

WifiOnOff

Generated by Doxygen 1.8.6

Mon Apr 2 2018 13:38:14

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Chapter 1

WIFIONOff

! [Build Status] (<https://travis-ci.org/peastone/WIFIONOff.svg?branch=master>)
! [License: GPL v3] (<https://img.shields.io/badge/License-GPL%20v3-blue.svg>)

Motivation

This repository was inspired by the article "[Bastelfreundlich](#)" by the German computer magazine "c't". The article there is pretty much introductory. If you speak German and you have difficulties to get started, you can have a look there.

Caution: Dragons ahead

The relay in the Sonoff S20 EU can only handle 10 A. Do NOT plug in devices with draw more current. The maximum amount of current is also noted on the backside of the Sonoff S20 EU. It may differ in other variants sold, so have a look.

Never program the Sonoff S20, if it is connected to the mains. In Germany, that's 230 volts and you don't want to get an electric shock, which might even kill you.

That put ahead, go forward and be cautious!

Flash it

1. Install Arduino IDE ([instructions](#)).
2. Install Arduino core for ESP8266 ([instructions](#)).
3. Install the library ([instructions](#)) for MQTT from Joël Gähwiler.
4. Get yourself a FTDI-232-USB-TTL converter and some jumper wires.
5. Connect the FTDI to the Sonoff S20 (Pins from top to button: GND, TX, RX, 3.3V; Top is located right underneath the socket. Pin connection may vary for other variants or over time. You flash at your own risk.).
6. Build the software and flash it.

The whole procedure may also be done with [PlatformIO](#). It should be easy to find out the analogous steps for yourself.

Use it

1. Close the Sonoff S20. BE cautious! The device MUST be absolutely closed. You are working at your own risk here. If the device is open, you risk getting an electric shock or worse. If in doubt, ask an expert!

2. Plug the Sonoff S20 into the mains.
3. Press the button until it flashes the first time. Press the button of the router immediately after that. The WPS procedure starts.
4. Find the device with an mDNS mobile phone app.
5. Open the web interface by entering the mDNS name into your browser.
6. Configure MQTT, if wanted.
7. Enjoy the web interface, MQTT and the physical button. Toggle the relay.

Last advice

Please read the [manual](#). It is pretty detailed and should answer most of your questions. Only the latest version is provided. All versions can be generated with [Doxygen](#).

Also thanks to

- Jeroen de Bruijn for his [gist](#) on how to auto-deploy Doxygen documentation on Github pages with Travis CI

Chapter 2

Use Case Analysis

Features Implemented

- WPS Push Button Configuration: I really ask myself, why WiFi Protected Setup is used so infrequently. It is convenient and you just need to push a button on your router and on your device. Many routers also offer the opportunity to press the push button over the web interface. So, you don't even have to walk. This is a must-have feature.
- HTTP interface: The user must be able to control the WIFIOff with a simple web interface. You don't want to walk to switch the coffee machine on or off. This is a must-have feature. It is also needed for MQTT support.
- MQTT support: If configured over the HTTP interface, the WIFIOff publishes the state of the relay and subscribes to a command channel. This is a nice-to-have feature. It is very interesting to experiment with MQTT to produce internet-of-things-like networks. In future, this feature might become more important.
- Arduino OTA: With over-the-air updates enabled, the WIFIOff can be flashed wirelessly. This is a nice-to-have feature. One can still flash over serial wire, but OTA is so much more convenient. This feature is NOT recommended to be used in an untrusted environment.

Features Not to Be Implemented

- Cloud: The WIFIOff does not need a cloud or an external internet connection to be useful. This is quite nice as your device does not become worthless, if the your cloud service provider discontinues service. It also offers some advantage in terms of data protection. You are still free to use external service providers.
- Timer: I tried to follow the UNIX philosophy when designing this program. The WIFIOff does one thing well: toggling the relay. It can be connected with other devices by MQTT. If you want to implement a timer, you can do this, as a script on a separate computer connected to the MQTT broker. You also get a GUI for free with an MQTT smartphone app.

Use Case Diagram

title WIFIOff - Use Case Diagram

rectangle WIFIOff { (Toggle relay by pushing a button) as PHYTOG (Toggle relay by web UI) as WEBTOG (Connect to WiFi by WPS) as CONNECT (Configure MQTT) as CONFIGMQTT (Publish) as MQTT_PUB (Subscribe) as MQTT_SUB (Arduino OTA) as OTA }

:User: :MQTT broker: as MQTT_Broker :Developer:

User -> PHYTOG User -> WEBTOG User -> CONNECT User -> CONFIGMQTT MQTT_Broker -> MQTT_PUB MQTT_SUB -> MQTT_Broker Developer -> OTA

Boundary Conditions

- XSS protection: The HTTP web interface accepts user input which must be sanitized. The approach that is used in this project is whitelisting. The goal is to prevent XSS attacks. For more information about XSS, look [here](#) (Prevention_Cheat_Sheet).

Button interaction

title User with button interaction - Activity Diagram start :User presses and holds the button; :User waits TIME; - :User releases the button; if (TIME > TRIGGER_TIME_FACTORY_RESET) then (yes) :Perform factory reset; elseif (TIME > TRIGGER_TIME_WIFI_DATA_RESET) then (yes) :Reset WIFI configuration; else if (TIME > TRIGGER_TIME_WPS) then (yes) if (WIFI configured) then (yes) else (no) :Perform WPS; endif else () :Toggle relay; endif stop

Chapter 3

Todo List

Member `DEV_OTA_PASSWD`

Despite the fact that over-the-air (OTA) updates are not highly secure, it is highly recommended to change the password. This is just a very bad default.

See Also

<https://media.readthedocs.org/pdf/arduino-esp8266/latest/arduino-esp8266.-pdf>

Chapter 4

File Index

4.1 File List

Here is a list of all files with brief descriptions:

/home/travis/build/peastone/WIFIONOff/src/[WIFIONOff.ino](#) 9

Chapter 5

File Documentation

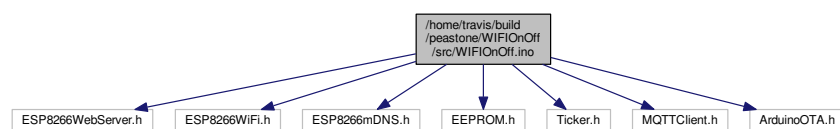
5.1 /home/travis/build/peastone/WIFIOff/README.md File Reference

5.2 /home/travis/build/peastone/WIFIOff/RequirementsAndDesign.md File Reference

5.3 /home/travis/build/peastone/WIFIOff/src/WIFIOff.ino File Reference

```
#include <ESP8266WebServer.h>
#include <ESP8266WiFi.h>
#include <ESP8266mDNS.h>
#include <EEPROM.h>
#include <Ticker.h>
#include <MQTTClient.h>
#include <ArduinoOTA.h>
```

Include dependency graph for WIFIOff.ino:



Macros

- `#define SERIAL_PRINTING`
Define SERIAL_PRINTING if you want to enable serial communication.
- `#define NUMERIC_RESPONSE`
Define NUMERIC_RESPONSE if you want the `mqttClient` to publish "1" or "0" instead of "on" or "off".
- `#define OUTPUT_RELAY_STATE_ON_GREEN_STATUS_LED`
The state of the relay is visible through the blue LED (connected == LED shines). Define OUTPUT_RELAY_STATE_ON_GREEN_STATUS_LED, if you want the state of the relay being visible also on the green LED (connected == LED shines).
- `#define DEV_OTA_UPDATES`
Define DEV_OTA_UPDATES if you want to perform OTA updates for development with Arduino IDE.
- `#define DEV_OTA_PASSWD "CwvpVzR33gKY"`
Define the password to protect OTA with DEV_OTA_PASSWD. This is not a high security procedure.

- `#define TRIGGER_TIME_WPS 7000`
time in ms to wait until WPS request is triggered when pressing the button (see [pressHandler\(\)](#))
- `#define TRIGGER_TIME_WIFI_DATA_RESET 30000`
time in ms to wait until the WIFI configuration reset
- `#define TRIGGER_TIME_FACTORY_RESET 60000`
time in ms to wait until factory reset is triggered when pressing the button (see [pressHandler\(\)](#))
- `#define HTTP_PORT 80`
standard port used for the HTTP protocol
- `#define MQTT_PORT 1883`
standard port used for the MQTT protocol
- `#define TIME_HALF_A_SECOND 500`
definition of the timespan of half a second
- `#define TIME_QUARTER_SECOND 250`
definition of the timespan of a quarter of a second
- `#define TIME_EEPROM_WARNING 7000`
definition of the time the LED stays on in case of an EEPROM warning (CRC failure, initialization, EEPROM incompatible)
- `#define CTR_MAX_TRIES_WIFI_CONNECTION 60`
maximum amount of tries to connect to WIFI
- `#define EEPROM_length 4096`
EEPROM_length defines the maximum amount of bytes to be stored in the EEPROM. At the time of writing, the maximum amount of bytes to be stored is 4096.
- `#define EEPROM_version_number 0`
A CRC is calculated for the EEPROM values to ensure that the values are untempered. The address of the stored CRC is at the beginning of the EEPROM.
- `#define EEPROM_version_number_address 0`
This version number is stored in EEPROM. It must not be longer than one byte. The version number defined here and that one stored in EEPROM are compared against each other. In case the two numbers are not equal, the EEPROM is re-/initialized. This number must change, if you change the EEPROM layout, basically if you change addresses.
- `#define EEPROM_address_CRC 1`
The EEPROM version number is stored at this address.
- `#define EEPROM_size_CRC (sizeof(unsigned long))`
A CRC is calculated for the EEPROM values to ensure that the values are untempered. The size of the stored CRC is defined by this macro.
- `#define EEPROM_address_start (EEPROM_address_CRC + EEPROM_size_CRC)`
A CRC is calculated for the EEPROM values to ensure that the values are untempered. The CRC takes some space to be stored in the EEPROM. The start address takes this into account.
- `#define EEPROM_enabled 0xEB`
If this magic number is set, a defined functionality is enabled.
- `#define EEPROM_enabled_size 1`
The amount of storage needed by [EEPROM_enabled](#) in EEPROM.
- `#define EEPROM_init_value 0x00`
If an init value is set, a defined functionality is disabled. The init value is also used to initialize the EEPROM in [setupEEPROM\(\)](#).
- `#define EEPROM_address_WPS_configured EEPROM_address_start`
WPS is the only choice to connect to WIFI. This shall improve usability. The state of WPS is stored in EEPROM at this address. The value 0x00 was chosen as it terminates Strings, which leads to perfect default data.
- `#define EEPROM_address_MQTT_server_configured (EEPROM_address_WPS_configured + EEPROM_enabled_size)`
This flag is used to check whether [mqttServer](#) has already been initialized with the value of the MQTT-Server (DNS name or IP)
- `#define EEPROM_address_MQTT_server (EEPROM_address_MQTT_server_configured + EEPROM_enabled_size)`

The variable `mqttServer` which contains the value of the MQTT-Server (DNS name or IP) is restored after startup from EEPROM, if MQTT is configured (`EEPROM_address_MQTT_server_configured`). The stored bytes can be found at this address.

- #define `EEPROM_size_MQTT_server` 256

The maximum amount of bytes used to store the MQTT server address. This address can be either an IP or a DNS name. DNS names are restricted to 255 octets. As a string is zero-terminated, one byte more is used. For more information, look at RFC 1035.

Functions

- unsigned long `calculate_crc` ()

This function calculates a CRC checksum for the EEPROM. It is taken from: <https://www.arduino.cc/en/Tutorial/EEPROMCrc>.

- void `storeCRC` ()

This function calculates the CRC value of the values in the EEPROM with the help of function `calculate_crc()`. The resulting CRC checksum is written to `EEPROM_address_CRC`. The caller must still call `EEPROM.commit()` afterwards to really trigger a write to EEPROM.

- unsigned long `retrieveCRC` ()

This function reads the CRC value stored at `EEPROM_address_CRC`.

- bool `checkCRC` ()

This function calculates the CRC value for the bytes stored in the EEPROM with the help of function `calculate_crc()` and compares the result to the CRC which was read from EEPROM with the help of function `retrieveCRC()`.

- void `storeEEPROMVersionNumber` ()

This function stores the `EEPROM_version_number` in EEPROM.

- bool `checkEEPROMVersionNumber` ()

This function checks the `EEPROM_version_number` stored in EEPROM against the version number required by the latest EEPROM layout.

- void `initEEPROM` ()

This function writes default data (`EEPROM_init_value`) to EEPROM and stores CRC and the `EEPROM_version_number`.

- void `setupEEPROM` ()

This function is setting up the EEPROM. If the CRC check fails, the EEPROM will be overwritten with init values. The CRC check makes only sense at initialization phase. Afterwards, the data is buffered by EEPROM lib in RAM.

- void `switchOffLED` ()

This function is used to switch the LED off. It keeps track of the internal state `stateLEDOn`.

- void `switchOnLED` ()

This function is used to switch the LED on. It keeps track of the internal state `stateLEDOn`.

- void `toggleLED` ()

This function is used to toggle the LED. Indirectly, it keeps track of the internal state `stateLEDOn`.

- bool `getStateLEDOn` ()

This function is used to get the state of the LED. It returns `stateLEDOn`.

- void `feedbackEEPROMInit` ()

This function is called to give the user feedback that the EEPROM has been re-/initialized. This means that all the user-entered data is gone and the device needs to be reconfigured.

- void `feedbackQuickBlink` ()

This function is called to give the user feedback about the menu the user selected. It will blink fast for a short period of time. The user has the choice to release and select the menu or to wait for the next menu. By counting the `feedbackQuickBlink()`-events, the user can determine which menu is selected, when the button is released now.

- void `feedbackWIFIisConnecting` ()

This function is called to give the user feedback that WIFI is about to connect. It will blink at a medium rate.

- bool `getUserActionFeedbackRequest` ()

Getter function for `userActionFeedbackRequest`.

- bool `setUserActionFeedbackRequest` ()

- Setter function for [userActionFeedbackRequest](#). The user should be notified that a menu can be selected.

 - bool [unsetUserActionFeedbackRequest](#) ()

Setter function for [userActionFeedbackRequest](#). The user has been notified that a menu can be selected.
- bool [checkWiFiConfigured](#) ()

This function checks whether WPS has already been performed once. In this case, one can directly connect to WiFi.
- void [setWiFiConfigured](#) ()

This function is a setter function which sets WiFi to configured, which means that WPS has already been performed successfully. This function is only called in [performWPS\(\)](#). The configuration is saved to EEPROM.
- void [unsetWiFiConfigured](#) ()

This function is a setter function which sets WiFi to not configured, which means that WPS is necessary before connecting to WIFI. The configuration is saved to EEPROM.
- void [performWPS](#) ()

This function is used to trigger WPS. If WPS has been successful, [setWiFiConfigured\(\)](#) is executed and [unsetWPS-Request\(\)](#) is called.
- String [getClientID](#) ()

This function returns the client name used for MQTT, see [mqttConnect\(\)](#).
- bool [connectToWiFi](#) ()

This function tries to connect to WIFI.
- void [setupMDNS](#) ()

This function sets up MDNS.
- bool [checkWiFiConnected](#) ()

This function checks whether WIFI is connected.
- bool [getWPSRequest](#) ()

Getter function for [wpsRequested](#).
- void [unsetWPSRequest](#) ()

Setter function to unset [wpsRequested](#).
- void [setWPSRequest](#) ()

Setter function to set [wpsRequested](#).
- bool [getWifiResetRequested](#) ()

Getter function for [wifiResetRequested](#).
- void [setWifiResetRequested](#) ()

Setter function to set [wifiResetRequested](#).
- void [unsetWifiResetRequested](#) ()

Setter function to unset [wifiResetRequested](#).
- void [disconnectRelay](#) ()

This function is used to disconnect the relay from the mains. It keeps track of the internal state [stateRelayConnected](#).
- void [connectRelay](#) ()

This function is used to connect the relay to the mains. It keeps track of the internal state [stateRelayConnected](#).
- bool [getStateRelayConnected](#) ()

This function is used to get the connection state of the relay with the mains. It returns [stateRelayConnected](#).
- void [toggleRelay](#) ()

This function is used to toggle the connection of the relay with the mains. Indirectly, it keeps track of the internal state [stateRelayConnected](#).
- void [configureOutputs](#) ()

This function configures the output pins of the microcontroller.
- String [renderHeader](#) ()

This function returns the first part of a HTML file which is reused for all responses.
- String [renderRelay](#) (bool [stateRelayConnected](#))

This function returns the middle part of a HTML file to.
- String [renderMQTTServerSettings](#) (String storedServerName, String failureMsg, bool stateMQTTActivated, bool stateMQTTConnected)

This function returns the middle part of a HTML file to.

- String [renderFooter](#) ()
This function returns the last part of a HTML file which is reused for all responses.
- void [mqttControlRelay](#) (String &topic, String &payload)
Callback which is called when MQTT receives an incoming topic.
- void [restoreMQTTConfigurationFromEEPROM](#) ()
Read back MQTT server / broker name from EEPROM and store it in global variable [mqttServer](#). Read back whether MQTT is configured and store it in global variable [stateMQTTConfigured](#).
- void [saveMQTTConfigurationToEEPROM](#) ()
Store MQTT server / broker name ([mqttServer](#)) and state (configured or not, [stateMQTTConfigured](#)) in EEPROM.
- void [configureMQTT](#) ()
Configure new MQTT server / broker. This will.
- void [setMQTTServer](#) (String input)
Setter function for MQTT server / broker [mqttServer](#).
- String [getMQTTServer](#) ()
Getter function for MQTT server / broker [mqttServer](#).
- void [setStateMQTTConfigured](#) (bool input)
Setter function for [stateMQTTConfigured](#).
- bool [getStateMQTTConfigured](#) ()
Getter function for [stateMQTTConfigured](#).
- void [setMQTTOutgoingTopic](#) (String input)
Setter function for [mqttOutgoingTopic](#).
- String [getMQTTOutgoingTopic](#) ()
Getter function for [mqttOutgoingTopic](#).
- void [setMQTTIncomingTopic](#) (String input)
Setter function for [mqttIncomingTopic](#).
- bool [checkMQTTConnected](#) ()
Get MQTT connection state.
- void [mqttConnect](#) ()
This function connects to broker and.
- void [mqttPublish](#) ()
With the call of this function, [mqttClient](#) publishes the state of the relay ([getStateRelayConnected\(\)](#)) on the outgoing topic ([getMQTTOutgoingTopic\(\)](#)) to the MQTT server / broker. The macro [NUMERIC_RESPONSE](#) is taken into account.
- bool [isNotWhitelisted](#) (char c)
This function is used for filtering out XSS attacks. This is done by whitelisting.
- bool [mqttServerValid](#) (String [mqttServer](#))
This function is used to check whether [mqttServer](#) is valid. Therefore, it is checked that the.
- void [configureWebServer](#) ()
This function is used configure the webserver. The webserver is configured by defining callback functions for handling incoming requests on.
- void [performFactoryReset](#) ()
Perform factory reset.
- bool [getFactoryResetRequested](#) ()
Getter function for [factoryResetRequested](#).
- void [setFactoryResetRequested](#) ()
Setter function to set [factoryResetRequested](#).
- void [unsetFactoryResetRequested](#) ()
Setter function to unset [factoryResetRequested](#).
- void [pressHandler](#) ()
This function triggers.
- void [setup](#) (void)
This function is executed once at the startup of the microcontroller.
- void [loop](#) (void)
This function is executed in a loop after [setup\(void\)](#) has been called.

Variables

- String `REPOSITORY_URL_STRING` = "https://github.com/peastone/WIFIOnOff"
Contains a link to the code repository which is embedded in the rendered HTML files in the function `renderFooter()`.
- const int `pinLED` = 13
Constant to map the green LED of the Sonoff S20.
- bool `stateLEDOn` = false
State to track whether the LED is on.
- bool `userActionFeedbackRequest` = false
State to track whether the user should be notified that a menu can be selected by releasing the button.
- WiFiClient `wifiClient`
Necessary to initialize a MQTTClient object.
- bool `wpsRequested` = false
State to track whether the WPS has been requested.
- bool `wifiResetRequested` = false
State to track whether the deletion of WIFI data has been requested.
- bool `stateRelayConnected` = false
State to track whether the LED is connected to the mains.
- const int `pinRelay` = 12
Constant to map the relay of the Sonoff S20.
- MQTTClient `mqttClient`
central object to manage MQTT
- String `mqttServer` = ""
Global variable to store the DNS name or IP address of the MQTT broker.
- bool `stateMQTTConfigured` = false
State to track whether MQTT is configured.
- String `mqttOutgoingTopic`
The topic `mqttClient` publishes.
- String `mqttIncomingTopic`
The topic which `mqttClient` subscribes.
- ESP8266WebServer `webserver`
This is the webserver object. It is used to serve the user interface over HTTP. Per default, port 80 is used.
- bool `factoryResetRequested` = false
State to track whether a factory reset has been requested.
- const int `buttonPin` = 0
Constant to map the hardware button of the Sonoff S20.
- bool `buttonLastPressed` = false
State to track whether the button was pressed since `pressHandler()` was called the last time.
- unsigned long `timeSincebuttonPressed` = 0
State to track the time since the button was pressed.
- unsigned long `selectionState` = 0
State to track which menu the user selects, if the button is released.
- Ticker `ticker`
This object is used to trigger the function `press` frequently. The button handler is implemented there.

5.3.1 Detailed Description

WIFIONOff is an alternative software for the Sonoff S20 which provides a web user interface (HTTP) and an internet of things interface (MQTT). The device can still be controlled by the normal user button. The connection to WiFi will be established by WPS for reasons of a better user experience. This device can be used in the local network without any dependency of a cloud.

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See Also

<http://mqtt.org/>
<http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.pdf>
<https://github.com/esp8266/Arduino>
<https://arduino-esp8266.readthedocs.io/en/latest/>
<https://media.readthedocs.org/pdf/arduino-esp8266/latest/arduino-esp8266.-pdf>
https://github.com/espressif/ESP8266_NONOS_SDK

5.3.2 Macro Definition Documentation

5.3.2.1 `#define CTR_MAX_TRIES_WIFI_CONNECTION 60`

maximum amount of tries to connect to WIFI

5.3.2.2 `#define DEV_OTA_PASSWD "CwpvVzR33gKY"`

Define the password to protect OTA with DEV_OTA_PASSWD. This is not a high security procedure.

Todo Despite the fact that over-the-air (OTA) updates are not highly secure, it is highly recommended to change the password. This is just a very bad default.

See Also

<https://media.readthedocs.org/pdf/arduino-esp8266/latest/arduino-esp8266.-pdf>

5.3.2.3 `#define DEV_OTA_UPDATES`

Define DEV_OTA_UPDATES if you want to perform OTA updates for development with Arduino IDE.

5.3.2.4 `#define EEPROM_address_CRC 1`

The EEPROM version number is stored at this address.

```
5.3.2.5 #define EEPROM_address_MQTT_server (EEPROM_address_MQTT_server_configured +
        EEPROM_enabled_size)
```

The variable `mqttServer` which contains the value of the MQTT-Server (DNS name or IP) is restored after startup from EEPROM, if MQTT is configured (`EEPROM_address_MQTT_server_configured`). The stored bytes can be found at this address.

```
5.3.2.6 #define EEPROM_address_MQTT_server_configured (EEPROM_address_WPS_configured +
        EEPROM_enabled_size)
```

This flag is used to check whether `mqttServer` has already been initialized with the value of the MQTT-Server (DNS name or IP)

```
5.3.2.7 #define EEPROM_address_start (EEPROM_address_CRC + EEPROM_size_CRC)
```

A CRC is calculated for the EEPROM values to ensure that the values are untempered. The CRC takes some space to be stored in the EEPROM. The start address takes this into account.

```
5.3.2.8 #define EEPROM_address_WPS_configured EEPROM_address_start
```

WPS is the only choice to connect to WIFI. This shall improve usability. The state of WPS is stored in EEPROM at this address. The value 0x00 was chosen as it terminates Strings, which leads to perfect default data.

```
5.3.2.9 #define EEPROM_enabled 0xEB
```

If this magic number is set, a defined functionality is enabled.

```
5.3.2.10 #define EEPROM_enabled_size 1
```

The amount of storage needed by `EEPROM_enabled` in EEPROM.

```
5.3.2.11 #define EEPROM_init_value 0x00
```

If an init value is set, a defined functionality is disabled. The init value is also used to initialize the EEPROM in `setupEEPROM()`.

```
5.3.2.12 #define EEPROM_length 4096
```

`EEPROM_length` defines the maximum amount of bytes to be stored in the EEPROM. At the time of writing, the maximum amount of bytes to be stored is 4096.

See Also

<https://git.io/vxYHO>
<https://git.io/vxYHG>

```
5.3.2.13 #define EEPROM_size_CRC (sizeof(unsigned long))
```

A CRC is calculated for the EEPROM values to ensure that the values are untempered. The size of the stored CRC is defined by this macro.

5.3.2.14 `#define EEPROM_size_MQTT_server 256`

The maximum amount of bytes used to store the MQTT server address. This address can be either an IP or a DNS name. DNS names are restricted to 255 octets. As a string is zero-terminated, one byte more is used. For more information, look at RFC 1035.

See Also

<https://www.ietf.org/rfc/rfc1035.txt>

5.3.2.15 `#define EEPROM_version_number 0`

A CRC is calculated for the EEPROM values to ensure that the values are untempered. The address of the stored CRC is at the beginning of the EEPROM.

5.3.2.16 `#define EEPROM_version_number_address 0`

This version number is stored in EEPROM. It must not be longer than one byte. The version number defined here and that one stored in EEPROM are compared against each other. In case the two numbers are not equal, the EEPROM is re-/initialized. This number must change, if you change the EEPROM layout, basically if you change addresses.

5.3.2.17 `#define HTTP_PORT 80`

standard port used for the HTTP protocol

5.3.2.18 `#define MQTT_PORT 1883`

standard port used for the MQTT protocol

5.3.2.19 `#define NUMERIC_RESPONSE`

Define NUMERIC_RESPONSE if you want the `mqttClient` to publish "1" or "0" instead of "on" or "off".

5.3.2.20 `#define OUTPUT_RELAY_STATE_ON_GREEN_STATUS_LED`

The state of the relay is visible through the blue LED (connected == LED shines). Define OUTPUT_RELAY_STATE_ON_GREEN_STATUS_LED, if you want the state of the relay being visible also on the green LED (connected == LED shines).

5.3.2.21 `#define SERIAL_PRINTING`

Define SERIAL_PRINTING if you want to enable serial communication.

5.3.2.22 `#define TIME_EEPROM_WARNING 7000`

definition of the time the LED stays on in case of an EEPROM warning (CRC failure, initialization, EEPROM incompatible)

5.3.2.23 `#define TIME_HALF_A_SECOND 500`

definition of the timespan of half a second

5.3.2.24 `#define TIME_QUARTER_SECOND 250`

definition of the timespan of a quarter of a second

5.3.2.25 `#define TRIGGER_TIME_FACTORY_RESET 60000`

time in ms to wait until factory reset is triggered when pressing the button (see [pressHandler\(\)](#))

5.3.2.26 `#define TRIGGER_TIME_WIFI_DATA_RESET 30000`

time in ms to wait until the WIFI configuration reset

5.3.2.27 `#define TRIGGER_TIME_WPS 7000`

time in ms to wait until WPS request is triggered when pressing the button (see [pressHandler\(\)](#))

5.3.3 Function Documentation

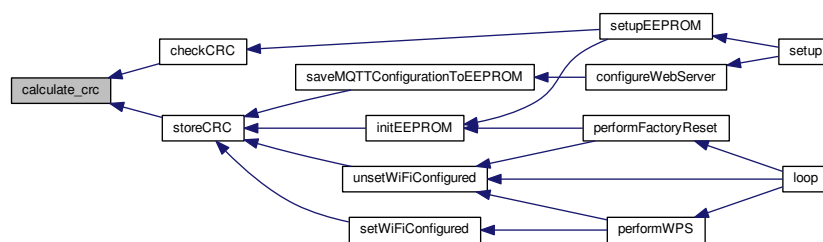
5.3.3.1 `unsigned long calculate_crc ()`

This function calculates a CRC checksum for the EEPROM. It is taken from: <https://www.arduino.cc/en/Tutorial/EEPROMCrc>.

Returns

calculated CRC

Here is the caller graph for this function:



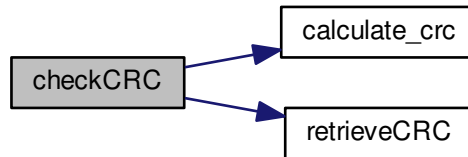
5.3.3.2 `bool checkCRC ()`

This function calculates the CRC value for the bytes stored in the EEPROM with the help of function [calculate_crc\(\)](#) and compares the result to the CRC which was read from EEPROM with the help of function [retrieveCRC\(\)](#).

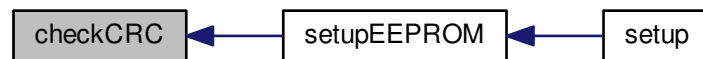
Returns

true if calculated CRC matches stored CRC

Here is the call graph for this function:



Here is the caller graph for this function:

**5.3.3.3 bool checkEEPROMVersionNumber ()**

This function checks the [EEPROM_version_number](#) stored in EEPROM against the version number required by the latest EEPROM layout.

Returns

true, if the stored and the required EEPROM version number match, false otherwise

Here is the caller graph for this function:

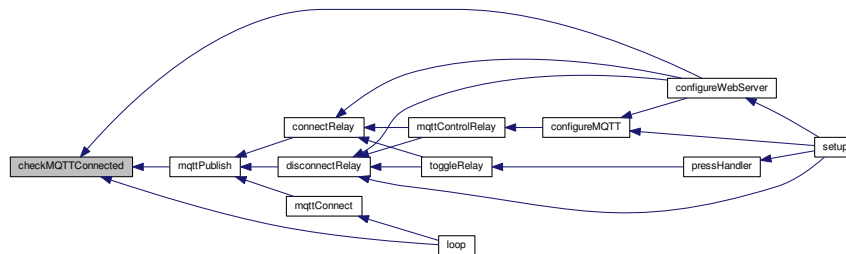
**5.3.3.4 bool checkMQTTConnected ()**

Get MQTT connection state.

Returns

true, if MQTT is connected, false otherwise

Here is the caller graph for this function:

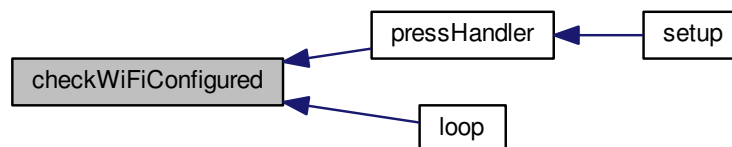
**5.3.3.5 bool checkWiFiConfigured ()**

This function checks whether WPS has already been performed once. In this case, one can directly connect to WiFi.

Returns

true if WPS has already been performed, false otherwise

Here is the caller graph for this function:

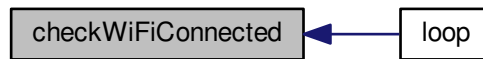
**5.3.3.6 bool checkWiFiConnected ()**

This function checks whether WIFI is connected.

Returns

true, if WiFi is connected, false otherwise

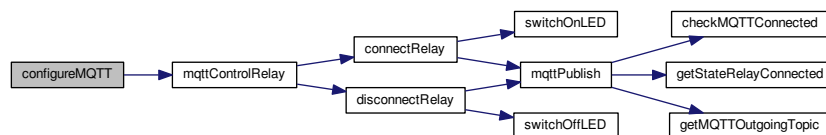
Here is the caller graph for this function:

**5.3.3.7 void configureMQTT ()**

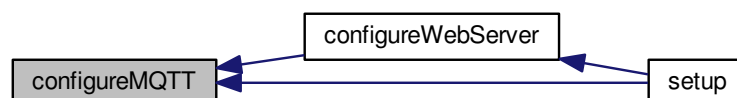
Configure new MQTT server / broker. This will.

- disconnect the MQTT client if connected
- set the server / broker name
- set the callback `mqttControlRelay()`

Here is the call graph for this function:

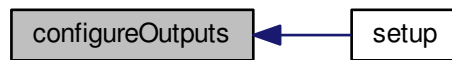


Here is the caller graph for this function:

**5.3.3.8 void configureOutputs ()**

This function configures the output pins of the microcontroller.

Here is the caller graph for this function:

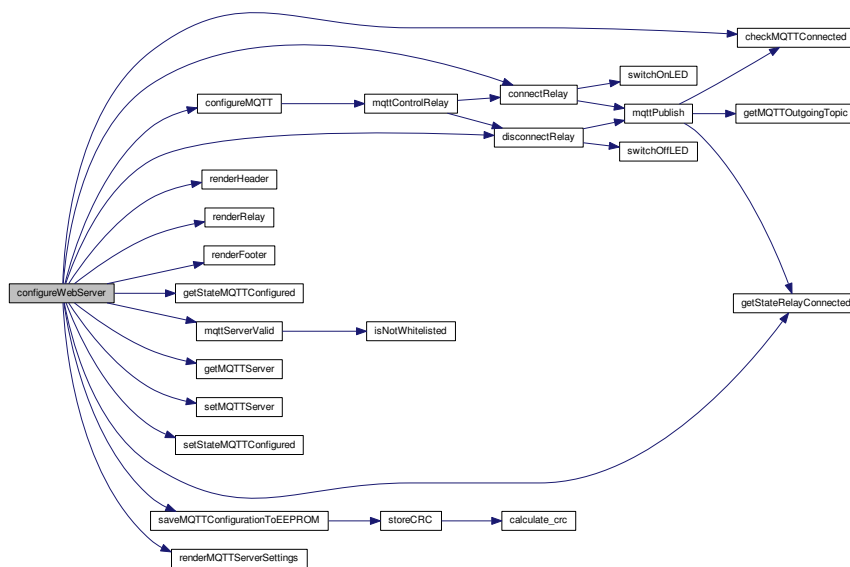


5.3.3.9 void configureWebServer ()

This function is used configure the webserver. The webserver is configured by defining callback functions for handling incoming requests on.

- /
- /settings.html

Here is the call graph for this function:



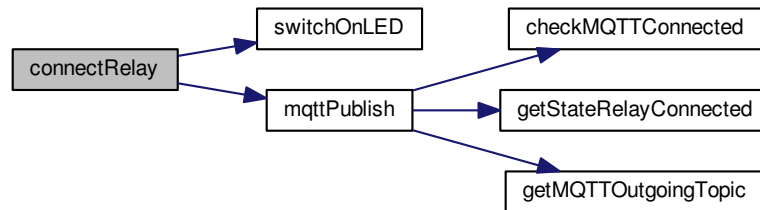
Here is the caller graph for this function:



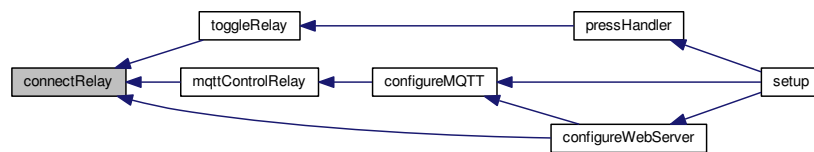
5.3.3.10 void connectRelay ()

This function is used to connect the relay to the mains. It keeps track of the internal state [stateRelayConnected](#).

Here is the call graph for this function:



Here is the caller graph for this function:



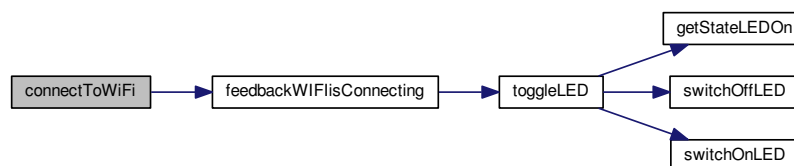
5.3.3.11 bool connectToWiFi ()

This function tries to connect to WIFI.

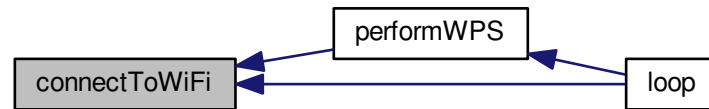
Returns

true, if the connection was successful, false otherwise.

Here is the call graph for this function:



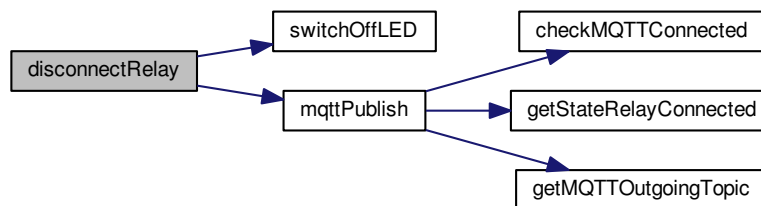
Here is the caller graph for this function:



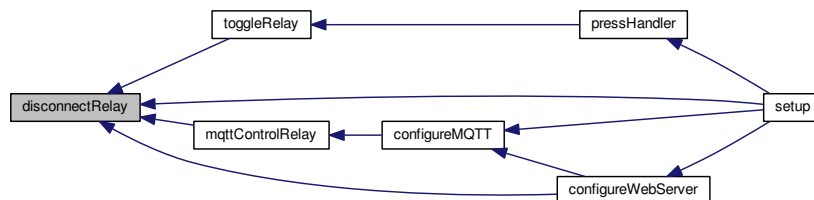
5.3.3.12 void disconnectRelay ()

This function is used to disconnect the relay from the mains. It keeps track of the internal state `stateRelayConnected`.

Here is the call graph for this function:



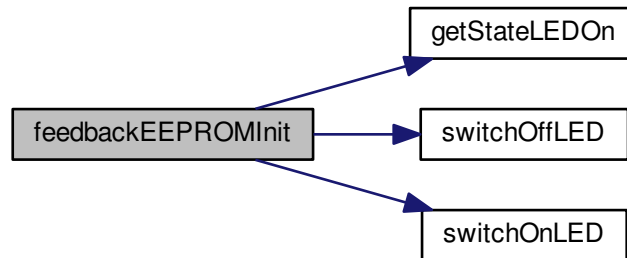
Here is the caller graph for this function:



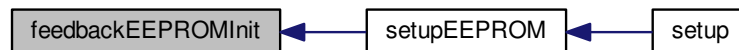
5.3.3.13 void feedbackEEPROMInit ()

This function is called to give the user feedback that the EEPROM has been re-/initialized. This means that all the user-entered data is gone and the device needs to be reconfigured.

Here is the call graph for this function:



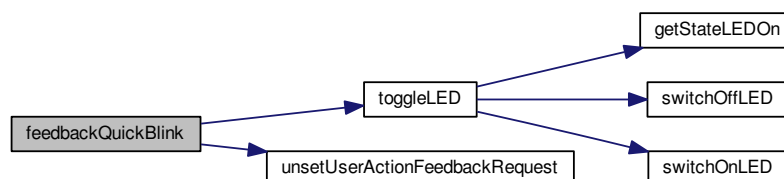
Here is the caller graph for this function:



5.3.3.14 void feedbackQuickBlink ()

This function is called to give the user feedback about the menu the user selected. It will blink fast for a short period of time. The user has the choice to release and select the menu or to wait for the next menu. By counting the `feedbackQuickBlink()`-events, the user can determine which menu is selected, when the button is released now.

Here is the call graph for this function:



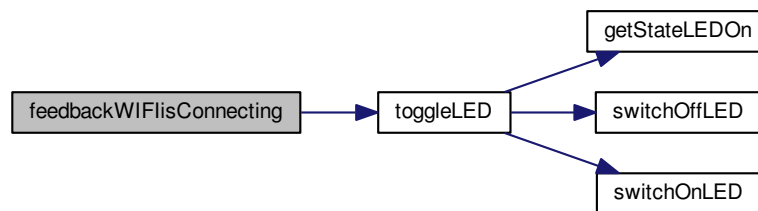
Here is the caller graph for this function:



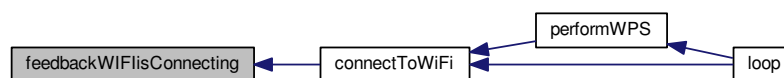
5.3.3.15 void feedbackWiFiIsConnecting ()

This function is called to give the user feedback that WIFI is about to connect. It will blink at a medium rate.

Here is the call graph for this function:



Here is the caller graph for this function:



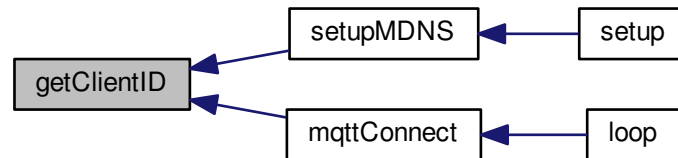
5.3.3.16 String getClientID ()

This function returns the client name used for MQTT, see [mqttConnect\(\)](#).

Returns

the client ID: "WIFIOff" + MAC address

Here is the caller graph for this function:

**5.3.3.17 bool getFactoryResetRequested ()**

Getter function for [factoryResetRequested](#).

Returns

true, if factory reset is requested, false otherwise.

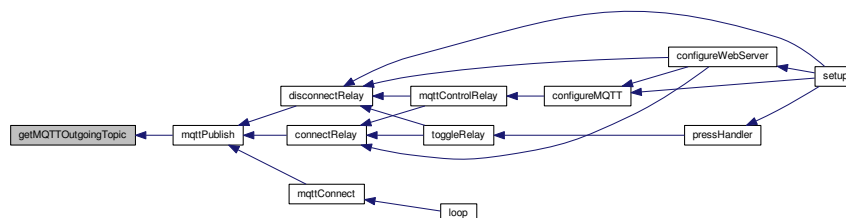
5.3.3.18 String getMQTTOutgoingTopic ()

Getter function for [mqttOutgoingTopic](#).

Returns

String of outgoing MQTT topic

Here is the caller graph for this function:

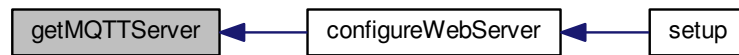
**5.3.3.19 String getMQTTServer ()**

Getter function for MQTT server / broker [mqttServer](#).

Returns

the latest MQTT server / broker

Here is the caller graph for this function:

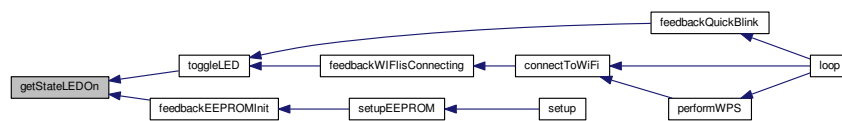
**5.3.3.20 bool getStateLEDOn ()**

This function is used to get the state of the LED. It returns [stateLEDOn](#).

Returns

true, if the LED is on, false otherwise.

Here is the caller graph for this function:

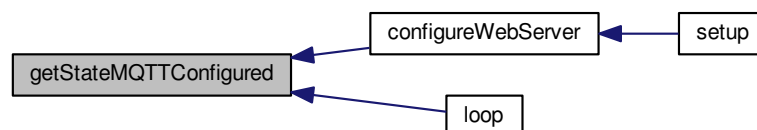
**5.3.3.21 bool getStateMQTTConfigured ()**

Getter function for [stateMQTTConfigured](#).

Returns

true if MQTT is configured, false otherwise

Here is the caller graph for this function:



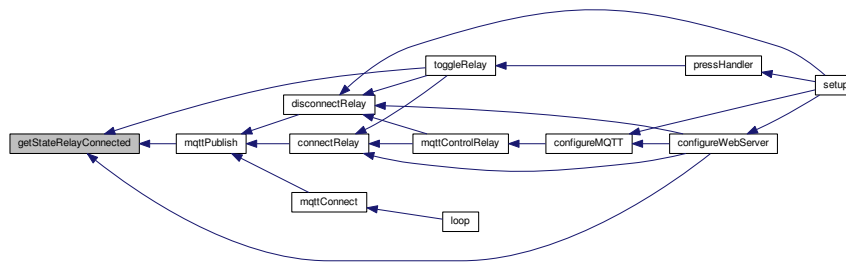
5.3.3.22 bool getStateRelayConnected ()

This function is used to get the connection state of the relay with the mains. It returns [stateRelayConnected](#).

Returns

true, if the relay is connected to the mains, false otherwise.

Here is the caller graph for this function:

**5.3.3.23 bool getUserActionFeedbackRequest ()**

Getter function for [userActionFeedbackRequest](#).

Returns

true, if the user should be notified that a menu can be selected, false otherwise

Here is the caller graph for this function:

**5.3.3.24 bool getWifiResetRequested ()**

Getter function for [wifiResetRequested](#).

Returns

true, if a deletion of WIFI data has been requested, false otherwise.

5.3.3.25 bool getWPSRequest ()

Getter function for [wpsRequested](#).

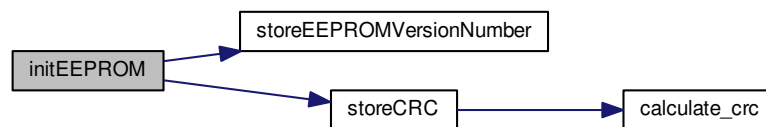
Returns

true, if WPS has been requested, false otherwise.

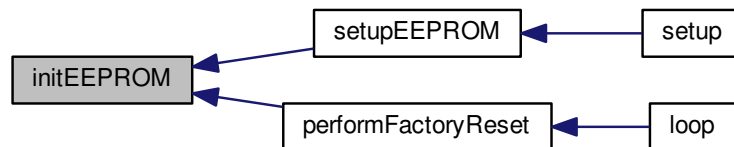
5.3.3.26 void initEEPROM ()

This function writes default data ([EEPROM_init_value](#)) to EEPROM and stores CRC and the [EEPROM_version_number](#).

Here is the call graph for this function:



Here is the caller graph for this function:

**5.3.3.27 bool isNotWhitelisted (char c)**

This function is used for filtering out XSS attacks. This is done by whitelisting.

- IPv4 addresses consist of numbers and dots (0..9 | .).
- IPv6 addresses consist of hexadecimal numbers, double dots or brackets (0..9 | a..f | A..F | [|])
- DNS names consist of letters, digits and hyphen (0..9 | a..z | A..Z | -). This function is not validating DNS, IPv4, IPv6. Rubbish DNS names can still pass. But characters which could be used for XSS, like <, >, &, " are blocked.

Parameters

in	c	character to check
----	---	--------------------

See Also

<https://www.ietf.org/rfc/rfc1035.txt>
<https://wonko.com/post/html-escaping>
[https://www.owasp.org/index.php/XSS_\(Cross_Site_Scripting\)_Prevention_-_Cheat_Sheet](https://www.owasp.org/index.php/XSS_(Cross_Site_Scripting)_Prevention_-_Cheat_Sheet)

Returns

true, if the argument character is not whitelisted, false otherwise.

Here is the caller graph for this function:



5.3.3.28 void loop (void)

This function is executed in a loop after `setup(void)` has been called.

At first it checks for incoming user requests:

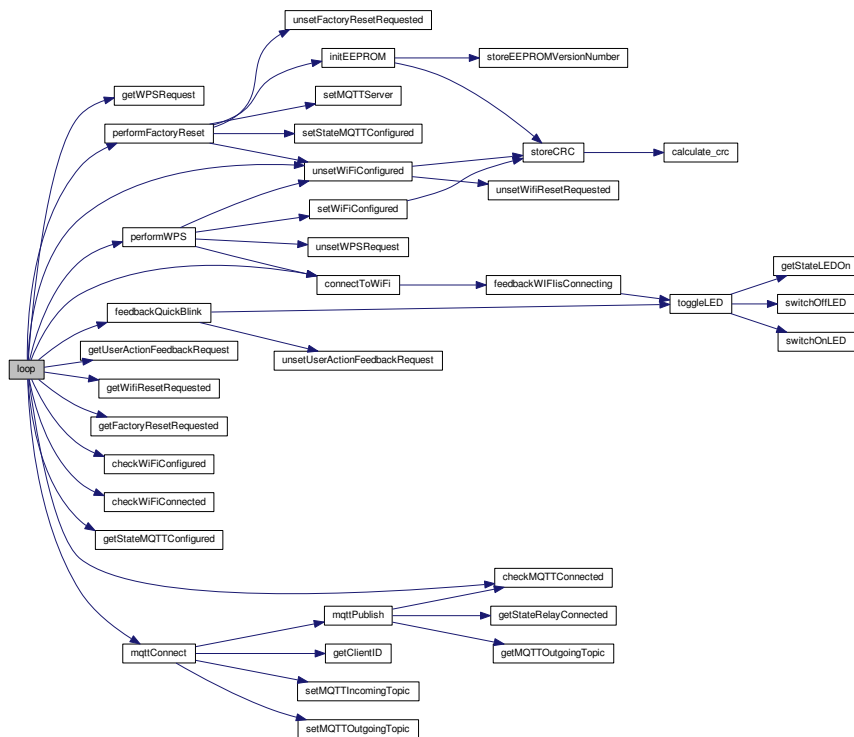
- to perform WPS (`performWPS()`)
- to delete the WiFi configuration (`unsetWiFiConfigured()`)
- to perform a factory reset (`performFactoryReset()`)

It is also checked for requests to inform the user about actions with the LED. These requests are triggered programmatically.

After all requests are handled, it is cyclically checked that WPS has been performed and that the WiFi is connected. If WPS has not been done or WiFi is not connected, it does not make any sense to check for HTTP, ArduinoOTA or MQTT. For MQTT to be checked, it is also required, that it was enabled by the user.

If MQTT is not connected, try to connect, otherwise handle MQTT.

Here is the call graph for this function:

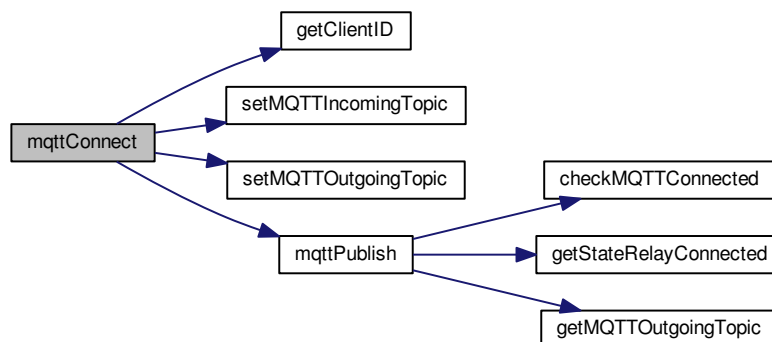


5.3.3.29 void mqttConnect ()

This function connects to broker and.

- subscribes topic wifionoff/getClientID()/set
- sets last will "disconnected" on wifionoff/getClientID()/get
- publishes latest state on wifionoff/getClientID()/get

Here is the call graph for this function:



Here is the caller graph for this function:



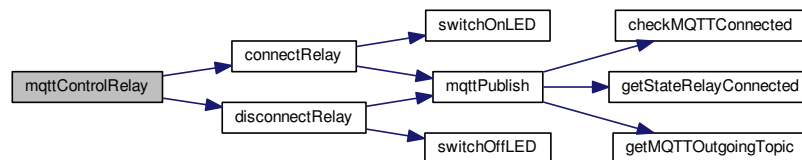
5.3.3.30 void mqttControlRelay (String & topic, String & payload)

Callback which is called when MQTT receives an incoming topic.

Parameters

in	topic	One of the incoming MQTT topics, which the mqttClient has been subscribed to. Currently there is only one connection, see mqttConnect() . So this parameter is irrelevant.
in	payload	Contains the received payload of the message of the incoming topic. If "on" or "1" is received, the relay is connected (connectRelay()), else if "off" or "0" is received, the relay is disconnected (disconnectRelay()).

Here is the call graph for this function:



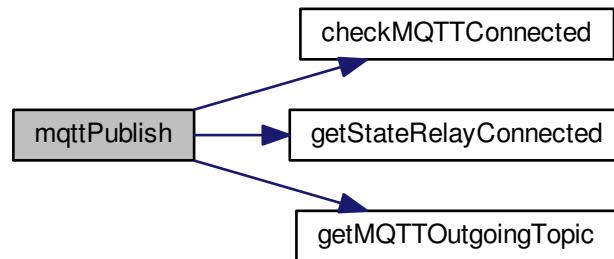
Here is the caller graph for this function:



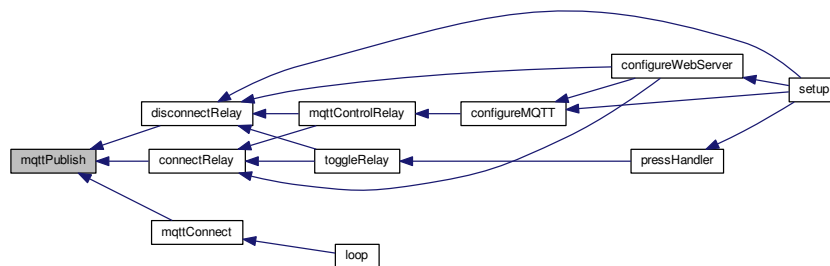
5.3.3.31 void mqttPublish ()

With the call of this function, [mqttClient](#) publishes the state of the relay ([getStateRelayConnected\(\)](#)) on the outgoing topic ([getMQTTOutgoingTopic\(\)](#)) to the MQTT server / broker. The macro [NUMERIC_RESPONSE](#) is taken into account.

Here is the call graph for this function:



Here is the caller graph for this function:



5.3.3.32 bool mqttServerValid (String mqttServer)

This function is used to check whether `mqttServer` is valid. Therefore, it is checked that the.

- length of `mqttServer` is less or equal than `EEPROM_size_MQTT_server`
- all characters are whitelisted (see `isNotWhitelisted()`)

Parameters

in	<i>mqttServer</i>	String to check for validity
----	-------------------	------------------------------

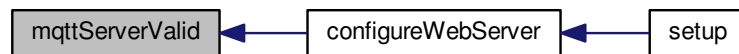
Returns

true, if mqttServer is valid, false otherwise.

Here is the call graph for this function:



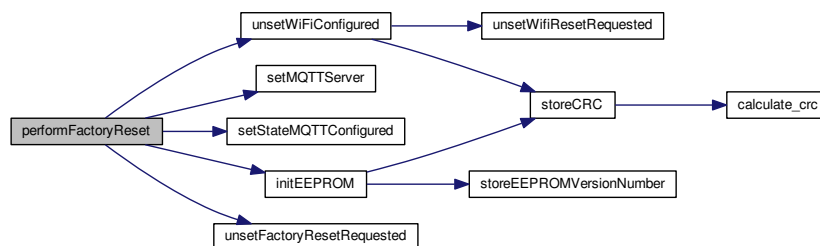
Here is the caller graph for this function:

**5.3.3.33 void performFactoryReset ()**

Perform factory reset.

- reset WiFi
- reset MQTT
- reset EEPROM

Here is the call graph for this function:



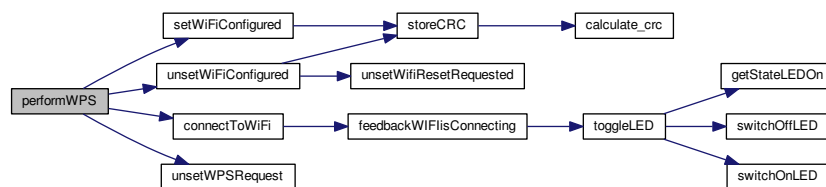
Here is the caller graph for this function:



5.3.3.34 void performWPS ()

This function is used to trigger WPS. If WPS has been successful, [setWiFiConfigured\(\)](#) is executed and [unsetWPSRequest\(\)](#) is called.

Here is the call graph for this function:



Here is the caller graph for this function:



5.3.3.35 void pressHandler ()

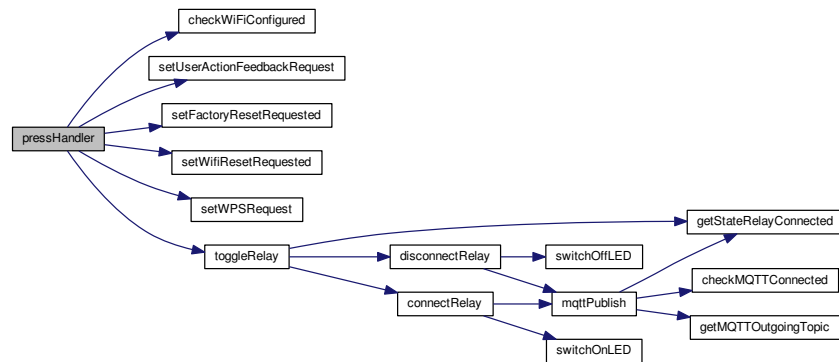
This function triggers.

- the toggling of the relay
- WPS button method request
- factory reset request. As this function is called regularly with [ticker](#), it should be quick, otherwise the ESP8266 might crash.

See Also

<https://arduino-esp8266.readthedocs.io/en/latest/faq/a02-my-esp-crashes.-html>

Here is the call graph for this function:



Here is the caller graph for this function:



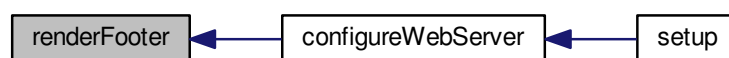
5.3.3.36 String renderFooter ()

This function returns the last part of a HTML file which is reused for all responses.

Returns

"</body></html>", look inside the function for more information.

Here is the caller graph for this function:



5.3.3.37 String renderHeader ()

This function returns the first part of a HTML file which is reused for all responses.

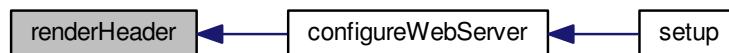
Returns

"<!doctype> ... <body>", look inside the function for more information.

See Also

<http://www.html.am/templates/css-templates/>

Here is the caller graph for this function:



5.3.3.38 String renderMQTTServerSettings (String storedServerName, String failureMsg, bool stateMQTTActivated, bool stateMQTTConnected)

This function returns the middle part of a HTML file to.

- show the settings for the MQTT server
- manipulate the settings for the MQTT server This function could be relevant concerning XSS.

Parameters

in	<i>storedServerName</i>	DNS name or IP address which is displayed on the HTML site
in	<i>failureMsg</i>	message that is displayed to the user in case of success or failure
in	<i>stateMQTTActivated</i>	shows the user, whether MQTT is activated
in	<i>stateMQTTConnected</i>	shows the user, whether MQTT is connected

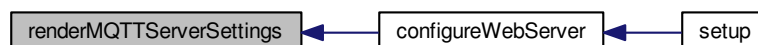
Returns

HTML, look inside the function for more information.

See Also

[https://www.owasp.org/index.php/XSS_\(Cross_Site_Scripting\)_Prevention_-_Cheat_Sheet](https://www.owasp.org/index.php/XSS_(Cross_Site_Scripting)_Prevention_-_Cheat_Sheet)

Here is the caller graph for this function:



5.3.3.39 String renderRelay (bool *stateRelayConnected*)

This function returns the middle part of a HTML file to.

- show the state of the relay (disconnected - off / connected - on).
- manipulate the state of the relay.

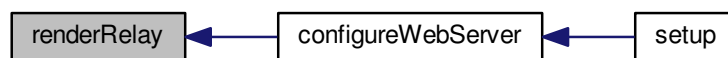
Parameters

in	<i>stateRelay-Connected</i>	if true, the relay is displayed as on, otherwise as off
----	-----------------------------	---

Returns

HTML, look inside the function for more information.

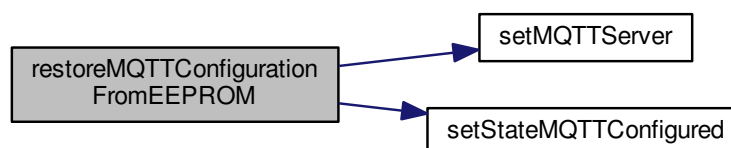
Here is the caller graph for this function:



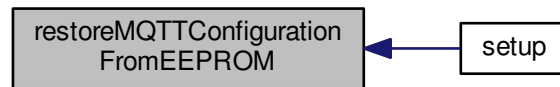
5.3.3.40 void restoreMQTTConfigurationFromEEPROM ()

Read back MQTT server / broker name from EEPROM and store it in global variable [mqttServer](#). Read back whether MQTT is configured and store it in global variable [stateMQTTConfigured](#).

Here is the call graph for this function:



Here is the caller graph for this function:



5.3.3.41 unsigned long retrieveCRC ()

This function reads the CRC value stored at [EEPROM_address_CRC](#).

Returns

CRC value from EEPROM

Here is the caller graph for this function:



5.3.3.42 void saveMQTTConfigurationToEEPROM ()

Store MQTT server / broker name ([mqttServer](#)) and state (configured or not, [stateMQTTConfigured](#)) in EEPROM.

Here is the call graph for this function:



Here is the caller graph for this function:



5.3.3.43 void setFactoryResetRequested ()

Setter function to set [factoryResetRequested](#).

Here is the caller graph for this function:



5.3.3.44 void setMQTTIncomingTopic (String input)

Setter function for [mqttIncomingTopic](#).

Parameters

<code>in</code>	<code>input</code>	String to be set
-----------------	--------------------	------------------

Here is the caller graph for this function:



5.3.3.45 void setMQTTOutgoingTopic (String input)

Setter function for [mqttOutgoingTopic](#).

Parameters

<code>in</code>	<code>input</code>	String to be set
-----------------	--------------------	------------------

Here is the caller graph for this function:



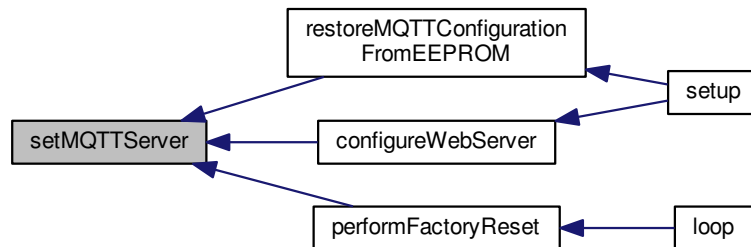
5.3.3.46 void setMQTTServer (String *input*)

Setter function for MQTT server / broker [mqttServer](#).

Parameters

in	input	MQTT server / broker
----	-------	----------------------

Here is the caller graph for this function:



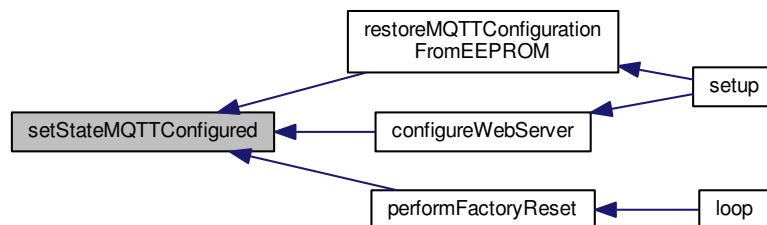
5.3.3.47 void setStateMQTTConfigured (bool input)

Setter function for [stateMQTTConfigured](#).

Parameters

in	input	true if MQTT is configured, false otherwise
----	-------	---

Here is the caller graph for this function:



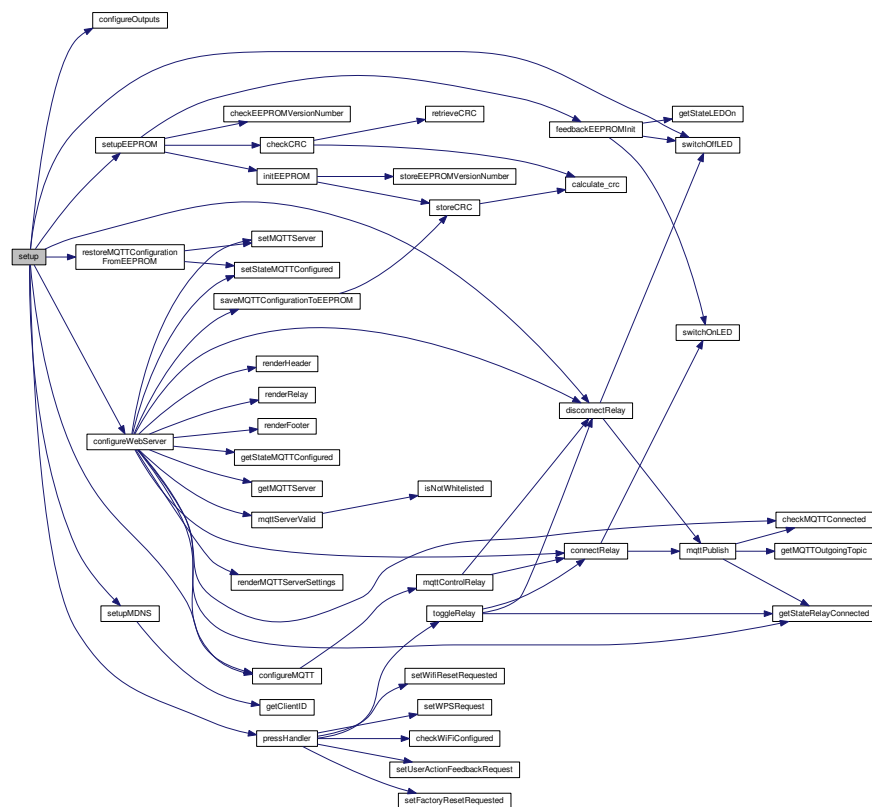
5.3.3.48 void setup (void)

This function is executed once at the startup of the microcontroller.

- The serial communication is setup with 115200 bauds. It is usefull for debugging or just information.
- The output pins are configured.
- The EEPROM is setup.
- The MQTT configuration is restored from EEPROM.
- MQTT is configured.

- The webservice is configured.
- MDNS is set up.
- The LED is switched off.
- The relay is disconnected. This is thought to be the natural experience, if you plug in a socket.
- The button handler is started.

Here is the call graph for this function:



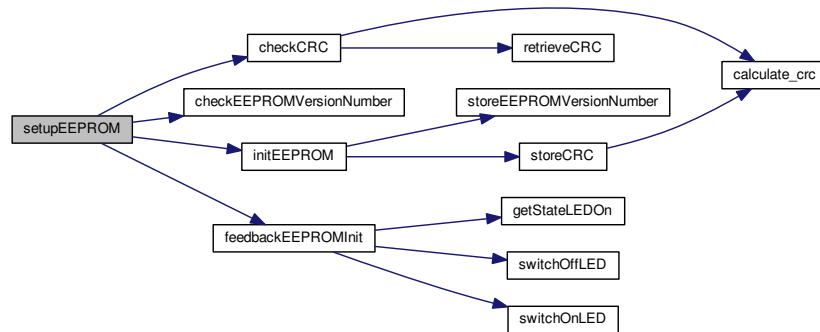
5.3.3.49 void setupEEPROM ()

This function is setting up the EEPROM. If the CRC check fails, the EEPROM will be overwritten with init values. The CRC check makes only sense at initialization phase. Afterwards, the data is buffered by EEPROM lib in RAM.

See Also

<https://git.io/vxOPf>

Here is the call graph for this function:



Here is the caller graph for this function:



5.3.3.50 void setupMDNS ()

This function sets up MDNS.

Here is the call graph for this function:



Here is the caller graph for this function:



5.3.3.51 `bool setUserActionFeedbackRequest ()`

Setter function for [userActionFeedbackRequest](#). The user should be notified that a menu can be selected.

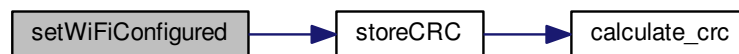
Here is the caller graph for this function:



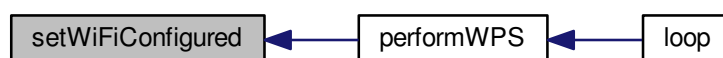
5.3.3.52 `void setWiFiConfigured ()`

This function is a setter function which sets WiFi to configured, which means that WPS has already been performed successfully. This function is only called in [performWPS\(\)](#). The configuration is saved to EEPROM.

Here is the call graph for this function:



Here is the caller graph for this function:



5.3.3.53 void setWifiResetRequested ()

Setter function to set [wifiResetRequested](#).

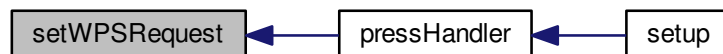
Here is the caller graph for this function:



5.3.3.54 void setWPSRequest ()

Setter function to set [wpsRequested](#).

Here is the caller graph for this function:



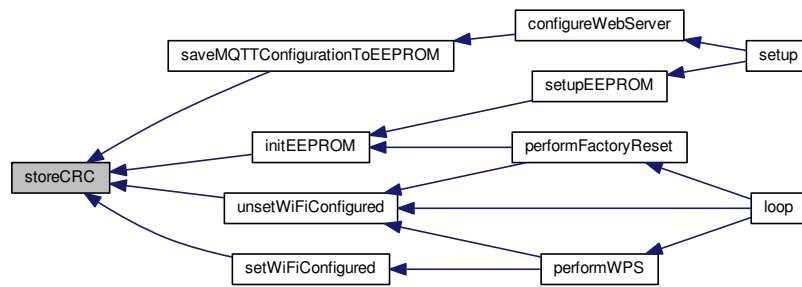
5.3.3.55 void storeCRC ()

This function calculates the CRC value of the values in the EEPROM with the help of function [calculate_crc\(\)](#). The resulting CRC checksum is written to [EEPROM_address_CRC](#). The caller must still call `EEPROM.commit()` afterwards to really trigger a write to EEPROM.

Here is the call graph for this function:



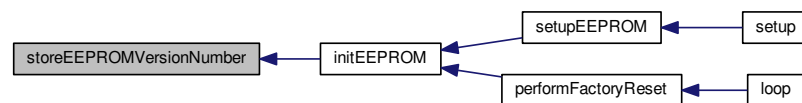
Here is the caller graph for this function:



5.3.3.56 void storeEEPROMVersionNumber ()

This function stores the `EEPROM_version_number` in EEPROM.

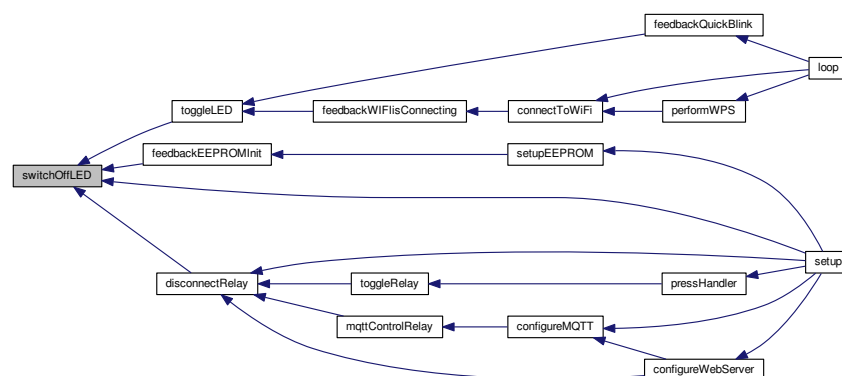
Here is the caller graph for this function:



5.3.3.57 void switchOffLED ()

This function is used to switch the LED off. It keeps track of the internal state `stateLEDOn`.

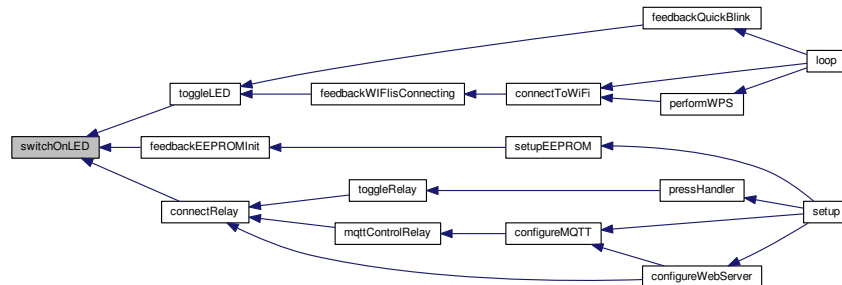
Here is the caller graph for this function:



5.3.3.58 void switchOnLED ()

This function is used to switch the LED on. It keeps track of the internal state [stateLEDOn](#).

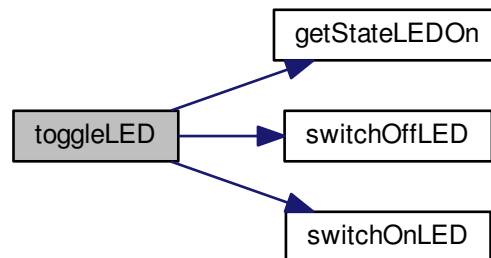
Here is the caller graph for this function:



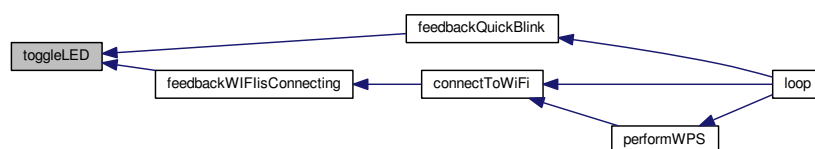
5.3.3.59 void toggleLED ()

This function is used to toggle the LED. Indirectly, it keeps track of the internal state [stateLEDOn](#).

Here is the call graph for this function:



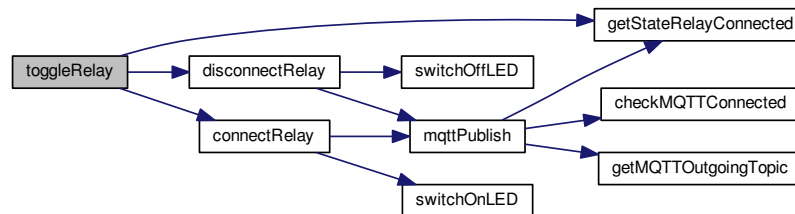
Here is the caller graph for this function:



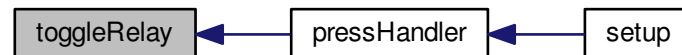
5.3.3.60 void toggleRelay ()

This function is used to toggle the connection of the relay with the mains. Indirectly, it keeps track of the internal state [stateRelayConnected](#).

Here is the call graph for this function:



Here is the caller graph for this function:



5.3.3.61 void unsetFactoryResetRequested ()

Setter function to unset [factoryResetRequested](#).

Here is the caller graph for this function:



5.3.3.62 bool unsetUserActionFeedbackRequest ()

Setter function for [userActionFeedbackRequest](#). The user has been notified that a menu can be selected.

Here is the caller graph for this function:



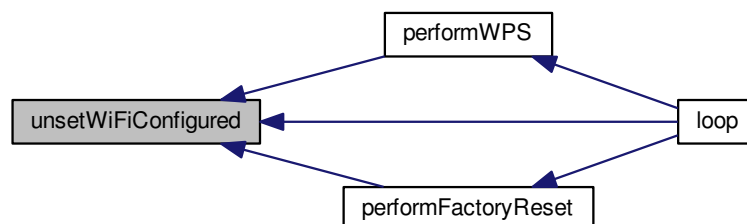
5.3.3.63 void unsetWiFiConfigured ()

This function is a setter function which sets WiFi to not configured, which means that WPS is necessary before connecting to WIFI. The configuration is saved to EEPROM.

Here is the call graph for this function:



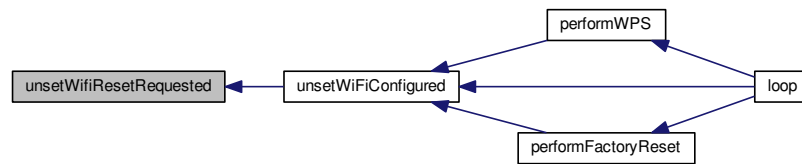
Here is the caller graph for this function:



5.3.3.64 void unsetWifiResetRequested ()

Setter function to unset [wifiResetRequested](#).

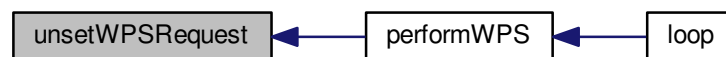
Here is the caller graph for this function:



5.3.3.65 void unsetWPSRequest ()

Setter function to unset `wpsRequested`.

Here is the caller graph for this function:



5.3.4 Variable Documentation

5.3.4.1 bool buttonLastPressed = false

State to track whether the button was pressed since `pressHandler()` was called the last time.

5.3.4.2 const int buttonPin = 0

Constant to map the hardware button of the Sonoff S20.

5.3.4.3 bool factoryResetRequested = false

State to track whether a factory reset has been requested.

5.3.4.4 MQTTClient mqttClient

central object to manage MQTT

See Also

MQTT protocol <http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-1-os.pdf>

5.3.4.5 String mqttIncomingTopic

The topic which `mqttClient` subscribes.

5.3.4.6 String mqttOutgoingTopic

The topic `mqttClient` publishes.

5.3.4.7 String mqttServer = ""

Global variable to store the DNS name or IP address of the MQTT broker.

5.3.4.8 const int pinLED = 13

Constant to map the green LED of the Sonoff S20.

5.3.4.9 const int pinRelay = 12

Constant to map the relay of the Sonoff S20.

5.3.4.10 String REPOSITORY_URL_STRING = "https://github.com/peastone/WIFIOff"

Contains a link to the code repository which is embedded in the rendered HTML files in the function `renderFooter()`.

5.3.4.11 unsigned long selectionState = 0

State to track which menu the user selects, if the button is released.

5.3.4.12 bool stateLEDOn = false

State to track whether the LED is on.

5.3.4.13 bool stateMQTTConfigured = false

State to track whether MQTT is configured.

5.3.4.14 bool stateRelayConnected = false

State to track whether the LED is connected to the mains.

5.3.4.15 Ticker ticker

This object is used to trigger the function `press` frequently. The button handler is implemented there.

5.3.4.16 unsigned long timeSincebuttonPressed = 0

State to track the time since the button was pressed.

5.3.4.17 bool userActionFeedbackRequest = false

State to track whether the user should be notified that a menu can be selected by releasing the button.

5.3.4.18 ESP8266WebServer webserver

This is the webserver object. It is used to serve the user interface over HTTP. Per default, port 80 is used.

5.3.4.19 WiFiClient wifiClient

Necessary to initialize a MQTTClient object.

5.3.4.20 bool wifiResetRequested = false

State to track whether the deletion of WIFI data has been requested.

5.3.4.21 bool wpsRequested = false

State to track whether the WPS has been requested.

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