Spec For TLSR827x-based BLE Audio Remote Control

PS-20033000-E1

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Keyword

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Brief

This document is a product specification for TLSR827x-based BLE (Bluetooth Low Energy) Audio Remote Control demo.

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Legal Disclaimer

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This is the Initial release.

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1. Introduction

This specification is described in details based on BLE remote control (RC) which is built on Telink's TLSR827x platform and has button function and voice command function support.

1.1 Supported features

The RC demo supports the following features:

- works with dual batteries
- 27 valid buttons and 2-color indicating LEDs
- Google voice service
- Voice compressed with ADPCM, supported sample rate 16Khz/16bit
- Repeated buttons
- Couch mode
- OTA firmware upgrade
- PC tool for button display and demonstration

1.2 Electrical specification

Current consumption for the RC demo is shown as below:

1) BLE mode
   - Voice commands: 11.5mA
   - Button press: <1 mA
   - Button long press (<60s): 0.4mA
   - Couch mode (long press time > 60s): ~11uA
   - Idle in connection state: 18uA
   - Deep sleep: 0.4uA
   - Advertising: 1.5mA
   - Low power current (Battery power below 1.9V): <18uA

2) IR mode:

- Button press: <13mA
- Long press single button (<60s): 5~9mA
- Couch mode (long press time > 60s): ~11uA
- Idle in IR mode:35uA
- Deep sleep: 0.5uA
- Low power current (Battery power below 1.9V): <18uA

Working distance:

- Button press: >30m
- Voice commands: >10m

Note

- *These numbers may vary depending on the host side BLE solution provider and the operating system configurability.*

1.3 Button layout

The RC demo supports 27 valid buttons as shown in Figure 1-1, including:

- ✧ Up
- ✧ Down
- ✧ Left
- ✧ Right
- ✧ OK
- ✧ Home
- ✧ Back
- ✧ Vol+
- ✧ Vol-

- ✧ Audio
- ✧ 0-9 Digits
- ✧ Menu
- ✧ Mute

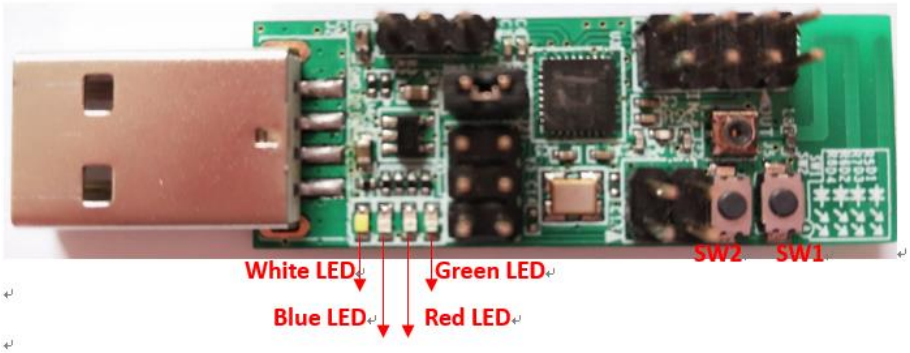
TV control area:

- ✧ Power
- ✧ Vol-
- ✧ Vol+
- ✧ Learn
- ✧ TV/AV

Figure 1-1 BLE RC demo

The Telink sample BLE dongle is shown in Figure 1-2.

Figure 1-2 Telink Sample BLE Dongle



2. BLE Configuration

2.1 BLE Local Device Configuration

MAC address is pre-assigned from the vendor, while the PID and VID values are defined in the table below.

Table 2-1 PID and VID table

Name	Value
VID (Vendor ID)	0x248a
PID (Product ID)	0x881d

2.2 BLE GATT Configuration

The relevant RCU GATT characteristics are defined in the table below.

Table 2-2 BLE GATT configuration

Name	Assigned Number	RC	Value
PnP ID	0x2A50	KRemote	0x02; 0x8a 0x24 (VID); 0x1d 0x88 (PID); 0x01 0x00

2.3 Advertising state

2.3.1 Indirect advertising

This section describes the remote control behavior when it's placed in the indirect advertising state, i.e. if the RCU with bonded pairing information is not paired and user presses a key, it will send direct advertising packets for 2s, and then send indirect advertising packets for 10s. While trying to pair, the RCU will send out advertising packets (ADV_IND) with the following data format:

Table 2-3 Advertising packet data

DATA field	Field Length	Length	Value
Flags	3	0x02	GAP_ADTYPE_FLAGS (0x01), GAP_ADTYPE_FLAGS_LIMITED GAP_ADTYPE_FLAGS_BREDR_NOT_SUPPORTED (0x05)
Appearance	4	0x03	GAP_ADTYPE_APPEARANCE (0x19), GAP_APPEAR_GENERIC_RC (0x0180)
Service UUIDs	6	0x05	GAP_ADTYPE_16BIT_MORE (0x02), HID_SERVICE_UUID (0x1812) Battery service (0x180F)

The total advertise data packet (field length) has to be ≤ 31 bytes. The data format above indicates the RCU will be advertised as a generic remote controller supporting the HID service and the battery service.

When the STB will be in active scan mode, it will issue a scan request (SCAN_REQ PDU) upon reception of an ADV_IND from the RCU. The RCU shall respond with a scan response (SCAN_RSP PDU) containing the following data:

Table 2-4 Scan response PDU data

Length	Type (Identifier)	Data meaning	Data Value
0x08	GAP_ADTYPE_LOCAL_NAME_COMPLETE (0x09)	RCU Complete name in ASCII	'K' 'R' 'e' 'm' 'o' 't' 'e'

2.3.2 Direct Advertising

After paired with Master, the RCU will enter BLE mode and store bonding information.

When the RCU is woken up from deep sleep by pressing any button, the RCU enters IR mode in non-connection state, and due to the stored bonding information, it will send directed advertising packets for 2 seconds and indirect advertising packets for 10 seconds. If connection fails to be established during this 2s duration, the RCU will send indirect advertising packets for 10 seconds. The RCU will enter deep sleep if adv time reaches the “10s” timeout duration.

After power cycle, the RCU with pairing information will send directed advertising packets for 2 seconds, and automatically reconnect with the dongle. If connection fails to be established during this 2s duration, the RCU will send indirect advertising packets for 10 seconds. The RCU will enter deep sleep if adv time reaches the “10s” timeout duration.

2.4 Pairing State

2.4.1 Pairing

The remote shall enter pairing mode with pressing the “OK” button and the “Right” button for 5 seconds and after “OK” and “Right” button are released.

Once in advertising mode (RCU will send in-direct adv pkt, adv timeout: 30s), the feedback red LED will blink at the rate of 160mS on and 160mS off.

Note

- *The LED blinking frequency has a deviation of 1~3ms (when Power Management is disabled)/up to 10ms (when Power Management is enabled).*

The ADV_IND packets will be sent at every PAIR_ADV_INTERVAL for up to PAIR_ADV_DURATION.

Within 30 seconds, click the “SW1” button of the dongle.

The red LED of the dongle will be always on to indicate pairing success. The red LEDs of the RC will be turned off.

If user presses the “OK” button and the “Right” button again to initiate pairing to an already paired remote, the RCU should delete previous pairing info and start pairing mode.

After paired with a dongle, if the RCU stays in idle state for 60s, it will enter deep sleep and disconnect from the dongle. After wakeup triggered by key press (not release the key), the RCU will send an IR code

and automatically reconnect with the dongle. After successful reconnection, the RCU will stop transmitting IR code.

Remove the dongle, or power off the dongle. Press any key and not release it, after wakeup from deep sleep the RCU will send directed advertising packets for 2s and then in-directed advertising packets for 10s. After 12s expires, the RCU enters couch mode. Release the key in couch mode, the RCU will send directed advertising packets for 2s and in-directed advertising packets for 10s, and then enter deep sleep.

2.4.2 Manual Un-Pairing

The remote shall un-pair and clear its pairing table when the “Down” button and the “OK” button are pressed for 5 seconds or more. The red LEDs of the RC will blink three times at the rate of 125ms on and 125ms off.

When entering un-pairing mode, if in connection state, first terminate the connection, disable advertising, and check whether there’s pairing information. If yes, delete the pairing info.

The white LED of the dongle will be turned on to indicate un-pairing success.

2.4.3 BLE - IR Switch

After each power on, the RCU will enter IR mode by default.

In order to reduce power consumption when RCU is in IR mode but unconnected BLE state, RCU goes into suspend mode in every 500ms, it will further go into deepsleep after 60s. When an IR key is released, RCU would similarly go into suspend mode in every 500ms, and further go into deepsleep after 60s.

After connection is established, the RCU will enter BLE mode. The red LED of the dongle will be always on to indicate BLE mode.

Whenever in non-connection state, the RCU is in IR mode.

2.5 Connected State

2.5.1 Idle Mode

When RCU is connected to the host, all communication between the remote and the target shall be Bluetooth Low Energy (BLE). Commands shall be sent as HID reports over GATT using standard HID.

RCU shall have connection parameters based on the Table 2-5. BLE connection parameters have been chosen for minimizing the power consumption, for not overloading the bandwidth and for minimizing the latency.

Table 2-5 Connection parameter configuration

BLE Connection Parameters	Value
Connection Interval	10ms
Slave Latency	99
Supervision Timeout	4s

2.5.2 Key Transmission

The RCU shall send key report as HID reports described in the BLE key table below.

Table 2-6 BLE HID reports

RC button	BLE HID
Power TV	-
TV AV Input	-
Power STB	0x0030
Vol-	0x00EA
MIC	0x0221
Vol+	0x00E9
Up	0x0042
Down	0x0043

RC button	BLE HID
Left	0x0044
Right	0x0045
OK	0x0041
Back/Exit	0x0224
Home	0x0089
Android Home	0x0223
Rewind	0x00B4
Play/Pause	0x00CD
Fast Forward	0x00B3
Digit 0	0x0027
Digit 1	0x001E
Digit 2	0x001F
Digit 3	0x0020
Digit 4	0x0021
Digit 5	0x0022
Digit 6	0x0023
Digit 7	0x0024
Digit 8	0x0025

RC button	BLE HID
Digit 9	0x0026

Note

- *Whether the RCU is in IR mode or BLE mode, both the "Power TV" and "TV AV Input" act as IR keys.*

2.5.3 Key Report Transmission

The RCU key reports are sent using HOGP (HID over GATT profile) profile.

The RCU shall send the Key press report anytime the key is pressed. No Key repeat reports will be sent if a key is held down for a long time.

The RCU shall send the Key release report (NULL) when the key is released.

2.5.4 HID Descriptor

The HID report descriptor describes how the HID report will be formatted. It will be defined as described in the following sections.

1) Standard Keyboard report descriptor

```
/* Key Board */
/* Key Board */
0x05, 0x01,   // Usage Pg (Generic Desktop)
  0x09, 0x06,   // Usage (Keyboard)
  0xA1, 0x01,   // Collection: (Application)
  0x85, 0x01,   // Report Id (1)
  0x05, 0x07,   //    Usage Pg (Key Codes)
  0x19, 0xE0,   //    Usage Min (224)
  0x29, 0xE7,   //    Usage Max (231)
  0x15, 0x00,   //    Log Min (0)
  0x25, 0x01,   //    Log Max (1)
  0x75, 0x01,   //    Report Size (1)
  0x95, 0x08,   //    Report Count (8)
```

```
  0x81, 0x02,   //    Input: (Data, Variable, Absolute)
  0x95, 0x01,   //    Report Count (1)
  0x75, 0x08,   //    Report Size (8)
  0x81, 0x01,   //    Input: (Constant)
0x95, 0x05,     //Report Count (5)
  0x75, 0x01,     //Report Size (1)
  0x05, 0x08,     //Usage Pg (LEDs )
  0x19, 0x01,     //Usage Min
  0x29, 0x05,     //Usage Max
  0x91, 0x02,     //Output (Data, Variable, Absolute)
  0x95, 0x01,     //Report Count (1)
  0x75, 0x03,     //Report Size (3)
  0x91, 0x01,     //Output (Constant)
 0x95, 0x06,   //    Report Count (6)
  0x75, 0x08,   //    Report Size (8)
  0x15, 0x00,   //    Log Min (0)
  0x25, 0xF1,   // LOGICAL_MAXIMUM (241)
  0x05, 0x07,   //    Usage Pg (Key Codes)
  0x19, 0x00,   //    Usage Min (0)
  0x29, 0xF1,   //    Usage Max (241)
  0x81, 0x00,   //    Input: (Data, Array)
  0xC0,       // End Collection
```

2) Consumer key report descriptor (HID_RPT_ID_CC_IN Report Id 3)

```
/* CC */
0x05, 0x0c,           // USAGE_PAGE (Consumer)
0x09, 0x01,           // USAGE (Consumer Control)
0xa1, 0x01,           // COLLECTION (Application)
0x85, 0x02,           // REPORT_ID (2)
0x75,0x10,      //global, report size 16 bits
0x95,0x01,      //global, report count 1
0x15,0x01,      //global, min  0x01
0x26,0x8c,0x02,  //global, max  0x28c
```

```
0x19,0x01,      //local, min   0x01
0x2a,0x8c,0x02,  //local, max    0x28c
0x81,0x00,      //main,  input data varible, absolute
0xc0,         //main, end collection
```

2.6 Connection Behaviors

Once a remote and STB are paired, the BLE connection will be kept maintained (using the connection parameters shown in the table - section 2.5.1).

If the connection is terminated, the RCU will enter deep sleep.

Note

- *If connection fails to be established, the RCU will directly enter deep sleep. If the RCU is already bonded, upon key press, it will send directed adv packets for 2s after wakeup from deep sleep; if it fails to be re-connected during this 2s duration, it starts to send general adv packets. The RCU will enter deep sleep if adv time reaches the "10s" timeout duration.*
- *The timeout has a deviation of 1~3ms (when Power Management is disabled)/up to 10ms (when Power Management is enabled).*

If no connection has been established after RECONNECT_ADV_DURATION, the RCU will go to deep sleep and then wake up upon user input is detected. The key value of the detected pressed key is sent via IR, and after connection is established, the key value of any pressed key will be sent via BLE instead.

Table 2-7 Connection timing configuration

Parameter	Value
PAIR_ADV_DURATION	30 sec
PAIR_ADV_INTERVAL_MIN	30 ms
PAIR_ADV_INTERVAL_MAX	35 ms
RECONNECT_ADV_DURATION	12 Sec
RECONNECT_ADV_BURST	2 sec

Parameter	Value
RECONNECT_ADV_INTERVAL_MIN	30 ms
RECONNECT_ADV_INTERVAL_MAX	35 ms

2.7 Battery Service

Battery detection is implemented with the interval of 100ms.

If the battery voltage has dropped below 2.0v, the RCU will enter deep sleep mode.

Table 2-8 Battery state table

Battery State	Battery Voltage (V)
GOOD	2.1 < V ⩽ 3.3
WARNING	2.0 ⩽ V ⩽ 2.1
DEAD	V < 2.0

Note

- *When the battery voltage is 2.0~2.1V, the red LED of the RCU will blink five times.*
- *When the battery voltage is 2.0~2.1V, the RCU allows OTA, but does not support Pairing/Un-pairing/FW version check, and all keys do not work.*
- *When the battery voltage drops below 2V, the RCU disables OTA function.*
- *The battery voltage detected via ADC may have about 50mV deviation.*

Table 2-9 Battery level table

Actual Voltage at the chip	Report sent in terms of percentage
2.9 V ≤ VDD ≤ 3.3 V	100%

2.8 V ≤ VDD < 2.9 V	90%
2.7 V ≤ VDD < 2.8 V	80%
2.6 V ≤ VDD < 2.7 V	70%
2.5 V ≤ VDD < 2.6 V	60%
2.4 V ≤ VDD ≤ 2.5 V	40%
2.3 V ≤ VDD < 2.4 V	20%
2.2 V ≤ VDD < 2.3 V	10%
2.0 V ≤ VDD < 2.2 V	0%
VDD < 2.0 V	dead

Note

- *The RCU will report battery level after successful pairing of the first time, or if battery voltage changes in connection state. And during reconnection, as per the software design, the RCU will report battery level only if it's less than 100%.*
- *The battery voltage detected via ADC may have about 50mV deviation*

3. Button Function

3.1 Single button function

After successfully paired with the dongle, the RC enters BLE mode, and it can send certain key value by pressing corresponding button. The function of each button is shown as in Section 1.3.

In BLE mode, user can use the PC tool “KeySimulator” to simulate press, release and repeat on the RC for all buttons except the “MIC” button, “Power TV” button and “TV AV Input” button.

In IR mode, user can use IR analyzer to test IR code of all buttons.

Table 3-1 IR code table

RC button	IR code
Power TV	0xee
TV AV Input	0xef
Power STB	0x21
Vol-	0x24
MIC	0x46
Vol+	0x23
Up	0x15
Down	0x16
Left	0x17
Right	0x18
OK	0x19
Back/Exit	0x48

RC button	IR code
Home	0x61
Android Home	0x47
Rewind	0x51
Play/Pause	0x52
Fast Forward	0x53
Digit 0	0x0A
Digit 1	0x01
Digit 2	0x02
Digit 3	0x03
Digit 4	0x04
Digit 5	0x05
Digit 6	0x06
Digit 7	0x07
Digit 8	0x08
Digit 9	0x09

Note

- *IR tolerance level is about ±3%.*

3.2 Repeatable Buttons

In IR mode, all buttons are treated as repeatable buttons. When any button is pressed and held, the key value will be sent continuously.

In BLE mode, all buttons are treated as non-repeatable buttons.

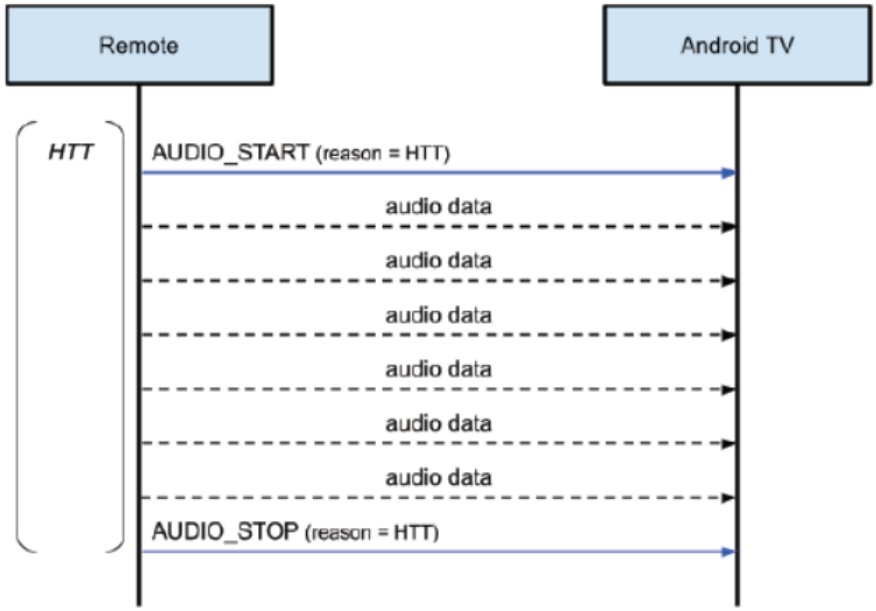
4. Audio

4.1 Audio Input Control

The audio input function can only be used in BLE mode, i.e. connection state. The voice function on the remote control can be able to function with Android 10 hosts.

The remote sends AUDIO_START followed by audio data as soon as “MIC” button is pressed. The remote sends AUDIO_STOP message as soon as “MIC” button is released. During the recording process, the red LEDs of the RC will be turned on.

Figure 4-1 Voice transmission forma



Audio transfer timeout on the remote is 15 seconds.

Note

- *Distance between mouth and RCU MIC should be kept within 40cm or less;*
- *During recording process, RCU does not support battery detection.*

Any audio input software (e.g. Audacity or Sound Recorder) can be used on the PC to record the audio input.

4.2 Audio Performance

Audio performance meets Google and Nuance requirements. Detail requirements as below table.

Table 4-2Audio performance requirement

Item	Requirement
Sample Size	16 bits
Sample Rate	16 kHz
Channels	1 channel
Frequency Response (after software EQ is applied)	+/- 3dB from 250 Hz – 4 kHz +/- 4dB from 4kHz – 7.3 kHz
Dynamic Range	≥72 dBA
Sensitivity	90 dB SPL @ 1kHz will produce RMS of 2500 for 16 bit sample (-19.34 dBFS) equivalent to 94dBSPL=> -15.34 dBFS
DC Offset	DC offset shall be avoided
Linearity	Amplitude should linearly track input SPL changes over at least a 30dB range from -18dB to +12dB, With coefficient of determination, R2>0.99.
THD	<1% @ 90dB SPL measured at 1kHz at the microphone, <5% @ 90dB SPL measured at 1kHz entire system.
SNR	40 dBA @ 90dB SPL measured at 1kHz entire system.

5. Couch Mode

This feature is used to save power for RC when some button is pressed by mistake and held for a long time.

- In IR mode, if any button is pressed and held for 60 seconds, the RC will enter low power couch mode. When the button is released, the RC will restore to IR mode.
- In BLE mode, if any button is pressed and held for 60 seconds, the RC will enter low power couch mode and disconnect from the dongle. When the button is released, the RC will restore to BLE mode.

6. OTA Firmware Upgrade

This feature is used to upgrade the RC firmware using a burning EVK board (Burning key), the sample dongle and Wtcdb.

The operation is described below:

1. Download the dongle firmware, test firmware 1 and test firmware 2 into the dongle.

   1) Connect hardware: Connect the EVK with PC via an USB cable, and connect the dongle with the EVK via USB interface.

Figure 6-1 Connect EVK, Dongle and PC

   1) Place the test firmware 1 and test firmware 2 under root directory, e.g. disk D.

   2) Open the Wtcdb tool. Click the “RstMCU” button to reset MCU.

      Burn the dongle firmware into dongle flash area starting from 0x0 by clicking the “SWB” button.

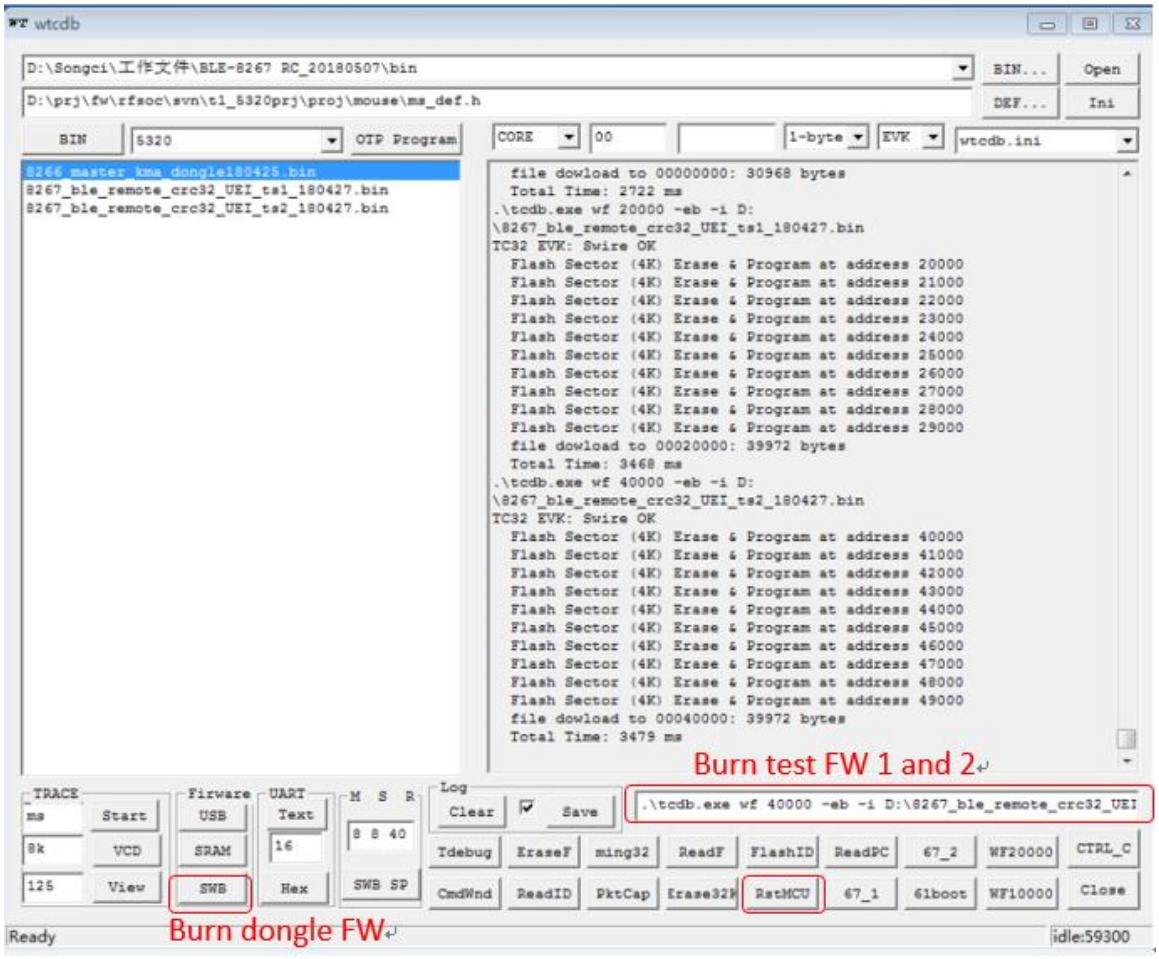
      By inputting the corresponding tcdb command and clicking the “Enter” key, burn the test firmware 1 into dongle flash area starting from 0x20000, and burn the test firmware 2 into dongle flash area starting from 0x40000.

      The tcdb commands to burn the test firmware 1 and test firmware 2 are shown as below:

.\tcdb.exe wf 20000 -eb -i D:\bin file name of test firmware 1 (e.g. 8278_ble_remote_ota_ts1.bin)

.\tcdb.exe wf 40000 -eb -i D:\ bin file name of test firmware 2 (e.g. 8278_ble_remote_ota_ts1.bin)

Figure 6-2 Firmware burning chart



2. Pair the RC with the dongle (refer to section 2.4).

3. Successively click the “SW1” button of the dongle for five times to trigger the dongle to enter OTA mode. The green LED and blue LED of the dongle will blink three times, which indicates the dongle has entered OTA mode.

4. To transmit and upgrade the test firmware 1 (starting from 0x20000) to the RC via OTA, click the “SW1” button of the dongle. The dongle’s blue LED will first be turned on, then blink three times. The white LED will be turned on to indicate OTA is finished.

5. To transmit and upgrade the test firmware 2 (starting from 0x40000) to the RC via OTA, click the “SW2” button of the dongle. The dongle’s green LED will first be turned on, then blink three times. The white LED will be turned on to indicate OTA is finished.

Note

- *During OTA process, audio function is disabled, and button function is normal.*
- *During OTA process, RCU does not allow Pairing/Un-pairing/FW version check.*
- *To ensure recording quality, it’s not recommended to make the RCU enter OTA during recording process.*