MicroEJ Platform Reference Implementation

Developer's Guide

STM32F746GDISCO 2.2.0

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Revision History		
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First release		

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Chapter 1. Introduction

1.1. Intended Audience

The intended audience for this document are developers who wish to develop their first MicroEJ plaform with MicroEJ SDK and deploy a MicroEJ standalone application onto. Notes:

- This document is for the STM32F746G-DISCO board.
- This document is not a user guide for the C development environment used for the final application link. Please consult the supplier of the C development environment for more information.
- Please visit the website https://developer.microej.com for more information about STM32F746G-DISCO products (platforms, videos, examples, application notes, etc.).

1.2. Scope

This document describes, step by step, how to start your development with MicroEJ SDK

- Create a MicroEJ platform for STM32F746G-DISCO board.
- Run a MicroEJ standalone application on the MicroEJ simulator.
- Run a MicroEJ standalone application on the MicroEJ platform and deploy it on the STM32F746G-DISCO board.

1.3. Prerequisites

- PC with Windows 7 or later.
- The MicroEJ SDK environment must be installed.
- STM32F746G-DISCO board.
- The STM32 ST-LINK utility (minimal version 3.7.1).
- Keil MDK-ARM µVision 5.18.0.0 or higher. The Keil µVision evaluation version is 32KB code size limited. To get a Keil µVision evaluation license for MicroEJ SDK, please consult the chapter “Install Keil MDK-ARM”.

Chapter 2. Create and Use Your First MicroEJ Platform

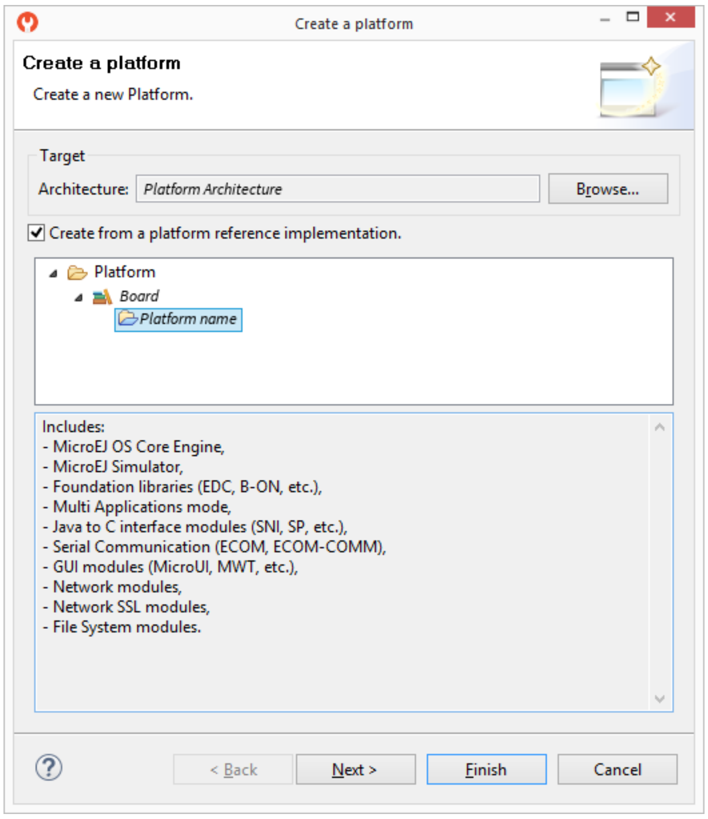
2.1. Create a MicroEJ Platform

The aim of this chapter is to create a MicroEJ platform from a MicroEJ architecture. The platform will then be used to run a MicroEJ standalone application in subsequent chapters.

Although it is possible to use MicroEJ SDK to create every aspect of a MicroEJ platform in accordance with specific requirements, in this chapter we will use a pre-packaged example of a MicroEJ platform that is already configured for the STM32F746G-DISCO.

- Open MicroEJ SDK.
- Open the MicroEJ platform wizard: `File > New > Platform`.
- Select the MicroEJ architecture STMicroelectronics STM32F7J ARMCC from the combo box. A MicroEJ Platform Reference Implementation is available:

Figure 2.1. MicroEJ Platform Reference Implementation Selection



Create a platform

Create a platform

Create a new Platform.

Target

Architecture: *Platform Architecture*

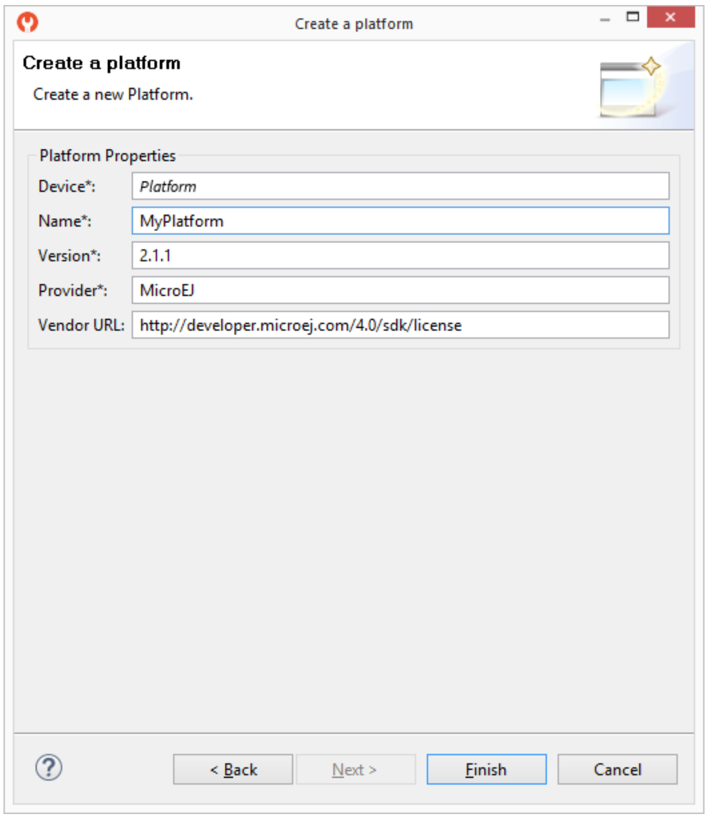
[✓] Create from a platform reference implementation.

- Platform
  - *Board*
    - *Platform name*

Includes:
- MicroEJ OS Core Engine,
- MicroEJ Simulator,
- Foundation libraries (EDC, B-ON, etc.),
- Multi Applications mode,
- Java to C interface modules (SNI, SP, etc.),
- Serial Communication (ECOM, ECOM-COMM),
- GUI modules (MicroUI, MWT, etc.),
- Network modules,
- Network SSL modules,
- File System modules.

- Select the MicroEJ platform Evaluation for the STM32F746G-DISCO from the combo box.
- Click on Next. Give a name which be used as prefix for all MicroEJ platform projects. For instance: `MyPlatform`.

Figure 2.2. New MicroEJ Platform Naming


Create a platform

Create a new Platform.

Platform Properties

Device*:	*Platform*
Name*:	MyPlatform
Version*:	2.1.1
Provider*:	MicroEJ
Vendor URL:	http://developer.microej.com/4.0/sdk/license

- Click on `Finish`. The selected example is imported as several projects prefixed by the given name:

  - STM32F746GDISCO-MyPlatform-CM7hardfp_ARMCC5-configuration: Contains the platform reference implementation configuration description. Some modules are described in a specific sub-folder / with some optional configuration files (`.properties` and / or `.xml`).

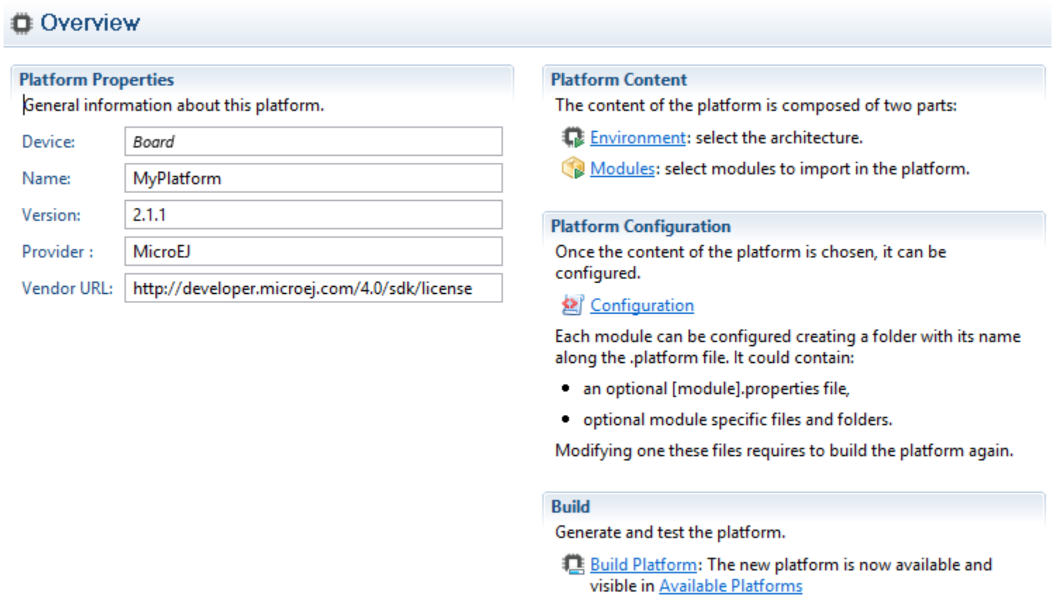
  - STM32F746GDISCO-MyPlatform-CM7hardfp_ARMCC5-bsp: Contains a ready-to-use BSP software project for the STM32F746G-DISCO board, including a Keil uVision project, an implementation of MicroEJ core engine (and extensions) port on FreeRTOS RTOS and the STM32F746G-DISCO board support package.

  - STM32F746GDISCO-MyPlatform-CM7hardfp_ARMCC5-fp: Contains the board description and images for the MicroEJ simulator. This project is updated once the platform is built. It

  The MicroEJ platform configuration file is automatically opened.

- From the MicroEJ platform configuration file, click on the link `Build Platform`

Figure 2.3. MicroEJ Platform Build



Overview

Platform Properties

General information about this platform.

Device:	Board
Name:	MyPlatform
Version:	2.1.1
Provider :	MicroEJ
Vendor URL:	http://developer.microej.com/4.0/sdk/license

Platform Content

The content of the platform is composed of two parts:

Environment: select the architecture.

Modules: select modules to import in the platform.

Platform Configuration

Once the content of the platform is chosen, it can be configured.

Configuration

Each module can be configured creating a folder with its name along the .platform file. It could contain:

- an optional [module].properties file,
- optional module specific files and folders.

Modifying one these files requires to build the platform again.

Build

Generate and test the platform.

Build Platform: The new platform is now available and visible in Available Platforms

The build starts. This step may take several minutes. You can see the progress of the build steps in the MicroEJ console. Please wait for the final message:

```
BUILD SUCCESSFUL
```

At the end of the execution the MicroEJ platform is fully built for the STM32F746G-DISCO board and is ready to be linked into the Keil uVision project. Its name is `STM32F746GDISCO-My-Platform-CM7hardfp_ARMCC5`.

The MicroEJ platform is now ready for use and available in the MicroEJ platforms list of your MicroEJ repository (`Windows > Preferences > MicroEJ > Platforms in workspace`).

2.2. Run an Example on the MicroEJ Simulator

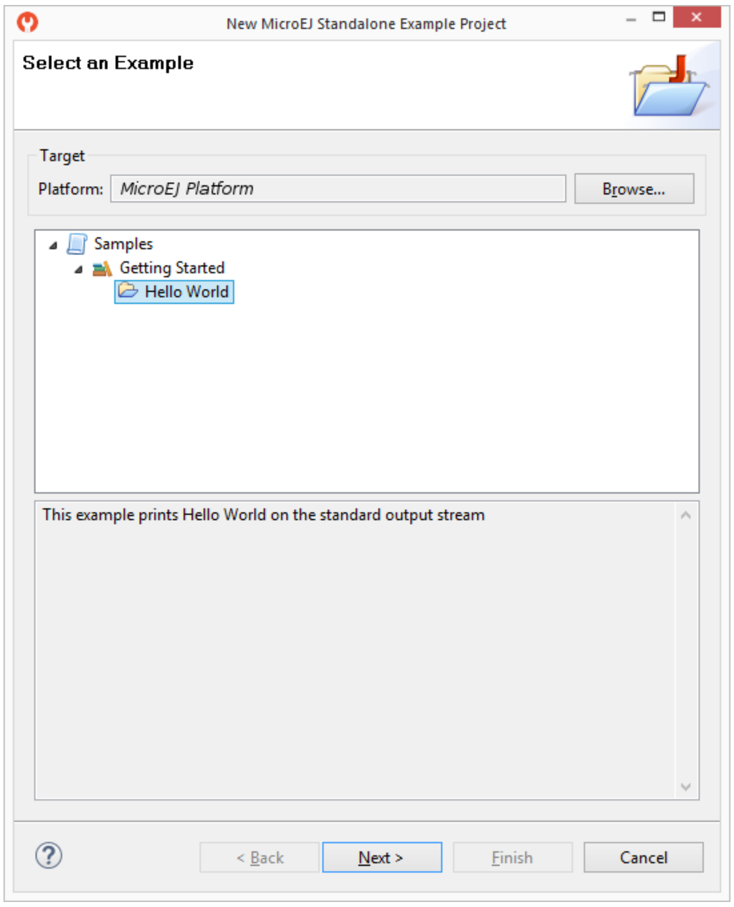
The aim of this chapter is to create a MicroEJ MicroEJ standalone application from a built-in example. This example will initially be run on the MicroEJ simulator. Then, in the next section, this application will be compiled and deployed on the STM32F746G-DISCO board using the MicroEJ platform.

2.2.1. Create Example

- Open MicroEJ SDK.
- Open the menu: `File > New > MicroEJ Standalone Example Project`.

- Select the MicroEJ platform STM32F746GDISCO-MyPlatform-CM7hardfp_ARMCC5 from the combo box.
- Select the example `Samples > Getting Started > Hello World`.

Figure 2.4. MicroEJ Standalone Application Selection



New MicroEJ Standalone Example Project

Select an Example

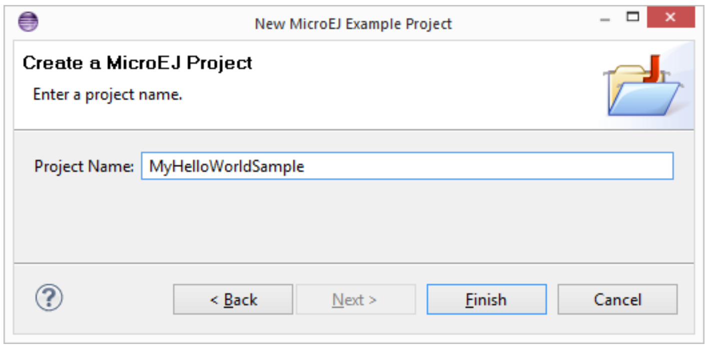
Target

Platform: *MicroEJ Platform*

This example prints Hello World on the standard output stream

- Click on Next. The next page suggests a name for the new project.

Figure 2.5. MicroEJ Standalone Application Naming



New MicroEJ Example Project

Create a MicroEJ Project

Enter a project name.

Project Name: MyHelloWorldSample

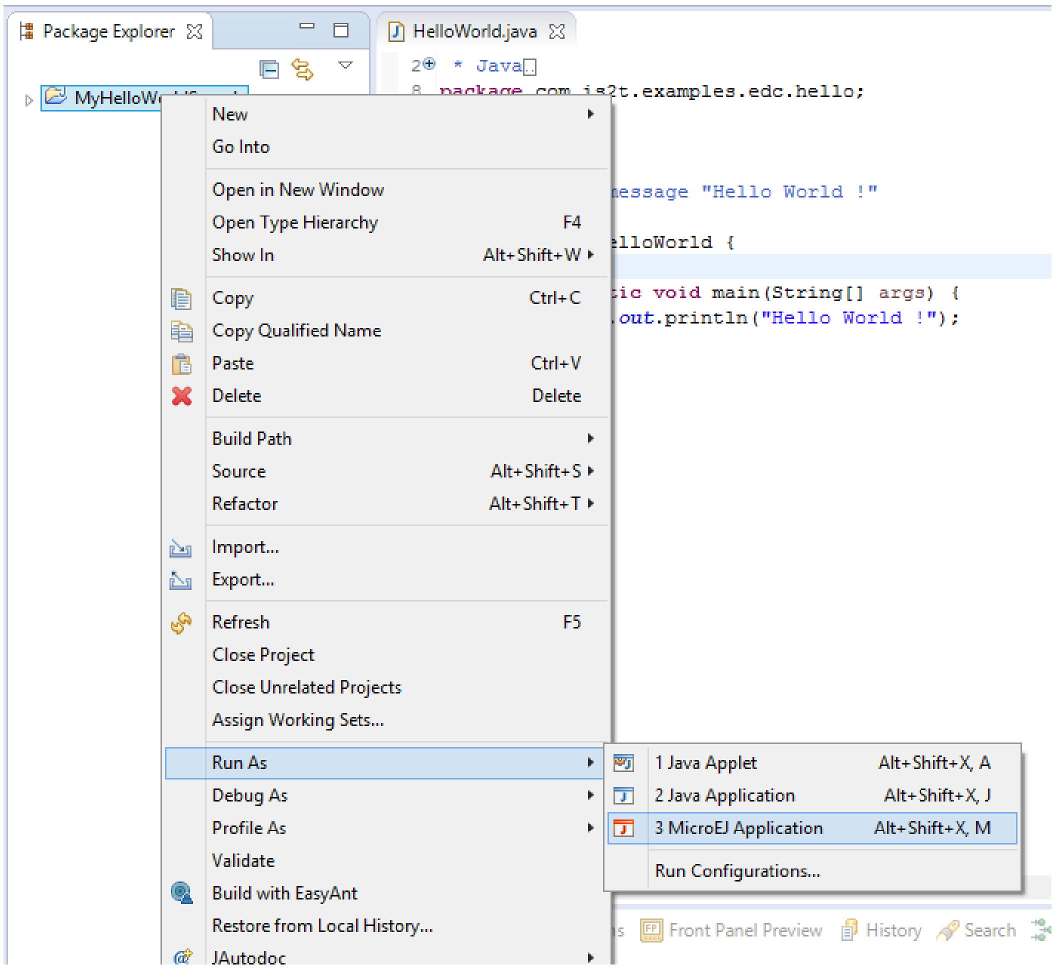
- Click on Finish. The selected example is imported into a project with the given name. The main class (the class which contains the `main()` method) is automatically opened.

2.2.2. Run Example

- Select the project in the Package Explorer tree

- Right-click on this project and select `Run As > MicroEJ Application`

Figure 2.6. MicroEJ Standalone Application Running



```
 * Java
package com.is2t.examples.edc.hello;
essage "Hello World !"
lloWorld {
ic void main(String[] args) {
.out.println("Hello World !");
```

The application starts. It is executed on the MicroEJ simulator of the selected MicroEJ platform (STM32F746GDISCO-MyPlatform-CM7hardfp_ARMCC5). The result of the test is printed in the console:

```
Hello World !
```

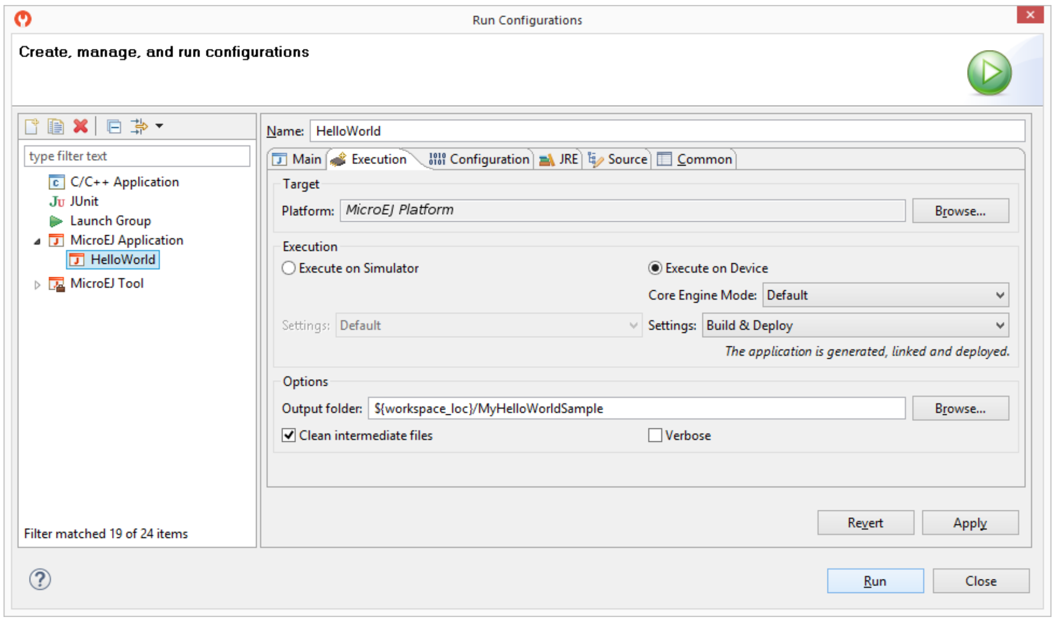
2.3. Run the Example on the STM32F746G-DISCO Board

2.3.1. Compile MicroEJ Standalone Application

- Open the run dialog (`Run > Run configurations...`).
- Select the MicroEJ Application launcher `HelloWorld`.

- Open `Execution` tab.
- Select `Execution on Device`.

Figure 2.7. Execution on Device



Run Configurations

Create, manage, and run configurations

Name: HelloWorld

Target
Platform: MicroEJ Platform

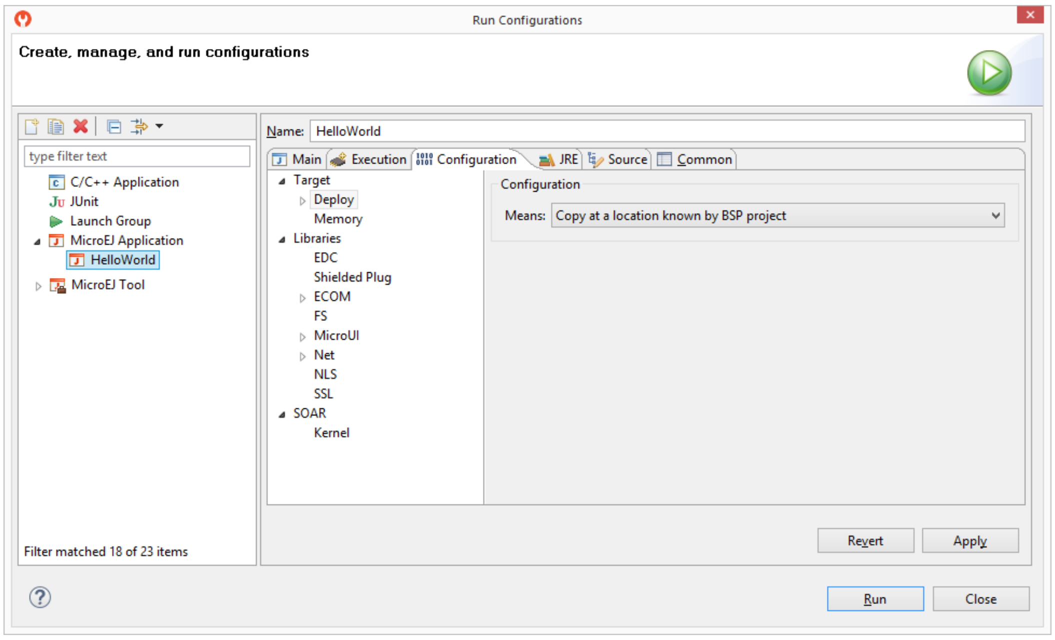
Execution
Execute on Simulator
Execute on Device
Core Engine Mode: Default
Settings: Default
Settings: Build & Deploy
The application is generated, linked and deployed.

Options
Output folder: ${workspace_loc}/MyHelloWorldSample
[✓] Clean intermediate files
[ ] Verbose

Filter matched 19 of 24 items

- Open `Configuration` tab and sub menu `Target > Deploy`. Select `Copy at location known by BSP project`

Figure 2.8. Deploy Configuration



Run Configurations

Create, manage, and run configurations

Name: HelloWorld

Configuration
Means: Copy at a location known by BSP project

Filter matched 18 of 23 items

- Click Run: the application is compiled, and the compilation result (an ELF file) is copied into a well known location in the workspace. The Keil uVision BSP project will search for it there when it performs the final link.

2.3.2. Link and Deploy MicroEJ Standalone Application

The aim of the final step is to:

- Compile the BSP project (such as drivers).
- Link the BSP and the others libraries (MicroEJ Core Engine, C stacks, MicroEJ standalone application etc.).
- Deploy a MicroEJ standalone application on the STM32F746G-DISCO board.

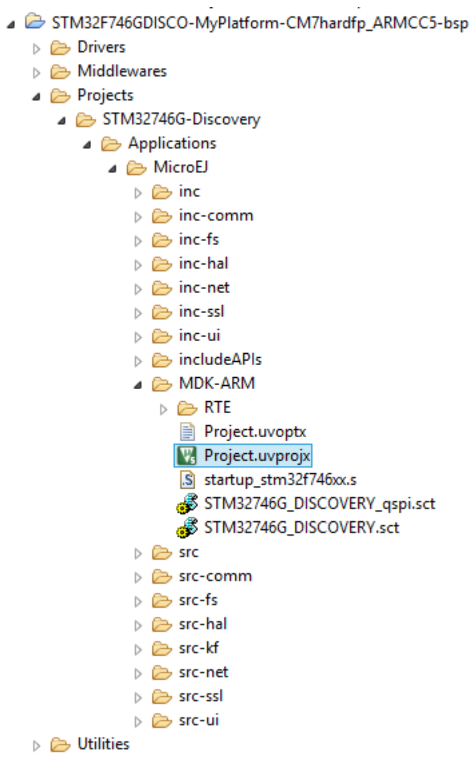
Note

This final step uses Keil uVision 5.18.0.0.

The following steps are performed within MicroEJ.

- In MicroEJ SDK, expand the project STM32F746GDISCO-MyPlatform-CM7hardfp_ARMCC5-bsp and the folder `Projects/STM32746G-Discovery/Applications/MicroEJ/MDK-ARM`. A Keil uVision project file (`Project.uvprojx`) is available.

Figure 2.9. Keil uVision Project Selection

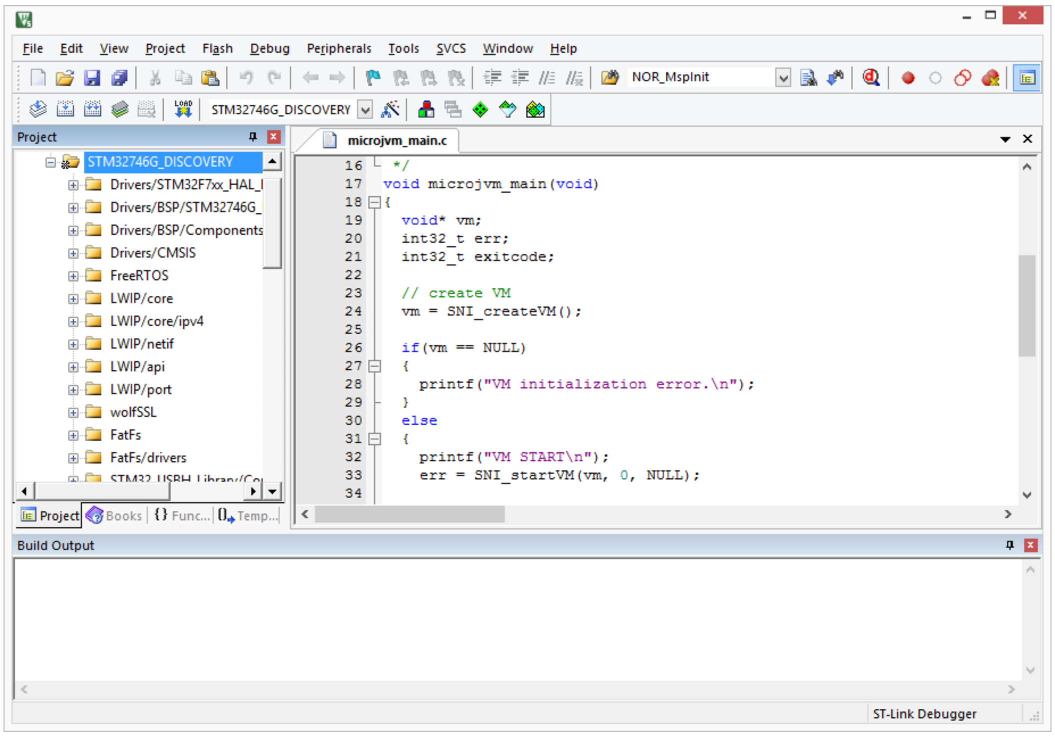


```
STM32F746GDISCO-MyPlatform-CM7hardfp_ARMCC5-bsp
  Drivers
  Middlewares
  Projects
    STM32746G-Discovery
      Applications
        MicroEJ
          inc
          inc-comm
          inc-fs
          inc-hal
          inc-net
          inc-ssl
          inc-ui
          includeAPIs
          MDK-ARM
            RTE
            Project.uvoptx
            Project.uvprojx
            startup_stm32f746xx.s
            STM32746G_DISCOVERY_qspi.sct
            STM32746G_DISCOVERY.sct
          src
          src-comm
          src-fs
          src-hal
          src-kf
          src-net
          src-ssl
          src-ui
  Utilities
```

Double-click on this file to open Keil uVision.

The following steps are performed within Keil uVision.

- Figure 2.10. Keil uVision IDE



```
*/
void microjvm_main(void)
{
  void* vm;
  int32_t err;
  int32_t exitcode;

  // create VM
  vm = SNI_createVM();

  if(vm == NULL)
  {
    printf("VM initialization error.\n");
  }
  else
  {
    printf("VM START\n");
    err = SNI_startVM(vm, 0, NULL);
```

Build the Keil uVision project by clicking on the menu `Project > Build target`. The project is compiled and linked. See “Mandatory Connectors” to use the right connectors.

- Deploy the link result on the STM32F746G-DISCO board by clicking on the menu `Flash > Download`.

The application starts. The result of the execution is output on printf COM port. Congratulations, you have deployed a MicroEJ standalone application on a MicroEJ platform.

Chapter 3. Specification

3.1. Overview

MicroEJ platform on STM32F746G-DISCO is based on board support package provided by STMicroelectronics: STM32CubeF7. It includes FreeRTOS, a graphical user interface, a TCP/IP network connection, a file system on microSD card, a serial connection and some custom GPIOs. MicroEJ platform has been built against Keil µVision.

3.2. MicroEJ Platform Configuration

MicroEJ platform is based on MicroEJ architecture for STMicroelectronics STM32F7J.

Table 3.1. MCU Technical Specifications

MCU architecture	Cortex-M7 (STM32F746NG)
MCU Clock speed	200 MHz
Internal Flash	1 MB
Internal RAM	320 KB
External Flash	16 MB (QSPI)
External RAM	8 MB (SDRAM)

MicroEJ platform uses several architecure extensions. The following table illustrates the MicroEJ architecture and extensions versions.

Table 3.2. MicroEJ Configuration

Name	Version
MicroEJ architecture	6.1.1
UI	7.2.1
Network	5.0.0
File System	2.1.1
HAL	1.0.2

3.3. Platform Output stream

MicroEJ platform uses USB Virtual COM port as output print stream. The virtual COM port is available on USB ST-Link/V2 connector and it is connected to the MCU USART 1.

Implementation Note

The COM port is also used as the output stream for the *printf* calls.

The COM port uses the following parameters:

- Baudrate: 115200
- Data bits bits: 8
- Parity bits: None
- Stop bits: 1
- Flow control: None

Implementation Note

On the STM32F746G-DISCO, the following parameters can be adjusted:

- Baudrate
- Parity bits
- Stop bits

3.4. RTOS Configuration

MicroEJ platform uses FreeRTOS 8.2.1. RTOS uses a heap to allocate all its objects: tasks stacks, task monitors, semaphores etc. The heap size is: 45 KB and is allocated in internal RAM. The following table illustrates the available tasks and their stack size.

Table 3.3. FreeRTOS Tasks

Task name	Size	Priority
Core Engine	12 KB	11
Touch	512 bytes	12
Network Dispatch	2 KB	12
Network DHCP	512 bytes	8
Network Ethernet Link	512 bytes	9
Network Ethernet Input	350 bytes	14
LWIP TCP	1 KB	13
File System	2 KB	12
MCU Charge Calculation	512 bytes	15
Framerate Calculation	512 bytes	3

3.5. Memories

MicroEJ Plaform uses several internal and external memories. The following table illustrates the MCU and board memory layouts and sizes fixed by the MicroEJ platform.

Table 3.4. Internal RAM: DTCM (64 KB)

Section Name	Size
Ethernet buffers	15560 KB
MicroEJ standalone application stack blocks	512 * *n* bytes [a]
MicroEJ platform internal heap	*n* bytes [b]

[a] *n* is the number of stack blocks defined in MicroEJ Application launcher options.

[b] *n* depends on memory configuration set in MicroEJ Application launcher options.

Table 3.5. Internal RAM: SRAM1 (240 KB)

Section Name	Size
SSL buffers	65 KB
Any RW	*n* bytes [a]

[a] *n* depends on MicroEJ application libraries used.

Table 3.6. External RAM: SDRAM (8 MB)

Section Name	Size
Display buffers	510 KB
MicroUI working buffer	3 MB
Multi applications working buffer	3 MB
MicroEJ standalone application heaps	1536 KB [a]

[a] Maximum size of the addition of MicroEJ heap size and MicroEJ immortal heap size. These sizes are defined in MicroEJ Application launcher options.

Table 3.7. Internal flash: AXIM interface (1 MB)

Section Name	Size
Any RO	*n* bytes [a]

[a] *n* depends on MicroEJ application, MicroEJ libraries, Board support package, RTOS, drivers, etc.

Table 3.8. External flash: QSPI (16 MB)

Section Name	Size
MicroEJ standalone application resources	*n* bytes [a]
Pre-installed MicroEJ sandboxed application	*n* bytes [b]

[a] *n* is the size of all MicroEJ standalone application resources.

[b] *n* depends on the size defined in MicroEJ Application launcher options.

3.6. Multi Applications

This MicroEJ platform includes the Multi applications mode. Multi applications mode allow to build a Multi applications firmware that can manage MicroEJ sandboxed application. Multi applications mode requires a specific memory area to load MicroEJ sandboxed application. This memory area is located in external SDRAM and its default size is 3 MB.

3.7. Graphical User Interface

MicroEJ plaform features a graphical user interface. It includes a display, a touch panel, an user button and a runtime PNG decoder.

3.7.1. Display

The display module drives a 480 x 272 TFT display. The pixel format is 16 bits-per-pixel: 5 bits for red color component, 6 bits for green color component and 5 bits for blue color component. The display device is clocked at 60Hz and the MicroEJ application drawings are synchronized on this display tick.

Implementation Note

The display stack implementation uses the double-buffering mode: the current MicroEJ application rendering is performed in a background buffer (called back buffer) and another buffer is used by the TFT display to refresh itself (called frame buffer). When the drawing is done, a copy of pixels data from the back buffer to the frame buffer is performed (stack `copy`). In order to avoid flickering, this copy is synchronized on display refresh tick.

Each buffer is allocated in external RAM (SDRAM). The size depends on the display size in pixels and on the number of bits-per-pixel (BPP):

`bufferSize = width * height * bpp / 8;`, where:

- `width` is the display width in pixels: 480
- `height` is the display width in pixels: 272
- bpp is the number of bits-per-pixel: 16

The buffers size is 2 `* 262120 = 510 KB`.

The display module uses the STM32F7 hardware acceleration to perform some drawings: the ChromArt (DMA2D). The DMA2D renders all *fill rectangles* (`GraphicsContext.fillRectangle()`) and performs the drawings of all images.

MicroUI requires a RAM buffer to store the dynamic images data. A dynamic is an image decoded at runtime (PNG image) or an image created by the MicroEJ application thanks the API `Image.create(width, height)`. This buffer is located in SDRAM and the reserved size is 3 MB.

Implementation Note

This buffer is called "working buffer". An image buffer size follows the same rule than the LCD buffer (see before).

3.7.2. Inputs

Touch panel: All touch panel events are sent to the MicroEJ application thanks a `Pointer` event generator.

Implementation Note

A touch *press* event is detected under interrupt. It wakes up a dedicated OS task. This task is used to communicate with the touch (I2C communication). For all next *drag* events, the touch task runs in polling mode. When a *release* is detected, the touch task goes to sleep and waiting a touch interrupt.

User button: The user button is reserved to the multi applications feature: it allows to force to kill a sandboxed application.

Implementation Note

The user button event treatment is performed under interrupt.

3.8. Network

MicroEJ plaform features a network interface. A limited number of 10 sockets could be used for TCP connections, 5 for TCP listening (server) connections and 6 for UDP connections. A DHCP client could be activated to retrieve IP address. All DNS requests could be handled by a MicroEJ software implementation or a native one.

Implementation Note

MicroEJ platform uses LwIP v1.5.0 fetched from git repository of the project. This implementation need a 50 KB internal heap to work. The TCP MSS is 1460 bytes.

The network portage use a BSD (Berkley Software Distribution) API with select feature. A mechanism named dispatch event, with a dedicated task, is used to request non blocking operations and wait for completion or timeout.

The DHCP client is handled by LwIP and the DNS features use a MicroEJ software implementation.

3.9. File System

MicroEJ plaform features a file system interface. A microSD card is used for the storage (previously formated to a FAT32 file system). Up to 2 files could be opened simultaneously.

Implementation Note

MicroEJ platform uses FatFS R0.11. The FAT FS driver is the SD driver port of STM32Cube v1.3.0.

3.10. Serial Communications

3.10.1. UART Connector

MicroEJ platform provides one serial communication (ECOM COMM) on UART6. UART6 pins are (RTS/CTS mode is not used):

- TX: PC6; available on connector CN4 D1
- RX: PC7; available on connector CN4 D0

Implementation Note

This implementation uses interrupt and relies on the MicroEJ `LLCOMM_BUFFERED_CONNECTION` API. This API is FIFO oriented. It requires two distincts software buffer for reception and transmission: reception buffer uses 1024 bytes and transmission buffer uses 5 bytes. These buffers are statically allocated in internal RAM.

3.10.2. USB Connector

MicroEJ platform features a serial communication (ECOM COMM) on USB port USBH: USB CDC. USBH connector is CN12.

Implementation Note

This implementation uses interrupt and using the MicroEJ `LLCOMM_BUFFERED_CONNECTION` API. This API is FIFO oriented. It requires two distincts software buffer for reception and transmission: reception buffer uses 1024 bytes and transmission buffer uses 5 bytes. Additionnally the USBH_CDC drivers requires two USB buffers of 64 bytes each. These buffers are statically allocated in internal RAM.

3.11. HAL

MicroEJ platform uses provides several GPIOs to connect HAL foundation library. All GPIOs are available on ARDUINO connectors (CN4 to CN7). Digital pins are implemented by a GPIO access, analog input pins (ADC) are driven by ADC channels of ADC 3 and analog output pins (DAC) drive PWM channels of timers 1, 3, 5 and 12.

Each GPIO port / pin value is accessible by several ways:

1. Using the global MCU declaration: all pins of all ports are grouped under only one virtual port (port 0) and have consecutive values: PA0 has the ID 0, PA1, the ID 1, PA15 the ID 15, PB0 the ID 16 and so on. For instance pin *PF6* is accessible by `(0, 86)`. This declaration is useful to target all MCU pins using only one virtual port.

2. Using the standard MCU declaration: PortA has the ID 1, PortB the ID 2 etc. Each pin of each port is a value between 0 (Port*N*-0) to 15 (Port*N*-15). For instance pin *PF6* is accessible by `(6, 6)`. This declaration is useful to target a specific MCU pin.

3. Using the virtual board connectors. Board has 2 virtual connectors: ARDUINO digital port and ARDUINO analog port, with respectively these IDs 30 and 31. For instance pin *PF6* is accessible on connector ARDUINO analog, pin A4: `(31, 5)`. This declaration is useful to target a virtual connector pin without knowing which MCU pin it is and on which physical connector pin is connected.

4. Using the physical board connectors. Board has 3 connectors: CN4, CN5 and CN7 (CN6 is not connected to the MCU), with respectively these IDs: 64, 65 and 67. For instance pin *PF6* is accessible on connector CN5, pin5: `(65, 6)`. This declaration is useful to target a physical connector pin without knowing which MCU pin it is.

The following table summaries the exhaustive list of GPIOs ports accessible from HAL library, and the ranges of pins IDs:

Table 3.9. HAL GPIOs Ports and Pins

Port name	HAL port ID	Pins range
Global MCU virtual port	0	0 to 143
MCU port A	1	0 to 15
MCU port B	2	0 to 15
MCU port F	6	0 to 15
MCU port G	7	0 to 15
MCU port H	8	0 to 15
MCU port I	9	0 to 15
Board virtual port "ARDUINO digital"	30	0 to 15
Board virtual port "ARDUINO analog"	31	0 to 7
Board physical port "CN4"	64	1 to 8
Board physical port "CN5"	65	1 to 10
Board physical port "CN7"	67	1 to 6

The following table illustrates the exhaustive list of GPIOs connected to the HAL library, their IDs according the ports IDs and pins IDs (see before):

Table 3.10. HAL GPIOs Declaration (port, pin)

Port / Pin	MCU virtual port (1)	MCU port (2)	Board virtual port (3)	Board physical port (4)
PA0	0, 0	1, 0	31, 0	65, 1
PA8	0, 8	1, 8	30, 10	67, 3
PA15	0, 15	1, 15	30, 9	67, 2
PB4	0, 20	2, 4	30, 3	64, 4
PB14	0, 30	2, 14	30, 12	67, 5
PB15	0, 31	2, 15	30, 11	67, 4
PF6	0, 86	6, 6	31, 5	65, 6
PF7	0, 87	6, 7	31, 4	65, 5
PF8	0, 88	6, 8	31, 3	65, 4
PF9	0, 89	6, 9	31, 2	65, 3
PF10	0, 90	6, 10	31, 1	65, 2
PG6	0, 102	7, 6	30, 2	64, 3
PG7	0, 103	7, 7	30, 4	64, 5
PH6	0, 118	8, 6	30, 6	64, 7
PI0	0, 128	9, 0	30, 5	64, 6
PI1	0, 129	9, 1	30, 13	67, 6
PI2	0, 130	9, 2	30, 8	67, 1
PI3	0, 131	9, 3	30, 7	64, 8

The following table lists the hardware analog devices (ADC / DAC channels) used by HAL analog pins:

Table 3.11. HAL Analog GPIOs Devices

Port / Pin	ADC 3 channel	PWM timer / channel
PA0	0	-
PA8	-	1 / 1
PB4	-	3 / 1
PB15	-	12 / 2
PF6	4	-
PF7	5	-
PF8	6	-
PF9	7	-
PF10	8	-
PH6	-	12 / 1
PI0	-	5 / 4

Chapter 4. Board Configuration

STM32F746G-DISCO provides several connectors, each connector is used by the MicroEJ Core Engine itself or by a foundation library.

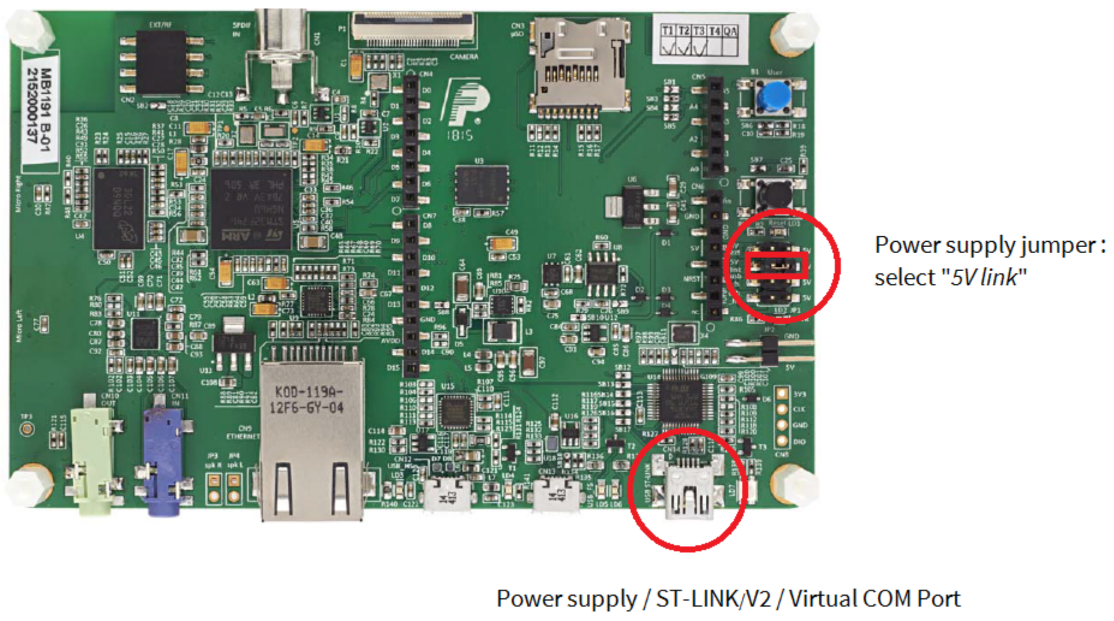
4.1. Mandatory Connectors

STM32F746G-DISCO provides a multi function USB port used as:

- Power supply connector
- Probe connector
- Virtual COM port

First of all, ensure the *Power Supply jumper* is fit to the second option: *5V Link*. Then just plug a mini-USB cable to a computer to power on the board, be able to program an application on it and to see the MicroEJ standalone application `System.out.print` traces.

Figure 4.1. Mandatory Connectors



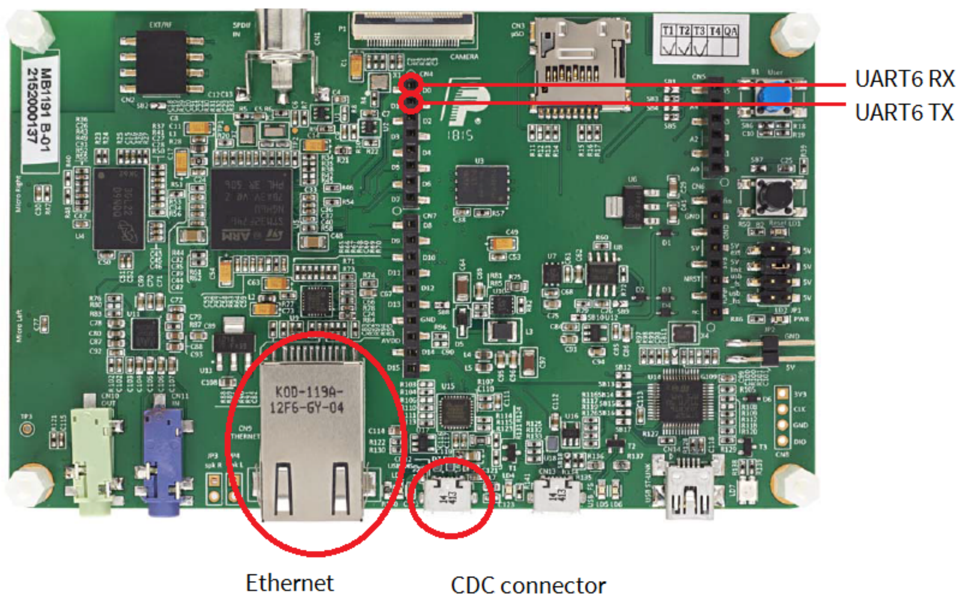
Power supply jumper : select "*5V link*"
Power supply / ST-LINK/V2 / Virtual COM Port

4.2. Communication Connectors

STM32F746G-DISCO provides several communication ports:

- Ethernet
- Serial communication
- CDC communication

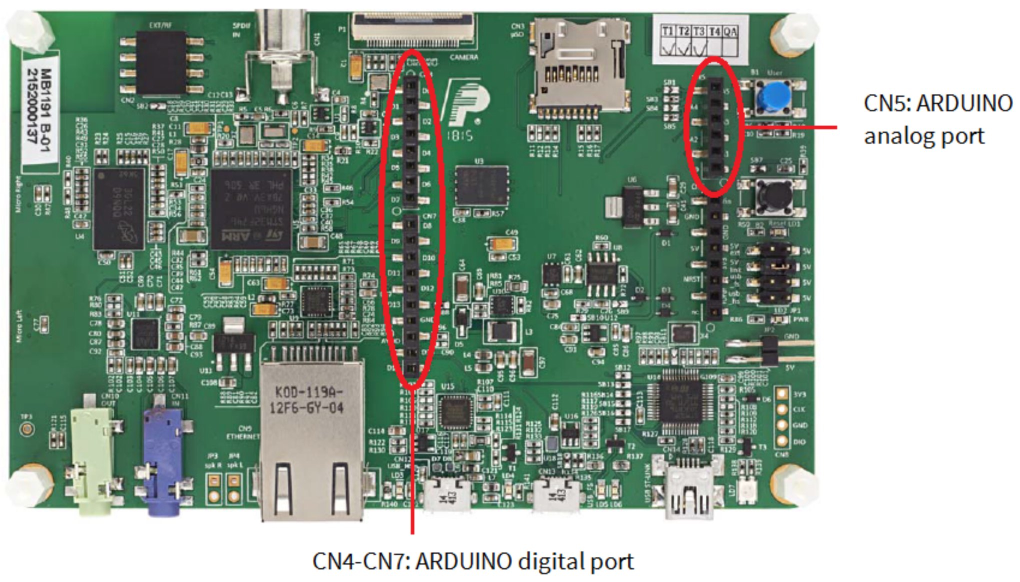
Figure 4.2. Communication Connectors



4.3. HAL Connectors

STM32F746G-DISCO provides several HAL GPIOs on connector CN4 to CN7

Figure 4.3. HAL Connectors



Chapter 5. Keil MDK-ARM Configuration

5.1. Install Keil MDK-ARM

This section describes how to install a Keil MDK-ARM Development Kit, how to activate the MDK-ARM license required for evaluating MicroEJ SDK and how to download the Keil pack related to the target microcontroller.

A right to activate a MDK-ARM evaluation license is granted with the MicroEJ SDK evaluation version. This evaluation license is a one month time limited that allows to compile and link up to 256KB of code.

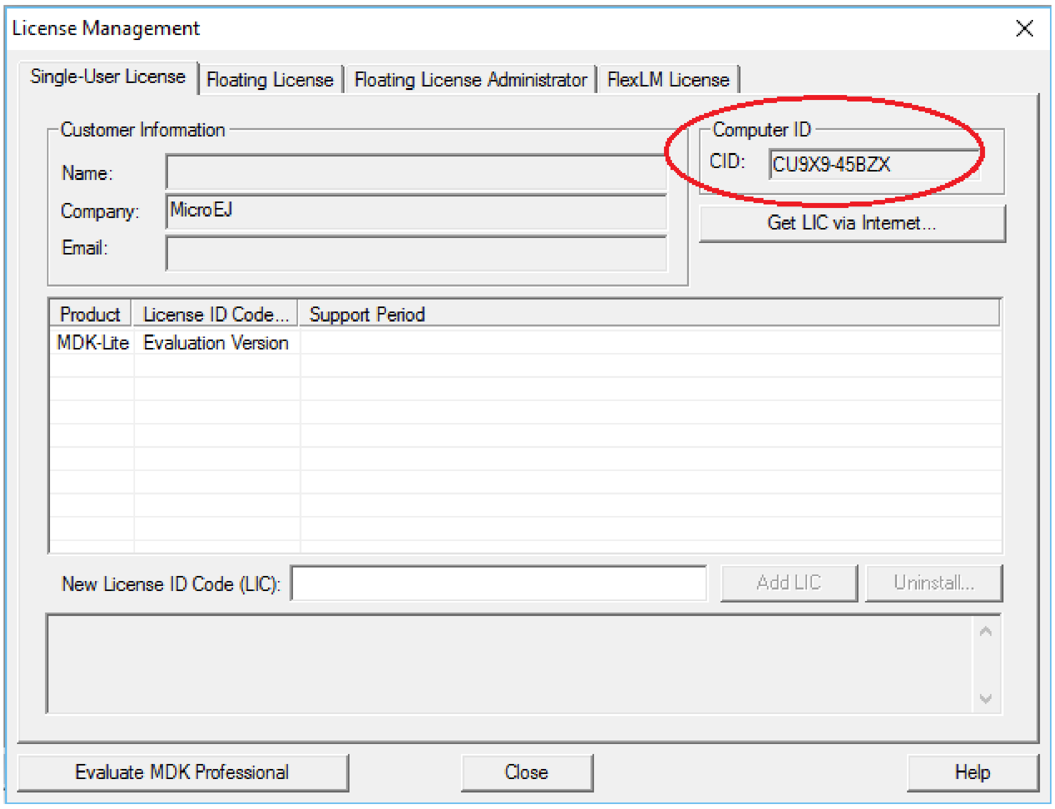
5.1.1. Download Keil MDK-ARM

- Go to `http://www.keil.com/demo/eval/arm.htm`.
- Fulfill the registration form and press `Submit` button.
- Download the executable file (e.g. `MDKxyz.exe`).
- Run executable file and follow installation steps. Install additional software and drivers if proposed. A new application named `Keil uVision5` shall have been created.

5.1.2. Activate the Evaluation License

- Start `Keil uVision5` application. If you are using Windows 7 or higher, you should run the application with administrator privileges (right-click on `Keil uVision5` shortcut `> Run as administrator`).
- Select `File > License Management...` and copy the computer ID (CID).

Figure 5.1. Keil MDK-ARM Computer ID


License Management

Single-User License | Floating License | Floating License Administrator | FlexLM License

Customer Information

Name:

Company: MicroEJ

Email:

Computer ID

CID: CU9X9-45BZX

Product	License ID Code...	Support Period
MDK-Lite	Evaluation Version	

New License ID Code (LIC):

- Go to `https://www.keil.com/license/install.htm`.
- Fulfill the registration form with the computer ID and the following Product Serial Number (PSN):

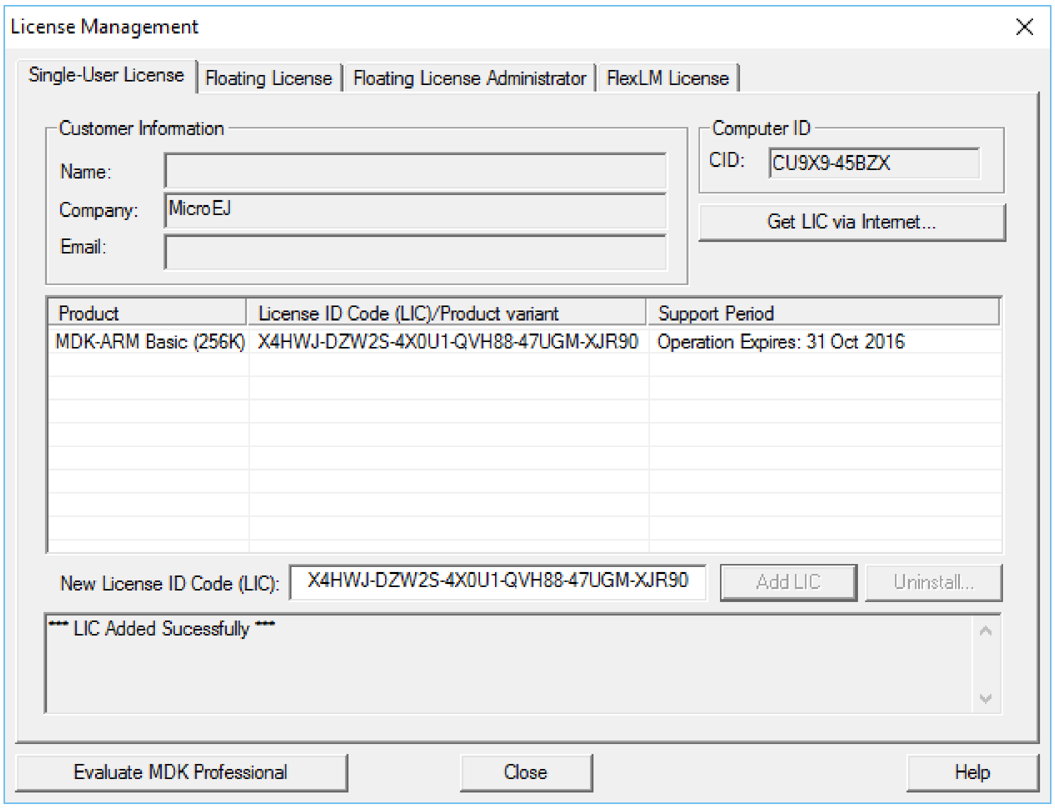
```
0YK7R-4V1PQ-R3KM9
```

Warning

This Product Serial Number is reserved to activate a Keil MDK-ARM product license solely for a usage through this MicroEJ SDK evaluation.

- Press `Submit` button.
- You should have received an email with an activation license.
- Copy/Paste the license ID code (LIC) included in the email and press on `Add LIC` button.
- License is now installed and should display the information as shown below.

Figure 5.2. Keil MDK-ARM License Installation



License Management

Single-User License | Floating License | Floating License Administrator | FlexLM License

Customer Information

Name:	
Company:	MicroEJ
Email:	

Computer ID

CID: CU9X9-45BZX

Get LIC via Internet...

Product	License ID Code (LIC)/Product variant	Support Period
MDK-ARM Basic (256K)	X4HWJ-DZW2S-4X0U1-QVH88-47UGM-XJR90	Operation Expires: 31 Oct 2016

New License ID Code (LIC): X4HWJ-DZW2S-4X0U1-QVH88-47UGM-XJR90

Add LIC | Uninstall...

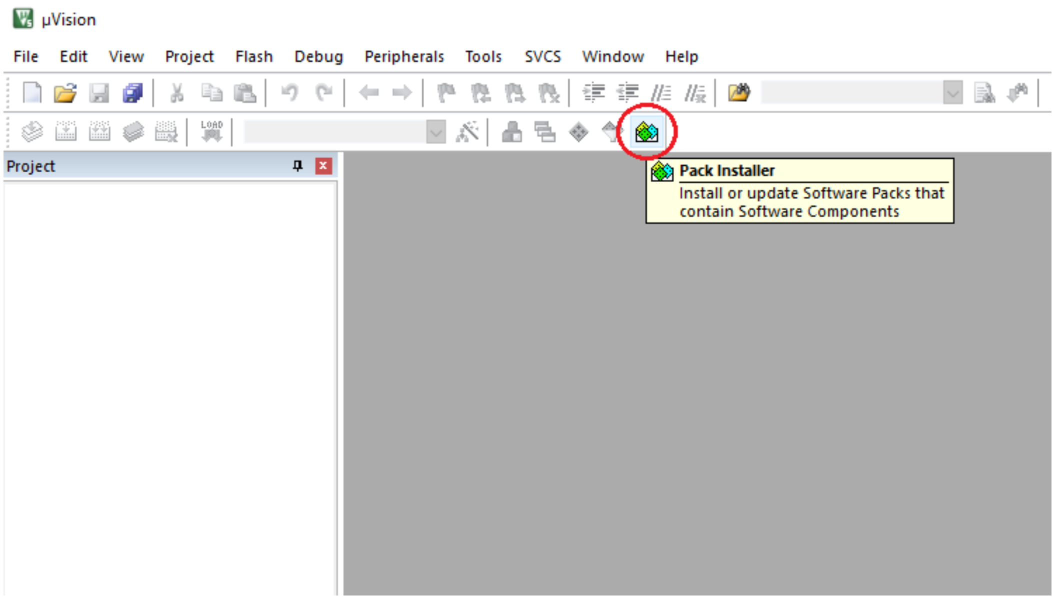
*** LIC Added Sucessfully ***

Evaluate MDK Professional | Close | Help

5.1.3. Install Microcontroller Specific Pack

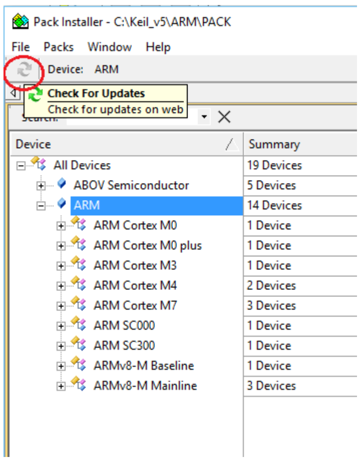
- In `Keil uVision5`, click on the pack installer icon.

Figure 5.3. Keil MDK-ARM Microcontroller Pack



- Click on the refresh icon `Check for Updates` and wait until all available pack description are downloaded.

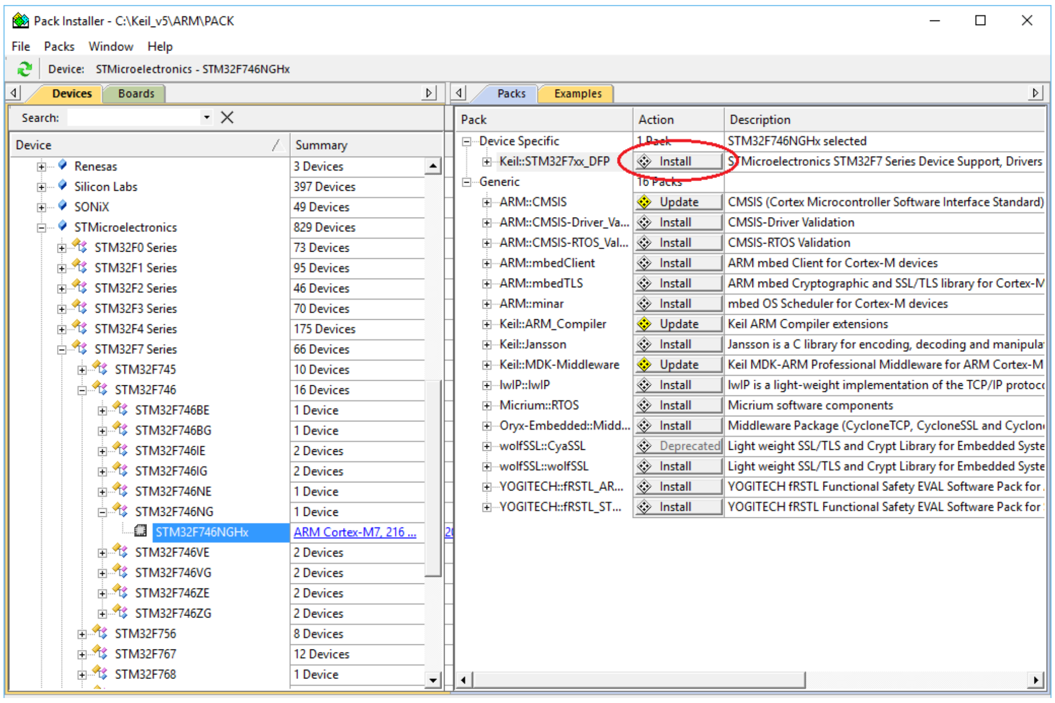
Figure 5.4. Microcontroller Pack Update



Device	Summary
All Devices	19 Devices
ABOV Semiconductor	5 Devices
ARM	14 Devices
ARM Cortex M0	1 Device
ARM Cortex M0 plus	1 Device
ARM Cortex M3	1 Device
ARM Cortex M4	2 Devices
ARM Cortex M7	3 Devices
ARM SC000	1 Device
ARM SC300	1 Device
ARMv8-M Baseline	1 Device
ARMv8-M Mainline	3 Devices

- In `Devices` tab, select the appropriate microcontrolleur part number `All Devices > STMicroElectronics > STM32F7 Series > STM32F746 > STM32F746NG > STM32F746NGHx` . In Packs Tab, select `Device Specific > Keil::STM32F7xxx_DFP` and click on `Install`.

Figure 5.5. Microcontroller Pack Selection


Pack Installer - C:\Keil_v5\ARM\PACK
File Packs Window Help
Device: STMicroelectronics - STM32F746NGHx
Devices
Boards
Search:
Packs
Examples

Device	Summary
Renesas	3 Devices
Silicon Labs	397 Devices
SONiX	49 Devices
STMicroelectronics	829 Devices
STM32F0 Series	73 Devices
STM32F1 Series	95 Devices
STM32F2 Series	46 Devices
STM32F3 Series	70 Devices
STM32F4 Series	175 Devices
STM32F7 Series	66 Devices
STM32F745	10 Devices
STM32F746	16 Devices
STM32F746BE	1 Device
STM32F746BG	1 Device
STM32F746IE	2 Devices
STM32F746IG	2 Devices
STM32F746NE	1 Device
STM32F746NG	1 Device
STM32F746NGHx	ARM Cortex-M7, 216 ...
STM32F746VE	2 Devices
STM32F746VG	2 Devices
STM32F746ZE	2 Devices
STM32F746ZG	2 Devices
STM32F756	8 Devices
STM32F767	12 Devices
STM32F768	1 Device

Pack	Action	Description
Device Specific	1 Pack	STM32F746NGHx selected
Keil::STM32F7xx_DFP	Install	STMicroelectronics STM32F7 Series Device Support, Drivers
Generic	16 Packs	
ARM::CMSIS	Update	CMSIS (Cortex Microcontroller Software Interface Standard)
ARM::CMSIS-Driver_Va...	Install	CMSIS-Driver Validation
ARM::CMSIS-RTOS_Val...	Install	CMSIS-RTOS Validation
ARM::mbedClient	Install	ARM mbed Client for Cortex-M devices
ARM::mbedTLS	Install	ARM mbed Cryptographic and SSL/TLS library for Cortex-M
ARM::minar	Install	mbed OS Scheduler for Cortex-M devices
Keil::ARM_Compiler	Update	Keil ARM Compiler extensions
Keil::Jansson	Install	Jansson is a C library for encoding, decoding and manipula
Keil::MDK-Middleware	Update	Keil MDK-ARM Professional Middleware for ARM Cortex-M
lwIP::lwIP	Install	lwIP is a light-weight implementation of the TCP/IP protoc
Micrium::RTOS	Install	Micrium software components
Oryx-Embedded::Midd...	Install	Middleware Package (CycloneTCP, CycloneSSL and Cyclon
wolfSSL::CyaSSL	Deprecated	Light weight SSL/TLS and Crypt Library for Embedded Syste
wolfSSL::wolfSSL	Install	Light weight SSL/TLS and Crypt Library for Embedded Syste
YOGITECH::fRSTL_AR...	Install	YOGITECH fRSTL Functional Safety EVAL Software Pack for
YOGITECH::fRSTL_ST...	Install	YOGITECH fRSTL Functional Safety EVAL Software Pack for

- The pack is downloaded and installed. Close the Pack Installer window.

5.2. BSP Project Structure

The MDK-ARM BSP project folder is included in a MicroEJ standard project. This project is visible from the MicroEJ workspace. This project uses the same tree than the computer file system:

- Drivers: all MCU drivers, board drivers and CMSIS drivers

- Middlewares: all 3rd-party files: USB host library, FatFs, FreeRTOS, LwIP
- Projects: the MicroEJ platform project itself
- Utilities: miscellaneous C files required by drivers

The MDK-ARM BSP project file is `Projects/STM32746G-Discovery/Applications/MicroEJ/MDK-ARM/Project.uvprojx`. This MDK-ARM BSP project has been written for µVision V5.18.0.0. The project follows the files structure of STMCubeF7 projects:

- Drivers/*: all MCU drivers, board drivers and CMSIS drivers
- FreeRTOS: FreeRTOS files
- LWIP/*: network LWIP files
- FatFS/*: file system files
- STM32_USBH/*: STMicroelectronics USBH drivers
- MicroEJ/*: all MicroEJ platform implementation files

The MicroEJ platform implementation files are grouped by MicroEJ features:

- MicroEJ/Core: Core Engine implementation over STM32CubeF7 and FreeRTOS (always required)
- MicroEJ/Comm: ECOM COMM implementation over UART and CDC
- MicroEJ/FS: File system implementation over FatFS
- MicroEJ/KF: Multi applications implementation over STM32CubeF7
- MicroEJ/HAL: HAL implementation over STM32CubeF7
- MicroEJ/Libs: MicroEJ platform C libraries
- MicroEJ/Net: Network implementation over LWIP
- MicroEJ/Net/SSL: SSL implementation over WolfSSL
- MicroEJ/UI: UI implementation over STM32CubeF7

Chapter 6. Changelog

6.1. Version 2.2.0

Initial release of the platform.