



GR55xx Sample Service Application and Customization

Version: 1.8

Release Date: 2021-04-26

Copyright © 2021 Shenzhen Goodix Technology Co., Ltd. All rights reserved.

Any excerpt, backup, modification, translation, transmission or commercial use of this document or any portion of this document, in any form or by any means, without the prior written consent of Shenzhen Goodix Technology Co., Ltd is prohibited.

Trademarks and Permissions

GOODIX and other Goodix trademarks are trademarks of Shenzhen Goodix Technology Co., Ltd. All other trademarks and trade names mentioned in this document are the property of their respective holders.

Disclaimer

Information contained in this document is intended for your convenience only and is subject to change without prior notice. It is your responsibility to ensure its application complies with technical specifications.

Shenzhen Goodix Technology Co., Ltd. (hereafter referred to as “Goodix”) makes no representation or guarantee for this information, express or implied, oral or written, statutory or otherwise, including but not limited to representation or guarantee for its application, quality, performance, merchantability or fitness for a particular purpose. Goodix shall assume no responsibility for this information and relevant consequences arising out of the use of such information.

Without written consent of Goodix, it is prohibited to use Goodix products as critical components in any life support system. Under the protection of Goodix intellectual property rights, no license may be transferred implicitly or by any other means.

Shenzhen Goodix Technology Co., Ltd.

Headquarters: 2F. & 13F., Tower B, Tengfei Industrial Building, Futian Free Trade Zone, Shenzhen, China

TEL: +86-755-33338828

FAX: +86-755-33338099

Website: www.goodix.com

Preface

Purpose

This document introduces how to use and verify the sample service example in the GR55xx SDK, to help users with secondary development.

Audience

This document is intended for:

- GR55xx user
- GR55xx developer
- GR55xx tester
- Hobbyist developer
- Technical writer

Release Notes

This document is the sixth release of *GR55xx Sample Service Application and Customization*, corresponding to GR55xx SoC series.

Revision History

Version	Date	Description
1.0	2019-12-08	Initial release
1.3	2020-03-16	Updated descriptions in “Add Sample Service to a New Project”.
1.5	2020-05-30	Updated pictures related to the project directory in “Application of Goodix Sample Service”.
1.6	2020-06-30	Updated the document version based on SDK changes.
1.7	2020-12-15	Updated GRToolbox UI figures based on software update.
1.8	2021-04-26	Optimized descriptions in “Application of Goodix Sample Service” and “Creating a Custom Service”.

Contents

Preface.....	I
1 Introduction.....	1
2 Sample Service Overview.....	2
3 Application of Goodix Sample Service.....	3
3.1 Supported Development Platform.....	3
3.2 Creating a Project Based on Template.....	3
3.3 Adding Sample Service to a New Project.....	4
3.4 Applying Sample Service.....	7
3.4.1 Initializing Sample Service.....	7
3.5 Firmware Download.....	8
3.6 Test and Verification.....	8
4 Creating a Custom Service.....	10
4.1 Adding a New Characteristic.....	10
4.2 Reading and Writing a New Characteristic.....	11
4.3 Adding Notify Function to a New Characteristic.....	13
4.4 Applying the Custom Service.....	14
4.5 Test and Verification.....	15

1 Introduction

To maintain the compatibility between all kinds of Bluetooth devices, Bluetooth Special Interest Group (Bluetooth SIG) defines a series of universal standard services in Bluetooth-related fields.

Bluetooth devices of all kinds are able to control the peer Bluetooth devices, or access relevant data easily based on these standard services.

However, in some circumstances, it is necessary to implement your own services. For example, your application may require some new functions which are not supported by these standard services.

This document focuses on the application and modification of a Goodix sample service.

Before you get started, you can refer to the documents as shown in [Table 1-1](#).

Table 1-1 Reference documents

Name	Description
Developer guide of the specific GR55xx SoC	Introduces the software/hardware and quick start guide of the specific GR55xx SoC in use.
Bluetooth Core Spec	Offers official Bluetooth standards and core specification from Bluetooth SIG.
J-Link/J-Trace User Guide	Provides J-Link operational instructions. Available at www.segger.com/downloads/jlink/UM08001_JLink.pdf .
Keil User Guide	Offers detailed Keil operational instructions. Available at www.keil.com/support/man/docs/uv4/ .

2 Sample Service Overview

GR55xx SoCs provide a sample service in compliance with Bluetooth SIG standards for your reference, to implement the basic Write and Notify communications between the Master and the Slave. The information interaction process is presented as below.

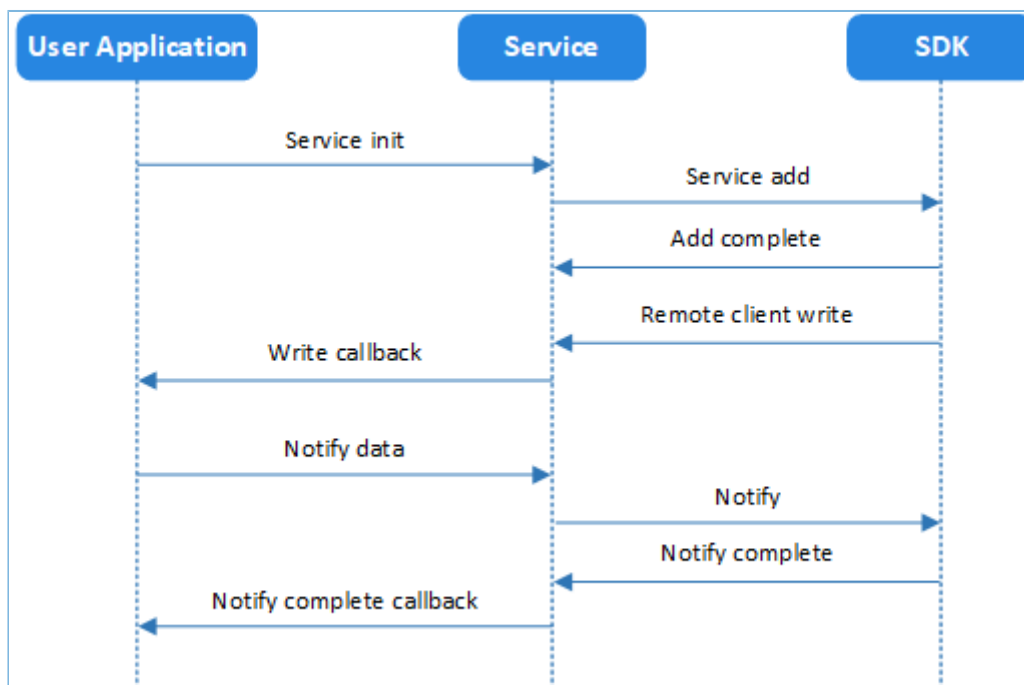


Figure 2-1 Information interaction process of the sample service

The sample service provides two characteristics: RX and TX, with the property as Write and Notify respectively. Detailed comparison between two characteristics is presented in [Table 2-1](#).

Table 2-1 Sample service characteristics

Characteristic	UUID	Type	Support	Security	Property
Service	A6ED0101-D344-460A-8075-B9E8EC90D71B	128 bits	Mandatory	None	-
RX Characteristic	A6ED0102-D344-460A-8075-B9E8EC90D71B	128 bits	Mandatory	None	Write without Response
TX Characteristic	A6ED0103-D344-460A-8075-B9E8EC90D71B	128 bits	Mandatory	None	Notify

3 Application of Goodix Sample Service

This chapter introduces how to create a project for the Goodix sample service in Keil with GR551x development kit.

Note:

SDK_Folder is the root directory of the GR55xx SDK in use.

3.1 Supported Development Platform

You can use and modify the Goodix sample service example on the following platform.

Table 3-1 Supported development platform

Hardware Platform	Development Board Model
GR551x development kit	GR5515-SK-BASIC

3.2 Creating a Project Based on Template

Open SDK_Folder\projects\ble\ble_peripheral, and copy the ble_app_template folder to the current directory. Rename the copied folder and the folder in the Keil directory as ble_app_template_mine, and open it in Keil. Taking GR551x SDK as an example, the file structure of the ble_app_template_mine project is shown in [Figure 3-1](#).

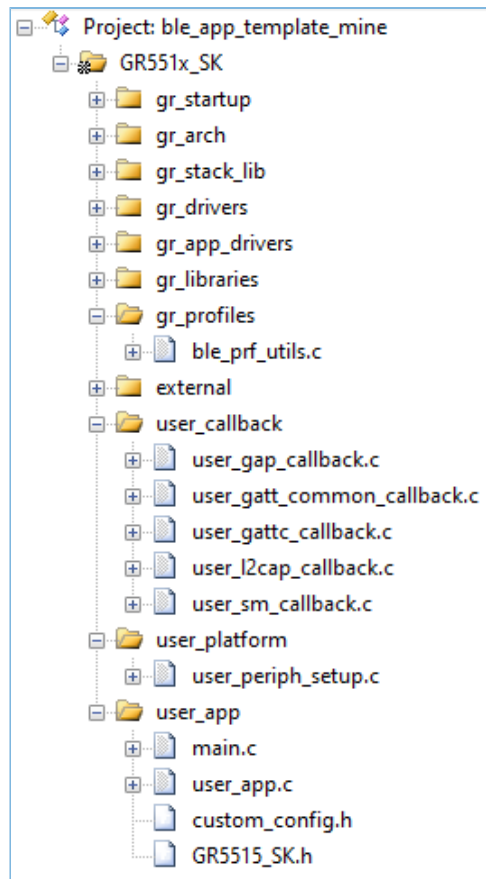


Figure 3-1 ble_app_template_mine project structure directory


Related files are described in Table 3-2.

Table 3-2 File description of ble_app_template_mine

Group	Description
gr_profiles	Contains profile source files.
user_callback	Contains user-defined Bluetooth LE callback functions.
user_platform	Initializes user peripherals.
user_app	Implements user application logics.

3.3 Adding Sample Service to a New Project

Copy the directory SDK_Folder\components\profiles\sample to SDK_Folder\projects\ble\ble_peripheral\ble_app_template_mine\Src. Follow the steps below to add *sample_service.c* from the copied sample directory to the new project, and start compiling.

1. Add *sample_service.c* to the new project.
 - (1). Click the **Options for Target...** icon  in the tool bar of Keil.

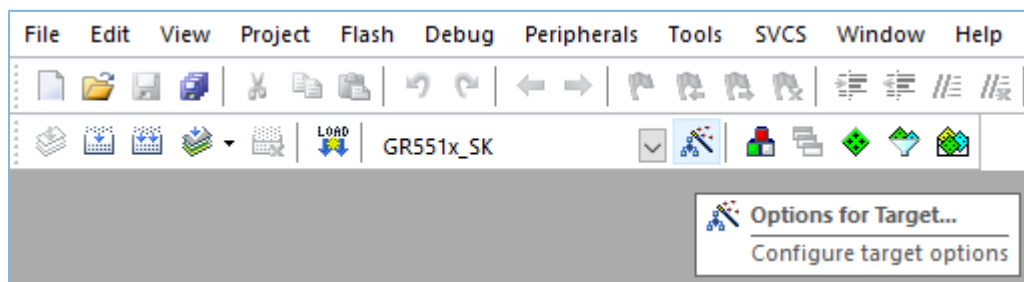



Figure 3-2 Clicking the **Options for Target...** icon

- (2). When the **Options for Target GR551x_SK** window pops up, select the **C/C++** tab page, and click  next to **Include Paths** to browse paths.

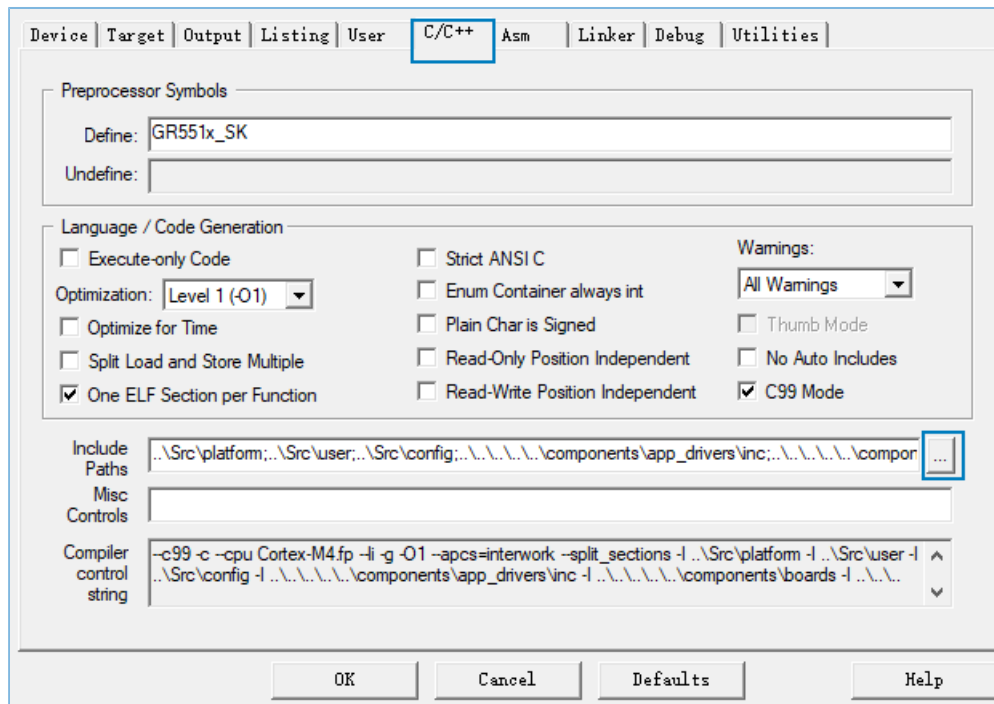


Figure 3-3 Browsing paths

- (3). Drag the scroll bar to the bottom of the **Include Paths** list in the **Folder Setup** window, and enter the path of the sample service (. . \Src\sample); or double-click any empty line at the bottom, click ... in the same line to browse the path for the sample service (. . \Src\sample), and click **OK**.

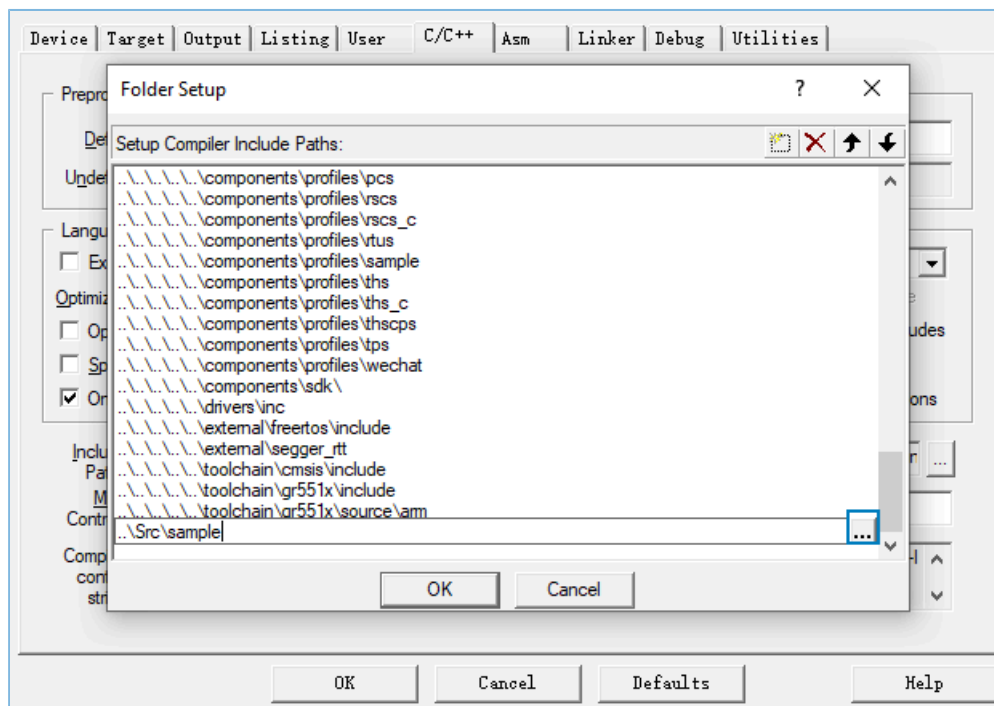


Figure 3-4 Entering the path of the sample service

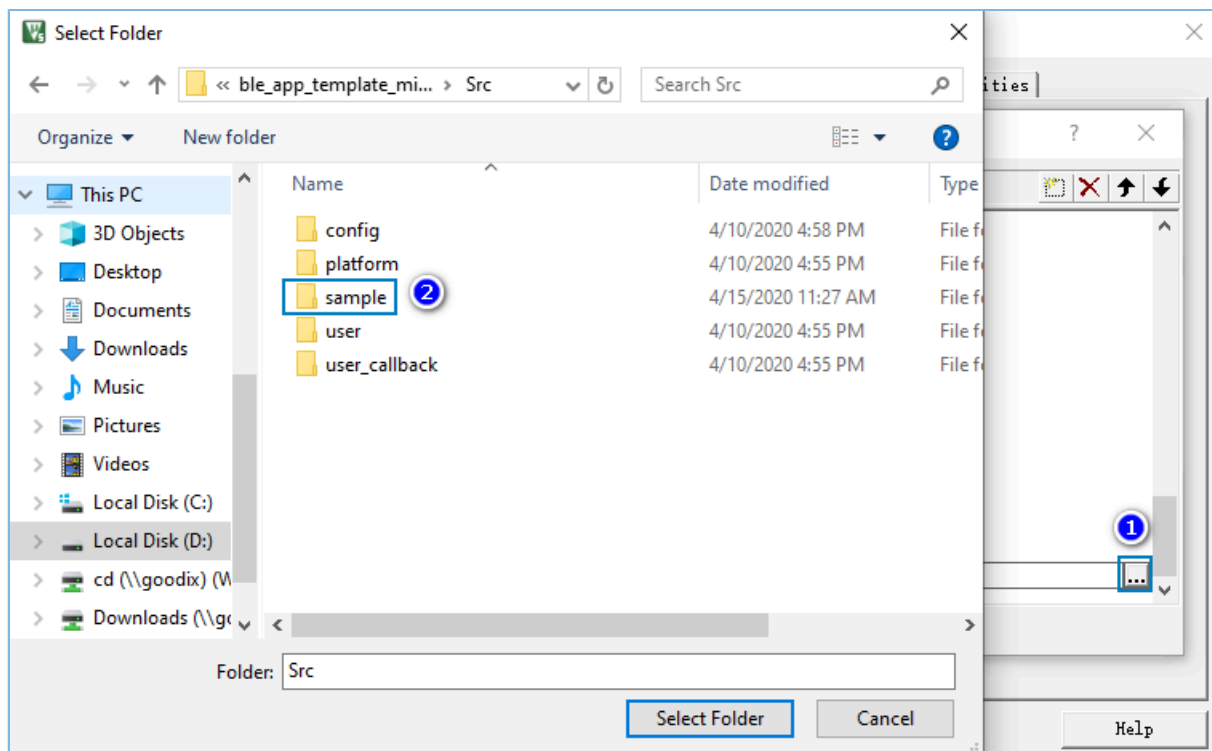


Figure 3-5 Browsing the path of the sample service

2. Add the Sample Service source file *sample_service.c* to Keil project. Select **gr_profiles** in the project directory, right-click and select **Add Existing Files to Groups 'gr_profiles'**. Choose the *sample_service.c* file in the *Src\Sample* directory, and add it to the *gr_profiles* folder by clicking **Add**.

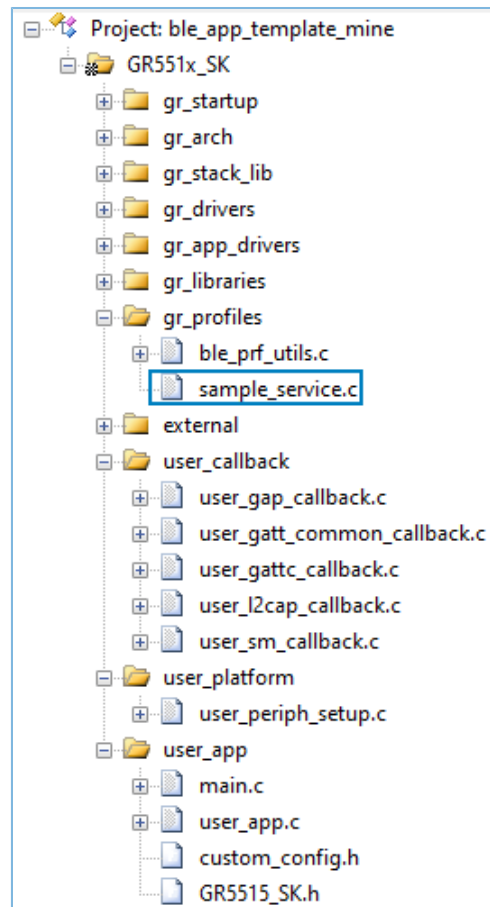


Figure 3-6 Adding the source file of the sample service to Keil project

3.4 Applying Sample Service

This section introduces how to initialize the sample service in the new project (ble_app_template_mine).

3.4.1 Initializing Sample Service

Operations in the *user_app.c* file are as below.

- Add header files of the sample service.

```
#include "user_app.h"
#include "gr55xx_sys.h"
#include "app_log.h"
#include "app_error.h"
#include "sample_service.h"
```

- Implement the callback function of the sample service.

```
static void sample_envt_process(samples_evt_t *p_evt)
{
    switch(p_evt->evt_type)
    {
        case SAMPLES_EVT_TX_NOTIFICATION_ENABLED:
            break;
    }
}
```

```
case SAMPLES_EVT_TX_NOTIFICATION_DISABLED:
    break;
case SAMPLES_EVT_RX_RECEIVE_DATA:
    break;
case SAMPLES_EVT_TX_NOTIFY_COMPLETE:
    break;
default:break;
}
}
```

- Initialize the environment variables in the `services_init()` function and call the `samples_service_init()` function to add Service.

```
static void services_init(void)
{
    samples_init_t sample_init[1];
    sample_init[0].evt_handler = sample_envt_process;
    samples_service_init(sample_init, 1);
}
```

3.5 Firmware Download

The source code of the Goodix sample service example is in `SDK_Folder\projects\ble\ ble_peripheral \ble_app_template_mine`.

You can download *ble_app_template_mine_fw.bin* to the GR55xx Starter Kit Board (GR55xx SK Board) through GProgrammer. For details, see GProgrammer User Manual.

Note:

- The *ble_app_template_mine_fw.bin* is in `SDK_Folder\projects\ble\ble_peripheral\ ble_app_template_mine\build\`.
- You can find GProgrammer in `SDK_Folder\tools\GProgrammer`.

3.6 Test and Verification

The hardware and software required for test and verification are listed in [Table 3-3](#).

Table 3-3 Hardware and software resources

Name	Description
GRToolbox (iOS)	A Bluetooth LE debugging tool. Available at the App Store.
GRToolbox (Android)	A Bluetooth LE debugging tool. Available in <code>SDK_Folder\tools\GRToolbox</code> .

Note:

Screenshots of GRToolbox in this document are for reference only, to help users better understand the software operation. In the case of interface differences due to version changes, the interface of GRToolbox in practice shall prevail.

1. Start GRToolbox to scan and discover the device with the advertising name of **Goodix_Tem**, as shown in [Figure 3-7](#).

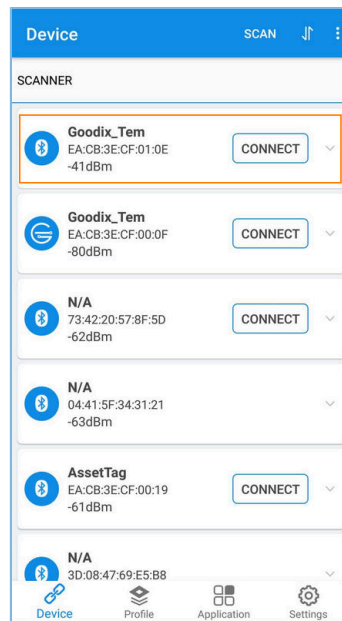


Figure 3-7 Discovering **Goodix_Tem**

2. Tap **CONNECT** in the **Goodix_Tem** pane to connect the device to the GR55xx SK Board through Bluetooth, and search for the sample service to check whether the two characteristics (RX and TX) are included in the service. If the values displayed under the discovered service are in accordance with the sample service characteristics listed in [Table 2-1](#), the sample service is applied successfully.

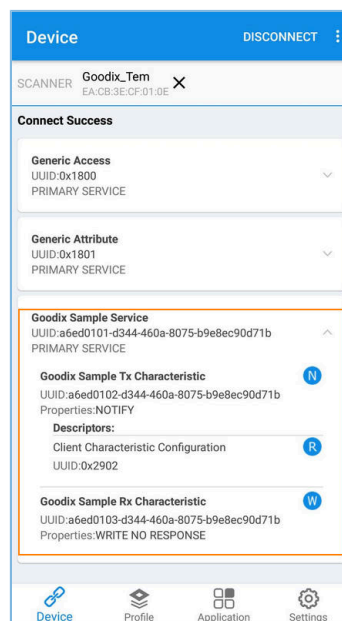


Figure 3-8 Successful application of the sample service

4 Creating a Custom Service

In some applications, standard services cannot meet demands. This chapter introduces how to apply a custom service by adding a new characteristic (with properties of Notify and Write without Response) to the sample service.

Note:

Custom services refer to modified services based on the sample service.

In this chapter, code in bold refers to those of the newly added characteristic, whereas the code not in bold is original.

4.1 Adding a New Characteristic

Follow the steps below to add a new characteristic.

1. Add the UUID of the new characteristic (in the *sample_service.c* file).

```
/**@brief The UUIDs of GUS characteristics. */
#define SAMPLE_SERVER_TX_UUID      {0x1B, 0xD7, 0x90, 0xEC, 0xE8, 0xB9, 0x75, 0x80, 0x0A, 0x46, 0x44, 0xD3, 0x02, 0x01, 0xED, 0xA6}
#define SAMPLE_SERVER_RX_UUID      {0x1B, 0xD7, 0x90, 0xEC, 0xE8, 0xB9, 0x75, 0x80, 0x0A, 0x46, 0x44, 0xD3, 0x03, 0x01, 0xED, 0xA6}
#define SAMPLE_SERVER_ADD_UUID      {0x1B, 0xD7, 0x90, 0xEC, 0xE8, 0xB9, 0x75, 0x80, 0x0A, 0x46, 0x44, 0xD3, 0x04, 0x01, 0xED, 0xA6}
```

2. Add Notify configuration variable of the new characteristic in the environment variable structure system (in the *sample_service.c* file).

```
/**@brief The UUIDs of GUS characteristics. */
/**@brief Samples Service environment variable. */
typedef struct
{
    /**< Sample Service initialization variables. */
    samples_init_t samples_init;
    /**< Service start handle. */
    uint16_t start_hdl;
    /**< TX Character Notification configuration of peer devices. */
    uint16_t tx_ntf_cfg[SAMPLES_CONNECTION_MAX];
    /**< ADD Character Notification configuration of peer devices. */
    uint16_t add_ntf_cfg[SAMPLES_CONNECTION_MAX];
} samples_env_t;
```

3. Add index enumerations of the new characteristic (in the *sample_service.c* file).

```
/**@brief Sample Service Attributes Indexes. */
enum samples_attr_idx_t
{
    SAMPLES_IDX_SVC,

    SAMPLES_IDX_TX_CHAR,
    SAMPLES_IDX_TX_VAL,
    SAMPLES_IDX_TX_CFG,
    SAMPLES_IDX_RX_CHAR,
    SAMPLES_IDX_RX_VAL,
    SAMPLES_IDX_ADD_CHAR,
    SAMPLES_IDX_ADD_VAL,
    SAMPLES_IDX_ADD_CFG,
}
```

```
SAMPLES_IDX_NB,
};
```

4. Add return event type of the new characteristic at the application layer (in the *sample_service.h* file).

```
/**@brief Sample Service event type. */
typedef enum
{
    SAMPLES_EVT_INVALID,
    SAMPLES_EVT_TX_NOTIFICATION_ENABLED,
    SAMPLES_EVT_TX_NOTIFICATION_DISABLED,
    SAMPLES_EVT_RX_RECEIVE_DATA,
    SAMPLES_EVT_TX_NOTIFY_COMPLETE,
    SAMPLES_EVT_ADD_NOTIFICATION_ENABLED,
    SAMPLES_EVT_ADD_NOTIFICATION_DISABLED,
    SAMPLES_EVT_ADD_RECEIVE_DATA,
    SAMPLES_EVT_ADD_NOTIFY_COMPLETE,
} samples_evt_type_t
```

5. Define attribute descriptions of the new characteristic (in the *sample_service.c* file).

After completing all steps above, a new characteristic is generated and displayed on the **Goodix_Tem** connection interface, as shown in [Figure 4-2](#).

```
/**@brief Full SAMPLES Database Description - Used to add attributes into the database. */
static const attm_desc_128_t samples_att_db[SAMPLES_IDX_NB] =
{
    ...
    [SAMPLES_IDX_RX_VAL] = {SAMPLE_SERVER_RX_UUID,
                           WRITE_CMD_PERM_UNSEC,
                           (ATT_VAL_LOC_USER |
                            ATT_UUID_TYPE_SET(UUID_TYPE_128)),
                           SAMPLES_MAX_DATA_LEN},

    //SAMPLE ADD Characteristic Declaration
    [SAMPLES_IDX_ADD_CHAR] = {ATT_128_CHARACTERISTIC, READ_PERM_UNSEC, 0, 0},
    //SAMPLE ADD Characteristic Value
    [SAMPLES_IDX_ADD_VAL] = {SAMPLE_SERVER_ADD_UUID,
                             NOTIFY_PERM_UNSEC | WRITE_CMD_PERM_UNSEC,
                             (ATT_VAL_LOC_USER |
                              ATT_UUID_TYPE_SET(UUID_TYPE_128)),
                             SAMPLES_MAX_DATA_LEN},

    //SAMPLE ADD Characteristic - Client Characteristic Configuration Descriptor
    [SAMPLES_IDX_ADD_CFG] = {ATT_128_CLIENT_CHAR_CFG,
                             READ_PERM_UNSEC | WRITE_REQ_PERM_UNSEC,
                             0,
                             0},
};
```

4.2 Reading and Writing a New Characteristic

1. Add the function of reading the new characteristic to the *samples_read_att_cb()* function.

```
static void samples_read_att_cb(uint8_t conn_idx, const gatts_read_req_cb_t *p_param)
{
```

```

...
switch (tab_index)
{
    case SAMPLES_IDX_TX_CFG:
        cfm.length = sizeof(uint16_t);
        cfm.value = (uint8_t *)(&s_samples_env[i].tx_ntf_cfg[conn_idx]);
        break;

    case SAMPLES_IDX_ADD_CFG:
        cfm.length = sizeof(uint16_t);
        cfm.value = (uint8_t *)(&s_samples_env[i].add_ntf_cfg[conn_idx]);
        break;

    default:
        break;
}

ble_gatts_read_cfm(conn_idx, &cfm);
}

```

2. Add the function of writing the new characteristic to the samples_write_att_cb() function.

```

static void samples_write_att_cb(uint8_t conn_idx, const gatts_write_req_cb_t *p_param)
{
    ...
    switch (tab_index)
    {
        case SAMPLES_IDX_RX_VAL:
            event.conn_idx = conn_idx;
            event.evt_type = SAMPLES_EVT_RX_RECEIVE_DATA;
            break;

        case SAMPLES_IDX_TX_CFG:
            cccd_value = le16toh(&p_param->value[0]);
            event.conn_idx = conn_idx;
            event.evt_type = (PRF_CLI_START_NTF == cccd_value) ? \
                SAMPLES_EVT_TX_NOTIFICATION_ENABLED : \
                SAMPLES_EVT_TX_NOTIFICATION_DISABLED;
            s_samples_env[i].tx_ntf_cfg[conn_idx] = cccd_value;

            break;

        case SAMPLES_IDX_ADD_VAL:
            event.conn_idx = conn_idx;
            event.evt_type = SAMPLES_EVT_ADD_RECEIVE_DATA;
            break;

        case SAMPLES_IDX_ADD_CFG:
            cccd_value = le16toh(&p_param->value[0]);
            event.conn_idx = conn_idx;
            event.evt_type = (PRF_CLI_START_NTF == cccd_value) ? \
                SAMPLES_EVT_ADD_NOTIFICATION_ENABLED : \
                SAMPLES_EVT_ADD_NOTIFICATION_DISABLED;
            s_samples_env[i].add_ntf_cfg[conn_idx] = cccd_value;

            break;

        default:
            cfm.status = BLE_ATT_ERR_INVALID_HANDLE;
            break;
    }
    ...
}

```

3. Add Client Characteristic Configuration Descriptor (CCCD) settings in the samples_cccd_set_cb() function.


```

static void samples_cccd_set_cb(uint8_t conn_idx, uint16_t handle, uint16_t cccd_value)
{
    ...
    switch (tab_index)
    {
        case SAMPLES_IDX_TX_CFG:
            event.conn_idx = conn_idx;
            event.evt_type = (PRF_CLI_START_NTF == cccd_value) ?\
                SAMPLES_EVT_TX_NOTIFICATION_ENABLED :\
                SAMPLES_EVT_TX_NOTIFICATION_DISABLED;
            s_samples_env[i].tx_ntf_cfg[conn_idx] = cccd_value;
            break;
        case SAMPLES_IDX_ADD_CFG:
            event.conn_idx = conn_idx;
            event.evt_type = (PRF_CLI_START_NTF == cccd_value) ?\
                SAMPLES_EVT_ADD_NOTIFICATION_ENABLED :\
                SAMPLES_EVT_ADD_NOTIFICATION_DISABLED;
            s_samples_env[i].add_ntf_cfg[conn_idx]=cccd_value;
            break;
        default:
            break;
    }
    ...
}

```

4.3 Adding Notify Function to a New Characteristic

Add the Notify function to the new characteristic, and make the declaration in the *sample_service.h* file. The code below is for your reference.

```

sdk_err_t samples_notify_add_data(uint8_t conn_idx, uint8_t ins_idx, uint8_t *p_data,
    uint16_t length)
{
    sdk_err_t error_code = SDK_ERR_NTF_DISABLED;
    gatts_noti_ind_t send_cmd;

    if (PRF_CLI_START_NTF == s_samples_env[ins_idx].add_ntf_cfg[conn_idx])
    {
        if (ins_idx <= s_samples_ins_cnt)
        {
            // Fill in the parameter structure
            send_cmd.type = BLE_GATT_NOTIFICATION;
            send_cmd.handle = prf_find_handle_by_idx(SAMPLES_IDX_ADD_VAL,
                s_samples_env[ins_idx].start_hdl,
                (uint8_t *)&s_samples_features);

            // pack measured value in database
            send_cmd.length = length;
            send_cmd.value = p_data;
            s_now_ins_cnt = ins_idx;
            s_now_notify_cmp_type = SAMPLES_EVT_ADD_NOTIFY_COMPLETE;
            // send notification to peer device
            error_code = ble_gatts_noti_ind(conn_idx, &send_cmd);
        }
    }
    return error_code;
}

```

4.4 Applying the Custom Service

To apply and verify the modified sample service, set a one-second timer to accumulate hexadecimal variables. Notify the accumulated value to the Master through the newly added characteristic (UUID: 0x1B, 0xD7, 0x90, 0xEC, 0xE8, 0xB9, 0x75, 0x80, 0x0A, 0x46, 0x44, 0xD3, 0x04, 0x01, 0xED, 0xA6; properties: Write Without Response/Notify).

The steps to add a timer in the *user_app.c* file are as below.

1. Add header files of the timer.

```
#include "user_app.h"
#include "gr55xx_sys.h"
#include "app_log.h"
#include "app_error.h"
#include "sample_service.h"
#include "app_timer.h"
```

2. Define the timer ID and a cumulative variable.

```
static app_timer_id_t s_add_timer_id;
static uint16_t s_add_count = 0;
```

3. Create a timer in *ble_init_cmp_callback()*.

```
void ble_init_cmp_callback(void)
{
    ...
    error_code = ble_gap_adv_start(0, &s_gap_adv_time_param);
    APP_ERROR_CHECK(error_code);

    APP_LOG_INFO("Template application example started.");

    app_timer_create(&s_add_timer_id, ATIMER_REPEAT, add_time_out_handler);
}
```

4. Implement the event processing logics of the sample service.

Note:

The timer has a time base of 1 millisecond. Therefore, set the value of the timer to 1000, which means 1 second.

```
static void sample_event_process(samples_evt_t *p_evt)
{
    switch(p_evt->evt_type)
    {
        case SAMPLES_EVT_TX_NOTIFICATION_ENABLED:
            break;
        case SAMPLES_EVT_TX_NOTIFICATION_DISABLED:
            break;
        case SAMPLES_EVT_RX_RECEIVE_DATA:
            break;
        case SAMPLES_EVT_TX_NOTIFY_COMPLETE:
            break;
        case SAMPLES_EVT_ADD_NOTIFICATION_ENABLED:
            app_timer_start(s_add_timer_id, 1000, NULL);
            break;
        case SAMPLES_EVT_ADD_NOTIFICATION_DISABLED:
```

```

        app_timer_stop (s_add_timer_id);
        break;
    case SAMPLES_EVT_ADD_RECEIVE_DATA:
        break;
    case SAMPLES_EVT_ADD_NOTIFY_COMPLETE:
        break;

    default:break;
}
}

```

5. Implement the timeout handler function of the timer.

```

static void add_time_out_handler(void *p_arg)
{
    s_add_count++;
    samples_notify_add_data(0,0,(uint8_t*)&s_add_count,2);
}

```

4.5 Test and Verification

For details about firmware download, refer to "[Section 3.5 Firmware Download](#)"; for details about hardware and software required for test and verification, refer to [Table 3-3](#). The steps for test and verification are as below.

1. Start the GRTtoolbox to scan and discover the device with the advertising name of **Goodix_Tem**.

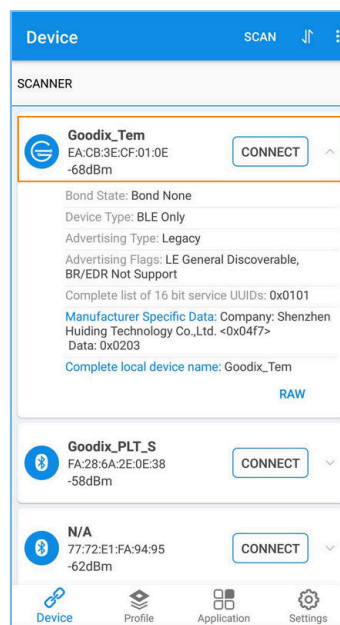


Figure 4-1 Discovering **Goodix_Tem**

2. Tap **CONNECT** in the **Goodix_Tem** pane, to connect the device to the GR55xx SK Board through Bluetooth. View the characteristics of the sample service to check whether the newly added characteristic is included.

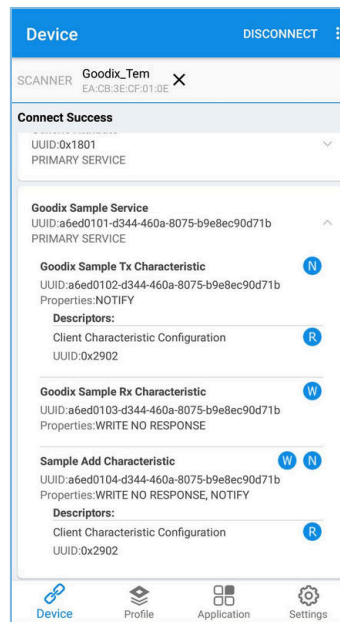


Figure 4-2 Viewing characteristics of the custom sample service

If the sample service includes a characteristic which shares the same UUID and properties with the newly added one, the modification to the sample service is successful.

3. Tap **N** on the right of **Sample Add Characteristic**. You can observe the value of the Notify characteristic ascends every second from the drop-down list.

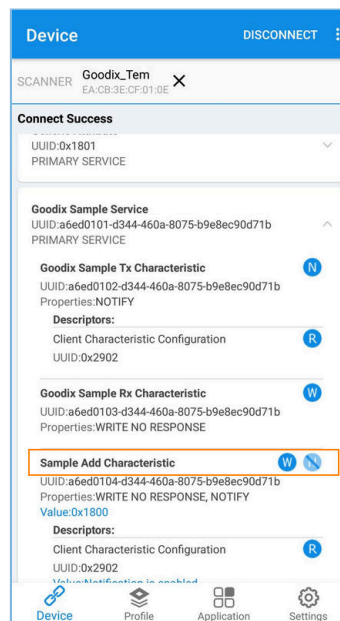


Figure 4-3 Successful application of the custom sample service

The custom sample service is applied successfully, as shown in [Figure 4-3](#).