



USER'S GUIDE

AMDTP Example

Ultra-Low Power Apollo MCU Family

A-MCUAP3-UGGA03EN v1.0



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Revision History

| Revision | Date | Description |
|----------|--------------------|------------------|
| 0.1 | September 14, 2017 | Initial release |
| 1.0 | March 8, 2022 | Updated template |

Reference Documents

| Document ID | Description |
|-------------|-------------|
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SECTION

1

Service Declaration

The service UUID of Ambiq DTP (Data Transfer Protocol) service is defined as below 00002760-08C2-11E1-9073-0E8AC72E1011.

NOTE: Base UUID of Bluetooth SIG is 00000000-0000-1000-8000-00805F9B34FB.
<https://www.bluetooth.com/specifications/assigned-numbers/service-discovery>

1.1 Service Characteristics Definitions

Rx: 00002760-08C2-11E1-9073-0E8AC72E0011

Tx: 00002760-08C2-11E1-9073-0E8AC72E0012

ACK/Control: 00002760-08C2-11E1-9073-0E8AC72E0013

Table 1-1: Service Characteristics Definitions

| Characteristic | Requirements | Mandatory Properties | Security Permissions | Description |
|--|--------------|----------------------|----------------------|----------------------------------|
| Characteristic Rx | M | Write | None | Data from client |
| Characteristic Rx User Description | O | Read | None | Value read by client |
| Characteristic Tx | M | Notify | None | Value notification to client |
| Characteristic Tx Client Characteristic Configuration descriptor | M | Read/Write | None | Value notification configuration |

Table 1-1: Service Characteristics Definitions (*Continued*)

| Characteristic | Requirements | Mandatory Properties | Security Permissions | Description |
|--|--------------|----------------------|----------------------|-----------------------------------|
| Characteristic ACK | M | Write/Notify | None | ACK/Control to client |
| Characteristic ACK Client Characteristic Configuration descriptor | M | Read/Write | None | ACK notification configuration |

1.2 Characteristics

The following characteristics are defined in the AM DTP Service. Only one instance of each characteristic is permitted within this service.

Table 1-2: AM DTP Service Characteristics

| Characteristic Name | Mandatory Properties | Security Permission |
|---------------------|----------------------|---------------------|
| Characteristic Rx | Write Command | None |
| Characteristic Tx | Notify | None |
| Characteristic ACK | Write Command/Notify | None |

1.3 Characteristic Descriptors

1.3.1 Characteristic User Description

This characteristic descriptor defines the AM DTP version with read permission property.

1.3.2 Client Characteristic Configuration Descriptor

The notification characteristic will start to notify if the value of the CCCD (Client Characteristic Configuration Descriptor) is set to 0x0001 by client. The send data characteristic will stop notifying if the value of the CCCD is set to 0x0000 by client.

SECTION

2

Service Behaviors

This section describes the service behaviors:

1. Either server or client may initiate data transfer.
2. Client enables notification of Tx over the CCCD upon connection establishment.
3. Client enables notification of ACK over its CCCD upon connection establishment.
4. Server to Client transmission (ACK mechanism enabled):
 - a. Server starts data transmission by sending data packet to the client via notification (Characteristic Tx).
 - b. Client response with acknowledgment by writing to ACK characteristic.
 - c. Upon the ACK, Server behaviors are as following:
 - i. **AMDTP_STATUS_SUCCESS** - Checksum is good. Server sends next packet.
 - ii. **AMDTP_STATUS_CRC_ERROR** - Checksum is bad. Server resend current packet.
 - iii. **AMDTP_STATUS_TIMEOUT** - Packet sent timeout. Server resend current packet.
5. Client to Server transmission (ACK mechanism enabled):
 - a. Client starts data transmission by sending data data packet to the server via writing to the RX characteristic (Characteristic Rx).
 - b. Server response with acknowledgment by ACK notification (Characteristic ACK).
 - c. Upon the ACK, Client behaviors are as following:
 - i. **AMDTP_STATUS_SUCCESS** - Checksum is good. Client sends next packet.
 - ii. **AMDTP_STATUS_CRC_ERROR** - Checksum is bad. Client resend current packet.
 - iii. **AMDTP_STATUS_TIMEOUT** - Packet sent timeout. Client resend current packet.

2.1 AMDTP Packet Definition

2.1.1 AMDTP Packet Format

Length: 2 bytes (data + checksum)

Header: 2 bytes

Data: 0 ~ 512 bytes

Checksum (CRC32): 4 bytes (Header and length are excluded, only data part is calculated)

Table 2-1: AMDTP Packet Format

| Length | Header | Data | Checksum (CRC32) |
|---------|---------|---------------|------------------|
| 2 bytes | 2 bytes | 0 ~ 512 bytes | 4 bytes |

Table 2-2: AMDTP Header Format

| Bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|----------|----|----|----|---------------|----|---|---|-----|-----|-----|---|---|---|---|---|--|
| Pkt Type | | | | Serial Number | | | | Enc | Ack | RFU | | | | | | |

Serial Number: Packet serial number

Enc: Encryption enabled

Ack: Ack mechanism enabled

2.1.2 Packet Types

```
typedef enum eAmdtpPktType
{
    AMDTP_PKT_TYPE_UNKNOWN,
    AMDTP_PKT_TYPE_DATA,
    AMDTP_PKT_TYPE_ACK,
    AMDTP_PKT_TYPE_CONTROL,
    AMDTP_PKT_TYPE_MAX
}eAmdtpPktType_t;
```

Data Packet

Prefix : 2 bytes length + 2 bytes header

Data : 0 ~ 512 bytes

Checksum : 4 bytes

ACK Packet

Prefix : 2 bytes length + 2 bytes header

Status : 1 byte

Checksum : 4 bytes

CONTROL Packet

Prefix: 2 bytes length + 2 bytes header

Status: 1 byte

Serial Number: 1 byte

Checksum: 4 bytes

2.1.3 AMDTP Status Code

```
typedef enum
{
    AMDTP_STATUS_SUCCESS,
    AMDTP_STATUS_CRC_ERROR,
    AMDTP_STATUS_INVALID_METADATA_INFO,
    AMDTP_STATUS_INVALID_PKT_LENGTH,
    AMDTP_STATUS_INSUFFICIENT_BUFFER,
    AMDTP_STATUS_UNKNOWN_ERROR,
    AMDTP_STATUS_BUSY,
    AMDTP_STATUS_NOTIFY_DISABLED,
    AMDTP_STATUS_TX_NOT_READY,
    AMDTP_STATUS_RESEND_REPLY,
    AMDTP_STATUS_RECEIVE_CONTINUE,
    AMDTP_STATUS_RECEIVE_DONE,
    AMDTP_STATUS_MAX
}eAmdtpStatus;
```

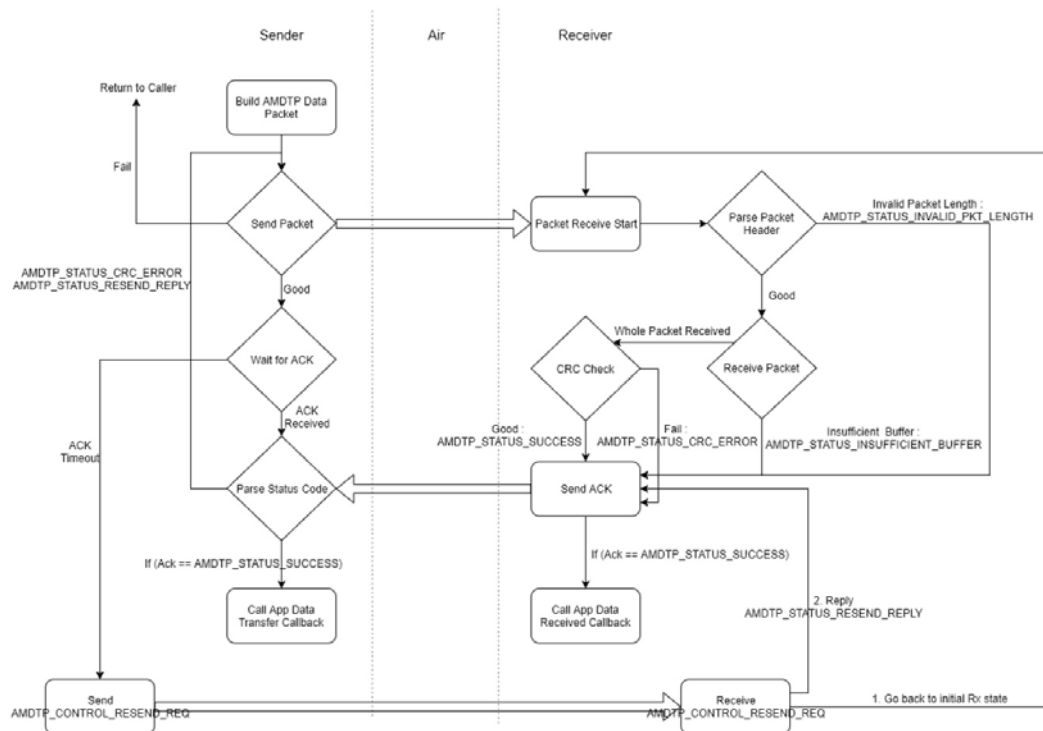
2.1.4 AMDTP Fragmentation and Reassemble

The maximum transmit unit size in ATT layer can be different from various products which introduced a limitation to the maximum payload size of a notification packet in Bluetooth Low Energy. In order to overcome above limitation, we have implemented an AMDTP packet fragmentation and reassemble mechanism in AMDTP service. The user can configure the maximum AMDTP packet size for fitting different applications. When transmitting, an AMDTP packet will be fragmented into maximum link layer MTU size and will be sent from the length field to the CRC field in an AMDTP packet. The receiver side will check the whole AMDTP packet is received based on the AMDTP packet length information and does a CRC check for AMDTP packet correctness.

2.1.5 AMDTP Data Deliver Reliability

An ACK mechanism is added into AMDTP profile level for the data deliver reliability. Figure 2-1 AMDTP Packet Transfer Flowchart shows the communications between sender and receiver.

Figure 2-1: AMDTP Packet Transfer Flowchart



2.2 AMDTP Integration with Applications

Below are the procedures to add AMDTP profile into an example that uses Cordio Bluetooth Low Energy stack.

1. Add below files into project
 - `amdtp_main.c`
 - `amdtp_common.c`
 - `amdtps_main.c`
 - `svc_amdtp.c`
2. Add below paths into "include" folder
 - `sdk_root/ambiq_ble/apps/amdtps`
 - `sdk_root/ambiq_ble/profiles/amdtpcommon`
 - `sdk_root/ambiq_ble/profiles/amdtps`
 - `sdk_root/ambiq_ble/services`
3. In application handler initialization function (e.g., `AmdtpHandlerInit()`), call below function to initialize AMDTP server. Two callback functions `amdtpDtpRecvCbback()` and `amdtpDtpTransCbback()` need to be created in the project


```
amdtps_init(handlerId, (AmdtpsCfg_t *) &amdtpAmdtpsCfg, amdtpDtpRecvCbback, amdtpDtpTransCbback);
```
4. Add `AMDTPS_TX_CH_CCC_HDL` and `AMDTPS_ACK_CH_CCC_HDL` to CCC set

5. Call function `amdtps_start()` or `amdtps_stop()` when `AMDTP_AMDTPS_TX_CC_IDX` value changed
6. Call function `amdtps_proc_msg()` in the message process function for below messages:
 - `AMDTP_TIMER_IND`
 - `ATTS_HANDLE_VALUE_CNF`
 - `DM_CONN_OPEN_IND`
 - `DM_CONN_CLOSE_IND`
 - `DM_CONN_UPDATE_IND`
7. Call below functions when add the characteristics

```
SvcAmdtpsCbackRegister(NULL, amdtps_write_cback);  
SvcAmdtpsAddGroup();
```

SECTION

3

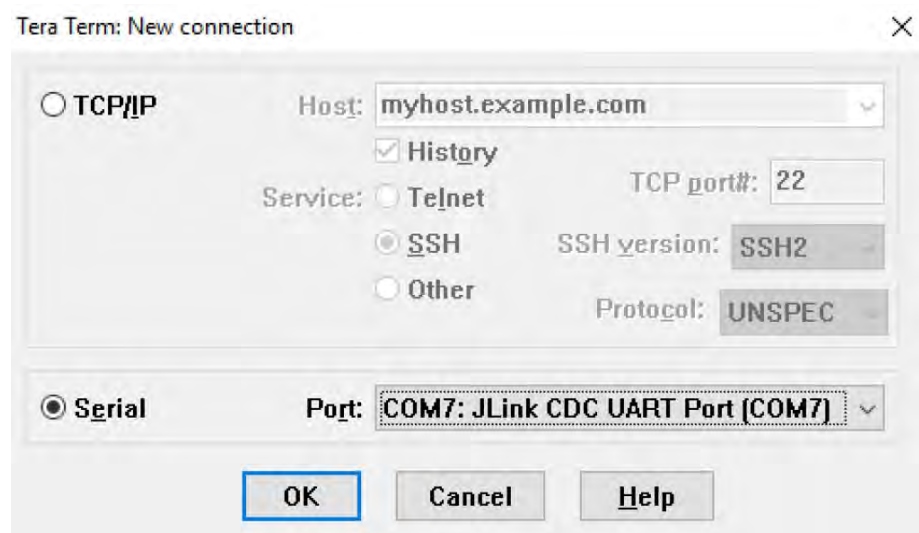
Hands on AMDTP Example

3.1 AMDTP Server

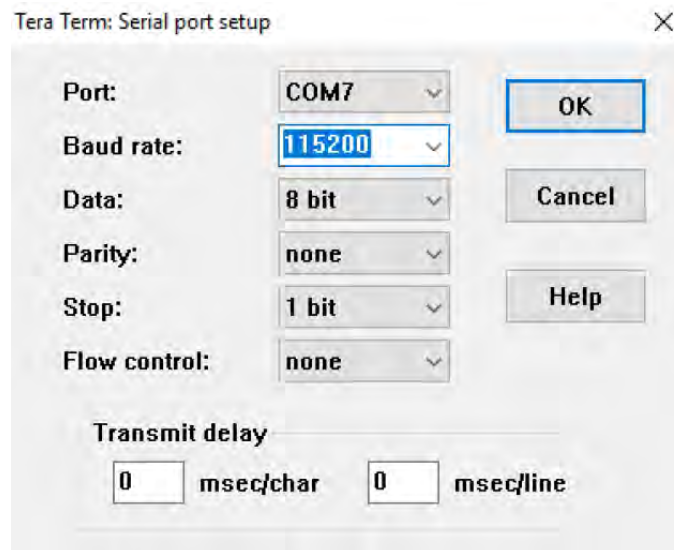
1. Program AMDTPS project into the development board.
2. Reset the board and it will start to advertise automatically.
3. Debug output is going through SWO.

3.2 AMDTP Client

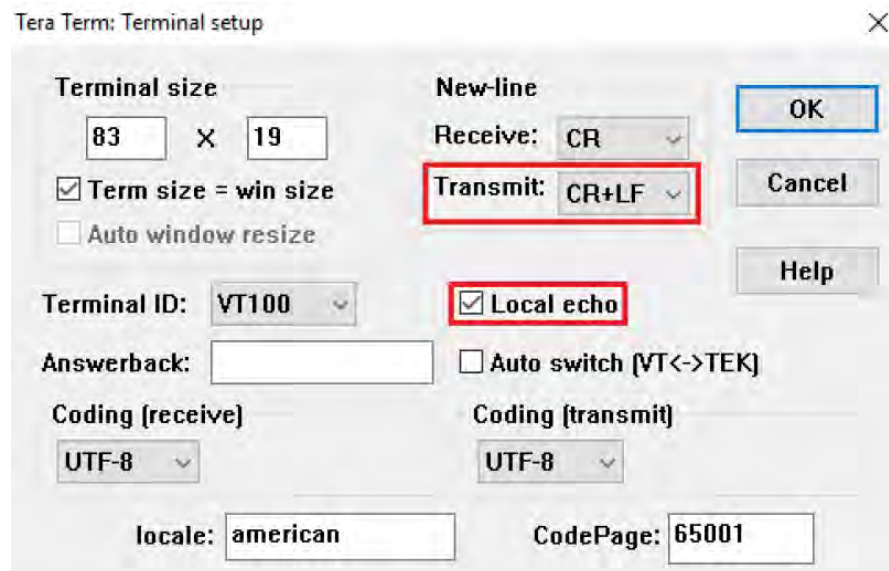
1. Program AMDTPC project into the development board.
2. Debug output is going through SWO.
3. Start a COM terminal tool (e.g., Tera Term) and connects to the board.



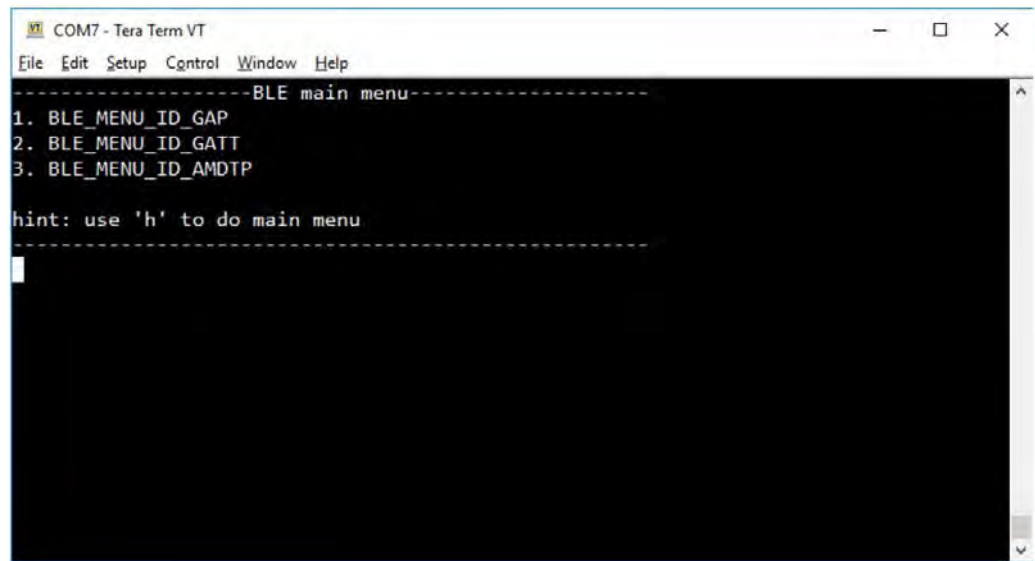
4. Click **Setup**, then select **Serial** port.
5. Change **Baud rate** to **115200**, then click **OK**.



6. Click **Setup**, then select **Terminal**.
7. Select **CR+LF** in the **Transmit** drop-down option.
8. Select the **Local echo** check box, then click **OK**.



After resetting the board, you should see the output in terminal.

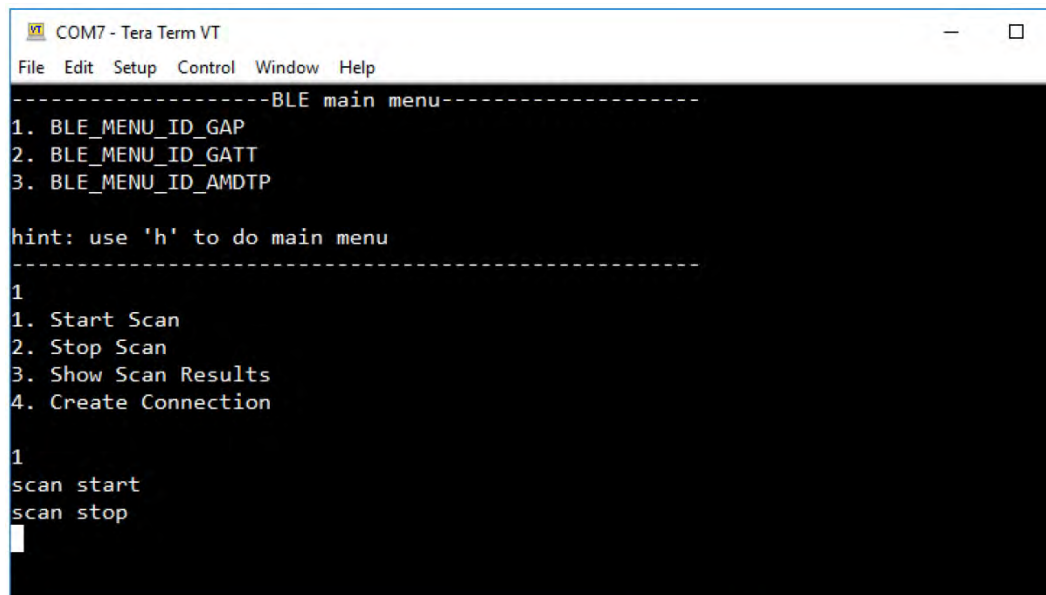


```

COM7 - Tera Term VT
File Edit Setup Control Window Help
-----BLE main menu-----
1. BLE_MENU_ID_GAP
2. BLE_MENU_ID_GATT
3. BLE_MENU_ID_AMDTP
hint: use 'h' to do main menu
-----

```

9. Complete the following to create connection with AMDTPS:
 - a. Input **1** and press **ENTER** to go into **BLE_MENU_ID_GAP**.
 - b. Input **1** again to **Start scan** and wait for 5 seconds for the scan to complete.
Hint: Observe AMDTP client activities from the J-link SWO output while operating.



```

COM7 - Tera Term VT
File Edit Setup Control Window Help
-----BLE main menu-----
1. BLE_MENU_ID_GAP
2. BLE_MENU_ID_GATT
3. BLE_MENU_ID_AMDTP
hint: use 'h' to do main menu
-----
1
1. Start Scan
2. Stop Scan
3. Show Scan Results
4. Create Connection
1
scan start
scan stop

```

10. After the scan completes, input **4** to **Create Connection**.

Note: Scan results will be popped as shown below. The first number in the list is the index and followed by BD address type and BD address.

```
COM7 - Tera Term VT
File Edit Setup Control Window Help
hint: use 'h' to do main menu
-----
1
1. Start Scan
2. Stop Scan
3. Show Scan Results
4. Create Connection

1
scan start
scan stop
4
choose an idx from scan results to connect:
-----Scan Results-----
0 : 0 09e430eef30c
1 : 0 ec9cd0c75204
2 : 0 60171f69ee18
-----
```

11. Input the target index to be connected to. A **Connection opened** message will show up after connecting to target device.

```
COM7 - Tera Term VT
File Edit Setup Control Window Help
1
1. Start Scan
2. Stop Scan
3. Show Scan Results
4. Create Connection

1
scan start
scan stop
4
choose an idx from scan results to connect:
-----Scan Results-----
0 : 0 09e430eef30c
1 : 0 ec9cd0c75204
2 : 0 60171f69ee18
-----
0
Connection opened
```


12. Input **h** to go back to root menu.

```
COM7 - Tera Term VT
File Edit Setup Control Window Help
scan stop
4
choose an idx from scan results to connect:
-----Scan Results-----
0 : 0 09e430eef30c
1 : 0 ec9cd0c75204
2 : 0 60171f69ee18
-----
0
Connection opened
h
-----BLE main menu-----
1. BLE_MENU_ID_GAP
2. BLE_MENU_ID_GATT
3. BLE_MENU_ID_AMDTP

hint: use 'h' to do main menu
-----
```

13. Input **3** to go into `BLE_MENU_ID_AMDTP` and it provides 4 commands to interact with AMDTP Server.

```
COM7 - Tera Term VT
File Edit Setup Control Window Help
2 : 0 60171f69ee18
-----
0
Connection opened
h
-----BLE main menu-----
1. BLE_MENU_ID_GAP
2. BLE_MENU_ID_GATT
3. BLE_MENU_ID_AMDTP

hint: use 'h' to do main menu
-----
3
1. Send test data continuously
2. Stop sending test data
3. Request Server to send
4. Request Server to stop sending
```



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