

[Programa] Lâmpada Zigbee

(provisório) [1]

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Lista de Material

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Notas (part I/II)

Este exemplo mostra como configurar o **dispositivo final Zigbee** e utilizá-lo como lâmpada de domótica de ligar/desligar.

Requisitos

Uma placa de desenvolvimento (ESP32-C6) como **dispositivo final Zigbee** (carregada com o exemplo **Lâmpada Zigbee**)

Arduino IDE

- Antes de Compilar/Verificar, seleccionar a placa correcta: `Ferramentas -> Placa`.
- Seleccionar o modo Zigbee do dispositivo final: `Ferramentas -> Modo Zigbee: Zigbee ED (dispositivo final)`
- Seleccionar Esquema de Partição para Zigbee: `Ferramentas -> Esquema de Partição: Zigbee 4MB com spiiffs`
- Seleccione a porta COM: `Ferramentas -> Porta: xxx` em que `xxx` é a porta COM detectada.

Lâmpada Zigbee

```
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/**
 * @brief This example demonstrates simple Zigbee light bulb.
 *
 * The example demonstrates how to use ESP Zigbee stack to create a end device light bulb.
 * The light bulb is a Zigbee end device, which is controlled by a Zigbee coordinator.
 *
 * Proper Zigbee mode must be selected in Tools->Zigbee mode
 * and also the correct partition scheme must be selected in Tools->Partition Scheme.
 *
 * Please check the README.md for instructions and more detailed description.
 */

#ifndef ZIGBEE_MODE_ED
#error "Zigbee end device mode is not selected in Tools->Zigbee mode"
#endif

#include "esp_zigbee_core.h"
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"
#include "ha/esp_zigbee_ha_standard.h"

#define LED_PIN RGB_BUILTIN

/* Default End Device config */
#define ESP_ZB_ZED_CONFIG() \
{ \
    .esp_zb_role = ESP_ZB_DEVICE_TYPE_ED, .install_code_policy = INSTALLCODE_POLICY_ENABLE, \
    .nwk_cfg = { \
        .zed_cfg = \
        { \
            .ed_timeout = ED_AGING_TIMEOUT, \
            .keep_alive = ED_KEEP_ALIVE, \
        } \
    } \
}

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    },
},
}

#define ESP_ZB_DEFAULT_RADIO_CONFIG() \
{ .radio_mode = ZB_RADIO_MODE_NATIVE, }

#define ESP_ZB_DEFAULT_HOST_CONFIG() \
{ .host_connection_mode = ZB_HOST_CONNECTION_MODE_NONE, }

/* Zigbee configuration */
#define INSTALLCODE_POLICY_ENABLE    false /* enable the install code policy for security */
#define ED_AGING_TIMEOUT             ESP_ZB_ED_AGING_TIMEOUT_64MIN
#define ED_KEEP_ALIVE                3000 /* 3000 millisecond */
/*
#define HA_ESP_LIGHT_ENDPOINT        10 /* esp light bulb
device endpoint, used to process light controlling commands */
#define ESP_ZB_PRIMARY_CHANNEL_MASK ESP_ZB_TRANSCEIVER_ALL_CHANNELS_MASK /* Zigbee primary
channel mask use in the example */

/***** Zigbee functions *****/
static void bdb_start_top_level_commissioning_cb(uint8_t mode_mask) {
    ESP_ERROR_CHECK(esp_zb_bdb_start_top_level_commissioning(mode_mask));
}

void esp_zb_app_signal_handler(esp_zb_app_signal_t *signal_struct) {
    uint32_t *p_sg_p = signal_struct->p_app_signal;
    esp_err_t err_status = signal_struct->esp_err_status;
    esp_zb_app_signal_type_t sig_type = (esp_zb_app_signal_type_t)*p_sg_p;
    switch (sig_type) {
        case ESP_ZB_ZDO_SIGNAL_SKIP_STARTUP:
            log_i("Zigbee stack initialized");
            esp_zb_bdb_start_top_level_commissioning(ESP_ZB_BDB_MODE_INITIALIZATION);
            break;
        case ESP_ZB_BDB_SIGNAL_DEVICE_FIRST_START:
        case ESP_ZB_BDB_SIGNAL_DEVICE_REBOOT:
            if (err_status == ESP_OK) {
                log_i("Device started up in %s factory-reset mode", esp_zb_bdb_is_factory_new() ? "" :
"non");
                if (esp_zb_bdb_is_factory_new()) {

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        log_i("Start network formation");
        esp_zb_bdb_start_top_level_commissioning(ESP_ZB_BDB_MODE_NETWORK_STEERING);
    } else {
        log_i("Device rebooted");
    }
} else {
    /* commissioning failed */
    log_w("Failed to initialize Zigbee stack (status: %s)", esp_err_to_name(err_status));
}
break;
case ESP_ZB_BDB_SIGNAL_STEERING:
    if (err_status == ESP_OK) {
        esp_zb_ieee_addr_t extended_pan_id;
        esp_zb_get_extended_pan_id(extended_pan_id);
        log_i(
            "Joined network successfully (Extended PAN ID:
%02x: %02x: %02x: %02x: %02x: %02x: %02x: %02x, PAN ID: 0x%04hx, Channel: %d, Short Address:
0x%04hx)",
            extended_pan_id[7], extended_pan_id[6], extended_pan_id[5], extended_pan_id[4],
extended_pan_id[3], extended_pan_id[2], extended_pan_id[1],
            extended_pan_id[0], esp_zb_get_pan_id(), esp_zb_get_current_channel(),
esp_zb_get_short_address()
        );
    } else {
        log_i("Network steering was not successful (status: %s)",
esp_err_to_name(err_status));
        esp_zb_scheduler_alarm((esp_zb_callback_t) bdb_start_top_level_commissioning_cb,
ESP_ZB_BDB_MODE_NETWORK_STEERING, 1000);
    }
    break;
default: log_i("ZDO signal: %s (0x%x), status: %s", esp_zb_zdo_signal_to_string(sig_type),
sig_type, esp_err_to_name(err_status)); break;
}
}

static esp_err_t zb_action_handler(esp_zb_core_action_callback_id_t callback_id, const void
*message) {
    esp_err_t ret = ESP_OK;
    switch (callback_id) {
        case ESP_ZB_CORE_SET_ATTR_VALUE_CB_ID: ret =

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zb_attribute_handler((esp_zb_zcl_set_attr_value_message_t *)message); break;
    default:
        log_w("Receive Zigbee action(0x%x) callback",
callback_id); break;
    }
    return ret;
}

static void esp_zb_task(void *pvParameters) {
    esp_zb_cfg_t zb_nwk_cfg = ESP_ZB_ZED_CONFIG();
    esp_zb_init(&zb_nwk_cfg);
    esp_zb_on_off_light_cfg_t light_cfg = ESP_ZB_DEFAULT_ON_OFF_LIGHT_CONFIG();
    esp_zb_ep_list_t *esp_zb_on_off_light_ep =
esp_zb_on_off_light_ep_create(HA_ESP_LIGHT_ENDPOINT, &light_cfg);
    esp_zb_device_register(esp_zb_on_off_light_ep);
    esp_zb_core_action_handler_register(zb_action_handler);
    esp_zb_set_primary_network_channel_set(ESP_ZB_PRIMARY_CHANNEL_MASK);

    //Erase NVRAM before creating connection to new Coordinator
    esp_zb_nvrn_erase_at_start(true); //Comment out this line to erase NVRAM data if you are
conneting to new Coordinator

    ESP_ERROR_CHECK(esp_zb_start(false));
    esp_zb_main_loop_iteration();
}

/* Handle the light attribute */

static esp_err_t zb_attribute_handler(const esp_zb_zcl_set_attr_value_message_t *message) {
    esp_err_t ret = ESP_OK;
    bool light_state = 0;

    if (!message) {
        log_e("Empty message");
    }
    if (message->info.status != ESP_ZB_ZCL_STATUS_SUCCESS) {
        log_e("Received message: error status(%d)", message->info.status);
    }

    log_i(
        "Received message: endpoint(%d), cluster(0x%x), attribute(0x%x), data size(%d)", message-

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>info.dst_endpoint, message->info.cluster, message->attribute.id,
    message->attribute.data.size
);
if (message->info.dst_endpoint == HA_ESP_LIGHT_ENDPOINT) {
    if (message->info.cluster == ESP_ZB_ZCL_CLUSTER_ID_ON_OFF) {
        if (message->attribute.id == ESP_ZB_ZCL_ATTR_ON_OFF_ON_OFF_ID && message-
>attribute.data.type == ESP_ZB_ZCL_ATTR_TYPE_BOOL) {
            light_state = message->attribute.data.value ? *(bool *)message->attribute.data.value :
light_state;
            log_i("Light sets to %s", light_state ? "On" : "Off");
            neopixelWrite(LED_PIN, 255 * light_state, 255 * light_state, 255 * light_state); //
Toggle light
        }
    }
}
return ret;
}

/***** Arduino functions *****/
void setup() {
    // Init Zigbee
    esp_zb_platform_config_t config = {
        .radio_config = ESP_ZB_DEFAULT_RADIO_CONFIG(),
        .host_config = ESP_ZB_DEFAULT_HOST_CONFIG(),
    };
    ESP_ERROR_CHECK(esp_zb_platform_config(&config));

    // Init RMT and leave light OFF
    neopixelWrite(LED_PIN, 0, 0, 0);

    // Start Zigbee task
    xTaskCreate(esp_zb_task, "Zigbee_main", 4096, NULL, 5, NULL);
}

void loop() {
    //empty, zigbee running in task
}

```

Notas (part II/II)

Este exemplo mostra como configurar o **coordenador Zigbee** e utilizá-lo como interruptor de luz de ligar/desligar para domótica.

Requisitos

- Uma placa de desenvolvimento (ESP32-C6) em modo **coordenador Zigbee** (carregada com o exemplo **Interruptor Zigbee**)
- fios de ligação
- interruptor

Configurar o projeto

Confirmar a definição do GPIO do interruptor Switch consultando a definição de ``GPIO_INPUT_IO_TOGGLE_SWITCH``.

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Arduino IDE

- Antes de Compilar/Verificar, seleccionar a placa correcta: ``Ferramentas -> Placa``.
- Seleccionar o modo Coordenador Zigbee: ``Ferramentas -> Modo Zigbee: Zigbee ZCZR (coordenador)``.
- Seleccionar Esquema de Partição para Zigbee: ``Ferramentas -> Esquema de Partição: Zigbee 4MB com spiffs``.
- Seleccionar a porta COM: ``Ferramentas -> Porta: xxx`` em que ``xxx`` é a porta COM detectada.

Interruptor Zigbee

```
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```

```

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/**
 * @brief This example demonstrates simple Zigbee light switch.
 *
 * The example demonstrates how to use ESP Zigbee stack to control a light bulb.
 * The light bulb is a Zigbee end device, which is controlled by a Zigbee coordinator.
 * Button switch and Zigbee runs in separate tasks.
 *
 * Proper Zigbee mode must be selected in Tools->Zigbee mode
 * and also the correct partition scheme must be selected in Tools->Partition Scheme.
 *
 * Please check the README.md for instructions and more detailed description.
 */

#ifndef ZIGBEE_MODE_ZCZR
#error "Zigbee coordinator mode is not selected in Tools->Zigbee mode"
#endif

#include "esp_zigbee_core.h"
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"
#include "ha/esp_zigbee_ha_standard.h"

/* Switch configuration */
#define GPIO_INPUT_IO_TOGGLE_SWITCH GPIO_NUM_9
#define PAIR_SIZE( TYPE_STR_PAIR)      (sizeof( TYPE_STR_PAIR) / sizeof( TYPE_STR_PAIR[ 0]))

typedef enum {
    SWITCH_ON_CONTROL,
    SWITCH_OFF_CONTROL,
    SWITCH_ONOFF_TOGGLE_CONTROL,
    SWITCH_LEVEL_UP_CONTROL,
    SWITCH_LEVEL_DOWN_CONTROL,
    SWITCH_LEVEL_CYCLE_CONTROL,
    SWITCH_COLOR_CONTROL,
} switch_func_t;

typedef struct {

```



```

uint8_t pin;
switch_func_t func;
} switch_func_pair_t;

typedef enum {
    SWITCH_IDLE,
    SWITCH_PRESS_ARMED,
    SWITCH_PRESS_DETECTED,
    SWITCH_PRESSED,
    SWITCH_RELEASE_DETECTED,
} switch_state_t;

static switch_func_pair_t button_func_pair[] = {{GPIO_INPUT_IO_TOGGLE_SWITCH,
SWITCH_ONOFF_TOGGLE_CONTROL}};

/* Default Coordinator config */
#define
ESP_ZB_ZC_CONFIG()
    \

{
    \
    .esp_zb_role = ESP_ZB_DEVICE_TYPE_COORDINATOR, .install_code_policy =
INSTALLCODE_POLICY_ENABLE, .nwk_cfg = { \
    .zc_zr_cfg
=
    \

{
    \
    .max_children =
MAX_CHILDREN,
\

},
    \

}

\

}

```

```

#define ESP_ZB_DEFAULT_RADIO_CONFIG() \
    { .radio_mode = ZB_RADIO_MODE_NATIVE, }

#define ESP_ZB_DEFAULT_HOST_CONFIG() \
    { .host_connection_mode = ZB_HOST_CONNECTION_MODE_NONE, }

typedef struct light_bulb_device_params_s {
    esp_zb_ieee_addr_t ieee_addr;
    uint8_t endpoint;
    uint16_t short_addr;
} light_bulb_device_params_t;

/* Zigbee configuration */
#define MAX_CHILDREN          10                                /* the max amount of
connected devices */
#define INSTALLCODE_POLICY_ENABLE    false                    /* enable the install
code policy for security */
#define HA_ONOFF_SWITCH_ENDPOINT    1                          /* esp light switch
device endpoint */
#define ESP_ZB_PRIMARY_CHANNEL_MASK ESP_ZB_TRANSCEIVER_ALL_CHANNELS_MASK /* Zigbee primary
channel mask use in the example */

/***** Zigbee functions *****/
static void esp_zb_buttons_handler(switch_func_pair_t *button_func_pair) {
    if (button_func_pair->func == SWITCH_ONOFF_TOGGLE_CONTROL) {
        /* implemented light switch toggle functionality */
        esp_zb_zcl_on_off_cmd_t cmd_req;
        cmd_req.zcl_basic_cmd.src_endpoint = HA_ONOFF_SWITCH_ENDPOINT;
        cmd_req.address_mode = ESP_ZB_APS_ADDR_MODE_DST_ADDR_ENDP_NOT_PRESENT;
        cmd_req.on_off_cmd_id = ESP_ZB_ZCL_CMD_ON_OFF_TOGGLE_ID;
        log_i("Send 'on_off toggle' command");
        esp_zb_zcl_on_off_cmd_req(&cmd_req);
    }
}

static void bdb_start_top_level_commissioning_cb(uint8_t mode_mask) {
    ESP_ERROR_CHECK(esp_zb_bdb_start_top_level_commissioning(mode_mask));
}

static void bind_cb(esp_zb_zdp_status_t zdo_status, void *user_ctx) {

```

```

if (zdo_status == ESP_ZB_ZDP_STATUS_SUCCESS) {
    log_i("Bound successfully!");
    if (user_ctx) {
        light_bulb_device_params_t *light = (light_bulb_device_params_t *)user_ctx;
        log_i("The light originating from address(0x%x) on endpoint(%d)", light->short_addr,
light->endpoint);
        free(light);
    }
}

static void user_find_cb(esp_zb_zdp_status_t zdo_status, uint16_t addr, uint8_t endpoint, void
*user_ctx) {
    if (zdo_status == ESP_ZB_ZDP_STATUS_SUCCESS) {
        log_i("Found light");
        esp_zb_zdo_bind_req_param_t bind_req;
        light_bulb_device_params_t *light = (light_bulb_device_params_t
*)malloc(sizeof(light_bulb_device_params_t));
        light->endpoint = endpoint;
        light->short_addr = addr;
        esp_zb_ieee_address_by_short(light->short_addr, light->ieee_addr);
        esp_zb_get_long_address(bind_req.src_address);
        bind_req.src_endp = HA_ONOFF_SWITCH_ENDPOINT;
        bind_req.cluster_id = ESP_ZB_ZCL_CLUSTER_ID_ON_OFF;
        bind_req.dst_addr_mode = ESP_ZB_ZDO_BIND_DST_ADDR_MODE_64_BIT_EXTENDED;
        memcpy(bind_req.dst_address_u.addr_long, light->ieee_addr, sizeof(esp_zb_ieee_addr_t));
        bind_req.dst_endp = endpoint;
        bind_req.req_dst_addr = esp_zb_get_short_address();
        log_i("Try to bind On/Off");
        esp_zb_zdo_device_bind_req(&bind_req, bind_cb, (void *)light);
    }
}

void esp_zb_app_signal_handler(esp_zb_app_signal_t *signal_struct) {
    uint32_t *p_sg_p = signal_struct->p_app_signal;
    esp_err_t err_status = signal_struct->esp_err_status;
    esp_zb_app_signal_type_t sig_type = (esp_zb_app_signal_type_t)*p_sg_p;
    esp_zb_zdo_signal_device_annce_params_t *dev_annce_params = NULL;
    switch (sig_type) {
        case ESP_ZB_ZDO_SIGNAL_SKIP_STARTUP:

```

```

    log_i("Zigbee stack initialized");
    esp_zb_bdb_start_top_level_commissioning(ESP_ZB_BDB_MODE_INITIALIZATION);
    break;
case ESP_ZB_BDB_SIGNAL_DEVICE_FIRST_START:
case ESP_ZB_BDB_SIGNAL_DEVICE_REBOOT:
    if (err_status == ESP_OK) {
        log_i("Device started up in %s factory-reset mode", esp_zb_bdb_is_factory_new() ? "" :
"non");
        if (esp_zb_bdb_is_factory_new()) {
            log_i("Start network formation");
            esp_zb_bdb_start_top_level_commissioning(ESP_ZB_BDB_MODE_NETWORK_FORMATION);
        } else {
            log_i("Device rebooted");
            log_i("Opening network for joining for %d seconds", 180);
            esp_zb_bdb_open_network(180);
        }
    } else {
        log_e("Failed to initialize Zigbee stack (status: %s)", esp_err_to_name(err_status));
    }
    break;
case ESP_ZB_BDB_SIGNAL_FORMATION:
    if (err_status == ESP_OK) {
        esp_zb_ieee_addr_t extended_pan_id;
        esp_zb_get_extended_pan_id(extended_pan_id);
        log_i(
            "Formed network successfully (Extended PAN ID:
%02x:%02x:%02x:%02x:%02x:%02x:%02x:%02x, PAN ID: 0x%04hx, Channel: %d, Short Address:
0x%04hx)",
            extended_pan_id[7], extended_pan_id[6], extended_pan_id[5], extended_pan_id[4],
extended_pan_id[3], extended_pan_id[2], extended_pan_id[1],
            extended_pan_id[0], esp_zb_get_pan_id(), esp_zb_get_current_channel(),
esp_zb_get_short_address()
        );
        esp_zb_bdb_start_top_level_commissioning(ESP_ZB_BDB_MODE_NETWORK_STEERING);
    } else {
        log_i("Restart network formation (status: %s)", esp_err_to_name(err_status));
        esp_zb_scheduler_alarm((esp_zb_callback_t) bdb_start_top_level_commissioning_cb,
ESP_ZB_BDB_MODE_NETWORK_FORMATION, 1000);
    }
    break;

```

```

case ESP_ZB_BDB_SIGNAL_STEERING:
    if (err_status == ESP_OK) {
        log_i("Network steering started");
    }
    break;
case ESP_ZB_ZDO_SIGNAL_DEVICE_ANNCE:
    dev_annce_params = (esp_zb_zdo_signal_device_annce_params_t
*) esp_zb_app_signal_get_params(p_sg_p);
    log_i("New device commissioned or rejoined (short: 0x%04hx)", dev_annce_params-
>device_short_addr);
    esp_zb_zdo_match_desc_req_param_t cmd_req;
    cmd_req.dst_nwk_addr = dev_annce_params->device_short_addr;
    cmd_req.addr_of_interest = dev_annce_params->device_short_addr;
    esp_zb_zdo_find_on_off_light(&cmd_req, user_find_cb, NULL);
    break;
case ESP_ZB_NWK_SIGNAL_PERMIT_JOIN_STATUS:
    if (err_status == ESP_OK) {
        if (*(uint8_t *) esp_zb_app_signal_get_params(p_sg_p)) {
            log_i("Network(0x%04hx) is open for %d seconds", esp_zb_get_pan_id(), *(uint8_t
*) esp_zb_app_signal_get_params(p_sg_p));
        } else {
            log_w("Network(0x%04hx) closed, devices joining not allowed.", esp_zb_get_pan_id());
        }
    }
    break;
default: log_i("ZDO signal: %s (0x%x), status: %s", esp_zb_zdo_signal_to_string(sig_type),
sig_type, esp_err_to_name(err_status)); break;
}
}

static void esp_zb_task(void *pvParameters) {
    esp_zb_cfg_t zb_nwk_cfg = ESP_ZB_ZC_CONFIG();
    esp_zb_init(&zb_nwk_cfg);
    esp_zb_on_off_switch_cfg_t switch_cfg = ESP_ZB_DEFAULT_ON_OFF_SWITCH_CONFIG();
    esp_zb_ep_list_t *esp_zb_on_off_switch_ep =
esp_zb_on_off_switch_ep_create(HA_ONOFF_SWITCH_ENDPOINT, &switch_cfg);
    esp_zb_device_register(esp_zb_on_off_switch_ep);
    esp_zb_set_primary_network_channel_set(ESP_ZB_PRIMARY_CHANNEL_MASK);
    ESP_ERROR_CHECK(esp_zb_start(false));
    esp_zb_main_loop_iteration();
}

```

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}

/***** GPIO functions *****/
static QueueHandle_t gpio_evt_queue = NULL;

static void IRAM_ATTR gpio_isr_handler(void *arg) {
    xQueueSendFromISR(gpio_evt_queue, (switch_func_pair_t *)arg, NULL);
}

static void switch_gpios_intr_enabled(bool enabled) {
    for (int i = 0; i < PAIR_SIZE(button_func_pair); ++i) {
        if (enabled) {
            enableInterrupt((button_func_pair[i]).pin);
        } else {
            disableInterrupt((button_func_pair[i]).pin);
        }
    }
}

/***** Arduino functions *****/
void setup() {
    // Init Zigbee
    esp_zb_platform_config_t config = {
        .radio_config = ESP_ZB_DEFAULT_RADIO_CONFIG(),
        .host_config = ESP_ZB_DEFAULT_HOST_CONFIG(),
    };

    ESP_ERROR_CHECK(esp_zb_platform_config(&config));

    // Init button switch
    for (int i = 0; i < PAIR_SIZE(button_func_pair); i++) {
        pinMode(button_func_pair[i].pin, INPUT_PULLUP);
        /* create a queue to handle gpio event from isr */
        gpio_evt_queue = xQueueCreate(10, sizeof(switch_func_pair_t));
        if (gpio_evt_queue == 0) {
            log_e("Queue was not created and must not be used");
            while (1);
        }
        attachInterruptArg(button_func_pair[i].pin, gpio_isr_handler, (void *) (button_func_pair +
i), FALLING);
    }
}

```

```

}

// Start Zigbee task
xTaskCreate(esp_zb_task, "Zigbee_main", 4096, NULL, 5, NULL);
}

void loop() {
    // Handle button switch in loop()
    uint8_t pin = 0;
    switch_func_pair_t button_func_pair;
    static switch_state_t switch_state = SWITCH_IDLE;
    bool evt_flag = false;

    /* check if there is any queue received, if yes read out the button_func_pair */
    if (xQueueReceive(gpio_evt_queue, &button_func_pair, portMAX_DELAY)) {
        pin = button_func_pair.pin;
        switch_gpios_intr_enabled(false);
        evt_flag = true;
    }
    while (evt_flag) {
        bool value = digitalRead(pin);
        switch (switch_state) {
            case SWITCH_IDLE:
                switch_state = (value == LOW) ? SWITCH_PRESS_DETECTED :
SWITCH_IDLE; break;
            case SWITCH_PRESS_DETECTED: switch_state = (value == LOW) ? SWITCH_PRESS_DETECTED :
SWITCH_RELEASE_DETECTED; break;
            case SWITCH_RELEASE_DETECTED:
                switch_state = SWITCH_IDLE;
                /* callback to button_handler */
                (*esp_zb_buttons_handler)(&button_func_pair);
                break;
            default: break;
        }
        if (switch_state == SWITCH_IDLE) {
            switch_gpios_intr_enabled(true);
            evt_flag = false;
            break;
        }
        vTaskDelay(10 / portTICK_PERIOD_MS);
    }
}

```

```
}
```

Exemplo

8_material_list.png

Image not found or type unknown

Referência

[1] Espressif. arduino-esp32 Zigbee examples. url: <https://github.com/espressif/arduino-esp32/tree/master/libraries/ESP32/examples/Zigbee> (acedido em 30/08/2024).

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