

User Guide

Femtosecond Clock Distribution System Series DexClock R1

June.2017

**RayMeasure Medical Technology
Co.,Ltd.(Suzhou)**

Guaranty and Declaration

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Communication Protocol Version

Protocol_ DexClock_R1_V1.3.1.0

Change or increase on product function may cause changes on the protocol contents, please focus on RayMeasure website to obtain the latest version of the protocol or contact RayMeasure to upgrade the software.

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Product Certification

RayMeasure guarantees this product to the national and industrial standards in China. International standard conformance certification is in progress, e.g. ISO.

Contact Us

If you have any problem or requirement when using our products, please contact RayMeasure or your local distributors.

Service and support hotline: 0512-69583787

Website: www.raymeasure.com

Safety Requirement

General Safety Summary

Please review the following safety precautions carefully before putting the instrument into operation so as to avoid any personal injuries or damages to the instrument and any product connected to it. To prevent potential hazards, please use the instrument only specified by this manual.

Use Proper Power Cord.

Only the power cord designed for the instrument and authorized for use within the local country could be used.

Ground The Instrument.

The instrument is grounded through the Protective Earth lead of the power cord. To avoid electric shock, it is essential to connect the earth terminal of power cord to the Protective Earth terminal before any inputs or outputs.

Connect the Probe Correctly.

If a probe is used, do not connect the ground lead to high voltage since it has the isobaric electric potential as ground.

Observe All Terminal Ratings.

To avoid fire or shock hazard, observe all ratings and markers on the instrument and check your manual for more information about ratings before connecting.

Use Proper Overvoltage Protection.

Make sure that no overvoltage (such as that caused by a thunderstorm) can reach the product, or else the operator might expose to danger of electrical shock.

Do Not Operate Without Covers.

Do not operate the instrument with covers or panels removed.

Do Not Insert Anything into the Holes of Fan.

Do not insert anything into the holes of the fan to avoid damaging the instrument.

Use Proper Fuse.

Please use the specified fuse.

Avoid Circuit or Wire Exposure.

Do not touch exposed junctions and components when the unit is powered.

Do Not Operate With Suspected Failures.

If you suspect damage occurs to the instrument, have it inspected by qualified service personnel before further operations. Any maintenance, adjustment or replacement especially to circuits or accessories must be performed by RayMeasure authorized personnel.

Keep Well Ventilation.

Inadequate ventilation may cause increasing of temperature or damages to the device. So please keep well ventilated and inspect the intake and fan regularly.

Do Not Operate in Wet Conditions.

In order to avoid short circuiting to the interior of the device or electric shock, please do not operate in a humid environment.

Do Not Operate in an Explosive Atmosphere.

In order to avoid damages to the device or personal injuries, it is important to operate the device away from an explosive atmosphere.

Keep Product Surfaces Clean and Dry.

To avoid the influence of dust and/or moisture in air, please keep the surface of device clean and dry.

Electrostatic Prevention.

Operate in an electrostatic discharge protective area environment to avoid damages induced by static discharges. Always ground both the internal and external conductors of the cable to release static before connecting.

Proper Use of Battery.

If a battery is supplied, it must not be exposed to high temperature or in contact with fire. Keep it out of the reach of children. Improper change of battery (note: lithium battery) may cause explosion. Use RayMeasure specified battery only.

Handling Safety.

Please handle with care during transportation to avoid damages to buttons, knob interfaces and other parts on the panels.

Safety Terms and Symbols

Terms Used in this Manual. These terms may appear in this manual:



WARNING

Warning statements indicate the conditions or practices that could result in injury or loss of life.



CAUTION

Caution statements indicate the conditions or practices that could result in damage to this product or other property.

Terms Used on the Product. These terms may appear on the Product:

- DANGER** indicates an injury or hazard may immediately happen.
- WARNING** indicates an injury or hazard may be accessible potentially.
- CAUTION** indicates potential damage to the instrument or other property might occur.

Symbols Used on the Product. These symbols may appear on the product:



**Hazardous
Voltage**



**Safety
Warning**



**Protective
Earth
Terminal**



**Classic
Ground**



**Test
Ground**

General Care and Cleaning

General Care

Do not leave or store the instrument exposed to direct sunlight for long periods of time.

Cleaning

Clean the instrument regularly according to its operating conditions. To clean the exterior surface, perform the following steps:

1. Disconnect the instrument from all power sources.
2. Clean the loose dust on the outside of the instrument with a lint- free cloth (with mild detergent or water).



CAUTION

To avoid damages to the instrument, do not expose them to liquids which have causticity.



WARNING

To avoid injury resulting from short circuit, make sure the instrument is completely dry before reconnecting into a power source.

Environmental Considerations

Product End-of-Life Handling

The equipment may contain substances that could be harmful to the environment or human health. In order to avoid release of such substances into the environment and harmful to human health, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately. Please contact your local authorities for disposal or recycling information.

Product Introduction

Femtosecond Clock Distribution System DexClock R1 is a high performance digital clock distribution system Researched, developed, and manufactured by RayMeasure Medical Technology Co., Ltd. (Suzhou). It features modularized design and expandability to be the recommended clock and reset signal supplier for digital PET detector module Scintector series. DexClock R1 allows free switch over between two functional modes: master and slave. The master is an independent 12-channel synchronized clock and reset signal source. By handling the slide switch, the module jumps to slave mode. The slave receives the clock and reset signals from another DexClock R1, it functions as a 12-channel fan-out buffer and keeps the clock and reset outputs synchronized. Therefore, multiple DexClock R1 modules can be cascaded in a tree structure to form the scalable clock distribution system, when the tree grows by one level, the maximum number of the synchronized clock and reset outputs becomes 12 times the amount of before. The output clock frequency, reset signal duration, relationship between the clock rising edge and reset edge can be dynamically specified.

Features

- Providing synchronized clock outputs meeting AC LVPECL voltage standard and synchronized reset outputs meeting LVDS voltage standard, low noise, jitter and skew is guaranteed.
- The scalable and modular design allows multiple DexClock R1 modules to be organized in a tree structure, the maximum number of the outputs becomes 12 times the amount of before when the tree grows by one level.
- Supporting Gigabit Ethernet interface, configuration of several parameters, e.g. clock frequency and reset duration are allowed to be executed in real time, the work status can be monitored as well.
- The firmware can be upgraded online to support more functions.

Overview

The main content of the document.

Chapter 1 Quick Start

This chapter introduces the appearance, interface, software user interface, parameter setting and the matters needing attention for first time use of the instrument.

Chapter 2 User Guide

This chapter introduces the principle of the product, parameter setting, data acquisition and the relevant application cases.

Chapter 3 Troubleshooting

Chapter 4 Technical Specifications

Chapter 5 Appendix

Contents

Safety Requirement.....	1
General Safety Summary	1
Safety Terms and Symbols	3
General Care and Cleaning	4
Environmental Considerations.....	4
Product Introduction	5
Overview.....	6
Chapter 6 Quick Start	8
General Inspection	9
Appearance.....	10
Dimensions	11
Button and Interface.....	12
1. Power Supply Interface	12
2. Power Switch	12
3. Slide Switch.....	12
4. Reset Button	13
5. Reserved Port	13
6. Data Configuration Interface – Gigabit Ethernet.....	13
7. Clock & Reset inputs.....	13
8. Clock & Reset Outputs.....	13
Power Supply.....	15
Chapter 7 User Guide	16
Principles	17
Parameter Settings	19
Software UI	19
Index Parameters.....	21
Network Parameters	22
Clock and Reset Outputs.....	23
Running Parameters	24
Firmware Update.....	25
Application Demonstration.....	26
Precautions	26
Chapter 8 Troubleshooting.....	27
Chapter 9 Technical Specifications	28
Technical Specifications.....	28
Environmental Conditions	29
Packing List.....	29
Chapter 10 Appendix	30
Appendix A: Attachments and Options	30
Appendix B: Summary of the warranty.....	31

Chapter 1 Quick Start

This chapter introduces the appearance, interface, software user interface, parameter setting and the matters needing attention for first time use of the instrument.

This chapter content as follows:

- General Inspection
- Appearance
- Dimensions
- Button and Interface
- Power supply
- User Interface

General Inspection

1. **Inspect the shipping container for damage.**

If there are damages in the container or foam, keep them until the whole machine and the accessories pass the electrical and mechanical tests. If your instrument has damaged during shipping, please contact your shipper and carrier for compensation. RayMeasure will not provide free repair or replacement.

2. **Inspect the instrument.**

In case of any mechanical damage or defect, or if the instrument does not operate properly or pass the electrical and mechanical tests, contact your local sales representative of RayMeasure.

3. **Check the Accessories**

If the contents are incomplete or damaged, please contact your local sales representative of RayMeasure.

Appearance

The appearance of DexClock R1 is shown in figure 1-1.



Figure 1-1 Product appearance

Dimensions

The dimensions of DexClock R1 femtosecond clock distribution system are shown in figure 1-2, the unit is mm.

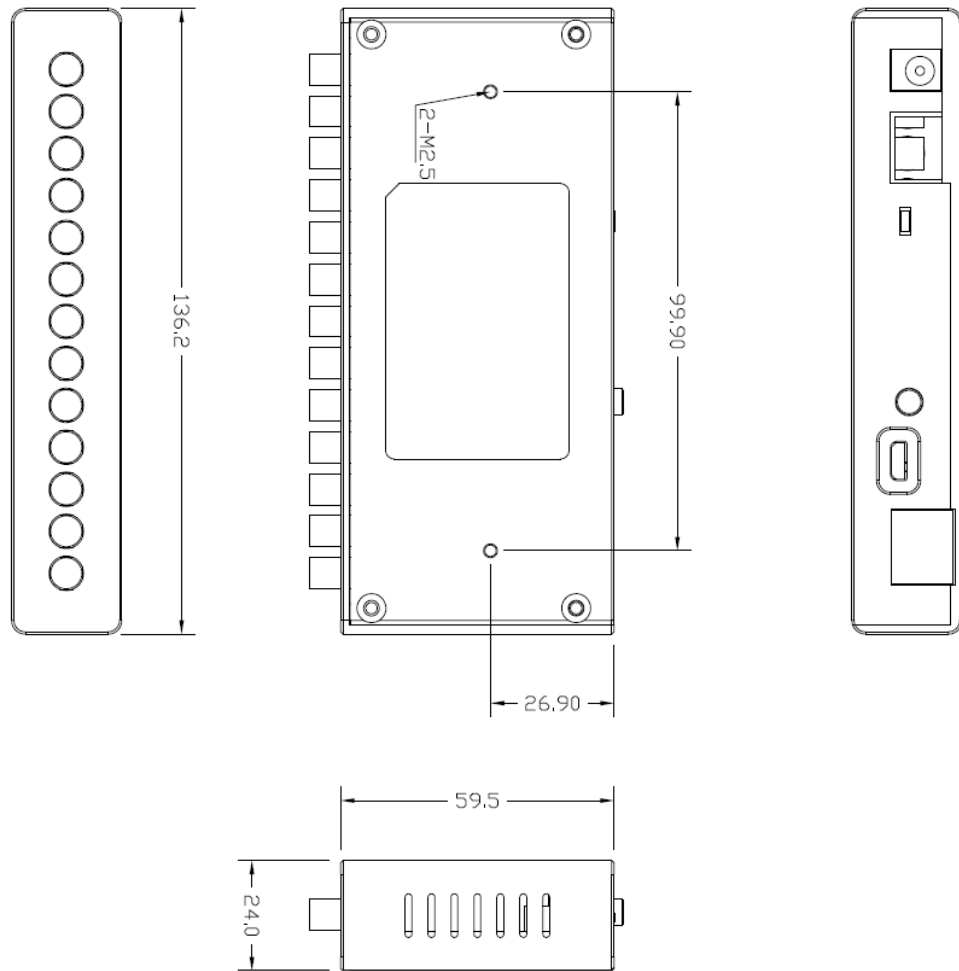


Figure 1-2 Product dimension information

Button and Interface

The interface of DexClock R1 is shown in figure 1-3.

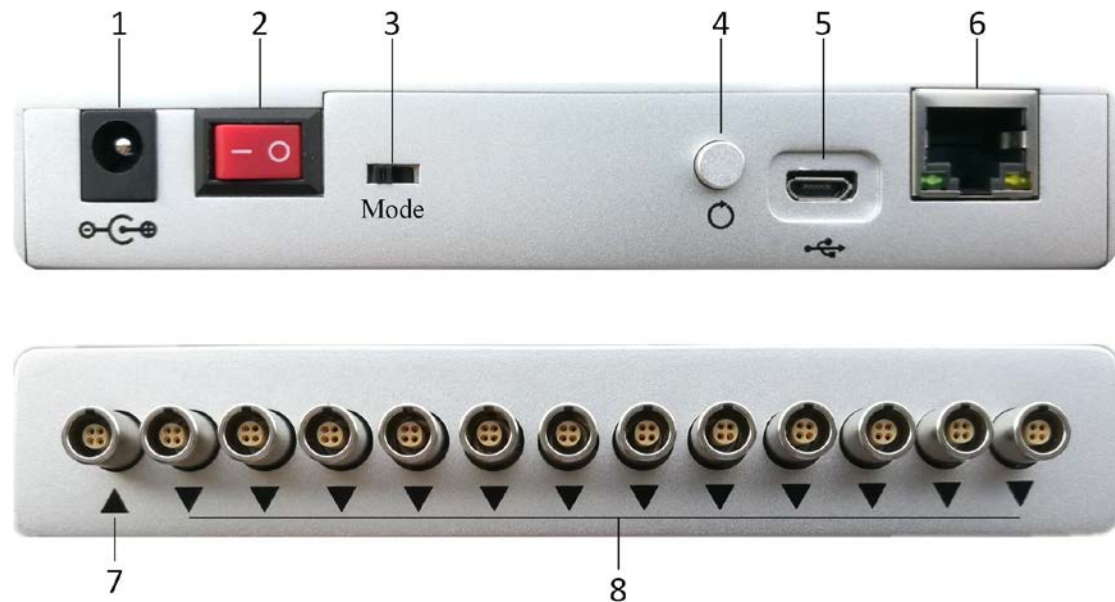


Figure 1-3 Product button and Interface

1. Power Supply Interface

DC power in. Normal power supply voltage specification of DexClock R1 is 12V DC. User can employ the supplied power adapter connecting DexClock R1 to a plug (AC 220V/50Hz ~ 110V/60Hz) and let DexClock R1 work.

WARNING



Only allowed to use the power supply that approved by your country for this product. For any safety accident or damage to the product by using of inferior power supply or power adapter, RayMeasure is not responsible.

2. Power Switch

Power up or down the DexClock R1, the symbol "1" means on and "0" means off.

3. Slide Switch

The switch between master and slave mode. When DexClock R1 works in the master mode, the switch should be on the left, DexClock R1 functions as an independent source of 12 channels of clock and reset signals. When the handle of the switch is on the right, DexClock R1 works in the slave mode, it is a clock and reset signal distributor depending on another DexClock R1.

4. Reset Button

Reset output button. When the handle of the slide switch is on the left, Press the button, DexClock R1 output 12-channel synchronous reset signals till the button is released.

5. Reserved Port

The interface for product testing is prohibited to users, forced plug in may cause damage on products.

6. Data Configuration Interface – Gigabit Ethernet

The parameter configuration interface of DexClock R1. User can connect the DexClock R1 to the switch or PC via a CAT6 cable and then configure DexClock R1 or send reset output instructions with the assorted Server software.

7. Clock & Reset inputs

DexClock R1 global clock and reset input interface. Cable type: LEMO SL520A. Connector type: LEMO EPG.00.304.HLN. When DexClock R1 works in the slave mode, the connector is used for receiving the clock and reset signal output from the master, the signal input is then distributed to 12 channels.

8. Clock & Reset Outputs

DexClock R1 global clock and reset output interface. Cable type: LEMO SL520A. Connector type: LEMO EPG.00.304.HLN. To ensure the signal transmission quality, the global clock and reset signal are adopted differential signal transmission to minimize common-mode noise, while the clock signal outputs are AC coupled in LVPECL standard and the reset signal outputs satisfy LVDS standard. The reset signals are valid when their levels are low. The pin definition of the interface and the timing diagram of the signal are illustrated in Figure 1-4. The internal crossing wiring of the cable should be noted, and thus the pin definition of the connector on the other side of the cable must be consistent with Figure 1-4.

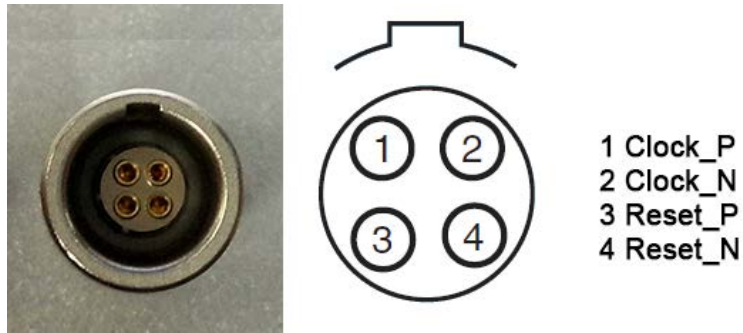


Figure 1-4 Signal definition of clock and reset output connector

- | | |
|------------------------------------|------------------------------------|
| 1 Positive channel of clock signal | 2 Negative channel of clock signal |
| 3 Positive channel of reset signal | 4 Negative channel of reset signal |

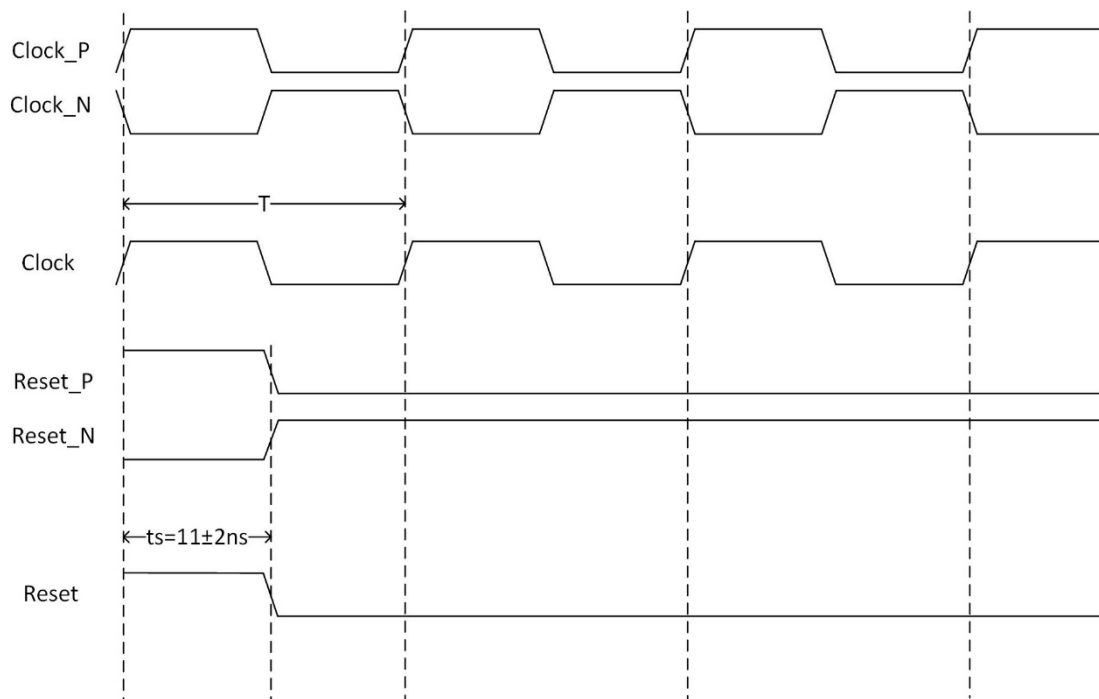


Figure 1-5 Timing diagram of global clock and reset signal. T is the global clock signal cycle, t_s is the time difference between the reset edge and clock rising edge, when T is set 20 ns, $t_s = 11 \pm 2\text{ns}$.

Power Supply

The normal power supply voltage specification of DexClock R1 is 12V DC. User can employ the supplied power adapter to connect DexClock R1 to a plug (220V/50Hz, 110V/60Hz) and let DexClock R1 work. To ensure the performance properties and safety of the product, it is strongly recommend to use the power adapter that provide by RayMeasure. Figure 1-6 shows the appearance of the assorted power adapter with 12V 3A specifications. When using other power supplies, it should be noted that the supply voltage cannot be greater than the maxim ratings specified in the datasheet, otherwise permanent damage on the product may occurs.



Figure 1-6 Power adapter with 12V DC output



WARNING

Only allowed to use the power supply that approved by your country for this product. Any safety accident or damage to the product by using of inferior power supply or power adapter, RayMeasure is not responsible.

Chapter 2 User Guide

This chapter introduces the principle of the product, parameter setting, data acquisition and the relevant application cases.

This chapter content as follows:

- Principles
- Parameter Setting and Data Acquisition
- Data Format and Analyzing
- Application Case

Principles

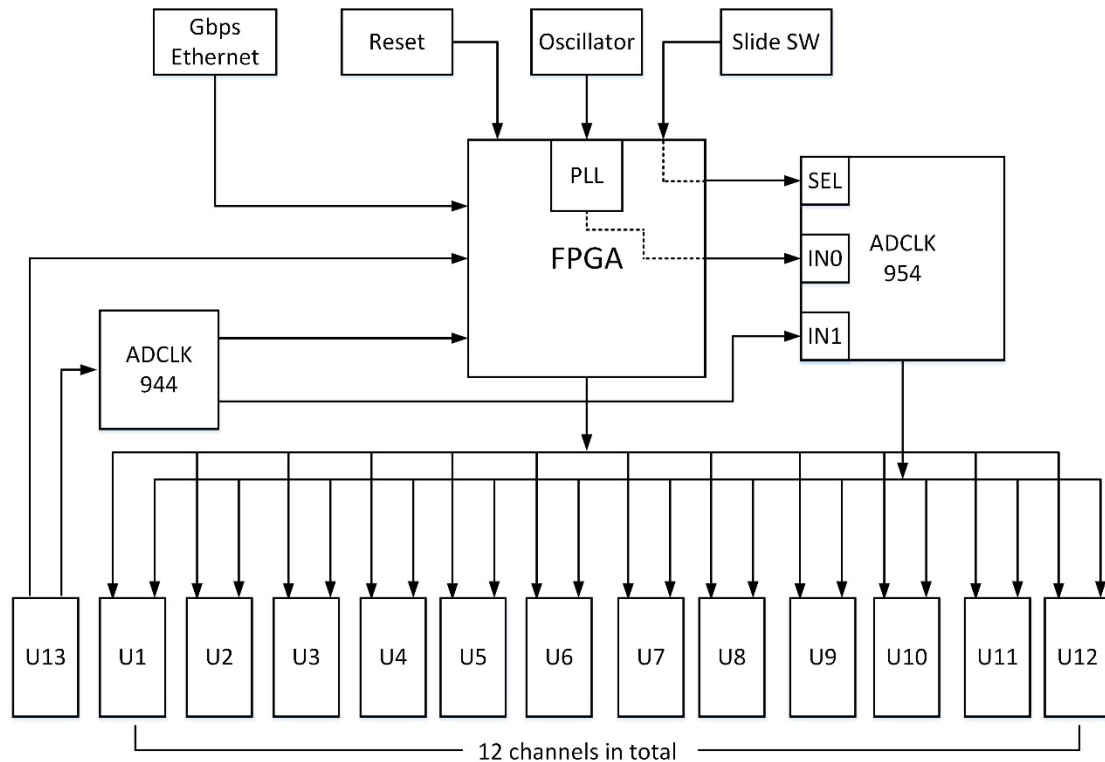


Figure 2-1 DexClock R1 Block Design

The block design of DexClock R1 is shown in Figure 2-1, its work status can be switched between master and slave modes. When DexClock R1 works in master mode, it functions as an independent clock distribution system providing 12-channel synchronized clock and reset signal outputs, the clock frequency is configurable from 5 MHz to 100 MHz, the time relationship between the clock rising edge and reset edge can be flexibly specified. By handling the slide switch to the other side, DexClock R1 jumps to the slave mode. When DexClock R1 works in slave mode, it receives clock and reset signals from the upper stage and provides 12-channel fan-outs. The clock parameters, for instance, frequency and duty cycle depend on the upper stage, but the time relationship between the clock rising edge and reset edge can be flexibly specified as well. A clock distribution system based on DexClock R1 features flexibility and expandability, it contains at least one master, and the number of the slaves is determined by the scale of the system.

In master mode, the clock generator on DexClock R1 contains a stable Oscillator, a clock distribution buffer(ADCLK954), and a PLL (Phase Locked Loop) supporting dynamic configuration integrated on FPGA (Field Programmable Gate Array) as Figure 2-1 shows. The clock distribution buffer has two selectable inputs, one of which is selected in the master mode. DexClock R1 applies FPGA to generate programmable reset outputs, the synchronized clock and reset signals are output via the specified connectors (type LEMO EPG.00.304.HLN) following differential level standard.

In slave mode, the clock signal from another DexClock R1 is selected as the input of the clock distribution buffer. The remote clock and reset signals from another DexClock R1 are input via the specified connectors (type LEMO EPG.00.304.HLN) and distributed to 12-way output. Reset signals keep synchronized to clock signals, they are output via specified connectors (type LEMO EPG_00_304_HLN) following differential level standard.

Parameter Settings

Users can configure the settings of Femtosecond Clock Distribution System DexClock R1 via the Ethernet interface and the assorted Server software. Besides, users can write other programs for configuration by referring to the protocol. Users should first power on the DexClock R1 and connect the DexClock R1 with PC by CAT6 cable, then users can open the server software and start configuration as follows.

Software UI

The communication between the Server software and DexClock R1 is based on Gigabit Ethernet, the protocol type is UDP, and the software UI is shown in Figure 2-2.

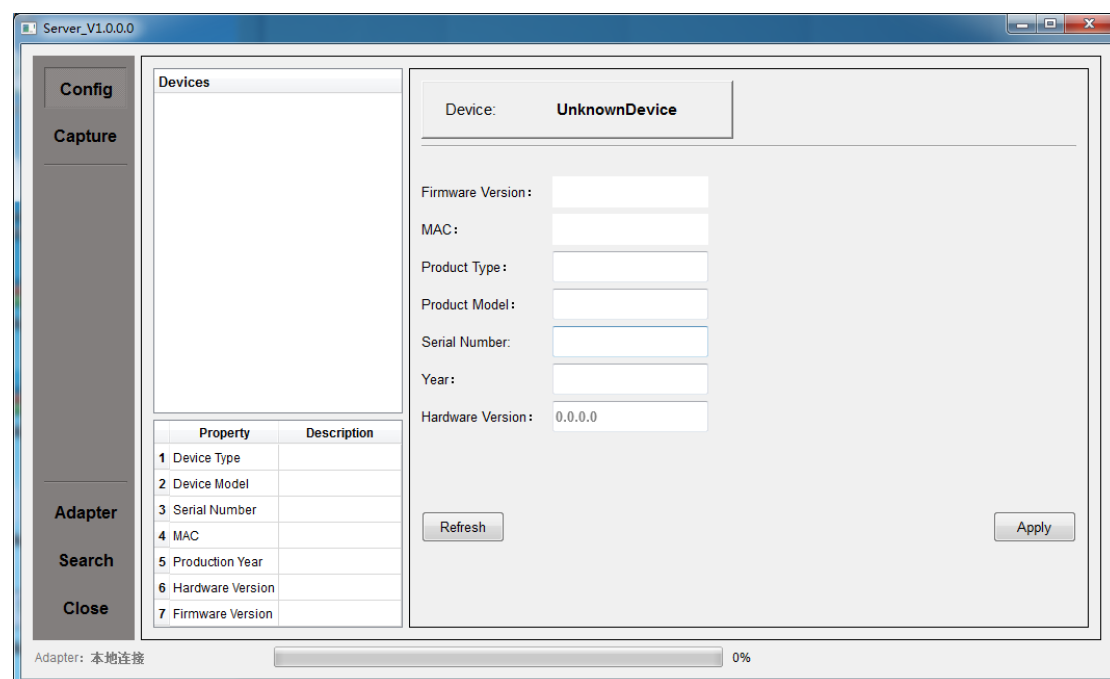


Figure 2-2 Configuration software UI

Click “Adapter” on the bottom-left and choose the corresponding LAN, then “DexClock_R1_x” will be found on the right side of the window, “x” is the product serial number.

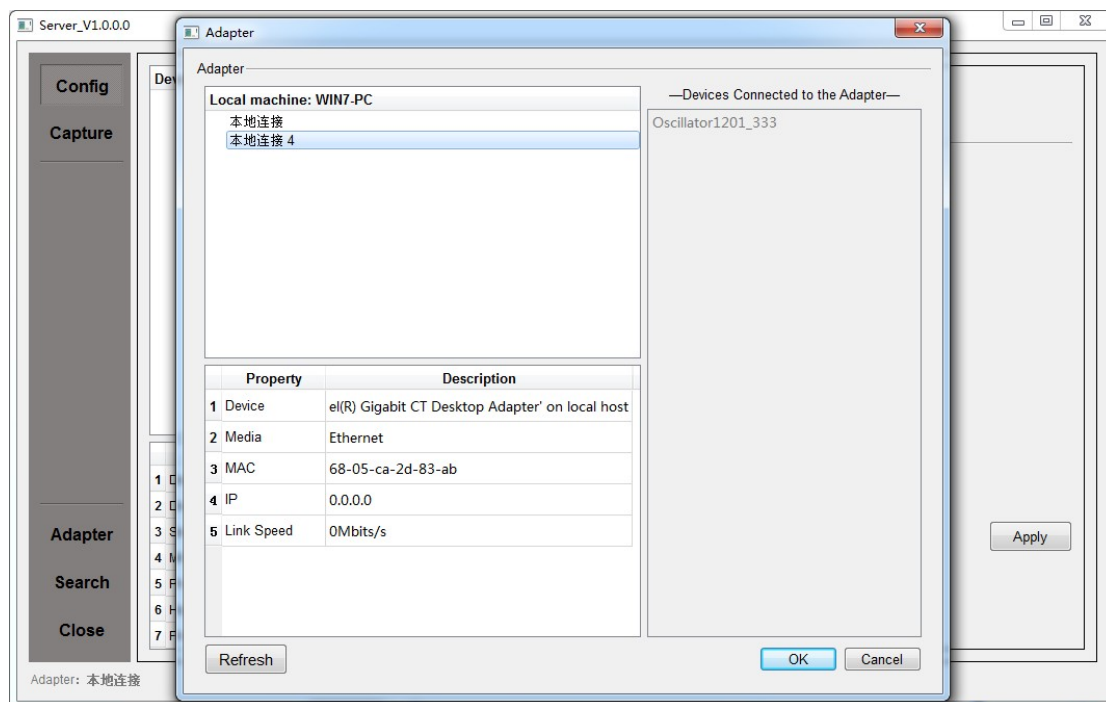


Figure 2-3 Selection on the proper LAN

Index Parameters

Any change on the product index parameters is not recommended. The text "Product Type", "Product Model", and "Serial Number" in this page are consistent with their literal meanings, the values of the product type and model are 1 and 0 by default respectively, and the applications of other values will cause incorrect recognition of products. The serial number is the signature of the product, other values may cause identification conflict. "Year" defines the year of manufacture, "Hardware Version" is the version number of the hardware, and they are the intrinsic information of the product.

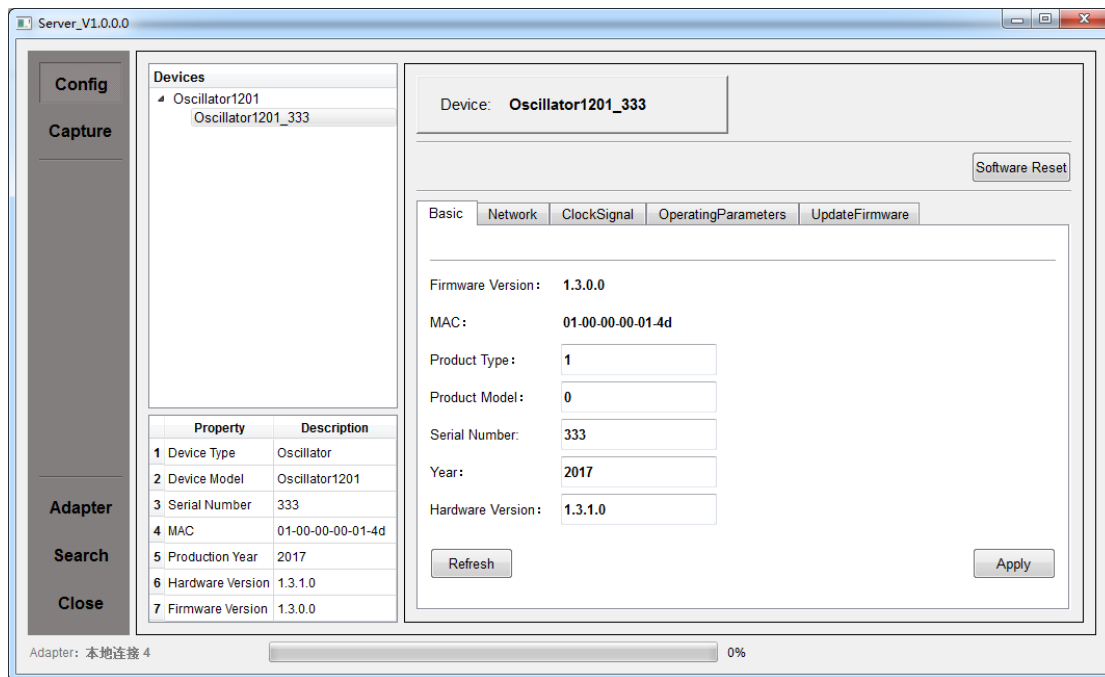
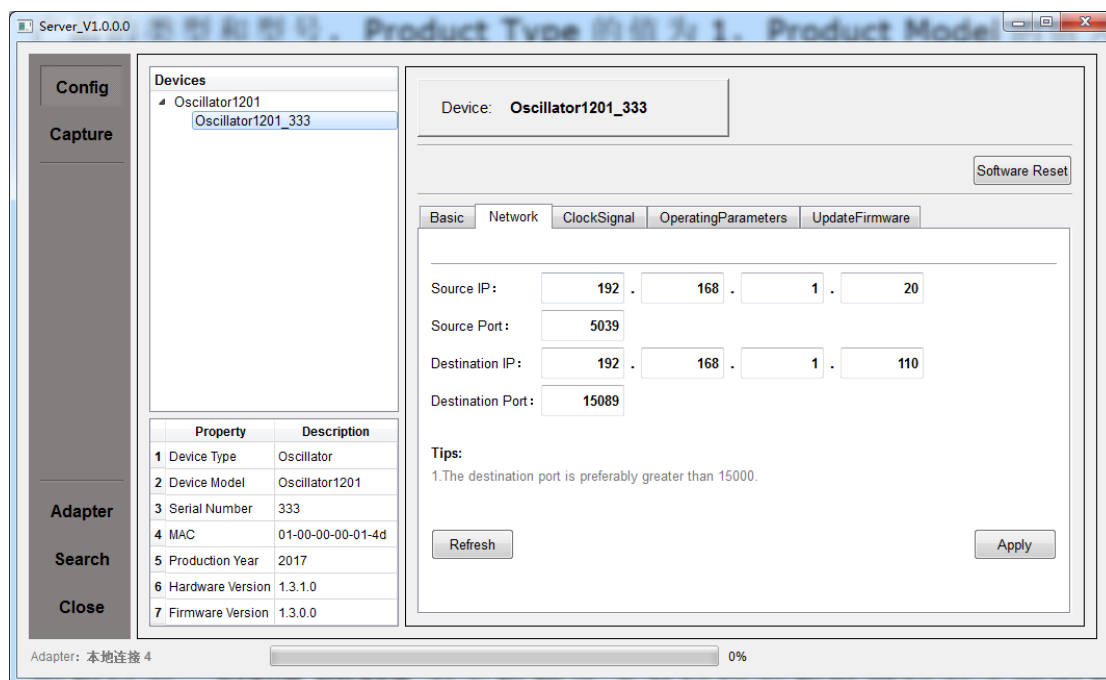


Figure 2-4 Configuration on the index parameters

Network Parameters

The text "Source IP", "Source Port" mean the IP address and the network port of DexClock R1, the text "Destination IP", "Destination Port" mean the IP address and the network port of the PC in communication with DexClock R1. After filling in the specified values, click the "Apply" button on the bottom right to make them work. Click the "Refresh" button to check the current network settings.



Configuration on the network parameters

Clock and Reset Outputs

Click the button "OutputReset" to make DexClock R1 output reset signals, the text "Pulse Width" refers to the duration of reset outputs and the unit is ms. The text "Frequency" refers to the frequency of the output clock signals, the unit is MHz and the default value is 50. The text "Master Phase" refers to the phase difference between the reset signal and the clock signal in master mode, the text "Slave Phase" refers to the phase difference between the reset signal and the clock signal in Slave mode. The default clock frequency is 50 MHz and the default phase differences are 0 degrees, the timing relationship is shown in Figure 1-5. Click the "Apply" button on the bottom right make the changes work, however, changes on phase difference settings is not recommended. Click the "Refresh" to check the current settings.

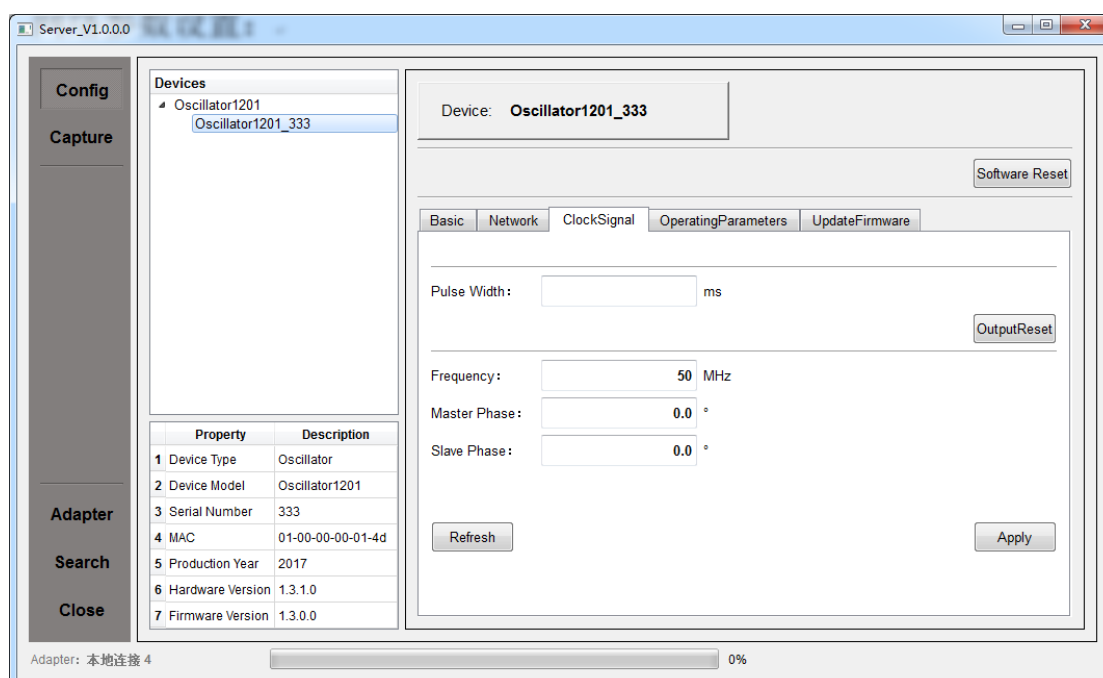


Figure 2-6 Configuration on the Clock and Reset Outputs

Running Parameters

The text "PowerOnCounts" means the device power on times, it is not recommend that user change the parameters.

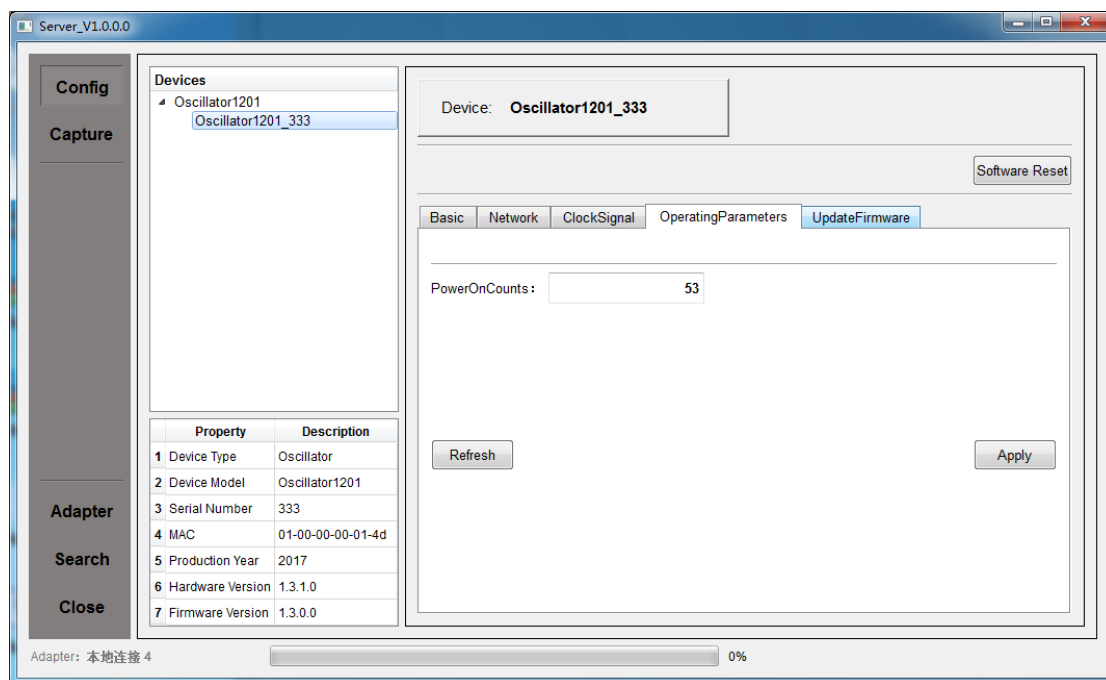


Figure 2-7 Configuration on the running parameters

Firmware Update

If the current firmware of the device requires update, prepare the file for update in advance. Click the “Open” on the right, choose the file (with the filename extension .rbf) , and click “Apply”. After waiting for around 35 seconds, there will be a pop-up window on the bottom right prompting that the firmware update is a success.

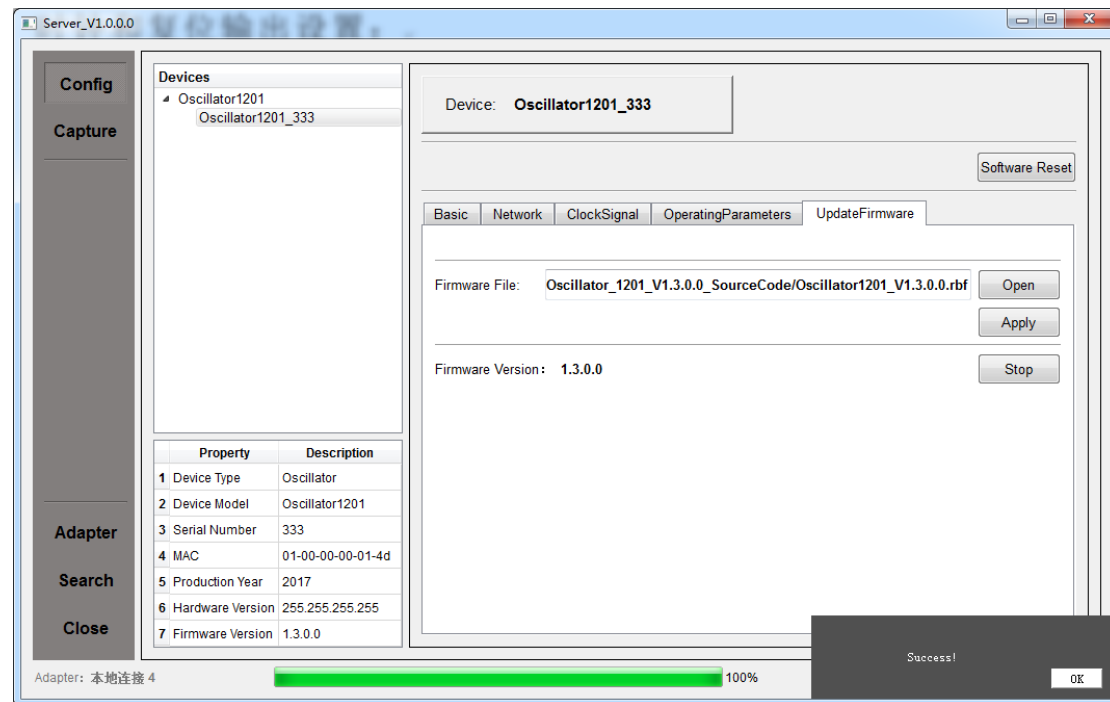


Figure 2-8 Firmware Update

Application Demonstration

DexClock R1 can provide the digital PET detectors of Scintector series being sold by RayMeasure with abundant, stable, synchronized clock and reset signals to build a digital PET. Figure 2-9 shows the System architecture of a brain PET scanner ring built with the clock distribution system made up of 22 DexClock R1 modules and 225 Scintector series digital PET detectors.

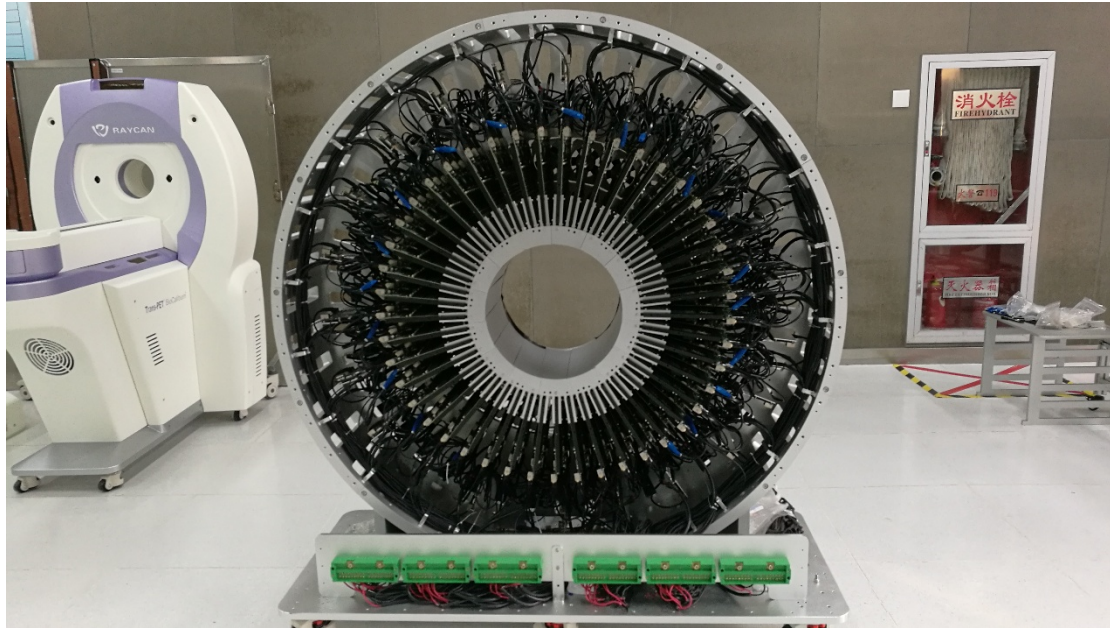


Figure 2-9 Brain PET scanner ring driven by DexClock R1

Precautions



Caution

- Avoid violent collisions or shock to the case body.
 - Avoid flames, moist areas, corrosive materials, and electrical shocks.
 - Removal of the shell is strictly prohibited.
-

Chapter 3 Troubleshooting

This chapter lists the commonly encountered failures of DexClock R1 and their solutions. When you encounter those problems, please solve them following the corresponding steps. If the problem persists, please contact RayMeasure and provide your device information (Obtain device serial number and firmware version number).

1. Clock or reset output failure

- (1) Check if the power is correctly connected.
- (2) Check if the slide switch handle is at the proper position.
- (3) Check if the reset button can be pressed.
- (4) Restart the device.
- (5) If it still works incorrectly, contact RayMeasure for our service.

2. Device configuration failure.

- (1) Check if the data configuration cable is CAT6 class and correctly connected.
- (2) Check if the PC used for configuration is equipped with Gigabit LAN.
- (3) Check if the Ethernet connection is good. Ensure that the PC for configuration is equipped with Gigabit LAN.
- (4) Restart the device.
- (5) If it does not work correctly, contact RayMeasure for our service.

Chapter 4 Technical Specifications

Technical Specifications

Feature	Product parameters
Product model	DexClock R1
Channel number	12
Clock Frequency range	5-100MHz
Clock level standard	AC LVPECL
Reset level standard	LVDS
Configuration access	Gigabit Ethernet
Power supply	DC 12V
Power dissipation	≤4.2W
Dimensions	136mm×60mm×24mm
Weight	210g

Environmental Conditions

Description	Environmental conditions
Operating temperature	-25 ~ +60°C
Storage temperature	-40 ~ +70°C
Relative humidity	10%~75%
Atmosphere pressure	70 ~ 110kPa

Packing List

Description	Quantity
DexClock R1 device	1
CAT6 cable	1
Power adapter	1
CD-ROM/U disk	1
User guide	1
Quality certificate card	1
Warranty card	1

Chapter 5 Appendix

Appendix A: Attachments and Options

	Description	Order Number
Product model	Femtosecond Clock Distribution System DexClock R1	
Product accessories	One CAT6 cable	
	One data configure cable	
	One power adapter(DC 12V)	
	One CD-ROM/U disk	
	One DexClock R1 user guide	
	One quality certificate card	
	One warranty card	
Optional product	One clock cable(LEMO SL520A)	

Caution: For all accessories and optional-products, please order from RayMeasure agent or factory.

Appendix B: Summary of the warranty

RayMeasure guarantees its products and accessories in warranty period are free from any material and process defects.

If the product was proved to have defects during the warranty period, RayMeasure will provide free repair or replacement. To know more about the detailed warranty, please refer to RayMeasure official website or product warranty card. For full text of maintenance service or warranty, please contact RayMeasure service center or agent.

Apart from the profile or other applicable guarantee provided by the warranty card, RayMeasure does not provide any express or implied warranty, including but not limited to any implied warranties that products can be traded or used for special purpose. In any case, RayMeasure does not undertake any responsibility for indirect or special loss.

FCC Caution

§ 15.19 Labelling requirements.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

§ 15.21 Information to user.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

§ 15.105 Information to the user.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.