



NRC7292 Evaluation Kit

User Guide

(Standalone)

Ultra-low power & Long-range Wi-Fi

Ver 1.6
Dec 4, 2020

NEWRACOM, Inc.

NRC7292 Evaluation Kit User Guide (Standalone)

Ultra-low power & Long-range Wi-Fi

© 2020 NEWRACOM, Inc.

All right reserved. No part of this document may be reproduced in any form without written permission from Newracom.

Newracom reserves the right to change in its products or product specification to improve function or design at any time without notice.

Office

Newracom, Inc.

25361 Commercentre Drive, Lake Forest, CA 92630 USA

<http://www.newracom.com>

Contents

1	Overview.....	6
1.1	H/W list	8
1.1.1	NRC7292 module board	8
1.1.2	NRC7292 adapter board	8
1.1.3	Host board.....	8
1.2	S/W list	9
1.2.1	NRC7292 SDK	9
1.2.2	NRC7292 standalone firmware downloader	9
2	Setup S/W build environment	10
2.1	Toolchain Setup.....	10
2.2	Download SDK.....	11
2.3	SDK application program	12
2.3.1	Sample application programs	12
2.3.2	Application program project structure	12
2.3.3	Build application program.....	13
2.3.4	SDK APIs	14
2.3.5	Sample applications	16
3	How to download compiled binaries	18
3.1	UART connection between PC and EVB	18
3.2	Download the unified binary	19
3.3	Standalone operation mode	20
4	Abbreviations and acronyms	21
5	Revision history.....	22

List of Tables

Table 2.1 NRC7292 SDK APIs..... 15

Table 2.2 NRC7292 sample applications..... 16

List of Figures

Figure 1.1	NRC7292 evaluation board (v.1.0)	6
Figure 1.2	NRC7292 evaluation board (v.2.0 – top view)	7
Figure 1.3	NRC7292 evaluation board (v.2.0 – bottom view)	7
Figure 1.4	NRC7292 evaluation board block diagram	8
Figure 3.1	COM port in Device Manager	18
Figure 3.2	NRC7292 standalone firmware downloader	19
Figure 3.3	Standalone mode DIP switch configuration	20

1 Overview

This document introduces the NRC7292 Software Development Kit (SDK) that allows users to develop their application program running on NRC7292 Evaluation Boards (EVB) without external hosts. Figure 1.1 to Figure 1.3 show the pictures of NRC7292 EVB.

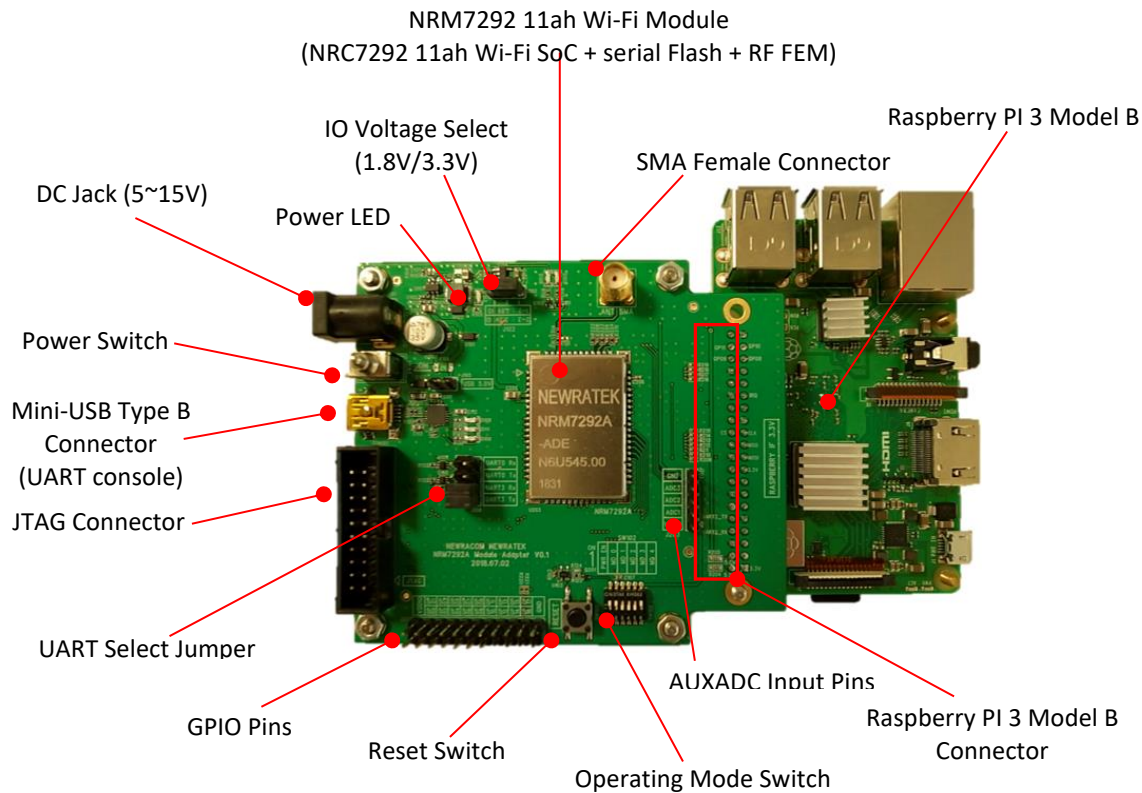


Figure 1.1 NRC7292 evaluation board (v.1.0)

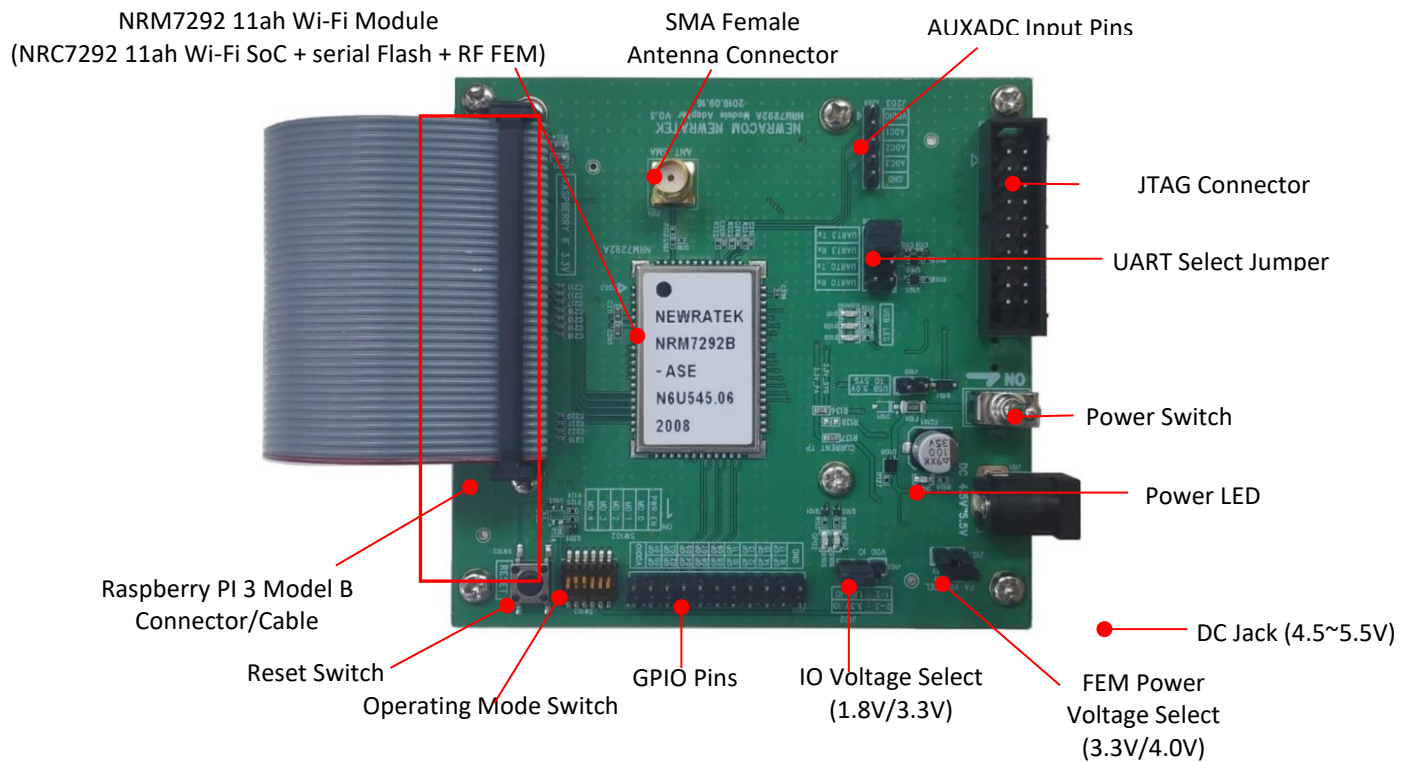


Figure 1.2 NRC7292 evaluation board (v.2.0 – top view)

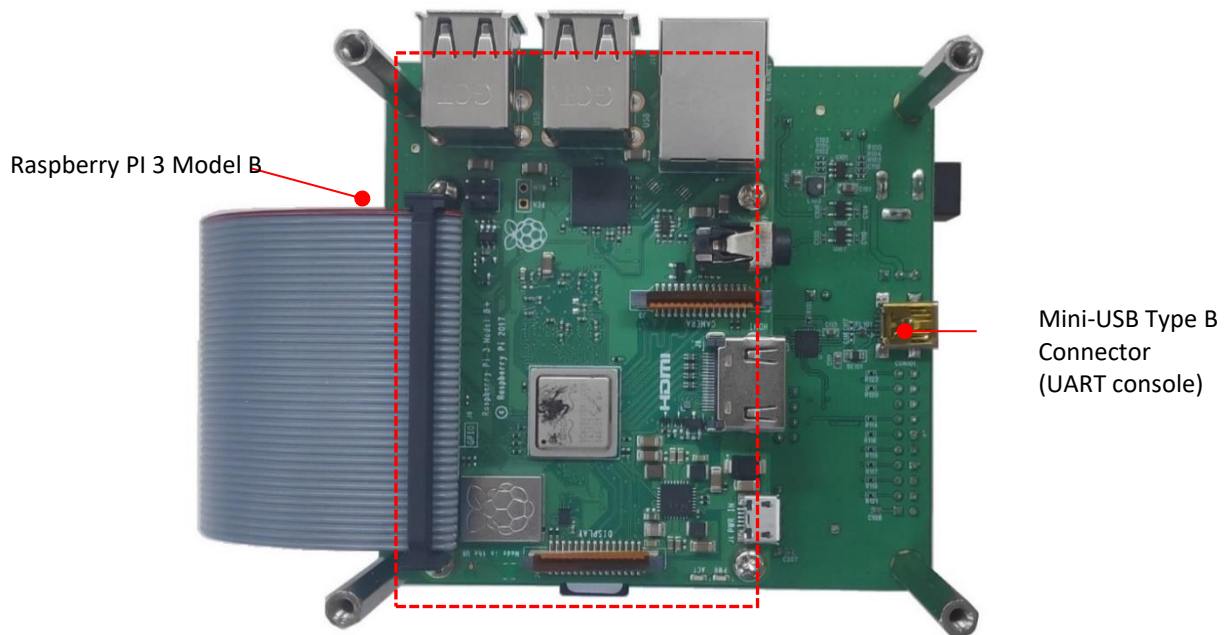


Figure 1.3 NRC7292 evaluation board (v.2.0 – bottom view)

1.1 H/W list

The NRC7292 EVB consists of three components: an 11ah Wi-Fi module, an adapter board, and a host board.

1.1.1 NRC7292 module board

The NRC7292 module contains the IEEE 802.11ah Wi-Fi SoC solution. It also includes an RF front end module to amplify the transmission power up to 23 dBm. The on-board serial flash memory can be used for Over-The-Air (OTA) firmware update, user configuration data storage. The module also supports Execution-In-Place (XIP) functionality along with the 32KB cache in the SoC.

1.1.2 NRC7292 adapter board

The NRC7292 adapter board mainly acts as a communication interface to sensors or an external host. It also supplies main power to the NRC7292 Wi-Fi module.

1.1.3 Host board

The use of a Raspberry Pi 3 (RPi3) host is optional for standalone operation. The NRC7292 module can be used either as a standalone or a slave to a host processor via serial peripheral interface (SPI) or universal asynchronous receive transmitter (UART). The RPi 3 host can be used for test or AT-command operation.

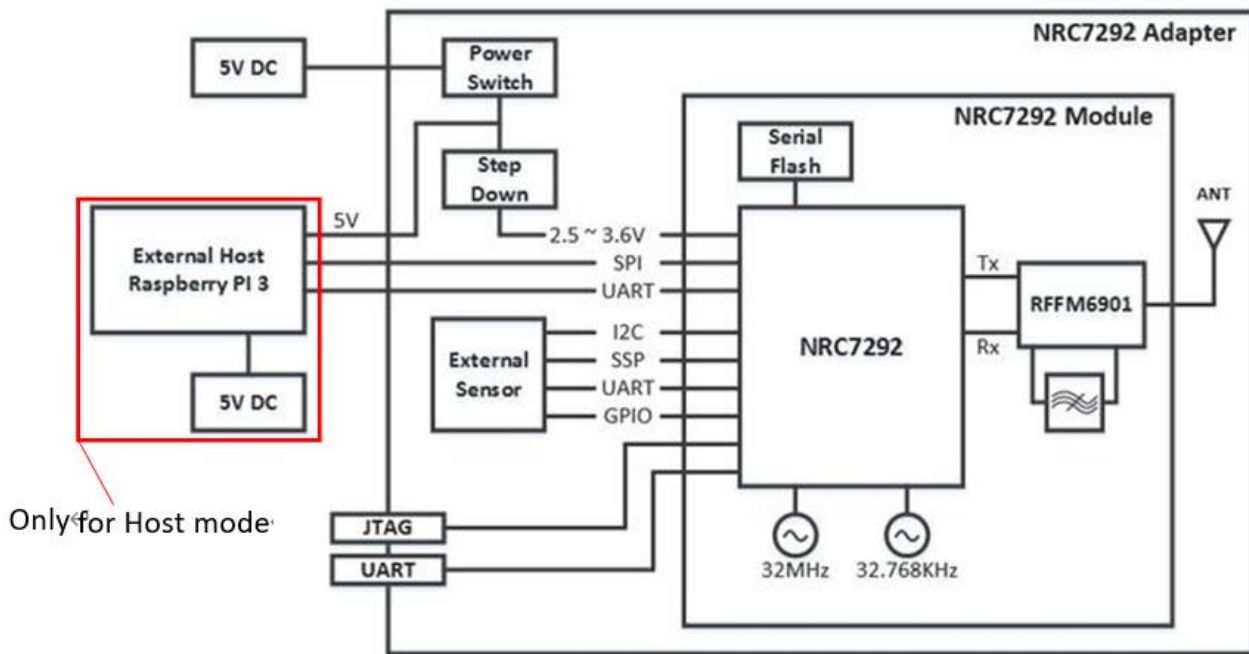


Figure 1.4 NRC7292 evaluation board block diagram

1.2 S/W list

1.2.1 NRC7292 SDK

The NRC7292 SDK can be used to develop user's application program running on NRC7292 EVB. The SDK includes various types of Application Program Interfaces (APIs) for controlling Wi-Fi connectivity, Transport Control Protocol/Internet Protocol (TCP/IP) communication, peripherals, timer, memory, etc. In addition, users can attach various sensors on the evaluation board and communicate with them via UART, SPI, or I2C APIs.

As all standalone applications run on FreeRTOS, users can take advantage of FreeRTOS features including multi-tasking, Inter-Task Communication (ITC), memory management, etc.

(Refer to at <https://www.freertos.org> for more information)

1.2.2 NRC7292 standalone firmware downloader

The NRC7292 Standalone Firmware Downloader for Windows included in the release package can be used to download a unified binary onto the flash memory on the EVB.

2 Setup S/W build environment

The NRC7292 SDK supports a Linux environment. This chapter describes how to set up the development environment, build a user's application program, and download the binary on the EVB.

2.1 Toolchain Setup

GNU ARM embedded toolchain is required to build the user's application program. Note that users should use 64-bit Linux machine to build successfully.

- Ubuntu 16.04 LTS (64-bit PC(AMD64) desktop image) or later
- GCC toolchain for ARM embedded processors
Download the GNU Arm embedded toolchain v7-2018Q2
gcc-arm-none-eabi-7-2018-q2-update-linux.tar.bz2 (version must exactly match)
<https://developer.arm.com/tools-and-software/open-source-software/developer-tools/gnu-toolchain/gnu-rm/downloads>

Before installing the ARM embedded toolchain, users need some additional packages which can be easily installed through the standard package manager (apt-get) for Ubuntu. The following instructions discuss which packages are required, with instructions on how to install them.

```
sudo apt-get update  
sudo apt-get install build-essential python2.7 python-pip git
```

Once the required packages are successfully installed, download the GCC toolchain (gcc-arm-none-eabi-7-2018-q2-update-linux.tar.bz2) from the ARM developer website, copy the file to \$HOME location, and extract it.

```
tar -xvf gcc-arm-none-eabi-7-2018-q2-update-linux.tar.bz2
```

The GCC toolchain will be extracted into ~/ gcc-arm-none-eabi-7-2018-q2-update-linux directory. If the PATH environmental variable is set as shown below, users can run the GCC toolchain anywhere without giving the complete path for the toolchain.

```
export PATH="$PATH:$HOME/gcc-arm-none-eabi-7-2018-q2-update/bin"
```

2.2 Download SDK

Users can download the NRC7292 SDK from GitHub (https://github.com/newracom/nrc7292_sdk.git).

```
git clone https://github.com/newracom/nrc7292\_sdk.git
```

The NRC7292 SDK in the repository consists of several subdirectories: doc, lib, make, sdk, apps, and tool. The doc directory contains all the documents for the users, including the user guides. The lib directory holds various third-party library codes including FreeRTOS, LwIP, Mbed TLS, etc. along with the SDK modem library. The make and apps directories carry makefiles and sample application programs, respectively. The tool holds the NRC7292 Standalone Firmware Downloader, AT cmd test tool and board data editor.

```
.
├── doc
├── lib
│   ├── FreeRTOS
│   ├── aws_iot
│   ├── cJSON
│   ├── hostap
│   ├── libcoap
│   ├── lwip
│   ├── mbedtls
│   ├── modem
│   ├── mxml
│   ├── paho.mqtt
│   ├── tinycbor
│   └── tr6260
├── make
├── sdk
│   ├── inc
│   └── apps
├── tools
│   ├── downloader
│   ├── AT_CMD_Test_Tool
│   └── BoardDataEditor
```

2.3 SDK application program

2.3.1 Sample application programs

```
|—— atcmd
|—— hello_world
|—— .....
|—— sample_tcp_client
|—— sample_tcp_server
|—— .....
|—— wifi-common
```

The package provides various sample application programs in the 'nrc7292_sdk/package/standalone/sdk/apps' directory. However, the 'atcmd' and the 'wifi-common' directory in the 'sdk/apps' are not a sample program but contains header and source files for AT-command and Wi-Fi connectivity, respectively. If users want to use Wi-Fi functionalities, they must include the header files in their application program.

The 'nrc7292_sdk/package/standalone/sdk/inc' directory contains the API header files for GPIO, I2C, UART, etc. Only the header files for these APIs are provided.

2.3.2 Application program project structure

Except for the AT-command application, every project directory has the .config, Makefile, and main source file that is the same name as the project. For example, as shown below, the sample application project for the TCP client has the main source file named 'sample_tcp_client', which is the same as its project name.

The main source file should contain the 'void user_init(void)' function that serves as the entry point of the application.

```
|—— sample_tcp_client
| |—— .config
| |—— Makefile
| |—— sample_tcp_client.c
|—— wifi_common
| |—— wifi_common.make
| |—— wifi_config.h
| |—— wifi_config_setup.c
| |—— wifi_config_setup.h
| |—— wifi_connect_common.c
| |—— wifi_connect_common.h
```

As mentioned above, to use the Wi-Fi connectivity, users should include the header files of 'wifi_common' in their main source file as well as adding 'wifi_common.make' at the end of the Makefile as shown below. Also, the application source files must be listed following the CSRCS variable in the Makefile.

```
CSRCS += \  
    sample_tcp_client.c  
  
include $(SDK_WIFI_COMMON)/wifi_common.make
```

Some third-party libraries (CJSON, MQTT, MXML, AWS, TINYCBOR, COAP, etc.) are provided in the package. Users can easily include these libraries by selecting each of them in the .config file. For example, if the application requires the CJSON library, the user can simply change 'n' to 'y' in the .config file for use.

```
CONFIG_CJSON = y  
CONFIG_MQTT = n  
CONFIG_MXML = n  
CONFIG_AWS = n  
CONFIG_TINYCBOR = n  
CONFIG_COAP = n
```

2.3.3 Build application program

Users can use the 'make' command at the standalone directory (nrc7292_sdk/package/standalone) to build the application program. Before running the 'make' command, however, users must create the build-target file (.build-target) which specifies the makefile used for build and the name of the application project.

Example of .build-target file:

```
MAKEFILE = nrc7292.sdk.release  
  
PARAM := -- APP_NAME=sample_tcp_client
```

Users can create the build-target file by following the instruction below at the standalone directory.

Usage of make command for build-target file:

```
make select target=nrc7292.sdk.release APP_NAME=$(APP_NAME)
```

For the general application programs, users need to give the name of the application project as the APP_NAME. For example, to build a sample TCP client application, users can write a command as shown below.

```
make select target=nrc7292.sdk.release APP_NAME=sample_tcp_client
```

For the AT-command application programs, pre-defined name of the application should be given as follows.

HSPI mode:

```
make select target=nrc7292.sdk.release APP_NAME=ATCMD_HSPI
```

UART mode (without hardware flow control):

```
make select target=nrc7292.sdk.release APP_NAME=ATCMD_UART
```

UART mode (with hardware flow control):

```
make select target=nrc7292.sdk.release APP_NAME=ATCMD_UART_HFC
```

Once the build-target file is created at the standalone directory, users can run the 'make' command at the same directory. This command will generate the map, elf, and unified binary file of the application program at the 'out/nrc7292/standalone_xip/{project_name}' directory.

The binary file 'nrc7292_standalone_xip_{project_name}.bin' can then be downloaded onto the module.

2.3.4 SDK APIs

Various SDK APIs in several categories are provided for user application programming as shown in Table 2.1. Please refer to UG-7292-005-Standalone SDK API in the packet for more information.

◆ *To print out logs via UART console (see Figure 1.1 and Figure 1.3), the debug UART console must first be enabled by calling the API function, "nrc_uart_console_enable()." Once the console is enabled, users can print the logs out to the UART console using the API function, "nrc_usr_print()."*

Table 2.1 NRC7292 SDK APIs

Category	Description
Wi-Fi	Wi-Fi connection
Timer	Timer-based application
UART	UART peripheral I/O
GPIO	GPIO peripheral I/O
I2C	I2C peripheral I/O
ADC	ADC peripheral I/O
PWM	PWM peripheral I/O
SPI	SPI peripheral I/O
HTTP Client	HTTP Client
FOTA	Firmware Over-The-Air

2.3.5 Sample applications

Table 2.2 provide the information of the various sample application programs included in the release package.

Table 2.2 NRC7292 sample applications

Category	Subcategory	Name	Description
Helloworld	Console print	hello_world	Repeatedly print hello message
AT-CMD	AT-CMD	Atcmd	AT command
Wi-Fi	Connection	sample_wifi_state	Repeat Wi-Fi connection and disconnection every 3 seconds
	SoftAP	sample_softap_udp_server	Run SoftAP and receive UDP data
		sample_softap_tcp_server	Run SoftAP and receive TCP data
Protocol	UDP	sample_udp_client	Send a UDP packet every 1 second
		sample_udp_server	Receive UDP packets
	TCP	sample_tcp_client	Connect to a TCP server and send 1000 packets to the TCP server
		sample_tcp_server	Start a TCP server, wait for an incoming TCP client connection and receive data from the connected TCP client
	HTTP	sample_http	Send a HTTP request and receive the corresponding HTTP response
	FOTA	sample_fota	Run FOTA operation
Peripheral	Timer	sample_timer	Start 6 timers with different periods
	Memory	sample_memory	Repeatedly allocate and free memory
	GPIO	sample_gpio	Set GPIO_01(LED) as a pin and toggle on and off every 1 second (LED blinks 1 sec)
	UART	sample_uart	Bytes fed into UART CH2 are sent to a remote UDP server
	SPI	sample_spi	Communicate with a sensor via SPI
	I2C	sample_i2c	Communicate with a sensor via I2C
	ADC	sample_adc	Communicate with a sensor via ADC
	PWM	sample_pwm	Enable PWM and configure the PWM duty cycle for an analog sensor
	Serial flash	sample_sf_userconfig	Read/write user config area
	Power Save	sample_ps_standalone	Deep sleep operation
		sample_ps_tcp_client	Repeatedly send TCP data and enter the deep sleep mode

Middleware	MQTT	Sample_mqtt	Send data to MQTT server using MQTT protocol
	XML	sample_xml	Test XML creation and conversion behavior
	CJSON	sample_json	Test JSON creation and conversion behavior
	AWS	sample_aws_client	Connect to aws and publish message
	OneM2M	sample_onem2m_client	Connect to oneM2M and receive data via MQTT
	CoAP	sample_coap_server	Execute CoAP server
		sample_coap_client	Execute CoAP client and get information from server

3 How to download compiled binaries

The NRC7292 Standalone Firmware Downloader in the ‘tool’ directory can be used to download the unified binary onto the EVB. The steps outlined below explain how to download the binary.

3.1 UART connection between PC and EVB

Connect the PC to the EVB using a UART-USB cable and check the corresponding COM port number using the Device Manager. The COM port number will be required in the next step.

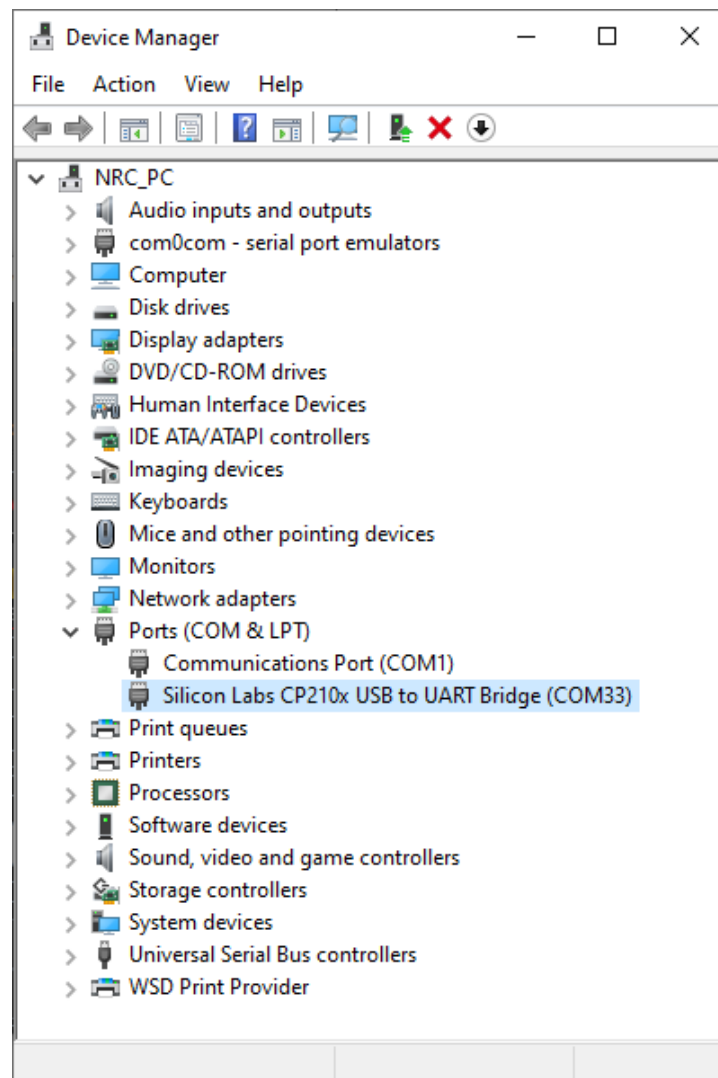


Figure 3.1 COM port in Device Manager

3.2 Download the unified binary

Launch the NRC7292 Standalone Firmware Downloader and select the correct serial port. Either directly type in the path to the standalone XIP boot and firmware binary or press the **'SET'** button to launch the file selector. MAC addresses (for WLAN0 and WLAN1) can be read from the flash.

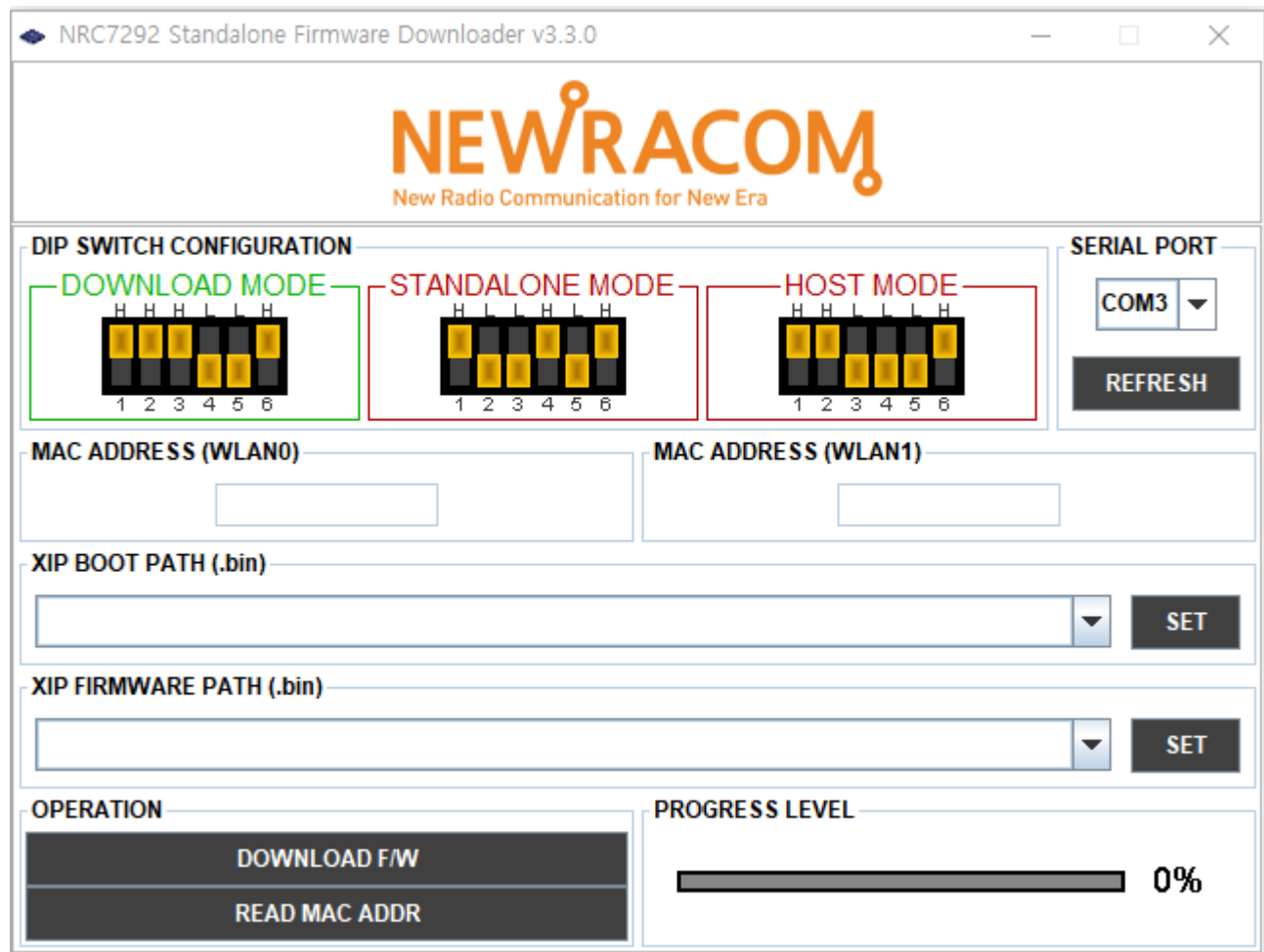


Figure 3.2 NRC7292 standalone firmware downloader

To start downloading the selected binary, click the **'DOWNLOAD F/W'** button.

3.3 Standalone operation mode

After downloading the firmware, the DIP switch must be configured to the standalone mode as shown in the figure below. Pressing the reset button on the module will start the standalone operation.



U D D U D U

U(Up), D(Down)

Figure 3.3 Standalone mode DIP switch configuration

4 Abbreviations and acronyms

Abbreviations Acronyms		Definition
ADC		Analog Digital Converter
AP		Access Point
API		Application Program Interface
AWS		Amazon Web Service
CJSON		C JavaScript Object Notation
CoAP		Constrained Application Protocol
EVb		Evaluation Board
EVK		Evaluation Kit
FEM		Front End Module
FOTA		Firmware Over the Air
GPIO		General Purpose Input Output
HTTP		Hypertext Transfer Protocol
IEEE		Institute of Electrical and Electronics Engineers
IP		Internet Protocol
ITC		Inter-Task Communication
I2C		Inter-Integrated Circuit
LAN		Local Area Network
LwIP		Lightweight Internet Protocol
LED		Light Emitting Diode
MQTT		Message Queuing Telemetry Transport
MXML		Music Extensible Markup Language
OTA		Over-the-Air
PWM		Pulse Width Modulation
RPi3		Raspberry Pi 3
RTOS		Real Time Operating System
SDK		Software Development Kit
SoC		System on Chip
SPI		Serial Peripheral Interface
STA		Station
TCP		Transmission Control Protocol
TINYCBOR		Tiny Concise Binary Object Representation
UART		Universal Asynchronous Receive Transmitter
UDP		User Datagram Protocol
USB		Universal Serial Bus
XIP		eXecution In Place

5 Revision history

Revision No	Date	Comments
Ver 1.0	11/01/2018	Initial version for customer review created
Ver 1.1	03/25/2019	APIs and sample App for SoftAP are added
Ver 1.2	07/02/2019	Description of Sample Applications updated
Ver 1.3	11/06/2019	Update Binary download & NRC7292 SDK directories and files
Ver 1.4	07/13/2020	Added linux build environment and remove eclispe environment
Ver 1.5	09/15/2020	Added folder location for make select
Ver 1.6	12/04/2020	Update supported ubuntu image (16.04 64bit or later)