visual Studio Code, click on File and then Open Folder, and open the folder you just created.



3. Create a new Python file.



4. Write code normally. You can refer to the Python examples included in the USB drive, specifically in the folder
 "\\Windows\\HTRA_API_Example\\HTRA_Python_Examples" for the project.

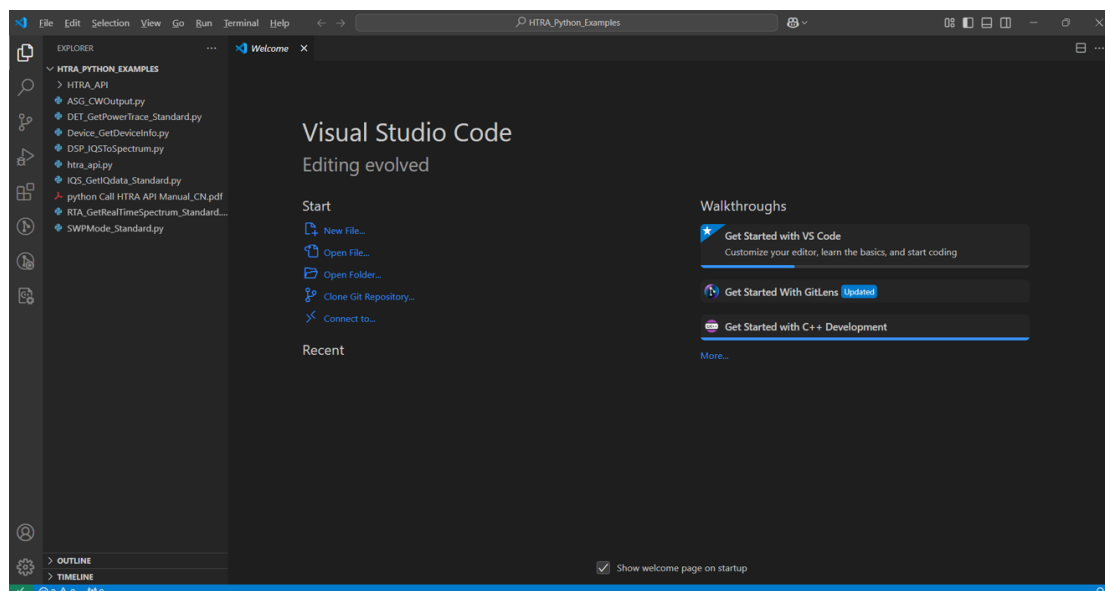


4.2 Python Example Usage Process

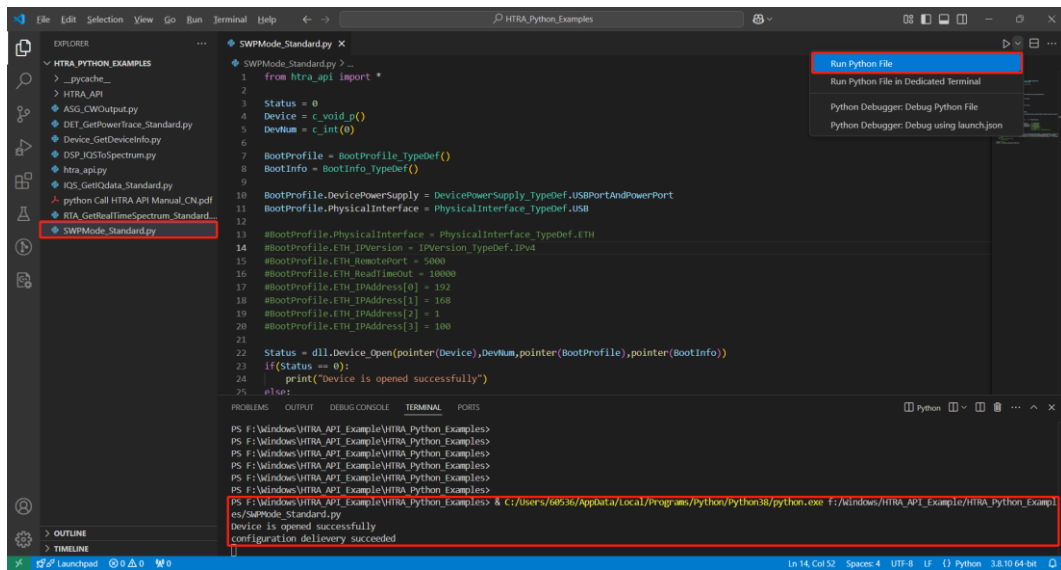
The usage process of the Python examples included in the USB drive is as follows:

1. As shown in the figure, open the entire project using vscode or another compiler from the USB drive provided:

Windows\HTRA_API_Example\HTRA_Python_Examples. The htra_api.py file in the project is the mapping file for the dynamic link library in Python, while the other files are example programs (the role of the examples will be described in subsequent chapters).



2. Select any example program, configure the Python environment for it, and run the program directly. For instance, when using the SWPMode_Standard.py example, the device is shown to be operating normally as illustrated.



4.3 Python Example Description

4.3.1 Get device information

Device_GetDeviceInfo.py: Retrieves various device information, including API version, USB version, device model, device UID, MCU version, FPGA version, and device temperature.

4.3.2 Obtain Standard Spectrum Data

SWP_GetSpectrum_Standard.py: Obtains complete spectrum data within a specified frequency band (Plotting the spectrum if the host computer includes the matplotlib library).

4.3.3 Obtain IQ Data for a Fixed Number of Points or Duration

IQS_GetIQdata_Standard.py: Obtains IQ data under different trigger modes in IQS mode.

4.3.4 Obtain Power Detection Data for a Fixed Number of Points or Duration

DET_GetPowerTrace_Standard.py: Obtains power detection data under different

trigger modes in DET mode (Plotting the Time-power graph if the host computer includes the matplotlib library).

4.3.5 Obtain real-time spectrum data for a fixed number of points or duration

RTA_GetRealTimeSpectrum_Standard.py: Obtain real-time spectrum data under different trigger modes in RTA mode.

4.3.6 IQ to Spectrum Data

DSP_IQSToSpectrum.py: Convert the IQ data obtained in IQS mode into spectrum data (If the host computer contains the matplotlib library then plot the spectrum and IQ time-domain graphs).

4.3.7 GNSS Related

Device_AboutGNSS.py: Obtain information such as longitude, latitude, altitude, and time acquired by the GNSS module; obtain the longitude, latitude, and time information from the MeasAuxInfo structure in IQS mode.

5. Matlab

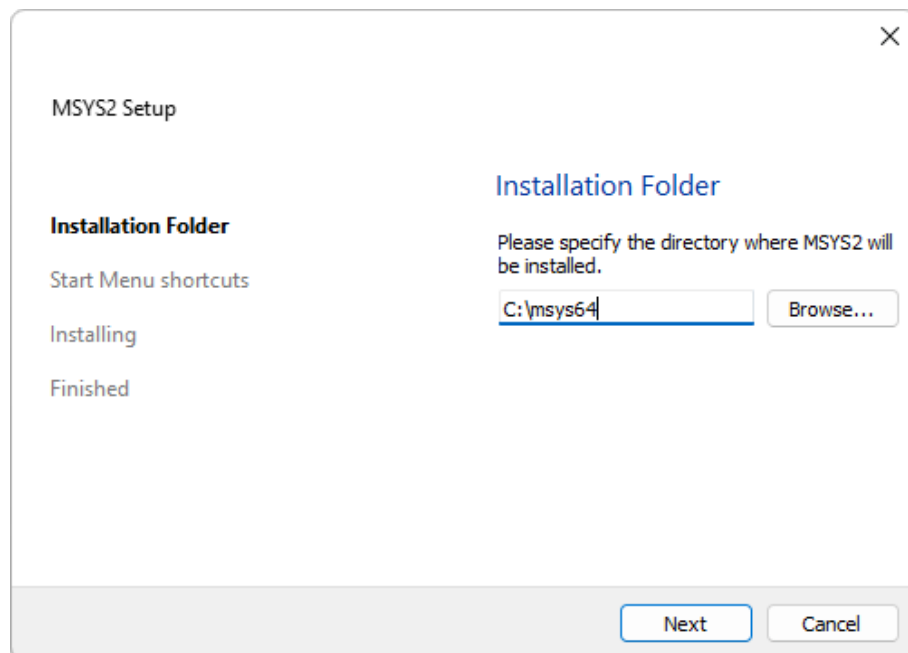
5.1 Configure Development Environment

The method of calling htra_api in 32-bit is basically the same as in 64-bit, so the following tutorial uses Matlab 2016a as an example to illustrate how to call the 64-bit htra_api.

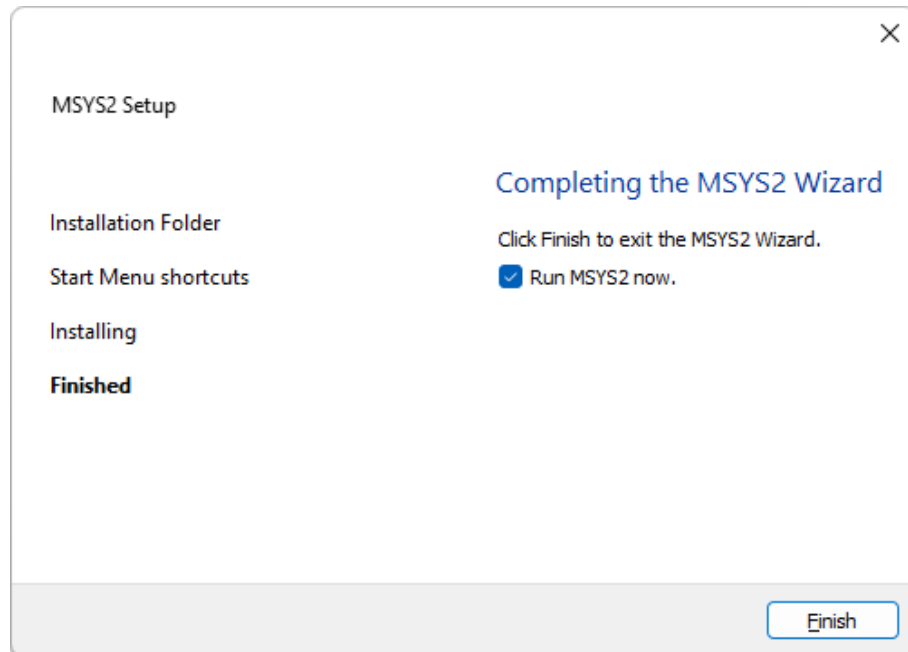
5.1.1 Install MSYS2

Download and installation link: <https://www.msys2.org/>

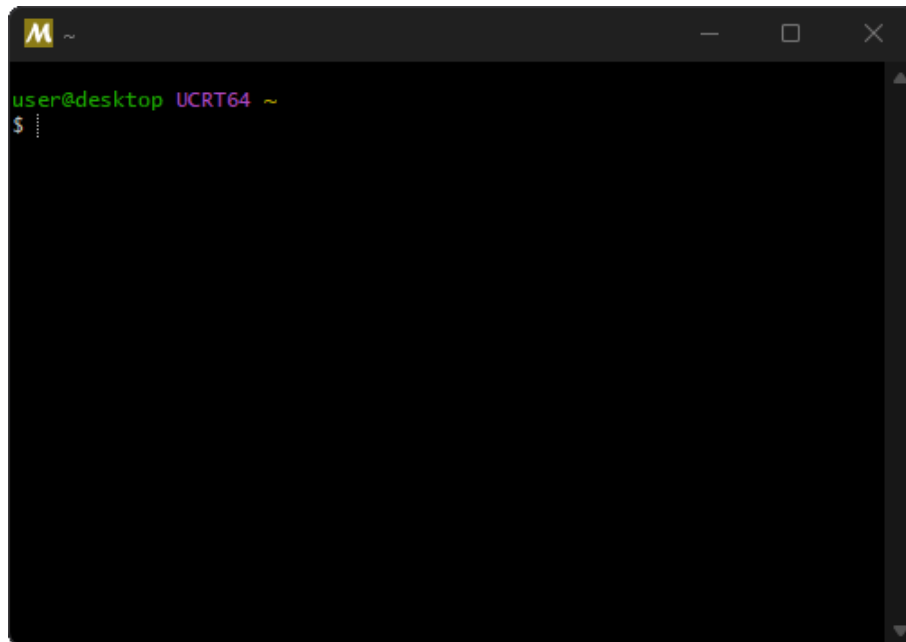
1. Download the installer MSYS2-x86_64-20231026.exe
2. Run the installer. MSYS2 requires 64-bit Windows 8.1 or higher.
3. The default installation path is C:\msys64, but you can choose a different path as needed.



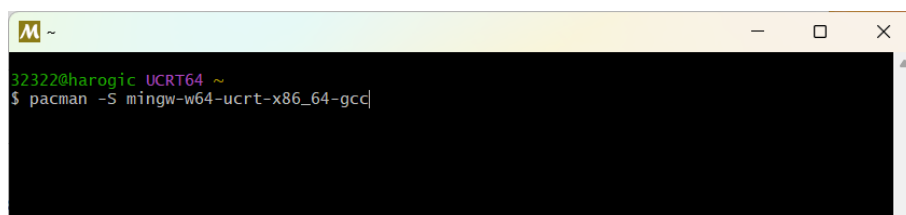
4. Once completed, click Finish.



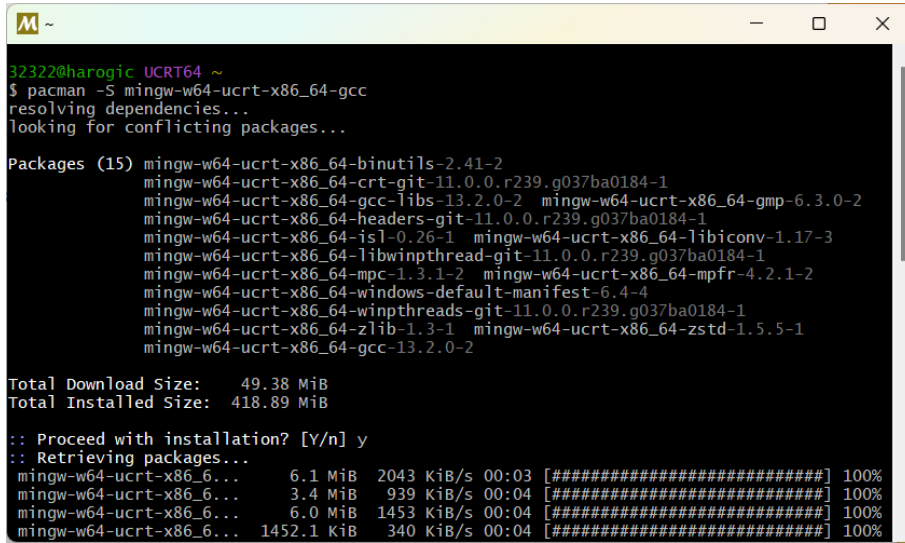
5. Now, MSYS2 is ready, and the terminal for the UCRT64 environment has started.



6. To install the GCC tools, enter the command: `pacman -S mingw-w64-ucrt-x86_64-gcc`



- The terminal window will display the following output. Press "Enter" to continue.



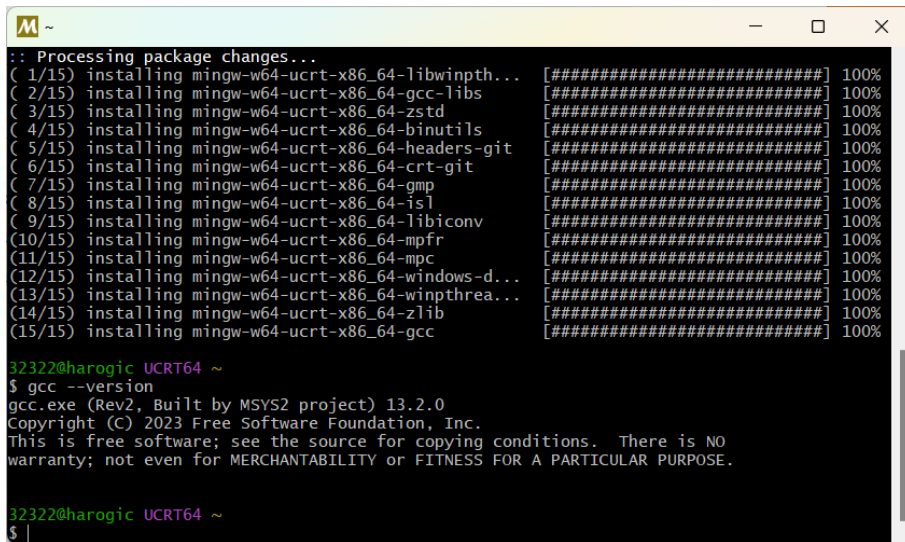
```
32322@harogic UCRT64 ~
$ pacman -S mingw-w64-ucrt-x86_64-gcc
resolving dependencies...
looking for conflicting packages...

Packages (15) mingw-w64-ucrt-x86_64-binutils-2.41-2
               mingw-w64-ucrt-x86_64-crt-git-11.0.0.r239.g037ba0184-1
               mingw-w64-ucrt-x86_64-gcc-libs-13.2.0-2 mingw-w64-ucrt-x86_64-gmp-6.3.0-2
               mingw-w64-ucrt-x86_64-headers-git-11.0.0.r239.g037ba0184-1
               mingw-w64-ucrt-x86_64-isl-0.26-1 mingw-w64-ucrt-x86_64-libiconv-1.17-3
               mingw-w64-ucrt-x86_64-libwinpthread-git-11.0.0.r239.g037ba0184-1
               mingw-w64-ucrt-x86_64-mpc-1.3.1-2 mingw-w64-ucrt-x86_64-mpfr-4.2.1-2
               mingw-w64-ucrt-x86_64-windows-default-manifest-6.4-4
               mingw-w64-ucrt-x86_64-winthreads-git-11.0.0.r239.g037ba0184-1
               mingw-w64-ucrt-x86_64-zlib-1.3-1 mingw-w64-ucrt-x86_64-zstd-1.5.5-1
               mingw-w64-ucrt-x86_64-gcc-13.2.0-2

Total Download Size: 49.38 MiB
Total Installed Size: 418.89 MiB

:: Proceed with installation? [Y/n] y
:: Retrieving packages...
mingw-w64-ucrt-x86_6... 6.1 MiB 2043 KiB/s 00:03 [#####] 100%
mingw-w64-ucrt-x86_6... 3.4 MiB 939 KiB/s 00:04 [#####] 100%
mingw-w64-ucrt-x86_6... 6.0 MiB 1453 KiB/s 00:04 [#####] 100%
mingw-w64-ucrt-x86_6... 1452.1 KiB 340 KiB/s 00:04 [#####] 100%
```

- Enter the command `gcc --version` to check the version information of GCC.



```
32322@harogic UCRT64 ~
:: Processing package changes...
( 1/15) installing mingw-w64-ucrt-x86_64-libwinpth... [#####] 100%
( 2/15) installing mingw-w64-ucrt-x86_64-gcc-libs [#####] 100%
( 3/15) installing mingw-w64-ucrt-x86_64-zstd [#####] 100%
( 4/15) installing mingw-w64-ucrt-x86_64-binutils [#####] 100%
( 5/15) installing mingw-w64-ucrt-x86_64-headers-git [#####] 100%
( 6/15) installing mingw-w64-ucrt-x86_64-crt-git [#####] 100%
( 7/15) installing mingw-w64-ucrt-x86_64-gmp [#####] 100%
( 8/15) installing mingw-w64-ucrt-x86_64-isl [#####] 100%
( 9/15) installing mingw-w64-ucrt-x86_64-libiconv [#####] 100%
(10/15) installing mingw-w64-ucrt-x86_64-mpfr [#####] 100%
(11/15) installing mingw-w64-ucrt-x86_64-mpc [#####] 100%
(12/15) installing mingw-w64-ucrt-x86_64-windows-d... [#####] 100%
(13/15) installing mingw-w64-ucrt-x86_64-winpthrea... [#####] 100%
(14/15) installing mingw-w64-ucrt-x86_64-zlib [#####] 100%
(15/15) installing mingw-w64-ucrt-x86_64-gcc [#####] 100%

32322@harogic UCRT64 ~
$ gcc --version
gcc.exe (Rev2, Built by MSYS2 project) 13.2.0
Copyright (C) 2023 Free Software Foundation, Inc.
This is free software; see the source for copying conditions. There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

32322@harogic UCRT64 ~
$ |
```

5.1.2 Configure Matlab

- Solve the case of Matlab 2016a opening .m file with Chinese garbled code.

Note: If you are using a version of Matlab higher than 2019a, ignore this step.

- View the current coding format:

At the Matlab command line type: `feature('locale')`

```
Command Window

>> feature('locale')

ans =

    ctype: 'zh_CN.GBK'
   collate: 'zh_CN.GBK'
      time: 'zh_CN.GBK'
   numeric: 'en_US_POSIX.GBK'
  monetary: 'zh_CN.GBK'
  messages: 'en_US.GBK'
   encoding: 'GBK'
terminalEncoding: 'GBK'
   jvmEncoding: 'GBK'
      status: 'MathWorks locale management system initialized.'
      warning: ''

fx >> |
```

As you can see from the figure, the encoding format is GBK.

- 2) Right-click on the Matlab2016a shortcut and select "Open File Location" to open the folder where Matlab.exe is located.
- 3) In the folder shown in step (2), find lclata.xml and lclata_utf8.xml, rename lclata.xml to lclata_old.xml, i.e., backup the original lclata.xml.
- 4) Make a copy of lclata_utf8.xml and put it in the same level folder, and rename the newly copied file lclata_utf8.xml to lclata.xml.
- 5) Open lclata.xml and delete the GBK related code shown below.

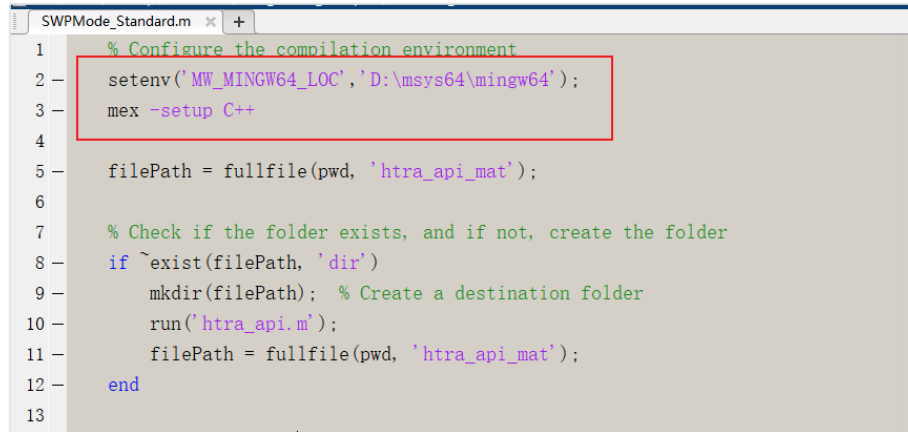
```
594 <encoding name="GBK">
595 | <encoding_alias name="936"/>
596 </encoding>
```

- 6) Find the "UTF-8" part, add the code in the marked line to the corresponding position in the figure, save lclata.xml and close the file.

```
529 <encoding name="UTF-8">
530 | <encoding_alias name="utf8"/>
531 | <encoding_alias name="GBK"/>
532 </encoding>
```

- 7) After restarting Matlab, the garbled Chinese is back to normal.

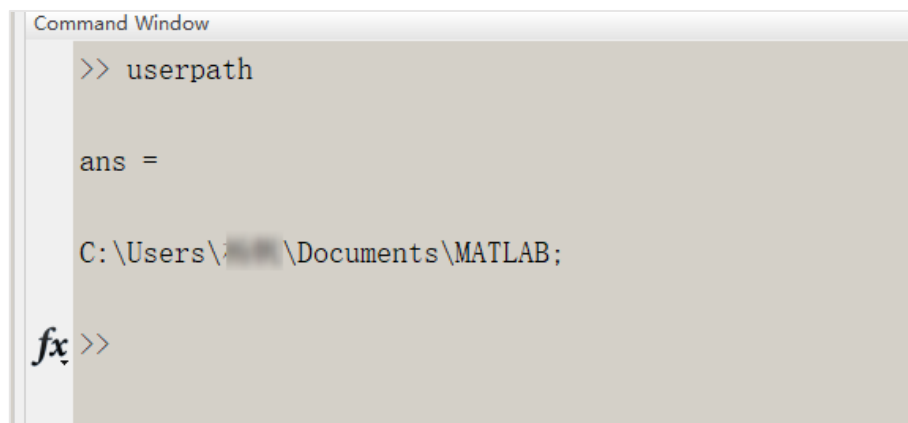
2. Configuration of the compilation environment Method 1: Configuration in scripts:
- At script runtime, run `setenv('MW_MINGW64_LOC', 'D:\msys64\ucrt64')` and the `mex -setup C++` command to configure the compilation environment for C++.



```
SWPMode_Standard.m x +
1 % Configure the compilation environment
2 setenv('MW_MINGW64_LOC', 'D:\msys64\mingw64');
3 mex -setup C++
4
5 filePath = fullfile(pwd, 'htra_api_mat');
6
7 % Check if the folder exists, and if not, create the folder
8 if ~exist(filePath, 'dir')
9     mkdir(filePath); % Create a destination folder
10     run('htra_api.m');
11     filePath = fullfile(pwd, 'htra_api_mat');
12 end
13
```

Note: D:\msys64\ucrt64 is the folder where the compilation environment is located. Please check if there are files such as `c++.exe`, `g++.exe`, and `gcc.exe` in the bin folder at this address. If they exist, this address is the compilation environment address; if not, please find the correct address of the compilation environment.

3. Configuration of the compilation environment method II: startup.m file modified.
- 1) In the Matlab terminal, input: `userpath`, and the command line window will output a result similar to: `C:\Users\YourUsername\Documents\MATLAB`



```
Command Window
>> userpath

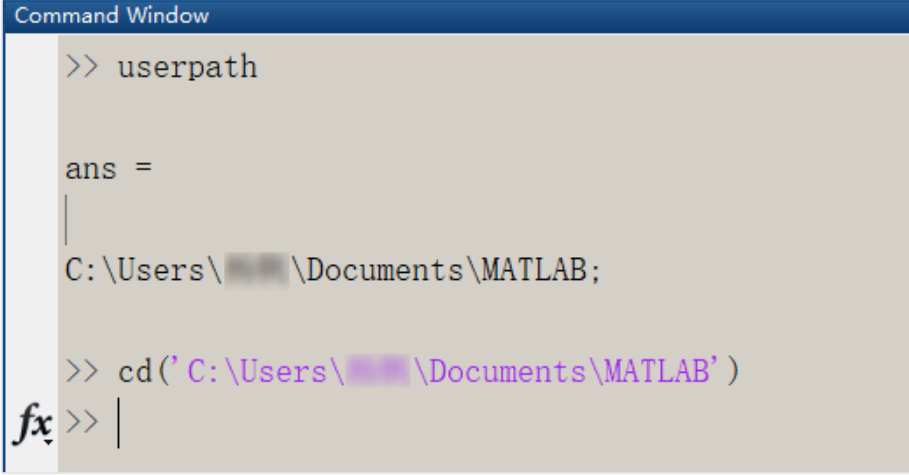
ans =

C:\Users\YourUsername\Documents\MATLAB;

fx >>
```

- 2) Check if the `startup.m` file exists at `C:\Users\YourUsername\Documents\MATLAB`. If it does not exist, create a new `startup.m` file at this location. The steps for creation are as follows:
- i. Matlab terminal input: `cd('C:\Users\YourUsername\Documents\MATLAB')`,

switch the working directory to C:\Users\YourUsername\Documents\MATLAB.



```
Command Window

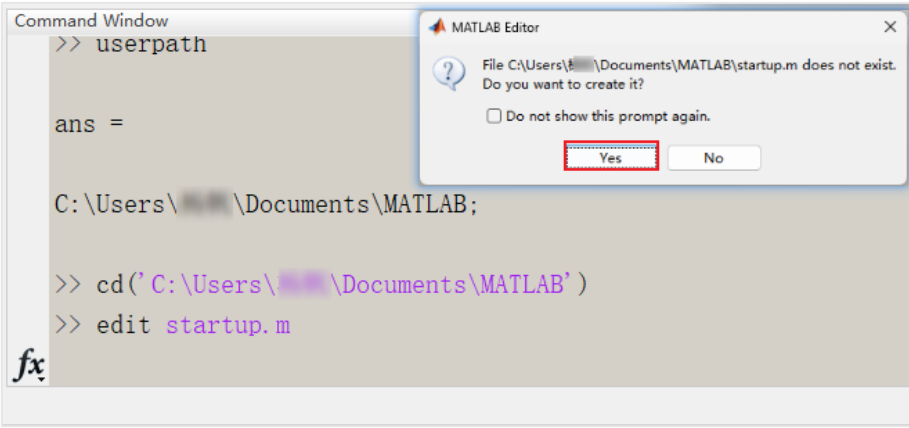
>> userpath

ans =

C:\Users\... \Documents\MATLAB;

>> cd('C:\Users\... \Documents\MATLAB')
fx >> |
```

- ii. Matlab terminal input: edit startup.m, select "Yes" in the pop-up window to create the startup.m file.



```
Command Window

>> userpath

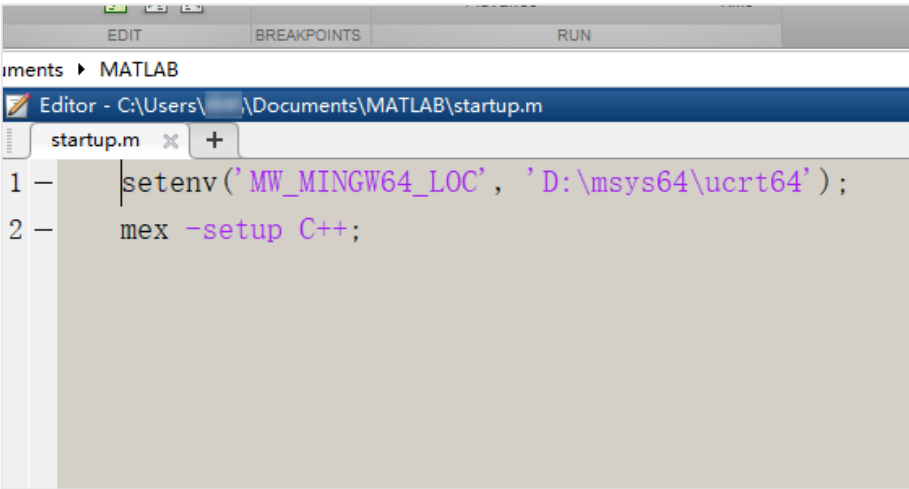
ans =

C:\Users\... \Documents\MATLAB;

>> cd('C:\Users\... \Documents\MATLAB')
fx >> edit startup.m
```

MATLAB Editor dialog box:
File C:\Users\... \Documents\MATLAB\startup.m does not exist.
Do you want to create it?
☐ Do not show this prompt again.
Yes No

- iii. Add commands in the startup.m file:
setenv('MW_MINGW64_LOC', 'D:\msys64\ucrt64'); and mex -setup C++.



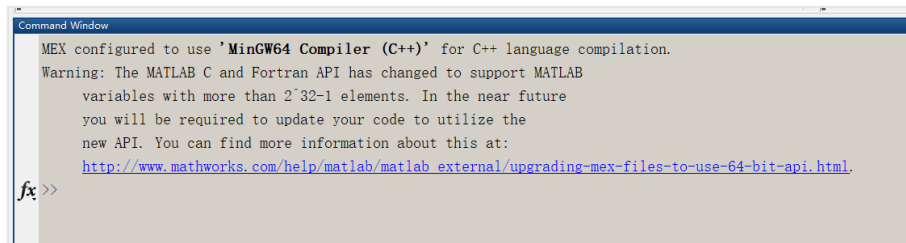
```
Editor - C:\Users\... \Documents\MATLAB\startup.m

startup.m x +

1 — setenv('MW_MINGW64_LOC', 'D:\msys64\ucrt64');
2 — mex -setup C++;
```

- iv. After editing the startup.m file, save and close it.

- v. Restart Matlab, and observe that the command line window appears as shown in the figure below, indicating that the configuration is complete.



5.1.3 Description of call htra_api.dll

1. loadlibrary

The loadlibrary function can load dynamic link libraries.

loadlibrary('.\htra_api\htra_api.dll','.\htra_api\htra_api.h'); Ensure that the file paths for .dll and .h are correct.

```
%Loadhtra_api.dll
if not(libisloaded('htra_api.dll'))
    %The file paths for .dll and .h files should be carefully noted
    loadlibrary('.\htra_api\htra_api.dll','.\htra_api\htra_api.h');
end
```

2. libfunctions

libfunctions('htra_api'); This is used to view all available functions in htra_api.dll.

```
%View all functions in the API
libfunctions('htra_api');
```

3. libpointer

libpointer allows the creation of data type pointers in Matlab and passes them to external library functions.

```
%Open the device
%Create a Device pointer
Device = libpointer;
DevNum = 0;
Status = 0;
```

4. libstruct

libstruct is used to define structure types in Matlab and pass them to external library functions.

```
%Create a BootProfile structure.
BootProfile = libstruct('BootProfile_TypeDef');
save(fullfile(folderPath, 'BootProfile.mat'), 'BootProfile');

%Create the DeviceInfo structure
DeviceInfo = libstruct('DeviceInfo_TypeDef');
save(fullfile(folderPath, 'DeviceInfo.mat'), 'DeviceInfo');
```

5. get

The get function is used to retrieve the property values of a structure.

```
%Call the Device_Open function
Status = calllib('htra_api', 'Device_Open', Device, DevNum, BootProfile_p, BootInfo_p);
get(BootInfo_p); %Print the value of BootInfo_p
```

6. calllib

calllib is the command in Matlab used to call functions in htra_api.dll.

```
%Call the Device_Open function
Status = calllib('htra_api', 'Device_Open', Device, DevNum, BootProfile, BootInfo);
get(BootProfile); %Prints the value of BootInfo_p
```

7. load

load is used to load the .mat structure files generated in htra_api.m.

```
% Load the BootProfile_TypeDef structure directly.
load(fullfile(filePath, 'BootProfile.mat'));
% Load the BootInfo_TypeDef structure directly
load(fullfile(filePath, 'BootInfo.mat'));
```

8. fullfile

fullfile is a function in MATLAB used to generate full file paths. Load the BootProfile.mat and BootInfo.mat files under the filePath.

```
% Load the BootProfile_TypeDef structure directly.
load(fullfile(filePath, 'BootProfile.mat'));
% Load the BootInfo_TypeDef structure directly
load(fullfile(filePath, 'BootInfo.mat'));
```

9. unloadlibrary

unloadlibrary is used to unload a previously loaded htra_api library, appearing in pairs

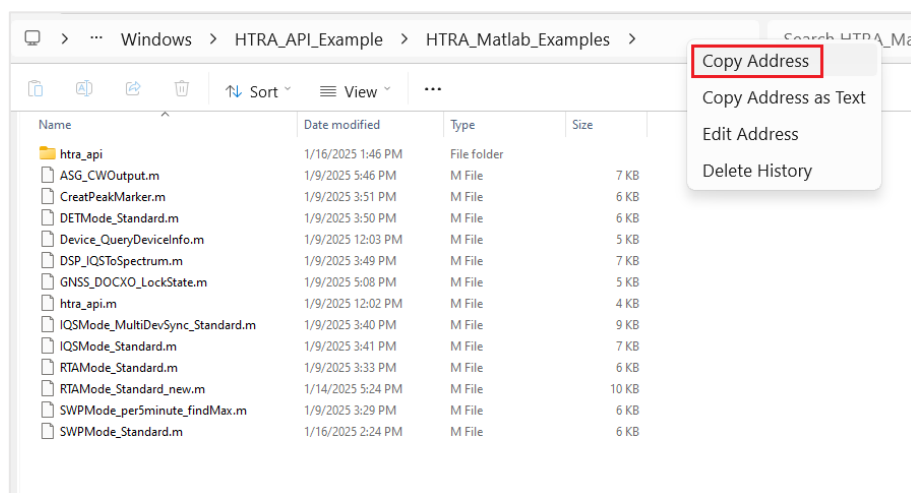
with loadlibrary.

```
%Unload library file
unloadlibrary('htra_api');
disp('Uninstall complete')
```

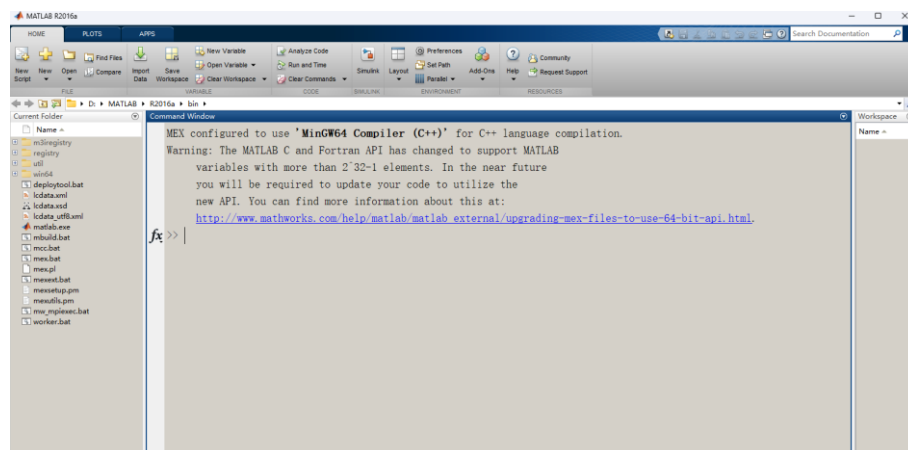
5.2 Matlab example usage process

The usage process for the Matlab examples included on the USB drive is as follows:

1. Open the Windows\HTRA_API_Example\HTRA_Matlab_Examples folder on the USB drive, and double-click any .m file to open the example. For instructions on how to run the example, please refer directly to step 4.
2. If you cannot open the example in step 1, please continue to this step and copy the address Windows\HTRA_API_Example\HTRA_Matlab_Examples.

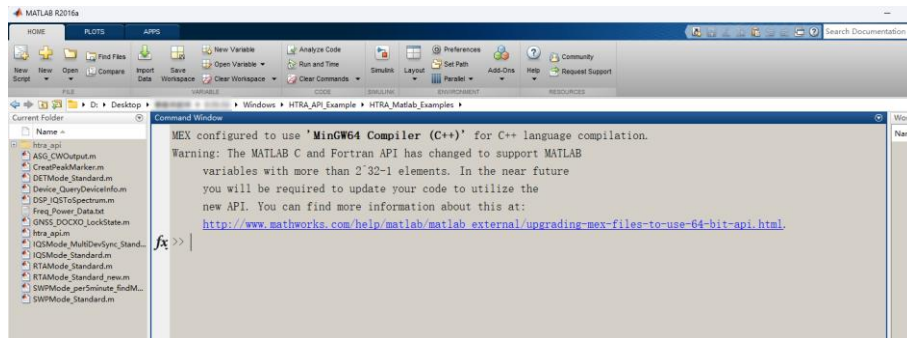


3. Open the Matlab software installed on your system.

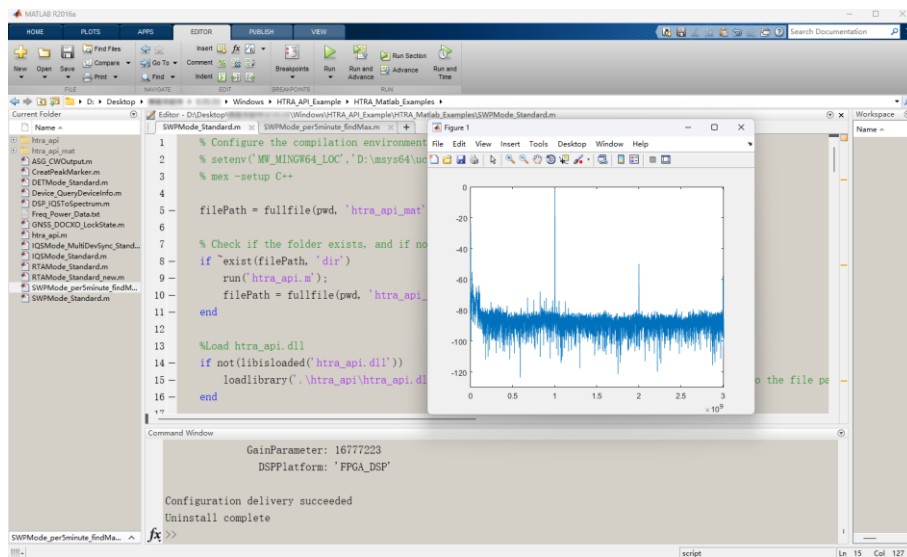


4. After pasting the copied address into the file address box, press Enter to navigate

to the \Windows\HTRA_API_Example\HTRA_Matlab_Examples folder included with the materials.



5. Click on the .m file on the left as needed, click "Run", and wait for the Figure 1 window to appear, indicating that the example has run successfully. For the functional descriptions of each example, please refer to section 5.2 Matlab Example Description.



5.3 Introduction to Accompanying Examples

5.3.1 Get device information

Device_QueryDeviceInfo.m: Retrieve device information, including API version, USB version, device model, device UID, MCU version, FPGA version, and device temperature.

5.3.2 Obtain Standard Spectrum Data

SWPMode_Standard.m: Obtain complete spectrum data within the specified frequency band.

5.3.3 Create multiple markers to display the frequency and power of the markers.

CreatPeakMarker.m: Obtain spectrum data within the specified frequency band, create markers, and perform peak searching.

5.3.4 Collect the peak spectrum every five minutes.

SWPMode_per5minute_findMax.m: Obtain spectrum data within the specified frequency band and search for the peak globally every five minutes.

5.3.5 Obtain continuous stream or fixed number of IQ data.

IQSMode_Standard.m: Acquire IQ data under different trigger modes in IQS mode.

5.3.6 The acquired IQ data is converted into spectrum data.

DSP_IQSToSpectrum.m: After acquiring IQ data, the obtained IQ data is converted into spectrum data.

5.3.7 Acquire continuous stream or fixed number of power detection data.

DET_GetPowerTrace_FixedPoints.m: Acquire power detection data under different triggering modes in DET mode.

5.3.8 Acquire continuous stream or fixed duration real-time spectrum data.

RTAMode_FixedPoints.m: Acquire real-time spectrum data under different triggering modes in RTA mode.

5.3.9 Internal signal source output signal.

ASG_CWOutput.m: Output single-tone signals, frequency sweep signals, and power sweep signals. Applicable only to devices with signal source options.

5.3.10 Lock GNSS antenna and DOCXO oscillator.

GNSS_DOCXO_LockState.m: Call the API interface to lock the GNSS antenna and DOCXO oscillator, applicable only to devices with IO expansion board options.

5.3.11 Multi-machine synchronization

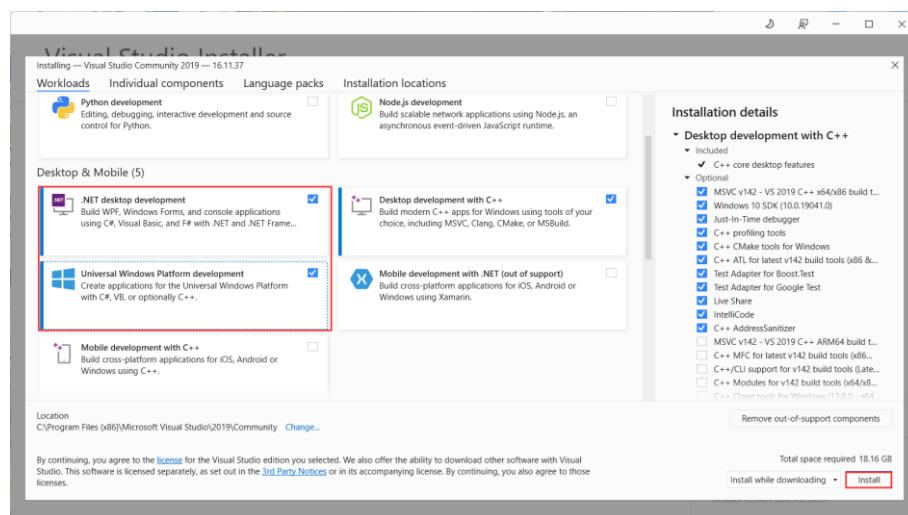
IQSMode_MultiDevSync_Standard.m: When using the same reference clock source input and the same trigger source input, two devices simultaneously acquire IQ data, allowing for the observation of the synchronization of their collected data.

6. C#

6.1 Configure Development Environment

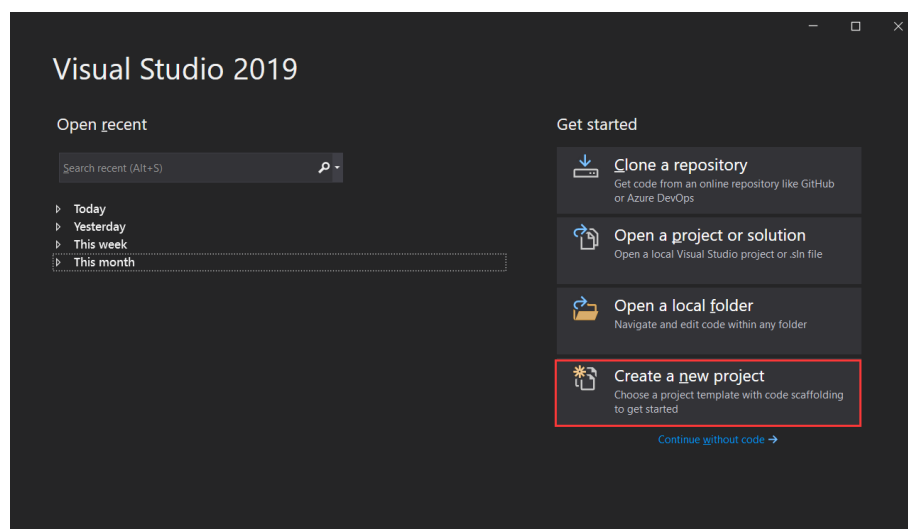
6.1.1 Development Environment Confirmation

Open Visual Studio Installer, check the .NET desktop development components and Universal Windows Platform development components, and click Modify to ensure that Visual Studio 2019 has the C# development environment.

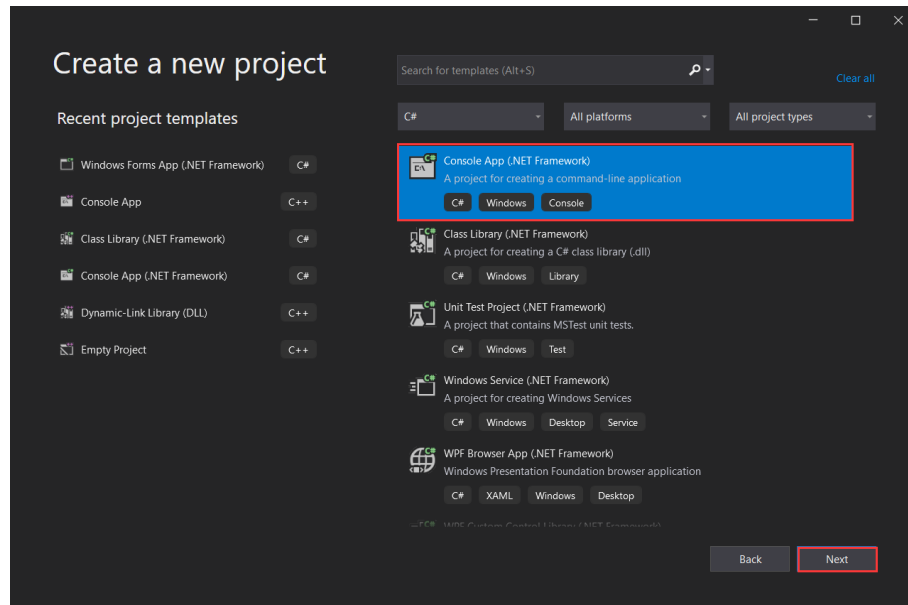


6.1.2 Project Setup

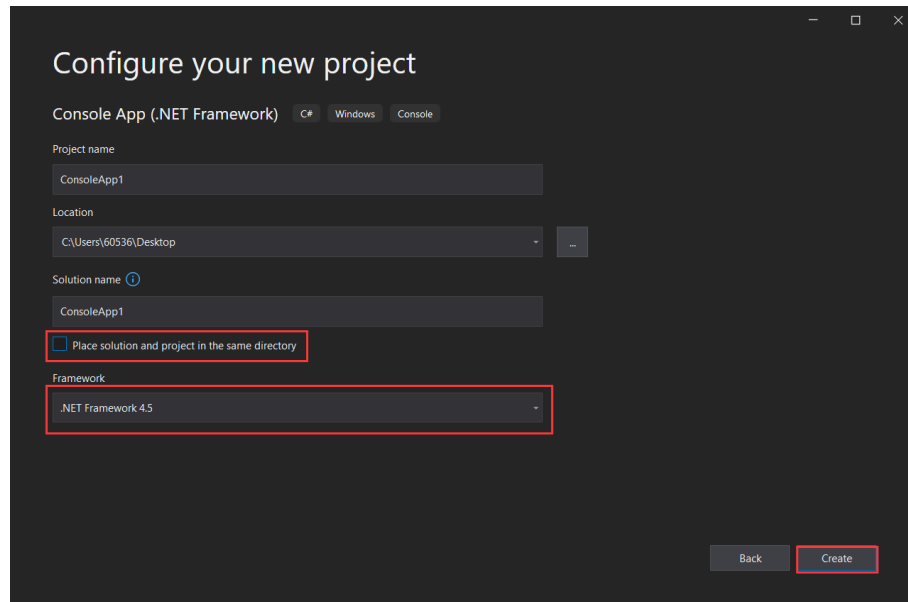
1. Open Visual Studio 2019 and click on Create a New Project.



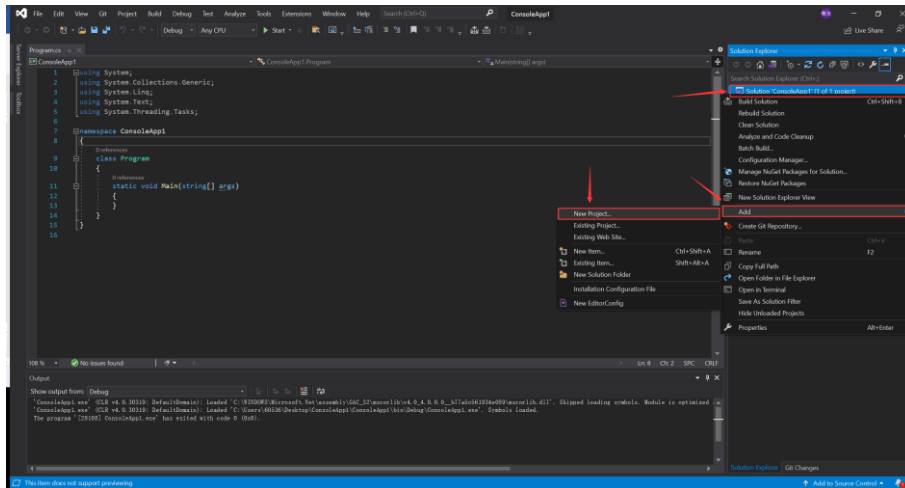
2. Select C# Console Application and click Next.



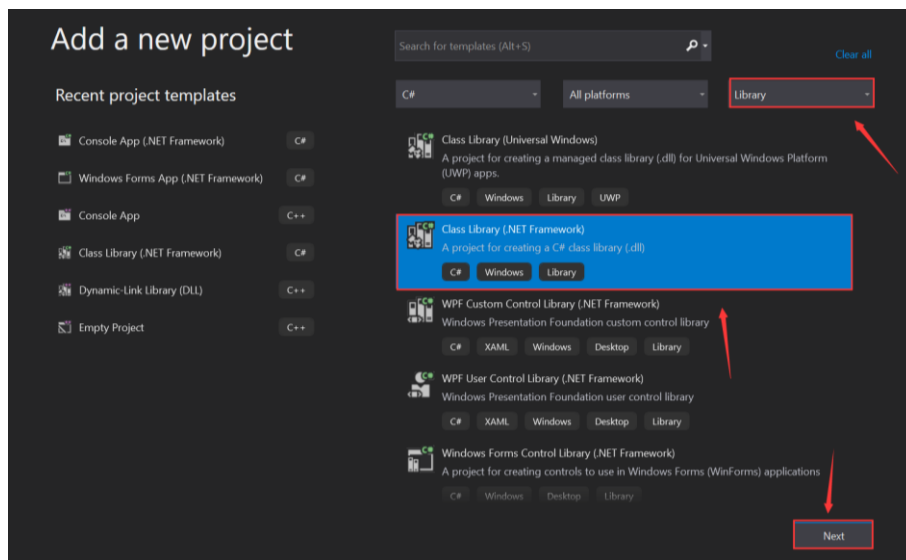
3. Enter the project name and storage location, uncheck the option to place the solution and project in the same directory. Select .NET Framework 4.5 as the framework, and finally click Create.



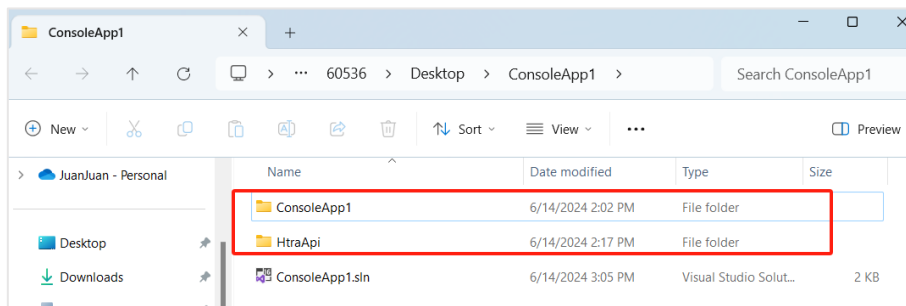
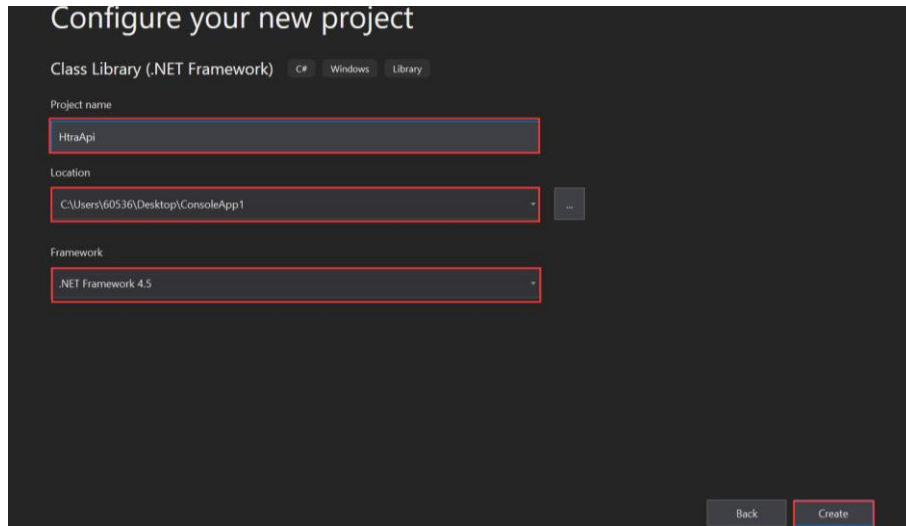
4. Once the creation is complete, open the project, right-click on the solution, and select Add New Project.



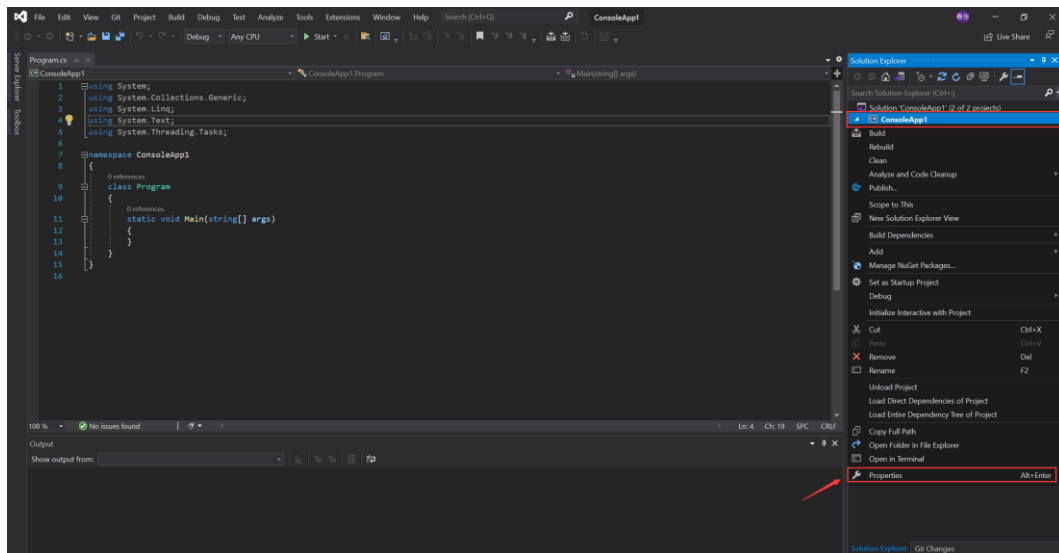
5. Select Class Library (.NET Framework) under Library type for the project type, and click Next.



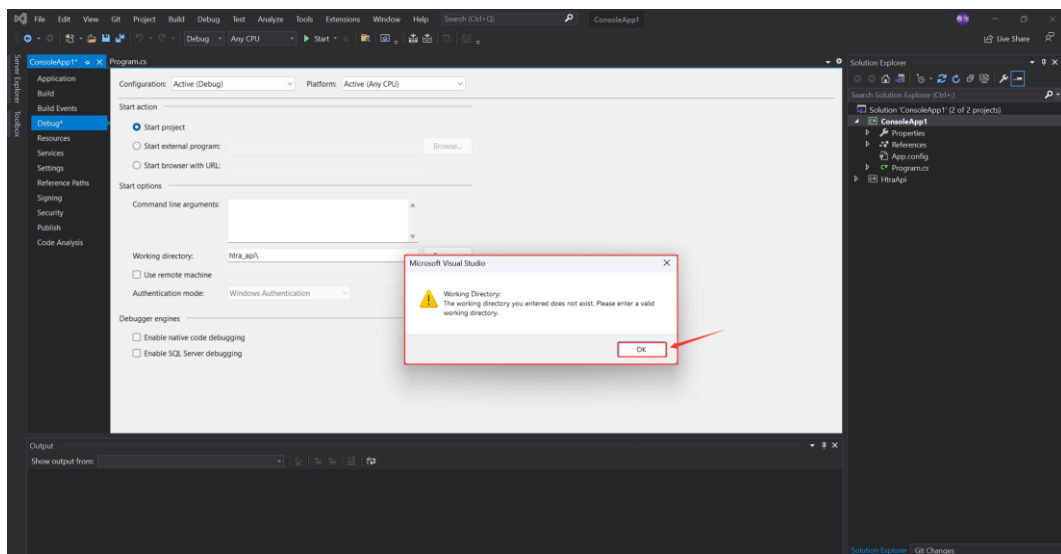
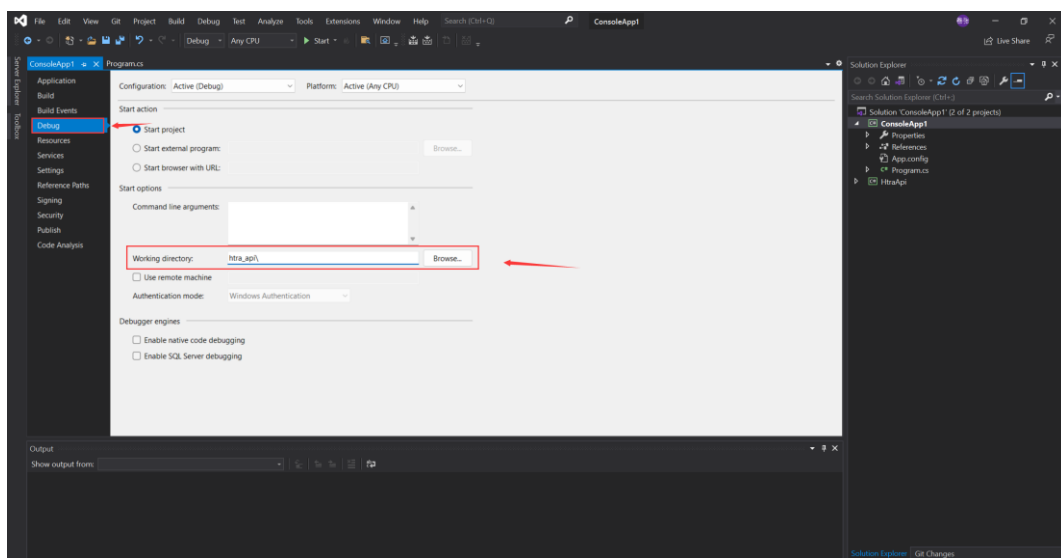
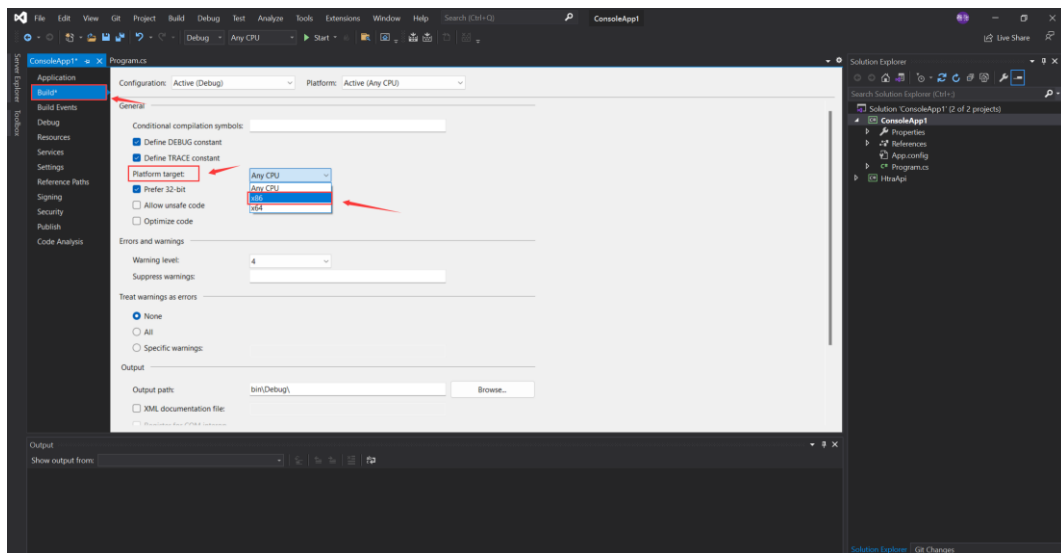
6. The library name can be modified as needed, such as HtraApi, and the location should not be changed, remaining at the same directory level as the solution. The result is shown in the figure, select the .NET Framework 4.5 framework, and click Create.



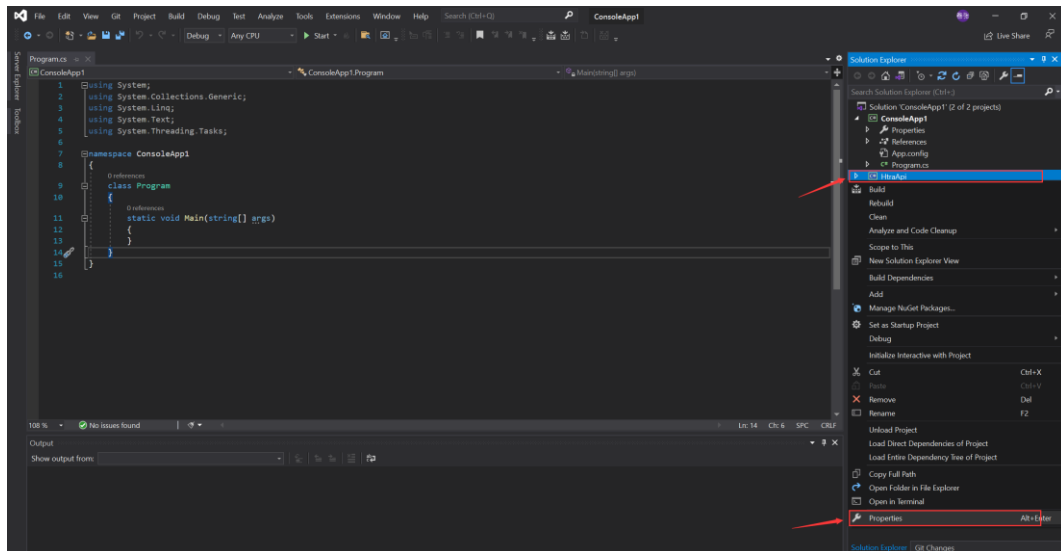
7. Right-click on ConsoleApp1 and select Properties.



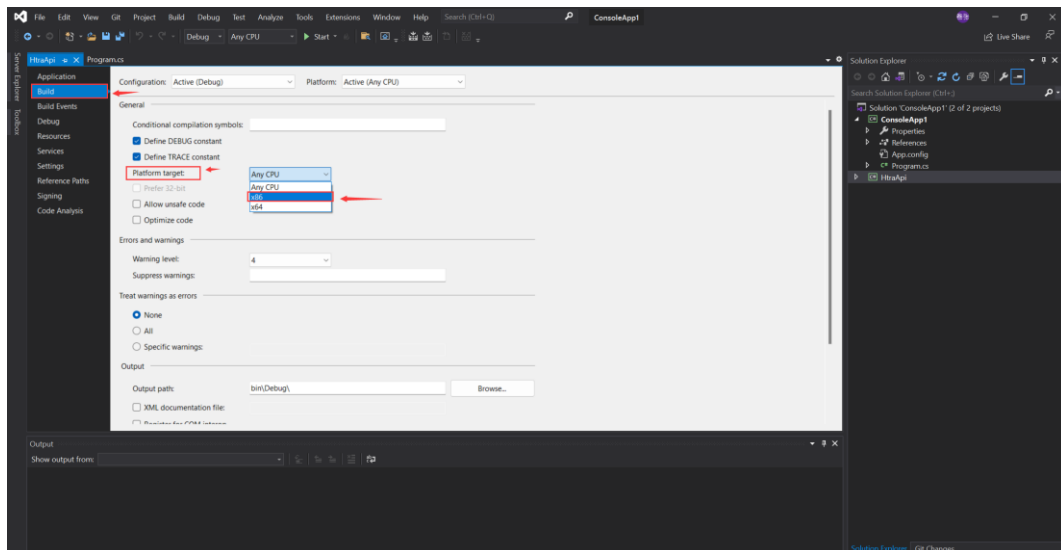
8. View the project's build properties, change the target platform to x86, click Debug, enter htra_api\ in the working directory, and save. If the situation in Figure 12 occurs, click OK and save again.



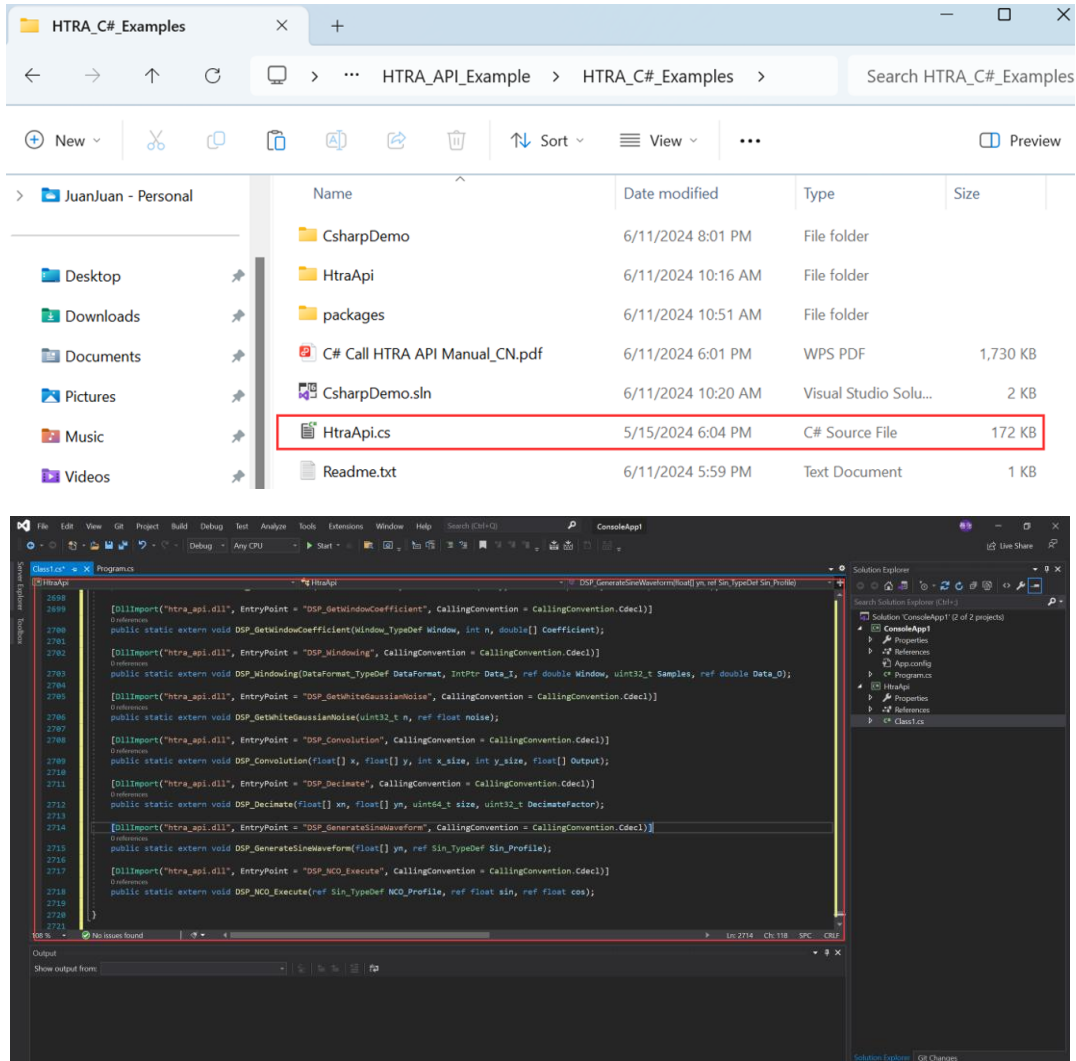
9. Right-click on the library HtraApi and select Properties.



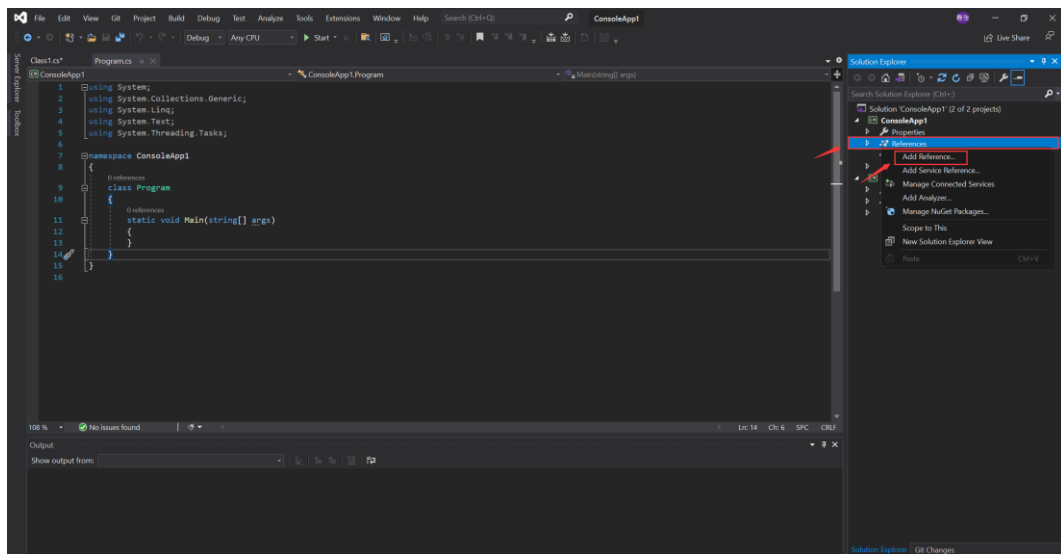
10. View the library's build properties, change the target platform to x86, and save.



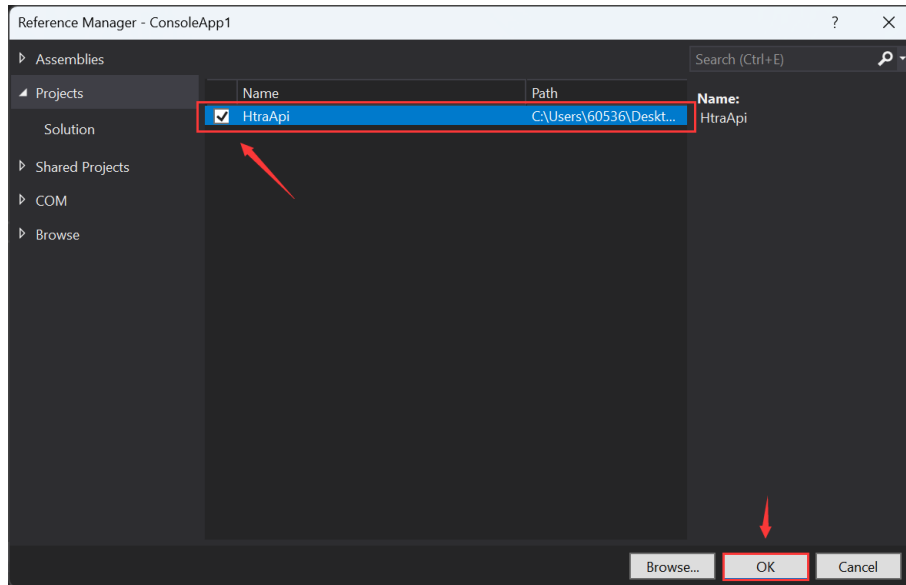
11. Copy the contents of the HtraApi.cs file from the folder \Windows\HTRA_API_Example\HTRA_C#_Examples included in the accompanying materials to the Class1.cs file in the project library and save.



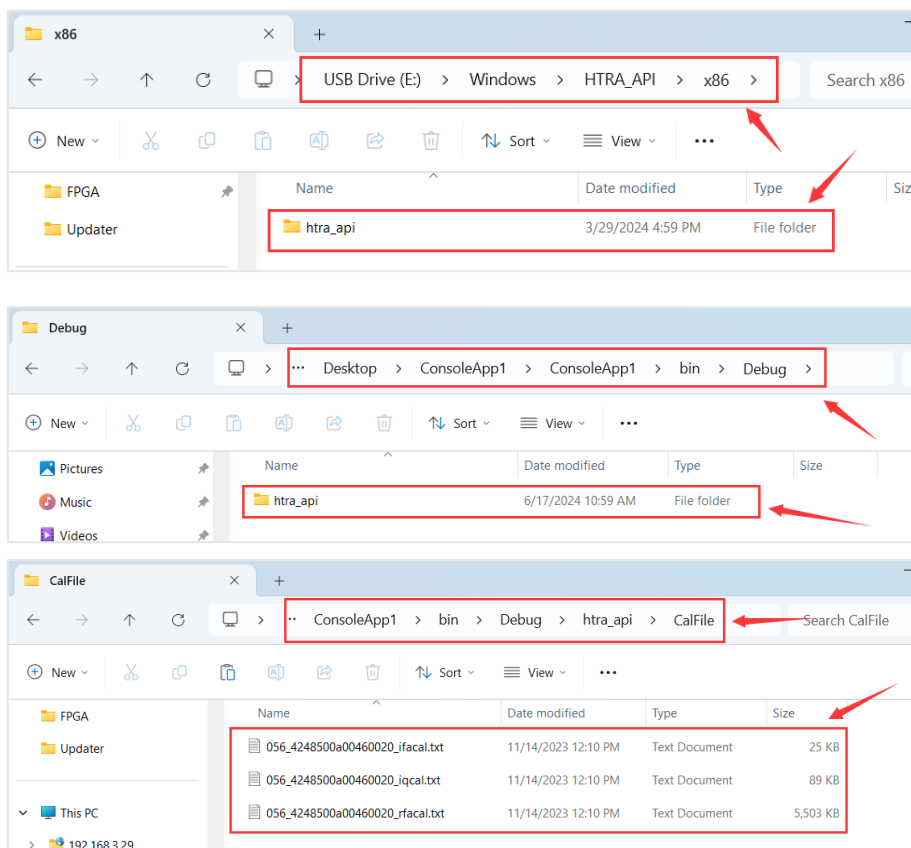
12. Select the ConsoleApp1 project, right-click on References, and choose Add Reference.



13. Select the HtraApi library and confirm the addition of the library reference.



14. Copy the htra_api folder from \Windows\HTRA_API\x86 on the accompanying USB drive to the Debug folder under the project's bin folder, and ensure that the CalFile folder within the htra_api folder contains the calibration files.

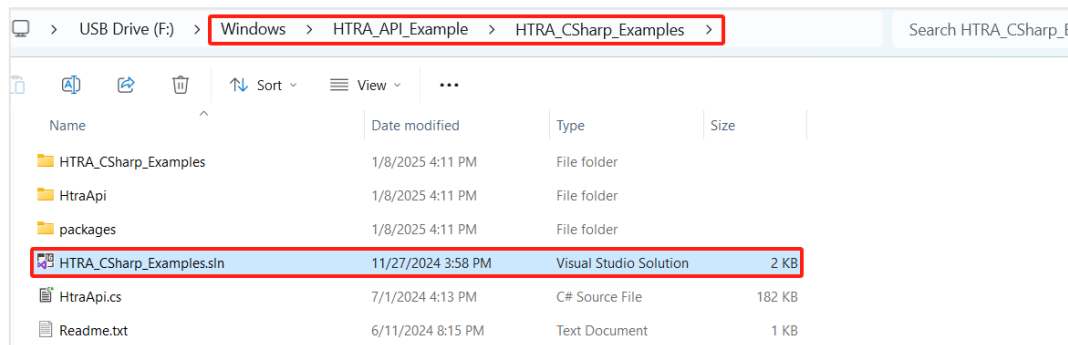


15. Write code normally. You can refer to the C# examples included in the accompanying USB drive, specifically the projects in \Windows\HTRA_API_Example\HTRA_C#_Examples.

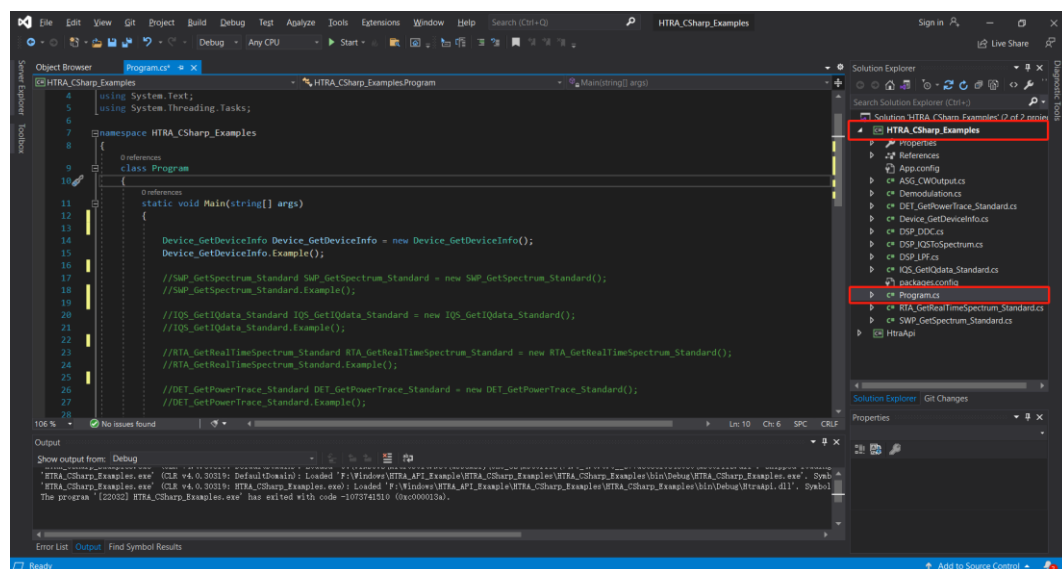
6.2 C# Example Usage Process

The usage process of the C# examples included in the USB drive is as follows:

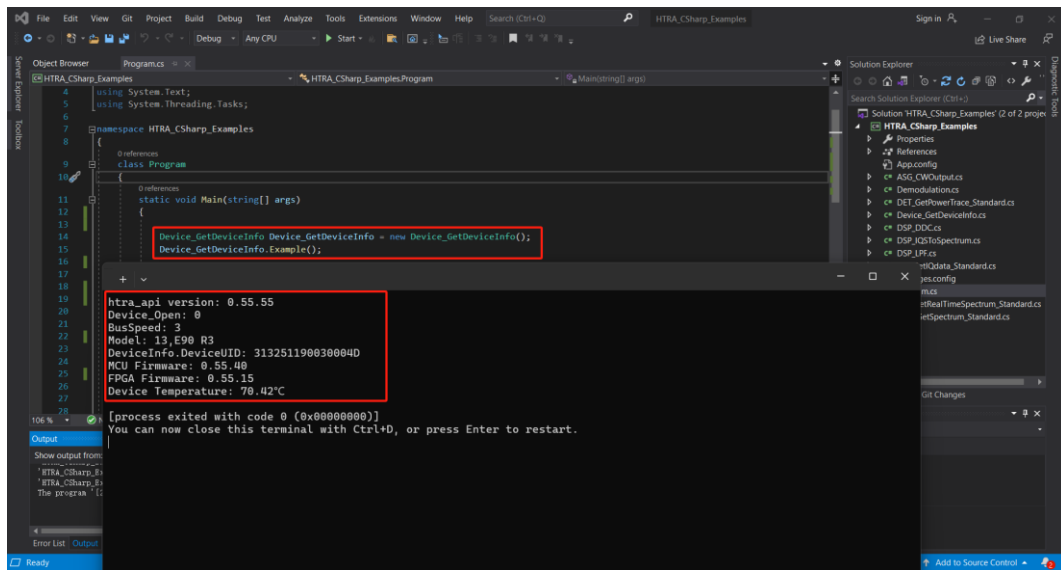
1. Open the USB drive using Visual Studio and navigate to the folder Windows\HTRA_API_Example\HTRA_CSharp_Examples, then open the solution file HTRA_CSharp_Examples.sln.



- Click on the HTRA_CSharp_Examples project on the right side, and then click on the Programe.cs file.



3. Since each example in the C# included examples is encapsulated in a separate class, you can run the examples by uncommenting them (multiple examples cannot be used simultaneously). For instance, when testing the Device_GetDeviceInfo example, uncomment it and click run; as shown in the figure, the device is running normally.



6.3 C# Example Descriptions

6.3.1 Get device information

Device_GetDeviceInfo.cs: Retrieves device information including API version, USB version, device model, device UID, MCU version, FPGA version, and device temperature.

6.3.2 Obtain Standard Spectrum Data

SWP_GetSpectrum_Standard.cs: Obtains complete spectrum data within a specified frequency band.

6.3.3 Obtain IQ Data for a Fixed Number of Points or Duration

IQS_GetIQdata_Standard.cs: Acquires IQ data under different trigger modes in IQS mode.

6.3.4 Obtain Power Detection Data for a Fixed Number of Points or Duration

DET_GetPowerTrace_Standard.cs: Obtains power detection data under different trigger modes in DET mode.

6.3.5 Obtain real-time spectrum data for a fixed number of points or duration

RTA_GetRealTimeSpectrum_Standard.cs: Retrieves real-time spectrum data under different trigger modes in RTA mode.

6.3.6 Output single-tone signal

ASG_CWOutput.cs: Devices with signal source functionality options output single-tone

signals, frequency sweep signals, or power sweep signals through ASG functionality.

6.3.7 AM/FM Demodulation

Demodulation.cs: DSP_FMDemod performs FM demodulation and playback of the acquired IQ data. DSP_AMDemod performs AM demodulation and playback of the acquired IQ data.

6.3.8 IQ to Spectrum Data

DSP_IQSToSpectrum.cs: Converts the IQ data obtained in IQS mode into spectrum data.

6.3.9 Low-pass filtering

DSP_LPF.cs: Applies low-pass filtering to the acquired IQ data and converts it to spectrum.

6.3.10 Digital Downconversion

DSP_DDC.cs: Performs digital down-conversion on the acquired IQ data and converts it to spectrum.

6.3.11 Phase noise test

DSP_TraceAnalysis_PhaseNoise.cs: Demonstration of Phase Noise Test Function.

7. Java (to be supplemented)

8. Labview

8.1 Configure Development Environment

8.1.1 Export library functions from htra_api.dll using LabVIEW

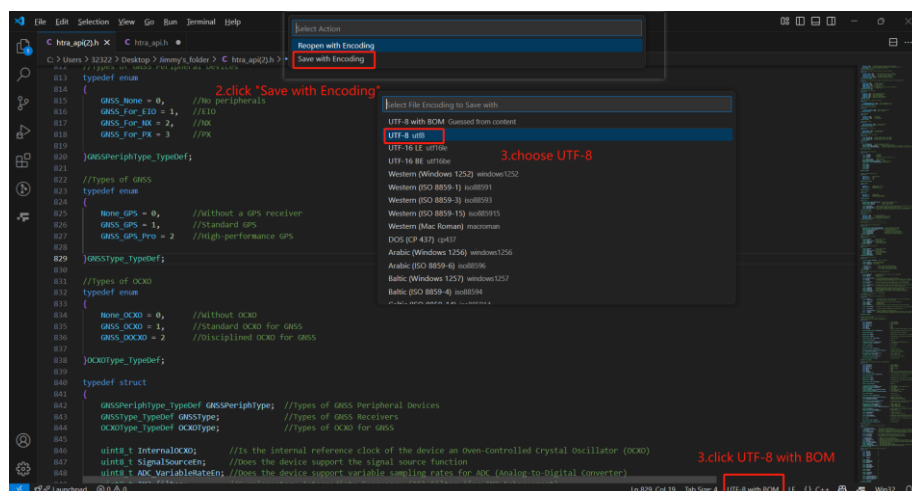
1. Create a folder (e.g., HTRA_Labview) and copy the htra_api folder from the USB drive located at Windows\HTRA_API\x86 into this folder. Then create another folder (e.g., VIS) to place the exported vi.

PC > OS (D:) > HTRA_Labview >				
Name	^	Date modified	Type	Size
VIS		5/14/2025 2:14 PM	File folder	
htra_api.dll		3/24/2025 3:46 PM	Application extens...	1,013 KB
htra_api.h		3/24/2025 8:11 PM	C Header Source F...	160 KB

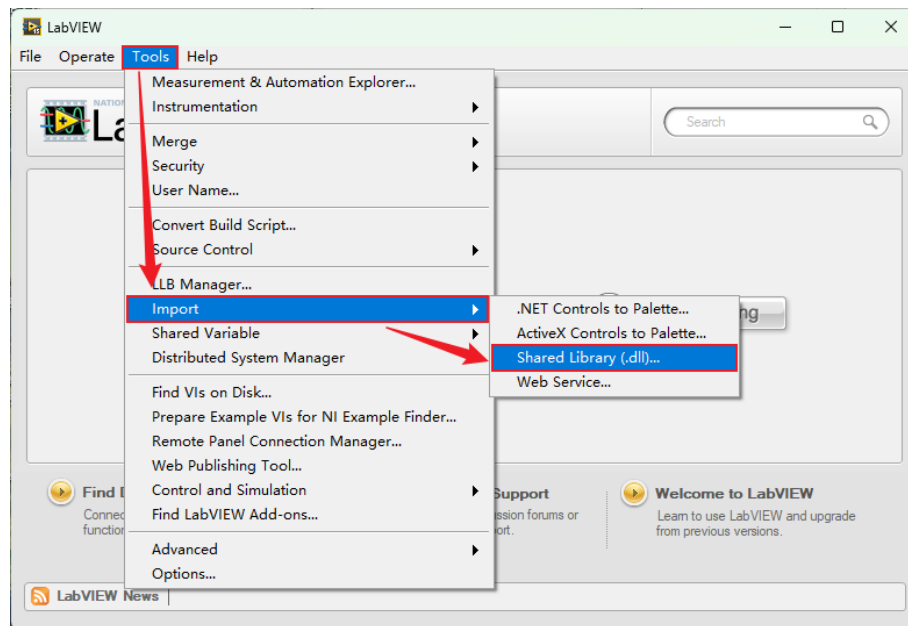
2. LabVIEW does not recognize the uint64_t and int64_t data types during import, so before importing, all parameters of type uint64_t and int64_t need to be changed to double. Note that after exporting the functions, these modified parameter types should be changed back to uint64_t or int64_t in the VIs.



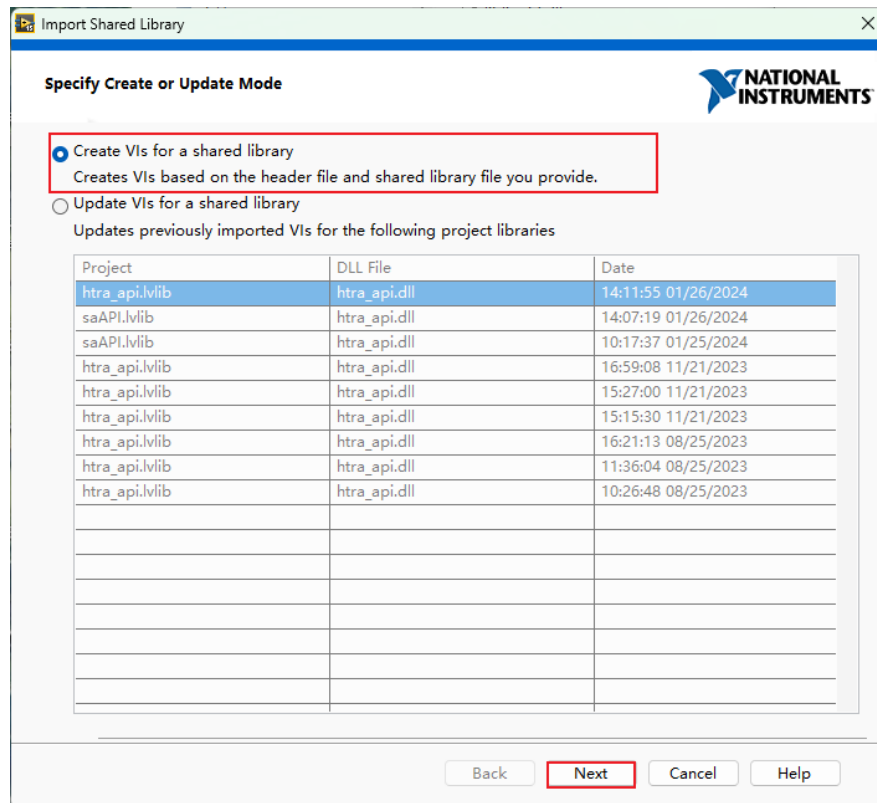
3. Change the encoding format of htra_api.h to UTF-8.



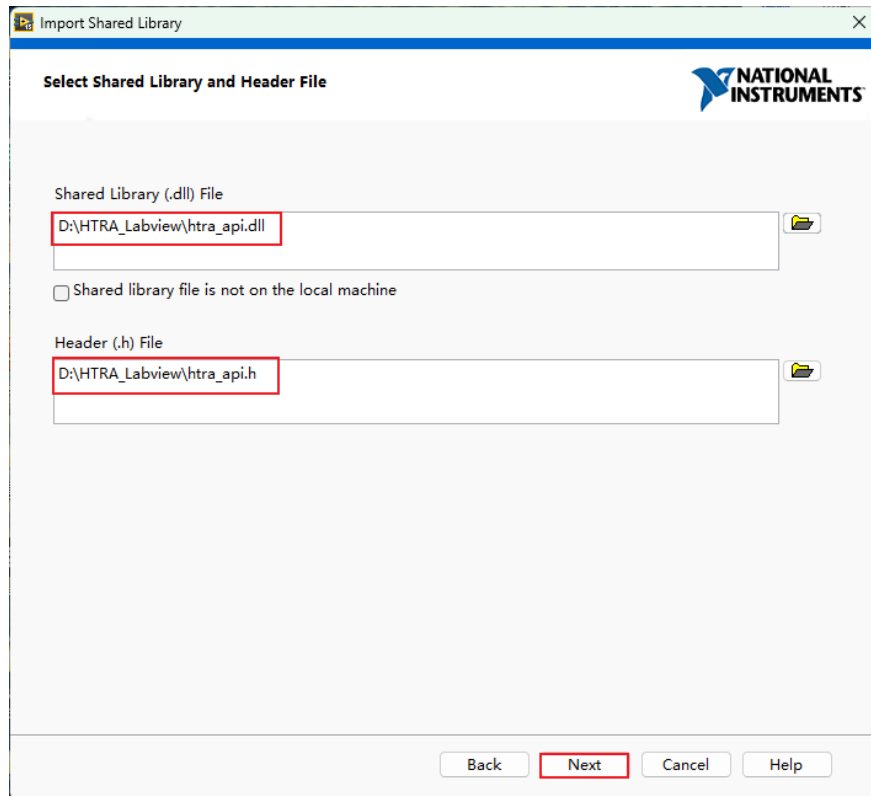
4. Open LabVIEW, and select "Tools--->Import--->Shared Library."



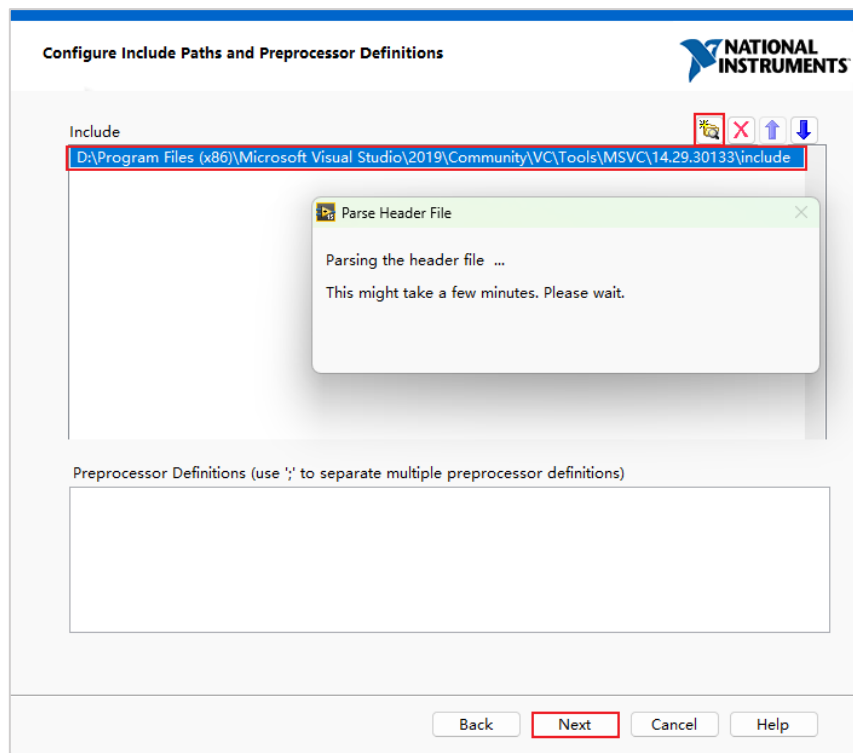
5. Select "Create VIs for a shared library" and click "Next."



6. In "Shared Library (.dll) File" and "Header (.h) File", select the corresponding library files in the previously created folder. After selecting the shared library file path, the header file path can be automatically recognized and does not need to be selected again. Then click "Next".

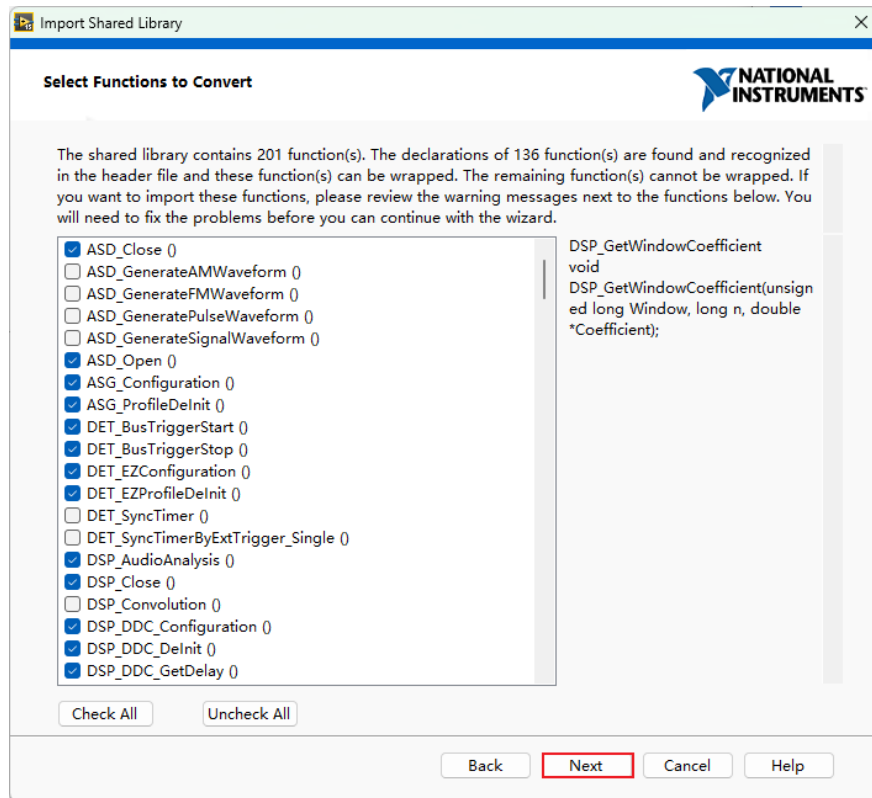


7. Configure the paths of other dependent files in "Include", which are generally located in the Visual Studio installation folder, as shown in the path in the figure below. Then click "Next" and wait for the resolution.

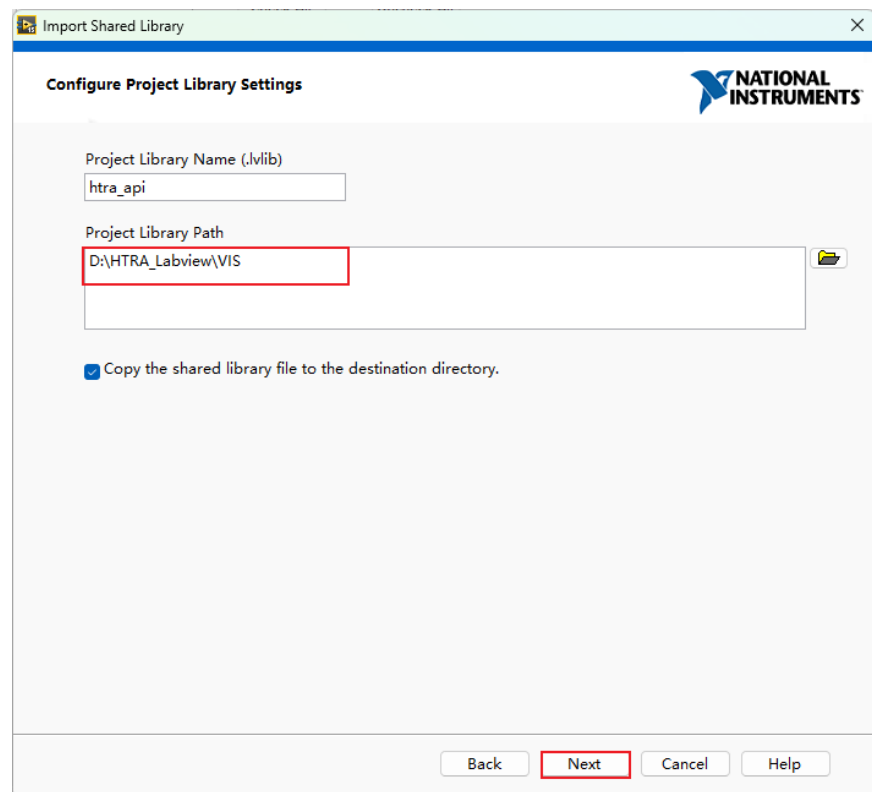


8. Select the functions that need to be exported. Some functions are deprecated or

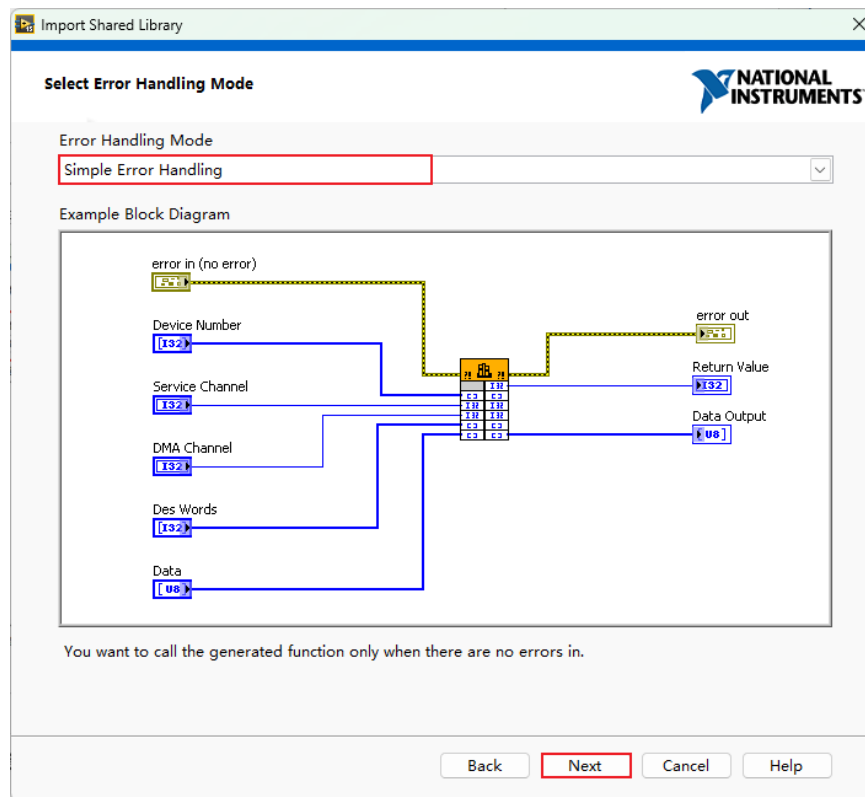
not yet open. You can refer to htra_api.h for selection. After selecting, click "Next".



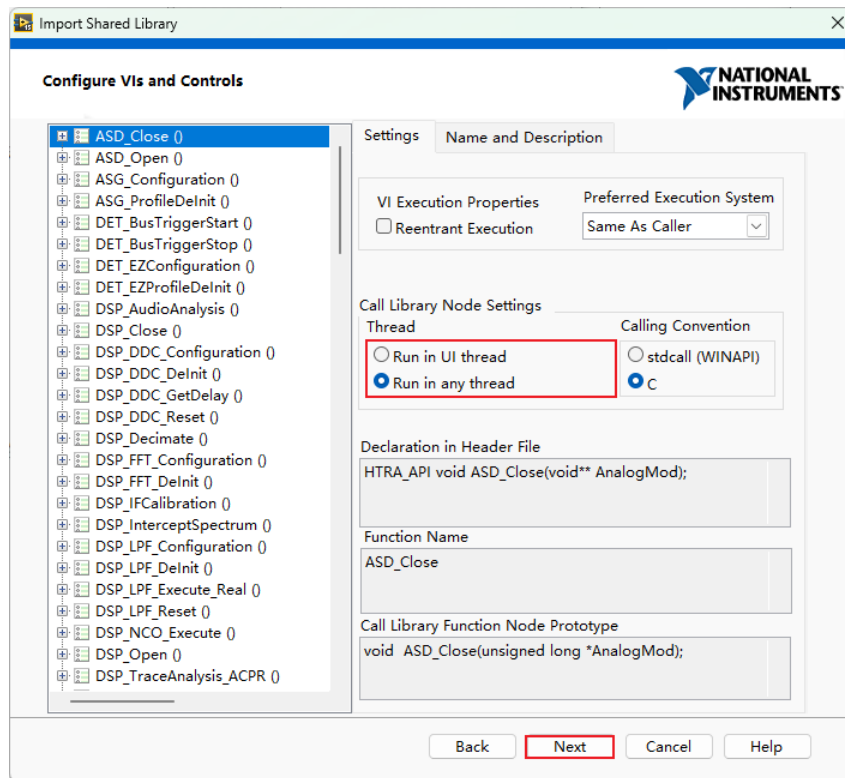
9. Select the "VIS" folder in the path where the library and header files are stored for "Project Library Path", then click "Next".



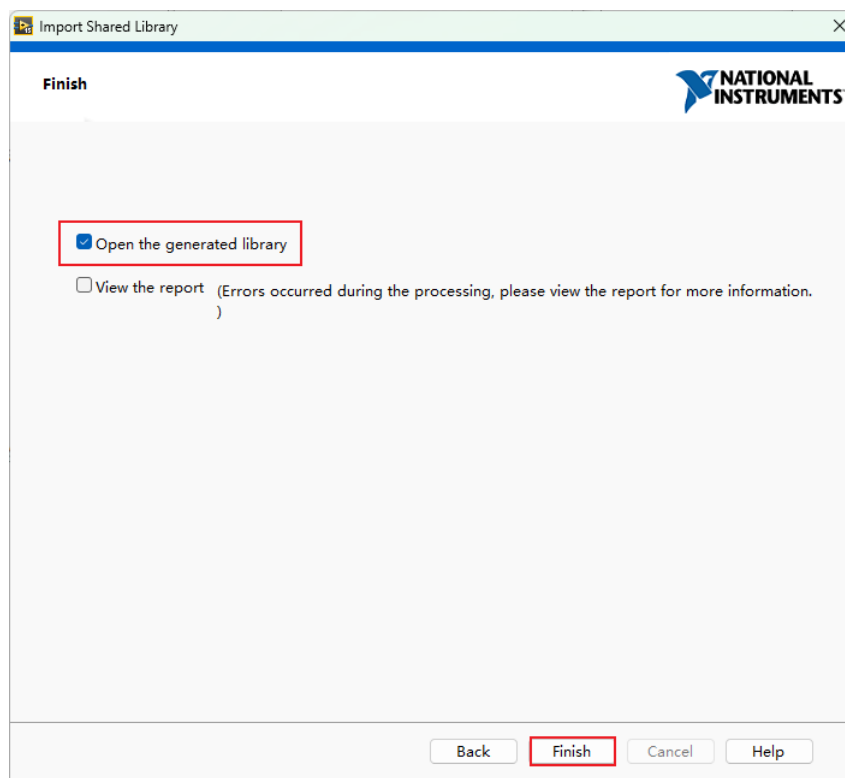
10. It is recommended to select "Simple Error Handling" for "Error Handling Mode", then click "Next".



11. Set the calling library node of each function to "Run in Any Thread". After all settings are completed, click "Next" and wait for the VI to be generated.



12. Check "Open the generated library". "View the report" is optional. Click "Finish".

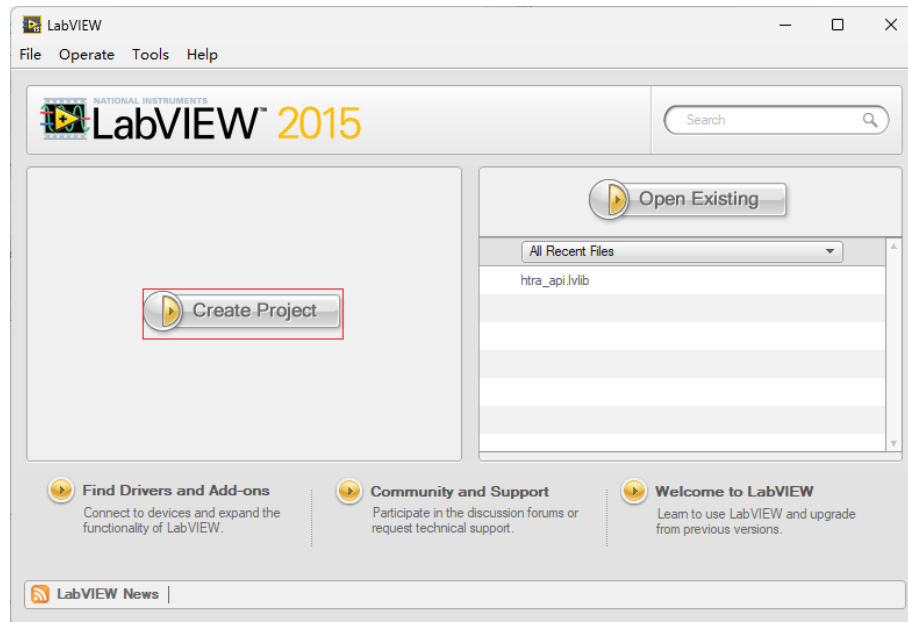


13. The VIs in the "VIS" folder are the exported API functions. This concludes the process of exporting the API functions.

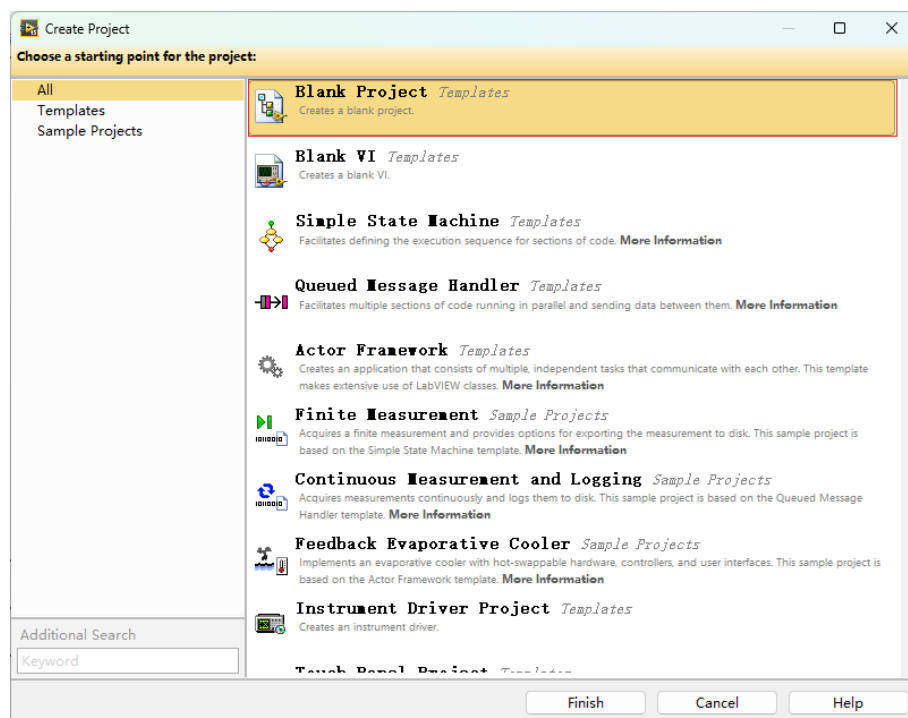
This PC > Data (D:) > HTRA_Labview > VIS > VIs					Search VIs	
					Preview	
Name	Date modified	Type	Size			
ASD Close.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	9 KB			
ASD Demodulate AM.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	23 KB			
ASD Demodulate FM.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	24 KB			
ASD Open.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	9 KB			
ASG Configuration.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	15 KB			
ASG Profile De Init.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	12 KB			
DET Bus Trigger Start.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	9 KB			
DET Bus Trigger Stop.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	9 KB			
DET Configuration.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	26 KB			
DET Get Power Stream.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	19 KB			
DET Profile De Init.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	20 KB			
Device Close.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	9 KB			
Device Open.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	15 KB			
Device Query Device State Realtime.vi	11/15/2024 10:35 AM	LabVIEW Instrume...	13 KB			

8.1.2 Using the API in the LabVIEW environment

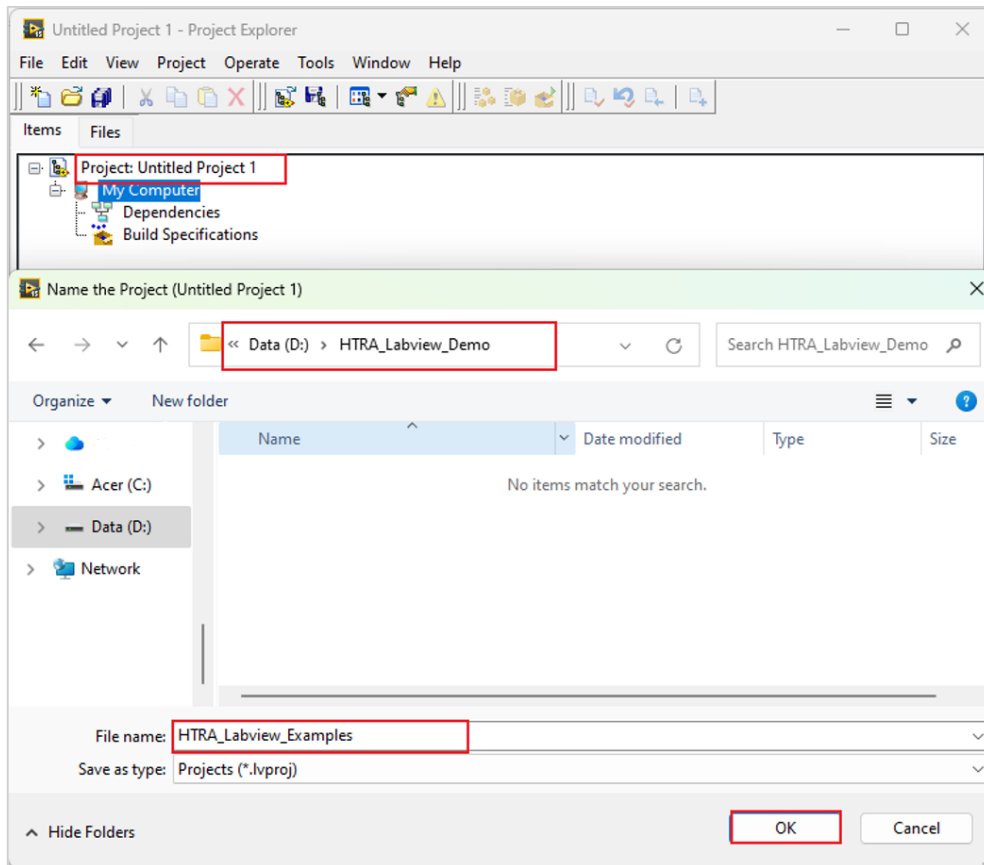
1. Open LabVIEW and click "Create Project."



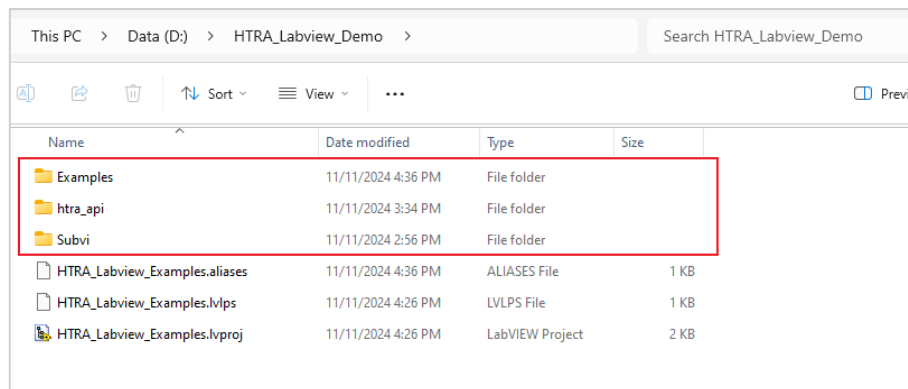
2. Select "Blank Project" and click "Finish."



3. An unnamed empty project will then appear. Save the project with "Ctrl+S", select the project save path and name the project, then click "OK".



4. Copy the "htra_api" folder from the "\\Windows\\HTRA_API\\x86" directory on the USB flash drive to the same directory level as this project. Additionally, you can create an "Examples" folder to store examples. If needed, you can also create another folder, such as "Subvi", to store sub-VIs.

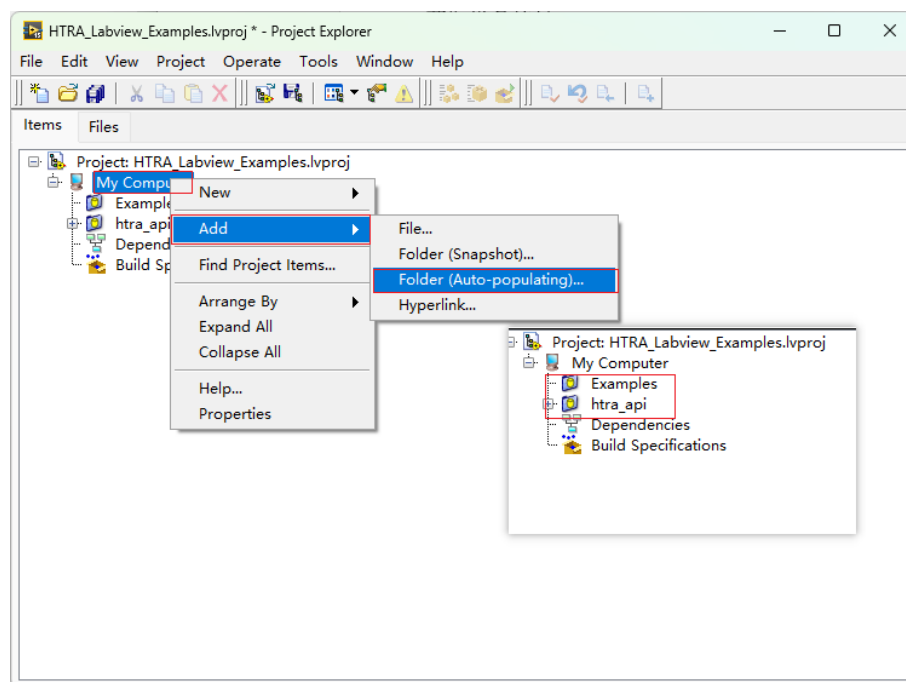


5. Copy the previously exported library functions, i.e., the contents of the "VIS" folder created in section 8.1.1, to the "htra_api" folder.

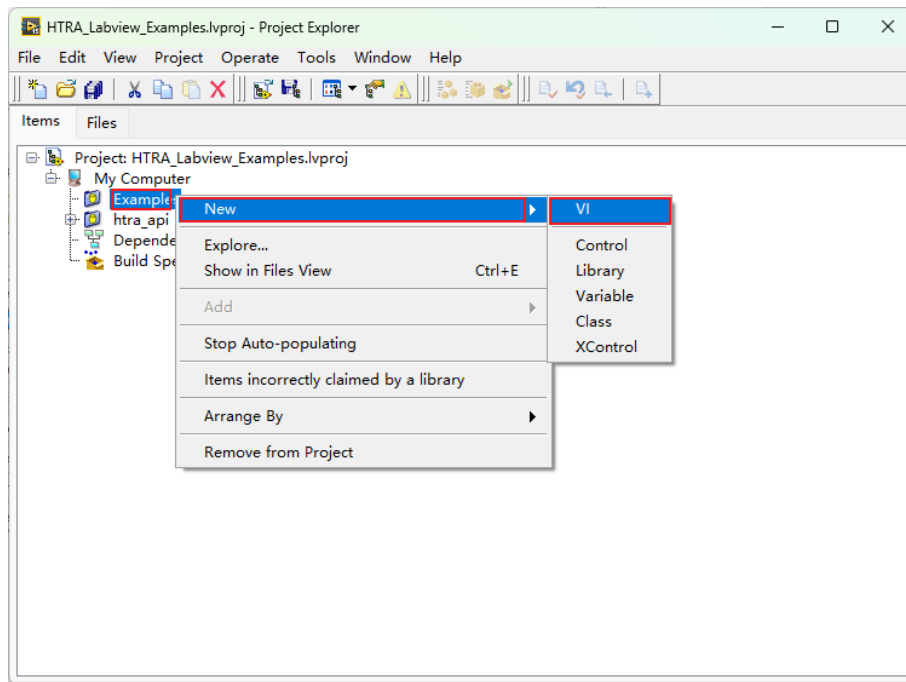
PC > OS (D:) > HTRA_Labview_Demo > htra_api

Name	Date modified	Type	Size
CalFile	5/9/2025 5:05 PM	File folder	
VIs	5/14/2025 2:19 PM	File folder	
htra_api.dll	3/24/2025 3:46 PM	Application extens...	1,013 KB
htra_api.h	3/24/2025 8:11 PM	C Header Source F...	160 KB
htra_api.lib	3/24/2025 3:46 PM	Object File Library	53 KB
htra_api.lvlib	11/17/2024 11:42 PM	LabVIEW Library	8 KB
htra_api_pnm.h	3/25/2025 9:42 AM	C Header Source F...	8 KB
libgcc_s_dw2-1.dll	1/12/2024 8:37 AM	Application extens...	123 KB
libiomp5md.dll	4/30/2024 3:30 AM	Application extens...	1,900 KB
libliquid.dll	1/12/2024 8:37 AM	Application extens...	1,743 KB
libliquid.lib	1/12/2024 8:37 AM	Object File Library	1,618 KB
libmkl.dll	4/30/2024 3:30 AM	Application extens...	42,043 KB
libmkl.lib	4/30/2024 3:30 AM	Object File Library	6 KB
libwinpthread-1.dll	1/12/2024 8:37 AM	Application extens...	67 KB
liquid.h	1/12/2024 8:37 AM	C Header Source F...	481 KB
mkl_dfti.h	4/30/2024 3:30 AM	C Header Source F...	11 KB
mkl_service.h	4/30/2024 3:30 AM	C Header Source F...	8 KB
mkl_types.h	4/30/2024 3:30 AM	C Header Source F...	5 KB
vcomp140.dll	5/10/2023 7:02 AM	Application extens...	159 KB
vcruntime140.dll	2/1/2002 6:02 PM	Application extens...	90 KB

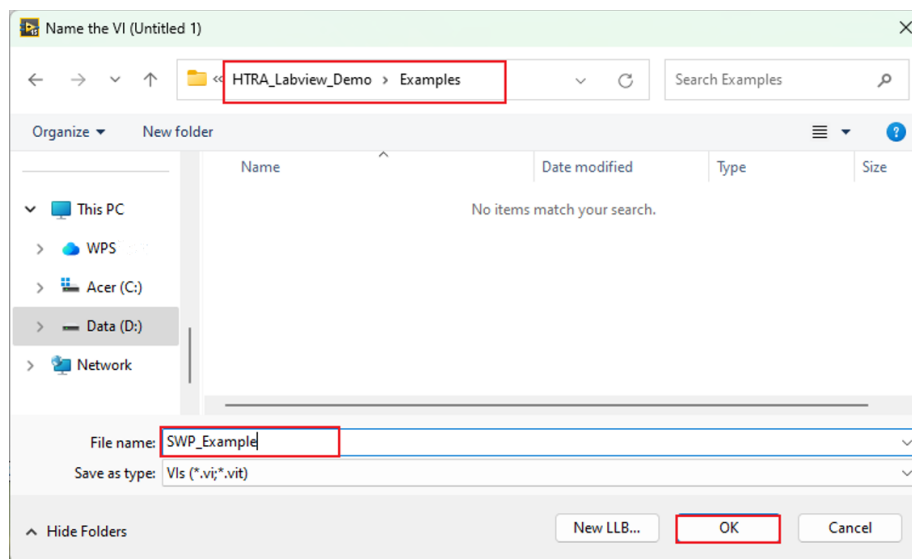
6. In the LabVIEW project, add the newly created Examples folder and the htra_api folder to the project, and then save.



7. Create a new VI in the "Examples" folder. You can then call the exported LabVIEW API functions within the block diagram. The calling process is consistent with that in the C environment.



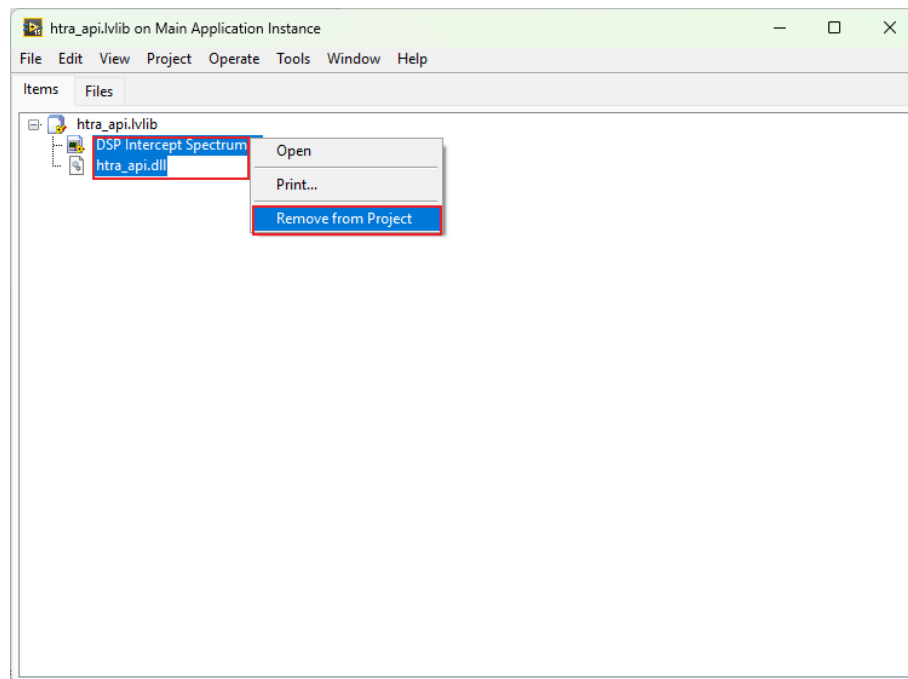
8. Finally, save this program to the Examples folder and rename it.



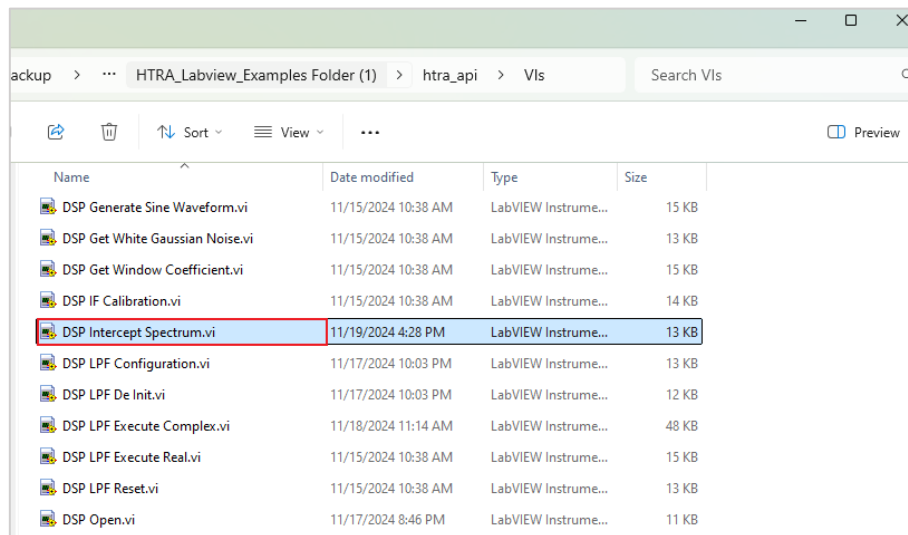
8.1.3 Use the newly exported library functions in an existing project.

The following uses the library function `DSP_InterceptSpectrum()` as an example to illustrate how to use newly imported functions within an existing project.

1. For the method of exporting library functions, please refer to section 8.1.1. Note that in the popped-up `htra_api.lvlib`, you should delete the exported functions and DLL files from the project, and then close `htra_api.lvlib`, as shown in the figure below.

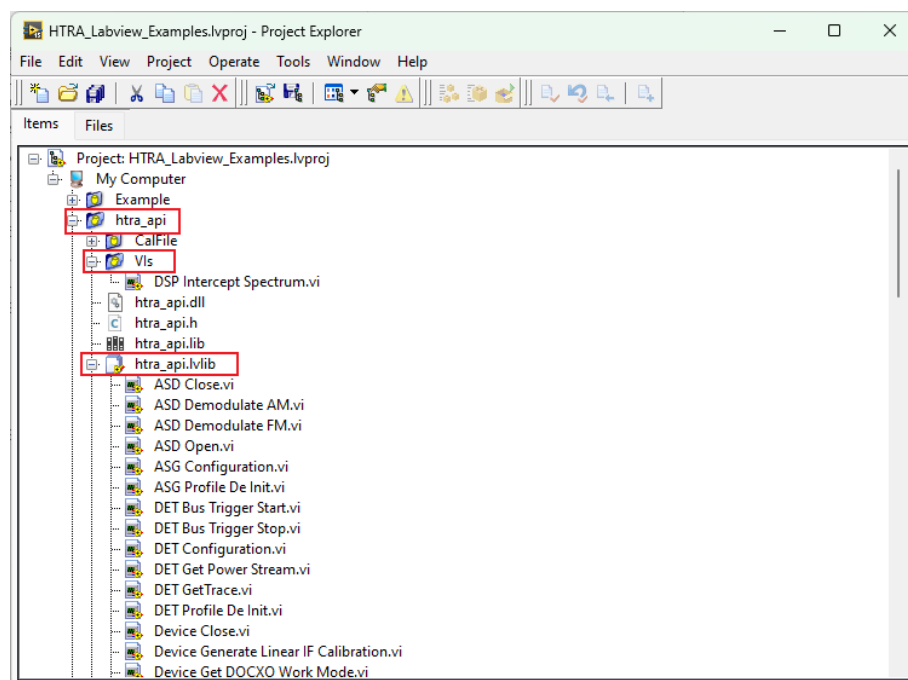


2. Copy the exported `DSP_InterceptSpectrum` function VI to the `htra_api\VIs` folder of the existing project.

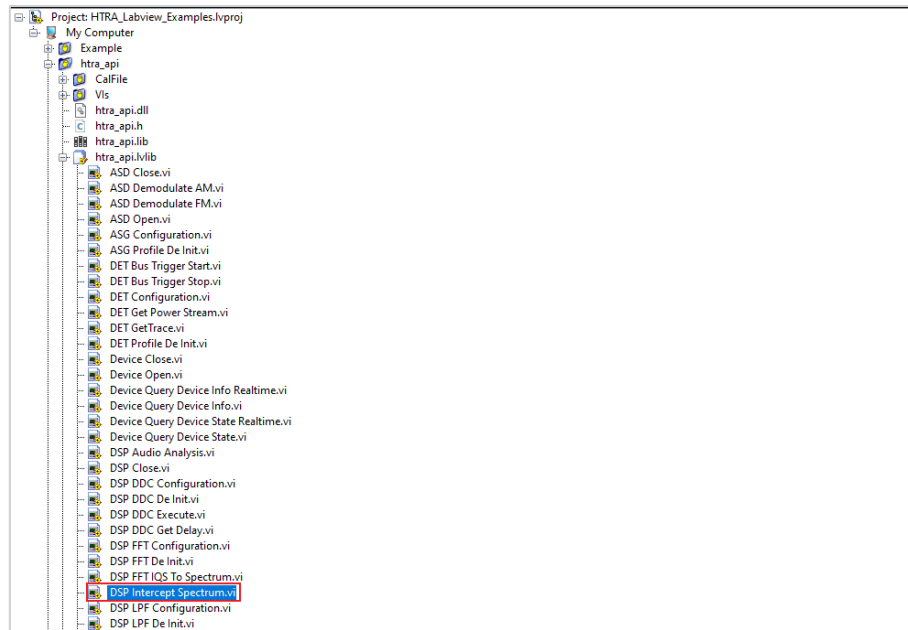


Name	Date modified	Type	Size
DSP Generate Sine Waveform.vi	11/15/2024 10:38 AM	LabVIEW Instrume...	15 KB
DSP Get White Gaussian Noise.vi	11/15/2024 10:38 AM	LabVIEW Instrume...	13 KB
DSP Get Window Coefficient.vi	11/15/2024 10:38 AM	LabVIEW Instrume...	15 KB
DSP IF Calibration.vi	11/15/2024 10:38 AM	LabVIEW Instrume...	14 KB
DSP Intercept Spectrum.vi	11/19/2024 4:28 PM	LabVIEW Instrume...	13 KB
DSP LPF Configuration.vi	11/17/2024 10:03 PM	LabVIEW Instrume...	13 KB
DSP LPF De Init.vi	11/17/2024 10:03 PM	LabVIEW Instrume...	12 KB
DSP LPF Execute Complex.vi	11/18/2024 11:14 AM	LabVIEW Instrume...	48 KB
DSP LPF Execute Real.vi	11/15/2024 10:38 AM	LabVIEW Instrume...	15 KB
DSP LPF Reset.vi	11/15/2024 10:38 AM	LabVIEW Instrume...	13 KB
DSP Open.vi	11/17/2024 8:46 PM	LabVIEW Instrume...	11 KB

- Open the project with LabVIEW, then open the `htra_api\Vis` folder and `htra_api.lvlib` within the project.



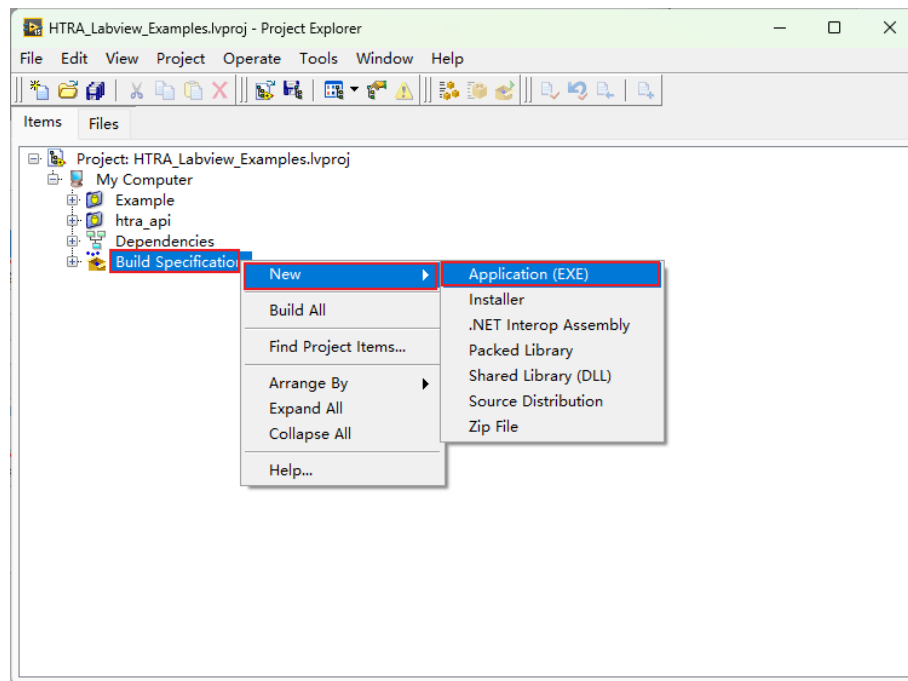
- Drag the `DSP_InterceptSpectrum` function VI from the `Vis` folder into `htra_api.lvlib`. At this point, you can use the newly added VI function normally.



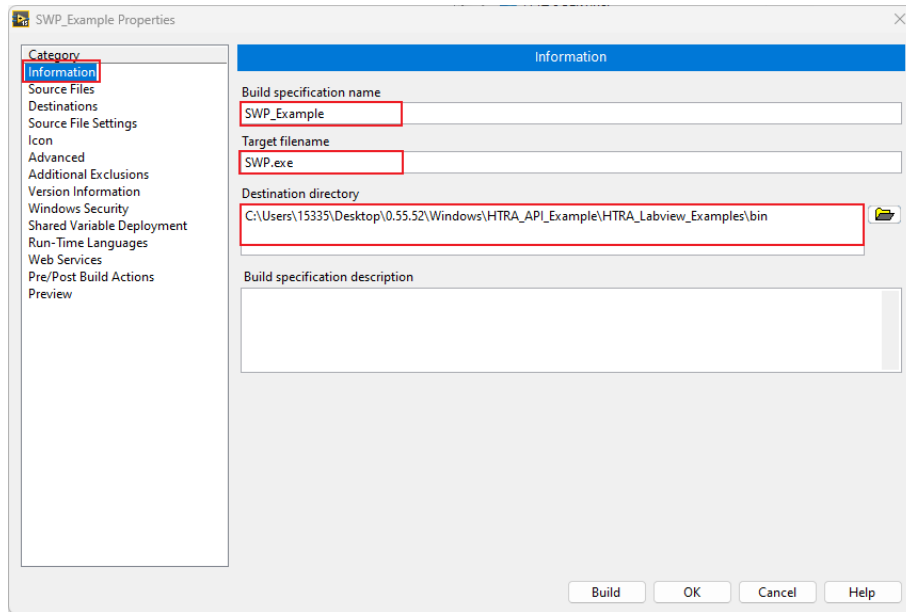
8.1.4 Generate an exe from the vi in Labview

The following uses the LabVIEW project located in the \Windows\HTRA_API_Example folder on the USB flash drive as an example to illustrate how to build a program VI into an executable (.exe) file.

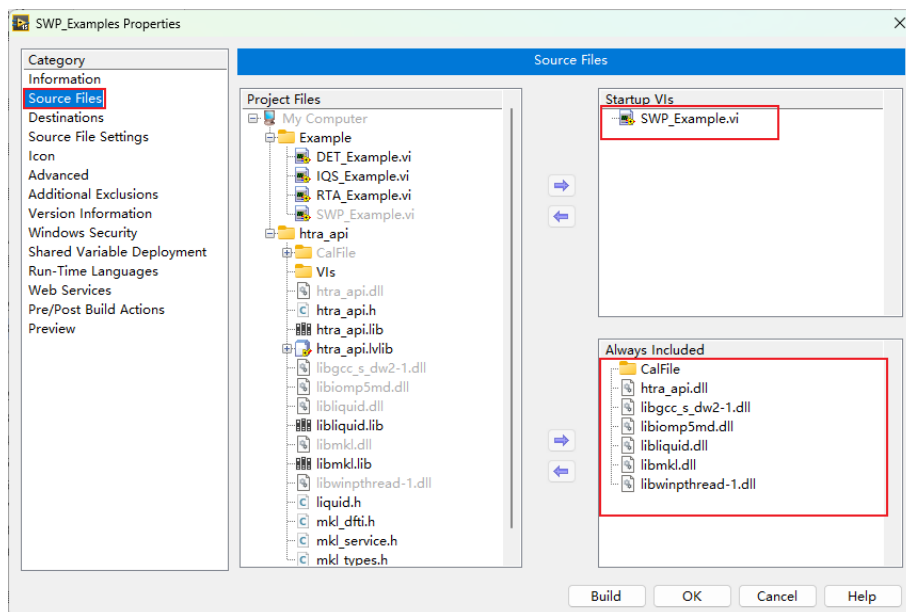
1. Open the LabVIEW project, then select "Build Specifications --> New --> Application (EXE)".



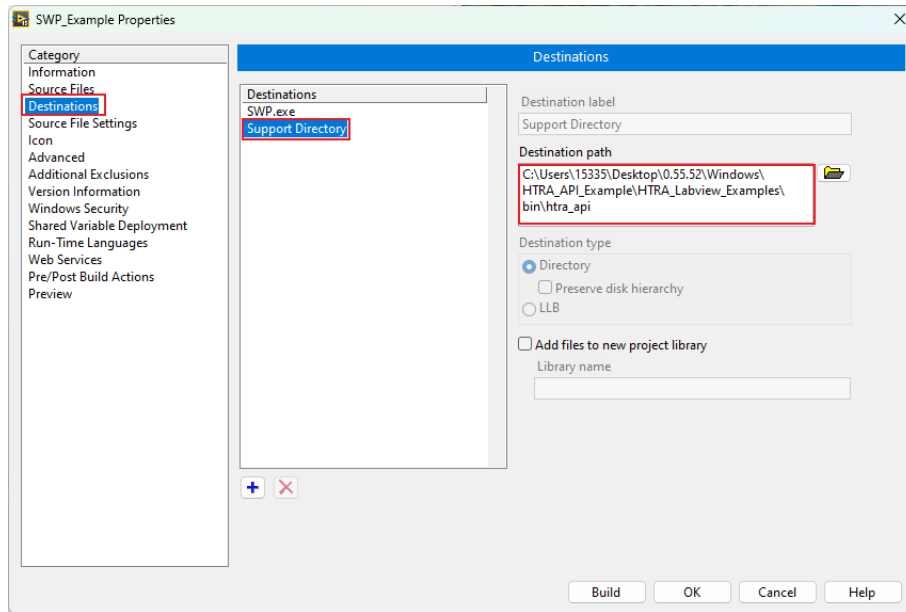
2. Fill in the standard name of the program file generated, the name of the exe, and the target directory path in "Information".



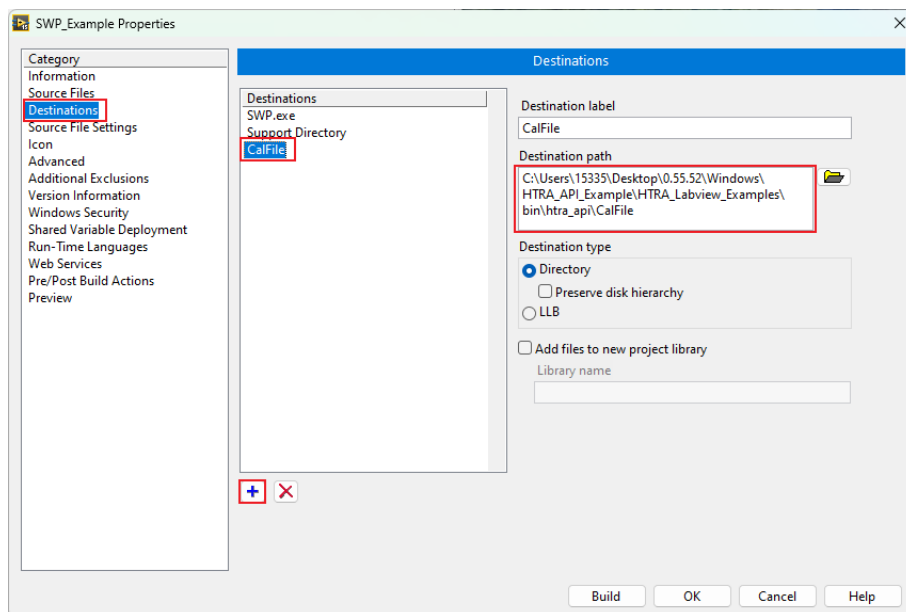
3. Select the vi programs, CalFile folder, and all dependent library files to be exported as exe in "Source Files".



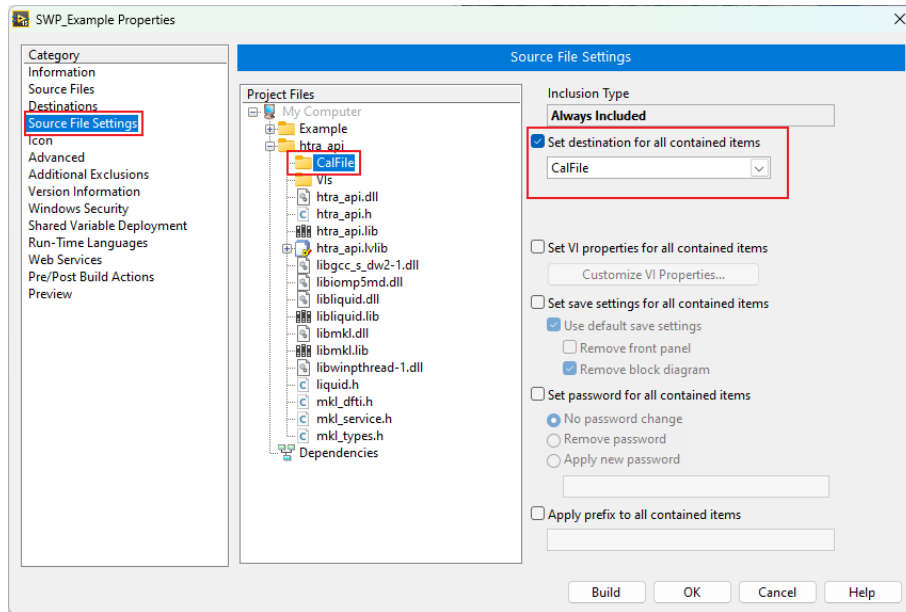
4. Add a layer of htra_api to the target path of "Support Directory" in "Destinations" to store the libraries and calibration folder.



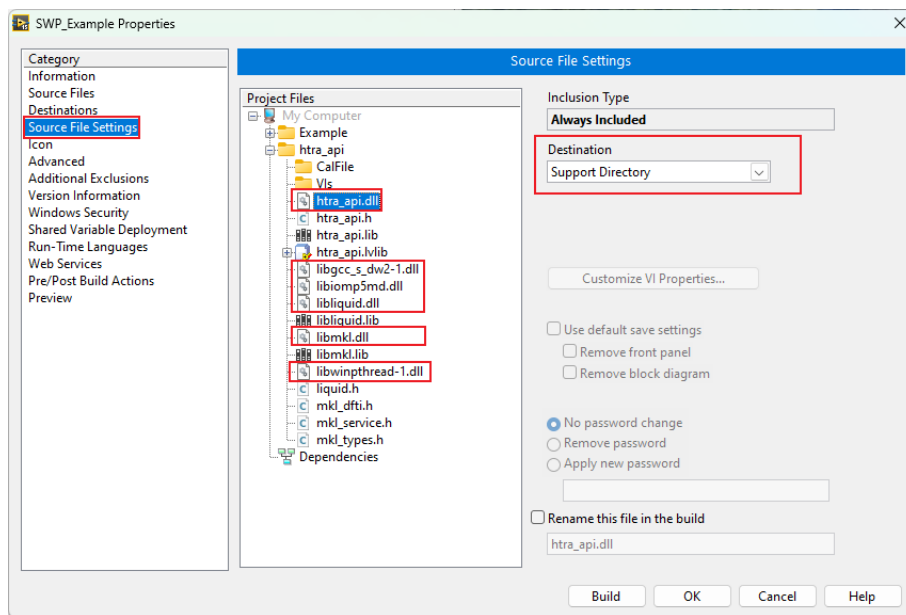
5. Add a CalFile folder to store the device's calibration files, and add the target path of CalFile to the directory under "Support Directory".



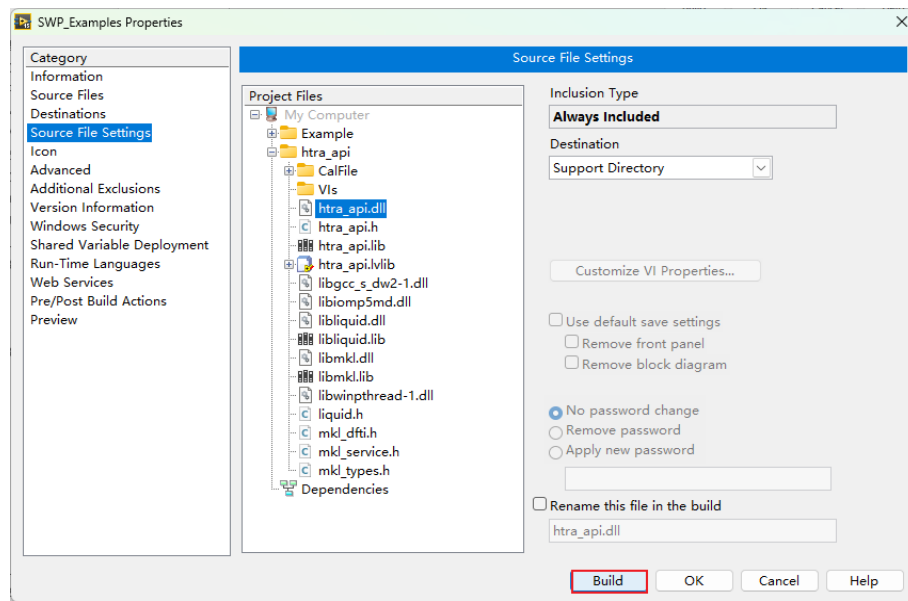
6. In "Source Files Settings", select the target path of the calibration files to "CalFile".



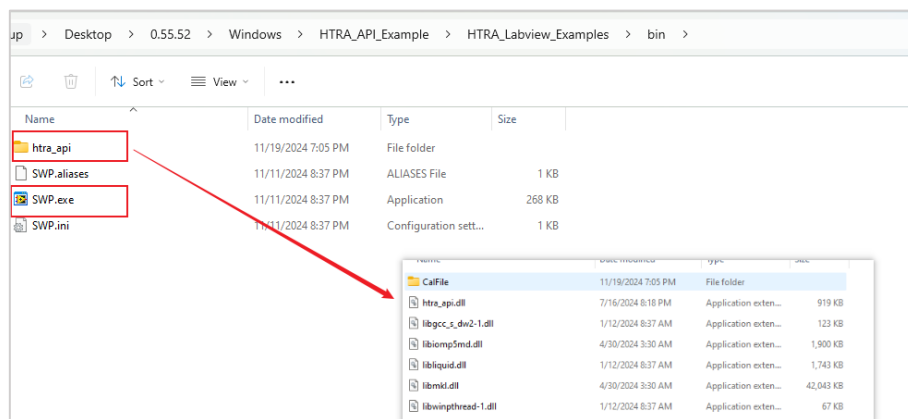
7. Select the target paths of all dependent libraries to the "Support Directory".



8. Click "Build".



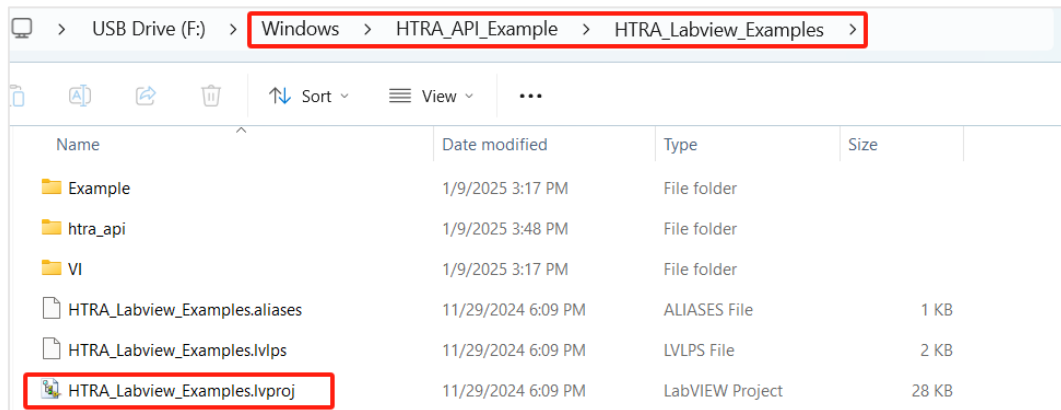
9. At this point, the generation of the exe program from the vi program in Labview is complete.



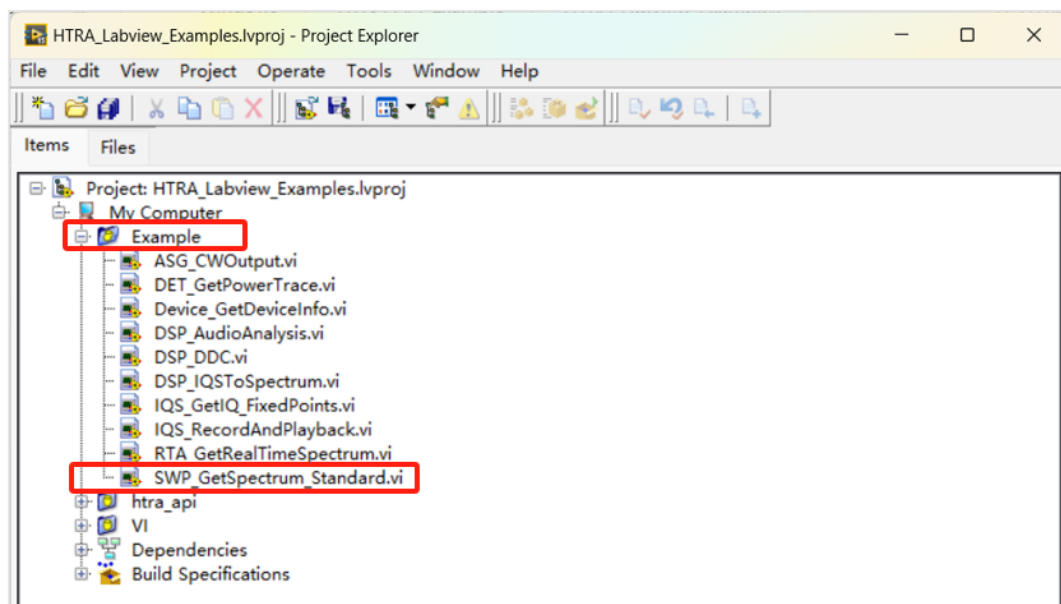
8.2 The usage process of Labview examples

The usage process of Labview examples included in the USB drive is as follows:

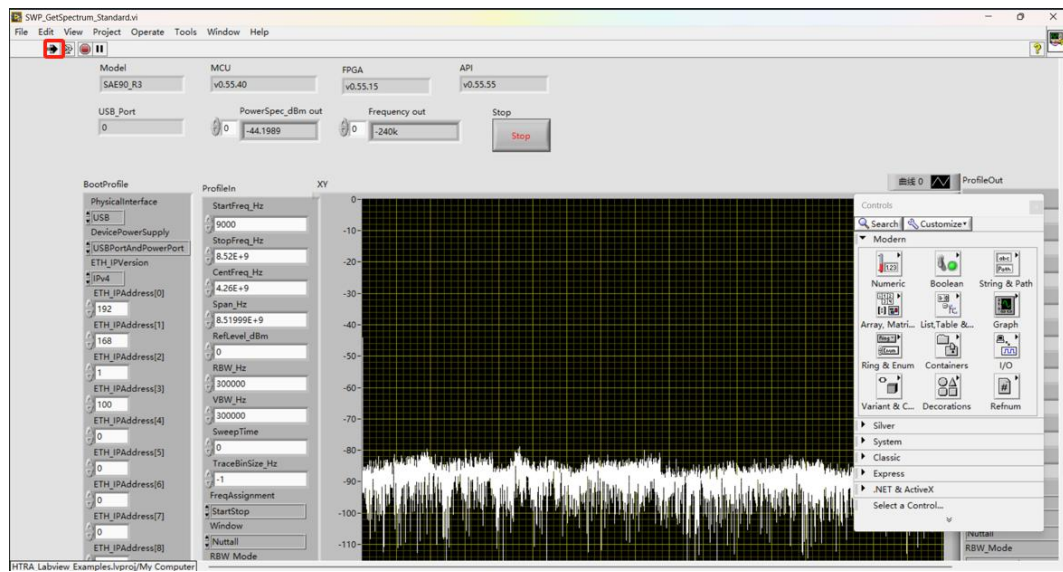
1. Open the accompanying USB drive using LabVIEW in the folder Windows\HTRA_API_Example\HTRA_Labview_Examples, and open the project HTRA_Labview_Examples.lvproj.



- After opening the project, double-click to open any routine vi in the Example folder. For example, here we open SWP_GetSpectrum_Standard.vi to use the SWP mode routine.



- Once the program is opened, simply click the run button in the upper left corner, as shown in the image where the program is running normally.



8.3 Labview Example Description

8.3.1 Get device information

Device_GetDeviceInfo.vi: An example for obtaining various device information, including: API version, device model, device UID, MCU version, FPGA version, and device temperature.

8.3.2 Standard spectrum acquisition

SWP_GetSpectrum_Standard.vi: Obtains standard spectrum data within a specified frequency band and displays the image.

8.3.3 Obtain IQ Data for a Fixed Number of Points or Duration

IQS_GetIQ_FixedPoints.vi: Obtains IQ data with a fixed number of points. When the device receives a Bus trigger signal, it returns IQ data with a fixed number of points.

8.3.4 Streaming and reading IQ data

IQS_RecordAndPlayback.vi: Obtains IQ data, records the IQ data as a txt file, and plays back the recorded IQ data.

8.3.5 IQ to Spectrum Data

DSP_IQSToSpectrum.vi: Obtains IQ data and converts the acquired IQ data into spectrum data.

8.3.6 Digital Downconversion

DSP_DDC.vi: Performs digital downconversion on the IQ data stream and resamples to generate a sub-IQ stream for further spectrum analysis.

8.3.7 Audio Analysis

DSP_AudioAnalysis.vi: Analyzes audio voltage (V), audio frequency (Hz), signal-to-noise ratio (dB), and total harmonic distortion (%).

8.3.8 Obtain Power Detection Data for a Fixed Number of Points or Duration

DET_GetPowerTrace.vi: Obtain a fixed number of DET data points. When the device receives a Bus trigger signal, it returns a fixed number of DET data points.

8.3.9 Obtain real-time spectrum data for a fixed number of points or duration

RTA_GetRealTimeSpectrum.vi: Obtain a fixed number of RTA data points. When the device receives a Bus trigger signal, it returns a fixed number of RTA data points.

8.3.10 ASG Signal Source Output Signal

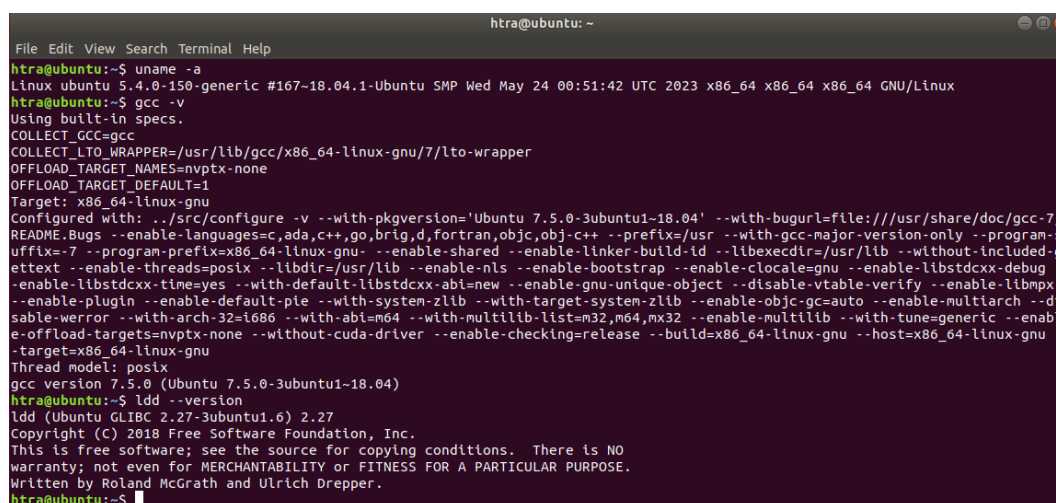
ASG_CWOutput.vi: Control the internal signal generator of the device to output single-tone signals, sweep signals, and power scan signals.

9. Linux

9.1 Environment Version Compatibility Self-Check

When using the device in a Linux system, you first need to confirm whether the current Linux environment's system architecture, gcc version, and GLIBC version are supported according to the following process:

1. Open the terminal and enter "uname -a" to check the Linux system architecture, for example, here the Linux system architecture is x86_64.
2. In the terminal, enter "gcc -v" to check the system gcc version, for example, here the gcc version is 7.5.0.
3. In the terminal, enter "ldd --version" to check the system GLIBC version, for example, here the GLIBC version is 2.27.



```
htra@ubuntu: ~  
File Edit View Search Terminal Help  
htra@ubuntu:~$ uname -a  
Linux ubuntu 5.4.0-150-generic #167~18.04.1-Ubuntu SMP Wed May 24 00:51:42 UTC 2023 x86_64 x86_64 x86_64 GNU/Linux  
htra@ubuntu:~$ gcc -v  
Using built-in specs.  
COLLECT_GCC=gcc  
COLLECT_LTO_WRAPPER=/usr/lib/gcc/x86_64-linux-gnu/7/lto-wrapper  
OFFLOAD_TARGET_NAMES=nvptx-none  
OFFLOAD_TARGET_DEFAULT=1  
Target: x86_64-linux-gnu  
Configured with: ../src/configure -v --with-pkgversion='Ubuntu 7.5.0-3ubuntu1~18.04' --with-bugurl=file:///usr/share/doc/gcc-7/README.Bugs --enable-languages=c,ada,c++,go,brig,d,fortran,objc,obj-c++ --prefix=/usr --with-gcc-major-version-only --program-suffix=-7 --program-prefix=x86_64-linux-gnu- --enable-shared --enable-linker-build-id --libexecdir=/usr/lib --without-included-g++ --enable-threads=posix --libdir=/usr/lib --enable-nls --enable-bootstrap --enable-clocale=gnu --enable-libstdcxx-debug --enable-libstdcxx-time=yes --with-default-libstdcxx-abi=new --enable-gnu-unique-object --disable-vtable-verify --enable-libmpx --enable-plugin --enable-default-pie --with-system-zlib --with-target-system-zlib --enable-objc-gc=auto --enable-multiarch --disable-werror --with-arch-32=i686 --with-abi=m64 --with-multilib-list=m32,m64,mx32 --enable-multilib --with-tune=generic --enable-offload-targets=nvptx-none --without-cuda-driver --enable-checking=release --build=x86_64-linux-gnu --host=x86_64-linux-gnu --target=x86_64-linux-gnu  
Thread model: posix  
gcc version 7.5.0 (Ubuntu 7.5.0-3ubuntu1~18.04)  
htra@ubuntu:~$ ldd --version  
ldd (Ubuntu GLIBC 2.27-3ubuntu1.6) 2.27  
Copyright (C) 2018 Free Software Foundation, Inc.  
This is free software; see the source for copying conditions. There is NO  
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  
Written by Roland McGrath and Ulrich Drepper.  
htra@ubuntu:~$
```

4. Confirm whether the current environment is supported according to the terminal information comparison table. If it is not yet supported, please contact technical support personnel.

X86 processor	Support Intel and AMD processors
ARM processor	aarch64 (armv8), armv7 processors, such as: Raspberry Pi 4b, RK3399, RK3568, RK3588, T507, NVIDIA Jetson TX2
Compilation	gcc4.8, glib2.17 and above

environment	
Distribution	Customized system for Raspberry Pi 4b, Ubuntu 18.04, etc.

9.2 Accompanying documentation

Currently, the Linux section of the accompanying USB drive contains the following materials:

9.2.1 HTRA_C++_Examples

The HTRA_C++_Examples folder contains:

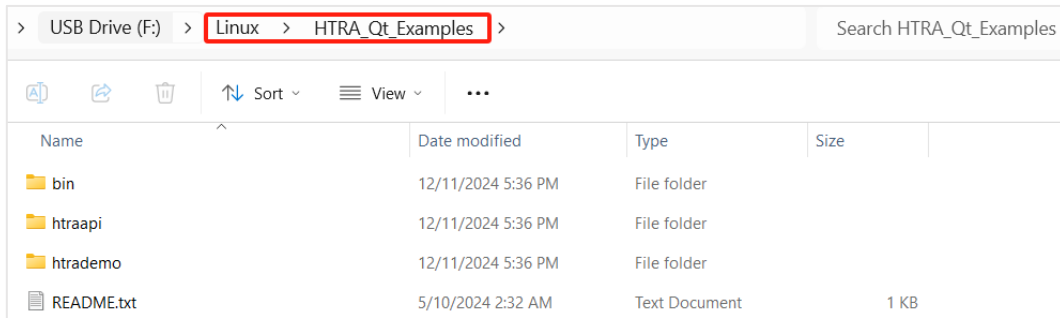
1. Examples folder: C++ example programs (see [Chapter9.4](#) for usage).
2. Makefile: A build script used to compile the example programs into executable files.
3. bin folder: Used to store device calibration files and executable files generated from the example programs.

Name	Date modified	Type	Size
bin	12/11/2024 5:36 PM	File folder	
Examples	12/11/2024 5:36 PM	File folder	
Makefile	4/30/2024 3:30 AM	File	1 KB
README.txt	4/30/2024 3:30 AM	Text Document	1 KB

9.2.2 HTRA_Qt_Examples

The HTRA_Qt_Examples folder contains:

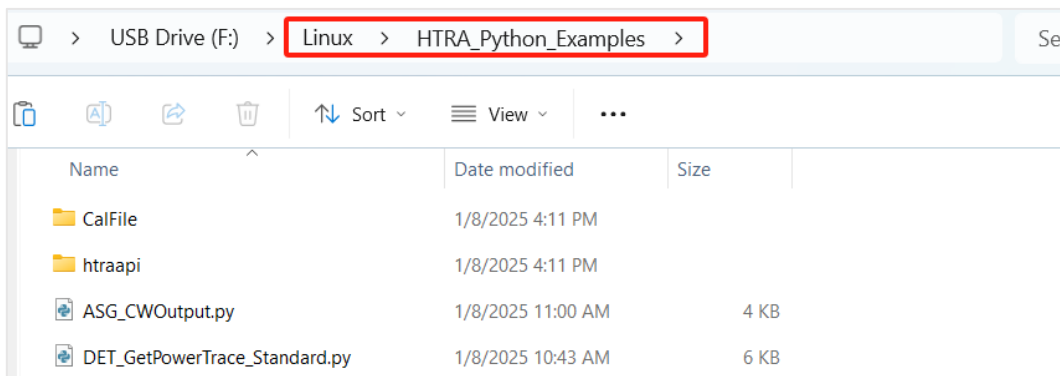
1. htrademo folder: Qt examples and pro files (see [Chapter9.5](#) for usage).
2. bin folder: Used to store device calibration files and executable files compiled from the example programs.
3. htraapi folder: Used to store dynamic link libraries.



9.2.3 HTRA_Python_Examples

HTRA_Python_Examples folder specifically contains:

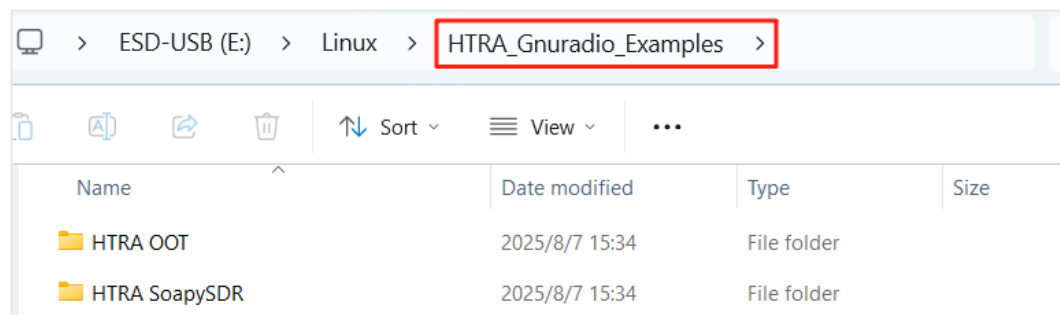
1. Python example programs (see [Chapter9.6](#) for usage).
2. CalFile folder: stores device calibration files.
3. Htraapi folder: used to store dynamic link libraries.



9.2.4 HTRA_Gnuradio

The HTRA_Gnuradio folder contains two adaptation for GNU Radio:

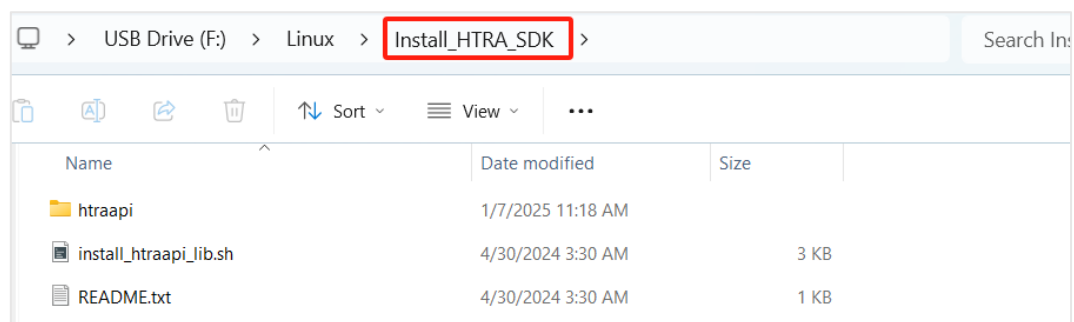
1. The HTRA OOT method.
2. The SoapySDR adaptation method.



9.2.5 Install_HTRA_SDK

Install_HTRA_SDK folder contains:

1. install_htraapi_lib.sh: driver configuration script.
2. Install_HTRA_SDK\htraapi\configs folder: driver configuration files.
3. Install_HTRA_SDK\htraapi\inc folder: header files.
4. Install_HTRA_SDK\htraapi\lib\arrch64 folder: arrch64 architecture dynamic link libraries.
5. Install_HTRA_SDK\htraapi\lib\arrch64_gcc7.5 folder: Dynamic link library for arrch64 architecture with more efficient FFT (requires system gcc version higher than 7.5).
6. Install_HTRA_SDK\htraapi\lib\x86_64 folder: Dynamic link library for x86_64 architecture.
7. Install_HTRA_SDK\htraapi\lib\x86_64_gcc5.4 folder: Dynamic link library for x86_64 architecture with more efficient FFT (requires system gcc version higher than 5.4).
8. Install_HTRA_SDK\htraapi\lib\armv7 folder: Dynamic link library for armv7 architecture.

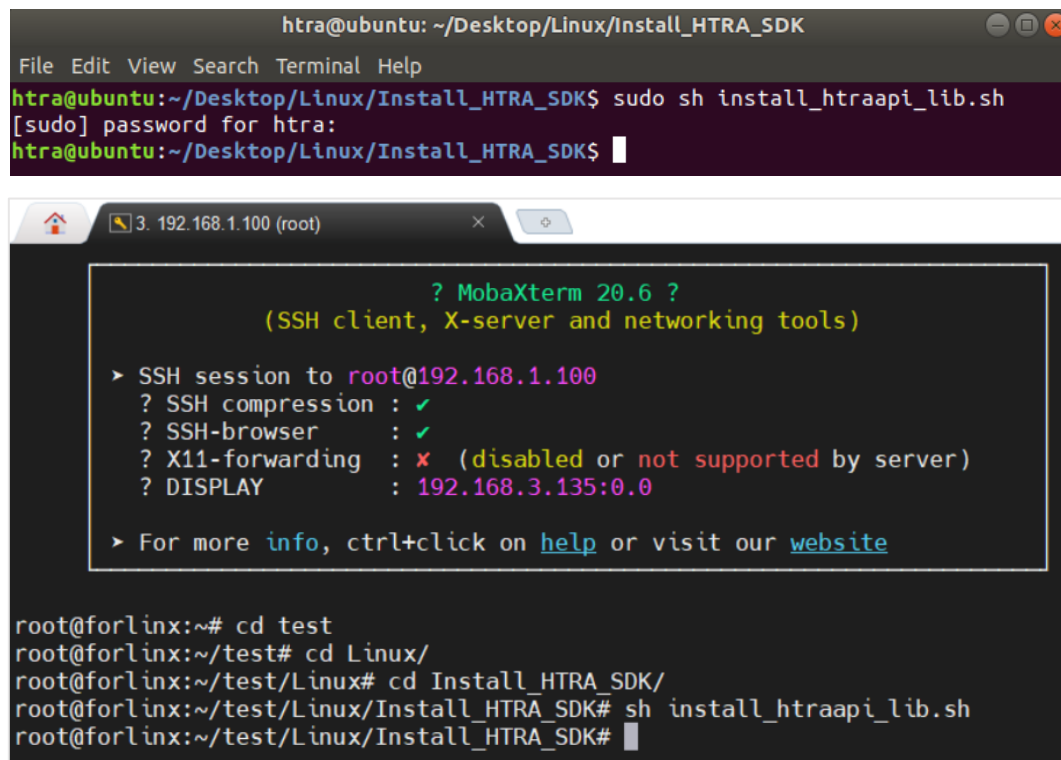


> USB Drive (F:) > Linux > Install_HTRA_SDK > htraapi > lib > Search lib				
Sort View ...				
Name	Date modified	Type	Size	
aarch64	12/11/2024 5:36 PM	File folder		
aarch64_gcc7.5	12/11/2024 5:36 PM	File folder		
armv7	12/11/2024 5:36 PM	File folder		
x86_64	12/11/2024 5:36 PM	File folder		
x86_64_gcc5.4	12/11/2024 5:36 PM	File folder		

9.3 Driver file configuration

To use the device in Linux, the driver file must be configured first. The specific process is as follows:

1. Driver file configuration: First, drag the Install_HTRA_SDK folder into the Linux host computer, then open a terminal in the Install_HTRA_SDK folder and enter "sudo sh install_htraapi_lib.sh" to configure the driver file. If the special development board does not have the sudo command, simply enter "sh install_htraapi_lib.sh".

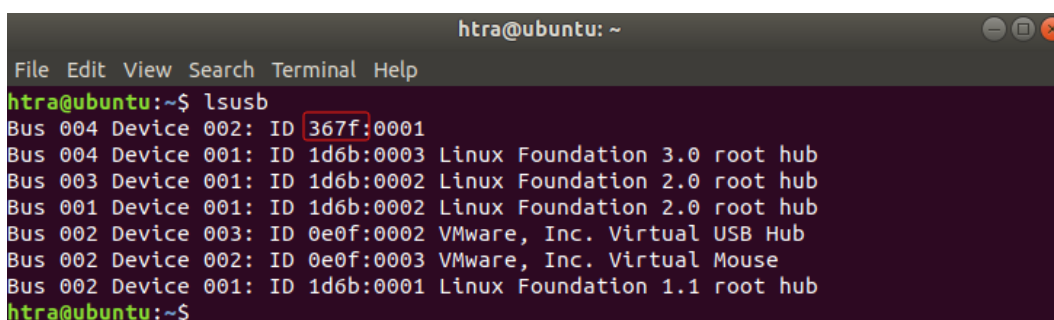


```
htra@ubuntu: ~/Desktop/Linux/Install_HTRA_SDK
File Edit View Search Terminal Help
htra@ubuntu:~/Desktop/Linux/Install_HTRA_SDK$ sudo sh install_htraapi_lib.sh
[sudo] password for htra:
htra@ubuntu:~/Desktop/Linux/Install_HTRA_SDK$ █

3. 192.168.1.100 (root)
? MobaXterm 20.6 ?
(SSH client, X-server and networking tools)
> SSH session to root@192.168.1.100
? SSH compression : ✓
? SSH-browser      : ✓
? X11-forwarding   : ✗ (disabled or not supported by server)
? DISPLAY          : 192.168.3.135:0.0
> For more info, ctrl+click on help or visit our website

root@forlinux:~# cd test
root@forlinux:~/test# cd Linux/
root@forlinux:~/test/Linux# cd Install_HTRA_SDK/
root@forlinux:~/test/Linux/Install_HTRA_SDK# sh install_htraapi_lib.sh
root@forlinux:~/test/Linux/Install_HTRA_SDK# █
```

2. Configuration check: Ensure the device is correctly connected to the host computer (if the host computer is a virtual machine, ensure the device is connected to the virtual machine and that USB compatibility is 3.1) and provide normal power to the device. At this point, as shown in the figure, enter "lsusb" in the terminal to view the list of USB devices on the machine, where "ID: 6430 (or ID: 3675 or ID: 04b5)" indicates successful device connection.



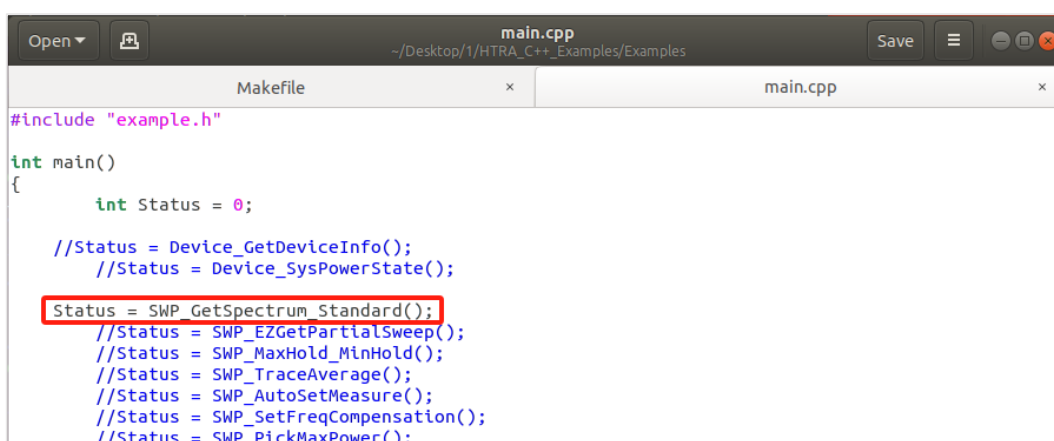
```
htra@ubuntu: ~  
File Edit View Search Terminal Help  
htra@ubuntu:~$ lsusb  
Bus 004 Device 002: ID 367f:0001  
Bus 004 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub  
Bus 003 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub  
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub  
Bus 002 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub  
Bus 002 Device 002: ID 0e0f:0003 VMware, Inc. Virtual Mouse  
Bus 002 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub  
htra@ubuntu:~$
```

9.4 C++ example usage and project creation

9.4.1 C++ example usage

Under the premise that the device is properly connected and the driver files have been correctly configured as per [Chapter9.3](#), if you wish to use the C++ examples included on the USB drive, you can refer to the following process (the specific functions of the examples can be directly viewed in the description in [Chapter 1](#)):

1. Select the program to compile: First, copy the Linux\ HTRA_C++_Examples folder from the USB drive to the host computer. Double-click to open main.cpp in the Examples folder, and uncomment the example you need to test (the following steps will take the SWP_GetSpectrum_Standard example as an example), as shown in the figure to uncomment.



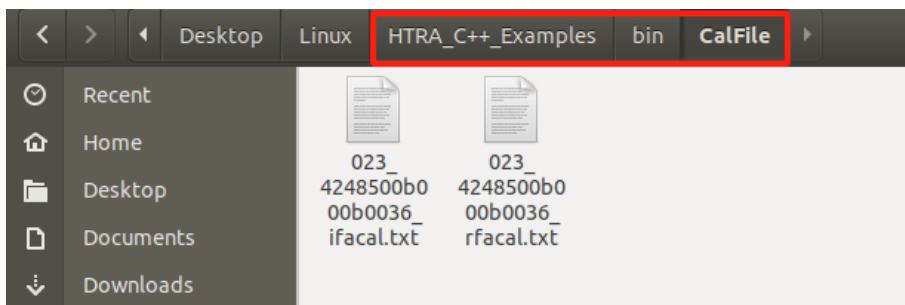
```
main.cpp  
~/Desktop/1/HTRA_C++_Examples/Examples  
Save  
Makefile x main.cpp x  
#include "example.h"  
  
int main()  
{  
    int Status = 0;  
  
    //Status = Device_GetDeviceInfo();  
    //Status = Device_SysPowerState();  
  
    Status = SWP_GetSpectrum_Standard();  
    //Status = SWP_EZGetPartialSweep();  
    //Status = SWP_MaxHold_MinHold();  
    //Status = SWP_TraceAverage();  
    //Status = SWP_AutoSetMeasure();  
    //Status = SWP_SetFreqCompensation();  
    //Status = SWP_PickMaxPower();  
}
```

2. Refer to the system architecture in [Chapter9.1](#), and based on the selected test example, open the terminal in the HTRA_C++_Examples folder, following the host computer's system architecture.

- 1) For x86_64 system, input:
(the example routine here is SWP_GetSpectrum_Standard)
make Example=SWP_GetSpectrum_Standard
- 2) For aarch64 system, input:
make TARG=aarch64 Example=SWP_GetSpectrum_Standard
- 3) For armv7 system, input:
make TARG=armv7 Example=SWP_GetSpectrum_Standard

```
htra@ubuntu: ~/Desktop/1/HTRA_C++_Examples
File Edit View Search Terminal Help
htra@ubuntu:~/Desktop/1/HTRA_C++_Examples$ make Example=SWP_GetSpectrum_Standard
g++ -o bin/SWP_GetSpectrum_Standard Examples/SWP_GetSpectrum_Standard.cpp Exampl
es/main.cpp Examples/Error_handling.cpp -std=c++11 -I/opt/htraapi/inc -L/opt/htr
aapi/lib/x86_64 -lhtraapi -Wl,-rpath='/opt/htraapi/lib/x86_64'
htra@ubuntu:~/Desktop/1/HTRA_C++_Examples$
```

3. Verify the calibration file: Open the HTRA_C++_Examples\bin\CalFile folder, and ensure that the folder contains the device calibration files, as shown in the figure.



4. Run the program: After the program compiles successfully and the calibration is confirmed to be correct, open the terminal and input:

./bin/SWP_GetSpectrum_Standard

The example shown in the figure is a normal operation example.

```
htra@ubuntu: ~/Desktop/1/HTRA_C++_Examples
File Edit View Search Terminal Help
htra@ubuntu:~/Desktop/1/HTRA_C++_Examples$ make Example=SWP_GetSpectrum_Standard
g++ -o bin/SWP_GetSpectrum_Standard Examples/SWP_GetSpectrum_Standard.cpp Exampl
es/main.cpp Examples/Error_handling.cpp -std=c++11 -I/opt/htraapi/inc -L/opt/htr
aapi/lib/x86_64 -lhtraapi -Wl,-rpath='/opt/htraapi/lib/x86_64'
htra@ubuntu:~/Desktop/1/HTRA_C++_Examples$ ./bin/SWP_GetSpectrum_Standard
Device is opened successfully
Configuration delievery succeeded.
```

9.4.2 C++ Project Creation and Compilation

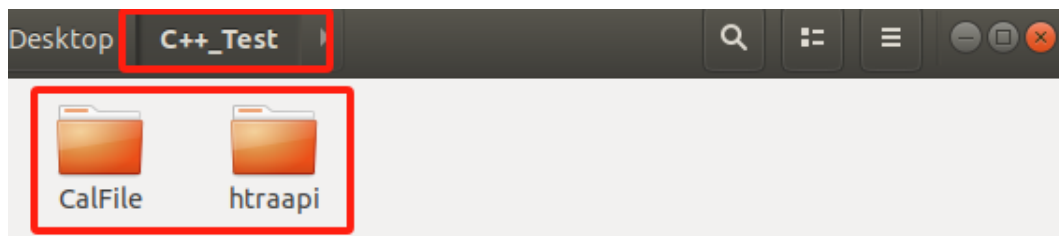
Assuming that the driver files have been correctly configured as per [Chapter9.3](#), if you

want to create a C++ project for compilation, please refer to the following process:

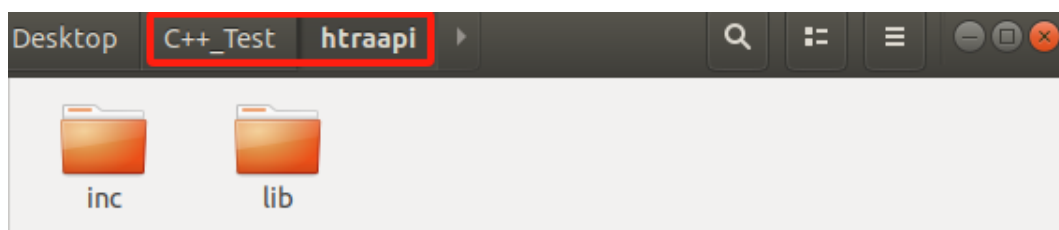
Write Code: Since the Linux dynamic link library provided with the USB drive is identical to that in Windows, the code only needs to comply with the API programming guidelines.

Compile and Run:

1. As shown in the figure, first create a new folder to store the entire project (taking C++_Test as an example), then create a CalFile folder within the folder to store calibration files, and create an htraapi folder to store header files and dynamic link libraries.

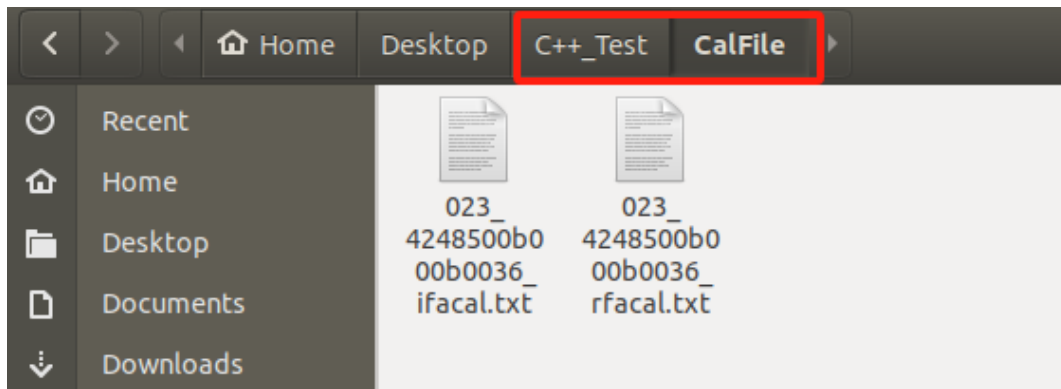


2. Create an inc folder under the htraapi folder to store header files, and a lib folder to store dynamic link libraries.

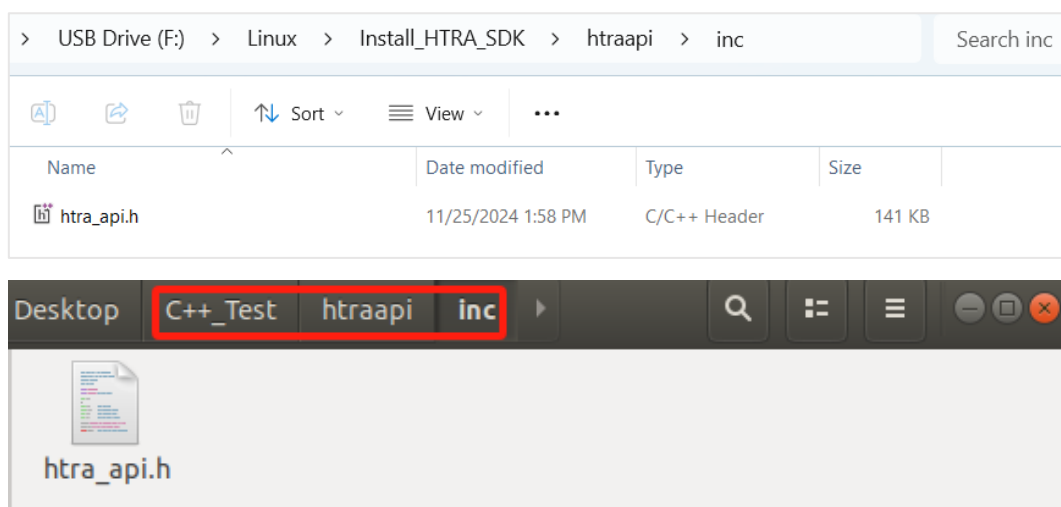


3. Copy the files from the CalFile folder on the provided USB drive to the newly created C++_Test\CalFile folder.

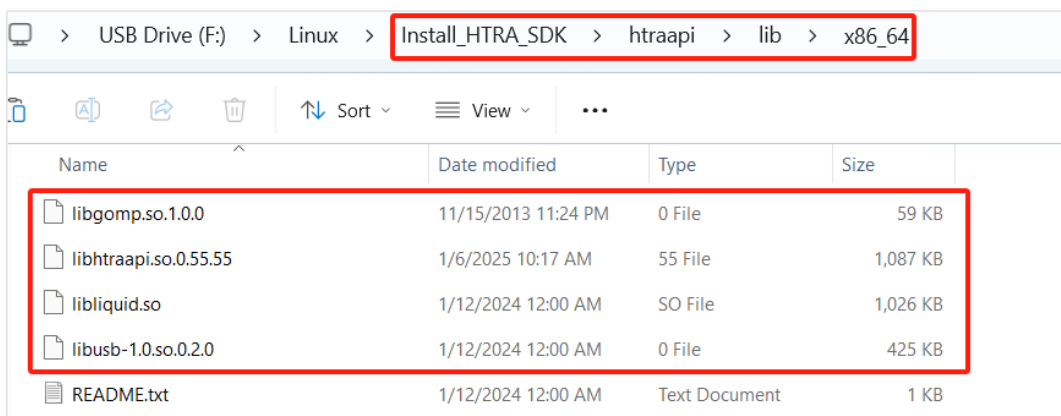
Name	Date modified	Type	Size
023_4248500b000b0036_ifacal.txt	8/9/2024 10:23 AM	Text Document	431 KB
023_4248500b000b0036_rfacal.txt	8/9/2024 10:23 AM	Text Document	12,214 KB

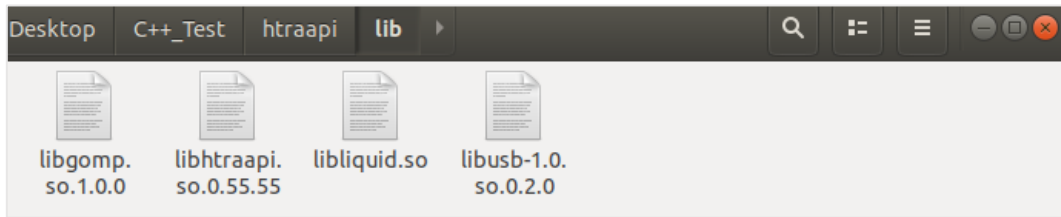


4. Copy the header files from the Linux\Install_HTRA_SDK\htraapi\inc folder on the provided USB drive to the newly created C++_Test\htraapi\inc folder.



5. Refer to the system architecture in Chapter9.1, and then according to the instructions in Chapter9.2.4, copy the dynamic link libraries corresponding to the architecture from the Linux\Install_HTRA_SDK\htraapi\lib folder to the newly created C++_Test\htraapi\lib folder (taking the x86_64 architecture host computer as an example).



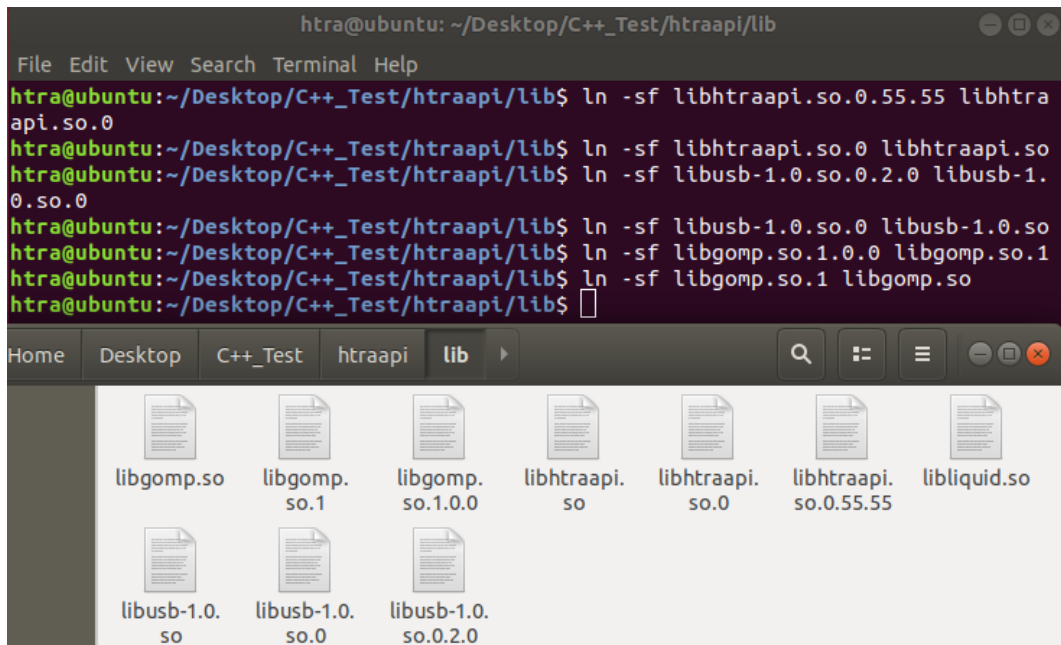


6. Open the terminal in the lib folder location and enter the following commands to create soft links for the copied dynamic link libraries (the commands for the dynamic link libraries of the three architectures are the same):

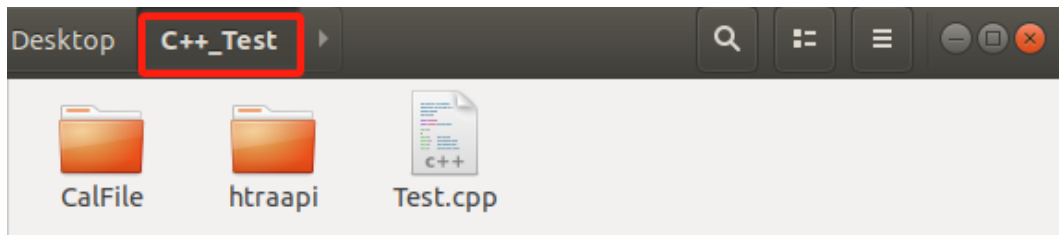
- In -sf libhtraapi.so.0.55.5 libhtraapi.so.0

(Here, the libhtraapi.so library is taken as an example with version 0.55.55; modify the version number for other versions.)

- In -sf libhtraapi.so.0 libhtraapi.so
- In -sf libusb-1.0.so.0.2.0 libusb-1.0.so.0
- In -sf libusb-1.0.so.0 libusb-1.0.so
- In -sf libgomp.so.1.0.0 libgomp.so.1
- In -sf libgomp.so.1 libgomp.so



7. Store the written code files in the outermost folder of C++_Test.



8. Compile to generate the executable file: First, check the system architecture according to the process in Chapter 9.1, then open the terminal in the C++_Test folder (the image below takes the x86_64 system as an example), and input according to the host system architecture.

1) For x86_64 system input (example test.cpp here):

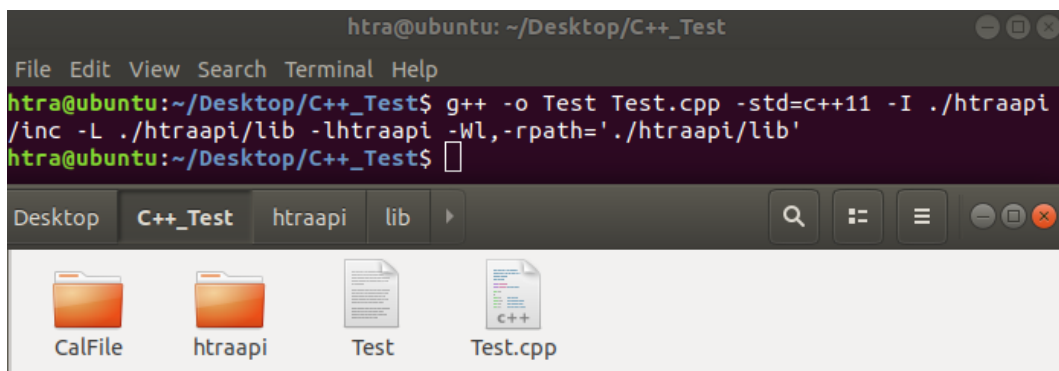
```
g++ -o Test Test.cpp -std=c++11 -I ./htraapi/inc -L ./htraapi/lib -lhtraapi -Wl,-rpath='./htraapi/lib'
```

2) Input for aarch64 system:

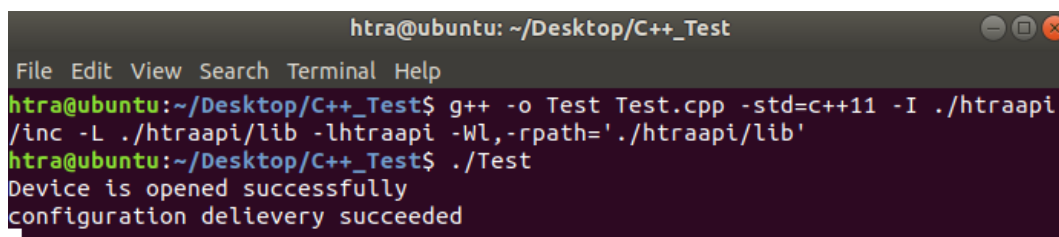
```
aarch64-linux-gnu-g++ -o Test Test.cpp -std=c++11 -I ./htraapi/inc -L ./htraapi/lib -lhtraapi -Wl,-rpath='./htraapi/lib'
```

3) For armv7 system, input:

```
arm-linux-gnueabi-g++ -o Test Test.cpp -std=c++11 -I ./htraapi/inc -L ./htraapi/lib -lhtraapi -Wl,-rpath='./htraapi/lib'
```



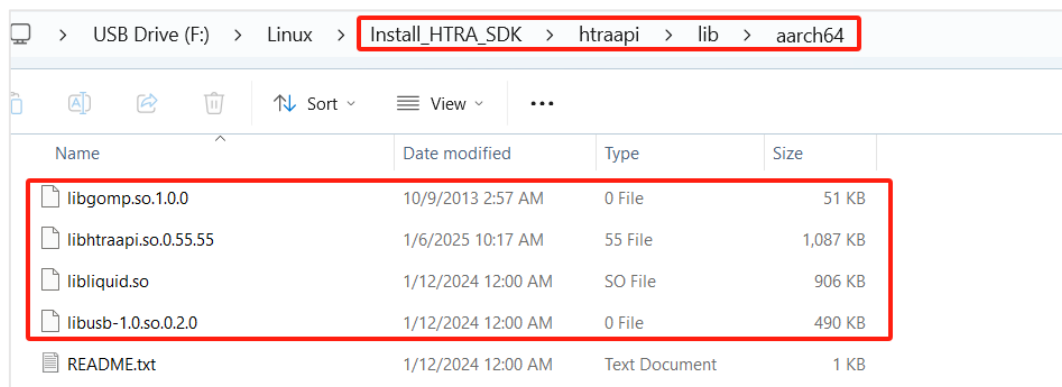
9. Run the program: Enter ./Test to start the executable file.



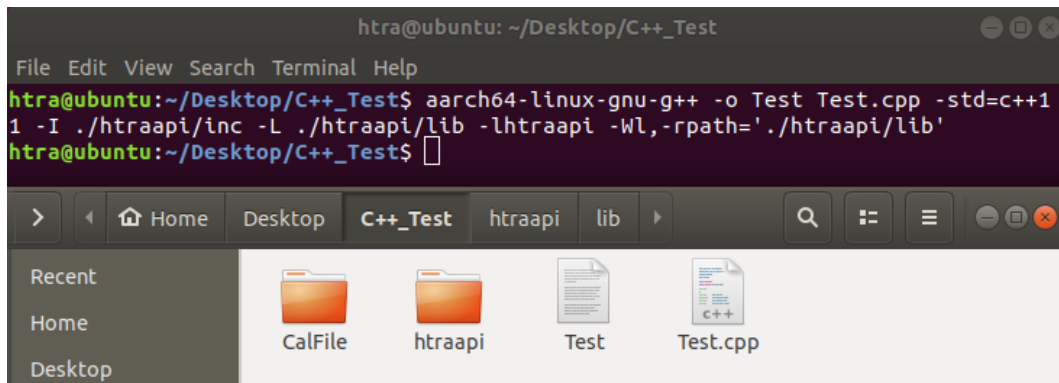
9.4.3 C++ Project Cross-Compilation

Under the premise that the host computer has a cross-compilation toolchain, if you want to cross-compile to use the device, please refer to the following process (taking the cross-compilation of an aarch64 executable program on an x86_64 host computer as an example):

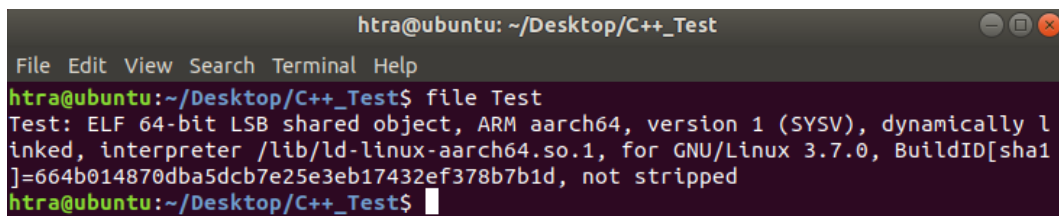
1. First, generate the executable file for the target architecture:
 - 1) Create a project and place the calibration files and header files according to steps 1 to 4 in the compilation and running method in [Chapter 9.4.2](#).
 - 2) Place the cross-compiled target architecture library files as per step 5. For example, when cross-compiling an executable for the aarch64 architecture, please place the library files for the aarch64 architecture.



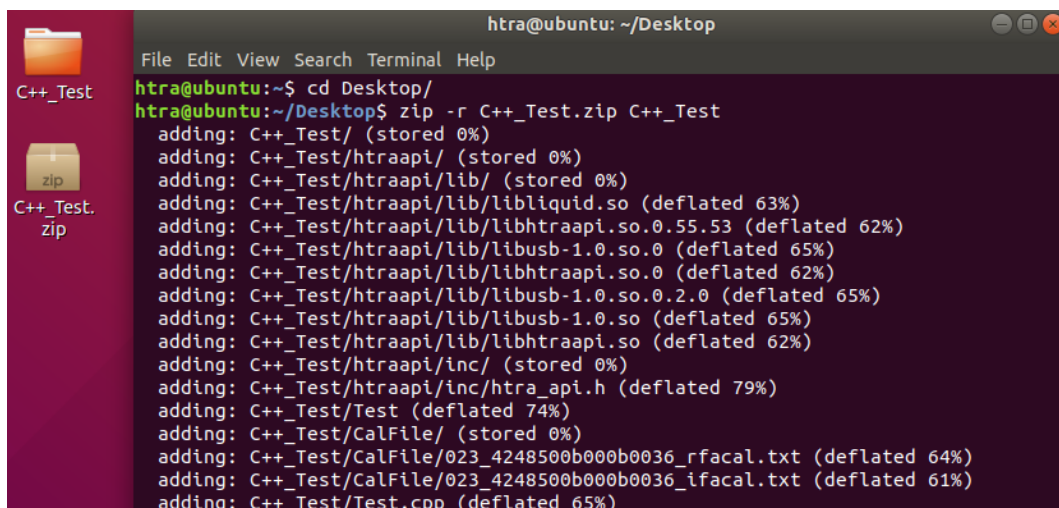
- 3) Perform soft linking and program writing storage according to steps 6 to 7.
 - 4) Compile the executable file using the target architecture compilation command as described in step 8. The compilation command for the aarch64 architecture is expected to be used when compiling the executable file for the aarch64 system, as shown in the figure below.



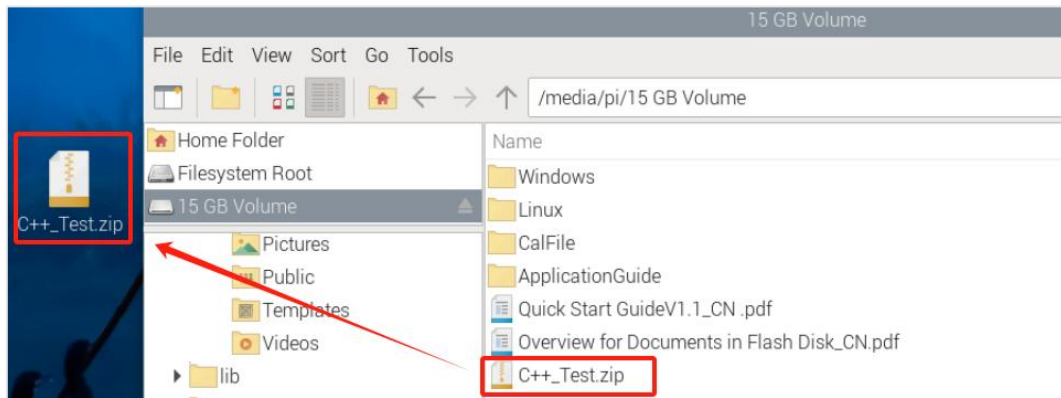
- 5) After generating the executable file, input 'file Test' to check the architecture of the executable program, and you will see that the current executable program architecture is aarch64.



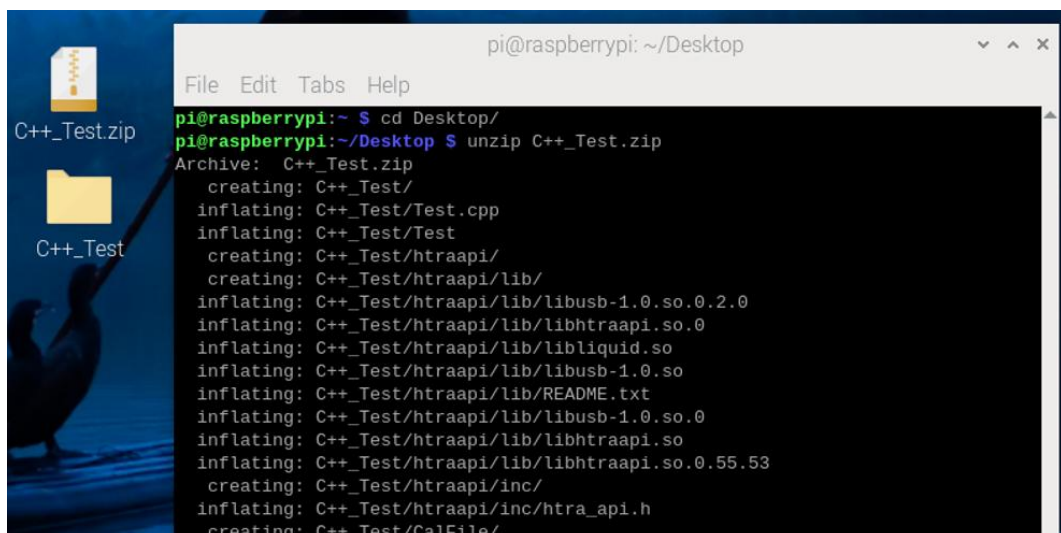
2. At this point, the executable program has been successfully generated, and you can now run the program on the aarch64 host machine using the device:
 - 1) Navigate to the project directory (the example project is located on the desktop, so input 'cd Desktop/'), and compress the entire folder into a zip file, for example, input 'zip -r C++_Test.zip C++_Test' to create the zip archive.



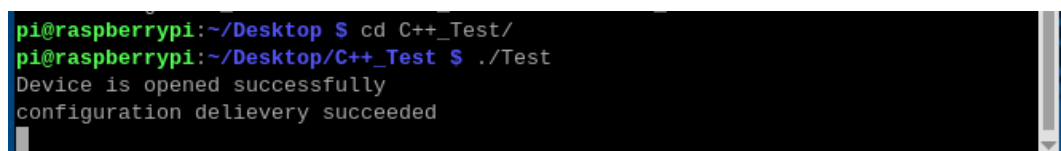
- 2) Copy the zip file to the aarch64 host machine.



- 3) Navigate to the location where the zip file is stored (in this example, the zip file is on the desktop, so input 'cd Desktop/'), and extract the project (input 'unzip C++_Test').



- 4) Configure the driver files on the aarch64 host machine as per the steps in [Chapter9.3](#).
- 5) After configuring the driver files, input 'cd C++_Test/' to enter the folder, and then simply input './Test' to run the program.

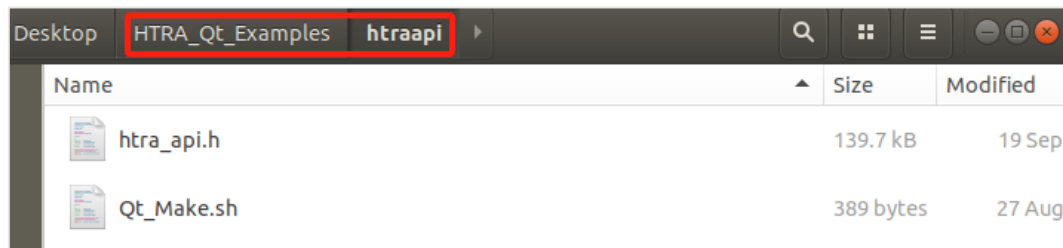


9.5 Using Qt Examples and Project Creation

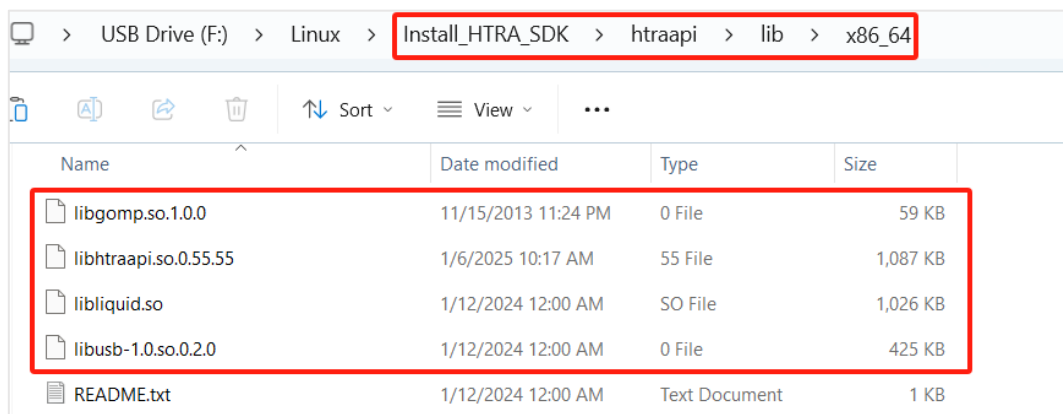
9.5.1 Using Qt Examples

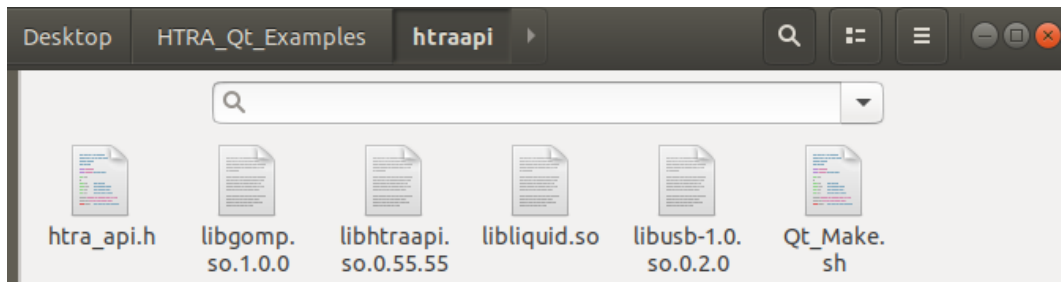
To use the Qt examples included on the USB drive, provided that the device is properly connected and the driver files have been configured correctly as per [Chapter 9.3](#), please refer to the following process (the purpose of this Qt example is to obtain complete spectrum data within a specified frequency band):

1. Copy the Linux\HTRA_Qt_Examples folder from the included USB drive to the host computer, and then navigate to the HTRA_Qt_Examples\htraapi subfolder as shown in the figure.

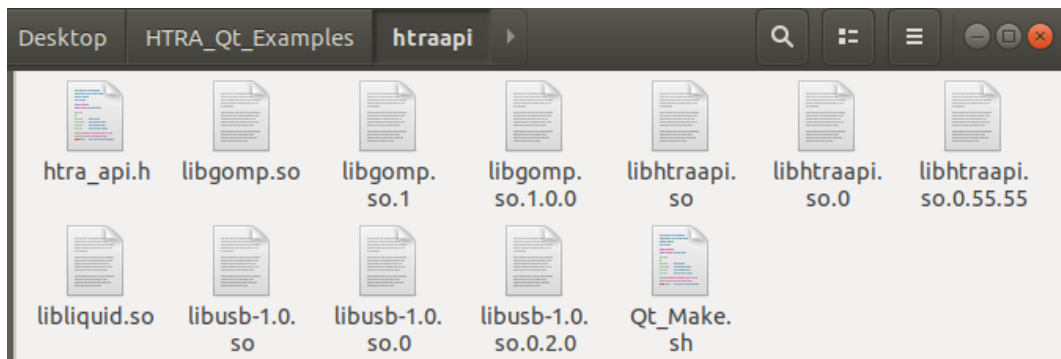
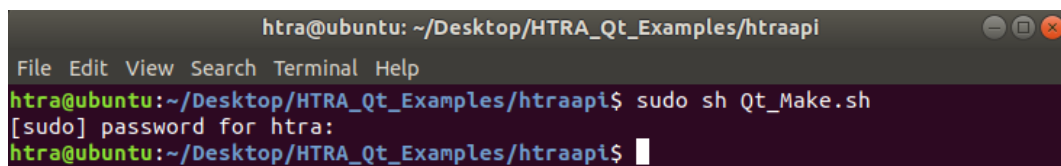


2. Refer to the system architecture in the process outlined in Chapter 9.1, and then follow the instructions in Chapter 9.2.4 to copy the dynamic link libraries corresponding to the system architecture from the Linux\Install_HTRA_SDK\htraapi\lib folder on the USB drive to the HTRA_Qt_Examples\htraapi folder (this example uses an x86_64 architecture host computer).

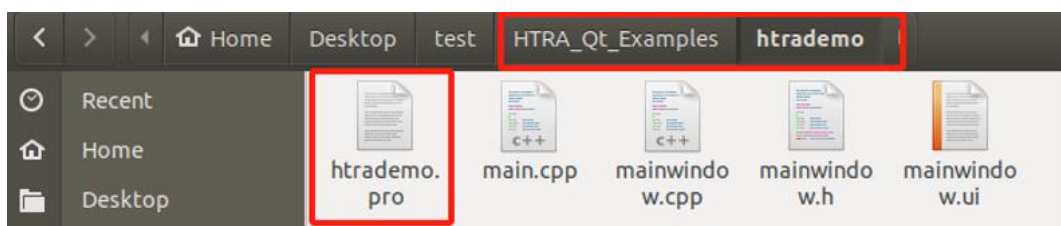




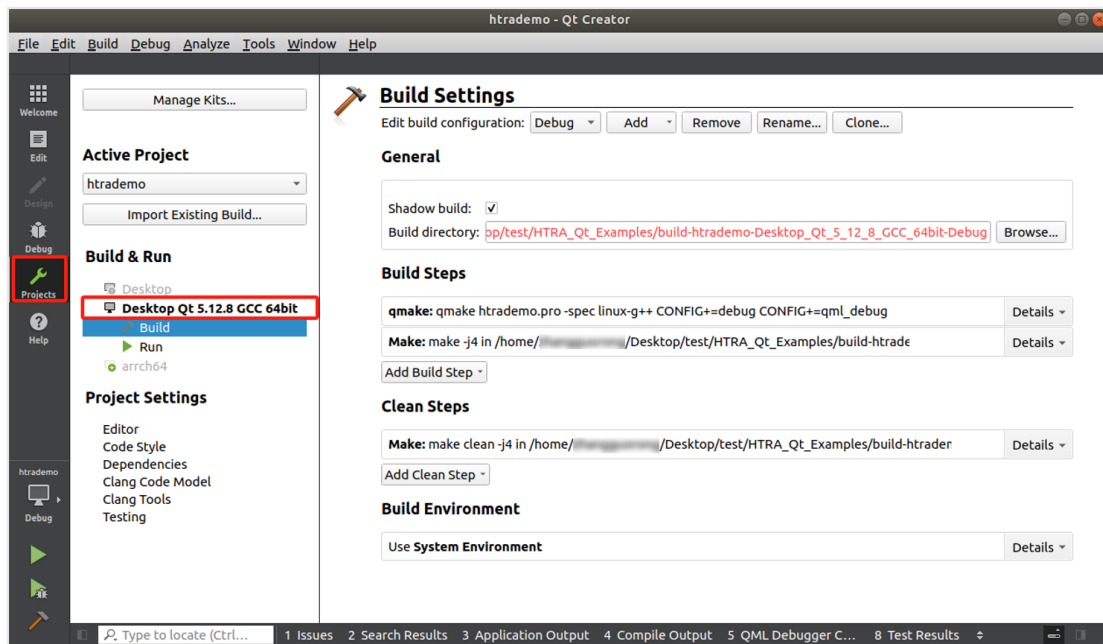
3. Open a terminal in the current folder, enter "sudo sh Qt_Make.sh", and then follow the prompts to enter the sudo password to grant permission for creating soft links to the libraries.



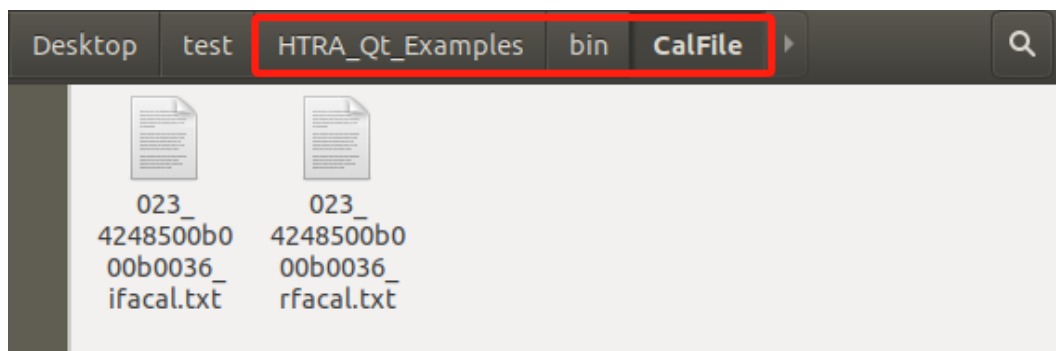
4. After running the script, use Qt Creator to open the htrademo.pro file in the htrademo folder.



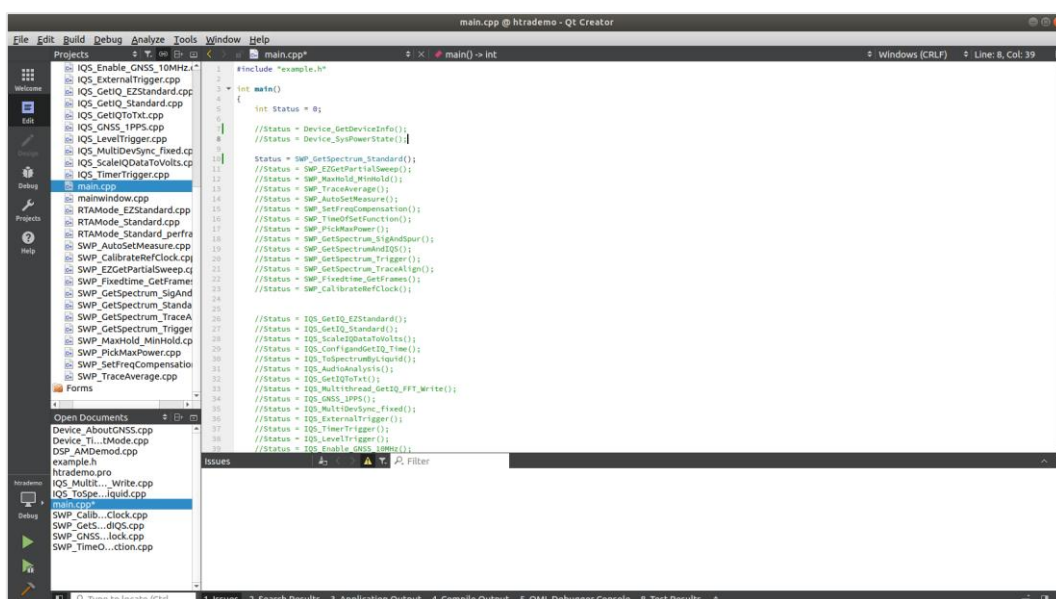
5. First, select the build environment for the project.



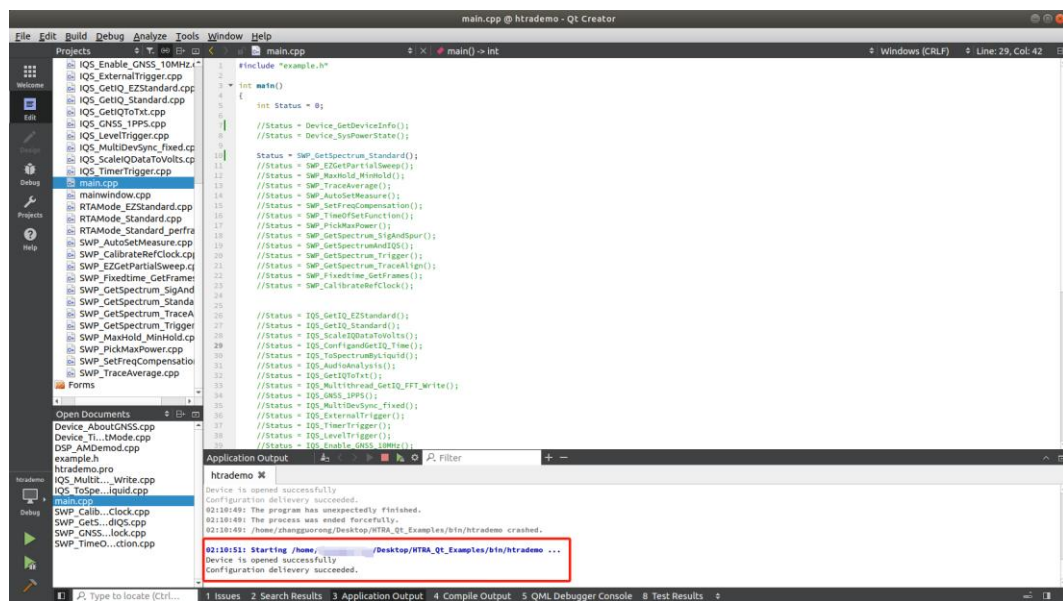
6. Open the HTRA_Qt_Examples\bin\CalFile folder and ensure that there is a device calibration file in the folder.



7. After confirming that there is a calibration file, select any example in main.cpp.



8. Click Run, and as shown in the figure, the device is functioning normally.



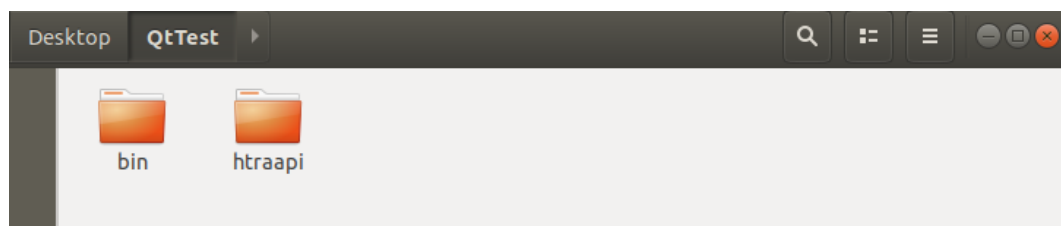
9.5.2 Qt Project Creation and Compilation

Under the premise that the driver files have been correctly configured according to [Chapter 9.3](#), if you want to create a Qt project for compilation, please refer to the following process:

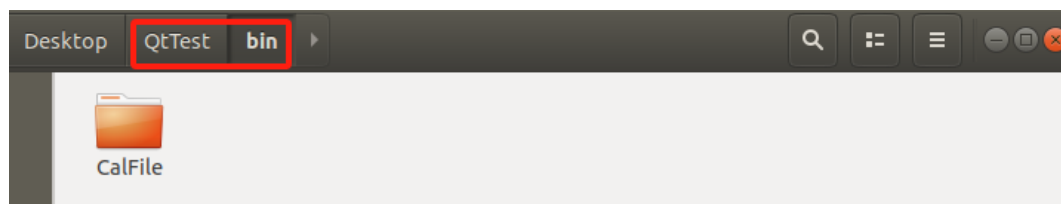
First, when writing code, since the Linux dynamic link libraries provided with the USB drive are identical to those for Windows, the code only needs to comply with the API programming guidelines.

Next, the process for creating the project is as follows:

1. As shown in the figure, first create a new folder to store the entire project (taking QtTest as an example), then create a bin folder within this folder to store calibration files and the generated executable files, and create an htraapi folder to store header files and dynamic link libraries.



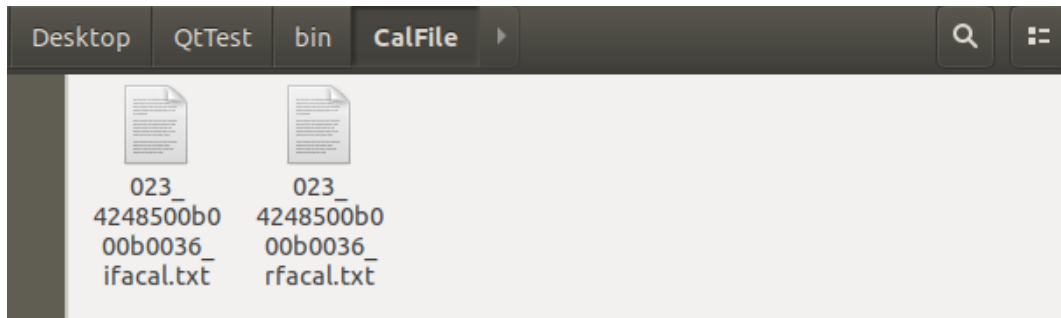
2. Create a CalFile folder under the bin folder to store the device calibration files.



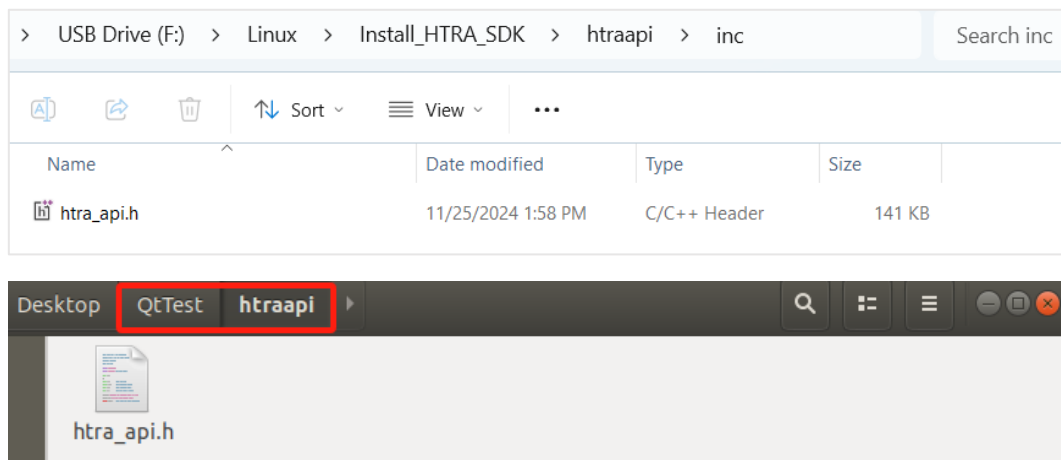
3. Copy the files from the CalFile folder on the provided USB drive to the newly created QtTest\bin\CalFile folder.

A screenshot of a file explorer window showing the contents of the 'CalFile' folder on a USB drive. The address bar shows 'USB Drive (F:) > CalFile'. The window displays a table of files.

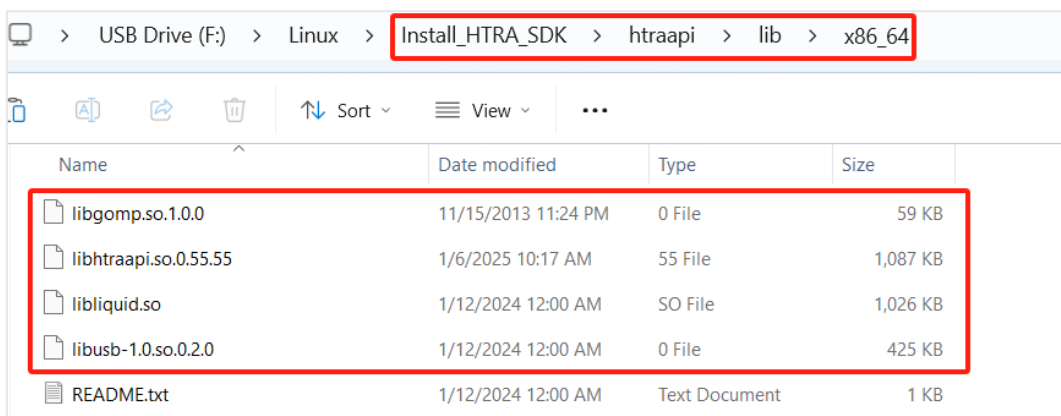
Name	Date modified	Type	Size
023_4248500b000b0036_ifacal.txt	8/9/2024 10:23 AM	Text Document	431 KB
023_4248500b000b0036_rfacal.txt	8/9/2024 10:23 AM	Text Document	12,214 KB

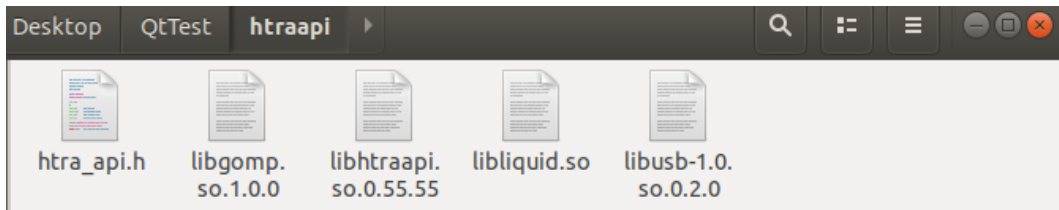


4. Copy the header files from the Linux\Install_HTRA_SDK\htraapi\inc folder on the provided USB drive to the newly created QTest\htraapi folder.



5. Refer to the system architecture in Chapter 9.1, and then according to Chapter 9.2.4, copy the dynamic link libraries corresponding to the system architecture from the Linux\Install_HTRA_SDK\htraapi\lib folder on the provided USB drive to the newly created QTest\htraapi folder (taking the x86_64 architecture for the host computer as an example).



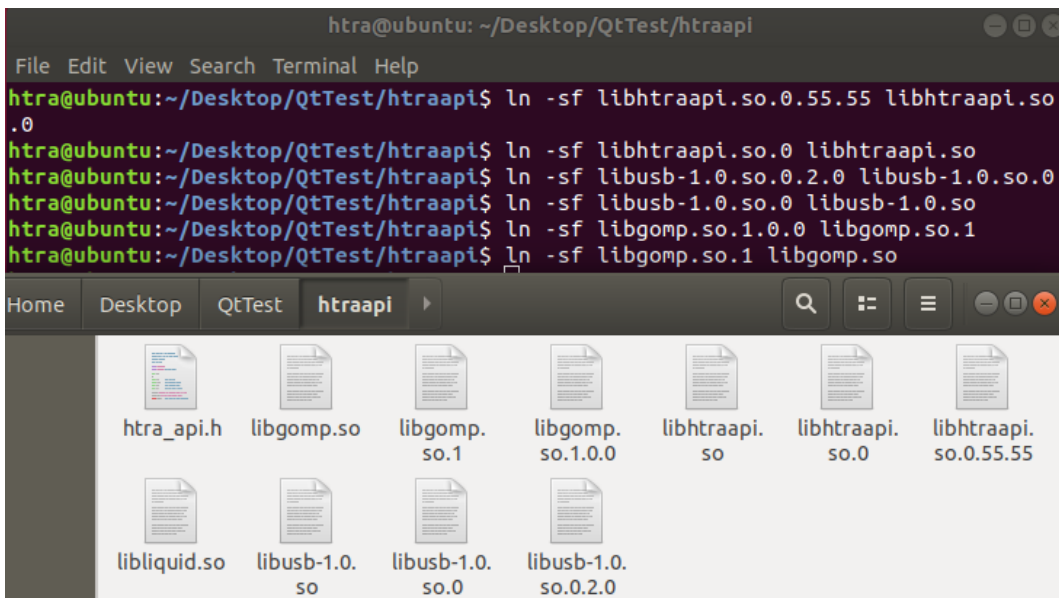


6. Open a terminal at the location of the htraapi folder and enter the following command to create a soft link for the copied dynamic link libraries (the soft link command for different architectures is the same):

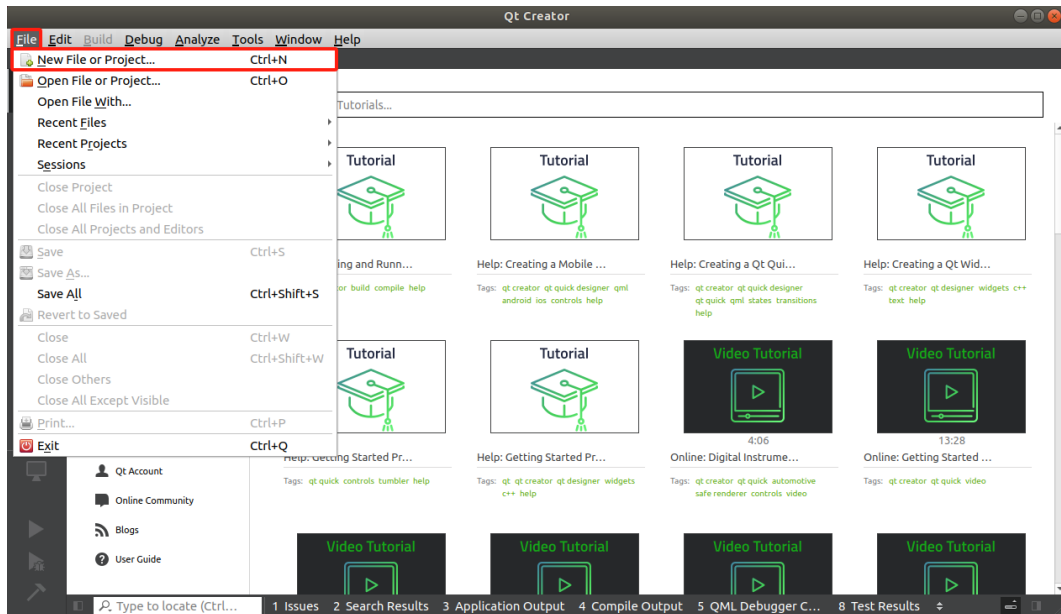
- `ln -sf libhtraapi.so.0.55.5 libhtraapi.so.0`

(Here, the libhtraapi.so library is taken as an example with version 0.55.55; modify the version number for other versions.)

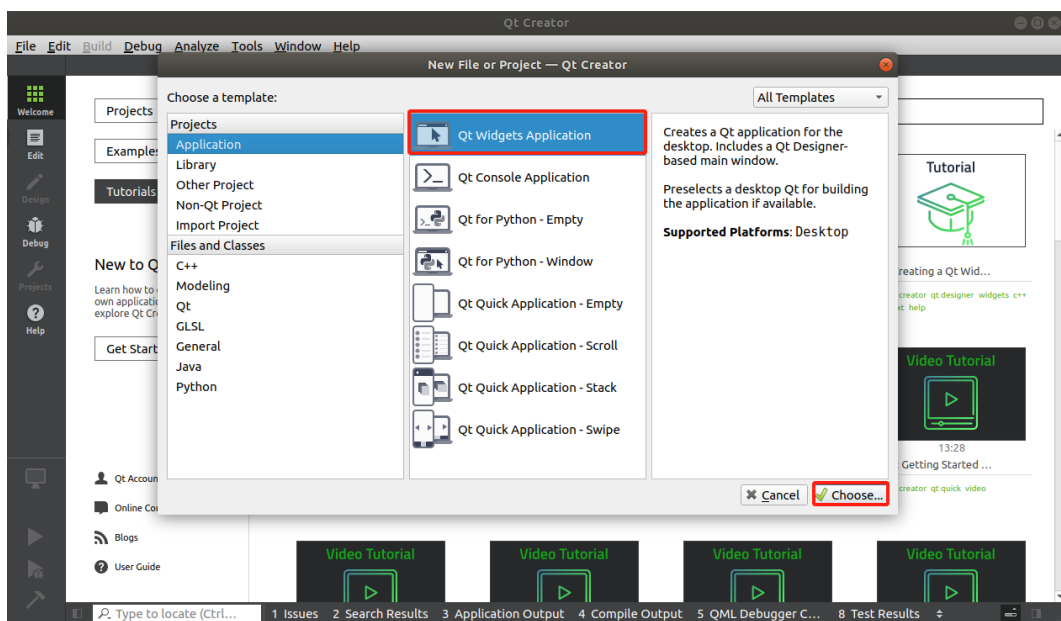
- `ln -sf libhtraapi.so.0 libhtraapi.so`
- `ln -sf libusb-1.0.so.0.2.0 libusb-1.0.so.0`
- `ln -sf libusb-1.0.so.0 libusb-1.0.so`
- `ln -sf libgomp.so.1.0.0 libgomp.so.1`
- `ln -sf libgomp.so.1 libgomp.so`



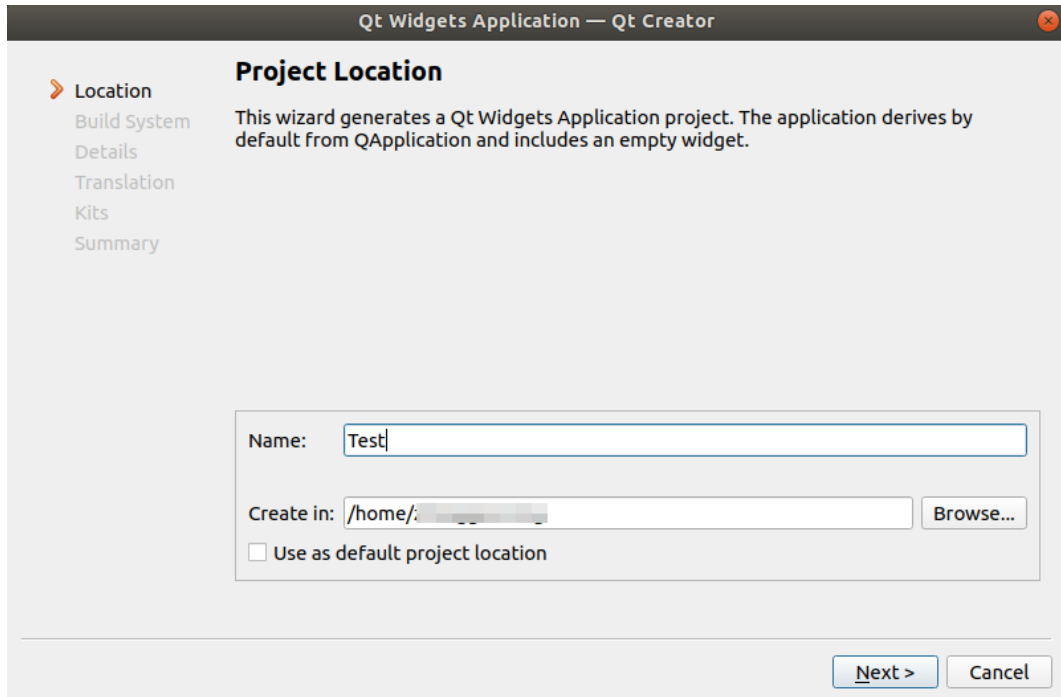
7. Open Qt Creator, click on File, and select New File or Project.



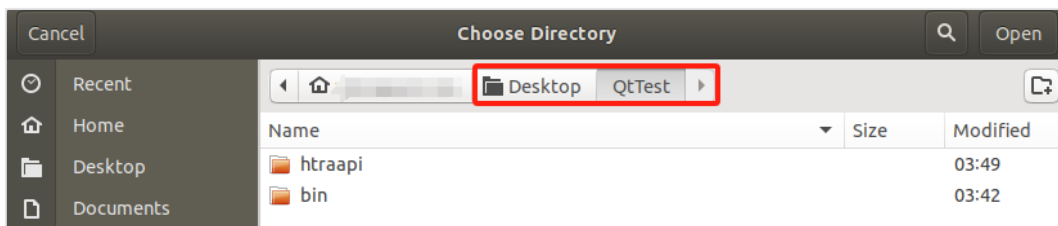
8. Select Create Qt Widgets Application.



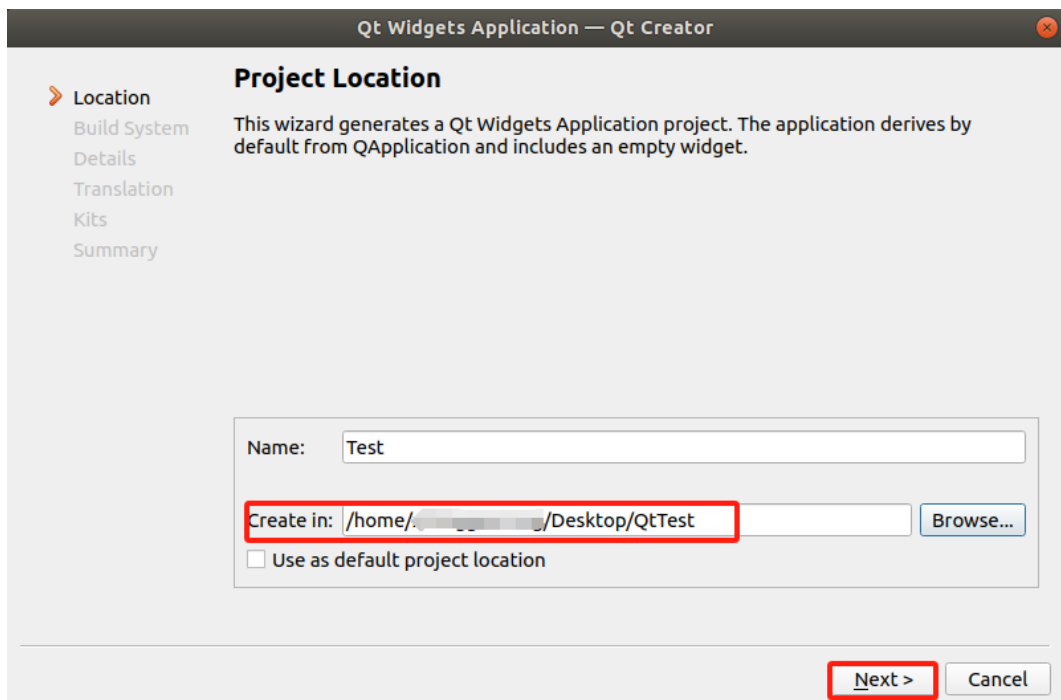
9. After filling in the project name, click Browse to change the project path.



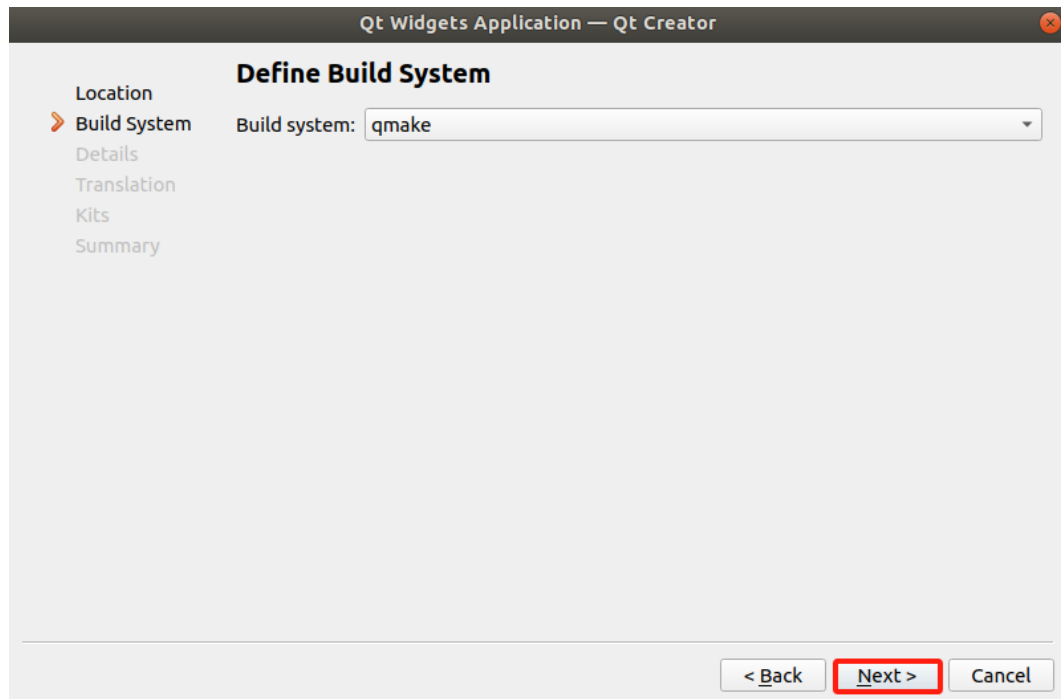
10. Select the directory as the QtTest address created in the first step and click Open.



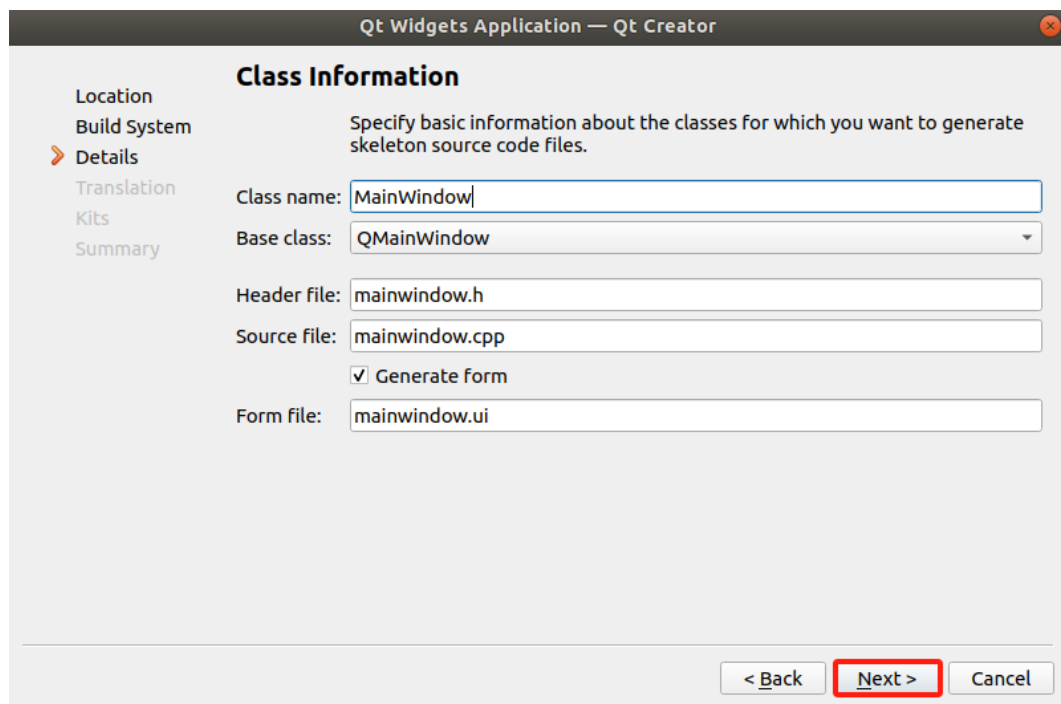
11. After selecting the path, click Next.



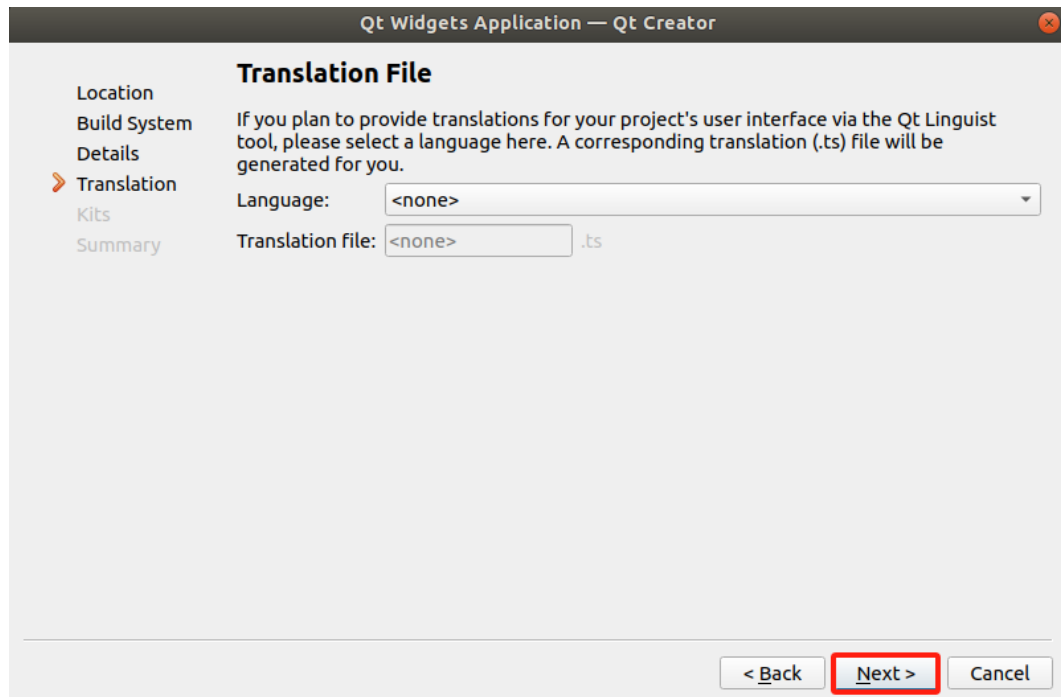
12. Click Next to continue.



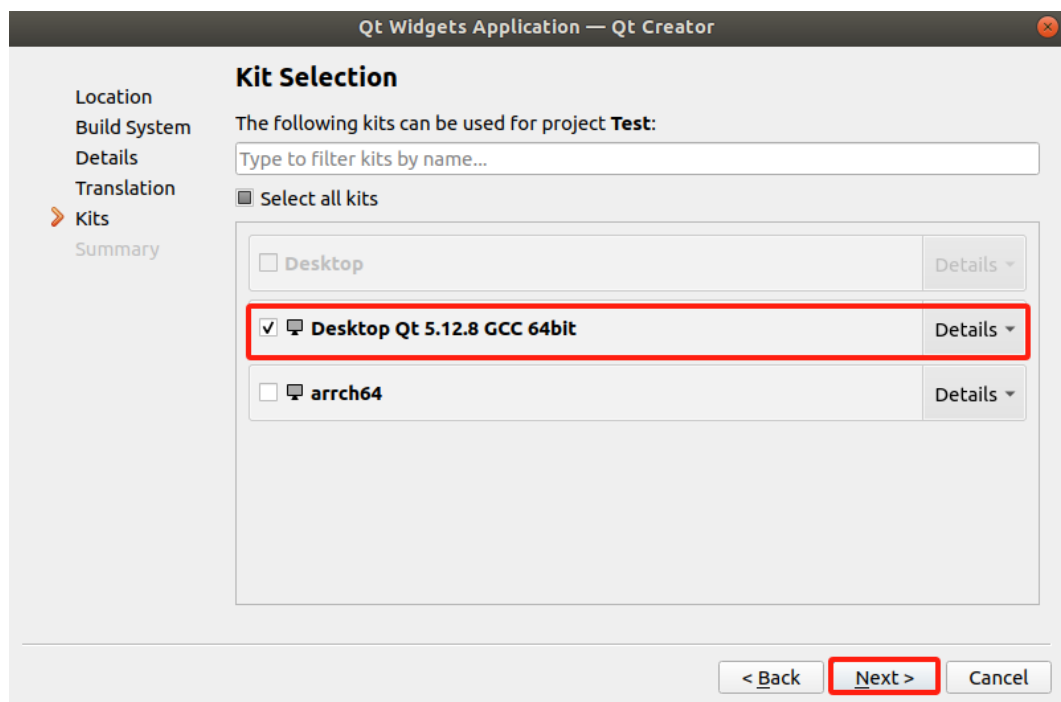
13. Click Next to continue.



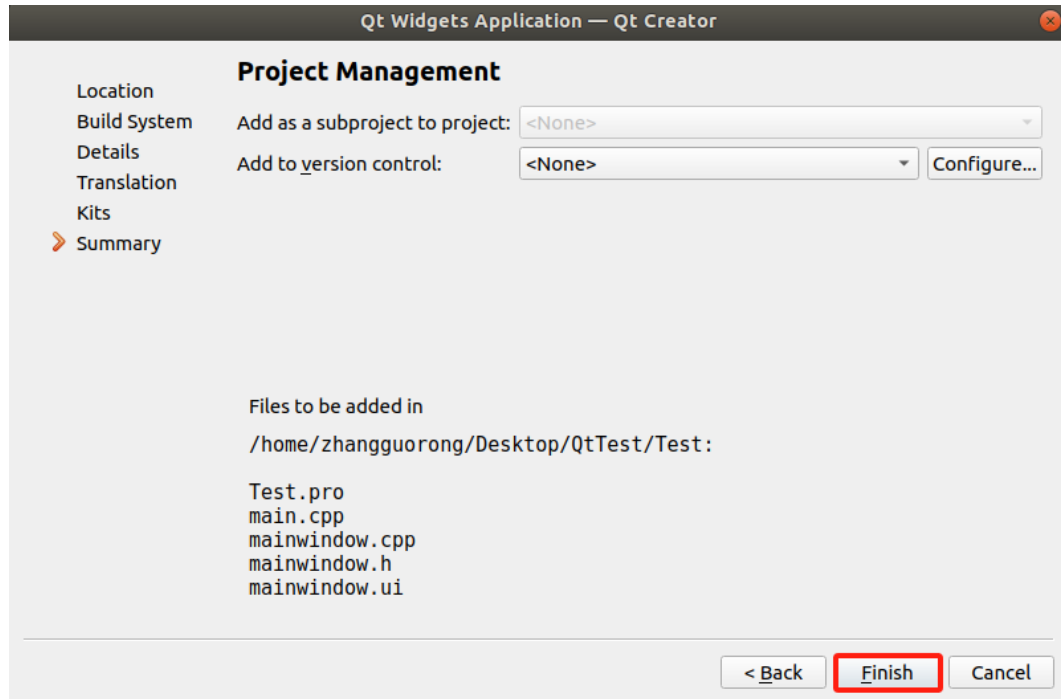
14. Click Next to continue.



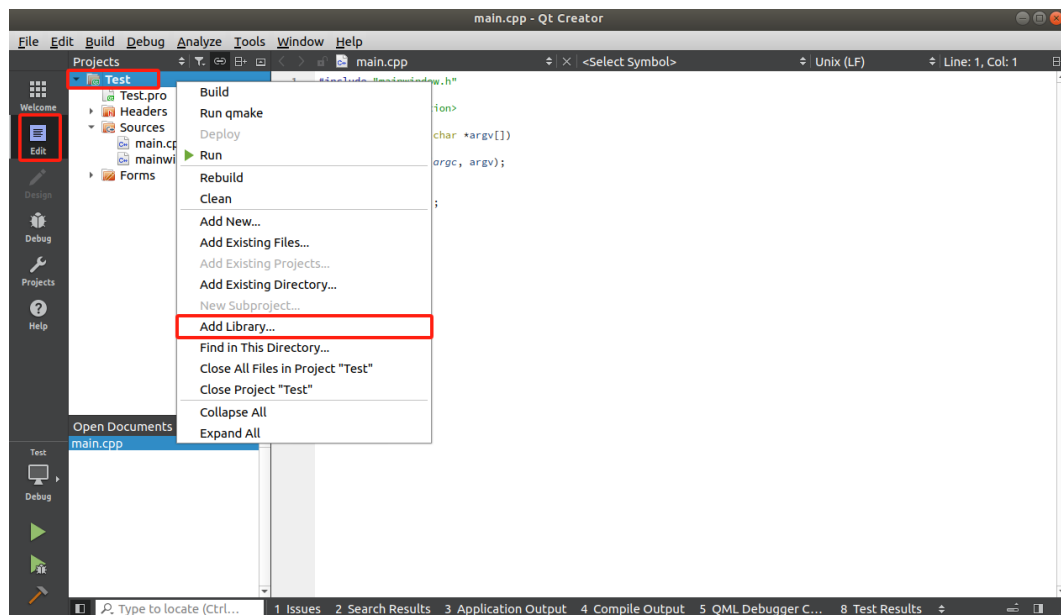
15. Select the x86_64 build environment for the project and then continue by clicking next.



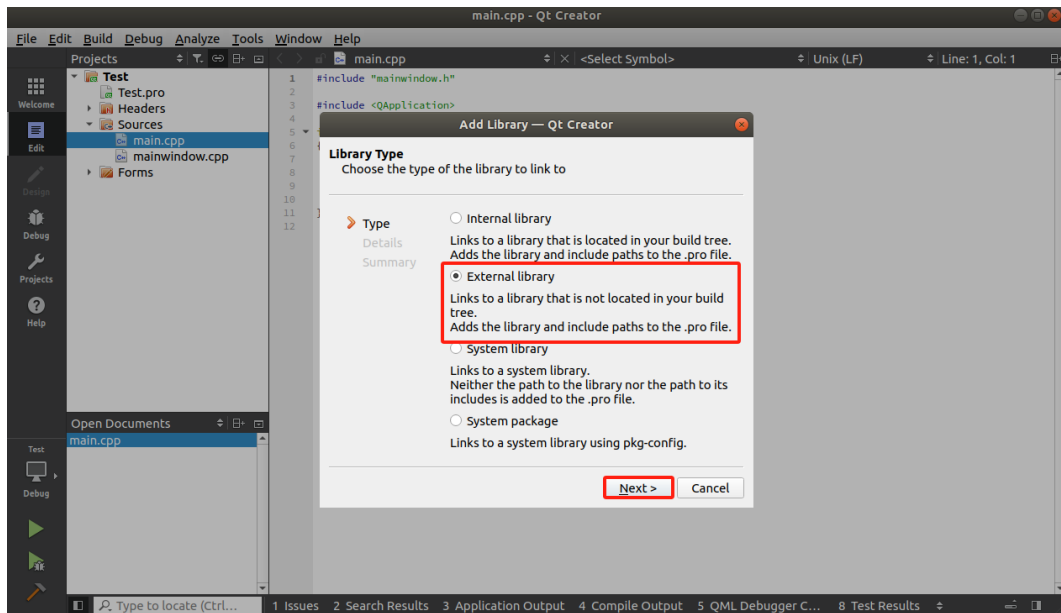
16. Click Finish to create the project.



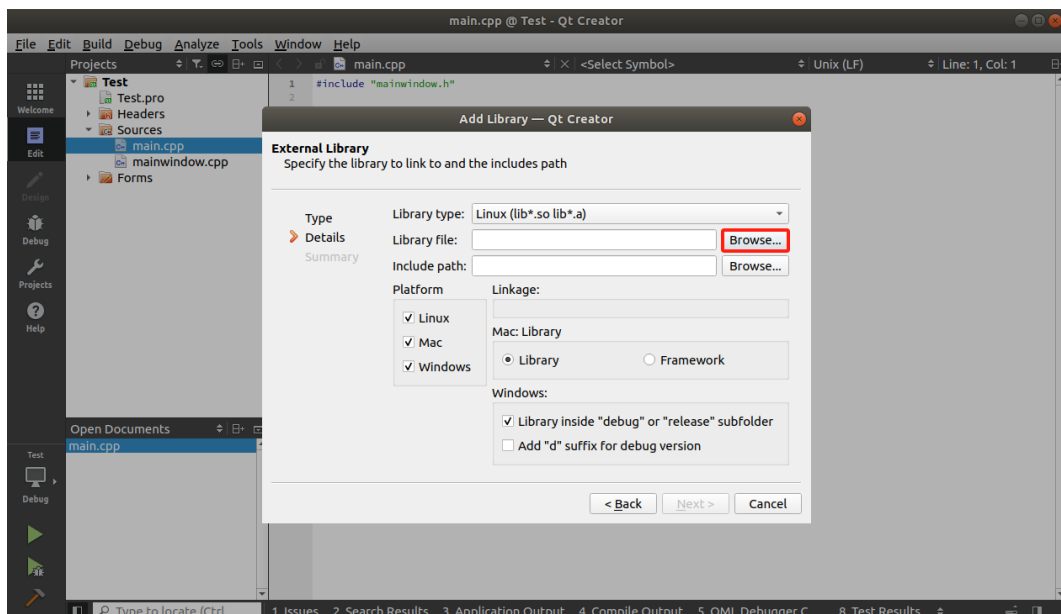
17. Click Edit, right-click the Test project, and click Add Library.



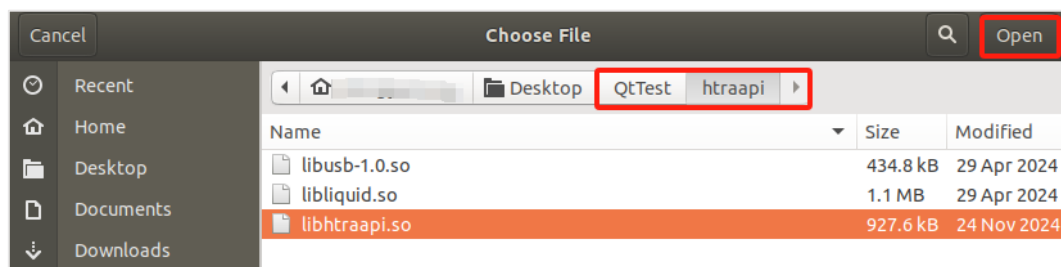
18. Select External Library and click Next.



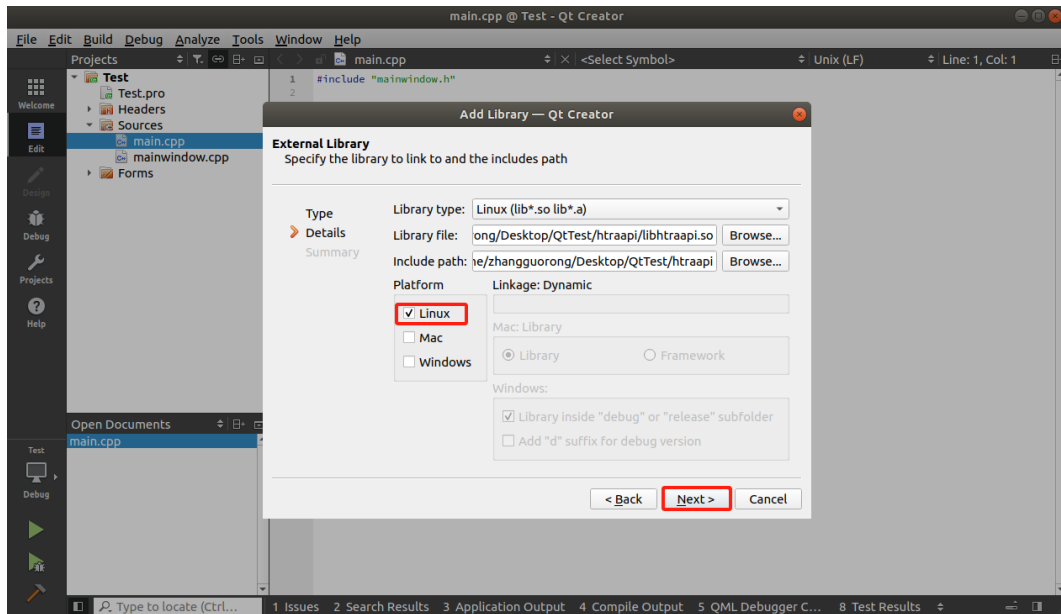
19. Click Browse Library File.



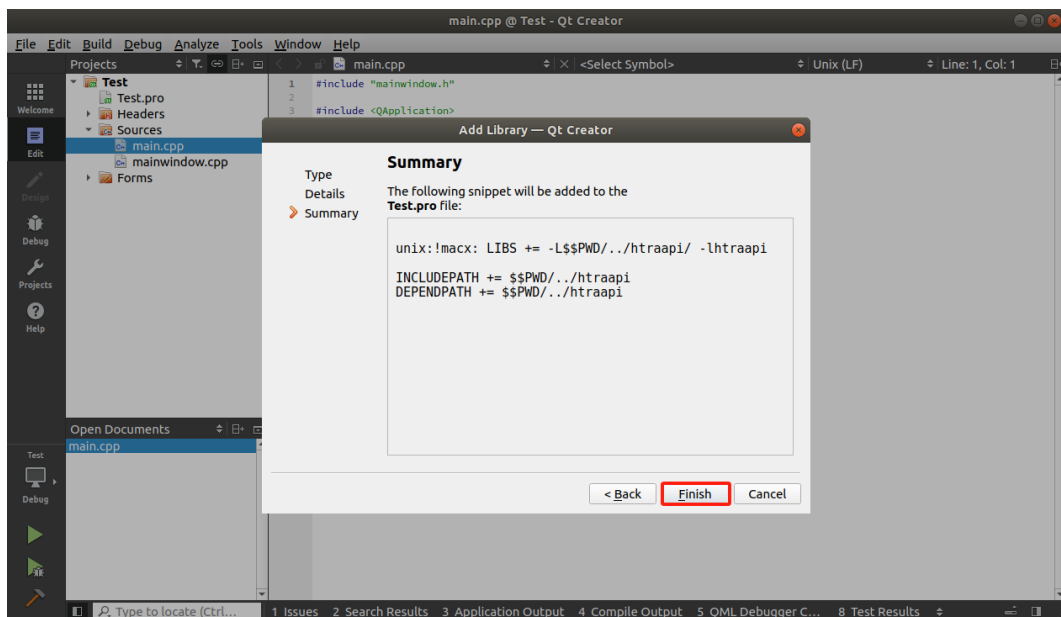
20. Select Q Test\htraapi, the library previously copied and soft-linked, and click Open.



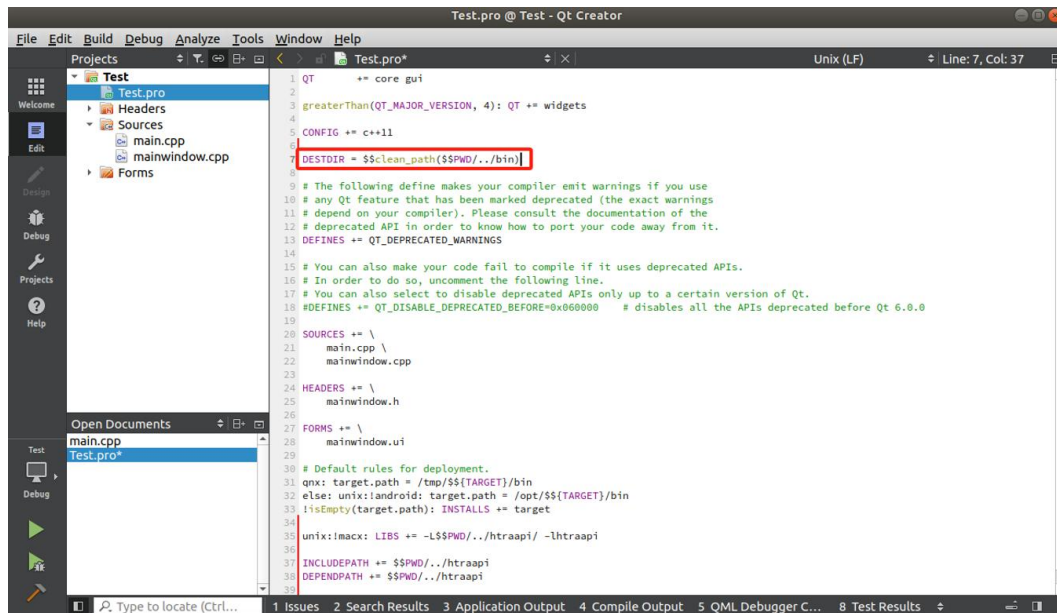
21. Select the Linux platform and click Next.



22. Click Finish to add the external library.



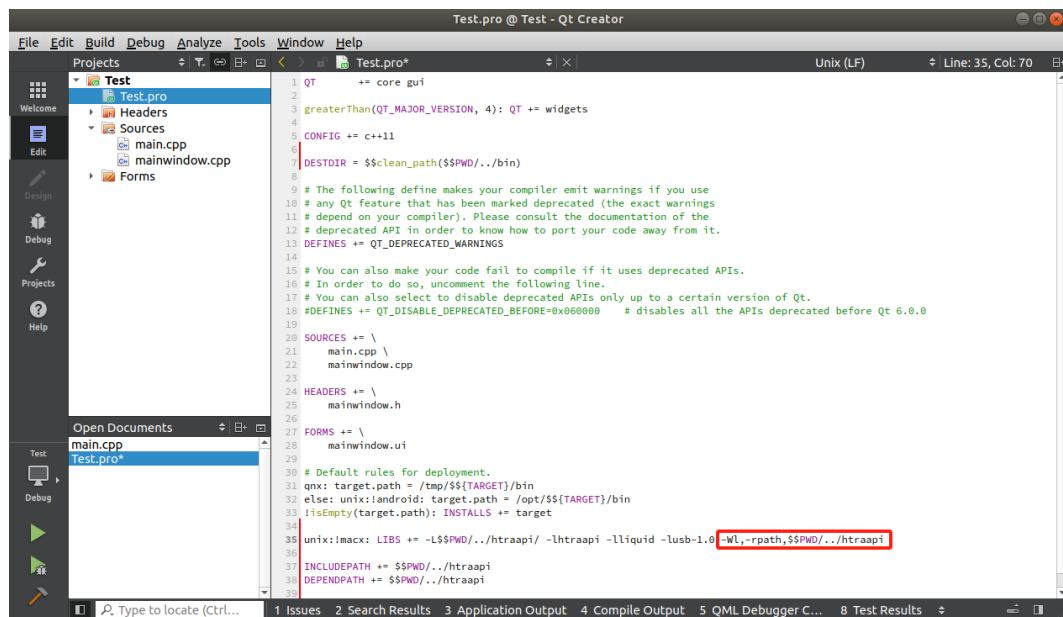
23. As shown below, add `DESTDIR = $$clean_path($$PWD/...)` after `CONFIG += c++11`.
/bin) (this step specifies where the executable is generated)



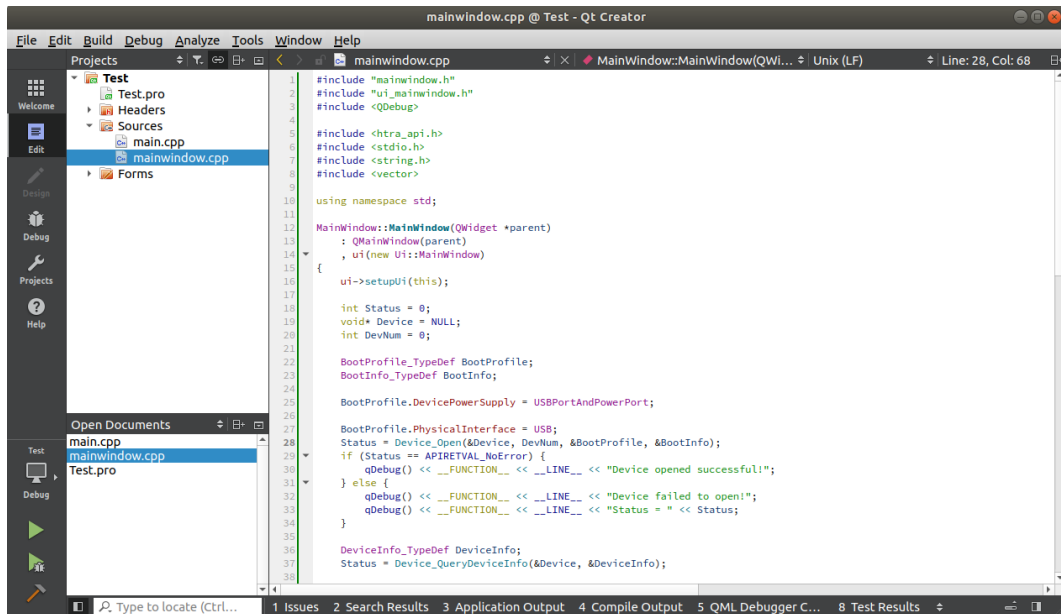
24. As shown in the figure below, after the library file, add

`-Wl,-rpath,$$PWD/... /htraapi`

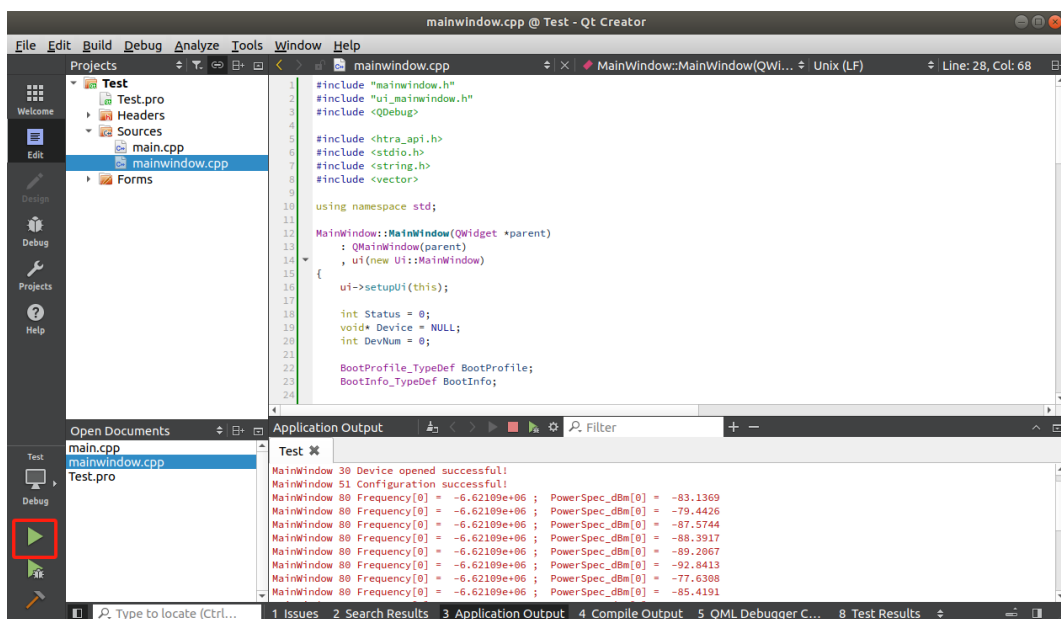
(this step specifies the library path for the executable).



25. Save the Test.pro file and write the code in mainwindow.cpp afterwards.



26. After writing the code correctly, click run. As shown in the figure, you can see that the program is running normally in the application output.



27. Close Qt Creator, enter the QtTest\bin folder, open the terminal, and type ./Test to run the executable program.

```

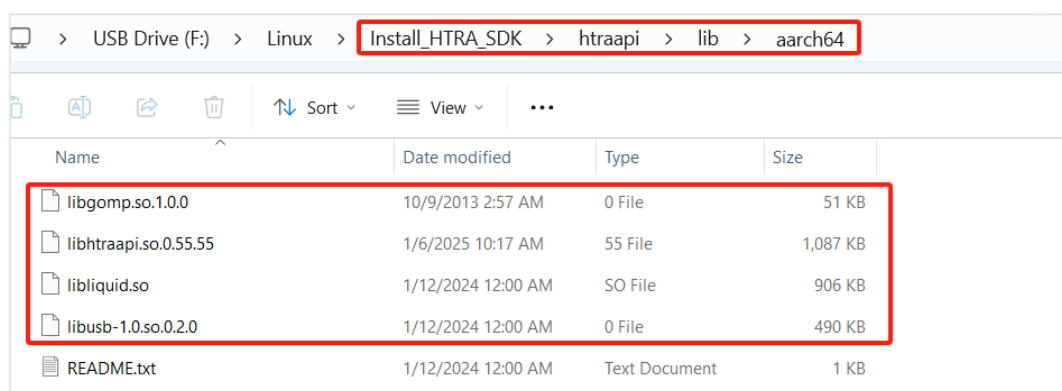
(base) z...@ubuntu: ~/Desktop/QtTest/bin$ ./Test
MainWindow 44 Device opened successful!
MainWindow 65 Configuration successful!
MainWindow 94 Frequency[0] = -6.62109e+06 ; PowerSpec_dBm[0] = -86.0967
MainWindow 94 Frequency[0] = -6.62109e+06 ; PowerSpec_dBm[0] = -87.1682
MainWindow 94 Frequency[0] = -6.62109e+06 ; PowerSpec_dBm[0] = -89.3518

```

9.5.3 Cross-compiling Qt projects

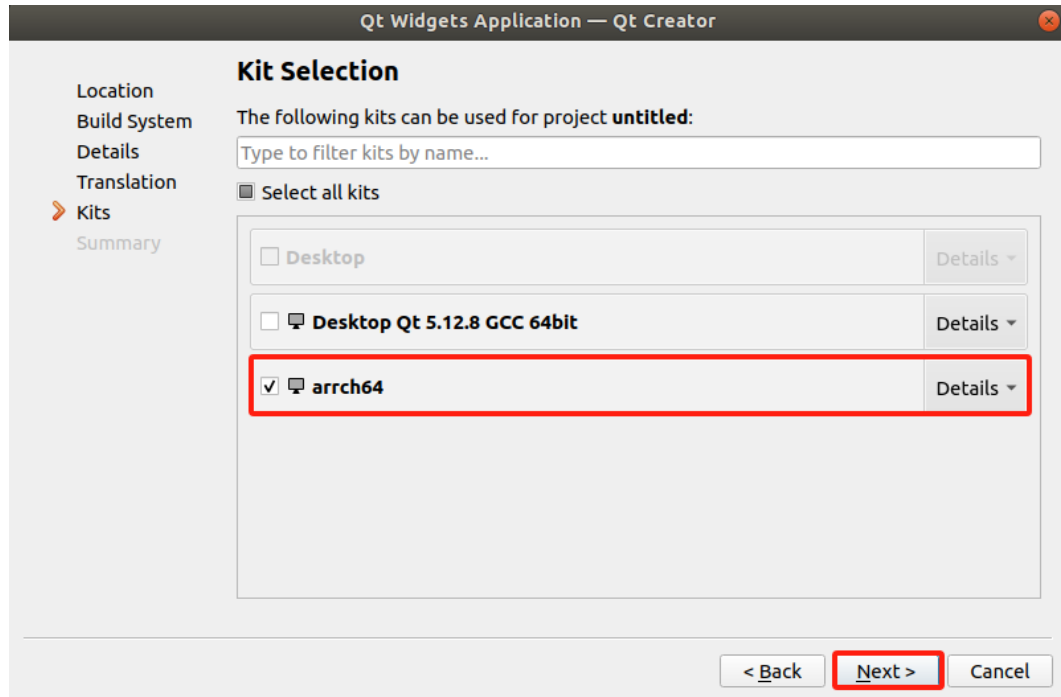
Under the premise that the host computer has a cross-compilation toolchain, if you want to cross-compile to use the device, please refer to the following process (taking the cross-compilation of an aarch64 executable program on an x86_64 host computer as an example):

1. First, generate the executable file for the target architecture:
 - 1) Create the project and place the calibration files and header files according to steps 1 to 4 of the [QtProject Creation and Compilation](#).
 - 2) Place the cross-compilation target architecture library files according to step 5 of the form program creation process. For example, if you expect to cross-compile an executable for the aarch64 architecture, please place the library files for the aarch64 architecture.

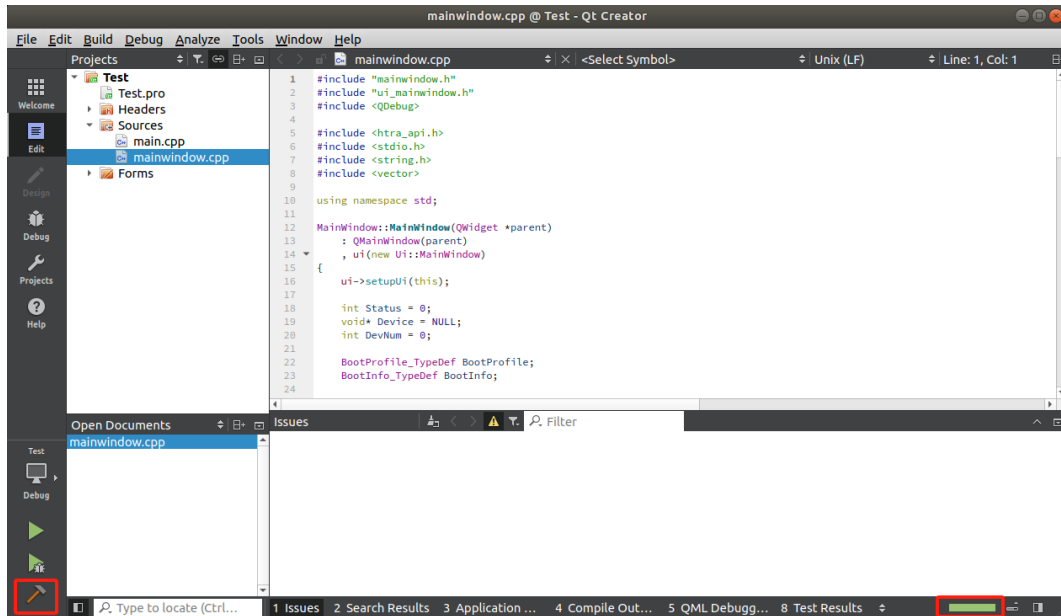


- 3) Create a soft link for the dynamic link library according to step 6 of the form program creation process.

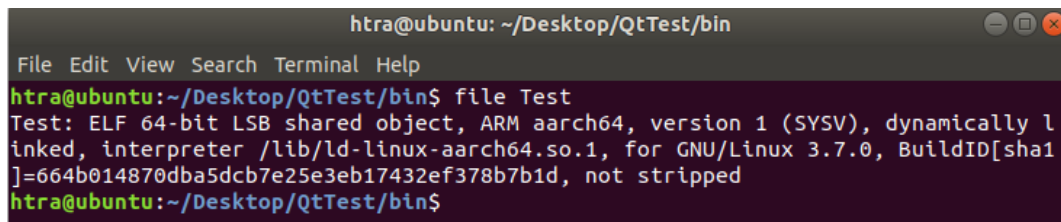
- 4) Create the program according to steps 7-13 of the form program creation process, and in step 14, select the build kit for the cross-compilation target architecture (for example, in this example, select the build kit for the arrch64 architecture).



- 5) Follow steps 16-26 of the form program creation process to create the project, reference the libraries, modify the location for generating the executable program, and write the project.
- 6) Click the build button in the lower left corner to build the executable program.



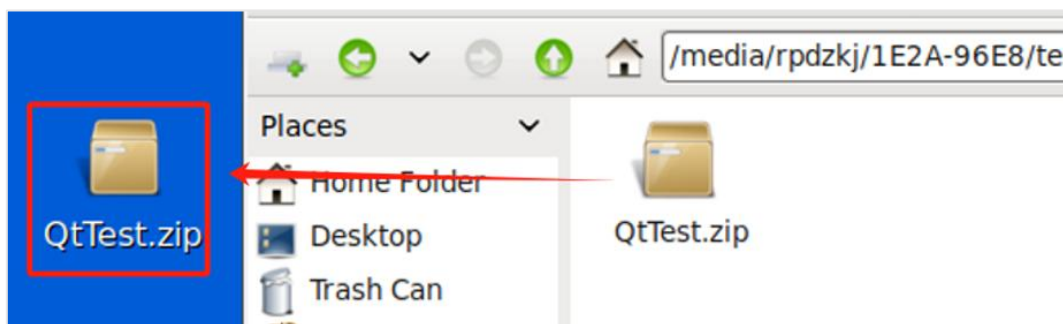
- 7) After building the executable program, open the terminal in the QtTest\bin folder and type file Test to check the architecture of the executable program (the name of the executable program here is Test, so type file Test).



2. At this point, the executable program has been successfully generated, and you can now run the program on the aarch64 host machine using the device:
 - 1) Navigate to the project location (in this example, the project is located on the desktop, so type `cd Desktop/`), and compress the entire folder into a zip file, for example, type `zip -r Qt Test.zip Qt Test` to create a zip archive.

```
htra@ubuntu: ~/Desktop
File Edit View Search Terminal Help
htra@ubuntu:~$ cd Desktop/
htra@ubuntu:~/Desktop$ zip -r QTest.zip QTest
updating: QTest/ (stored 0%)
updating: QTest/htraapi/ (stored 0%)
updating: QTest/htraapi/libliquid.so (deflated 60%)
updating: QTest/htraapi/libhtraapi.so.0.55.53 (deflated 64%)
updating: QTest/htraapi/libusb-1.0.so.0 (deflated 62%)
updating: QTest/htraapi/libhtraapi.so.0 (deflated 64%)
updating: QTest/htraapi/libusb-1.0.so.0.2.0 (deflated 62%)
updating: QTest/htraapi/libusb-1.0.so (deflated 62%)
updating: QTest/htraapi/libhtraapi.so (deflated 64%)
updating: QTest/htraapi/htra_api.h (deflated 79%)
updating: QTest/Test/ (stored 0%)
updating: QTest/Test/main.cpp (deflated 27%)
```

- 2) Copy the zip file to the aarch64 host machine.



- 3) Navigate to the location of the compressed package (in this example, the compressed package is located on the desktop, so input `cd Desktop/`), and unzip the project (input `unzip QTest` here).

```
rpdkj@localhost: ~/Desktop
File Edit Tabs Help
rpdkj@localhost:~$ cd Desktop/
rpdkj@localhost:~/Desktop$ unzip QTest.zip
Archive: QTest.zip
  creating: QTest/
  creating: QTest/Test/
  inflating: QTest/Test/mainwindow.ui
  inflating: QTest/Test/mainwindow.cpp
  inflating: QTest/Test/mainwindow.h
  inflating: QTest/Test/main.cpp
  inflating: QTest/Test/Test.pro
  inflating: QTest/Test/Test.pro.user
  creating: QTest/htraapi/
```

- 4) Configure the driver files on the aarch64 host machine as per the steps in [Chapter9.3](#).
- 5) After configuring the driver files, input `cd QTest/` to enter the folder, then input `chmod 777 Test` to provide execution permissions for the program, and finally input `./Test` to run the program.

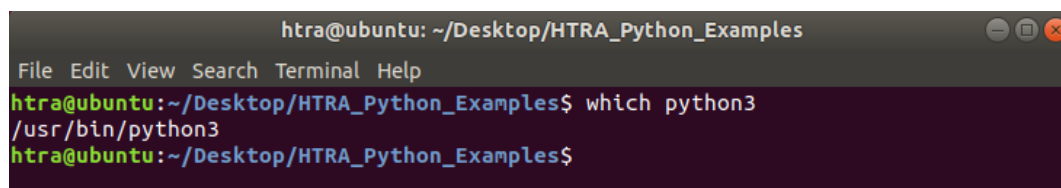
```
rpdkj@localhost: ~/Desktop/QtTest/bin
File Edit Tabs Help
rpdkj@localhost:~/Desktop/QtTest/bin$ chmod 777 Test
rpdkj@localhost:~/Desktop/QtTest/bin$ ./Test
arm release_ver of this libmali is 'g6p0-01eac0', rk so ver is '5'.
Failed creating base context during opening of kernel driver.
Kernel module may not have been loaded
arm release_ver of this libmali is 'g6p0-01eac0', rk so ver is '5'.
Failed creating base context during opening of kernel driver.
Kernel module may not have been loaded
MainWindow 44 Device opened successful!
MainWindow 65 Configuration successful!
MainWindow 94 Frequency[0] = -1.2e+06 ; PowerSpec_dBm[0] = -38.5426
MainWindow 94 Frequency[0] = -1.2e+06 ; PowerSpec_dBm[0] = -36.4309
MainWindow 94 Frequency[0] = -1.2e+06 ; PowerSpec_dBm[0] = -32.2113
MainWindow 94 Frequency[0] = -1.2e+06 ; PowerSpec_dBm[0] = -29.7813
MainWindow 94 Frequency[0] = -1.2e+06 ; PowerSpec_dBm[0] = -29.3889
```


9.6 Usage of Python examples and project creation

9.6.1 Usage of Python examples

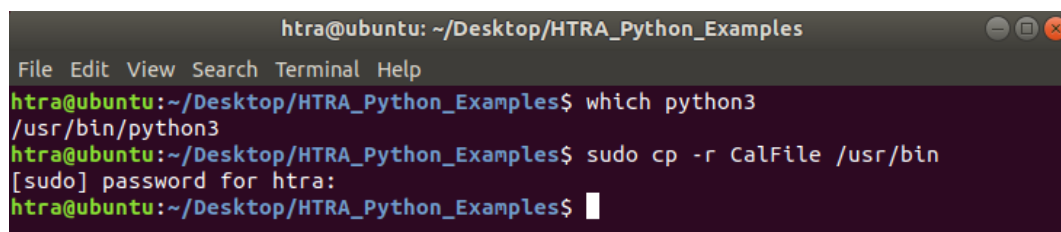
Assuming the device is properly connected and the driver files have been configured correctly as per [Chapter 9.3](#), if you want to use the Python examples included on the USB drive, you can refer to the following process (the specific functions of the Python examples can be directly viewed in [Chapter 4.2](#)):

1. Copy the Linux\ HTRA_ Python_ Examples folder from the included USB drive to the host computer, then open a terminal in the HTRA_ Python_ Examples folder and input which python3 to check the location of the Python interpreter (for example, it may be located at /usr/bin).



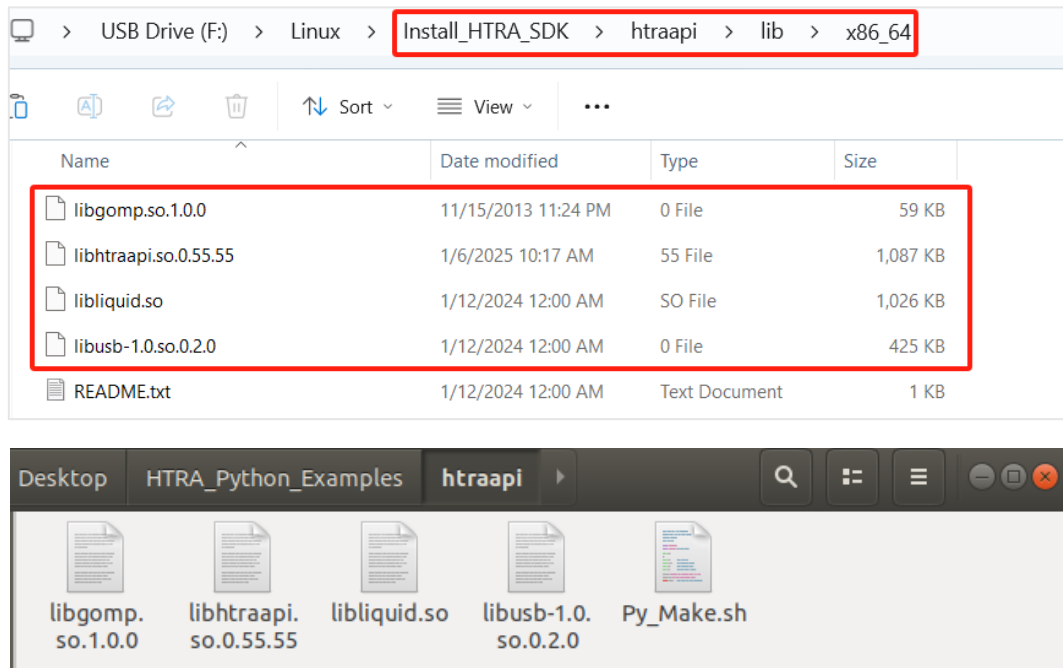
```
htra@ubuntu: ~/Desktop/HTRA_Python_Examples
File Edit View Search Terminal Help
htra@ubuntu:~/Desktop/HTRA_Python_Examples$ which python3
/usr/bin/python3
htra@ubuntu:~/Desktop/HTRA_Python_Examples$
```

2. Based on the interpreter address obtained earlier, input `sudo cp -r CalFile /usr/bin` to copy the device calibration file to the same directory as the interpreter (Python3) (for example, in this case, the same directory is /usr/bin; if the actual interpreter location is different, modify the address accordingly).

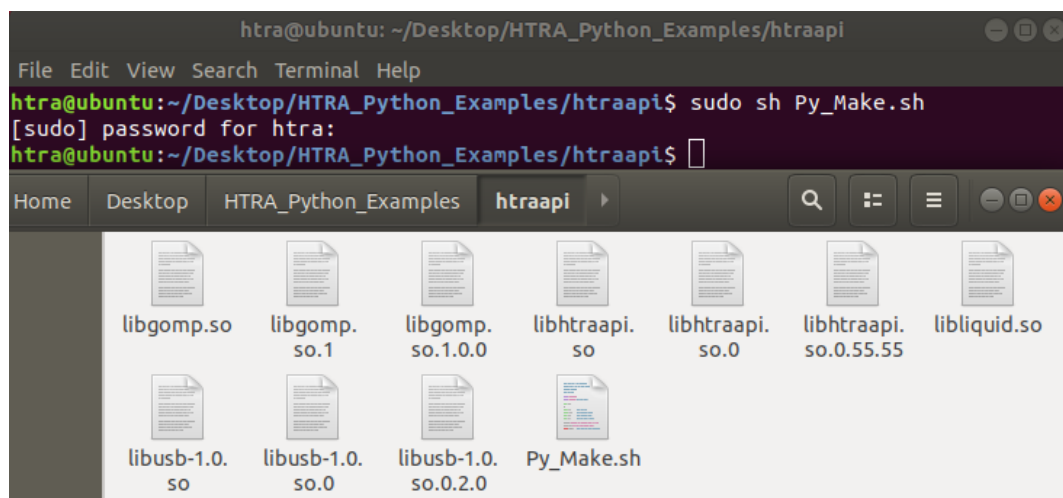


```
htra@ubuntu: ~/Desktop/HTRA_Python_Examples
File Edit View Search Terminal Help
htra@ubuntu:~/Desktop/HTRA_Python_Examples$ which python3
/usr/bin/python3
htra@ubuntu:~/Desktop/HTRA_Python_Examples$ sudo cp -r CalFile /usr/bin
[sudo] password for htra:
htra@ubuntu:~/Desktop/HTRA_Python_Examples$
```

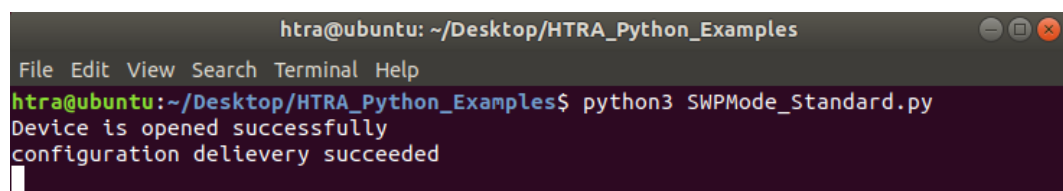
3. First, refer to the system architecture in [Chapter9.1](#), then according to [Chapter9.2.4](#), copy the dynamic link libraries from the corresponding system architecture folder under the included USB drive Linux\Install_HTRA_SDK\htraapi\lib to the HTRA_Python_Examples\htraapi folder (this example uses the x86_64 architecture host computer).



- Open a terminal in the current folder and input "sudo sh Py_Make.sh", then follow the prompts to enter the sudo password to provide permissions for creating soft links to the libraries.



- In the HTRA_Python_Examples location, open a terminal and input python3 SWPMode_Standard.py to run the example. (This example uses SWPMode_Standard.py as an example)



9.6.2 Python Project Creation

Under the premise that the driver files have been correctly configured according to [Chapter9.3](#), if you want to create and write a Python project, please refer to the following process:

First, when writing code, since the Linux dynamic link library provided with the USB drive is identical to that in Windows, the code only needs to comply with the API programming guidelines.

Secondly, when running the program, simply place the program in the example folder and follow the process outlined in [Python Example Usage](#).

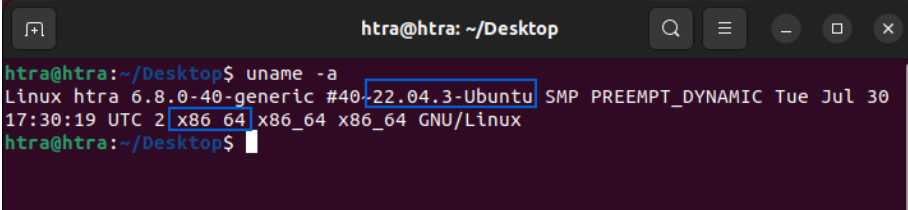
9.7 GNU Radio Module Construction and Use

After the device is properly connected and the driver files are configured as described in Section 9.3, you can use the device with GNU Radio in either of the following two ways.

9.7.1 Architecture and Operating System Requirements

- Architecture: x86_64
- Operating System: Ubuntu22.04 or later
- GNU Radio Version: 3.9 or later

Enter **uname -a** in the terminal to check whether your operating system and architecture meet the requirements for running the HAROGIC spectrum analyzer in GNU Radio. If they do not, please update to the required versions.

A terminal window titled 'htra@htra: ~/Desktop' showing the command 'uname -a' and its output. The output is: 'Linux htra 6.8.0-40-generic #40~22.04.3-Ubuntu SMP PREEMPT_DYNAMIC Tue Jul 30 17:30:19 UTC 2|x86_64|x86_64 x86_64 GNU/Linux'. The 'x86_64' and '22.04.3-Ubuntu' parts are highlighted with red and blue boxes respectively.

```
htra@htra:~/Desktop$ uname -a
Linux htra 6.8.0-40-generic #40~22.04.3-Ubuntu SMP PREEMPT_DYNAMIC Tue Jul 30
17:30:19 UTC 2|x86_64|x86_64 x86_64 GNU/Linux
htra@htra:~/Desktop$
```

9.7.2 Installing and Configuration GNU Radio

1. In the terminal, enter **sudo apt update && sudo apt-get install gnuradio** and wait for the installation to complete;
2. In the terminal, enter **gnuradio-config-info --version** to check the installed version and ensure that GNU Radio was installed successfully;

```
htra@htra: ~/Desktop
htra@htra:~/Desktop$ sudo apt update && sudo apt-get install gnuradio
Get:1 http://security.ubuntu.com/ubuntu jammy-security InRelease [129 kB]
Hit:2 http://mirrors.tuna.tsinghua.edu.cn/ubuntu jammy InRelease
Get:4 http://security.ubuntu.com/ubuntu jammy-security/main amd64 DEP-11 Metadat
a [54.6 kB]
Hit:3 http://mirrors.tuna.tsinghua.edu.cn/ubuntu jammy-updates InRelease
Processing triggers for desktop-file-utils (0.26-1ubuntu3) ...
Processing triggers for hicolor-icon-theme (0.17-2) ...
Processing triggers for gnome-menus (3.36.0-1ubuntu3) ...
Processing triggers for libc-bin (2.35-0ubuntu3.8) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for shared-mime-info (2.1-2) ...
Processing triggers for mailcap (3.70+nmu1ubuntu1) ...
Processing triggers for fontconfig (2.13.1-4.2ubuntu5) ...
htra@htra:~/Desktop$ gnuradio-config-info --version
3.10.1.1
htra@htra:~/Desktop$
```

9.7.3 Building the HRTA OOT Module

1. Open the terminal and enter: ***sudo apt update && sudo apt install -y git cmake g++ libpython3-dev python3-numpy python3-pip python3-setuptools pybind11-dev***, this will install all the toolchains and dependencies required to build GNU Radio and third-party modules in one step.

```
htra@htra: ~/Desktop
htra@htra:~/Desktop$ sudo apt update && sudo apt install -y git cmake g++
libpython3-dev python3-numpy python3-pip python3-setuptools pybind11-dev
[sudo] password for htra:
Hit:1 http://mirrors.tuna.tsinghua.edu.cn/ubuntu jammy InRelease
Get:2 http://mirrors.tuna.tsinghua.edu.cn/ubuntu jammy-updates InRelease [
128 kB]
Get:3 http://mirrors.tuna.tsinghua.edu.cn/ubuntu jammy-backports InRelease
[127 kB]
Setting up git-man (1:2.34.1-1ubuntu1.15) ...
Setting up cmake-data (3.22.1-1ubuntu1.22.04.2) ...
Setting up libalgorithm-diff-xs-perl (0.04-6build3) ...
Setting up libalgorithm-merge-perl (0.08-3) ...
Setting up dpkg-dev (1.21.1ubuntu2.6) ...
Setting up git (1:2.34.1-1ubuntu1.15) ...
Setting up cmake (3.22.1-1ubuntu1.22.04.2) ...
Setting up build-essential (12.9ubuntu3) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.11) ...
htra@htra:~/Desktop$
```

2. In the terminal, enter: ***git clone <https://github.com/HAROGIC-Technologies/gr-htra.git>*** to download the HTRA OOT module(Alternatively, the gr-htra folder may be obtained directly from the Linux\HTRA_Gnuradio_Examples folder within the accompanying documentation.);

```
htra@htra: ~/Desktop
htra@htra:~/Desktop$ git clone https://github.com/HAROGIC-Technologies/gr-htra.git
Cloning into 'gr-htra'...
remote: Enumerating objects: 248, done.
remote: Counting objects: 100% (5/5), done.
remote: Compressing objects: 100% (5/5), done.
remote: Total 248 (delta 1), reused 0 (delta 0), pack-reused 243 (from 1)
Receiving objects: 100% (248/248), 4.27 MiB | 118.00 KiB/s, done.
Resolving deltas: 100% (114/114), done.
htra@htra:~/Desktop$
```

3. In the terminal, enter **`cd gr-htra`** to navigate to the root directory of the HTRA OOT module;
4. Enter **`mkdir build && cd build`** to create a build directory under the project root and switch to it;
5. Enter **`sudo cmake .. && sudo make install`** to configure the project, compile the source code, and install the module to the system directory.

```
htra@htra: ~/Desktop/gr-htra/build
htra@htra:~/Desktop$ cd gr-htra/
htra@htra:~/Desktop/gr-htra$ mkdir build && cd build
htra@htra:~/Desktop/gr-htra/build$ sudo cmake .. && sudo make install
[sudo] password for htra:
-- The CXX compiler identification is GNU 11.4.0
-- The C compiler identification is GNU 11.4.0
-- Detecting CXX compiler ABI info

[ 66%] Linking CXX static library libgnuradio-htra_device.a
[ 66%] Built target gnuradio-htra_device
[ 83%] Building CXX object bindings/CMakeFiles/htra_source.dir/htra_source_pybind.cc.o
[100%] Linking CXX shared module htra_source.cpython-310-x86_64-linux-gnu.so
lto-wrapper: warning: using serial compilation of 6 LTRANS jobs
[100%] Built target htra_source
Install the project...
-- Install configuration: "Release"
-- Installing: /usr/local/include/htra_device/htra_source.h
-- Installing: /usr/local/lib/libgnuradio-htra_device.a
-- Installing: /usr/local/share/gnuradio/grc/blocks/htra_device_htra_source.block.yml
-- Installing: /usr/local/lib/python3.10/dist-packages/htra_source.cpython-310-x86_64-linux-gnu.so
htra@htra:~/Desktop/gr-htra/build$
```

6. Copy the instrument's calibration files into the gr-htra/CalFile folder, then run **`cd.. && sudo sh CopyCalFile.sh`** to install the device calibration files.

```
htra@htra: ~/Desktop/gr-htra
htra@htra:~/Desktop/gr-htra/build$ cd .. && sudo sh CopyCalFile.sh
[sudo] password for htra:
=====
Copying calibration files from /home/htra/Desktop/gr-htra/CalFile to /bin/CalFile
=====
Done. All calibration files copied to /bin/CalFile
=====
htra@htra:~/Desktop/gr-htra$
```

9.7.4 Uninstalling the HTRA OOT Module

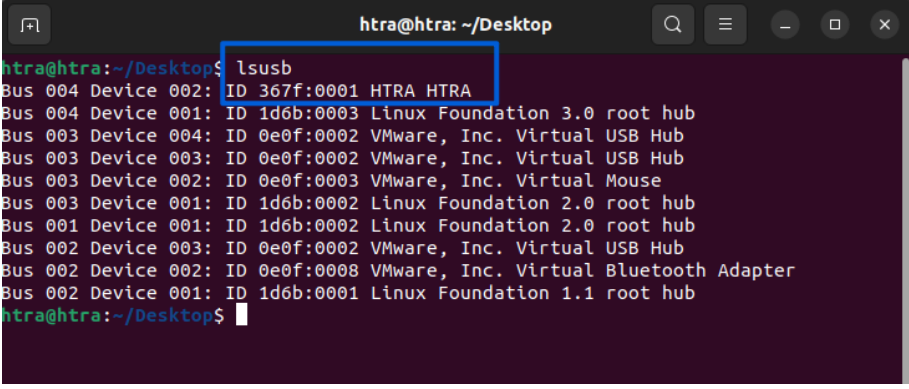
To uninstall the HTRA OOT module along with its related configuration files, run the following command in the gr-htra folder: `sudo sh uninstall.sh`.

9.7.5 Running the HTRA OOT Module

The following section demonstrates the operation of the HTRA OOT module using a USB device as an example.

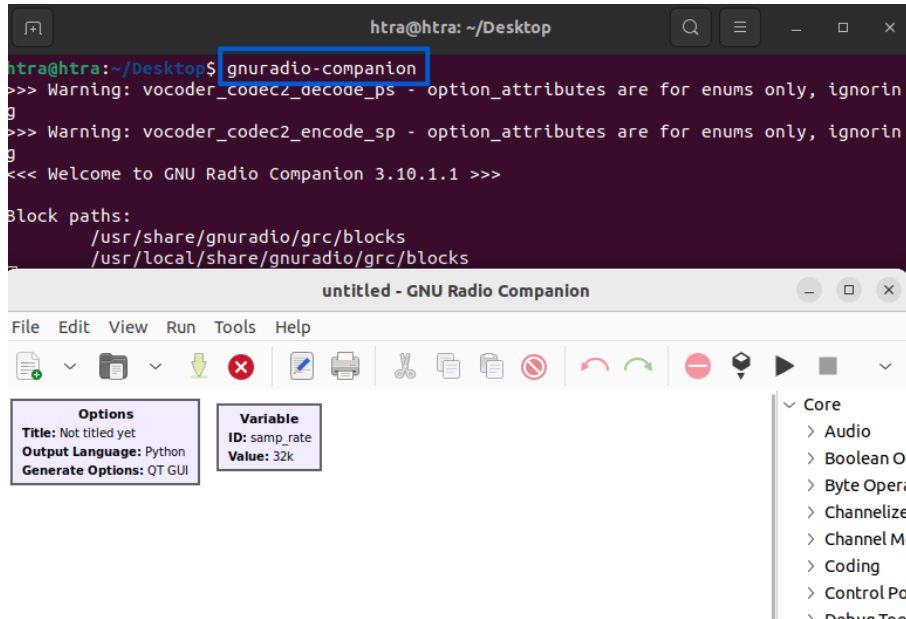
1. Connect the device to the host computer, then enter **lsusb** in the terminal. If the output shows IDs 6430, 3675, 04b5, or 367f, it indicates that the instrument is correctly connected to the host.

(If the host is a virtual machine, after a successful connection, you can check the hardware device icon at the bottom-right corner of the VM interface. Hovering the mouse over the icon should display the HTRA logo, confirming that the device is connected to the VM. Also, ensure that the USB compatibility setting is set to USB 3.1 to guarantee proper device operation.)

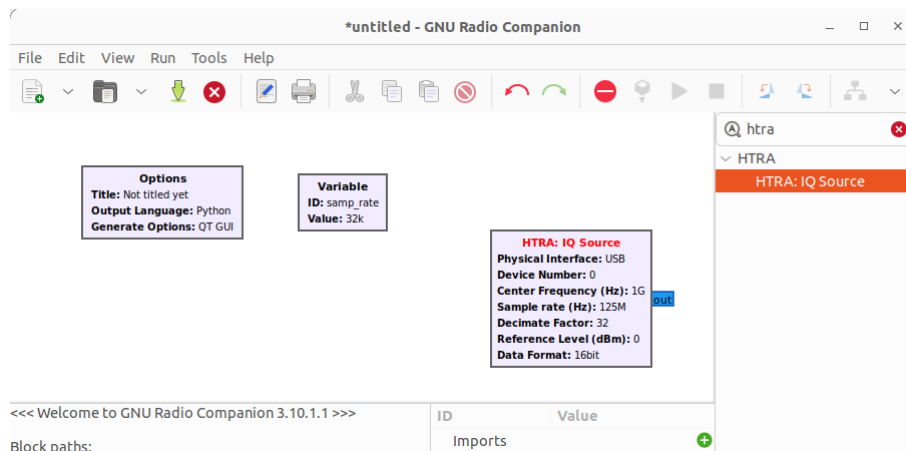
A terminal window titled 'htra@htra: ~/Desktop' showing the output of the 'lsusb' command. The output lists various USB devices. The line 'Bus 004 Device 002: ID 367f:0001 HTRA HTRA' is highlighted with a red rectangular box. Other visible lines include 'Bus 004 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub', 'Bus 003 Device 004: ID 0e0f:0002 VMware, Inc. Virtual USB Hub', 'Bus 003 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub', 'Bus 003 Device 002: ID 0e0f:0003 VMware, Inc. Virtual Mouse', 'Bus 003 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub', 'Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub', 'Bus 002 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub', 'Bus 002 Device 002: ID 0e0f:0008 VMware, Inc. Virtual Bluetooth Adapter', and 'Bus 002 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub'. The prompt 'htra@htra:~/Desktop\$' is visible at the bottom.

```
htra@htra:~/Desktop$ lsusb
Bus 004 Device 002: ID 367f:0001 HTRA HTRA
Bus 004 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 003 Device 004: ID 0e0f:0002 VMware, Inc. Virtual USB Hub
Bus 003 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub
Bus 003 Device 002: ID 0e0f:0003 VMware, Inc. Virtual Mouse
Bus 003 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 002 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub
Bus 002 Device 002: ID 0e0f:0008 VMware, Inc. Virtual Bluetooth Adapter
Bus 002 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
htra@htra:~/Desktop$
```

2. In the terminal, navigate to the built gr-htra folder and enter **gnuradio-companion** to launch the graphical interface;

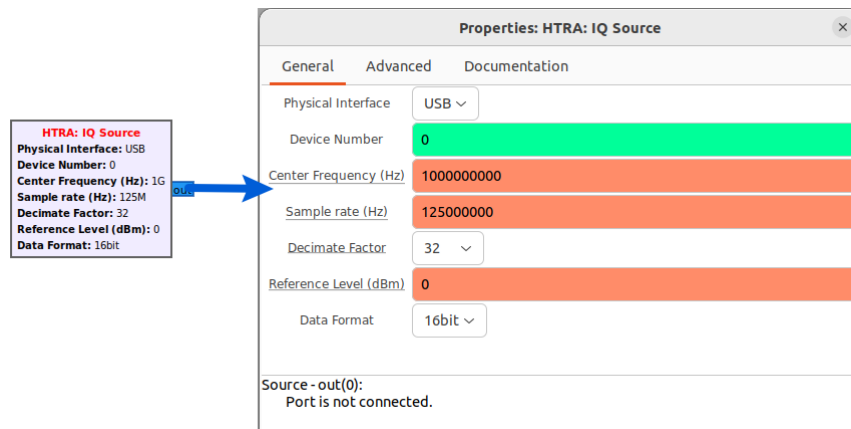


3. In the GNU Radio Companion graphical interface, press Ctrl+F to open the search box. Enter HTRA in the top-right corner and press Enter to load HTRA: IQ Source into the flowgraph;

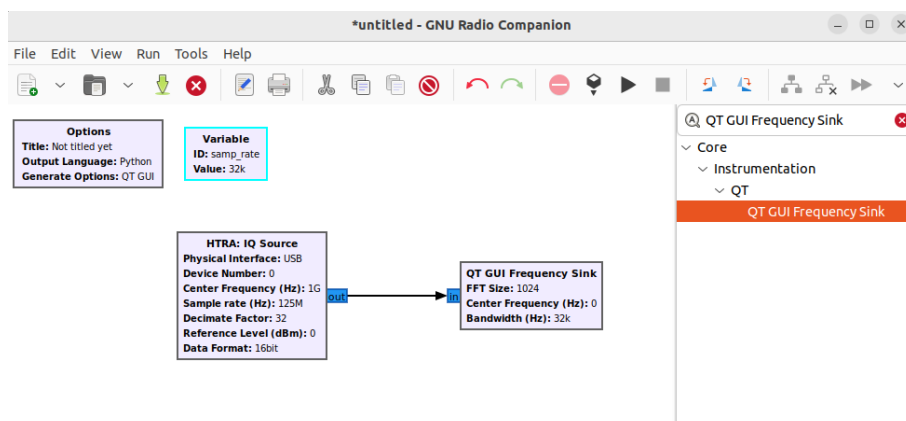


4. The HTRA: IQ Source module is used to receive IQ data streams from the HAROGIC spectrum analyzer and process them within GNU Radio. You can double-click the HTRA: IQ Source module to open its configuration window, modify or select the desired parameter values, and then click OK at the bottom of the window to apply the changes;
- **Physical Interface:** Interface type. Select either USB or Ethernet (ETH) from the drop-down menu to connect to the device

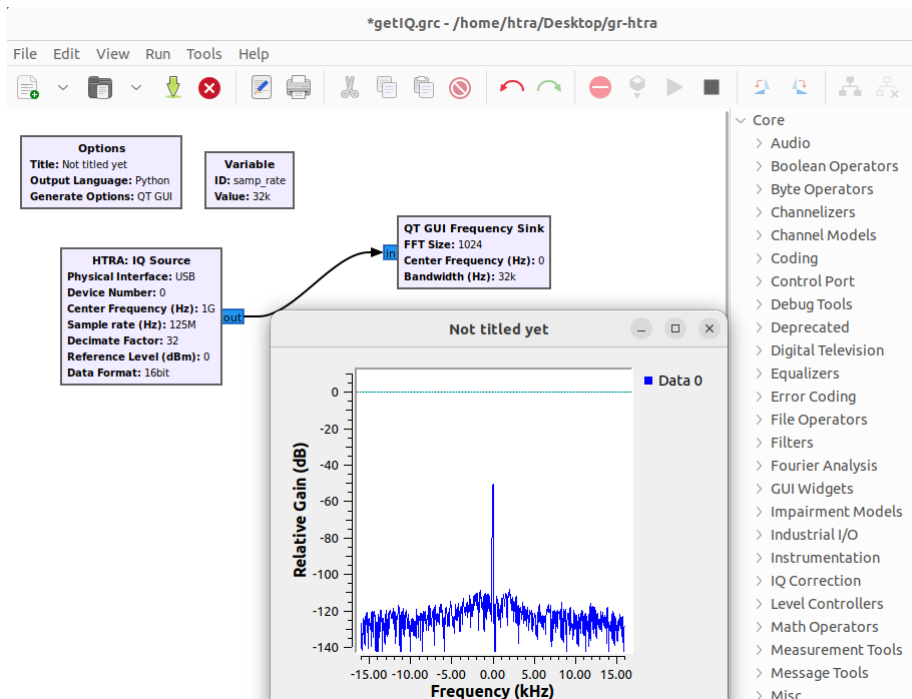
- **Device Number:** Set different device numbers when multiple devices are connected simultaneously
- **Center Frequency:** Center frequency, ranging from 9 kHz to the device's cutoff frequency
- **Sample rate:** Sampling rate
- **Decimation Factor:** Decimation factor, selectable from the drop-down menu in the module settings
- **Reference Level:** Reference level, ranging from -50 to +23 dBm
- **Data Format:** Data format used for the acquired IQ data



5. In the search box, enter QT GUI Frequency Sink and press Enter to add the spectrum display module. Connect the input of this module to the output of the HTRA: IQ Source module to display the IQ signal spectrum in real time;



6. Click "File" -> "Save" to save the file as Spectrum_display, then click the Run button at the top of the graphical interface to view the spectrum of the input signal.

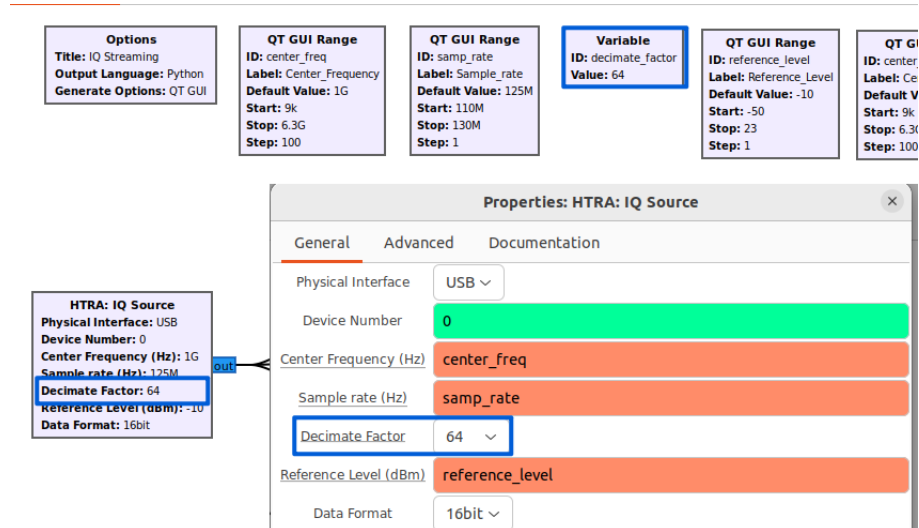


9.7.6 Acquiring IQ Stream

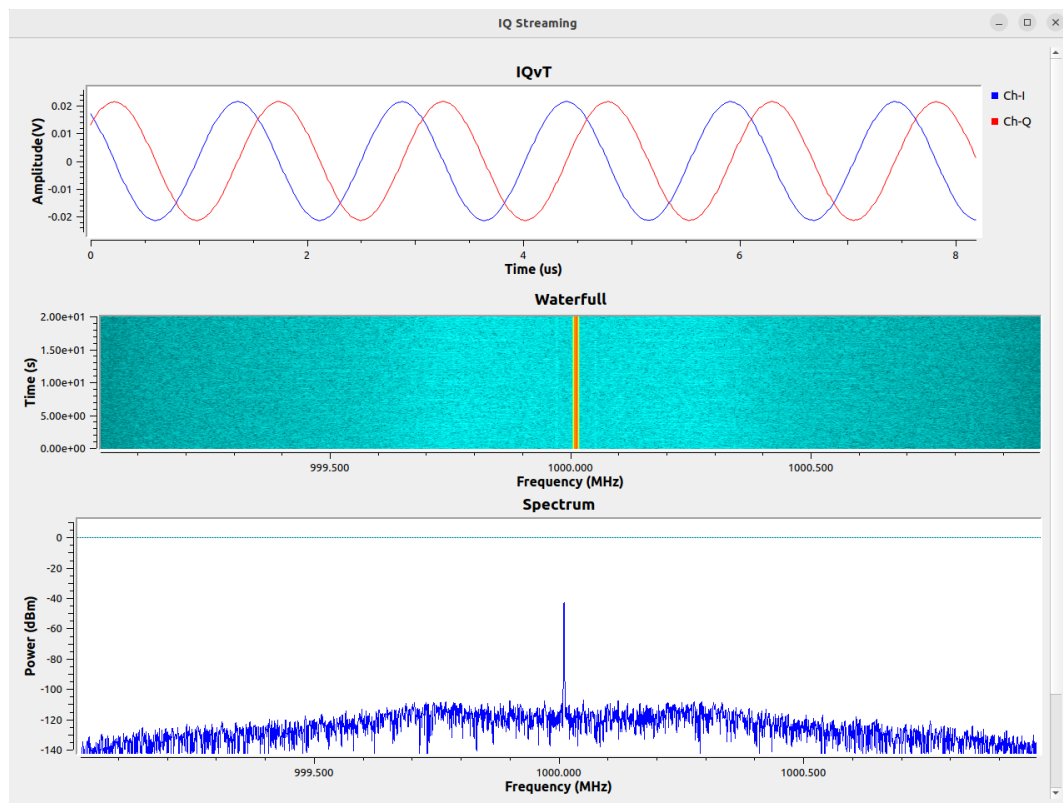
This example demonstrates how to acquire IQ data and provides the IQ time-domain waveform, spectrum, and waterfall display.

The following example uses a 1 GHz, -20 dBm single-tone signal to illustrate the process.

1. Open a terminal in the built gr-htra folder, type ***gnuradio-companion***, and press Enter to launch the graphical interface;
2. In the pop-up graphical interface, click "File" -> "Open" -> "Examples" -> "IQ_streaming.grc" -> "Open" to load the IQ streaming acquisition example from the routine;
3. Keep the parameters at their default configuration. You can double-click the corresponding QT GUI Range module and Variable parameter node at the top of the example to modify the relevant parameters in the HTRA: IQ Source module (Note: the Decimate Factor must be consistent between the Variable and the module); Also, double-click the HTRA: IQ Source module itself to select the appropriate the interface device and data type.



- Click the Run button at the top of the GNU Radio Companion graphical interface to view the time-domain waveform, spectrum, and spectrogram corresponding to the IQ stream;

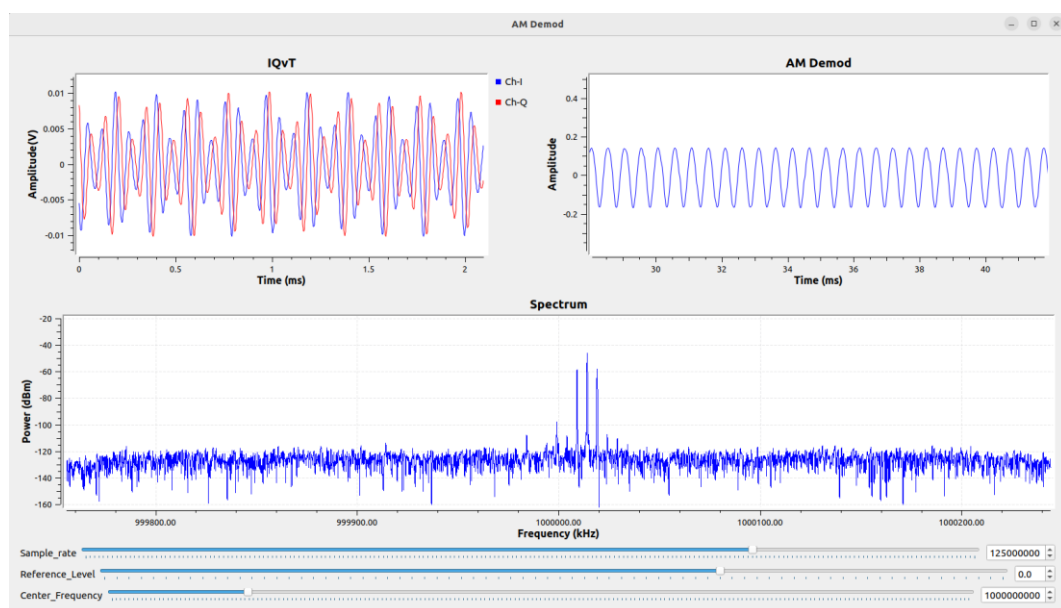


9.7.7 AM Demodulation

This example is used for AM signal demodulation and demonstrates the time-domain waveform, spectrum, and demodulated audio waveform of the AM signal. It demodulates AM signals with a modulation rate ≤ 15 kHz only. You can design or adjust the demodulation chain according to your actual requirements.

The following uses the demodulation of a 1 GHz, -20 dBm AM signal with a symbol rate of 5 kHz and a modulation depth of 50% as an example.

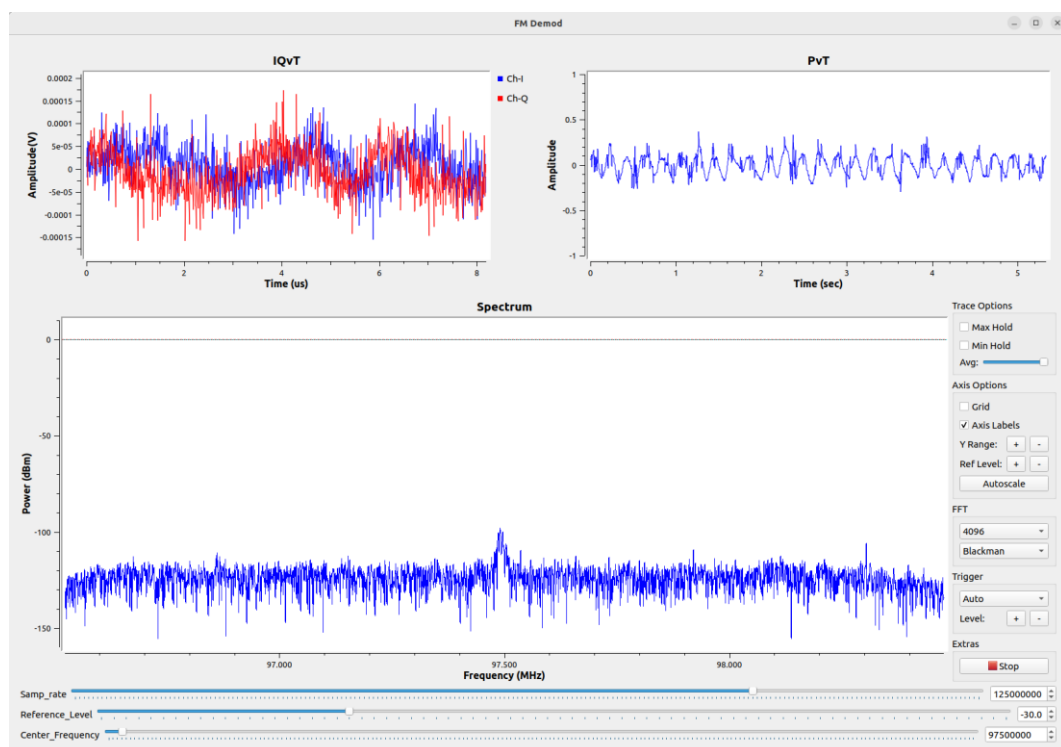
1. Refer to [steps 1 to 2 in the "Acquiring IQ Stream"](#) chapter to open the "AM_demod.grc" example;
2. The Center Frequency and Reference Level maintain their default configuration. You can double-click the corresponding QT GUI Range block and adjust the "Default Value" in its properties window to adapt to AM signals of different frequencies and power levels.
3. Click the Run button at the top of the GNU Radio Companion graphical interface to view the IQ time-domain plot, spectrum, and demodulated audio waveform of the AM signal.



9.7.8 FM Demodulation

This example is used for demodulating FM broadcast signals and demonstrates the time-domain waveform, spectrum, and demodulated audio waveform of the FM signal. The following uses the demodulation of a 97.5 MHz broadcast signal as an example.

1. Refer to [steps 1 to 2 in the "Acquiring IQ Stream" chapter](#) to open the "FM_demod.grc" example;
2. The Center maintains its default configuration. You can double-click the QT GUI Range block corresponding to "center_freq" and adjust the "Default Value" in its properties window to demodulate FM broadcast signals at different frequencies.
3. Click the Run button at the top of the GNU Radio Companion graphical interface to view the IQ waveform, spectrum, and demodulated time-domain waveform of the FM signal.



9.7.9 QPSK Demodulation

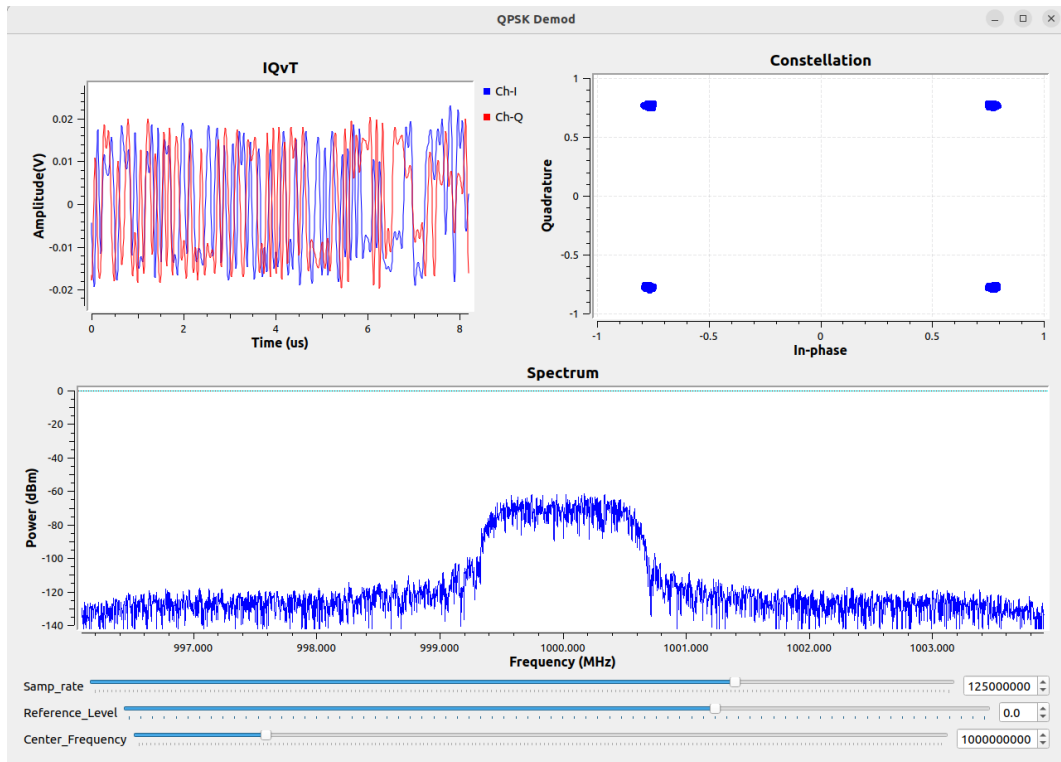
This example is used for demodulating QPSK signals and demonstrates the IQ time-domain waveform, spectrum, and demodulated constellation diagram of the QPSK signal, facilitating real-time verification of symbol synchronization, carrier recovery, and signal quality for users.

The following uses the demodulation of a 1 GHz, -20 dBm QPSK signal with a symbol rate of 1 MHz and a filter alpha (roll-off factor) of 0.35 as an example.

1. Refer to [steps 1-2 in the "Acquiring IQ Stream" chapter](#) to open the "QPSK_demod.grc" example;
2. Double-click the Variable parameter nodes corresponding to "decimate_factor" and "symbol_rate", and modify their respective "Value" in the properties window to set the Decimate Factor to 16 and the Symbol Rate to 1 MHz. Then, double-click "HTRA: IQ Source" and update the value of the Decimate Factor in the pop-up window. Keep other parameters at their default configuration. You can double-click other QT GUI Range or Variable nodes to adjust Center, Ref.Level, SampleRate, Decimate Factor, and Filter Alpha as needed to adapt to different signals.

Note: $\text{SampleRate} / \text{Decimate Factor} \geq 4 * \text{Symbol Rate}$

3. Click the Run button at the top of the GNU Radio Companion graphical interface to view the time-domain graph, spectrum, and demodulated constellation diagram corresponding to the IQ stream;



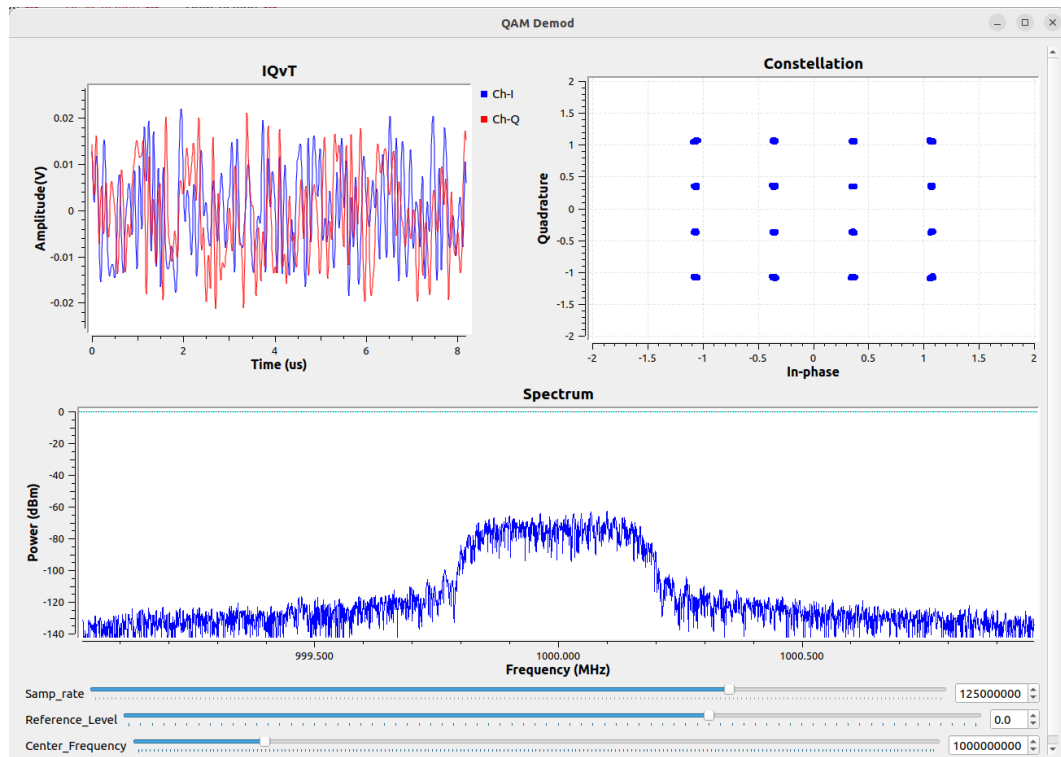
9.7.10 QAM Demodulation

This example is used for demodulating QAM16 and QAM64 signals and demonstrates the IQ time-domain waveform, spectrum, and demodulated constellation diagram of the QAM signal.

The following uses the demodulation of a QAM16 signal with a center frequency of 1 GHz, a reference level of -20 dBm, a symbol rate of 300 kHz, and a filter alpha (roll-off factor) of 0.35 as an example.

1. Refer to steps 1-2 in the "Acquiring IQ Stream" chapter to open the "QAM_demod.grc" example;
2. Double-click the Variable parameter node corresponding to "symbol_rate", and modify its "Value" in the properties window to set the Symbol Rate to 300 kHz. Keep other parameters at their default settings. You can double-click other QT GUI Range or Variable nodes to adjust Center, Reference Level, SampleRate, Decimate Factor (setting rules refer to the QPSK Demodulation chapter), and Filter Alpha as needed to adapt to different signals;

3. Click the Run button at the top of the GNU Radio Companion graphical interface to view the time-domain graph, spectrum, and demodulated constellation diagram corresponding to the IQ stream.



9.7.11 DAB Demodulation

The DBA demodulation example relies on the open-source project gr-dab. Please install the gr-dab project according to the following chapter before running it.

Enter the following commands in the terminal sequentially to install gr-dab and its required dependencies:

```
sudo apt-get update
sudo apt-get install gnuradio libboost-all-dev libcppunit-dev libfaad-dev
git clone https://github.com/gnuradio/gr-dab.git
cd gr-dab
mkdir build
cd build
cmake ..
make
sudo make install
```



```
sudo ldconfig
```

9.7.12 WLAN Signal Demodulation

The WLAN demodulation example relies on the open-source projects `gr-ieee802-11` and `gr-foo`. Please install these projects according to the following chapter before running it.

This example demonstrates the demodulation of an IEEE 802.11a signal at 2.412 GHz, –20 dBm reference level, 20 MHz symbol rate, and 12 Mb/s rate.

1. Enter the following commands in the terminal, in sequence, to install `gr-foo`:

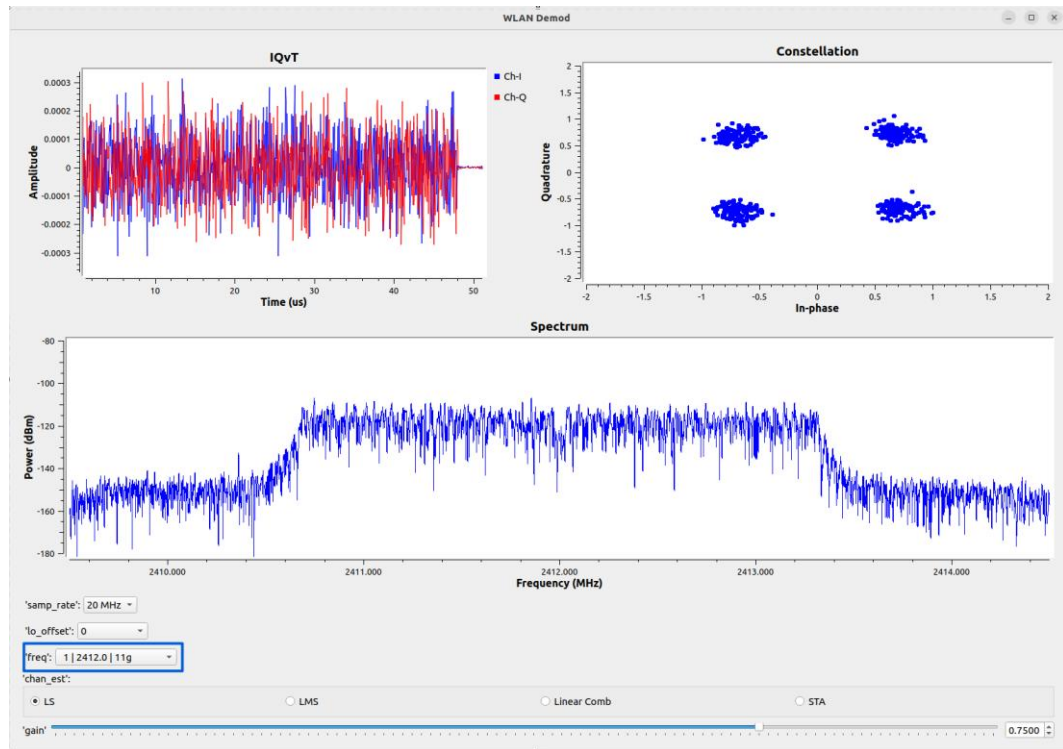
```
git clone https://github.com/bastibl/gr-foo
cd gr-foo
mkdir build
cd build
cmake ..
make
sudo make install
sudo ldconfig
```

2. Enter the following commands in the terminal, in sequence, to install `gr-ieee802-11`:

```
git clone https://github.com/bastibl/gr-ieee802-11
cd gr-ieee802-11
mkdir build
cd build
cmake ..
make
sudo make install
sudo ldconfig
sudo sysctl -w kernel.shmmax=2147483648
```

3. Refer to [steps 1 to 2 in the chapter "Acquiring IQ Stream"](#) to open the "WLAN_demod.grc" example;

- Click the Run button at the top of the GNU Radio Companion graphical interface.
Set the "freq" parameter in the result display window to 1|2412.0|11g to view the corresponding time-domain graph, spectrum, and demodulated constellation diagram of the IQ stream.



9.8 Java (to be supplemented)

It is important to note that when writing programs in Java to control devices on a Linux system, the CalFile folder needs to be placed in the same directory as the Java interpreter.

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