ubpulse H3 Measurement Data Communication standard

LXSDF T2 based Bluetooth serial communication specification of ubpulse H3 measurement Data

Doc. ID. LXE13 V1

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Abstract – The LXSDF T2 format is used as the data format for Bluetooth serial communication of ubpulse H3 and LXSDF T2 describes the arrangement of data generated in ubpulse H3. ubpulse H3 can send two kinds of data of measurement and inspection data to host, in the article, measurement data communication standard is summarized.Inspection data communication standard is organized in a separate document. According to this data communication standard, the host device (PC, smart phone, etc.) capable of communicating with the device can make Bluetooth connection with the ubpulse H3 utilize the information provided by the device. This information is based on the LXSDF T2 format and can only be understood by reading the following essential reference documents.

Required reference documentation

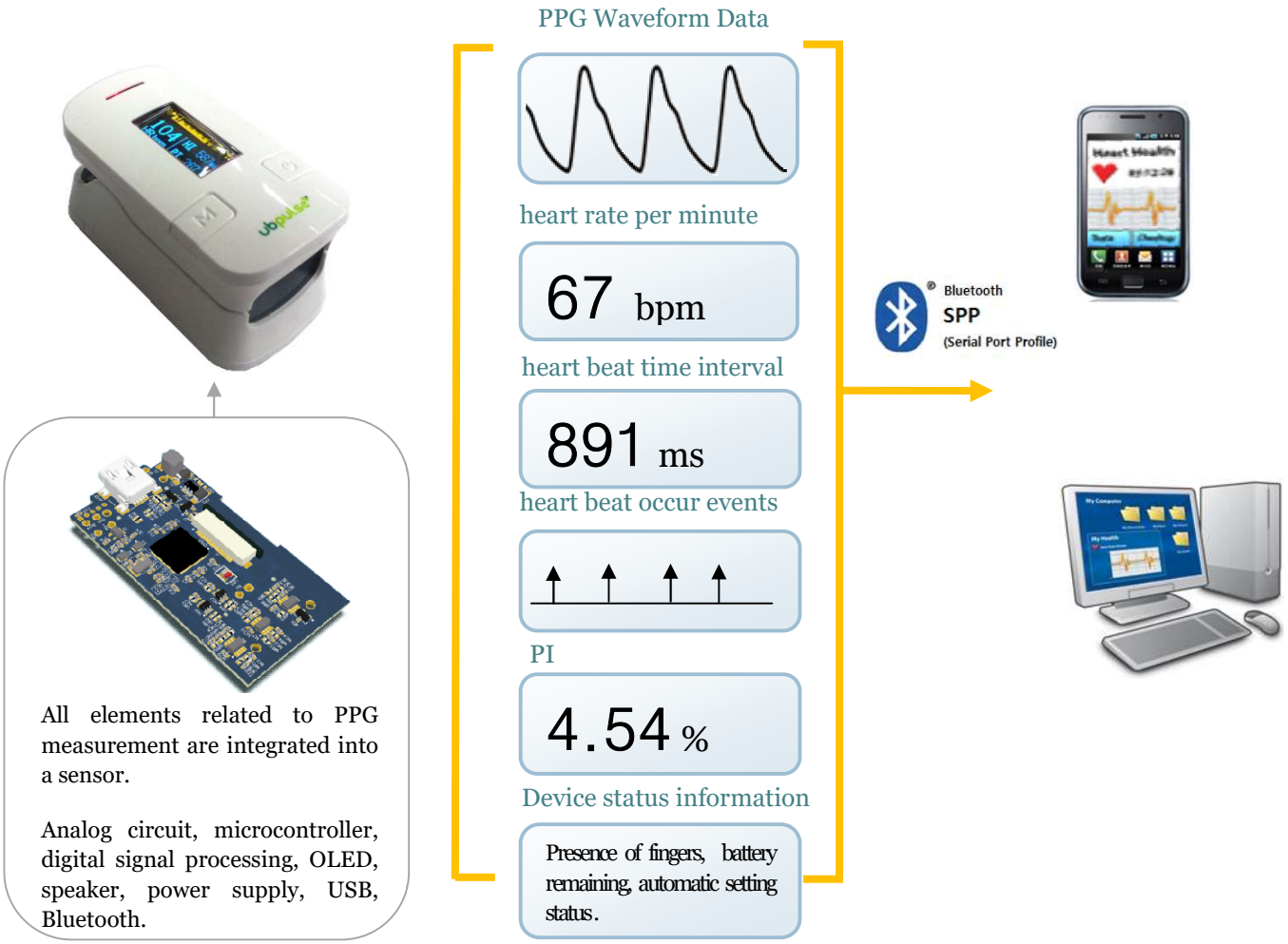
Document ID: LXE12, Document Title: LXSDF T2 communication specification
Download URL :
https://github.com/LAXTHA/LXSDF/raw/master/LXE12_LXSDFT2_CommunicationStandard_en.pdf

Contents

Measurement data communication function of ubpulse H3

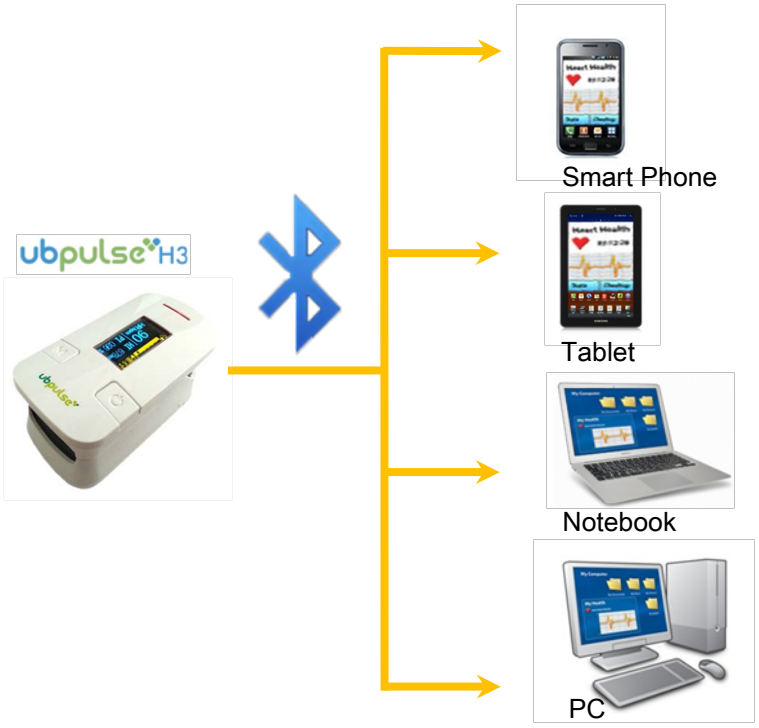
The ubpulse H3 has all the necessary circuitry for measurement of pulse waves (PPG, PhotoPlethysmoGraph) in the sensor and all necessary elements for measuring such as digital processor, speaker, OLED display, power supply, and all measurements and autonomic nervous test procedures are done automatically. By recognizing the state of the finger placed on the sensor, the optimum measurement setting is performed automatically, and continuous measurement, digital signal processing and data transmission are performed. ubpulse H3 can transmit both measurement data and inspection result data to the host side, and this document is about "measurement data"

The calculated raw waveform data and heart rate per minute calculations are digitized and stored in ubpulse H3. It is possible to transmit in real time to the host device via Bluetooth. It can be connected to any device that supports Bluetooth SPP (Serial Port Profile), and it can utilize person's PPG measurement information on smartphone, tablet, PC. Developers who have introduced ubpulse H3 are working part of the development program to open the serial port and receive data from the device.



ubpulse H3 Bluetooth communication

This document defines Bluetooth serial communication specification of ubpulse H3. ubpulse H3 Bluetooth is an SPP profile and is recognized as a serial port (COM port) in host devices such as smart phones and PCs.



Note: ubpulse H3 connectable smart phone

The smartphone must support the Bluetooth SPP profile to communicate with the device.

- For example: Galaxy S3, Galaxy Note, Galaxy Tab, etc. (Other latest Android phones support Bluetooth SPP)
- Non-communicable devices: All of Apple's products such as iPhone.

ubpulse H3 based communication data specification - LXSDF T2

The ubpulse H3 complies with the serial port (com port) communication standard and transmits measured and calculated measurement data and device status information in real time. The serial port (com port) communication standard repeats the basic transmission data 1 byte (8 bits) Format. To transmit various types of data, there must be a separate data format (packet) grouped by several tens of bytes. The data format used in ubpulse H3 uses a serial communication data format called LXSDF T2.

Figure (a) shows the data communication between the device and the host device. LXSDF T2 Tx is the data format transmitted from the device to the host, and LXSDF T2 Rx is the data format in which the device receives data from the host. Figure (b) shows the detailed structure of LXSD T2 Tx. The packet is continuously transmitted as a basic transmission unit, and the data of a certain meaning is shown for each byte in one packet consisting of several tens of bytes. 255, and 254 are sequentially transmitted to the start point of one packet, and then data bytes within one packet are transmitted.

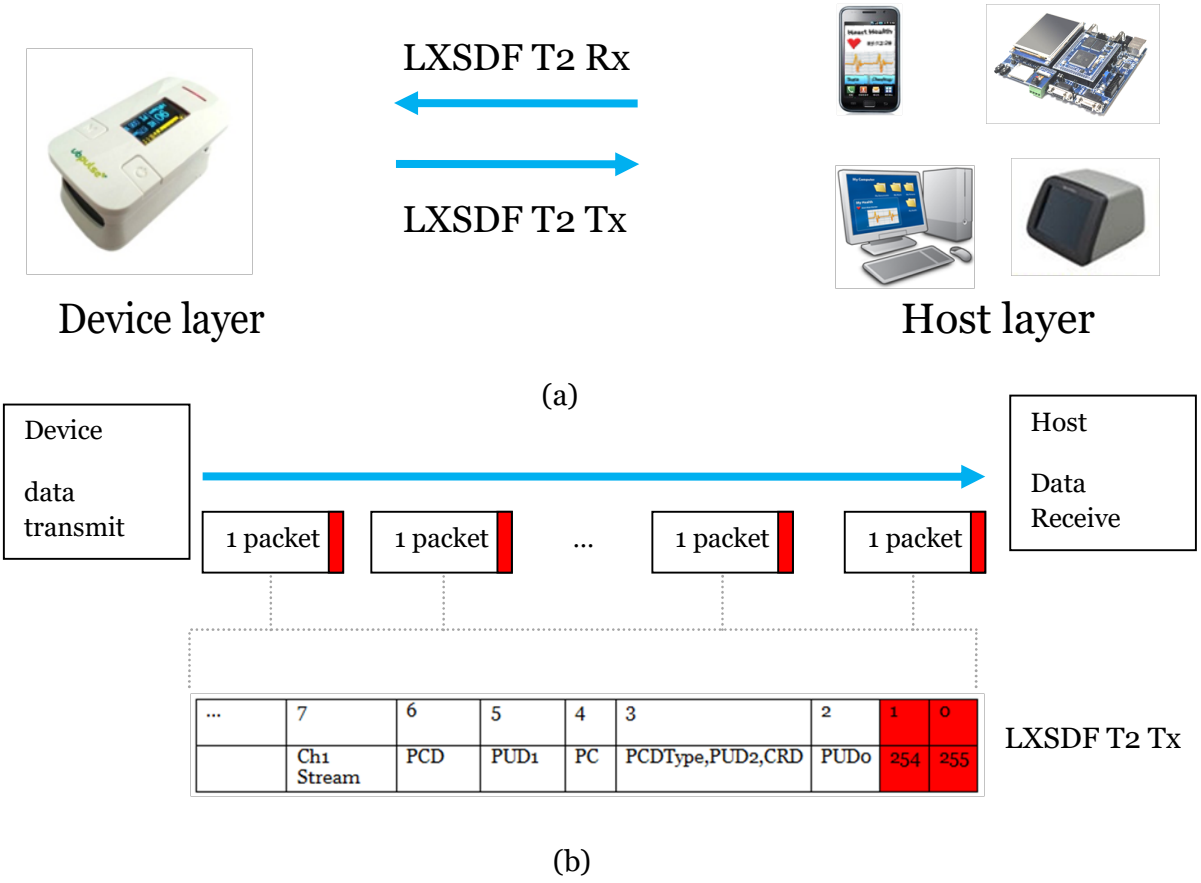


Figure 1.(A)Data communication LXSDF T2 format between device layer and host layer

. (B) LXSDF T2 Tx Detailed structure

The overall flow of the communication program development process.

The development tool of the host device achieves a state in which communication is possible by opening a COM port, extracts information from the received data in accordance with the data format by referring to the communication standard document, acquires the information, and develops a postprocessing code . Required developer capabilities: Ability to use development tools on host devices. Ability to generate com port communication code of the device.

The overall operation flow of the communication program is as shown in the figure. First, open the device's com port Comport setting values are shown. In "1. Reading data from the com port", the byte sequence received from the com port is sequentially read. In the "2. LXSDF T2 Tx Packet Extraction &quot" which detects sync bytes (data is arranged in the order of 255 and 254) indicating the start point of the packet from the byte strings, data is separated on a packet "3. Packet data parsing". The information of ubpulse H3 is arranged in each data element secured in the process of 3. These information are obtained and utilized at the stage of "4. Obtaining information on the public H3".

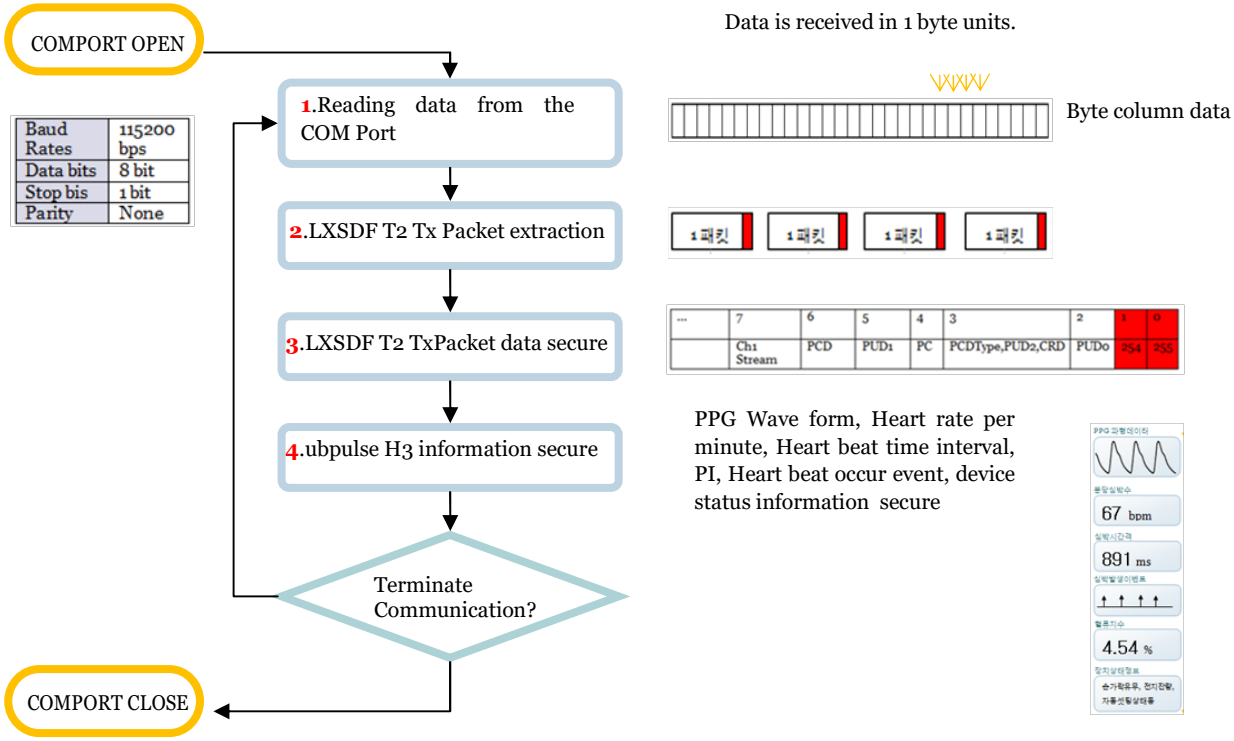


Figure 2. Program structure communicating with UBPULSE H3.

ubpulse H3 is recognized as a serial port on the host device.

Since Bluetooth uses the SPP profile, the host device automatically recognizes it as a serial port (com port).

When connecting Bluetooth on host side, password: 1234

COM port setting: baud rate: 11520 bps, data bit: 8bit, stop bit: 1, parity: none, flow control: non

This communication standard is based on serial communication format and is based on LXSDF T2 (LX Serial Data Format Type 2) as a format for transmitting various types of data.

This manual explains what data is placed in the LXSDF T2 format for ubpulse H3.

The description of LXSDF T2 is beyond the scope of this document.

Document ID: LXE12 must be an essential reference.

download : https://github.com/LAXTHA/LXSDF/raw/master/LXE12_LXSDFT2_CommunicationStandard_en.pdf

Constants applied to ubpulse H3 to LXSDF T2 format.

Item	Explanation
LXSDF T2 TX 1 packet transmission cycle	256 times per second
Product unique ID assigned to LXSDF T2 TX packet When the PC (packet count) is 30, value recorded in the PCD (packet circulation data).	1
Number of channels, value recorded in PCD when PC.	6 (Note 1)
Number of samples, value recorded in PCD when PC .	1 (Note 1)

(Note 1)

The host-side program can be used to separate stream data by dynamically securing the number of channels and the number of samples transmitted in the packet, but it is also possible to use fixed constants 6 and 1 for simplicity of code.

ubpulse H3 data assignment in the LXSDF T2 Rx data format.

Instruction Contents	LXSDF T2 RX Data Placement	Explanation.
Heartbeat sound ON	Cmd0: 128 Cmd1: 3 Cmd2: 1	Making a device sound when a heart beat occurs.
Heartbeat sound OFF	Cmd0: 128 Cmd1: 3 Cmd2: 0	Mute on the device during a heart Beat. (Other sound effects such as power on / off, finger insertion sound remain ON)

ubpulse H3 data assignment in the LXSDF T2 TX data format.

Data item	LXSDF T2 TX Packet Data Placement.	Explanation
photoplethysmographic pulse wave(PPG)	StreamData Ch1 high bit3,2,1,0 StreamData Ch1 low, bit7~0	
Heartbeat	Record in bit 6 of PUD1.	1 : Heart beat 0 : No heart Beat
HeartBeat time interval	PUD 0, PUD 1 Bit2,1,0 of PUD 1 : Upper of heart Beat time interval 3 bits Bits 7to 0 of PUD 0 : Lower of Heart Beat time interval 8bits.	The Time interval (in milliseconds) between the current heartbeat and the immediately preceding heartbeat
Heart rate per minute	PCD of PC=2	
Perfusion Index(PI)	PCD of PC=3 : Upper of PI 4 Bits PCD of PC=4 : Lower of PI 8 Bits Actual PI% value multiplied by 100 is sent	The PI value should be divided by the value obtained by the upper 4 bits x256 + lower 8 bits by 100. unit : %
whether the Low Blood Flow or not.	PCD bit 7 of PC=3	1: Measurable 0: Not measurable (cause of low blood flow)
Heart rate per minute - Average	PCD of PC=5	
Perfusion Index(PI)- Average	PCD of PC=6 : Upper of PI 4Bits PCD of PC=7 : Lower of PI 8 Bits Actual PI% value multiplied by 100 is sent	
whether the Low Blood Flow or not - Average	PCD bit7 of PC=6	
whether sensor is worn	bit5 of PUD2	1: finger on the sensor 0: No finger on the sensor.
Automatic setting status	bit4 of PUD2	1: Not automatic setting 0: Automatic setting.
steady state	bit3 of PUD2	1: stable, 0: unstable.

remaining battery	PCD of PC=1	0~100 unit: %
Power status information	PCD of PC=0 bit7 : Low battery warning bit1 : Power in use	1: Low battery, 0: Normal 1: Use battery, 0: Use USB power
whether heart beat sound	PCD bit 7 of PC=8	1: ON, 0 : OFF

Data placement situation by packet count.

PC(Packet Count)	Data placed on the PCD.	remark
0	Bit7 : Low battery warning Bit1 : Power in use.	
1	remaining battery.(0~100%)	
2	Heart rate per minute.	
3	upper of PI 4Bits.	
4	Lower of PI 8Bits.	
5.	Heart rate per minute - Average	
6	Upper of Average of PI 4Bits	
7	Lower of Average of PI 8Bits	
8	Bit7 : whether heart beat sound	

Detailed desciption by data item.

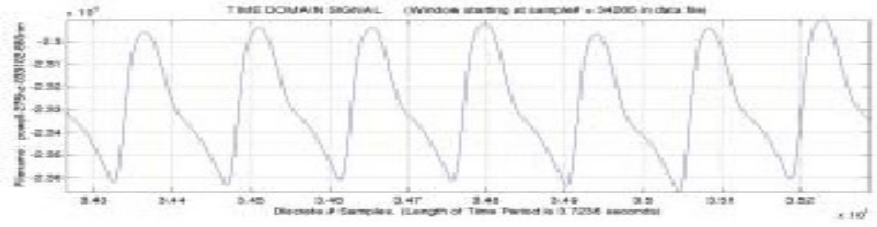
photoplethysmographic pulse wave(ppg).

Measure on current device, Transmits AD converted PPG waveform data in real time in one sampling unit.

AD conversion characteristics of PPG waveforms performed in the device

- Sampling frequency : 256Hz
- Bit resolution : 12bit.

Example of PPG waveform.



PPG waveform Placement of LXSDF T2

When 1 packet is transmitted, 1 sampling data is transmitted to Ch1 stream high and Ch1 stream Low.

Sampling Data value range: 0 to 4095 Center value: 2048 (2048 means analog 0V point)

Ch1 StreamData High bit 3, 2, 1, 0 places the upper 4 bits of 12 bits of 1 sampling data.

Ch1 StreamData Low's bit7 ~ 0 places the lower 8 bits of 12 bits of 1 sampling data.

Processing data received from the host.

Sampling data of PPG waveform = upper 4 bits x 256 + lower 8 bits.

Example: If the value of the upper 4 bits is 9 in decimal number and the value of the lower 1 byte is 126, then 2430 is obtained by sampling data = 9 x 256 + 126 in the Sampling data of PPG waveform.

Heart Beat.

At the time of heartbeat, 1 is recorded and transmitted, And the other situation, 0 is recorded and transmitted.

Heartbeat detection method: rising zero crossing of PPG waveform.

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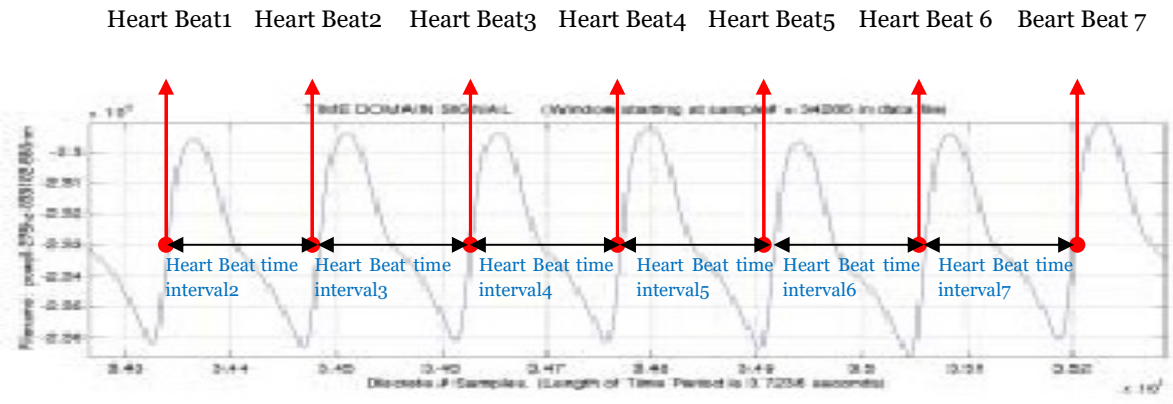


Heat Beat time interval

The time interval between the current heartbeat and the immediately preceding heartbeat is recorded in milliseconds.

Process interval time data received from the host.

Heart rate time interval = upper 34 bits x 256 + lower 8 bits.

Heart rate per minute

For each heartbeat, the value calculated by 60 seconds / heart rate time interval(in seconds) using the time of the immediately preceding heartbeat and timer interval is Transmitted.

Prefusion Index(PI)

PPG is a method to detect blood flow. Perfusion Index is a value that quantifies the degree of blood flow difference. Units are in units of%, usually 20% for very large, and less than 0.1% for very small.

Since the value transmitted from the device is multiplied by the original PI value multiplied by 100, the transmitted value should be divided by 100 when used by the host.

Example: If the transmitted value is 120, it should be 1.2% when expressed.

Whether the low blood flow or not.

If the PI is too small, heart rate detection and normal measurement on the device is not possible.

When the PI is too small to ensure the accuracy of the measurement, this value is recorded as 0.

Note : Currently the device has a low blood flow criterion value of 0.1%, but the value of the final product can be changed.

Heart rate per minute - Average.

The preceding heart rate per minute is the heart rate per minute, which is calculated as the time with the immediately preceding heart rate every time a heart rate is generated.

The "heart rate per minute - average" transmits the moving average value of the heart rate per minute.

Prefusion Index(PI) - Average.

The previous PI is the PI at the past time interval (1 second) from the point of data transmission, and the "PI-average" is the moving average value of the PI value.

Whether the low blood flow or not - Average.

The presence of low blood flow - mean is the low blood flow judgment value judged by using the PI - average value.

NOTE. Currently, the low blood flow criterion value is 0.1%, but the final reference product criterion value can be changed.

Whether sensor is worn.

Indicates whether a finger is placed on the sensor.

1: finger on the sensor/ 0: No finger on the sensor.

Time required to determine whether or not the sensor has a finger attached: within 0.5 sec.

Automatic setting status.

When the device is first placed on the finger, the automatic setting function is activated to detect the optimum signal and reliable measurement data is not obtained during the automatic setting.

A value of 0 is transmitted during automatic setting, and a value of 1 is transmitted during non-automatic setting.

Time required for automatic setting: Most people normally complete the automatic setting in less than 5 seconds and take up to 10 seconds for some specific signals.

steady state.

If the subject moves his / her finger during the measurement, the accuracy of the measurement can not be guaranteed. A state value of 1 means a stable state, meaning that the movement of the finger is not enough to interfere with the measurement, and 0 means unstable, meaning that the measurement data of this interval is unreliable.

When the steady state goes to 0: When the finger is inserted into the sensor at the beginning, when the finger is pulled out from the sensor, when the finger is placed on the sensor, or when the finger is moved severely.

Unstable time: It is usually less than 1 second when you put your finger on the sensor. It has a non-steady state value while the fingers are moving with the finger placed on the sensor.

Note : This means that normal measurement is possible when sensor wear, automatic setting, and stable state are all 1s.

remaining battery

The remaining battery level is transferred between 0 and 100%. If this value is less than 20%, a low-battery warning occurs at the lower power state.

Power status information

Battery Alert

Occurs when the battery level is less than 20% and is used to signal the battery replacement.

Power in use.

ubpulse H3 can be used for both battery and USB power. When USB is connected, the device always operates with usb power. 0 when USB power is in use and 1 when battery is in use.

Whether heart beat sound.

Indicates the presence or absence of sound in the device during a heart Beat.

1: Sounding state, 0: No sound, Power on / off button other than heartbeat sound, effect sound when finger is put on and off is always maintained.

Appendix A. ubpulse H3 Bluetooth connection(Smart Phone)

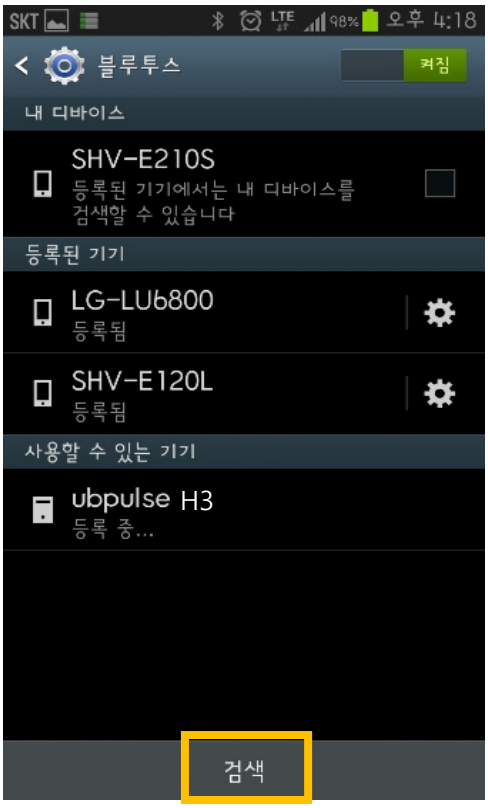
This example shows how to connect to the built-in Bluetooth on the smartphone (Galaxy S3). Depending on the smartphone model, Bluetooth connection method is slightly different, but the overall configuration method is similar.

Bluetooth normal connection (communicating) status

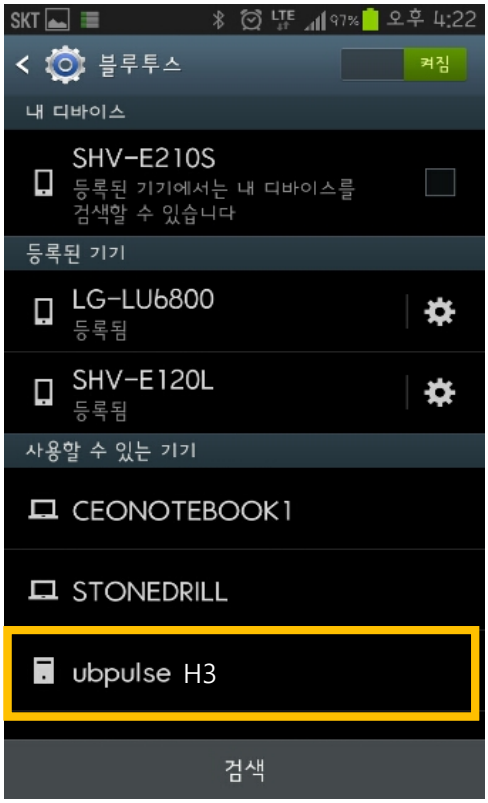
Bluetooth disconnected status

If Bluetooth is normally connected and communication is in progress, the Bluetooth icon changes to connected status.

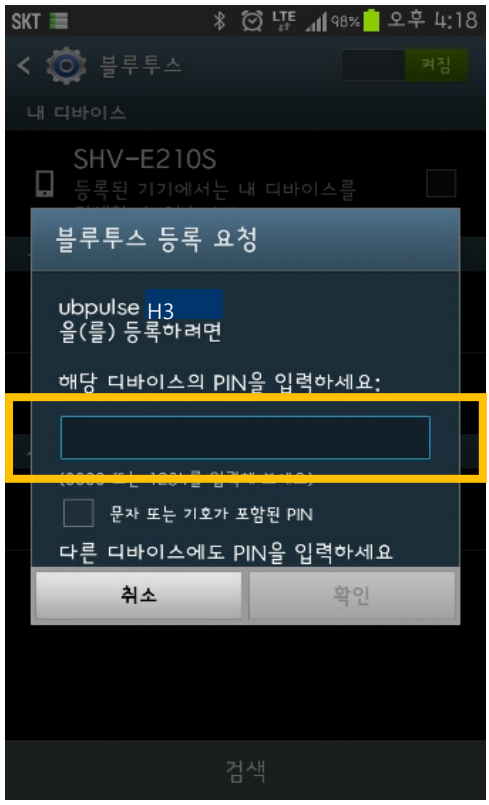
1. [System Settings] - [Bluetooth], Press 'ON'.



2. Press 'Serach' to find devices.

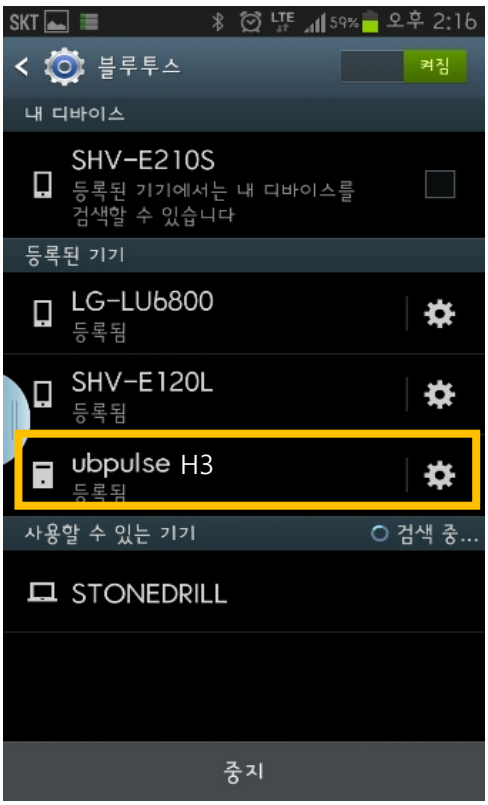


3. Press [ubpulse H3] for 2 second.



4. [Bluetooth pariring request] window open.

5. Enter pin number "1234".



6. Successful connection with smart phone

Appendix B. ubpulse H3 Bluetooth connection (general PC).

This example is an example of a Bluetooth setting built into a notebook. Since different programs are used in accordance with the Bluetooth dongle used for each notebook, the overall setting method is similar, though not completely identical to the setting method presented in this example. Once the Bluetooth setting is done for the first time, you can use the Bluetooth connection directly with the device without additional setting.

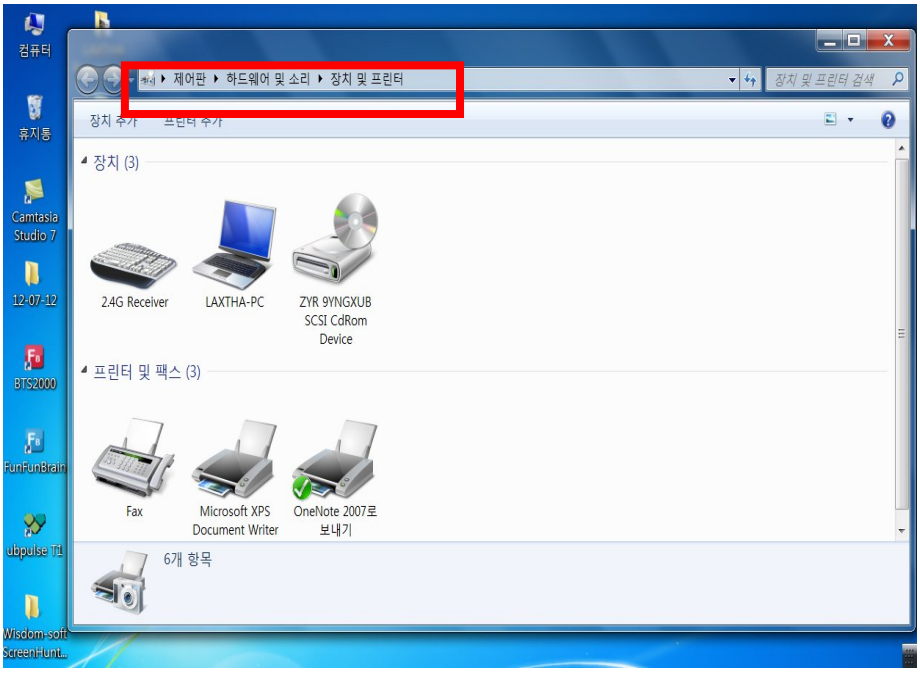
Bluetooth normal connection (communicating) status

Bluetooth disconnected status

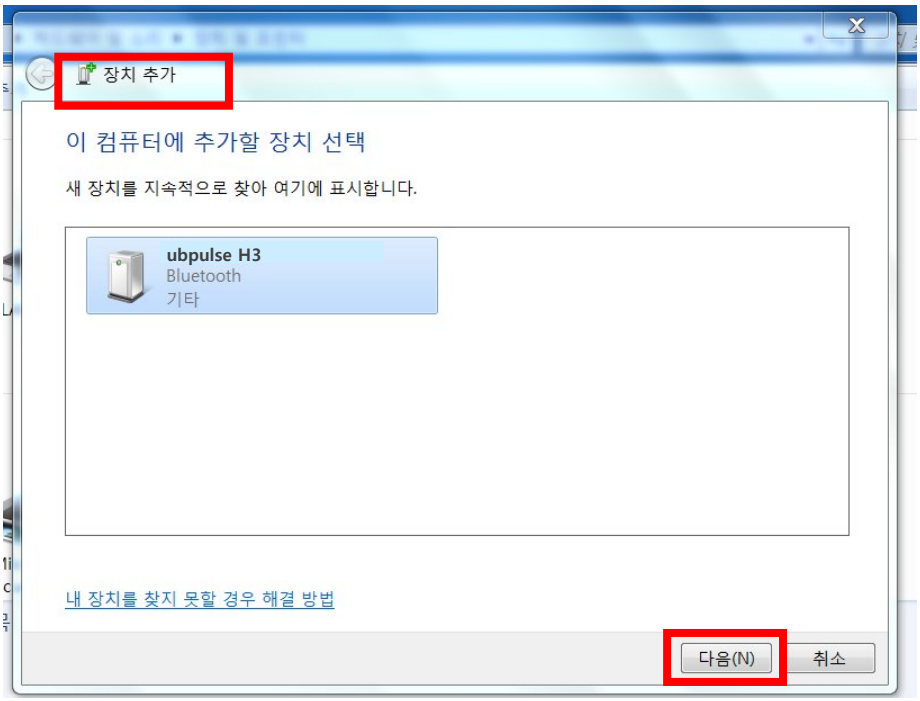
If the Bluetooth connection is normal and communication is in progress, the Bluetooth icon on the device shows the normal connection status..

Bluetooth connection example in Windows 7.

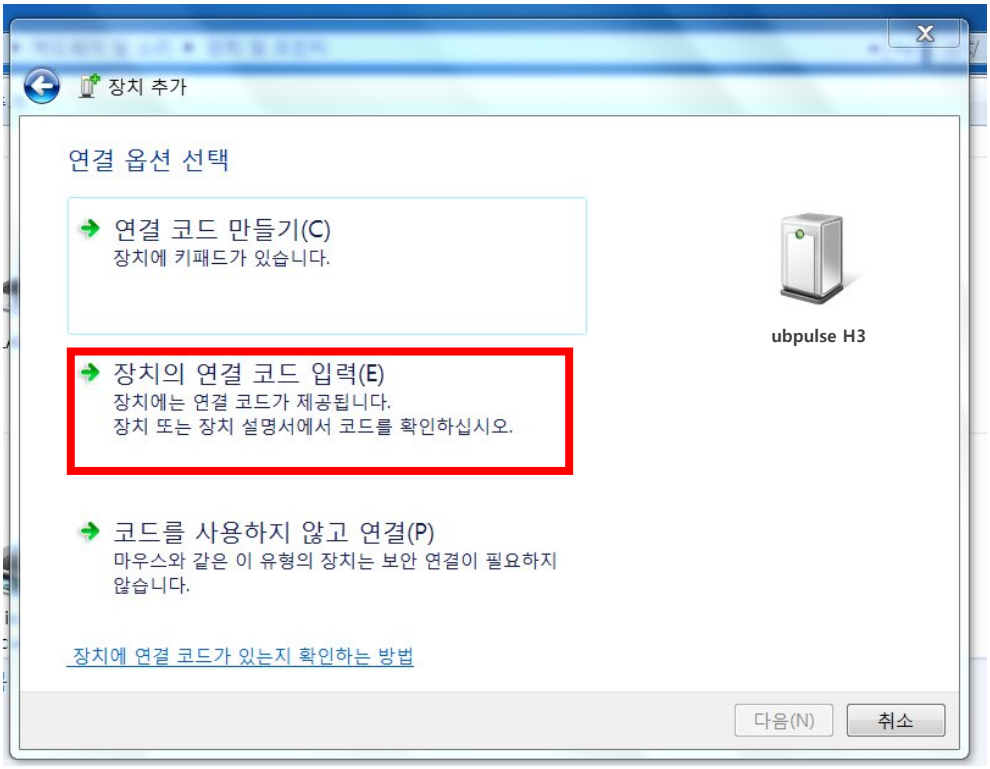
1. Click [Contorl Panel] - [Hardware and Sound] - [Devices and printers]



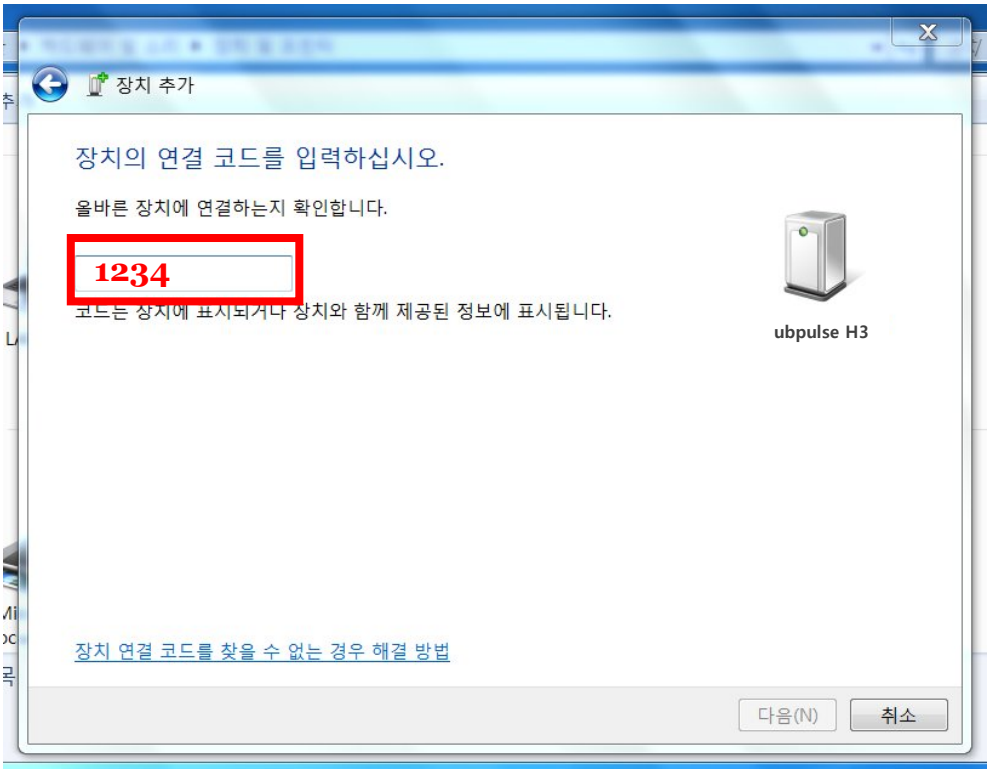
2. When you click the [Add Device] button, ubpulse H3 is selected. Click [Next]



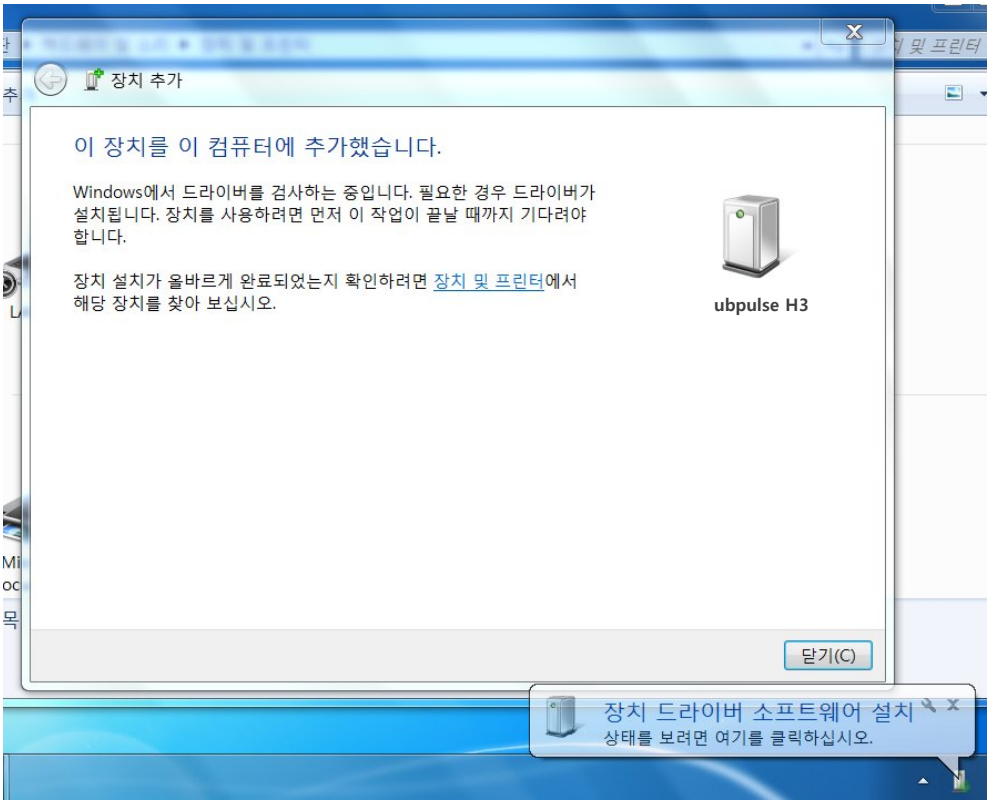
3. When Bluetooth pairing is completed, [Create Link(connection) code] is displayed as follows. Click [Create Link(connection) Code].

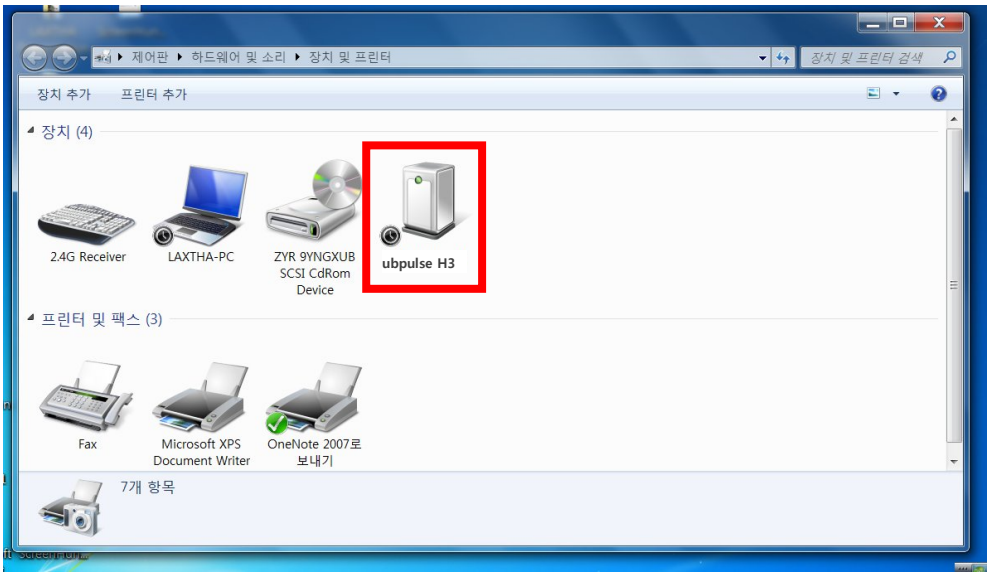


4. Enter [1234] in the Link (connection) code..



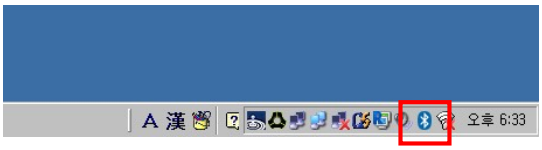
5. ubpulse H3 device added.



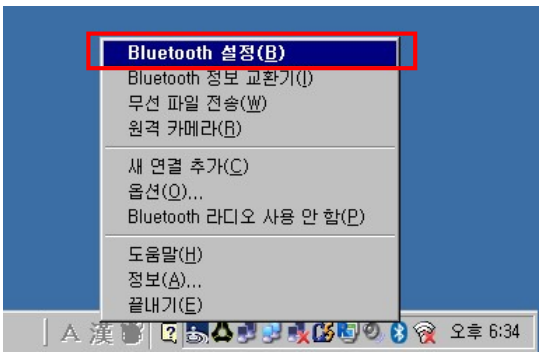


Bluetooth connection example in Windows XP.

This example is an example of Bluetooth settings built into the notebook (Windows XP). Since different programs are used depending on the Bluetooth dongle used for each computer, the overall configuration is similar, although not exactly the same as the one shown in this example. Once the Bluetooth setting is done for the first time, you can use the Bluetooth connection directly with the device without additional setting.

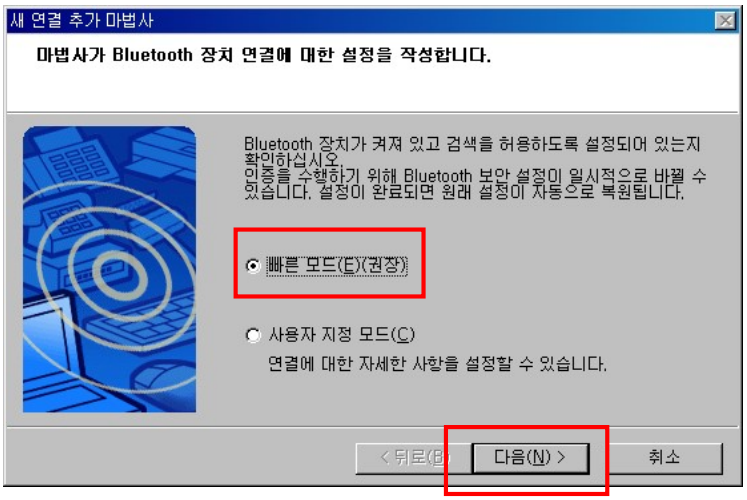


1. With ubpulse H3 turned on, click the Bluetooth settings icon on your PC.

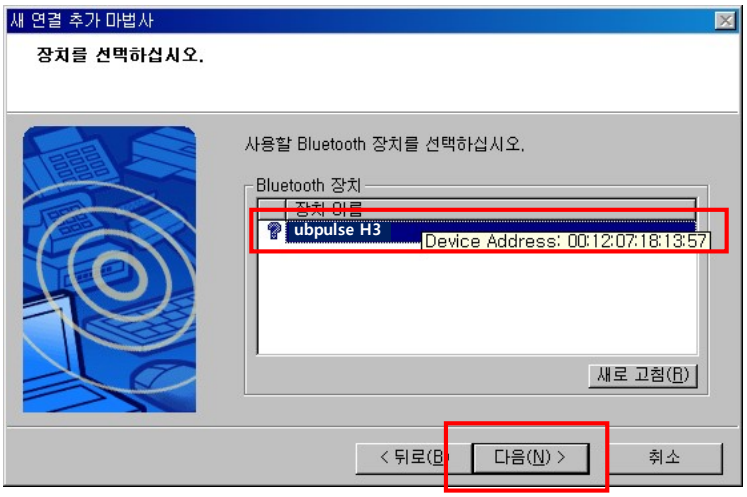


2. Click Bluetooth Settings.

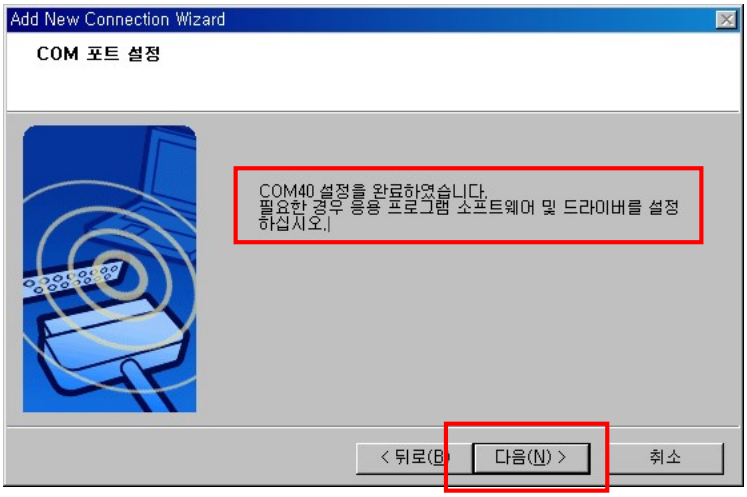
3. Click the New Link(connection) button in the Settings window.



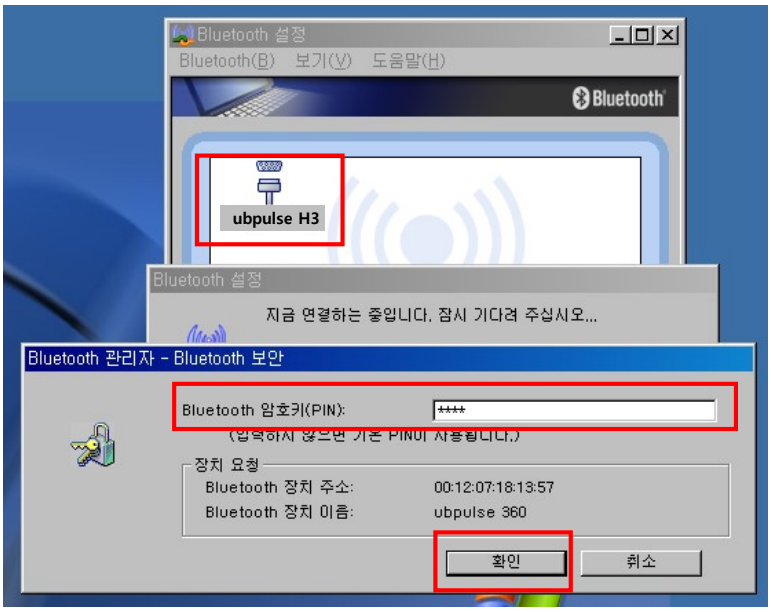
4. In the "Add New Connection" dialog box, select Quick Mode (Automatic Connection) and click the Next button.



5. It automatically detects and displays the Bluetooth devices found in the vicinity. You can see that ubpulse H3 is found. Select ubpulse H3, and then click the Next button.



6. Check the com port number that is auto set and click the Next button.



7. In step 6 , the Bluetooth setting is completed and the connection is ready. The icon was created. At this stage, double-click the icon to pair with Bluetooth. A window will pop up and asking you to enter your passkey, enter 1234 here and click OK.

8. Bluetooth pairing succeeded and a connected indicator appears.

Appendix C. ubpulse H3 communication form Bluetooth connected PC

Ubpulse H3 can be communicated with ubpulse H3 from any development tool that can communicate with com port because it is recognized as general com port on PC when PC is connected with Bluetooth. You can use a common programming language such as MS Visual Studio or Java, or you can use specialized tool software such as LabVIEW MATLAB.

Figure 4.When ubpulse H3 is connected to the PC via Bluetooth, it is recognized as a common com port on the PC. Comport to communicate with all communication tools available.

In the example shown in the figure below, the LX Device Manager communicates with the ubpulse H3 connected via Bluetooth and shows an example of real-time monitoring of the measured values in the device.

LX Device Manager information : http://www.laxtha.com/ProductView.asp?Model=LX%20Device%20Manager
LX Device Manager install file download: https://github.com/LAXTHA/LXDeviceManager/raw/master/LXDeviceManagerSetup.msi

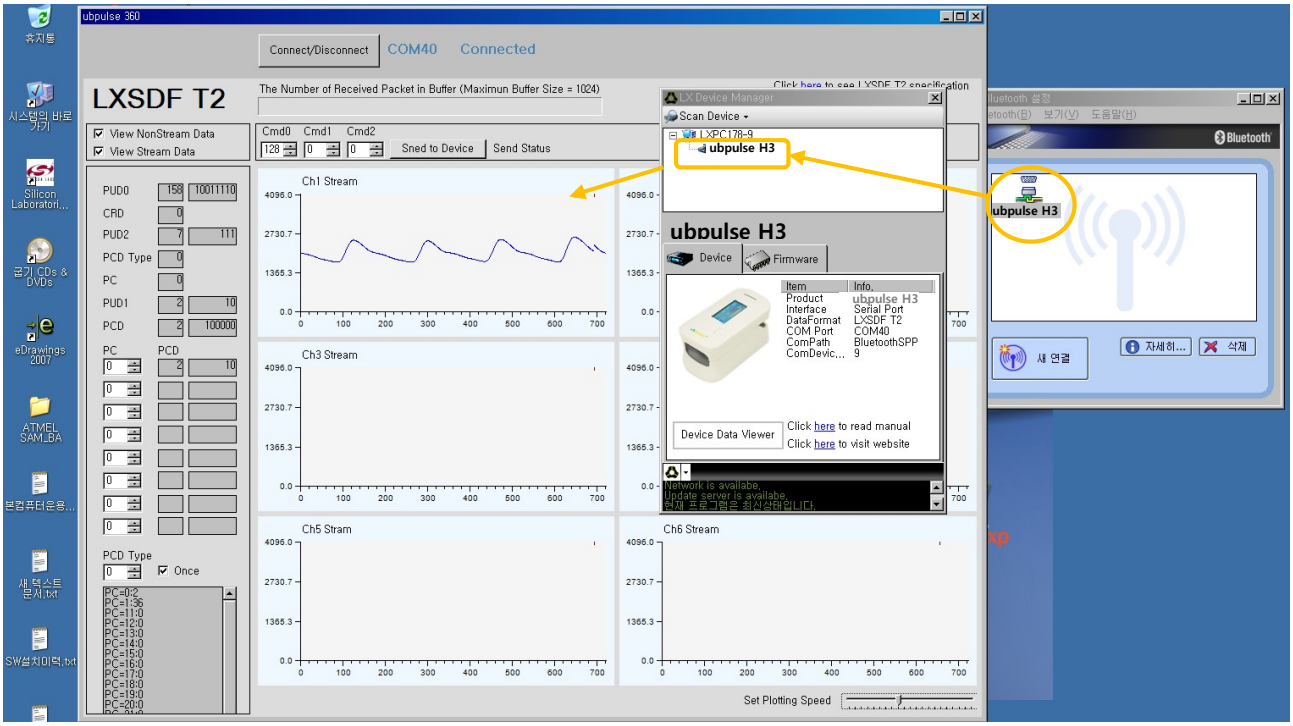


Figure 5. An example of communicating with Bluetooth-connected ubpulse H3 and LX Device Manager.

Revision History

Release Date	Doc. ID	Description of Change
2018-03-14	LXE13 V1	First release.