OPL1000

ULTRA-LOW POWER 2.4GHZ WI-FI + BLUETOOTH SMART SOC

SDK Getting Start Guide

OPULINKS

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REVISION HISTORY

Date	Version	Contents Updated
2018-05-11	0.1	• Initial Release
2018-05-17	0.2	• Add section 3.3 to introduce how to download compiled M3 bin file
2018-05-31	0.3	• Fix some typo error • Update section 3.3
2018-06-05	0.4	• Update section 3.1, 3.2 because hello_world project setting is changed.
2018-08-02	0.5	• Update section3 images
2018-08-15	0.6	• Update section 2.1 add OTA image file introduction • Update section 2.2, add OTA support description
2019-07-10	0.7	• Change fw_binary folder to fw_pack

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1. INTRODUCTION

1.1. Scope of Document Application

This document outlines the procedure and methods of development of OPL1000 application procedure on OPL1000 DEVKIT. Through the reading of this article, users can quickly grasp the theory and process of the development of OPL1000 user application procedure.

1.2. Abbreviations

Abbr.	Explanation
APP	APPlication
APS	Application Sub-system ，and it refers to M3 MCU in this document
AT	Attention Terminal Command Index
DevKit	Development Kit
EVB	Evaluation Board
FW	FirmWare , Operating Software embedded on Processor
ICE	In-Circuit Emulator
OTA	Over-the-Air Technology
RX	Receive
SWD	Serial Wire Debug
TX	Transmit

1.3. Reference

[1] OPL1000-patch-download-tool-user-guide.pdf

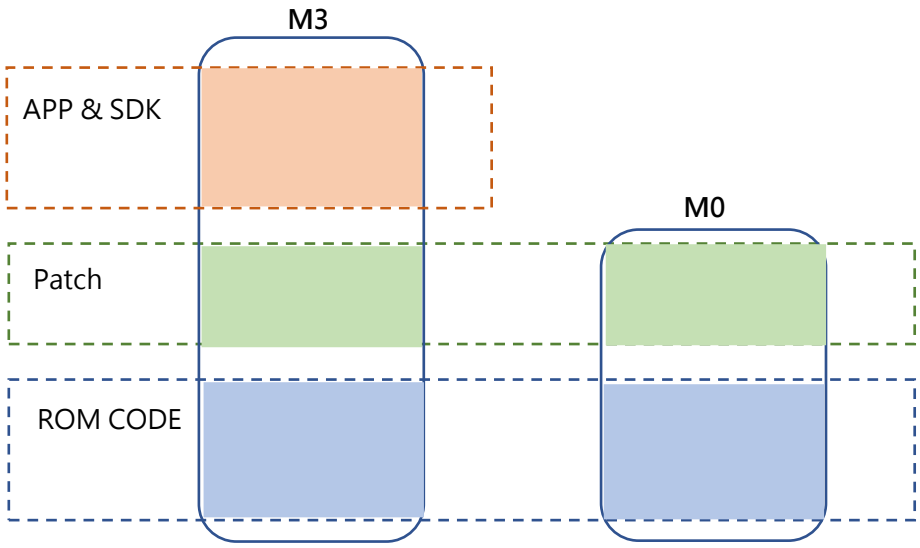
[2] OPL1000-DEVKIT-getting-start-guide.pdf

2. OPL 1000 APP DEVELOPMENT PROCEDURE

2.1. Relationship between APP & ROM Code & Patch

OPL1000 consists of two MCU's of ARM Cortex M3 and Cortex M0. The so-called OPL1000 APP Development refers to the application procedure for development users on M3 MCU of OPL1000. The initial M3, M0 firmware of OPL1000 is comprised in the Chip as ROM CODE. Furthermore, as functions expand and bugs resolved, OPL1000 also provides firmware patch of M3 and M0. Therefore, the development of user APP is completed based on the foundation of ROM code and firmware patch. Their relationship can be demonstrated with Figure 1.

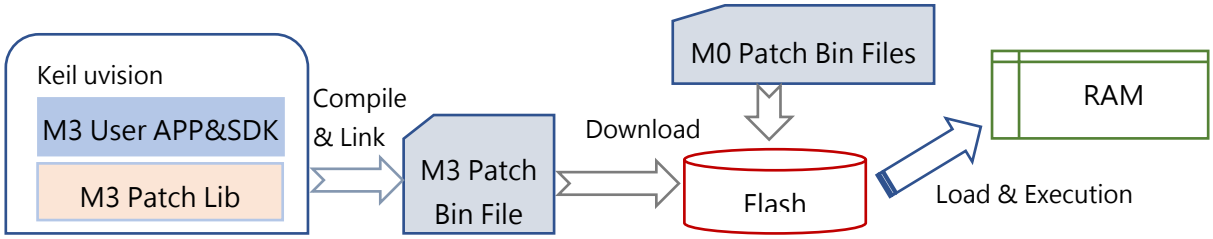
Figure 1: The Relationship Between User APP & ROM CODE and Patch



The M0 Patch is sent out via Opulinks in the format of binary files. M3 Patch is provided in the format for lib documents, as the user APP and SDK source code from Opulinks are used as Keil C project for coding, therefore, the generated M3 bin document include M3 Firmware Patch, SDK and user APP application procedure. Ultimately, M0 Patch Bin documents and M3 Bin documents

are combined and then downloaded to external Flash, and after OPL1000 is powered up, M3/M0 Bin documents in the Flash is loaded into RAM to execute. The overall process can be shown with Figure 2.

Figure 2: Compiling of User APP & Patch, Loading Process (without OTA Function)



The two types of Bin documents, supported by OPL1000, are "Pure Bin" documents as shown in Figure 2, as M3 bin document coded with users' procedure, then combined with M0 bin document in generating opl1000.bin file. This file stored in Flash 0x0000 position, neither including OTA loader, nor supporting OTA (Over-The-Air Download) function, and the other is called "OTA Image" document which is based on "Pure Bin" document, with messages such as OTA Loader and Bin Header, etc. included, in generating firmware documents that support OTA download, with the document generated by using download tool named as "opl1000_ota.bin".

In order to understand the structure of OTA Image document, we need to first understand the working process of OPL1000 OTA upgrade firmware. When OPL1000 firmware supports OTA download for upgrade, there are two firmware maintained in Flash, as shown in Table 1,as the first OTA Bin file and the second OTA Bin file are placed in 0x00005000 and 0x0003E000 locations respectively, with the maximum size of 228K Bytes. At the locations of 0x00003000 and 0x00004000 there are Header message of the first and the second OTA bin. Header messages include the chip type, version message, firmware calibration and firmware size and Header Calibration, etc., of OTA Bin Firmware. The first OTA bin file and the second OTA bin use ping-

pong switch method to execute upgrade. For example, when the currently executing firmware corresponding to the first OTA Bin document, then the firmware (and its Header message) downloaded through OTA download would be placed in the second OTA Bin document location (firmware in 0x0003E000, and header in 0x00004000). If the currently executing firmware corresponding to the second OTA Bin document, then the newly downloaded upgrade firmware would be placed in the first OTA Bin document location (firmware in 0x00005000, and header in 0x00003000)

Table 1: Reflective Address of OTA Image Stored in Flash

Number	Address	Size	Content
1	0x00000000 ~ 0x00003000	12K Bytes	OTA Firmware Loading Procedure
2	0x00003000 ~ 0x00004000	4K Bytes	The Header of the first OTA Bin document only uses up 64 bytes, and the rest is filled up with 0xFF.
3	0x00004000 ~ 0x00005000	4K Bytes	The header of the second OTA Bin document, with the same format as above.
4	0x00005000 ~ 0x0003E000	228K Bytes	The first OTA Bin document, just like the previously mentioned opl1000.bin document. It and the second OTA Bin document using ping-pong switch upgrade.
5	0x0003E000 ~ 0x00077000	228K Bytes	The second OTA Bin document, just like the previously mentioned opl1000.bin document. It and the first OTA Bin document using ping-pong switch upgrade.

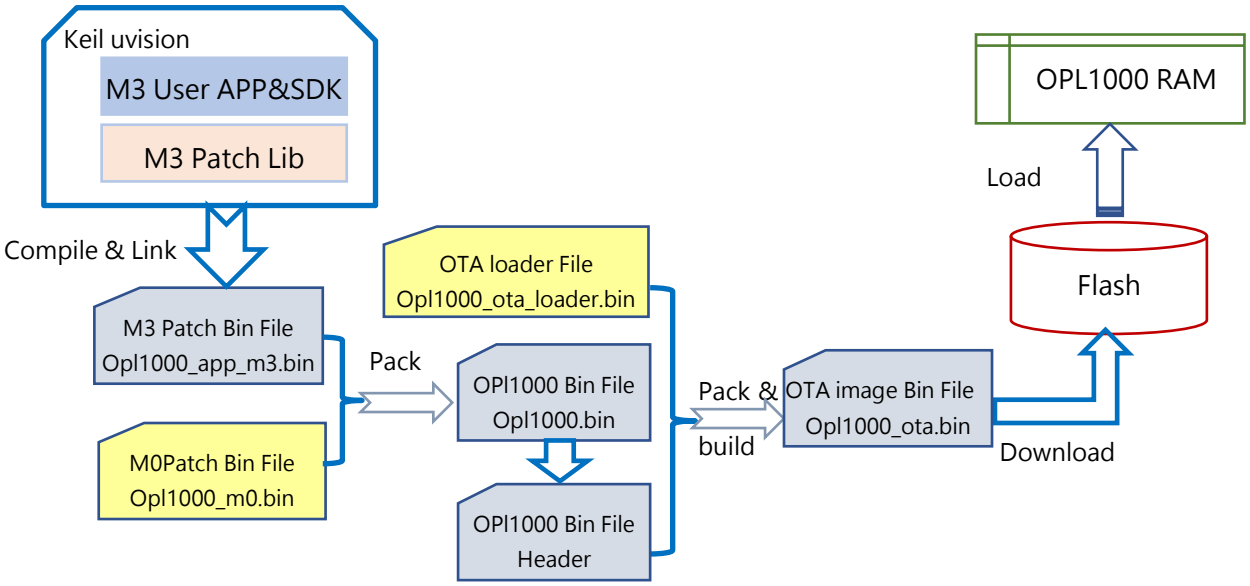
The composition of opl1000_ota.bin document, corresponding to Table 1, is shown in Table 2. Its first 3 sectors are the same as Table 1. As opl1000_ota.bin document only contains 1 Bin document, therefore it does not have the 5th sector, i.e. the 2nd OTA BIN document data. Also, the size of the 4th sector is determined by firmware size. Assumed that there is already an OTA image in Flash, e.g. the first OTA Bin document corresponding to Table 1. Then the content of the 2nd and 4th sectors of the newly downloaded opl1000_ota.bin document will be written into the 3rd and 5th sectors shown in Flash Table 1.

Table 2: Composition of OPL1000 OTA

Number.	Address	Size	content
1	0x00000000 ~ 0x00003000	12K Bytes	OTA Firmware Loading Procedure
2	0x00003000 ~ 0x00004000	4K Bytes	The Header of the first OTA Bin document only uses up 64 bytes, and the rest is filled up with 0xFF.
3	0x00004000 ~ 0x00005000	4K Bytes	The header of the second OTA Bin document, with the same format as above.
4	0x00005000 ~ 0x00005000+N	N Bytes	OTA Bin file which is the previous mention opl1000 bin file

Please note that there are two premises for OPL1000 firmware supporting OTA download that firstly, being structured on opl1000_ota.bin, and the other being OTA Bin document supporting the function of obtaining firmware through BLE or WIFI. Regarding user APP coding that supports OTA function, download process is shown in Figure 3, as it includes two-time Pack combination functions. One is to combine user APP bin document and M0 bin document as opl1000.bin. The second is to combine opl1000.bin, OTA loader and the Header message of opl1000.bin, in forming opl1000_ota.bin document.

Figure 3: Coding of User APP & Patch, Loading Process (Supporting OTA Function)



2.2. APP Development Procedure

User can use two modes to develop application procedure.

Mode 1: IDE Online Debugging Development Mode

The development entails four steps, as shown in Figure 4.

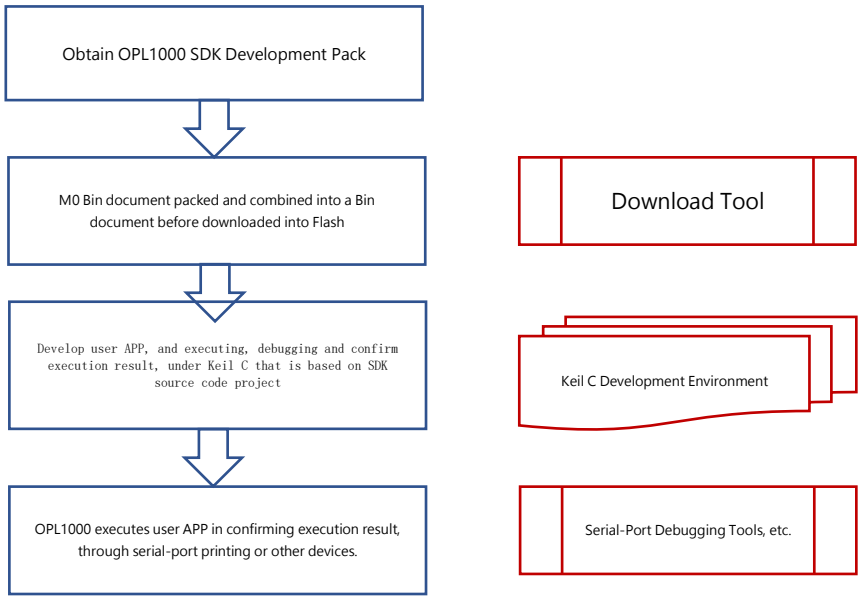
1. Obtain OPL1000 SDK software pack from the original manufacturer.

2. Pack the M0 Bin document under the "FW_Pack" folder that contains SDK software pack, according to the download tool guide outlined in Reference (1), into a Bin document and download it to Flash. Please note that M0 bin document needs only be downloaded from SPI flash once, when there is no update on SDK Development Pack.

3. Develop user APP on Keil uVision (based on SDK example source code project)

4. Under Keil C environment, as online emulator operates and debugs, and confirm execution result through serial-port, while taking note that code has not yet been downloaded to flash yet, as code is only operating in RAM.

Figure 4: IDE Online Debug Development Mode



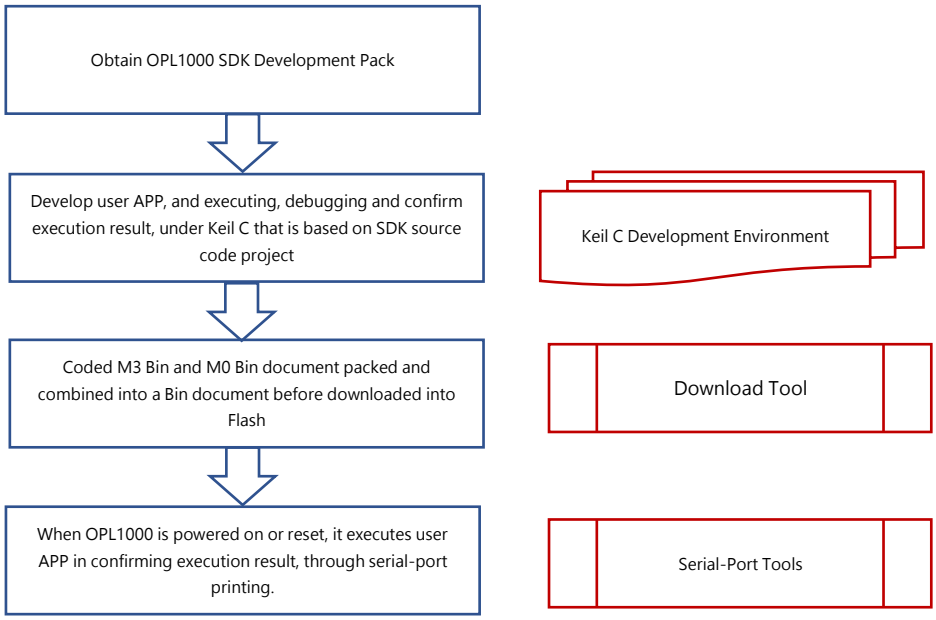
Mode 2: Serial-Port Debugging Development Mode

The development entails five steps, as shown in figure 5.

1. Obtain OPL1000SDK software pack from the original manufacturer.
2. Develop user APP, and executing, debugging and confirm execution result, under Keil C that is based on SDK source project.
3. Obtain coded M3 Bin Document
4. Pack the M0 Bin document under the "FW_Pack" folder that contains SDK software pack, according to the download tool guide outlined in Reference (1), into a Bin document and download it to Flash. Please note that M0 bin document needs only be downloaded from SPIflash once, when there is no update on SDK Development Pack.

5. As OPL1000 is powered on or reset. Execute user APP, and confirm execution result through serial-port messages.

Figure 5: Serial-Port Debug Mode



During the actual development process, users can combine his/her own development needs to switch between these two development modes with flexibility.

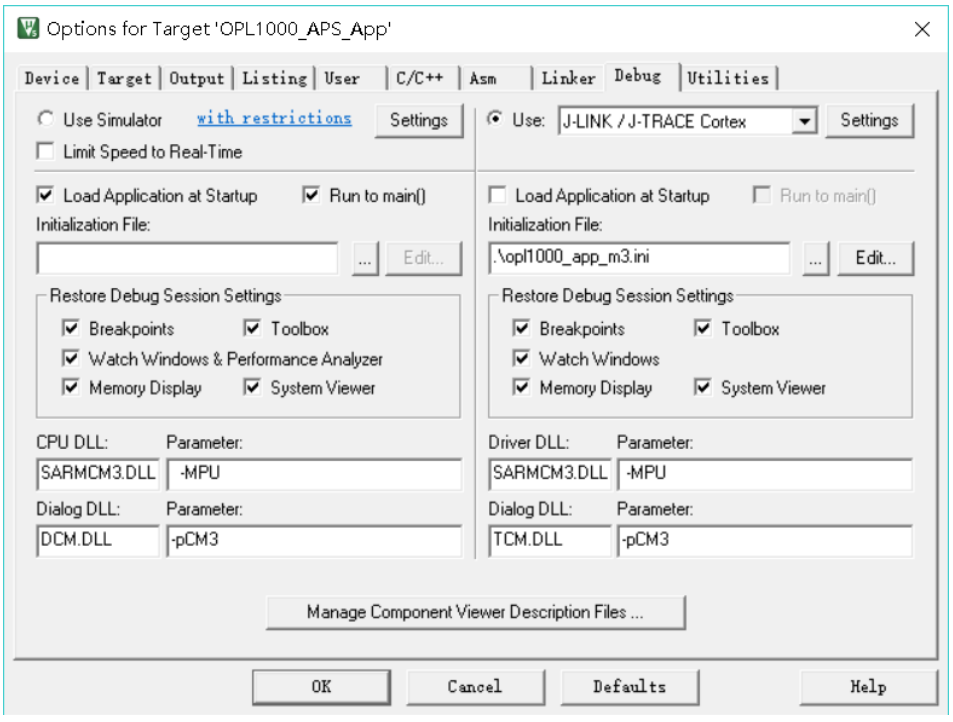
3. USING KEIL TO DEBUG APPLICATION PROCEDURE

User application procedure can carry out development and debugging on DEVKIT board. For the usage of DEVKIT board, please refer to reference (2) DEVKIT Quick Usage Guide.

3.1. Keil Engineering Setting

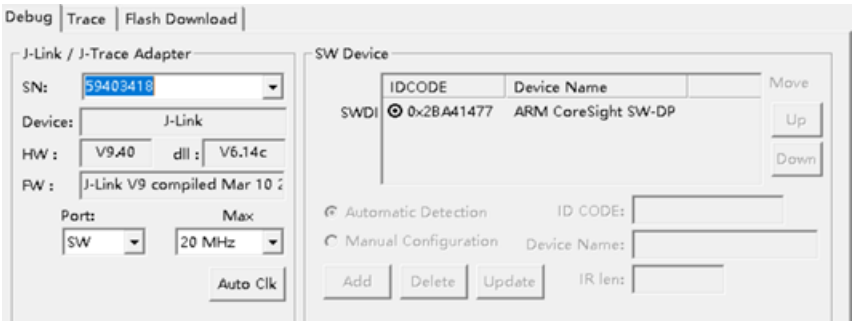
DevKit board uses USB as power-supply, while correctly connecting K-link emulator and DevKit Board. Opening up project: **SDK\APS_PATCH\examples\get_started\hello_world. Select** "Options of Target" button, with dialogue box prompted, before selecting Debug interface, before the prompted interface shown below appears.

Figure 6: Option for Target Dialogue setting



For debugging port, select the port of JLINK / J-TRACE Cortex port, and if users use other emulator, please select the corresponding emulator port type, e.g. when using CMSIS DAP emulator, then the port of CMSIS-DAP Debugger should be chosen. After having selected the correct port, press Settings button, before what's illustrated in Figure 7 appears. What is displayed in SW Device is the designated number of device, indicating the device is properly connected and operating normally, and if the field of "SW Device" is empty, then device connection should be checked to ensure correct connection.

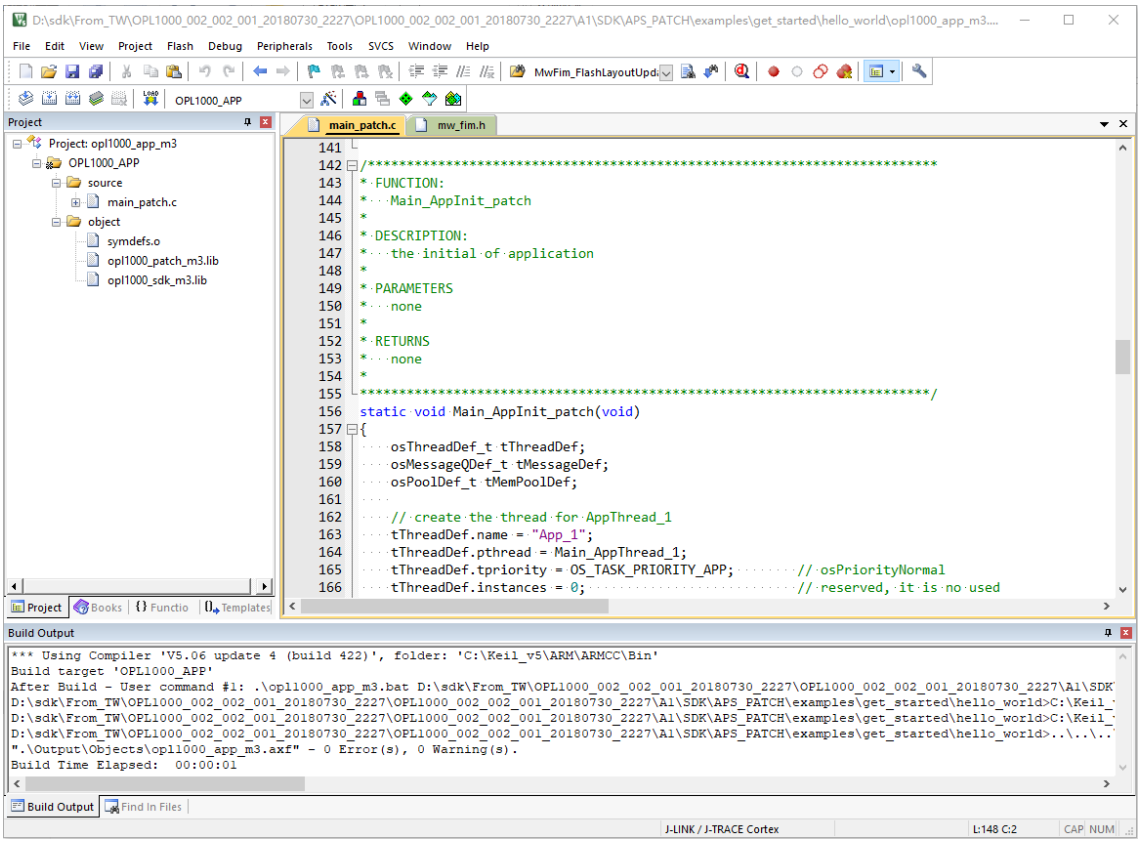
Figure 7: Correct Identification of J-link ICE Emulator



3.2. Application Procedure of Online Debugging

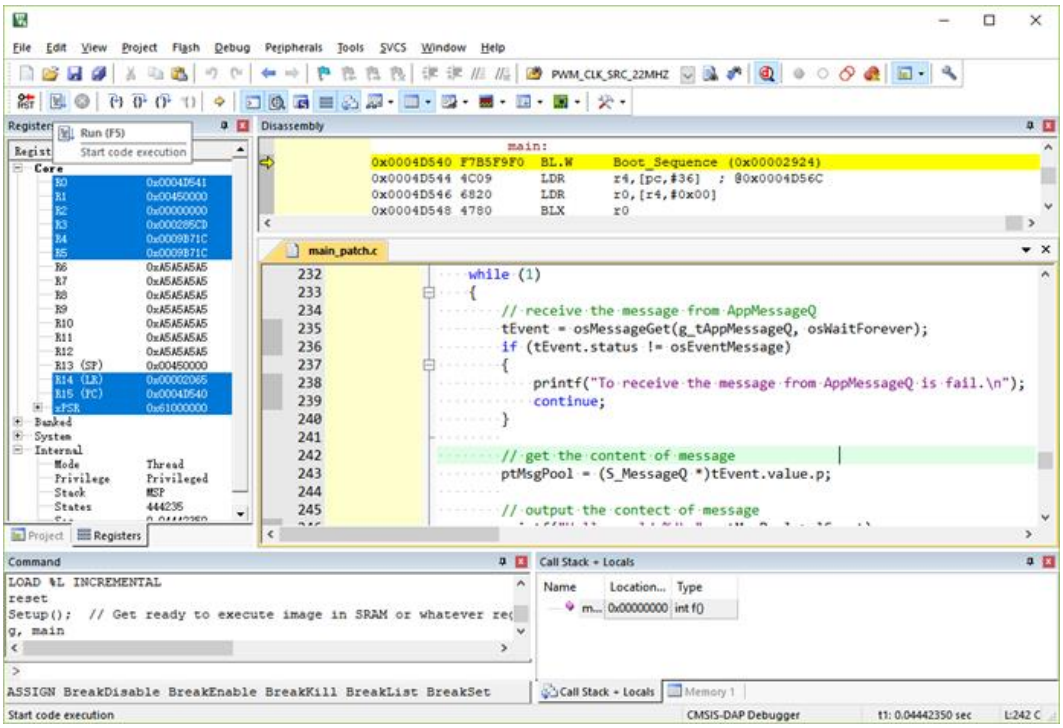
Once Keil software correctly identified OPL1000 device, and build example project, before arriving at the displayed image as shown in Figure 8, which means coding has been correctly completed.

Figure 8: Keil coding hello_world Example Code



After coding is completed, click "Debug " button, before correctly entering debugger environment, as shown in Figure 9.

Figure 9: Using Keil Online Debugging



When proper connection to serial-port is maintained, use serial-port tool to open up APS serial-port, while clicking "Full-Speed Operation  " in keil, and when APS serial-port prints out log message as shown in Figure 10, it indicates that the procedure is executing correctly in RAM.

Figure 10: Execution Result of Printing Confirmation Procedure of APS Serial Port

```
The init of MW_FIM is done.

[SVN REV] SVN_REVISION:1655

[Lib] SDK version info: 2221
[Lib] Compile time: 2018/07/30 11:47:02
wifiMac Task create successful
Supplicant task is created successfully!
controller_queue creates successful!
controller_queue_ble creates successful!
controller_task_create successful!
LE Task create successful
[SYS_COMMON]: OTP not support yet, read STA default mac addres.
WIFI sta cfg REQ idx=1, value=0!
There is no any OTA image.
Sw patch is changed successfully.
Hello world 1
Hello world 2
Hello world 3
Hello world 4
Hello world 5
Hello world 6
Hello world 7
Hello world 8
Hello world 9
Hello world 10
```

3.3. Procedure Download

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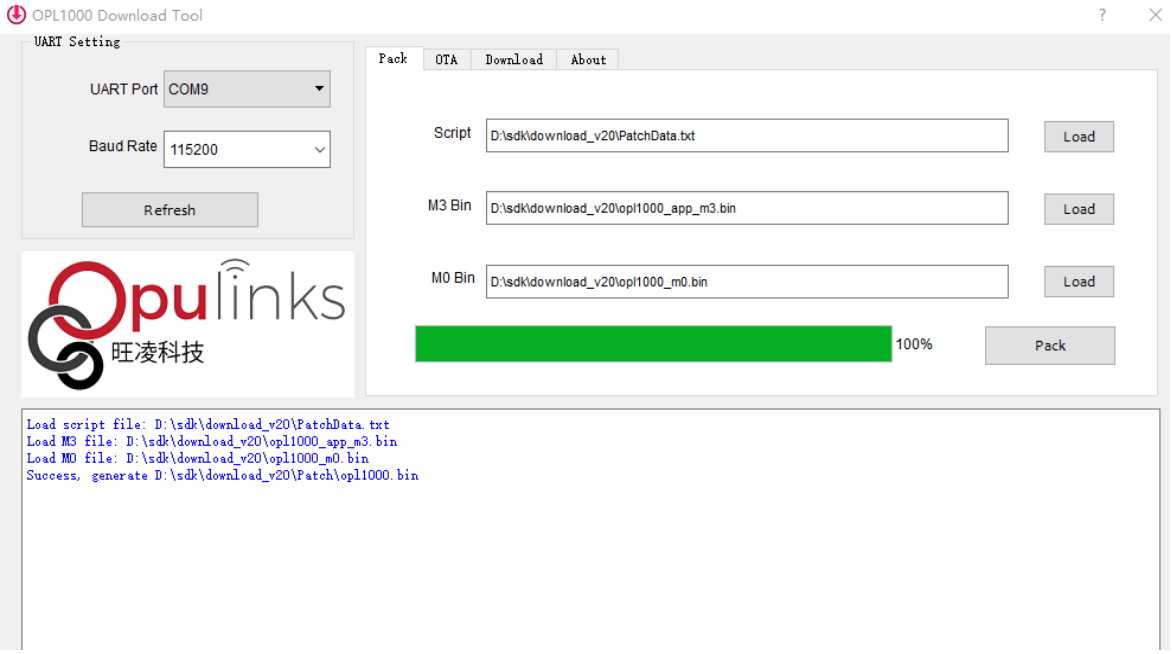
When performing online debugging, codes will only be loaded to OPL1000 RAM area, and once users complete APP development through online debugging, and they need to download APP procedure, through download tool, to flash that is external to OPL1000.

Users first use download tool to load corresponding script document and bin document, and take note of user APP added to the location of M3 patch. Script document and M0 bin document are stored under the FW_Pack folder in SDK, which can be accessed by users under this folder.

Figure 11: Add Script and bin Document



Once script document and bin document are added, click “pack” button, and the procedure will combine user’s M3 bin and M0 bin documents to generate an opl1000.bin document, according to script definition, and stored in the patch document folder, the same folder as that of download tool.

When looking at Download page, the previously combined opl1000.bin document address has been automatically written in the location of Patch Bin. As outlined in reference (2) DEVKIT Quick Usage Guide, select the serial-port number connected with mini-USB in the selection box of UART Port, and click "Download" button, and resetting OPL1000 DEVKIT within 5 seconds, before opl10000.bin begins to be downloaded to Flash, as shown in Figure 12. When the green progress bar reaches 100%, it means that the download is complete, and the interface is shown as in Figure 13.

Figure 12: Download APP Procedure

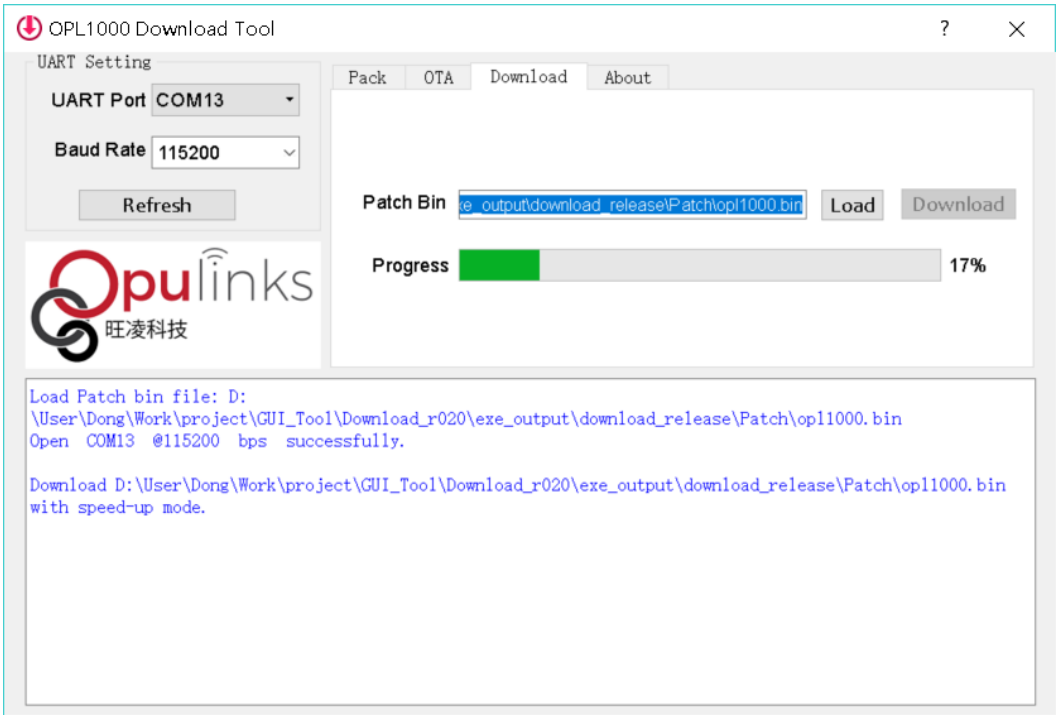
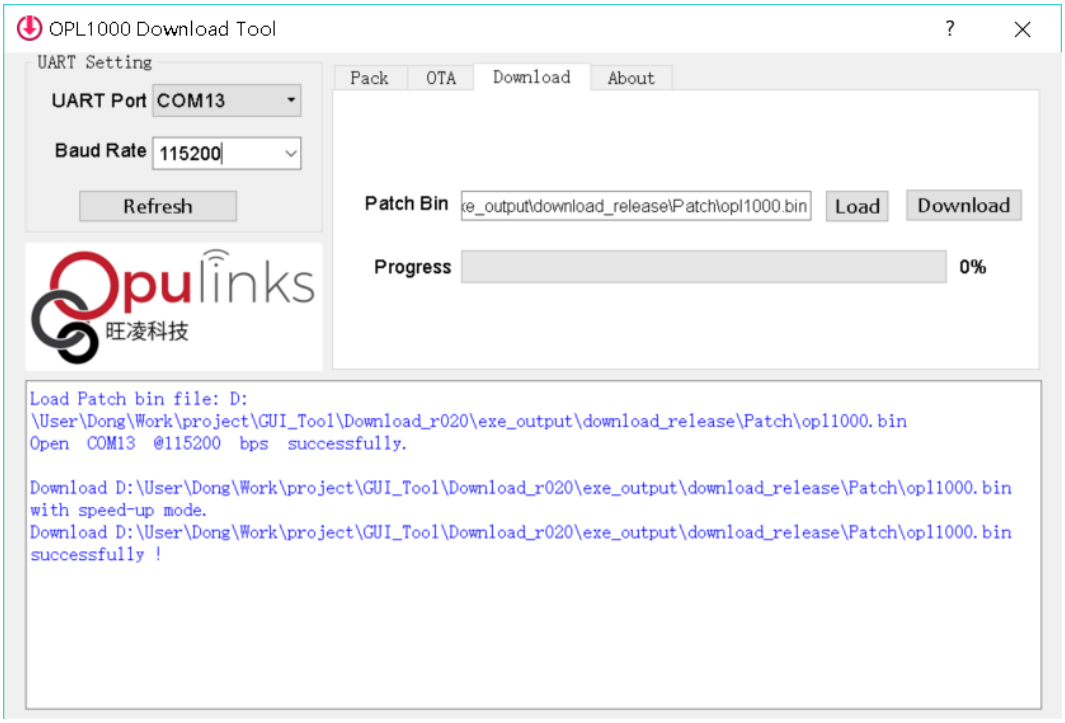


Figure 13: Successful Download of OPL1000 Firmware



Users use serial-port tool to open APS serial-port to reset OPL1000 DEVKIT board, and relevant log of APP procedure can be observed

CONTACT

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