

ESP8266 SDK

API Guide



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About This Guide

This document lists ESP8266_NONOS_SDK APIs.

The document is structured as follows.

Chapter	Title	Subject
Chapter 1	Preambles	An instruction 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	Application specific APIs (AT command set and JSON parser)
Chapter 7	Definitions & Structures	Important definitions and data structures
Chapter 8	Peripheral Related Drivers	APIs for peripheral interfacing (GPIO, UART, I2C, PWM and SDIO)
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 Chapter 3.2, Chapter 9.5 and Chapter 3.3.37.
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2016.05	V1.5.4	Added Chapter 3.3.8 and Chapter 3.7.8.
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Table of Contents

1. Preambles.....	13
2. Overview	14
3. Application Programming Interface (APIs)	15
3.1. Software Timer	15
1. os_timer_arm.....	15
2. os_timer_disarm.....	16
3. os_timer_setfn.....	16
4. system_timer_reinit	16
5. os_timer_arm_us.....	17
3.2. Hardware Timer.....	17
1. hw_timer_init.....	18
2. hw_timer_arm.....	18
3. hw_timer_set_func	19
4. Hardware timer example.....	19
3.3. System APIs.....	20
1. system_get_sdk_version.....	20
2. system_restore	20
3. system_restart.....	21
4. system_init_done_cb.....	21
5. system_get_chip_id	22
6. system_get_vdd33	22
7. system_adc_read.....	23
8. system_adc_read_fast.....	23
9. system_deep_sleep	25
10. system_deep_sleep_set_option.....	25
11. system_phy_set_rfoption.....	26
12. system_phy_set_powerup_option.....	27
13. system_phy_set_max_tpw	27
14. system_phy_set_tpw_via_vdd33.....	28
15. system_set_os_print.....	28
16. system_print_meminfo	28
17. system_get_free_heap_size.....	29
18. system_os_task.....	29
19. system_os_post.....	30
20. system_get_time.....	31
21. system_get_rtc_time.....	31
22. system_rtc_clock_cali_proc.....	32

23.	system_rtc_mem_write	32
24.	system_rtc_mem_read.....	33
25.	system_uart_swap.....	33
26.	system_uart_de_swap.....	34
27.	system_get_boot_version.....	34
28.	system_get_userbin_addr.....	34
29.	system_get_boot_mode.....	35
30.	system_restart_enhance.....	35
31.	system_update_cpu_freq.....	36
32.	system_get_cpu_freq.....	36
33.	system_get_flash_size_map.....	36
34.	system_get_rst_info.....	37
35.	system_soft_wdt_stop.....	38
36.	system_soft_wdt_restart	38
37.	system_soft_wdt_feed.....	39
38.	system_show_malloc.....	39
39.	os_memset.....	40
40.	os_memcpy.....	40
41.	os_strlen.....	41
42.	os_printf.....	41
43.	os_bzero.....	41
44.	os_delay_us.....	42
45.	os_install_putc1.....	42
46.	os_random.....	42
47.	os_get_random.....	43
48.	user_rf_cal_sector_set.....	43
3.4.	SPI Flash Related APIs.....	45
1.	spi_flash_get_id.....	45
2.	spi_flash_erase_sector	45
3.	spi_flash_write	46
4.	spi_flash_read	46
5.	system_param_save_with_protect	47
6.	system_param_load	48
7.	spi_flash_set_read_func.....	49
3.5.	Wi-Fi Related APIs	49
1.	wifi_get_opmode	49
2.	wifi_get_opmode_default.....	50
3.	wifi_set_opmode.....	50
4.	wifi_set_opmode_current	51
5.	wifi_station_get_config.....	51
6.	wifi_station_get_config_default.....	51

7.	wifi_station_set_config.....	52
8.	wifi_station_set_config_current.....	53
9.	wifi_station_set_cert_key	53
10.	wifi_station_clear_cert_key.....	55
11.	wifi_station_set_username	55
12.	wifi_station_clear_username.....	55
13.	wifi_station_connect.....	56
14.	wifi_station_disconnect.....	56
15.	wifi_station_get_connect_status.....	56
16.	wifi_station_scan.....	57
17.	scan_done_cb_t	58
18.	wifi_station_ap_number_set.....	58
19.	wifi_station_get_ap_info.....	59
20.	wifi_station_ap_change	59
21.	wifi_station_get_current_ap_id	59
22.	wifi_station_get_auto_connect	60
23.	wifi_station_set_auto_connect.....	60
24.	wifi_station_dhcpc_start.....	61
25.	wifi_station_dhcpc_stop.....	61
26.	wifi_station_dhcpc_status	62
27.	wifi_station_dhcpc_set_maxtry	62
28.	wifi_station_set_reconnect_policy.....	62
29.	wifi_station_get_rssi.....	63
30.	wifi_station_set_hostname.....	63
31.	wifi_station_get_hostname	63
32.	wifi_softap_get_config.....	64
33.	wifi_softap_get_config_default.....	64
34.	wifi_softap_set_config.....	64
35.	wifi_softap_set_config_current.....	65
36.	wifi_softap_get_station_num	65
37.	wifi_softap_get_station_info	66
38.	wifi_softap_free_station_info.....	66
39.	wifi_softap_dhcps_start.....	67
40.	wifi_softap_dhcps_stop	67
41.	wifi_softap_set_dhcps_lease	68
42.	wifi_softap_get_dhcps_lease.....	69
43.	wifi_softap_set_dhcps_lease_time.....	69
44.	wifi_softap_get_dhcps_lease_time	70
45.	wifi_softap_reset_dhcps_lease_time.....	70
46.	wifi_softap_dhcps_status.....	70
47.	wifi_softap_set_dhcps_offer_option.....	71

48.	wifi_set_phy_mode	71
49.	wifi_get_phy_mode	72
50.	wifi_get_ip_info	72
51.	wifi_set_ip_info	73
52.	wifi_set_macaddr	74
53.	wifi_get_macaddr	75
54.	wifi_set_sleep_type	75
55.	wifi_get_sleep_type	76
56.	wifi_status_led_install	76
57.	wifi_status_led_uninstall	77
58.	wifi_set_broadcast_if	77
59.	wifi_get_broadcast_if	77
60.	wifi_set_event_handler_cb	78
61.	wifi_wps_enable	79
62.	wifi_wps_disable	80
63.	wifi_wps_start	80
64.	wifi_set_wps_cb	80
65.	wifi_register_send_pkt_freedom_cb	81
66.	wifi_unregister_send_pkt_freedom_cb	82
67.	wifi_send_pkt_freedom	82
68.	wifi_rfid_locp_rcv_open	83
69.	wifi_rfid_locp_rcv_close	83
70.	wifi_register_rfid_locp_rcv_cb	83
71.	wifi_unregister_rfid_locp_rcv_cb	84
3.6.	Rate Control APIs	84
1.	wifi_set_user_fixed_rate	84
2.	wifi_get_user_fixed_rate	85
3.	wifi_set_user_sup_rate	86
4.	wifi_set_user_rate_limit	86
5.	wifi_set_user_limit_rate_mask	88
6.	wifi_get_user_limit_rate_mask	88
3.7.	Force Sleep APIs	89
1.	wifi_fpm_open	89
2.	wifi_fpm_close	89
3.	wifi_fpm_do_wakeup	90
4.	wifi_fpm_set_wakeup_cb	90
5.	wifi_fpm_do_sleep	91
6.	wifi_fpm_set_sleep_type	91
7.	wifi_fpm_get_sleep_type	92
8.	wifi_fpm_auto_sleep_set_in_null_mode	92
9.	Example	93

3.8.	ESP-NOW APIs.....	95
1.	esp_now_init.....	95
2.	esp_now_deinit.....	96
3.	esp_now_register_rcv_cb.....	96
4.	esp_now_unregister_rcv_cb.....	97
5.	esp_now_register_send_cb.....	97
6.	esp_now_unregister_send_cb.....	98
7.	esp_now_send.....	98
8.	esp_now_add_peer.....	98
9.	esp_now_del_peer.....	99
10.	esp_now_set_self_role.....	99
11.	esp_now_get_self_role.....	100
12.	esp_now_set_peer_role.....	100
13.	esp_now_get_peer_role.....	101
14.	esp_now_set_peer_key.....	101
15.	esp_now_get_peer_key.....	102
16.	esp_now_set_peer_channel.....	102
17.	esp_now_get_peer_channel.....	103
18.	esp_now_is_peer_exist.....	103
19.	esp_now_fetch_peer.....	103
20.	esp_now_get_cnt_info.....	104
21.	esp_now_set_kok.....	104
3.9.	Upgrade (FOTA) APIs.....	105
1.	system_upgrade_userbin_check.....	105
2.	system_upgrade_flag_set.....	105
3.	system_upgrade_flag_check.....	105
4.	system_upgrade_start.....	106
5.	system_upgrade_reboot.....	106
3.10.	Sniffer Related APIs.....	106
1.	wifi_promiscuous_enable.....	106
2.	wifi_promiscuous_set_mac.....	107
3.	wifi_set_promiscuous_rx_cb.....	107
4.	wifi_get_channel.....	108
5.	wifi_set_channel.....	108
3.11.	Smart Config APIs.....	108
1.	smartconfig_start.....	109
2.	smartconfig_stop.....	111
3.	smartconfig_set_type.....	111
4.	airkiss_version.....	112
5.	airkiss_lan_rcv.....	112
6.	airkiss_lan_pack.....	113

3.12.	SNTP APIs.....	115
1.	sntp_setserver	115
2.	sntp_getserver	115
3.	sntp_setservername	115
4.	sntp_getservername.....	116
5.	sntp_init.....	116
6.	sntp_stop	116
7.	sntp_get_current_timestamp.....	117
8.	sntp_get_real_time.....	117
9.	sntp_set_timezone.....	117
10.	sntp_get_timezone	118
11.	SNTP Example.....	118
4.	TCP/UDP APIs.....	120
4.1.	Generic TCP/UDP APIs	120
1.	espconn_delete.....	120
2.	espconn_gethostbyname.....	120
3.	espconn_port	121
4.	espconn_regist_sentcb	122
5.	espconn_regist_recvcb	122
6.	espconn_sent_callback	123
7.	espconn_rcv_callback	123
8.	espconn_get_connection_info.....	123
9.	espconn_send.....	124
10.	espconn_sent	125
4.2.	TCP APIs.....	126
1.	espconn_accept	126
2.	espconn_regist_time	126
3.	espconn_connect	127
4.	espconn_connect_callback.....	128
5.	espconn_regist_connectcb.....	128
6.	espconn_set_opt	129
7.	espconn_clear_opt.....	129
8.	espconn_set_keepalive	130
9.	espconn_get_keepalive	131
10.	espconn_reconnect_callback.....	132
11.	espconn_regist_reconcb	133
12.	espconn_disconnect	133
13.	espconn_regist_disconcb.....	134
14.	espconn_abort.....	134
15.	espconn_regist_write_finish.....	134

16.	espconn_tcp_get_max_con.....	135
17.	espconn_tcp_set_max_con.....	135
18.	espconn_tcp_get_max_con_allow	136
19.	espconn_tcp_set_max_con_allow.....	136
20.	espconn_recv_hold	137
21.	espconn_recv_unhold.....	137
22.	espconn_secure_accept	137
23.	espconn_secure_delete.....	138
24.	espconn_secure_set_size	139
25.	espconn_secure_get_size.....	139
26.	espconn_secure_connect.....	140
27.	espconn_secure_send	140
28.	espconn_secure_sent	141
29.	espconn_secure_disconnect.....	142
30.	espconn_secure_ca_disable.....	142
31.	espconn_secure_ca_enable	142
32.	espconn_secure_cert_req_enable.....	143
33.	espconn_secure_cert_req_disable	144
34.	espconn_secure_set_default_certificate.....	144
35.	espconn_secure_set_default_private_key.....	145
4.3.	UDP APIs.....	145
1.	espconn_create	145
2.	espconn_sendto.....	146
3.	espconn_igmp_join	146
4.	espconn_igmp_leave.....	146
5.	espconn_dns_setserver	147
4.4.	mDNS APIs.....	147
1.	espconn_mdns_init	147
2.	espconn_mdns_close.....	148
3.	espconn_mdns_server_register	148
4.	espconn_mdns_server_unregister.....	149
5.	espconn_mdns_get_servername	149
6.	espconn_mdns_set_servername.....	149
7.	espconn_mdns_set_hostname	149
8.	espconn_mdns_get_hostname.....	150
9.	espconn_mdns_disable	150
10.	espconn_mdns_enable.....	150
11.	Example of mDNS.....	151
5.	Mesh APIs.....	152
6.	Application Related	153

6.1.	AT APIs	153
1.	at_response_ok	153
2.	at_response_error	153
3.	at_cmd_array_regist	153
4.	at_get_next_int_dec	154
5.	at_data_str_copy	154
6.	at_init	155
7.	at_port_print	155
8.	at_set_custom_info	156
9.	at_enter_special_state	156
10.	at_leave_special_state	156
11.	at_get_version	156
12.	at_register_uart_rx_intr	157
13.	at_response	158
14.	at_register_response_func	158
15.	at_fake_uart_enable	158
16.	at_fake_uart_rx	159
17.	at_set_escape_character	159
6.2.	Related JSON APIs	159
1.	jsonparse_setup	159
2.	jsonparse_next	160
3.	jsonparse_copy_value	160
4.	jsonparse_get_value_as_int	161
5.	jsonparse_get_value_as_long	161
6.	jsonparse_get_len	161
7.	jsonparse_get_value_as_type	162
8.	jsonparse_strcmp_value	162
9.	jsontree_set_up	162
10.	jsontree_reset	163
11.	jsontree_path_name	163
12.	jsontree_write_int	163
13.	jsontree_write_int_array	164
14.	jsontree_write_string	164
15.	jsontree_print_next	165
16.	jsontree_find_next	165
7.	Definitions & Structures	166
7.1.	Timer	166
7.2.	WiFi Related Structures	166
1.	Station Related	166
2.	soft-AP related	166

3.	scan related.....	167
4.	WiFi event related structures.....	167
5.	smart config structures.....	170
7.3.	JSON Related Structure	171
1.	json structures.....	171
2.	json macro definitions.....	172
7.4.	espconn parameters.....	172
1.	callback functions.....	172
2.	espconn structures.....	173
7.5.	interrupt related definitions.....	175
8.	Peripheral Related Drivers	177
8.1.	GPIO Related APIs.....	177
1.	PIN Related Macros.....	177
2.	gpio_output_set.....	177
3.	GPIO input and output macros.....	178
4.	GPIO interrupt.....	178
5.	gpio_pin_intr_state_set	178
6.	GPIO Interrupt Handler.....	179
8.2.	UART Related APIs	179
1.	uart_init.....	179
2.	uart0_tx_buffer.....	180
3.	uart0_rx_intr_handler	180
8.3.	I2C Master Related APIs	181
1.	i2c_master_gpio_init.....	181
2.	i2c_master_init.....	181
3.	i2c_master_start.....	181
4.	i2c_master_stop	181
5.	i2c_master_send_ack.....	182
6.	i2c_master_send_nack.....	182
7.	i2c_master_checkAck.....	182
8.	i2c_master_readByte.....	183
9.	i2c_master_writeByte	183
8.4.	PWM Related.....	184
1.	pwm_init.....	184
2.	pwm_start.....	185
3.	pwm_set_duty.....	185
4.	pwm_get_duty	185
5.	pwm_set_period.....	186
6.	pwm_get_period	186
7.	get_pwm_version.....	186

8.5.	SDIO APIs.....	187
1.	sdio_slave_init.....	187
2.	sdio_load_data.....	187
3.	sdio_register_rcv_cb.....	187
9.	Appendix.....	189
9.1.	ESPCONN Programming	189
1.	TCP Client Mode.....	189
2.	TCP Server Mode	189
3.	espcnncallback.....	190
9.2.	RTC APIs Example.....	190
9.3.	Sniffer Structure Introduction	192
9.4.	ESP8266 soft-AP and station channel configuration	196
9.5.	ESP8266 boot messages.....	197



1.

Preambles

ESP8266 WiFi 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, power management modules, 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. ESP8266EX is often integrated with external sensors and other application specific devices through its GPIOs. Codes for such applications are provided as examples in the SDK. The examples also demonstrate the use APIs listed in this document.

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 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 for embedded software developers to help them program on ESP8266 IoT platform.



2.

Overview

The SDK provides a set of interfaces for data receive and transmit functions over the Wi-Fi and TCP/IP layers so programmers can focus on application development at a higher level. Users can easily make use of the corresponding interfaces to receive and transmit data.

All networking functions on the ESP8266 IoT platform are realized in the library, and are not transparent to users. Instead, users can initialize the interface in `user_main.c`.

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

`void user_rf_pre_init (void)` is to be added in `user_main.c` since `ESP8266_NONOS_SDK_V1.1.0` and is provided for RF initialization. User can call `system_phy_set_rfoption` to set RF option in `user_rf_pre_init`, or call `system_deep_sleep_set_option` before deep-sleep. If RF is disabled, ESP8266 station and soft-AP will both be disabled, so the related APIs must not be called, and Wi-Fi function can not be used either.

⚠ Notice:

- Using non-OS SDK which is single-threaded, the CPU should not take long to execute tasks:
 - If a task occupies the CPU for too long, and the watchdog cannot be fed, it will cause a watchdog reset.
 - If interrupt is disabled, CPU can only be occupied in us range and the time should not be more than 10 us; if interrupt is not disabled, it is suggested that CPU should not be occupied more than 500 ms.
 - It is suggested that interrupt should not be disabled, if it has to be disabled, the disabled time should be kept to a bare minimum.
- We suggest using a timer to check periodically, if users need to call function `os_delay_us` or `while`, or for in timer callback, please do not occupy CPU more than 15 ms.
- Using non-OS SDK, please do not call any function defined with `ICACHE_FLASH_ATTR` from inside an interrupt handler.
- We suggest using RTOS SDK, RTOS to schedule different tasks.
- Read and write RAM has to be aligned by 4 bytes, so please do not cast pointer directly, for example, please use `os_memcpy` instead of `float temp = *((float*)data);`.
- For printing logs inside interrupt handlers, please use API `os_printf_plus`. Printing excess logging data from inside an interrupt handler may occupy the CPU for too long, causing errors.
- `esp_init_data.bin` has to be downloaded into flash at least once.
- `user_rf_cal_sector_set` has to be added in the user application.



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 task, hence 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. 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`).

1. `os_timer_arm`

Function:

Enable a millisecond timer.

Prototype:

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

Parameters:

`os_timer_t *ptimer` : Timer structure

`uint32_t milliseconds` : Timing, Unit: millisecond

- if `system_timer_reinit` has been called, the timer value allowed range from 100 to 0x689D0.
- if didn't call `system_timer_reinit` has NOT been called, the timer value allowed range from 5 to 0x68D7A3.

`bool repeat_flag` : Whether the timer will be invoked repeatedly or not

Return:

null



2. `os_timer_disarm`

Function:

Disarm timer

Prototype:

```
void os_timer_disarm (os_timer_t *ptimer)
```

Parameters:

`os_timer_t *ptimer` : Timer structure

Return:

null

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  
)
```

Parameters:

`os_timer_t *ptimer` : Timer structure

`os_timer_func_t *pfunction` : timer callback function, use typecasting to pass function as `(os_timer_func_t *) your_function`

`void *parg` : callback function parameter

Return:

null

4. `system_timer_reinit`

Function:

Reinitiate the timer when you need to use microsecond timer

Notes:

1. Define `USE_US_TIMER`;
2. Put `system_timer_reinit` at the beginning of `user_init`, in the first sentence.

Prototype:

```
void system_timer_reinit (void)
```


**Parameters:**

null

Return:

null

5. `os_timer_arm_us`

Function:

Enable a microsecond timer.

Notes:

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 us.

Prototype:

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

Parameters:`os_timer_t *ptimer` : Timer structure`uint32_t microseconds` : Timing, Unit: microsecond, the minimum value is 0x64, the maximum value allowed to input is 0xFFFFFFFF`bool repeat_flag` : Whether the timer will be invoked repeatedly or not**Return:**

null

3.2. Hardware Timer

Hardware timer APIs can be found in `/ESP8266_NONOS_SDK/examples/driver_lib/hw_timer.c`. User can use it according to "readme.txt" which can be found in the folder `driver_lib`.

**Notes:**

- If NMI 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.

1. hw_timer_init

Function:

Initialize the hardware ISR timer

Prototype:

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

Parameters:

[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

2. hw_timer_arm

Function:

Set a trigger timer delay to enable this timer.

Prototype:

```
void hw_timer_arm (uint32 val)
```

Parameters:

[uint32 val](#) : Timing



- in autoload mode :
 - For [FRC1_SOURCE](#), range : 50 ~ 0x199999;
 - For [NMI_SOURCE](#), range : 100 ~ 0x199999;
- in non autoload mode, range : 10 ~ 0x199999;

Return:

none

3. [hw_timer_set_func](#)

Function:

Set timer callback function.

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

Notes:[ICACHE_FLASH_ATTR](#) is not allowed to be added before the timer callback.**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

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](#).

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\(\));
```

2. system_restore

Function:

Reset to 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](#)

Note:

Call [system_restart](#) to restart after reset by [system_restore](#).

**Prototype:**

`void system_restore(void)`

Parameters:

null

Return:

null

3. `system_restart`

Function:

Restart

Note:

The ESP8266 will not restart immediately, please do not call other functions after calling this API.

Prototype:

`void system_restart(void)`

Parameters:

null

Return:

null

4. `system_init_done_cb`

Function:

Call this API in `user_init` to register a system-init-done callback.

Note:

`wifi_station_scan` has to be called after system initialization is done and station is enabled.

Prototype:

`void system_init_done_cb(init_done_cb_t cb)`

Parameter:

`init_done_cb_t cb` : system-init-done callback

Return:

null

**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);  
}
```

5. system_get_chip_id

Function:

Get chip ID

Prototype:

```
uint32 system_get_chip_id (void)
```

Parameters:

null

Return:

Chip ID

6. system_get_vdd33

Function:

Measure the power voltage of VDD3P3 pin 3 and 4, 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](#)(0~127byte) is named as "vdd33_const" , when TOUT pin is suspended vdd33_const must be set as 0xFF, that is 255.
- The return value of [system_get_vdd33](#) may be a little different in different WiFi mode, for example, in modem sleep mode or in normal WiFi working mode.

Prototype:

```
uint16 system_get_vdd33(void)
```

Parameter:

none

Return:

power voltage of VDD33, unit:1/1024 V



7. `system_adc_read`

Function:

Measure the 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`(0~127byte) 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 use 3.3V by default.
- The return value of `system_adc_read` may be a little different in different WiFi mode, for example, in modem sleep mode or in normal WiFi working mode.
- If high precision is needed, please use `system_adc_read_fast` instead.

Prototype:

```
uint16 system_adc_read(void)
```

Parameter:

none

Return:

input voltage of TOUT pin 6, unit:1/1024 V

8. `system_adc_read_fast`

Function:

Fast and high-precision sampling of ADC.

Note:

- `system_adc_read_fast` 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`(0~127byte) 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 use 3.3V by default.



- To use `system_adc_read_fast`, WiFi 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 `system_adc_read_fast` is calling.

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

Example:

```
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);  
    }
```

9. system_deep_sleep

Function:

Configures chip for deep-sleep mode. When the device is in deep-sleep, it automatically wakes up periodically; the period is configurable. Upon waking up, the device boots up from [user_init](#).

Note:

- Hardware has to support deep-sleep wake up ([XPD_DCDC](#) connects to [EXT_RSTB](#) with 0 ohm resistor).
- [system_deep_sleep\(0\)](#): there is no wake up timer; in order to wakeup, connect a GPIO to pin [RST](#), the chip will wake up by a falling-edge on pin [RST](#).

Prototype:

```
void system_deep_sleep(uint32 time_in_us)
```

Parameters:

[uint32 time_in_us](#) : during the time (us) device is in deep-sleep

Return:

null

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 wake up depends on both the times of entering deep-sleep ([deep_sleep_number](#), returns to 0 in every power up) and the byte 108 of [esp_init_data_default.bin](#)(0~127byte).

- if [deep_sleep_number](#) < byte 108, no RF calibration after deep-sleep wake up; this reduces the current consumption.
- if [deep_sleep_number](#) = byte 108, the behavior after deep-sleep wake up will be the same as power-up, and [deep_sleep_number](#) returns to 0.



- 1 : the behavior after deep-sleep wake up will be the same as power-up.
- 2 : No RF calibration after deep-sleep wake up; this reduces the current consumption.
- 4 : Disable RF after deep-sleep wake up, just like modem sleep; this has the least current consumption; the device is not able to transmit or receive data after wake up.

Return:

true : Success
false: Failure

11. system_phy_set_rfoption

Function:

Enable RF or not when wakeup from deep-sleep.

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 they are both 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 when deep-sleep wake up.
- Before calling this API, [system_deep_sleep_set_option](#) should be called at least once.

Prototype:

```
void system_phy_set_rfoption(uint8 option)
```

Parameter:

[uint8 option](#) :

- 0 : RF calibration after deep-sleep wake up depends on both the times of entering deep-sleep (deep_sleep_number, returns to 0 in every power up) and the byte 108 of [esp_init_data_default.bin](#)(0~127byte).
 - if deep_sleep_number < byte 108, no RF calibration after deep-sleep wake up; this reduces the current consumption.
 - if deep_sleep_number = byte 108, the behavior after deep-sleep wake up will be the same as power-up, and deep_sleep_number returns to 0.
- 1 : the behavior after deep-sleep wake up will be the same as power-up.
- 2 : No RF calibration after deep-sleep wake up; this reduces the current consumption.
- 4 : Disable RF after deep-sleep wake up, just like modem sleep; this has the least current consumption; the device is not able to transmit or receive data after wake up.

**Return:**

none

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 when power up.

0 : RF initialization when power up depends on [esp_init_data_default.bin](#)(0~127byte) byte

114. More details in appendix of documentation "2A-ESP8266-SDK_Getting_Started_Guide_v1.4".

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

13. system_phy_set_max_tpw

Function:

Set maximum value of RF TX Power, unit : 0.25dBm

Prototype:

```
void system_phy_set_max_tpw(uint8 max_tpw)
```

Parameter:

uint8 max_tpw : maximum value of RF Tx Power, unit : 0.25dBm, range [0, 82]

it can be set refer to the 34th byte ([target_power_qdb_0](#)) of

[esp_init_data_default.bin](#)(0~127byte)

Return:

none



14. system_phy_set_tpw_via_vdd33

Function:

Adjust RF TX Power according to VDD33, unit : 1/1024 V

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.

Prototype:

```
void system_phy_set_tpw_via_vdd33(uint16 vdd33)
```

Parameter:

[uint16 vdd33](#) : VDD33, unit : 1/1024V, range [1900, 3300]

Return:

none

15. system_set_os_print

Function:

Turn log printing on or off.

Prototype:

```
void system_set_os_print (uint8 onoff)
```

Parameters:

[uint8 onoff](#)

Note:

[onoff==0](#): print function off

[onoff==1](#): print function on

Default:

print function on

Return:

none

16. system_print_meminfo

Function:

Print memory information, including data/rodata/bss/heap

Prototype:

```
void system_print_meminfo (void)
```

**Parameters:**

none

Return:

none

17. system_get_free_heap_size

Function:

Get free heap size

Prototype:`uint32 system_get_free_heap_size(void)`**Parameters:**

none

Return:`uint32` : available heap size

18. system_os_task

Function:

Set up tasks

Prototype:

```
bool system_os_task(
    os_task_t task,
    uint8 prio,
    os_event_t *queue,
    uint8 qlen
)
```

Parameters:`os_task_t task` : task function`uint8 prio` : task priority. 3 priorities are supported: 0/1/2; 0 is the lowest priority. This means only 3 tasks are allowed to set up.`os_event_t *queue` : message queue pointer`uint8 qlen` : message queue depth**Return:**

true: Success

false: Failure

**Example:**

```
#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);
}
```

19. system_os_post

Function: send message to task

Prototype:

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

Parameters:

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

Referring to the above example:

```
void task_post(void) {
    system_os_post(USER_TASK_PRIO_0, SIG_RX, 'a');
}
```

**Printout:**[sig_rx a](#)

20. `system_get_time`

Function:

Get system time (us).

Prototype:[uint32 system_get_time\(void\)](#)**Parameter:**

none

Return:

System time in microsecond.

21. `system_get_rtc_time`

Function: Get RTC time, as denoted by the number of RTC clock periods.**Example:**

If [system_get_rtc_time](#) returns 10 (it means 10 RTC cycles), and [system_rtc_clock_calib_proc](#) returns 5.75 (means 5.75us per RTC cycle), then the real time is $10 \times 5.75 = 57.5$ us.

Note:System time will return to zero because of [system_restart](#), but RTC still goes on.

- reset by pin [EXT_RST](#) : RTC memory won't change, RTC timer returns 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 random value, RTC timer starts from zero
- reset by pin [CHIP_EN](#) : RTC memory contains random value, RTC timer starts from zero

Prototype:[uint32 system_get_rtc_time\(void\)](#)**Parameter:**

none

Return:

RTC time



22. system_rtc_clock_cali_proc

Function:

Get RTC clock period.

Note:

RTC clock period has decimal part.

RTC clock period tends to drift with change in temperature, so RTC timer is not very precise.

Prototype:

```
uint32 system_rtc_clock_cali_proc(void)
```

Parameter:

none

Return:

RTC clock period (in us), bit11~ bit0 are decimal.

Note:

see RTC demo in Appendix.

Example:

```
os_printf("clk cal : %d \r\n",system_rtc_clock_cali_proc()>>12);
```

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)----->|

Note:

Data read/write accesses to the RTC memory must be word aligned (4 bytes 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 $256/4 = 64$, `save_size` will be data length.

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

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)----->|

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.

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, byte

Return:

true: Success

false: Failure

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 needs to be used as UART0 in hardware.

Prototype:

```
void system_uart_swap (void)
```

**Parameter:**

none

Return:

none

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

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 (refer to [system_restart_enhance](#))

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 bin.

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).

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.

31. system_update_cpu_freq

Function:

Set CPU frequency. Default is 80MHz.

Note:

System bus frequency is 80MHz, 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.

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

32. system_get_cpu_freq

Function:

Get CPU frequency.

Prototype:

```
uint8 system_get_cpu_freq(void)
```

Parameter:

none

Return:

CPU frequency, unit : MHz.

33. system_get_flash_size_map

Function:

Get current flash size and flash map.



Flash map depends on the selection when compiling, more details in documentation "2A-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  
};
```

Prototype:

```
enum flash_size_map system_get_flash_size_map(void)
```

Parameter:

none

Return:

flash map

34. system_get_rst_info

Function:

Get information about current startup.

Structure:

```
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;  
};
```

Prototype:

```
struct rst_info* system_get_rst_info(void)
```

Parameter:

none

Return:

Information about startup.

35. system_soft_wdt_stop

Function:

Stop software watchdog

Note:

The software watchdog must not be stopped for too long (over 6 seconds), otherwise it will trigger hardware watchdog reset.

Prototype:

```
void system_soft_wdt_stop(void)
```

Parameter:

none

Return:

none

36. system_soft_wdt_restart

Function:

Restart software watchdog

Note:



This API can only be called if software watchdog is stopped ([system_soft_wdt_stop](#))

Prototype:

[void system_soft_wdt_restart\(void\)](#)

Parameter:

none

Return:

none

37. system_soft_wdt_feed

Function:

Feed software watchdog

Note:

This API can only be called if software watchdog is enabled.

Prototype:

[void system_soft_wdt_feed\(void\)](#)

Parameter:

none

Return:

none

38. system_show_malloc

Function:

For debugging memory leak issue, to print the memory usage.

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.

Prototype:

[void system_show_malloc\(void\)](#)

Parameter:

none

**Return:**

none

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));
```

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

Example:

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




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));
```

42. os_printf

Function:

print format

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.

Prototype:

`os_printf(const char *s)`

Parameter:

`const char *s` : string

Return:

none

Example:

```
os_printf("SDK version: %s \n", system_get_sdk_version());
```

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

44. os_delay_us

Function:

Time delay, max : 65535 us

Prototype:

`void os_delay_us(uint16 us)`

Parameter:

`uint16 us` : time, unit: us

Return:

none

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.

46. os_random

Function:

Get a random number.

**Prototype:**

```
unsigned long os_random(void)
```

Parameter:

none.

Return:

the random number

47. os_get_random

Function:

Get a random number of bits specified.

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 bits of the random number

Return:

0 : Success

others : 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]);
```

48. user_rf_cal_sector_set

Function:

Set the target flash sector to store RF_CAL parameters.

Note:

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.

Prototype:

```
uint32 user_rf_cal_sector_set(void)
```

Parameter:

none

Return:

the target flash sector to store RF_CAL parameters

Example:

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;
    }
```



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

    return rf_cal_sec;
}
```

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 in documentation "99A-SDK-Espressif IOT Flash RW Operation"

1. spi_flash_get_id

Function:

Get ID info of spi flash

Prototype:

`uint32 spi_flash_get_id (void)`

Parameters:

null

Return:

SPI flash ID

2. spi_flash_erase_sector

Function:

Erase sector in flash

Prototype:

`SpiFlashOpResult spi_flash_erase_sector (uint16 sec)`

Parameters:

`uint16 sec` : Sector number, the count starts at sector 0, 4KB per sector.

**Return:**

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

3. spi_flash_write

Function:

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

Prototype:

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

Parameters:

`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-bytes boundary.

Return:

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

4. spi_flash_read

Function:

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

Prototype:

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

**Parameters:**

`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]);
```

5. system_param_save_with_protect

Function:

Write data into flash with protection. Flash read/write has to be aligned to the 4-bytes boundary.

Protection of flash read/write : use 3 sectors (4KBytes per sector) to save 4KB data with protect, sector 0 and sector 1 are data sectors, back up each other, save data alternately, sector 2 is flag sector, point out which sector is keeping the latest data, sector 0 or sector 1.

Note:

More details about protection of flash read/write in documentation "99A-SDK-Espressif IOT Flash RW Operation".

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 * 4KB) 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

6. system_param_load

Function:

Read protected data from flash. Flash read/write has to be aligned to the 4-bytes boundary.

Protection of flash read/write: use 3 sectors (4KBytes per sector) to save 4KB data with protection, sector 0 and sector 1 are data sectors, back up each other, save data alternately, sector 2 is flag sector, point out which sector is keeping the latest data, sector 0 or sector 1.

Note:

More details about protection of flash read/write in documentation "99A-SDK-Espressif IOT Flash RW Operation".

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 are 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 * 4KB) starts from flash 0x3D000 for flash read/write protection, so the parameter `start_sec` is 0x3D, can not be 0x3E or 0x3F.

`uint16 offset` : offset of data saved in sector

`void *param` : data pointer

`uint16 len` : data length, $\text{offset} + \text{len} \leq 4 * 1024$

Return:

true: Success

false: Failure



7. spi_flash_set_read_func

Function:

Register user-defined SPI flash read API.

Note:

This API can be only used in SPI overlap mode, please refer to ESP8266_NONOS_SDK\driver_lib\driver\spi_overlap.c

Prototype:

```
void spi_flash_set_read_func (user_spi_flash_read read)
```

Parameter:

`user_spi_flash_read read` : user-defined SPI flash read API

Parameter Definition:

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

Return:

none

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 soft-AP can only be called if the ESP8266 soft-AP is enabled.

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

1. wifi_get_opmode

Function:

Get WiFi current operating mode

Prototype:

```
uint8 wifi_get_opmode (void)
```

Parameters:

none

**Return:**

WiFi working modes:

0x01: station mode

0x02: soft-AP mode

0x03: station+soft-AP

2. `wifi_get_opmode_default`

Function:

Get WiFi operating mode that saved in flash

Prototype:

`uint8 wifi_get_opmode_default (void)`

Parameters:

none

Return:

WiFi working modes:

0x01: station mode

0x02: soft-AP mode

0x03: station+soft-AP

3. `wifi_set_opmode`

Function:

Sets WiFi working mode as station, soft-AP or station+soft-AP, and save it to flash. Default is soft-AP mode.

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.

Prototype:

`bool wifi_set_opmode (uint8 opmode)`

Parameters:

`uint8 opmode`: WiFi operating modes:

0x01: station mode

0x02: soft-AP mode

0x03: station+soft-AP

**Return:**

true: Success

false: Failure

4. **wifi_set_opmode_current**

Function:

Sets WiFi working mode as station, soft-AP or station+soft-AP, and does not update flash

Prototype:`bool wifi_set_opmode_current (uint8 opmode)`**Parameters:**`uint8 opmode`: WiFi operating modes:

0x01: station mode

0x02: soft-AP mode

0x03: station+soft-AP

Return:

true: Success

false: Failure

5. **wifi_station_get_config**

Function:

Get WiFi station current configuration

Prototype:`bool wifi_station_get_config (struct station_config *config)`**Parameters:**`struct station_config *config` : WiFi station configuration pointer**Return:**

true: Success

false: Failure

6. **wifi_station_get_config_default**

Function:

Get WiFi station configuration from flash memory

Prototype:`bool wifi_station_get_config_default (struct station_config *config)`

**Parameters:**

`struct station_config *config` : WiFi station configuration pointer

Return:

true: Success

false: Failure

7. `wifi_station_set_config`

Function:

Set WiFi station configuration, and save it to flash

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, need `wifi_station_connect` to connect.
- In general, `station_config.bssid_set` 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.

Prototype:

`bool wifi_station_set_config(struct station_config *config)`

Parameters:

`struct station_config *config`: WiFi 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();
}
```

8. `wifi_station_set_config_current`

Function:

Set WiFi station configuration, setting in flash is not updated.

Note:

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

Prototype:

```
bool wifi_station_set_config_current (struct station_config *config)
```

Parameters:

`struct station_config *config`: WiFi station configuration pointer

Return:

true: Success

false: Failure

9. `wifi_station_set_cert_key`

Function:

Set certificate and private key for connecting to WPA2-ENTERPRISE AP.

Note:

- 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_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).

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

[int private_key_len](#) : length of private key

[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

non-0 : Failure

Example:

For example, the private key is ----- BEGIN PRIVATE KEY -----

Then then 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.



10. wifi_station_clear_cert_key

Function:

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

11. wifi_station_set_username

Function:

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

non-0 : Failure

12. wifi_station_clear_username

Function:

Release the user name resources and clear related status after connected to the WPA2-ENTERPRISE AP.

Prototype:

```
void wifi_station_clear_cert_key (void)
```

Parameter:

none

Return:

none



13. wifi_station_connect

Function:

To connect WiFi station to AP

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 [user_init](#). This API need to be called after system initializes and the ESP8266 station mode is enabled.

Prototype:

[bool wifi_station_connect \(void\)](#)

Parameters:

none

Return:

true: Success

false: Failure

14. wifi_station_disconnect

Function:

Disconnects WiFi station from AP

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.

Prototype:

[bool wifi_station_disconnect \(void\)](#)

Parameters:

none

Return:

true: Success

false: Failure

15. wifi_station_get_connect_status

Function:

Get WiFi connection status of ESP8266 station to AP.

Notice:



If in a special case, called [wifi_station_set_reconnect_policy](#) to disable reconnect, and did not call [wifi_set_event_handler_cb](#) to register WiFi event handler, [wifi_station_get_connect_status](#) becomes invalid and can not get the right status.

Prototype:

```
uint8 wifi_station_get_connect_status (void)
```

Parameters:

none

Return:

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

16. wifi_station_scan

Function:

Scan all available APs

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.

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.  
};
```

**Parameters:**

`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 will scan the specific channel.
`scan_done_cb_t cb`: callback function after scan

Return:

true: Success
false: Failure

17. scan_done_cb_t

Function:

Callback function for `wifi_station_scan`

Prototype:

`void scan_done_cb_t (void *arg, STATUS status)`

Parameters:

`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;  
        ...  
    }  
}
```

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.

Note:

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

**Prototype:**

```
bool wifi_station_ap_number_set (uint8 ap_number)
```

Parameters:

`uint8 ap_number`: the number of APs that can be recorded (MAX: 5)

Return:

true: Success

false: Failure

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[])
```

Parameters:

`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);
```

20. wifi_station_ap_change

Function:

Switch ESP8266 station connection to AP as specified

Prototype:

```
bool wifi_station_ap_change (uint8 new_ap_id)
```

Parameters:

`uint8 new_ap_id` : AP's record id, start counting from 0.

Return:

true: Success

false: Failure

21. wifi_station_get_current_ap_id

Function:

Get the current record id of AP.

**Prototype:**

```
uint8 wifi_station_get_current_ap_id ();
```

Parameter:

null

Return:

The index of the AP, which ESP8266 is currently connected to, in the cached AP list.

22. wifi_station_get_auto_connect

Function:

Checks if ESP8266 station mode will connect to AP (which is cached) automatically or not when it is powered on.

Prototype:

```
uint8 wifi_station_get_auto_connect(void)
```

Parameter:

none

Return:

0: will not connect to AP automatically;

Non-0: will connect to AP automatically.

23. wifi_station_set_auto_connect

Function:

Setting the ESP8266 station to connect to the AP (which is recorded) automatically or not when powered on. Enable auto-connect by default.

Note:

When called from [user_init](#), the feature is effective from the current session. When called from elsewhere, the changes take affect after the subsequent power cycle.

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

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

24. wifi_station_dhcpc_start

Function:

Enable ESP8266 station DHCP client.

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.

Prototype:`bool wifi_station_dhcpc_start(void)`**Parameter:**

none

Return:

true: Success

false: Failure

25. wifi_station_dhcpc_stop

Function:

Disable ESP8266 station DHCP client.

Note:

DHCP is enabled by default.

Prototype:`bool wifi_station_dhcpc_stop(void)`**Parameter:**

none

Return:

true: Success

false: Failure



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  
};
```

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

28. wifi_station_set_reconnect_policy

Function:

Set whether the ESP8266 will attempt to reconnect to an AP if disconnected.

Note:

It is recommended that the API be called from `user_init`

This API can only be called when the ESP8266 station is enabled.

Prototype:

```
bool wifi_station_set_reconnect_policy(bool set)
```

Parameter:

`bool set` : true, enable reconnect; false, disable reconnect

**Return:**

true: Success

false: Failure

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.

others : Success, value of rssi, in general, rssi value < 10

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

Return:

true: Success

false: Failure

31. wifi_station_get_hostname

Function:

Get ESP8266 station DHCP hostname

Prototype:

`char* wifi_station_get_hostname(void)`

**Parameter:**

none

Return:

hostname

32. wifi_softap_get_config

Function:

Get WiFi soft-AP current configuration

Prototype:`bool wifi_softap_get_config(struct softap_config *config)`**Parameter:**`struct softap_config *config` : ESP8266 soft-AP configuration information**Return:**

true: Success

false: Failure

33. wifi_softap_get_config_default

Function:

Get WiFi soft-AP configurations saved in flash

Prototype:`bool wifi_softap_get_config_default(struct softap_config *config)`**Parameter:**`struct softap_config *config` : ESP8266 soft-AP configuration information**Return:**

true: Success

false: Failure

34. wifi_softap_set_config

Function:

Set WiFi soft-AP configuration and save it to flash

Note:

- This API can be called only if the ESP8266 soft-AP is enabled.
- This configuration will be saved in flash system parameter area if changed.



- In soft-AP + station mode, the ESP8266 soft-AP will adjust its channel configuration to be the as same as the ESP8266. More details in appendix or BBS <http://bbs.espressif.com/viewtopic.php?f=10&t=324>

Prototype:

`bool wifi_softap_set_config (struct softap_config *config)`

Parameter:

`struct softap_config *config` : WiFi soft-AP configuration pointer

Return:

true: Success

false: Failure

35. wifi_softap_set_config_current

Function:

Set WiFi soft-AP configuration, settings are not updated in flash memory.

Note:

- This API can be called only if the ESP8266 soft-AP is enabled.
- In the soft-AP + station mode, ESP8266 soft-AP will adjust its channel configuration to be as same as the ESP8266. More details in appendix or BBS <http://bbs.espressif.com/viewtopic.php?f=10&t=324>

Prototype:

`bool wifi_softap_set_config_current (struct softap_config *config)`

Parameter:

`struct softap_config *config` : WiFi soft-AP configuration pointer

Return:

true: Success

false: Failure

36. wifi_softap_get_station_num

Function:

count the number of stations connected to the ESP8266 soft-AP

Prototype:

`uint8 wifi_softap_get_station_num(void)`

Parameter:

none

**Return:**

Number of stations connected to ESP8266 soft-AP

37. wifi_softap_get_station_info

Function:

Get information on connected station devices under soft-AP mode, including MAC and IP

Note:

This API depends on DHCP, so it cannot get static IP, etc in case DHCP is not used.

Prototype:

```
struct station_info * wifi_softap_get_station_info(void)
```

Input Parameters:

none

Return:

[struct station_info](#)* : station information structure

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)
```

Input Parameters:

none

Return:

none

Examples 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;
}
```

**Examples 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
```

39. wifi_softap_dhcps_start

Function: Enable ESP8266 soft-AP DHCP server.

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;

This will depend on the last configuration.

Prototype:

```
bool wifi_softap_dhcps_start(void)
```

Parameter:

none

Return:

true: Success

false: Failure

40. wifi_softap_dhcps_stop

Function: Disable ESP8266 soft-AP DHCP server.

Note: DHCP is enabled by default.

Prototype:

```
bool wifi_softap_dhcps_stop(void)
```

Parameter:

none

Return:

true: Success

false: Failure



41. wifi_softap_set_dhcps_lease

Function:

Set the IP range that can be allocated by the ESP8266 soft-AP DHCP server.

Note:

- IP range has to be in the same sub-net with the ESP8266 soft-AP 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_soft-AP_dhcps_start](#); if then [wifi_softap_dhcps_stop](#) is called, user needs to call this API to set IP range again if needed, and then call [wifi_softap_dhcps_start](#) for the configuration to take effect.

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(&dhcpc_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);  
    dhcpc_lease_test();  
    wifi_softap_dhcps_start();  
}
```

42. wifi_softap_get_dhcps_lease

Function:

Query the IP range that can be allocated by the ESP8266 soft-AP DHCP server.

Note:

This API can only be called when ESP8266 soft-AP DHCP server is enabled.

Prototype:

```
bool wifi_softap_get_dhcps_lease(struct dhcpc_lease *please)
```

Return:

true: Success

false: Failure

43. wifi_softap_set_dhcps_lease_time

Function:

Set ESP8266 soft-AP DHCP server lease time, default is 120 minutes.

Note:

This API can only be called when ESP8266 soft-AP DHCP server is enabled.

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

44. wifi_softap_get_dhcps_lease_time

Function:

Get ESP8266 soft-AP DHCP server lease time

Note:

This API can only be called when ESP8266 soft-AP DHCP server is enabled.

Prototype:

`uint32 wifi_softap_get_dhcps_lease_time(void)`

Return:

lease time, uint: minute.

45. wifi_softap_reset_dhcps_lease_time

Function:

Reset ESP8266 soft-AP DHCP server lease time to its default value, which is 120 minutes.

Note:

This API can only be called when ESP8266 soft-AP DHCP server is enabled.

Prototype:

`bool wifi_softap_reset_dhcps_lease_time(void)`

Return:

true: Success;
false: Failure

46. wifi_softap_dhcps_status

Function: Get ESP8266 soft-AP DHCP server status.

Prototype:

`enum dhcp_status wifi_softap_dhcps_status(void)`

Parameter:

none

**Return:**

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

47. wifi_softap_set_dhcps_offer_option

Function:

Set ESP8266 soft-AP 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 disable router information from ESP8266 softAP DHCP server;

bit0, 1 enable 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);
```

48. wifi_set_phy_mode

Function:

Set ESP8266 physical mode (802.11b/g/n).

Note:



- ESP8266 soft-AP only support 802.11b/g.
- Users can set to be 802.11g mode for consumption.

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

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  
};
```

50. wifi_get_ip_info

Function:

Get IP info of WiFi station or soft-AP interface

Note:

This API is available after initialization, do not call it in [user_init](#).

**Prototype:**

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

Parameters:

`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

51. wifi_set_ip_info

Function:

Set IP address of ESP8266 station or soft-AP

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;

Prototype:

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

Prototype:

`uint8 if_index` : set station IP or soft-AP IP

```
#define STATION_IF    0x00
```

```
#define SOFTAP_IF     0x01
```

`struct ip_info *info` : IP information

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();
```

Return:

true: Success

false: Failure

52. wifi_set_macaddr

Function:

Sets MAC address

Note:

- This API can only be called in [user_init](#).
- ESP8266 soft-AP 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".

Prototype:

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

Parameter:

[uint8 if_index](#) : set station MAC or soft-AP mac

```
#define STATION_IF    0x00
```

```
#define SOFTAP_IF     0x01
```

[uint8 *macaddr](#) : MAC address

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);
```

Return:

true: Success

false: Failure

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 soft-AP MAC

#define STATION_IF 0x00

#define SOFTAP_IF 0x01

uint8 *macaddr : MAC address

Return:

true: Success

false: Failure

54. wifi_set_sleep_type

Function:Sets sleep type for power saving. Set [NONE_SLEEP_T](#) to disable power saving.**Note:** Default mode: Modem sleep.**Prototype:**

```
bool wifi_set_sleep_type(enum sleep_type type)
```

Parameters:

enum sleep_type type : sleep type

Return:

true: Success

false: Failure



55. wifi_get_sleep_type

Function:

Gets sleep type.

Prototype:

```
enum sleep_type wifi_get_sleep_type(void)
```

Parameters:

none

Return:

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

56. wifi_status_led_install

Function:

Installs WiFi 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);
```



57. wifi_status_led_uninstall

Function: Uninstall WiFi status LED

Prototype:

`void wifi_status_led_uninstall ()`

Parameter:

none

Return:

none

58. wifi_set_broadcast_if

Function:

Set ESP8266 to send UDP broadcast from station interface or soft-AP interface, or both station and soft-AP interfaces. Default is soft-AP.

Note:

If broadcast is set to be in station interface only, the soft-AP DHCP server will be disabled.

Prototype:

`bool wifi_set_broadcast_if (uint8 interface)`

Parameter:

`uint8 interface` : 1:station; 2:soft-AP, 3:station+soft-AP

Return:

true: Success

false: Failure

59. wifi_get_broadcast_if

Function:

Get interface which ESP8266 sends UDP broadcast from. This is usually used when you have STA + soft-AP mode to avoid ambiguity.

Prototype:

`uint8 wifi_get_broadcast_if (void)`

Parameter:

none

Return:

1: station

2: soft-AP

3: both station and soft-AP



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_handler_cb(wifi_handle_event_cb);
}
```

61. wifi_wps_enable

Function:

Enable Wi-Fi WPS function

Note:

WPS can only be used when ESP8266 station is enabled.

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

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

63. wifi_wps_start

Function:

WPS starts to work

Note:

WPS can only be used when ESP8266 station is enabled.

Prototype:`bool wifi_wps_start(void)`**Parameter:**

none

Return:

true: means that WPS starts to work successfully, does not mean WPS succeeded.

false: Failure

64. wifi_set_wps_cb

Function:

Set WPS callback, parameter of the callback is the status of WPS.

Callback and parameter structure:`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  
};
```

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.

Prototype:

```
bool wifi_set_wps_cb(wps_st_cb_t cb)
```

Parameter:

`wps_st_cb_t cb` : callback

Return:

true: Success

false: Failure

65. wifi_register_send_pkt_freedom_cb

Function:

Register a callback for sending user-defined 802.11 packets.

Note:

Only after the previous packet was sent, entered the `freedom_outside_cb_t`, the next packet is allowed to be sent.

Callback Definition:

```
typedef void (*freedom_outside_cb_t)(uint8 status);
```

parameter `status` : 0, packet sending succeeded; otherwise, 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

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

67. wifi_send_pkt_freedom

Function:

Send user-defined 802.11 packets.

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.

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 sent.

**Return:**

0: Success

-1: Failure

68. wifi_rfid_locp_rcv_open**Function:**

Enable RFID LOCP (Location Control Protocol) to receive WDS packets.

Prototype:`int wifi_rfid_locp_rcv_open(void)`**Parameter:**

none

Return:

0: Success

otherwise: Failure

69. wifi_rfid_locp_rcv_close**Function:**

Disable RFID LOCP (Location Control Protocol).

Prototype:`void wifi_rfid_locp_rcv_close(void)`**Parameter:**

none

Return:

none

70. wifi_register_rfid_locp_rcv_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_rcv_cb(rfid_locp_cb_t cb)`

Parameter:

`rfid_locp_cb_t cb` : callback

Return:

0: Success

otherwise: Failure

71. wifi_unregister_rfid_locp_rcv_cb

Function:

Unregister the callback of receiving WDS packets.

Prototype:

`void wifi_unregister_rfid_locp_rcv_cb(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`.

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)
```

Note:

- Only if the corresponding bit in enable_mask is 1, ESP8266 station or soft-AP will send data in the fixed rate.
- If the enable_mask is 0, both ESP8266 station and soft-AP will not send data in the fixed rate.
- ESP8266 station and soft-AP share the same rate, they can not be set to different data rates.

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 soft-AP
 0x03 - use the fixed rate on ESP8266 station and soft-AP

uint8 rate : value of the fixed rate

Return:

0: Success

otherwise: Failure

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. 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.

Note:

This API can only support 802.11g now, but it will support 802.11b in next version.

Parameter Definition:

```
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);
```

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	: WiFi mode						
	<table><tbody><tr><td>#define RC_LIMIT_11B</td><td>0</td></tr><tr><td>#define RC_LIMIT_11G</td><td>1</td></tr><tr><td>#define RC_LIMIT_11N</td><td>2</td></tr></tbody></table>	#define RC_LIMIT_11B	0	#define RC_LIMIT_11G	1	#define RC_LIMIT_11N	2
#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 soft-AP

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);
```

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:

```
bool wifi_set_user_limit_rate_mask(uint8 enable_mask)
```

Parameter:

uint8 enable_mask :

0x00 - disable the limitation on both ESP8266 station and soft-AP

0x01 - enable the limitation on ESP8266 station

0x02 - enable the limitation on ESP8266 soft-AP

0x03 - enable the limitation on both ESP8266 station and soft-AP

Return:

true: Success

false: Failure

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 soft-AP are not limited

[0x01](#) - ESP8266 station is limited

[0x02](#) - ESP8266 soft-AP is limited

[0x03](#) - both ESP8266 station and soft-AP 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.

More details in "Example" below.

1. wifi_fpm_open

Function:

Enable force sleep function.

Prototype:

[void wifi_fpm_open \(void\)](#)

Parameter:

none

Default:

Force sleep function is disabled.

Return:

none

2. wifi_fpm_close

Function:

Disable force sleep function.

Prototype:

[void wifi_fpm_close \(void\)](#)

**Parameter:**

none

Return:

none

3. `wifi_fpm_do_wakeup`

Function:

Wake ESP8266 up from `MODEM_SLEEP_T` force sleep.

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`.

Prototype:

```
void wifi_fpm_do_wakeup(void)
```

Parameter:

none

Return:

none

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.

Notice:

- 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 `0xFFFFFFFF`).
- `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.

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



5. `wifi_fpm_do_sleep`

Function:

Force ESP8266 to enter sleep mode, and it will wake up automatically on time out.

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`.
- If this API returned 0 means that the configuration is set successfully, but the ESP8266 will not enter sleep mode immediately, it is going to sleep in the system idle task. Please do not call other WiFi related function right after calling this API.

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(0xFFFFFFFF)

If `sleep_time_in_us` is 0xFFFFFFFF, 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.

6. `wifi_fpm_set_sleep_type`

Function:

Set sleep type for force sleep function.

Note:

This API can only be called before `wifi_fpm_open`.

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

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,
};
```

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



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 (disable RF)

```
#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
}

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 (disable 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_MTCK_U,3);
    gpio_pin_wakeup_enable(13, 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**.

Please note the following points carefully:

- ESP-NOW do not support broadcast and multicast.
- ESP-NOW is targeted to Smart-Light project, so it is suggested that slave role corresponding to soft-AP or soft-AP+station mode, controller role corresponding to station mode.
- When ESP8266 is in soft-AP+station mode, it will communicate through station interface if it is in slave role, and communicate through soft-AP 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 soft-AP mode or soft-AP + 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.

1. esp_now_init

Function:

ESP-NOW initialization

Prototype:

`init esp_now_init(void)`

**Parameter:**

none

Return:

0: Success

otherwise: Failure

2. esp_now_deinit

Function:

Deinitialize ESP-NOW

Prototype:`int esp_now_deinit(void)`**Parameter:**

none

Return:

0: Success

otherwise: Failure

3. esp_now_register_recv_cb

Function:

Register ESP-NOW receive callback

Note:

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

4. esp_now_unregister_rcv_cb

Function:

Unregister ESP-NOW receive callback

Prototype:

```
int esp_now_unregister_rcv_cb(void)
```

Parameter:

none

Return:

0: Success

otherwise: Failure

5. esp_now_register_send_cb

Function:

Register ESP-NOW send callback

Notice:

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 {  
    T_TX_STATUS_OK = 0,  
    MT_TX_STATUS_FAILED,  
}
```

The status will be `T_TX_STATUS_OK`, if ESP-NOW send packet successfully. Users should make sure by themselves that the key for communication is correct.

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

6. 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

7. esp_now_send

Function:

Send ESP-NOW packet

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, packet is sent to the target MAC address only.

`u8 *data` : data need to send

`u8 len` : data length

Return:

0: Success

otherwise: Failure

8. esp_now_add_peer

Function:

Add an ESP-NOW peer, store MAC address of target device into ESP-NOW MAC list.

Structure:`typedef enum mt_role {`



```
    MT_ROLE_IDLE = 0,  
    MT_ROLE_CONTROLLER,  
    MT_ROLE_SLAVE,  
    MT_ROLE_MAX,  
}  
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  
  
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
```

9. 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

10. esp_now_set_self_role

Function:
Set ESP-NOW role of device itself

Structure:
`typedef enum mt_role {
 MT_ROLE_IDLE = 0,`



```
    MT_ROLE_CONTROLLER,  
    MT_ROLE_SLAVE,  
    MT_ROLE_MAX,  
}
```

Prototype:

```
int esp_now_set_self_role(u8 role)
```

Parameter:

u8 role : role type

Return:

0: Success

otherwise: Failure

11. esp_now_get_self_role

Function:

Get ESP-NOW role of device itself

Prototype:

```
u8 esp_now_get_self_role(void)
```

Parameter:

none

Return:

role type

12. esp_now_set_peer_role

Function:

Set ESP-NOW role for a target device. If it is set multiple times, the new role setting will override the old role.

Structure:

```
typedef enum mt_role {  
    MT_ROLE_IDLE = 0,  
    MT_ROLE_CONTROLLER,  
    MT_ROLE_SLAVE,  
    MT_ROLE_MAX,  
}
```

Prototype:

```
int esp_now_set_peer_role(u8 *mac_addr, u8 role)
```

**Parameter:**

`u8 *mac_addr` : MAC address of target device

`u8 role` : role type

Return:

0: Success

otherwise: Failure

13. esp_now_get_peer_role

Function:

Get 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:

`MT_ROLE_CONTROLLER`, role type is controller;

`MT_ROLE_SLAVE`, role type is slave;

otherwise: Failure

14. 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`, current key will be reset to be none.

`u8 key_len` : key length, has to be 16 bytes now

Return:

0: Success

otherwise: Failure



15. 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

16. esp_now_set_peer_channel

Function:

Record channel information of a 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



17. 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 target device

Return:

1 ~ 13 (some area may get 14): Success

otherwise: Failure

18. 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 target device

Return:

0: Device does not exist

< 0: Error, check for device failed

> 0: Device exists

19. 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

Note:

- This API can not re-entry
- Parameter has to be `true` when you call it the first time.

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:

`NULL`, no ESP-NOW devices exist

Otherwise, MAC address of ESP-NOW device which is pointed now

20. 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

21. 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.

Prototype:

```
int esp_now_set_kok(u8 *key, u8 len)
```

Parameter:

`u8 *key` : pointer of encryption key

`u8 len` : key length, has to be 16 bytes now

Return:

0: Success

otherwise: Failure



3.9. Upgrade (FOTA) APIs

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

1. `system_upgrade_userbin_check`

Function:

Checks 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`

2. `system_upgrade_flag_set`

Function:

Sets upgrade status flag.

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.

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

3. `system_upgrade_flag_check`

Function:

Gets 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
```

4. system_upgrade_start

Function:

Configures parameters and start upgrade

Prototype:

```
bool system_upgrade_start (struct upgrade_server_info *server)
```

Parameters:

```
struct upgrade_server_info *server : server related parameters
```

Return:

true: start upgrade

false: upgrade cannot be started.

5. system_upgrade_reboot

Function: reboot system and use new version

Prototype:

```
void system_upgrade_reboot (void)
```

Parameters:

none

Return:

none

3.10. Sniffer Related APIs

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

1. wifi_promiscuous_enable

Function:

Enable promiscuous mode for sniffer

**Note:**

- promiscuous mode can only be enabled in station mode.
- During promiscuous mode(sniffer), ESP8266 station and soft-AP 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.

Prototype:

```
void wifi_promiscuous_enable(uint8 promiscuous)
```

Parameter:

[uint8 promiscuous](#) :

- 0: disable promiscuous;
- 1: enable promiscuous

Return:

none

2. [wifi_promiscuous_set_mac](#)

Function:

Set MAC address filter for sniffer.

Note:

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.

Prototype:

```
void wifi_promiscuous_set_mac(const uint8_t *address)
```

Parameter:

[const uint8_t *address](#) : MAC address

Return:

none

Example:

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

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

4. `wifi_get_channel`

Function:

Get Wi-Fi channel

Prototype:

```
uint8 wifi_get_channel(void)
```

Parameters:

none

Return:

Channel number

5. `wifi_set_channel`

Function:

Set Wi-Fi channel, for sniffer mode

Prototype:

```
bool wifi_set_channel (uint8 channel)
```

Parameters:

`uint8 channel` : channel number

Return:

true: Success

false: Failure

3.11. Smart Config APIs

Smart-Config 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 enable Smart-Config.



1. smartconfig_start

Function:

Start smart configuration mode, to 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.

Note:

- This API can only be called in station mode.
- During smart-config, ESP8266 station and soft-AP 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.

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 suggest that this log is only used for debugging. Users should not set it to be 1 while SmartConfig is working properly.

Return:

true: Success

false: Failure

Example:

`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);
```

2. smartconfig_stop

Function:

Stop smart config, free the buffer taken by [smartconfig_start](#).

Note:

Irrespective of whether connection to AP succeeded or not, this API should be called to free memory taken by [smartconfig_start](#).

Prototype:

[bool smartconfig_stop\(void\)](#)

Parameter:

none

Return:

true: Success

false: Failure

3. smartconfig_set_type

Function:

Set the protocol type of SmartConfig

Note:

This API can only be called before calling [smartconfig_start](#).

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

4. airkiss_version

Function:

Get version information of the AirKiss lib.

Notice:

The length of the version information is unknown.

Prototype:

```
const char* airkiss_version(void)
```

Parameter:

none

Return:

Version information of the AirKiss lib.

5. airkiss_lan_recv

Function:

For the function that AirKiss can detect the ESP8266 devices in LAN, more details of this function refer to WeChat: <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

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



3.12. SNTP APIs

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

1. `sntp_setserver`

Function:

Set SNTP server by IP address, supports 3 SNTP server at most

Prototype:

```
void sntp_setserver(unsigned char idx, ip_addr_t *addr)
```

Parameter:

`unsigned char idx` : SNTP server index, support 3 SNTP server at most (0 ~ 2); index 0 is the main server, index 1 and 2 are as backup.

`ip_addr_t *addr` : IP address; users need to ensure that it is an SNTP server

Return:

none

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. `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, index 1 and 2 are as backup.

`char *server` : domain name; users need to ensure that it is an SNTP server

**Return:**

none

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

5. `sntp_init`

Function:

SNTP initialize

Prototype:[void sntp_init\(void\)](#)**Parameter:**

none

Return:

none

6. `sntp_stop`

Function:

Stop SNTP

Prototype:[void sntp_stop\(void\)](#)**Parameter:**

none

Return:

none



7. `sntp_get_current_timestamp`

Function:

Get current timestamp from basic time (1970.01.01 00:00:00 GMT + 8), unit: second

Prototype:

`uint32 sntp_get_current_timestamp()`

Parameter:

none

Return:

time stamp

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

9. `sntp_set_timezone`

Function:

Set time zone

Prototype:

`bool sntp_set_timezone (sint8 timezone)`

Note:

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

Parameter:

`sint8 timezone` – time zone, range: -11 ~ 13

Return:

true: Success

false: Failure

Example:



```
sntp_stop();

if( true == sntp_set_timezone(-5) ) {

    sntp_init();

}
```

10. sntp_get_timezone

Function:

Get time zone

Prototype:

```
sint8 sntp_get_timezone (void)
```

Parameter:

none

Return:

time zone, range: -11 ~ 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));  
    }  
}
```



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

1. espconn_delete

Function:

Delete a transmission.

Note:

Corresponding creation API :

TCP: [espconn_accept](#),

UDP: [espconn_create](#)

Prototype:

[sint8 espconn_delete\(struct espconn *espconn\)](#)

Parameter:

[struct espconn *espconn](#) : corresponding connected control block structure

Return:

0 : Success

Non-0 : 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.

2. espconn_gethostbyname

Function:

DNS

**Prototype:**

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

Parameters:

`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`

Example as follows. Pls refer to source code of IoT_Demo:

```
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);  
}
```

3. espconn_port

Function: get an available port

Prototype:

```
uint32 espconn_port(void)
```

**Parameter:**

none

Return:[uint32](#) : ID of the port you get

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  
)
```

Parameters:[struct espconn *espconn](#) : corresponding connected control block structure[espconn_sent_callback sent_cb](#) : registered callback function**Return:**

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find network transmission according to structure [espconn](#)

5. `espconn_regist_recvcb`

Function:

register data receive function which will be called back when data are received

Prototype:

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

Parameters:[struct espconn *espconn](#) : corresponding connected control block structure[espconn_recv_callback recv_cb](#) : registered callback function**Return:**

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find network transmission according to structure [espconn](#)



6. `espconn_sent_callback`

Function:

Callback after the data are sent

Prototype:

```
void espconn_sent_callback (void *arg)
```

Parameters:

`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:

null

7. `espconn_recv_callback`

Function:

callback after data are received

Prototype:

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

Parameters:

`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

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  
)
```

Parameters:

`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

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure `espconn`

Example:

```
void user_udp_rcv_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));  
    }  
}
```

9. espconn_send

Function:

Send data through network

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`.

Prototype:

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

Parameters:

`struct espconn *espconn` : corresponding connected control block structure

`uint8 *psent` : pointer of data

`uint16 length` : data length

Return:

0 : Success

Non-0 : 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` - send UDP data fail

10. espconn_sent

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

Function:

Send data through network

Note:

- Please call `espconn_sent` 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_sent`.

Prototype:

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

**Parameters:**

`struct espconn *espconn` : corresponding connected control block structure

`uint8 *psent` : sent data pointer

`uint16 length` : sent data length

Return:

0 : Success

Non-0 : Error code

`ESPCONN_MEM` - Out of memory

`ESPCONN_ARG` - illegal argument, cannot find network transmission according to

structure `espconn`

`ESPCONN_MAXNUM` - buffer of sending data is full

`ESPCONN_IF` - send UDP data fail

4.2. TCP APIs

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

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

Non-0 : Error code

`ESPCONN_MEM` - Out of memory

`ESPCONN_ISCONN` - Already connected

`ESPCONN_ARG` - illegal argument, cannot find TCP connection according to structure `espconn`

2. `espconn_regist_time`

Function:

Register timeout interval of ESP8266 TCP server.

**Note:**

Call this API after [espconn_accept](#), before listened to a TCP connection. This API can not be used for SSL connection.

This timeout interval is not very precise, only as 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.

Prototype:

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

Parameters:

[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

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)

3. espconn_connect

Function:

Connect to a TCP server (ESP8266 acting as TCP client).

Note:

- If [espconn_connect](#) fail, returns non-0 value, there is no connection, so it won't enter any [espconn](#) callback.
- It is suggested to use [espconn_port](#) to get an available local port.

Prototype:

```
sint8 espconn_connect(struct espconn *espconn)
```

Parameters:

[struct espconn *espconn](#) : corresponding connected control block structure

Return:

0 : Success

Non-0 : 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](#)

4. [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

5. [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  
)
```

Parameters:

[struct espconn *espconn](#) : corresponding connected control block structure

[espconn_connect_callback connect_cb](#) : registered callback function

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)



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, refer to `espconn_option`

bit 0: 1: free memory after TCP disconnection - need not wait 2 minutes;

bit 1: 1: disable nagle algorithm during TCP data transmission, quiken 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

Non-0 : Error code `ESPCONN_ARG` - illegal argument, cannot find TCP connection according to structure `espconn`

Note:

In general, this API need not be called.

However, if `espconn_set_opt` is called, please call it from `espconn_connect_callback`.

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_KEEPAIVE = 0x08,  
  
    ESPCONN_END  
  
}
```

Parameters:

`struct espconn *espconn` : corresponding connected control block structure

`uint8 opt` : option of TCP connection, refer to `espconn_option`

Return:

0 : Success

Non-0 : error code `ESPCONN_ARG` - illegal argument, cannot find TCP connection according to structure `espconn`

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_KEEPIBLE,  
  
    ESPCONN_KEEPIVL,  
  
    ESPCONN_KEEPCNT  
  
}
```

**Parameters:**

`struct espconn *espconn` : corresponding connected control block structure

`uint8 level` : Default to do TCP keep-alive detection every `ESPCONN_KEEPIDLE`, if there is 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`.

Notice, 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

Non-0 : 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.

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

Non-0 : Error code `ESPCONN_ARG` - illegal argument, cannot find TCP connection according to structure `espconn`

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)`

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

`ESPCONN_TIMEOUT` - Timeout

`ESPCONN_ABRT` - TCP connection aborted

`ESPCONN_RST` - TCP connection reset

`ESPCONN_CLSD` - TCP connection closed

`ESPCONN_CONN` - TCP connection

`ESPCONN_HANDSHAKE` - TCP SSL handshake fail

`ESPCONN_PROTO_MSG` - SSL application invalid

Return:

none



11. espconn_regist_reconcb

Function:

Register reconnect callback

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, [espconn_reconnect_callback](#) will be called because the network is broken.

Prototype:

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

Parameters:

[struct espconn *espconn](#) : corresponding connected control block structure

[espconn_reconnect_callback recon_cb](#) : registered callback function

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)

12. espconn_disconnect

Function:

Disconnect a TCP connection

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](#)

Prototype:

```
sint8 espconn_disconnect(struct espconn *espconn)
```

Parameters:

[struct espconn *espconn](#) : corresponding connected control structure

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)



13. espconn_regist_disconcb

Function:

Register disconnection function which will be called back under successful TCP disconnection

Prototype:

```
sint8 espconn_regist_disconcb(  
    struct espconn *espconn,  
    espconn_connect_callback_t discon_cb  
)
```

Parameters:

[struct espconn *espconn](#) : corresponding connected control block structure

[espconn_connect_callback_t discon_cb](#) : registered callback function

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)

14. espconn_abort

Function:

Forcefully abort a TCP connection

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](#).

Prototype:

```
sint8 espconn_abort(struct espconn *espconn)
```

Parameters:

[struct espconn *espconn](#) : corresponding network connection

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)

15. espconn_regist_write_finish

Function:

Register a callback which will be called when all sending data is completely written into write buffer or sent. Need to call [espconn_set_opt](#) to enable write-buffer first.

**Note:**

- This API can not be used for SSL connection.
- write-buffer is used to keep TCP data that is waiting to be sent, queue number of the write-buffer is 8 which means that it can keep 8 packets at most. The size of write-buffer is 2920 bytes.
- Users can enable it by using [espconn_set_opt](#).
- Users can call [espconn_send](#) to send the next packet in [write_finish_callback](#) instead of using [espconn_sent_callback](#).

Prototype:

```
sint8 espconn_regist_write_finish (  
    struct espconn *espconn,  
    espconn_connect_callback write_finish_fn  
)
```

Parameters:

[struct espconn *espconn](#) : corresponding network connection
[espconn_connect_callback write_finish_fn](#) : registered callback function

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)

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.

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

Non-0 : Error code `ESPCONN_ARG` - illegal argument, cannot find TCP connection according to structure `espconn`

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`

19. espconn_tcp_set_max_con_allow

Function:

Set 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

Non-0 : Error code `ESPCONN_ARG` - illegal argument, cannot find TCP connection according to structure `espconn`



20. espconn_recv_hold

Function:

Puts in a request to block the TCP receive function.

Note:

The function does not act immediately; we recommend calling it while reserving 5*1460 bytes of memory.

This API can be called more than once.

Prototype:

```
sint8 espconn_recv_hold(struct espconn *espconn)
```

Parameter:

`struct espconn *espconn` : corresponding network connection

Return:

0 : Success

Non-0 : Error code `ESPCONN_ARG` - illegal argument, cannot find TCP connection according to structure `espconn`

21. espconn_recv_unhold

Function:

Unblock TCP receiving data (i.e. undo `espconn_recv_hold`).

Note:

This API takes effect immediately.

Prototype:

```
sint8 espconn_recv_unhold(struct espconn *espconn)
```

Parameter:

`struct espconn *espconn` : corresponding network connection

Return:

0 : Success

Non-0 : Error code `ESPCONN_ARG` - illegal argument, cannot find TCP connection according to structure `espconn`

22. espconn_secure_accept

Function:

Creates an SSL TCP server.

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 SSL encrypted packet size is larger than ESP8266 SSL buffer size (default 2KB, set by [espconn_secure_set_size](#)), SSL connection will fail, 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.

Prototype:

[sint8 espconn_secure_accept\(struct espconn *espconn\)](#)

Parameter:

[struct espconn *espconn](#) : corresponding network connection

Return:

0 : Success

Non-0 : Error code

[ESPCONN_MEM](#) - Out of memory

[ESPCONN_ISCONN](#) - Already connected

[ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure

[espconn](#)

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

Non-0 : 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.

24. espconn_secure_set_size

Function:

Set buffer size of encrypted data (SSL)

Note:

Buffer size default to be 2Kbytes. If need to change, please call this API before [espconn_secure_accept](#) (ESP8266 as TCP SSL server) or [espconn_secure_connect](#) (ESP8266 as TCP SSL client)

Prototype:

[bool espconn_secure_set_size](#) (uint8 level, uint16 size)

Parameters:

[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

25. espconn_secure_get_size

Function:

Get buffer size of encrypted data (SSL)

Prototype:

[sint16 espconn_secure_get_size](#) (uint8 level)

Parameters:

[uint8 level](#) : buffer for ESP8266 SSL server/client:

- [0x01](#) SSL client;
- [0x02](#) SSL server;
- [0x03](#) both SSL client and SSL server

Return:

buffer size



26. espconn_secure_connect

Function:

Secure connect (SSL) to a TCP server (ESP8266 is acting as TCP client).

Note:

- If [espconn_connect](#) fails, returns non-0 value, it is not connected and therefore 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, or call [espconn_secure_disconnect](#) to disconnect first, then call this API to create another SSL connection.
- If SSL encrypted packet size is larger than the ESP8266 SSL buffer size (default 2KB, set by [espconn_secure_set_size](#)), the SSL connection will fail, 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.

Prototype:

```
sint8 espconn_secure_connect (struct espconn *espconn)
```

Parameters:

[struct espconn *espconn](#) : corresponding network connection

Return:

0 : Success

Non-0 : Error code

[ESPCONN_MEM](#) - Out of memory

[ESPCONN_ISCONN](#) - Already connected

[ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure

[espconn](#)

27. espconn_secure_send

Function: send encrypted data (SSL)

Note:

Please call [espconn_secure_send](#) after [espconn_sent_callback](#) of the pre-packet.

**Prototype:**

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

Parameters:

[struct espconn *espconn](#) : corresponding network connection

[uint8 *psent](#) : sent data pointer

[uint16 length](#) : sent data length

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)

28. espconn_secure_send

[@deprecated] This API is deprecated, please use [espconn_secure_send](#) instead.

Function: send encrypted data (SSL)

Note:

Please call [espconn_secure_send](#) after [espconn_sent_callback](#) of the pre-packet.

Prototype:

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

Parameters:

[struct espconn *espconn](#) : corresponding network connection

[uint8 *psent](#) : sent data pointer

[uint16 length](#) : sent data length

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)



29. espconn_secure_disconnect

Function: secure TCP disconnection(SSL)

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](#)

Prototype:

[sint8 espconn_secure_disconnect\(struct espconn *espconn\)](#)

Parameters:

[struct espconn *espconn](#) : corresponding network connection

Return:

0 : Success

Non-0 : Error code [ESPCONN_ARG](#) - illegal argument, cannot find TCP connection according to structure [espconn](#)

30. espconn_secure_ca_disable

Function:

Disable SSL CA (certificate authenticate) function

Note:

- CA function is disabled by default, more details in document "5A-ESP8266__SDK__SSL_User_Manual"

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

31. espconn_secure_ca_enable

Function:

Enable SSL CA (certificate authenticate) function

**Note:**

- CA function is disabled by default, more details in document "5A-ESP8266__SDK__SSL_User_Manual"
- This API must be called before [espconn_secure_accept](#) (ESP8266 as TCP SSL server) or [espconn_secure_connect](#) (ESP8266 as TCP SSL client)

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

32. espconn_secure_cert_req_enable

Function:

Enable certification verification function when ESP8266 runs as SSL client

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

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 into 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 BINs or system parameter BINs in the flash memory.

**Return:**

true: Success

false: Failure

33. espconn_secure_cert_req_disable

Function:

Disable certification verification function when ESP8266 runs as SSL client

Note:

- Certification verification function is disabled by default

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

34. espconn_secure_set_default_certificate

Function:

Set the certificate when ESP8266 runs as SSL server

Note:

- Demos can be found in ESP8266_NONOS_SDK\examples\IoT_Demo
- This API has to be called before `espconn_secure_accept`.

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



35. espconn_secure_set_default_private_key

Function:

Set the secure key when ESP8266 runs as SSL server

Note:

- Demos can be found in ESP8266_NONOS_SDK\examples\IoT_Demo
- This API has to be called before [espconn_secure_accept](#).

Prototype:

```
bool espconn_secure_set_default_private_key (const uint8_t* key, uint16_t length)
```

Parameter:

[const uint8_t* key](#) : pointer to the secure key

[uint16_t length](#) : length of the secure key

Return:

true : Success

false: Failure

4.3. UDP APIs

1. espconn_create

Function:

Create UDP transmission.

Note:

Parameter remote_ip and remote_port need to be set, do not set to be 0.

Prototype:

```
sin8 espconn_create(struct espconn *espconn)
```

Parameter:

[struct espconn *espconn](#) : corresponding network transmission

Return:

0 : Success

Non-0 : Error code

[ESPCONN_ISCONN](#) - Already connected

[ESPCONN_MEM](#) - Out of memory

[ESPCONN_ARG](#) - illegal argument, cannot find UDP transmission according to structure

[espconn](#)



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

Non-0 : Error code

`ESPCONN_ISCONN` - Already connected

`ESPCONN_MEM` - Out of memory

`ESPCONN_IF` - send UDP data fail

3. espconn_igmp_join

Function:

Join a multicast group

Note:

This API can only be called after the ESP8266 station connects to a router.

Prototype:

`sin8 espconn_igmp_join(ip_addr_t *host_ip, ip_addr_t *multicast_ip)`

Parameters:

`ip_addr_t *host_ip` : IP of host

`ip_addr_t *multicast_ip` : IP of multicast group

Return:

0 : Success

Non-0 : Error code `ESPCONN_MEM` - Out of memory

4. espconn_igmp_leave

Function:

Quit a multicast group

Prototype:

`sin8 espconn_igmp_leave(ip_addr_t *host_ip, ip_addr_t *multicast_ip)`

**Parameters:**

`ip_addr_t *host_ip` : IP of host
`ip_addr_t *multicast_ip` : IP of multicast group

Return:

0 : Success
Non-0 : Error code `ESPCONN_MEM` - Out of memory

5. `espconn_dns_setserver`

Function:

Set default DNS server. Two DNS servers are allowed to be set.

Note:

Only if ESP8266 DHCP client is disabled (`wifi_station_dhpc_stop`), this API can be used.

Prototype:

`void espconn_dns_setserver(char numdns, ip_addr_t *dnsserver)`

Parameter:

`char numdns` : DNS server ID, 0 or 1
`ip_addr_t *dnsserver` : DNS server IP

Return:

none

4.4. mDNS APIs

1. `espconn_mdns_init`

Function:

mDNS initialization

Note:

- In soft-AP+station mode, call `wifi_set_broadcast_if(STATIONAP_MODE)`; first to enable broadcast for both soft-AP 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` ", as **Example**;

**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

2. espconn_mdns_close

Function:

Close mDNS, corresponding creation API : [espconn_mdns_init](#)

Prototype:

```
void espconn_mdns_close(void)
```

Parameter:

none

Return:

none

3. espconn_mdns_server_register

Function:

Register mDNS server

Prototype:

```
void espconn_mdns_server_register(void)
```

Parameter:

none

Return:

none



4. espconn_mdns_server_unregister

Function:

Unregister mDNS server

Prototype:

```
void espconn_mdns_server_unregister(void)
```

Parameter:

none

Return:

none

5. espconn_mdns_get_servername

Function:

Get mDNS server name

Prototype:

```
char* espconn_mdns_get_servername(void)
```

Parameter:

none

Return:

server name

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

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
```

8. espconn_mdns_get_hostname

Function:

Get mDNS host name

Prototype:

```
char* espconn_mdns_get_hostname(void)
```

Parameter:

```
none
```

Return:

```
host name
```

9. espconn_mdns_disable

Function:

Disable mDNS, corresponding creation API : [espconn_mdns_enable](#)

Prototype:

```
void espconn_mdns_disable(void)
```

Parameter:

```
none
```

Return:

```
none
```

10. espconn_mdns_enable

Function:

Enable mDNS

Prototype:

```
void espconn_mdns_enable(void)
```

Parameter:

```
none
```

**Return:**

none

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 refer to documentation "30A_ESP8266__Mesh_User Guide".

Download: <http://bbs.espressif.com/viewtopic.php?f=51&t=1977>



6. Application Related

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`.

1. `at_response_ok`

Function:

Output `OK` to AT Port (UART0)

Prototype:

```
void at_response_ok(void)
```

Parameter:

none

Return:

none

2. `at_response_error`

Function:

output `ERROR` to AT Port (UART0)

Prototype:

```
void at_response_error(void)
```

Parameter:

none

Return:

none

3. `at_cmd_array_regist`

Function:

register user-defined AT commands.

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:

refer to [ESP8266_NONOS_SDK/examples/at/user/user_main.c](#)

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 (NOTE: 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 more than 10 bytes;
string contains termination characters '\r'; string contains only '-'.

Example:

refer to [ESP8266_NONOS_SDK/examples/at/user/user_main.c](#)

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:

refer to [ESP8266_NONOS_SDK/examples/at/user/user_main.c](#)

6. at_init

Function:

AT initialize

Prototype:

`void at_init (void)`

Parameter:

none

Return:

none

Example:

refer to [ESP8266_NONOS_SDK/examples/at/user/user_main.c](#)

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:

refer to [ESP8266_NONOS_SDK/examples/at/user/user_main.c](#)



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

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

10. `at_leave_special_state`

Function:

Exit from AT processing state.

Prototype:

```
void at_leave_special_state (void)
```

Parameter:

none

Return:

none

11. `at_get_version`

Function:

Get Espressif AT lib version.

**Prototype:**

```
uint32 at_get_version (void)
```

Parameter:

none

Return:

Espressif AT lib version

12. at_register_uart_rx_intr

Function:

Set UART0 to be used by user or AT commands.

Note:

This API can be called multiple times.

Running AT,UART0 default to be used by 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); }
```



13. `at_response`

Function:

Set AT response

Note:

`at_response` outputs from UART0 TX by default which is same as `at_port_print`. But on calling `at_register_response_func`, the string of `at_response` will be the parameter of `response_func`, users can define their own behavior.

Prototype:

```
void at_response (const char *str)
```

Parameter:

`const char *str` : string

Return:

none

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 their own 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

15. `at_fake_uart_enable`

Function:

Enable UART simulation, 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

16. at_fake_uart_rx

Function:

UART RX simulation, 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, failure

17. at_set_escape_character

Function:

Set an escape character for AT commands. 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`

1. jsonparse_setup

Function:

Initialize JSON parser

**Prototype:**

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

Parameters:

`struct jsonparse_state *state` : json parsing pointer

`const char *json` : json parsing character string

`int len` : character string length

Return:

none

2. jsonparse_next

Function:

Returns jsonparse next object

Prototype:

```
int jsonparse_next(struct jsonparse_state *state)
```

Parameters:

`struct jsonparse_state *state` : json parsing pointer

Return:

int : parsing result

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  
)
```

Parameters:

`struct jsonparse_state *state` : json parsing pointer

`char *str` : buffer pointer

`int size` : buffer size

**Return:**

`int` : copy result

4. `jsonparse_get_value_as_int`

Function:

Parses json to get integer

Prototype:

`int jsonparse_get_value_as_int(struct jsonparse_state *state)`

Parameters:

`struct jsonparse_state *state` : json parsing pointer

Return:

`int` : parsing result

5. `jsonparse_get_value_as_long`

Function:

Parses json to get long integer

Prototype:

`long jsonparse_get_value_as_long(struct jsonparse_state *state)`

Parameters:

`struct jsonparse_state *state` : json parsing pointer

Return:

`long` : parsing result

6. `jsonparse_get_len`

Function:

Gets parsed json length

Prototype:

`int jsonparse_get_value_len(struct jsonparse_state *state)`

Parameters:

`struct jsonparse_state *state` : json parsing pointer

Return:

`int` : parsed jason length



7. jsonparse_get_value_as_type

Function:

Parses json data type

Prototype:

```
int jsonparse_get_value_as_type(struct jsonparse_state *state)
```

Parameters:

`struct jsonparse_state *state` : json parsing pointer

Return:

`int` : parsed json data type

8. jsonparse_strcmp_value

Function:

Compares parsed json and certain character string

Prototype:

```
int jsonparse_strcmp_value(struct jsonparse_state *state, const char *str)
```

Parameters:

`struct jsonparse_state *state` : json parsing pointer

`const char *str` : character buffer

Return:

`int` : comparison result

9. jsontree_set_up

Function:

Creates json data tree

Prototype:

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

Parameters:

`struct jsontree_context *js_ctx` : json tree element pointer

`struct jsontree_value *root` : root element pointer

`int (* putchar)(int)` : input function

**Return:**

none

10. jsontree_reset

Function:

Resets json tree

Prototype:

```
void jsontree_reset(struct jsontree_context *js_ctx)
```

Parameters:

```
struct jsontree_context *js_ctx : json data tree pointer
```

Return:

none

11. jsontree_path_name

Function:

get json tree parameters

Prototype:

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

Parameters:

```
struct jsontree_context *js_ctx : json tree pointer
```

```
int depth : json tree depth
```

Return:

```
char* : parameter pointer
```

12. jsontree_write_int

Function:

write integer to json tree

Prototype:

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

**Parameters:**

`struct jsontree_context *js_ctx` : json tree pointer

`int value` : integer value

Return:

none

13. jsontree_write_int_array

Function:

Writes integer array to json tree

Prototype:

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

Parameters:

`struct jsontree_context *js_ctx` : json tree pointer

`int *text` : array entry address

`uint32 length` : array length

Return:

none

14. jsontree_write_string

Function:

Writes string to json tree

Prototype:

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

Parameters:

`struct jsontree_context *js_ctx` : json tree pointer

`const char* text` : character string pointer

Return:

none



15. jsontree_print_next

Function:

json tree depth

Prototype:

```
int jsontree_print_next(struct jsontree_context *js_ctx)
```

Parameters:

`struct jsontree_context *js_ctx` : json tree pointer

Return:

`int` : json tree depth

16. jsontree_find_next

Function:

find json tree element

Prototype:

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

Parameters:

`struct jsontree_context *js_ctx` : json 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. WiFi Related Structures

1. Station Related

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

Note:

BSSID as MAC address of AP, 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.

2. soft-AP related

```
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 soft-AP mode
    uint8 ssid_hidden; // default 0
    uint8 max_connection; // default 4, max 4
    uint16 beacon_interval; // 100 ~ 60000 ms, default 100
};
```

Note:

If `softap_config.ssid_len==0`, SSID is checked till a termination character is found; otherwise, it depends on `softap_config.ssid_len`.

3. scan related

```
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;
    u8 bssid[6];
    u8 ssid[32];
    u8 channel;
    s8 rssi;
    u8 authmode;
    uint8 is_hidden; // SSID of current AP is hidden or not.
    sint16 freq_offset; // AP's frequency offset
};

typedef void (* scan_done_cb_t)(void *arg, STATUS status);
```

4. WiFi 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_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 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_Info_u;

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

5. smart config 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

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];
};
```

2. 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

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);
```

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
};
```



7.5. 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

Peripheral drivers can refer to /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.

1. PIN Related Macros

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

`PIN_PULLUP_DIS(PIN_NAME)`

Disable pin pull up

`PIN_PULLUP_EN(PIN_NAME)`

Enable pin pull up

`PIN_FUNC_SELECT(PIN_NAME, FUNC)`

Select pin function

Example:

`PIN_FUNC_SELECT(PERIPHS_IO_MUX_MTDI_U, FUNC_GPIO12); // Use MTDI pin as GPIO12.`

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
)
```

Input Parameters:

`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, GPIO13 as low-level output.

```
gpio_output_set(0, 0, 0, BIT12):
```

Set GPIO12 as input

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 5.1.2

```
GPIO_DIS_OUTPUT(gpio_no)
```

Set `gpio_no` as input, the same as the input example in 5.1.2.

```
GPIO_INPUT_GET(gpio_no)
```

Get the level status of `gpio_no`.

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

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  
)
```

**Input Parameters:**

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

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.

1. uart_init

Function:

Initialize baud rates of the two UARTs

Prototype:

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

Parameters:

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

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

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



8.3. I2C Master Related APIs

1. i2c_master_gpio_init

Function:

Set GPIO in I2C master mode

Prototype:

```
void i2c_master_gpio_init (void)
```

Parameters:

none

Return:

none

2. i2c_master_init

Function:

Initialize I2C

Prototype:

```
void i2c_master_init(void)
```

Parameters:

none

Return:

none

3. i2c_master_start

Function: configures I2C to start sending data

Prototype:

```
void i2c_master_start(void)
```

Parameters:

none

Return:

none

4. i2c_master_stop

Function:

configures I2C to stop sending data

**Prototype:**

```
void i2c_master_stop(void)
```

Parameters:

none

Return:

none

5. i2c_master_send_ack

Function:

Sends I2C ACK

Prototype:

```
void i2c_master_send_ack (void)
```

Parameters:

none

Return:

none

6. i2c_master_send_nack

Function:

Sends I2C NACK

Prototype:

```
void i2c_master_send_nack (void)
```

Parameters:

none

Return:

none

7. i2c_master_checkAck

Function:

Checks ACK from slave

Prototype:

```
bool i2c_master_checkAck (void)
```

Parameters:

none

**Return:**

true: ACK received from I2C slave

false: NACK received from I2C slave

8. i2c_master_readByte

Function:

Read one byte from I2C slave

Prototype:`uint8 i2c_master_readByte (void)`**Input Parameters:**

none

Return:`uint8` : the value that was read

9. i2c_master_writeByte

Function:

Write one byte to slave

Prototype:`void i2c_master_writeByte (uint8 wrdata)`**Input Parameters:**`uint8 wrdata` : data to write**Return:**

none



8.4. PWM Related

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(LIGHT_SLEEP);`), because that Light Sleep will stop the CPU, it can not be interrupted by NMI during light sleep.

To enter Deep Sleep mode, PWM needs to be stopped first.

1. `pwm_init`

Function:

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

Note:

This API can be called only once.

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);
```




2. pwm_start

Function:

Starts PWM. This function needs to be called after PWM config is changed.

Prototype:

`void pwm_start(void)`

Parameter:

none

Return:

none

3. pwm_set_duty

Function:

Sets duty cycle of a PWM output. Set the time that high-level signal will last, duty depends on period, the maximum value can be $\text{Period} * 1000 / 45$. For example, 1KHz PWM, duty range is 0 ~ 22222

Note:

After updating the configuration, `pwm_start` must be called for the changes to take effect.

Prototype:

`void pwm_set_duty(uint32 duty, uint8 channel)`

Input Parameters:

`uint32 duty` : the time that high-level single will last, duty cycle will be $(\text{duty} * 45) / (\text{period} * 1000)$

`uint8 channel` : PWM channel, depends on how many PWM channels is used, in `IOT_Demo` it depends on `#define PWM_CHANNEL`

Return:

none

4. pwm_get_duty

Function:

Gets duty cycle of PWM output, duty cycle will be $(\text{duty} * 45) / (\text{period} * 1000)$

Prototype:

`uint8 pwm_get_duty(uint8 channel)`

Input Parameters:

`uint8 channel` : PWM channel, depends on how many PWM channels is used, in `IOT_Demo` it depends on `#define PWM_CHANNEL`

**Return:**

[uint8](#) : duty cycle of PWM output

5. `pwm_set_period`

Function:

Sets PWM period, unit: us. For example, for 1KHz PWM, period is 1000 us

Note:

After updating the configuration, [pwm_start](#) must be called for the changes to take effect.

Prototype:

[void pwm_set_period\(uint32 period\)](#)

Input Parameters:

[uint32 period](#) : PWM period, unit: us

Return:

none

6. `pwm_get_period`

Function:

Gets PWM period.

Prototype:

[uint32 pwm_get_period\(void\)](#)

Parameter:

none

Return:

PWM period, unit: us.

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.

1. `sdio_slave_init`

Function:

SDIO slave initialization.

Prototype:

```
void sdio_slave_init(void)
```

Parameter:

none

Return:

none

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.

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.

**Prototype:**

`bool sdio_register_rcv_cb(sdio_rcv_data_callback cb)`

Parameter:

`sdio_rcv_data_callback cb` : callback

Return:

true: Success

false: Failure



9.

Appendix

9.1. ESPCONN Programming

1. TCP Client Mode

Notes:

- ESP8266, working in Station mode, will start client connections when given an IP address.
- ESP8266, working in soft-AP 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 register reconnect callback function.
 - (Call espconn_regist_connectcb and espconn_regist_reconcb)
3. Call espconn_connect function and set up the 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 receive callback function or sent callback function to run disconnect, it is recommended to set a time delay to make sure that the all firmware functions are completed.

2. TCP Server Mode

Notes:

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

Steps

1. Initialize espconn parameters according to protocols.
2. Register connect callback and reconnect callback function.
 - (Call espconn_regist_connectcb and espconn_regist_reconcb)
3. Call espconn_accept function 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)

3. espconn callback

Register Function	Callback	Description
<code>espconn_regist_connectcb</code>	<code>espconn_connect_callback</code>	TCP connected successfully
<code>espconn_regist_reconcb</code>	<code>espconn_reconnect_callback</code>	Error occur,TCP disconnected
<code>espconn_regist_sentcb</code>	<code>espconn_sent_callback</code>	Sent TCP or UDP data
<code>espconn_regist_recvcb</code>	<code>espconn_recv_callback</code>	Received TCP or UDP data
<code>espconn_regist_write_finish</code>	<code>espconn_write_finish_callback</code>	Write data into TCP-send-buffer
<code>espconn_regist_disconcb</code>	<code>espconn_disconnect_callback</code>	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 non-0 value, 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`).

9.2. 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);
}
```

9.3. Sniffer Structure Introduction

The ESP8266 can enter the promiscuous mode (sniffer) and capture IEEE 802.11 packets in the air.

The following HT20 packet types are supported:

- 802.11b
- 802.11g
- 802.11n (from MCS0 to MCS7)
- AMPDU

The following packet types are not supported:

- HT40
- LDPC



Although the ESP8266 can not decipher some IEEE80211 packets completely, it can Get the length of these packets.

Therefore, when in the sniffer mode, the ESP8266 can either (1) completely capture the packets or (2) Get the length of the packets.

- For packets that ESP8266 can decipher completely, the ESP8266 returns with the
 - MAC addresses of both communication sides and the encryption type
 - the length of the entire packet.
- For packets that ESP8266 cannot completely decipher, the ESP8266 returns with
 - the length of the entire packet.

Structure RxControl and sniffer_buf are used to represent these two kinds of packets. Structure sniffer_buf contains structure RxControl.

```
struct RxControl {
    signed rssi:8;          // signal intensity of packet
    unsigned rate:4;
    unsigned is_group:1;
    unsigned:1;
    unsigned sig_mode:2;    // 0: is not 11n packet; non-0: is 11n packet;
    unsigned legacy_length:12; // if not 11n packet, shows length of packet.
    unsigned damatch0:1;
    unsigned damatch1:1;
    unsigned bssidmatch0:1;
    unsigned bssidmatch1:1;
    unsigned MCS:7;        // if is 11n packet, shows the modulation
                          // and code used (range from 0 to 76)
    unsigned CWB:1; // if is 11n packet, shows if is HT40 packet or not
    unsigned HT_length:16; // if is 11n packet, shows length of packet.
    unsigned Smoothing:1;
    unsigned Not_Sounding:1;
    unsigned:1;
    unsigned Aggregation:1;
    unsigned STBC:2;
    unsigned FEC_CODING:1; // if is 11n packet, shows if is LDPC packet or not.
    unsigned SGI:1;
    unsigned rxend_state:8;
    unsigned ampdu_cnt:8;
    unsigned channel:4; //which channel this packet in.
    unsigned:12;
};
```



```
struct LenSeq{
    u16 len; // length of packet
    u16 seq; // serial number of packet, the high 12bits are serial number,
            // low 14 bits are Fragment number (usually be 0)
    u8 addr3[6]; // the third address in packet
};

struct sniffer_buf{
    struct RxControl rx_ctrl;
    u8 buf[36]; // head of ieee80211 packet
    u16 cnt;    // number count of packet
    struct LenSeq lenseq[1]; //length of packet
};

struct sniffer_buf2{
    struct RxControl rx_ctrl;
    u8 buf[112];
    u16 cnt;
    u16 len; //length of packet
};
```

The callback function `wifi_promiscuous_rx` contains two parameters (`buf` and `len`). `len` shows the length of `buf`, it can be: `len = 128`, `len = X * 10`, `len = 12`.

LEN == 128

- `buf` contains structure `sniffer_buf2`: it is the management packet, it has 112 bytes of data.
- `sniffer_buf2.cnt` is 1.
- `sniffer_buf2.len` is the length of the management packet.

LEN == X * 10

- `buf` contains structure `sniffer_buf`: this structure is reliable, data packets represented by it have been verified by CRC.
- `sniffer_buf.cnt` shows the number of packets in `buf`. The value of `len` is decided by `sniffer_buf.cnt`.
 - `sniffer_buf.cnt==0`, invalid `buf`; otherwise, `len = 50 + cnt * 10`
- `sniffer_buf.buf` contains the first 36 bytes of IEEE80211 packet. Starting from `sniffer_buf.lenseq[0]`, each structure `lenseq` shows the length of a packet. `lenseq[0]` shows the length of the first packet. If there are two packets where (`sniffer_buf.cnt == 2`), `lenseq[1]` shows the length of the second packet.



- If `sniffer_buf.cnt > 1`, it is a AMPDU packet. Because headers of each MPDU packets are similar, we only provide the length of each packet (from the header of MAC packet to FCS)
- This structure contains: length of packet, MAC address of both communication sides, length of the packet header.

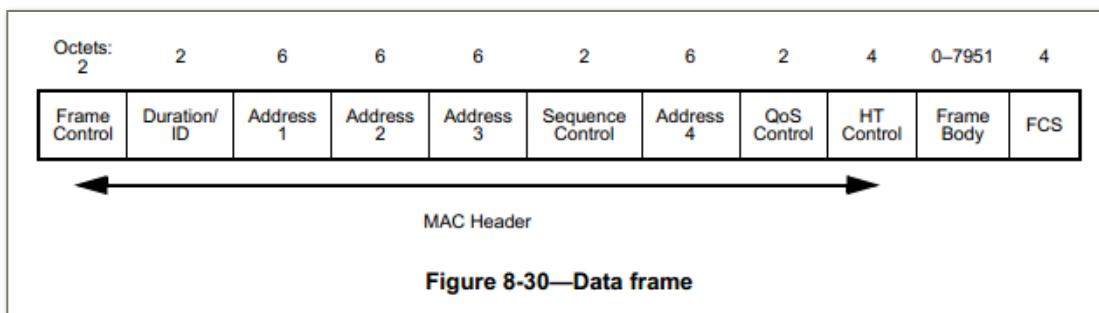
LEN == 12

- `buf` contains structure `RxControl`; but this structure is not reliable. It cannot show the MAC addresses of both communication sides, or the length of the packet header.
- It does not show the number or the length of the sub-packets of AMPDU packets.
- This structure contains: length of the packet, `rssi` and `FEC_CODING`.
- `RSSI` and `FEC_CODING` are used to judge whether the packets are from the same device.

Summary

It is recommended that users speed up the processing of individual packets, otherwise, some follow-up packets may be lost.

Format of an entire IEEE802.11 packet is shown as below.



- The first 24 bytes of MAC header of the data packet are needed:
 - `Address 4` field is decided by `FromDS` and `ToDS` in `Frame Control`;
 - `QoS Control` field is decided by `Subtype` in `Frame Control`;
 - `HT Control` field is decided by `Order Field` in `Frame Control`;
 - For more details, refer to *IEEE Std 80211-2012*.
- For WEP encrypted packets, the MAC header is followed by an 4-byte IV, and there is a 4-byte ICV before the FCS.
- For TKIP encrypted packets, the MAC header is followed by a 4-byte IV and a 4-byte EIV, and there are an 8-byte MIC and a 4-byte ICV before the FCS.
- For CCMP encrypted packets, the MAC header is followed by an 8-byte CCMP header, and there is an 8-byte MIC before the FCS.



9.4. ESP8266 soft-AP 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 soft-AP will adjust its channel configuration to be 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 the user connects the ESP8266 to a router (for example, channel 6),
- (2) and sets the ESP8266 soft-AP through [wifi_softap_set_config](#),
- (3) If the value is effective, the API will return to 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 the user sets the channel of the ESP8266 soft-AP through [wifi_softap_set_config](#) (for example, channel 5),
- (2) other stations will connect to the ESP8266 soft-AP,
- (3) then the user connects the ESP8266 station to a router (for example, channel 6),
- (4) the ESP8266 softAP will adjust its channel to be as same as 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 soft-AP 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-end connection may break.

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-end connection may break.

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 the router. Or use `wifi_station_set_reconnect_policy` or `wifi_station_set_auto_connect` to disable the ESP8266 station from reconnecting to the router.



9.5. ESP8266 boot messages

ESP8266 outputs boot messages through UART0 with baud rate 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 (first parameter)	1 :	ESP8266 is in UART-down mode (download firmware into Flash)
	3 :	ESP8266 is in Flash-boot mode (boot up from Flash)
chksum		If chksum == csum, it means that read Flash correctly during booting.



Espressif System

IOT Team

<http://bbs.espressif.com>

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