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NRC7292 Standalone SDK Release Note (v1.7)

Ultra-low power & Long-range Wi-Fi

Feb. 7, 2025

NEWRACOM, Inc.

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Ultra-low power & Long-range Wi-Fi

Office
Newracom, Inc.
505 Technology Drive, Irvine, CA 92618 USA
http://www.newracom.com

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1 Overview

The IEEE 802.11ah is a new Wi-Fi standard created to fulfill the requirements of a variety of IoT applications. Newracom's NRC7292 chip provides two modes of operation: host mode and standalone mode. Host mode necessitates an external host device, like the Raspberry Pi3 included in Newracom's EVK, to supply 11ah Wi-Fi connectivity. On the other hand, standalone mode enables users to develop their own applications using the APIs provided in the standalone package, compile binaries with the SDK, and execute them on the NRC7292. In standalone mode, users can use the NRC7292's various peripheral interfaces to collect sensor data and transmit it to the server over the 11ah network. Furthermore, the NRC7292 offers an AT commands application in standalone mode, allowing users to utilize the 11ah Wi-Fi network.

This document outlines the NRC7292 software package for standalone mode.

2 Contents of software release package

The software release package encompasses all the necessary components for utilizing the most recent features, including firmware libraries, header files, APIs, sample codes, downloader tool, makefile, and documentation. Figure 2.1 illustrates the directory structure of the package, while Table 2.1 presents a summary of its contents.

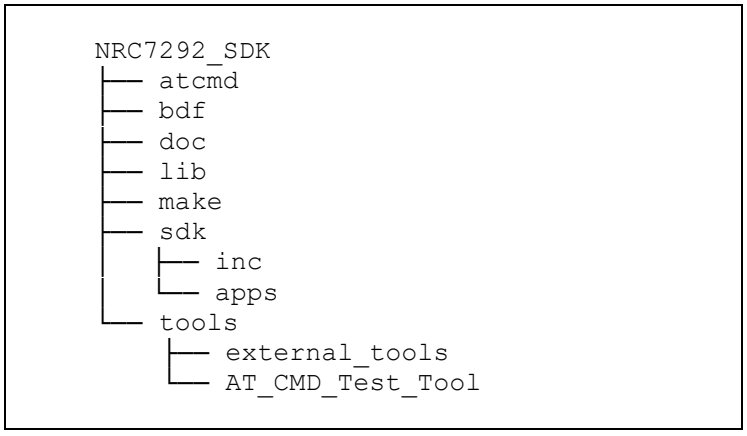

Figure 2.1 NRC7292 standalone SDK package directory

Table 2.1 Contents of NRC7292 standalone SDK package

Directory	Description
doc	Documents for standalone guide document and SDK API lists
lib	NRC7292 modem library and 3rd party libraries.
make	makefiles and configuration files
sdk/inc	SDK API header files and SDK common header files.
sdk/apps	Several kinds of reference sample applications.
atcmd	ATCMD binaries and reference codes for the host platform
bdf	A Board Data File (BDF) contains power tables based on a country, channel, target hardware version, MCS (Modulation Coding Scheme).
tools/AT_CMD_Test_Tool	AT command test tool for UART interface
tools/external_tools	The FirmwareFlashTool is a firmware uploader.

The information of the library released in this package is as follows.

- Library (including 3rd party)
  - Name : libModem.a (md5sum: 9f3089402e4ecd82a5da7dc841cbd897)
  - Location : lib/modem
  - Version : 1.7
  - Build date : Feb. 7, 2024

3 Standalone SDK Package

3.1 General guide

To gain a broad understanding of the software package, developers can refer to the 'UG-7292-004-Standalone SDK.pdf' document. This resource offers instructions on configuring the software build environment, compiling standalone binaries, and downloading binary and sample applications. Furthermore, developers can utilize the 'UG-7292-005-Standalone SDK API.docx' document, which provides a list of supported APIs that can be used in conjunction with the NRC7292. These APIs enable users to implement services connected to Wi-Fi connections and peripherals. For additional assistance, the 'UG-7292-006-AT_Command.pdf' document offers a guide to AT commands.

3.2 Supported 3rd party libraries

The standalone SDK package for the NRC7292 contains numerous third-party libraries, which are detailed in the 'UG-7292-005-Standalone SDK API.docx' document along with their corresponding URLs. FreeRTOS, LwIP, and Mbed TLS are among these libraries, and they are essential for the standalone SDK to function properly.

- **FreeRTOS**
- **LwIP**
- **Mbed TLS**
- **MQTT**
- **cJSON**
- **Mini-XML**
- **AWS (Amazon web service)**
- **NVS (Non-volatile storage)**
- **Device libraries**
    - **BME680 (Gas, humidity, pressure, and temperature sensor)**
    - **SSD1306 (OLED/PLED controller)**
    - **SGP30 (Air quality sensor)**
    - **SHT30 (Temperature and humidity sensor)**

4 SW Release Package

4.1 Features

The NRC7292 software release package contains the following features.

- **Build Environment**
  - Update Linux based build environment (v1.3.0)
- **AT-CMD**
  - FOTA command (v1.3.2)
  - Power save (v1.3.4)
  - WPA3-SAE/OWE (v1.3.4)
    - WPA3-SAE H2E support (STA only) (v1.7)
  - Passive receiving mode (v1.4)
  - Broadcast FOTA (v1.5)
  - Background scan for roaming (v1.7)
  - Wi-Fi Protected Setup (WPS) (v1.7)
- **Firmware Refactoring with following updates (v1.4)**
  - SDK API updates
  - AT-CMD updates

	Command	Event
Remove	AT+WROAM AT+SRXLOGLEVEL	+WEVENT:”CONNECT_FAIL”
Update	AT+WTXPOWER AT+WCONN AT+WDHCP AT+WTIMEOUT AT+SOPEN AT+SSEND	

Add	AT+WDNS AT+SRECV AT+SRECVMODE AT+SRECVINFO AT+SADDRINFO AT+STCPNODELAY	+WEVENT:"DHCP_START" +WEVENT:"DHCP_STOP" +WEVENT:"DHCP_BUSY" +WEVENT:"DHCP_FAIL" +WEVENT:"DHCP_SUCCESS" +WEVENT:"DHCP_TIMEOUT" +WEVENT:"STA_CONNECT" +WEVENT:"STA_DISCONNECT" +SEVENT:"RECV_READY"

  - Duty cycle support
  - Power save enhancement: deep sleep optimization
  - Remove modem sleep support
  - Support for multiple regulatory domains with a single firmware
  - Regulatory domain updates: KR MIC, JP
  - ARM GNU toolchain upgrade to version 10.3-2021.10
  - Sample application updates
- ~~RSSI based rate adaptation (v1.6) (obsolete)~~
- Enhanced rate adaptation (v1.6.1)

4.2 Resolved issues

The table is the resolve issues since v1.3.1.

Table 4.1 Resolved issues

Version	Description
v1.3.1	**Sending block in softap tcp server** Sending block during multiple tcp receiving and sending operations in non-blocking socket
	Fix AT+ATZ operation
	Fix the system assert when the unsupported channel is assigned in softap
v1.3.2	**Fix ToS(IP Header) to TID/AC mapping issue**
	Fixed to reflect beacon rssi value in scan results
	Fixed Background scan issue in standalone STA

	Fix an issue where UART settings are not changed with the AT+UART set command.
	Improvement downlink throughput in 4MHz
	Fix Association Timeout Issue : Set Fragment Number to be 0
v1.3.4	**Improvement reconnection time after deep sleep**
	Fix a hang issue during modem sleep
	Fix abnormal addba/delba operation for AMPDU
	Fix an issue that the scan is repeated without reassociation
	Fix an issue that DHCP client is blocked
v1.3.4 rev01	**Fix wakeup issues in modem sleep**
	Fix scan results flags for WPA3 in atcmd
v1.3.4 rev02	**Fix iperf bug in raspi-atcmd-clli (v1.2.2)**
	Fix channel setting issue. Add new country code for ATCMD
v1.3.4 rev03	**N/A**
v1.3.4 rev04	**Added US full channels (45 Channels) for 11AH : 'a' channels and some 'g' channels**
	Added return value when buffer allocation is failed
	Fixed ATCMD FOTA download issue
	Fixed ATCMD ROAMING connection issue
	Fixed Roaming and Scan issues
	Fixed NDP Probe Request after deep sleep
	Added to set BI/SBI during connection on STA
	Fixed not enter modem sleep
v1.3.4 rev05	**Fixed DHCP server's MTU size for fixing unintended MPDU size after association**
	Fixed scan operation with channel lists
v1.3.4 rev06	**Exception handling of IP length mismatch**
v1.3.4	**N/A**

rev07	
v1.3.4 rev08	**Fix TX power setting for response control frame**
v1.3.4 rev09	**Improve the spurious emission performance in JP channels**
v1.4	**Firmware refactoring**
v1.5	**Bug fix for following issues** (1) Duplicated memory free bug when disabling and enabling the network (2) UART2 flow control GPIO setting bugs (3) DHCP server to assign the same IP for the same station
	(4) CSA failure on the same center frequency channels (5) Beacon loss check for switching to new channel using the same 1MHz primary channel (6) Remove redundant TIM checking (7) Wrong 1MHz primary channel location and primary channel number (8) Fail to receive BU from AP after waking up from deep sleep (9) Heap leakage in updating beacon (10) Multicast frame's sequence number is non sequencial when the duty cycle is on (11) AP sends legacy CTS even when receiving RTS with response indication option of 1 (NDP-Response)
v1.5.1	**Bug fix for following issues** (1) Incorrect peer MAC address copy at 4-address enabled W5500 device (2) Memory leakage under frequent connection/disconnection (3) Invalid secondary CCA on JP 2/4MHz channels (4) EU country code configuration failure
v1.5.2	**Hotfix** (1) Fix the recovery of the listen interval setting upon waking from deep sleep (2) Remove echo check code from lwip
v1.6	**Bug fix for following issues** (1) AT-CMD lwIP keepalive issue: TCP client socket would close when TCP keep-alive was enabled (2) Power Save issue : Inaccurate Dynamic PS timer for Power Save (3) Power Save issue : PS STA cannot wake up from deep sleep

	(4) SoftAP NDP CTS issue : data transmission failure when NDP CTS is enabled on SoftAP (5) Connection Issue : (STA) Aperiodic failure to connect NRC 4M BW AP (version 1.2.x ~ 1.3.x) (6) Reset Issue : (STA) Aperiodic WDT (Watchdong Timer) reset and recovery while transmitting frames
v1.6.1	**Hotfix for slow rate adaptation in specific RF environments** (1) Enhanced RSSI-based rate adaptation
v1.6.2	**Hotfix for corner cases related to 1MHz primary channel location**
v1.7	**Bug fix for following issues** (1) Modify the short guard interval to apply only in 4M bandwidth and high modulation states (always) (2) Issue where EAPOL fails during WPA2/WPA3 implementation, resulting in failure to generate PTK/GTK (non-periodic) (3) Memory leak issue occurring during repeated connect/disconnect actions (non-periodic) (4) CCA threshold being set to -60 upon waking up from deep sleep (always) (5) Failure of downlink (AP->STA) block acknowledgment session (for aggregation) (always) (6) Intermittent dropping of management frames by the AP for duplicated sequence number (non-periodic) (7) Inaccurate scan results after scan completion (non-periodic) (8) System freezing during scanning (non-periodic) (9) Issues with interoperability with third-party APs at specific bandwidths and channels (always) (10) Memory leak during the scan operation (11) Wrong S1G channel index in KR 2MBW in 'show config' (12) Wrong listen interval value when it's assigned as big value (13) SoftAP restart failure issue (14) Failed wake-up from deep sleep in non-TIM mode (non-periodic)

4.3 Changed items

The table is the changed items since v1.3.1.

Table 4.2 Changed items

Version	Description
v1.3.1	**Support KR MIC band (925.5-930.5) in host_kr_mic package** standalone_kr_mic package supports 925.5 – 930.5 Mhz for KR.
	Enhancement ATCMD with uart Increase the supported max baudrate (115200) using DMA
	Added i2c sensor read operation in sample_ps_tcp_client
	Added Non-tim mode deep sleep in sample_ps_standalone & sample_ps_tcp_client Assign interval for deep sleep duration
	Change temperature compensation value Temperature power offset is now linearly interpolated, etc.
v1.3.2	**RX gain table, RSSI offset, LNA Swithcing point, 2Mhz mode threshold value**
	Restructuring sf_sys_config_t data structure in FLASH
	Rename for add_network function and added remove_network in wifi api
	Added 'AT+WFOTA' and 'AT+WROAM'
v1.3.4	**Support APIs for WPA3 SAE/OWE**
	Added WPS-PBC in sample_wps_pbc
	Enhancement of stability with WDT Reset
	Support BSS Max Idle
	Support CSA (Channel Switch Announcement)
	Add new events for FOTA operation
	Add AT+WSTAINFO, AT+WSLEEP and removed AT+SLEEP, AT+WMCS
v1.3.4 rev01	**Add ATCMD sources in a package**
	Disable the default CONFIG_WPS feature in FreeRTOS.config
v1.3.4 rev02	**Add build configuration info in ATCMD logs**

v1.3.4 rev03	**Change ATCMD task priority from 0 to 2**
v1.3.4 rev04	**Update FOTA operation using json file**
	Enable NDP Probe Request by default
	Update Wi-Fi events (v1.22.4)
	Added time & wakeup api
	Added NVS to start default if CONFIG_NVS_FLASH is defined
	Sample for Power save (Non-Tim mode)
	Added API for Carrier sensing(CS) time and Pause time
	Update console print function to enable/disable print from user app
v1.3.4 rev05	**Added APIs (ATCMD & SDK API)** **: duty cycle, CCA threshold, set mcs, bss max idle**
v1.3.4 rev06	**Updated APIs and related samples** **: spi, uart, i2c**
	Added standalone board data
	Added set/get scan frequency list
	Updated an ATCMD host application
v1.3.4 rev07	**Update reverse_scrambler configuration to interoperate with HaLow certified device** To be interoperable with nrc7292_sw_pkg v1.3.4 rev04
v1.3.4 rev08	**Update AU/NZ channels according to IEEE 802.11-2020**
	Update JP channels
v1.3.4 rev09	**Enable the 1MHz TX filter for JP channel**
	Enable traveling pilot
v1.4	**Firmware refactoring**
v1.5	**Update ATCMD** (1) Update raspi-atcmd-cli (2) Update AT commands: refer to UG-7292-006-AT_Command document
	Update SDK

	(1) Update connection event notification (2) Support to register multiple event handler (3) Update and modified sample applications (4) Add netmask, gateway parameter for softap IP setting (5) Update sample applications (6) Increase max number of scan results (7) Set 1M Primary location according to AP's S1G operation IE (8) Update SDK APIs: refer to UG-7292-005-Standalone SDK API document
	Update 3rd party libraries (1) Update http_server
	Power save operation enhancement (1) Enhancement PM1 QoS Null frame transmission process (2) Update TIM mode sleep (3) Update GPIO configuration for deep sleep mode
	Regulation related updates (1) Update board data for K0/K1/K2 channels (2) K0/K1/K2 channel table (3) Refactoring of LBT
v1.5.1	**Update SDK** (1) Add API for setting max station number in SoftAP (2) Hidden SSID support in SoftAP (3) Duty cycle 2.8% support only for EU STA (4) Update KR domain: remove K0 channels (5) Update SDK APIs: refer to UG-7292-005-Standalone SDK API document (6) Enhanced RSSI accuracy of system_api_get_rssi() (7) SoftAP's association grant only if listen interval is less than BSS max idle period (8) SoftAP's disable/enable sequence support (9) Extend condition check coverage for broadcast FOTA: chip id, FW version, app version **Update AT-CMD** (1) Add AT+WMAXSTA command (2) Add AT+WCTX command for continuous TX
v1.5.2	**N/A**

v1.6	**Update SDK APIs** (1) Update SDK APIs: refer to UG-7292-005-Standalone SDK API document **Update AT-CMD** (1) Update AT commands: refer to UG-7292-006-AT_Command document **Update samples** (1) sample_aws_switch: Control GPIO for on/off functionality (2) sample_sntp: Retrieve NTP (Network Time Protocol) data (3) sample_user_factory: Read data from the user factory area in the serial flash (4) sample_w5500_eth: Change the default address mode to 3 address **Update iperf: enable support for LWIP_IPERF while disabling LWIP_PING when using the modem library** **Set the default listen interval to 0 for wifi_config** **1/2MHz STA support at 4MHz SoftAP** **Add auto guard interval control** **Add auto RX gain control** **Add serial flash support: FM25W32A** **Update to filter RX data that was sent from local** (1) Filter the packet forwarded back from AP to Station that sent packet **Update NRCTools binaries**
v1.6.1	**Update raspi-atcmd-cli tool** **Update AT-CMD** (1) Set country code from RF CAL data (2) Enable UDP broadcasting
v1.6.2	**N/A**
v1.7	**Update SDK APIs** (1) Update SDK APIs: refer to UG-7292-005-Standalone SDK API document **Update AT-CMD** (1) Update AT commands: refer to UG-7292-006-AT_Command document **Update samples** (1) Update samples: refer to UG-7292-004-Standalone SDK document **Appl the additional duty cycle condition which is defined in ARIB Standard, chapter 3.4.1** **SoftAP can support a bridged STA which uses 4-address**

	Support frame defrgamentation **Optimizing the wake-up time after deep sleep** **Update FirmwareFlashTool v6.4.0** **Enhanced TIM mode to support operation without RTC wakeup source**

4.4 Known issues

Table 4.3 presents all know issues.

Table 4.3 Known issues

Category	Description
Security	The initial connection time for WPA3-SAE/OWE can be quite lengthy (> 15 seconds) due to the substantial computational load required by software for large number operations.