ESP8266 Non-OS SDK
API Reference

Version 2.1.2

About This Guide

This document lists ESP8266_NONOS_SDK APIs. The document is structured as follows.

Chapter	Title	Subject
Chapter 1	Preambles	An introduction to the ESP8266EX
Chapter 2	Overview	An overview of the ESP8266_NONOS_SDK
Chapter 3	System APIs	Important system APIs for timer control, SPI flash operations, Wi-Fi radio control and OTA firmware upgrade
Chapter 4	TCP/UDP APIs	APIs for TCP/UDP operation
Chapter 5	Mesh APIs	Mesh APIs for the ESP8266
Chapter 6	Application-Related APIs	Application specific APIs (AT command set and JSON parser)
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Chapter 9	Appendix	Other relevant information

Release Notes

Date	Version	Release notes
2016.01	V1.5.2	First Release.
2016.03	V1.5.2	Updated Section 3.2, 9.5 and 3.3.37.
2016.04	V1.5.3	Added Section 3.5.11 and 3.5.12. Updated Section 3.5.67 and 3.7.9.
2016.06	V1.5.4	Added Section 3.3.8 and 3.7.8. Added Section 3.3.46, 3.3.47, and 3.3.48. Updated Section 3.7.
2016.07	V2.0.0	Added Section 3.9, 3.14, 3.3.48, 3.5.72. and 3.5.73. Updated Section 3.8.6 and 3.5.65.
2016.11	V2.0.1	Changed prototype `wifi_station_get_hostname` to `wifi_station_set_hostname` in Section 3.5.30.
2017.01	V2.0.2	Updated Chapter 2.
2017.05	V2.1.0	Added Section 3.3.49, 3.3.50, 4.3.6 and 8.2.4.
2017.05	V2.1.1	Updated Chapter 2.
2017.06	V2.1.2	Updated Section 3.3.9.

Documentation Change Notification

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1. Preambles

ESP8266 Wi-Fi SoC offers a complete and self-contained Wi-Fi networking solution; it can be used to host applications or to offload Wi-Fi networking functions from another application processor. When the ESP8266 hosts application, it boots up directly from an external flash. It has an integrated cache to improve the performance of system's running applications. Alternately, serving as a Wi-Fi adapter, wireless internet access can be added into any microcontroller-based design with simple connectivity through UART interface or the CPU AHB bridge interface.

ESP8266EX is amongst the most integrated Wi-Fi chips in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, and power management modules. Thus, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor, with on-chip SRAM, on top of its Wi-Fi functionalities. It is integrated with external sensors and other application specific devices through its GPIOs. Codes for such applications are provided as examples in the SDK.

Sophisticated system-level features include fast sleep/wake switching for energy-efficient VoIP, adaptive radio biasing for low-power operations, advanced signal processing, spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

The SDK based on ESP8266 IoT platform offers the users an easy, fast and efficient way to develop IoT devices. This programming guide provides overview of the SDK as well as detailed description of the APIs. It is written to help embedded software developers program on ESP8266 IoT platform.

2. Non-OS SDK

2.1. Non-OS SDK Introduction

The non-OS SDK provides a set of application programming interfaces (APIs) for core ESP8266 functionalities such as data reception/transmission over Wi-Fi, TCP/IP stack functions, hardware interface functions and basic system management functions. Thus, the SDK APIs allow programmers to focus on the application under development at a higher level. Users can access all core capabilities of ESP8266 without studying its chip architecture in detail.

All networking functions on the ESP8266 IoT platform are realized in the library, and are available to users in the form of well-defined APIs. Users can initialize the system hardware and network interface in ***user_main.c*** when ESP8266 boots up.

`void user_init (void)` is the default method provided. Users can add functions like firmware initialization, network parameters setting, and timer initialization within `user_init`.

`void user_rf_pre_init (void)` and `uint32 user_rf_cal_sector_set(void)` need to be added to ***user_main.c*** from ***ESP8266_NONOS_SDK_V1.5.2*** onwards. For an example of how to set the RF calibration sector, please refer to ***ESP8266_NONOS_SDK/examples/IOT_Demo/user/user_main.c***. Users can call `system_phy_set_rfoption` to set the RF option in `user_rf_pre_init`, or call `system_deep_sleep_set_option` before Deep-sleep. If RF is disabled, ESP8266 Station and SoftAP will both be disabled, so the related APIs must not be called. Wi-Fi radio functions and network stack management APIs are not available when the radio is disabled.

From ***ESP8266_NONOS_SDK_V2.1.0*** onwards, when the DIO-to-QIO flash is not used, users can add an empty function `void user_spi_flash_dio_to_qio_pre_init(void)` on the application side to reduce iRAM usage.

APIs for JSON packet construction and parsing are included in the SDK. Users themselves can define the format of data packets.

2.2. Code Structure

The non-OS SDK is meant to be used for applications where users require complete control over the execution sequence of code. Due to a lack of operating system, the non-OS SDK does not schedule tasks or preempt the user functions.

The non-OS SDK is most suitable for use in event-driven applications. As there is no RTOS overhead, the non-OS SDK does not impose stack size restrictions or execution time slots on any user functions.

The RTOS SDK is an alternative to non-OS SDK, and may be used where task-based, modular programming is desirable. To read more about the RTOS SDK, please refer to the *ESP8266 SDK Getting Started Guide*.

The code structure in non-OS SDK may be described as follows:

- The non-OS SDK does not implement user task scheduling like RTOS based systems do. The non-OS SDK uses four types of functions:

  - Application functions
  - Callback functions
  - Interrupt service routines (ISRs)
  - User tasks

  Application functions refer to the usual type of C functions used in embedded C programming. These functions must be called by another function. Application functions may be attributed with `ICACHE_FLASH_ATTR` to fetch and execute programs from the flash. `IRAM_ATTR`-attributed functions are stored in the iRAM prior to execution.

  Callback functions refer to functions that are not called directly from the user program. Callback functions are executed by the non-OS SDK core when a system event occurs. This enables the programmer to respond to real-time events without using RTOS or polling for events.

  To program a callback function, users first need to register the callback function using the corresponding `register_cb` API. Examples of callback functions include timer callback functions and network event callback functions.

  Interrupt Service Routines (ISRs) are simply callback functions of a special type. These functions are called when a hardware interrupt occurs. When an interrupt is enabled, a corresponding interrupt handler functions must be registered. Note that ISRs must be attributed as `IRAM_ATTR`.

  User tasks can be classified according to three priority levels: 0, 1, 2. Priority level has the following order: 2>1>0. Non-OS SDK can only support up to three tasks at a time. One priority level for one task.

  User tasks are normally used when a function cannot be called directly. To create a user task, please refer to the API description of `system_os_task()` in this document. For example, `espconn_disconnect()` API may not be called from within an `espconn` callback, therefore a user task must be created within the `espconn` callback to execute `espconn_disconnect`.

- As stated earlier, the non-OS SDK does not preempt tasks or switch context. Users are responsible for the proper execution of code and the user code must not occupy the CPU on a particular function for too long. This may cause a watchdog reset and prompt ESP8266 to reboot.

  If for some reason the user application must execute a task for too long (say, longer than 500 ms), it is recommended that the `system_soft_wdt_feed()` API be called often to reset the WDT. Disabling the softWDT is not recommended.

- For proper system operation, it is highly recommended that the ***esp_init_data.bin*** and ***blank.bin*** files be flashed to the correct location in memory at least once. The RF calibration sector must be set correctly in the application `user_rf_cal_sector_set`.

2.3. Timer and Interrupt

- For polling purposes, it is highly recommended that system timer task be used check for an event periodically.
  - Using a loop is inefficient and blocks the CPU.
  - Users need to call function `os_delay_us` or `while`, or `for` in timer callback. Please do not occupy CPU for more than 15 ms.
- Timer APIs may not be used to generate a callback more frequently than every 5 ms (100 μs for microsecond timer). Please refer to descriptions of `os_timer_arm()` and related APIs for detailed information on timer usage.
- The microsecond timer is not very precise. Even though timer callbacks are assigned a higher priority over user functions, there might be a 500 μs jitter in callbacks. For high accuracy timing purposes, please use the hardware timer by referring to the driver program (***driver_lib***). Note that PWM APIs may not be used when the hardware timer is in use.
- Do not disable interrupts for too long. ISRs should occupy very little time as well (in microseconds only).

2.4. System Performance

- ESP8266 is typically run at 80 MHz. The CPU may be configured to run at 160 MHz in high performance applications. Note that the peripherals are not affected by the CPU frequency setting because they are run off a different clock source from that of the CPU.
- Higher clock frequency and disabled sleep modes cause greater power consumption in return for better performance. The user application should prioritize between the two.
- Code attributed with `ICACHE_FLASH_ATTR` is generally executed slower than the code marked with `IRAM_ATTR`. However, like most embedded platforms, iRAM is limited on ESP8266 and thus must be used sparingly for high performance code.
- The flash mode and frequency directly influence the code execution speed. Setting the flash to a higher frequency and QIO mode may produce the best results in terms of performance, though it costs in terms of power consumption.

2.5. System Memory

- ESP8266 supports a primary standard external QSPI flash memory of up to 128 Mbits for code and data storage. There may be secondary memory chips for user data storage as well.
- There is no internal non-volatile storage within ESP8266 for storing user code or data. The ESP8285 chip is an ESP8266 variant with integrated flash memory. Please refer to the ESP8285 Datasheet for more details.
- ESP8266 features 160 Kbytes of RAM, of which iRAM is 64 KB and dRAM is 96KB (dRAM: 80 KB for SDK+HEAP, 16 KB for ROM). The iRAM is further segmented into two

blocks. A 32 KB iRAM block stores code marked with `IRAM_ATTR` and the other 32 KB block is used to cache code from flash, i.e. code marked with `ICACHE_FLASH_ATTR`.

- RAM and flash access has to be word-aligned (4 byte boundary aligned access only). Casting pointers directly is not recommended. Please use `os_memcpy`, or other APIs for memory operations.

3. Application Programming Interface (APIs)

3.1. Software Timer

Timer APIs can be found in ***/ESP8266_NONOS_SDK/include/osapi.h***.

Please note that `os_timer` APIs listed below are software timers executed in tasks, thus timer callbacks may not be precisely executed at the right time; it depends on priority. If you need a precise timer, please use a hardware timer which can be executed in hardware interrupt. For details please refer to ***hw_timer.c***.

- For the same timer, `os_timer_arm` (or `os_timer_arm_us`) cannot be invoked repeatedly. `os_timer_disarm` should be invoked first.
- `os_timer_setfn` can only be invoked when the timer is not enabled, i.e., after `os_timer_disarm` or before `os_timer_arm` (or `os_timer_arm_us`).

3.1.1. os_timer_arm

Function	Enable a millisecond timer.

Prototype	`void os_timer_arm (`
	`    os_timer_t *ptimer,`
	`    uint32_t milliseconds,`
	`    bool repeat_flag`
	`)`

Parameter	`os_timer_t *ptimer`: timer structure. `uint32_t milliseconds`: timing; unit: millisecond. If `system_timer_reinit` has been called, the timer value allowed ranges from 100 to 0x689D0. If `system_timer_reinit` has NOT been called, the timer value allowed ranges from 5 to 0x68D7A3. `bool repeat_flag`: whether the timer will be invoked repeatedly or not.
Return	none

3.1.2. os_timer_disarm

Function	Disarm the timer.
Prototype	`void os_timer_disarm (os_timer_t *ptimer)`
Parameter	`os_timer_t *ptimer`: timer structure.
Return	none

3.1.3. os_timer_setfn

Function	Set timer callback function. The timer callback function must be set before arming a timer.

Prototype	`void os_timer_setfn(`
	`    os_timer_t *ptimer,`
	`    os_timer_func_t *pfunction,`
	`    void *parg`
	`)`

Parameter	`os_timer_t *ptimer`: timer structure. `os_timer_func_t *pfunction`: timer callback function; use typecasting to pass function as your function. `void *parg`: callback function parameter.
Return	none

3.1.4. system_timer_reinit

Function	Reinitiate the timer when you need to use microsecond timer.
Prototype	`void system_timer_reinit (void)`
Parameter	none
Return	none
Note	1. Define `USE_US_TIMER`; 2. Put `system_timer_reinit` at the beginning of `user_init`, in the first sentence.

3.1.5. os_timer_arm_us

Function	Enable a microsecond timer.

Prototype	`void os_timer_arm_us (`
	`    os_timer_t *ptimer,`
	`    uint32_t microseconds,`
	`    bool repeat_flag`
	`)`

Parameter	`os_timer_t *ptimer`: timer structure. `uint32_t microseconds`: timing; unit: microsecond, the minimum value is 0x64, the maximum value allowed to input is 0xFFFFFFF. `bool repeat_flag`: whether the timer will be invoked repeatedly or not.
Return	none
Note	1. Define `USE_US_TIMER`, and put `system_timer_reinit` at the beginning of `user_init`, in the first sentence. 2. The highest precision is 500 μs.

3.2. Hardware Timer

Hardware timer APIs can be found in ***/ESP8266_NONOS_SDK/examples/driver_lib/hw_timer.c***. Users can use it according to ***driver_lib/readme.txt***.

> 📖 ***Notes:***
>
> - *If NM is used as the ISR source for auto-loading the timer, parameter* `val` *of* `hw_timer_arm` *can not be less than 100.*
> - *When NMI source is used, the timer has the highest priority. It can interrupt other ISRs. FRC1 source should be used to prevent the timer from interrupting other ISRs.*
> - *APIs in **hw_timer.c** can not be called when PWM APIs are in use, because they all use the same hardware timer.*
> - *The hardware timer callback function must NOT be defined with* `ICACHE_FLASH_ATTR`*.*
> - *The system must not be allowed to enter Light-sleep mode (*`wifi_set_sleep_type(LIGHT_SLEEP)`*) when hardware timer is enabled. Light-sleep stops the CPU and it can not be interrupted by NMI.*

3.2.1. hw_timer_init

Function	Initialize the hardware ISR timer.

Prototype	`void hw_timer_init (`
	`    FRC1_TIMER_SOURCE_TYPE source_type,`
	`    u8 req`
	`)`

Parameter	`FRC1_TIMER_SOURCE_TYPE source_type`: ISR source of timer. `FRC1_SOURCE`: timer uses FRC1 ISR as ISR source. `NMI_SOURCE`: timer uses NMI ISR as ISR source. `u8 req`: 0: autoload disabled; 1: autoload enabled.
Return	none

3.2.2. hw_timer_arm

Function	Set a trigger timer delay to enable this timer.
Prototype	`void hw_timer_arm (uint32 val)`
Parameter	`uint32 val`: timing • In autoload mode: - For FRC1_SOURCE, range: 50 ~ 0x199999 μs; - For NMI_SOURCE, range: 100 ~ 0x199999 μs. • In non autoload mode, range: 10 ~ 0x199999 μs.
Return	none

3.2.3. hw_timer_set_func

Function	Set timer callback function. The timer callback function must be set before arming a timer.
Prototype	`void hw_timer_set_func (void (* user_hw_timer_cb_set)(void) )`
Parameters	`void (* user_hw_timer_cb_set)(void)`: timer callback function, must NOT be defined as `ICACHE_FLASH_ATTR`.
Return	none
Notes	`ICACHE_FLASH_ATTR` is not allowed to be added before the timer callback.

3.2.4. Hardware Timer Example

```
#define REG_READ(_r)     (*(volatile uint32 *)(_r))
#define WDEV_NOW()    REG_READ(0x3ff20c00)
uint32 tick_now2 = 0;
void hw_test_timer_cb(void)
{
    static uint16 j = 0;
    j++;

    if( (WDEV_NOW() - tick_now2) >= 1000000 )
    {
        static u32 idx = 1;
        tick_now2 = WDEV_NOW();
        os_printf("b%u:%d\n",idx++,j);
        j = 0;
    }
}

void ICACHE_FLASH_ATTR user_init(void)
{
        hw_timer_init(FRC1_SOURCE,1);
        hw_timer_set_func(hw_test_timer_cb);
        hw_timer_arm(100);
}
```

3.3. System APIs

System APIs can be found in ***/ESP8266_NONOS_SDK/include/user_interface.h.***

os_XXX APIs can be found in ***/ESP8266_NONOS_SDK/include/osapi.h.***

3.3.1. system_get_sdk_version

Function	Get SDK version.
Prototype	`const char* system_get_sdk_version(void)`
Parameter	none
Return	SDK version
Example	`os_printf("SDK version: %s \n", system_get_sdk_version());`

3.3.2. system_restore

Function	Reset default settings of following APIs: `wifi_station_set_auto_connect`, `wifi_set_phy_mode`, `wifi_softap_set_config` related, `wifi_station_set_config` related, `wifi_set_opmode`, and APs' information recorded by `#define AP_CACHE`.
Prototype	`void system_restore(void)`
Parameter	none
Return	none
Note	Call `system_restart` to restart after reset by `system_restore`.

3.3.3. system_restart

Function	Restart.
Prototype	`void system_restart(void)`
Parameter	none
Return	none
Note	The ESP8266 will not restart immediately. Please do not call other functions after calling this API.

3.3.4. system_init_done_cb

Function	Call this API in `user_init` to register a system-init-done callback.
Prototype	`void system_init_done_cb(init_done_cb_t cb)`
Parameter	`init_done_cb_t cb`: system_init_done callback.
Return	none

Example	`void to_scan(void)  { wifi_station_scan(NULL,scan_done); }`
	`void user_init(void)  {`
	`    wifi_set_opmode(STATION_MODE);`
	`    system_init_done_cb(to_scan);`
	`}`

3.3.5. system_get_chip_id

Function	Get chip ID.
Prototype	`uint32 system_get_chip_id (void)`
Parameter	none
Return	Chip ID.

3.3.6. system_get_vdd33

Function	Measure the power voltage of VDD3P3 pin 3 and 4; unit: 1/1024 V.
Prototype	`uint16 system_get_vdd33(void)`
Parameter	none
Return	Power voltage of VDD33; unit: 1/1024 V.
Note	• `system_get_vdd33` can only be called when TOUT pin is suspended. • The 107th byte in ***esp_init_data_default.bin*** (0 ~ 127 bytes) is named as `vdd33_const`. When TOUT pin is suspended, `vdd33_const` must be set as 0xFF, which is 255. • The return value of `system_get_vdd33` may be different in different Wi-Fi modes, for example, in Modem-sleep mode or in normal Wi-Fi working mode.

3.3.7. system_adc_read

Function	Measure the input voltage of TOUT pin 6; unit: 1/1024 V.
Prototype	`uint16 system_adc_read(void)`
Parameter	none
Return	Input voltage of TOUT pin 6; unit:1/1024 V.

Note	• `system_adc_read` is only available when TOUT pin is wired to external circuitry. Input Voltage Range restricted to 0 ~ 1.0V. • The 107th byte in ***esp_init_data_default.bin*** (0 ~ 127 bytes) is named as `vdd33_const`, and when TOUT pin is wired to external circuitry, the `vdd33_const` must be set as real power voltage of VDD3P3 pin 3 and 4, and has to be less than 0xFF. • The range of operating voltage of ESP8266 is 1.8V ~ 3.6V, the unit of `vdd33_const` is 0.1V, so effective value range of `vdd33_const` is [18, 36]. If `vdd33_const` is an ineffective value in the range of (0, 18) or (36, 255), ESP8266 RF calibration will be 3.3V by default. • The return value of `system_adc_read` may be different in different Wi-Fi modes, for example, in Modem-sleep mode or in normal Wi-Fi working mode. • If high precision is needed, please use `system_adc_read_fast` instead.

3.3.8. system_adc_read_fast

Function	Fast and high-precision sampling of ADC.
Prototype	`void system_adc_read_fast (uint16 *adc_addr, uint16 adc_num, uint8 adc_clk_div)`
Parameter	`uint16 *adc_addr`: point to the address of ADC continuously fast sampling output. `uint16 adc_num`: sampling number of ADC continuously fast sampling; range [1, 65535]. `uint8 adc_clk_div`: ADC working clock = 80M/adc_clk_div; range [8, 32], the recommended value is 8.
Return	none

<table>
<tr><td><b>Example</b></td><td><pre><code>extern void system_adc_read_fast(uint16 *adc_addr, uint16 adc_num,
uint8 adc_clk_div);
os_timer_t timer;

void ICACHE_FLASH_ATTR ADC_TEST(void *p)
{
        wifi_set_opmode(NULL_MODE);
        ets_intr_lock( );   //close interrupt

        uint16 adc_addr[10];
        uint16 adc_num = 10;
        uint8 adc_clk_div = 8;
        uint32 i;
        system_adc_read_fast(adc_addr, adc_num, adc_clk_div);

        for(i=0; i<adc_num; i++)
                os_printf("i=%d, adc_v=%d\n", i, adc_addr[i]);

        ets_intr_unlock();   //open interrupt

        os_timer_disarm(&timer);
        os_timer_setfn(&timer, ADC_TEST, NULL);
        os_timer_arm(&timer,1000,1);
}</code></pre></td></tr>
<tr><td><b>Note</b></td><td><ul>
<li>To use <code>system_adc_read_fast</code>, Wi-Fi has to be disabled. And if ADC continuously sampling is needed, all interrupts have to be disabled, so PWM or NMI hardware timer can not be used when <code>system_adc_read_fast</code> is calling.</li>
<li><code>system_adc_read_fast</code> is only available when TOUT pin is wired to external circuitry. Input voltage range is restricted to 0 ~ 1.0V.</li>
<li>The [107] byte in <b><i>esp_init_data_default.bin</i></b> (0 ~ 127 bytes) is named as <code>vdd33_const</code>, and when TOUT pin is wired to external circuitry working as an ADC input, the <code>vdd33_const</code> must be less than 0xFF.</li>
<li>Details of the [107] byte <code>vdd33_const</code> are as follows:
<ul>
<li>If the [107] byte = 0XFF, VDD33 is measured internally, TOUT pin cannot work as ADC input.</li>
<li>When the valid value range of the [107] byte <code>vdd33_const</code> is [18, 36], the unit is 0.1V, and the value should be set as the real power voltage of VDD33 to optimize the RF working condition. TOUT pin can work as ADC input.</li>
<li>When the [107] byte <code>vdd33_const</code> is in the range of (0, 18) or (36, 255), the default 3.3V will be used as the power voltage to optimize the RF working condition. TOUT pin can work as ADC input.</li>
</ul></li>
</ul></td></tr>
</table>

3.3.9. system_deep_sleep

Function	Configures chip for Deep-sleep mode. When the device is in Deep-sleep, it automatically wakes up when time out. Upon waking up, the device boots up from `user_init`.
Prototype	`bool system_deep_sleep(uint64 time_in_us)`

Parameter	`uint64 time_in_us`: the duration of time (µs) when the device is in Deep-sleep. The theoretical maximum value of `time_in_us` can be calculated by formula: `(time_in_us / cali) << 12 = 2^31 - 1` • `cali = system_rtc_clock_cali_proc()`, the `cali` is the RTC clock period (in us); bit11 ~ bit0 are decimal. For more details about the `cali`, please see the API: `system_rtc_clock_cali_proc`. • The input value of `time_in_us` should be less than the theoretical maximum value.
Return	true: Success false: Failure
Note	• Hardware has to support deep-sleep wake up (XPD_DCDC connects to EXT_RSTB with a 0-Ω resistor). • `system_deep_sleep(0)`: there is no wakeup timer; in order to wake up, connect a GPIO to pin RST; the chip will wake up by a falling-edge on pin RST. • After configuration, the chip will not enter Deep-sleep mode immediately, but will wait for a while till the Wi-Fi core is closed safely.

3.3.10. system_deep_sleep_set_option

Function	Call this API before `system_deep_sleep` to set whether the chip will do RF calibration or not when it wakes up from deep-sleep again. The option is 1 by default.
Prototype	`bool system_deep_sleep_set_option(uint8 option)`
Parameter	`uint8 option`: 0: RF calibration after deep-sleep wakeup depends on both the times of entering Deep-sleep (`deep_sleep_number`, returns 0 upon each power-up) and byte 108 of ***esp_init_data_default.bin*** (0 ~ 127 bytes). • If `deep_sleep_number` <= byte 108, no RF calibration after Deep-sleep wakeup; this reduces the current consumption. • If `deep_sleep_number` = byte 108 +1, the behavior after Deep-sleep wakeup will be the same as power-up, and `deep_sleep_number` returns to 0. - The behavior after Deep-sleep wakeup will be the same as power-up. - No RF calibration after Deep-sleep wakeup; this reduces the current consumption. - Disable RF after Deep-sleep wakeup, just like Modem-sleep; this has the least current consumption; the device is not able to transmit or receive data after wakeup.
Return	true: Success false: Failure
Note	• Hardware has to support deep-sleep wake up (XPD_DCDC connects to EXT_RSTB with a 0-Ω resistor). • `system_deep_sleep(0)`: there is no wakeup timer; in order to wake up, connect a GPIO to pin RST; the chip will wake up by a falling-edge on pin RST.

3.3.11. system_phy_set_rfoption

Function	Enable RF or not when wakeup from Deep-sleep.
Prototype	`void system_phy_set_rfoption(uint8 option)`
Parameter	`uint8 option`: • 0: RF calibration after deep-sleep wakeup depends on both the times of entering Deep-sleep (`deep_sleep_number`, returns 0 upon each power-up) and byte 108 of ***esp_init_data_default.bin*** (0 ~ 127 bytes). - If `deep_sleep_number` <= byte 108, no RF calibration after wakeup from Deep-sleep; this reduces the current consumption. - If `deep_sleep_number` = byte 108 +1, the behavior after Deep-sleep wakeup will be the same as power-up, and `deep_sleep_number` becomes 0. • The behavior after Deep-sleep wakeup will be the same as power-up. • No RF calibration after Deep-sleep wakeup; this reduces the current consumption. • Disable RF after Deep-sleep wakeup, just like modem sleep; this has the least current consumption; the device is not able to transmit or receive data after wakeup.
Return	none
Note	• This API can only be called in `user_rf_pre_init`. • Function of this API is similar to `system_deep_sleep_set_option`. If called, it will disregard `system_deep_sleep_set_option` which is called before Deep-sleep, and refer to `system_phy_set_rfoption` which is called upon Deep-sleep wakeup. • Before calling this API, `system_deep_sleep_set_option` should be called at least once.

3.3.12. system_phy_set_powerup_option

Function	Set whether the chip will do RF calibration or not when power up. The option is 0 by default.
Prototype	`void system_phy_set_powerup_option(uint8 option)`
Parameter	`uint8 option`: RF initialization upon powerup. • 0: RF initialization when powerup depends on byte 114 of ***esp_init_data_default.bin*** (0 ~ 127 bytes). For more details please see ESP8266 SDK Getting Started Guide. • 1: RF initialization only calibrate VDD33 and Tx power which will take about 18 ms; this reduces the current consumption. • 2: RF initialization only calibrate VDD33 which will take about 2 ms; this has the least current consumption. • 3: RF initialization will do the whole RF calibration which will take about 200 ms; this increases the current consumption.
Return	none

3.3.13. system_phy_set_rfoption

Function	Set maximum value of RF Tx Power; unit : 0.25 dBm.
Prototype	`void system_phy_set_max_tpw(uint8 max_tpw)`
Parameter	`uint8 max_tpw`: maximum value of RF Tx Power, unit: 0.25 dBm, range [0, 82]. It can be set by referring to the 34th byte (`target_power_qdb_0`) of ***esp_init_data_default.bin*** (0 ~ 127 bytes).
Return	none

3.3.14. system_phy_set_tpw_via_vdd33

Function	Adjust RF Tx Power according to VDD33; unit : 1/1024 V.
Prototype	`void system_phy_set_tpw_via_vdd33(uint16 vdd33)`
Parameter	`uint16 vdd33`: VDD33, unit : 1/1024V, range [1900, 3300]
Return	none
Note	When TOUT pin is suspended, VDD33 can be got by `system_get_vdd33`; When TOUT pin is wired to external circuitry, `system_get_vdd33` can not be used.

3.3.15. system_set_os_print

Function	Turn log printing on or off.
Prototype	`void system_set_os_print (uint8 onoff)`
Parameter	`uint8 onoff`
Return	none

Note	onoff = 0: print function off
	onoff = 1: print function on

Default	Print function on.

3.3.16. system_print_meminfo

Function	Print memory information, including data/rodata/bss/heap.
Prototype	`void system_print_meminfo (void)`
Parameter	none
Return	none

3.3.17. system_get_free_heap_size

Function	Get free heap size.
Prototype	`uint32 system_get_free_heap_size(void)`
Parameter	none
Return	`uint32`: available heap size

3.3.18. system_os_task

<table>
<tr><th>Function</th><td>Set up tasks.</td></tr>
<tr><th>Prototype</th><td><pre>bool system_os_task(
    os_task_t   task,
    uint8   prio,
    os_event_t   *queue,
    uint8   qlen
)</pre></td></tr>
<tr><th>Parameters</th><td><code>os_task_t task</code>: task function.
<code>uint8 prio</code>: task priority.
Three priorities are supported: 0/1/2; 0 is the lowest priority. This means only 3 tasks are allowed to be set up.
<code>os_event_t *queue</code>: message queue pointer.
<code>uint8 qlen</code>: message queue depth.</td></tr>
<tr><th>Return</th><td>true:Success
false:Failure</td></tr>
<tr><th>Example</th><td><pre>#define SIG_RX   0
#define TEST_QUEUE_LEN   4
os_event_t *testQueue;
void test_task (os_event_t *e) {
    switch (e->sig) {
        case SIG_RX:
            os_printf(sig_rx %c/n, (char)e->par);
            break;
        default:
            break;
    }
}
void task_init(void) {
    testQueue=(os_event_t
*)os_malloc(sizeof(os_event_t)*TEST_QUEUE_LEN);

system_os_task(test_task,USER_TASK_PRIO_0,testQueue,TEST_QUEUE_LEN);
}</pre></td></tr>
</table>

3.3.19. system_os_post

Function	Send messages to task.

Prototype	`bool system_os_post (`
	`    uint8 prio,`
	`    os_signal_t sig,`
	`    os_param_t par`
	`)`

Parameter	`uint8 prio`: task priority, corresponding to that you set up. `os_signal_t sig`: message type. `os_param_t par`: message parameters.
Return	true:Success false:Failure

Example	`void task_post(void) {`
	`    system_os_post(USER_TASK_PRIO_0, SIG_RX, ‘a’ );`
	`}`

Print	`sig_rx a`

3.3.20. system_get_time

Function	Get system time (μs).
Prototype	`uint32 system_get_time(void)`
Parameter	none
Return	System time in microsecond.

3.3.21. system_get_rtc_time

Function	Get RTC time, as denoted by the number of RTC clock periods.
Prototype	`uint32 system_get_rtc_time(void)`
Parameter	none
Return	RTC time.
Example	If `system_get_rtc_time` returns 10 (which means 10 RTC cycles), and `system_rtc_clock_cali_proc` returns 5.75 (which means 5.75 μs per RTC cycle), the real time is 10 x 5.75 = 57.5 μs.
Note	System time will return to zero because of `system_restart`, but RTC still goes on. If an external hardware reset the chip via EXT_RST or CHIP_EN (such as timed wakeup from Deep-sleep), the RTC timer will be reset. • Reset by pin EXT_RST: RTC memory won’t change; RTC timer starts to zero. • Watchdog reset: RTC memory won’t change; RTC timer won’t change. • `system_restart`: RTC memory won’t change; RTC timer won’t change. • Power-on: RTC memory contains a random value; RTC timer starts from zero. • Reset by pin CHIP_EN: RTC memory contains a random value; RTC timer starts from zero.

3.3.22. system_rtc_clock_cali_proc

Function	Get RTC clock period.
Prototype	`uint32 system_get_rtc_time(void)`
Parameter	none
Return	RTC clock period (in us); bit11 ~ bit0 are decimal.
Example	`os_printf("clk cal : %d \r\n",system_rtc_clock_cali_proc()>>12);`
Note	• RTC clock period has decimal part. • RTC clock period tends to drift with changes in temperature, so RTC timer is not very precise. • See RTC demo in ***Appendix.A***.

3.3.23. system_rtc_mem_write

Function	Writes data to the RTC memory. During Deep-sleep mode, the RTC is still operational and can store user data in the defined user-data area. |<------system data (256 bytes)------->|<-----------------user data (512 bytes)--------------->|

Prototype	`bool system_rtc_mem_write (`
	`    uint32 des_addr,`
	`    void * src_addr,`
	`    uint32 save_size`
	`)`

Parameter	`uint32 des_addr`: destination address (block number) in RTC memory, `des_addr` >=64 `void * src_addr`: data pointer `uint32 save_size`: data length (byte)
Return	true: Success false: Failure
Example	`os_printf("clk cal : %d \r\n",system_rtc_clock_cali_proc()>>12);`
Note	Data read/write accesses to the RTC memory must be word-aligned (4-byte boundary aligned). Parameter `des_addr` means block number (4 bytes per block). For example, to save data at the beginning of user data area, `des_addr` will be 256/4 = 64, and `save_size` will be data length.

3.3.24. system_rtc_mem_read

Function	Read user data from RTC memory. Only user data area should be accessed by the user. |<------system data (256 bytes)------->|<-----------------user data (512 bytes)--------------->|

Prototype	`bool system_rtc_mem_read (`
	`    uint32 src_addr,`
	`    void * des_addr,`
	`    uint32 save_size`
	`)`

Parameter	`uint32 src_addr`: source address (block number) in RTC memory, src_addr >= 64 `void * des_addr`: data pointer `uint32 save_size`: data length; unit: byte
Return	true: Success false: Failure
Note	Data read/write accesses to the RTC memory must be word aligned (4 bytes boundary aligned). Parameter `src_addr` means block number(4 bytes per block). For example, to read data from the beginning of user data area, `src_addr` will be 256/4=64, `save_size` will be data length.

3.3.25. system_uart_swap

Function	UART0 swap. Use MTCK as UART0 Rx, MTDO as UART0 Tx, so ROM log will not output from this new UART0. MTDO (U0RTS) and MTCK (U0CTS) also need to be used as UART0 in hardware.
Prototype	`void system_uart_swap (void)`
Parameter	none
Return	none

3.3.26. system_uart_de_swap

Function	Disable UART0 swap. Use original UART0, not MTCK and MTDO.
Prototype	`void system_uart_de_swap (void)`
Parameter	none
Return	none

3.3.27. system_get_boot_version

Function	Get version info of boot.
Prototype	`uint8 system_get_boot_version (void)`
Parameter	none
Return	Version info of boot.
Note	If boot version >= 3, it is possible to enable enhanced boot mode (for details of which please see `system_restart_enhance`).

3.3.28. system_get_userbin_addr

Function	Get address of the current running user bin (***user1.bin*** or ***user2.bin***).
Prototype	`uint32 system_get_userbin_addr (void)`
Parameter	none
Return	Start address info of the current running user binary.

3.3.29. system_get_boot_mode

Function	Get boot mode.
Prototype	`uint8 system_get_boot_mode (void)`
Parameter	none

Return	`#define SYS_BOOT_ENHANCE_MODE 0`
	`#define SYS_BOOT_NORMAL_MODE  1`

Note	• Enhance boot mode: can load and run FW at any address. • Normal boot mode: can only load and run normal ***user1.bin*** (or ***user2.bin***).

3.3.30. system_restart_enhance

Function	Restarts system, and enters enhance boot mode.

Prototype	`bool system_restart_enhance(`
	`    uint8 bin_type,`
	`    uint32 bin_addr`
	`)`

Parameter	`uint8 bin_type`: type of bin
	`#define SYS_BOOT_NORMAL_BIN  0  // user1.bin or user2.bin`
	`#define SYS_BOOT_TEST_BIN  1    // can only be Espressif test bin`
	`uint32 bin_addr`: start address of bin file

Return	true: Success false: Failure
Note	`SYS_BOOT_TEST_BIN` is for factory test during production; you can apply for the test bin from Espressif Systems.

3.3.31. system_update_cpu_freq

Function	Set CPU frequency. Default is 80 MHz.
Prototype	`bool system_update_cpu_freq(uint8 freq)`

Parameter	`uint8 freq`: CPU frequency
	`#define SYS_CPU_80MHz  80`
	`#define SYS_CPU_160MHz 160`

Return	true: Success false: Failure
Note	System bus frequency is 80 MHz, and it is not affected by CPU frequency. The frequency of UART, SPI, or other peripheral devices, are divided from system bus frequency, so they will not be affected by CPU frequency either.

3.3.32. system_get_cpu_freq

Function	Get CPU frequency.
Prototype	`uint8 system_get_cpu_freq(void)`
Parameter	none
Return	CPU frequency; unit : MHz.

3.3.33. system_get_flash_size_map

Function	Get current flash size and flash map. Flash map depends on selection when compiling; for more details please see ESP8266 SDK Getting Started Guide.

Structure	`enum flash_size_map {`
	`        FLASH_SIZE_4M_MAP_256_256 = 0,`
	`        FLASH_SIZE_2M,`
	`        FLASH_SIZE_8M_MAP_512_512,`
	`        FLASH_SIZE_16M_MAP_512_512,`
	`        FLASH_SIZE_32M_MAP_512_512,`
	`        FLASH_SIZE_16M_MAP_1024_1024,`
	`        FLASH_SIZE_32M_MAP_1024_1024,`
	`        FLASH_SIZE_64M_MAP_1024_1024,`
	`        FLASH_SIZE_128M_MAP_1024_1024,`
	`};`

Prototype	`enum flash_size_map system_get_flash_size_map(void)`
Parameter	none
Return	flash map

3.3.34. system_get_rst_info

<table>
<tr><th>Function</th><th>Get information about current startup.</th></tr>
<tr><td>Structure</td><td><pre>
enum rst_reason {
        REANSON_DEFAULT_RST   = 0,   // normal startup by power on
        REANSON_WDT_RST   = 1,   // hardware watch dog reset
        // exception reset, GPIO status won’ t change
        REANSON_EXCEPTION_RST   = 2,
        // software watch dog reset, GPIO status won’ t change
        REANSON_SOFT_WDT_RST   = 3,
        // software restart ,system_restart , GPIO status won’ t
change
        REANSON_SOFT_RESTART   = 4,
        REANSON_DEEP_SLEEP_AWAKE= 5,   // wake up from deep-sleep
        REANSON_EXT_SYS_RST   = 6,   // external system reset
};

struct rst_info {
        uint32 reason;   // enum rst_reason
        uint32 exccause;
        uint32 epc1;   // the address that error
occurred
        uint32 epc2;
        uint32 epc3;
        uint32 excvaddr;
        uint32 depc;
};
</pre></td></tr>
<tr><td>Prototype</td><td><code>struct rst_info* system_get_rst_info(void)</code></td></tr>
<tr><td>Parameter</td><td>none</td></tr>
<tr><td>Return</td><td>Information about startup.</td></tr>
</table>

3.3.35. system_soft_wdt_stop

Function	Stop software watchdog.
Prototype	`void system_soft_wdt_stop(void)`
Parameter	none
Return	none
Note	The software watchdog must not be stopped for too long (over 6 seconds), otherwise it will trigger hardware watchdog reset.

3.3.36. system_soft_wdt_restart

Function	Restart software watchdog.

Prototype	`void system_soft_wdt_restart(void)`
Parameter	none
Return	none
Note	This API can only be called if software watchdog is stopped (`system_soft_wdt_stop`).

3.3.37. system_soft_wdt_feed

Function	Feed software watchdog.
Prototype	`void system_soft_wdt_feed(void)`
Parameter	none
Return	none
Note	This API can only be called if software watchdog is enabled.

3.3.38. system_show_malloc

Function	For debugging memory leak issue and printing the memory usage.
Prototype	`void system_show_malloc(void)`
Parameter	none
Return	none
Note	• To use this API, users need to enable #define `MEMLEAK_DEBUG` in ***user_config.h***, then refer to the note which is at the beginning of ***ESP8266_NONOS_SDK\included\mem.h***. • The memory usage which cause memory leak issue may be in the logs, not ensure, just for reference. • This API is only for debugging. After calling this API, the program may go wrong, so please do not call it in normal usage.

3.3.39. os_memset

Function	Set value of memory.
Prototype	`os_memset(void *s, int ch, size_t n)`
Parameter	`void *s`: pointer of memory `int ch`: set value `size_t n`: size
Return	none

Example	`uint8 buffer[32];`
	`        os_memset(buffer, 0, sizeof(buffer));`

3.3.40. os_memcpy

Function	Standard function for copying memory content.
Prototype	os_memcpy(void *des, void *src, size_t n)
Parameter	void *des: pointer of destination void *src: pointer of source size_t n: memory size
Return	none

Note	uint8 buffer[4] = {0};
	os_memcpy(buffer, "abcd", 4);

3.3.41. os_strlen

Function	Get string length.
Prototype	os_strlen(char *s)
Parameter	char *s: string
Return	string length

Example	char *ssid = "ESP8266";
	os_memcpy(softAP_config.ssid, ssid, os_strlen(ssid));

3.3.42. os_printf

Function	Print format.
Prototype	os_printf(const char *s)
Parameter	const char *s: string
Return	none
Example	os_printf("SDK version: %s \n", system_get_sdk_version());
Note	• Default to be output from UART 0. uart_init in IOT_Demo can set baud rate of UART, and os_install_putc1((void *)uart1_write_char) in it will set os_printf to be output from UART 1. • Continuously printing more than 125 bytes or repeated calls to this API may cause loss of print data.

3.3.43. os_bzero

Function	Set the first n bytes of string p to be 0, include '\0'.
Prototype	void os_bzero(void *p, size_t n)

Parameter	void *p: pointer of memory need to be set 0 size_t n: length
Return	none

3.3.44. os_delay_us

Function	Time delay, max : 65535 µs.
Prototype	void os_delay_us(uint16 μs)
Parameter	uint16 μs: time, unit: µs
Return	none

3.3.45. os_install_putc1

Function	Register print output function.
Prototype	void os_install_putc1(void(*p)(char c))
Parameter	void(*p)(char c): pointer of print function.
Return	none
Example	os_install_putc1((void *)uart1_write_char) in uart_init will set os_printf to be output from UART 1; otherwise, os_printf default output from UART 0.

3.3.46. os_random

Function	Get a random number.
Prototype	unsigned long os_random(void)
Parameter	none
Return	The random number.

3.3.47. os_get_random

Function	Get a random number of specified bytes.
Prototype	int os_get_random(unsigned char *buf, size_t len)
Parameter	unsigned char *buf: pointer of the random number it gets size_t len: specified bytes of the random number
Return	0: Success otherwise: Failure

Example	`int ret = os_get_random((unsigned char *)temp, 7);`
	`os_printf("ret %d, value 0x%08x%08x\n\r", ret, temp[1], temp[0]);`

3.3.48. user_rf_cal_sector_set

Function	Set the target flash sector to store `RF_CAL` parameters.
Prototype	`uint32 user_rf_cal_sector_set(void)`
Parameter	none
Return	The target flash sector to store `RF_CAL` parameters.
Notes	• The `user_rf_cal_sector_set` has to be added in application, but need NOT to be called. It will be called inside the SDK. • The system parameter area (4 flash sectors) has already been used, so the `RF_CAL` parameters will be stored in the target sector set by `user_rf_cal_sector_set`. Since we do not know which sector is available in user data area, users need to set an available sector in the `user_rf_cal_sector_set` for the SDK to store `RF_CAL` parameter. • If the `user_rf_cal_sector_set` is not added in the application, the compilation will fail in link stage. • Download blank.bin to initialize the sector stored `RF_CAL` parameter, and download ***esp_init_data.bin*** into flash, when the system needs to be initialized, or RF needs to be calibrated again.

<table>
<tr>
<td>Example</td>
<td>

Set the 5th sector from the end of the flash to store the RF_CAL parameter.

```
uint32 user_rf_cal_sector_set(void)
{
    enum flash_size_map size_map = system_get_flash_size_map();
    uint32 rf_cal_sec = 0;

    switch (size_map) {
        case FLASH_SIZE_4M_MAP_256_256:
            rf_cal_sec = 128 - 5;
            break;
        case FLASH_SIZE_8M_MAP_512_512:
            rf_cal_sec = 256 - 5;
            break;

        case FLASH_SIZE_16M_MAP_512_512:
        case FLASH_SIZE_16M_MAP_1024_1024:
            rf_cal_sec = 512 - 5;
            break;

        case FLASH_SIZE_32M_MAP_512_512:
        case FLASH_SIZE_32M_MAP_1024_1024:
            rf_cal_sec = 512 - 5;
            break;

        case FLASH_SIZE_64M_MAP_1024_1024:
            rf_cal_sec = 2048 - 5;
            break;

        case FLASH_SIZE_128M_MAP_1024_1024:
            rf_cal_sec = 4096 - 5;
            break;

        default:
            rf_cal_sec = 0;
            break;
    }
    return rf_cal_sec;
}
```

</td>
</tr>
</table>

3.3.49. system_phy_freq_trace_enable

Function	Enable RF frequency offset trace.
Prototype	`void system_phy_freq_trace_enable(bool enable)`
Parameter	`bool enable`: 0, disable frequency offset trace; 1, enable frequency offset trace
Return	none
Note	The frequency offset trace function is disabled by default, user can call `system_phy_freq_trace_enable(1)` in `user_rf_pre_init` to enable it.

3.3.50. system_deep_sleep_instant

Function	Configures chip to enter Deep-sleep mode immediately. When the device is in Deep-sleep, it automatically wakes up when time out. Upon waking up, the device boots up from `user_init`.
Prototype	`bool system_deep_sleep_instant(uint64 time_in_us)`
Parameter	`uint64 time_in_us`: the duration of time (μs) when the device is in Deep-sleep. The theoretical maximum value of `time_in_us` can be calculated by formula: `(time_in_us / cali) << 12 = 2^32 - 1` • `cali = system_rtc_clock_cali_proc()`, the `cali` is the RTC clock period (in us); bit11 ~ bit0 are decimal. For more details about the `cali`, please see the API: `system_rtc_clock_cali_proc`. • The input value of `time_in_us` should be less than the theoretical maximum value.
Return	true: Success false: Failure
Note	• Hardware has to support deep-sleep wake up (XPD_DCDC connects to EXT_RSTB with a 0-Ω resistor). • `system_deep_sleep_instant(0)`: there is no wakeup timer; in order to wake up, connect a GPIO to pin RST; the chip will wake up by a falling-edge on pin RST. • After configuration, the chip enters Deep-sleep mode immediately, will not wait till the Wi-Fi core is closed safely. Or you can use `system_deep_sleep` instead.

3.4. SPI Flash Related APIs

SPI flash APIs can be found in: ***/ESP8266_NONOS_SDK/include/spi_flash.h***.

`system_param_xxx` APIs can be found in: ***/ESP8266_NONOS_SDK/include/user_interface.h***.

More details about flash read/write operation please see document ESP8266 Flash RW Operation.

3.4.1. spi_flash_get_id

Function	Get ID info of SPI flash.
Prototype	`uint32 spi_flash_get_id (void)`
Parameter	none
Return	SPI flash ID

3.4.2. spi_flash_erase_sector

Function	Erase sector in flash.
Prototype	`SpiFlashOpResult spi_flash_erase_sector (uint16 sec)`
Parameter	`uint16 sec`: Sector number, the count starts at sector 0, 4 KB per sector.

Return	`typedef enum{`
	`    SPI_FLASH_RESULT_OK,`
	`    SPI_FLASH_RESULT_ERR,`
	`    SPI_FLASH_RESULT_TIMEOUT`
	`} SpiFlashOpResult;`

3.4.3. spi_flash_write

Function	Write data to flash. Flash read/write has to be aligned to the 4-byte boundary.

Prototype	`SpiFlashOpResult spi_flash_write (`
	`    uint32 des_addr,`
	`    uint32 *src_addr,`
	`    uint32 size`
	`)`

Parameter	`uint32 des_addr`: destination address in flash. `uint32 *src_addr`: source address of the data. `uint32 size`: length of data, uint: byte, has to be aligned to the 4-byte boundary.

Return	`typedef enum{`
	`    SPI_FLASH_RESULT_OK,`
	`    SPI_FLASH_RESULT_ERR,`
	`    SPI_FLASH_RESULT_TIMEOUT`
	`} SpiFlashOpResult;`

3.4.4. spi_flash_read

Function	Read data to flash. Flash read/write has to be aligned to the 4-byte boundary.

Prototype	`SpiFlashOpResult spi_flash_read(`
	`    uint32 src_addr,`
	`    uint32 * des_addr,`
	`    uint32 size`
	`)`

Parameter	`uint32 src_addr`: source address in flash. `uint32 *des_addr`: destination address to keep data. `uint32 size`: length of data; unit: byte, has to be aligned to the 4-bytes boundary.

Return	`typedef enum {`
	`    SPI_FLASH_RESULT_OK,`
	`    SPI_FLASH_RESULT_ERR,`
	`    SPI_FLASH_RESULT_TIMEOUT`
	`} SpiFlashOpResult;`

Example	`uint32 value;`
	`uint8 *addr = (uint8 *)&value;`
	`spi_flash_read(0x3E * SPI_FLASH_SEC_SIZE, (uint32 *)addr, 4);`
	`os_printf("0x3E sec:%02x%02x%02x%02x\r\n", addr[0], addr[1], addr[2], addr[3]);`

3.4.5. system_param_save_with_protect

Function	Write data into flash with protection. Flash read/write has to be aligned to the 4-byte boundary. Protection of flash read/write : 3 sectors (4 KB per sector) are used to save 4 KB data with protection; sector 0 and sector 1 are data sectors and back up each other; data is saved alternately; sector 2 is flag sector that points out which sector is keeping the latest data—sector 0 or sector 1.

Prototype	`bool system_param_save_with_protect (`
	`    uint16 start_sec,`
	`    void *param,`
	`    uint16 len`
	`)`

Parameter	`uint16 start_sec`: start sector (sector 0) of the 3 sectors which used for flash read/write protection. For example, in `IOT_Demo` we could use the 3 sectors (3*4 KB) starts from flash 0x3D000 for flash read/write protection, so the parameter `start_sec` should be 0x3D. `void *param`: pointer of data need to save. `uint16 len`: data length, should less than a sector which is 4*1024.
Return	true: Success false: Failure

Example	`uint32 value;`
	`uint8 *addr = (uint8 *)&value;`
	`spi_flash_read(0x3E * SPI_FLASH_SEC_SIZE, (uint32 *)addr, 4);`
	`os_printf("0x3E sec:%02x%02x%02x%02x\r\n", addr[0], addr[1], addr[2], addr[3]);`

Note	For more details about protection of flash read/write, please see ESP8266 Flash RW Operation.

3.4.6. system_param_load

Function	Read protected data from flash. Flash read/write has to be aligned to the 4-byte boundary. Protection of flash read/write : 3 sectors (4 KB per sector) are used to save 4 KB data with protection; sector 0 and sector 1 are data sectors and back up each other; data is saved alternately; sector 2 is flag sector that points out which sector is keeping the latest data—sector 0 or sector 1.

Prototype	`bool system_param_load (`
	`        uint16 start_sec,`
	`        uint16 offset,`
	`        void *param,`
	`        uint16 len`
	`)`

Parameter	`uint16 start_sec`: start sector (sector 0) of the 3 sectors which used for flash read/write protection. It cannot be sectors 1 or 2. For example, in `IOT_Demo` we could use the 3 sectors (3*4 KB) starts from flash 0x3D000 for flash read/write protection, so the parameter `start_sec` should be 0x3D. `uint16 offset`: offset of data saved in sector. `void *param`: pointer of data need to save. `uint16 len`: data length, should less than a sector which is 4*1024.
Return	true: Success false: Failure

Example	`uint32 value;`
	`uint8 *addr = (uint8 *)&value;`
	`spi_flash_read(0x3E * SPI_FLASH_SEC_SIZE, (uint32 *)addr, 4);`
	`os_printf("0x3E sec:%02x%02x%02x%02x\r\n", addr[0], addr[1], addr[2], addr[3]);`

Note	For more details about protection of flash read/write, please see ESP8266 Flash RW Operation.

3.4.7. spi_flash_set_read_func

Function	Register user-defined SPI flash read API.
Prototype	`void spi_flash_set_read_func (user_spi_flash_read read)`
Parameter	`user_spi_flash_read`: user-defined SPI flash read API.
Return	none

Parameter Definition	`typedef SpiFlashOpResult (*user_spi_flash_read)(`
	`    SpiFlashChip *spi,`
	`    uint32 src_addr,`
	`    uint32 * des_addr,`
	`    uint32 size`
	`)`

Note	This API can be only used in SPI overlap mode, for details please see ***ESP8266_NONOS_SDK\driver_lib\driver\spi_overlap.c***.

3.5. Wi-Fi Related APIs

Wi-Fi APIs can be found in ***/ESP8266_NONOS_SDK/include/user_interface.h***.

`wifi_station_xxx` APIs and other APIs which set/get configurations of the ESP8266 Station can only be called if the ESP8266 Station is enabled.

`wifi_softap_xxx` APIs and other APIs which set/get configurations of the ESP8266 SoftAP can only be called if the ESP8266 SoftAP is enabled.

Flash system parameter area is the last 16 KB of flash.

3.5.1. wifi_get_opmode

Function	Get the current operating mode of Wi-Fi.
Prototype	`uint8 wifi_get_opmode (void)`
Parameter	none
Return	Wi-Fi working modes: • `0x01`: Station mode • `0x02`: SoftAP mode • `0x03`: Station + SoftAP
Note	This API can be only used in SPI overlap mode, for details please see ***ESP8266_NONOS_SDK\driver_lib\driver\spi_overlap.c.***

3.5.2. wifi_get_opmode_default

Function	Get the Wi-Fi operating mode that saved in flash.
Prototype	`uint8 wifi_get_opmode_default (void)`
Parameter	none
Return	Wi-Fi working modes: • `0x01`: Station mode • `0x02`: SoftAP mode • `0x03`: Station + SoftAP
Note	This API can be only used in SPI overlap mode, for details please see ***ESP8266_NONOS_SDK\driver_lib\driver\spi_overlap.c.***

3.5.3. wifi_set_opmode

Function	Set Wi-Fi working mode to Station mode, SoftAP or Station + SoftAP, and save it in flash. The default mode is SoftAP mode.
Prototype	`bool wifi_set_opmode (uint8 opmode)`

Parameter	uint8 opmode: Wi-Fi working modes: • 0x01: Station mode • 0x02: SoftAP mode • 0x03: Station + SoftAP
Return	true: Success false: Failure
Note	Versions before ESP8266_NONOS_SDK_V0.9.2, need to call system_restart() after this API; after ESP8266_NONOS_SDK_V0.9.2, need not to restart. This configuration will be saved in flash system parameter area if changed.

3.5.4. wifi_set_opmode_current

Function	Set Wi-Fi working mode to Station mode, SoftAP or Station + SoftAP, and do not update flash.
Prototype	bool wifi_set_opmode_current (uint8 opmode)
Parameter	uint8 opmode: Wi-Fi working modes: • 0x01: Station mode • 0x02: SoftAP mode • 0x03: Station + SoftAP
Return	true: Success false: Failure

3.5.5. wifi_station_get_config

Function	Get Wi-Fi Station's current configuration.
Prototype	bool wifi_station_get_config (struct station_config *config)
Parameter	struct station_config *config: Wi-Fi Station configuration pointer
Return	true: Success false: Failure

3.5.6. wifi_station_get_config_default

Function	Get Wi-Fi Station's configuration from flash memory.
Prototype	bool wifi_station_get_config_default (struct station_config *config)
Parameter	struct station_config *config: Wi-Fi Station configuration pointer
Return	true: Success false: Failure

3.5.7. wifi_station_set_config

<table>
<tr><th>Function</th><td>Set Wi-Fi Station configuration, and save it to flash.</td></tr>
<tr><th>Prototype</th><td><code>bool wifi_station_set_config (struct station_config *config)</code></td></tr>
<tr><th>Parameter</th><td><code>struct station_config *config</code>: Wi-Fi Station configuration pointer</td></tr>
<tr><th>Return</th><td>true: Success
false: Failure</td></tr>
<tr><th>Example</th><td>

```
void ICACHE_FLASH_ATTR
user_set_station_config(void)
{
        char ssid[32] = SSID;
        char password[64] = PASSWORD;
        struct station_config stationConf;

        stationConf.bssid_set = 0;      //need not check MAC address of AP

        os_memcpy(&stationConf.ssid, ssid, 32);
        os_memcpy(&stationConf.password, password, 64);
        wifi_station_set_config(&stationConf);
}
void user_init(void)
{
        wifi_set_opmode(STATIONAP_MODE); //Set softAP + station mode
        user_set_station_config();
}
```

</td></tr>
<tr><th>Note</th><td>• This API can be called only if ESP8266 Station is enabled.
• If <code>wifi_station_set_config</code> is called in <code>user_init</code> , there is no need to call <code>wifi_station_connect</code> after that, ESP8266 will connect to router automatically; otherwise, <code>wifi_station_connect</code> is needed to connect.
• In general, <code>station_config.bssid_set</code> need to be 0, otherwise it will check BSSID which is the MAC address of AP.
• This configuration will be saved in flash system parameter area if changed.</td></tr>
</table>

3.5.8. wifi_station_set_config_current

Function	Set Wi-Fi Station configuration; setting in flash is not updated.
Prototype	`bool wifi_station_set_config (struct station_config *config)`
Parameter	`struct station_config *config`: Wi-Fi Station configuration pointer
Return	true: Success false: Failure

Example	`void ICACHE_FLASH_ATTR`
	`user_set_station_config(void)`
	`{`
	`        char ssid[32] = SSID;`
	`        char password[64] = PASSWORD;`
	`        struct station_config stationConf;`
	
	`        stationConf.bssid_set = 0;      //need not check MAC address of AP`
	
	`        os_memcpy(&stationConf.ssid, ssid, 32);`
	`        os_memcpy(&stationConf.password, password, 64);`
	`        wifi_station_set_config(&stationConf);`
	`}`
	`void user_init(void)`
	`{`
	`        wifi_set_opmode(STATIONAP_MODE);//Set softAP + station mode`
	`        user_set_station_config();`
	`}`

Note	• This API can be called only if ESP8266 Station is enabled. • If `wifi_station_set_config` is called in `user_init` , there is no need to call `wifi_station_connect` after that, ESP8266 will connect to router automatically; otherwise, `wifi_station_connect` is needed to connect. • In general, `station_config.bssid_set` need to be 0, otherwise it will check BSSID which is the MAC address of AP.

3.5.9. wifi_station_set_cert_key

Function	This API is deprecated; please use `wifi_station_set_enterprise_cert_key` instead. Set certificate and private key for connecting to WPA2-ENTERPRISE AP.

Prototype	`bool wifi_station_set_cert_key (`
	`        uint8 *client_cert, int client_cert_len,`
	`        uint8 *private_key, int private_key_len,`
	`        uint8 *private_key_passwd, int private_key_passwd_len,)`

Parameter	`uint8 *client_cert`: certificate; HEX array. `int client_cert_len`: length of certificate. `uint8 *private_key`: private key; HEX array; can NOT be longer than 2048 bits. `int private_key_len`: length of private key; less than 2048 bits. `uint8 *private_key_passwd`: password for private key; to be supported; can only be NULL now. `int private_key_passwd_len`: length of password; to be supported; can only be 0 now.
Return	0: Success otherwise: Failure

Example	For example, the private key is - - - - - BEGIN PRIVATE KEY - - - - - … … … … Then the array should be uint8 key[]={0x2d, 0x2d, 0x2d, 0x2d, 0x2d, 0x42, 0x45, 0x47, … … 0x00 }; It is the ASCII of the characters, and the array needs to terminate with 0x00.
Note	• Connecting to WPA2-ENTERPRISE AP needs more than 26 KB of memory, please ensure enough space (`system_get_free_heap_size`). • So far, WPA2-ENTERPRISE can only support unencrypted certificate and private key, and only in PEM format. - Header of certificate: - - - - - BEGIN CERTIFICATE - - - - - - Header of private key: - - - - - BEGIN RSA PRIVATE KEY - - - - - or - - - - - BEGIN PRIVATE KEY - - - - - • Please call this API to set certificate and private key before connecting to WPA2-ENTERPRISE AP and the application needs to hold the certificate and private key. Call `wifi_station_clear_cert_key` to release resources and clear status after connected to the target AP, and then the application can release the certificate and private key. • If the private key is encrypted, please use OpenSSL PKey command to change it to unencrypted file to use, or use OpenSSl RSA related commands to change it (or change the start TAG).

3.5.10. wifi_station_clear_cert_key

Function	This API is deprecated, please use `wifi_station_clear_enterprise_cert_key` instead. Release certificate and private key resources and clear related status after connected to the WPA2-ENTERPRISE AP.
Prototype	`void wifi_station_clear_cert_key (void)`
Parameter	none
Return	none

3.5.11. wifi_station_set_username

Function	This API is deprecated, please use `wifi_station_clear_enterprise_cert_key` instead. Set ESP8266 Station's user name for connecting to WPA2-ENTERPRISE AP.
Prototype	`int wifi_station_set_username (uint8 *username, int len)`
Parameter	`uint8 *username`: the user name. `int len`: length of user name.
Return	0 : Success otherwise: Failure

3.5.12. wifi_station_clear_username

Function	This API is deprecated, please use `wifi_station_clear_enterprise_username` instead. Release the user name resources and clear related status after connected to the WPA2-ENTERPRISE AP.
Prototype	`void wifi_station_clear_username (void)`
Parameter	none
Return	none

3.5.13. wifi_station_connect

Function	Connect Wi-Fi Station to AP.
Prototype	`void wifi_station_clear_username (void)`
Parameter	none
Return	true: Success false: Failure
Note	• If the ESP8266 is already connected to a router, `wifi_station_disconnect` must be called first, before calling `wifi_station_connect`. • Do not call this API in this API need to be called after system initializes and the ESP8266 Station mode is enabled.

3.5.14. wifi_station_disconnect

Function	Disconnects Wi-Fi Station from AP.
Prototype	`void wifi_station_clear_username (void)`
Parameter	none
Return	true: Success false: Failure
Note	Do not call this API in `user_init`. This API need to be called after system initializes and the ESP8266 Station mode is enabled.

3.5.15. wifi_station_get_connect_status

Function	Get Wi-Fi connection status of ESP8266 Station to AP.
Prototype	`uint8 wifi_station_get_connect_status (void)`
Parameter	none

Return	`enum{`
	`    STATION_IDLE = 0,`
	`    STATION_CONNECTING,`
	`    STATION_WRONG_PASSWORD,`
	`    STATION_NO_AP_FOUND,`
	`    STATION_CONNECT_FAIL,`
	`    STATION_GOT_IP`
	`};`

Note	In a special case, if you call `wifi_station_set_reconnect_policy` to disable reconnection, and do not call `wifi_set_event_handler_cb` to register Wi-Fi event handler, `wifi_station_get_connect_status` will become invalid and can not get the right status.

3.5.16. wifi_station_scan

Function	Scan all available APs.
Prototype	`bool wifi_station_scan (struct scan_config *config, scan_done_cb_t cb);`

Structure	`struct scan_config {`
	`    uint8 *ssid;       // AP’ s ssid`
	`    uint8 *bssid;      // AP’ s bssid`
	`    uint8 channel;     //scan a specific channel`
	`    uint8 show_hidden; //scan APs of which ssid is hidden.`
	`};`

Parameter	• `struct scan_config *config`: AP config for scan. - If config==null, scan all APs. - If config.ssid==null && config.bssid==null && config.channel!=null, ESP8266 Station interface will scan the APs in a specific channel. - If `config.ssid!=null && config.bssid==null && config.channel==null`, ESP8266 Station will scan the APs with a specific SSID in all channels. • `scan_done_cb_t cb`: callback function after scanning.
Return	true: Success false: Failure
Note	Do not call this API in `user_init`. This API need to be called after system initializes and the ESP8266 Station mode is enabled.

3.5.17. scan_done_cb_t

Function	Callback function for `wifi_station_scan`.
Prototype	`void scan_done_cb_t (void *arg, STATUS status)`
Parameter	`void *arg`: information of APs that were found, refer to struct `bss_info`. `STATUS status`: get status.
Return	none

Example	`wifi_station_scan(&config, scan_done);`
	`static void ICACHE_FLASH_ATTR scan_done(void *arg, STATUS status) {`
	`    if (status == OK) {`
	`        struct bss_info *bss_link = (struct bss_info *)arg;`
	`        ...`
	`    }`
	`}`

3.5.18. wifi_station_ap_number_set

Function	Sets the number of APs that will be cached for ESP8266 Station mode. Whenever ESP8266 Station connects to an AP, it caches a record of this AP's SSID and password. The cached ID index starts from 0.
Prototype	`bool wifi_station_ap_number_set (uint8 ap_number)`
Parameter	`uint8 ap_number`: the number of APs that can be recorded (MAX: 5)
Return	true: Success false: Failure

Example	`wifi_station_scan(&config, scan_done);`
	`static void ICACHE_FLASH_ATTR scan_done(void *arg, STATUS status) {`
	`    if (status == OK) {`
	`        struct bss_info *bss_link = (struct bss_info *)arg;`
	`        ...`
	`    }`
	`}`

Note	This configuration will be saved in flash system parameter area if changed.

3.5.19. wifi_station_get_ap_info

Function	Get information of APs recorded by ESP8266 Station.
Prototype	`uint8 wifi_station_get_ap_info(struct station_config config[])`
Parameter	`struct station_config config[]`: information of APs; array size has to be 5.
Return	The number of APs recorded.

Example	`struct station_config config[5];`
	`int i = wifi_station_get_ap_info(config);`

3.5.20. wifi_station_ap_change

Function	Switch ESP8266 Station connection to AP as specified.
Prototype	`bool wifi_station_ap_change (uint8 new_ap_id)`
Parameter	`uint8 new_ap_id`: AP's record ID; start counting from 0.
Return	true: Success false: Failure

3.5.21. wifi_station_get_current_ap_id

Function	Get the current cached ID of AP. ESP8266 records the ID of each AP it connects with. The ID number starts from 1.
Prototype	`uint8 wifi_station_get_current_ap_id ();`
Parameter	none
Return	The ID of the AP to which ESP8266 is currently connected, in the cached AP list.

3.5.22. wifi_station_get_auto_connect

Function	Check if ESP8266 Station will connect to AP (whose ID is cached) automatically or not when it is powered on.
Prototype	`uint8 wifi_station_get_auto_connect(void)`
Parameter	none
Return	0: wil not connect to AP automatically; otherwise: will connect to AP automatically.

3.5.23. wifi_station_set_auto_connect

Function	Set the ESP8266 Station to connect to the AP (whose ID is cached) automatically or not when powered on. Auto-connection is enabled by default.
Prototype	`bool wifi_station_set_auto_connect(uint8 set)`
Parameter	`uint8 set`: Automatically connect or not: • 0: will not connect automatically • 1: to connect automatically
Return	true: Success false: Failure
Note	Setting the ESP8266 Station to connect to the AP (whose ID is cached) automatically or not when powered on. Auto-connection is enabled by default.

3.5.24. wifi_station_dhcpc_start

Function	Enable ESP8266 Station DHCP client.
Prototype	`bool wifi_station_dhcpc_start(void)`
Parameter	none
Return	true: Success false: Failure

Note	• DHCP is enabled by default. • This configuration interacts with static IP API (`wifi_set_ip_info`): - If DHCP is enabled, static IP will be disabled; - If static IP is enabled, DHCP will be disabled; • These settings depend on the last configuration.

3.5.25. wifi_station_dhcpc_stop

Function	Disable ESP8266 Station DHCP client.
Prototype	`bool wifi_station_dhcpc_stop(void)`
Parameter	none
Return	true: Success false: Failure
Note	DHCP is enabled by default.

3.5.26. wifi_station_dhcpc_status

Function	Get ESP8266 Station DHCP client status.
Prototype	`enum dhcp_status wifi_station_dhcpc_status(void)`
Parameter	none

Return	`enum dhcp_status {`
	`    DHCP_STOPPED,`
	`    DHCP_STARTED`
	`};`

3.5.27. wifi_station_dhcpc_set_maxtry

Function	Set the maximum number that ESP8266 Station DHCP client will try to reconnect to the AP.
Prototype	`bool wifi_station_dhcpc_set_maxtry(uint8 num)`
Parameter	`uint8 num`: the maximum number count.
Return	true: Success false: Failure

3.5.28. wifi_station_set_reconnect_policy

Function	Set whether the ESP8266 will attempt to reconnect to an AP if disconnected or failed to connect.
Prototype	`bool wifi_station_set_reconnect_policy(bool set)`

Parameter	`bool set`: true, enable reconnection; false, disable reconnection.
Return	true: Success false: Failure
Note	• It is recommended that the API be called from `user_init`. • This API can only be called when the ESP8266 Station is enabled.

3.5.29. wifi_station_get_rssi

Function	Get RSSI of the AP to which the ESP8266 is connected.
Prototype	`sint8 wifi_station_get_rssi(void)`
Parameter	none
Return	31: Failure, invalid value. other : Success, value of RSSI, in general, RSSI value < 10

3.5.30. wifi_station_set_hostname

Function	Set ESP8266 Station DHCP hostname.
Prototype	`bool wifi_station_set_hostname(char* hostname)`
Parameter	`char* hostname`: hostname, max length: 32 characters.
Return	true: Success false: Failure

3.5.31. wifi_station_get_hostname

Function	Get ESP8266 Station DHCP hostname.
Prototype	`char* wifi_station_get_hostname(void)`
Parameter	none
Return	hostname

3.5.32. wifi_softap_get_config

Function	Get the current configuration of Wi-Fi SoftAP.
Prototype	`bool wifi_softap_get_config(struct softap_config *config)`
Parameter	`struct softap_config *config`: ESP8266 SoftAP configuration information.
Return	true: Success false: Failure

3.5.33. wifi_softap_get_config_default

Function	Get Wi-Fi SoftAP configuration saved in flash.
Prototype	`bool wifi_softap_get_config_default(struct softap_config *config)`
Parameter	`struct softap_config *config`: ESP8266 SoftAP configuration information.
Return	true: Success false: Failure

3.5.34. wifi_softap_set_config

Function	Set Wi-Fi SoftAP configuration and save it in flash.
Prototype	`bool wifi_softap_set_config (struct softap_config *config)`
Parameter	`struct softap_config *config`: Wi-Fi SoftAP configuration pointer
Return	true: Success false: Failure
Note	• This API can be called only if the ESP8266 SoftAP is enabled. • This configuration will be saved in flash system parameter area if changed. • In SoftAP + Station mode, the ESP8266 SoftAP will adjust its channel configuration to be the as same as that of the ESP8266 Station. More details please see ***Appendix.A***.

3.5.35. wifi_softap_set_config_current

Function	Set Wi-Fi SoftAP configuration; settings are not updated in flash memory.
Prototype	`bool wifi_softap_set_config_current (struct softap_config *config)`
Parameter	`struct softap_config *config`: Wi-Fi SoftAP configuration pointer
Return	true: Success false: Failure
Note	• This API can be called only if the ESP8266 SoftAP is enabled. • In SoftAP + Station mode, the ESP8266 SoftAP will adjust its channel configuration to be the as same as that of the ESP8266 Station. For more details please see ***Appendix A***.

3.5.36. wifi_softap_get_station_num

Function	Count the number of Stations connected to the ESP8266 SoftAP.
Prototype	`uint8 wifi_softap_get_station_num(void)`

Parameter	none
Return	Number of Stations connected to ESP8266 SoftAP.

3.5.37. wifi_softap_get_station_info

Function	Get information on connected Station devices under SoftAP mode, including MAC and IP.
Prototype	`struct station_info * wifi_softap_get_station_info(void)`
Parameter	none
Return	`struct station_info*`: station information structure.
Note	This API depends on DHCP, so it cannot get static IP, etc. in case DHCP is not used.

3.5.38. wifi_softap_free_station_info

Function	Frees the struct `station_info` by calling the `wifi_softap_get_station_info` function.
Prototype	`void wifi_softap_free_station_info(void)`
Parameter	none
Return	none

Example	Example 1 (getting MAC and IP information):
	`struct station_info * station = wifi_softap_get_station_info();`
	`struct station_info * next_station;`
	`while(station) {`
	`    os_printf(bssid : MACSTR, ip : IPSTR/n,`
	`            MAC2STR(station->bssid), IP2STR(&station->ip));`
	`    next_station = STAILQ_NEXT(station, next);`
	`    os_free(station);               // Free it directly`
	`    station = next_station;`
	`}`
	Example 2 (getting MAC and IP information):
	`struct station_info * station = wifi_softap_get_station_info();`
	`while(station){`
	`    os_printf(bssid : MACSTR, ip : IPSTR/n,`
	`            MAC2STR(station->bssid), IP2STR(&station->ip));`
	`    station = STAILQ_NEXT(station, next);`
	`}`
	`wifi_softap_free_station_info();    // Free it by calling functions`

3.5.39. wifi_softap_dhcps_start

Function	Enable ESP8266 SoftAP DHCP server.
Prototype	`bool wifi_softap_dhcps_start(void)`
Parameter	none

Return	true: Success false: Failure
Note	• DHCP is enabled by default. • This configuration interacts with static IP API (`wifi_set_ip_info`): - If DHCP is enabled, static IP will be disabled; - If static IP is enabled, DHCP will be disabled; - These settings depend on the last configuration.

3.5.40. wifi_softap_dhcps_stop

Function	Disable ESP8266 SoftAP DHCP server.
Prototype	`bool wifi_softap_dhcps_stop(void)`
Parameter	none
Return	true: Success false: Failure
Note	DHCP is enabled by default.

3.5.41. wifi_softap_set_dhcps_lease

Function	Set the IP range that can be allocated by the ESP8266 SoftAP DHCP server.
Prototype	`bool wifi_softap_set_dhcps_lease(struct dhcps_lease *please)`

Parameter	`struct dhcps_lease {`
	`    struct ip_addr start_ip;`
	`    struct ip_addr end_ip;`
	`};`

Return	true: Success false: Failure

Example	void dhcps_lease_test(void)
	{
	struct dhcps_lease dhcp_lease;
	const char* start_ip = "192.168.5.100";
	const char* end_ip = "192.168.5.105";
	
	dhcp_lease.start_ip.addr = ipaddr_addr(start_ip);
	dhcp_lease.end_ip.addr = ipaddr_addr(end_ip);
	wifi_softap_set_dhcps_lease(&dhcp_lease);
	}
	or
	void dhcps_lease_test(void)
	{
	struct dhcps_lease dhcp_lease;
	IP4_ADDR(&dhcp_lease.start_ip, 192, 168, 5, 100);
	IP4_ADDR(&dhcp_lease.end_ip, 192, 168, 5, 105);
	wifi_softap_set_dhcps_lease(&dhcp_lease);
	}
	void user_init(void)
	{
	struct ip_info info;
	wifi_set_opmode(STATIONAP_MODE); //Set softAP + station mode
	wifi_softap_dhcps_stop();
	
	IP4_ADDR(&info.ip, 192, 168, 5, 1);
	IP4_ADDR(&info.gw, 192, 168, 5, 1);
	IP4_ADDR(&info.netmask, 255, 255, 255, 0);
	wifi_set_ip_info(SOFTAP_IF, &info);
	dhcps_lease_test();
	wifi_softap_dhcps_start();
	}

Note	• IP range has to be in the same sub-net with the ESP8266 SoftAP IP address. • This API can only be called when DHCP server is disabled (wifi_softap_dhcps_stop). • This configuration only takes effect on next wifi_ SoftAP_dhcps_start; if then wifi_softap_dhcps_stop is called, users need to call this API to set IP range again if needed, and then call wifi_softap_dhcps_start for the configuration to take effect.

3.5.42. wifi_softap_get_dhcps_lease

Function	Query the IP range that can be allocated by the ESP8266 SoftAP DHCP server.
Prototype	bool wifi_softap_get_dhcps_lease(struct dhcps_lease *please)
Return	true: Success false: Failure
Note	This API can only be called when ESP8266 SoftAP DHCP server is enabled.

3.5.43. wifi_softap_set_dhcps_lease_time

Function	Set ESP8266 SoftAP DHCP server lease time, 120 minutes by default.
Prototype	`bool wifi_softap_set_dhcps_lease_time(uint32 minute)`
Parameter	`uint32 minute`: lease time, uint: minute, range: [1, 2880].
Return	true: Success false: Failure
Note	This API can only be called when ESP8266 SoftAP DHCP server is enabled.

3.5.44. wifi_softap_get_dhcps_lease_time

Function	Get ESP8266 SoftAP DHCP server lease time.
Prototype	`uint32 wifi_softap_get_dhcps_lease_time(void)`
Return	Lease time; uint: minute.
Note	This API can only be called when ESP8266 SoftAP DHCP server is enabled.

3.5.45. wifi_softap_reset_dhcps_lease_time

Function	Reset ESP8266 SoftAP DHCP server lease time to its default value, which is 120 minutes.
Prototype	`bool wifi_softap_reset_dhcps_lease_time(void)`
Return	true: Success false: Failure
Note	This API can only be called when ESP8266 SoftAP DHCP server is enabled.

3.5.46. wifi_softap_dhcps_status

Function	Get ESP8266 SoftAP DHCP server status.
Prototype	`enum dhcp_status wifi_softap_dhcps_status(void)`
Parameter	none

Return	`enum dhcp_status {`
	`    DHCP_STOPPED,`
	`    DHCP_STARTED`
	`};`

Note	This API can only be called when ESP8266 SoftAP DHCP server is enabled.

3.5.47. wifi_softap_set_dhcps_offer_option

Function	Set ESP8266 SoftAP DHCP server option.

Structure	`enum dhcps_offer_option{`
	`OFFER_START = 0x00,`
	`OFFER_ROUTER = 0x01,`
	`OFFER_END`
	`};`

Prototype	`bool wifi_softap_set_dhcps_offer_option(uint8 level, void* optarg)`
Parameter	`uint8 level`: OFFER_ROUTER set router option `void* optarg`: enabled by default • bit0, 0 disables router information from ESP8266 SoftAP DHCP server; • bit0, 1 enables router information from ESP8266 SoftAP DHCP server.
Return	true: Success false: Failure

Example	`uint8 mode = 0;`
	`wifi_softap_set_dhcps_offer_option(OFFER_ROUTER, &mode);`

3.5.48. wifi_set_phy_mode

Function	Set ESP8266 physical mode (802.11b/g/n).
Prototype	`bool wifi_set_phy_mode(enum phy_mode mode)`

Parameter	`enum phy_mode mode : physical mode`
	`enum phy_mode {`
	`PHY_MODE_11B = 1,`
	`PHY_MODE_11G = 2,`
	`PHY_MODE_11N = 3`
	`};`

Return	true: Success false: Failure
Note	• ESP8266 SoftAP only support 802.11b/g. • Users can set to be 802.11g mode for consumption.

3.5.49. wifi_get_phy_mode

Function	Get ESP8266 physical mode (802.11b/g/n).
Prototype	`enum phy_mode wifi_get_phy_mode(void)`
Parameter	none

Return	`enum phy_mode{`
	`    PHY_MODE_11B = 1,`
	`    PHY_MODE_11G = 2,`
	`    PHY_MODE_11N = 3`
	`};`

3.5.50. wifi_get_ip_info

Function	Get IP info of Wi-Fi Station or SoftAP interface.

Prototype	`bool wifi_get_ip_info(`
	`   uint8 if_index,`
	`   struct ip_info *info`
	`)`

Parameter	`uint8 if_index`: the interface to get IP info: `0x00` for `STATION_IF`; `0x01` for `SOFTAP_IF`. `struct ip_info *info`: pointer to get IP info of a certain interface.
Return	true: Success false: Failure
Note	This API is available after initialization, do not call it in `user_init`.

3.5.51. wifi_set_ip_info

Function	Set the IP address of ESP8266 Station or SoftAP.

Prototype	`bool wifi_set_ip_info(`
	`   uint8 if_index,`
	`   struct ip_info *info`
	`)`

Parameter	`uint8 if_index`: set Station IP or SoftAP IP.
	`#define STATION_IF      0x00`
	`#define SOFTAP_IF       0x01`
	`struct ip_info *info`: IP information.

Return	true: Success false: Failure

Example	`wifi_set_opmode(STATIONAP_MODE); //Set softAP + station mode`
	`struct ip_info info;`
	`wifi_station_dhcpc_stop();`
	`wifi_softap_dhcps_stop();`
	
	`IP4_ADDR(&info.ip, 192, 168, 3, 200);`
	`IP4_ADDR(&info.gw, 192, 168, 3, 1);`
	`IP4_ADDR(&info.netmask, 255, 255, 255, 0);`
	`wifi_set_ip_info(STATION_IF, &info);`
	
	`IP4_ADDR(&info.ip, 10, 10, 10, 1);`
	`IP4_ADDR(&info.gw, 10, 10, 10, 1);`
	`IP4_ADDR(&info.netmask, 255, 255, 255, 0);`
	`wifi_set_ip_info(SOFTAP_IF, &info);`
	`wifi_softap_dhcps_start();`

Note	To set static IP, please disable DHCP first (`wifi_station_dhcpc_stop` or `wifi_softap_dhcps_stop`): • If static IP is enabled, DHCP will be disabled; • If DHCP is enabled, static IP will be disabled.

3.5.52. wifi_set_macaddr

Function	Set MAC address.

Prototype	`bool wifi_set_macaddr(`
	`   uint8 if_index,`
	`   uint8 *macaddr`
	`)`

Parameter	`uint8 if_index`: set station MAC or SoftAP MAC.
	`#define STATION_IF      0x00`
	`#define SOFTAP_IF       0x01`
	`uint8 *macaddr`: MAC address.

Return	true: Success false: Failure

Example	`wifi_set_opmode(STATIONAP_MODE);`
	`char sofap_mac[6] = {0x16, 0x34, 0x56, 0x78, 0x90, 0xab};`
	`char sta_mac[6] = {0x12, 0x34, 0x56, 0x78, 0x90, 0xab};`
	`wifi_set_macaddr(SOFTAP_IF, sofap_mac);`
	`wifi_set_macaddr(STATION_IF, sta_mac);`

Note	• This API can only be called in `user_init`. • ESP8266 SoftAP and station have different MAC addresses, please do not set them to be the same. • The bit 0 of the first byte of ESP8266 MAC address can not be 1. For example, MAC address can be “1a:XX:XX:XX:XX:XX”, but can not be “15:XX:XX:XX:XX:XX”.

3.5.53. wifi_get_macaddr

Function	Get MAC address.

Prototype	`bool wifi_get_macaddr(`
	`   uint8 if_index,`
	`   uint8 *macaddr`
	`)`

Parameter	`uint8 if_index`: get station MAC or SoftAP MAC.
	`#define STATION_IF      0x00`
	`#define SOFTAP_IF       0x01`
	`uint8 *macaddr`: MAC address.

Return	true: Success false: Failure

3.5.54. wifi_set_sleep_type

Function	Sets sleep type for power saving. Set `NONE_SLEEP_T` to disable power saving.
Prototype	`bool wifi_set_sleep_type(enum sleep_type type)`
Parameter	`enum sleep_type type`: sleep type.
Return	true: Success false: Failure
Note	Default mode: Modem-sleep.

3.5.55. wifi_get_sleep_type

Function	Get sleep type.
Prototype	`enum sleep_type wifi_get_sleep_type(void)`
Parameter	none

Return	`enum sleep_type {`
	`    NONE_SLEEP_T = 0;`
	`    LIGHT_SLEEP_T,`
	`    MODEM_SLEEP_T`
	`};`

3.5.56. wifi_status_led_install

Function	Install Wi-Fi status LED.

Prototype	`void wifi_status_led_install (`
	`    uint8 gpio_id,`
	`    uint32 gpio_name,`
	`    uint8 gpio_func`
	`)`

Parameter	`uint8 gpio_id`: GPIO number. `uint8 gpio_name`: GPIO mux name. `uint8 gpio_func`: GPIO function.
Return	none

Example	`Use GPIO0 as WiFi status LED`
	`#define HUMITURE_WIFI_LED_IO_MUX     PERIPHS_IO_MUX_GPIO0_U`
	`#define HUMITURE_WIFI_LED_IO_NUM     0`
	`#define HUMITURE_WIFI_LED_IO_FUNC    FUNC_GPIO0`
	`wifi_status_led_install(HUMITURE_WIFI_LED_IO_NUM,`
	`        HUMITURE_WIFI_LED_IO_MUX, HUMITURE_WIFI_LED_IO_FUNC);`

3.5.57. wifi_status_led_uninstall

Function	Uninstall Wi-Fi status LED.
Prototype	`void wifi_status_led_uninstall ()`
Parameter	none
Return	none

3.5.58. wifi_set_broadcast_if

Function	Set ESP8266 to send UDP broadcast from Station interface or SoftAP interface, or both Station and SoftAP interfaces. The default interface is SoftAP.
Prototype	`bool wifi_set_broadcast_if (uint8 interface)`
Parameter	`uint8 interface`: • 1: Station • 2: SoftAP • 3: Station + SoftAP
Return	true: Success false: Failure
Note	If broadcast is set to be in station interface only, the SoftAP DHCP server will be disabled.

3.5.59. wifi_get_broadcast_if

Function	Get interface which ESP8266 sends UDP broadcast from. This is usually used when you have Station + SoftAP mode to avoid ambiguity.
Prototype	`uint8 wifi_get_broadcast_if (void)`

Parameter	none
Return	1: Station 2: SoftAP 3: Both Station and SoftAP

3.5.60. wifi_set_event_handler_cb

Function	Register Wi-Fi event handler.
Prototype	`void wifi_set_event_handler_cb(wifi_event_handler_cb_t cb)`
Parameter	`wifi_event_handler_cb_t cb`: callback
Return	none

Example

```
void wifi_handle_event_cb(System_Event_t *evt)
{
          os_printf("event %x\n", evt->event);
          switch (evt->event) {
          case EVENT_STAMODE_CONNECTED:
                     os_printf("connect to ssid %s, channel %d\n",
                                                    evt->event_info.connected.ssid,
                                                    evt->event_info.connected.channel);
                     break;
          case EVENT_STAMODE_DISCONNECTED:
                     os_printf("disconnect from ssid %s, reason %d\n",
                                                    evt->event_info.disconnected.ssid,
                                                    evt->event_info.disconnected.reason);
                     break;
          case EVENT_STAMODE_AUTHMODE_CHANGE:
              os_printf("mode: %d -> %d\n",
                                                    evt->event_info.auth_change.old_mode,
                                                    evt->event_info.auth_change.new_mode);
              break;
          case EVENT_STAMODE_GOT_IP:
                     os_printf("ip:" IPSTR ",mask:" IPSTR ",gw:" IPSTR,
                                                      IP2STR(&evt->event_info.got_ip.ip),
                                                      IP2STR(&evt->event_info.got_ip.mask),
                                                      IP2STR(&evt->event_info.got_ip.gw));
                     os_printf("\n");
                     break;
          case EVENT_SOFTAPMODE_STACONNECTED:
              os_printf("station: " MACSTR "join, AID = %d\n",
                                         MAC2STR(evt->event_info.sta_connected.mac),
                                         evt->event_info.sta_connected.aid);
              break;
              case EVENT_SOFTAPMODE_STADISCONNECTED:
                  os_printf("station: " MACSTR "leave, AID = %d\n",
                                         MAC2STR(evt->event_info.sta_disconnected.mac),
                                         evt->event_info.sta_disconnected.aid);
              break;
          default:
                     break;
          }
}
void user_init(void)
{
    // TODO: add your own code here....
    wifi_set_event_hander_cb(wifi_handle_event_cb);
}                    break;
          }
}
void user_init(void)
{
    // TODO: add your own code here....
    wifi_set_event_hander_cb(wifi_handle_event_cb);
}
```

3.5.61. wifi_wps_enable

Function	Enable Wi-Fi WPS function.

Structure	`typedef enum wps_type {`
	`        WPS_TYPE_DISABLE=0,`
	`        WPS_TYPE_PBC,`
	`        WPS_TYPE_PIN,`
	`        WPS_TYPE_DISPLAY,`
	`        WPS_TYPE_MAX,`
	`}WPS_TYPE_t;`

Prototype	`bool wifi_wps_enable(WPS_TYPE_t wps_type)`
Parameter	`WPS_TYPE_t wps_type`: WPS type; so far only `WPS_TYPE_PBC` is supported.
Return	true: Success false: Failure
Note	WPS can only be used when ESP8266 Station is enabled.

3.5.62. wifi_wps_disable

Function	Disable Wi-Fi WPS function and release resources allocated to it.
Prototype	`bool wifi_wps_disable(void)`
Parameter	none
Return	true: Success false: Failure

3.5.63. wifi_wps_start

Function	WPS starts.
Prototype	`bool wifi_wps_start(void)`
Parameter	none
Return	true: WPS starts. But it does not mean Wi-Fi protection setup is successfully completed. false: Failure

3.5.64. wifi_set_wps_cb

Function	Set WPS callback; parameter of the callback is the status of WPS.

Callback and Parameter Struture	`typedef void (*wps_st_cb_t)(int status);`
	`enum wps_cb_status {`
	`WPS_CB_ST_SUCCESS = 0,`
	`WPS_CB_ST_FAILED,`
	`WPS_CB_ST_TIMEOUT,`
	`WPS_CB_ST_WEP,   // WPS failed because that WEP is not supported`
	`WPS_CB_ST_SCAN_ERR, // can not find the target WPS AP`

Prototype	`bool wifi_set_wps_cb(wps_st_cb_t cb)`
Parameter	`wps_st_cb_t cb`: callback
Return	true: Success false: Failure
Note	• If parameter status == `WPS_CB_ST_SUCCESS` in WPS callback, it means WPS got AP's information, user can call `wifi_wps_disable` to disable WPS and release resource, then call `wifi_station_connect` to connect to target AP. • Otherwise, it means that WPS failed, user can create a timer to retry WPS by `wifi_wps_start` after a while, or call `wifi_wps_disable` to disable WPS and release resource.

3.5.65. wifi_register_send_pkt_freedom_cb

Function	Register a callback for sending user-defined 802.11 packets.
Callback Definition	`typedef void (*freedom_outside_cb_t)(uint8 status);` parameter status: 0 — packet sending succeeds; otherwise — failed. The send callback can determine the status of a transmitted packet, however, note that: • For unicast packet: - If the status is OK in the `freedom_outside_cb_t`, but the target device failed to receive the packet, the reasons may be as follows: 1. It may have been corrupted by other unexpected devices. 2. Incorrect key for communication. 3. the application is lost or missed the packet. Solution: handshake mechanism should be used in application to get a high success rate with packet transmission. - If the status is FAIL in the `freedom_outside_cb_t`, and the target device does receive the packet, the possible reason could be that the sender fails to receive the ACK because of busy channel. Solution: the sender application should re-transmit the packet, and the receiver should detect the retransmitted packet. • For multicast packet (include broadcast packet): - If the status is OK in the `freedom_outside_cb_t`, it indicates that the packet is sent successfully. - If the status is FAIL in the `freedom_outside_cb_t`, it indicates that sending failed.
Prototype	`int wifi_register_send_pkt_freedom_cb(freedom_outside_cb_t cb)`
Parameter	`freedom_outside_cb_t cb`: callback
Return	0: Success -1: Failure
Note	Only after the previous packet was sent, entered the `freedom_outside_cb_t`, the next packet is allowed to be sent.

3.5.66. wifi_unregister_send_pkt_freedom_cb

Function	Unregister the callback for sending packets freedom.
Prototype	`void wifi_unregister_send_pkt_freedom_cb(void)`
Parameter	none
Return	none

3.5.67. wifi_send_pkt_freedom

Function	Send user-defined 802.11 packets.
Prototype	`int wifi_send_pkt_freedom(uint8 *buf, int len,bool sys_seq)`
Parameter	`uint8 *buf`: pointer of packet `int len`: packet length `bool sys_seq`: follow the system's 802.11 packets sequence number or not; if it is true, the sequence number will be increased 1 every time a packet is sent.
Return	0: Success -1: Failure
Note	• Packet has to be the whole 802.11 packet, excluding the FCS. The length of the packet has to be longer than the minimum length of the header of 802.11 packet, which is 24 bytes, and less than 1400 bytes. • Duration area is invalid for user, it will be filled in SDK. • The rate of sending packet is same as the management packet which is the same as the system rate of sending packets. • Can send: unencrypted data packet, unencrypted beacon/probe req/probe resp. • Can NOT send: all encrypted packets (the encrypt bit in the packet has to be 0, otherwise it is not supported), control packet, other management packet except unencrypted beacon/probe req/probe resp. • Only after the previous packet was sent, and the sent callback is entered, the next packet is allowed to send. Otherwise, `wifi_send_pkt_freedom` will return "fail".

3.5.68. wifi_rfid_locp_recv_open

Function	Enable RFID LOCP (Location Control Protocol) to receive WDS packets.
Prototype	`int wifi_rfid_locp_recv_open(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.5.69. wifi_rfid_locp_recv_close

Function	Disable RFID LOCP (Location Control Protocol).
Prototype	`void wifi_rfid_locp_recv_close(void)`
Parameter	none
Return	none

3.5.70. wifi_register_rfid_locp_recv_cb

Function	Register a callback on receiving WDS packets, only if the first MAC address of the WDS packet is a multicast address.
Callback Definition	`typedef void (*rfid_locp_cb_t)(uint8 *frm, int len, int rssi);`
Parameter	`uint8 *frm`: point to the head of 802.11 packet. `int len`: packet length. `int rssi`: signal strength.
Prototype	`int wifi_register_rfid_locp_recv_cb(rfid_locp_cb_t cb)`
Return	0: Success otherwise: Failure

3.5.71. wifi_unregister_rfid_locp_recv_cb

Function	Unregister the callback of receiving WDS packets.
Prototype	`void wifi_unregister_rfid_locp_recv_cb(void)`
Parameter	none
Return	none

3.5.72. wifi_enable_gpio_wakeup

Function	Set a GPIO to wake the ESP8266 up from light-sleep mode.
Prototype	`void wifi_enable_gpio_wakeup(uint32 i, GPIO_INT_TYPE intr_status)`
Parameter	`uint32 i`: GPIO number, range: [0, 15]. `GPIO_INT_TYPE intr_status`: status of GPIO interrupt to trigger the wakeup process.
Return	none

Example	ESP8266 will be wakened from Light-sleep, when the GPIO12 is in low-level.
	`GPIO_DIS_OUTPUT(12);`
	`PIN_FUNC_SELECT(PERIPHS_IO_MUX_MTDI_U, FUNC_GPIO12);`
	`wifi_enable_gpio_wakeup(12, GPIO_PIN_INTR_LOLEVEL);`

Note	If the ESP8266 enters light-sleep automatically (`wifi_set_sleep_type(LIGHT_SLEEP_T);`), after being waken up by GPIO, when the chip attempts to sleep again, it will check the status of the GPIO: • If the GPIO is still in the wakeup status, the EP8266 will enter modem-sleep mode instead; • If the GPIO is NOT in the wakeup status, the ESP8266 will enter light-sleep mode.

3.5.73. wifi_disable_gpio_wakeup

Function	Disable the function that the GPIO can wake the ESP8266 up from light-sleep mode.
Prototype	`void wifi_disable_gpio_wakeup(void)`
Parameter	none
Return	none

3.6. Rate Control APIs

Wi-Fi rate control APIs can be found in ***/ESP8266_NONOS_SDK/include/user_interface.h***.

3.6.1. wifi_set_user_fixed_rate

Function	Set the fixed rate and mask of sending data from ESP8266.

Structure and Definition	`enum FIXED_RATE {`
	`        PHY_RATE_48    =    0x8,`
	`        PHY_RATE_24    =    0x9,`
	`        PHY_RATE_12    =    0xA,`
	`        PHY_RATE_6     =    0xB,`
	`        PHY_RATE_54    =    0xC,`
	`        PHY_RATE_36    =    0xD,`
	`        PHY_RATE_18    =    0xE,`
	`        PHY_RATE_9     =    0xF,`
	`}`
	`#define FIXED_RATE_MASK_NONE            (0x00)`
	`#define FIXED_RATE_MASK_STA                     (0x01)`
	`#define FIXED_RATE_MASK_AP                      (0x02)`
	`#define FIXED_RATE_MASK_ALL                     (0x03)`

Prototype	`int wifi_set_user_fixed_rate(uint8 enable_mask, uint8 rate)`
Parameter	`uint8 enable_mask`: • `0x00`: disable the fixed rate • `0x01`: use the fixed rate on ESP8266 Station • `0x02`: use the fixed rate on ESP8266 SoftAP • `0x03`: use the fixed rate on ESP8266 Station and SoftAP `uint8 rate`: value of the fixed rate
Return	0: Success otherwise: Failure
Note	• Only if the corresponding bit in `enable_mask` is 1, ESP8266 Station or SoftAP will send data in the fixed rate. • If the `enable_mask` is 0, both ESP8266 Station and SoftAP will not send data in the fixed rate. • ESP8266 Station and SoftAP share the same rate, they can not be set to different data rates.

3.6.2. wifi_get_user_fixed_rate

Function	Get the fixed rate and mask of ESP8266.
Prototype	`int wifi_get_user_fixed_rate(uint8 *enable_mask, uint8 *rate)`

Parameter	`uint8 *enable_mask`: pointer of the `enable_mask`. `uint8 *rate`: pointer of the fixed rate.
Return	0: Success otherwise: Failure

3.6.3. wifi_set_user_sup_rate

Function	Set the rate range in the IE of support rate in ESP8266's beacon, probe req/resp and other packets. Tell other devices about the rate range supported by ESP8266 to limit the rate of sending packets from other devices.

Parameter	`enum support_rate {`
	`RATE_11B5M = 0,`
	`RATE_11B11M = 1,`
	`RATE_11B1M = 2,`
	`RATE_11B2M = 3,`
	`RATE_11G6M = 4,`
	`RATE_11G12M = 5,`
	`RATE_11G24M = 6,`
	`RATE_11G48M = 7,`
	`RATE_11G54M = 8,`
	`RATE_11G9M = 9,`
	`RATE_11G18M = 10,`
	`RATE_11G36M = 11,`
	`};`

Prototype	`int wifi_set_user_sup_rate(uint8 min, uint8 max)`
Parameter	`uint8 min`: the minimum value of the support rate, according to enum support_rate. `uint8 max`: the maximum value of the support rate, according to enum support_rate.
Return	0: Success otherwise: Failure
Example	`wifi_set_user_sup_rate(RATE_11G6M, RATE_11G24M);`
Note	This API can only support 802.11g now, but it will support 802.11b in next version.

3.6.4. wifi_set_user_rate_limit

Function	Limit the initial rate of sending data from ESP8266. The rate of retransmission is not limited by this API.

Parameter Definition	enum RATE_11B_ID {
	RATE_11B_B11M = 0,
	RATE_11B_B5M = 1,
	RATE_11B_B2M = 2,
	RATE_11B_B1M = 3,
	}
	enum RATE_11G_ID {
	RATE_11G_G54M = 0,
	RATE_11G_G48M = 1,
	RATE_11G_G36M = 2,
	RATE_11G_G24M = 3,
	RATE_11G_G18M = 4,
	RATE_11G_G12M = 5,
	RATE_11G_G9M = 6,
	RATE_11G_G6M = 7
	RATE_11G_B5M = 8,
	RATE_11G_B2M = 9,
	RATE_11G_B1M = 10
	}
	enum RATE_11N_ID {
	RATE_11N_MCS7S = 0,
	RATE_11N_MCS7 = 1,
	RATE_11N_MCS6 = 2,
	RATE_11N_MCS5 = 3,
	RATE_11N_MCS4 = 4,
	RATE_11N_MCS3 = 5,
	RATE_11N_MCS2 = 6,
	RATE_11N_MCS1 = 7,
	RATE_11N_MCS0 = 8,
	RATE_11N_B5M = 9,
	RATE_11N_B2M = 10,
	RATE_11N_B1M = 11
	}

Prototype	`bool wifi_set_user_rate_limit(uint8 mode, uint8 ifidx, uint8 max, uint8 min)`

Parameter	`uint8 mode`: Wi-Fi mode
	`#define RC_LIMIT_11B          0`
	`#define RC_LIMIT_11G          1`
	`#define RC_LIMIT_11N          2`
	`uint8 ifidx`: interface of ESP8266
	• `0x00`: ESP8266 Station
	• `0x01`: ESP8266 SoftAP
	`uint8 max`: the maximum value of the rate, according to the enum rate corresponding to the first parameter mode.
	`uint8 min`: the minimum value of the rate, according to the enum rate corresponding to the first parameter mode.

Return	true: Success false: Failure

Example	`// Set the rate limitation of ESP8266 Station in 11G mode, 6M ~ 18M.`
	`wifi_set_user_rate_limit(RC_LIMIT_11G, 0, RATE_11G_G18M, RATE_11G_G6M);`

3.6.5. wifi_set_user_limit_rate_mask

Function	Set the interfaces of ESP8266 whose rate of sending packets is limited by `wifi_set_user_rate_limit`.

Definition	`#define LIMIT_RATE_MASK_NONE    (0x00)`
	`#define LIMIT_RATE_MASK_STA     (0x01)`
	`#define LIMIT_RATE_MASK_AP            (0x02)`
	`#define LIMIT_RATE_MASK_ALL     (0x03)`

Prototype	`uint8 wifi_get_user_limit_rate_mask(void)`
Parameter	`uint8 enable_mask:` `0x00` - disable the limitation on both ESP8266 Station and SoftAP; `0x01` - enable the limitation on ESP8266 Station; `0x02` - enable the limitation on ESP8266 SoftAP; `0x03` - enable the limitation on both ESP8266 Station and SoftAP.
Return	true: Success false: Failure

3.6.6. wifi_get_user_limit_rate_mask

Function	Get the interfaces of ESP8266 whose rate of sending data is limited by `wifi_set_user_rate_limit`.
Prototype	`uint8 wifi_get_user_limit_rate_mask(void)`
Parameter	none
Return	`0x00`: both ESP8266 Station and SoftAP are not limited. `0x01`: ESP8266 Station is limited. `0x02`: ESP8266 SoftAP is limited. `0x03`: both ESP8266 Station and SoftAP are limited.

3.7. Force Sleep APIs

Force Sleep APIs can be found in: ***/ESP8266_NONOS_SDK/include/user_interface.h***.

`wifi_set_opmode` has to be set to NULL_MODE before entering forced sleep mode. Then users need to wake ESP8266 up from sleep, or wait till the sleep time out and enter the wakeup callback (register by `wifi_fpm_set_wakeup_cb`). Disable the force sleep function by `wifi_fpm_close` before setting Wi-Fi mode back to normal mode.

Timer will prevent the chip from entering Light-sleep mode, please disable all timers in application before entering Light-sleep.

For more details please see ***3.7.9 Example***.

3.7.1. wifi_fpm_open

Function	Enable force sleep function.
Prototype	`void wifi_fpm_open (void)`
Parameter	none
Return	none
Default	Force sleep function is disabled.

3.7.2. wifi_fpm_close

Function	Disable force sleep function.
Prototype	`void wifi_fpm_close (void)`
Parameter	none
Return	none

3.7.3. wifi_fpm_do_wakeup

Function	Wake ESP8266 up from `MODEM_SLEEP_T` force sleep.
Prototype	`void wifi_fpm_do_wakeup (void)`
Parameter	none
Return	none
Note	This API can only be called when `MODEM_SLEEP_T` force sleep function is enabled, after calling `wifi_fpm_open`. This API can not be called after calling `wifi_fpm_close`.

3.7.4. wifi_fpm_set_wakeup_cb

Function	Set a wake-up callback function to be called on wake-up from force sleep because of timeout.
Prototype	`void wifi_fpm_set_wakeup_cb(void (*fpm_wakeup_cb_func)(void))`
Parameter	`void (*fpm_wakeup_cb_func)(void) : callback on wake-up`
Return	none
Note	This API can only be called when force sleep function is enabled, after calling `wifi_fpm_open`. This API can not be called after calling `wifi_fpm_close`. `fpm_wakeup_cb_func` will be called after system wakes up only if the force sleep time out (`wifi_fpm_do_sleep` and the parameter is not 0xFFFFFFF). fpm_wakeup_cb_func will not be called if wake-up is caused by `wifi_fpm_do_wakeup` from `MODEM_SLEEP_T` type force sleep.

3.7.5. wifi_fpm_do_sleep

Function	Force ESP8266 to enter sleep mode, and it will wake up automatically on time out.
Prototype	`int8 wifi_fpm_do_sleep (uint32 sleep_time_in_us)`
Parameter	`uint32 sleep_time_in_us`: sleep time, ESP8266 will wake up automatically on time out. Unit: us. Range: 10000 ~ 268435455(0xFFFFFFF) • If `sleep_time_in_us` is 0xFFFFFFF, the ESP8266 will sleep till be woke up as below: • If `wifi_fpm_set_sleep_type` is set to be `LIGHT_SLEEP_T`, ESP8266 can wake up by GPIO. • If `wifi_fpm_set_sleep_type` is set to be `MODEM_SLEEP_T`, ESP8266 can wake up by `wifi_fpm_do_wakeup`.
Return	0, setting successful; -1, failed to sleep, sleep status error; -2, failed to sleep, force sleep function is not enabled.
Note	This API can only be called when force sleep function is enabled, after calling `wifi_fpm_open`. This API can not be called after calling `wifi_fpm_close`. `fpm_wakeup_cb_func` will be called after system wakes up only if the force sleep time out (`wifi_fpm_do_sleep` and the parameter is not 0xFFFFFFF). fpm_wakeup_cb_func will not be called if wake-up is caused by `wifi_fpm_do_wakeup` from `MODEM_SLEEP_T` type force sleep.

3.7.6. wifi_fpm_set_sleep_type

Function	Set sleep type for force sleep function.
Prototype	`void wifi_fpm_set_sleep_type (enum sleep_type type)`

Parameter	`enum sleep_type{`
	`NONE_SLEEP_T = 0,`
	`LIGHT_SLEEP_T,`
	`MODEM_SLEEP_T,`
	`};`

Return	none
Note	This API can only be called before `wifi_fpm_open`.

3.7.7. wifi_fpm_get_sleep_type

Function	Get sleep type of force sleep function.
Prototype	`enum sleep_type wifi_fpm_get_sleep_type (void)`
Parameter	none

Return	`enum sleep_type{`
	`NONE_SLEEP_T = 0,`
	`LIGHT_SLEEP_T,`
	`MODEM_SLEEP_T,`
	`};`

3.7.8. wifi_fpm_auto_sleep_set_in_null_mode

Function	Set whether enter modem sleep mode automatically or not after disabled Wi-Fi mode (`wifi_set_opmode(NULL_MODE)`).
Prototype	`void wifi_fpm_auto_sleep_set_in_null_mode (uint8 req)`
Parameter	`uint8 req`: • 0: disable auto-sleep function; • 1: enable auto modem sleep when Wi-Fi mode is `NULL_MODE`.
Return	none

3.7.9. Example

For example, forced sleep interface can be called, the RF circuit can be closed mandatorily so as to lower the power.

> 📖 ***Note:***
>
> *When forced sleep interface is called, the chip will not enter sleep mode instantly, it will enter sleep mode when the system is executing idle task. Please refer to the below sample code.*

Example one: Modem-sleep mode (disabling RF)

```
#define FPM_SLEEP_MAX_TIME      0xFFFFFFF
```

```
 void fpm_wakup_cb_func1(void)
{
   wifi_fpm_close();                            // disable force sleep function
   wifi_set_opmode(STATION_MODE);               // set station mode
   wifi_station_connect();                      // connect to AP
}
void user_func(...)
{
   wifi_station_disconnect();
   wifi_set_opmode(NULL_MODE);                  // set WiFi mode to null mode.
   wifi_fpm_set_sleep_type(MODEM_SLEEP_T);      // modem sleep
   wifi_fpm_open();                             // enable force sleep

 #ifdef SLEEP_MAX
 /* For modem sleep, FPM_SLEEP_MAX_TIME can only be wakened by calling
wifi_fpm_do_wakeup. */
   wifi_fpm_do_sleep(FPM_SLEEP_MAX_TIME);
#else
   // wakeup automatically when timeout.
   wifi_fpm_set_wakeup_cb(fpm_wakup_cb_func1);  // Set wakeup callback
   wifi_fpm_do_sleep(50*1000);
#endif
}

  #ifdef SLEEP_MAX
void func1(void)
{
    wifi_fpm_do_wakeup();
    wifi_fpm_close();                         // disable force sleep function
    wifi_set_opmode(STATION_MODE);            // set station mode
    wifi_station_connect();                   // connect to AP
}
#endif
```

Example two: Light-sleep mode (disabling RF and CPU)

```
#define FPM_SLEEP_MAX_TIME      0xFFFFFFFF

void fpm_wakup_cb_func1(void)
{
   wifi_fpm_close();                    // disable force sleep function
   wifi_set_opmode(STATION_MODE);       // set station mode
   wifi_station_connect();              // connect to AP
}

#ifndef SLEEP_MAX
// Wakeup till time out.
void user_func(...)
{
   wifi_station_disconnect();
   wifi_set_opmode(NULL_MODE);          // set WiFi mode to null mode.
   wifi_fpm_set_sleep_type(LIGHT_SLEEP_T);      // light sleep
   wifi_fpm_open();                     // enable force sleep
   wifi_fpm_set_wakeup_cb(fpm_wakup_cb_func1); // Set wakeup callback
   wifi_fpm_do_sleep(50*1000);
}

#else

// Or wake up by GPIO
void user_func(...)
{
   wifi_station_disconnect();
   wifi_set_opmode(NULL_MODE);                  // set WiFi mode to null mode.
   wifi_fpm_set_sleep_type(LIGHT_SLEEP_T);      // light sleep
   wifi_fpm_open();                     // enable force sleep
```

```
  PIN_FUNC_SELECT(PERIPHS_IO_MUX_MTDI_U, FUNC_GPIO12);

   wifi_enable_gpio_wakeup(12, GPIO_PIN_INTR_LOLEVEL);

   wifi_fpm_set_wakeup_cb(fpm_wakup_cb_func1);   // Set wakeup callback
   wifi_fpm_do_sleep(FPM_SLEEP_MAX_TIME);
   ...
}
#endif
```

3.8. ESP-NOW APIs

ESP-NOW APIs can be found in: ***/ESP8266_NONOS_SDK/include/espnow.h***.

More details about ESP-NOW are in *ESP-NOW User Guide*. Please note the following points carefully:

- ESP-NOW does not support multicast.
- For ***ESP8266_NONOS_SDK_V2.1*** and later versions, ESP-NOW supports sending broadcast packets; however, please make sure that the packets are unencrypted.
- It is suggested that slave and combo roles corresponding to SoftAP or SoftAP + Station mode, controller role corresponding to Station mode.
- When ESP8266 is in SoftAP + Station mode, it will communicate through SoftAP interface if it is in slave or combo role, and communicate through Station interface if it is in controller role.
- ESP-NOW can not wake ESP8266 up from sleep, so if the target ESP8266 Station is in sleep, ESP-NOW communication will fail.
- In station mode, ESP8266 supports 10 encrypt ESP-NOW peers at most, with the unencrypted peers, it can be 20 peers in total at most.
- In the SoftAP mode or SoftAP + Station mode, the ESP8266 supports 6 encrypt ESP-NOW peers at most, with the unencrypted peers, it can be 20 peers in total at most.

3.8.1. Roles of ESP-NOW

```
enum esp_now_role {
        ESP_NOW_ROLE_IDLE = 0,
        ESP_NOW_ROLE_CONTROLLER,
        ESP_NOW_ROLE_SLAVE,
        ESP_NOW_ROLE_COMBO,     // both slave and controller
        ESP_NOW_ROLE_MAX,
};
```

3.8.2. esp_now_init

Function	ESP-NOW initialization.
Prototype	`init esp_now_init(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.8.3. esp_now_deinit

Function	Deinitialize ESP-NOW.
Prototype	`int esp_now_deinit(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.8.4. esp_now_register_recv_cb

Function	Register ESP-NOW receive callback.
	When received an ESP-NOW packet, enter receive callback: `typedef void (*esp_now_recv_cb_t)(u8 *mac_addr, u8 *data, u8 len)` Parameters of ESP-NOW receive callback: `u8 *mac_addr`: MAC address of the sender `u8 *data`: data received `u8 len`: data length
Prototype	`int esp_now_register_recv_cb(esp_now_recv_cb_t cb)`
Parameter	`esp_now_recv_cb_t cb`: receive callback.
Return	0: Success otherwise: Failure

3.8.5. esp_now_unregister_recv_cb

Function	Unregister ESP-NOW receive callback.
Prototype	`int esp_now_unregister_recv_cb(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.8.6. esp_now_register_send_cb

Function	Register ESP-NOW send callback.
Prototype	`u8 esp_now_register_send_cb(esp_now_send_cb_t cb)`
Parameter	`esp_now_send_cb_t cb`: callback.

Return	0: Success otherwise: Failure

Note	ESP-NOW send callback:
	`void esp_now_send_cb_t(u8 *mac_addr, u8 status)`
	Parameter:
	`u8 *mac_addr`: MAC address of target device
	`u8 status`: status of ESP-NOW sending packet
	`mt_tx_status {`
	`MT_TX_STATUS_OK = 0,`
	`MT_TX_STATUS_FAILED,`
	`}`
	The status will be updated to `MT_TX_STATUS_OK`, if ESP-NOW send the packet successfully. Users must explicitly make sure that the key for communication is correct.
	The send callback can determine the status of a transmitted packet, however, please note the following points:
	• For unicast packet:
	- If the status is OK in the `esp_now_send_cb_t`, but the target device failed to receive the packet, the reasons may be as follows:
	1. It may have been corrupted by other unexpected devices;
	2. Incorrect key for communication;
	3. The application was lost or missed the packet.
	Solution: handshake mechanism should be used in application to get a high success rate with packet transmission.
	- If the status is FAIL in the `esp_now_send_cb_t`, but the target device does receive the packet, the reason may be that the sender fails to receive the ACK because of busy channel.
	Solution: the sender application should re-transmit the packet, and the receiver should detect the retransmitted packet.
	• For multicast packet (include broadcast packet):
	- If the status is OK in the `esp_now_send_cb_t`, it indicates that the packet is sent successfully.
	- If the status is FAIL in the `esp_now_send_cb_t`, it indicates that sending failed.

3.8.7. esp_now_unregister_send_cb

Function	Unregister ESP-NOW send callback.
Prototype	`int esp_now_unregister_send_cb(void)`

Parameter	none
Return	0: Success otherwise: Failure

3.8.8. esp_now_send

Function	Send ESP-NOW packets.
Prototype	`int esp_now_send(u8 *da, u8 *data, int len)`
Parameter	`u8 *da`: Destination MAC address. If it's NULL, the packet is sent to all MAC addresses recorded by ESP-NOW; otherwise, the packet is sent to the target MAC address only. `u8 *data`: data to be sent. `int len`: data length.
Return	0: Success otherwise: Failure

3.8.9. esp_now_add_peer

Function	Add an ESP-NOW peer, store MAC address of target device into ESP-NOW MAC list.
Prototype	`int esp_now_add_peer(u8 *mac_addr, u8 role, u8 channel, u8 *key, u8 key_len)`
Parameter	`u8 *mac_addr`: MAC address of device. `u8 role`: role type of device; see `esp_now_role` for details. `u8 channel`: channel of device. `u8 *key`: 16 bytes key which is needed for ESP-NOW communication. `u8 key_len`: length of key, has to be 16 bytes now.
Return	0: Success otherwise: Failure

3.8.10. esp_now_del_peer

Function	Delete an ESP-NOW peer, delete MAC address of the device from ESP-NOW MAC list.
Prototype	`int esp_now_del_peer(u8 *mac_addr)`
Parameter	`u8 *mac_addr`: MAC address of device.
Return	0: Success otherwise: Failure

3.8.11. esp_now_set_self_role

Function	Set the ESP-NOW role of the device.
Prototype	`int esp_now_set_self_role(u8 role)`
Parameter	`u8 role`: role type; see `esp_now_role` for details.
Return	0: Success otherwise: Failure

3.8.12. esp_now_get_self_role

Function	Get the ESP-NOW role of the device.
Prototype	`u8 esp_now_get_self_role(void)`
Parameter	none
Return	Role type.

3.8.13. esp_now_set_peer_role

Function	Set the ESP-NOW role for a target device. If it is set more than one times, the new role setting will override the old role.
Prototype	`int esp_now_set_peer_role(u8 *mac_addr,u8 role)`
Parameter	`u8 *mac_addr`: MAC address of the target device. `u8 role`: role type; see `esp_now_role` for details.
Return	0: Success otherwise: Failure

3.8.14. esp_now_get_peer_role

Function	Get the ESP-NOW role of a target device.
Prototype	`int esp_now_get_peer_role(u8 *mac_addr)`
Parameter	`u8 *mac_addr`: MAC address of target device.
Return	`esp_now_role`: the role type otherwise: Failure

3.8.15. esp_now_set_peer_key

Function	Set ESP-NOW key for a target device. If it is set multiple times, the latest setting will be valid.

Prototype	`int esp_now_set_peer_key(u8 *mac_addr,u8 *key,u8 key_len)`
Parameter	`u8 *mac_addr`: MAC address of target device. `u8 *key`: 16 bytes key which is needed for ESP-NOW communication; if it is NULL, set the current key to be none. `u8 key_len`: key length; 16 bytes.
Return	0: Success otherwise: Failure

3.8.16. esp_now_get_peer_key

Function	Get ESP-NOW key of a target device.
Prototype	`int esp_now_set_peer_key(u8 *mac_addr,u8 *key,u8 *key_len)`
Parameter	`u8 *mac_addr`: MAC address of target device. `u8 *key`: pointer to the key, buffer size has to be 16 bytes at least. `u8 *key_len`: key length.
Return	0: Success > 0: Found target device but cannot get key < 0: Failure

3.8.17. esp_now_set_peer_channel

Function	Record channel information of an ESP-NOW device. To communicate with a device, • call `esp_now_get_peer_channel` to get its channel first; • then call `wifi_set_channel` to be on the same channel and continue further communication.
Prototype	`int esp_now_set_peer_channel(u8 *mac_addr,u8 channel)`
Parameter	`u8 *mac_addr`: MAC address of target device. `u8 channel`: channel, usually to be 1 ~ 13, some area may use channel 14.
Return	0: Success otherwise: Failure

3.8.18. esp_now_get_peer_channel

Function	Get channel information of a ESP-NOW device. ESP-NOW communication needs to be at the same channel.
Prototype	`int esp_now_get_peer_channel(u8 *mac_addr)`
Parameter	`u8 *mac_addr`: MAC address of the target device.

Return	1 ~ 13 (14 for some areas): Success otherwise: Failure

3.8.19. esp_now_is_peer_exist

Function	Check if target device exists or not.
Prototype	`int esp_now_is_peer_exist(u8 *mac_addr)`
Parameter	`u8 *mac_addr`: MAC address of the target device.
Return	0: Device does not exist. < 0: Error, check for device failed. > 0: Device exists.

3.8.20. esp_now_fetch_peer

Function	Get MAC address of ESP-NOW device which is pointed now, and move the pointer to next one in ESP-NOW MAC list or move the pointer to the first one in ESP-NOW MAC list.
Prototype	`u8 *esp_now_fetch_peer(bool restart)`
Parameter	`bool restart`: • true: move pointer to the first one in ESP-NOW MAC list; • false: move pointer to the next one in ESP-NOW MAC list.
Return	• none, no ESP-NOW devices exist; • Otherwise, MAC address of ESP-NOW device which is pointed now.
Note	This API can not re-entry. Parameter has to be true when you call it the first time.

3.8.21. esp_now_get_cnt_info

Function	Get the total number of ESP-NOW devices which are associated, and the number count of encrypted devices.
Prototype	`int esp_now_get_cnt_info(u8 *all_cnt, u8 *encryp_cnt)`
Parameter	`u8 *all_cnt`: total number of ESP-NOW devices which are associated. `u8 *encryp_cnt`: number count of encrypted devices.
Return	0: Success otherwise: Failure

3.8.22. esp_now_set_kok

Function	Set the encryption key for the communication key. All ESP-NOW devices share the same encrypt key. If users do not set the encrypt key, ESP-NOW communication key will be encrypted by a default key. If this API needs to be called, please call it before `esp_now_add_peer` and `esp_now_set_peer_key`.
Prototype	`int esp_now_set_kok(u8 *key, u8 len)`
Parameter	`u8 *key`: pointer of encryption key; `u8 len`: key length; 16 bytes.
Return	0: Success otherwise: Failure

3.9. Simple Pair APIs

Simple Pair APIs can be found in: ***/ESP8266_NONOS_SDK/include/simple_pair.h***.

3.9.1. Status of Simple Pair

```
typedef enum {
        SP_ST_STA_FINISH = 0,   // station finished negotiation
        SP_ST_AP_FINISH = 0,    // AP finished negotiation
        SP_ST_AP_RECV_NEG,      // AP received a request of negotiation from station
        SP_ST_STA_AP_REFUSE_NEG,        // station received the refusal to negotiate
from AP
        /* definitions below are error codes */
        SP_ST_WAIT_TIMEOUT,     // Error: time out
        SP_ST_SEND_ERROR,       // Error: error occur when sending data
        SP_ST_KEY_INSTALL_ERR,  // Error: error occur during key installation
        SP_ST_KEY_OVERLAP_ERR,  // Error: one MAC address uses multiple keys
        SP_ST_OP_ERROR,         // Error: operational error
        SP_ST_UNKNOWN_ERROR,    // Error: unknown error
        SP_ST_MAX,
} SP_ST_t;
```

3.9.2. register_simple_pair_status_cb

Function	Register a callback of status for status of simple pair.
Prototype	`init register_simple_pair_status_cb(simple_pair_status_cb_t cb)`
Callback Definition	`typedef void (*simple_pair_status_cb_t)(u8 *sa, u8 status);` Parameters: • `u8 *sa`: the MAC address of the remote device; • `u8 status`: status of simple pair, refer to `SP_ST_t`.
Parameter	`simple_pair_status_cb_t cb`: callback.
Return	0: Success otherwise: Failure

3.9.3. unregister_simple_pair_status_cb

Function	Unregister the callback of status of simple pair.
Prototype	`void unregister_simple_pair_status_cb(void)`
Parameter	none

Return	none

3.9.4. simple_pair_init

Function	Simple pair initialization.
Prototype	`int simple_pair_init(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.9.5. simple_pair_deinit

Function	Deinitialize simple pair.
Prototype	`int simple_pair_deinit(void)`
Parameter	none
Return	none

3.9.6. simple_pair_state_reset

Function	Reset the state of simple pair. When simple pair needs to be restarted again, this API can be called to reset the state.
Prototype	`int simple_pair_state_reset(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.9.7. simple_pair_ap_enter_announce_mode

Function	The AP peer of simple pair enters announce mode.
Prototype	`int simple_pair_ap_enter_announce_mode(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.9.8. simple_pair_sta_enter_scan_mode

Function	The station peer of simple pair enters scan mode.

Prototype	`int simple_pair_ap_enter_announce_mode(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.9.9. simple_pair_sta_start_negotiate

Function	The station peer of simple pair starts to negotiate.
Prototype	`int simple_pair_sta_start_negotiate(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.9.10. simple_pair_ap_start_negotiate

Function	The AP peer of simple pair agrees to negotiate.
Prototype	`int simple_pair_ap_start_negotiate(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.9.11. simple_pair_ap_refuse_negotiate

Function	The AP peer of simple pair refuses to negotiate.
Prototype	`int simple_pair_ap_refuse_negotiate(void)`
Parameter	none
Return	0: Success otherwise: Failure

3.9.12. simple_pair_set_peer_ref

Function	Set configuration of the peer which needs to negotiate. Note that this only sets the configuration of the peer, and does not install keys or perform any other relevant operations. If the device runs as the station peer, this API needs to be called before `simple_pair_sta_start_negotiate`. If the device runs as the AP peer, this API needs to be called before `simple_pair_ap_start_negotiate` or `simple_pair_ap_refuse_negotiate`.

Prototype	`int simple_pair_set_peer_ref(u8 *peer_mac, u8 *tmp_key, u8 *ex_key)`
Parameter	`u8 *peer_mac`: MAC address of the target peer of negotiation, length: 6 bytes, can NOT be null. `u8 *tmp_key`: a temporary key to encrypt the negotiation, length: 16 bytes, can NOT be null. `u8 *ex_key`: a key for exchange, length: 16 bytes. If it is null, the 0x0000…0000 will be used as the `ex_key` by default.
Return	0: Success otherwise: Failure

3.9.13. simple_pair_get_peer_ref

Function	Get the configuration of the negotiation. If passing a null pointer, the corresponding parameter will not be got.
Prototype	`int simple_pair_get_peer_ref(u8 *peer_mac, u8 *tmp_key, u8 *ex_key)`
Parameter	`u8 *peer_mac`: MAC address of the target peer of negotiation, length: 6 bytes. `u8 *tmp_key`: the temporary key to encrypt the negotiation, length: 16 bytes. `u8 *ex_key`: a key for exchange, length: 16 bytes. If it is null, the 0x0000…0000 will be used as the `ex_key` by default.
Return	0: Success otherwise: Failure

3.10. Upgrade (FOTA) APIs

FOTA APIs can be found in: ***/ESP8266_NONOS_SDK/include/user_interface.h & upgrade.h.***

3.10.1. system_upgrade_userbin_check

Function	Check user bin.
Prototype	`uint8 system_upgrade_userbin_check()`
Parameter	none
Return	`0x00`: `UPGRADE_FW_BIN1`, i.e. ***user1.bin***. `0x01`: `UPGRADE_FW_BIN2`, i.e. ***user2.bin***.

3.10.2. system_upgrade_flag_set

Function	Set upgrade status flag.
Prototype	`void system_upgrade_flag_set(uint8 flag)`

Parameter	`uint8 flag:`
	`#define UPGRADE_FLAG_IDLE      0x00`
	`#define UPGRADE_FLAG_START     0x01`
	`#define UPGRADE_FLAG_FINISH    0x02`

Return	none
Note	If you using `system_upgrade_start` to upgrade, this API need not be called. If you using `spi_flash_write` to upgrade firmware yourself, this flag need to be set to `UPGRADE_FLAG_FINISH`, then call `system_upgrade_reboot` to reboot to run new firmware.

3.10.3. system_upgrade_flag_check

Function	Get upgrade status flag.
Prototype	`uint8 system_upgrade_flag_check()`
Parameter	none

Return	`#define UPGRADE_FLAG_IDLE      0x00`
	`#define UPGRADE_FLAG_START     0x01`
	`#define UPGRADE_FLAG_FINISH    0x02`

3.10.4. system_upgrade_start

Function	Configure parameters and start upgrading.

Prototype	`bool system_upgrade_start (struct upgrade_server_info *server)`
Parameter	`struct upgrade_server_info *server`: server related parameters.
Return	`true`: start upgrade. `false`: upgrade cannot be started.

3.10.5. system_upgrade_reboot

Function	Reboot system and use new version.
Prototype	`void system_upgrade_reboot (void)`
Parameter	none
Return	none

3.11. Sniffer Related APIs

Sniffer APIs can be found in: ***/ESP8266_NONOS_SDK/include/user_interface.h***.

3.11.1. wifi_promiscuous_enable

Function	Enable promiscuous mode for sniffer.
Prototype	`void wifi_promiscuous_enable(uint8 promiscuous)`
Parameter	`uint8 promiscuous`: • 0: disable promiscuous; • 1: enable promiscuous
Return	none
Note	• Promiscuous mode can only be enabled in Station mode. • During promiscuous mode (sniffer), ESP8266 Station and SoftAP are disabled. • Before enable promiscuous mode, please call `wifi_station_disconnect` first. • Don't call any other APIs during sniffer, please call `wifi_promiscuous_enable(0)` first.

3.11.2. wifi_promiscuous_set_mac

Function	Set a destination MAC address filter for sniffer. It will filter all packets sent to the specific MAC address, including broadcast packets.
Prototype	`void wifi_promiscuous_set_mac(const uint8_t *address)`
Parameter	`const uint8_t *address`: MAC address
Return	none
Note	• This API should be called after calling `wifi_promiscuous_enable(1)`. • This filter only be available in the current sniffer phase, if you disable sniffer and then enable sniffer, you need to set filter again if you need it.

Example	`char ap_mac[6] = {0x16, 0x34, 0x56, 0x78, 0x90, 0xab};`
	`wifi_promiscuous_set_mac(ap_mac);`

3.11.3. wifi_set_promiscuous_rx_cb

Function	Registers an Rx callback function in promiscuous mode, which will be called when data packet is received.
Prototype	`void wifi_set_promiscuous_rx_cb(wifi_promiscuous_cb_t cb)`
Parameter	`wifi_promiscuous_cb_t cb`: callback
Return	none

3.11.4. wifi_get_channel

Function	Get Wi-Fi channel.
Prototype	`uint8 wifi_get_channel(void)`
Parameter	none
Return	Channel number.

3.11.5. wifi_set_channel

Function	Set Wi-Fi channel, for sniffer mode.
Prototype	`bool wifi_set_channel (uint8 channel)`
Parameter	`uint8 channel`: channel number
Return	true: Success false: Failure

3.12. Smart Config APIs

SmartConfig APIs can be found in ***/ESP8266_NONOS_SDK/include/smartconfig.h***.

AirKiss APIs can be found in **/ESP8266_NONOS_SDK/include/airkiss.h**.

Please make sure the target AP is enabled before enabling SmartConfig.

3.12.1. smartconfig_start

Function	Start smart configuration mode. Connect ESP8266 Station to AP, by sniffing for special packets from the air, containing SSID and password of desired AP. You need to broadcast the SSID and password (e.g. from mobile device or computer) with the SSID and password encoded.

Structure	`typedef enum {`
	`    SC_STATUS_WAIT = 0,       // Please don’t start connection in this phase`
	`    SC_STATUS_FIND_CHANNEL,   // Start connection by APP in this phase`
	`    SC_STATUS_GETTING_SSID_PSWD,`
	`    SC_STATUS_LINK,`
	`    SC_STATUS_LINK_OVER,      // Got IP, connect to AP successfully`
	`} sc_status;`
	`typedef enum {`
	`    SC_TYPE_ESPTOUCH = 0,`
	`    SC_TYPE_AIRKISS,`
	`} sc_type;`

Prototype	`bool smartconfig_start(`
	`   sc_callback_t cb,`
	`   uint8 log`
	`)`

Parameter	`sc_callback_t cb`: smart config callback; executed when smart-config status changed. Parameter status of this callback shows the status of smart-config: • If `status == SC_STATUS_GETTING_SSID_PSWD`, parameter `void *pdata` is a pointer of `sc_type`, means smart-config type: AirKiss or ESP-TOUCH. • If `status == SC_STATUS_LINK`, parameter `void *pdata` is a pointer of struct station_config; • If `status == SC_STATUS_LINK_OVER`, parameter `void *pdata` is a pointer of mobile phone’s IP address, 4 bytes. This is only available in ESPTOUCH, otherwise, it is NULL. • otherwise, parameter `void *pdata` is NULL. `uint8 log`: 1: UART outputs logs; otherwise: UART only outputs the result. It is suggested that this log is only used for debugging. Users should not set it to 1 while SmartConfig is working.

<table>
<tr><td><b>Return</b></td><td>true: Success
false: Failure</td></tr>
<tr><td><b>Example</b></td><td>

```
void ICACHE_FLASH_ATTR
smartconfig_done(sc_status status, void *pdata)
{
    switch(status) {
        case SC_STATUS_WAIT:
            os_printf("SC_STATUS_WAIT\n");
            break;
        case SC_STATUS_FIND_CHANNEL:
            os_printf("SC_STATUS_FIND_CHANNEL\n");
            break;
        case SC_STATUS_GETTING_SSID_PSWD:
            os_printf("SC_STATUS_GETTING_SSID_PSWD\n");
            sc_type *type = pdata;
            if (*type == SC_TYPE_ESPTOUCH) {
                os_printf("SC_TYPE:SC_TYPE_ESPTOUCH\n");
            } else {
                os_printf("SC_TYPE:SC_TYPE_AIRKISS\n");
            }
            break;
        case SC_STATUS_LINK:
            os_printf("SC_STATUS_LINK\n");
            struct station_config *sta_conf = pdata;
            wifi_station_set_config(sta_conf);
            wifi_station_disconnect();
                 wifi_station_connect();
            break;
        case SC_STATUS_LINK_OVER:
            os_printf("SC_STATUS_LINK_OVER\n");
                if (pdata != NULL) {
                uint8 phone_ip[4] = {0};
                memcpy(phone_ip, (uint8*)pdata, 4);
                os_printf("Phone ip: %d.%d.%d.
%d\n",phone_ip[0],phone_ip[1],phone_ip[2],phone_ip[3]);
                }
            smartconfig_stop();
            break;
    }
}
smartconfig_start(smartconfig_done);
```

</td></tr>
<tr><td><b>Note</b></td><td>

- This API can only be called in station mode.
- During smart-config, ESP8266 Station and SoftAP are disabled.
- Can not call `smartconfig_start` twice before it finish, please call `smartconfig_stop` first.
- Don't call any other APIs during smart-config, please call `smartconfig_stop` first.

</td></tr>
</table>

3.12.2. smartconfig_stop

Function	Stop smart config, free the buffer taken by `smartconfig_start`.
Prototype	`bool smartconfig_stop(void)`
Parameter	none
Return	true: Success false: Failure
Note	Irrespective of whether connection to AP succeeded or not, this API should be called to free memory taken by `smartconfig_start`.

3.12.3. smartconfig_set_type

Function	Set the protocol type of SmartConfig.
Prototype	`bool smartconfig_set_type(sc_type type)`

Parameter	`typedef enum {`
	`    SC_TYPE_ESPTOUCH = 0,`
	`    SC_TYPE_AIRKISS,`
	`    SC_TYPE_ESPTOUCH_AIRKISS,`
	`} sc_type;`

Return	true: Success false: Failure
Note	This API can only be called before calling `smartconfig_start`.

3.12.4. airkiss_version

Function	Get version information of the AirKiss lib.
Prototype	`const char* airkiss_version(void)`
Parameter	none
Return	Version information of the AirKiss lib.
Note	The length of the version information is unknown.

3.12.5. airkiss_lan_recv

Function	For the function that AirKiss can detect the ESP8266 devices in LAN, more details of this function refer to http://iot.weixin.qq.com. Workflow: Create a UDP transmission. When UDP data is received in espconn_recv_callback, call API airkiss_lan_recv and input the UDP data; if airkiss_lan_recv returns AIRKISS_LAN_SSDP_REQ, airkiss_lan_pack can be called to make a response packet. This API is to parse the UDP packet sent by WeChat.

Prototype	`int airkiss_lan_recv(`
	`const void* body,`
	`unsigned short length,`
	`const airkiss_config_t* config)`

Parameter	`const void* body`: the received UDP packet;
	`unsigned short length`: the length of UDP packet;
	`airkiss_config_t* config`: AirKiss structure.

Return	Refer to airkiss_lan_ret_t, >= 0: Success, < 0: Failure

3.12.6. airkiss_lan_pack

Function	User packet assembly for the function that AirKiss can detect the ESP8266 devices in LAN.

Prototype	`int airkiss_lan_pack(`
	`airkiss_lan_cmdid_t ak_lan_cmdid,`
	`void* appid,`
	`void* deviceid,`
	`void* _datain,`
	`unsigned short inlength,`
	`void* _dataout,`
	`unsigned short* outlength,`
	`const airkiss_config_t* config)`

Parameter	`airkiss_lan_cmdid_t ak_lan_cmdid`: packet type. `void* appid`: WeChat public number, got from WeChat. `void* deviceid`: device ID, got from WeChat. `void* _datain`: user data waiting for packet assembly. `unsigned short inlength`: length of the user data. `void* _dataout`: the packet got by `_datain` packet assembly. `unsigned short* outlength`: length of the packet. `const airkiss_config_t* config`: AirKiss structure.
Return	Refer to airkiss_lan_ret_t >= 0: Success, < 0: Failure

3.13. SNTP APIs

SNTP APIs can be found in: ***/ESP8266_NONOS_SDK/include/sntp.h***.

3.13.1. sntp_setserver

Function	Set SNTP server by IP address; it supports 3 SNTP servers at most.
Prototype	`void sntp_setserver(unsigned char idx, ip_addr_t *addr)`
Parameter	`unsigned char idx`: SNTP server index; 3 SNTP server is supported at most (0 ~ 2); index 0 is the main server, and index 1 and 2 are backups. `ip_addr_t *addr`: IP address; users need to ensure that it is an SNTP server.
Return	none

3.13.2. sntp_getserver

Function	Get IP address of SNTP server as set by `sntp_setserver`.
Prototype	`ip_addr_t sntp_getserver(unsigned char idx)`
Parameter	`unsigned char idx`: SNTP server index; supports 3 SNTP servers at most (0 ~ 2).
Return	IP address

3.13.3. sntp_setservername

Function	Set SNTP server by domain name; support 3 SNTP server at most.
Prototype	`void sntp_setservername(unsigned char idx, char *server)`
Parameter	`unsigned char idx`: SNTP server index, supports 3 SNTP servers at most (0 ~ 2); index 0 is the main server, and index 1 and 2 are as backup. `char *server`: domain name; users need to ensure that it is an SNTP server.
Return	none

3.13.4. sntp_getservername

Function	Get domain name of SNTP server which set by `sntp_setservername`.
Prototype	`char * sntp_getservername(unsigned char idx)`
Parameter	`unsigned char idx`: SNTP server index; supports 3 SNTP servers at most (0 ~ 2).
Return	Domain name

3.13.5. sntp_init

Function	Initialize SNTP.
Prototype	`void sntp_init(void)`
Parameter	none
Return	none

3.13.6. sntp_stop

Function	Stop SNTP.
Prototype	`void sntp_stop(void)`
Parameter	none
Return	none

3.13.7. sntp_get_current_timestamp

Function	Get current timestamp from basic time (1970.01.01 00:00:00 GMT + 8); uint: second.
Prototype	`uint32 sntp_get_current_timestamp()`
Parameter	none
Return	Time stamp

3.13.8. sntp_get_real_time

Function	Get real time(GMT + 8)
Prototype	`char* sntp_get_real_time(long t)`
Parameter	`long t`: time stamp
Return	Real time

3.13.9. sntp_set_timezone

Function	Set time zone.
Prototype	`bool sntp_set_timezone (sint8 timezone)`
Parameter	`sint8 timezone`: time zone; range:-11 ~ 13.
Return	true: Success false: Failure

Example	`sntp_stop();`
	`if( true == sntp_set_timezone(-5) ) {`
	`        sntp_init();`
	`}`

Note	Before calling `sntp_set_timezone`, please call `sntp_stop` first.

3.13.10.sntp_get_timezone

Function	Get time zone.
Prototype	`sint8 sntp_get_timezone (void)`
Parameter	none
Return	Time zone; range: -11 ~ 13.

3.13.11.SNTP Example

Step 1. Enable SNTP.

```
ip_addr_t *addr = (ip_addr_t *)os_zalloc(sizeof(ip_addr_t));
sntp_setservername(0, "us.pool.ntp.org"); // set server 0 by domain name
sntp_setservername(1, "ntp.sjtu.edu.cn"); // set server 1 by domain name
ipaddr_aton("210.72.145.44", addr);
sntp_setserver(2, addr); // set server 2 by IP address
sntp_init();
os_free(addr);
```

Step 2. Set a timer to check SNTP timestamp.

```
LOCAL os_timer_t sntp_timer;
os_timer_disarm(&sntp_timer);
os_timer_setfn(&sntp_timer, (os_timer_func_t *)user_check_sntp_stamp, NULL);
os_timer_arm(&sntp_timer, 100, 0);
```

Step 3. Timer Callback

```
void ICACHE_FLASH_ATTR user_check_sntp_stamp(void *arg){
        uint32 current_stamp;
        current_stamp = sntp_get_current_timestamp();
        if(current_stamp == 0){
                os_timer_arm(&sntp_timer, 100, 0);
        } else{
                os_timer_disarm(&sntp_timer);
                os_printf("sntp: %d, %s \n",current_stamp,
sntp_get_real_time(current_stamp));
        }
}
```

3.14. WPA2_Enterprise APIs

ESP8266 Station can connect to WPA2_Enterprise APs.

WPA2_Enterprise APIs can be found in ***/ESP8266_NONOS_SDK/include/wpa2_enterprise.h.***

3.14.1. wifi_station_set_wpa2_enterprise_auth

Function	Set authentication of WPA2_Enterprise. To connect to WPA2_Enterprise AP, `wifi_station_set_wpa2_enterprise_auth(1);` should be called first. For connecting to a regular AP at a later stage, `wifi_station_set_wpa2_enterprise_auth(0);` should be called to clear the WPA2_Enterprise status.
Prototype	`int wifi_station_set_wpa2_enterprise_auth(int enable)`
Parameter	`int enable`: • 0, disable authentication of WPA2_Enterprise, clear the status; • otherwise, enable authentication of WPA2_Enterprise.
Return	0: Success otherwise: Failure

3.14.2. wifi_station_set_enterprise_cert_key

Function	Set user certificate and private key for connecting to WPA2_Enterprise AP. It is used for EAP-TLS authentication.

Prototype	`int wifi_station_set_enterprise_cert_key (`
	`u8 *client_cert, int client_cert_len,`
	`u8 *private_key, int private_key_len,`
	`u8 *private_key_passwd, int private_key_passwd_len,)`

Parameter	`u8 *client_cert`: user certificate, HEX array `int client_cert_len`: length of certificate `u8 *private_key`: private key, HEX array, can NOT be longer than 2048 bits `int private_key_len`: length of private key, less than 2048 `u8 *private_key_passwd:` password for private key, to be supported, can only be NULL now. `int private_key_passwd_len`: length of password, to be supported, can only be 0 now.
Return	0: Success otherwise: Failure
Example	For example, the private key is - - - - - BEGIN PRIVATE KEY - - - - - … … … …, then array should be uint8 key[]={0x2d, 0x2d, 0x2d, 0x2d, 0x2d, 0x42, 0x45, 0x47, … … 0x00 }; It is the ASCII code for the characters, and the array needs to terminate with 0x00.

	• Connecting to WPA2-ENTERPRISE AP needs more than 26 KB memory, please ensure enough space (`system_get_free_heap_size`). • So far, WPA2-ENTERPRISE can only support unencrypted certificate and private key, and only in PEM format. - Header of certificate: - - - - - BEGIN CERTIFICATE - - - - - - Header of private key: - - - - - BEGIN RSA PRIVATE KEY - - - - - or - - - - - BEGIN PRIVATE KEY - - - - - • Please call this API to set certificate and private key before connecting to WPA2_ Enterprise AP and the application needs to hold the certificate and private key. Call `wifi_station_clear_enterprise_cert_key` to release resources and clear status after being connected to the target AP, and then the application can release the certificate and private key. • If the private key is encrypted, please use openssl pkey command to change it to unencrypted file to use, or use openssl rsa related commands to change it (or change the start TAG).

3.14.3. wifi_station_clear_enterprise_cert_key

Function	Release user certificate and private key resources and clear related status after being connected to the WPA2_Enterprise AP.
Prototype	`void wifi_station_clear_enterprise_cert_key (void)`
Parameter	none
Return	none

3.14.4. wifi_station_set_enterprise_ca_cert

Function	Set root certificate for connecting to WPA2_Enterprise AP. It is an option in EAP-TTLS/PEAP authentication.
Prototype	`int wifi_station_set_enterprise_ca_cert(u8 *ca_cert, int ca_cert_len)`
Parameter	`u8 *ca_cert`: root certificate, HEX array `int ca_cert_len`: length of root certificate
Return	0 : Success otherwise : Failure

3.14.5. wifi_station_clear_enterprise_ca_cert

Function	Release root certificate resources and clear related status after being connected to the WPA2_Enterprise AP.
Prototype	`void wifi_station_clear_enterprise_ca_cert (void)`
Parameter	none
Return	none

3.14.6. wifi_station_set_enterprise_username

Function	Set ESP8266 Station's user name for connecting to WPA2_Enterprise AP.
Prototype	`int wifi_station_set_enterprise_username (u8 *username, int len)`
Parameter	`u8 *username`: the user name `int len`: length of user name
Return	0: Success otherwise: Failure
Note	• For EAP-TTLS and EAP-PEAP authentication, the user name has to be set. It is used in phase 2 of the authentication, only the user name that the server supported can pass the authentication. • For EAP-TTLS and EAP-PEAP authentication, the user name is only an option. Without setting user name, the authentication can still be done anonymously.

3.14.7. wifi_station_clear_enterprise_username

Function	Release the user name resources and clear related status after being connected to the WPA2_Enterprise AP.
Prototype	`void wifi_station_clear_enterprise_username (void)`
Parameter	none
Return	none

3.14.8. wifi_station_set_enterprise_password

Function	Set the password for connecting to WPA2_Enterprise AP. It is used for EAP-TTLS / EAP-PEAP authentication.
Prototype	`int wifi_station_set_enterprise_password (u8 *password, int len)`
Parameter	`u8 *password`: the user password `int len`: length of the password
Return	0: Success otherwise: Failure

3.14.9. wifi_station_clear_enterprise_password

Function	Clear the password resources and clear related status data after being connected to the WPA2_Enterprise AP.
Prototype	`void wifi_station_clear_enterprise_password (void)`
Parameter	none
Return	none

3.14.10.wifi_station_set_enterprise_new_password

Function	Set the new password for connecting to WPA2_Enterprise AP. It is used for MSCHAPV2.
Prototype	`int wifi_station_set_enterprise_new_password (u8 *new_password, int len)`
Parameter	`u8 *new_password`: the new password `int len`: length of the password
Return	0: Success otherwise: Failure

3.14.11.wifi_station_clear_enterprise_new_password

Function	Release the new password resources and clear related status after being connected to the WPA2_Enterprise AP.
Prototype	`void wifi_station_clear_enterprise_new_password (void)`
Parameter	none
Return	none

3.14.12.wifi_station_set_enterprise_disable_time_check

Function	Determines whether expiration time is checked in authentication. The expiration time will not be checked by default.
Prototype	`void wifi_station_set_enterprise_disable_time_check (bool disable)`
Parameter	`bool disable`: • true, will NOT check the expiration time; • false, check the expiration time, `wpa2_enterprise_set_user_get_time` has to be called.
Return	none

3.14.13.wifi_station_get_enterprise_disable_time_check

Function	Check whether the expiration time will be observed in authentication.
Prototype	`bool wifi_station_get_enterprise_disable_time_check (void)`
Parameter	none
Return	True: will NOT check the expiration time False: check the expiration time

3.14.14.wpa2_enterprise_set_user_get_time

Function	Set time callback to get current time from user. wifi_station_set_enterprise_disable_time_check(false); should be called as the example below.
Prototype	void wpa2_enterprise_set_user_get_time(get_time_func_t cb)
Parameter	get_time_func_t cb: callback
Return	none

Example	static int sys_get_current_time(struct os_time *t) {
	        t->sec = CURRENT_TIME; // User set current time.
	         return 0;
	}
	//Set Callback
	wpa2_enterprise_set_user_get_time(sys_get_current_time);
	//Enable Time check
	wifi_station_set_enterprise_disable_time_check(false);

3.14.15.WPA2_Enterprise Work Flow

Here is the work flow that prepares ESP266 station to connect to WPA2_Enterprise AP.

- Call wifi_station_set_config to set the configuration of target AP.
- Call wifi_station_set_wpa2_enterprise_auth(1); to enable WPA2_Enterprise authentication.
  - For EAP-TLS authentication, call wifi_station_set_enterprise_cert_key to set certificate and private key. wifi_station_set_enterprise_username is an optional choice, it can be called to set user name.
  - For EAP-TTLS or EAP-PEAP authentication, call wifi_station_set_enterprise_username and wifi_station_set_enterprise_password to set user name and password. wifi_station_set_enterprise_ca_cert is an optional choice, it can be called to set root certificate.
- Call wifi_station_connect to connect to target AP.
- After being connected to an AP, or failing to connect to AP and on stopped retries, please call the corresponding wifi_station_clear_enterprise_XXX APIs to release the resources.

4. TCP/UDP APIs

Found in ***ESP8266_NONOS_SDK/include/espconn.h***. The network APIs can be grouped into the following types:

- General APIs: APIs can be used for both TCP and UDP .
- TCP APIs: APIs that are only used for TCP.
- UDP APIs: APIs that are only used for UDP.
- mDNS APIs: APIs that related to mDNS.

4.1. Generic TCP/UDP APIs

4.1.1. espconn_delete

Function	Delete a transmission.
Prototype	`sint8 espconn_delete(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding connected control block structure
Return	0: Success Otherwise: error, return error code • `ESPCONN_ARG`: illegal argument, cannot find network transmission according to structure espconn. • `ESPCONN_INPROGRESS`: the connection is still in progress; please call espconn_disconnect to disconnect before deleting it.
Note	Corresponding API: TCP: `espconn_accept`; UDP: `espconn_create`.

4.1.2. espconn_gethostbyname

Function	DNS

Prototype	`err_t espconn_gethostbyname(`
	`    struct espconn *pespconn,`
	`    const char *hostname,`
	`    ip_addr_t *addr,`
	`    dns_found_callback found`
	`)`

Parameter	`struct espconn *espconn`: corresponding connected control block structure `const char *hostname`: domain name string pointer `ip_addr_t *addr`: IP address `dns_found_callback found`: callback
Return	`err_t`: • `ESPCONN_OK`: Success. • `ESPCONN_INPROGRESS`: Error code : already connected. • `ESPCONN_ARG`: Error code: illegal argument; cannot find network transmission according to structure `espconn`.
Note	Corresponding creation API: TCP: `espconn_accept`; UDP: `espconn_create`.

Example	`ip_addr_t esp_server_ip;`
	`LOCAL void ICACHE_FLASH_ATTR`
	`user_esp_platform_dns_found(const char *name, ip_addr_t *ipaddr, void *arg) {`
	`    struct espconn *pespconn = (struct espconn *)arg;`
	`            if (ipaddr != NULL)`
	`     os_printf(user_esp_platform_dns_found %d.%d.%d.%d/n,`
	`        *((uint8 *)&ipaddr->addr), *((uint8 *)&ipaddr->addr + 1),`
	`        *((uint8 *)&ipaddr->addr + 2), *((uint8 *)&ipaddr->addr + 3));`
	`}`
	`void dns_test(void) {`
	`    espconn_gethostbyname(pespconn,"iot.espressif.cn", &esp_server_ip,`
	`            user_esp_platform_dns_found);`
	`}`

4.1.3. espconn_port

Function	Get an available port.
Prototype	`uint32 espconn_port(void)`
Parameter	none
Return	`uint32`: ID of the port you get

4.1.4. espconn_regist_sentcb

Function	Register data sent function which will be called back when data are successfully sent.

Prototype	`sint8 espconn_regist_sentcb(`
	`    struct espconn *espconn,`
	`    espconn_sent_callback sent_cb`
	`)`

Parameter	`struct espconn *espconn`: corresponding connected control block structure `espconn_sent_callback sent_cb`: registered callback function
Return	`0`: Success `Otherwise`: Error code `ESPCONN_ARG`: illegal argument; cannot find network transmission according to structure `espconn`.

4.1.5. espconn_regist_recvcb

Function	Register data receive function which will be called back when data is received.

Prototype	`sint8 espconn_regist_recvcb(`
	`    struct espconn *espconn,`
	`    espconn_recv_callback recv_cb`
	`)`

Parameter	`struct espconn *espconn`: corresponding connected control block structure; `espconn_connect_callback connect_cb`: registered callback function.
Return	`0`: Success `Otherwise`: Error code `ESPCONN_ARG`: illegal argument; cannot find network transmission according to structure `espconn`.

4.1.6. espconn_sent_callback

Function	Callback after the data are sent.
Prototype	`void espconn_sent_callback (void *arg)`
Parameter	`void *arg`: pointer corresponding structure `espconn`. This pointer may be different in different callbacks, please don't use this pointer directly to distinguish one from another in multiple connections, use `remote_ip` and `remote_port` in `espconn` instead.
Return	none

4.1.7. espconn_recv_callback

Function	Callback after data are received.

Prototype	`void espconn_recv_callback (`
	`    void *arg,`
	`    char *pdata,`
	`    unsigned short len`
	`)`

Parameter	void *arg: pointer corresponding structure espconn. This pointer may be different in different callbacks, please don't use this pointer directly to distinguish one from another in multiple connections, use remote_ip and remote_port in espconn instead. char *pdata: received data entry parameters. unsigned short len: received data length.
Return	none

4.1.8. espconn_get_connection_info

Function	Get the information about a TCP connection or UDP transmission. Usually used in the espconn_recv_callback.
Prototype	sint8 espconn_get_connection_info(struct espconn *espconn, remot_info **pcon_info, uint8 typeflags)
Parameter	• struct espconn *espconn: corresponding connected control block structure; • remot_info **pcon_info: connect to client info; • uint8 typeflags: - 0, regular server; - 1, ssl server.
Return	0: Success

Example	`void user_udp_recv_cb(void *arg, char *pusrdata, unsigned short length)`
	`{`
	`    struct espconn *pesp_conn = arg;`
	`    remot_info *premot = NULL;`
	`    if (espconn_get_connection_info(pesp_conn,&premot,0) == ESPCONN_OK){`
	`        pesp_conn->proto.tcp->remote_port = premot->remote_port;`
	`        pesp_conn->proto.tcp->remote_ip[0] = premot->remote_ip[0];`
	`        pesp_conn->proto.tcp->remote_ip[1] = premot->remote_ip[1];`
	`        pesp_conn->proto.tcp->remote_ip[2] = premot->remote_ip[2];`
	`        pesp_conn->proto.tcp->remote_ip[3] = premot->remote_ip[3];`
	`        espconn_sent(pesp_conn, pusrdata, os_strlen(pusrdata));`
	`    }`
	`}`

4.1.9. espconn_send

Function	Send data through network.

Prototype	`sint8 espconn_send(`
	`    struct espconn *espconn,`
	`    uint8 *psent,`
	`    uint16 length`
	`)`

Parameter	`struct espconn *espconn`: corresponding connected control block structure; `uint8 *psent`: pointer of sent data; `uint16 length`: data length.
Return	0: Success Otherwise: Error code • `ESPCONN_MEM`: Out of memory; • `ESPCONN_ARG`: illegal argument; cannot find network transmission according to structure `espconn`; • `ESPCONN_MAXNUM`: buffer (or 8 packets at most) of sending data is full; • `ESPCONN_IF`: fail to send UDP data.
Note	• Please call `espconn_send` after `espconn_sent_callback` of the pre-packet. • If it is a UDP transmission, please set `espconn->proto.udp->remote_ip` and `remote_port` before every calling of `espconn_send`.

4.1.10. espconn_sent

[@deprecated] This API is deprecated, please use espconn_send instead.

Function	Send data through network.

Prototype	`sint8 espconn_send(`
	`    struct espconn *espconn,`
	`    uint8 *psent,`
	`    uint16 length`
	`)`

Parameter	struct espconn *espconn: corresponding connected control block structure; uint8 *psent: pointer of sent data; uint16 length: data length.
Return	0: Success Otherwise: Error code • ESPCONN_MEM: Out of memory; • ESPCONN_ARG: illegal argument; cannot find network transmission according to structure espconn; • ESPCONN_MAXNUM: buffer (or 8 packets at most) of sending data is full; • ESPCONN_IF: fail to send UDP data.
Note	• Please call espconn_send after espconn_sent_callback of the pre-packet. • If it is a UDP transmission, please set espconn->proto.udp->remote_ip and remote_port before every calling of espconn_send.

4.2. TCP APIs

TCP APIs act only on TCP connections and do not affect nor apply to UDP connections.

4.2.1. espconn_accept

Function	Creates a TCP server (i.e. accepts connections).
Prototype	`sint8 espconn_accept(struct espconn *espconn)`
Parameter	struct espconn *espconn: corresponding connected control block structure.
Return	0: Success Otherwise: Error code • ESPCONN_MEM: Out of memory; • ESPCONN_ISCONN: Already connected; • ESPCONN_ARG: illegal argument; cannot find TCP connection according to structure espconn.

4.2.2. espconn_regist_time

Function	Register timeout interval of ESP8266 TCP server.

Prototype	`sint8 espconn_regist_time(`
	`        struct espconn *espconn,`
	`        uint32 interval,`
	`        uint8 type_flag`
	`)`

Parameter	`struct espconn *espconn`: corresponding connected control block structure; `uint32 interval`: timeout interval; unit: second; maximum: 7200 seconds; `uint8 type_flag`: 0, set all connections; 1, set a single connection.
Return	0: Success. `ESPCONN_ARG`: illegal argument, cannot find TCP connection according to structure `espconn`.
Note	• Call this API after `espconn_accept`, before listening to a TCP connection. This API can not be used for SSL connection. • This timeout interval is not precise. Please use it only as a reference. • If timeout is set to 0, timeout will be disabled and ESP8266 TCP server will not disconnect if a TCP client has stopped communication. This usage of `timeout=0`, is deprecated.

4.2.3. espconn_connect

Function	Connect to a TCP server (ESP8266 acting as TCP client).
Prototype	`sint8 espconn_connect(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding connected control block structure.
Return	0: Success Otherwise: Error code • `ESPCONN_RTE`: Routing Problem • `ESPCONN_MEM`: Out of memory • `ESPCONN_ISCONN`: Already connected • `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.
Note	If `espconn_connect` fails, returns otherwise value. There is no connection, so it won't enter any `espconn` callback. It is recommended to use `espconn_port` to get an available local port.

4.2.4. espconn_regist_connectcb

Function	Register a connected callback which will be called on successful TCP connection.

Prototype	`sint8 espconn_regist_connectcb(`
	`        struct espconn *espconn,`
	`        espconn_connect_callback connect_cb`
	`)`

Parameter	`struct espconn *espconn`: corresponding connected control block structure; `espconn_connect_callback connect_cb`: registered callback function.
Return	0: Success Otherwise: error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.

4.2.5. espconn_connect_callback

Function	Callback for successful connection (ESP8266 as TCP server or ESP8266 as TCP client). Callback can be registered by `espconn_regist_connectcb`.
Prototype	`void espconn_connect_callback (void *arg)`
Parameter	`void *arg`: pointer to corresponding structure `espconn`. This pointer may be different in different callbacks. Please don't use this pointer directly to distinguish one from another in multiple connections; use `remote_ip` and `remote_port` in `espconn` instead.
Return	none

4.2.6. espconn_set_opt

Function	Set configuration options for TCP connection.
Prototype	`sint8 espconn_set_opt( struct espconn *espconn, uint8 opt)`

Structure	`enum espconn_option{`
	`        ESPCONN_START = 0x00,`
	`        ESPCONN_REUSEADDR = 0x01,`
	`        ESPCONN_NODELAY = 0x02,`
	`        ESPCONN_COPY = 0x04,`
	`        ESPCONN_KEEPALIVE = 0x08,`
	`        ESPCONN_END`
	`}`

Parameter	• struct espconn *espconn: corresponding connected control structure. • uint8 opt: options for TCP connection; please refer to espconn_option. - bit 0: 1: free memory after TCP disconnection. Need not wait for 2 minutes. - bit 1: 1: disable nagle algorithm during TCP data transmission, thus quickening the data transmission. - bit 2: 1: enable espconn_regist_write_finish. Enter write finish callback once the data has been sent using espconn_send (data was written to 2920 bytes write-buffer for sending or has already been sent). - bit 3: 1: enable TCP keep alive.
Return	0: Success Otherwise: error code ESPCONN_ARG: illegal argument; cannot find TCP connection according to structure espconn.

4.2.7. espconn_clear_opt

Function	Clear option of TCP connection.

Prototype	`sint8 espconn_clear_opt(`
	`        struct espconn *espconn,`
	`        uint8 opt`
	`)`

Structure	`enum espconn_option{`
	`        ESPCONN_START = 0x00,`
	`        ESPCONN_REUSEADDR = 0x01,`
	`        ESPCONN_NODELAY = 0x02,`
	`        ESPCONN_COPY = 0x04,`
	`        ESPCONN_KEEPALIVE = 0x08,`
	`        ESPCONN_END`
	`}`

Parameter	struct espconn *espconn: corresponding connected control block structure uint8 opt: option of TCP connection, refer to espconn_option.
Return	0: Success Otherwise: error code ESPCONN_ARG: illegal argument; cannot find TCP connection according to structure espconn.

4.2.8. espconn_set_keepalive

Function	Set configuration of TCP keep alive.
Prototype	`sint8 espconn_set_keepalive(struct espconn *espconn, uint8 level, void* optarg)`

Structure	`enum espconn_level{`
	`        ESPCONN_KEEPIDLE,`
	`        ESPCONN_KEEPINTVL,`
	`        ESPCONN_KEEPCNT`
	`}`

Parameter	• `struct espconn *espconn`: corresponding connected control block structure • `uint8 level`: Default to do TCP keep-alive detection every `ESPCONN_KEEPIDLE`, if there in no response, retry `ESPCONN_KEEPCNT` times every `ESPCONN_KEEPINTVL`. If there is still no response, it is considered as a broken TCP connection and program calls `espconn_reconnect_callback`. Please note that keep alive interval is not precise, only for reference, it depends on priority. Description: - `ESPCONN_KEEPIDLE`: TCP keep-alive interval; unit:second. - `ESPCONN_KEEPINTVL`: packet interval during TCP keep-alive; unit: second. - `ESPCONN_KEEPCNT`: maximum packet count of TCP keep-alive. • `void* optarg`: value of parameter.
Return	0: Success Otherwise: error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.
Note	In general, this API need not be called. If needed, please call it in `espconn_connect_callback` and call `espconn_set_opt` to enable keep alive first.

4.2.9. espconn_get_keepalive

Function	Get value of TCP keep-alive parameter.
Prototype	`sint8 espconn_set_keepalive(struct espconn *espconn, uint8 level, void* optarg)`

Structure	`enum espconn_level{`
	`        ESPCONN_KEEPIDLE,`
	`        ESPCONN_KEEPINTVL,`
	`        ESPCONN_KEEPCNT`
	`}`

Parameter	• `struct espconn *espconn`: corresponding connected control block structure. • `uint8 level`: - `ESPCONN_KEEPIDLE`: TCP keep-alive interval; unit:second. - `ESPCONN_KEEPINTVL`: packet interval during TCP keep-alive; unit: second. - `ESPCONN_KEEPCNT`: maximum packet count of TCP keep-alive. • `void* optarg`: value of parameter.
Return	0: Success Otherwise: error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.

4.2.10. espconn_reconnect_callback

Function	This callback is entered when an error occurs, TCP connection broken. This callback is registered by `espconn_regist_reconcb`.
Prototype	`void espconn_reconnect_callback (void *arg, sint8 err)`

Structure	`enum espconn_level{`
	`ESPCONN_KEEPIDLE,`
	`ESPCONN_KEEPINTVL,`
	`ESPCONN_KEEPCNT`
	`}`

Parameter	• `void *arg`: pointer corresponding structure `espconn`. This pointer may be different in different callbacks, please do not use this pointer directly to distinguish one from another in multiple connections, use `remote_ip` and `remote_port` in `espconn` instead. • `sint8 err`: error code - `ESCONN_TIMEOUT`: Timeout. - `ESPCONN_ABRT`: TCP connection aborted. - `ESPCONN_RST`: TCP connection reset. - `ESPCONN_CLSD`: TCP connection closed. - `ESPCONN_CONN`: TCP connection fails. - `ESPCONN_HANDSHAKE`: TCP SSL handshake fails. - `ESPCONN_PROTO_MSG`: SSL application is invalid.
Return	none

4.2.11. espconn_regist_reconcb

Function	Register reconnection callback.

Prototype	`sint8 espconn_regist_reconcb(`
	`        struct espconn *espconn,`
	`        espconn_reconnect_callback recon_cb`
	`)`

Structure	`enum espconn_level{`
	`        ESPCONN_KEEPIDLE,`
	`        ESPCONN_KEEPINTVL,`
	`        ESPCONN_KEEPCNT`
	`}`

Parameter	• `struct espconn *espconn`: corresponding connected control block structure; • `espconn_reconnect_callback recon_cb`: registered callback function.
Return	0: Success. Otherwise: Error code `ESPCONN_ARG`: illegal argument, cannot find TCP connection according to structure `espconn`.
Note	`espconn_reconnect_callback` is more like a network-broken error handler; it handles errors that occurs in any phase of the connection. For instance, if `espconn_send` fails, the network is assumed to have broken and `espconn_reconnect_callback`.

4.2.12. espconn_disconnect

Function	Disconnect a TCP connection.
Prototype	`sint8 espconn_disconnect(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding connected control structure.
Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument, cannot find TCP connection according to structure `espconn`.
Note	Do not call this API in any espconn callback. If needed, please use `system_os_task` and `system_os_post` to trigger `espconn_disconnect`.

4.2.13. espconn_regist_disconcb

Function	Disconnect a TCP connection. Register disconnection function which will be called back under successful TCP disconnection.

Prototype	`sint8 espconn_regist_disconcb(`
	`        struct espconn *espconn,`
	`        espconn_connect_callback discon_cb`
	`)`

Parameter	• `struct espconn *espconn`: corresponding connected control block structure. • `espconn_connect_callback connect_cb`: registered callback function.

Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument, cannot find TCP connection according to structure `espconn`.

4.2.14. espconn_abort

Function	Forcefully abort a TCP connection.
Prototype	`sint8 espconn_abort(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding network connection.
Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.
Note	Do not call this API in any `espconn` callback. If needed, please use `system_os_task` and `system_os_post` to trigger `espconn_abort`.

4.2.15. espconn_regist_write_finish

Function	Get the number of maximum TCP connections allowed.
Prototype	`uint8 espconn_tcp_get_max_con(void)`
Parameter	none
Return	Maximum number of TCP connections allowed.

4.2.16. espconn_tcp_get_max_con

Function	Get the number of maximum TCP connections allowed.
Prototype	`uint8 espconn_tcp_get_max_con(void)`
Parameter	none
Return	Maximum number of TCP connections allowed.

4.2.17. espconn_tcp_set_max_con

Function	Set the maximum number of TCP connections allowed.
Prototype	`sint8 espconn_tcp_set_max_con(uint8 num)`
Parameter	`uint8 num`: Maximum number of TCP connections allowed.
Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.

4.2.18. espconn_tcp_get_max_con_allow

Function	Get the maximum number of TCP clients allowed to connect to ESP8266 TCP server.
Prototype	`sint8 espconn_tcp_get_max_con_allow(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding network connection.
Return	> 0: Maximum number of TCP clients allowed. < 0: Error code `ESPCONN_ARG`: illegal argument, cannot find TCP connection according to structure `espconn`.

4.2.19. espconn_tcp_set_max_con_allow

Function	Get the maximum number of TCP clients allowed to connect to ESP8266 TCP server.
Prototype	`sint8 espconn_tcp_set_max_con_allow(struct espconn *espconn, uint8 num)`
Parameter	• `struct espconn *espconn`: corresponding network connection. • `uint8 num`: Maximum number of TCP clients allowed.
Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.

4.2.20. espconn_recv_hold

Function	Puts in a request to block the TCP receive function.
Prototype	`sint8 espconn_recv_hold(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding network connection.
Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.

4.2.21. espconn_recv_unhold

Function	Unblock TCP receiving data (i.e. undo `espconn_recv_hold`).
Prototype	`sint8 espconn_recv_unhold(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding network connection.
Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.

Note	This API takes effect immediately.

4.2.22. espconn_secure_accept

Function	Creates an SSL TCP server.
Prototype	`sint8 espconn_secure_accept(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding network connection.
Return	0: Success Otherwise: Error code • `ESPCONN_MEM`: Out of memory. • `ESPCONN_ISCONN`: Already connected. • `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.
Note	• This API can be called only once. Only one SSL server is allowed to be created, and only one SSL client can be connected. • If the SSL encrypted packet size is larger than ESP8266's SSL buffer size (default 2 KB, set by `espconn_secure_set_size`), SSL connection will fail. ESP8266 will enter `espconn_reconnect_callback`. • SSL-related APIs named as `espconn_secure_XXX` are different from normal TCP APIs and must not be used interchangeably. In SSL connection, only `espconn_secure_XXX` APIs, `espconn_regist_XXXcb` APIs and `espconn_port` can be used. • Users should call API `espconn_secure_set_default_certificate` and `espconn_secure_set_default_private_key` to set SSL certificate and secure key first.

4.2.23. espconn_secure_delete

Function	Delete the SSL connection when ESP8266 runs as SSL server.
Prototype	`sint8 espconn_secure_delete(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding SSL connection.
Return	0: Success; Otherwise: Error, return error code. • `ESPCONN_ARG`: illegal argument, cannot find network transmission according to structure `espconn`. • `ESPCONN_INPROGRESS`: the SSL connection is still in progress, please call `espconn_secure_disconnect` to disconnect before deleting it.

4.2.24. espconn_secure_set_size

Function	Set buffer size of encrypted data (SSL).
Prototype	`bool espconn_secure_set_size (uint8 level, uint16 size)`
Parameter	• `uint8 level`: set buffer for ESP8266 SSL server/client: - `0x01`: SSL client; - `0x02`: SSL server; - `0x03`: both SSL client and SSL server • `uint16 size`: buffer size; range: 1 ~ 8192; unit: byte, default to be 2048.
Return	true: Success false: Failure
Note	The default buffer size is 2 KB. Please call this API before `espconn_secure_accept` (ESP8266 as TCP SSL server) or `espconn_secure_connect` (ESP8266 as TCP SSL client) to change buffer size.

4.2.25. espconn_secure_get_size

Function	Get buffer size of encrypted data (SSL).
Prototype	`sint16 espconn_secure_get_size (uint8 level)`
Parameter	`uint8 level`: buffer for ESP8266 SSL server/client: • `0x01`: SSL client; • `0x02`: SSL server; • `0x03`: both SSL client and SSL server
Return	buffer size

4.2.26. espconn_secure_connect

Function	Securely connect (SSL) to a TCP server (ESP8266 acts as TCP client).
Prototype	`sint8 espconn_secure_connect (struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding network connection
Return	0: Success Otherwise: Error code • `ESPCONN_MEM`: Out of memory. • `ESPCONN_ISCONN`: Already connected. • `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.

	• If espconn_connect fails, a otherwise value will be returned. TCP connection fails and and therefore the ESP8266 will not enter any espconn callback. • Only one connection is allowed when the ESP8266 acts as a SSL client. This API can be called only once. Users can call espconn_secure_disconnect to disconnect first before calling this API to create another SSL connection. • If the SSL encrypted packet size is larger than the ESP8266 SSL buffer size (2 KB by default, set by espconn_secure_set_size), the SSL connection will fail. The ESP8266 will enter espconn_reconnect_callback • SSL-related APIs named as espconn_secure_XXX are different from normal TCP APIs and must not be used interchangeably. In SSL connection, only espconn_secure_XXX APIs, espconn_regist_XXXcb APIs and espconn_port can be used.

4.2.27. espconn_secure_send

Function	Send encrypted data (SSL).

Prototype	`sint8 espconn_secure_send (`
	`struct espconn *espconn,`
	`uint8 *psent,`
	`uint16 length`
	`)`

Parameter	struct espconn *espconn: corresponding network connection. uint8 *psent: sent data pointer. uint16 length: sent data length.
Return	0: Success Otherwise: Error code ESPCONN_ARG: illegal argument; cannot find TCP connection according to structure espconn.
Note	• Please call espconn_secure_send after espconn_sent_callback of the pre-packet. • The unencrypted data can be 1024 bytes at most per packet; the encrypted data can be 1460 bytes at most per packet.

4.2.28. espconn_secure_sent

[@deprecated] This API is deprecated; please use espconn_secure_send instead.

Function	Send encrypted data (SSL).

Prototype	`sint8 espconn_secure_send (`
	`struct espconn *espconn,`
	`uint8 *psent,`
	`uint16 length`
	`)`

Parameter	`struct espconn *espconn`: corresponding network connection `uint8 *psent`: sent data pointer `uint16 length`: sent data length
Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.
Note	• Please call `espconn_secure_send` after `espconn_sent_callback` of the pre-packet. • The unencrypted data can be 1024 bytes at most per packet; the encrypted data can be 1460 bytes at most per packet.

4.2.29. espconn_secure_disconnect

Function	Secure TCP disconnection(SSL).
Prototype	`sint8 espconn_secure_disconnect(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding network connection
Return	0: Success Otherwise: Error code `ESPCONN_ARG`: illegal argument; cannot find TCP connection according to structure `espconn`.
Note	Do not call this API in any `espconn` callback. If needed, please use `system_os_task` and `system_os_post` to trigger `espconn_secure_disconnect`.

4.2.30. espconn_secure_ca_enable

Function	Enable SSL CA (certificate authenticate) function.
Prototype	`bool espconn_secure_ca_enable (uint8 level, uint32 flash_sector)`
Parameter	• `uint8 level`: set configuration for ESP8266 SSL server/client: - `0x01`: SSL client; - `0x02`: SSL server; - `0x03`: both SSL client and SSL server. • `uint32 flash_sector`: flash sector in which CA (***esp_ca_cert.bin***) is downloaded. For example, if the `flash_sector` is 0x3B, then ***esp_ca_cert.bin*** must be downloaded to flash at 0x3B000.
Return	true: Success false: Failure

Note	- CA function is disabled by default. For more information please see ESP8266 SDK SSL User_Manual. - This API must be called before `espconn_secure_accept` (when the ESP8266 acts as TCP SSL server) or `espconn_secure_connect` (when the ESP8266 acts as TCP SSL client).

4.2.31. espconn_secure_ca_disable

Function	Disable SSL CA (certificate authenticate) function.
Prototype	`bool espconn_secure_ca_disable (uint8 level)`
Parameter	`uint8 level`: set configuration for ESP8266 SSL server/client: - `0x01`: SSL client; - `0x02`: SSL server; - `0x03`: both SSL client and SSL server.
Return	true: Success false: Failure
Note	CA function is disabled by default. For more information please see ESP8266 SDK SSL User_Manual.

4.2.32. espconn_secure_cert_req_enable

Function	Enable certification verification function when the ESP8266 runs as SSL client.
Prototype	`bool espconn_secure_cert_req_enable (uint8 level, uint32 flash_sector)`
Parameter	`uint8 level`: can only be set as `0x01` when ESP8266 runs as SSL client; `uint32 flash_sector`: set the address where secure key (***esp_cert_private_key.bin***) will be written in the flash. For example, parameters 0x3A should be written into address 0x3A000 in the flash. Please note that the secure key written into flash must not overlap with code binaries or system parameter binaries in the flash memory.
Return	true: Success false: Failure
Note	- Certification verification function is disabled by defaults. If the SSL server does not require certification verification, this API need not be called. - This API must be called before `espconn_secure_connect` is called.

4.2.33. espconn_secure_cert_req_disable

Function	Disable certification verification function when ESP8266 runs as SSL client.

Prototype	`bool espconn_secure_ca_disable (uint8 level)`
Parameter	`uint8 level`: can only be set as `0x01` when ESP8266 runs as SSL client.
Return	true: Success false: Failure
Note	Certification verification function is disabled by defaults.

4.2.34. espconn_secure_set_default_certificate

Function	Set the certificate when ESP8266 runs as SSL server.
Prototype	`bool espconn_secure_set_default_certificate (const uint8_t* certificate, uint16_t length)`
Parameter	`const uint8_t* certificate`: pointer to the certificate; `uint16_t length`: length of the certificate.
Return	true: Success false: Failure
Note	• Demos can be found in ***ESP8266_NONOS_SDK/examples/IoT_Demo***; • This API has to be called before espconn_secure_accept.

4.2.35. espconn_secure_set_default_private_key

Function	Set the secure key when ESP8266 runs as SSL server.
Prototype	`bool espconn_secure_set_default_private_key (const uint8_t* key, uint16_t length)`
Parameter	`const uint8_t* certificate`: pointer to the certificate; `uint16_t length`: length of the certificate.
Return	true: Success false: Failure
Note	• Demos can be found in ***ESP8266_NONOS_SDK/examples/IoT_Demo***; • This API has to be called before `espconn_secure_accept`.

4.3. UDP APIs

4.3.1. espconn_create

Function	Create UDP transmission.
Prototype	`sin8 espconn_create(struct espconn *espconn)`
Parameter	`struct espconn *espconn`: corresponding network transmission.

Return	0: Success Otherwise: Error code • ESPCONN_ISCONN: Already connected. • ESPCONN_MEM: Out of memory. • ESPCONN_ARG: illegal argument, cannot find UDP transmission according to structure espconn.
Note	Parameter remote_ip and remote_port need to be set. Do not set them to be 0.

4.3.2. espconn_sendto

Function	Send UDP data.
Prototype	`sin16 espconn_sendto(struct espconn *espconn, uint8 *psent, uint16 length)`
Parameter	struct espconn *espconn: corresponding network transmission uint8 *psent: pointer of data uint16 length: data length
Return	0: Success Otherwise: Error code • ESPCONN_ISCONN: Already connected. • ESPCONN_MEM: Out of memory. • ESPCONN_ARG: illegal argument, cannot find UDP transmission according to structure espconn.

4.3.3. espconn_igmp_join

Function	Join a multicast group.
Prototype	`sint8 espconn_igmp_join(ip_addr_t *host_ip, ip_addr_t *multicast_ip)`
Parameter	ip_addr_t *host_ip: IP of host ip_addr_t *multicast_ip: IP of multicast group
Return	0: Success Otherwise: Error code ESPCONN_MEM: Out of memory.
Note	This API can only be called after the ESP8266 Station connects to a router.

4.3.4. espconn_igmp_leave

Function	Quit a multicast group.
Prototype	`sint8 espconn_igmp_leave(ip_addr_t *host_ip, ip_addr_t *multicast_ip)`

Parameter	`ip_addr_t *host_ip`: IP of host `ip_addr_t *multicast_ip`: IP of multicast group
Return	0: Success Otherwise: Error code `ESPCONN_MEM`: Out of memory.

4.3.5. espconn_dns_setserver

Function	Set default DNS server. Two DNS servers are allowed to be set.
Prototype	`void espconn_dns_setserver(uint8 numdns, ip_addr_t *dnsserver)`
Parameter	`uint8 numdns`: DNS server ID, 0 or 1 `ip_addr_t *dnsserver`: DNS server IP
Return	none
Note	Only when ESP8266 DHCP client is disabled (`wifi_station_dhcpc_stop`) can this API be used.

4.3.6. espconn_dns_getserver

Function	Get DNS server IP.
Prototype	`ip_addr_t espconn_dns_getserver(uint8 numdns)`
Parameter	`uint8 numdns`: DNS server ID, 0 or 1
Return	DNS server IP

4.4. mDNS APIs

4.4.1. espconn_mdns_init

Function	mDNS initialization

Structure	`struct mdns_info{`
	`        char *host_name;`
	`        char *server_name;`
	`        uint16 server_port;`
	`        unsigned long ipAddr;`
	`        char *txt_data[10];`
	`};`

Prototype	`void espconn_mdns_init(struct mdns_info *info)`
Parameter	`struct mdns_info *info`: mDNS information
Return	none
Example	• In SoftAP + Station mode, call `wifi_set_broadcast_if` (`STATIONAP_MODE`); first to enable broadcast for both SoftAP and Station interface. • Using Station interface, please obtain IP address of the ESP8266 Station first before calling the API to initialize mDNS; • `txt_data` has to be set as "key = value".

4.4.2. espconn_mdns_close

Function	Close mDNS, corresponding creation API: `espconn_mdns_init`.
Prototype	`void espconn_mdns_close(void)`
Parameter	none
Return	none

4.4.3. espconn_mdns_server_register

Function	Register mDNS server.
Prototype	`void espconn_mdns_server_register(void)`
Parameter	none
Return	none

4.4.4. espconn_mdns_server_unregister

Function	Unregister mDNS server.
Prototype	`void espconn_mdns_server_unregister(void)`

Parameter	none
Return	none

4.4.5. espconn_mdns_get_servername

Function	Get mDNS server name.
Prototype	`char* espconn_mdns_get_servername(void)`
Parameter	none
Return	server name

4.4.6. espconn_mdns_set_servername

Function	Set mDNS server name.
Prototype	`void espconn_mdns_set_servername(const char *name)`
Parameter	`const char *name`: server name.
Return	none

4.4.7. espconn_mdns_set_hostname

Function	Set mDNS host name.
Prototype	`void espconn_mdns_set_hostname(char *name)`
Parameter	`char *name`: host name.
Return	none

4.4.8. espconn_mdns_get_hostname

Function	Get mDNS host name.
Prototype	`char* espconn_mdns_get_hostname(void)`
Parameter	none
Return	host name.

4.4.9. espconn_mdns_enable

Function	Enable mDNS.
Prototype	`void espconn_mdns_enable(void)`
Parameter	none
Return	none

4.4.10. espconn_mdns_disable

Function	Disable mDNS, corresponding creation API: `espconn_mdns_enable`.
Prototype	`void espconn_mdns_disable(void)`
Parameter	none
Return	none

4.4.11. Example of mDNS

Please do not use special characters (for example, "." character), or use a protocol name (for example, "http"), when defining `host_name` and `server_name` for mDNS.

```
struct mdns_info info;

void user_mdns_config()

{

        struct ip_info ipconfig;

        wifi_get_ip_info(STATION_IF, &ipconfig);

        info->host_name = "espressif";
        info->ipAddr = ipconfig.ip.addr; //ESP8266 Station IP
        info->server_name = "iot";
        info->server_port = 8080;
        info->txt_data[0] = "version = now";
        info->txt_data[1] = "user1 = data1";
        info->txt_data[2] = "user2 = data2";
        espconn_mdns_init(&info);

}
```

5. Mesh APIs

For more information on Mesh, please see document *ESP8266 Mesh User Guide*.

6. Application-Related APIs

6.1. AT APIs

AT APIs can be found in ***/ESP8266_NONOS_SDK/include/at_custom.h***.

For AT APIs examples, refer to ***ESP8266_NONOS_SDK/examples/at***.

6.1.1. at_response_ok

Function	Output `OK` to AT Port (UART0).
Prototype	`void at_response_ok(void)`
Parameter	none
Return	none

6.1.2. at_response_error

Function	Output `OK` to AT Port (UART0).
Prototype	`void at_response_ok(void)`
Parameter	none
Return	none

6.1.3. at_cmd_array_regist

Function	Register user-defined AT commands. It can be called only once to register all user-defined AT commands.

Prototype	`void at_cmd_array_regist (`
	`at_function * custom_at_cmd_arrar,`
	`uint32 cmd_num`
	`)`

Parameter	`at_function * custom_at_cmd_arrar`: Array of user-defined AT commands; `uint32 cmd_num:` Number counts of user-defined AT commands.
Return	none
Example	For examples please refer to ***ESP8266_NONOS_SDK/examples/at/user/user_main.c***.

6.1.4. at_get_next_int_dec

Function	Parse int from AT command.

Prototype	`bool at_get_next_int_dec (char **p_src,int* result,int* err)`
Parameter	• `char **p_src`: `*p_src` is the AT command that need to be parsed; • `int* result`: int number parsed from the AT command; • `int* err`: - 1: no number is found; - 3: only "`-`" is found.
Return	true: parser succeeds (Notes: if no number is found, it will return True, but returns error code 1); false: parser is unable to parse string; some probable causes are: int number is more than 10 bytes; string contains termination characters `\r`; string contains only `-`.
Example	For examples please refer to ***ESP8266_NONOS_SDK/examples/at/user/user_main.c***.

6.1.5. at_data_str_copy

Function	Parse string from AT command.
Prototype	`int32 at_data_str_copy (char * p_dest, char ** p_src,int32 max_len)`
Parameter	`char * p_dest`: string parsed from the AT command. `char ** p_src`: *p_src is the AT command that needs to be parsed. `int32 max_len`: max string length allowed.
Return	length of string: • >=0: Success, and returns the length of the string; • <0 : Failure, and returns -1.
Example	For examples please refer to ***ESP8266_NONOS_SDK/examples/at/user/user_main.c***.

6.1.6. at_init

Function	Initialize AT.
Prototype	`void at_init (void)`
Parameter	none
Return	none
Example	For examples please refer to ***ESP8266_NONOS_SDK/examples/at/user/user_main.c***.

6.1.7. at_port_print

Function	Output string to AT port (UART0).
Prototype	`void at_port_print(const char *str)`
Parameter	`const char *str`: string that need to output.
Return	none
Example	For examples please refer to ***ESP8266_NONOS_SDK/examples/at/user/user_main.c***.

6.1.8. at_set_custom_info

Function	User-defined version info of AT which can be got by AT+GMR.
Prototype	`void at_set_custom_info (char *info)`
Parameter	`char *info`: version info.
Return	none
Example	For examples please refer to ***ESP8266_NONOS_SDK/examples/at/user/user_main.c***.

6.1.9. at_enter_special_state

Function	Enter processing state. In processing state, AT core will return `busy` for any further AT commands.
Prototype	`void at_enter_special_state (void)`
Parameter	none
Return	none

6.1.10. at_leave_special_state

Function	Exit from AT processing state.
Prototype	`void at_leave_special_state (void)`
Parameter	none
Return	none

6.1.11. at_get_version

Function	Get Espressif AT lib version.
Prototype	`uint32 at_get_version (void)`

Parameter	none
Return	Espressif AT lib version.

6.1.12. at_register_uart_rx_intr

Function	Set UART0 to be used by user or AT commands.
Prototype	`void at_register_uart_rx_intr(at_custom_uart_rx_intr rx_func)`
Parameter	`at_custom_uart_rx_intr`: register a UART0 Rx interrupt handler so that UART0 can be used by the customer; but if it is NULL, UART0 is assigned to AT commands.
Return	none

Example	`void user_uart_rx_intr(uint8* data, int32 len)`
	`{`
	`        // UART0 rx for user`
	`        os_printf("len=%d \r\n",len);`
	`        os_printf(data);`
	
	`        // change UART0 for AT`
	`        at_register_uart_rx_intr(NULL);`
	`}`
	`void user_init(void){ at_register_uart_rx_intr(user_uart_rx_intr); }`

Note	• This API can be called multiple times. • When running AT, UART0 is used by AT commands by default.

6.1.13. at_response

Function	Set AT response.
Prototype	`void at_response (const char *str)`
Parameter	`const char *str`: string
Return	none
Note	• `at_response` outputs from UART0 Tx by default, which is same as `at_port_print`. • On `calling at_register_response_func`, the string of `at_response` will be the parameter of `response_func`.

6.1.14. at_register_response_func

Function	Register callback of `at_response` for user-defined responses. After calling `at_register_response_func`, the string of `at_response` will be the parameter of response_func. Users can define this behavior.
Prototype	`void at_register_response_func (at_custom_response_func_type response_func)`
Parameter	`at_custom_response_func_type`: callback of `at_response`.
Return	none

6.1.15. at_fake_uart_enable

Function	Enable UART simulation, which can be used to develop AT commands through SDIO or network.
Prototype	`bool at_fake_uart_enable(bool enable, at_fake_uart_tx_func_type func)`
Parameter	`bool enable`: enable UART simulation. `at_fake_uart_tx_func_type func`: callback for UART Tx simulation.
Return	true: Success false: Failure

6.1.16. at_fake_uart_rx

Function	UART Rx; can be used to develop AT commands through SDIO or network.
Prototype	`uint32 at_fake_uart_rx(uint8* data, uint32 length)`
Parameter	`uint8* data`: data for UART(simulation) Rx; `uint32 length`: length of data.
Return	If successful, the return value will be equal to `length`, otherwise, the API fails to perform its function.

6.1.17. at_set_escape_character

Function	Set an escape character for AT commands. The default escape character is \.
Prototype	`bool at_set_escape_character(uint8 ch)`
Parameter	`uint8 ch`: escape character, can be character !, or #, or $, or @, or &, or \.
Return	true: Success false: Failure

6.2. Related JSON APIs

Found in ***ESP8266_NONOS_SDK/include/json/jsonparse.h & jsontree.h***.

6.2.1. jsonparse_setup

Function	Initialize JSON parser.

Prototype	`void jsonparse_setup(`
	`        struct jsonparse_state *state,`
	`        const char *json,`
	`        int len`
	`)`

Parameter	`struct jsonparse_state *state`: JSON parsing pointer. `const char *json`: JSON parsing character string. `int len`: character string length.
Return	none

6.2.2. jsonparse_next

Function	Returns next object of JSONparse.
Prototype	`int jsonparse_next(struct jsonparse_state *state)`
Parameter	`struct jsonparse_state *state`: JSON parsing pointer.
Return	`int`: parsing result.

6.2.3. jsonparse_copy_value

Function	Copies current parsing character string to a certain buffer.

Prototype	`int jsonparse_copy_value(`
	`    struct jsonparse_state *state,`
	`    char *str,`
	`    int size`
	`)`

Parameter	`struct jsonparse_state *state`: JSON parsing pointer. `char *str:` buffer pointer. `int size`: buffer size.
Return	`int`: copy result.

6.2.4. jsonparse_get_value_as_int

Function	Parse JSON to get integer.

Prototype	`int jsonparse_get_value_as_int(struct jsonparse_state *state)`
Parameter	`struct jsonparse_state *state`: JSON parsing pointer.
Return	`int`: parsing result.

6.2.5. jsonparse_get_value_as_long

Function	Parse JSON to get long integer.
Prototype	`long jsonparse_get_value_as_long(struct jsonparse_state *state)`
Parameter	`struct jsonparse_state *state`: JSON parsing pointer.
Return	`long`: parsing result.

6.2.6. jsonparse_get_len

Function	Get parsed JSON length.
Prototype	`long jsonparse_get_value_as_long(struct jsonparse_state *state)`
Parameter	`struct jsonparse_state *state`: JSON parsing pointer.
Return	`long`: parsing JSON result.

6.2.7. jsonparse_get_value_as_type

Function	Parse JSON data type.
Prototype	`int jsonparse_get_value_as_type(struct jsonparse_state *state)`
Parameter	`struct jsonparse_state *state`: JSON parsing pointer.
Return	`int`: parsed JSON data type.

6.2.8. jsonparse_strcmp_value

Function	Compare parsed JSON and certain character string.
Prototype	`int jsonparse_strcmp_value(struct jsonparse_state *state, const char *str)`
Parameter	`struct jsonparse_state *state`: JSON parsing pointer; `const char *str`: character buffer.
Return	`int`: comparison result.

6.2.9. jsontree_set_up

Function	Create JSON data tree.

Prototype	`void jsontree_setup(`
	`        struct jsontree_context *js_ctx,`
	`        struct jsontree_value *root,`
	`        int (* putchar)(int)`
	`)`

Parameter	`struct jsontree_context *js_ctx`: JSON data tree pointer;
	`struct jsontree_value *root`: root element pointer;
	`int (* putchar)(int)`: input function.

Return	none

6.2.10. jsontree_reset

Function	Resets JSON tree.
Prototype	`void jsontree_reset(struct jsontree_context *js_ctx)`
Parameter	`struct jsontree_context *js_ctx`: JSON data tree pointer;
Return	none

6.2.11. jsontree_path_name

Function	Get JSON tree parameters.

Prototype	`const char *jsontree_path_name(`
	`        const struct jsontree_cotext *js_ctx,`
	`        int depth`
	`)`

Parameter	`struct jsontree_context *js_ctx`: JSON data tree pointer; `int depth`: JSON tree depth
Return	`char*`: parameter pointer

6.2.12. jsontree_write_int

Function	Write integer to JSON tree.

Prototype	`void jsontree_write_int(`
	`        const struct jsontree_context *js_ctx,`
	`        int value`
	`)`

Parameter	`struct jsontree_context *js_ctx`: JSON data tree pointer; `int value`: integer value
Return	none

6.2.13. jsontree_write_int_array

Function	Write integer array to JSON tree.

Prototype	`void jsontree_write_int_array(`
	`        const struct jsontree_context *js_ctx,`
	`        const int *text,`
	`        uint32 length`
	`)`

Parameter	`struct jsontree_context *js_ctx`: JSON data tree pointer;
	`int *text`: array entry address;
	`uint32 length`: array length.

Return	none

6.2.14. jsontree_write_string

Function	Writes string to JSON tree.

Prototype	`void jsontree_write_string(`
	`        const struct jsontree_context *js_ctx,`
	`        const char *text`
	`)`

Parameter	`struct jsontree_context *js_ctx`: JSON data tree pointer; `const char* text`: character string pointer.
Return	none

6.2.15. jsontree_print_next

Function	JSON tree depth.
Prototype	`int jsontree_print_next(struct jsontree_context *js_ctx)`
Parameter	`struct jsontree_context *js_ctx`: JSON data tree pointer.
Return	JSON tree depth.

6.2.16. jsontree_find_next

Function	Find JSON tree element.

Prototype	`struct jsontree_value *jsontree_find_next(`
	`        struct jsontree_context *js_ctx,`
	`        int type`
	`)`

Parameter	`struct jsontree_context *js_ctx`: JSON data tree pointer; `int`: type.
Return	`struct jsontree_value *`: JSON tree element pointer.

7. Definitions & Structures

7.1. Timer

```
typedef void ETSTimerFunc(void *timer_arg);
typedef struct _ETSTIMER_ {
    struct _ETSTIMER_    *timer_next;
    uint32_t              timer_expire;
    uint32_t              timer_period;
    ETSTimerFunc         *timer_func;
    void                 *timer_arg;
} ETSTimer;
```

7.2. Wi-Fi-Related Structures

7.2.1. Station Parameters

```
  struct station_config {
    uint8 ssid[32];
    uint8 password[64];
    uint8 bssid_set;
    uint8 bssid[6];
};
```

> ⚠ ***Notice:***
>
> *BSSID is the MAC address of AP, which will be used when several APs have the same SSID. If* `station_config.bssid_set==1`*,* `station_config.bssid` *has to be set; otherwise, the connection will fail. In general,* `station_config.bssid_set` *need to be 0.*

7.2.2. SoftAP Parameters

```
typedef enum _auth_mode {
    AUTH_OPEN = 0,
    AUTH_WEP,
    AUTH_WPA_PSK,
    AUTH_WPA2_PSK,
    AUTH_WPA_WPA2_PSK
} AUTH_MODE;
struct softap_config {
    uint8 ssid[32];
    uint8 password[64];
    uint8 ssid_len;
    uint8 channel;           // support 1 ~ 13
    uint8 authmode;          // Don’ t support AUTH_WEP in  SoftAP mode
    uint8 ssid_hidden;       // default 0
    uint8 max_connection;    // default 4, max 4
    uint16 beacon_interval;  // 100 ~ 60000 ms, default 100
};
```

> ⚠ ***Notice:***
>
> *If* `softap_config.ssid_len==0`*, SSID is checked till a termination character is found; otherwise, set the length of SSID according to* `softap_config.ssid_len`*.*

7.2.3. Scan Parameters

```
struct scan_config {
    uint8 *ssid;
    uint8 *bssid;
    uint8 channel;
    uint8 show_hidden; // Scan APs which are hiding their SSID or not.
};
struct bss_info {
    STAILQ_ENTRY(bss_info)     next;

    uint8 bssid[6];
    uint8 ssid[32];
    uint8 ssid_len;
    uint8 channel;
    sint8 rssi;
    AUTH_MODE authmode;
    uint8 is_hidden;    // SSID of current AP is hidden or not.
    sint16 freq_offset;         // AP’ s frequency offset
    sint16 freqcal_val;
    uint8 *esp_mesh_ie;
    uint8 simple_pair;
};
typedef void (* scan_done_cb_t)(void *arg, STATUS status);
```

7.2.4. Wi-Fi Event-Related Structures

```
enum {
    EVENT_STAMODE_CONNECTED = 0,
    EVENT_STAMODE_DISCONNECTED,
    EVENT_STAMODE_AUTHMODE_CHANGE,
    EVENT_STAMODE_GOT_IP,
    EVENT_STAMODE_DHCP_TIMEOUT,
    EVENT_SOFTAPMODE_STACONNECTED,
    EVENT_SOFTAPMODE_STADISCONNECTED,
    EVENT_SOFTAPMODE_PROBEREQRECVED,
    EVENT_OPMODE_CHANGED,
    EVENT_MAX
```

```
};

enum {
        REASON_UNSPECIFIED              = 1,
        REASON_AUTH_EXPIRE              = 2,
        REASON_AUTH_LEAVE               = 3,
        REASON_ASSOC_EXPIRE             = 4,
        REASON_ASSOC_TOOMANY            = 5,
        REASON_NOT_AUTHED               = 6,
        REASON_NOT_ASSOCED              = 7,
        REASON_ASSOC_LEAVE              = 8,
        REASON_ASSOC_NOT_AUTHED         = 9,
        REASON_DISASSOC_PWRCAP_BAD      = 10,  /* 11h */
        REASON_DISASSOC_SUPCHAN_BAD     = 11,  /* 11h */
        REASON_IE_INVALID               = 13,  /* 11i */
        REASON_MIC_FAILURE              = 14,  /* 11i */
        REASON_4WAY_HANDSHAKE_TIMEOUT   = 15,  /* 11i */
        REASON_GROUP_KEY_UPDATE_TIMEOUT = 16,  /* 11i */
        REASON_IE_IN_4WAY_DIFFERS       = 17,  /* 11i */
        REASON_GROUP_CIPHER_INVALID     = 18,  /* 11i */
        REASON_PAIRWISE_CIPHER_INVALID  = 19,  /* 11i */
        REASON_AKMP_INVALID             = 20,  /* 11i */
        REASON_UNSUPP_RSN_IE_VERSION    = 21,  /* 11i */
        REASON_INVALID_RSN_IE_CAP       = 22,  /* 11i */
        REASON_802_1X_AUTH_FAILED       = 23,  /* 11i */
        REASON_CIPHER_SUITE_REJECTED    = 24,  /* 11i */

        REASON_BEACON_TIMEOUT           = 200,
        REASON_NO_AP_FOUND              = 201,
        REASON_AUTH_FAIL                = 202,
        REASON_ASSOC_FAIL               = 203,
        REASON_HANDSHAKE_TIMEOUT        = 204,
};

typedef struct {
        uint8 ssid[32];
        uint8 ssid_len;
        uint8 bssid[6];
        uint8 channel;
} Event_StaMode_Connected_t;

typedef struct {
        uint8 ssid[32];
        uint8 ssid_len;
        uint8 bssid[6];
        uint8 reason;
} Event_StaMode_Disconnected_t;

typedef struct {
        uint8 old_mode;
        uint8 new_mode;
} Event_StaMode_AuthMode_Change_t;

typedef struct {
        struct ip_addr ip;
        struct ip_addr mask;
        struct ip_addr gw;
} Event_StaMode_Got_IP_t;

typedef struct {
        uint8 mac[6];
        uint8 aid;
} Event_SoftAPMode_StaConnected_t;

typedef struct {
        uint8 mac[6];
        uint8 aid;
} Event_SoftAPMode_StaDisconnected_t;

typedef struct {
        int rssi;
        uint8 mac[6];
} Event_SoftAPMode_ProbeReqRecved_t;

typedef struct {
        uint8 old_opmode;
        uint8 new_opmode;
} Event_OpMode_Change_t;

typedef union {
        Event_StaMode_Connected_t               connected;
        Event_StaMode_Disconnected_t            disconnected;
        Event_StaMode_AuthMode_Change_t         auth_change;
        Event_StaMode_Got_IP_t                  got_ip;
        Event_SoftAPMode_StaConnected_t         sta_connected;
        Event_SoftAPMode_StaDisconnected_t      sta_disconnected;
        Event_SoftAPMode_ProbeReqRecved_t       ap_probereqrecved;
        Event_OpMode_Change_t                   opmode_changed;
} Event_Info_u;

typedef struct _esp_event {
    uint32 event;
    Event_Info_u event_info;
} System_Event_t;
```

7.2.5. SmartConfig Structures

```
typedef enum  {
    SC_STATUS_WAIT = 0,       // Please don’ t start connection in this phase
    SC_STATUS_FIND_CHANNEL,   // Start connection by APP in this phase
    SC_STATUS_GETTING_SSID_PSWD,
    SC_STATUS_LINK,
    SC_STATUS_LINK_OVER,      // Got IP, connect to AP successfully
} sc_status;
typedef enum  {
    SC_TYPE_ESPTOUCH = 0,
    SC_TYPE_AIRKISS,
    SC_TYPE_ESPTOUCH_AIRKISS,
} sc_type;
```

7.3. JSON-Related Structure

7.3.1. JSON Structures

```
struct jsontree_value {
    uint8_t type;
};

struct jsontree_pair {
    const char *name;
    struct jsontree_value *value;
};

struct jsontree_context {
    struct jsontree_value *values[JSONTREE_MAX_DEPTH];
    uint16_t index[JSONTREE_MAX_DEPTH];
    int (* putchar)(int);
    uint8_t depth;
    uint8_t path;
    int callback_state;
};

struct jsontree_callback {
    uint8_t type;
    int (* output)(struct jsontree_context *js_ctx);
    int (* set)(struct jsontree_context *js_ctx,
              struct jsonparse_state *parser);
};

struct jsontree_object {
    uint8_t type;
    uint8_t count;
    struct jsontree_pair *pairs;
};

struct jsontree_array {
    uint8_t type;
    uint8_t count;
    struct jsontree_value **values;
};
```

```
struct jsonparse_state {
    const char *json;
    int pos;
    int len;
    int depth;
    int vstart;
    int vlen;
    char vtype;
    char error;
    char stack[JSONPARSE_MAX_DEPTH];
};
             JSON Macro Definitions
#define JSONTREE_OBJECT(name, ...)                                      /
static struct jsontree_pair jsontree_pair_##name[] = {__VA_ARGS__};     /
static struct jsontree_object name = {                                  /
    JSON_TYPE_OBJECT,                                                   /
sizeof(jsontree_pair_##name)/sizeof(struct jsontree_pair),              /
    jsontree_pair_##name }

#define JSONTREE_PAIR_ARRAY(value) (struct jsontree_value *)(value)
#define JSONTREE_ARRAY(name, ...)                                       /
static struct jsontree_value* jsontree_value_##name[] = {__VA_ARGS__};  /
static struct jsontree_array name = {                                   /
    JSON_TYPE_ARRAY,                                                        /
    sizeof(jsontree_value_##name)/sizeof(struct jsontree_value*),       /
    jsontree_value_##name }
```

7.4. espconn Parameters

7.4.1. Callback Functions

```
/** callback prototype to inform about events for a espconn */
typedef void (* espconn_recv_callback)(void *arg, char *pdata, unsigned short len);
typedef void (* espconn_callback)(void *arg, char *pdata, unsigned short len);
typedef void (* espconn_connect_callback)(void *arg);
```

7.4.2. espconn Structures

```
typedef void* espconn_handle;
typedef struct _esp_tcp {
    int remote_port;
    int local_port;
    uint8 local_ip[4];
    uint8 remote_ip[4];
        espconn_connect_callback connect_callback;
        espconn_reconnect_callback reconnect_callback;
        espconn_connect_callback disconnect_callback;
        espconn_connect_callback write_finish_fn;
} esp_tcp;

typedef struct _esp_udp {
    int remote_port;
    int local_port;
    uint8 local_ip[4];
    uint8 remote_ip[4];
} esp_udp;

/** Protocol family and type of the espconn */
enum espconn_type {
    ESPCONN_INVALID    = 0,
    /* ESPCONN_TCP Group */
    ESPCONN_TCP        = 0x10,
    /* ESPCONN_UDP Group */
    ESPCONN_UDP        = 0x20,
};

/** Current state of the espconn. Non-TCP espconn are always in state ESPCONN_NONE! */
enum espconn_state {
    ESPCONN_NONE,
    ESPCONN_WAIT,
    ESPCONN_LISTEN,
    ESPCONN_CONNECT,
    ESPCONN_WRITE,
    ESPCONN_READ,
    ESPCONN_CLOSE
};

enum espconn_option{
        ESPCONN_START = 0x00,
        ESPCONN_REUSEADDR = 0x01,
        ESPCONN_NODELAY = 0x02,
        ESPCONN_COPY = 0x04,
        ESPCONN_KEEPALIVE = 0x08,
        ESPCONN_END
}

enum espconn_level{
        ESPCONN_KEEPIDLE,
        ESPCONN_KEEPINTVL,
        ESPCONN_KEEPCNT
}
/** A espconn descriptor */
struct espconn {
    /** type of the espconn (TCP, UDP) */
    enum espconn_type type;
    /** current state of the espconn */
    enum espconn_state state;
    union {
        esp_tcp *tcp;
        esp_udp *udp;
    } proto;
    /** A callback function that is informed about events for this espconn */
    espconn_recv_callback recv_callback;
    espconn_sent_callback sent_callback;
    uint8 link_cnt;
    void *reverse; // reversed for customer use
};
```

7.4.3. Interrupt-Related Definitions

```
/* interrupt related */
#define ETS_SPI_INUM    2
#define ETS_GPIO_INUM   4
#define ETS_UART_INUM   5
#define ETS_UART1_INUM  5
#define ETS_FRC_TIMER1_INUM     9

/* disable all interrupts */
#define ETS_INTR_LOCK()         ets_intr_lock()
/* enable all interrupts */
#define ETS_INTR_UNLOCK()               ets_intr_unlock()

/* register interrupt handler of frc timer1 */
#define ETS_FRC_TIMER1_INTR_ATTACH(func, arg) \
ets_isr_attach(ETS_FRC_TIMER1_INUM, (func), (void *)(arg))

/* register interrupt handler of GPIO */
#define ETS_GPIO_INTR_ATTACH(func, arg) \
ets_isr_attach(ETS_GPIO_INUM, (func), (void *)(arg))
/* register interrupt handler of UART */
#define ETS_UART_INTR_ATTACH(func, arg) \
ets_isr_attach(ETS_UART_INUM, (func), (void *)(arg))

/* register interrupt handler of SPI */
#define ETS_SPI_INTR_ATTACH(func, arg) \
ets_isr_attach(ETS_SPI_INUM, (func), (void *)(arg))

/* enable a interrupt */
#define ETS_INTR_ENABLE(inum)   ets_isr_unmask((1<<inum))
/* disable a interrupt */
#define ETS_INTR_DISABLE(inum)  ets_isr_mask((1<<inum))

/* enable SPI interrupt */
#define ETS_SPI_INTR_ENABLE()   ETS_INTR_ENABLE(ETS_SPI_INUM)
/* enable UART interrupt */
#define ETS_UART_INTR_ENABLE()  ETS_INTR_ENABLE(ETS_UART_INUM)
/* disable UART interrupt */
```

```
#define ETS_UART_INTR_DISABLE() ETS_INTR_DISABLE(ETS_UART_INUM)

/* enable frc1 timer interrupt */
#define ETS_FRC1_INTR_ENABLE()  ETS_INTR_ENABLE(ETS_FRC_TIMER1_INUM)
/* disable frc1 timer interrupt */
#define ETS_FRC1_INTR_DISABLE() ETS_INTR_DISABLE(ETS_FRC_TIMER1_INUM)

/* enable GPIO interrupt */
#define ETS_GPIO_INTR_ENABLE()  ETS_INTR_ENABLE(ETS_GPIO_INUM)
/* disable GPIO interrupt */
#define ETS_GPIO_INTR_DISABLE() ETS_INTR_DISABLE(ETS_GPIO_INUM)
```

8. Peripheral-Related Drivers

For peripheral drivers please see ***/ESP8266_NONOS_SDK/driver_lib***.

8.1. GPIO Related APIs

GPIO APIs can be found in ***/ESP8266_NONOS_SDK/include/eagle_soc.h & gpio.h***.

Please refer to ***/ESP8266_NONOS_SDK/examples/IoT_Demo/user/user_plug.c***.

8.1.1. PIN-Related Macros

The following macros are used to control the GPIO pins' status.

`PIN_PULLUP_DIS(PIN_NAME)`	Disable pin pull-up.	Example:
		`// Use MTDI pin as GPIO12.`
		`PIN_FUNC_SELECT(PERIPHS_IO_MUX_MTDI_U, FUNC_GPIO12);`

`PIN_PULLUP_EN(PIN_NAME)`	Enable pin pull up.	
`PIN_FUNC_SELECT(PIN_NAME, FUNC)`	Select pin function.	

8.1.2. gpio_output_set

Function	Set GPIO property.

Prototype	`void gpio_output_set(`
	`    uint32 set_mask,`
	`    uint32 clear_mask,`
	`    uint32 enable_mask,`
	`    uint32 disable_mask`
	`)`

Parameter	`uint32 set_mask`: set high output; 1: high output; 0: no status change;
	`uint32 clear_mask`: set low output; 1: low output; 0: no status change;
	`uint32 enable_mask`: enable output bit;
	`uint32 disable_mask`: enable input bit.

Return	none
Example	`gpio_output_set(BIT12, 0, BIT12, 0)`: Set GPIO12 as high-level output. `gpio_output_set(0, BIT12, BIT12, 0)`: Set GPIO12 as low-level output. `gpio_output_set(BIT12, BIT13, BIT12|BIT13, 0)`: Set GPIO12 as high-level output, and GPIO13 as low-level output. `gpio_output_set(0, 0, 0, BIT12)`: Set GPIO12 as input.

8.1.3. GPIO input and output macros

`GPIO_OUTPUT_SET(gpio_no, bit_value)`	Set `gpio_no` as output `bit_value`, the same as the output example in 8.1.2.
`GPIO_DIS_OUTPUT(gpio_no)`	Set `gpio_no` as input, the same as the input example in 8.1.2.
`GPIO_INPUT_GET(gpio_no)`	Get the level status of `gpio_no`.

8.1.4. GPIO interrupt

`ETS_GPIO_INTR_ATTACH(func, arg)`	Register GPIO interrupt control function.
`ETS_GPIO_INTR_DISABLE()`	Disable GPIO interrupt.
`ETS_GPIO_INTR_ENABLE()`	Enable GPIO interrupt.

8.1.5. gpio_pin_intr_state_set

Function	Set GPIO interrupt state.

Prototype	`void gpio_pin_intr_state_set(`
	`    uint32 i,`
	`    GPIO_INT_TYPE intr_state`
	`)`

Parameter	`uint32 i : GPIO pin ID, if you want to set GPIO14, pls use GPIO_ID_PIN(14);`
	`GPIO_INT_TYPE intr_state : interrupt type as the following:`
	`typedef enum {`
	`    GPIO_PIN_INTR_DISABLE = 0,`
	`    GPIO_PIN_INTR_POSEDGE = 1,`
	`    GPIO_PIN_INTR_NEGEDGE = 2,`
	`    GPIO_PIN_INTR_ANYEDGE = 3,`
	`    GPIO_PIN_INTR_LOLEVEL = 4,`
	`    GPIO_PIN_INTR_HILEVEL = 5`
	`} GPIO_INT_TYPE;`

Return	none

8.1.6. GPIO Interrupt Handler

Follow the steps below to clear interrupt status in GPIO interrupt processing function:

```
uint32 gpio_status;

gpio_status = GPIO_REG_READ(GPIO_STATUS_ADDRESS);

//clear interrupt status

GPIO_REG_WRITE(GPIO_STATUS_W1TC_ADDRESS, gpio_status);
```

8.2. UART-Related APIs

By default, UART0 is a debug output interface. In the case of a dual UART, UART0 works as data receive and transmit interface, while UART1 acts as the debug output interface. Please make sure all hardware is correctly connected.

For detailed information on UART, please see *ESP8266 Technical Reference*.

8.2.1. uart_init

Function	Initialize baud rates of the two UARTs.

Prototype	`void uart_init(`
	`    UartBautRate uart0_br,`
	`    UartBautRate uart1_br`
	`)`

Parameter	`UartBautRate uart0_br`: UART0 baud rate; `UartBautRate uart1_br`: UART1 baud rate.

Baud rates	`typedef enum {`
	`    BIT_RATE_9600   = 9600,`
	`    BIT_RATE_19200  = 19200,`
	`    BIT_RATE_38400  = 38400,`
	`    BIT_RATE_57600  = 57600,`
	`    BIT_RATE_74880  = 74880,`
	`    BIT_RATE_115200 = 115200,`
	`    BIT_RATE_230400 = 230400,`
	`    BIT_RATE_460800 = 460800,`
	`    BIT_RATE_921600 = 921600`
	`} UartBautRate;`

Return	none

8.2.2. uart0_tx_buffer

Function	Send user-defined data through UART0.
Prototype	`void uart0_tx_buffer(uint8 *buf, uint16 len)`
Parameter	`uint8 *buf`: data to be sent; `uint16 len`: the length of data to be sent.
Return	none

8.2.3. uart0_rx_intr_handler

Function	UART0 interrupt processing function. Users can process the received data in this function.
Prototype	`void uart0_rx_intr_handler(void *para)`
Parameter	`void *para`: the pointer pointing to RcvMsgBuff structure.

Return	none

8.2.4. uart_div_modify

Function	Set baud rate of UART.
Prototype	`void uart_div_modify(uint8 uart_no, uint32 DivLatchValue)`
Parameter	`uint8 uart_no`: UART number, UART0 or UART1. `uint32 DivLatchValue`: Clock division parameter.
Return	none

Example	`void ICACHE_FLASH_ATTR UART_SetBaudrate(uint8 uart_no, uint32 baud_rate)`
	`{`
	`    uart_div_modify(uart_no, UART_CLK_FREQ /baud_rate);`
	`}`

8.3. I2C Master-Related APIs

8.3.1. i2c_master_gpio_init

Function	Set GPIO in I2C master mode.
Prototype	`void i2c_master_gpio_init (void)`
Parameter	none
Return	none

8.3.2. i2c_master_init

Function	Initialize I2C.
Prototype	`void i2c_master_init(void)`
Parameter	none
Return	none

8.3.3. i2c_master_start

Function	Configure I2C to start sending data.
Prototype	`void i2c_master_start(void)`
Parameter	none
Return	none

8.3.4. i2c_master_stop

Function	Configure I2C to stop sending data.
Prototype	`void i2c_master_stop(void)`
Parameter	none
Return	none

8.3.5. i2c_master_send_ack

Function	Sends I2C ACK.
Prototype	`void i2c_master_send_ack (void)`
Parameter	none
Return	none

8.3.6. i2c_master_send_nack

Function	Sends I2C NACK.
Prototype	`void i2c_master_send_nack (void)`
Parameter	none
Return	none

8.3.7. i2c_master_checkAck

Function	Checks the ACK from the slave.
Prototype	`bool i2c_master_checkAck (void)`
Parameter	none
Return	true: ACK received from I2C slave false: NACK received from I2C slave

8.3.8. i2c_master_readByte

Function	Read one byte from I2C slave.
Prototype	`uint8 i2c_master_readByte (void)`
Parameter	none
Return	uint8: the value that was read

8.3.9. i2c_master_writeByte

Function	Write one byte to the slave.
Prototype	`void i2c_master_writeByte (uint8 wrdata)`
Parameter	`uint8 wrdata`: data to write
Return	none

8.4. PWM-Related APIs

The document will introduce PWM-related APIs from ***pwm.h***. For more information on PWM-related APIs please see ESP8266 Technical Reference.

PWM APIs can not be called when APIs in ***hw_timer.c*** are in use, because they use the same hardware timer.

Do not set the system to be Light-sleep mode (`wifi_set_sleep_type(LIGT_SLEEP);`), because CPU is halted and will not be interrupted by NMI during Light-sleep. To enter Deep-sleep mode, PWM needs to be stopped first.

8.4.1. pwm_init

Function	Initialize PWM function, including GPIO selection, period and duty cycle.

Prototype	`void pwm_init(`
	`uint32 period,`
	`uint8 *duty,`
	`uint32 pwm_channel_num,`
	`uint32 (*pin_info_list)[3])`

Parameter	`uint32 period`: PWM period `uint8 *duty`: duty cycle of each output `uint32 pwm_channel_num`: PWM channel number `uint32 (*pin_info_list)[3]`: GPIO parameter of PWM channel.It is a pointer of n * 3 array which defines GPIO register, IO reuse of corresponding PIN and GPIO number.
Return	none

Example	`uint32 io_info[][3] =`
	`{{PWM_0_OUT_IO_MUX,PWM_0_OUT_IO_FUNC,PWM_0_OUT_IO_NUM},`
	`{PWM_1_OUT_IO_MUX,PWM_1_OUT_IO_FUNC,PWM_1_OUT_IO_NUM},`
	`{PWM_2_OUT_IO_MUX,PWM_2_OUT_IO_FUNC,PWM_2_OUT_IO_NUM}};`
	`pwm_init(light_param.pwm_period, light_param.pwm_duty, 3, io_info);`

Note	This API can be called only once.

8.4.2. pwm_start

Function	Starts PWM. This function needs to be called after PWM configuration is changed.
Prototype	`void pwm_start (void)`
Parameter	none
Return	none

8.4.3. pwm_set_duty

Function	Sets duty cycle of a PWM output. Set the time that high-level signal will last. The range of `duty` depends on PWM period. Its maximum value of which can be Period * 1000 /45. For example, for 1-KHz PWM, the duty range is 0 ~ 22222.
Prototype	`void pwm_set_duty(uint32 duty, uint8 channel)`
Parameter	`uint32 duty`: the time that high-level single will last, duty cycle will be (duty*45)/ (period*1000); `uint8 channel`: PWM channel, which depends on how many PWM channels is used. In `IOT_Demo` it depends on `#define PWM_CHANNEL`.
Return	none

8.4.4. pwm_get_duty

Function	Get duty cycle of PWM output; duty cycle will be (duty*45)/ (period*1000).
Prototype	`uint8 pwm_get_duty(uint8 channel)`
Parameter	`uint8 channel`: PWM channel, which depends on how many PWM channels is used. In `IOT_Demo` it depends on `#define PWM_CHANNEL`.
Return	`uint8`: duty cycle of PWM output.

8.4.5. pwm_set_period

Function	Set PWM period, unit: μs. For example, for 1-KHz PWM, the period is 1000 μs.
Prototype	`void pwm_set_period(uint32 period)`
Parameter	`uint32 period`: PWM period, unit: μs.
Return	none
Note	After updating the configuration, `pwm_start` must be called for the changes to take effect.

8.4.6. pwm_get_period

Function	Get PWM period.
Prototype	`uint32 pwm_get_period(void)`
Parameter	none
Return	PWM period; unit: μs.

8.4.7. get_pwm_version

Function	Get version information of PWM.
Prototype	`uint32 get_pwm_version(void)`
Parameter	none
Return	PWM version

8.5. SDIO APIs

ESP8266 can only work as SDIO slave.

8.5.1. sdio_slave_init

Function	SDIO slave initialization.
Prototype	`void sdio_slave_init(void)`
Parameter	none
Return	none

8.5.2. sdio_load_data

Function	Load data into SDIO buffer, and inform SDIO host to read it.
Prototype	`int32 sdio_load_data(const uint8* data, uint32 len)`
Parameter	`const uint8* data`: data that will be transmitted; `uint32 len`: the length of data.
Return	The length of data that be loaded successfully. If the data length is too long to fit in SDIO buffer, this API will return 0, which means it failed to load data.

8.5.3. sdio_register_recv_cb

Function	Register a callback which will be called when ESP8266 receives data from the host through SDIO.

Callback function	`typedef void(*sdio_recv_data_callback)(uint8* data, uint32 len)` The `sdio_recv_data_callback` can not be stored in cache, so please do not define `ICACHE_FLASH_ATTR` before it.
Callback Definition	`bool sdio_register_recv_cb(sdio_recv_data_callback cb)`
Parameter	`sdio_recv_data_callback cb`: callback
Return	true: Success false: Failure

A. Appendix

A.1. ESPCONN Programming

For Espressif sample codes, please see：
https://github.com/espressif/esp8266-nonos-sample-code

https://github.com/espressif/esp8266-rtos-sample-code

A.1.1. TCP Client Mode

⚠ ***Notice:***

- *ESP8266, working in Station mode, will start client connections when given an IP address of the AP (the router) it connects to.*
- *ESP8266, working in SoftAP mode, will start client connections when the devices connected to the ESP8266 are given IP addresses.*

Steps:

1. Initialize `espconn` parameters according to protocols.
2. Register connect callback function and reconnect callback function.
    - Call `espconn_regist_connectcb` and `espconn_regist_reconcb`.
3. Call `espconn_connect` function and set up connection with TCP Server.
4. Registered connected callback functions will be called after successful connection, which will register corresponding callback function. We recommend registering a disconnect callback function.
    - Call `espconn_regist_recvcb`, `espconn_regist_sentcb` and `espconn_regist_disconcb` in connected callback.
5. When using callback function of received data or callback function of sent data to close connection, it is recommended to set a time delay to make sure that the all firmware functions are completed.

A.1.2. TCP Server Mode

⚠ ***Notice:***

- *If the ESP8266 is in Station mode, it will start server listening when given an IP address.*
- *If the ESP8266 is in SoftAP mode, it will start server listening directly.*

Steps:

1. Initialize `espconn` parameters according to protocols.
2. Register connect callback function and reconnect callback function.

- Call espconn_regist_connectcb and espconn_regist_reconcb.

3. Call espconn_accept to listen to the connection with host..
4. Registered connect function will be called after a successful connection, which will register a corresponding callback function.
    - Call espconn_regist_recvcb, espconn_regist_sentcb and espconn_regist_disconcb in connected callback.

A.1.3. espconn callback

Register Function	Callback	Description
espconn_regist_connectcb	espconn_connect_callback	TCP connected successfully.
espconn_regist_reconcb	espconn_reconnect_callback	TCP connected successfully.
espconn_regist_sentcb	espconn_sent_callback	TCP or UDP data is successfully sent.
espconn_regist_recvcb	espconn_recv_callback	Received TCP or UDP data.
espconn_regist_write_finish	espconn_write_finish_callback	Write data into TCP-send-buffer.
espconn_regist_disconcb	espconn_disconnect_callback	TCP disconnected successfully.

⚠ ***Notice:***

- *Parameter arg of callback is the pointer corresponding structure espconn. This pointer may be different in different callbacks, please do not use this pointer directly to distinguish one from another in multiple connections. Use remote_ip and remote_port in espconn instead.*
- *If espconn_connect (or espconn_secure_connect) fails and returns a otherwise value, that means there is no connection, so it won't enter any espconn callback.*
- *Don't call espconn_disconnect (or espconn_secure_disconnect) to break the TCP connection in any espconn callback.*
- *If it is needed, please use system_os_task and system_os_post to trigger the disconnection (espconn_disconnect or espconn_secure_disconnect).*

A.2. RTC APIs Example

Demo code below shows how to get RTC time and to read and write to RTC memory.

```
#include "ets_sys.h"
#include "osapi.h"
#include "user_interface.h"

os_timer_t rtc_test_t;
#define  RTC_MAGIC  0x55aaaa55
typedef struct {
        uint64 time_acc;
        uint32 magic ;
        uint32 time_base;
}RTC_TIMER_DEMO;

void rtc_count()
{
    RTC_TIMER_DEMO rtc_time;
    static uint8 cnt = 0;
    system_rtc_mem_read(64, &rtc_time, sizeof(rtc_time));

    if(rtc_time.magic!=RTC_MAGIC){
        os_printf("rtc time init...\r\n");
        rtc_time.magic = RTC_MAGIC;
        rtc_time.time_acc= 0;
        rtc_time.time_base = system_get_rtc_time();
        os_printf("time base : %d \r\n",rtc_time.time_base);
    }

    os_printf("==================\r\n");
    os_printf("RTC time test : \r\n");

    uint32 rtc_t1,rtc_t2;
    uint32 st1,st2;
    uint32 cal1, cal2;

    rtc_t1 = system_get_rtc_time();
    st1 = system_get_time();
    cal1 = system_rtc_clock_cali_proc();
    os_delay_us(300);

    st2 = system_get_time();
    rtc_t2 = system_get_rtc_time();
    cal2 = system_rtc_clock_cali_proc();
    os_printf(" rtc_t2-t1 : %d \r\n",rtc_t2-rtc_t1);
    os_printf(" st2-t2 :  %d  \r\n",st2-st1);
    os_printf("cal 1  : %d.%d  \r\n", ((cal1*1000)>>12)/1000, ((cal1*1000)>>12)%1000 );
    os_printf("cal 2  : %d.%d \r\n",((cal2*1000)>>12)/1000,((cal2*1000)>>12)%1000 );
    os_printf("==================\r\n\r\n");
    rtc_time.time_acc += (  ((uint64)(rtc_t2 - rtc_time.time_base))  *  ( (uint64)
((cal2*1000)>>12))  ) ;
    os_printf("rtc time acc  : %lld \r\n",rtc_time.time_acc);
    os_printf("power on time :  %lld  us\r\n", rtc_time.time_acc/1000);
    os_printf("power on time :  %lld.%02lld  S\r\n", (rtc_time.time_acc/10000000)/100,
(rtc_time.time_acc/10000000)%100);

    rtc_time.time_base = rtc_t2;
    system_rtc_mem_write(64, &rtc_time, sizeof(rtc_time));
    os_printf("------------------------\r\n");

    if(5== (cnt++)){
        os_printf("system restart\r\n");
        system_restart();
    }else{
        os_printf("continue ...\r\n");
    }
}
void user_init(void)
{
    rtc_count();
    os_printf("SDK version:%s\n", system_get_sdk_version());

    os_timer_disarm(&rtc_test_t);
    os_timer_setfn(&rtc_test_t,rtc_count,NULL);
    os_timer_arm(&rtc_test_t,10000,1);
}
```

A.3. Sniffer Introduction

For more details on sniffer, please refer to ESP8266 Technical Reference.

A.4. ESP8266 SoftAP and Station Channel Configuration

Even though ESP8266 supports the SoftAP + Station mode, it is limited to only one hardware channel.

In the SoftAP + Station mode, the ESP8266 SoftAP will adjust its channel configuration to be the same as the ESP8266 Station.

This limitation may cause some inconveniences in the SoftAP + Station mode that users need to pay special attention to, for example:

Case 1:

(1) When users connect the ESP8266 Station to a router (for example, channel 6),

(2) and sets the ESP8266 SoftAP through `wifi_softap_set_config`,

(3) if the value set is effective, the API will return `true`. However, the channel will be automatically adjusted to channel 6 in order to be in line with the ESP8266 Station interface. This is because there is only one hardware channel in this mode.

Case 2:

(1) If users set the channel of the ESP8266 SoftAP through `wifi_softap_set_config` (for example, channel 5),

(2) other Stations will connect to the ESP8266 SoftAP.

(3) When the users connects the ESP8266 Station to a router (for example, channel 6),

(4) the ESP8266 SoftAP will adjust its channel to be the same as that of the ESP8266 Station (which is channel 6 in this case).

(5) As a result of the change of channel, the Station Wi-Fi connected to the ESP8266 SoftAP in Step Two will be disconnected.

Case 3:

(1) Other stations are connected to the ESP8266 SoftAP.

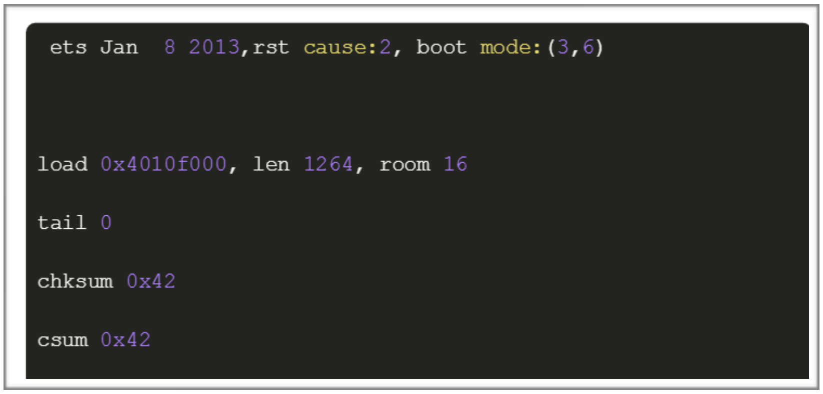
(2) If the ESP8266's Station interface has been scanning or trying to connect to a target router, the ESP8266 SoftAP's connection may terminate.

(3) This is because the ESP8266 Station will try to find its target router in different channels, which means it will keep changing channels, and as a result, the ESP8266 channel is changing, too. Therefore, the ESP8266 SoftAP's connection may terminate.

(4) In cases like this, users can set a timer to call `wifi_station_disconnect` to stop the ESP8266 Station from continuously trying to connect to a router. Or use `wifi_station_set_reconnect_policy` or `wifi_station_set_auto_connect` to disable the ESP8266 Station from reconnecting to the router.

A.5. ESP8266 Boot Messages

ESP8266 outputs boot messages through UART0 with a baud rate of 74880.



```
 ets Jan  8 2013,rst cause:2, boot mode:(3,6)


load 0x4010f000, len 1264, room 16

tail 0

chksum 0x42

csum 0x42
```

Messages	Description
rst cause	1: power on
	2: external reset
	4: hardware watchdog reset
boot mode (the first parameter)	1: ESP8266 is in UART-down mode (and downloads firmware into flash).
	3: ESP8266 is in Flash-boot mode (and boots up from flash).
chksum	If chksum == csum, it means that flash is correctly read during booting.

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