ESP32 RFID Cloner using MFRC522 and BLE

Generated by Doxygen 1.9.7

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Chapter 4

Module Documentation

4.1 MFRC522 Register Addresses

Macros

- #define **MFRC522_REG_RESERVED00** 0x00 << 1
- #define **MFRC522_REG_COMMAND** 0x01 << 1
- #define **MFRC522_REG_COMIEN** 0x02 << 1
- #define **MFRC522_REG_DIVIEN** 0x03 << 1
- #define **MFRC522_REG_COMIRQ** 0x04 << 1
- #define **MFRC522_REG_DIVIRQ** 0x05 << 1
- #define **MFRC522_REG_ERROR** 0x06 << 1
- #define **MFRC522_REG_STATUS1** 0x07 << 1
- #define **MFRC522_REG_STATUS2** 0x08 << 1
- #define **MFRC522_REG_FIFO_DATA** 0x09 << 1
- #define **MFRC522_REG_FIFO_LEVEL** 0x0A << 1
- #define **MFRC522_REG_WATER_LEVEL** 0x0B << 1
- #define **MFRC522_REG_CONTROL** 0x0C << 1
- #define **MFRC522_REG_BIT_FRAMING** 0x0D << 1
- #define **MFRC522_REG_COLL** 0x0E << 1
- #define **MFRC522_REG_RESERVED01** 0x0F << 1
- #define **MFRC522_REG_RESERVED10** 0x10 << 1
- #define **MFRC522_REG_MODE** 0x11 << 1
- #define **MFRC522_REG_TX_MODE** 0x12 << 1
- #define **MFRC522_REG_RX_MODE** 0x13 << 1
- #define **MFRC522_REG_TX_CONTROL** 0x14 << 1
- #define **MFRC522_REG_TX_AUTO** 0x15 << 1
- #define **MFRC522_REG_TX_SEL** 0x16 << 1
- #define **MFRC522_REG_RX_SEL** 0x17 << 1
- #define **MFRC522_REG_RX_THRESHOLD** 0x18 << 1
- #define **MFRC522_REG_DEMOD** 0x19 << 1
- #define **MFRC522_REG_RESERVED11** 0x1A << 1
- #define **MFRC522_REG_RESERVED12** 0x1B << 1
- #define **MFRC522_REG_MIFARE** 0x1C << 1
- #define **MFRC522_REG_RESERVED13** 0x1D << 1
- #define **MFRC522_REG_RESERVED14** 0x1E << 1
- #define **MFRC522_REG_SERIALSPEED** 0x1F << 1
- #define **MFRC522_REG_RESERVED20** 0x20 << 1

- #define **MFRC522_REG_CRC_RESULT_M** 0x21 << 1
- #define **MFRC522_REG_CRC_RESULT_L** 0x22 << 1
- #define **MFRC522_REG_RESERVED21** 0x23 << 1
- #define **MFRC522_REG_MOD_WIDTH** 0x24 << 1
- #define **MFRC522_REG_RESERVED22** 0x25 << 1
- #define **MFRC522_REG_RF_CFG** 0x26 << 1
- #define **MFRC522_REG_GS_N** 0x27 << 1
- #define **MFRC522_REG_CWGS_PREG** 0x28 << 1
- #define **MFRC522_REG_MOD_GS_PREG** 0x29 << 1
- #define **MFRC522_REG_T_MODE** 0x2A << 1
- #define **MFRC522_REG_T_PRESCALER** 0x2B << 1
- #define **MFRC522_REG_T_RELOAD_H** 0x2C << 1
- #define **MFRC522_REG_T_RELOAD_L** 0x2D << 1
- #define **MFRC522_REG_T_COUNTER_VALUE_H** 0x2E << 1
- #define **MFRC522_REG_T_COUNTER_VALUE_L** 0x2F << 1
- #define **MFRC522_REG_RESERVED30** 0x30 << 1
- #define **MFRC522_REG_TEST_SEL1** 0x31 << 1
- #define **MFRC522_REG_TEST_SEL2** 0x32 << 1
- #define **MFRC522_REG_TEST_PIN_EN** 0x33 << 1
- #define **MFRC522_REG_TEST_PIN_VALUE** 0x34 << 1
- #define **MFRC522_REG_TEST_BUS** 0x35 << 1
- #define **MFRC522_REG_AUTO_TEST** 0x36 << 1
- #define **MFRC522_REG_VERSION** 0x37 << 1
- #define **MFRC522_REG_ANALOG_TEST** 0x38 << 1
- #define **MFRC522_REG_TEST_DAC1** 0x39 << 1
- #define **MFRC522_REG_TEST_DAC2** 0x3A << 1
- #define **MFRC522_REG_TEST_ADC** 0x3B << 1
- #define **MFRC522_REG_RESERVED31** 0x3C << 1
- #define **MFRC522_REG_RESERVED32** 0x3D << 1
- #define **MFRC522_REG_RESERVED33** 0x3E << 1
- #define **MFRC522_REG_RESERVED34** 0x3F << 1

4.1.1 Detailed Description

4.2 MFRC522 Commands

Macros

- #define **PCD_CMD_IDLE** 0x00
- #define **PCD_CMD_MEM** 0x01
- #define **PCD_CMD_GEN_RANDOM_ID** 0x02
- #define **PCD_CMD_CALC_CRC** 0x03
- #define **PCD_CMD_TRANSMIT** 0x04
- #define **PCD_CMD_NO_CMD_CHANGE** 0x07
- #define **PCD_CMD_RECEIVE** 0x08
- #define **PCD_CMD_TRANSCEIVE** 0x0C
- #define **PCD_CMD_MF_AUTHENT** 0x0E
- #define **PCD_CMD_SOFT_RESET** 0x0F

Enumerations

- enum **piccCmds_t** {
  PICC_CMD_REQA = 0x26 , **PICC_CMD_WUPA** = 0x52 , **PICC_CMD_CT** = 0x88 , **PICC_CMD_SEL_CL1** = 0x93 ,
  PICC_CMD_SEL_CL2 = 0x95 , **PICC_CMD_SEL_CL3** = 0x97 , **PICC_CMD_HLTA** = 0x50 , **PICC_CMD_RATS** = 0xE0 ,
  PICC_CMD_MF_AUTH_KEY_A = 0x60 , **PICC_CMD_MF_AUTH_KEY_B** = 0x61 , **PICC_CMD_MF_READ** = 0x30 , **PICC_CMD_MF_WRITE** = 0xA0 ,
  PICC_CMD_MF_DECREMENT = 0xC0 , **PICC_CMD_MF_INCREMENT** = 0xC1 , **PICC_CMD_MF_RESTORE** = 0xC2 , **PICC_CMD_MF_TRANSFER** = 0xB0 ,
  PICC_CMD_UL_WRITE = 0xA2 , **MFRC522_MIFARE_ACK** = 0x0A }

4.2.1 Detailed Description

Chapter 5

Class Documentation

5.1 gatts_profile_inst Struct Reference

Public Attributes

- esp_gatts_cb_t **gatts_cb**
- uint16_t **gatts_if**
- uint16_t **app_id**
- uint16_t **conn_id**
- uint16_t **service_handle**
- esp_gatt_srvc_id_t **service_id**
- uint16_t **char_handle**
- esp_bt_uuid_t **char_uuid**
- esp_gatt_perm_t **perm**
- esp_gatt_char_prop_t **property**
- uint16_t **descr_handle**
- esp_bt_uuid_t **descr_uuid**

The documentation for this struct was generated from the following file:

- Sources/bluetooth_contr/BLE_Controller.h

5.2 Mifare1kKey_t Struct Reference

Public Attributes

- UniqueIdentifier_t uid
- uint8_t blockKey [6]
- uint8_t keyData [16][64]

5.2.1 Member Data Documentation

5.2.1.1 blockKey

```
uint8_t Mifare1kKey_t::blockKey[6]
```

Block key.

5.2.1.2 keyData

```
uint8_t Mifare1kKey_t::keyData[16][64]
```

Key data for 1k card (1024 bytes).

5.2.1.3 uid

```
UniqueIdentifier_t Mifare1kKey_t::uid
```

7 byte uid, the default

The documentation for this struct was generated from the following file:

- Sources/drivers/MFRC522.h

5.3 prepare_type_env_t Struct Reference

Public Attributes

- uint8_t ∗ **prepare_buf**
- int **prepare_len**

The documentation for this struct was generated from the following file:

- Sources/bluetooth_contr/BLE_Controller.h

5.4 UniqueIdentifier_t Struct Reference

Public Attributes

- uidSize_t uidSize
- union {
  singleSizeUID_t singleSizeUidData
  doubleSizeUID_t doubleSizeUidData
  trippleSizeUID_t trippleSizeUidData
  } **uidData**
- uint8_t sakByte
- uint8_t bccByte

5.4.1 Member Data Documentation

5.4.1.1 bccByte

```
uint8_t UniqueIdentifier_t::bccByte
```

BCC byte.

5.4.1.2 doubleSizeUidData

```
doubleSizeUID_t UniqueIdentifier_t::doubleSizeUidData
```

Data for a double size UID.

5.4.1.3 sakByte

```
uint8_t UniqueIdentifier_t::sakByte
```

The SAK (Select acknowledge) byte returned from the PICC after successful selection.

5.4.1.4 singleSizeUidData

```
singleSizeUID_t UniqueIdentifier_t::singleSizeUidData
```

Data for a single size UID.

5.4.1.5 trippleSizeUidData

```
trippleSizeUID_t UniqueIdentifier_t::trippleSizeUidData
```

Data for a triple size UID.

5.4.1.6 uidSize

```
uidSize_t UniqueIdentifier_t::uidSize
```

The size of the UID.

The documentation for this struct was generated from the following file:

- Sources/drivers/MFRC522.h

Chapter 6

File Documentation

6.1 BLE_Controller.h

```
/******************************************************************************
* File Name: ESP 32 BLE Driver
* Author: Jaime Malone
* File Description:
*
*
*
*****************************************************************************/

#ifndef BLE_CONTROLLER_H
#define BLE_CONTROLLER_H

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <inttypes.h>
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"
#include "freertos/event_groups.h"
#include "esp_system.h"
#include "esp_log.h"
#include "nvs_flash.h"

#include "C:\Espressif\frameworks\esp-idf-v5.0.2\components\bt\include\esp32\include\esp_bt.h"
#include "C:\Espressif\frameworks\esp-idf-v5.0.2\components\bt\host\bluedroid\api\include\api\esp_gap_ble_api.h"
#include "C:\Espressif\frameworks\esp-idf-v5.0.2\components\bt\host\bluedroid\api\include\api\esp_gatts_api.h"
#include "C:\Espressif\frameworks\esp-idf-v5.0.2\components\bt\host\bluedroid\api\include\api\esp_bt_defs.h"
#include "C:\Espressif\frameworks\esp-idf-v5.0.2\components\bt\host\bluedroid\api\include\api\esp_bt_main.h"
#include "C:\Espressif\frameworks\esp-idf-v5.0.2\components\bt\host\bluedroid\api\include\api\esp_gatt_common_api.h"

#include "sdkconfig.h"

typedef struct {
    uint8_t                 *prepare_buf;
    int                     prepare_len;
} prepare_type_env_t;

struct gatts_profile_inst {
    esp_gatts_cb_t gatts_cb;
    uint16_t gatts_if;
    uint16_t app_id;
    uint16_t conn_id;
    uint16_t service_handle;
    esp_gatt_srvc_id_t service_id;
    uint16_t char_handle;
    esp_bt_uuid_t char_uuid;
    esp_gatt_perm_t perm;
    esp_gatt_char_prop_t property;
    uint16_t descr_handle;
    esp_bt_uuid_t descr_uuid;
};

```

```
void example_write_event_env(esp_gatt_if_t gatts_if, prepare_type_env_t *prepare_write_env, esp_ble_gatts_cb_param_t *param);

void example_exec_write_event_env(prepare_type_env_t *prepare_write_env, esp_ble_gatts_cb_param_t *param);

static void gap_event_handler(esp_gap_ble_cb_event_t event, esp_ble_gap_cb_param_t *param);

void example_write_event_env(esp_gatt_if_t gatts_if, prepare_type_env_t *prepare_write_env, esp_ble_gatts_cb_param_t *param);

void example_exec_write_event_env(prepare_type_env_t *prepare_write_env, esp_ble_gatts_cb_param_t *param);

static void gatts_profile_a_event_handler(esp_gatts_cb_event_t event, esp_gatt_if_t gatts_if, esp_ble_gatts_cb_param_t *param);

static void gatts_event_handler(esp_gatts_cb_event_t event, esp_gatt_if_t gatts_if, esp_ble_gatts_cb_param_t *param);

void BLE_init(void);

#endif /* BLE_CONTROLLER_H */
```

6.2 Sources/drivers/MFRC522.h File Reference

MFRC522 RFID Module.

```
#include ¨../unit_tests/unit_tests.h¨
#include ¨driver/spi_master.h¨
#include ¨esp_timer.h¨
#include <freertos/FreeRTOS.h>
#include <freertos/task.h>
#include <driver/gpio.h>
#include <stdlib.h>
#include <string.h>
#include <time.h>
#include <assert.h>
```

Classes

- struct UniqueIdentifier_t
- struct Mifare1kKey_t

Macros

- #define NUM_SECTORE_MIFARE_1K 16
- #define NUM_BLOCKS_PER_SECTOR 4
- #define MIFARE_KEY_SIZE 6
- #define **MFRC522_REG_RESERVED00** 0x00 << 1
- #define **MFRC522_REG_COMMAND** 0x01 << 1
- #define **MFRC522_REG_COMIEN** 0x02 << 1
- #define **MFRC522_REG_DIVIEN** 0x03 << 1
- #define **MFRC522_REG_COMIRQ** 0x04 << 1
- #define **MFRC522_REG_DIVIRQ** 0x05 << 1
- #define **MFRC522_REG_ERROR** 0x06 << 1
- #define **MFRC522_REG_STATUS1** 0x07 << 1
- #define **MFRC522_REG_STATUS2** 0x08 << 1
- #define **MFRC522_REG_FIFO_DATA** 0x09 << 1

- #define **MFRC522_REG_FIFO_LEVEL** 0x0A << 1
- #define **MFRC522_REG_WATER_LEVEL** 0x0B << 1
- #define **MFRC522_REG_CONTROL** 0x0C << 1
- #define **MFRC522_REG_BIT_FRAMING** 0x0D << 1
- #define **MFRC522_REG_COLL** 0x0E << 1
- #define **MFRC522_REG_RESERVED01** 0x0F << 1
- #define **MFRC522_REG_RESERVED10** 0x10 << 1
- #define **MFRC522_REG_MODE** 0x11 << 1
- #define **MFRC522_REG_TX_MODE** 0x12 << 1
- #define **MFRC522_REG_RX_MODE** 0x13 << 1
- #define **MFRC522_REG_TX_CONTROL** 0x14 << 1
- #define **MFRC522_REG_TX_AUTO** 0x15 << 1
- #define **MFRC522_REG_TX_SEL** 0x16 << 1
- #define **MFRC522_REG_RX_SEL** 0x17 << 1
- #define **MFRC522_REG_RX_THRESHOLD** 0x18 << 1
- #define **MFRC522_REG_DEMOD** 0x19 << 1
- #define **MFRC522_REG_RESERVED11** 0x1A << 1
- #define **MFRC522_REG_RESERVED12** 0x1B << 1
- #define **MFRC522_REG_MIFARE** 0x1C << 1
- #define **MFRC522_REG_RESERVED13** 0x1D << 1
- #define **MFRC522_REG_RESERVED14** 0x1E << 1
- #define **MFRC522_REG_SERIALSPEED** 0x1F << 1
- #define **MFRC522_REG_RESERVED20** 0x20 << 1
- #define **MFRC522_REG_CRC_RESULT_M** 0x21 << 1
- #define **MFRC522_REG_CRC_RESULT_L** 0x22 << 1
- #define **MFRC522_REG_RESERVED21** 0x23 << 1
- #define **MFRC522_REG_MOD_WIDTH** 0x24 << 1
- #define **MFRC522_REG_RESERVED22** 0x25 << 1
- #define **MFRC522_REG_RF_CFG** 0x26 << 1
- #define **MFRC522_REG_GS_N** 0x27 << 1
- #define **MFRC522_REG_CWGS_PREG** 0x28 << 1
- #define **MFRC522_REG_MOD_GS_PREG** 0x29 << 1
- #define **MFRC522_REG_T_MODE** 0x2A << 1
- #define **MFRC522_REG_T_PRESCALER** 0x2B << 1
- #define **MFRC522_REG_T_RELOAD_H** 0x2C << 1
- #define **MFRC522_REG_T_RELOAD_L** 0x2D << 1
- #define **MFRC522_REG_T_COUNTER_VALUE_H** 0x2E << 1
- #define **MFRC522_REG_T_COUNTER_VALUE_L** 0x2F << 1
- #define **MFRC522_REG_RESERVED30** 0x30 << 1
- #define **MFRC522_REG_TEST_SEL1** 0x31 << 1
- #define **MFRC522_REG_TEST_SEL2** 0x32 << 1
- #define **MFRC522_REG_TEST_PIN_EN** 0x33 << 1
- #define **MFRC522_REG_TEST_PIN_VALUE** 0x34 << 1
- #define **MFRC522_REG_TEST_BUS** 0x35 << 1
- #define **MFRC522_REG_AUTO_TEST** 0x36 << 1
- #define **MFRC522_REG_VERSION** 0x37 << 1
- #define **MFRC522_REG_ANALOG_TEST** 0x38 << 1
- #define **MFRC522_REG_TEST_DAC1** 0x39 << 1
- #define **MFRC522_REG_TEST_DAC2** 0x3A << 1
- #define **MFRC522_REG_TEST_ADC** 0x3B << 1
- #define **MFRC522_REG_RESERVED31** 0x3C << 1
- #define **MFRC522_REG_RESERVED32** 0x3D << 1
- #define **MFRC522_REG_RESERVED33** 0x3E << 1
- #define **MFRC522_REG_RESERVED34** 0x3F << 1
- #define **PCD_CMD_IDLE** 0x00

- #define **PCD_CMD_MEM** 0x01
- #define **PCD_CMD_GEN_RANDOM_ID** 0x02
- #define **PCD_CMD_CALC_CRC** 0x03
- #define **PCD_CMD_TRANSMIT** 0x04
- #define **PCD_CMD_NO_CMD_CHANGE** 0x07
- #define **PCD_CMD_RECEIVE** 0x08
- #define **PCD_CMD_TRANSCEIVE** 0x0C
- #define **PCD_CMD_MF_AUTHENT** 0x0E
- #define **PCD_CMD_SOFT_RESET** 0x0F

Typedefs

- typedef uint8_t **singleSizeUID_t**[4]

  Typedef for single size UID. It consists of 4 bytes.
- typedef uint8_t **doubleSizeUID_t**[7]

  Typedef for double size UID. It consists of 7 bytes.
- typedef uint8_t **trippleSizeUID_t**[10]

  Typedef for triple size UID. It consists of 10 bytes.

Enumerations

- enum bitFraming_t { sevenBit = 0x07 , eightBit = 0x08 }

  Enum typedef for bit framing. It can either be sevenBit or eightBit.
- enum uidSize_t { fourBytesSingle = 4 , sevenBytesDouble = 7 , tenBytesTripple = 10 }

  Enum typedef for UID size. It can be either fourBytesSingle, sevenBytesDouble or tenBytesTripple.
- enum **piccCmds_t** {
  PICC_CMD_REQA = 0x26 , **PICC_CMD_WUPA** = 0x52 , **PICC_CMD_CT** = 0x88 , **PICC_CMD_SEL_CL1** = 0x93 ,
  PICC_CMD_SEL_CL2 = 0x95 , **PICC_CMD_SEL_CL3** = 0x97 , **PICC_CMD_HLTA** = 0x50 , **PICC_CMD_RATS** = 0xE0 ,
  PICC_CMD_MF_AUTH_KEY_A = 0x60 , **PICC_CMD_MF_AUTH_KEY_B** = 0x61 , **PICC_CMD_MF_READ** = 0x30 , **PICC_CMD_MF_WRITE** = 0xA0 ,
  PICC_CMD_MF_DECREMENT = 0xC0 , **PICC_CMD_MF_INCREMENT** = 0xC1 , **PICC_CMD_MF_RESTORE** = 0xC2 , **PICC_CMD_MF_TRANSFER** = 0xB0 ,
  PICC_CMD_UL_WRITE = 0xA2 , **MFRC522_MIFARE_ACK** = 0x0A }

Functions

- esp_err_t xMFRC522_WriteRegister (spi_device_handle_t ∗spiHandle, uint8_t registerAddress, uint8_t value)

  Writes a value to the specified register in the MFRC522.
- esp_err_t xMFRC522_ReadRegister (spi_device_handle_t ∗spiHandle, uint8_t registerAddress, uint8_t ∗data)

  Reads the value from the specified register in the MFRC522.
- esp_err_t xMFRC522_ReadRegisterArr (spi_device_handle_t ∗spiHandle, uint8_t registerAddress, uint8_t ∗dataArr, uint8_t dataSize)

  Reads multiple consecutive registers in the MFRC522.
- esp_err_t xMFRC522_WriteRegisterArr (spi_device_handle_t ∗spiHandle, uint8_t registerAddress, uint8_t ∗dataArr, uint8_t dataSize)

  Writes multiple consecutive registers in the MFRC522.
- esp_err_t xMFRC522_Init (spi_device_handle_t ∗spiHandle, uint8_t rstPin)

Initializes the MFRC522 RFID module.

- esp_err_t xMFRC522_ClrRegBitMask (spi_device_handle_t ∗spiHandle, uint8_t registerAdress, uint8_↩ t mask)

  Clears the specified bits in the register of the MFRC522.
- bool xMFRC522_IsCardPresent (spi_device_handle_t ∗spiHandle)

  Checks if a card is present.
- esp_err_t xMFRC522_AntennaOn (spi_device_handle_t ∗spiHandle)

  Turns on the antenna of the MFRC522.
- esp_err_t xMFRC522_SelfTest (spi_device_handle_t ∗spiHandle, uint8_t rstPin)

  Performs a self-test of the MFRC522.
- esp_err_t xMFRC522_Reset (spi_device_handle_t ∗spiHandle)

  Resets the MFRC522.
- esp_err_t xMFRC522_Transcieve (spi_device_handle_t ∗spiHandle, uint8_t waitIrq, uint8_t ∗cmdBuf, uint8↩ _t bufSize, bitFraming_t bitFrame)

  Transmits data to the MFRC522 and receives the response.
- esp_err_t xMFRC522_MF_Authent (spi_device_handle_t ∗spiHandle, uint8_t waitIrq, uint8_t ∗cmdBuf, uint8_t bufSize, bitFraming_t bitFrame)

  Performs MIFARE authentication with the MFRC522.
- esp_err_t xMFRC522_CommWithMifare (uint8_t cmd, spi_device_handle_t ∗spiHandle, uint8_t waitIrq, uint8_t ∗cmdBuf, uint8_t bufSize, bitFraming_t bitFrame)

  Performs communication with a MIFARE card using the MFRC522.
- esp_err_t xMFRC522_SetRegBitMask (spi_device_handle_t ∗spiHandle, uint8_t registerAddress, uint8_↩ t mask)

  Sets the specified bits in the register of the MFRC522.
- esp_err_t xMFRC522_CalculateCRC (spi_device_handle_t ∗spiHandle, uint8_t ∗buf, uint8_t bufLen, uint8_t resultBuf[2])

  Calculates the CRC value for the given buffer.
- UniqueIdentifier_t ∗ xMifare_ReadUID (spi_device_handle_t ∗spiHandle, uidSize_t uidSize)

  Reads the UID from the MFRC522 for the specified UID size.
- Mifare1kKey_t ∗ xMifare_GetKeyData (spi_device_handle_t ∗spiHandle, UniqueIdentifier_t ∗UID)

  Retrieves the key data for the specified UID from the MFRC522.
- esp_err_t xMifare_WriteKey (spi_device_handle_t ∗spiHandle, UniqueIdentifier_t ∗UID, uint8_t data[45][16])

  Writes the provided key data to the specified UID in the MFRC522.
- esp_err_t xMifare_WriteKeyBlock (spi_device_handle_t ∗spiHandle, uint8_t blockAddress, UniqueIdentifier_t ∗UID, uint8_t data[16])

  Writes the provided data to the specified block address for the specified UID in the MFRC522.
- esp_err_t xMifare_ReadKeyBlock (spi_device_handle_t ∗spiHandle, uint8_t blockAddress, UniqueIdentifier_t ∗UID)

  Reads the key block at the specified block address for the specified UID in the MFRC522.
- esp_err_t xMifare_Authenticate (spi_device_handle_t ∗spiHandle, uint8_t cmd, uint8_t blockAddress, uint8↩ _t ∗key, UniqueIdentifier_t ∗UID)

  Performs MIFARE authentication for the specified block address and key with the MFRC522.
- void vMifare_PrintUID (UniqueIdentifier_t ∗UID)

  Prints the UID information to the console.
- void vMFRC522_GetAndPrintFifoBuf (spi_device_handle_t ∗spiHandle, uint8_t ∗fifoBuf, bool print)

  Retrieves and prints the FIFO buffer data from the MFRC522.
- void vMifare_PrintKey (Mifare1kKey_t ∗key)

  Prints the key data to the console.

6.2.1 Detailed Description

MFRC522 RFID Module.

Author

Jack Lukomski

Date

Date: 2023-06-02

This file contains the declarations for the MFRC522 RFID module. It provides functions for initializing, communicating, and authenticating with MIFARE RFID cards using the MFRC522 chip.

6.2.2 Macro Definition Documentation

6.2.2.1 MIFARE_KEY_SIZE

```
#define MIFARE_KEY_SIZE 6
```

Size of MIFARE key.

6.2.2.2 NUM_BLOCKS_PER_SECTOR

```
#define NUM_BLOCKS_PER_SECTOR 4
```

Number of blocks per sector.

6.2.2.3 NUM_SECTORE_MIFARE_1K

```
#define NUM_SECTORE_MIFARE_1K 16
```

Number of sectors in MIFARE 1k.

6.2.3 Enumeration Type Documentation

6.2.3.1 bitFraming_t

```
enum bitFraming_t
```

Enum typedef for bit framing. It can either be sevenBit or eightBit.

Enumerator

sevenBit	7 bit framing
eightBit	8 bit framing

6.2.3.2 uidSize_t

```
enum uidSize_t
```

Enum typedef for UID size. It can be either fourBytesSingle, sevenBytesDouble or tenBytesTripple.

Enumerator

fourBytesSingle	UID of 4 bytes
sevenBytesDouble	UID of 7 bytes
tenBytesTripple	UID of 10 bytes

6.2.4 Function Documentation

6.2.4.1 vMFRC522_GetAndPrintFifoBuf()

```
void vMFRC522_GetAndPrintFifoBuf (
            spi_device_handle_t * spiHandle,
            uint8_t * fifoBuf,
            bool print )
```

Retrieves and prints the FIFO buffer data from the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
fifoBuf	Pointer to the buffer to store the FIFO data.
print	Flag indicating whether to print the FIFO data or not.

6.2.4.2 vMifare_PrintKey()

```
void vMifare_PrintKey (
            Mifare1kKey_t * key )
```

Prints the key data to the console.

Parameters

key	Pointer to the Mifare1kKey_t structure containing the key data.

6.2.4.3 vMifare_PrintUID()

```
void vMifare_PrintUID (
            UniqueIdentifier_t * UID )
```

Prints the UID information to the console.

Parameters

UID	Pointer to the UniqueIdentifier_t structure containing the UID.

6.2.4.4 xMFRC522_AntennaOn()

```
esp_err_t xMFRC522_AntennaOn (
             spi_device_handle_t * spiHandle )
```

Turns on the antenna of the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.5 xMFRC522_CalculateCRC()

```
esp_err_t xMFRC522_CalculateCRC (
             spi_device_handle_t * spiHandle,
             uint8_t * buf,
             uint8_t bufLen,
             uint8_t resultBuf[2] )
```

Calculates the CRC value for the given buffer.

Parameters

spiHandle	Pointer to the SPI device handle.
buf	Pointer to the buffer for which the CRC is to be calculated.
bufLen	Length of the buffer.
resultBuf	Pointer to the buffer to store the calculated CRC value (2 bytes).

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.6 xMFRC522_ClrRegBitMask()

```
esp_err_t xMFRC522_ClrRegBitMask (
             spi_device_handle_t * spiHandle,
             uint8_t registerAdress,
             uint8_t mask )
```

Clears the specified bits in the register of the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
registerAdress	The address of the register to modify.
mask	The bitmask of the bits to clear.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.7 xMFRC522_CommWithMifare()

```
esp_err_t xMFRC522_CommWithMifare (
            uint8_t cmd,
            spi_device_handle_t * spiHandle,
            uint8_t waitIrq,
            uint8_t * cmdBuf,
            uint8_t bufSize,
            bitFraming_t bitFrame )
```

Performs communication with a MIFARE card using the MFRC522.

Parameters

cmd	Command to be sent to the MIFARE card.
spiHandle	Pointer to the SPI device handle.
waitIrq	Wait for the command to complete (1) or not (0).
cmdBuf	Pointer to the command buffer to be transmitted.
bufSize	Size of the command buffer.
bitFrame	The bit framing type.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.8 xMFRC522_Init()

```
esp_err_t xMFRC522_Init (
            spi_device_handle_t * spiHandle,
            uint8_t rstPin )
```

Initializes the MFRC522 RFID module.

Parameters

spiHandle	Pointer to the SPI device handle.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.9 xMFRC522_IsCardPresent()

```
bool xMFRC522_IsCardPresent (
             spi_device_handle_t * spiHandle )
```

Checks if a card is present.

Parameters

spiHandle	Pointer to the SPI device handle.

Returns

True if a card is present, false otherwise.

6.2.4.10 xMFRC522_MF_Authent()

```
esp_err_t xMFRC522_MF_Authent (
             spi_device_handle_t * spiHandle,
             uint8_t waitIrq,
             uint8_t * cmdBuf,
             uint8_t bufSize,
             bitFraming_t bitFrame )
```

Performs MIFARE authentication with the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
waitIrq	Wait for the command to complete (1) or not (0).
cmdBuf	Pointer to the command buffer to be transmitted.
bufSize	Size of the command buffer.
bitFrame	The bit framing type.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.11 xMFRC522_ReadRegister()

```
esp_err_t xMFRC522_ReadRegister (
             spi_device_handle_t * spiHandle,
             uint8_t registerAddress,
             uint8_t * data )
```

Reads the value from the specified register in the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
registerAddress	The address of the register to read.
data	Pointer to store the read value.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.12 xMFRC522_ReadRegisterArr()

```
esp_err_t xMFRC522_ReadRegisterArr (
            spi_device_handle_t * spiHandle,
            uint8_t registerAddress,
            uint8_t * dataArr,
            uint8_t dataSize )
```

Reads multiple consecutive registers in the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
registerAddress	The address of the first register to read.
dataArr	Pointer to the array to store the read values.
dataSize	The number of registers to read.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.13 xMFRC522_Reset()

```
esp_err_t xMFRC522_Reset (
            spi_device_handle_t * spiHandle )
```

Resets the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.14 xMFRC522_SelfTest()

```
esp_err_t xMFRC522_SelfTest (
            spi_device_handle_t * spiHandle,
            uint8_t rstPin )
```

Performs a self-test of the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.15 xMFRC522_SetRegBitMask()

```
esp_err_t xMFRC522_SetRegBitMask (
            spi_device_handle_t * spiHandle,
            uint8_t registerAddress,
            uint8_t mask )
```

Sets the specified bits in the register of the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
registerAddress	The address of the register to modify.
mask	The bitmask of the bits to set.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.16 xMFRC522_Transcieve()

```
esp_err_t xMFRC522_Transcieve (
            spi_device_handle_t * spiHandle,
            uint8_t waitIrq,
            uint8_t * cmdBuf,
            uint8_t bufSize,
            bitFraming_t bitFrame )
```

Transmits data to the MFRC522 and receives the response.

Parameters

spiHandle	Pointer to the SPI device handle.
waitIrq	Wait for the command to complete (1) or not (0).
cmdBuf	Pointer to the command buffer to be transmitted.
bufSize	Size of the command buffer.
bitFrame	The bit framing type.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.17 xMFRC522_WriteRegister()

```
esp_err_t xMFRC522_WriteRegister (
            spi_device_handle_t * spiHandle,
            uint8_t registerAddress,
            uint8_t value )
```

Writes a value to the specified register in the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
registerAddress	The address of the register to write.
value	The value to write to the register.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.18 xMFRC522_WriteRegisterArr()

```
esp_err_t xMFRC522_WriteRegisterArr (
            spi_device_handle_t * spiHandle,
            uint8_t registerAddress,
            uint8_t * dataArr,
            uint8_t dataSize )
```

Writes multiple consecutive registers in the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
registerAddress	The address of the first register to write.
dataArr	Pointer to the array of values to write.
dataSize	The number of registers to write.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.19 xMifare_Authenticate()

```
esp_err_t xMifare_Authenticate (
            spi_device_handle_t * spiHandle,
            uint8_t cmd,
            uint8_t blockAddress,
            uint8_t * key,
            UniqueIdentifier_t * UID )
```

Performs MIFARE authentication for the specified block address and key with the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
cmd	The command for the authentication (PICC_CMD_MF_AUTH_KEY_A or PICC_CMD_MF_AUTH_KEY_B).
blockAddress	The block address to authenticate.
key	The key for authentication.
UID	Pointer to the UniqueIdentifier_t structure containing the UID.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.20 xMifare_GetKeyData()

```
Mifare1kKey_t * xMifare_GetKeyData (
            spi_device_handle_t * spiHandle,
            UniqueIdentifier_t * UID )
```

Retrieves the key data for the specified UID from the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
UID	Pointer to the UniqueIdentifier_t structure containing the UID.

Returns

Pointer to the Mifare1kKey_t structure containing the key data, or NULL on failure.

6.2.4.21 xMifare_ReadKeyBlock()

```
esp_err_t xMifare_ReadKeyBlock (
            spi_device_handle_t * spiHandle,
            uint8_t blockAddress,
            UniqueIdentifier_t * UID )
```

Reads the key block at the specified block address for the specified UID in the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
blockAddress	The block address to read from.
UID	Pointer to the UniqueIdentifier_t structure containing the UID.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.22 xMifare_ReadUID()

```
UniqueIdentifier_t * xMifare_ReadUID (
             spi_device_handle_t * spiHandle,
             uidSize_t uidSize )
```

Reads the UID from the MFRC522 for the specified UID size.

Parameters

spiHandle	Pointer to the SPI device handle.
uidSize	The size of the UID.

Returns

Pointer to the UniqueIdentifier_t structure containing the UID information, or NULL on failure.

6.2.4.23 xMifare_WriteKey()

```
esp_err_t xMifare_WriteKey (
             spi_device_handle_t * spiHandle,
             UniqueIdentifier_t * UID,
             uint8_t data[45][16] )
```

Writes the provided key data to the specified UID in the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
UID	Pointer to the UniqueIdentifier_t structure containing the UID.
data	The key data to be written.

Returns

ESP_OK if successful, otherwise an error code.

6.2.4.24 xMifare_WriteKeyBlock()

```
esp_err_t xMifare_WriteKeyBlock (
             spi_device_handle_t * spiHandle,
             uint8_t blockAddress,
             UniqueIdentifier_t * UID,
             uint8_t data[16] )
```

Writes the provided data to the specified block address for the specified UID in the MFRC522.

Parameters

spiHandle	Pointer to the SPI device handle.
blockAddress	The block address to write the data to.
UID	Pointer to the UniqueIdentifier_t structure containing the UID.
data	The data to be written.

Returns

ESP_OK if successful, otherwise an error code.

6.3 MFRC522.h

Go to the documentation of this file.

```
#ifndef _MFRC522_H_
#define _MFRC522_H_

#include "../unit_tests/unit_tests.h"
#include "driver/spi_master.h"
#include "esp_timer.h"
#include <freertos/FreeRTOS.h>
#include <freertos/task.h>
#include <driver/gpio.h>
#include <stdlib.h>
#include <string.h>
#include <time.h>
#include <assert.h>

// Number of bytes in the UID. 4, 7 or 10.
typedef uint8_t singleSizeUID_t[4];

typedef uint8_t doubleSizeUID_t[7];

typedef uint8_t trippleSizeUID_t[10];

typedef enum {
    sevenBit = 0x07,
    eightBit = 0x08,
} bitFraming_t;

typedef enum {
    fourBytesSingle = 4,
    sevenBytesDouble = 7,
    tenBytesTripple = 10,
} uidSize_t;

typedef struct {
    uidSize_t uidSize;
    union {
        singleSizeUID_t singleSizeUidData;
        doubleSizeUID_t doubleSizeUidData;
        trippleSizeUID_t trippleSizeUidData;
    } uidData;
    uint8_t sakByte;
    uint8_t bccByte;
} UniqueIdentifier_t;

typedef struct {
    UniqueIdentifier_t uid;
    uint8_t blockKey[6];
    uint8_t keyData[16][64];
} Mifare1kKey_t;

// Definitions for some constants
#define NUM_SECTORE_MIFARE_1K 16
#define NUM_BLOCKS_PER_SECTOR 4
#define MIFARE_KEY_SIZE 6
#define MFRC522_REG_RESERVED00           0x00 « 1
#define MFRC522_REG_COMMAND              0x01 « 1
#define MFRC522_REG_COMIEN               0x02 « 1
#define MFRC522_REG_DIVIEN               0x03 « 1
#define MFRC522_REG_COMIRQ               0x04 « 1
#define MFRC522_REG_DIVIRQ               0x05 « 1
```

```
#define MFRC522_REG_ERROR                0x06 « 1
#define MFRC522_REG_STATUS1              0x07 « 1
#define MFRC522_REG_STATUS2              0x08 « 1
#define MFRC522_REG_FIFO_DATA            0x09 « 1
#define MFRC522_REG_FIFO_LEVEL           0x0A « 1
#define MFRC522_REG_WATER_LEVEL          0x0B « 1
#define MFRC522_REG_CONTROL              0x0C « 1
#define MFRC522_REG_BIT_FRAMING          0x0D « 1
#define MFRC522_REG_COLL                 0x0E « 1
#define MFRC522_REG_RESERVED01           0x0F « 1

// Page 1: Command
#define MFRC522_REG_RESERVED10           0x10 « 1
#define MFRC522_REG_MODE                 0x11 « 1
#define MFRC522_REG_TX_MODE              0x12 « 1
#define MFRC522_REG_RX_MODE              0x13 « 1
#define MFRC522_REG_TX_CONTROL           0x14 « 1
#define MFRC522_REG_TX_AUTO              0x15 « 1
#define MFRC522_REG_TX_SEL               0x16 « 1
#define MFRC522_REG_RX_SEL               0x17 « 1
#define MFRC522_REG_RX_THRESHOLD         0x18 « 1
#define MFRC522_REG_DEMOD                0x19 « 1
#define MFRC522_REG_RESERVED11           0x1A « 1
#define MFRC522_REG_RESERVED12           0x1B « 1
#define MFRC522_REG_MIFARE               0x1C « 1
#define MFRC522_REG_RESERVED13           0x1D « 1
#define MFRC522_REG_RESERVED14           0x1E « 1
#define MFRC522_REG_SERIALSPEED          0x1F « 1

// Page 2: Configuration
#define MFRC522_REG_RESERVED20           0x20 « 1
#define MFRC522_REG_CRC_RESULT_M         0x21 « 1
#define MFRC522_REG_CRC_RESULT_L         0x22 « 1
#define MFRC522_REG_RESERVED21           0x23 « 1
#define MFRC522_REG_MOD_WIDTH            0x24 « 1
#define MFRC522_REG_RESERVED22           0x25 « 1
#define MFRC522_REG_RF_CFG               0x26 « 1
#define MFRC522_REG_GS_N                 0x27 « 1
#define MFRC522_REG_CWGS_PREG            0x28 « 1
#define MFRC522_REG_MOD_GS_PREG          0x29 « 1
#define MFRC522_REG_T_MODE               0x2A « 1
#define MFRC522_REG_T_PRESCALER          0x2B « 1
#define MFRC522_REG_T_RELOAD_H           0x2C « 1
#define MFRC522_REG_T_RELOAD_L           0x2D « 1
#define MFRC522_REG_T_COUNTER_VALUE_H    0x2E « 1
#define MFRC522_REG_T_COUNTER_VALUE_L    0x2F « 1

// Page 3: Test
#define MFRC522_REG_RESERVED30           0x30 « 1
#define MFRC522_REG_TEST_SEL1            0x31 « 1
#define MFRC522_REG_TEST_SEL2            0x32 « 1
#define MFRC522_REG_TEST_PIN_EN          0x33 « 1
#define MFRC522_REG_TEST_PIN_VALUE       0x34 « 1
#define MFRC522_REG_TEST_BUS             0x35 « 1
#define MFRC522_REG_AUTO_TEST            0x36 « 1
#define MFRC522_REG_VERSION              0x37 « 1
#define MFRC522_REG_ANALOG_TEST          0x38 « 1
#define MFRC522_REG_TEST_DAC1            0x39 « 1
#define MFRC522_REG_TEST_DAC2            0x3A « 1
#define MFRC522_REG_TEST_ADC             0x3B « 1
#define MFRC522_REG_RESERVED31           0x3C « 1
#define MFRC522_REG_RESERVED32           0x3D « 1
#define MFRC522_REG_RESERVED33           0x3E « 1
#define MFRC522_REG_RESERVED34           0x3F « 1
// Commands sent to the PICC.
typedef enum {
    PICC_CMD_REQA         = 0x26,
    PICC_CMD_WUPA         = 0x52,
    PICC_CMD_CT           = 0x88,
    PICC_CMD_SEL_CL1      = 0x93,
    PICC_CMD_SEL_CL2      = 0x95,
    PICC_CMD_SEL_CL3      = 0x97,
    PICC_CMD_HLTA         = 0x50,
    PICC_CMD_RATS         = 0xE0,
    PICC_CMD_MF_AUTH_KEY_A = 0x60,
    PICC_CMD_MF_AUTH_KEY_B = 0x61,
    PICC_CMD_MF_READ      = 0x30,
    PICC_CMD_MF_WRITE     = 0xA0,
    PICC_CMD_MF_DECREMENT = 0xC0,
    PICC_CMD_MF_INCREMENT = 0xC1,
    PICC_CMD_MF_RESTORE   = 0xC2,
    PICC_CMD_MF_TRANSFER  = 0xB0,
    PICC_CMD_UL_WRITE     = 0xA2,
    MFRC522_MIFARE_ACK    = 0x0A,
} piccCmds_t;


```

```
// MFRC522's commands for the PCD.
#define PCD_CMD_IDLE                0x00  // NO action; cancels current command execution
#define PCD_CMD_MEM                 0x01  // Stores 25 bytes into the internal buffer
#define PCD_CMD_GEN_RANDOM_ID       0x02  // Generates a 10-byte random ID number
#define PCD_CMD_CALC_CRC            0x03  // Activates the CRC coprocessor or performs a self-test
#define PCD_CMD_TRANSMIT            0x04  // Transmits data from the FIFO buffer
#define PCD_CMD_NO_CMD_CHANGE       0x07  // Can be used to modify the CommandReg register bits without affecting the command, if any, currently being executed
#define PCD_CMD_RECEIVE             0x08  // Activates the receiver circuits
#define PCD_CMD_TRANSCEIVE          0x0C  // Transmits data from FIFO buffer to antenna and automatically activates the receiver after transmission
#define PCD_CMD_MF_AUTHENT          0x0E  // Performs the MIFARE standard authentication as a reader
#define PCD_CMD_SOFT_RESET          0x0F  // Resets the MFRC522
esp_err_t xMFRC522_WriteRegister(spi_device_handle_t *spiHandle, uint8_t registerAddress, uint8_t value);

esp_err_t xMFRC522_ReadRegister(spi_device_handle_t *spiHandle, uint8_t registerAddress, uint8_t *data);

esp_err_t xMFRC522_ReadRegisterArr(spi_device_handle_t *spiHandle, uint8_t registerAddress, uint8_t *dataArr, uint8_t dataSize);

esp_err_t xMFRC522_WriteRegisterArr(spi_device_handle_t *spiHandle, uint8_t registerAddress, uint8_t *dataArr, uint8_t dataSize);

esp_err_t xMFRC522_Init(spi_device_handle_t *spiHandle, uint8_t rstPin);

esp_err_t xMFRC522_ClrRegBitMask(spi_device_handle_t *spiHandle, uint8_t registerAdress, uint8_t mask);

bool xMFRC522_IsCardPresent(spi_device_handle_t *spiHandle);

esp_err_t xMFRC522_AntennaOn(spi_device_handle_t *spiHandle);

esp_err_t xMFRC522_SelfTest(spi_device_handle_t *spiHandle, uint8_t rstPin);

esp_err_t xMFRC522_Reset(spi_device_handle_t *spiHandle);

esp_err_t xMFRC522_Transcieve(spi_device_handle_t *spiHandle, uint8_t waitIrq, uint8_t *cmdBuf, uint8_t bufSize, bitFraming_t bitFrame);

esp_err_t xMFRC522_MF_Authent(spi_device_handle_t *spiHandle, uint8_t waitIrq, uint8_t *cmdBuf, uint8_t bufSize, bitFraming_t bitFrame);

esp_err_t xMFRC522_CommWithMifare(uint8_t cmd, spi_device_handle_t *spiHandle, uint8_t waitIrq, uint8_t *cmdBuf, uint8_t bufSize, bitFraming_t bitFrame);

esp_err_t xMFRC522_SetRegBitMask(spi_device_handle_t *spiHandle, uint8_t registerAddress, uint8_t mask);

esp_err_t xMFRC522_CalculateCRC(spi_device_handle_t *spiHandle, uint8_t *buf, uint8_t bufLen, uint8_t resultBuf[2]);

UniqueIdentifier_t *xMifare_ReadUID(spi_device_handle_t *spiHandle, uidSize_t uidSize);

Mifare1kKey_t *xMifare_GetKeyData(spi_device_handle_t *spiHandle, UniqueIdentifier_t *UID);

esp_err_t xMifare_WriteKey(spi_device_handle_t *spiHandle, UniqueIdentifier_t *UID, uint8_t data[45][16]);

esp_err_t xMifare_WriteKeyBlock(spi_device_handle_t *spiHandle, uint8_t blockAddress, UniqueIdentifier_t *UID, uint8_t data[16]);

static esp_err_t xMifare_SetSakByte(spi_device_handle_t *spiHandle, UniqueIdentifier_t *UID);

esp_err_t xMifare_ReadKeyBlock(spi_device_handle_t *spiHandle, uint8_t blockAddress, UniqueIdentifier_t *UID);

static bool xPrv_Mifare_BlockCheckChar(uint8_t *bufData, uint8_t bufSize, UniqueIdentifier_t *UID);

esp_err_t xMifare_Authenticate(spi_device_handle_t *spiHandle, uint8_t cmd, uint8_t blockAddress, uint8_t *key, UniqueIdentifier_t *UID);

void vMifare_PrintUID(UniqueIdentifier_t *UID);

void vMFRC522_GetAndPrintFifoBuf(spi_device_handle_t *spiHandle, uint8_t *fifoBuf, bool print);

void vMifare_PrintKey(Mifare1kKey_t *key);


#endif // _MFRC522_H_
```

6.4 Sources/unit_tests/unit_tests.h File Reference

Unit Test Framework.

```
#include <stdio.h>
```

Macros

- #define **UNIT_TESTS** 0
- #define ESP_ASSERT(name, condition, message)

  Macro for performing unit test assertions.

6.4.1 Detailed Description

Unit Test Framework.

This file contains macros and utilities for performing unit tests.

Author

Jack Lukomski

6.4.2 Macro Definition Documentation

6.4.2.1 ESP_ASSERT

```
#define ESP_ASSERT(
                name,
                condition,
                message )
```

Value:

```
    { \
    printf("Unit Test Name: %s, Test Result: ", name); \
    if (!(condition)) { \
        printf("Test Failed: %s\n", message); \
    } else { \
        printf("Test Passed!\n"); \
    } \
}
```

Macro for performing unit test assertions.

This macro checks the condition and prints the test result. If the condition is false, it prints the test failure message.

Parameters

name	The name of the unit test.
condition	The condition to be checked.
message	The failure message to be printed.

6.5 unit_tests.h

Go to the documentation of this file.

```

#ifndef UNIT_TESTS_H
#define UNIT_TESTS_H

#include <stdio.h>

#define UNIT_TESTS 0

#define ESP_ASSERT(name, condition, message) { \
    printf("Unit Test Name: %s, Test Result: ", name); \
    if (!(condition)) { \
        printf("Test Failed: %s\n", message); \
    } else { \
        printf("Test Passed!\n"); \
    } \
}

#endif /* UNIT_TESTS_H */
```

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