WHALETEQ

PPG Heart Rate Simulator Test System (HRS200)

User Manual

Software Version 1.0.0.6

Version 2024-03-29

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1 System Introduction

WhaleTeq Heart Rate Simulator (HRS200) is a test system designed for "Photoplethysmography" (PPG) technology. For PPG sensor suppliers, IC Solution providers, and wearable manufacturers, the HRS200 simulates the reflected light of human skin, and provides different adjustable parameters such as brightness, heart rate, and so on.
The HRS200 supports ''4.3.1 PPG simulator test'' of IEC 63203-402-3:2024.

1.1 Basic Concept

1.1.1 Photoplethysmography (PPG)

This technology captures blood information via optical signal. Most Pulse Oximeter (SpO_2) equipment on market now uses PPG technology. In the recent years, wearable devices are becoming increasingly popular and most manufacturers and brand companies use PPG technology as the key technology to capture heart rate value.

The theory behind this technology: By shining LED light to the skin and while the light would be partially absorbed by the skin and reflected (or refracted) back to photodiode, the system can then collect and calculate the value differences into heart rate (BPM).

1.1.2 Perfusion Index (PI)

Following the description stated in section 1.1.1, the below diagram can be explained as X axis representing for the time while Y axis representing the light reflection received by photodiode.

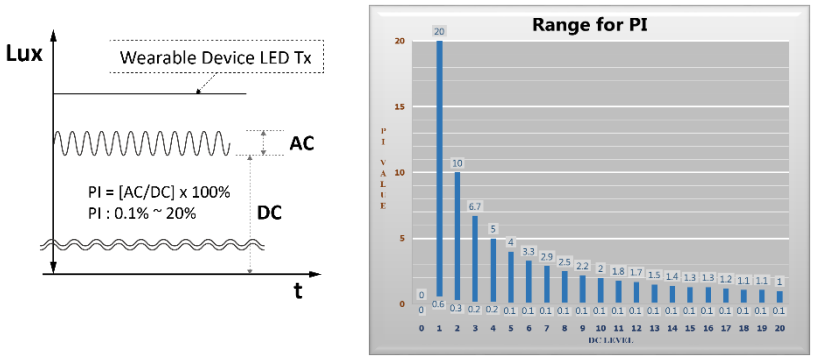


Figure 1: Perfusion Index (PI)

As shown in the above diagram, there are slight signal fluctuations (AC, refers to Heart rate signal) above the carrier signal (DC) and the ratio of AC to DC is defined as Perfusion Index (PI).

Note: PI value can be adjusted, but the value range would be varied due to the changes of DC value. See upper-right figure.

1.1.3 WhaleTeq Heart Rate Simulator Test System

WhaleTeq HRS test system is based on the concept described in section 1.1.1 and 1.1.2. The simulated light source provided by the system verify if the photodiode of the wearables can receive the LED light properly, and if the module can react well with different simulated light. Meanwhile, the test system has built-in photodiode as well. Users can use the built-in photodiode to verify the light source of different wearables.

On top of simulation of heart rate signals, users can also adjust parameters to simulate reflection of different brightness levels (DC), conditions of peripheral circulation (PI). The WhaleTeq HRS test system provides various settings and multiple operation modes for different PPG sensors and different scenarios.

WhaleTeq HRS test system has 2 different models – HRS200 and HRS100+.

- **HRS200**:
  Premium Model. Designed for R&D and test engineers to provide multiple and stable signal simulations to facilitate the verification of system and heart rate accuracy.
- **HRS100+**:
  Advanced Model. Designed for test engineers and production line application. This model can quickly measure DUT's PD and LED. Furthermore, this test system can conduct heart rate test procedure and quickly sort out defective LED.

This document is mainly for HRS200 and you may contact WhaleTeq at service@whaleteq.com for details of HRS100+.

1.1.4 How HRS200 interacts with DUT

In order to accurately simulate heart rate, HRS200 test system has built-in LED and PD, which are individually corresponding to the wearable's PD and LED. Please note that LED and PD shown in HRS200 PC software from the view of HRS200. For example, PD sampling (section 3.2.1) shown in HRS200 PC software indicates DUT's LED status.

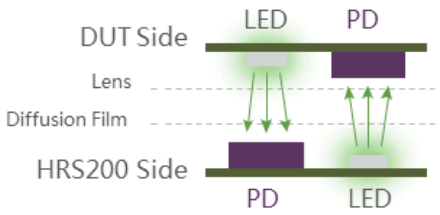


Figure 2: The Interaction Between HRS200 and DUT

1.2 Appearance and Package Content

This section introduces HRS200's appearance and usage. Package content and specification are also listed in this section.

1.2.1 HRS200 Appearance

HRS200 is designed for R&D and test engineers. The below illustration shows the product appearance and functions:

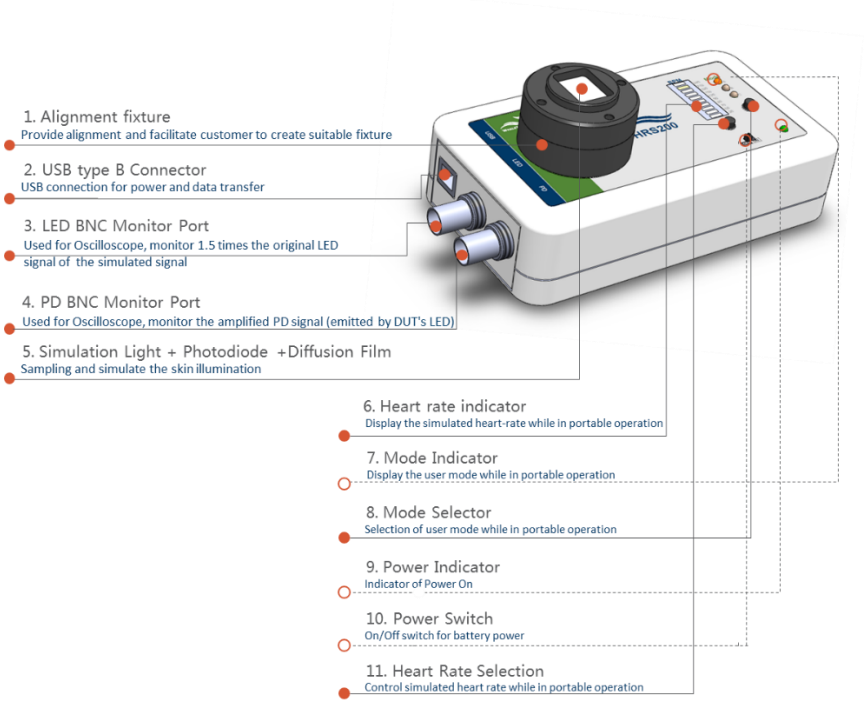


Figure 3: HRS200 Hardware Overview

1.2.2 Package Contents

The HRS200 package contains the following items:

Table 1: Package Contents

No.	Item
1	HRS200 Unit
2	Warranty Card
3	USB Type-A to Type-B Cable (male to male)

1.2.3 Specifications for HRS200 Alignment Fixture

User may use the below mechanical drawing to develop the alignment fixture for fitting your wearable.
User can also download the HRS200 3D model Here.

- Mechanical Drawing:

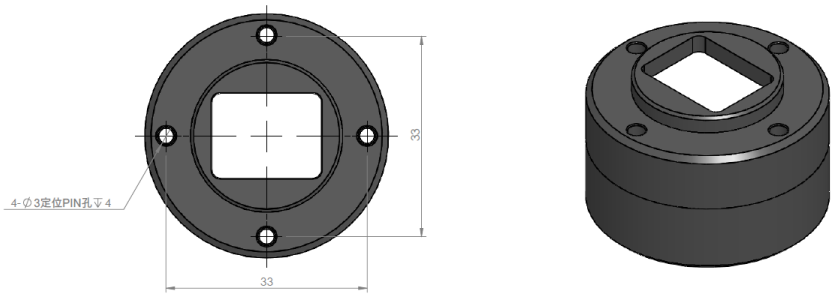


Figure 4: Mechanical Drawing of Fixture Mounting Base

✓ Top LED Holder:

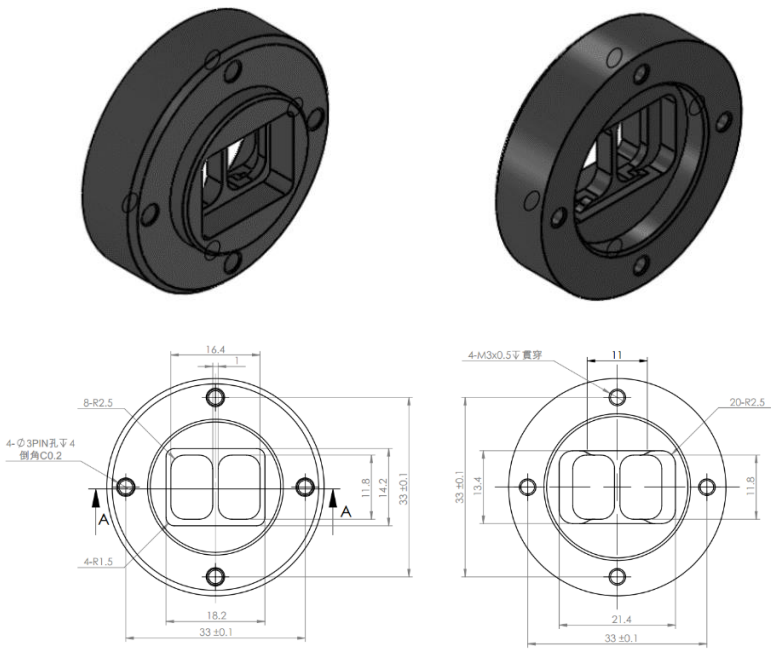


Figure 5: Mechanical Drawing of Top LED Holder

✓ Bottom LED Holder:

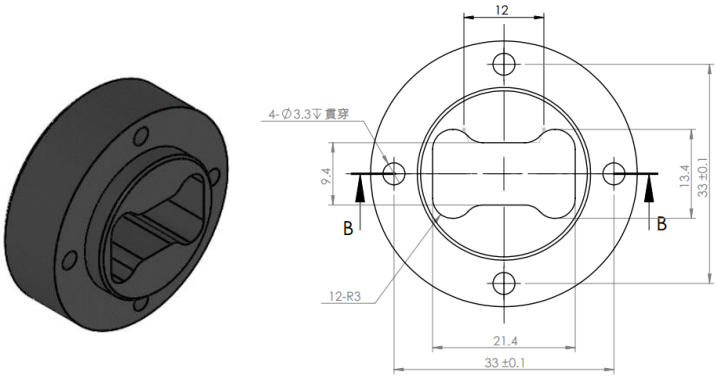


Figure 6: Mechanical Drawing of Bottom LED Holder

- Sectional View:

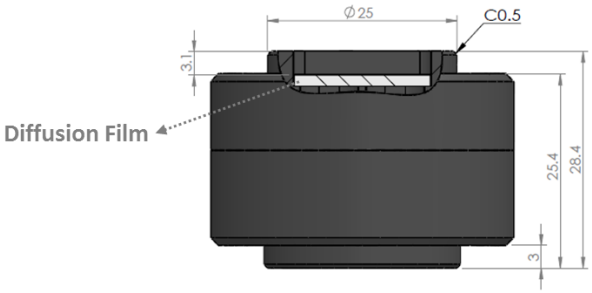


Figure 7: Sectional View of Fixture Mounting Base

Here is the length and width (135mm x 76mm) of HRS200:

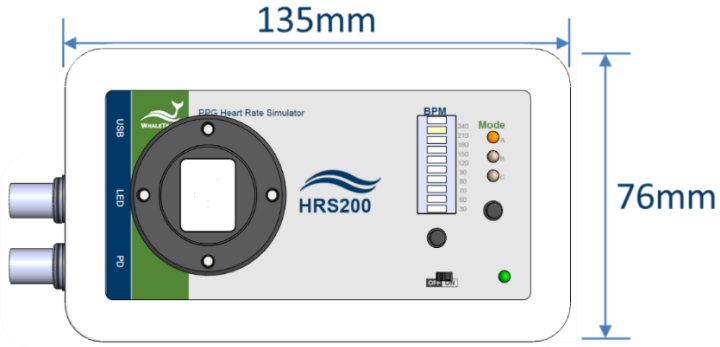


Figure 8: Length and Width of HRS200

The following is the height of the machine:

- Fixture mounting base height: 25.4mm

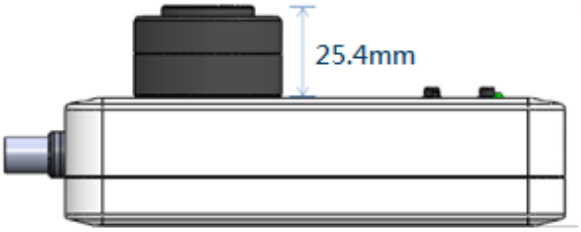


Figure 9: Height of Fixture Mounting Base

- Entire machine height: 60.2mm

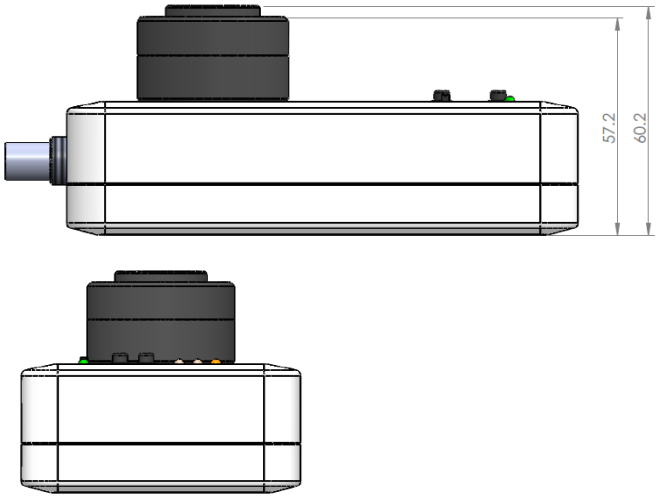


Figure 10: Height of Fixture Mounting Base and HRS200

1.3 Using the HRS200

This chapter introduces the usage modes, cabling diagrams, and recommendations for using this product.

1.3.1 Usage Categories

This product provides standalone mode and PC software mode. Details are listed as below:

1. **Standalone Mode:**
   User can directly place the DUT onto HRS200 to testify BPM rates.
   I. In HRS100+ standalone mode, user can measure 10 specific heart rate values. If needed, users may modify the default parameter settings via PC software.
   II. In HRS200 standalone mode, in addition to measure 10 specific heart rate values, user may also test DUT under 3 preset settings pre-defined by user.

   For detailed descriptions, please refer to chapter 2.

2. **PC Software Mode:**
   Software operations require the HRS series product to be connected to a Windows-based PC. HRS100+ software offers main function and command mode function. HRS200 provides main function, fine tune function, raw-date playback function, and command mode function.

   I. **Main function:** The major operation mode of this software. It allows user to adjust parameters such as DC, PI, and BPM. Also, it can detect LED brightness of DUT. For detailed descriptions, please refer to section 3.2.1.
   II. **Fine Tune mode:** It provides sine, triangle, PPG waveforms and simulates 50Hz/60Hz/1KHz noise. (This function is only available for HRS200)
   III. **Raw-data Playback mode:** User can record or manually produce a period of waveform signals, and then play under raw-data playback mode. This is the optimal tool

for developers to improve algorithm. (This function is only available for HRS200)

IV. **Command Mode:** User can use specified command scripts to play test sequences automatically. Detailed descriptions please refer to section 3.2.1.

1.3.2 Cabling Diagram

Cabling diagram is as illustrated below in PC software mode or operate via USB power.

Figure 11: Testing Cabling Diagram

If connecting via BNC ports to an oscilloscope, user can measure the original signal of LED and amplified signal of photodiode. Cabling diagram is as illustrated below.

Figure 12: Cabling Diagram of Connecting the HRS200 to an Oscilloscope

1.3.3 Recommended Usage

- **Recommendation 1:**
  As shown in section 1.3.2, WhaleTeq software could fully control the HRS200 when connected to a PC via USB interface. The panel buttons would have no function at that time.

- **Recommendation 2:**
  As shown in below figure, user can directly place the DUT onto HRS200 and proceed tests in standalone mode. The recommended distance between the diffusion film and DUT is 1 cm.

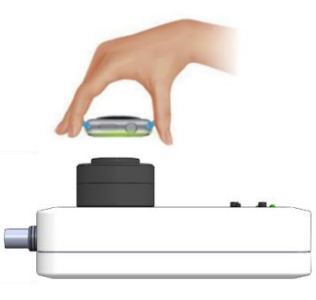


Figure 13: Standalone Mode

1.4 Functions and Specifications

1.4.1 Functions in Standalone mode

Below is the function chart in standalone mode:

Table 2: Functions in Standalone Mode

Feature	HRS200	HRS100+
Heart rate (BPM) setting 30/60/70/80/90/120/150/180/210/240	●	●
Build-in Photodiode	●	●
Three customizable user modes	●	
Save customizable start-up settings	●	●
USB port (Type B)	●	●
PD BNC monitor port	●	
LED BNC monitor port	●	
Battery powered	●	●
Alignment fixture	●	●

1.4.2 Functions in PC software mode

Below is the function list in PC software mode:

Table 3: Functions in PC Software Mode

Mode	Function	HRS200	HRS100+
Main	Parameter: Reflected brightness (DC), Heart rate (BPM)	●	●
	Parameter: Perfusion index (PI)	●	●
	Save settings to user modes	●	
	Save customizable start-up settings	●	●
	View PD sampling	●	
	Show peak maximum	●	●
	LED quick testing, acceptable range settings	●	●
Fine Tune	Parameter: Reflected brightness (DC), Heart rate (BPM)	●	
	Parameter: Amplitude (AC)	●	
	Triangle, PPG waveform	●	
	Noise simulation	●	
Play Raw Data	Clinical Database (Optional)	●	
	Parameter: DC, AC, Gain, Offset, Sample Rate	●	
	Save parameters, Restore parameters	●	
	Load file, Playback, stop and replay	●	
	Browse Waveform, Calibration Waveform	●	
Command	File upload	●	●
	Input command	●	●
	Storing files	●	●
	Execute, stop, replay command	●	●

1.4.3 Specifications

The HRS200 product specification is listed as below:

Table 4: HRS200 Specifications

Parameters	Supported Range / Types	Accuracy
BPM (1)	30 ~ 300BPM (PC software); 30 ~ 240BPM (Standalone usage)	±1BPM
DC in PC software HRS mode	1 ~ 20 Level	N/A
DC in PC software Fine Tune mode	100mV ~ 2500mV	±5mV
PI in PC software HRS mode	0.1% ~ 20% (AC / DC, differs with DC level)	N/A
AC in PC software Fine Tune mode	0.75mV ~ 25mV (BNC measurement is magnified 100 times)	N/A
Lumen (2)	50 ~ 800Lux (5mm from diffusion film)	±3%
Light Wavelength	525nm	±10nm
PD Sampling Rate (3)	<8 ksps (Normal Mode of software); 30 ksps (High Resolution Mode of software)	±5µS
S/N Ratio	>51dB (with USB isolator)	N/A
Power - USB	USB Type-B Plug connector, DC 5V IN	N/A
Power - Battery	Type AA battery x 3	N/A
Size (L x W x H)	6.12cm x 13.5cm x 7.6cm	N/A
Temperature	10 °C ~ 40 °C	N/A

Note:

(1) Heart rate test range is different in standalone mode and PC mode. In PC software mode, heart rate range is from 30 to 300BPM; in standalone mode, heart rate value can be set to 30, 60, 70, 80, 90, 120, 150, 180, 210, 240BPM, plus users can manually select other 3 values from 30 to 300BPM as preset parameters.

(2) Lumen accuracy would be ±10Lux when the light source is lower than 400Lux.
(3) We suggest users to observe PD's analog signals via connecting HRS200's BNC port to an oscilloscope. Under High Resolution Mode, users need to check “LED Off” option to switch off HRS200's LED and no optical signals will be sent then.

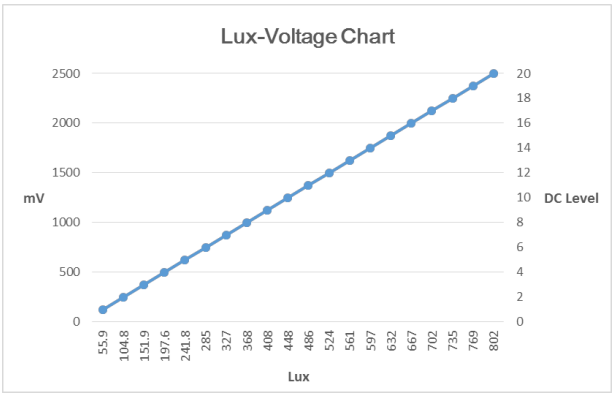


Figure 14: Lux-Voltage (and DC Level) Chart

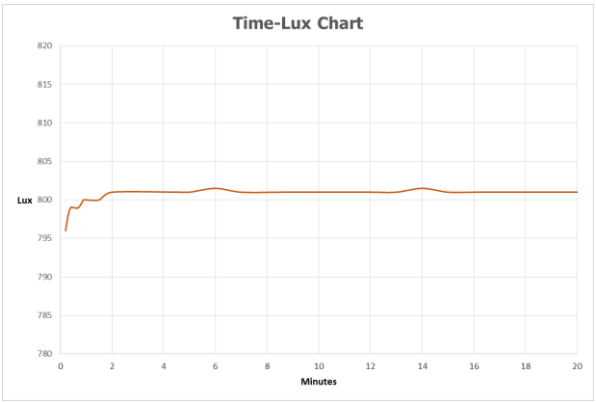


Figure 15: Time-Lux Chart

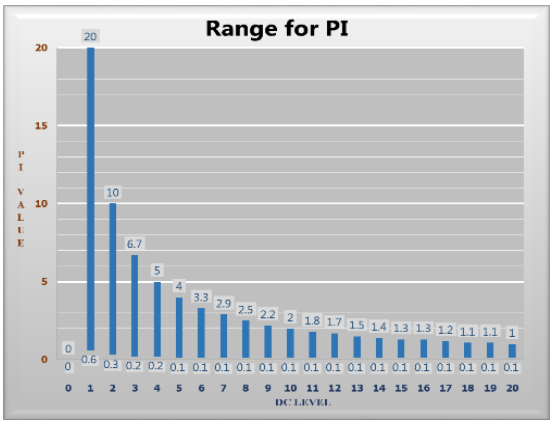


Figure 16: Setting Range for PI (in every DC Level)

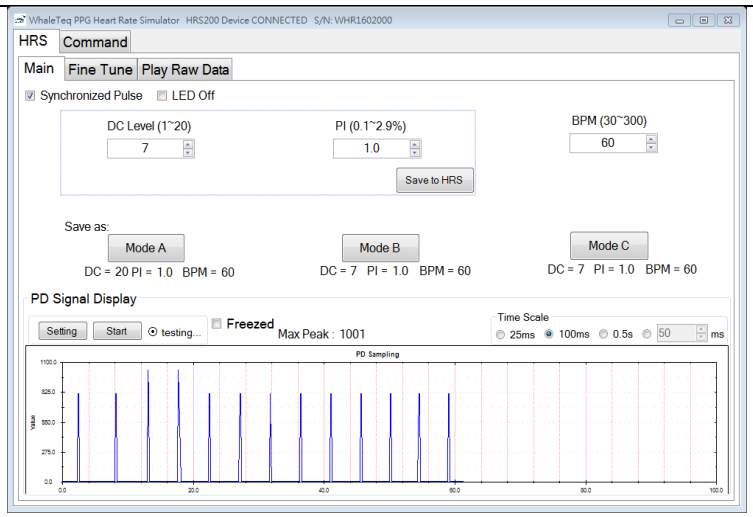
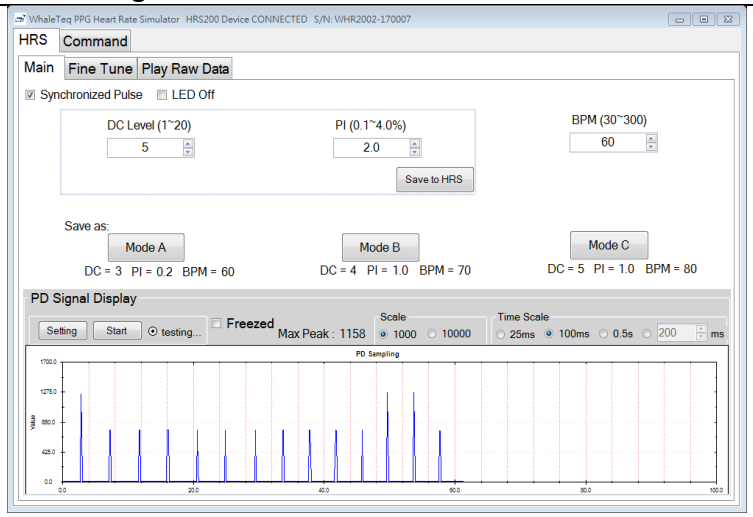
*Tested by Konica Minolta illuminance meter, model T-10MA

1.4.4 Instruction for different version of HRS200

The photodiode detection range of HRS200 was enhanced in July, 2017. Therefore, the HRS200 can measure DUTs with higher LED brightness after the enhancement.

* Please refer to below table for software UI differences between the new version and former version of HRS200:

Table 5: Version Difference of HRS200

Former Version	 - Background color is all white
New Version	 - Background color of PD Signal Display section is gray - Two different PD scale ranges: “1000” and “10000”

2 Usage in standalone mode

1. Setting Mechanism

Optical measurement is quite sensitive against the distance and angle. Before HRS200 is in use, please secure the particular distance and angle between HRS200 diffusion film and DUT PPG sensor.

2. Power Supply

HRS200 can be powered via USB interface or Three AA batteries.

3. Heart Rate Measurement

Please use BPM button to select and simulate heart rate. In standalone mode, HRS200 provides 30, 60,70,80,90,120,150,180,210,240 BPM for selection. The default heart rate value is 60 BPM.

4. Preset Setting (Mode A/B/C)

In standalone mode, there are limitations of adjusting DC Level, PI value, and heart rate. User can adjust those parameters via PC software and save up to 3 preset settings (Mode A/B/C). User may directly choose preset setting via pressing the mode button.

5. Default Test Parameters

Characteristics of photodiode vary from one to another. This might cause certain DUT being not able to use HRS200 default test parameters. If this occurs, please use HRS200/HRS100+ PC software. In the main function page, user can adjust and find out the ideal DC level and PI value. After that, user can click “Save to HRS” button to save as default parameters.[1]

6. Observe Analog Signals of Photodiode via HRS200 BNC Port

If user would like to observe DUT LED’s waveform, user can connect HRS200 to the oscilloscope via HRS200’s PD BNC port. When connecting, user can directly observe HRS200’s hardware signals and it gives a higher accuracy compared with HRS200 software or HRS200 SDK.

[1] Default parameters for shipments are DC Level = 5, PI = 2.

3 PC Software Mode

3.1 Installation and Environment

3.1.1 System Requirements

The PPG Heart Rate Simulator Test System uses a Windows PC to connect and control the USB module of HRS200.

PC requirements:
- Windows PC (Windows 7 or later, suggest to use the genuine version)
- Microsoft .NET 4.0 or higher
- Administrator access (essential for installing software, driver, and Microsoft .Net Framework)
- 1.5 GHz CPU or higher
- 1GB RAM or higher[2]
- USB port

3.1.2 HRS200 Software Installation

Please follow the below steps to download and execute HRS200 software.

- Download HRS200 software from WhaleTeq website.
- Browse to the download location
- Unzip the file to your destination folder
- Click the installation file in the destination folder to initiate the installation process.
- When the installation is completed, HRS200 software would be executed automatically. User can also execute HRS200 software via selecting “All Programs” → “WhaleTeq” → “WhaleTeq” in Windows startup program manager.

[2] Relative to normal PC processing, there is no special use of PC speed. However, there has been noted a slow increase in system RAM usage over long periods of time up to 30-40MB (related to MS Windows “garbage collection”). PCs with only 512MB or less installed and are running several other programs (in particular, Internet Explorer), may exceed the available RAM, requiring access to the hard drive and dramatically impacting speed. In this case, streaming interruptions and other problems may occur.

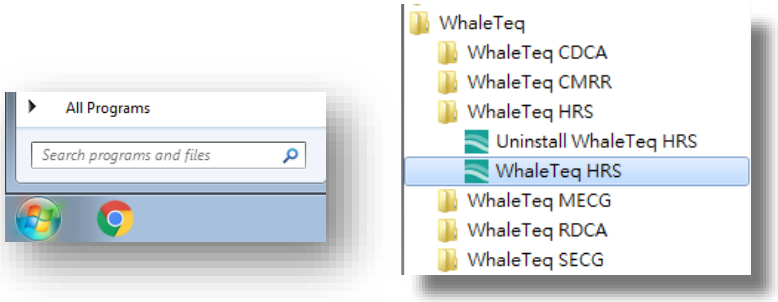


Figure 17: HRS200 Software

If HRS200 software can't be executed properly or this is the first time using WhaleTeq product, please refer to section 3.1.3 and 3.1.4 to confirm that USB driver and Microsoft .Net Framework 4.0 are all installed.

3.1.3 First Time Using WhaleTeq Product - USB Driver Installation

If Windows device manager can't recognize WhaleTeq product, please follow the below instructions to Install Microchip® USB driver.

Microsoft Windows 10

As Windows 10 has built-in Microchip® USB Driver, there're no needs to install any drivers. It just takes a while for Windows Device manager to recognize and install the driver.

Microsoft Windows 8 and Windows 8.1

- Windows 8 and Windows 8.1 can't recognize HRS200, please download "mchpcdc.inf" from WhaleTeq website. This driver is provided by Microchip® for using with PIC microprocessors having built-in USB function.
- As mchpcdc.inf provided by Microchip® does not contain digital signature, please disable driver signature enforcement in Windows 8 and Windows 8.1. Please click here to watch the tutorial video.

- When the USB module is connected for the first time, select manual installation, and point to the folder containing the above file. Then continue to follow the instructions to finish the installation. There may be a warning that the driver is not recognized by Windows®, and this can be ignored. Please click here to watch the tutorial video.

Microsoft Windows 7

- Windows 7 can't recognize HRS200, please download "mchpcdc.inf" from WhaleTeq website. This driver is provided by Microchip® for using with PIC microprocessors having built-in USB function.
- When the USB module is connected for the first time, select manual installation, and point to the folder containing the above file. Then continue to follow the instructions to finish the installation. There may be a warning that the driver is not recognized by Windows®, and this can be ignored. Please click here to watch the tutorial video.

3.1.4 First Time Using WhaleTeq Product – Microsoft .Net Framework 4.0 Installation

WhaleTeq software is developed by Microsoft .Net Framework 4.0. If HRS200 software fails to launch properly, please check whether Microsoft .Net Framework 4.0 or higher versions was installed in the operation system.

If your PC does not install Microsoft .Net Framework 4.0 or higher versions, please download from Microsoft website. Please click here to watch the tutorial video (from 2:03).

3.2 HRS200 Software Operation

3.2.1 Main Mode

The screen in Main Mode can be briefly separated into two parts:

- "LED" relative settings are on upper half
- "PD" relative settings are on lower half

Below are the details of the interface:

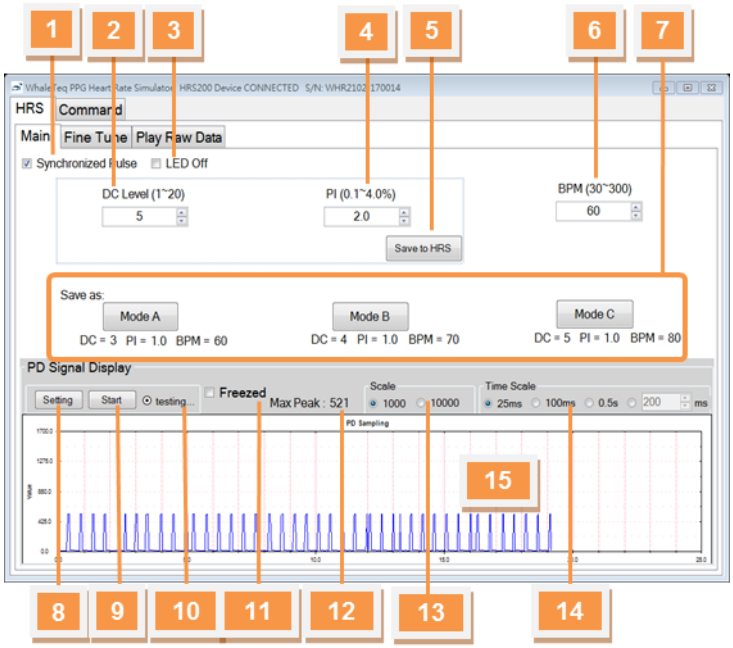


Figure 18: Main Mode

- **<u>LED Relative Settings</u>**

01 – Synchronized Pulse:

Select whether HRS200 LED flashes synchronously with DUT LED.

02 – DC Level:

This parameter simulates the reflection of different brightness levels. Range: Level 1 to level 20[3]

03 – LED Off:

Select whether totally turn OFF HRS200 LED.

04 – PI Value:

This parameter simulates different AC/DC ratio. Please refer to Section1.1.2 for more details.

05 – Save to HRS:

Save DC Level and PI value into HRS200 internal system memory as the startup default values.

06– BPM Value:

Adjust this parameter to change Heart Rate setting. Range: 30 to 300 Beats-Per-Minute.

07 – Save as Mode:

This feature allows users to save their own settings into HRS200 internal memory and be later used in HRS200 standalone mode by pressing the mode button. There are 3 Modes can be saved (Mode A/B/C), and each Mode contains 3 parameters (DC Level, PI value, and BPM value).

- **PD Relative Settings (refers to Section 1.1.4)**

08 – Filter Settings:

Click this button to set “Pass/Fail” condition for sorting LED. Please refer to Section 3.2.1.1 for details.

09 – Start/Stop Filter:

After clicking this button, Start or Stop to judge whether the peak value of LED is in range. Please refer to Section 3.2.1.1 for details.

10 – Filter Result:

Show the result or remaining seconds. Please refer to Section 3.2.1.1 for details.

[3] "Main Mode of DC Level" and "Fine Tune the DC (mV)" corresponding relationship:
"DC Level" x 125 = "DC (mV)"

11 – Freezed:

Select whether stay “Display PD Sampling” and “Max Peak” parts no change.

12 – Max Peak:

Show the maximum peak value during the specific time period.

13 – PD range Settings:

Change the PD scale to “1000” or “10000”. Select the scale to “1000” while testing DUTs with lower LED brightness. Select the scale to “10000” while testing DUTs with higher LED brightness.

14 – Time Scale Setting:

Select and set the display time interval of PD Sampling.

15 – Display PD Sampling:

Show the received data from HRS200 PD. It means the transmitted data from DUT LED.

3.2.1.1 LED Sorting

During production, PPG manufacturers/vendors may face a problem – how to certify the quality? WhaleTeq designs the “LED Sorting” feature to help customers to sort out unacceptable LEDs.

Measurement principles for “Filter LED”:

1. *Whether the brightness of the LED is within acceptable range*
2. *Whether the LED itself is stable*

Please refer to below diagram for how HRS200 works these two principles out:

[3] HRS200 software would have missed certain <120μs signals. Therefore, WhaleTeq strongly suggests to observe HRS200’s PD signal directly by connecting HRS200’s PD BNC port with the oscilloscope.

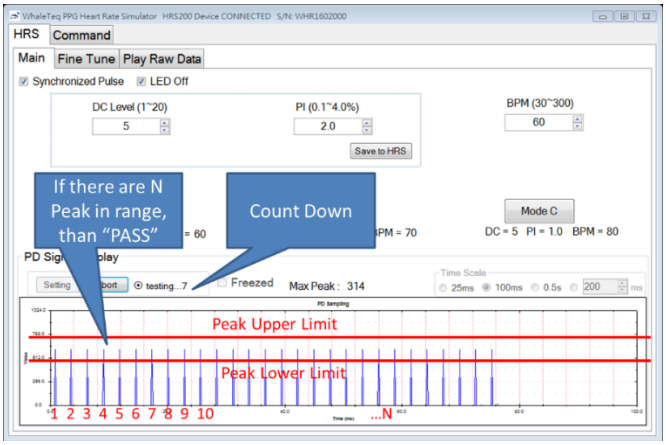


Figure 19: Method of LED Sorting

In above diagram, there are many pulses displayed on "PD Signal Display" section. The Max Peaks of those pulses are nearly the same. If *the brightness of the LED is in acceptable range*, the Max Peak pulses should be between "Peak Lower Limit" and "Peak Upper Limit". And *if the LED itself is stable*, the LED could emit the N Max Peak in particular seconds.

Therefore, there are 4 parameters for user settings:

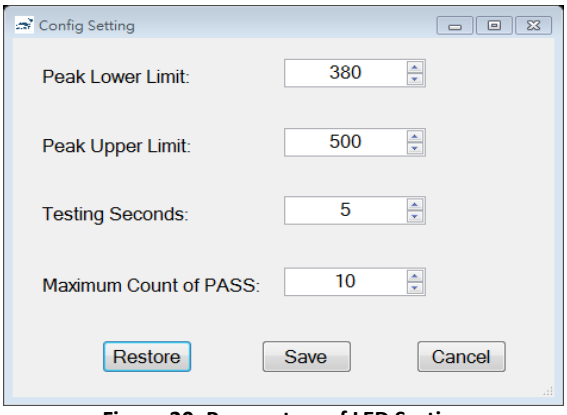


Figure 20: Parameters of LED Sorting

- **Peak Lower Limit**: Set the acceptable minimum limit for the brightness of LED.

- **Peak Upper Limit:** Set the acceptable maximum limit for the brightness of LED.

- **Testing Seconds:** The shorter testing time for production test is better. Therefore, we provide “Testing Seconds” parameter to assist the production line to set and count down testing time.
- **Maximum Count of PASS**: Correspond to N in the diagram. The device achieves how many Max Peak pulses can PASS directly.

In **Testing Seconds** period, if there are enough Max Peak pulses in acceptable range (between **Peak Lower Limit** and **Peak Upper Limit**), HRS200 will show ***“Pass”***, vice versa. In Testing Seconds, if there is no Max Peak of pulse in acceptable range, HRS200 will show ***“Fail”.*** To reduce the testing time, as long as HRS200 counts N (=Maximum Count of PASS) Max Peak pulses, HRS200 will directly show ***“Pass”***.

3.2.1.2 PD Signal Display

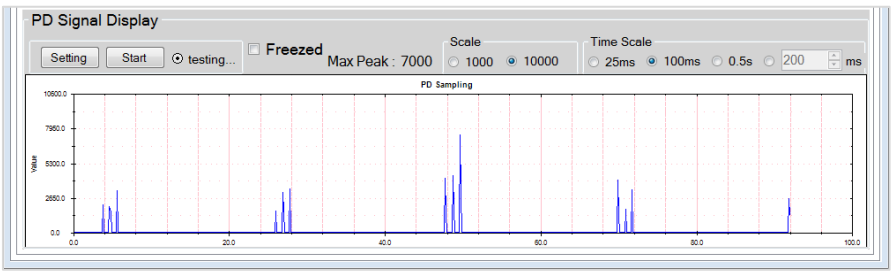


Figure 21: PD Signal Display

If HRS200 software shows up “Saturated” in PD Signal Display section, it means the brightness of DUT is over the detection range of HRS200 PD. Please increase the distance between HRS200 diffusion film and DUT PPG sensor.

3.2.2 Fine Tune Mode

Below are the details of Fine Tune Mode interface:

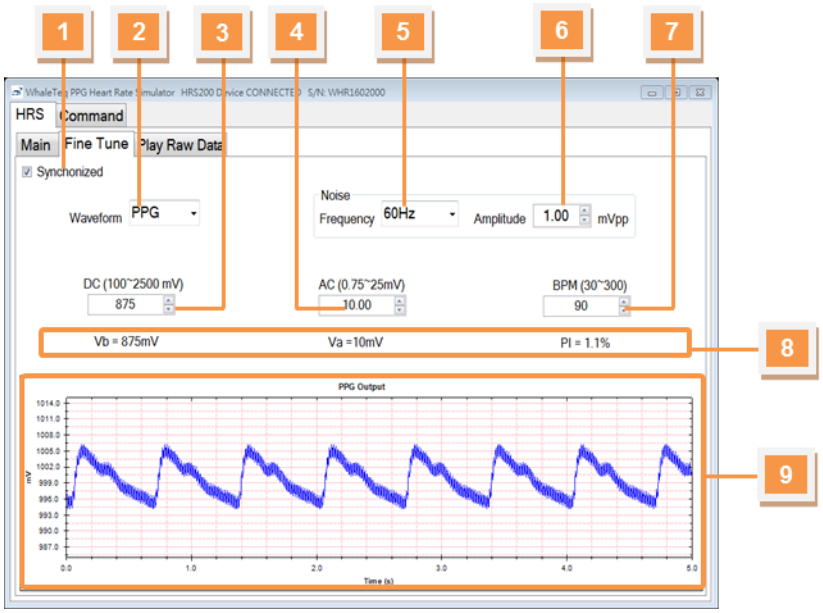


Figure 22: Fine Tune Mode

01 – Synchronized Pulse:

Select whether HRS200 LED flashes synchronously with DUT LED.

02 – Waveform Setting:

Allows user to select Sine wave, Triangle wave, and PPG wave in the test.

03 – DC Value:

This parameter simulates the reflection of different brightness levels. Range: 100 mv to 2500 mV.

04 – AC Value:

This parameter simulates AC changes. Range: 0.75 mv to 25 mV.

05 – Noise Frequency:

Allows user to select the noise in 50Hz, 60Hz or 1000Hz (1kHz) frequency.

06 – Noise Amplitude:

This parameter simulates different amplitudes of noise. Peak-to-peak voltage range: 0.01mVpp to 2mVpp.

07 – BPM Value:

Adjust this parameter to change Heart Rate setting. Range: 30 to 300 Beats-Per-Minute.

08 – Display Settings:

Automatically calculate the output PI value of HRS200.

09 – Output Waveform:

Provides a semi-real time graphical display of the current signal

3.2.3 Play Raw Data Mode

Play Raw Data mode supports the following waveform types:

(1) Built-in clinical databases – HRS200 software has built-in several clinical symptom waveforms.
(2) Recorded raw data waveform with normal range signal – HRS200 can play waveforms that recorded in statistic condition of human activities.
(3) Recorded raw data waveform with dynamic range signal – HRS200 can play waveforms that recorded in dynamic condition of human activities. Need to enable “Dynamic” option before playing recorded waveforms.

The instruction of software user interface is as below. Details to be described in the sub-sections.

Figure 23: Play Raw Data Mode

01 – Load Raw Data:

Load built-in database or Raw Data file from local PC.

02 – Source Information:

Display information such as source name, sample rate and length.

03 – Time Interval Selector:

Before use the play raw data function, user can use the forward and rewind buttons to check the waveform of selected time interval.

04 – Help:

List all the supported raw-data formats. For details please refer to section 3.2.3.4.

05 – Original Waveform Display:

To display the waveform of loaded raw data. With the use of **03 Time Interval Selector**, user can quickly check the waveform with preferred time interval.

06 – Loop:

Enable the loops function to allow automatically play the waveform again once the playback is finished.

07 – Synchronized:

Enable the synchronized function to allow HRS200 LED to response in accordance with DUT LED.

08 – Brightness Parameters:

User can set, save and restore brightness parameters including overall brightness, gain and offset in statistic and dynamic conditions.

09 – Time Parameters:

User can adjust Sample Rate and observe the time frame of current waveform playback.

10 – Play and Stop:

Play and Stop the loaded raw-data waveforms.

11 – Output Waveform Display:

Display the current output waveform.

3.2.3.1 Clinical Database Waveform Playback (Optional)[4]

To have wearable to perform more closely to medical grade device and decrease the time and cost of clinical trials, HRS200 is now built in clinical database
waveforms. All those PPG database waveforms are recorded simultaneously with ECG signals and have physician to determine the arrhythmia marks via ECG signals.

HRS200 clinical database includes: AF (Atrial Fibrillation), APC (Atrial Premature Complex), VPC (Ventricular Premature Complex) and 1st AV block (First-degree Atrioventricular block).

Please follow the below instructions to initiate the use:

[4] For HRS200 serial number after WHR1602025, please directly download the latest HRS200 software (V1.0.0.6) for the trial use of AF database playback function. If HRS200 serial number is before WHR1602025, please contact WhaleTeq for the upgrade solution.

Step 1. Click “Load” button and select “Database”.

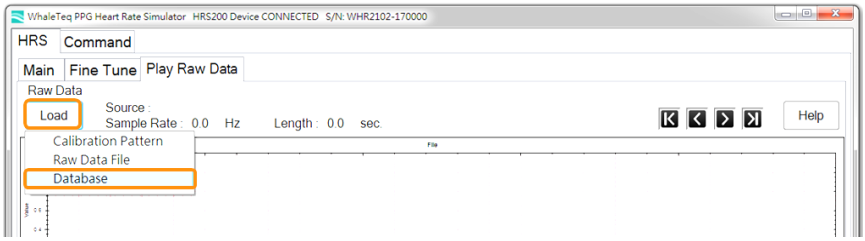


Figure 24: Clinical Database Waveform Playback (Step 1)

Step 2. Select the preferred record and click “OK”.

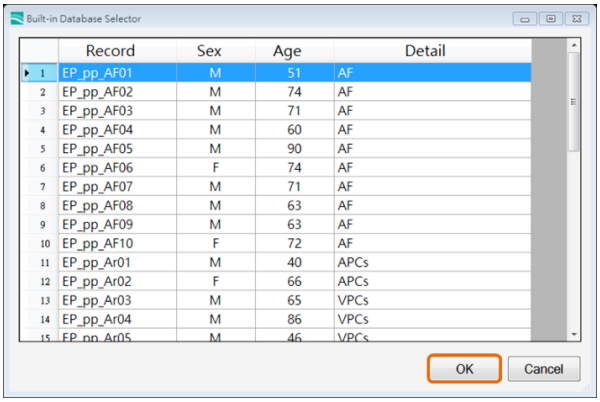


Figure 25: Clinical Database Waveform Playback (Step 2)

Note: Only the first record is available as the trial purpose. Please contact WhaleTeq (service@whaleteq.com) to enable all the database records.

Step 3. Click “Play”.

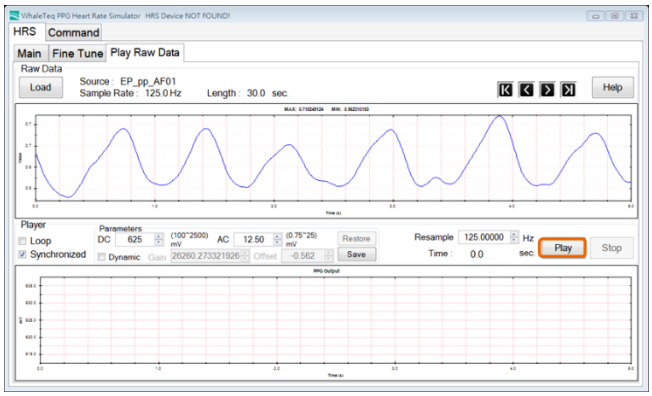


Figure 26: Clinical Database Waveform Playback (Step 3)

Step 4. Adjust “DC” value to change the LED brightness and adjust “AC” value to change the signal amplitude.

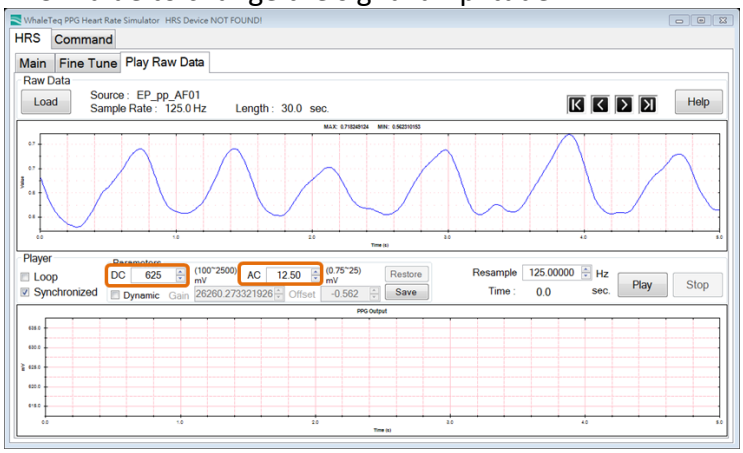


Figure 27: Clinical Database Waveform Playback (Step 4)

- **How to activate HRS200 Full Database Set**

  Please follow the below steps to activate all clinical databases.

  Step 1. Click “Database” and select 2nd record or any other databases which can’t not use.

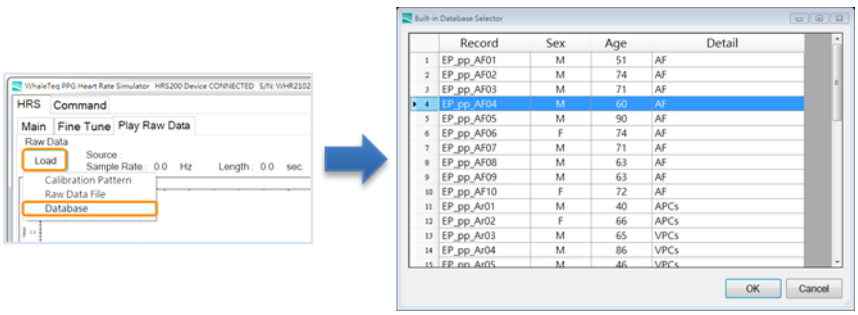


Figure 28: Activate HRS200 Full Database Set (Step 1)

Step 2. Select and copy HRS200 ID. Send HRS200 ID to service@whaleteq.com to request Activation Key.

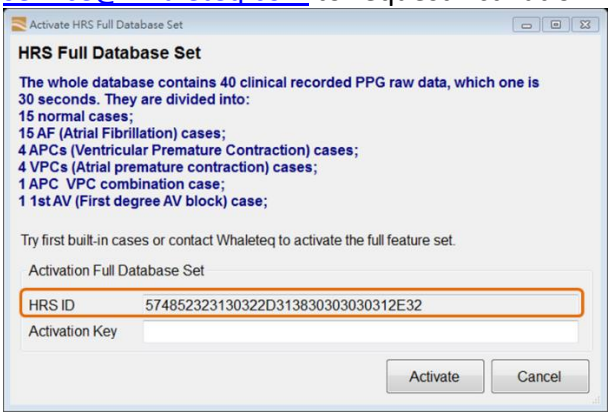


Figure 29: Activate HRS200 Full Database Set (Step 2)

Step 3. Key-in or paste Activation Key to activate the full access of HRS200 Full Database Set.

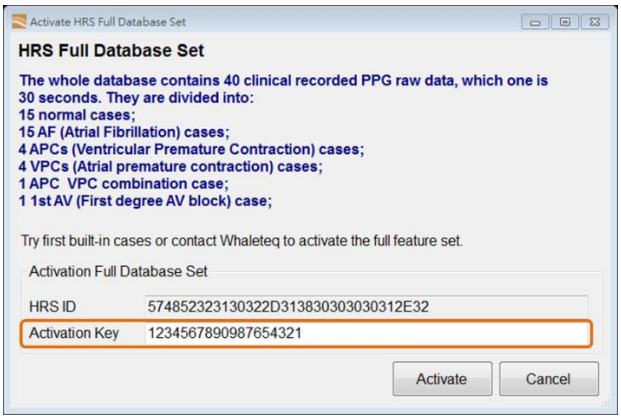


Figure 30: Activate HRS200 Full Database Set (Step 3)

3.2.3.2 Play Recorded Raw Data Waveform with Normal Range Signal

Please follow the below instructions if you'd like to pay recorded PPG waveforms from statistic condition of human activities.

Step 1. Click "Load" and select "Raw Data File.

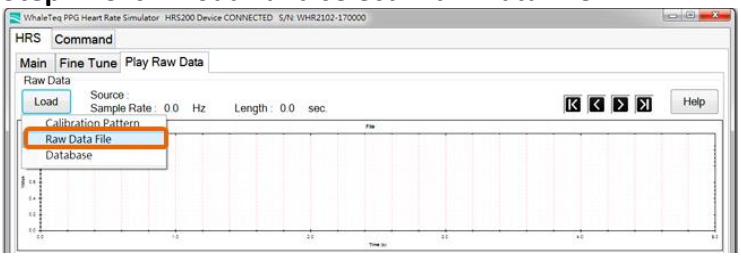


Figure 31: Play Recorded Raw Data Waveform with Normal Range Signal (Step 1)

Step 2. Select the preferred file and then click "Play".

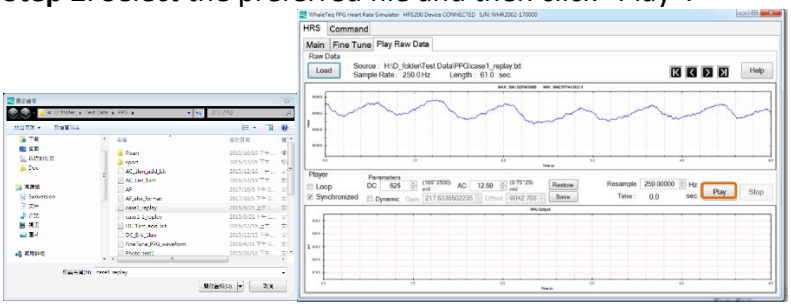


Figure 32: Play Recorded Raw Data Waveform with Normal Range Signal (Step 2)

Step 3. Adjust DC, AC and Resample parameters to control brightness and speed of optical waveforms.

- DC: Adjust overall brightness
- AC: Adjust the signal amplitude of selected raw data file
- Resample: Adjust speed. Can also use to test the same waveform with different BPM values.

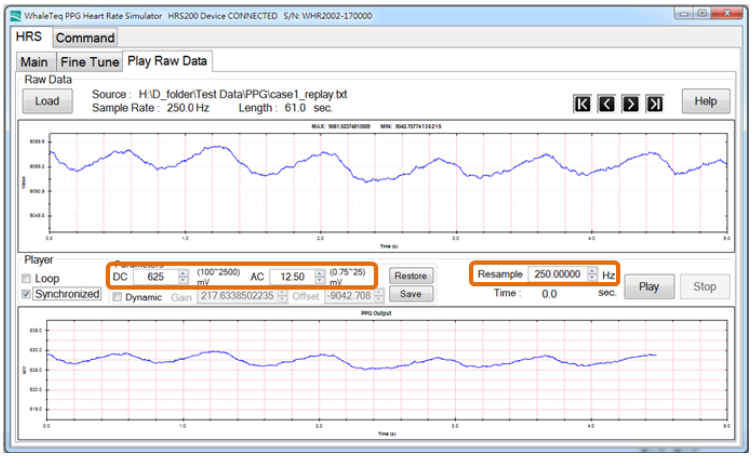


Figure 33: Play Recorded Raw Data Waveform with Normal Range Signal (Step 3)

Step 4. Click “Save” to save preferred parameters. “Restore” button is used for loading saved parameters.

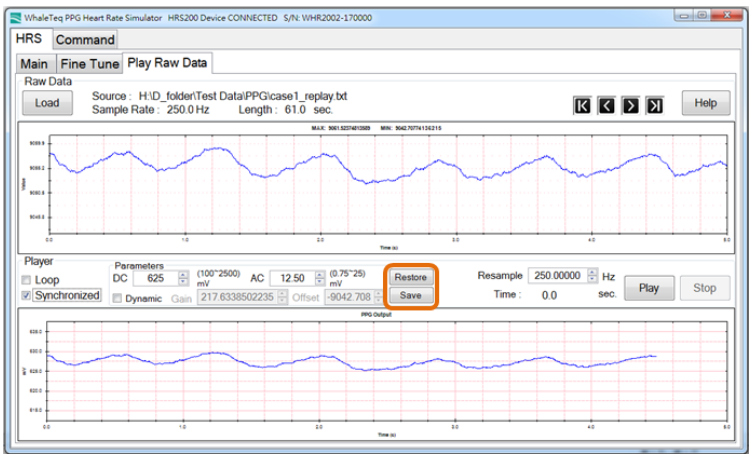


Figure 34: Play Recorded Raw Data Waveform with Normal Range Signal (Step 4)

3.2.3.3 Play Recorded Raw Data Waveform with Dynamic Range Signal

If the raw data you recorded is from human motion state, it is necessary to use a special mode called “Dynamic” to increase the output range. Please follow the below instructions-

Step 1. Click “Load” and select “Raw Data File”.

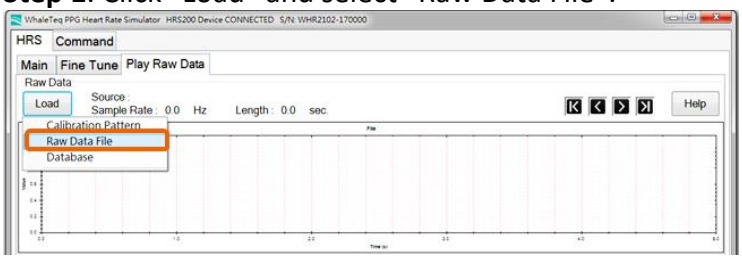


Figure 35: Play Recorded Raw Data Waveform with Dynamic Range Signal (Step 1)

Step 2. Select the file you’d like to play.

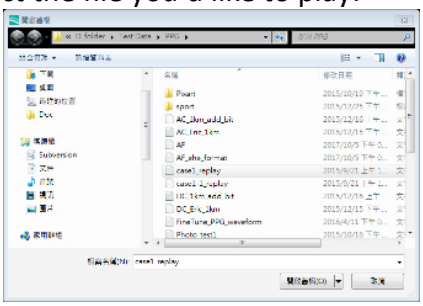


Figure 36: Play Recorded Raw Data Waveform with Dynamic Range Signal (Step 2)

Step 3. Check “Dynamic” to increase the output range and then click “Play”.

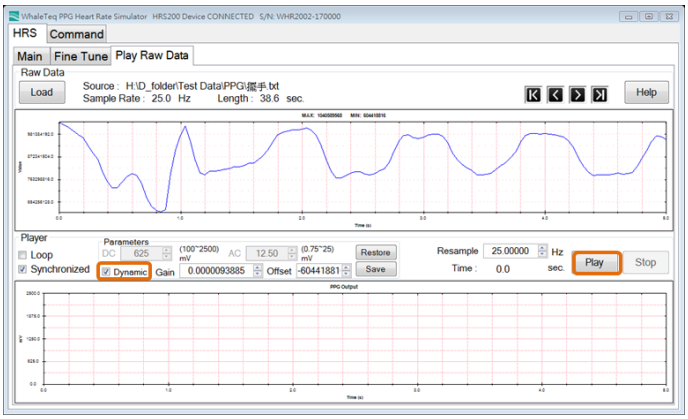


Figure 37: Play Recorded Raw Data Waveform with Dynamic Range Signal (Step 3)

Step 4. Adjust Gain, Offset, Resample parameters to change brightness, baseline and so on.

- Gain: Adjust the overall signal amplitude
- Offset: Adjust the overall signal brightness
- Resample: Adjust speed. Can also use to test the same waveform with different BPM values.

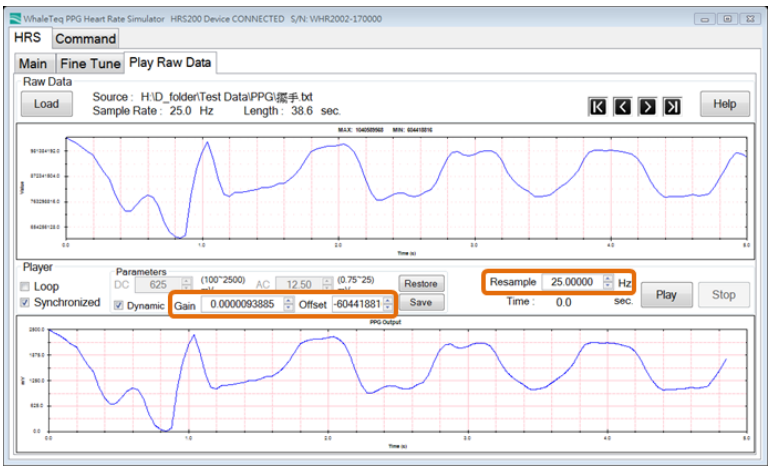


Figure 38: Play Recorded Raw Data Waveform with Dynamic Range Signal (Step 4)

Step 5. Click “Save” to save preferred parameters. “Restore” button is used for loading saved parameters.

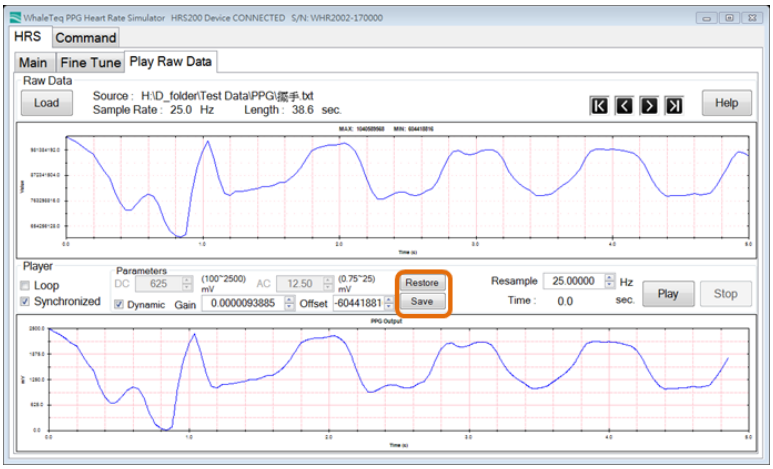


Figure 39: Play Recorded Raw Data Waveform with Dynamic Range Signal (Step 5)

3.2.3.4 HRS200 Raw Data Format

HRS200 supports Text file (*.txt) only, the detail format is as below:

Table 6: Raw Data Format

Line	Item	Description
1	Sample Rate (Hz)	The frequency of sampling per unit time.
2	Number of Samples	The file has how many number of samples (N)
3	Sample Date 1	The first sample data in the file
4	Sample Data 2	The seconds sample data in the file
…	…	…
N	Sample Data(N-2)	The (N-2) sample data in the file

Note: The maximum number of samples and playback time depend on the memory space of computer. If HRS200 software can obtain more memory space from computer, the playback time can be longer. In normal situation, the playback time is around 2 hours.

3.2.4 Command Mode

Below are the details of Command Mode interface:

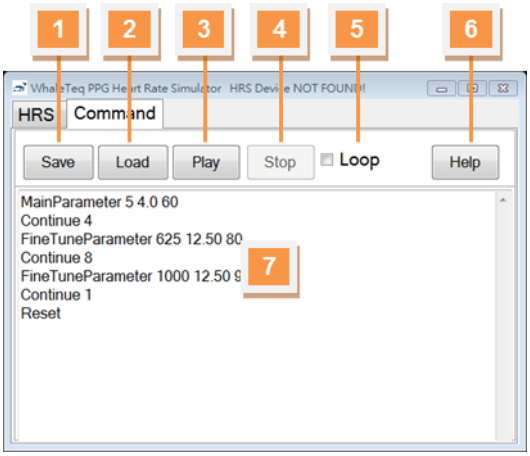


Figure 40: Command Mode

01 – Save File:

Save the completed command list into local PC.

02 – Load File:

Load the command file from local PC.

03 – Execute Command:

Play and execute the programmed commands.

04 – Stop Command:

Stop to execute the ongoing command.

05 – Loop/Replay:

Whenever the command has finished executing, re-execute the command from the beginning.

06 – Help:

List the command list. Please refer to 3.2.4.1.

07 – Command List:

List the programmed or loaded commands. HRS200 will highlight the ongoing command.

3.2.4.1 Command Table

Table 7: Command Table

Command	Parameter	Range	Description	Example
MainParameter	*DC_Level*	Integer: 1~20	Send sine wave with specific DC Level, PI Value and BPM	MainParameter 8 1.0 60
	PI	Change with DC		
	BPM	Integer: 30~300		
FineTuneParameter	*DC_Value*	Integer: 100~2500	Send wave with specific DC Value, AC Value and BPM	FineTuneParameter 300 2000 70
	AC_Value	Integer: 0.75~25		
	BPM	Integer: 30~300		
LoadRawData	*RawDataFilePath*	Valid Path, Valid File	Load raw data from specific path and file	LoadRawData D:\Test Data \case1_replay.txt
PlayRawData	*Gain*	0.00000000 1 ~64	Play Raw Data with resize *Gain* times AC part	PlayRawData 0.5
Continue	*Duration*	Integer	Continue to play *Duration* seconds specific waveform	Continue 8
Reset	*N/A*	Appear with Play Raw data	Stop and reset output	Reset

* The detail range for PI, please refer to1.1.2

3.2.4.2 Command Example

Table 8: Command Example

Example	Explain
MainParameter 8 1.0 60	Play Sine Wave with DC Level=8, PI=1, BPM=60
Continue 17	Continue this wave for 17 seconds
FineTuneParameter 300 20.00 70	Play wave with DC=300 mV, AC=20mV, BPM=70
Continue 6	Continue this wave for 6 seconds
LoadRawData D:\Test Data\case1_replay.txt	Load the wave from D:\Test Data\case1_reply.txt
PlayRawData 1.0	Play the case1_reply wave with Gain=1
Continue 20	Continue this wave for 20 seconds
Reset	Stop and reset output signal
MainParameter 8 2.0 60	Play Sine Wave with DC Level=8, PI=2, BPM=60
Continue 25	Continue this wave for 25 seconds

3.3 HRS200 Software and Firmware Update

HRS200 which were shipped from early 2017 does all support firmware update. HRS200 software supports auto-update after software version 1.0.0.6.
If you have any questions, please contact WhaleTeq for detailed information.

3.3.1 Software and Firmware Auto Update

When new firmware or software release, a pop-up window shows as below.
It would directly update your firmware or software to the latest version when you click “Yes”.

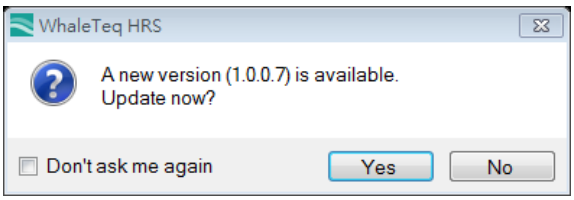


Figure 41: Software and Firmware Update Notification Window

3.3.2 Manually Update Firmware

Please follow the below steps to update firmware manually:

Step 1. Connect HRS200 to PC and launch HRS200 software.
Step 2. Move the cursor to title bar and right click to select “About”.

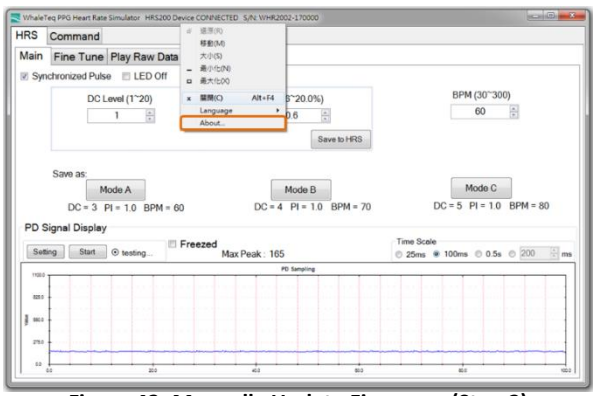


Figure 42: Manually Update Firmware (Step 2)

Step 3. Click “Update F/W” button and then select the firmware file.

Figure 43: Manually Update Firmware (Step 3)

Step 4. HRS200 software would display the firmware update information.
Cautions:

(1) Do not remove USB cable during the firmware update process.
(2) Once clicking “Yes”, the firmware update process cannot be cancelled.

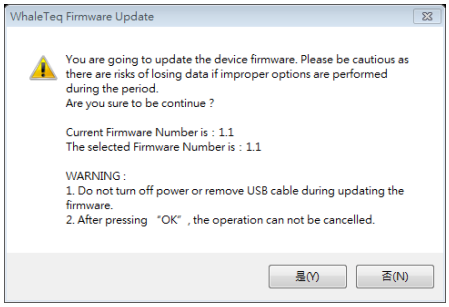


Figure 44: Manually Update Firmware (Step 4)

Step 5. Wait till the firmware update is completed.

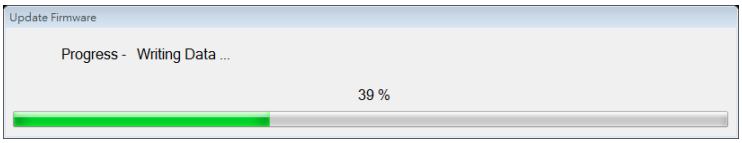


Figure 45: Manually Update Firmware (Step 5)

Step 6. Please restart the system to complete firmware update process.

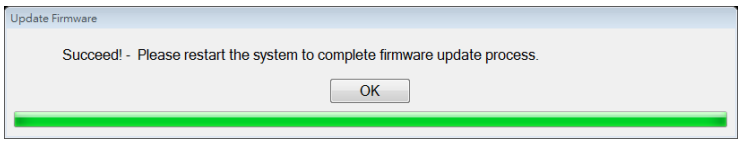


Figure 46: Manually Update Firmware (Step 6)

4 Software Development Kit (SDK)

WhaleTeq provides HRS200 software development kit. All operating parameters and options have corresponding commands in the software development kit. The software development kit contains DLL (Dynamic-link library), which will provide highly efficient program binding and version upgrade, supports C/C++ header and C# interface, and can also be integrated with third-party tools and script languages.

5 Calibration and Validation

Both WHALETEQ HRS200 and software have been system verified, and reports can be provided according to your needs.

Prior to shipping, each unit is tested for component values and output voltages, using a calibrated precision multi-meter. As WhaleTeq cannot provide ISO 17025 accredited calibration, laboratories which are required to follow ISO 17025 should perform calibration either periodically or on a before use basis, following normal procedures and practice. The extent of calibration may be limited depending on the needs of the laboratory.

6 Cautions

- We suggest warm up HRS200 for at least 5 minutes before testing.
- Before using HRS200, please assure the distance between HRS200 diffusion film and DUT PPG sensor is fixed. Also, it requires to control the ambient light as it would influence the test result as well.
- PD sample rate of HRS200 is lower than 8ksps (Normal) and 30ksps (High Resolution)
- If HRS200 software shows up “Saturated” in PD Signal Display section, it means the brightness of DUT is over the detection range of HRS200 PD. Please increase the distance between the diffusion film of HRS200 and DUT PPG sensor.
- The built-in database in Play Raw Data mode is only available for the 1st database as a trial purpose. Please contact WhaleTeq (service@whaleteq.com) for details of enabling all the other databases.
- When HRS100+/HRS200 is powered by batteries and not in use, please switch off the power to save battery life.
- The blinking Power LED is the indication of low battery. Please replace with new batteries immediately.
- LED luminous decay occurs after using for a certain period. It is recommended to send your unit to WhaleTeq for calibration every year and replace the LED base every second year, to ensure LED brightness is qualified. For more details, please contact WhaleTeq Co, Ltd service@whaleteq.com
- When upgrading HRS200 firmware, DO NOT turn off power or close the software during the process.
- Warranty void if QC PASS label is removed or tampered with.
- The professional testing instrument, not a medical device, is for testing only, and will not involve human or clinical use.

7 Ordering Information

7.1 Standard Package

Table 9: Standard Package

Part No.	Description	Quantity
100-HR00001	**Model No.**: HRS200 Advanced PPG heart rate simulator for healthcare wearable. Supports fine tune / play raw data / command line test modes. Package contents: • HRS200 x 1 • USB cable x 1	1

7.2 Optional Accessory

Table 10: Optional Accessory

Part No.	Description	Quantity
100-OT00001	USB isolator for reducing the power noise from PC.	1

7.3 Optional Software Add-on Pack

Table 11: Optional Software Add-on Pack

Part No.	Description
HC0-HR00001	Playback capability of 40 clinical-recorded PPG databases. 25 PPG records are with arrhythmia symptoms as AF, APC, VPC and 1st AV block.

7.4 Optional Calibration Service and Warranty Extension

Table 12: Optional Calibration Service and Warranty Extension

Part No.	Description
YY0007	**Model No.**: C3 Provides (3) years of calibration service coverage. WhaleTeq equipment can be calibrated to original performance on the basis of (1) year interval.
YY0008	**Model No.**: R3 Extends the limited warranty from (1) year to (3) years.

8 Revision History

Table 13: Revision History

Version	Modified Contents	Issued Date
2020-12-31	Add Ch 4 Software Development Kit (SDK) Ch 5 Calibration and Validation Ch 6 Cautions Ch 7 Ordering information Ch 8 Version information	2020-12-31
2021-06-24	Add Ch 6 Cautions	2021-06-24
2024-03-29	• Update Ch 1 System Introduction 1.2.2 Package Contents 7 Ordering Information • Add List of Table List of Figure	2024-04-30

9 Contact WhaleTeq

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