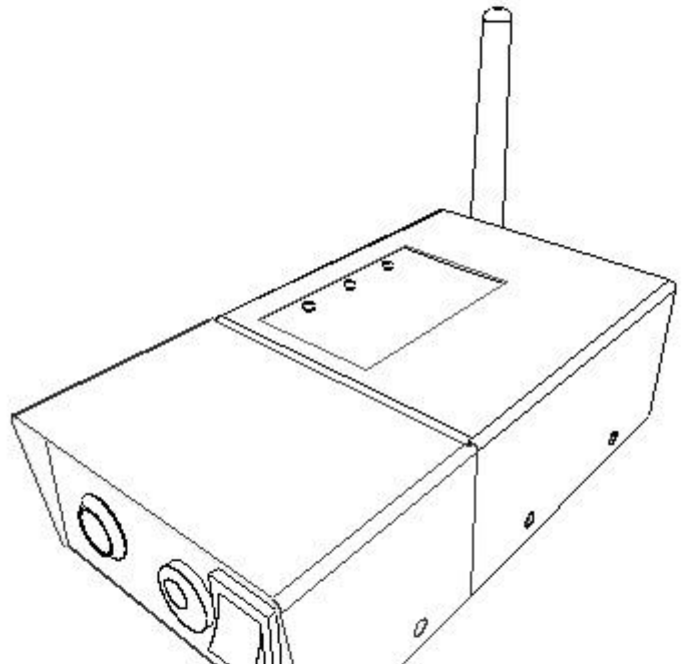
Konnect-Wi

Quick Reference Guide



Crevavi

Version: 1.1

Date: 1 December 2017

Contents

1. Introduction

Konnect-Wi is a device to Monitor/control machines from a central server over Wi-Fi to implement IOT/M2M applications.

It connects to smart machines via RS232/RS485 port, and also has direct Digital and Analog inputs of wide voltage range that can read sensors inputs and voltages from the machine. Konnect-Wi also has Signal/power output to trigger external device or control the machines.

Built-in RTC helps user to schedule tasks to monitor and control the machines at defined time / interval.

User can write customized program using the development environment provided for Konnect-Wi, and program the device through an USB port. User friendly, and easy to understand APIs provided to access all the input data from Digital, Analog ports, read and write to communication ports, and to trigger digital signal outputs. APIs provide easy access to the Wi-Fi modem to connect to desired network, request access and connect to server, send/receive data to server, and schedule tasks.

2. Product Overview

Konnect-Wi device consists of following functionalities:

- Communication with Server
    - Connects to Local Area Network through Wi-Fi
    - Sends periodic packet data parsed as per custom program to server
    - Server may send command to fetch data, and perform GPO (General Purpose Output) task
- Machine interface
    - 4 Analog inputs to measure input voltage level configurable using jumpers (0-5V / 0-12V)
    - 4 Digital inputs to measure input signal (up-to 12V)
    - 2 Digital outputs to send signal / trigger (5V / Unregulated Supply Voltage)
    - RS232/RS485 interface to fetch data from smart machines
    - USB interface for programming
- User interface
    - Power ON/OFF
    - LED indication for Power, data connection, data publish

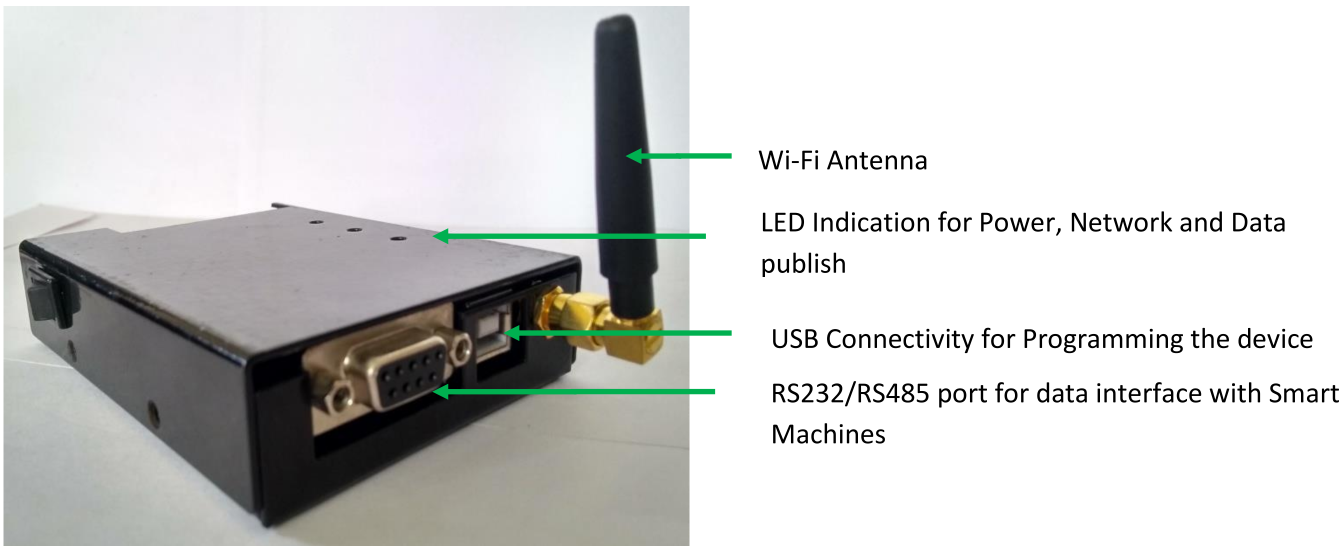

Wi-Fi Antenna
LED Indication for Power, Network and Data publish
USB Connectivity for Programming the device
RS232/RS485 port for data interface with Smart Machines

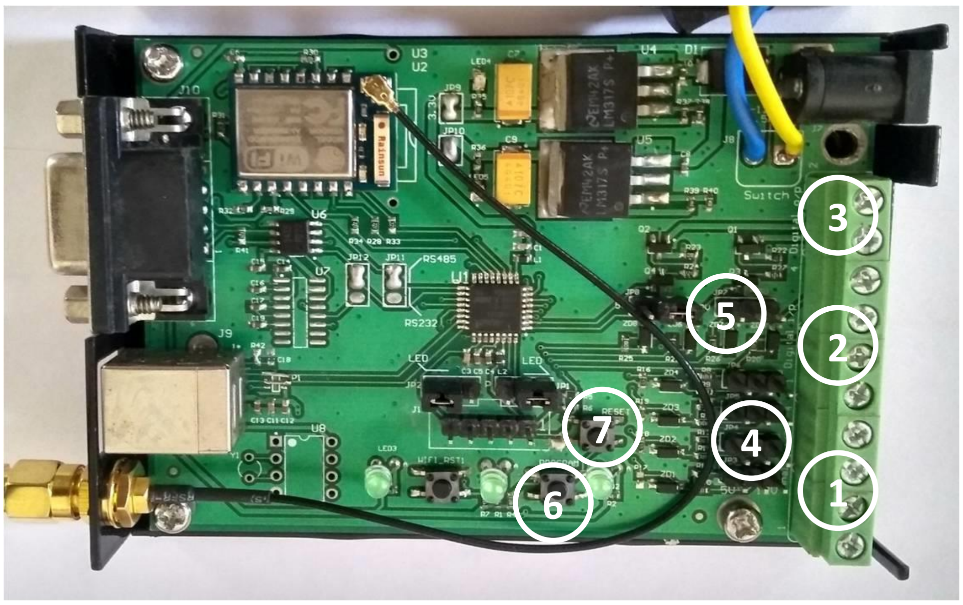
Figure 1

Benefits to client:

- M2M / IOT using smart device with Digital/Analog inputs to monitor and control non-smart machines
- Wi-Fi network without the need of having wired connectivity
- Programmable device, which can be customized to interface/control any device, unlike off-the-shelf products
- Enables clients to cost-optimize field service operations, personnel and fleet expenses
- Reduces down-time of devices and enables clients to make informed decisions with alerts and validation by deploying analytics of collected data
- Device IP can be used for variety of IOT/M2M applications to monitor/control mobile tower infrastructure, POS, water and electric meters, heavy equipment, medical devices, vending machines, vehicles, and more.

3. Technical Specification

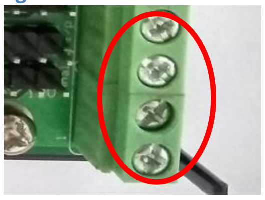
Figure 2



Sl. No.	Particular
1	4 Analog inputs with input protection circuit Selectable range of 0-5V or 0-12V using jumpers (indicated as ‘8’)
2	4 Digital inputs Wide range of input voltage (1.6-12V) with input protection circuit
3	2 Digital signal outputs Selectable output voltage of 5V or 12V using jumpers (indicated as ‘9’) Maximum supply capacity of 0.5A
4	Jumpers for selecting range of Analog inputs
5	Jumpers for selecting voltage for digital outputs
6	Button for initiating SAMD21 microcontroller programming mode Press the button and power on the device to enter programming mode Boots from the SAM-BA boot-loader, and enables USB interface to program
7	Microcontroller RESET

4. Operation

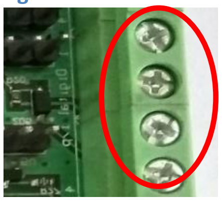
Figure 3



4.1. Connecting Digital inputs

Connect digital inputs to any of the 4 ports marked in Figure-3
Also marked “1” in Figure-2
Please note that the input voltage in the port should not cross 12V DC.

Figure 4



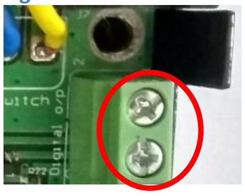
4.2. Connecting Analog inputs

Connect analogue inputs to any of the 4 ports marked in Figure-4
Also, marked “2” in Figure-2

- There are two ranges of voltage configurable using the jumpers beside it, marked “4”.
- If maximum voltage is 5V, put the corresponding jumper at 5V side to get optimum resolution.
- If maximum voltage is 12V, put the corresponding jumper at 12V side.

Please note that the input voltage in the port should not cross 12V DC.

Figure 5



4.3. Connecting Digital Outputs

Connect digital outputs to any of the 2 ports marked in Figure-5
Also, marked “3” in Figure-4

- There are two ranges of output voltage configurable using the jumpers beside it, marked “5”
- If output voltage requirement is 5V, put the corresponding jumper at 5V side
- If output voltage requirement is 12V, put the corresponding jumper at 12V side

Please note that the maximum outputcurrent capacity is 500mA.

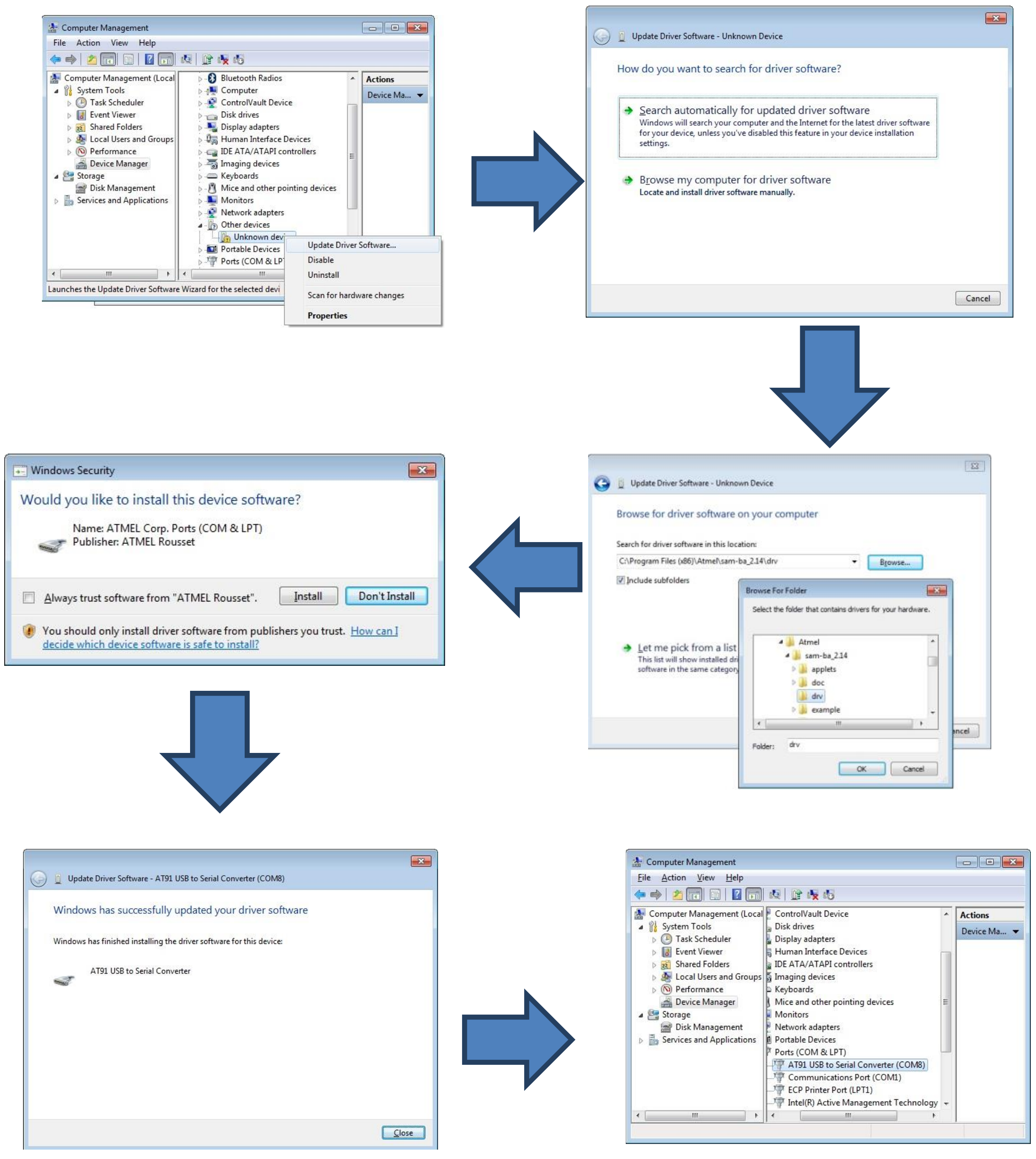
4.4. Install SAM-BA

SAM-BA (SAM Boot Assistant) tool is used for programming applications in Konnect-Wi

- Install SAM-BA in development/programming PC

- Interface USB programming cable between device and PC
- It may show as “unknown device” in device manager
- Right click on the device and select "Update Driver Software"
- You may select "Browse my computer for driver software"
- Navigate to the sam-ba install folder that contains the sam-ba driver
- Install the driver

- You may have to repeat the process if you connect to a different USB port


Update Driver Software - Unknown Device

How do you want to search for driver software?

Search automatically for updated driver software
Windows will search your computer and the Internet for the latest driver software for your device, unless you've disabled this feature in your device installation settings.

Browse my computer for driver software
Locate and install driver software manually.

Browse for driver software on your computer

Search for driver software in this location:
C:\Program Files (x86)\Atmel\sam-ba_2.14\drv

Include subfolders

Browse For Folder
Select the folder that contains drivers for your hardware.
Folder: drv

Let me pick from a list
This list will show installed dri software in the same categor

Windows Security

Would you like to install this device software?

Name: ATMEL Corp. Ports (COM & LPT)
Publisher: ATMEL Rousset

Always trust software from "ATMEL Rousset".

You should only install driver software from publishers you trust. How can I decide which device software is safe to install?

Update Driver Software - AT91 USB to Serial Converter (COM8)

Windows has successfully updated your driver software

Windows has finished installing the driver software for this device:

AT91 USB to Serial Converter

4.5.Program using SAM-BA

- Press “Program” button on PCB and Power ON the device while the button is still pressed
- You may also press and hold “Program” button, and press “Reset” while the button is still pressed
- Program button marked in Figure-6, also marked “6” in Figure-2
- Interface PC and Konnect-Wi using USB cable

- Once device is enumerated, a COM port will be assigned
- It may show as “AT91 UAB to Serial Converter (COMx)”

- Start SAM-BA utility
- Select correct COM port, select the board as “samd21_xplained_pro”
- Click Connect

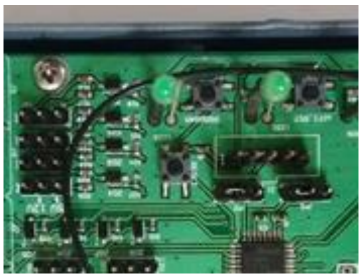
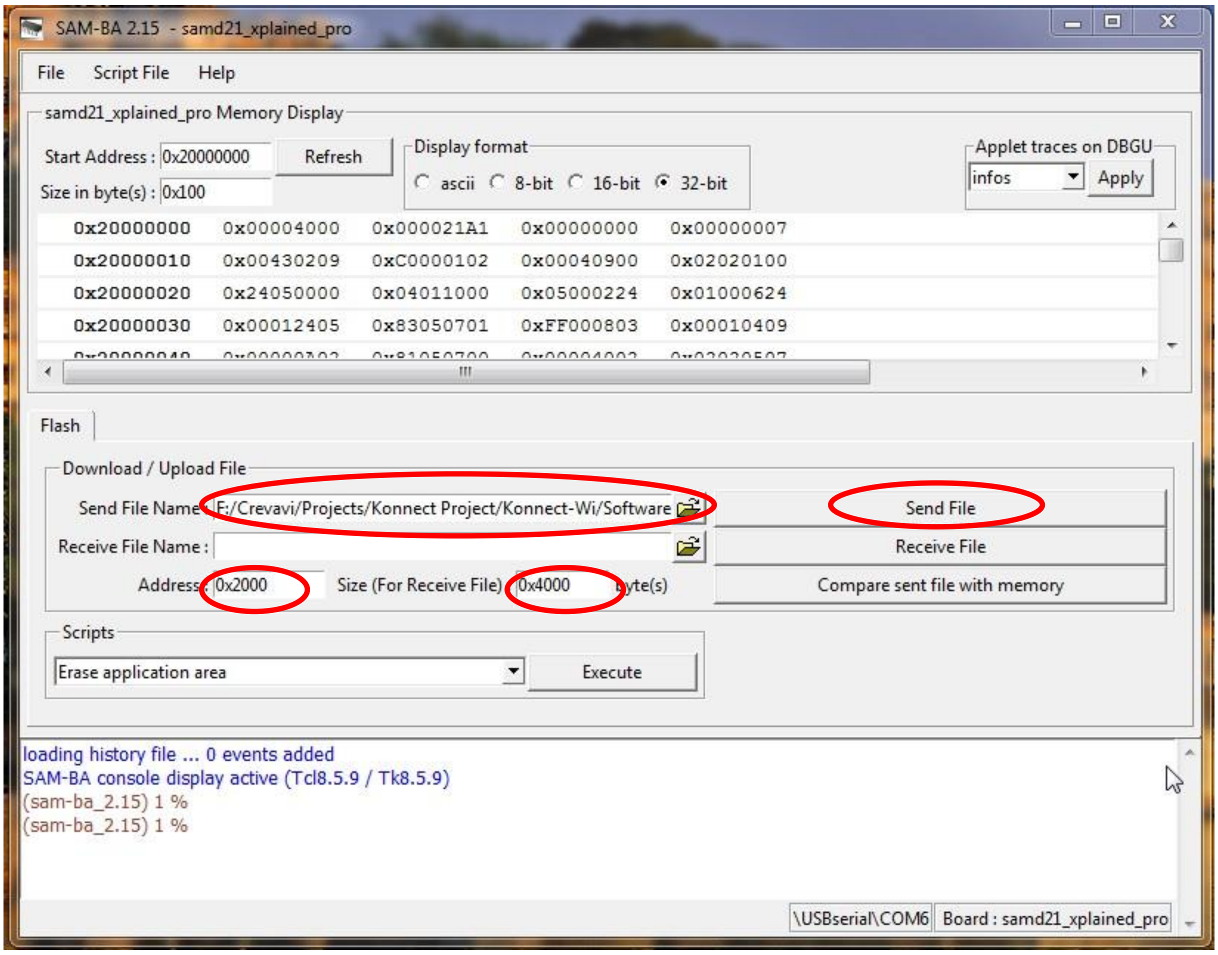


Figure 6



samd21_xplained_pro Memory Display

Start Address : 0x20000000
Size in byte(s) : 0x100
Display format: ascii, 8-bit, 16-bit, [✓ 32-bit]
Applet traces on DBGU: infos

```
0x20000000   0x00004000   0x000021A1   0x00000000   0x00000007
0x20000010   0x00430209   0xC0000102   0x00040900   0x02020100
0x20000020   0x24050000   0x04011000   0x05000224   0x01000624
0x20000030   0x00012405   0x83050701   0xFF000803   0x00010409
```

Download / Upload File

Send File Name : F:/Crevavi/Projects/Konnect Project/Konnect-Wi/Software
Receive File Name :
Address : 0x2000   Size (For Receive File) : 0x4000 byte(s)

Scripts: Erase application area

```
loading history file ... 0 events added
SAM-BA console display active (Tcl8.5.9 / Tk8.5.9)
(sam-ba_2.15) 1 %
(sam-ba_2.15) 1 %
```

\USBserial\COM6   Board : samd21_xplained_pro

Figure 7

- Select the built .bin file from your working directory
- Give starting address as 0x2000
- Give ending address as 0x4000 (may vary based on code size)
- Click send
- You may also click “Compare sent file with memory” to verify the data
- Disconnect USB cable and Restart the device by switching off and on

- Close and restart SAM-BA application each time device is powered off or USB port is removed

1. Application References

1.1. Programming Environment

The development environment (IDE) for Application program is **Atmel Studio 7**

- Install Atmel Studio 7 in development PC
- Open Konnect-Wi project provided by Crevavi in the IDE

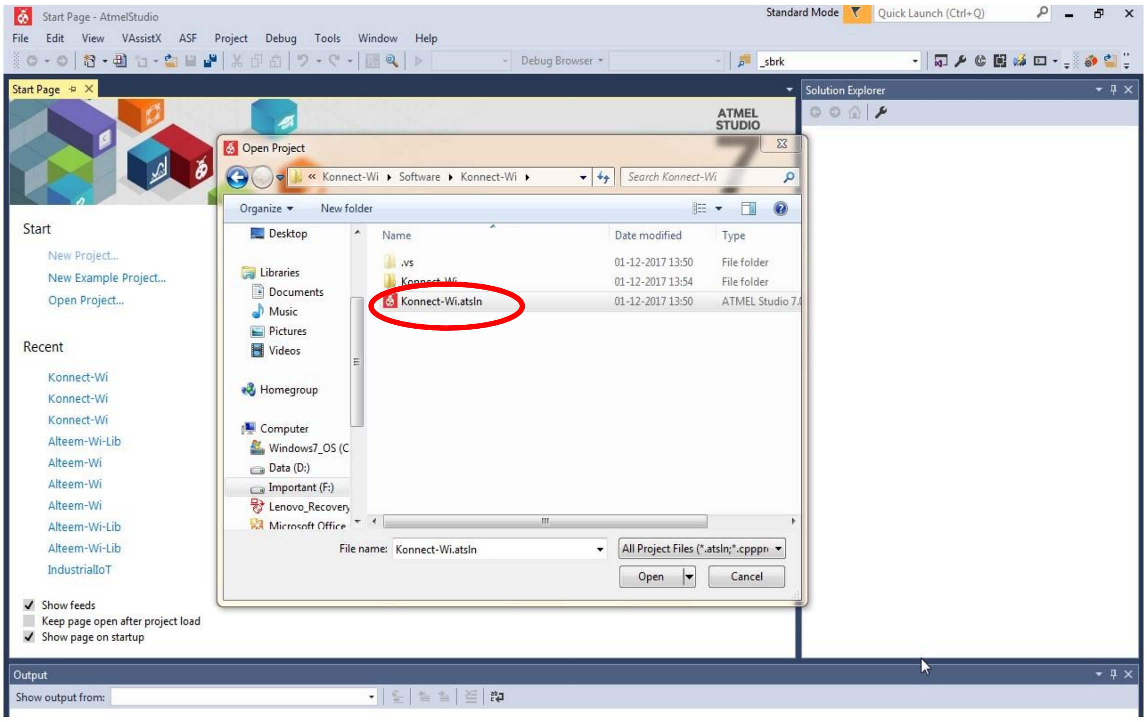
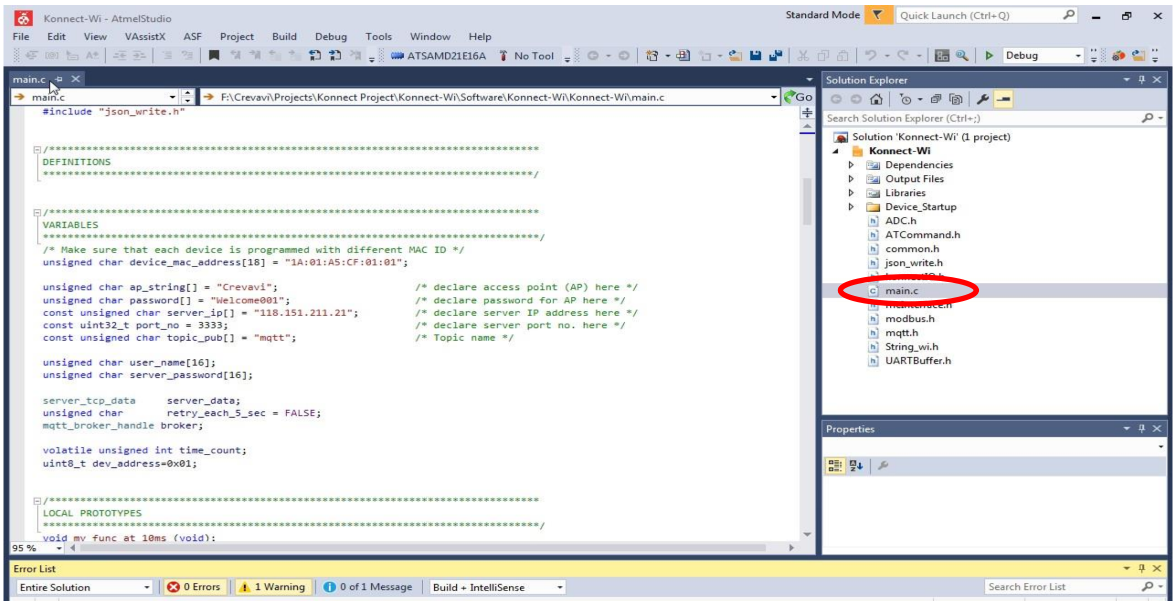


Figure 8

- The Sample main.c code in the project can be modified to read/write the ports, send/receive Wi-Fi data to server and schedule new tasks
- Refer API references for easy access to the ports and scheduler for various operation



```
#include "json_write.h"


/********************************************************************************
DEFINITIONS
********************************************************************************/


/********************************************************************************
VARIABLES
********************************************************************************/
/* Make sure that each device is programmed with different MAC ID */
unsigned char device_mac_address[18] = "1A:01:A5:CF:01:01";

unsigned char ap_string[] = "Crevavi";                /* declare access point (AP) here */
unsigned char password[] = "Welcome001";              /* declare password for AP here */
const unsigned char server_ip[] = "118.151.211.21";   /* declare server IP address here */
const uint32_t port_no = 3333;                        /* declare server port no. here */
const unsigned char topic_pub[] = "mqtt";             /* Topic name */

unsigned char user_name[16];
unsigned char server_password[16];

server_tcp_data     server_data;
unsigned char       retry_each_5_sec = FALSE;
mqtt_broker_handle broker;

volatile unsigned int time_count;
uint8_t dev_address=0x01;


/********************************************************************************
LOCAL PROTOTYPES
********************************************************************************/
void my_func_at_10ms (void);
```

Figure 9

1.2. API References

Following are list of APIs provided to access all required controller and peripheral functions. Explanation of each API provided, with example code below.

Sl. No.	Purpose	Function
1	Check / Set / Clear Konnect Status Flag	check_konnect_status set_konnect_status clear_konnect_status
2	Wi-Fi Connection Operation	at_check_access_point at_join_access_point
3	TCP Operations	at_tcp_connect at_connect_to_server at_send_tcp_data at_receive_tcp_data at_close_server
4	GPIO Operations	app_config_konnect_ports app_read_input_port_curr app_read_input_port_stats app_set_output_port
5	UART Operations	app_config_ext_com_port app_read_com_data app_write_com_data
6	Schedule Function Callbacks	app_schedule_function_callback
7	String Operations	strLen strCopy strCopyLen strCat strCmp val2String string2Val strTrim float2String
8	MQTT	mqtt_connect mqtt_disconnect mqtt_publish mqtt_subscribe mqtt_display_message
9	Modbus	crc16_compute modbus_send_data modbus_query ModRTU_CRC
10	JSON Write	jwOpen jwClose jwErrorPos jwObj_string jwObj_int jwObj_double jwObj_bool jwObj_null jwObj_object jwObj_array jwArr_string jwArr_int jwArr_double

		jwArr_bool jwArr_null jwArr_object jwArr_array jwEnd jwObj_raw jwArr_raw

1.2.1. *Check / Set / Clear Konnect Status Flag*

Name	*check_konnect_status(<Flag>)*
	set_konnect_status(<Flag>)
	clear_konnect_status(<Flag>)

Purpose	Checks / sets / clears Konnect status flag These functions don't perform any interface/communication with Wi-Fi modem. It only handles a Flag. This can be used for business logic writing in the application.
Input parameters	Konnect Status Flag **Bit No** / **Flag**: **0** STATUS_AP_CONNECTED **1** STATUS_SERVER_CONNECTED **2** X **3** X **4** X **5** X **6** X **7** X
Output Parameter	For check_konnect_status - 1: If desired flag is high - 0: If desired flag is low

Bit No	Flag
0	STATUS_AP_CONNECTED
1	STATUS_SERVER_CONNECTED
2	X
3	X
4	X
5	X
6	X
7	X

Example

```
/* Check if AP is already connected */
if(check_konnect_status(STATUS_AP_CONNECTED) == TRUE)
{
	/* It is connected to Crevavi_AP, you can connect to server now */
}
```

1.2.2. *Wi-Fi Connection Operations*

Name	*at_check_access_point* *at_join_access_point*	
Purpose	at_check_access_point	Checks if the device is connected to the desired Access Point (AP) based on communication with Wi-Fi modem. Use this in conjunction with status Flags to avoid repeated query.
	at_join_access_point	Joins a given Access Point (AP) and request for IP
Input parameters	at_check_access_point	unsigned char * ap_string - A pointer to string containing target AP name
	at_join_access_point	unsigned char * ap_string - A pointer to string containing target AP name unsigned char * password A pointer to string containing password for the target AP

Output Parameter	at_check_access_point — Returns unsigned character - 1: If connected to the desired AP - 0: if not connected at_join_access_point — Returns unsigned character - 1: If connection is successful 0: if not connected

Example

```
unsigned char ap_string[] = "Crevavi_AP";
unsigned char password[] = "MyPassword0";

/* Check if AP is already connected – query to Wi-Fi modem*/
if(at_check_access_point(ap_string) == TRUE)
{
      set_konnect_flag(STATUS_AP_CONNECTED);    /* Set the flag */
      /* It is connected to Crevavi_AP, you can proceed with next task */

}
/* Check if AP is not connected – checking Flag */
if(check_konnect_flag(STATUS_AP_CONNECTED) == FALSE)
{
      /* It is not connected to any AP, now you can try to connect */
      if (at_join_access_point(ap_string, password)== PASS)
      {
            /* It is connected to Crevavi_AP, you can connect to server
now */
      }
}
```

1.2.3. TCP Operations

Name	`at_tcp_connect`
	`at_connect_to_server`
	`at_send_tcp_data`
	`at_receive_tcp_data`
	`at_close_server`

Purpose	at_tcp_connect — Connect to TCP at_connect_to_server — Requests for a connection to server at_sent_tcp_data — Sends data to server at_receive_tcp_data — Read data from Server at_close_server — It is recommended to close connection to server after data transmission / receipt is complete, for other devices to gain connection
Input parameters	at_tcp_connect — None at_connect_to_server — mqtt_broker_handle *broker - A pointer to broker unsigned char * server_ip - A pointer to string containing server IP address or URL unsigned char * port_no A pointer to string containing port number for the server at_sent_tcp_data — mqtt_broker_handle *broker

		- A pointer to broker unsigned char *server_data - A pointer to a string containing server data unsigned int data_len Length of data to be sent
	at_receive_tcp_data	mqtt_broker_handle *broker - A pointer to broker unsigned char *server_data - A pointer to a string to which server data is received
	at_close_server	None
Output Parameter	at_tcp_connect	Returns unsigned character - 1: If connection is successful - 0: if not connected
	at_connect_to_server	Returns unsigned character - 1: If connection is successful - 0: if not connected
	at_sent_tcp_data	Returns unsigned int - Returns data_len if data is sent else returns zero.
	at_receive_tcp_data	Returns unsigned int - Length of data read from server
	at_close_server	Returns unsigned character - 1: If disconnection is successful - 0: if failed to disconnect or already disconnected

Example
```
unsigned char ap_string[] = “Crevavi_AP”;
unsigned char server_ip[] = “192.168.0.150”;
unsigned char port_no[] = “8080”;
unsigned char *server_data;
unsigned char data_len;
unsigned int retVal;

data_len=stringLen(server_data);
/* Check if AP is already connected */
if(at_check_access_point(ap_string) == TRUE)
{
	/* It is connected to Crevavi_AP, you can connect to server now */
	if (at_connect_to_server(broker,server_ip, port_no)== PASS)
	{
		/* Now that it has established a connection to the server, you
can start sending and receiving data */
		retVal = at_send_tcp_data(broker,server_data,data_len);
	}
}be True if connection is established else False */
```

1.2.4. GPIO Operations

1.2.4.1. Configure/Enable input ports

Name	*void app_**config_konnect_ports** (port_config_struct config_data)*

Purpose	Configures Digital and Analog Ports. For each Analog input ports, following parameters are configurable: 1. Enable/disable 2. Sampling interval – Read ADC once in this interval 3. Sample count – Average of last this many ADC readings For each Digital input ports, following parameters are configurable: 1. Enable/disable 2. Sample duration – count number of pulses during this duration For each Digital output ports, following parameters are configurable: 1. Enable/disable If a port is enabled, then only read/write operation can be performed on that. Read data from a disabled port will always return 0. Writing high/low on output port that is not enabled, will not output any result.
Input parameters	port_config_struct config_data port_config_struct contains: analog_in_port_conf ain_conf[4] digital_in_port_conf dinx_conf[4] analog_out_port_conf doutx_conf[2] Where, analog_in_port_conf contains: unsigned char enable; unsigned char sampling_interval;(interval in multiple of 1.024ms) unsigned char sample_count; digital_in_port_conf contains: unsigned char enable; unsigned char sample_duration; (Duration of sampling in multiple of 1.024ms) digital_out_port_conf contains: unsigned char enable;
Output Parameter	None

Example:

```
/* Analog input port configuration */
config_data.ain_conf[0].enable = TRUE;
/* Configure for averaging last 10 readings, each reading at 100ms
interval */
config_data.ain_conf[0].sample_count = 10;
config_data.ain_conf[0].sampling_interval = 100; /* Always multiple of
1.024ms ->1.024ms x100 = 102.4ms */

/* Digital input port configuration */
config_data.din_conf[0].enable = TRUE;
/* Configure for getting number of pulses in each ~1sec */
config_data.din_conf[0].sample_duration = 500; /* Always multiple of
1.024ms ->1.024ms x 500 = 512ms ~= 0.5sec */

/* Digital output port configuration */
config_data.dout_conf[1].enable = TRUE;

/* Call to configure the ports */
app_config_konnect_ports(config_data);
```

1.2.4.2. Configure/EnablRead all input port's current status

Name	`void app_read_input_port_curr (port_reading_curr * port_data)`
Purpose	Reads Digital and Analog Ports and gives the current status Enabled Digital ports read 1/0, whereas analog ports read 10bit ADC value. Disabled ports always read 0.
Input parameters	port_reading_curr * port_data port_reading_curr contains: unsigned char ain_curr[4] –reads 1/0 unsigned int dinx_curr[4] – reads 10bit ADC value
Output Parameter	None

Example:

```
port_reading_curr * port_data;      /* Declare port i/p data structure */

/* Read input port’s current data */
app_read_input_port_curr(port_data);

if(port_data.ain_curr[0]> 500)      /* Performing a check on analog data
port1 read*/
{
      /*You have current ADC reading… Do business logic */
}

if(port_data.din_curr[2]==HIGH)     /* Performing a check on digital data
port3 read*/
{
      /* You have current 1/0 status of digital port… Do business logic */

}
```

1.2.4.3. Read all input port statistics (Average, Frequency)

Name	`void app_read_input_port_stats (port_reading_stats * port_data)`
Purpose	Gets the cumulative statistic data of all input ports Enabled Digital ports read the number of pulses during last sample duration, which is configured by ***config_konnect_ports*** API. Similarly, Enabled analog ports read the average of ADC readings based on sampling count and sample interval configured. Disabled ports always read 0.
Input parameters	port_reading_stats * port_data port_reading_stats contains: unsigned int ain_stats[4] – reads no of pulses in configured duration unsigned int din_stats[4] – reads average of configured no. of ADCreadings
Output Parameter	None

Example:

```
port_reading_stats * port_data;      /* Declare port i/p data structure */


/* Read input port's statistics data */
app_read_input_port_stats(port_data);

if(port_data.ain_stats[0]> 500)      /* Performing a check on analog data
port1 read */
{
      /* You have average of ADC readings…
      Do business logic */
}

if(port_data.din_stats[2]>0)  /* Performing a check on digital data port3
read*/
{
      /* You have number of pulses in configured duration…
      Do business logic */
}
```

1.2.4.4. Write output port

Name	`unsigned charapp_write_dout_port(unsigned char port, unsigned char state)`
Purpose	Sets the desired output port status to Low/High as per input. The port must be enabled using `app_config_konnect_ports`before executing this command.
Input parameters	unsigned char port 2 Ports are defined - GPO_DOUT1 - GPO_DOUT2 unsigned char state 2 States are defined - HIGH - LOW
Output Parameter	PASS / FAIL
Example: `app_write_dout_port(GPO_DOUT2, HIGH);`	

1.2.5. UART Operations

1.2.5.1. Configure COM Port

Name	`unsigned charapp_config_ext_com_port (com_config_structcom_port_config)`
Purpose	Configures external COM port for baud rate, data bits, parity, and stop bits At initialization, default values are: BAUD_115200, DATA_BITS_8, PARITY_NONE, STOP_BITS_1
Input parameters	com_config_structcom_port_config com_config_struct contains:

	unsigned char baud_rate • different baud rates defined: - BAUD_9600 - BAUD_19200 - BAUD_38400 - BAUD_57600 - BAUD_115200 unsigned char data_bits • different data bits defined: - DATA_BITS_8 - DATA_BITS_7 unsigned char parity • different parity defined: - PARITY_NONE - PARITY_EVEN - PARITY_ODD unsigned char stop_bits • different baud rates defined: - STOP_BITS_1 - STOP_BITS_2
Output Parameter	PASS / FAIL

Example:

```
Com_config_datacom_port_config;     /* Declare com port config data
structure */

/* Initialize external COM port*/
com_port_config.baud_rate = BAUD_9600;
com_port_config.data_bits = DATA_BITS_8;
com_port_config.parity = PARITY_NONE;
com_port_config.stop_bits = STOP_BITS_1;

app_config_ext_com_port (com_port_config);
```

1.2.5.2. Read Data from COM port

Name	`unsigned intapp_read_com_data(unsigned char *str, unsigned intmax_len)`
Purpose	Reads data from buffer of external COM port and copies to a given buffer
Input parameters	unsigned char *str - Pointer to the string where data to be copied unsigned intmax_len - Maximum length of the data to be copied - Say, max_len is 50, and input data in 10 bytes. Only 10 bytes will be copied. If max_len is 40, and input data is 60 bytes, only 40 bytes will be copied.
Output Parameter	unsigned int – length of copied bytes

Example:

```
unsigned intchCount;
unsigned char str[24];
```

```
chCount = app_read_com_data(str, 24);
```

1.2.5.3. Write data to COM Port

Name	`void app_write_com_data(unsigned char *str)`
Purpose	Transmits a given string of data through external COM port
Input parameters	unsigned char *str - Pointer to the string where data to be copied
Output Parameter	None

Example:

```
unsigned char str[] = "Hello World!";

app_write_com_data(str);
```

1.2.6. Schedule a function callback

Name	`unsigned char app_schedule_function_callback (unsigned char fp_id, fpfunc_ptr, unsigned int interval)`
Purpose	Schedules a repeating function callback in a given interval. Be careful not to make the callback function as blocking one. I case of a blocked function, the other scheduled function calls also will get blocked till the block is removed. Maximum 10 such callbacks can be scheduled.
Input parameters	unsigned char fp_id An unique ID for identifying the function, can be used in future to stop/pause scheduler. Value can be anything between 0 to 9 (maximum value limited by the definition MAX_AP) fpfunc_ptr Address of the function. Please note that name of a function itself represents the address of it. unsigned int interval Interval for callback in milliseconds, max value 65535;
Output Parameter	Returns 1 if scheduling is successful

Example:

```
void my_func1 (void)
{
        /* Do business logic */
}

void my_func2 (void)
{
        /* Do business logic */
}

void main (void)
{
        init_konnect_wi();      /* Initializes the board */

        app_schedule_function_callback(0, my_func1, 500);
        app_schedule_function_callback(1, my_func2, 1000);

        /* my_func1 will automatically get called in every 500ms
        And my_func2 will automatically get called in every 1s */
}
```

1.2.7. String operations

Names	`strLen`
	`strCopy`
	`strCat`
	`strCmp`
	`val2String`
	`string2Val`
	`strTrim`

Purpose	strLen — Returns length of a given string strCopy — Copies one string to other strCopyLen — Copies one string to other of defined length strCat — Concatenates one string to other strCmp — Compares one string to other strTrim — Trims from Source String and copies to destination val2String — Converts value (char/int/long) to a string string2Val — Converts a string of digits to a value (long) float2String — Converts a float to string
Input parameters	strLen — unsigned char *str - Pointer to the String strCopy — unsigned char * sourceStr, unsigned char * destStr - Pointer to the Source and Destination Strings strCopyLen — `unsigned char * destStr, const unsigned char * sourceStr, unsigned int len` - Pointer to Destination, Source string and length of string strCat — unsigned char * sourceStr, unsigned char * destStr - Pointer to the Source and Destination Strings strCmp — unsigned char * str1, unsigned char * str2 - Pointer to 2 Strings to be compared strTrim — unsigned char * sourceStr, unsigned char * destStr, unsigned int startIndex, unsigned int endIndex - Pointer to the Source and Destination Strings, starting index and ending index for trimming val2String — unsigned long val, unsigned char * datStr - Value and Pointer to the Strings string2Val — unsigned char * datStr - Pointer to the String of digits float2String — float val, unsigned char * datStr - Value and Pointer to the Strings
Output Parameter	strLen — unsigned int – Length of the String strCopy — unsigned int– Length of the copied String strCopyLen — Unsigned int–Length of the copied String strCat — unsigned int– Length of the concatenated String

	strCmp — unsigned char – PASS / FAIL strTrim — unsigned int– Length of the copied String val2String — unsigned char – Length of the converted String string2Val — unsigned long – converted value float2String — unsigned char– PASS / FAIL

Example
 	
`unsigned char           tempStr[10];`
`unsigned int            charCount;`
`port_reading_stats      port_data;`
`server_tcp_data         server_data;`
 	
`/* Read port statistical data */`
`app_read_input_port_stats(&port_data);`
 	
`/* Converting the first reading value to a string */`
`val2String(port_data.ain_stats[0], tempStr);`
 	
`/* Copying the source string to another stringtcp_data */`
`strCopy(tempStr, server_data.tcp_data[0])`
 	
`/* Getting string length */`
`charCount = strLen(tempStr);`	

1.2.8. MQTT Operations

Names	`mqtt_connect`
	`mqtt_disconnect`
	`mqtt_publish`
	`mqtt_subscribe`
	`mqtt_display_message`

Purpose	mqtt_connect — Connects to the MQTT server mqtt_disconnect — Disconnects from MQTT server mqtt_publish — Publish a topic to MQTT server mqtt_subscribe — Subscribe to the topic in MQTT server mqtt_display_message — Display the message in MQTT server
Input parameters	mqtt_connect — mqtt_broker_handle *broker, const unsigned char * server_ip, uint32_t port - Pointer to the Broker, Server IP address and Port number mqtt_disconnect — mqtt_broker_handle *broker - Pointer to the broker mqtt_publish — `mqtt_broker_handle *broker, const unsigned char *topic, const unsigned char *msg, QoS qos` - Pointer to Broker, Topic, Message and Quality of Service mqtt_subscribe — `mqtt_broker_handle *broker, const unsigned char *topic, QoS qos` - Pointer to Broker, Topic and Quality of Service mqtt_display_message — `mqtt_broker_handle *broker, int (*print)(int)`

	- Pointer to the Broker and Message
Output Parameter	mqtt_connect int – PASS/FAIL mqtt_disconnect void –No return value mqtt_publish int – PASS/FAIL mqtt_subscribe int – PASS/FAIL mqtt_display_message void –No return value

Example

```
const unsigned char server_ip[] = "117.214.51.87"; // server IP address
const uint32_t port_no = 5151; // Port number of the server

if(broker.socket == FALSE)
            {
                  /* Connecting to MQTT server*/
                  mqtt_connect(&broker, server_ip, port_no);

            }
if(broker.connected == TRUE)
            {
                  /* Publishing the data to server */
                  mqtt_publish(&broker, topic_pub,buffer, QoS0);
            }
```

1.2.9. Modbus Operations

Names	modbus_send_data modbus_query ModRTU_CRC	
Purpose	modbus_send_data	Sending data using RS485
	modbus_query	Receiving data from RS485
	ModRTU_CRC	Computes Cyclic Redundancy Check
Input parameters	modbus_send_data	modbus_write_struct *modbus_data - Pointer to modbus data
	modbus_query	modbus_write_struct *write_data, unsigned char * read_data - Pointer to Write and Read data
	ModRTU_CRC	uint8_t *buf, uint8_t len - Pointer to Buffer and Data length
Output Parameter	modbus_send_data	void –No return value
	modbus_query	unsigned int –data length
	ModRTU_CRC	uint16_t – Cyclic Redundancy Check of 16 bit

Example

```
modbus_write_struct *temp_data;
modbus_write_struct *write_data;

/*Send data to slave using modbus*/
modbus_send_data(temp_data);

/*Verifies the data received data from the slave*/
modbus_query(write_data, temp_data);
```

1.2.10. JSON Write

Names	`jwOpen`
	`jwClose`
	`jwErrorPos`
	`jwObj_string`
	`jwObj_int`
	`jwObj_double`
	`jwObj_bool`
	`jwObj_null`
	`jwObj_object`
	`jwObj_array`
	`jwArr_string`
	`jwArr_int`
	`jwArr_double`
	`jwArr_bool`
	`jwArr_null`
	`jwArr_object`
	`jwArr_array`
	`jwEnd`
	`jwObj_raw`
	`jwArr_raw`	

Purpose	jwOpen	Initializes JSON write operation
	jwClose	Closes all elements opened by jwOpen()
	jwErrorPos	If jwClose() returned an error, this function returns the number of the jWrite function call which caused that error
	jwObj_string	Object insertion function for string - Used to insert "key":"value" pairs into an object
	jwObj_int	Object insertion function for integer - Used to insert "key":"value" pairs into an object
	jwObj_double	Object insertion function for double - Used to insert "key":"value" pairs into an object
	jwObj_bool	Object insertion function for boolean - Used to insert "key":"value" pairs into an object
	jwObj_null	Object insertion function for null - Used to insert "key":"value" pairs into an object
	jwObj_object	Object insertion function for object - Used to insert "key":"value" pairs into an object
	jwObj_array	Object insertion function for array - Used to insert "key":"value" pairs into an object
	jwArr_string	Array insertion function for string - Used to insert "value" elements into an array
	jwArr_int	Array insertion function for integer - Used to insert "value" elements into an array

	jwArr_double	Array insertion function for double - Used to insert "value" elements into an array
	jwArr_bool	Array insertion function for boolean - Used to insert "value" elements into an array
	jwArr_null	Array insertion function for null - Used to insert "value" elements into an array
	jwArr_object	Array insertion function for object - Used to insert "value" elements into an array
	jwArr_array	Array insertion function for array - Used to insert "value" elements into an array
	jwEnd	Defines the end of Object or Array definition
	jwObj_raw	Writes the JSON value as the contents of rawtext
	jwArr_raw	Writes the JSON value as the contents of rawtext
Input parameters		
	jwOpen	char *buffer, unsigned int buflen, enum jwNodeType rootType, int isPretty - Pointer to Buffer and buffer length - rootType is the base JSON type: JW_OBJECT or JW_ARRAY - isPretty controls 'prettifying' the output: JW_PRETTY or JW_COMPACT
	jwClose	None
	jwErrorPos	None
	jwObj_string	char *key, char *value - Pointer to Key and Value
	jwObj_int	char *key, int value - Pointer to Key and Value
	jwObj_double	char *key, double value - Pointer to Key and Value
	jwObj_bool	char *key, int oneorZero - Pointer to Key and Value
	jwObj_null	char *key - Pointer to Key
	jwObj_object	char *key - Pointer to Key
	jwObj_array	char *key - Pointer to Key
	jwArr_string	char *value - Pointer to Value
	jwArr_int	int value - Input Integer value
	jwArr_double	double value - Input Double value
	jwArr_bool	int oneorZero - Input Boolean value
	jwArr_null	None
	jwArr_object	None
	jwArr_array	None
	jwEnd	None
	jwObj_raw	char *key, char *rawtext - Pointer to Key and rawtext

	jwArr_raw	char *rawtext - Pointer to Key and rawtext
Output Parameter	jwOpen	void –No return value
	jwClose	int – returns error code (0 = JWRITE_OK)
	jwErrorPos	int –if jwClose returned an error, this function returns the number of the jWrite function call which caused that error
	jwObj_string	void –No return value
	jwObj_int	void –No return value
	jwObj_double	void –No return value
	jwObj_bool	void –No return value
	jwObj_null	void –No return value
	jwObj_object	void –No return value
	jwObj_array	void –No return value
	jwArr_string	void –No return value
	jwArr_int	void –No return value
	jwArr_double	void –No return value
	jwArr_bool	void –No return value
	jwArr_null	void –No return value
	jwArr_object	void –No return value
	jwArr_array	void –No return value
	jwEnd	void –No return value
	jwObj_raw	void –No return value
	jwArr_raw	void –No return value

Example

```
jwOpen( buffer, buflen, JW_OBJECT, JW_PRETTY );       // open root node as
object
      jwObj_string( "key", "value" );
      jwObj_int( "int", 1 );
      jwObj_array( "anArray");
            jwArr_int( 0 );
            jwArr_int( 1 );
            jwArr_int( 2 );
      jwEnd();
      err= jwClose();                                             // close
root object

Result
      {
            "key": "value",
            "int": 1,
            "anArray": [
                0,
                1,
                2
            ]
      }
```

1.1. Important Variable Configurations

Following are list of variables that need to be modified to configure the devices for different access point and servers. The variables are declared in main.c.

Sl. No.	Variable	Purpose
1	ap_string	Name of access point
2	password	Password for joining Access Point
3	server_ip	IP address of the Server
4	port_no	Port no of the Server
5	device_mac_address	Machine ID of the device, this is preferable to be unique for each device... In future version of software, this parameter will be programmable through serial / USB port
6	topic_pub	Topic to publish data to the server
7	user_name	User name of server
8	server_password	Password of the server

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