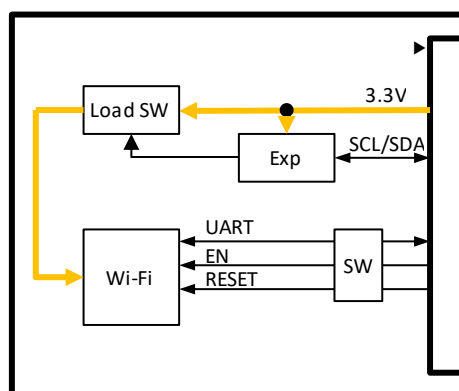# AC01A Wi-Fi Echo

1. 概要

　Espressif Systems の技的認証済み Wi-Fi モジュール ESP-WROOM-02 を搭載したリーフである。MCU リーフとは UART で接続される。

2. リーフ仕様

### 2-1. ブロック図

2-2. 電源仕様

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	Power Supply Voltage	−	2.7V	3.3V	3.6V
Idd	Operating current	Active	-	80mA	-
		Sleep	-	1uA	-

2-3. 主要部品

部品番号	部品名	型番	ベンダー名	備考
IC540	Wi-Fi モジュール	ESP-WROOM-02	Espressif Systems	−
IC542	I2C Expander	PCA9557RGVR	Texas Instruments	−
IC543	Load Switch	XC8102AA01NR-G	TOREX	−
IC541	Analog Switch	TS3A4751RUCR	Texas Instruments	−

2-4. 外観

表面	裏面
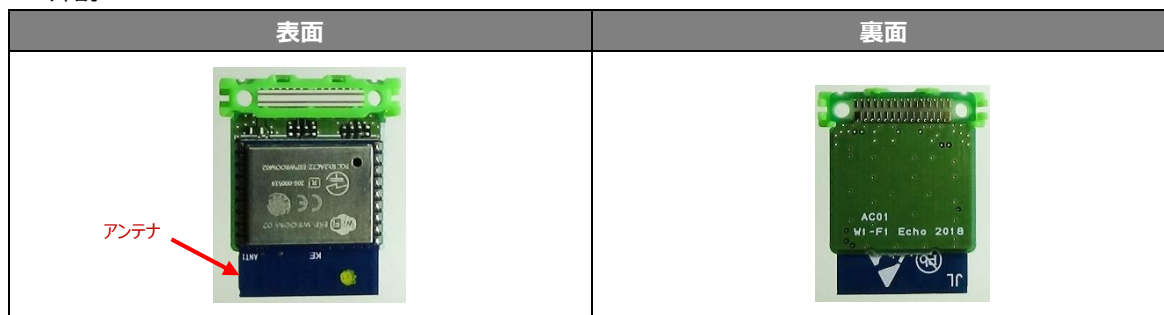
2-5. ピンアウト

Name	Function
D9	TXD：UART 送信 チップ抵抗の付け替えで A2 に変更可
D8	RXD：UART 受信 チップ抵抗の付け替えで A1 に変更可
D4	EN：チップイネーブル　H：イネーブル
RESET	RST：リセット
SCL	I2C 通信クロック
SDA	I2C 通信データ
3V3	3.3V 入力
GND	GND

3. Wi-Fi モジュール(ESP-WROOM-02)仕様

3-1. 概要

項目	内容
SoC	ESP8266EX (CPU:Tensilica L106 32-bit RISC)
Wi-Fi protocols	IEEE 802.11b/g/n
Frequency range	2400M ~ 2483.5MHz
Wi-Fi mode	Station/SoftAP/SoftAP + Station
Security	WPA/WPA2
Encryption	WEP/TKIP/AES
Network protocols	IPv4, TCP/UDP/HTTP/FTP
User configuration	AT Instruction Set, Cloud Server, Android/iOS app
RF certification	SRRC, FCC, CE (RED), IC, NCC, KCC, TELEC (MIC)
Wi-Fi certifaction	Wi-Fi Alliance
Flash	2MB
Interfaces	UART

3-2. 仕様

3-2-1. 最大定格

Parameter	Value
Operating Temperature	-40℃ to +85℃
Maximum Operation Voltage	3.6V

3-2-2. 電気的特性

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	Power Supply Voltage	−	2.7V	3.3V	3.6V
Idd	Operating current	Average	-	80mA	
		Minimum current delivered	500mA	-	-
		Tx 802.11b, CCK 11 Mbps, POUT = +17 dBm	-	170mA	-

		Tx 802.11g, OFDM 54 Mbps, POUT = +15 dBm	-	140mA	-
		Tx 802.11n, MCS7, POUT = +13 dBm	-	120mA	-
		Rx 802.11b, 1024 bytes packet length , -80 dBm	-	50mA	-
		Rx 802.11g, 1024 bytes packet length , -70 dBm	-	56mA	-
		Rx 802.11n, 1024 bytes packet length , -65 dBm	-	56mA	-
	Modem-sleep	–	-	15mA	-
	Light-sleep	–	-	0.9mA	-
	Deep-sleep	–	-	20uA	-
	Power Off	–	-	0.5uA	-

3-3. データシートリンク先

https://www.espressif.com/en/products/hardware/esp-wroom-02/resources

3-4. 主な関数とライブラリ

3-4-1. Wi-Fi 通信

include file：WiFiEsp.h（Arduino WiFi library for ESP8266 modules）

https://github.com/bportaluri/WiFiEsp

関数	概要
WiFi.init(mySerial)	WiFi リーフと接続する UART を設定 【パラメータ】 シリアルポートのインスタンス SoftwareSerial を使用する場合は事前に SoftwareSerial の設定をする必要がある 　例　Serial1 begin(9600); 　　　WiFi.init(Serial1); 【戻り値】 なし

3-5. コマンド(Basic AT Commands)

参照先：https://www.espressif.com/sites/default/files/documentation/4a-esp8266_at_instruction_set_en.pdf

Definition	Commands	Description
Tests AT Startup	AT	Tests AT startup. 【Parameters】 non 【Response】 OK
Restarts the Module	AT+RST	Restarts the module. 【Parameters】 non 【Response】 OK

Checks Version Information	AT+GMR	Checks version information. 【Parameters】 • <AT version info>: information about the AT version. • <SDK version info>: information about the SDK version. • <compile time>: the duration of time for compiling the BIN. 【Response】 <AT version info> <SDK version info> <compile time> OK
Enters Deep-sleep Mode	AT+GSLP=<time>	Enters Deep-sleep mode. A minor adjustment has to be made before the module enter the Deep-sleep mode, i.e., connecting XPD_DCDC to EXT_RSTB via a 0-ohm resistor. 【Execute Command】 AT+GSLP=<time> 【Parameters】 <time>: the duration of ESP8266's sleep. Unit: ms. ESP8266 will wake up after Deep-sleep for as many milliseconds (ms) as <time> indicates. 【Response】 <time> OK
AT Commands Echoing	ATE	Configures echoing of AT commands. This command ATE is used to trigger command echo. It means that entered commands can be echoed back to the sender when ATE command is used. Two parameters are possible. The command returns OK in normal cases and ERROR when a parameter other than 0 or 1 was specified. 【Parameters】 • ATE0: Switches echo off. • ATE1: Switches echo on. 【Response】 OK
Restores the Factory Default Settings	AT+RESTORE	Restores the factory default settings of the module. The execution of this command will reset all parameters saved in flash, and restore the factory default settings of the module. The chip will be restarted when this command is executed. 【Parameters】 non 【Response】 OK

| Current UART Configuration ; Not Saved in the Flash | AT+UART_ CUR | The current UART configuration.
1. The configuration changes will NOT be saved in the flash.
2. The use of flow control requires the support of hardware:
3. The range of baud rates supported: 110~115200*40.

·Set Command:
【Execute Command】
AT+UART_CUR=<baudrate>,<databits>,<stopbits>,<parity>,<flow control>
【Response】
  OK

·Query Command:
【Execute Command】
  AT+UART_CUR?
【Response】
+UART_CUR:<baudrate>,<databits>,<stopbits>,<parity>,<flow control>
OK

Command AT+UART_CUR? will return the actual value of UART configuration parameters, which may have allowable errors compared with the set value because of the clock division.
For example, if the UART baud rate is set as 115200, the baud rate returned by using command AT+UART_CUR? could be 115273.
【Parameters】
• <baudrate>: UART baud rate
• <databits>: data bits
  ‣ 5: 5-bit data
  ‣ 6: 6-bit data
  ‣ 7: 7-bit data
  ‣ 8: 8-bit data
• <stopbits>: stop bits
  ‣ 1: 1-bit stop bit
  ‣ 2: 1.5-bit stop bit
  ‣ 3: 2-bit stop bit
• <parity>: parity bit
  ‣ 0: None
  ‣ 1: Odd
  ‣ 2: Even
• <flow control>: flow control
  ‣ 0: flow control is not enabled
  ‣ 1: enable RTS
  ‣ 2: enable CTS
  ‣ 3: enable both RTS and CTS |

Default UART Configuration ; Saved in the Flash	AT+UART_DEF	The default UART configuration, saved in flash.
		1. The configuration changes will be saved in the user parameter area in the flash, and will still be valid when the chip is powered on again.
		2. The use of flow control requires the support of hardware:
		3. The range of baud rates supported: 110~115200*40.
		
		·Set Command:
		【Execute Command】
		AT+UART_DEF=<baudrate>,<databits>,<stopbits>,<parity>,<flow control>
		【Response】
		OK
		
		·Query Command:
		【Execute Command】
		AT+UART_DEF?
		【Response】
		+UART_DEF:<baudrate>,<databits>,<stopbits>,<parity>,<flow control>
		OK
		
		【Parameters】
		• <baudrate>: UART baud rate
		• <databits>: data bits
		  ‣ 5: 5-bit data
		  ‣ 6: 6-bit data
		  ‣ 7: 7-bit data
		  ‣ 8: 8-bit data
		• <stopbits>: stop bits
		  ‣ 1: 1-bit stop bit
		  ‣ 2: 1.5-bit stop bit
		  ‣ 3: 2-bit stop bit
		• <parity>: parity bit
		  ‣ 0: None
		  ‣ 1: Odd
		  ‣ 2: Even
		• <flow control>: flow control
		  ‣ 0: flow control is not enabled
		  ‣ 1: enable RTS
		  ‣ 2: enable CTS
		  ‣ 3: enable both RTS and CTS

Configures the Sleep Modes	AT+SLEEP= <sleep mode>	Configures the sleep modes.
		This command can only be used in Station mode. Modem-sleep is the default sleep mode.
		・Set Command:
		【Execute Command】
		AT+SLEEP=<sleep mode>
		【Response】
		OK
		
		・Query Command:
		【Execute Command】
		AT+SLEEP?
		【Response】
		+SLEEP:<sleep mode>
		OK
		
		【Parameters】
		<sleep mode>:
		  ‣ 0: disables sleep mode
		  ‣ 1: Light-sleep mode
		  ‣ 2: Modem-sleep mode

| Configures a GPIO to Wake ESP8266 up from Light-sleep Mode | AT+WAKEU PGPIO | Configures a GPIO to wake ESP8266 up from Light-sleep mode.

• Since the system needs some time to wake up from light sleep, it is suggested that wait at least 5ms before sending next AT command.

• The value of <trigger_GPIO> and <awake_GPIO> in the command should not be the same.

• After being woken up by <trigger_GPIO> from Light-sleep, when the ESP8266 attempts to sleep again, it will check the status of the <trigger_GPIO>:

‣ if it is still in the wakeup status, the EP8266 will enter Modem-sleep mode instead;

‣ if it is NOT in the wakeup status, the ESP8266 will enter Light-sleep mode.

【Execute Command】
AT+WAKEUPGPIO=<enable>,<trigger_GPIO>,<trigger_level>[,<awake_GPIO>,<awake_level>]
【Parameters】
• <enable>
‣ 0: ESP8266 can NOT be woken up from light-sleep by GPIO.
‣ 1: ESP8266 can be woken up from light-sleep by GPIO.
• <trigger_GPIO>
‣ Sets the GPIO to wake ESP8266 up; range of value: [0, 15].
• <trigger_level>
‣ 0: The GPIO wakes up ESP8266 on low level.
‣ 1: The GPIO wakes up ESP8266 on high level.
• [<awake_GPIO>]
‣ Optional; this parameter is used to set a GPIO as a flag of ESP8266's being awoken form Light-sleep; range of value: [0, 15].
• [<awake_level>]
‣ Optional;
‣ 0: The GPIO is set to be low level after the wakeup process.
‣ 1: The GPIO is set to be high level after the wakeup process.
【Response】
OK |
| Sets the Maximum Value of RF TX Power | AT+RFPOW ER | Sets the maximum value of the RF TX Power.
This command sets the maximum value of ESP8266 RF TX power; it is not precise. The actual value could be smaller than the set value.
【Execute Command】
AT+RFPOWER=<TX Power>
【Parameters】
<TX Power>: the maximum value of RF TX power; range: [0, 82]; unit: 0.25 dBm.
【Response】
OK |

| Sets RF TX Power According to VDD33 | AT+RFVDD | Sets the RF TX Power according to VDD33.

·Set Command:Sets the RF TX Power according to <VDD33>.
【Execute Command】
AT+RFVDD=<VDD33>
【Parameters】
<VDD33>: power voltage of ESP8266 VDD33 ; range:[1900, 3300].
【Response】
OK

·Set Command:Automatically sets the RF TX Power.
【Execute Command】
AT+RFVDD
【Parameters】
non
【Response】
OK

·Query Command:
【Execute Command】
AT+RFVDD?
【Parameters】
<VDD33>: power voltage of ESP8266 VDD33;unit: 1/1024 V.
【Response】
+RFVDD:<VDD33>
OK |

Set Current System Messages	AT+SYSMSG_CUR	Sets current system messages. The configuration changes will NOT be saved in the flash.
		【Execute Command】
		AT+SYSMSG_CUR=<n>
		【Parameters】
		<n>:
		• bit0: configure the message of quitting WiFi-UART passthrough transmission
		  ‣ if the bit0 is 0, there is no message when quitting WiFi-UART passthrough transmission;default is 0
		  ‣ if the bit0 is 1, when quitting WiFi-UART passthrough transmission, it will prompt the message +QUITT // Quit transparent transmission
		• bit1: configure the message of establishing a network transmission
		  ‣ if the bit1 is 0, when a network connection is established, it will prompt the message <Link_ID>,CONNECT; default is 0
		  ‣ if the bit1 is 1, when establishing a network connection, it will prompt the message
		
		+LINK_CONN:<status_type>,<link_id>,"UDP/TCP/SSL",<c/s>,<remote_ip>,<remote_port>,<local_port>;
		  - <status_type> : 0 - the connection is established successfully;
		                1 - fail to establish the connection
		  - <c/s> : 0 - the ESP works as a client; 1 - the ESP works as a server
		【Response】
		OK

Set Default System Messages	AT+SYSMSG_DEF	Sets default system messages.
		The configuration changes will be saved in the flash user parameter area.
		【Execute Command】
		AT+SYSMSG_DEF=<n>
		【Parameters】
		<n>:
		• bit0: configure the message of quitting WiFi-UART passthrough transmission
		  ‣ if the bit0 is 0, there is no message when quitting WiFi-UART passthrough transmission;default is 0
		  ‣ if the bit0 is 1, when quitting WiFi-UART passthrough transmission, it will prompt the message +QUITT // Quit transparent transmission
		• bit1: configure the message of establishing a network transmission
		  ‣ if the bit1 is 0, when a network connection is established, it will prompt the message
		  <Link_ID>,CONNECT; default is 0
		  ‣ if the bit1 is 1, when establishing a network connection, it will prompt the message
		+LINK_CONN:<status_type>,<link_id>,"UDP/TCP/SSL",<c/s>,<remote_ip>,<remote_port>,<local_port>;
		  - <status_type> : 0 - the connection is established successfully;
		                1 - fail to establish the connection
		  - <c/s> : 0 - the ESP works as a client; 1 - the ESP works as a server
		【Response】
		OK

Sets the Default Wi-Fi mode	AT+CWMODE_DEF=<mode>	Sets the Default Wi-Fi mode Function: to set the current Wi-Fi mode of ESP8266. 【Parameters】 ‣ 1: Station mode ‣ 2: SoftAP mode ‣ 3: SoftAP+Station mode 【Response】 OK
Connects to an AP	AT+CWJAP_DEF=<ssid>,<pwd>,[<bssid>][,<pci_en>]	Connects to an AP Function: to set the AP to which the ESP8266 Station needs to be connected. 【Parameters】 • <ssid>: the SSID of the target AP, MAX: 32 bytes. • <pwd>: password, MAX: 64-byte ASCII. • [<bssid>]: optional parameter, the target AP's MAC address, used when multiple APs have the same SSID.

		• [<pci_en>]: optional parameter, disable the connection to WEP or OPEN AP, and can be used for PCI authentication. • <error code>: (for reference only) ‣ 1: connection timeout. ‣ 2: wrong password. ‣ 3: cannot find the target AP. ‣ 4: connection failed. 【Response】 OK or +CWJAP_DEF:<error code> FAIL
Disconnects from the AP	AT+CWQAP	Disconnects from the AP 【Response】 OK
Configures the ESP8266 SoftAP	"AT+CWSAP_DEF=<ssid>,<pwd>,<chl>,<ecn>[,<max conn>][,<ssid hidden>]"	Configures the ESP8266 SoftAP Function: to list all available APs. 【Parameters】 • <ssid>: string parameter, SSID of AP. • <pwd>: string parameter, length of password: 8 ~ 64 bytes ASCII. • <chl>: channel ID. • <ecn>: encryption method; WEP is not supported. ‣ 0: OPEN ‣ 2: WPA_PSK ‣ 3: WPA2_PSK ‣ 4: WPA_WPA2_PSK • [<max conn>] (optional): maximum number of Stations to which ESP8266 SoftAP can be connected; within the range of [1, 8]. • [<ssid hidden>] (optional): ‣ 0: SSID is broadcasted. (the default setting) ‣ 1: SSID is not broadcasted. 【Response】 OK or ERROR

IP of Stations to Which the ESP8266 SoftAP is Connected	AT+CWLIF	IP of Stations to Which the ESP8266 SoftAP is Connected 【Parameters】 • <ip addr>: IP address of Stations to which ESP8266 SoftAP is connected. • <mac>: MAC address of Stations to which ESP8266 SoftAP is connected. 【Response】 <ip addr>,<mac> OK
Enables/Disables DHCP	AT+CWDHCP_DEF=<mode>,<en>	Enables/Disables DHCP Function: to enable/disable DHCP. 【Parameters】 • <mode>: ‣ 0: Sets ESP8266 SoftAP ‣ 1: Sets ESP8266 Station ‣ 2: Sets both SoftAP and Station • <en>: ‣ 0: Disables DHCP ‣ 1: Enables DHCP 【Response】 OK

3-6. 省電力制御

ESP-WROOM-02 は、EN 端子を High にすることで Deep Sleep に移行する。

EN 端子を Low にすることで Wakeup する。

しかし、EN 端子での Deep Sleep では消費電流が小さくならないため、I2C エクスパンダを制御して ESP-WROOM-02 の電源をオフできる回路を実装する。

4. I2C Expander (PCA9557RGVR)仕様

4-1. 概要

項目	内容
Type	Parallel Port Expander
GIO Port	8Port
IO	5V Tolerant
Interfaces	I2C

4-2. 仕様

4-2-1. 最大定格

Parameter	Value
Operating Temperature	-40℃ to +85℃
Maximum Operation Voltage	6.0V

4-2-2. 電気的特性

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	Supply Voltage	Internal Oscillator	2.3V	-	5.5V
Idd	Operating mode	3.6V 100kHz	-	1uA	4uA
	Standby mode	3.6V Vi=Vcc or GND, Io=0	-	0.25uA	0.9uA

4-3. データシートリンク先

http://www.tij.co.jp/product/jp/PCA9557/

4-4. レジスタ

Name	D7	D6	D5	D4	D3	D2	D1	D0
Control Register	0	0	0	0	0	0	B1	B0

Control Register Field Descriptions

B1	B0	Register
0	0	Input Port
0	1	Output Port
1	0	Polarity Inversion
1	1	Configuration

Name	Control	D7	D6	D5	D4	D3	D2	D1	D0
Input Port	00h	I7	I6	I5	I4	I3	I2	I1	I0

Input Port Register Field Descriptions

Field	Description
I[7:0]	The input port register (register 0) reflects the incoming logic levels of the pins, regardless of whether the pin is defined as an input or an output by the configuration register. It only acts on read operation. Writes to these registers have no effect. The default value, X, is determined by the externally applied logic level. Before a read operation, a write transmission is sent with the command byte to signal the I2C device that the input port register will be accessed next.

Name	Pointer	D7	D6	D5	D4	D3	D2	D1	D0
Output Port	01h	O7	O6	O5	O4	O3	O2	O1	O0

Output Port Register Field Descriptions

Field	Description
O[7:0]	The output port register (register 1) shows the outgoing logic levels of the pins defined as outputs by the configuration register. Bit values in this register have no effect on pins defined as inputs. In turn, reads from this register reflect the value that is in the flip-flop controlling the output selection, not the actual pin value.

Name	Pointer	D7	D6	D5	D4	D3	D2	D1	D0
Polarity Inversion	02h	N7	N6	N5	N4	N3	N2	N1	N0

Polarity Inversion Register Field Descriptions

Field	Description
N[3:0]	The polarity inversion register (register 2) allows polarity inversion of pins defined as inputs by the configuration register. If a bit in this register is set (written with 1), the corresponding port pin's polarity is inverted. If a bit in this register is cleared (written with a 0), the corresponding port pin's original polarity is retained.

Name	Pointer	D7	D6	D5	D4	D3	D2	D1	D0
Configuration	03h	C7	C6	C5	C4	C3	C2	C1	C0

Configuration Register Field Descriptions

Field	Description
C[7:0]	The configuration register (register 3) configures the directions of the I/O pins. If a bit in this register is set to 1, the corresponding port pin is enabled as an input with high impedance output driver. If a bit in this register is cleared to 0, the corresponding port pin is enabled as an output.

5. Load Switch(XC8102AA01NR-G)仕様

5-1. 概要

項目	内容
保護回路	過電流保護回路とフォールドバック(フの字)回路を内蔵

5-2. 仕様

5-2-1. 最大定格

Parameter	Value
Operating Temperature	-40℃ to +85℃
Maximum Operation Voltage	6.5V

5-2-2. 電気的特性

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	Supply Voltage	Internal Oscillator	1.2V	-	6.0V
Ron	スイッチオン抵抗	2.9V	-	0.35Ω	0.475Ω
Ilim	制限電流	VIN≧2.9V, VOUT = VIN -0.8V	400mA	480mA	-
Ishort	短絡電流	VCE=VIN, VOUT=0V	-	30mA	75mA
Idd	Operating mode	4.0V	-	3.8uA	6.5uA
	Standby mode	6V	-	0.01uA	0.10uA

6. Analog Switch(TS3A4751RUCR)仕様

6-1. 仕様

6-1-1. 最大定格

Parameter	Value
Operating Temperature	-40℃ to +85℃
Maximum Operation Voltage	4V

6-1-2. 電気的特性

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	Supply Voltage	Internal Oscillator	1.65V	-	3.6V
Ron	スイッチオン抵抗	2.7V	-	0.7Ω	1.1Ω
Idd	supply current	3.6V	-	-	0.75uA