

Application Note

ARM GCC Development Environment Based on Windows Application Note

Contens

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1. Overview

Using N32G45x series MCU as an example, this paper introduces the methods of setting up development environment, compiling, firmware downloading and code debugging based on VSCode editor, GCC compilation tool chain and GDB debugging tool under Windows environment.

2. Development Tools

2.1 Software

- Editor Visual Studio Code 1.5x.x or above
- Compile tool chain arm-none-eabi-gcc 6.3.1 or above
- Make for Windows
- Download and debugging tool JLink_v6.40 or above (not exceeding hardware supported version)

2.2 Hardware

- Development board N32G457QEL_EVB
- JLink downloader V9.2 or above (not below the software supported version)

3. Development Environment Setup

3.1 Installing VSCode

- **Download the software:** <https://code.visualstudio.com/>

VSCode is used for code viewing and editing. It also provides powershell and bash terminals for command-line operations, which will be used throughout our development process.

3.2 Installing the GCC Compilation Tool Chain

- **Download address:**
<https://launchpad.net/gcc-arm-embedded/+announcement/28093>

Example version: 10-2020-q4-major

Check whether the installation is successful: Open a DOS command line window, type “arm-none-eabi-gcc -v”

The installation is successful if the content shown in the following figure appears:

Figure 3-1 Information About the Successful Installation of GCC

```
C:\Users\tan.dengwang>arm-none-eabi-gcc --version
arm-none-eabi-gcc (GNU Arm Embedded Toolchain 10-2020-q4-major) 10.2.1 20201103
(release)
Copyright (C) 2020 Free Software Foundation, Inc.
```

If the installation is not successful, please do the following two checks.

1. Check whether environment variables are properly added
2. Go to “C:\Program Files (x86)\GNU Arm Embedded Toolchain\10-2020-q4-major\bin” and check whether the “arm-none-eabi-gcc.exe” file name is correct

3.3 Installing Make for Windows

This tool is used to parse Makefile scripts. You can choose to install one of the following two software.

- **Install the cmake.exe tool**
Download address: <http://www.equation.com/servlet/equation.cmd?fa=make>
- **Install MinGW and use its own make tool.**

Check whether the installation is successful: Open a DOS command line window and type “make -v”.

The installation is successful if the content shown in the following figure appears:

Figure 3-2 Information About The Successful Installation of Make for Windows

```
C:\Users\tan.dengwang>make -v
GNU Make 3.82.90
Built for i686-pc-mingw32
Copyright (C) 1988-2012 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
```

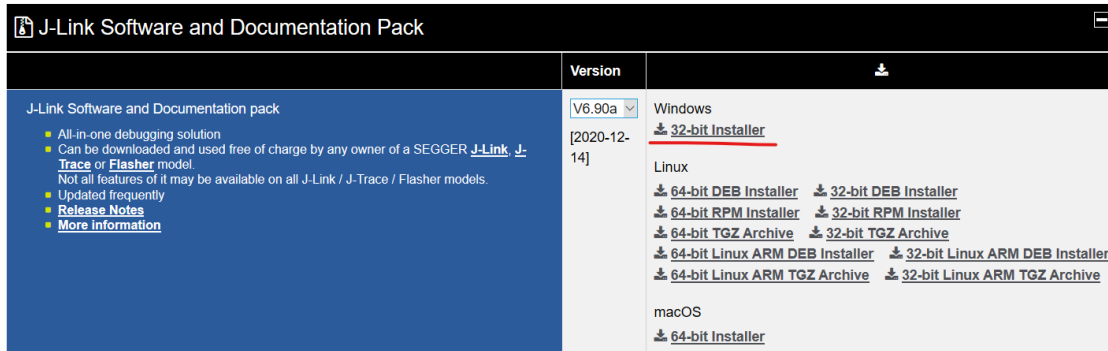
If the installation is not successful, please do the following two checks

1. Check that the environment variables are properly added
2. Go to the bin folder of the corresponding “make” installation directory to check whether the “make.exe” file name is correct

3.4 Installing the JLink Tool

- Download the JLINK installation package, V6.90a or others version
<https://www.segger.com/downloads/jlink/#-LinkSoftwareAndDocumentationPack>

Figure 3-3 Installation Interface



3.5 Adding Chip Support

After installing JLink, you need to add our company's chip patch package to JLink, so that the download algorithm can be correctly obtained during downloading and debugging.

For details, refer to <JLink Tool Adding Nsing Chip.7z>.

3.6 JLink Download Test

- Test the JLink environment installation
 1. Connect the PC and JLink debugger, connect the development board, and power on;
 2. Open cmd.exe command line tool, go to JLink installation directory “C:\Program Files (x86)\SEGGER\JLink_V690a”, type “jlink.exe”.

The below figure shows that the PC successfully connected to the JLink debugger.

Figure 3-4 Information About PC Successfully Connected To The JLink Debugger.

```

C:\Program Files (x86)\SEGGER\JLink_V690a>JLink.exe
SEGGER J-Link Commander V6.90a (Compiled Dec 14 2020 17:16:04)
DLL version V6.90a, compiled Dec 14 2020 17:14:31

Connecting to J-Link via USB...O.K.
Firmware: J-Link V9 compiled Dec 13 2019 11:14:50
Hardware version: V9.20
S/N: 59800902
License(s): RDI, GDB, FlashDL, FlashBP, JFlash
VTref=3.340V

Type "connect" to establish a target connection, '?' for help
J-Link>_
    
```

3. Then type the information sequentially as prompted: “connect”, “N32G457QE”, “SWD”, “4000”. If the previous operation is successful, you will see the following output information, JLink download debugging environment can be used normally.

Figure 3-5 Information About That JLink Download Debugging Environment Can Be Used Normally

```
Type "connect" to establish a target connection, '?' for help
J-Link>connect
Please specify device / core. <Default>: N32G457QE
Type '?' for selection dialog
Device>
Please specify target interface:
  J) JTAG (Default)
  S) SWD
  T) cJTAG
TIF>S
Specify target interface speed [kHz]. <Default>: 4000 kHz
Speed>
Device "N32G457QE" selected.

Connecting to target via SWD
Found SW-DP with ID 0x2BA01477
DPv0 detected
Scanning AP map to find all available APs
AP[1]: Stopped AP scan as end of AP map has been reached
AP[0]: AHB-AP (IDR: 0x24770011)
Iterating through AP map to find AHB-AP to use
AP[0]: Core found
AP[0]: AHB-AP ROM base: 0xE00FF000
CPUID register: 0x410FC241. Implementer code: 0x41 (ARM)
Found Cortex-M4 r0p1, Little endian.
FPUnit: 6 code (BP) slots and 2 literal slots
CoreSight components:
ROMTbl[0] @ E00FF000
ROMTbl[0][0]: E000E000, CID: B105E00D, PID: 000BB00C SCS-M7
ROMTbl[0][1]: E0001000, CID: B105E00D, PID: 003BB002 DWT
ROMTbl[0][2]: E0002000, CID: B105E00D, PID: 002BB003 FPB
ROMTbl[0][3]: E0000000, CID: B105E00D, PID: 003BB001 ITM
ROMTbl[0][4]: E0040000, CID: B105900D, PID: 000BB9A1 TPIU
ROMTbl[0][5]: E0041000, CID: B105900D, PID: 000BB925 ETM
Cortex-M4 identified.
J-Link>
```

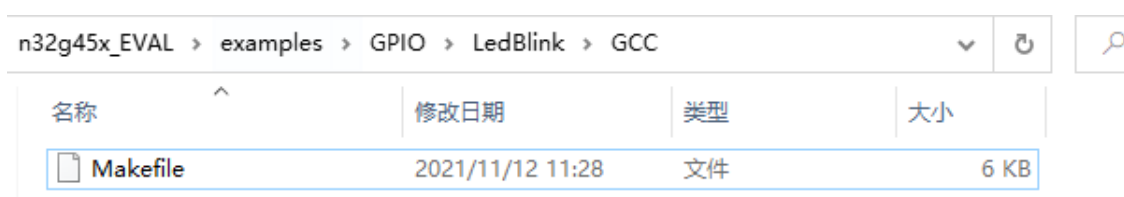
4. SDK Contens

SDK follows the issued SDK version, currently using V2.0.0. On this basis, the following modifications are made to adapt to GCC development environment.

4.1 Makefile

Add "GCC" folder under module routines directory in SDK package: (please copy "GCC" folder to each routine)

Figure 4-1 Add "GCC" Folder



The “Makefile” file is the GCC compilation script file.

4.2 .s File

In “Nationstech.N32G45x_Library.2.0.0\firmware\CMSIS\device\startup” path of the SDK package, there is a “startup_n32g45x_gcc.s” file corresponding to the .s file.

Figure 4-2 The “startup_n32g45x_gcc.s” File

名称	修改日期	类型	大小
startup_n32g45x.s	2021/11/22 10:45	S 文件	18 KB
startup_n32g45x_EWARM.s	2021/11/22 10:45	S 文件	21 KB
startup_n32g45x_gcc.s	2021/11/19 11:56	S 文件	23 KB

4.3 .ld File

In “Nationstech.N32G45x_Library.2.0.0\firmware\CMSIS\device” path of the SDK package, there is a corresponding .s file for the GCC compiler named “n32g45x_flash.ld”.

Figure 4-3 The “n32g45x_flash.ld” File

名称	修改日期	类型	大小
startup	2021/11/23 16:35	文件夹	
n32g45x.h	2021/11/22 10:45	H 文件	553 KB
n32g45x_conf.h	2021/11/22 10:45	H 文件	4 KB
n32g45x_flash.ld	2021/11/19 14:05	LD 文件	5 KB
system_n32g45x.c	2021/11/22 10:45	C 文件	14 KB
system_n32g45x.h	2021/11/22 10:45	H 文件	2 KB

4.4 Printing Remapping

The “print_remap.c” file is added in the “bsp/src” directory of the SDK package for serial port printing remapping. Added the “delay.c” file to achieve microsecond and millisecond delays using the SysTick timer.

Figure 4-4 The “print_remap.c” and “delay.c” File

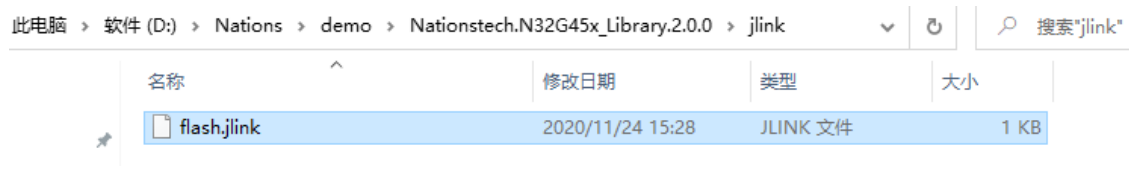
名称	修改日期	类型	大小
delay.c	2021/11/22 10:45	C 文件	4 KB
log.c	2021/11/22 10:45	C 文件	4 KB
print_remap.c	2021/10/12 15:04	C 文件	3 KB

4.5 JLink Script

Added the “jlink” folder in home directory of the SDK package, which contains a JLink download script for downloading

firmware using the JLink tool.

Figure 4-5 Add The “jlink” Folder



4.6 Clearing Scripts

The “script” folder is added in home directory of the SDK package, and there is a “.bat” script in this folder, which is used to clear intermediate files generated during compilation.

Figure 4-6 A “.bat” Script in “script” Folder

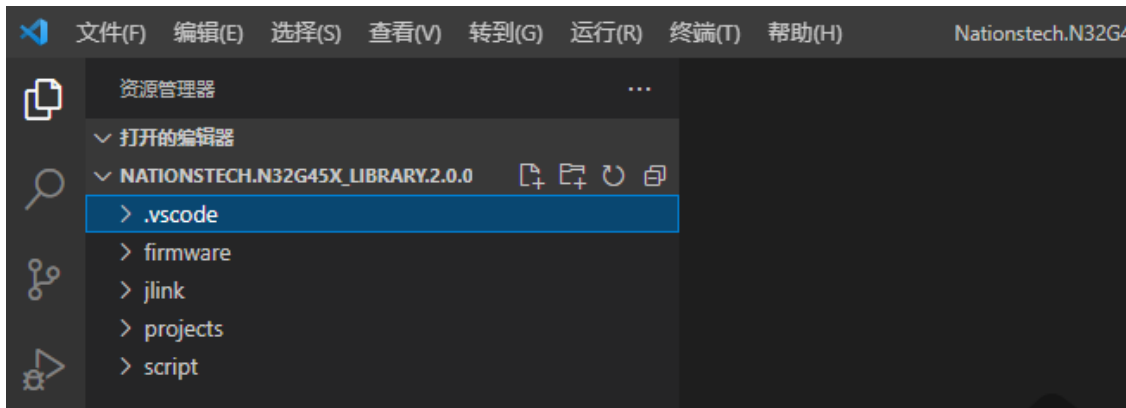


5. Compile and Download

5.1 Workspace

Open the SDK folder in VSCode and save it as a workspace. The “.vscode” folder will be generated under the SDK folder to place the workspace configuration file.

Figure 5-1 The “.vscode” Folder



5.2 Working Directory

Using the GPIO routine LedBlink as an example to enter the project directory:

“Nationtech.N32G45x_Library.2.0.0\projects\n32g45x_EVAL\examples\GPIO\LedBlink”

KEIL project “MDK-ARM”

GCC project “GCC”

Project source file “src /xxx.c”

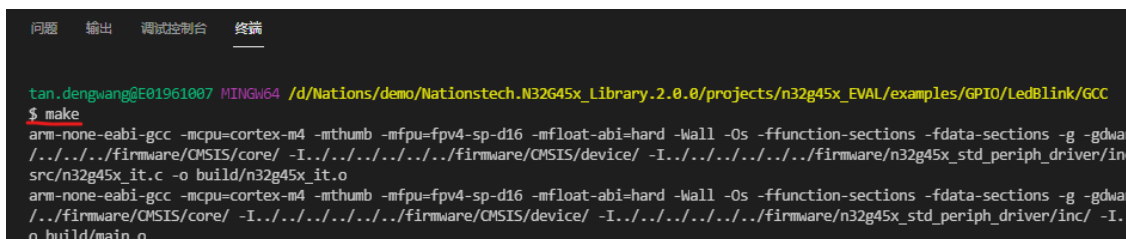
Project header file “inc/XXX.h”

Makefile file “GCC/Makefile”

5.3 Code Compilation

In the terminal of the VSCode editor, switch to the “GCC” folder directory, then type “make” to start compiling

Figure 5-2 Type “make” in The “GCC” Folder Directory



The .elf, .bin and .hex files will be generated after successful compilation without errors.

Figure 5-3 The .elf, .bin and .hex Files

```

问题 输出 调试控制台 终端
arm-none-eabi-gcc build/n32g45x_it.o build/main.o build/delay.o build/log.o build/print_remap.o build/system_n32g45x.o build/n32g45x_gpio.o build/n32g45x_rcc.o build/n32g45x_sdio.o build/n32g45x_eth.o build/misc.o build/n32g45x_qspi.o build/n32g45x_pwr.o build/n32g45x_dma.o build/n32g45x_wwdg.o build/n32g45x_tim.o build/n32g45x_exti.o build/n32g45x_comp.o build/n32g45x_dvp.o build/n32g45x_iwdg.o build/n32g45x_dbg.o build/startup_n32g45x.o build/startup_n32g45x.o -mcpu=cortex-m4 -mthumb -mfpv4-sp-d16 -mfloat-abi=hard -Wl,--gc-sections -Wl,--start-group CMSIS/device/n32g45x_flash.ld -o build/output.elf
arm-none-eabi-size build/output.elf
text data bss dec hex filename
1632 1088 2592 5312 14c0 build/output.elf
arm-none-eabi-objcopy -O ihex -S build/output.elf build/output.hex
arm-none-eabi-objcopy -O binary -S build/output.elf build/output.bin

tan.dengwang@E01961007 MINGW64 /d/Nations/demo/Nationtech.N32G45x_Library.2.0.0/projects/n32g45x_EVAL/examples/GPIO/LedBlink/GCC
$

```

The “build” folder is created under the “GCC” folder. The compiled firmware and intermediate files are stored in this folder.

5.4 Downloading Firmware

1. Connect PC -> JLink -> development board
2. In the terminal, type “make download”

Figure 5-4 Type “make download” in The “GCC” Folder Directory

```

问题 输出 调试控制台 终端
tan.dengwang@E01961007 MINGW64 /d/Nations/demo/Nationtech.N32G45x_Library.2.0.0/projects/n32g45x_EVAL/examples/GPIO/LedBlink/GCC
$ make download
SEGGER J-Link Commander V6.90a (Compiled Dec 14 2020 17:16:04)
DLL version V6.90a, compiled Dec 14 2020 17:14:31

J-Link Command File read successfully.
Processing script file...

```

Some information will be printed in the process. Finally, the download is complete

Figure 5-5 Information About Download Completed

```

问题 输出 调试控制台 终端
J-Link: Flash download: Bank 0 @ 0x08000000: 1 range affected (4096 bytes)
J-Link: Flash download: Total: 0.577s (Prepare: 0.143s, Compare: 0.208s, Erase: 0.025s, Program: 0.164s, Verify: 0.030s, Restore: 0.004s)
J-Link: Flash download: Program speed: 23 KB/s
O.K.

Reset delay: 0 ms
Reset type NORMAL: Resets core & peripherals via SYSRESETREQ & VECTRESET bit.
Reset: Halt core after reset via DEMCR.VC_CORERESET.
Reset: Reset device via AIRCR.SYSRESETREQ.

Script processing completed.

Download Completed!

```

3. After download is complete, the system will automatically reset and start running
4. If the download fails, please check the JLink configuration

5.5 Clearing Intermediate Files

Type “make clean” on the terminal to clear the intermediate files generated by the compilation.

6. Code Debugging

6.1 VSCode Settings

There is a “.vscode” folder in the SDK working path, which contains “launch.json” workspace configuration file that needs to be configured for code debugging:

Figure 6-1 The “launch.json” Workspace Configuration File

tasks.json	2021/11/12 10:51	JSON 文件	1 KB
launch.json	2021/11/12 11:28	JSON 文件	3 KB

launch.json:

Figure 6-2 The Code of The VSCode Debugger Configuration File

```

1  {
2    "version": "0.2.0",
3    "configurations": [
4      {
5        "name": "gdb-arm",
6        "type": "cppdbg",
7        "request": "launch",
8        "targetArchitecture": "arm",
9        "program": "blink",
10       "args": [],
11       "stopAtEntry": true,
12       "cwd": "${workspaceFolder}",
13       "environment": [],
14       "externalConsole": false,
15       "MIMode": "gdb",
16       "miDebuggerPath": "C:\\Program Files (x86)\\GNU Arm Embedded Toolchain\\10-2020-q4-major\\bin\\arm-none-eabi-gdb.exe",
17       "miDebuggerServerAddress": "localhost:2331",
18       "setupCommands": [
19         {
20           "description": "Enable pretty-printing for gdb",
21           "text": "-enable-pretty-printing",
22           "ignoreFailures": false
23         }
24       ],
25       "customLaunchSetupCommands": [
26         {
27           "text": "target remote :2331",
28           "description": "connect to server",
29           "ignoreFailures": false
30         },
31         {
32           "text": "file 'D:/Nations/demo/Nationstech.N32G45x_Library.2.0.0/projects/n32g45x_EVAL/examples/GPIO/LedBlink/gcc/build/output.elf'",
33           "description": "load file to gdb",
34           "ignoreFailures": false
35         },
36         {
37           "text": "load",
38           "description": "download file to MCU",
39           "ignoreFailures": false
40         },
41         {
42           "text": "monitor reset",
43           "description": "reset MCU",
44           "ignoreFailures": false
45         }
46       ],
47       "text": "b main",
48       "description": "set breakpoints at main",
49       "ignoreFailures": false
50     },
51     "launchCompleteCommand": "None",
52     // "preLaunchTask": "build"
53   }
54 ]
55 }
56

```

This is the VSCode debugger configuration file, and the following changes should be made according to your project path:

1. Specify the path to the GDB debugger: (absolute path)

Figure 6-3 The Path To The GDB Debugger

```
"miDebuggerPath": "C:\\Program Files (x86)\\GNU Arm Embedded Toolchain\\10-2020-q4-major\\bin\\arm-none-eabi-gdb.exe",
```

The version of the GDB tool must match the version of the compiler tool. Otherwise, errors will be reported or some

functions will be unavailable. The arm-none-eabi-gdb.exe tool is usually in the same directory as the arm-none-eabi-gcc.exe tool.

- Specify the debug code “xxx.elf” file path: (Note: path cannot be too long)

Figure 6-4 The Path of Debug Code “xxx.elf” File

```
"text": "file 'E:/workspace_linqi/3605/GCC/Nations.N32G430_Library.1.0.0/projects/n32g430_EVAL/examples/GPIO/LedBlink/GCC/build/output.elf'"
```

If the relative path cannot be recognized correctly, please specify the absolute path: (Note: path cannot be too long)

Figure 6-5 The Absolute Path of Debug Code “xxx.elf” File

```
"text": "file 'D:/Nations/demo/Nationstech.N32G45x_Library.2.0.0/projects/n32g45x_EVAL/examples/GPIO/LedBlink/GCC/build/output.elf'"
```

6.2 Makefile Settings

Open the routine “GCC/Makefile” file:

Figure 6-6 The Code From The Routine “GCC/Makefile” File

```
165 #####
166 # download .hex/.bin by jlink
167 #####
168 #Your JLink installation directory
169 PATH_WINPC = 'C:/Program Files (x86)/SEGGER/JLink_V690a/'
170 #PATH_LINUX = /opt/SEGGER/JLink_V640b/JLinkExe
171 JK_DPATH = $(PATH_WINPC)
172 #Jlink script store directory
173 JKS_DIR = ../../../../jlink
174 #Chip type
175 CHIP_TYPE = N32G457QE
176 download:
177     @$$(JK_DPATH)JLink.exe -device $(CHIP_TYPE) -if SWD -speed 4000 -autoconnect 1 -CommanderScript $(JKS_DIR)/flash.jlink
178     @echo "Download Completed!"
179
180 debug:
181     @$$(JK_DPATH)JLinkGDBServer.exe -select USB -device $(CHIP_TYPE) -if SWD -speed auto -noir -localhostonly
182
183 # *** EOF ***
```

- There is a debug startup configuration pointing to the JLinkGDBserver in the JLink installation directory.
- The “make” command is in debug mode by default, with some debugging information. If you want to switch to the release version, you need to use the following command when compiling the code: “make release=y”

6.3 Debugging Examples

Using the GPIO LedBlink project as an example to show how to start code debugging:

- Open SDK project in VScode, switch to “LedLink/GCC” directory in terminal, and type “make” to compile code

Figure 6-7 Information About Typing “make” To Compile Code

```
tan.dengwang@E01961007 MINGW64 /d/Nations/demo/Nationstech.N32G45x_Library.2.0.0/projects/n32g45x_EVAL/examples/GPIO/LedBlink/GCC
$ make
arm-none-eabi-gcc -mcpu=cortex-m4 -mthumb -mfpv4-sp-d16 -mfloat-abi=hard -Wall -Os -ffunction-sections -fdata-sections -g -gdwarf-4 -I../../firmware/CMSIS/core/ -I../../firmware/CMSIS/device/ -I../../firmware/n32g45x_std_periph_driver/inc/ -I../../firmware/n32g45x_it.c -o build/n32g45x_it.o
arm-none-eabi-gcc -mcpu=cortex-m4 -mthumb -mfpv4-sp-d16 -mfloat-abi=hard -Wall -Os -ffunction-sections -fdata-sections -g -gdwarf-4 -I../../firmware/CMSIS/core/ -I../../firmware/CMSIS/device/ -I../../firmware/n32g45x_std_periph_driver/inc/ -I../../firmware/n32g45x_it.o build/main.o
```

```

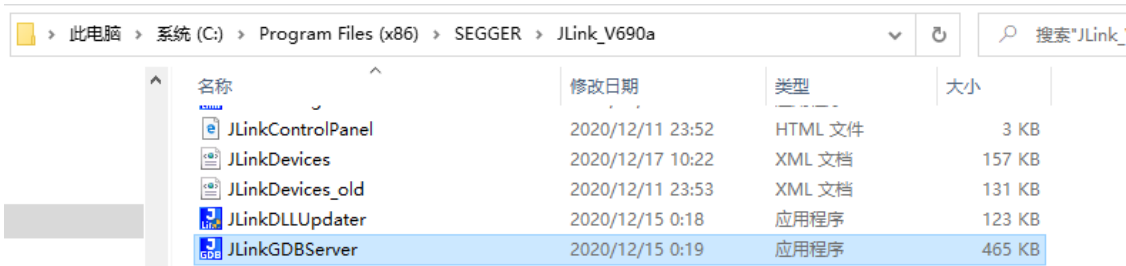
问题 输出 调试控制台 终端
arm-none-eabi-gcc build/n32g45x_it.o build/main.o build/delay.o build/log.o build/print_remap.o build/system_n32g45x.o build/n32g45
g45x_gpio.o build/n32g45x_rcc.o build/n32g45x_sdio.o build/n32g45x_eth.o build/misc.o build/n32g45x_qspi.o build/n32g45x_pwm.o buil
ld/n32g45x_dma.o build/n32g45x_wwdg.o build/n32g45x_tim.o build/n32g45x_exti.o build/n32g45x_comp.o build/n32g45x_dvp.o build/n32g4
x_iwdg.o build/n32g45x_dbg.o build/startup_n32g45x_gcc.o -mcpu=cortex-m4 -mthumb -mfpv4-fpv4-sp-d16 -mfloat-abi=hard -Wl,--gc-sectio
re/CMSIS/device/n32g45x_flash.ld -o build/output.elf
arm-none-eabi-size build/output.elf
text data bss dec hex filename
1632 1088 2592 5312 14c0 build/output.elf
arm-none-eabi-objcopy -O ihex -S build/output.elf build/output.hex
arm-none-eabi-objcopy -O binary -S build/output.elf build/output.bin

tan.dengwang@E01961007 MINGW64 /d/Nations/demo/Nationtech.N32G45x_Library.2.0.0/projects/n32g45x_EVAL/examples/GPIO/LedBlink/GCC
$ █
    
```

The output.elf, output.bin, output.hex files are generated in “GCC/build” folder.

2. Refer to Section 6.1 and 6.2 to configure the path in the launch.json file.
3. Connect the JLink debugger to the development board and power on.
4. Go to JLink installation directory and double-click JlinkGDBServer.exe

Figure 6-8 The JlinkGDBServer.exe in JLink Installation Directory



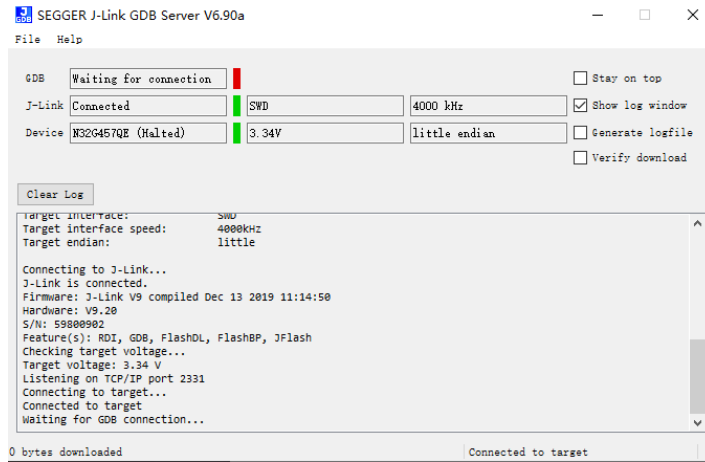
Configure port, protocol, and chip model, click “OK”

Figure 6-9 Configure Information



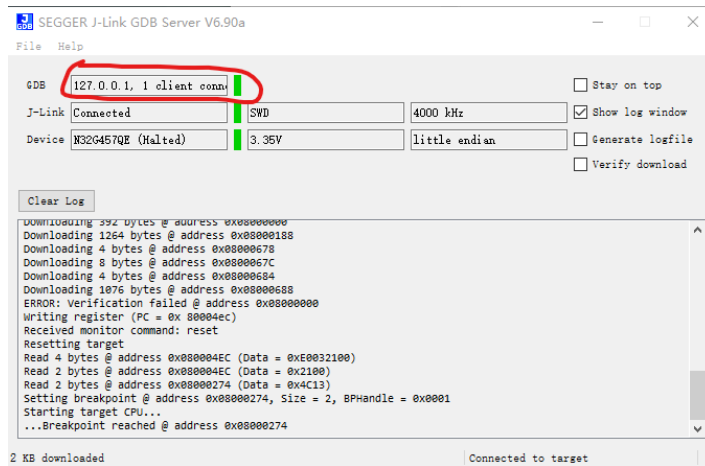
If the JLink debugger is successfully connected to the chip:

Figure 6-10 The Interface That JLink Debugger Successfully Connected To The Chip



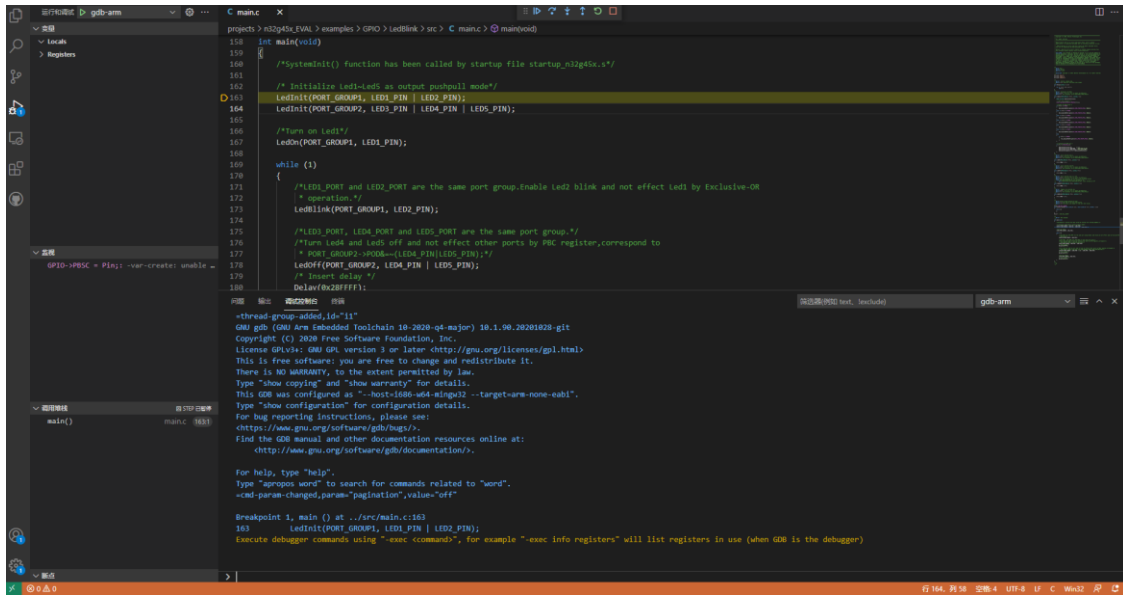
- Under VSCode working environment, press "F5" or click "Run" -> "Start debugging". At this time, it can be seen that the label below turns green, indicating that GDB tool successfully connects to JLinkGDBserver.

Figure 6-11 The Interface That GDB Tool Successfully Connect To JLinkGDBserver



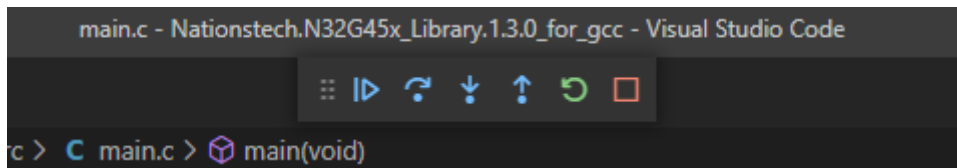
- VSCode automatically switches to the debug window.

Figure 6-12 The Debug Interface



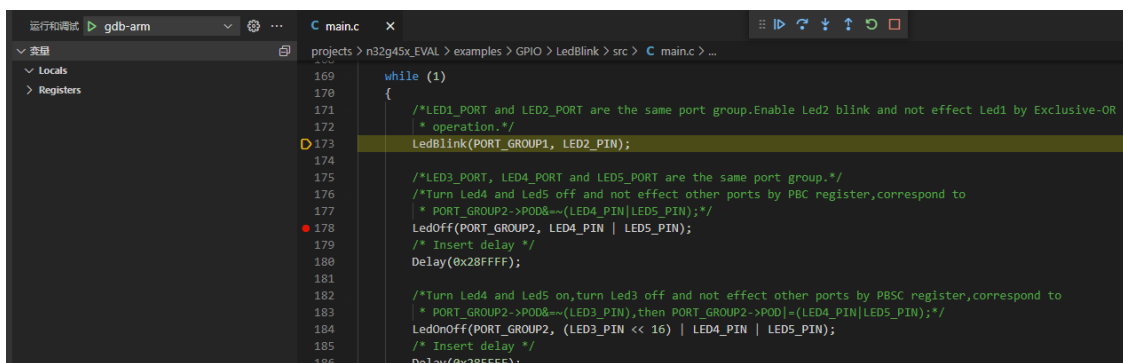
7. Debug buttons in the debug window: single step, continuous execution, restart, stop, etc.

Figure 6-13 The Debug Button



8. Now the program can run in single step or continuous execution mode

Figure 6-14 The Program Running in Single Step Or Continuous Execution Mode



7. Configuration Changes

7.1 Chip Model

If the chip used is not the N32G45x series, you need to modify the variables “TARGET_PLATFORM” and “DEFS” in the “Makefile” file.

Figure 7-1 The Variables “TARGET_PLATFORM” And “DEFS” in The “Makefile” File

```

33 #####
34 # chip platform info
35 #####
36 TARGET_PLATFORM := n32g45x
37 DEFS += -DN32G45X
38 DEFS += -DUSE_STDPERIPH_DRIVER

```

7.2 Firmware Download Algorithm

You need to type the chip type so that JLink can properly match the download algorithm.

Figure 7-2 Chip type in The “Makefile” File

```

174 #Chip type
175 CHIP_TYPE = N32G457QE

```

Configure the download tool path according to the installation directory

Figure 7-3 The Download Tool Path in The “Makefile” File

```

168 #Your JLink installation directory
169 PATH_WINPC = 'C:/Program Files (x86)/SEGGER/JLink_V690a/'
170 #PATH_LINUX = /opt/SEGGER/JLink_V640b/JLinkExe
171 JK_DPATH = $(PATH_WINPC)

```

7.3 Using the SDK Algorithm Library

By default, the algorithm library is not used. Please modify the variable “USELIB = 1” to use the algorithm library.

Figure 7-4 The Variables “USELIB” in The “Makefile” File

```

36 #####
37 # Algo libs
38 #####
39 USELIB = 0

```

7.4 Debug Configuration

The default “make” compilation is with “-g” debugging information. To compile a release version, use “make release =y”.

7.5 Optimization Level

The default optimization level is set to “-Os”, which takes into account both code size and execution speed.

8. Version History

Version	Date	Changes
V1.0	2021.10.12	The initial release
V1.1	2021.11.15	1. Updated some descriptions 2. Added Chapter 6
V3.0	2021.11.24	1. Removed the description related to automatic startup of JLinkGDBserver 2. Updated SDK development package to V2.0.0. 3. Modified the requirements for software and hardware versions in development tools

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