

PC application for ML7105 evaluation kit

User's Manual

NOTES

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Preface

This user's manual describes the functional specification of PC application bundled with evaluation kit for the Bluetooth® Low Energy ML7105.

The following related manual is available and should be referenced as needed.

- ML7105 data sheet
- ML7105 user's manual
- Bluetooth Application Controller Interface (BACI) Command Manual
- ML7105 Wireless Sensor Node BOARD (WSN7105GD-01) Hardware Manual
- ML7105 USB BOARD Hardware Manual
- Wireless Sensor Node Application for ML7105 Evaluation Kit User's Manual

Notation

Classification	Notation	Description
● Numeric value	0xnnn 0bnnnnn	Represents a hexadecimal number. Represents a binary number.
● Address	0xnnnn_nnnn	Represents a hexadecimal number. (indicates 0xnnnnnnnn)
● Unit	word, W byte, B Mega, M Kilo, K (uppercase) Kilo, k (lowercase) Milli, m Micro, μ Nano, n Second, s (lowercase)	1 word = 32 bits 1 byte = 8 bits 10^6 $2^{10}=1024$ $10^3=1000$ 10^{-3} 10^{-6} 10^{-9} Second
● Terminology	"H" level "L" level	Signal level on the high voltage side; indicates the voltage level of V_{IH} and V_{OH} as defined in electrical characteristics. Signal level on the low voltage side; indicates the voltage level of V_{IL} and V_{OL} as defined in electrical characteristics.
● Register description	Read/write attribute: R indicates read-enabled; W indicates write-enabled. MSB: Most significant bit in an 8-bit register (memory) LSB: Least significant bit in an 8-bit register (memory)	

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1. General Description

This document describes operating manual of PC application software bundled to evaluation kit ML7105. The Kit include USB dongle + ML7105 wireless module as HOST role, and Sensor Node + ML7105 wireless module as Peripheral role. Please refer to hardware manual for both environment. PC application for evaluation kit ML7105 control Sensor Node and receive data from Sensors mounted on Sensor Node over Bluetooth Low Energy network. The profile is based on the proprietary profile and is called VSP (Vendor Specific Profile). It is possible to perform the feature of the simple data transmission of Bluetooth Low Energy.

1.1 System Overview

Figure 1.1 shows the protocol stack configuration figure of the Bluetooth Low Energy with using ML7105. ML7105 contains the Bluetooth Low Energy stack and can communicate with windows PC via Virtual Com Port over USB interface. In Windows PC application, profile and control software are implemented. Software architecture is shown below.

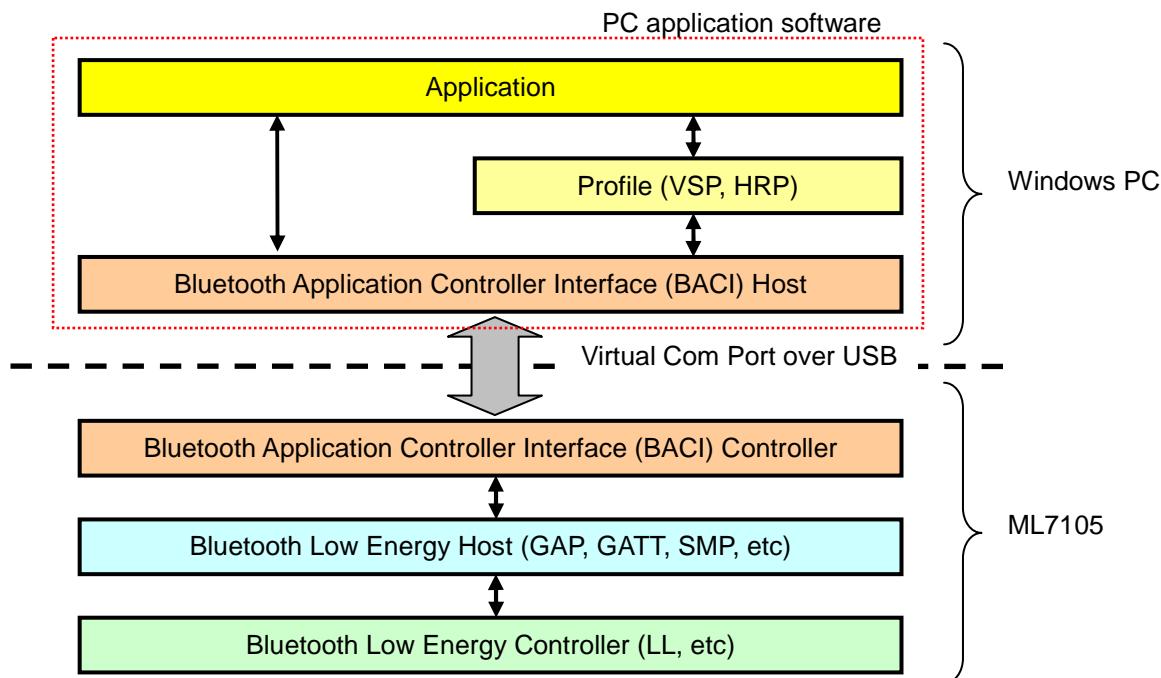


Figure 1.1 Protocol stack configuration

Figure 1.2 shows the system overview of the evaluation kit ML7105. PC application has master side (HOST or Central role). Connection between USB conversion board and Windows PC is Virtual Com Port over USB.

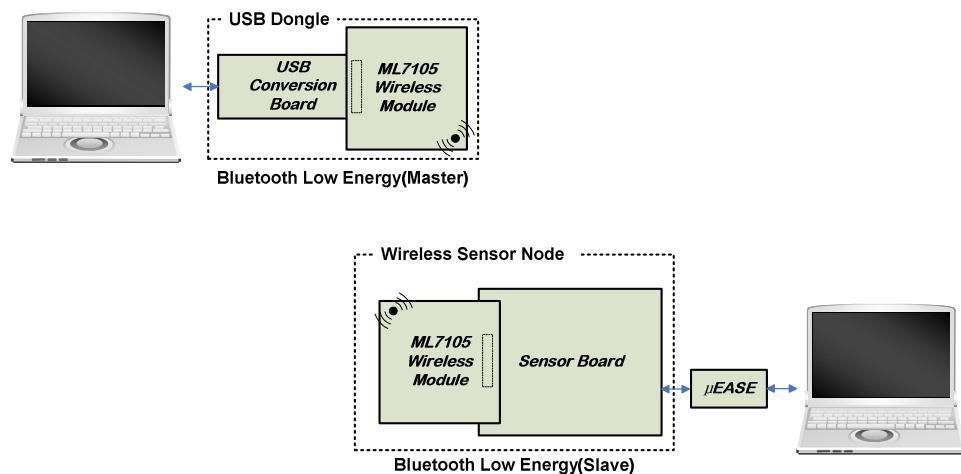


Figure 1.2 System overview

1.2 PC application Software Package

PC application software for evaluation kit ML7105 includes following files.

- baci_app_rev4.exe : command line application executable
- baci_app_config.txt : Initial setup file
- README_BACI_PC_APP.txt : Simplified version of user's manual

The screenshot shows a Windows command-line application window titled "C:\\$work_dir\\$baci_app_rev4\\$baci_app_rev4.exe". The window displays the following text:

```

Sending RESET...
TX: 1 1 0 0 L 2

-----
CLIENT APPL MENU
-----
0 - Exit
1 - Refresh
2 - Advertise/Scan & Connect
3 - Bond
4 - Disconnect
5 - Read Connection RSSI
6 - Add to white list
7 - Clear white list
8 - Connection Parameter Update
10 - HRS Operations
11 - Temperature Operations
12 - Battery Operations
13 - Accelerometer Operations
14 - LED Operations
20 - GATT Client Operations

Your Option ?
Enter you choice : Received Startup
Read local device address ...
TX: 1 b 1 0 L 3
Received Command Complete Event
Status [0x00]
Length of the command complete event packet [0x0C]
Dumping Event Data
0xD1 0xD2 0xD3 0xD3 0xD2 0xD1 0xD1 0xD2 0xD3 0xD3 0xD2 0xD1
Public Address: 0xD1-D2-D3-D3-D2-D1
Random Static Address: 0xD1-D2-D3-D3-D2-D1

```

Figure 1.3 baci_app_rev4

1.3 Initial setup

1.3.1 Configuration of ML7105 wireless module

ML7105 wireless module has to be in BACI over UART mode. As a default, ML7105 wireless module will be provided by BACI mode. It is possible to select physical layer of BACI mode either over SPI or over UART. See ML7105 USB BOARD Hardware Manual for more detail.

1.3.2 Configuration of BT transport

When ML7105 USB board is connected to PC, a Com port number will be assigned if you have installed driver software for USB serial IC properly. You can check assigned Com port number by using device manager.

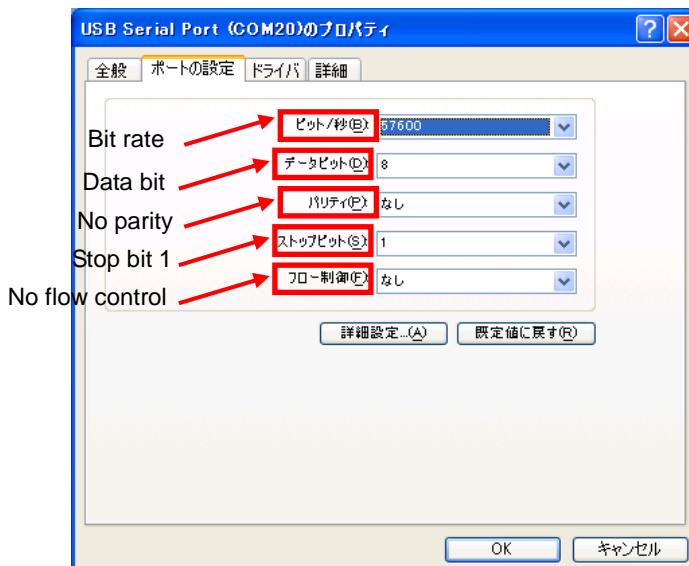


Figure 1.4 UART port configuration

Com port has to be configured as shown above, 57.6kbps baud rate, 8bit data, no parity, 1-stop bita and no flow control. Same information has to be configured in 'baci_app_config.txt'

```
#=====
#   BT Transport settings
#=====

## Transport selection: UART 0, USB 1, SOCKET 2
HCI_TRANSPORT=0

# UART Transport device settings
# For Ports greater than COM9 on Windows devices, UART Device Name
# should be of the format 'YY.YCOMX'
BT_UART_DEVICE_NAME=YY.YCOM20
BT_UART_DEVICE_BAUD=57600
```

1.3.3 Configure BD_ADD and address type

In the 'baci_app_config.txt' there is section configure BD_ADDR for peer device and address type.

```
#=====
#   Local Device settings
#=====

BT_LOCAL_DEVICE_NAME=MindTree

# Sensor Node
BT_PEER_DEVICE_ADDR=070001000571

# Public 0, Random 1
BT_PEER_DEVICE_ADDR_TYPE=0
```

Please mind that BD_ADDR has to be written LSO to MSO.

```
#BT_PEER_DEVICE_ADDR_TYPE=0 for Public address
#BT_PEER_DEVICE_ADDR_TYPE=1 for Random address.
```

1.3.4 Configure device role

In the ‘baci_app_config.txt’ there is section configure device role.

```
## Device Role: Peripheral 0 or Central 1
BT_DEVICE_ROLE=1
#BT_DEVICE_ROLE=1 for Central (Host) device
#BT_DEVICE_ROLE=0 for Peripheral (Sensor) device
```

1.3.5 Advertizing parameters

In the ‘baci_app_config.txt’ there is section configure advertizing parameters. Table 1.1 shows advertizing parameter. In the ‘baci_app_config.txt’ file, there are two type of advertizing parameters are described. One for Bonded device, the other for UnBonded device, which parameters starting from “BT_PERIPHERAL_BONDED_XXXX” and “BT_PERIPHERAL_UNBONDED_XXXX” respectively. (Here XXXX will be filled in parameter name shown Table.1.1.

Table 1.1 Advertisement parameters

Advertisement Parameter	Value [dec]	Value range	Parameter Description
ADVERTISING_INTERVAL_MIN	32	20ms-10.24	Advertizing interval minimum, 20 msec (32 x 0.625ms)
ADVERTISING_INTERVAL_MAX	32	20ms-10.24	Advertizing interval maximum, 20 msec (32 x 0.625ms)
ADVERTISING_TYPE	0	0-3	0: Connectable undirected advertising (ADV_IND) 1: Connectable directed advertising (ADV_DIRECT_IND) 2: Scannable undirected advertising (ADV_SCAN_IND) 3:Non connectable undirected advertising (ADV_NONCONN_IND)
OWN_ADDR_TYPE	0	0-1	0: Public Device Address (default) 1: Random Device Address
DIRECT_ADDR_TYPE	0	0-1	0: Public Device Address (default) 1: Random Device Address
ADVERTISING_CHANNEL_MAP	7	0-7	Channel map for advertizing, all channels (37, 38, 39) enabled
ADVERTISING_FILTER_POLICY	0	0-3	0: Allow Scan Request from Any, Allow Connect Request from Any 1: Allow Scan Request from White List Only, Allow Connect Request from Any 2:Allow Scan Request from Any, Allow Connect Request from White List Only. 3 Allow Scan Request from White List Only, Allow Connect Request from White List Only.

1.3.6 Scan parameters

Table 1.2 shows scan parameter. In the ‘baci_app_config.txt’ file, there are two type of scan parameters are described. One for Bonded device, the other for UnBonded device, which parameters starting from “BT_CENTRAL_BONDED_XXXX” and “BT_CENTRAL_UNBONDED_XXXX” respectively. (Here XXXX will be filled in parameter name shown Table.1.2.

Table 1.2 Scan parameters

Scan Parameter	Value [dec]	Value range	Parameter Description
LE_SCAN_TYPE	1	0-1	0: Passive Scanning. No SCAN_REQ packets shall be sent. 1: Active scanning. SCAN_REQ packets may be sent.
LE_SCAN_INTERVAL	64	2.5ms -10.24s	Scanning interval, 40 msec (64 x 0.625ms)

LE_SCAN_WINDOW	64	2.5ms -10.2 4s	Duration of scanning, 40msec (64 x 0.625ms)
OWN_ADDRESS_TYPE	0	0-1	0: Public Device Address (default) 1: Random Device Address
SCANNING_FILTER_POLICY	0	0-1	0: Accept all advertisement packets (default). 1: Ignore advertisement packets from devices not in the White List Only.

1.3.7 Connection request parameters

Table 1.3 shows parameter used for connection request. In the ‘baci_app_config.txt’ file, there is a set of parameters for connection request, which parameters starting from “BT_CENTRAL_ XXXX”. (Here XXXX will be filled in parameter name shown Table.1.3

Table 1.3 Connection request parameters

Connection request Parameter	Value [dec]	Value range	Parameter Description
LE_SCAN_INTERVAL	4	2.5ms -10.2 4s	Scanning interval, 2.5 msec (64 x 0.625ms)
LE_SCAN_WINDOW	4	2.5ms -10.2 4s	Duration of scanning, 2.5 msec (64 x 0.625ms)
INITIATOR_FILTER_POLICY	0	0-1	0: White list is not used to determine which advertiser to connect to. Peer_Address_Type and Peer_Address shall be used.Accept all advertisement packets (default). 1: White list is used to determine which advertiser to connect to. Peer_Address_Type and Peer_Address shall be ignored.
OWN_ADDRESS_TYPE	0	0-1	0: Public Device Address (default) 1: Random Device Address
CONN_INTERVAL_MIN	40	7.5ms - 4s	Minimum value for the connection event interval. 50 msec (40 x 1.25ms)
CONN_INTERVAL_MAX	56	7.5ms - 4s	Maximum value for the connection event interval. 70 msec (56 x 1.25ms)
CONN_LATENCY	0	0-500	Slave latency for the connection in number of connection events.
SUPERVISION_TIMEOUT	955	0-320 0	Supervision timeout for the LE Link. 9550 msec (955 x 10ms)
MINIMUM_CE_LENGTH	32	0-655 35	Information parameter about the minimum length of connection needed for this LE connection. 20 msec (32 x 0.625ms)
MAXIMUM_CE_LENGTH	32	0-655 35	Information parameter about the maximum length of connection needed for this LE connection. 20 msec (32 x 0.625ms)

1.3.8 Connection update parameters

Table 1.4 shows parameter used for connection update. In the ‘baci_app_config.txt’ file, there is a set of parameters for connection update, which parameters starting from “BT_PERIPHERAL_XXXX”. (Here XXXX will be filled in parameter name shown Table.1.4.

Table 1.4 Connection updated parameters

Connection update parameter	Value [dec]	Value range	Parameter Description
CONN_INTERVAL_MIN	40	7.5ms - 4s	Minimum value for the connection event interval. 50 msec (40 x 1.25ms)
CONN_INTERVAL_MAX	56	7.5ms - 4s	Maximum value for the connection event interval. 70 msec (56 x 1.25ms)
CONN_LATENCY	0	0-500	Slave latency for the connection in number of connection events.
SUPERVISION_TIMEOUT	955	0-320 0	Supervision timeout for the LE Link. 9550 msec (955 x 10ms)
MINIMUM_CE_LENGTH	32	0-655 35	Information parameter about the minimum length of connection needed for this LE connection. 20 msec (32 x 0.625ms)
MAXIMUM_CE_LENGTH	32	0-655 35	Information parameter about the maximum length of connection needed for this LE connection. 20 msec (32 x 0.625ms)

2. Operating Manual

2.1 Command Window

When configuration of 'baci_app_config.txt' completed, it is now ready to start up application 'baci_app_rev4.exe'. By double click application icon, you will see command line window with following start up message. After starting up, the application performs to read own local device address. Please confirm the display of address information which is in red line as below.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
Sending RESET...

-----
CLIENT APPL MENU
-----
0 - Exit
1 - Refresh
2 - Advertise/Scan & Connect
3 - Bond
4 - Disconnect
5 - Read Connection RSSI
6 - Add to white list
7 - Clear white list
8 - Connection Parameter Update
10 - HRS Operations
11 - Temperature Operations
12 - Battery Operations
13 - Accelerometer Operations
14 - LED Operations
20 - GATT Client Operations

Your Option ?
TX: 1 1 0 0 L 2
Enter you choice : Received Startup
Read local device address ...
TX: 1 b 1 0 L 3
Received Command Complete Event
Status [0x00]
Length of the command complete event packet [0x0C]
Dumping Event Data
0xD1 0xD2 0xD3 0xD3 0xD2 0xD1 0xD1 0xD2 0xD3 0xD3 0xD2 0xD1
Public Address: 0xD1-D2-D3-D3-D2-D1
Random Static Address: 0xD1-D2-D3-D3-D2-D1

```

Figure 2.1 baci app_rev4

2.2 Debug Messages

After starting up, the application issues the reset command and read command of local address to ML7105. The following messages are related to the first reset command.

Sending RESET...
TX: 1 1 0 0 L 2

The meaning of the character string which continues behind "TX:" is as follows.

- 1 BACI packet type = 0x01 (BACI command packet)
- 1 Opcode/Event type = 0x01 (Reset command)
- 0 Parameter total length = 0x00 (Reset command does not have any parameters)
- 0 1st byte of parameters (If parameter total length is zero, then ignore this byte)
- L Identifier of "Length"
- 2 Total packet length excluding packet type = 0x02

After the application issues BACI reset command, the application will receive the Start-up event from ML7105 as follows.

Received Startup

After receiving of the Start-up event, the application will issue the read command of local address.

Read local device address ...
TX: 1 b 1 0 L 3

The meaning of the character string which continues behind "TX:" is as follows.

- 1 BACI packet type = 0x01 (BACI command packet)
- b Opcode/Event type = 0x0B (Read Local Device Address command)
- 1 Parameter total length = 0x01
- 0 1st byte of parameters = 0x00 (Read Public Static Random Address)
- L Identifier of "Length"
- 3 Total packet length excluding packet type = 0x03

After the application issues Read Local Deice Address command, the application will receive the Command Complete event from ML7105 as follows.

Received Command Complete Event
Status [0x00]
Length of the command complete event packet [0x0C]
Dumping Event Data
0xD1 0xD2 0xD3 0xD3 0xD2 0xD1 0xD1 0xD2 0xD3 0xD3 0xD2 0xD1
Public Address: 0xD1-D2-D3-D3-D2-D1
Random Static Address: 0xD1-D2-D3-D3-D2-D1

Regarding the detail of the format of Command/Event, please refer to “Bluetooth Application Controller Interface (BACI) Command Manual.

2.3 Navigation menu

Figure 2.3.1 shows state diagram of PC application for evaluation kit ML7105.

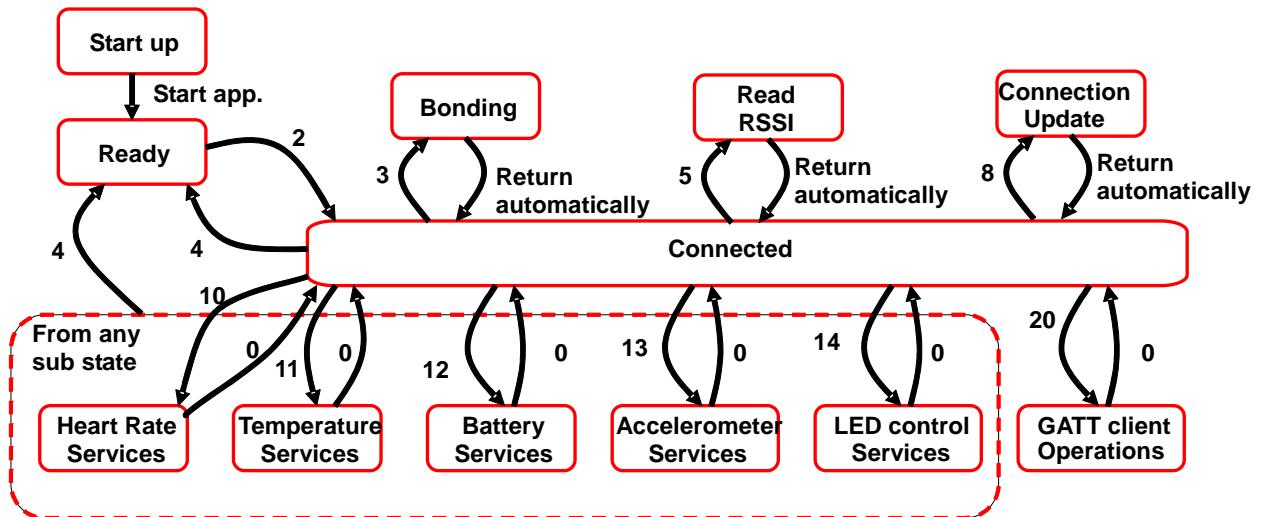


Figure 2.3.1 Menu navigation

In each service sub state, basically same principle of sub menu navigation to be applied.

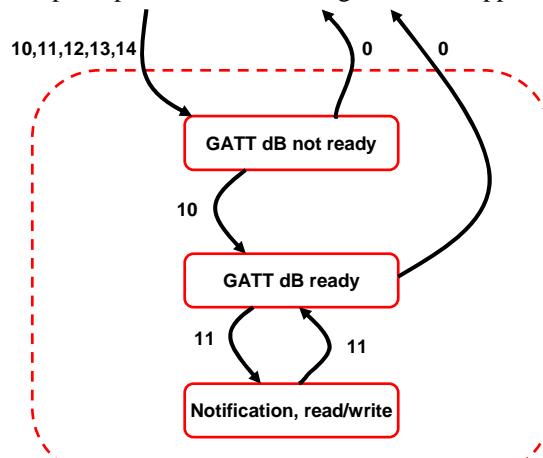


Figure 2.3.2 Service state

2.4 Refresh and Exit

In the command line window, there are menu displaying available command called "refresh". By typing "1", you can display available command whenever software is waiting for input.

In any state, you can exit from current state to previously located state by typing "0".

2.5 Connection setup

3 options of the connection setup are suprpted by PC application for the master device.

1. Scanning device in the config file and establish connection (added option to change connection parameter)
2. Scanning device in the white list and establish connection
3. Scanning device address and establish connection

Figure 2.5.1 shows screenshot when PC app performing scan&connect by typing “0” and “2”. 3 options are shown.

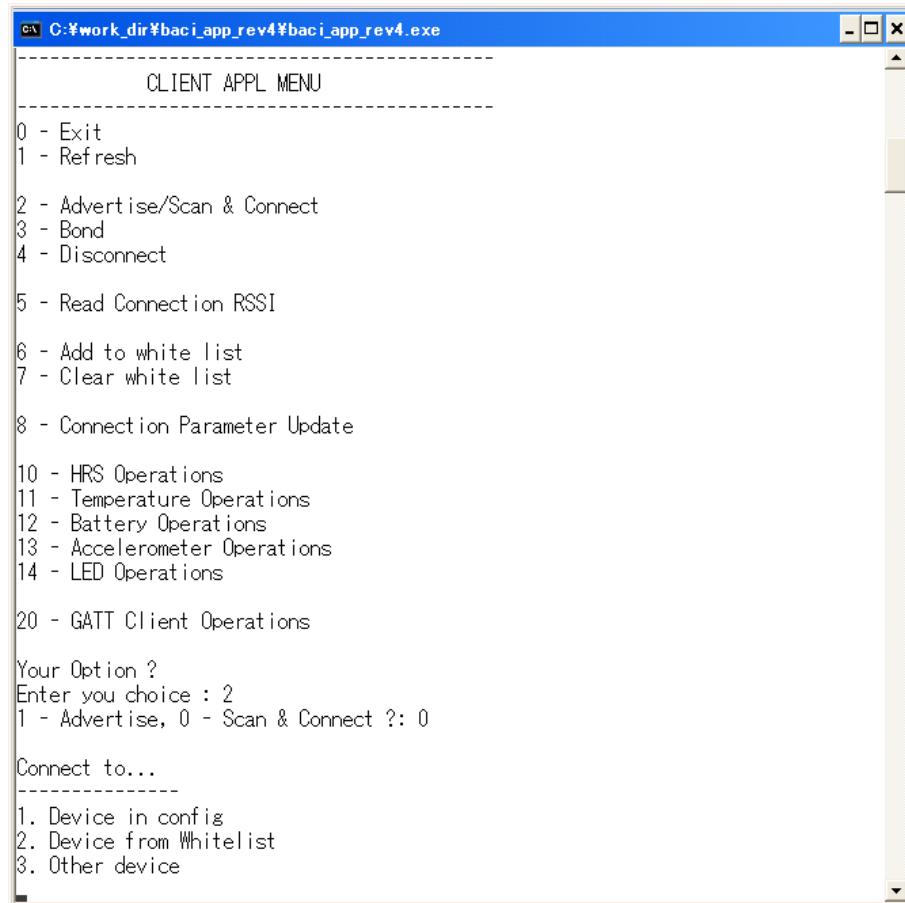


Figure 2.5.1 Scanning and Connect options

2.5.1 Connection with device in the config file

Figure 2.5.2 shows screen shot when selecting option1 in “Scan & Connect” menu 2. Pre-defined BDADDR wrtten in baci_app_config.txt is scanned and connected if the device was found by scan process.

In baci_app_config.txt, BDADDR is defined as shown below. The public address “d1 d2 d3 d3 d2 d1” is listed. In the end of command lines, there is a message showing “Received Connection Complete Event” and the address of connected device.

```
#=====
# Local Device settings
#=====
BT_LOCAL_DEVICE_NAME=MindTree

BT_PEER_DEVICE_ADDR=d1d2d3d3d2d1
#BT_PEER_DEVICE_ADDR=070001000571
# Public 0, Random 1
BT_PEER_DEVICE_ADDR_TYPE=0
```

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
20 - GATT Client Operations

Your Option ?
TX: 1 4 0 40 L 2      .....Sending of Wakeup command
Enter you choice : Received Command Complete Event
Status [0x00]
Length of the command complete event packet [0x00]
Dumping Event Data

TX: 1 f 30 0 L 32      .....Sending of Configure command (Start of scanning)
Received Advertising Report Event
Event Type [0x00]
Address Type [0x00]
Address: D1-D2-D3-D3-D2-D1
Dumping Advertising Data
0x02 0x01 0x06 0x07 0x03 0x0A 0x18 0x09 0x18 0x0D 0x18 0x09 0x08 0x42 0x6C 0x75
0x65 0x4C 0x69 0x74 0x45
RSSI [0xD4]
TX: 1 22 3 1 L 5      ..... Sending of Set_adv_scan command (Stop of scanning)
TX: 1 8 19 4 L 1b      ..... Sending of Connect command
[ATT]:[0x00]: Received ATT Event 0x81 with result 0x0000
[0x00]:Received Connection Indtication, Result 0x0000!
Received Connection Complete Event      ..... Receiving of Connection Complete event
Peer BD ADDR: D1-D2-D3-D3-D2-D1. Type 0x00
Status [0x00], Connection Handle [0x0060]

```

Figure 2.5.2 Connection with device in the config file

There is an option to change connection parameter such as connection interval so that shorted or longer interval of connection events. Following snapshot reprents menu changing connection parameter when master start scanning.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
Your Option ?
Enter you choice : 2
1 - Advertise, 0 - Scan & Connect ?: 0

Connect to...
-----
1. Device in config
2. Device from Whitelist
3. Other device
1
Update Connection Params? (1/0): 1
Enter the Scan Interval (in HEX): 40
Enter the Scan Window (in HEX): 40
Enter the Initiator Filter Policy (in HEX): 0
Enter the Own Address Type (in HEX): 0
Enter the Min Connection Interval (in HEX): 6
Enter the Max Connection Interval (in HEX): 6
Enter the Connection Latency (in HEX): 0
Enter the Supervision Timeout (in HEX): 100
Enter the Max CE Length (in HEX): 0
Enter the Min CE Length (in HEX): 0
Sending WAKEUP ...

```

Fig. 2.5.2.1 Changing connection parameter

Figure 2.5.3 shows Message Sequence Chart (MSC) while establishing baseband connection. Scanner send connection request and received Sensor Node as CONNECT_REQ (at Frame #1533)

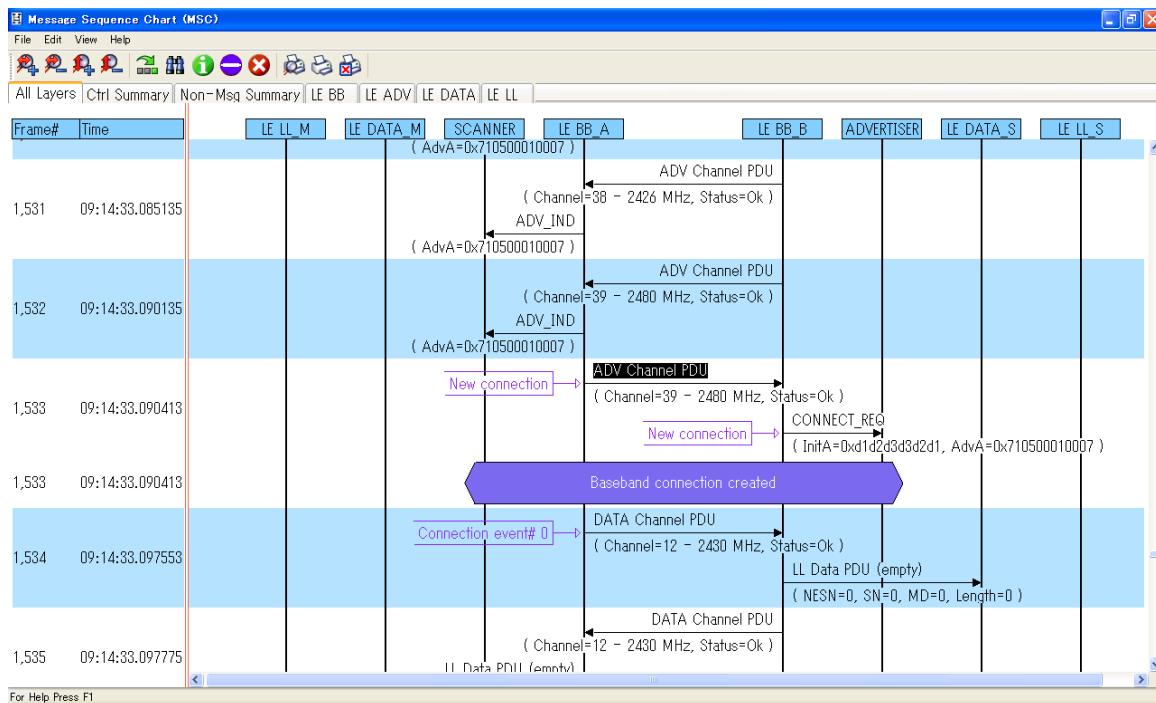


Figure 2.5.3 MSC Connection Setup

2.5.2 Connection with device in the White lists

The White lists is a list of remote device address, can be used for device filtering. It can be used to limit remote device to advertise, scan and connection procedures. Following example shows usage of white lists. Figure 2.5.4 is showing case when putting device into white list, in this application, user has to input address type and device address manually.

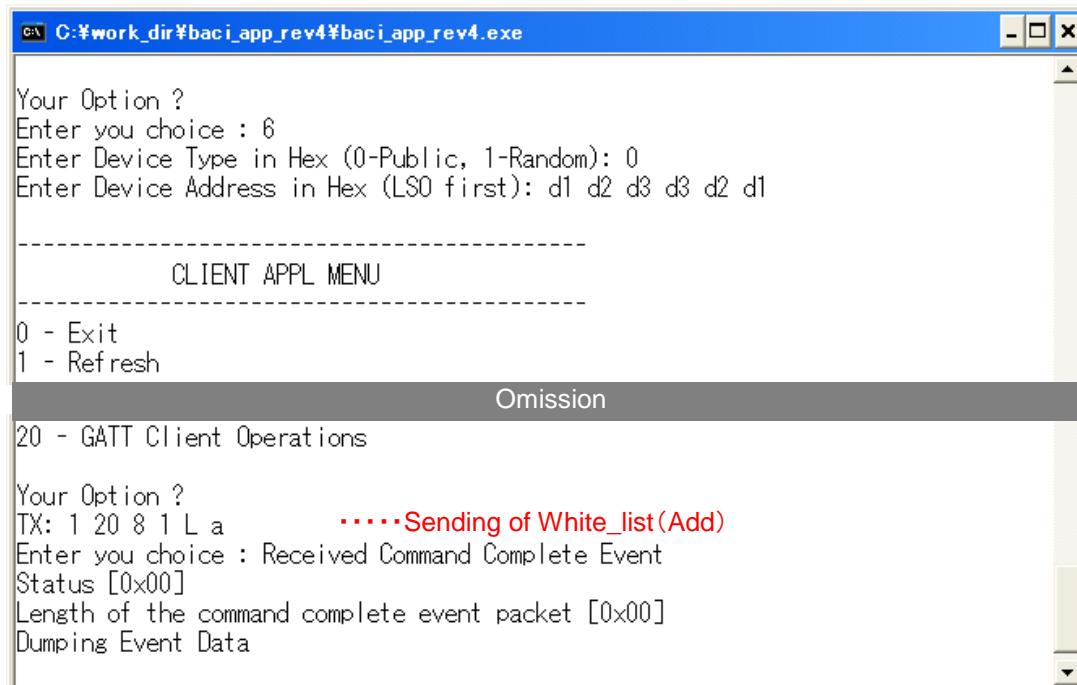


Figure 2.5.4 Putting device address in the White Lists

Once the device was registerd in the White Lists, option2 of “Advertise/Scan & Connect” will establish connection with device in the white lists. Figure 2.5.5 shows case when connecting device in the White Lists. In this example, connection is established because device address “d1 d2 d3 d3 d2 d1” is already registered in the White Lists”.

The screenshot shows a Windows application window titled "C:\work_dir\baci_app_rev4\baci_app_rev4.exe". The application interface is a command-line tool for managing Bluetooth connections. It displays the following sequence of events:

- User input: "Enter you choice : 2" (option 2: Scan & Connect).
- Application output: "1 - Advertise, 0 - Scan & Connect ?: 0"
- User input: "Connect to..." followed by a list of options:
 - 1. Device in config
 - 2. Device from Whitelist
 - 3. Other device
- User selection: "2" (Device from Whitelist).
- User input: "Update Connection Params? (1/0): 0" (0 = No).
- User input: "Sending WAKEUP ...".
- User input: "TX: 1 4 0 0 L 2" (indicating a Wakeup command is being transmitted). A red annotation next to this line says "----- Sending of Wakeup command".
- Application output: "----- CLIENT APPL MENU -----".
- User input: "0 - Exit" or "1 - Refresh".
- A horizontal bar labeled "Omission" covers several lines of text.
- User input: "20 - GATT Client Operations".
- User input: "Your Option ?".
- Application output: "Received Command Complete Event".
- User input: "Enter you choice : Status [0x00]".
- Application output: "Length of the command complete event packet [0x00]".
- Application output: "Dumping Event Data".
- User input: "TX: 1 f 30 0 L 32" (indicating a Configure command is being transmitted). A red annotation next to this line says "----- Sending of Configure command (Start of scanning, FilterPolicy=0x01)".
- Application output: "Received Advertising Report Event".
- Application output: "Event Type [0x00]".
- Application output: "Address Type [0x00]".
- Application output: "Address: D1-D2-D3-D3-D2-D1" (highlighted by a brace). A red annotation next to this line says "----- Receiving of Advertising data".
- Application output: "Dumping Advertising Data".
- Application output: "0x02 0x01 0x06 0x07 0x03 0x0A 0x18 0x09 0x18 0x0D 0x18 0x09 0x08 0x42 0x6C 0x75 0x65 0x4C 0x69 0x74 0x45 RSSI [0xD2]" (hexadecimal data dump and RSSI value).
- User input: "TX: 1 22 3 1 L 5" (indicating a Set_adv_scan command is being transmitted). A red annotation next to this line says "----- Sending of Set_adv_scan command (Stop of scanning)".
- User input: "TX: 1 8 19 4 L 1b" (indicating a Connect command is being transmitted). A red annotation next to this line says "----- Sending of Connect command".
- Application output: "[ATT]:[0x00]: Received ATT Event 0x81 with result 0x0000".
- Application output: "[0x00]:Received Connection Indt ication, Result 0x0000!".
- Application output: "Received Connection Complete Event" (highlighted by a brace). A red annotation next to this line says "----- Receiving of Connection Complete event".
- Application output: "Peer BD ADDR: D1-D2-D3-D3-D2-D1. Type 0x00".
- Application output: "Status [0x00], Connection Handle [0x0060]".

Figure 2.5.5 Connecting device in the White Lists

Current version of PC application support to clear the White Lists. Figure 2.5.6 shows case when clear the White Lists.

C:\\$work_dir\\$baci_app_rev4\\$baci_app_rev4.exe

14 - LED Operations
20 - GATT Client Operations
Your Option ?
Enter you choice : 7

CLIENT APPL MENU

0 - Exit
1 - Refresh
2 - Advertise/Scan & Connect
3 - Other device
4 - Device in config
5 - Device from Whitelist
6 - Scan & Connect
7 - Clear White List
8 - Set Whitelist
9 - Refresh Whitelist
Omission

20 - GATT Client Operations
Your Option ?
TX: 1 20 8 0 L a**Sending of White_list (Clear)**
Enter you choice : Received Command Complete Event
Status [0x00]
Length of the command complete event packet [0x00]
Dumping Event Data

Figure 2.5.6 Clear the White Lists

Next example shows when trying connection establishment while white lists is empty, connection will not be established because white lists is empty.

C:\\$work_dir\\$baci_app_rev4\\$baci_app_rev4.exe

Your Option ?
Enter you choice : 2
1 - Advertise, 0 - Scan & Connect ?: 0

Connect to...

1. Device in config
2. Device from Whitelist
3. Other device
2

Please add device to whitelist

CLIENT APPL MENU

0 - Exit
1 - Refresh
2 - Advertise/Scan & Connect

Figure 2.5.7 Connection with empty white lists

2.5.3 Scanning device address and establish connection

If the device address of remote device is unknown, it is possible to know by scanning device with option3 of “Advertise/Scan & Connect” menu. Scanning device with dummy address will list found device address.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe

Your Option ?
Enter you choice : 2
1 - Advertise, 0 - Scan & Connect ?: 0

Connect to...
-----
1. Device in config
2. Device from Whitelist
3. Other device
3
Enter Device Type in Hex (0-Public, 1-Random): 0
Enter Device Address in Hex (LS0 first): 0 0 0 0 0 0
Update Connection Params? (1/0): 0
Sending WAKEUP ...

-----
CLIENT APPL MENU
-----
0 - Exit
1 - Refresh

Omission

20 - GATT Client Operations

Your Option ?
TX: 1400L2      .....Sending of Wakeup command
Enter you choice : Received Command Complete Event
Status [0x00]
Length of the command complete event packet [0x00]
Dumping Event Data

TX: 1f300L32      .....Sending of Configure command (Start of scanning)
Received Advertising Report Event
Event Type [0x00]
Address Type [0x00]
Address: D1-D2-D3-D3-D2-D1
Dumping Advertising Data
0x02 0x01 0x06 0x07 0x03 0x0A 0x18 0x09 0x18 0x0D 0x18 0x09 0x08 0x42 0x6C 0x75
0x65 0x4C 0x69 0x74 0x45
RSSI [0xD1]

```

Figure 2.5.8 Scanning device address

In the end of command lines, found device “d1 d2 d3 d3 d2 d1” is listed. By using found device address with option3, it is possible to connect to arbitrary device address.

2.5.4 Advertising

PC application can perform as slave role also. If you select option 1 (“Advertise”) in “Advertise/Scan & Connect” menu, the device will start advertising. Figure 2.5.9 shows case when advertising.

```
C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
Your Option ?
Enter you choice : 2
1 - Advertise, 0 - Scan & Connect ?: 1
Sending WAKEUP ...

-----
CLIENT APPL MENU
-----
0 - Exit
1 - Refresh
Omission
20 - GATT Client Operations

Your Option ?
TX: 1 4 0 0 L 2      ..... Sending of Wakeup command
Enter you choice : Received Command Complete Event
Status [0x00]
Length of the command complete event packet [0x00]
Dumping Event Data

TX: 1 23 17 0 L 19      ..... Sending of Set_adv_data command
TX: 1 f 30 1 L 32      ..... Sending of Configure command (Start of advertising)
```

Figure 2.5.9 Advertising

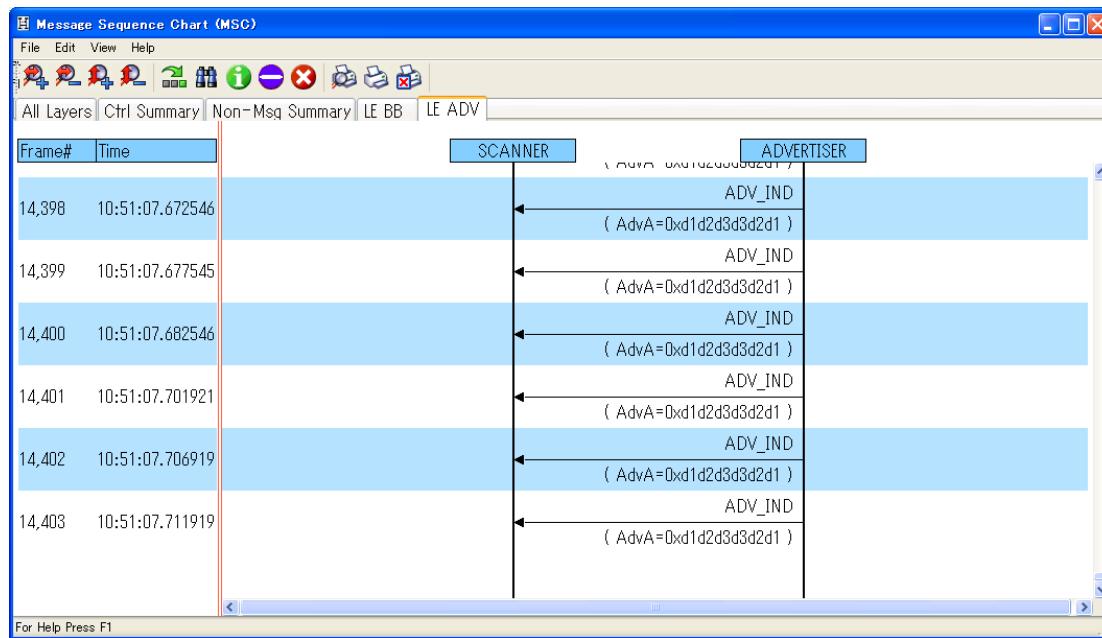


Figure 2.5.10 MSC of advertising

2.6 Disconnect

Figure2.6.1 shows screenshot when PC application perform disconnection event by typing “4”.

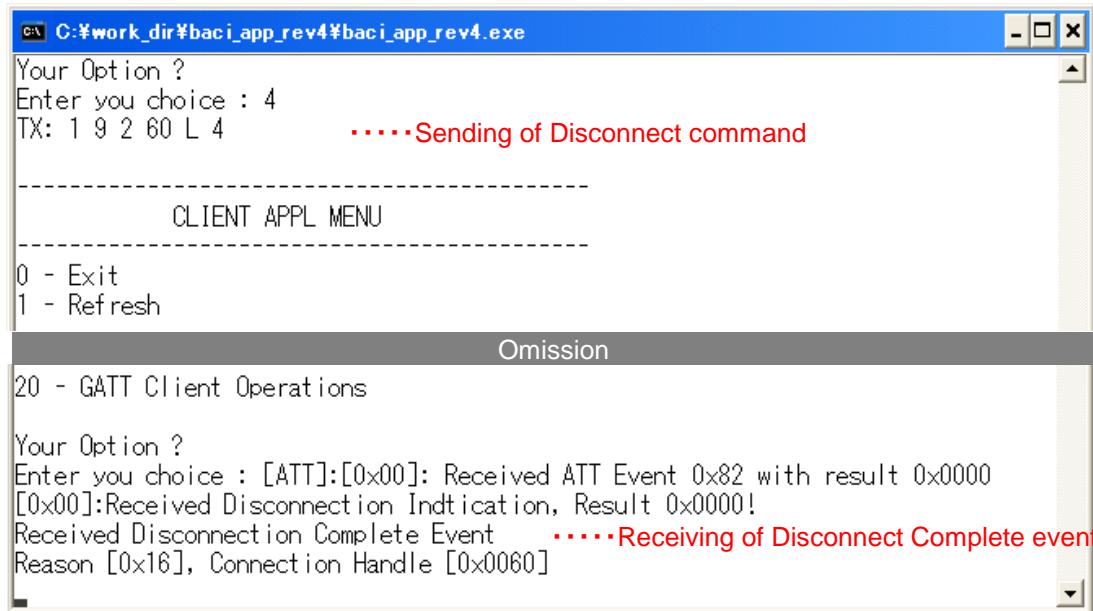


Figure 2.6.1 Disconnection

Figure2.6.2 shows MSC when HOST disconnect baseband connection. (at Frame #1552), when baseband connection terminated, Sensor Node start advertizing again.

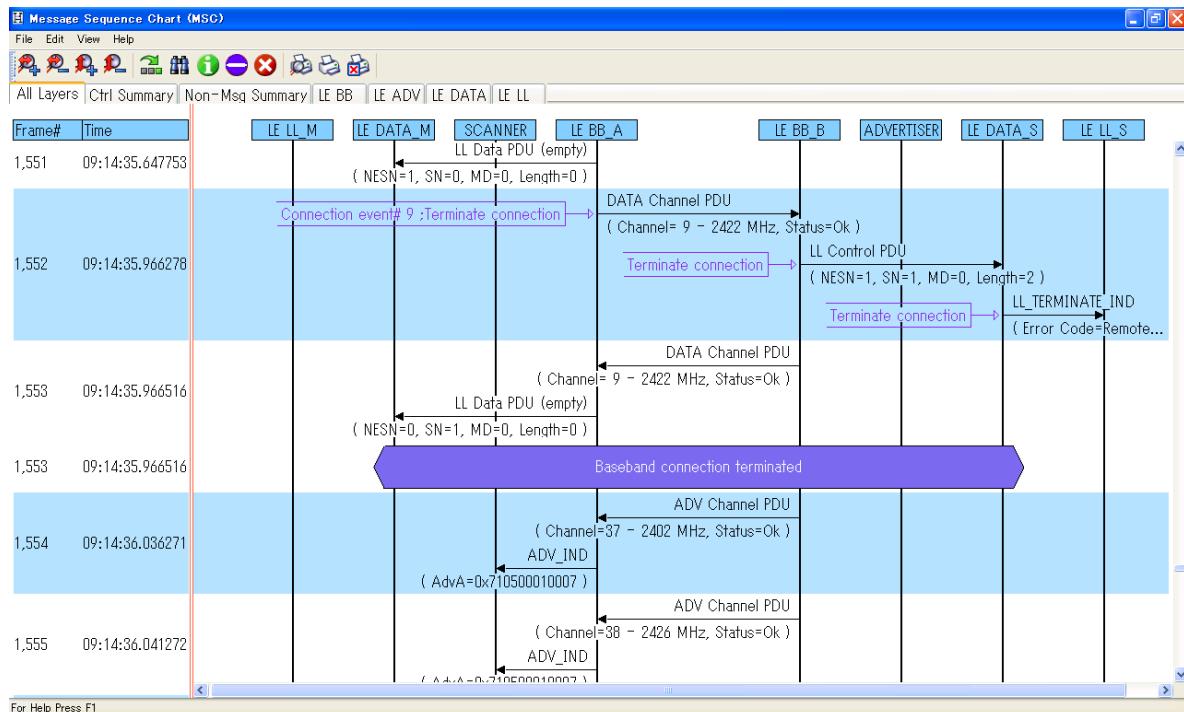


Figure 2.6.2 MSC of disconnection

2.7 Bonding

Figure 2.7.1 and Figure 2.7.2 shows screenshot when performing “Bonding device with Unbonded device” and “Bonding device with Bonded device” respectively. Bonding with Unbonded device perform Authentication process including registration of encryption keys, device will be bonded in the end. On the other hand Bonding with Bonded device does not perform authentication and perform encryption with registered information.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
Your Option ?
Enter you choice : 3

-----
CLIENT APPL MENU
-----
0 - Exit
1 - Refresh

Omission
20 - GATT Client Operations

Your Option ?
TX: 2 4 a 0 L c .....Sending of SMP_AUTHENTICATION_REQUEST
Enter you choice : [SMP CB] Event Type: 0x07

Reccv SMP_KEY_EXCHANGE_INFO .....Receiving of SMP_KEY_EXCHANGE_INFO
Status - 0x0000
Remote keys negotiated - 0x03
Encryption Key Size negotiated - 0x10
Peer Key Info Read:

Encryption Info:
-- Dumping 16 Bytes --
01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 00 ......

Master Identification Info:
-- Dumping 10 Bytes --
30 05 01 02 03 04 05 06 07 08 0.....0

Identity Info:
-- Dumping 16 Bytes --
01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 00 ......

Identity Address Info:
-- Dumping 7 Bytes --
01 00 C0 FF EE DE DA ......

Signing Info:
-- Dumping 16 Bytes --
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ......

[SMP CB] Event Type: 0x06

Event : SMP_KEY_EXCHANGE_INFO_REQUEST
BD Address : D1 D2 D3 D3 D2 D1
BD addr type : Public Address
Local keys negotiated - 0x03
Encryption Key Size negotiated - 0x10
TX: 2 4 44 0 L 46 .....Sending of
[SMP CB] Event Type: 0x01 SMP_KEY_EXCHANGE_INFO_
REQUEST_REPLY

Reccv SMP_AUTHENTICATION_COMPLETE
BD Address : D1 D2 D3 D3 D2 D1
BD addr type : Public Address
Status : 0000
Authentication type : Encryption Only (without MITM)
Bonding type : Bonding
Encryption Key size : 16

```

Figure 2.7.1 Bonding with Unbonded device

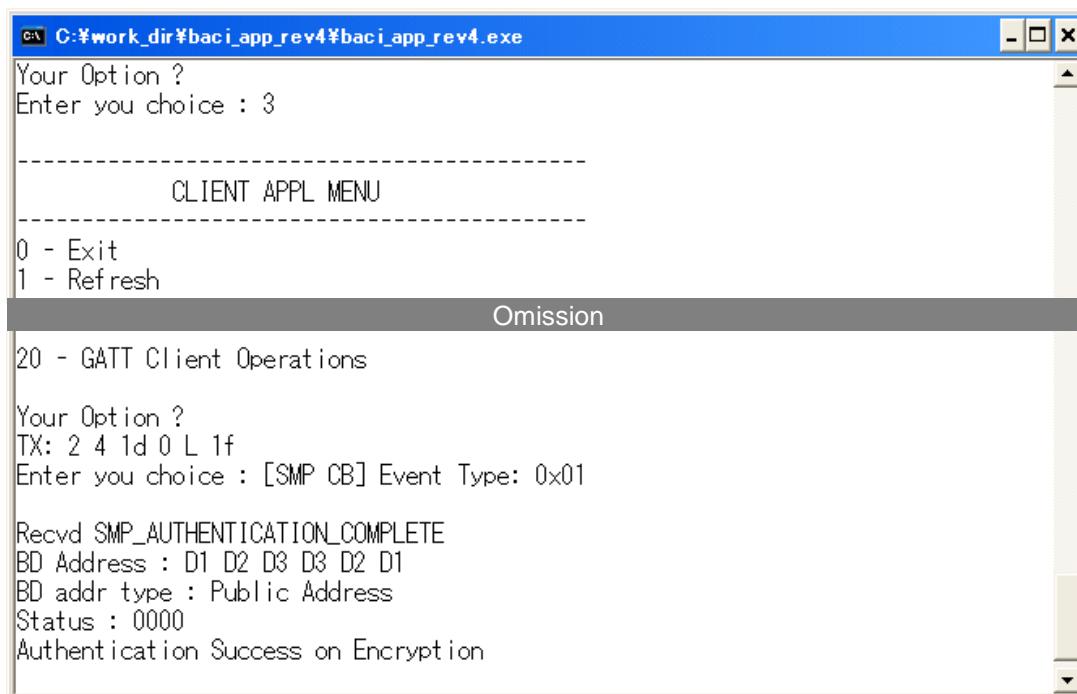


Figure 2.7.2 Bonding with Bonded device

Figure 2.7.3 shows MSC when making SMP pairing, as device information is not registered (UnBonded), pairing process has to be done prior to encryption proess. On the other hand, Figure 2.7.4 shows MSC when start encryption with Bonded device. No implicit SMP process performed because SMP pairing information has been registered already.

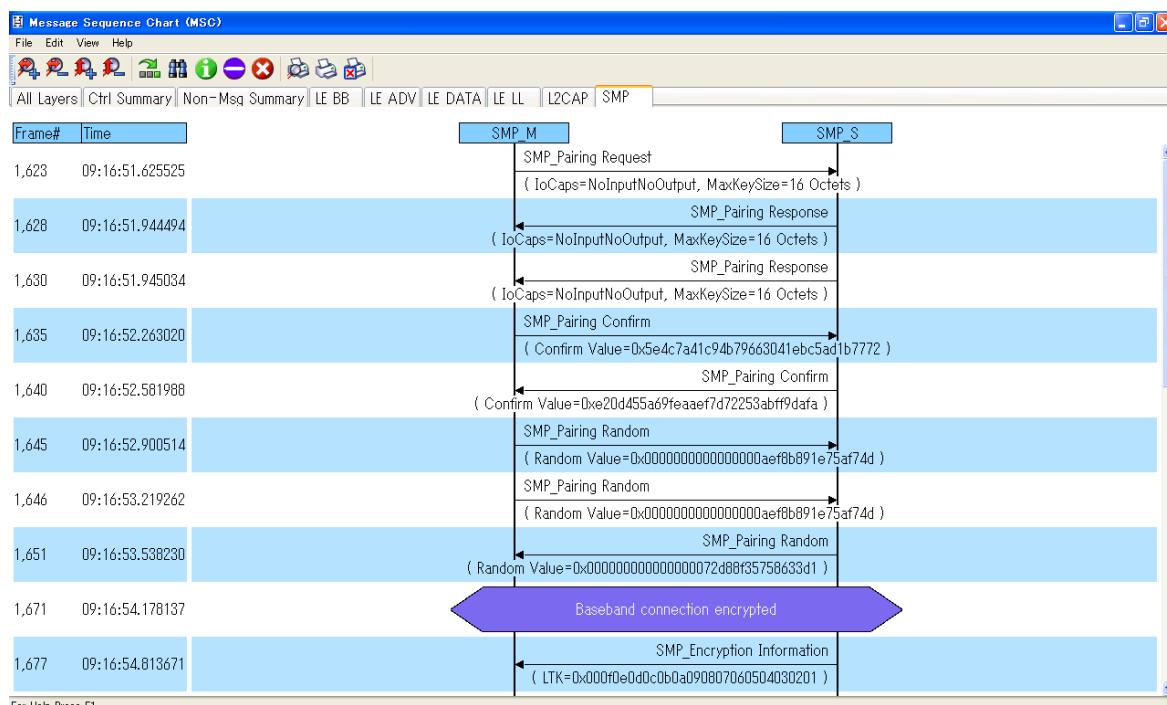


Figure 2.7.3 Making SMP Pairing

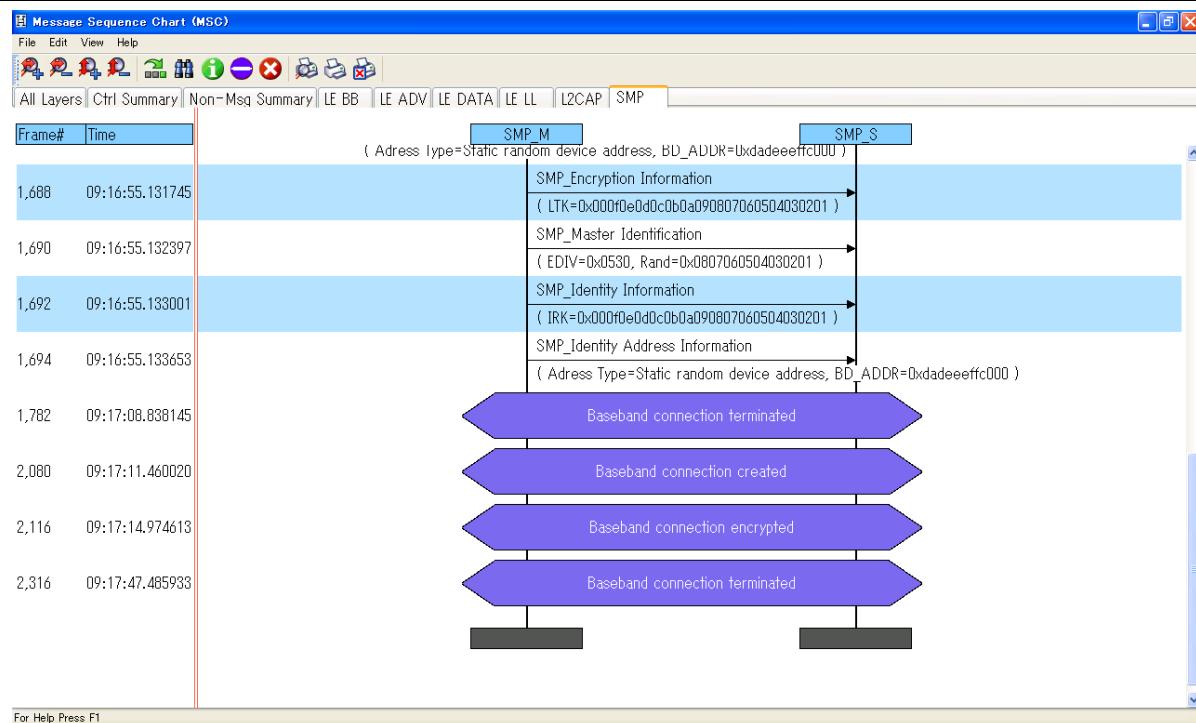


Figure 2.7.4 Encryption with Bonded device

2.8 GATT services

Following sub state will describe services supported by Sensor Node device in evaluation kit ML7105. They are Heart Rate Service (HRS), Temperature Service (HTS), Battery Service (BAS), Accelerometer Service (VSP), LED control (VSP)

2.8.1 Heart Rate Services

Figure 2.8.1.1 shows screenshot when performing Discover HRS menu. GATT service and Characteristics are found.

C:\\$work_dir\\$baci_app_rev4\\$baci_app_rev4.exe

Your Option ?
Enter you choice : 10Selection of "HRS Operations"

HRP CLIENT MENU

0 - Exit
1 - Refresh

10 - Discover HRS
11 - Enable/Disable HR Notifacation

Your Option ?
Enter you choice : 10Selection of "Discover HRS"

HRP CLIENT MENU

0 - Exit
1 - Refresh

10 - Discover HRS
11 - Enable/Disable HR Notifacation

Your Option ?Sening of ATT_FIND_BY_TYPE_VAL_REQ

TX: 2 2 e 0 L 10 Handle search range : 0x0001~0xFFFF

Enter you choice : TX: 2 2 e 0 L 10 Primary Service search complete.. Target service : GATT_PRIMARY_SERVICE=0x180D

[ATT]:[0x00]: Received ATT Event 0xF0 with result 0x0000

Received GATT_PS_DISCOVERY_RSP

No. Primary Services - 1

UUID: 0x180D (Heart Rate Service)
Start Hdl: 0x0037, End Hdl: 0x003E } HRS (0x180D) was detected in the handle of 0x0037 to 0x003E.

TX: 2 2 b 0 L d

TX: 2 2 8 0 L a

[ATT]:[0x00]: Received ATT Event 0xF3 with result 0x0000

Received GATT_CHAR_DISCOVERY_RSP

No. Characteristics - 3

(Heart Rate Measurement)
Char Handle: 0x0038, UUID: 0x2A37
Property: 0x10, Value Handle: 0x0039 } Heart Rate Measurement (0x2A37) was detected in the handle of 0x0038.

HR Handle 0x0039

No. Characteristic Descriptors: 1

Desc Handle: 0x003A, Desc UUID: 0x2902 (Unknown)

HR CCCD Handle 0x003A

(Heart Rate Sensor Location)
Char Handle: 0x003B, UUID: 0x2A38
Property: 0x02, Value Handle: 0x003C } Heart Rate Sensor Location (0x2A38) was detected in the handle of 0x003B.

(Heart Rate Control Point)
Char Handle: 0x003D, UUID: 0x2A39
Property: 0x08, Value Handle: 0x003E } Heart Rate Control Point (0x2A39) was detected in the handle of 0x003D.

Figure 2.8.1.1 Discover HRS

Figure 2.8.1.2 shows Heart Rate data (dummy data with inclemental values) are shown after enabled HR notification by typing “11”. Notification will be kept running until user disable notification by typing “11” again.

The screenshot shows a terminal window titled "C:\>work_dir\>baci_app_rev4\>baci_app_rev4.exe". The window displays a sequence of commands and their responses related to heart rate notifications:

- Line 1: "11" (highlighted with a red circle) followed by ".....Selection of ‘Enable of HR Notification’".
- Line 2: "0x 2 2 a 0 L c" followed by ".....Sending of ATT_WRITE_REQ: Enable Notifacation for HR CCCD 0x003A Writing of 0x0001 (Notification) to the handle of 0x003A."
- Line 3: "----- HRP CLIENT MENU -----"
- Line 4: "0 - Exit" (highlighted with a red box)
- Line 5: "1 - Refresh"
- Line 6: "10 - Discover HRS" (highlighted with a red box)
- Line 7: "11 - Enable/Disable HR Notifacation" (highlighted with a red box)
- Line 8: "Your Option ?"
- Line 9: "Enter you choice : [ATT]:[0x00]: Received ATT Event 0x13 with result 0x0000" (highlighted with a red bracket labeled "Receiving of ATT_WRITE_RESPONSE")
- Line 10: "Received Write Response Opcode!"
- Line 11: "[ATT]:[0x00]: Received ATT Event 0x1B with result 0x0000" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 12: "Received HVN"
- Line 13: "Handle - 0x0039"
- Line 14: "Handle Value Received -"
- Line 15: "-- Dumping 4 Bytes --" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 16: "0E 0B 00 00" (highlighted with a red box)
- Line 17: "....." (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 18: "Heart Rate: 11 beats per minute" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 19: "[ATT]:[0x00]: Received ATT Event 0x1B with result 0x0000" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 20: "Received HVN"
- Line 21: "Handle - 0x0039" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 22: "Handle Value Received -" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 23: "-- Dumping 4 Bytes --" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 24: "0E 0C 00 00" (highlighted with a red box)
- Line 25: "....." (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 26: "Heart Rate: 12 beats per minute" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 27: "[ATT]:[0x00]: Received ATT Event 0x1B with result 0x0000" (highlighted with a red bracket labeled "Receiving of the heart rate data")
- Line 28: "Received HVN" (highlighted with a red bracket labeled "Receiving of the heart rate data")

Figure 2.8.1.2 Enable/Disable HR Notification

Figure 2.8.1.3 shows MSC while finding HRS service and characteristics.

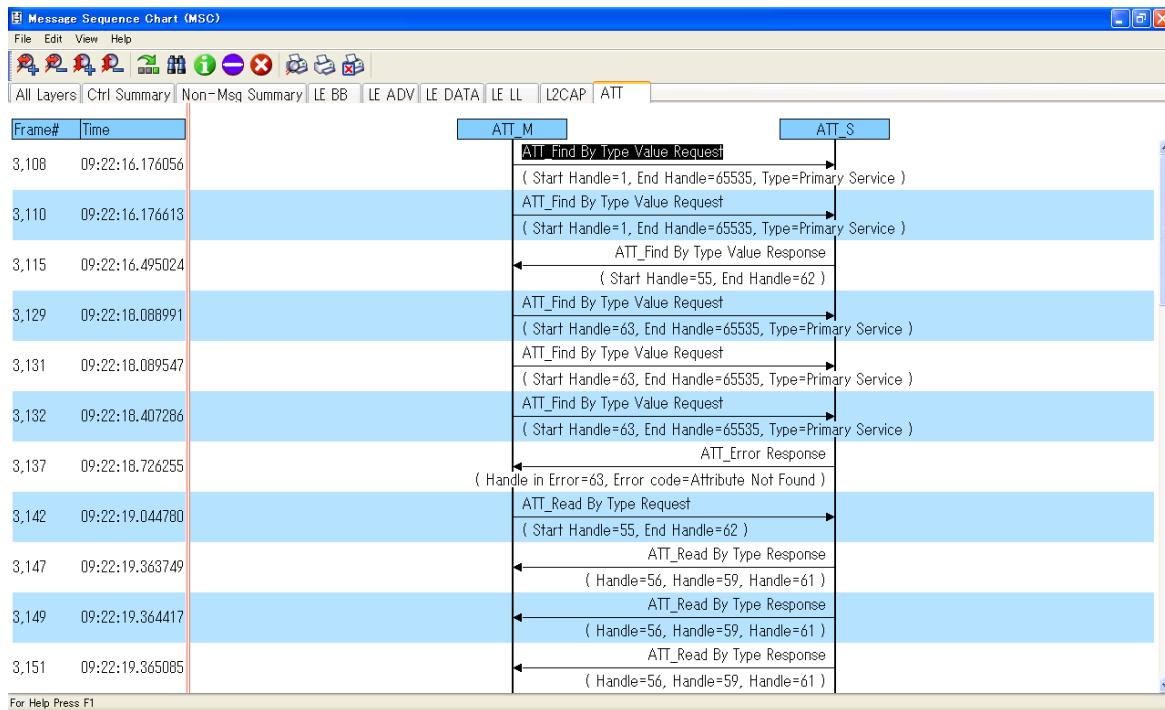


Figure 2.8.1.3 Finding HRS service and characteristics

Figure 2.8.1.4 shows MSC while receiving notification of HRS service.

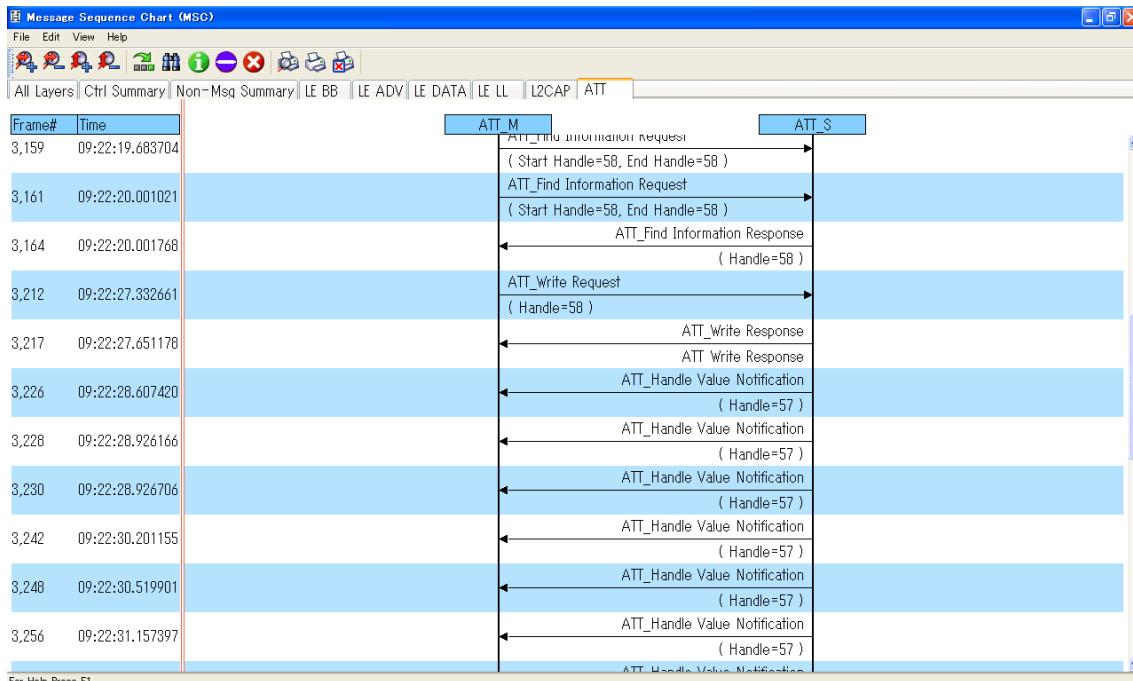


Figure 2.8.1.4 HRS notification

2.8.2 Temperature Services

Figure 2.8.2.1 shows screenshot when performing Discover HTS menu. GATT service and Characteristics are found.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
Your Option ?
Enter you choice : 11 .....Selection of "Temperature Operations"

-----
HTP CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover HTS
11 - Enable/Disable Temperature Indication
Your Option ?
Enter you choice : 10 .....Selection of "Discover HTS"

-----
HTP CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover HTS
11 - Enable/Disable Temperature Indication
Your Option ?
TX: 2 2 e 0 L 10 .....Sening of ATT_FIND_BY_TYPE_VAL_REQ
Enter you choice : TX: 2 2 e 0 L 10 Handle search range : 0x0001~0xFFFF
Primary Service search complete.. Target service : GATT_PRIMARY_SERVICE=0x1809
[ATT]:[0x00]: Received ATT Event 0xF0 with result 0x0000
Received GATT_PS_DISCOVERY_RSP
No. Primary Services - 1
UUID: 0x1809 (Health Thermometer) } Health Thermometer (0x1809) was detected
Start Hdl: 0x001E, End Hdl: 0x0026 in the handle of 0x001E to 0x0026.

TX: 2 2 b 0 L d .....Sending of ATT_READ_BY_TYPE_REQ
TX: 2 2 8 0 L a Handle search range : 0x001E~0x0026
TX: 2 2 8 0 L a Target UUID : GATT_CHARACTERISTICS
[ATT]:[0x00]: Received ATT Event 0xF3 with result 0x0000
Received GATT_CHAR_DISCOVERY_RSP
No. Characteristics - 3

(Temperature Measurement)
Char Handle: 0x001F, UUID: 0x2A1C Property: 0x20, Value Handle: 0x0020 } Temperature Measurement (0x2A1C) was detected
HTS Handle 0x0020 in the handle of 0x001F.

No. Characteristic Descriptors: 1
Desc Handle: 0x0021, Desc UUID: 0x2902 (Unknown)
HTS CCCD Handle 0x0021

(Intermediate Temperature)
Char Handle: 0x0022, UUID: 0x2A1E Property: 0x10, Value Handle: 0x0023 } Intermediate Temperature (0x2A1E) was detected
No. Characteristic Descriptors: 1 in the handle of 0x0022.
Desc Handle: 0x0024, Desc UUID: 0x2902 (Unknown)

(Temperature Type)
Char Handle: 0x0025, UUID: 0x2A1D Property: 0x02, Value Handle: 0x0026 } Temperature Type (0x2A1D) was detected
No. Characteristic Descriptors: 1 in the handle of 0x0025.

```

Figure 2.8.2.1 Discover HTS

Figure 2.8.2.2 shows Temperature data (Raw data from sensor) are shown after enabled Temperature indication by typing "11". Data indication will be kept running until user disable notification by typing "11" again.

```

C:\>work_dir\baci_app_rev4\baci_app_rev4.exe
11 .....Selection of "Enable Temperature Indication"
Enable Notification for HR CCCD 0x003A
TX: 2 2 a 0 L c .....Sending of ATT_WRITE_REQ:
Writing of 0x0002 (Indication) to the handle of 0x0021.

----- HTP CLIENT MENU -----
0 - Exit
1 - Refresh

10 - Discover HTS
11 - Enable/Disable Temperature Indication
Your Option ?
Enter you choice : [ATT]:[0x00]: Received ATT Event 0x13 with result 0x0000
Received Write Response Opcode!
[ATT]:[0x00]: Received ATT Event 0x1D with result 0x0000
Received HVI
Handle - 0x0020
Handle Value Received -
-- Dumping 5 Bytes --
00 97 FD 0A FC .....Receiving of ATT_WRITE_RESPONSE

TX: 2 2 4 0 L 6 .....Sending of ATT_HANDLE_VALUE_CNF
[ATT]:[0x00]: Received ATT Event 0x1D with result 0x0000
Received HVI
Handle - 0x0020
Handle Value Received -
-- Dumping 5 Bytes --
00 0E 03 0B FC .....Receiving of the temperature data

TX: 2 2 4 0 L 6 .....Sending of ATT_HANDLE_VALUE_CNF
[ATT]:[0x00]: Received ATT Event 0x1D with result 0x0000
Received HVI
Handle - 0x0020
Handle Value Received -
-- Dumping 5 Bytes --
00 97 FD 0A FC .....Receiving of the temperature data

TX: 2 2 4 0 L 6
11 .....Selection of "Disable Temperature Indication"
Enable Notification for HR CCCD 0x003A
TX: 2 2 a 0 L c .....Sending of ATT_WRITE_REQ:
Writing of 0x0000 (None) to the handle of 0x0021.

```

The screenshot shows a terminal window titled "C:\>work_dir\baci_app_rev4\baci_app_rev4.exe". The user enters "11" to enable temperature indication. A red circle highlights "11" and the text ".....Selection of 'Enable Temperature Indication'". The terminal then sends an ATT_WRITE_REQ to handle 0x0021 with value 0x0002. A red bracket on the right indicates "Receiving of ATT_WRITE_RESPONSE". The response shows an ATT_EVENT with opcode 0x13 and result 0x0000. The terminal then receives an ATT_EVENT with opcode 0x1D and result 0x0000, indicating a successful write response. A red bracket on the right indicates "Receiving of the temperature data". The terminal then sends an ATT_HANDLE_VALUE_CNF to handle 0x0020 with value 0x0000. A red bracket on the right indicates "Receiving of the temperature data". Finally, the user enters "11" again to disable temperature indication, which triggers another ATT_WRITE_REQ to handle 0x0021 with value 0x0000. A red circle highlights "11" and the text ".....Selection of 'Disable Temperature Indication'".

Figure 2.8.2.2 Enable/Disable Temperature Indication

Figure 2.8.2.3 shows MSC while finding HTS service and characteristics.

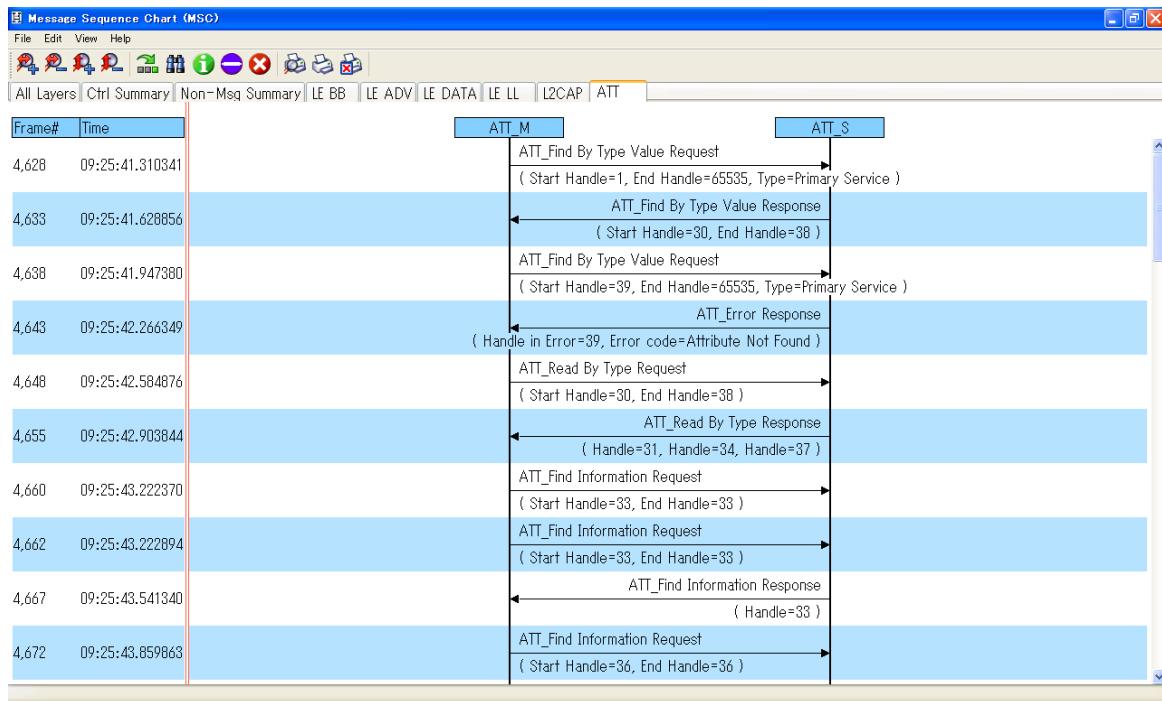


Figure 2.8.2.3 Finding HTS service and characteristics

Figure 2.8.2.4 shows MSC while receiving HTS indication, there are corresponding confirmation from HOST.

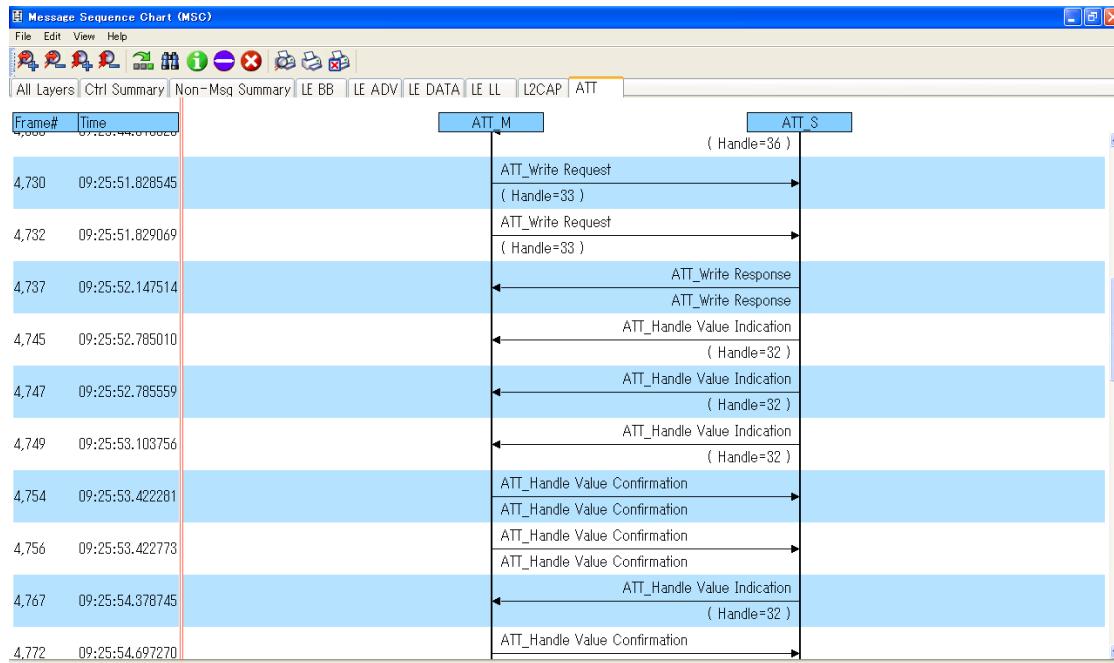


Figure 2.8.2.4 HTS indication

2.8.3 Battery Services

Figure 2.8.3.1 shows screenshot when performing Discover Battery Service menu. GATT service and Characteristics are found.

```

C:\$work_dir\$baci.app.rev4\$baci_app_rev4.exe
Your Option ?
Enter you choice :12 ..... Selection of "Battery Operations"

-----
Battery CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover Battery Service
11 - Read Battery Level
Your Option ?
Enter you choice :10 ..... Selection of "Discover Battery Service"

-----
Battery CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover Battery Service
11 - Read Battery Level
Your Option ? ..... Sening of ATT_FIND_BY_TYPE_VAL_REQ
TX: 2 2 e 0 L 10 Handle search range : 0x0001~0xFFFF
Enter you choice : TX: 2 2 e 0 L 10 Target service : GATT_PRIMARY_SERVICE=0x180F
Primary Service search complete..
[ATT]:[0x00]: Received ATT Event 0xF0 with result 0x0000
Received GATT_PS_DISCOVERY_RSP
No. Primary Services - 1
UUID: 0x180F (Battery Service)
Start Hdl: 0x000A, End Hdl: 0x000C } Battery Service (0x180F) was detected
in the handle of 0x000A to 0x000C.

TX: 2 2 b 0 L d ..... Sending of ATT_READ_BY_TYPE_REQ
[ATT]:[0x00]: Received ATT Event 0xF3 with result 0x0000
Received GATT_CHAR_DISCOVERY_RSP
No. Characteristics - 1
(Battery Level)
Char Handle: 0x000B, UUID: 0x2A19
Property: 0x02, Value Handle: 0x000C } Battery Level Characteristics (0x2A19) was detected
in the handle of 0x000C.
Battery Handle 0x000C

```

Figure 2.8.3.1 Discover Battery Service

Figure 2.8.3.2 shows screen shot whenever read Battery data by typing “11”.

The screenshot shows a terminal window titled "C:\\$work_dir\\$baci_app_rev4\\$baci_app_rev4.exe". The window displays a menu for a "Battery CLIENT MENU" with options 0 - Exit, 1 - Refresh, 10 - Discover Battery Service, and 11 - Read Battery Level. The option 11 is circled in red and labeled "Selection of 'Read Battery Service'". Below the menu, the text "Your Option ?" is followed by "11" and a series of numbers "TX: 2 2 6 0 L 8". A red bracket groups these numbers with the text "Sending of ATT_READ_REQ Read from the handle 0x000C.". The next line shows "Enter you choice : [ATT]:[0x00]:" followed by "Received ATT Event 0x0B with result 0x0000". The text "Received Read Response Opcode!" is displayed. The "Handle Value Received -" section shows "1F" preceded by "-- Dumping 1 Bytes --". A red bracket groups this with the text "Reading of Battery Level". Finally, the "Battery Level: 31%" is shown.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe

11 .....Selection of "Read Battery Service"

-----
Battery CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover Battery Service
11 - Read Battery Level
Your Option ?
TX: 2 2 6 0 L 8 .....Sending of ATT_READ_REQ
                                         Read from the handle 0x000C.
Enter you choice : [ATT]:[0x00]: Received ATT Event 0x0B with result 0x0000
Received Read Response Opcode!
Handle Value Received -
-- Dumping 1 Bytes --
1F
-----
Battery Level: 31% } Reading of Battery Level

```

Figure 2.8.3.2 Read Battery Level

Figure 2.8.3.3 shows MSC while finding BAS service and characteristics.

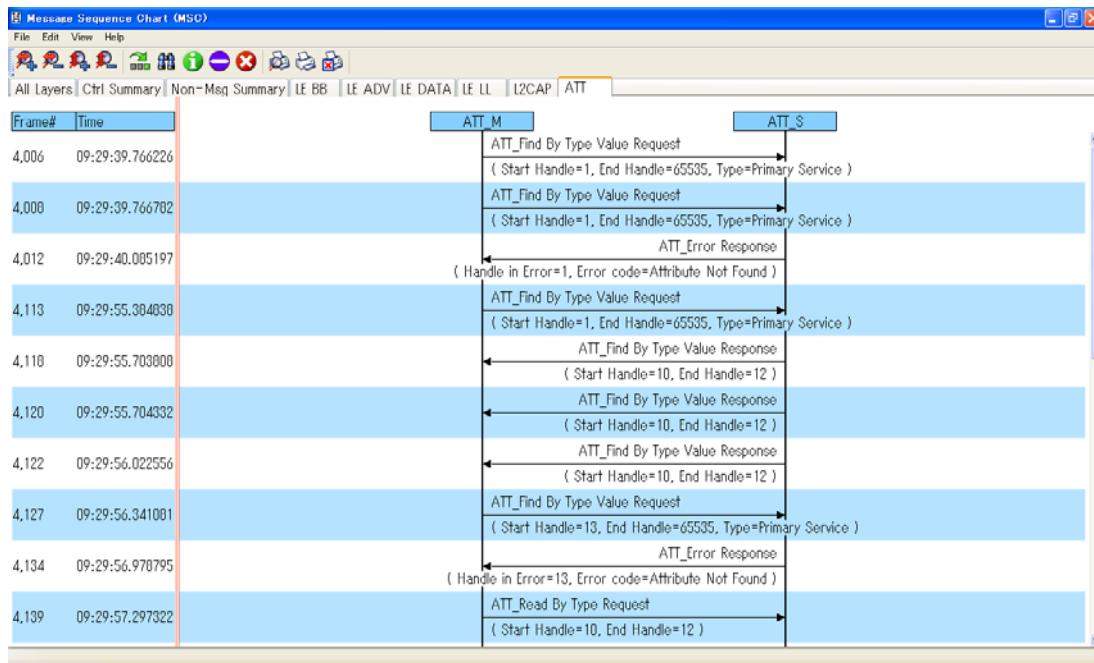


Figure 2.8.3.3 Finding BAS service and characteristics

Figure 2.8.3.4 shows MSC while reading battery level from Sensor Node.

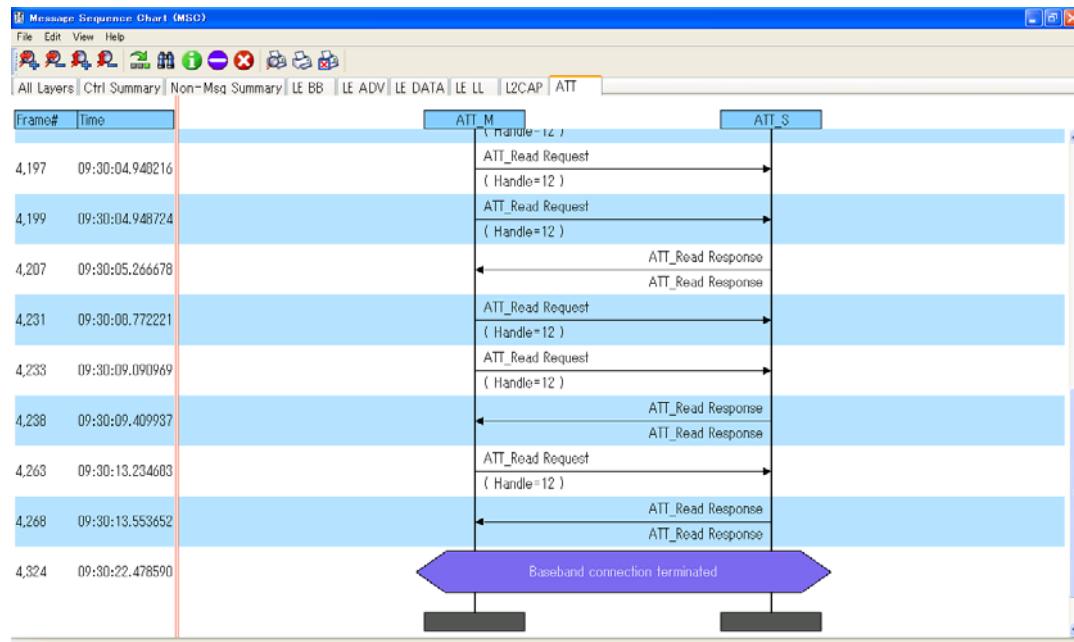


Figure 2.8.3.4 Reading Battery level

2.8.4 Accelerometer Services

Figure 2.8.4.1 shows screenshot when performing Discover Accelerometer menu. GATT service and Characteristics are found.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
Your Option ?
Enter you choice : 13 .....Selection of "Accelerometer Operations"

-----
ACCL CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover Accelerometer Service
11 - Enable/Disable Accelerometer Not ification
Your Option ?
Enter you choice : 10 .....Selection of "Discover Accelerometer Service"

-----
ACCL CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover Accelerometer Service
11 - Enable/Disable Accelerometer Not ification
Your Option ?
TX: 2 2 e 0 L 10 .....Sening of ATT_FIND_BY_TYPE_VAL_REQ
Enter you choice : TX: 2 2 e 0 L 10 Handle search range : 0x0001~0xFFFF
Primary Service search complete.. Target service : GATT_PRIMARY_SERVICE=0xCCCC
[ATT]:[0x00]: Received ATT Event 0xF0 with result 0x0000
Received GATT_PS_DISCOVERY_RSP
No. Primary Services - 1
        } Unknown Service (0xCCCC) was detected
        } in the handle of 0x0033 to 0x0036.
        } Accelerometer is a vendor specific service.

UUID: 0xCCCC (Unknown)
Start Hdl: 0x0033, End Hdl: 0x0036

TX: 2 2 b 0 L d .....Sending of ATT_READ_BY_TYPE_REQ
TX: 2 2 8 0 L a
[ATT]:[0x00]: Received ATT Event 0xF3 with result 0x0000
Received GATT_CHAR_DISCOVERY_RSP Handle search range : 0x0033~0x0036
No. Characteristics - 1 Target UUID : GATT_CHARACTERISTICS

(Unknown)
Char Handle: 0x0034, UUID: 0xDDDD
Property: 0x10, Value Handle: 0x0035
ACCEL Handle 0x0035
        } Accelerometer Characteristics (0xDDDD) was detected
        } in the handle of 0x0035.

No. Characteristic Descriptors: 1
Desc Handle: 0x0036, Desc UUID: 0x2902 (Unknown)
Accelerometer CCCD Handle 0x0036

```

Figure 2.8.4.1 Discover Accelerometer Service

Figure 2.8.4.2 shows Accelerometer data (data from Sensor on board) are shown after enabled Accelerometer notification by typing "11". Notification will be kept running until user disable notification by typing "11" again.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
11 .....Selection of "Enable Accelerometer Notification"
Enable Notification for Accel CCCD 0x0036
TX: 2 2 a 0 L c .....Sending of ATT_WRITE_REQ:
Writing of 0x0001 (Nortification) to the handle of 0x0036.

ACCL CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover Accelerometer Service
11 - Enable/Disable Accelerometer Notifcation
Your Option ?
Enter you choice : [ATT]:[0x00]: Received ATT Event 0x13 writh result 0x0000
Received Write Response Opcode!
[ATT]:[0x00]: Received ATT Event 0x1B with result 0x0000
Received HVN
Handle - 0x0035
Handle Value Received -
-- Dumping 6 Bytes --
90 03 B0 FF 60 41 ....`A
-----
[ATT]:[0x00]: Received ATT Event 0x1B with result 0x0000
Received HVN
Handle - 0x0035
Handle Value Received -
-- Dumping 6 Bytes --
B0 03 D0 FF 70 41 ....pA
-----
11 .....Selection of "Disable Accelerometer Notification"
Enable Notification for Accel CCCD 0x0036
TX: 2 2 a 0 L c .....Sending of ATT_WRITE_REQ:
Writing of 0x0000 (None) to the handle of 0x0036.

```

Receiving of ATT_WRITE_RESPONSE

Receiving the accelerometer data

Receiving the accelerometer data

Figure 2.8.4.2 Enable/Disable Accelerometer Notification

Figure 2.8.4.3 shows MSC while finding service and characteristics for Acceleromter data.

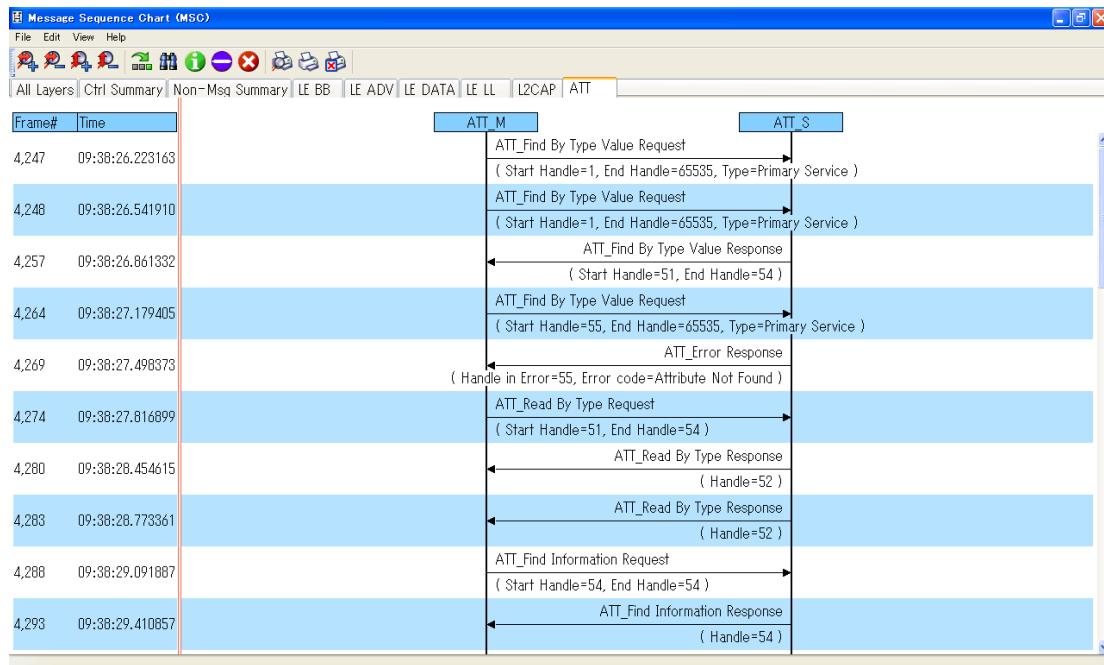


Figure 2.8.4.3 Finding accelerometer service and characteristics

Figure 2.8.4.4 shows MSC while receving accelerometer data from Sensor Node.

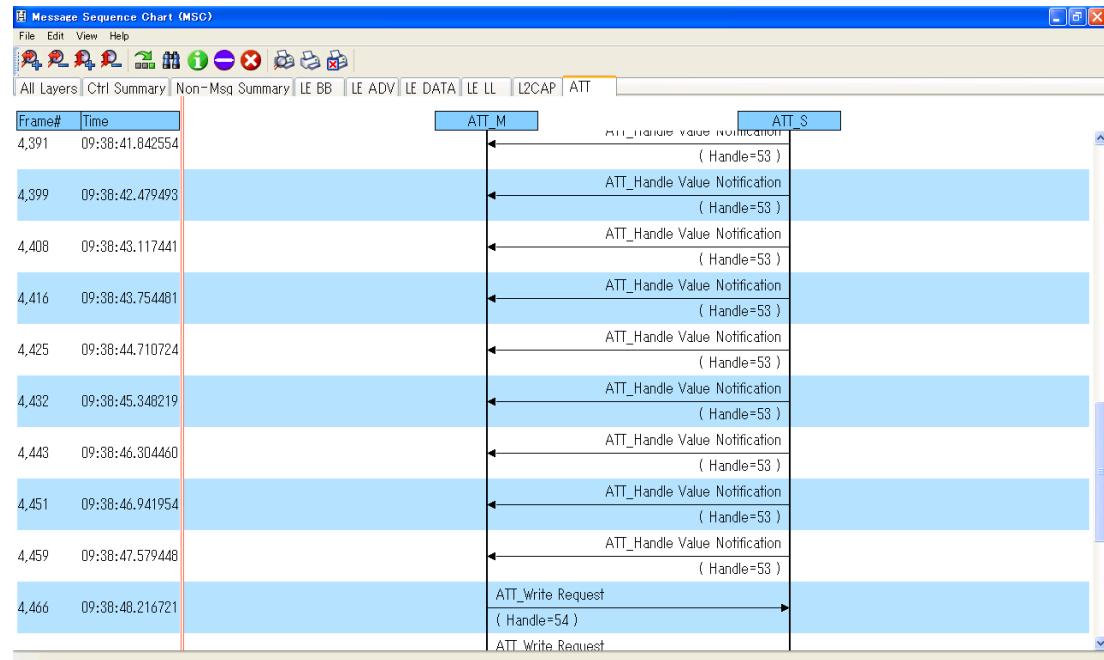


Figure 2.8.4.4 Receiving notification for accelerometer data

2.8.5 LED control Services

Figure 2.8.5.1 shows screenshot when performing Discover LED service menu. GATT service (VSP) found but characteristics is not defined in this service.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
Your Option ?
Enter you choice : 14 .....Selection of "LED Operations"

-----
LED CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover LED Service
11 - Toggle LED Control
Your Option ?
Enter you choice : 10 .....Selection of "Discover LED Service"

-----
LED CLIENT MENU
-----
0 - Exit
1 - Refresh

10 - Discover LED Service
11 - Toggle LED Control
Your Option ? .....Sening of ATT_FIND_BY_TYPE_VAL_REQ
TX: 2 2 e 0 L 10 Handle search range : 0x0001~0xFFFF
Enter you choice : TX: 2 2 e 0 L 10 Primary Service search complete.. Target service : GATT_PRIMARY_SERVICE=0xAAAA
[ATT]:[0x00]: Received ATT Event 0xF0 with result 0x0000
Received GATT_PS_DISCOVERY_RSP
No. Primary Services - 1
    Uuid: 0xAAAA (Unknown)
    Start Hdl: 0x0030, End Hdl: 0x0032 } Unknown Service (0xAAAA) was detected
                                            in the handle of 0x0030 to 0x0032.
                                            LED is a vendor specific service.

TX: 2 2 b 0 L d .....Sending of ATT_READ_BY_TYPE_REQ
[ATT]:[0x00]: Received ATT Event 0xF3 with result 0x0000
Received GATT_CHAR_DISCOVERY_RSP Handle search range : 0x0030~0x0032
No. Characteristics - 1 Target UUID : GATT_CHARACTERISTICS
(Unknown)
Char Handle: 0x0031, UUID: 0xB BBBB
Property: 0x08, Value Handle: 0x0032 } LED Characteristics (0xB BBBB) was detected
                                            in the handle of 0x0032.
LED Handle 0x0032

```

Figure 2.8.5.1 Discover LED Service

Figure 2.8.5.2 shows screenshot whenever typing “11” as toggle LED control. Each time write operation performed, LED on Sensor Node Board is toggled his state.

```

C:\> C:\work_dir\baci_app_rev4\baci_app_rev4.exe
11 .....Selection of "Toggle LED Control"

-----LED CLIENT MENU-----
0 - Exit
1 - Refresh

10 - Discover LED Service
11 - Toggle LED Control      .....Sending of ATT_WRITE_REQ:
Your Option ?                Writing of 0x00 to the handle of 0x0032.
TX: 2 2 9 0 L b
Enter you choice : [ATT]:[0x00]: Received ATT Event 0x13 with result 0x0000
Received Write Response Opcode!

11 .....Selection of "Toggle LED Control"

-----LED CLIENT MENU-----
0 - Exit
1 - Refresh

10 - Discover LED Service
11 - Toggle LED Control      .....Sending of ATT_WRITE_REQ:
Your Option ?                Writing of 0x01 to the handle of 0x0032.
TX: 2 2 9 0 L b
Enter you choice : [ATT]:[0x00]: Received ATT Event 0x13 with result 0x0000
Received Write Response Opcode!

```

Figure 2.8.5.2 Toggle LED

Figure 2.8.5.3 shows MSC while finding LED service related information.

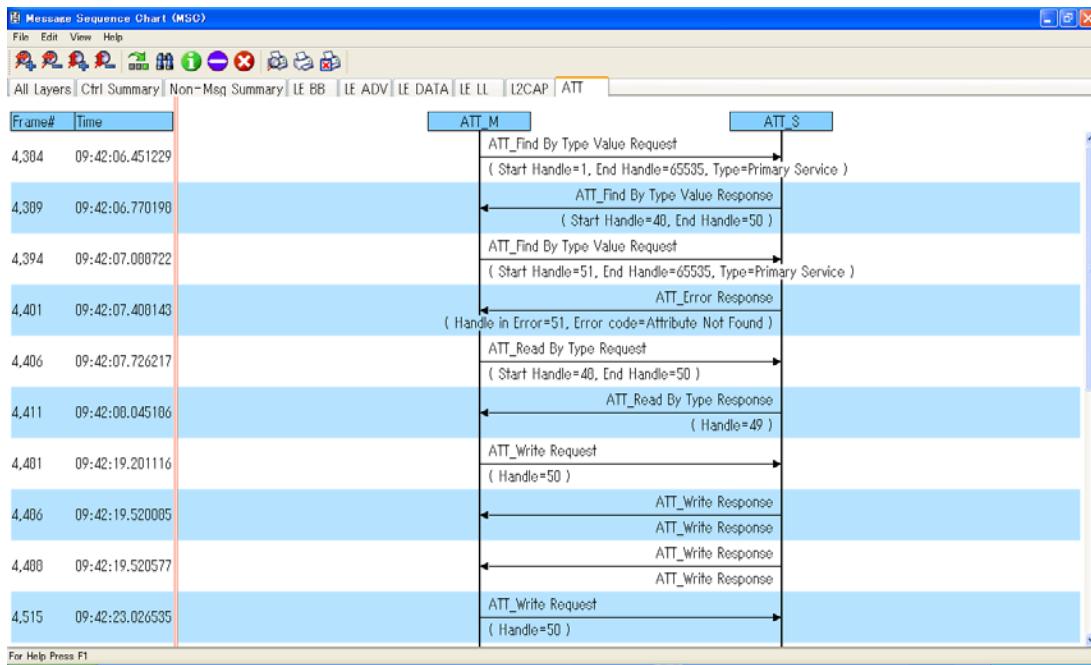


Figure 2.8.5.3 Finding LED services characteristics

Figure 2.8.5.4 shows MSC while writing command to control LED status. Each time, write command received by sensor node, LED mounted on the board change his status (on, off, ...)

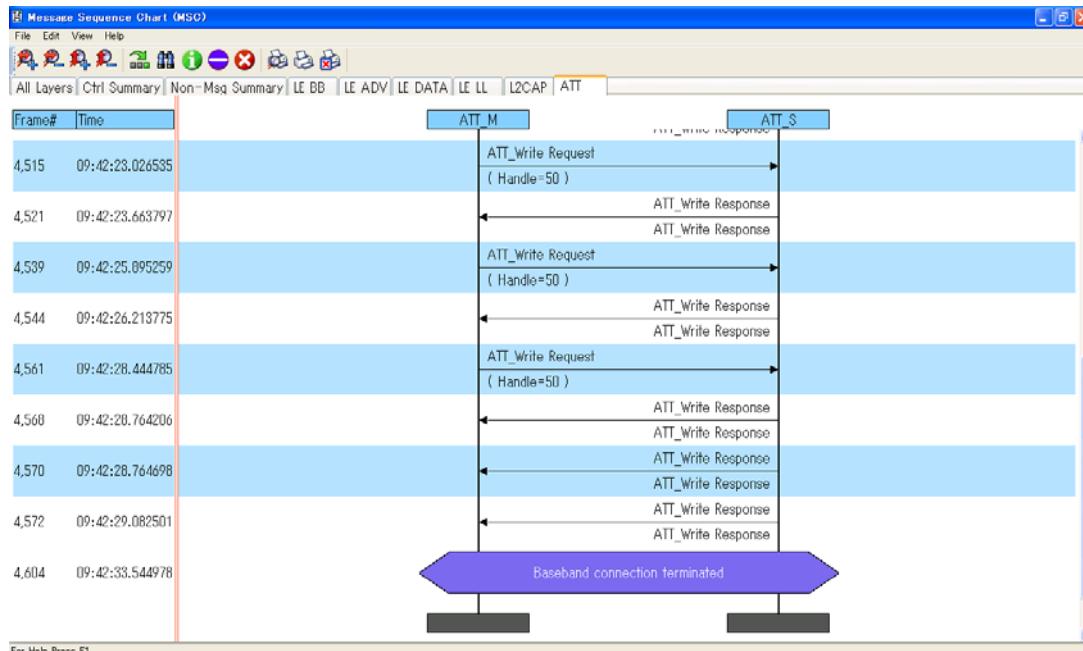


Figure 2.8.5.4 Controlling LED

2.9 GATT client operation

Figure 2.9.1 shows GATT client menu supported by PC application for evaluation kit ML7105. Most of GATT/ATT operation can be controlled by this menu.

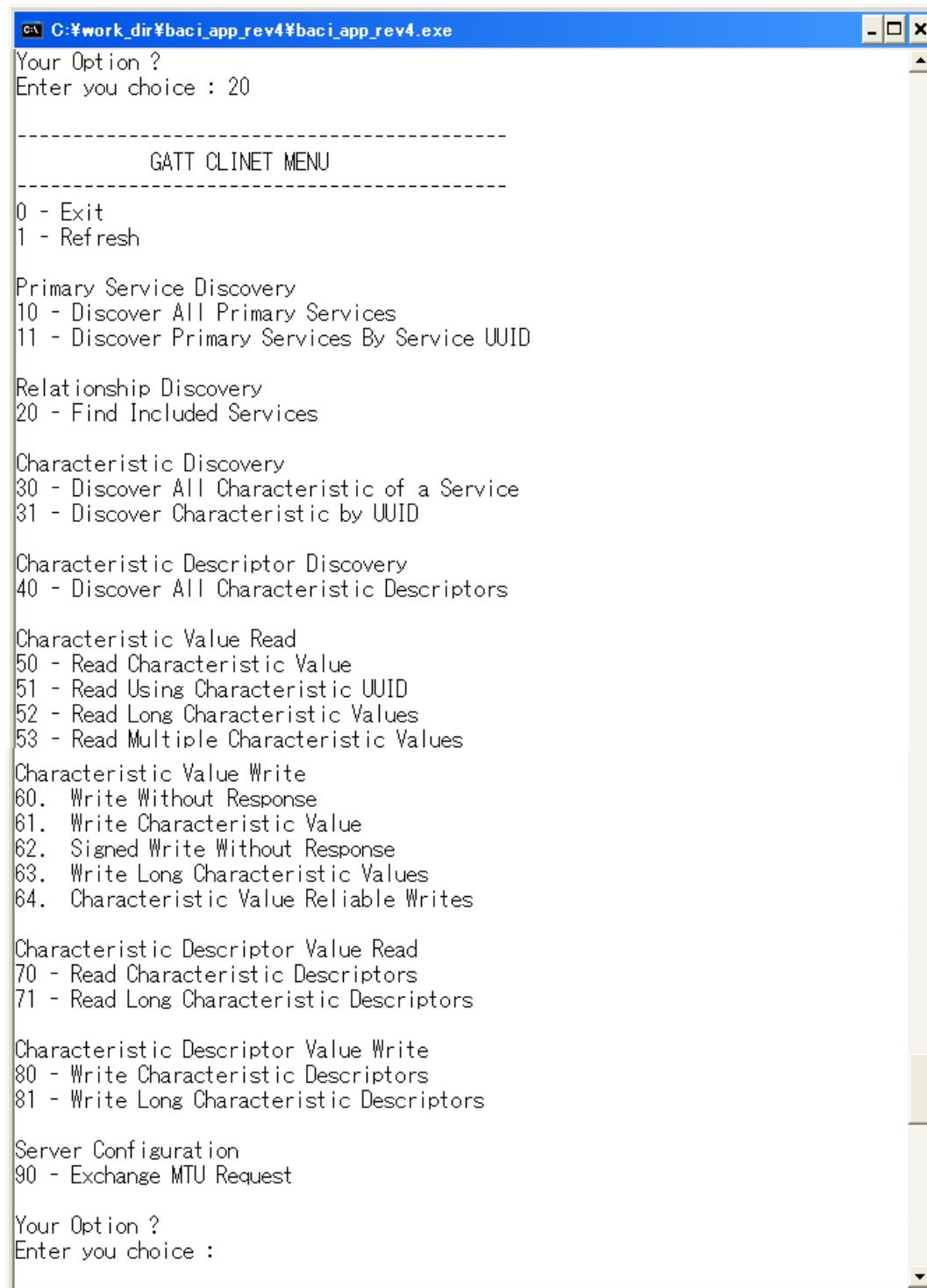


Figure 2.9.1 GATT client menu

Example shown in Figure 2.9.2 is screenshot when performing “Discover all primary services”. Primary service supported by Sensor Node Board were found.

```

C:\$work_dir\$baci_app_rev4\$baci_app_rev4.exe
Your Option ?
TX: 2 2 b 0 L d .....Sening of ATT_READ_BY_GROUP_TYPE_REQ
Enter you choice : TX: 2 2 b 0 L d Handle search range : 0x0001~0xFFFF
TX: 2 2 b 0 L d Target service : GATT_PRIMARY_SERVICE (0x2800)
TX: 2 2 b 0 L d
TX: 2 2 b 0 L d
TX: 2 2 b 0 L d
Primary Service search complete..
[ATT]:[0x00]: Received ATT Event 0xF0 with result 0x0000
Received GATT_PS_DISCOVERY_RSP
No. Primary Services - 11

UUID: 0x1800 (GAP Service)
Start Hdl: 0x0001, End Hdl: 0x0005

UUID: 0x1801 (GATT Service)
Start Hdl: 0x0006, End Hdl: 0x0009

UUID: 0x180F (Battery Service)
Start Hdl: 0x000A, End Hdl: 0x000C

UUID: 0x180A (Device Information)
Start Hdl: 0x000D, End Hdl: 0x001D

UUID: 0x1809 (Health Thermometer)
Start Hdl: 0x001E, End Hdl: 0x0026

UUID: 0x1803 (Link Loss Service)
Start Hdl: 0x0027, End Hdl: 0x0029

UUID: 0x1802 (Immediate Alert Service)
Start Hdl: 0x002A, End Hdl: 0x002C

UUID: 0x1804 (Tx Power Service)
Start Hdl: 0x002D, End Hdl: 0x002F

UUID: 0xAAAA (Unknown)
Start Hdl: 0x0030, End Hdl: 0x0032

UUID: 0xCCCC (Unknown)
Start Hdl: 0x0033, End Hdl: 0x0036

UUID: 0x180D (Heart Rate Service)
Start Hdl: 0x0037, End Hdl: 0x003E

[ATT]:[0x00]: Received ATT Event 0x82 with result 0x0000
[0x00]:Received Disconnection Indtication, Result 0x0000!
Received Disconnection Complete Event
Reason [0x08], Connection Handle [0x0060]

```

Figure 2.9.2 Finding primary services

2.10 Connection Update

Figure 2.10.1 shows screenshot when PC application perform connection update event by typing “8”. Figure 2.10.2 shows MSC of the connection update. The connection update can be executed from the slave side, too.

C:\\$work_dir\\$baci_app_rev4\\$baci_app_rev4.exe

```

Enter you choice : 8
Enter the Min Connection Interval (in HEX): 28
Enter the Max Connection Interval (in HEX): 38
Enter the Connection Latency (in HEX): 0
Enter the Supervision Timeout (in HEX): 3bb
Enter the Max CE Length (in HEX): 20
Enter the Min CE Length (in HEX): 20

-----
CLIENT APPL MENU
-----
0 - Exit
1 - Refresh
Omission
20 - GATT Client Operations

Your Option ?
TX: 1 a e e0 L 10      .....Sending of Connection Update command
Enter you choice : Received Connection Update Complete Event
Status [0x00], Connection Handle [0x00E0], Int [0x0030], Lat [0x0000], STO [0x03
BB]      .....Receiving of Connection Update Complete event

```

Figure 2.10.1 Connection Update

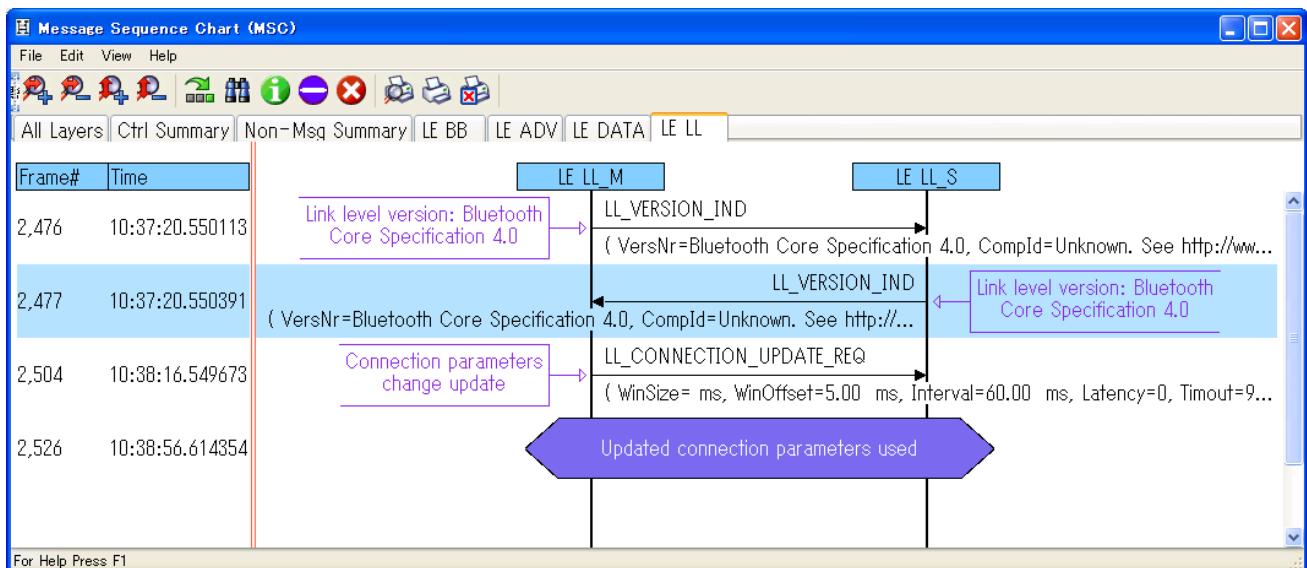


Figure 2.10.2 MSC Connection Update

2.11 Reading of RSSI value

Figure2.11.1 shows screenshot when PC application perform reading of RSSI (Received Signal Strength Indication) value by typing “5”. In this example, “0xD4” is indicated. This value is signed 1 byte data, so this means “-44 dBm” in this example.

The screenshot shows a Windows application window titled "C:\work_dir\baci_app_rev4\baci_app_rev4.exe". The window displays a menu structure:

- CLIENT APPL MENU
- 0 - Exit
- 1 - Refresh

Below the menu, there is a section labeled "Omission" followed by "20 - GATT Client Operations". The application is interacting with a device, showing the following text:

Your Option ?
Enter you choice : 5

TX: 1 d 2 e0 L 4**Sending of Read RSSI command**
Enter you choice : Received Command Complete Event
Status [0x00]
Length of the command complete event packet [0x03]
Dumping Event Data
0xE0 0x00 0xD8

Figure 2.11.1 Reading of RSSI value

Revision History

Document No.	Issue date	Page		NOTE
		Before	After	
PEXL7105_PCap-01	2012.08.17	–	–	Preliminary 1 st version
PEXL7105_PCap-02	2012.08.20	–	–	Added MSCs
PEXL7105_PCap-03	2012.09.04	10	10-14	Updated Connection Setup section, added 3options for scanning and connection.
PEXL7105_PCap-04	2013.03.26	16	16	Added option to change connection parameter.
PEXL7105_PCap-05	2013.05.31	9	9	Modified 2.2 Navigation Menu
		–	15	Added 2.4.4 Advertising
		–	31	Added 2.9 Connection Update
FEXL7105_PCap-01	2013.05.31	–	–	Final 1 st Edition
FEXL7105_PCap-02	2013.08.01	8	7	Modified 2.1 Command Window
		–	8	Added 2.2 Debug Messages
		9 - 31	9 - 38	Correction of the chapter number due to the addition of chapter 2.2
		–	39	Added 2.11 Reading of RSSI value
		10 - 31	10 - 38	Added the explanation for the command/event